KESS Telemetry Cruise Report
June 17 - July 17, 2005
R/V Roger Revelle

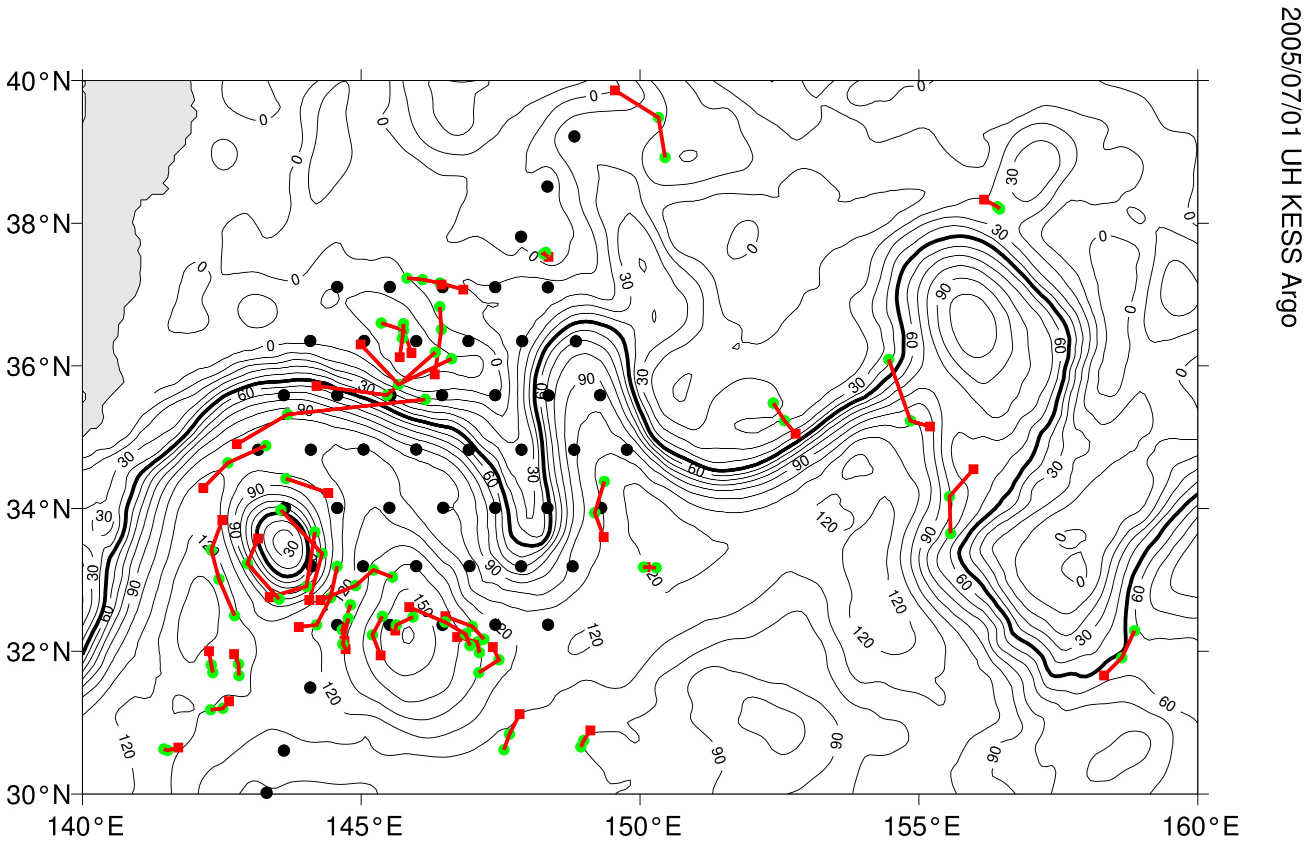

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Table of Contents

1 Introduction **6**
1.1 Summary Overview 6
1.2 CTD Summary 7
1.3 ADCP Summary 8
1.4 Argo Float Summary 9
1.5 NOAA Surface Drifter Summary 10

