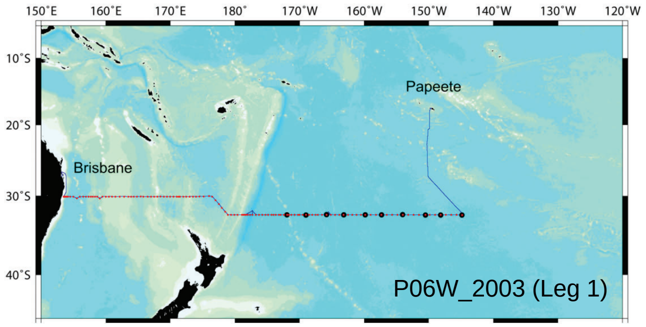
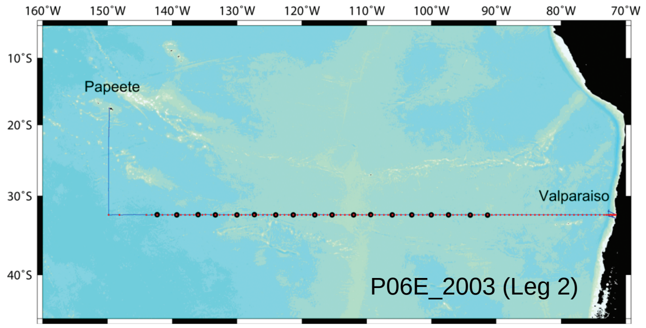
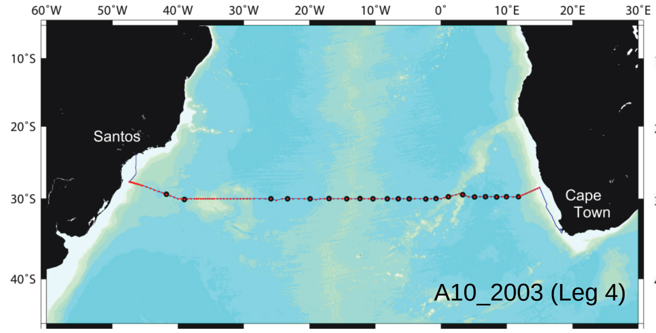
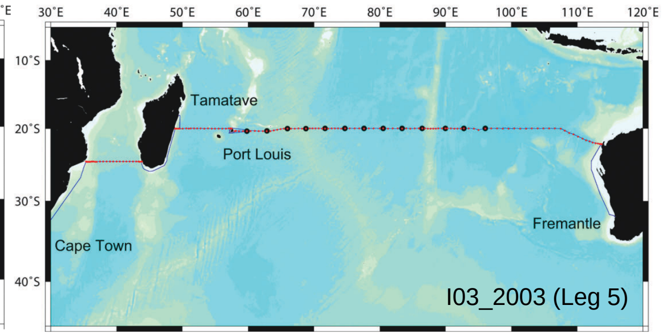
CRUISE REPORT: P06W_2003, P06E_2003, I03_2003, A10_2003

(Updated OCT 2005)









A. HIGHLIGHTS

A.1. Cruise Summary Information

WOCE section designation	**P06W_2003 (Leg 1)**
Expedition designation (ExpoCodes)	**49NZ20030803**
Chief Scientists	**Fukasawa/JAMSTEC**
Cruise Dates	**August 3, 2003 - September 5, 2003**
Ship	R/V MIRAI
Ports of call	Brisbane, Australia - Papeete, Tahiti
Number of Stations	121
Geographic Boundaries	29° 59.72' S 153° 29.00' E 144° 49.87' W 32° 31.77' S
Floats and drifters deployed	10 Argo Floats
Moorings deployed or recovered	none

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WOCE section designation	**P06E_2003 (Leg 2)**
Expedition designation (ExpoCodes)	**49NZ20030909**
Chief Scientists	**Watanabe/NIRE**
Cruise Dates	**September 9, 2003 – October 16, 2003**
Ship	R/V MIRAI
PORTS OF CALL	Papeete, Tahiti - Valparaiso, Chile
Number of Stations	116
Geographic Boundaries	32° 10.17' S 149° 49.49' W 71° 29.94' W 32° 40.43' S
Floats and drifters deployed	18 Argo Floats
Moorings deployed or recovered	none

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WOCE section designation	**A10_2003 (Leg 4)**
Expedition designation (ExpoCodes)	**49NZ200311060**
Chief Scientists	**Yoshikawa/JAMSTEC**
Dates	**November 6, 2003 – December 5, 2003**
Ship	R/V MIRAI
PORTS OF CALL	Santos, Brazil – Cape Town, South Africa
Number of Stations	111
Geographic Boundaries	27° 43.90’ S 47° 23.27’ W 15° 00.15’ E 30° 13.21’ S
Floats and drifters deployed	21 Argo Floats
Moorings deployed or recovered	none

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WOCE section designation	**I03_2003 (Leg 5)**
Expedition designation (ExpoCodes)	**49NZ20031209**
Chief Scientists	**Fukasawa/JAMSTEC**
Cruise Dates	**December 9, 2003 – January 24, 2004**
Ship	R/V MIRAI
PORTS OF CALL	Cape Town, South Africa - Tamatave, Madagascar - Port Louis, Mauritius - Fremantle, Australia
Number of Stations	145
Geographic Boundaries	19° 58.06' S 35° 21.94' E 113° 45.52' E 24° 40.29' S
Floats and drifters deployed	13 Argo Floats
Moorings deployed or recovered	None

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Cruise and Data Information

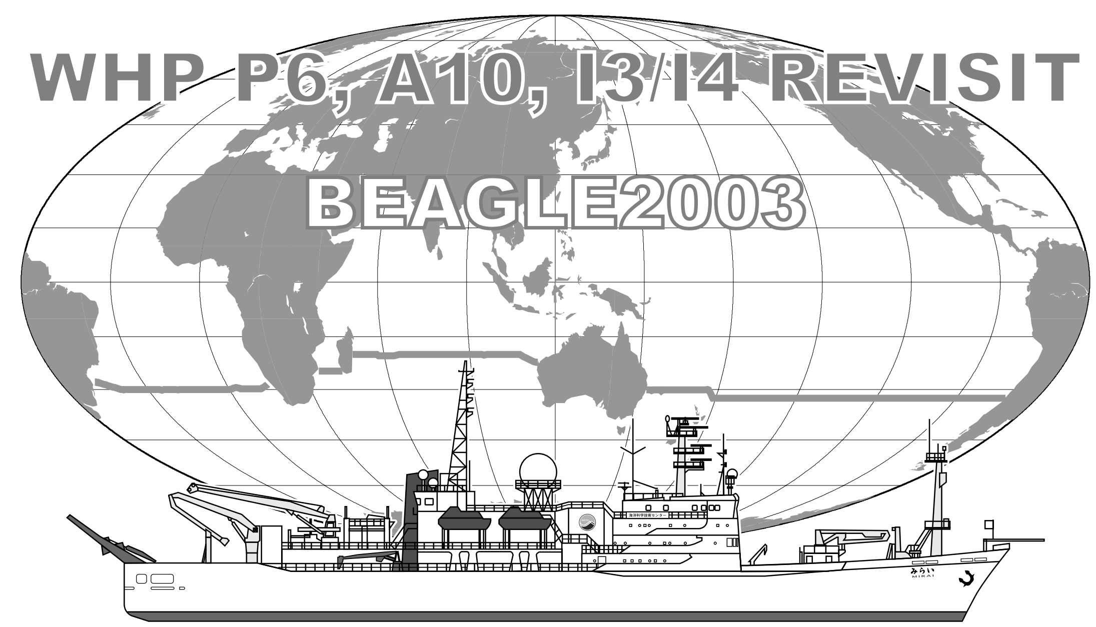
Links to text locations. Shaded sections are not relevant to this cruise or were not available when this report was compiled

Cruise Summary Information	**Hydrographic Measurements**	
Description of Scientific Program	***CTD Data***	
Geographic Boundaries	Overview	
Cruise Track	Pre-cruise Calibration	Post-Cruise Calibration
Description of Stations	Pressure	Pressure
Description of Parameters Sampled	Temperature	Temperature
Bottle Depth Distributions (Figure)	Conductivity	Salinity
	Oxygen	Oxygen
Floats and Drifters Deployed		
	Bottle Data	
	Salinity	
Principal Investigators	Oxygen	
Cruise Participants	Nutrients	
	Dissolved inorganic carbon (C_T)	
Problems and Goals Not Achieved	Total Alkalinity (A_T)	
Other Incidents of Note	pH	
Underway Data Information		
Navigation		
Bathymetry		
Acoustic Doppler Current Profiler (ADCP)	Lowered Acoustic Doppler Current Profiler (LADCP)	
Thermosalinograph		
XBT and/or XCTD	**References**	
Meteorological Observations	**Acknowledgments**	
Atmospheric Chemistry Data	**Data Processing Notes**	

WHP P6, A10, I3/I4 REVISIT DATA BOOK

Blue Earth Global Expedition 2003 (BEAGLE2003)

Volume 1



WHP P6, A10, I3/I4 REVISIT DATA BOOK

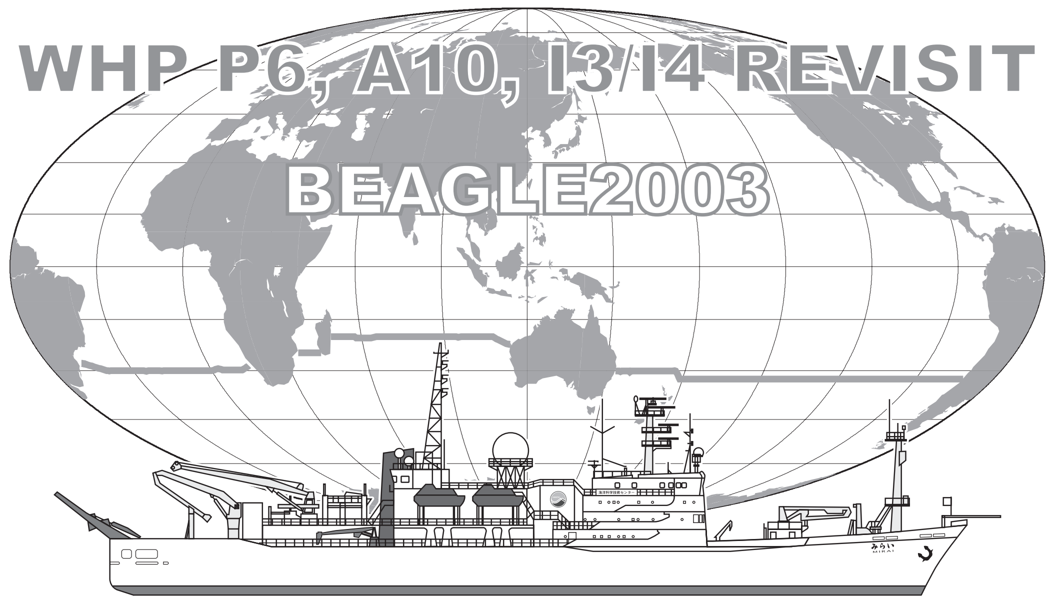
Blue Earth Global Expedition 2003 (BEAGLE2003)

Volume 1

Edited by

Hiroshi Uchida (JAMSTEC),

Masao Fukasawa (JAMSTEC)



WHP P6, A10, I3/I4 REVISIT DATA BOOK

Blue Earth Global Expedition 2003 (BEAGLE2003)

Volume 1

10, March, 2005 Published

Edited by Hiroshi Uchida (JAMSTEC) and Masao Fukasawa (JAMSTEC)

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Documents

Preface

Dedicated to late Professor Yasunobu Matsuura from Sao Paulo University .

Zonal WOCE Hydrographic Program lines (WHP lines) of P06, A10, and I05 are located in the southern hemisphere and well known that they compose the Scorpio line in the southern hemisphere. Ocean Observation Research Department of Japan Marine Science and Technology Center, which was reformed as Institute of Observational Research for Global Change of Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in 2004, planned an ambitious scientific cruise to occupy all of these lines at a time in order to investigate the possible decadal changes in the Antarctic Overturn System. They had reached a puzzling observational fact that the bottom water temperature increased along P01 and P17N, which were located at the terminal regions of the global overturn system in the northern-end of the North Pacific, through collaborative WHP revisits with IOS, Canada. Same warming of the bottom water as this one was also found at each WHP cross-point between P03 (23.5N) and several meridional WHP lines. The warming rate was so large that the increase in the temperature of bottom water corresponded to 0.5 degree Celsius warming for one century of duration. It was natural, at least for us, to suspect some non-linear and abrupt changes was taking place in the Antarctic Overturn System in the southern hemisphere which could have propagated in the bottom water at much faster phase speed than the advection of water itself.

This plan of the hydrographic observation around the southern hemisphere, which might compare with the global cruise of Magellan, was named as Blue Earth Global Expedition 2003 (BEAGLE2003) and promoted by JAMSTEC as a commemorative action of 30's anniversary of its establishment and also supported by the Partnership for Observation of the Global Ocean (POGO) as a following-up of the Sao Paulo Declaration in POGO2001 that recommended the enhancement of the ocean observation and the capacity building in the southern hemisphere. Although, during the preparation for the cruise, the Indian sector I05 in the original plan was substituted to I4 and I3 in order to make the international collaboration of global hydrography more effective, JAMSTEC could invite more than 30 scientists and students from countries in the southern hemisphere as participants of BEAGLE2003 on the board of R/V Mirai. Also International Ocean Color Coordinating Group (IOCCG) dispatched eight trainees from various countries through POGO. The cruise was started on 3 August 2003 from Brisbane, Australia and finished 19 February 2004 at Fremantle, Australia. During BEAGLE2003, four hundreds and ninety three (493) WOCE hydrographic stations were re-occupied, sixty Argo floats were launched and bottom cores were sampled at six stations.

This data book contains CTD data, bottle data and data from underway observations with their documentations along the circum southern hemispheric cruise track of BEAGLE2003. Also the bottom topography data measured by the multi narrow beam on R/V Mirai are included. At this stage, unfortunately, analyses of some radioactive carbon samples are not completed yet and they will be supplemented to this data book later. I heartily hope that BEAGLE2003 cruise will inspire young scientists with deep interests in the ocean science and that data from BEAGLE2003 will help ocean scientists to have better understanding of the ocean through this data book.

Finally, it should be noted here that BEAGLE2003 was supported by many people in the world. Without their supports, we could not work out this ambitious cruise. I would like to express my heartfelt thanks to all people who supported BEAGLE2003 though I do not name all of them here because they are so many. However, special thanks should be extended to Capt. Akamine from R/V Mirai with all crew members, Dr. Sathyendranath from POGO, Dr. Church from CSIRO, Dr. Stuardo from University of Conception, Dr. Weber from Sao Paulo University and Dr. Field from University of Cape Town because they were the first colleagues when we set sail into "the ocean of BEAGLE2003".

at Mutsu Institute of Oceanography, 2005 Spring

BEAGLE2003 Chief Scientist
Masao Fukasawa

Ocean General Circulation Observational Research Program
Institute of Observational Research for Global Change
Japan Agency for Marine-Earth Science and Technology

1 Cruise Narrative

1.1 Highlight

WOCE Line Designation: P6W, P6C, P6E, A10, I3 and I4

Expedition Designation: MR03-K04 Leg 1, Leg 2, Leg 4 and Leg 5

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Ship: R/V MIRAI

Ports of Call:	Leg 1	Brisbane, Australia – Papeete, Tahiti
	Leg 2	Papeete, Tahiti – Valparaiso, Chile
	Leg 4	Santos, Brazil – Cape Town, South Africa
	Leg 5	Cape Town, South Africa – Tamatave, Madagascar – Port Louis, Mauritius – Fremantle, Australia
Cruise Dates:	Leg 1	August 3, 2003 – September 5, 2003
	Leg 2	September 9, 2003 – October 16, 2003
	Leg 4	November 6, 2003 – December 5, 2003
	Leg 5	December 9, 2003 – January 24, 2004
Number of Stations:	Leg 1	121 CTD/Carousel Water Sampler
	Leg 2	116 CTD/Carousel Water Sampler
	Leg 4	111 CTD/Carousel Water Sampler
	Leg 5	145 CTD/Carousel Water Sampler
Geographic boundaries:	Leg 1	153° 29.00’ E - 144° 49.87’ W 29° 59.72’ S - 32° 31.77’ S
	Leg 2	149° 49.49’ W to 71° 29.94’ W 32° 10.17’ S to 32° 40.43’ S
	Leg 4	47° 23.27’ W to 15° 00.15’ E 27° 43.90’ S to 30° 13.21’ S
	Leg 5	35° 21.94’ E to 113° 45.52’ E 19° 58.06’ S to 24° 40.29’ S

Floats and drifters deployed:

Leg 1	10 Argo Floats
Leg 2	18 Argo Floats
Leg 4	21 Argo Floats
Leg 5	13 Argo Floats

Mooring deployed or recovered mooring: NONE

1.2 Cruise Summary

(1) Geographic boundaries

MR03-K04 leg 1 occupied stations along 32°30' S from 153°29' E to 144°50' W. MR03-K04 leg 2 occupied stations along 32°30' S from 149°50' W to 71°30' W. Two stations, No. 125 and 127, were revisited to be compared with leg 1. MR03-K04 leg 4 occupied stations along 30° S from 47°23' W to 15°E. MR03-K04 leg 5a (Cape Town to Tamatave) occupied stations along 24°40' S from 35°22' E to 43°52' E. MR03-K04 leg 5b (Tamatave to Fremantle via Port Louise) occupied stations along 20°S from 48°55' E to 113°46' E.

(2) Station occupied

A total of 493 stations were occupied using a Sea-Bird Electronics 36 bottle Carousel equipped with 36 12 liter Niskin X water sample bottles, a SBE911plus equipped with SBE35 deep ocean standards thermometer, SBE43 oxygen sensor, Seapoint sensors Inc. Chlorophyll Fluorometer (except for Leg.2) and Benthos Inc. Altimeter and RDI Workhorse Monitor ADCP. Cruise track and station location are shown in Fig. 1.2.1 to Fig. 1.2.5.

(3) Sampling and measurements

Water samples were analyzed for salinity, oxygen, nutrients, CFC11,12, 113, total alkalinity, DIC and pH. The sampling layers in dbar were 10, 50, 100, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 3250, 3500, 3750, 4000, 4250, 4500, 4750, 5000, 5250, 5500, 5750 and bottom (minus 10 m). Sample for Ar, ^{14}C, ^{13}C, $^{3}He/^{4}He$, ^{137}Cs, Plutonium and ^{3}H, TOC were also collected. The bottle depth diagram is shown in Fig. 1.2.6. Measurements of autotrophic biomass (epifluorescence and chlorophyll a) by surface LV and bio-optical measurement (scatter and transfer) were made in the day time. Underway measurements of pCO_2, temperature, salinity, oxygen, surface current, bathymetry and meteorological parameters were made along the cruise track.

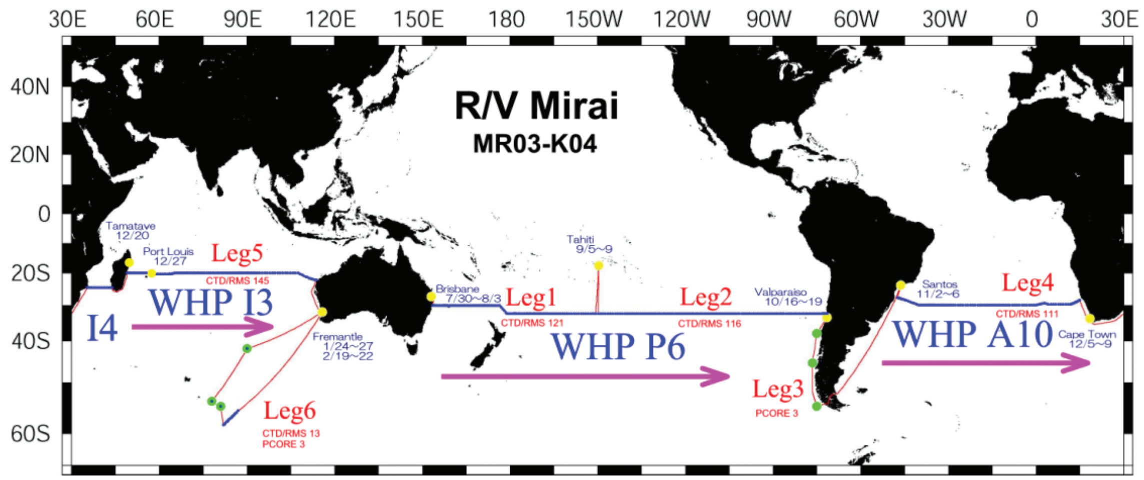

Figure 1.2.1. Cruise track.

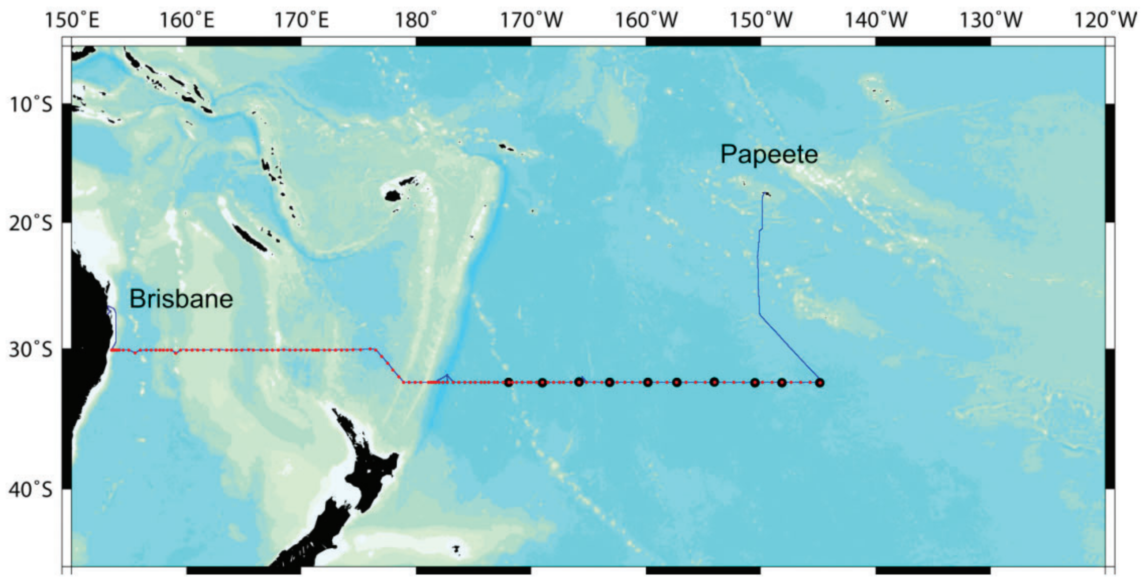

Figure 1.2.2. Station location of leg 1. Red dot and closed circle indicate CTD station and Argo float deployment position, respectively.

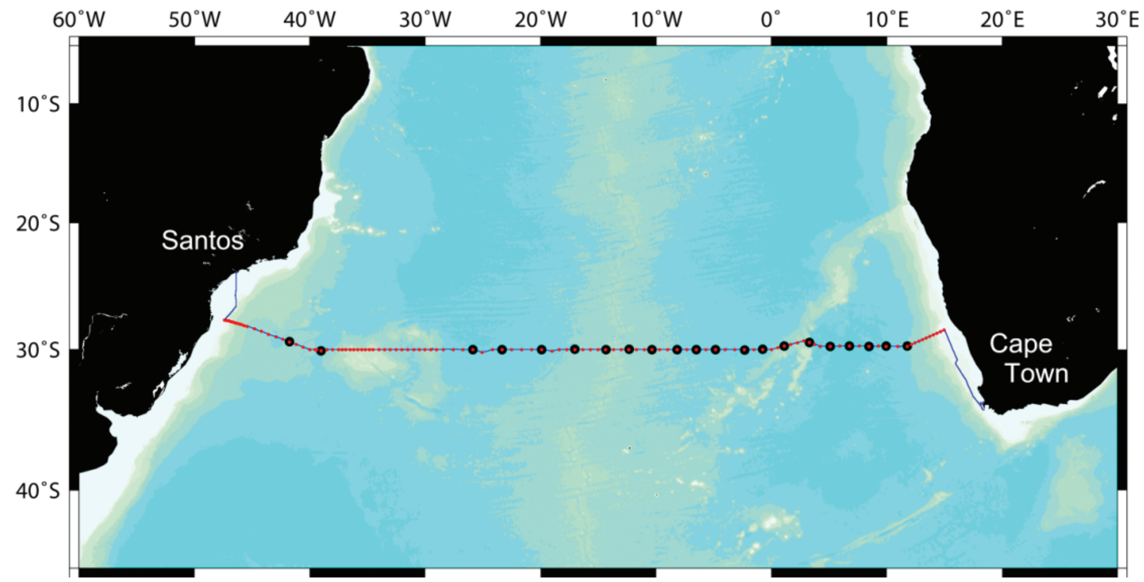

Figure 1.2.4. Same as Figure 1.2.2, but for leg 4.

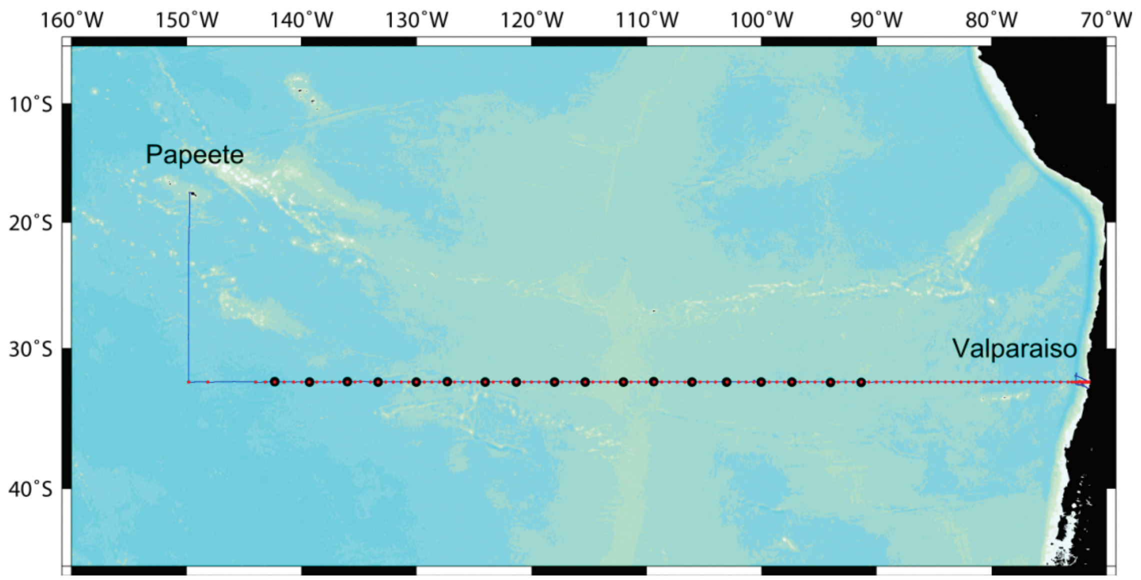

Figure 1.2.3. Same as Figure 1.2.2, but for leg 2.

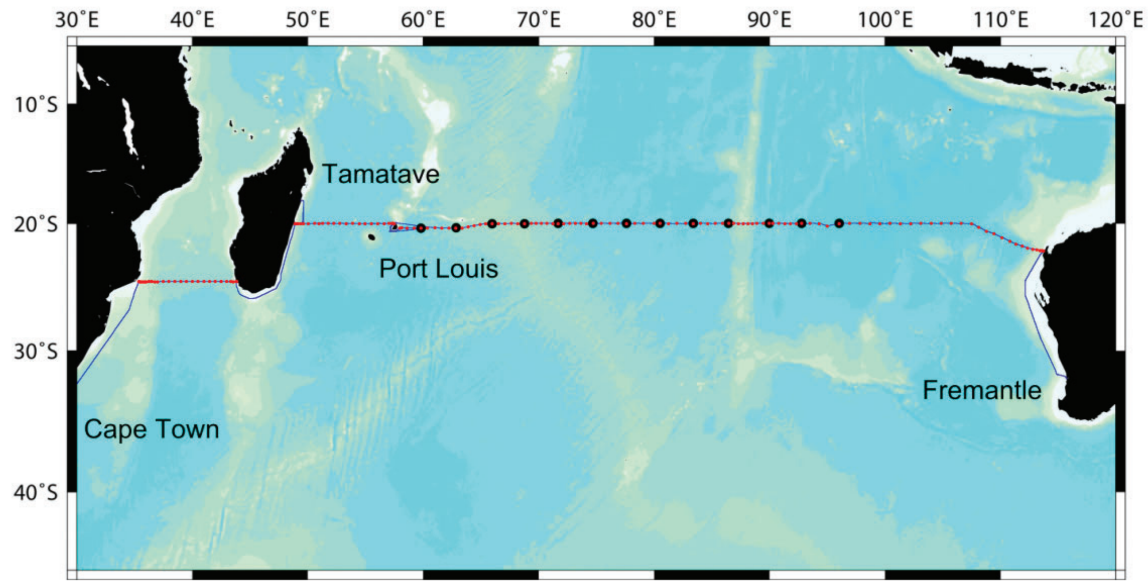

Figure 1.2.5. Same as Figure 1.2.2, but for leg 5.

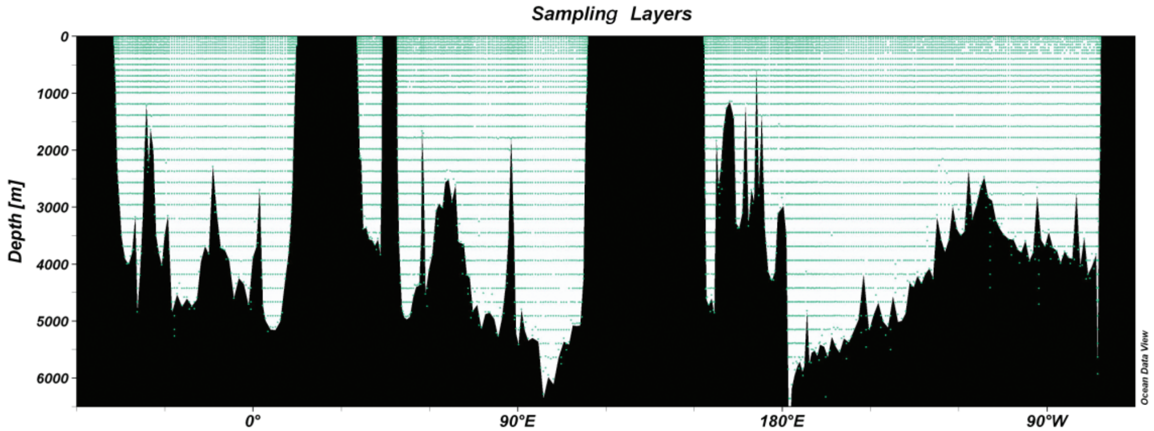

Figure 1.2.6. Bottle depth diagram.

(4) Floats and Drifters deployed

62 ARGO floats were launched along the cruise track as a joint research program among JAMSTEC (FORGC), Scripps Institute of Oceanography (SIO), Atlantic Oceanographic and Meteorological Laboratory (AOML) and the Southampton Oceanography Centre (SOC). The Launched positions of the ARGO floats are listed in Table.1.2.1.

Table 1.2.1. Launched positions of the ARGO floats.

Owner	Type	S/N	ARGOS PTT ID	Date and Time of Reset (UTC)	Date and Time of Launch (UTC)	Location of Launch
FORSGC	APEX	927	25184	19:36, Aug. 21	20:42, Aug. 21	32-30.74 S, 171-55.13 W
SIO	SOLO	2185	unknown	00:08, Jul. 31	09:56, Aug. 23	32-31.01 S, 168-59.49 W
FORSGC	APEX	928	25185	00:08, Jul. 31	18:24, Aug. 24	32-28.23 S, 165-48.00 W
SIO	SOLO	2199	unknown	00:08, Jul. 31	03:42, Aug. 27	32-29.45 S, 163-08.99 W
FORSGC	APEX	929	25186	07:22, Aug. 28	09:13, Aug. 28	32-30.21 S, 159-48.14 W
FORSGC	APEX	930	25187	03:21, Aug. 29	04:21, Aug. 29	32-30.38 S, 157-17.91 W
FORSGC	APEX	931	25263	02:58, Aug. 30	05:19, Aug. 30	32-28.46 S, 154-01.00 W
SIO	SOLO	2202	unknown	08:35, Jul. 31	09:02, Aug. 31	32-30.95 S, 150-30.71 W
FORSGC	APEX	932	25280	01:55, Sep. 01	03:25, Sep. 01	32-31.12 S, 148-08.70 W
SIO	SOLO	2203	unknown	00:11, Jul. 31	07:25, Sep. 02	32-31.12 S, 144-50.01 W
FORSGC	APEX	933	25284	06:45, Sep. 14	08:05, Sep. 14	32-28.94 S, 142-20.93 W
SIO	SOLO	2204	unknown	22:52, Jul. 30	09:18, Sep. 15	32-30.46 S, 139-17.46 W
FORSGC	APEX	934	25287	12:11, Sep. 16	13:25, Sep. 16	32-28.94 S, 136-00.61 W
SIO	SOLO	2205	unknown	22:55, Jul. 30	15:43, Sep. 17	32-29.30 S, 133-19.78 W
FORSGC	APEX	935	25288	19:40, Sep. 18	20:41, Sep. 18	32-29.19 S, 129-59.26 W
SIO	SOLO	2206	unknown	22:57, Jul. 30	18:32, Sep. 19	32-28.75 S, 127-19.00 W
FORSGC	APEX	936	25293	13:41, Sep. 21	14:53, Sep. 21	32-29.58 S, 124-00.23 W
SIO	SOLO	2207	unknown	22:59, Jul. 30	11:53, Sep. 22	32-29.87 S, 121-18.95 W
FORSGC	APEX	660	11478	14:10, Sep. 23	15:27, Sep. 23	32-30.42 S, 117-59.04 W
SIO	SOLO	2208	unknown	23:00, Jul. 30	13:18, Sep. 24	32-29.33 S, 115-19.56 W
FORSGC	APEX	938	25594	12:40, Sep. 25	14:00, Sep. 25	32-29.97 S, 111-59.55 W
SIO	SOLO	2209	unknown	23:02, Jul. 30	11:03, Sep. 26	32-28.79 S, 109-20.87 W
FORSGC	APEX	940	25596	16:57, Sep. 27	17:30, Sep. 27	32-29.46 S, 106-01.87 W
SIO	SOLO	2210	unknown	23:59, Jul. 30	16:20, Sep. 28	32-30.13 S, 103-00.53 W
FORSGC	APEX	939	25595	18:20, Sep. 30	20:06, Sep. 30	32-30.80 S, 100-00.49 W
SIO	SOLO	2211	unknown	00:02, Jul. 31	17:08, Oct. 01	32-30.67 S, 097-20.23 W
FORSGC	APEX	941	25597	18:27, Oct. 02	19:50, Oct. 02	32-30.93 S, 093-59.28 W
SIO	SOLO	2212	unknown	00:04, Jul. 31	16:50, Oct. 03	32-31.49 S, 091-18.75 W
AOML	SOLO	262	unknown	04:47, Nov. 10	06:24, Nov. 10	29-23.73 S, 041-44.59 W

AOML	SOLO	260	unknown	11:15, Nov. 11	12:32, Nov. 11	30-05.90 S, 039-01.21 W
AOML	SOLO	264	unknown	12:15, Nov. 17	13:46, Nov. 17	29-59.34 S, 025-51.76 W
AOML	SOLO	261	unknown	08:15, Nov. 18	09:44, Nov. 18	30-00.19 S, 023-18.64 W
AOML	SOLO	263	unknown	10:50, Nov. 19	12:03, Nov. 19	29-59.69 S, 019-53.28 W
AOML	SOLO	265	unknown	09:55, Nov. 20	11:22, Nov. 20	29-59.02 S, 017-01.38 W
SOC	APEX	865	unknown	06:35, Nov. 21	08:32, Nov. 21	29-59.55 S, 014-19.74 W
SOC	APEX	1190	unknown	21:48, Nov. 21	23:10, Nov. 21	29-58.61 S, 012-18.93 W
SOC	APEX	1191	unknown	13:26, Nov. 22	15:17, Nov. 22	29-59.65 S, 010-19.76 W
SOC	APEX	1192	unknown	07:02, Nov. 23	08:54, Nov. 23	29-59.62 S, 008-09.22 W
SOC	APEX	886	unknown	20:44, Nov. 23	21:52, Nov. 23	30-00.33 S, 006-28.91 W
SOC	APEX	1193	unknown	09:07, Nov. 24	10:27, Nov. 24	29-59.70 S, 004-48.50 W
SOC	APEX	1194	unknown	01:17, Nov. 26	02:39, Nov. 26	30-01.98 S, 002-18.17 W
SOC	APEX	1195	unknown	14:10, Nov. 26	15:13, Nov. 26	29-58.98 S, 000-43.56 W
SOC	APEX	1196	unknown	05:05, Nov. 27	06:51, Nov. 27	29-43.13 S, 001-08.20 E
SOC	APEX	887	unknown	01:47, Nov. 28	02:53, Nov.28	29-27.83 S, 003-19.07 E
SOC	APEX	1197	unknown	18:58, Nov. 28	20:17, Nov. 28	29-44.82 S, 005-07.75 E
SOC	APEX	1198	unknown	08:07, Nov. 29	09:30, Nov. 29	29-43.79 S, 006-47.35 E
SOC	APEX	1199	unknown	22:12, Nov. 29	23:30, Nov. 29	29-44.65 S, 008-29.14 E
SOC	APEX	1200	unknown	10:39, Nov. 30	12:42, Nov. 30	29-43.97 S, 009-58.78 E
SOC	APEX	1201	unknown	06:25, Dec. 01	07:46, Nov. 01	29-44.47 S, 011-47.97 E
FORSGC	APEX	1077	20647	00:21, Dec. 26	01:49, Dec. 26	20-22.87 S, 059-49.40 E
FORSGC	APEX	1078	20724	16:45, Dec. 28	17:47, Dec. 28	20-21.16 S, 062-51.36 E
FORSGC	APEX	1080	20773	18:42, Dec. 29	20:24, Dec. 29	19-59.85 S, 065-58.88 E
FORSGC	APEX	1079	20725	17:37, Dec. 30	18:48, Dec. 30	19-59.81 S, 068-47.65 E
FORSGC	APEX	1097	21997	20:16, Jan. 01	21:50, Jan. 01	19-58.97 S, 071-41.65 E
FORSGC	APEX	1098	22083	05:47, Jan. 03	06:15, Jan. 03	19-59.11 S, 074-43.92 E
FORSGC	APEX	1075	20590	07:39, Jan. 04	09:05, Jan. 04	19-59.74 S, 077-37.42 E
FORSGC	APEX	1076	20644	09:53, Jan. 05	11:18, Jan. 05	19-58.41 S, 080-32.71 E
FORSGC	APEX	1094	21341	12:04, Jan. 06	13:28, Jan. 06	19-59.53 S, 083-24.76 E
FORSGC	APEX	1073	20572	18:39, Jan. 07	20:00, Jan. 07	19-58.51 S, 086-28.15 E
FORSGC	APEX	947	26426	04:45, Jan. 10	06:20, Jan. 10	19-59.53 S, 089-59.70 E
FORSGC	APEX	946	26080	14:05, Jan. 11	15:58, Jan. 11	19-58.80 S, 092-48.40 E
FORSGC	APEX	1096	21561	18:35, Jan. 12	20:10, Jan. 12	19-59.36 S, 096-04.02 E

(5) Moorings deployed or recovered

No mooring was deployed nor recovered during the cruise.

1.3 List of Principal Investigator and Person in Charge on the Ship

The principal investigator (PI) and the person in charge responsible for the major parameters measured on the cruise are listed in Table 1.3.1.

Table 1.3.1. List of PI and person in charge.

Item	Principal Investigator(s)	Person in Charge
Hydrography		
CTDO	Hiroshi Uchida (JAMSTEC) [1-5]	Mark Rosenberg (ACE CRC) [1,4]
	huchida@jamstec.go.jp	*mark.rosenberg@utas.edu.au*
	Masao Fukasawa (JAMSTEC) [1-5]	Satoshi Ozawa (MWJ) [1,4,5]
	fksw@jamstec.go.jp	*satoshi@mwj.co.jp*
	Wolfgang Schneider	Hiroshi Matsunaga (MWJ) [2,5]
	(Univ. of Concepcion) [4,5]	*matsunaga@mwj.co.jp*
	wschneid@udec.cl	
LADCP	Yasushi Yoshikawa (JAMSTEC) [1-5]	Satoshi Ozawa (MWJ) [1]
	yoshikaway@jamstec.go.jp	*satoshi@mwj.co.jp*
		Hiroshi Matsunaga (MWJ) [2]
		matsunaga@mwj.co.jp
		On Sugimoto (JAMSTEC) [4]
		Luiz Vianna Nonnato
		(Univ. of Sao Paulo) [4]
		luiz@ceres.io.usp.br
		Masao Fukasawa (JAMSTEC) [5]
		fksw@jamstec.go.jp
XCTD	Tamaryn Morris (MCM) [5]	Yasutaka Imai (GODI) [5]
	tmorris@mcm.wcape.gov.za	*imai@godi.co.jp*
	Masao Fukasawa (JAMSTEC) [5]	
	fksw@jamstec.go.jp	
Salinity	Takeshi Kawano (JAMSTEC) [1-5]	Naoko Takahashi (MWJ) [1,4]
	kawanot@jamstec.go.jp	*takahashi@mwj.co.jp*
		Takeo Matsumoto (MWJ) [2]
		takem@mwj.co.jp
		Ken-ichi Katayama (MWJ) [5]
		katayama@mwj.co.jp
Oxygen	Shuichi Watanabe (JAMSTEC) [1-4]	Takayoshi Seike (MWJ) [1,4,5]
	swata@jamstec.go.jp	*seike@mwj.co.jp*
	Ayako Nishina (Kagoshima Univ.) [5]	Tomoko Miyashita (MWJ) [2,5]
	nishina@fish.kagoshima-u.ac.jp	*miyashita@mwj.co.jp*
Nutrients	Michio Aoyama (MRI/JMA) [1-5]	Junko Hamanaka (MWJ) [1,4]
	maoyama@mri-jma.go.jp	*hamanaka@mwj.co.jp*
		Ken-ichiro Sato (MWJ) [2,5]
		satok@mwj.co.jp
TCO_2	Akihiko Murata (JAMSTEC) [1-5]	Minoru Kamata (MWJ) [1,4]
	akihiko.murata@jamstec.go.jp	*kamata@mwj.co.jp*
		Mikio Kitada (MWJ) [2,5]
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Alkalinity	Akihiko Murata (JAMSTEC) [1-5]	Fuyuki Shibata (MWJ) [1,4]
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		Taeko Ohama (MWJ) [2,5]			Mikio Kitada (MWJ)[5]
		ohama@mwj.co.jp			*kitada@mwj.co.jp*
pH	Akihiko Murata (JAMSTEC) [1-5]	Toru Fujiki (MWJ) [1,4]	$^3He/^4He$	Shuichi Watanabe (JAMSTEC) [1,2,5]	Yuichiro Kumamoto (JAMSTEC) [1]
	akihiko.murata@jamstec.go.jp	*fujiki@mwj.co.jp*		*swata@jamstec.go.jp*	*kumamoto@jamstec.go.jp*
		Masaki Moro (MWJ) [2]			Shuichi Watanabe (JAMSTEC) [2]
		moro@mwj.co.jp			*swata@jamstec.go.jp*
		Taeko Ohama (MWJ) [5]			Masahide Wakita (JAMSTEC) [5]
		ohama@mwj.co.jp			*mwakita@jamstec.go.jp*
CFCs	Yutaka Watanabe (Hokkaido Univ.) [1-5]	Ken-ichi Sasaki (JAMSTEC) [1,4,5]	Cs,Pu,^3H,Sr	Michio Aoyama (MRI/JMA) [1-5]	Akira Takeuchi (KANSO) [1,2]
	yywata@ees.hokudai.ac.jp	*ksasaki@jamstec.go.jp*		*maoyama@mri-jma.go.jp*	*takeuti_akira@kanso.co.jp*
		Masahide Wakita (JAMSTEC) [2]			Sang-Han Lee (IAEA) [4]
		mwakita@jamstec.go.jp			*S.Lee@iaea.org*
		Katsuhiro Sagishima (MWJ) [4]			Beniamino Oregioni (IAEA) [5]
		ksagi@mwj.co.jp			*B.Oregioni@iaea.org*
		Yuichi Sonoyama (MWJ) [5]	Ar/N_2	Yutaka Watanabe (Hokkaido Univ.) [1-5]	Shin-ichi Tanaka (Hokkaido Univ.) [1-5]
		sonoyama@mwj.co.jp		*yywata@ees.hokudai.ac.jp*	*shinichi@ees.hokudai.ac.jp*
$\Delta^{14}C$	Yuichiro Kumamoto (JAMSTEC) [1-5]	Yuichiro Kumamoto (JAMSTEC) [1,2]	N_2O	Laura Farias (RP POC) [2]	Mauricio Gallegos (RP POC) [2]
	kumamoto@jamstec.go.jp	*kumamoto@jamstec.go.jp*		*lfarias@profc.udec.cl*	*mauricio@profc.udec.cl*
		Akihiko Murata (JAMSTEC) [4,5]	Primary	Brian Irwin (BIO) [1]	Brian Irwin (BIO) [1]
		akihiko.murata@jamstec.go.jp	Productivity	*brian.Irwin@ns.sympatico.ca*	*brian.Irwin@ns.sympatico.ca*
TOC	Akihiko Murata (JAMSTEC) [1-5]	Akihiko Murata (JAMSTEC) [1,2]		Gadiel Alarcon (Univ. of Concepcion) [2]	Gadiel Alarcon (Univ. of Concepcion) [2]
	akihiko.murata@jamstec.go.jp	*akihiko.murata@jamstec.go.jp*		*gadiel@profc.udec.cl*	*gadiel@profc.udec.cl*
		Minoru Kamata (MWJ) [4]		Vivian Lutz (INIDEP) [4]	Vivian Lutz (INIDEP) [4]
		kamata@mwj.co.jp		*vlutz@inidep.edu.ar*	*vlutz@inidep.edu.ar*

	Prudence Bonham (CSIRO) [5] *Pru.Bonham@csiro.au*	Prudence Bonham (CSIRO) [5] *Pru.Bonham@csiro.au*
Chlorophyll-a	Brian Irwin (BIO) [1] *brian.Irwin@ns.sympatico.ca*	Brian Irwin (BIO) [1] *brian.Irwin@ns.sympatico.ca*
	Gadiel Alarcon (Univ. of Concepcion) [2] *gadiel@profc.udec.cl*	Gadiel Alarcon (Univ. of Concepcion) [2] *gadiel@profc.udec.cl*
	Vivian Lutz (INIDEP) [4] *vlutz@inidep.edu.ar*	Vivian Lutz (INIDEP) [4] *vlutz@inidep.edu.ar*
	Prudence Bonham (CSIRO) [5] *Pru.Bonham@csiro.au*	Prudence Bonham (CSIRO) [5] *Pru.Bonham@csiro.au*
Underway		
ADCP	Yasushi Yoshikawa (JAMSTEC) [1-5] *yoshikaway@jamstec.go.jp*	Sou-ichiro Sueyoshi (GODI) [1,4] *sueyoshi@godi.co.jp*
		Satoshi Okumura (GODI) [2] *okumura@godi.co.jp*
		Yasutaka Imai (GODI) [5] *imai@godi.co.jp*
Bathymetry	Toshiya Fujiwara (JAMSTEC) [1-5] *toshi@jamstec.go.jp*	Sou-ichiro Sueyoshi (GODI) [1,4] *sueyoshi@godi.co.jp*
		Satoshi Okumura (GODI) [2] *okumura@godi.co.jp*
		Yasutaka Imai (GODI) [5] *imai@godi.co.jp*

Meteorology	Kunio Yoneyama (JAMSTEC) [1-5] *yoneyamak@jamstec.go.jp*	Sou-ichiro Sueyoshi (GODI) [1,4] *sueyoshi@godi.co.jp*
		Satoshi Okumura (GODI) [2] *okumura@godi.co.jp*
		Yasutaka Imai (GODI) [5] *imai@godi.co.jp*
Thermosalinograph	Takeshi Kawano (JAMSTEC) [1] *kawanot@jamstec.go.jp*	Takayoshi Seike (MWJ) [1,4] *seike@mwj.co.jp*
	Masao Fukasawa (JAMSTEC) [2,4,5] *fksw@jamstec.go.jp*	Tomoko Miyashita (MWJ) [2,5] *miyashita@mwj.co.jp*
pCO_2	Akihiko Murata (JAMSTEC) [1-5] *akihiko.murata@jamstec.go.jp*	Minoru Kamata (MWJ) [1,4] *kamata@mwj.co.jp*
		Mikio Kitada (MWJ) [2,5] *kitada@mwj.co.jp*
Fluorescence	Brian Irwin (BIO) [1] *brian.Irwin@ns.sympatico.ca*	Takayoshi Seike (MWJ) [1] *seike@mwj.co.jp*
	Gadiel Alarcon (Univ. of Concepcion) [2] *gadiel@profc.udec.cl*	Tomoko Miyashita (MWJ) [2] *miyashita@mwj.co.jp*
pN_2O	Laura Farias (RP POC) [2] *lfarias@profc.udec.cl*	Mauricio Gallegos (RP POC) [2] *mauricio@profc.udec.cl*
Floats, Drifters		
Argo float	Kensuke Takeuchi (JAMSTEC) [1-5] *takeuchi@fish-u.ac.jp*	Tomoyuki Takamori (MWJ) [1,5] *takamori@mwj.co.jp*

Dean Roemmich (SIO) [1-5]
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ACE CRC: Antarctic Climate and Ecosystems Cooperative Research Centre, Australia

BIO: Bedford Institute of Oceanography, Canada

CSIRO: Commonwealth Scientific and Industrial Research Organisation, Australia

GODI: Global Ocean Development Inc.

IAEA: International Atomic Energy Agency

INIDEP: Institute Nacional de Investigacion y Desarrollo Pesquero, Argentina

JAMSTEC: Japan Marine Science and Technology Center

KANSO: Kansai Environmental Engineering Center Co., Ltd.

MCM: Marine and Coastal Management, South Africa

MRI/JMA: Meteorological Research Institute, Japan Meteorological Agency

MWJ: Marine Works Japan, Ltd.

RP POC: Regional Program of Physical Oceanographic and Climate,
University of Concepcion, Chile

SIO: Scripps Institution of Oceanography, U.S.A.

1.4 Scientific Program and Methods

(1) Nature and objectives of MR03-K04 cruise project

It has been a decade since WOCE (World Ocean Circulation Experiment under WCRP) Hydrographic Program (WHP) was carried out in the world ocean. Not only accurate hydrographic sections but also mass transports and their divergence/convergence have been clarified on a basin scale. On the other hand, skills of measurements, especially those for carbon and CFC parameters, have been developed remarkably since the WOCE period. Thus, repeated land-to-land hydrography is recommended by CLIVAR and JGOFS strongly. At the same time, the repeated hydrography or WHP revisit is desirable to investigate long term changes in inventories of heat, water mass, materials and their transports; in fact, revisit of a WHP line in the North Pacific found a bottom water warming, which can be attributed to changes in the water column in the southern ocean. The magnitude of the warming was significant along its path way although very small.

Ocean Observation and Research Department of JAMSTEC plans to revisit WHP lines in the Southern Hemisphere as one of research actions of their project TAV-PI (Transport And Variability in the Pacific and the Indian) to detect long term changes in the hydrographic structure and the Antarctic overturn by surveying WHP lines in the Pacific, the Atlantic and the Indian at one cruise. This southern hemispheric circum navigation was highlighted at POGO-3 (December, 2001) as a following-up of the Sao Paulo Declaration of POGO-2 (January, 2001) that encourages and promotes both oceanographic studies and scientific capacity building in the southern hemisphere.

The main purpose of this research cruise is to detect and quantify temporal changes in the Antarctic overturn System corresponding to the global ocean and the Southern Ocean warming during the last decade through high quality and spatially dense observation along old WHP (WOCE Hydrographic Program: 1991-2002) lines. Scientific priorities, which lead to the above interest, are (1) changes in inventories of heat and freshwater, (2) changes in production rate, mass and pathway, (3) carbon and nutrients transport, (4) data base for model validation, and (5) ARGO sensor calibration.

The other purposes of this cruise are (1) to observe surface meteorological and hydrological parameters as a basic dataset of the meteorology and oceanography, (2) to launch ARGO floats in order to monitor the changes of sub-surface temperature and salinity, (3) to observe global warming gas distribution, (4) to observe sea bottom topography, gravity and magnetic fields along the cruise track in order to understand the dynamics of ocean plate and the accompanying geophysical activities, (5) to obtain data on global distribution and optical characteristics of aerosols and clouds for the climatology and for study of the feasibility of the satellite observations, (6) to construct a model to predict a primary production from satellite observation and (7) to observe concentration of cloud droplets for verification of satellite observation.

(2) Cruise overview

MR03-K04 cruise was carried out during the period from August 3, 2003 to February 19, 2004. The cruise was realized by the cooperation of Australia (CSIRO,ACE-CRC), Chile, Brazil, South Africa, IOCCG, Argo Science Team (Scripps, AOML, SOC) and IAEA. The cruise contained six legs. Legs 1, 2, 4 and 5 were revisit of WOCE Hydrographic Program sections P6W, P6C, P6E, A10, I4 and I3. A total of 493 stations were set to agree with the 1990s WOCE hydrographic observation stations. At each station, full-depth CTD profile and up to 36 water samples were taken and analyzed. Water samples were obtained from fixed layers with 12-liter Niskin bottles attached to 36-position SBE carousel water sampler. The layers were 10, 50, 100, 150, 200, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 3250, 3500, 3750, 4000, 4250, 4500, 4750, 5000, 5250, 5500, 5750 dbar and about 10 dbar above the bottom. Scientists from various institutions and technicians from Marine Works Japan Ltd. (MWJ) were responsible for analyzing water sample for salinity, dissolved oxygen, nutrients, CFCs, total carbon contents, alkalinity and pH. They also contributed sampling for total organic carbon, radiocarbon and He. A student of Hokkaido University joined CFCs measurement. We accepted 18 POGO trainees from Indonesia, Sri Lanka, Argentina, Chile, Turkey, Peru, Colombia, Uruguay, Brazil, Namibia, Tanzania and South Africa. POGO group mainly analyzed Chlorophyll-a contents and bioactivity in seawater. Twelve scientists from Chile, Brazil, Namibia, South Africa, Kenya, Mozambique, Madagascar and Mauritius were invited to the cruise. A part of Chilean group brought pN_2O system and collected seawater samples for N_2O analysis. Technicians from Global Ocean Development Inc. (GODI) have responsibility on a part of underway measurements such as current velocity by Acoustic Doppler Current Profiler (ADCP), geological parameters (topography, geo-magnetic field and gravity), and meteorological parameters. Sixty-two ARGO floats prepared by JAMSTEC, Scripps Institute of Oceanography (SIO), Atlantic Oceanographic and Meteorological Laboratory (AOML) and the Southampton Oceanography Centre (SOC) were launched by MWJ technicians and ship crew.

(3) Cruise narrative

R/V Mirai departed Brisbane, (Australia) on August 3, 2003. She arrived at the first station on the same day and made a cast for 93m. Although the depth was so shallow to trip only three bottles for analysis, we tripped additional 33 bottles to drill the method of sample drawing into all watchstanders. We made a cast at station P06-121 on September 2, 2003 and then went to Papeete, Tahiti. We observed 121 stations during leg 1 along approximately 32°30'S, which is WHP P06E and a half of P06C. She arrived at Papeete on September 5 and left on September 9, 2003 for the hydrographic section. She arrived at the first station, P06-127, on September 12, 2003. Although the station was observed once during leg 1, we observed the station again to confirm the continuity. P06-125 was also observed again for the same purpose. We made a cast at station P06-4 on 12 October, 2003 and then headed to Valparaiso, Chile. We observed 116 stations (excluding two doubled stations) along approximately 32°30'S, which corresponds to the rest half of P06C and P06W. R/V Mirai left Valparaiso on October 19, 2003 for Santos, Brazil. She went through Magellan Strait and arrived at Santos on November 2, 2003. She left Santos on November 6, 2003 for Cape Town, South Africa. The first station of the leg 4 was A10-622 and observed on November 7, 2003. We observed 111 stations along approximately 32°S, which corresponds to WHP A10. We observed the last station of leg 4, A10-100 on December 2, 2003 and arrived at Cape Town on December 5, 2003. She left Cape Town on December 9, 2003 and called at Tamatave, Madagascar on December 20 and Port Louise, Mauritius on December 27 on her way to Fremantle, Australia. The navigation along approximately 24°40' S from Cape Town to Tamatave is called leg 5a and corresponds to WHP I4. The navigation along approximately 20°S from Tamatave to Fremantle is called leg 5b and corresponds to WHP I3. We observed 145 stations during leg 5 and arrived at Fremantle, Australia on January 24, 2004.

1.5 Major Problems and Goals not Achieved

Fluorometer attached to CTD was broken at Station P06-166. We replaced it with new one from leg 4. So fluoresence was not measured after P06-166 and during leg 2.

Since an instrument for CFCs did not work during leg 1 and a half of leg 2, CFCs were measured at selected layers during this period.

1.6 List of Participants

The members of the scientific party are listed in Table 1.6.1 to 1.6.5 along with their main tasks undertaken on the cruise.

Table 1.6.1. List of cruise participants in leg 1.

Name	Main tasks	Affiliation
A. Albertino	Sampling	Bogor Agricultural University
E. Barberi	Sampling	Estacion de Fotobiologia Playa Union
T. Fujiki	TCO_2	MWJ
M. Fujisaki	CTD	MWJ
M. Fukasawa	LADCP, Thermosalinograph, ARGO	JAMSTEC
J. Hamanaka	Nutrients	MWJ
Y. Iribe	Sampling	MWJ
B. Irwin	Bio-Optics	BIO
M. Kamata	TCO_2	MWJ
T. Kawano	Salinity	JAMSTEC
A. Kubo	Nutrients	MWJ
Y. Kumamoto	Oxygen, ^{14}C	JAMSTEC
K. Maeno	ADCP, Bathymetry, Meteorology	GODI
A. Murata	pH, Alkalinity, TCO_2, pCO_2, TOC	JAMSTEC
T. Nishihashi	Sampling	MWJ
S. Okumura	ADCP, Bathymetry, Meteorology	GODI
Y. Oyama	Sampling	MWJ
S. Ozawa	CTD	MWJ
M. Rosenberg	CTD Data Processing	ACE CRC
K. Sagishima	CFC	MWJ
K. Sasaki	CFC	JAMSTEC
T. Seike	Oxygen	MWJ
F. Shibata	pH, Alkalinity	MWJ
A. Shioya	Sampling	MWJ
S. Sueyoshi	ADCP, Bathymetry, Meteorology	GODI
N. Takahashi	Salinity	MWJ
T. Takamori	CTD Operation	MWJ
A. Takeuchi	Radio Nuclides	KANSO
S. Tanaka	Ar, N_2, CFC	Hokkaido University
T. Tanaka	Sampling, Salinity	MWJ
A. Wada	Sampling, CFC	MWJ
M. Wakita	CFC	JAMSTEC
K. Wataki	CFC	MWJ
H. Yamazaki	Sampling	MWJ
I. Yamazaki	Oxygen	MWJ
K. Yapa	Sampling	Univ. of Ruhuna, Matara, Sri Lanka
S. Yokogawa	Nutrients	MWJ
M. Yokota	Sampling, CFC	MWJ
Y. Yoshikawa	ADCP, LADCP	JAMSTEC

ACE CRC: Antarctic Climate and Ecosystems Cooperative Research Centre, Australia

BIO: Bedford Institute of Oceanography, Canada

GODI: Global Ocean Development Inc.

JAMSTEC: Japan Marine Science and Technology Center

KANSO: Kansai Environmental Engineering Center Co., Ltd.

MWJ: Marine Works Japan, Ltd.

Table 1.6.2. List of cruise participants in leg 2.

Name	Main tasks	Affiliation
G. Alarcon	Bio-Optics	Univ. of Concepcion
T. Chihara	Sampling	MWJ
R. Fuenzalida	Sampling	Univ. of Concepcion
M. Fukasawa	Data Management, LADCP	JAMSTEC
K. Katayama	ARGO, Salinity	MWJ
R. Kimura	ADCP, Bathymetry, Meteorology	GODI
M. Kitada	DIC, pCO_2	MWJ
N. Komai	Oxygen	MWJ
Y. Kumamoto	Oxygen, ^{14}C, Sampling	JAMSTEC
D.B. Matellini	Bio-Optics	Peruvian Marine Research Institute
K. Matsumoto	Sampling	MWJ
T. Matsumoto	Salinity	MWJ
H. Matsunaga	CTD	MWJ
A.G. Mejia	Bio-Optics	Univ. of Concepcion
T. Miyashita	Thermosalinograph, Oxygen	MWJ
M. Moro	TCO_2	MWJ
S.G. Munoz	Observer (Chile)	Armada de Chile
A. Murata	Alkalinity, pH	JAMSTEC
S. Okumura	ADCP, Bathymetry, Meteorology	GODI
Y. Otsubo	Nutrients	MWJ
S. Sancak	Bio-Optics	Middle East Technical University
W. Schneider	CTD	Univ. of Concepcion
T. Ohama	Alkalinity, pH	MWJ
K. Sato	Nutrients	MWJ
Y. Sonoyama	CFC	MWJ
O. Sugimoto	Sampling	JAMSTEC
M. Gallegos	Nitrous Oxide	RP POC
A. Takeuchi	Radio Nuclides	KANSO
S. Tanaka	CFC, Ar, N_2	Hokkaido University
W. Tokunaga	ADCP, Bathymetry, Meteorology	GODI
H. Uchida	CTD	JAMSTEC
V. Villagran	Elec. Engineer	Univ. of Concepcion
M. Wakita	CFC	JAMSTEC
S. Watanabe	CFC, $^3He/^4He$	JAMSTEC
T. Watanabe	Sampling	MWJ
Hideki Yamamoto	Data Management, LADCP, CFC	MWJ
Hirofumi Yamamoto	Sampling	JAMSTEC
A. Yasuda	Nutrients	MWJ
M. Yoshiike	ARGO, CTD	MWJ

Armada de Chile: Servicio Hidrografico y Oceanografico de la Armada de Chile

GODI: Global Ocean Development Inc.

JAMSTEC: Japan Marine Science and Technology Center

KANSO: Kansai Environmental Engineering Center Co., Ltd.

MWJ: Marine Works Japan, Ltd.

RP POC: Regional Program of Physical Oceanographic and Climate

Table 1.6.3. List of cruise participants in leg 4.

Name	Main tasks	Affiliation
E. Braga	Oxygen	Univ. of Sao Paulo
A. Claudia	Sampling, Bio-Optics	Univ. of Sao Paulo
B. Currie	Sampling	MFMR
T. Fujiki	TCO_2	MWJ
J. Hamanaka	Nutrients	MWJ
J. Hashimoto	CTD Operation	MWJ
S. Ikeda	Sampling	MWJ
M. Kamata	TCO_2	MWJ
T. Kawano	Salinity	JAMSTEC
A. Kubo	Nutrients	MWJ
S. Lee	Radio Nuclides	IAEA
V. Lutz	Bio-Optics	INIDEP
J. Madruga	Sampling, Bio-Optics	Univ. of Sao Paulo
K. Maeno	ADCP, Bathymetry, Meteorology	GODI
K. Matsumoto	Oxygen, Sampling	JAMSTEC
A. Murata	pH, Alkalinity, TOC, ^{14}C	JAMSTEC
L. Nonnato	LADCP, Sampling	Univ. of Sao Paulo
S. Okumura	ADCP, Bathymetry, Meteorology	GODI
S. Ozawa	CTD	MWJ
K. Peard	Sampling	LMR
M. Rosenberg	CTD, Data Processing	ACE CRC
K. Sagishima	CFC	MWJ
K. Sasaki	CFC	JAMSTEC
S. Sasaki	Sampling	MWJ
V. Segura	Sampling, Bio-Optics	INIDEP
T. Seike	Oxygen	MWJ
W. Schneider	CTD	Univ. of Concepcion
F. Shibata	pH, Alkalinity	MWJ
N. Silulwane	Sampling	MCM
S. Sueyoshi	ADCP, Bathymetry, Meteorology	GODI
O. Sugimoto	Sampling	JAMSTEC
N. Takahashi	Salinity	MWJ
S. Tanaka	CFC, Ar, N_2	Hokkaido Univ.
H. Uchida	LADCP	JAMSTEC
K. Wataki	CFC	MWJ
S. Watanabe	CFC, $^3He/^4He$	JAMSTEC
S. Yokogawa	Nutrients	MWJ
I. Yamazaki	Oxygen	MWJ
M. Yokota	Sampling	MWJ
M. Yoshiike	CTD Operation, ARGO	MWJ
Y. Yoshikawa	LADCP	JAMSTEC

ACE CRC: Antarctic Climate and Ecosystems Cooperative Research Centre, Australia
GODI: Global Ocean Development Inc.
IAEA: International Atomic Energy Agency
INIDEP: Institute Nacional de Investigacion y Desarrollo Pesquero, Argentina
JAMSTEC: Japan Marine Science and Technology Center
LMR: Luederitz Marine Research, Namibia
MCM: Marine and Coastal Management, South Africa
MFMR: Ministry of Fisheries and Marine Resources, Namibia
MWJ: Marine Works Japan, Ltd.

Table 1.6.4. List of cruise participants in leg 5a.

Name	Main tasks	Affiliation
J. Bemiasa	Sampling	IHSM
P. Bonham	Bio-Optics	CSIRO
L. Bravo	Sampling	Univ. of Concepcion
A. Forbes	LADCP	CSIRO
T. Fujiki	TCO_2	MWJ
M. Fukasawa	LADCP, ARGO, Thermosalinograph	JAMSTEC
J. Githaiga-Mwicigi	Sampling	MCM
A. Hoguane	Sampling	Univ. of Eduardo Mondlane
Y. Imai	ADCP, Bathymetry, Meteorology, XCTD	GODI
K. Katayama	Salinity	MWJ
T. Kawano	Salinity	JAMSTEC
M. Kawazoe	Sampling	MWJ
M. Kitada	TCO_2, TOC	MWJ
T. Kurokawa	Sampling	MWJ
M. Kyewalyanga	Sampling, Bio-Optics	Univ. of Dar es Salaam
K. Matsumoto	Sampling	MWJ
H. Matsunaga	CTD	MWJ
T. Miyashita	Oxygen, Thermosalinograph	MWJ
T. Morris	Sampling	MCM
A. Murata	pH, Alkalinity, pCO_2, TOC, ^{14}C	JAMSTEC
Y. Naito	Sampling	MWJ
A. Nishina	CTD, Oxygen	Kagoshima University
T. Ohama	pH, Alkalinity	MWJ
S. Okumura	ADCP, Bathymetry, Meteorology, XCTD	GODI
B. Oregioni	Radio Nuclides	IAEA
S. Ozawa	CTD	MWJ
S. Persand	Sampling	Mauritius Oceanography Institute
T. Sagara	Sampling	MWJ
K. Sasaki	CFC	JAMSTEC
K. Sato	Nutrients	MWJ
W. Schneider	CTD	Univ. of Concepcion
T. Seike	Oxygen, Thermosalinograph	MWJ
Y. Sonoyama	CFC	MWJ
T. Takamori	CTD Operation, ARGO	MWJ
S. Tanaka	CFC, Ar, N_2	Hokkaido University
W. Tokunaga	ADCP, Bathymetry, Meteorology, XCTD	GODI
M. Wakita	CFC, $^3He/^4He$	JAMSTEC
T. Watanabe	Salinity	MWJ
B. Wigly	Sampling, Bio-Optics	Univ. of Cape Town
Hideki Yamamoto	LADCP	MWJ
Hirofumi Yamamoto	Sampling	JAMSTEC
A. Yasuda	Nutrients	MWJ
S. Yokogawa	Nutrients	MWJ

CSIRO: Commonwealth Scientific and Industrial Research Organisation
GODI: Global Ocean Development Inc.
IAEA: International Atomic Energy Agency
IHSM: Institut Halieutique et des Sciences Marines
JAMSTEC: Japan Marine Science and Technology Center
MCM: Marine and Coastal Management, South Africa
MWJ: Marine Works Japan, Ltd.

Table 1.6.5. List of cruise participants in leg 5b.

Name	Main tasks	Affiliation
P. Bonham	Bio-Optics	CSIRO
L. Bravo	Sampling	Univ. of Concepcion
A. Forbes	Bio-Optics	CSIRO
M. Fukasawa	LADCP, ARGO, Thermosalinograph	JAMSTEC
J. Gasutaud	Radio Nuclides	IAEA
Y. Imai	ADCP, Bathymetry, Meteorology, XCTD	GODI
K. Katayama	Salinity	MWJ
T. Kawano	Salinity	JAMSTEC
M. Kawazoe	Sampling	MWJ
R. Kimura	ADCP, Bathymetry, Meteorology, XCTD	GODI
M. Kitada	TCO_2, TOC	MWJ
N. Komai	Oxygen, Thermosalinograph	MWJ
A. Kubo	Nutrients	MWJ
T. Kurokawa	Sampling	MWJ
M. Kyewalyanga	Sampling, Bio-Optics	Univ. of Dar es Salaam
K. Matsumoto	Sampling	MWJ
H. Matsunaga	CTD	MWJ
T. Miyashita	Oxygen, Thermosalinograph	MWJ
M. Moro	TCO_2, TOC	MWJ
A. Murata	pH, Alkalinity, pCO_2, TOC, ^{14}C	JAMSTEC
Y. Naito	Sampling	MWJ
A. Nishina	CTD, Oxygen	Kagoshima University
T. Ohama	pH, Alkalinity	MWJ
Y. Okamoto	Sampling	MWJ
T. Sagara	Sampling	MWJ
K. Sasaki	CFC	JAMSTEC
K. Sato	Nutrients	MWJ
W. Schneider	CTD	Univ. of Concepcion
A. Shioya	Sampling	MWJ
Y. Sonoyama	CFC	MWJ
T. Takamori	CTD Operation, ARGO	MWJ
S. Tanaka	CFC, Ar, N_2	Hokkaido University
W. Tokunaga	ADCP, Bathymetry, Meteorology, XCTD	GODI
H. Uno	CTD	MWJ
A. Wada	Sampling	MWJ
M. Wakita	CFC, $^3He/^4He$	JAMSTEC
T. Watanabe	Salinity	MWJ
Hideki Yamamoto	LADCP	MWJ
Hirofumi Yamamoto	Sampling	JAMSTEC
A. Yasuda	Nutrients	MWJ
A. Yenluk	Sampling	Mauritius Oceanography Institute

CSIRO: Commonwealth Scientific and Industrial Research Organisation

GODI: Global Ocean Development Inc.

IAEA: International Atomic Energy Agency

JAMSTEC: Japan Marine Science and Technology Center

MWJ: Marine Works Japan, Ltd.

2 Underway Measurements

2.1 Navigation and Bathymetry

28 February 2005

(1) Personnel

Souichiro Sueyoshi (GODI)

Satoshi Okumura (GODI)

Yasutaka Imai (GODI)

Katsuhisa Maeno (GODI)

Shinya Okumura (GODI)

Wataru Tokunaga (GODI)

Ryo Kimura (GODI)

Toshiya Fujiwara (JAMSTEC)

(2) Navigation

(2.1) Overview of the equipment

Ship's position was measured by navigation system, made by Sena Co. Ltd, Japan. The system has two 12-channel GPS receivers (Leica MX9400N). GPS antennas located at Navigation deck, offset to starboard and portside, respectively. We switched them to choose better state of receiving when the number of GPS satellites decreased or HDOP increased. But the system sometimes lost the position while the receiving status became worse. The system also integrates gyro heading (Tokimec TG-6000), log speed (Furuno DS-30) and other navigation devices data on HP workstation. The workstation keeps accurate time using GPS Time server (Datum Tymserv2100) via NTP (Network Time Protocol). Navigation data was recorded as "SOJ" data every 60 seconds.

The differential GPS (DGPS) system, *THALES Geosolutions* SkyFix, has also installed, but we had few chances to use this system because it needs reference stations within 2,000 km from the ship, so that differential corrections became available just before the end of this cruise. Two antennas for Leica GPS receiver located on the navigation deck, offset to starboard and portside, respectively. We switched them to choose better state of receiving when the number of satellites decreased or HDOP increased. But the system sometimes lost the position while the receiving status became worse.

(2.2) Data period

Leg 1: 01:00, 3 Aug. 2003 to 22:00, 5 Sep. 2003

Leg 2: 18:30, 9 Sep. 2003 to 12:08, 16 Oct. 2003

Leg 4: 11:20, 6 Nov. 2003 to 07:10, 5 Dec. 2003

Leg 5: 04:22, 9 Dec. 2003 to 00:52, 24 Jan. 2004

(2.3) Remarks

Leg 1

None

Leg 2

26 Sep. 2003	11:27 – 11:29	(GPS positioning error)
27 Sep. 2003	07:10 – 07:22	(GPS positioning error)

* GPS system was changed at 07:22, 27 Sep. 2003, from GPS1 to GPS2.

28 Sep. 2003	11:25 – 11:30	(GPS positioning error)
03 Oct. 2003	08:09 – 08:13	(GPS positioning error)
03 Oct. 2003	09:22 – 09:27	(GPS positioning error)
03 Oct. 2003	13:03 – 13:18	(GPS positioning error)
04 Oct. 2003	12:16 – 12:21	(GPS positioning error)
09 Oct. 2003	12:01 – 12:04	(GPS positioning error)
11 Oct. 2003	11:56 – 11:58	(GPS positioning error)

* GPS system was changed at 15:50, 11 Oct. 2003, from GPS2 to DGPS1

* GPS system was changed at 17:58, 11 Oct. 2003, from DGPS1 to GPS2.

Leg 4

* GPS system was changed at 10:24, 06 Nov. 2003, from GPS1 to DGPS2

* GPS system was changed at 19:36, 06 Nov. 2003, from DGPS2 to GPS1

* GPS system was changed at 16:17, 07 Nov. 2003, from GPS1 to DGPS2

* GPS system was changed at 16:29, 08 Nov. 2003, from DGPS2 to GPS1

09 Nov. 2003 13:15 – 13:27 (SOJ logging program trouble)

10 Nov. 2003 10:35 – 10:37 (SOJ logging program trouble)

11 Nov. 2003 10:11 – 12:41 (GPS positioning error)

* GPS system was changed at 12:42, 11 Nov. 2003, from GPS1 to GPS2

* GPS system was changed at 14:59, 23 Nov. 2003, from GPS2 to GPS1

23 Nov. 2003 22:29 – 22:40 (GPS positioning error)

* GPS system was changed at 22:51, 23 Nov. 2003, from GPS1 to GPS2

24 Nov. 2003 15:34 – 16:13 (Power failure)

* GPS system was changed at 17:25, 24 Nov. 2003, from GPS2 to GPSN

26 Nov. 2003 15:05 (GPS positioning error)

* GPS system was changed at 14:29, 27 Nov. 2003, from GPS2 to DGPS1

* GPS system was changed at 15:23, 27 Nov. 2003, DGPS1 to GPS2

Leg 5

21 Dec. 2003 13:16 – 13:46 (Network server trouble)

01 Jan. 2004 21:15 – 21:19 (GPS positioning error)

(3) Bathymetry

(3.1) Overview of the equipment

R/V MIRAI equipped a Multi Narrow Beam Echo Sounding system (MNBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.). The main objective of MNBES survey is collecting continuous bathymetry data along ship's track to make a contribution to geological and geophysical investigations and global datasets. Data interval along ship's track was max. 16 seconds at 6,000 m. To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data at the surface (6.2m), and sound velocity profiles calculated from temperature and salinity data obtained from the nearest CTD cast by the equation of Mackenzie (1981).

(3.2) System configuration and performance

System:	SEABEAM2112.004
Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 kW
Transmit pulse length:	3 to 20 msec.
Depth range:	100 to 11,000 m
Beam spacing:	1 degree athwart ship
Swath width:	150 degree (max.)
	120 degree to 4,500 m
	100 degree to 6,000 m
	90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or +/-1m, whichever is greater, over the entire swath.

(Nadir beam has greater accuracy; typically within < 0.2%
of depth or +/-1m, whichever is greater)

(3.3) Data period

We carried out bathymetric survey on the CTD observation lines during each leg.

Leg 1: 3 Aug. 2003 (P06_246) to 2 Sep. 2003 (P06_121)

Leg 2: 12 Sep. 2003 (P06_127) to 12 Oct. 2003 (P06_004)

Leg 4: 7 Nov. 2003 (A10_622) to 2 Dec. 2003 (A10_100)

Leg 5: 13 Dec. 2003 (I04_610) to 17 Dec. 2003 (I04_585)

19 Dec. 2003 (I03_562) to 20 Jan. 2004 (I03_444)

(3.4) Data processing

(3.4.1) Checking the navigation data

Navigation data is checked and removed outliers identified. Then the removed position data is interpolated.

(3.4.2) Sound velocity correction

The continuous bathymetry data is split into small area at the center of the adjoining CTD stations. For each small area, the bathymetry data is corrected using sound velocity profile calculated by the CTD data in the area. The equation of Mackenzie (1981) is used for the calculation of sound velocity in sea water. These data processing are carried out using "mbbath" module of the mbsystem.

(3.4.3) Girdding

The data editing and gridding are carried out using the HIPS software version 5.4 (CARIS, Canada). Firstly, low quality data during the CTD cast and the drift of the ship are removed. Secondly, the data is despiked by the function "Surface Cleaning" of the software using following parameters.

Tiling: by size (Minimum size of tile: 163.84 [m])

Degree of polynomial: 1 (tiled plane)

Cleaning

Shallow threshold: 3.000, sigma = 99.74 [%]

Deep threshold: 3.000, sigma = 99.74 [%]

Minimum residual required for rejection: 1.000 [m]

Thirdly, remaining error data are removed manually and normal data, which removed by the function "Surface Cleaning" are returned manually by the function "Swath Editor" and "Subset Editor" of the software. Finally, the data is gridded by the function "Interpolate" of the software using following parameters.

Matrix size: 5 x 5

Number of nearneighbors: 10

Reference

Mackenzie, K.V. (1981): Nine-term equation for the sound speed in the oceans, J. Acoust. Soc. Am., 70 (3), pp 807-812.

2.2 Surface Meteorological Observation

1 February 2005

(1) Personnel

Kunio Yoneyama (JAMSTEC)

Satoshi Okumura (GODI)

Souichiro Sueyoshi (GODI)

Yasutaka Imai (GODI)

Shinya Okumura (GODI)

Katsuhisa Maeno (GODI)

Wataru Tokunaga (GODI)

Norio Nagahama (GODI)

Ryo Kimura (GODI)

(2) Objective

As a basic dataset that describes weather conditions during the cruise, surface meteorological observation had been continuously conducted.

(3) Methods

There are two different surface meteorological observation systems on the R/V MIRAI. One is the MIRAI surface meteorological measurement station (SMET), and the other is the Shipboard Oceanographic and Atmospheric Radiation (SOAR) system.

Instruments of SMET whose data are used here are listed in Table 2.2.1. All SMET data were collected and processed by KOAC-7800 weather data processor made by Koshin Denki, Japan. Note that although SMET contains rain gauge, anemometer and radiometers in their system, we adopted those data from not SMET but SOAR due to the following reasons. Namely, 1) since SMET rain gauge is located near the base of the mast, there is a possibility that its capture rate might be affected, 2) SOAR's anemometer has better starting threshold wind speed (1 m/sec) comparing to SMET's anemometer (2 m/sec), and 3) SMET's radiometers record data with 10 W/m^2 unit, while SOAR takes 1 W/m^2 unit.

SOAR system was designed and constructed by the Brookhaven National Laboratory (BNL), USA for an accurate measurement of solar radiation on the ship. Details of SOAR can be found at http://www.gim.bnl.gov/soar/. SOAR consists of 1) Portable Radiation Package (PRP) that measures short and long wave downwelling radiation, 2) Zeno meteorological system that measures pressure, air temperature, relative humidity, wind speed/direction, and rainfall, and 3) Scientific Computer System (SCS), that is developed by the National Oceanic and Atmospheric Administration (NOAA) of USA for data collection, management, real-time monitoring, and so on. Information on sensors used here are listed in Table 2.2.2.

Table 2.2.1. Instruments and locations of SMET.

Sensor	Parameter	Manufacturer / type	Location / height from sea level
Thermometer*1	air temperature relative humidity	Vaisala, Finland / HMP45A	compass deck*2 / 21 m
Thermometer	sea temperature	Koshin Denki, Japan / RFN1-0	4th deck / -5 m
Barometer	pressure	Yokogawa, Japan / F-451	captain deck / 13 m

*1 Gill aspirated radiation shield 43408 made by R. M. Young, USA is attached.

*2 There are two thermometers at starboard and port sides.

Table 2.2.2. Instruments and locations of SOAR.

Sensor	Parameter	Manufacturer / type	Location / height from sea level
Anemometer	wind speed/direction	R. M. Young, USA / 05106	foremast / 25 m
Rain gauge	rainfall accumulation	R. M. Young, USA / 50202	foremast / 24 m
Radiometer	short wave radiation	Eppley, USA / PSP	foremast / 25 m
	long wave radiation	Eppley, USA / PIR	foremast / 25 m

(4) Data processing and data format

All raw data were recorded every 6 seconds. Datasets produced here are 1-minute mean values (time stamp at the beginning of the average). They are simple mean of 8 samples (10 samples minus maximum/minimum values) to exclude singular values. Liner interpolation onto missing values was applied only when their interval is less than 4 minutes.

Since the thermometers are equipped on both starboard/port sides on the deck, we used air temperature/relative humidity (and dew point temperature) data taken at upwind side. Dew point temperature was produced from relative humidity and air temperature data.

No adjustment to sea level values is applied except pressure data.

Data are stored as ASCII format and contain the following parameters.

Time in UTC expressed as YYYYMMDDHHMM, time in Julian day (1.0000 = January 1, 0000Z), longitude (°E), latitude (°N), pressure (hPa), air temperature (°C), dew point temperature (°C), relative humidity (%), sea surface temperature (°C), zonal wind component (m/sec), meridional wind component (m/sec), precipitation (mm/hr), downwelling shortwave radiation (W/m^2), and downwelling longwave radiation (W/m^2).

Missing values are expressed as "9999".

(5) Data Quality

To ensure the data quality, each sensor was calibrated as follows. It is remarked, however, since there is a possibility that fine time resolution data sets may have some noises caused by turbulence, it is recommended to create smoothed data sets (e.g., 1-hour mean) from this 1-minute mean data sets depending on the scientific purpose.

T/RH sensor:

Temperature and humidity probes were calibrated before/after the cruise by the manufacturer. Certificated accuracy for T/RH sensors are better than ± 0.2 °C and ± 2 %, respectively. In addition, their time drifts between the leg 1 and the leg 5 were 0.0 °C for T sensor and -1.3 % for RH sensor.

We also checked T/RH values using another calibrated portable T/RH sensor (Vaisala, HMP45A) before each cruise. The results are listed below.

Check date	Jul.31	Sep.06	Oct.17	Nov.03	Dec.05	Jan.24
Temperature (°C)						
SMET	12.1	28.2	19.2	21.9	28.3	22.6
portable	12.4	28.3	19.4	21.8	28.8	22.3
Relative Humidity (%)						
SMET	42	66	52	57	41	65
portable	38	65	51	56	41	66

Pressure sensor:

Using calibrated portable barometer (Vaisala, Finland / PTB220, certificated accuracy is better than ± 0.1 hPa, and it was calibrated at the manufacturer on Feb. 6, 2003), pressure sensor was checked before/after the each cruise. From the result listed below, pressure accuracy is better than ± 1 hPa.

Check date	Aug.02	Sep.02	Oct.17	Nov.03	Dec.05	Jan.24
SMET	1023.3	1014.1	1015.3	1017.0	1009.4	1008.1
reference	1022.6	1013.6	1014.6	1016.4	1008.8	1007.5
difference	0.7	0.5	0.7	0.6	0.6	0.6

Anemometer:

Using digital tester (Hioki, Japan / 3805), pre-/post calibration were conducted by the GODI technical staff.

Pre-calibration date: Apr. 09, 2003

Starting threshold wind speed: 0.2 m/sec for clockwise

0.4 m/sec for counter-clockwise

Wind direction check better than ± 3 °

Set value	0	30	60	90	120	150	180	210	240	270	300	330
Measured value	1	32	63	93	122	153	180	210	240	270	300	331
Difference	-1	-2	-3	-3	-2	-3	0	0	0	0	0	-1

Post-calibration date: Sep. 10, 2004

Starting threshold wind speed: 0.9 m/sec for clockwise

0.9 m/sec for counter-clockwise

Wind direction check: better than ± 4 °

Set value	0	30	60	90	120	150	180	210	240	270	300	330
Measured value	0	30	61	92	122	153	182	212	242	273	304	334
Difference	0	0	-1	-2	-2	-2	-2	-2	-2	-3	-4	-4

Precipitation:

Before each cruise, we put the water into the rain gauge to check their linearity between the indicated values and water amount input. Expected accuracy is better than ± 1 mm that corresponds to sensor's specification.

Calibration date	Jul. 30	Sep. 05	Oct. 16	Nov. 04	Dec. 05	Jan. 24
minimum input water volume (cc)	0.0	0.0	0.0	0.0	0.0	0.0
minimum measured value (mm)	1.0	0.9	0.8	0.9	0.9	0.1
maximum input water volume (cc)	513.7	511.0	512.3	511.7	513.0	511.7
maximum measured value (mm)	51.7	51.2	51.7	51.4	51.2	50.7

Radiation sensors:

Short wave and long wave radiometers were calibrated at the Brookhaven National Laboratory prior to the cruise. Sensors used here were calibrated in September 2002. Some results are shown below.

For PSP: $y = 3.875 x + 0.2$

For PIR: $y = 1.228 x + 5.7$, where y = insolation (W/m^2), and x = ADC value (mV).

$1 / (T + T0) = p_1 a^3 + p_2 a^2 + p_3 a + p_4$, where a = ln(ADC mV), and T0 = 273.15 K

Case temperature fit: max error = 0.004 °C

$p_1 = 3.0922e\text{-}6$, $p_2 = -3.7240e\text{-}5$, $p_3 = 4.3175e\text{-}4$, $p_4 = 1.7014e\text{-}3$

Dome temperature fit: max error = 0.004 °C

$p_1 = 2.9703e\text{-}6$, $p_2 = -3.6790e\text{-}5$, $p_3 = 4.3686e\text{-}4$, $p_4 = 1.6788e\text{-}3$

(6) Data periods

Leg 1 (Brisbane - Papeete): 2100Z, Aug.03, 2003 - 0700Z, Sep.02, 2003

Periods of missing values:

wind speed / direction 0002Z, Aug.16, 2003 - 0010Z, Aug.16, 2003

precipitation 0002Z, Aug.16, 2003 - 0010Z, Aug.16, 2003

short/long wave radiation	0002Z, Aug.16, 2003 - 0010Z, Aug.16, 2003
	2152Z, Aug.20, 2003 - 0020Z, Aug.21, 2003

Leg 2 (Papeete - Valparaiso):	0600Z, Sep.12, 2003 - 1100Z, Oct.16, 2003
Periods of missing values:	
wind speed / direction	0001Z, Sep.23, 2003 - 0012Z, Sep.23, 2003
	0816Z, Oct.12, 2003 - 0821Z, Oct.12, 2003
precipitation	0001Z, Sep.23, 2003 - 0012Z, Sep.23, 2003
	0816Z, Oct.12, 2003 - 0821Z, Oct.12, 2003
short / long wave radiation	0001Z, Sep.23, 2003 - 0011Z, Sep.23, 2003
	0816Z, Oct.12, 2003 - 0825Z, Oct.12, 2003

Leg 4 (Santos - Cape Town):	0000Z, Nov.09, 2003 - 0000Z, Dec.05, 2003
Periods of missing values:	
wind speed / direction	1534Z, Nov.24, 2003 - 1538Z, Nov.24, 2003
	1544Z, Nov.24, 2003 - 1558Z, Nov.24, 2003
short wave radiation	1548Z, Nov.09, 2003 - 1552Z,Nov.09, 2003
	1411Z, Nov.19, 2003 - 1417Z, Nov.19, 2003
	1427Z, Nov.19, 2003 - 1431Z, Nov.19, 2003

Leg 5 (Cape Town - Tamatave - Fremantle):	0600Z, Dec.09, 2003 - 2100Z, Jan.23, 2004
Periods of missing values:	
sea surface temperature	0601Z, Jan.21, 2004 - 2100Z, Jan.23, 2004
wind	0008Z, Dec.24, 2003 - 0013Z, Dec.24, 2003
precipitation	0008Z, Dec.24, 2003 - 0013Z, Dec.24, 2003
short wave radiation	1201Z, Dec.09, 2003 - 1214Z, Dec.09, 2003
	1029Z, Dec.15, 2003 - 1048Z, Dec.15, 2003
	1022Z, Dec.17, 2003 - 1030Z, Dec.17, 2003
	0953Z, Dec.22, 2003 - 0957Z, Dec.22, 2003
	0933Z, Dec.23, 2003 - 0941Z, Dec.23, 2003
	0008Z, Dec.24, 2003 - 0013Z, Dec.24, 2003
	0804Z, Jan.03, 2004 - 0822Z, Jan.03, 2004
	0726Z, Jan.06, 2004 - 0734Z, Jan.06, 2004
	0743Z, Jan.06, 2004 - 0751Z, Jan.06, 2004
	0720Z, Jan.07, 2004 - 0725Z, Jan.07, 2004
	0741Z, Jan.07, 2004 - 0746Z, Jan.07, 2004
	0419Z, Jan.15, 2004 - 0419Z, Jan.15, 2004
long wave radiation	0008Z, Dec.24, 2003 - 0013Z, Dec.24, 2003

(7) Preliminary results

Figures 2.2.1, 2.2.2, 2.2.3, and 2.2.4 show the time series of surface meteorological observation for each cruise. One hour mean values (time stamp at the medium of the average) instead of 1 minute mean are used to depict these figures.

(8) Point of contact

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JAMSTEC / IORGC, 2-15, Natsushima, Yokosuka 237-0061, Japan

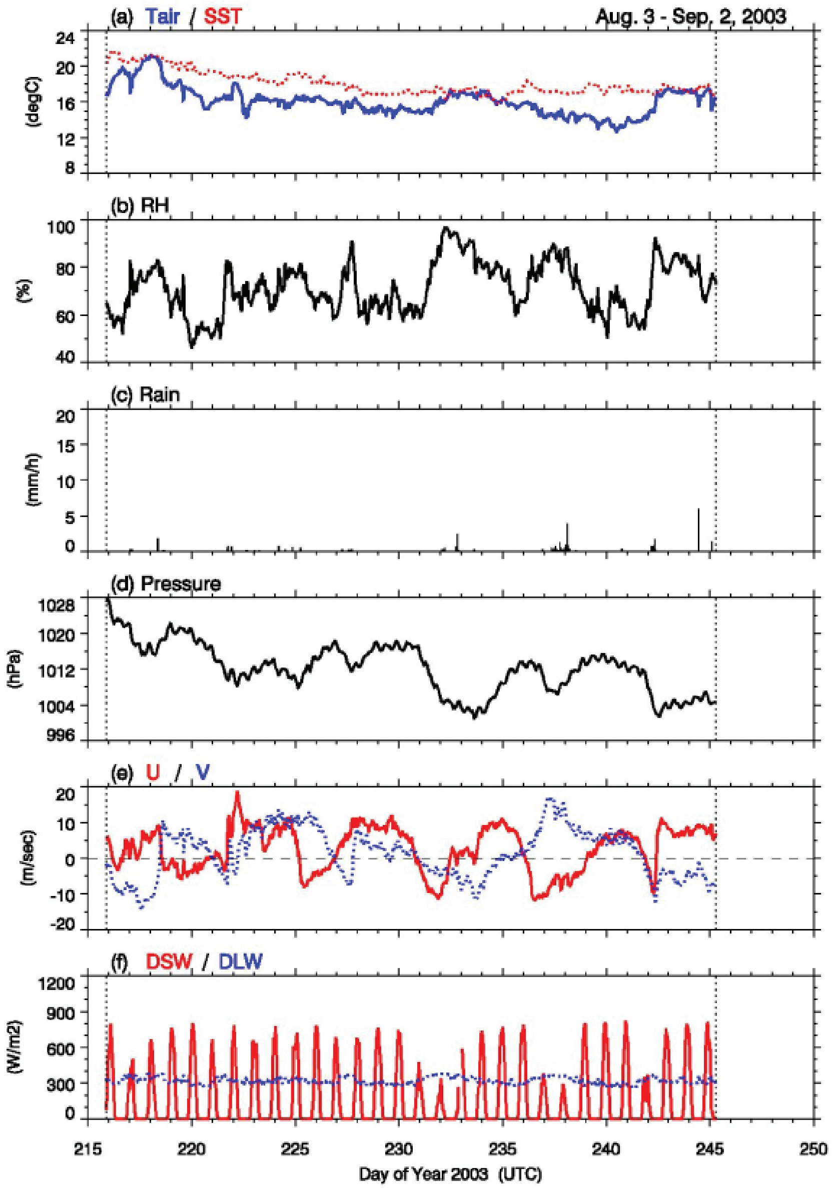

Figure 2.2.1. Time series of (a) air and sea surface temperature, (b) relative humidity, (c) precipitation, (d) pressure, (e) zonal and meridional wind components, and (e) short and long wave radiation for the leg 1 cruise. Day216 corresponds to Aug. 3, 2003.

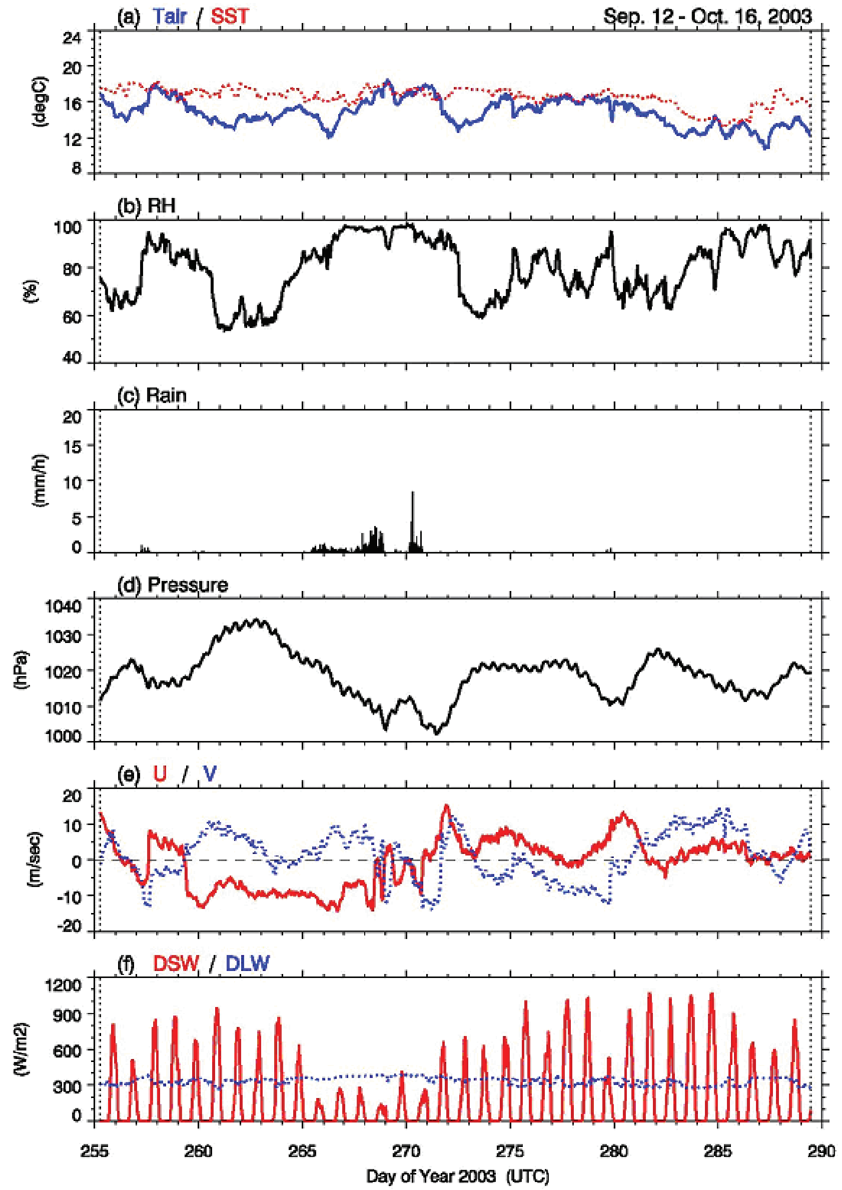

Figure 2.2.2. Same as Figure 2.2.1, but for the leg 2 cruise. Day255 corresponds to Sep. 12, 2003.

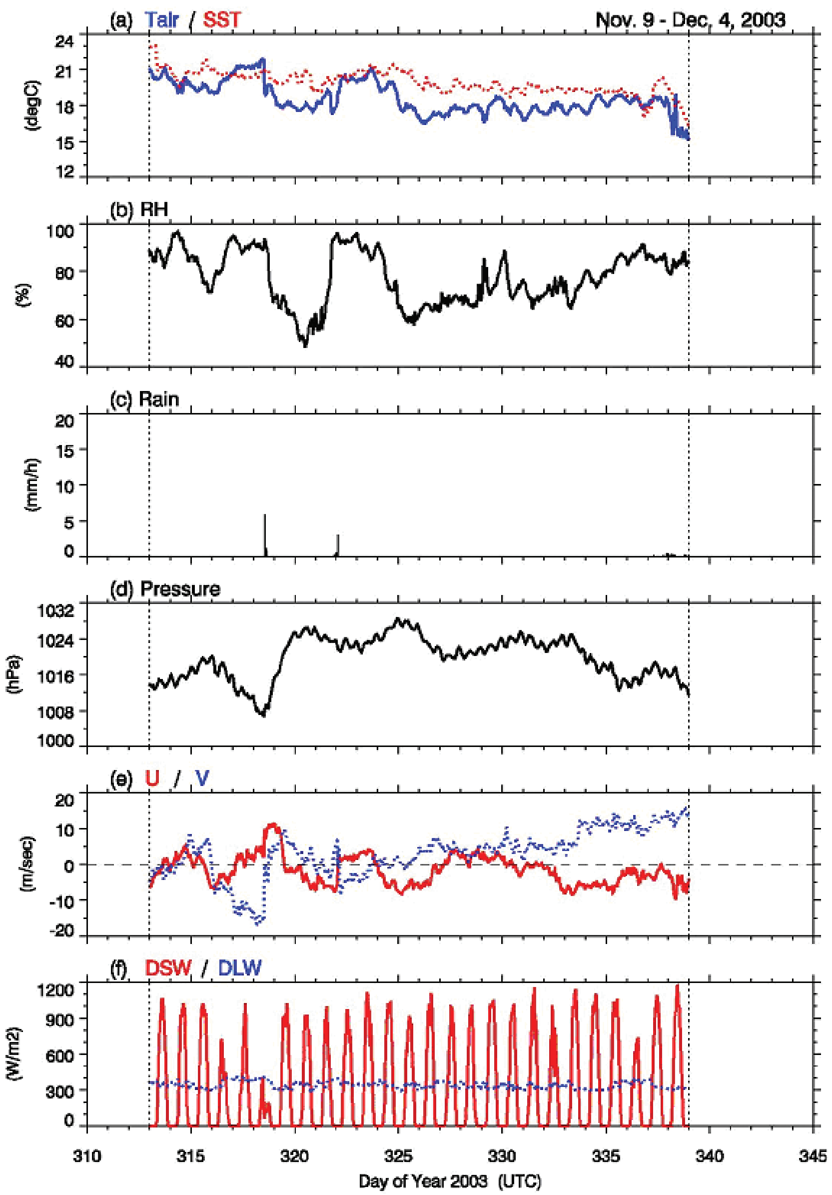

Figure 2.2.3. Same as Figure 2.2.1, but for the leg 4 cruise. Day313 corresponds to Nov. 9, 2003.

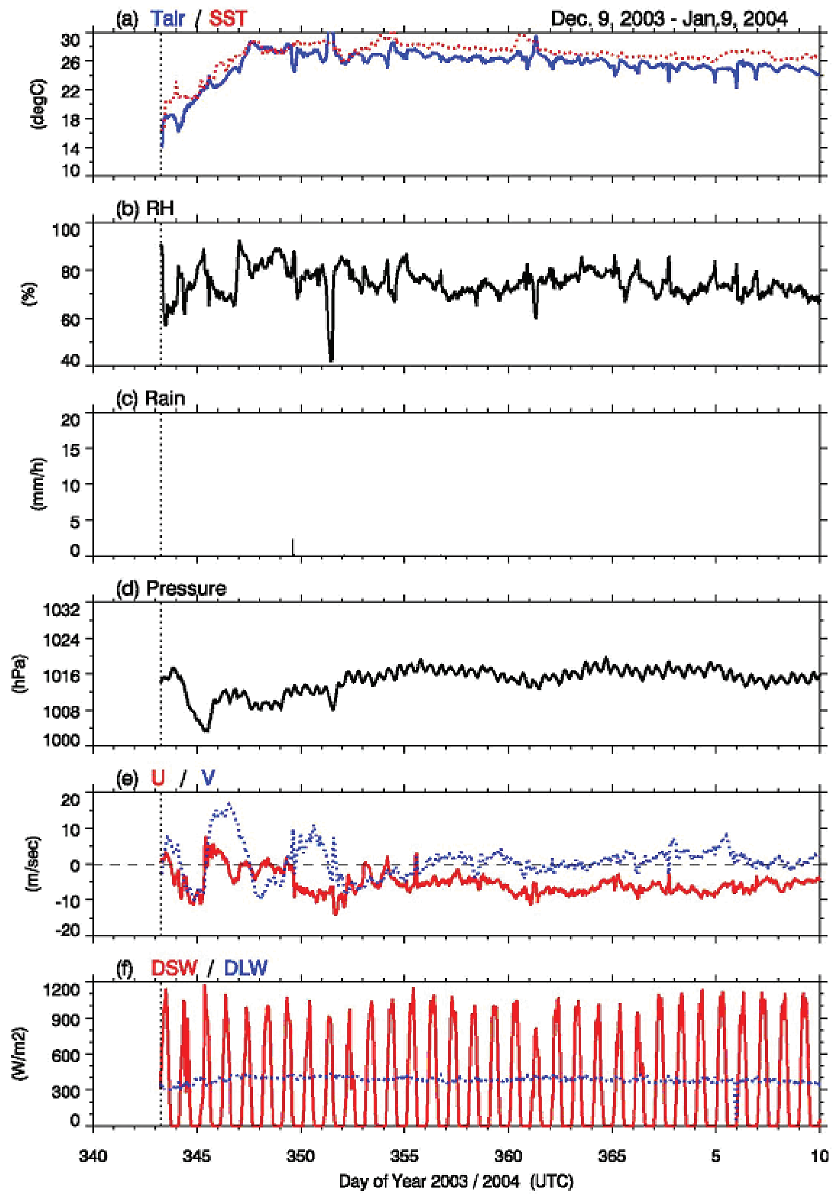

Figure 2.2.4. Same as Figure 2.2.1, but for the leg 5 cruise. Day343 corresponds to Dec. 9, 2003.

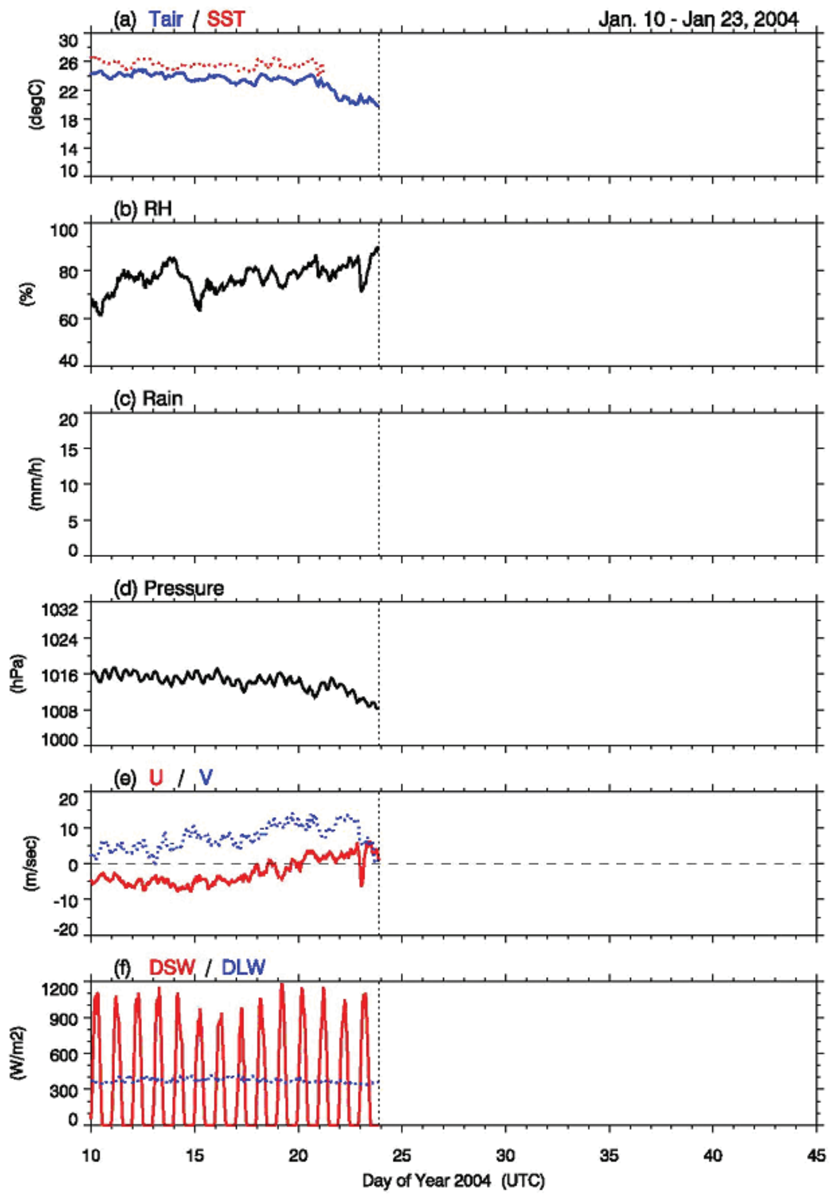

Figure 2.2.4. (continued) Day10 corresponds to Jan. 10, 2004.

2.3 Thermosalinograph and related measurements

22 January 2004

(1) Personnel

Masao Fukasawa (JAMSTEC)

Takeshi Kawano (JAMSTEC)

Takayoshi Seike (MWJ)

Tomoko Miyashita (MWJ)

Nobuharu Komai (MWJ)

(2) Objective

To measure salinity, temperature, dissolved oxygen, and fluorescence of near-sea surface water.

(3) Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co., Ltd.) has six kind of sensors and can automatically measure salinity, temperature, dissolved oxygen, fluorescence and particle size of plankton in near-sea surface water, continuously every 1-minute. This system is located in the "*sea surface monitoring laboratory*" on R/V Mirai. This system is connected to shipboard LAN-system. Measured data is stored in a hard disk of PC every 1-minute together with time and position of ship, and displayed in the data management PC machine.

Near-surface water was continuously pumped up to the laboratory and flowed into the *Continuous Sea Surface Water Monitoring System* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves and was 12 L/min except with fluorometer (about 0.3 L/min). The flow rate is measured with two flow meters and each value was checked every day.

Specification of the each sensor in this system of listed below.

a) Temperature and Salinity sensors

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, Sea-Bird Electronics, Inc.
Serial number:	2118859-2641 (for leg 1 and 2)
	2118859-3126 (for leg 4 and 5)
Measurement range:	Temperature -5 to +35 °C
	Salinity 0 to 6.5 S m^{-1}
Accuracy:	Temperature 0.01 °C 6 $month^{-1}$
	Salinity 0.001 S m^{-1} $month^{-1}$
Resolution:	Temperatures 0.001 °C
	Salinity 0.0001 S m^{-1}

b) Bottom of ship thermometer

Model:	SBE 3S, Sea-Bird Electronics, Inc.
Serial number:	032175 (for leg 1 and 2)
	032607 (for leg 4 and 5)
Measurement range:	-5 to +35 °C
Resolution:	± 0.001 °C
Stability:	0.002 °C $year^{-1}$

c) Dissolved oxygen sensor

Model:	2127A, Oubisufair Laboratories Japan Inc.
Serial number:	44733
Measurement range:	0 to 14 ppm
Accuracy:	± 1 % at 5 °C of correction range
Stability:	1 % $month^{-1}$

d) Fluorometer

Model: 10-AU-005, Turner Designs

Serial number: 5562 FRXX

Detection limit: 5 ppt or less for chlorophyll-a

Stability: 0.5 % month^{-1} of full scale

e) Particle Size sensor

Model: P-05, Nippon Kaiyo Co., Ltd.

Serial number: P5024

Measurement range: 0.02681 mmt to 6.666 mm

Accuracy: ± 10 % of range

Reproducibility: ± 5 %

Stability: 5 % week^{-1}

f) Flow meter

Model: EMARG2W, Aichi Watch Electronics Ltd.

Serial number: 8672

Measurement range: 0 to 30 l min^{-1}

Accuracy: ± 1 %

Stability: ± 1 % day^{-1}

The monitoring periods (UTC) are listed below.

Leg 1: 3 Aug. 2003, 11:00 to 3 Sep. 2003, 2:00

Leg 2: 11 Sep. 2003, 23:30 to 13 Oct. 2003, 14:00

Leg 4: 7 Nov. 2003, 11:07 to 2 Dec. 2003, 17:05

Leg 5: 9 Dec. 2003, 14:02 to 21 Jan. 2004, 01:16

(4) Comparison of salinity data with sampled salinity

We sampled about three times every day for salinity sensor calibration. All salinity samples were collected from the course of the system while on station or from regions with weak horizontal gradients. All samples were analyzed on the Guildline 8400B. The results were shown in Table 2.3.1 to 2.3.4.

Table 2.3.1. Comparison between salinity obtained from *Continuous Sea Surface Water Monitoring System* and sampled salinity for leg 1.

Date [UTC]	Time [UTC]	Salinity data	Sampled Salinity [PSS-78]
2003/08/03	18:54	35.5879	35.5776
2003/08/04	2:25	35.6021	35.5977
2003/08/04	9:59	35.6077	35.6023
2003/08/04	18:01	35.6732	35.7100
2003/08/05	1:54	35.6752	35.7049
2003/08/05	9:50	35.6532	35.6842
2003/08/05	18:01	35.6003	35.6289
2003/08/06	1:51	35.5960	35.6247
2003/08/06	10:27	35.6214	35.6512
2003/08/06	20:40	35.6474	35.6757
2003/08/06	21:50	35.6564	35.6859
2003/08/07	6:14	35.6663	35.6854
2003/08/07	15:20	35.6338	35.6642
2003/08/07	22:00	35.6880	35.7229
2003/08/08	6:01	35.6572	35.6895
2003/08/08	21:10	35.6394	35.6733
2003/08/09	5:05	35.7028	35.7333

2003/08/09	12:57	35.6875	35.7201
2003/08/09	20:58	35.6833	35.7181
2003/08/10	5:00	35.6743	35.7086
2003/08/10	21:54	35.6847	35.7183
2003/08/11	4:50	35.6789	35.7130
2003/08/11	17:09	35.6461	35.6810
2003/08/11	20:55	35.6490	35.6857
2003/08/12	5:03	35.6290	35.6705
2003/08/12	12:55	35.6526	35.6881
2003/08/12	20:54	35.6345	35.6703
2003/08/13	5:04	35.6611	35.6964
2003/08/13	11:57	35.6644	35.7019
2003/08/13	20:58	35.6236	35.6593
2003/08/14	4:11	35.6377	35.6739
2003/08/14	12:04	35.6180	35.6571
2003/08/14	20:08	35.6064	35.6447
2003/08/15	3:57	35.6112	35.6496
2003/08/15	12:15	35.5664	35.6030
2003/08/15	20:18	35.5552	35.5950
2003/08/16	7:48	35.4951	35.5322
2003/08/16	16:16	35.4935	35.5294
2003/08/16	23:56	35.4875	35.5251
2003/08/17	7:55	35.4698	35.5070
2003/08/17	15:40	35.5015	35.5427
2003/08/18	0:33	35.4962	35.5350
2003/08/18	8:14	35.4878	35.5273
2003/08/18	16:05	35.4888	35.5312
2003/08/19	0:05	35.5214	35.5527
2003/08/19	7:54	35.5274	35.5679
2003/08/19	16:00	35.5244	35.5650
2003/08/19	23:56	35.5482	35.5841
2003/08/20	8:08	35.4433	35.4880
2003/08/20	16:08	35.5156	35.5571
2003/08/20	19:58	35.4993	35.5407
2003/08/21	3:58	35.5171	35.5598
2003/08/21	11:33	35.5097	35.5511
2003/08/21	18:55	35.4674	35.5105
2003/08/22	2:57	35.3707	35.4655
2003/08/22	10:50	35.3744	35.4391
2003/08/22	18:56	35.2718	35.3405
2003/08/23	2:48	35.3186	35.3660
2003/08/23	10:51	35.4549	35.5079
2003/08/23	18:44	35.4632	35.5062
2003/08/24	3:01	35.4781	35.5308
2003/08/24	10:57	35.4741	35.5188
2003/08/24	18:58	35.4474	35.4910
2003/08/25	3:05	35.4212	35.4646
2003/08/25	11:09	35.4394	35.4823
2003/08/25	18:54	35.4106	35.4549
2003/08/26	2:54	35.3799	35.4229

2003/08/26	11:31	35.4319	35.4754
2003/08/27	7:00	35.4600	35.5030
2003/08/27	14:57	35.4578	35.5008
2003/08/27	23:07	35.3555	35.4095
2003/08/28	6:58	35.4548	35.4993
2003/08/28	15:09	35.4504	35.4941
2003/08/28	23:00	35.3639	35.4040
2003/08/29	6:54	35.3661	35.4016
2003/08/29	15:27	35.4121	35.4533
2003/08/29	23:05	35.3417	35.3944
2003/08/30	11:23	35.2927	35.3342
2003/08/30	15:00	35.2908	35.3325
2003/08/30	22:58	35.4069	35.4482
2003/08/31	6:58	35.3776	35.4200
2003/08/31	23:04	35.2608	35.3023
2003/09/01	7:00	35.3240	35.3648
2003/09/01	14:55	35.3516	35.3940
2003/09/01	22:57	35.3651	35.4015
2003/09/02	6:56	35.0834	35.1256
2003/09/02	21:59	35.3719	35.4129

Table 2.3.2. Comparison between salinity obtained from *Continuous Sea Surface Water Monitoring* and sampled salinity for leg 2.

Date [UTC]	Time [UTC]	Salinity data	Sampled Salinity [PSS-78]
2003/09/12	0:04	35.4439	35.4388
2003/09/12	4:50	35.3963	35.3872
2003/09/12	13:57	35.4003	35.3969
2003/09/12	21:53	35.3118	35.3038
2003/09/13	5:50	35.4051	35.3944
2003/09/13	14:12	35.3712	35.3756
2003/09/13	21:49	35.3911	35.3844
2003/09/14	5:55	35.3108	35.3050
2003/09/14	13:57	35.3014	35.2981
2003/09/14	21:54	35.3744	35.3707
2003/09/15	6:06	35.2835	35.2799
2003/09/15	13:58	35.1876	35.1810
2003/09/15	21:51	35.1790	35.1674
2003/09/16	6:14	34.9382	34.9259
2003/09/16	12:41	35.0919	35.0850
2003/09/16	20:51	35.1629	35.1564
2003/09/17	4:51	35.0098	35.0148
2003/09/17	13:00	35.0033	34.9987
2003/09/17	20:51	35.0895	35.0844
2003/09/18	5:08	35.1236	35.0788
2003/09/18	13:04	35.1737	35.1689
2003/09/18	20:57	34.9896	34.9934

2003/09/19	5:05	35.1949	35.1894
2003/09/19	13:45	35.1500	35.1461
2003/09/19	20:49	34.9999	34.9976
2003/09/20	4:54	34.8266	34.8203
2003/09/20	12:04	35.0261	35.0190
2003/09/20	19:50	34.9281	34.9238
2003/09/21	15:52	35.1231	35.1174
2003/09/21	20:12	35.1562	35.1505
2003/09/22	12:01	34.7262	34.7236
2003/09/22	19:47	34.6572	34.6524
2003/09/23	3:54	34.5923	34.5870
2003/09/23	11:54	34.6121	34.6025
2003/09/23	19:44	34.7548	34.7495
2003/09/24	3:28	34.6148	34.5793
2003/09/24	11:52	34.6804	34.6772
2003/09/24	19:56	34.6641	34.7457
2003/09/25	3:24	35.1447	35.1417
2003/09/25	11:54	34.9619	34.9601
2003/09/25	19:53	34.7201	34.7183
2003/09/26	3:47	34.8324	34.8302
2003/09/26	11:52	34.5981	34.5895
2003/09/26	19:51	34.6506	34.6458
2003/09/27	3:29	34.7590	34.7481
2003/09/27	10:46	34.5932	34.5780
2003/09/27	18:53	34.7409	34.7540

2003/09/28	2:42	34.5840	34.5791
2003/09/28	10:54	34.2848	34.2899
2003/09/28	18:54	34.3686	34.3644
2003/09/29	3:09	34.4975	34.4959
2003/09/29	10:58	34.8530	34.8501
2003/09/29	18:57	34.8608	34.8580
2003/09/30	14:52	34.8546	34.8509
2003/09/30	18:50	34.7904	34.7903
2003/10/01	2:39	34.6251	34.6164
2003/10/01	10:54	34.8408	34.8399
2003/10/01	18:53	34.8261	34.8265
2003/10/02	2:10	34.6571	34.6547
2003/10/02	10:53	34.9884	34.9745
2003/10/02	18:54	34.4697	34.4692
2003/10/03	2:50	34.2944	34.2984
2003/10/03	10:00	34.2395	34.2355
2003/10/03	17:48	34.2884	34.2893
2003/10/04	1:11	34.3806	34.3789
2003/10/04	9:55	34.4391	34.4373
2003/10/04	17:50	34.4851	34.4850
2003/10/05	2:00	34.2875	34.2835
2003/10/05	10:01	34.3031	34.3025
2003/10/05	17:50	34.4102	34.4096
2003/10/06	1:27	34.4638	34.4738
2003/10/06	9:56	34.5224	34.5197

2003/10/06	17:49	34.5731	34.5723
2003/10/07	0:34	34.4679	34.4655
2003/10/07	10:11	34.4325	34.4312
2003/10/07	17:50	34.4260	34.4274
2003/10/08	12:54	34.4017	34.4126
2003/10/08	17:06	34.4433	34.4455
2003/10/09	0:04	34.2978	34.3073
2003/10/09	8:49	34.3004	34.2992
2003/10/09	16:55	34.2764	34.2782
2003/10/10	0:27	34.1796	34.1775
2003/10/10	8:56	34.1458	34.1464
2003/10/10	16:50	34.2664	34.2686
2003/10/11	0:11	34.2401	34.2395
2003/10/11	8:58	34.2382	34.2358
2003/10/11	16:49	34.2659	34.2650
2003/10/11	23:26	34.6082	34.6093

Table 2.3.3. Comparison between salinity obtained from *Continuous Sea Surface Water Monitoring* and sampled salinity for leg 4.

Date [UTC]	Time [UTC]	Salinity data	Sampled Salinity [PSS-78]
2003/11/07	17:55	36.1938	36.1807
2003/11/08	1:58	36.2261	36.2155
2003/11/08	9:59	36.5223	36.5107
2003/11/08	18:02	37.1111	37.1012
2003/11/09	2:10	36.9197	36.9104
2003/11/09	9:51	36.1602	36.1485
2003/11/09	17:53	35.9997	35.9989
2003/11/10	1:59	36.0251	36.0113
2003/11/10	9:49	35.7294	35.7069
2003/11/10	17:57	35.7728	35.7581
2003/11/11	1:58	36.0776	36.0665
2003/11/11	9:56	36.0963	36.0859
2003/11/11	17:58	36.4694	36.4562
2003/11/12	1:54	36.1788	36.1679
2003/11/12	9:56	36.0033	35.9918
2003/11/12	18:02	36.0591	36.0479
2003/11/13	1:57	36.0285	36.0178
2003/11/13	10:02	36.0261	36.0285
2003/11/13	17:53	35.8561	35.8478
2003/11/14	2:04	35.9495	35.9412
2003/11/14	9:58	35.9992	35.9889
2003/11/14	18:01	36.0190	36.0086

2003/11/15	1:57	35.9047	35.8949
2003/11/15	9:57	35.9049	35.8949
2003/11/15	17:58	35.9818	35.9718
2003/11/16	1:54	36.0762	36.0671
2003/11/16	10:01	36.1472	36.1375
2003/11/16	18:00	36.0770	36.0673
2003/11/17	2:08	35.4934	35.4839
2003/11/17	9:53	35.8994	35.8891
2003/11/17	17:57	35.7057	35.6967
2003/11/18	1:58	36.0270	36.0165
2003/11/18	10:06	35.9530	35.9444
2003/11/18	18:02	35.8323	35.8216
2003/11/19	2:01	36.0499	36.0429
2003/11/19	9:59	35.9020	35.8931
2003/11/19	18:01	36.0589	36.0523
2003/11/20	0:56	35.9941	35.9846
2003/11/20	8:50	36.0124	36.0030
2003/11/20	17:03	36.1284	36.1210
2003/11/21	1:00	36.1766	36.1659
2003/11/21	8:49	36.0655	36.0578
2003/11/21	16:56	36.0378	36.0288
2003/11/22	0:56	35.8476	35.8372
2003/11/22	8:48	35.9853	35.9764
2003/11/22	17:03	35.8738	35.8642
2003/11/23	0:55	35.8052	35.7957

2003/11/23	8:47	35.7842	35.7746
2003/11/23	16:59	36.1174	36.1141
2003/11/24	0:59	36.0071	35.9972
2003/11/24	8:45	35.9418	35.9332
2003/11/24	17:05	35.9580	35.9500
2003/11/24	23:56	36.0008	35.9927
2003/11/25	7:57	35.9606	35.9538
2003/11/25	16:00	36.0141	36.0069
2003/11/25	23:58	35.8938	35.8864
2003/11/26	8:09	35.8466	35.8371
2003/11/26	15:59	35.8641	35.8579
2003/11/26	23:59	35.7779	35.7695
2003/11/27	7:52	35.9645	35.9598
2003/11/27	16:08	35.8023	35.7946
2003/11/27	23:57	35.7883	35.7797
2003/11/28	8:01	35.7803	35.7724
2003/11/28	15:57	35.6961	35.6885
2003/11/29	0:01	35.7615	35.7524
2003/11/29	7:53	35.8114	35.8036
2003/11/29	16:02	35.6035	35.5984
2003/11/29	23:56	35.3958	35.3908
2003/11/30	7:54	35.6416	35.6358
2003/11/30	15:57	35.5562	35.5515
2003/12/01	6:45	35.5899	35.6257
2003/12/01	14:54	35.4484	35.4906

2003/12/01	21:55	35.4547	35.4953
2003/12/02	5:43	35.3556	35.3501
2003/12/02	13:59	35.2902	35.2840

Table 2.3.4. Comparison between salinity obtained from *Continuous Sea Surface Water Monitoring* and sampled salinity for leg 5.

Date [UTC]	Time [UTC]	Salinity data	Sampled Salinity [PSS-78]
2003/12/09	14:31	35.5513	35.5438
2003/12/10	7:03	35.6051	35.5966
2003/12/10	15:21	35.6132	35.6084
2003/12/10	23:10	35.6429	35.6401
2003/12/11	7:06	35.5615	35.5515
2003/12/11	16:43	35.4587	35.4493
2003/12/11	22:11	35.3541	35.3453
2003/12/12	5:49	35.3233	35.3163
2003/12/12	14:09	35.3667	35.3576
2003/12/13	6:05	35.1934	35.1889
2003/12/13	17:25	35.2872	35.2744
2003/12/13	21:55	35.3049	35.2942
2003/12/14	6:05	35.3170	35.3018
2003/12/14	14:29	35.3484	35.3395
2003/12/14	22:17	35.2367	35.2346
2003/12/15	6:10	35.3267	35.3150
2003/12/15	22:02	35.1947	35.1857
2003/12/16	6:03	35.2692	35.2608
2003/12/16	22:14	35.2649	35.2563
2003/12/17	6:10	35.1445	35.1364
2003/12/17	14:02	35.1797	35.1685
2003/12/17	22:09	35.2711	35.2556

2003/12/18	6:05	35.1811	35.1779
2003/12/18	14:04	34.5516	34.5406
2003/12/18	22:00	34.7189	34.7142
2003/12/19	5:42	33.9081	33.9088
2003/12/19	14:33	34.8810	34.8727
2003/12/21	5:36	35.0581	35.0529
2003/12/21	21:15	35.0091	35.0119
2003/12/22	5:24	35.0580	35.0516
2003/12/22	13:01	34.9832	34.9781
2003/12/22	21:07	35.0369	35.0310
2003/12/23	4:52	34.9513	34.9449
2003/12/23	12:59	34.9354	34.9188
2003/12/23	21:23	34.9353	34.9256
2003/12/24	5:18	34.9253	34.9196
2003/12/24	12:53	34.9528	34.9435
2003/12/24	21:06	35.0308	35.0188
2003/12/25	5:44	35.0635	35.0560
2003/12/25	13:11	35.1809	35.1728
2003/12/25	21:28	34.9931	34.9905
2003/12/26	5:00	35.0093	35.0030
2003/12/28	2:55	35.0815	35.0731
2003/12/28	11:16	34.9481	34.9407
2003/12/29	3:13	35.0996	35.0946
2003/12/29	11:13	35.1619	35.1544
2003/12/29	17:58	35.0522	35.0443

2003/12/30	3:13	35.0370	35.0297
2003/12/30	10:51	34.9865	34.9810
2003/12/30	18:54	34.8960	34.8873
2003/12/31	3:05	35.0512	35.0462
2003/12/31	10:51	34.9369	34.9289
2004/01/01	2:19	35.0381	35.0326
2004/01/01	10:01	35.0385	35.0325
2004/01/01	17:45	35.0455	35.0376
2004/01/02	2:04	35.0559	35.0509
2004/01/02	9:52	35.0417	35.0360
2004/01/02	17:53	35.1282	35.1227
2004/01/03	1:59	35.0194	35.0694
2004/01/03	9:49	35.1302	35.1237
2004/01/03	17:54	35.0556	35.0494
2004/01/04	3:54	35.2286	35.2220
2004/01/04	9:50	35.0483	35.0443
2004/01/04	17:22	35.2565	35.2510
2004/01/05	2:08	35.1113	35.1068
2004/01/05	9:49	34.8085	34.8027
2004/01/05	17:32	34.5824	34.5768
2004/01/06	2:06	34.5421	34.5342
2004/01/06	9:48	34.5069	34.5013
2004/01/06	17:08	34.5338	34.5289
2004/01/07	1:56	34.6087	34.6038
2004/01/07	9:53	34.5409	34.5364

2004/01/07	17:41	34.9639	34.9567
2004/01/08	2:08	34.9691	34.9635
2004/01/08	8:52	34.9903	34.9846
2004/01/08	16:41	34.9707	34.9652
2004/01/09	0:53	34.9801	34.9741
2004/01/09	13:03	35.0055	35.0031
2004/01/09	16:37	34.9339	34.9278
2004/01/10	0:58	34.7494	34.7441
2004/01/10	8:56	35.1022	35.0979
2004/01/10	16:46	35.0116	35.0046
2004/01/11	0:57	34.9449	34.9392
2004/01/11	8:56	35.0376	35.0314
2004/01/11	16:04	35.2834	35.2772
2004/01/12	0:59	35.1986	35.1942
2004/01/12	9:00	34.9156	34.9097
2004/01/12	16:27	34.6938	34.6848
2004/01/13	1:07	34.8813	34.8761
2004/01/13	8:50	35.0236	35.0229
2004/01/13	16:57	35.1179	35.1127
2004/01/14	0:59	35.1151	35.1101
2004/01/14	8:48	35.0928	35.0882
2004/01/14	16:36	35.0652	35.0609
2004/01/15	0:59	34.9545	34.9496
2004/01/15	8:44	34.9191	34.9075
2004/01/15	15:55	35.0167	35.0112

2004/01/16	0:10	34.9761	34.9714
2004/01/16	8:15	34.9115	34.9055
2004/01/16	16:05	34.9545	34.9495
2004/01/16	23:55	34.8065	34.7996
2004/01/17	7:42	35.0691	35.0653
2004/01/17	15:50	35.2378	35.2319
2004/01/18	0:03	34.9854	34.9813
2004/01/18	7:53	35.1433	35.1390
2004/01/18	16:05	35.2309	35.2260
2004/01/19	0:01	35.0320	35.0272
2004/01/19	7:49	35.1260	35.1202
2004/01/19	15:46	35.3380	35.3321
2004/01/19	23:58	35.3243	35.3150
2004/01/20	7:55	35.2197	35.2148
2004/01/20	15:24	35.1860	35.1802
2004/01/21	0:04	35.0948	35.0942

2.4 Underway pCO_2

3 February 2005

(1) Personnel

Akihiko Murata (IORGC, JAMSTEC)

Mikio Kitada (MWJ)

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(2) Introduction

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} due to human activities such as burning of fossil fuels, deforestation, cement production, etc. It is an urgent task to estimate as accurately as possible the absorption capacity of the ocean against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the predicted global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

In the BEAGLE, we were aimed at quantifying how much anthropogenic CO_2 absorbed in the Southern Ocean, where intermediate and deep waters are formed, are transported and redistributed in the southern hemisphere subtropical oceans. For the purpose, we measured CO_2-system properties such as dissolved inorganic carbon (C_T), total alkalinity (A_T), pH and underway pCO_2.

In this section, we describe data on pCO_2 in the atmosphere and surface seawater obtained in the BEAGLE in detail.

(3) Apparatus and shipboard measurement

Continuous underway measurements of atmospheric and surface seawater pCO_2 were made with the CO_2 measuring system (Nippon ANS, Ltd) installed in the R/V *Mirai* of JAMSTEC. The system comprises of a non-dispersive infrared gas analyzer (NDIR; BINOS® model 4.1, Fisher-Rosemount), an air-circulation module and a showerhead-type equilibrator. To measure concentrations (mole fraction) of CO_2 in dry air (xCO_2a), air sampled from the bow of the ship (approx. 30 m above the sea level) was introduced into the NDIR through a dehydrating route with an electric dehumidifier (kept at ~2 °C), a Perma Pure dryer (GL Sciences Inc.), and a chemical desiccant ($Mg(ClO_4)_2$). The flow rate of the air was 500 ml min^{-1}. To measure surface seawater concentrations of CO_2 in dry air (xCO_2s), the air equilibrated with seawater within the equilibrator was introduced into the NDIR through the same flow route as the dehydrated air used in measuring xCO_2a. The flow rate of the equilibrated air was 600 – 800 ml min^{-1}. The seawater was taken by a pump from the intake placed at the approx. 4.5 m below the sea surface. The flow rate of seawater in the equilibrator was 500 – 800 ml min^{-1}.

The CO_2 measuring system was set to repeat the measurement cycle such as 4 kinds of CO_2 standard gases (Table 2.4.1), xCO_2a (twice), xCO_2s (7 times). This measuring system was run automatically throughout the cruise by a PC control.

(4) Quality control

Concentrations of CO_2 of the standard gases are listed in Table 2.4.1, which were calibrated by the JAMSTEC primary standard gases. The CO_2 concentrations of the primary standard gases were calibrated by C.D. Keeling of the Scripps Institution of Oceanography, La Jolla, CA, U.S.A.

Since differences of concentrations of the standard gases between before and after the cruise were allowable (< 0.1 ppmv), the averaged concentrations (Table 2.4.1) were adopted for the subsequent calculations.

In actual shipboard observations, the signals of NDIR usually reveal a trend. The trends were adjusted linearly using the signals of the standard gases analyzed before and after the sample measurements.

Effects of water temperature increased between the inlet of surface seawater and the equilibrator on xCO_2s were adjusted based on Gordon and Jones (1973), although the temperature increases were slight, being ~ 0.1 °C.

We checked values of xCO_2a and xCO_2s by examining signals of the NDIR on recorder charts, and by plotting the xCO_2a and xCO_2s as a function of sequential day, longitude, sea surface temperature and sea surface salinity.

Table 2.4.1. Concentrations of CO_2 standard gases used in the BEAGLE.

Cylinder no.	Concentrations (ppmv)	Leg no.
CQB15429	270.08	1, 2, 4
CQB15808	268.84	5
CQB15428	328.87	1, 2, 4
CQB15809	330.16	5
CQB15434	359.10	1, 2, 4
CQB15810	369.37	5
CQB15426	409.23	1, 2, 4
CQB15811	414.39	5

Reference

Gordon, L. I. and L. B. Jones (1973): The effect of temperature on carbon dioxide partial pressure in seawater. Mar. Chem., 1, 317-322.

2.5 Acoustic Doppler Current Profiler

28 February 2005

(1) Personnel

Yasushi Yoshikawa (JAMSTEC)

Souichiro Sueyoshi (GODI)

(2) Instrument and method

The instrument used was the RDI broadband 76.8 kHz unit, hull-mounted on the centerline and approximately 23 m aft of the bow at the water line. The firmware version was 5.59 and the data acquisition software was the VMDAS Ver. 1.3. Operation was made from the first CTD station to the last CTD station in each leg. The instrument was used in the water-tracking mode during the most of operations, recording each ping raw data in 100 x 8 m bins from 18.5 m to 818.5 m in deep. Sampling interval was 9.01 seconds. The bottom-tracking mode was added in the westernmost shallow water region, giving the data to evaluate the misalignment of the transducer on the hull. In the course the scale factor of the ADCP was also evaluated. GPS gave the navigation data. A compass we used was the INU (Inertial Navigation Unit) instead of the ship's gyrocompass. Its accuracy was 1.0 mil (about 0.056 degree) and had already set on zero bias before the beginning of the cruise. An electronic trouble occurred at 15:33 on 24 November, between A10_67 and A10_68 in the Atlantic sector. Though it recovered at 16:06, the INU compass had to be initialized. The initialization on the sea brought the bias error as 2.0 mil (about 0.112 degree) after the trouble. The bias value was evaluated again at port of Cape Town again, and fortunately, we found these values are same each other. Therefore the accuracy of the heading was same value of 0.056 degree during the cruise.

The performance of the ADCP instrument was almost good throughout the cruise: on streaming, profiles usually reached to about 600 m, except in heaviest weather and except in whilst streaming. Profiles were rather bad on CTD stations. It is probably due to the babbles originated from the bow-thruster. The profiles on the stations did not reach so far, from 200 m to 500 m and the ADCP signal was weak typically at about 350 m in deep. Echo intensity was relatively weak in the sea east of 160 W in the Pacific sector and Atlantic sector.

(3) Data processing

The first processing was the evaluation both of the ADCP scale factor and the misalignment by using the bottom-tracking mode data between P6_246 and P6_244 in the westernmost Pacific sector. The error velocity was less than 2.0 cm/s, and ratio ADCP/Navigation was 1.0259. Therefore the scale factor 1 / 1.0259 = 0.9748 was adopted to measured velocity magnitude of each ping. The misalignment angle was calculated as -0.17 degree between the ADCP and the INU. The values are almost same to the values those were obtained near the African coast: the difference of misalignments is less than 0.02 degree. The error of the heading, 0.056 degree, would give an estimation of the velocity error as 0.8 cm/s for the maximum ship speed 16 knots, and it would affect to the meridional velocity because the ship had almost zonal course.

The second processing is applying misalignment correction to raw data, and then calculating flow field on time series as a preliminary result that would make us an overview. Every ping data those error velocity, the difference between two vertical velocities, less than 20 cm/s and correlation value higher than 64 in the four beam solutions are used to the calculation. Median filter is used to make the 5 minutes mean field. The grids are put at the interval of 20 m. The roll and pitch data of the INU are not used to compensate the tilt motion because the INU was not put near the ADCP transducer. Therefore it would give a mismatch of the tilt motion. Depth correction is also made using the CTD data. The calculation is carried using less than about 100 independent data, 33 profiles x 3 bins. The error roughly estimated by the difference of the vertical velocities in each composite field is reduced to less than 2.0 cm/s.

We made the ADCP data set giving two types of profiles: one is at each CTD station and another is a mean profile on streaming between CTD stations. The mean velocities and their standard deviation are calculated using the 5 minutes composite velocity field. About 25 data on average are used in the calculation, which would reduce the error 0.4 cm/s, one fifth of the velocity error in each composite field. Then the final estimation of the error should be 0.9 cm/s, which is given by square root of $[0.8^2 + 0.4^2]$. The velocity in the data set has both of the temporal and spatial variations. Its standard deviation is 7.6 cm/s on average. It shows no significant difference between the standard deviations in each leg. However, the standard deviation at streaming is about 9.1 cm/s, and it is somewhat greater than that at the CTD station, 6.2 cm/s.

BEAGLE2003 .sum files

P06 REV R/V MIRAI CRUISE MR03K04 LEG1

SHIP/CRS EXPOCODE	WOCE SECT	STNNBR	CASTNO	CAST TYPE	DATE	UTC TIME	EVENT CODE	POSITION LATITUDE	POSITION LONGITUDE	NAV	UNC DEPTH	COR DEPTH	HT ABOVE BOTTOM	WIRE OUT	MAX PRESS	NO. OF BOTTLES	PARAMETERS	COMMENTS
49MR03K04_1	P06	246	1	ROS	080303	1957	BE	30 5.59 S	153 29.04 E	GPS	93	93				36	1-6	33 BTLS FOR DRILL OF WATER SMPL COLLECTION
49MR03K04_1	P06	246	1	ROS	080303	2003	BO	30 5.67 S	153 29.00 E	GPS	92	92	4	82	87			
49MR03K04_1	P06	246	1	ROS	080303	2021	EN	30 5.73 S	153 28.96 E	GPS	92	92						
49MR03K04_1	P06	246	1	BUC	080303	2031	UN	30 5.77 S	153 28.91 E	GPS	92	91					1	19.6C
49MR03K04_1	P06	246	1	BIO	080303	2050	UN	30 5.87 S	153 28.84 E	GPS	92	91					34,35,48	BIO-OPTICAL SAMPLING (NISKIN, 5M)
49MR03K04_1	P06	245	1	ROS	080303	2327	BE	30 5.09 S	153 31.42 E	GPS	134	134				4	1-6	
49MR03K04_1	P06	245	1	BUC	080303	2331	UN	30 5.13 S	153 31.39 E	GPS	134	133					1	20.3C
49MR03K04_1	P06	245	1	ROS	080303	2333	BO	30 5.15 S	153 31.38 E	GPS	133	134	2	125	129			
49MR03K04_1	P06	245	1	ROS	080303	2349	EN	30 5.27 S	153 31.25 E	GPS	131	130						
49MR03K04_1		401	1	XBT	080403	0027	DE	30 5.09 S	153 34.81 E	GPS	824	837						FOR SOUND SPEED CORRECTION (T-7)
49MR03K04_1	P06	244	1	ROS	080403	0053	BE	30 5.11 S	153 35.88 E	GPS	1126	1127				17	1-6,7,8,23,24,26,27,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	244	1	BUC	080403	0056	UN	30 5.15 S	153 35.86 E	GPS	1131	1133					1	20.8C
49MR03K04_1	P06	244	1	ROS	080403	0124	BO	30 5.43 S	153 35.67 E	GPS	1130	1136	9	1133	1132			
49MR03K04_1	P06	244	1	UNK	080403	0148	BE	30 5.66 S	153 35.50 E	GPS	1140	1141						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	244	1	UNK	080403	0155	EN	30 5.73 S	153 35.45 E	GPS	1151	1147						
49MR03K04_1	P06	244	1	ROS	080403	0211	EN	30 5.94 S	153 35.33 E	GPS	1163	1162						
49MR03K04_1	P06	243	1	ROS	080403	0336	BE	30 4.60 S	153 41.10 E	GPS	2557	2547				21	1-6,23,24,26	
49MR03K04_1	P06	243	1	BUC	080403	0343	UN	30 4.64 S	153 41.01 E	GPS	2574	2590					1	21.0C
49MR03K04_1	P06	243	1	ROS	080403	0422	BO	30 4.80 S	153 40.78 E	GPS	2666	2620	6	2681	2702			
49MR03K04_1	P06	243	1	ROS	080403	0536	EN	30 5.19 S	153 40.28 E	GPS	2556	2567						
49MR03K04_1	P06	242	1	ROS	080403	0655	BE	30 4.65 S	153 45.27 E	GPS	1982	1982				19	1-6	
49MR03K04_1	P06	242	1	BUC	080403	0658	UN	30 4.67 S	153 45.25 E	GPS	1976	1980					1	20.4C
49MR03K04_1	P06	242	1	ROS	080403	0734	BO	30 4.84 S	153 45.07 E	GPS	1948	1946	22	1930	1945			
49MR03K04_1	P06	242	1	ROS	080403	0836	EN	30 5.15 S	153 44.81 E	GPS	2024	2041						
49MR03K04_1	P06	241	1	ROS	080403	0955	BE	30 5.34 S	153 55.53 E	GPS	3389	3357				24	1-8,23,24,26,27	
49MR03K04_1	P06	241	1	BUC	080403	1000	UN	30 5.32 S	153 55.45 E	GPS	3240	3240					1	20.5C
49MR03K04_1	P06	241	1	ROS	080403	1041	BO	30 5.47 S	153 54.94 E	GPS	2742	2749	140	2748	2763			
49MR03K04_1	P06	241	1	ROS	080403	1158	EN	30 5.51 S	153 54.22 E	GPS	2425	2423						
49MR03K04_1	P06	240	1	ROS	080403	1336	BE	30 5.07 S	153 59.94 E	GPS	4453	4454				30	1-6	
49MR03K04_1	P06	240	1	ROS	080403	1444	BO	30 5.40 S	153 59.43 E	GPS	4438	4435	4	4464	4516			IRREGULAR SPOOL AT 2620M
49MR03K04_1	P06	240	1	BUC	080403	1602	UN	30 5.78 S	153 58.97 E	GPS	4411	4415					1	19.8C
49MR03K04_1	P06	240	1	ROS	080403	1657	EN	30 6.26 S	153 58.61 E	GPS	4418	4420						
49MR03K04_1	P06	239	1	ROS	080403	1813	BE	30 5.20 S	154 9.89 E	GPS	4610	4608				31	1-6,12,13,23,24,26	IRREGULAR SPOOL AT 2620M
49MR03K04_1	P06	239	1	ROS	080403	1928	BO	30 5.66 S	154 9.19 E	GPS	4608	4609	4	4640	4682			NOISE FROM RETURN VALVE (CTD WINCH)
49MR03K04_1	P06	239	1	BUC	080403	2049	UN	30 5.96 S	154 8.60 E	GPS	4608	4609					1	19.9C
49MR03K04_1	P06	239	1	ROS	080403	2144	EN	30 6.14 S	154 8.14 E	GPS	4609	4609						
49MR03K04_1	P06	238	1	ROS	080403	2336	BE	30 5.09 S	154 29.98 E	GPS	4594	4596				30	1-6,9,22,47	6 BTLS FOR R.N.
49MR03K04_1	P06	238	1	UNK	080403	2338	BE	30 5.10 S	154 29.98 E	GPS	4593	4594						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	238	1	UNK	080503	0028	EN	30 5.26 S	154 29.75 E	GPS	4595	4595						
49MR03K04_1	P06	238	1	BUC	080503	0049	UN	30 5.39 S	154 29.57 E	GPS	4598	4594					1	19.9C
49MR03K04_1	P06	238	1	ROS	080503	0053	BO	30 5.40 S	154 29.52 E	GPS	4594	4595	4	4612	4665			NOISE FROM RETURN VALVE (CTD WINCH)
49MR03K04_1	P06	238	1	BIO	080503	0100	UN	30 5.43 S	154 29.43 E	GPS	4594	4595					34,35,48	BIO-OPTICAL SAMPLING (NISKIN, 5M)

49MR03K04_1	P06	238	1	ROS	080503	0250	EN	30 6.16 S	154 28.48 E	GPS	4702	4704					
49MR03K04_1	P06	237	1	ROS	080503	0455	BE	30 4.95 S	154 59.91 E	GPS	4722	4723				31 1-6	
49MR03K04_1	P06	237	1	ROS	080503	0616	BO	30 5.17 S	154 59.22 E	GPS	4719	4722	10	4777	4795		NOISE FROM RETURN VALVE (CTD WINCH)
49MR03K04_1	P06	237	1	BUC	080503	0723	UN	30 5.33 S	154 58.90 E	GPS	4721	4721				1	19.9C
49MR03K04_1	P06	237	1	ROS	080503	0819	EN	30 5.53 S	154 58.54 E	GPS	4722	4723					
49MR03K04_1	P06	X11	1	ROS	080503	1043	BE	30 17.11 S	155 33.12 E	GPS	4858	4860				33 1-6,23,24,26	#1=#18 DUPLICATE SMPLS (2000DB)
49MR03K04_1	P06	X11	1	ROS	080503	1157	BO	30 17.73 S	155 32.59 E	GPS	4857	4860	3	4887	4929		A SMALL FISH IN TC DUCT CONTAMINATED PRIMARY SENSORS
49MR03K04_1	P06	X11	1	BUC	080503	1303	UN	30 18.17 S	155 32.18 E	GPS	4859	4863				1	20.2C
49MR03K04_1	P06	X11	1	ROS	080503	1402	EN	30 19.03 S	155 31.53 E	GPS	4865	4865					
49MR03K04_1	P06	235	1	ROS	080503	1620	BE	30 4.48 S	155 59.80 E	GPS	4591	4587				31 1-6	START FROM 10DB
49MR03K04_1	P06	235	1	ROS	080503	1733	BO	30 5.07 S	155 58.85 E	GPS	4605	4600	1	4635	4629		
49MR03K04_1	P06	235	1	BUC	080503	1844	UN	30 5.61 S	155 58.18 E	GPS	4556	4564				1	20.6C
49MR03K04_1	P06	235	1	ROS	080503	1945	EN	30 6.20 S	155 57.27 E	GPS	4653	4650					
49MR03K04_1	P06	234	1	ROS	080503	2206	BE	30 4.84 S	156 31.94 E	GPS	4824	4830				34 1-6,7,8,12,13,15,23,24,26,27,34,35,45,48	WIPED BTLS WITH ACETON
49MR03K04_1	P06	234	1	UNK	080503	2306	BE	30 5.04 S	156 31.58 E	GPS	4824	4825					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	234	1	ROS	080503	2322	BO	30 5.06 S	156 31.48 E	GPS	4828	4829	5	4838	4899		2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	234	1	BUC	080603	0039	UN	30 5.36 S	156 31.37 E	GPS	4829	4828				1	20.8C
49MR03K04_1	P06	234	1	UNK	080603	0044	EN	30 5.39 S	156 31.38 E	GPS	4824	4830					
49MR03K04_1	P06	234	1	ROS	080603	0144	EN	30 5.59 S	156 31.14 E	GPS	4825	4826					
49MR03K04_1	P06	232	1	ROS	080603	0344	BE	30 4.80 S	156 55.34 E	GPS	4882	4879				34 1-6,23,24,26,34,35,46,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	232	1	ROS	080603	0502	BO	30 5.03 S	156 55.14 E	GPS	4865	4873	5	4875	4946		
49MR03K04_1	P06	232	1	BUC	080603	0610	UN	30 5.31 S	156 54.84 E	GPS	4870	4873				1	20.6C
49MR03K04_1	P06	232	1	ROS	080603	0710	EN	30 5.45 S	156 54.58 E	GPS	4868	4877					
49MR03K04_1	P06	231	1	ROS	080603	0854	BE	30 5.13 S	157 19.86 E	GPS	3222	3223				26 1-6,23,24,26	#1=#24 DUPLICATE SMPLS (900DB)
49MR03K04_1	P06	231	1	ROS	080603	0949	BO	30 5.29 S	157 20.01 E	GPS	3213	3214	5	3217	3252		
49MR03K04_1	P06	231	1	BUC	080603	1020	UN	30 5.39 S	157 20.06 E	GPS	3201	3208				1	20.6C
49MR03K04_1	P06	231	1	ROS	080603	1117	EN	30 5.58 S	157 20.43 E	GPS	3173	3173					
49MR03K04_1	P06	230	1	ROS	080603	1241	BE	30 5.23 S	157 40.04 E	GPS	1860	1854				19 1-6	
49MR03K04_1	P06	230	1	BUC	080603	1249	UN	30 5.24 S	157 40.24 E	GPS	1840	1839				1	20.3C
49MR03K04_1	P06	230	1	ROS	080603	1315	BO	30 5.23 S	157 40.67 E	GPS	1852	1851	6	1868	1856		
49MR03K04_1	P06	230	1	ROS	080603	1414	EN	30 5.12 S	157 41.67 E	GPS	1799	1798					
49MR03K04_1	P06	229	1	ROS	080603	1538	BE	30 5.08 S	158 0.03 E	GPS	2015	2018				20 1-6,23,24,26	#1=#27 DUPLICATE SMPLS (1000DB)
49MR03K04_1	P06	229	1	BUC	080603	1543	UN	30 5.03 S	158 0.11 E	GPS	2047	2029				1	20.2C
49MR03K04_1	P06	229	1	ROS	080603	1617	BO	30 4.87 S	158 0.40 E	GPS	2026	2023	7	1999	2016		
49MR03K04_1	P06	229	1	ROS	080603	1717	EN	30 4.62 S	158 1.25 E	GPS	2093	2092					
49MR03K04_1	P06	228	1	ROS	080603	1846	BE	30 4.95 S	158 20.12 E	GPS	2656	2655				29 1-6,9,15,22,45,47	6 BTLS FOR R.N.
49MR03K04_1	P06	228	1	BUC	080603	1849	UN	30 4.91 S	158 20.15 E	GPS	2657	2655				1	19.7C
49MR03K04_1	P06	228	1	ROS	080603	1931	BO	30 4.64 S	158 20.57 E	GPS	2704	2702	9	2668	2687		
49MR03K04_1	P06	228	1	ROS	080603	2058	EN	30 4.25 S	158 21.33 E	GPS	2717	2713					
49MR03K04_1	P06	227	1	ROS	080603	2222	BE	30 4.76 S	158 40.98 E	GPS	3194	3197				28 1-6,12,13,22,23,24,26,34,35,46,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	227	1	UNK	080603	2232	BE	30 4.67 S	158 41.14 E	GPS	3201	3198					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	227	1	ROS	080603	2316	BO	30 4.59 S	158 41.59 E	GPS	3202	3199	6	3205	3236		
49MR03K04_1	P06	227	1	BUC	080603	2346	UN	30 4.61 S	158 41.82 E	GPS	3201	3196				1	19.7C
49MR03K04_1	P06	227	1	UNK	080603	2358	EN	30 4.65 S	158 41.93 E	GPS	3201	3197					
49MR03K04_1	P06	227	1	ROS	080703	0049	EN	30 4.58 S	158 42.68 E	GPS	3212	3208					
49MR03K04_1	P06	226	1	ROS	080703	0235	BE	30 19.90 S	159 4.79 E	GPS	2346	2346				23 1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	226	1	BUC	080703	0239	UN	30 19.95 S	159 4.88 E	GPS	2355	2354				1	19.6C
49MR03K04_1	P06	226	1	UNK	080703	0258	BE	30 20.04 S	159 5.22 E	GPS	2355	2351					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	226	1	ROS	080703	0318	BO	30 20.13 S	159 5.44 E	GPS	2351	2347	6	2382	2368		

49MR03K04_1	P06	226	1	UNK	080703	0359	EN	30 20.46 S	159 5.72 E	GPS	2342	2335						
49MR03K04_1	P06	226	1	ROS	080703	0432	EN	30 20.63 S	159 6.50 E	GPS	2301	2299						
49MR03K04_1	P06	225	1	ROS	080703	0624	BE	30 5.06 S	159 29.86 E	GPS	2692	2690				23	1-6,23,24,26	#1=#27 DUPLICATE SMPLS (600DB)
49MR03K04_1	P06	225	1	BUC	080703	0630	UN	30 4.98 S	159 29.95 E	GPS	2689	2691						
49MR03K04_1	P06	225	1	ROS	080703	0713	BO	30 4.99 S	159 30.37 E	GPS	2687	2689	3	2711	2720		1	19.3C
49MR03K04_1	P06	225	1	ROS	080703	0830	EN	30 4.49 S	159 31.50 E	GPS	2663	2665						
49MR03K04_1	P06	224	1	ROS	080703	1023	BE	30 5.07 S	160 0.26 E	GPS	1656	1659				17	1-6	
49MR03K04_1	P06	224	1	BUC	080703	1031	UN	30 5.09 S	160 0.47 E	GPS	1660	1655					1	19.4C
49MR03K04_1	P06	224	1	ROS	080703	1055	BO	30 5.04 S	160 0.78 E	GPS	1630	1633	3	1634	1651			
49MR03K04_1	P06	224	1	ROS	080703	1156	EN	30 4.92 S	160 1.71 E	GPS	1601	1602						
49MR03K04_1	P06	223	1	ROS	080703	1347	BE	30 4.96 S	160 29.96 E	GPS	1518	1521				18	1-6,9,22,23,24,26,46,47	
49MR03K04_1	P06	223	1	BUC	080703	1354	UN	30 4.89 S	160 29.98 E	GPS	1528	1521					1	19.3C
49MR03K04_1	P06	223	1	ROS	080703	1409	BO	30 4.77 S	160 30.06 E	GPS	1521	1520	7	1514	1527			
49MR03K04_1	P06	223	1	ROS	080703	1514	EN	30 4.45 S	160 30.26 E	GPS	1524	1523						
49MR03K04_1	P06	222	1	ROS	080703	1715	BE	30 5.08 S	160 59.87 E	GPS	1275	1275				16	1-6	
49MR03K04_1	P06	222	1	BUC	080703	1717	UN	30 5.07 S	160 59.86 E	GPS	1274	1275					1	18.7C
49MR03K04_1	P06	222	1	ROS	080703	1743	BO	30 4.97 S	160 59.76 E	GPS	1272	1272	5	1268	1278			
49MR03K04_1	P06	222	1	ROS	080703	1838	EN	30 4.72 S	160 59.57 E	GPS	1266	1266						
49MR03K04_1	P06	221	1	ROS	080703	2047	BE	30 5.15 S	161 30.01 E	GPS	1181	1182				18	1-6,12,13,1523,24,26,34,35,45,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	221	1	BUC	080703	2051	UN	30 5.15 S	161 29.99 E	GPS	1181	1182					1	19.7C
49MR03K04_1	P06	221	1	ROS	080703	2112	BO	30 5.11 S	161 29.91 E	GPS	1181	1181	4	1176	1186			
49MR03K04_1	P06	221	1	ROS	080703	2201	EN	30 5.02 S	161 29.83 E	GPS	1182	1182						IRREGULAR OSCILLATION WITH SHIFTER OF THE WINCH
49MR03K04_1	P06	220	1	ROS	080803	0032	BE	30 4.95 S	162 10.10 E	GPS	1151	1151				17	1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	220	1	UNK	080803	0038	BE	30 4.91 S	162 10.12 E	GPS	1152	1152						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	220	1	BUC	080803	0041	UN	30 4.88 S	162 10.12 E	GPS	1151	1152					1	18.7C
49MR03K04_1	P06	220	1	ROS	080803	0101	BO	30 4.73 S	162 10.24 E	GPS	1152	1152	8	1135	1154			
49MR03K04_1	P06	220	1	UNK	080803	0128	EN	30 4.53 S	162 10.40 E	GPS	1151	1152						
49MR03K04_1	P06	220	1	ROS	080803	0202	EN	30 4.20 S	162 10.60 E	GPS	1150	1151						
49MR03K04_1	P06	219	1	UNK	080803	0456	BE	30 4.94 S	162 49.95 E	GPS	1150	1149						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	219	1	UNK	080803	0524	EN	30 5.00 S	162 49.86 E	GPS	1149	1149						
49MR03K04_1	P06	219	1	ROS	080803	0639	BE	30 4.97 S	162 50.00 E	GPS	1150	1150				16	1-6,7,8,23,24,26,27	
49MR03K04_1	P06	219	1	BUC	080803	0648	UN	30 4.93 S	162 50.01 E	GPS	1150	1149					1	18.6C
49MR03K04_1	P06	219	1	ROS	080803	0707	BO	30 4.79 S	162 50.07 E	GPS	1150	1150	4	1148	1155			
49MR03K04_1	P06	219	1	ROS	080803	0753	EN	30 4.53 S	162 50.32 E	GPS	1150	1150						
49MR03K04_1	P06	218	1	ROS	080803	1029	BE	30 4.92 S	163 30.26 E	GPS	1445	1443				16	1-6	
49MR03K04_1	P06	218	1	BUC	080803	1036	UN	30 4.87 S	163 30.32 E	GPS	1445	1443					1	18.4C
49MR03K04_1	P06	218	1	ROS	080803	1100	BO	30 4.81 S	163 30.45 E	GPS	1443	1440	6	1435	1448			
49MR03K04_1	P06	218	1	ROS	080803	1150	EN	30 4.52 S	163 30.87 E	GPS	1452	1451						
49MR03K04_1	P06	217	1	ROS	080803	1332	BE	30 4.93 S	163 55.04 E	GPS	1954	1951				20	1-6,23,24,26	
49MR03K04_1	P06	217	1	BUC	080803	1336	UN	30 4.90 S	163 55.02 E	GPS	1953	1952					1	19.1C
49MR03K04_1	P06	217	1	ROS	080803	1406	BO	30 4.76 S	163 54.93 E	GPS	1962	1960	5	1957	1972			
49MR03K04_1	P06	217	1	ROS	080803	1506	EN	30 4.51 S	163 54.64 E	GPS	1977	1970						
49MR03K04_1	P06	216	1	ROS	080803	1655	BE	30 4.86 S	164 20.01 E	GPS	3291	3292				26	1-6	
49MR03K04_1	P06	216	1	ROS	080803	1752	BO	30 4.97 S	164 19.68 E	GPS	3290	3292	6	3295	3330			
49MR03K04_1	P06	216	1	BUC	080803	1835	UN	30 5.05 S	164 19.39 E	GPS	3288	3290					1	18.8C
49MR03K04_1	P06	216	1	ROS	080803	1922	EN	30 5.15 S	164 19.01 E	GPS	3281	3284						
49MR03K04_1	P06	215	1	ROS	080803	2121	BE	30 5.20 S	164 50.06 E	GPS	3375	3380				29	1-6,12,13,23,24,26,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	215	1	UNK	080803	2127	BE	30 5.16 S	164 50.04 E	GPS	3379	3380						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	215	1	ROS	080803	2217	BO	30 4.88 S	164 50.04 E	GPS	3376	3381	5	3391	3421			#3=#20 DUPLICATE SMPLS (1600DB)

49MR03K04_1	P06	215	1	UNK	080803	2250	EN	30	4.63 S	164 50.27 E	GPS	3375	3379						
49MR03K04_1	P06	215	1	BUC	080803	2252	UN	30	4.62 S	164 50.27 E	GPS	3378	3381					1	18.7C
49MR03K04_1	P06	215	1	ROS	080803	2349	EN	30	4.18 S	164 50.47 E	GPS	3377	3380						
49MR03K04_1	P06	214	1	ROS	080903	0203	BE	30	4.51 S	165 24.39 E	GPS	3374	3375				36	1-6,9,22,34,35,47,48	2 BTLS FOR BIO (4DB), 7 BTLS FOR R.N.
49MR03K04_1	P06	214	1	UNK	080903	0220	BE	30	4.32 S	165 24.40 E	GPS	3375	3374						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	214	1	ROS	080903	0258	BO	30	4.14 S	165 24.63 E	GPS	3374	3376	6	3391	3415			
49MR03K04_1	P06	214	1	UNK	080903	0300	EN	30	4.12 S	165 24.63 E	GPS	3376	3378						
49MR03K04_1	P06	214	1	BUC	080903	0325	UN	30	3.96 S	165 24.71 E	GPS	3376	3377					1	18.7C
49MR03K04_1	P06	214	1	ROS	080903	0422	EN	30	3.68 S	165 25.02 E	GPS	3375	3376						
49MR03K04_1	P06	213	1	ROS	080903	0615	BE	30	5.10 S	165 49.97 E	GPS	2421	2420				22	1-8,15,23,24,26,27,45	
49MR03K04_1	P06	213	1	BUC	080903	0620	UN	30	5.05 S	165 50.02 E	GPS	2415	2419					1	18.6C
49MR03K04_1	P06	213	1	ROS	080903	0656	BO	30	4.97 S	165 50.15 E	GPS	2411	2412	3	2413	2437			
49MR03K04_1	P06	213	1	ROS	080903	0806	EN	30	4.88 S	165 50.40 E	GPS	2423	2423						
49MR03K04_1		402	1	UNK	080903	2059	BE	30	4.66 S	166 29.84 E	GPS	3118	3115						MAGNETOMETER CALIBRATION
49MR03K04_1		402	1	UNK	080903	2122	EN	30	4.66 S	166 29.84 E	GPS	3116	3115						
49MR03K04_1		403	1	UNK	080903	2314	BE	30	5.75 S	166 32.50 E	GPS	3120	3122						SOLAR LIGHT MEASUREMENT
49MR03K04_1		403	1	UNK	080903	2350	EN	30	5.96 S	166 33.48 E	GPS	3120	3119						
49MR03K04_1		403	1	BIO	081003	0004	UN	30	6.03 S	166 33.86 E	GPS	3116	3116				4	34,35,48	BIO-OPTICAL SAMPLING (NISKIN, 5M)
49MR03K04_1	P06	212	1	ROS	081003	1317	BE	30	4.56 S	166 29.72 E	GPS	3115	3117				25	1-6	START FROM 20DB
49MR03K04_1	P06	212	1	ROS	081003	1407	BO	30	4.84 S	166 30.07 E	GPS	3110	3115	7	3134	3148			#18 LEAK, #22 NO SMPL
49MR03K04_1	P06	212	1	BUC	081003	1437	UN	30	5.00 S	166 30.21 E	GPS	3114	3114					1	18.1C
49MR03K04_1	P06	212	1	ROS	081003	1534	EN	30	5.39 S	166 30.47 E	GPS	3113	3112						
49MR03K04_1	P06	211	1	ROS	081003	1734	BE	30	5.08 S	166 59.97 E	GPS	2841	2840				24	1-6,12,13,23,24,26,46	START FROM 10DB
49MR03K04_1	P06	211	1	BUC	081003	1740	UN	30	5.12 S	166 59.96 E	GPS	2844	2840					1	17.8C
49MR03K04_1	P06	211	1	ROS	081003	1820	BO	30	5.24 S	167 0.25 E	GPS	2843	2845	6	2861	2874			
49MR03K04_1	P06	211	1	ROS	081003	1940	EN	30	5.63 S	167 0.56 E	GPS	2871	2876						
49MR03K04_1	P06	210	1	ROS	081103	0047	BE	30	4.84 S	167 29.95 E	GPS	1245	1247				17	1-6,34,35,48	START FROM 15DB, 2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	210	1	UNK	081103	0049	BE	30	4.85 S	167 29.95 E	GPS	1251	1247						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	210	1	BUC	081103	0051	UN	30	4.87 S	167 29.96 E	GPS	1231	1247					1	18.2C
49MR03K04_1	P06	210	1	UNK	081103	0112	EN	30	5.00 S	167 30.07 E	GPS	1200	1192						
49MR03K04_1	P06	210	1	ROS	081103	0113	BO	30	5.00 S	167 30.08 E	GPS	1180	1187	32	1188	1189			
49MR03K04_1	P06	210	1	ROS	081103	0201	EN	30	5.35 S	167 30.50 E	GPS	1047	1050						
49MR03K04_1	P06	209	1	ROS	081103	0403	BE	30	4.94 S	167 59.69 E	GPS	1199	1194				18	1-6,7,8,23,24,26,27,34,35,48	#3=#25 DUPLICATE SMPLS (800DB), 2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	209	1	UNK	081103	0405	BE	30	4.92 S	167 59.76 E	GPS	1194	1197						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	209	1	BUC	081103	0407	UN	30	4.91 S	167 59.77 E	GPS	1191	1194					1	18.5C
49MR03K04_1	P06	209	1	ROS	081103	0426	BO	30	4.89 S	167 59.93 E	GPS	1201	1207	7	1193	1192			
49MR03K04_1	P06	209	1	UNK	081103	0440	EN	30	4.91 S	168 0.03 E	GPS	1221	1222						
49MR03K04_1	P06	209	1	ROS	081103	0516	EN	30	5.03 S	168 0.29 E	GPS	1250	1249						
49MR03K04_1	P06	208	1	ROS	081103	0719	BE	30	4.18 S	168 29.74 E	GPS	3339	3341				26	1-6	
49MR03K04_1	P06	208	1	ROS	081103	0812	BO	30	4.30 S	168 29.92 E	GPS	3338	3338	6	3352	3381			
49MR03K04_1	P06	208	1	BUC	081103	0846	UN	30	4.38 S	168 30.01 E	GPS	3334	3341					1	17.8C
49MR03K04_1	P06	208	1	ROS	081103	0943	EN	30	4.46 S	168 30.14 E	GPS	3339	3340						
49MR03K04_1	P06	207	1	ROS	081103	1147	BE	30	5.04 S	168 59.96 E	GPS	3165	3166				26	1-6,12,13,23,24,26,46	START FROM 15DB
49MR03K04_1	P06	207	1	ROS	081103	1241	BO	30	5.22 S	169 0.30 E	GPS	3124	3126	27	3135	3153			#11=#14 DUPLICATE SMPLS (2800DB)
49MR03K04_1	P06	207	1	BUC	081103	1308	UN	30	5.20 S	169 0.49 E	GPS	3135	3127					1	17.8C
49MR03K04_1	P06	207	1	ROS	081103	1412	EN	30	5.07 S	169 0.94 E	GPS	3114	3120						
49MR03K04_1	P06	206	1	ROS	081103	1615	BE	30	5.07 S	169 29.66 E	GPS	2702	2704				29	1-6,9,22,47	6 BTLS FOR R.N.
49MR03K04_1	P06	206	1	BUC	081103	1629	UN	30	4.95 S	169 29.91 E	GPS	2708	2707					1	17.4C
49MR03K04_1	P06	206	1	ROS	081103	1709	BO	30	4.88 S	169 30.16 E	GPS	2720	2720	4	2723	2743			

49MR03K04_1	P06	206	1	ROS	081103	1829	EN	30	4.78 S	169 30.66 E	GPS	2740	2744					
49MR03K04_1	P06	205	1	ROS	081103	2047	BE	30	4.81 S	169 59.86 E	GPS	2945	2944				25 1-6,7,8,23,24,26,27,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	205	1	BUC	081103	2056	UN	30	4.86 S	169 59.80 E	GPS	2943	2940				1	17.5C
49MR03K04_1	P06	205	1	ROS	081103	2141	BO	30	4.78 S	169 59.97 E	GPS	2945	2943	5	2951	2975		#3=#32 DUPLICATE SMPLS (200DB)
49MR03K04_1	P06	205	1	UNK	081103	2152	BE	30	4.78 S	170 0.03 E	GPS	2947	2944					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	205	1	UNK	081103	2237	EN	30	4.69 S	170 0.22 E	GPS	2945	2946					
49MR03K04_1	P06	205	1	ROS	081103	2309	EN	30	4.62 S	170 0.49 E	GPS	2951	2951					
49MR03K04_1	P06	204	1	ROS	081203	0113	BE	30	5.01 S	170 29.97 E	GPS	2931	2929				25 1-6,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	204	1	BUC	081203	0125	UN	30	4.86 S	170 30.06 E	GPS	2903	2900				1	17.4C
49MR03K04_1	P06	204	1	UNK	081203	0145	BE	30	4.76 S	170 30.33 E	GPS	2767	2753					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	204	1	UNK	081203	0207	EN	30	4.77 S	170 30.55 E	GPS	2700	2707					
49MR03K04_1	P06	204	1	ROS	081203	0209	BO	30	4.76 S	170 30.57 E	GPS	2704	2699	38	2717	2712		LADCP SOUNDING
49MR03K04_1	P06	204	1	ROS	081203	0333	EN	30	4.65 S	170 31.17 E	GPS	2577	2575					
49MR03K04_1	P06	203	1	ROS	081203	0640	BE	30	5.07 S	171 0.24 E	GPS	2136	2141				20 1-6,23,24,26	WAITING FOR WIND/WAVE CONDITION (1HR)
49MR03K04_1	P06	203	1	BUC	081203	0645	UN	30	5.09 S	171 0.27 E	GPS	2140	2140				1	17.4C
49MR03K04_1	P06	203	1	ROS	081203	0726	BO	30	5.18 S	171 1.02 E	GPS	2130	2131	5	2241	2154		#22 NO SMPL (1200DB)
49MR03K04_1	P06	203	1	ROS	081203	0837	EN	30	5.50 S	171 1.83 E	GPS	2112	2111					
49MR03K04_1	P06	202	1	ROS	081203	0953	BE	30	4.89 S	171 16.68 E	GPS	585	583				11 1-6	#22 TEST
49MR03K04_1	P06	202	1	BUC	081203	0957	UN	30	4.89 S	171 16.77 E	GPS	589	587				1	17.2C
49MR03K04_1	P06	202	1	ROS	081203	1019	BO	30	4.92 S	171 17.14 E	GPS	603	604	7	611	599		
49MR03K04_1	P06	202	1	ROS	081203	1051	EN	30	5.03 S	171 17.68 E	GPS	648	669					
49MR03K04_1	P06	201	1	ROS	081203	1200	BE	30	5.28 S	171 30.06 E	GPS	2238	2238				21 1-6,7,8,12,13,15,23,24,26,27,45	#16=#35 DUPLICATE SMPLS (50DB)
49MR03K04_1	P06	201	1	BUC	081203	1205	UN	30	5.34 S	171 30.18 E	GPS	2239	2246				1	17.9C
49MR03K04_1	P06	201	1	ROS	081203	1249	BO	30	5.74 S	171 30.96 E	GPS	2257	2254	6	2357	2266		
49MR03K04_1	P06	201	1	ROS	081203	1408	EN	30	6.25 S	171 32.27 E	GPS	2268	2271					
49MR03K04_1	P06	200	1	ROS	081203	1612	BE	30	5.19 S	172 0.17 E	GPS	2787	2783				31 1-6,9,22,47	8 BTLS FOR R.N.
49MR03K04_1	P06	200	1	BUC	081203	1615	UN	30	5.24 S	172 0.21 E	GPS	2789	2794				1	18.2C
49MR03K04_1	P06	200	1	ROS	081203	1713	BO	30	5.69 S	172 0.89 E	GPS	2771	2775	3	2883	2837		
49MR03K04_1	P06	200	1	ROS	081203	1840	EN	30	6.23 S	172 1.80 E	GPS	2743	2743					
49MR03K04_1	P06	199	1	ROS	081203	2048	BE	30	5.10 S	172 29.77 E	GPS	2135	2136				23 1-6,23,24,26,34,35,46,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	199	1	BUC	081203	2055	UN	30	5.15 S	172 29.77 E	GPS	2136	2135				1	18.3C
49MR03K04_1	P06	199	1	UNK	081203	2125	BE	30	5.40 S	172 29.74 E	GPS	2141	2141					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	199	1	ROS	081203	2132	BO	30	5.41 S	172 29.75 E	GPS	2135	2139	7	2141	2156		#3=#31 DUPLICATE SMPLS (250DB)
49MR03K04_1	P06	199	1	UNK	081203	2146	EN	30	5.49 S	172 29.77 E	GPS	2129	2128					
49MR03K04_1	P06	199	1	ROS	081203	2238	EN	30	5.89 S	172 30.08 E	GPS	2127	2127					
49MR03K04_1	P06	198	1	ROS	081303	0040	BE	30	5.04 S	172 59.87 E	GPS	1383	1380				19 1-6,34,35,48	2 BTLS FOR BIO (10DB), #3 BACKUP OF #22
49MR03K04_1	P06	198	1	BUC	081303	0052	UN	30	5.00 S	173 0.07 E	GPS	1403	1403				1	18.5C
49MR03K04_1	P06	198	1	ROS	081303	0117	BO	30	4.97 S	173 0.47 E	GPS	1413	1417	8	1430	1423		
49MR03K04_1	P06	198	1	UNK	081303	0132	BE	30	4.95 S	173 0.68 E	GPS	1401	1416					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	198	1	UNK	081303	0202	EN	30	4.93 S	173 1.15 E	GPS	1412	1417					
49MR03K04_1	P06	198	1	ROS	081303	0210	EN	30	4.89 S	173 1.29 E	GPS	1433	1432					
49MR03K04_1	P06	197	1	ROS	081303	0401	BE	30	5.15 S	173 29.70 E	GPS	2458	2459				23 1-6,23,24,26	
49MR03K04_1	P06	197	1	BUC	081303	0403	UN	30	5.12 S	173 29.75 E	GPS	2459	2458				1	18.9C
49MR03K04_1	P06	197	1	ROS	081303	0451	BO	30	4.98 S	173 30.50 E	GPS	2608	2604	7	2636	2615		
49MR03K04_1	P06	197	1	ROS	081303	0604	EN	30	4.48 S	173 31.53 E	GPS	2781	2780					
49MR03K04_1	P06	196	1	ROS	081303	0802	BE	30	5.07 S	173 59.91 E	GPS	3368	3364				26 1-6	
49MR03K04_1	P06	196	1	ROS	081303	0858	BO	30	4.74 S	174 0.37 E	GPS	3357	3354	5	3402	3401		
49MR03K04_1	P06	196	1	BUC	081303	0930	UN	30	4.53 S	174 0.64 E	GPS	3347	3343				1	18.1C
49MR03K04_1	P06	196	1	ROS	081303	1028	EN	30	4.04 S	174 1.28 E	GPS	3344	3343					
49MR03K04_1	P06	195	1	ROS	081303	1241	BE	30	4.96 S	174 29.82 E	GPS	3636	3592				28 1-6,12,13,23,24,26	

49MR03K04_1	P06	195	1	ROS	081303	1347	BO	30 4.32 S	174 30.68 E	GPS	3732	3739	7	3728	3692			
49MR03K04_1	P06	195	1	BUC	081303	1432	UN	30 3.93 S	174 31.10 E	GPS	3782	3781					1	18.5C
49MR03K04_1	P06	195	1	ROS	081303	1533	EN	30 3.39 S	174 31.93 E	GPS	3865	3866						
49MR03K04_1	P06	194	1	ROS	081303	1821	BE	30 4.80 S	175 10.02 E	GPS	4129	4124				36	1-6,9,22,47	START FROM 15DB
49MR03K04_1	P06	194	1	ROS	081303	1934	BO	30 4.25 S	175 10.67 E	GPS	4149	4149	4	4203	4203			7 BTLS FOR R.N.
49MR03K04_1	P06	194	1	BUC	081303	2026	UN	30 4.04 S	175 11.01 E	GPS	4153	4150					1	17.5C
49MR03K04_1	P06	194	1	BIO	081303	2038	UN	30 4.01 S	175 11.07 E	GPS	4153	4153					34,35,48	BIO-OPTICAL SAMPLING (NISKIN AND BUCKET)
49MR03K04_1	P06	194	1	ROS	081303	2122	EN	30 3.85 S	175 11.53 E	GPS	4154	4155						
49MR03K04_1	P06	X14	1	ROS	081403	0052	BE	30 0.63 S	176 0.81 E	GPS	4272	4275				33	1-6,7,8,15,23,24,26,27,34,35,45,48	2 BTLS FOR BIO (10DB), #4 BACKUP OF #22
49MR03K04_1	P06	X14	1	UNK	081403	0126	BE	30 0.44 S	176 1.07 E	GPS	4272	4271						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	X14	1	ROS	081403	0210	BO	30 0.34 S	176 1.48 E	GPS	4276	4276	6	4319	4332			
49MR03K04_1	P06	X14	1	UNK	081403	0231	EN	30 0.21 S	176 1.60 E	GPS	4271	4272						
49MR03K04_1	P06	X14	1	BUC	081403	0325	UN	29 59.98 S	176 1.95 E	GPS	4272	4274					1	17.7C
49MR03K04_1	P06	X14	1	ROS	081403	0424	EN	29 59.72 S	176 2.48 E	GPS	4272	4271						
49MR03K04_1	P06	192	1	ROS	081403	0626	BE	30 4.95 S	176 29.98 E	GPS	4292	4294				30	1-6	
49MR03K04_1	P06	192	1	ROS	081403	0738	BO	30 4.77 S	176 30.68 E	GPS	4294	4292	4	4328	4352			
49MR03K04_1	P06	192	1	BUC	081403	0831	UN	30 4.59 S	176 30.98 E	GPS	4294	4292					1	18.1C
49MR03K04_1	P06	192	1	ROS	081403	0934	EN	30 4.35 S	176 31.61 E	GPS	4292	4291						
49MR03K04_1	P06	191	1	ROS	081403	1253	BE	30 34.92 S	177 0.00 E	GPS	4297	4299				31	1-6,12,13,23,24,26	
49MR03K04_1	P06	191	1	ROS	081403	1400	BO	30 34.48 S	177 0.31 E	GPS	4296	4297	7	4335	4354			
49MR03K04_1	P06	191	1	BUC	081403	1529	UN	30 34.00 S	177 0.67 E	GPS	4289	4289					1	17.5C
49MR03K04_1	P06	191	1	ROS	081403	1629	EN	30 33.71 S	177 0.63 E	GPS	4286	4285						
49MR03K04_1	P06	190	1	ROS	081403	1942	BE	31 4.98 S	177 32.36 E	GPS	4136	4132				31	1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	190	1	ROS	081403	2047	BO	31 4.76 S	177 32.17 E	GPS	4137	4136	7	4135	4189			
49MR03K04_1	P06	190	1	UNK	081403	2121	BE	31 4.77 S	177 31.84 E	GPS	4138	4143						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	190	1	BUC	081403	2146	UN	31 4.64 S	177 31.71 E	GPS	4144	4143					1	17.4C
49MR03K04_1	P06	190	1	UNK	081403	2205	EN	31 4.54 S	177 31.60 E	GPS	4142	4140						
49MR03K04_1	P06	190	1	ROS	081403	2242	EN	31 4.42 S	177 31.55 E	GPS	4140	4140						
49MR03K04_1	P06	186	1	ROS	081503	0131	BE	31 35.00 S	178 0.08 E	GPS	3817	3818				31	1-6,23,24,26,34,35,48	#3=#13 DUPLICATE SMPLS (3500DB), 2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	186	1	UNK	081503	0146	BE	31 34.91 S	178 0.06 E	GPS	3820	3820						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	186	1	UNK	081503	0203	EN	31 34.86 S	178 0.11 E	GPS	3824	3825						
49MR03K04_1	P06	186	1	ROS	081503	0233	BO	31 34.88 S	178 0.19 E	GPS	3824	3824	6	3816	3869			
49MR03K04_1	P06	186	1	BUC	081503	0308	UN	31 35.03 S	178 0.32 E	GPS	3816	3817					1	17.2C
49MR03K04_1	P06	186	1	ROS	081503	0415	EN	31 35.62 S	178 0.76 E	GPS	3811	3812						
49MR03K04_1	P06	185	1	ROS	081503	0706	BE	32 5.06 S	178 30.21 E	GPS	3112	3117				26	1-6	
49MR03K04_1	P06	185	1	ROS	081503	0759	BO	32 5.12 S	178 30.87 E	GPS	3161	3158	8	3183	3161			
49MR03K04_1	P06	185	1	BUC	081503	0828	UN	32 5.20 S	178 30.91 E	GPS	3152	3148					1	17.3C
49MR03K04_1	P06	185	1	ROS	081503	0929	EN	32 5.35 S	178 31.55 E	GPS	3134	3132						
49MR03K04_1	P06	184	1	ROS	081503	1155	BE	32 30.04 S	178 54.92 E	GPS	1544	1543				18	1-6,23,24,26	
49MR03K04_1	P06	184	1	BUC	081503	1200	UN	32 30.07 S	178 54.95 E	GPS	1545	1548					1	16.7C
49MR03K04_1	P06	184	1	ROS	081503	1224	BO	32 30.15 S	178 54.78 E	GPS	1527	1530	4	1560	1556			#19=#21 DUPLICATE SMPLS (1400DB)
49MR03K04_1	P06	184	1	ROS	081503	1318	EN	32 30.42 S	178 54.53 E	GPS	1536	1538						
49MR03K04_1	P06	183	1	ROS	081503	1519	BE	32 30.03 S	179 25.14 E	GPS	3063	3062				24	1-6	
49MR03K04_1	P06	183	1	ROS	081503	1608	BO	32 30.46 S	179 25.13 E	GPS	3079	3077	6	3034	3057			
49MR03K04_1	P06	183	1	BUC	081503	1634	UN	32 30.60 S	179 25.12 E	GPS	3049	3059					1	17.0C
49MR03K04_1	P06	183	1	ROS	081503	1733	EN	32 31.34 S	179 25.10 E	GPS	2931	2900						
49MR03K04_1	P06	182	1	ROS	081503	1931	BE	32 30.05 S	179 55.02 E	GPS	2797	2790				27	1-6,12,13,23,24,26,34,35,46,48	#3=#18 DUPLICATE SMPLS (2000DB), 2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	182	1	BUC	081503	1936	UN	32 30.14 S	179 55.11 E	GPS	2806	2797					1	16.9C

49MR03K04_1	P06	182	1	ROS	081503	2018	BO	32 30.55 S	179 55.36 E	GPS	2979	2978	6	2888	2874			
49MR03K04_1	P06	182	1	ROS	081503	2139	EN	32 31.06 S	179 55.93 E	GPS	3001	3023						
49MR03K04_1	P06	181	1	ROS	081503	2328	BE	32 30.25 S	179 35.05 W	GPS	2990	2990				26	1-6,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	181	1	UNK	081503	2330	BE	32 30.27 S	179 35.03 W	GPS	2985	2985						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	181	1	BUC	081503	2336	UN	32 30.29 S	179 34.81 W	GPS	2966	2979					1	17.1C
49MR03K04_1	P06	181	1	UNK	081603	0001	EN	32 30.34 S	179 34.61 W	GPS	2946	2952						
49MR03K04_1	P06	181	1	ROS	081603	0025	BO	32 30.47 S	179 34.51 W	GPS	2933	2934	8	2986	2995			
49MR03K04_1	P06	181	1	ROS	081603	0147	EN	32 30.99 S	179 33.71 W	GPS	2824	2827						
49MR03K04_1	P06	180	1	ROS	081603	0413	BE	32 29.95 S	178 54.77 W	GPS	1999	2001				21	1-6,23,24,26	#1=#33 DUPLICATE SMPLS (150DB), #2 BACKUP OF #22
49MR03K04_1	P06	180	1	BUC	081603	0415	UN	32 29.92 S	178 54.75 W	GPS	2000	2001					1	16.3C
49MR03K04_1	P06	180	1	ROS	081603	0452	BO	32 29.89 S	178 54.32 W	GPS	2010	2010	4	2014	2015			
49MR03K04_1	P06	180	1	ROS	081603	0552	EN	32 29.90 S	178 53.77 W	GPS	2071	2070						
49MR03K04_1	P06	179	1	ROS	081603	0727	BE	32 30.05 S	178 38.70 W	GPS	3488	3487				27	1-6	#1 BACKUP OF #22
49MR03K04_1	P06	179	1	ROS	081603	0826	BO	32 30.23 S	178 38.20 W	GPS	3572	3570	8	3550	3568			
49MR03K04_1	P06	179	1	BUC	081603	0904	UN	32 30.35 S	178 37.92 W	GPS	3608	3607					1	16.0C
49MR03K04_1	P06	179	1	ROS	081603	0959	EN	32 30.43 S	178 37.36 W	GPS	3601	3599						
49MR03K04_1	P06	178	1	ROS	081603	1054	BE	32 30.04 S	178 27.92 W	GPS	4465	4459				31	1-6,23,24,26,46	
49MR03K04_1	P06	178	1	ROS	081603	1208	BO	32 30.36 S	178 27.42 W	GPS	4522	4519	7	4499	4527			
49MR03K04_1	P06	178	1	BUC	081603	1312	UN	32 30.62 S	178 27.13 W	GPS	4532	4541					1	16.3C
49MR03K04_1	P06	178	1	ROS	081603	1404	EN	32 30.92 S	178 26.70 W	GPS	4546	4541						
49MR03K04_1		404	1	UNK	081603	1907	BE	31 55.43 S	177 19.84 W	GPS	9833	9833						CTD CABLE RESPOOLING (WO 7800M)
49MR03K04_1		404	2	UNK	081603	2254	BE	31 56.65 S	177 18.29 W	GPS	9997	9997						SOLAR LIGHT MEASUREMENT
49MR03K04_1		404	1	BIO	081603	2300	UN	31 56.70 S	177 18.24 W	GPS	9999	9999		7934			34,35,48	BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1		404	2	UNK	081603	2323	EN	31 56.91 S	177 17.89 W	GPS	9997	9996						
49MR03K04_1		404	1	UNK	081703	0050	EN	31 57.59 S	177 17.05 W	GPS	9904	9905						
49MR03K04_1	P06	177	1	ROS	081703	1759	BE	32 30.05 S	178 16.99 W	GPS	5104	5111				35	1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	177	1	ROS	081703	1921	BO	32 30.33 S	178 16.98 W	GPS	5198	5197	9	5189	5272			
49MR03K04_1	P06	177	1	BUC	081703	2035	UN	32 30.77 S	178 16.72 W	GPS	5140	5134					1	16.3C
49MR03K04_1	P06	177	1	UNK	081703	2041	BE	32 30.81 S	178 16.66 W	GPS	5076	5074						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	177	1	UNK	081703	2118	EN	32 31.12 S	178 16.47 W	GPS	5035	5033						SPOOL ADJUSTMENTS 4250, 3550M
49MR03K04_1	P06	177	1	ROS	081703	2127	EN	32 31.24 S	178 16.41 W	GPS	5027	5027						
49MR03K04_1	P06	176	1	ROS	081703	2241	BE	32 30.21 S	178 0.14 W	GPS	5876	5874				36	1-6,23,24,26	
49MR03K04_1	P06	176	1	ROS	081803	0015	BO	32 30.85 S	177 59.62 W	GPS	5888	5889	6	5943	5975			SPOOL ADJUSTMENTS 5299M
49MR03K04_1	P06	176	1	UNK	081803	0030	BE	32 30.88 S	177 59.61 W	GPS	5889	5900						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	176	1	UNK	081803	0123	EN	32 31.11 S	177 59.37 W	GPS	5916	5916						
49MR03K04_1	P06	176	1	BUC	081803	0141	UN	32 31.20 S	177 59.28 W	GPS	5916	5917					1,34,35,48	16.8C, 20L FOR BIO
49MR03K04_1	P06	176	1	ROS	081803	0236	EN	32 31.52 S	177 58.97 W	GPS	5946	5946						
49MR03K04_1	P06	175	1	ROS	081803	0413	BE	32 30.06 S	177 39.95 W	GPS	7458	7452				36	1-6,9,22,47	REMOVE LADCP, ALTIMETER, FLUOROMETER
49MR03K04_1	P06	175	1	ROS	081803	0543	BO	32 30.21 S	177 39.68 W	GPS	7510	7509	-9	6380	6502			
49MR03K04_1	P06	175	1	BUC	081803	0730	UN	32 30.70 S	177 39.48 W	GPS	7551	7549					1	16.5C
49MR03K04_1	P06	175	1	ROS	081803	0818	EN	32 30.91 S	177 39.35 W	GPS	7602	7597						
49MR03K04_1	P06	174	1	ROS	081803	1000	BE	32 30.07 S	177 15.18 W	GPS	7421	7414				36	1-6,12,13,15,23,24,26,45,46	REMOVE LADCP, ALTIMETER, FLUOROMETER
49MR03K04_1	P06	174	1	ROS	081803	1132	BO	32 29.75 S	177 15.51 W	GPS	7182	7166	-9	6391	6500			
49MR03K04_1	P06	174	1	BUC	081803	1326	UN	32 29.59 S	177 15.82 W	GPS	7180	7179					1	16.8C
49MR03K04_1	P06	174	1	ROS	081803	1422	EN	32 29.37 S	177 15.90 W	GPS	7192	7195						
49MR03K04_1		405	1	UNK	081803	1722	BE	31 59.52 S	177 20.01 W	GPS	9962	9965						CTD CABLE RESPOOLING (WO 8054M)
49MR03K04_1		405	1	BIO	081803	2058	UN	31 59.73 S	177 18.61 W	GPS	9839	9838					34,35,48	BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1		405	2	UNK	081803	2115	BE	31 59.73 S	177 18.46 W	GPS	9833	9831						SOLAR LIGHT MEASUREMENT
49MR03K04_1		405	2	UNK	081803	2125	EN	31 59.72 S	177 18.34 W	GPS	9814	9833						