2 Tables & Plots **11**
2.1 C-PIES/PIES Sites 11
2.2 CTD 14
2.3 ARGO Floats 15
2.4 NOAA Surface Drifters 15

3 Figures **16**
3.1 Feature Survey 16
3.1.1 Potential temperature 16
3.1.2 Salinity 17
3.1.3 Zonal velocity 18
3.1.4 Meridional velocity 19
3.2 CPIES Data 20
3.2.1 Taus 20
3.2.2 Dedrifted Bottom Pressures 21
3.2.3 Bottom Currents 21
3.2 External Data on Kuroshio Paths 23
3.2.1 Satellite SST Tohoku Model 23
3.2.2 SSH for 7/1/2005 from NLOM model output 24
3.3 Ship track segments 25
3.4 ADCP Plots 26
3.4.1 Along Track 26
3.4.2 Cross Sections of the Kuroshio Extension 29
3.4.3 BT correction to HDSS 40

Appendix **41**
A Daily Log by AG/DL 41
B Cruise Prospectus 54
C UNOLS Post-Cruise Assessment Report Form 61
D Cruise Participants 64
E IES Problems and Solutions 64

List of Tables

1 Start and Stop of data sets. 9
2 Major gaps in ADCP data acquisition 9
3 Table of hardware and firmware information on the CPIES/PIES 11
4 Table of position information on the CPIES/PIES 12
5 Lost & recovered instruments 13
6 CPIES/PIES with a bad acoustic command system 13
7 Calibration CTDs taken at CPIES/PIES sites 14
8 Argo Floats Launch Information 15
9 NOAA Surface Drifters Launch Information 15

List of Figures

1 Feature survey of potential temperature 16
2 Feature survey of salinity 17
3 Feature survey of zonal velocity 18
4 Feature survey of meridional velocity 19
5 Time series of τ anomaly 20
6 Time series of dedrifted bottom pressure anomaly 21
7 Time series of bottom currents 22
8 Merged SST by Tohuku University for 4/25/2005 23
9 SSH for 7/1/2005 from NLOM model output with KESS array and ARGO float displacements added by Bo Qiu. 24
10 Cruise track for 6/17–7/5/2005 25
11 Cruise track for 7/5–7/16/2005 25
12 Along track ADCP vector plots with OI mapped streamfunctions and velocity vectors. 26
13 OI mapped total, baroclinic, and barotropic streamfunctions. 27
14 OI mapped total, baroclinic, and barotropic streamfunctions. 28
15 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 6/21–6/22/2005 29
16 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 6/23–6/25/2005 30
17 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/3/2005 31
18 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/5–7/6/2005 32
19 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/7–7/8/2005 33
20 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/8–7/9/2005 34
21 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/9–7/10/2005 35
22 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/11–7/12/2005 36
23 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/13/2005 37
24 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/14–7/15/2005 38

25 Zonal and meridional velocity from the ADCP & ADCP vectors superimposed on bathymetry for 7/14–7/15/2005 39
26 Barotropic correction applied to the HDSS 50 40
27 Schematic of CPIES 55
28 Anticipated deployment sites of CPIES/PIES and Argo floats 58
29 Physical schematic of the Kuroshio Extension 60

1 Introduction

1.1 Summary Overview

This was the mid-experiment cruise for KESS, conducted aboard R/V Revelle. URI had the second leg, the subject of this report, entailing 29 working days at sea. [1] We departed from and returned to Yokohama, Japan. Randy Watts served as Chief Scientist. The main objectives of our leg were as follows:

1. service an array of 46 moored CPIES (current and pressure recording inverted echo sounders) that had been deployed in the Kuroshio Extension in Summer 2004, on a grid spanning from the southern recirculation region to the mixed water regime with site locations coordinated with Jason satellite altimeter groundtracks;

2. collect deep CTD profiles at each CPIES site for calibration purposes;

3. collect by acoustic telemetry (simultaneous with most CTDs) the previous year's records of daily-processed $(\tau, P, (u, v))$ data;

4. conduct a closely-resolved feature survey of a Kuroshio meander / ring using CTDs to 1500 m and the deep-reaching (700 - 900+ m) Doppler current profiling capabilities of R/V Revelle.

Additional ancillary objectives included,

- launch, on behalf of co-PIs Peter Hacker and Bo Qiu (Univ. Hawaii), eight Apex-ARGO profiling floats,

- launch ten NOAA surface drifters, and

- collect intensive atmospheric profiles of temperature, humidity, wind velocity versus pressure across the Kuroshio Extension using 120 weather balloons with radiosondes.

  We also replaced one radiometer sensor on the NOAA KEO meteorological buoy. These objectives were entirely achieved.

The serious difficulties that we had encountered in 2004 with CPIES on the deployment cruise appear to have been mainly fixed, with the exceptions that one instrument was silent (C5, presumably dead) for unknown reasons, and two new sites (D3, N1) had non-responding acoustic command systems, for which we deployed a duplicate instrument at D3, but had insufficient instruments to duplicate site N1.[2]

[1] WHOI had the first leg, on which Nelson Hogg served as Chief Scientist, for servicing profiling moorings and a NOAA meterological buoy.

[2] Three additional sites identified in 2004 have non-responding ACS, at which time we deployed duplicate working instruments at those sites (F3, E6, E7).

However, new problems were evident, of two main sorts: battery passivation, and water-shorts in current meter cables. Battery passivation caused 9 sites to quit sampling, variably after March – July, typically collecting about 12 of the possible 14 months; all those sites were recovered and replaced, and their internally-recorded record is available for processing.

- Eleven sites returned DCS cables which had leaked salt water into the jacket and caused partial shorts between wires. Fortunately the leaks did not enter either the DCS or the PIES electronics. Only two (S2, E4) among these sites with failed-DCS measurements had actually quit earlier than the entire CPIES, whose System quit because of battery passivation, which is apparently unrelated to these cable leaks. (Oddly, the small extra current drain arising from a cable leak might help avoid battery passivation.)
- Six sites (C2, C3, D2, E1, E4, E7) were converted to PIES rather than CPIES, (an increase from three preplanned PIES in 2004 at WHOI mooring sites, where currents were already being measured), because the failures of the current meter cables left us without materials to replace the DCS sensors as we redeployed PIES.
- This approach was necessitated because as the end of the cruise approached, we did not have enough instruments to replace some sites at which only a subset of detectors were telemetering good data:
  - two sites (C1, H3) had bad (u,v) likely due to a bad cable;
  - one site (H3) had questionable τ;
  - all P measurements were okay.

1.2 CTD Summary

A mooring deployment, acoustic file telemetry, and a hydrographic survey was carried out in the Kuroshio Extension (KE) region of the western North Pacific June to July 2005. The work consisted of CPIES mooring deployments where coincident CTD profiles were collected for calibration purposes and a high resolution feature survey with CTD/ADCP sections were taken. The feature survey consisted of 5 KE crossings, with 4 leading into a meander crest and the other leading into a trough. The R/V Roger Revelle departed Yokohama, Japan on June 17, 2005. The basic CTD/hydrographic measurements consisted of salinity measurements made from bottle samples taken on CTD casts, plus pressure, temperature and salinity from CTD profiles. Unlike the previous year, the first cast of the cruise was successful and only minor adjustments were needed along the way.

A total of 44 CPIES/PIES mooring sites were occupied by the end of the cruise (see the CPIES table in section 2.1 of the report), 116 CTD stations were taken, and 8 profiling ARGO floats were launched. Water samples (up to 12 bottles) and CTD data were collected from CTD casts to within 100 meters of the bottom on 36 casts, and to depths of 1500–4000 meters on the other 70 casts. Salinity was measured from every water sample collected during CTD casts. For a more detailed account of CTD stations versus CPIES/PIES sites refer to section 2.2 of the report.