49MR03K04_1		405	1	UNK	081803	2141	EN	31 59.75 S	177 18.04 W	GPS	9876	9876						
49MR03K04_1	P06	173	1	ROS	081903	0034	BE	32 29.91 S	176 45.13 W	GPS	6135	6136				36	1-6	
49MR03K04_1	P06	173	1	UNK	081903	0056	BE	32 29.72 S	176 45.02 W	GPS	6136	6137						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	173	1	UNK	081903	0125	EN	32 29.55 S	176 44.85 W	GPS	6136	6136						
49MR03K04_1	P06	173	1	ROS	081903	0207	BO	32 29.38 S	176 44.67 W	GPS	6139	6140	7	6166	6253			
49MR03K04_1	P06	173	1	BUC	081903	0340	UN	32 29.11 S	176 44.37 W	GPS	6134	6135					1,34,35,48	16.6C, 20L FOR BIO
49MR03K04_1	P06	173	1	ROS	081903	0441	EN	32 28.87 S	176 44.48 W	GPS	6139	6139						
49MR03K04_1	P06	172	1	ROS	081903	0636	BE	32 30.14 S	176 14.98 W	GPS	5711	5711				36	1-6,23,24,26	#1=#5 DUPLICATE SMPLS (5000DB)
49MR03K04_1	P06	172	1	ROS	081903	0802	BO	32 29.78 S	176 15.11 W	GPS	5820	5826	7	5754	5862			
49MR03K04_1	P06	172	1	BUC	081903	0933	UN	32 29.41 S	176 15.38 W	GPS	5843	5839					1	16.8C
49MR03K04_1	P06	172	1	ROS	081903	1024	EN	32 29.19 S	176 15.56 W	GPS	5867	5846						
49MR03K04_1	P06	171	1	ROS	081903	1225	BE	32 30.06 S	175 44.93 W	GPS	5886	5884				36	1-6	
49MR03K04_1	P06	171	1	ROS	081903	1355	BO	32 29.72 S	175 45.19 W	GPS	5878	5879	7	5891	5986			
49MR03K04_1	P06	171	1	BUC	081903	1518	UN	32 29.57 S	175 45.50 W	GPS	5871	5872					1	16.6C
49MR03K04_1	P06	171	1	ROS	081903	1621	EN	32 29.69 S	175 45.92 W	GPS	5863	5863						
49MR03K04_1	P06	170	1	ROS	081903	1826	BE	32 29.96 S	175 15.18 W	GPS	5732	5734				36	1-6,7,8,23,24,26,27,46	#1=#3 DUPLICATE SMPLS (5500DB)
49MR03K04_1	P06	170	1	ROS	081903	1950	BO	32 29.80 S	175 15.31 W	GPS	5735	5736	4	5726	5835			
49MR03K04_1	P06	170	1	BIO	081903	2110	UN	32 29.58 S	175 15.43 W	GPS	5751	5746					1,34,35,48	17.0C, 20L FOR BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1	P06	170	1	ROS	081903	2205	EN	32 29.34 S	175 15.75 W	GPS	5743	5741						
49MR03K04_1	P06	169	1	ROS	081903	2356	BE	32 30.18 S	174 50.01 W	GPS	5752	5752				35	1-6	
49MR03K04_1	P06	169	1	UNK	082003	0101	BE	32 29.94 S	174 50.21 W	GPS	5757	5757						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	169	1	UNK	082003	0118	EN	32 29.93 S	174 50.25 W	GPS	5760	5761						
49MR03K04_1	P06	169	1	ROS	082003	0125	BO	32 29.91 S	174 50.29 W	GPS	5756	5758	5	5775	5863			
49MR03K04_1	P06	169	1	BIO	082003	0156	UN	32 29.77 S	174 50.36 W	GPS	5761	5762					1,34,35,48	17.0C, 20L FOR BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1	P06	169	1	ROS	082003	0338	EN	32 29.28 S	174 50.70 W	GPS	5761	5763						
49MR03K04_1	P06	168	1	ROS	082003	0543	BE	32 29.83 S	174 19.75 W	GPS	5862	5862				36	1-6,12,13,15,23,24,26,45	
49MR03K04_1	P06	168	1	ROS	082003	0712	BO	32 29.58 S	174 19.96 W	GPS	5832	5832	6	5854	5959			
49MR03K04_1	P06	168	1	BUC	082003	0825	UN	32 29.24 S	174 19.94 W	GPS	5852	5847					1	16.4C
49MR03K04_1	P06	168	1	ROS	082003	0932	EN	32 29.03 S	174 20.34 W	GPS	5781	5782						
49MR03K04_1	P06	167	1	ROS	082003	1100	BE	32 30.10 S	173 59.84 W	GPS	5677	5675				36	1-6,9,22,47	#1=#4 DUPLICATE SMPLS (5250DB)
49MR03K04_1	P06	167	1	ROS	082003	1226	BO	32 30.37 S	174 0.12 W	GPS	5676	5673	6	5665	5761			
49MR03K04_1	P06	167	1	BUC	082003	1401	UN	32 30.60 S	174 0.44 W	GPS	5672	5672					1	16.8C
49MR03K04_1	P06	167	1	ROS	082003	1442	EN	32 30.74 S	174 0.55 W	GPS	5672	5671						
49MR03K04_1	P06	166	1	ROS	082003	1610	BE	32 30.25 S	173 39.89 W	GPS	5675	5677				19	1-6,23,24,26	
49MR03K04_1	P06	166	1	ROS	082003	1734	BO	32 30.51 S	173 40.25 W	GPS	5703	5699	7	5712	5802			
49MR03K04_1	P06	166	1	BIO	082003	1830	UN	32 30.48 S	173 40.64 W	GPS	5689	5689					1,34,35,48	16.9C, 20L FOR BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1	P06	166	1	ROS	082003	1931	EN	32 30.53 S	173 41.13 W	GPS	5696	5696						UPCAST INTERRUPTED AT 1750DB
49MR03K04_1	P06	166	2	ROS	082003	2119	BE	32 30.17 S	173 40.00 W	GPS	5672	5672				22	1-6,23,24,26	REMOVE FLUOROMETER
49MR03K04_1	P06	166	1	BUC	082003	2124	UN	32 30.20 S	173 40.04 W	GPS	5676	5670					1	16.1C
49MR03K04_1	P06	166	2	ROS	082003	2202	BO	32 30.36 S	173 40.40 W	GPS	5660	5661	-9	2602	2601			
49MR03K04_1	P06	166	1	UNK	082003	2238	BE	32 30.60 S	173 40.64 W	GPS	5705	5706						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	166	1	UNK	082003	2300	EN	32 30.64 S	173 40.86 W	GPS	5706	5705						
49MR03K04_1	P06	166	2	ROS	082003	2314	EN	32 30.64 S	173 40.99 W	GPS	5701	5700						
49MR03K04_1	P06	165	1	ROS	082103	0110	BE	32 29.96 S	173 10.41 W	GPS	5859	5855				36	1-6,34,35	
49MR03K04_1	P06	165	1	BUC	082103	0200	UN	32 29.77 S	173 10.65 W	GPS	5837	5839					1,34,35,48	16.8C, 20L FOR BIO
49MR03K04_1	P06	165	1	ROS	082103	0239	BO	32 29.76 S	173 10.75 W	GPS	5863	5863	4	5845	5967			
49MR03K04_1	P06	165	1	UNK	082103	0252	BE	32 29.71 S	173 10.80 W	GPS	5842	5843						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	165	1	UNK	082103	0312	EN	32 29.65 S	173 10.84 W	GPS	5848	5848						
49MR03K04_1	P06	165	1	ROS	082103	0459	EN	32 29.66 S	173 11.07 W	GPS	5866	5865						
49MR03K04_1	P06	164	1	ROS	082103	0606	BE	32 29.91 S	172 54.86 W	GPS	5978	5973				36	1-6,7,8,23,24,26,27	

49MR03K04_1	P06	164	1	ROS	082103	0732	BO	32 30.17 S	172 55.04 W	GPS	5978	5975	6	5970	6087			
49MR03K04_1	P06	164	1	BUC	082103	0855	UN	32 30.16 S	172 55.26 W	GPS	5980	5980					1	16.9C
49MR03K04_1	P06	164	1	ROS	082103	0956	EN	32 30.38 S	172 55.30 W	GPS	5979	5979						
49MR03K04_1	P06	163	1	ROS	082103	1153	BE	32 30.04 S	172 25.01 W	GPS	5747	5745				35	1-6	
49MR03K04_1	P06	163	1	ROS	082103	1321	BO	32 30.30 S	172 25.28 W	GPS	5750	5748	6	5752	5849			
49MR03K04_1	P06	163	1	BUC	082103	1429	UN	32 30.56 S	172 25.69 W	GPS	5757	5757					1	17.1C
49MR03K04_1	P06	163	1	ROS	082103	1540	EN	32 30.56 S	172 26.02 W	GPS	5758	5762						
49MR03K04_1	P06	162	1	ROS	082103	1743	BE	32 29.98 S	171 54.56 W	GPS	4142	4147				32	1-6,12,13,23,24,26,34,35,48	#3=#12 DUPLICATE SMPLS (3250DB), 2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	162	1	ROS	082103	1850	BO	32 30.18 S	171 54.80 W	GPS	4146	4133	7	4153	4201			
49MR03K04_1	P06	162	1	BUC	082103	1929	UN	32 30.41 S	171 55.00 W	GPS	4194	4182					1	17.0C
49MR03K04_1	P06	162	1	ROS	082103	2033	EN	32 30.68 S	171 55.31 W	GPS	4265	4266						
49MR03K04_1	P06	162	1	FLT	082103	2042	DE	32 30.74 S	171 55.12 W	GPS	4153	4153						ARGO/APEX#927
49MR03K04_1	P06	161	1	ROS	082103	2202	BE	32 30.09 S	171 35.06 W	GPS	4844	4848				34	1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	161	1	UNK	082103	2241	BE	32 30.33 S	171 35.26 W	GPS	4826	4844						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	161	1	ROS	082103	2317	BO	32 30.56 S	171 35.37 W	GPS	4828	4827	6	4870	4910			
49MR03K04_1	P06	161	1	UNK	082103	2330	EN	32 30.66 S	171 35.39 W	GPS	4816	4818						
49MR03K04_1	P06	161	1	BUC	082203	0037	UN	32 31.08 S	171 35.61 W	GPS	4783	4783					1	16.4C
49MR03K04_1	P06	161	1	ROS	082203	0107	EN	32 31.39 S	171 35.70 W	GPS	4757	4746						
49MR03K04_1	P06	160	1	ROS	082203	0231	BE	32 29.90 S	171 15.07 W	GPS	5466	5465				35	1-6,7,8,23,24,26,27	#1=#9 DUPLICATE SMPLS (4000DB)
49MR03K04_1	P06	160	1	ROS	082203	0354	BO	32 30.25 S	171 14.98 W	GPS	5468	5471	3	5474	5561			
49MR03K04_1	P06	160	1	BUC	082203	0455	UN	32 30.53 S	171 15.09 W	GPS	5460	5462					1	16.4C
49MR03K04_1	P06	160	1	ROS	082203	0616	EN	32 30.78 S	171 15.18 W	GPS	5451	5444						
49MR03K04_1	P06	159	1	ROS	082203	0816	BE	32 29.89 S	170 45.03 W	GPS	5722	5723				35	1-6,11	
49MR03K04_1	P06	159	1	ROS	082203	0944	BO	32 30.24 S	170 44.98 W	GPS	5735	5735	6	5728	5837			
49MR03K04_1	P06	159	1	BUC	082203	1100	UN	32 30.62 S	170 45.16 W	GPS	5732	5732					1	16.2C
49MR03K04_1	P06	159	1	ROS	082203	1158	EN	32 30.90 S	170 45.03 W	GPS	5726	5725						
49MR03K04_1	P06	158	1	ROS	082203	1357	BE	32 29.95 S	170 15.12 W	GPS	5749	5748				36	1-6,23,24,26,46	#1=#3 DUPLICATE SMPLS (5500DB)
49MR03K04_1	P06	158	1	ROS	082203	1529	BO	32 30.42 S	170 15.10 W	GPS	5747	5747	5	5777	5854			
49MR03K04_1	P06	158	1	BUC	082203	1658	UN	32 30.75 S	170 14.96 W	GPS	5747	5741					1	15.5C
49MR03K04_1	P06	158	1	ROS	082203	1747	EN	32 31.21 S	170 14.75 W	GPS	5730	5726						
49MR03K04_1	P06	X15	1	ROS	082203	1921	BE	32 30.25 S	170 0.07 W	GPS	5526	5530				35	1-6,7,8,12,13,15,23,24,26,27,34,35,45,48	
49MR03K04_1	P06	X15	1	UNK	082203	2009	BE	32 30.64 S	169 59.93 W	GPS	5503	5500						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	X15	1	UNK	082203	2039	EN	32 30.82 S	169 59.88 W	GPS	5506	5504						
49MR03K04_1	P06	X15	1	ROS	082203	2046	BO	32 30.86 S	169 59.87 W	GPS	5523	5502	5	5576	5611			
49MR03K04_1	P06	X15	1	BUC	082203	2058	UN	32 30.90 S	169 59.83 W	GPS	5503	5515					1,34,35,48	16.1C, 20L FOR BIO
49MR03K04_1	P06	X15	1	ROS	082203	2252	EN	32 31.48 S	169 59.46 W	GPS	5501	5499						
49MR03K04_1	P06	156	1	ROS	082303	0043	BE	32 30.14 S	169 30.15 W	GPS	5520	5516				36	1-6,9,22,34,35,47	#2=#27 DUPLICATE SMPLS FOR R.N. (600DB)
49MR03K04_1	P06	156	1	UNK	082303	0104	BE	32 30.34 S	169 29.95 W	GPS	5518	5515						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	156	1	UNK	082303	0127	EN	32 30.34 S	169 30.00 W	GPS	5516	5516						
49MR03K04_1	P06	156	1	BUC	082303	0129	UN	32 30.44 S	169 30.00 W	GPS	5515	5516					1,34,35,48	16.1C, 20L FOR BIO
49MR03K04_1	P06	156	1	ROS	082303	0206	BO	32 30.68 S	169 29.93 W	GPS	5518	5516	5	5537	5613			
49MR03K04_1	P06	156	1	ROS	082303	0420	EN	32 31.59 S	169 29.47 W	GPS	5544	5547						
49MR03K04_1	P06	155	1	ROS	082303	0614	BE	32 29.96 S	169 0.17 W	GPS	5449	5510				34	1-6	
49MR03K04_1	P06	155	1	ROS	082303	0737	BO	32 30.29 S	169 0.04 W	GPS	5553	5546	8	5539	5636			
49MR03K04_1	P06	155	1	BUC	082303	0901	UN	32 30.70 S	168 59.91 W	GPS	5527	5530					1	16.4C
49MR03K04_1	P06	155	1	ROS	082303	0946	EN	32 30.96 S	168 59.83 W	GPS	5556	5552						
49MR03K04_1	P06	155	1	FLT	082303	0956	DE	32 31.01 S	168 59.49 W	GPS	5512	5506						ARGO/SOLO#2185
49MR03K04_1	P06	154	1	ROS	082303	1146	BE	32 29.98 S	168 30.18 W	GPS	5487	5486				35	1-6,23,24,26,46	
49MR03K04_1	P06	154	1	ROS	082303	1307	BO	32 30.50 S	168 30.23 W	GPS	5507	5502	6	5516	5586			

49MR03K04_1	P06	154	1	BUC	082303	1429	UN	32 31.02 S	168 30.29 W	GPS	5518	5518					1	16.3C
49MR03K04_1	P06	154	1	ROS	082303	1521	EN	32 31.48 S	168 30.48 W	GPS	5509	5508						
49MR03K04_1	P06	153	1	ROS	082303	1719	BE	32 30.20 S	168 0.86 W	GPS	5586	5587				34	1-6,34,35	
49MR03K04_1		406	1	UNK	082303	1815	BE	32 30.24 S	168 0.57 W	GPS	5584	5583						CONTINUOUS SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	153	1	ROS	082303	1843	BO	32 30.30 S	168 0.51 W	GPS	5579	5589	5	5582	5582			
49MR03K04_1	P06	153	1	UNK	082303	2000	BE	32 30.49 S	168 0.35 W	GPS	5576	5565						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	153	1	BUC	082303	2008	UN	32 30.51 S	168 0.31 W	GPS	5562	5564					1,34,35,48	16.5C, 20L FOR BIO
49MR03K04_1	P06	153	1	UNK	082303	2020	EN	32 30.55 S	168 0.27 W	GPS	5559	5559						
49MR03K04_1	P06	153	1	ROS	082303	2051	EN	32 30.65 S	168 0.18 W	GPS	5554	5555						
49MR03K04_1	P06	152	1	ROS	082303	2258	BE	32 30.23 S	167 30.14 W	GPS	5629	5627				36	1-6,23,24,26,34,35	#1=#13 DUPLICATE SMPLS (3000DB)
49MR03K04_1	P06	152	1	UNK	082403	0000	BE	32 30.11 S	167 29.47 W	GPS	5724	5717						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	152	1	UNK	082403	0020	EN	32 30.05 S	167 29.32 W	GPS	5727	5731						
49MR03K04_1	P06	152	1	ROS	082403	0027	BO	32 30.01 S	167 29.29 W	GPS	5730	5726	5	5762	5807			
49MR03K04_1	P06	152	1	BUC	082403	0100	UN	32 29.98 S	167 29.18 W	GPS	5698	5729					1,34,35,48	17.1C, 20L FOR BIO
49MR03K04_1	P06	152	1	ROS	082403	0245	EN	32 29.32 S	167 29.06 W	GPS	5711	5712						
49MR03K04_1		406	1	UNK	082403	0340	EN	32 29.72 S	167 15.49 W	GPS	5483	5478						
49MR03K04_1	P06	151	1	ROS	082403	0412	BE	32 30.07 S	167 9.77 W	GPS	5391	5396				34	1-6	
49MR03K04_1	P06	151	1	ROS	082403	0535	BO	32 30.17 S	167 9.53 W	GPS	5384	5385	8	5383	5481			
49MR03K04_1	P06	151	1	BUC	082403	0655	UN	32 30.36 S	167 9.35 W	GPS	5384	5387					1	17.6C
49MR03K04_1	P06	151	1	ROS	082403	0745	EN	32 30.47 S	167 9.24 W	GPS	5382	5387						
49MR03K04_1	P06	150	1	ROS	082403	1012	BE	32 29.82 S	166 29.94 W	GPS	5476	5477				34	1-6,7,8,12,13,15,23,24,26,27,45	
49MR03K04_1	P06	150	1	ROS	082403	1135	BO	32 29.20 S	166 29.89 W	GPS	5235	5228	139	5297	5355			
49MR03K04_1	P06	150	1	BUC	082403	1226	UN	32 28.73 S	166 29.90 W	GPS	5218	5217					1	17.1C
49MR03K04_1	P06	150	1	ROS	082403	1335	EN	32 27.96 S	166 29.59 W	GPS	5312	5312						
49MR03K04_1	P06	149	1	ROS	082403	1621	BE	32 29.76 S	165 49.70 W	GPS	5424	5421				36	1-6,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	149	1	ROS	082403	1745	BO	32 29.21 S	165 49.29 W	GPS	5438	5437	5	5468	5520			
49MR03K04_1	P06	149	1	BUC	082403	1836	UN	32 28.98 S	165 48.88 W	GPS	5439	5439					1	16.6C
49MR03K04_1	P06	149	1	ROS	082403	1957	EN	32 28.34 S	165 48.30 W	GPS	5448	5431						
49MR03K04_1	P06	149	1	FLT	082403	2006	DE	32 28.23 S	165 48.00 W	GPS	5404	5392						ARGO/APEX#928
49MR03K04_1		407	1	BIO	082503	2001	UN	32 27.23 S	165 12.90 W	GPS	5616	5576					34,35,48	20L FOR BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1		408	1	BIO	082603	0157	UN	32 30.28 S	165 9.87 W	GPS	6356	6355					34,35,48	20L FOR BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1	P06	148	1	ROS	082603	0306	BE	32 30.40 S	165 10.15 W	GPS	6355	6366				36	1-6,23,24,26,34,35,46	REMOVE LADCP
49MR03K04_1	P06	148	1	ROS	082603	0455	BO	32 29.78 S	165 9.76 W	GPS	6357	6355	12	6388	6472			
49MR03K04_1	P06	148	1	BUC	082603	0630	UN	32 29.15 S	165 9.36 W	GPS	6353	6355					1	16.1C
49MR03K04_1	P06	148	1	ROS	082603	0756	EN	32 28.63 S	165 9.09 W	GPS	6332	6335						
49MR03K04_1	P06	147	1	ROS	082603	1104	BE	32 29.97 S	164 29.60 W	GPS	5609	5604				36	1-6	REINSTALL LADCP
49MR03K04_1	P06	147	1	ROS	082603	1234	BO	32 29.08 S	164 29.19 W	GPS	5648	5645	5	5655	5684			
49MR03K04_1	P06	147	1	BUC	082603	1333	UN	32 28.59 S	164 28.83 W	GPS	5652	5655					1	16.1C
49MR03K04_1	P06	147	1	ROS	082603	1455	EN	32 27.82 S	164 28.41 W	GPS	5647	5640						
49MR03K04_1	P06	146	1	ROS	082603	1751	BE	32 29.90 S	163 49.89 W	GPS	5528	5533				35	1-8,12,13,23,24,26,27,34,35	#1=#5 DUPLICATE SMPLS (5000DB)
49MR03K04_1	P06	146	1	ROS	082603	1919	BO	32 29.68 S	163 49.63 W	GPS	5562	5556	5	5548	5631			
49MR03K04_1	P06	146	1	BUC	082603	1955	UN	32 29.68 S	163 49.32 W	GPS	5589	5587					1,34,35,48	16.3C, 20L FOR BIO
49MR03K04_1	P06	146	1	UNK	082603	2041	BE	32 29.67 S	163 48.98 W	GPS	5657	5656						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	146	1	UNK	082603	2113	EN	32 29.67 S	163 48.73 W	GPS	5702	5704						
49MR03K04_1	P06	146	1	ROS	082603	2129	EN	32 29.66 S	163 48.58 W	GPS	5727	5727						
49MR03K04_1	P06	145	1	ROS	082703	0006	BE	32 29.88 S	163 9.86 W	GPS	5259	5259				35	1-6,9,22,34,35,47	#2=#27 DUPLICATE SMPLS (600DB)
49MR03K04_1	P06	145	1	UNK	082703	0016	BE	32 29.90 S	163 9.82 W	GPS	5272	5272						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	145	1	UNK	082703	0043	EN	32 29.87 S	163 9.77 W	GPS	5230	5215						
49MR03K04_1	P06	145	1	BUC	082703	0056	UN	32 29.76 S	163 9.75 W	GPS	5225	5221					1,34,35,48	16.9C, 20L FOR BIO
49MR03K04_1	P06	145	1	ROS	082703	0129	BO	32 29.70 S	163 9.71 W	GPS	5217	5220	3	5236	5331			

49MR03K04_1	P06	145	1	ROS	082703	0334	EN	32 29.48 S	163 9.19 W	GPS	5229	5230						
49MR03K04_1	P06	145	1	FLT	082703	0343	DE	32 29.45 S	163 8.91 W	GPS	5182	5198						ARGO/SOLO#2199
49MR03K04_1	P06	144	1	ROS	082703	0616	BE	32 30.15 S	162 29.99 W	GPS	5178	5189				34	1-6,23,24,26,46	#1=#19 DUPLICATE SMPLS (1800DB)
49MR03K04_1	P06	144	1	ROS	082703	0736	BO	32 30.01 S	162 29.34 W	GPS	5056	5067	5	5143	5213			
49MR03K04_1	P06	144	1	BUC	082703	0828	UN	32 29.85 S	162 29.56 W	GPS	5120	5137					1	17.4C
49MR03K04_1	P06	144	1	ROS	082703	0940	EN	32 29.51 S	162 28.13 W	GPS	5368	5356						
49MR03K04_1	P06	143	1	ROS	082703	1207	BE	32 30.00 S	161 50.00 W	GPS	5425	5423				34	1-6	
49MR03K04_1	P06	143	1	ROS	082703	1331	BO	32 29.75 S	161 49.38 W	GPS	5456	5455	5	5443	5519			
49MR03K04_1	P06	143	1	BUC	082703	1441	UN	32 29.54 S	161 48.73 W	GPS	5528	5478					1	16.5C
49MR03K04_1	P06	143	1	ROS	082703	1536	EN	32 29.44 S	161 48.28 W	GPS	5540	5536						
49MR03K04_1	P06	142	1	ROS	082703	1804	BE	32 30.00 S	161 9.80 W	GPS	5134	5132				34	1-8,12,13,15,23,24,26,27,34,35,45	#1=#9 DUPLICATE SMPLS (4000DB)
49MR03K04_1	P06	142	1	ROS	082703	1923	BO	32 29.85 S	161 9.12 W	GPS	5138	5137	5	5167	5222			
49MR03K04_1	P06	142	1	BUC	082703	2037	UN	32 29.92 S	161 8.41 W	GPS	5129	5128					1	16.2C
49MR03K04_1	P06	142	1	ROS	082703	2123	EN	32 29.88 S	161 7.87 W	GPS	5132	5130						
49MR03K04_1	P06	140	1	ROS	082703	2341	BE	32 29.90 S	160 29.55 W	GPS	5531	5533				34	1-6,34,35	
49MR03K04_1	P06	140	1	UNK	082803	0007	BE	32 30.01 S	160 29.37 W	GPS	5538	5533						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	140	1	UNK	082803	0054	EN	32 30.18 S	160 29.08 W	GPS	5543	5544						
49MR03K04_1	P06	140	1	ROS	082803	0106	BO	32 30.18 S	160 28.96 W	GPS	5531	5524	6	5561	5628			
49MR03K04_1	P06	140	1	BUC	082803	0150	UN	32 30.21 S	160 28.72 W	GPS	5526	5525					1,34,35,48	16.8C, 20L FOR BIO
49MR03K04_1	P06	140	1	ROS	082803	0315	EN	32 30.44 S	160 27.94 W	GPS	5495	5492						
49MR03K04_1	P06	139	1	ROS	082803	0532	BE	32 30.05 S	159 50.22 W	GPS	5325	5329				34	1-6,23,24,26,46	#1=#9 DUPLICATE SMPLS (4000DB)
49MR03K04_1	P06	139	1	ROS	082803	0657	BO	32 30.20 S	159 49.68 W	GPS	5314	5312	6	5336	5410			
49MR03K04_1	P06	139	1	BUC	082803	0802	UN	32 30.20 S	159 49.10 W	GPS	5313	5313					1	16.5C
49MR03K04_1	P06	139	1	ROS	082803	0906	EN	32 30.23 S	159 48.29 W	GPS	5309	5308						
49MR03K04_1	P06	139	1	FLT	082803	0913	DE	32 30.22 S	159 48.16 W	GPS	5307	5309						ARGO/APEX#929
49MR03K04_1	P06	138	1	ROS	082803	1206	BE	32 30.14 S	158 59.82 W	GPS	5282	5281				33	1-6	
49MR03K04_1	P06	138	1	ROS	082803	1325	BO	32 30.26 S	158 59.11 W	GPS	5282	5283	6	5315	5379			
49MR03K04_1	P06	138	1	BUC	082803	1440	UN	32 30.40 S	158 58.57 W	GPS	5275	5285					1	16.9C
49MR03K04_1	P06	138	1	ROS	082803	1529	EN	32 30.46 S	158 57.92 W	GPS	5278	5277						
49MR03K04_1	P06	137	1	ROS	082803	1820	BE	32 29.98 S	158 9.99 W	GPS	5693	5686				36	1-6,7,8,12,13,23,25,26,27,34,35	
49MR03K04_1	P06	137	1	ROS	082803	1950	BO	32 29.70 S	158 9.20 W	GPS	5620	5619	2	5721	5782			
49MR03K04_1	P06	137	1	BUC	082803	2100	UN	32 29.59 S	158 8.78 W	GPS	5599	5580					1,34,35,48	16.3C, 20L FOR BIO
49MR03K04_1	P06	137	1	UNK	082803	2134	BE	32 29.51 S	158 8.36 W	GPS	5583	5592						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	137	1	UNK	082803	2158	EN	32 29.52 S	158 8.13 W	GPS	5594	5589						
49MR03K04_1	P06	137	1	ROS	082803	2202	EN	32 29.51 S	158 8.05 W	GPS	5596	5595						
49MR03K04_1	P06	136	1	ROS	082903	0053	BE	32 29.74 S	157 19.80 W	GPS	5352	5356				36	1-6,9,22,34,35,47	#1=#3 (B-10DB), #2=#27 (600DB) DUPLICATE SMPLS FOR R.N.
49MR03K04_1	P06	136	1	UNK	082903	0103	BE	32 29.76 S	157 19.69 W	GPS	5358	5358						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	136	1	UNK	082903	0134	EN	32 29.75 S	157 19.47 W	GPS	5374	5363						
49MR03K04_1	P06	136	1	BUC	082903	0153	UN	32 29.76 S	157 19.35 W	GPS	5384	5369					1,34,35,48	17.2C, 20L FOR BIO
49MR03K04_1	P06	136	1	ROS	082903	0213	BO	32 29.85 S	157 19.26 W	GPS	5383	5381	5	5375	5452			
49MR03K04_1	P06	136	1	ROS	082903	0417	EN	32 30.39 S	157 18.13 W	GPS	5354	5355						
49MR03K04_1	P06	136	1	FLT	082903	0424	DE	32 30.38 S	157 17.91 W	GPS	5340	5336						ARGO/APEX#930
49MR03K04_1	P06	135	1	ROS	082903	0708	BE	32 30.10 S	156 30.07 W	GPS	5310	5318				35	1-6,23,24,26,46	#1=#16 DUPLICATE SMPLS (2400DB)
49MR03K04_1	P06	135	1	ROS	082903	0829	BO	32 30.40 S	156 29.63 W	GPS	5306	5306	5	5297	5380			
49MR03K04_1	P06	135	1	BUC	082903	0953	UN	32 30.65 S	156 29.20 W	GPS	5300	5298					1	16.4C
49MR03K04_1	P06	135	1	ROS	082903	1034	EN	32 30.78 S	156 28.76 W	GPS	5294	5299						
49MR03K04_1	P06	134	1	ROS	082903	1331	BE	32 29.96 S	155 40.05 W	GPS	5159	5158				33	1-6	
49MR03K04_1	P06	134	1	BUC	082903	1402	UN	32 30.03 S	155 39.83 W	GPS	5148	5149					1	16.5C
49MR03K04_1	P06	134	1	ROS	082903	1449	BO	32 30.15 S	155 39.65 W	GPS	5133	5124	4	5165	5241			

49MR03K04_1	P06	134	1	ROS	082903	1650	EN	32 30.50 S	155 38.97 W	GPS	5110	5109						
49MR03K04_1	P06	133	1	ROS	082903	1939	BE	32 30.26 S	154 50.82 W	GPS	4985	4976				35	1-8,12,13,15,23,24,26,27,34,35,45,48	#3=#13 DUPLICATE SMPLS (3000DB), 2 BTLS FOR BIO
49MR03K04_1	P06	133	1	UNK	082903	2018	BE	32 30.33 S	154 50.55 W	GPS	4992	4995						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	133	1	BUC	082903	2024	UN	32 30.35 S	154 50.55 W	GPS	4989	4995					1	16.5C
49MR03K04_1	P06	133	1	UNK	082903	2045	EN	32 30.44 S	154 50.51 W	GPS	4977	4980						
49MR03K04_1	P06	133	1	ROS	082903	2056	BO	32 30.49 S	154 50.46 W	GPS	4982	4981	4	5002	5078			
49MR03K04_1	P06	133	1	ROS	082903	2252	EN	32 30.20 S	154 49.24 W	GPS	5006	5000						
49MR03K04_1	P06	132	1	ROS	083003	0148	BE	32 29.57 S	153 59.64 W	GPS	4959	4971				32	1-6,34,35	
49MR03K04_1	P06	132	1	UNK	083003	0156	BE	32 29.51 S	153 59.75 W	GPS	4956	4961						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	132	1	UNK	083003	0215	EN	32 29.36 S	153 59.81 W	GPS	4923	4923						
49MR03K04_1	P06	132	1	BUC	083003	0303	UN	32 29.13 S	154 0.01 W	GPS	4807	4810					1,34,35,48	16.3C, 20L FOR BIO
49MR03K04_1	P06	132	1	ROS	083003	0312	BO	32 29.13 S	154 0.08 W	GPS	4809	4807	3	4946	4998			ALTITUDE DECREASED DOWN TO 7M
49MR03K04_1	P06	132	1	ROS	083003	0511	EN	32 28.40 S	154 1.02 W	GPS	5010	5009						
49MR03K04_1	P06	132	1	FLT	083003	0519	DE	32 28.46 S	154 1.00 W	GPS	4996	5003						ARGO/APEX#931
49MR03K04_1	P06	131	1	ROS	083003	1022	BE	32 29.78 S	153 9.80 W	GPS	5252	5239				34	1-6,23,24,26	#1=#23 DUPLICATE SMPLS (1000DB)
49MR03K04_1	P06	131	1	ROS	083003	1144	BO	32 30.09 S	153 10.03 W	GPS	5199	5202	7	5229	5308			
49MR03K04_1	P06	131	1	BUC	083003	1256	UN	32 30.27 S	153 10.18 W	GPS	5193	5194					1	16.8C
49MR03K04_1	P06	131	1	ROS	083003	1342	EN	32 30.46 S	153 10.26 W	GPS	5198	5203						
49MR03K04_1	P06	130	1	ROS	083003	1643	BE	32 30.08 S	152 19.91 W	GPS	4196	4208				28	1-6,34,35	
49MR03K04_1	P06	130	1	BUC	083003	1737	UN	32 30.33 S	152 20.06 W	GPS	4293	4293					1	17.6C
49MR03K04_1	P06	130	1	ROS	083003	1747	BO	32 30.33 S	152 20.16 W	GPS	4295	4286	5	4316	4371			
49MR03K04_1	P06	130	1	BIO	083003	1818	UN	32 30.66 S	152 20.05 W	GPS	4435	4435					34,35,48	BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1	P06	130	1	ROS	083003	1927	EN	32 31.40 S	152 19.73 W	GPS	4774	4773						
49MR03K04_1	P06	129	1	ROS	083003	2225	BE	32 30.11 S	151 29.83 W	GPS	5576	5560				35	1-8,23,24,26,27,34,35,46	#1=#6 DUPLICATE SMPLS (4750DB)
49MR03K04_1	P06	129	1	UNK	083003	2233	BE	32 30.19 S	151 29.84 W	GPS	5545	5547						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	129	1	UNK	083003	2306	EN	32 30.48 S	151 29.82 W	GPS	5433	5435						
49MR03K04_1	P06	129	1	ROS	083003	2351	BO	32 30.83 S	151 29.93 W	GPS	5334	5336	3	5519	5567			
49MR03K04_1	P06	129	1	BUC	083103	0057	UN	32 31.33 S	151 29.94 W	GPS	5363	5370					1,34,35,48	17.5C, 20L FOR BIO
49MR03K04_1	P06	129	1	ROS	083103	0156	EN	32 31.77 S	151 30.10 W	GPS	5328	5343						
49MR03K04_1	P06	X16	1	ROS	083103	0536	BE	32 29.95 S	150 29.91 W	GPS	5164	5166				34	1-8,12,13,23,24,26,27	#1=#8 DUPLICATE SMPLS (4250DB)
49MR03K04_1	P06	X16	1	ROS	083103	0653	BO	32 30.35 S	150 30.24 W	GPS	5140	5137	6	5164	5234			
49MR03K04_1	P06	X16	1	BUC	083103	0755	UN	32 30.64 S	150 30.48 W	GPS	5101	5103					1	17.3C
49MR03K04_1	P06	X16	1	ROS	083103	0854	EN	32 30.93 S	150 30.82 W	GPS	5133	5134						
49MR03K04_1	P06	X16	1	FLT	083103	0902	DE	32 30.95 S	150 30.69 W	GPS	5119	5121						ARGO/SOLO#2202
49MR03K04_1	P06	127	1	ROS	083103	1128	BE	32 30.04 S	149 49.59 W	GPS	5102	5102				36	1-6,9,22,47	
49MR03K04_1	P06	127	1	ROS	083103	1244	BO	32 30.35 S	149 49.77 W	GPS	5075	5085	6	5107	5182			
49MR03K04_1	P06	127	1	BUC	083103	1325	UN	32 30.53 S	149 49.87 W	GPS	5088	5092					1	17.1C
49MR03K04_1	P06	127	1	ROS	083103	1441	EN	32 30.89 S	149 50.19 W	GPS	5093	5101						
49MR03K04_1	P06	126	1	ROS	083103	1804	BE	32 29.93 S	149 0.55 W	GPS	4897	4909				34	1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_1	P06	126	1	ROS	083103	1918	BO	32 30.09 S	149 0.68 W	GPS	4865	4877	4	4912	4995			INTERNAL CLOCK ERROR OF SBE35 (NO RESET)
49MR03K04_1	P06	126	1	BUC	083103	1930	UN	32 30.12 S	149 0.68 W	GPS	4864	4880					1	17.2C
49MR03K04_1	P06	126	1	UNK	083103	1956	BE	32 30.21 S	149 0.69 W	GPS	4863	4876						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	126	1	UNK	083103	2030	EN	32 30.42 S	149 0.63 W	GPS	4873	4873						
49MR03K04_1	P06	126	1	ROS	083103	2112	EN	32 30.66 S	149 0.67 W	GPS	4839	4830						
49MR03K04_1	P06	125	1	ROS	090103	0009	BE	32 30.25 S	148 9.60 W	GPS	4588	4586				33	1-8,12,13,15,23,24,26,27,34,35,45,46	#1=#11 DUPLICATE SMPLS (3500DB), #4 MISS FIRE
49MR03K04_1	P06	125	1	BUC	090103	0028	UN	32 30.41 S	148 9.40 W	GPS	4553	4544					1	16.8C
49MR03K04_1	P06	125	1	ROS	090103	0121	BO	32 30.76 S	148 9.10 W	GPS	4499	4500	3	4603	4628			
49MR03K04_1	P06	125	1	UNK	090103	0129	BE	32 30.80 S	148 9.10 W	GPS	4519	4509						SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	125	1	UNK	090103	0150	EN	32 30.88 S	148 9.09 W	GPS	4517	4517						

49MR03K04_1	P06	125	1	ROS	090103	0313	EN	32 31.21 S	148 9.08 W	GPS	4538	4511					
49MR03K04_1	P06	125	1	BIO	090103	0323	UN	32 31.11 S	148 8.82 W	GPS	4479	4482				34,35,48	20L FOR BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_1	P06	125	1	FLT	090103	0325	DE	32 31.12 S	148 8.70 W	GPS	4489	4477					ARGO/APEX#932
49MR03K04_1	P06	124	1	ROS	090103	0617	BE	32 29.93 S	147 20.61 W	GPS	4677	4676			31	1-6	
49MR03K04_1	P06	124	1	ROS	090103	0730	BO	32 30.21 S	147 20.80 W	GPS	4620	4615	7	4678	4750		
49MR03K04_1	P06	124	1	BUC	090103	0826	UN	32 30.46 S	147 20.82 W	GPS	4650	4617				1	17.1C
49MR03K04_1	P06	124	1	ROS	090103	0922	EN	32 30.84 S	147 20.80 W	GPS	4647	4643					
49MR03K04_1	P06	123	1	ROS	090103	1222	BE	32 30.14 S	146 29.94 W	GPS	5177	5189			34	1-8,23,24,26,27	#1=#10 DUPLICATE SMPLS (3750DB)
49MR03K04_1	P06	123	1	ROS	090103	1339	BO	32 30.47 S	146 29.85 W	GPS	5118	5119	4	5134	5213		
49MR03K04_1	P06	123	1	BUC	090103	1438	UN	32 30.83 S	146 29.86 W	GPS	5087	5087				1	17.3C
49MR03K04_1	P06	123	1	ROS	090103	1539	EN	32 31.36 S	146 29.83 W	GPS	5070	5088					
49MR03K04_1	P06	122	1	ROS	090103	1837	BE	32 29.77 S	145 39.84 W	GPS	4999	5002			34	1-6,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_1	P06	122	1	ROS	090103	1953	BO	32 29.99 S	145 40.15 W	GPS	5010	5014	6	5018	5092		
49MR03K04_1	P06	122	1	UNK	090103	2045	BE	32 30.38 S	145 40.12 W	GPS	5089	5076					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	122	1	BUC	090103	2057	UN	32 30.45 S	145 40.13 W	GPS	5115	5122				1	17.6C
49MR03K04_1	P06	122	1	UNK	090103	2103	EN	32 30.50 S	145 40.12 W	GPS	5116	5125					
49MR03K04_1	P06	122	1	ROS	090103	2155	EN	32 30.96 S	145 40.38 W	GPS	5130	5123					
49MR03K04_1	P06	121	1	ROS	090203	0052	BE	32 30.47 S	144 49.88 W	GPS	5273	5285			34	1-8,12,13,23,24,26,27,46	#1=#12 DUPLICATE SMPLS (3250DB)
49MR03K04_1	P06	121	1	UNK	090203	0105	BE	32 30.62 S	144 49.87 W	GPS	5276	5274					SOLAR LIGHT MEASUREMENT
49MR03K04_1	P06	121	1	UNK	090203	0127	EN	32 30.66 S	144 49.86 W	GPS	5269	5269					
49MR03K04_1	P06	121	1	BUC	090203	0156	UN	32 30.86 S	144 49.83 W	GPS	5281	5283				1,34,35,48	16.0C, 20L FOR BIO
49MR03K04_1	P06	121	1	ROS	090203	0212	BO	32 31.00 S	144 49.83 W	GPS	5287	5279	3	5301	5354		
49MR03K04_1	P06	121	1	ROS	090203	0415	EN	32 31.46 S	144 49.97 W	GPS	5251	5244					
49MR03K04_1	P06	121	2	UNK	090203	0434	BE	32 30.45 S	144 49.79 W	GPS	5300	5305					CTD CABLE RESPOOLING (WO 5115M)
49MR03K04_1	P06	121	2	UNK	090203	0719	EN	32 31.15 S	144 49.94 W	GPS	5291	5283					
49MR03K04_1	P06	121	1	FLT	090203	0725	DE	32 31.11 S	144 50.02 W	GPS	5259	5265					ARGO/SOLO#2203

P06 REV R/V MIRAI CRUISE MR03K04 LEG2

SHIP/CRS EXPOCODE	WOCE SECT	STNNBR	CASTNO	CAST TYPE	DATE	UTC TIME	EVENT CODE	POSITION LATITUDE	LONGITUDE	NAV	UNC DEPTH	COR DEPTH	HT ABOVE BOTTOM	WIRE OUT	MAX PRESS	NO. OF BOTTLES	PARAMETERS	COMMENTS
49MR03K04_2	P06	127	2	ROS	091203	0616	BE	32 29.90 S	149 49.49 W	GPS	5061	5060						REDUNDANT STATION WITH LEG1
49MR03K04_2	P06	127	2	BUC	091203	0625	UN	32 29.93 S	149 49.38 W	GPS	5061	5396					1,34,35	16.8C
49MR03K04_2	P06	127	2	ROS	091203	0644	UN	32 30.09 S	149 49.36 W	GPS	5003	5024						OPERATION INTERRUPTED AT 887DB
																		(PRIMARY T NOISE)
49MR03K04_2	P06	127	2	ROS	091203	0700	EN	32 30.19 S	149 49.26 W	GPS	5003	4996						REPLACED PRIMARY T SENSOR AND
																		CONNECTING CABLE
49MR03K04_2	P06	127	3	ROS	091203	0755	BE	32 30.06 S	149 49.38 W	GPS	4995	4995						
49MR03K04_2	P06	127	3	ROS	091203	0810	UN	32 30.13 S	149 49.39 W	GPS	4997	-9						OPERATION INTERRUPTED AT 636DB
																		(PRIMARY T NOISE)
49MR03K04_2	P06	127	3	ROS	091203	0841	EN	32 30.21 S	149 49.27 W	GPS	4983	-9						REPLACED SBE9 AND CONNECTING CABLES
49MR03K04_2	P06	127	4	ROS	091203	1236	BE	32 30.09 S	149 49.58 W	GPS	5091	5093				36	1-6,9,22,47	#1-3 FOR R.N.
49MR03K04_2	P06	127	4	ROS	091203	1358	BO	32 30.66 S	149 49.17 W	GPS	5017	5025	8	5124	5150			
49MR03K04_2	P06	127	1	UNK	091203	1429	UN	32 30.78 S	149 48.95 W	GPS	4948	4935					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	127	4	ROS	091203	1608	EN	32 31.53 S	149 48.48 W	GPS	5004	5022						
49MR03K04_2	P06	125	2	ROS	091203	2203	BE	32 30.36 S	148 9.86 W	GPS	4608	4618				36	1-8,23,24,26,27,34,35	REDUNDANT STATION WITH LEG1, #1=#6 DUPLICATE
																		SMPLS (B-10DB), 3 BTLS FOR BIO
49MR03K04_2	P06	125	2	BUC	091203	2208	UN	32 30.41 S	148 9.77 W	GPS	4597	4603					1,48	16.8C, 20L FOR BIO
49MR03K04_2	P06	125	2	UNK	091203	2218	BE	32 30.01 S	148 9.65 W	GPS	4580	4589						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	125	2	ROS	091203	2314	BO	32 30.71 S	148 9.04 W	GPS	4459	4469	10	4635	4640			LADCP SOUNDING
49MR03K04_2	P06	125	2	UNK	091303	0013	EN	32 30.94 S	148 8.41 W	GPS	4254	4297						
49MR03K04_2	P06	125	2	ROS	091303	0113	EN	32 31.29 S	148 7.77 W	GPS	4220	4263						#31 NO WATER, #2 MISS FIRE
49MR03K04_2	P06	120	1	ROS	091303	1512	BE	32 30.07 S	144 0.24 W	GPS	5103	5104				36	1-6,9,22,34,35,47	#1-3 FOR R.N.
49MR03K04_2	P06	120	1	BUC	091303	1526	UN	32 30.13 S	144 0.20 W	GPS	5096	5098					1	17.5C
49MR03K04_2	P06	120	1	ROS	091303	1632	BO	32 30.41 S	143 59.78 W	GPS	4961	4957	7	5100	5151			
49MR03K04_2	P06	120	1	UNK	091303	1646	UN	32 30.54 S	143 59.76 W	GPS	4950	4944					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	120	2	BUC	091303	1700	UN	32 30.62 S	143 59.72 W	GPS	4959	4956					34,35,48	20L FOR BIO
49MR03K04_2	P06	120	1	ROS	091303	1854	EN	32 30.92 S	143 59.26 W	GPS	4771	4824						
49MR03K04_2	P06	119	1	ROS	091303	2205	BE	32 30.60 S	143 9.05 W	GPS	5525	5522				35	1-8,23,24,26,27,34,35	#1=#4 DUPLICATE SMPLS (5250DB)
49MR03K04_2	P06	119	1	BUC	091303	2215	UN	32 30.58 S	143 9.11 W	GPS	5518	5520					1	17.4C
49MR03K04_2	P06	119	1	UNK	091303	2300	BE	32 30.51 S	143 9.05 W	GPS	5508	5511						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	119	1	ROS	091303	2329	BO	32 30.50 S	143 9.07 W	GPS	5519	5510	10	5517	5616			
49MR03K04_2	P06	119	1	UNK	091303	2341	EN	32 30.54 S	143 9.10 W	GPS	5504	5515						
49MR03K04_2	P06	119	2	BUC	091403	0025	UN	32 30.73 S	143 9.35 W	GPS	5524	5528					34,35,48	
49MR03K04_2	P06	119	1	ROS	091403	0141	EN	32 30.99 S	143 9.56 W	GPS	5324	5339						
49MR03K04_2	P06	118	1	ROS	091403	0441	BE	32 29.74 S	142 19.68 W	GPS	4572	4573				30	1-6,11	
49MR03K04_2	P06	118	1	BUC	091403	0447	UN	32 29.68 S	142 19.72 W	GPS	4474	4510					1	16.9C
49MR03K04_2	P06	118	2	BUC	091403	0515	UN	32 29.51 S	142 19.90 W	GPS	4447	4428					34,35	500ML FOR BIO
49MR03K04_2	P06	118	1	ROS	091403	0551	BO	32 29.43 S	142 20.07 W	GPS	4438	4427	11	4451	4500			
49MR03K04_2	P06	118	1	ROS	091403	0756	EN	32 29.12 S	142 21.00 W	GPS	4378	4379						
49MR03K04_2	P06	118	1	FLT	091403	0804	DE	32 28.94 S	142 20.94 W	GPS	4374	4374						ARGO/APEX#933
49MR03K04_2	P06	117	1	ROS	091403	1117	BE	32 29.86 S	141 29.58 W	GPS	4689	4692				32	1-8,12,13,15,23,24,26,27,45,46	#1=#8 DUPLICATE SMPLS (4250DB)
49MR03K04_2	P06	117	1	BUC	091403	1124	UN	32 29.82 S	141 29.57 W	GPS	4694	4693					1	16.9C
49MR03K04_2	P06	117	1	UNK	091403	1229	UN	32 29.82 S	141 29.66 W	GPS	4682	4690					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	117	1	ROS	091403	1230	BO	32 29.82 S	141 29.66 W	GPS	4685	4688	11	4685	4763			
49MR03K04_2	P06	117	1	ROS	091403	1427	EN	32 29.78 S	141 30.04 W	GPS	4591	4576						
49MR03K04_2	P06	116	1	ROS	091403	1731	BE	32 29.90 S	140 40.06 W	GPS	5005	4958				32	1-6,34,35	

49MR03K04_2	P06	116	1	BUC	091403	1736	UN	32 30.03 S	140 40.05 W	GPS	4953	4950					1	17.8C
49MR03K04_2	P06	116	2	BUC	091403	1827	UN	32 30.59 S	140 40.27 W	GPS	4915	4916					34,35,48	20L FOR BIO
49MR03K04_2	P06	116	1	ROS	091403	1847	BO	32 30.76 S	140 40.39 W	GPS	4888	4893	10	4975	4977			
49MR03K04_2	P06	116	1	UNK	091403	2007	BE	32 31.22 S	140 40.87 W	GPS	4890	4890						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	116	1	UNK	091403	2033	EN	32 31.34 S	140 40.97 W	GPS	4876	4878						
49MR03K04_2	P06	116	1	ROS	091403	2101	EN	32 31.54 S	140 41.13 W	GPS	4892	4887						
49MR03K04_2	P06	115	1	ROS	091403	2331	BE	32 29.96 S	139 59.71 W	GPS	4726	4731				32	1-8,23,24,26,27,34,35	#1=#7 DUPLICATE SMPLS (4500DB)
49MR03K04_2	P06	115	1	BUC	091403	2336	UN	32 29.90 S	139 59.62 W	GPS	4707	4715					1	17.9C
49MR03K04_2	P06	115	1	UNK	091503	0026	BE	32 30.06 S	139 59.25 W	GPS	4729	4734						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	115	1	ROS	091503	0042	BO	32 30.16 S	139 59.19 W	GPS	4735	4734	20	4713	4752			
49MR03K04_2	P06	115	1	UNK	091503	0050	EN	32 30.20 S	139 59.17 W	GPS	4734	4733						
49MR03K04_2	P06	115	2	BUC	091503	0130	UN	32 30.35 S	139 59.02 W	GPS	4787	4785					34,35,48	20L FOR BIO
49MR03K04_2	P06	115	1	ROS	091503	0242	EN	32 30.66 S	139 58.90 W	GPS	4790	4791						
49MR03K04_2	P06	114	1	ROS	091503	0506	BE	32 29.96 S	139 20.14 W	GPS	4985	4985				36	1-6,9,22,47	#1-4 FOR R.N.
49MR03K04_2	P06	114	1	BUC	091503	0511	UN	32 29.99 S	139 20.10 W	GPS	4987	4986					1	17.2C
49MR03K04_2	P06	114	1	ROS	091503	0633	BO	32 30.22 S	139 19.30 W	GPS	4831	4842	32	5027	5052			LADCP SOUNDING
49MR03K04_2	P06	114	1	UNK	091503	0641	UN	32 30.25 S	139 19.27 W	GPS	4825	4822					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	114	1	ROS	091503	0910	EN	32 30.37 S	139 17.74 W	GPS	4791	4793						IRREGULAR SPOOL AT 1400M AND 800M
49MR03K04_2	P06	114	1	FLT	091503	0918	DE	32 30.46 S	139 17.43 W	GPS	4799	4797						ARGO/SOLO#2204
49MR03K04_2	P06	113	1	ROS	091503	1138	BE	32 30.05 S	138 39.91 W	GPS	4588	4588				32	1-8,12,13,23,24,26,27,46	#1=#9 DUPLICATE SMPLS (4000DB)
49MR03K04_2	P06	113	1	BUC	091503	1145	UN	32 30.12 S	138 39.94 W	GPS	4578	4581					1	16.6C
49MR03K04_2	P06	113	1	ROS	091503	1248	BO	32 30.51 S	138 40.22 W	GPS	4553	4552	6	4607	4640			
49MR03K04_2	P06	113	1	ROS	091503	1449	EN	32 30.92 S	138 40.66 W	GPS	4529	4526						
49MR03K04_2	P06	112	1	ROS	091503	1720	BE	32 30.18 S	137 59.78 W	GPS	4851	4852				32	1-6,34,35	
49MR03K04_2	P06	112	1	BUC	091503	1827	UN	32 30.63 S	137 59.95 W	GPS	4850	4852					1,48	17.2C, 20L FOR BIO
49MR03K04_2	P06	112	1	ROS	091503	1835	BO	32 30.69 S	137 59.97 W	GPS	4853	4851	15	4881	4920			
49MR03K04_2	P06	112	1	UNK	091503	2000	BE	32 31.20 S	138 0.34 W	GPS	4845	4848						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	112	1	UNK	091503	2043	EN	32 31.47 S	138 0.61 W	GPS	4829	4828						
49MR03K04_2	P06	112	1	ROS	091503	2046	EN	32 31.51 S	138 0.64 W	GPS	4828	4827						
49MR03K04_2	P06	111	1	ROS	091503	2320	BE	32 30.07 S	137 19.90 W	GPS	4319	4313				30	1-8,23,24,26,27,34,35	#1=#10 DUPLICATE SMPLS (3750DB)
49MR03K04_2	P06	111	1	UNK	091603	0010	BE	32 30.37 S	137 19.36 W	GPS	4318	4314						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	111	1	ROS	091603	0026	BO	32 30.54 S	137 19.32 W	GPS	4318	4311	10	4379	4367			
49MR03K04_2	P06	111	1	UNK	091603	0043	EN	32 30.71 S	137 19.28 W	GPS	4311	4309						
49MR03K04_2	P06	111	1	BUC	091603	0059	UN	32 30.86 S	137 19.26 W	GPS	4307	4306					1,34,35,48	16.1C, 20L FOR BIO
49MR03K04_2	P06	111	1	ROS	091603	0217	EN	32 31.48 S	137 19.00 W	GPS	4308	4308						
49MR03K04_2	P06	110	1	ROS	091603	0445	BE	32 29.77 S	136 39.75 W	GPS	4333	4333				30	1-6	
49MR03K04_2	P06	110	1	BUC	091603	0450	UN	32 29.71 S	136 39.61 W	GPS	4332	4330					1	16.3C
49MR03K04_2	P06	110	1	ROS	091603	0552	BO	32 29.62 S	136 39.22 W	GPS	4325	4325	6	4345	4391			
49MR03K04_2	P06	110	1	ROS	091603	0743	EN	32 29.41 S	136 38.81 W	GPS	4317	4320						
49MR03K04_2	P06	109	1	ROS	091603	1013	BE	32 29.94 S	136 0.15 W	GPS	4402	4396				30	1-8,12,13,15,23,24,26,27,45,46	#1=#11 DUPLICATE SMPLS (3500DB)
49MR03K04_2	P06	109	1	BUC	091603	1019	UN	32 29.94 S	136 0.14 W	GPS	4411	4392					1	16.4C
49MR03K04_2	P06	109	1	ROS	091603	1121	BO	32 29.63 S	136 0.33 W	GPS	4385	4390	7	4421	4455			
49MR03K04_2	P06	109	1	ROS	091603	1319	EN	32 28.90 S	136 0.69 W	GPS	4402	4401						
49MR03K04_2	P06	109	1	FLT	091603	1325	DE	32 28.94 S	136 0.61 W	GPS	4390	4377						ARGO/APEX#934
49MR03K04_2	P06	108	1	ROS	091603	1602	BE	32 30.01 S	135 19.99 W	GPS	4408	4392				36	1-6,9,22,34,35,47	#1-6 FOR R.N.
49MR03K04_2	P06	108	1	UNK	091603	1706	UN	32 29.46 S	135 19.98 W	GPS	4390	4393					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	108	1	ROS	091603	1711	BO	32 29.43 S	135 19.97 W	GPS	4394	4388	8	4359	4384			
49MR03K04_2	P06	108	1	BUC	091603	1728	UN	32 29.30 S	135 19.98 W	GPS	4410	4420					1,34,35,48	16.6C, 20L FOR BIO
49MR03K04_2	P06	108	1	ROS	091603	1906	EN	32 28.36 S	135 19.97 W	GPS	4349	4310						
49MR03K04_2	P06	X17	1	ROS	091603	2114	BE	32 28.42 S	134 50.86 W	GPS	4325	4321				0		

49MR03K04_2	P06	X17	1	UNK	091603	2131	BE	32 28.28 S	134 50.97 W	GPS	4347	4347						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	X17	1	UNK	091603	2140	EN	32 28.25 S	134 50.97 W	GPS	4336	4349						
49MR03K04_2	P06	X17	2	UNK	091603	2142	BE	32 28.25 S	134 50.97 W	GPS	4336	4356						
49MR03K04_2	P06	X17	1	ROS	091603	2147	EN	32 28.23 S	134 50.98 W	GPS	4359	4353						OPERATION INTERRUPTED AT 1300DB (POWER FAILURE), NO DATA EXCEPT FOR LADCP
49MR03K04_2	P06	X17	2	ROS	091603	2245	BE	32 28.39 S	134 50.91 W	GPS	4326	4325				30	1-8,23,24,26,27	#1=#12 DUPLICATE SMPLS (3250DB)
49MR03K04_2	P06	X17	2	UNK	091603	2310	EN	32 28.33 S	134 50.95 W	GPS	4344	4337						
49MR03K04_2	P06	X17	1	BUC	091603	2328	UN	32 28.25 S	134 51.00 W	GPS	4356	4351					1,34,35,48	16.7C, 30L FOR BIO
49MR03K04_2	P06	X17	2	ROS	091603	2353	BO	32 28.02 S	134 51.08 W	GPS	4361	4365	10	4388	4389			
49MR03K04_2	P06	X17	2	ROS	091703	0148	EN	32 27.99 S	134 51.08 W	GPS	4362	4363						#18 DISCONNECTED MIDDLE AND LOWER LANYARD
49MR03K04_2	P06	106	1	ROS	091703	0549	BE	32 29.94 S	134 0.36 W	GPS	4216	4220				29	1-6,11,34,35	
49MR03K04_2	P06	106	1	BUC	091703	0601	UN	32 29.89 S	134 0.32 W	GPS	4200	4213					1,34,35	16.4C
49MR03K04_2	P06	106	1	ROS	091703	0658	BO	32 29.60 S	134 0.24 W	GPS	4169	4158	12	4173	4211			
49MR03K04_2	P06	106	1	ROS	091703	0849	EN	32 29.04 S	133 59.81 W	GPS	4143	4151						
49MR03K04_2	P06	105	1	ROS	091703	1227	BE	32 30.11 S	133 20.58 W	GPS	4302	4292				30	1-8,12,13,23,24,26,27,46	#1=#13 DUPLICATE SMPLS (3000DB)
49MR03K04_2	P06	105	1	BUC	091703	1237	UN	32 30.03 S	133 20.58 W	GPS	4282	4302					1	16.0C
49MR03K04_2	P06	105	1	ROS	091703	1335	BO	32 29.78 S	133 20.24 W	GPS	4251	4248	22	4266	4307			
49MR03K04_2	P06	105	1	ROS	091703	1535	EN	32 29.19 S	133 19.78 W	GPS	4263	4252						
49MR03K04_2	P06	105	1	FLT	091703	1543	DE	32 29.30 S	133 19.77 W	GPS	4246	4243						ARGO/SOLO#2205
49MR03K04_2	P06	104	1	ROS	091703	1845	BE	32 30.10 S	132 39.89 W	GPS	4351	4348				30	1-6,34,35	
49MR03K04_2	P06	104	1	BUC	091703	1855	UN	32 30.05 S	132 39.85 W	GPS	4349	4349					1,34,35,48	16.2C
49MR03K04_2	P06	104	1	UNK	091703	1932	BE	32 29.88 S	132 39.86 W	GPS	4352	4347						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	104	1	ROS	091703	1954	BO	32 29.87 S	132 39.91 W	GPS	4345	4347	15	4343	4405			
49MR03K04_2	P06	104	2	UNK	091703	2003	UN	32 29.88 S	132 39.93 W	GPS	4360	4347					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	104	1	UNK	091703	2020	EN	32 29.87 S	132 39.91 W	GPS	4345	4347						
49MR03K04_2	P06	104	1	ROS	091703	2147	EN	32 29.82 S	132 39.82 W	GPS	4349	4346						
49MR03K04_2	P06	103	1	ROS	091803	0040	BE	32 29.85 S	132 0.61 W	GPS	4262	4262				30	1-8,23,24,26,27,34,35	#1=#14 DUPLICATE SMPLS (2800DB)
49MR03K04_2	P06	103	1	BUC	091803	0046	UN	32 29.84 S	132 0.57 W	GPS	4263	4261					1,34,35,48	16.8C, 40L FOR BIO
49MR03K04_2	P06	103	1	UNK	091803	0106	BE	32 29.82 S	132 0.44 W	GPS	4262	4260						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	103	1	UNK	091803	0138	EN	32 29.84 S	132 0.40 W	GPS	4261	4260						
49MR03K04_2	P06	103	1	ROS	091803	0149	BO	32 29.86 S	132 0.31 W	GPS	4260	4259	14	4259	4315			
49MR03K04_2	P06	103	1	ROS	091803	0342	EN	32 29.52 S	132 0.05 W	GPS	4260	4261						
49MR03K04_2	P06	102	1	ROS	091803	0639	BE	32 30.08 S	131 20.09 W	GPS	4176	4167				30	1-6	BTL #12015 AND #12021 WERE EXCHANGED
49MR03K04_2	P06	102	1	BUC	091803	0645	UN	32 30.11 S	131 20.07 W	GPS	4178	4179					1	17.2C
49MR03K04_2	P06	102	1	ROS	091803	0745	BO	32 30.22 S	131 19.72 W	GPS	4183	4183	11	4191	4234			
49MR03K04_2	P06	102	1	ROS	091803	0931	EN	32 30.13 S	131 19.13 W	GPS	4162	4151						
49MR03K04_2	P06	101	1	ROS	091803	1216	BE	32 29.93 S	130 39.88 W	GPS	3599	3588				28	1-8,12,13,23,24,26,27,34,35,46	#1=#15 DUPLICATE SMPLS (2600DB), NISKIN #12021 WAS REPLACED WITH #12012
49MR03K04_2	P06	101	1	BUC	091803	1222	UN	32 29.88 S	130 39.89 W	GPS	3602	3603					1	16.6C
49MR03K04_2	P06	101	1	ROS	091803	1315	BO	32 29.66 S	130 39.59 W	GPS	3663	3681	19	3620	3648			
49MR03K04_2	P06	101	1	ROS	091803	1505	EN	32 28.97 S	130 39.02 W	GPS	3764	3757						SAMPING LAYER OF 3500DB WAS CHANGED TO 3400DB
49MR03K04_2	P06	100	1	ROS	091803	1742	BE	32 30.11 S	129 59.98 W	GPS	4052	4065				36	1-6,9,22,34,35,47	#1-8 FOR R.N.
49MR03K04_2	P06	100	1	BUC	091803	1758	UN	32 29.98 S	129 59.89 W	GPS	4086	4090					1,34,35,48	16.9C
49MR03K04_2	P06	100	1	ROS	091803	1846	BO	32 29.63 S	129 59.79 W	GPS	4084	4085	9	4133	4149			
49MR03K04_2	P06	100	1	UNK	091803	1856	UN	32 29.59 S	129 59.72 W	GPS	4061	4051					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	100	2	UNK	091803	1956	BE	32 29.33 S	129 59.51 W	GPS	4055	4072						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	100	2	UNK	091803	2033	EN	32 29.19 S	129 59.40 W	GPS	4146	4149						
49MR03K04_2	P06	100	1	ROS	091803	2035	EN	32 29.18 S	129 59.38 W	GPS	4135	4158						#2 DISCONNECTED MIDDLE AND LOWER LANYARD
49MR03K04_2	P06	100	1	FLT	091803	2041	DE	32 29.19 S	129 59.25 W	GPS	4147	4150						ARGO/APEX#935
49MR03K04_2	P06	99	1	ROS	091803	2316	BE	32 29.93 S	129 19.73 W	GPS	4126	4130				30	1-8,15,23,24,26,27,34,35,45	#1=#16 DUPLICATE SMPLS (2400DB)

49MR03K04_2	P06	99	1	BUC	091803	2324	UN	32 29.90 S	129 19.72 W	GPS	4127	4131					1,34,35,48	16.9C, 40L FOR BIO
49MR03K04_2	P06	99	1	UNK	091903	0004	BE	32 29.81 S	129 19.66 W	GPS	4115	4117						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	99	1	ROS	091903	0020	BO	32 29.76 S	129 19.60 W	GPS	4116	4116	8	4133	4183			
49MR03K04_2	P06	99	1	UNK	091903	0032	EN	32 29.72 S	129 19.52 W	GPS	4116	4111						
49MR03K04_2	P06	99	1	ROS	091903	0210	EN	32 29.28 S	129 19.47 W	GPS	4046	4036						
49MR03K04_2	P06	98	1	ROS	091903	0448	BE	32 29.70 S	128 40.37 W	GPS	4256	4265				29	1-6	
49MR03K04_2	P06	98	1	BUC	091903	0453	UN	32 29.71 S	128 40.34 W	GPS	4266	4264					1	17.0C
49MR03K04_2	P06	98	1	ROS	091903	0555	BO	32 29.74 S	128 40.05 W	GPS	4248	4266	12	4223	4321			
49MR03K04_2	P06	98	1	ROS	091903	0745	EN	32 29.64 S	128 39.60 W	GPS	4236	4236						
49MR03K04_2	P06	97	1	ROS	091903	1026	BE	32 30.01 S	128 0.06 W	GPS	4136	4180				29	1-8,12,13,23,24,26,27,46	#1=#17 DUPLICATE SMPLS (2200DB)
49MR03K04_2	P06	97	1	BUC	091903	1033	UN	32 30.00 S	128 0.01 W	GPS	4139	4125					1	16.6C
49MR03K04_2	P06	97	1	ROS	091903	1129	BO	32 29.66 S	127 59.84 W	GPS	3949	3955	104	3958	3986			LADCP SOUNDING
49MR03K04_2	P06	97	1	UNK	091903	1242	UN	32 29.27 S	127 59.73 W	GPS	3901	3899					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	97	1	ROS	091903	1318	EN	32 29.15 S	127 59.56 W	GPS	3900	3904						
49MR03K04_2	P06	96	1	ROS	091903	1557	BE	32 29.94 S	127 19.43 W	GPS	3204	3201				25	1-6,34,35	
49MR03K04_2	P06	96	1	ROS	091903	1649	BO	32 29.54 S	127 19.38 W	GPS	3149	3145	9	3155	3182			
49MR03K04_2	P06	96	1	BUC	091903	1727	UN	32 29.28 S	127 19.31 W	GPS	3180	3185					1,48	16.9C, 20L FOR BIO
49MR03K04_2	P06	96	1	ROS	091903	1825	EN	32 28.82 S	127 19.20 W	GPS	3217	3197						
49MR03K04_2	P06	96	1	FLT	091903	1832	DE	32 28.75 S	127 18.98 W	GPS	3131	3119						ARGO/SOLO#2206
49MR03K04_2	P06	95	1	ROS	091903	2102	BE	32 29.95 S	126 40.14 W	GPS	2379	2375				24	1-8,23,24,26,27,34,35,48	#1=#18 DUPLICATE SMPLS (2000DB), IRREGULAR TRIP SEQUENCE
49MR03K04_2	P06	95	1	BUC	091903	2109	UN	32 29.86 S	126 40.14 W	GPS	2356	2357					1	16.2C
49MR03K04_2	P06	95	1	ROS	091903	2140	BO	32 29.61 S	126 40.11 W	GPS	2342	2340	10	2301	2296			SPOOLED IN 6M BEFORE BOTTOM SAMPLING
49MR03K04_2	P06	95	1	UNK	091903	2158	BE	32 29.48 S	126 40.08 W	GPS	2379	2378						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	95	1	UNK	091903	2237	EN	32 29.15 S	126 40.06 W	GPS	2406	2404						
49MR03K04_2	P06	95	1	ROS	091903	2257	EN	32 29.03 S	126 40.04 W	GPS	2378	2374						
49MR03K04_2	P06	94	1	ROS	092003	0139	BE	32 29.72 S	125 59.44 W	GPS	3527	3524				28	1-8,23,24,26,27,46	#1=#19 DUPLICATE SMPLS (1800DB)
49MR03K04_2	P06	94	1	BUC	092003	0146	UN	32 29.65 S	125 59.37 W	GPS	3584	3585					1	15.9C
49MR03K04_2	P06	94	1	ROS	092003	0239	BO	32 29.26 S	125 59.29 W	GPS	3611	3611	12	3611	3631			
49MR03K04_2	P06	94	1	ROS	092003	0423	EN	32 28.56 S	125 59.17 W	GPS	3425	3442						
49MR03K04_2	P06	93	1	ROS	092103	0301	BE	32 30.57 S	125 19.96 W	GPS	2139	2133				21	1-8,12,13,23,24,26,27,34,35	#1=#20 DUPLICATE SMPLS (1600DB)
49MR03K04_2	P06	93	1	BUC	092103	0306	UN	32 30.53 S	125 19.97 W	GPS	2159	2148					1,34,35	15.8C
49MR03K04_2	P06	93	1	ROS	092103	0341	BO	32 30.33 S	125 20.02 W	GPS	2234	2217	12	2170	2182			
49MR03K04_2	P06	93	1	ROS	092103	0451	EN	32 30.03 S	125 20.31 W	GPS	2220	2216						
49MR03K04_2	P06	92	1	ROS	092103	0731	BE	32 30.27 S	124 39.99 W	GPS	3802	3804				36	1-6,9,22,47	#1-9 FOR R.N.
49MR03K04_2	P06	92	1	BUC	092103	0737	UN	32 30.29 S	124 40.06 W	GPS	3779	3770					1	16.7C
49MR03K04_2	P06	92	1	ROS	092103	0830	BO	32 30.37 S	124 40.22 W	GPS	3741	3758	24	3780	3783			
49MR03K04_2	P06	92	1	UNK	092103	0846	UN	32 30.32 S	124 40.15 W	GPS	3736	3732					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	92	1	ROS	092103	1010	EN	32 30.17 S	124 40.09 W	GPS	3748	3745						
49MR03K04_2	P06	91	1	ROS	092103	1245	BE	32 29.86 S	123 59.98 W	GPS	2365	2359				24	1-8,23,24,26,27,34,35,46,48	#1=#21 DUPLICATE SMPLS (1400DB), 2 BTLS FOR BIO (5DB)
49MR03K04_2	P06	91	1	BUC	092103	1251	UN	32 29.88 S	123 59.99 W	GPS	2362	2366					1	16.6C
49MR03K04_2	P06	91	1	ROS	092103	1327	BO	32 29.82 S	124 0.12 W	GPS	2364	2382	9	2414	2432			
49MR03K04_2	P06	91	1	ROS	092103	1446	EN	32 29.55 S	124 0.43 W	GPS	2418	2426						
49MR03K04_2	P06	91	1	FLT	092103	1453	DE	32 29.58 S	124 0.24 W	GPS	2369	2364						ARGO/APEX#936
49MR03K04_2	P06	90	1	ROS	092103	1724	BE	32 29.84 S	123 19.89 W	GPS	3568	3551				29	1-6,34,35,48	#1=#2 DUPLICATE SMPLS (5DB), 2 BTLS FOR BIO (5DB)
49MR03K04_2	P06	90	1	BUC	092103	1728	UN	32 29.79 S	123 19.92 W	GPS	3476	3497					1	16.8C
49MR03K04_2	P06	90	1	ROS	092103	1823	BO	32 29.52 S	123 20.06 W	GPS	3596	3590	10	3595	3628			
49MR03K04_2	P06	90	1	UNK	092103	1902	BE	32 29.20 S	123 20.29 W	GPS	3530	3534						SOLAR LIGHT MEASUREMENT

49MR03K04_2	P06	90	1	UNK	092103	1949	EN	32 28.77 S	123 20.36 W	GPS	3440	3440						
49MR03K04_2	P06	90	1	ROS	092103	2013	EN	32 28.56 S	123 20.42 W	GPS	3403	3401						
49MR03K04_2	P06	89	1	ROS	092103	2253	BE	32 29.51 S	122 39.38 W	GPS	2440	2437				23	1-8,12,13,15,23,24,26,27,45	#1=#22 DUPLICATE SMPLS (1200DB)
49MR03K04_2	P06	89	1	BUC	092103	2259	UN	32 29.44 S	122 39.42 W	GPS	2494	2510					1	16.4C
49MR03K04_2	P06	89	1	UNK	092103	2316	BE	32 29.36 S	122 39.54 W	GPS	2582	2580						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	89	1	ROS	092103	2340	BO	32 29.20 S	122 39.63 W	GPS	2690	2688	15	2612	2625			LADCP SOUNDING
49MR03K04_2	P06	89	1	UNK	092103	2340	UN	32 29.21 S	122 39.63 W	GPS	2672	2688					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	89	1	UNK	092103	2350	EN	32 29.11 S	122 39.64 W	GPS	2753	2781						
49MR03K04_2	P06	89	1	ROS	092203	0122	EN	32 28.21 S	122 39.93 W	GPS	3295	3294						
49MR03K04_2	P06	88	1	ROS	092203	0402	BE	32 30.15 S	122 0.08 W	GPS	3008	3004				24	1-6	
49MR03K04_2	P06	88	1	BUC	092203	0407	UN	32 30.15 S	122 0.05 W	GPS	3004	3004					1	15.8C
49MR03K04_2	P06	88	1	ROS	092203	0451	BO	32 29.91 S	122 0.13 W	GPS	2995	2993	14	2993	3019			
49MR03K04_2	P06	88	1	ROS	092203	0627	EN	32 29.33 S	122 0.19 W	GPS	3195	3189						
49MR03K04_2	P06	87	1	ROS	092203	0906	BE	32 30.05 S	121 19.34 W	GPS	3245	3254				26	1-8,23,24,26,27,46	
49MR03K04_2	P06	87	1	BUC	092203	0913	UN	32 30.06 S	121 19.34 W	GPS	3262	3262					1	15.7C
49MR03K04_2	P06	87	1	ROS	092203	0959	BO	32 29.95 S	121 19.36 W	GPS	3288	3267	10	3252	3290			
49MR03K04_2	P06	87	1	ROS	092203	1144	EN	32 29.80 S	121 19.33 W	GPS	3231	3233						
49MR03K04_2	P06	87	1	FLT	092203	1153	DE	32 29.86 S	121 18.98 W	GPS	3406	3412						ARGO/SOLO#2207
49MR03K04_2	P06	86	1	ROS	092203	1418	BE	32 30.17 S	120 39.69 W	GPS	3398	3392				28	1-6,34,35	#2 DID NOT FIRE (OPERATION MISS)
49MR03K04_2	P06	86	1	ROS	092203	1514	BO	32 30.12 S	120 39.74 W	GPS	3383	3384	10	3380	3421			
49MR03K04_2	P06	86	1	BUC	092203	1627	UN	32 30.16 S	120 39.88 W	GPS	3383	3384					1	16.4C
49MR03K04_2	P06	86	1	ROS	092203	1712	EN	32 29.98 S	120 40.17 W	GPS	3464	3407						
49MR03K04_2	P06	86	2	BUC	092203	1715	UN	32 29.90 S	120 39.88 W	GPS	3482	3393					48	30L FOR BIO
49MR03K04_2	P06	85	1	ROS	092203	1956	BE	32 30.07 S	119 59.49 W	GPS	3021	3032				27	1-8,12,13,15,23,24,26,27,34,35,45,48	#1=#24 DUPLICATE SMPLS (900DB), 2 BTLS FOR BIO (5DB)
49MR03K04_2	P06	85	1	BUC	092203	2001	UN	32 30.02 S	119 59.51 W	GPS	3034	3036					1	15.7C
49MR03K04_2	P06	85	1	ROS	092203	2052	BO	32 29.57 S	119 59.74 W	GPS	3013	3012	4	3071	3090			
49MR03K04_2	P06	85	1	ROS	092203	2230	EN	32 28.63 S	120 0.56 W	GPS	3057	3057						
49MR03K04_2	P06	84	1	ROS	092303	0113	BE	32 30.05 S	119 20.15 W	GPS	3516	3510				36	1-6,9,22,47	#1-10 FOR R.N.
49MR03K04_2	P06	84	1	BUC	092303	0118	UN	32 30.00 S	119 20.23 W	GPS	3519	3517					1	15.4C
49MR03K04_2	P06	84	1	ROS	092303	0209	BO	32 29.55 S	119 20.29 W	GPS	3517	3511	11	3538	3574			
49MR03K04_2	P06	84	1	UNK	092303	0211	UN	32 29.53 S	119 20.28 W	GPS	3510	3512					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	84	1	ROS	092303	0402	EN	32 28.74 S	119 20.41 W	GPS	3477	3477						
49MR03K04_2	P06	83	1	ROS	092303	0652	BE	32 30.02 S	118 39.62 W	GPS	3434	3435				27	1-8,23,24,26,27,46	#1=#25 DUPLICATE SMPLS (800DB)
49MR03K04_2	P06	83	1	BUC	092303	0657	UN	32 29.99 S	118 39.69 W	GPS	3435	3436					1	15.6C
49MR03K04_2	P06	83	1	ROS	092303	0748	BO	32 29.90 S	118 39.72 W	GPS	3432	3433	30	3397	3437			
49MR03K04_2	P06	83	1	ROS	092303	0940	EN	32 29.55 S	118 39.61 W	GPS	3446	3448						
49MR03K04_2	P06	82	1	ROS	092303	1230	BE	32 30.19 S	117 59.34 W	GPS	3434	3425				26	1-6	
49MR03K04_2	P06	82	1	BUC	092303	1236	UN	32 30.19 S	117 59.28 W	GPS	3423	3425					1	15.5C
49MR03K04_2	P06	82	1	ROS	092303	1327	BO	32 29.98 S	117 59.24 W	GPS	3422	3424	12	3431	3463			
49MR03K04_2	P06	82	1	ROS	092303	1520	EN	32 29.44 S	117 59.11 W	GPS	3430	3433						
49MR03K04_2	P06	82	1	FLT	092303	1527	DE	32 29.42 S	117 59.04 W	GPS	3444	3445						ARGO/APEX#660
49MR03K04_2	P06	81	1	ROS	092303	1846	BE	32 29.95 S	117 19.05 W	GPS	3300	3300				29	1-8,12,13,23,24,26,27,34,35,48	#1=#26 DUPLICATE SMPLS (700DB)
49MR03K04_2	P06	81	1	ROS	092303	1946	BO	32 29.44 S	117 19.05 W	GPS	3320	3316	9	3351	3352			
49MR03K04_2	P06	81	1	UNK	092303	2047	UN	32 28.87 S	117 19.03 W	GPS	3325	3335					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	81	1	ROS	092303	2135	EN	32 28.41 S	117 18.93 W	GPS	3296	3296						
49MR03K04_2	P06	80	1	ROS	092403	0038	BE	32 29.67 S	116 39.01 W	GPS	2381	2381				23	1-6,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_2	P06	80	1	BUC	092403	0044	UN	32 29.63 S	116 39.00 W	GPS	2401	2400					1	15.8C
49MR03K04_2	P06	80	1	ROS	092403	0121	BO	32 29.42 S	116 39.01 W	GPS	2387	2382	14	2378	2391			
49MR03K04_2	P06	80	1	ROS	092403	0243	EN	32 28.77 S	116 39.08 W	GPS	2534	2552						

49MR03K04_2	P06	79	1	ROS	092403	0519	BE	32 29.43 S	116 0.68 W	GPS	3142	3142					26	1-8,23,24,26,27,46	#1=#27 DUPLICATE SMPLS (600DB)
49MR03K04_2	P06	79	1	BUC	092403	0523	UN	32 29.40 S	116 0.65 W	GPS	3128	3131						1	15.3C
49MR03K04_2	P06	79	1	ROS	092403	0612	BO	32 29.12 S	116 0.49 W	GPS	3123	3122	11	3124	3153				
49MR03K04_2	P06	79	1	ROS	092403	0754	EN	32 28.37 S	116 0.29 W	GPS	2970	2990							
49MR03K04_2	P06	78	1	ROS	092403	1033	BE	32 30.01 S	115 19.90 W	GPS	3230	3230					25	1-6	
49MR03K04_2	P06	78	1	BUC	092403	1039	UN	32 29.97 S	115 19.87 W	GPS	3230	3222						1	15.8C
49MR03K04_2	P06	78	1	ROS	092403	1127	BO	32 29.65 S	115 19.93 W	GPS	3219	3222	12	3232	3252				
49MR03K04_2	P06	78	1	ROS	092403	1310	EN	32 29.33 S	115 19.78 W	GPS	3212	3220							
49MR03K04_2	P06	78	1	FLT	092403	1318	DE	32 29.33 S	115 19.56 W	GPS	3231	3233							ARGO/SOLO#2208
49MR03K04_2	P06	77	1	ROS	092403	1547	BE	32 30.03 S	114 40.08 W	GPS	2933	2937					27	1-8,12,13,23,24,26,27,34,35,48	#1=#28 DUPLICATE SMPLS (500DB), 2 BTLS FOR BIO (5DB)
49MR03K04_2	P06	77	1	BUC	092403	1552	UN	32 30.00 S	114 40.04 W	GPS	2933	2938						1	16.4C
49MR03K04_2	P06	77	1	ROS	092403	1634	BO	32 29.87 S	114 39.87 W	GPS	2965	2967	8	2947	2973				
49MR03K04_2	P06	77	1	ROS	092403	1804	EN	32 29.58 S	114 39.52 W	GPS	3045	3046							
49MR03K04_2	P06	76	1	ROS	092403	2036	BE	32 30.20 S	113 59.77 W	GPS	2979	2980					36	1-6,9,22,34,35,47,48	2 BTLS FOR BIO (5DB), #1-7,9,10 FOR R.N.
49MR03K04_2	P06	76	1	BUC	092403	2041	UN	32 30.18 S	113 59.73 W	GPS	2955	2958						1	17.0C
49MR03K04_2	P06	76	1	ROS	092403	2125	BO	32 30.08 S	113 59.42 W	GPS	2978	2979	7	2979	3000				
49MR03K04_2	P06	76	1	UNK	092403	2126	UN	32 30.08 S	113 59.42 W	GPS	2975	2977						9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	76	1	ROS	092403	2307	EN	32 29.68 S	113 59.11 W	GPS	2972	2976							#8 DID NOT FIRE (OPERATION MISS)
49MR03K04_2	P06	75	1	ROS	092503	0139	BE	32 30.26 S	113 20.07 W	GPS	2837	2845					25	1-8,15,23,24,26,27,45,46	#1=#28 (500DB), #2=#15 (2600DB) DUPLICATE SMPLS
49MR03K04_2	P06	75	1	BUC	092503	0144	UN	32 30.20 S	113 20.06 W	GPS	2860	2862						1	17.4C
49MR03K04_2	P06	75	1	ROS	092503	0226	BO	32 29.91 S	113 19.95 W	GPS	2805	2803	12	2841	2850				
49MR03K04_2	P06	75	1	ROS	092503	0400	EN	32 29.11 S	113 19.64 W	GPS	2443	2437							
49MR03K04_2	P06	72	1	ROS	092503	0641	BE	32 29.87 S	112 40.26 W	GPS	2684	2678					22	1-6	
49MR03K04_2	P06	72	1	BUC	092503	0645	UN	32 29.77 S	112 40.29 W	GPS	2672	2675						1	16.7C
49MR03K04_2	P06	72	1	ROS	092503	0725	BO	32 29.52 S	112 40.17 W	GPS	2668	2669	30	2647	2657				LADCP SOUNDING
49MR03K04_2	P06	72	1	ROS	092503	0853	EN	32 29.00 S	112 40.14 W	GPS	2665	2669							
49MR03K04_2	P06	71	1	ROS	092503	1139	BE	32 29.95 S	112 0.00 W	GPS	2714	2711					25	1-8,12,13,23,24,26,27	#1=#30 (300DB), #2=#23 (1000DB) DUPLICATE SMPLS
49MR03K04_2	P06	71	1	BUC	092503	1152	UN	32 29.88 S	112 0.06 W	GPS	2714	2712						1	17.4C
49MR03K04_2	P06	71	1	ROS	092503	1227	BO	32 29.87 S	112 0.13 W	GPS	2720	2708	9	2696	2720				
49MR03K04_2	P06	71	1	UNK	092503	1239	UN	32 29.87 S	112 0.09 W	GPS	2715	2712						9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	71	1	ROS	092503	1353	EN	32 29.93 S	111 59.82 W	GPS	2724	2725							
49MR03K04_2	P06	71	1	FLT	092503	1400	DE	32 29.97 S	111 59.56 W	GPS	2720	2720							ARGO/APEX#938
49MR03K04_2	P06	70	1	ROS	092503	1628	BE	32 29.79 S	111 19.98 W	GPS	2499	2485					24	1-6,34,35,48	2 BTLS FOR BIO (5DB)
49MR03K04_2	P06	70	1	BUC	092503	1632	UN	32 29.82 S	111 20.01 W	GPS	2482	2477						1	17.6C
49MR03K04_2	P06	70	1	ROS	092503	1711	BO	32 29.88 S	111 19.99 W	GPS	2477	2476	12	2477	2500				
49MR03K04_2	P06	70	1	ROS	092503	1829	EN	32 29.72 S	111 19.94 W	GPS	2517	2512							17.4C
49MR03K04_2	P06	69	1	ROS	092503	2106	BE	32 29.87 S	110 40.08 W	GPS	3004	3003					28	1-8,23,24,26,27,34,35,46,48	#1=#29 (400DB), #2=#14 (2800DB) DUPLICATE SMPLS, 2 BTLS FOR BIO (10DB)
49MR03K04_2	P06	69	1	BUC	092503	2118	UN	32 29.73 S	110 40.11 W	GPS	3012	3011						1	17.5C
49MR03K04_2	P06	69	1	ROS	092503	2200	BO	32 29.31 S	110 40.07 W	GPS	3025	3026	8	3055	3051				
49MR03K04_2	P06	69	1	ROS	092503	2341	EN	32 28.93 S	110 40.75 W	GPS	3058	3058							
49MR03K04_2	P06	68	1	ROS	092603	0221	BE	32 30.07 S	109 59.98 W	GPS	2855	2855					23	1-6,11	
49MR03K04_2	P06	68	1	BUC	092603	0231	UN	32 30.16 S	110 0.07 W	GPS	2822	2831						1	17.7C
49MR03K04_2	P06	68	1	ROS	092603	0310	BO	32 30.39 S	110 0.38 W	GPS	2724	2740	22	2848	2813	2853			
49MR03K04_2	P06	68	1	ROS	092603	0440	EN	32 30.63 S	110 0.87 W	GPS	2669	2669							
49MR03K04_2	P06	67	1	ROS	092603	0718	BE	32 30.00 S	109 20.15 W	GPS	4479	4480					31	1-8,12,13,15,23,24,26,27,45	#1=#7 DUPLICATE SMPLS (B-10DB)
49MR03K04_2	P06	67	1	BUC	092603	0729	UN	32 29.96 S	109 20.17 W	GPS	4470	4478						1	16.8C

49MR03K04_2	P06	67	1	ROS	092603	0833	BO	32 29.75 S	109 20.42 W	GPS	4448	4456	9	4442	4498			
49MR03K04_2	P06	67	1	UNK	092603	0922	UN	32 29.47 S	109 20.61 W	GPS	4463	4461					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	67	1	ROS	092603	1054	EN	32 28.82 S	109 20.97 W	GPS	4480	4508						
49MR03K04_2	P06	67	1	FLT	092603	1103	DE	32 28.79 S	109 20.87 W	GPS	4496	4456						ARGO/SOLO#2209
49MR03K04_2	P06	66	1	ROS	092603	1801	BE	32 30.30 S	108 40.02 W	GPS	2906	2927				24	1-6	
49MR03K04_2	P06	66	1	BUC	092603	1819	UN	32 30.26 S	108 40.19 W	GPS	2867	2866					1,34,35,48	16.8C, 30L FOR BIO
49MR03K04_2	P06	66	1	UNK	092603	1856	BE	32 30.35 S	108 40.72 W	GPS	2850	2844						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	66	1	ROS	092603	1904	BO	32 30.29 S	108 40.74 W	GPS	2848	2848	10	2829	2823			
49MR03K04_2	P06	66	1	UNK	092603	1927	EN	32 30.10 S	108 40.88 W	GPS	2868	2879						
49MR03K04_2	P06	66	1	ROS	092603	2030	EN	32 29.81 S	108 41.32 W	GPS	2964	2983						
49MR03K04_2	P06	65	1	ROS	092603	2308	BE	32 29.99 S	108 0.15 W	GPS	3238	3221				26	1-8,23,24,26,27,34,35,46	#13=#36 DUPLICATE SMPLS (3000DB)
49MR03K04_2	P06	65	1	BUC	092603	2327	UN	32 30.24 S	108 0.34 W	GPS	3257	3255					1,34,35,48	17.1C
49MR03K04_2	P06	65	1	ROS	092703	0003	BO	32 30.31 S	108 0.61 W	GPS	3256	3255	9	3272	3290			
49MR03K04_2	P06	65	1	ROS	092703	0139	EN	32 30.54 S	108 1.12 W	GPS	3172	3182						
49MR03K04_2	P06	64	1	ROS	092703	0434	BE	32 29.98 S	107 19.86 W	GPS	3251	3250				25	1-6	
49MR03K04_2	P06	64	1	BUC	092703	0443	UN	32 29.99 S	107 19.85 W	GPS	3249	3247					1	17.1C
49MR03K04_2	P06	64	1	ROS	092703	0529	BO	32 30.00 S	107 19.80 W	GPS	3249	3249	13	3246	3280			
49MR03K04_2	P06	64	1	ROS	092703	0706	EN	32 29.98 S	107 19.47 W	GPS	3168	3166						
49MR03K04_2	P06	63	1	ROS	092703	0935	EN	32 30.03 S	106 39.98 W	GPS	3311	3306				27	1-8,12,13,23,24,26,27,	#12=#35 DUPLICATE SMPLS (3250DB)
49MR03K04_2	P06	63	1	BUC	092703	0946	UN	32 29.88 S	106 39.91 W	GPS	3305	3306					1	16.6C
49MR03K04_2	P06	63	1	ROS	092703	1033	BO	32 29.85 S	106 40.26 W	GPS	3309	3310	8	3318	3344			
49MR03K04_2	P06	63	1	ROS	092703	1211	EN	32 29.36 S	106 40.98 W	GPS	3323	3318						
49MR03K04_2	P06	62	1	ROS	092703	1449	BE	32 30.02 S	106 0.43 W	GPS	3397	3397				36	1-6,9,22,34,35,47,48	2 BTLS FOR BIO (10DB), #1-8 FOR R.N.
49MR03K04_2	P06	62	1	BUC	092703	1459	UN	32 29.98 S	106 0.51 W	GPS	3394	3390					1	17.1C
49MR03K04_2	P06	62	1	ROS	092703	1545	BO	32 29.96 S	106 0.99 W	GPS	3345	3345	11	3396	3402			
49MR03K04_2	P06	62	1	UNK	092703	1548	UN	32 29.96 S	106 1.02 W	GPS	3345	3344					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	62	1	ROS	092703	1723	EN	32 29.52 S	106 1.87 W	GPS	3263	3262						
49MR03K04_2	P06	62	1	FLT	092703	1729	DE	32 29.47 S	106 1.88 W	GPS	3257	3258						ARGO/APEX#940
49MR03K04_2	P06	61	1	ROS	092703	2014	BE	32 30.09 S	105 20.10 W	GPS	3271	3275				29	1-8,23,24,26,27,34,35,46,48	#12=#34 DUPLICATE SMPLS (3250DB), 2 BTLS FOR BIO (10DB)
49MR03K04_2	P06	61	1	BUC	092703	2020	UN	32 30.15 S	105 20.20 W	GPS	3294	3300					1	16.6C
49MR03K04_2	P06	61	1	ROS	092703	2109	BO	32 30.16 S	105 20.42 W	GPS	3359	3358	10	3306	3341			
49MR03K04_2	P06	61	1	ROS	092703	2255	EN	32 30.20 S	105 20.96 W	GPS	3558	3559						
49MR03K04_2	P06	60	1	ROS	092803	0203	BE	32 29.92 S	104 40.07 W	GPS	3499	3509				26	1-6	REMOVE SECONDARY DO SENSOR
49MR03K04_2	P06	60	1	BUC	092803	0213	UN	32 29.97 S	104 40.09 W	GPS	3493	3493					1	16.6C
49MR03K04_2	P06	60	1	ROS	092803	0302	BO	32 30.02 S	104 40.22 W	GPS	3507	3506	19	3494	3536			
49MR03K04_2	P06	60	1	ROS	092803	0445	EN	32 30.04 S	104 40.40 W	GPS	3504	3505						
49MR03K04_2	P06	59	1	ROS	092803	0713	BE	32 30.04 S	104 0.04 W	GPS	3043	3041				25	1-8,15,23,24,26,27,45	#33=#14 DUPLICATE SMPLS (2800DB)
49MR03K04_2	P06	59	1	BUC	092803	0725	UN	32 30.00 S	103 59.96 W	GPS	3044	3043					1	15.9C
49MR03K04_2	P06	59	1	ROS	092803	0801	BO	32 30.02 S	104 0.10 W	GPS	3018	3004	84	2986	3013			LADCP SOUNDING
49MR03K04_2	P06	59	1	ROS	092803	0948	EN	32 30.07 S	104 0.53 W	GPS	2950	2920						
49MR03K04_2	P06	X18	1	ROS	092803	1326	BE	32 29.93 S	102 59.82 W	GPS	3556	3557				30	1-8,12,13,23,24,26,27,34,35,46,48	#32=#11 DUPLICATE SMPLS (3500DB), 2 BTLS FOR BIO (10DB)
49MR03K04_2	P06	X18	1	BUC	092803	1338	UN	32 29.92 S	102 59.89 W	GPS	3566	3560					1	16.2C
49MR03K04_2	P06	X18	1	ROS	092803	1428	BO	32 29.93 S	103 0.26 W	GPS	3585	3590	13	3595	3618			
49MR03K04_2	P06	X18	1	UNK	092803	1433	UN	32 29.95 S	103 0.29 W	GPS	3589	3592					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	X18	1	ROS	092803	1613	EN	32 30.42 S	103 0.67 W	GPS	3622	3632						
49MR03K04_2	P06	X18	1	FLT	092803	1620	DE	32 30.14 S	103 0.54 W	GPS	3661	3633						ARGO/SOLO#2210
49MR03K04_2	P06	56	1	ROS	092803	1950	BE	32 30.14 S	101 59.97 W	GPS	3865	3865				30	1-6,34,35,48	2 BTLS FOR BIO (10DB)
49MR03K04_2	P06	56	1	BUC	092803	2001	UN	32 30.30 S	101 59.80 W	GPS	3857	3868					1	16.0C

49MR03K04_2	P06	56	1	UNK	092803	2044	BE	32 30.48 S	101 59.59 W	GPS	3873	3879						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	56	1	ROS	092803	2055	BO	32 30.52 S	101 59.53 W	GPS	3896	3898	13	3870	3904			
49MR03K04_2	P06	56	1	UNK	092803	2112	EN	32 30.66 S	101 59.33 W	GPS	3904	3903						
49MR03K04_2	P06	56	1	ROS	092803	2250	EN	32 31.27 S	101 58.40 W	GPS	3846	3839						
49MR03K04_2	P06	55	1	ROS	092903	0113	BE	32 30.25 S	101 19.83 W	GPS	3587	3587				28	1-8,12,13,23,24,26,27,33	#31=#1 DUPLICATE SMPLS (3500DB)
49MR03K04_2	P06	55	1	ROS	092903	0212	BO	32 30.70 S	101 19.26 W	GPS	3605	3601	15	3622	3620			
49MR03K04_2	P06	55	1	UNK	092903	0230	UN	32 30.83 S	101 19.25 W	GPS	3601	3594					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	55	1	ROS	092903	0359	EN	32 31.28 S	101 18.50 W	GPS	3568	3567						
49MR03K04_2	P06	54	1	ROS	093003	1157	BE	32 29.84 S	100 40.05 W	GPS	3528	3533				29	1-6,34,35,48	3 BTLS FOR BIO (10DB)
49MR03K04_2	P06	54	1	BUC	093003	1202	UN	32 29.80 S	100 40.03 W	GPS	3529	3530					1	16.7C
49MR03K04_2	P06	54	1	ROS	093003	1255	BO	32 29.65 S	100 40.01 W	GPS	3531	3531	9	3528	3572			
49MR03K04_2	P06	54	1	ROS	093003	1435	EN	32 29.51 S	100 39.74 W	GPS	3530	3531						
49MR03K04_2	P06	53	1	ROS	093003	1702	BE	32 29.80 S	99 59.89 W	GPS	3758	3754				30	1-8,23,24,26,27,34,35,46,48	#30=#11 DUPLICATE SMPLS (3500DB), 3 BTLS FOR BIO (10DB)
49MR03K04_2	P06	53	1	BUC	093003	1706	UN	32 29.82 S	99 59.92 W	GPS	3752	3753					1	16.7C
49MR03K04_2	P06	53	1	ROS	093003	1802	BO	32 30.16 S	100 0.18 W	GPS	3752	3752	10	3782	3797			
49MR03K04_2	P06	53	1	UNK	093003	1912	BE	32 30.64 S	100 0.25 W	GPS	3755	3754						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	53	1	UNK	093003	1940	EN	32 30.78 S	100 0.28 W	GPS	3754	3756						
49MR03K04_2	P06	53	1	ROS	093003	2001	EN	32 30.85 S	100 0.33 W	GPS	3755	3756						
49MR03K04_2	P06	53	1	FLT	093003	2007	DE	32 30.80 S	100 0.49 W	GPS	3756	3758						ARGO/APEX#940
49MR03K04_2	P06	52	1	ROS	093003	2231	BE	32 29.68 S	99 20.03 W	GPS	3995	3994				36	1-6,9,22,47	#1-8 FOR R.N.
49MR03K04_2	P06	52	1	BUC	093003	2237	UN	32 29.69 S	99 20.05 W	GPS	3988	3995					1	16.6C
49MR03K04_2	P06	52	1	ROS	093003	2333	BO	32 29.96 S	99 20.05 W	GPS	3999	3999	11	4007	4045			
49MR03K04_2	P06	52	1	UNK	093003	2338	UN	32 29.98 S	99 20.07 W	GPS	3996	3995					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	52	1	ROS	100103	0141	EN	32 30.57 S	99 20.33 W	GPS	4014	4013						
49MR03K04_2	P06	51	1	ROS	100103	0409	BE	32 30.03 S	98 40.00 W	GPS	3816	3815				29	1-8,12,13,15,23,24,26,27,45	#29=#12 DUPLICATE SMPLS (3500DB)
49MR03K04_2	P06	51	1	BUC	100103	0413	UN	32 30.04 S	98 39.98 W	GPS	3809	3813					1	16.4C
49MR03K04_2	P06	51	1	ROS	100103	0510	BO	32 30.49 S	98 39.84 W	GPS	3815	3816	20	3832	3846			
49MR03K04_2	P06	51	1	ROS	100103	0711	EN	32 31.01 S	98 39.78 W	GPS	3834	3828						
49MR03K04_2	P06	50	1	ROS	100103	0936	BE	32 30.17 S	97 59.99 W	GPS	2806	2793				23	1-6	
49MR03K04_2	P06	50	1	BUC	100103	0943	UN	32 30.17 S	97 59.97 W	GPS	2796	2805					1	16.9C
49MR03K04_2	P06	50	1	ROS	100103	1025	BO	32 30.18 S	98 0.14 W	GPS	2842	2837	3	2794	2820			
49MR03K04_2	P06	50	1	ROS	100103	1152	EN	32 30.60 S	97 59.98 W	GPS	2883	2874						
49MR03K04_2	P06	49	1	ROS	100103	1418	BE	32 29.80 S	97 20.06 W	GPS	3614	3615				28	1-8,23,24,26,27,34,35,46	#28=#11 DUPLICATE SMPLS (3500DB)
49MR03K04_2	P06	49	1	ROS	100103	1516	BO	32 29.97 S	97 20.12 W	GPS	3598	3595	10	3606	3649			
49MR03K04_2	P06	49	1	BUC	100103	1601	UN	32 29.95 S	97 20.19 W	GPS	3591	3591					1,34,35,48	16.9C
49MR03K04_2	P06	49	1	UNK	100103	1637	BE	32 30.06 S	97 20.13 W	GPS	3586	3592						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	49	1	ROS	100103	1702	EN	32 30.23 S	97 20.09 W	GPS	3600	3597						
49MR03K04_2	P06	49	1	FLT	100103	1707	DE	32 30.35 S	97 20.23 W	GPS	3589	3590						ARGO/SOLO#2211
49MR03K04_2	P06	49	1	UNK	100103	1713	EN	32 30.46 S	97 19.85 W	GPS	3637	3635						
49MR03K04_2	P06	48	1	ROS	100103	1935	BE	32 29.84 S	96 39.60 W	GPS	3871	3871				28	1-6,34,35	
49MR03K04_2	P06	48	1	UNK	100103	2022	BE	32 30.18 S	96 39.63 W	GPS	3875	3877						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	48	1	ROS	100103	2037	BO	32 30.30 S	96 39.67 W	GPS	3875	3877	13	3911	3924			
49MR03K04_2	P06	48	1	UNK	100103	2048	EN	32 30.38 S	96 39.71 W	GPS	3880	3882						
49MR03K04_2	P06	48	1	BUC	100103	2127	UN	32 30.74 S	96 39.88 W	GPS	3895	3896					1,34,35,48	16.9C
49MR03K04_2	P06	48	1	ROS	100103	2239	EN	32 31.27 S	96 39.93 W	GPS	3900	3900						
49MR03K04_2	P06	47	1	ROS	100203	0105	BE	32 29.81 S	95 59.90 W	GPS	3936	3927				29	1-8,12,13,23,24,26,27,33	#27=#10 DUPLICATE SMPLS (3750DB)
49MR03K04_2	P06	47	1	BUC	100203	0111	UN	32 29.84 S	95 59.90 W	GPS	3923	3922					1	16.4C
49MR03K04_2	P06	47	1	ROS	100203	0206	BO	32 30.00 S	95 59.74 W	GPS	3967	3966	12	3964	4012			
49MR03K04_2	P06	47	1	ROS	100203	0359	EN	32 30.33 S	95 59.23 W	GPS	3944	3943						

49MR03K04_2	P06	46	1	ROS	100203	0619	BE	32 30.05 S	95 20.08 W	GPS	3777	3775				36	1-6,9,22,47	#1-8,10 FOR R.N.
49MR03K04_2	P06	46	1	BUC	100203	0624	UN	32 30.07 S	95 20.06 W	GPS	3771	3775					1,33	16.2C
49MR03K04_2	P06	46	1	ROS	100203	0719	BO	32 30.44 S	95 19.89 W	GPS	3777	3778	12	3793	3820			
49MR03K04_2	P06	46	1	UNK	100203	0735	UN	32 30.50 S	95 19.84 W	GPS	3774	3774					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	46	1	ROS	100203	0912	EN	32 30.96 S	95 19.48 W	GPS	3750	3753						
49MR03K04_2	P06	45	1	ROS	100203	1135	BE	32 29.86 S	94 39.96 W	GPS	3810	3813				30	1-8,23,24,26,27,34,35,46,48	#11=#26 DUPLICATE SMPLS (3500DB), 2 BTLS FOR BIO
49MR03K04_2	P06	45	1	BUC	100203	1141	UN	32 29.87 S	94 39.91 W	GPS	3818	3814					1	16.1C
49MR03K04_2	P06	45	1	ROS	100203	1233	BO	32 29.93 S	94 39.70 W	GPS	3797	3786	8	3815	3858			
49MR03K04_2	P06	45	1	ROS	100203	1423	EN	32 29.99 S	94 39.15 W	GPS	3837	3839						
49MR03K04_2	P06	44	1	ROS	100203	1648	BE	32 30.22 S	93 59.90 W	GPS	3930	3933				31	1-6,34,35,48	3 BTLS FOR BIO (10DB)
49MR03K04_2	P06	44	1	BUC	100203	1657	UN	32 30.25 S	93 59.80 W	GPS	3935	3933					1	16.4C
49MR03K04_2	P06	44	1	ROS	100203	1754	BO	32 30.47 S	93 59.59 W	GPS	3933	3930	11	3939	3980			
49MR03K04_2	P06	44	1	UNK	100203	1817	BE	32 30.52 S	93 59.48 W	GPS	3934	3931						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	44	1	UNK	100203	1848	EN	32 30.62 S	93 59.42 W	GPS	3932	3932						
49MR03K04_2	P06	44	1	ROS	100203	1943	EN	32 30.84 S	93 59.24 W	GPS	3932	3931						
49MR03K04_2	P06	44	1	FLT	100203	1949	DE	32 30.94 S	93 59.28 W	GPS	3930	3932						ARGO/APEX#941
49MR03K04_2	P06	43	1	ROS	100203	2211	BE	32 30.15 S	93 20.23 W	GPS	2840	2837				24	1-8,12,13,23,24,26,27	#15=#25 DUPLICATE SMPLS (2600DB)
49MR03K04_2	P06	43	1	BUC	100203	2216	UN	32 30.21 S	93 20.18 W	GPS	2779	2793					1	16.6C
49MR03K04_2	P06	43	1	ROS	100203	2257	BO	32 30.44 S	93 19.89 W	GPS	2728	2714	7	2689	2690			
49MR03K04_2	P06	43	1	UNK	100203	2259	UN	32 30.46 S	93 19.88 W	GPS	2719	2728					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	43	2	UNK	100203	2336	BE	32 30.68 S	93 19.59 W	GPS	2813	2836						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	43	2	UNK	100203	2358	EN	32 30.83 S	93 19.40 W	GPS	2902	2896						
49MR03K04_2	P06	43	1	ROS	100303	0025	EN	32 31.07 S	93 19.16 W	GPS	2954	2954						
49MR03K04_2	P06	42	1	ROS	100303	0250	BE	32 30.26 S	92 40.11 W	GPS	4665	4668				32	1-8,15,23,24,26,27,33,45	#7=#24 DUPLICATE SMPLS (4500DB)
49MR03K04_2	P06	42	1	BUC	100303	0255	UN	32 30.27 S	92 40.03 W	GPS	4684	4673					1	15.8C
49MR03K04_2	P06	42	1	ROS	100303	0405	BO	32 30.60 S	92 39.84 W	GPS	4726	4732	11	4729	4788			
49MR03K04_2	P06	42	1	ROS	100303	0622	EN	32 30.89 S	92 39.56 W	GPS	4721	4696						
49MR03K04_2	P06	41	1	ROS	100303	0853	BE	32 30.00 S	91 59.81 W	GPS	3593	3590				27	1-8,23,24,26,27,46	#12=#23 DUPLICATE SMPLS (3250DB)
49MR03K04_2	P06	41	1	BUC	100303	0858	UN	32 30.00 S	91 59.74 W	GPS	3594	3587					1	15.5C
49MR03K04_2	P06	41	1	ROS	100303	0950	BO	32 30.21 S	91 59.52 W	GPS	3560	3559	10	3547	3585			
49MR03K04_2	P06	41	1	ROS	100303	1142	EN	32 30.62 S	91 59.54 W	GPS	3526	3528						
49MR03K04_2	P06	40	1	ROS	100303	1405	BE	32 30.08 S	91 19.78 W	GPS	3543	3544				26	1-6,11,34,35	#24 DID NOT TRIP
49MR03K04_2	P06	40	1	BUC	100303	1458	UN	32 30.58 S	91 19.48 W	GPS	3483	3489					1,34,35,48	16.0C, 20L FOR BIO
49MR03K04_2	P06	40	1	ROS	100303	1502	BO	32 30.62 S	91 19.47 W	GPS	3532	3531	10	3482	3476			
49MR03K04_2	P06	40	1	UNK	100303	1551	BE	32 30.98 S	91 19.07 W	GPS	3512	3524						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	40	1	UNK	100303	1625	EN	32 31.24 S	91 18.91 W	GPS	3484	3503						
49MR03K04_2	P06	40	1	ROS	100303	1645	EN	32 31.34 S	91 18.78 W	GPS	3504	3494						
49MR03K04_2	P06	40	1	FLT	100303	1650	DE	32 31.49 S	91 18.75 W	GPS	3477	3478						ARGO/SOLO#2212
49MR03K04_2	P06	39	1	ROS	100303	1909	BE	32 29.93 S	90 40.06 W	GPS	3713	3715				28	1-8,12,13,23,24,26,27	#11=#22 DUPLICATE SMPLS (3500DB)
49MR03K04_2	P06	39	1	UNK	100303	1923	BE	32 30.04 S	90 40.06 W	GPS	3703	3701						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	39	1	UNK	100303	1945	EN	32 30.21 S	90 39.97 W	GPS	3705	3698						
49MR03K04_2	P06	39	2	UNK	100303	1954	BE	32 30.29 S	90 40.00 W	GPS	3702	3703						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	39	2	UNK	100303	1957	EN	32 30.32 S	90 40.02 W	GPS	3702	3704						
49MR03K04_2	P06	39	1	ROS	100303	2009	BO	32 30.43 S	90 40.12 W	GPS	3700	3699	9	3733	3742			
49MR03K04_2	P06	39	3	UNK	100303	2015	UN	32 30.47 S	90 40.13 W	GPS	3693	3692					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	39	1	BUC	100303	2026	UN	32 30.55 S	90 40.18 W	GPS	3689	3690					1,34,35,48	16.7C
49MR03K04_2	P06	39	4	UNK	100303	2103	BE	32 30.84 S	90 40.21 W	GPS	3697	3691						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	39	4	UNK	100303	2111	EN	32 30.90 S	90 40.23 W	GPS	3689	3690						
49MR03K04_2	P06	39	5	UNK	100303	2116	BE	32 30.95 S	90 40.23 W	GPS	3693	3692						

49MR03K04_2	P06	39	5	UNK	100303	2142	EN	32 31.16 S	90 40.31 W	GPS	3677	3680						
49MR03K04_2	P06	39	1	ROS	100303	2214	EN	32 31.42 S	90 40.39 W	GPS	3676	3679						
49MR03K04_2	P06	38	1	ROS	100403	0042	BE	32 30.20 S	90 0.01 W	GPS	3687	3687				27	1-6	
49MR03K04_2	P06	38	1	BUC	100403	0049	UN	32 30.21 S	89 59.90 W	GPS	3685	3681					1	16.1C
49MR03K04_2	P06	38	1	ROS	100403	0140	BO	32 30.05 S	89 59.40 W	GPS	3682	3682	12	3685	3707			
49MR03K04_2	P06	38	1	ROS	100403	0341	EN	32 29.85 S	89 58.71 W	GPS	3734	3734						
49MR03K04_2	P06	37	1	ROS	100403	0603	BE	32 29.93 S	89 20.02 W	GPS	3464	3463				27	1-8,23,24,26,27,46	#12=#21 DUPLICATE SMPLS (3250DB)
49MR03K04_2	P06	37	1	BUC	100403	0613	UN	32 29.87 S	89 20.08 W	GPS	3472	3473					1	16.3C
49MR03K04_2	P06	37	1	ROS	100403	0702	BO	32 29.99 S	89 20.42 W	GPS	3409	3407	18	3432	3450			
49MR03K04_2	P06	37	1	ROS	100403	0911	EN	32 30.71 S	89 21.02 W	GPS	3237	3231						
49MR03K04_2	P06	36	1	ROS	100403	1139	BE	32 29.92 S	88 39.95 W	GPS	3879	3883				31	1-6,34,35,48	3 BTLS FOR BIO (5DB)
49MR03K04_2	P06	36	1	BUC	100403	1144	UN	32 29.93 S	88 39.97 W	GPS	3886	3877					1	16.3C
49MR03K04_2	P06	36	1	ROS	100403	1240	BO	32 30.16 S	88 40.10 W	GPS	3943	3942	10	3937	3979			
49MR03K04_2	P06	36	1	ROS	100403	1436	EN	32 30.46 S	88 40.39 W	GPS	3916	3916						
49MR03K04_2	P06	X19	1	ROS	100403	1704	BE	32 30.07 S	87 59.46 W	GPS	3730	3730				31	1-8,12,13,15,23,24,26,27,34,35,45,48	#11=#20 DUPLICATE SMPLS (3500DB), 2 BTLS FOR BIO (5DB)
49MR03K04_2	P06	X19	1	BUC	100403	1708	UN	32 30.07 S	87 59.46 W	GPS	3733	3732					1	16.5C
49MR03K04_2	P06	X19	1	UNK	100403	1751	BE	32 30.09 S	87 59.65 W	GPS	3741	3732						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	X19	1	ROS	100403	1804	BO	32 30.06 S	87 59.71 W	GPS	3731	3734	10	3728	3774			
49MR03K04_2	P06	X19	1	UNK	100403	1816	EN	32 30.04 S	87 59.78 W	GPS	3734	3730						
49MR03K04_2	P06	X19	1	ROS	100403	1951	EN	32 29.97 S	88 0.29 W	GPS	3719	3718						
49MR03K04_2	P06	34	1	ROS	100403	2213	BE	32 30.18 S	87 19.84 W	GPS	3833	3836				36	1-6,9,22,47	#1-8 FOR R.N.
49MR03K04_2	P06	34	1	BUC	100403	2218	UN	32 30.16 S	87 19.84 W	GPS	3827	3826					1	15.8C
49MR03K04_2	P06	34	1	ROS	100403	2313	BO	32 30.12 S	87 20.14 W	GPS	3819	3819	19	3817	3859			
49MR03K04_2	P06	34	1	UNK	100403	2321	UN	32 30.13 S	87 20.17 W	GPS	3823	3824					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	34	1	ROS	100503	0113	EN	32 30.27 S	87 20.78 W	GPS	3853	3851						
49MR03K04_2	P06	33	1	ROS	100503	0341	BE	32 29.84 S	86 39.94 W	GPS	3782	3777				28	1-8,23,24,26,27,33,46	#11=#19 DUPLICATE SMPLS (3500DB)
49MR03K04_2	P06	33	1	BUC	100503	0346	UN	32 29.83 S	86 39.97 W	GPS	3787	3782					1	15.7C
49MR03K04_2	P06	33	1	ROS	100503	0442	BO	32 29.82 S	86 40.34 W	GPS	3726	3727	10	3795	3827			
49MR03K04_2	P06	33	1	ROS	100503	0658	EN	32 30.01 S	86 41.28 W	GPS	3809	3806						
49MR03K04_2	P06	32	1	ROS	100503	0928	BE	32 29.81 S	86 0.11 W	GPS	3933	3935				28	1-6	
49MR03K04_2	P06	32	1	BUC	100503	0933	UN	32 29.87 S	86 0.13 W	GPS	3936	3936					1	15.8C
49MR03K04_2	P06	32	1	ROS	100503	1029	BO	32 29.93 S	86 0.40 W	GPS	3954	3969	11	3933	3979			
49MR03K04_2	P06	32	1	ROS	100503	1224	EN	32 29.98 S	86 0.89 W	GPS	3996	3994						
49MR03K04_2	P06	31	1	ROS	100503	1453	BE	32 29.83 S	85 19.99 W	GPS	3993	3999				29	1-8,12,13,23,24,26,27,34,35	#10=#18 DUPLICATE SMPLS (3750DB)
49MR03K04_2	P06	31	1	BUC	100503	1531	UN	32 29.93 S	85 20.20 W	GPS	4004	4005					1,34,35,48	16.4C
49MR03K04_2	P06	31	1	ROS	100503	1557	BO	32 29.98 S	85 20.34 W	GPS	4024	4010	12	4009	4053			
49MR03K04_2	P06	31	1	UNK	100503	1602	UN	32 29.99 S	85 20.36 W	GPS	4016	4016					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	31	2	UNK	100503	1700	BE	32 30.00 S	85 20.57 W	GPS	4025	4019						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	31	2	UNK	100503	1724	EN	32 30.04 S	85 20.67 W	GPS	4026	4027						
49MR03K04_2	P06	31	1	ROS	100503	1751	EN	32 30.03 S	85 20.77 W	GPS	4023	4027						
49MR03K04_2	P06	30	1	ROS	100503	2014	BE	32 29.82 S	84 40.12 W	GPS	3893	3892				28	1-6,34,35	
49MR03K04_2	P06	30	1	UNK	100503	2037	BE	32 29.92 S	84 40.21 W	GPS	3872	3871						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	30	1	UNK	100503	2103	EN	32 29.88 S	84 40.32 W	GPS	3879	3874						
49MR03K04_2	P06	30	1	ROS	100503	2113	BO	32 29.90 S	84 40.34 W	GPS	3863	3871	8	3872	3923			
49MR03K04_2	P06	30	1	BUC	100503	2128	UN	32 29.90 S	84 40.36 W	GPS	3868	3864					1,34,35,48	16.4C
49MR03K04_2	P06	30	1	ROS	100503	2306	EN	32 29.97 S	84 40.54 W	GPS	3812	3812						
49MR03K04_2	P06	29	1	ROS	100603	0134	BE	32 29.84 S	84 0.28 W	GPS	3796	3796				29	1-8,15,23,24,26,27,45,46	#10=#17 DUPLICATE SMPLS (3840DB)
49MR03K04_2	P06	29	1	BUC	100603	0140	UN	32 29.82 S	84 0.29 W	GPS	3794	3793					1	16.5C
49MR03K04_2	P06	29	1	ROS	100603	0235	BO	32 29.97 S	84 0.50 W	GPS	3793	3793	10	3801	3840			

49MR03K04_2	P06	29	1	ROS	100603	0428	EN	32 30.39 S	84 1.23 W	GPS	3803	3798						
49MR03K04_2	P06	28	1	ROS	100603	0702	BE	32 29.97 S	83 20.09 W	GPS	3816	3812				27	1-6	
49MR03K04_2	P06	28	1	BUC	100603	0707	UN	32 29.95 S	83 20.11 W	GPS	3814	3814					1	16.5C
49MR03K04_2	P06	28	1	ROS	100603	0802	BO	32 30.14 S	83 20.48 W	GPS	3824	3802	11	3844	3872			
49MR03K04_2	P06	28	1	ROS	100603	0947	EN	32 30.44 S	83 21.12 W	GPS	3698	3698						
49MR03K04_2	P06	27	1	ROS	100603	1217	BE	32 30.00 S	82 39.72 W	GPS	3903	3898				32	1-8,12,13,23,24,26,27,34,35,48	#10=#16 DUPLICATE SMPLS (3750DB), 2 BTLS FOR BIO
49MR03K04_2	P06	27	1	BUC	100603	1223	UN	32 30.03 S	82 39.72 W	GPS	3877	3881					1	16.8C
49MR03K04_2	P06	27	1	ROS	100603	1317	BO	32 30.27 S	82 40.03 W	GPS	3921	3922	10	3901	3934			
49MR03K04_2	P06	27	1	ROS	100603	1510	EN	32 30.80 S	82 40.42 W	GPS	3982	3982						
49MR03K04_2	P06	26	1	ROS	100603	1734	BE	32 29.57 S	81 59.82 W	GPS	4010	4010				36	1-6,9,22,34,35,47	#1-8 FOR R.N.
49MR03K04_2	P06	26	1	ROS	100603	1837	BO	32 29.84 S	81 59.94 W	GPS	3994	3994	8	4024	4057			
49MR03K04_2	P06	26	1	UNK	100603	1843	UN	32 29.86 S	81 59.96 W	GPS	4000	3995					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	26	1	BUC	100603	1957	UN	32 30.33 S	81 59.91 W	GPS	3982	3983					1,34,35,48	16.7C
49MR03K04_2	P06	26	1	ROS	100603	2025	EN	32 30.56 S	81 59.80 W	GPS	3984	3995						
49MR03K04_2	P06	25	1	ROS	100603	2245	BE	32 29.92 S	81 19.56 W	GPS	3922	3922				29	1-8,23,24,26,27,33,46	#10=#15 DUPLICATE SMPLS (3750DB)
49MR03K04_2	P06	25	1	BUC	100603	2251	UN	32 29.97 S	81 19.43 W	GPS	3934	3907					1	16.2C
49MR03K04_2	P06	25	1	ROS	100603	2348	BO	32 30.13 S	81 19.46 W	GPS	3918	3913	13	3904	3956			
49MR03K04_2	P06	25	1	ROS	100703	0148	EN	32 30.33 S	81 19.37 W	GPS	3933	3925						
49MR03K04_2	P06	24	1	ROS	100703	0412	BE	32 30.08 S	80 39.87 W	GPS	3939	3941				29	1-6	#7 FOR SAL (2000DB)
49MR03K04_2	P06	24	1	BUC	100703	0416	UN	32 30.09 S	80 39.83 W	GPS	3941	3939					1	
49MR03K04_2	P06	24	1	ROS	100703	0516	BO	32 30.43 S	80 39.84 W	GPS	3948	3945	12	3963	3985			16.0C
49MR03K04_2	P06	24	1	ROS	100703	0709	EN	32 30.92 S	80 39.93 W	GPS	3949	3952						
49MR03K04_2	P06	23	1	ROS	100803	1000	BE	32 30.14 S	79 59.72 W	GPS	2808	2804				27	1-8,12,13,23,24,26,27,34,35,48	#1=#14 DUPLICATE SMPLS (B-10DB), 3 BTLS FOR BIO
49MR03K04_2	P06	23	1	BUC	100803	1013	UN	32 30.25 S	79 59.69 W	GPS	2821	2823					1	15.9C
49MR03K04_2	P06	23	1	ROS	100803	1053	BO	32 30.46 S	79 59.59 W	GPS	2728	2732	9	2788	2811			
49MR03K04_2	P06	23	1	UNK	100803	1054	UN	32 30.46 S	79 59.59 W	GPS	2765	2765					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	23	1	ROS	100803	1221	EN	32 30.83 S	79 59.13 W	GPS	2481	2491						
49MR03K04_2	P06	22	1	ROS	100803	1454	BE	32 29.86 S	79 19.93 W	GPS	3769	3771				31	1-6,34,35,48	#7=#18 DUPLICATE SMPLS (2000DB) FOR SAL AND OXY, 3 BTLS FOR BIO (10DB)
49MR03K04_2	P06	22	1	BUC	100803	1503	UN	32 29.87 S	79 19.82 W	GPS	3769	3767						16.0C
49MR03K04_2	P06	22	1	ROS	100803	1556	BO	32 30.02 S	79 19.42 W	GPS	3762	3762	10	3786	3807			
49MR03K04_2	P06	22	1	UNK	100803	1618	BE	32 30.07 S	79 19.24 W	GPS	3760	3760						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	22	1	UNK	100803	1649	EN	32 30.17 S	79 19.01 W	GPS	3741	3743						
49MR03K04_2	P06	22	1	ROS	100803	1744	EN	32 30.39 S	79 18.67 W	GPS	3772	3773						
49MR03K04_2	P06	21	1	UNK	100803	2006	BE	32 30.49 S	78 39.43 W	GPS	4054	4054						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	21	1	ROS	100803	2008	BE	32 30.50 S	78 39.41 W	GPS	4053	4057				29	1-8,15,23,24,26,27,33,45	#10=#13 DUPLICATE SMPLS (3750DB)
49MR03K04_2	P06	21	1	BUC	100803	2013	UN	32 30.47 S	78 39.33 W	GPS	4057	4057					1	16.2C
49MR03K04_2	P06	21	1	UNK	100803	2039	EN	32 30.47 S	78 39.18 W	GPS	4059	4059						
49MR03K04_2	P06	21	1	ROS	100803	2112	BO	32 30.59 S	78 39.10 W	GPS	4070	4066	10	4061	4106			
49MR03K04_2	P06	21	1	ROS	100803	2313	EN	32 30.79 S	78 38.86 W	GPS	4073	4077						
49MR03K04_2	P06	20	1	ROS	100903	0134	BE	32 30.15 S	78 0.18 W	GPS	4006	4006				29	1-6	#7 FOR SAL (2000DB)
49MR03K04_2	P06	20	1	BUC	100903	0140	UN	32 30.11 S	78 0.10 W	GPS	4009	4008					1	15.9C
49MR03K04_2	P06	20	1	ROS	100903	0241	BO	32 30.06 S	77 59.51 W	GPS	4062	4062	12	4073	4090			
49MR03K04_2	P06	20	1	ROS	100903	0439	EN	32 29.92 S	77 59.00 W	GPS	4062	4062						
49MR03K04_2	P06	19	1	ROS	100903	0713	BE	32 29.82 S	77 19.49 W	GPS	3567	3570				27	1-8,12,13,23,24,26,27	#1=#12 DUPLICATE SMPLS (3250DB)
49MR03K04_2	P06	19	1	BUC	100903	0719	UN	32 29.84 S	77 19.46 W	GPS	3567	3566					1	15.6C
49MR03K04_2	P06	19	1	ROS	100903	0811	BO	32 29.85 S	77 19.28 W	GPS	3579	3580	11	3567	3608			
49MR03K04_2	P06	19	1	ROS	100903	1001	EN	32 29.43 S	77 18.80 W	GPS	3633	3633						

49MR03K04_2	P06	18	1	ROS	100903	1225	BE	32 30.12 S	76 39.94 W	GPS	4280	4284				36	1-6,9,22,34,35,47	#1-7 FOR R.N.
49MR03K04_2	P06	18	1	ROS	100903	1333	BO	32 29.88 S	76 39.23 W	GPS	4265	4266	10	4328	4333			
49MR03K04_2	P06	18	1	UNK	100903	1335	UN	32 29.89 S	76 39.20 W	GPS	4263	4263					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	18	1	BUC	100903	1356	UN	32 29.89 S	76 39.19 W	GPS	4260	4266					1,34,35,48	15.6C
49MR03K04_2	P06	18	2	UNK	100903	1453	BE	32 29.89 S	76 38.46 W	GPS	4130	4104						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	18	2	UNK	100903	1519	EN	32 29.99 S	76 38.23 W	GPS	4114	4115						
49MR03K04_2	P06	18	1	ROS	100903	1541	EN	32 29.91 S	76 37.93 W	GPS	3997	3978						
49MR03K04_2	P06	17	1	ROS	100903	1802	BE	32 29.98 S	76 0.05 W	GPS	4193	4193				30	1-8,23,24,26,27,33-35,46	#9=#11 DUPLICATE SMPLS (4000DB)
49MR03K04_2	P06	17	1	UNK	100903	1821	BE	32 29.98 S	75 59.80 W	GPS	4201	4201						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	17	1	UNK	100903	1852	EN	32 29.93 S	75 59.61 W	GPS	4216	4213						
49MR03K04_2	P06	17	1	ROS	100903	1906	BO	32 29.88 S	75 59.54 W	GPS	4219	4221	10	4208	4252			
49MR03K04_2	P06	17	1	BUC	100903	1928	UN	32 29.82 S	75 59.43 W	GPS	4226	4229					1,34,35,48	15.6C, 30L FOR BIO
49MR03K04_2	P06	17	1	ROS	100903	2122	EN	32 29.52 S	75 58.08 W	GPS	4265	4273						
49MR03K04_2	P06	16	1	ROS	100903	2343	BE	32 29.84 S	75 19.93 W	GPS	4246	4253				30	1-6	#7 FOR SAL (2000DB)
49MR03K04_2	P06	16	1	BUC	100903	2350	UN	32 29.76 S	75 19.88 W	GPS	4257	4269					1	14.9C
49MR03K04_2	P06	16	1	ROS	101003	0052	BO	32 29.58 S	75 19.42 W	GPS	4265	4261	11	4296	4325			
49MR03K04_2	P06	16	1	ROS	101003	0301	EN	32 29.47 S	75 18.23 W	GPS	4221	4222						
49MR03K04_2	P06	15	1	ROS	101003	0527	BE	32 29.90 S	74 40.34 W	GPS	4048	4055				29	1-8,12,13,15,23,24,26,27,45	#1=#10 DUPLICATE SMPLS (3750DB)
49MR03K04_2	P06	15	1	BUC	101003	0533	UN	32 29.92 S	74 40.33 W	GPS	4030	4033					1	14.4C
49MR03K04_2	P06	15	1	ROS	101003	0629	BO	32 30.00 S	74 39.86 W	GPS	3838	3840	144	3857	3885			LADCP SOUNDING
49MR03K04_2	P06	15	1	UNK	101003	0645	UN	32 30.01 S	74 39.74 W	GPS	3759	3779					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	15	1	ROS	101003	0833	EN	32 29.96 S	74 38.90 W	GPS	3568	3588						
49MR03K04_2	P06	14	1	ROS	101003	1101	BE	32 29.75 S	73 59.93 W	GPS	4100	4101				33	1-6,34,35,48	#7=#18 DUPLICATE SMPLS (2000DB) FOR SAL AND OXY, 3 BTLS FOR BIO (10DB)
49MR03K04_2	P06	14	1	BUC	101003	1107	UN	32 29.73 S	73 59.90 W	GPS	4105	4103					1	14.0C
49MR03K04_2	P06	14	1	ROS	101003	1204	BO	32 29.73 S	73 59.74 W	GPS	4106	4103	10	4101	4150			
49MR03K04_2	P06	14	1	ROS	101003	1404	EN	32 29.75 S	73 59.02 W	GPS	4107	4103						
49MR03K04_2	P06	13	1	ROS	101003	1628	BE	32 29.96 S	73 20.09 W	GPS	3858	3860				32	1-8,12,13,23,24,26,27,33-35,46,48	3 BTLS FOR BIO (10DB)
49MR03K04_2	P06	13	1	BUC	101003	1633	UN	32 29.99 S	73 20.04 W	GPS	3864	3859					1	13.8C
49MR03K04_2	P06	13	1	ROS	101003	1728	BO	32 30.29 S	73 19.72 W	GPS	3839	3837	7	3871	3887			
49MR03K04_2	P06	13	1	UNK	101003	1814	BE	32 30.42 S	73 19.42 W	GPS	3772	3769						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	13	1	UNK	101003	1843	EN	32 30.41 S	73 19.30 W	GPS	3770	3773						
49MR03K04_2	P06	13	1	ROS	101003	1924	EN	32 30.50 S	73 19.11 W	GPS	3881	3892						
49MR03K04_2	P06	12	1	ROS	101003	2127	BE	32 30.19 S	72 59.76 W	GPS	4658	4655				32	1-6	#5 FOR SAL (2000DB)
49MR03K04_2	P06	12	1	BUC	101003	2130	UN	32 30.21 S	72 59.75 W	GPS	4655	4658					1	14.0C
49MR03K04_2	P06	12	1	UNK	101003	2156	BE	32 30.29 S	72 59.78 W	GPS	4656	4659						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	12	1	UNK	101003	2203	EN	32 30.28 S	72 59.77 W	GPS	4657	4659						
49MR03K04_2	P06	12	1	ROS	101003	2238	BO	32 30.35 S	72 59.69 W	GPS	4658	4658	11	4654	4717			
49MR03K04_2	P06	12	1	ROS	101103	0057	EN	32 30.55 S	73 0.10 W	GPS	4645	4640						
49MR03K04_2	P06	11	1	ROS	101103	0303	BE	32 29.68 S	72 42.92 W	GPS	5946	5949				36	1-8,12,13,15,23,24,26,27,45,46	
49MR03K04_2	P06	11	1	BUC	101103	0308	UN	32 29.66 S	72 42.89 W	GPS	5948	5951					1	13.5C
49MR03K04_2	P06	11	1	ROS	101103	0435	BO	32 29.65 S	72 42.63 W	GPS	5952	5952	12	5956	6054			
49MR03K04_2	P06	11	1	ROS	101103	0727	EN	32 29.47 S	72 42.16 W	GPS	5961	5961						
49MR03K04_2	P06	10	1	ROS	101103	0930	BE	32 29.83 S	72 29.57 W	GPS	4666	4666				36	1-6,9,22,47	#1-5 FOR R.N.
49MR03K04_2	P06	10	1	BUC	101103	0935	UN	32 29.83 S	72 29.55 W	GPS	4666	4664					1	13.5C
49MR03K04_2	P06	10	1	ROS	101103	1039	BO	32 29.79 S	72 29.25 W	GPS	4622	4617	10	4669	4721			
49MR03K04_2	P06	10	1	UNK	101103	1043	UN	32 29.79 S	72 29.23 W	GPS	4619	4621					9,22,47	86L THROUGH HULL PUMP FOR R.N.
49MR03K04_2	P06	10	1	ROS	101103	1302	EN	32 29.74 S	72 27.98 W	GPS	4161	4165						
49MR03K04_2	P06	9	1	ROS	101103	1459	BE	32 28.77 S	72 19.78 W	GPS	2970	2964				26	1-8,23,24,26,27,34,35	#7=#14 DUPLICATE SMPLS (2800DB)
49MR03K04_2	P06	9	1	BUC	101103	1504	UN	32 28.77 S	72 19.73 W	GPS	2947	2938					1,34,35,48	13.8C, 30L FOR BIO

49MR03K04_2	P06	9	1	UNK	101103	1549	BE	32 28.85 S	72 19.46 W	GPS	2824	2815						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	9	1	ROS	101103	1551	BO	32 28.85 S	72 19.44 W	GPS	2819	2808	7	2883	2907			
49MR03K04_2	P06	9	1	UNK	101103	1626	EN	32 28.82 S	72 19.27 W	GPS	2737	2731						
49MR03K04_2	P06	9	1	ROS	101103	1720	EN	32 28.86 S	72 19.07 W	GPS	2616	2619						
49MR03K04_2	P06	8	1	ROS	101103	1925	BE	32 29.81 S	72 10.27 W	GPS	2176	2178				20	1-6	
49MR03K04_2	P06	8	1	UNK	101103	1927	BE	32 29.79 S	72 10.24 W	GPS	2168	2170						SOLAR LIGHT MEASUREMENT
49MR03K04_2	P06	8	1	UNK	101103	1942	EN	32 29.83 S	72 10.23 W	GPS	2159	2155						
49MR03K04_2	P06	8	1	ROS	101103	2002	BO	32 29.83 S	72 10.21 W	GPS	2157	2148	10	2164	2179			
49MR03K04_2	P06	8	1	BUC	101103	2014	UN	32 29.82 S	72 10.19 W	GPS	2139	2136					1,34,35,48	13.9C, 30L FOR BIO
49MR03K04_2	P06	8	1	ROS	101103	2119	EN	32 29.69 S	72 10.04 W	GPS	2090	2095						
49MR03K04_2	P06	7	1	ROS	101103	2321	BE	32 29.45 S	71 59.90 W	GPS	2435	2438				22	1-8,23,24,26,27	
49MR03K04_2	P06	7	1	BUC	101103	2327	UN	32 29.47 S	71 59.88 W	GPS	2437	2440					1	13.6C
49MR03K04_2	P06	7	1	ROS	101203	0001	BO	32 29.58 S	71 59.81 W	GPS	2439	2440	10	2438	2453			
49MR03K04_2	P06	7	1	ROS	101203	0124	EN	32 29.73 S	71 59.30 W	GPS	2447	2448						
49MR03K04_2	P06	6	1	ROS	101203	0322	BE	32 29.95 S	71 50.19 W	GPS	2034	2035				20	1-6,33	
49MR03K04_2	P06	6	1	ROS	101203	0402	BO	32 29.98 S	71 50.06 W	GPS	2023	2024	13	2020	2030			
49MR03K04_2	P06	6	1	ROS	101203	0511	EN	32 30.07 S	71 49.83 W	GPS	2004	2006						
49MR03K04_2	P06	5	1	ROS	101203	0622	BE	32 30.04 S	71 40.36 W	GPS	515	516				10	1-6,33,34,35	#1 FOR BIO (5DB)
49MR03K04_2	P06	5	1	ROS	101203	0637	BO	32 30.00 S	71 40.29 W	GPS	507	508	11	498	498			
49MR03K04_2	P06	5	1	ROS	101203	0701	EN	32 30.00 S	71 40.20 W	GPS	499	500						
49MR03K04_2	P06	4	1	ROS	101203	0759	BE	32 29.96 S	71 30.08 W	GPS	123	123				3	1-6,33	
49MR03K04_2	P06	4	1	ROS	101203	0806	BO	32 30.02 S	71 30.02 W	GPS	123	122	11	105	107			
49MR03K04_2	P06	4	1	ROS	101203	0814	EN	32 30.05 S	71 29.94 W	GPS	122	122						

A10 REV R/V MIRAI CRUISE MR03K04 LEG4

SHIP/CRS EXPOCODE	WOCE SECT	STNNBR	CASTNO	CAST TYPE	DATE	UTC TIME	EVENT CODE	POSITION LATITUDE	LONGITUDE	NAV	UNC DEPTH	COR DEPTH	HT ABOVE BOTTOM	WIRE OUT	MAX PRESS	NO. OF BOTTLES	PARAMETERS	COMMENTS
49MR03K04_4	A10	622	1	ROS	110703	1055	BE	27 43.90 S	47 23.27 W	GPS	182	181				5	1-6	
49MR03K04_4	A10	622	1	BUC	110703	1055	UN	27 43.90 S	47 23.27 W	GPS	182	181					1	21.9C
49MR03K04_4	A10	622	1	ROS	110703	1102	BO	27 43.91 S	47 23.39 W	GPS	182	181	11	166	168			
49MR03K04_4	A10	622	1	ROS	110703	1121	EN	27 43.97 S	47 23.68 W	GPS	179	179						
49MR03K04_4	A10	623	1	ROS	110703	1256	BE	27 46.11 S	47 12.20 W	GPS	334	334				9	1-6,34,35,48	#18 FOR BIO (5DB)
49MR03K04_4	A10	623	1	BUC	110703	1257	UN	27 46.11 S	47 12.20 W	GPS	334	334					1,34,35,48	21.8C, 18L FOR BIO
49MR03K04_4	A10	623	1	ROS	110703	1306	BO	27 46.11 S	47 12.23 W	GPS	334	333	10	318	322			
49MR03K04_4	A10	623	1	ROS	110703	1335	EN	27 46.03 S	47 12.58 W	GPS	323	323						
49MR03K04_4	A10	624	1	ROS	110703	1458	BE	27 48.92 S	47 1.44 W	GPS	540	539				10	1-6	
49MR03K04_4	A10	624	1	BUC	110703	1504	UN	27 48.91 S	47 1.48 W	GPS	540	539					1	22.2C
49MR03K04_4	A10	624	1	ROS	110703	1512	BO	27 48.88 S	47 1.53 W	GPS	539	538	10	530	531			
49MR03K04_4	A10	624	1	ROS	110703	1542	EN	27 48.79 S	47 1.62 W	GPS	538	537						
49MR03K04_4	A10	625	1	ROS	110703	1704	BE	27 51.41 S	46 50.88 W	GPS	760	760				13	1-8,23,24,26,27	#23=#26 DUPLICATE SMPLS (700DB)
49MR03K04_4	A10	625	1	BUC	110703	1710	UN	27 51.34 S	46 50.89 W	GPS	761	760					1	22.1C
49MR03K04_4	A10	625	1	ROS	110703	1721	BO	27 51.25 S	46 50.94 W	GPS	760	761	9	752	752			
49MR03K04_4	A10	625	1	ROS	110703	1758	EN	27 50.97 S	46 51.12 W	GPS	757	757						
49MR03K04_4	A10	626	1	ROS	110703	2001	BE	27 54.45 S	46 39.94 W	GPS	1257	1257				16	1-6,34,35,48	#2 FOR BIO (75DB)
49MR03K04_4	A10	626	1	BUC	110703	2007	UN	27 54.42 S	46 39.93 W	GPS	1258	1258					1,34,35,48	22.0C, 18L FOR BIO
49MR03K04_4	A10	626	1	ROS	110703	2026	BO	27 54.35 S	46 39.96 W	GPS	1258	1257	12	1238	1251			#24 MISS FIRE
49MR03K04_4	A10	626	1	ROS	110703	2126	EN	27 53.78 S	46 40.35 W	GPS	1245	1245						
49MR03K04_4	A10	627	1	ROS	110703	2259	BE	27 57.11 S	46 29.28 W	GPS	1686	1686				19	1-8,23,24,26,27	#20=#22 DUPLICATE SMPLS (1600DB)
49MR03K04_4	A10	627	1	BUC	110703	2304	UN	27 57.10 S	46 29.28 W	GPS	1687	1687					1	22.1C
49MR03K04_4	A10	627	1	ROS	110703	2329	BO	27 57.02 S	46 29.32 W	GPS	1683	1684	11	1678	1687			
49MR03K04_4	A10	627	1	ROS	110803	0041	EN	27 56.97 S	46 29.56 W	GPS	1676	1674						
49MR03K04_4	A10	628	1	ROS	110803	0213	BE	27 59.86 S	46 18.55 W	GPS	2222	2220				20	1-6	
49MR03K04_4	A10	628	1	BUC	110803	0219	UN	27 59.85 S	46 18.57 W	GPS	2220	2221					1	22.1C
49MR03K04_4	A10	628	1	ROS	110803	0251	BO	27 59.86 S	46 18.60 W	GPS	2218	2218	12	2212	2230			
49MR03K04_4	A10	628	1	ROS	110803	0414	EN	28 0.13 S	46 18.63 W	GPS	2222	2222						
49MR03K04_4	A10	629	1	ROS	110803	0527	BE	28 2.69 S	46 7.56 W	GPS	2415	2415				22	1-8,12,13,23,24,26,27,46	#17=#21 DUPLICATE SMPLS (2200DB)
49MR03K04_4	A10	629	1	BUC	110803	0532	UN	28 2.71 S	46 7.55 W	GPS	2416	2417					1	22.0C
49MR03K04_4	A10	629	1	ROS	110803	0607	BO	28 2.85 S	46 7.60 W	GPS	2414	2415	11	2411	2430			
49MR03K04_4	A10	629	1	ROS	110803	0736	EN	28 3.01 S	46 7.86 W	GPS	2417	2415						
49MR03K04_4	A10	630	1	ROS	110803	0906	BE	28 5.46 S	45 56.67 W	GPS	2599	2599				22	1-6	
49MR03K04_4	A10	630	1	BUC	110803	0911	UN	28 5.48 S	45 56.74 W	GPS	2597	2598					1	22.1C
49MR03K04_4	A10	630	1	ROS	110803	0950	BO	28 5.62 S	45 56.93 W	GPS	2595	2596	13	2591	2613			
49MR03K04_4	A10	630	1	ROS	110803	1122	EN	28 6.06 S	45 57.39 W	GPS	2586	2586						
49MR03K04_4	A10	631	1	ROS	110803	1247	BE	28 9.56 S	45 40.66 W	GPS	2788	2790				25	1-8,23,24,26,27,34,35,48	#15=#20 DUPLICATE SMPLS (2600DB), #2 FOR BIO (70DB)
49MR03K04_4	A10	631	1	BUC	110803	1252	UN	28 9.54 S	45 40.66 W	GPS	2788	2790					1,34,35,48	22.9C, 18L FOR BIO
49MR03K04_4	A10	631	1	ROS	110803	1332	BO	28 9.59 S	45 40.90 W	GPS	2786	2787	12	2786	2809			
49MR03K04_4	A10	631	1	UNK	110803	1337	BE	28 9.59 S	45 40.91 W	GPS	2787	2787						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	631	1	UNK	110803	1437	EN	28 9.64 S	45 41.05 W	GPS	2779	2778						
49MR03K04_4	A10	631	1	ROS	110803	1517	EN	28 9.66 S	45 41.09 W	GPS	2778	2779						
49MR03K04_4	A10	632	1	ROS	110803	1701	BE	28 13.60 S	45 24.44 W	GPS	2967	2968				27	1-6,34,35,48	#1-3 FOR BIO (5DB, 100DB)
49MR03K04_4	A10	632	1	BUC	110803	1706	UN	28 13.55 S	45 24.44 W	GPS	2966	2968					1	22.8C
49MR03K04_4	A10	632	1	UNK	110803	1706	BE	28 13.55 S	45 24.44 W	GPS	2966	2968						SOLAR LIGHT MEASUREMENT

49MR03K04_4	A10	632	1	ROS	110803	1749	BO	28 13.54 S	45 24.50 W	GPS	2966	2964	10	2964	2992			
49MR03K04_4	A10	632	1	UNK	110803	1751	EN	28 13.54 S	45 24.50 W	GPS	2965	2966						
49MR03K04_4	A10	632	1	ROS	110803	1943	EN	28 13.37 S	45 24.35 W	GPS	2975	2975						
49MR03K04_4	A10	1	1	ROS	110803	2227	BE	28 25.25 S	44 47.03 W	GPS	3525	3518				27	1-8,23,24,26,27,46	#12=#19 DUPLICATE SMPLS (3250DB)
49MR03K04_4	A10	1	1	BUC	110803	2232	UN	28 25.24 S	44 47.09 W	GPS	3519	3516					1	22.4C
49MR03K04_4	A10	1	1	ROS	110803	2324	BO	28 25.21 S	44 47.27 W	GPS	3509	3505	10	3495	3540			
49MR03K04_4	A10	1	1	ROS	110903	0128	EN	28 24.80 S	44 48.10 W	GPS	3488	3490						
49MR03K04_4	A10	2	1	ROS	110903	0405	BE	28 36.95 S	44 13.10 W	GPS	3702	3697				27	1-6	
49MR03K04_4	A10	2	1	BUC	110903	0411	UN	28 36.90 S	44 13.11 W	GPS	3698	3700					1	22.3C
49MR03K04_4	A10	2	1	ROS	110903	0503	BO	28 36.64 S	44 13.37 W	GPS	3707	3706	12	3729	3738			
49MR03K04_4	A10	2	1	ROS	110903	0702	EN	28 35.85 S	44 13.59 W	GPS	3706	3706						
49MR03K04_4	A10	3	1	ROS	110903	0944	BE	28 50.10 S	43 34.91 W	GPS	3906	3904				32	1-8,12,13,23,24,26,27,34,35,48	#10=#18 DUPLICATE SMPLS (3750DB), #2-4 FOR BIO (107DB, 5DB)
49MR03K04_4	A10	3	1	BUC	110903	0950	UN	28 50.11 S	43 34.98 W	GPS	3904	3904					1	20.7C
49MR03K04_4	A10	3	1	ROS	110903	1043	BO	28 50.03 S	43 35.24 W	GPS	3890	3891	13	3887	3934			
49MR03K04_4	A10	3	1	UNK	110903	1155	BE	28 49.87 S	43 35.50 W	GPS	3886	3887						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	3	1	ROS	110903	1248	EN	28 49.75 S	43 35.76 W	GPS	3892	3891						
49MR03K04_4	A10	3	1	UNK	110903	1251	EN	28 49.73 S	43 35.77 W	GPS	3895	3892						
49MR03K04_4	A10	4	1	ROS	110903	1535	BE	29 2.16 S	42 54.48 W	GPS	4010	4015				31	1-6,34,35,48	#1-3 FOR BIO (130DB, 5DB)
49MR03K04_4	A10	4	1	BUC	110903	1540	UN	29 2.16 S	42 54.52 W	GPS	4011	4016					1	20.6C
49MR03K04_4	A10	4	1	UNK	110903	1620	BE	29 2.14 S	42 54.63 W	GPS	4015	4016						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	4	1	ROS	110903	1637	BO	29 2.08 S	42 54.59 W	GPS	4013	4014	13	4006	4059			
49MR03K04_4	A10	4	1	UNK	110903	1657	EN	29 2.06 S	42 54.67 W	GPS	4012	4014						
49MR03K04_4	A10	4	1	ROS	110903	1838	EN	29 2.06 S	42 55.07 W	GPS	4016	4015						
49MR03K04_4	A10	5	1	ROS	110903	2106	BE	29 13.91 S	42 19.52 W	GPS	4006	4007				29	1-8,23,24,26,27,46	#10=#17 DUPLICATE SMPLS (3750DB)
49MR03K04_4	A10	5	1	BUC	110903	2112	UN	29 13.84 S	42 19.50 W	GPS	4006	4007					1	20.7C
49MR03K04_4	A10	5	1	ROS	110903	2221	BO	29 13.69 S	42 19.45 W	GPS	4006	4006	10	4004	4053			
49MR03K04_4	A10	5	1	ROS	111003	0034	EN	29 13.23 S	42 19.54 W	GPS	4008	4008						
49MR03K04_4	A10	6	1	ROS	111003	0301	BE	29 25.34 S	41 44.38 W	GPS	3880	3874				28	1-6	
49MR03K04_4	A10	6	1	BUC	111003	0311	UN	29 25.25 S	41 44.36 W	GPS	3874	3877					1	20.0C
49MR03K04_4	A10	6	1	ROS	111003	0401	BO	29 24.85 S	41 44.58 W	GPS	3892	3885	10	3899	3921			
49MR03K04_4	A10	6	1	ROS	111003	0615	EN	29 23.78 S	41 44.81 W	GPS	3899	3897						
49MR03K04_4	A10	6	1	FLT	111003	0624	DE	29 23.75 S	41 44.54 W	GPS	3901	3896						ARGO/SOLO#262
49MR03K04_4	A10	7	1	ROS	111003	0847	BE	29 36.67 S	41 9.60 W	GPS	3813	3806				31	1-8,12,13,15,23,24,26,27,34,35,45,48	#15=#16 DUPLICATE SMPLS (2600DB), #2-4 FOR BIO (95DB, 5DB)
49MR03K04_4	A10	7	1	BUC	111003	0853	UN	29 36.63 S	41 9.62 W	GPS	3809	3804					1	19.3C
49MR03K04_4	A10	7	1	ROS	111003	0947	BO	29 36.45 S	41 9.70 W	GPS	3802	3795	12	3796	3834			
49MR03K04_4	A10	7	1	UNK	111003	1057	BE	29 36.37 S	41 9.73 W	GPS	3817	3815						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	7	1	UNK	111003	1140	EN	29 36.20 S	41 9.69 W	GPS	3814	3807						
49MR03K04_4	A10	7	1	ROS	111003	1147	EN	29 36.15 S	41 9.66 W	GPS	3814	3810						
49MR03K04_4	A10	8	1	ROS	111003	1408	BE	29 48.54 S	40 34.92 W	GPS	3778	3780				35	1-6,9,22,34,35,47,48	#9 FOR BIO (105DB), #1-7 FOR R.N.
49MR03K04_4	A10	8	1	UNK	111003	1410	BE	29 48.54 S	40 34.90 W	GPS	3776	3783						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	8	1	ROS	111003	1506	BO	29 48.35 S	40 34.70 W	GPS	3783	3782	25	3773	3804			JELLYFISH IN #25
49MR03K04_4	A10	8	1	UNK	111003	1513	EN	29 48.41 S	40 34.75 W	GPS	3779	3776						
49MR03K04_4	A10	8	1	UNK	111003	1513	BE	29 48.41 S	40 34.75 W	GPS	3779	3776					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	8	1	UNK	111003	1529	EN	29 48.48 S	40 34.84 W	GPS	3778	3775						
49MR03K04_4	A10	8	1	BUC	111003	1559	UN	29 48.47 S	40 34.82 W	GPS	3783	3775					1,34,35,48	19.6C, 18L FOR BIO
49MR03K04_4	A10	8	1	ROS	111003	1700	EN	29 48.40 S	40 34.80 W	GPS	3783	3778						
49MR03K04_4	A10	9	1	ROS	111003	1919	BE	30 0.35 S	39 59.97 W	GPS	3186	3186				26	1-8,23,24,26,27,46	#13=#15 DUPLICATE SMPLS (3000DB)
49MR03K04_4	A10	9	1	BUC	111003	1924	UN	30 0.40 S	39 59.95 W	GPS	3188	3188					1	20.3C

49MR03K04_4	A10	9	1	ROS	111003	2011	BO	30 0.52 S	39 59.62 W	GPS	3185	3184	10	3200	3219			
49MR03K04_4	A10	9	1	ROS	111003	2154	EN	30 0.76 S	39 59.08 W	GPS	3182	3185						
49MR03K04_4	A10	10	1	ROS	111003	2340	BE	30 0.25 S	39 31.77 W	GPS	3975	3976				28	1-6	
49MR03K04_4	A10	10	1	BUC	111003	2344	UN	30 0.27 S	39 31.74 W	GPS	3976	3978					1	20.1C
49MR03K04_4	A10	10	1	ROS	111103	0040	BO	30 0.40 S	39 31.38 W	GPS	3978	3986	10	4006	4042			
49MR03K04_4	A10	10	1	ROS	111103	0247	EN	30 0.56 S	39 30.87 W	GPS	3965	3969						
49MR03K04_4	A10	11	1	ROS	111103	0402	BE	29 59.98 S	39 22.82 W	GPS	4865	4865				33	1-8,23,24,26,27,46	#6=#14 DUPLICATE SMPLS (4750DB)
49MR03K04_4	A10	11	1	BUC	111103	0407	UN	29 59.96 S	39 22.80 W	GPS	4862	4865					1	19.8C
49MR03K04_4	A10	11	1	ROS	111103	0517	BO	29 59.89 S	39 22.54 W	GPS	4859	4857	13	4868	4927			
49MR03K04_4	A10	11	1	ROS	111103	0747	EN	29 59.84 S	39 22.20 W	GPS	4839	4839						
49MR03K04_4	A10	X17	1	ROS	111103	0924	BE	30 5.94 S	39 2.10 W	GPS	4213	4215				33	1-8,12,13,15,23,24,26,27,34,35,45,48	#9=#13 DUPLICATE SMPLS (4000DB), #2-4 FOR BIO (100DB, 5DB)
49MR03K04_4	A10	X17	1	BUC	111103	0930	UN	30 5.93 S	39 2.04 W	GPS	4212	4213					1	20.0C
49MR03K04_4	A10	X17	1	UNK	111103	1020	BE	30 5.95 S	39 1.60 W	GPS	4216	4213						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	X17	1	ROS	111103	1029	BO	30 5.98 S	39 1.51 W	GPS	4229	4232	17	4221	4248			
49MR03K04_4	A10	X17	1	UNK	111103	1105	EN	30 5.91 S	39 1.24 W	GPS	4229	4230						
49MR03K04_4	A10	X17	1	ROS	111103	1225	EN	30 5.90 S	39 1.21 W	GPS	4207	4204						
49MR03K04_4	A10	X17	1	FLT	111103	1232	DE	30 5.90 S	39 1.21 W	GPS	4211	4207						ARGO/SOLO#260
49MR03K04_4	A10	13	1	ROS	111103	1424	BE	30 0.03 S	38 30.09 W	GPS	4209	4212				36	1-6,9,22,34,35,47,48	#7 FOR BIO (100DB), #1-6 FOR R.N.
49MR03K04_4	A10	13	1	UNK	111103	1428	BE	30 0.01 S	38 30.04 W	GPS	4220	4217						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	13	1	UNK	111103	1503	BE	29 59.77 S	38 29.74 W	GPS	4208	4212					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	13	1	UNK	111103	1518	EN	29 59.86 S	38 29.56 W	GPS	4228	4227						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	13	1	ROS	111103	1530	BO	29 59.91 S	38 29.43 W	GPS	4230	4232	13	4263	4266			
49MR03K04_4	A10	13	1	UNK	111103	1540	EN	29 59.91 S	38 29.34 W	GPS	4231	4232						81L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	13	1	BUC	111103	1700	UN	29 59.69 S	38 28.99 W	GPS	4230	4231					1,34,35,48	21.3C, 18L FOR BIO
49MR03K04_4	A10	13	1	ROS	111103	1729	EN	29 59.64 S	38 28.75 W	GPS	4235	4237						
49MR03K04_4	A10	14	1	ROS	111103	1921	BE	30 0.10 S	37 59.98 W	GPS	3822	3822				28	1-6	
49MR03K04_4	A10	14	1	BUC	111103	1926	UN	30 0.07 S	37 59.95 W	GPS	3822	3824					1	20.8C
49MR03K04_4	A10	14	1	UNK	111103	1930	BE	30 0.05 S	37 59.93 W	GPS	3822	3824						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	14	1	UNK	111103	2014	EN	29 59.83 S	37 59.65 W	GPS	3840	3842						
49MR03K04_4	A10	14	1	ROS	111103	2023	BO	29 59.78 S	37 59.60 W	GPS	3844	3843	11	3862	3871			
49MR03K04_4	A10	14	1	ROS	111103	2237	EN	29 59.08 S	37 58.88 W	GPS	3852	3855						
49MR03K04_4	A10	15	1	ROS	111203	0034	BE	29 59.95 S	37 29.66 W	GPS	3167	3169				26	1-8,23,24,26,27	#12=#13 DUPLICATE SMPLS (3000DB)
49MR03K04_4	A10	15	1	BUC	111203	0039	UN	29 59.90 S	37 29.71 W	GPS	3208	3209					1	20.2C
49MR03K04_4	A10	15	1	ROS	111203	0124	BO	29 59.79 S	37 29.75 W	GPS	3192	3188	10	3208	3197			
49MR03K04_4	A10	15	1	ROS	111203	0328	EN	29 59.29 S	37 30.26 W	GPS	3159	3161						
49MR03K04_4	A10	16	1	ROS	111203	0453	BE	30 0.09 S	37 10.16 W	GPS	2324	2326				21	1-6	
49MR03K04_4	A10	16	1	BUC	111203	0458	UN	30 0.12 S	37 10.23 W	GPS	2326	2325					1	20.1C
49MR03K04_4	A10	16	1	ROS	111203	0531	BO	30 0.15 S	37 10.29 W	GPS	2326	2327	13	2316	2335			
49MR03K04_4	A10	16	1	ROS	111203	0657	EN	30 0.24 S	37 10.49 W	GPS	2329	2330						
49MR03K04_4	A10	X23	1	ROS	111203	0846	BE	30 0.26 S	36 52.68 W	GPS	2007	2014				23	1-8,23,24,26,27,34,35,46,48	#11=#19 DUPLICATE SMPLS (1800DB), #1-3 FOR BIO (110DB, 5DB)
49MR03K04_4	A10	X23	1	BUC	111203	0853	UN	30 0.27 S	36 52.69 W	GPS	2016	2020					1	20.0C
49MR03K04_4	A10	X23	1	ROS	111203	0927	BO	30 0.33 S	36 52.71 W	GPS	2042	2036	14	2025	2042			
49MR03K04_4	A10	X23	1	UNK	111203	0948	BE	30 0.35 S	36 52.73 W	GPS	2045	2048						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	X23	1	UNK	111203	1027	EN	30 0.38 S	36 52.82 W	GPS	2076	2080						
49MR03K04_4	A10	X23	1	ROS	111203	1035	EN	30 0.37 S	36 52.87 W	GPS	2101	2101						
49MR03K04_4	A10	18	1	ROS	111203	1209	BE	29 59.98 S	36 29.84 W	GPS	1777	1776				19	1-8,23,24,26,27	#10=#16 DUPLICATE SMPLS (1600DB)
49MR03K04_4	A10	18	1	BUC	111203	1214	UN	29 59.96 S	36 29.82 W	GPS	1772	1775					1	20.0C
49MR03K04_4	A10	18	1	ROS	111203	1239	BO	29 59.93 S	36 29.74 W	GPS	1771	1772	12	1761	1774			

49MR03K04_4	A10	18	1	UNK	111203	1316	BE	29 59.74 S	36 29.65 W	GPS	1773	1772						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	18	1	ROS	111203	1336	EN	29 59.65 S	36 29.66 W	GPS	1778	1778						
49MR03K04_4	A10	18	1	UNK	111203	1341	EN	29 59.55 S	36 29.62 W	GPS	1781	1782						
49MR03K04_4	A10	19	1	ROS	111203	1456	BE	29 59.94 S	36 9.92 W	GPS	1222	1223				19	1-8,23,24,26,27,34,35,48	#9=#23 DUPLICATE SMPLS (1000DB), #1-3 FOR BIO (125DB, 10DB)
49MR03K04_4	A10	19	1	BUC	111203	1502	UN	29 59.90 S	36 9.91 W	GPS	1225	1225					1	20.1C
49MR03K04_4	A10	19	1	ROS	111203	1521	BO	29 59.78 S	36 9.84 W	GPS	1251	1257	13	1221	1229			JELLYFISH CLINGING TO SECONDARY T-SENSOR
49MR03K04_4	A10	19	1	ROS	111203	1610	EN	29 59.41 S	36 9.77 W	GPS	1284	1280						
49MR03K04_4	A10	20	1	ROS	111203	1730	BE	30 0.06 S	35 49.86 W	GPS	2393	2390				21	1-6	
49MR03K04_4	A10	20	1	BUC	111203	1734	UN	30 0.06 S	35 49.81 W	GPS	2396	2399					1	20.4C
49MR03K04_4	A10	20	1	ROS	111203	1810	BO	30 0.00 S	35 49.69 W	GPS	2389	2398	11	2394	2416			
49MR03K04_4	A10	20	1	ROS	111203	1943	EN	29 59.83 S	35 49.93 W	GPS	2421	2433						
49MR03K04_4	A10	21	1	ROS	111203	2107	BE	30 0.00 S	35 29.22 W	GPS	2312	2312				22	1-8,12,13,23,24,26,27,46	#8=#17 DUPLICATE SMPLS (2200DB)
49MR03K04_4	A10	21	1	BUC	111203	2113	UN	29 59.97 S	35 29.28 W	GPS	2312	2311					1	20.1C
49MR03K04_4	A10	21	1	ROS	111203	2147	BO	29 59.82 S	35 29.31 W	GPS	2323	2327	9	2312	2328			
49MR03K04_4	A10	21	1	ROS	111203	2305	EN	29 59.62 S	35 29.40 W	GPS	2326	2324						
49MR03K04_4	A10	22	1	ROS	111303	0038	BE	30 0.03 S	35 10.07 W	GPS	2127	2126				26	1-6,9,22,47	#1-6 FOR R.N.
49MR03K04_4	A10	22	1	BUC	111303	0042	UN	30 0.04 S	35 10.08 W	GPS	2127	2126					1	20.3C
49MR03K04_4	A10	22	1	ROS	111303	0114	BO	30 0.06 S	35 10.10 W	GPS	2127	2126	10	2117	2133			
49MR03K04_4	A10	22	1	UNK	111303	0130	BE	30 0.16 S	35 10.16 W	GPS	2124	2124					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	22	1	UNK	111303	0210	EN	30 0.29 S	35 10.32 W	GPS	2122	2121						
49MR03K04_4	A10	22	1	ROS	111303	0227	EN	30 0.34 S	35 10.35 W	GPS	2120	2121						
49MR03K04_4	A10	23	1	ROS	111303	0352	BE	30 0.06 S	34 49.78 W	GPS	1654	1653				18	1-8,15,23,24,26,27,45	#7=#21 DUPLICATE SMPLS (1400DB)
49MR03K04_4	A10	23	1	BUC	111303	0357	UN	30 0.07 S	34 49.81 W	GPS	1655	1653					1	20.4C
49MR03K04_4	A10	23	1	ROS	111303	0422	BO	30 0.01 S	34 49.83 W	GPS	1658	1659	11	1645	1658			
49MR03K04_4	A10	23	1	ROS	111303	0522	EN	30 0.01 S	34 49.95 W	GPS	1661	1663						
49MR03K04_4	A10	24	1	ROS	111303	0655	BE	30 0.11 S	34 29.85 W	GPS	1420	1419				17	1-8,23,24,26,27	#6=#22 DUPLICATE SMPLS (1200DB)
49MR03K04_4	A10	24	1	BUC	111303	0701	UN	30 0.14 S	34 29.88 W	GPS	1422	1420					1	20.0C
49MR03K04_4	A10	24	1	ROS	111303	0722	BO	30 0.09 S	34 29.92 W	GPS	1422	1422	13	1409	1419			
49MR03K04_4	A10	24	1	ROS	111303	0819	EN	30 0.01 S	34 30.10 W	GPS	1427	1424						
49MR03K04_4	A10	25	1	ROS	111303	1014	BE	29 59.75 S	33 59.79 W	GPS	2003	2005				22	1-8,23,24,26,27,34,35,46,48	#5=#19 DUPLICATE SMPLS (1800DB), #2,3,34 FOR BIO (5DB, 100DB)
49MR03K04_4	A10	25	1	BUC	111303	1019	UN	29 59.82 S	33 59.80 W	GPS	2001	2001					1	20.3C
49MR03K04_4	A10	25	1	UNK	111303	1030	BE	29 59.83 S	33 59.82 W	GPS	1999	2001					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	25	1	ROS	111303	1050	BO	29 59.78 S	33 59.86 W	GPS	2002	1999	11	1975	2006			
49MR03K04_4	A10	25	1	UNK	111303	1055	EN	29 59.79 S	33 59.86 W	GPS	1999	1996						
49MR03K04_4	A10	25	1	ROS	111303	1151	EN	29 59.69 S	34 0.04 W	GPS	1991	1990						
49MR03K04_4	A10	26	1	ROS	111303	1344	BE	30 0.01 S	33 29.85 W	GPS	3157	3153				28	1-6,34,35,48	#1-3 FOR BIO (130DB, 5DB)
49MR03K04_4	A10	26	1	BUC	111303	1349	UN	30 0.01 S	33 29.86 W	GPS	3151	3151					1	20.0C
49MR03K04_4	A10	26	1	ROS	111303	1436	BO	30 0.01 S	33 29.93 W	GPS	3142	3143	14	3141	3179			
49MR03K04_4	A10	26	1	UNK	111303	1508	BE	29 59.90 S	33 29.96 W	GPS	3141	3142						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	26	1	UNK	111303	1543	EN	29 59.89 S	33 30.03 W	GPS	3141	3141						
49MR03K04_4	A10	26	1	ROS	111303	1619	EN	29 59.82 S	33 30.10 W	GPS	3143	3142						
49MR03K04_4	A10	27	1	ROS	111303	1812	BE	29 59.55 S	32 59.87 W	GPS	3515	3514				27	1-8,23,24,26,27	#4=#12 DUPLICATE SMPLS (3250DB)
49MR03K04_4	A10	27	1	BUC	111303	1818	UN	29 59.56 S	32 59.91 W	GPS	3514	3513					1	20.0C
49MR03K04_4	A10	27	1	ROS	111303	1910	BO	29 59.63 S	33 0.20 W	GPS	3510	3509	12	3510	3547			
49MR03K04_4	A10	27	1	ROS	111303	2130	EN	29 59.74 S	33 1.49 W	GPS	3499	3498						
49MR03K04_4	A10	28	1	ROS	111303	2336	BE	30 0.03 S	32 29.92 W	GPS	3714	3715				27	1-6	
49MR03K04_4	A10	28	1	BUC	111303	2341	UN	30 0.06 S	32 29.97 W	GPS	3714	3714					1	20.2C
49MR03K04_4	A10	28	1	ROS	111403	0034	BO	30 0.08 S	32 30.27 W	GPS	3711	3712	10	3713	3756			FIRING MISSOPERATION AT #33 (100DB)

																		AND #34 (50DB)
49MR03K04_4	A10	28	1	ROS	111403	0233	EN	30 0.22 S	32 30.97 W	GPS	3710	3707						
49MR03K04_4	A10	29	1	ROS	111403	0441	BE	30 0.10 S	31 59.98 W	GPS	3825	3824				28	1-8,12,13,23,24,26,27,46	#3=#11 DUPLICATE SMPLS (3500DB)
49MR03K04_4	A10	29	1	BUC	111403	0448	UN	30 0.16 S	31 59.98 W	GPS	3825	3823					1	20.2C
49MR03K04_4	A10	29	1	ROS	111403	0541	BO	30 0.39 S	32 0.29 W	GPS	3832	3835	11	3832	3860			
49MR03K04_4	A10	29	1	ROS	111403	0745	EN	30 1.11 S	32 0.86 W	GPS	3824	3826						
49MR03K04_4	A10	30	1	ROS	111403	0951	BE	30 0.02 S	31 30.09 W	GPS	3820	3800				36	1-6,9,22,34,35,47,48	#8 FOR BIO, #1,2,4-7,24 FOR R.N.
49MR03K04_4	A10	30	1	UNK	111403	1020	BE	30 0.15 S	31 30.27 W	GPS	3836	3817					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	30	1	UNK	111403	1040	EN	30 0.16 S	31 30.40 W	GPS	3831	3826						
49MR03K04_4	A10	30	1	ROS	111403	1053	BO	30 0.18 S	31 30.52 W	GPS	3793	3811	13	3817	3848			#26 LEAK
49MR03K04_4	A10	30	1	BUC	111403	1128	UN	30 0.29 S	31 30.68 W	GPS	3803	3809					1,34,35,48	20.6C, 18L FOR BIO
49MR03K04_4	A10	30	1	ROS	111403	1252	EN	30 0.49 S	31 31.03 W	GPS	3769	3785						
49MR03K04_4	A10	31	1	ROS	111403	1453	BE	29 59.92 S	30 59.58 W	GPS	4032	4033				32	1-8,15,23,24,26,27,34,35,45,48	#2=#10 DUPLICATE SMPLS (3750DB),
																		#1,3,4 FOR BIO (130DB, 10DB)
49MR03K04_4	A10	31	1	BUC	111403	1504	UN	30 0.05 S	30 59.54 W	GPS	4035	4037					1	20.3C
49MR03K04_4	A10	31	1	ROS	111403	1602	BO	30 0.44 S	30 59.50 W	GPS	4043	4042	17	4049	4082			
49MR03K04_4	A10	31	1	ROS	111403	1805	EN	30 1.29 S	30 59.46 W	GPS	4043	4047						
49MR03K04_4	A10	32	1	ROS	111403	2002	BE	30 0.03 S	30 29.92 W	GPS	3906	3907				28	1-6	
49MR03K04_4	A10	32	1	BUC	111403	2013	UN	30 0.06 S	30 29.84 W	GPS	3902	3902					1	19.4C
49MR03K04_4	A10	32	1	ROS	111403	2109	BO	30 0.20 S	30 29.71 W	GPS	3901	3901	11	3904	3950			
49MR03K04_4	A10	32	1	ROS	111403	2315	EN	30 0.41 S	30 29.35 W	GPS	3894	3896						
49MR03K04_4	A10	33	1	ROS	111503	0121	BE	30 0.04 S	29 59.42 W	GPS	3500	3491				27	1-8,23,24,26,27,46	#1=#12 DUPLICATE SMPLS (3250DB)
49MR03K04_4	A10	33	1	BUC	111503	0131	UN	30 0.04 S	29 59.42 W	GPS	3501	3500					1	19.1C
49MR03K04_4	A10	33	1	ROS	111503	0224	BO	30 0.16 S	29 59.34 W	GPS	3513	3488	30	3503	3545			
49MR03K04_4	A10	33	1	ROS	111503	0417	EN	30 0.39 S	29 59.27 W	GPS	3455	3461						
49MR03K04_4		401	1	UNK	111503	1500	BE	29 58.27 S	29 30.59 W	GPS	2238	2235						MAGNETOMETER CALIBRATION
49MR03K04_4		401	1	UNK	111503	1530	EN	29 58.13 S	29 31.09 W	GPS	2247	2253						
49MR03K04_4	A10	34	1	ROS	111603	0559	BE	29 59.98 S	29 30.06 W	GPS	2242	2241				20	1-6	REPLACED BTL
49MR03K04_4	A10	34	1	BUC	111603	0605	UN	30 0.00 S	29 30.01 W	GPS	2242	2242					1	19.2C
49MR03K04_4	A10	34	1	ROS	111603	0640	BO	29 59.86 S	29 29.73 W	GPS	2243	2244	19	2242	2249			
49MR03K04_4	A10	34	1	ROS	111603	0756	EN	29 59.70 S	29 29.26 W	GPS	2255	2256						
49MR03K04_4	A10	35	1	ROS	111603	0952	BE	30 0.03 S	28 59.58 W	GPS	3172	3174				29	1-8,12,13,23,24,26,27,34,35,48	#13=#23 DUPLICATE SMPLS (3000DB),
																		#2-4 FOR BIO (150DB, 5DB)
49MR03K04_4	A10	35	1	BUC	111603	0957	UN	30 0.06 S	28 59.54 W	GPS	3166	3169					1	19.9C
49MR03K04_4	A10	35	1	ROS	111603	1042	BO	30 0.02 S	28 59.50 W	GPS	3167	3169	13	3162	3199			
49MR03K04_4	A10	35	1	UNK	111603	1106	BE	30 0.04 S	28 59.55 W	GPS	3172	3173						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	35	1	UNK	111603	1145	EN	30 0.02 S	28 59.52 W	GPS	3169	3170						
49MR03K04_4	A10	35	1	ROS	111603	1223	EN	30 0.02 S	28 59.55 W	GPS	3171	3172						
49MR03K04_4	A10	36	1	ROS	111603	1434	BE	29 59.72 S	28 24.97 W	GPS	3747	3747				34	1-6,9,22,34,35,47	#8 FOR BIO, #1-6 FOR R.N.
49MR03K04_4	A10	36	1	UNK	111603	1454	BE	29 59.58 S	28 25.04 W	GPS	3758	3753						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	36	1	UNK	111603	1505	BE	29 59.49 S	28 25.04 W	GPS	3762	3757					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	36	1	UNK	111603	1528	EN	29 59.32 S	28 24.90 W	GPS	3764	3763						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	36	1	ROS	111603	1532	BO	29 59.29 S	28 24.90 W	GPS	3775	3768	10	3775	3799			
49MR03K04_4	A10	36	1	UNK	111603	1545	EN	29 59.21 S	28 24.94 W	GPS	3794	3796						80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	36	1	BUC	111603	1658	UN	29 58.62 S	28 24.87 W	GPS	3745	3771					1,34,35,48	19.8C, 18L FOR BIO
49MR03K04_4	A10	36	1	ROS	111603	1726	EN	29 58.31 S	28 24.87 W	GPS	3726	3716						
49MR03K04_4	A10	37	1	ROS	111603	2027	BE	29 59.92 S	27 33.83 W	GPS	4845	4845				32	1-6	REPLACED LADCP
49MR03K04_4	A10	37	1	BUC	111603	2032	UN	29 59.87 S	27 33.74 W	GPS	4827	4830					1	18.4C
49MR03K04_4	A10	37	1	ROS	111603	2144	BO	29 59.24 S	27 33.64 W	GPS	4893	4893	11	4856	4881			
49MR03K04_4	A10	37	1	ROS	111703	0014	EN	29 58.17 S	27 33.32 W	GPS	4977	4977						

49MR03K04_4	A10	38	1	ROS	111703	0320	BE	29 59.91 S	26 42.86 W	GPS	5280	5278				35	1-8,12,13,15,23,24,26,27,45,46	#4=#22 DUPLICATE SMPLS (5250DB)
49MR03K04_4	A10	38	1	BUC	111703	0325	UN	29 59.94 S	26 42.85 W	GPS	5280	5277					1	18.6C
49MR03K04_4	A10	38	1	ROS	111703	0441	BO	30 0.14 S	26 43.09 W	GPS	5275	5278	10	5289	5368			
49MR03K04_4	A10	38	1	ROS	111703	0714	EN	30 0.35 S	26 43.71 W	GPS	5099	5090						
49MR03K04_4	A10	39	1	ROS	111703	1024	BE	29 59.92 S	25 51.60 W	GPS	4529	4512				33	1-6,34,35,48	#1-3 FOR BIO, #12 DID NOT TRIP
49MR03K04_4	A10	39	1	BUC	111703	1029	UN	29 59.89 S	25 51.59 W	GPS	4515	4517					1	19.3C
49MR03K04_4	A10	39	1	ROS	111703	1135	BO	29 59.67 S	25 51.68 W	GPS	4546	4544	13	4538	4599			
49MR03K04_4	A10	39	1	UNK	111703	1201	UN	29 59.62 S	25 51.77 W	GPS	4556	4557						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	39	1	UNK	111703	1235	UN	29 59.54 S	25 51.85 W	GPS	4571	4577						
49MR03K04_4	A10	39	1	ROS	111703	1339	EN	29 59.33 S	25 51.84 W	GPS	4618	4620						
49MR03K04_4	A10	39	1	FLT	111703	1346	DE	29 59.34 S	25 51.75 W	GPS	4611	4600						ARGO/SOLO#264
49MR03K04_4	A10	X16	1	UNK	111703	1645	BE	30 13.10 S	25 3.23 W	GPS	4213	4300					9,22,47	90L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	X16	1	ROS	111703	1651	BE	30 13.21 S	25 2.71 W	GPS	4350	4350				32	1-8,12,13,23,24,26,27,34,35	#8=#21 DUPLICATE SMPLS (4250DB), #2 FOR BIO (120DB)
49MR03K04_4	A10	X16	1	UNK	111703	1730	EN	30 13.09 S	25 2.71 W	GPS	4336	4343						90L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	X16	1	ROS	111703	1759	BO	30 13.03 S	25 2.77 W	GPS	4351	4349	11	4330	4411			
49MR03K04_4	A10	X16	1	BUC	111703	1800	UN	30 13.03 S	25 2.78 W	GPS	4353	4348					1,34,35,48	19.1C, 18L FOR BIO
49MR03K04_4	A10	X16	1	ROS	111703	2018	EN	30 12.54 S	25 2.83 W	GPS	4447	4443						
49MR03K04_4	A10	41	1	ROS	111703	2336	BE	30 0.07 S	24 9.93 W	GPS	4742	4745				31	1-6	
49MR03K04_4	A10	41	1	BUC	111703	2341	UN	30 0.09 S	24 9.89 W	GPS	4749	4747					1	19.8C
49MR03K04_4	A10	41	1	ROS	111803	0049	BO	30 0.07 S	24 9.86 W	GPS	4757	4747	10	4735	4810			
49MR03K04_4	A10	41	1	ROS	111803	0313	EN	30 0.42 S	24 9.42 W	GPS	4896	4893						
49MR03K04_4	A10	42	1	ROS	111803	0612	BE	30 0.26 S	23 18.81 W	GPS	4599	4599				34	1-6,34,35,48	#1-3 FOR BIO (130DB, 5DB)
49MR03K04_4	A10	42	1	BUC	111803	0617	UN	30 0.27 S	23 18.73 W	GPS	4600	4603					1	19.8C
49MR03K04_4	A10	42	1	ROS	111803	0724	BO	30 0.33 S	23 18.69 W	GPS	4600	4602	11	4595	4663			
49MR03K04_4	A10	42	1	UNK	111803	0912	BE	30 0.33 S	23 18.75 W	GPS	4617	4601						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	42	1	ROS	111803	0936	EN	30 0.30 S	23 18.75 W	GPS	4601	4600						
49MR03K04_4	A10	42	1	UNK	111803	0940	EN	30 0.29 S	23 18.75 W	GPS	4600	4600						
49MR03K04_4	A10	42	1	FLT	111803	0943	DE	30 0.19 S	23 18.64 W	GPS	4598	4601						ARGO/SOLO#261
49MR03K04_4	A10	43	1	ROS	111803	1236	BE	30 0.05 S	22 28.85 W	GPS	4600	4601				35	1-8,12,13,15,23,24,26,27,34,35,45,46,48	#7=#20 DUPLICATE SMPLS (4500DB), #2-4 FOR BIO (135DB, 5DB)
49MR03K04_4	A10	43	1	BUC	111803	1241	UN	30 0.04 S	22 28.83 W	GPS	4597	4597					1	19.6C
49MR03K04_4	A10	43	1	UNK	111803	1320	BE	29 59.90 S	22 28.85 W	GPS	4592	4591						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	43	1	ROS	111803	1347	BO	30 0.04 S	22 28.96 W	GPS	4609	4611	13	4595	4659			
49MR03K04_4	A10	43	1	UNK	111803	1438	EN	29 59.90 S	22 29.16 W	GPS	4568	4566						
49MR03K04_4	A10	43	1	ROS	111803	1554	EN	30 0.07 S	22 29.76 W	GPS	4565	4567						
49MR03K04_4	A10	44	1	ROS	111803	1906	BE	29 59.87 S	21 36.96 W	GPS	4766	4782				36	1-6,9,22,47	#1-4 FOR R.N.
49MR03K04_4	A10	44	1	BUC	111803	1911	UN	29 59.84 S	21 37.00 W	GPS	4789	4784					1	20.0C
49MR03K04_4	A10	44	1	UNK	111803	1919	BE	29 59.84 S	21 37.06 W	GPS	4785	4791						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	44	1	UNK	111803	1956	EN	29 59.88 S	21 37.41 W	GPS	4825	4825						
49MR03K04_4	A10	44	1	UNK	111803	2010	BE	29 59.79 S	21 37.44 W	GPS	4823	4821					9,22,47	90L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	44	1	ROS	111803	2023	BO	29 59.69 S	21 37.42 W	GPS	4816	4819	10	4827	4878			
49MR03K04_4	A10	44	1	UNK	111803	2028	EN	29 59.67 S	21 37.43 W	GPS	4818	4816						90L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	44	1	ROS	111803	2248	EN	29 59.58 S	21 38.09 W	GPS	4836	4832						
49MR03K04_4	A10	45	1	ROS	111903	0159	BE	30 0.17 S	20 45.84 W	GPS	4712	4716				32	1-8,23,24,26,27	#7=#19 DUPLICATE SMPLS (4500DB)
49MR03K04_4	A10	45	1	BUC	111903	0204	UN	30 0.22 S	20 45.88 W	GPS	4715	4711					1	20.5C
49MR03K04_4	A10	45	1	ROS	111903	0313	BO	30 0.41 S	20 46.40 W	GPS	4818	4823	13	4777	4825			
49MR03K04_4	A10	45	1	ROS	111903	0529	EN	30 0.53 S	20 47.08 W	GPS	4848	4848						
49MR03K04_4	A10	46	1	ROS	111903	0840	BE	29 59.97 S	19 54.84 W	GPS	4780	4770				35	1-6,34,35,48	#1-3 FOR BIO (150DB, 5DB)
49MR03K04_4	A10	46	1	BUC	111903	0845	UN	29 59.96 S	19 54.80 W	GPS	4774	4772					1	20.0C

49MR03K04_4	A10	46	1	ROS	111903	0954	BO	29 59.86 S	19 54.41 W	GPS	4824	4825	15	4813	4871			
49MR03K04_4	A10	46	1	UNK	111903	1120	BE	29 59.69 S	19 53.80 W	GPS	4881	4877						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	46	1	ROS	111903	1157	EN	29 59.65 S	19 53.49 W	GPS	4868	4865						
49MR03K04_4	A10	46	1	UNK	111903	1201	EN	29 59.66 S	19 53.39 W	GPS	4873	4870						
49MR03K04_4	A10	46	1	FLT	111903	1203	DE	29 59.68 S	19 53.32 W	GPS	4867	4863						ARGO/SOLO#263
49MR03K04_4	A10	X15	1	ROS	111903	1512	BE	30 6.67 S	18 59.92 W	GPS	4610	4607				35	1-8,12,13,15,23,24,26,27,34,35,45,46,48	#9=#18 DUPLICATE SMPLS (4000DB), #2-4 FOR BIO (160DB, 5DB)
49MR03K04_4	A10	X15	1	BUC	111903	1517	UN	30 6.68 S	18 59.90 W	GPS	4619	4608					1	20.6C
49MR03K04_4	A10	X15	1	UNK	111903	1520	BE	30 6.67 S	18 59.91 W	GPS	4613	4615					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	X15	1	UNK	111903	1540	EN	30 6.70 S	18 59.90 W	GPS	4612	4612						
49MR03K04_4	A10	X15	1	ROS	111903	1622	BO	30 6.47 S	19 0.06 W	GPS	4614	4612	10	4605	4670			
49MR03K04_4	A10	X15	1	UNK	111903	1654	BE	30 6.43 S	19 0.00 W	GPS	4607	4609						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	X15	1	UNK	111903	1748	EN	30 6.48 S	18 59.84 W	GPS	4615	4615						
49MR03K04_4	A10	X15	1	ROS	111903	1842	EN	30 6.33 S	18 59.66 W	GPS	4610	4610						
49MR03K04_4	A10	48	1	ROS	111903	2101	BE	29 59.89 S	18 23.14 W	GPS	4125	4145				29	1-6	
49MR03K04_4	A10	48	1	BUC	111903	2106	UN	29 59.86 S	18 23.13 W	GPS	4126	4134					1	20.4C
49MR03K04_4	A10	48	1	ROS	111903	2209	BO	29 59.46 S	18 23.01 W	GPS	4164	4148	16	4172	4203			
49MR03K04_4	A10	48	1	ROS	112003	0007	EN	29 58.88 S	18 23.73 W	GPS	4162	4170						
49MR03K04_4	A10	49	1	ROS	112003	0250	BE	30 0.03 S	17 41.95 W	GPS	3959	3971				29	1-8,23,24,26,27	#10=#17 DUPLICATE SMPLS (3750DB)
49MR03K04_4	A10	49	1	BUC	112003	0255	UN	30 0.02 S	17 42.01 W	GPS	3941	3924					1	19.9C
49MR03K04_4	A10	49	1	ROS	112003	0351	BO	29 59.88 S	17 42.37 W	GPS	3941	3944	10	3898	3935			
49MR03K04_4	A10	49	1	ROS	112003	0547	EN	29 59.54 S	17 42.97 W	GPS	3990	3997						
49MR03K04_4	A10	50	1	ROS	112003	0836	BE	29 59.99 S	17 0.27 W	GPS	3596	3603				30	1-6,34,35,48	#1-3 FOR BIO (160DB, 5DB)
49MR03K04_4	A10	50	1	BUC	112003	0841	UN	29 59.96 S	17 0.35 W	GPS	3590	3595					1	20.0C
49MR03K04_4	A10	50	1	ROS	112003	0934	BO	29 59.56 S	17 0.83 W	GPS	3709	3690	10	3754	3743			
49MR03K04_4	A10	50	1	UNK	112003	0948	BE	29 59.47 S	17 0.88 W	GPS	3710	3716						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	50	1	UNK	112003	1019	EN	29 59.29 S	17 0.98 W	GPS	3755	3755						
49MR03K04_4	A10	50	1	ROS	112003	1116	EN	29 59.02 S	17 1.40 W	GPS	3802	3816						
49MR03K04_4	A10	50	1	FLT	112003	1122	DE	29 59.02 S	17 1.38 W	GPS	3787	3768						ARGO/SOLO#265
49MR03K04_4	A10	51	1	ROS	112003	1357	BE	30 0.13 S	16 20.04 W	GPS	3697	3695				31	1-8,12,13,23,24,26,27,34,35,46,48	#11=#16 DUPLICATE SMPLS (3500DB), #2-4 FOR BIO (150DB, 5DB)
49MR03K04_4	A10	51	1	BUC	112003	1402	UN	30 0.12 S	16 20.06 W	GPS	3699	3697					1	20.5C
49MR03K04_4	A10	51	1	ROS	112003	1458	BO	30 0.06 S	16 20.34 W	GPS	3700	3701	10	3696	3741			
49MR03K04_4	A10	51	1	UNK	112003	1503	BE	30 0.06 S	16 20.34 W	GPS	3702	3700						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	51	1	UNK	112003	1557	EN	30 0.02 S	16 20.25 W	GPS	3697	3699						
49MR03K04_4	A10	51	1	ROS	112003	1648	EN	30 0.05 S	16 20.40 W	GPS	3701	3701						
49MR03K04_4	A10	52	1	ROS	112003	1922	BE	30 0.03 S	15 39.85 W	GPS	3265	3254				32	1-6,9,22,47	#1-7 FOR R.N.
49MR03K04_4	A10	52	1	UNK	112003	1925	BE	30 0.01 S	15 39.85 W	GPS	3231	3240					9,22,47	100L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	52	1	BUC	112003	1927	UN	29 59.99 S	15 39.87 W	GPS	3248	3239					1	20.4C
49MR03K04_4	A10	52	1	UNK	112003	1940	EN	29 59.91 S	15 39.83 W	GPS	3260	3263						
49MR03K04_4	A10	52	1	ROS	112003	2015	BO	29 59.73 S	15 39.96 W	GPS	3260	3265	10	3245	3265			
49MR03K04_4	A10	52	1	ROS	112003	2158	EN	29 58.95 S	15 40.23 W	GPS	3262	3259						
49MR03K04_4	A10	53	1	ROS	112103	0027	BE	30 0.02 S	14 59.99 W	GPS	3836	3835				29	1-8,15,23,24,26,27,45	#10=#15 DUPLICATE SMPLS (3750DB)
49MR03K04_4	A10	53	1	BUC	112103	0032	UN	29 59.96 S	14 59.99 W	GPS	3836	3837					1	20.1C
49MR03K04_4	A10	53	1	ROS	112103	0128	BO	29 59.57 S	14 59.95 W	GPS	3835	3836	11	3857	3883			
49MR03K04_4	A10	53	1	ROS	112103	0330	EN	29 58.67 S	15 0.22 W	GPS	3846	3849						
49MR03K04_4	A10	54	1	ROS	112103	0606	BE	29 59.90 S	14 19.82 W	GPS	2891	2891				23	1-6	
49MR03K04_4	A10	54	1	BUC	112103	0612	UN	29 59.88 S	14 19.90 W	GPS	2899	2899					1	19.7C
49MR03K04_4	A10	54	1	ROS	112103	0655	BO	29 59.76 S	14 19.95 W	GPS	2894	2894	18	2865	2886			LADCP SOUNDING
49MR03K04_4	A10	54	1	ROS	112103	0824	EN	29 59.49 S	14 19.90 W	GPS	3002	2987						

49MR03K04_4	A10	54	1	FLT	112103	0832	DE	29 59.55 S	14 19.74 W	GPS	2923	2909						ARGO/APEX#865
49MR03K04_4	A10	55	1	ROS	112103	1100	BE	30 0.15 S	13 39.87 W	GPS	2286	2291				25	1-8,12,13,23,24,26,27,34,35,46,48	#14=#17 DUPLICATE SMPLS (2200DB), #1-3 FOR BIO (150DB, 5DB)
49MR03K04_4	A10	55	1	BUC	112103	1105	UN	30 0.11 S	13 39.86 W	GPS	2294	2298					1	19.9C
49MR03K04_4	A10	55	1	UNK	112103	1110	BE	30 0.06 S	13 39.87 W	GPS	2293	2295					9,22,47	90L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	55	1	UNK	112103	1125	EN	29 59.94 S	13 39.82 W	GPS	2300	2304						
49MR03K04_4	A10	55	1	ROS	112103	1139	BO	29 59.81 S	13 39.87 W	GPS	2297	2293	10	2311	2317			
49MR03K04_4	A10	55	1	UNK	112103	1154	BE	29 59.67 S	13 39.94 W	GPS	2302	2306						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	55	1	UNK	112103	1230	EN	29 59.38 S	13 40.13 W	GPS	2220	2222						
49MR03K04_4	A10	55	1	ROS	112103	1243	EN	29 59.26 S	13 40.15 W	GPS	2236	2238						
49MR03K04_4	A10	56	1	ROS	112103	1517	BE	30 0.17 S	12 59.49 W	GPS	3106	3093				28	1-6,34,35,48	#1-3 FOR BIO (155DB, 5DB)
49MR03K04_4	A10	56	1	BUC	112103	1521	UN	30 0.14 S	12 59.48 W	GPS	3113	3097					1	19.8C
49MR03K04_4	A10	56	1	ROS	112103	1608	BO	29 59.76 S	12 59.39 W	GPS	3119	3098	10	3140	3136			
49MR03K04_4	A10	56	1	ROS	112103	1801	EN	29 59.26 S	12 59.14 W	GPS	3159	3137						
49MR03K04_4	A10	57	1	ROS	112103	2026	BE	29 59.80 S	12 19.95 W	GPS	3110	3122				26	1-8,23,24,26,27	#1=#13 DUPLICATE SMPLS (3000DB)
49MR03K04_4	A10	57	1	BUC	112103	2032	UN	29 59.76 S	12 19.90 W	GPS	3101	3125					1	19.1C
49MR03K04_4	A10	57	1	ROS	112103	2121	BO	29 59.35 S	12 19.73 W	GPS	3027	3049	11	3128	3131			
49MR03K04_4	A10	57	1	ROS	112103	2304	EN	29 58.70 S	12 19.15 W	GPS	3215	3234						
49MR03K04_4	A10	57	1	FLT	112103	2310	DE	29 58.61 S	12 18.92 W	GPS	3215	3234						ARGO/APEX#1190
49MR03K04_4	A10	58	1	ROS	112203	0130	BE	29 59.88 S	11 40.45 W	GPS	3488	3490				26	1-6	
49MR03K04_4	A10	58	1	BUC	112203	0135	UN	29 59.80 S	11 40.43 W	GPS	3488	3489					1	18.8C
49MR03K04_4	A10	58	1	ROS	112203	0228	BO	29 59.52 S	11 40.28 W	GPS	3496	3492	10	3500	3524			
49MR03K04_4	A10	58	1	ROS	112203	0417	EN	29 58.86 S	11 40.18 W	GPS	3498	3499						
49MR03K04_4	A10	59	1	ROS	112203	0650	BE	30 0.09 S	11 0.01 W	GPS	3726	3724				31	1-8,12,13,23,24,26,27,34,35,46,48	#11=#12 DUPLICATE SMPLS (3500DB), #1-3 FOR BIO (150DB, 5DB)
49MR03K04_4	A10	59	1	BUC	112203	0702	UN	30 0.07 S	11 0.06 W	GPS	3720	3721					1	19.5C
49MR03K04_4	A10	59	1	ROS	112203	0750	BO	30 0.06 S	11 0.17 W	GPS	3718	3718	10	3724	3767			
49MR03K04_4	A10	59	1	UNK	112203	0836	BE	30 0.09 S	11 0.30 W	GPS	3710	3712						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	59	1	UNK	112203	0909	EN	30 0.09 S	11 0.33 W	GPS	3709	3710						
49MR03K04_4	A10	59	1	ROS	112203	0934	EN	30 0.05 S	11 0.39 W	GPS	3709	3710						
49MR03K04_4	A10	60	1	ROS	112203	1217	BE	29 59.84 S	10 19.79 W	GPS	3752	3753				36	1-6,9,22,34,35,47,48	#8 FOR BIO (122DB), #1-7 FOR R.N.
49MR03K04_4	A10	60	1	UNK	112203	1240	BE	29 59.81 S	10 19.98 W	GPS	3745	3749					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	60	1	UNK	112203	1255	EN	29 59.78 S	10 20.07 W	GPS	3762	3753						
49MR03K04_4	A10	60	1	ROS	112203	1330	BO	29 59.75 S	10 20.08 W	GPS	3749	3745	26	3742	3789			LADCP SOUNDING
49MR03K04_4	A10	60	1	UNK	112203	1356	BE	29 59.74 S	10 20.02 W	GPS	3742	3738						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	60	1	BUC	112203	1400	UN	29 59.73 S	10 20.02 W	GPS	3739	3740					1,34,35,48	19.2C, 18L FOR BIO
49MR03K04_4	A10	60	1	UNK	112203	1426	EN	29 59.70 S	10 19.96 W	GPS	3734	3735						
49MR03K04_4	A10	60	1	ROS	112203	1511	EN	29 59.68 S	10 19.95 W	GPS	3734	3734						
49MR03K04_4	A10	60	1	FLT	112203	1516	DE	29 59.65 S	10 19.76 W	GPS	3763	3764						ARGO/APEX#1191
49MR03K04_4	A10	61	1	ROS	112203	1757	BE	30 0.05 S	9 39.70 W	GPS	3755	3766				28	1-8,15,23,24,26,27,45	#1=#11 DUPLICATE SMPLS (3500DB)
49MR03K04_4	A10	61	1	BUC	112203	1802	UN	30 0.04 S	9 39.68 W	GPS	3761	3764					1	18.9C
49MR03K04_4	A10	61	1	ROS	112203	1857	BO	30 0.07 S	9 39.52 W	GPS	3786	3785	10	3774	3813			
49MR03K04_4	A10	61	1	ROS	112203	2053	EN	29 59.85 S	9 39.26 W	GPS	3801	3801						
49MR03K04_4	A10	X14	1	ROS	112203	2328	BE	30 0.09 S	8 59.93 W	GPS	3942	3937				29	1-8,12,13,23,24,26,27,46	#1=#10 DUPLICATE SMPLS (3750DB)
49MR03K04_4	A10	X14	1	BUC	112203	2333	UN	29 59.99 S	8 59.93 W	GPS	3936	3937					1	18.6C
49MR03K04_4	A10	X14	1	ROS	112303	0032	BO	29 59.50 S	8 59.72 W	GPS	3922	3917	11	3965	3980			
49MR03K04_4	A10	X14	1	ROS	112303	0236	EN	29 58.52 S	8 58.90 W	GPS	3910	3909						
49MR03K04_4	A10	63	1	ROS	112303	0549	BE	30 0.08 S	8 9.94 W	GPS	3932	3931				31	1-6,34,35,48	#1-3 FOR BIO (105DB, 5DB)
49MR03K04_4	A10	63	1	BUC	112303	0555	UN	30 0.08 S	8 9.93 W	GPS	3932	3934					1	18.3C
49MR03K04_4	A10	63	1	ROS	112303	0653	BO	29 59.94 S	8 9.78 W	GPS	3939	3937	11	3936	3981			

49MR03K04_4	A10	63	1	UNK	112303	0811	BE	29 59.74 S	8 9.44 W	GPS	3943	3942						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	63	1	UNK	112303	0838	EN	29 59.71 S	8 9.30 W	GPS	3954	3952						
49MR03K04_4	A10	63	1	ROS	112303	0847	EN	29 59.65 S	8 9.28 W	GPS	3954	3952						
49MR03K04_4	A10	63	1	FLT	112303	0853	DE	29 59.62 S	8 9.22 W	GPS	3949	3951						ARGO/APEX#1192, DID NOT TURN VERTICAL
49MR03K04_4	A10	64	1	ROS	112303	1203	BE	30 0.09 S	7 19.89 W	GPS	4181	4181				32	1-6,34,35,48	#1-3 FOR BIO (90DB, 5DB)
49MR03K04_4	A10	64	1	BUC	112303	1208	UN	30 0.14 S	7 19.86 W	GPS	4181	4179					1	18.7C
49MR03K04_4	A10	64	1	ROS	112303	1309	BO	30 0.15 S	7 19.87 W	GPS	4175	4178	12	4175	4231			
49MR03K04_4	A10	64	1	UNK	112303	1353	BE	30 0.00 S	7 20.01 W	GPS	4170	4171						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	64	1	UNK	112303	1426	EN	29 59.86 S	7 20.14 W	GPS	4170	4165						
49MR03K04_4	A10	64	1	ROS	112303	1508	EN	29 59.82 S	7 19.95 W	GPS	4172	4172						
49MR03K04_4	A10	65	1	ROS	112303	1817	BE	30 0.25 S	6 29.68 W	GPS	4596	4603				32	1-8,23,24,26,27,46	#7=#9 DUPLICATE SMPLS (4500DB)
49MR03K04_4	A10	65	1	BUC	112303	1822	UN	30 0.20 S	6 29.62 W	GPS	4602	4595					1	19.4C
49MR03K04_4	A10	65	1	ROS	112303	1929	BO	30 0.23 S	6 29.26 W	GPS	4623	4627	11	4622	4682			
49MR03K04_4	A10	65	1	ROS	112303	2145	EN	30 0.22 S	6 29.03 W	GPS	4629	4631						
49MR03K04_4	A10	65	1	FLT	112303	2152	DE	30 0.33 S	6 28.91 W	GPS	4627	4634						ARGO/APEX#886, DID NOT TURN VERTICAL
49MR03K04_4	A10	66	1	ROS	112403	0052	BE	29 59.99 S	5 40.03 W	GPS	4329	4331				36	1-6,9,22,47	#1-6 FOR R.N.
49MR03K04_4	A10	66	1	BUC	112403	0057	UN	29 59.95 S	5 40.00 W	GPS	4345	4341					1	THERMOMETER BROKEN
49MR03K04_4	A10	66	2	BUC	112403	0122	UN	29 59.77 S	5 39.81 W	GPS	4359	4359						19.1C (TEMPERATURE ONLY)
49MR03K04_4	A10	66	1	ROS	112403	0202	BO	29 59.63 S	5 39.56 W	GPS	4378	4378	10	4375	4415			
49MR03K04_4	A10	66	1	UNK	112403	0220	BE	29 59.53 S	5 39.49 W	GPS	4395	4393					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	66	1	UNK	112403	0235	EN	29 59.48 S	5 39.41 W	GPS	4407	4401						
49MR03K04_4	A10	66	1	ROS	112403	0409	EN	29 59.24 S	5 39.21 W	GPS	4417	4415						
49MR03K04_4	A10	67	1	ROS	112403	0714	BE	30 0.02 S	4 49.69 W	GPS	4246	4245				34	1-8,12,13,23,24,26,27,34,35,48	#8=#9 DUPLICATE SMPLS (4000DB),
																		#3-5 FOR BIO (120DB, 5DB)
49MR03K04_4	A10	67	1	BUC	112403	0720	UN	29 59.97 S	4 49.67 W	GPS	4227	4226					1	18.6C
49MR03K04_4	A10	67	1	ROS	112403	0821	BO	29 59.80 S	4 49.30 W	GPS	4248	4247	26	4268	4302			LADCP SOUNDING
49MR03K04_4	A10	67	1	UNK	112403	1006	BE	29 59.60 S	4 48.71 W	GPS	4399	4399						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	67	1	ROS	112403	1021	EN	29 59.56 S	4 48.60 W	GPS	4405	4403						
49MR03K04_4	A10	67	1	UNK	112403	1027	EN	29 59.70 S	4 48.50 W	GPS	4410	4407						
49MR03K04_4	A10	67	1	FLT	112403	1029	DE	29 59.79 S	4 48.45 W	GPS	4403	4404						ARGO/APEX#1193
49MR03K04_4	A10	68	1	ROS	112503	1053	BE	29 59.65 S	4 0.06 W	GPS	3966	3966				31	1-6,34,35,48	REPLACED BTL, #2-4 FOR BIO (100DB, 5DB)
49MR03K04_4	A10	68	1	BUC	112503	1058	UN	29 59.66 S	4 0.02 W	GPS	3970	3971					1	18.9C
49MR03K04_4	A10	68	1	UNK	112503	1117	BE	29 59.72 S	3 59.85 W	GPS	3970	3971						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	68	1	ROS	112503	1156	BO	29 59.69 S	3 59.52 W	GPS	3951	3951	11	3976	4016			
49MR03K04_4	A10	68	1	UNK	112503	1158	EN	29 59.68 S	3 59.51 W	GPS	3951	3951						
49MR03K04_4	A10	68	1	ROS	112503	1353	EN	29 59.73 S	3 58.22 W	GPS	4096	4096						
49MR03K04_4	A10	69	1	ROS	112503	1647	BE	30 0.46 S	3 10.20 W	GPS	4344	4341				31	1-8,15,23,24,26,27,45,46	#7=#8 DUPLICATE SMPLS (4250DB)
49MR03K04_4	A10	69	1	BUC	112503	1652	UN	30 0.49 S	3 10.15 W	GPS	4337	4329					1	19.2C
49MR03K04_4	A10	69	1	ROS	112503	1756	BO	30 0.68 S	3 9.74 W	GPS	4305	4307	11	4360	4389			
49MR03K04_4	A10	69	1	ROS	112503	2005	EN	30 0.90 S	3 8.32 W	GPS	4412	4417						
49MR03K04_4	A10	70	1	ROS	112503	2305	BE	30 0.10 S	2 19.51 W	GPS	4333	4346				30	1-6	
49MR03K04_4	A10	70	1	BUC	112503	2310	UN	30 0.18 S	2 19.47 W	GPS	4366	4372					1	18.7C
49MR03K04_4	A10	70	1	ROS	112603	0014	BO	30 0.78 S	2 19.27 W	GPS	4402	4407	11	4423	4446			
49MR03K04_4	A10	70	1	ROS	112603	0233	EN	30 1.85 S	2 18.44 W	GPS	4466	4471						
49MR03K04_4	A10	70	1	FLT	112603	0239	DE	30 1.99 S	2 18.19 W	GPS	4261	4248						ARGO/APEX#1194
49MR03K04_4	A10	71	1	ROS	112603	0531	BE	30 0.14 S	1 29.96 W	GPS	4721	4725				36	1-8,12,13,23,24,26,27,34,35,48	#6=#7 DUPLICATE SMPLS (4500DB),
																		#2-4 FOR BIO (75DB, 5DB)
49MR03K04_4	A10	71	1	BUC	112603	0537	UN	30 0.18 S	1 29.89 W	GPS	4738	4734					1	18.2C
49MR03K04_4	A10	71	1	ROS	112603	0643	BO	30 0.29 S	1 29.42 W	GPS	4749	4749	9	4756	4786			
49MR03K04_4	A10	71	1	ROS	112603	0854	EN	30 0.45 S	1 28.08 W	GPS	4772	4776						

49MR03K04_4	A10	72	1	ROS	112603	1139	BE	30 0.90 S	0 43.89 W	GPS	4815	4813				36	1-6,9,22,34,35,47	#35 FOR BIO (50DB), #1-4 FOR R.N.
49MR03K04_4	A10	72	1	ROS	112603	1254	BO	30 0.14 S	0 43.80 W	GPS	4826	4823	12	4833	4885			
49MR03K04_4	A10	72	1	BUC	112603	1357	UN	29 59.84 S	0 43.75 W	GPS	4825	4822					1,34,35,48	18.9C, 18L FOR BIO
49MR03K04_4	A10	72	1	UNK	112603	1420	BE	29 59.68 S	0 43.73 W	GPS	4827	4825					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	72	1	UNK	112603	1428	BE	29 59.62 S	0 43.71 W	GPS	4825	4825						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	72	1	UNK	112603	1440	EN	29 59.53 S	0 43.70 W	GPS	4825	4825						81L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	72	1	UNK	112603	1502	EN	29 59.21 S	0 43.70 W	GPS	4823	4823						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	72	1	ROS	112603	1508	EN	29 59.07 S	0 43.66 W	GPS	4825	4824						
49MR03K04_4	A10	72	1	FLT	112603	1513	DE	29 58.99 S	0 43.56 W	GPS	4824	4822						ARGO/APEX#1195
49MR03K04_4	A10	73	1	ROS	112603	1757	BE	29 59.85 S	0 0.25 E	GPS	3882	3887				29	1-8,15,23,24,26,27,45	#5=#10 DUPLICATE SMPLS (3750DB)
49MR03K04_4	A10	73	1	BUC	112603	1802	UN	29 59.80 S	0 0.25 E	GPS	3887	3902					1	18.7C
49MR03K04_4	A10	73	1	ROS	112603	1901	BO	29 59.38 S	0 0.48 E	GPS	3964	3969	11	3912	3941			
49MR03K04_4	A10	73	1	ROS	112603	2056	EN	29 58.73 S	0 0.61 E	GPS	3984	3971						
49MR03K04_4	A10	74	1	ROS	112603	2307	BE	29 51.89 S	0 34.06 E	GPS	3276	3272				25	1-6	
49MR03K04_4	A10	74	1	BUC	112603	2312	UN	29 51.85 S	0 34.10 E	GPS	3283	3284					1	18.2C
49MR03K04_4	A10	74	1	ROS	112703	0001	BO	29 51.64 S	0 34.47 E	GPS	3262	3261	9	3293	3306			
49MR03K04_4	A10	74	1	ROS	112703	0145	EN	29 51.22 S	0 35.09 E	GPS	3217	3220						
49MR03K04_4	A10	75	1	ROS	112703	0355	BE	29 43.91 S	1 7.95 E	GPS	3707	3706				28	1-8,12,13,23,24,26,27,46	#4=#11 DUPLICATE SMPLS (3500DB)
49MR03K04_4	A10	75	1	BUC	112703	0400	UN	29 43.87 S	1 7.91 E	GPS	3704	3705					1	19.2C
49MR03K04_4	A10	75	1	ROS	112703	0454	BO	29 43.58 S	1 7.91 E	GPS	3707	3705	10	3708	3747			
49MR03K04_4	A10	75	1	ROS	112703	0643	EN	29 43.20 S	1 8.07 E	GPS	3715	3714						
49MR03K04_4	A10	75	1	FLT	112703	0650	DE	29 43.13 S	1 8.20 E	GPS	3716	3714						ARGO/APEX#1196
49MR03K04_4	A10	76	1	ROS	112703	0900	BE	29 36.13 S	1 41.94 E	GPS	3647	3648				30	1-6,34,35,48	#1-3 FOR BIO (100DB, 5DB)
49MR03K04_4	A10	76	1	BUC	112703	0905	UN	29 36.12 S	1 42.00 E	GPS	3647	3647					1	19.1C
49MR03K04_4	A10	76	1	ROS	112703	0958	BO	29 36.10 S	1 42.16 E	GPS	3646	3646	10	3652	3688			
49MR03K04_4	A10	76	1	UNK	112703	1114	BE	29 36.00 S	1 42.35 E	GPS	3645	3645						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	76	1	UNK	112703	1141	EN	29 35.98 S	1 42.48 E	GPS	3644	3645						
49MR03K04_4	A10	76	1	ROS	112703	1143	EN	29 35.97 S	1 42.48 E	GPS	3643	3644						
49MR03K04_4	A10	77	1	ROS	112703	1356	BE	29 28.18 S	2 15.75 E	GPS	2717	2716				27	1-8,23,24,26,27,34,35,48	#3=#15 DUPLICATE SMPLS (2600DB), #4-6 FOR BIO (130DB, 5DB)
49MR03K04_4	A10	77	1	BUC	112703	1401	UN	29 28.20 S	2 15.76 E	GPS	2717	2717					1	19.0C
49MR03K04_4	A10	77	1	ROS	112703	1441	BO	29 28.30 S	2 15.94 E	GPS	2713	2712	11	2718	2737			
49MR03K04_4	A10	77	1	UNK	112703	1517	BE	29 28.27 S	2 15.87 E	GPS	2715	2715						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	77	1	UNK	112703	1548	EN	29 28.40 S	2 16.04 E	GPS	2710	2709						
49MR03K04_4	A10	77	1	ROS	112703	1610	EN	29 28.35 S	2 15.95 E	GPS	2712	2712						
49MR03K04_4	A10	78	1	ROS	112703	1824	BE	29 19.96 S	2 49.87 E	GPS	4244	4247				29	1-6	
49MR03K04_4	A10	78	1	BUC	112703	1829	UN	29 19.93 S	2 49.90 E	GPS	4253	4248					1	18.6C
49MR03K04_4	A10	78	1	ROS	112703	1931	BO	29 19.80 S	2 50.20 E	GPS	4262	4254	11	4270	4304			
49MR03K04_4	A10	78	1	ROS	112703	2129	EN	29 19.61 S	2 50.76 E	GPS	4285	4282						
49MR03K04_4	A10	79	1	ROS	112703	2325	BE	29 28.21 S	3 18.17 E	GPS	4718	4722				32	1-8,12,13,15,23,24,26,27,45,46	#2=#7 DUPLICATE SMPLS (4500DB)
49MR03K04_4	A10	79	1	BUC	112703	2331	UN	29 28.17 S	3 18.20 E	GPS	4734	4739					1	18.5C
49MR03K04_4	A10	79	1	ROS	112803	0040	BO	29 28.06 S	3 18.45 E	GPS	4752	4749	11	4750	4816			
49MR03K04_4	A10	79	1	ROS	112803	0248	EN	29 27.76 S	3 18.89 E	GPS	4716	4708						
49MR03K04_4	A10	79	1	FLT	112803	0253	DE	29 27.84 S	3 19.06 E	GPS	4708	4706						ARGO/APEX#887, DID NOT TURN VERTICAL
49MR03K04_4	A10	80	1	ROS	112803	0445	BE	29 36.82 S	3 46.95 E	GPS	4898	4901				36	1-6,9,22,34,35,47	#35 FOR BIO (50DB), #1-4 FOR R.N.
49MR03K04_4	A10	80	1	BUC	112803	0450	UN	29 36.83 S	3 46.96 E	GPS	4900	4901					1	18.5C
49MR03K04_4	A10	80	1	UNK	112803	0600	BE	29 36.51 S	3 46.89 E	GPS	4897	4899					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	80	1	ROS	112803	0601	BO	29 36.51 S	3 46.89 E	GPS	4900	4898	11	4897	4971			
49MR03K04_4	A10	80	1	UNK	112803	0620	EN	29 36.46 S	3 46.92 E	GPS	4896	4895						
49MR03K04_4	A10	80	1	UNK	112803	0738	BE	29 36.09 S	3 47.08 E	GPS	4888	4888						SOLAR LIGHT MEASUREMENT

49MR03K04_4	A10	80	2	BUC	112803	0805	UN	29 36.01 S	3 47.30 E	GPS	4888	4886					34,35,48	18L FOR BIO
49MR03K04_4	A10	80	1	ROS	112803	0808	EN	29 36.00 S	3 47.32 E	GPS	4884	4885						
49MR03K04_4	A10	80	1	UNK	112803	0811	EN	29 36.00 S	3 47.43 E	GPS	4886	4888						
49MR03K04_4	A10	81	1	ROS	112803	0956	BE	29 44.86 S	4 14.30 E	GPS	4978	4976				36	1-8,23,24,26,27,34,35,48	#1=#6 DUPLICATE SMPLS (4750DB), #2-4 FOR BIO (80DB, 5DB)
49MR03K04_4	A10	81	1	BUC	112803	1001	UN	29 44.86 S	4 14.34 E	GPS	4978	4979					1	18.7C
49MR03K04_4	A10	81	1	ROS	112803	1112	BO	29 44.84 S	4 14.62 E	GPS	4978	4978	13	4984	5049			
49MR03K04_4	A10	81	1	ROS	112803	1329	EN	29 44.70 S	4 15.31 E	GPS	4999	4998						
49MR03K04_4	A10	82	1	ROS	112803	1629	BE	29 45.15 S	5 5.95 E	GPS	5187	5191				33	1-6	
49MR03K04_4	A10	82	1	BUC	112803	1634	UN	29 45.13 S	5 5.98 E	GPS	5185	5196					1	19.0C
49MR03K04_4	A10	82	1	ROS	112803	1750	BO	29 45.07 S	5 6.46 E	GPS	5208	5211	10	5207	5287			
49MR03K04_4	A10	82	1	ROS	112803	2012	EN	29 44.88 S	5 7.62 E	GPS	5169	5170						
49MR03K04_4	A10	82	1	FLT	112803	2017	DE	29 44.82 S	5 7.75 E	GPS	5168	5167						ARGO/APEX#1197
49MR03K04_4	A10	83	1	ROS	112803	2310	BE	29 44.73 S	5 55.92 E	GPS	5131	5128				34	1-8,12,13,23,24,26,27,46	#5=#23 DUPLICATE SMPLS (5000DB)
49MR03K04_4	A10	83	1	BUC	112803	2315	UN	29 44.71 S	5 56.02 E	GPS	5128	5129					1	18.6C
49MR03K04_4	A10	83	1	ROS	112903	0029	BO	29 44.43 S	5 57.02 E	GPS	5113	5111	10	5149	5204			
49MR03K04_4	A10	83	1	ROS	112903	0259	EN	29 43.52 S	5 58.66 E	GPS	5048	5045						
49MR03K04_4	A10	84	1	ROS	112903	0555	BE	29 45.04 S	6 46.64 E	GPS	5137	5137				36	1-6,9,22,47,48	#34 FOR BIO (100DB), #1-3 FOR R.N.
49MR03K04_4	A10	84	1	ROS	112903	0714	BO	29 44.59 S	6 46.96 E	GPS	5140	5141	11	5140	5214			
49MR03K04_4	A10	84	1	UNK	112903	0805	BE	29 44.37 S	6 47.07 E	GPS	5140	5141					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	84	1	UNK	112903	0825	EN	29 44.28 S	6 47.18 E	GPS	5137	5138						81L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	84	1	UNK	112903	0836	BE	29 44.22 S	6 47.21 E	GPS	5136	5136						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	84	1	BUC	112903	0857	UN	29 44.09 S	6 47.33 E	GPS	5135	5136					1,34,35,48	18.8C, 18L FOR BIO
49MR03K04_4	A10	84	1	UNK	112903	0902	EN	29 44.06 S	6 47.34 E	GPS	5141	5141						
49MR03K04_4	A10	84	1	ROS	112903	0925	EN	29 43.87 S	6 47.30 E	GPS	5137	5141						
49MR03K04_4	A10	84	1	FLT	112903	0930	DE	29 43.79 S	6 47.35 E	GPS	5137	5142						ARGO/APEX#1198
49MR03K04_4	A10	85	1	ROS	112903	1244	BE	29 44.94 S	7 37.24 E	GPS	5138	5131				35	1-8,15,23,24,26,27,34,35,45	#5=#22 DUPLICATE SMPLS (5000DB), #2 FOR BIO (90DB)
49MR03K04_4	A10	85	1	ROS	112903	1403	BO	29 44.26 S	7 37.76 E	GPS	5142	5139	11	5228	5205			
49MR03K04_4	A10	85	1	BUC	112903	1455	UN	29 43.94 S	7 37.90 E	GPS	5144	5143					1,34,35,48	18.9C, 18L FOR BIO
49MR03K04_4	A10	85	1	UNK	112903	1511	BE	29 43.88 S	7 38.03 E	GPS	5141	5143						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	85	1	UNK	112903	1543	EN	29 43.68 S	7 38.29 E	GPS	5143	5142						
49MR03K04_4	A10	85	1	ROS	112903	1630	EN	29 43.16 S	7 38.65 E	GPS	5141	5139						
49MR03K04_4	A10	86	1	ROS	112903	1948	BE	29 44.77 S	8 27.80 E	GPS	5046	5046				33	1-6	
49MR03K04_4	A10	86	1	BUC	112903	1953	UN	29 44.75 S	8 27.82 E	GPS	5044	5046					1	18.7C
49MR03K04_4	A10	86	1	ROS	112903	2106	BO	29 44.82 S	8 28.24 E	GPS	5043	5046	10	5042	5118			
49MR03K04_4	A10	86	1	ROS	112903	2325	EN	29 44.59 S	8 29.11 E	GPS	5042	5043						
49MR03K04_4	A10	86	1	FLT	112903	2331	DE	29 44.65 S	8 29.14 E	GPS	5044	5044						ARGO/APEX#1199, DID NOT TURN VERTICAL
49MR03K04_4	A10	87	1	ROS	113003	0253	BE	29 44.70 S	9 17.27 E	GPS	4991	4992				34	1-8,12,13,23,24,26,27,46	#5=#21 DUPLICATE SMPLS (5000DB)
49MR03K04_4	A10	87	1	BUC	113003	0303	UN	29 44.60 S	9 17.28 E	GPS	4989	4990					1	18.3C
49MR03K04_4	A10	87	1	ROS	113003	0411	BO	29 44.08 S	9 17.71 E	GPS	4992	4994	11	5028	5066			
49MR03K04_4	A10	87	1	UNK	113003	0610	BE	29 43.27 S	9 18.11 E	GPS	4992	4993					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	87	1	ROS	113003	0622	EN	29 43.17 S	9 18.12 E	GPS	4995	4996						
49MR03K04_4	A10	87	1	UNK	113003	0640	EN	29 43.11 S	9 19.68 E	GPS	4993	4994						
49MR03K04_4	A10	X13	1	ROS	113003	0912	BE	29 45.87 S	9 57.03 E	GPS	4863	4867				36	1-8,23,24,26,27,34,35,48	#6=#20 DUPLICATE SMPLS (4750DB), #2-4 FOR BIO (75DB, 10DB)
49MR03K04_4	A10	X13	1	BUC	113003	0917	UN	29 45.83 S	9 57.08 E	GPS	4868	4864					1	18.4C
49MR03K04_4	A10	X13	1	ROS	113003	1029	BO	29 45.20 S	9 57.69 E	GPS	4876	4872	11	4924	4942			
49MR03K04_4	A10	X13	1	UNK	113003	1103	BE	29 44.92 S	9 57.91 E	GPS	4873	4873						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	X13	1	UNK	113003	1133	EN	29 44.66 S	9 58.18 E	GPS	4874	4873						

49MR03K04_4	A10	X13	1	ROS	113003	1237	EN	29 44.04 S	9 58.65 E	GPS	4876	4872						
49MR03K04_4	A10	X13	1	FLT	113003	1242	DE	29 43.98 S	9 58.76 E	GPS	4879	4873						ARGO/APEX#1200
49MR03K04_4	A10	89	1	ROS	113003	1652	BE	29 44.94 S	10 58.82 E	GPS	4276	4277				1	34,35	#1 FOR BIO (60DB)
49MR03K04_4	A10	89	1	BUC	113003	1759	UN	29 44.89 S	10 58.88 E	GPS	4274	4275					1,34,35,48	18.7C, 18L FOR BIO
49MR03K04_4	A10	89	1	ROS	113003	1802	BO	29 44.89 S	10 58.87 E	GPS	4273	4274	10	4278	4333			
49MR03K04_4	A10	89	1	ROS	113003	2003	EN	29 44.56 S	10 58.77 E	GPS	4274	4274						PRIMARY SENSORS SHOWED UNUSUAL PROFILES
49MR03K04_4	A10	89	2	ROS	113003	2138	BE	29 45.01 S	10 58.99 E	GPS	4272	4273				32	1-6,34,35,48	CLEANED SENSORS BY TRITON-X,
																		#1,2 FOR BIO (55DB, 10DB)
49MR03K04_4	A10	89	2	BUC	113003	2144	UN	29 45.00 S	10 58.91 E	GPS	4272	4274					1	18.6C
49MR03K04_4	A10	89	2	ROS	113003	2246	BO	29 44.87 S	10 58.67 E	GPS	4280	4276	10	4279	4334			
49MR03K04_4	A10	89	2	ROS	120103	0047	EN	29 44.80 S	10 58.22 E	GPS	4272	4276						
49MR03K04_4	A10	90	1	ROS	120103	0449	BE	29 44.99 S	11 49.19 E	GPS	4001	4001				28	1-6	
49MR03K04_4	A10	90	1	BUC	120103	0454	UN	29 45.00 S	11 49.13 E	GPS	4039	4001					1	18.5C
49MR03K04_4	A10	90	1	ROS	120103	0554	BO	29 44.77 S	11 48.69 E	GPS	4003	4003	9	4017	4053			
49MR03K04_4	A10	90	1	ROS	120103	0739	EN	29 44.45 S	11 48.05 E	GPS	4006	4003						
49MR03K04_4	A10	90	1	FLT	120103	0745	DE	29 44.47 S	11 47.97 E	GPS	4003	4000						ARGO/APEX#1201
49MR03K04_4	A10	91	1	ROS	120103	0938	BE	29 37.32 S	12 10.25 E	GPS	3811	3811				36	1-9,15,22-24,26,27,45-47	#10=#19 DUPLICATE SMPLS (3750DB),
																		#2-8 FOR R.N.
49MR03K04_4	A10	91	1	BUC	120103	0943	UN	29 37.31 S	12 10.22 E	GPS	3811	3811					1,34,35,48	18.7C, 18L FOR BIO
49MR03K04_4	A10	91	1	UNK	120103	0945	BE	29 37.31 S	12 10.20 E	GPS	3811	3811					9,22,47	80L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	91	1	UNK	120103	0955	BE	29 37.24 S	12 10.11 E	GPS	3812	3812						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	91	1	UNK	120103	1005	EN	29 37.21 S	12 10.00 E	GPS	3813	3812						81L THROUGH HULL PUMP FOR R.N.
49MR03K04_4	A10	91	1	UNK	120103	1030	EN	29 37.18 S	12 9.72 E	GPS	3816	3815						SOLAR LIGHT MEASUREMENT
49MR03K04_4	A10	91	1	ROS	120103	1046	BO	29 37.11 S	12 9.56 E	GPS	3814	3814	12	3843	3856			
49MR03K04_4	A10	91	1	ROS	120103	1229	EN	29 36.71 S	12 8.73 E	GPS	3821	3821						
49MR03K04_4	A10	92	1	ROS	120103	1409	BE	29 29.90 S	12 28.06 E	GPS	3643	3640				27	1-6	
49MR03K04_4	A10	92	1	BUC	120103	1414	UN	29 29.86 S	12 28.03 E	GPS	3643	3641					1	18.7C
49MR03K04_4	A10	92	1	ROS	120103	1509	BO	29 29.50 S	12 27.68 E	GPS	3644	3641	10	3663	3683			
49MR03K04_4	A10	92	1	ROS	120103	1706	EN	29 28.76 S	12 27.54 E	GPS	3639	3639						
49MR03K04_4	A10	93	1	ROS	120103	1846	BE	29 22.31 S	12 47.37 E	GPS	3348	3346				27	1-8,12,13,23,24,26,27	#8=#12 DUPLICATE SMPLS (3250DB)
49MR03K04_4	A10	93	1	BUC	120103	1851	UN	29 22.25 S	12 47.34 E	GPS	3347	3347					1	18.9C
49MR03K04_4	A10	93	1	ROS	120103	1940	BO	29 22.19 S	12 47.41 E	GPS	3346	3344	11	3346	3382			
49MR03K04_4	A10	93	1	ROS	120103	2123	EN	29 21.72 S	12 47.74 E	GPS	3338	3337						
49MR03K04_4	A10	94	1	ROS	120103	2257	BE	29 14.88 S	13 6.25 E	GPS	3109	3107				25	1-6	
49MR03K04_4	A10	94	1	BUC	120103	2302	UN	29 14.84 S	13 6.25 E	GPS	3104	3102					1	18.3C
49MR03K04_4	A10	94	1	ROS	120103	2348	BO	29 14.68 S	13 6.39 E	GPS	3103	3102	10	3102	3126			
49MR03K04_4	A10	94	1	ROS	120203	0124	EN	29 14.50 S	13 6.90 E	GPS	3103	3102						
49MR03K04_4	A10	95	1	ROS	120203	0253	BE	29 7.25 S	13 25.18 E	GPS	2669	2666				24	1-8,12,13,23,24,26,27,46	#15=#17 DUPLICATE SMPLS (2600DB)
49MR03K04_4	A10	95	1	BUC	120203	0257	UN	29 7.23 S	13 25.20 E	GPS	2668	2664					1	18.3C
49MR03K04_4	A10	95	1	ROS	120203	0335	BO	29 7.09 S	13 25.29 E	GPS	2661	2661	12	2670	2686			
49MR03K04_4	A10	95	1	ROS	120203	0501	EN	29 6.77 S	13 25.70 E	GPS	2650	2648						
49MR03K04_4	A10	96	1	ROS	120203	0629	BE	28 59.93 S	13 43.75 E	GPS	2143	2140				21	1-6	#15 FOR DO MIN (666DB)
49MR03K04_4	A10	96	1	BUC	120203	0633	UN	28 59.94 S	13 43.73 E	GPS	2141	2140					1	18.5C
49MR03K04_4	A10	96	1	ROS	120203	0708	BO	28 59.77 S	13 43.79 E	GPS	2141	2140	9	2145	2155			
49MR03K04_4	A10	96	1	ROS	120203	0815	EN	28 59.79 S	13 43.90 E	GPS	2136	2135						
49MR03K04_4	A10	97	1	ROS	120203	0945	BE	28 52.67 S	14 2.63 E	GPS	1506	1509				18	1-8,12,13,23,24,26,27	#16=#21 DUPLICATE SMPLS (1400DB)
49MR03K04_4	A10	97	1	BUC	120203	0951	UN	28 52.63 S	14 2.58 E	GPS	1515	1520					1	18.6C
49MR03K04_4	A10	97	1	ROS	120203	1016	BO	28 52.57 S	14 2.45 E	GPS	1536	1536	17	1528	1531			
49MR03K04_4	A10	97	1	ROS	120203	1104	EN	28 52.43 S	14 2.33 E	GPS	1568	1566						
49MR03K04_4	A10	98	1	ROS	120203	1235	BE	28 45.27 S	14 21.32 E	GPS	489	490				9	1-6	

49MR03K04_4	A10	98	1	BUC	120203	1237	UN	28 45.27 S	14 21.32 E	GPS	487	489				1	18.3C
49MR03K04_4	A10	98	1	ROS	120203	1245	BO	28 45.25 S	14 21.33 E	GPS	489	489	11	478	481		
49MR03K04_4	A10	98	1	ROS	120203	1304	EN	28 45.20 S	14 21.34 E	GPS	489	488					
49MR03K04_4	A10	99	1	ROS	120203	1438	BE	28 37.32 S	14 41.16 E	GPS	168	168				4 1-6	
49MR03K04_4	A10	99	1	BUC	120203	1439	UN	28 37.31 S	14 41.18 E	GPS	168	168				1	18.3C
49MR03K04_4	A10	99	1	ROS	120203	1444	BO	28 37.31 S	14 41.20 E	GPS	169	169	10	153	154		
49MR03K04_4	A10	99	1	ROS	120203	1452	EN	28 37.24 S	14 41.23 E	GPS	170	169					
49MR03K04_4	A10	100	1	ROS	120203	1618	BE	28 30.18 S	14 59.98 E	GPS	176	177				4 1-6	
49MR03K04_4	A10	100	1	BUC	120203	1619	UN	28 30.17 S	14 59.99 E	GPS	178	178				1	17.7C
49MR03K04_4	A10	100	1	ROS	120203	1623	BO	28 30.15 S	15 0.07 E	GPS	177	178	11	162	163		
49MR03K04_4	A10	100	1	ROS	120203	1632	EN	28 30.05 S	15 0.15 E	GPS	178	178					

I04/I03 REV R/V MIRAI CRUISE MR03K04 LEG5

SHIP/CRS EXPOCODE	WOCE SECT	STNNBR	CASTNO	CAST TYPE	DATE	UTC TIME	EVENT CODE	POSITION LATITUDE	LONGITUDE	NAV	UNC DEPTH	COR DEPTH	HT ABOVE BOTTOM	WIRE OUT	MAX PRESS	NO. OF BOTTLES	PARAMETERS	COMMENTS
49MR03K04_5		1001	1	UNK	121003	0440	BE	37 5.28 S	23 16.40 E	GPS	5289	-9						CTD CABLE RESPOOLING
49MR03K04_5		1001	1	UNK	121003	0647	BO	37 5.22 S	23 13.59 E	GPS	5279	-9		6839				
49MR03K04_5		1001	1	UNK	121003	0925	EN	37 5.90 S	23 12.23 E	GPS	5289	-9						
49MR03K04_5	I04	610	1	ROS	121303	0857	BE	24 39.97 S	35 21.94 E	GPS	123	124				7	1-6,34,35,48	#16-18 FOR BIO (5DB, 45DB)
49MR03K04_5	I04	610	1	BUC	121303	0858	UN	24 39.98 S	35 21.93 E	GPS	123	124					1	27.3C
49MR03K04_5	I04	610	1	ROS	121303	0902	BO	24 40.02 S	35 21.88 E	GPS	122	124	10	109	109			
49MR03K04_5	I04	610	1	ROS	121303	0913	EN	24 40.09 S	35 21.83 E	GPS	123	123						
49MR03K04_5		1002	1	XCT	121303	0939	DE	24 39.99 S	35 25.71 E	GPS	205	211						XCTD01
49MR03K04_5	I04	609	1	BUC	121303	1003	UN	24 39.96 S	35 29.18 E	GPS	298	301					1	27.4C
49MR03K04_5	I04	609	1	ROS	121303	1003	BE	24 39.97 S	35 29.18 E	GPS	298	301				7	1-6	
49MR03K04_5	I04	609	1	ROS	121303	1012	BO	24 40.06 S	35 29.13 E	GPS	296	300	11	284	287			
49MR03K04_5	I04	609	1	ROS	121303	1027	EN	24 40.22 S	35 29.02 E	GPS	294	299						
49MR03K04_5		1003	1	XCT	121303	1043	DE	24 40.12 S	35 31.09 E	GPS	396	404						XCTD02
49MR03K04_5	I04	608	1	BUC	121303	1111	UN	24 40.17 S	35 33.06 E	GPS	592	592					1	27.5C
49MR03K04_5	I04	608	1	ROS	121303	1112	BE	24 40.17 S	35 33.05 E	GPS	592	592				10	1-6	
49MR03K04_5	I04	608	1	ROS	121303	1127	BO	24 40.32 S	35 32.93 E	GPS	588	588	11	577	579			
49MR03K04_5	I04	608	1	ROS	121303	1155	EN	24 40.60 S	35 32.69 E	GPS	580	579						#18 UNMOUNTED BOTTLE PLUNGER ON UPPER ADAPTER PLATE
49MR03K04_5		1004	1	XCT	121303	1224	DE	24 40.09 S	35 38.18 E	GPS	792	792						XCTD03
49MR03K04_5	I04	607	1	ROS	121303	1259	BE	24 39.99 S	35 43.28 E	GPS	937	932				14	1-8,23,24,26,27	#23=#25 DUPLICATE SMPLS (800DB)
49MR03K04_5	I04	607	1	BUC	121303	1304	UN	24 40.06 S	35 43.24 E	GPS	935	930					1	27.9C
49MR03K04_5	I04	607	1	ROS	121303	1320	BO	24 40.24 S	35 43.13 E	GPS	931	927	10	917	921			
49MR03K04_5	I04	607	1	ROS	121303	1356	EN	24 40.65 S	35 42.89 E	GPS	935	930						
49MR03K04_5		1005	1	XCT	121303	1428	DE	24 39.98 S	35 48.14 E	GPS	1030	1026						XCTD04
49MR03K04_5	I04	606	1	ROS	121303	1512	BE	24 40.03 S	35 53.46 E	GPS	1220	1219				15	1-6	
49MR03K04_5	I04	606	1	BUC	121303	1517	UN	24 40.06 S	35 53.41 E	GPS	1217	1212					1	27.9C
49MR03K04_5	I04	606	1	ROS	121303	1540	BO	24 40.28 S	35 53.18 E	GPS	1206	1207	10	1194	1203			
49MR03K04_5	I04	606	1	ROS	121303	1621	EN	24 40.63 S	35 52.74 E	GPS	1188	1183						
49MR03K04_5		1006	1	XCT	121303	1655	DE	24 40.28 S	35 56.74 E	GPS	1468	1461						XCTD05
49MR03K04_5	I04	605	1	BUC	121303	1800	UN	24 40.01 S	35 59.92 E	GPS	1632	1632					1	27.8C
49MR03K04_5	I04	605	1	ROS	121303	1801	BE	24 40.01 S	35 59.92 E	GPS	1632	1632				18	1-8,23,24,26,27	#12=#24 DUPLICATE SMPLS (1400DB)
49MR03K04_5	I04	605	1	ROS	121303	1833	BO	24 40.34 S	35 59.64 E	GPS	1623	1623	11	1617	1624			
49MR03K04_5	I04	605	1	ROS	121303	1925	EN	24 40.79 S	35 59.29 E	GPS	1616	1615						
49MR03K04_5		1007	1	XCT	121303	2006	DE	24 39.92 S	36 7.45 E	GPS	1935	1935						XCTD06
49MR03K04_5	I04	604	1	ROS	121303	2052	BE	24 39.69 S	36 14.85 E	GPS	2159	2163				20	1-6	
49MR03K04_5	I04	604	1	BUC	121303	2057	UN	24 39.76 S	36 14.76 E	GPS	2172	2168					1	28.2C
49MR03K04_5	I04	604	1	ROS	121303	2128	BO	24 40.02 S	36 14.42 E	GPS	2140	2143	10	2168	2166			
49MR03K04_5	I04	604	1	ROS	121303	2239	EN	24 40.24 S	36 13.65 E	GPS	2080	2082						
49MR03K04_5		1008	1	XCT	121303	2324	DE	24 39.62 S	36 22.55 E	GPS	2152	2140						XCTD07
49MR03K04_5	I04	603	1	ROS	121403	0002	BE	24 39.52 S	36 30.11 E	GPS	2112	2113				21	1-8,15,23,24,26,27,45	#10=#25 DUPLICATE SMPLS (2000DB)
49MR03K04_5	I04	603	1	BUC	121403	0008	UN	24 39.56 S	36 30.02 E	GPS	2112	2114					1	27.6C
49MR03K04_5	I04	603	1	ROS	121403	0039	BO	24 39.61 S	36 29.63 E	GPS	2113	2114	9	2123	2125			
49MR03K04_5	I04	603	1	ROS	121403	0145	EN	24 39.78 S	36 28.71 E	GPS	2117	2120						
49MR03K04_5		1009	1	XCT	121403	0229	DE	24 39.76 S	36 37.54 E	GPS	2052	2054						XCTD08
49MR03K04_5	I04	602	1	ROS	121403	0321	BE	24 40.06 S	36 44.97 E	GPS	2173	2173				23	1-6,34,35,48	#1-3 FOR BIO (5DB, 90DB)
49MR03K04_5	I04	602	1	BUC	121403	0332	UN	24 40.17 S	36 44.85 E	GPS	2165	2166					1	26.7C

49MR03K04_5	I04	602	1	ROS	121403	0400	BO	24 40.32 S	36 44.56 E	GPS	2153	2154	10	2160	2165			
49MR03K04_5	I04	602	1	ROS	121403	0509	EN	24 40.70 S	36 43.78 E	GPS	2142	2143						
49MR03K04_5		1010	1	XCT	121403	0552	DE	24 40.11 S	36 52.59 E	GPS	2419	2433						XCTD09
49MR03K04_5	I04	601	1	ROS	121403	0632	BE	24 40.05 S	37 0.11 E	GPS	3062	3063				25	1-8,12,13,23,24,26,27	#14=#21 DUPLICATE SMPLS (2800DB)
49MR03K04_5	I04	601	1	BUC	121403	0637	UN	24 40.17 S	37 0.03 E	GPS	3061	3062					1	26.3C
49MR03K04_5	I04	601	1	ROS	121403	0722	BO	24 40.40 S	36 59.47 E	GPS	3075	3075	10	3099	3084			
49MR03K04_5	I04	601	1	ROS	121403	0904	EN	24 40.78 S	36 58.06 E	GPS	3145	3146						
49MR03K04_5		1011	1	XCT	121403	1017	DE	24 40.01 S	37 15.09 E	GPS	3338	3341						XCTD10
49MR03K04_5	I04	600	1	ROS	121403	1123	BE	24 39.92 S	37 29.99 E	GPS	3360	3361				33	1-6,9,22,47	#1-7 FOR R.N.
49MR03K04_5	I04	600	1	UNK	121403	1125	BE	24 39.93 S	37 29.96 E	GPS	3360	3366						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I04	600	1	BUC	121403	1126	UN	24 39.95 S	37 29.93 E	GPS	3369	3370					1	26.0C
49MR03K04_5	I04	600	1	UNK	121403	1208	EN	24 40.02 S	37 29.44 E	GPS	3403	3405						
49MR03K04_5	I04	600	1	ROS	121403	1216	BO	24 40.02 S	37 29.40 E	GPS	3405	3407	10	3408	3431			
49MR03K04_5	I04	600	1	ROS	121403	1353	EN	24 40.17 S	37 28.41 E	GPS	3335	3335						
49MR03K04_5	I04	599	1	ROS	121403	1605	BE	24 40.05 S	37 59.17 E	GPS	3183	3182				26	1-8,23,24,26,27,46	#13=#20 DUPLICATE SMPLS (3000DB)
49MR03K04_5	I04	599	1	BUC	121403	1610	UN	24 40.02 S	37 59.05 E	GPS	3185	3184					1	26.7C
49MR03K04_5	I04	599	1	ROS	121403	1657	BO	24 39.61 S	37 58.54 E	GPS	3174	3173	14	3223	3206			
49MR03K04_5	I04	599	1	ROS	121403	1831	EN	24 39.01 S	37 57.77 E	GPS	3176	3176						
49MR03K04_5	I04	598	1	ROS	121403	2048	BE	24 39.86 S	38 30.01 E	GPS	3370	3369				26	1-6	
49MR03K04_5	I04	598	1	BUC	121403	2053	UN	24 39.80 S	38 29.94 E	GPS	3372	3369					1	26.6C
49MR03K04_5	I04	598	1	ROS	121403	2143	BO	24 39.31 S	38 29.60 E	GPS	3358	3358	13	3424	3407			
49MR03K04_5	I04	598	1	ROS	121403	2328	EN	24 38.66 S	38 28.77 E	GPS	3385	3384						
49MR03K04_5	I04	597	1	ROS	121503	0139	BE	24 39.96 S	38 59.95 E	GPS	3474	3473				27	1-8,15,23,24,26,27,45	#12=#19 DUPLICATE SMPLS (3250DB)
49MR03K04_5	I04	597	1	BUC	121503	0145	UN	24 39.92 S	38 59.88 E	GPS	3478	3473					1	26.3C
49MR03K04_5	I04	597	1	ROS	121503	0233	BO	24 39.55 S	38 59.73 E	GPS	3476	3476	11	3489	3508			A FISH IN PRIMARY TC DUCT AT DEPTHS SHALLOWER THAN 800DB ON UP-CAST
49MR03K04_5	I04	597	1	ROS	121503	0411	EN	24 38.96 S	38 59.24 E	GPS	3470	3469						
49MR03K04_5	I04	596	1	ROS	121503	0618	BE	24 40.00 S	39 30.11 E	GPS	3571	3570				30	1-6,34,35,48	#1-3 FOR BIO (5DB, 75DB)
49MR03K04_5	I04	596	1	UNK	121503	0620	BE	24 39.97 S	39 30.09 E	GPS	3571	3570						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I04	596	1	BUC	121503	0623	UN	24 39.95 S	39 30.05 E	GPS	3569	3570					1	26.9C
49MR03K04_5	I04	596	1	UNK	121503	0644	EN	24 39.94 S	39 30.00 E	GPS	3568	3567						
49MR03K04_5	I04	596	1	ROS	121503	0713	BO	24 39.92 S	39 30.08 E	GPS	3569	3570	11	3600	3605			
49MR03K04_5	I04	596	2	UNK	121503	0728	BE	24 39.89 S	39 30.10 E	GPS	3565	3564						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I04	596	2	UNK	121503	0807	EN	24 39.75 S	39 30.20 E	GPS	3563	3562						
49MR03K04_5	I04	596	1	ROS	121503	0857	EN	24 39.47 S	39 30.24 E	GPS	3563	3563						
49MR03K04_5	I04	595	1	ROS	121503	1102	BE	24 39.92 S	39 59.96 E	GPS	3532	3531				27	1-8,12,13,23,24,26,27,46	#12=#18 DUPLICATE SMPLS (3250DB)
49MR03K04_5	I04	595	1	BUC	121503	1105	UN	24 39.90 S	39 59.93 E	GPS	3533	3532					1	27.8C
49MR03K04_5	I04	595	1	ROS	121503	1158	BO	24 39.67 S	39 59.77 E	GPS	3543	3543	10	3546	3578			
49MR03K04_5	I04	595	1	ROS	121503	1336	EN	24 39.20 S	39 59.74 E	GPS	3535	3533						
49MR03K04_5	I04	594	1	ROS	121503	1542	BE	24 40.01 S	40 30.03 E	GPS	3583	3580				33	1-6,9,22,47	#1-7 FOR R.N.
49MR03K04_5	I04	594	1	BUC	121503	1545	UN	24 39.99 S	40 30.02 E	GPS	3581	3579					1	27.6C
49MR03K04_5	I04	594	1	ROS	121503	1639	BO	24 39.73 S	40 29.89 E	GPS	3564	3563	8	3566	3603			
49MR03K04_5	I04	594	1	ROS	121503	1816	EN	24 39.24 S	40 29.82 E	GPS	3576	3578						
49MR03K04_5	I04	593	1	ROS	121503	2027	BE	24 40.03 S	40 59.91 E	GPS	3635	3632				28	1-8,23,24,26,27	#11=#17 DUPLICATE SMPLS (3500DB)
49MR03K04_5	I04	593	1	BUC	121503	2032	UN	24 39.99 S	40 59.92 E	GPS	3632	3633					1	27.6C
49MR03K04_5	I04	593	1	ROS	121503	2124	BO	24 39.79 S	40 59.92 E	GPS	3638	3637	11	3641	3669			
49MR03K04_5	I04	593	1	ROS	121503	2310	EN	24 39.14 S	41 0.00 E	GPS	3635	3634						
49MR03K04_5	I04	592	1	ROS	121603	0124	BE	24 39.96 S	41 29.87 E	GPS	3678	3680				30	1-6,34,35,48	#1-3 FOR BIO (5DB, 60DB)
49MR03K04_5	I04	592	1	BUC	121603	0131	UN	24 39.91 S	41 29.80 E	GPS	3677	3677					1	27.6C
49MR03K04_5	I04	592	1	ROS	121603	0224	BO	24 39.70 S	41 29.67 E	GPS	3675	3678	12	3701	3717			

49MR03K04_5	I04	592	1	ROS	121603	0402	EN	24 39.41 S	41 29.14 E	GPS	3673	3674						
49MR03K04_5	I04	591	1	ROS	121603	0619	BE	24 39.87 S	41 59.86 E	GPS	3760	3761				31	1-8,23,24,26,27,34,35,46,48	#2-4 FOR BIO (5DB, 55DB)
49MR03K04_5	I04	591	1	BUC	121603	0624	UN	24 39.82 S	41 59.78 E	GPS	3762	3763					1	27.5C
49MR03K04_5	I04	591	1	UNK	121603	0625	BE	24 39.81 S	41 59.76 E	GPS	3769	3765						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I04	591	1	UNK	121603	0658	EN	24 39.71 S	41 59.50 E	GPS	3762	3764						
49MR03K04_5	I04	591	1	ROS	121603	0718	BO	24 39.70 S	41 59.38 E	GPS	3763	3766	10	3758	3804			
49MR03K04_5	I04	591	1	ROS	121603	0912	EN	24 39.21 S	41 58.49 E	GPS	3801	3806						
49MR03K04_5	I04	590	1	ROS	121603	1134	BE	24 39.97 S	42 29.91 E	GPS	3573	3575				26	1-6	
49MR03K04_5	I04	590	1	BUC	121603	1147	UN	24 39.92 S	42 29.73 E	GPS	3571	3573					1	27.9C
49MR03K04_5	I04	590	1	ROS	121603	1232	BO	24 39.76 S	42 29.31 E	GPS	3555	3557	11	3580	3604			
49MR03K04_5	I04	590	1	ROS	121603	1408	EN	24 39.16 S	42 28.38 E	GPS	3567	3565						
49MR03K04_5	I04	589	1	ROS	121603	1629	BE	24 39.95 S	43 0.09 E	GPS	3692	3696				24	1-8,12,13,23,24,26,27	#11=#15 DUPLICATE SMPLS (3500DB)
49MR03K04_5	I04	589	1	BUC	121603	1641	UN	24 39.93 S	43 0.06 E	GPS	3691	3697					1	27.8C
49MR03K04_5	I04	589	1	ROS	121603	1727	BO	24 39.90 S	42 59.84 E	GPS	3702	3695	10	3680	3724			
49MR03K04_5	I04	589	1	ROS	121603	1915	EN	24 40.20 S	42 59.38 E	GPS	3732	3732						
49MR03K04_5	I04	588	1	ROS	121603	2053	BE	24 39.78 S	43 20.18 E	GPS	3864	3857				35	1-6,9,22,47	#1-7 FOR R.N.
49MR03K04_5	I04	588	1	BUC	121603	2104	UN	24 39.77 S	43 20.20 E	GPS	3857	3857					1	27.8C
49MR03K04_5	I04	588	1	ROS	121603	2153	BO	24 39.53 S	43 20.22 E	GPS	3854	3855	10	3868	3899			
49MR03K04_5	I04	588	1	ROS	121603	2341	EN	24 39.23 S	43 20.26 E	GPS	3852	3853						
49MR03K04_5	I04	587	1	ROS	121703	0405	BE	24 40.50 S	43 33.15 E	GPS	2979	2992				25	1-8,15,23,24,26,27,45	
49MR03K04_5	I04	587	1	BUC	121703	0416	UN	24 40.46 S	43 33.22 E	GPS	2982	2986					1	28.0C
49MR03K04_5	I04	587	1	ROS	121703	0455	BO	24 40.29 S	43 33.10 E	GPS	3024	3023	13	3010	3042			
49MR03K04_5	I04	587	1	ROS	121703	0628	EN	24 40.12 S	43 32.97 E	GPS	3058	3060						
49MR03K04_5		1012	1	XCT	121703	0712	DE	24 40.19 S	43 40.66 E	GPS	2700	2747						XCTD11
49MR03K04_5	I04	586	1	ROS	121703	0800	BE	24 40.04 S	43 48.24 E	GPS	2018	2014				23	1-8,23,24,26,27,34,35,48	#10=#13 DUPLICATE SMPLS (1800DB), #22-24 FOR BIO (5DB, 65DB)
49MR03K04_5	I04	586	1	UNK	121703	0800	BE	24 40.04 S	43 48.24 E	GPS	2018	2014						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I04	586	1	BUC	121703	0812	UN	24 40.05 S	43 48.17 E	GPS	2010	2011					1	27.9C
49MR03K04_5	I04	586	1	UNK	121703	0828	EN	24 39.98 S	43 48.15 E	GPS	1996	1999						
49MR03K04_5	I04	586	1	ROS	121703	0836	BO	24 39.94 S	43 48.15 E	GPS	1963	1963	9	2001	2013			
49MR03K04_5	I04	586	1	ROS	121703	0940	EN	24 39.79 S	43 47.88 E	GPS	2034	2030						
49MR03K04_5		1013	1	XCT	121703	1008	DE	24 39.94 S	43 50.28 E	GPS	1614	1626						XCTD12
49MR03K04_5	I04	585	1	ROS	121703	1057	BE	24 39.90 S	43 52.29 E	GPS	1095	1098				14	1-6	
49MR03K04_5	I04	585	1	BUC	121703	1057	UN	24 39.90 S	43 52.30 E	GPS	1101	1098					1	28.0C
49MR03K04_5	I04	585	1	ROS	121703	1123	BO	24 39.97 S	43 52.13 E	GPS	1168	1164	18	1145	1160			
49MR03K04_5	I04	585	1	ROS	121703	1200	EN	24 40.09 S	43 51.83 E	GPS	1307	1308						
49MR03K04_5	I03	562	1	ROS	121903	0646	BE	20 0.08 S	48 54.96 E	GPS	231	231				9	1-6,34,35,48	#1-3 FOR BIO (5DB, 60DB)
49MR03K04_5	I03	562	1	BUC	121903	0650	UN	20 0.15 S	48 54.91 E	GPS	228	231					1	27.5C
49MR03K04_5	I03	562	1	ROS	121903	0655	BO	20 0.25 S	48 54.85 E	GPS	232	233	8	223	222			
49MR03K04_5	I03	562	1	ROS	121903	0707	EN	20 0.39 S	48 54.74 E	GPS	237	238						
49MR03K04_5		1014	1	XCT	121903	0726	DE	20 0.03 S	48 57.25 E	GPS	909	860						XCTD13
49MR03K04_5	I03	561	1	ROS	121903	0743	BE	20 0.14 S	48 59.48 E	GPS	1105	1097				16	1-8,23,24,26,27	#11=#12 DUPLICATE SMPLS (1000DB)
49MR03K04_5	I03	561	1	BUC	121903	0747	UN	20 0.22 S	48 59.46 E	GPS	1131	1136					1	27.7C
49MR03K04_5	I03	561	1	ROS	121903	0808	BO	20 0.45 S	48 59.30 E	GPS	1299	1290	10	1277	1278			
49MR03K04_5	I03	561	1	ROS	121903	0847	EN	20 0.87 S	48 59.02 E	GPS	1143	1148						
49MR03K04_5		1015	1	XCT	121903	0921	DE	20 0.13 S	49 4.26 E	GPS	1665	1666						XCTD14
49MR03K04_5	I03	560	1	UNK	121903	0952	BE	20 0.26 S	49 9.09 E	GPS	2280	2278						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	560	1	ROS	121903	0957	BE	20 0.31 S	49 9.04 E	GPS	2254	2255				23	1-6,34,35,48	#1-3 FOR BIO (5DB, 95DB)
49MR03K04_5	I03	560	1	BUC	121903	1000	UN	20 0.37 S	49 9.00 E	GPS	2229	2230					1	27.8C
49MR03K04_5	I03	560	1	UNK	121903	1017	EN	20 0.55 S	49 8.83 E	GPS	2154	2154						

49MR03K04_5	I03	560	1	UNK	121903	1030	BE	20 0.68 S	49 8.69 E	GPS	2153	2154						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	560	1	ROS	121903	1033	BO	20 0.70 S	49 8.66 E	GPS	2141	2140	13	2160	2156			
49MR03K04_5	I03	560	1	UNK	121903	1102	EN	20 0.82 S	49 8.39 E	GPS	2018	2015						
49MR03K04_5	I03	560	1	ROS	121903	1141	EN	20 1.26 S	49 8.02 E	GPS	1974	1976						
49MR03K04_5		1016	1	XCT	121903	1223	DE	20 0.09 S	49 16.22 E	GPS	2444	2442						XCTD15
49MR03K04_5	I03	559	1	ROS	121903	1258	BE	20 0.02 S	49 23.37 E	GPS	2909	2907				25	1-8,23,24,26,27	#11=#14 DUPLICATE SMPLS (2800DB)
49MR03K04_5	I03	559	1	BUC	121903	1301	UN	20 0.04 S	49 23.33 E	GPS	2901	2903					1	27.6C
49MR03K04_5	I03	559	1	ROS	121903	1343	BO	20 0.19 S	49 22.93 E	GPS	2874	2873	11	2871	2890			
49MR03K04_5	I03	559	1	ROS	121903	1502	EN	20 0.35 S	49 22.18 E	GPS	2777	2779						
49MR03K04_5		1017	1	XCT	121903	1542	DE	20 0.00 S	49 30.75 E	GPS	3367	3370						XCTD16
49MR03K04_5	I03	558	1	ROS	122003	2105	BE	20 0.10 S	49 38.01 E	GPS	3651	3648				27	1-6	
49MR03K04_5	I03	558	1	BUC	122003	2110	UN	20 0.10 S	49 37.98 E	GPS	3651	3648					1	27.7C
49MR03K04_5	I03	558	1	ROS	122003	2204	BO	20 0.06 S	49 37.67 E	GPS	3643	3640	12	3639	3677			
49MR03K04_5	I03	558	1	ROS	122003	2347	EN	20 0.23 S	49 36.64 E	GPS	3618	3615						
49MR03K04_5		1018	1	XCT	122103	0051	DE	20 0.02 S	49 51.02 E	GPS	4080	4080						XCTD17
49MR03K04_5	I03	557	1	ROS	122103	0149	BE	20 0.08 S	50 3.90 E	GPS	4345	4342				34	1-8,12,13,23,24,26,27,34,35,48	#8=#10 DUPLICATE SMPLS (4250DB), #2-4 FOR BIO (5DB, 120DB)
49MR03K04_5	I03	557	1	BUC	122103	0155	UN	20 0.06 S	50 3.88 E	GPS	4349	4343					1	27.6C
49MR03K04_5	I03	557	1	ROS	122103	0257	BO	19 59.79 S	50 3.61 E	GPS	4350	4348	11	4367	4399			
49MR03K04_5	I03	557	1	ROS	122103	0453	EN	19 59.67 S	50 3.14 E	GPS	4366	4368						
49MR03K04_5	I03	556	1	ROS	122103	0711	BE	19 59.98 S	50 36.04 E	GPS	4759	4758				34	1-6,34,35,48	#1-3 FOR BIO (5DB, 100DB)
49MR03K04_5	I03	556	1	UNK	122103	0711	BE	19 59.98 S	50 36.04 E	GPS	4758	4758						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	556	1	BUC	122103	0717	UN	19 59.95 S	50 36.07 E	GPS	4759	4760					1	27.7C
49MR03K04_5	I03	556	1	UNK	122103	0736	EN	19 59.88 S	50 36.06 E	GPS	4761	4759						
49MR03K04_5	I03	556	1	ROS	122103	0826	BO	19 59.72 S	50 36.03 E	GPS	4750	4759	10	4761	4823			
49MR03K04_5	I03	556	1	ROS	122103	1024	EN	19 59.42 S	50 35.78 E	GPS	4759	4757						
49MR03K04_5	I03	555	1	ROS	122103	1204	BE	20 0.06 S	51 0.03 E	GPS	4851	4848				33	1-8,23,24,26,27,46	#6=#8 DUPLICATE SMPLS (4750DB)
49MR03K04_5	I03	555	1	BUC	122103	1209	UN	20 0.05 S	51 0.08 E	GPS	4850	4851					1	27.9C
49MR03K04_5	I03	555	1	ROS	122103	1315	BO	20 0.01 S	51 0.14 E	GPS	4850	4850	11	4790	4916			
49MR03K04_5	I03	555	1	ROS	122103	1519	EN	19 59.78 S	51 0.46 E	GPS	4846	4848						
49MR03K04_5	I03	554	1	ROS	122103	1646	BE	20 0.02 S	51 17.95 E	GPS	4904	4900				32	1-6	
49MR03K04_5	I03	554	1	BUC	122103	1651	UN	19 59.98 S	51 17.98 E	GPS	4902	4901					1	27.6C
49MR03K04_5	I03	554	1	ROS	122103	1800	BO	19 59.76 S	51 17.86 E	GPS	4901	4900	13	4894	4966			
49MR03K04_5	I03	554	1	ROS	122103	2004	EN	19 59.13 S	51 17.54 E	GPS	4903	4904						
49MR03K04_5	I03	553	1	ROS	122103	2205	BE	19 59.90 S	51 47.08 E	GPS	4937	4939				36	1-8,23,24,26,27	#6=#8 DUPLICATE SMPLS (4750DB), #2-4 FOR BIO (5DB, 100DB)
49MR03K04_5	I03	553	1	BUC	122103	2211	UN	19 59.85 S	51 47.06 E	GPS	4940	4938					1	27.5C
49MR03K04_5	I03	553	1	ROS	122103	2321	BO	19 59.48 S	51 46.85 E	GPS	4940	4938	11	4957	5007			
49MR03K04_5	I03	553	1	ROS	122203	0133	EN	19 59.10 S	51 46.27 E	GPS	4939	4938						
49MR03K04_5	I03	552	1	ROS	122203	0339	BE	20 0.01 S	52 16.07 E	GPS	4951	4952				35	1-6,34,35,48	#1-3 FOR BIO (5DB, 100DB)
49MR03K04_5	I03	552	1	BUC	122203	0344	UN	20 0.03 S	52 16.01 E	GPS	4952	4953					1	27.4C
49MR03K04_5	I03	552	1	ROS	122203	0455	BO	19 59.78 S	52 15.65 E	GPS	4951	4950	11	4949	5012			
49MR03K04_5	I03	552	1	UNK	122203	0550	BE	19 59.61 S	52 15.26 E	GPS	4947	4948						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	552	1	ROS	122203	0708	EN	19 59.37 S	52 14.78 E	GPS	4947	4949						
49MR03K04_5	I03	552	1	UNK	122203	0712	EN	19 59.37 S	52 14.76 E	GPS	4951	4950						
49MR03K04_5	I03	551	1	ROS	122203	0924	BE	19 59.87 S	52 47.10 E	GPS	4931	4932				33	1-8,12,13,15,23,24,26,27,45,46	#6=#7 DUPLICATE SMPLS (4750DB)
49MR03K04_5	I03	551	1	BUC	122203	0930	UN	19 59.79 S	52 47.08 E	GPS	4934	4933					1	27.7C
49MR03K04_5	I03	551	1	ROS	122203	1041	BO	19 59.12 S	52 46.64 E	GPS	4930	4933	10	5004	5000			
49MR03K04_5	I03	551	1	ROS	122203	1247	EN	19 58.41 S	52 45.90 E	GPS	4931	4935						
49MR03K04_5	I03	550	1	ROS	122203	1508	BE	19 59.96 S	53 20.02 E	GPS	4904	4907				36	1-6,9,22,47	#1-4 FOR R.N.

49MR03K04_5	I03	550	1	BUC	122203	1513	UN	19 59.95 S	53 19.99 E	GPS	4907	4906					1	27.5C
49MR03K04_5	I03	550	1	ROS	122203	1622	BO	19 59.94 S	53 19.78 E	GPS	4905	4906	12	4897	4972			
49MR03K04_5	I03	550	1	ROS	122203	1825	EN	19 59.23 S	53 19.37 E	GPS	4907	4905						
49MR03K04_5	I03	549	1	ROS	122203	2042	BE	19 59.98 S	53 53.05 E	GPS	4876	4876				33	1-8,23,2426,27	#1=#6 DUPLICATE SMPLS (4750DB)
49MR03K04_5	I03	549	1	BUC	122203	2047	UN	19 59.96 S	53 53.07 E	GPS	4876	4875					1	27.4C
49MR03K04_5	I03	549	1	ROS	122203	2159	BO	19 59.66 S	53 52.90 E	GPS	4878	4878	11	4868	4938			#8 ILLEGAL TRIP
49MR03K04_5	I03	549	1	ROS	122303	0003	EN	19 59.09 S	53 52.69 E	GPS	4883	4880						
49MR03K04_5	I03	X07	1	ROS	122303	0234	BE	19 59.83 S	54 30.18 E	GPS	4571	4573				35	1-8,23,24,26,27,34,35,46,48	#5=#7 DUPLICATE SMPLS (4500DB), #1-3 FOR BIO (5DB, 110DB)
49MR03K04_5	I03	X07	1	BUC	122303	0240	UN	19 59.81 S	54 30.22 E	GPS	4571	4570					1	27.3C
49MR03K04_5	I03	X07	1	ROS	122303	0345	BO	19 59.89 S	54 30.33 E	GPS	4570	4570	11	4561	4629			
49MR03K04_5	I03	X07	1	ROS	122303	0544	EN	19 59.95 S	54 30.68 E	GPS	4566	4565						
49MR03K04_5	I03	547	1	ROS	122303	0739	BE	20 0.03 S	54 59.20 E	GPS	4397	4402				33	1-6,9,11,34,35,48	#1-3 FOR BIO (5DB, 100DB)
49MR03K04_5	I03	547	1	BUC	122303	0745	UN	20 0.05 S	54 59.28 E	GPS	4389	4386					1	27.0C
49MR03K04_5	I03	547	1	UNK	122303	0839	BE	20 0.19 S	54 59.43 E	GPS	4413	4403						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	547	1	ROS	122303	0850	BO	20 0.19 S	54 59.32 E	GPS	4411	4410	11	4376	4436			
49MR03K04_5	I03	547	1	UNK	122303	0909	EN	20 0.22 S	54 59.52 E	GPS	4456	4455						
49MR03K04_5	I03	547	1	ROS	122303	1040	EN	20 0.26 S	54 59.79 E	GPS	4428	4428						#32 DISCONNECTED MIDDLE AND LOWER LANYARD
49MR03K04_5	I03	546	1	ROS	122303	1248	BE	19 59.97 S	55 32.20 E	GPS	4394	4393				30	1-6	#8 ILLEGAL TRIP
49MR03K04_5	I03	546	1	BUC	122303	1253	UN	19 59.94 S	55 32.24 E	GPS	4394	4393					1	27.2C
49MR03K04_5	I03	546	1	ROS	122303	1356	BO	19 59.89 S	55 32.26 E	GPS	4392	4392	12	4387	4447			
49MR03K04_5	I03	546	1	ROS	122303	1552	EN	19 59.63 S	55 32.71 E	GPS	4392	4393						
49MR03K04_5	I03	545	1	ROS	122303	1759	BE	20 0.00 S	56 5.15 E	GPS	4387	4385				31	1-8,12,13,23,24,26,27	#4=#8 DUPLICATE SMPLS (4250DB)
49MR03K04_5	I03	545	1	BUC	122303	1804	UN	19 59.96 S	56 5.20 E	GPS	4386	4386					1	27.2C
49MR03K04_5	I03	545	1	ROS	122303	1906	BO	19 59.94 S	56 5.53 E	GPS	4385	4385	10	4381	4441			
49MR03K04_5	I03	545	1	ROS	122303	2104	EN	19 59.28 S	56 5.63 E	GPS	4385	4386						
49MR03K04_5	I03	544	1	ROS	122303	2316	BE	20 0.16 S	56 37.92 E	GPS	4366	4366				36	1-6,9,22,47	#1-6 FOR R.N.
49MR03K04_5	I03	544	1	BUC	122303	2322	UN	20 0.14 S	56 38.01 E	GPS	4366	4369					1	27.0C
49MR03K04_5	I03	544	1	ROS	122403	0023	BO	20 0.06 S	56 38.02 E	GPS	4358	4367	12	4367	4419			
49MR03K04_5	I03	544	1	ROS	122403	0232	EN	19 59.62 S	56 38.16 E	GPS	4367	4367						
49MR03K04_5	I03	543	1	ROS	122403	0417	BE	19 59.89 S	57 2.96 E	GPS	4370	4371				34	1-8,15,23,24,26,27,34,35,45,46,48	#3=#8 DUPLICATE SMPLS (4250DB), #4-6 FOR BIO (5DB, 100DB)
49MR03K04_5	I03	543	1	BUC	122403	0422	UN	19 59.84 S	57 2.97 E	GPS	4369	4370					1	27.1C
49MR03K04_5	I03	543	1	ROS	122403	0526	BO	19 59.67 S	57 2.45 E	GPS	4372	4372	11	4419	4424			
49MR03K04_5	I03	543	1	ROS	122403	0740	EN	19 59.47 S	57 1.59 E	GPS	4370	4370						
49MR03K04_5	I03	542	1	ROS	122403	0921	BE	19 59.96 S	57 16.96 E	GPS	3420	3419				26	1-6	
49MR03K04_5	I03	542	1	BUC	122403	0927	UN	19 59.90 S	57 16.97 E	GPS	3428	3427					1	27.3C
49MR03K04_5	I03	542	1	UNK	122403	1013	BE	19 59.70 S	57 16.81 E	GPS	3467	3469						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	542	1	ROS	122403	1018	BO	19 59.62 S	57 16.82 E	GPS	3492	3489	13	3458	3478			
49MR03K04_5	I03	542	1	UNK	122403	1041	EN	19 59.52 S	57 16.70 E	GPS	3514	3515						
49MR03K04_5	I03	542	1	ROS	122403	1207	EN	19 58.78 S	57 16.17 E	GPS	3563	3568						
49MR03K04_5	I03	541	1	ROS	122403	1256	BE	19 59.93 S	57 25.01 E	GPS	2609	2615				23	1-8,23,24,26,27	#2=#16 DUPLICATE SMPLS (2400DB)
49MR03K04_5	I03	541	1	BUC	122403	1301	UN	19 59.89 S	57 24.97 E	GPS	2621	2620					1	27.2C
49MR03K04_5	I03	541	1	ROS	122403	1341	BO	19 59.71 S	57 24.70 E	GPS	2680	2681	15	2648	2652			
49MR03K04_5	I03	541	1	ROS	122403	1457	EN	19 59.53 S	57 24.39 E	GPS	2732	2733						
49MR03K04_5	I03	540	1	ROS	122403	1610	BE	19 59.95 S	57 29.14 E	GPS	1665	1683				17	1-6	
49MR03K04_5	I03	540	1	BUC	122403	1615	UN	19 59.94 S	57 29.16 E	GPS	1668	1666					1	27.0C
49MR03K04_5	I03	540	1	ROS	122403	1645	BO	19 59.88 S	57 29.24 E	GPS	1656	1651	4	1674	1681			
49MR03K04_5	I03	540	1	ROS	122403	1738	EN	19 59.81 S	57 29.24 E	GPS	1660	1660						
49MR03K04_5	I03	539	1	ROS	122503	0004	BE	20 21.90 S	57 58.01 E	GPS	1729	1722				19	1-8,23,24,26,27	#1=#10 DUPLICATE SMPLS (1600DB)

49MR03K04_5	I03	539	1	BUC	122503	0010	UN	20 21.85 S	57 58.08 E	GPS	1723	1715					1	26.9C
49MR03K04_5	I03	539	1	ROS	122503	0037	BO	20 21.77 S	57 58.12 E	GPS	1732	1750	13	1712	1722			
49MR03K04_5	I03	539	1	ROS	122503	0131	EN	20 21.64 S	57 58.31 E	GPS	1738	1742						
49MR03K04_5	I03	538	1	ROS	122503	0234	BE	20 22.02 S	58 0.39 E	GPS	2566	2569				25	1-6,34,35,48	#1-3 FOR BIO (5DB, 115DB)
49MR03K04_5	I03	538	1	BUC	122503	0238	UN	20 21.98 S	58 0.43 E	GPS	2557	2568					1	26.9C
49MR03K04_5	I03	538	1	ROS	122503	0317	BO	20 21.91 S	58 0.60 E	GPS	2631	2630	13	2571	2589			
49MR03K04_5	I03	538	1	ROS	122503	0439	EN	20 21.34 S	58 0.67 E	GPS	2378	2372						
49MR03K04_5	I03	537	1	ROS	122503	0532	BE	20 21.88 S	58 9.38 E	GPS	4358	4358				31	1-8,23,24,26,27,46	#8=#23 DUPLICATE SMPLS (4250DB)
49MR03K04_5	I03	537	1	BUC	122503	0539	UN	20 21.79 S	58 9.35 E	GPS	4360	4356					1	26.8C
49MR03K04_5	I03	537	1	ROS	122503	0643	BO	20 21.24 S	58 8.90 E	GPS	4337	4333	11	4408	4398			
49MR03K04_5	I03	537	1	UNK	122503	0717	BE	20 21.18 S	58 8.57 E	GPS	4345	4342						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	537	1	UNK	122503	0745	EN	20 21.18 S	58 8.30 E	GPS	4326	4328						
49MR03K04_5	I03	537	1	ROS	122503	0839	EN	20 20.95 S	58 7.71 E	GPS	4301	4300						
49MR03K04_5	I03	536	1	ROS	122503	1041	BE	20 21.97 S	58 37.08 E	GPS	4531	4533				36	1-6,9,22,47	#1-6 FOR R.N.
49MR03K04_5	I03	536	1	BUC	122503	1046	UN	20 21.93 S	58 37.09 E	GPS	4513	4537					1	27.2C
49MR03K04_5	I03	536	1	ROS	122503	1151	BO	20 21.52 S	58 36.92 E	GPS	4535	4540	14	4570	4601			
49MR03K04_5	I03	536	1	ROS	122503	1354	EN	20 20.92 S	58 36.50 E	GPS	4523	4522						
49MR03K04_5	I03	535	1	ROS	122503	1617	BE	20 22.20 S	59 13.65 E	GPS	4792	4775				33	1-8,12,13,23,24,26,27	#7=#22 DUPLICATE SMPLS (4500DB)
49MR03K04_5	I03	535	1	BUC	122503	1623	UN	20 22.25 S	59 13.74 E	GPS	4788	4793					1	26.9C
49MR03K04_5	I03	535	1	ROS	122503	1733	BO	20 22.80 S	59 13.65 E	GPS	4776	4777	14	4784	4823			
49MR03K04_5	I03	535	1	ROS	122503	1944	EN	20 23.68 S	59 13.24 E	GPS	4762	4768						
49MR03K04_5	I03	534	1	ROS	122503	2206	BE	20 22.12 S	59 49.38 E	GPS	4102	4105				29	1-6	
49MR03K04_5	I03	534	1	BUC	122503	2211	UN	20 22.14 S	59 49.41 E	GPS	4117	4120					1	27.1C
49MR03K04_5	I03	534	1	ROS	122503	2311	BO	20 22.33 S	59 49.44 E	GPS	4156	4160	11	4127	4173			
49MR03K04_5	I03	534	1	ROS	122603	0143	EN	20 22.89 S	59 49.33 E	GPS	4188	4205						
49MR03K04_5	I03	534	1	FLT	122603	0150	DE	20 22.87 S	59 49.42 E	GPS	4199	4200						ARGO/APEX#1077
49MR03K04_5	I03	533	1	ROS	122603	0357	BE	20 21.97 S	60 22.69 E	GPS	3915	3916				32	1-8,23,24,26,27,34,35,46,48	#10=#21 DUPLICATE SMPLS (3750DB), #2-4 FOR BIO (5DB, 110DB)
49MR03K04_5	I03	533	1	BUC	122603	0402	UN	20 21.90 S	60 22.71 E	GPS	3906	3925					1	27.0C
49MR03K04_5	I03	533	1	ROS	122603	0503	BO	20 21.60 S	60 22.57 E	GPS	3923	3902	12	3930	3951			
49MR03K04_5	I03	533	1	UNK	122603	0620	BE	20 20.87 S	60 22.34 E	GPS	3870	3880						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	533	1	UNK	122603	0650	EN	20 20.52 S	60 22.29 E	GPS	3989	3995						
49MR03K04_5	I03	533	1	ROS	122603	0703	EN	20 20.31 S	60 22.30 E	GPS	4033	4034						
49MR03K04_5	I03	532	1	ROS	122703	2308	BE	20 21.91 S	61 1.81 E	GPS	3767	3759				27	1-6	
49MR03K04_5	I03	532	1	BUC	122703	2313	UN	20 21.84 S	61 1.78 E	GPS	3786	3786					1	26.7C
49MR03K04_5	I03	532	1	ROS	122803	0015	BO	20 21.37 S	61 1.69 E	GPS	3784	3777	17	3870	3892			
49MR03K04_5	I03	532	1	ROS	122803	0208	EN	20 20.12 S	61 1.42 E	GPS	3771	3775						
49MR03K04_5	I03	531	1	ROS	122803	0440	BE	20 22.11 S	61 38.41 E	GPS	3579	3573				32	1-8,12,13,23,24,26,27,34,35,48	#12=#20 DUPLICATE SMPLS (3250DB), #2-4 FOR BIO (5DB, 115DB), #6 FOR FREONS (10DB)
49MR03K04_5	I03	531	1	BUC	122803	0445	UN	20 22.15 S	61 38.33 E	GPS	3579	3585					1	26.5C
49MR03K04_5	I03	531	1	ROS	122803	0539	BO	20 22.08 S	61 37.87 E	GPS	3673	3673	13	3640	3648			
49MR03K04_5	I03	531	1	UNK	122803	0542	BE	20 22.07 S	61 37.85 E	GPS	3680	3679						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	531	1	UNK	122803	0614	EN	20 21.99 S	61 37.63 E	GPS	3686	3688						
49MR03K04_5	I03	531	1	ROS	122803	0733	EN	20 21.98 S	61 37.21 E	GPS	3612	3612						
49MR03K04_5	I03	530	1	ROS	122803	1010	BE	20 22.07 S	62 14.25 E	GPS	3051	3055				33	1-6,9,15,22,34,35,45,47,48	#8-10 FOR BIO (5DB, 120DB), #2-7 FOR R.N.
49MR03K04_5	I03	530	1	BUC	122803	1017	UN	20 22.07 S	62 14.22 E	GPS	3059	3065					1	26.7C
49MR03K04_5	I03	530	1	ROS	122803	1102	BO	20 21.96 S	62 14.00 E	GPS	3118	3112	12	3085	3106			
49MR03K04_5	I03	530	1	ROS	122803	1236	EN	20 21.59 S	62 13.79 E	GPS	3117	3098						
49MR03K04_5	I03	529	1	ROS	122803	1508	BE	20 22.01 S	62 50.99 E	GPS	3360	3360				27	1-8,23,24,26,27,46	#12=#19 DUPLICATE SMPLS (3250DB)
49MR03K04_5	I03	529	1	BUC	122803	1513	UN	20 21.93 S	62 51.02 E	GPS	3358	3358					1	26.5C

49MR03K04_5	I03	529	1	ROS	122803	1603	BO	20 21.57 S	62 51.07 E	GPS	3333	3334	8	3353	3373			
49MR03K04_5	I03	529	1	ROS	122803	1741	EN	20 21.22 S	62 51.22 E	GPS	3340	3341						JELLYFISH IN THE SECONDARY TC DUCT AROSE ERRONEOUS CONDUCTIVITY (UPPER THAN 3208DB)
49MR03K04_5	I03	529	1	FLT	122803	1746	DE	20 21.16 S	62 51.36 E	GPS	3341	3341						ARGO/APEX#1078
49MR03K04_5	I03	528	1	ROS	122803	1955	BE	20 21.98 S	63 22.78 E	GPS	2940	2943				24	1-6	
49MR03K04_5	I03	528	1	BUC	122803	2000	UN	20 21.91 S	63 22.80 E	GPS	2918	2917					1	26.8C
49MR03K04_5	I03	528	1	ROS	122803	2042	BO	20 21.82 S	63 22.78 E	GPS	2921	2917	9	2914	2942			
49MR03K04_5	I03	528	1	ROS	122803	2214	EN	20 20.98 S	63 22.76 E	GPS	2936	2935						
49MR03K04_5	I03	527	1	ROS	122903	0030	BE	20 16.46 S	63 53.80 E	GPS	2932	2950				25	1-8,23,24,26,27	#14=#18 DUPLICATE SMPLS (2800DB)
49MR03K04_5	I03	527	1	BUC	122903	0035	UN	20 16.38 S	63 53.79 E	GPS	2953	2963					1	26.4C
49MR03K04_5	I03	527	1	ROS	122903	0120	BO	20 15.96 S	63 53.90 E	GPS	2975	2978	8	3028	3020			
49MR03K04_5	I03	527	1	ROS	122903	0256	EN	20 15.37 S	63 53.77 E	GPS	3019	3014						
49MR03K04_5	I03	526	1	ROS	122903	0509	BE	20 10.91 S	64 25.05 E	GPS	3039	3035				27	1-6,34,35,48	#1-3 FOR BIO (5DB, 110DB)
49MR03K04_5	I03	526	1	BUC	122903	0514	UN	20 10.80 S	64 25.05 E	GPS	3034	3031					1	26.4C
49MR03K04_5	I03	526	1	ROS	122903	0558	BO	20 10.62 S	64 24.72 E	GPS	3030	3031	11	3032	3049			
49MR03K04_5	I03	526	1	UNK	122903	0600	BE	20 10.93 S	64 25.05 E	GPS	3034	3030						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	526	1	UNK	122903	0632	EN	20 10.66 S	64 24.45 E	GPS	3046	3042						
49MR03K04_5	I03	526	1	ROS	122903	0733	EN	20 10.53 S	64 23.85 E	GPS	3010	2985						
49MR03K04_5	I03	525	1	ROS	122903	0947	BE	20 5.51 S	64 56.02 E	GPS	2927	2921				25	1-8,12,13,15,23,24,26,27,45,46	#14=#17 DUPLICATE SMPLS (2800DB)
49MR03K04_5	I03	525	1	BUC	122903	0953	UN	20 5.49 S	64 56.04 E	GPS	2910	2912					1	26.5C
49MR03K04_5	I03	525	1	ROS	122903	1035	BO	20 5.35 S	64 56.05 E	GPS	2909	2909	11	2910	2934			
49MR03K04_5	I03	525	1	ROS	122903	1207	EN	20 5.09 S	64 56.05 E	GPS	2870	2871						
49MR03K04_5	I03	524	1	ROS	122903	1411	BE	20 0.08 S	65 25.88 E	GPS	2567	2553				22	1-6	
49MR03K04_5	I03	524	1	BUC	122903	1415	UN	20 0.05 S	65 25.92 E	GPS	2556	2543					1	26.3C
49MR03K04_5	I03	524	1	ROS	122903	1452	BO	19 59.85 S	65 25.90 E	GPS	2583	2578	8	2533	2539			
49MR03K04_5	I03	524	1	ROS	122903	1603	EN	19 59.64 S	65 25.79 E	GPS	2554	2551						
49MR03K04_5	I03	523	1	ROS	122903	1821	BE	20 0.17 S	65 58.96 E	GPS	2338	2353				22	1-8,23,24,26,27	#16=#18 DUPLICATE SMPLS (2000DB)
49MR03K04_5	I03	523	1	BUC	122903	1826	UN	20 0.17 S	65 58.95 E	GPS	2345	2352					1	26.5C
49MR03K04_5	I03	523	1	ROS	122903	1902	BO	20 0.09 S	65 58.83 E	GPS	2471	2473	24	2362	2378			
49MR03K04_5	I03	523	1	ROS	122903	2018	EN	19 59.82 S	65 58.69 E	GPS	2612	2610						
49MR03K04_5	I03	523	1	FLT	122903	2023	DE	19 59.85 S	65 58.88 E	GPS	2588	2562						ARGO/APEX#1080
49MR03K04_5	I03	522	1	ROS	122903	2241	BE	20 0.10 S	66 31.98 E	GPS	2509	2513				21	1-6	
49MR03K04_5	I03	522	1	BUC	122903	2245	UN	20 0.09 S	66 31.96 E	GPS	2527	2527					1	26.6C
49MR03K04_5	I03	522	1	ROS	122903	2324	BO	19 59.90 S	66 31.89 E	GPS	2481	2484	14	2536	2551			
49MR03K04_5	I03	522	1	ROS	123003	0037	EN	19 59.59 S	66 31.78 E	GPS	2410	2404						
49MR03K04_5	I03	521	1	ROS	123003	0300	BE	20 0.07 S	67 5.97 E	GPS	2436	2430				25	1-8,23,24,26,27,34,35,46,48	#15=#17 DUPLICATE SMPLS (2200DB), #1-3 FOR BIO (5DB, 115DB)
49MR03K04_5	I03	521	1	BUC	123003	0306	UN	20 0.07 S	67 5.96 E	GPS	2460	2412					1	26.4C
49MR03K04_5	I03	521	1	ROS	123003	0340	BO	20 0.01 S	67 5.82 E	GPS	2389	2390	11	2377	2394			
49MR03K04_5	I03	521	1	ROS	123003	0457	EN	20 0.03 S	67 5.53 E	GPS	2459	2457						
49MR03K04_5	I03	520	1	UNK	123003	0719	BE	20 0.02 S	67 39.06 E	GPS	2912	2922						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	520	1	ROS	123003	0721	BE	20 0.02 S	67 39.07 E	GPS	2920	2930				27	1-6,34,35,48	#4-6 FOR BIO (5DB, 120DB)
49MR03K04_5	I03	520	1	BUC	123003	0725	UN	19 59.99 S	67 38.99 E	GPS	2950	2952					1	26.3C
49MR03K04_5	I03	520	1	UNK	123003	0748	EN	19 59.91 S	67 38.87 E	GPS	2909	2905						
49MR03K04_5	I03	520	1	ROS	123003	0813	BO	19 59.77 S	67 38.75 E	GPS	2886	2876	14	2993	2947			
49MR03K04_5	I03	520	1	ROS	123003	0936	EN	19 59.50 S	67 38.25 E	GPS	2983	2988						
49MR03K04_5	I03	519	1	ROS	123003	1210	BE	19 59.96 S	68 12.95 E	GPS	2531	2524				23	1-8,12,13,23,24,26,27	#14=#16 DUPLICATE SMPLS (2400DB)
49MR03K04_5	I03	519	1	BUC	123003	1214	UN	19 59.95 S	68 12.96 E	GPS	2525	2526					1	26.8C
49MR03K04_5	I03	519	1	ROS	123003	1256	BO	19 59.87 S	68 12.80 E	GPS	2572	2572	?	2521	2541			
49MR03K04_5	I03	519	1	ROS	123003	1419	EN	19 59.76 S	68 12.64 E	GPS	2590	2589						

49MR03K04_5	I03	518	1	ROS	123003	1642	BE	20 0.07 S	68 47.99 E	GPS	2634	2626				28	1-6,9,22,47	#1-3,5-7 FOR R.N.
49MR03K04_5	I03	518	1	BUC	123003	1647	UN	20 0.08 S	68 47.98 E	GPS	2627	2625					1	26.6C
49MR03K04_5	I03	518	1	ROS	123003	1725	BO	20 0.01 S	68 47.89 E	GPS	2656	2651	10	2616	2639			
49MR03K04_5	I03	518	1	ROS	123003	1842	EN	19 59.86 S	68 47.53 E	GPS	2663	2663						
49MR03K04_5	I03	523	1	FLT	123003	1847	DE	19 59.81 S	68 47.66 E	GPS	2674	2670						ARGO/APEX#1079
49MR03K04_5	I03	517	1	ROS	123003	2105	BE	20 0.07 S	69 22.03 E	GPS	3309	3324				26	1-8,15,23,24,26,27,45,46	#11=#13 DUPLICATE SMPLS (3000DB)
49MR03K04_5	I03	517	1	BUC	123003	2110	UN	20 0.01 S	69 21.98 E	GPS	3337	3321					1	26.4C
49MR03K04_5	I03	517	1	ROS	123003	2159	BO	19 59.78 S	69 21.93 E	GPS	3346	3332	8	3342	3372			
49MR03K04_5	I03	517	1	ROS	123003	2332	EN	19 59.06 S	69 21.44 E	GPS	3344	3344						
49MR03K04_5	I03	516	1	ROS	123103	0126	BE	20 0.04 S	69 48.01 E	GPS	3618	3618				30	1-6,34,35,48	#1-3 FOR BIO (5DB, 130DB)
49MR03K04_5	I03	516	1	BUC	123103	0132	UN	20 0.00 S	69 48.03 E	GPS	3617	3617					1	26.2C
49MR03K04_5	I03	516	1	ROS	123103	0225	BO	19 59.60 S	69 47.99 E	GPS	3635	3598	13	3625	3640			
49MR03K04_5	I03	516	1	ROS	123103	0412	EN	19 58.63 S	69 47.79 E	GPS	3439	3440						
49MR03K04_5	I03	515	1	ROS	123103	0606	BE	20 0.07 S	70 14.98 E	GPS	3282	3282				29	1-8,23,24,26,27,34,35,48	#12=#13 DUPLICATE SMPLS (3000DB), #1-3 FOR BIO (5DB, 130DB)
49MR03K04_5	I03	515	1	BUC	123103	0611	UN	20 0.01 S	70 15.01 E	GPS	3318	3288					1	26.2C
49MR03K04_5	I03	515	1	UNK	123103	0611	BE	20 0.01 S	70 15.01 E	GPS	3318	3288						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	515	1	UNK	123103	0640	EN	19 59.85 S	70 14.87 E	GPS	3359	3357						
49MR03K04_5	I03	515	1	ROS	123103	0658	BO	19 59.73 S	70 14.78 E	GPS	3349	3340	4	3333	3338			
49MR03K04_5	I03	515	1	ROS	123103	0837	EN	19 58.59 S	70 14.17 E	GPS	3342	3335						
49MR03K04_5	I03	514	1	ROS	123103	1042	BE	19 59.95 S	70 44.82 E	GPS	3638	3636				27	1-6	
49MR03K04_5	I03	514	1	BUC	123103	1050	UN	19 59.89 S	70 44.80 E	GPS	3643	3627					1	26.6C
49MR03K04_5	I03	514	1	ROS	123103	1143	BO	19 59.41 S	70 44.62 E	GPS	3545	3540	9	3677	3665			
49MR03K04_5	I03	514	1	ROS	123103	1337	EN	19 58.60 S	70 44.12 E	GPS	3514	3518						
49MR03K04_5	I03	513	1	ROS	010104	1402	BE	19 59.98 S	71 15.31 E	GPS	4187	4185				30	1-8,12,13,23,24,26,27,46	#9=#11 DUPLICATE SMPLS (4000DB)
49MR03K04_5	I03	513	1	BUC	010104	1412	UN	19 59.94 S	71 15.33 E	GPS	4186	4184					1	26.1C
49MR03K04_5	I03	513	1	ROS	010104	1512	BO	19 59.82 S	71 15.35 E	GPS	4192	4189	10	4183	4239			REPLACED CAROUSEL FROM #0391 TO #0278
49MR03K04_5	I03	513	1	ROS	010104	1708	EN	19 59.69 S	71 15.32 E	GPS	4184	4185						
49MR03K04_5	I03	512	1	ROS	010104	1903	BE	20 0.13 S	71 41.99 E	GPS	3639	3655				34	1-6,9,15,22,45,47	#1-9 FOR R.N.
49MR03K04_5	I03	512	1	BUC	010104	1909	UN	20 0.12 S	71 41.94 E	GPS	3692	3690					1	26.1C
49MR03K04_5	I03	512	1	ROS	010104	2003	BO	19 59.80 S	71 41.78 E	GPS	3640	3650	8	3673	3703			
49MR03K04_5	I03	512	1	ROS	010104	2145	EN	19 59.00 S	71 41.55 E	GPS	3771	3753						
49MR03K04_5	I03	512	1	FLT	010104	2150	DE	19 58.97 S	71 41.65 E	GPS	3678	3633						ARGO/APEX#1097
49MR03K04_5	I03	511	1	ROS	010104	2352	BE	20 0.11 S	72 11.86 E	GPS	3973	3963				32	1-8,23,24,26,27,34,35,48	#1=#10 DUPLICATE SMPLS (3750DB), #2-4 FOR BIO (5DB, 125DB)
49MR03K04_5	I03	511	1	BUC	010104	2358	UN	20 0.08 S	72 11.83 E	GPS	3976	3976					1	25.8C
49MR03K04_5	I03	511	1	ROS	010204	0056	BO	19 59.85 S	72 11.71 E	GPS	3994	4000	0	3907	3956			DOUBTFUL ALTIMETER VALUE AS NEGATIVE
49MR03K04_5	I03	511	1	ROS	010204	0305	EN	19 59.02 S	72 11.27 E	GPS	4008	4006						
49MR03K04_5	I03	510	1	ROS	010204	0517	BE	20 0.11 S	72 42.79 E	GPS	4160	4159				32	1-6,34,35,38,48	#1-3 FOR BIO (5DB, 125DB)
49MR03K04_5	I03	510	1	BUC	010204	0522	UN	20 0.05 S	72 42.76 E	GPS	4184	4184					1	26.2C
49MR03K04_5	I03	510	1	UNK	010204	0527	BE	20 0.00 S	72 42.73 E	GPS	4197	4202						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	510	1	UNK	010204	0604	EN	19 59.62 S	72 42.68 E	GPS	4216	4227						
49MR03K04_5	I03	510	1	ROS	010204	0625	BO	19 59.44 S	72 42.64 E	GPS	4209	4214	12	4261	4257			
49MR03K04_5	I03	510	1	ROS	010204	0826	EN	19 58.25 S	72 42.42 E	GPS	4242	4242						REPLACED ALTIMETER FROM #1026 TO #0396
49MR03K04_5	I03	509	1	ROS	010204	1034	BE	19 59.94 S	73 11.90 E	GPS	4542	4530				32	1-8,23,24,26,27,46	#1=#9 DUPLICATE SMPLS (4000DB)
49MR03K04_5	I03	509	1	BUC	010204	1038	UN	19 59.85 S	73 11.85 E	GPS	4517	4513					1	26.2C
49MR03K04_5	I03	509	1	UNK	010204	1128	BE	19 59.36 S	73 11.93 E	GPS	4650	4650						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	509	1	UNK	010204	1136	EN	19 59.26 S	73 11.97 E	GPS	4618	4617						
49MR03K04_5	I03	509	1	ROS	010204	1144	BO	19 59.21 S	73 12.00 E	GPS	4585	4570	15	4597	4604			
49MR03K04_5	I03	509	1	ROS	010204	1347	EN	19 58.32 S	73 12.28 E	GPS	4568	4570						

49MR03K04_5	I03	508	1	ROS	010204	1547	BE	19 59.85 S	73 39.92 E	GPS	4220	4215				30	1-6	
49MR03K04_5	I03	508	1	BUC	010204	1551	UN	19 59.80 S	73 39.89 E	GPS	4214	4212					1	25.9C
49MR03K04_5	I03	508	1	ROS	010204	1653	BO	19 59.23 S	73 39.83 E	GPS	4275	4278	12	4303	4300			
49MR03K04_5	I03	508	1	ROS	010204	1844	EN	19 58.34 S	73 39.69 E	GPS	4209	4192						
49MR03K04_5	I03	507	1	ROS	010204	2055	BE	20 0.07 S	74 10.00 E	GPS	4958	4953				33	1-8,12,13,23,24,26,27	#6=#8 DUPLICATE SMPLS (4750DB)
49MR03K04_5	I03	507	1	BUC	010204	2100	UN	20 0.07 S	74 9.97 E	GPS	4938	4953					1	26.4C
49MR03K04_5	I03	507	1	ROS	010204	2210	BO	20 0.02 S	74 10.03 E	GPS	4938	4942	9	4956	5031			
49MR03K04_5	I03	507	1	ROS	010304	0023	EN	19 59.83 S	74 10.03 E	GPS	4890	4882						
49MR03K04_5	I03	506	1	ROS	010304	0244	BE	19 59.97 S	74 43.99 E	GPS	4809	4812				35	1-6,34,35,48	#2-4 FOR BIO (5DB, 145DB)
49MR03K04_5	I03	506	1	BUC	010304	0250	UN	19 59.94 S	74 43.95 E	GPS	4810	4824					1	25.8C
49MR03K04_5	I03	506	1	ROS	010304	0359	BO	19 59.67 S	74 44.02 E	GPS	4855	4855	10	4847	4911			
49MR03K04_5	I03	506	1	UNK	010304	0505	BE	19 59.44 S	74 43.97 E	GPS	4908	4908						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	506	1	UNK	010304	0528	EN	19 59.32 S	74 43.96 E	GPS	4930	4929						
49MR03K04_5	I03	506	1	ROS	010304	0610	EN	19 59.12 S	74 43.87 E	GPS	4928	4928						
49MR03K04_5	I03	506	1	FLT	010304	0615	DE	19 59.11 S	74 43.92 E	GPS	4933	4927						ARGO/APEX#1098
49MR03K04_5	I03	505	1	ROS	010304	0911	BE	19 59.93 S	75 27.48 E	GPS	4474	4483				32	1-8,15,23,24,26,27,45	#7=#8 DUPLICATE SMPLS (4250DB)
49MR03K04_5	I03	505	1	BUC	010304	0917	UN	19 59.82 S	75 27.44 E	GPS	4474	4477					1	25.9C
49MR03K04_5	I03	505	1	ROS	010304	1021	BO	19 59.44 S	75 27.54 E	GPS	4521	4516	9	4505	4560			
49MR03K04_5	I03	505	1	ROS	010304	1214	EN	19 58.83 S	75 27.68 E	GPS	4456	4443						
49MR03K04_5	I03	504	1	ROS	010304	1511	BE	19 59.96 S	76 11.08 E	GPS	4702	4697				31	1-6	
49MR03K04_5	I03	504	1	BUC	010304	1516	UN	19 59.91 S	76 11.06 E	GPS	4688	4663					1	25.8C
49MR03K04_5	I03	504	1	ROS	010304	1623	BO	19 59.44 S	76 11.27 E	GPS	4659	4658	10	4709	4738			
49MR03K04_5	I03	504	1	ROS	010304	1826	EN	19 58.64 S	76 11.34 E	GPS	4733	4733						
49MR03K04_5	I03	503	1	ROS	010304	2123	BE	19 59.92 S	76 54.46 E	GPS	5073	5086				36	1-8,12,13,23,24,26,27,34,35,46	#1=#8 DUPLICATE SMPLS (4750DB), #2 FOR BIO (110DB)
49MR03K04_5	I03	503	1	BUC	010304	2129	UN	19 59.89 S	76 54.49 E	GPS	5075	5084					1,34,35,48	25.7C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	503	1	ROS	010304	2259	BO	19 59.23 S	76 54.47 E	GPS	5047	5048	11	5126	5168			PRIMARY CONDUCTIVITY CELL FAILED AT 5000DB DURING THE DOWN-CAST
49MR03K04_5	I03	503	1	ROS	010404	0138	EN	19 58.56 S	76 54.55 E	GPS	5004	5007						
49MR03K04_5	I03	502	1	ROS	010404	0433	BE	20 0.08 S	77 37.95 E	GPS	5125	5132						PRIMARY CONDUCTIVITY CELL WAS REPLACED FROM #041088 TO #042435
49MR03K04_5	I03	502	1	ROS	010404	0436	EN	20 0.07 S	77 37.96 E	GPS	5133	5134						PRIMARY CONDUCTIVITY CELL WAS MISS-INSTALLED, NO DATA
49MR03K04_5	I03	502	2	ROS	010404	0455	BE	20 0.14 S	77 37.94 E	GPS	5147	5133						
49MR03K04_5	I03	502	2	ROS	010404	0457	EN	20 0.16 S	77 37.94 E	GPS	5140	5123						SECONDARY CONDUCTIVITY CELL WAS MISS-INSTALLED, NO DATA
49MR03K04_5	I03	502	3	ROS	010404	0515	BE	20 0.11 S	77 38.28 E	GPS	5131	5132				33	1-6,9,22,34,35,47	#1=#4 DUPLICATE SMPLS (B-10DB), #3 FOR BIO (135DB), #2 FOR R.N. (600DB)
49MR03K04_5	I03	502	1	BUC	010404	0521	UN	20 0.13 S	77 38.30 E	GPS	5129	5129					1,34,35,48	26.0C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	502	1	UNK	010404	0550	BE	20 0.16 S	77 38.25 E	GPS	5123	5122						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	502	1	UNK	010404	0620	EN	20 0.14 S	77 38.19 E	GPS	5122	5127						
49MR03K04_5	I03	502	3	ROS	010404	0635	BO	20 0.12 S	77 38.13 E	GPS	5130	5131	11	5127	5201			
49MR03K04_5	I03	502	2	UNK	010404	0841	BE	19 59.75 S	77 37.44 E	GPS	5122	5120						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	502	2	UNK	010404	0848	EN	19 59.74 S	77 37.42 E	GPS	5121	5121						
49MR03K04_5	I03	502	3	ROS	010404	0859	EN	19 59.72 S	77 37.37 E	GPS	5127	5132						
49MR03K04_5	I03	502	1	FLT	010404	0905	DE	19 59.74 S	77 37.44 E	GPS	5129	5127						ARGO/APEX#1075
49MR03K04_5	I03	501	1	ROS	010404	1202	BE	20 0.05 S	78 21.54 E	GPS	4532	4532				32	1-8,23,24,26,27	#5=#8 DUPLICATE SMPLS (4250DB)
49MR03K04_5	I03	501	1	BUC	010404	1207	UN	20 0.03 S	78 21.54 E	GPS	4534	4534					1	25.0C
49MR03K04_5	I03	501	1	ROS	010404	1312	BO	19 59.61 S	78 21.41 E	GPS	4537	4536	10	4545	4587			
49MR03K04_5	I03	501	1	ROS	010404	1513	EN	19 58.75 S	78 21.47 E	GPS	4621	4620						

49MR03K04_5	I03	500	1	ROS	010404	1816	BE	19 59.96 S	79 4.99 E	GPS	4857	4856				32	1-6	
49MR03K04_5	I03	500	1	BUC	010404	1821	UN	19 59.93 S	79 4.95 E	GPS	4857	4858					1	25.2C
49MR03K04_5	I03	500	1	ROS	010404	1931	BO	19 59.52 S	79 4.87 E	GPS	4841	4833	10	4876	4928			
49MR03K04_5	I03	500	1	ROS	010404	2136	EN	19 58.73 S	79 4.80 E	GPS	4973	4967						CTD CABLE CUT (450DB)
49MR03K04_5	I03	X08	1	ROS	010504	0138	BE	20 0.00 S	79 59.99 E	GPS	4869	4872				36	1-8,12,13,23,24,26,27,34,35,46	#4=#6 DUPLICATE SMPLS (4750DB), #1 FOR BIO (120DB)
49MR03K04_5	I03	X08	1	BUC	010504	0143	UN	20 0.00 S	79 59.95 E	GPS	4865	4864					1	25.8C
49MR03K04_5	I03	X08	1	ROS	010504	0252	BO	19 59.75 S	79 59.85 E	GPS	4864	4867	11	4867	4927			
49MR03K04_5	I03	X08	1	BUC	010504	0446	UN	19 59.31 S	79 59.86 E	GPS	4852	4855					34,35,48	BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	X08	1	ROS	010504	0511	EN	19 59.19 S	79 59.81 E	GPS	4848	4845						
49MR03K04_5	I03	498	1	ROS	010504	0730	BE	19 59.90 S	80 32.18 E	GPS	4833	4831				35	1-6,15,34,35,45,48	#2-3,34 FOR BIO (5DB, 140DB)
49MR03K04_5	I03	498	1	UNK	010504	0733	BE	19 59.90 S	80 32.21 E	GPS	4842	4842						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	498	1	BUC	010504	0735	UN	19 59.91 S	80 32.23 E	GPS	4835	4846					1	26.5C
49MR03K04_5	I03	498	1	UNK	010504	0755	EN	19 59.81 S	80 32.27 E	GPS	4857	4857						
49MR03K04_5	I03	498	1	ROS	010504	0846	BO	19 59.54 S	80 32.32 E	GPS	4894	4880	15	4878	4930			
49MR03K04_5	I03	498	1	ROS	010504	1113	EN	19 58.47 S	80 32.61 E	GPS	4985	4986						
49MR03K04_5	I03	498	1	FLT	010504	1119	DE	19 58.41 S	80 32.72 E	GPS	4978	4973						ARGO/APEX#1076
49MR03K04_5	I03	497	1	ROS	010504	1409	BE	20 0.05 S	81 16.09 E	GPS	4604	4607				32	1-8,23,24,26,27	#3=#7 DUPLICATE SMPLS (4500DB)
49MR03K04_5	I03	497	1	BUC	010504	1414	UN	20 0.04 S	81 16.14 E	GPS	4607	4595					1	26.4C
49MR03K04_5	I03	497	1	ROS	010504	1519	BO	19 59.86 S	81 16.29 E	GPS	4545	4544	9	4579	4635			
49MR03K04_5	I03	497	1	ROS	010504	1724	EN	19 59.16 S	81 16.45 E	GPS	4633	4633						
49MR03K04_5	I03	496	1	ROS	010504	2019	BE	20 0.00 S	82 0.06 E	GPS	4942	4937				32	1-6,11	
49MR03K04_5	I03	496	1	BUC	010504	2024	UN	19 59.97 S	82 0.12 E	GPS	4937	4932					1	26.6C
49MR03K04_5	I03	496	1	ROS	010504	2137	BO	19 59.69 S	82 0.11 E	GPS	4894	4884	8	4938	5003			
49MR03K04_5	I03	496	1	ROS	010604	0003	EN	19 58.93 S	81 59.93 E	GPS	4885	4882						
49MR03K04_5	I03	495	1	ROS	010604	0259	BE	20 0.00 S	82 44.13 E	GPS	5232	5229				36	1-8,12,13,23,24,26,27,34,35,46	#2=#5 DUPLICATE SMPLS (5000DB), #1 FOR BIO (100DB)
49MR03K04_5	I03	495	1	BUC	010604	0312	UN	19 59.97 S	82 44.22 E	GPS	5216	5220					1	26.8C
49MR03K04_5	I03	495	1	ROS	010604	0419	BO	19 59.76 S	82 44.18 E	GPS	5118	5120	9	5227	5304			
49MR03K04_5	I03	495	1	UNK	010604	0500	BE	19 59.59 S	82 44.07 E	GPS	5162	5102						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	495	1	UNK	010604	0548	EN	19 59.41 S	82 44.04 E	GPS	5099	5099						
49MR03K04_5	I03	495	1	BUC	010604	0556	UN	19 59.37 S	82 44.03 E	GPS	5116	5118					34,35,48	BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	495	1	ROS	010604	0648	EN	19 59.26 S	82 44.14 E	GPS	5115	5116						
49MR03K04_5	I03	494	1	ROS	010604	0929	BE	20 0.00 S	83 24.07 E	GPS	5261	5264				36	1-6,9,22,47	#1-2 FOR R.N.
49MR03K04_5	I03	494	1	BUC	010604	0935	UN	19 59.97 S	83 24.14 E	GPS	5267	5279					1	26.9C
49MR03K04_5	I03	494	1	UNK	010604	0951	BE	19 59.92 S	83 24.21 E	GPS	5279	5276						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	494	1	UNK	010604	1024	EN	19 59.86 S	83 24.39 E	GPS	5275	5277						
49MR03K04_5	I03	494	1	ROS	010604	1052	BO	19 59.83 S	83 24.49 E	GPS	5291	5291	12	5271	5349			
49MR03K04_5	I03	494	1	ROS	010604	1322	EN	19 59.52 S	83 24.67 E	GPS	5292	5298						
49MR03K04_5	I03	494	1	FLT	010604	1328	DE	19 59.53 S	83 24.76 E	GPS	5298	5316						ARGO/APEX#1094
49MR03K04_5	I03	493	1	ROS	010604	1557	BE	19 59.95 S	84 1.97 E	GPS	4805	4811				33	1-8,23,24,26,27	#1=#6 DUPLICATE SMPLS (4750DB)
49MR03K04_5	I03	493	1	BUC	010604	1601	UN	19 59.88 S	84 2.02 E	GPS	4801	4803					1	26.7C
49MR03K04_5	I03	493	1	ROS	010604	1709	BO	19 59.36 S	84 2.14 E	GPS	4932	4930	11	4819	4852			
49MR03K04_5	I03	493	1	ROS	010604	1921	EN	19 58.58 S	84 2.66 E	GPS	4894	4892						
49MR03K04_5	I03	492	1	ROS	010604	2156	BE	19 59.96 S	84 39.88 E	GPS	4947	4937				35	1-6,34,35,48	#1-3 FOR BIO (5DB, 115DB)
49MR03K04_5	I03	492	1	BUC	010604	2201	UN	19 59.94 S	84 39.87 E	GPS	4945	4947					1	26.4C
49MR03K04_5	I03	492	1	ROS	010604	2312	BO	19 59.87 S	84 39.94 E	GPS	4957	4941	12	4938	5012			
49MR03K04_5	I03	492	1	ROS	010704	0213	EN	19 59.08 S	84 40.57 E	GPS	4991	4992						
49MR03K04_5	I03	491	1	ROS	010704	0448	BE	20 0.00 S	85 17.99 E	GPS	4895	4889				36	1-9,12,13,15,22-24,26,27,34,35,45,46,48	#6=#23 DUPLICATE SMPLS (4750DB), #2-4 FOR BIO (5DB, 80DB)

49MR03K04_5	I03	491	1	BUC	010704	0454	UN	19 59.94 S	85 18.05 E	GPS	4882	4885					1	26.7C
49MR03K04_5	I03	491	1	UNK	010704	0456	BE	19 59.90 S	85 18.07 E	GPS	4880	4881						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	491	1	UNK	010704	0527	EN	19 59.67 S	85 18.14 E	GPS	4887	4889						
49MR03K04_5	I03	491	1	ROS	010704	0605	BO	19 59.40 S	85 18.26 E	GPS	4923	4898	11	4923	4951			
49MR03K04_5	I03	491	1	ROS	010704	0829	EN	19 58.75 S	85 18.59 E	GPS	4943	4938						
49MR03K04_5	I03	490	1	ROS	010704	1107	BE	19 59.99 S	85 56.19 E	GPS	4380	4388				30	1-6	
49MR03K04_5	I03	490	1	BUC	010704	1112	UN	19 59.93 S	85 56.21 E	GPS	4404	4392					1	26.6C
49MR03K04_5	I03	490	1	ROS	010704	1218	BO	19 59.41 S	85 56.28 E	GPS	4433	4442	10	4451	4477			
49MR03K04_5	I03	490	1	ROS	010704	1428	EN	19 58.56 S	85 56.38 E	GPS	4467	4467						
49MR03K04_5	I03	489	1	ROS	010704	1646	BE	19 59.94 S	86 29.05 E	GPS	4352	4352				31	1-8,23,24,26,27,	#8=#22 DUPLICATE SMPLS (4250DB)
49MR03K04_5	I03	489	1	BUC	010704	1651	UN	19 59.91 S	86 29.04 E	GPS	4350	4351					1	25.8C
49MR03K04_5	I03	489	1	ROS	010704	1754	BO	19 59.49 S	86 28.79 E	GPS	4347	4348	9	4387	4405			
49MR03K04_5	I03	489	1	ROS	010704	1954	EN	19 58.56 S	86 28.04 E	GPS	4336	4338						
49MR03K04_5	I03	489	1	FLT	010704	2000	DE	19 58.51 S	86 28.15 E	GPS	4337	4338						ARGO/APEX#1073
49MR03K04_5	I03	488	1	ROS	010804	1857	BE	19 59.76 S	86 54.43 E	GPS	3534	3533				27	1-6	
49MR03K04_5	I03	488	1	BUC	010804	1903	UN	19 59.70 S	86 54.41 E	GPS	3535	3535					1	25.5C
49MR03K04_5	I03	488	1	ROS	010804	1956	BO	19 59.41 S	86 54.34 E	GPS	3531	3532	9	3551	3577			
49MR03K04_5	I03	488	1	ROS	010804	2143	EN	19 58.82 S	86 54.13 E	GPS	3544	3544						
49MR03K04_5	I03	487	1	ROS	010804	2336	BE	20 0.03 S	87 20.01 E	GPS	2012	2011				23	1-8,12,13,23,24,26,27,34,35,46,48	#19=#21 DUPLICATE SMPLS (1800DB), #2-4 FOR BIO (5DB, 130DB)
49MR03K04_5	I03	487	1	BUC	010804	2341	UN	20 0.03 S	87 20.00 E	GPS	2009	2010					1	25.7C
49MR03K04_5	I03	487	1	ROS	010904	0021	BO	19 59.98 S	87 19.99 E	GPS	2012	2013	10	2007	2020			
49MR03K04_5	I03	487	1	ROS	010904	0131	EN	19 59.79 S	87 19.78 E	GPS	2032	2030						
49MR03K04_5	I03	486	1	ROS	010904	0318	BE	19 59.98 S	87 45.08 E	GPS	1813	1811				21	1-6,34,35,48	#1-3 FOR BIO (5DB, 100DB)
49MR03K04_5	I03	486	1	BUC	010904	0321	UN	19 59.97 S	87 45.09 E	GPS	1813	1813					1	25.9C
49MR03K04_5	I03	486	1	ROS	010904	0349	BO	19 59.84 S	87 45.03 E	GPS	1820	1822	11	1808	1816			
49MR03K04_5	I03	486	1	UNK	010904	0355	EN	19 59.81 S	87 45.04 E	GPS	1826	1823						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	486	1	UNK	010904	0432	EN	19 59.66 S	87 45.05 E	GPS	1839	1837						
49MR03K04_5	I03	486	1	ROS	010904	0455	EN	19 59.51 S	87 45.03 E	GPS	1843	1844						
49MR03K04_5	I03	485	1	ROS	010904	0640	BE	20 0.01 S	88 10.09 E	GPS	2327	2332				22	1-8,23,24,26,27	#17=#20 DUPLICATE SMPLS (2200DB)
49MR03K04_5	I03	485	1	BUC	010904	0644	UN	19 59.97 S	88 10.15 E	GPS	2339	2336					1	26.3C
49MR03K04_5	I03	485	1	ROS	010904	0719	BO	19 59.83 S	88 10.19 E	GPS	2327	2324	11	2331	2347			
49MR03K04_5	I03	485	1	ROS	010904	0840	EN	19 59.61 S	88 10.40 E	GPS	2336	2338						
49MR03K04_5	I03	484	1	ROS	010904	1008	BE	20 0.05 S	88 31.04 E	GPS	3160	3160				25	1-6	
49MR03K04_5	I03	484	1	BUC	010904	1013	UN	20 0.03 S	88 31.11 E	GPS	3159	3159					1	25.8C
49MR03K04_5	I03	484	1	ROS	010904	1058	BO	19 59.83 S	88 31.18 E	GPS	3159	3159	10	3164	3188			
49MR03K04_5	I03	484	1	ROS	010904	1239	EN	19 59.22 S	88 31.28 E	GPS	3157	3157						ALTIMETER UNSTABLE
49MR03K04_5	I03	483	1	ROS	010904	1416	BE	20 0.00 S	88 55.03 E	GPS	5000	5002				33	1-6	
49MR03K04_5	I03	483	1	BUC	010904	1421	UN	19 59.98 S	88 55.10 E	GPS	4999	4998					1	25.7C
49MR03K04_5	I03	483	1	ROS	010904	1533	BO	19 59.64 S	88 55.45 E	GPS	4992	4996	11	5021	5065			
49MR03K04_5	I03	483	1	ROS	010904	1754	EN	19 58.76 S	88 55.71 E	GPS	4931	4928						
49MR03K04_5	I03	482	1	ROS	010904	2010	BE	19 59.96 S	89 27.96 E	GPS	5196	5192				34	1-8,23,24,26,27,46	#5=#19 DUPLICATE SMPLS (5000DB)
49MR03K04_5	I03	482	1	BUC	010904	2015	UN	19 59.92 S	89 27.96 E	GPS	5189	5180					1	
49MR03K04_5	I03	482	1	ROS	010904	2129	BO	19 59.74 S	89 27.95 E	GPS	5149	5144	7	5157	5230			
49MR03K04_5	I03	482	1	ROS	011004	0020	EN	19 59.05 S	89 28.58 E	GPS	5122	5092						
49MR03K04_5	I03	481	1	ROS	011004	0224	BE	19 59.99 S	89 59.06 E	GPS	5091	5079				33	1-6,34,35	#1 FOR BIO (115DB)
49MR03K04_5	I03	481	1	BUC	011004	0228	UN	19 59.94 S	89 59.08 E	GPS	5082	5076					1,34,35,48	26.0C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	481	1	ROS	011004	0350	BO	19 59.35 S	89 59.38 E	GPS	4728	4737	20	4950	4994			
49MR03K04_5	I03	481	1	UNK	011004	0401	BE	19 59.28 S	89 59.41 E	GPS	4707	4713						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	481	1	UNK	011004	0427	EN	19 59.14 S	89 59.43 E	GPS	4669	4665						

49MR03K04_5	I03	481	1	ROS	011004	0613	EN	19 58.58 S	89 59.56 E	GPS	4571	4576						
49MR03K04_5	I03	481	1	FLT	011004	0620	DE	19 58.53 S	89 59.72 E	GPS	4559	4542						ARGO/APEX#947
49MR03K04_5	I03	480	1	ROS	011004	0733	BE	20 0.04 S	90 17.07 E	GPS	5388	5397				36	1-8,12,13,15,23,24,26,27,34,35,45	#4=#18 DUPLICATE SMPLS (5250DB), #2 FOR BIO (145DB)
49MR03K04_5	I03	480	1	BUC	011004	0738	UN	20 0.04 S	90 17.09 E	GPS	5403	5402					1,34,35,48	25.6C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	480	1	ROS	011004	0857	BO	19 59.52 S	90 17.27 E	GPS	5420	5421	9	5452	5515			
49MR03K04_5	I03	480	1	ROS	011004	1129	EN	19 58.06 S	90 17.97 E	GPS	5445	5446						
49MR03K04_5	I03	479	1	ROS	011004	1334	BE	20 0.07 S	90 48.93 E	GPS	5141	5134				36	1-6,9,22,47	#1-3 FOR R.N.
49MR03K04_5	I03	479	1	BUC	011004	1339	UN	20 0.07 S	90 48.94 E	GPS	5135	5135					1	25.3C
49MR03K04_5	I03	479	1	ROS	011004	1453	BO	19 59.68 S	90 49.09 E	GPS	5137	5135	10	5154	5214			
49MR03K04_5	I03	479	1	ROS	011004	1718	EN	19 58.80 S	90 49.73 E	GPS	5100	5106						
49MR03K04_5	I03	478	1	ROS	011004	1923	BE	20 0.51 S	91 19.40 E	GPS	4791	4798				32	1-6	
49MR03K04_5	I03	478	1	BUC	011004	1927	UN	20 0.48 S	91 19.39 E	GPS	4800	4802					1	25.1C
49MR03K04_5	I03	478	1	ROS	011004	2038	BO	20 0.22 S	91 19.43 E	GPS	4812	4813	9	4823	4879			
49MR03K04_5	I03	478	1	ROS	011004	2258	EN	19 59.64 S	91 19.53 E	GPS	4825	4828						
49MR03K04_5	I03	477	1	ROS	011104	0103	BE	20 0.08 S	91 49.05 E	GPS	5032	5035				34	1-8,23,24,26,27,34,35,46	#6=#17 DUPLICATE SMPLS (3750DB), #2 FOR BIO (85DB)
49MR03K04_5	I03	477	1	BUC	011104	0108	UN	20 0.06 S	91 49.03 E	GPS	5031	5034					1,34,35,48	25.4C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	477	1	ROS	011104	0223	BO	19 59.80 S	91 48.90 E	GPS	5025	5028	9	5037	5105			
49MR03K04_5	I03	481	1	UNK	011104	0330	BE	19 59.53 S	91 48.88 E	GPS	5029	5032						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	481	1	UNK	011104	0351	EN	19 59.42 S	91 48.88 E	GPS	5026	5023						
49MR03K04_5	I03	477	1	ROS	011104	0442	EN	19 59.08 S	91 48.81 E	GPS	4949	4953						
49MR03K04_5	I03	476	1	ROS	011104	0653	BE	20 0.03 S	92 21.24 E	GPS	5144	5143				34	1-6	#1 FOR BIO (125DB)
49MR03K04_5	I03	476	1	BUC	011104	0658	UN	20 0.03 S	92 21.29 E	GPS	5142	5142					1,34,35,48	25.3C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	476	1	ROS	011104	0812	BO	19 59.80 S	92 21.45 E	GPS	5128	5130	11	5141	5212			
49MR03K04_5	I03	476	1	ROS	011104	1034	EN	19 59.04 S	92 21.63 E	GPS	5170	5172						
49MR03K04_5	I03	475	1	ROS	011104	1223	BE	20 0.05 S	92 48.03 E	GPS	5046	5051				33	1-6	
49MR03K04_5	I03	475	1	BUC	011104	1228	UN	20 0.03 S	92 48.01 E	GPS	5033	5039					1	24.5C
49MR03K04_5	I03	475	1	ROS	011104	1341	BO	19 59.68 S	92 48.27 E	GPS	5079	5081	11	5058	5110			
49MR03K04_5	I03	475	1	ROS	011104	1553	EN	19 58.82 S	92 48.30 E	GPS	5172	5172						
49MR03K04_5	I03	475	1	FLT	011104	1558	DE	19 58.80 S	92 48.40 E	GPS	5164	5173						ARGO/APEX#946
49MR03K04_5	I03	474	1	ROS	011104	1849	BE	19 59.98 S	93 31.93 E	GPS	5317	5312				35	1-8,12,13,23,24,26,27	
49MR03K04_5	I03	474	1	BUC	011104	1854	UN	19 59.93 S	93 31.94 E	GPS	5323	5320					1	24.6C
49MR03K04_5	I03	474	1	ROS	011104	2010	BO	19 59.47 S	93 31.97 E	GPS	5329	5325	10	5361	5408			
49MR03K04_5	I03	474	1	ROS	011104	2300	EN	19 58.92 S	93 32.08 E	GPS	5178	5177						CTD LOWERED 50M ILLEGALLY AFTER THE SAMPLING AT 5000DB
49MR03K04_5	I03	473	1	ROS	011204	0200	BE	20 0.08 S	94 18.16 E	GPS	5111	5108				36	1-6,9,22,34,35,47,48	#3 FOR BIO (110DB), #1-2 FOR R.N.
49MR03K04_5	I03	473	1	BUC	011204	0205	UN	20 0.07 S	94 18.23 E	GPS	5107	5109					1,34,35,48	25.3C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	473	1	ROS	011204	0318	BO	19 59.88 S	94 18.49 E	GPS	5134	5133	10	5108	5177			
49MR03K04_5	I03	473	1	UNK	011204	0400	BE	19 59.77 S	94 18.65 E	GPS	5163	5162						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	473	1	UNK	011204	0428	EN	19 59.71 S	94 18.73 E	GPS	5191	5188						
49MR03K04_5	I03	473	1	ROS	011204	0546	EN	19 59.68 S	94 19.15 E	GPS	5204	5201						
49MR03K04_5	I03	X09	1	ROS	011204	0831	BE	20 11.99 S	95 0.15 E	GPS	5267	5264				35	1-8,23,24,26,27,46	#4=#15 DUPLICATE SMPLS (5250DB)
49MR03K04_5	I03	X09	1	BUC	011204	0836	UN	20 11.99 S	95 0.26 E	GPS	5264	5264					1	26.0C
49MR03K04_5	I03	X09	1	ROS	011204	0952	BO	20 11.70 S	95 0.74 E	GPS	5270	5273	9	5309	5352			
49MR03K04_5	I03	X09	1	ROS	011204	1224	EN	20 11.43 S	95 1.51 E	GPS	5275	5271						
49MR03K04_5	I03	471	1	ROS	011204	1624	BE	20 0.08 S	96 4.01 E	GPS	5140	5128				33	1-6,15,45	
49MR03K04_5	I03	471	1	BUC	011204	1629	UN	20 0.06 S	96 4.04 E	GPS	5143	5137					1	25.8C
49MR03K04_5	I03	471	1	ROS	011204	1742	BO	19 59.81 S	96 3.99 E	GPS	5138	5126	10	5125	5196			
49MR03K04_5	I03	471	1	ROS	011204	2005	EN	19 59.40 S	96 3.90 E	GPS	5163	5165						

49MR03K04_5	I03	471	1	FLT	011204	2010	DE	19 59.36 S	96 4.02 E	GPS	5153	5152						ARGO/APEX#1096
49MR03K04_5	I03	470	1	ROS	011204	2334	BE	19 59.97 S	96 57.11 E	GPS	5332	5330				36	1-8,12,13,23,24,26,27,34,35	#4=#14 DUPLICATE SMPLS (5250DB), #2 FOR BIO (115DB)
49MR03K04_5	I03	470	1	BUC	011204	2341	UN	19 59.92 S	96 57.12 E	GPS	5334	5331					1,34,35,48	25.1C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	470	1	ROS	011304	0056	BO	19 59.46 S	96 57.20 E	GPS	5336	5339	10	5355	5419			
49MR03K04_5	I03	470	1	ROS	011304	0336	EN	19 58.56 S	96 57.02 E	GPS	5372	5369						
49MR03K04_5	I03	469	1	ROS	011304	0702	BE	19 59.99 S	97 49.96 E	GPS	5838	5839				36	1-6,34.35	#34 FOR BIO (100DB)
49MR03K04_5	I03	469	1	BUC	011304	0708	UN	19 59.95 S	97 49.97 E	GPS	5845	5846					1,34,35,48	24.9C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	469	1	ROS	011304	0833	BO	19 59.31 S	97 50.19 E	GPS	5837	5839	10	5887	5935			
49MR03K04_5	I03	469	1	UNK	011304	0837	BE	19 59.33 S	97 50.22 E	GPS	5841	5841						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	469	1	UNK	011304	0904	EN	19 59.39 S	97 50.29 E	GPS	5842	5841						
49MR03K04_5	I03	469	1	ROS	011304	1118	EN	19 59.21 S	97 50.43 E	GPS	5842	5842						
49MR03K04_5	I03	468	1	ROS	011304	1544	BE	19 59.97 S	98 43.00 E	GPS	6307	6305				36	1-8,23,24,26,27,46	REMOVE LADCP AND FLUOROMETER
49MR03K04_5	I03	468	1	BUC	011304	1549	UN	19 59.93 S	98 43.02 E	GPS	6308	6306					1	24.5C
49MR03K04_5	I03	468	1	ROS	011304	1721	BO	19 59.98 S	98 42.97 E	GPS	6307	6305	17	6302	6417			ALTIMETER UNSTABLE
49MR03K04_5	I03	468	1	ROS	011304	2023	EN	19 59.05 S	98 42.93 E	GPS	6299	6294						
49MR03K04_5		1019	1	UNK	011304	2048	BE	19 56.31 S	98 43.52 E	GPS	6264	6259						CTD CABLE RESPOOLING (WO 6351M)
49MR03K04_5		1019	1	UNK	011404	0223	EN	19 55.03 S	98 42.71 E	GPS	6266	6270						
49MR03K04_5	I03	467	1	ROS	011404	0601	BE	20 0.12 S	99 35.06 E	GPS	5844	5840				36	1-6,9,22,34,35,47	
49MR03K04_5	I03	467	1	BUC	011404	0607	UN	20 0.10 S	99 34.99 E	GPS	5839	5839					1,34,35,48	25.0C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	467	1	UNK	011404	0729	BE	19 59.93 S	99 34.64 E	GPS	5864	5872					SOLAR LIGHT MEASUREMENT.	SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	467	1	ROS	011404	0731	BO	19 59.92 S	99 34.64 E	GPS	5872	5871	5	5847	5941			
49MR03K04_5	I03	467	1	UNK	011404	0753	EN	19 59.96 S	99 34.62 E	GPS	5875	5871						
49MR03K04_5	I03	467	1	ROS	011404	1018	EN	19 59.59 S	99 33.98 E	GPS	5942	5952						
49MR03K04_5	I03	466	1	ROS	011404	1405	BE	19 59.97 S	100 27.89 E	GPS	5937	5934				0		
49MR03K04_5	I03	466	1	BUC	011404	1409	UN	19 59.94 S	100 27.86 E	GPS	5938	5934					1	24.5C
49MR03K04_5	I03	466	1	ROS	011404	1505	EN	19 59.58 S	100 27.83 E	GPS	5982	5977						OPERATION INTERRUPTED AT 1600DB, NO DATA
49MR03K04_5	I03	466	2	ROS	011404	1527	BE	19 59.72 S	100 27.87 E	GPS	5961	5960				36	1-8,12,13,23,24,26,27	REPLACED DECKUNIT FROM #0272 TO #0344
49MR03K04_5	I03	466	2	ROS	011404	1700	BO	19 59.41 S	100 27.95 E	GPS	5983	5985	10	5971	6067			
49MR03K04_5	I03	466	2	ROS	011404	1941	EN	19 58.43 S	100 28.15 E	GPS	6027	6031						
49MR03K04_5	I03	465	1	ROS	011404	2343	BE	20 0.04 S	101 20.84 E	GPS	5659	5664				35	1-6,11	
49MR03K04_5	I03	465	1	BUC	011404	2348	UN	20 0.00 S	101 20.80 E	GPS	5664	5670					1	25.0C
49MR03K04_5	I03	465	1	ROS	011504	0108	BO	19 59.96 S	101 20.66 E	GPS	5698	5687	10	5679	5773			
49MR03K04_5	I03	465	1	ROS	011504	0345	EN	19 59.66 S	101 20.32 E	GPS	5726	5719						
49MR03K04_5	I03	464	1	ROS	011604	0231	BE	20 0.02 S	102 14.16 E	GPS	6060	6054				36	1-8,15,23,24,26,27,34,35,45,46	REMOVE FLUOROMETER
49MR03K04_5	I03	464	1	BUC	011604	0243	UN	20 0.06 S	102 14.22 E	GPS	6051	6052					1,34,35,48	24.9C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	464	1	ROS	011604	0405	BO	19 59.84 S	102 14.56 E	GPS	6047	6052	19	6046	6142			
49MR03K04_5	I03	464	1	UNK	011604	0410	BE	19 59.83 S	102 14.58 E	GPS	6045	6048						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	464	1	UNK	011604	0444	EN	19 59.72 S	102 14.68 E	GPS	6048	6043						
49MR03K04_5	I03	464	1	ROS	011604	0701	EN	19 59.21 S	102 15.18 E	GPS	6042	6044						
49MR03K04_5	I03	463	1	ROS	011604	1032	BE	20 0.02 S	103 7.03 E	GPS	5705	5706				36	1-8,12,13,23,24,26,27	#3=#13 DUPLICATE SMPLS (5550DB)
49MR03K04_5	I03	463	1	BUC	011604	1038	UN	20 0.01 S	103 7.11 E	GPS	5697	5697					1	24.9C
49MR03K04_5	I03	463	1	ROS	011604	1159	BO	19 59.52 S	103 7.72 E	GPS	5620	5619	9	5717	5751			
49MR03K04_5	I03	463	1	ROS	011604	1433	EN	19 59.13 S	103 8.51 E	GPS	5625	5631						
49MR03K04_5	I03	462	1	ROS	011604	1802	BE	19 59.93 S	104 0.10 E	GPS	5603	5603				36	1-6,9,22,47	#1 FOR R.N. (5612DB)
49MR03K04_5	I03	462	1	BUC	011604	1807	UN	19 59.92 S	104 0.14 E	GPS	5603	5600					1	24.7C
49MR03K04_5	I03	462	1	ROS	011604	1928	BO	19 59.66 S	104 0.62 E	GPS	5486	5479	10	5541	5612			
49MR03K04_5	I03	462	1	ROS	011604	2215	EN	19 58.96 S	104 1.86 E	GPS	5509	5509						
49MR03K04_5	I03	461	1	ROS	011704	0144	BE	19 59.97 S	104 53.15 E	GPS	5770	5771				36	1-8,23,24,26,27,34,35,46	#34 FOR BIO (100DB)
49MR03K04_5	I03	461	1	BUC	011704	0149	UN	19 59.89 S	104 53.16 E	GPS	5773	5772					1,34,35,48	24.2C, BIO-OPTICAL SAMPLING (BUCKET)

49MR03K04_5	I03	461	1	ROS	011704	0314	BO	19 59.24 S	104 53.69 E	GPS	5781	5784	10	5853	5866			
49MR03K04_5	I03	461	1	UNK	011704	0401	BE	19 58.97 S	104 53.90 E	GPS	5787	5787						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	461	1	UNK	011704	0433	EN	19 58.83 S	104 54.02 E	GPS	5790	5792						
49MR03K04_5	I03	461	1	ROS	011704	0610	EN	19 58.26 S	104 54.43 E	GPS	5786	5793						
49MR03K04_5	I03	460	1	ROS	011704	0934	BE	19 59.98 S	105 44.93 E	GPS	5331	5329				34	1-6	
49MR03K04_5	I03	460	1	BUC	011704	0940	UN	19 59.99 S	105 45.01 E	GPS	5327	5325					1	24.6C
49MR03K04_5	I03	460	1	ROS	011704	1056	BO	19 59.57 S	105 45.50 E	GPS	5307	5305	8	5372	5402			
49MR03K04_5	I03	460	1	ROS	011704	1316	EN	19 58.80 S	105 46.25 E	GPS	5317	5311						
49MR03K04_5	I03	459	1	ROS	011704	1639	BE	20 0.09 S	106 37.05 E	GPS	5538	5535				36	1-8,12,13,15,23,24,26,27,45	#3=#12 DUPLICATE SMPLS (5500DB)
49MR03K04_5	I03	459	1	BUC	011704	1644	UN	20 0.03 S	106 37.10 E	GPS	5537	5535					1	24.2C
49MR03K04_5	I03	459	1	ROS	011704	1805	BO	19 59.77 S	106 37.48 E	GPS	5527	5527	13	5550	5616			
49MR03K04_5	I03	459	1	ROS	011704	2043	EN	19 59.23 S	106 38.42 E	GPS	5508	5515						
49MR03K04_5	I03	458	1	ROS	011804	0012	BE	20 0.10 S	107 30.06 E	GPS	5386	5388				35	1-6,34,35	#1 FOR BIO (85DB)
49MR03K04_5	I03	458	1	BUC	011804	0017	UN	20 0.10 S	107 30.10 E	GPS	5391	5391					1,34,35,48	25.7C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	458	1	ROS	011804	0135	BO	20 0.04 S	107 30.33 E	GPS	5390	5391	11	5406	5472			
49MR03K04_5	I03	458	1	UNK	011804	0253	BE	20 0.03 S	107 30.30 E	GPS	5393	5391						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	458	1	UNK	011804	0313	EN	19 59.99 S	107 30.33 E	GPS	5393	5393						
49MR03K04_5	I03	458	1	ROS	011804	0416	EN	19 59.75 S	107 30.36 E	GPS	5389	5390						
49MR03K04_5	I03	457	1	ROS	011804	0721	BE	20 18.84 S	108 8.82 E	GPS	4995	5000				34	1-8,23,24,26,27	#5=#11 DUPLICATE SMPLS (5000DB)
49MR03K04_5	I03	457	1	BUC	011804	0726	UN	20 18.78 S	108 8.84 E	GPS	4997	5003					1	24.9C
49MR03K04_5	I03	457	1	ROS	011804	0838	BO	20 18.44 S	108 9.37 E	GPS	5008	5007	10	5059	5073			
49MR03K04_5	I03	457	1	ROS	011804	1058	EN	20 18.03 S	108 10.35 E	GPS	5016	5018						
49MR03K04_5	I03	456	1	ROS	011804	1405	BE	20 37.85 S	108 47.93 E	GPS	5058	5060				33	1-6	
49MR03K04_5	I03	456	1	BUC	011804	1409	UN	20 37.81 S	108 47.96 E	GPS	5060	5061					1	24.8C
49MR03K04_5	I03	456	1	ROS	011804	1522	BO	20 37.53 S	108 48.32 E	GPS	5060	5059	10	5096	5134			
49MR03K04_5	I03	456	1	ROS	011804	1745	EN	20 37.22 S	108 48.89 E	GPS	5030	5022						
49MR03K04_5	I03	455	1	ROS	011804	2038	BE	20 49.97 S	109 26.43 E	GPS	5066	5066				34	1-8,12,13,23,24,26,27,46	#5=#10 DUPLICATE SMPLS (5000DB)
49MR03K04_5	I03	455	1	BUC	011804	2043	UN	20 50.01 S	109 26.45 E	GPS	5065	5066					1	25.7C
49MR03K04_5	I03	455	1	ROS	011804	2155	BO	20 49.93 S	109 26.67 E	GPS	5071	5069	10	5074	5140			
49MR03K04_5	I03	455	1	ROS	011904	0043	EN	20 48.90 S	109 26.90 E	GPS	5067	5066						
49MR03K04_5	I03	454	1	ROS	011904	0404	BE	21 8.97 S	110 9.04 E	GPS	5065	5068				36	1-6,9,22,34,35,47	#3 FOR BIO (90DB), #1,6 FOR R.N. (5635DB, 600DB)
49MR03K04_5	I03	454	1	BUC	011904	0409	UN	21 8.88 S	110 9.09 E	GPS	5063	5067					1,34,35,48	25.0C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	454	1	ROS	011904	0523	BO	21 8.61 S	110 9.68 E	GPS	5066	5068	13	5134	5135			
49MR03K04_5	I03	454	1	UNK	011904	0539	BE	21 8.48 S	110 9.91 E	GPS	5067	5068						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	454	1	UNK	011904	0607	EN	21 8.38 S	110 10.15 E	GPS	5067	5069						
49MR03K04_5	I03	454	1	ROS	011904	0807	EN	21 8.03 S	110 11.11 E	GPS	5064	5068						
49MR03K04_5	I03	X10	1	ROS	011904	1122	BE	21 26.95 S	110 50.38 E	GPS	5058	5057				34	1-8,23,24,26,27	#5=#9 DUPLICATE SMPLS (5000DB)
49MR03K04_5	I03	X10	1	BUC	011904	1127	UN	21 26.86 S	110 50.41 E	GPS	5057	5056					1	24.5C
49MR03K04_5	I03	X10	1	ROS	011904	1240	BO	21 26.86 S	110 50.52 E	GPS	5055	5058	9	5053	5130			
49MR03K04_5	I03	X10	1	ROS	011904	1502	EN	21 26.65 S	110 50.66 E	GPS	5057	5054						
49MR03K04_5	I03	452	1	ROS	011904	1744	BE	21 39.99 S	111 21.92 E	GPS	5057	5057				33	1-6,15,45	
49MR03K04_5	I03	452	1	BUC	011904	1749	UN	21 39.97 S	111 21.89 E	GPS	5059	5056					1	24.6C
49MR03K04_5	I03	452	1	ROS	011904	1902	BO	21 39.73 S	111 22.23 E	GPS	5056	5058	10	5074	5130			
49MR03K04_5	I03	452	1	ROS	011904	2134	EN	21 39.56 S	111 23.09 E	GPS	5056	5055						
49MR03K04_5	I03	451	1	ROS	012004	0007	BE	21 49.83 S	111 53.94 E	GPS	4949	4948				34	1-8,12,13,23,24,26,27,34,35,46	#6=#8 DUPLICATE SMPLS, #2 FOR BIO (75DB)
49MR03K04_5	I03	451	1	BUC	012004	0013	UN	21 49.78 S	111 53.95 E	GPS	4949	4946					1,34,35,48	24.7C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	451	1	ROS	012004	0125	BO	21 49.49 S	111 54.11 E	GPS	4941	4942	9	4953	5018			
49MR03K04_5	I03	451	1	UNK	012004	0245	BE	21 49.27 S	111 54.30 E	GPS	4941	4938						SOLAR LIGHT MEASUREMENT
49MR03K04_5	I03	451	1	UNK	012004	0310	EN	21 49.20 S	111 54.44 E	GPS	4937	4934						

49MR03K04_5	I03	451	1	ROS	012004	0355	EN	21 48.93 S	111 54.75 E	GPS	4927	4927						
49MR03K04_5	I03	450	1	ROS	012004	0613	BE	22 0.10 S	112 22.87 E	GPS	4267	4264				36	1-6,9,22,34,35,47	#6 FOR BIO (85DB), #1-5 FOR R.N.
49MR03K04_5	I03	450	1	BUC	012004	0622	UN	22 0.11 S	112 22.87 E	GPS	4265	4264					1,34,35,48	25.2C, BIO-OPTICAL SAMPLING (BUCKET)
49MR03K04_5	I03	450	1	ROS	012004	0721	BO	22 0.15 S	112 22.91 E	GPS	4259	4261	10	4273	4327			
49MR03K04_5	I03	450	1	ROS	012004	0937	EN	22 0.20 S	112 23.07 E	GPS	4270	4273						
49MR03K04_5	I03	449	1	ROS	012004	1133	BE	22 4.79 S	112 49.06 E	GPS	2215	2212				22	1-8,23,24,26,27	#7=#17 DUPLICATE SMPLS (2200DB)
49MR03K04_5	I03	449	1	BUC	012004	1139	UN	22 4.80 S	112 49.09 E	GPS	2206	2211					1	25.3C
49MR03K04_5	I03	449	1	ROS	012004	1212	BO	22 4.84 S	112 49.15 E	GPS	2204	2204	8	2204	2221			
49MR03K04_5	I03	449	1	ROS	012004	1323	EN	22 4.74 S	112 49.44 E	GPS	2175	2175						
49MR03K04_5	I03	448	1	ROS	012004	1500	BE	22 8.18 S	113 10.18 E	GPS	1310	1311				16	1-6	
49MR03K04_5	I03	448	1	BUC	012004	1504	UN	22 8.23 S	113 10.19 E	GPS	1312	1312					1	25.6C
49MR03K04_5	I03	448	1	ROS	012004	1525	BO	22 8.24 S	113 10.24 E	GPS	1312	1313	10	1304	1310			
49MR03K04_5	I03	448	1	ROS	012004	1610	EN	22 8.30 S	113 10.44 E	GPS	1315	1314						
49MR03K04_5	I03	447	1	ROS	012004	1727	BE	22 10.69 S	113 26.33 E	GPS	1295	1297				17	1-8,23,24,26,27	#6=#22 DUPLICATE SMPLS (1200DB)
49MR03K04_5	I03	447	1	BUC	012004	1731	UN	22 10.70 S	113 26.33 E	GPS	1293	1294					1	25.5C
49MR03K04_5	I03	447	1	ROS	012004	1752	BO	22 10.73 S	113 26.49 E	GPS	1278	1279	10	1289	1287			
49MR03K04_5	I03	447	1	ROS	012004	1838	EN	22 10.80 S	113 26.86 E	GPS	1255	1254						
49MR03K04_5	I03	446	1	ROS	012004	1943	BE	22 12.09 S	113 35.83 E	GPS	865	864				13	1-6	
49MR03K04_5	I03	446	1	BUC	012004	1947	UN	22 12.10 S	113 35.87 E	GPS	861	862					1	25.4C
49MR03K04_5	I03	446	1	ROS	012004	2002	BO	22 12.13 S	113 36.04 E	GPS	857	858	9	855	855			
49MR03K04_5	I03	446	1	ROS	012004	2035	EN	22 12.07 S	113 36.45 E	GPS	842	842						
49MR03K04_5	I03	445	1	ROS	012004	2139	BE	22 12.90 S	113 41.92 E	GPS	390	392				8	1-6	
49MR03K04_5	I03	445	1	BUC	012004	2144	UN	22 12.86 S	113 41.96 E	GPS	383	385					1	24.0C
49MR03K04_5	I03	445	1	ROS	012004	2152	BO	22 12.86 S	113 42.00 E	GPS	382	380	10	369	371			
49MR03K04_5	I03	445	1	ROS	012004	2209	EN	22 12.90 S	113 42.13 E	GPS	362	362						
49MR03K04_5	I03	444	1	BUC	012004	2253	UN	22 13.48 S	113 45.55 E	GPS	161	161					1	23.2C
49MR03K04_5	I03	444	1	ROS	012004	2301	BE	22 13.52 S	113 45.54 E	GPS	162	160				6	1-6,34,35	#1-2 FOR BIO (5DB, 45DB)
49MR03K04_5	I03	444	1	ROS	012004	2307	BO	22 13.55 S	113 45.54 E	GPS	159	159	10	145	149			
49MR03K04_5	I03	444	1	ROS	012004	2318	EN	22 13.55 S	113 45.52 E	GPS	162	161						

Parameter number:

1=SALNTY, 2=OXYGEN, 3=SILCAT, 4=NITRAT, 5=NITRIT, 6=PHSPHT, 7=CFC-11, 8=CFC-12, 9=TRITUM, 11=DELHE3, 12=DELC14, 13=DELC13, 15=ARGON, 22=CS-137, 23=TCARBN, 24=ALKALI, 26=PH, 27=CFC113, 33=N2O, 34=CHLORA, 35=PPHYTN, 45=Nitrogen, 46=TOC, 47=Plutonium, 48=Primary_productivity

Figure caption

Figure 1 Observation lines for WHP P6, A10 and I3/I4 revisit in Blue Earth Global Expedition 2003 (BEAGLE2003) with bottom topography based on ETOPO5 (Data announcement 88-MGG-02, 1988).

Figure 2 Station locations for WHP P6, A10 and I3/I4 revisit in BEAGLE2003 with bottom topography based on Smith and Sandwell (1997).

Figure 3 Bathymetry measured by Multi Narrow Beam Echo Sounding system. Cross mark indicates CTD location.

Figure 4 Surface wind measured at 25 m above sea level. Wind data is averaged over 1-hour and plotted every 1 degree in longitude.

Figure 5 Sea surface temperature and salinity. Temperature and salinity data are averaged over 1-hour.

Figure 6 Difference in the partial pressure of CO_2 between the ocean and atmosphere, ΔpCO_2.

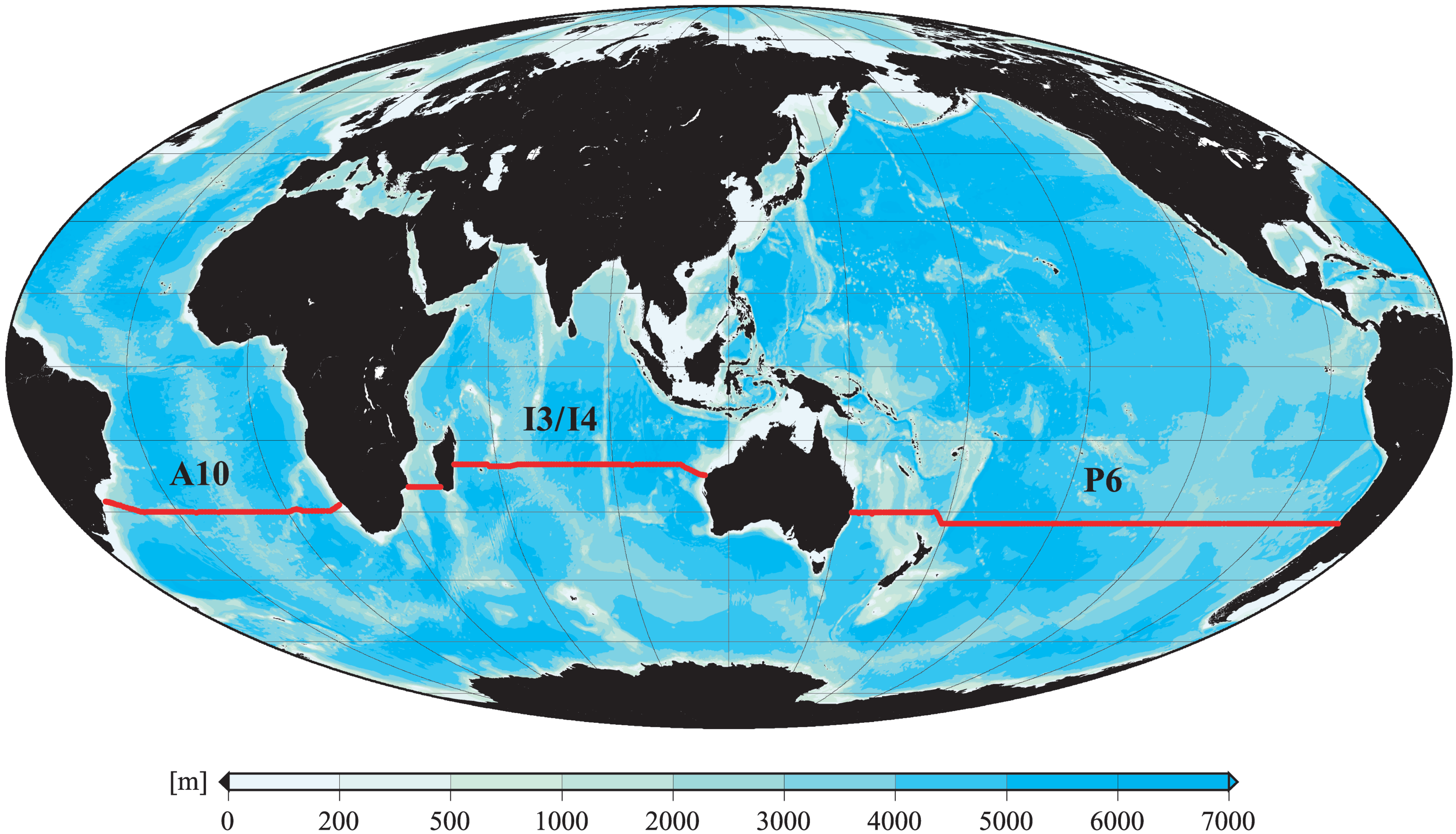
Figure 7 Surface current at 100 m depth measured by shipboard acoustic Doppler current profiler (ADCP).

References

Data Announcement 88-MGG-02 (1988): Digital relief of the Surface of the Earth, NOAA, National Geophysical Data Center, Boulder, Colorado.

Smith, W. H. F. and D. T. Sandwell (1997): Global seafloor topography from satellite altimetry and ship depth soundings, Science, 277, 1956-1962.

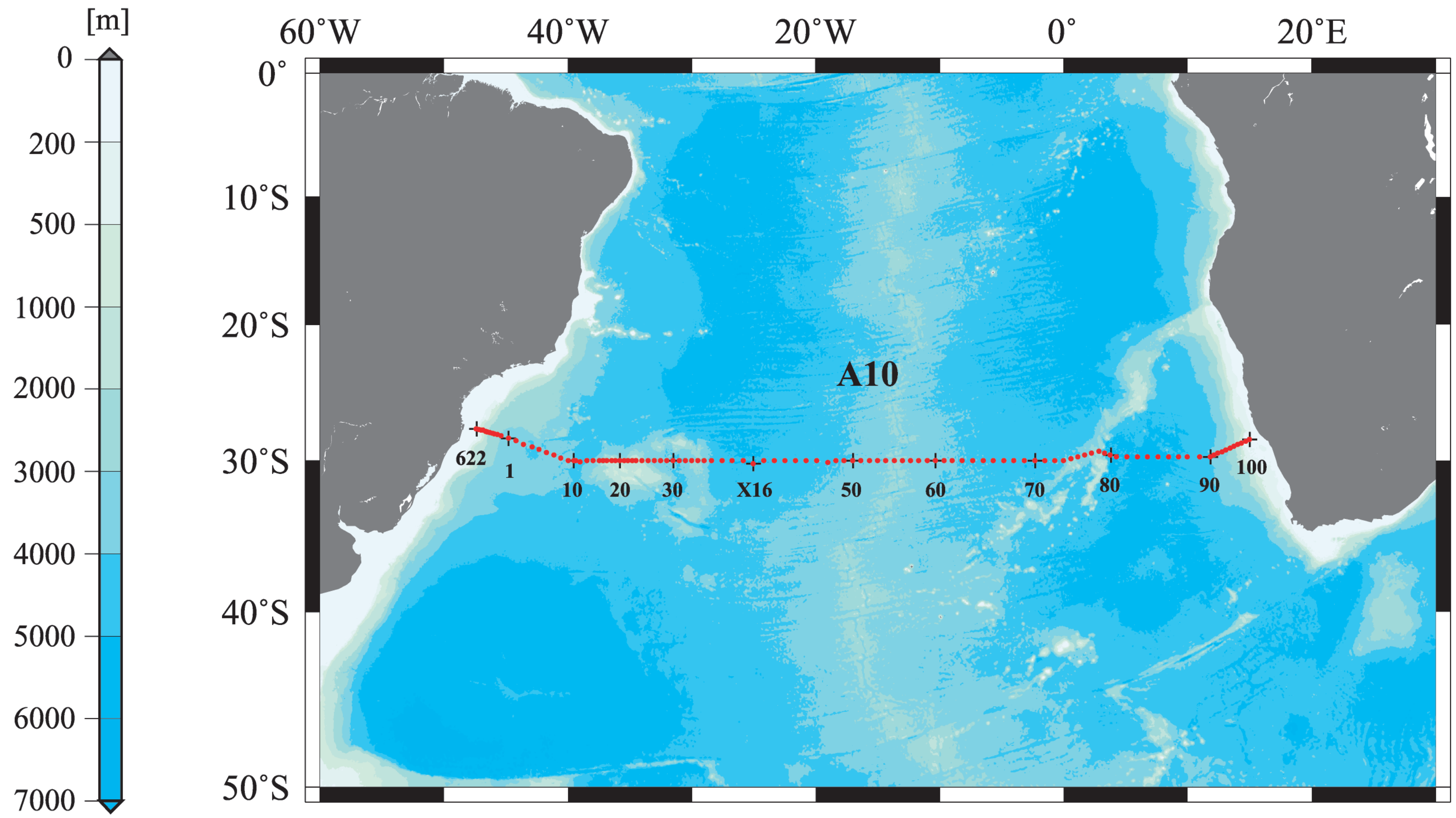
Figure 1

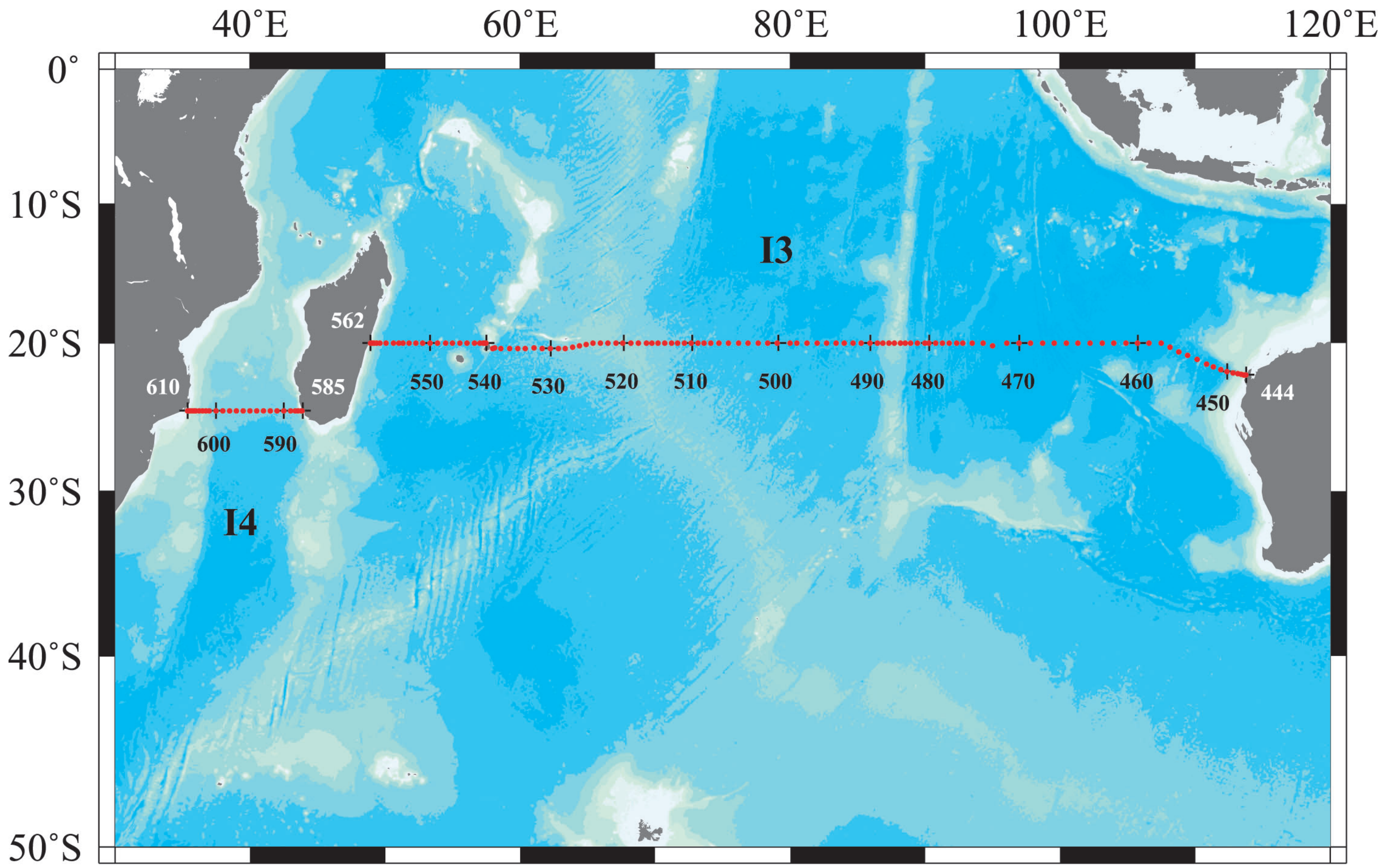


OBSERVATION LINES FOR WHP P6, A10, I3/I4 REVISIT IN 2003

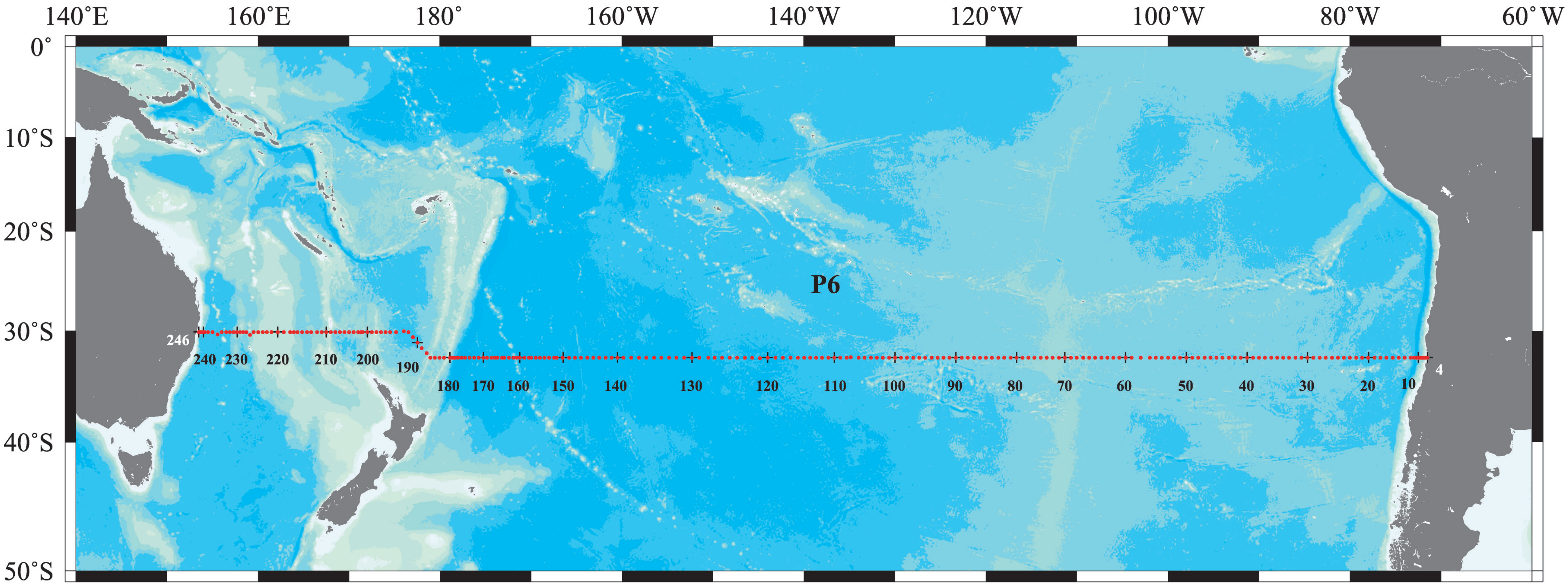
Figure 2

STATION LOCATIONS FOR WHP P6, A10, I3/I4 REVISIT IN 2003





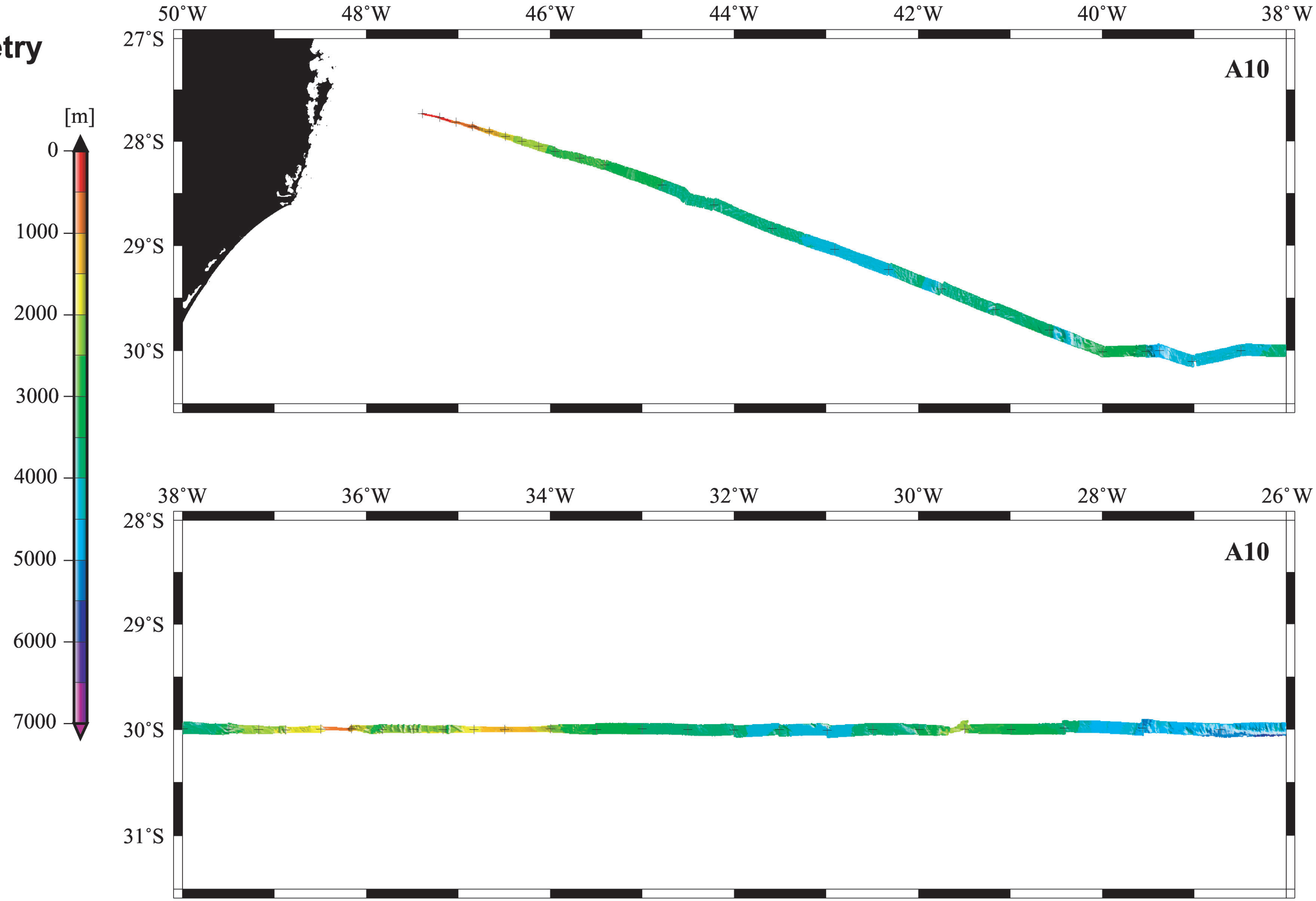
40˚E
60˚E
80˚E
100˚E
120˚E
0˚
10˚S
20˚S
30˚S
40˚S
50˚S
I3
I4
562
585
610
600
590
550
540
530
520
510
500
490
480
470
460
450
444

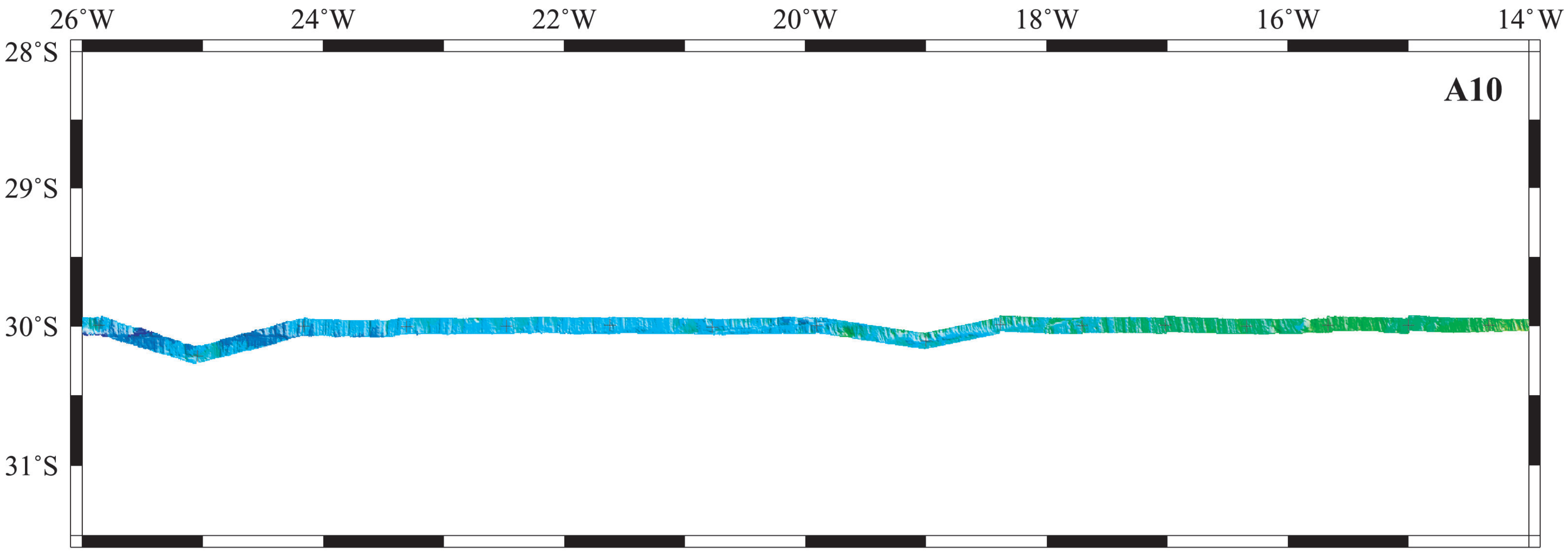


140°E
160°E
180°
160°W
140°W
120°W
100°W
80°W
60°W
0°
10°S
20°S
30°S
40°S
50°S
P6
246
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
4

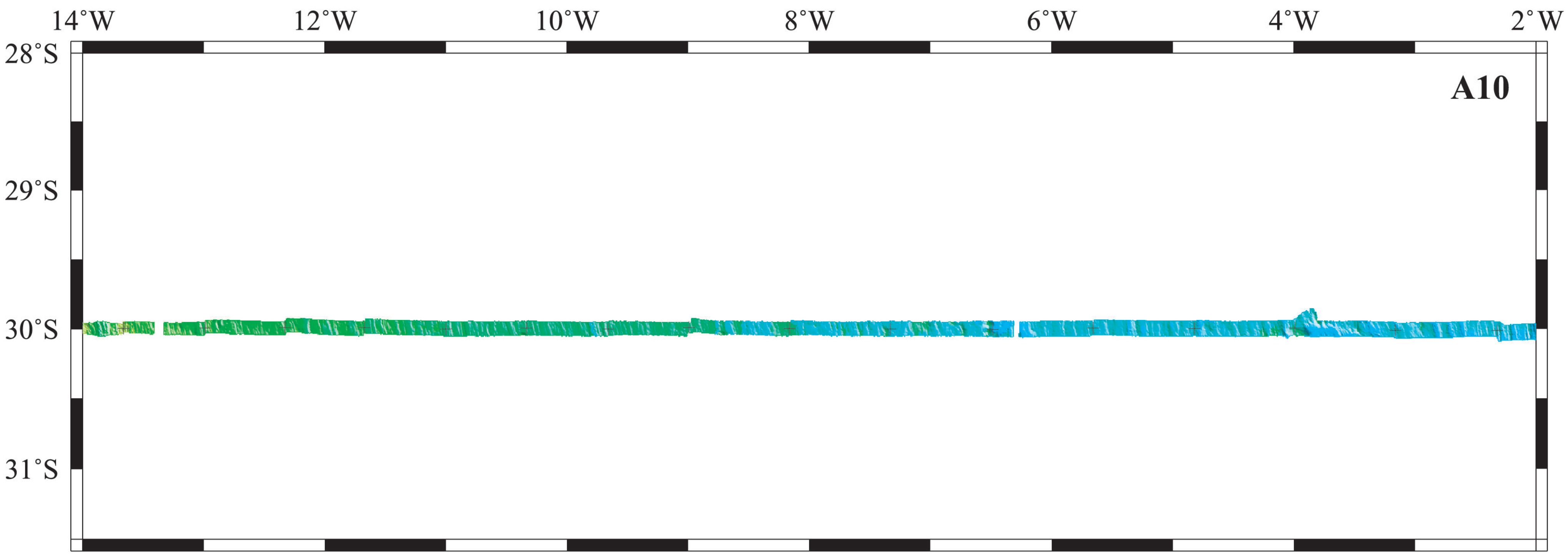
Figure 3

Bathymetry

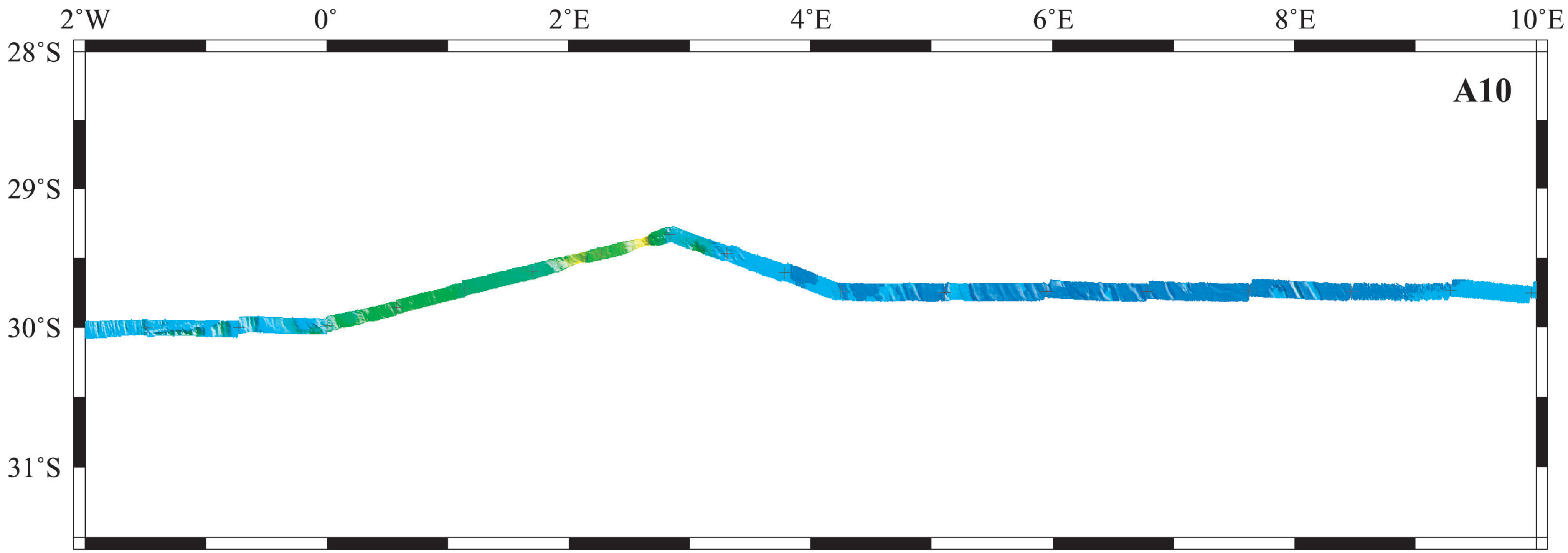




26°W
24°W
22°W
20°W
18°W
16°W
14°W
28°S
29°S
30°S
31°S
A10



14°W
12°W
10°W
8°W
6°W
4°W
2°W
28°S
29°S
30°S
31°S
A10


2°W
0°
2°E
4°E
6°E
8°E
10°E
28°S
29°S
30°S
31°S
A10

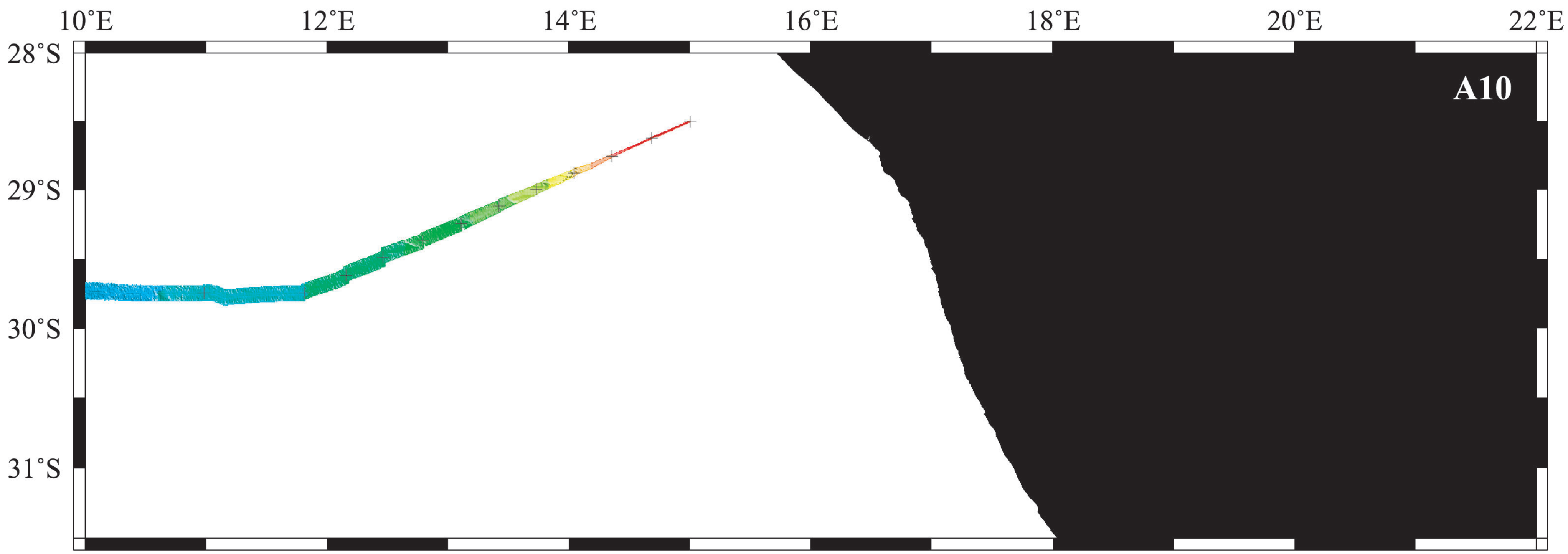
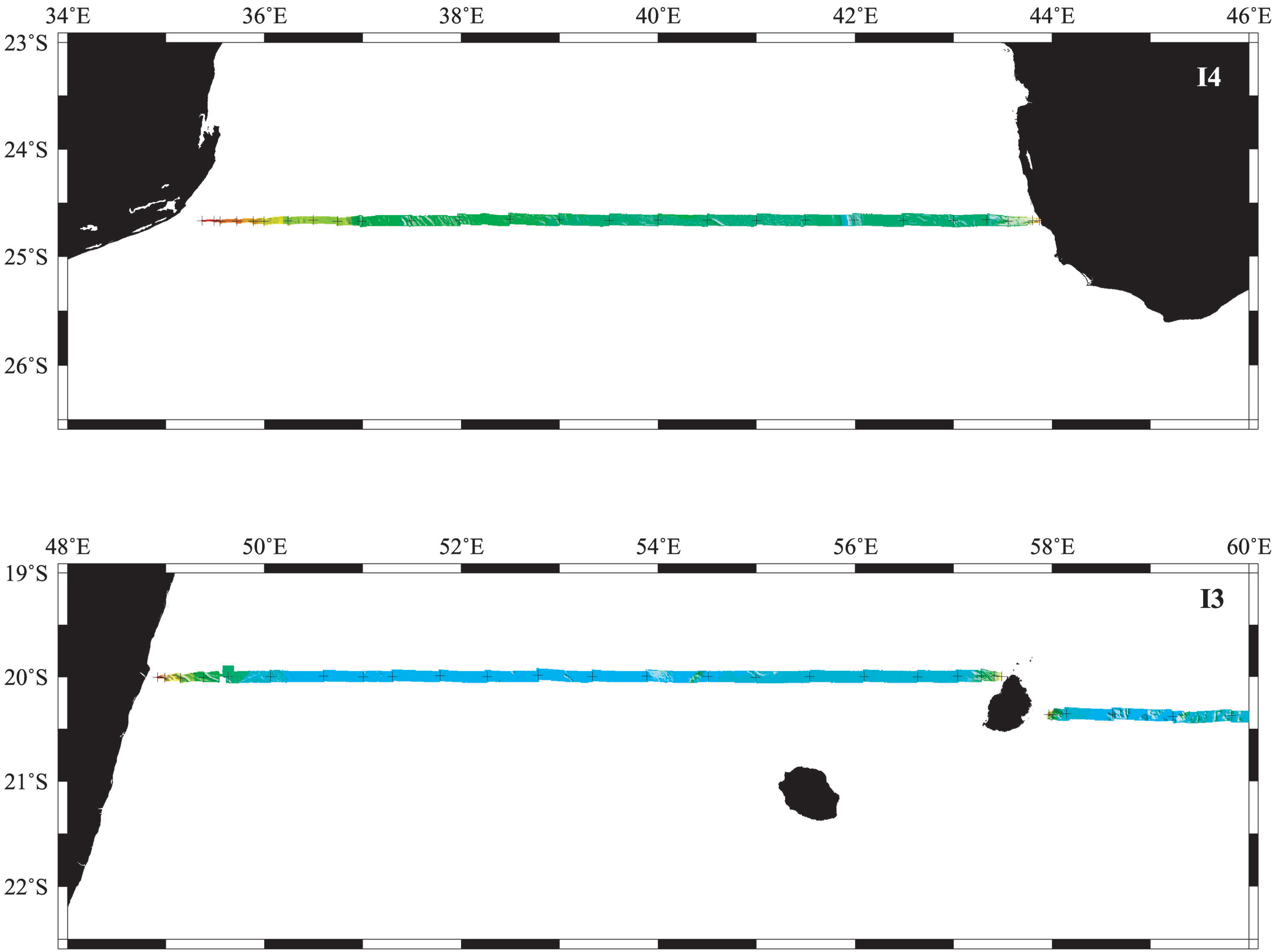
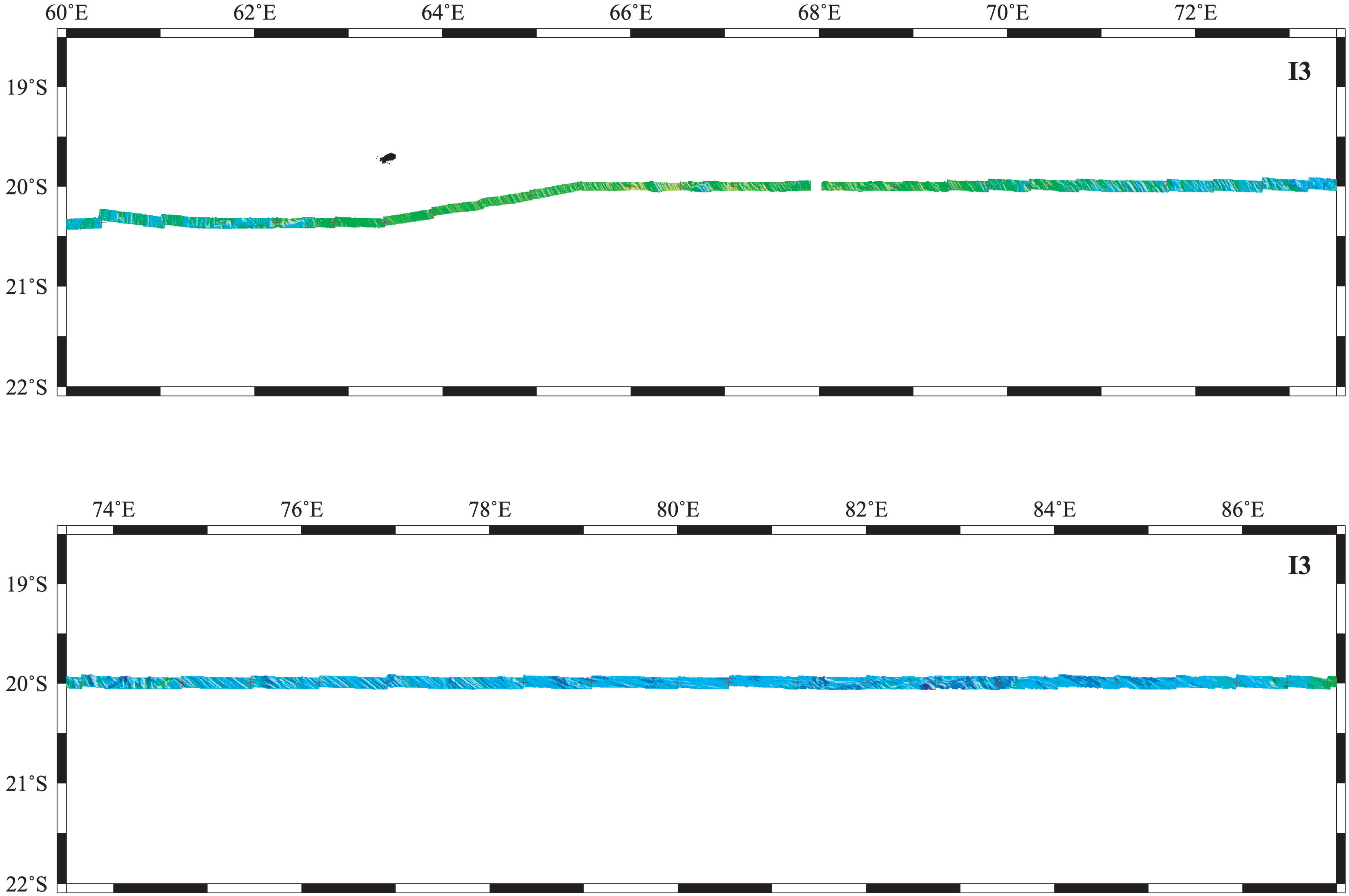

10°E
12°E
14°E
16°E
18°E
20°E
22°E
28°S
29°S
30°S
31°S
A10

Figure 3 (continued)