Salinity bottle comparisons, for the several conductivity sensors that were used, showed that agreement between conductivity sensors and with salinity bottles was outstanding. Given this, the CTD data is essentially in final form and will need no further corrections.

1.3 ADCP Summary

Three hull mounted doppler sonar systems measured upper-ocean currents during the cruise. Here we report the performance for the 150 kHz RD Instruments narrowband and the R/V Revelle Hydrographic Doppler Sonar System (HDSS) 50 kHz Deep Sonar. The 140 kHz High Resolution Sonar, part of HDSS, operated and recorded data during the cruise but data were not processed.

150 kHz RD Instruments narrowband (RDI 150) Dr. Jules Hummon, University of Hawaii left a linux laptop, Adelie, on the R/V Revelle after a Jan/Feb 2005 CLIVAR. Adelie utilized the UH data acquisition software to recorded single ping data. In addition, Adelie processed and displayed the data in near real time. Processing entailed the following operations: edit and average single-ping data into 5-minute profiles, plot the latest 5-min averages, and perform full CODAS processing on the averaged data (including an Ashtech rotation that corrects the gyrocompass heading). These processing steps were duplicated on a second linux machine by Erik Fields. A nearly 7-hour gap in data acquisition occurred July 14 (Table 2). The data set begins June 16 and ends July 15 (Table 1). RDI 150 configuration was 8-m blank and pulse and 50 8-m bins. Speed of sound correction was temperature dependent. Processing applied a 0.978 scale factor and heading misalignment of 2.09 degrees. Typically good velocity data reached 300 m depth. Information about UH data acquisition and CODAS processing may be found on the web site currents.soest.hawaii.edu.

HDSS 50kHz (HDSS 50) The 50kHz HDSS instrument consists of two forward facing beams (not working at the time of the cruise) and two aft-facing beams. During the Jan/Feb 2005 CLIVAR

	Start	End
HDSS 50		
	06/18 02:12	07/15 01:53
RDI 150		
	06/16 09:10	07/15 02:16

Table 1: Start and Stop of data sets.

	Acquisition gap length (hours)	Start	End
HDSS 50			
	1.28	06/21 23:54	06/22 01:11
	20.77	07/03 05:11	07/04 01:57
RDI 150			
	6.88	07/14 07:38	07/14 14:31

Table 2: Major gaps in ADCP data acquisition

cruise, Hummon wrote software to read the single-ping HDSS 50 data and make 5-minute averages of the data so that the data could ultimately be processed with the CODAS processing suite. Typically velocities were measured to at least 600 m underway and extended nearly 1000 m on station. The system experienced two gaps: 1 hour on June 22 and 21 hours on July 3 (Table 2). The data set begins June 18 and ends July 17 (Table 1). The initial scale factor and heading misalignment were set to 1.0 and 0, respectively. The RDI 150 was used to adjust the HDSS 50 by matching the mean velocity between 50 and 200 m. This 'barotropic correction' was intended to improve the hdss 50 system which only had two working beams (Figure 26). The mean and standard deviation of the speed correction is 8 cm s^{-1} and 7 cm s^{-1}, respectively. Information about the HDSS system maybe be found on the web site http://opg1.ucsd.edu/ hdss/.

1.4 Argo Float Summary

In conjunction with the University of Hawaii's KESS component, eight Autonomous Profiling Explorer (APEX) Argo floats were launched aboard the Roger Revelle. Five of the eight floats were launched at CPIES sites that are located in the most north-northeastern, in the Mixed Water Region (MWR), or southeastern portion of the KESS array. The general location had been pre-selected by the University of Hawaii and final deployment positions were chosen by Randy Watts. The remaining floats were deployed in a triangle array just northeast of site N1. The were separated by ≈ 12 nm. For more detailed information on the launches refer to Table 2.3 of this document.