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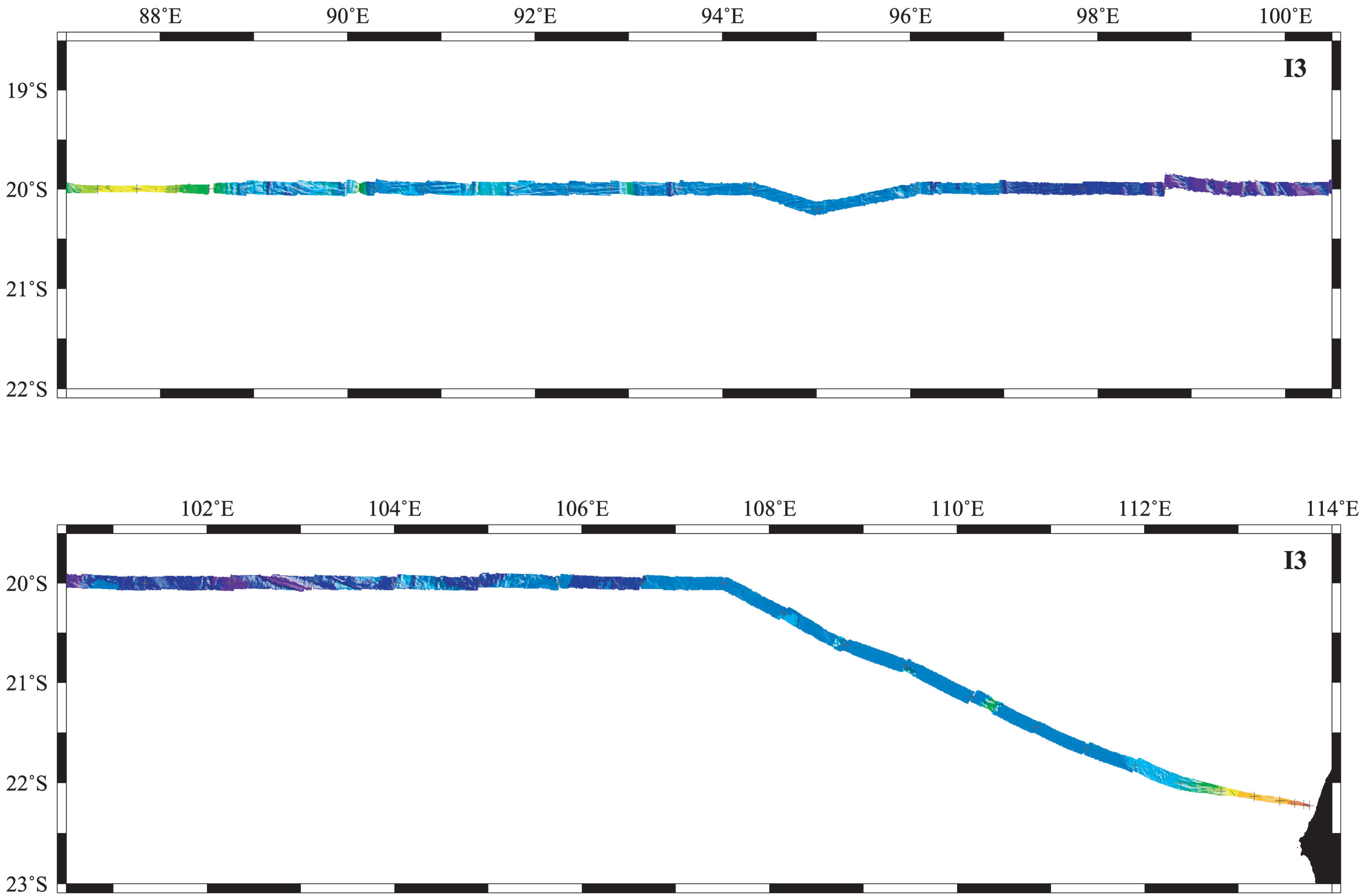
64°E
66°E
68°E
70°E
72°E
I3
19°S
20°S
21°S
22°S
74°E
76°E
78°E
80°E
82°E
84°E
86°E
I3
19°S
20°S
21°S
22°S


I3
88°E
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92°E
94°E
96°E
98°E
100°E
19°S
20°S
21°S
22°S
I3
102°E
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108°E
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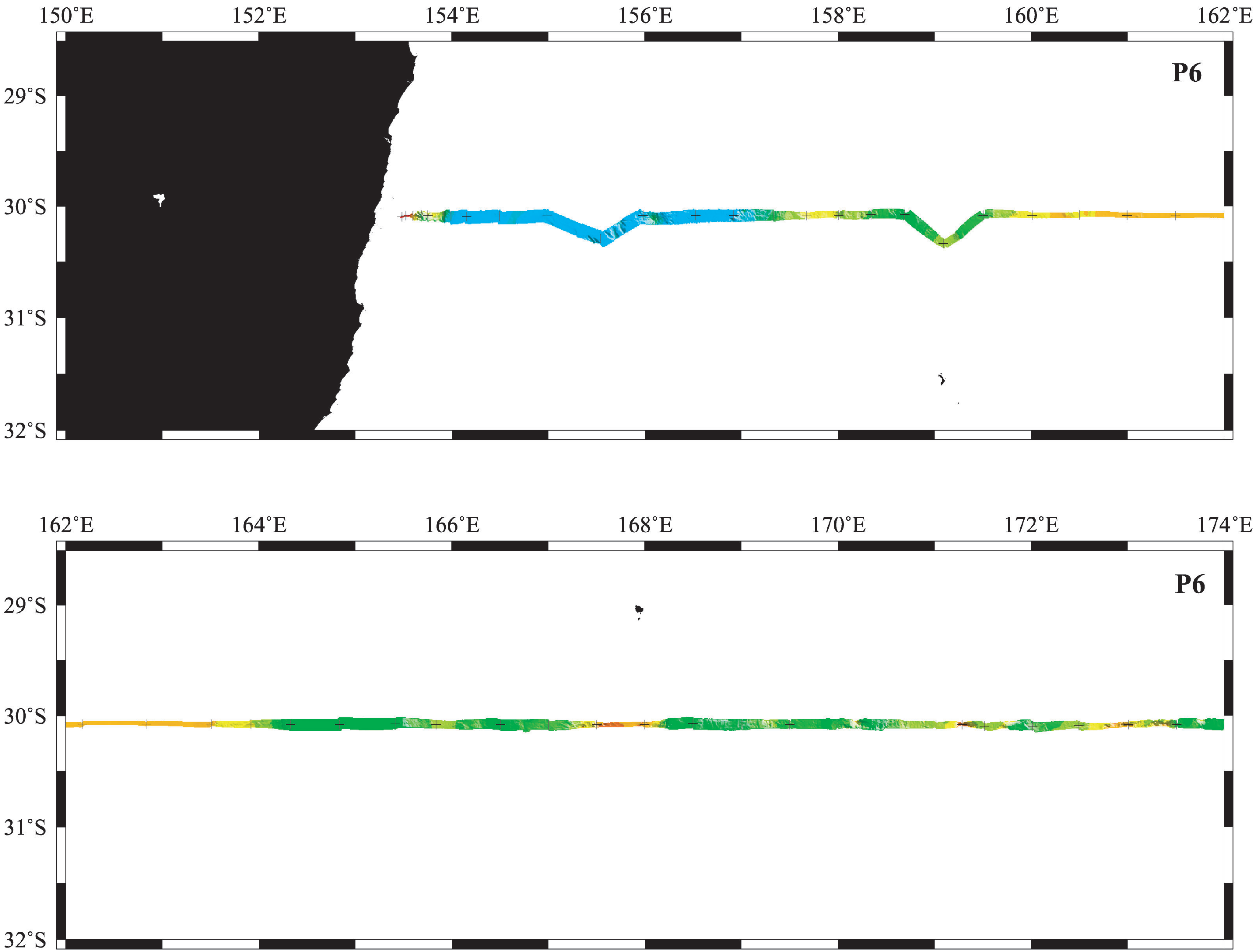
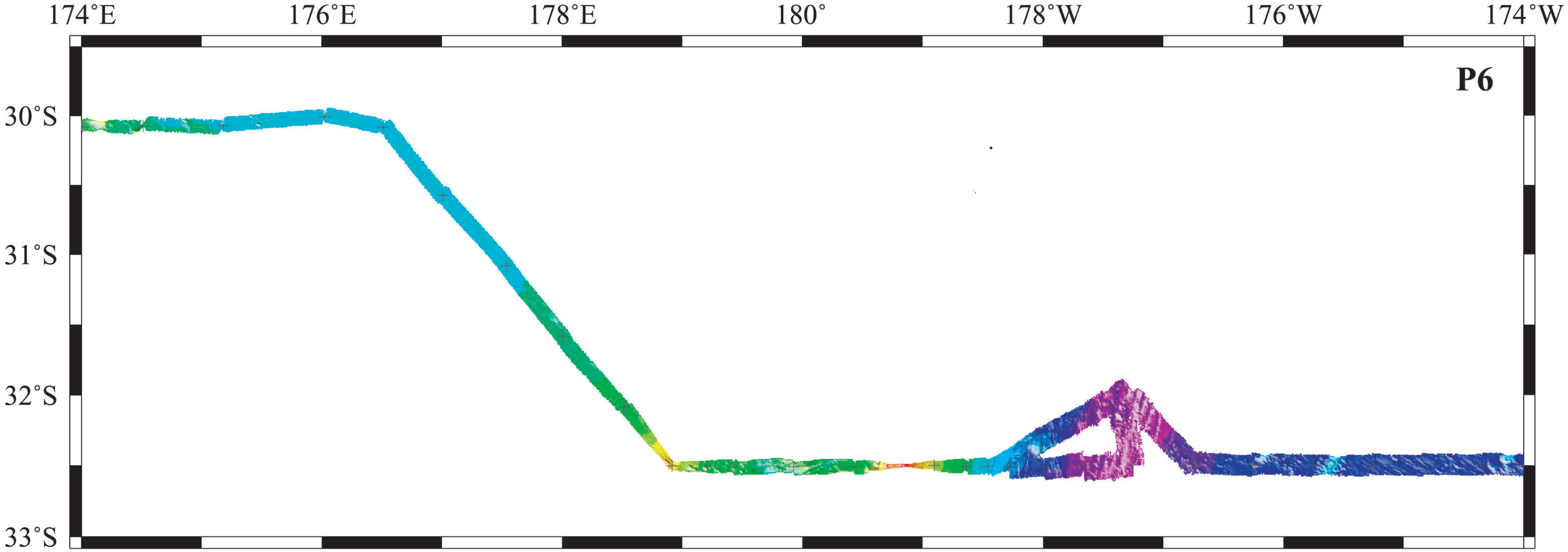
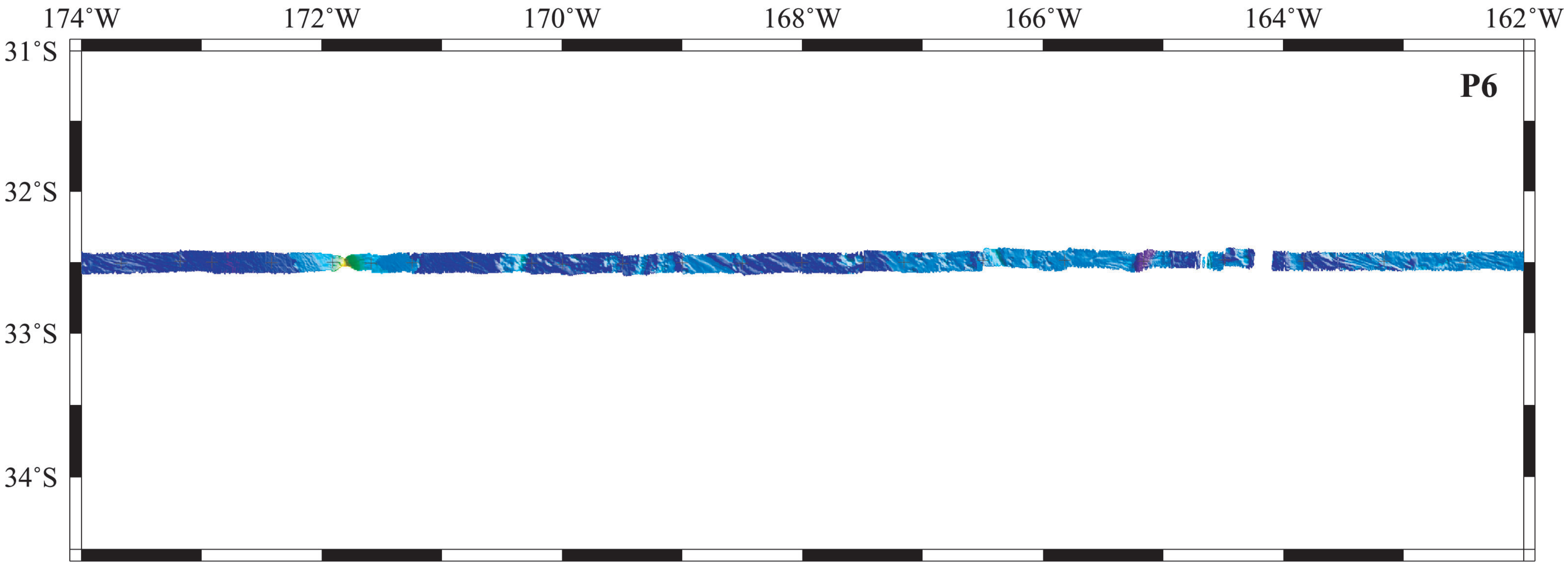
114°E
20°S
21°S
22°S
23°S

Figure 3 (continued)




174˚E
176˚E
178˚E
180˚
178˚W
176˚W
174˚W
P6
30˚S
31˚S
32˚S
33˚S


174˚W
172˚W
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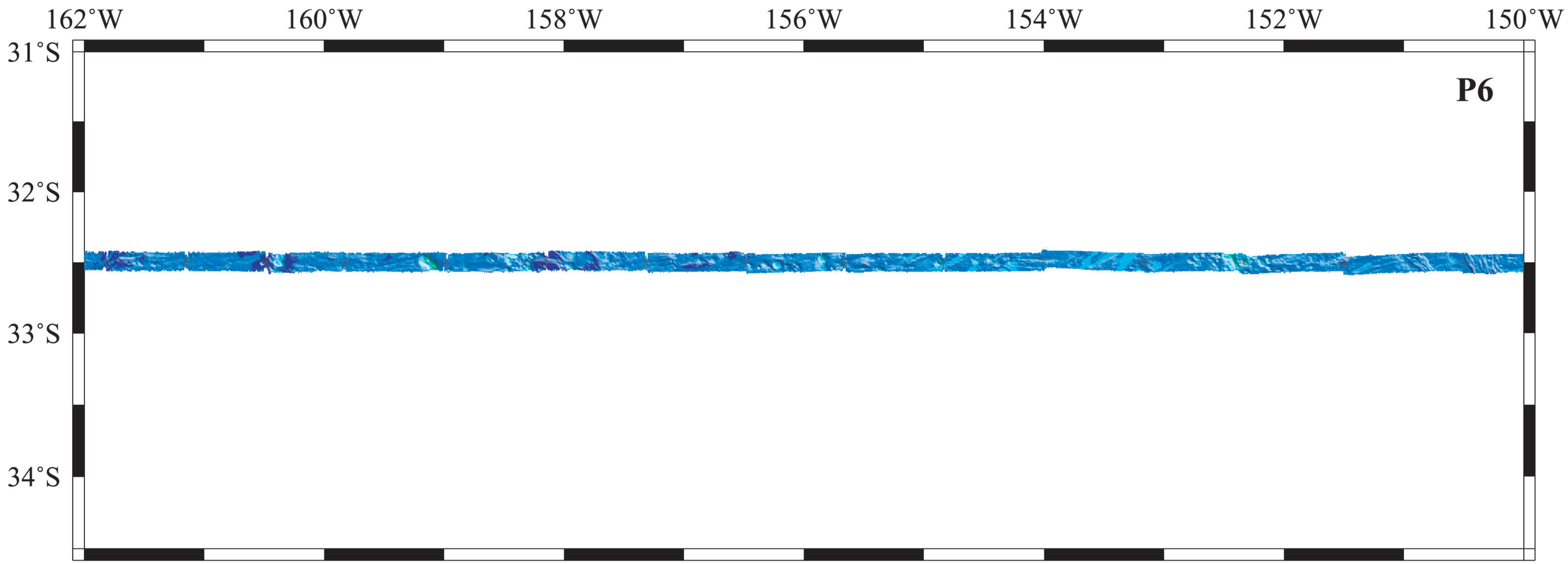
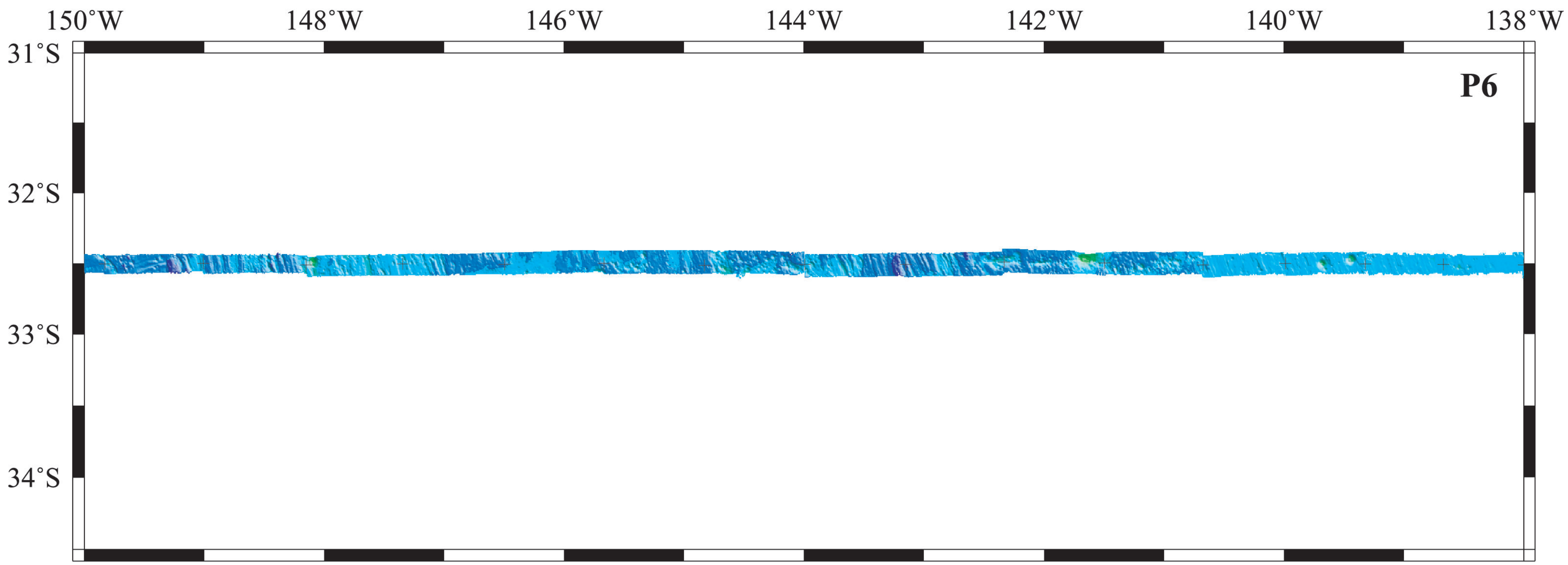
168˚W
166˚W
164˚W
162˚W
P6
31˚S
32˚S
33˚S
34˚S


162°W
160°W
158°W
156°W
154°W
152°W
150°W
31°S
32°S
33°S
34°S
P6


150°W
148°W
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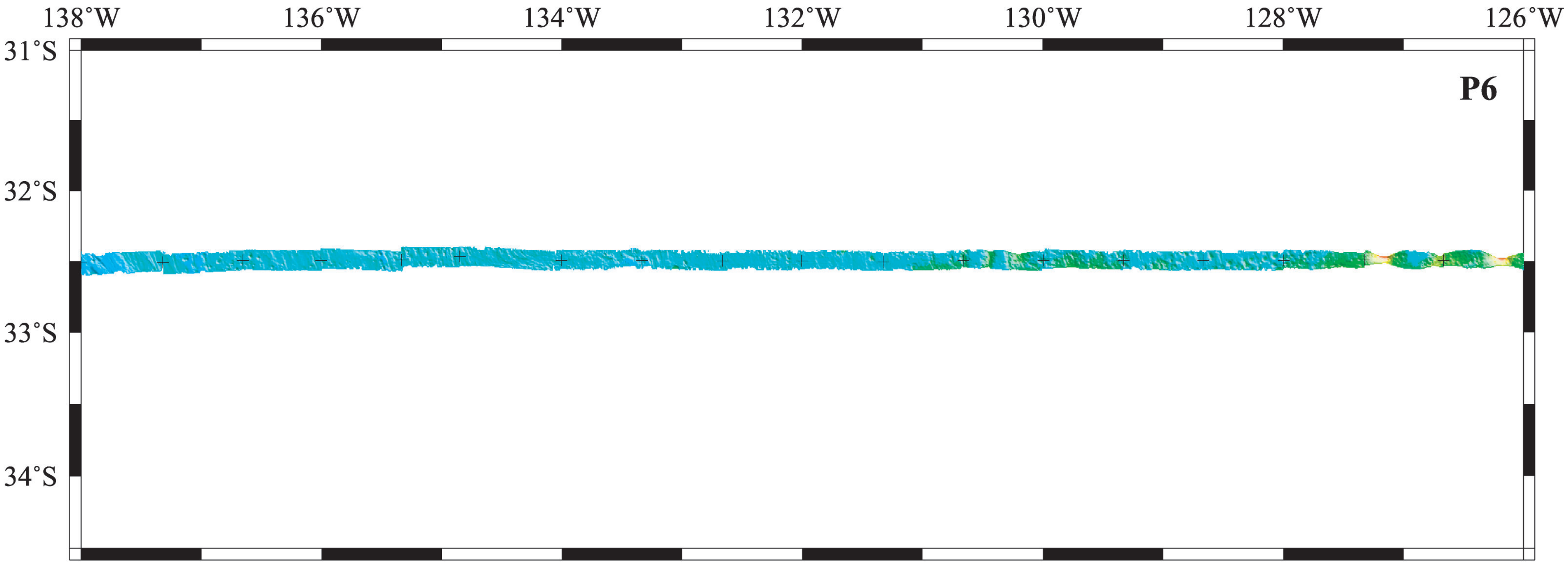
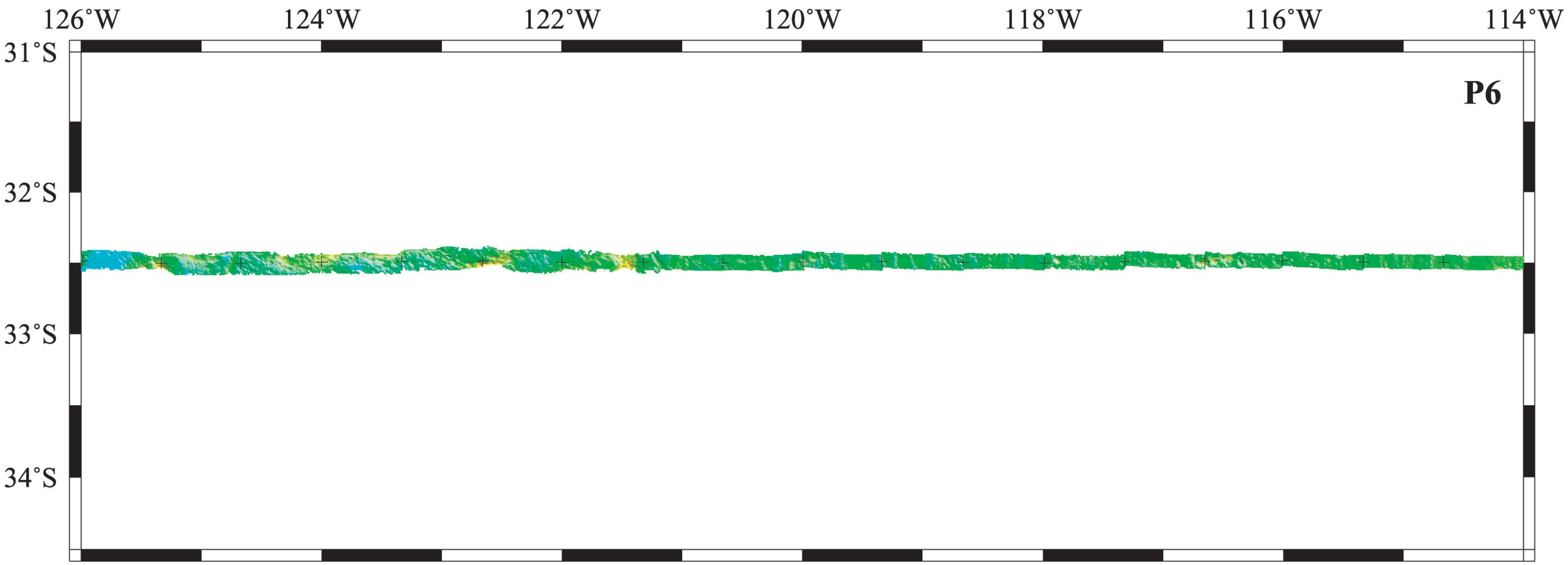
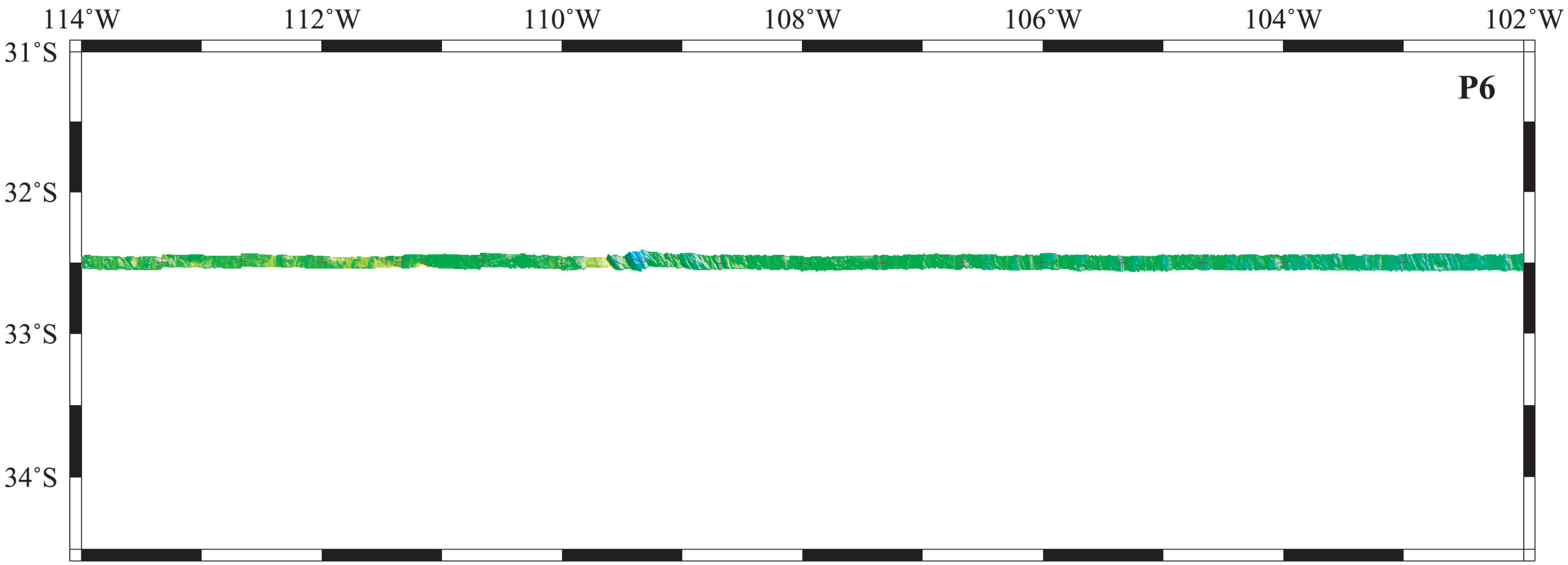
144°W
142°W
140°W
138°W
31°S
32°S
33°S
34°S
P6

Figure 3 (continued)



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110°W
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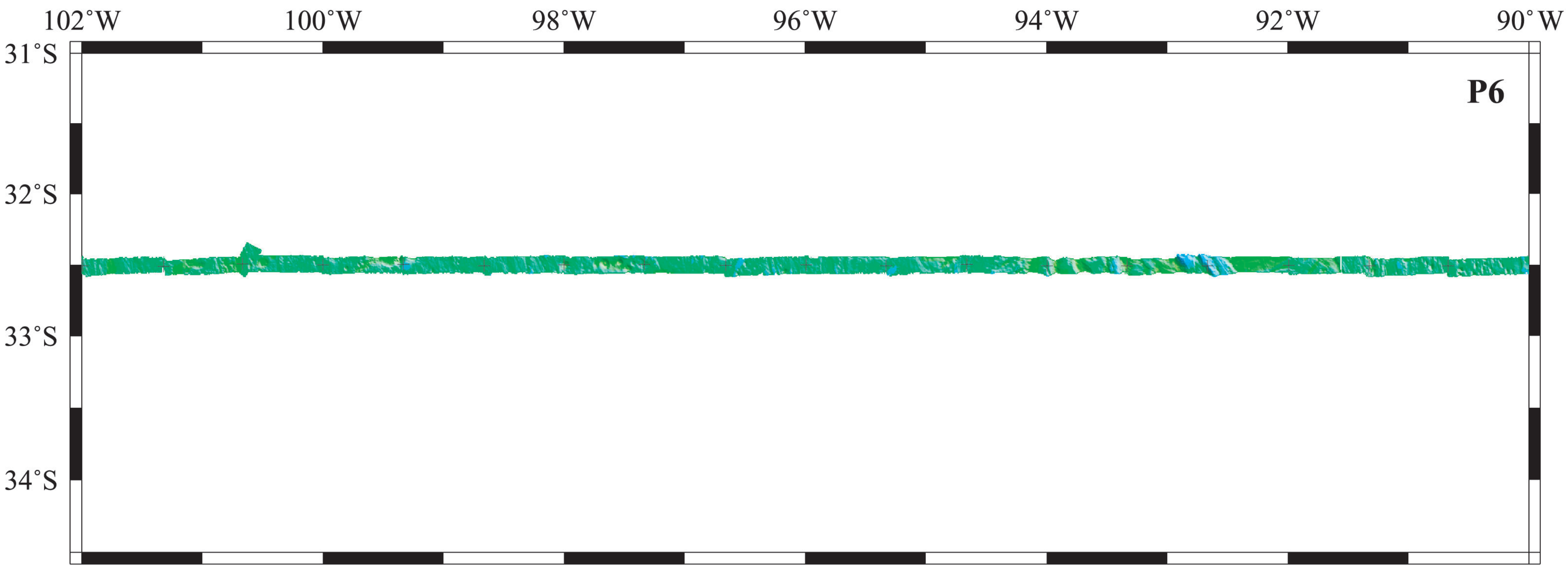
106°W
104°W
102°W
31°S
32°S
33°S
34°S
P6


102°W
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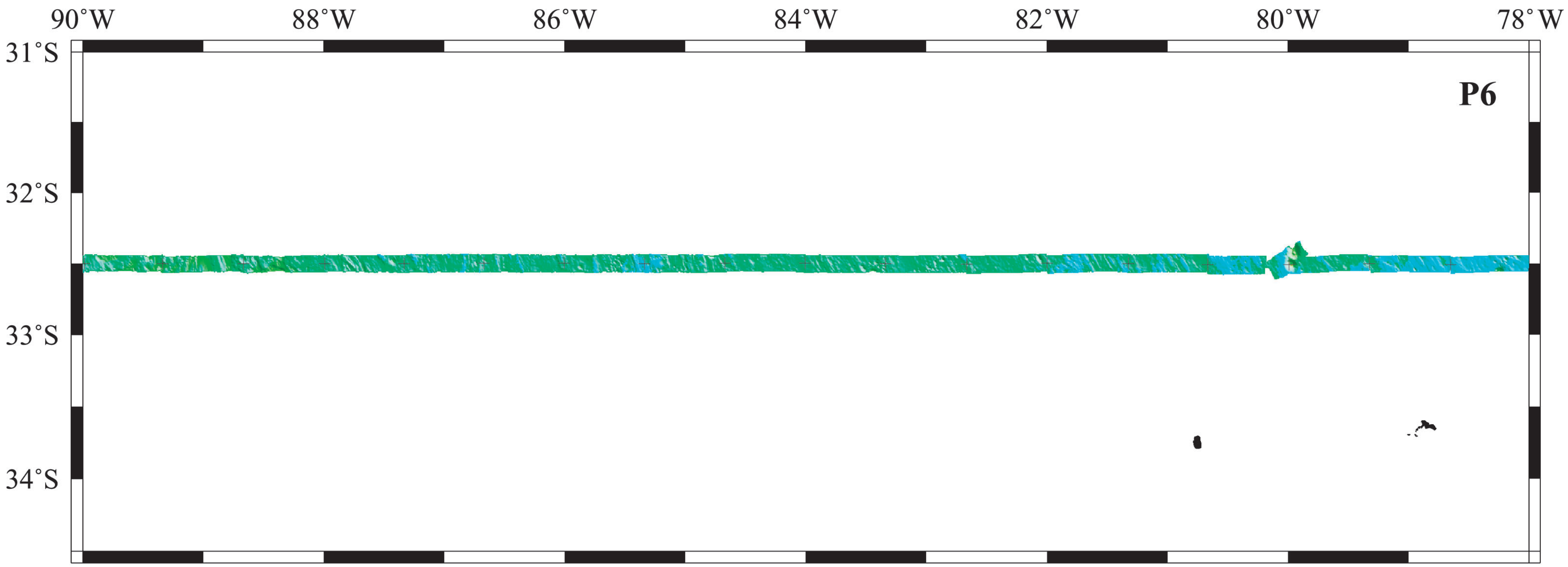
31°S
32°S
33°S
34°S
P6


90°W
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86°W
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32°S
33°S
34°S
P6

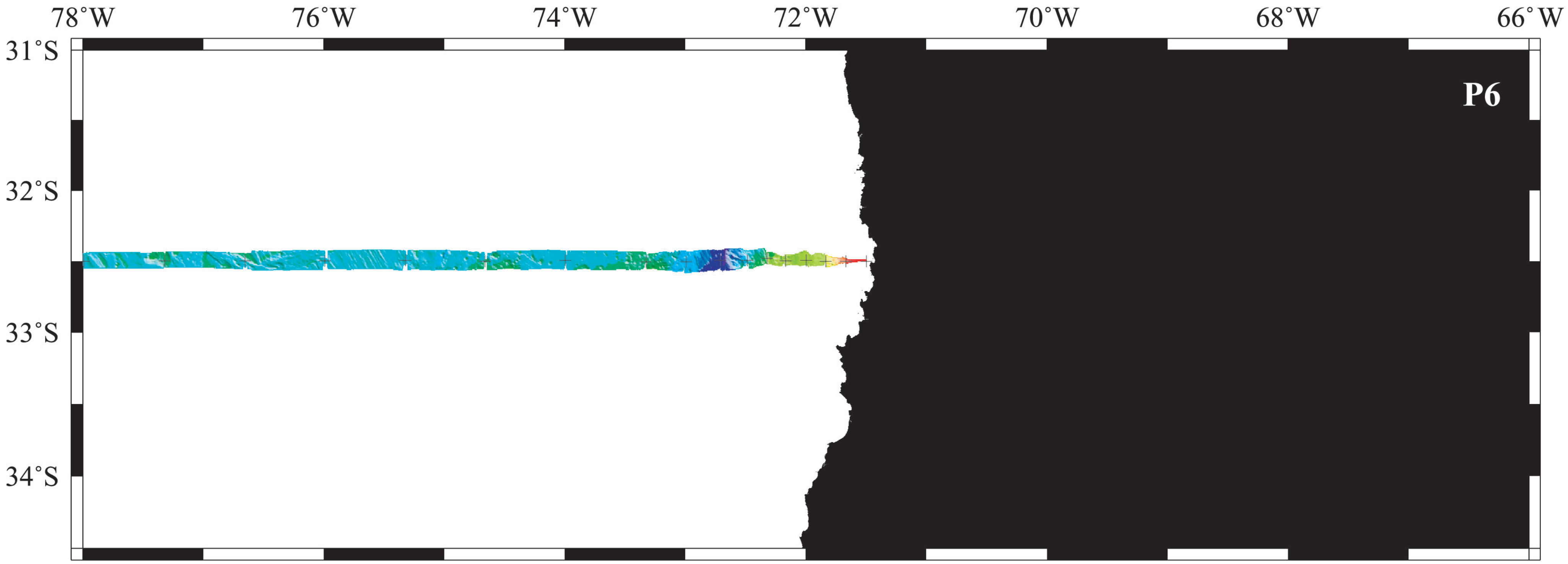
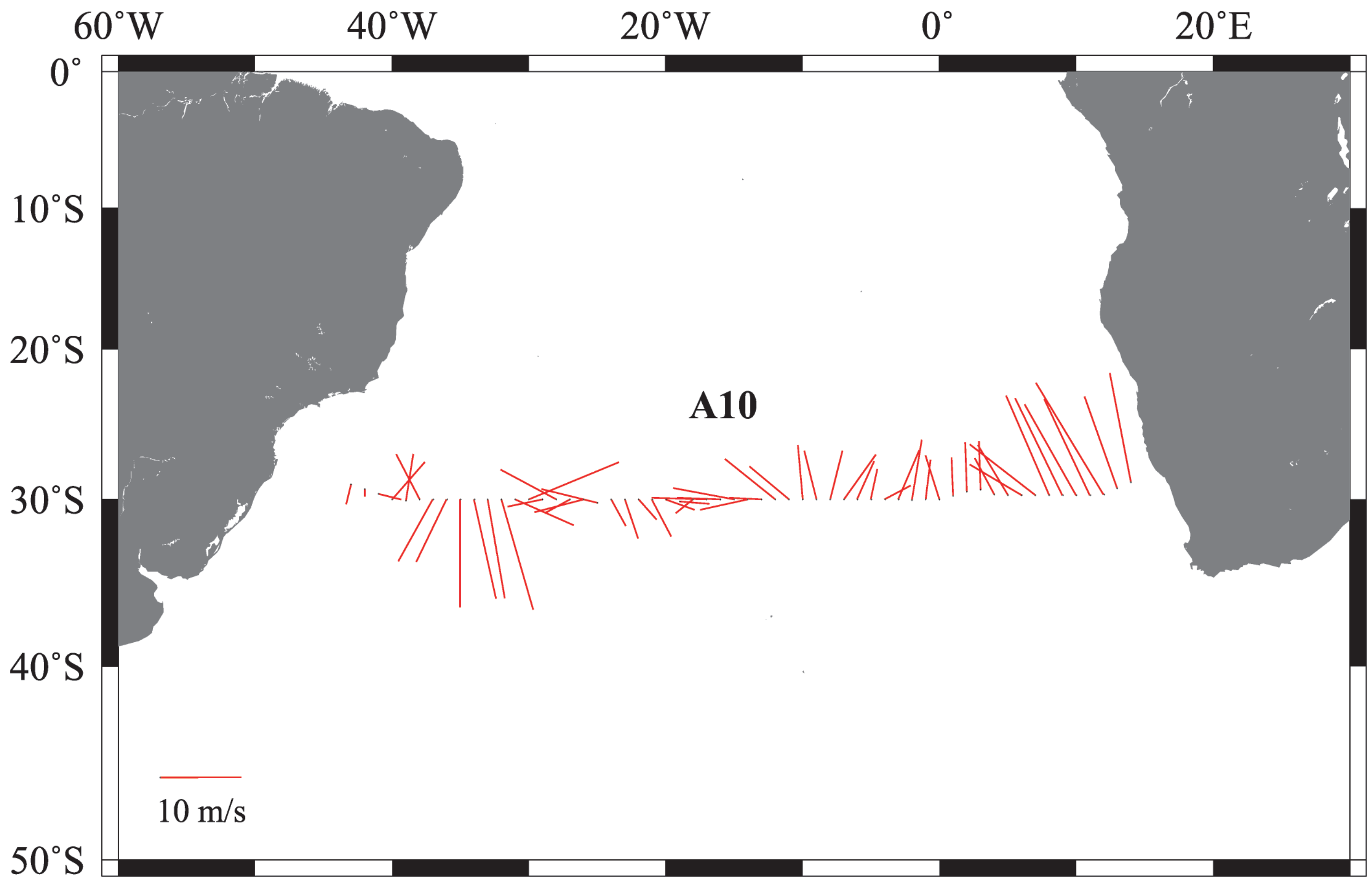
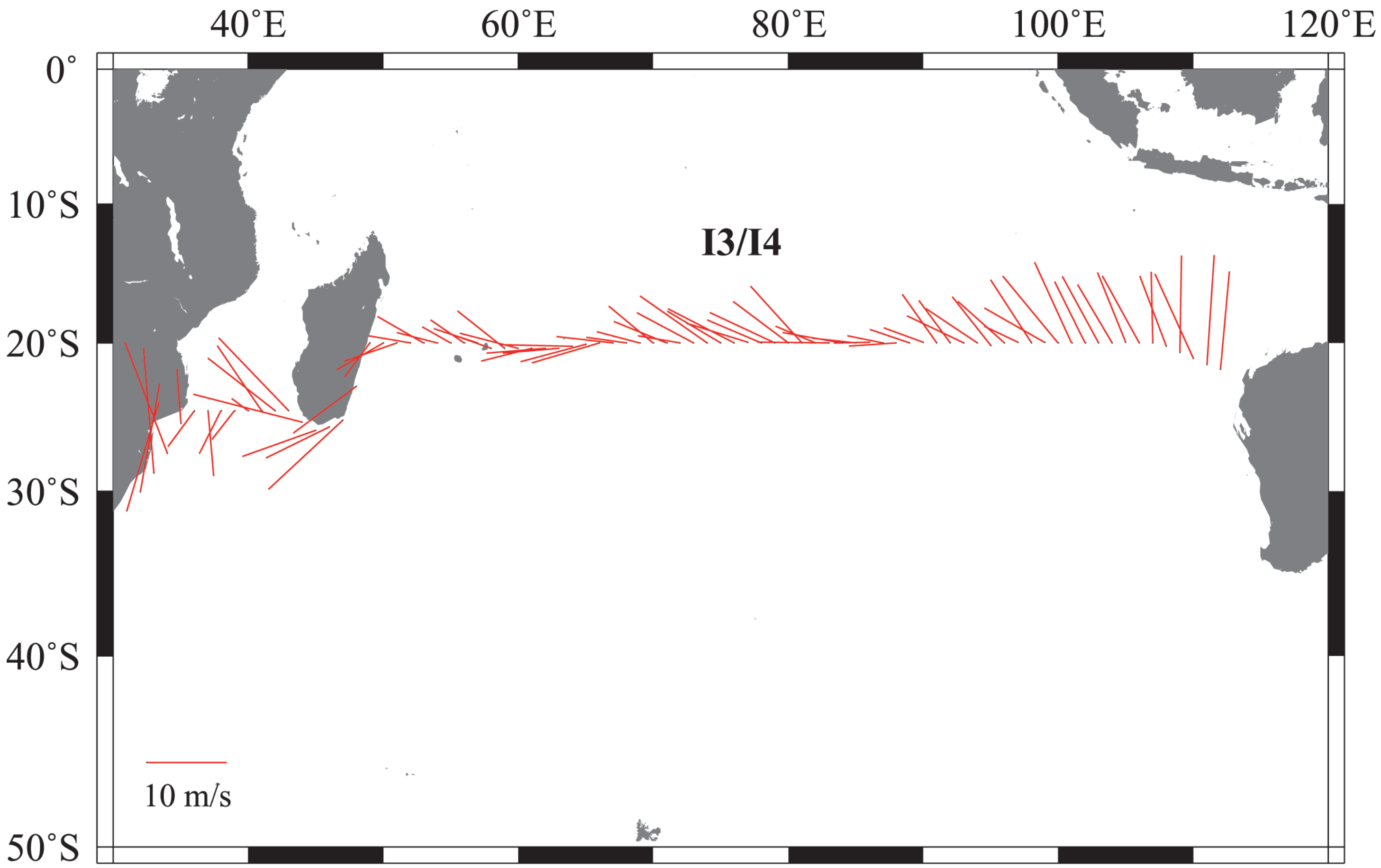

78°W
76°W
74°W
72°W
70°W
68°W
66°W
31°S
32°S
33°S
34°S
P6

Figure 4

SURFACE WIND MEASURED AT 25 M ABOVE SEA LEVEL





40°E
60°E
80°E
100°E
120°E
0°
10°S
20°S
30°S
40°S
50°S
I3/I4
10 m/s

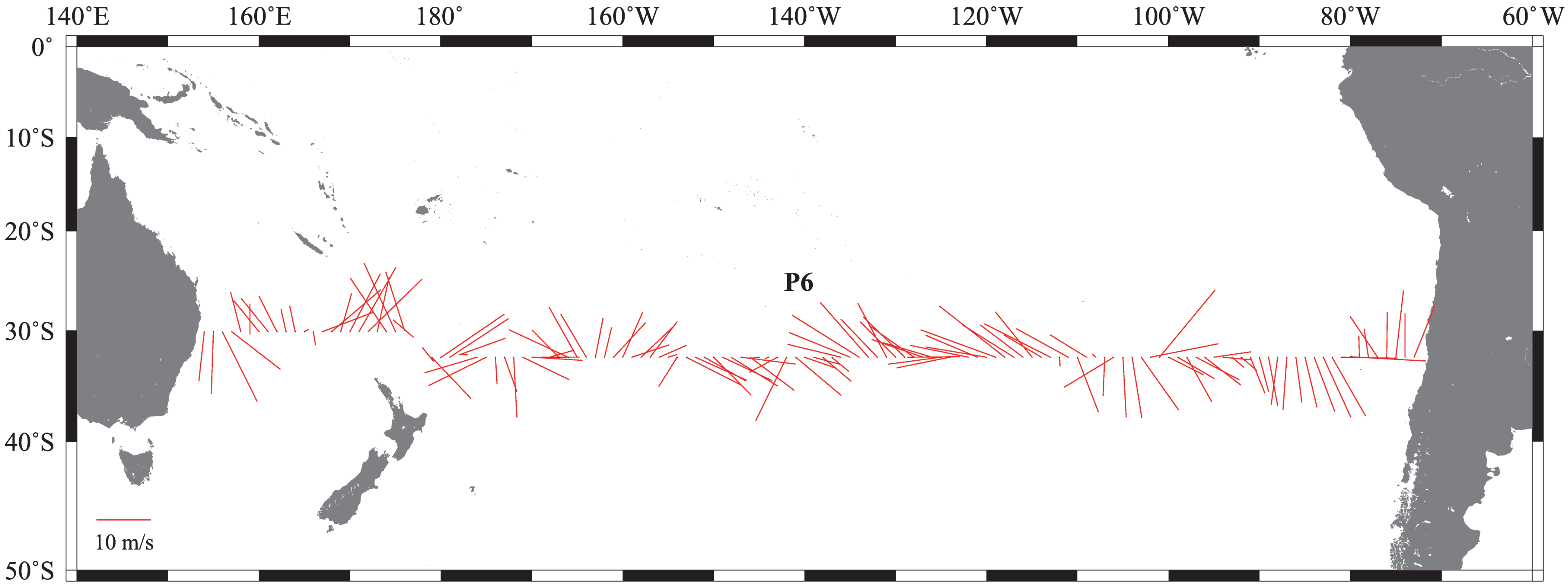
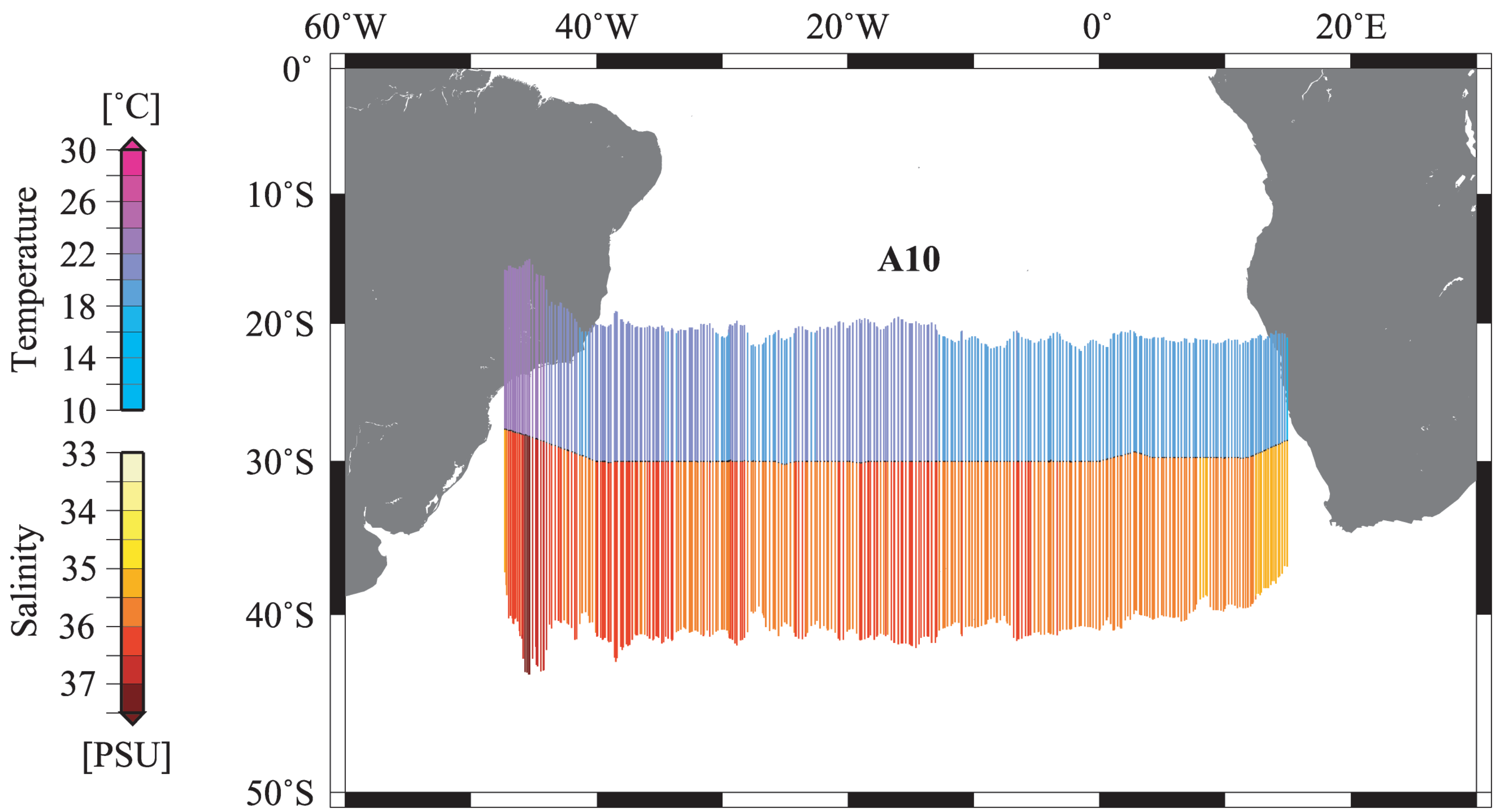
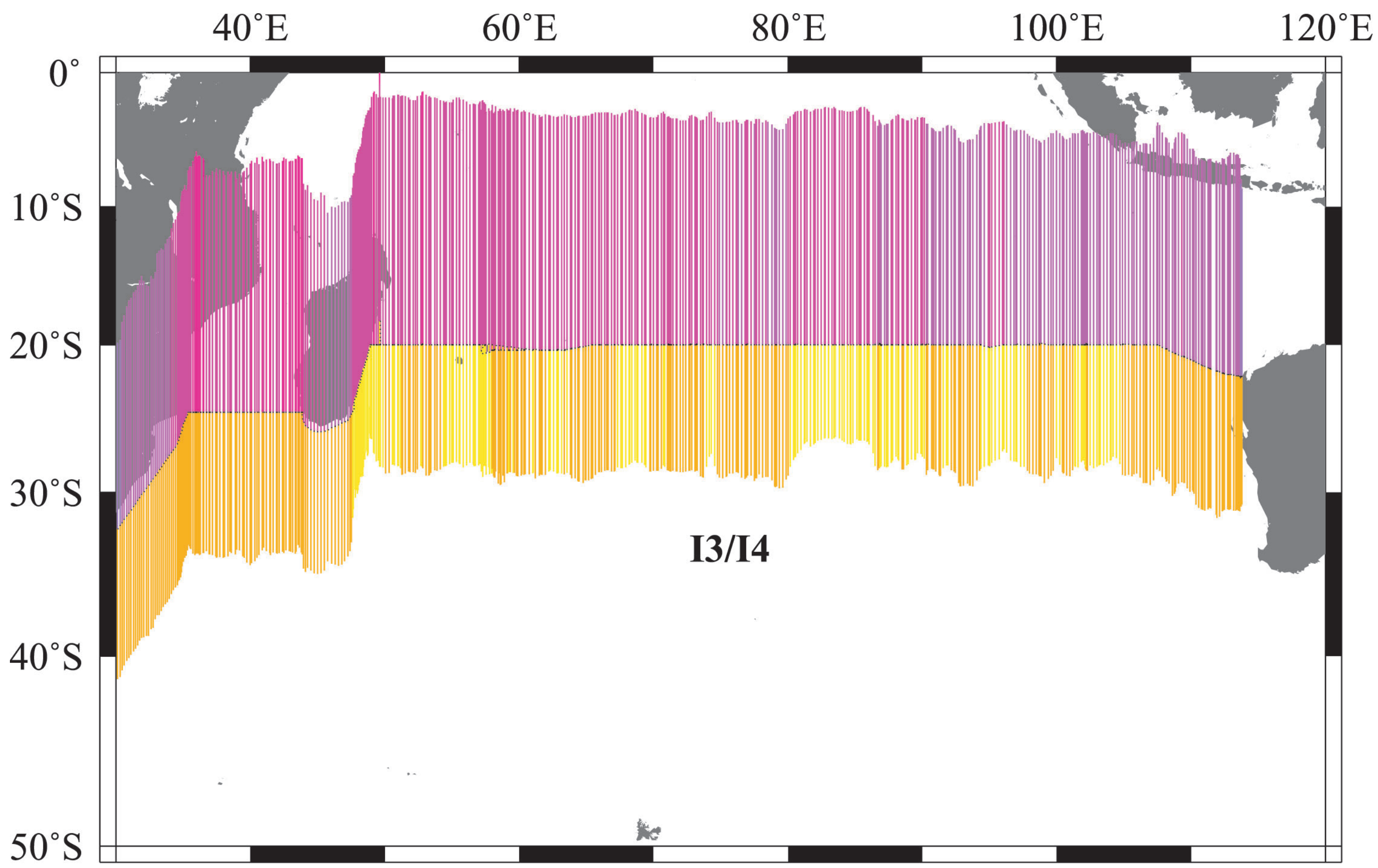
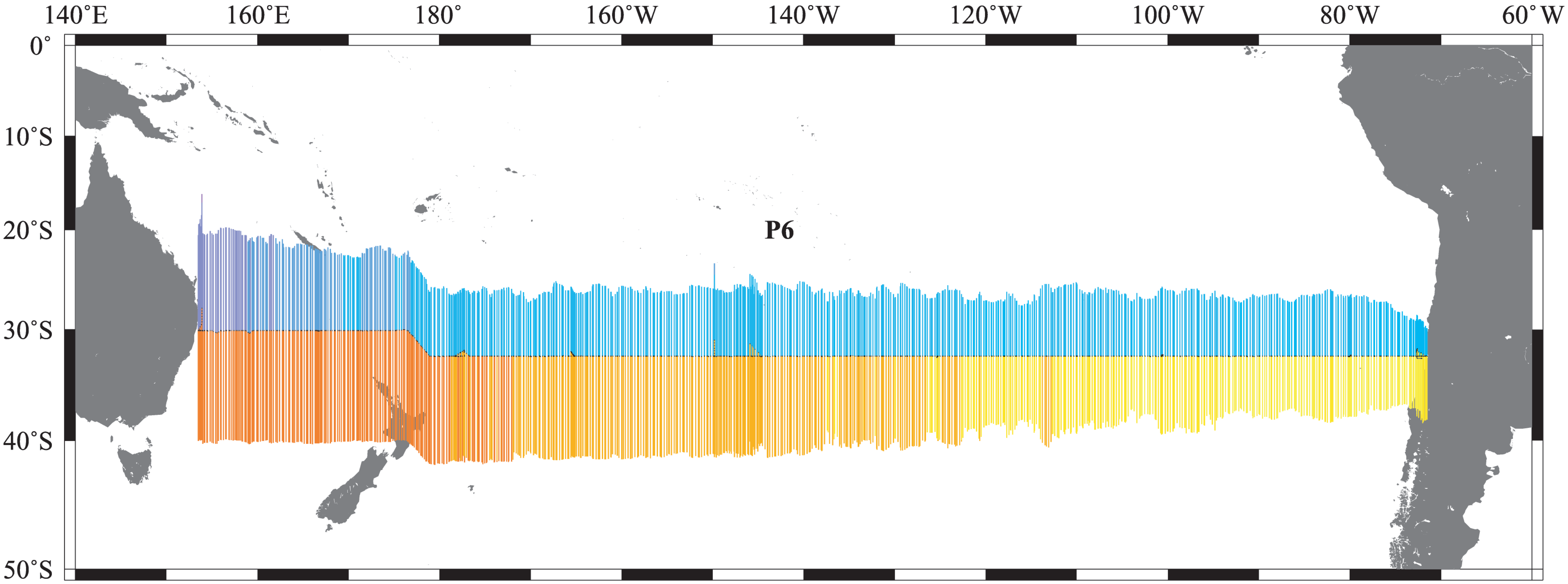

140°E
160°E
180°
160°W
140°W
120°W
100°W
80°W
60°W
0°
10°S
20°S
30°S
40°S
50°S
P6
10 m/s

Figure 5

Sea surface temperature and salinity



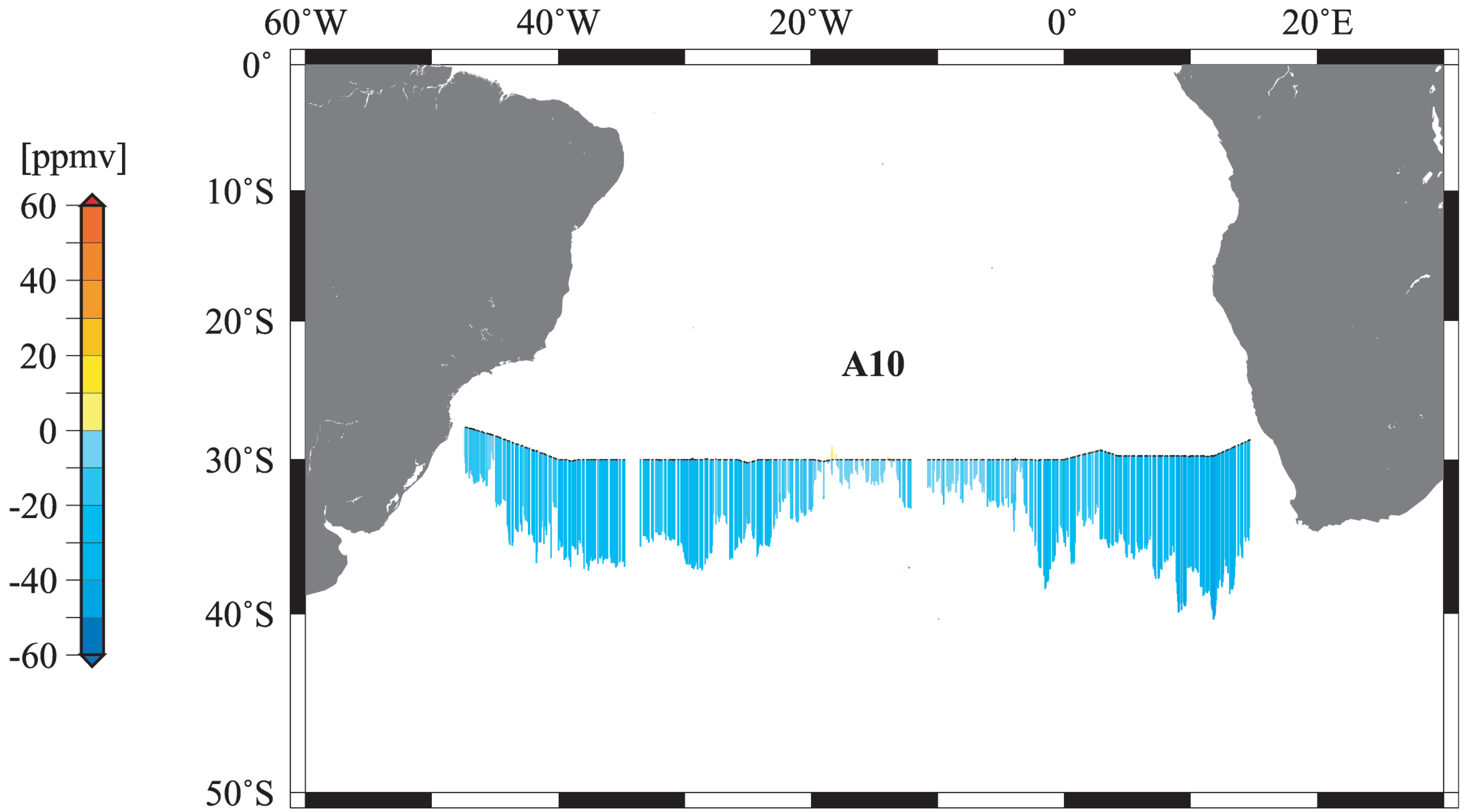

40˚E
60˚E
80˚E
100˚E
120˚E
0˚
10˚S
20˚S
30˚S
40˚S
50˚S
I3/I4

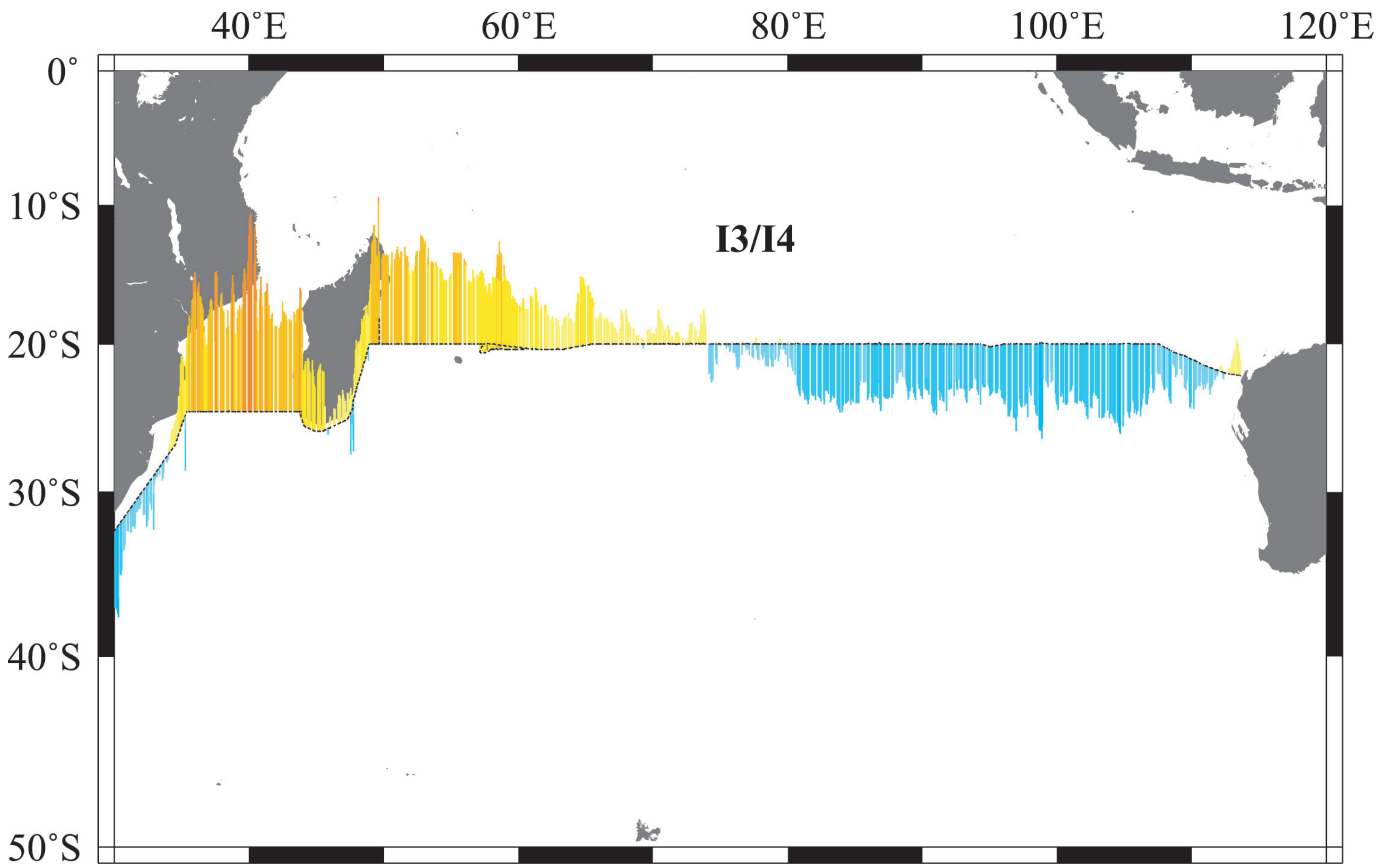


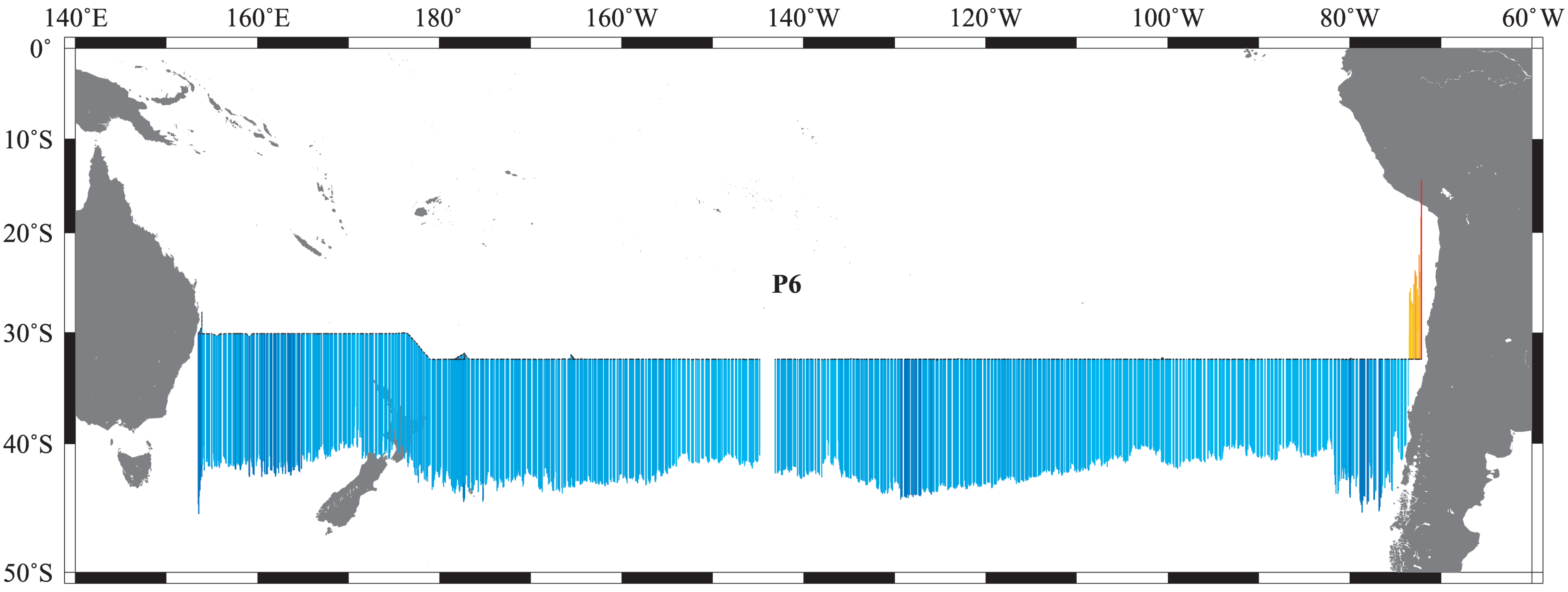
140˚E
160˚E
180˚
160˚W
140˚W
120˚W
100˚W
80˚W
60˚W
0˚
10˚S
20˚S
30˚S
40˚S
50˚S
P6

Figure 6

ΔpCO_2




40˚E
60˚E
80˚E
100˚E
120˚E
0˚
10˚S
20˚S
30˚S
40˚S
50˚S
I3/I4



140˚E
160˚E
180˚
160˚W
140˚W
120˚W
100˚W
80˚W
60˚W
0˚
10˚S
20˚S
30˚S
40˚S
50˚S
P6

Figure 7

SURFACE CURRENT
AT 100 M DEPTH

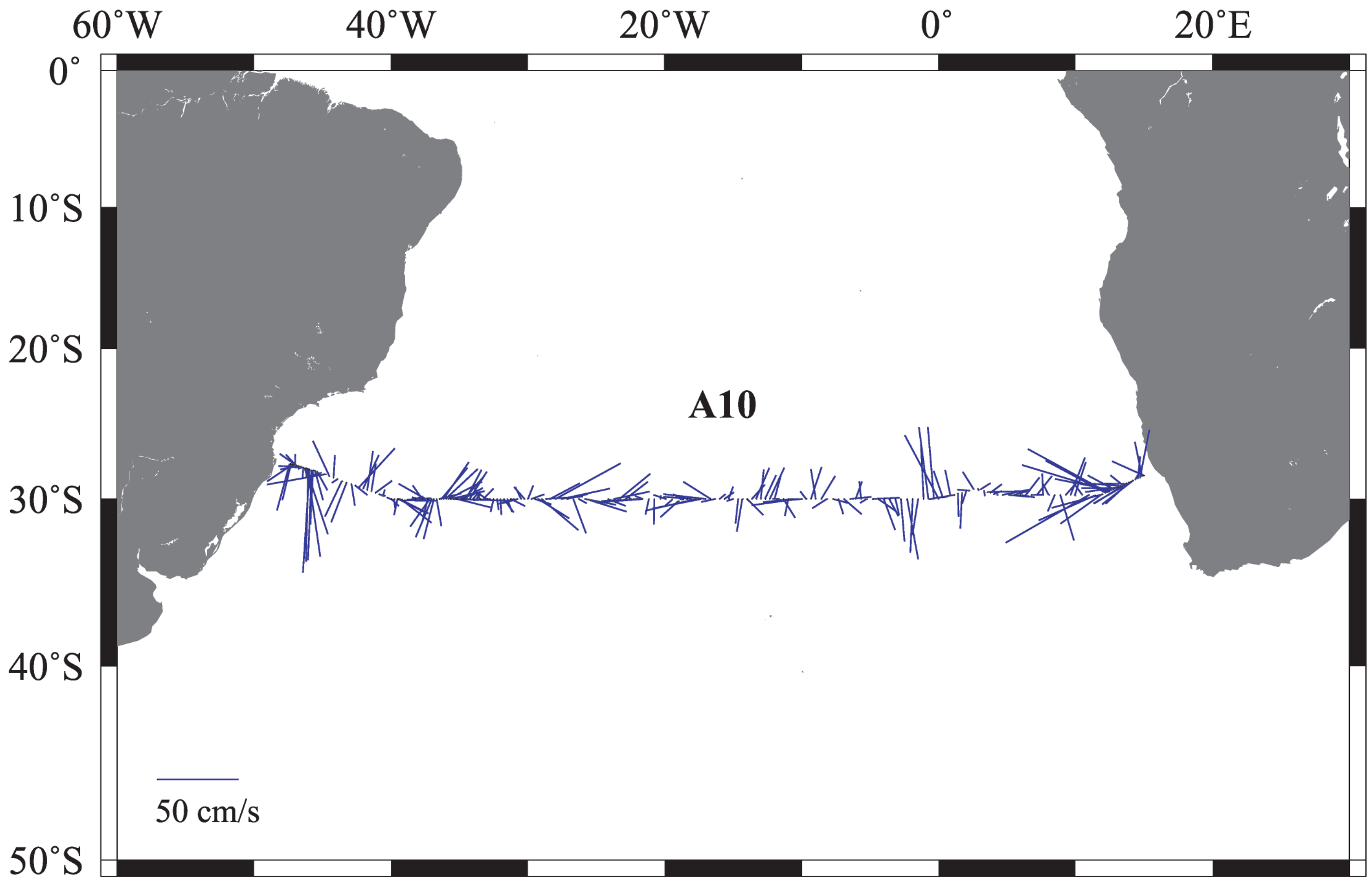
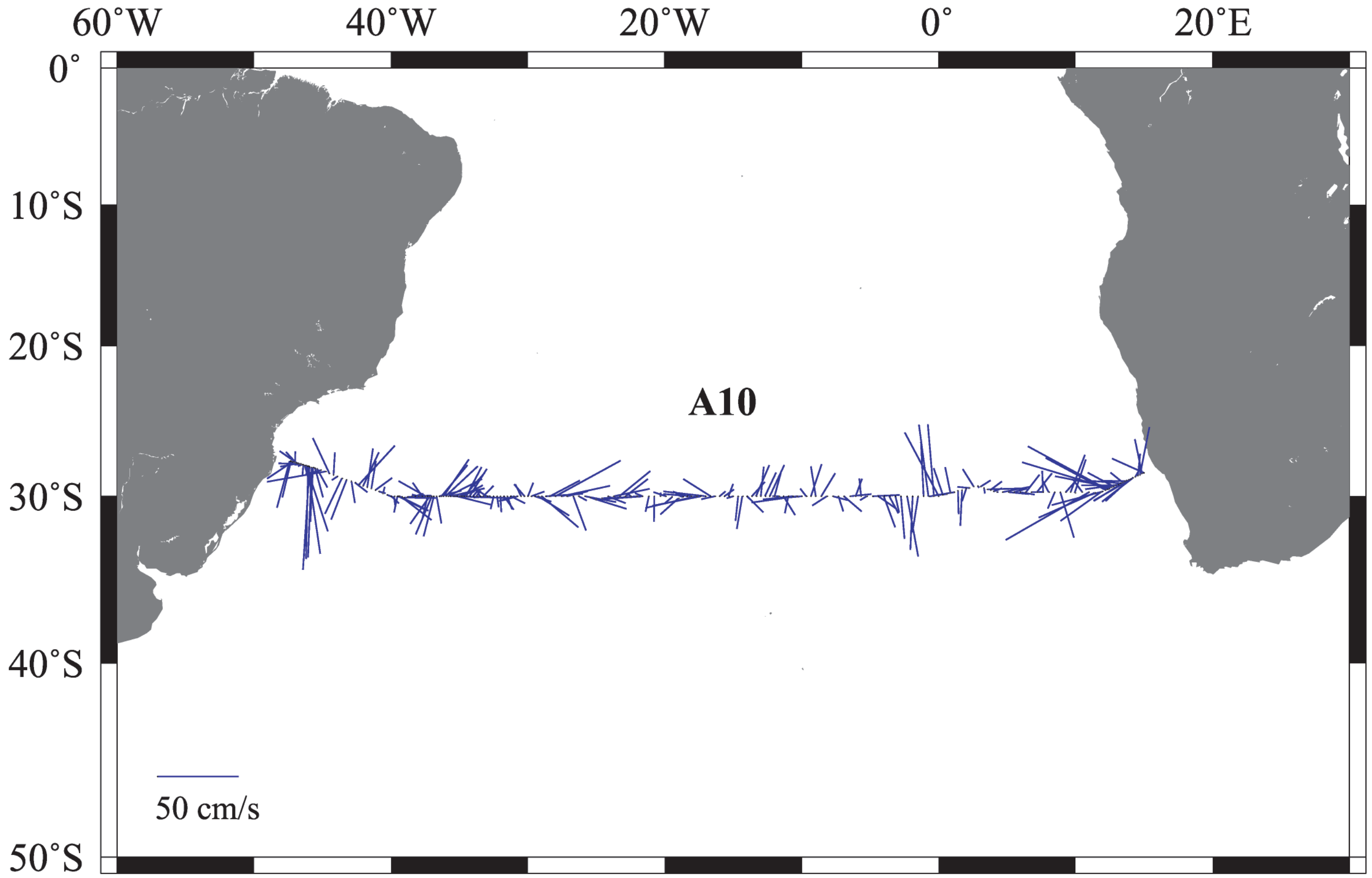
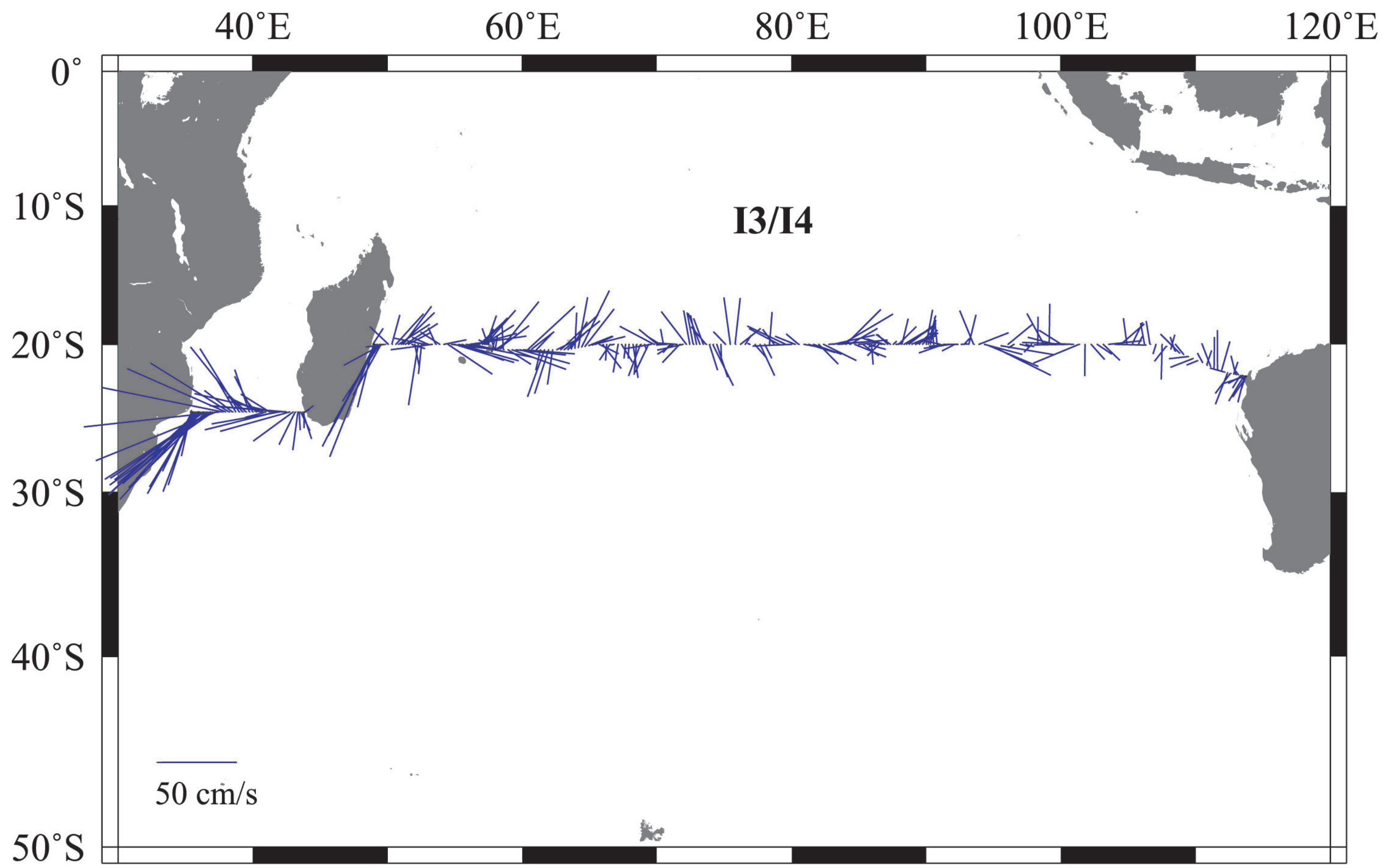
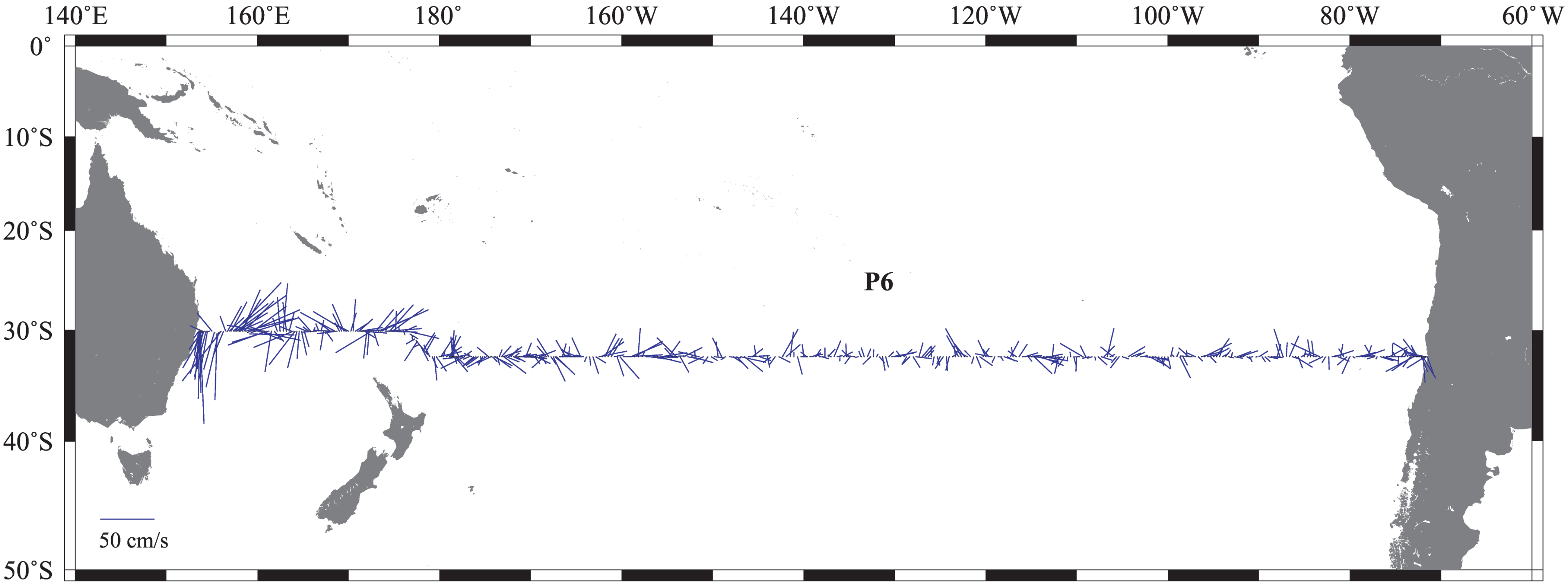


Figure 7

SURFACE CURRENT AT 100 M DEPTH




40°E
60°E
80°E
100°E
120°E
0°
10°S
20°S
30°S
40°S
50°S
I3/I4
50 cm/s

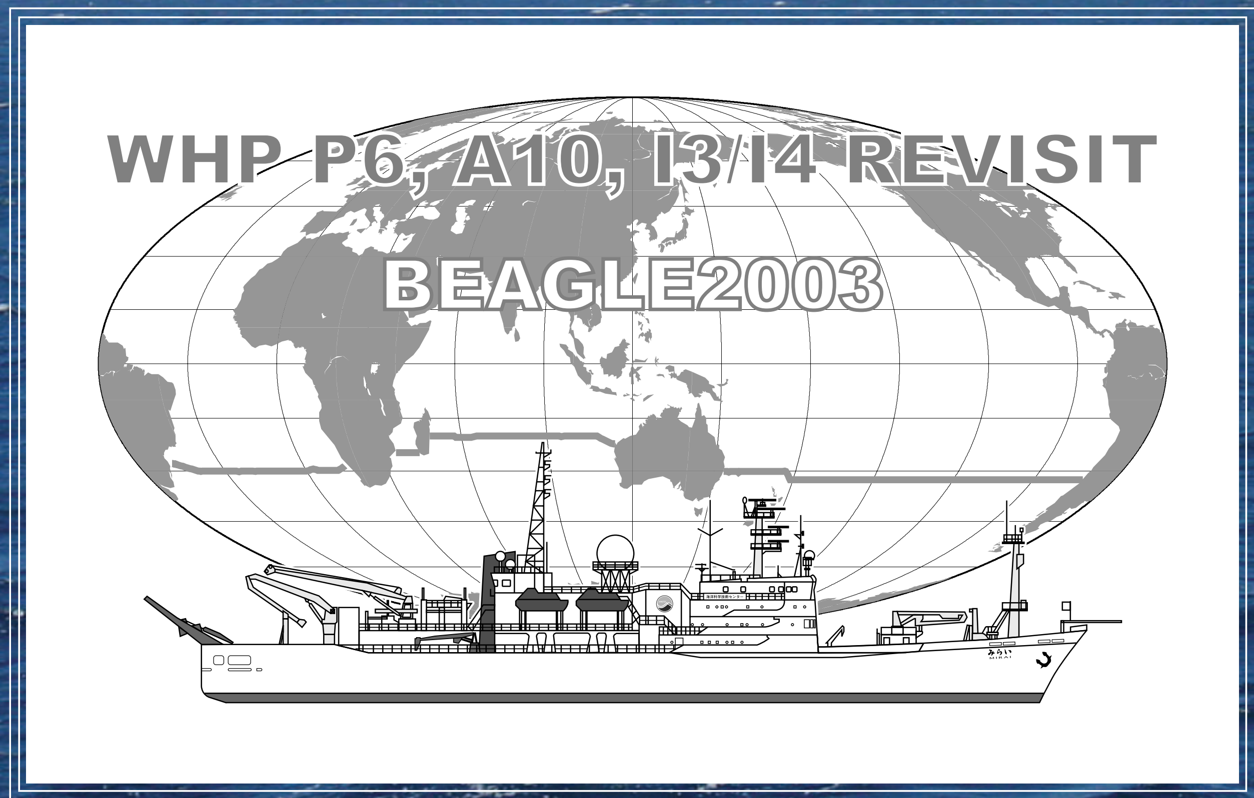


140°E
160°E
180°
160°W
140°W
120°W
100°W
80°W
60°W
0°
10°S
20°S
30°S
40°S
50°S
P6
50 cm/s

WHP P6, A10, I3/I4 REVISIT DATA BOOK

Blue Earth Global Expedition 2003 (BEAGLE2003)

Volume 2



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Blue Earth Global Expedition 2003 (BEAGLE2003)

Volume 2

Edited by

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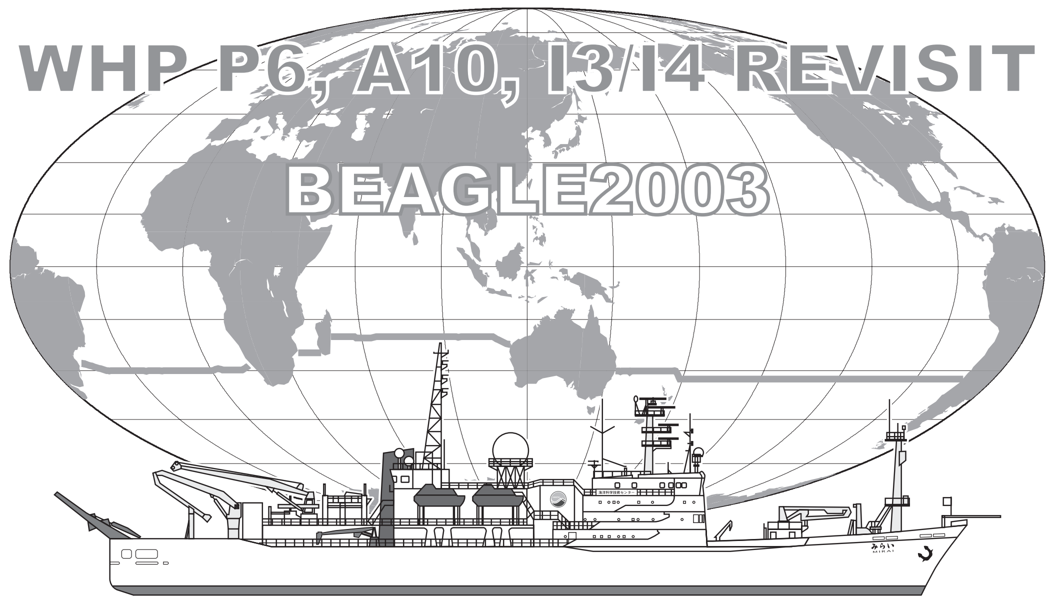
Masao Fukasawa (JAMSTEC)



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Volume 2

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Contents (Volume 2)

3 Hydrographic Measurement Techniques and Calibrations

3.1 CTD/O_2

28 February 2005

(1) Personnel

Hiroshi Uchida (JAMSTEC)

Masao Fukasawa (JAMSTEC)

Wolfgang Schneider (University of Concepcion)

Mark Rosenberg (ACE CRC)

Satoshi Ozawa (MWJ)

Hiroshi Matsunaga (MWJ)

Kentaro Oyama (MWJ)

(2) Winch arrangements

The CTD package wad deployed using 4.5 Ton Traction Winch System (Dynacon, Inc., USA) which was installed on the R/V Mirai in April 2001. The CTD Traction Winch System with the Heave Compensation Systems (Dynacon, Inc., USA) is designed to reduce cable stress resulting from load variation caused by wave or vessel motion. The system is operated passively by providing a nodding boom crane that moves up or down in response to line tension variations. Primary system components include a complete CTD Traction Winch System with up to 10 km of 9.53 mm armored cable (Ocean Cable and Communication Co.), cable rocker and Electro-Hydraulic Power Unit, nodding-boom crane assembly, two hydraulic cylinders and two hydraulic oil/nitrogen accumulators mounted within a single frame assembly. The system also contains related electronic hardware interface and a heave compensation computer control program.

(3) Overview of the equipment

The CTD system, SBE 911plus system (Sea-Bird Electronics, Inc., USA), is a real time data system with the CTD data transmitted from a SBE 9plus underwater unit via a conducting cable to the SBE 11plus deck unit. The SBE 11plus deck unit is a rack-mountable interface which supplies DC power to the underwater unit, decodes the serial data stream, formats the data under microprocessor control, and passes the data to a companion computer. The serial data from the underwater unit is sent to the deck unit in RS-232 NRZ format using a 34,560 Hz carrier-modulated differential-phase-shift-keying (DPSK) telemetry link. The deck unit decodes the serial data and sends them to a personal computer to display, at the same time, to storage in a disk file using SBE SEASOFT software.

The SBE 911plus system acquires data from primary, secondary and auxiliary sensors in the form of binary numbers corresponding to the frequency or voltage outputs from those sensors at 24 samples per second. The calculations required to convert from raw data to engineering units of the parameters are performed by the SBE SEASOFT in real-time. The same calculations can be carried out after the observation using data stored in a disk file.

The SBE 911plus system controls the 36-position SBE 32 Carousel Water Sampler. The Carousel accepts 12-litre water sample bottles. Bottles were fired through the RS-232C modem connector on the back of the SBE 11plus deck unit while acquiring real time data. The 12-litre Niskin-X water sample bottle (General Oceanics, Inc., USA) is equipped externally with two stainless steel springs. The external springs are ideal for applications such as the trace metal analysis because the inside of the sampler is free from contaminants from springs.

SBE's temperature (SBE 3) and conductivity (SBE 4) sensor modules were used with the SBE 9plus underwater unit fixed by a single clamp and "L" bracket to the lower end cap. The conductivity cell entrance is co-planar with the tip of the temperature sensor's protective steel sheath. The pressure sensor is mounted in the main housing of the underwater unit and is ported to outside through the oil-filled plastic capillary tube. A compact, modular unit consisting of a centrifugal pump head and a brushless DC ball bearing motor contained in an aluminum underwater housing pump (SBE 5T) flushes water through sensor tubing at a constant rate independent of the CTD's motion. Motor speed and pumping rate (3,000 rpm) remain nearly constant over the entire input voltage range of 12-18 volts DC. Flow speed of pumped water in standard TC duct is about 2.4 m/s.

SBE's dissolved oxygen sensor (SBE 43) was placed between the conductivity sensor module and the pump. Auxiliary sensors, Deep Ocean Standards Thermometer (SBE 35), altimeter and fluorometer, were also used with the SBE 9plus underwater unit. The SBE 35 position in regard to the SBE 3 is shown in Figure 3.1.1.

It is known that the CTD temperature data is influenced by the motion (pitching and rolling) of the CTD package. In order to reduce the motion of the CTD package, a heavy stainless frame (total weight of the CTD package without sea water in the bottles is about 1,000 kg) was used and an aluminum plate (54 x 90 cm) was attached to the frame (Figure 3.1.2).

Summary of the system used in this cruise

Leg 1

Deck unit:

SBE, Inc., SBE 11plus, S/N 0272

Under water unit:

SBE, Inc., SBE 9plus, S/N 79492 (Pressure sensor: S/N 0575)

Temperature sensor:

SBE, Inc., SBE 3plus, S/N 4188 (primary)

SBE, Inc., SBE 3, S/N 1464 (secondary)

Conductivity sensor:

SBE, Inc., SBE 4, S/N 1088 (primary)

SBE, Inc., SBE 4, S/N 1202 (secondary)

Oxygen sensor:

SBE, Inc., SBE 43, S/N 0390 (primary)

SBE, Inc., SBE 43, S/N 0205 (secondary)

Pump:

SBE, Inc., SBE 5T, S/N 3575 (primary)

SBE, Inc., SBE 5T, S/N 0984 (secondary)

Altimeter:

Benthos Inc., PSA-900D, S/N 1026 (except for P06_148)

Benthos Inc., 2110-2, S/N 206 (P06_148)

Deep Ocean Standards Thermometer:

SBE, Inc., SBE 35, S/N 0022

Fluorometer:

Seapoint sensors, Inc., S/N 2148 (from P06_246 to P06_166 cast 1)

(no fluorometer from P06_166 cast 2 to P06_004)

Carousel Water Sampler:

SBE, Inc., SBE 32, S/N 0278

Water sample bottle:

General Oceanics, Inc., 12-litre Niskin-X (no TEFLON coating)

Leg 2

Deck unit:

SBE, Inc., SBE 11plus, S/N 0272

Under water unit:

SBE, Inc., SBE 9plus, S/N 42423 (Pressure sensor: S/N 0357)

Temperature sensor:

SBE, Inc., SBE 3, S/N 1524 (primary, P06_127)

SBE, Inc., SBE 3plus, S/N 4216 (primary, from P06_125 to P06_004)

SBE, Inc., SBE 3plus, S/N 2453 (secondary)

Conductivity sensor:

SBE, Inc., SBE 4, S/N 2240 (primary)

SBE, Inc., SBE 4, S/N 1206 (secondary)

Oxygen sensor:

SBE, Inc., SBE 43, S/N 0391 (primary)

SBE, Inc., SBE 43, S/N 0069 (secondary, from P06_127 to P06_061)

(no secondary sensor from P06_060 to P06_004)

Pump:

SBE, Inc., SBE 5T, S/N 3575 (primary)

SBE, Inc., SBE 5T, S/N 0984 (secondary)

Altimeter:

Benthos Inc., PSA-900D, S/N 1026

Deep Ocean Standards Thermometer:

SBE, Inc., SBE 35, S/N 0022

Fluorometer:

None

Carousel Water Sampler:

SBE, Inc., SBE 32, S/N 0278

Water sample bottle:

General Oceanics, Inc., 12-litre Niskin-X (no TEFLON coating)

Leg 4

Deck unit:

SBE, Inc., SBE 11plus, S/N 0272

Under water unit:

SBE, Inc., SBE 9plus, S/N 42423 (Pressure sensor: S/N 0357)

Temperature sensor:

SBE, Inc., SBE 3, S/N 1464 (primary)

SBE, Inc., SBE 3plus, S/N 4188 (secondary)

Conductivity sensor:

SBE, Inc., SBE 4, S/N 1203 (primary)

SBE, Inc., SBE 4, S/N 2435 (secondary)

Oxygen sensor:

SBE, Inc., SBE 43, S/N 0391 (primary)

SBE, Inc., SBE 43, S/N 0394 (secondary)

Pump:

SBE, Inc., SBE 5T, S/N 3575 (primary)

SBE, Inc., SBE 5T, S/N 0984 (secondary)

Altimeter:

Benthos Inc., PSA-900D, S/N 1026

Deep Ocean Standards Thermometer:

SBE, Inc., SBE 35, S/N 0045

Fluorometer:

Seapoint sensors, Inc., S/N 2579

Carousel Water Sampler:

SBE, Inc., SBE 32, S/N 0391

Water sample bottle:

General Oceanics, Inc., 12-litre Niskin-X (no TEFLON coating)

Leg 5

Deck unit:

SBE, Inc., SBE 11plus, S/N 0272 (from I04_610 to I03_467)

SBE, Inc., SBE 11plus, S/N 0344 (from I03_466 to I03_444)

Under water unit:

SBE, Inc., SBE 9plus, S/N 42423 (Pressure sensor: S/N 0357)

Temperature sensor:

SBE, Inc., SBE 3, S/N 1464 (primary)

SBE, Inc., SBE 3, S/N 4323 (secondary)

Conductivity sensor:

SBE, Inc., SBE 4, S/N 1088 (primary, from I04_610 to I03_503)

SBE, Inc., SBE 4, S/N 2435 (primary, from I03_502 to I03_444)

SBE, Inc., SBE 4, S/N 1202 (secondary)

Oxygen sensor:

SBE, Inc., SBE 43, S/N 0391 (primary)

SBE, Inc., SBE 43, S/N 0205 (secondary)

Pump:

SBE, Inc., SBE 5T, S/N 3575 (primary)

SBE, Inc., SBE 5T, S/N 0984 (secondary)

Altimeter:

Benthos Inc., PSA-900D, S/N 1026 (from I04_610 to I03_511)

Benthos Inc., PSA-900D, S/N 0396

(from I03_510 to I03_469, I03_466, I03_467,

from I03_463 to I03_444)

Benthos Inc., 2110-2, S/N 206 (from I03_468 to I03_467, I03_464)

Deep Ocean Standards Thermometer:

SBE, Inc., SBE 35, S/N 0045

Fluorometer:

Seapoint sensors, Inc., S/N 2579

Carousel Water Sampler:

SBE, Inc., SBE 32, S/N 0391 (from I04_610 to I03_514)

SBE, Inc., SBE 32, S/N 0278 (from I03_513 to I03_444)

Water sample bottle:

General Oceanics, Inc., 12-litre Niskin-X (no TEFLON coating)

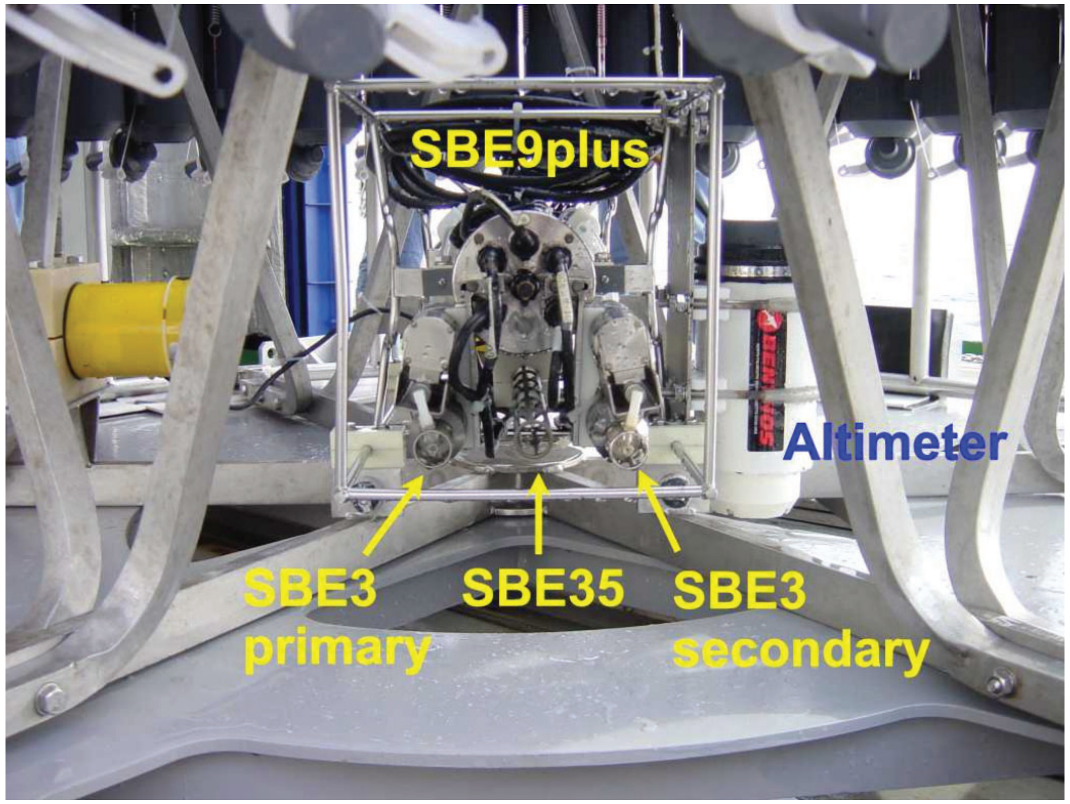

Figure 3.1.1. The SBE 35 position in regard to the SBE 3 temperature sensors.

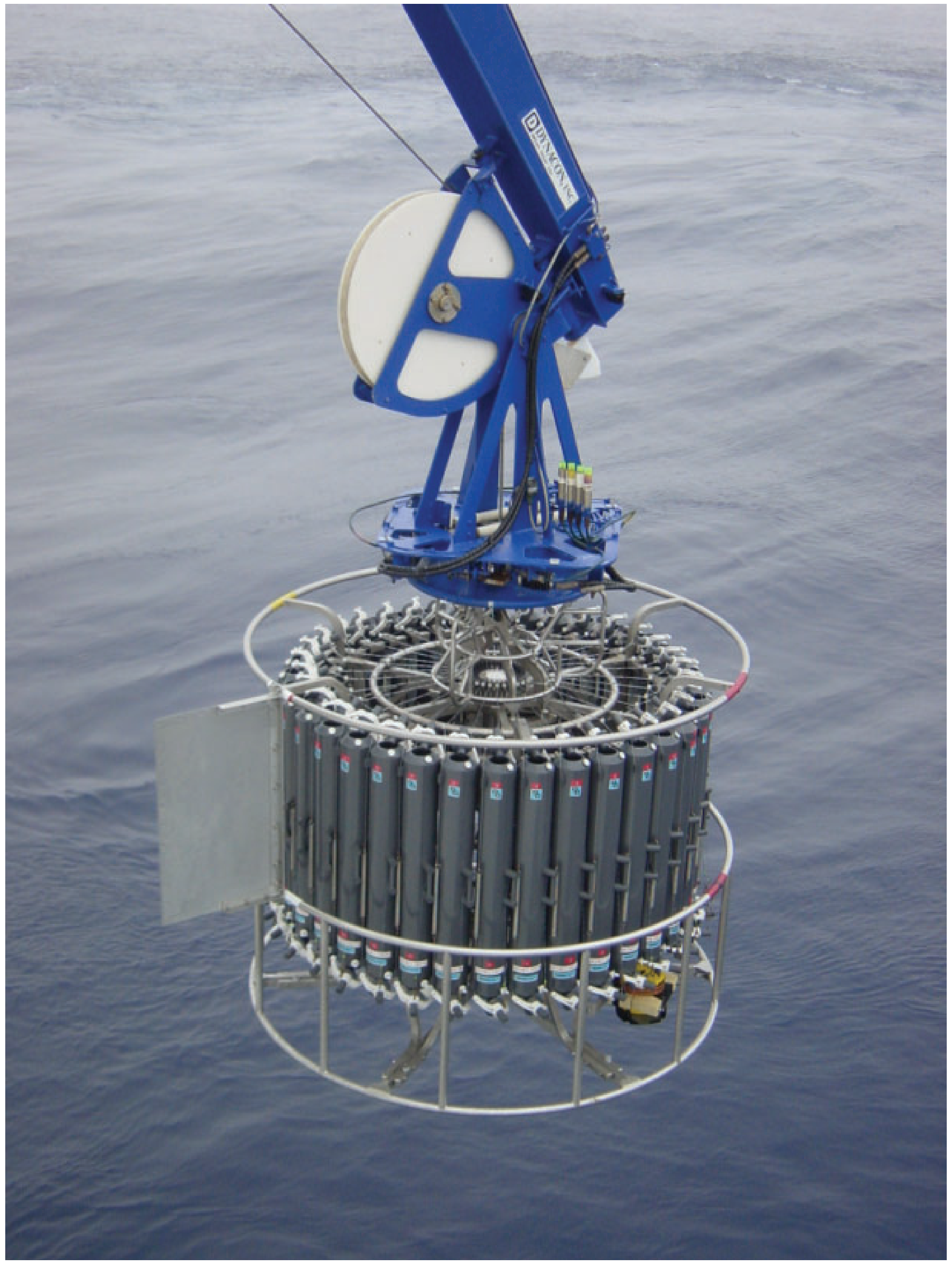

Figure 3.1.2. The CTD package.

(4) Pre-cruise calibration

(4.1) Pressure

The Paroscientific series 4000 Digiquartz high pressure transducer (Paroscientific, Inc., USA) uses a quartz crystal resonator whose frequency of oscillation varies with pressure induced stress with 0.01 per million of resolution over the absolute pressure range of 0 to 15,000 psia (0 to 10,332 dbar). Also, a quartz crystal temperature signal is used to compensate for a wide range of temperature changes at the time of an observation. The pressure sensor (MODEL 415K-187) has a nominal accuracy of 0.015 % FS (1.5 dbar), typical stability of 0.0015 % FS/month (0.15 dbar/month) and resolution of 0.001 % FS (0.1 dbar).

Pre-cruise sensor calibrations were performed at SBE, Inc., USA. The following coefficients were used in the SEASOFT:

S/N 0575 (Leg 1), 27 October 1999

c_1 = -65706.8

c_2 = -0.1758329

c_3 = 2.04245e-02

d_1 = 0.027146

d_2 = 0.0

t_1 = 29.92375

t_2 = -2.63869e-04

t_3 = 3.92132e-06

t_4 = 1.35947e-09

t_5 = 4.49704e-12

(The coefficients c_1, c_2, t_1 and t_2 were changed on 6 December 1999.)

S/N 0357 (Leg 2, 4 and 5), 17 May 1994

c_1 = -69582.91

c_2 = -1.619244

$c_3 = 2.34327e\text{-}02$

$d_1 = 0.029679$

$d_2 = 0$

$t_1 = 28.12082$

$t_2 = -4.595919e\text{-}04$

$t_3 = 3.89464e\text{-}06$

$t_4 = 0$

$t_5 = 0$

Pressure coefficients are first formulated into

$c = c_1 + c_2 * U + c_3 * U^2$

$d = d_1 + d_2 * U$

$t_0 = t_1 + t_2 * U + t_3 * U^2 + t_4 * U^3 + t_5 * U^4$

where U is temperature in degrees Celsius. The pressure temperature, U, is determined according to

U (°C) = M * (12 bit pressure temperature compensation word) – B

The following coefficients were used in SEASOFT:

S/N 0575 (Leg 1)

M = 0.01284934

B = -8.388034

(in the underwater unit system configuration sheet dated on 30 November 1999)

S/N 0357 (Leg 2, 4 and 5)

M = 0.01161

B = -8.32759

(in the underwater unit system configuration sheet dated on 24 May 1994)

Finally, pressure is computed as

$$P\ (\text{psi}) = c * [1 - (t_0^2 / t^2)] * \{1 - d * [1 - (t_0^2 / t^2)]\}$$

where t is pressure period (μsec). Since the pressure sensor measures the absolute value, it inherently includes atmospheric pressure (about 14.7 psi). SEASOFT subtracts 14.7 psi from computed pressure above automatically.

Pressure sensor calibrations against a dead-weight piston gauge (Bundenberg Gauge Co. Ltd., UK; Model 480DA, S/N 23906) are performed at JAMSTEC (Yokosuka, Kanagawa, JAPAN) by Marine Works Japan Ltd. (MWJ), usually once in a year in order to monitor sensor time drift and linearity. The pressure sensor drift is known to be primarily an offset drift at all pressures rather than a change of span slope. The pressure sensor hysterisis is typically 0.2 dbar. The following coefficients for the sensor drift correction were also used in SEASOFT through the software module SEACON:

S/N 0575 (Leg 1), 21 April 2003

slope = 0.9999235

offset = 2.4157361

S/N 0357 (Leg 2, 4 and 5), 18 April 2003

slope = 0.9999112

offset = -0.0295469

The drift-corrected pressure is computed as

Drift-corrected pressure (dbar) = slope * (computed pressure in dbar) + offset

Results of the pressure sensor calibrations against the dead weight piston gauge are shown in Figure 3.1.3 and 3.1.4.

Time drifts of the pressure sensors based on the offset of the calibrations are also shown in Figure 3.1.5 and 3.1.6.

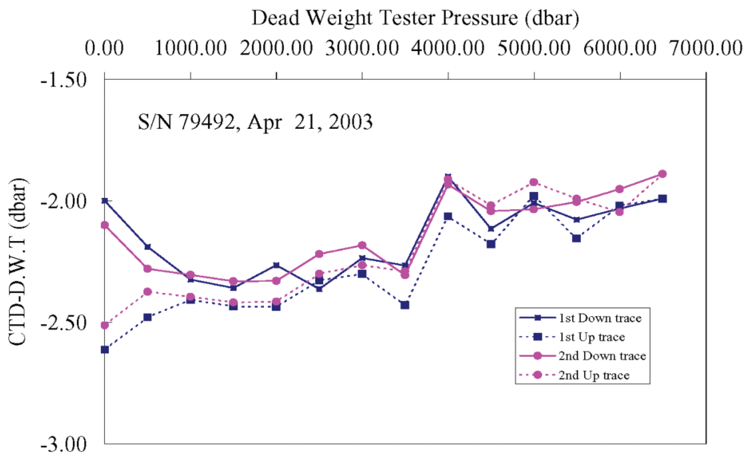

Figure 3.1.3. The residual pressures between the dead weight piston gauge and the CTD pressure (S/N 0575).

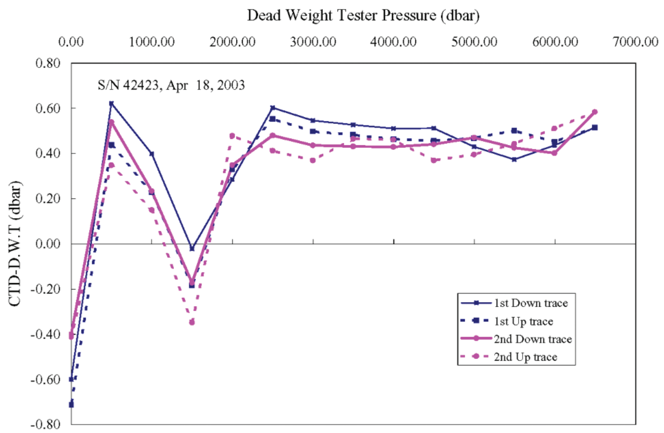

Figure 3.1.4. Same as Figure 3.1.3, but for the pressure sensor S/N 0357.

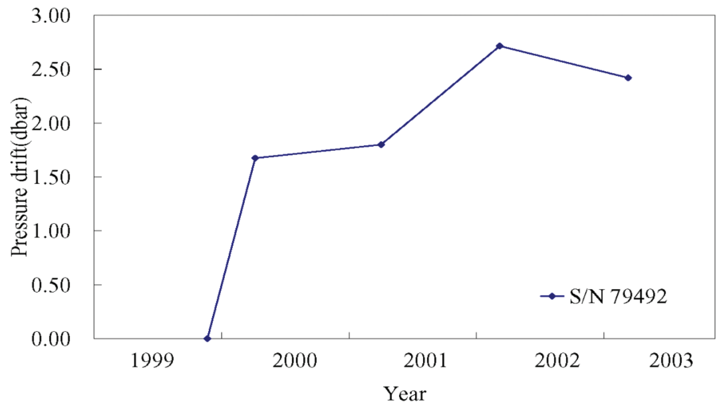

Figure 3.1.5. Pressure sensor (S/N 0575) time drift based on laboratory calibrations performed by MWJ.

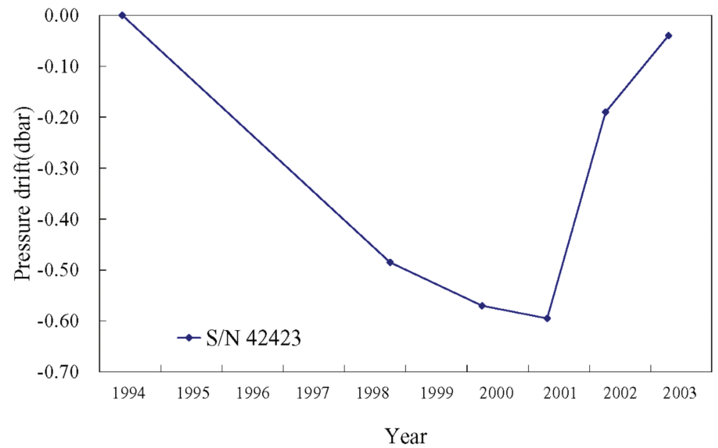

Figure 3.1.6. Same as Figure 3.1.5, but for the pressure sensor S/N 0357.

(4.2) Temperature (SBE 3)

The temperature sensing element is a glass-coated thermistor bead in a stainless steel tube, providing a pressure-free measurement at depths up to 10,500 (6,800) meters by titanium (aluminum) housing. The sensor output frequency ranges from approximately 5 to 13 kHz corresponding to temperature from –5 to 35 °C. The output frequency is inversely proportional to the square root of the thermistor resistance, which controls the output of a patented Wien Bridge circuit. The thermistor resistance is exponentially related to temperature. The SBE 3 thermometer has a nominal accuracy of 0.001 °C, typical stability of 0.0002 °C/month and resolution of 0.0002 °C at 24 samples per second. The premium temperature sensor, SBE 3plus, is a more rigorously tested and calibrated version of standard temperature sensor (SBE 3). A sensor is designated as an SBE 3plus only after demonstrating drift of less than 0.001 °C during a six-month screening period. In addition, the time response is carefully measured and verified to be 0.065 ± 0.010 seconds.

Pre-cruise sensor calibrations were performed at SBE, Inc., USA. The following coefficients were used in SEASOFT:

S/N 4188 (Leg 1), 25 June 2003

g = 4.39868209e-03

h = 6.45272514e-04

i = 2.26066338e-05

j = 1.89127504e-06

f_0 = 1000.000

S/N 1464 (Leg 1), 24 June 2003

g = 4.84388979e-03

h = 6.80795615e-04

i = 2.70029675e-05

j = 2.13380253e-06

f_0 = 1000.000

S/N 1524 (Leg 2), 15 April 2003

g = 4.85928482e-03

h = 6.85560499e-04

i = 2.72682203e-05

j = 2.04591608e-06

f_0 = 1000.000

S/N 4216 (Leg 2), 29 July 2003

g = 4.35956769e-03

h = 6.45664029e-04

i = 2.25867675e-05

j = 1.88325427e-06

f_0 = 1000.000

S/N 2453 (Leg 2), 25 July 2003

g = 4.4010773e-03

h = 6.47307314e-04

i = 2.32721826e-05

j = 2.09881293e-06

f_0 = 1000.000

S/N 1464 (Leg 4 and 5), 23 September 2003

g = 4.84390595e-03

h = 6.80838076e-04

i = 2.70300539e-05

j = 2.13906165e-06

f_0 = 1000.000

S/N 4188 (Leg 4), 23 September 2003

g = 4.39869651e-03

h = 6.45292266e-04

i = 2.26138218e-05

j = 1.89143037 e-06

f_0 = 1000.000

S/N 4323 (Leg 5), 29 October 2003

g = 4.36386026e-03

h = 6.48493108e-04

i = 2.28715193e-05

j = 1.84823185 e-06

f_0 = 1000.000

Temperature (ITS-90) is computed according to

Temperature (ITS-90) =

$$1 / \{g + h * [\ln(f0 / f)] + i * [\ln^2(f0 / f)] + j * [\ln^3(f_0 / f)]\} - 273.15$$

where f is the instrument frequency (kHz).

(4.3) Conductivity (SBE 4)

The flow-through conductivity sensing element is a glass tube (cell) with three platinum electrodes to provide in-situ measurements at depths up to 10,500 meters. The impedance between the center and the end electrodes is determined by the cell geometry and the specific conductance of the fluid within the cell. The conductivity cell composes a Wien Bridge circuit with other electric elements of which frequency output is approximately 3 to 12 kHz corresponding to conductivity of the fluid of 0 to 7 S/m. The conductivity cell SBE 4 has a nominal accuracy of 0.0003 S/m, typical stability of 0.0003 S/m/month and resolution of 0.00004 S/m at 24 samples per second.

Pre-cruise sensor calibrations were performed at SBE, Inc., USA. The following coefficients were used in SEASOFT:

S/N 1088 (Leg 1), 3 July 2003

g = -4.01946189e+00

h = 5.50802658e-01

i = -1.68736617e-04

j = 3.83962022e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 1202 (Leg 1), 3 July 2003

g = -3.94210124e+00

h = 4.38993142e-01

i = -9.59762118e-06

j = 2.09906225e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 2240 (Leg 2), 30 July 2003

g = -1.06122361e+01

h = 1.51071990e+00

i = -2.24813805e-03

j = 2.43876786e-04

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 1206 (Leg 2), 30 July 2003

g = -4.29002369+00

h = 5.03379521e-01

i = 1.18152789e-04

j = 2.02164093e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 1203 (Leg 4), 25 September 2003

g = -4.05196392e+00

h = 4.93501401e-01

i = 8.12083631e-05

j = 2.24962840e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 2453 (Leg 4 and 5), 23 September 2003

g = -1.03013001e+00

h = 1.49755131e+00

i = 2.74099344e-04

j = 6.35607354e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 1088 (Leg 5), 4 November 2003

g = -4.02167245e+00

h = 5.51410012e-01

i = -2.94330837e-04

j = 4.48686818e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

S/N 1202 (Leg 5), 4 November 2003

g = -3.94477408e+00

h = 4.39537561e-01

i = -8.82455063e-05

j = 2.54499450e-05

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

Conductivity of a fluid in the cell is expressed as:

$$C\ (S/m) = (g + h * f^2 + i * f^3 + j * f^4) / [10\ (1 + CTcor * t + CPcor * p)]$$

where f is the instrument frequency (kHz), t is the water temperature (°C) and p is the water pressure (dbar). The value of conductivity at salinity of 35, temperature of 15 °C (IPTS-68) and pressure of 0 dbar is 4.2914 S/m.

(4.4) Oxygen (SBE 43)

The SBE 43 oxygen sensor uses a Clark polarographic element to provide in-situ measurements at depths up to 7,000 meters. Calibration stability is improved by an order of magnitude and pressure hysterisis is largely eliminated in the upper ocean (1,000 m) compared with the previous oxygen sensor (SBE 13). Continuous polarization eliminates the wait-time for stabilization after power-up. Signal resolution is increased by on-board temperature compensation. The oxygen sensor is also included in the path of pumped sea water. The oxygen sensor determines the dissolved oxygen concentration by counting the number of oxygen molecules per second (flux) that diffuse through a membrane, where the permeability of the membrane to oxygen is a function of temperature and ambient pressure. Computation of dissolved oxygen in engineering units is done in SEASOFT software. The range for dissolved oxygen is 120 % of surface saturation in all natural waters; nominal accuracy is 2 % of saturation; typical stability is 2 % per 1,000 hours.

Pre-cruise sensor calibrations were performed at SBE, Inc., USA. The following coefficients were used in SEASOFT:

S/N 0390 (Leg 1), 14 July 2003

Soc = 0.3158

TCor = 0.0019

PCor = 1.350e-04

Offset = -0.5041

S/N 0205 (Leg 1), 18 June 2003

Soc = 0.3982

TCor = 0.0003

PCor = 1.350e-04

Offset = -0.4885

S/N 0391 (Leg 2, 4 and 5), 17 July 2003

Soc = 0.4108

TCor = 0.0012

PCor = 1.350e-04

Offset = -0.4851

S/N 0069 (Leg 2), 7 August 2003

Soc = 0.3001

TCor = 0.0009

PCor = 1.350e-04

Offset = 0.5984

S/N 0394 (Leg 4), 6 October 2003

Soc = 0.3003

TCor = 0.0016

PCor = 1.350e-04

Offset = 0.5016

S/N 0205 (Leg 5), 17 November 2003

Soc = 0.3982

TCor = 0.0002

PCor = 1.350e-04

Offset = -0.4808

Oxygen (ml/l) is computed as

$$\text{Oxygen (ml/l)} = \{Soc * (v + offset)\} * \exp(TCor * t + PCor * p) * Oxsat(t, s)$$

$$Oxsat(t, s) = \exp[A_1 + A_2 * (100 / t) + A_3 * \ln(t / 100) + A_4 * (t / 100) + s * \{B_1 + B_2 * (t / 100) + B_3 * (t / 100) * (t / 100)\}]$$

A_1 = -173.4292

A_2 = 249.6339

A_3 = 143.3483

A_4 = -21.8482

B_1 = -0.033096

B_2 = -0.00170

where p is pressure in dbar, t is absolute temperature and s is salinity in psu. Oxsat is oxygen saturation value minus the volume of oxygen gas (STP) absorbed from humidity-saturated air.

(4.5) Deep Ocean Standards Thermometer

The Deep Ocean Standards Thermometer (SBE 35) is an accurate, ocean-range temperature sensor that can be standardized against Triple Point of Water and Gallium Melt Point cells and is also capable of measuring temperature in the ocean to depths of 6,800 m.

Temperature is determined by applying an AC excitation to reference resistances and an ultrastable aged thermistor with a drift rate of less than 0.001 °C/year. Each of the resulting outputs is digitized by a 20-bit A/D converter. The reference resistor is a hermetically sealed, temperature-controlled VISHAY. The switches are mercury wetted reed relays with a stable contact resistance. AC excitation and ratiometric comparison using a common processing channel removes measurement errors due to parasitic thermocouples, offset voltages, leakage currents, and gain errors. Maximum power dissipated in the thermistor is 0.5 μwatts, and contributes less than 200 μK of overheat error.

The SBE 35 communicates via a standard RS-232 interface at 300 baud, 8 bits, no parity. The SBE 35 can be used with the SBE 32 Carousel Water Sampler and SBE 911plus CTD system. The SBE 35 makes a temperature measurement each time a bottle fire confirmation is received, and stores the value in EEPROM. Calibration coefficients stored in EEPROM allow the SBE 35 to transmit data in engineering units. Commands can be sent to SBE 35 to provide status display, data acquisition setup, data retrieval, and diagnostic test using terminal software.

Following the methodology used for standards-grade platinum resistance thermometers (SPRT), the calibration of the SBE 35 is accomplished in two steps. The first step is to characterize and capture the non-linear resistance vs temperature response of the sensor. The SBE 35 calibrations are performed at SBE, Inc., in a low-gradient temperature bath and against ITS-90 certified SPRTs maintained at Sea-Bird's primary temperature metrology laboratory. The second step is frequent certification of the sensor by measurements in thermodynamic fixed-point cells. Triple point of water (TPW) and gallium melt point (GaMP) cells are appropriate for the SBE 35. The SBE 35 resolves temperature in the fixed-point cells to approximately 25 μK. Like SPRTs, the slow time drift of the SBE 35 is adjusted by a slope and offset correction to the basic non-linear calibration equation.

Pre-cruise sensor calibrations were performed at SBE, Inc., USA. The following coefficients were stored in EEPROM:

S/N 0022 (Leg 1 and 2), 12 October 1999 (1st step: linearization)

a_0 = 4.320725498e-3

a_1 = -1.189839279e-3

a_2 = 1.836299593e-3

a_3 = -1.032916769e-5

a_4 = 2.225491125e-7

S/N 0045 (Leg 4 and 5), 27 October 2002 (1st step: linearization)

a_0 = 5.84093815e-03

a_1 = -1.65529280e-03

a_2 = 2.37944937e-04

a_3 = -1.32611385e-05

a_4 = 2.83355203e-07

Linearized temperature (ITS-90) is computed according to

Linearized temperature (ITS-90) =

$$1 / \{a_0 + a_1 * [\ln(n)] + a_2 * [\ln^2(n)] + a_3 * [\ln^3(n)] + a_4 * [\ln^4(n)]\} - 273.15$$

where n is the instrument output. Then the SBE 35 is certified by measurements in thermodynamic fixed-point cells of the TPW (0.0100 °C) and GaMP (29.7646 °C). Like SPRTs, the slow time drift of the SBE 35 is adjusted by periodic recertification corrections.

S/N 0022 (Leg 1 and 2), 26 March 2003 (2nd step: fixed point calibration)

Slope = 1.000012

Offset = 0.000052

S/N 0045 (Leg 4 and 5), 26 September 2003 (2nd step: fixed point calibration)

Slope = 1.000007

Offset = -0.000376

Temperature (ITS-90) is calibrated according to

Temperature (ITS-90) = Slope * Linearized temperature + Offset

The SBE 35 has a time constant of 0.5 seconds. The time required per sample = 1.1 * NCYCLES + 2.7 seconds. The 1.1 seconds is total time per an acquisition cycle. NCYCLES is the number of acquisition cycles per sample. The 2.7 seconds is required for converting the measured values to temperature and storing average in EEPROM. Root mean square (rms) temperature noise for a SBE 35 in a Triple Point of Water cell is typically expressed as 82 / $NCYCLES^{1/2}$ in μK. In this cruise NCYCLES was set to 4 and the rms noise is estimated to be 0.04 m°C.

When using the SBE 911 system with SBE 35, the deck unit receives incorrect signal from the under water unit for confirmation of firing bottle #16. In order to correct the signal, a module (Yoshi Ver. 1, EMS Co. Ltd., JAPAN) was used between the under water unit and the deck unit.

(4.6) Altimeter

The Benthos 2110 Series Altimeter (Benthos, Inc., USA) follows the basic principal of most echo ranging devices. That is, a burst of acoustic energy is transmitted and the time until the first reflection is received is determined. In this unit, a 400 microsecond pulse at 100 kHz is transmitted twice a second; concurrent with the transmission, a clock is turned off, thus the number of pulses out relates directly to the distance of the target from the unit. The internal ranging oscillator has an accuracy of approximately 5 % and is set assuring a speed of sound of 1,500 m/s. Thus the unit itself, neglecting variations in the speed of sound, can be considered accurate to 5 % or 0.1 meter, whichever is greater. The unit is rated to a depth of 12,000 meters.

The Benthos PSA-900 Programmable Sonar Altimeter (Benthos, Inc., USA) determines the distance of the target from the unit in almost the same way as the Benthos 2110. PSA-900 also uses the nominal speed of sound of 1,500 m/s. But, PSA-900 compensates for sound velocity errors due to temperature. In a PSA-900 operating at a 350 microsecond pulse at 200 kHz, the jitter of the detectors can be as small as 5 microseconds or approximately 0.4 centimeters total distance. Since the total travel time is divided by two, the jitter error is 0.25 centimeters. The PSA-900D is rated to a depth of 6,000 meters.

The following scale factors were used in SEASOFT:

PSA-900D, S/N 1026 and S/N 0396

FSVolt * 300 / FSRange = 10

Offset = 0.0

Model 2110-2, S/N 206

FSVolt * 300 / FSRange = 15

Offset = 0.0

(4.7) Fluorometer

The Seapoint Chlorophyll Fluorometer (Seapoint sensors, Inc., USA) is a high-performance, low power instrument to provide in-situ measurements of chlorophyll-a at depths up to 6,000 meters. The instrument uses modulated blue LED lamps and a blue excitation filter to excite chlorophyll-a. The fluorescent light emitted by the chlorophyll-a passes through a red emission filter and is detected by a silicon photodiode. The low level signal is then processed using synchronous demodulation circuitry, which generates an output voltage proportional to chlorophyll-a concentration.

The following coefficients were used in SEASOFT:

S/N 2148 (Leg 1)

Gain = 30

Offset = 0.0

S/N 2579 (Leg 4 and 5)

Gain = 30

Offset = 0.0

Chlorophyll-a concentration is computed as

Chlorophyll-a (μg/l) = (Voltage * 30 / Gain) + Offset

(5) Data collection and processing

(5.1) Data collection

CTD measurements were made using a SBE 9plus CTD equipped with two pumped temperature-conductivity (TC) sensors. The TC pairs were monitored to check drift and shifts by examining the differences between the two pairs. Dissolved oxygen sensor was placed between the conductivity sensor module and the pump. Auxiliary sensors included Deep Ocean Standards Thermometer, altimeter and fluorometer. The SBE 9plus CTD (sampling rate of 24 Hz) was mounted horizontally in a 36-position carousel frame.

CTD system was powered on at least two minutes in advance of the operation and was powered off at least two minutes after the operation in order to acquire pressure data on ship's deck.

The package was lowered into the water from the starboard side and held 10 m beneath the surface for about one minute in order to activate the pump. After the pump was activated, the package was lifted to the surface and lowered at a rate of 0.5 m/s down to 100 m, where the package was stopped in order to operate the heave compensator of the crane. The package was lowered again at a rate of 1.2 m/s to the bottom. The position of the package relative to the bottom was monitored by the altimeter reading. Also the bottom depth was monitored by the SEABEAM multi-narrow beam sounder on board. For the up cast, the package was lifted at a rate of 1.2 m/s except for bottle firing stops. At each bottle firing stops, the bottle was fired after waiting 30 seconds and the package was stayed 7 seconds in order to sample temperature by the Deep Ocean Standards Thermometer. At 100 m from the surface, the package was stopped in order to stop the heave compensator of the crane.

Water samples were collected using a 36-bottle SBE 32 Carousel Water Sampler with 12-litre Nisken-X bottles. Before a cast for CFCs, the 36-bottle frame and Niskin-X bottles were wiped with acetone.

The SBE 11plus deck unit received the data signal from the CTD. Digitized data were forwarded to a personal computer running the SEASAVE data acquisition software. Temperature, conductivity, salinity, oxygen and descent rate profiles were displayed in real-time with the package depth and altimeter reading.

Data acquisition software (Leg 1, 2, 4 and 5)

SBE, Inc., SEASAVE-Win32, version 5.27b

After each CTD cast the SBE 35 data was retrieved using terminal software.

Terminal software (Leg 1, 2, 4 and 5)

SBE, Inc., SEATERM-Win32, version 1.33

(5.2) Data collection problems

Leg 1

At station P06_X11, a small fish was found in the primary TC-duct after the CTD cast and influenced on the primary salinity and oxygen data.

At station P06_166, communication between under water unit and deck unit broken at 1,800 m depth during the up cast, so the CTD cast was aborted. The system was checked after the cast and the fluorometer was found to be broken. Second cast was carried out at the site without fluorometer.

Frequently date and time of the SBE 35 (S/N 0022) did not change from "01 Jan 1980 00:00:-1" by the setup commands "ddmmyy" and "hhmmss". In such a case, test command (*rtctest) to reset date and time to default value (01 Jan 1980 00:00:00) did not work and date and time of the samples in the data file did not change from " 01 Jan 1980 00:00:-1". This problem was found at stations P06_126, 125, 123, 122 and 121. It was found that the lithium backup battery had reached the end of its life expectancy by the post-cruise calibration (19 November 2003).

Leg 2

At station P06_127 second cast (first cast of this leg), frequent noise in primary temperature (its magnitude was about one to two °C) was found during 400 to 900 m depths in the down cast. So the cast was aborted and the CTD package was lifted to the deck. Primary temperature sensor was replaced from S/N 4216 to 1524 and the connection cable was also replaced. A third cast was done at the site. But similar noise in primary temperature was found at about 600 m depths in the down cast. So the cast was aborted. After replacing SBE 9plus from S/N 0575 to S/N 0357 and all of the connection cables used, a fourth cast was done at the site. After the cast primary temperature sensor was replaced again from S/N 1524 to 4216.

At station P06_X17, the personal computer, which displays and stores the serial data from the deck unit, was suddenly rebooted at about 1,500 m in the down cast. So the cast was aborted and the CTD package was lifted to the deck. Connection of the AC power cable was checked and an AC power supply, CVFT1-500H (TOKYO

SEIDEN Co., JAPAN), was used in order to remove voltage fluctuations and irregularities in power lines. A second cast was done at the site.

After station P06_102, Niskin-X bottle #9 (NX(NC)12021) was replaced with bottle #3 (NX(NC)12015) in order to check leakage or miss-trip of the bottle #9 that was guessed from analyzed values of salinity, oxygen and nutrients at station P06_114.

After station P06_101, a hook that was connecting top and bottom caps of Niskin-X bottle #9 by nylon line was away from the bottom cap. So the bottle #9 was replaced from NX(NC)12015 to NX(NC)12012 after the cast.

At station P06_061, output from secondary dissolved oxygen sensor (S/N 0069) showed unusual (negative) value. The secondary oxygen sensor was removed after the cast.

At the beginning of the down cast of station P06_044, the bottle confirmation signal correction module for SBE 35 continued to display unusual signal during the package was lifting from 10 m beneath the surface after activating the pump. The status lamp did not change from red to green though the module was turned on again. So the SEASAVE software was re-started from the surface in order to acquire the data in a new file, 044M02.

The SBE 35 (S/N 0022) backup battery problem was found at following stations: P06_119, 118, 117, 109, 108, X17, 106, 105, 104, 103, 102, 101, 100, 099, 098, 097, 096, 095, 094, 091, 089, 087, 086, 085, 084, 083, 082, 081, 080, 078, 077, 076, P06_069, 056, 055, 054, 053, 052, 050, 049, 045, 036, 031, 028, 027, 024, 023, 022, 021, 019, 016, 015, 014, 013, 012, 011, 010, 009, 008, 007, 006 and 005.

Leg 4

At stations A10_043 and 068, the same bottle was fired by mistake. Because the SEASAVE module didn’t accept firing bottles more than 36 times, a bottle was fired using a fire button of the SBE 11plus deck unit in order to close all bottles. Bottles can be fired sequentially from its home position (#1) using the fire button of the SBE 11plus deck unit. Therefore the bottle #4 for the station A10_043 and #5 for the station A10_068 were closed by pushing the fire button of the deck unit 4 and 5 times, respectively.

At station A10_089, abnormal value (greater than 37 psu) in primary salinity was found between 60 and 100 m depths. Obtained data was carefully checked after the cast and unusual profiles in primary conductivity and primary temperature were seen. Therefore second cast was done at the site after the temperature, conductivity and oxygen sensors were washed with Triton X for 10 minutes.

When the SBE 35 (S/N 0045) data was uploaded by SEATERM, transmission error occurred at all casts except for A10_98, 99 and 100. Randomly dropped one character in the SBE 35 data file was estimated and the file was corrected manually.

Leg 5

At station I04_597, a small fish was found in primary TC-duct after the cast and influenced on the primary temperature, salinity and oxygen data shallower than 800 dbar of the up cast.

At station I03_529, the secondary conductivity sensor (S/N 1202) showed unusual value from 3,208 dbar of the up cast.

After station I03_551, a crack was found inside of the Niskin-X bottle #9 (NX(NC)12017) and the bottle was replaced to Niskin-X bottle (NX(NC)12021).

After station I03_513, carousel water sampler was replaced from S/N 0391 to S/N 0278.

At station I03_513 first cast, the scan number of the CTD data was not increased at 10 m beneath the surface. Therefore the SEASAVE software was re-started and the data was acquired from the surface in the same file, 513M01.

At station I03_511, the altimeter showed unusual values (negative). So the altimeter was replaced from S/N 1026 to S/N 0396.

At station I03_503, primary conductivity sensor (S/N 1088) showed unusual value from 4,995 dbar of the down cast. So the primary conductivity sensor was replaced to S/N 2435 after the cast.

At station I03_466, SEASAVE software was hung upped at about 120 m depths in the down cast. So the cast was aborted and the CTD package was lifted to the deck. The deck unit (SBE 11plus) was replaced from

S/N 0272 to S/N 0344 and SEASAVE software was re-started. The second cast was done at the site in a new file, 466M03.

When the SBE 35 (S/N 0045) data was uploaded by SEATERM, transmission error occurred at all casts except for I03_524 and 448. Randomly dropped one character in the SBE 35 data file was estimated and the file was corrected manually.

(5.3) Data processing

SEASOFT consists of modular menu driven routines for acquisition, display, processing, and archiving of oceanographic data acquired with SBE equipment, and is designed to work with a compatible personal computer. Raw data are acquired from instruments and are stored as unmodified data. The conversion module DATCNV uses the instrument configuration and calibration coefficients to create a converted engineering unit data file that is operated on by all SEASOFT post processing modules. Each SEASOFT module that modifies the converted data file adds proper information to the header of the converted file permitting tracking of how the various oceanographic parameters were obtained. The converted data is stored in rows and columns of ascii numbers. The last data column is a flag field used to mark scans as good or bad.

The following are the SEASOFT data processing module sequence and specifications used in the reduction of CTD data in this cruise.

Data processing software (Leg 1, 2, 4 and 5)

SBE, Inc., SEASOFT-Win32, version 5.27b

DATCNV converted the raw data to scan number, pressure, depth, temperatures, conductivities, oxygen voltage, descent rate, altitude and fluorescence. DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 4.4 seconds, and the offset was set to 0.0 seconds.

ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, temperatures, conductivities, oxygen voltage, descent rate, altitude and fluorescence were averaged over 4.4 seconds. And salinity, potential temperature, density (σ_θ) and oxygen were computed.

ALIGNCTD converted the time-sequence of conductivity and oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. For a SBE 9plus CTD with the ducted temperature and conductivity sensors and a 3,000-rpm pump, the typical net advance of the conductivity relative to the temperature is 0.073 seconds. So, the SBE 11plus deck unit was set to advance the primary conductivity for 1.73 scans (1.75/24 = 0.073 seconds). As a result, the secondary conductivity was advanced 0.073 seconds relative to the temperature. Oxygen data are also systematically delayed with respect to depth mainly because of the long time constant of the oxygen sensor and of an additional delay from the transit time of water in the pumped plumbing line. This delay was compensated by 6 seconds advancing oxygen sensor output (oxygen voltage) relative to the temperature.

WILDEDIT marked extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to all variables.

CELLTM used a recursive filter to remove conductivity cell thermal mass effects from the measured conductivity. Typical values used were thermal anomaly amplitude alpha = 0.03 and the time constant 1/beta = 7.0.

FILTER performed a low pass filter on pressure with a time constant of 0.15 seconds. In order to produce zero phase lag (no time shift) the filter runs forward first then backwards.

WFILTER performed a median filter to remove spikes in the Fluorometer data. A median value was determined from a window of 49 scans.

SECTION selected a time span of data based on scan number in order to reduce a file size. The minimum number was set to be the start time when the CTD package was beneath the sea-surface after activation of the pump. The maximum number was set to be the end time when the package came up from the surface. Data to check the CTD pressure drift were prepared before SECTION.

LOOPEDIT marked scans where the CTD was moving less than the minimum velocity of 0.0 m/s (traveling backwards due to ship roll).

DERIVE was used to compute oxygen.

BINAVG averaged the data into 1 dbar pressure bins. The center value of the first bin was set equal to the bin size. The bin minimum and maximum values are the center value plus and minus half the bin size. Scans with pressures greater than the minimum and less than or equal to the maximum were averaged. Scans were interpolated so that a data record exists every dbar.

DERIVE was re-used to compute salinity, potential temperature, and density (σ_θ).

SPLIT was used to split data into the down cast and the up cast.

(5.4) Additional data processing

After the data processing mentioned above the CTD data was carefully checked. Fine-tuning adjustments between the temperature measurement and the conductivity measurement to the default advance (0.073 seconds) were determined by looking for potential temperature – salinity plot as follows.

+ 0.031 seconds for P06_227, P06_192 (leg 1, secondary conductivity)

– 0.021 seconds for P06_081 (leg 2, primary conductivity)

– 0.042 seconds for A10 all stations (leg 4, primary conductivity)

– 0.030 seconds for I3/I4 all stations (leg 5, primary conductivity)

+ 0.045 seconds for I3/I4 all stations (leg 5, secondary conductivity)

For these stations the CTD data were re-processed with the additions following the data processing sequence mentioned above. Remaining spikes were removed by hand for the data file processed by LOOPEDIT and processed again following the data processing sequence after LOOPEDIT mentioned above.

(6) Post-cruise calibration

(6.1) Pressure

The CTD pressure sensor drift in the period of the cruise is estimated from the pressure readings on the ship deck. For best results the Paroscientific sensor has to be powered for at least 10 minutes before the operation and carefully temperature equilibrated. However, CTD system was powered only several minutes before the operation at most of stations. In order to get the calibration data for the pre- and post-cast pressure sensor drift, the CTD deck pressure is averaged over first and last two minutes, respectively. Then the atmospheric pressure deviation from a standard atmospheric pressure (14.7 psi) is subtracted from the CTD deck pressure. The atmospheric pressure was measured at the captain deck (20 m high from the base line) and sub-sampled one-minute interval for a meteorological data. Time series of the CTD deck pressure are shown in Figure 3.1.7 – 3.1.10.

The CTD pressure sensor drift is estimated from the deck pressure obtained above. Mean of the pre- and the post-casts data over the whole period for each leg gave an estimation of the pressure sensor drift from the pre-cruise calibration date at each leg. Mean residual pressure between the dead weight piston gauge and the calibrated CTD data at 0 dbar of the pre-cruise calibration is subtracted from the mean deck pressure. Offset of the pressure data is estimated to be within ± 0.4 dbar (Table 3.1.1). So the post-cruise calibration is not deemed necessary for the pressure sensors.

Table 3.1.1. Offset of the pressure data. Mean and standard deviation are calculated from time series of the average of the pre- and the post-cast deck pressures.

Leg	S/N	Mean deck pressure (dbar)	Standard deviation (dbar)	Residual pressure (dbar)	Estimated offset (dbar)
Leg 1	0575	0.52	0.11	0.12	0.40
Leg 2	0357	-0.71	0.10	-0.57	-0.14
Leg 4	0357	-0.84	0.18	-0.57	-0.27
Leg 5	0357	-0.92	0.17	-0.57	-0.35

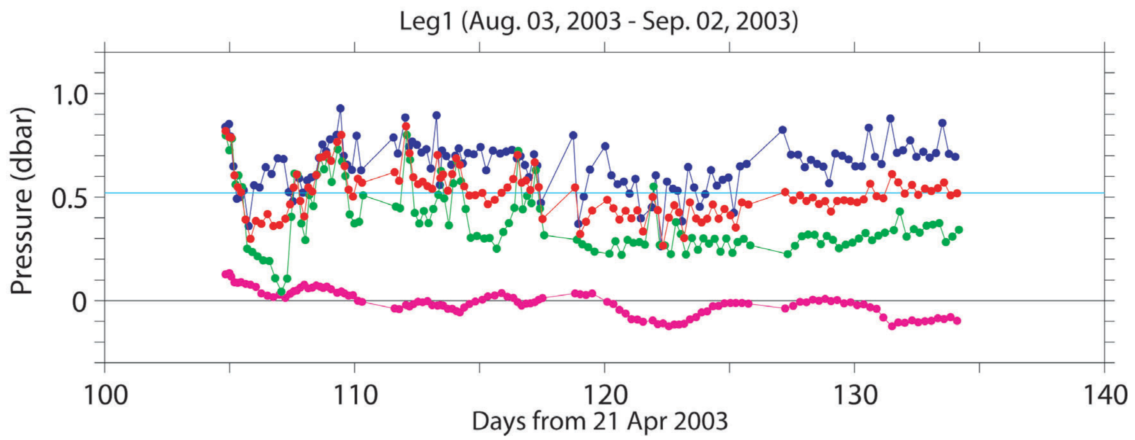

Figure 3.1.7. Time series of the CTD deck pressure for leg 1. Pink dot indicates atmospheric pressure anomaly. Blue and green dots indicate pre- and post-cast deck pressures, respectively. Red dot indicates an average of the pre- and the post-cast deck pressures.

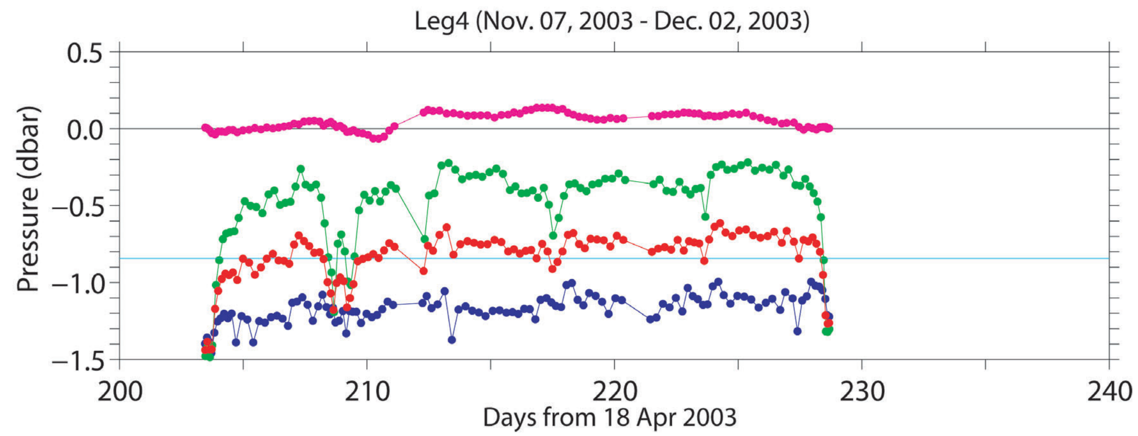

Figure 3.1.9. Same as Figure 3.1.7, but for leg 4.

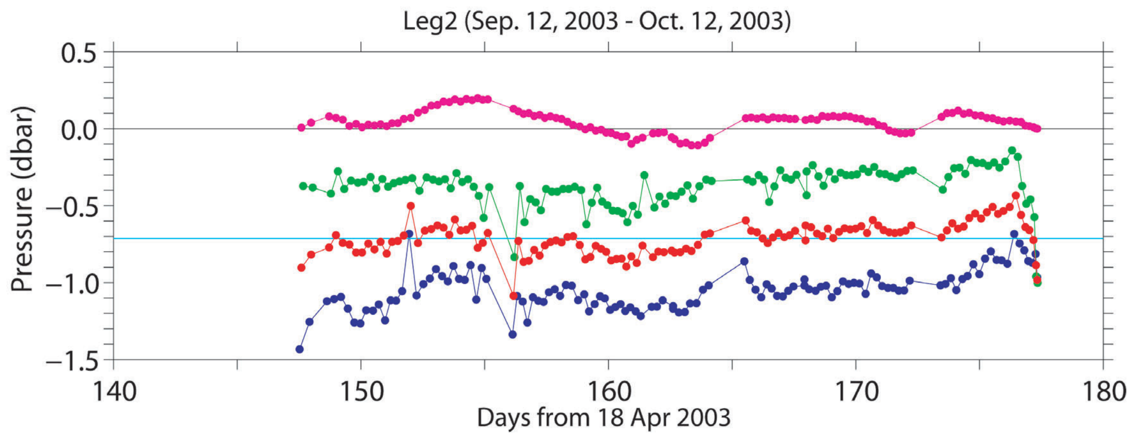

Figure 3.1.8. Same as Figure 3.1.7, but for leg 2.

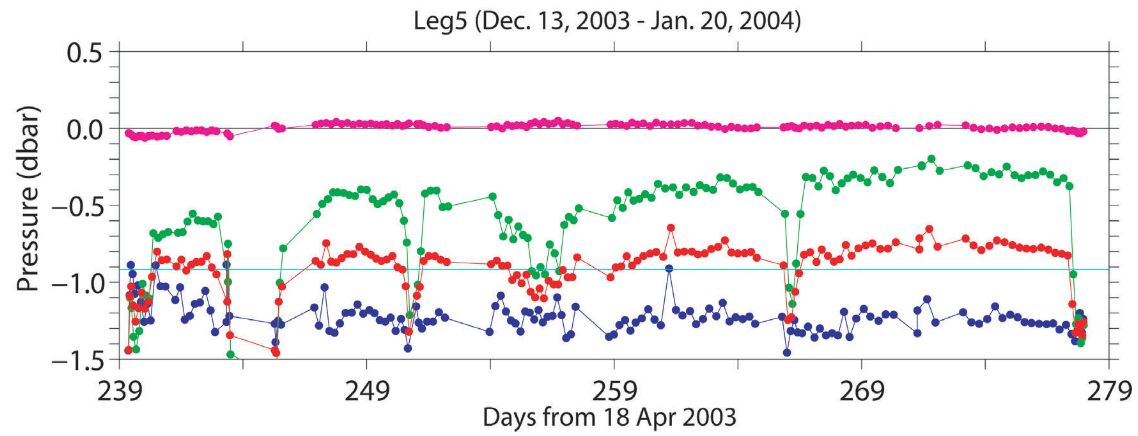

Figure 3.1.10. Same as Figure 3.1.7, but for leg 5.

(6.2) Temperature

The CTD temperature sensor (SBE 3) is made with a glass encased thermistor bead inside a needle. The needle protects the thermistor from seawater. If the thermistor bead is slightly large of specification, it receives mechanical stress when the needle is compressed at high pressure (Budeus and Schneider, 1998). The pressure sensitivity for a SBE 3 sensor is usually less than +2 mK / 6000 dbar. It is somewhat difficult to measure this effect in the laboratory and it is one of the primary reasons to use the SBE 35 at sea for critical work. Also SBE 3 measurements may be affected by viscous heating that occurs in a TC duct and does not occur for un-pumped SBE 35 measurements (Larson and Pederson, 1996). Furthermore the SBE 35 calibrations have some uncertainty (about 0.2 mK) and SBE 3 calibrations have some uncertainty (about 1 mK). So the practical corrections for CTD temperature data can be made by using a SBE 35, correcting the SBE 3 to agree with the SBE 35 (a linear pressure correction, a viscous heating correction and an offset for drift and/or calibration uncertainty).

Post-cruise sensor calibrations for the SBE 35 were performed at SBE, Inc., USA.

S/N 0022 (Leg 1 and 2), 19 November 2003 (2nd step: fixed point calibration)

Slope = 1.000018

Offset = 0.000116

S/N 0045 (Leg 4 and 5), 31 March 2004 (2nd step: fixed point calibration)

Slope = 1.000009

Offset = -0.000772

Offsets of the SBE 35 data from the pre-cruise calibration are estimated to be 0.0 (leg 1), 0.1 (leg 2), 0.1 (leg 4) and 0.2 (leg 5) m°C for temperature less than 4 °C. So the post-cruise calibration is not deemed necessary for the SBE 35 sensors.

The discrepancy between the CTD temperature and the standard thermometer (SBE 35) is considered to be a function of pressure and time. Since the pressure sensitivity is thought to be constant in time at least during observation period, the CTD temperature is calibrated as

$$\text{Calibrated temperature} = T - (c_0 * P + c_1 * t + c_2)$$

where T is CTD temperature in °C, P is pressure in dbar, t is time in days from pre-cruise calibration date of CTD temperature and c_0, c_1, and c_2 are calibration coefficients. The best fit sets of coefficients are determined by minimizing the sum of absolute deviation from the SBE 35 data. The MATLAB® function FMINSEARCH is used to determine the sets. The FMINSEARCH uses the simplex search method (Lagarias et al., 1998). This is a direct search method that does not use numerical or analytic gradients.

The calibration is performed for the following temperature data.

Leg 1: secondary (S/N 1464)

Leg 2: primary (S/N 1254) for P06_127

primary (S/N 4216) from P06_125 to P06_004

Leg 4: primary (S/N 1464)

Leg 5: primary (S/N 1464) except for I04_597 and I03_503

secondary (S/N 4323) for I04_597 and I03_503

The CTD data created by the software module ROSSUM are used. The deviation of CTD temperature from the SBE 35 at depth shallower than 2,000 dbar is large for determining the coefficients with sufficient accuracy since the vertical temperature gradient is strong in the regions. So the coefficients are determined using the data in the depth deeper than 1,950 dbar.

Since pressure sensitivity for the secondary temperature sensor (S/N 1464) is small compared with that of the primary temperature sensor (S/N 4188) in leg 1, data from the secondary temperature sensor are used in leg 1. Since the secondary temperature sensor (S/N 2453) had unusually large pressure sensitivity (+ 5m°C / 6,000 dbar) in leg 2, data from the primary temperature sensor (S/N 1254 and S/N 4216) are used in leg 2 although the primary temperature sensor (S/N 4216) reading showed unusually large time drift (an order of 1 m°C / month). Since the difference between primary temperature (S/N 4216) and SBE 35 data showed different tendency of the time drift during leg 2, the data was divided four periods and the coefficients are determined for each period with fixed pressure sensitivity (c_0 is constant). For station I04_597 and I03_503 in leg 5, data quality of the primary conductivity sensor were bad, so the secondary temperature sensor is also calibrated and the data from the secondary temperature sensor are used for the two stations in leg 5.

The number of data used for the calibration and the mean absolute deviation from the SBE 35 are listed in Table 3.1.2 and the calibration coefficients are listed in Table 3.1.3. The results of the post-cruise calibration for the CTD temperature are summarized in Table 3.1.4 and shown in Figure 3.1.11 to Figure 3.1.14.

Table 3.1.2. Number of data used for the calibration (pressure > 1,950 dbar) and mean absolute deviation (ADEV) between the CTD temperature and the SBE 35.

Leg	S/N	Number of data	ADEV (m°C)	Note
Leg 1	1464	1724	0.15	
Leg 2	1254	16	0.10	only P06_127
	4216	1108	0.11	
Leg 4	1464	1136	0.17	
Leg 5	1464	1659	0.14	
	4323	1659	0.18	

Table 3.1.3. Calibration coefficients for the CTD temperature sensor

Leg	S/N	c_0 (°C/dbar)	c_1 (°C/day)	c_2 (°C)	Note
Leg 1	1464	–8.26735877e–008	1.48131e–005	0.37e–3	
Leg 2	1254	2.65640509e–007	–	–0.68e–3	P06_127
	4216	–5.25359666e–008	1.09403e–004	–3.18e–3	P06_125 – P06_094
		–5.25359666e–008	–2.08090e–005	4.01e–3	P06_093 – P06_055
		–5.25359666e–008	–3.24966e–005	5.12e–3	P06_054 – P06_024
		–5.25359666e–008	3.14971e–005	0.79e–3	P06_023 – P06_004
Leg 4	1464	–7.07002361e–008	9.73776e–006	–0.03e–3	
Leg 5	1464	–6.97861330e–008	–1.26196e–006	0.83e–3	
	4323	2.51539456e–007	–1.65317e–005	0.95e–3	I04_597, I03_503

Table 3.1.4. Difference between the CTD temperature and the SBE 35 after the post-cruise calibration. Mean and standard deviation (Sdev) are calculated below and above 2,000 dbar for each leg. Number of data used is also shown.

Leg	Pressure >= 2,000 dbar			Pressure < 2,000 dbar		
	Num	Mean (m°C)	Sdev (m°C)	Num	Mean (m°C)	Sdev (m°C)
Leg 1	1687	0.01	0.21	2660	–0.26	2.74
Leg 2	1087	0.00	0.18	3027	0.20	3.75
Leg 4	1113	?0.01	0.33	2795	–0.01	4.64
Leg 5	1624	0.00	0.22	3140	0.27	6.61

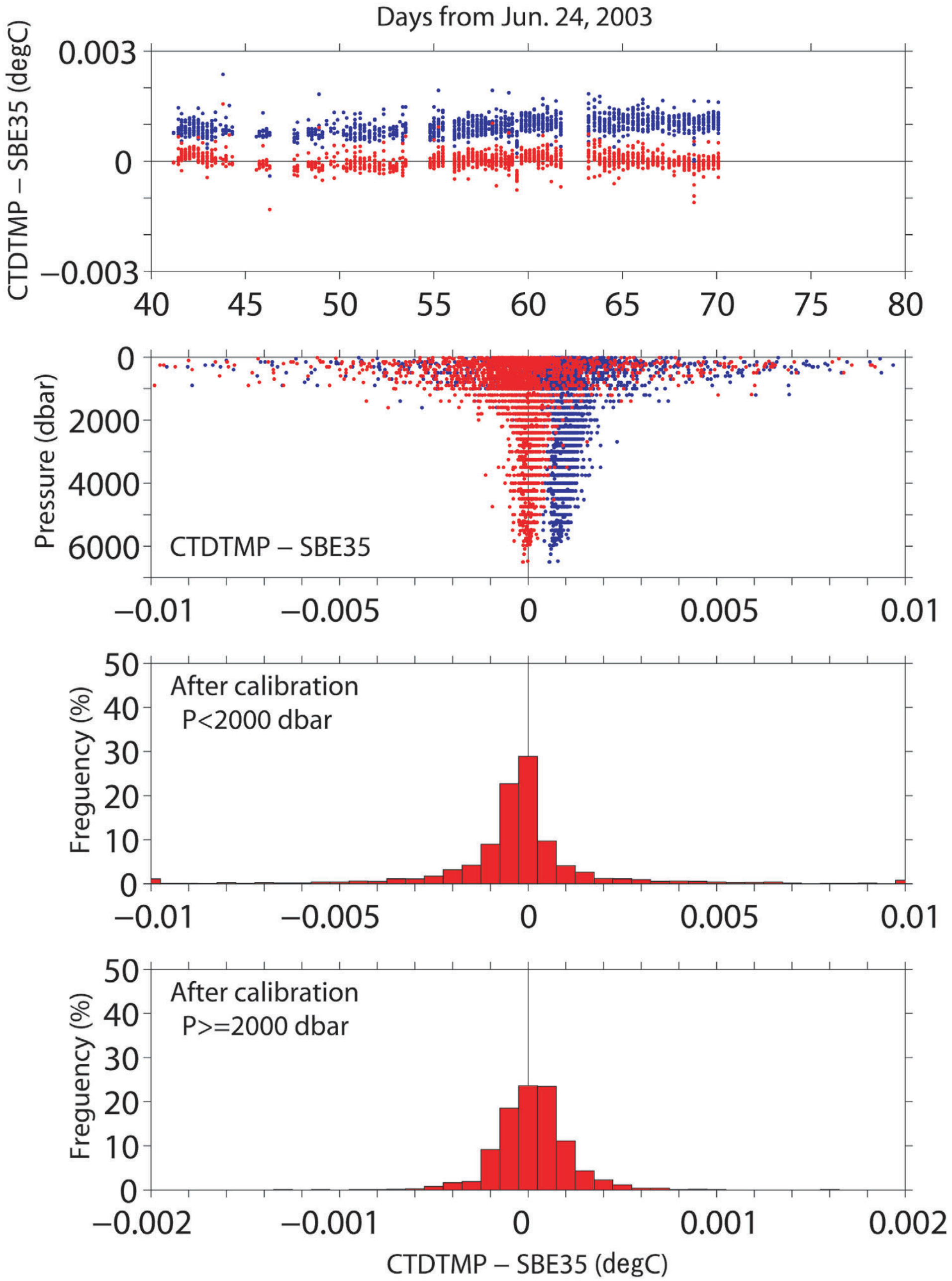

Figure 3.1.11. Difference between the CTD temperature and the Deep Ocean Standards thermometer (SBE 35) for leg 1. Blue and red dots indicate before and after the post-cruise calibration using the SBE 35 data, respectively. Lower two panels show histogram of the difference after the calibration.

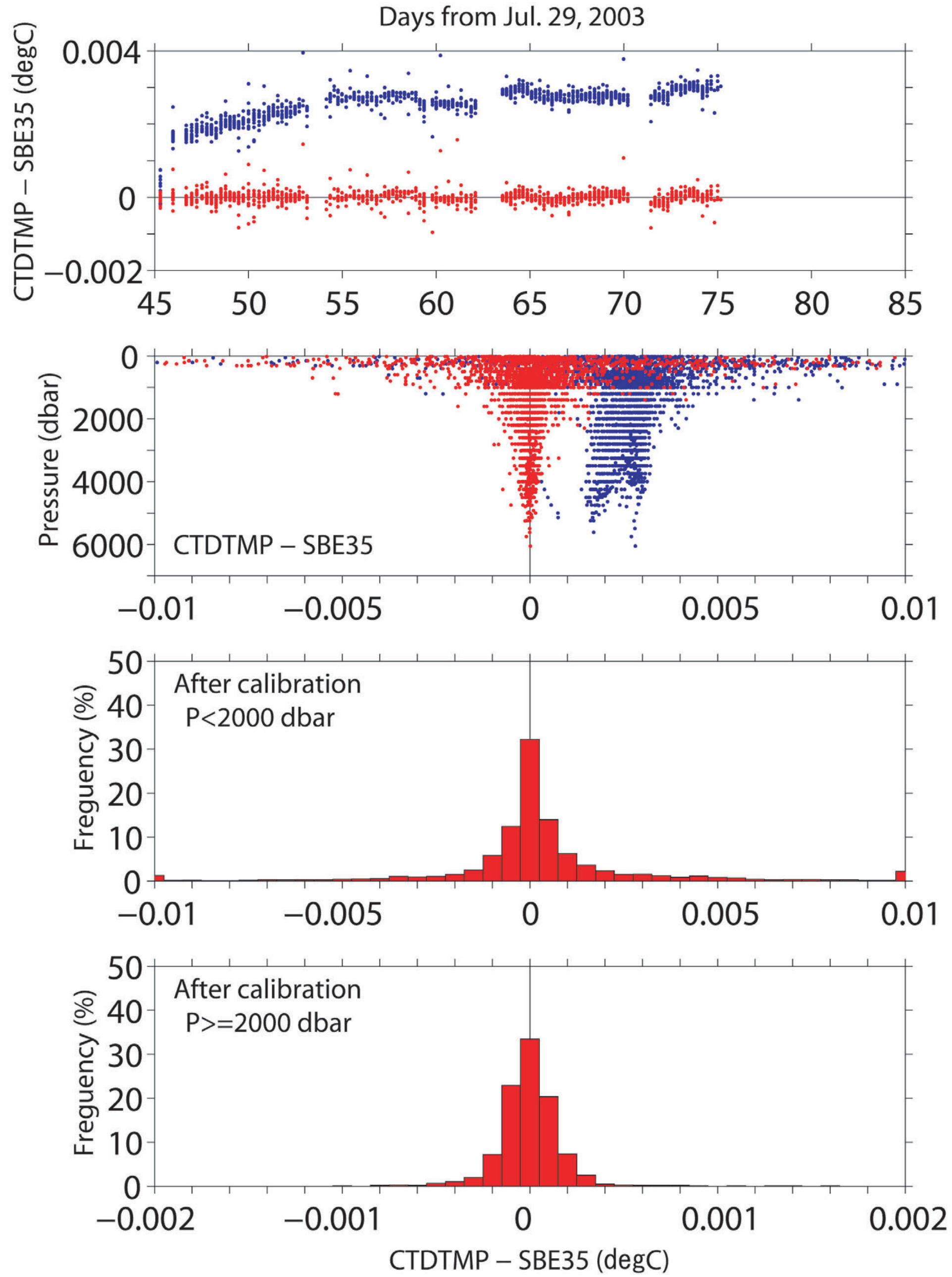

Figure 3.1.12. Same as Figure 3.1.11, but for leg 2.

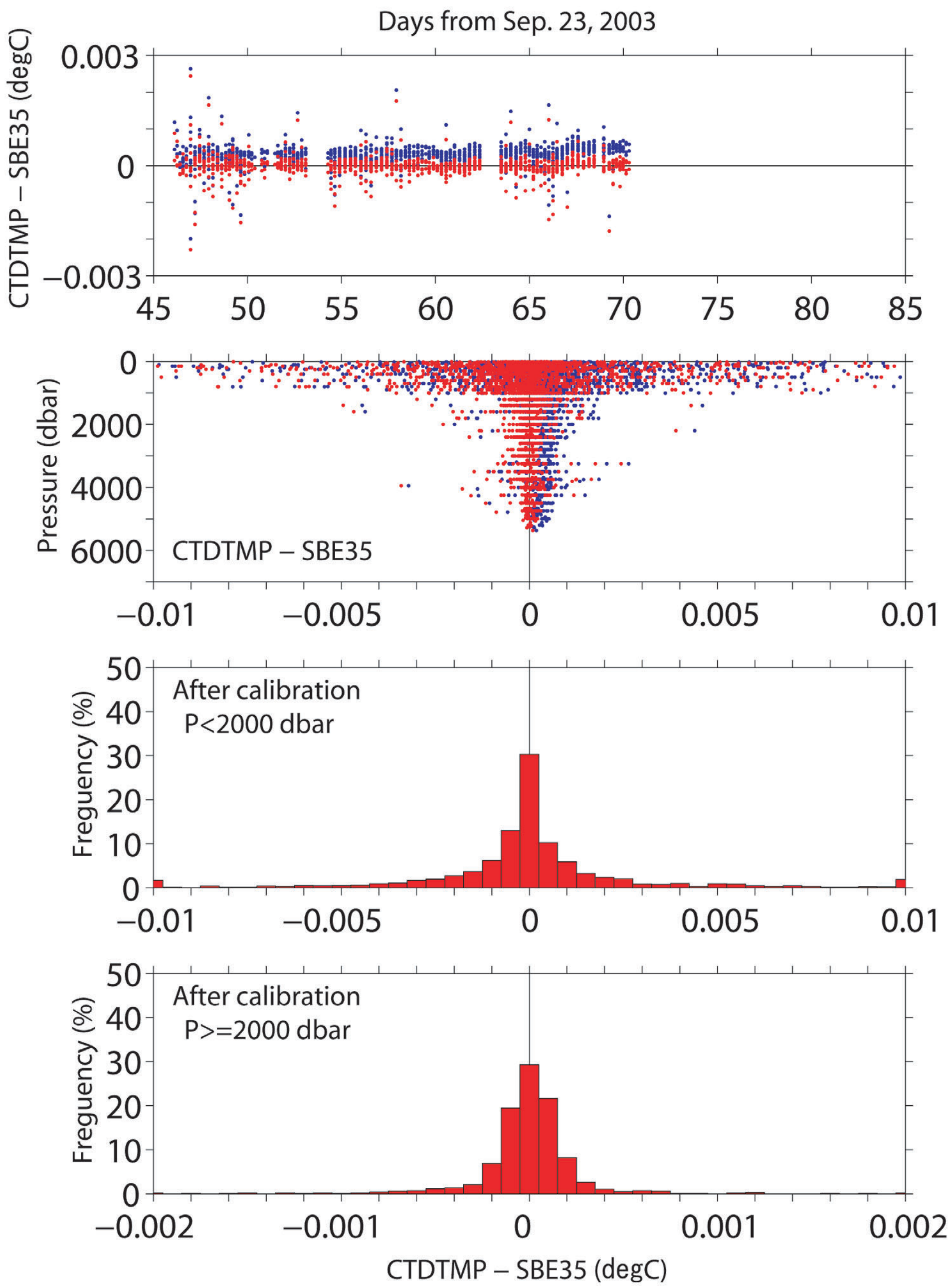

Figure 3.1.13. Same as Figure 3.1.11, but for leg 4.

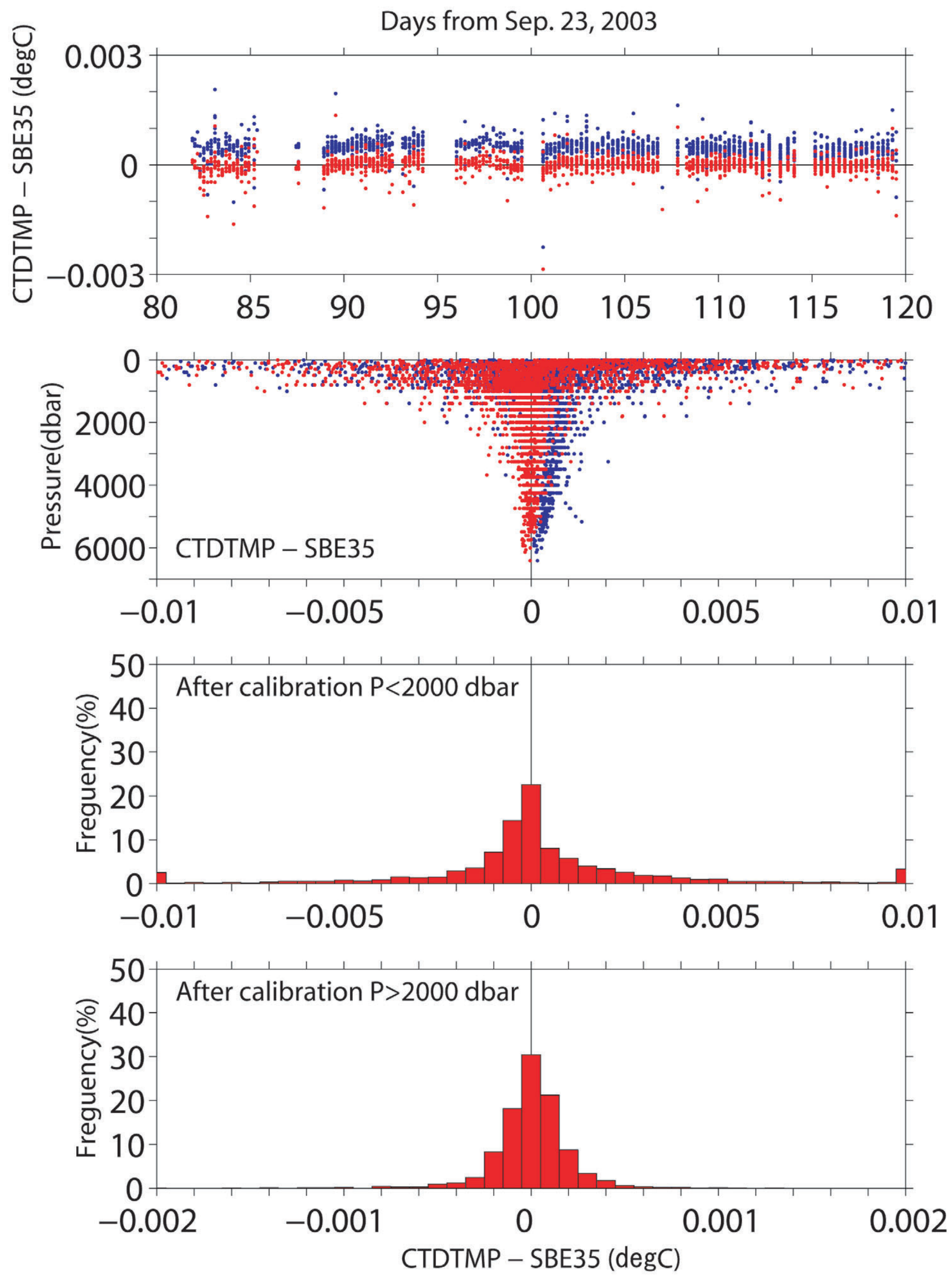

Figure 3.1.14. Same as Figure 3.1.11, but for leg 5.

(6.3) Salinity

The discrepancy between the CTD salinity and the bottle salinity is considered to be a function of conductivity and pressure. The CTD salinity is calibrated as

$$\text{Calibrated salinity} = S - (c_0 * P + c_1 * C + c_2 * C * P + c_3)$$

where S is CTD salinity, P is pressure in dbar, C is conductivity in S/m and c_0, c_1, c_2 and c_3 are calibration coefficients. The best fit sets of coefficients are determined by minimizing the sum of absolute deviation with a weight from the bottle salinity data. The MATLAB® function FMINSEARCH is used to determine the sets. The weight is given as a function of vertical salinity gradient and pressure as

$$\text{Weight} = \min[4, \exp\{\log(4) * Gr / Grad\}] * \min[4, \exp\{\log(4) * P^2 / PR^2\}]$$

where Grad is vertical salinity gradient in PSU $dbar^{-1}$, P is pressure in dbar. Gr and PR are threshold of the salinity gradient (default value is 0.5 mPSU $dbar^{-1}$) and pressure (1,000 dbar), respectively. When salinity gradient is small (large) and pressure is large (small), the weight is large (small) at maximum (minimum) value of 16 (1). The salinity gradient is calculated using up-cast CTD salinity data. The up-cast CTD salinity data is low-pass filtered with a 3-point (weights are 1/4, 1/2, 1/4) triangle filter before the calculation.

The calibration is performed for the salinity derived from the following conductivity sensor.

Leg 1: secondary (S/N 1202)

Leg 2: primary (S/N 2240)

Leg 4: primary (S/N 1203)

Leg 5: primary (S/N 1088) from I04_610 to I03_504 except for I04_597

secondary (S/N 1202) for I04_597 and I03_503

primary (S/N 2435) from I03_502 to I03_444

The CTD data created by the software module ROSSUM are used after the post-cruise calibration for the CTD temperature. For station I04_597 and I03_503 in leg 5, data quality of the primary conductivity sensor were bad, so the data from the secondary conductivity sensor are used for the two stations in leg 5.

The coefficients are basically determined for each station. Some stations, especially for shallow stations, are grouped for determining the calibration coefficients. In order to obtain better result, the threshold of the salinity gradient is changed to 0.3 mPSU/dbar for P06_206, P06_205, P06_056, I03_554, I03_518, I03_517, I03_506, I03_500, I03_490, I03_488, I03_480, I03_X09 and changed to 0.2 mPSU/dbar for I04_604, I04_588, I03_562, I03_561, I03_560, I03_599, I03_557, I03_556, I03_555. An example of the calibration is shown in Figure 3.1.15.

The results of the post-cruise calibration for the CTD salinity are summarized in Table 3.1.5 and shown in Figure 3.1.16 to Figure 3.1.19. And the calibration coefficients, the mean absolute deviation (ADEV) from the bottle salinity and the number of the data (NUM) used for the calibration are listed in Table 3.1.6 to Table 3.1.9.

Table 3.1.5. Difference between the CTD salinity and the bottle salinity after the post-cruise calibration. Mean and standard deviation (Sdev) are calculated below and above 1,000 dbar for each leg. Number of data used is also shown.

Leg	Pressure >= 1,000 dbar			Pressure < 1,000 dbar		
	Num	Mean (mPSU)	Sdev (mPSU)	Num	Mean (mPSU)	Sdev (mPSU)
Leg 1	1789	–0.01	0.34	1579	–0.24	1.25
Leg 2	1612	0.04	0.33	1427	–0.27	1.44
Leg 4	1433	–0.02	0.55	1336	–0.10	1.90
Leg 5	2070	–0.01	0.57	1822	0.42	4.46

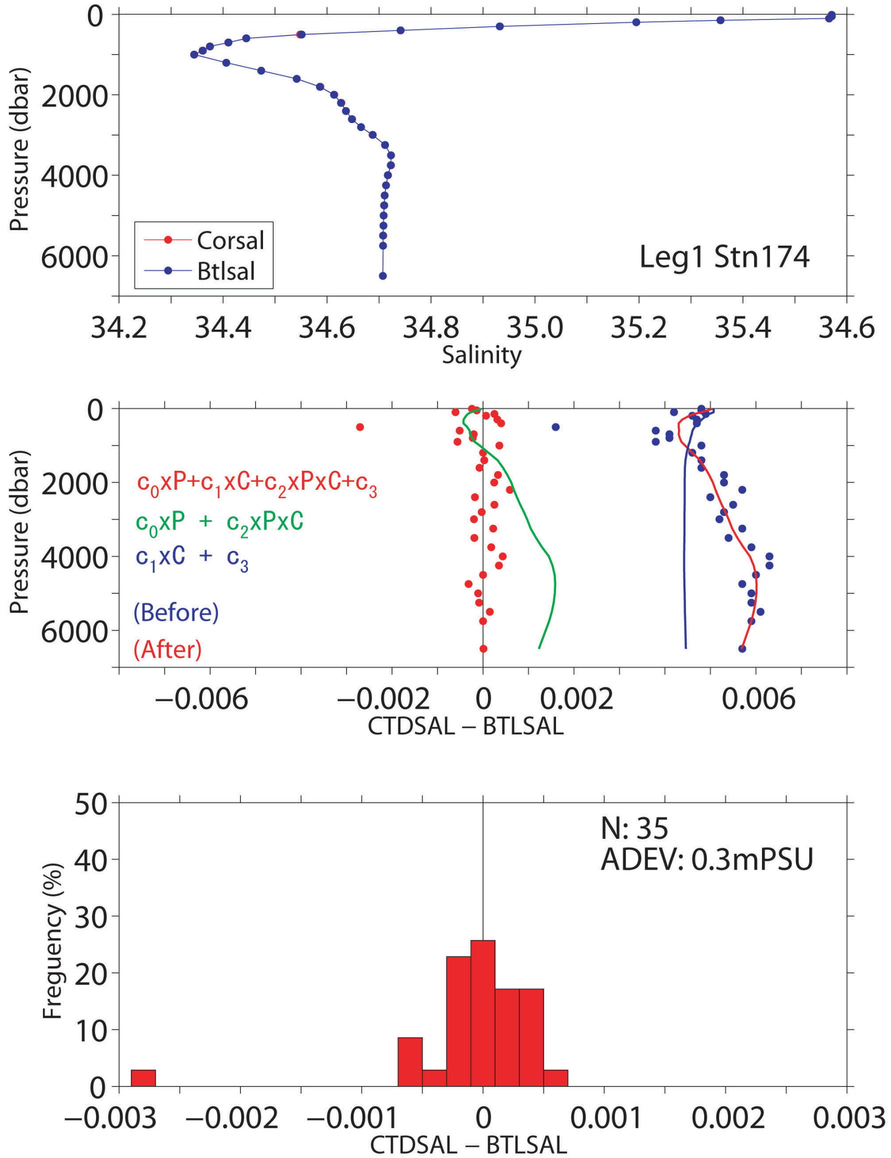

Figure 3.1.15. An example of difference between the CTD salinity and the bottle salinity (leg 1, P06_174). Upper panel shows vertical profile of bottle salinity (blue) and calibrated CTD salinity (red). Middle panel shows vertical distribution of the difference (blue dot: before the calibration, red dot: after the calibration). Lower panel shows histogram of the difference after the calibration.

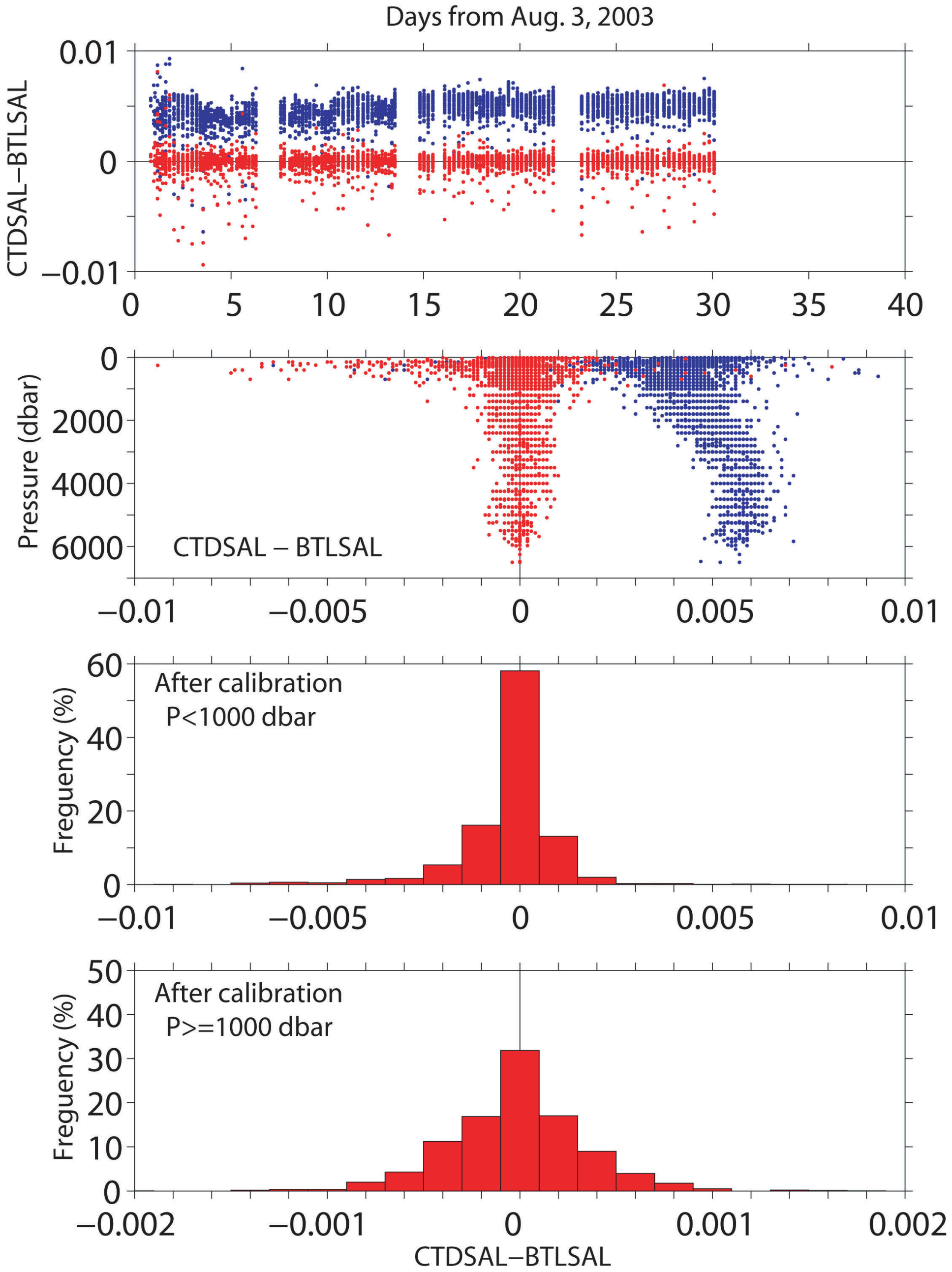

Figure 3.1.16. Difference between the CTD salinity and the bottle salinity for leg 1. Blue and red dots indicate before and after the post-cruise calibration using the bottle salinity data, respectively. Lower two panels show histogram of the difference after the calibration.

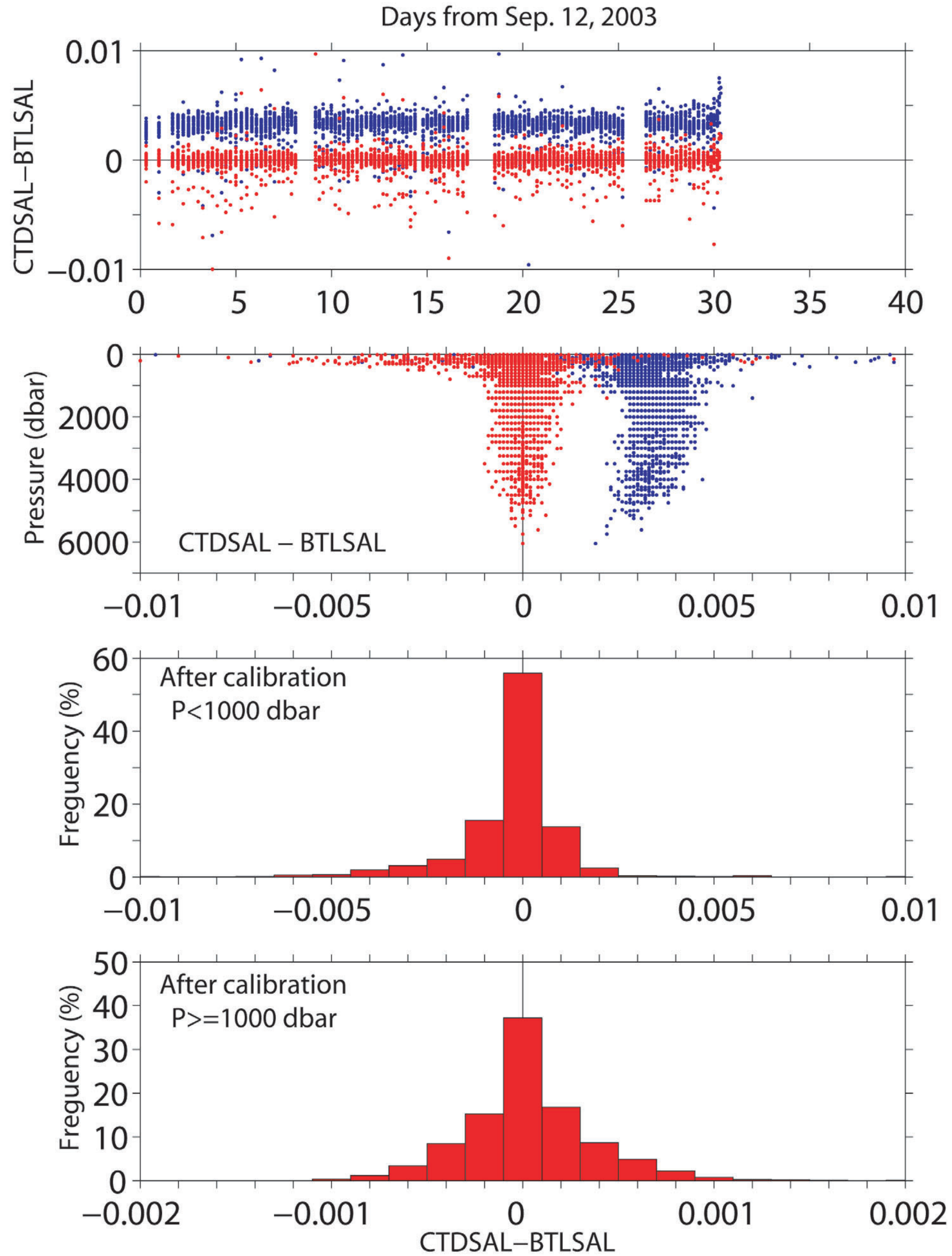

Figure 3.1.17. Same as Figure 3.1.16, but for leg 2.

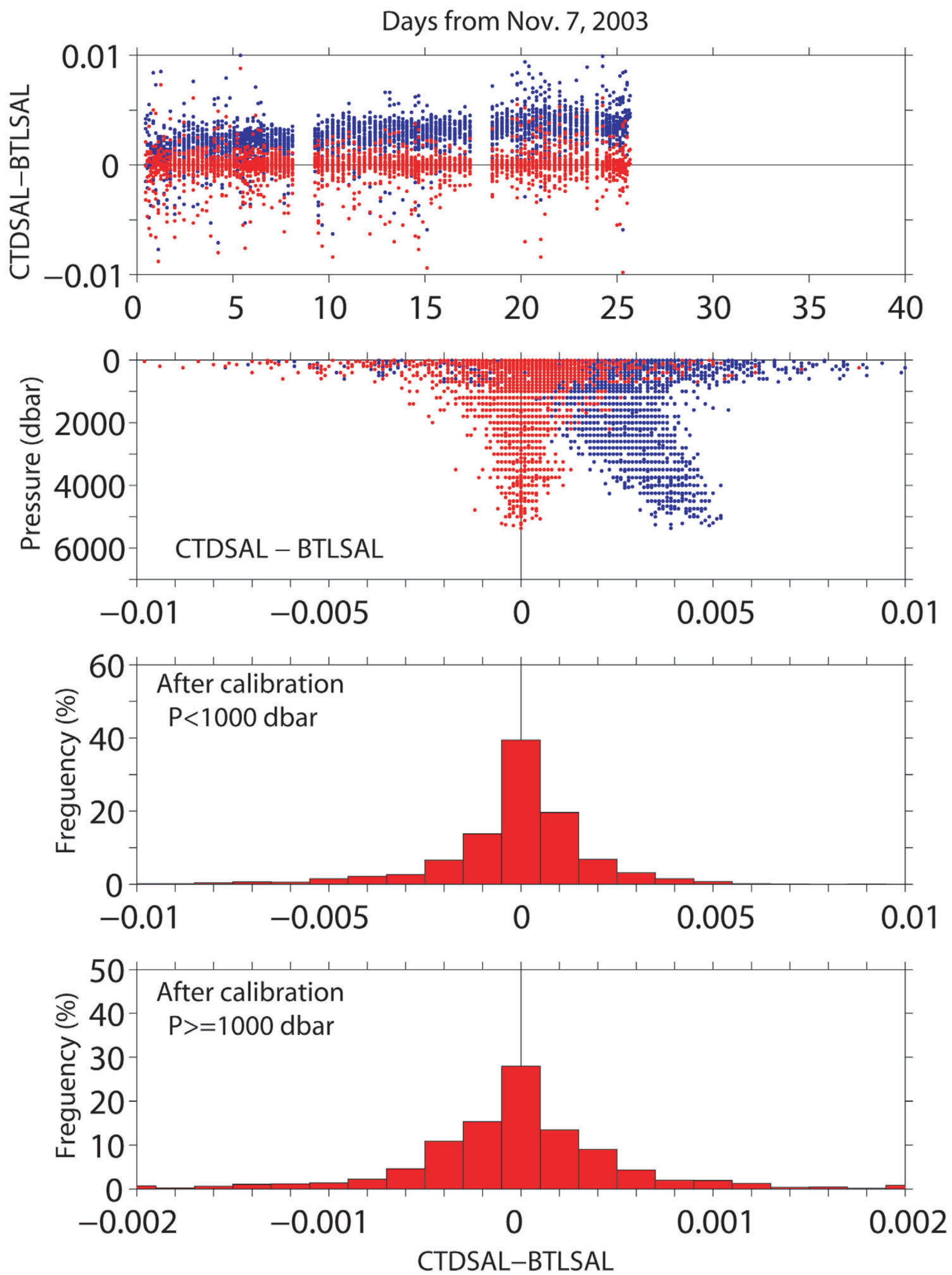

Figure 3.1.18. Same as Figure 3.1.16, but for leg 4.

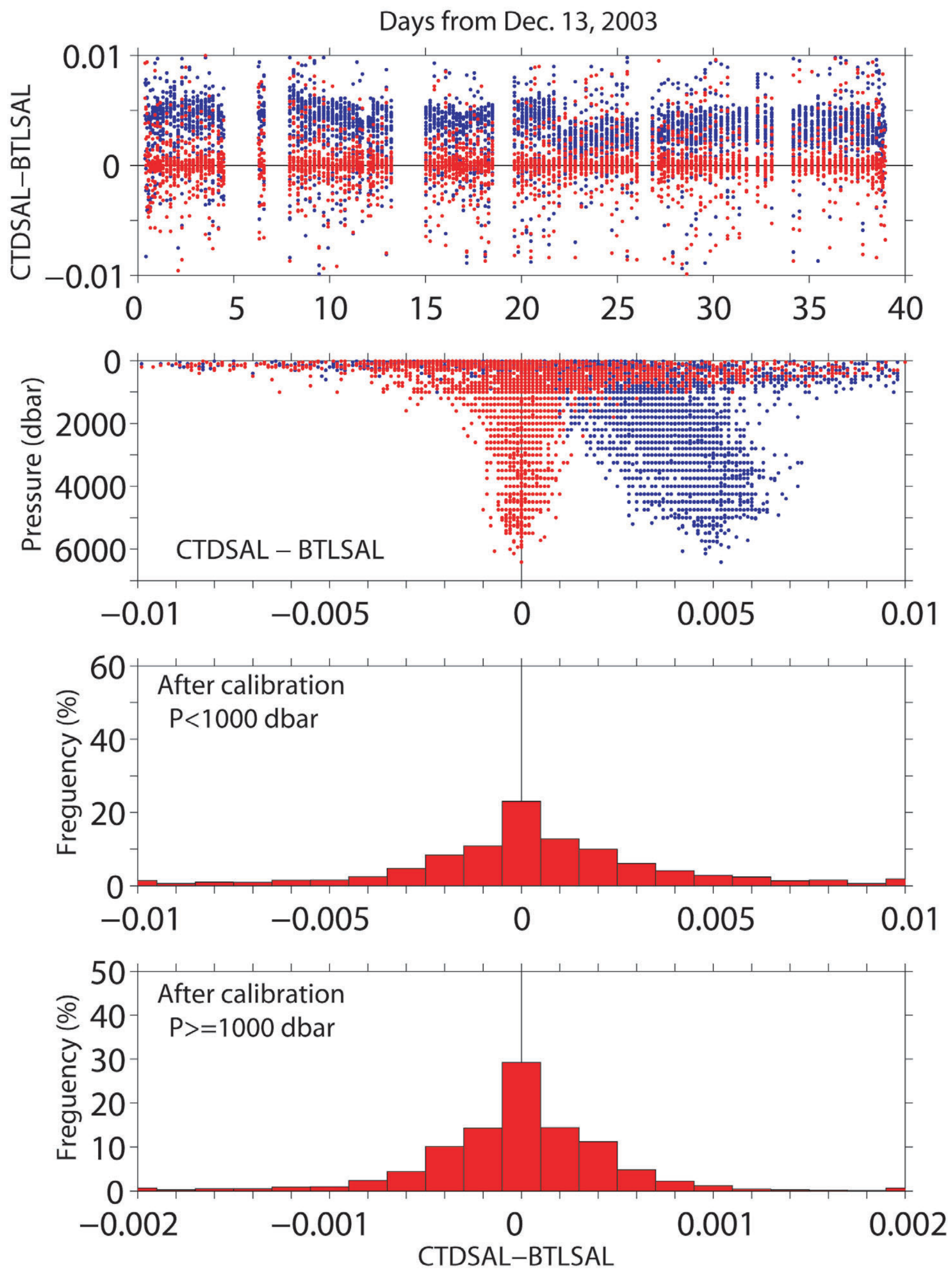

Figure 3.1.19. Same as Figure 3.1.16, but for leg 5.

Table 3.1.6. Calibration coefficients of CTD salinity for leg 1.

STN	CAST	C0	C1	C2	C3	ADEV	NUM
246	1	-8.44921852e-004	-2.85322312e-003	1.81725396e-004	1.803606e-002	0.0006	7
245	1	(grouped with 246_1)					
244	1	-1.47654312e-005	1.11424343e-003	5.44875346e-006	-3.051446e-003	0.0004	15
243	1	-1.79330975e-005	8.46786425e-004	6.20987575e-006	-2.352588e-003	0.0017	20
242	1	-1.20142899e-005	3.04629234e-005	4.00144337e-006	2.260560e-003	0.0012	17
241	1	-2.25460230e-005	7.90014896e-004	7.65734005e-006	-1.883926e-003	0.0006	23
240	1	-3.35783607e-006	-3.49316637e-004	1.25325739e-006	4.565917e-003	0.0008	29
239	1	1.87397745e-006	-5.71412527e-005	-3.92860256e-007	3.322891e-003	0.0008	59
238	1	(grouped with 239_1)					
237	1	2.64161321e-006	3.52397720e-005	-7.19020107e-007	3.966363e-003	0.0006	31
X11	1	7.30912244e-006	-2.53152179e-005	-2.19970046e-006	4.315417e-003	0.0006	31
235	1	5.84202460e-006	3.87539699e-004	-1.72260317e-006	2.607640e-003	0.0007	53
234	1	(grouped with 235_1)					
232	1	8.70486638e-006	6.37993089e-004	-2.60151800e-006	1.543716e-003	0.0003	31
231	1	6.11016031e-006	-3.72985934e-004	-1.97669852e-006	5.943458e-003	0.0004	25
230	1	2.96737331e-006	-7.64139173e-004	-9.84921598e-007	6.996191e-003	0.0014	19
229	1	1.26996147e-006	3.28470606e-005	-1.34484981e-007	3.177876e-003	0.0004	20
228	1	7.89709461e-006	6.39901918e-005	-2.42633393e-006	4.087286e-003	0.0004	23
227	1	8.65204446e-006	-1.52417874e-004	-2.70309984e-006	4.493966e-003	0.0005	23
226	1	-1.07097512e-005	3.92906474e-005	3.71731142e-006	2.065750e-003	0.0005	19
225	1	-2.20553882e-006	2.37242621e-005	8.08133270e-007	3.727567e-003	0.0005	19
224	1	6.15823612e-007	-8.51015027e-004	-3.93290815e-007	7.805595e-003	0.0005	35
223	1	(grouped with 224_1)					
222	1	-8.99080114e-007	4.61002001e-004	4.12410329e-007	1.347728e-003	0.0004	16
221	1	1.27055039e-005	-5.14927796e-004	-4.10890266e-006	6.499679e-003	0.0009	15
220	1	1.24780052e-005	-1.02552600e-003	-4.36665341e-006	9.753479e-003	0.0005	31
219	1	(grouped with 220_1)					
218	1	1.01570889e-005	-1.53666287e-003	-3.65050307e-006	1.134517e-002	0.0005	16
217	1	3.86843912e-006	-3.62020053e-004	-1.30369207e-006	5.937949e-003	0.0009	20
216	1	4.16830514e-006	-4.74682430e-004	-1.18058902e-006	5.237779e-003	0.0008	26
215	1	-1.34263454e-006	3.27945081e-004	6.33548548e-007	2.046815e-003	0.0003	27
214	1	-5.56460950e-007	-5.89527539e-005	4.17718601e-007	3.494895e-003	0.0007	26
213	1	5.67612683e-006	1.83933823e-004	-1.73643769e-006	3.955490e-003	0.0008	22
212	1	-7.03287620e-007	-3.12265776e-005	3.90167326e-007	3.811262e-003	0.0005	47
211	1	(grouped with 212_1)					
210	1	6.70476379e-007	-1.69865867e-004	-4.41131503e-007	5.114473e-003	0.0004	29
209	1	(grouped with 210_1)					
208	1	6.00448142e-006	5.53934416e-004	-1.69982380e-006	1.802479e-003	0.0004	50
207	1	(grouped with 208_1)					
206	1	4.64729710e-006	5.51338341e-004	-1.32887650e-006	1.887632e-003	0.0005	23
205	1	4.46584551e-006	2.41688748e-004	-1.24654155e-006	3.010707e-003	0.0005	25
204	1	1.11735252e-005	-5.90853683e-004	-3.71856012e-006	8.006403e-003	0.0004	23
203	1	8.92220866e-006	-4.45411947e-005	-2.87789296e-006	5.234556e-003	0.0008	27
202	1	(grouped with 203_1)					
201	1	2.29414210e-006	1.79889353e-004	-7.03472865e-007	3.764313e-003	0.0002	20
200	1	1.32837969e-005	1.65883247e-004	-4.12477547e-006	3.724246e-003	0.0004	23
199	1	1.61941924e-005	-6.44720860e-004	-5.36094718e-006	7.715184e-003	0.0003	21
198	1	6.63995463e-006	4.91363693e-006	-1.91723854e-006	3.827215e-003	0.0006	15
197	1	1.66161967e-006	3.40098144e-004	-3.67081829e-007	2.530356e-003	0.0003	21
196	1	-3.40672772e-007	-5.45591857e-005	2.40743442e-007	4.329603e-003	0.0005	26
195	1	4.85126884e-006	3.23742436e-004	-1.39681428e-006	3.215058e-003	0.0005	28
194	1	-5.91621548e-007	4.13475021e-004	3.48093238e-007	2.281777e-003	0.0006	29
X14	1	4.36130896e-006	4.87129753e-004	-1.19534662e-006	2.203125e-003	0.0004	29
192	1	4.73715417e-006	-5.05407481e-005	-1.40783772e-006	4.868068e-003	0.0005	30
191	1	5.66689933e-006	1.04193655e-003	-1.58098979e-006	6.440119e-005	0.0005	30
190	1	4.58971446e-006	6.87439418e-004	-1.24081105e-006	1.241718e-003	0.0005	29
186	1	1.77554072e-006	3.57225378e-004	-4.08899732e-007	2.904227e-003	0.0005	52
185	1	(grouped with 186_1)					
184	1	6.05036365e-006	6.09492650e-004	-1.79427236e-006	2.338878e-003	0.0004	42
183	1	(grouped with 184_1)					
182	1	9.31364571e-006	6.24912932e-004	-2.84500763e-006	2.418508e-003	0.0003	25
181	1	1.66782395e-006	5.71395515e-004	-3.67542094e-007	1.882624e-003	0.0005	44
180	1	(grouped with 181_1)					
179	1	8.21732475e-006	1.89135720e-004	-2.49999890e-006	3.585721e-003	0.0005	26
178	1	8.11707228e-006	1.24818302e-004	-2.48566469e-006	4.372921e-003	0.0004	31
177	1	5.01861440e-006	1.85703446e-004	-1.52658721e-006	4.311616e-003	0.0004	33
176	1	3.93625092e-006	-4.97027861e-004	-1.18218223e-006	6.443305e-003	0.0004	35
175	1	4.90157974e-006	-3.24991307e-004	-1.49084401e-006	5.845508e-003	0.0003	35
174	1	7.28611528e-006	7.14660953e-004	-2.19913549e-006	2.137212e-003	0.0003	35
173	1	6.90761231e-006	3.84842309e-004	-2.10431211e-006	3.580063e-003	0.0005	71
172	1	(grouped with 173_1)					
171	1	1.09957947e-005	6.61805896e-004	-3.36843324e-006	2.252232e-003	0.0003	36
170	1	3.04515354e-006	1.20656919e-004	-8.91119987e-007	4.181596e-003	0.0005	36
169	1	5.90458809e-006	4.64638977e-004	-1.77508955e-006	2.989842e-003	0.0004	35
168	1	1.04974083e-005	5.51221615e-004	-3.23380400e-006	3.008517e-003	0.0004	35
167	1	9.05723629e-006	2.98655342e-004	-2.79299442e-006	3.776791e-003	0.0003	36
166	1	8.76123405e-006	7.81454759e-004	-2.67576425e-006	2.017443e-003	0.0004	41
166	2	(grouped with 166_1)					
165	1	6.21575086e-006	1.41320186e-004	-1.90572054e-006	4.445729e-003	0.0004	36
164	1	7.16036872e-006	3.52755766e-004	-2.19101704e-006	3.675030e-003	0.0004	36
163	1	5.93241947e-006	6.19063038e-004	-1.79279380e-006	2.661226e-003	0.0003	35
162	1	4.61148087e-006	1.14754591e-003	-1.32940870e-006	2.435759e-004	0.0003	30
161	1	4.89394898e-006	3.14059500e-004	-1.47204459e-006	3.631388e-003	0.0003	32
160	1	1.04735892e-005	4.09791272e-004	-3.25235473e-006	3.589668e-003	0.0003	34
159	1	7.79802795e-006	3.64777958e-004	-2.38263486e-006	4.707916e-003	0.0004	33
158	1	7.76758181e-006	1.22943137e-003	-2.41217442e-006	8.789758e-004	0.0004	35
X15	1	8.43044661e-006	1.68680708e-003	-2.54792303e-006	-1.179840e-003	0.0003	35
156	1	9.51594534e-006	8.13382424e-005	-2.98835981e-006	4.898382e-003	0.0003	34
155	1	6.25805827e-006	1.02407590e-003	-1.86689109e-006	8.142096e-004	0.0003	33
154	1	1.31895787e-005	1.01724270e-003	-4.09766594e-006	1.556987e-003	0.0004	34
153	1	5.61720560e-006	5.55948486e-004	-1.66118623e-006	2.146719e-003	0.0005	34
152	1	6.73934693e-006	7.53233905e-004	-2.06317085e-006	2.075086e-003	0.0003	35
151	1	1.12644256e-005	2.68759087e-004	-3.50182361e-006	3.779136e-003	0.0004	34
150	1	4.36485623e-007	1.33518007e-004	-3.57097825e-008	3.859029e-003	0.0003	32
149	1	7.15101838e-006	-8.37715293e-004	-2.19317263e-006	7.674617e-003	0.0005	34
148	1	9.04790218e-006	-2.47945695e-004	-2.81743284e-006	5.725332e-003	0.0008	70
147	1	(grouped with 148_1)					
146	1	1.07713646e-005	3.06075602e-004	-3.32942549e-006	3.584444e-003	0.0004	35
145	1	4.76273039e-006	-1.99446420e-004	-1.44535436e-006	5.500238e-003	0.0003	33
144	1	5.03127166e-006	6.47469365e-004	-1.51891835e-006	2.384802e-003	0.0003	34
143	1	7.73139705e-006	4.81401641e-004	-2.33450864e-006	2.859026e-003	0.0004	32
142	1	3.25671257e-006	3.48568251e-004	-8.91398066e-007	2.631821e-003	0.0003	34
140	1	7.32182800e-006	-3.49420748e-004	-2.27004404e-006	6.323928e-003	0.0003	34
139	1	8.77662364e-006	9.75436246e-004	-2.67023956e-006	1.014160e-003	0.0003	33
138	1	9.79491837e-006	-6.51408320e-006	-3.04294828e-006	5.342095e-003	0.0003	33
137	1	6.28053857e-006	6.37077901e-004	-1.87505136e-006	2.056861e-003	0.0004	35
136	1	4.66363859e-006	-1.24081499e-004	-1.37841981e-006	4.828283e-003	0.0004	34
135	1	6.06439832e-006	5.14468918e-004	-1.84274970e-006	2.800154e-003	0.0004	35
134	1	-2.46184900e-007	8.40833961e-004	2.22207117e-007	1.073010e-003	0.0004	33
133	1	5.07778139e-006	5.66576138e-004	-1.48740825e-006	2.435355e-003	0.0004	33
132	1	2.45673475e-006	2.57294721e-004	-6.71430885e-007	3.537284e-003	0.0003	31
131	1	8.67642085e-006	6.82928641e-004	-2.64135510e-006	2.438083e-003	0.0006	33
130	1	3.09855870e-006	5.52698196e-004	-8.56241860e-007	2.273537e-003	0.0007	28
129	1	3.10945947e-006	6.19295127e-004	-8.78810341e-007	2.299027e-003	0.0003	34
X16	1	8.55322212e-006	1.02077904e-003	-2.58183277e-006	1.068700e-003	0.0003	33
127	1	1.74214746e-006	1.08857352e-003	-3.75360023e-007	1.630400e-004	0.0005	33
126	1	6.49071488e-006	-1.46894634e-006	-1.95334308e-006	4.316887e-003	0.0004	32
125	1	9.12138422e-006	-1.79016143e-005	-2.81375058e-006	4.923972e-003	0.0005	30
124	1	5.83734046e-006	1.04547347e-003	-1.74636309e-006	1.005527e-003	0.0003	31
123	1	7.08998739e-006	7.14488226e-004	-2.12736420e-006	2.325255e-003	0.0004	34
122	1	1.07192523e-005	8.84941221e-004	-3.25804652e-006	1.390653e-003	0.0004	32
121	1	1.20942395e-005	7.84158040e-004	-3.69298708e-006	1.855098e-003	0.0006	33

Table 3.1.7. Same as Table 3.1.6, but for leg 2.

STN	CAST	C0	C1	C2	C3	ADEV	NUM
127	4	1.60096925e-005	-2.31849095e-004	-5.09262295e-006	4.002200e-003	0.0003	33
125	2	1.45066917e-005	2.65489176e-004	-4.63099435e-006	2.507485e-003	0.0005	29
120	1	1.20243482e-005	3.44556409e-004	-3.82550676e-006	2.569366e-003	0.0005	31
119	1	1.55241523e-005	4.18790606e-004	-4.85113891e-006	1.750518e-003	0.0004	33
118	1	1.56280140e-005	5.90327476e-004	-4.99615201e-006	1.773563e-003	0.0004	30
117	1	1.40123154e-005	3.81476800e-004	-4.45601954e-006	2.414953e-003	0.0005	32
116	1	9.37686789e-006	9.98721456e-005	-2.98840926e-006	3.069497e-003	0.0003	32
115	1	1.83487197e-005	3.23552670e-004	-5.81414005e-006	3.014449e-003	0.0004	32
114	1	1.51957739e-005	3.73878103e-004	-4.81316163e-006	2.457442e-003	0.0007	30
113	1	4.10622780e-006	6.71247445e-004	-1.26102321e-006	9.223753e-004	0.0003	32
112	1	8.35680011e-006	5.76530317e-004	-2.58491374e-006	1.182687e-003	0.0007	32
111	1	4.40602524e-006	-2.06597593e-004	-1.36331262e-006	3.919643e-003	0.0005	30
110	1	8.22362270e-006	-1.89586126e-004	-2.68855927e-006	4.434407e-003	0.0006	27
109	1	1.00212407e-005	2.49361399e-004	-3.15810536e-006	2.662811e-003	0.0005	31
108	1	1.29927747e-005	4.50114261e-004	-4.11000979e-006	2.166668e-003	0.0005	28
X17	2	1.06543944e-005	4.80189795e-004	-3.39930315e-006	2.445633e-003	0.0006	28
106	1	2.33321401e-005	3.31859944e-004	-7.45259243e-006	2.977453e-003	0.0007	29
105	1	8.05917189e-006	-1.65045722e-003	-2.51821705e-006	9.074284e-003	0.0005	29
104	1	2.03247888e-005	4.31870097e-004	-6.49625041e-006	2.733146e-003	0.0004	28
103	1	1.11247507e-005	-2.67226908e-004	-3.51547513e-006	4.244473e-003	0.0004	29
102	1	2.26641065e-005	4.15016643e-004	-7.18589700e-006	1.992428e-003	0.0006	29
101	1	1.79694387e-005	-5.21909572e-004	-5.80346576e-006	6.162435e-003	0.0004	28
100	1	1.94579284e-005	5.74671974e-004	-6.19715917e-006	2.020436e-003	0.0003	28
099	1	4.44019797e-006	4.41236875e-004	-1.34214493e-006	1.695179e-003	0.0006	29
098	1	1.17086812e-005	4.60939194e-004	-3.69067181e-006	1.783707e-003	0.0004	29
097	1	2.29664660e-005	1.11272451e-004	-7.33008262e-006	4.319058e-003	0.0004	29
096	1	2.52740622e-005	1.75757128e-004	-8.12218768e-006	4.474658e-003	0.0003	25
095	1	1.40392504e-005	1.58358691e-004	-4.41168561e-006	3.449537e-003	0.0004	22
094	1	1.69535773e-005	7.01565075e-004	-5.37245903e-006	1.118249e-003	0.0002	27
093	1	1.39626792e-005	6.55522357e-004	-4.35128124e-006	1.579819e-003	0.0009	21
092	1	1.51949904e-005	1.96221023e-004	-4.80503820e-006	3.284795e-003	0.0004	27
091	1	2.83718571e-005	6.28157739e-004	-9.05163593e-006	1.912157e-003	0.0005	22
090	1	9.48933593e-006	1.99762935e-004	-2.96585247e-006	2.653749e-003	0.0003	27
089	1	1.25632314e-005	1.35573839e-004	-4.13240113e-006	3.959579e-003	0.0004	23
088	1	9.86832859e-006	2.78405943e-004	-3.15267572e-006	2.530385e-003	0.0005	24
087	1	1.67632354e-005	3.19108052e-004	-5.29970304e-006	2.372513e-003	0.0008	22
086	1	1.15863593e-005	2.11859725e-004	-3.69764809e-006	3.300483e-003	0.0006	25
085	1	2.51191800e-005	5.95248399e-004	-8.03908224e-006	2.187668e-003	0.0006	25
084	1	8.29392470e-006	3.88808095e-004	-2.62769212e-006	1.983113e-003	0.0003	26
083	1	9.17454160e-006	8.92111651e-004	-2.91144448e-006	4.747475e-004	0.0004	26
082	1	6.98337086e-006	1.51058249e-004	-2.17102451e-006	2.817945e-003	0.0003	25
081	1	8.12400027e-006	-1.77515840e-005	-2.60753675e-006	3.986962e-003	0.0002	23
080	1	8.16475603e-006	6.22410195e-004	-2.60417115e-006	1.448883e-003	0.0003	19
079	1	5.79417592e-006	-8.32877822e-004	-1.93839249e-006	6.549927e-003	0.0005	26
078	1	7.22760344e-006	-1.36012433e-003	-2.35870118e-006	8.419678e-003	0.0007	48
077	1	(grouped with 078_1)					
076	1	1.51548565e-005	-4.27964129e-004	-4.89673209e-006	5.473128e-003	0.0005	24
075	1	1.48965753e-005	4.86664203e-004	-4.74683919e-006	2.350944e-003	0.0005	24
072	1	2.58477027e-005	-1.00266940e-004	-8.42639144e-006	5.416360e-003	0.0009	22
071	1	1.92143216e-005	-4.71830655e-004	-6.23062332e-006	5.971606e-003	0.0005	23
070	1	1.79631231e-005	-1.35110736e-004	-5.83106586e-006	4.753136e-003	0.0008	46
069	1	(grouped with 070_1)					
068	1	1.07442806e-005	-5.30063376e-004	-3.49712754e-006	5.786034e-003	0.0009	23
067	1	7.36843937e-006	9.99780900e-004	-2.27659194e-006	3.984857e-005	0.0005	30
066	1	-1.68449206e-005	-1.61601505e-003	5.53909973e-006	7.238042e-003	0.0005	21
065	1	5.70020560e-006	7.87708481e-004	-1.74420388e-006	9.414940e-004	0.0003	21
064	1	1.06798064e-005	-3.21153103e-005	-3.41776198e-006	3.872670e-003	0.0004	24
063	1	3.51624683e-006	-1.41559831e-003	-1.10736945e-006	8.261195e-003	0.0006	25
062	1	1.00565727e-005	-3.66899992e-004	-3.31729557e-006	5.578486e-003	0.0005	26
061	1	4.19859030e-006	-1.03551962e-003	-1.39411940e-006	6.985349e-003	0.0008	52
060	1	(grouped with 061_1)					
059	1	7.03279568e-006	-4.08933658e-004	-2.27647752e-006	4.965680e-003	0.0002	24
X18	1	-2.99230565e-007	-2.75624574e-004	1.05381070e-007	4.061828e-003	0.0006	28
056	1	-2.37662229e-007	-6.24097370e-004	1.91933691e-008	5.701486e-003	0.0006	27
055	1	5.92242781e-006	1.24142899e-003	-1.85744158e-006	-7.199049e-004	0.0005	27
054	1	1.03747959e-005	-3.50573579e-004	-3.32438149e-006	5.199271e-003	0.0006	26
053	1	-1.37295616e-006	3.91326178e-004	4.40515980e-007	2.230503e-003	0.0006	28
052	1	5.48862411e-006	-4.25882955e-005	-1.72550879e-006	3.768952e-003	0.0005	28
051	1	5.07750038e-006	6.33855958e-004	-1.58453442e-006	1.228957e-003	0.0002	28
050	1	1.81210638e-006	6.86510324e-004	-5.22058924e-007	9.303875e-004	0.0004	22
049	1	2.98772870e-007	2.74029563e-004	-1.13222551e-007	2.452574e-003	0.0005	28
048	1	3.96688009e-006	-7.26065244e-004	-1.31807618e-006	6.271469e-003	0.0005	27
047	1	9.04719375e-006	-5.28276115e-005	-2.84305324e-006	3.617206e-003	0.0004	26
046	1	6.36260472e-006	4.14011299e-004	-2.03196946e-006	2.306912e-003	0.0009	25
045	1	-2.89527664e-007	-8.54108128e-005	9.40290869e-008	3.565308e-003	0.0004	27
044	2	1.67326574e-006	-1.36121522e-004	-4.89649043e-007	3.403952e-003	0.0006	28
043	1	1.41208284e-006	-2.08855015e-004	-4.68231433e-007	4.192787e-003	0.0005	51
042	1	(grouped with 043_1)					
041	1	-3.78283851e-007	-1.19945908e-003	7.75847481e-008	7.428228e-003	0.0005	48
040	1	(grouped with 041_1)					
039	1	6.41841101e-006	8.43548604e-005	-2.04763155e-006	3.184993e-003	0.0004	28
038	1	-7.84413083e-007	9.30432200e-005	2.39650945e-007	3.189844e-003	0.0005	25
037	1	-1.23076885e-005	-5.38586903e-004	3.87899630e-006	5.288723e-003	0.0005	27
036	1	-1.99653060e-006	-5.42498096e-004	5.92262536e-007	5.435406e-003	0.0005	24
X19	1	2.92471870e-006	3.24367422e-004	-8.83683236e-007	1.833603e-003	0.0003	24
034	1	1.94008435e-005	2.10998151e-004	-6.14878222e-006	2.919276e-003	0.0004	28
033	1	3.85067889e-006	-6.91888977e-005	-1.21536039e-006	3.370414e-003	0.0007	28
032	1	9.18534831e-006	3.82437966e-004	-2.87762345e-006	1.904242e-003	0.0003	27
031	1	5.51058716e-006	-5.44278976e-004	-1.76952146e-006	5.460779e-003	0.0006	29
030	1	-4.15096515e-006	-4.95189143e-004	1.25902239e-006	5.740019e-003	0.0004	25
029	1	5.03439762e-006	-8.37157827e-004	-1.62905040e-006	6.367002e-003	0.0003	27
028	1	1.08962451e-006	-1.27350760e-003	-4.32242247e-007	8.051753e-003	0.0004	25
027	1	5.20552058e-007	-5.01310568e-004	-1.52551105e-007	4.856422e-003	0.0004	27
026	1	4.18383915e-006	-9.95425350e-004	-1.36184864e-006	6.998052e-003	0.0006	28
025	1	4.83074409e-006	-2.97602030e-004	-1.49744447e-006	3.934537e-003	0.0005	26
024	1	-3.67334058e-006	-7.57246379e-004	1.12191531e-006	5.784922e-003	0.0006	28
023	1	1.04517667e-005	-6.52969936e-004	-3.36592828e-006	6.170618e-003	0.0006	50
022	1	(grouped with 023_1)					
021	1	2.17252686e-007	-9.47641934e-004	-8.75053079e-008	6.572313e-003	0.0006	26
020	1	-2.78325647e-007	-8.64399004e-004	6.41896515e-008	6.505357e-003	0.0005	53
019	1	(grouped with 020_1)					
018	1	-3.15638349e-006	-4.56331499e-004	9.44796645e-007	5.152968e-003	0.0003	26
017	1	1.00164313e-006	1.56077348e-004	-3.69275642e-007	3.296823e-003	0.0005	28
016	1	1.40645355e-006	-4.94482081e-004	-5.19319409e-007	5.456275e-003	0.0004	29
015	1	3.01724842e-007	-1.06884025e-003	-1.51252199e-007	7.167729e-003	0.0004	27
014	1	-5.31108489e-006	-2.16747637e-003	1.60246446e-006	1.074758e-002	0.0004	29
013	1	6.45702719e-007	-6.81847892e-004	-2.90377921e-007	5.909747e-003	0.0006	25
012	1	3.39404975e-006	1.76227832e-003	-1.11847649e-006	-2.114059e-003	0.0004	31
011	1	9.83751331e-006	2.00807378e-003	-3.08236605e-006	-3.198761e-003	0.0003	35
010	1	6.28556451e-007	1.36173656e-003	-2.27150476e-007	-8.990060e-004	0.0006	28
009	1	6.81827859e-006	1.69478851e-003	-2.22914159e-006	-1.820368e-003	0.0005	21
008	1	-3.27840997e-005	-9.90847906e-004	1.07644772e-005	4.826919e-003	0.0005	19
007	1	-2.24167443e-005	9.49611092e-004	7.35526696e-006	-1.046712e-003	0.0008	22
006	1	-2.21586208e-005	2.40937917e-003	7.21970986e-006	-5.634535e-003	0.0008	30
005	1	(grouped with 006_1)					
004	1	(grouped with 006_1)					

Table 3.1.8. Same as Table 3.1.6, but for leg 4.

STN	CAST	C0	C1	C2	C3	ADEV	NUM
622	1	8.24466088e-006	1.57561087e-003	-2.38716803e-006	-4.694306e-003	0.0015	66
623	1	(grouped with 622_1)					
624	1	(grouped with 622_1)					
625	1	(grouped with 622_1)					
626	1	(grouped with 622_1)					
627	1	(grouped with 622_1)					
628	1	-7.72755984e-006	1.42733640e-005	2.53791102e-006	2.779590e-004	0.0011	80
629	1	(grouped with 628_1)					
630	1	(grouped with 628_1)					
631	1	(grouped with 628_1)					
632	1	7.84805038e-007	7.18393369e-004	-7.46349019e-008	-2.360764e-003	0.0009	22
001	1	2.49984579e-007	6.90580998e-004	6.55718628e-008	-1.601801e-003	0.0010	26
002	1	2.73668077e-006	1.05649748e-003	-6.09787734e-007	-3.378457e-003	0.0008	55
003	1	(grouped with 002_1)					
004	1	3.30982069e-006	1.22016440e-003	-8.36614761e-007	-3.515901e-003	0.0005	26
005	1	1.70477403e-006	7.38726165e-004	-2.72422503e-007	-2.016103e-003	0.0010	28
006	1	1.57017271e-006	2.18999639e-004	-3.42244980e-007	2.657153e-005	0.0007	28
007	1	4.54235134e-006	1.11068638e-003	-1.24689490e-006	-2.822972e-003	0.0007	26
008	1	1.01574820e-006	1.30035166e-003	-1.41824587e-007	-3.610257e-003	0.0008	24
009	1	2.88518758e-007	1.35315005e-005	2.43562058e-008	1.025170e-003	0.0006	25
010	1	1.89032160e-006	1.01021255e-003	-4.75475294e-007	-1.896583e-003	0.0008	28
011	1	4.22070865e-006	6.79095382e-004	-1.12037258e-006	-2.103258e-003	0.0010	31
X17	1	6.95603050e-006	1.09315498e-003	-1.95357940e-006	-3.185929e-003	0.0005	25
013	1	-2.36044427e-006	1.62672945e-003	8.96518703e-007	-4.857742e-003	0.0006	27
014	1	-5.25945653e-006	9.98132665e-004	1.80694746e-006	-2.567029e-003	0.0005	50
015	1	(grouped with 014_1)					
016	1	4.28382492e-007	7.39832156e-005	5.57343759e-008	1.035969e-003	0.0014	21
X23	1	6.24746070e-006	1.35893675e-004	-1.80417262e-006	1.063619e-003	0.0011	20
018	1	6.77972144e-006	6.05964588e-004	-1.97508985e-006	-3.321299e-004	0.0011	54
019	1	(grouped with 018_1)					
020	1	(grouped with 018_1)					
021	1	7.75255043e-006	5.92430724e-004	-2.26648005e-006	-1.642034e-004	0.0010	21
022	1	1.24400763e-005	6.53731821e-004	-3.74482868e-006	-2.611572e-004	0.0007	20
023	1	-2.85049400e-006	8.91836818e-004	1.28104955e-006	-1.925115e-003	0.0008	55
024	1	(grouped with 023_1)					
025	1	(grouped with 023_1)					
026	1	2.65056558e-006	9.35278165e-004	-6.58943954e-007	-1.767912e-003	0.0007	51
027	1	-6.31621570e-007	1.37702100e-003	4.59951783e-007	-4.258577e-003	0.0003	27
028	1	(grouped with 026_1)					
029	1	4.72566904e-006	8.73963940e-004	-1.35695047e-006	-1.565746e-003	0.0006	84
030	1	(grouped with 029_1)					
031	1	(grouped with 029_1)					
032	1	-9.24401907e-007	7.17363727e-004	4.29856395e-007	-1.619151e-003	0.0007	26
033	1	1.57971762e-006	7.25679308e-004	-3.61488808e-007	-1.025822e-003	0.0005	26
034	1	5.42176058e-006	4.64870913e-004	-1.55912539e-006	6.214506e-005	0.0008	138
035	1	(grouped with 034_1)					
036	1	(grouped with 034_1)					
037	1	(grouped with 034_1)					
038	1	(grouped with 034_1)					
039	1	2.33647568e-006	6.26961319e-004	-5.33630125e-007	-1.069787e-003	0.0006	30
X16	1	1.78217003e-006	8.51290941e-004	-4.07064690e-007	-1.088936e-003	0.0008	90
041	1	(grouped with X16_1)					
042	1	(grouped with X16_1)					
043	1	2.26019471e-006	1.19790631e-003	-5.37505061e-007	-2.500387e-003	0.0005	60
044	1	(grouped with 043_1)					
045	1	4.70295566e-006	6.90234604e-004	-1.27546314e-006	-1.094622e-003	0.0008	32
046	1	-4.40922586e-006	7.54992793e-004	1.55059893e-006	-1.349111e-003	0.0005	32
X15	1	5.14772965e-006	8.61752613e-004	-1.40424108e-006	-1.862612e-003	0.0008	32
048	1	5.72750294e-006	1.25176363e-003	-1.60942049e-006	-2.537675e-003	0.0006	28
049	1	-2.08152101e-006	1.52439728e-003	8.56785071e-007	-3.629352e-003	0.0007	29
050	1	4.74646838e-007	9.79015226e-004	3.43528792e-008	-1.554232e-003	0.0008	24
051	1	-1.17247204e-005	8.31258304e-004	3.86523902e-006	-1.769965e-003	0.0005	28
052	1	5.60590683e-006	3.52090148e-004	-1.58594000e-006	9.875759e-004	0.0007	25
053	1	3.23773029e-007	4.42676884e-004	5.83918895e-008	1.692069e-004	0.0005	29
054	1	-4.41877391e-006	4.82538473e-004	1.43260841e-006	9.877304e-004	0.0007	23
055	1	3.26014413e-006	-1.63209850e-004	-9.41154797e-007	3.382969e-003	0.0012	22
056	1	-5.24937354e-006	6.54777696e-004	1.80772573e-006	-3.308948e-004	0.0009	51
057	1	(grouped with 056_1)					
058	1	-1.19523696e-005	8.06616797e-004	3.89130953e-006	-9.053909e-004	0.0006	26
059	1	-2.23262272e-007	-2.76130244e-004	2.03849118e-007	2.962791e-003	0.0008	27
060	1	-2.44325157e-006	2.09752664e-004	9.29026895e-007	1.038234e-003	0.0005	28
061	1	3.84528619e-006	9.70509341e-004	-1.01568581e-006	-1.156196e-003	0.0006	28
X14	1	-6.82058929e-006	3.82235858e-004	2.25166266e-006	1.043727e-003	0.0004	28
063	1	-1.43864740e-007	7.75314328e-004	1.72494419e-007	-2.894878e-004	0.0005	26
064	1	2.17794538e-006	3.14169041e-004	-5.23176328e-007	9.945333e-004	0.0005	26
065	1	-4.06221559e-006	2.82751267e-004	1.32753555e-006	1.651734e-003	0.0004	29
066	1	4.15879145e-006	1.53396445e-003	-1.10787340e-006	-3.154008e-003	0.0005	28
067	1	-1.12308096e-005	-3.79582731e-004	3.56818041e-006	3.372584e-003	0.0004	27
068	1	-1.12116653e-005	4.61150814e-005	3.53049404e-006	2.625733e-003	0.0005	85
069	1	(grouped with 068_1)					
070	1	(grouped with 068_1)					
071	1	-1.26747763e-005	-2.00840616e-004	3.92914781e-006	3.883769e-003	0.0005	54
072	1	(grouped with 071_1)					
073	1	-3.03306565e-006	1.61672157e-003	1.19298946e-006	-4.197925e-003	0.0011	28
074	1	-2.36105504e-005	1.23543997e-003	7.66150721e-006	-3.000897e-003	0.0007	24
075	1	-1.68502925e-005	9.04435647e-004	5.39351251e-006	-6.705600e-004	0.0010	71
076	1	(grouped with 075_1)					
077	1	(grouped with 075_1)					
078	1	-1.27215884e-007	2.43829405e-003	2.56226048e-007	-6.319276e-003	0.0010	156
079	1	(grouped with 078_1)					
080	1	(grouped with 078_1)					
081	1	(grouped with 078_1)					
082	1	(grouped with 078_1)					
083	1	5.60729617e-006	1.85828831e-003	-1.54423942e-006	-4.527516e-003	0.0011	33
084	1	5.63740768e-006	1.74853624e-003	-1.59303715e-006	-3.849752e-003	0.0007	62
085	1	(grouped with 084_1)					
086	1	5.71119403e-006	1.52063196e-003	-1.63260596e-006	-2.835121e-003	0.0008	30
087	1	2.10911679e-006	1.61542518e-003	-5.01312019e-007	-3.187693e-003	0.0007	65
X13	1	(grouped with 087_1)					
089	2	-4.89895023e-007	1.52287953e-003	3.16504361e-007	-2.522387e-003	0.0008	29
090	1	-9.57506340e-006	8.21533287e-004	3.18407810e-006	-6.891242e-004	0.0009	28
091	1	-2.55316193e-005	1.06583682e-003	8.14813509e-006	-2.040584e-003	0.0005	28
092	1	-2.32074246e-005	1.24389610e-004	7.33658393e-006	1.993603e-003	0.0006	25
093	1	-1.77733944e-005	-1.13142403e-004	5.60671427e-006	3.352599e-003	0.0006	27
094	1	-2.71043477e-005	1.12742780e-003	8.63314944e-006	-1.703758e-003	0.0007	24
095	1	-7.67177610e-005	1.04296472e-003	2.39906277e-005	-1.868357e-003	0.0007	24
096	1	-4.95997394e-005	1.89563680e-004	1.54703967e-005	2.066740e-003	0.0015	21
097	1	-3.81008901e-005	1.44265298e-003	1.22235289e-005	-2.557692e-003	0.0010	32
098	1	(grouped with 097_1)					
099	1	(grouped with 097_1)					
100	1	(grouped with 097_1)					

Table 3.1.9. Same as Table 3.1.6, but for leg 5.

STN	CAST	C0	C1	C2	C3	ADEV	NUM
610	1	-6.27006654e-006	-1.50534247e-003	2.33515446e-006	8.032903e-003	0.0022	63
609	1	(grouped with 610_1)					
608	1	(grouped with 610_1)					
607	1	(grouped with 610_1)					
606	1	(grouped with 610_1)					
605	1	(grouped with 610_1)					
604	1	-1.79908270e-005	-1.34557990e-004	6.31710288e-006	1.551262e-003	0.0017	20
603	1	8.69313195e-007	-1.36494031e-003	-1.31005619e-007	8.501456e-003	0.0014	39
602	1	(grouped with 603_1)					
601	1	-4.53055806e-007	-1.40495683e-003	1.98409536e-007	9.183896e-003	0.0013	71
600	1	(grouped with 601_1)					
599	1	(grouped with 601_1)					
598	1	-2.36253710e-005	-8.67063118e-005	7.92223040e-006	1.980483e-003	0.0010	26
597	1	-6.98483402e-006	-2.13469290e-004	2.32334666e-006	2.349481e-003	0.0010	27
596	1	-1.79171078e-007	3.18640307e-005	3.06233610e-007	2.862295e-003	0.0015	104
595	1	-1.35946786e-005	-6.67640940e-004	4.71993585e-006	3.882184e-003	0.0012	25
594	1	(grouped with 596_1)					
593	1	(grouped with 596_1)					
592	1	(grouped with 596_1)					
591	1	-2.68230022e-006	-2.05639103e-003	9.94978193e-007	1.047476e-002	0.0015	81
590	1	(grouped with 591_1)					
589	1	(grouped with 591_1)					
588	1	-8.75740559e-006	-1.52547310e-003	2.97543982e-006	7.850023e-003	0.0019	26
587	1	-9.06313392e-006	-2.25755109e-003	3.05667163e-006	1.032604e-002	0.0012	58
586	1	(grouped with 587_1)					
585	1	(grouped with 587_1)					
562	1	-9.54133923e-006	-8.95562771e-004	3.33168159e-006	5.655964e-003	0.0026	96
561	1	(grouped with 562_1)					
560	1	(grouped with 562_1)					
559	1	(grouped with 562_1)					
558	1	-1.96939009e-005	-2.75673415e-003	6.54076830e-006	1.134263e-002	0.0024	27
557	1	(grouped with 562_1)					
556	1	-1.50031451e-005	-1.70659783e-003	4.98455587e-006	8.620262e-003	0.0015	30
555	1	-1.08087252e-005	-1.20691814e-004	3.70739927e-006	2.656038e-003	0.0014	32
554	1	-2.39606993e-006	-1.89419725e-003	9.39943060e-007	8.772416e-003	0.0014	32
553	1	-1.07877436e-005	-2.12862501e-003	3.66337864e-006	9.075630e-003	0.0012	64
552	1	(grouped with 553_1)					
551	1	-1.09787516e-005	-2.95264692e-003	3.66422490e-006	1.195778e-002	0.0012	31
550	1	-1.14721337e-005	-2.60918661e-003	3.87419938e-006	1.021941e-002	0.0021	31
549	1	-1.15584607e-005	-2.05079735e-003	3.85610264e-006	9.130251e-003	0.0010	31
X07	1	-1.32590080e-005	-2.20447799e-003	4.43226662e-006	9.586011e-003	0.0010	32
547	1	-1.69045951e-006	-2.48909826e-003	7.27208736e-007	1.076582e-002	0.0013	27
546	1	-4.68475314e-006	-1.41889807e-003	1.76572036e-006	6.537306e-003	0.0011	27
545	1	-1.03367795e-005	-1.41882123e-003	3.49861576e-006	6.625867e-003	0.0011	30
544	1	-2.17187493e-007	-1.72930656e-003	2.70694674e-007	8.252850e-003	0.0010	106
543	1	(grouped with 544_1)					
542	1	(grouped with 544_1)					
541	1	(grouped with 544_1)					
540	1	-2.30997452e-006	-2.05237371e-003	8.19947783e-007	1.016727e-002	0.0012	55
539	1	(grouped with 540_1)					
538	1	(grouped with 540_1)					
537	1	-4.22997068e-006	-9.23161027e-004	1.63499833e-006	4.734415e-003	0.0007	31
536	1	-1.68657396e-008	-6.63397621e-004	2.41632409e-007	4.355113e-003	0.0007	30
535	1	7.09944310e-006	-1.38179982e-003	-2.01978969e-006	6.777923e-003	0.0014	30
534	1	3.59953449e-006	-2.18248654e-003	-9.99509958e-007	1.033101e-002	0.0016	28
533	1	-1.60642257e-006	-1.00101170e-003	7.78787144e-007	5.005822e-003	0.0005	27
532	1	9.06724912e-006	-9.99053191e-004	-2.67221787e-006	6.066836e-003	0.0012	27
531	1	-3.78613942e-006	-8.98792251e-004	1.53496603e-006	4.779762e-003	0.0017	51
530	1	(grouped with 531_1)					
529	1	-1.47872352e-005	-6.83814528e-004	5.10668167e-006	2.910582e-003	0.0023	51
528	1	2.55582641e-006	-4.53423222e-004	-5.78396892e-007	4.321839e-003	0.0011	47
527	1	(grouped with 529_1)					
526	1	(grouped with 528_1)					
525	1	-1.10999458e-005	-1.51450079e-003	3.91933170e-006	6.307145e-003	0.0009	89
524	1	(grouped with 525_1)					
523	1	(grouped with 525_1)					
522	1	(grouped with 525_1)					
521	1	-5.82583917e-006	-1.60492488e-003	2.17218472e-006	7.242433e-003	0.0018	44
520	1	(grouped with 521_1)					
519	1	-1.47867581e-005	-1.04974800e-003	5.20831407e-006	4.220547e-003	0.0014	23
518	1	-1.26221134e-005	-1.29922753e-003	4.29708086e-006	6.268759e-003	0.0014	46
517	1	(grouped with 518_1)					
516	1	-2.43585617e-006	-1.12920421e-003	1.07470263e-006	5.402513e-003	0.0015	26
515	1	3.59429473e-006	-1.74797169e-003	-9.44142375e-007	8.875346e-003	0.0010	53
514	1	(grouped with 515_1)					
513	1	1.07840143e-006	-4.58455542e-004	-1.01971052e-007	4.134275e-003	0.0018	27
512	1	1.66687965e-006	-1.96890758e-003	-3.08878103e-007	9.325882e-003	0.0012	56
511	1	-4.64847216e-006	-8.38798071e-004	1.79822255e-006	4.481942e-003	0.0010	29
510	1	(grouped with 512_1)					
509	1	3.78942111e-006	-7.90053253e-004	-1.00021160e-006	5.602723e-003	0.0023	62
508	1	(grouped with 509_1)					
507	1	-1.48091255e-006	-2.43630029e-004	7.15196157e-007	3.159122e-003	0.0009	31
506	1	-1.23973523e-006	-1.68827113e-003	5.82545990e-007	8.527942e-003	0.0011	32
505	1	-3.97041418e-007	-9.33419085e-004	3.64573177e-007	5.786953e-003	0.0013	29
504	1	-2.51910335e-006	-8.28443072e-004	1.00149664e-006	5.324988e-003	0.0014	31
503	1	6.87187352e-006	-1.54280430e-004	-1.98472713e-006	1.318677e-003	0.0009	32
502	3	5.23075074e-006	7.90499722e-004	-1.46467094e-006	-2.286335e-003	0.0010	31
501	1	-3.30876873e-006	5.30202747e-005	1.22707661e-006	4.810831e-004	0.0007	32
500	1	-1.98611421e-006	9.23771116e-004	8.93924268e-007	-3.154713e-003	0.0011	32
X08	1	7.79173704e-006	5.63101209e-004	-2.26032361e-006	-1.564133e-003	0.0009	33
498	1	8.86666324e-006	-9.08231422e-004	-2.63311699e-006	3.878586e-003	0.0015	30
497	1	-2.12855132e-006	-6.67540389e-004	8.60896058e-007	2.909338e-003	0.0018	32
496	1	1.44474577e-007	8.93218380e-004	2.00772792e-007	-2.650212e-003	0.0010	32
495	1	-1.51456396e-006	5.06491703e-004	6.88922742e-007	-1.070817e-003	0.0010	33
494	1	3.15950404e-006	-2.04016360e-004	-7.91686402e-007	1.720293e-003	0.0009	33
493	1	-3.43531146e-007	7.11328339e-004	3.29319550e-007	-1.427084e-003	0.0014	32
492	1	-2.92827943e-006	7.04502226e-004	1.12338042e-006	-1.435029e-003	0.0012	32
491	1	-7.81750280e-006	8.10557281e-004	2.64680052e-006	-1.644513e-003	0.0012	30
490	1	-1.70773556e-006	-8.83873186e-004	7.35794251e-007	4.185723e-003	0.0019	29
489	1	-4.36813192e-007	1.36530916e-005	3.43939552e-007	1.011228e-003	0.0008	29
488	1	-3.79638899e-006	3.09737434e-005	1.44334004e-006	8.958927e-004	0.0010	27
487	1	-2.14687025e-005	8.45371626e-004	7.26750703e-006	-3.312295e-003	0.0015	85
486	1	(grouped with 487_1)					
485	1	(grouped with 487_1)					
484	1	(grouped with 487_1)					
483	1	-4.69022275e-006	1.60040433e-005	1.71015489e-006	9.751253e-004	0.0011	32
482	1	-4.98154353e-006	-4.35648947e-004	1.78849116e-006	2.565485e-003	0.0028	33
481	1	-9.73662159e-006	1.53981357e-004	3.27793295e-006	1.017600e-003	0.0009	32
480	1	-1.94913763e-006	-1.21769231e-003	7.77768338e-007	5.532095e-003	0.0011	32
479	1	1.46144205e-005	3.27127300e-004	-4.44230913e-006	8.071872e-004	0.0015	33
478	1	3.80640109e-006	1.42427386e-004	-1.02320729e-006	1.147879e-003	0.0012	32
477	1	8.82738033e-007	4.17149631e-005	-4.21535300e-008	1.169362e-003	0.0011	32
476	1	9.22610874e-006	1.51302189e-003	-2.70757634e-006	-3.120623e-003	0.0014	63
475	1	(grouped with 476_1)					
474	1	-4.29339346e-006	-7.75170897e-005	1.57229698e-006	1.556561e-003	0.0013	34
473	1	-1.18617638e-006	4.14337429e-004	6.03737076e-007	3.576929e-004	0.0024	31
X09	1	5.51844177e-006	1.00336863e-003	-1.48140665e-006	-2.463196e-003	0.0017	33
471	1	6.70695611e-006	1.29468267e-003	-1.91709885e-006	-2.208427e-003	0.0020	33
470	1	-3.07154406e-006	6.92876733e-004	1.17913649e-006	-9.673363e-004	0.0011	34
469	1	1.01593979e-005	3.54490995e-004	-3.02347833e-006	1.028683e-003	0.0012	33
468	1	4.32302926e-006	5.29324881e-004	-1.18697823e-006	3.347436e-004	0.0008	34
467	1	3.12948261e-006	5.92911707e-004	-7.78564113e-007	-1.416340e-004	0.0012	35
466	2	5.95556443e-006	7.85834601e-004	-1.68983971e-006	-8.588997e-004	0.0010	36
465	1	1.26177187e-006	-1.94794132e-004	-2.04137428e-007	2.442344e-003	0.0009	34
464	1	4.64247874e-006	-6.16275625e-004	-1.29880667e-006	4.104732e-003	0.0012	34
463	1	8.85879093e-006	3.83411279e-004	-2.59249367e-006	6.134981e-004	0.0013	35
462	1	1.61821098e-007	1.61876655e-004	1.11197164e-007	1.710292e-003	0.0006	34
461	1	4.39375299e-007	1.97363208e-004	3.85585282e-008	1.263258e-003	0.0006	35
460	1	-6.33977905e-007	4.96337874e-004	4.14878396e-007	3.624089e-004	0.0012	33
459	1	4.61813631e-006	7.52172475e-004	-1.25106332e-006	-8.766801e-004	0.0006	35
458	1	8.74194134e-006	9.84112103e-004	-2.58590311e-006	-8.864227e-004	0.0038	34
457	1	-2.80244556e-006	6.64000404e-004	1.06996972e-006	-9.127725e-005	0.0011	31
456	1	2.12087784e-006	4.04052512e-004	-4.67031159e-007	7.443910e-004	0.0014	64
455	1	7.20103871e-006	8.92161247e-005	-2.08922352e-006	1.598103e-003	0.0011	32
454	1	(grouped with 456_1)					
X10	1	3.45530815e-006	2.61139682e-004	-9.23388332e-007	1.281920e-003	0.0017	33
452	1	9.20851383e-006	2.06622868e-004	-2.73576377e-006	1.617532e-003	0.0025	32
451	1	2.60591545e-006	1.05992445e-003	-6.08890208e-007	-1.611725e-003	0.0015	63
450	1	(grouped with 451_1)					
449	1	-3.08662273e-005	2.08615688e-003	1.05260430e-005	-8.908595e-003	0.0023	78
448	1	(grouped with 449_1)					
447	1	(grouped with 449_1)					
446	1	(grouped with 449_1)					
445	1	(grouped with 449_1)					
444	1	(grouped with 449_1)					

(6.4) Oxygen

The CTD oxygen is calibrated using the oxygen model (see 4.4) as

Calibrated oxygen (ml/l)

= {(Soc + dSoc) * {v + offset + doffset} * exp{(TCor + dTCor) * t + (PCor + dPCor) * p}}

* Oxsat(t, s)

where p is pressure in dbar, t is absolute temperature and s is salinity in psu. Oxsat is oxygen saturation value minus the volume of oxygen gas (STP) absorbed from humidity-saturated air (see 4.4). Soc, offset, TCor and PCor are the pre-cruise calibration coefficients (see 4.4) and dSoc, doffset, dTCor and dPCor are calibration coefficients. The best fit sets of coefficients are determined by minimizing the sum of absolute deviation with a weight from the bottle oxygen data. The MATLAB® function FMINSEARCH is used to determine the sets. The weight is given as a function of vertical oxygen gradient and pressure as

$$Weight = \min[4, \exp\{\log(4) * Gr / Grad\}] * \min[4, \exp\{\log(4) * P^2 / PR^2\}]$$

where Grad is vertical oxygen gradient in μmol kg^{-1} dbar^{-1}, P is pressure in dbar. Gr and PR are threshold of the oxygen gradient (default value is 0.3 μmol kg^{-1} dbar^{-1}) and pressure (1,000 dbar), respectively. When oxygen gradient is small (large) and pressure is large (small), the weight is large (small) at maximum (minimum) value of 16 (1). The oxygen gradient is calculated using up-cast CTD oxygen data. The up-cast CTD oxygen data is low-pass filtered with a 3-point (weights are 1/4, 1/2, 1/4) triangle filter before the calculation.

The calibration is performed for the output from following oxygen sensor.

Leg 1: primary (S/N 0390) with secondary temperature and salinity data

Leg 2: primary (S/N 0391)

Leg 4: primary (S/N 0391)

Leg 5: primary (S/N 0391) except for I04_597 and I03_503

secondary (S/N 0205) for I04_597 and I03_503

The down-cast CTD data sampled at same density of the CTD data created by the software module ROSSUM are used after the post-cruise calibration for the CTD temperature and salinity.

The coefficients are basically determined for each station. Some stations, especially for shallow stations, are grouped for determining the calibration coefficients. Following stations are exceptionally grouped with fixing only the coefficient dTCor in order to obtain better result.

P06_175 & P06_174, P06_122 & P06_121, P06_011 & P06_010 & P06_009,

I03_546 & I03_545, I03_531 & I03_530, I03_528 & I03_527, I03_515 & I03_514,

I03_505 & I03_504 & I03_503, I03_452 & I03_451 & I03_450

Two examples of the calibration are shown in Figure 3.1.15 and Figure 3.1.16. For leg 1, the secondary oxygen sensor (S/N 0205) data could not be calibrated with sufficient accuracy through this calibration method (Figure 3.1.15). Therefore the primary oxygen sensor (S/N 0390) data are used with secondary temperature and salinity data (Figure 3.1.16).

The results of the post-cruise calibration for the CTD oxygen are summarized in Table 3.1.10 and shown in Figure 3.1.22 to Figure 3.1.25. And the calibration coefficients, the mean absolute deviation (ADEV) from the bottle oxygen and the number of the data (NUM) used for the calibration are listed in Table 3.1.11 to Table 3.1.14.

Table 3.1.10. Difference between the CTD oxygen and the bottle oxygen after the post-cruise calibration. Mean and standard deviation (Sdev) are calculated below and above 1,000 dbar for each leg. Number of data used is also shown.

Leg	Pressure >= 1,000 dbar			Pressure < 1,000 dbar		
	Num	Mean	Sdev	Num	Mean	Sdev
		(μmol/kg)	(μmol/kg)		(μmol/kg)	(μmol/kg)
Leg 1	1776	0.00	0.59	1581	–0.25	2.58
Leg 2	1570	0.09	0.71	1532	0.00	2.98
Leg 4	1438	–0.06	0.76	1412	–0.02	2.78
Leg 5	2088	0.00	1.14	1881	0.34	3.27

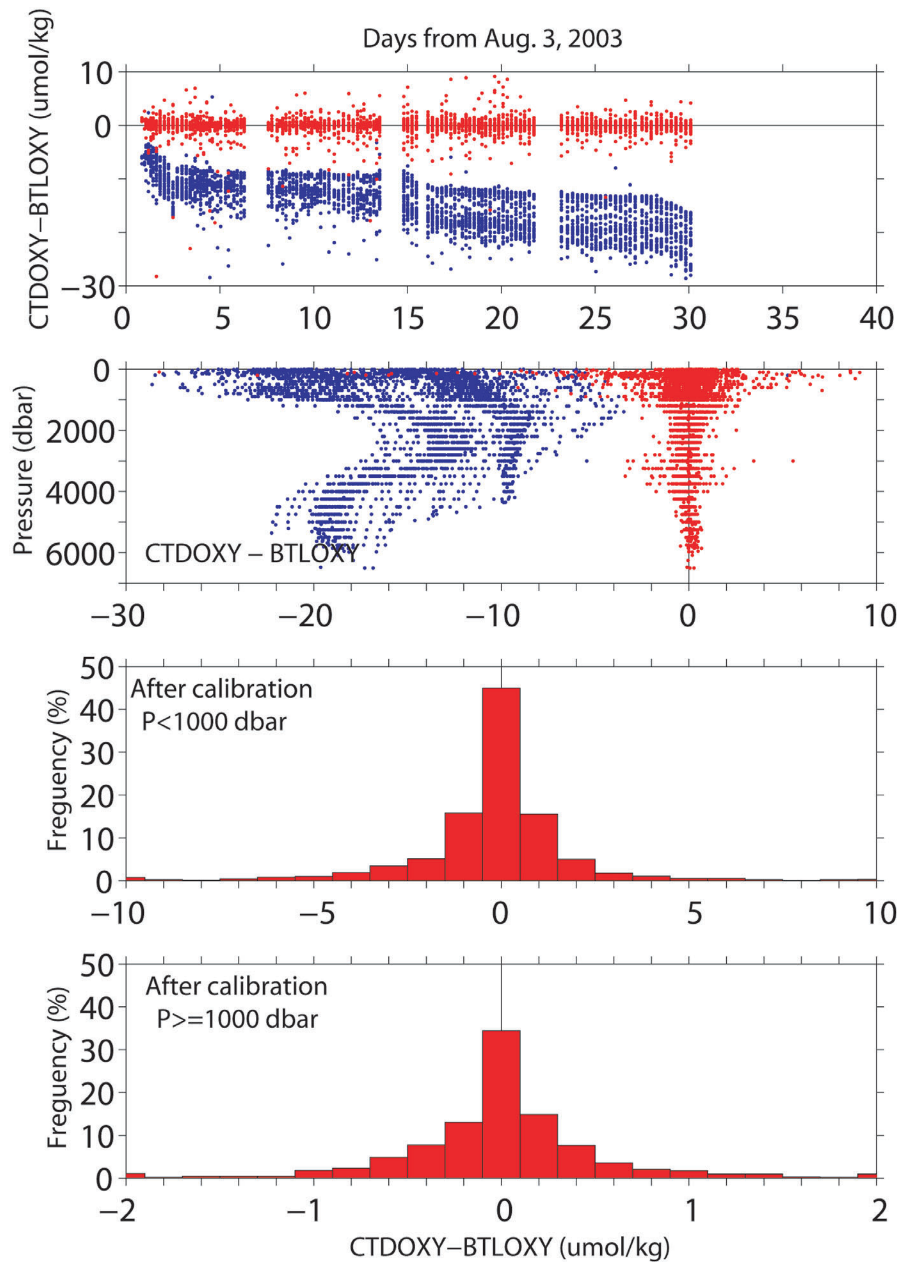

Figure 3.1.22. Difference between the CTD oxygen and the bottle oxygen for leg 1. Blue and red dots indicate before and after the post-cruise calibration using the bottle oxygen data, respectively. Lower two panels show histogram of the difference after the calibration.

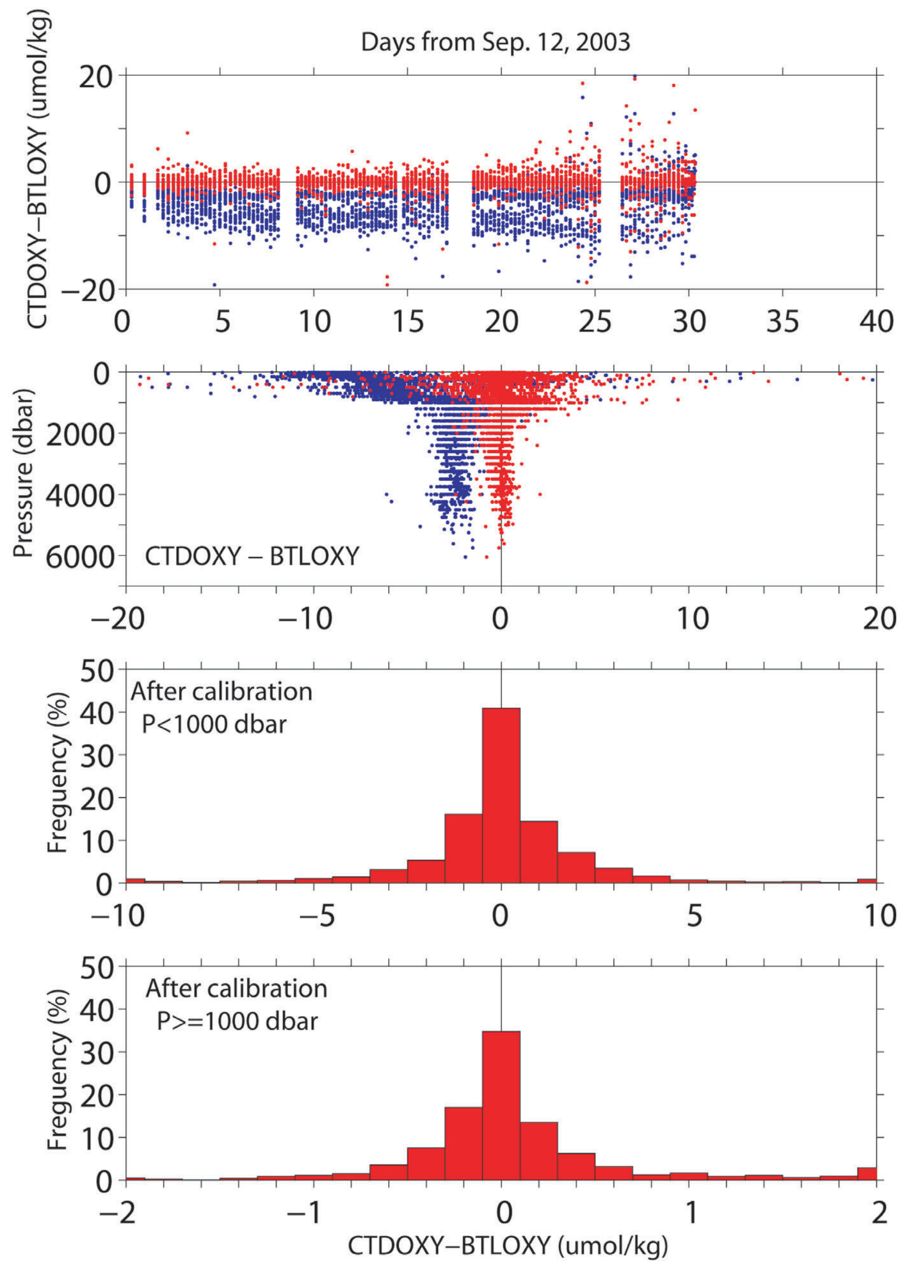

Figure 3.1.23. Same as Figure 3.1.22, but for leg 2.

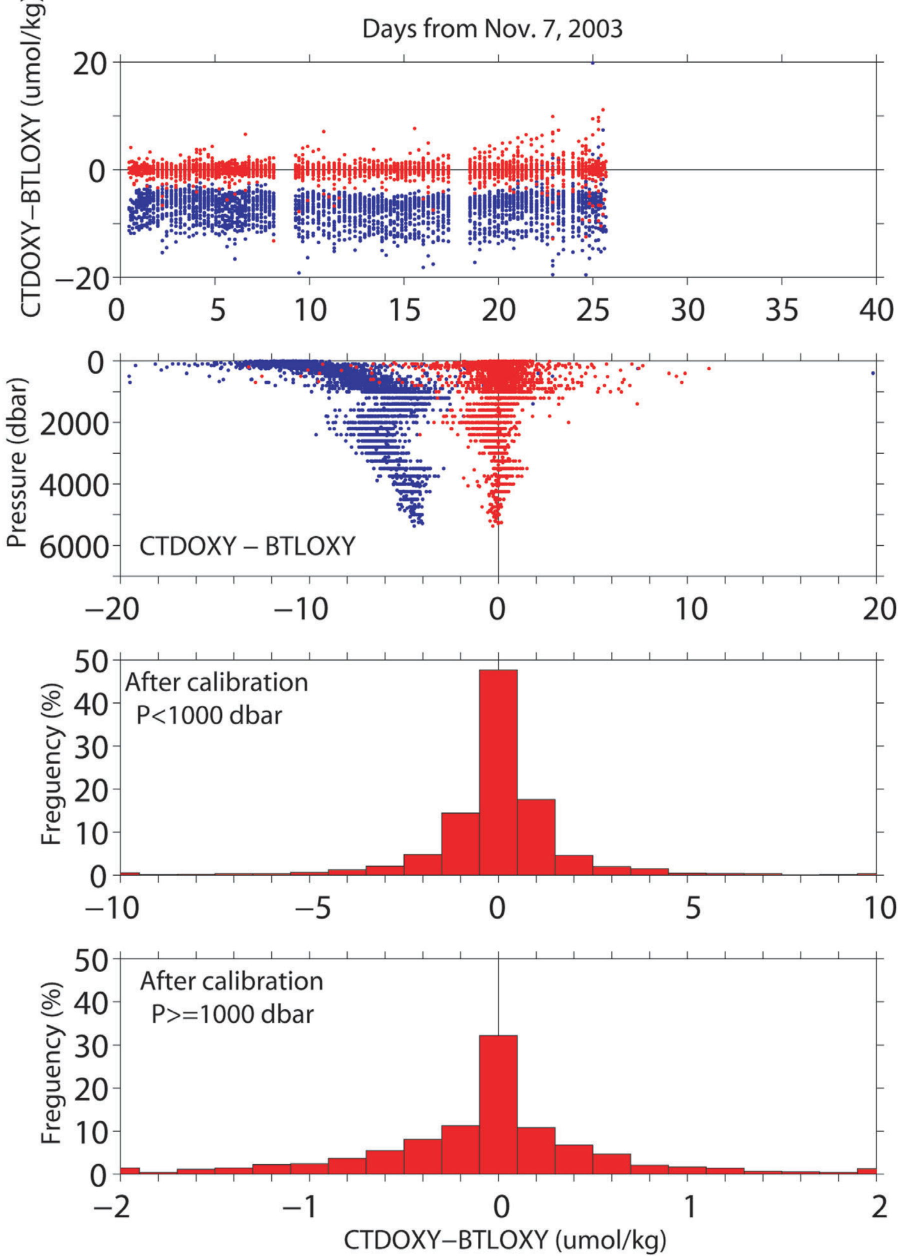

Figure 3.1.24. Same as Figure 3.1.22, but for leg 4.

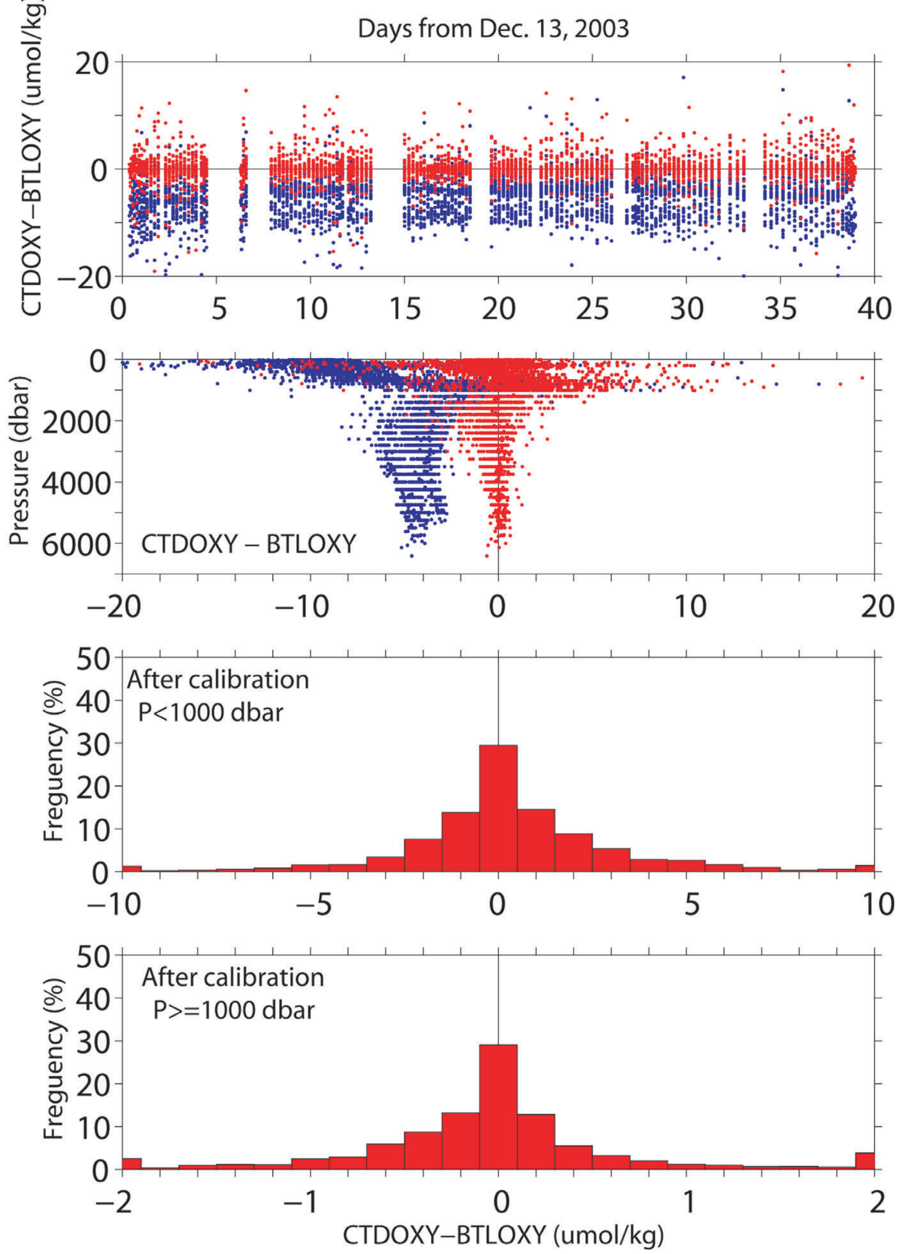

Figure 3.1.25. Same as Figure 3.1.22, but for leg 5.

Table 3.1.11. Calibration coefficients of CTD oxygen for leg 1.

STN	CAST	dSOC	doffset	dTCor	dPCor	ADEV	NUM
246	1	2.38582090e-003	1.887111e-003	1.48955051e-003	1.01158483e-005	1.0222	41
245	1	(grouped with 246_1)					
244	1	(grouped with 246_1)					
243	1	(grouped with 246_1)					
242	1	1.96219702e-002	-4.768921e-002	-1.69310871e-004	8.28571766e-006	0.8231	18
241	1	2.09523345e-002	-6.285339e-002	4.55776312e-004	1.25161338e-005	0.9124	24
240	1	7.32701374e-003	-1.965882e-002	1.51889513e-003	1.18141936e-005	1.5916	30
239	1	1.09973336e-002	7.086056e-003	5.81005416e-004	4.63627641e-006	0.7618	30
238	1	1.52088062e-002	-2.687566e-002	1.06131300e-003	1.07691510e-005	0.5609	30
237	1	1.69483728e-002	-1.832307e-002	6.52204023e-004	7.58211796e-006	0.5598	31
X11	1	2.30535862e-002	5.414177e-002	-1.12186694e-003	-9.19460122e-006	1.3567	33
235	1	1.92487631e-002	-1.587548e-002	-8.45506001e-006	6.43657688e-006	0.3632	29
234	1	1.70941074e-002	-6.287279e-003	3.24244778e-004	5.65441573e-006	0.5210	23
232	1	1.96361830e-002	-2.157541e-002	5.03860863e-004	8.02631561e-006	0.7912	32
231	1	8.52011498e-003	7.824986e-003	1.98053266e-003	1.06535798e-005	2.9007	24
230	1	1.66220798e-002	-3.093979e-002	1.19719391e-003	1.67226710e-005	0.5738	17
229	1	2.17858207e-002	-9.793618e-003	4.63808386e-006	2.11889898e-007	1.2303	19
228	1	1.70203655e-002	-6.999983e-003	7.52699424e-004	6.36132952e-006	0.7301	22
227	1	1.27340850e-002	-1.081054e-003	1.52753424e-003	9.67463030e-006	0.9325	23
226	1	1.27356348e-002	2.370764e-002	8.65588505e-004	-7.88346212e-007	0.7562	18
225	1	1.34323389e-002	-4.777866e-003	1.36717210e-003	1.00117132e-005	1.1864	35
224	1	(grouped with 225_1)					
223	1	1.72491859e-002	-7.885494e-003	8.95765560e-004	6.08006705e-006	1.2634	116
222	1	(grouped with 223_1)					
221	1	(grouped with 223_1)					
220	1	(grouped with 223_1)					
219	1	(grouped with 223_1)					
218	1	(grouped with 223_1)					
217	1	(grouped with 223_1)					
216	1	1.43851861e-002	1.334883e-002	8.36621684e-004	1.05968498e-006	0.4325	26
215	1	1.60120845e-002	1.408044e-004	1.02632654e-003	3.80264393e-006	0.5611	26
214	1	1.54383735e-002	2.469768e-003	1.01120263e-003	4.31263793e-006	0.5565	26
213	1	1.97484020e-002	-1.293050e-002	6.86284387e-004	4.56955146e-006	0.6883	42
212	1	(grouped with 213_1)					
211	1	1.15339829e-002	2.352442e-002	1.30678348e-003	-3.50720791e-007	0.4582	22
210	1	1.19521280e-002	3.787796e-002	1.03716016e-003	-5.87638101e-006	0.7936	52
209	1	(grouped with 210_1)					
208	1	(grouped with 210_1)					
207	1	1.83647636e-002	-2.022739e-003	5.82575411e-004	2.38730414e-006	0.9064	48
206	1	(grouped with 207_1)					
205	1	1.57243966e-002	1.256451e-002	8.92227219e-004	-6.59272746e-007	0.9430	47
204	1	(grouped with 205_1)					
203	1	1.68041639e-002	1.254249e-003	9.05164341e-004	2.83191955e-006	0.6897	73
202	1	(grouped with 203_1)					
201	1	(grouped with 203_1)					
200	1	(grouped with 203_1)					
199	1	1.90164157e-002	2.312641e-003	3.92984271e-004	-5.77434750e-009	0.4700	59
198	1	(grouped with 199_1)					
197	1	(grouped with 199_1)					
196	1	5.14578578e-003	4.544205e-002	2.36327120e-003	-1.84873190e-006	0.8618	26
195	1	1.56669191e-002	1.236898e-002	7.19222256e-004	-3.77852598e-007	0.3629	27
194	1	1.15354963e-002	3.361402e-002	1.39325069e-003	-4.21996334e-006	0.8988	28
X14	1	1.84000869e-002	2.649477e-003	7.06666160e-004	1.04379763e-006	0.7189	29
192	1	2.67368609e-002	-2.915823e-002	-6.77651652e-005	5.26758668e-006	0.6830	29
191	1	3.29050209e-002	-5.546260e-002	-7.65931385e-004	9.66482398e-006	0.5235	30
190	1	1.62697194e-002	1.617597e-002	9.33702967e-004	-2.00265537e-006	0.9525	29
186	1	1.69719541e-002	6.763835e-003	1.04352693e-003	1.13618883e-006	0.5401	28
185	1	2.48010752e-002	-2.549541e-002	1.62272759e-004	6.14933921e-006	0.8327	26
184	1	1.87704489e-002	1.051108e-002	4.24005384e-004	-2.19257733e-006	0.9231	42
183	1	(grouped with 184_1)					
182	1	2.20045670e-002	-2.016613e-002	5.53496058e-004	6.10130301e-006	0.5214	25
181	1	1.32249175e-002	3.646574e-002	1.10721356e-003	-6.20976884e-006	1.0281	43
180	1	(grouped with 181_1)					
179	1	1.87222549e-002	-1.477391e-002	1.18836829e-003	8.20735406e-006	1.6390	26
178	1	1.98860517e-002	-1.915872e-002	9.22288924e-004	7.38557353e-006	0.9050	30
177	1	2.06493657e-002	-1.057594e-002	8.18024036e-004	5.28978299e-006	1.1566	32
176	1	2.04550178e-002	-1.075094e-002	1.00851163e-003	5.62614860e-006	0.9945	36
175	1	2.42465264e-002	-1.826848e-002	8.00875863e-005	5.71561698e-006	1.1673	71
174	1	2.82908744e-002	-1.308557e-002	8.00875863e-005	2.99933551e-006	0.6080	71
173	1	3.18702655e-002	-2.685952e-002	1.28591177e-005	4.86180818e-006	0.6253	36
172	1	2.89911863e-002	-9.394000e-003	1.48387045e-004	2.93866278e-006	0.7515	35
171	1	3.15402716e-002	-1.562983e-002	-3.54025098e-004	3.03193404e-006	0.4653	33
170	1	2.92569924e-002	-1.194463e-002	-1.09474305e-004	3.35102881e-006	0.7037	36
169	1	2.68419905e-002	-6.161658e-003	5.92733683e-004	3.53521281e-006	0.8244	35
168	1	3.10648438e-002	-1.645999e-002	-1.52321359e-004	3.79836128e-006	1.6206	34
167	1	3.13862115e-002	-1.431032e-002	1.75003723e-004	3.21061164e-006	0.4295	36
166	1	3.25962716e-002	-2.126453e-002	-2.93401620e-005	4.15446915e-006	0.4985	41
166	2	(grouped with 166_1)					
165	1	3.13416164e-002	-1.742716e-002	-8.10465395e-005	3.98219083e-006	0.9254	72
164	1	(grouped with 165_1)					
163	1	3.48398044e-002	-2.633253e-002	-2.75654449e-004	4.19186733e-006	0.6397	35
162	1	3.04956807e-002	-1.238719e-002	1.10739155e-004	3.65117545e-006	0.5299	30
161	1	3.10885459e-002	-1.369728e-002	2.63961999e-004	3.81475328e-006	0.6977	32
160	1	3.13641340e-002	-1.696865e-002	1.00400571e-004	4.21787756e-006	1.1353	103
159	1	(grouped with 160_1)					
158	1	(grouped with 160_1)					
X15	1	3.35376368e-002	-1.838064e-002	-3.39126912e-004	3.77014859e-006	0.7931	35
156	1	3.77102348e-002	-2.190094e-002	-7.67051284e-004	2.04281956e-006	1.1912	34
155	1	2.91790424e-002	-5.186495e-003	2.70503019e-004	2.80822996e-006	0.8127	34
154	1	3.35985576e-002	-2.160858e-002	-1.11728456e-004	4.47796268e-006	0.7651	34
153	1	3.16556495e-002	-1.145357e-002	4.77295143e-005	3.12465601e-006	0.4189	34
152	1	3.22853325e-002	-9.941596e-003	-2.36615248e-004	2.48648438e-006	0.9098	36
151	1	3.02502361e-002	-5.966700e-003	2.90176684e-004	2.75248141e-006	0.5385	34
150	1	2.81804035e-002	-6.506802e-003	5.75029470e-004	4.19079955e-006	0.8227	34
149	1	3.11456957e-002	-6.967424e-003	5.18660266e-005	2.91721787e-006	0.6199	34
148	1	3.47348862e-002	-1.684690e-002	-2.29582275e-004	2.82516719e-006	0.7443	68
147	1	(grouped with 148_1)					
146	1	3.53410982e-002	-2.046191e-002	-1.11844595e-004	3.43154569e-006	0.3174	34
145	1	3.62919880e-002	-2.120630e-002	-1.55453128e-004	3.34846046e-006	0.5929	66
144	1	(grouped with 145_1)					
143	1	3.36266628e-002	-1.371444e-002	1.55735719e-004	2.97005323e-006	0.5543	32
142	1	3.26068071e-002	-1.343652e-002	7.40464793e-004	3.68768905e-006	0.5138	34
140	1	3.19586591e-002	-9.780018e-003	5.57610736e-004	3.31379058e-006	0.5453	66
139	1	(grouped with 140_1)					
138	1	3.37279205e-002	-9.370842e-003	3.65654229e-005	1.86486177e-006	0.8831	30
137	1	3.63150433e-002	-1.950630e-002	-3.15347606e-004	2.76325448e-006	0.6029	36
136	1	3.22872791e-002	-6.775344e-003	4.30712788e-004	2.06319894e-006	0.9276	34
135	1	3.29996810e-002	-5.472943e-003	3.53114357e-005	1.50420915e-006	0.4154	35
134	1	3.72861207e-002	-2.213754e-002	-2.48397916e-004	2.89717034e-006	0.7042	33
133	1	3.35635774e-002	-1.214661e-002	3.09875111e-004	2.92718053e-006	0.7336	33
132	1	2.72692079e-002	1.837957e-003	1.53006774e-003	3.14546947e-006	0.7034	32
131	1	3.38276184e-002	-1.373936e-002	3.77339262e-004	2.94799311e-006	0.3778	33
130	1	3.45000073e-002	-2.197492e-002	3.59766822e-004	5.83398902e-006	0.5472	26
129	1	3.50350563e-002	-1.245277e-002	-5.87154649e-005	2.05119992e-006	0.8191	34
X16	1	3.23858223e-002	-6.221201e-003	2.23999058e-004	2.09230315e-006	0.5398	66
127	1	(grouped with X16_1)					
126	1	3.58576508e-002	-8.846458e-003	-2.02242075e-004	1.94536337e-006	0.4036	32
125	1	2.96552275e-002	1.562307e-003	1.05726902e-003	3.66817745e-006	1.0164	31
124	1	3.13219439e-002	-6.211164e-004	7.46450419e-004	3.82288286e-006	0.7973	31
123	1	4.04501789e-002	-1.358723e-002	-3.54051940e-004	1.85413544e-006	0.5865	34
122	1	3.47054822e-002	6.965114e-003	4.64724281e-004	8.32092898e-007	0.6458	66
121	1	3.60269589e-002	1.461146e-003	4.64724281e-004	1.81556937e-006	0.7168	66

Table 3.1.12. Same as Table 3.1.11, but for leg 2.

STN	CAST	dSOC	doffset	dTCor	dPCor	ADEV	NUM
127	4	-1.09274080e-003	-9.642248e-003	1.50130547e-003	5.30811735e-006	0.5607	33
125	2	1.45679332e-003	-1.657886e-002	1.85376125e-003	6.81714046e-006	0.6603	29
120	1	-7.81977270e-003	1.643640e-002	1.91010375e-003	1.73135670e-006	0.6464	32
119	1	2.45926851e-003	-3.551664e-003	1.27334726e-003	2.05691219e-006	0.4482	33
118	1	8.74016303e-003	-1.883221e-002	9.40779721e-004	4.55476214e-006	0.8577	30
117	1	3.99051347e-004	2.072205e-003	1.62885202e-003	2.37402168e-006	0.5698	32
116	1	7.47493664e-003	-1.627756e-002	1.16633447e-003	4.09526968e-006	0.6458	32
115	1	4.69541047e-003	-8.605837e-003	1.35055494e-003	3.51015996e-006	0.7595	62
114	1	(grouped with 115_1)					
113	1	3.08295193e-003	-5.180368e-003	1.75481716e-003	3.08785085e-006	0.5985	32
112	1	-2.08564354e-003	9.224806e-003	1.94034066e-003	1.30094617e-006	0.6752	32
111	1	1.66887700e-002	-2.838172e-002	-4.57225340e-004	3.86551232e-006	0.6704	30
110	1	1.21875571e-002	-1.875040e-002	5.81443019e-004	2.61866766e-006	0.5569	28
109	1	7.37942776e-003	-9.168366e-003	1.44016227e-003	2.23844225e-006	0.4737	30
108	1	5.82680563e-003	-9.584403e-003	1.65645010e-003	3.24617142e-006	0.9119	30
X17	2	1.22319553e-002	-1.590105e-002	6.65168181e-004	2.10046660e-006	0.4956	29
106	1	1.41271210e-002	-2.608612e-002	6.92971740e-004	4.99233252e-006	0.6274	29
105	1	1.19095315e-002	-1.766180e-002	9.77996680e-004	3.05979585e-006	0.5593	28
104	1	1.01039359e-002	-1.197509e-002	1.11095785e-003	1.74786763e-006	0.4229	30
103	1	1.16737262e-002	-1.721616e-002	7.85935207e-004	2.77226908e-006	0.4831	28
102	1	8.67632966e-003	-1.726645e-002	1.31463987e-003	5.12263247e-006	0.7849	29
101	1	5.43022332e-003	-4.102882e-003	1.63767352e-003	1.65849417e-006	0.6098	27
100	1	1.01358495e-002	-1.799370e-002	1.58545060e-003	4.54472094e-006	0.3997	27
099	1	1.09938825e-002	-1.037107e-002	9.04954968e-004	4.73373066e-007	0.4579	28
098	1	1.19863923e-002	-1.196383e-002	7.70085100e-004	4.88695245e-007	0.5202	27
097	1	1.04906792e-002	-1.161558e-002	9.89786901e-004	1.07592910e-006	0.4959	28
096	1	1.00183012e-002	-1.391625e-002	1.19566599e-003	2.72057855e-006	0.5366	25
095	1	1.26054247e-002	-3.221627e-002	1.32205530e-003	9.93640834e-006	0.4060	21
094	1	-8.79253048e-003	3.318282e-002	3.18228491e-003	-3.22862977e-006	0.6676	27
093	1	2.36744233e-003	-1.182664e-002	2.42565918e-003	8.38307154e-006	0.6600	21
092	1	7.34297175e-003	-8.555440e-003	1.06337858e-003	2.02041928e-006	0.5711	27
091	1	9.74745476e-003	-3.296311e-002	1.50853917e-003	1.26202328e-005	0.4855	22
090	1	1.75626063e-004	9.451891e-003	1.82513675e-003	-4.41355713e-007	0.6162	26
089	1	9.79129790e-003	-2.955496e-002	1.50830787e-003	1.07057009e-005	0.6860	23
088	1	5.89084240e-003	-1.410234e-002	1.63753372e-003	5.96518950e-006	0.5562	24
087	1	-3.63729020e-003	1.564703e-002	2.48632724e-003	-3.15856407e-007	0.6354	24
086	1	1.18997793e-002	-1.099894e-002	-1.37906591e-004	1.49268816e-007	1.1285	25
085	1	7.49243370e-003	-1.322353e-002	1.53041534e-003	4.49091684e-006	0.5874	25
084	1	1.61843752e-002	-2.674799e-002	4.03006384e-004	3.39762207e-006	0.5542	25
083	1	1.10955361e-002	-1.575595e-002	9.59456371e-004	2.14033432e-006	0.5787	27
082	1	1.02702377e-002	-1.283594e-002	1.05576044e-003	1.44338445e-006	0.5816	26
081	1	1.20686931e-002	-1.418798e-002	7.16178313e-004	8.99708179e-007	0.4142	26
080	1	8.81364097e-003	-1.388094e-002	1.14330628e-003	3.45310873e-006	0.6839	20
079	1	1.88905722e-002	-3.427543e-002	1.32864542e-004	4.40922771e-006	0.5470	26
078	1	1.73401052e-002	-3.008971e-002	2.71658744e-004	4.24281896e-006	0.6289	25
077	1	1.14511360e-002	-2.036342e-002	1.02401160e-003	3.72734983e-006	0.5449	25
076	1	1.25188282e-002	-1.710343e-002	7.05872161e-004	1.63736491e-006	0.8367	24
075	1	9.84956264e-003	-2.121272e-002	1.20306827e-003	6.27295106e-006	0.5378	24
072	1	9.74597273e-003	-1.563567e-002	1.09316155e-003	3.29436115e-006	0.6366	22
071	1	6.22872864e-004	9.106210e-003	1.61219720e-003	-2.21128469e-007	0.5449	24
070	1	2.15245527e-003	6.689708e-003	1.62266305e-003	1.01094161e-007	0.6773	22
069	1	1.30137238e-002	-1.386944e-002	5.38979596e-004	5.91962487e-007	2.8002	25
068	1	1.03509138e-002	-1.316118e-002	7.22406700e-004	2.00768809e-006	0.7732	23
067	1	1.98547673e-003	1.717993e-002	1.36832806e-003	-5.23856596e-006	0.5011	31
066	1	1.20119393e-002	-2.653336e-002	9.95283507e-004	7.07856393e-006	0.6510	23
065	1	3.05908526e-003	1.299736e-002	1.19343084e-003	-3.92929871e-006	0.9623	26
064	1	1.34349983e-002	-2.663693e-002	5.97615018e-004	5.79015520e-006	0.6654	25
063	1	1.25716313e-002	-1.237644e-002	5.80223732e-004	-8.72689407e-007	1.0818	27
062	1	7.28264565e-003	-1.205697e-002	1.32092146e-003	2.50764789e-006	0.5047	26
061	1	1.00884127e-002	-2.074392e-002	1.15050276e-003	4.49796300e-006	0.9244	25
060	1	4.34177327e-003	8.413468e-003	1.31569749e-003	-2.73605743e-006	1.0060	26
059	1	1.16003831e-003	-2.011026e-003	1.92968027e-003	3.80299211e-006	0.7332	25
X18	1	5.36886273e-003	-6.214541e-003	1.45261837e-003	2.25518592e-006	0.6637	28
056	1	1.80161432e-002	-2.068603e-002	-3.72581169e-004	-3.80431070e-007	1.3363	28
055	1	7.28194471e-003	1.453630e-003	9.52421315e-004	-1.86558914e-006	0.9417	28
054	1	1.34960001e-002	-1.388723e-002	8.36348987e-004	-1.31052250e-007	0.6511	26
053	1	1.00680155e-002	-8.060877e-003	1.15128733e-003	3.12893901e-007	0.6401	28
052	1	1.60378839e-002	-1.943119e-002	5.81110578e-004	3.67969435e-007	0.4389	28
051	1	1.96401386e-002	-3.387229e-002	2.37542095e-004	3.93319368e-006	0.6208	29
050	1	1.10244510e-002	-1.776897e-002	1.07591263e-003	4.19968241e-006	0.5021	23
049	1	1.37580325e-002	-1.688490e-002	7.50700948e-004	7.25174589e-007	0.4526	28
048	1	4.21626501e-003	7.039748e-003	1.45828931e-003	-2.78845820e-006	1.3134	28
047	1	1.19684791e-002	-3.674009e-003	4.71270943e-004	-2.79621313e-006	0.5761	29
046	1	1.16803277e-002	-9.865014e-003	8.26541140e-004	-3.05238682e-007	0.8536	26
045	1	2.96906980e-003	1.316666e-002	1.56583699e-003	-3.96086670e-006	0.9888	27
044	2	1.39257539e-002	-1.485845e-002	7.57731383e-004	1.27989904e-007	0.6508	28
043	1	1.17536989e-002	-2.273718e-002	1.23339630e-003	5.88797024e-006	0.5036	23
042	1	1.54655244e-002	-2.276579e-002	4.51193169e-004	1.80637423e-006	0.7682	31
041	1	-1.25788572e-003	1.372234e-002	2.85039072e-003	-1.00162249e-006	0.7456	27
040	1	2.00944031e-002	-3.254338e-002	3.10536254e-004	3.27020593e-006	0.6612	25
039	1	2.08580441e-002	-3.136754e-002	1.59401060e-004	2.43423257e-006	1.0773	27
038	1	6.64215269e-003	2.297505e-003	1.26911449e-003	-1.86946987e-006	0.9411	26
037	1	2.85323179e-002	-3.715319e-002	-9.30202501e-004	9.32867192e-008	0.8750	27
036	1	1.16317264e-002	-7.820167e-003	9.15187336e-004	-1.17852891e-006	1.2289	50
X19	1	(grouped with 036_1)					
034	1	8.95215938e-003	-7.590728e-003	1.18567895e-003	2.59452772e-007	1.1124	55
033	1	(grouped with 034_1)					
032	1	2.38439155e-002	-3.346548e-002	-5.10602019e-004	1.47333953e-006	1.1909	28
031	1	1.63175724e-002	-1.466377e-002	4.62483980e-004	-1.47116988e-006	1.3595	29
030	1	1.46143667e-002	-1.323884e-002	7.36158672e-004	-4.14895511e-007	1.2963	56
029	1	(grouped with 030_1)					
028	1	3.42341110e-002	-4.172630e-002	-1.52121804e-003	-1.14299593e-006	1.7616	27
027	1	1.95720258e-002	-2.601583e-002	1.31962391e-004	1.36705148e-006	2.4139	57
026	1	(grouped with 027_1)					
025	1	2.01451779e-003	8.728897e-003	2.06449860e-003	-1.64137362e-006	1.4384	28
024	1	2.35844381e-002	-3.274074e-002	-4.00403360e-004	1.47364928e-006	2.5723	29
023	1	5.87619565e-003	-8.046247e-003	1.79860830e-003	3.02774552e-006	1.0755	24
022	1	-2.44953424e-003	6.234976e-003	2.72784324e-003	3.17453867e-006	2.0046	26
021	1	1.41028592e-003	4.466761e-003	1.95022506e-003	1.09382219e-006	2.5842	29
020	1	1.97227794e-002	-2.456271e-002	1.58722559e-004	1.52734238e-006	2.5708	27
019	1	1.32212009e-002	-1.617882e-002	8.69539066e-004	1.66235937e-006	1.1578	55
018	1	(grouped with 019_1)					
017	1	2.07804045e-002	-2.047416e-002	1.65884421e-004	-9.27506981e-007	1.1217	30
016	1	7.74830842e-003	-1.674730e-003	1.23603255e-003	-9.36544303e-007	1.2977	29
015	1	2.31298922e-002	-2.461991e-002	-8.17213748e-004	-6.05252479e-007	1.0854	29
014	1	1.86895576e-002	-1.858824e-002	3.78966116e-004	-4.02108471e-007	1.3674	30
013	1	1.83186106e-002	-1.426752e-002	6.20149126e-004	-2.53211715e-006	1.2964	29
012	1	2.51052836e-002	-2.527728e-002	-6.42565782e-004	-1.04879622e-006	1.2292	31
011	1	1.74778447e-002	-1.559639e-002	5.43633136e-004	-8.67071178e-007	1.2646	89
010	1	1.63077298e-002	-1.105469e-002	5.43633136e-004	-1.83781829e-006	1.2092	89
009	1	1.64860551e-002	-1.303505e-002	5.43633136e-004	-6.03752877e-007	1.9520	89
008	1	2.19710018e-002	-2.210537e-002	-4.79957453e-004	1.35429696e-006	1.8917	66
007	1	(grouped with 008_1)					
006	1	(grouped with 008_1)					
005	1	(grouped with 008_1)					
004	1	(grouped with 008_1)					

Table 3.1.13. Same as Table 3.1.11, but for leg 4.

STN	CAST	dSOC	doffset	dTCor	dPCor	ADEV	NUM
622	1	1.19460307e-002	-1.238833e-002	1.23972220e-003	1.73074430e-007	0.6496	70
623	1	(grouped with 622_1)					
624	1	(grouped with 622_1)					
625	1	(grouped with 622_1)					
626	1	(grouped with 622_1)					
627	1	(grouped with 622_1)					
628	1	8.08956689e-003	-6.220221e-003	1.61355750e-003	2.97165215e-006	0.4276	20
629	1	1.23927280e-002	-1.275307e-002	1.11852434e-003	7.94633571e-007	0.3864	22
630	1	1.21865078e-002	-1.740439e-002	1.28209318e-003	1.56388565e-006	0.6582	21
631	1	1.22695064e-002	-1.590750e-002	1.12142000e-003	1.36664664e-006	0.5053	23
632	1	1.53017807e-002	-1.521908e-002	7.33845636e-004	-1.91470701e-006	0.4659	23
001	1	1.63703046e-002	-2.475552e-002	9.99122316e-004	-3.56449492e-008	0.5506	27
002	1	1.57347664e-002	-1.353171e-002	5.88736034e-004	-1.94079587e-006	0.9337	27
003	1	1.49867601e-002	-3.334577e-002	1.57269811e-003	4.34600767e-006	0.6673	29
004	1	1.46189162e-002	-1.359686e-002	8.75802415e-004	-2.00882142e-006	0.3686	28
005	1	1.21119088e-002	-1.352664e-002	1.18380675e-003	-2.05495950e-007	0.6281	29
006	1	1.26743087e-002	-1.149839e-002	1.11494816e-003	-6.92780764e-007	0.4888	28
007	1	1.14939891e-002	-7.198705e-003	1.04079914e-003	-1.26835223e-006	0.5054	28
008	1	1.66534716e-002	-2.525800e-002	1.04490982e-003	-2.66597826e-007	0.6440	26
009	1	1.87968469e-002	-2.665526e-002	7.00893586e-004	-9.46484074e-007	0.4262	25
010	1	7.08772760e-003	1.015941e-002	1.36572486e-003	-2.62669973e-006	1.0179	28
011	1	8.09877281e-003	5.892469e-003	1.15118709e-003	-1.90882487e-006	0.7568	33
X17	1	9.45648936e-003	-2.910608e-003	1.35514436e-003	-7.03116325e-007	0.6818	30
013	1	1.19036751e-002	-1.479927e-003	9.16114463e-004	-2.66366816e-006	0.7239	28
014	1	5.81682828e-003	1.651614e-003	1.68721291e-003	5.36373565e-007	0.7090	28
015	1	2.49255576e-002	-4.325531e-002	3.25798890e-004	-3.37942498e-007	0.4482	26
016	1	1.35354445e-002	-2.215709e-002	1.33053965e-003	2.84850971e-006	0.6458	21
X23	1	6.16378653e-003	4.118997e-003	1.77776819e-003	9.18330187e-007	0.3706	20
018	1	6.83222393e-003	-2.974464e-003	1.80392870e-003	3.25458203e-006	0.7454	55
019	1	(grouped with 018_1)					
020	1	(grouped with 018_1)					
021	1	1.53295265e-002	-2.115045e-002	9.91540826e-004	1.58346555e-006	0.4492	22
022	1	9.61716512e-003	-1.336717e-002	2.02569844e-003	4.79303555e-006	0.8348	19
023	1	1.08247842e-002	-9.317714e-003	1.34021413e-003	7.47641272e-007	0.2895	18
024	1	1.54278469e-002	-2.947011e-002	1.13529779e-003	6.28646063e-006	0.3530	17
025	1	1.20151338e-002	-1.569901e-002	1.33615489e-003	2.92576256e-006	0.4120	20
026	1	2.15863387e-002	-3.331918e-002	4.63559933e-004	1.68714349e-007	0.7305	25
027	1	1.24698089e-002	-1.484383e-002	1.16944869e-003	8.08998097e-007	0.7570	26
028	1	2.15012608e-002	-3.082625e-002	4.78759683e-004	-1.08134842e-006	0.3289	27
029	1	1.61358969e-002	-2.224921e-002	1.01879151e-003	8.14005621e-008	0.5804	27
030	1	1.77462765e-002	-2.794173e-002	8.40465409e-004	9.73978731e-007	0.5118	28
031	1	1.84583618e-002	-3.053622e-002	1.03220689e-003	9.45114250e-007	0.3815	28
032	1	1.33639632e-002	-7.363043e-003	9.45374770e-004	-1.58462344e-006	0.6724	28
033	1	1.22656543e-002	-1.810905e-003	9.79904388e-004	-1.86250880e-006	1.0447	27
034	1	1.21025499e-002	2.668724e-003	9.45282016e-004	-2.34251481e-006	0.5943	20
035	1	8.98603652e-003	6.972679e-003	1.55623427e-003	-1.32894216e-006	0.8113	26
036	1	1.64209820e-002	-1.440089e-002	9.60325914e-004	-9.76379458e-007	0.9917	27
037	1	1.23192885e-002	-5.910177e-003	1.43848556e-003	-1.03444371e-006	0.6851	32
038	1	1.32601640e-002	-1.006011e-002	1.36780509e-003	-2.35621543e-007	0.4556	35
039	1	1.40252661e-002	-1.451711e-002	1.33708899e-003	4.11380674e-007	0.6692	29
X16	1	1.17639342e-002	4.149995e-003	1.05158481e-003	-2.99660726e-006	0.9274	31
041	1	1.26145984e-002	-6.655124e-003	1.30215365e-003	-7.00108237e-007	0.4527	31
042	1	1.31273290e-002	-3.172715e-003	1.25977204e-003	-1.60632591e-006	0.9332	30
043	1	1.47413015e-002	-5.812054e-003	9.77066402e-004	-2.18787118e-006	0.5921	32
044	1	1.51597126e-002	-8.448579e-003	7.72679750e-004	-1.34047938e-006	0.6151	32
045	1	1.45679702e-002	-9.658047e-003	1.07929015e-003	-6.12702663e-007	0.4844	31
046	1	1.66700040e-002	-1.127564e-002	8.62028680e-004	-1.50712201e-006	0.5236	31
X15	1	1.21696205e-002	-2.160569e-003	1.40832484e-003	-1.66002472e-006	0.4344	32
048	1	1.76950237e-002	-1.676019e-002	9.55459209e-004	-6.73610749e-007	0.5064	29
049	1	1.58802632e-002	-8.291853e-003	8.37587663e-004	-1.92014630e-006	0.5884	55
050	1	(grouped with 049_1)					
051	1	2.50538097e-002	-3.394725e-002	3.38584953e-004	-9.45196059e-007	0.6024	27
052	1	2.50079573e-002	-3.840986e-002	8.63142023e-004	7.97451532e-007	0.5092	25
053	1	1.95501389e-002	-1.639460e-002	8.85447428e-004	-1.53289655e-006	0.5314	29
054	1	2.15437389e-002	-2.237765e-002	5.18226273e-004	-9.24638943e-007	0.4029	22
055	1	1.54200792e-002	-8.205450e-003	1.10988866e-003	-1.75089544e-006	0.5035	72
056	1	(grouped with 055_1)					
057	1	(grouped with 055_1)					
058	1	3.03345901e-002	-4.907400e-002	1.14779507e-004	3.80617180e-008	0.5185	54
059	1	(grouped with 058_1)					
060	1	2.15018503e-002	-2.848844e-002	8.05592347e-004	-1.85852402e-007	0.6939	27
061	1	1.76551818e-002	-1.492066e-002	9.11079057e-004	-1.65918456e-006	0.5173	28
X14	1	1.95987008e-002	-2.052938e-002	1.02583629e-003	-1.10269771e-006	0.7835	29
063	1	1.80746085e-002	-1.511890e-002	8.68231648e-004	-1.59755872e-006	0.8123	28
064	1	2.91936029e-002	-4.859550e-002	2.12192251e-004	7.73721323e-007	0.7360	29
065	1	1.71586901e-002	-1.086844e-002	9.93254092e-004	-2.57375867e-006	0.4127	32
066	1	2.12719174e-002	-1.707289e-002	2.91449105e-004	-2.74589444e-006	0.6316	30
067	1	1.98544820e-002	-1.009702e-002	2.95178264e-004	-3.77050125e-006	0.5261	31
068	1	1.99380500e-002	-1.325896e-002	5.52925286e-004	-2.88075045e-006	0.6975	28
069	1	2.39454326e-002	-3.353565e-002	7.53322993e-004	-4.46688515e-007	0.7946	31
070	1	1.89640275e-002	-1.158135e-002	6.43918978e-004	-2.85252549e-006	1.0858	30
071	1	2.33875867e-002	-2.660745e-002	3.79954793e-004	-1.18208558e-006	1.0062	30
072	1	1.67774431e-002	-2.134682e-003	6.49432437e-004	-4.08231549e-006	0.8040	32
073	1	2.35503690e-002	-2.969429e-002	3.29612428e-004	-1.00313106e-006	0.5985	29
074	1	1.88295466e-002	-3.338946e-002	1.24004326e-003	3.36388360e-006	0.6702	25
075	1	2.25811536e-002	-3.156603e-002	6.29669927e-004	8.38036877e-009	0.8971	28
076	1	3.07743878e-002	-5.218067e-002	1.94753168e-004	8.57265544e-007	0.6289	27
077	1	9.65008917e-003	2.863497e-003	9.54057446e-004	-7.59163286e-008	0.9108	23
078	1	1.76187174e-002	-1.193663e-002	7.42492887e-004	-2.03486649e-006	0.9003	28
079	1	1.61850649e-002	-1.706836e-002	8.64550489e-004	2.59055814e-007	1.1742	32
080	1	1.32468143e-002	-9.204188e-003	1.36956379e-003	-1.09447089e-007	0.7653	29
081	1	1.56201792e-002	-1.334751e-002	1.01720967e-003	-3.77589331e-007	0.9621	32
082	1	1.65487991e-002	-1.142550e-002	7.70429133e-004	-1.17118285e-006	0.9250	33
083	1	1.10998663e-002	1.475583e-002	8.86634351e-004	-5.45472046e-006	0.8739	30
084	1	1.43930715e-002	-2.139139e-002	1.49544719e-003	2.54010078e-006	1.0532	32
085	1	1.42946636e-002	1.378177e-003	8.31565051e-004	-3.60640617e-006	0.9981	34
086	1	1.33151051e-002	6.753291e-003	1.02322280e-003	-4.46082654e-006	3.7508	31
087	1	1.36777457e-002	-2.723718e-003	1.16024137e-003	-1.95332943e-006	1.9374	33
X13	1	8.43106107e-003	2.192290e-002	1.23873579e-003	-5.94444250e-006	0.8429	33
089	2	1.76864488e-002	-1.843653e-002	1.01115059e-003	-8.02266851e-007	0.8694	30
090	1	1.70316790e-002	-9.748997e-003	6.61637426e-004	-2.53025527e-006	0.7475	28
091	1	2.38612552e-002	-3.308860e-002	6.85820669e-004	-6.84203394e-007	1.2473	29
092	1	2.21868941e-002	-2.240719e-002	1.66571357e-004	-2.23781863e-006	1.7122	26
093	1	2.08670181e-002	-2.619265e-002	4.61822749e-004	-4.54456988e-007	1.9235	52
094	1	(grouped with 093_1)					
095	1	2.64634247e-002	-3.655167e-002	1.33632464e-004	-1.58701618e-006	0.6288	24
096	1	1.07604073e-002	-5.553448e-004	1.15924505e-003	1.36311468e-006	2.3242	54
097	1	(grouped with 096_1)					
098	1	(grouped with 096_1)					
099	1	(grouped with 096_1)					
100	1	(grouped with 096_1)					

Table 3.1.14. Same as Table 3.1.11, but for leg 5.

STN	CAST	dSOC	doffset	dTCor	dPCor	ADEV	NUM
610	1	1.20733575e-002	-2.356255e-002	1.63218378e-003	9.83774066e-006	2.1660	67
609	1	(grouped with 610_1)					
608	1	(grouped with 610_1)					
607	1	(grouped with 610_1)					
606	1	(grouped with 610_1)					
605	1	(grouped with 610_1)					
604	1	2.26872987e-002	-3.475949e-002	5.91361349e-004	5.63393254e-006	1.7576	41
603	1	(grouped with 604_1)					
602	1	-6.86448944e-004	-3.933016e-003	2.56103293e-003	1.40847510e-005	0.9603	20
601	1	1.87935719e-002	-2.095474e-002	9.22658094e-004	1.45803290e-006	1.9468	24
600	1	1.92819046e-003	3.357785e-002	1.76702373e-003	-4.36132975e-006	0.9974	26
599	1	-5.46730002e-003	5.204253e-002	1.78975989e-003	-3.95628613e-006	3.0401	22
598	1	2.03488348e-002	-2.088571e-002	4.66454603e-004	2.63106480e-007	2.0001	80
597	1	(grouped with 598_1)					
596	1	(grouped with 598_1)					
595	1	1.59338416e-002	-1.851902e-002	7.02688756e-004	2.27013493e-006	2.2699	26
594	1	1.83132706e-002	-1.226940e-002	2.40686026e-004	-1.15502189e-006	1.5586	25
593	1	2.36860164e-002	-3.387828e-002	2.34852141e-004	1.96119010e-006	0.9235	28
592	1	2.17850196e-002	-2.491920e-002	2.85082514e-004	9.59659422e-007	1.4176	55
591	1	(grouped with 592_1)					
590	1	5.78591338e-003	1.049697e-002	1.07738238e-003	2.70964561e-009	2.3647	25
589	1	2.20929963e-002	-3.663022e-002	4.77204922e-004	3.65165964e-006	1.6937	55
588	1	(grouped with 589_1)					
587	1	4.69595550e-003	-2.547314e-004	1.69228873e-003	4.33360893e-006	1.3863	59
586	1	(grouped with 587_1)					
585	1	(grouped with 587_1)					
562	1	8.94782046e-003	-9.538858e-003	1.29144265e-003	2.94523759e-006	1.8189	67
561	1	(grouped with 562_1)					
560	1	(grouped with 562_1)					
559	1	(grouped with 562_1)					
558	1	1.28631166e-002	-1.837581e-002	8.50089454e-004	3.77456639e-006	0.8449	27
557	1	1.27680634e-002	-1.387040e-002	9.41950733e-004	2.62307342e-006	0.6177	31
556	1	1.44702524e-002	-1.522080e-002	7.71926880e-004	1.74817211e-006	0.9905	31
555	1	1.45267653e-002	-1.491045e-002	8.89060867e-004	1.55864623e-006	0.8382	32
554	1	1.65097376e-002	-2.022990e-002	8.21704365e-004	2.60498057e-006	0.6716	31
553	1	2.15052072e-002	-2.778208e-002	2.89823408e-004	1.95590704e-006	0.8638	32
552	1	2.23312523e-002	-3.213603e-002	2.13366671e-004	2.91994727e-006	1.3416	32
551	1	9.26503010e-003	-3.337131e-003	9.22094847e-004	8.25085694e-007	1.0847	32
550	1	1.40516165e-002	-1.413590e-002	7.02786187e-004	2.00289810e-006	1.9510	32
549	1	2.26653312e-002	-3.160432e-002	2.34834551e-004	2.66451443e-006	0.8366	32
X07	1	1.40393950e-002	-1.568025e-002	1.02348083e-003	2.36932115e-006	0.8593	32
547	1	1.44264524e-002	-1.483491e-002	7.34582917e-004	1.90049881e-006	1.2330	28
546	1	1.57136503e-002	-2.288942e-002	8.29120894e-004	3.68924908e-006	0.9175	60
545	1	1.22962466e-002	-1.118712e-002	8.29120894e-004	2.07144221e-006	1.1151	60
544	1	5.78415032e-003	-2.928588e-004	1.27863101e-003	2.11437298e-006	1.4338	30
543	1	1.52193485e-002	-1.955116e-002	8.27753220e-004	3.06487731e-006	2.0633	31
542	1	1.08762747e-002	-7.646221e-003	9.72237017e-004	1.24285159e-006	2.0368	26
541	1	1.15954715e-002	-1.602106e-002	1.04204522e-003	4.93711638e-006	1.3834	59
540	1	(grouped with 541_1)					
539	1	(grouped with 541_1)					
538	1	1.29136221e-002	-2.559967e-002	9.75662261e-004	8.48647023e-006	1.1207	22
537	1	1.70985806e-002	-2.857047e-002	6.04636421e-004	4.23044587e-006	1.5239	31
536	1	6.26128039e-003	5.594300e-003	1.07682114e-003	-3.47522296e-007	1.1130	30
535	1	1.57537667e-002	-2.557984e-002	5.79980689e-004	4.31517410e-006	1.5601	33
534	1	1.79850222e-002	-3.209968e-002	6.87246500e-004	5.28446924e-006	1.6509	29
533	1	2.21324398e-002	-3.771872e-002	3.40806879e-004	4.82790470e-006	1.0153	28
532	1	5.32308758e-003	1.657021e-003	1.39162661e-003	1.54656822e-006	1.3700	26
531	1	1.50355983e-002	-9.705487e-003	1.05640760e-003	-6.74130677e-007	1.2476	50
530	1	1.16863387e-002	-1.847372e-002	1.05640760e-003	5.30808172e-006	1.2939	50
529	1	1.66950775e-002	-1.861653e-002	4.53355320e-004	1.24461964e-006	0.9021	27
528	1	-3.04226705e-003	2.716174e-002	1.90480253e-003	-1.70107779e-006	1.5513	48
527	1	3.27018603e-003	-1.269075e-002	1.90480253e-003	8.43831908e-006	1.4882	48
526	1	1.15908782e-002	-1.787599e-002	9.20205984e-004	4.96445747e-006	0.4229	23
525	1	1.67927497e-002	-1.963366e-002	4.92743902e-004	1.26334442e-006	0.7109	25
524	1	1.16500091e-002	-1.647379e-002	9.85577218e-004	5.14476124e-006	1.0911	65
523	1	(grouped with 524_1)					
522	1	(grouped with 524_1)					
521	1	1.04742811e-002	5.654989e-003	7.07803941e-004	-1.54587022e-006	0.5859	22
520	1	9.25994936e-003	-2.037964e-003	1.07477067e-003	4.54406383e-007	1.0096	24
519	1	5.98836558e-003	-3.283487e-003	1.38163824e-003	5.33520381e-006	0.7880	23
518	1	1.20558840e-002	-2.630609e-002	9.95838992e-004	9.87556498e-006	0.8110	22
517	1	7.68910592e-003	-8.638711e-003	1.22004509e-003	4.80930438e-006	1.4739	26
516	1	2.63683334e-002	-4.938961e-002	2.66292527e-004	6.32455119e-006	1.3326	26
515	1	1.29855564e-002	-1.122212e-002	7.93212419e-004	1.17103633e-006	1.1375	52
514	1	1.19759719e-002	-2.150073e-002	7.93212419e-004	5.95530280e-006	1.1821	52
513	1	1.80191449e-002	-3.013670e-002	5.53073597e-004	4.17396356e-006	1.4089	30
512	1	2.04048826e-002	-4.185628e-002	6.83170929e-004	6.86633328e-006	0.9317	27
511	1	1.71072949e-002	-1.863332e-002	4.69457008e-004	7.74440534e-007	0.9950	58
510	1	(grouped with 511_1)					
509	1	1.65355694e-002	-1.577446e-002	4.45665283e-004	5.28626655e-009	0.9374	62
508	1	(grouped with 509_1)					
507	1	2.20386557e-002	-3.539696e-002	3.36933455e-004	3.49846270e-006	0.6331	33
506	1	1.80924612e-002	-2.378328e-002	5.40986585e-004	1.79867344e-006	0.6165	32
505	1	1.73962430e-002	-1.698524e-002	3.49645469e-004	3.84005411e-008	1.1031	96
504	1	1.77261161e-002	-1.548565e-002	3.49645469e-004	-3.11724107e-007	1.6332	96
503	1	1.65748153e-002	-9.598480e-003	3.49645469e-004	-2.69754264e-006	1.1548	96
502	3	6.58393881e-003	1.412302e-002	9.53436042e-004	-4.18651890e-006	0.9023	33
501	1	1.29566445e-002	-9.694914e-003	6.98072834e-004	-9.89406755e-008	1.3990	32
500	1	2.07405573e-002	-2.737847e-002	7.64443985e-005	1.82324974e-006	1.2776	32
X08	1	2.13234733e-002	-2.766904e-002	1.83454134e-004	1.52235470e-006	0.7252	33
498	1	1.60195786e-002	-1.229022e-002	3.99026623e-004	-5.65712235e-007	1.4079	64
497	1	(grouped with 498_1)					
496	1	2.32553574e-002	-2.725099e-002	4.07060822e-005	9.91017546e-007	1.6508	32
495	1	1.63855016e-002	-1.325975e-002	3.88275447e-004	-4.38865623e-007	1.0970	68
494	1	(grouped with 495_1)					
493	1	1.63351581e-002	-1.333914e-002	5.32329407e-004	-3.21998901e-007	0.6716	32
492	1	1.58652012e-002	-1.630124e-002	4.73905021e-004	1.01673839e-006	0.7462	32
491	1	1.65183116e-002	-1.369055e-002	3.74294099e-004	-3.61598286e-007	1.9280	31
490	1	2.22911297e-002	-2.649723e-002	-1.69008936e-004	1.30726000e-006	1.0821	30
489	1	2.36482213e-002	-3.140866e-002	1.10897675e-006	2.06073321e-006	1.1129	30
488	1	2.47084291e-002	-3.315586e-002	6.93550407e-005	1.45973299e-006	0.9835	27
487	1	9.50517022e-003	-2.034890e-002	1.35342846e-003	9.66172765e-006	0.9078	59
486	1	(grouped with 487_1)					
485	1	(grouped with 487_1)					
484	1	1.84118608e-003	2.284413e-003	1.90613324e-003	4.05400885e-006	0.8307	24
483	1	2.48630010e-002	-3.442443e-002	-1.16668010e-005	1.88055407e-006	1.3219	66
482	1	(grouped with 483_1)					
481	1	1.56370554e-002	-2.704344e-002	1.00210303e-003	5.35087499e-006	0.7942	32
480	1	2.36714768e-002	-3.426183e-002	3.27332658e-004	2.53671740e-006	0.7125	35
479	1	2.05578830e-002	-2.365292e-002	2.18657632e-004	1.13320664e-006	0.9296	33
478	1	1.58739015e-002	-1.198638e-002	4.51704565e-004	2.16942432e-008	0.7977	32
477	1	1.08275337e-002	-5.682384e-003	8.66836875e-004	6.37671375e-007	0.9900	33
476	1	1.68789385e-002	-1.994522e-002	6.09043805e-004	1.94204029e-006	0.8893	31
475	1	2.41584445e-002	-3.504365e-002	2.36384764e-004	2.33285537e-006	0.9349	33
474	1	1.49516716e-002	-1.515027e-002	5.58467827e-004	1.30799187e-006	1.5531	68
473	1	(grouped with 474_1)					
X09	1	1.02464788e-002	-1.434700e-003	6.72262824e-004	-7.31353091e-007	1.0896	35
471	1	1.69216510e-002	-1.780537e-002	6.66279603e-004	1.32666252e-006	0.6013	33
470	1	1.67613903e-002	-1.110524e-002	3.85723698e-004	-6.87201085e-007	1.0439	35
469	1	2.06306989e-002	-3.138044e-002	3.51416449e-004	3.37199222e-006	0.8335	35
468	1	1.88801626e-002	-2.131457e-002	2.44166217e-004	1.62442580e-006	1.0408	69
467	1	(grouped with 468_1)					
466	2	1.77667428e-002	-1.984535e-002	5.60613233e-004	1.65827779e-006	0.6359	36
465	1	2.94787046e-002	-3.565211e-002	-1.03476807e-004	1.41489366e-006	0.9559	35
464	1	9.15391953e-003	9.192285e-003	1.00184536e-003	-1.98908186e-006	1.3125	33
463	1	2.47907819e-002	-2.831757e-002	-5.43543645e-005	1.54463977e-006	0.9193	71
462	1	(grouped with 463_1)					
461	1	3.08628069e-002	-3.628466e-002	-5.30929540e-004	1.29530211e-006	1.4283	70
460	1	(grouped with 461_1)					
459	1	2.55983334e-002	-2.454466e-002	-1.87337337e-004	2.71908668e-007	1.0392	36
458	1	2.67249510e-002	-2.519048e-002	-2.78660015e-005	-1.17734315e-007	2.0619	34
457	1	2.97323786e-002	-3.243428e-002	-1.70528579e-004	6.00385893e-007	1.3377	33
456	1	2.81231640e-002	-2.873369e-002	-1.75359249e-004	1.58534866e-007	1.6877	66
455	1	(grouped with 456_1)					
454	1	2.82130394e-002	-3.057740e-002	-5.33335444e-005	5.13770273e-007	1.2198	66
X10	1	(grouped with 454_1)					
452	1	2.21467901e-002	-1.728687e-002	4.02496008e-004	-4.13637519e-007	1.4883	96
451	1	2.26801475e-002	-1.927730e-002	4.02496008e-004	-1.94684516e-007	1.5860	96
450	1	2.25222950e-002	-2.401352e-002	4.02496008e-004	1.41703266e-006	0.8803	96
449	1	1.22912392e-002	-2.239432e-002	1.48122044e-003	1.13127369e-005	1.6334	79
448	1	(grouped with 449_1)					
447	1	(grouped with 449_1)					
446	1	(grouped with 449_1)					
445	1	(grouped with 449_1)					
444	1	(grouped with 449_1)					

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3.2 Salinity

8 February 2005

(1) Personnel

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(2) Objectives

Bottle salinities were measured in order to be compared with CTD salinities to identify leaking bottles and calibrate CTD salinities.

(3) Instrument and Method

(3.1) Salinity Sample Collection

The bottles in which the salinity samples are collected and stored are 250 ml Phoenix brown glass bottles with screw caps. Each bottle was rinsed three times with sample water and was filled to the shoulder of the bottle. The caps were also thoroughly rinsed. Salinity samples were stored for about 24 hours in the same laboratory as the salinity measurement was made.

(3.2) Instruments and Method

The salinity analysis was carried out on two sets of Guildline Autosal salinometers model 8400B (S/N 62556 and S/N 62827), which were modified by addition of an Ocean Science International peristaltic-type sample intake pump and two Guildline platinum thermometers model 9450. One thermometer monitored an ambient temperature and the other monitored a bath temperature. The resolution of the thermometers was 0.001 °C. The measurement system was almost same as Aoyama et al (2003). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 °C. An ambient temperature varied from approximately 19 °C to 23 °C, while a bath temperature is very stable and varied within +/- 0.002 °C on rare occasion. A measure of a double conductivity ratio of a sample is taken as a median of thirty-one reading. Data collection was started after 5 seconds and it took about 10 seconds to collect 31 readings by a personal computer. Data were sampled for the sixth and seventh filling of the cell. In case the difference between the double conductivity ratio of this two fillings is smaller than 0.00003, the average value of the two double conductivity ratios was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If the difference was grater than or equal to the 0.0003, we measured eighth filling of the cell. In case the double conductivity ratio of eighth filling did not satisfy the criteria above, we measured ninth and tenth filling of the cell and the median of the double conductivity ratios of five fillings are used to calculate the bottle salinity.

The measurement was conducted 16 hours per day (typically from noon to 04:00 in the next day in leg 1, from 17:00 to 04:00 in the next day in leg 2, from 8:00 to 24:00 in leg 4, from 7:00 to 23:00 in leg 5) and the cell was rinsed by pure water every day and cleaned by ethanol or soap or both almost every day after the measurement of the day.

(3.3) Preliminary Result

(i) Leg 1

Stand Seawater

Standardization control was set to 638 and all the measurements were done by this setting. During the whole measurement, the STANDBY was 6107 +/- 0001 and ZERO was 0.00000 to 0.00001. We used IAPSO Standard Seawater batch P142 whose conductivity ratio was 0.99991 (double conductivity ratio is 1.99982) as the standard for salinity. We measured 178 ampoules of P142 and the average of the double conductivity ratio was 1.99978 and the standard deviation was 0.000014, which is equivalent to 0.0003 in salinity. Figure 3.2.1 shows the history of double conductivity ratio of the Standard Seawater batch P142. Since there was no significant trend in Figure 3.2.1 and the average of the double conductivity ratio was 1.99978, we add 0.00004 to all of the measured double conductivity ratio.

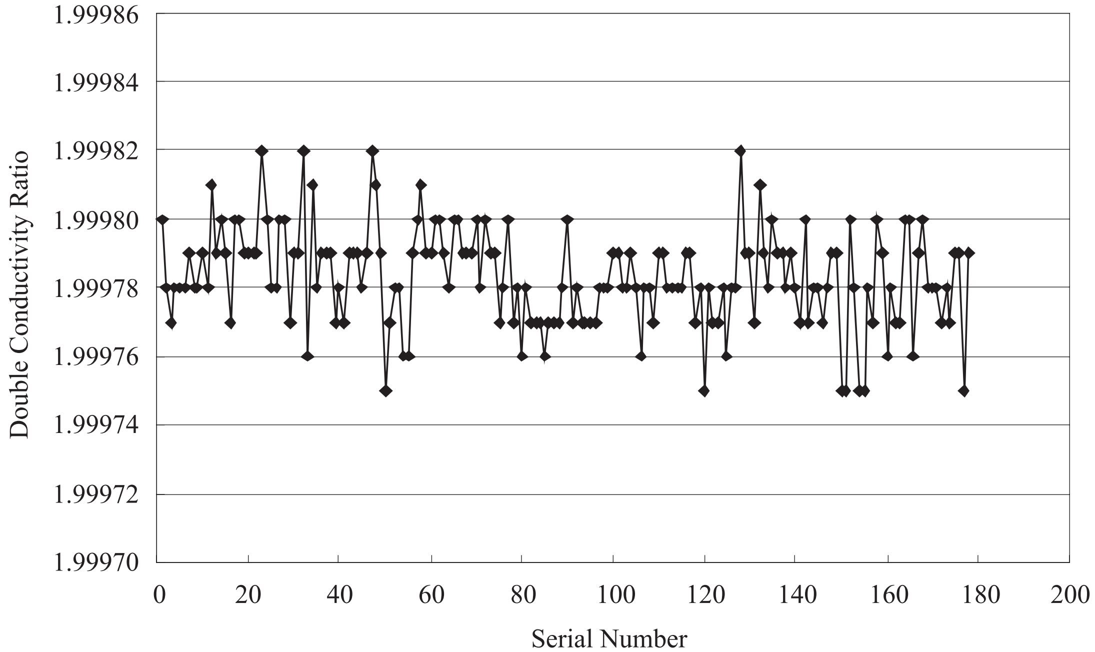

Figure 3.2.1. The history of double conductivity ratio of the Standard Seawater batch P142.

Sub-Standard Seawater

We also used sub-standard seawater which was deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter cubitainer made of polyethylene and stirred for at least 24 hours before measuring. It was measured every six samples in order to check the possible sudden drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

Replicate and Duplicate Samples

We took 692 pairs of replicate and 49 pairs of duplicate samples. Figure 3.2.2 (a) and (b) shows the histogram of the absolute difference between replicate samples and duplicate samples, respectively. There were seven bad measurements and six questionable measurements of replicate samples. As for questionable measurements, one of the pair is extremely high (more than 0.01 in salinity). This might be cause insufficient seal of the sample bottles. Excluding these bad and questionable measurements, the standard deviation of the absolute deference of 679 pairs of replicate samples was 0.0002 in salinity and that of 49 pairs of duplicate samples was 0.0003 in salinity.

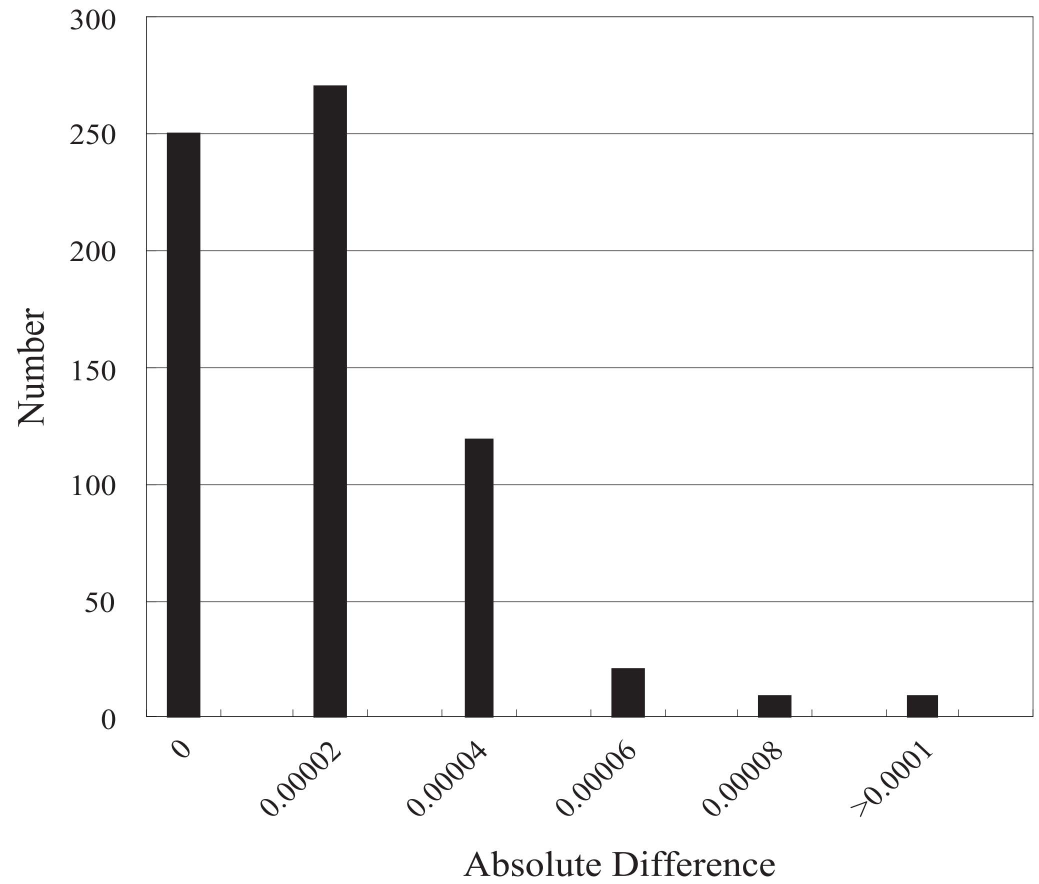

Figure 3.2.2 (a). The histogram of the absolute difference between replicate samples.

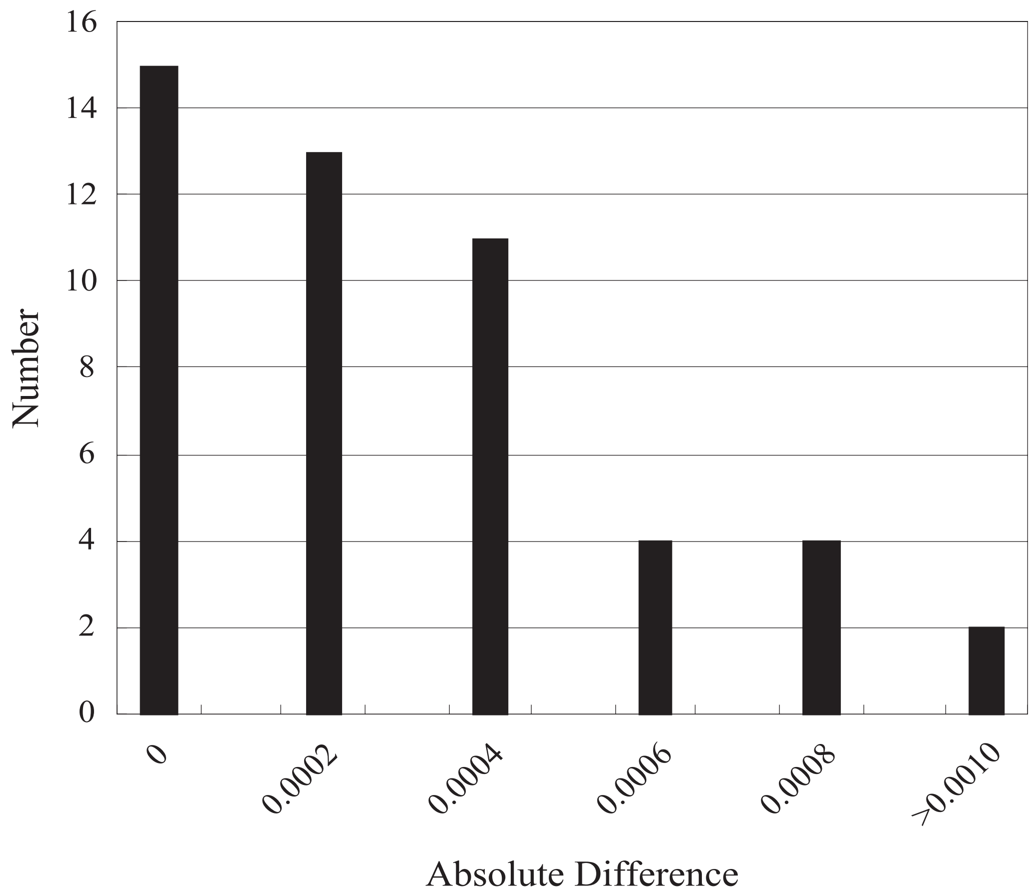

Figure 3.2.2 (b). The histogram of the absolute samples between duplicate samples.

(ii) Leg 2

Stand Seawater

Standardization control was set to 506 and all the measurements were done by this setting. During the whole measurement, the STANDBY was 6110 +/- 0001 and ZERO was -0.00001 to 0.00001. We used IAPSO Standard Seawater batch P142 which conductivity ratio was 0.99991 (double conductivity ratio is 1.99982) as the standard for salinity. We measured 157 ampoules of P142. Figure 3.2.3 shows the history of double conductivity ratio of the Standard Seawater batch P142. The values are rather scattered during the period from the beginning to the serial number 47 (from station 127 to 95). The average of double conductivity ratio was 1.99976 and the standard deviation was 0.00018, which is equivalent to 0.0004 in salinity. We add 0.00006 to the measured double conductivity ratio during this period. As mentioned above, the cell of Autosal was removed and washed thoroughly between the serial number 47 and 48 (between station 94 and 95). The measurement system became stable after washing. The average became 1.99978 and the standard deviation became 0.00001, which is equivalent to 0.0002 in salinity. We add 0.00004 to the measured double conductivity ratio after station 94.

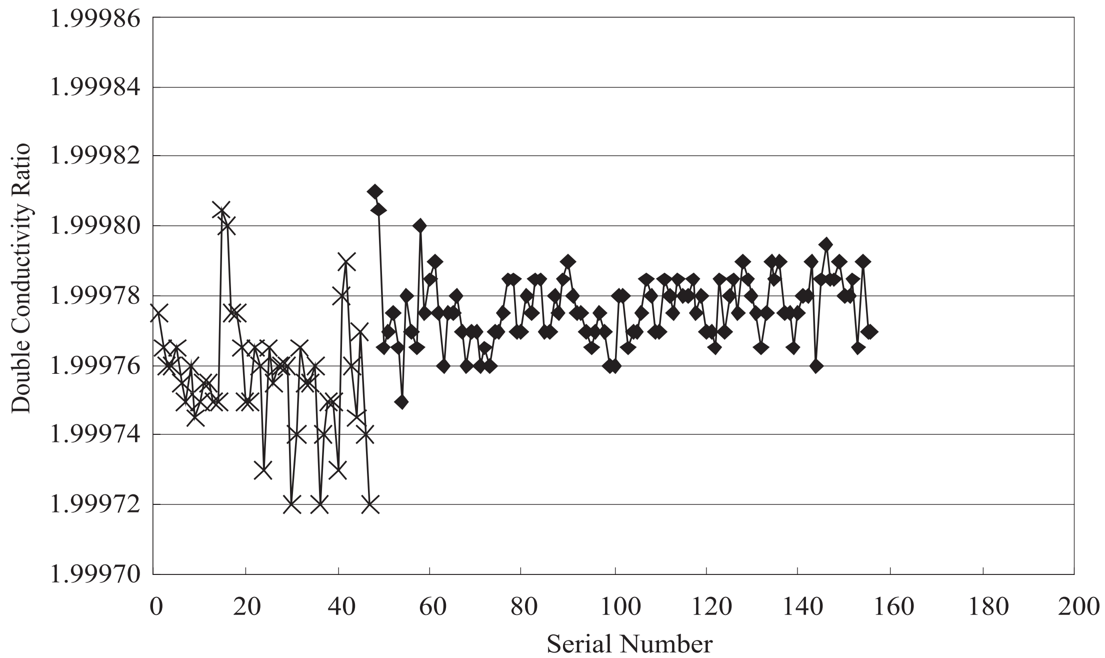

Figure 3.2.3. The history of double conductivity ratio of the Standard Seawater batch P142.

Sub-Standard Seawater

We also used sub-standard seawater which was deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter cubitainer made of polyethylene and stirred for at least 24 hours before measuring. It was measured every six samples in order to check the possible sudden drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

Replicate and Duplicate Samples

We took 685 pairs of replicate and 67 pairs of duplicate samples. Figure 3.2.4 (a) and (b) shows the histogram of the absolute difference between replicate samples and duplicate samples, respectively. There were 11 bad measurements and 7 questionable measurements of replicate samples. As for questionable measurements, one of the pairs is extremely high (more than 0.01 in salinity). This might be cause insufficient seal of the sample bottles. Excluding these bad and questionable measurements, the standard deviation of the absolute deference of 667 pairs of replicate samples was 0.0002 in salinity and that of 67 pairs of duplicate samples was 0.0003 in salinity.

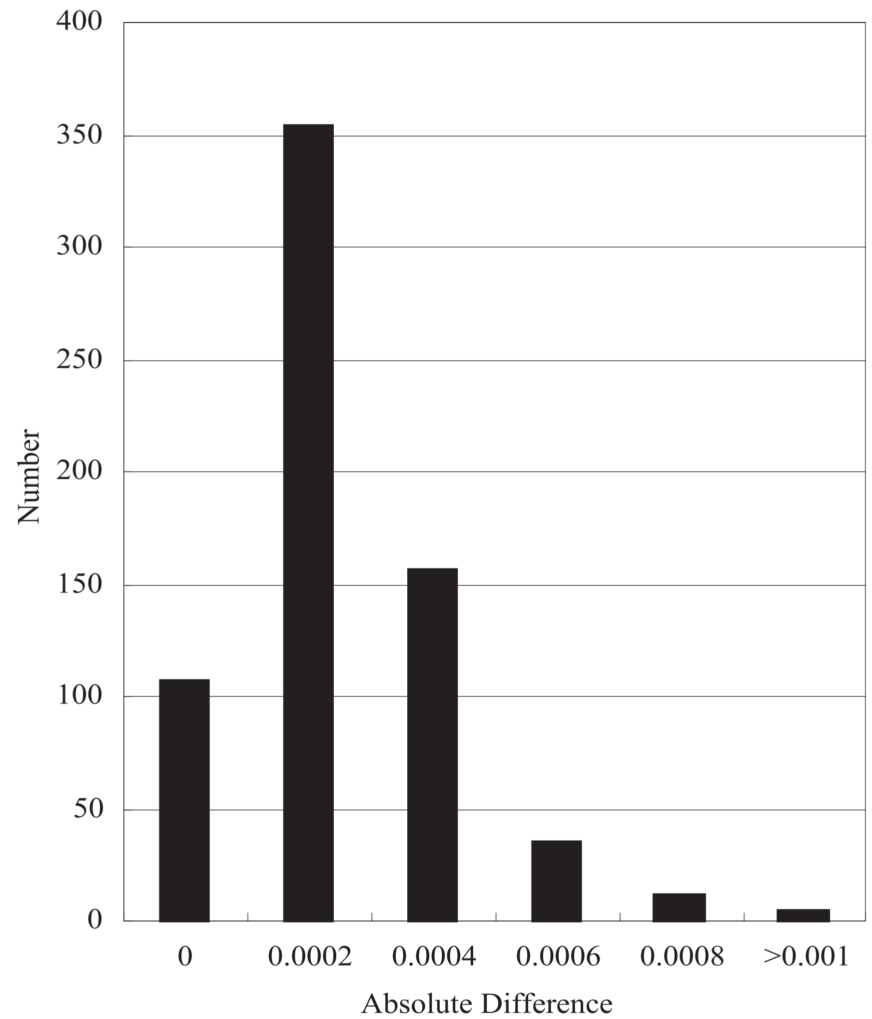

Figure 3.2.4 (a). The histogram of the absolute difference between replicate samples.

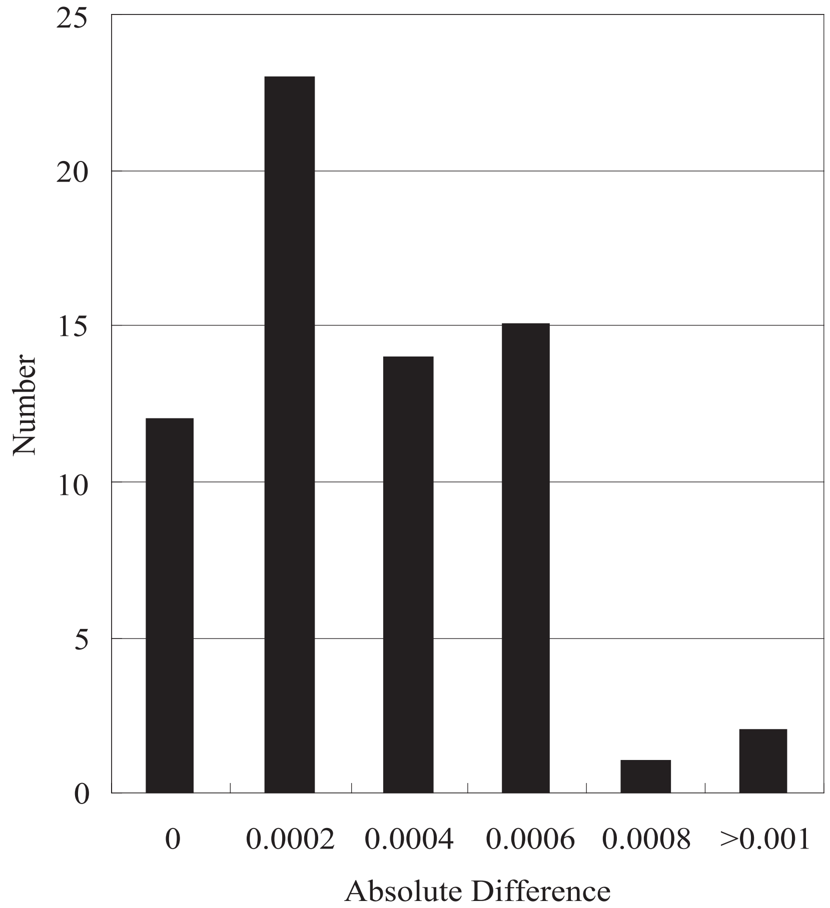

Figure 3.2.4 (b). The histogram of the absolute samples between duplicate samples.

(iii) Leg 4

Stand Seawater

Standardization control was set to 638 and all the measurements were done by this setting. During the whole measurement, the STANDBY was 6106 +/- 0001 and ZERO was 0.00000 to 0.00001. We used IAPSO Standard Seawater batch P142 whose conductivity ratio was 0.99991 (double conductivity ratio is 1.99982) as the standard for salinity. We measured 141 ampoules of P142 and the average of the double conductivity ratio was 1.99974 and the standard deviation was 0.000009, which is equivalent to 0.0002 in salinity. Figure 3.2.5 shows the history of double conductivity ratio of the Standard Seawater batch P142. Since there was no significant trend in Figure 3.2.5 and the average of the double conductivity ratio was 1.99974, we add 0.00008 to all of the measured double conductivity ratios.

Sub-Standard Seawater

We also used sub-standard seawater which was deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter cubitainer made of polyethylene and stirred for at least 24 hours before measuring. It was measured every six samples in order to check the possible sudden drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

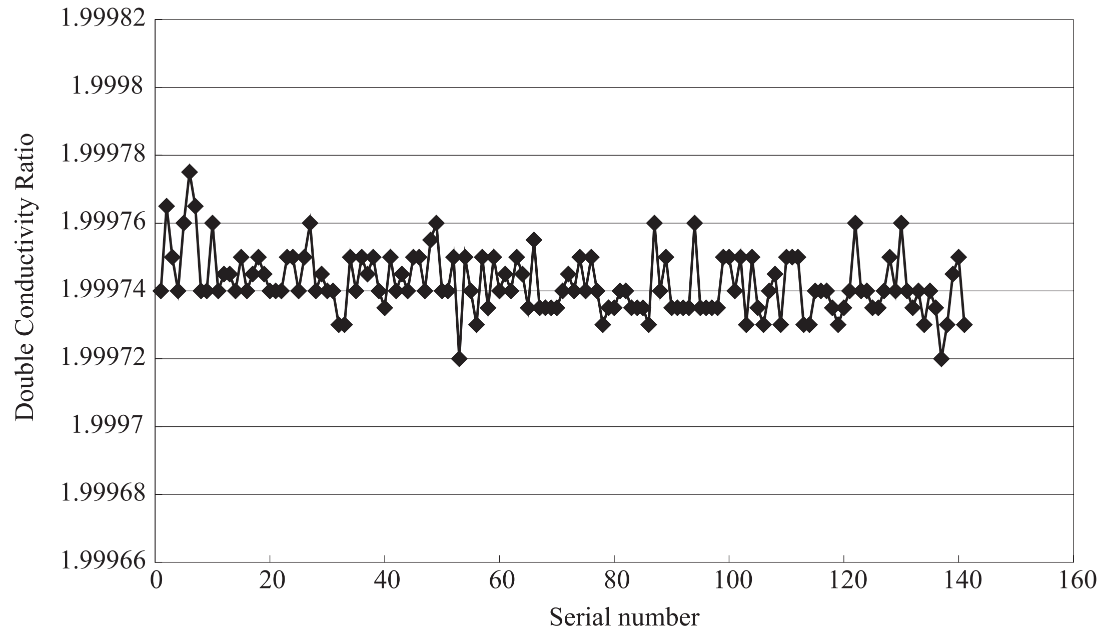

Figure 3.2.5. The history of double conductivity ratio of the Standard Seawater batch P142.

Replicate and Duplicate Samples

We took 627 pairs of replicate and 55 pairs of duplicate samples. Figure 3.2.6 (a) and (b) shows the histogram of the absolute difference between replicate samples and duplicate samples, respectively. There were one bad measurement and five questionable measurements in replicate samples and five questionable measurements in duplicate samples. As for questionable measurements, one of the pair is extremely high. This might be cause insufficient seal of the sample bottles. Excluding these bad and questionable measurements, the standard deviation of the absolute deference of 621 pairs of replicate samples was 0.0002 in salinity and that of 50 pairs of duplicate samples was 0.0003 in salinity.

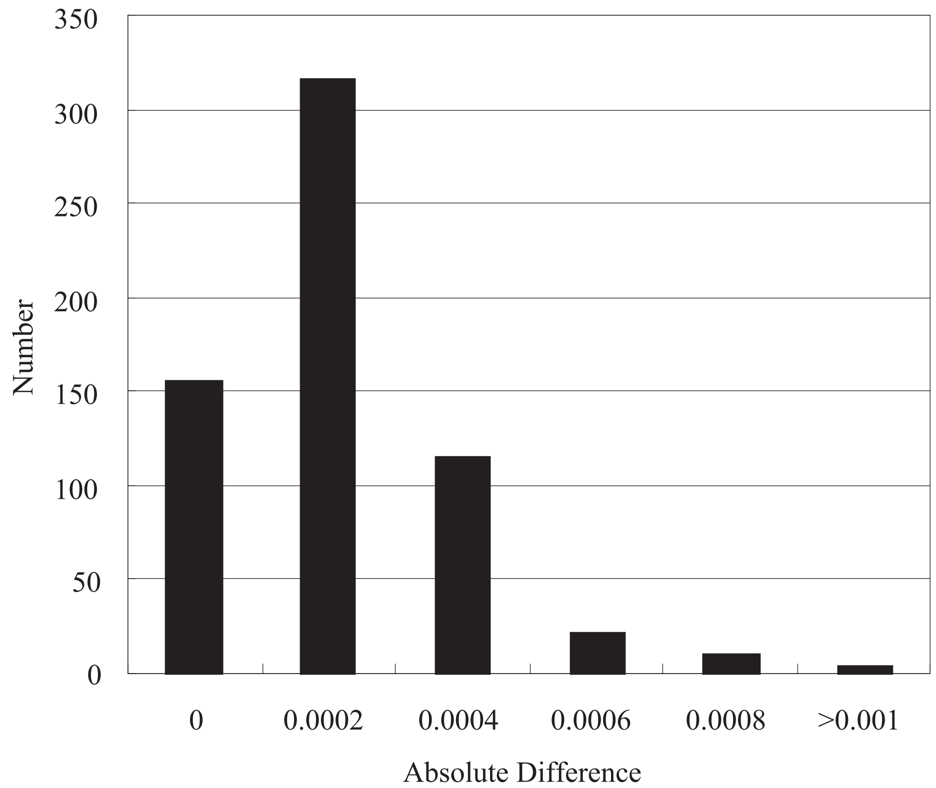

Figure 3.2.6 (a). The histogram of the absolute difference between replicate samples.

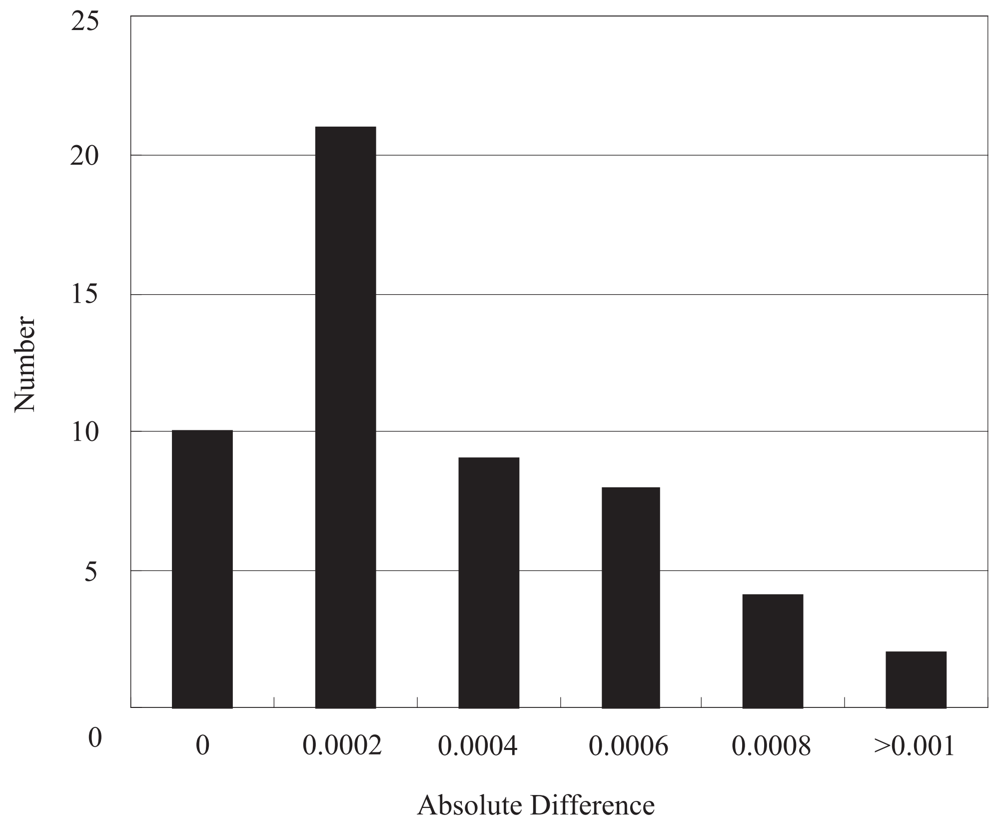

Figure 3.2.6 (b). The histogram of the absolute difference between duplicate samples.

(iv) Leg.5

Stand Seawater

Standardization control of the salinometer with serial number of 62827 and 62556 was set to 508 and 638, respectively. During the measurement, the STANDBY of 62827 was 5410 +/- 0001 and ZERO was 0.00000 to 0.00001. The STANBY of 62556 was 6107 +/- 0001 and ZERO was 0.00000 to 0.00001. We used IAPSO Standard Seawater batch P142 whose conductivity ratio was 0.99991 (double conductivity ratio is 1.99982) as the standard for salinity. We measured 194 ampoules of P142. There were 7 bad ampoules whose conductivities are extremely high. Data of these 7 ampoules is not taken into consideration hereafter.

Figure 3.2.7 shows the history of double conductivity ratio of the Standard Seawater batch P142. The average of double conductivity ratio from Stn.610 to Stn.555 was 1.99977 and the standard deviation was 0.00008, which is equivalent to 0.0002 in salinity. We add 0.00005 to the measured double conductivity ratio during this period. The average from Stn.554 to Stn.444 was 1.99974 and the standard deviation was 0.00008. We add 0.00008 to the measured double conductivity ratio during this period.

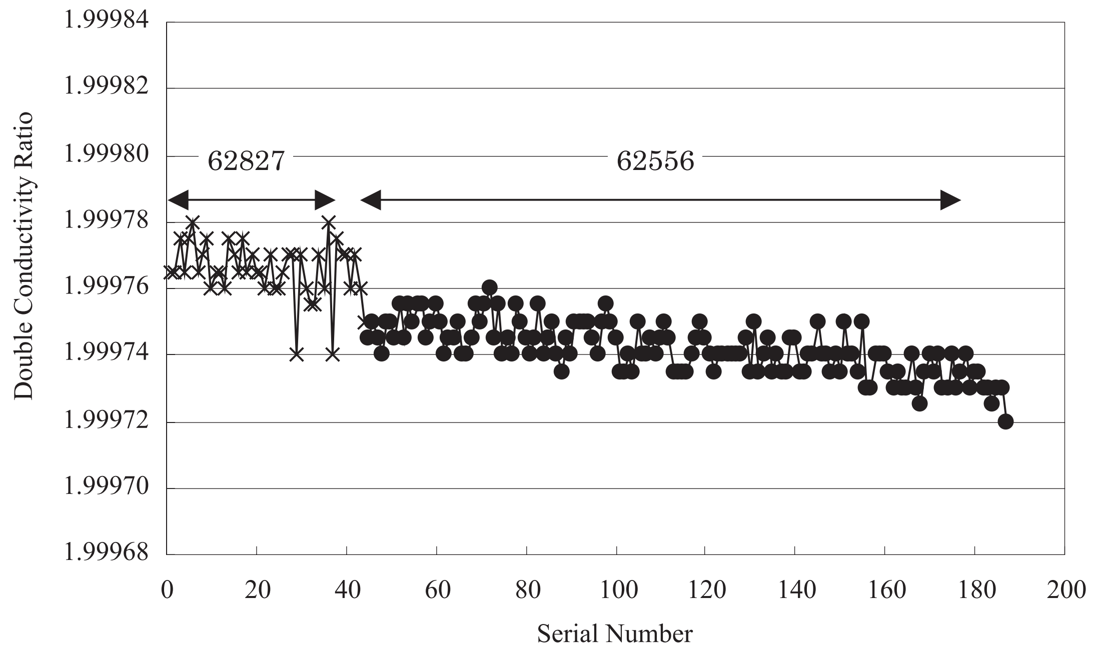

Figure 3.2.7. The history of double conductivity ratio of the Standard Seawater batch P142.

Sub-Standard Seawater

We also used sub-standard seawater which was deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter cubitainer made of polyethylene and stirred for at least 24 hours before measuring. It was measured every six samples in order to check the possible sudden drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

Replicate and Duplicate Samples

We took 830 pairs of replicate and 66 pairs of duplicate samples. Figure 3.2.8 (a) and (b) shows the histogram of the absolute difference between replicate samples and duplicate samples, respectively. There were eight bad measurements and 20 questionable measurements of replicate samples and eight questionable measurements of duplicate samples. As for questionable measurements, one of the pair is extremely high (more than 0.01 in salinity). This might be cause insufficient seal of the sample bottles. Excluding these bad and questionable measurements, the standard deviation of the absolute deference of 802 pairs of replicate samples was 0.0002 in salinity and that of 58 pairs of duplicate samples was 0.0003 in salinity.

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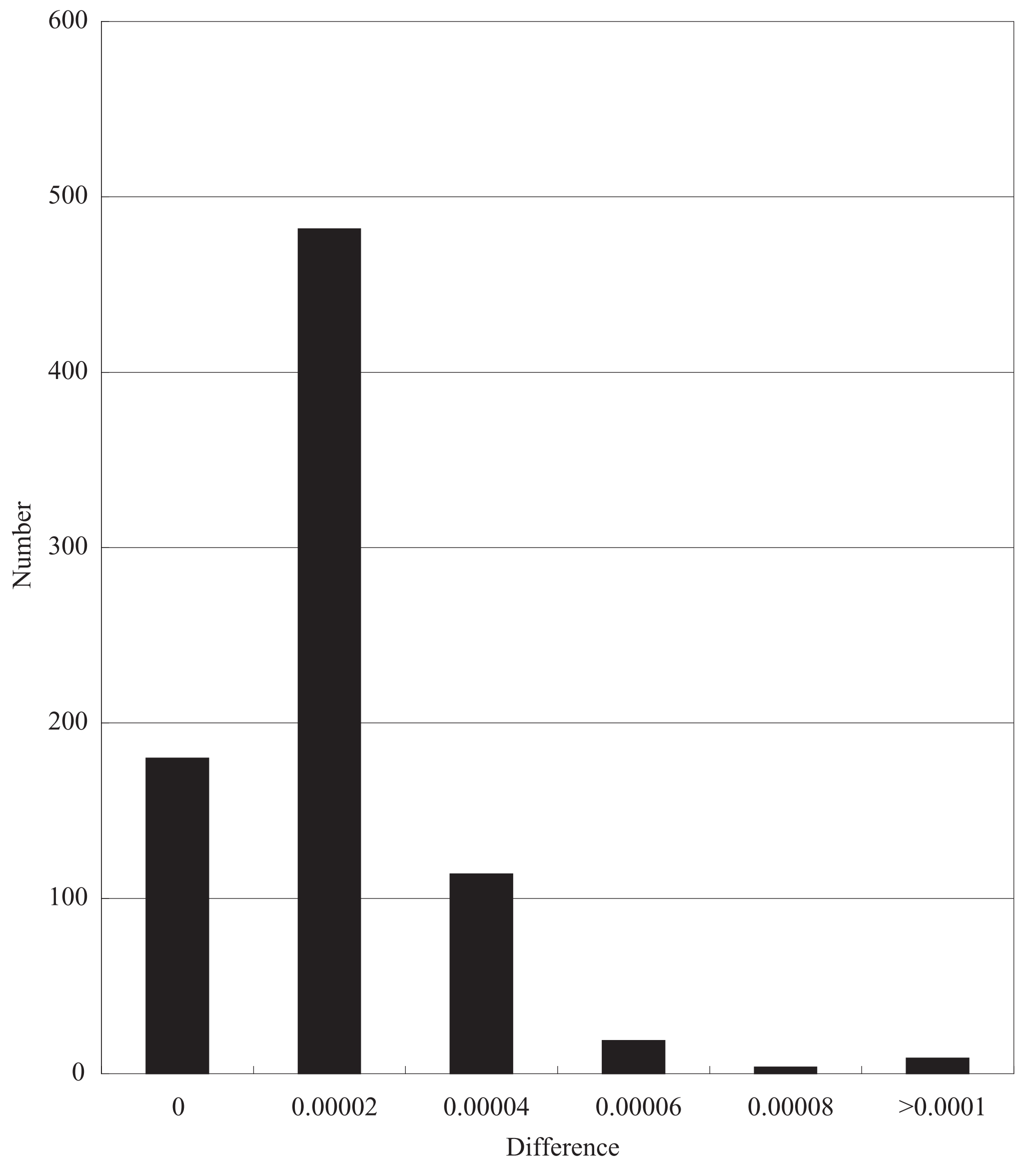

Figure 3.2.8 (a). The histogram of the absolute difference between replicate samples.

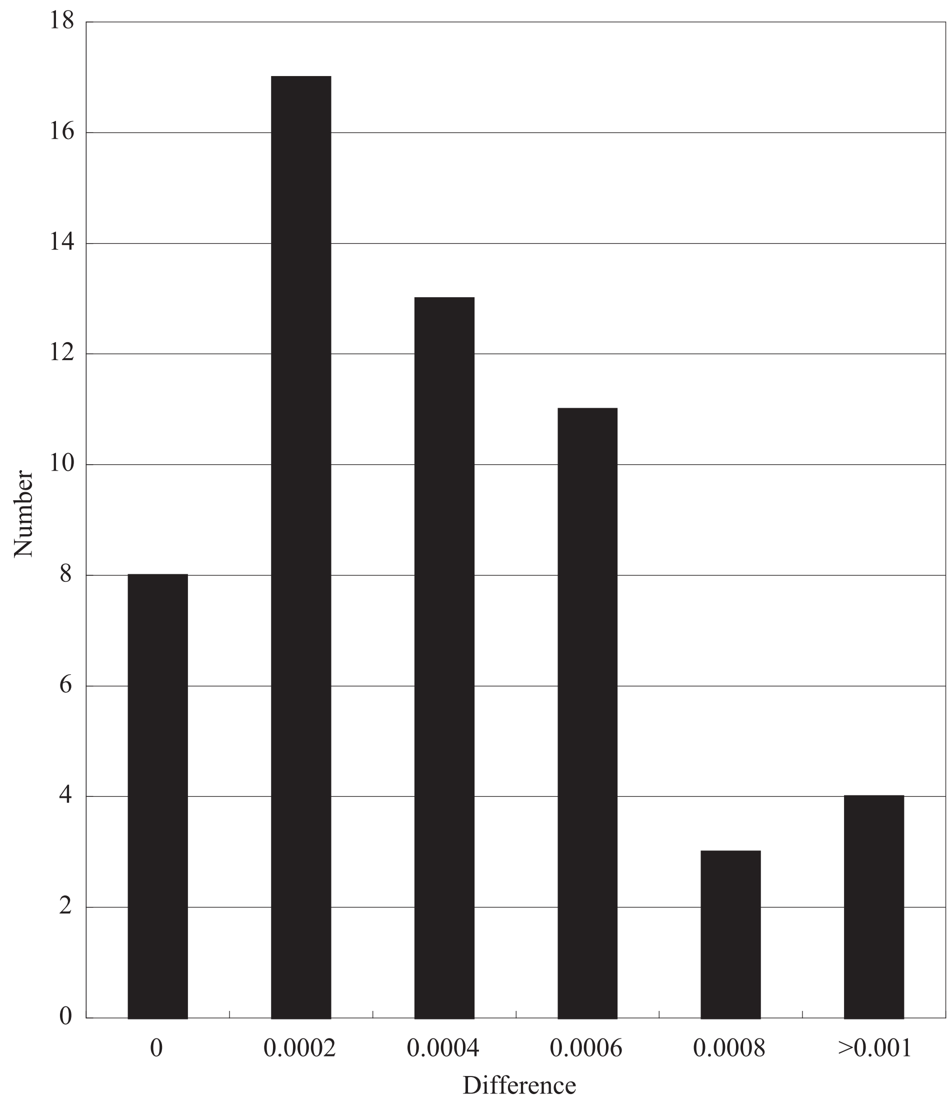

Figure 3.2.8 (b). The histogram of the absolute samples between duplicate samples.

3.3 Oxygen

28 January 2005

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(2) Objectives

Dissolved oxygen is one of the most significant tracers for the ocean circulation study. Recent studies indicated that dissolved oxygen concentration in intermediate layers changed in basin wide scale. The causes of the change, however, are still unclear. During MR03-K04, we measured dissolved oxygen concentration at all the stations along WHP P06 in the South Pacific, WHP A10 in the South Atlantic, and WHP I03 and I04 in the Indian Ocean. Our purposes are to evaluate decadal change of dissolved oxygen in the southern hemisphere.

(3) Methods

Reagents

Pickling Reagent I: Manganous chloride solution (3M)

Pickling Reagent II: Sodium hydroxide (8M) / sodium iodide solution (4M)

Sulfuric acid solution (5M)

Sodium thiosulfate (0.025M)

Potassium iodate (0.001667M)

CSK standard solution of potassium iodate: Lot TCK8677, 0.0100N, Wako Pure Chemical Industries Ltd.

Instruments

Burette for sodium thiosulfate:

APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel

Burette for potassium iodate:

APB-410 manufactured by Kyoto Electronic Co. Ltd. / 20 cm^3 of titration vessel

Detector and Software: Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

Sampling

Following procedure is based on the WHP Operations and Methods (Dickson, 1996). Seawater samples were collected with Niskin bottle attached to the CTD-system. Seawater for oxygen measurement was transferred from Niskin sampler bottle to a volume calibrated flask (ca. 100 cm^3). Three times volume of the flask of seawater was overflowed. Temperature was measured by digital thermometer during the overflowing. Then two reagent solutions (Reagent I, II) of 0.5 cm^3 each were added immediately into the sample flask and the stopper was inserted carefully into the flask. The sample flask was then shaken vigorously to mix the contents and to disperse the precipitate finely throughout. After the precipitate has settled at least halfway down the flask, the flask was shaken again vigorously to disperse the precipitate. The sample flasks containing pickled samples were stored in a laboratory until they were titrated.

Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose molarity was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise we measured dissolved oxygen concentration using two sets of the titration apparatus (DOT-1 and DOT-2). Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sample, and titrated volume of sodium thiosulfate solution.

Standardization

Concentration of sodium thiosulfate titrant (ca. 0.025M) was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130 °C. 1.7835 g potassium iodate weighed out accurately was dissolved in deionized water and diluted to final volume of 5 dm^3 in a calibrated volumetric flask (0.001667M). 10 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 90 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Amount of sodium thiosulfate titrated gave the molarity of sodium thiosulfate titrant.

Table 3.3.1, 3.3.2, 3.3.3, and 3.3.4 show result of the standardization during leg 1, 2, 4, and 5, respectively. Reproducibility (C.V.) of each standardization was less than 0.1 % (n = 5). Moreover a series of the standardizations using same sodium thiosulfate also gave errors (C.V.) less than 0.1 %.

Determination of the blank

The oxygen in the pickling reagents I (0.5 cm^3) and II (0.5 cm^3) was assumed to be 3.8 x 10^{-8} mol (Dickson, 1996). The blank from the presence of redox species apart from oxygen in the reagents was determined as follows. 1 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Just after titration of the first potassium iodate, a further 1 cm^3 of standard potassium iodate was added and titrated. The blank was determined by difference between the first and second titrated volumes of the sodium thiosulfate.

The results are shown in Table 1, 2, 3, and 4. The blank was ranged from -0.012 to 0.003 cm^3 (c.a. -0.7 ~ 0.2 μmol/kg). Most of them are negative, implying that there are deoxidizers in the reagents. We also found that the blank of DOT-2 is systematically larger than that of DOT-1 by about 0.003 cm^3 (c.a. 0.2 μmol/kg). Because we could not explain the deoxidizers in the reagents and the systematic difference between DOT-1 and DOT-2, we assumed that the reagent blank due to redox species was negligible.

Table 3.3.1. Results of the standardization and the blank determinations during MR03-K04 leg 1.

Date	Time	KIO_3		DOT-1 (cm^3)			DOT-2 (cm^3)			Samples
(UTC)	(UTC)	#	bottle	$Na_2S_2O_3$	E.P.	blank	$Na_2S_2O_3$	E.P.	blank	(Stations)
08-03-03	18:44		030414-31	030411-7	3.969	-0.004	030411-8	3.969	-0.003	246,245,244
08-04-03	09:43		030414-32	030411-7	3.967	-0.008	030411-8	3.967	-0.002	243,242
08-04-03	15:57		030414-33	030411-7	3.964	-0.005	030411-8	3.968	-0.003	241
08-04-03	22:38		030414-34	030804-1	3.971	-0.006	030804-2	3.968	-0.006	240
08-05-03	05:09		030414-35	030804-1	3.968	-0.003	030804-2	3.966	-0.004	239
08-05-03	11:07	1	030414-36	030804-1	3.968	-0.003	030804-2	3.968	-0.003	238
08-05-03	16:53		030414-37	030804-1	3.966	-0.005	030804-2	3.968	-0.005	237
08-05-03	21:18		030414-38	030804-1	3.965	-0.005	030804-2	3.970	-0.004	X11
08-06-03	02:44		030414-39	030804-1	3.965	-0.002	030804-2	3.968	-0.005	235
08-06-03	09:50		030414-40	030804-3	3.970	-0.003	030804-4	3.971	-0.004	234,232
08-06-03	18:02		030414-41	030804-3	3.970	-0.005	030804-4	3.969	-0.005	231,230

08-06-03	23:48	1	030414-42	030804-3	3.967	-0.005	030804-4	3.969	-0.003	229,228
08-07-03	05:04		030414-43	030804-3	3.962	-0.006	030804-4	3.965	-0.004	227,226
08-07-03	14:14		030415-1	030804-5	3.968	-0.003	030807-1	3.958	-0.004	225,224,223
08-07-03	23:10		030415-2	030804-5	3.968	-0.008	030807-1	3.957	-0.005	222,221,220
08-08-03	07:11		030415-3	030804-5	3.965	-0.004	030807-1	3.957	-0.005	219,218
08-08-03	16:21		030415-4	030804-5	3.963	-0.007	030807-1	3.956	-0.005	217,216
08-09-03	01:30		030415-5	030804-5	3.963	-0.007	030807-1	3.951	-0.003	216
08-09-03	05:17	2	030415-6	030807-2	3.957	-0.006	030807-3	3.958	-0.004	215,214,213
08-10-03	13:48		030415-7	030807-2	3.954	-0.006	030807-3	3.956	-0.005	212,211
08-11-03	02:49		030415-8	030807-2	3.953	-0.005	030807-3	3.950	-0.003	210
08-11-03	06:31		030415-9	030807-2	3.953	-0.005	030807-3	3.951	-0.003	209,208
08-11-03	15:28		030415-10	030807-2	3.954	-0.007	030807-3	3.953	-0.003	207
08-11-03	21:44		030415-11	030807-4	3.957	-0.006	030807-5	3.959	-0.003	206,205
08-12-03	04:55		030415-12	030807-4	3.957	-0.008	030807-5	3.956	-0.002	204,203
08-12-03	12:36		030415-13	030807-4	3.954	-0.007	030807-5	3.955	-0.003	202,201
08-12-03	22:14		030415-16	030810-1	3.960	-0.008	030810-2	3.961	-0.003	200,199
08-13-03	04:12		030415-17	030810-1	3.959	-0.007	030810-2	3.958	-0.004	198,197
08-13-03	12:43		030415-18	030810-1	3.958	-0.007	030810-2	3.958	-0.002	196,195
08-13-03	23:12		030415-19	030810-1	3.958	-0.007	030810-2	3.959	-0.003	194,X14
08-14-03	12:08	3	030415-20	030810-3	3.961	-0.005	030810-4	3.961	-0.002	192,191
08-15-03	00:50		030415-21	030810-3	3.960	-0.007	030810-4	3.959	-0.002	190,186
08-15-03	10:32		030415-22	030810-3	3.960	-0.006	030810-4	3.959	-0.001	185,184
08-15-03	19:00		030415-23	030810-3	3.961	-0.006	030810-4	3.959	-0.002	183,182
08-16-03	05:06		030415-24	030810-5	3.963	-0.002	030815-1	3.960	-0.002	181,180

08-16-03	11:14		030415-25	030810-5	3.960	-0.006	030815-1	3.957	-0.002	179,178
08-17-03	23:02	3	030415-26	030810-5	3.960	-0.007	030815-1	3.953	0.001	177
08-18-03	04:19		030415-27	030810-5	3.960	-0.004	030815-1	3.951	-0.003	176
08-18-03	12:31		030415-31	030815-2	3.959	-0.007	030815-3	3.959	-0.003	175
08-18-03	17:45		030415-32	030815-2	3.960	-0.005	030815-3	3.955	-0.001	174
08-19-03	03:37		030415-33	030815-2	3.958	-0.006	030815-3	3.958	-0.001	173,172
08-19-03	18:00		030415-34	030815-2	3.958	-0.005	030815-3	3.958	-0.001	171
08-20-03	11:12	4	030415-36	030815-4	3.958	-0.005	030815-5	3.959	-0.002	170,169,168,167
08-20-03	21:21		030415-37	030815-4	3.960	-0.006	030815-5	3.960	0.001	166-1,2
08-21-03	03:54		030815-38	030815-4	3.960	-0.004	030815-5	3.959	0.001	165
08-21-03	12:46		030415-39	030819-1	3.960	-0.006	030819-2	3.961	0.000	164,163,162
08-22-03	03:43		030415-41	030819-1	3.957	-0.008	030819-2	3.958	-0.001	161,160
08-22-03	13:35		030415-42	030819-1	3.958	-0.008	030819-2	3.960	-0.001	159
08-22-03	19:24		030415-43	030819-1	3.959	-0.008	030819-2	3.958	-0.001	158
08-23-03	05:01		030417-1	030819-3	3.960	-0.006	030819-4	3.961	0.000	X15,156
08-23-03	12:01		030417-2	030819-3	3.961	-0.005	030819-4	3.961	0.000	155,154
08-24-03	23:08		030417-3	030819-3	3.960	-0.006	030819-4	3.961	0.001	153,152
08-24-03	09:21		030417-4	030819-3	3.959	-0.006	030819-4	3.960	0.001	151
08-24-03	17:22	5	030417-5	030819-5	3.959	-0.008	030823-1	3.960	0.002	150,149
08-26-03	05:30		030417-6	030819-5	3.959	-0.007	030823-1	3.959	-0.002	148
08-26-03	16:05		030417-7	030819-5	3.957	-0.006	030823-1	3.959	0.000	147
08-26-03	22:48		030417-8	030819-5	3.958	-0.006	030823-1	3.960	0.000	146
08-27-03	05:13		030417-9	030819-5	3.957	-0.005	030823-1	3.956	0.002	145
08-27-03	12:49		030417-10	030823-2	3.959	-0.007	030823-3	3.957	-0.005	144,143

08-27-03	23:51		030417-11	030823-2	3.959	-0.007	030823-3	3.960	-0.004	142
08-28-03	04:50	5	030417-12	030823-2	3.959	-0.006	030823-3	3.958	-0.006	140
08-28-03	10:06		030417-13	030823-2	3.958	-0.004	030823-3	3.957	-0.004	139,138
08-28-03	02:25		030417-16	030823-4	3.961	-0.005	030823-5	3.962	-0.002	137,136
08-29-03	11:54		030417-17	030823-4	3.959	-0.005	030823-5	3.960	-0.003	135
08-29-03	19:00		030417-18	030823-4	3.961	-0.008	030823-5	3.963	0.001	134,133
08-30-03	06:30		030417-19	030823-4	3.959	-0.006	030823-5	3.960	-0.001	132,131
08-30-03	21:51		030417-20	030828-1	3.960	-0.005	030828-2	3.962	-0.003	130,129
08-31-03	07:44	6	030417-21	030828-1	3.960	-0.006	030828-2	3.963	-0.001	X16
08-31-03	15:51		030417-22	030828-1	3.961	-0.005	030828-2	3.962	-0.001	127
08-31-03	22:59		030417-23	030828-1	3.961	-0.005	030828-2	3.963	-0.001	126
09-01-03	04:50		030417-24	030828-1	3.962	-0.005	030828-2	3.963	-0.001	125
09-01-03	11:54		030417-25	030828-3	3.958	-0.007	030828-4	3.961	-0.002	124,123
09-02-03	00:17		030417-26	030828-3	3.959	-0.007	030828-4	3.962	0.000	122
09-02-03	06:12		030417-27	030828-3	3.958	-0.007	030828-4	3.958	-0.002	121

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Table 3.3.2. Results of the standardization and the blank determinations during MR03-K04 leg 2.

Date	Time	KIO_3		DOT-1 (cm^3)			DOT-2 (cm^3)			Samples
(UTC)	(UTC)	#	bottle	$Na_2S_2O_3$	E.P.	blank	$Na_2S_2O_3$	E.P.	blank	(Stations)
09-12-03	05:11		030417-31	030828-4	3.960	-0.006	030828-5	3.962	-0.001	127,125
09-13-03	12:38		030417-32	030910-1	3.961	-0.006	030910-2	3.964	0.000	120,119
09-14-03	11:22		030417-33	030910-1	3.959	-0.006	030910-2	3.963	0.000	118,117,116
09-15-03	07:24		030417-45	030910-3	3.961	-0.004	030910-4	3.963	0.001	115,114,113
09-15-03	20:23	7	030417-34	030910-3	3.961	-0.005	030910-4	3.963	0.001	112,111,110
09-16-03	16:05		030417-35	030910-5	3.962	-0.005	030910-6	3.961	0.002	109,108,X17
09-17-03	10:15		030417-36	030910-5	3.959	-0.004	030910-5	3.962	0.002	106,105,104
09-18-03	08:31		030417-37	030916-1	3.961	-0.004	030916-2	3.965	0.001	103,102,101
09-18-03	23:02		030417-38	030916-1	3.961	-0.005	030916-2	3.963	0.000	100,099,098
09-19-03	17:34		030417-39	030916-3	3.962	-0.005	030916-4	3.965	-0.002	097,096,095,094
09-21-03	03:48		030418-1	030916-6	3.966	-0.005	030916-7	3.970	0.002	093,092,091
09-21-03	21:40		030418-2	030916-6	3.966	-0.005	030916-7	3.968	-0.001	090,089,088,087
09-22-03	18:21		030418-3	030916-6	3.965	-0.004	030916-7	3.965	-0.001	086,085,084
09-23-03	11:27		030418-4	030921-1	3.966	-0.004	030921-2	3.968	-0.001	083,082,081
09-24-03	05:36	8	030418-5	030921-1	3.964	-0.005	030921-2	3.969	0.001	080,079,078,077
09-25-03	07:20		030418-6	030921-3	3.965	-0.004	030921-4	3.968	0.002	076,075,072,071
09-25-03	19:31		030418-7	030921-3	3.962	-0.003	030921-4	3.963	0.002	070,069,068,067
09-26-03	18:45		030418-9	030921-6	3.964	-0.005	030921-7	3.970	-0.001	066,065,064
09-27-03	13:12		030418-10	030921-6	3.968	-0.004	030921-7	3.971	0.001	063,062,061,060
09-28-03	12:29		030418-11	030925-1	3.967	-0.004	030925-2	3.969	0.000	059,X18,056
09-29-03	10:52		030418-12	030925-1	3.964	-0.005	030925-2	3.969	-0.001	055

09-30-03	16:58	9	030418-16	030925-1	3.961	-	030925-2	3.967	-	054,053
10-01-03	05:09		030418-17	030925-3	3.964	-0.004	030925-4	3.970	0.000	052,051,050
10-01-03	18:34		030418-18	030925-3	3.967	-0.003	030925-4	3.967	0.000	049,048,047
10-02-03	11:46		030418-19	030925-6	3.963	-0.006	030925-7	3.968	0.000	046,045,044
10-03-03	03:43		030418-20	030925-6	3.964	-0.005	030925-7	3.970	0.003	043,042,041
10-03-03	19:06		030418-21	030930-1	3.963	-0.005	030930-2	3.968	0.002	040,039,038
10-04-03	10:37		030418-22	030930-1	3.963	-0.003	030930-2	3.965	-0.001	037,036,X19
10-05-03	06:03		030418-23	030930-3	3.964	-0.003	030930-4	3.970	-0.001	034,033,032
10-05-03	18:54		030418-24	030930-3	3.961	-0.003	030930-4	3.964	-0.002	031,030,029
10-06-03	12:07		030418-25	030930-6	3.964	-0.005	030930-7	3.966	-0.001	028,027,026
10-07-03	05:19		030418-26	030930-6	3.965	-0.005	030930-7	3.967	0.003	025,024
10-08-03	13:45	10	030418-32	031005-1	3.966	-0.005	031005-2	3.971	0.001	023,022,021
10-09-03	08:02		030418-33	031005-1	3.968	-0.004	031005-2	3.969	0.000	020,019,018
10-10-03	01:15		030418-34	031005-3	3.965	-0.006	031005-4	3.969	-0.001	017,016,015
10-10-03	15:13		030418-35	031005-3	3.966	-0.006	031005-4	3.970	0.000	014,013,012
10-11-03	09:23		030418-36	031005-6	3.966	-0.005	031005-7	3.969	-0.001	011,010,009
10-11-03	23:31		030418-37	031005-6	3.966	-0.003	031005-7	3.970	0.002	008,007,006,005,004

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Table 3.3.3. Results of the standardization and the blank determinations during MR03-K04 leg 4.

Date	Time	KIO_3		DOT-1 (cm^3)			DOT-2 (cm^3)			Samples
(UTC)	(UTC)	#	bottle	$Na_2S_2O_3$	E.P.	blank	$Na_2S_2O_3$	E.P.	blank	(Stations)
11-07-03	06:09	11	030418-47	031010-2	3.961	-0.005	031010-3	3.956	-0.007	622,623,624,625
11-07-03	23:26		030418-48	031010-2	3.960	-0.005	031010-3	3.957	-0.003	626,627,628
11-08-03	16:33		030418-49	031010-4	3.964	-0.005	031010-5	3.963	-0.004	629,630,631
11-09-03	00:46		030418-50	031010-4	3.965	-0.006	031010-5	3.964	-0.003	632,001,002
11-09-03	14:35		030418-51	031108-1	3.965	-0.005	031108-2	3.964	-0.004	003,004,005
11-10-03	08:15		030418-52	031108-1	3.963	-0.004	031108-2	3.963	-0.004	006,007,008
11-10-03	23:27		030418-53	031108-3	3.964	-0.006	031108-4	3.962	-0.005	009,010,011
11-11-03	14:49		030418-54	031108-3	3.962	-0.004	031108-4	3.960	-0.004	X17,013,014
11-12-03	05:04		030418-55	031108-5	3.963	-0.011	031111-1	3.959	-0.004	015,016,X.23, 018,019
11-12-03	21:01		030418-56	031108-5	3.964	-0.006	031111-1	3.959	-0.005	020,021,022,023,024
11-13-03	15:35		030418-57	031111-2	3.964	-0.005	031111-3	3.961	-0.010	025,026,027
11-14-03	04:13		030418-58	031111-2	3.963	-0.004	031111-3	3.961	-0.004	028,029,030
11-14-03	21:52	12	030418-61	031111-4	3.962	-0.006	031111-5	3.959	-0.004	031,032,033
11-15-03	15:48		030418-63	031111-4	3.959	-0.006	031111-5	3.958	-0.004	some samples of 031
11-16-03	07:14		030418-64	031111-4	3.958	-0.008	031111-5	3.954	-0.005	034,035,036
11-16-03	01:21		030418-65	031115-1	3.957	-0.008	031115-2	3.957	-0.004	037,038,039
11-17-03	18:47		030418-66	031115-1	3.956	-0.006	031115-2	3.957	-0.004	X16,041,042
11-18-03	18:16		030418-67	031115-3	3.960	-0.007	031115-4	3.959	-0.003	043,044,045
11-19-03	10:36		030418-68	031115-3	3.959	-0.006	031115-4	3.958	-0.003	046,X15,048
11-20-03	08:01		030418-69	031115-5	3.960	-0.006	031119-1	3.956	-0.004	049,050,051
11-20-03	22:47		030418-70	031115-5	3.950	-0.007	031119-1	3.948	-0.004	052,053,054
11-21-03	14:43		030418-71	031119-2	3.957	-0.006	031119-3	3.954	-0.004	055,056,057,058
11-22-03	10:19		030418-72	031119-2	3.953	-0.009	031119-3	3.952	-0.007	059,060,061
11-23-03	23:49		030418-75	031119-4	3.956	-0.010	031119-5	3.955	-0.007	X14,063,064,065,066 067

11-25-03	10:00		030418-76	031125-1	3.963	-0.009	031125-2	3.961	-0.007	068,069,070
11-26-03	07:54		030418-77	031125-1	3.959	-0.009	031125-2	3.957	-0.006	071,072,073
11-27-03	04:47		030418-78	031125-3	3.958	-0.008	031125-4	3.959	-0.006	074,075,076
11-27-03	17:17		030418-79	031125-3	3.958	-0.011	031125-4	3.959	-0.006	077,078,079
11-28-03	10:24	13	030418-80	031125-5	3.957	-0.010	031128-1	3.959	-0.007	080,081,082
11-29-03	01:19		030418-81	031125-5	3.955	-0.010	031128-1	3.959	-0.006	083,084,085
11-30-03	01:21		030418-82	031128-2	3.961	-0.011	031128-3	3.960	-0.004	086,087,X13
11-30-03	18:09		030418-83	031128-2	3.958	-0.009	031128-3	3.960	-0.006	089,090,091
12-01-03	19:56		030418-84	031128-4	3.960	-0.011	031128-5	3.963	-0.004	092,093,094
12-02-03	06:02		030418-85	031128-4	3.962	-0.008	031128-5	3.962	-0.005	095,096,097,098,099 100

#: Batch number of the KIO_3 standard series.

Table 3.3.4. Results of the standardization and the blank determinations during MR03-K04 leg 5.

Date (UTC)	Time (UTC)	KIO_3		DOT-1			DOT-2			Stations
		#	bottle	$Na_2S_2O_3$	E.P.	Blank	$Na_2S_2O_3$	E.P.	Blank	
12-13-03	02:32		030418-91	031209-1	3.961	-0.008	031209-2	3.962	-0.006	610,609,608,607,606 605
12-14-03	01:07		030418-92	031209-1	3.957	-0.009	031209-2	3.959	-0.007	604,603,602
12-14-03	12:06		030418-93	031209-6	3.959	-0.012	031209-7	3.960	-0.008	601,600,599
12-15-03	01:14		030418-94	031209-6	3.960	-0.011	031209-7	3.961	-0.008	598,597,596
12-16-03	00:43	14	030418-96	031209-6	3.958	-0.008	031209-7	3.959	-0.008	595,594
12-16-03	01:59		030418-96	031209-4	3.955	-0.011	031209-5	3.959	-0.010	593,592,591
12-16-03	15:28		030418-97	031209-4	3.957	-0.012	031209-5	3.960	-0.007	590,589,588
12-17-03	05:40		030418-98	031209-4	3.959	-0.011	031209-5	3.960	-0.008	587,586,585
12-19-03	05:30		030418-100	031215-1	3.957	-0.011	031215-2	3.959	-0.008	562,561,560,559
12-20-03	22:34		030418-102	031215-1	3.953	-0.011	031215-2	3.955	-0.009	558,557,556
12-21-03	18:52		030418-106	031215-3	3.955	-0.012	031215-4	3.956	-0.008	555,554,553
12-22-03	06:22		030418-107	031215-3	3.958	-0.012	031215-4	3.958	-0.009	552,551,550
12-23-03	02:12		030418-108	031215-5	3.956	-0.012	031221-1	3.955	-0.008	549,X07,547
12-23-03	17:53		030418-109	031215-5	3.958	-0.011	031221-1	3.955	-0.009	546,545,544
12-24-03	10:01	15	030418-110	031221-2	3.955	-0.011	031221-3	3.957	-0.007	543,542,541,540
12-24-03	23:05		030418-111	031221-2	3.956	-0.011	031221-3	3.957	-0.007	539,538,537,536
12-25-03	21:06		030418-112	031221-4	3.956	-0.011	031221-5	3.956	-0.009	535,534,533
12-28-03	01:07		030418-114	031221-4	3.955	-0.010	031221-5	3.957	-0.008	532,531,530
12-28-03	22:01		030418-115	031224-1	3.953	-0.009	031224-2	3.954	-0.010	529,528,527
12-29-03	09:07		030418-116	031224-1	3.955	-0.011	031224-2	3.955	-0.008	526,525,524,523

12-30-03	01:45	15	030418-117	031224-3	3.956	-0.009	031224-4	3.957	-0.008	522,521,520
12-30-03	16:51		030418-118	031224-3	3.954	-0.009	031224-4	3.956	-0.008	519,518,517
12-31-03	05:55	16	030418-121	031224-5	3.957	-0.012	031229-1	3.961	-0.008	516,515,514
01-01-04	15:35		030418-123	031224-5	3.954	-0.009	031229-1	3.958	-0.007	513,512,511
01-02-04	09:30		030418-124	031229-2	3.961	-0.009	031229-3	3.961	-0.007	510,509,508
01-03-04	23:45		030418-125	031229-2	3.960	-0.009	031229-3	3.959	-0.008	507,506,505
01-03-04	21:41		030418-126	031229-4	3.958	-0.010	031229-5	3.958	-0.008	504,503,502
01-04-04	17:47		030418-127	031229-4	3.959	-0.009	031229-5	3.958	-0.009	501,500,X08
01-05-04	10:36		030418-128	031229-6	3.956	-0.008	040102-1	3.958	-0.007	498,497,496
01-06-04	04:57		030418-129	031229-6	3.958	-0.009	040102-1	3.958	-0.008	495,494,493
01-07-04	01:09		030418-130	040102-2	3.960	-0.010	040102-3	3.959	-0.008	492,491,490,489
01-08-04	19:31	17	030418-136	040102-2	3.961	-0.009	040102-3	3.961	-0.007	488,487,486,485
01-09-04	16:37		030418-137	040102-4	3.961	-0.009	040102-5	3.960	-0.008	484,483,482
01-10-04	04:46		030418-138	040102-4	3.959	-0.010	040102-5	3.959	-0.008	481,480,479
01-11-04	00:24		030418-139	040108-1	3.960	-0.009	040108-2	3.960	-0.007	478,477,476
01-11-04	17:58		030418-140	040108-1	3.959	-0.009	040108-2	3.959	-0.008	475,474,473
01-13-04	08:41		030418-142	040108-3	3.958	-0.009	040108-4	3.960	-0.007	X09,471,470,469,468
01-14-04	04:55		030418-144	040108-5	3.956	-0.010	040112-1	3.958	-0.007	467,466,465
01-16-04	04:38		030418-146	040108-5	3.958	-0.009	040112-1	3.960	-0.008	464,463,462
01-17-04	04:00		030418-147	040112-2	3.958	-0.010	040112-3	3.959	-0.008	461,460,459
01-18-04	02:31		030418-148	040112-2	3.959	-0.010	040112-3	3.959	-0.008	458,457,456
01-19-04	01:40	18	030418-151	040112-4	3.959	-0.008	040112-5	3.959	-0.008	455,454,X10
01-19-04	20:27		030418-152	040112-4	3.959	-0.008	040112-5	3.960	-0.008	452,451,450
01-20-04	21:05		030418-155	040112-4	3.962	-0.009	040112-5	3.961	-0.007	449,448,447(DOT-02)

#: Batch number of the KIO_3 standard series.