The Argo floats deployed last year have become entrained in the recirculation gyre believed to exist to the south of the Kuroshio Extension Current, where subtropical mode water (≈ 17.5°C) is found. Over the next three years they should serve as "roving hydrographers", many of which hopefully will remain within this gyre and the MWR. Each APEX Argo float was equipped with a SBE CTD profiler. The floats will periodically ascend to transmit their location and the CTD data gained during its ascension to the ARGOS satellite. In between these vertical profiles, the floats will descend to a parking depth of 2000m, where the currents are expected to be weak. The Argo floats are considered expendable and no effort will be made to retrieve them.

1.5 NOAA Surface Drifter Summary

As part of NOAA's global surface drifter program, we deployed 10 drifters aboard the R/V Roger Revelle. The deployments were separated as evenly as possible in space and time and were subject to the ever changing cruise plan. The surface drifters measure sea surface temperature and pressure. It floats in the water and is powered by batteries located in the dome. The drifter data that are collected including location with a GPS, are sent to a satellite and then to a land station where we can all access the data. These drifters combined with the Argo floats should provide a good Lagrangian description of the Kuroshio Extension region.

2 Tables

2.1 C-PIES/PIES Sites

Site	SN #	Good/ Bad	5 min. offset	TELEM	XPND	BEA	REL	DCS Minutes	ACS	Firmware Number	Timed Released
A2	145	G		65	69	73	17	20	No	IESe4_5_11.APP	2006/10/19 8
B1	151	G		65	69	73	23	20	No	IESe4_5_11.APP	2006/10/20 16
B2	152	Unknown		66	70	74	27	20	No	IESe4_5_11.APP	2006/10/20 8
B3	148	G		65	69	73	20	20	No	IESe4_5_11.APP	2006/10/13 8
B4	164	G		66	70	74	36	0	11.75	IESe4_5_12.APP	2006/10/13 16
B5	167	G		66	70	74	39	20	No	IESe4_5_11.APP	2006/10/19 0
C1	153	Bad u,v		67	71	75	25	20	No	IESe4_5_11.APP	2006/10/21 0
C2	68	G		66	70	74	4	0	No	IESe5_7_9.APP	2006/10/09 8
C3	63	50% taus	Yes	67	71	75	63	0	No	IESe5_7_9.APP	2006/10/09 16
C3	124	Bad u,v		65	69	73	60	20	No	IESe4_5_11.APP	2006/10/09 16
C4	144	G		67	71	75	16	20	No	IESe4_5_11.APP	2006/10/13 0
C5	116	G		66	70	74	52	20	11.75	IESe5_6_21.APP	2006/10/14 1
C6	173	G		66	70	74	45	20	No	IESe4_5_11.APP	2006/10/18 16
D1	157	G		65	69	73	29	20	No	IESe4_5_11.APP	2006/10/21 16
D2	155	G		66	70	74	27	0	No	IESe5_6_28.APP	2006/10/09 0
D3	104	G	Yes	66	70	74	40	20	No	IESe5_6_21.APP	2006/10/10 2
D4	105	G		64	68	72	0	0	No	IESe4_5_12.APP	2006/10/12 16
D5	111	G		67	71	75	47	20	No	IESe4_5_11.APP	2006/10/14 8
D6	101	G		66	70	74	37	20	No	IESe5_6_21.APP	2006/10/18 8
E1	122	G		66	70	74	58	0	No	IESe5_7_9.APP	2006/10/21 16
E2	162	G		67	71	75	34	20	No	IESe4_5_11.APP	2006/10/22 8
E3	121	G		65	69	73	57	20	No	IESe4_5_9.APP	2006/10/08 8
E4	137	G	Yes	66	70	74	9	0	No	IESe5_7_9.APP	2006/10/10 8
E5	143	?able Pmsb		66	70	74	15	20	No	IESe4_5_11.APP	2006/10/12 8
E6	146	N		66	70	74	18	20	BAD	IESe4_5_11.APP	2006/10/14 16
E6	156	G	Yes	67	71	75	28	20	No	IESe4_5_11.APP	2006/10/14 17
E7	110	N		66	70	74	46	20	BAD	IESe4_5_11.APP	2006/10/17 16
E7	170	G	Yes	66	70	74	42	0	No	IESe5_6_28.APP	2006/10/17 17
F1	114	G		67	71	75	50	20	No	IESe4_5_11.APP	2006/10/22 0
F2	102	G		67	71	75	38	20	No	IESe5_6_21.APP	2006/10/08 2
F3	134	G	Yes	66	70	74	6	0	No	IESe4_5_12.APP	2006/10/10 17
F3	147	N		67	71	75	19	0	BAD	IES6e4_5_12.APP	2006/10/10 16
F4	142	G		65	69	73	14	20	No	IESe4_5_11.APP	2006/10/12 0
F5	158	G		66	70	74	30	20	No	IESe4_5_11.APP	2006/10/15 0
F6	174	G		67	71	75	46	20	No	IESe4_5_11.APP	2006/10/16 16
G1	115	G		65	69	73	51	20	No	IESe4_5_11.APP	2006/10/06 8
G2	119	G		66	70	74	55	20	No	IESe4_5_9.APP	2006/10/07 16
G3	138	G		67	71	75	10	20	No	IESe4_5_11.APP	2006/10/11 0
G4	109	G		65	69	73	45	20	No	IESe4_5_11.APP	2006/10/11 16
G5	149	fair tau's		66	70	74	21	20	No	IESe4_5_11.APP	2006/10/15 8
G6	107	G		66	70	74	43	20	No	IESe4_5_11.APP	2006/10/16 8
H2	118	G		65	69	73	54	20	No	IESe4_5_6.APP	2006/10/06/ 16
H3	112	fair tau's		65	69	73	48	10	11.75-12.0	IESe4_25_4.APP	2006/10/07 8
H4	132	G		67	71	75	4	20	No	IESe4_5_11.APP	2006/10/11 8
H5	168	G		67	71	75	40	20	No	IESe4_5_11.APP	2006/10/16 0
H6	166	G		65	69	73	38	20	No	IESe4_5_11.APP	2006/10/15 16
I1	163	G		65	69	73	35	20	No	IESe4_5_11.APP	2006/10/08 16
N1	45	G	Yes	67	71	75	45		11.75	IESe5_6_21.APP	2006/10/19 15
S1	36	G	Yes	67	71	75	36		No	IESe5_4_12.APP	2006/10/04 22
S2	43	bad tau's	Yes	65	69	73	43		No	IESe5_4_12.APP	2006/10/05 10