(4) Reproducibility of sample measurement

Replicate samples were taken at every CTD cast. These were 5 - 10 % of seawater samples of each cast. Results of the replicate samples were shown in Table 3.3.5. The standard deviation of the replicate measurement was about 0.1 μmol/kg during the whole legs (leg 1, 2, 4, and 5) and there was no significant difference between DOT-1 and DOT-2 measurements. The standard deviation was calculated by a procedure (SOP23) in DOE (1994).

Table 3.3.5. Results of the replicate sample measurements.

	Leg 1	Leg 2	Leg 4	Leg 5
Number of replicate sample pairs	388	380	368	489
Standard deviation (μmol/kg)	0.09	0.13	0.09	0.08

(5) CSK standard measurements

During the whole legs (leg 1, 2, 4, and 5), we carried out measurement of the CSK standard solution of potassium iodate every the KIO_3 standard series (# in Table 1) in order to trace stability of our oxygen measurement on board. Table 3.3.6 shows the result of the CSK standard measurements. Averaged values all through the legs of DOT-1 and DOT-2 are 0.009991 ± 0.000006 N and 0.009991 ± 0.000005 N respectively, suggesting that there was no systematic difference between DOT-1 and DOT-2 measurements. Furthermore, these results indicate stability of oxygen measurement during the whole legs. The averaged value of the CSK standard solution is so close to the certified value (0.0100 N) that we did not correct sample measurements with the CSK standard measurements.

Table 3.3.6. Results of the CSK standard measurements.

Leg	Date (UTC)	Time (UTC)	KIO_3 #	DOT-1		DOT-2	
				Conc. (N)	error (N)	Conc. (N)	error (N)
1	08-03-03	17:49	1	0.009998	0.000008	0.009989	0.000003
1	08-08-03	06:11	2	0.009990	0.000005	0.009990	0.000009
1	08-13-03	11:28	3	0.009988	0.000003	0.009987	0.000007
1	08-19-03	02:58	4	0.009983	0.000003	0.009994	0.000005
1	08-23-03	22:26	5	0.009988	0.000002	0.009993	0.000004
1	09-02-03	12:42	6	0.009989	0.000002	0.009989	0.000004
2	09-12-03	14:35	7	0.009994	0.000003	0.009988	0.000004
2	09-21-03	22:42	8	0.009983	0.000003	0.009984	0.000008
2	10-01-03	18:01	9	0.009985	0.000007	0.009983	0.000007
2	10-09-03	07:23	10	0.009985	0.000004	0.009990	0.000003
4	11-07-03	08:21	11	0.009991	0.000004	0.009985	0.000008
4	11-17-03	21:15	12	0.009993	0.000012	0.009997	0.000004
4	11-27-03	18:37	13	0.009985	0.000003	0.009988	0.000006
5	12-13-03	06:29	14	0.009996	0.000002	0.009994	0.000002
5	12-23-03	17:00	15	0.010002	0.000001	0.009997	0.000001
5	01-03-04	02:24	16	0.009999	0.000002	0.009997	0.000004
5	01-10-04	05:51	17	0.009997	0.000003	0.009994	0.000002
5	01-19-04	22:35	18	0.009999	0.000001	0.009996	0.000002
			average	0.009991	0.000006	0.009991	0.000005

(6) Quality control flag assignment

Quality flag values were assigned to oxygen measurements using the code defined in Table 0.2 of WHP Office Report WHPO 91-1 Rev.2 section 4.5.2 (Joyce *et al*., 1994). Measurement flags of 2, 3, 4, and 5 have been assigned (Table 3.3.7). For the choice between 2 (good), 3 (questionable) or 4 (bad), we basically followed a flagging procedure as listed below:

a. On a station-by-station basis, a datum was plotted against depth. Any points not lying on a generally smooth trend were noted.

b. If the bottle flag was marked with "problem", a datum was noted and flagged 3.

c. Dissolved oxygen was then plotted against nitrate concentration and CTD oxygen. If a datum deviated from both the depth and plots, it was flagged 3.

d. Vertical sections against depth and potential density were drawn. If a datum was anomalous on the section plots, datum flag was degraded from 2 to 3, or from 3 to 4.

e. We did not use flag of 6 for the replicate samples. If both of replicate sample data were flagged 2, averaged value was shown with flag of 2. If either of them was flagged 3 or 4, a datum with a younger flag was shown.

Table 3.3.7. Summary of assigned quality control flags.

Flag	Definition	Leg 1	Leg 2	Leg 4	Leg 5
2	Good	3373	3101	2850	3969
3	Questionable	9	9	15	1
4	Bad	18	29	17	23
5	Not report (missing)	8	8	3	6
	Total	3408	3147	2885	3999

References

Dickson, A. (1996): Dissolved Oxygen, in WHP Operations and Methods, Woods Hole, pp 1-13.

DOE (1994): Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2. A.G. Dickson and C. Goyet (eds), ORNL/CDIAC-74.

Joyce, T., and C. Corry, eds., C. Corry, A. Dessier, A. Dickson, T. Joyce, M. Kenny, R. Key, D. Legler, R. Millard, R. Onken, P. Saunders, M. Stalcup, contrib. (1994): Requirements for WOCE Hydrographic Programme Data Reporting, WHPO Pub. 90-1 Rev. 2, 145 pp.

3.4 Nutrients

3 February 2005

(1) Personnel

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(2) Objectives

The objectives of nutrients analyses during the R/V Mirai around the world cruises along ca. 30 °S in the Southern Hemisphere are as follows;

Describe the present status of nutrients in 2003-2004 in good traceability throughout the cruises. The target nutrients are nitrate, nitrite, phosphate and silicate (Although silicic acid is correct, we use silicate because a term of silicate is widely used in oceanographic community.).

Study the temporal and spatial variation of nutrients based on the previous high quality experiments data of WOCE, GOESECS, IGY and so on.

Study of temporal and spatial variation of nitrate: phosphate ratio, so called Redfield ratio.

Obtain more accurate estimation of total amount of nitrate, phosphate and silicate in the interested area.

Provide more accurate nutrients data for physical oceanographers to use as tracers of water mass movement.

(3) Equipment and techniques

a. Analytical detail using TRAACS 800 systems (BRAN+LUEBBE)

The phosphate analysis is a modification of the procedure of Murphy and Riley (1962).

Molybdic acid is added to the seawater sample to form phosphomolybdic acid which is in turn reduced to phosphomolybdous acid using L-ascorbic acid as the reductant.

Nitrate + nitrite and nitrite are analyzed according to the modification method of Grasshoff (1970).

The sample nitrate is reduced to nitrite in a cadmium tube inside of which is coated with metallic copper. The sample stream with its equivalent nitrite is treated with an acidic, sulfanilamide reagent and the nitrite forms nitrous acid which reacts with the sulfanilamide to produce a diazonium ion. N1-Naphthylethylene-diamine added to the sample stream then couples with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite react and are measured; without reduction, only nitrite reacts. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference.

The silicate method is analogous to that described for phosphate. The method used is essentially that of Grasshoff et al. (1983), wherein silicomolybdic acid is first formed from the silicic acid in the sample and added molybdic acid; then the silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue," using ascorbic acid as the reductant.

The flow diagrams and regents for each parameter are shown in Figures 3.4.1-3.4.4.

Nitrate Reagents

Imidazole (buffer), 0.06M (0.4 % w/v)

Dissolve 4 g imidazole, $C_3H_4N_2$, in ca. 900 ml DIW; add 2ml concentrated HCl; make up to 1000 ml with DIW. After mixing, 1 ml Triton(R)X-100 (50 % solution in ethanol) is added.

Sulfanilamide, 0.06M (1 % w/v) in 1.2M HCl

Dissolve 10 g sulfanilamide, 4-$NH_2C_6H_4SO_3H$, in 1000ml of 1.2M (10 %) HCl. After mixing, 1 ml Triton(R)X-100 (50 % solution in ethanol) is added.

N-1-Napthylethylene-diamine dihydrochloride, 0.004 M (0.1 % w/v)

Dissolve 1 g NEDA, $C_{10}H_7NHCH_2CH_2NH_2 \cdot 2HCl$, in 1000 ml of DIW; containing 10 ml concentrated HCl. Stored in a dark bottle.

Nitrite Reagents

Sulfanilamide, 0.06M (1 % w/v) in 1.2M HCl

Dissolve 10 g sulfanilamide, 4-$NH_2C_6H_4SO_3H$, in 1000 ml of 1.2M (10 %) HCl. After mixing, 1 ml Triton(R)X-100 (50 % solution in ethanol) is added.

N-1-Napthylethylene-diamine dihydrochloride , 0.004 M (0.1 % w/v)

Dissolve 1 g NEDA, $C_{10}H_7NHCH_2CH_2NH_2 \cdot 2HCl$, in 1000 ml of DIW; containing 10 ml concentrated HCl. Stored in a dark bottle.

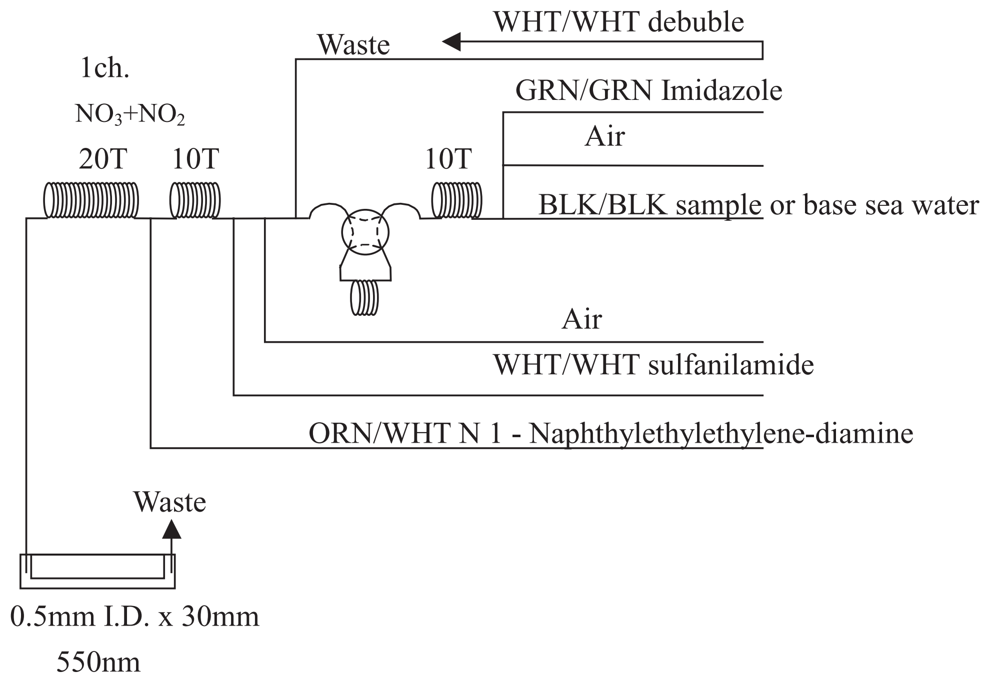

Figure 3.4.1. 1ch. (NO_3+NO_2) flow diagram.

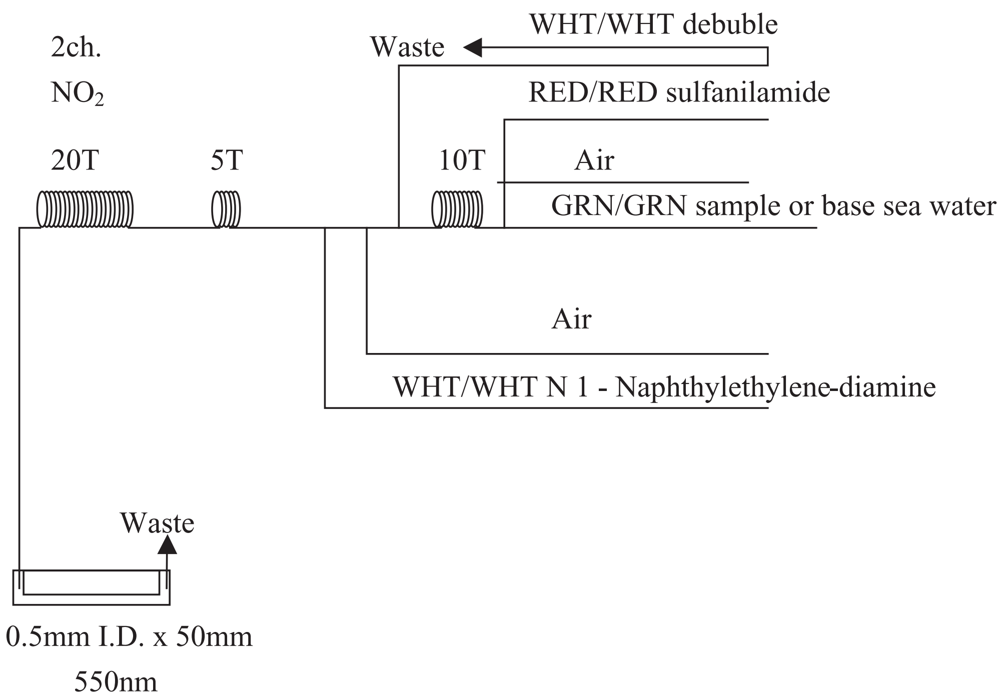

Figure 3.4.2. 2ch. (NO_2) flow diagram.

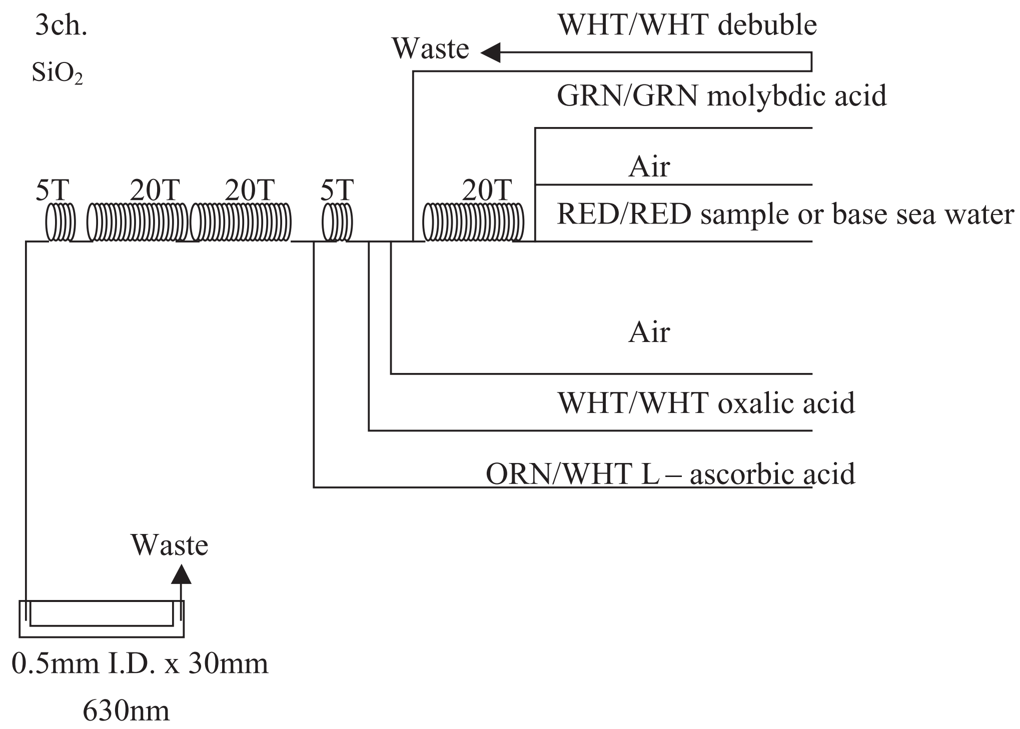

Figure 3.4.3. 3ch. (SiO_2) flow diagram.

Silicic Acid Reagents

Molybdic acid, 0.06M (2 % w/v)

Dissolve 15 g Disodium Molybdate (VI) Dihydrate, $Na_2MoO_4 \cdot 2H_2O$, in 1000 ml DIW containing 6 ml H_2SO_4. After mixing, 20 ml sodium dodecyl sulphate (15 % solution in water) is added.

Oxalic acid, 0.6M (5 % w/v)

Dissolve 50 g Oxalic Acid Anhydrous, HOOC: COOH, in 1000 ml of DIW.

Ascorbic acid, 0.01M (3 % w/v)

Dissolve 2.5 g L (+)-Ascorbic Acid, $C_6H_8O_6$, in 100 ml of DIW. Stored in a dark bottle and freshly prepared before every measurement.

Phosphate Reagents

Stock molybdate solution, 0.03M (0.8 % w/v)

Dissolve 8 g Disodium Molybdate (VI) Dihydrate, $Na_2MoO_4 \cdot 2H_2O$, and 0.17 g Antimony Potassium Tartrate, $C_8H_4K_2O_{12}Sb_2 \cdot 3H_2O$, in 1000 ml of DIW containing 50 ml concentrated H_2SO_4.

Mixed Reagent

Dissolve 0.8 g L (+)-Ascorbic Acid, $C_6H_8O_6$, in 100 ml of stock molybdate solution. After mixing, 2 ml sodium dodecyl sulphate (15 % solution in water) is added. Stored in a dark bottle and freshly prepared before every measurement.

PO4 dilution

Dissolve Sodium Hydrate, NaCl, 10 g in ca. 900 ml, add 50 ml Acetone and 4 ml concentrated H_2SO_4, make up to 1000 ml. After mixing, 5 ml sodium dodecyl sulphate (15 % solution in water) is added.

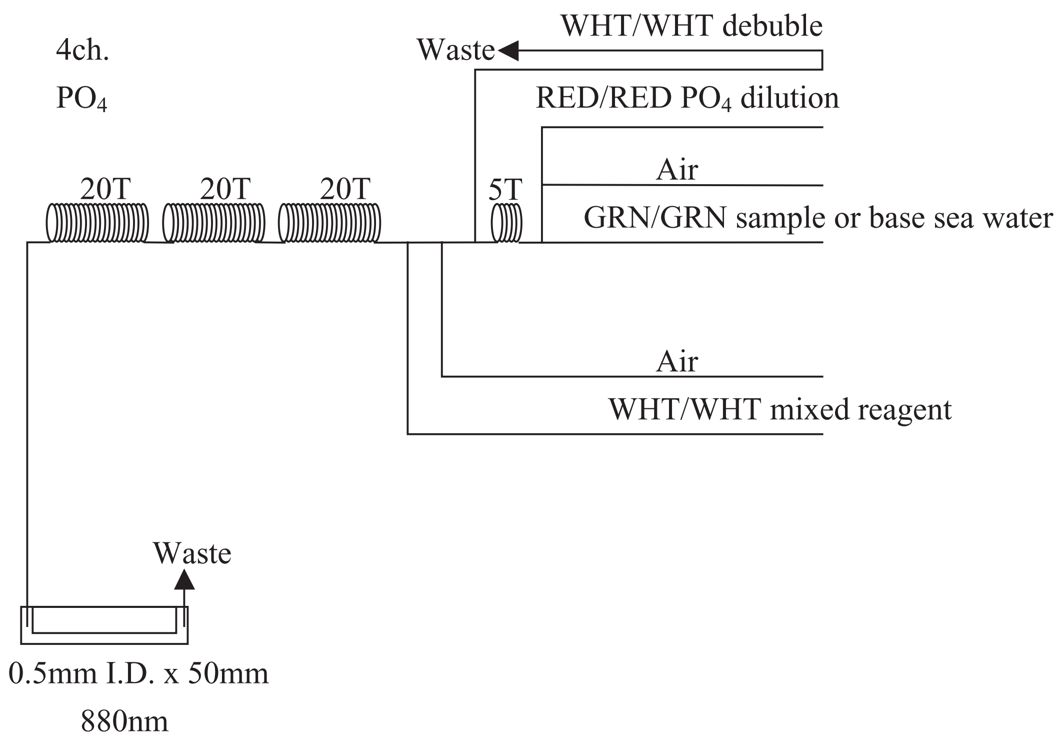

Figure 3.4.4. 4ch. (PO_4) flow diagram.

b. Sampling procedures

Sampling of nutrients followed that oxygen, trace gases and salinity. Samples were drawn into two of virgin 10 ml polyacrylates vials without sample drawing tubes. These were rinsed three times before filling and vials were caped immediately after the drawing. The vials are put into water bath at 23 °C in 10 minutes before use to stabilize the temperature of samples.

No transfer was made and the vials were set an auto sampler tray directly. Samples were analyzed as rapidly as possible after collection, and then the samples were analyzed within 5 hours.

c. Data processing

Raw data from TRAACS800 were treated as follows;

Check baseline shift.

Check the shape of each peak and positions of peak values taken, and then change the positions of peak values taken if necessary.

Carriover correction and baseline drift correction were applied to peak heights of each samples followed by sensitivity correction.

Baseline correction and sensitivity correction were done basically using liner regression.

Load pressure and salinity from CTD data to calculate density of seawater.

Calibration curves to get nutrients concentration were assumed second order equations.

(4) Nutrients standards

a. In-house standards

(i) Volumetric Laboratory Ware

All volumetric glass- and plastic (PMP)-ware used were gravimetrically calibrated. Plastic volumetric flasks were gravimetrically calibrated at the temperature of use within 2-3 K.

Volumetric flasks

Volumetric flasks of Class quality (Class A) are used because their nominal tolerances are 0.05 % or less over the size ranges likely to be used in this work. Class A flasks are made of borosilicate glass, and the standard solutions were transferred to plastic bottles as quickly as possible after they are made up to volume and well mixed in order to prevent excessive dissolution of silicic acid from the glass. High quality plastic (polymethylpentene, PMP, or polypropylene) volumetric flasks were gravimetrically calibrated and used only within 2-3 K of the calibration temperature.

The computation of volume contained by glass flasks at various temperatures other than the calibration temperatures were done by using the coefficient of linear expansion of borosilicate crown glass.

Because of their larger temperature coefficients of cubical expansion and lack of tables constructed for these materials, the plastic volumetric flasks were gravimetrically calibrated over the temperature range of intended use and used at the temperature of calibration within 2 K. The weights obtained in the calibration weightings were corrected for the density of water and air buoyancy.

Pipettes and pipettors

All pipettes have nominal calibration tolerances of 0.1 % or better. These were gravimetrically calibrated in order to verify and improve upon this nominal tolerance.

(ii) Reagents, General considerations

General Specifications

All reagents were of very high purity such as "Analytical Grade," "Analyzed Reagent Grade" and others. And assay of nitrite was determined according JISK8019 and assays of nitrite salts were 98.9 %. We use that value to adjust the weights taken.

For the silicate standards solution, we use commercial available silicon standard solution for atomic absorption spectrometry of 1000 mg L^{-1}. Since this solution is alkaline solution of 0.5 M KOH, an aliquot of 70 ml solution were diluted to 500 ml as B standard together with an aliquot of 35 ml of 1M HCl. Then the pH of B standard for silicate prepared to be 6.9.

Ultra pure water

Ultra pure water (MilliQ water) freshly drawn was used for preparation of reagents, higher concentration standards and for measurement of reagent and system blanks.

Low-Nutrient Seawater (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.45 μm pore size membrane filter. This water is stored in 20 liter cubitainer with paper box. The concentrations of nutrient of this water were measured carefully in May 2003.

(iii) Concentrations of nutrients for A, B and C standards

Concentrations of nutrients for A, B and C standards are set as shown in Table 3.4.1. The C standard is prepared according recipes as shown in Table 3.4.2. All volumetric laboratory tools were calibrated prior the cruise as stated in chapter (i). Then the actual concentration of nutrients in each fresh standard was calculated based on the ambient, solution temperature and determined factors of volumetric lab. wares.

Table 3.4.1. Nominal concentrations of nutrients for A, B and C standards.

	A	B	C-1	C-2	C-3	C-4	C-5
NO_3 (μM)	45000	1350	0.0	13.5	27.0	40.5	54.0
NO_2 (μM)	4000	40	0.0	0.4	0.8	1.2	1.6
SiO_2 (μM)	36000	5040	0.0	50	100	150	200
PO_4 (μM)	4500	90	0.0	0.9	1.8	2.7	3.6

Table 3.4.2. Working calibration standard recipes.

C-STD	B-1 STD	B-2 STD	MAT
C-1	0 ml	0 ml	40 ml
C-2	5 ml	5 ml	30 ml
C-3	10 ml	10 ml	20 ml
C-4	15 ml	15 ml	10 ml
C-5	20 ml	20 ml	0 ml

B-1 STD: Mixture of nitrate, silicate and phosphate

B-2 STD: Nitrite

(iv) Renewal of in-house standard solutions

In-house standard solutions as stated in (iii) were renewed as shown in Table 3.4.3.

Table 3.4.3. Timing of renewal of in-house standards.

NO_3, SiO_2, PO_4	Renewal
A-1 Std. (NO_3)	maximum 10 days
A-3 Std. (SiO_2)	commercial prepared solution
A-4 Std. (PO_4)	maximum 14 days
B-1 Std. (mixture of NO_3, SiO_2, PO_4)	2 days

NO_2	Renewal
A-2 Std. (NO_2)	maximum 14 days
B-2 Std. (NO_2)	maximum 14 days

C Std	Renewal
C-1 ~ C-5 Std (mixture of B1 and B2 Std.)	24 hours

Reduction estimation	Renewal
D-1 Std.	when A-1renewed
44 μM NO_3	when C-std renewed
47 μM NO_2	when C-std renewed

b. RMNS

To get the more accurate and high quality nutrients data to achieve the objectives stated above, huge numbers of the bottles of the reference material of nutrients in seawater (hereafter RMNS) are prepared (Aoyama et al., submitted). In the previous world wide expeditions, such as WOCE cruises, the higher reproducibility and precision of nutrients measurements were required (Joyce and Corry, 1994). Since no standards were available for the measurement of nutrients in seawater at that time, the requirements were described in term of reproducibility. The required reproducibility was 1 %, 1-2 %, 1-3 % for nitrate, phosphate and silicate, respectively. Although nutrient data from the WOCE one-time survey was of unprecedented quality and coverage due to much care in sampling and measurements, the differences of nutrients concentration at crossover points are still found among the expeditions (Aoyama and Joyce, 1996, Mordy et al., 2000, Gouretski and Jancke, 2001). For instance, the mean offset of nitrate concentration at deep waters was 0.5 μmol kg^{-1} for 345 crossovers at world oceans, though the maximum was 1.7 μmol kg^{-1} (Gouretski and Jancke, 2001). At the 31 crossover points in the Pacific WHP one-time lines, the WOCE standard of reproducibility for nitrate of 1 % was fulfilled at about half of the crossover points and the maximum difference was 7% at deeper layers below 1.6 °C in potential temperature (Aoyama and Joyce, 1996).

(i) RMNS preparation

RMNS preparation and homogeneity for previous lots

The study on reference material for nutrients in seawater (RMNS) on the seawater base has been carried out to establish traceability on nutrient analyses in seawater since 1994 in Japan. Autoclaving to produce RMNS has been studied (Aminot and Kerouel, 1991, 1995) and autoclaving was used to stabilize the samples for the 5th intercompariosn exercise in 1992/1993 (Aminot and Kirkwood, 1995). Aminot and Kerouel (1995) concluded that nitrate and nitrite were extremely stable throughout their 27 months storage experiment with overall standard deviations lower than 0.3 % (range 5-50 μmol l^{-1}) and 0.8 % (range 0.5-5 μmol l^{-1}), respectively. For phosphate, slight increase by 0.02-0.07 μmol l^{-1} per year was observed due to the leaching from the container glass. The main source of nutrient variation in seawater is believed to be microorganism activity, hence, production of RMNS depends on biological inactivation of samples. In this point of view, previous study showed that autoclaving to inactivate the biological activity is acceptable for RMNS preparation.

The seawater for RMNS production was sampled in the North Pacific Ocean at the depths of surface where the nutrients are almost depleted and 1500-2000 meters depth where the nutrients concentrations are the maximum. The seawater was gravity-filtered through a membrane filter with a pore size of 0.45 μm (Millipore HA). The latest procedure of autoclaving for RMNS preparation is that the seawater in a stainless steel container of 40 liters was autoclaved at 120 °C, 2 hours, 2 times during two days. The filling procedure of autoclaved seawater was basically same throughout our study. Following cooling at room temperature in two days, polypropylene bottle of 100 ml capacity were filled by the autoclaved seawater of 90 ml through a membrane filter with a pore size of 0.2 μm (Millipore HA) at a clean bench in a clean room. The polypropylene caps were immediately tightly screwed on and a label containing lot number and serial number of the bottle was attached on all of the bottles. Then the bottles were vacuum-sealed to avid potential contamination from the environment.

180 RMNS packages and 500 bottles of lot AH for this cruise

RMNS lots T, AN, AK, AM and O are prepared to cover the nutrients concentrations in the interested sea area. About 180 sets of 5 RMNS lots are prepared. These packages will be used daily when in-house standard solutions renewed daily. 500 bottles of RMNS lot AH are prepared to use every analysis at every hydrographic stations planed about 500 during the cruise. These RMNS assignment were completely done based on random number. The RMNS bottles were stored at a room, REGENT STORE, where the temperature was maintained around 22 °C.

(ii) The homogeneity of RMNS and consensus values of the lot AH

The homogeneity of lot AH and analytical precision are shown in Table 3.4.4. These are for the assessment of the magnitude of homogeneity of the RMNS bottles those are used during the cruise. As shown in Table 3.4.4, the homogeneity of RMNS lot AH for nitrate and silicate are the same magnitude of analytical precision derived from fresh raw seawater. The homogeneity for phosphate, however, exceeded the analytical precision at about factor two. The homogeneity for lot AH is same order of magnitude for previous RMNS of lot K.

Table 3.4.4. Homogeneity of lot AH derived from 30 samples measurements and analytical precision onboard R/V Mirai in May 2003.

	Phosphate CV%	Nitrate	Silcate
RMNS			
AH	0.83 %	0.39 %	0.13 %
(K)	(1.0 %)	(0.3 %)	(0.2 %)
Precision	0.39 %	0.36 %	0.13 %

Note: N = 30 x 2

(5) Quality control

a. Precision of nutrients analyses during the cruise

Precision of nutrients analyses during the cruise was evaluated based on the 13 measurements, which are measured every 10-15 samples, during a run at the concentration of C-5. We also evaluated the reproducibility based on the replicate analyses of five samples in each run. Summary of precisions are shown in Table 3.4.5. As shown in Table 3.4.5 and Figures 3.4.5-3.4.7, the precisions for each parameter are generally good considering the analytical precisions estimated from the simultaneous analyses of 60 samples in May 2003. Analytical precisions previously evaluated were 0.39 % for phosphate, 0.36 % for nitrate and 0.13 % for silicate, respectively. During leg 5, analytical precisions were 0.17 % for phosphate, 0.13 % for nitrate and 0.12 % for silicate in terms of median, respectively. Then we can conclude that the analytical precisions for phosphate, nitrate and silicate were maintained or better throughout leg 5 comparing the pre-cruise evaluations.

Table 3.4.5. Summary of precision based on the replicate analyses of 13 samples in each run through out cruise.

	Nitrate CV%	Phosphate CV%	Silicate CV%
Median	0.15	0.18	0.15
Mean	0.16	0.19	0.16
Maximum	1.37	1.10	0.4
Minimum	0.04	0.06	0.04
N	491	490	490

The time series of precision are shown in Figures 3.4.5-3.4.7.

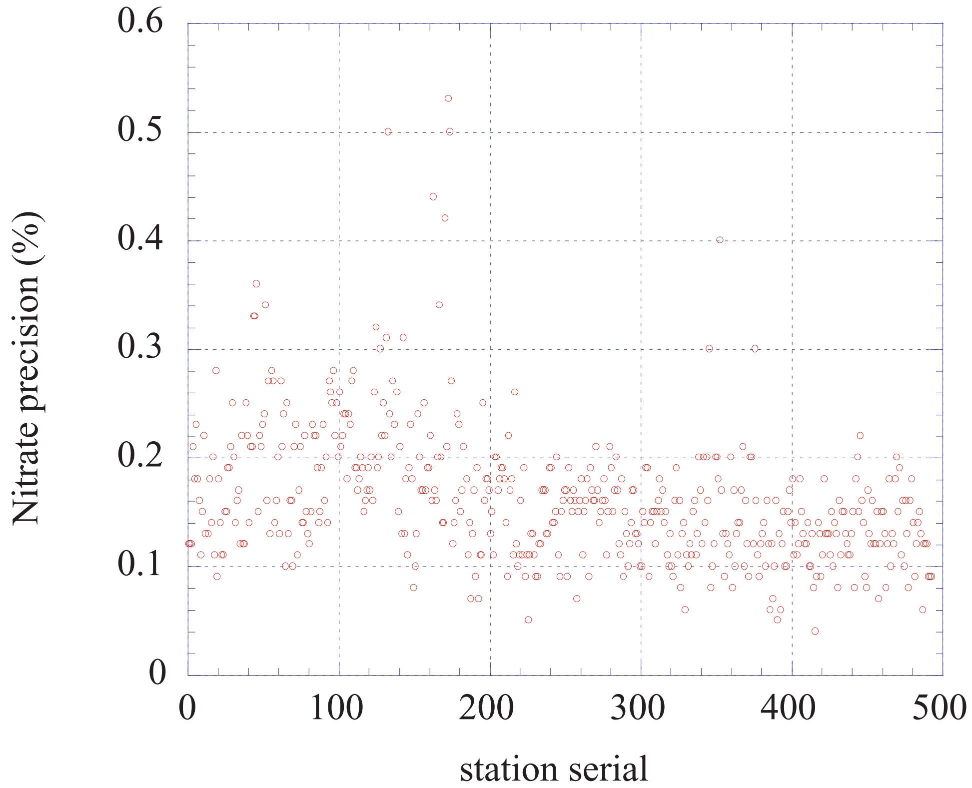

Figure 3.4.5. Time series of precision of nitrate.

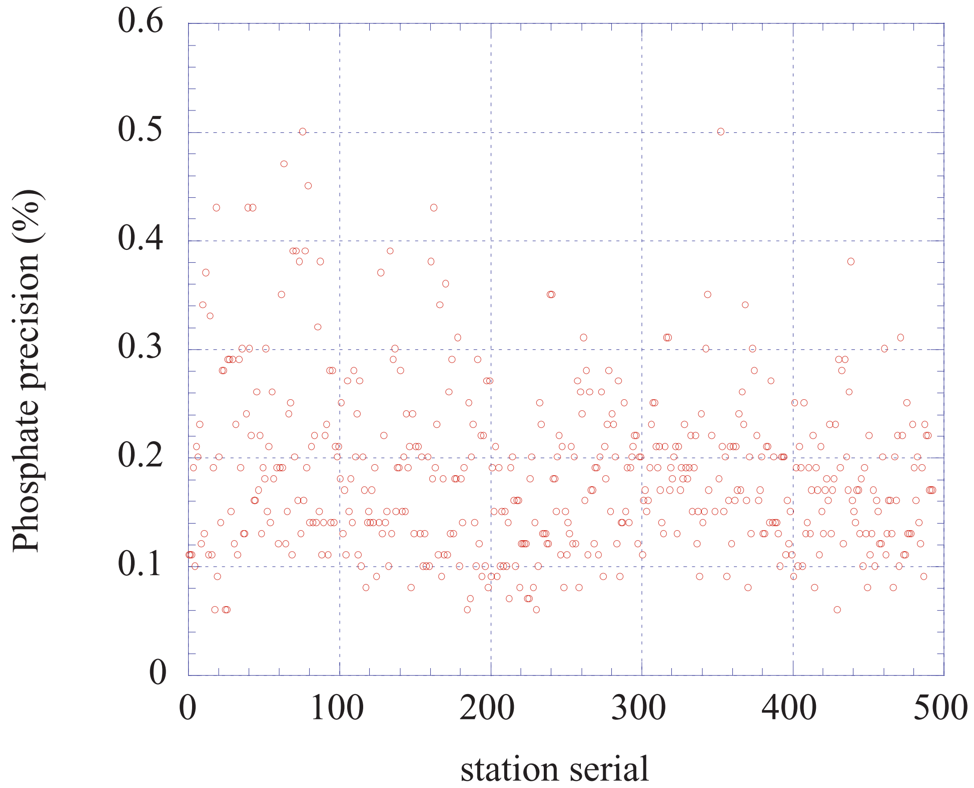

Figure 3.4.6. Time series of precision of phosphate.

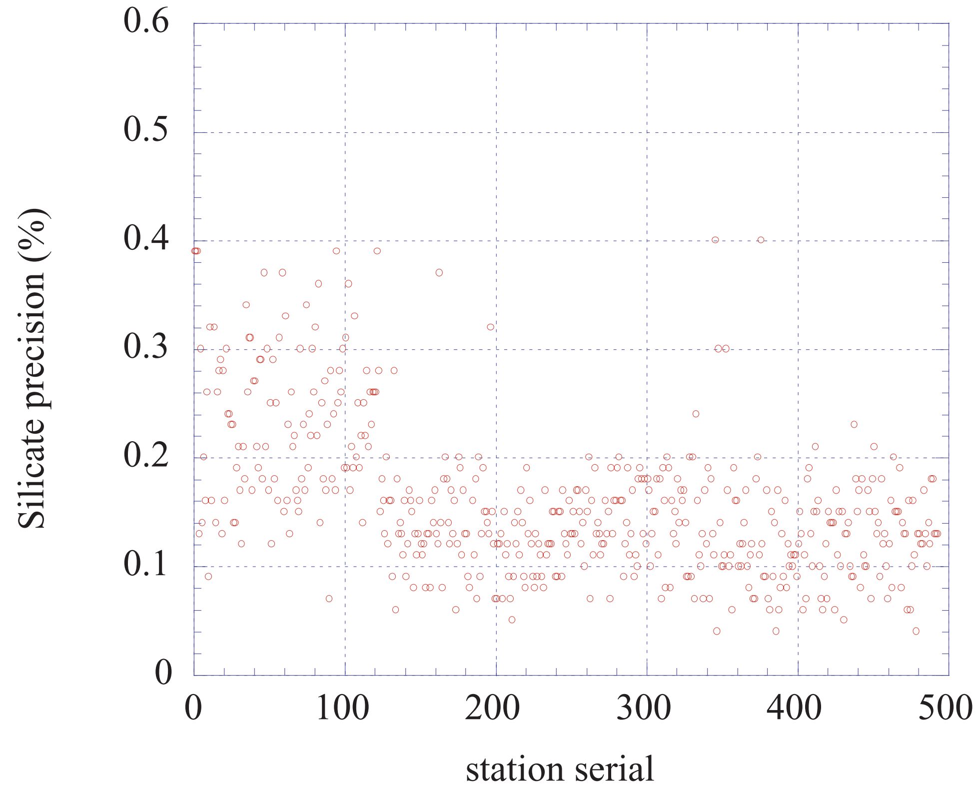

Figure 3.4.7. Time series of precision of silicate.

b. Carry over

We can also summarize the magnitudes of carry over throughout the cruise. These are as shown in Table 3.4.6. The average of carry over for nitrate was 0.45, which is relatively high rather than those of Phosphate and Silicate.

Table 3.4.6. Summary of carry over through out cruise.

	Nitrate	Phosphate	Silicate
	CV%	CV%	CV%
Median	0.49	0.20	0.12
Mean	0.48	0.20	0.10
Maximum	0.94	1.25	0.47
Minimum	0.03	0.00	0.00
N	491	491	491

c. Concentrations of low nutrients seawater

Concentrations of low nutrients seawater obtained from each measurement were summarized in Table 3.4.7. As shown in Table 3.4.7, the concentrations of low nutrients seawater used in this cruise are well reproduced against nominal concentrations given in May 2003. The phosphate concentration of low nutrients seawater was calculated as 0.15 μmol kg^{-1} while nominal concentration was 0.16 μmol kg^{-1}. This discrepancy might be caused by the difference of automated decision process of peak positions of baseline between “base” and others. Then, we concluded that this difference as shown in Table 3.4.7 will not affect on the samples.

Table 3.4.7. Summary of low nutrients seawater through out cruise.

	Nitrate	Phosphate	Silicate
	micro mol kg-1	micro mol kg-1	micro mol kg-1
Median	0.01	0.15	0.99
Mean	0.01	0.15	0.98
Maximum	0.15	0.35	1.36
Minimum	-0.13	0.08	0.01
Nominal	0.00	0.16	1.01

The numbers of analysis were 490 for three parameters.

(6) Evaluation of trueness of nutrients concentrations using RMNSs

We have been using RMNS for all runs, then, we can evaluate the trueness of nutrients concentration throughout cruise. Results of RMNS measurements are shown in Figures 3.4.8-3.4.13.

The uncertainties of nitrate, phosphate and silicate measurements for this cruise were evaluated as functions of concentrations of those. Uncertainties of nitrate measurement are expressed by equation (1).

$$\text{Uncertainties (\%)} = 0.28 + 3.28 / \text{Cnitrate} \quad (1)$$

Where Cnitrate is nitrate concentration in μmol kg^{-1}.

Uncertainties of phosphate measurement are expressed equation (2).

$$\text{Uncertainties (\%)} = 0.26 + 0.942 / \text{Cphos} + 0.125 / (\text{Cphos x Cphos}) \quad (2)$$

Where Cphos is phosphate concentration in μmol kg^{-1}.

Uncertainties of silicate measurement are expressed equation (3).

$$\text{Uncertainties (\%)} = 0.22 + 11.9 / \text{Csilicate} \quad (3)$$

Where Csilicate is silicate concentration in μmol kg^{-1}.

Then, we add new three columns to show the uncertainties of nutrients measurement in the sea file of this cruise.

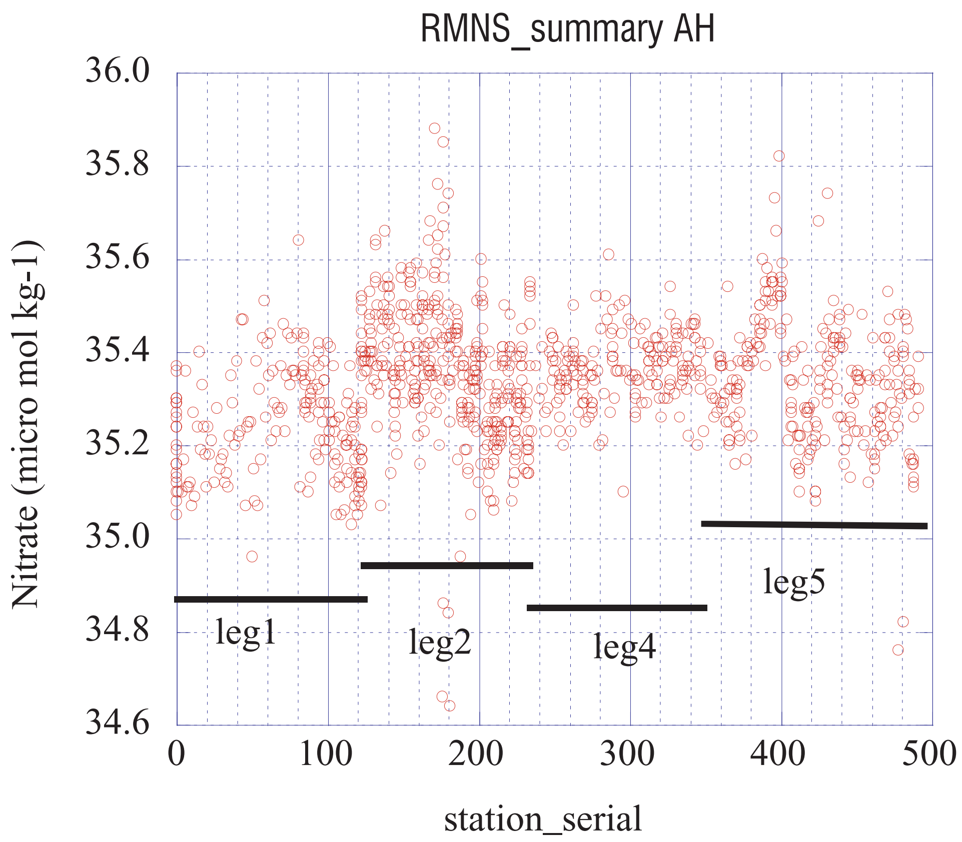

Figure 3.4.8. Time series of nitrate concentration for RMNS lot AH ordered as measurement.

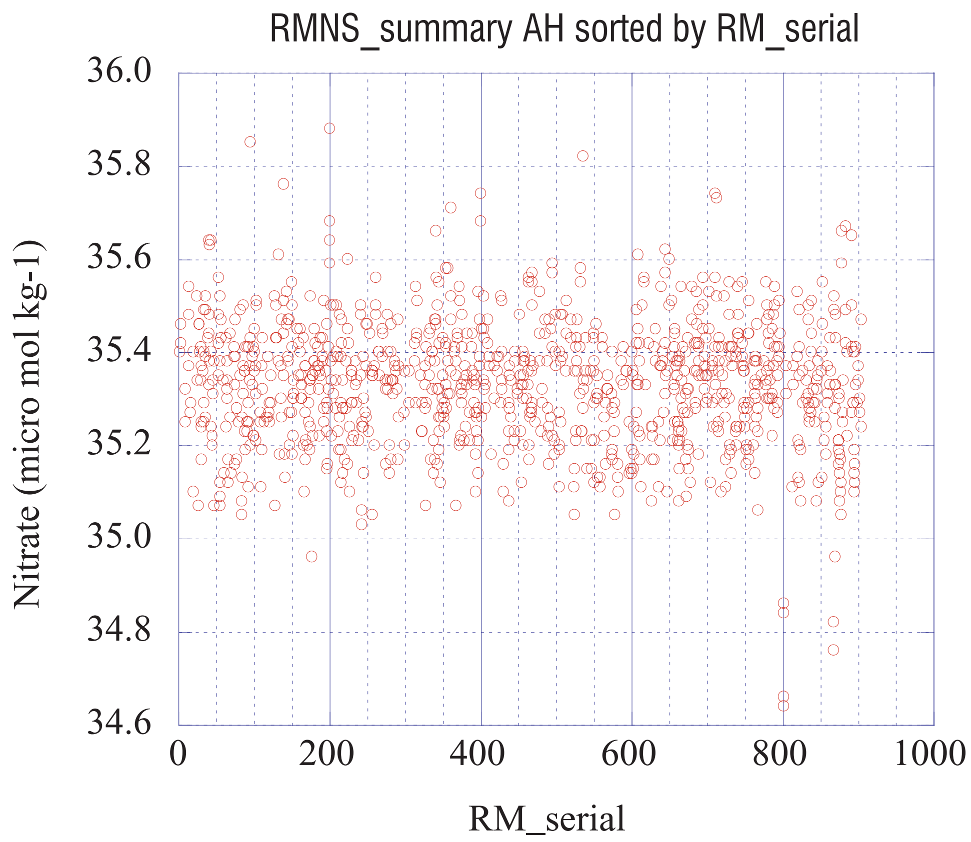

Figure 3.4.9. Time series of nitrate concentration for RMNS lot AH sorted by RMNS serial number.

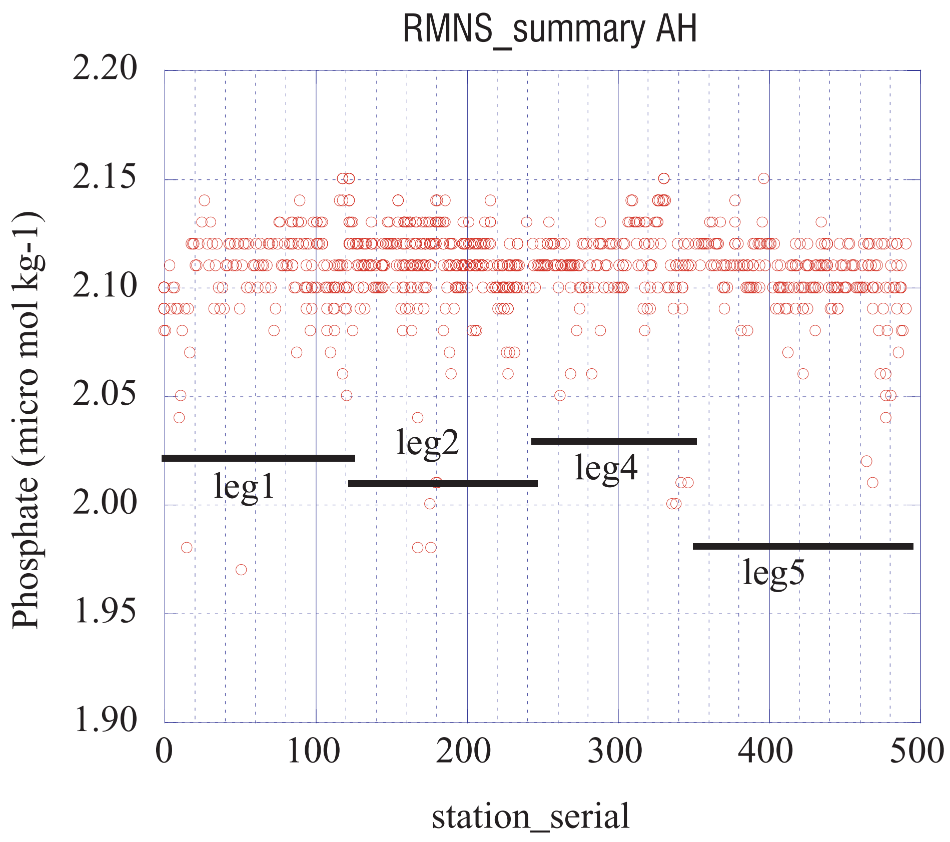

Figure 3.4.10. Same as Figure 3.4.8, but for phosphate.

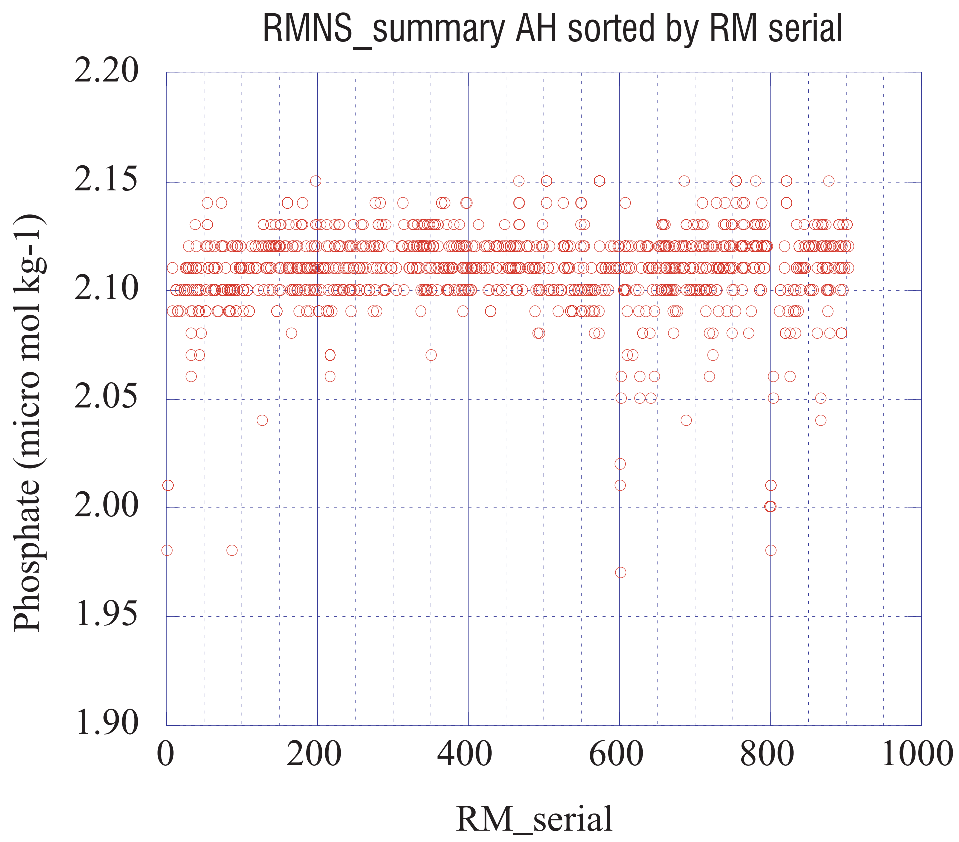

Figure 3.4.11. Same as Figure 3.4.9, but for phosphate.

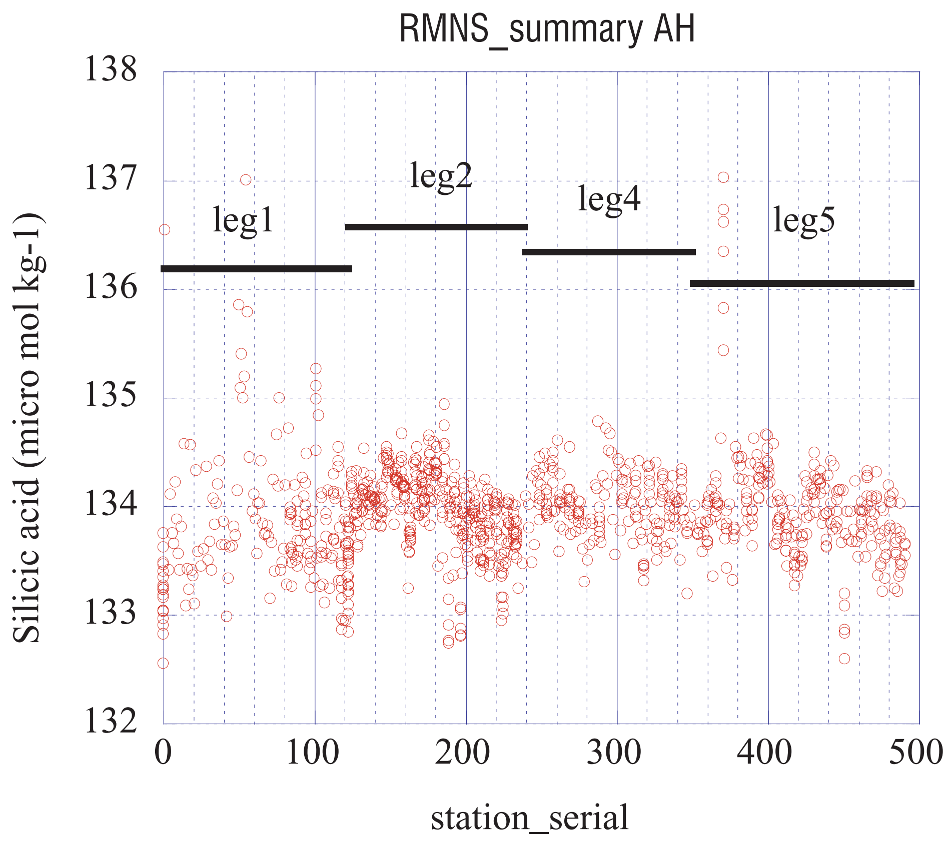

Figure 3.4.12. Same as Figure 3.4.8, but for silicic acid.

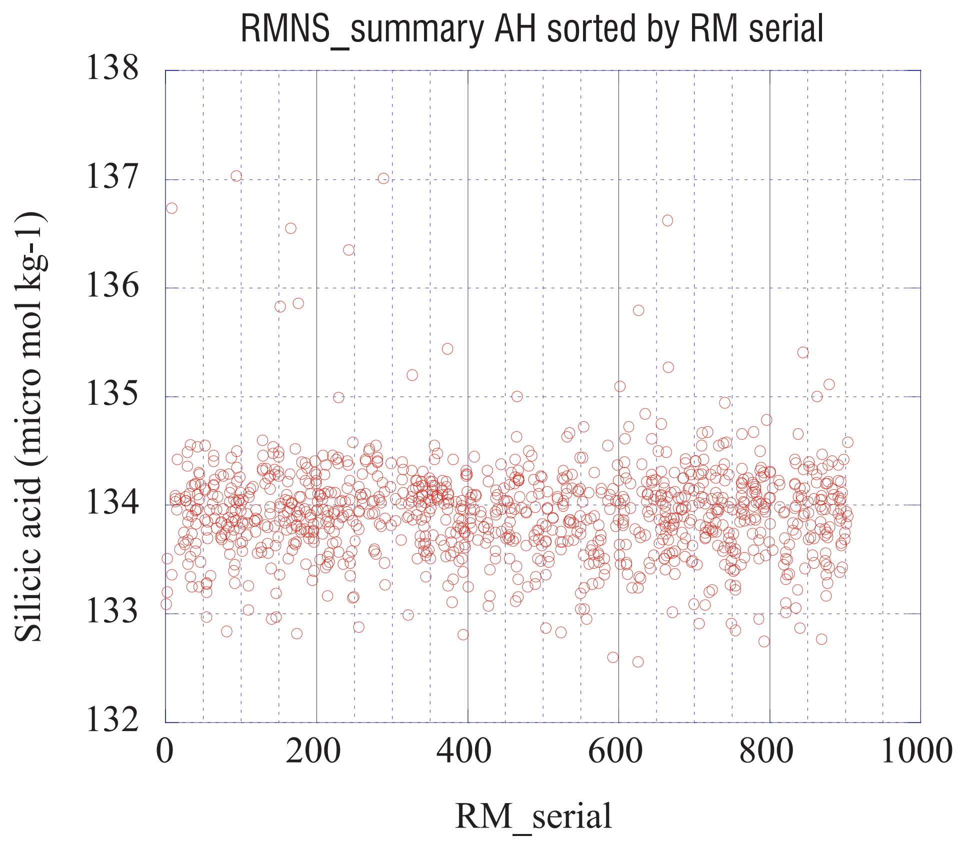

Figure 3.4.13. Same as Figure 3.4.9, but for silicic acid.

(7) Leg-to-leg traceability

Leg-to-leg traceability was examined based on the results of the statistics of RMNS-AH concentrations. As shown in Table 3.4.8 and 3.4.9, the medians and averages of the nutrients concentration of RMNS-AH were in good agreement among leg 1, 2, 4 and 5. The deviations among four legs were less than 0.3 % for nitrate, 0.2 % for silicate and 0 % for phosphate, respectively.

Table 3.4.8. Results of the statistics of RMNS-AH concentrations.

	NO3_Pacific	SiO2_Pacific	PO4_Pacific
median	35.33	133.95	2.11
mean	35.32	133.94	2.11
stdev	0.15	0.45	0.02
CV%	0.42	0.34	1.00
max	35.88	137	2.15
min	34.64	132.74	1.97
max-min	1.24	4.26	0.18
count	537	535	535

	NO3_Leg 1	SiO2_Leg 1	PO4_Leg 1
median	35.25	133.75	2.11
mean	35.25	133.88	2.11
stdev	0.12	0.62	0.02
CV%	0.33	0.46	1.13
max	35.64	137	2.15
min	34.96	132.86	1.97
max-min	0.68	4.14	0.18
count	166	165	165

	NO3_Leg 2	SiO2_Leg 2	PO4_Leg 2
median	35.37	134.00	2.11
mean	35.36	133.96	2.11
stdev	0.15	0.35	0.02
CV%	0.43	0.26	0.94
max	35.88	134.94	2.15
min	34.64	132.74	1.98
max-min	1.24	2.2	0.17
count	371	370	370

	NO3_Leg 4	SiO2_Leg 4	PO4_Leg 4
median	35.37	134.02	2.11
mean	35.37	134.02	2.11
stdev	0.07	0.30	0.02
CV%	0.21	0.23	1.02
max	35.61	134.90	2.15
min	35.10	133.19	2.00
max-min	0.51	1.71	0.15
count	181	183	183

	NO3_Leg 5	SiO2_Leg 5	PO4_Leg 5
median	35.34	133.93	2.11
average	35.34	133.95	2.11
stdev	0.13	0.51	0.02
cv%	0.38	0.38	1.14
max	35.82	137.02	2.39
min	34.76	131.99	2.01
max-min	1.06	5.03	0.38
count	267	267	267

Table 3.4.9. Summary of leg-to-leg traceability.

	Nitrate	Phosphate	Silicate
Leg 1	35.25	2.11	133.75
Leg 2	35.37	2.11	134.00
Leg 4	35.37	2.11	134.02
Leg 5	35.34	2.11	133.93

(8) Problems/improvements occurred and solutions

Leg 1

a. Silicate concentration decrease in 3-4 days in B-standard solution

A decrease of silicate concentration in B-standard solution was found three to four days after its renewal. This was found by the apparent change of RMNS-AH silicate concentrations.

We, then, decided to renew B-std solution of silicate every two days from the measurements of the sample at station P06C-166. We, also, did additional measurements of RM-AH to monitor the stability of B-std. After introducing this new procedure, the apparent stability of RMNS-AH silicate concentration becomes better.

b. Base line shift at 3 and 4 ch, silicate and phosphate channels, of #2 machine of TRAACS800

Base line shift at 3 and 4 ch, silicate and phosphate channels, of #2 machine of TRAACS800 were observed during leg 1. From station P06C-123, we had stopped to use #2 machine of TRAACS800. The measurements were continued using #1 machine of TRAACS800 until the station P06C-121.

At Tahiti, #2 machine of TRAACS800 were checked and a board and two cables were replaced.

c. Silicate concentration drift related with the direct flow from air conditioner in the laboratory

Silicate concentration drift related with the direct flow from air conditioner in the laboratory were observed in the results of #1 TRAACS. We, then, put temporally shield from the measurements of the sample at station P06C-160. The drift of the results of #1 TRAACS, however, did not become smaller after station P06X-160 during leg 1.

d. Nitrate concentration might decrease within a few weeks in A-standard solution after preparation

A decrease of nitrate concentration in A-standard solution was found within a few weeks after its renewal. This was found by the apparent change of RMNS-AH nitrate concentrations.

We, then, decided to renew A-std solution of nitrate every 10 days.

Leg 2

a. At Tahiti, a slave unit of #2 machine of TRAACS800 were checked and a board, a drive belt and two cables were replaced because baseline shift were occurred frequently at the end of leg 1

During the leg 2, baseline shift occurred few due to a same reason as that during leg 1 at the salve unit of #2 machine of TRAACS800, which were for silicate and phosphate. This might contribute an improvement of reproducibility of silicate analyses during leg 2, as shown in Table 3.4.8.

b. Decrease a reproducibility of nitrate analyses

Since the interval of pump tubes was relatively long rather than expected due to the heavy load of analyses, this might decrease the reproducibility of nitrate analyses. We also got a problem that air had invaded into sample lines through a four-way valve at a reduction column and it was replaced at station P06C-105.

c. Lower phosphate concentration for a few RMNS-AH bottles

We found that phosphate concentrations for 4 bottles of RM-AH during leg 2 were unreasonably low comparing the concentrations of RMNS bottles. Those are AH-34, 218, 802 and 895, respectively.

Leg 4

a. Lower phosphate concentration for a few RMNS-AH bottles

We found that phosphate concentrations for 4 bottles of RM-AH during leg 4 were unreasonably low comparing the concentrations of RMNS bottles. Those are AH-4, 720, 801 and 805, respectively.

b. Simultaneous base line shift at 3 and 4 ch, silicate and phosphate channels, of #2 machine of TRAACS800

Simultaneous base line shift at 3 and 4 ch, silicate and phosphate channels, of #2 machine of TRAACS800 were occurred seven times during leg 4. Although, #2 machine of TRAACS800 were checked at Tahiti and a board, two cables and a drive belt were replaced and base line shift becomes less, these simultaneous base line shifts may be caused by different reason.

c. Preventive replacements of pump tubes and flow cells, and careful treatment of the peak position determination might contribute excellent results on analytical precision

We did preventive replacements of pump tubes before baseline noise would increase due to the aging of pump tubes. We also did preventive replacements of flow cells to maintain good condition of the TRAACS800s.

We pay more attention to determine peak positions before the calculation of concentrations of nutrients.

Leg 5

a. Silicate TRAACS800s #1 #2 systematic difference between two machines about 0.7 %

b. Pump tube replacement interval ca. 5days same as leg 4 lead better precision

c. A pump and a drive belt for ch3, ch4 were replaced prior leg 5, then, no shift occurred during leg 5

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3.5 Dissolved inorganic carbon (C_T)

5 February 2005

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(2) Introduction

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} due to human activities such as burning of fossil fuels, deforestation, cement production, etc. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the predicted global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

In this cruise (BEAGLE), we were aimed at quantifying how much anthropogenic CO_2 absorbed in the Southern Ocean, where intermediate and deep waters are formed, are transported and redistributed in the southern hemisphere subtropical oceans. For the purpose, we measured CO_2-system properties such as dissolved inorganic carbon (C_T), total alkalinity (A_T), pH and underway pCO_2.

In this section, we describe data on C_T obtained in the BEAGLE in detail.

(3) Apparatus

Measurements of C_T were made with two total CO_2 measuring systems (systems A and B; Nippon ANS, Inc.), which are slightly different from each other. The systems comprise of a seawater dispensing system, a CO_2 extraction system and a coulometer (Model 5012, UIC Inc.).

The seawater dispensing system has an auto-sampler (6 ports), which takes seawater in a 300 ml borosilicate glass bottle and dispenses the seawater to a pipette of nominal 20 ml volume by a PC control. The pipette is kept at 20 °C by a water jacket, in which water from a water bath set at 20 °C is circulated.

CO_2 dissolved in a seawater sample is extracted in a stripping chamber of the CO_2 extraction system by adding phosphoric acid (10 % v/v). The stripping chamber is approx. 25 cm long and has a fine frit at the bottom. To degas CO_2 as quickly as possible, a heating wire kept at 40 °C was rolled from the bottom to a 1/3 height of the stripping chamber. The acid is added to the stripping chamber from the bottom of the chamber by pressurizing an acid bottle for a given time to push out the right amount of acid. The pressurizing is made with nitrogen gas (99.9999 %). After the acid is transferred to the stripping chamber, a seawater sample kept in a pipette is introduced to the stripping chamber by the same method as in adding an acid. The seawater reacted with phosphoric acid is stripped of CO_2 by bubbling the nitrogen gas through a fine frit at the bottom of the stripping chamber. The CO_2 stripped in the stripping chamber is carried by the nitrogen gas (flow rates of 130 ml min^{-1} and 140 ml min^{-1} for the systems A and B, respectively) to the coulometer through a dehydrating module. For the system A, the module consists of two electric dehumidifiers (kept at 1 - 2 °C) and a chemical desiccant ($Mg(ClO_4)_2$). For the system B, it consists of three electric dehumidifiers with a chemical desiccant.

(4) Shipboard measurement

Sampling

All seawater samples were collected from depth with 12 liter Niskin bottles basically at every other stations. The seawater samples for C_T were taken with a plastic drawing tube (PFA tubing connected to silicone rubber tubing) into a 300 ml borosilicate glass bottle. The glass bottle was filled with seawater smoothly from the bottom following a rinse with a seawater of 2 full, bottle volumes. The glass bottle was closed by a stopper, which was fitted to the bottle mouth gravimetrically without additional force.

At a chemical laboratory on the ship, a headspace of approx. 1 % of the bottle volume was made by removing seawater using a plastic pipette. A saturated mercuric chloride of 100 μl was added to poison seawater samples. The glass bottles were sealed with a greased (Apiezon M, M&I Materials Ltd) ground glass stopper and the clips were secured. The seawater samples were kept at 4 °C in a refrigerator until analysis. A few hours just before analysis, the seawater samples were kept at 20 °C in a water bath.

Analysis

At the start of each leg, we calibrated the measuring systems by blank and 5 kinds of Na_2CO_3 solutions (nominally 500, 1000 1500, 2000, 2500 μmol/L). As it was empirically known that coulometers do not show a stable signal (low repeatability) with fresh (low absorption of carbon) coulometer solutions. Therefore we measured 2 % CO_2 gas repeatedly until the measurements became stable. Then we started the calibration.

The measurement sequence such as system blank (phosphoric acid blank), 2 % CO_2 gas in a nitrogen base, seawater samples (6) was programmed to repeat. The measurement of 2 % CO_2 gas was made to monitor response of coulometer solutions (from UIC, Inc.). For every renewal of coulometer solutions, certified reference materials (CRM, batch 60) provided by Prof. A. G. Dickson of Scripps Institution of Oceanography were analyzed. In addition, reference materials (RM) provided by JAMSTEC (2 kinds) and KANSO were measured at the initial, intermediate and end times of a coulometer solution's lifetime.

The preliminary values were reported in a data sheet on the ship. Repeatability and vertical profiles of C_T based on raw data for each station helped us check performances of the measuring systems.

In each leg, we finished all the analyses for C_T on board the ship. As we used two systems, we had not encountered such a situation as we had to abandon the measurement. However, we experienced some malfunctions of the measuring systems during the cruise, which are described in the followings:

In the leg 1, due to malfunction of the coulometer of the system B, we replaced it to a back-up coulometer;

There occurred lowering of repeatability, mostly due to dirt. This situation was recovered by cleaning the measuring systems;

The "undershooting" of coulometer detection was often found. This happened in measuring seawater samples subsequent to the measurement of phosphoric acid blank. To avoid the "undershooting" occurred in seawater sample measurement, we measured a dummy seawater sample subsequent to the bank measurement.

(5) Quality control

Leg 1

Calibration factors of the systems A and B were listed in Table 3.5.1. With these factors, we calculated C_T of CRM (batch 60), and plotted the values as a function of sequential day (Fig. 3.5.1). From Fig. 3.5.1, it is found that there were no trends of CRM measurements for the system A during the leg 1. The average and standard deviation were 1991.0 and 1.5 μmol kg^{-1} (n = 40), respectively. Since the certified value of the batch 60 is 1991.24 μmol kg^{-1}, very close to the average, it implies that the measurement had been conducted in a good condition.

For the system B, however, we had to replace the coulometer with a back-up one, because repeatability for the system B had been worse (3.0 μmol kg^{-1} for CRM measurements) than usually expected value (~1.5 μmol kg^{-1}). Before and after the replacement, the calibration factor changed largely from 0.31322 to 0.31644 (Table 3.5.1). This change of a calibration factor caused CRM measurements to be 2011.7±1.5 μmol kg^{-1}, which were 1991.9 μmol kg^{-1} before the replacement.

Based on the results of CRM measurements stated above, we re-calculated the calibration factors so that measurements of seawater samples become traceable to the certified value of batch 60. For example, the initial factor of 0.31322 for the system A became 0.31333 by such a calculation as 0.31322/(1990.24/1991.0).

Temporal variations of RM measurements are shown in Fig. 3.5.2. From Fig. 3.5.2, it is evident that RM measurements included a linear trend, implying that measurements of seawater samples also have the trend. The trend was also found in temporal changes of 2 % CO_2 gas measurements. The trend seems to be due to "cell age" change (Johnson et al., 1998) of a coulometer solution.

Considering the trends, we adjusted measurements of seawater samples so as to be traceable to the certified value of batch 60, although the adjustments were usually slight.

Finally we surveyed vertical profiles of C_T. In particular, we examined whether systematic differences between measurements of the systems A and B existed or not. Then taking other information of analyses into account, we determined a flag of each value of C_T.

The average and standard deviation of absolute values of differences of C_T analyzed consecutively were 1.5 and 1.3 μmol kg^{-1} (n = 203), respectively.

Leg 2

Calibration factors of the systems A and B for the leg 2 are listed in Table 3.5.1, and temporal variations of CRM C_T are shown in Fig. 3.5.3.

From Fig. 3.5.3, it is found that the CRM C_T for the system A changes discontinuously at the 268th sequential day. In the former period, no trends are found, while in the latter period, a significant trend exists. We do not know the causes of this discontinuity and the subsequent trend. For the system B, no such a variation of CRM C_T is found (Fig. 3.5.3).

The average and standard deviation of CRM C_T in the former period (before the 268 sequential day) for the system A were calculated to be 1990.9 and 1.2 μmol kg^{-1} (n = 16), respectively. Those in the latter period were 1990.7 and 1.4 μmol kg^{-1} (n = 20), respectively. For the system B, the average and standard deviation were 1994.1 and 1.9 μmol kg^{-1} (n = 34), respectively.

Based on the information of CRM C_T stated above, we re-calculated the calibration factors as made for the leg 1, considering the trend.

Based on RM measurements, we adjusted the trend of C_T of seawater samples as conducted for the data on leg 1. Then, we checked the vertical profiles of C_T, and determined a flag of each C_T value.

The average and standard deviation of absolute values of differences of C_T analyzed consecutively were 1.5 and 1.4 μmol kg^{-1} (n = 188), respectively.

Leg 4

Calibration factors of the systems A and B for the leg 4 are listed in Table 3.5.1, and temporal variations of CRM C_T are shown in Fig. 3.5.4.

From Fig. 3.5.4, it is found that there existed no trends for the system A, but a slight decreasing trend for the system B, which was not significant statistically.

The average and standard deviation of CRM C_T for the system A were 1988.2 and 1.1 μmol kg^{-1} (n = 35), respectively, while those for the system B were 1998.6 and 0.9 μmol kg^{-1} (n = 28), respectively.

Based on the information of CRM C_T stated above, we re-calculated the calibration factors as made for the leg 1.

Based on RM measurements, we adjusted the trend of C_T of seawater samples as conducted for the data on leg 1. Then, we checked the vertical profiles of C_T, and determined a flag of each C_T value.

The average and standard deviation of absolute values of differences of C_T analyzed consecutively were 1.0 and 0.8 μmol kg^{-1} (n = 166), respectively.

Leg 5

Calibration factors of the systems A and B for the leg 5 are listed in Table 3.5.1, and temporal variations of CRM C_T are shown in Fig. 3.5.5. From this figure, if is found that for both the systems, the CRM C_Ts show statistically significant increasing trends, but in a discontinuous manner. Therefore we divided the time series into the two periods. Then we calculated the averages and standard deviations of each period separately.

The average and standard deviation of CRM C_T for the former period (before the 367th sequential day) of the system A were 1989.7 and 1.3 μmol kg^{-1} (n = 25), respectively, while those for the latter period were 1990.1 and 1.0 μmol kg^{-1} (n = 17), respectively. For the system B, the average and standard deviation for the former period (before 377th sequential day) were 1988.6 and 0.9 μmol kg^{-1} (n = 29), respectively, while those for the latter period were 1990.1 and 0.5 μmol kg^{-1} (n = 6), respectively.

Based on RM measurements, we adjusted the trend of C_T of seawater samples as conducted for the data on leg 1. Then, we checked the vertical profiles of C_T, and determined a flag of each C_T value.

The average and standard deviation of absolute values of differences of C_T analyzed consecutively were 0.9 and 0.7 μmol kg^{-1} (n = 229), respectively.

Reference

Johnson, K.M., A.G. Dickson, G. Eischeid, C. Goyet, P. Guenther, R.M. Key, F. J. Millero, D. Purkerson, C.L. Sabine, R.G. Schottle, D.W.R. Wallace, R.J. Wilke and C.D. Winn (1998): Coulometric total carbon dioxide analysis for marine studies: assessment of the quality of total inorganic carbon measurements made during the US Indian Ocean CO_2 survey 1994-1996, Mar. Chem., 63, 21-37.

Table 3.5.1. Calibration factors determined from Na_2CO_3 solutions.

Leg no.	Calibration factors A	Calibration factors B	Remarks
1	0.31322	0.31322	Replacement of coulometer was
		0.31644	conducted for the system B.
2	0.31281	0.31589	
4	0.31399	0.30895	
5	0.31398	0.31140	

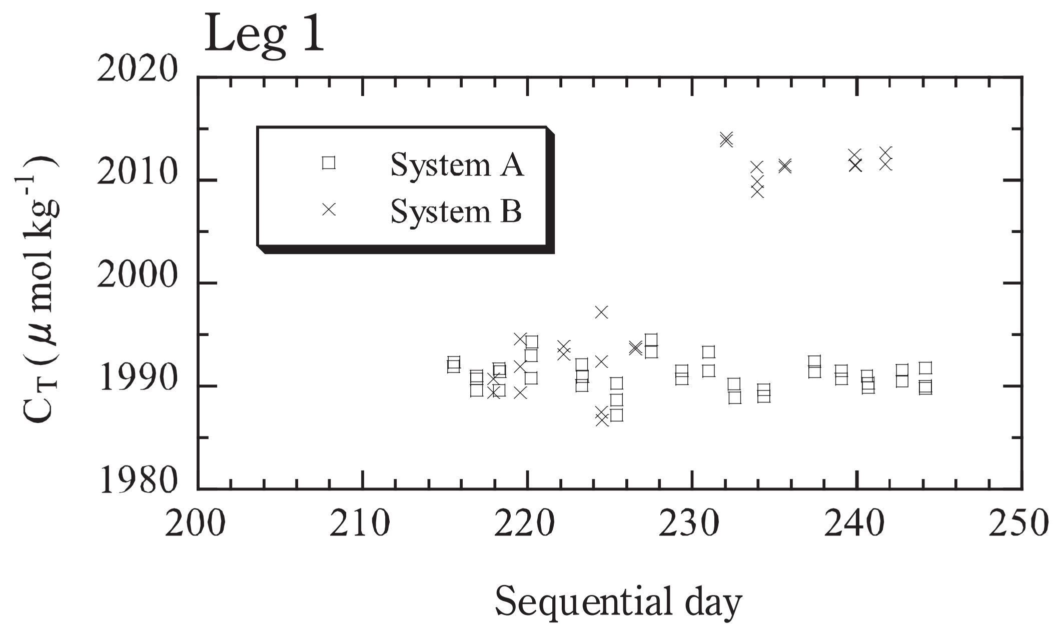

Figure 3.5.1. Temporal variations of CRM C_T measured by the systems A and B in the leg 1.

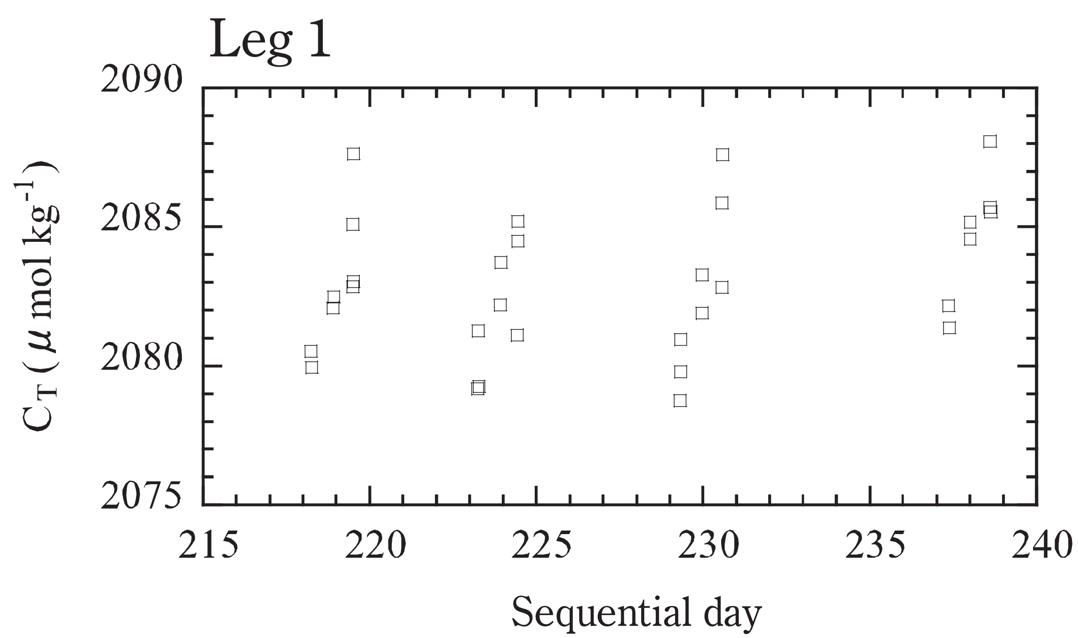

Figure 3.5.2. An example of temporal variations of RM C_T.

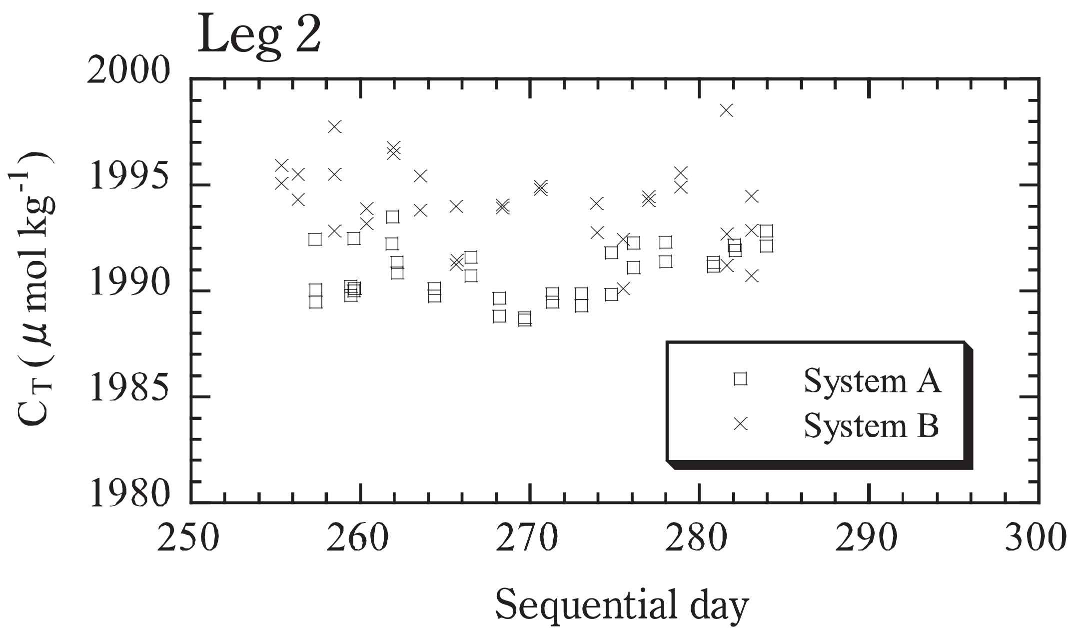

Figure 3.5.3. Temporal variations of CRM C_T measured by the systems A and B in the leg 2.

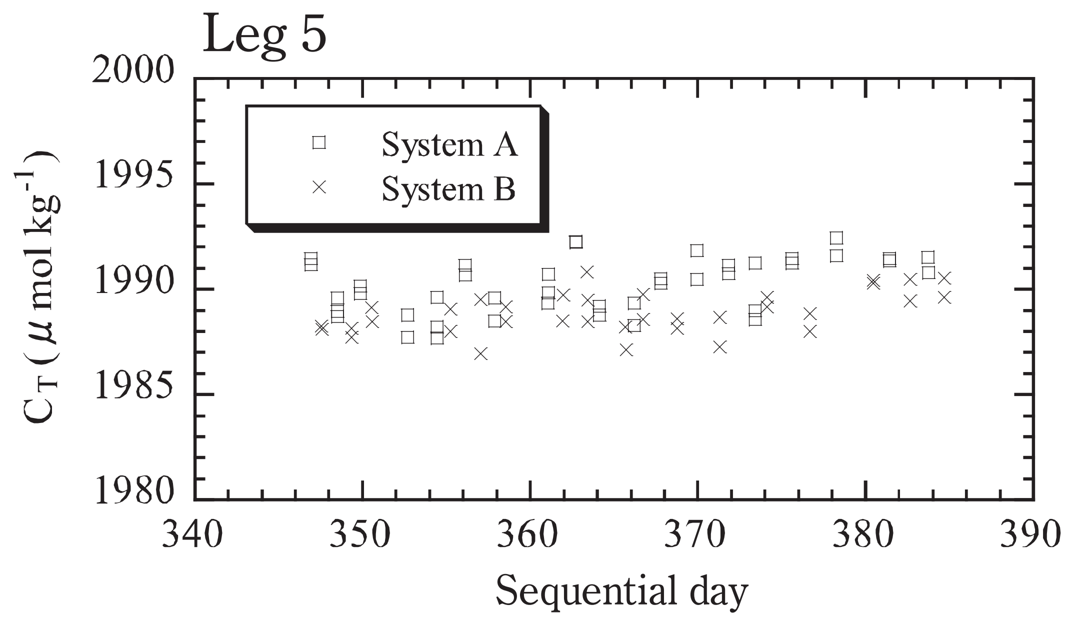

Figure 3.5.5. Temporal variations of CRM C_T measured by the systems A and B in the leg 5.

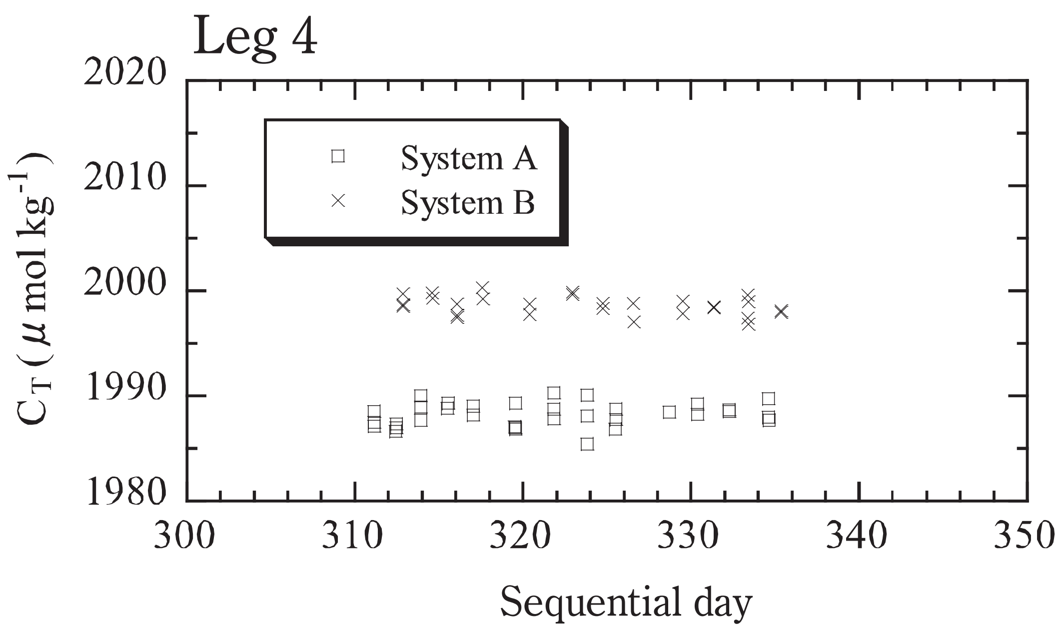

Figure 3.5.4. Temporal variations of CRM C_T measured by the systems A and B in the leg 4.

3.6 Total alkalinity (A_T)

3 February 2005

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(2) Introduction

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} due to human activities such as burning of fossil fuels, deforestation, cement production, etc. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the predicted global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

In the BEAGLE, we were aimed at quantifying how much anthropogenic CO_2 absorbed in the Southern Ocean, where intermediate and deep waters are formed, are transported and redistributed in the southern hemisphere subtropical oceans. For the purpose, we measured CO_2-system properties such as dissolved inorganic carbon (C_T), total alkalinity (A_T), pH and underway pCO_2.

In this section, we describe data on A_T obtained in the BEAGLE in detail.

(3) Apparatus

The measuring system for A_T (customized by Nippon ANS, Inc.) comprises of a water dispensing unit with an auto-sampler (6 ports), an auto-burette (Metrohm) and a pH meter (Thermo Orion). They are automatically controlled by a PC. We prepared two systems for the BEAGLE, but a single system was enough for the measurement except for the leg 1, because the system could perform a high speed titration (5-6 min.). Combined electrodes (Model 8103BN ROSS™) were used through the cruise.

A seawater of approx. 40 ml is transferred from a sample bottle (borosilicate glass bottle; 130 ml) into a water-jacketed (25 °C) pipette by pressurized N_2 gas, and is introduced into a water-jacketed (25 °C) titration cell. Next, a given volume of a titrant is injected into the titration cell so that pH of a seawater sample becomes 4.5 – 4.0. The seawater sample mixed with the titrant is stirred for three minutes by a stirring chip. Then an aliquot of titrant (~0.1 ml) is added consecutively until pH or e.m.f. reaches a given value. The concentration of the acid titrant is nominally 0.05 M HCl in 0.65 M NaCl.

Calculation of A_T is made based on a modified Gran approach.

(4) Shipboard measurement

Sampling

All seawater samples were collected from depth using 12 liter Niskin bottles basically at every other stations. The seawater samples for A_T were taken with a plastic drawing tube (PFA tubing connected to silicone rubber tubing) into borosilicate glass bottles of 130 ml. The glass bottle was filled with seawater smoothly from the bottom after rinsing it with a seawater of half a or a full bottle volume. A few hours before analysis, the seawater samples were kept at 25 °C in a water bath.

Analysis

For the A_T measurement, we selected electrodes, which showed signals close to theoretical Nernstian behavior.

At the start of each leg, we conducted calibration of the acid titrant, which was prepared on land. The calibration was made by measuring A_T of 5 solutions of Na_2CO_3 in 0.7 M NaCl solutions (nominally 0, 100, 1000, 2000 and 2500 μmol kg^{-1}). The measured values of A_T (calculated by assuming 0.05 M acid titrant) should be a linear function of the A_T computed from concentrations of the Na_2CO_3 solutions. The linear function was fitted by the method of least squares. Theoretically, the slope of the linear function should be unity. If the measured slope is not equal to one, the acid normality should be adjusted by dividing initial normality by the slope, and the whole set of calculations is repeated until the slope = 1.

Before starting analyses of seawater samples, we measured A_T of dummy seawater samples to confirm a condition of the measuring systems. If repeat measurements of A_T were constant within ~3 μmol kg^{-1}, we initiated measurement of seawater samples. We analyzed reference materials (RM), which were produced for C_T by JAMSTEC and KANSO, but were efficient also for the monitor of A_T measurement. In addition, certified reference materials (CRM, batch 60, certified value = 2199.55 μmol kg^{-1}) were also analyzed periodically to monitor systematic differences of measured A_T.

The preliminary values were reported in a data sheet on the ship. Repeatability calculated from replicate samples and vertical profiles of A_T based on raw data for each station helped us check performances of the measuring systems.

In each leg, we finished all the analyses for A_T on board the ship. We did not encounter so serious a problem as we had to give up the analyses. However, we experienced some malfunction of the system during the cruise, which are listed in the followings:

Small bubbles were often found in a pipette, probably due to stagnation of a seawater flow in the joint at an inlet of a pipette. In this case, we re-sealed the joint properly;

After analyses of a large number of samples, we often experienced a drift of an electrode, which appeared as differences of pH or e.m.f. in spite of an injection of a constant volume of an acid titrant into a seawater sample of almost a same A_T. In this case, we changed ranges of pH or e.m.f. used for the determination of A_T.

(5) Quality control

Leg 1

We used two systems (systems A and B) in this leg, but about 2/3 of the all the samples were analyzed by the system A.

Temporal variations of CRM A_T are displayed in Fig. 3.6.1. From this figure, it is found that for both the systems, such characteristic patterns as trend, discontinuity, etc. do not exist in the variations. Therefore, we re-calculated A_T of seawater samples using the concentration of HCl, which was re-calculated from the average of measured CRM A_T and the certified value of CRM A_T.

We surveyed vertical profiles of A_T. In particular, we examined whether systematic differences between measurements of the systems A and B existed or not. Then taking other information of analyses into account, we determined a flag of each value of A_T.

The average and standard deviation of absolute values of differences of A_T analyzed consecutively were 2.2 and 1.8 μmol kg^{-1} (n = 188), respectively.

We compared A_T measured in the BEAGLE with A_T calculated from C_T and pCO_2 measured in the WOCE P6 (Fig. 3.6.5). We judged that differences of A_T between the two observation periods are due to analytical errors, because the differences are also found in the deep layer.

Leg 2

We analyzed all seawater samples by the system B.

Temporal variations of CRM A_T are displayed in Fig. 3.6.2. From this figure, it is found that there exists a decreasing trend of A_T. In addition, we also found some gaps of measured A_T, when we examined the vertical profiles of A_T. Considering these results, we decided to calculate averages of CRM A_T separating the data into three periods. Since in the first period (before the 270th sequential day, Fig. 3.6.2), the A_T includes a decreasing trend, we determined the values of CRM A_T at each sequential day of measurements of seawater samples considering the trend. Then we determined concentration of HCl from the corrected values of CRM A_T and the certified value of CRM A_T.

We surveyed vertical profiles of A_T. Then taking other information of analyses into account, we determined a flag of each value of A_T.

The average and standard deviation of absolute values of differences of A_T analyzed consecutively were 2.5

and 2.0 μmol kg^{-1} (n = 168), respectively.

We compared A_T measured in the BEAGLE with A_T calculated from C_T and pCO_2 measured in the WOCE P6 (Fig. 3.6.5). We judged that differences of A_T (5 – 10 μmol kg^{-1}) between the two observation periods are due to analytical errors, because the differences are also found in the deep layer.

Leg 4

We analyzed all seawater samples by the system B.

Temporal variations of CRM A_T are displayed in Fig. 3.6.3. From this figure, it is found that there exists a discontinuous change of A_T. That is, before the 320 sequential day, the A_T shows a decreasing trend, but after the day, the A_T displays a stationary variation. From this characteristics of temporal variation, we re-calculated concentrations of HCl, separating the data for CRM A_T into two periods, as conducted in the quality control for the leg 2.

We surveyed vertical profiles of A_T. Then taking other information of analyses into account, we determined a flag of each value of A_T.

The average and standard deviation of absolute values of differences of A_T analyzed consecutively were 2.2 and 1.7 μmol kg^{-1} (n = 162), respectively.

We compared A_T measured in the BEAGLE with A_T measured in the WOCE A10 (Fig. 3.6.6). We judged that differences of A_T (5 – 10 μmol kg^{-1}) between the two observation periods are due to analytical errors, except for the upper layer. The differences in the upper layer might be related to seasonal differences.

Leg 5

We analyzed all seawater samples by the system B.

Temporal variations of CRM A_T are displayed in Fig. 3.6.4. The A_T shows a decreasing trend. Therefore, we reflected the trend in re-determining concentration of HCl, as conducted in the quality control for the leg 2.

We surveyed vertical profiles of A_T. Then taking other information of analyses into account, we determined a flag of each value of A_T.

The average and standard deviation of absolute values of differences of A_T analyzed consecutively were 2.0 and 1.8 μmol kg^{-1} (n = 220), respectively.

We compared A_T measured in the BEAGLE with A_T measured in the WOCE I3 and I4 (Fig. 3.6.7). It is evident that A_Ts obtained in the BEAGLE are systematically lower by 5 – 10 μmol kg^{-1} than those in the WOCE. At present, we do not know the reason why such a difference occurs.

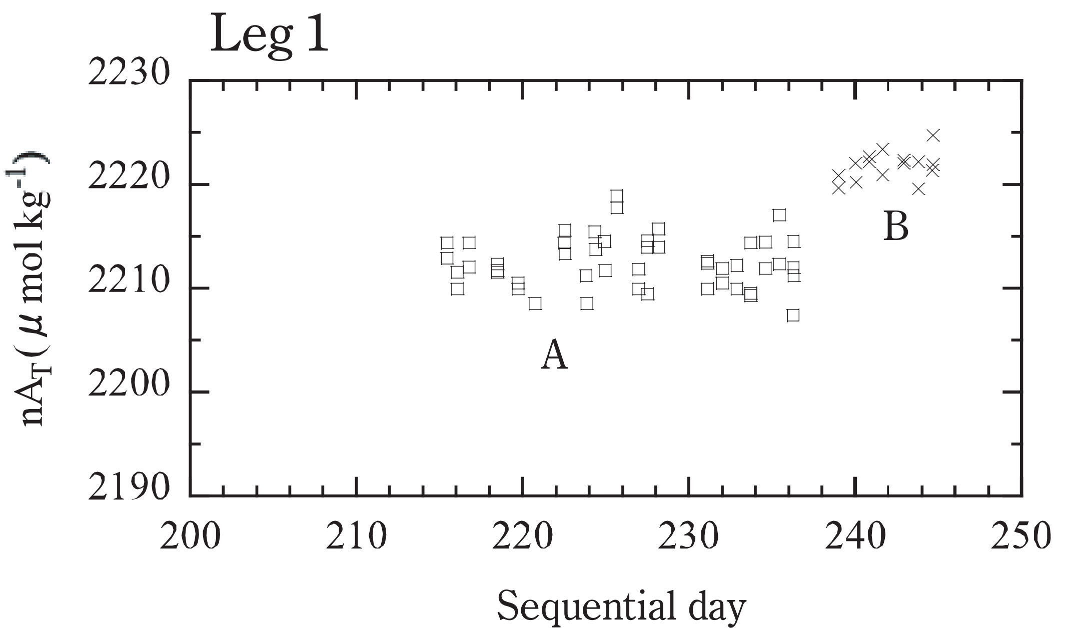

Figure 3.6.1. Temporal variations of CRM A_T measured in the leg 1. The sequential day is counted from 1 January, 2003. The "A" and "B" indicate results of the systems A and B, respectively.

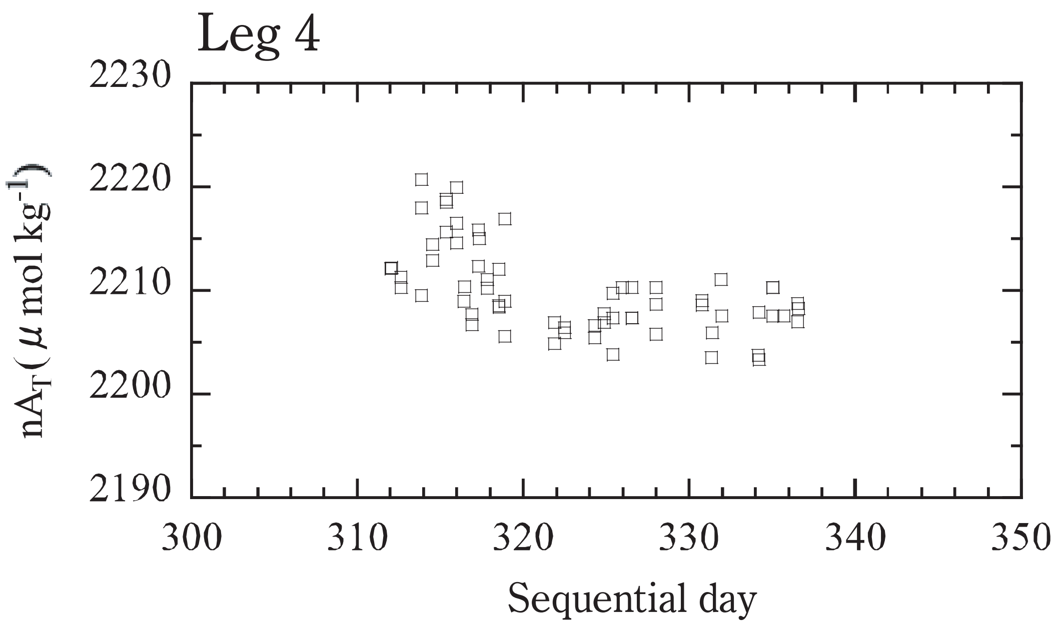

Figure 3.6.3. Temporal variations of CRM A_T measured in the leg 4.

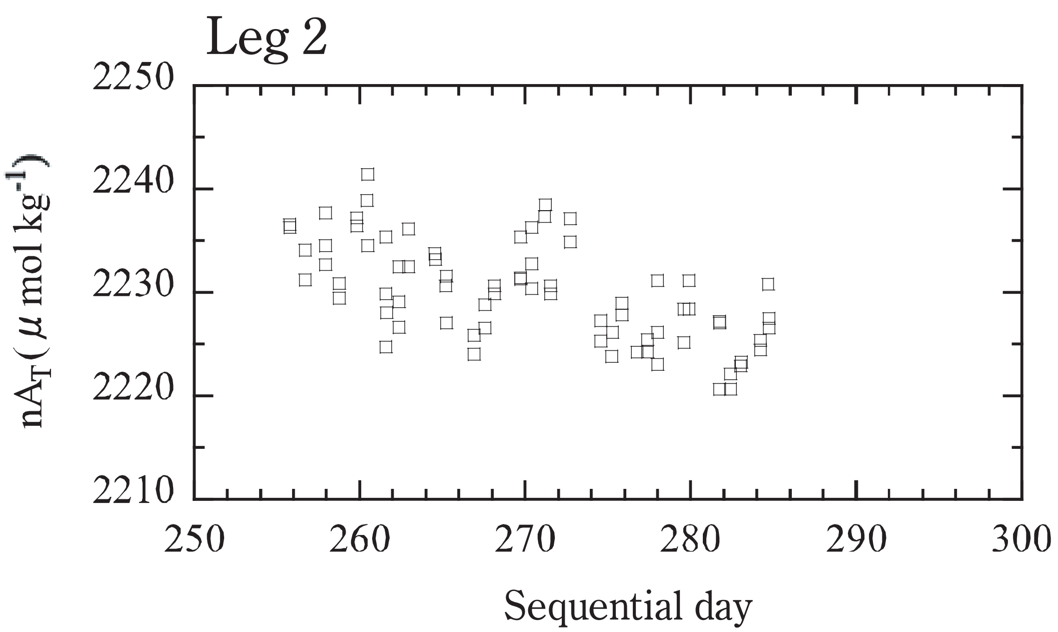

Figure 3.6.2. Temporal variations of CRM A_T measured in the leg 2.

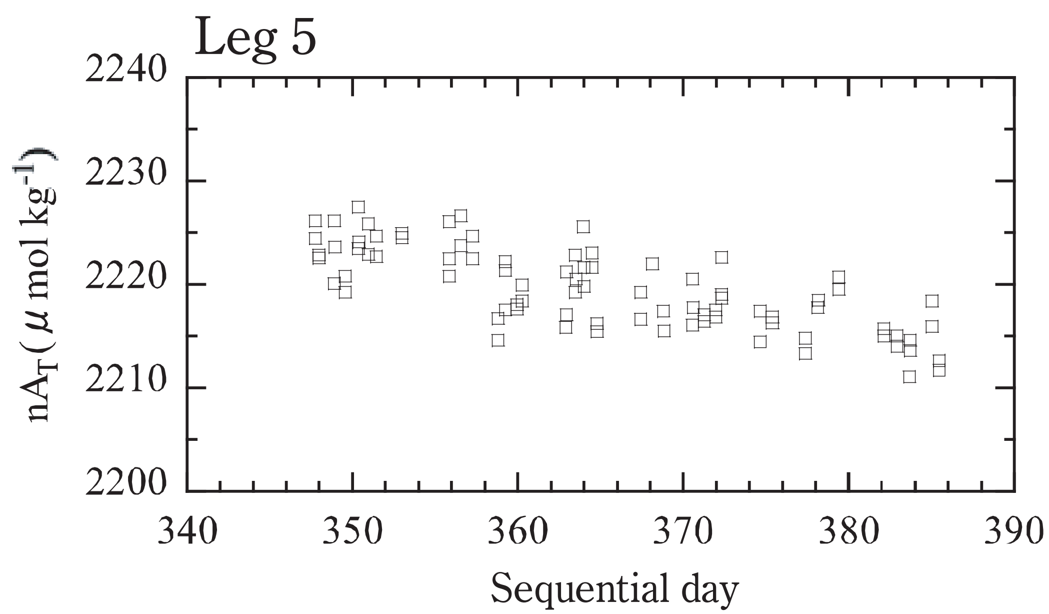

Figure 3.6.4. Temporal variations of CRM A_T measured in the leg 5.

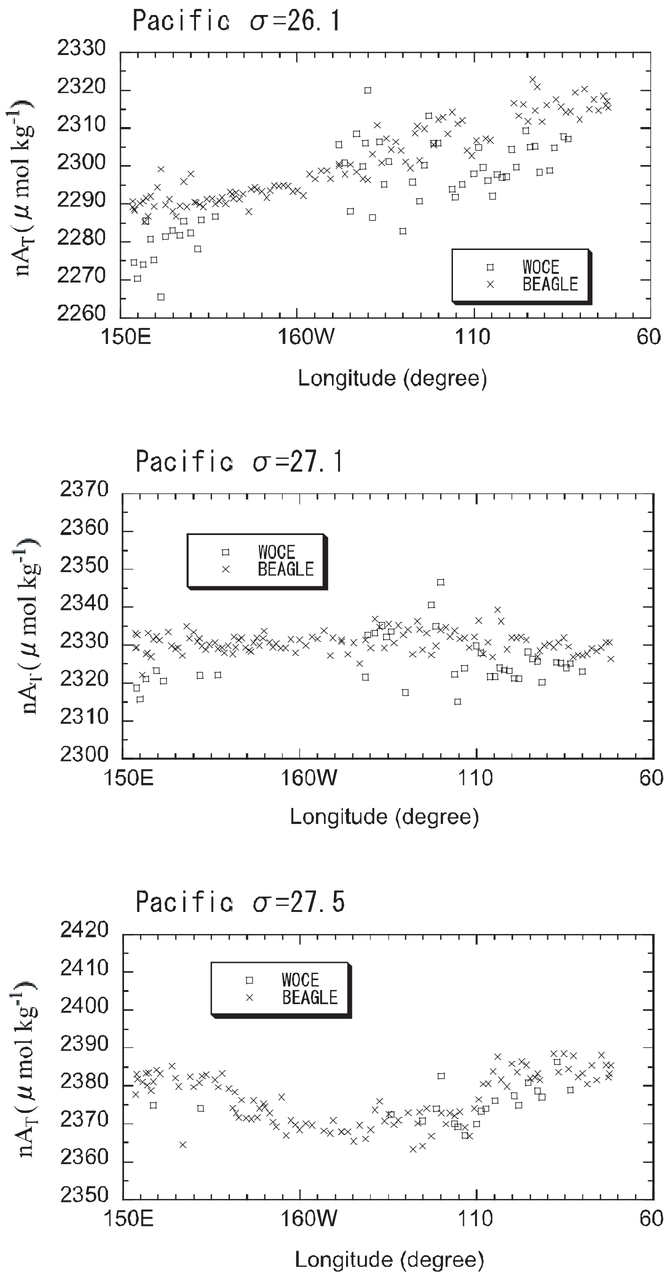

Figure 3.6.5. Comparisons of A_T measured in the BEAGLE with A_T calculated from C_T and pCO_2 measured along the WOCE P6 on isopycnal surfaces of 26.1 σ_θ (top panel), 27.1 σ_θ (middle panel) and 27.5 σ_θ (bottom panel).

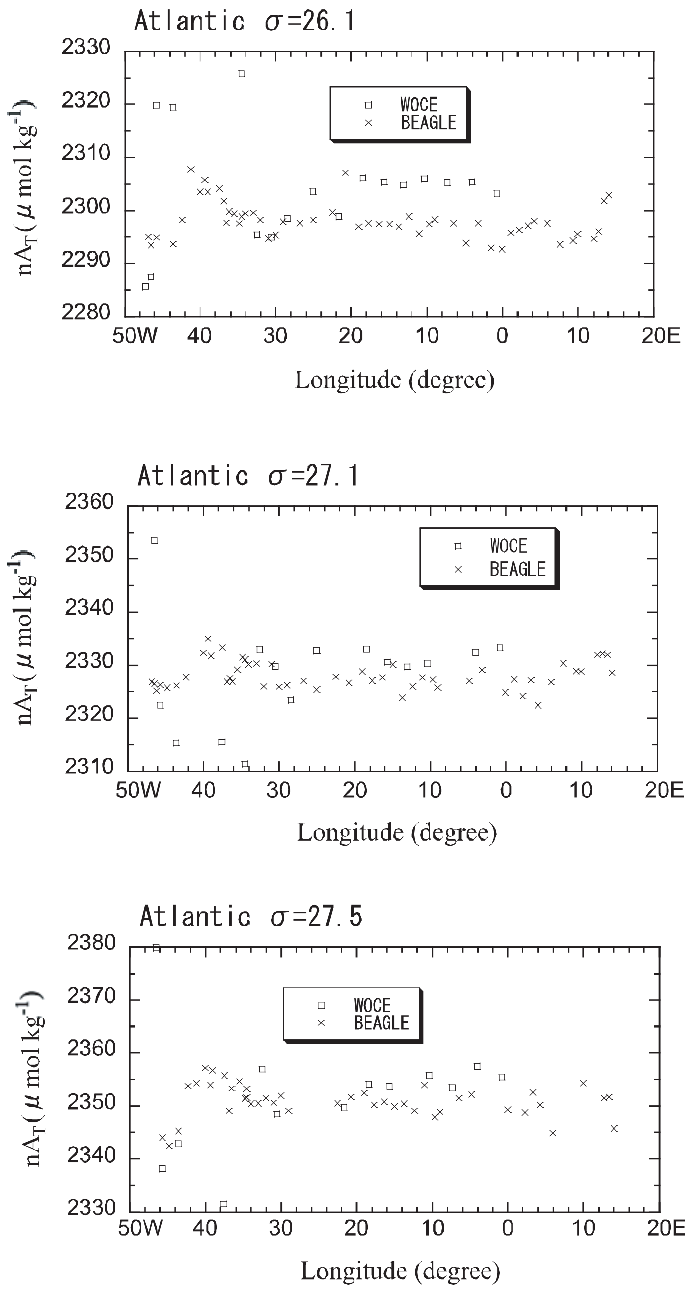

Figure 3.6.6. Comparisons of A_T measured in the BEAGLE with A_T calculated from C_T and pCO_2 measured along the WOCE A10 on isopycnal surfaces of 26.1 σ_θ (top panel), 27.1 σ_θ (middle panel) and 27.5 σ_θ (bottom panel).

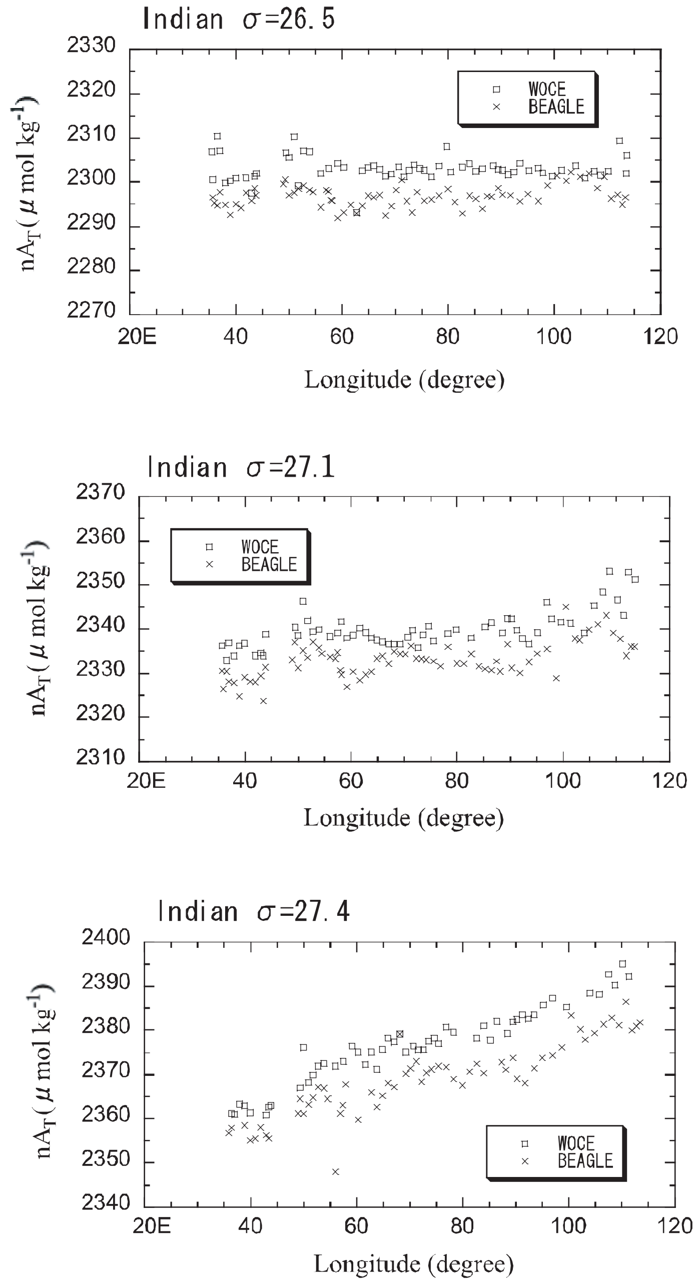

Figure 3.6.7. Comparisons of A_T measured in the BEAGLE with A_T calculated from C_T and pCO_2 measured along the WOCE I3/I4 on isopycnal surfaces of 26.1 σ_θ (top panel), 27.1 σ_θ (middle panel) and 27.5 σ_θ (bottom panel).

3.7 pH

3 February 2005

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(2) Introduction

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} due to human activities such as burning of fossil fuels, deforestation, cement production, etc. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the predicted global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

In the BEAGLE, we were aimed at quantifying how much anthropogenic CO_2 absorbed in the Southern Ocean, where intermediate and deep waters are formed, are transported and redistributed in the southern hemisphere subtropical oceans. For the purpose, we measured CO_2-system properties such as dissolved inorganic carbon (C_T), total alkalinity (A_T), pH and underway pCO_2.

In this section, we describe data on pH obtained in the BEAGLE in detail.

(3) Apparatus

Measurement of pH was made by a pH measuring system (Nippon ANS, Inc.), which adopts a method of the spectrophotometric determination. The measuring system comprises of a water dispensing unit with an auto-sampler and a spectrophotometer (Carry 50 Scan, Varian).

Seawater is transferred from borosilicate glass bottle (300 ml) to a sample cell in the spectrophotometer. The length and volume of the cell are 8 cm and 13 ml, respectively, and the sample cell is kept at 25.00 ± 0.05 °C in a thermostatic compartment. First, absorbance of seawater is measured at three wavelengths (730, 578 and 434 nm). Then an indicator solution is injected and circulated for about 4 minutes to mix the indicator solution and seawater sufficiently by a peristaltic pump. After the pump is stopped, the absorbance of seawater + indicator solution is measured at the three wavelengths. The pH is calculated based on the following equation (Clayton and Byrne, 1993):

$$pH = pK_2 + \log\left(\frac{A_1 / A_2 - 0.00691}{2.2220 - 0.1331(A_1 / A_2)}\right), \qquad (1)$$

where A_1 and A_2 indicate absorbance at 578 and 434 nm, respectively, and pK_2 is calculated as a function of water temperature and salinity.

(4) Shipboard measurement

Sampling

All seawater samples were collected from depth with 12 liter Niskin bottles basically at every other stations. The seawater samples for pH were taken with a plastic drawing tube (PFA tubing connected to silicone rubber tubing) into a 300 ml borosilicate glass bottle, which is the same as used for C_T sampling. The glass bottle was filled with seawater smoothly from the bottom following a rinse with a sea water of 2 full, bottle volumes. The glass bottle was closed by a stopper, which was fitted to the bottle mouth gravimetrically without additional force.

We analyzed seawater samples as soon as possible within half a day.

Analysis

For an indicator solution, m-cresol purple (2 mM) was used. NaCl was added to the indicator solution so that the solution had a density close to seawater. The indicator solution was produced on board the ship, and retained in a 1000 ml DURAN® laboratory bottle. To minimize absorption of CO_2 in an indicator solution, a holder of soda lime was attached. We renewed an indicator solution periodically when the headspace of the bottle became large, and monitored pH or absorbance ratio of the indicator solution by another spectrophotometer (Carry 50 Scan, Varian) using a cell with a short path length of 0.5 mm. In most indicator solutions, the absorbance ratios were initially in the range 1.4 – 1.6, and decreased to 1.1.

It is difficult to mix seawater with an indicator solution sufficiently under no headspace condition. However, by circulating the mixed solution with a peristaltic pump and by increasing density of indicator solutions, a well-mixed condition came to be attained rather shortly, leading to a rapid stabilization of absorbance (Fig. 3.7.1). We renewed a TYGON® tube of a peristaltic pump periodically, when the tube deteriorated in an impaired condition.

Absorbance of seawater only and seawater + indicator solutions was measured 12 and 30 times, respectively, and the last five values of absorbance were used for the calculation of pH (Equation 1).

The preliminary values of pH were reported in a data sheet on the ship. Repeatability calculated from replicate samples and vertical profiles of pH based on raw data for each station helped us check performance of the measuring system.

In each leg, we finished all the analyses for pH on board the ship. We did not encounter so serious a problem as we had to give up the analyses. However, we sometimes experienced malfunction of the system during the cruise:

The difference between absorbance of seawater only and absorbance of seawater + indicator solution was infrequently greater than ± 0.001. This implies dirt of the cell. In this case, we cleaned or replaced the cell.

(5) Quality control

It is recommended that correction for pH change resulting from addition of indicator solutions is made (DOE, 1994). To check the perturbation of pH due to the addition, we measured absorbance ratios by changing the volume of indicator solutions added to a same seawater sample. We corrected absorbance ratios based on an empirical method (DOE, 1994).

We surveyed vertical profiles of pH. In particular, we examined whether systematic differences between before and after the renewal of indicator solutions existed or not. Then taking other information of analyses into account, we determined a flag of each value of pH.

The average and standard deviation of absolute values of differences of pH analyzed consecutively are listed in Table 3.7.1.

References

Clayton, T.D. and R.H. Byrne (1993): Spectrophotometric seawater pH measurements: total hydrogen ion concentration scale calibration of m-cresol purple and at-sea results. Deep-Sea Research 40, 2115-2129.

DOE (1994): Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water, version 2, A. G. Dickson & C. Goyet, eds. (unpublished manuscript).

Table 3.7.1. Averages and standard deviations (s.t.d.) of absolute values differences of pH analyzed consecutively, separately for legs 1, 2, 4 and 5.

Leg no.	N	Average	s.t.d
1	140	0.0014	0.0017
2	176	0.0017	0.0014
4	155	0.0010	0.0009
5	208	0.0008	0.0007

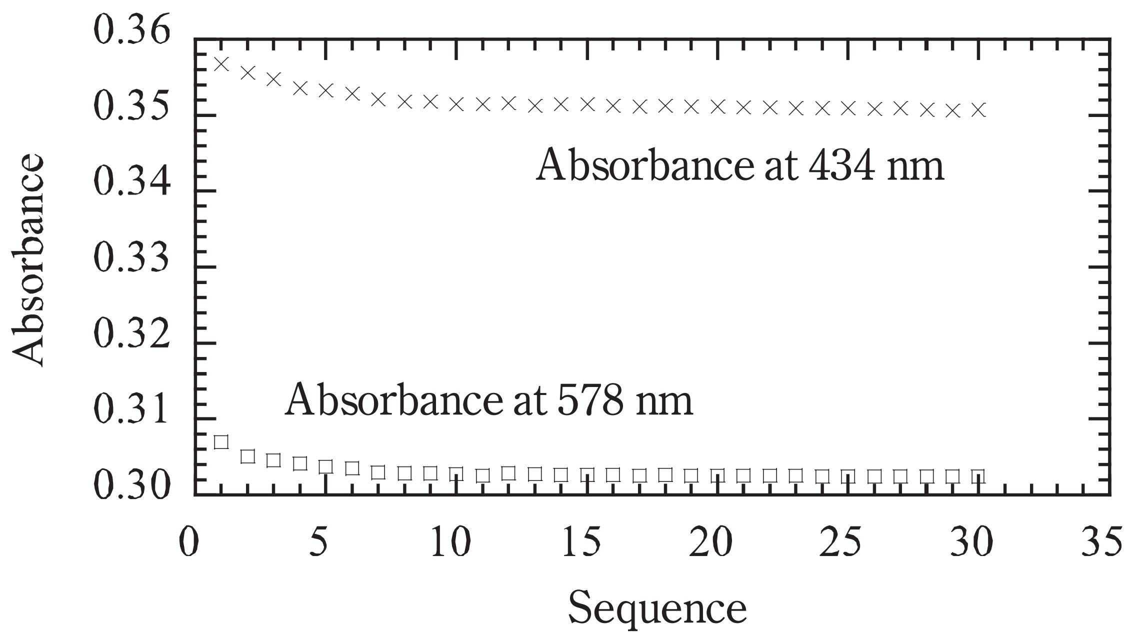

Figure 3.7.1. An example of temporal changes of absorbances. A unit of sequence corresponds to about 5 seconds.

3.8 Lowered Acoustic Doppler Current Profiler

28 February 2005

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On Sugimoto (JAMSTEC)

(2) Instrument and method

Direct flow measurement from sea surface to the bottom was carried out using a lowered acoustic Doppler current profiler (LADCP). The instrument used was the RDI Workhorse Monitor 307.2 kHz unit (RD Instruments, USA). The instrument was attached on the CTD/RMS frame, orientating downward. The CPU firmware version was 16.20.

One ping raw data were recorded, where the bin number was 32 and the bin length was 8 m, except 4m at CTD stations from P6_246 to P6_232 in the beginning of the cruise. The accuracies of each ping were 2.0 cm/s for 8 m bin and 3.0 cm/s for 4 m bin, respectively. Sampling interval was 1.29 seconds originally, and then it was changed to 1.20 seconds in leg 5. The bottom-tracking mode was used, which made the LADCP capture the sea floor 200 m above. Salinity value in the sound speed calculation was set as a constant value 34 PSU. We found the one of the four beams sounded weak signal during the cruise, and then we replaced another instrument at A10_37 station in the Atlantic sector. A pressure sensor was added to the first instrument.

A total of 118 operations were made with the CTD observations in the leg 1. Because the depth was too deep, operation was not made at the CTD stations, P6_175, P6_174 and P6_148. The performance of the LADCP instrument was good in western stations. Profiles were obtained over 100 m distance in shallow depth and almost 60 m in deeper depth. On the other hand in eastern stations in the leg 1 the performance was bad. In the deeper depth good quality data were obtained only 3 or 4 bins, which means the LADCP could observe only 25 m. It would due to a weak echo intensity, which agreed with ship's ADCP. A total of 112 operations are made in the leg 2. In the leg 4 a total of 111 operations were made. As mentioned above, we replace the instrument at A10_37. For the first instrument, the performance was bad; profiles were obtained less than 60 m in deeper depth. Three beam solutions gradually appeared more, sometimes in the leg 1, and often in the leg 2 and leg 4 before the replacement. After the replacement the profile was obtained about 80 m in deeper depth, as a four-beam solution. The sea bottom was detected during the instrument was lowered less than 200 m above the bottom. A total of 142 operations were made in the leg 5. The LADCP measurement was not operated at the station I3_468 where the depth was too deep. The performance of the instrument was relatively better in the shallow ocean, where profiles were obtained over 100 m. In the deep ocean it reached almost 60 m. The performance looked unchanged during the leg. Data transfer errors were often occurred during upload process from the LADCP to PC.

(3) Preliminary results

Vertical profiles of velocity field are analyzed by the inverse method (Visbeck, 2002). The bottom-track data and GPS navigation data are used in the calculation. Shipboard ADCP data are not included in the calculation. At this stage the CTD data are used for the sound speed and depth calculation. Figure 3.8.1 and 3.8.2 show the results at station A10_087 and A10_010, respectively, in the Atlantic. They would be a typical good and bad result, respectively. The results are somewhat sensitive to parameters. It is probably due to the short range of the LADCP signal, which makes less overlap in the inversion. More three-beam solution should affect it worse. On the other hand the bottom tracking was valid even if the sound did not reach so long.

Reference

Visbeck, M. (2002): Deep velocity profiling using Lowered Acoustic Doppler Current Profilers: Bottom track and inverse solutions. *J. Atmos. Oceanic Technol.*, 19, 794-807.

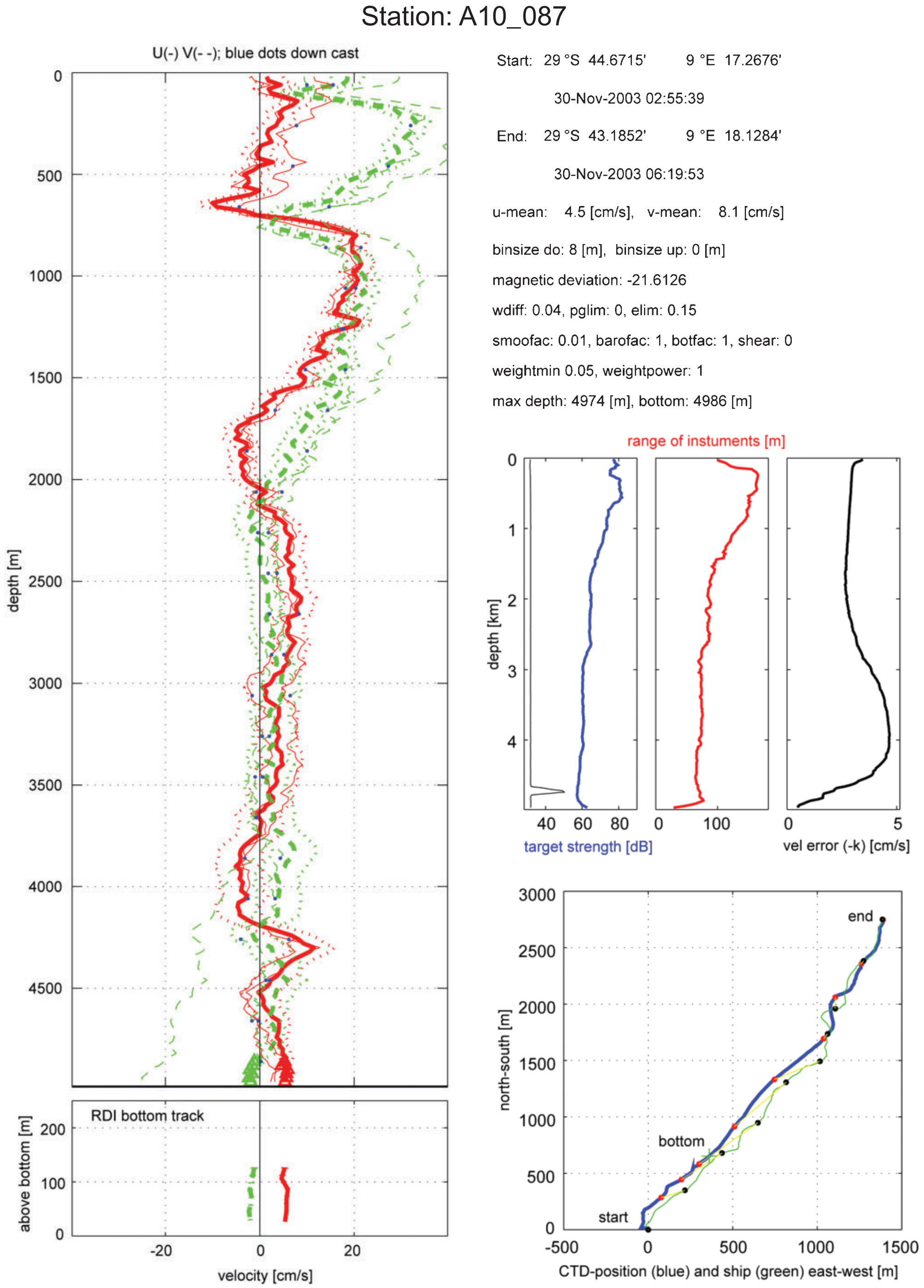


Figure 3.8.1. Vertical profiles of velocity at station A10_87.

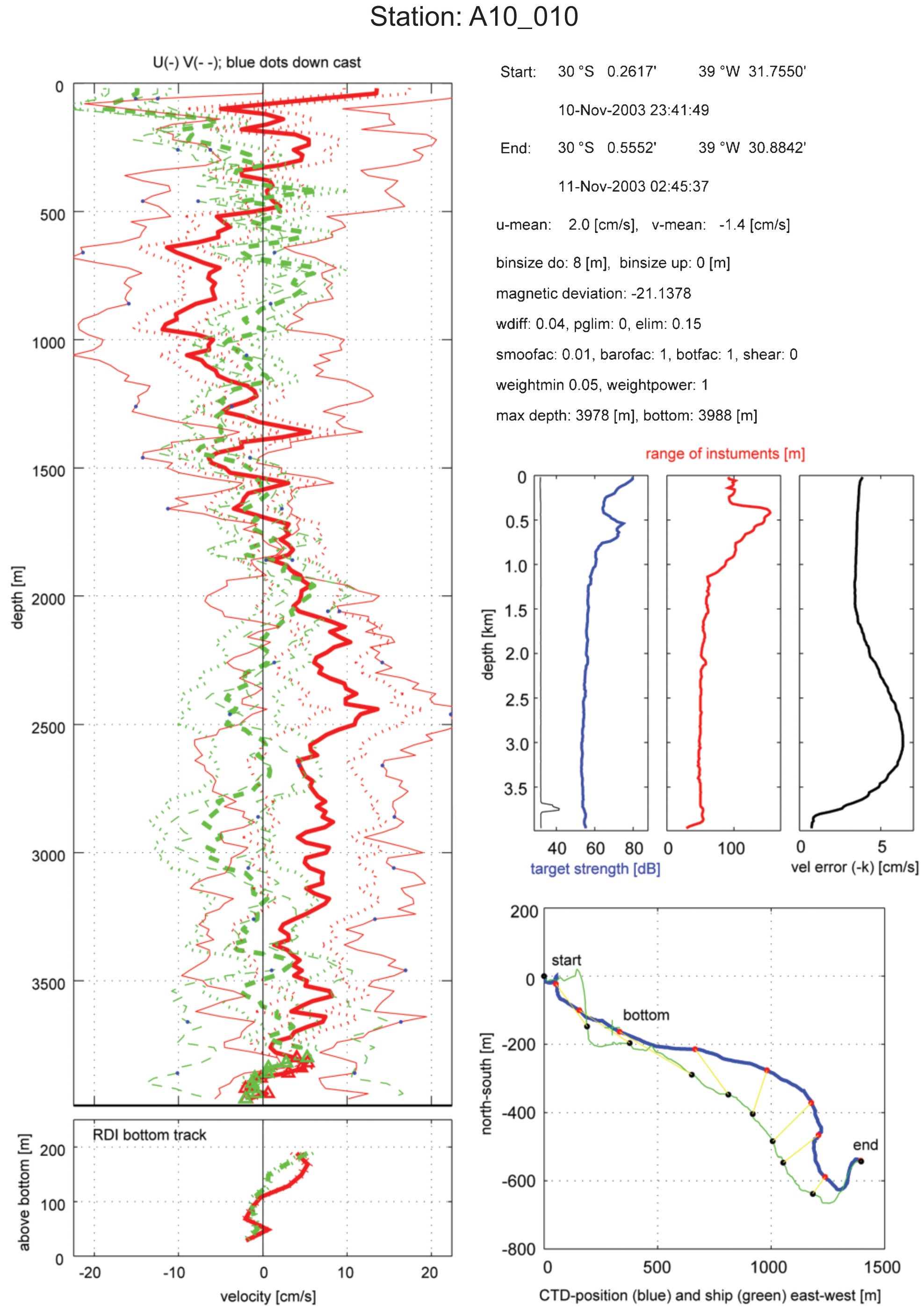


Figure 3.8.2. Vertical profiles of velocity at station A10_10.

Figure caption

Figure 1 Observation lines for WHP P6, A10 and I3/I4 revisit in Blue Earth Global Expedition 2003 (BEAGLE2003) with bottom topography based on ETOPO5 (Data announcement 88-MGG-02, 1988).

Figure 2 Station locations for WHP P6, A10 and I3/I4 revisit in BEAGLE2003 with bottom topography based on Smith and Sandwell (1997).

Figure 3 Potential temperature (°C) cross section calculated using CTD temperature and salinity data calibrated by bottle salinity measurements. Vertical exaggeration of the 0-6,500 m section is 1000:1. Expanded section of the upper 1000 m is made with a vertical exaggeration of 2500:1.

Figure 4 CTD salinity (psu) cross section calibrated by bottle salinity measurements. Vertical exaggeration is same as Figure 3.

Figure 5 Same as Figure 4 but with SSW batch correction[1].

Figure 6 Density (σ_0) (kg/m^3) cross section calculated using CTD temperature and calibrated salinity data with SSW batch correction. Vertical exaggeration is same as Figure 3.

Figure 7 Same as Figure 6 but for σ_4 (kg/m^3).

Figure 8 Neutral density (γ^n) (kg/m^3) cross section calculated using CTD temperature and calibrated salinity data with SSW batch correction. Vertical exaggeration is same as Figure 3.

Figure 9 Cross section of bottle sampled dissolved oxygen (μmol/kg). Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 10 Silicate (μmol/kg) cross section. Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 11 Nitrate (μmol/kg) cross section. Data with quality flags of 2 were plotted. Vertical exaggeration of the upper 1000 m section is same as Figure 3.

Figure 12 Nitrite (μmol/kg) cross section. Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 13 Phosphate (μmol/kg) cross section. Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 14 Dissolved inorganic carbon (μmol/kg) cross section. Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 15 Total alkalinity (μmol/kg) cross section. Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 16 pH cross section. Data with quality flags of 2 were plotted. Vertical exaggeration is same as Figure 3.

Figure 17 Difference in potential temperature (°C) between results from WOCE (from May to Jul. 1992 for P6, from Dec. 1992 to Jan. 1993 for A10, from Apr. to June 1995 for I3/I4) and BEAGLE2003 (from

Jul. to Oct. 2003 for P6, from Nov. to Dec. 2003 for A10, from Dec. 2003 to Jan. 2004 for I3/I4). Red and blue areas show areas where potential temperature increased and decreased in BEAGLE2003, respectively. On white areas differences in temperature do not exceed the detection limit of 0.002 °C. Vertical exaggeration is same as Figure 3.

Figure 18 Difference in salinity (psu) between results from WOCE and BEAGLE2003. Red and blue areas show areas where salinity increased and decreased in BEAGLE2003, respectively. CTD salinity data with SSW batch correction[1] are used. On white areas differences in salinity do not exceed the detection limit of 0.002 psu. Vertical exaggeration is same as Figure 3.

Figure 19 Difference in dissolved oxygen (μmol/kg) between results from WOCE and BEAGLE2003. Red and blue areas show areas where salinity increased and decreased in 2001, respectively. CTD oxygen data[2] are used. On white areas differences in salinity do not exceed the detection limit of 2 μmol/kg. Vertical exaggeration is same as Figure 3.

Note

1. As for the traceability of SSW to Mantyla's value, the offset for the batches P116 (WOCE P6), P120 (WOCE A10), P126 (WOCE I3/I4) and P142 (BEAGLE2003) are +0.0001, -0.0022, -0.0007 and -0.0011, respectively (Aoyama et al, 2002, Aoyama, 2005).
2. As for the WOCE A10 data, there are systematic differences between CTD oxygen and bottle oxygen data (Millard, 2000). Therefore the CTD oxygen of WOCE A10 was modified as

$$\text{Modified CTD oxygen} = \text{CTD oxygen} - (a_0 + b_0 * p) \quad [\text{where } p < 2{,}000 \text{ dbar}]$$
$$= \text{CTD oxygen} - (a_1 + b_1 * p) \quad [\text{where } p >= 2{,}000 \text{ dbar}]$$
$$a_0 + b_0 * pr = a_1 + b_1 * pr \quad [\text{where } pr = 2{,}000 \text{ dbar}]$$

where p is CTD pressure in dbar. The best fit sets of coefficients (a0, b0, a1 and b0) were determined by minimizing the sum of absolute deviation from the bottle oxygen data as follows.

a_0 = -3.9577e-4

b_0 = 6.4409

a_1 = 6.3317e-4

b_1 = 4.3830

References

Data Announcement 88-MGG-02 (1988): Digital relief of the Surface of the Earth, NOAA, National Geophysical Data Center, Boulder, Colorado.

Jackett, D. R. and R. J. McDougall (1997): A neutral density variable for the world's oceans, Journal of Physical Oceanography, 27, 237-263.

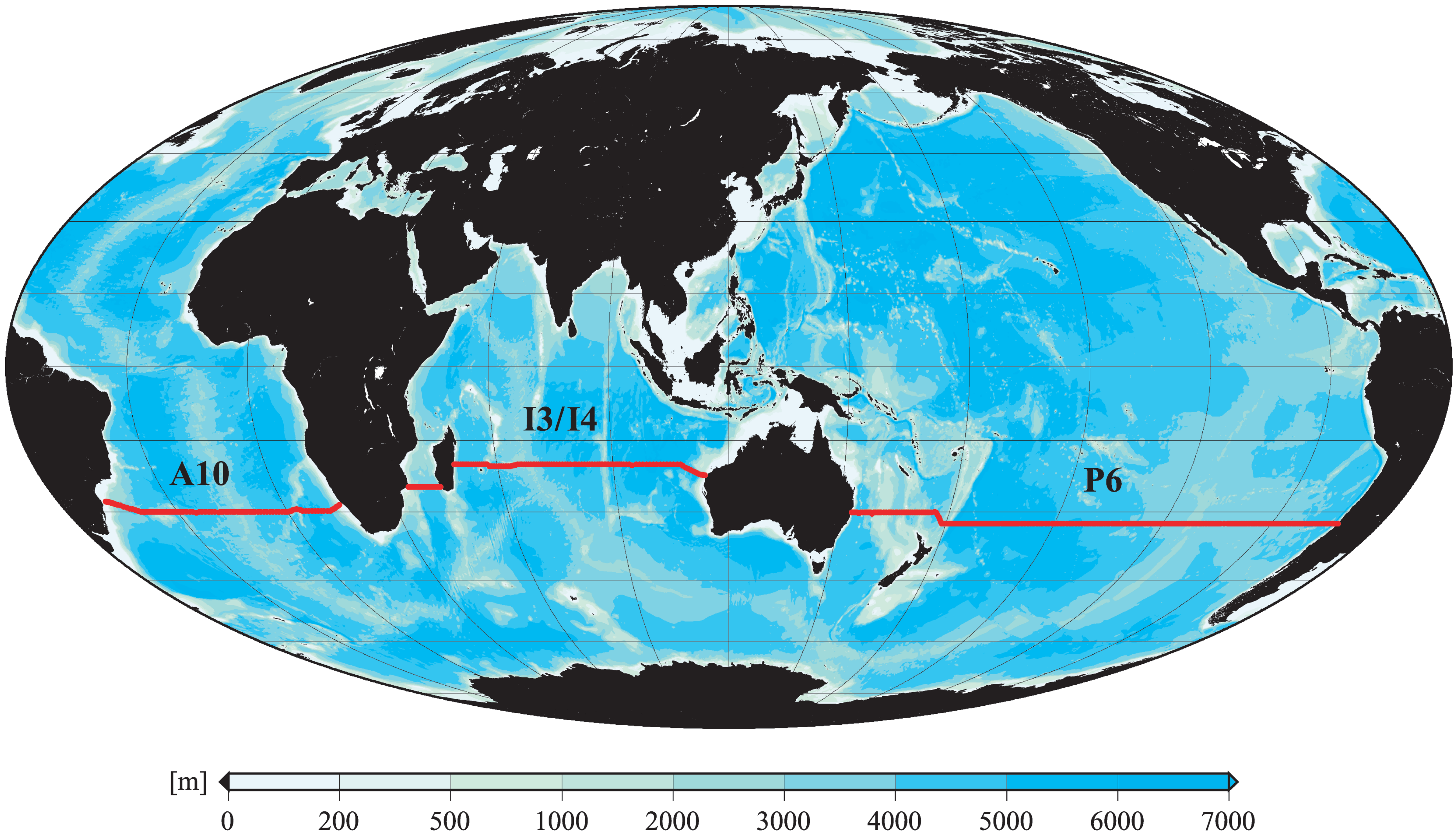
Smith, W. H. F. and D. T. Sandwell (1997): Global seafloor topography from satellite altimetry and ship depth soundings, Science, 277, 1956-1962.

Aoyama, M., T. M. Joyce, T. Kawano and Y. Takatsuki (2002): Standard seawater comparison up to P129, Deep-Sea Res. I, 49, 1103-1114.

Aoyama, M. (2005): Study on the traceability of reference material for salinity in seawater, Report of Research Project, Grant-in-Aid for Scientific Research (C)(2), 2002-2004, pp. 24.

Millard, R. (2000): DQE of CTD & water sample salinity and oxygen data of WOCE section A10, Cruise and data documentation for WHP A10, AR04EW, AR15, http://whpo.ucsd.edu/data/onetime/atlantic/a10/index.htm

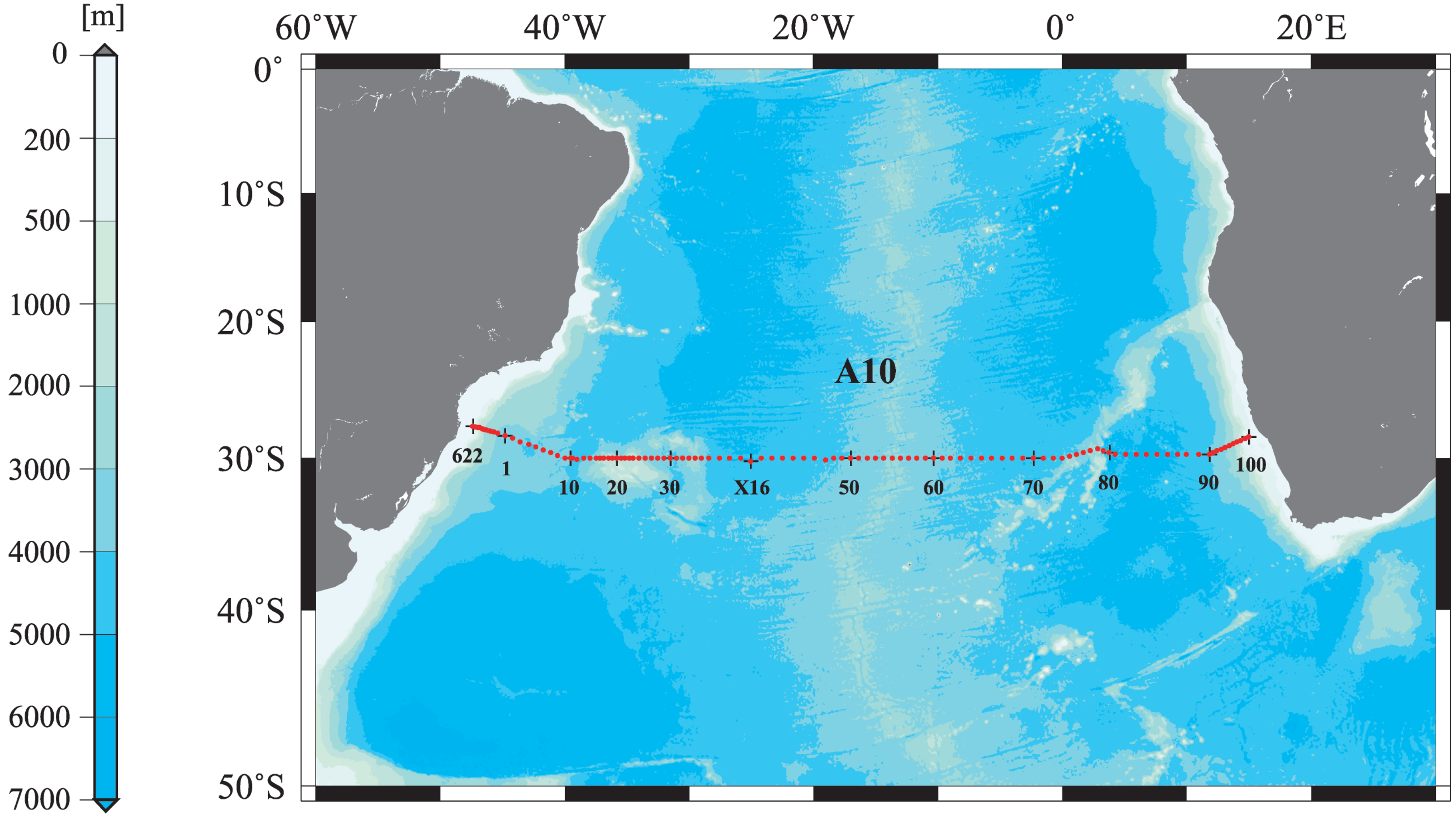
Figure 1

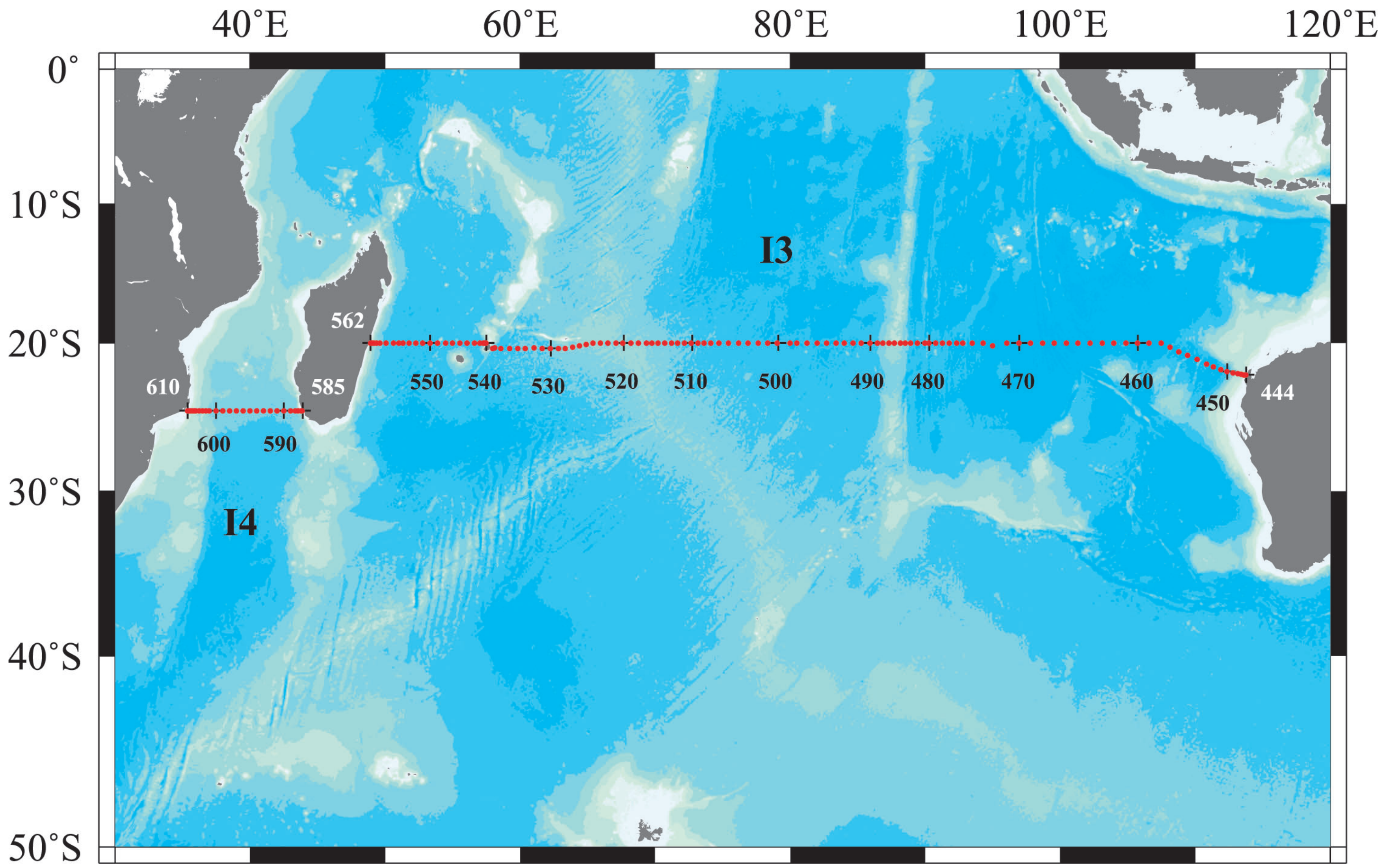


OBSERVATION LINES FOR WHP P6, A10, I3/I4 REVISIT IN 2003

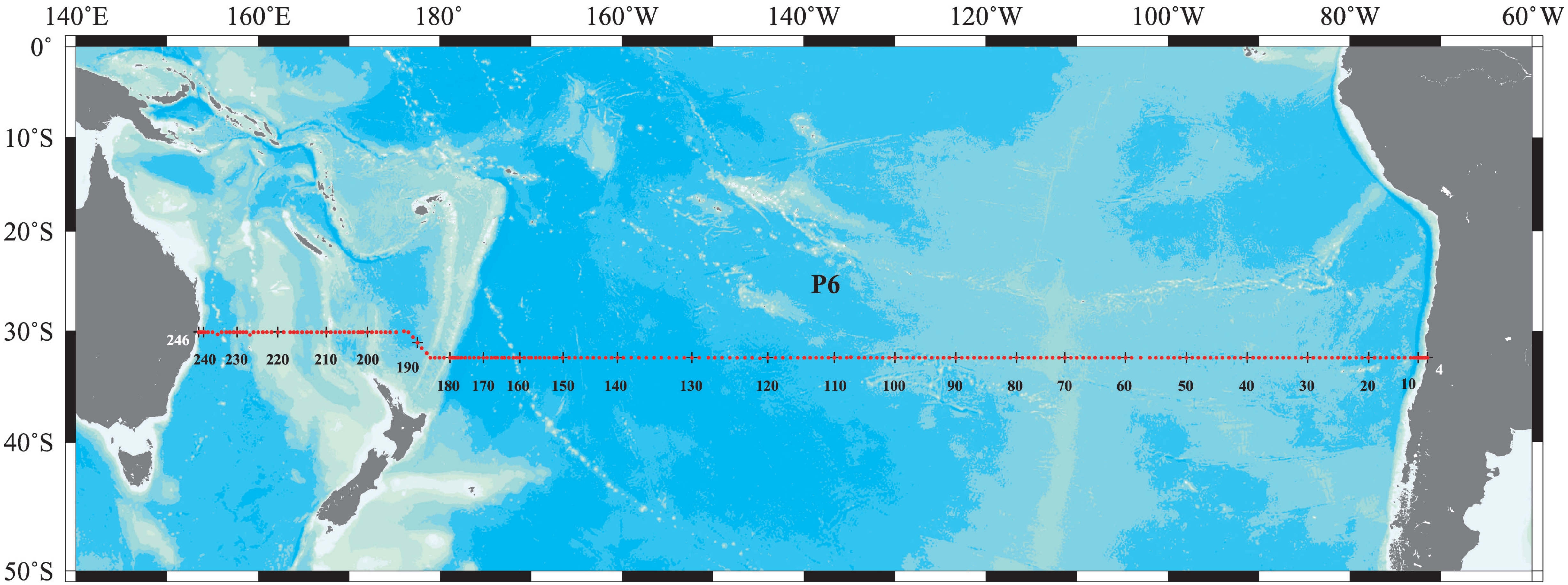
Figure 2

STATION LOCATIONS FOR WHP P6, A10, I3/I4 REVISIT IN 2003





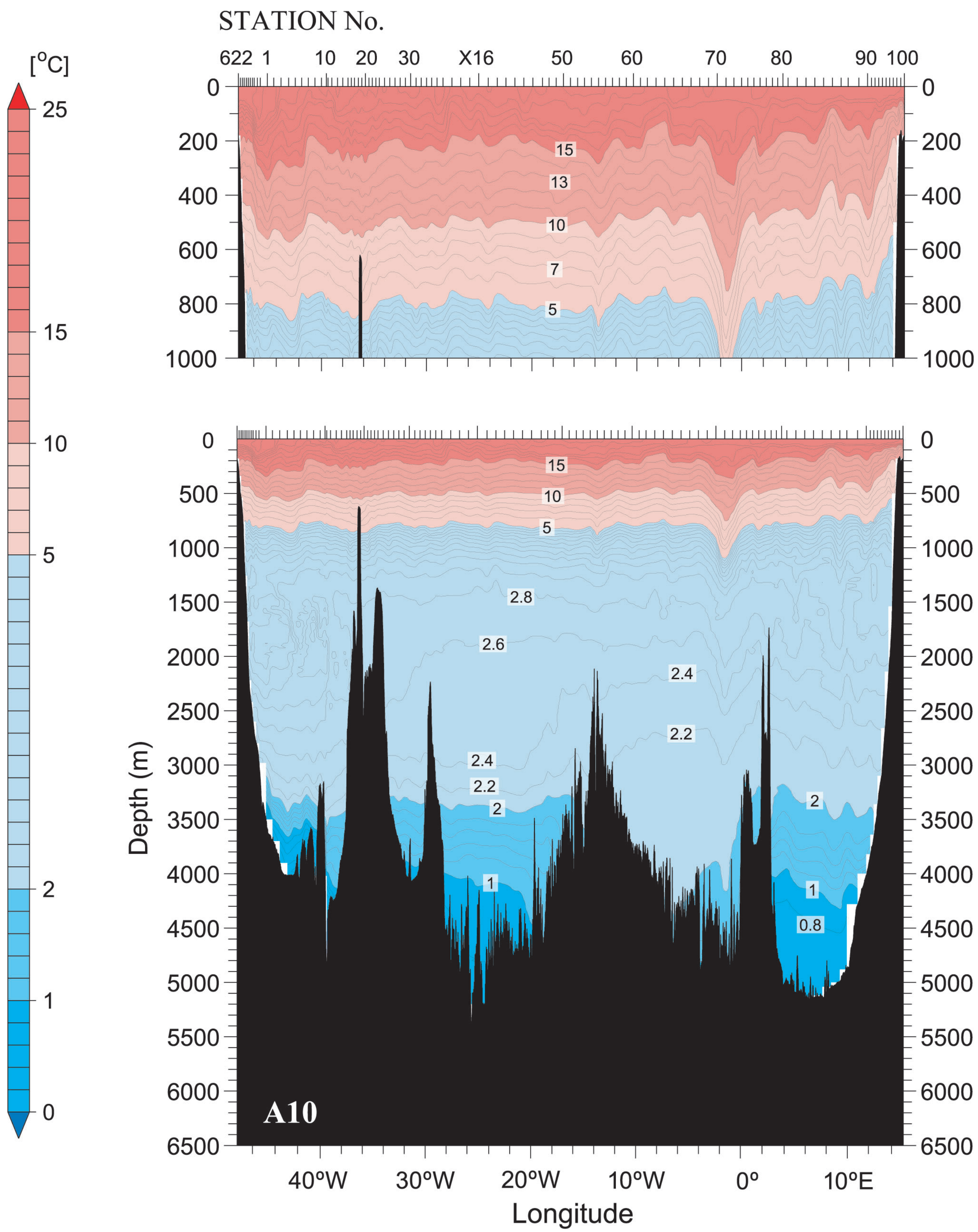
40°E
60°E
80°E
100°E
120°E
0°
10°S
20°S
30°S
40°S
50°S
I3
I4
562
585
610
600
590
550
540
530
520
510
500
490
480
470
460
450
444

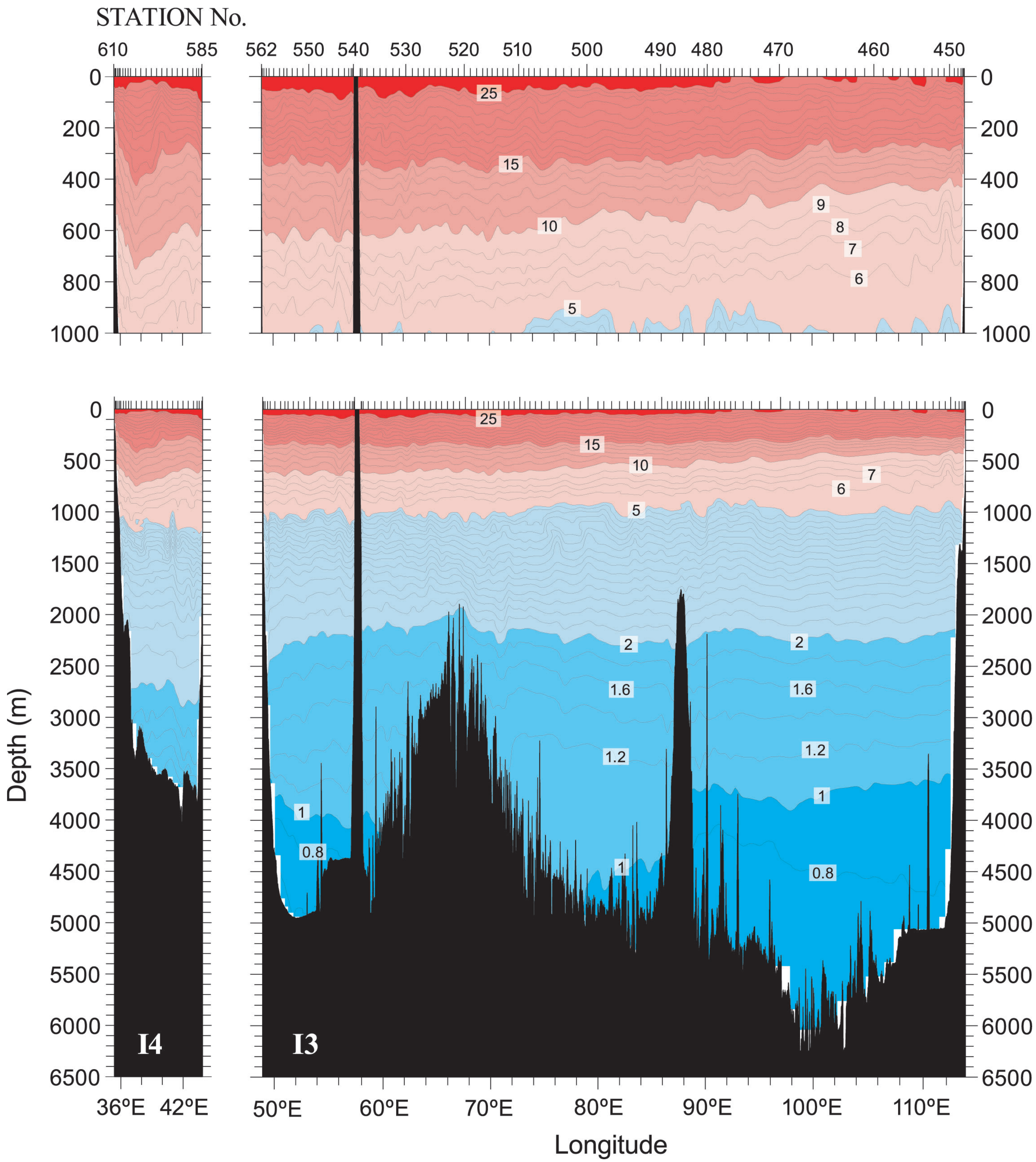


140°E
160°E
180°
160°W
140°W
120°W
100°W
80°W
60°W
0°
10°S
20°S
30°S
40°S
50°S
P6
246
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
4

Figure 3

POTENTIAL TEMPERATURE [ºC]





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540
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520
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480
470
460
450
25
15
10
9
8
7
6
5
2
1.6
1.2
1
0.8
Depth (m)
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I3
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42ºE
50ºE
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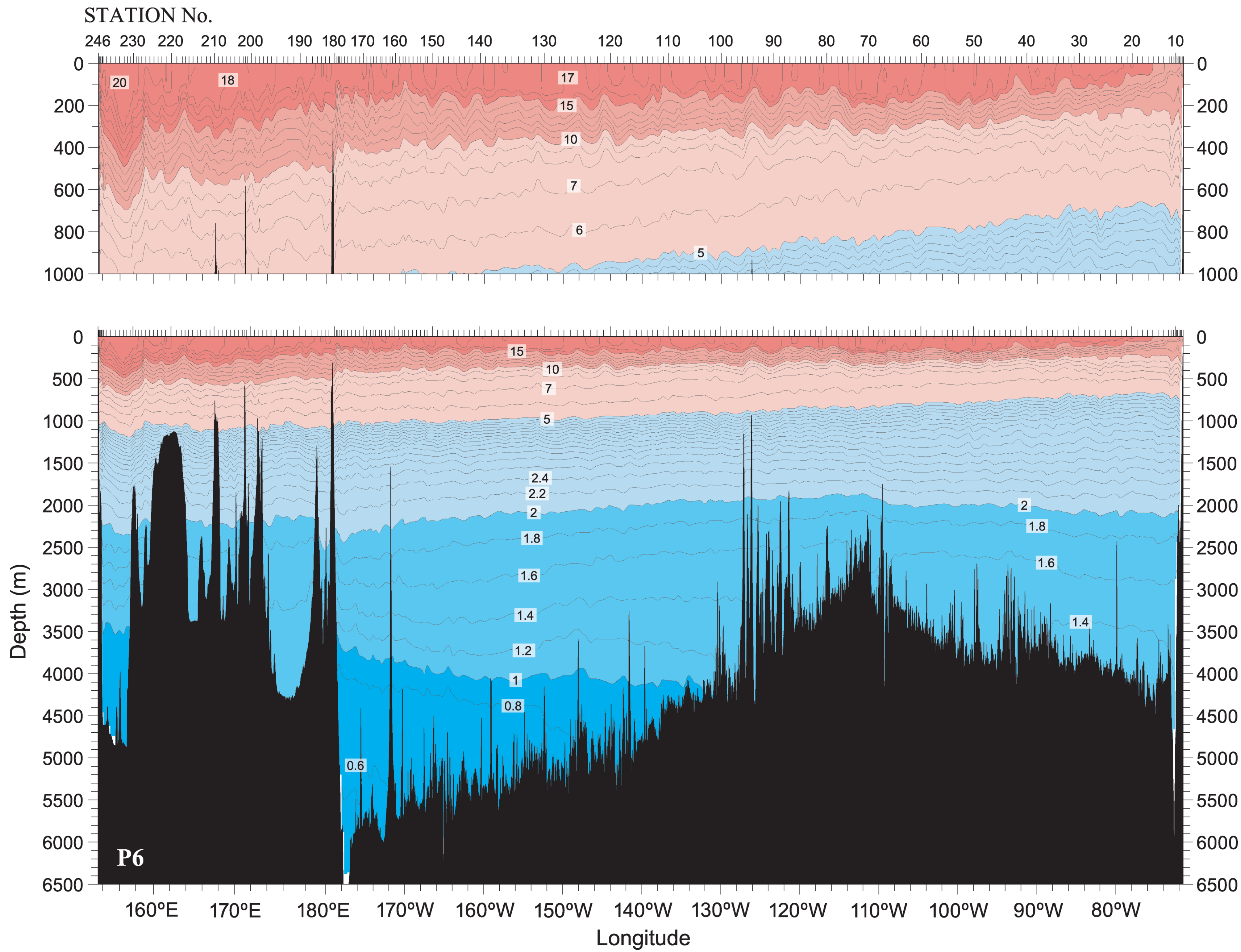
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude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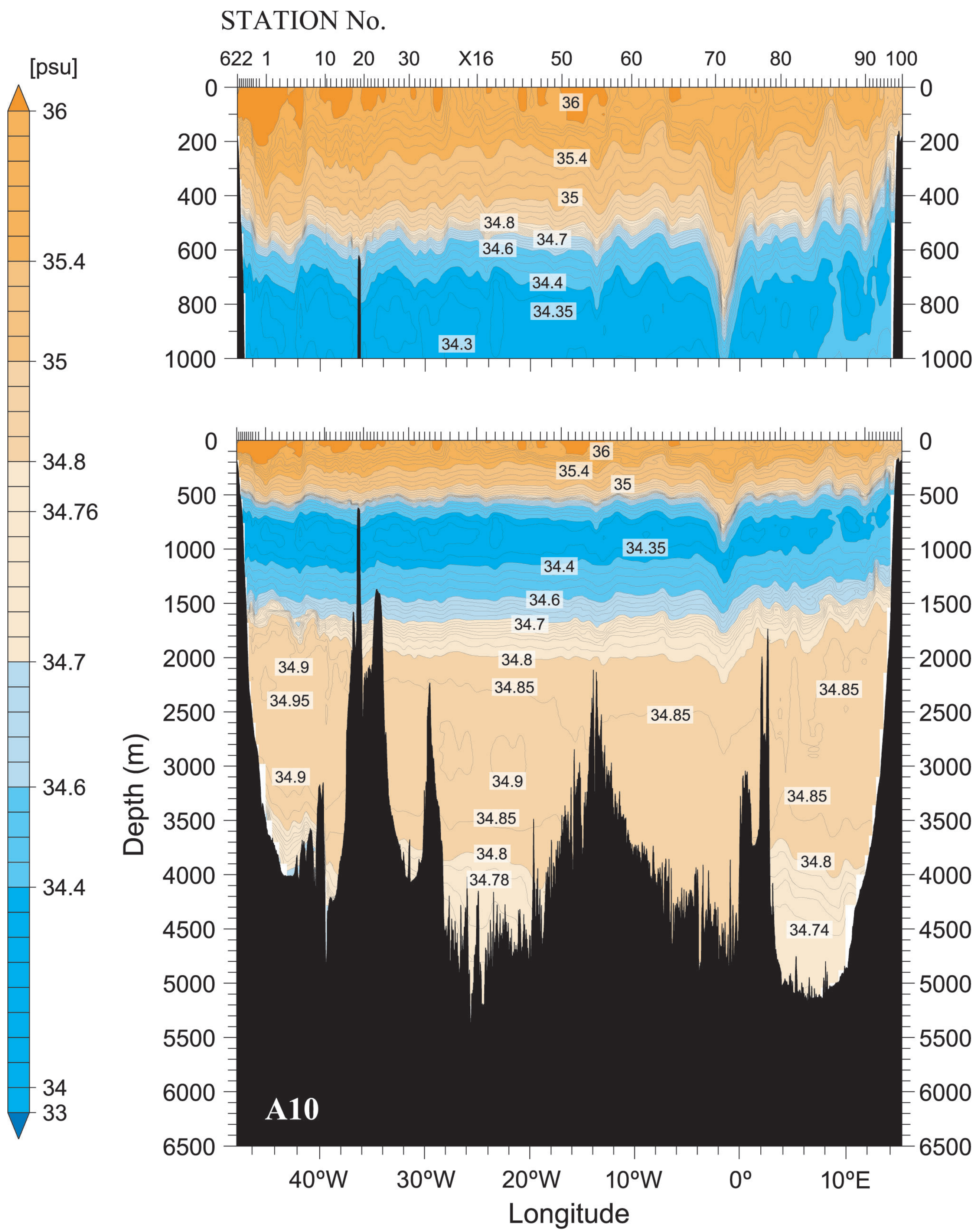
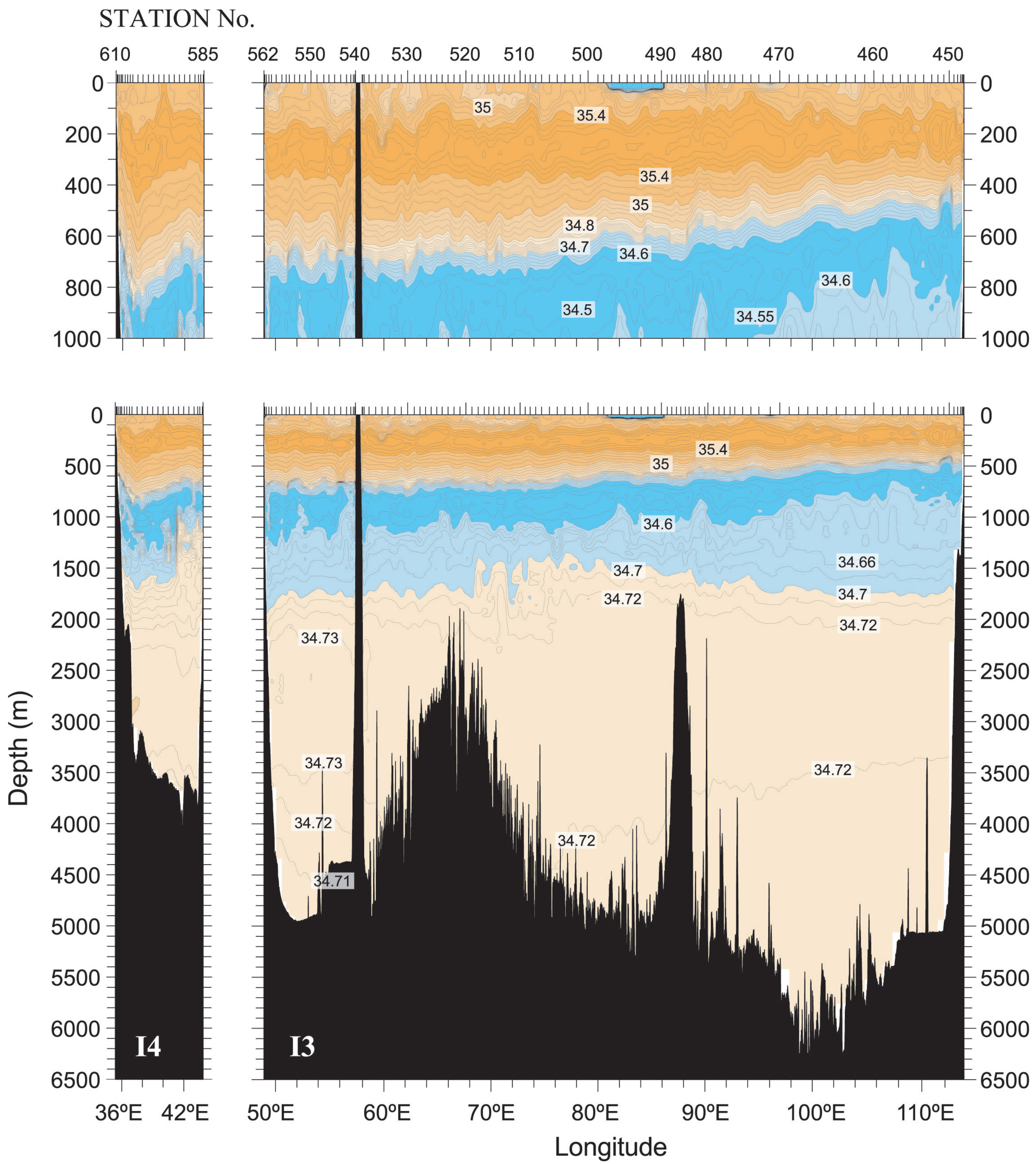
P6

Figure 4

SALINITY [PSU]





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34.8
34.7
34.6
34.6
34.5
34.55
35.4
35
34.6
34.66
34.7
34.7
34.72
34.72
34.73
34.73
34.72
34.72
34.72
34.71
Depth (m)
I4
I3
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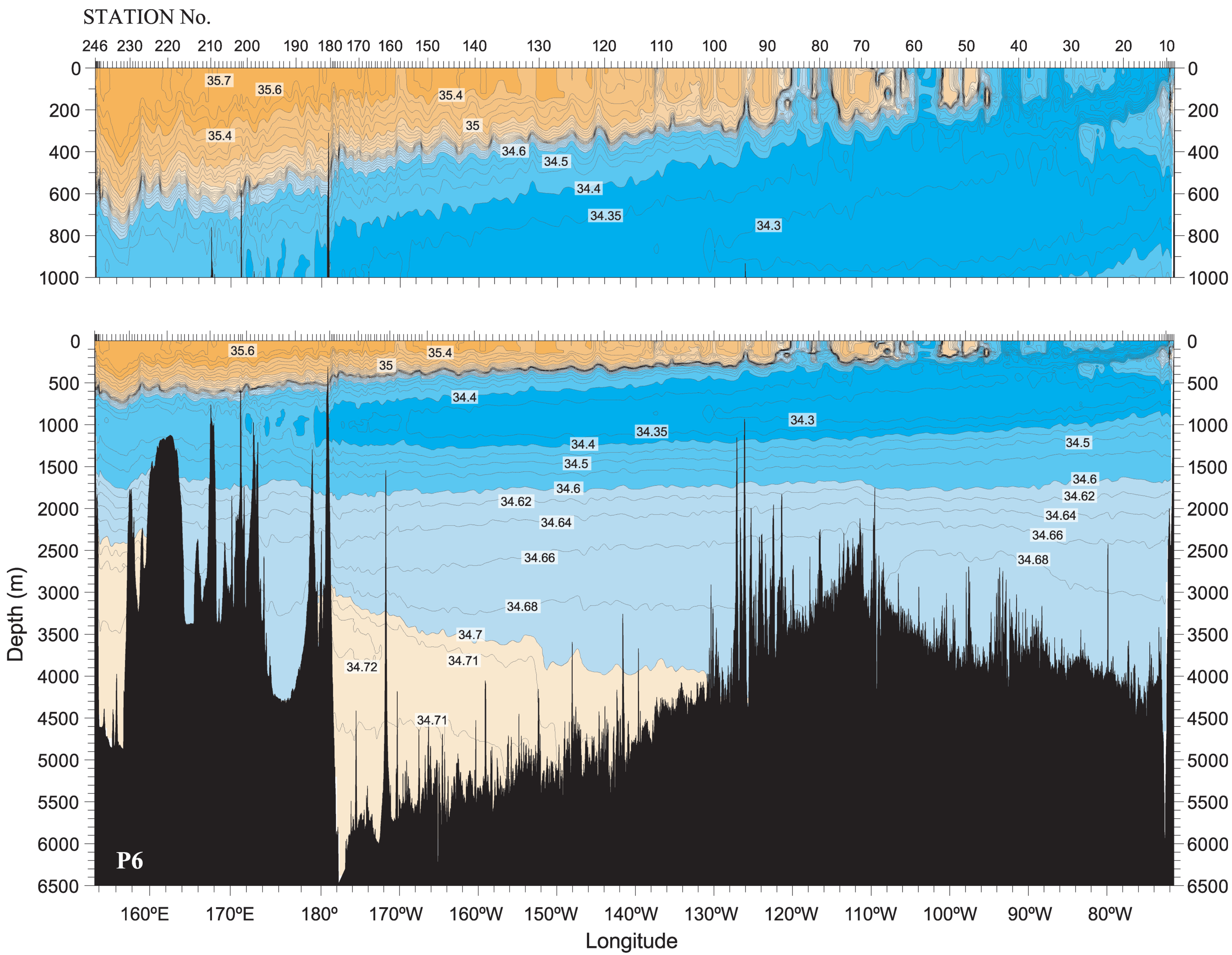
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude



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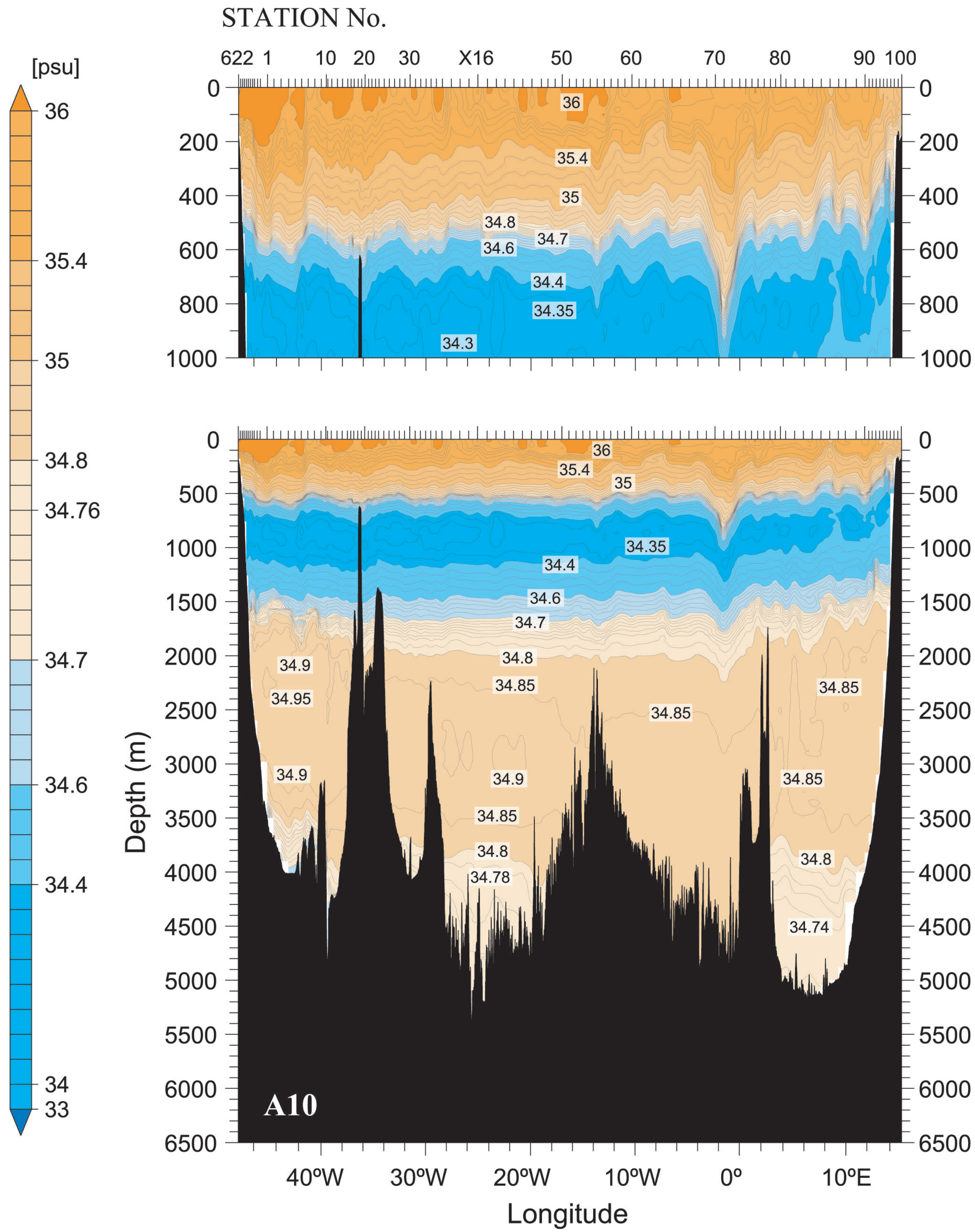
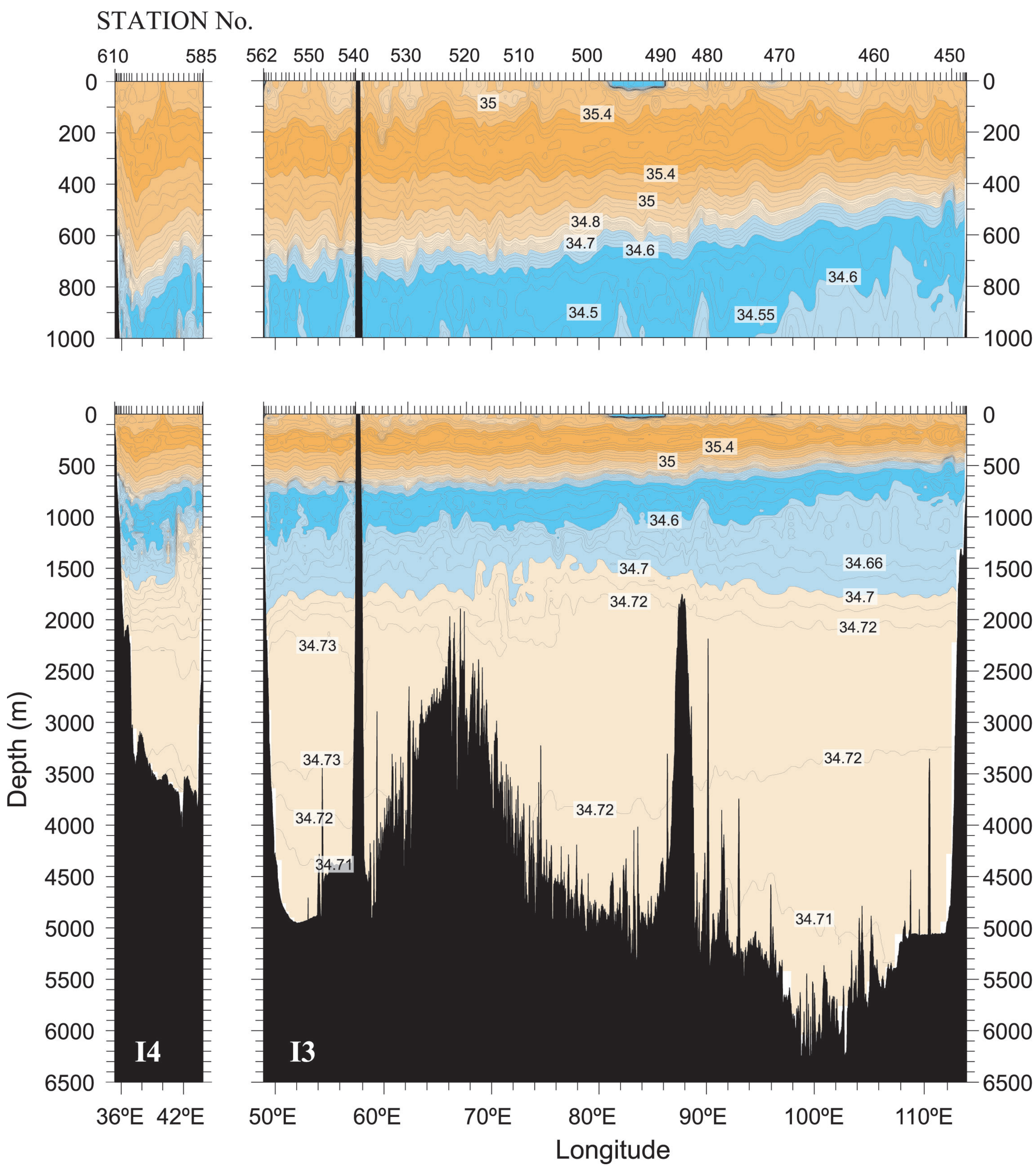
34.35
34.3
35.6
35.4
35
34.4
34.3
34.35
34.4
34.5
34.6
34.62
34.64
34.66
34.68
34.7
34.71
34.72
34.71
34.5
34.6
34.62
34.64
34.66
34.68
Depth (m)
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

Figure 5

SALINITY
(WITH SSW CORRECTION)
[PSU]

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34.7
34.6
34.6
34.5
34.55
35.4
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34.6
34.7
34.66
34.72
34.7
34.72
34.73
34.73
34.72
34.72
34.72
34.71
34.71
I4
I3
Depth (m)
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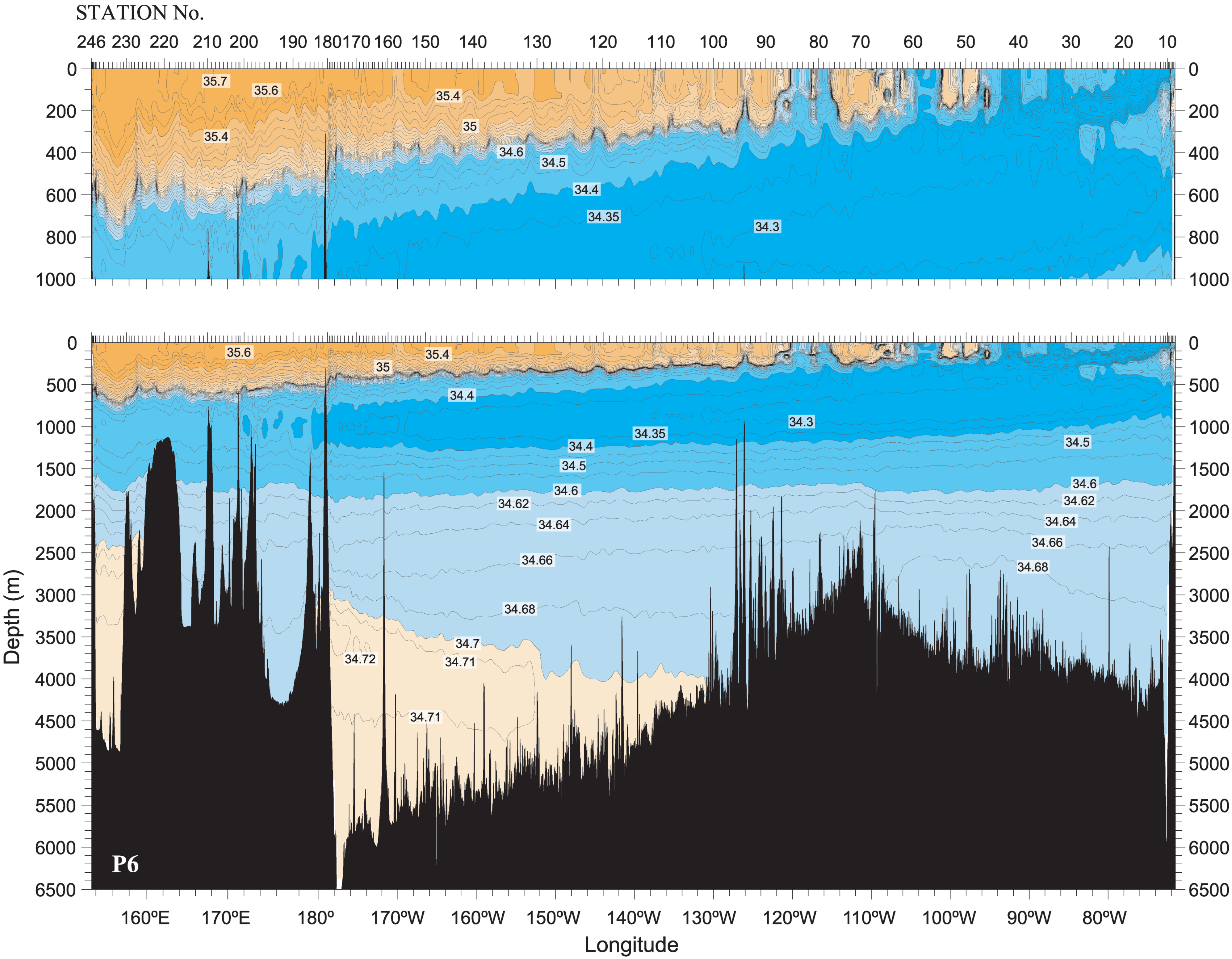
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude



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34.64
34.66
34.68
P6
Depth (m)
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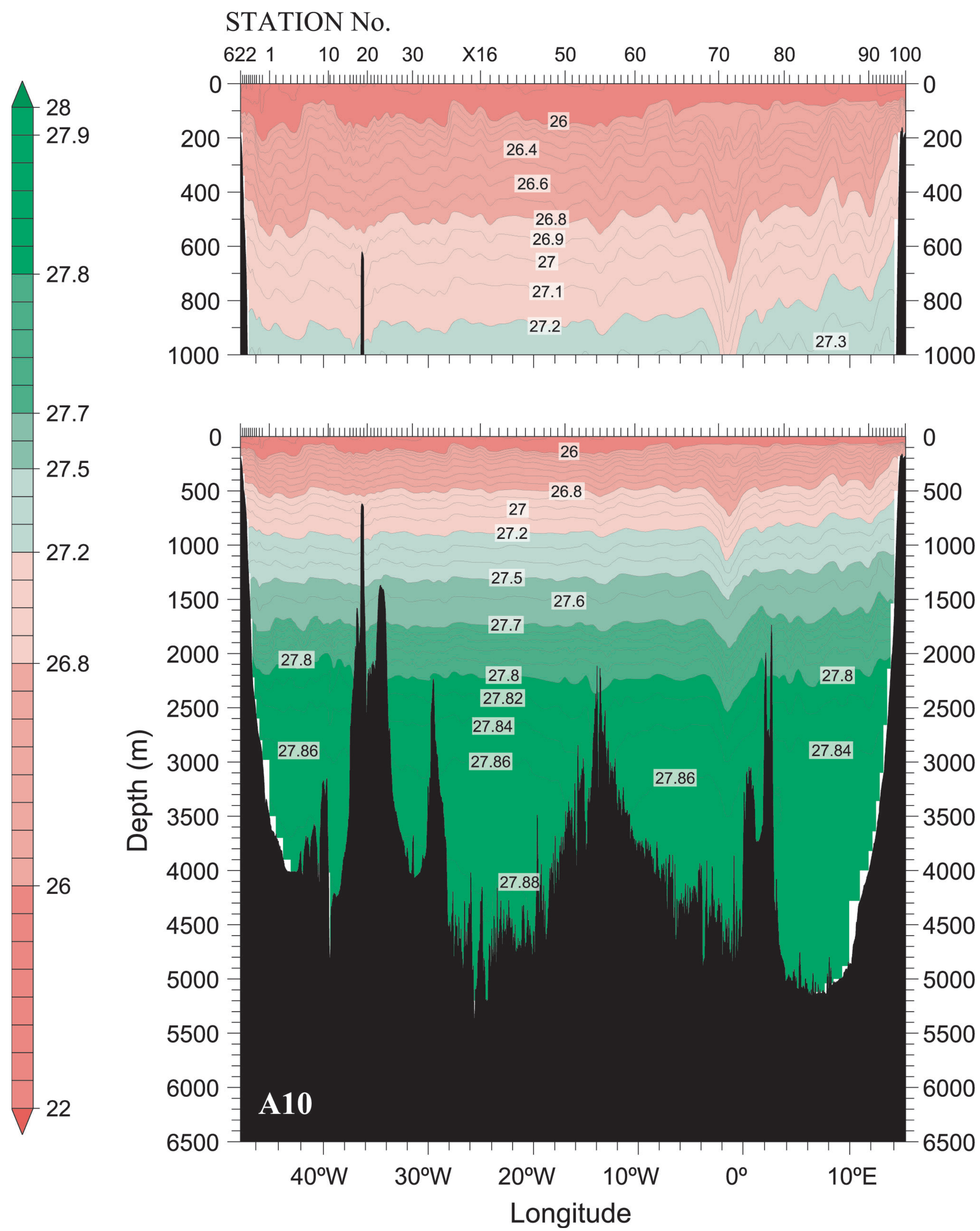
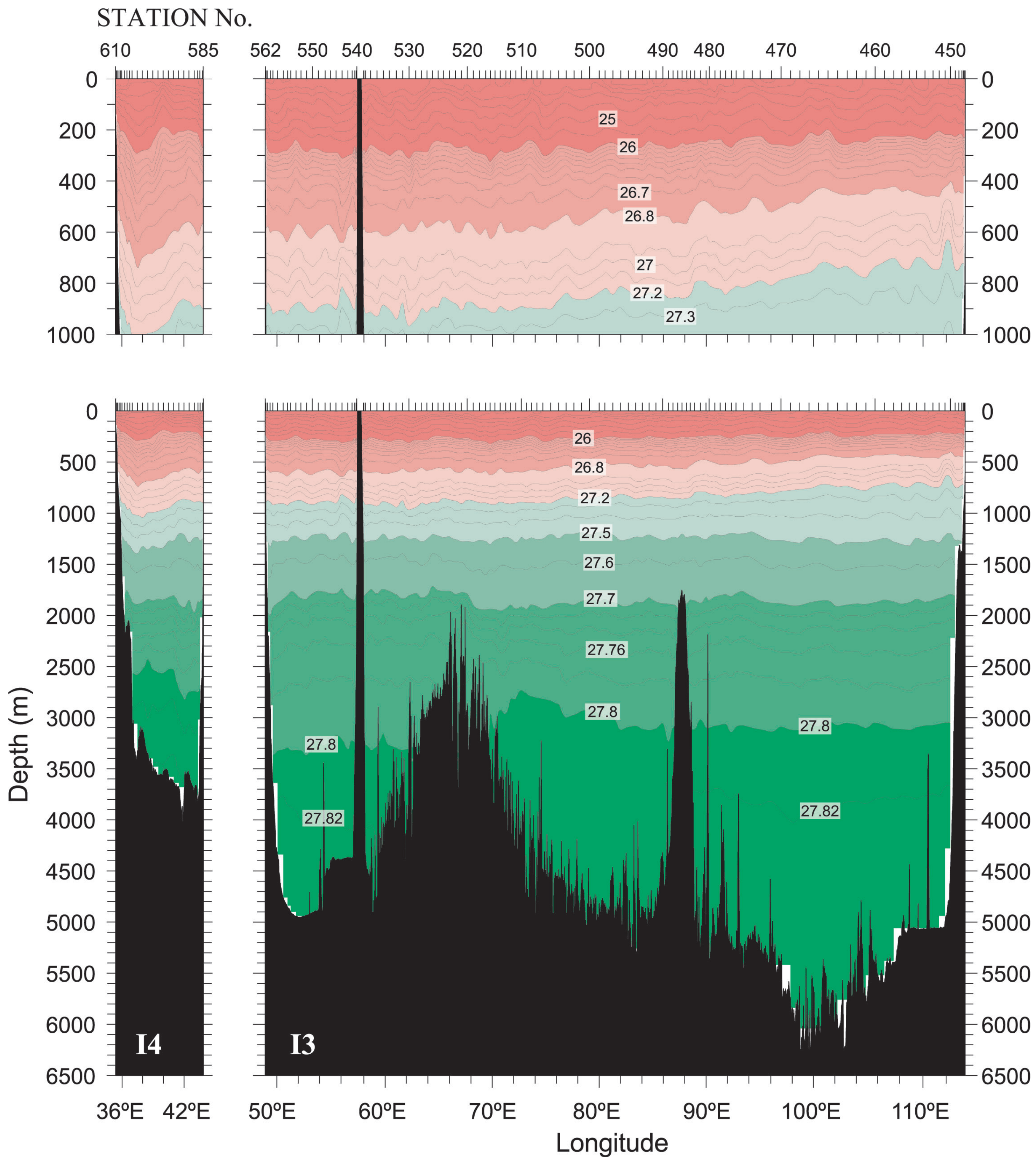
Longitude