Table 3: Table of hardware and firmware information on the CPIES/PIES

Site	SN #	Good/ Bad	Launch Date	Latit	Long	Depth (m)	Launch Time (Z)	Bottom Time (Z)	CPIES YES/NO
A2	145	G	5/27/2004	37 48.5185	147 51.9355	5689	2:20	3:38	
B1	151	G	5/18/2004	37 06.31	144 34.26	5568	4:09:00	5:26:00	
B2	152	unknown	5/17/2004	37 06.2538	145 30.8607	5425	21:26:00	22:40:00	
B3	148	G	5/17/2004	37 06.17	146 27.53	5596	12:40:00	13:58:00	
B4	164	G	5/17/2004	37 06.15	147 24.22	5644	5:14	6:24	NO
B5	167	G	5/25/2004	37 06.0881	148 20.9105	5722	23:02	0:22	
C1	153	bad u,v	5/18/2004	36 21.11	144 05.44	5617	11:27:00	12:45:00	
C2	68	G	7/14/2005	36 20.89	145 3.19	5761	2:40	4:30	NO
C3	124	bad u,v	5/12/2004	36 20.82	145 59.25	5567	11:25	12:37	
C3	63	50% taus	7/11/2005	36 20.81	145 59.27	5567	9:47	11:00	NO
C4	144	G	5/16/2004	36 20.7883	146 55.2560	5631	21:16	22:34	
C5	116	G	6/28/2005	36 20.79	147 53.19	5798	16:27	17:45	
C6	173	G	5/25/2004	36 20.73	148 51.08	5888	12:45	14:06	
D1	157	G	5/18/2004	35 25.9928	143 31.2200	5719	20:43:00	22:02:00	
D2	155	G	7/14/2005	35 35.2	144 34.4	5765	15:58	17:10	NO
D3	104	G	6/24/2005	35 35.42	145 31.58	5849	13:53	15:20	
D4	105	G	5/16/2004	35 35.28	146 26.97	5969	3:47	5:00	NO
D5	111	G	5/16/2004	35 35.24	147 24.24	5845	9:27	10:48	
D6	101	G	6/29/2005	35 35.218	148 21.47	5945	0:59	2:25	
E1	122	G	7/15/2005	34 49.65	143 9.30	5305	12:38	14:23	NO
E2	162	G	5/19/2004	34 49.592	144 05.81	5754	9:07:00	10:27:00	
E3	121	G	5/11/2004	34 49.60	145 02.59	5885	8:38	9:58	
E4	137	G	7/12/2005	34 49.6	145 59.6	5935	8:25	9:49	NO
E5	143	?able Pmsb	5/15/2004	34 49.2570	146 55.6831	5800	21:31	22:50	
E6	156	G	5/20/2004	34 49.488	147 52.544	5943	3:41	5:04	
E7	170	G	7/6/2005	34 49.50	148 49.22	6127	23:06	0:26	NO
F2	102	G	6/25/2005	33 55.15	144 37.37	5782	22:14	23:35	
F3	134	G	5/15/2004	34 00.61	145 30.28	5796	7:07	8:25	NO
F4	142	G	5/14/2004	34 00.6411	146 28.2199	5847	23:48	1:09	
F5	158	G	5/23/2004	34 00.60	147 24.25	6034	14:08	15:31	
F6	174	G	5/24/2004	33 50.9965	148 14.6842	6196	0:45	2:07	
G1	115	G	5/29/2004	33 11.44	144 06.43	5465	12:39	13:55	
G2	119	G	5/10/2004	33 11.46	145 01.92	5800	13:07	14:27	
G3	138	G	5/13/2004	33 11.4976	145 59.2570	5733	22:59	0:23	
G4	109	fair tau's	5/14/2004	33 11.53	146 56.52	5949	12:01	13:23	
G5	149	G	5/23/2004	33 11.48	147 51.98	6233	4:22	5:48	
H2	118	G	5/9/2004	32 22.19	144 34.17	5695	12:14	13:33	
H3	112	fair tau's	4/29/2004	32 22.24	145 30.87	5845	16:53	18:11	
H4	132	recpt. prob.	5/14/2004	32 22.26	146 27.56	5957	5:29	6:49	
H5	168	G	5/22/2004	32 22.2467	147 24.2528	6035	21:57	23:20	
H6	166	G	5/22/2004	32 22.33	148 20.99	5744	7:24	8:43	
I1	163	G	5/28/2004	31 29.4517	144 05.2339	5869	23:33	0:54	
N1	45	G	7/4/2005	38 30.87	148 20.47	5703	14:20	15:42	
S1	36	G	6/18/2005	30 01.13	143 18.31	5867	18:07	19:33	
S2	43	bad tau's	6/19/2005	30 36.67	143 36.98	5691	6:29	7:38	