Figure 6

DENSITY [σ_θ]





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480
470
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450
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26.8
27
27.2
27.3
26
26.8
27.2
27.5
27.6
27.7
27.76
27.8
27.8
27.82
27.8
27.82
Depth (m)
I4
I3
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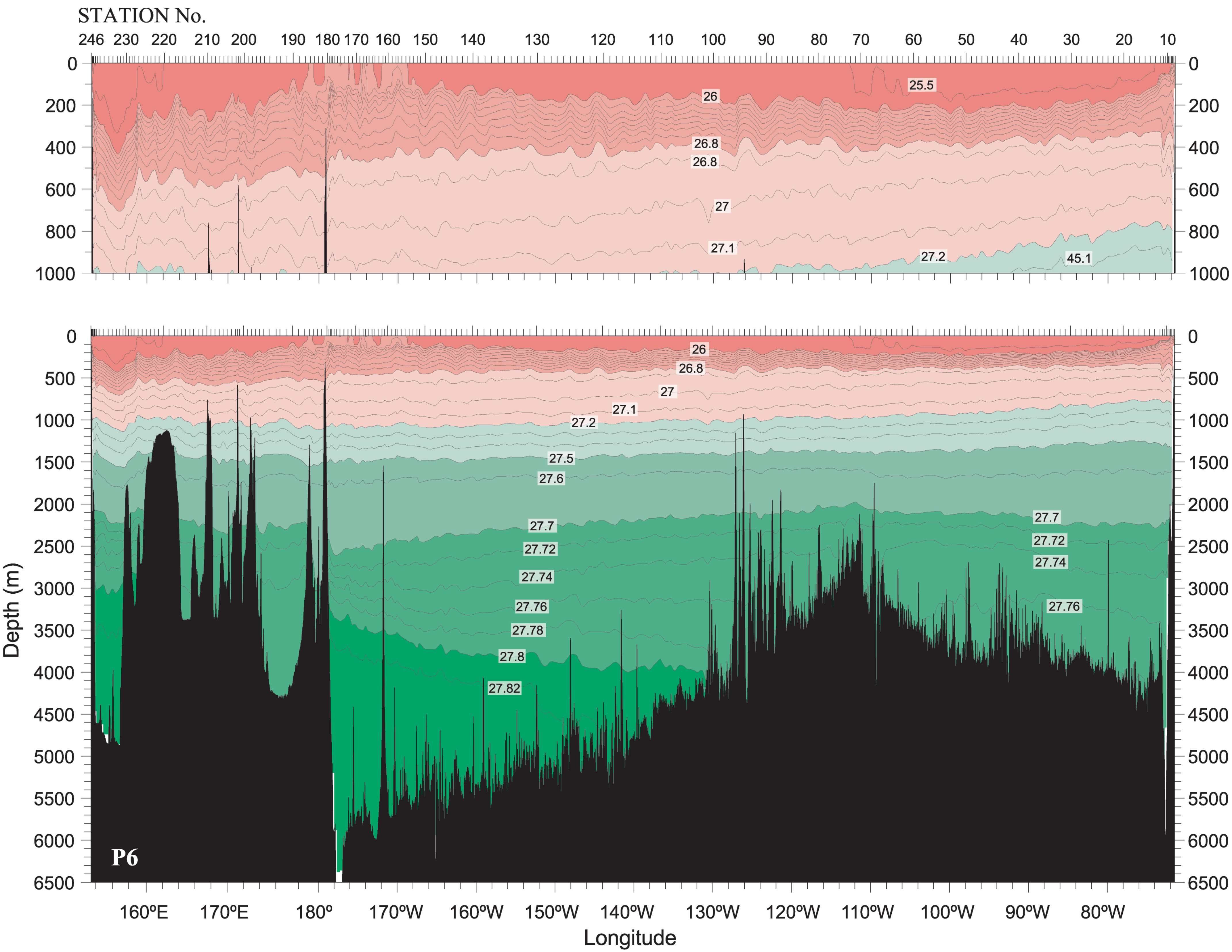
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude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800
1000
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26.8
27
27.1
27.2
45.1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
26
26.8
27
27.1
27.2
27.5
27.6
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27.72
27.74
27.76
27.78
27.8
27.82
27.7
27.72
27.74
27.76
Depth (m)
P6
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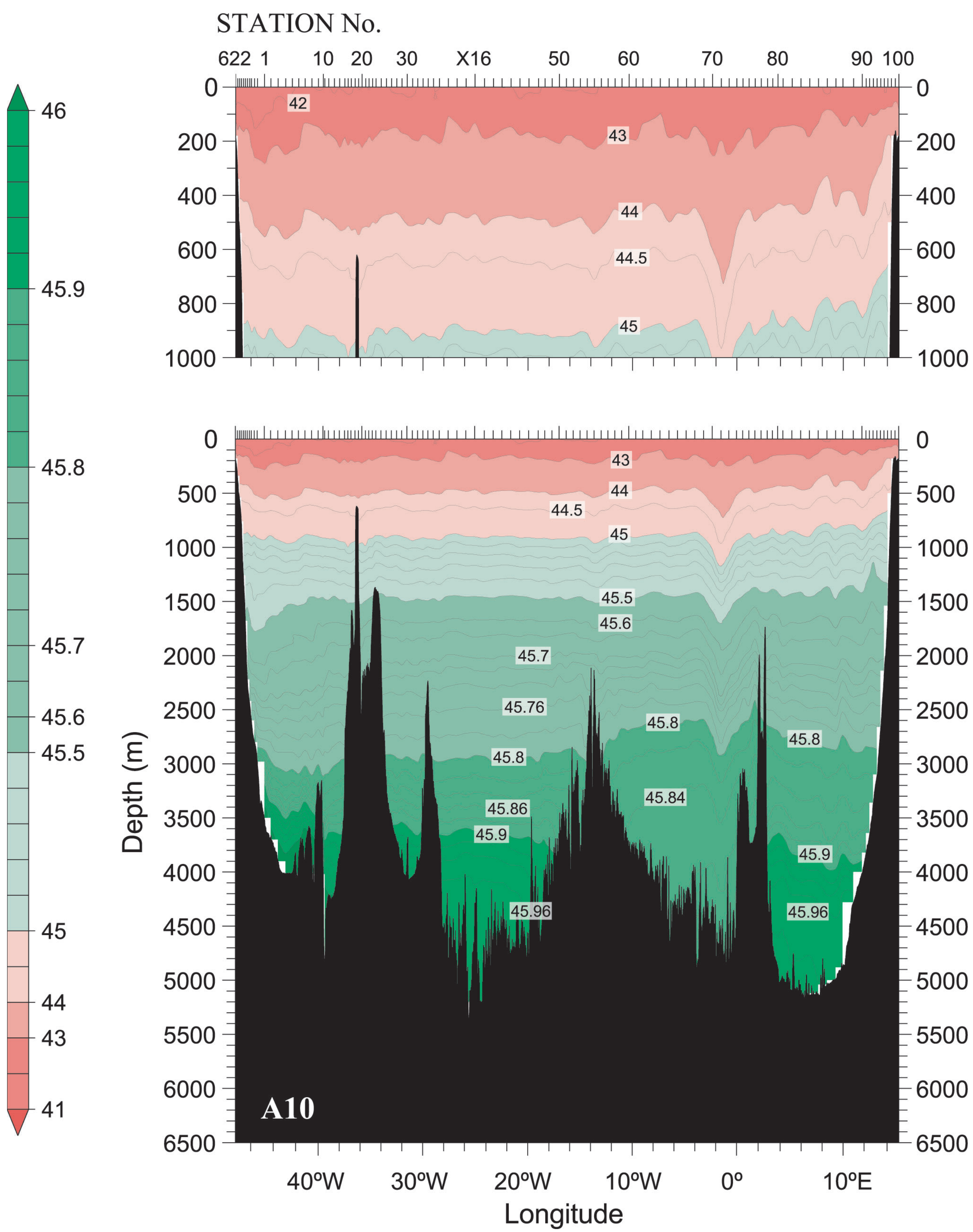
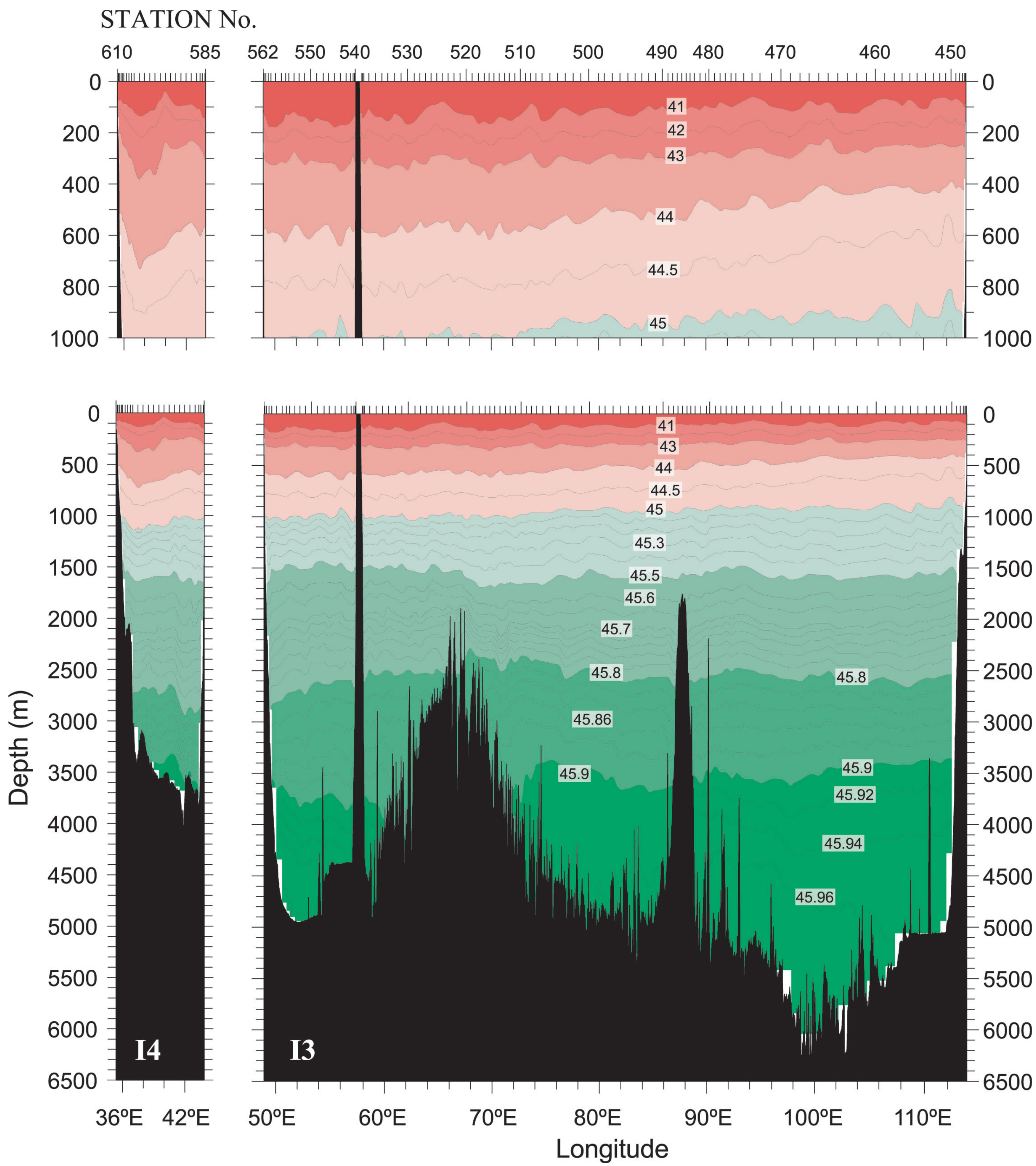
Longitude

Figure 7

DENSITY [σ_4]





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45
45.3
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45.7
45.8
45.86
45.9
45.92
45.94
45.96
Depth (m)
I4
I3
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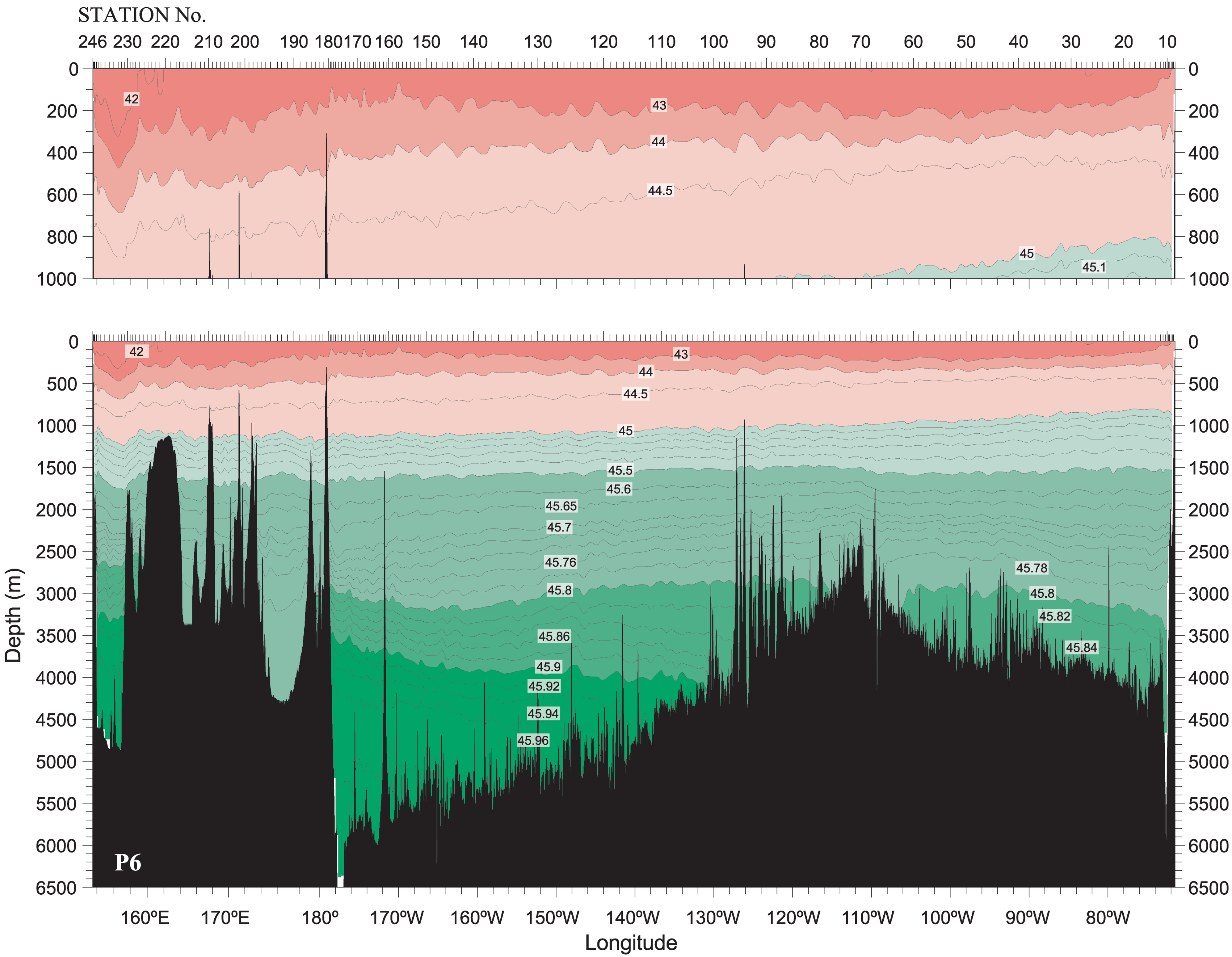
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude



STATION No.
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43
44
44.5
45
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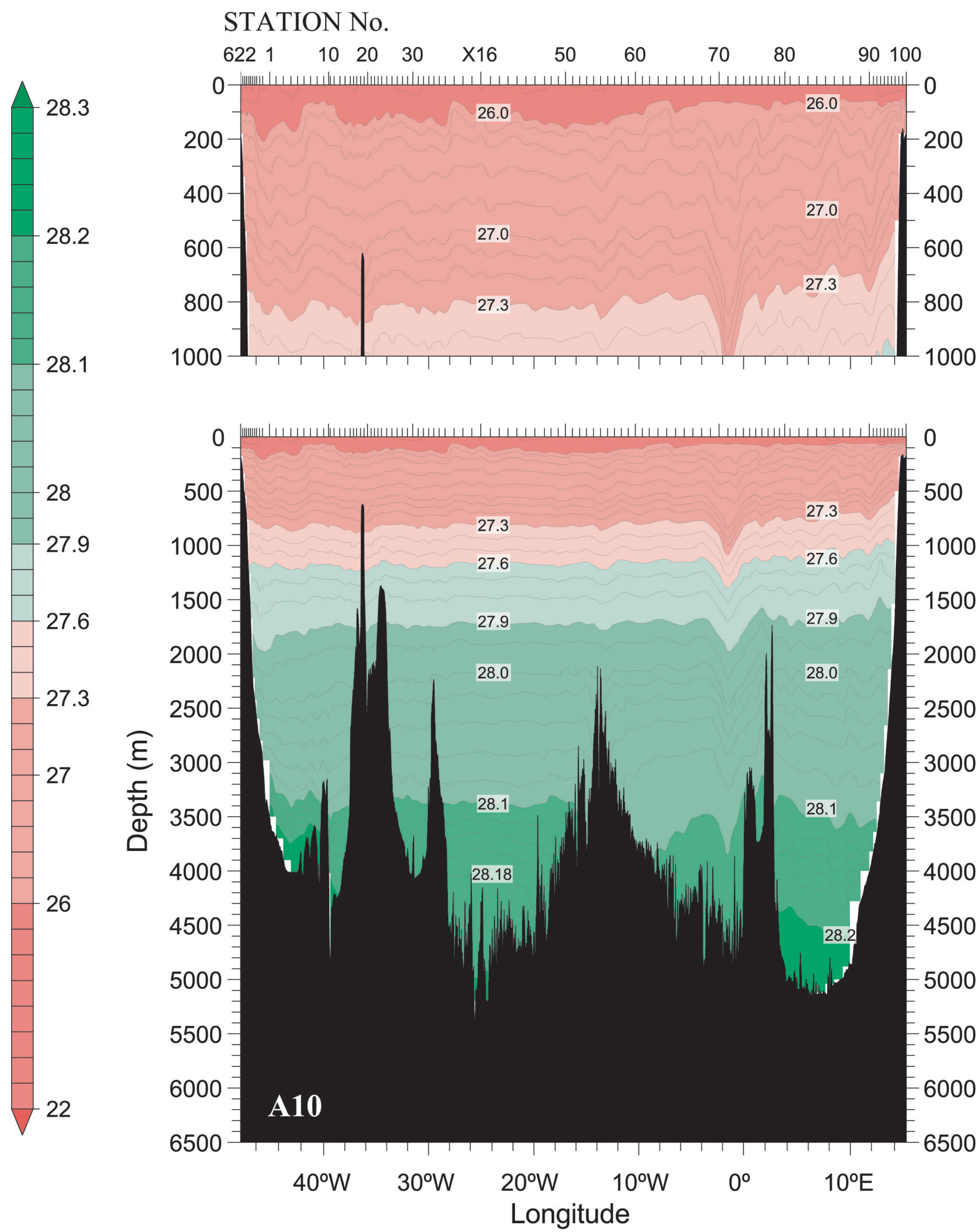
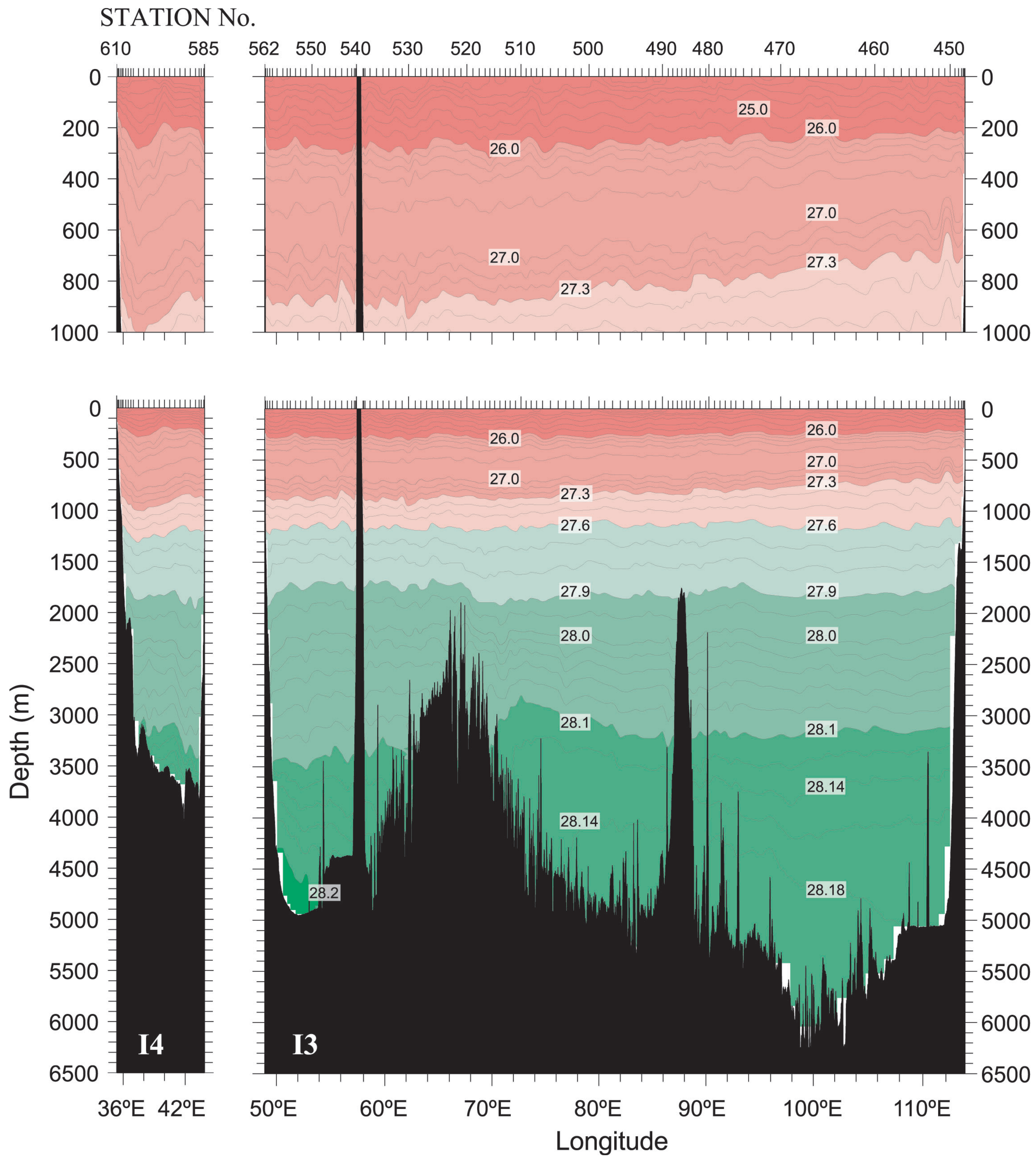
45.65
45.7
45.76
45.78
45.8
45.82
45.84
45.86
45.9
45.92
45.94
45.96
Depth (m)
P6
160ºE
170ºE
180º
170ºW
160ºW
150ºW
140ºW
130ºW
120ºW
110ºW
100ºW
90ºW
80ºW
Longitude

Figure 8

NEUTRAL DENSITY [γ^n]





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450
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27.0
27.3
27.6
27.9
28.0
28.1
28.14
28.18
28.2
Depth (m)
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I3
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80ºE
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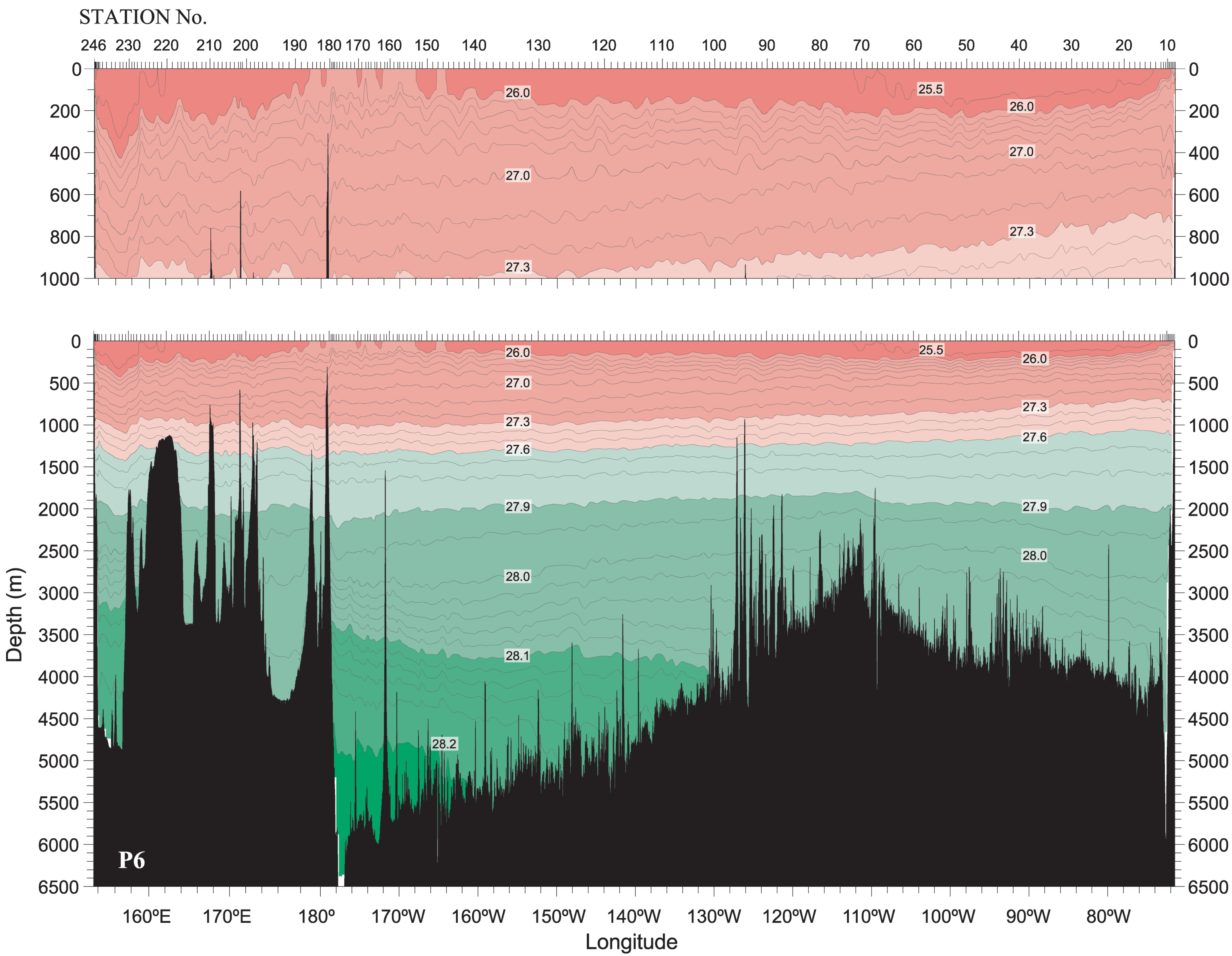
100ºE
110ºE
Longitude



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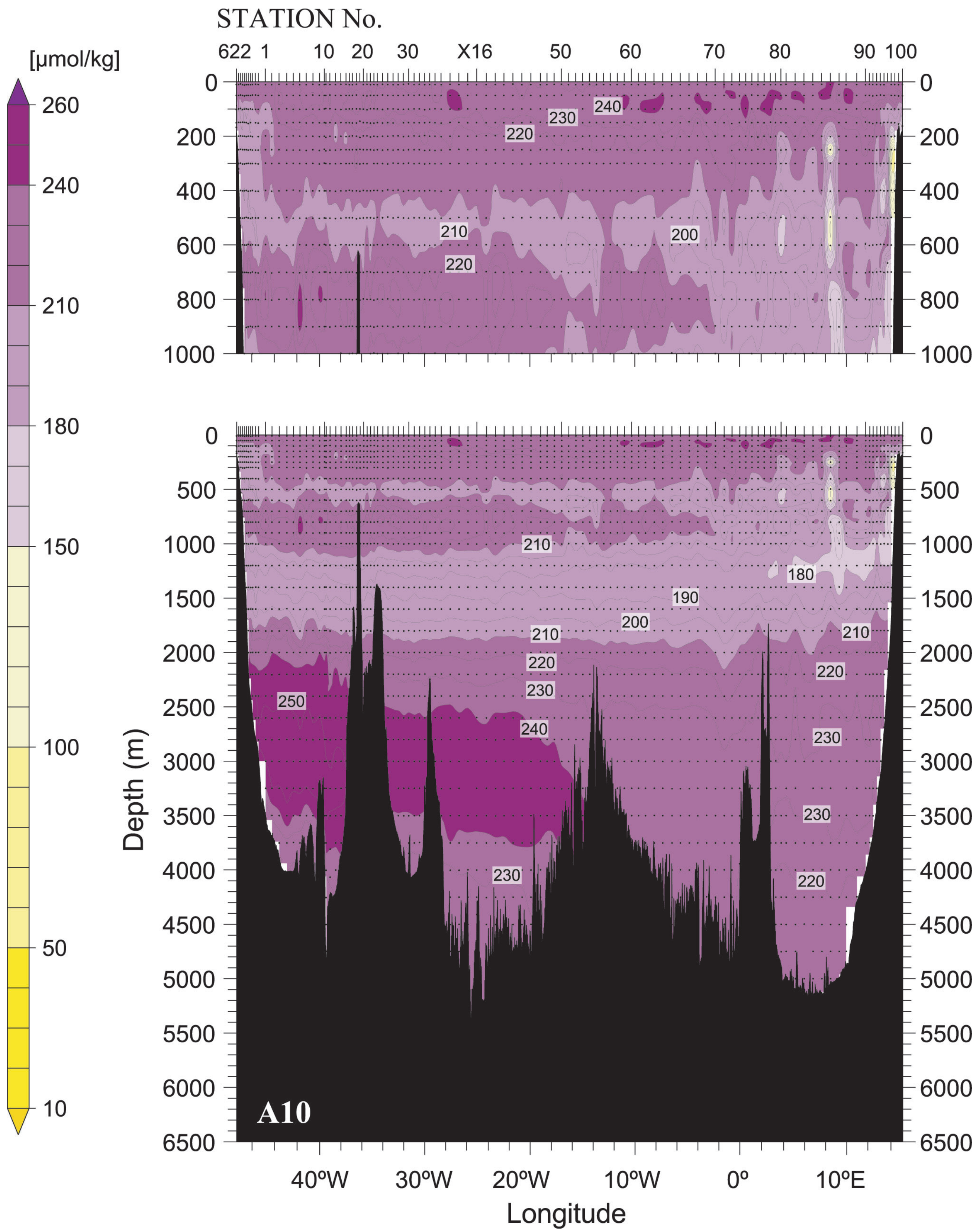
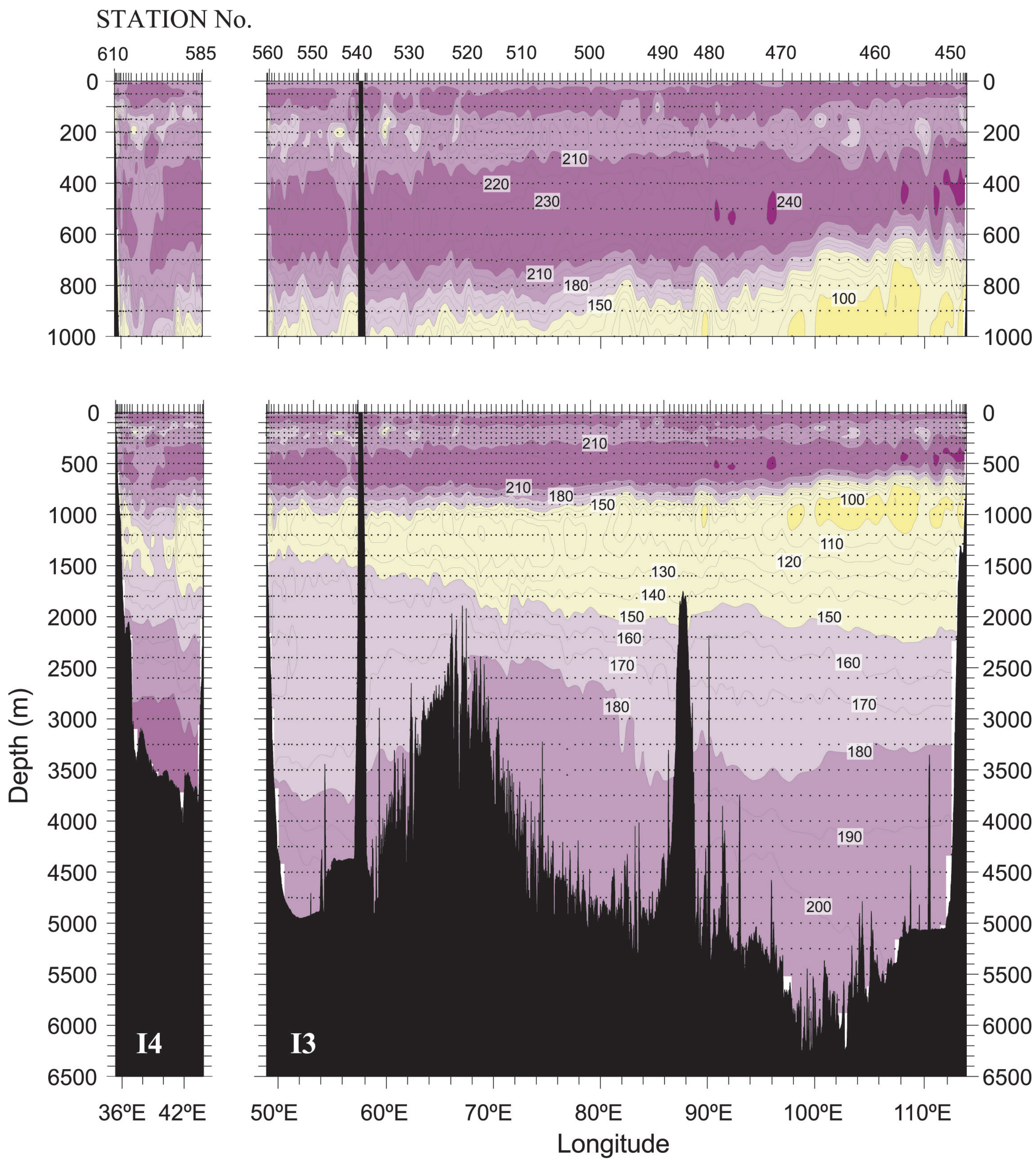
25.5
27.0
27.3
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500
27.6
27.9
28.0
28.1
28.2
Depth (m)
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

Figure 9

OXYGEN [μmol/kg]





STATION No.
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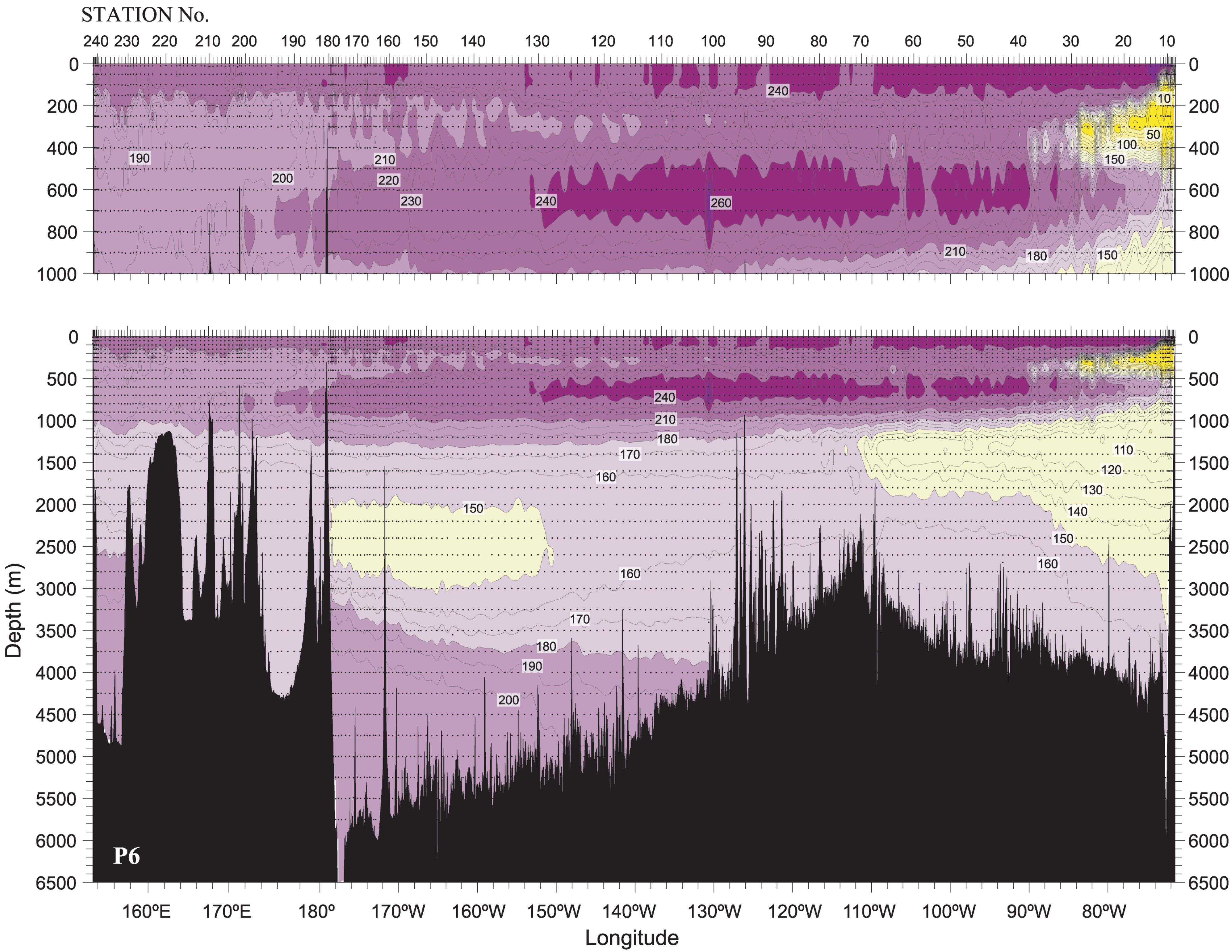
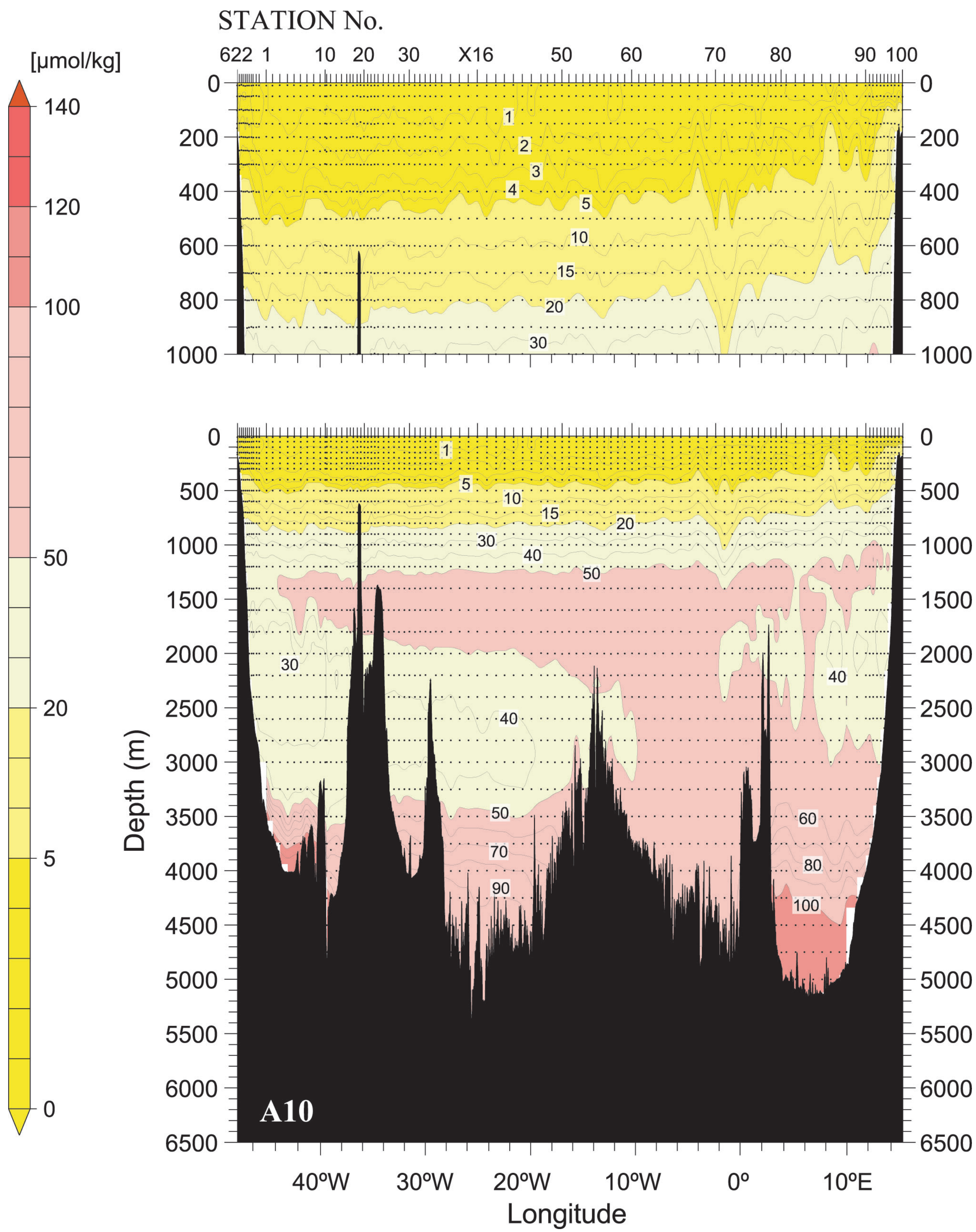
560
550
540
530
520
510
500
490
480
470
460
450
210
220
230
240
180
150
100
110
120
130
140
160
170
190
200
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

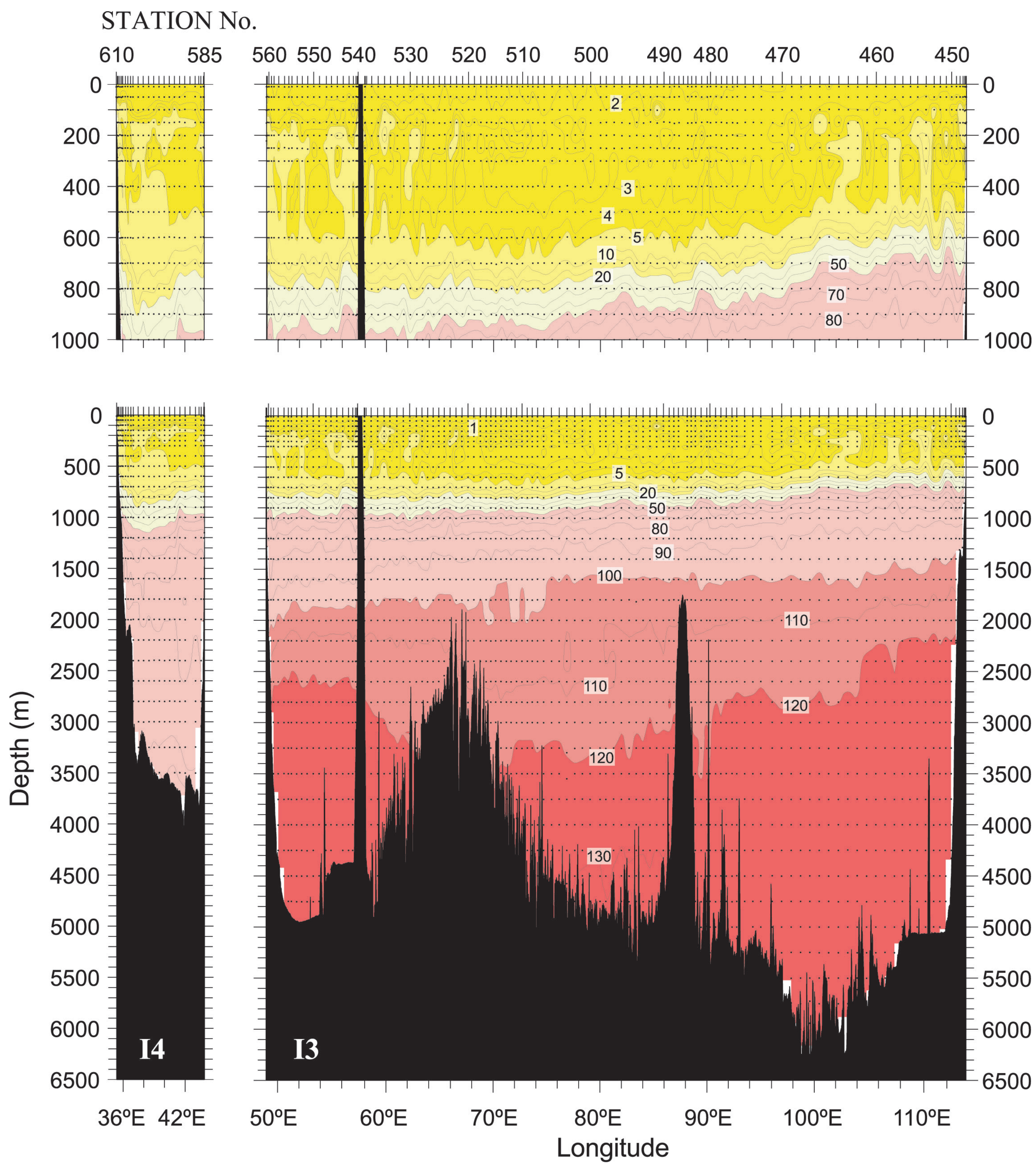


STATION No.
Depth (m)
Longitude
P6
160ºE
170ºE
180º
170ºW
160ºW
150ºW
140ºW
130ºW
120ºW
110ºW
100ºW
90ºW
80ºW

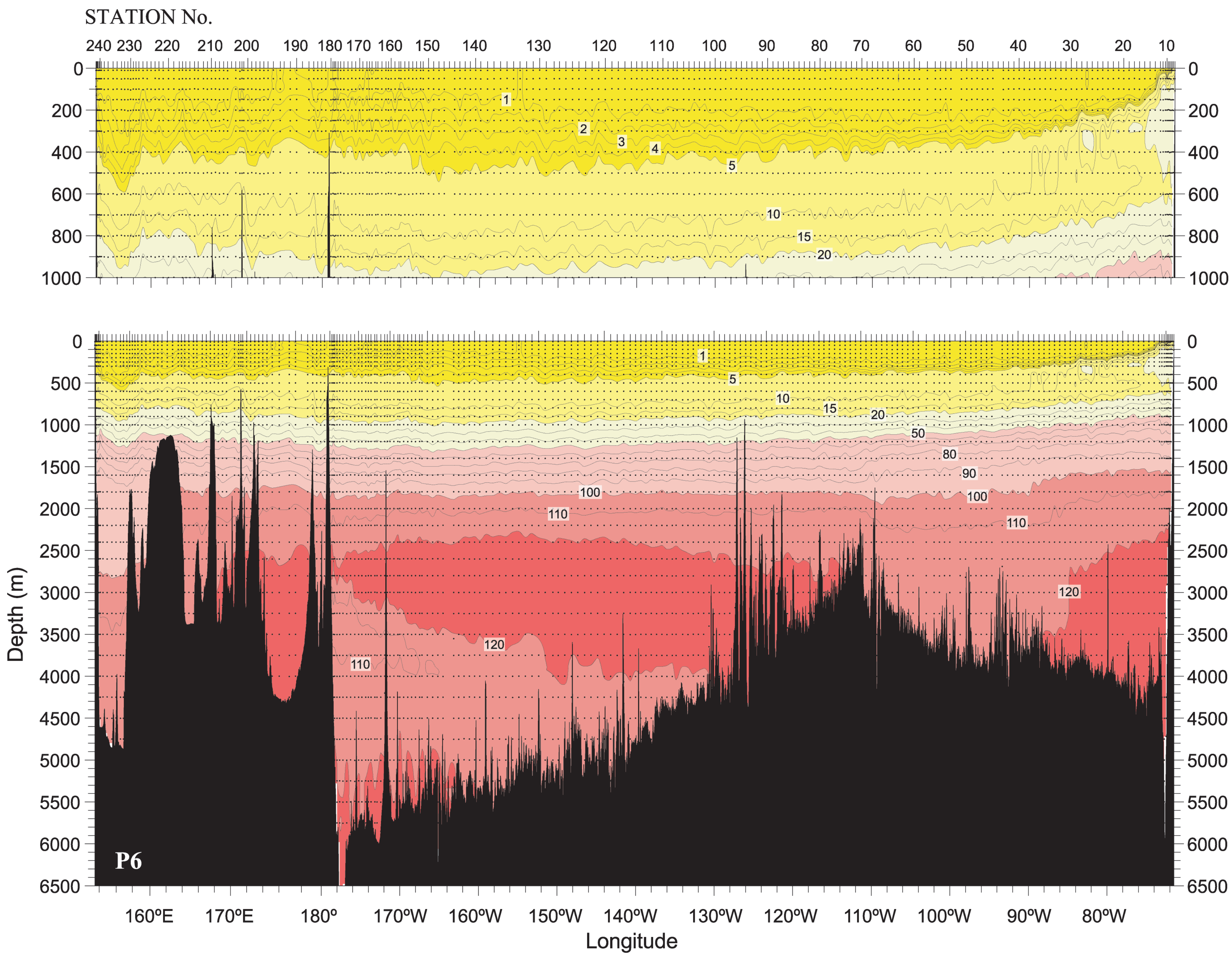
Figure 10

SILICATE [μmol/kg]





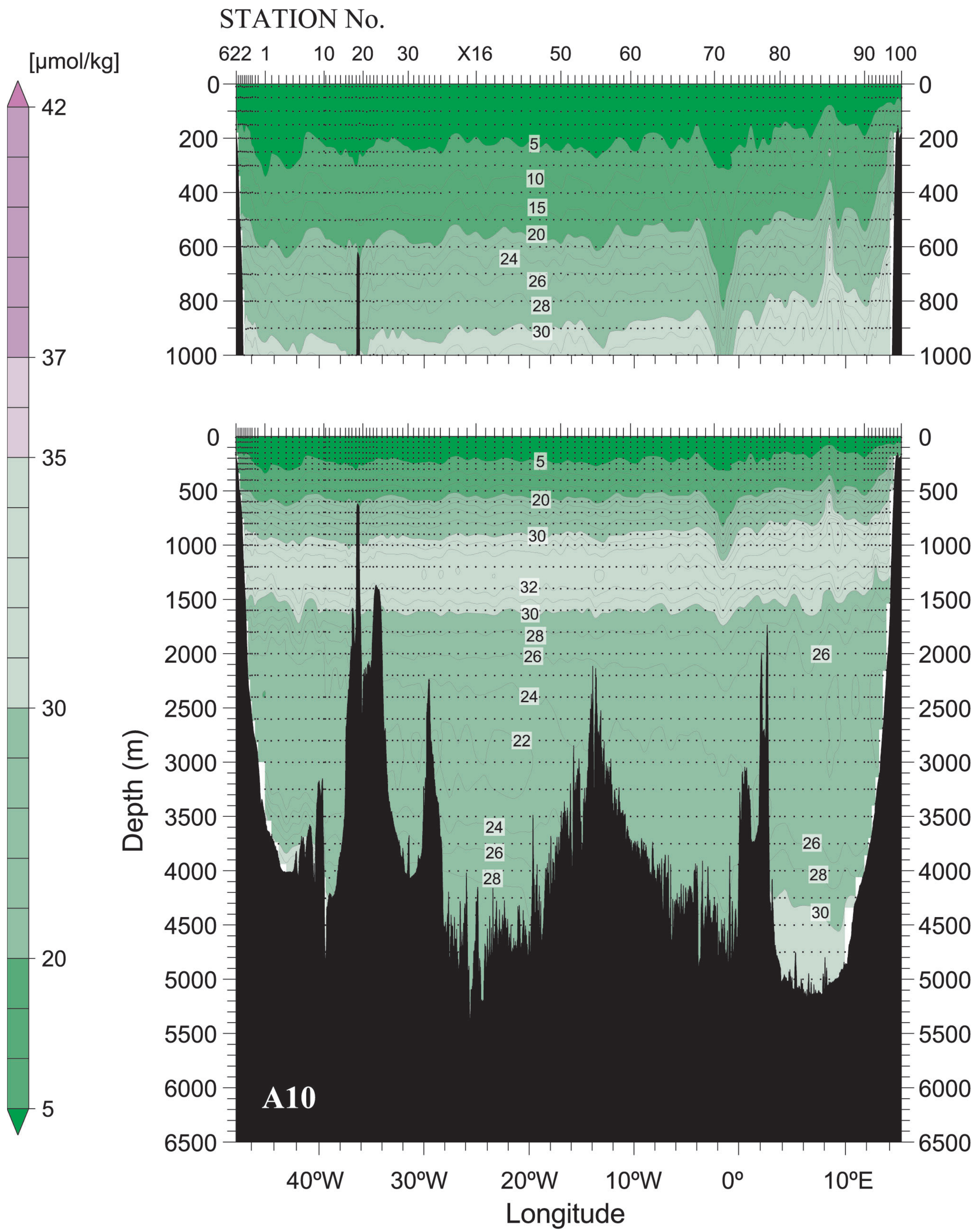
STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
0
200
400
600
800
1000
2
3
4
5
10
20
50
70
80
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
1
5
20
50
80
90
100
110
110
120
120
130
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

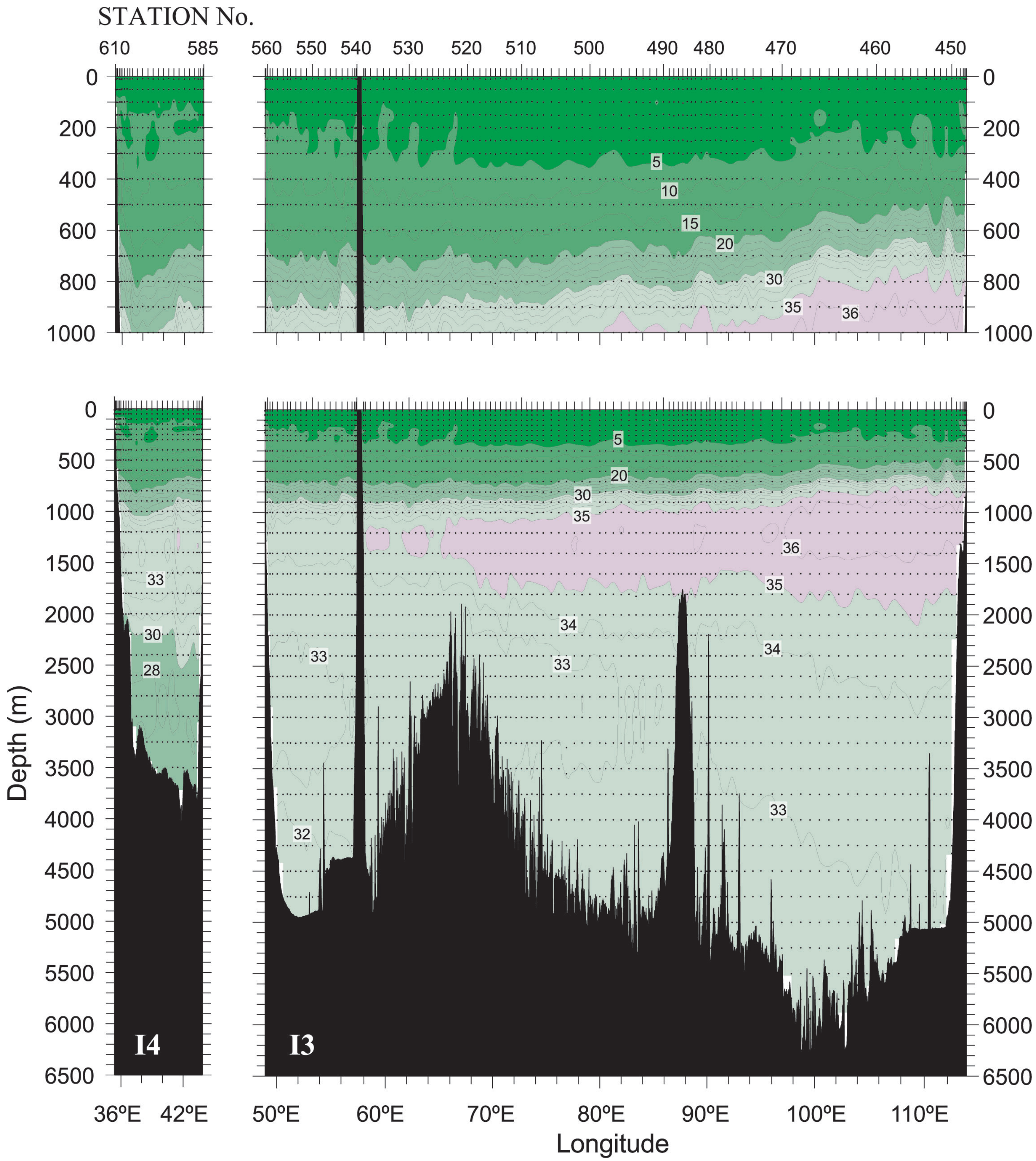


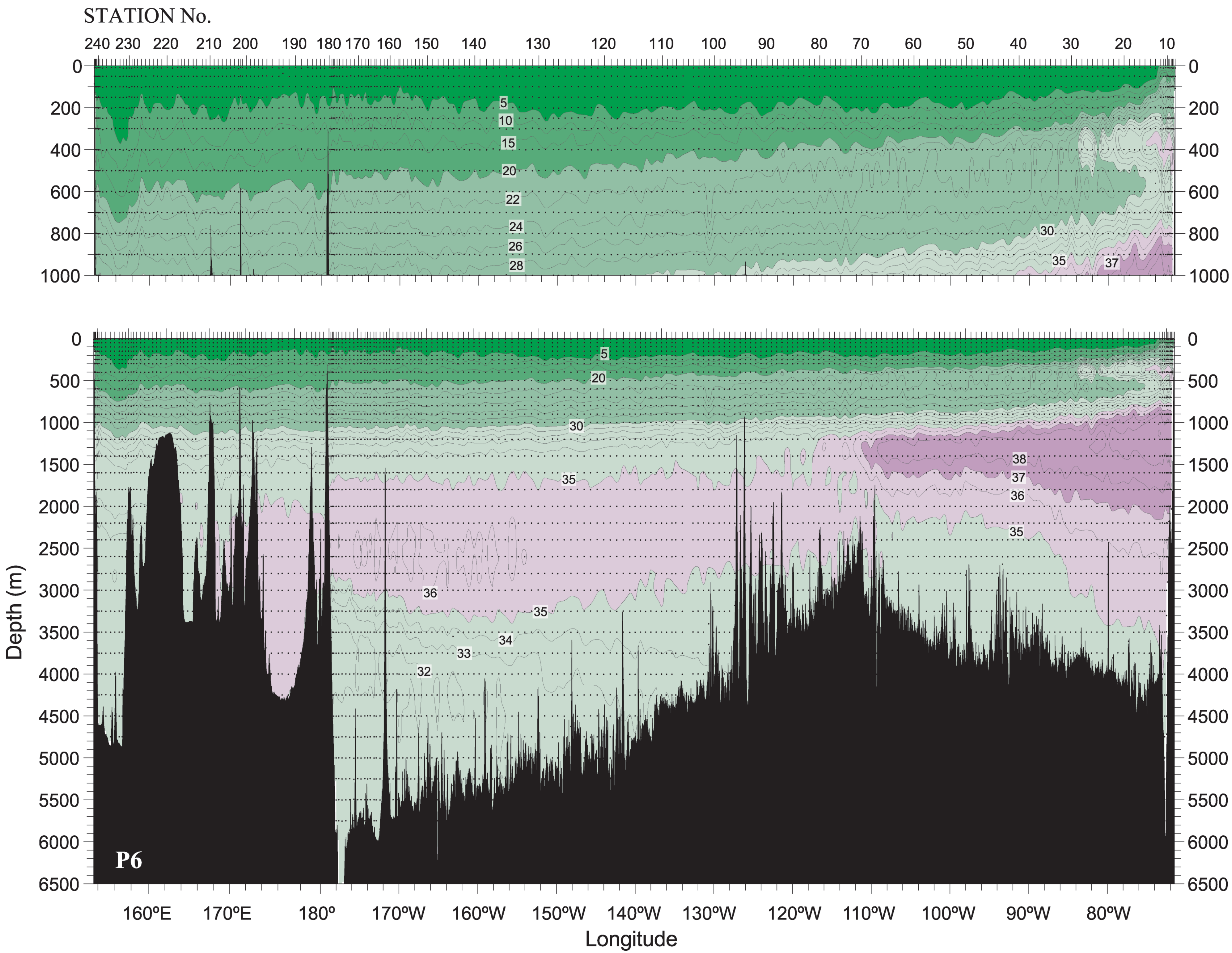
STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
0
200
400
600
800
1000
1
2
3
4
5
10
15
20
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Depth (m)
1
5
10
15
20
50
80
90
100
110
120
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

Figure 11

NITRATE [μmol/kg]



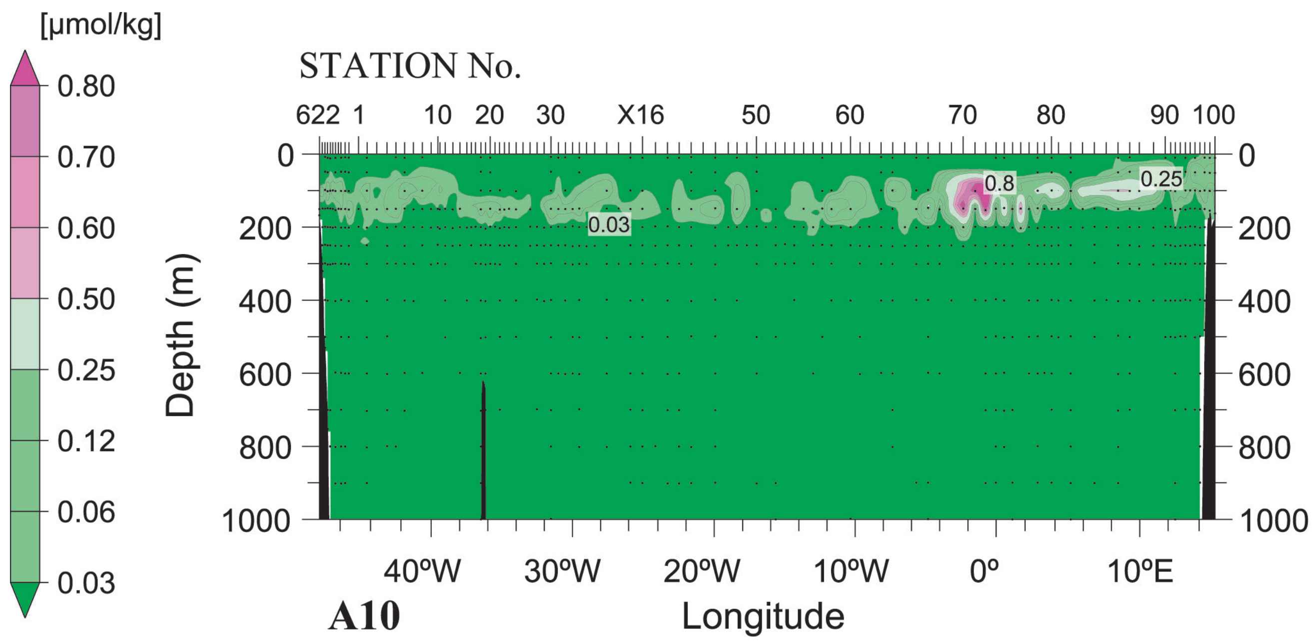

STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
Depth (m)
Longitude
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
I4
I3

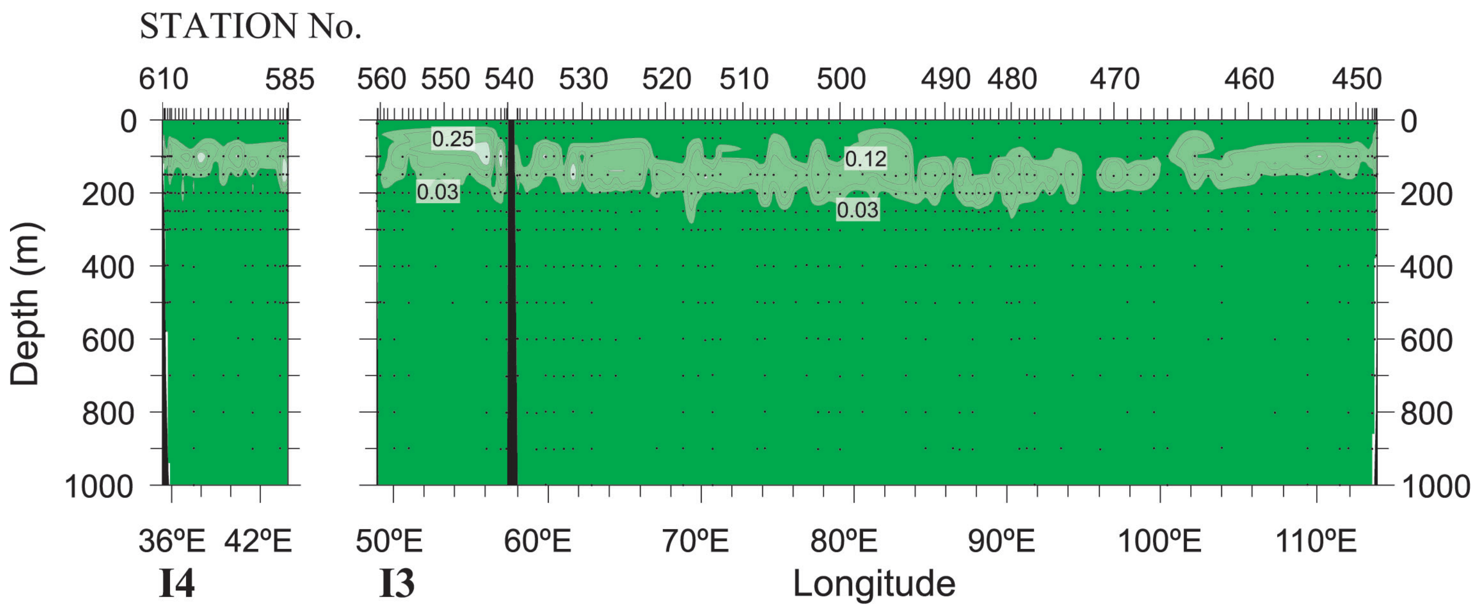


STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
5
10
15
20
22
24
26
28
30
35
37
38
36
34
33
32
P6
Depth (m)
0
200
400
600
800
1000
500
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

Figure 12

NITRITE [μmol/kg]




STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
0
200
400
600
800
1000
Depth (m)
0.25
0.03
0.12
0.03
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
I4
I3
Longitude

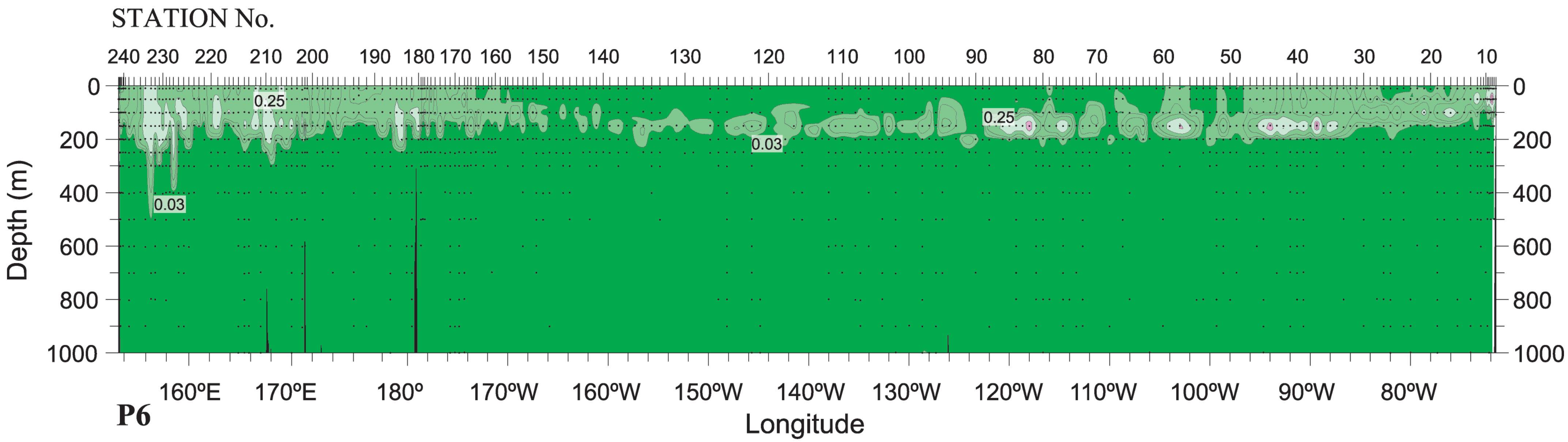
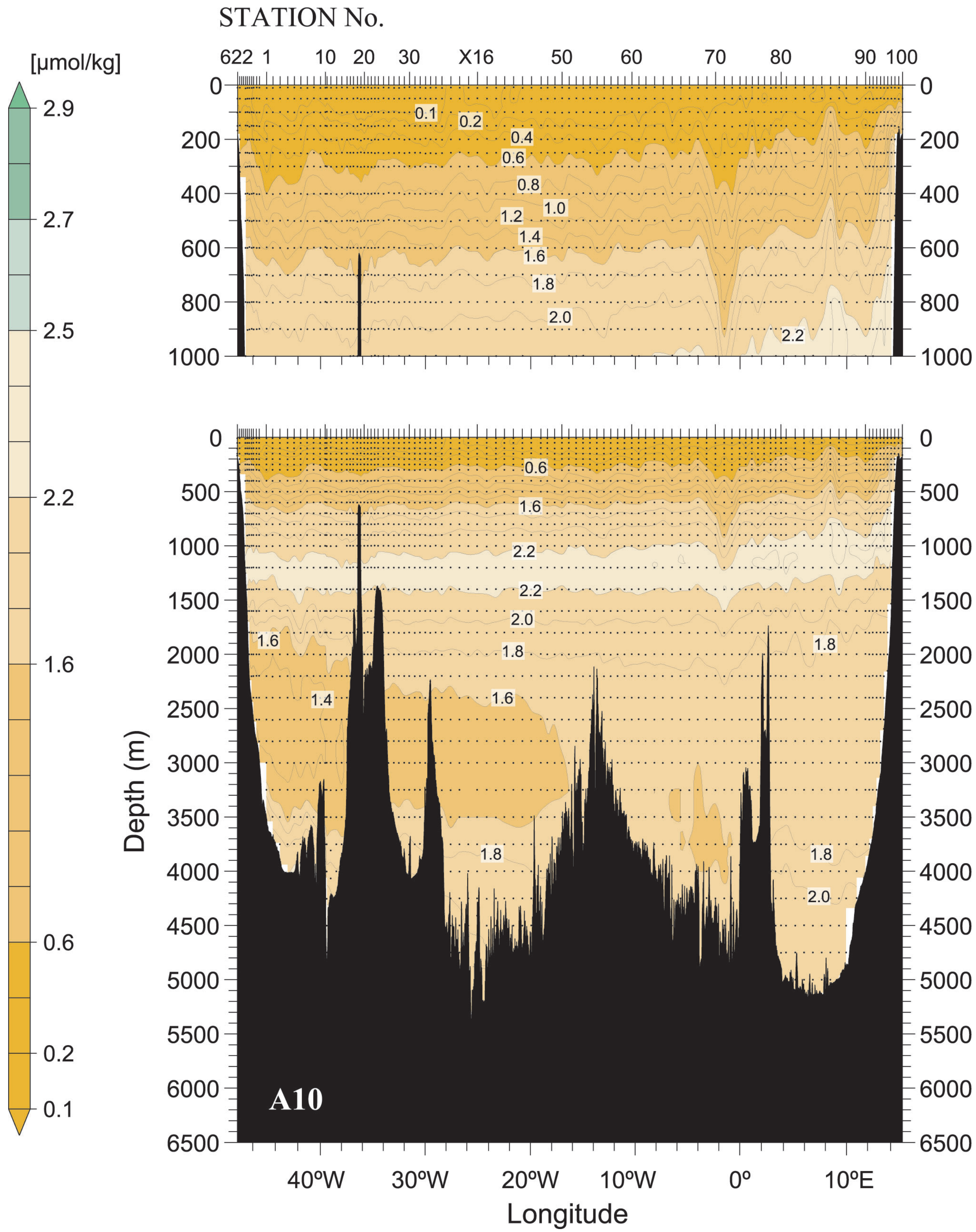
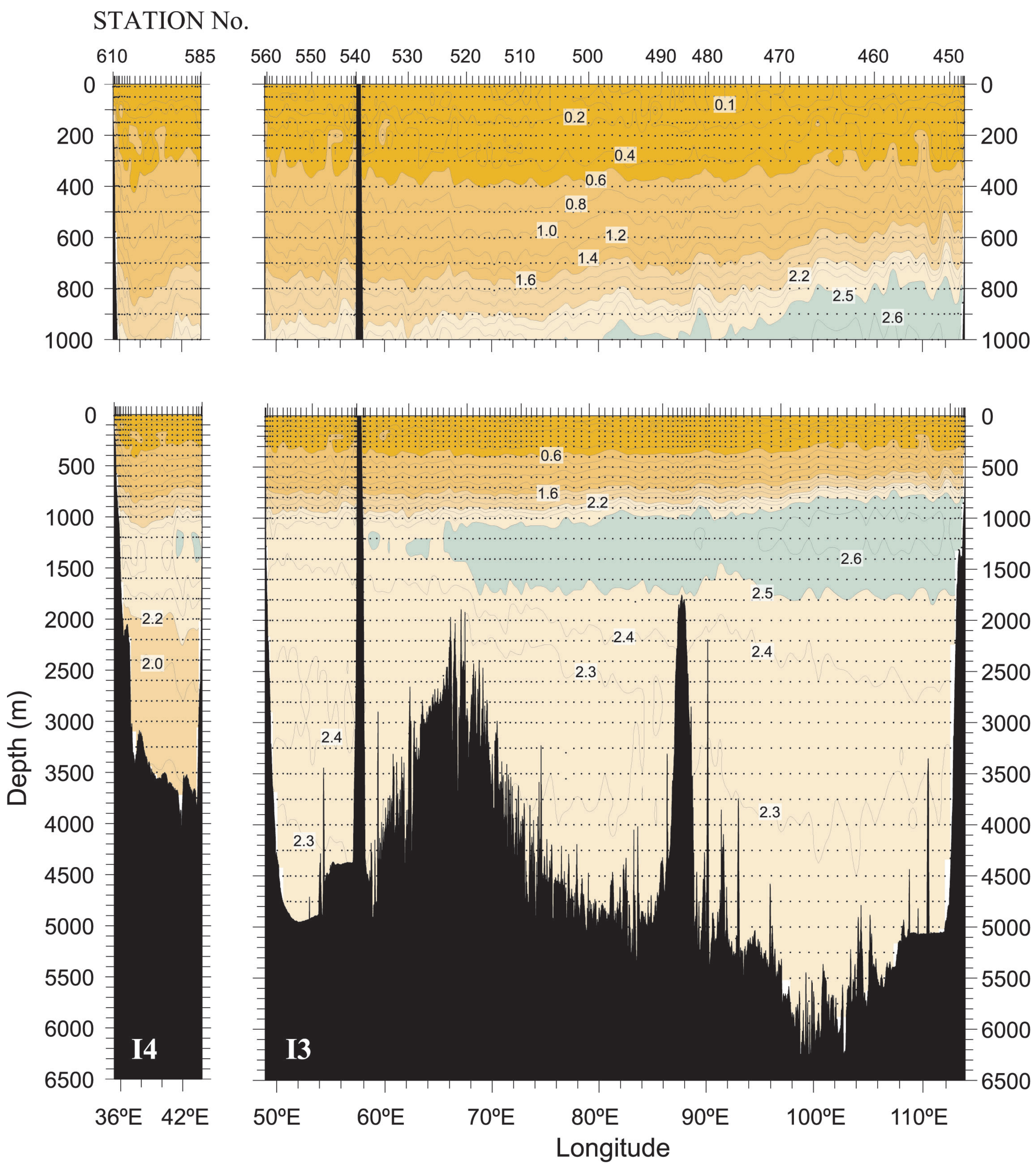

STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
0.25
0.03
0.25
0.03
Depth (m)
0
200
400
600
800
1000
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
P6
Longitude

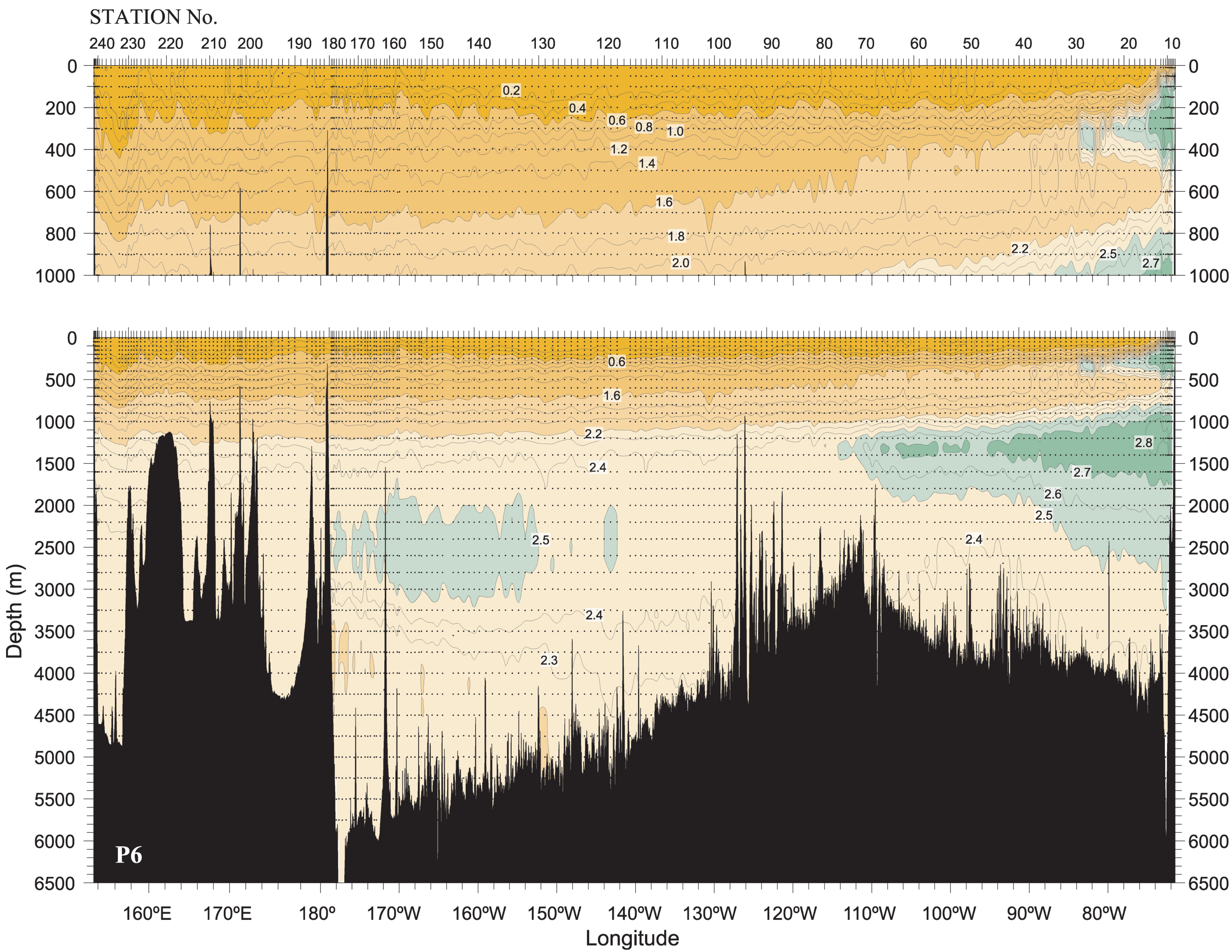
Figure 13

PHOSPHATE [μmol/kg]





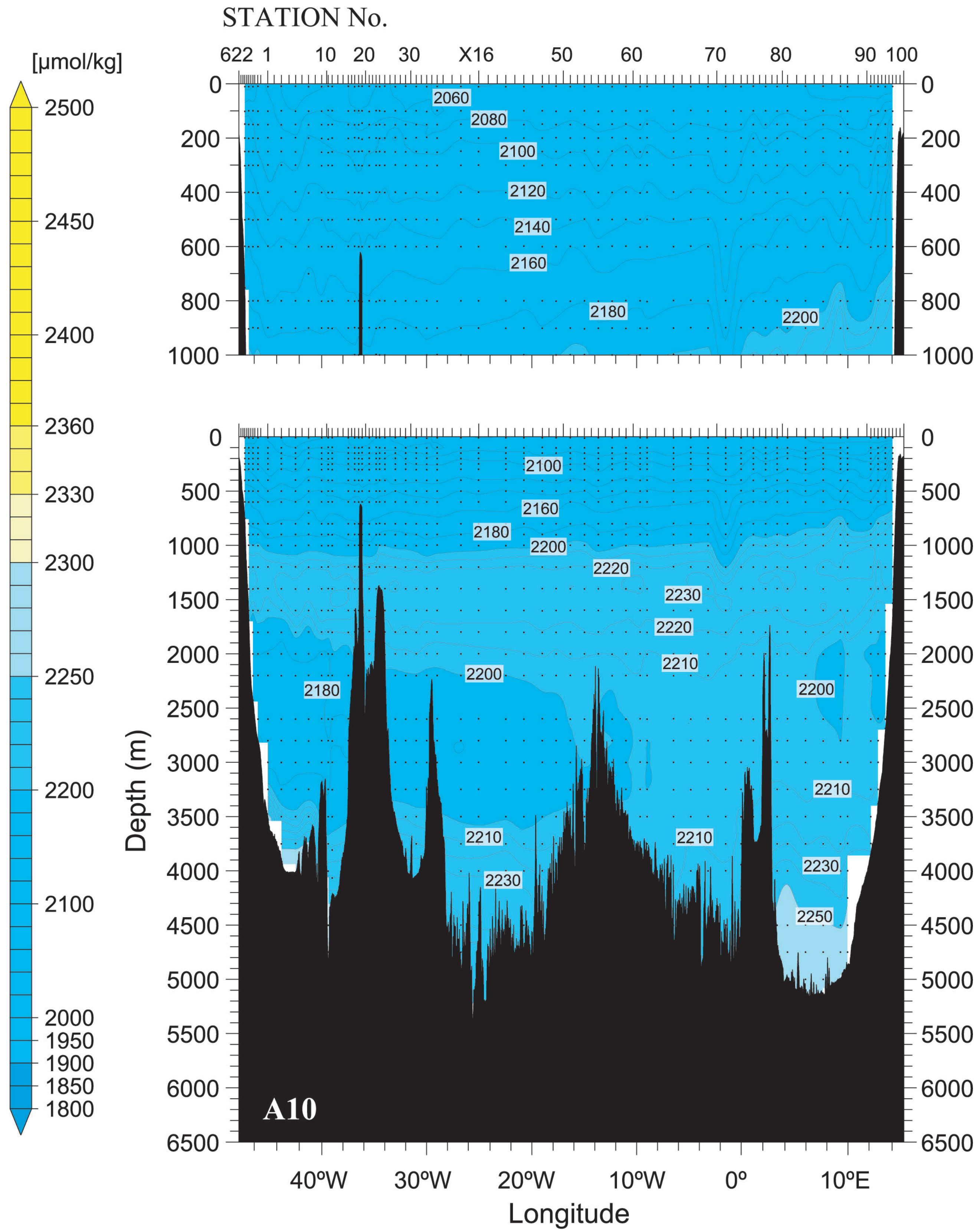
STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
0.1
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
2.2
2.5
2.6
0.6
1.6
2.2
2.6
2.5
2.4
2.3
2.2
2.0
2.4
2.3
2.4
2.3
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

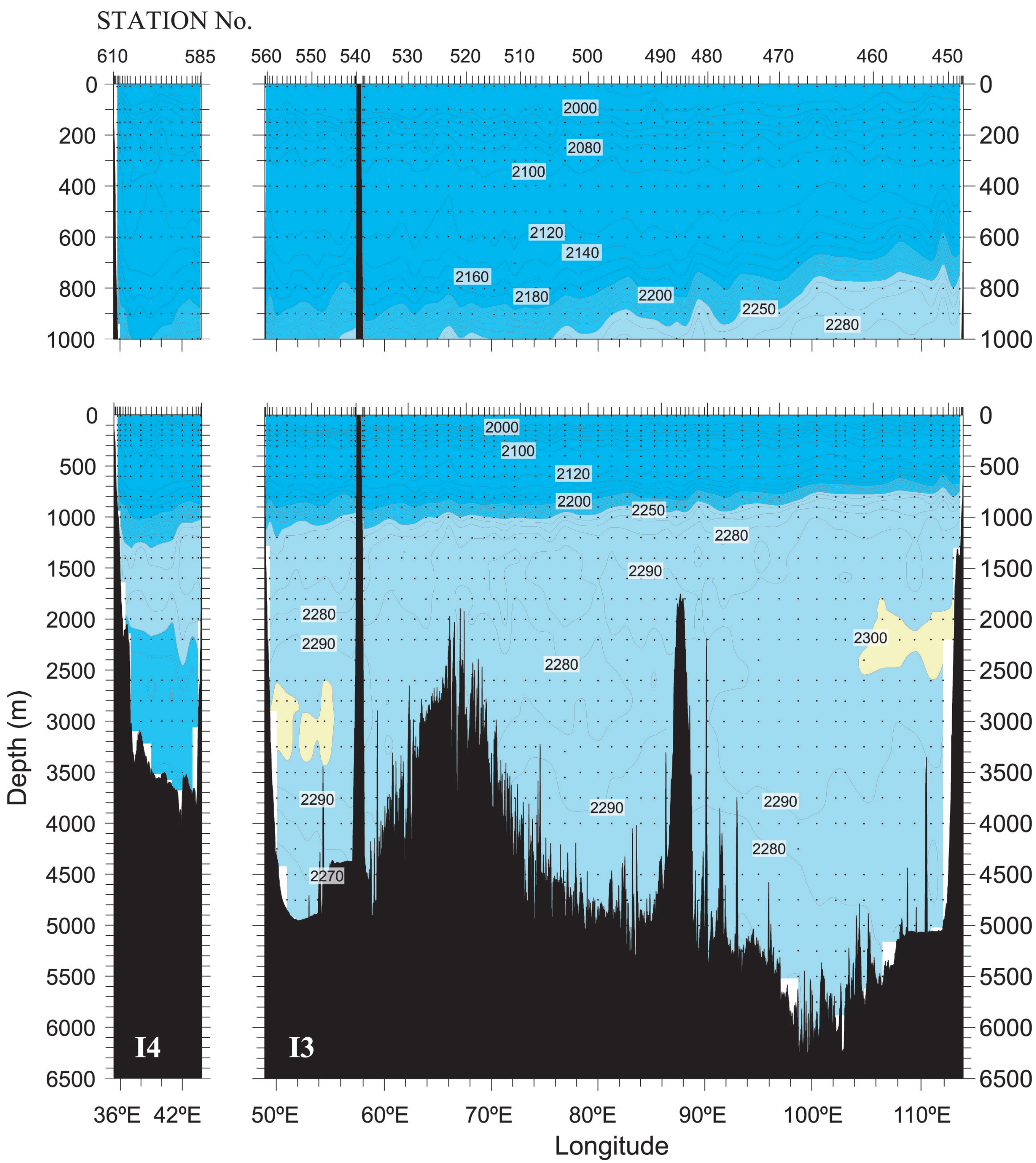


STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.5
2.7
2.8
2.4
2.6
2.3
Depth (m)
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

Figure 14

DISSOLVED INORGANIC CARBON [μmol/kg]





STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
2000
2080
2100
2120
2140
2160
2180
2200
2250
2280
2290
2300
2270
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

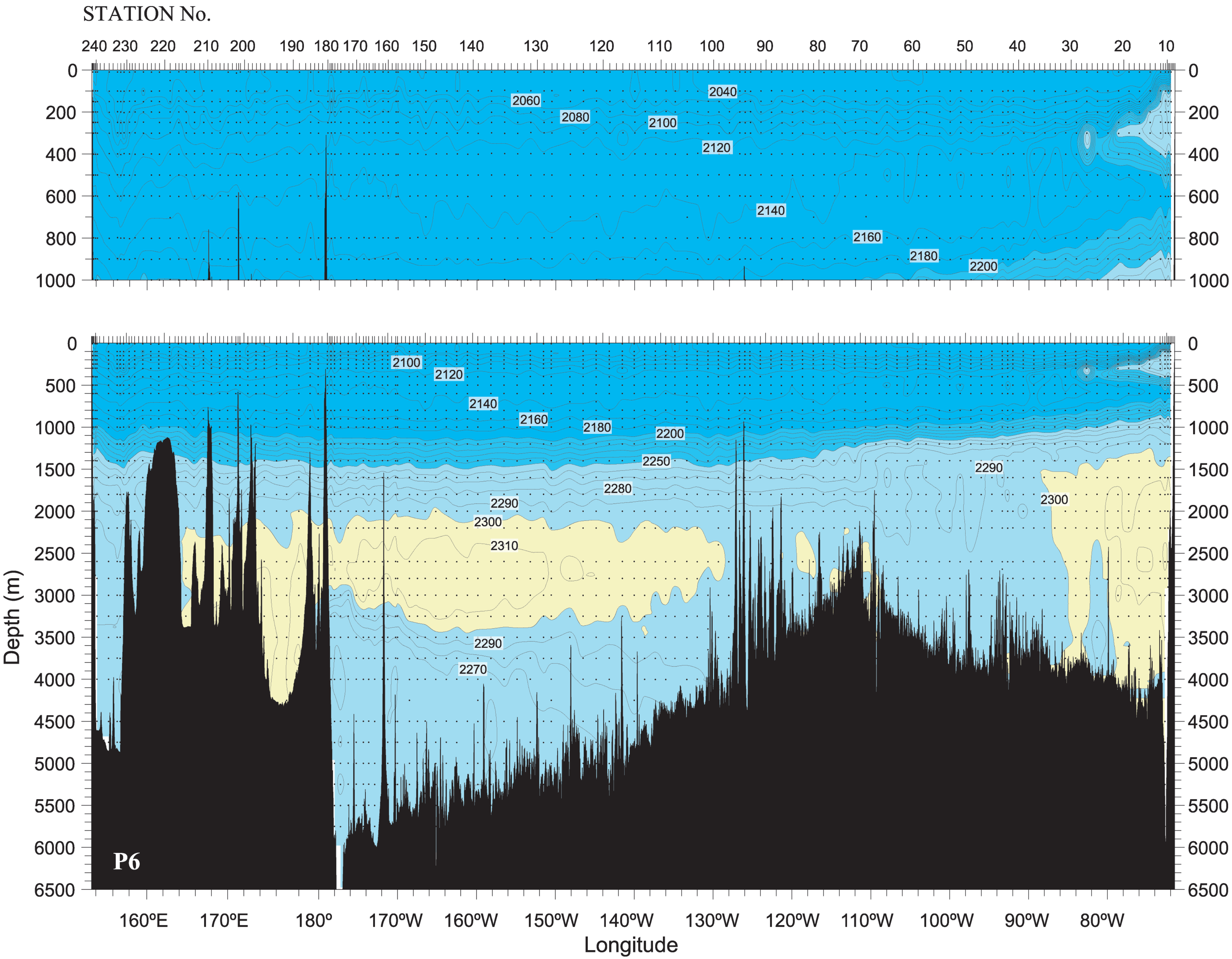
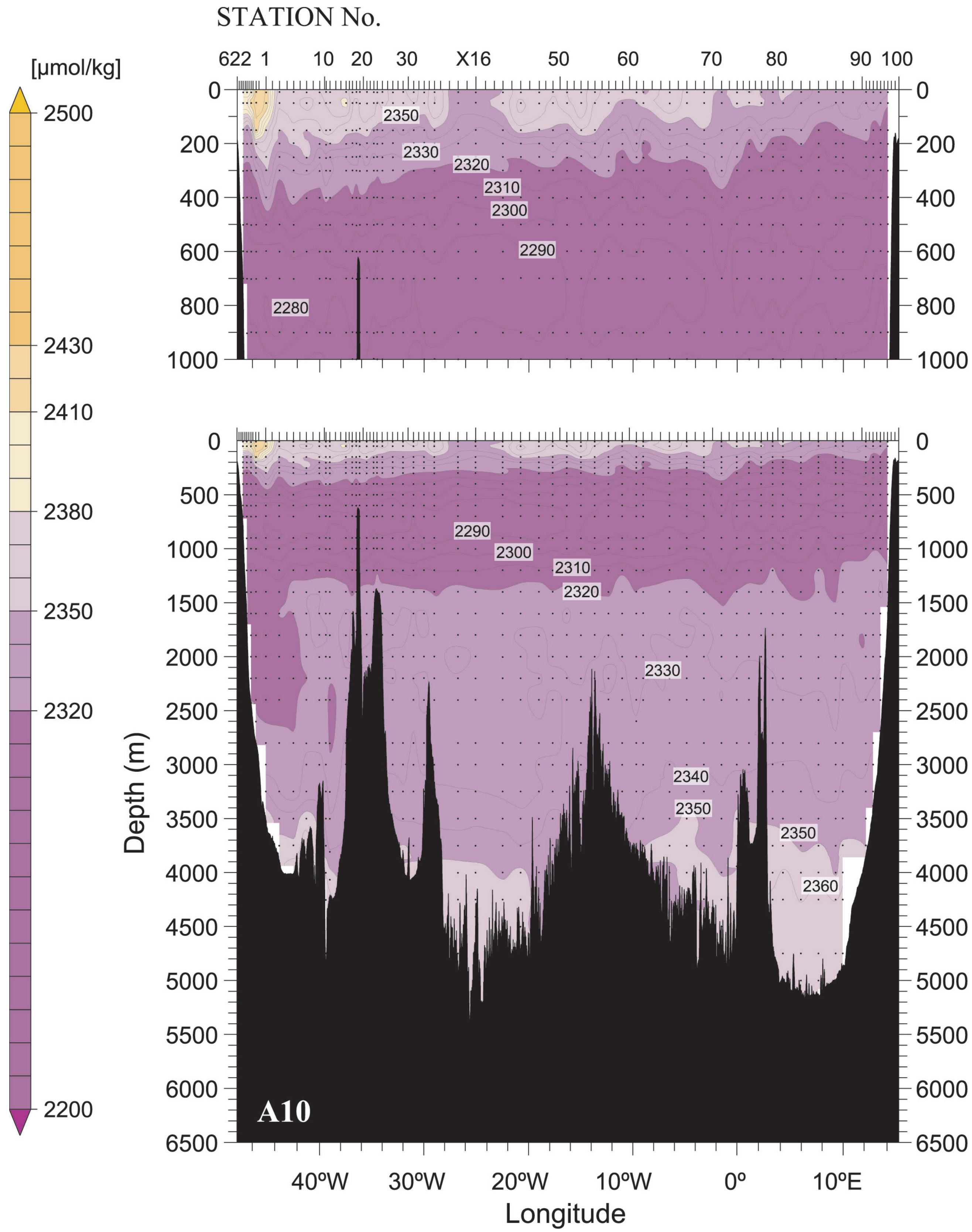
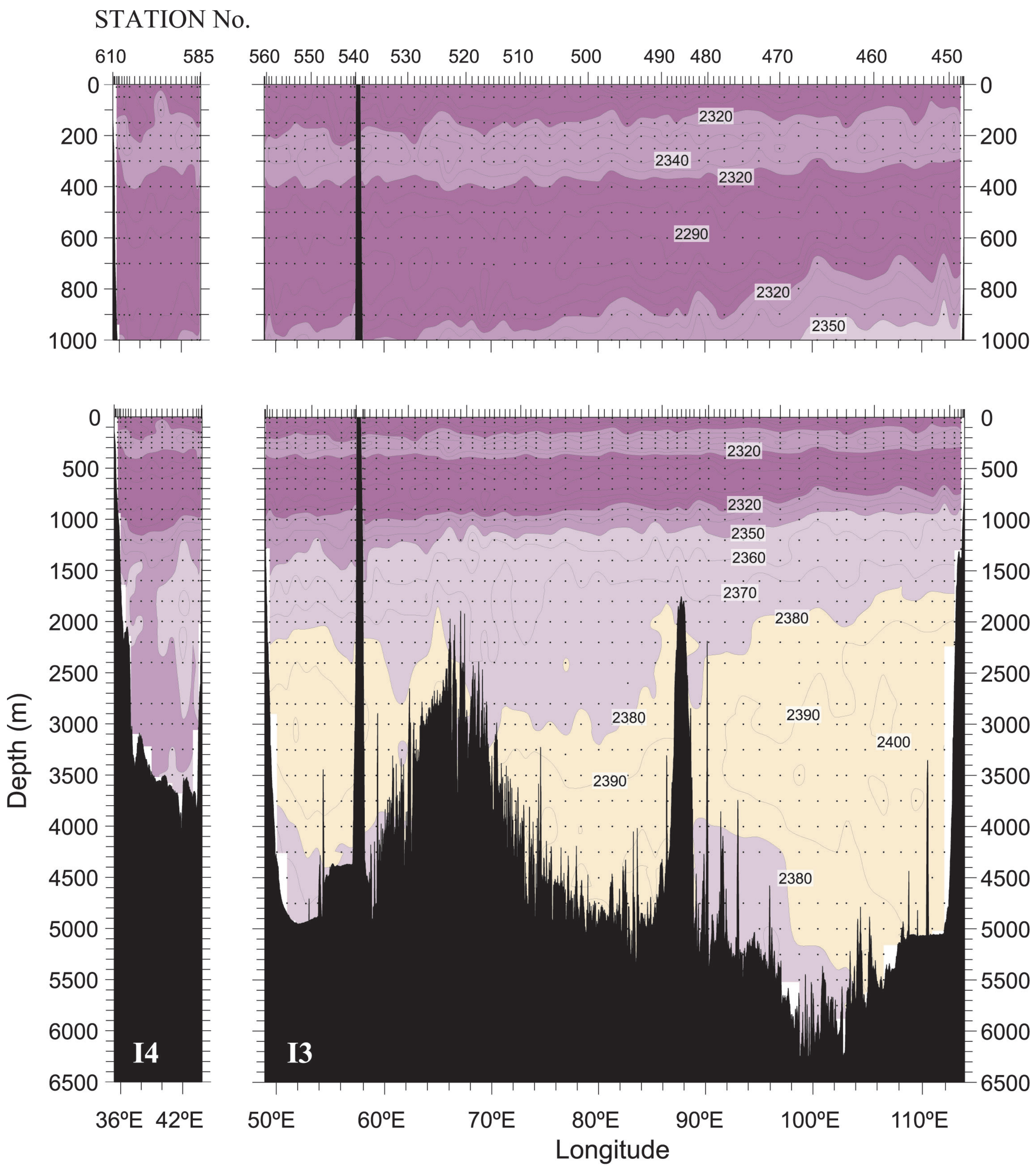

STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
2040
2060
2080
2100
2120
2140
2160
2180
2200
2250
2270
2280
2290
2300
2310
Depth (m)
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

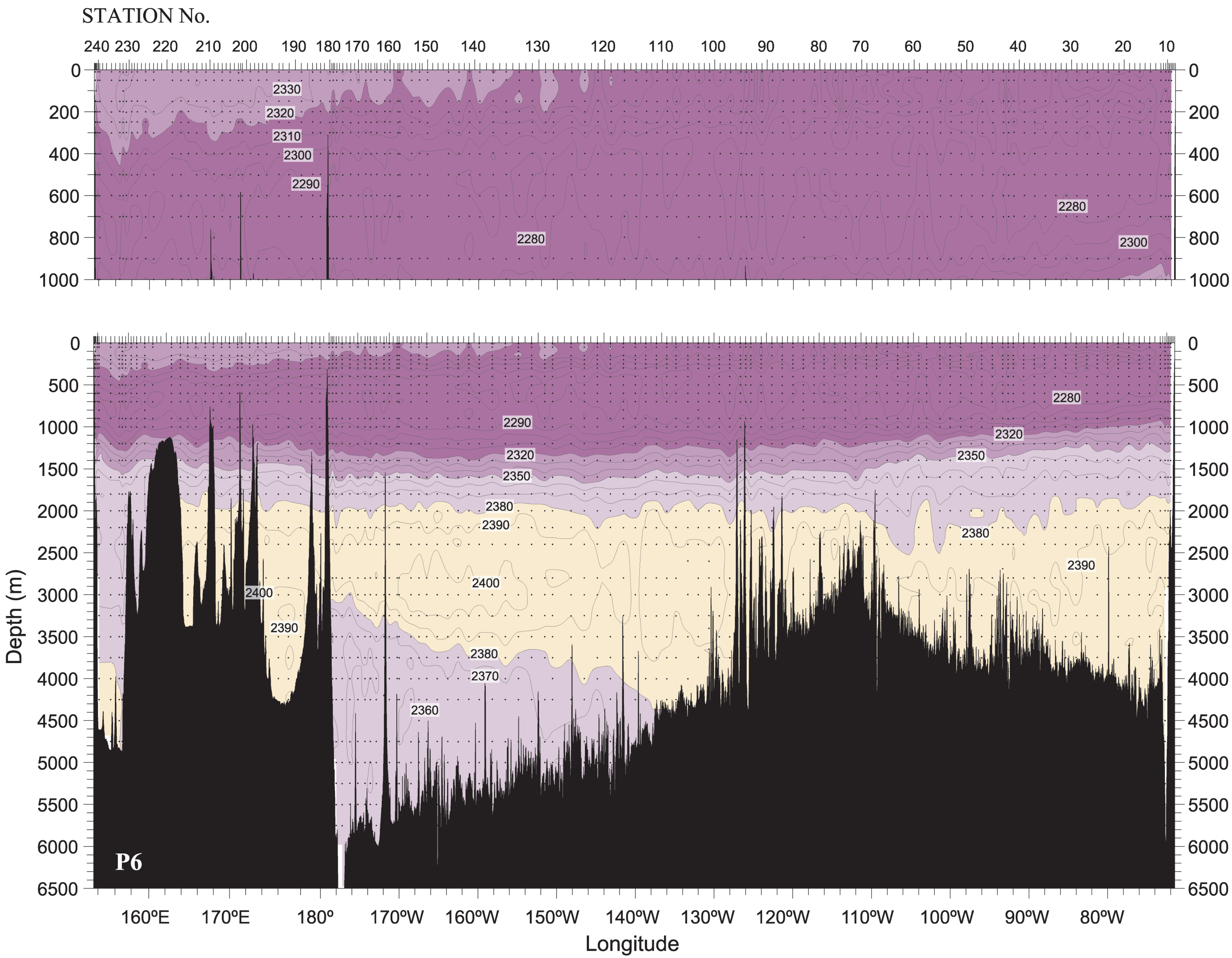
Figure 15

TOTAL ALKALINITY [μmol/kg]





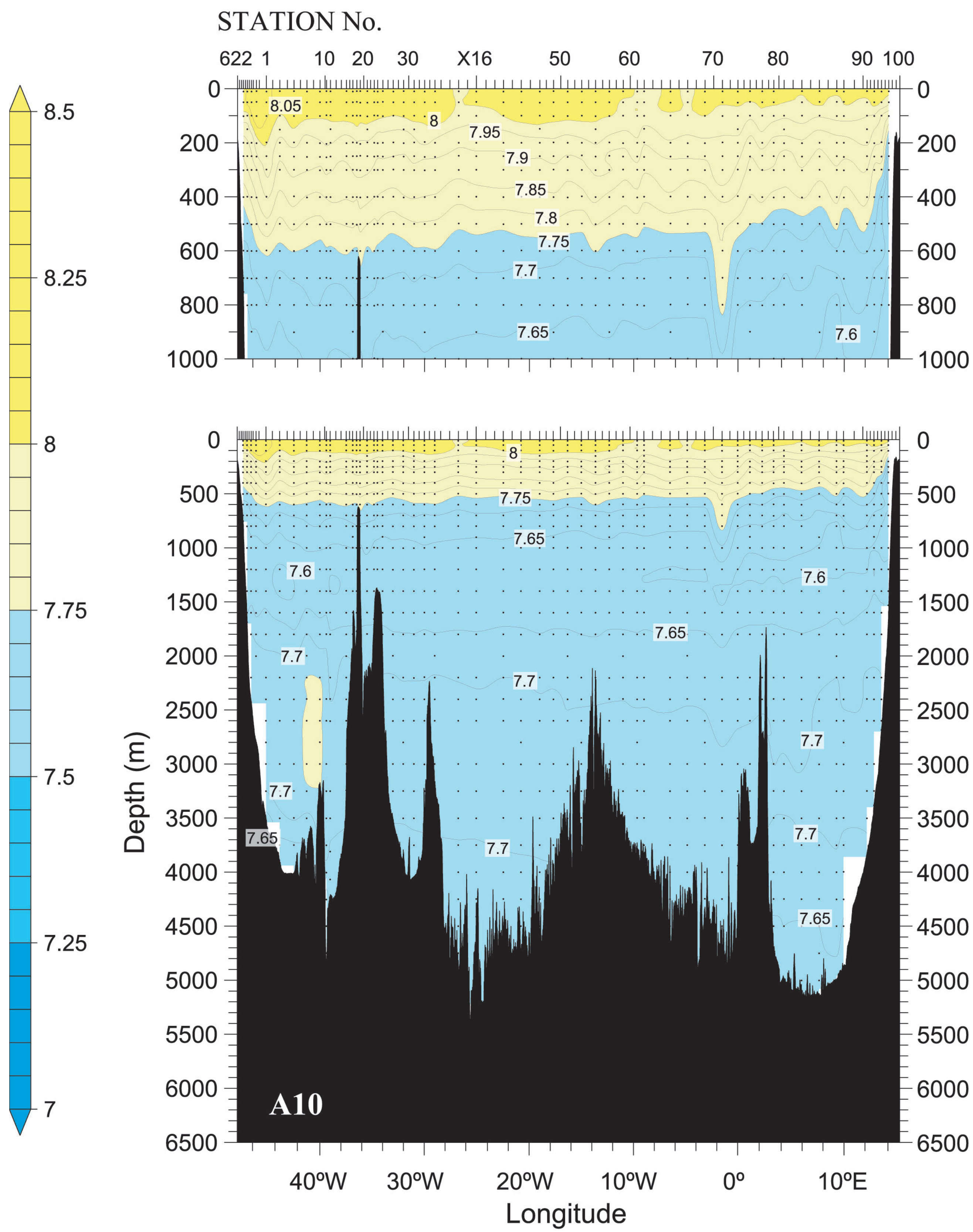
STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
2320
2340
2320
2290
2320
2350
2320
2320
2350
2360
2370
2380
2380
2390
2390
2400
2380
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude



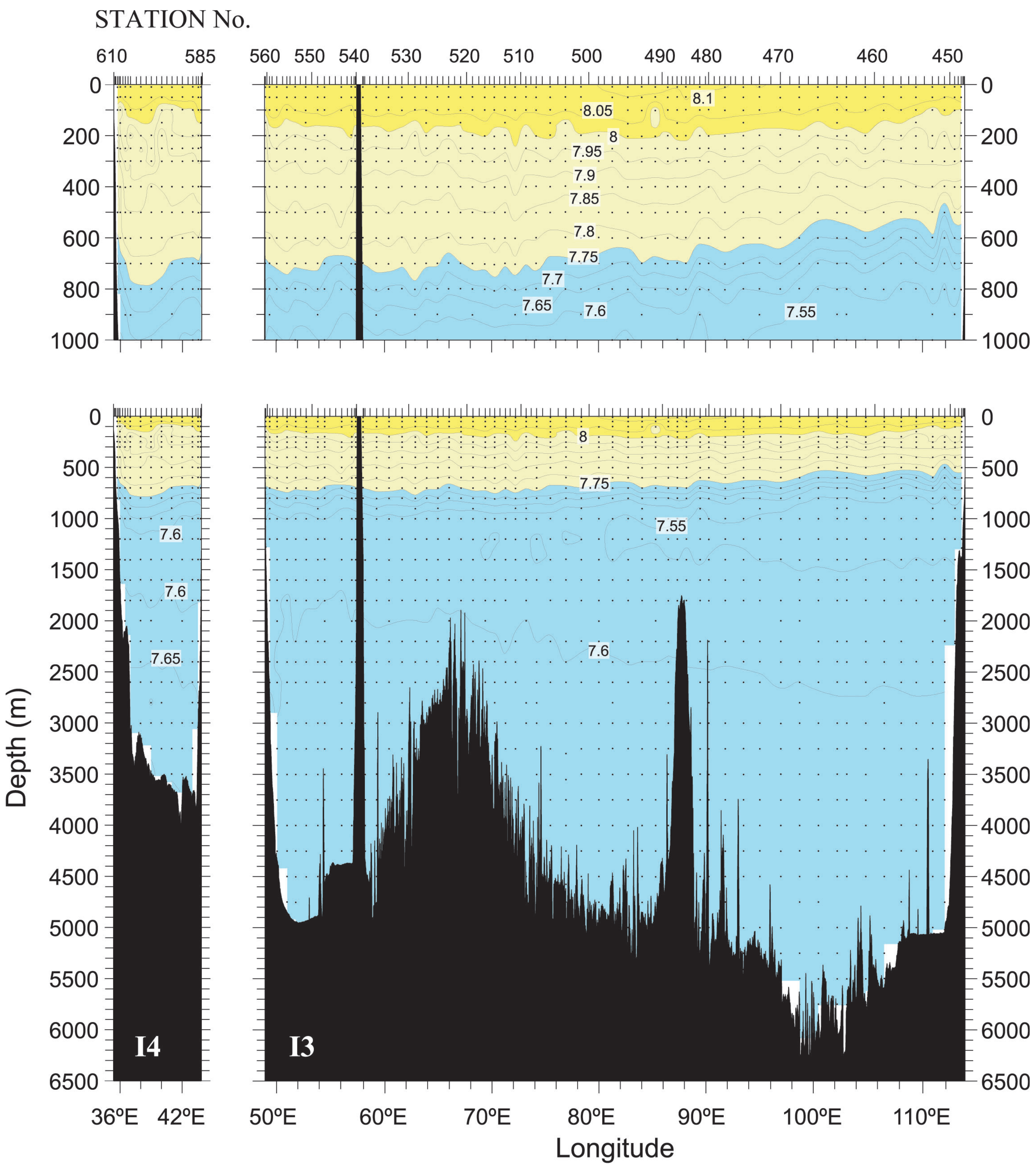
STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
2330
2320
2310
2300
2290
2280
2280
2300
2280
2290
2320
2350
2320
2350
2380
2390
2380
2390
2400
2400
2390
2380
2370
2360
P6
Depth (m)
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

Figure 16

pH



STATION No.
622 1 10 20 30 X16 50 60 70 80 90 100
8.5
8.25
8
7.75
7.5
7.25
7
8.05
8
7.95
7.9
7.85
7.8
7.75
7.7
7.65
7.6
Depth (m)
A10
40°W 30°W 20°W 10°W 0° 10°E
Longitude


STATION No.
610
585
560
550
540
530
520
510
500
490
480
470
460
450
8.1
8.05
8
7.95
7.9
7.85
7.8
7.75
7.7
7.65
7.6
7.55
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

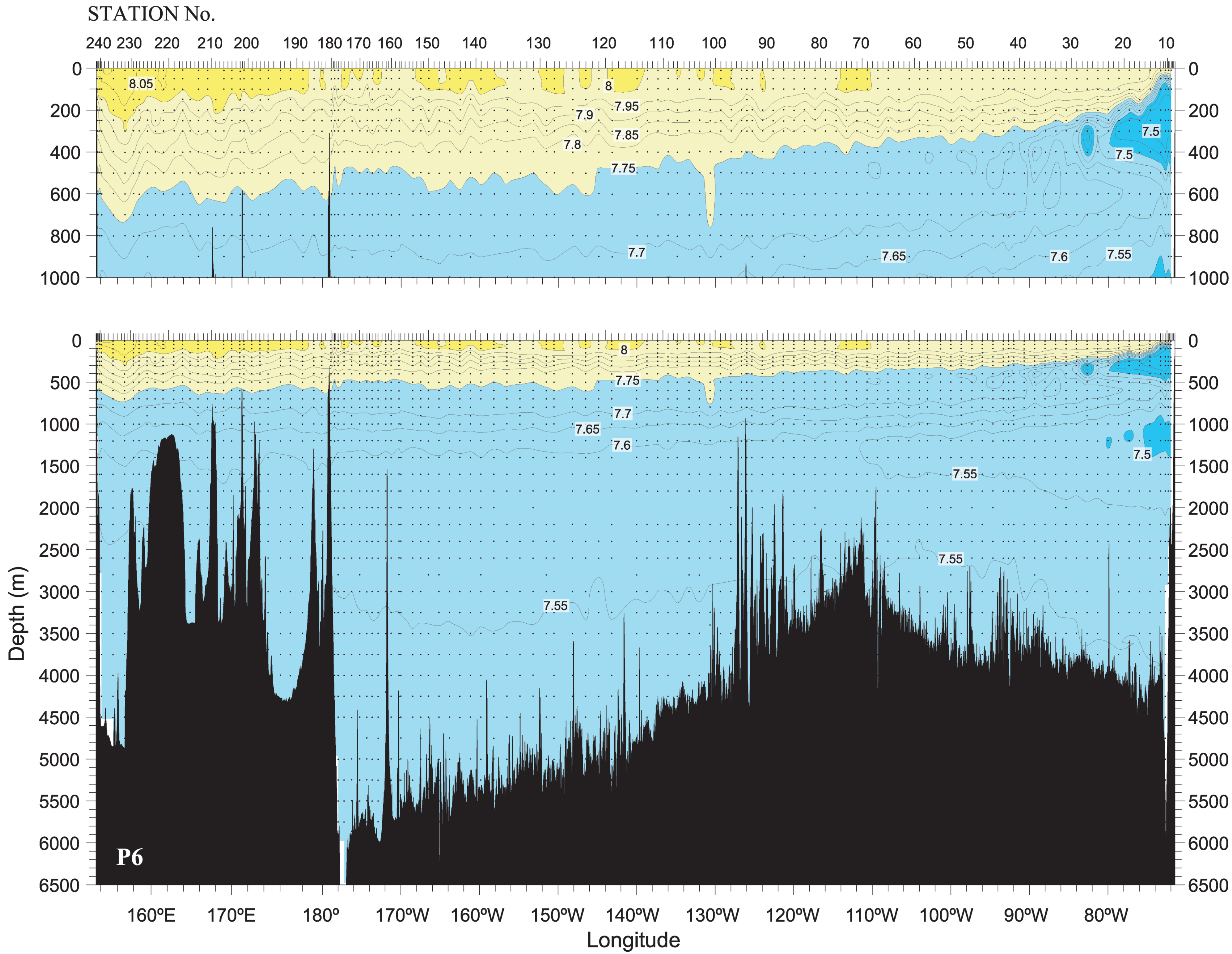
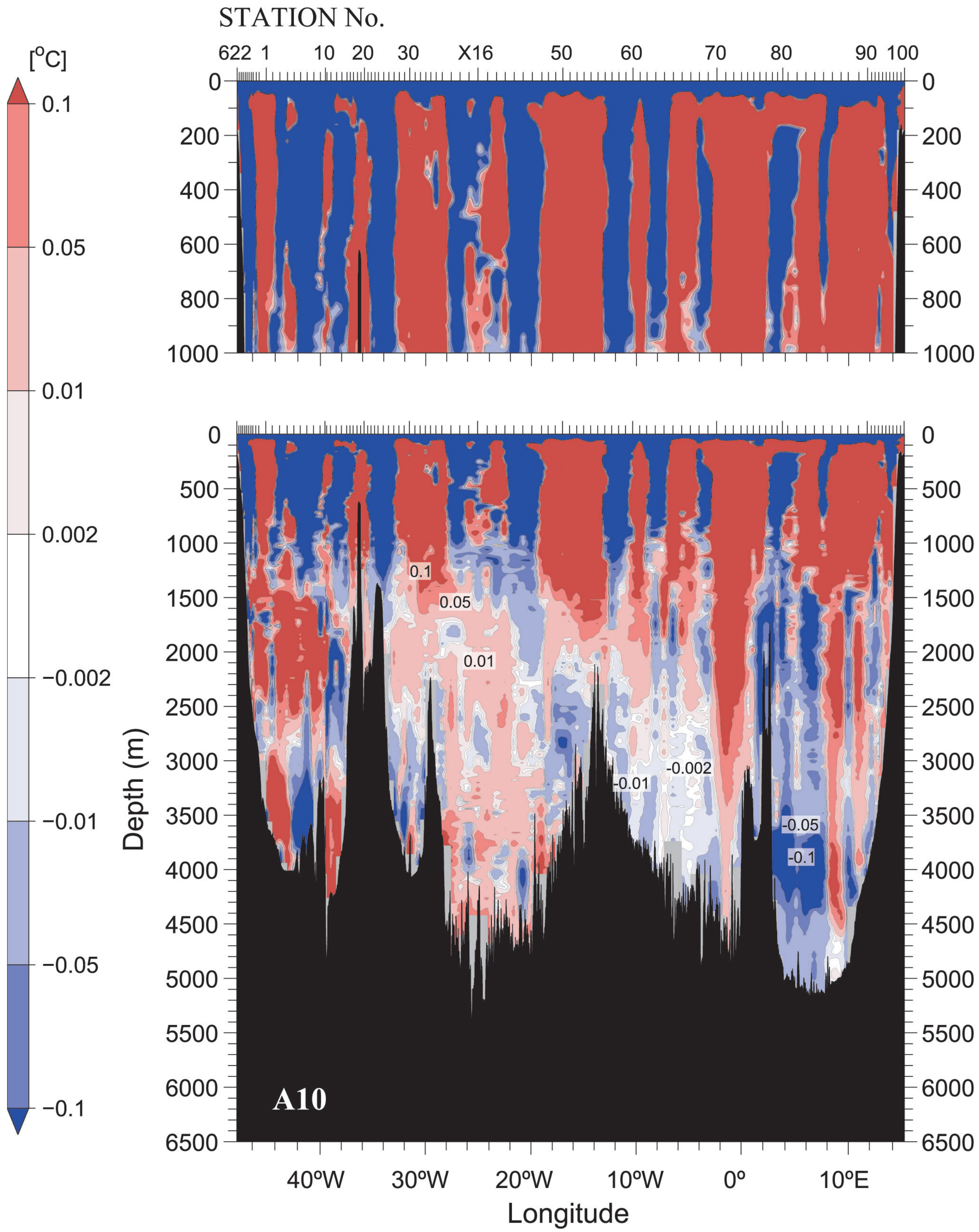
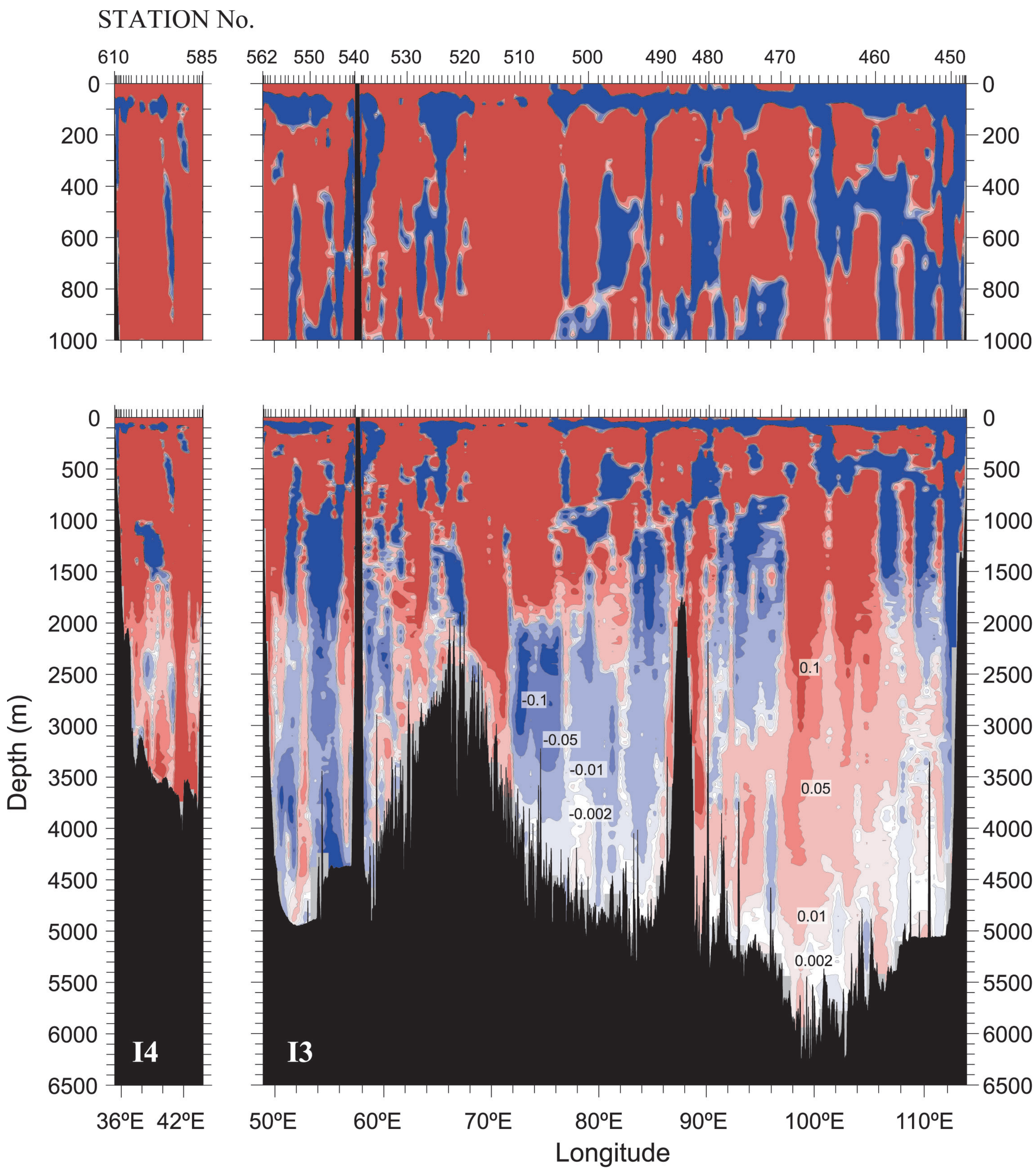

STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
8.05
8
7.95
7.9
7.85
7.8
7.75
7.7
7.65
7.6
7.55
7.5
Depth (m)
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

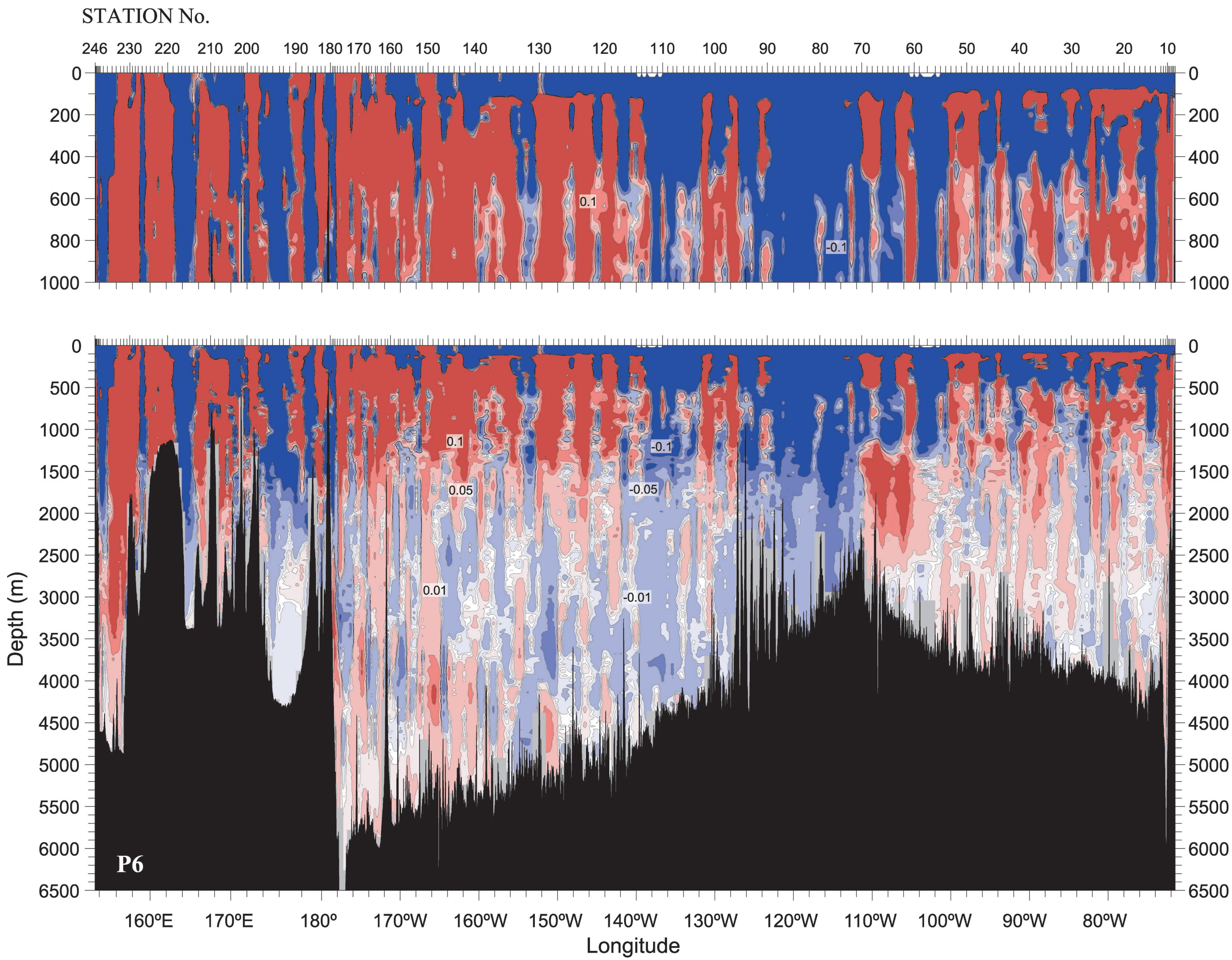
Figure 17

POTENTIAL TEMPERATURE DIFFERENCE BETWEEN WOCE AND BEAGLE2003 [ºC]





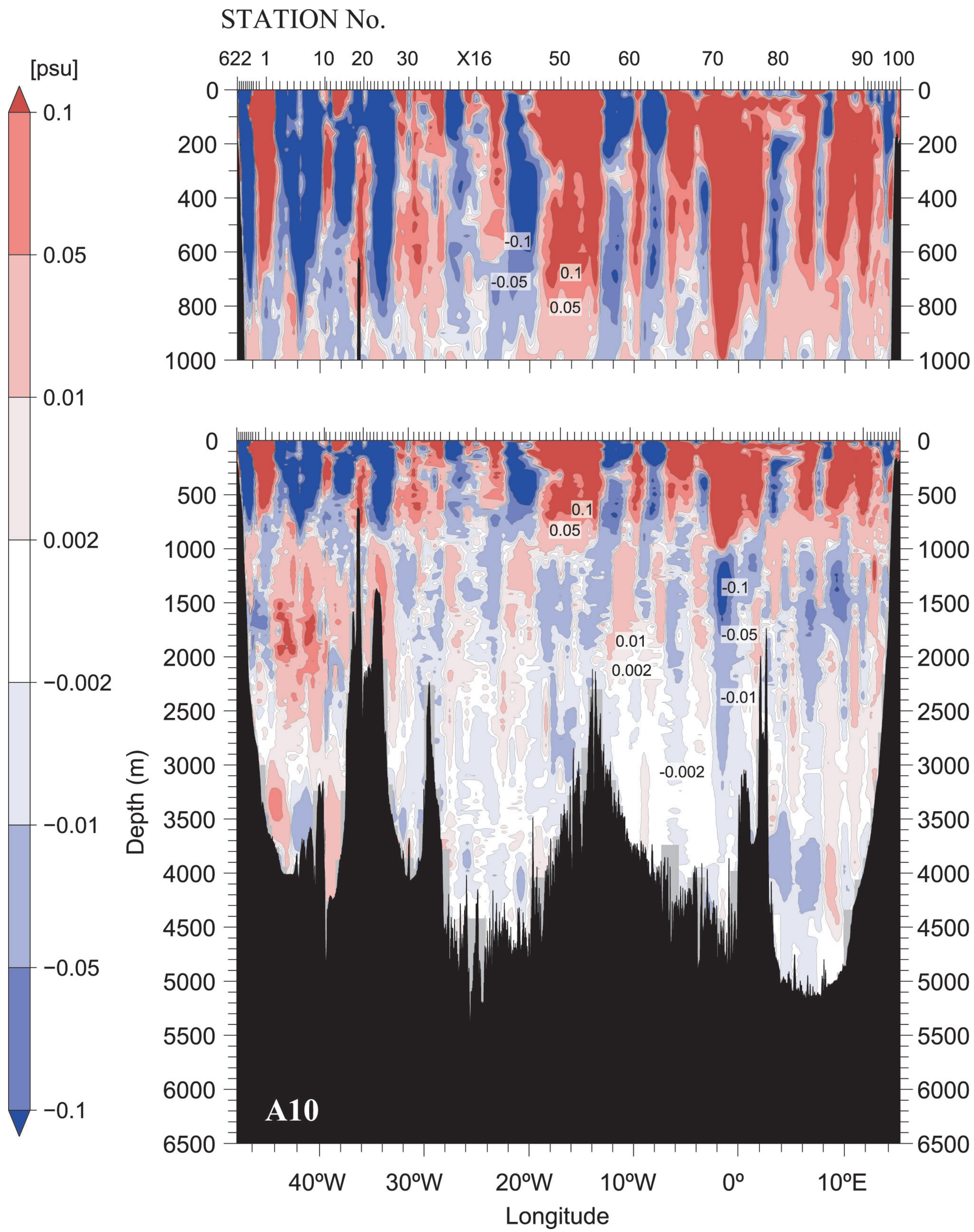
STATION No.
610
585
562
550
540
530
520
510
500
490
480
470
460
450
Depth (m)
0.1
-0.1
-0.05
-0.01
-0.002
0.05
0.01
0.002
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

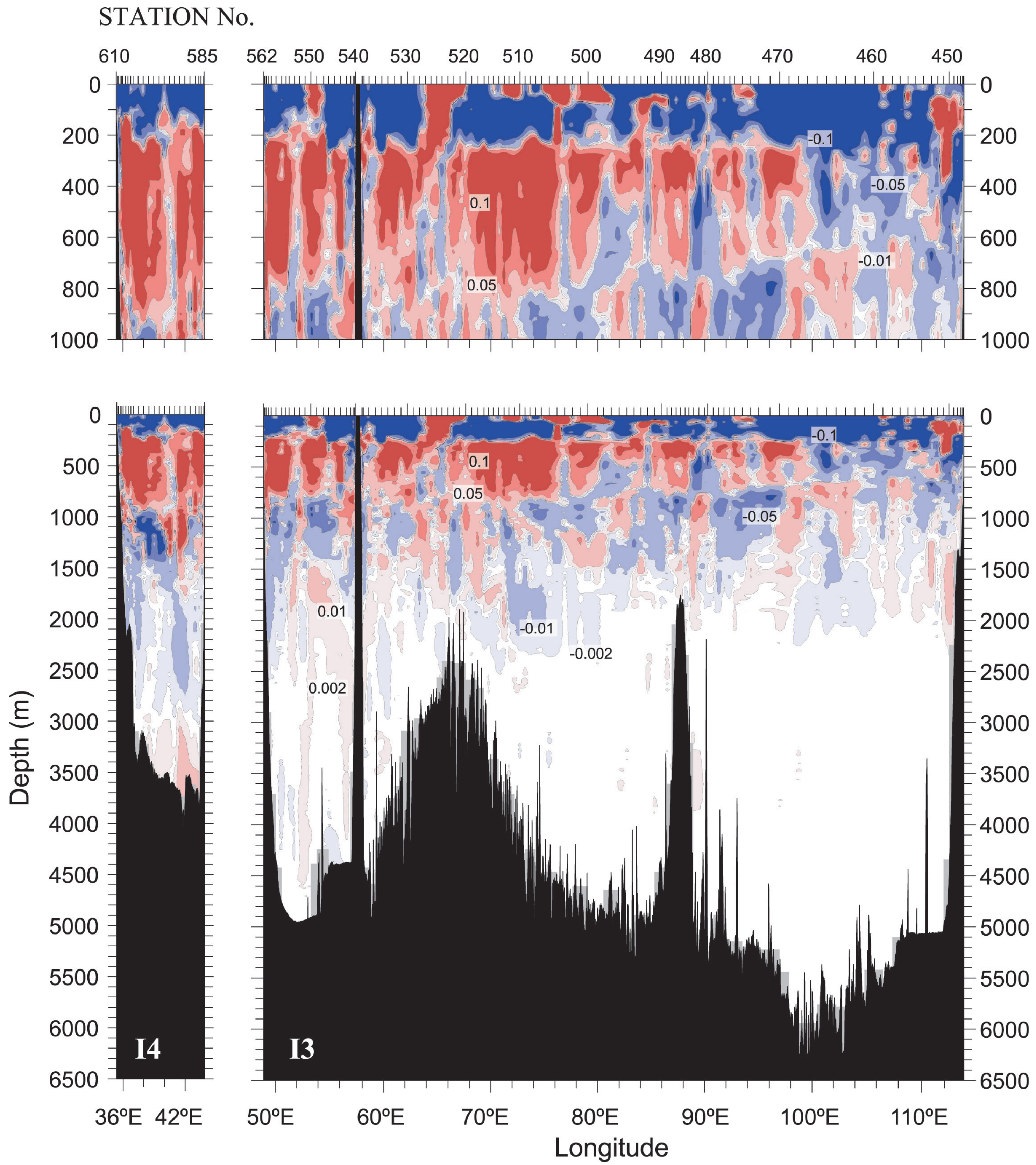


STATION No.
246 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
0 200 400 600 800 1000
0.1
-0.1
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500
Depth (m)
0.1
-0.1
0.05
-0.05
0.01
-0.01
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

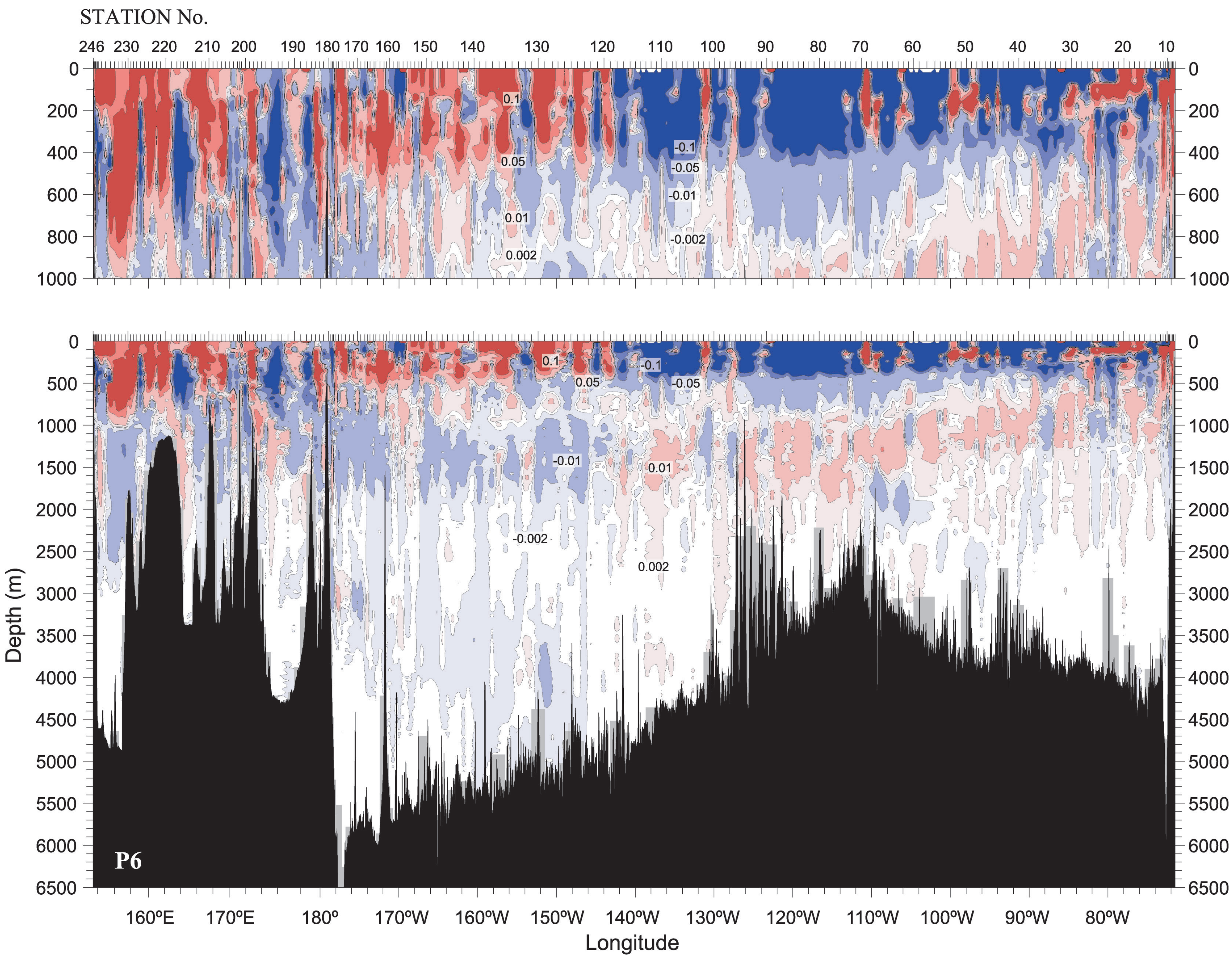
Figure 18

SALINITY DIFFERENCE BETWEEN WOCE AND BEAGLE2003 [PSU]





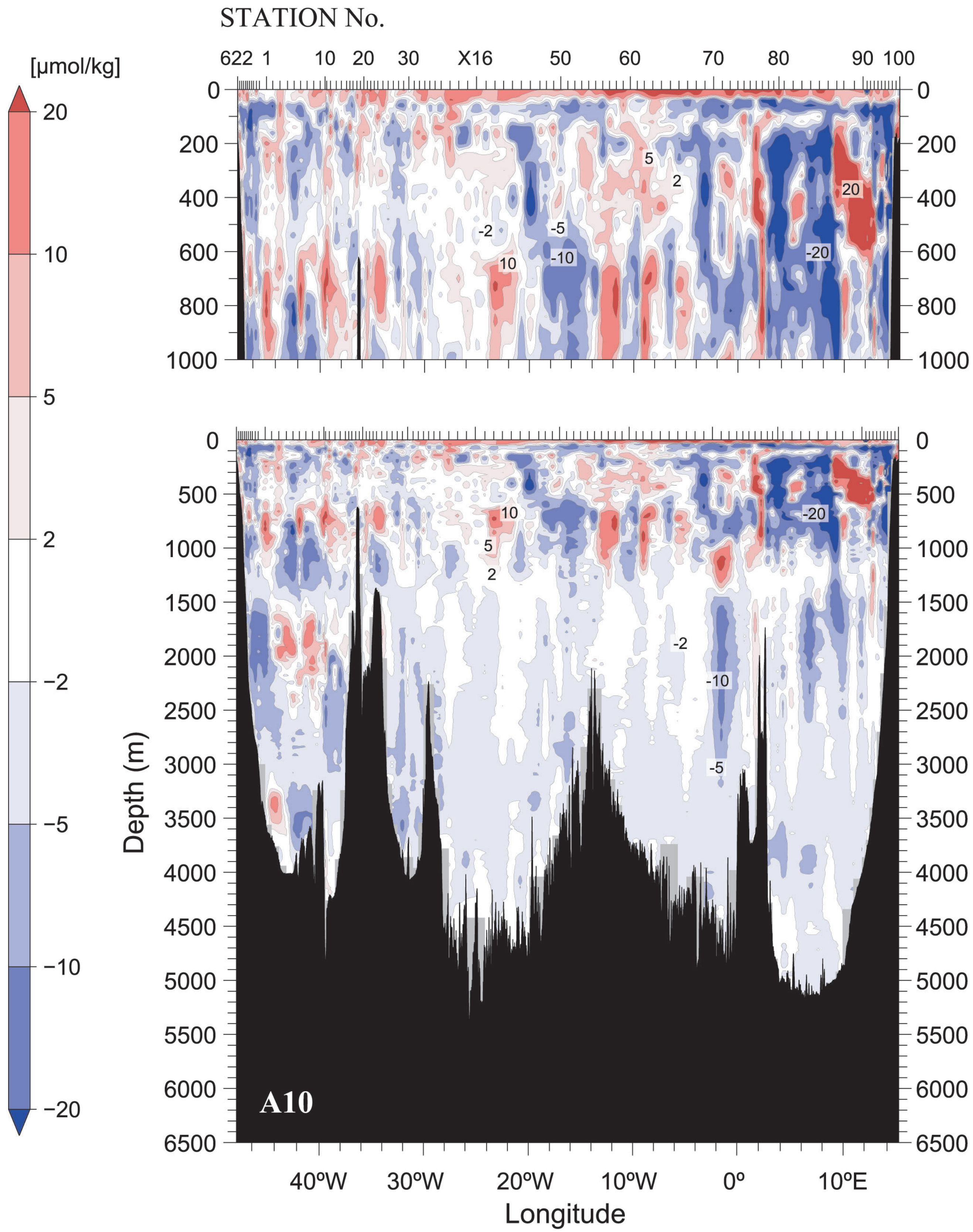
STATION No.
610
585
562
550
540
530
520
510
500
490
480
470
460
450
0
200
400
600
800
1000
-0.1
-0.05
0.1
-0.01
0.05
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
0.01
-0.01
-0.002
0.002
Depth (m)
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude

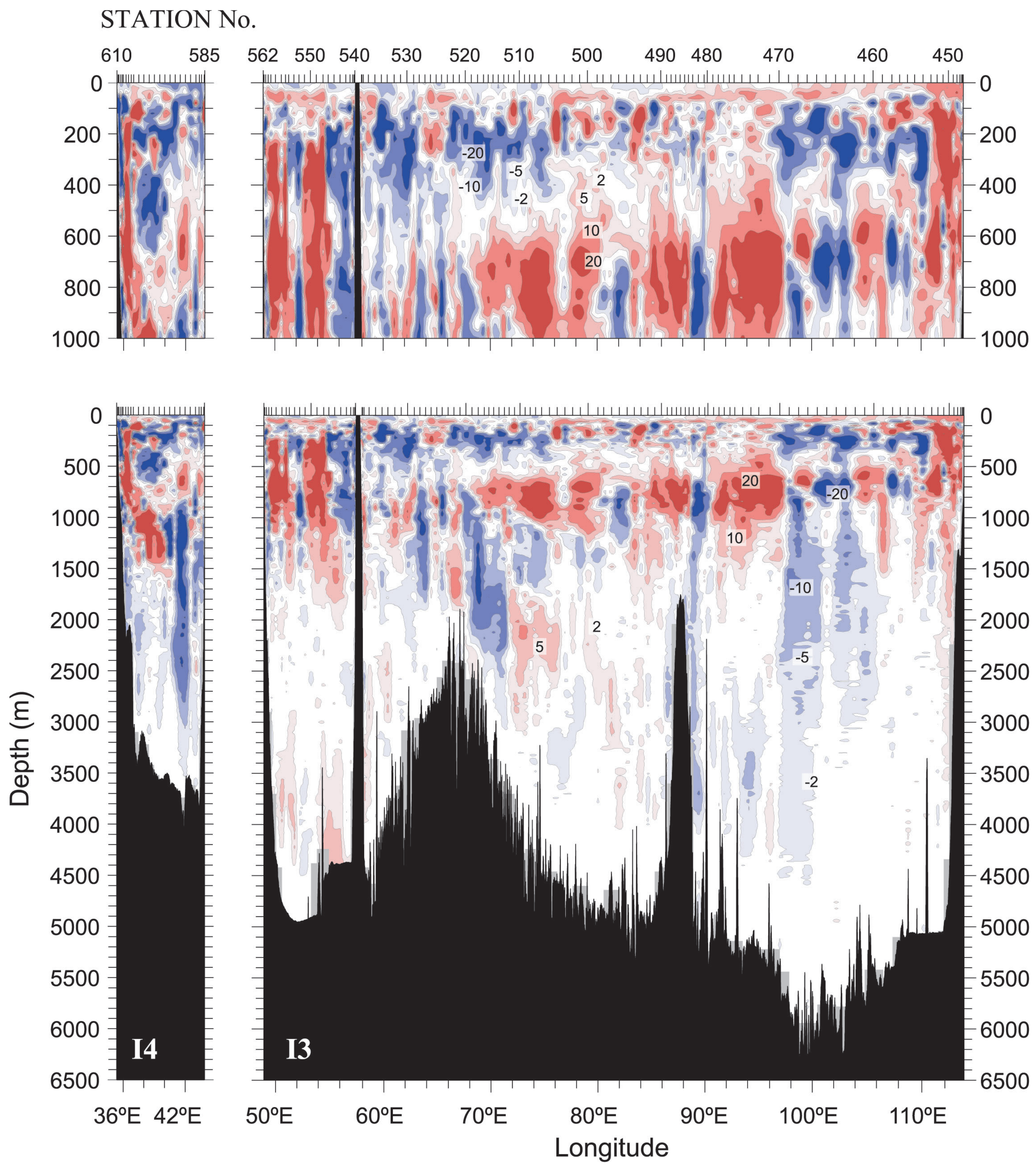


STATION No.
246 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
0.1
0.05
0.01
0.002
-0.1
-0.05
-0.01
-0.002
Depth (m)
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

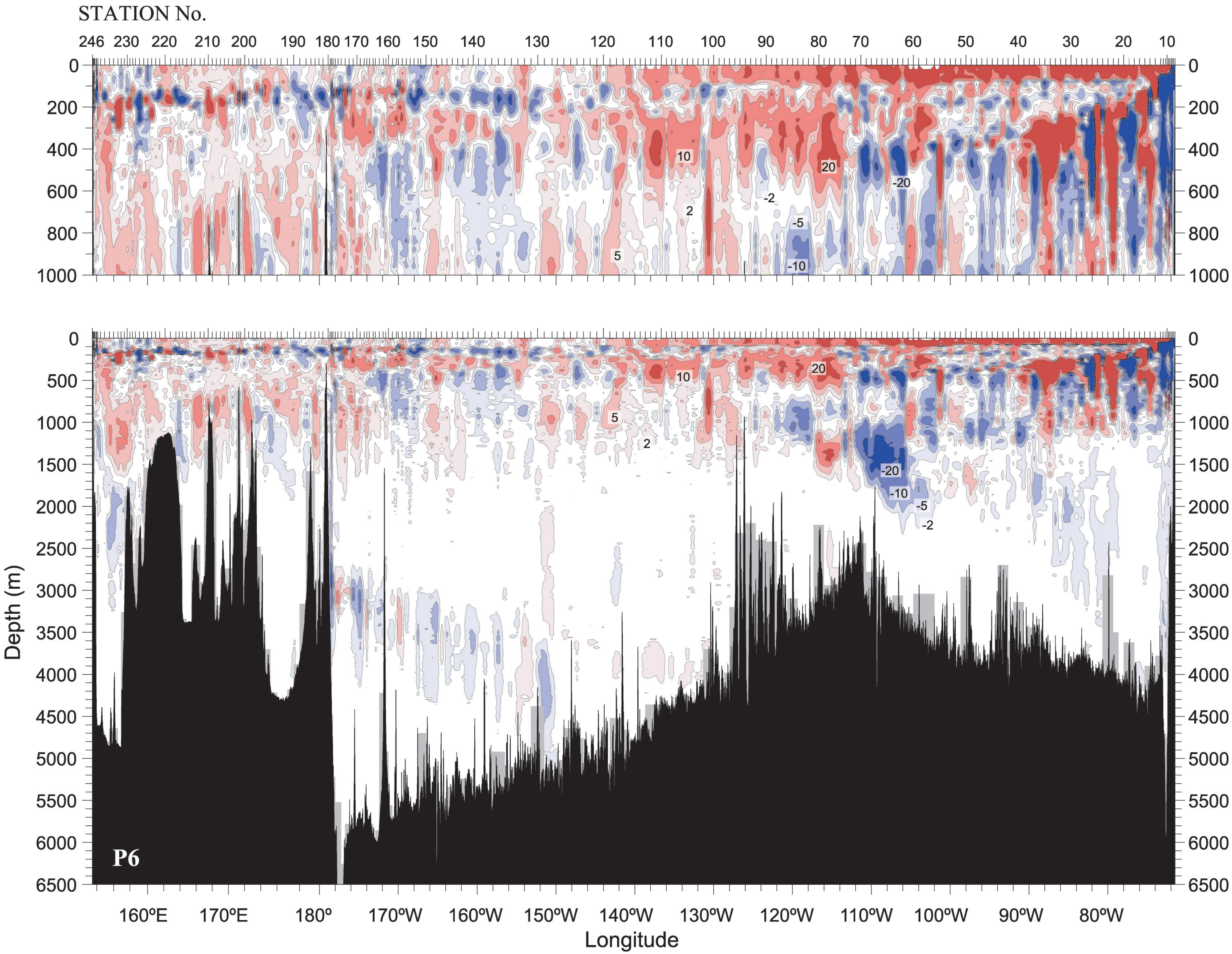
Figure 19

OXYGEN DIFFERENCE BETWEEN WOCE AND BEAGLE2003 [μmol/kg]





STATION No.
610
585
562
550
540
530
520
510
500
490
480
470
460
450
0
200
400
600
800
1000
-20
-10
-5
-2
2
5
10
20
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Depth (m)
-20
10
-10
2
5
-5
-2
I4
I3
36ºE
42ºE
50ºE
60ºE
70ºE
80ºE
90ºE
100ºE
110ºE
Longitude



STATION No.
246 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
0 200 400 600 800 1000
10
20
-20
-2
2
-5
5
-10
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500
Depth (m)
10
20
5
2
-20
-10
-5
-2
P6
160ºE 170ºE 180º 170ºW 160ºW 150ºW 140ºW 130ºW 120ºW 110ºW 100ºW 90ºW 80ºW
Longitude

WHP P6, A10, I3/I4 REVISIT DATA BOOK

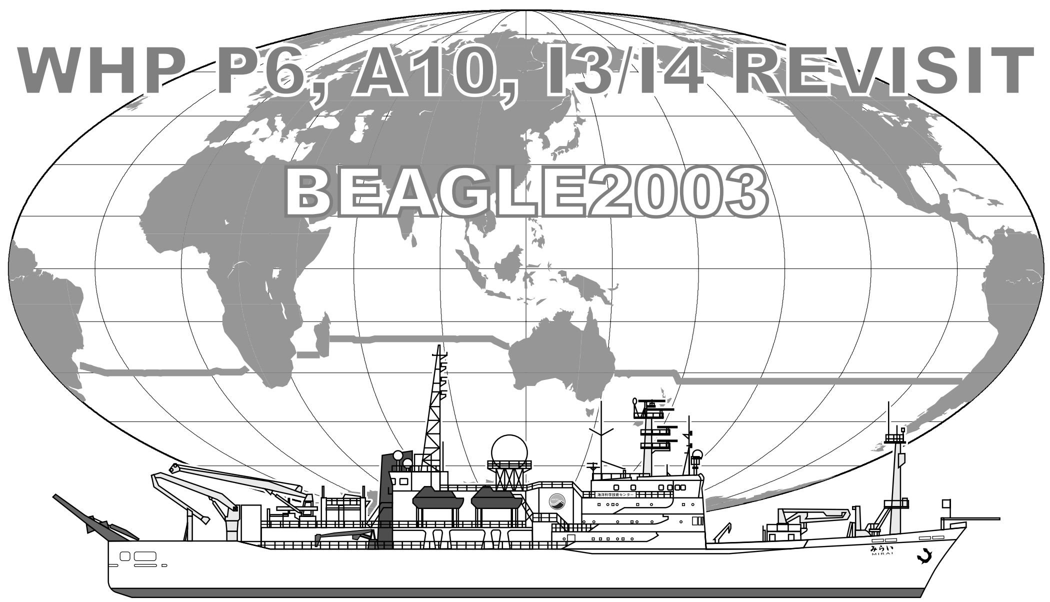
Blue Earth Global Expedition 2003 (BEAGLE2003)

Volume 3

Edited by

Yuichiro Kumamoto (JAMSTEC),

Shuichi Watanabe (JAMSTEC)



WHP P06, A10, I3/I4 REVISIT DATA BOOK

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Volume 3

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3. Hydrographic Measurement Techniques and Calibrations (continued from Volume 2)

3.9 Chlorofluorocarbons (CFCs)

7 December 2006

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(2) Introduction

Chlorofluorocarbons (CFCs) are completely man-made gasses that are chemically and biologically stable gasses in the environment. The CFCs have been accumulated in the atmosphere since 1930's (Walker et al., 2000) and the atmospheric CFCs can slightly dissolve in sea surface water. The dissolved CFC concentrations in sea surface water should have changed year by year and then penetrated into the ocean interior by water circulation. Three chemical species of CFCs, namely CFC-11 (CCl_3F), CFC-12 (CCl_2F_2) and CFC-113 ($C_2Cl_3F_3$), dissolved in seawater are useful transient tracers for the ocean circulation with time scale on the order of decades.

In this cruise, we determined the concentrations of these CFCs in seawater on board.

(3) Apparatus

Dissolved CFCs were measured by a method modified from the original design of Bullister and Weiss (1988). Two systems were used for CFCs measurement. A custom made purging and trapping system was attached to gas chromatograph (GC-14B: Shimadzu Ltd) having an electron capture detector (ECD-14: Shimadzu Ltd). Porapak T® filler was packed in a 1/8" stainless steel trap column. PoraPlot Q-HT capillary columns [i.d.: 0.53mm, length: 2m, film layer thickness: 20μm] was used as a pre-column. PoraPlot Q-HT capillary columns [i.d.: 0.53mm, length: 20m, film layer thickness: 20μm] was used as a main analytical column in leg 1 and 2. The main analytical column was replaced by PoraBond Q capillary columns [i.d.: 0.53mm, length: 25m, film layer thickness: 10μm] in legs 4 and 5.

The change in main analytical columns has been due to serious problems found in the columns used in legs 1 and 2. The main columns used in legs 1 and 2 were clogged by particles peeled from column wall and carrier gas could not flow sufficiently. This problem affected to separation of compounds and analytical time.

(4) Shipboard measurement

Sampling

Seawater sub-samples for CFCs measurement were collected from 12 litter Niskin bottles to 300ml sub-sampling glass bottles which were developed for CFCs analyses in JAMSTEC. The sub-sampling bottles have stainless steel union altered from original design of Swagelok® on the top. A 1/4" ϕ stainless steel tube goes through the union into the bottle interior and reaches to near the bottom of bottle. A small plastic stop valve was on the upper tip of stainless steel tube. The bottles were filled by nitrogen gas before sampling. The valve was connected to Niskin bottle. The sub-sampling bottles were filled by seawater sample from the bottom. Two times of the bottle volumes of seawater sample were overflowed from vent valve put on side of the union and then the all valves closed from downstream. The bottles filled by seawater sample were kept in water bathes roughly controlled on sample temperature. The CFC concentrations were determined as soon as possible after sampling. These procedures were needed in order to minimize contamination from atmospheric CFCs.

Analysis

The CFCs analytical system is modified from the original design of Bullister and Weiss (1988). Constant volume of sample water is taken into the purging & trapping system. The volume of sample was 150 ml in legs 1 and 2 and 100 ml in legs 4 and 5. Dissolved CFCs are de-gassed by N_2 gas purge and concentrated in a 1/8" SUS packed trap column (Porapak T) cooled to –40 degree centigrade. The CFCs are desorbed by electrically heating the trap column to 130 °C, and lead into the pre-column. CFCs and other compounds are roughly separated in the pre-column and the compounds having earlier retention time than CFC-113 are sent to main analytical column. And then the pre-column is flushed buck by counter flow of pure nitrogen gas (Back flush system). The back flush system is prevent to enter any compounds that have higher retention time than CFC-113 into main analytical column and permits short time analysis. CFCs which are sent into main column are separated further and detected by an electron capture detector (ECD).

In legs 1 and 2, temperature rising analysis has been used because of too long of retention times of CFCs to use temperature constant analysis. The long retention time was due to problems on main analytical column mentioned above.

In legs 4 and 5, we can use temperature constant analysis due to applying new column for main analytical column. Analytical conditions are listed in Table 3.9.1.

Gas loops that the volumes were around 1, 3 and 10 ml were used for introducing standard gases into the analytical system.

Table 3.9.1. Analytical conditions of dissolved CFCs in seawater.

Leg 1	
Temperature	
Analytical Column:	70 or 100 °C constant for 10 minutes followed by temperature changing stage in 10 °C/min of the rate to 140 °C.
Detector (ECD):	200 or 250 °C
Trap column:	–45 °C (at adsorbing) & 130 °C (at desorbing)
Mass flow rate of nitrogen gas (99.9999%)	
Carrier gas:	3 - 7 ml/min
Detector make-up gas:	17 ml/min
Back flush gas:	>10 ml/min
Sample purge gas:	100 ml/min
Leg 2	
Temperature	
Analytical Column:	75 °C constant for 5 minutes followed by temperature changing stage in 20°C/min of the rate to 130 °C.
Detector (ECD):	270 or 290 °C
Trap column:	–45 °C (at adsorbing) & 130 °C (at desorbing)
Mass flow rate of nitrogen gas (99.9999%)	
Carrier gas:	8 - 9 ml/min
Detector make-up gas:	16 - 21 ml/min

Table 3.9.1. continued

Back flush gas:	4 - 7 ml/min
Sample purge gas:	200 ml/min
Legs 4 and 5	
Temperature	
Analytical Column:	95 °C constant.
Detector (ECD):	290 °C
Trap column:	–45 °C (at adsorbing) & 130 °C (at desorbing)
Mass flow rate of nitrogen gas (99.9999%)	
Carrier gas:	27 ml/min
Detector make-up gas:	28 ml/min
Back flush gas:	>15 ml/min
Sample purge gas:	300 ml/min
Standard gas (Taiyo Toyo Sanso co. ltd.) in all legs	
Base gas:	Nitrogen
CFC-11:	850 ppt (v/v)
CFC-12:	500 ppt (v/v)
CFC-113:	90 ppt (v/v)

(5) Quality control

Analytical conditions of CFCs have been changed among legs. Data qualities are mentioned for each leg.

Legs 1

One of two analytical systems had serious problem in cold trap heating system. We needed considerable time for repairing the problem and we could not obtain CFCs data in around half of planed stations. Another system also had some problems in the analytical columns. It was closed by the resins and considerable high pressure of carrier gas had been needed to obtain the mass flow rate of 5 ml/min. Additionally, the column cannot separate CFC-11 peak from unknown interference peaks. Almost all CFC-11 data was bad in the quality and flag was "4". Considerable numbers of CFC-12 and -113 data were also not good in quality due to unstable condition of analytical systems and were given flag of "4".

Legs 2

Before starting leg 2, analytical conditions have been coordinated again. The peaks of CFC-11 and -113 cannot separate from unknown interference peaks. Separation of CFC-12 peak was better than that in leg 1. Most CFC-12 data was good in quality and given flag of "2". The analytical precision was estimated from replicate sample analysis of CFC-12. The precision was estimated from average of absolute difference to be 0.009 ± 0.011 pmol/kg (n = 24).

Legs 4

We got new analytical columns at before Leg 3 that did not have plan for CFCs analyses. During Leg 3, we have tested the columns and successfully decided the analytical condition for CFC-11 and 12. CFC-113 however had been interfered by unknown large peak. We tried to calculate CFC-113 peak by post analyses of the chromatogram and gave the data flag "4". In the case of that the CFC-113 peak had completely been covered by interference peaks, we could not calculate the area of peak and given the data flag "5". The analytical precisions are estimated from replicate sample analyses for CFC-11 and -12. The precisions were estimated from average of absolute difference to be 0.012 ± 0.013 (n = 98) and 0.007 ± 0.008 pmol/kg (n = 98) for CFC-11 and -12, respectively.

Legs 5

Analytical conditions were same as that in leg 4. In the one of the analytical systems, serious problem has been found in several stations of this leg. The problem was considerable high blank for CFC-12 chromatogram peak. We could not find the causes of the problems by end of this leg. The problems interfered in determination of CFC-12. This problem was remarkable in 5 stations namely stations of I03-557, I03-480, I03-455, I03-451 and I03-447. Although we tried to correct the blank, quality of the data is not good. CFC-12 data in these stations had been given flag of "4". In CFC-113 analyses, there are same problems as that of leg 4 and almost all quality flags were "4". The precisions were estimated from average of absolute difference to be 0.009 ± 0.010 pmol/kg (n = 131) and 0.006 ± 0.006 pmol/kg (n = 122) for CFC-11 and -12, respectively.

Standard Gasses

Standard gasses used in this cruise have been made by Taiyo Nissan Co. Ltd. CFC mixing ratios of the standard gases have been determined by the maker using gravimetric method. The standard gases used in this cruise have not been calibrated to SIO scale standard gases yet because SIO scale standard gasses is hard to obtain due to legal difficulties for CFCs import into Japan. The data will be corrected as soon as possible when we will obtain the standard gasses.

Blank correction

CFCs concentrations in deep water which was one of oldest water masses of the ocean were low but not zero for CFC-11 and -12. In leg 2, Average concentrations of CFC-12 in water samples collected from density range of 27.5 - 27.8 sigma-theta were 0.009 ± 0.004 (n = 226). Average concentrations of CFC-11 and -12 in water samples collected from density range of sigma-theta > 27.8 and sigma-4 < 45.87 were 0.029 ± 0.005 (n = 195), 0.011 ± 0.003 (n = 195) in leg 4 except data from western region where relatively new deep water mass could come by western boundary current (on Santos Plateau and Vema Channel). Average concentrations of CFC-11 and -12 in water samples collected from density range of sigma-theta > 27.76 and sigma-4 < 45.87 were 0.021 ± 0.006 (n = 251), 0.011 ± 0.003 (n = 243) in leg 5 except data from I04 section where relatively new deep water mass could come (on Mozambique Basin). These values would be sampling blanks which was contaminations from Niskin bottle and/or during sub-sampling and were subtracted from all measurements.

(6) References

Walker, S.J., Weiss, R.F. and Salameh, P.K., Reconstructed histories of the annual mean atmospheric mole fractions for the halocarbons CFC-11, CFC-12, CFC-113 and Carbon Tetrachloride, Journal of Geophysical Research, 105, 14,285-14,296, (2000).

Bullister, J.L and Weiss, R.F. Determination of CCl_3F and CCl_2F_2 in seawater and air. Deep Sea Research, 35, 839-853 (1988).

3.10 $\delta^{13}C$ and $\Delta^{14}C$ of Dissolved Inorganic Carbon

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(2) Introduction

Stable and radioactive carbon isotopic ratios ($\delta^{13}C$ and $\Delta^{14}C$) of dissolved inorganic carbon (DIC) are good tracers for the anthropogenic carbon in the ocean. During MR03-K04 cruise, named BEAGLE2003, we collected seawater samples for $\delta^{13}C$ and $\Delta^{14}C$ analyses at stations along the WOCE-P6 (Leg-1&2), WOCE-A10 (Leg-4), and WOCE-I3&I4 (Leg-5) lines in the southern hemisphere. Here we report the final results of $\delta^{13}C$ and $\Delta^{14}C$ of DIC. Our preliminary reports of $\delta^{13}C$ and $\Delta^{14}C$ measurements are replaced by this final report. General information and other hydrographic data of BEAGLE2003 cruise have already published in our previous data books of BEAGLE2003 (Uchida and Fukasawa, 2005a,b)

(3) Sample collection

The sampling stations are summarized in Figure 3.10.1 and Table 3.10.1-4. A total of 3,060 seawater samples, including 233 replicate samples, were collected between surface (about 10 m depth) and near bottom at 97 stations using 12-liter X-Niskin bottles. The seawater in the X-Niskin bottle was siphoned into a 250 cm^3 glass bottle with enough seawater to fill the glass bottle 2 times. Immediately after sampling, 10 cm^3 of seawater was removed from the bottle and poisoned by 50 μl of saturated $HgCl_2$ solution. Then the bottle was sealed by a glass stopper with Apiezon M grease and stored in a cool and dark space on board. Theses procedures on board basically follow the methods described in WOCE Operation Manual (McNichol and Jones, 1991).

(4) Sample preparation

In our laboratory, DIC in the seawater samples were stripped cryogenically and split into three aliquots: Accelerator Mass Spectrometry (AMS) ^{14}C measurement (about 200 μmol), ^{13}C measurement (about 100 μmol), and archive (about 200 μmol). Efficiency of the CO_2 stripping from seawater sample was more than 95 % that was calculated from concentration of DIC in the seawater samples. The stripped CO_2 gas for ^{14}C was then converted to graphite catalytically on iron powder with pure hydrogen gas. Yield of graphite powder from CO_2 gas was estimated to be 73 ± 9 % in average by weighing of sample graphite powder. Details of these preparation procedures were described by Kumamoto et al. (2000).

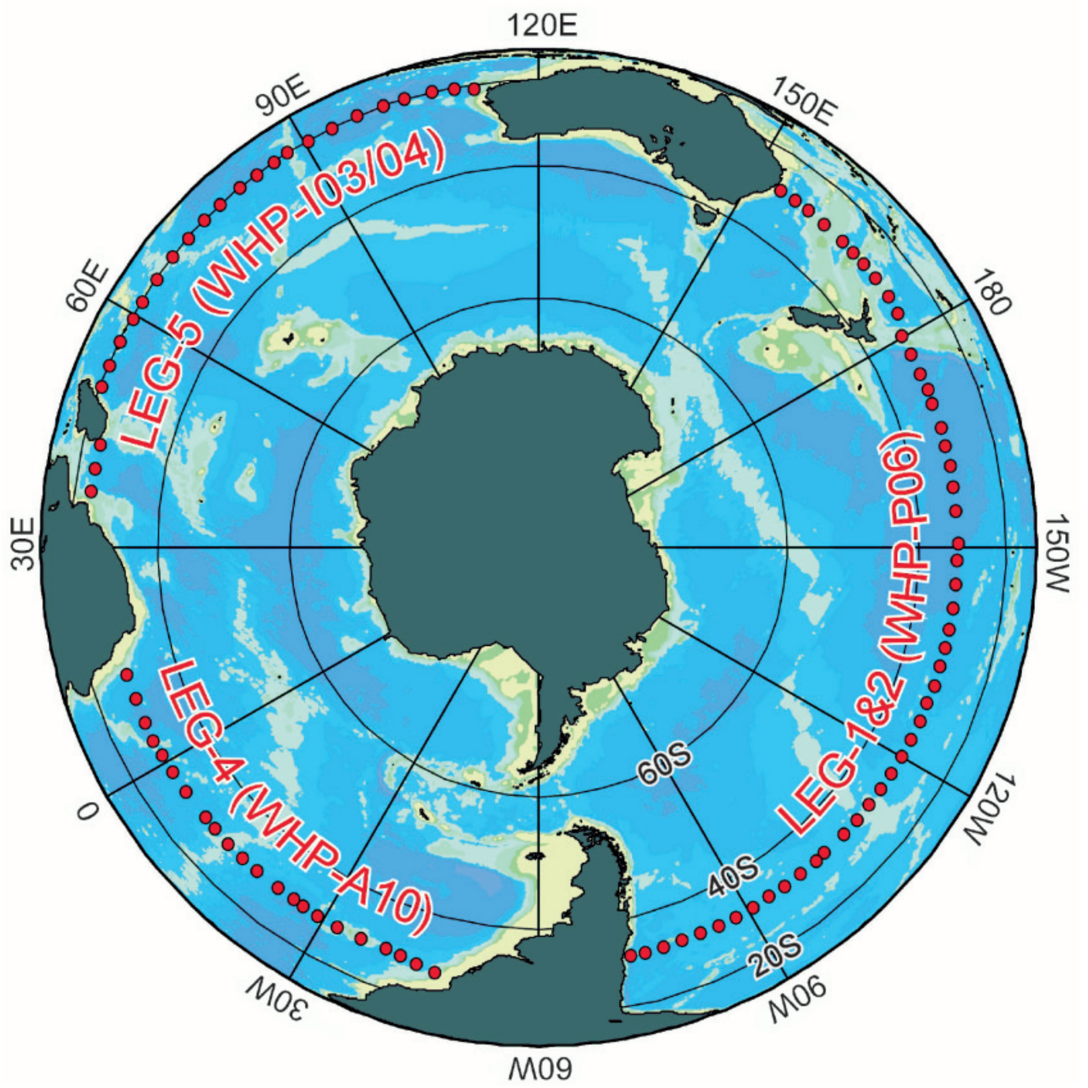

Figure 3.10.1. Sampling stations for $\delta^{13}C$ and $\Delta^{14}C$ of dissolved inorganic carbon during BEAGLE2003 Leg-1 (August-September, 2003), Leg-2 (September-October, 2003), Leg-4 (November-December, 2003), and Leg-5 (December, 2003-January, 2004).

Table 3.10.1. The sampling dates, locations, number of samples, and maximum sampling pressure for carbon isotopes in DIC during BEAGLE2003 Leg-1.

Station	Date (UTC)	Latitude	Longitude	Number of samples	Number of replicates	Max. pressure /db
P06W-239	04/Aug/2003	30.087 S	154.165 E	31	3	4,680
P06W-234	05/Aug/2003	30.081 S	156.533 E	32	3	4,898
P06W-227	06/Aug/2003	30.079 S	158.682 E	24	3	3,235
P06W-221	07/Aug/2003	30.086 S	161.500 E	15	1	1,185
P06W-215	08/Aug/2003	30.086 S	164.834 E	26	2	3,419
P06W-211	10/Aug/2003	30.084 S	166.999 E	23	2	2,873
P06W-207	11/Aug/2003	30.084 S	168.999 E	25	3	3,153
P06W-201	12/Aug/2003	30.089 S	171.501 E	20	2	2,264
P06W-195	13/Aug/2003	30.083 S	174.497 E	27	3	3,689
P06W-191	14/Aug/2003	30.582 S	177.000 E	30	3	4,353
P06C-182	15/Aug/2003	32.501 S	179.917 E	24	3	2,872
P06C-174	18/Aug/2003	32.502 S	177.251 W	36	3	6,503
P06C-168	20/Aug/2003	32.497 S	174.330 W	36	3	5,958
P06C-162	21/Aug/2003	32.500 S	171.909 W	29	3	4,200
P06C-X15	22/Aug/2003	32.504 S	170.001 W	34	3	5,610
P06C-150	24/Aug/2003	32.497 S	166.500 W	33	3	5,357
P06C-146	26/Aug/2003	32.491 S	163.832 W	34	3	5,630
P06C-142	27/Aug/2003	32.500 S	161.164 W	33	3	5,221
P06C-137	28/Aug/2003	32.500 S	158.166 W	35	3	5,781
P06C-133	29/Aug/2003	32.504 S	154.847 W	32	3	5,076
P06C-X16	31/Aug/2003	32.499 S	150.499 W	33	3	5,234
P06C-125	01/Sep/2003	32.501 S	148.160 W	30	3	4,626
P06C-121	02/Sep/2003	32.508 S	144.831 W	33	3	5,354
Total				675	64	

Table 3.10.2. As same as Table 3.10.1 but for Leg-2.

Station	Date (UTC)	Latitude	Longitude	Number of samples	Number of replicates	Max. pressure /db
P06C-117	14/Sep/2003	32.497 S	141.494 W	31	3	4,762
P06C-113	15/Sep/2003	32.501 S	138.665 W	31	3	4,640
P06C-109	16/Sep/2003	32.499 S	136.003 W	31	3	4,456
P06C-105	17/Sep/2003	32.502 S	133.344 W	29	3	4,306
P06C-101	18/Sep/2003	32.494 S	130.660 W	27	3	3,650
P06C-097	19/Sep/2003	32.494 S	127.997 W	28	3	3,988
P06C-093	21/Sep/2003	32.509 S	125.336 W	20	2	2,183
P06C-089	21/Sep/2003	32.492 S	122.658 W	22	2	2,625
P06C-085	22/Sep/2003	32.501 S	119.992 W	24	3	3,089
P06C-081	23/Sep/2003	32.499 S	117.320 W	26	3	3,352
P06C-077	24/Sep/2003	32.500 S	114.668 W	24	2	2,970
P06E-071	25/Sep/2003	32.499 S	111.999 W	23	2	2,722
P06E-067	26/Sep/2003	32.500 S	109.343 W	30	3	4,496
P06E-063	27/Sep/2003	32.501 S	106.674 W	26	3	3,343
P06E-X18	28/Sep/2003	32.500 S	103.000 W	27	3	3,617
P06E-055	29/Sep/2003	32.503 S	101.332 W	27	3	3,622
P06E-051	01/Oct/2003	32.501 S	98.667 W	28	3	3,847
P06E-047	02/Oct/2003	32.498 S	96.000 W	28	3	4,012
P06E-043	02/Oct/2003	32.501 S	93.338 W	23	2	2,691
P06E-039	03/Oct/2003	32.500 S	90.682 W	27	3	3,741
P06E-X19	04/Oct/2003	32.503 S	87.994 W	27	3	3,774
P06E-031	05/Oct/2003	32.497 S	85.334 W	28	3	4,054
P06E-027	06/Oct/2003	32.501 S	82.664 W	28	3	3,934
P06E-023	08/Oct/2003	32.502 S	79.997 W	23	2	2,811
P06E-019	09/Oct/2003	32.495 S	77.328 W	26	3	3,608
P06E-015	10/Oct/2003	32.497 S	74.673 W	28	3	3,886
P06E-011	11/Oct/2003	32.495 S	72.716 W	36	3	6,054
Total				728	75	

Table 3.10.3. As same as Table 3.10.1 but for Leg-4.

Station	Date (UTC)	Latitude	Longitude	Number of samples	Number of replicates	Max. pressure /db
A10-629	08/Nov/2003	28.044 S	46.127 W	22	2	2,429
A10-003	09/Nov/2003	28.832 S	43.593 W	28	3	3,935
A10-007	10/Nov/2003	29.613 S	41.161 W	28	3	3,835
A10-X17	11/Nov/2003	30.098 S	39.037 W	30	2	4,249
A10-021	12/Nov/2003	30.001 S	35.488 W	22	1	2,328
A10-029	14/Nov/2003	30.000 S	32.007 W	28	2	3,862
A10-035	16/Nov/2003	29.998 S	29.003 W	26	2	3,199
A10-038	17/Nov/2003	29.999 S	26.716 W	35	2	5,368
A10-X16	17/Nov/2003	30.220 S	25.049 W	31	2	4,411
A10-043	18/Nov/2003	30.000 S	22.482 W	32	2	4,660
A10-X15	19/Nov/2003	30.109 S	19.007 W	31	2	4,671
A10-051	20/Nov/2003	30.002 S	16.334 W	28	2	3,741
A10-055	21/Nov/2003	30.003 S	13.665 W	22	2	2,317
A10-059	22/Nov/2003	30.000 S	11.001 W	28	2	3,767
A10-X14	22/Nov/2003	30.003 S	8.999 W	29	2	3,981
A10-067	24/Nov/2003	30.000 S	4.829 W	31	2	4,302
A10-071	26/Nov/2003	30.001 S	1.505 W	32	2	4,789
A10-075	27/Nov/2003	29.732 S	1.122 E	28	2	3,747
A10-079	27/Nov/2003	29.467 S	3.302 E	32	2	4,816
A10-083	29/Nov/2003	29.746 S	5.931 E	34	2	5,204
A10-087	30/Nov/2003	29.745 S	9.288 E	34	2	5,067
A10-093	01/Dec/2003	29.372 S	12.790 E	28	3	3,250
Total				639	46	

Table 3.10.4. As same as Table 3.10.1 but for Leg-5.

Station	Date (UTC)	Latitude	Longitude	Number of samples	Number of replicates	Max. pressure /db
I04-601	14/Dec/2003	24.673 S	36.991 E	25	2	3,084
I04-595	15/Dec/2003	24.661 S	39.996 E	27	2	3,578
I04-589	16/Dec/2003	24.665 S	42.997 E	28	2	3,725
I03-557	21/Dec/2003	19.997 S	50.060 E	31	2	4,401
I03-551	22/Dec/2003	19.985 S	52.777 E	34	1	5,002
I03-545	23/Dec/2003	19.999 S	56.092 E	31	2	4,441
I03-535	25/Dec/2003	20.380 S	59.228 E	33	2	4,823
I03-531	28/Dec/2003	20.368 S	61.631 E	28	2	3,650
I03-525	29/Dec/2003	20.089 S	64.934 E	27	1	2,935
I03-519	30/Dec/2003	19.998 S	68.213 E	23	1	2,541
I03-513	01/Jan/2004	19.997 S	71.256 E	30	1	4,240
I03-507	02/Jan/2004	20.000 S	74.167 E	33	2	5,032
I03-503	03/Jan/2004	19.987 S	76.908 E	34	2	5,168
I03-X08	05/Jan/2004	19.996 S	79.998 E	34	2	4,928
I03-495	06/Jan/2004	19.996 S	82.736 E	34	2	5,305
I03-491	07/Jan/2004	19.990 S	85.304 E	33	2	4,951
I03-487	09/Jan/2004	20.000 S	87.333 E	20	1	2,022
I03-480	10/Jan/2004	19.992 S	90.288 E	35	2	5,251
I03-474	11/Jan/2004	19.991 S	93.533 E	35	2	5,410
I03-470	13/Jan/2004	19.991 S	96.953 E	35	2	5,419
I03-466	14/Jan/2004	19.990 S	100.466 E	36	2	6,067
I03-463	16/Jan/2004	19.992 S	103.129 E	36	2	5,751
I03-459	17/Jan/2004	19.996 S	106.625 E	36	3	5,617
I03-455	18/Jan/2004	20.932 S	109.445 E	34	3	5,140
I03-451	20/Jan/2004	21.825 S	111.902 E	33	3	5,019
Total				785	48	

(5) Sample measurements

$\delta^{13}C$ of the sample CO_2 gas was measured using Finnigan MAT252 mass spectrometer. The $\delta^{13}C$ value was calculated by a following equation:

$$\delta^{13}C\ (‰) = (R_{sample} / R_{standard} - 1) \times 1000, \quad (1)$$

where R_{sample} and $R_{standard}$ denote $^{13}C / ^{12}C$ ratios of the sample CO_2 gas and the standard CO_2 gas, respectively. The working standard gas was purchased from Oztech Gas Co. with assigned $\delta^{13}C$ value of –3.64 ‰ versus VPDB (Lot No. SHO-873C). The gas has been calibrated relative to the appropriate internationally accepted IAEA primary standards. $\Delta^{14}C$ in the graphite sample was measured in AMS facilities of Institute of Accelerator Analysis Ltd in Shirakawa (Pelletron 9SDH-2, NEC) and Paleo Labo Co. Ltd in Kiryu (Compact-AMS, NEC), Japan. The $\Delta^{14}C$ value was calculated by:

$$\delta^{14}C\ (‰) = (R_{sample} / R_{standard} - 1) \times 1000, \quad (2)$$

$$\Delta^{14}C\ (‰) = \delta^{14}C - 2\ (\delta^{13}C + 25)\ (1 + \delta^{14}C / 1000), \quad (3)$$

where R_{sample} and $R_{standard}$ denote, respectively, $^{14}C / ^{12}C$ ratios of the sample and the international standard, NIST Oxalic Acid SRM4990-C (HOxII). $R_{standard}$ was corrected for decay since A.D. 1950 (Stuiver and Polach, 1977; Stuiver, 1983). Equation 3 is normalization for isotopic fractionation. When quality of $\delta^{13}C$ data was not "good", $\Delta^{14}C$ was calculated by interpolated $\delta^{13}C$ value derived from data at just above and below layers. Finally $\Delta^{14}C$ value was corrected for radiocarbon decay between the sampling and the measurement dates. Individual errors of $\delta^{13}C$ were given by standard deviation of repeat measurements. Errors of $\Delta^{14}C$ were derived from larger of the standard deviation of repeat measurements and the counting error. Means of the $\delta^{13}C$ and $\Delta^{14}C$ errors were calculated to be 0.004 ‰ and 3.6 ‰ that probably correspond to "repeatabilities" of our $\delta^{13}C$ and $\Delta^{14}C$ measurements. It should be noted that these errors did not include error due to sample preparation.

(6) Replicate measurements

Replicate samples were taken at all the 97 stations. Results of 233 pairs of the replicate samples are shown in Table 3.10.5. The standard deviations of the $\delta^{13}C$ and $\Delta^{14}C$ replicate analyses were calculated to be 0.020 ‰ (n = 217) and 3.9 ‰ (n = 214), respectively. The standard deviations of $\delta^{13}C$ replicate analyses during Leg-1, Leg-2, Leg-4, and Leg-5 were 0.021 (n = 58), 0.019 (n = 74), 0.020 (n = 42), and 0.019 ‰ (n = 43), respectively. The standard deviation of $\Delta^{14}C$ replicate analyses during Leg-1, Leg-2, Leg-4, and Leg-5 were 3.6 (n = 62), 3.7 (n = 68), 4.4 (n = 37), and 3.9 ‰ (n = 47), respectively.

Table 3.10.5. Summary of replicate analyses.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06W-239	32	0.949	0.002	0.930	0.028	79.5	3.8	78.0	3.0
		0.910	0.002			75.7	4.8		
P06W-239	21	0.484	0.003	0.483	0.003	–170.4	3.3	–171.0	2.3
		0.482	0.003			–171.4	3.1		
P06W-239	13	0.437	0.005	0.408	0.028	–165.5	3.2	–167.7	3.0
		0.397	0.003			–169.8	3.2		
P06W-234	32	1.135	0.004	1.124	0.012	83.6	3.8	81.9	2.7
		1.118	0.003			80.1	3.8		
P06W-234	21	0.608	0.003	0.615	0.009	–147.3	3.2	–146.1	2.3
		0.621	0.003			–144.9	3.2		
P06W-234	13	0.385	0.004	0.471	0.064	–155.8	4.4	–159.2	4.7
		0.476	0.001			–162.5	4.4		
P06W-227	32	0.918	0.002	0.914	0.006	92.8	5.4	91.1	3.7
		0.910	0.002			89.5	5.2		
P06W-227	21	0.542	0.002	0.540	0.007	–166.9	4.4	–165.6	3.1
		0.532	0.004			–164.2	4.4		
P06W-227	13	0.440	0.003	0.394	0.036	–165.9	4.4	–164.9	3.1
		0.389	0.001			–163.9	4.4		
P06W-221	32	0.956	0.004	0.941	0.022	-	-	-	-
		0.925	0.004			-	-		
P06W-215	32	0.979	0.003	0.963	0.023	-	-	-	-
		0.947	0.003			-	-		
P06W-215	21	0.530	0.002	0.531	0.002	–142.7	4.2	–140.1	3.7
		0.533	0.003			–137.4	4.3		
P06W-211	32	0.994	0.002	0.975	0.043	88.6	4.0	91.1	3.5
		0.933	0.003			93.6	4.0		
P06W-211	21	0.546	0.006	0.542	0.004	–158.5	3.3	–161.4	3.7
		0.541	0.003			–163.7	2.9		
P06W-207	32	1.086	0.003	1.091	0.005	85.3	4.0	83.2	3.1
		1.093	0.002			80.9	4.1		

Table 3.10.5. continued.

Station	Btl	δ^{13}C / ‰				Δ^{14}C / ‰			
		δ^{13}C	Error[a]	E.W.Mean[b]	Uncertainty[c]	Δ^{14}C	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06W-207	21	0.615	0.005	0.594	0.025	–148.3	3.4	–153.7	7.6
		0.580	0.004			–159.1	3.4		
P06W-207	13	0.197	0.003	0.182	0.022	–208.4	3.1	–207.4	2.2
		0.166	0.003			–206.3	3.1		
P06W-201	32	-	-	-	-	80.7	3.8	80.8	2.7
		-	-			80.9	3.7		
P06W-201	21	0.548	0.002	0.579	0.044	–149.4	3.3	–151.6	4.5
		0.610	0.002			–155.8	4.5		
P06W-195	32	0.984	0.002	0.985	0.005	86.9	6.1	89.9	3.1
		0.991	0.005			90.9	3.6		
P06W-195	21	0.533	0.003	0.547	0.020	–163.2	3.2	–163.1	2.3
		0.561	0.003			–162.9	3.2		
P06W-195	13	-	-	-	-	–202.6	3.1	–206.8	5.9
		-	-			–211.0	3.1		
P06W-191	32	0.987	0.004	0.988	0.002	77.3	3.7	74.6	4.0
		0.988	0.003			71.7	3.8		
P06W-191	21	0.540	0.002	0.539	0.003	–173.5	3.1	–171.9	2.3
		0.536	0.004			–170.3	3.1		
P06W-191	13	0.190	0.003	0.173	0.017	–209.3	3.0	–212.1	4.2
		0.166	0.002			–215.2	3.2		
P06C-182	32	1.039	0.004	1.033	0.009	73.3	4.0	71.9	3.1
		1.026	0.004			69.5	5.0		
P06C-182	21	0.653	0.005	0.645	0.013	–143.8	3.4	–148.5	6.2
		0.634	0.006			–152.5	3.1		
P06C-182	13	0.294	0.003	0.297	0.006	–197.8	3.2	–201.3	4.8
		0.303	0.004			–204.6	3.1		
P06C-174	32	1.043	0.002	1.047	0.009	73.4	4.2	74.6	3.0
		1.056	0.003			75.7	4.3		
P06C-174	21	0.664	0.005	0.657	0.006	–147.0	3.4	–150.9	5.4
		0.656	0.002			–154.6	3.3		

Table 3.10.5. continued.

Station	Btl	δ^{13}C / ‰				Δ^{14}C / ‰			
		δ^{13}C	Error[a]	E.W.Mean[b]	Uncertainty[c]	Δ^{14}C	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06C-174	13	-	-	-	-	–177.3	3.1	–180.1	4.3
		-	-			–183.4	3.4		
P06C-168	32	1.067	0.002	1.070	0.013	75.1	4.5	75.4	3.0
		1.086	0.005			75.6	4.1		
P06C-168	21	0.619	0.004	0.636	0.015	–150.4	3.4	–153.2	4.1
		0.640	0.002			–156.2	3.5		
P06C-168	13	0.202	0.005	0.215	0.013	–219.0	3.1	–218.7	2.3
		0.220	0.003			–218.3	3.3		
P06C-162	32	1.077	0.005	1.077	0.002	71.6	4.5	73.4	3.1
		1.077	0.002			75.0	4.4		
P06C-162	21	0.639	0.002	0.636	0.018	–143.0	3.6	–144.7	2.6
		0.614	0.005			–146.6	3.7		
P06C-162	13	0.255	0.005	0.263	0.008	–204.1	3.4	–207.2	4.4
		0.266	0.003			–210.3	3.4		
P06C-X15	32	1.106	0.003	1.098	0.021	69.7	3.7	69.1	2.7
		1.077	0.005			68.4	4.0		
P06C-X15	21	0.595	0.003	0.615	0.021	–146.2	3.2	–152.2	8.8
		0.624	0.002			–158.7	3.3		
P06C-X15	13	0.228	0.004	0.226	0.001	–210.4	3.1	–208.4	3.0
		0.226	0.001			–206.2	3.2		
P06C-150	32	1.138	0.004	1.126	0.017	78.6	3.8	77.1	2.7
		1.114	0.004			75.5	3.7		
P06C-150	21	0.659	0.005	0.657	0.004	–151.7	3.4	–148.8	4.0
		0.654	0.005			–146.1	3.3		
P06C-150	13	0.212	0.001	0.210	0.011	–214.2	3.2	–214.9	2.2
		0.196	0.003			–215.5	3.1		
P06C-146	32	1.178	0.004	1.152	0.037	81.2	4.2	80.4	2.9
		1.126	0.004			79.6	4.1		
P06C-146	21	-	-	-	-	–142.7	3.5	–143.5	2.5
		-	-			–144.3	3.5		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06C-146	13	0.168	0.004	0.191	0.033	–222.9	3.3	–220.6	3.4
		0.214	0.004			–218.1	3.4		
P06C-142	32	1.163	0.003	1.151	0.018	76.4	3.8	71.3	7.7
		1.138	0.003			65.5	4.1		
P06C-142	21	0.671	0.004	0.654	0.015	–144.7	3.4	–142.4	3.2
		0.650	0.002			–140.2	3.4		
P06C-142	13	0.182	0.005	0.185	0.005	–212.2	2.9	–213.3	2.1
		0.189	0.006			–214.7	3.1		
P06C-137	32	1.131	0.003	1.120	0.029	84.7	3.6	82.9	2.5
		1.090	0.005			81.2	3.5		
P06C-137	21	0.597	0.003	0.600	0.005	–145.7	3.0	–142.0	5.2
		0.604	0.004			–138.3	3.0		
P06C-137	13	0.210	0.003	0.227	0.023	–209.3	3.0	–213.1	5.6
		0.243	0.003			–217.2	3.1		
P06C-133	32	-	-	-	-	86.7	4.3	89.8	4.3
		-	-			92.8	4.2		
P06C-133	21	0.639	0.004	0.615	0.034	–146.7	3.6	–144.9	2.5
		0.591	0.004			–143.1	3.6		
P06C-133	13	0.232	0.002	0.234	0.008	–214.9	3.5	–212.7	3.0
		0.244	0.005			–210.7	3.4		
P06C-X16	32	1.230	0.004	1.222	0.008	99.8	3.7	100.9	2.7
		1.218	0.003			102.0	3.8		
P06C-X16	21	0.573	0.004	0.596	0.032	–145.1	3.2	–147.7	3.6
		0.618	0.004			–150.2	3.2		
P06C-X16	13	0.198	0.003	0.228	0.031	–210.8	3.2	–211.8	2.2
		0.242	0.002			–212.7	3.0		
P06C-125	32	1.282	0.002	1.278	0.006	83.6	3.8	83.0	2.7
		1.274	0.002			82.5	3.7		
P06C-125	21	0.607	0.004	0.619	0.009	–155.4	3.1	–158.9	5.4
		0.620	0.001			–163.0	3.3		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06C-125	13	0.245	0.007	0.263	0.017	–214.7	3.0	–212.5	3.0
		0.269	0.004			–210.5	2.9		
P06C-121	32	-	-	-	-	79.9	3.8	80.3	2.7
		-	-			80.7	3.8		
P06C-121	21	0.571	0.003	0.587	0.016	–154.9	4.2	–151.0	4.4
		0.594	0.002			–148.7	3.2		
P06C-121	13	0.258	0.002	0.262	0.013	–211.2	3.0	–208.9	3.4
		0.277	0.004			–206.4	3.1		
P06C-117	32	1.236	0.004	1.249	0.023	-	-	-	-
		1.269	0.005			-	-		
P06C-117	21	0.592	0.003	0.571	0.021	–148.1	3.3	–153.5	7.6
		0.562	0.002			–158.8	3.3		
P06C-117	13	0.261	0.005	0.260	0.003	–205.8	3.0	–206.9	2.1
		0.260	0.003			–207.8	2.9		
P06C-113	32	1.257	0.004	1.221	0.040	92.5	3.7	91.6	2.6
		1.201	0.003			90.6	3.7		
P06C-113	21	0.585	0.005	0.630	0.033	–145.1	3.2	–145.6	2.3
		0.632	0.001			–146.2	3.3		
P06C-113	13	0.262	0.002	0.266	0.013	–213.1	3.0	–210.3	4.2
		0.280	0.004			–207.2	3.2		
P06C-109	32	1.323	0.004	1.276	0.052	91.1	3.8	86.1	7.4
		1.250	0.003			80.7	4.0		
P06C-109	21	0.532	0.003	0.542	0.013	–160.6	3.4	–156.2	6.2
		0.551	0.003			–151.9	3.4		
P06C-109	13	0.293	0.002	0.295	0.004	–213.6	3.2	–213.9	2.3
		0.299	0.003			–214.2	3.3		
P06C-105	32	1.359	0.002	1.348	0.025	88.4	3.9	84.6	5.4
		1.323	0.003			80.7	4.0		
P06C-105	21	0.552	0.005	0.569	0.016	–158.2	3.3	–157.0	2.3
		0.575	0.003			–156.0	3.2		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06C-105	13	0.276	0.005	0.328	0.038	–208.5	3.1	–210.8	3.3
		0.330	0.001			–213.2	3.1		
P06C-101	32	1.231	0.004	1.244	0.014	95.0	3.8	92.5	6.6
		1.251	0.003			85.7	6.3		
P06C-101	21	0.555	0.006	0.562	0.005	–145.8	3.2	–147.4	2.3
		0.562	0.001			–149.0	3.2		
P06C-101	13	0.297	0.005	0.259	0.044	–208.6	2.9	–207.3	2.1
		0.235	0.004			–206.0	3.0		
P06C-097	32	-	-	-	-	100.4	3.8	105.7	7.6
		-	-			111.2	3.9		
P06C-097	21	0.617	0.005	0.577	0.033	–138.7	3.1	–138.8	2.2
		0.571	0.002			–138.8	3.0		
P06C-097	13	0.303	0.003	0.297	0.009	–198.7	2.9	–201.7	4.0
		0.290	0.003			–204.4	2.8		
P06C-093	32	1.208	0.001	1.209	0.007	83.7	3.6	87.5	5.4
		1.218	0.003			91.4	3.7		
P06C-093	21	0.515	0.004	0.517	0.002	–155.6	3.1	–156.8	2.2
		0.518	0.003			–157.8	3.0		
P06C-089	32	1.267	0.007	1.251	0.013	90.6	3.7	89.5	2.6
		1.248	0.003			88.4	3.7		
P06C-089	21	0.578	0.003	0.562	0.042	–157.9	3.1	–156.8	2.2
		0.519	0.005			–155.6	3.2		
P06C-085	32	1.374	0.002	1.375	0.004	90.4	3.5	91.7	2.5
		1.379	0.006			93.1	3.7		
P06C-085	21	0.543	0.003	0.548	0.005	–151.6	2.9	–153.7	3.1
		0.550	0.002			–156.0	3.0		
P06C-085	13	0.283	0.004	0.282	0.002	–204.5	2.9	–206.8	3.3
		0.282	0.003			–209.2	3.0		
P06C-081	32	1.275	0.005	1.271	0.004	87.4	3.5	83.2	6.4
		1.270	0.003			78.4	3.7		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06C-081	21	0.565	0.003	0.565	0.003	–155.3	4.2	–146.6	9.3
		0.565	0.005			–142.2	3.0		
P06C-081	13	0.287	0.004	0.286	0.002	–204.0	2.9	–203.5	2.1
		0.286	0.002			–202.9	3.0		
P06C-077	32	1.450	0.004	1.444	0.018	69.9	3.7	70.2	2.6
		1.425	0.007			70.4	3.7		
P06C-077	21	0.473	0.004	0.496	0.032	–150.5	3.1	–150.3	2.1
		0.518	0.004			–150.1	2.9		
P06E-071	32	1.294	0.004	1.290	0.006	90.6	4.0	91.0	2.8
		1.286	0.004			91.4	4.0		
P06E-071	21	0.477	0.004	0.481	0.006	–153.8	3.4	–157.2	4.7
		0.486	0.005			–160.4	3.3		
P06E-067	32	1.296	0.004	1.293	0.003	89.5	4.0	92.2	3.6
		1.292	0.002			94.6	3.8		
P06E-067	21	0.383	0.002	0.375	0.007	–173.5	3.2	–174.8	2.3
		0.373	0.001			–176.3	3.4		
P06E-067	13	0.322	0.004	0.300	0.031	–202.9	3.2	–201.6	2.3
		0.278	0.004			–200.3	3.2		
P06E-063	32	1.356	0.002	1.358	0.008	98.1	3.9	97.5	2.8
		1.368	0.004			96.7	4.0		
P06E-063	21	0.337	0.005	0.352	0.018	–175.2	3.3	–174.7	2.8
		0.362	0.004			–173.2	5.6		
P06E-063	13	0.329	0.003	0.331	0.004	–197.9	3.3	–195.8	3.0
		0.334	0.004			–193.6	3.3		
P06E-X18	21	0.353	0.001	0.352	0.023	–182.0	3.0	–179.1	4.1
		0.320	0.005			–176.2	3.0		
P06E-X18	13	0.314	0.002	0.319	0.018	–198.1	2.9	–194.6	5.2
		0.340	0.004			–190.7	3.0		
P06E-X18	1	1.417	0.004	1.407	0.008	88.3	3.6	87.5	2.5
		1.405	0.002			86.7	3.6		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06E-055	32	1.393	0.007	1.366	0.023	93.0	3.7	89.1	5.4
		1.361	0.003			85.3	3.6		
P06E-055	21	0.310	0.004	0.310	0.002	–185.6	3.2	–186.0	2.2
		0.310	0.003			–186.3	3.1		
P06E-055	13	0.319	0.006	0.321	0.003	-	-	-	-
		0.322	0.004			-	-		
P06E-051	32	1.330	0.001	1.332	0.011	85.9	3.6	88.9	4.5
		1.346	0.003			92.2	3.8		
P06E-051	21	0.297	0.004	0.303	0.013	–187.3	3.0	–183.7	5.0
		0.315	0.006			–180.2	2.9		
P06E-051	13	0.304	0.001	0.308	0.013	–196.6	2.9	–195.5	2.1
		0.322	0.002			–194.3	3.0		
P06E-047	32	1.456	0.004	1.466	0.008	75.3	3.6	76.2	2.9
		1.468	0.002			77.8	5.0		
P06E-047	21	0.313	0.003	0.326	0.025	–186.7	3.0	–183.9	4.1
		0.348	0.004			–180.9	3.1		
P06E-047	13	0.305	0.003	0.316	0.021	–190.8	2.9	–188.5	3.3
		0.335	0.004			–186.1	2.9		
P06E-043	32	1.389	0.004	1.401	0.021	85.8	3.5	87.1	2.9
		1.419	0.005			89.7	5.0		
P06E-043	21	0.272	0.002	0.275	0.011	-	-	-	-
		0.288	0.004			-	-		
P06E-039	32	1.326	0.007	1.365	0.030	83.1	2.5	82.2	1.8
		1.368	0.002			81.4	2.6		
P06E-039	21	0.298	0.004	0.288	0.018	–191.1	2.3	–192.4	1.7
		0.273	0.005			–193.5	2.2		
P06E-039	13	0.286	0.002	0.277	0.020	–196.8	2.2	–195.0	2.3
		0.258	0.003			–193.5	2.0		
P06E-X19	32	1.515	0.003	1.521	0.011	83.8	3.6	84.0	2.5
		1.531	0.004			84.3	3.6		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06E-X19	21	0.266	0.004	0.270	0.004	–184.8	3.0	–184.4	2.1
		0.272	0.003			–184.1	2.9		
P06E-X19	13	0.304	0.003	0.305	0.003	-	-	-	-
		0.306	0.005			-	-		
P06E-031	32	1.402	0.004	1.430	0.030	80.2	4.1	82.4	2.9
		1.445	0.003			84.4	4.0		
P06E-031	21	0.244	0.003	0.274	0.031	–190.7	3.3	–194.6	5.5
		0.288	0.002			–198.5	3.3		
P06E-031	13	0.276	0.002	0.290	0.032	–198.4	3.3	–201.8	4.8
		0.321	0.003			–205.2	3.3		
P06E-027	32	1.357	0.004	1.352	0.008	54.4	4.0	50.8	5.3
		1.345	0.005			46.9	4.1		
P06E-027	21	0.227	0.002	0.234	0.009	–212.8	3.5	–210.2	3.5
		0.240	0.002			–207.8	3.4		
P06E-027	13	0.229	0.003	0.233	0.008	–215.2	3.3	–218.6	4.7
		0.240	0.004			–221.8	3.2		
P06E-023	32	1.310	0.005	1.316	0.006	-	-	-	-
		1.318	0.003			-	-		
P06E-023	21	0.204	0.003	0.204	0.003	–189.3	3.2	–188.9	2.3
		0.203	0.005			–188.4	3.2		
P06E-019	32	0.474	0.003	0.461	0.025	21.7	3.5	22.8	2.5
		0.438	0.004			24.0	3.6		
P06E-019	21	0.211	0.004	0.214	0.004	–193.5	3.1	–195.8	3.1
		0.216	0.004			–197.9	3.0		
P06E-019	13	0.206	0.004	0.210	0.006	–224.3	3.0	–219.8	6.4
		0.215	0.005			–215.3	3.0		
P06E-015	32	0.084	0.004	0.076	0.011	–6.9	3.5	–7.4	2.5
		0.068	0.004			–8.0	3.5		
P06E-015	21	0.177	0.005	0.184	0.013	–207.2	3.2	–206.3	2.2
		0.195	0.006			–205.4	3.0		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06E-015	13	0.249	0.004	0.246	0.009	–215.0	2.9	–217.7	3.9
		0.236	0.007			–220.5	3.0		
P06E-011	32	–0.082	0.003	–0.078	0.010	-	-	-	-
		–0.068	0.005			-	-		
P06E-011	21	0.208	0.003	0.203	0.014	–200.1	3.1	–199.5	2.1
		0.188	0.005			–198.9	2.9		
P06E-011	13	0.211	0.003	0.202	0.013	-	-	-	-
		0.193	0.003			-	-		
A10-629	32	1.098	0.003	1.091	0.010	-	-	-	-
		1.084	0.003			-	-		
A10-629	1	-	-	-	-	–114.9	3.5	–113.7	2.5
		-	-			–112.5	3.5		
A10-003	32	1.251	0.005	1.250	0.003	103.0	4.1	102.3	3.0
		1.250	0.003			101.6	4.3		
A10-003	21	0.655	0.003	0.670	0.030	–118.6	3.3	–117.3	3.7
		0.697	0.004			–113.3	5.9		
A10-003	13	1.043	0.004	1.009	0.030	–99.7	3.3	–100.0	2.8
		1.000	0.002			–100.6	5.1		
A10-007	32	1.174	0.003	1.180	0.015	83.9	4.0	81.3	3.7
		1.195	0.005			78.6	4.0		
A10-007	21	0.677	0.001	0.677	0.006	–128.1	3.5	–131.8	5.0
		0.668	0.005			–135.2	3.4		
A10-007	13	0.992	0.005	1.002	0.021	–104.6	3.7	–103.9	2.6
		1.022	0.007			–103.2	3.6		
A10-X17	21	0.694	0.003	0.686	0.012	–119.3	3.3	–121.7	3.5
		0.677	0.003			–124.2	3.3		
A10-X17	1	1.028	0.004	1.046	0.033	-	-	-	-
		1.074	0.005			-	-		
A10-021	32	1.238	0.002	1.237	0.002	83.9	4.0	83.0	2.8
		1.235	0.004			82.1	4.0		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
A10-029	32	1.217	0.002	1.213	0.026	88.9	4.1	90.2	3.7
		1.180	0.006			94.1	7.1		
A10-029	21	0.670	0.003	0.995	0.004	-	-	-	-
		0.681	0.003			-	-		
A10-035	21	0.671	0.003	0.660	0.016	–120.0	3.3	–117.3	3.8
		0.648	0.003			–114.6	3.4		
A10-035	13	-	-	-	-	–107.0	3.3	–103.4	5.1
		-	-			–99.8	3.3		
A10-038	32	1.173	0.004	1.171	0.004	-	-	-	-
		1.168	0.004			-	-		
A10-038	21	0.678	0.004	0.661	0.019	–123.7	3.3	–120.7	4.2
		0.651	0.003			–117.7	3.3		
A10-X16	32	1.204	0.002	1.203	0.006	74.4	6.0	77.6	3.3
		1.195	0.005			79.0	4.0		
A10-X16	13	0.983	0.006	0.935	0.037	–99.1	3.4	–98.5	2.4
		0.930	0.002			–97.9	3.4		
A10-043	21	0.648	0.004	0.654	0.008	–130.0	3.3	–126.9	4.5
		0.660	0.004			–123.7	3.4		
A10-043	13	0.954	0.004	0.935	0.021	–98.2	3.3	–103.9	8.6
		0.924	0.003			–110.4	3.5		
A10-X15	32	1.233	0.002	1.209	0.034	88.3	3.9	83.9	6.4
		1.185	0.002			79.3	4.0		
A10-X15	13	0.927	0.004	0.950	0.032	–113.1	3.6	–113.7	2.5
		0.972	0.004			–114.3	3.4		
A10-051	32	1.092	0.004	1.123	0.034	70.3	3.9	70.3	2.8
		1.140	0.003			70.3	3.9		
A10-051	21	0.576	0.002	0.581	0.025	–127.9	3.2	–123.2	7.0
		0.612	0.005			–118.0	3.4		
A10-055	21	0.600	0.003	0.574	0.037	–121.2	3.6	–119.5	2.5
		0.548	0.003			–117.8	3.6		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
A10-059	32	1.191	0.002	1.190	0.002	71.6	3.8	74.4	6.6
		1.188	0.003			80.9	5.8		
A10-059	13	0.880	0.003	0.871	0.009	–111.2	3.4	–112.2	2.9
		0.867	0.002			–114.9	5.4		
A10-X14	32	1.219	0.005	1.215	0.004	-	-	-	-
		1.214	0.003			-	-		
A10-X14	21	0.623	0.003	0.580	0.044	–120.9	3.5	–116.7	5.7
		0.561	0.002			–112.8	3.4		
A10-067	21	0.618	0.003	0.595	0.033	–129.4	3.4	–125.1	5.5
		0.571	0.003			–121.6	3.1		
A10-067	13	0.904	0.002	0.893	0.016	–115.7	3.4	–117.1	2.4
		0.882	0.002			–118.5	3.4		
A10-071	32	0.917	0.003	0.925	0.011	89.6	3.7	88.2	2.7
		0.933	0.003			86.7	3.8		
A10-071	13	0.874	0.004	0.872	0.002	–118.4	3.5	–112.6	7.4
		0.872	0.002			–107.9	3.2		
A10-075	32	1.030	0.003	1.034	0.006	94.3	3.8	93.4	2.7
		1.038	0.003			92.5	3.7		
A10-075	21	0.661	0.007	0.649	0.010	–122.3	3.3	–122.1	2.3
		0.647	0.003			–121.9	3.3		
A10-079	21	0.653	0.002	0.655	0.010	-	-	-	-
		0.667	0.005			-	-		
A10-079	13	0.846	0.004	0.850	0.005	–128.8	3.4	–123.8	6.8
		0.853	0.004			–119.2	3.3		
A10-083	32	1.042	0.002	1.035	0.016	-	-	-	-
		1.020	0.003			-	-		
A10-083	13	0.852	0.002	0.850	0.004	–117.2	3.3	–114.4	4.2
		0.847	0.003			–111.3	3.5		
A10-087	32	1.034	0.005	1.027	0.006	-	-	-	-
		1.026	0.002			-	-		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
A10-087	1	0.593	0.004	0.591	0.004	–126.1	3.4	–123.5	3.6
		0.587	0.005			–121.0	3.4		
A10-093	32	1.032	0.005	1.026	0.007	74.6	4.0	81.1	9.5
		1.022	0.004			88.0	4.1		
A10-093	21	-	-	-	-	–124.2	5.3	–119.7	4.5
		-	-			–117.8	3.5		
A10-093	13	0.877	0.003	0.882	0.007	–114.5	3.7	–113.8	2.5
		0.887	0.003			–113.3	3.5		
I04-601	21	0.683	0.005	0.683	0.004	–141.4	3.1	–141.2	2.3
		0.683	0.007			–140.8	3.3		
I04-601	13	0.681	0.003	0.696	0.015	–144.0	3.3	–147.0	4.2
		0.702	0.002			–150.0	3.3		
I04-595	32	0.671	0.006	0.632	0.047	67.4	3.8	64.9	3.6
		0.605	0.005			62.3	3.9		
I04-595	13	0.723	0.005	0.705	0.018	–142.6	3.2	–144.3	2.3
		0.698	0.003			–145.8	3.1		
I04-589	32	-	-	-	-	80.2	3.7	81.7	2.7
		-	-			83.3	3.8		
I04-589	21	0.377	0.002	0.378	0.004	–153.3	4.3	–150.4	3.2
		0.382	0.004			–148.7	3.3		
I03-557	21	0.467	0.003	0.469	0.008	–165.7	3.0	–163.9	2.5
		0.479	0.006			–162.2	3.0		
I03-557	13	0.293	0.004	0.288	0.008	–184.3	3.0	–184.9	2.2
		0.281	0.005			–185.7	3.2		
I03-551	13	0.339	0.003	0.333	0.012	–190.5	3.0	–189.7	2.2
		0.322	0.004			–188.9	3.1		
I03-545	32	0.512	0.006	0.502	0.010	51.4	3.5	49.5	2.8
		0.498	0.004			47.4	3.6		
I03-545	21	0.416	0.001	0.418	0.008	–153.9	3.0	–156.4	3.7
		0.427	0.002			–159.2	3.1		

Table 3.10.5. continued.

Station	Btl	δ13C / ‰				Δ14C / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
I03-535	21	0.384	0.003	0.383	0.003	–172.6	3.1	–168.4	6.0
		0.380	0.004			–164.1	3.2		
I03-535	13	0.378	0.003	0.379	0.003	–186.1	3.3	–185.9	2.3
		0.382	0.004			–185.7	3.3		
I03-531	32	0.735	0.006	0.679	0.044	67.3	3.9	64.1	4.5
		0.673	0.002			61.0	3.8		
I03-531	13	0.380	0.004	0.379	0.003	–172.9	3.2	–171.8	2.3
		0.377	0.005			–170.8	3.3		
I03-525	32	0.860	0.005	0.870	0.013	68.9	3.7	63.9	6.9
		0.879	0.005			59.2	3.6		
I03-519	21	-	-	-	-	–167.6	3.1	–172.1	6.2
		-	-			–176.4	3.0		
I03-513	32	0.736	0.003	0.712	0.035	-	-	-	-
		0.687	0.003			-	-		
I03-513	21	0.274	0.004	0.244	0.026	–170.2	2.9	–167.6	3.7
		0.237	0.002			–165.0	2.9		
I03-507	21	0.234	0.003	0.222	0.017	–163.5	3.1	–168.8	7.6
		0.210	0.003			–174.3	3.2		
I03-507	13	0.435	0.003	0.432	0.003	–175.9	3.3	–179.2	4.5
		0.431	0.002			–182.2	3.2		
I03-503	32	0.825	0.002	0.823	0.004	75.0	3.6	75.9	2.6
		0.819	0.003			76.8	3.8		
I03-503	13	0.415	0.005	0.433	0.021	–184.7	3.0	–183.5	2.1
		0.445	0.004			–182.3	3.0		
I03-X08	32	0.869	0.004	0.846	0.017	61.8	3.5	61.6	2.5
		0.845	0.001			61.3	3.5		
I03-X08	21	0.255	0.001	0.255	0.006	–175.6	3.1	–176.1	2.2
		0.264	0.005			–176.6	3.1		
I03-495	21	0.308	0.005	0.307	0.003	–174.6	3.0	–177.9	4.6
		0.306	0.004			–181.1	3.0		

Table 3.10.5. continued.

Station	Btl	δ13C / ‰				Δ14C / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
I03-495	13	-	-	-	-	–186.1	3.0	–183.0	4.5
		-	-			–179.8	3.0		
I03-491	32	0.856	0.003	0.854	0.002	68.4	3.7	70.2	2.6
		0.853	0.002			72.0	3.6		
I03-491	13	0.415	0.002	0.414	0.003	–184.2	3.1	–182.7	2.3
		0.411	0.003			–181.0	3.2		
I03-487	1	0.304	0.005	0.324	0.019	–179.1	3.3	–180.6	2.3
		0.331	0.003			–181.8	3.1		
I03-480	32	0.934	0.008	0.926	0.007	65.7	3.7	66.4	2.6
		0.924	0.004			67.1	3.6		
I03-480	21	0.287	0.004	0.291	0.006	–180.8	3.1	–179.6	2.2
		0.295	0.004			–178.3	3.2		
I03-474	32	0.845	0.003	0.852	0.014	63.5	3.6	66.4	4.1
		0.865	0.004			69.3	3.6		
I03-474	13	0.362	0.003	0.351	0.008	–190.3	2.8	–193.1	4.1
		0.350	0.001			–196.1	2.9		
I03-470	32	0.785	0.007	0.764	0.018	77.6	3.4	78.4	2.4
		0.760	0.003			79.3	3.3		
I03-470	21	0.290	0.003	0.293	0.008	–171.4	2.9	–170.9	2.1
		0.302	0.005			–170.4	2.9		
I03-466	21	0.255	0.005	0.257	0.003	–177.6	3.1	–175.8	2.6
		0.259	0.004			–173.9	3.1		
I03-466	13	0.326	0.006	0.352	0.027	–196.7	2.9	–194.5	3.3
		0.364	0.004			–192.0	3.0		
I03-463	32	0.717	0.005	0.695	0.016	71.4	3.5	73.0	2.5
		0.694	0.001			74.7	3.5		
I03-463	1	0.318	0.004	0.325	0.013	–183.9	3.1	–183.6	2.2
		0.337	0.005			–183.3	3.0		
I03-459	32	0.788	0.004	0.775	0.015	57.3	3.7	62.6	7.2
		0.767	0.003			67.5	3.6		

Table 3.10.5. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
I03-459	21	0.277	0.004	0.280	0.004	–187.8	3.1	–180.5	10.3
		0.282	0.003			–173.2	3.1		
I03-459	13	0.397	0.003	0.374	0.045	–190.3	3.1	–188.8	2.7
		0.334	0.004			–186.5	3.9		
I03-455	32	-	-	-	-	38.0	3.7	43.0	7.2
		-	-			48.2	3.8		
I03-455	21	0.284	0.005	0.269	0.022	–192.9	3.1	–188.3	6.5
		0.253	0.005			–183.7	3.1		
I03-455	13	0.349	0.001	0.343	0.042	–186.1	3.1	–186.5	2.2
		0.290	0.003			–187.0	3.2		
I03-451	32	0.826	0.004	0.825	0.003	-	-	-	-
		0.824	0.006			-	-		
I03-451	21	-	-	-	-	–177.7	3.2	–177.0	2.3
		-	-			–176.4	3.2		
I03-451	13	-	-	-	-	–189.5	3.2	–192.5	4.3
		-	-			–195.6	3.2		

a. Standard deviation of repeat measurements.
b. Error weighted mean of the replicate pair.
c. Larger of the standard deviation and the error weighted standard deviation of the replicate pair.
d. Larger of the standard deviation of repeat measurements and the counting errors.

(7) Duplicate measurements

At 48 stations, seawater samples were taken from two X-Niskin bottles that were collected at same depth (duplicate sampling). Most of the duplicate samples were collected in deep layers below 1,000 dbar. Results of the duplicate pair analyses are shown in Table 3.10.6. The standard deviations of the $\delta^{13}C$ and $\Delta^{14}C$ duplicate analyses in good measurement were calculated to be 0.014 ‰ (n = 39) and 3.7 ‰ (n = 40), respectively. These deviations are almost same as those obtained by the replicate analyses (0.020 ‰ for $\delta^{13}C$ and 3.9 ‰ for $\Delta^{14}C$). The results of replicate and duplicate measurements suggested that "reproducibilities" of our $\delta^{13}C$ and $\Delta^{14}C$ measurements including errors due to the sample preparation were less than 0.02 ‰ and 4 ‰, respectively.

Table 3.10.6. Summary of duplicate analyses.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
P06W-201	35	1.206	0.002	1.201	0.024	91.5	3.9	87.7	5.4
	16	1.172	0.005			83.9	3.9		
P06E-039	22	0.321	0.001	0.320	0.006	–196.6	2.5	–193.6	3.7
	11	0.313	0.003			–191.3	2.2		
P06E-X19	20	0.274	0.002	0.278	0.006	–190.4	3.0	–191.2	2.1
	11	0.282	0.002			–191.9	3.0		
P06E-027	16	0.274	0.006	0.256	0.016	–208.7	3.2	–210.7	2.9
	10	0.252	0.003			–212.8	3.3		
P06E-023	14	0.201	0.004	0.200	0.002	–210.0	3.1	–213.7	5.2
	1	0.199	0.003			–217.3	3.1		
P06E-019	12	0.250	0.004	0.236	0.016	–218.0	3.0	–217.2	2.1
	1	0.228	0.003			–216.4	2.9		
A10-629	21	1.035	0.003	1.026	0.018	-	-	-	-
	17	1.010	0.004			-	-		
A10-007	16	1.014	0.004	0.994	0.018	–99.6	3.6	–101.2	2.5
	15	0.989	0.002			–102.9	3.6		
A10-X17	13	0.727	0.006	0.729	0.004	–136.5	3.3	–136.5	2.3
	9	0.730	0.006			–136.6	3.3		
A10-021	17	0.882	0.004	0.876	0.011	–126.8	3.4	–125.2	2.4
	8	0.866	0.005			–123.6	3.5		
A10-035	23	0.974	0.005	0.967	0.006	-	-	-	-
	13	0.965	0.003			-	-		
A10-038	22	0.639	0.002	0.634	0.011	-	-	-	-
	4	0.623	0.003			-	-		
A10-X16	21	0.664	0.005	0.651	0.013	-	-	-	-
	8	0.646	0.003			-	-		
A10-043	20	0.650	0.003	0.668	0.018	–145.2	3.5	–146.6	2.4
	7	0.676	0.002			–147.9	3.4		
A10-X15	18	0.794	0.003	0.805	0.016	–124.5	3.4	–122.8	2.4
	9	0.816	0.003			–121.3	3.3		
A10-051	16	0.880	0.005	0.869	0.016	–117.3	3.4	–116.1	2.5
	11	0.858	0.005			–114.9	3.6		

Table 3.10.6. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
A10-055	17	0.796	0.002	0.801	0.007	-	-	-	-
	14	0.806	0.002			-	-		
A10-059	12	-	-	-	-	–105.9	3.5	–106.5	2.5
	11	-	-			–107.3	3.6		
A10-X14	10	0.844	0.002	0.885	0.036	–105.0	3.5	–107.9	4.2
	1	0.895	0.001			–110.9	3.5		
A10-067	9	0.884	0.004	0.867	0.025	–111.8	3.3	–113.0	2.3
	8	0.849	0.004			–114.3	3.2		
A10-071	7	0.788	0.004	0.793	0.006	–121.3	3.4	–117.9	4.7
	6	0.797	0.004			–114.7	3.3		
A10-075	11	0.842	0.001	0.846	0.013	–125.9	3.5	–121.7	5.6
	4	0.860	0.002			–118.0	3.3		
A10-079	7	-	-	-	-	–148.5	3.4	–150.9	3.4
	2	-	-			–153.3	3.3		
A10-083	23	0.554	0.005	0.546	0.009	-	-	-	-
	5	0.541	0.004			-	-		
A10-087	21	0.576	0.002	0.553	0.021	-	-	-	-
	5	0.547	0.001			-	-		
A10-093	12	0.855	0.003	0.835	0.021	-	-	-	-
	8	0.826	0.002			-	-		
I04-601	21	0.683	0.004	0.684	0.002	–141.2	2.3	–141.1	1.8
	14	0.684	0.002			–141.0	3.2		
I04-595	18	0.668	0.003	0.676	0.016	–137.5	3.3	–142.8	7.1
	12	0.690	0.004			–147.6	3.2		
I04-589	15	-	-	-	-	–142.7	3.1	–142.8	2.2
	11	-	-			–142.9	3.1		
I03-557	10	0.474	0.002	0.480	0.015	–174.8	3.1	–170.7	5.6
	8	0.495	0.003			–166.9	3.0		
I03-551	7	0.502	0.008	0.490	0.010	–161.3	3.1	–160.2	2.3
	6	0.488	0.003			–159.0	3.3		
I03-545	8	-	-	-	-	–170.5	3.2	–168.7	2.5
	4	-	-			–166.9	3.2		

Table 3.10.6. continued.

Station	Btl	$\delta^{13}C$ / ‰				$\Delta^{14}C$ / ‰			
		$\delta^{13}C$	Error[a]	E.W.Mean[b]	Uncertainty[c]	$\Delta^{14}C$	Error[d]	E.W.Mean[b]	Uncertainty[c]
I03-535	22	0.444	0.004	0.424	0.015	–167.0	3.1	–171.0	5.7
	7	0.423	0.001			–175.1	3.1		
I03-535	23	0.622	0.005	0.637	0.021	–125.8	3.4	–123.7	3.0
	3	0.652	0.005			–121.6	3.4		
I03-525	17	-	-	-	-	–177.9	3.0	–176.8	2.2
	14	-	-			–175.8	3.1		
I03-519	16	0.445	0.002	0.446	0.004	–162.9	3.0	–165.1	3.0
	14	0.451	0.004			–167.2	3.0		
I03-513	11	-	-	-	-	–177.1	3.0	–176.6	2.1
	9	-	-			–176.2	2.9		
I03-507	8	-	-	-	-	–193.3	3.1	–189.1	6.1
	6	-	-			–184.6	3.2		
I03-503	6	0.411	0.003	0.396	0.022	–189.7	2.9	–189.4	2.1
	1	0.380	0.003			–189.0	2.9		
I03-X08	6	0.357	0.003	0.364	0.009	–191.3	2.9	–189.2	3.3
	4	0.370	0.003			–186.7	3.1		
I03-495	5	-	-	-	-	–187.6	3.0	–186.8	2.1
	2	-	-			–186.0	3.0		
I03-491	23	0.381	0.002	0.384	0.003	–193.5	3.0	–191.5	2.9
	6	0.385	0.001			–189.4	3.1		
I03-487	21	0.321	0.003	0.322	0.002	–189.4	3.1	–188.9	2.2
	19	0.322	0.003			–188.4	3.1		
I03-480	18	0.484	0.004	0.481	0.004	–179.2	3.2	–175.7	5.1
	4	0.478	0.004			–172.0	3.3		
I03-474	16	-	-	-	-	–163.7	2.8	–170.0	9.3
	6	-	-			–176.8	2.9		
I03-470	14	0.451	0.002	0.453	0.006	–161.8	2.9	–162.6	2.0
	4	0.459	0.003			–163.4	2.8		
I03-463	13	0.430	0.004	0.434	0.004	–170.1	2.9	–166.9	5.1
	3	0.436	0.003			–162.9	3.2		
I03-455	10	0.437	0.004	0.436	0.003	–176.2	3.2	–173.8	3.3
	5	0.434	0.004			–171.6	3.1		

a. Standard deviation of repeat measurements.
b. Error weighted mean of the replicate pair.
c. Larger of the standard deviation and the error weighted standard deviation of the replicate pair.
d. Larger of the standard deviation of repeat measurements and the counting errors.

(8) Reference seawater measurements

During the sample measurements period from May 2004 to October 2006, we synchronously carried out $\delta^{13}C$ and $\Delta^{14}C$ measurements of reference seawaters. The reference seawater was prepared from a large volume of surface seawater collected in open ocean. The surface seawater was filtered, exposed to ultraviolet irradiation, poisoned by $HgCl_2$, and then dispensed in 250 cm^3 glass bottles. The $\delta^{13}C$ and $\Delta^{14}C$ of the reference seawater was measured at every 40 samples analyses approximately. The results are shown in Figure 3.10.2 and Table 3.10.7. The standard deviations of $\delta^{13}C$ and $\Delta^{14}C$ were 0.027 ‰ and 5.8 ‰, respectively. These deviations were slightly larger than those obtained by the replicate and duplicate measurements (0.02 ‰ for $\delta^{13}C$ and 4 ‰ for $\Delta^{14}C$). Finally we concluded that "precisions" of our $\delta^{13}C$ and $\Delta^{14}C$ analyses including error due to the sample preparation and storage were about 0.03 ‰ and 6 ‰, respectively.

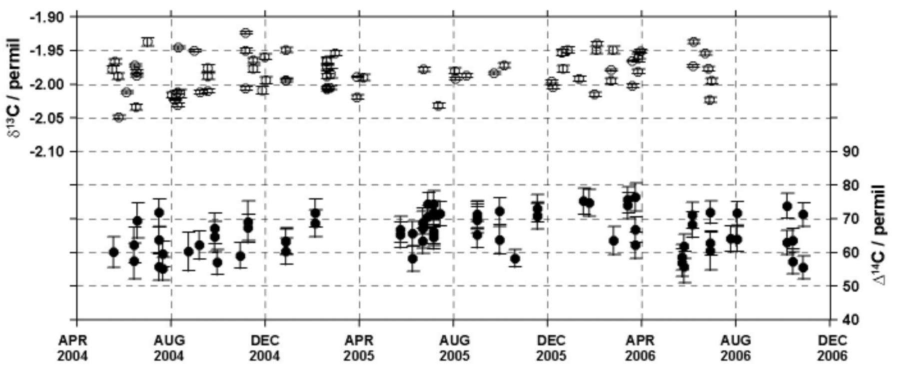

Figure 3.10.2. $\delta^{13}C$ (open circles) and $\Delta^{14}C$ (closed circles) measurements of the reference seawaters.

Table 3.10.7. Summary of reference seawaters measurements.

No.	RS No.	$\delta^{13}C$ / ‰			$\Delta^{14}C^a$ / ‰		
		Measurement date	$\delta^{13}C$	Error[b]	Measurement date	$\Delta^{14}C$	Error[c]
1	RM0204-026	17-May-04	–1.978	0.005	18-May-04	60.2	4.6
2	RM0204-156	20-May-04	–1.966	0.004	14-Jun-04	62.3	5.3
3	RM0204-093	24-May-04	–1.988	0.005	14-Jun-04	57.5	5.3
4	RM0204-103	25-May-04	–2.049	0.003	18-Jun-04	69.5	5.2
5	RM0204-028	04-Jun-04	–2.012	0.002	16-Jul-04	71.9	4.1
6	RM0204-148	15-Jun-04	–1.972	0.002	16-Jul-04	55.7	3.9
7	RM0204-022	16-Jun-04	–2.034	0.004	16-Jul-04	63.8	3.8
8	RM0204-152	17-Jun-04	–1.987	0.002	21-Jul-04	55.2	3.5
9	RM0204-064	01-Jul-04	–1.937	0.006	21-Jul-04	59.6	3.8
10	RM0204-076	02-Aug-04	–2.016	0.004	23-Aug-04	60.3	5.7
11	RM0204-115	05-Aug-04	–2.023	0.001	06-Sep-04	62.2	4.2
12	RM0204-092	10-Aug-04	–1.945	0.002	26-Sep-04	67.2	4.6
13	RM0204-027	12-Aug-04	–2.014	0.006	26-Sep-04	64.7	4.5
14	RM0204-018	31-Aug-04	–1.950	0.002	29-Sep-04	57.1	3.7
15	RM0204-169	17-Jun-04	–1.981	0.002	29-Oct-04	59.2	3.8
16	RM0204-062	12-Jul-05	–2.032	0.004	08-Nov-04	69.2	6.2
17	RM0204-048	09-Aug-04	–2.031	0.003	08-Nov-04	67.5	3.9
18	RM0204-004	15-Nov-04	–1.977	0.005	27-Dec-04	60.5	3.9
19	RM0204-119	26-Nov-04	–2.009	0.006	27-Dec-04	63.5	3.9
20	RM0204-108	09-Aug-04	–2.012	0.003	27-Dec-04	63.3	3.8
21	RM0204-123	30-Nov-04	–1.959	0.004	03-Feb-05	68.8	4.0
22	RM0204-065	01-Dec-04	–1.994	0.005	03-Feb-05	71.8	4.2
23	RM0204-159	22-Feb-05	–2.005	0.003	24-May-05	65.3	3.8
24	RM0204-055	18-Feb-05	–1.966	0.006	24-May-05	66.9	3.9
25	RM0204-177	23-Feb-05	–1.984	0.007	09-Jun-05	58.3	3.7
26	RM0204-111	01-Mar-05	–1.954	0.004	09-Jun-05	65.7	3.6
27	RM0204-138	07-Sep-04	–2.012	0.003	22-Jun-05	69.0	3.5
28	RM0204-058	17-Sep-04	–2.010	0.003	22-Jun-05	63.5	3.7
29	RM0204-165	17-Sep-04	–1.976	0.005	22-Jun-05	67.3	6.0
30	RM0204-183	17-Sep-04	–1.988	0.005	29-Jun-05	70.7	3.5

Table 3.10.7. continued.

No.	RS No.	$\delta^{13}C$ / ‰			$\Delta^{14}C^a$ / ‰		
		Measurement date	$\delta^{13}C$	Error[b]	Measurement date	$\Delta^{14}C$	Error[c]
31	RM0204-135	05-Nov-04	–2.006	0.003	29-Jun-05	74.4	3.6
32	RM0204-070	05-Nov-04	–1.923	0.002	06-Jul-05	65.9	3.8
33	RM0204-081	05-Nov-04	–1.950	0.004	06-Jul-05	71.5	3.8
34	RM0204-179	15-Nov-04	–1.964	0.004	06-Jul-05	74.4	4.0
35	RM0204-016	27-Dec-04	–1.949	0.004	06-Jul-05	72.0	3.5
36	RM0204-075	27-Dec-04	–1.995	0.002	06-Jul-05	66.4	3.7
37	RM0204-133	27-Dec-04	–1.994	0.003	06-Jul-05	64.7	3.6
38	RM0204-098	18-Feb-05	–2.007	0.003	14-Jul-05	71.6	3.6
39	RM0204-087	18-Feb-05	–1.964	0.005	19-Oct-05	58.5	2.5
40	RM0204-014	18-Feb-05	–1.988	0.004	31-Aug-05	71.1	3.5
41	RM0204-182	18-Feb-05	–1.975	0.005	31-Aug-05	71.5	4.1
42	RM0204-145	18-Feb-05	–2.005	0.002	31-Aug-05	69.9	3.9
43	RM0204-106	18-Feb-05	–1.974	0.004	31-Aug-05	65.5	3.9
44	RM0204-035	29-Mar-05	–1.989	0.001	31-Aug-05	71.2	4.1
45	RM0204-147	29-Mar-05	–2.019	0.003	29-Sep-05	63.9	4.1
46	RM0204-061	06-Apr-05	–1.990	0.005	29-Sep-05	72.5	4.0
47	RM0204-132	23-Jun-05	–1.978	0.003	17-Nov-05	71.0	3.8
48	RM0204-044	02-Aug-05	–1.980	0.004	17-Nov-05	73.3	4.1
49	RM0204-176	03-Aug-05	–1.992	0.002	17-Nov-05	71.2	4.0
50	RM0204-053	17-Aug-05	–1.987	0.003	16-Jan-06	75.5	3.9
51	RM0204-097	22-Sep-05	–1.983	0.002	23-Jan-06	75.0	4.0
52	RM0204-160	05-Oct-05	–1.972	0.004	24-Feb-06	63.7	4.2
53	RM0204-034	05-Dec-05	–1.996	0.002	14-Mar-06	75.9	3.9
54	RM0204-141	07-Dec-05	–2.004	0.003	14-Mar-06	74.2	3.9
55	RM0204-188	19-Dec-05	–1.953	0.005	24-Mar-06	62.4	3.9
56	RM0204-083	20-Dec-05	–1.977	0.005	24-Mar-06	67.0	3.8
57	RM0204-010	26-Dec-05	–1.949	0.005	24-Mar-06	76.7	4.1
58	RM0204-173	30-Jan-06	–2.015	0.003	23-May-06	59.0	3.8
59	RM0204-001	01-Feb-06	–1.949	0.006	23-May-06	57.3	4.0
60	RM0204-172	02-Feb-06	–1.940	0.003	26-May-06	62.1	3.6

Table 3.10.7. continued.

No.	RS No.	$\delta^{13}C$ / ‰			$\Delta^{14}C^a$ / ‰		
		Measurement date	$\delta^{13}C$	Error[b]	Measurement date	$\Delta^{14}C$	Error[c]
61	RM0204-144	20-Feb-06	–1.979	0.001	26-May-06	56.0	4.6
62	RM0204-080	23-Feb-06	–1.949	0.006	05-Jun-06	71.4	3.9
63	RM0204-146	27-Mar-06	–1.981	0.003	05-Jun-06	68.6	3.8
64	RM0204-126	28-Mar-06	–1.957	0.005	29-Jun-06	63.1	3.6
65	RM0204-021	30-Mar-06	–1.951	0.003	29-Jun-06	72.3	3.4
66	RM0204-039	06-Jun-06	–1.973	0.002	29-Jun-06	72.3	3.8
67	RM0204-105	07-Jun-06	–1.937	0.003	29-Jun-06	60.8	5.6
68	RM0204-178	10-Jan-06	–1.992	0.004	25-Jul-06	64.4	3.8
69	RM0204-029	20-Feb-06	–1.995	0.004	02-Aug-06	72.0	3.5
70	RM0204-167	20-Mar-06	–2.002	0.003	02-Aug-06	64.3	3.7
71	RM0204-117	20-Mar-06	–1.965	0.001	06-Oct-06	63.2	3.6
72	RM0204-024	27-Mar-06	–1.961	0.006	06-Oct-06	74.2	3.7
73	RM0204-067	22-Jun-06	–1.954	0.003	13-Oct-06	57.6	3.7
74	RM0204-107	26-Jun-06	–1.977	0.003	13-Oct-06	63.9	3.5
75	RM0204-153	28-Jun-06	–2.023	0.004	27-Oct-06	71.6	3.5
76	RM0204-051	30-Jun-06	–1.995	0.004	27-Oct-06	55.9	3.5
		mean	–1.983		mean	66.3	
		standard deviation	0.027		standard deviation	5.8	

a. Decay corrected for 01/May/2004.
b. Standard deviation of repeat measurements.
c. Larger of the standard deviation and the counting error.

(9) Quality control flag assignment

Quality flag values were assigned to all δ^{13}C and Δ^{14}C measurements using the code defined in Table 0.2 of WHP Office Report WHPO 91-1 Rev.2 section 4.5.2 (Joyce et al., 1994). Measurement flags of 2, 3, 4, 5, and 6 have been assigned (Table 3.10.8). For the choice between 2 (good), 3 (questionable) or 4 (bad), we basically followed a flagging procedure in Key et al. (1996) as listed below:

a. On a station-by-station basis, a datum was plotted against pressure. Any points not lying on a generally smooth trend were noted.

b. δ^{13}C (Δ^{14}C) was then plotted against dissolved oxygen (silicate) concentration and deviant points noted. If a datum deviated from both the depth and oxygen (silicate) plots, it was flagged 3.

c. Vertical sections against depth were prepared using the Ocean Data View (Schlitzer, 2006). If a datum was anomalous on the section plots, datum flag was degraded from 2 to 3, or from 3 to 4.

Table 3.10.8. Summary of assigned quality control flags.

Flag	Definition	Number	
		δ^{13}C	Δ^{14}C
2	Good	2,486	2,518
3	Questionable	94	80
4	Bad	19	3
5	Not report (missing)	11	12
6	Replicate	217	214
Total		2,827	2,827

(10) Data Summary

Figure 3.10.3 and 3.10.4 show vertical sections of δ^{13}C and Δ^{14}C against depth, respectively. Maximum of δ^{13}C was observed in the mode waters (SAMW: Subantarctic Mode Water) in the Pacific and Indian Oceans. In the Southwest Pacific Basin (180° - 130°W), Madagascan Basin (50°E - 60°E), and West Australian Basin (90°E - 110°E), high δ^{13}C waters near bottom well correspond to the Circumpolar Deep Water (CDW). In the South Atlantic Ocean, one can distinguish low-δ^{13}C water of the Antarctic Bottom Water (AABW) from high-δ^{13}C water of the North Atlantic Deep Water (NADW). Low δ^{13}C was found in deep waters in the Indian Ocean (IDW: Indian Deep Water) and in the Pacific Ocean (PDW: Pacific Deep Water) from 1,000 to 4,000 m depth approximately. The global distribution of δ^{13}C well agree with that presented in a previous study (Kroopnick, 1985). Temporal increase of the anthropogenic CO_2 inventory can be estimated by comparison the BEAGLE2003 δ^{13}C with historical data because atmospheric δ^{13}C decrease, named "^{13}C-Suess Effect", has been imprinted in δ^{13}C of DIC in surface ocean.

Higher Δ^{14}C values were observed in the thermocline (< about 1,000 m depth) of the three basins because of the bomb-produced radiocarbon penetration. Deep Δ^{14}C data clearly indicate the global pattern of thermohaline circulation. Relative higher Δ^{14}C was measured in CDW where the high-δ^{13}C water was found. In the South Atlantic Ocean, one can distinguish low-Δ^{14}C water of AABW from high-Δ^{14}C water of NADW. Minimum of Δ^{14}C was measured in IDW and PDW where the δ^{13}C minimum was found. The global distribution of Δ^{14}C in deep and bottom waters supports a previous study (Key et al., 2004). Difference between BEAGLE2003 and historical radiocarbon data will suggest temporal change of bomb radiocarbon in the thermocline.

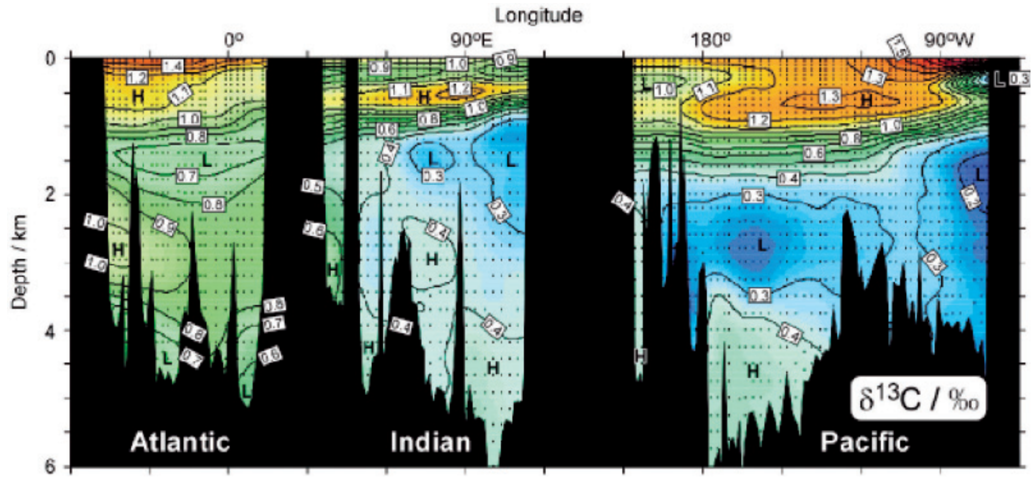

Figure 3.10.3. Vertical sections of $\delta^{13}C$ against depth during BEAGLE2003 cruise in 2003/2004.

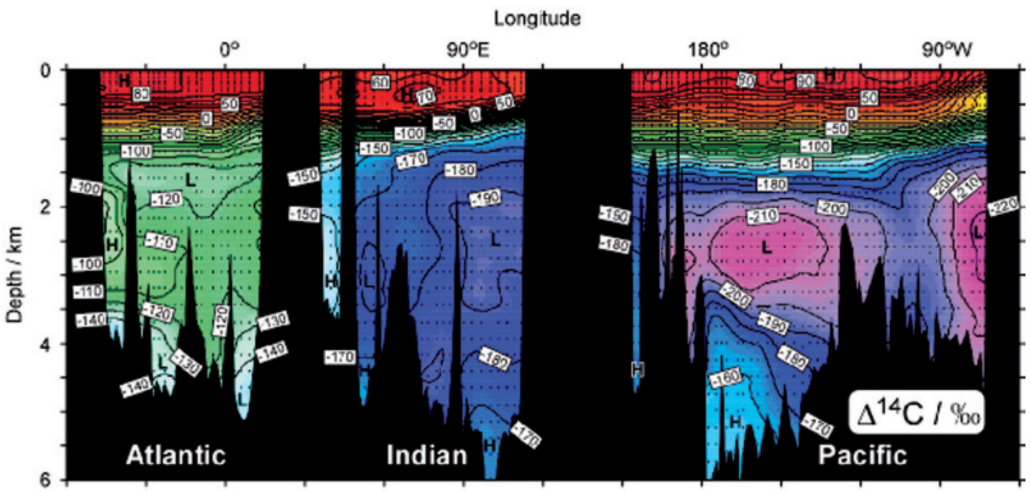

Figure 3.10.4. Vertical sections of $\Delta^{14}C$ against depth during BEAGLE2003 cruise in 2003/2004.

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3.11 Anthropogenic radionuclides

23 January 2007

3.11.1 General information

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(2) Objectives

1) Geochemical studies of global fallout, anthropogenic radionuclides such as ^{137}Cs, ^{90}Sr and Pu isotopes, including studies on the long term behaviour of ^{137}Cs in the world ocean, and to learn more about the present geographical distribution of ^{137}Cs in the oceans in the southern hemisphere.

2) Use of anthropogenic radionuclides as tracers for oceanographic and climate change studies. Development of the anthropogenic radionuclides database for validation and update of ocean general circulation models.

(3) Target radionuclides

Main target radionuclides are ^{137}Cs, Pu isotopes and tritium. In some samples analysis of ^{90}Sr will be carried out as well.

(4) Sampling procedures

Seawater sampling for analysis of radionuclides in the water column was carried out using adopted procedures. If additional Niskin bottles filled with samples were available, volumes of water column samples varied from 6 L to 20 L. The samples were drawn from Niskin bottles into 20 L cubitainers. The samples were then filtered through 0.45 μm pore size filters and filled into cubitainers or bottles of appropriate sizes. Filters were also archived. Concentrated nitric acid was added to the samples to keep pH at 1.6, except for tritium samples.

Surface water samples were drawn through an intake pump located several meters below the sea surface. Volumes up to 85 L were collected for ^{137}Cs and Pu analysis. For tritium analysis, samples of 1 L were collected.

All samples were stored in a storage room at a stable temperature by the end of the cruise. In March 2004 the samples were loaded on land and transported to MRI at Tsukuba for the analysis of radionuclides on land. In June 2004, selected samples were sent to IAEA-MEL at Monaco for the analysis of radionuclides on land, too.

(5) Samples accomplished during the cruises

A total of 91 samples were collected for surface seawater samples. At the 56 stations, a total of 777 samples were collected for water column samples (Table 3.11.1). The sampling locations and depths are shown in Figure 3.11.1. A total weight of the samples was around 22,000 kg.

Table 3.11.1. Number of stations for each ocean.

	The Pacific Ocean	The Atlantic Ocean	The Indian Ocean	Total
Surface	51	18	22	91
Water column	27	12	17	56

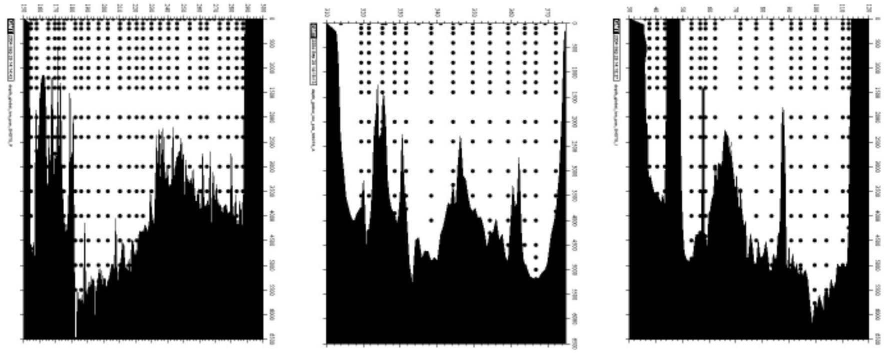

Figure 3.11.1. locations and depths of sampling sites.

(6) Problems during the cruise and solutions

No serious problems occurred during the cruise.

(7) Comparability on the analysis of radionuclides among the laboratories on land

Since the samples were measured by several laboratories on land, we checked the comparability of the measurements. Results are presented in Table 3.11.2, 3.11.3 and 3.11.4.

Table 3.11.2. Results of intercomparison of ^{137}Cs measurements.

	MRI ($Bq\ m^{-3}$)	MEL ($Bq\ m^{-3}$)	LLRL ($Bq\ m^{-3}$)	Comenius Univ. ($Bq\ m^{-3}$)
P06C-127	1.23±0.00	1.24±0.06		
	1.20±0.04			
I03-507	1.36±0.07			1.32±0.07
	1.19±0.05			
A10-X15	1.23±0.06	1.15±0.03		
	1.20±0.04			
165E-33-800	0.97±0.03		1.14±0.05	
165E-33-900	0.63±0.02		0.78±0.04	
165E-33-1000	0.50±0.05		0.66±0.06	
165E-37-800	0.55±0.03		0.69±0.05	

Table 3.11.3. Results of measurements of ^{137}Cs in IAEA-381 reference material (Irish seawater).

	MRI ($Bq\ kg^{-1}$)	MEL ($Bq\ kg^{-1}$)	Certified value ($Bq\ kg^{-1}$)
IAEA381	0.445±0.002		0.49±0.01

Table 3.11.4. Results of intercomparison of Pu measurements.

	MRI ($mBq\ m^{-3}$)	MEL ($mBq\ m^{-3}$)	KINS ($mBq\ m^{-3}$)
P06C-175	1.1±0.3		1.41±0.24
P06C-124	1.5±0.4		
P06C-127			

3.11.2 Analyses at Meteorological Research Institute (MRI) and Low Level Radioactivity Laboratory , Kanazawa University (LLRL) in Japan

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(2) Analytical method of ^{137}Cs analysis in seawater at MRI and LLRL

Cs is one of the alkali metals, which exists in ionic form in natural water, and chemically shows less affinity than other chemicals. Known adsorbents to collect Cs in seawater are ammonium phosphomolybdate (AMP) and hexacyanoferrate compounds (Folsom and Sreekumaran, 1966; La Rosa et al., 2001). The AMP has been an effective ion exchanger of alkali metals (Van R. Smit et al., 1959). Aoyama et al. (2000) re-examined the AMP procedure and their experiments revealed that the stable Cs carrier of the same equivalent amount as AMP is required to form insoluble Cs-AMP compounds in an acidic solution (pH from 1.2 to 2.2). The improved method has achieved high chemical yields of more than 95 % for sample volumes of less than 100 L. Another improvement is a reduction of the amount of AMP from ~10 g to 4 g to adsorb ^{137}Cs from seawater samples. As a result, it has been possible to reduce the sample volumes from ~100 L to less than 20 L, so after final sample treatment high-efficiency well-type Ge-detectors can be used for analysis of ^{137}Cs. These improvements have enabled to apply ^{137}Cs as a chemical tracer for studying oceanographic processes in much larger scales, as has been documented during the BEAGLE cruise.

Recently Komura (Komura, 2004; Komura and Hamajima, 2004) has established an underground facility (Ogoya Underground Laboratory, OUL) to achieve an extremely low background of γ-spectrometers, operating with Ge detectors of high efficiency. The OUL has been constructed in 1995 by Low Level Radioactivity Laboratory of the Kanazawa University in the tunnel of former Ogoya copper mine (235 m above the sea level, Ishikawa prefecture). The shielding depth of the OUL is 270 m of water equivalent, where contributions of meaon are more than four orders of magnitude lower than at the ground level. In order to achieve an extremely low background of γ-spectrometers, high efficiency well type Ge detectors specially designed for low level γ-ray spectrometry were shielded with low background lead prepared from old roof tiles of the Kanazawa Castle. As a result, the background of γ-ray spectrometers in the energy range of ^{137}Cs is two orders of magnitude lower than that in ground-level facilities, as shown in Table 3.11.5. A detection limit of ^{137}Cs at the OUL is 0.18 mBq for a counting time of 10000 minutes (Hirose et al., 2005).

There is a residual problem in low-level γ-spectrometry for ^{137}Cs measurements as AMP adsorbs trace amounts of potassium when Cs is extracted from seawater. Potassium is a major component in seawater, and natural potassium compounds contains 0.0118 % of radioactive potassium (^{40}K) to stable potassium. Therefore even trace amounts of ^{40}K cause elevation of background in the ^{137}Cs energy window due to Compton scattering of gamma-rays from ^{40}K. If ^{40}K can be removed from AMP(Cs) compound samples, a better sensitivity of underground γ-spectrometers for ^{137}Cs measurements can be achieved. To remove ^{40}K from AMP(Cs) compounds, a precipitation method including insoluble platinate salt of Cs was developed for purification of Cs. This method helped to remove trace amounts of ^{40}K from from AMP(Cs) compounds with a chemical yield of around 90 % for ^{137}Cs (Hirose et al., 2007).This metod has been applied for seawater samples collected below the 1200 m water depth.

Materials and procedures of chemical separation

All reagents used for ^{137}Cs, ^{90}Sr and Pu assay are special (G.R.) grade for analytical use. All experiments and sample treatments have been carried out at ambient temperatures. It is very important to know background γ-activity of reagents. The ^{137}Cs activity of CsCl and AMP reagents was less than 0.03 mBq g^{-1} and 0.008 mBq g^{-1}, respectively. There has not been any ^{137}Cs contamination observed from other reagents.

An improved AMP procedure of chemical separation of ^{137}Cs from seawater samples for the ground-level γ-spectrometry was as follows:

1) Measure the seawater volume (5-100 L) and put the sample into a tank of appropriate size.

2) pH should be adjusted to be 1.6-2.0 by adding concentrated HNO_3 (addition of 40 mL conc. HNO_3 for 20 L seawater sample makes pH of seawater sample about 1.6).

3) Add CsCl of 0.26 g to form an insoluble compound, and stir at a rate of 25 L per minute for several minutes.

4) Weigh AMP of 4 g and pour it into a tank to disperse the AMP with seawater.

5) 1 hour stirring at the rate of 25 L air per minute.

6) Settle until the supernate becomes clear. A settling time is usually 6 hours to overnight, but no longer than 24 hours.

7) Take an aliquot of 50 mL supernate to calculate the amount of the residual caesium in the supernate.

8) Loosen the AMP(Cs) compound from the bottom of the tank and transfer into a 1-2 L beaker, if it is necessary do an additional step of decantation.

9) Collect the AMP/Cs compound onto 5 B filter by filtration and wash the compound with 1 M HNO_3

10) Dry up the AMP(Cs) compound for several days in room temperature

11) Weigh the AMP(Cs) compound and determine weight yield

12) Transfer the AMP(Cs) compound into a teflon tube of 4 mL volume and analyze in a γ-ray spectrometer.

^{137}Cs measurements were carried out by γ-spectrometry using well-type Ge detectors coupled with multi-channel pulse height analyzers. The performance of the well-type Ge detectors is summarized in Table 3.11.5. The detector energy calibration was done using IPL mixed γ-ray sources, while the geometry calibration was done using an internal reference material of similar density, placed in the same sample tube.

Table 3.11.5. The performance of HPGe coaxial well-type detectors (Hirose et al., 2007).

Institute	Type	Active volume (cm^3)	Absolute efficiency[a] (%)	Background[b] (cpm/1keV)
MRI	ORTEC 6	280	20.5	0.092
	7	80	10.8	0.033
	8	280	16.5	0.109
	9	600	23.7	0.074
Ogoya	Canberra	199	14.5	0.0005
	EYRISYS	315	20	0.0016

a: The absolute efficiencies of HPGE are calculated at 662 keV photo-peak of ^{137}Cs.

b: The background values were calculated as a sum from 660 keV to 664 keV corresponding to 662 keV photo-peak of ^{137}Cs.

For samples collected deeper than 1200 m, an additional treatment using $Cs_2Pt(Cl)_6$ precipitate was applied to remove traces of ^{40}K. These samples were analyzed for ^{137}Cs in the underground facility at Ogoya.

1) the same procedure from step 1) to step 12).

2) Dissolve the AMP(Cs) compound by adding alkali solution.

3) pH should be adjusted to 8.1 by adding 2 M HCl and adjust the volume of solution to 70-100 mL.

4) Perform precipitation of $Cs_2Pt (Cl)_6$ adding chloroplatinic acid (1g/5mL DW) at pH = 8.1 and keep in refrigerator during a half-day.

5) Collect the $Cs_2Pt (Cl)_6$ precipitate onto a filter by filtration and wash the compound with solution (pH = 8.1).

10) Dry up the $Cs_2Pt (Cl)_6$ precipitate for several days at room temperature.

11) Weigh the $Cs_2Pt (Cl)_6$ precipitate and determine weight yield.

12) Transfer the $Cs_2Pt(Cl)_6$ precipitate into a teflon tube of 4 mL volume and analyze by underground γ-spectrometry.

(3) Analytical method of $^{239+240}$Pu in seawater at MRI

Preconcentration of Pu

Co-precipitation method of Pu with Fe hydroxides was used as a preconcentration method. Seawater sample of 60 L was acidified to pH=2 with 12 M HCl (60 mL). After addition of ferric chloride (0.6 g), a known amount of tracer (^{242}Pu) and $K_2S_2O_5$ (30 g), the solution was stirred for 1 h. In this stage, all Pu species in solution were reduced to Pu(III). Coprecipitation of Pu with ferric hydroxide was formed at pH=10 to adding dilute NaOH solution (0.5-1 M). The formed ferric oxide precipitation contained small amounts of $Ca(OH)_2$ and $Mg(OH)_2$.

Radiochemical separation

Precipitates (Fe, Mg, Ca hydroxides) were dissolved with 12 M HCl and added to bring the acid strength to 9 M (three times of the dissolved materials). One drop of 30 % H_2O_2 was added for each 10 mL solution, and the solution was heated just below boiling for 1 h. After the solution had cooled, Pu was isolated by anion exchange techniques (Dowex 1-X2 resin, 100 mesh; a large column (15 mm of diameter and 250 mm long) was used.) The sample solution passed through the column and was washed with 50 ml 9 M HCl. In this stage, Pu, Fe and U were retained onto resin, whereas Am and Th were in effluents. Fe and U fractions were sequentially eluted with 8 M HNO_3. After elution of U, the column was washed with 5 ml 1.2 M HCl. Finally Pu fraction was eluted with 1.2 M HCl (100 ml) containing 2 ml of 30% H_2O_2. The solution was dried onto hot plate. The chemical yield was around 70 %.

Electrodeposition

Pu samples for α-spectrometry were electroplated onto stainless steel disks. The diameter of stainless steel disk depends on the active surface area of detectors. The electrodeposition was performed using an electrolysis apparatus with electrodeposition cell consisting of teflon cylinder, a cathode of platinum electrode and an anode of stainless steel disk.

The purified Pu fraction was dissolved in 1 mL of 2 M HCl and transferred into an electrodeposition cell using 20 mL ethanol. Pu was then electroplated onto a stainless steel disk (30 mm in diameter) at 15 V and 250 mA for 2 hours.

α-spectrometry

The α-spectrometers consist of several vacuum chambers with solid-state detectors, a pulse height analyzer and a computer system. The detector, which is silicone surface barrier type (PIPS, energy resolution: <25 keV (FWHM), counting efficiency: 15 - 25 %), has an active surface area of 450 - 600 mm^2 and a minimum depletion thickness of 100 μm. The vacuum in the chamber is less than 100 mTorr by using a vacuum pump. The counting time was more than 800000 s. Counting uncertainties (1σ) for BEAGLE samples were 10 - 20 %.

3.11.3 Analyses at Marine Environmental Laboratories (IAEA-MEL) in Monaco, Comenius University of Bratislava in Slovakia, and Risoe National Laboratory (RNL) in Denmark

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(2) Introduction

IAEA-MEL performed the radiochemical separation of samples from the Atlantic and Indian Oceans. The seawater samples were filtered (0.45 μm) and acidified on board RV Mirai and sent to Monaco. In average, the volumes received were 80 L for surface and 20 L for deeper samples. For all samples, plutonium and caesium were analyzed. Strontium was analyzed all surface samples and 4 profiles. Therefore, 3 separation processes were sequentially performed based on co-precipitation techniques. Also, selected samples were analyzed for tritium.

(3) Sample preparation

When transferring the acidified filtered sea water samples to the precipitation containers, sample volume and weight were determined. After adjusting pH to1, plutonium tracer (^{242}Pu: 1,022 dpm per sample) and carriers (caesium: 40 to 800 mg, depending on sample volume; strontium: 1 g) were added.

Pre-concentration of plutonium with manganese dioxide

After mixing of the tracer and the carriers to equilibrium, saturated $KMnO_4$ (0.5 mL per liter of sample) was added to the samples and stirred. To precipitate MnO_2, 0.5 M $MnCl_2$ (1 mL per liter of sample) was added to the sample and pH was increased to 9 with 10M NaOH. After precipitation and stirring, the pH was readjusted to 8. The precipitate was allowed to settle overnight. The supernatant was carefully siphoned and transferred to another container for the caesium separation. The MnO_2 (Pu) precipitate was poured into a beaker for further chemical separation.

Pre-concentration of caesium with ammonium molybdophosphate (AMP)

The supernatant solution was re-acidified to pH 1.5 - 2 with concentrated HCl (1 to 1.5 mL per liter of sample). Addition of a few ml of 30 % H_2O_2 was needed to dissolve a small amount of MnO_2 suspension carried over from the previous step. A slurry of AMP (0.2 g per liter of sample) in water was added and the suspension stirred for 30 minutes. The AMP was let to settle in the tank. For the subsequent precipitation of Ca(Sr) oxalate, the samples were transferred to another container. The AMP(Cs) precipitate was poured into a beaker for further chemical processing.

Pre-concentration of strontium with calcium oxalate

The strontium is co-precipitated with calcium as an insoluble oxalate from solution containing excess oxalic acid and adjusted to pH 5 - 6. As the Sr chemical recovery is estimated by X-Ray fluorescence, an aliquot of the seawater was collected kept before the Ca(Sr) precipitation. The mixed Ca(Sr) oxalate precipitation was carried out by adding an appropriate quantity of oxalic acid dissolved in very hot de-ionized water (10g per liter of sample) to the AMP(Cs) supernatant solution, mixing well and adjusting to a final pH 5 - 6 with 10M NaOH. The Ca(Sr) oxalate precipitate was let to settle overnight. Afterwards, the supernate was pumped out. The Ca(Sr) mixed oxalate precipitate was recovered from the tank bottom and transferred into a beaker for further separation.

The schematic diagram of pre-concentration of radionuclides in seawater is shown in Figure 3.11.2.

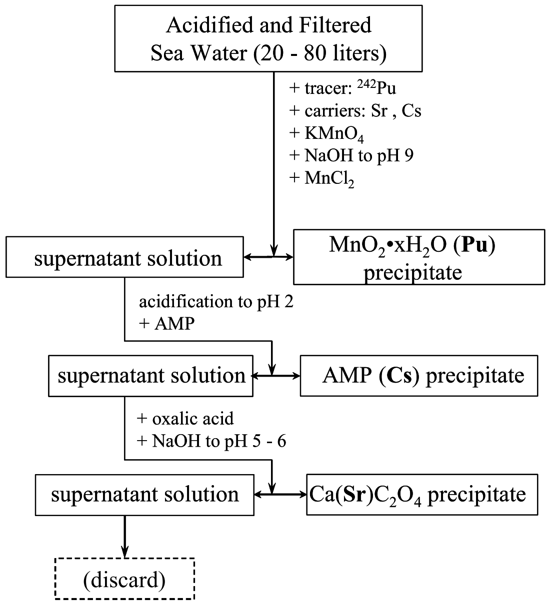

Figure 3.11.2. Pre-concentration of radionuclides in sea water.

(4) Plutonium analysis

Dissolution of manganese dioxide

After the precipitate settled in the beaker, the supernatant was siphoned out. The solution containing the MnO_2 precipitate was acidified to pH 1 and a solution of hydroxylammonium hydrochloride (NH_2OH•HCl, 0.1 g/ml) was added in small portions to the hot suspension until all of the manganese dioxide had dissolved by reduction from Mn(IV) dioxide to soluble Mn(II).

Oxidation state adjustment of plutonium

Fifty milligrams of Fe(III) were added. A few mL of NH_2OH•HCl solution were added and the manganese-iron-Pu solution was heated to reduce Fe(III) to Fe(II). The Fe(II) rapidly reduced all soluble Pu species to Pu(III). After the reduction to Fe(II) and Pu(III), 2 g of $NaNO_2$ dissolved in 20 mL of water was added to the hot solution in order to oxidize the excess NH_2OH•HCl and to convert Fe(II) and Pu(III) to Fe(III) and Pu(IV), respectively.

Iron hydroxide precipitation

NH_4OH was added to the hot solution to make the pH 8 - 9, causing precipitation of $Fe(OH)_3$ and co-precipitation of Pu(IV). The freshly precipitated iron hydroxide was flocculated by heating. After heating, the pH of the suspension was adjusted to 6 - 7 with HCl. At this pH, manganese will stay in solution but the flocculated iron hydroxide and its co-precipitated Pu(IV) remain insoluble.

The iron hydroxide (Pu) was left to settle overnight. The $Fe(OH)_3$ (Pu) was separated from the supernatant solution by siphoning and the precipitate was separated by centrifugation of the suspension left in the precipitating vessel. Hot, concentrated HCl was used to dissolve the separated iron hydroxide, including that on the wall of the precipitating beaker. Concentrated nitric acid additions and evaporations were used to convert this to a nitrate salt residue. (Figure 3.11.3)

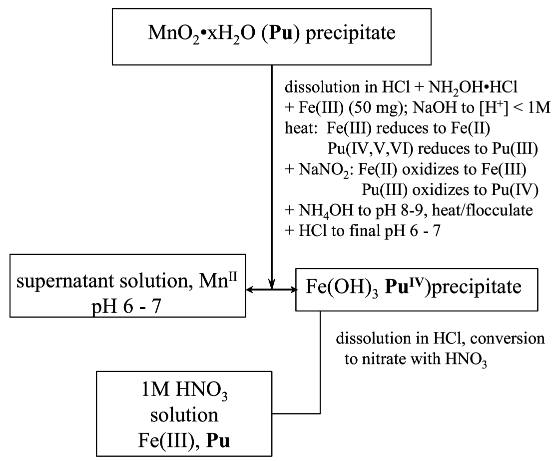

Figure 3.11.3. Dissolution and treatment of MnO_2•xH_2O (Pu) concentrate.

Preparations for Pu separation by anion exchange

The Fe(Pu) precipitate was dissolved in 1 M HNO_3 and after adding hydrazinium hydrate (1 to 2 mL). The solution was heated to facilitate the reduction of Fe(III) to Fe(II). Successful conversion of the iron to the ferrous state ensures that the dissolved Pu species are brought to their lower oxidation states of III and IV. Excess $N_2H_4 \bullet H_2O$ was destroyed by adding 70 % HNO_3 and heating the solution strongly. At this stage, Pu was in the Pu(IV) oxidation state, but this was further assured by adding $NaNO_2$ to the cooled solution and boiled. Finally, the solution was adjusted to 7 - 8 M HNO_3 with 70 % HNO_3.

Plutonium separation by column chromatography

The anion exchange resin used was analytical grade AG 1-X8, 100 - 200 mesh bead size, supplied in the chloride form from Bio-Rad. A water slurry of the resin (10 mL) was loaded into a 30 cm glass column (1 cm inner diameter). The resin was conditioned from chloride to nitrate form by passing 8 M HNO_3 (50 mL) through the resin bed.

The sample solution (7 - 8 M HNO_3) from the previous step and the rinse solution of the beaker were loaded into the column reservoir. This was followed by 50 ml of 8 M HNO_3 "wash" to rinse the feed solution thoroughly out of the column (removing non-retained species such as Am, Fe, Al, Ca, K). After this wash, 100 mL of 10 M HCl were passed through the column to elute thorium. The plutonium was eluted with freshly prepared 0.1 M NH_4I-9M HCl. The so-called "Pu strip" was collected in a beaker. This solution was evaporated down. Iodine was removed as volatile iodine (I_2) vapour by repeated additions of concentrated HNO_3 with small portions of 30 % H_2O_2. (Figure 3.11.4)

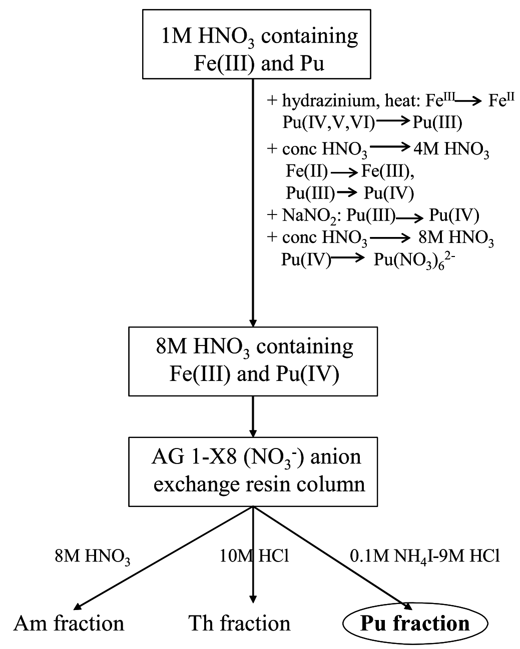

Figure 3.11.4. Separation of Plutonium by oxidation state adjustment and anion exchange chromatography.

Neodynium fluoride precipitate

Considering that Pu was to be measured by ICP-MS, it is important to efficiently remove the uranium with NdF_3 precipitations. The solution residue (Pu) was dissolved in 1 M HNO_3 and transferred to a centrifuge tube with the rinsing solution of the beaker. 10 mg of Nd (from a neodymium oxide solution) was added and a sequence of reduction-oxidation of the Pu was done by adding Mohr's salts followed by 25 % $NaNO_2$ solution. The Pu was co-precipitated as NdF_3 by adding concentrated HF (5 ml). This precipitate was centrifuged to remove the supernatant. The dissolution of the precipitate was done with 4 M HNO_3-H_3BO_3 (10 mg/ml). A second precipitation was carried out in the same conditions. Finally, after dissolution, the precipitate was conditioned in 3 M HNO_3. (Figure 3.11.5)

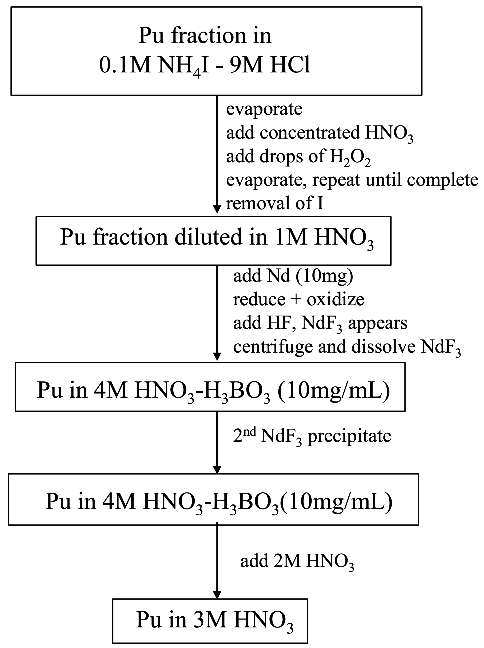

Figure 3.11.5. Separation of Plutonium by NdF_3 precipitation.

Plutonium separation by Eichrom-TEVA column

The purpose is to separate thorium traces in the solution. The pre-packed TEVA column (2 mL) was conditioned in 3 M HNO_3 and the solution was passed through it. The rinsing and following cleaning steps were processed with Ultra-Pure (UP) acids. First, thorium was eluted with 10 M HCL UP. Then Pu was eluted with a 0.1 M HCl-0.1 M HF UP solution in a Teflon beaker. (Figure 3.11.6)

Preparation of samples for ICP-MS measurements

The final solution was evaporated to dryness, treated a few times with concentrated HNO_3 UP and dried. The residue was diluted and the walls of the beaker were rinsed with 1 M HNO_3 UP. The 3 successively small volumes (0.5 mL, 0.5 mL and 0.25 mL) used were transferred to closed plastic tubes for further analysis by ICP-MS.

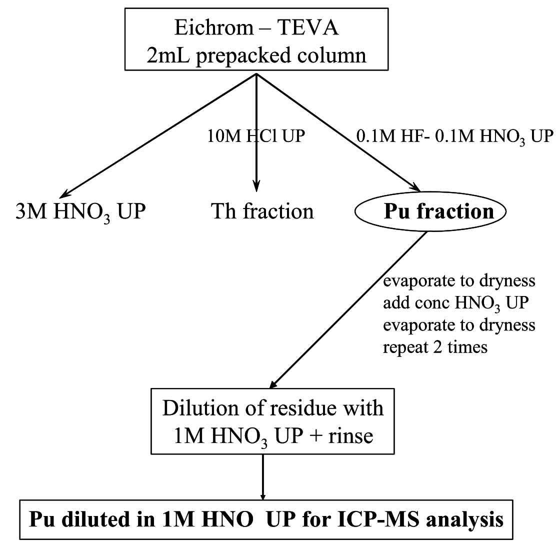

Figure 3.11.6. Plutonium separation by Eichrom-TEVA column and preparation for ICP-MS analysis.

ICP-MS analysis

Samples were analyzed using a high resolution ICP-MS at Risoe National Laboratory. An ultrasonic nebuliser was used for introduction of samples into the spectrometer. The settings of the system were as follow:

Xs- cones with Cetac USN 5000+. Heater 140 °C, cooler 3 °C

Extraction voltage –694 V

Lens 1 –1019 V

Lens 2 –69 V

Auxiliary gas 0.7 lpm

Nebuliser gas 0.92 lpm

RF power 1405 W

Hexapole bias –2 V

Sample uptake rate: 0.5 ml/min

Sensitivity ^{238}U: 4.5 MHz/ppb

Number of points per peak: 1

Dwell time: 50 ms ($^{239\&240}Pu$), 1ms (^{238}U), 2ms (^{242}Pu)

Number of sweeps: 250

Repetitions per sample: 20

Reagent blanks and reference materials were analyzed together with the seawater samples. An example of the mass spectrum obtained is shown in Figure 3.11.7.

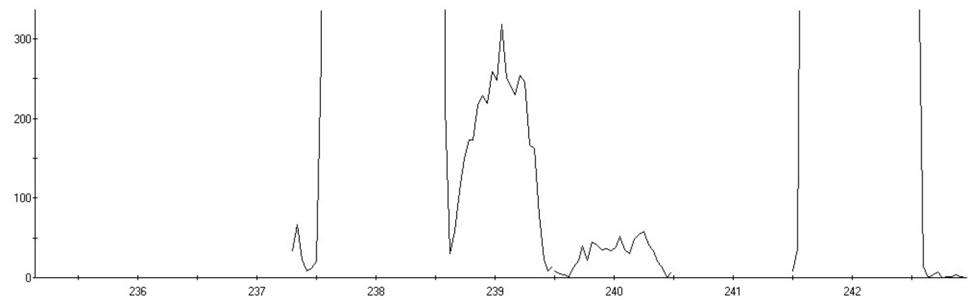

Figure 3.11.7. mass spectrum of plutonium solutions.

(5) Caesium analysis

AMP(Cs) was transferred into a beaker, decanted and the supernatant was siphoned. The AMP(Cs) was finally centrifuged. The separated AMP was dissolved in a minimum amount of 10 M NaOH. As some fine-particle suspension of MnO_2 was carried over in the supernatant solution from the first pre-concentration step (MnO_2 precipitation for Pu) and subsequently scavenged by the AMP, the insoluble fraction was separated by centrifugation. The AMP(Cs) solution in NaOH was transferred to a beaker, heated and boiled to drive off ammonia in order to minimize precipitation of AMP when the solution is re-acidified.

The boiled Cs-AMP-NaOH solution was cooled and diluted to about 500 mL with water. Concentrated HCl was added to adjust the solution to pH 2. Then, 1 g of fresh AMP was added and stirred to collect the Cs (2nd AMP-Cs precipitation). After settling and decantation, the 2nd AMP-Cs was separated by centrifugation and washed. It was again dissolved in a minimum amount of 10 M NaOH, and any eventual insoluble fraction was discarded by centrifugation. The solution was introduce into a standard geometry for gamma-ray counting. (Figure 3.11.8)

The recovery of this process was finally estimated by AAS from a small aliquot of the final solution.

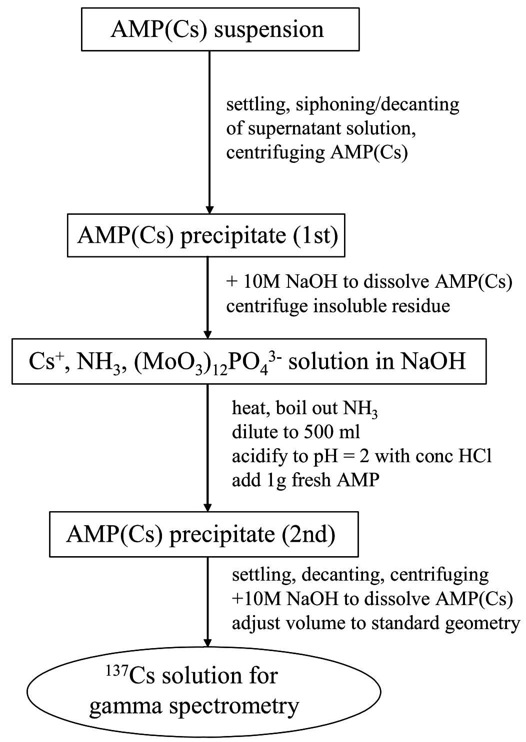

Figure 3.11.8. Caesium separation for gamma-spectrometry.

Gamma-spectrometry at IAEA-MEL

The AMP(Cs) samples were analyzed with high-purity well-type germanium detectors in the underground laboratory at IAEA-MEL. Ultra-low background is achieved by using very old lead and an anticosmic shield (Figure 3.11.9, Povinec et al., 2005). The detectors used had relative efficiencies ranging from 100 to 200 %, and ^{40}K background count rates ranging from 1 - 5 10^{-4} s^{-1}. A typical spectrum from a sample taken at 1000 m water depth is shown in Figure 3.11.10.

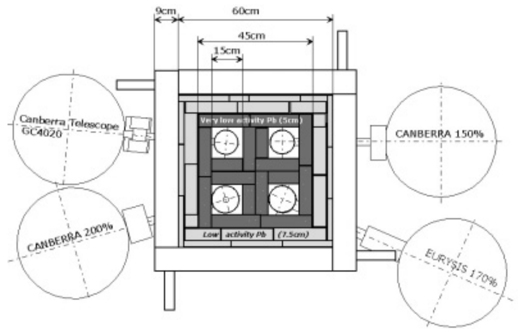

Figure 3.11.9. Schematic diagram of the IAEA-MEL underground (CAVE) facility (Povinec et al., 2005).

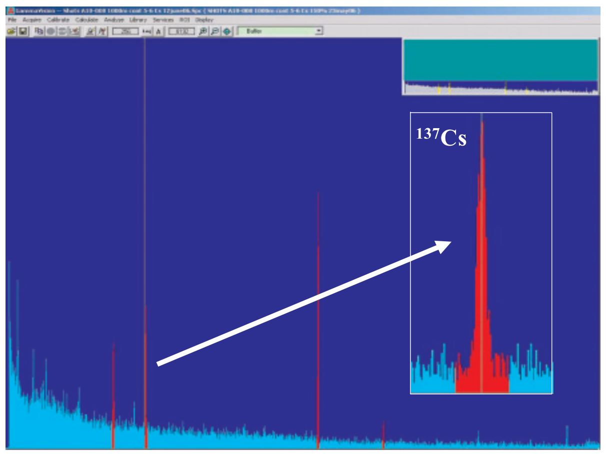

Figure 3.11.10. Gamma-ray spectrum of a sweater sample collected at 1000 m water depth in the Atlantic Ocean.

^{137}Cs gamma-ray spectrometry of seawater samples from the Indian Ocean carried out at the Comenius University of Bratislava, Slovakia

Indian Ocean seawater samples prepared in IAEA-MEL as AMP(Cs) samples were analyzed in the Comenius University of Bratislava, Slovakia. Two shields for low background gamma-ray spectrometers located at about 10 m of water equivalent were built in the Department of Nuclear Physics of the Comenius University of Bratislava, Slovakia (Figure 3.11.11; Sykora et al., 1992; Sykora et al. 2006). The larger one has the outer dimensions of 2×1.5×1.5 m. It is composed of the following layers (from the outside to the inside): 10 cm of lead, 10 cm of electrolytic cooper, 10 cm of polyethylene with boric acid, 0.1 cm of electrolytic cooper, 0.1 cm of cadmium and 1cm of perspex. On the top, a layer of 12 cm of iron is added. The inner dimensions of the shield are 80×90×172 cm. To further reduce the detector background, and to decrease the radon contribution and stabilize its content in the shield (by flushing the detector chamber with nitrogen evaporated from a cooling Dewar), an extra copper shield (12×20×30 cm) has been inserted inside the large shield (Figure 3.11.11).

Figure 3.11.11. Small (left) and large (centre and right) shields for low-level gamma-ray spectrometry constructed in the Department of Nuclear Physics of the Comenius University of Bratislava, Slovakia.

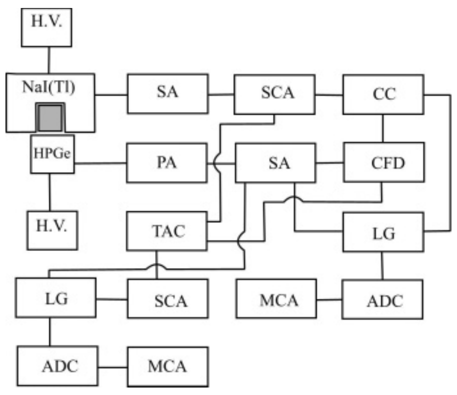

Figure 3.11.12. Schematic diagram of electronic circuits of the coincidence-anticoincidence spectrometer.

The copper has been used because of its low radioactive contamination by uranium and thorium and their decay products. A HPGe coaxial detector produced by PGT (USA) with 70 % relative efficiency (for 1332.5 keV and relative to 75×75 mm NaI(Tl) crystal) and of 270 cm^3 sensitive volume operates in this shield. The smaller shield (Figure 3.11.11) has a similar composition of layers to the large shield, however, its inner dimensions are 38×38×62 cm only.

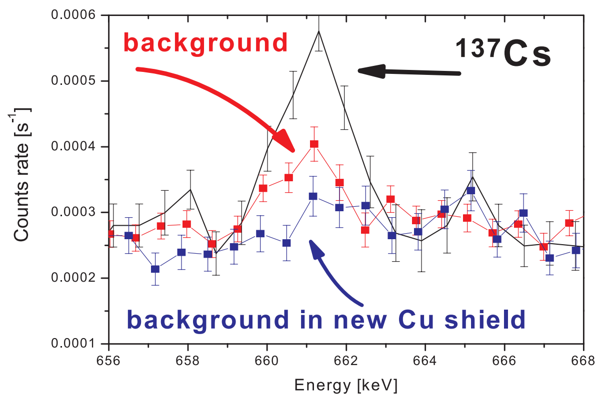

Figure 3.11.13. Comparison of background and sample counting rates in the old and in the additional Cu shield under the 661.6 keV peak of ^{137}Cs.

A HPGe coaxial detector of 50 % relative efficiency produced by Canberra (USA), or a HPGe detector of 6 % relative efficiency with Be window produced by ORTEC (USA), operates in this shield. A block scheme of electronics used for coincidence-anticoincidence measurements, anti-Compton (with NaI(Tl) well detector) and/or with anti-cosmic shielding (with plastic scintillation detector) is schown in Figure 3.11.12. A background reduction in the ^{137}Cs window after introduction of the additional copper shield into the large shield is shown in Figure 3.11.13.

Typical applications have included non-destructive analysis of natural and anthropogenic radionuclides (mainly cosmogenic ^{7}Be, radiogenic ^{210}Pb and anthropogenic ^{137}Cs) in marine and terrestrial samples.

(6) Strontium analysis

Strontium purification

The calcium oxalate suspension was allowed to settle after transferring into a large beaker. The supernatant solution was siphoned off and the precipitate was centrifuged. It was then dried and ashed at 600 °C to convert the oxalate to carbonate. The ashed sample was weighed to determine the amount of 70 % HNO_3 to be added. A volume of 70 % HNO_3 in mL equal to seven times the ash weight in grams was slowly added to the calcium-strontium carbonate ash in an appropriate beaker. Strontium nitrate (1st) precipitates from this medium while the calcium remains in solution. Barium, radium and lead are expected to accompany the strontium nitrate.

The 1st strontium nitrate precipitate was separated from the mother solution containing the dissolved calcium-strontium ash by decanting the supernatant solution after settling. Heating the strontium nitrate suspension for some hours before allowing it to settle improves the separation by producing a $Sr(NO_3)_2$ precipitate of larger crystal size. This 1st $Sr(NO_3)_2$ precipitate was transferred to a pre-weighed 150 ml beaker, then washed with three 30 - 50 mL portions of acetone to remove HNO_3 and more soluble calcium nitrate. The washed $Sr(NO_3)_2$ was dried under a heat lamp and weighed. A volume of water in ml equal to 1.5 times the weight of dried precipitate in grams was added. This precipitate of $Sr(NO_3)_2$ will easily dissolve to give a clear solution.

After the salt was dissolved, a second $Sr(NO_3)_2$ precipitate was obtained by adding a volume of 70 % HNO_3 equal to ten times the volume of water used to dissolve the salt. This 2nd $Sr(NO_3)_2$ was separated by decantation of the supernatant liquid and washed again with small portions of acetone. After drying and weighing, the dissolution, concentrated nitric acid addition and acetone washings steps were repeated to give a 3rd $Sr(NO_3)_2$ precipitate.

Further purification of the Sr from barium, radium and lead contaminants was performed by a Ba chromate precipitation from an acetate-buffered solution at pH 5. A final clean-up of the Sr from ingrown Y-90 and some other possible beta-emitting radionuclides (e.g., Bi-210) was made by an iron hydroxide scavenge using 10 - 50 mg of Fe(III) and concentrated ammonia to pH 9. The iron hydroxide precipitate was centrifuged off and the Sr-acetate-chromate solution was acidified with concentrated HCl to pH 1. The purified Sr fraction was diluted with 0.1 M HCl. The chemical recovery of the Sr was determined by X-Ray fluorescence on a sample aliquot.

Milking of ^{90}Y from the purified strontium fraction

This step consists in the separation of the produced ^{90}Y from the ^{90}Sr contained in the solution. For that reason, an ingrowth period of 2 - 3 weeks was allowed before separation of the ^{90}Y. Then, the Sr solution was transferred to a beaker. An accurately known amount of yttrium carrier (10 mg) was added and the solution was evaporated down to 20 ml. The solution was transferred to a centrifuge tube, 1 g of NH_4Cl was dissolved in it and concentrated NH_4OH was added to pH 9 to precipitate yttrium hydroxide. The supernatant solution was decanted away from the Y hydroxide precipitate. The time at which the decantation occurred was noted as the Y-Sr separation time.

After the Y hydroxide dissolution with concentrated HCl, the solution was diluted to 25 mL, and 1 g of NH_4Cl was dissolved in it. Ten mg of stable Sr holdback carrier were added and a second mixed Y hydroxide was precipitated with NH_4OH. The flocculated precipitate was centrifuged and the supernatant solution was decanted. This 2nd Y hydroxide was dissolved in concentrated HCl, diluted and filtered through a membrane filter to remove any insoluble material.

To the Y solution, 0.5 g of oxalic acid was added, the solution was heated and a white yttrium oxalate was precipitated by the addition of NH_4OH to pH 1.5 - 2. This preliminary yttrium oxalate is separated from the solution by filtration through a membrane filter. Then it was dissolved by treatment with concentrated HCl and passed through the filter with rinses into a 100 ml beaker. The final yttrium oxalate precipitate was obtained from 40 - 50 mL of hot solution by dissolving 0.1 g of oxalic acid and adding concentrated ammonia until pH 1.5 - 2. The yttrium oxalate was digested for about 30 minutes to obtain a crystalline form. Then it was filtered onto a pre-washed, pre-weighed 0.2 μm polysulfone membrane filter (22 mm diameter, Gellman Sciences, Inc.). The yttrium oxalate was washed with 0.5 % ammonium oxalate solution and 80 % ethanol.

The final filtered yttrium oxalate was dried in a 70 °C oven for ca. 30 minutes and weighed to determine the yttrium chemical recovery from the stable weighing form of $Y_2(C_2O_4)_3 \cdot 9\ H_2O$ (10 mg of Y gives 34 mg of yttrium oxalate). Then, the yttrium oxalate-loaded filter was mounted to fit in a Risoe GM-25-5 Beta Multicounter System (Riso National Laboratory, Roskilde, Denmark), a gas-flow proportional counter with anti-coincidence background reduction. Counting generally starts 6 to 8 hours after the Y-Sr separation time. The measured beta-activity decay curve must be consistent with the known 64 hour half-life of ^{90}Y which indicates the high radiochemical purity of the yttrium sources.

(7) Tritium analysis

One liter seawater samples were collected in plastic bottles, tightly sealed and transferred to MEL for storage before analysis. Samples were then sent to Dr. Jurgen Sültenfuß, , University of Bremen, for analysis in the Bremen Mass Spectrometric Facility for tritium analysis using the He-3 ingrowth method (Figure 3.11.14, Sültenfuß et al., 2005). For ingrowth of tritiugenic ^3He in the laboratory, typically 500 mL are sucked into an evacuated 1-L soda-glass bulb. The contained helium is removed (to < 10^{-6} of solubility equilibrium concentration) by flushing the head space with water vapour under heavy shaking for 30 min, where after the bulb is flame sealed. The shaking ensures timely escape of dissolved helium into the head space. The flushing (50 mL/s) is enforced by pumping through a capillary connection that regulates the flow, and, together with a narrowing in the bulb's head tubing, prevents any diffusion back into the bulb; the resulting water loss amounts to about 2 g, so that isotopic tritium fractionation remains negligible. Beforehand, the bulb's walls are made helium-free by heating the bulb in vacuo to 400 °C for 24 hours. After typically a six-month storage, enough tritiugenic ^3He has been generated to obtain a tritium detection limit of 10 mTU. Any ^3He other than tritiugenic is corrected for using a concurrent measurement of ^4He (the ^3He / ^4He ratio is approximately the atmospheric one). That correction is a prerequisite for precise measurement of the minute amounts of tritiugenic ^3He produced.

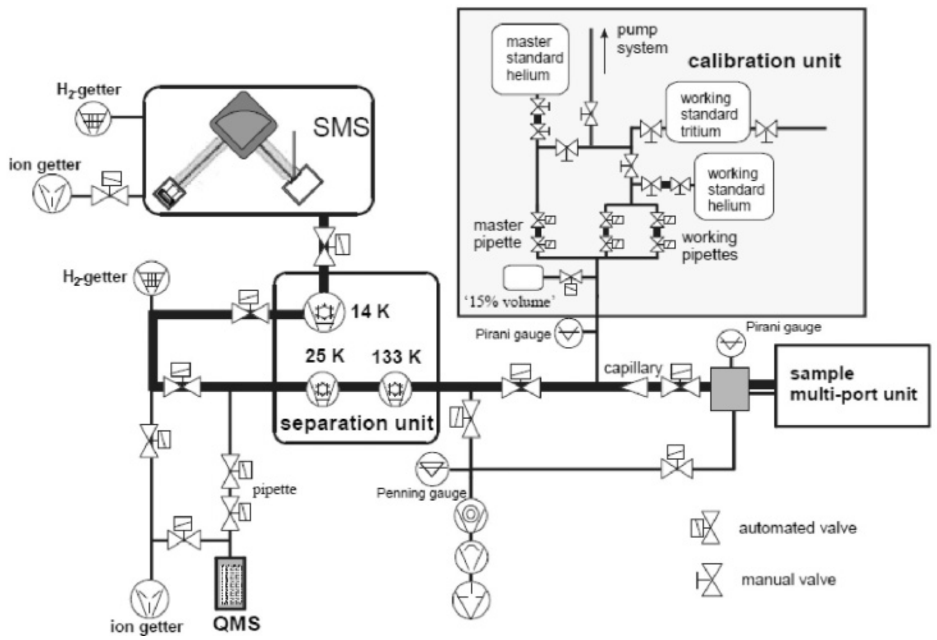

Figure 3.11.14. Scheme of the mass spectrometry system used for tritium analysis (Sültenfuß et al., 2005).

3.11.4 Analyses at Korean Institute of Nuclear Safety (KINS) in South Korea

C. S. Kim (KINS)

(1) Personnel

C. S. Kim: Korean Institute of Nuclear Safety (KINS)

(2) Sample preparation

Iron hydroxide precipitation

Weight of the acidified and filtered seawater was determined and poured into the seawater treatment cistern, and then 30 mg of Fe^{3+} carrier added. After stirring for 1 hour, Pu was co-precipitated with $Fe(OH)_3$ by addition of NH_4OH up to pH 8-9. $Fe(OH)_3$ precipitate was collected with 5 L beaker and then heated until boiling on a hot plate. With heating, the pH of suspension was re-adjusted to pH 8 with HCl. After cooling, supernatant was discarded by decantation and the $Fe(OH)_3$ was recovered on a glass fiber filter by suction filtration, and then the precipitate was dissolved with conc. HCl. The dissolved solution was dried on a hot plate and then dissolved with 12 mL 5 M HNO_3. The solution was filtered with a membrane filter (0.45 μm) and then the oxidation state of Pu was adjusted according to next procedure prior to loading to an on-line automated separation system.

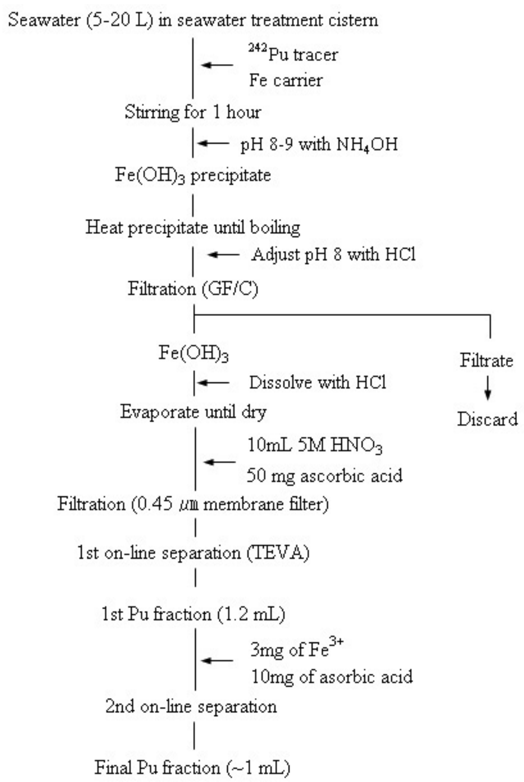

Figure 3.11.15. Pre-treatment of seawater for Pu chemical purification.

Adjustment of oxidation state of plutonium

The oxidation state of Pu in the loading solution was kept to +4 oxidation state by dissolving with 5 M HNO_3 and extra high oxidation state (VI) was reduced to (IV) by the treatment of ascorbic acid. The loading solution was treated with ascorbic acid for at least 20 minutes before loading to on-line separation system.

(3) Chemical purification

Plutonium purification by on-line separation

Chemical separation was carried out by on-line automated purification system as shown schematically in Figure 3.11.15, which is developed by Kim *et* al. (2002). The on-line automated purification process consist of 10 purification steps including the sample loading, rinsing and elution, which is described in Table 3.11.6. The 5 M HNO_3, 1 M HNO_3 and 9 M HCl solutions were used to remove U, Th and bulk matrix elements in sample solution, which were injected into TEVA-Spec resin by two peristaltic tubing pumps. Separation column (3 mm i.d. × 25 mm long) of borosilicate column (Omnifit, Cambridge, England) packed with TEVA resin (Eichrom Industries, Inc., Darien, IL, USA) was installed in the on-line purification system.

To minimize the interference effect of ^{238}U on 239 m/z, the 1st purified Pu fraction was treated once more by the 2nd on-line purification procedure. The 2nd separation is the same as that of the 1st separation process. To adjust matrix and oxidation state of Pu, 3 mg of Fe^{3+} carrier, 1.2 mL 10 M HNO_3, 10 mg of ascorbic acid and 2.6 mL 5 M HNO_3 were sequentially added to the 1st Pu fraction. Approximately 5 mL 5 M HNO_3 was injected into the 2nd on-line purification system.

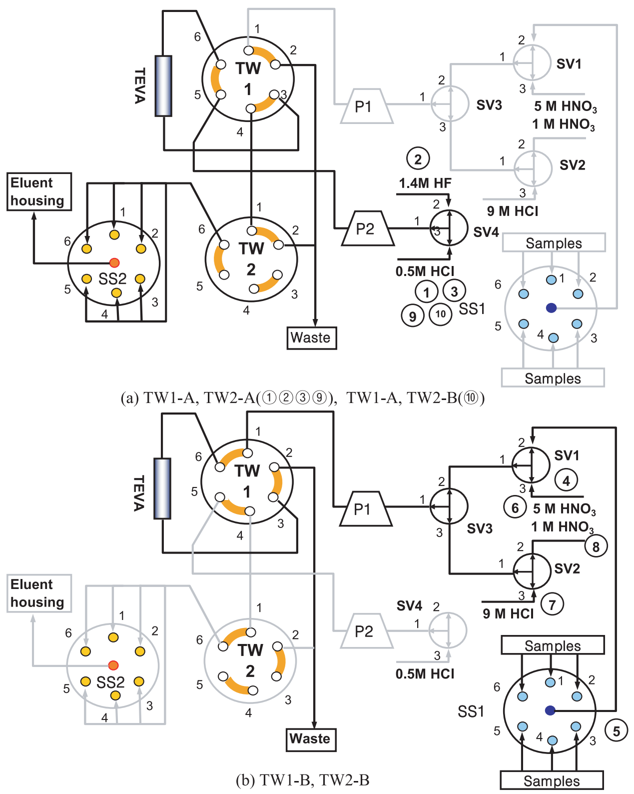

Figure 3.11.16. Schematic diagram of the on-line separation system for Pu isotopes. P1 and P2, peristaltic pump; SS1 and SS2, six-fort solvent selector; TW, two-way valve; SV1 ~ SV4, isolation valve. The circled numbers indicate the procedure order, as described in Table 3.11.6.

Table 3.11.6. Description of sequential separation steps in on-line automated purification for Pu.

Step	Pumped medium	two-way 6 port valve 1	two-way 6 port valve 2	Flow rate/ ml min^{-1}		SV1	SV2	SV3	SV4	Time/s
				Pump1	Pump2					
1	0.5 M HCl	2	1	0	0.83	-	-	-	Bottom	40
2	1.4 M HF	2	1	0	0.83	-	-	-	Top	90
3	5 M HNO_3	1	2	1.6	0	-	-	-	Bottom	50
4	5 M HNO_3	1	2	1.6	0	Bottom	-	Top	-	240
5	5 M HNO_3	1	1	1.6	0	Top	-	Top	-	700
6	5 M HNO_3	1	2	1.6	0	Bottom	-	Top	-	240
7	9 M HCl	2	1	0	0.83	-	Bottom	Bottom	-	100
8	1 M HNO_3	1	1	1.6	0	-	Top	Bottom	-	160
9	0.5 M HCl	2	1	0	0.83	-	-	-	Bottom	6
10	0.5 M HCl	2	2	0	0.83	-	-	-	Bottom	75

	Description of step
1	0.5 M HCl is pumped through resin to rinse residual elements.
2	1.4 M HF is pumped through resin to rinse residual elements.
3	0.5 M HCl is pumped through resin to fill the eluent line and exchange HF solution
4	5 M HNO_3 is pumped through column to pre-treat resin at 1.6 ml min^{-1}.
5	Sample is loaded to TEVA-Spec at 1.6 ml min^{-1}.
6	5 M HNO_3 is pumped to rinse residual sample and interference materials.
7	9 M HCl is pumped through resin to clean Th in resin.
8	1 M HNO_3 is pumped to rinse residual U.
9	0.5 M HCl is pumped through TEVA-Spec to elute Np at 0.83 ml min^{-1} for 6 seconds until 0.5 M HCl reach the two-way valve.
10	About 1.1 ml 0.5 M HCl is pumped to elute Np and Pu on TEVA-Spec.

(4) ICP-MS analysis

Sample was measured by ICP-SF-MS, a PlasmaTrace 2 (Micromass, Manchester, UK), under the optimum sensitivity and stability. Approximately 1 mL of final Pu fraction was injected into plasma by an Aridus desolvating introduction system (Cetac Technologies, Omaha, NE, USA) involving a T1-H microconcentric nebulizer. The Pu isotopes (^{239}Pu, ^{240}Pu, ^{242}Pu) and ^{238}U were measured three times in peak hopping mode. The details of operation condition used for ICP-SFMS and the sample introduction system are described in Table 3.11.7. To increase integrated count, eluent completely used up and sample was measured three runs to get relative standard deviation. Sample blank was positioned in the first row before samples and ^{242}Pu standard solutions were finally measured to check the chemical recovery. An example of the mass spectrum for Pu isotopes and ^{238}U obtained by ICP-SF-MS is shown in Figure 3.11.17. The concentration of Pu isotopes was calculated base on the isotope dilution analysis (IDA) using following equation.

$$C \pm \sigma_c = \left[(R_s - R_t) \pm \sqrt{(\sigma_{R_s})^2 + (\sigma_{R_t})^2} \right] \frac{T}{W}$$

C : Concentration of ^{239}Pu or ^{240}Pu (pg/g)

R_s : ($[^{239}Pu]_s - [^{239}Pu]_b$)/($[^{242}Pu]_s - [^{242}Pu]_b$) or

($[^{240}Pu]_s - [^{240}Pu]_b$)/($[^{242}Pu]_s - [^{242}Pu]_b$)

R_t : ($[^{239}Pu]_t - [^{239}Pu]_b$)/($[^{242}Pu]_t - [^{239}Pu]_b$) or

($[^{240}Pu]_t - [^{240}Pu]_b$)/($[^{242}Pu]_t - [^{242}Pu]_b$)

s ; sample, b ; blank sample, t ; tracer (^{242}Pu)

$[^{239}Pu]$, $[^{240}Pu]$, $[^{242}Pu]$: ^{239}Pu , ^{240}Pu, ^{242}Pu count rate (cps)

T : Amounts of tracer added (^{242}Pu) (pg)

W : Sample amounts (g)

σ_c : ^{239}Pu or ^{240}Pu standard deviation (pg/g)

σ_{Rs} : $[^{239}Pu]_s/[^{242}Pu]_s$ or $[^{240}Pu]_s/[^{242}Pu]_s$ standard deviation of sample

σ_{Rt} : $[^{239}Pu]_t/[^{242}Pu]_t$ or $[^{240}Pu]_t/[^{242}Pu]_t$ standard deviation of tracer

Table 3.11.7. Operation condition of ICP-SF-MS (PT2).

ICP and interface				
RF power, W	1350			
Coolant gas flow, L/min	14			
Auxiliary gas flow, L/min	2.2			
Carrier gas flow, L/min	1.1			
Expansion chamber pressure, mbar	1.6			
Aridus				
Sweeping gas flow. L/min	2.4			
Spray chamber temp., °C	80			
Membrane desolvator temp., °C	160			
Sample uptake rate, mL/min	0.1			
Type of nebulizer	T1			
date acquisition				
Element	^{238}U	^{239}Pu	^{240}Pu	^{242}Pu
Mass range, amu	237.8 - 238.6	238.4 - 239.6	239.4 -240.6	241.4 - 242.6
Dwell time, ms	7	60	120	15
Width Points	100	100	100	100
Peak widths	1.7	1.6	1.6	1.8
Sweep no.	3			
Runs	3			
Resolving Power	430			
Total analysis time, s/sample	3.57	28.8	57.6	8.1

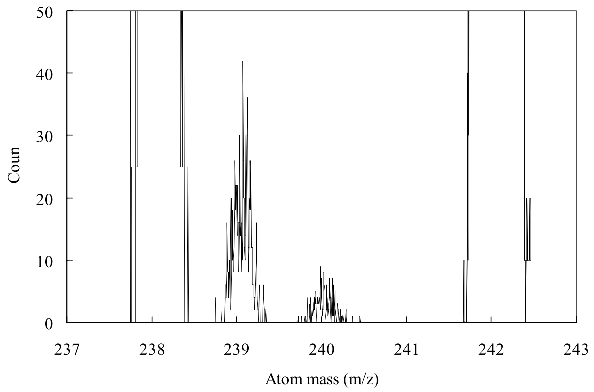

Figure 3.11.17. Mass spectrum of plutonium isotopes and ^{238}U in deep (600 meter) seawater.

3.11.5 Preliminary results of ^{137}Cs and Pu isotopes in the surface layers

M. Aoyama (MRI), M. Eriksson (IAEA-MEL), J. Gastaud (IAEA-MEL), K. Hirose (MRI, LLRL), Y. Hamajima (LLRL), C. S. Kim (KINS), K. Komura (LLRL), I. Levy-Palomo (IAEA-MEL), P. P. Povinec (Comenius Univ. of Bratislava), S. Rezzoug (IAEA-MEL), P. Ross (RNL), J. A. Sanchez-Cabeza (IAEA-MEL), and I. Sykora (Comenius Univ. of Bratislava)

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(2) Preliminary results of ^{137}Cs along the BEAGLE lines

^{137}Cs concentrations in surface waters in the mid latitude region of the Southern Ocean along P06, A10 and I03/4 lines are shown in Figure 3.11.18. Those were in the range from 0.1 to 2.3 Bq m^{-3}, which is no significant difference with that in the North Pacific mid-latitude region (Aoyama et al., 2004, 2006; Povinec et al., 2003). Large ^{137}Cs concentration gradients, with high values in the North Pacific mid-latitude region, and low ones in the South Pacific were observed in the 1970s and 1980s (Bowen et al., 1980; Hirose and Aoyama, 2003).

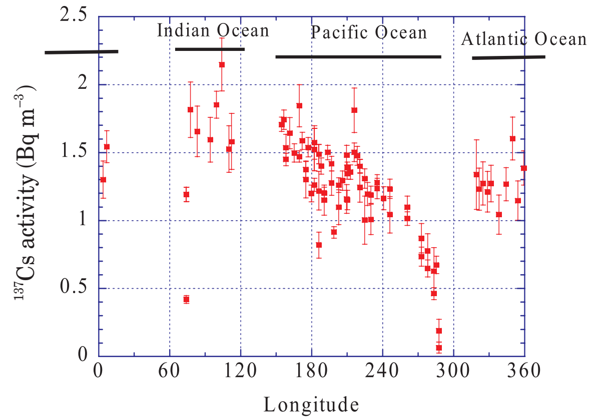

Figure 3.11.18. ^{137}Cs concentration in the surface layers, surface and 100 m depth, along BEAGLE lines in 2003/2004.

The high density ^{137}Cs data revealed a typical longitudinal distribution as shown in Fig. 3.11.18, which depends on sea areas. In the Pacific Ocean, the ^{137}Cs concentrations in the Tasman Sea, 155 deg. E to 180 deg. E, ranged from 1.37 to 1.74 Bq m^{-3}, showing higher values compared with that in the subtropical gyre in the South Pacific. In the Tasman Sea, the ^{137}Cs concentrations gradually decreased from west to east, which corresponds from upstream and downstream of East Australian Current System (EAC), respectively. The surface ^{137}Cs concentration was high in the upstream of EAC and low in the downstream of EAC. In the subtropical gyre, there was no longitudinal gradient of the surface ^{137}Cs concentrations, which ranged from 0.91 to 1.53 Bq m^{-3}, although the surface ^{137}Cs levels varied spatially. In the Eastern South Pacific, the ^{137}Cs concentrations, ranged from 0.07 to 1.14 Bq m^{-3}, showing lower values than that in the Tasman Sea and subtropical gyre.

In the Indian Ocean, the ^{137}Cs concentrations ranged from 1.5 to 2.2 Bq m^{-3}, showing higher values compared with that in the Southern Hemisphere. The ^{137}Cs concentrations in the Mozambique Channel ranged from 0.4 to 1.2 Bq m^{-3}, showing lower values than those in the Indian Ocean and Tasman Sea.

In the Atlantic Ocean, the ^{137}Cs concentrations ranged from 1.1 to 1.6 Bq m^{-3}, showing similar with that in the subtropical gyre in the Pacific Ocean.

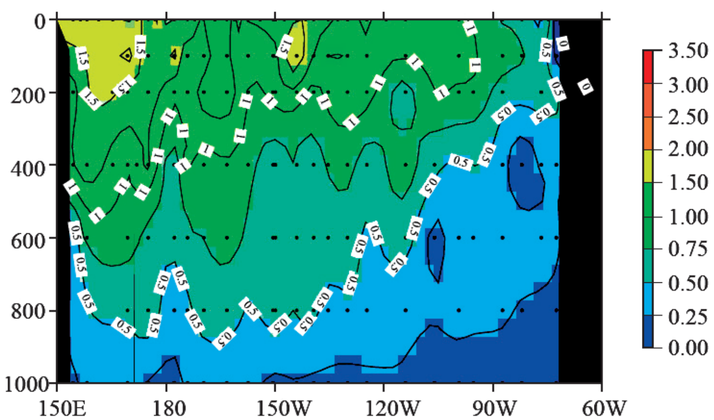

Figure 3.11.19. ^{137}Cs section in the surface layers, surface - 1000 m depth, along P6 line.

The ^{137}Cs concentrations in the layers between the surface to 1000 m depth are shown in Figure 3.11.19.

As well as the general trend of ^{137}Cs concentration in the surface layers (Figure 3.11.18), the ^{137}Cs concentrations in the Tasman Sea was higher than 1.5 Bq m^{-3} between surface to 200 m depth, showing higher values than those in the subtropical gyre and the Eastern South Pacific. The ^{137}Cs concentrations in the layers between surface to 200 m depth ranged from 1.0 to 1.5 Bq m^{-3} in the subtropical gyre and it decreased rapidly in the Eastern South Pacific. This tendency that ^{137}Cs decreased from west to east in general is observed for the depths between the surface to 1000 m depth throughout the Pacific sector.

(3) Preliminary results of Pu isotopes along the BEAGLE lines

$^{239,240}Pu$ concentrations in surface water in the mid-latitudes of the South Pacific were in the range of 0.5 to 4.1 mBq m^{-3}. The surface $^{239,240}Pu$ in the South Pacific was the same order of magnitude as that in the subtropical gyre in the North Pacific (1.5 to 9.2 mBq m^{-3}) (Hirose et al., 2001, 2006; Povinec et al., 2003; Yamada et al., 2006). The observation of the current surface $^{239,240}Pu$ concentrations suggests that there has not been a marked inter-hemisphere distribution in the Pacific, although rather large spatial variation of surface $^{239,240}Pu$ concentration has been observed.

Close sampling spacing revealed that the surface $^{239,240}Pu$ concentration shows a different longitudinal distribution from that of ^{137}Cs (seen in Fig. 3.11.18). The $^{239,240}Pu$ concentrations in the Tasman Sea, ranged from 1.0 to 2.9 mBq m^{-3}, showed a similar longitudinal distribution as did ^{137}Cs. In the subtropical gyre, there was no longitudinal gradient of the surface $^{239,240}Pu$ concentrations, which ranged from 0.8 to 4.1 mBq m^{-3}, although peaks of the higher $^{239,240}Pu$ concentrations were observed near 165 °W and 135 °W. In the Eastern South Pacific, the surface $^{239,240}Pu$ concentrations which ranged from 0.5 to 3.2 mBq m^{-3}, showed a larger variation than that in the Tasman Sea and subtropical gyre. The surface $^{239,240}Pu$ concentrations in the mid-latitude region of the South Pacific broadly decreased from west to east.

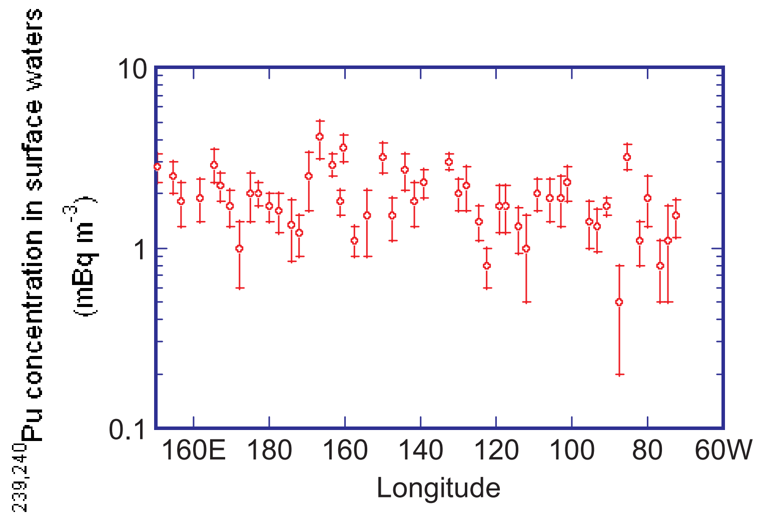

Figure 3.11.20. ^{239,240}Pu concentration in the surface layers along P6 line.

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4. Errata and Updated Data of the Data Books Volume 1 and 2

4.1 Errata in the documents

Coefficients of Note 2 in Figure caption of Volume 2 (p. 91) should be corrected as follows.

$a_0 = 6.4409$, $b_0 = -3.9577e-4$, $a_1 = 4.3830$, $b_1 = 6.3317e-4$

4.2 Mistakes in the figures

In Figures 14, 15 and 16 in Volume 2 (vertical sections for dissolved inorganic carbon, total alkalinity and pH), data with quality flags of 6 (mean of replicate measurements) were not included.

4.3 Updates in the data files

(1) FLUOR in the CTD data

Flags for FLUOR in the CTD exchange format files were wrong (flags for CTDOXV were set by mistake) and corrected.

(2) pH

Reporting precision for pH increased from F7.3 to F7.4 (FORTRAN format).

(3) Total alkalinity and dissolved inorganic carbon

Following flags and a value for carbon related parameters were revised.

EXPOCODE	STNNBR	CASTNO	SAMPNO	PARAMETER: Change
49MR03K04_1	172	1	4	ALKALI_FLAG_W: 2 -> 3
49MR03K04_1	172	1	1	ALKALI_FLAG_W: 2 -> 3
49MR03K04_1	X15	1	6	ALKALI_FLAG_W: 2 -> 3
49MR03K04_1	150	1	16	ALKALI_FLAG_W: 2 -> 3
49MR03K04_1	137	1	1	ALKALI_FLAG_W: 2 -> 3
49MR03K04_2	95	1	1	ALKALI: 2291.3 -> 2381.2
49MR03K04_2	59	1	33	ALKALI_FLAG_W: 2 -> 3
49MR03K04_2	59	1	14	ALKALI_FLAG_W: 2 -> 3
49MR03K04_2	47	1	27	ALKALI_FLAG_W: 2 -> 4
49MR03K04_2	11	1	9	TCARBN_FLAG_W: 2 -> 3
49MR03K04_4	7	1	17	ALKALI_FLAG_W: 2 -> 3
49MR03K04_4	9	1	19	ALKALI_FLAG_W: 2 -> 3
49MR03K04_4	11	1	19	ALKALI_FLAG_W: 2 -> 3
49MR03K04_4	11	1	15	ALKALI_FLAG_W: 6 -> 3
49MR03K04_4	X17	1	13	ALKALI_FLAG_W: 2 -> 4
49MR03K04_4	18	1	16	TCARBN_FLAG_W: 2 -> 3
49MR03K04_4	27	1	32	TCARBN_FLAG_W: 2 -> 3
49MR03K04_4	27	1	12	ALKALI_FLAG_W: 2 -> 3
49MR03K04_4	33	1	1	ALKALI_FLAG_W: 2 -> 3
49MR03K04_4	38	1	22	ALKALI_FLAG_W: 2 -> 3
49MR03K04_4	38	1	15	ALKALI_FLAG_W: 6 -> 3
49MR03K04_4	38	1	3	ALKALI_FLAG_W: 2 -> 4

4.4 Planned updates

In the future, data of total organic carbon (TOC) will be available through our web site: http://www.jamstec.go.jp/iorgc/ocorp/data/beagle2003/index.html. In addition, data of the artificial radionuclides will be updated.

Figure captions

Figure 1 Observation lines for WHP P6, A10 and I3/I4 revisit in Blue Earth Global Expedition 2003 (BEAGLE2003) with bottom topography based on ETOPO5 (Data announcement 88-MGG-02,1988).

Figure 2 Station locations for WHP P6, A10 and I3/I4 revisit in BEAGLE2003 with bottom topography based on Smith and Sandwell (1997).

Figure 3 CFC-11 (CCl_3F ; pmol kg^{-1}) cross section. Data with quality flags of 2 and 6 were plotted. Vertical exaggeration of the 0-6,500 m section is 1000:1. Expanded section of the upper 1000 m is made with a vertical exaggeration of 2500:1.

Figure 4 Same as Figure 3 but for CFC-12 (CCl_2F_2 ; pmol kg^{-1})

Figure 5 Same as Figure 3 but for Δ^{14} C of dissolved inorganic carbon (‰).

Figure 6 Same as Figure 3 but for δ^{13} C of dissolved inorganic carbon (‰).

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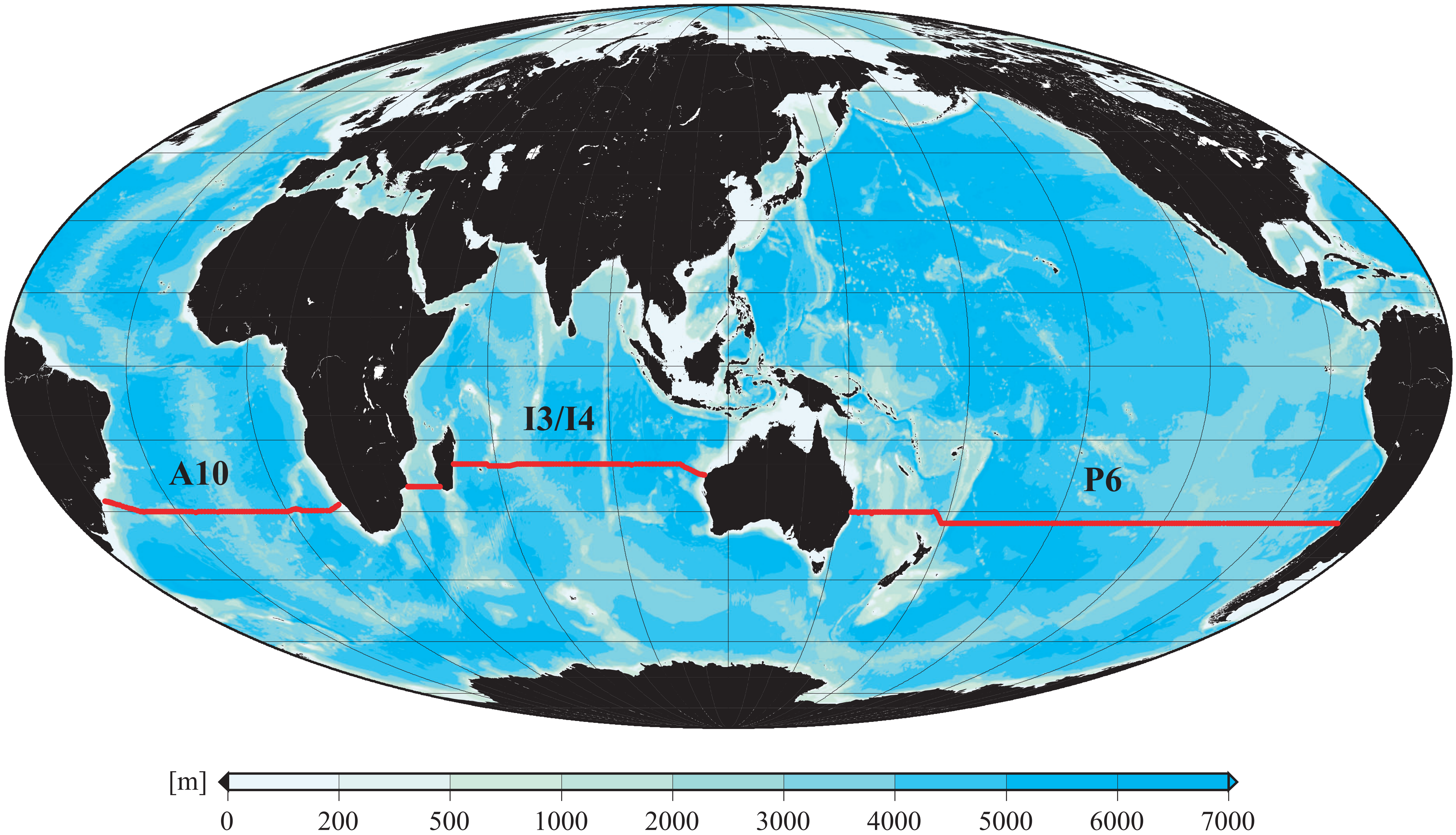
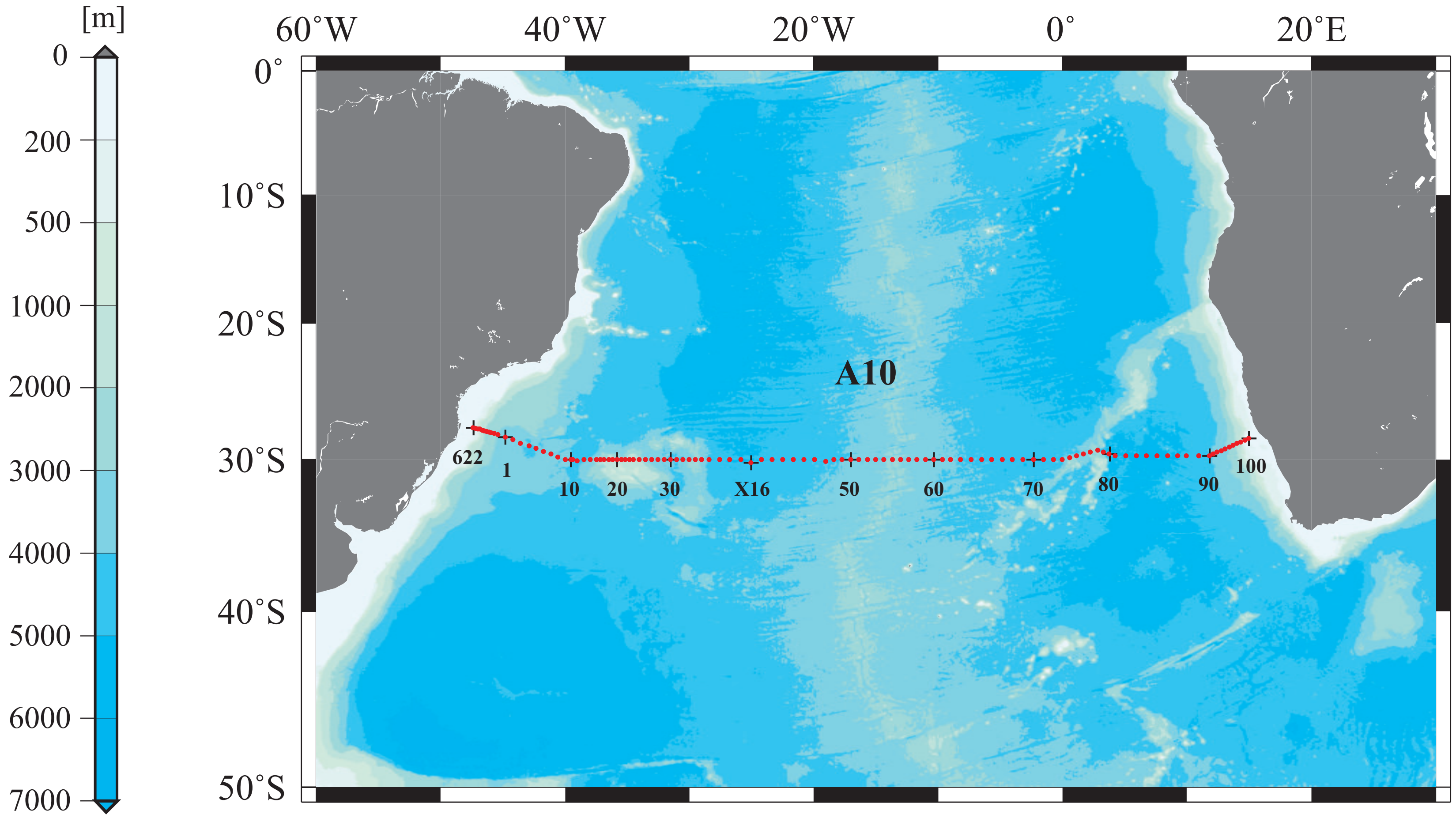
Figure 1

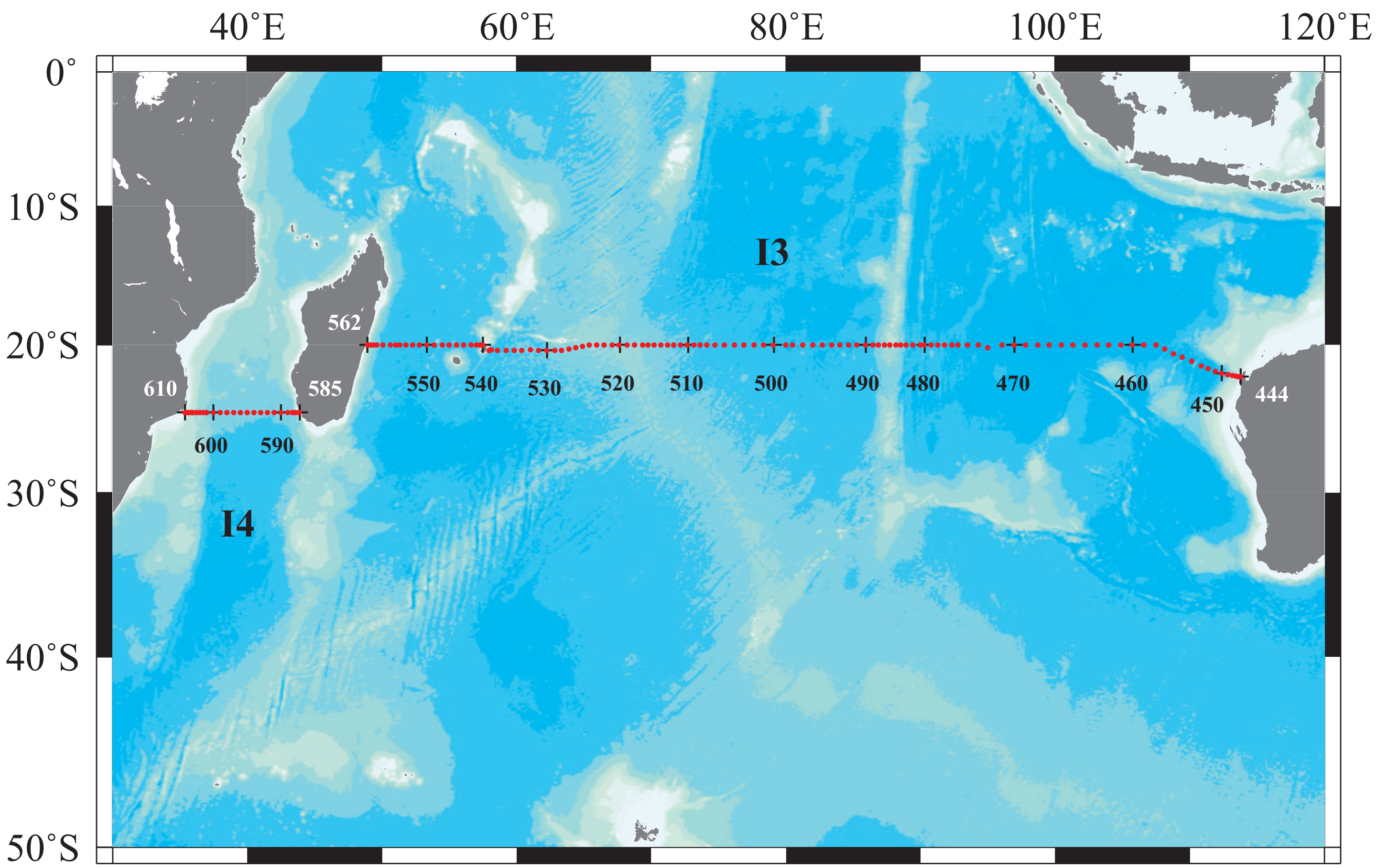


OBSERVATION LINES FOR WHP P6, A10, I3/I4 REVISIT IN 2003

Figure 2

STATION LOCATIONS FOR WHP P6, A10, I3/I4 REVISIT IN 2003





40˚E
60˚E
80˚E
100˚E
120˚E
0˚
10˚S
20˚S
30˚S
40˚S
50˚S
I3
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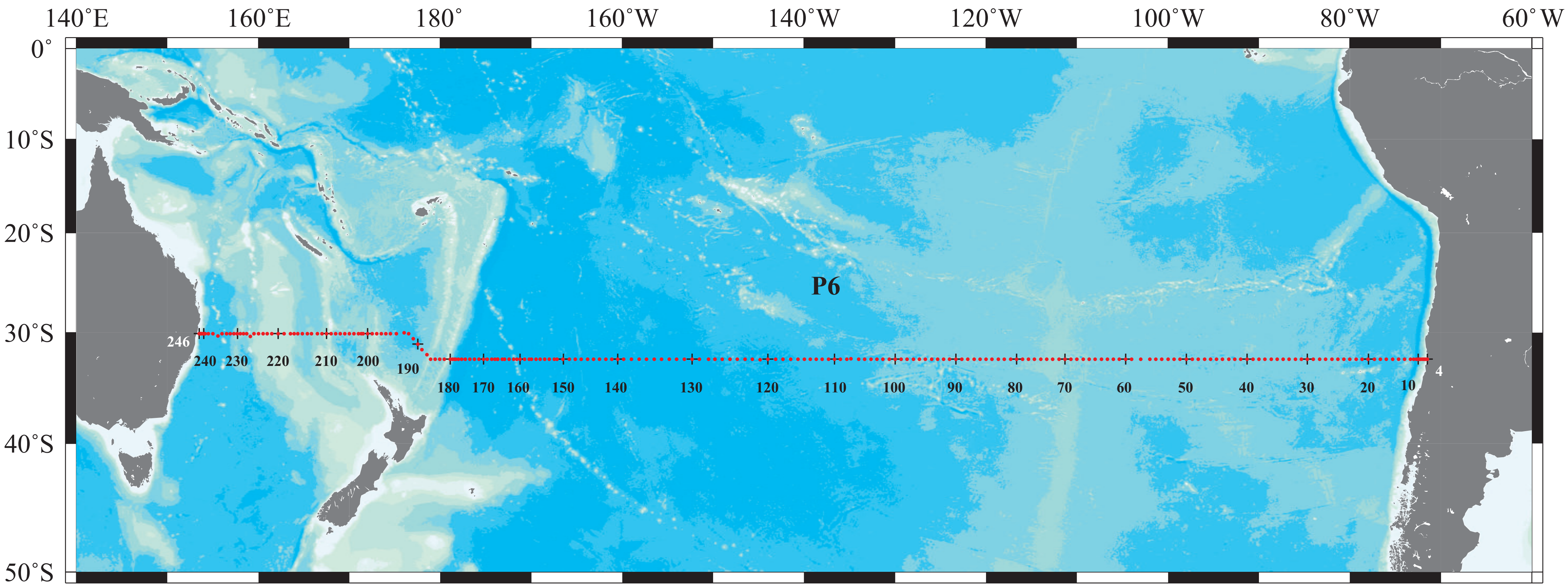
480
470
460
450
444



140°E
160°E
180°
160°W
140°W
120°W
100°W
80°W
60°W
0°
10°S
20°S
30°S
40°S
50°S
P6
246
240
230
220
210
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190
180
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160
150
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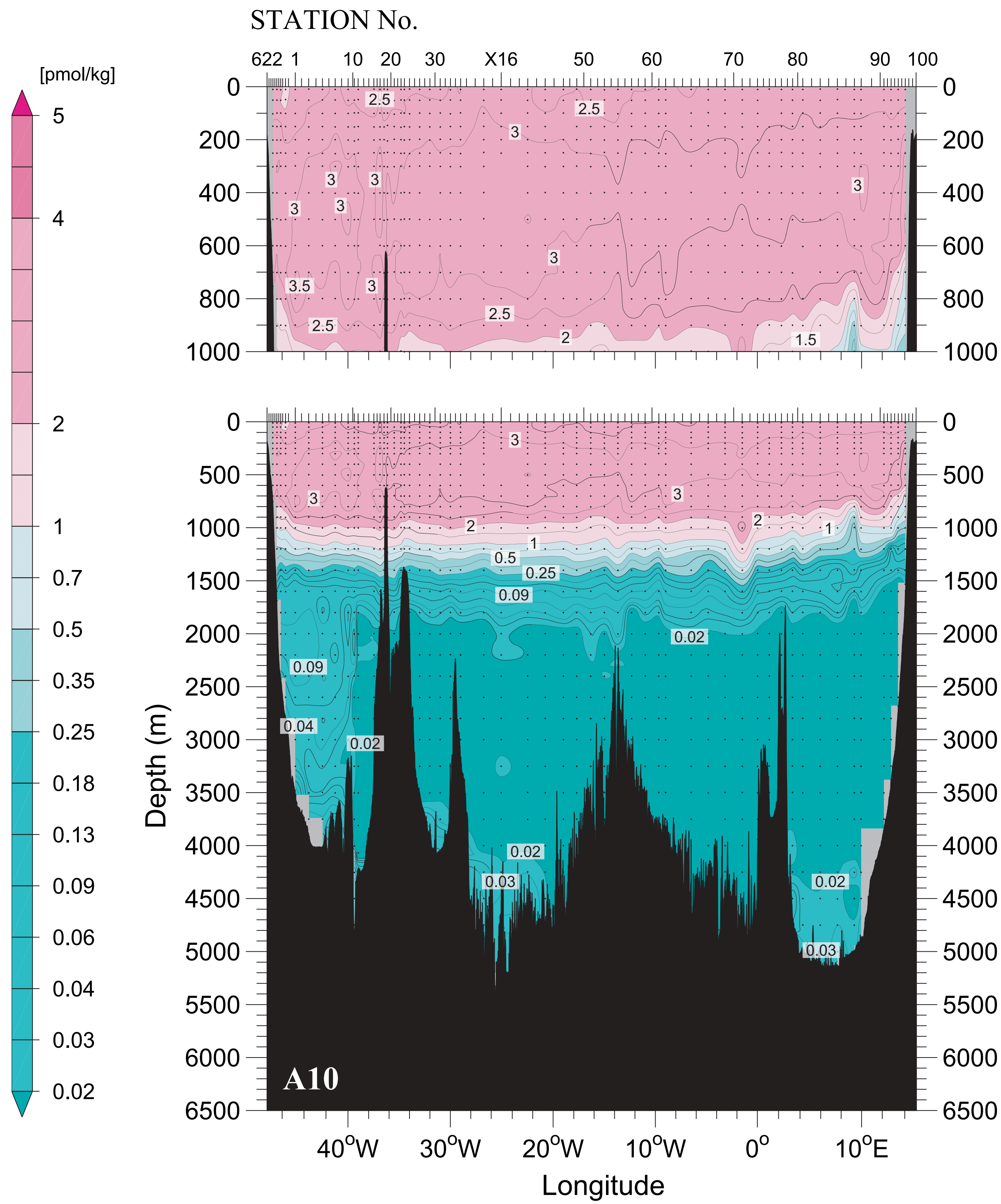
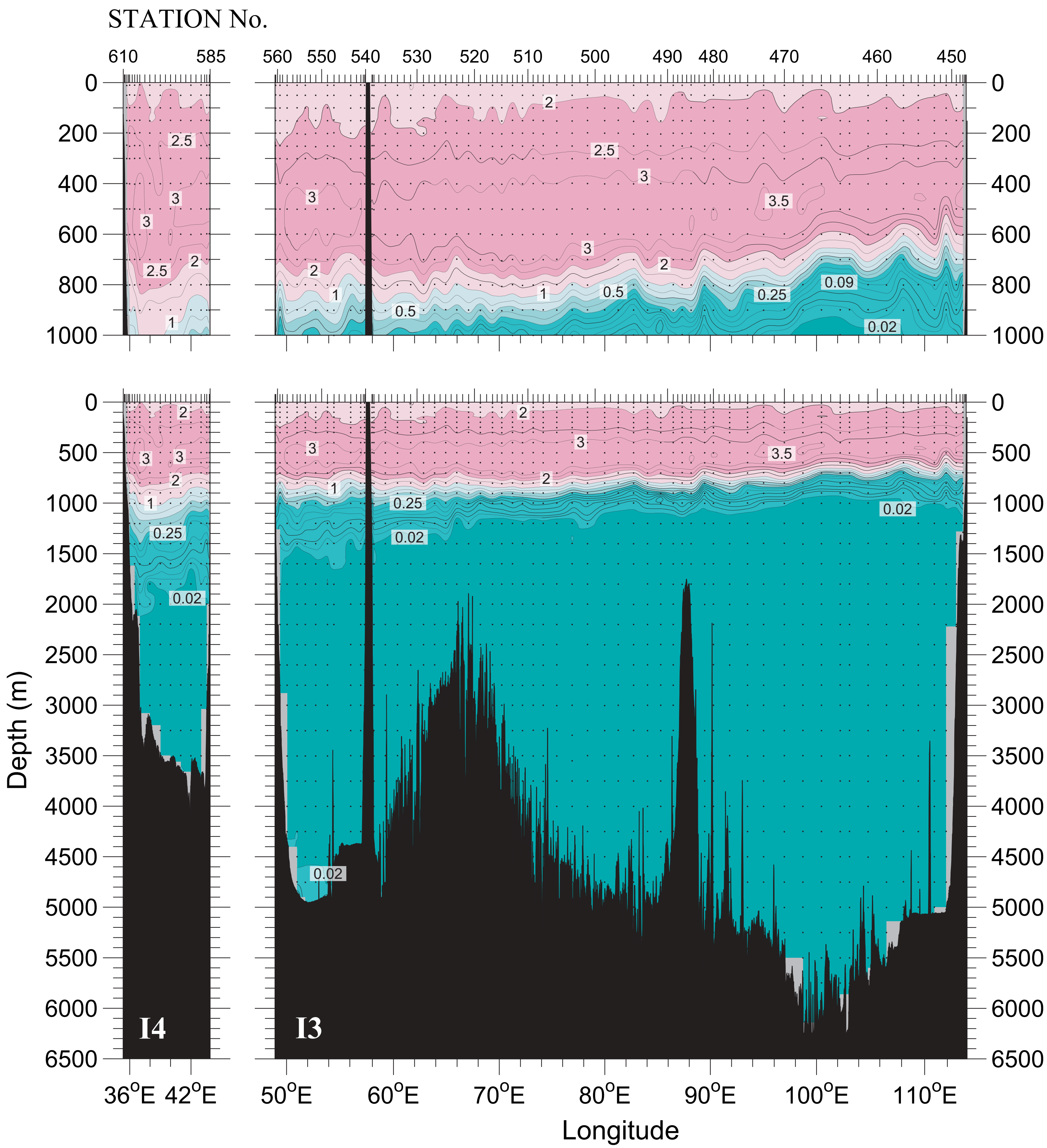
4

Figure 3

CFC-11 [pmol kg^{-1}]




STATION No.
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585
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450
Depth (m)
Longitude
I4
I3
36°E
42°E
50°E
60°E
70°E
80°E
90°E
100°E
110°E
0.02
0.09
0.25
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1
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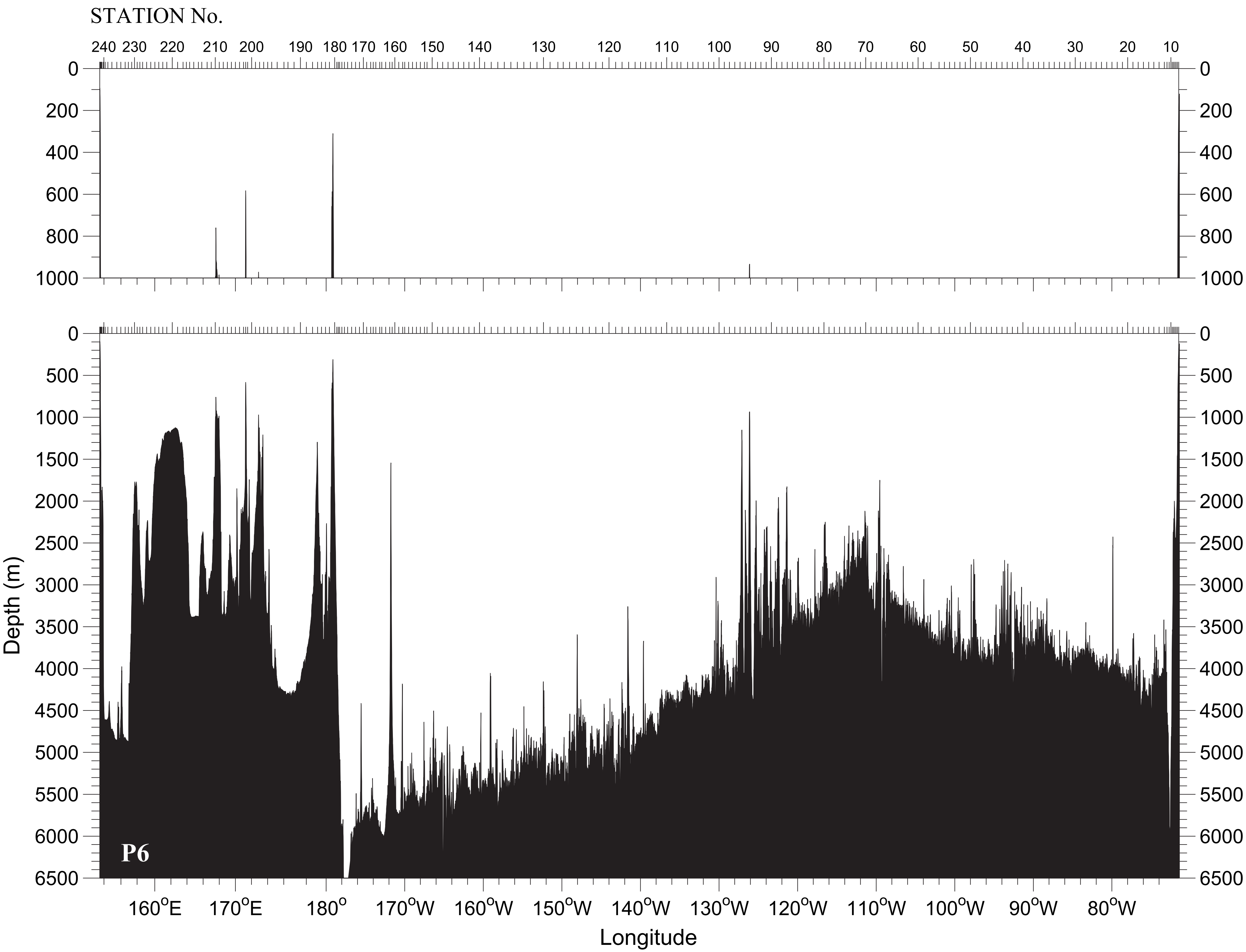
2.5
3
3.5



STATION No.
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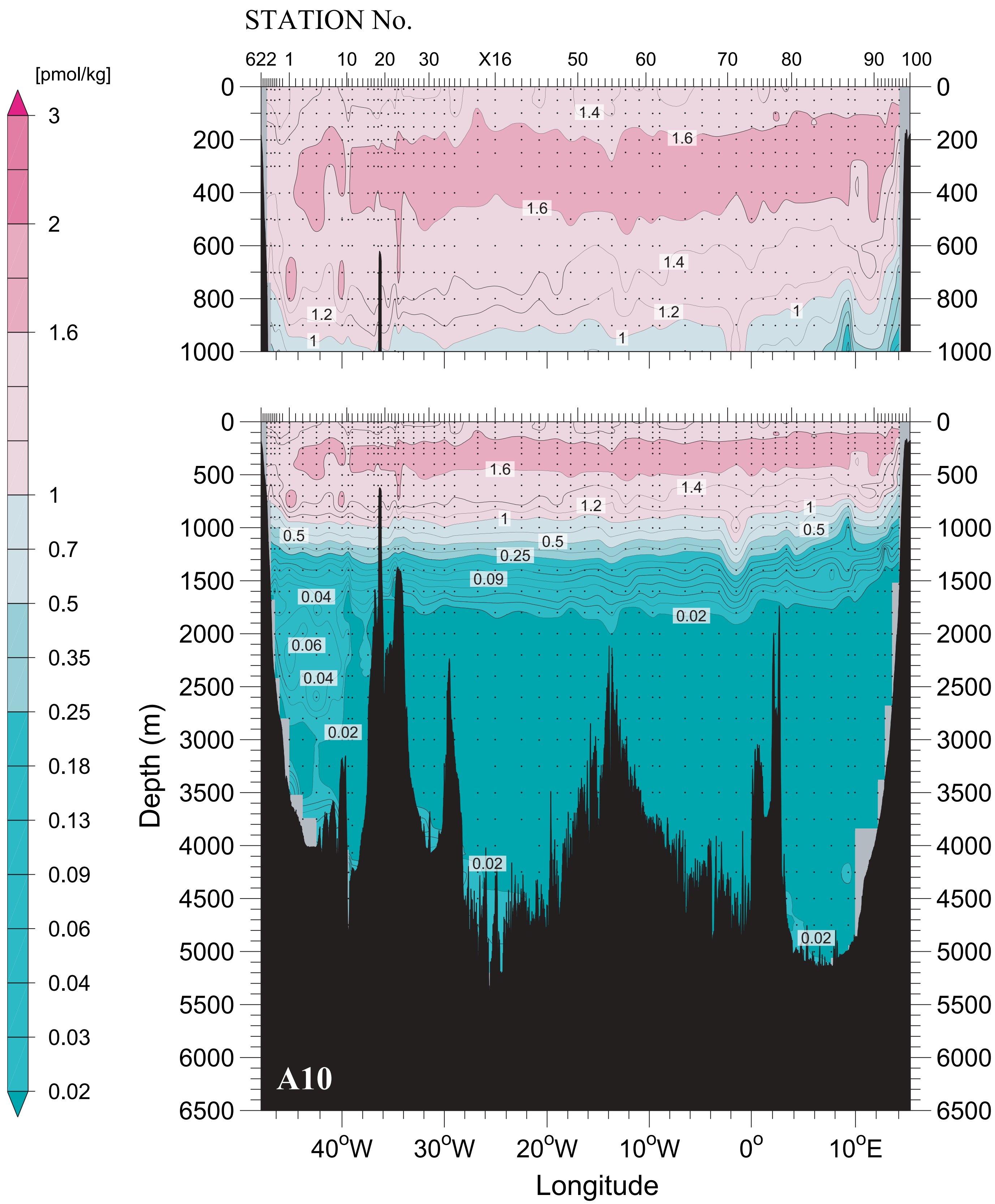
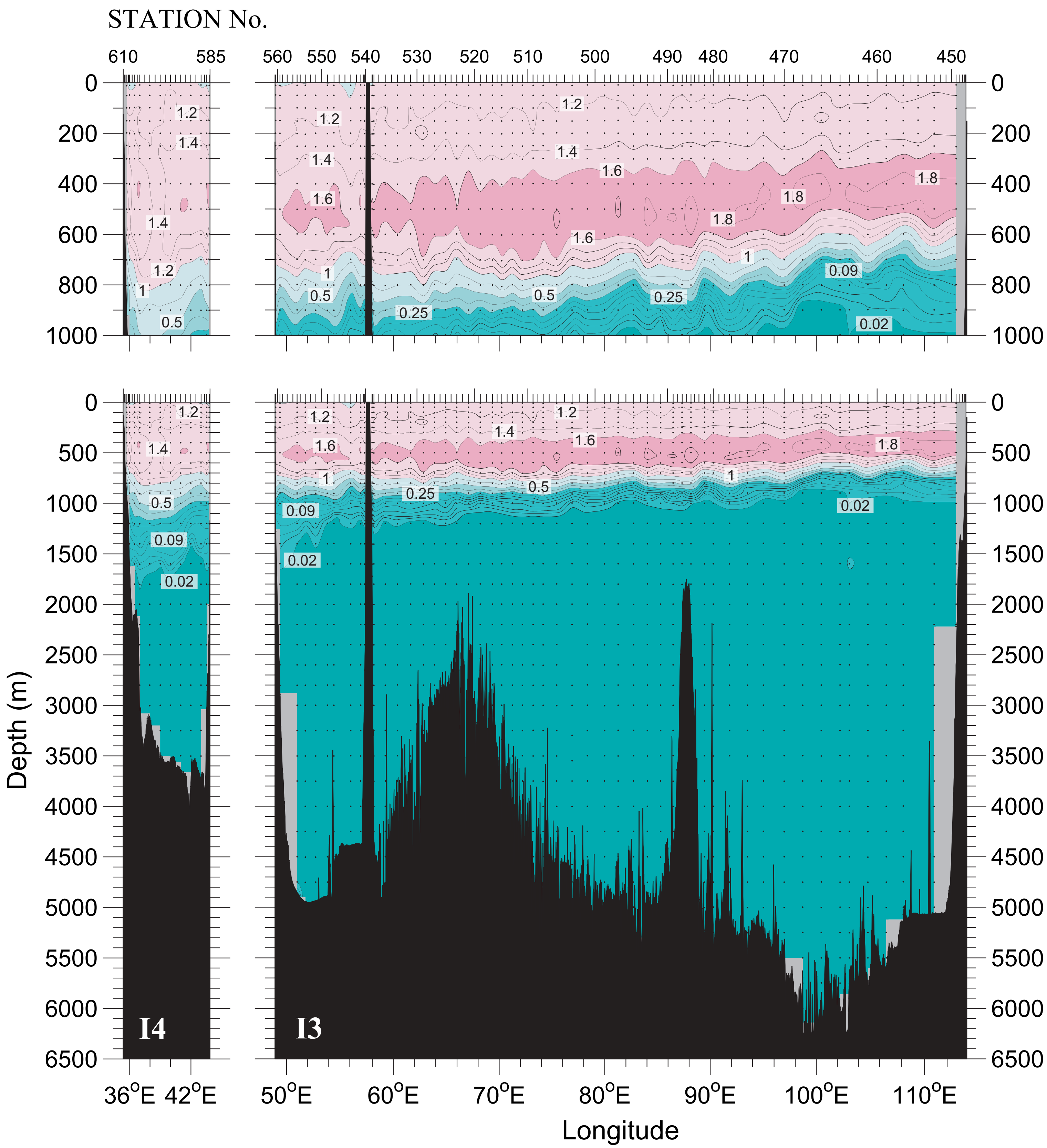
0 200 400 600 800 1000
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500
Depth (m)
P6
160°E 170°E 180° 170°W 160°W 150°W 140°W 130°W 120°W 110°W 100°W 90°W 80°W
Longitude

Figure 4

CFC-12 [pmol kg^{-1}]

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Depth (m)
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60°E
70°E
80°E
90°E
100°E
110°E
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I3
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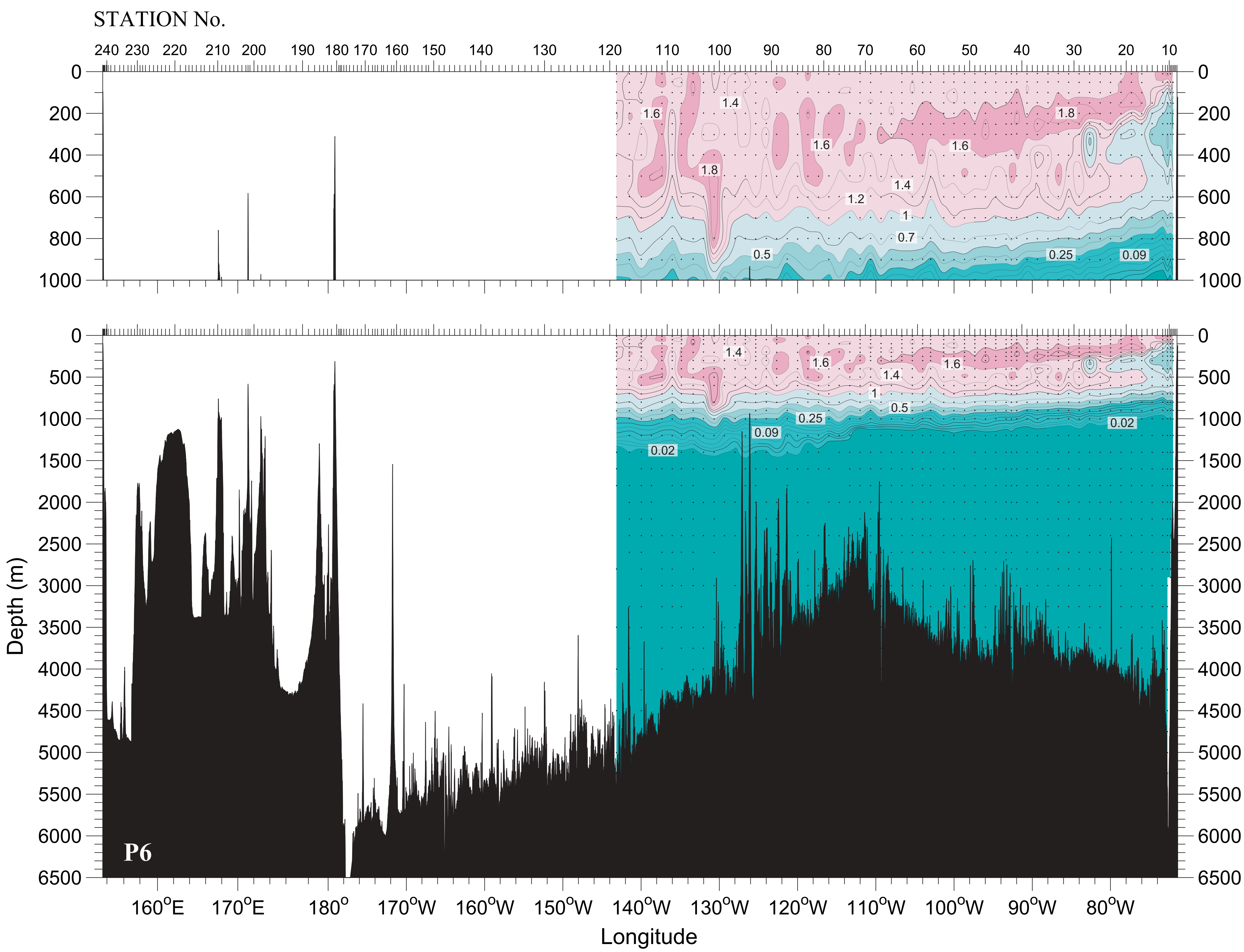
1.4
1.6
1.8
1
0.5
0.25
0.09
0.02



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Depth (m)
P6
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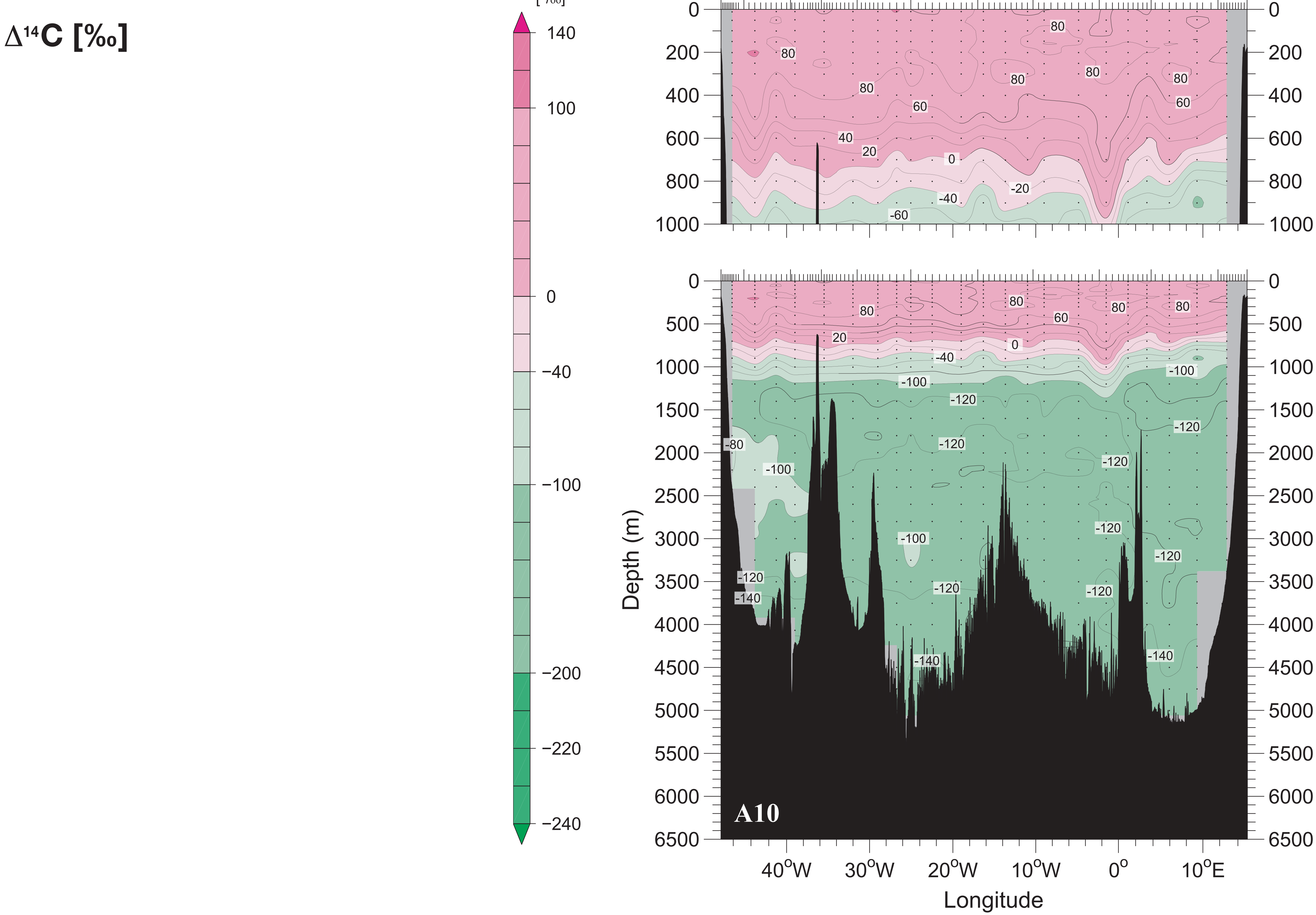
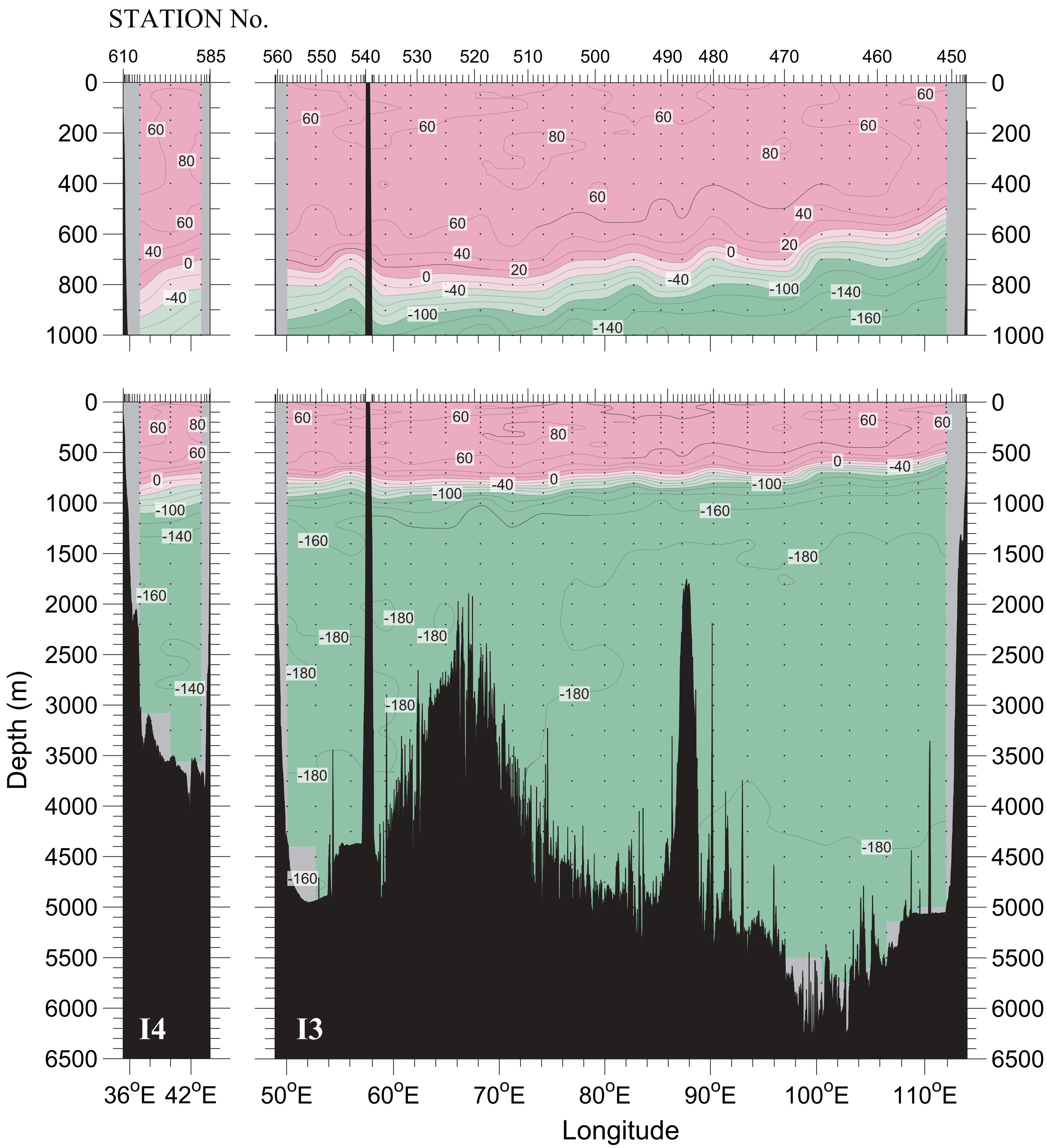
Longitude

Figure 5



Δ14C [‰]
[°/₀₀]
140
100
0
−40
−100
−200
−220
−240
STATION No.
622 1 10 20 30 X16 50 60 70 80 90 100
Depth (m)
Longitude
40°W 30°W 20°W 10°W 0° 10°E
A10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Depth (m)
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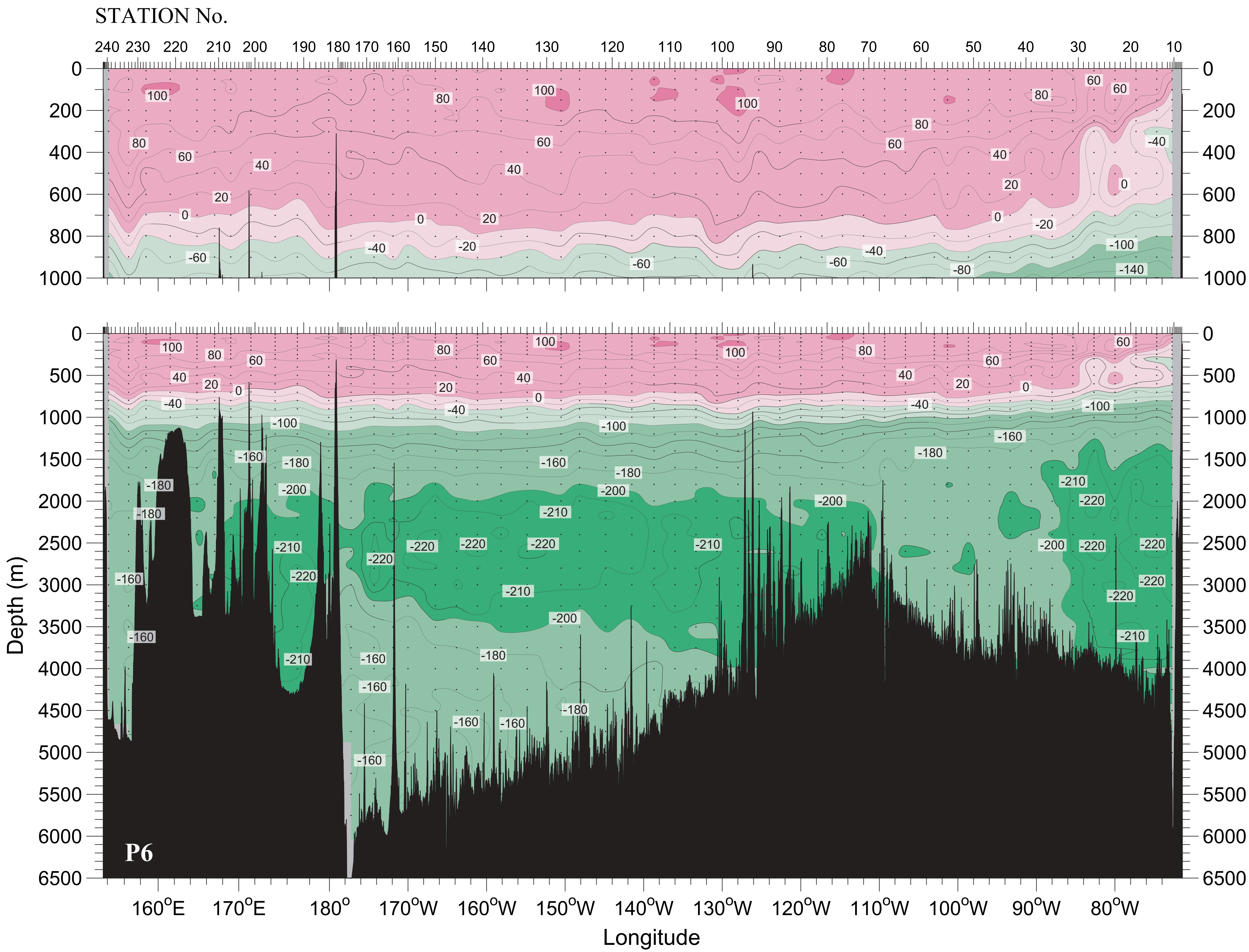
80°E
90°E
100°E
110°E
I4
I3



STATION No.
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Depth (m)
Longitude
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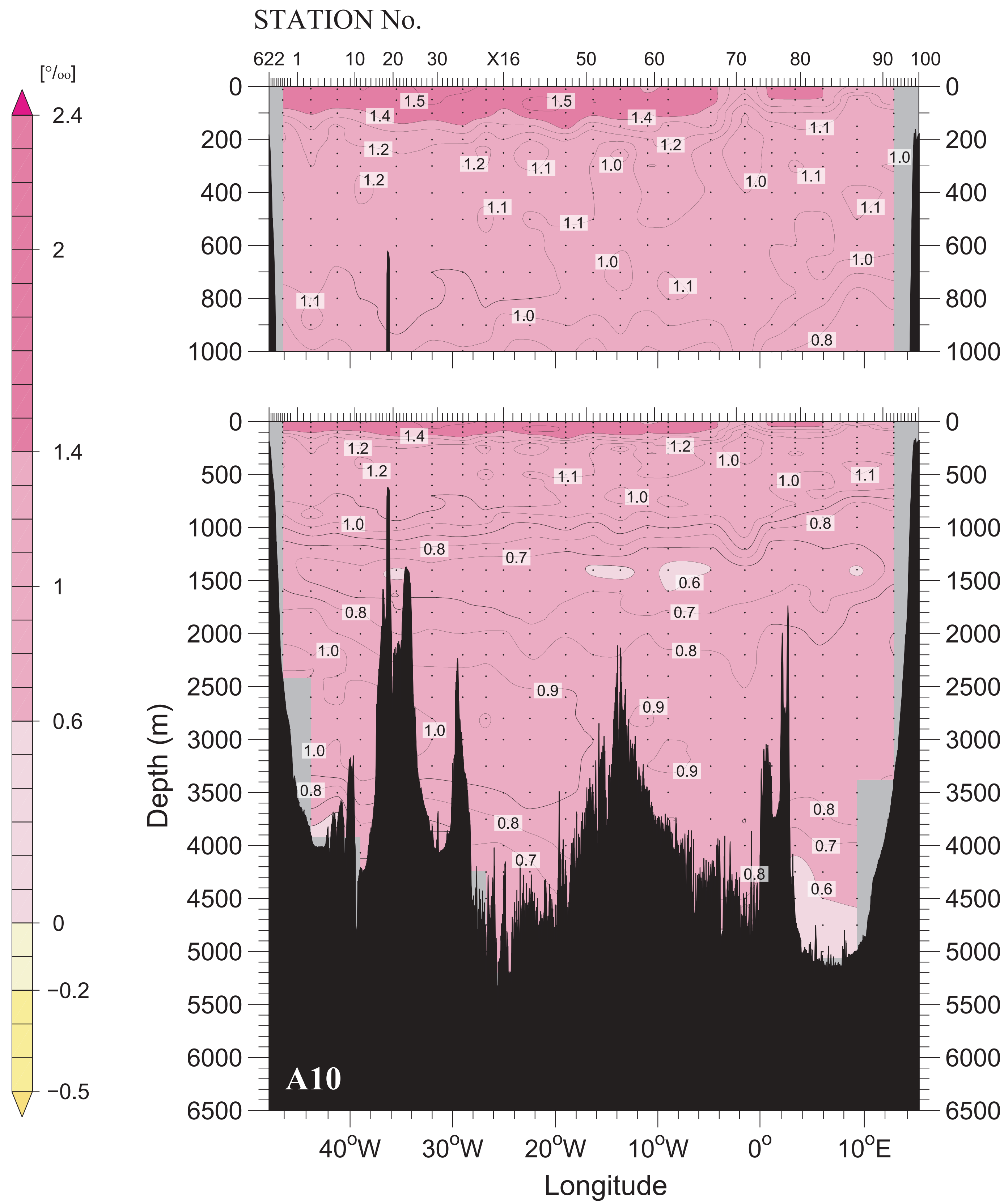
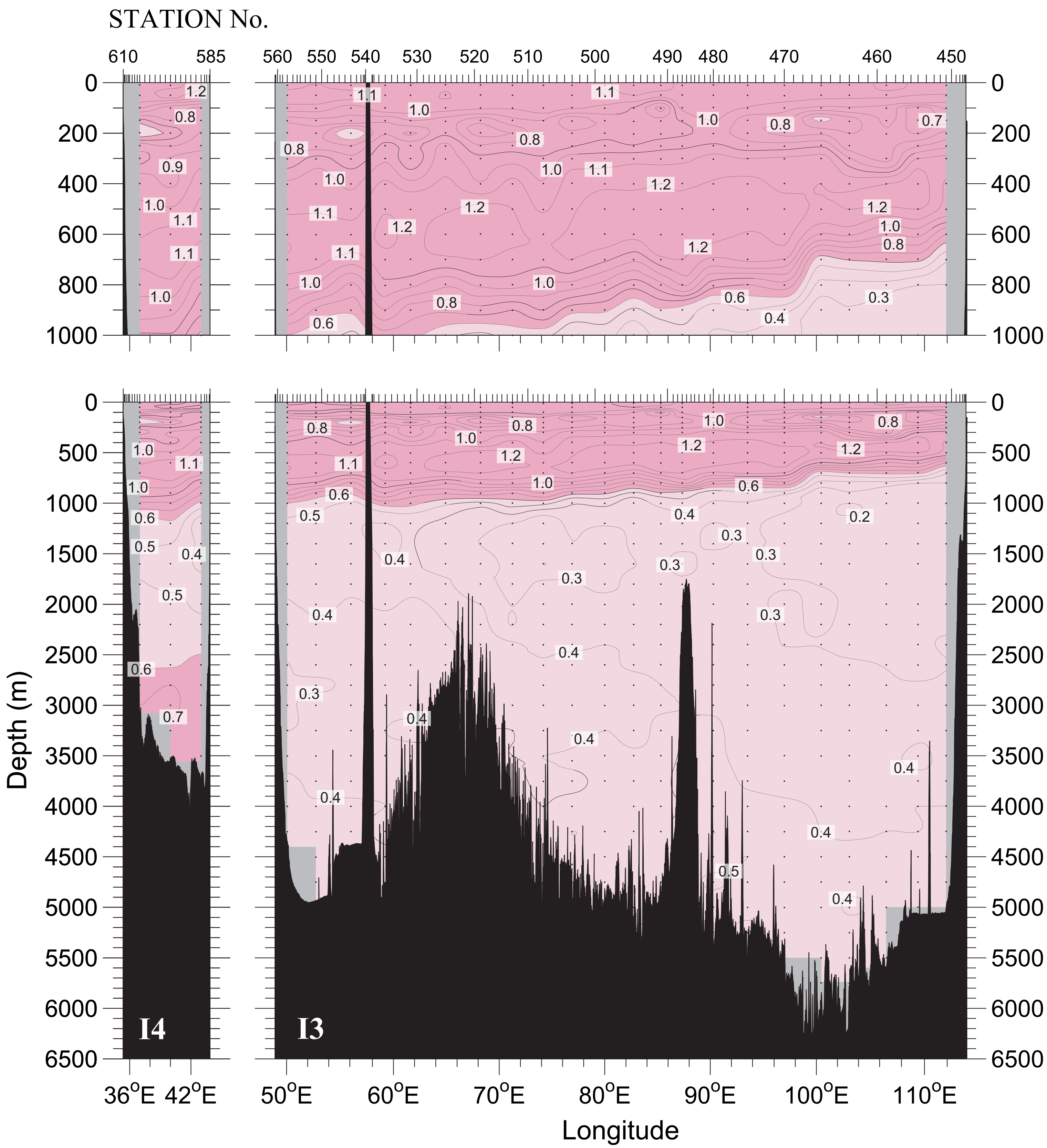
P6

Figure 6

Δ¹³C [‰]





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Depth (m)
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70°E
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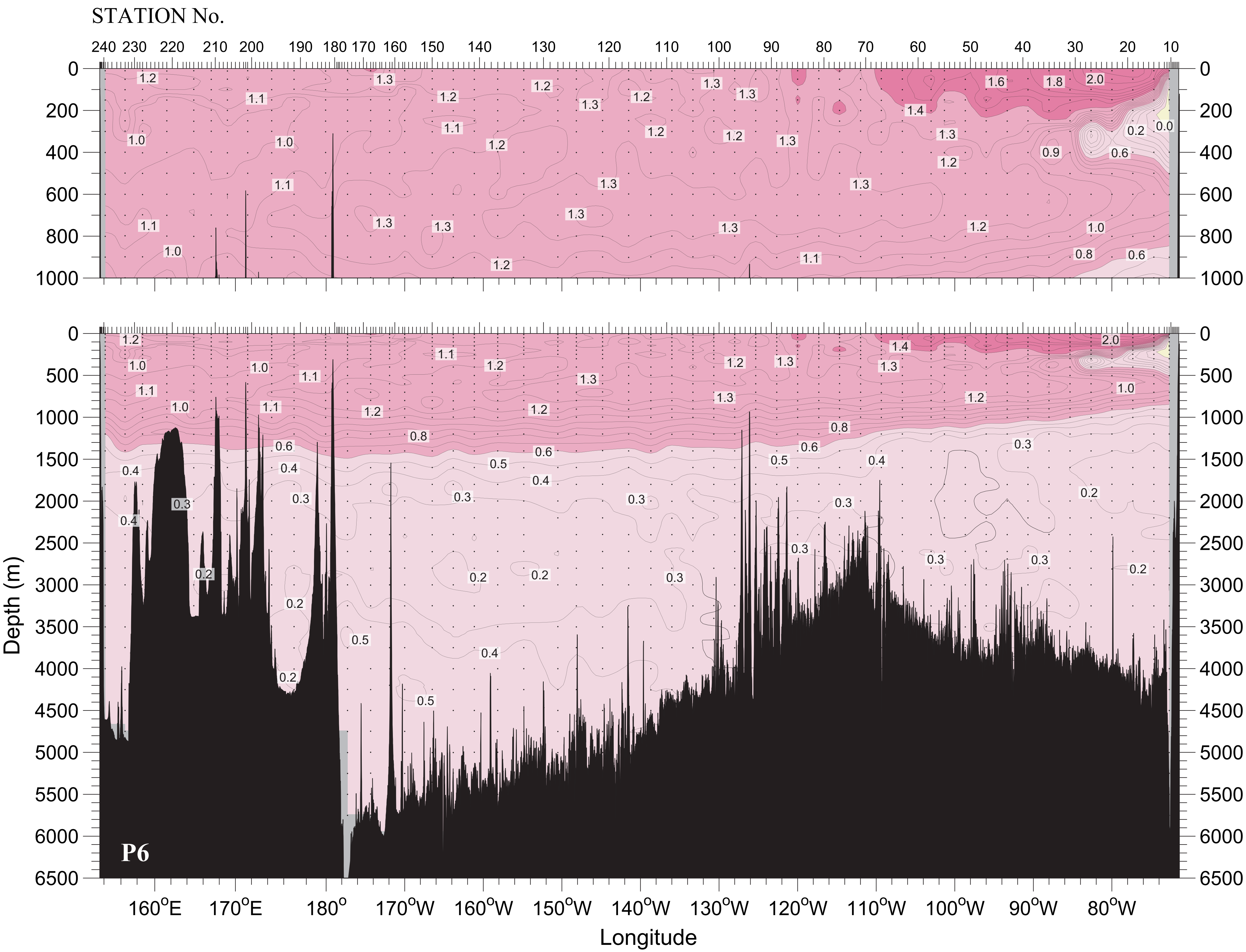
90°E
100°E
110°E
I4
I3



STATION No.
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
Depth (m)
Longitude
160°E 170°E 180° 170°W 160°W 150°W 140°W 130°W 120°W 110°W 100°W 90°W 80°W
P6

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CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
07/11/05	Anderson	CTD/BTL/SUM	Initial CCHDO evaluation
	I took a quick look at the p06 west files. There are woce and exchange format files. The only odd thing I can find is that in the bottle file a parameter called SBE35 uses 9 cols, it is reported to 5 decimal places. The ctd files have CTDCND (conductivity), also 9 cols, 5 decimal places. There is also a parameter CTDOXV, I assume oxygen, units are volts, and FLOUR. I'll be happy to check all the file and get them ready and put them online if someone will let me know where they should go and if we are going to change the EXPOCODEs the Japanese have assigned to them.		
07/11/05	Swift	CTD/BTL/SUM	Initial CCHDO evaluation
	The SBE35 is a reference temperature probe. It's data should look like bottle in-site temperature data (not theta), and are useful to 4 decimal places (accurate to about 1 decimal place). The FLOUR can be changed to FLUOR. I presume we round the decimal places to better match reality?		
07/11/05	Fukasawa	CTD/BTL/SUM	Submitted; available via ftp
	It is truly my great pleasure to tell you that QC'd data with documentations from BEAGLE2003 cruise are completed to be opened at last. I asked Dr. Hiroshi Uchida to send them to Jim and Alex electrically as soon as possible. We also prepared beautiful data books for BEAGLE2003 with a CD ROM.		
07/11/05	Uchida	CTD/BTL/SUM	Submitted; available via ftp
	I prepared CD-ROM contents (documents, data, and figures) of the BEAGLE2003 data book for you on a following web page in advance of sending the data book with the CD-ROM to you. You can access to the web page using following user_id and password.		
10/12/05	Bartolacci	Cruise ID	Data Ready to go online
	We decided to call the Beagle cruises by their individual WOCE lines. Directories are set up for p6 and a10, however the directory for i03/i04 (which we decided was to be all together under i03) isn't set up correctly, there needs to be a subdirectory for it (i03_2003a).		
02/17/06	Kappa	Cruise ID	changed fist 4 characters to 49NZ
	According to Francis Mitchell at NOAA the "NODC Code for the Mirai is 49NZ." Therefore, I changed the first 4 characters of the expocode from 49MR to 49NZ.		
05/10/06	Kappa	Cruise Report	Submitted; Ready to go online
	I just put pdf and text docs for the Beagle cruises in my directory. Please put them online with p06_2004, a10_2004, and i03/i04_2004.		
10/04/06	Kappa	Cruise ID	changed to 49NZ200308_1
	Following a discussion with Justin, I changed the expocode for line P06W_2003 from 49NZ03K04_1 to 49NZ200308_1 to match the expocode in the data files.		
10/04/06	Kappa	Cruise ID	changed expocode to 49NZ200309_2
	Following a discussion with Justin, I changed the expocode for line P06E_2003 from 49NZ03K04_2 to 49NZ200309_2 to match the expocode in the data files.		
10/04/06	Kappa	Cruise ID	changed the expocode to 49NZ200311_4
	Following a discussion with Justin, I changed the expocode for line A10_2003 from 49NZ03K04_4 to 49NZ200311_4 to match the expocode in the data files.		

CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
10/04/06	Kappa	Cruise Report	Updated Cruise Report; Combined Volumes 1 and 2
	Combined Volumes 1 and 2 in both the PDF and ASCII formatted reports Added CCHDO Summary pages (pages 1 and 2) Added these Data Processing Notes Added links and bookmarks to the PDF version		