Table 4: Table of position information on the CPIES/PIES

Site	SN #	Lost/ Recovered	Launch Latit	Launch Long	Date Released	Released Time (Z)
C2	131	R	36 20.89	145 3.16	7/14/2005	1:02
C5	171	L	36 20.75	147 53.17	6/28/2005	11:54
C5	45	R	36 20.70	147 53.36	6/28/2005	15:42
D2	122	R	35 35.3033	144 34.2218	7/12/2005	14:58
D6	155	R	35 35.2256	148 21.5053	6/28/2005	22:53
E1	161	R	34 49.597	143 9.149	7/15/2005	11:42
E4	68	R	34 49.59	145 59.27	7/12/2005	5:45
E7	170	R	34 49.47	148 49.19	7/2/2005	20:57
F1	114	R	34 0.577	143 26.017	7/15/2005	20:42
F2	136	R	33 55.1509	144 37.4006	6/25/2005	20:12
G6	107	R	33 11.4715	148 47.3451	7/2/2005	4:50
H3	63	R	33 22.24	145 30.87	6/20/2005	9:53
S1	101	R	30 00.93	143 18.149	6/18/2005	23:31
S2	102	R	30 36.55	143 36.86	6/19/2005	10:28

Table 5: Lost & recovered instruments

Site	SN #	Launch Date	Latit	Long	Depth (m)	CPIES YES/NO	Timed Release	Sampling (Yes/No)	Failure Year
C5	171	5/25/2004	36 20.75	147 53.17	5846		2006/10/18 16	No	2005
E7	110	5/20/2004	34 49.52	148 49.16	6110		2006/10/17 16		2004
N1	160	5/26/2004	38 30.76	148 20.32	5687		2006/10/19 16		2005
E6	146	5/20/2004	34 49.5032	147 52.5613	5943		2006/10/14 16		2004
F3	147	5/13/2004	34 00.62	145 30.28	5815	No	2006/10/10 16		2004
D3	150	5/12/2004	35 35.324	145 31.506	5849		2006/10/10 0		2005

Table 6: CPIES/PIES with a bad acoustic command system

2.2 CTD

Site	SN #	CTD Station #	CTD Cast #	Before/After Launch	Deep/Shallow	Good/Not Good
S1	36	1	1			
S2	43	2	1			bad tau's
I1	163	3	1			
H3	63	4	1			
H2	118	5	1			
G1	115	6	1			
E3	121	7	1			
C3	124	8	1			Bad u,v
B3	148	9	1			
B4	164	10	1			
C4	144	11	1			
D4	105	12	1			
D3	104	13	1			
E4	68	14	1	Before		Bad u,v
F3	134	15	1			
F2	102	16	1			
G2	119	17	1			
G3	138	18	1			
F4	142	19	1			
E5	143	20	1			?able Pmsb
D5	111	21	1			
C5	116	22	1	Before	Shallow (3000 m)	
D6	101	23	1			
E6	156	24	1			
F6	158	25	1			
G4	109	26	1			fair tau's
H4	132	27	1			
H5	168	28	1			
G5	149	29	1			
H6	166	30	1			
F6	174	31	1			
C6	173	32	1			
B5	167	33	1			
A2	145	34	1			
N1	45	35	1			
E7	170	54	1		Shallow (3000 m)	
B5	167	72	1		4000 m	
C3	63	97	1		4000 m	50% taus
E4	137	105	1		4000 m	
E2	162	110	1		4000 m	
D2	155	111	1		4000 m	
C2	68	112	1		4000 m	
B1	151	113	1		4000 m	
C1	153	114	1		5000 m	Bad u,v
D1	157	115	1		5000 m	
E1	122	116	1		4000 m	

Table 7: Calibration CTDs taken at CPIES/PIES sites

2.3 Argo Floats

float number	date (GMT)	time (GMT)	latitude	longitude	C-PIES site	launched by
2095	6/23/2005	2:36	37 6.22	146 27.75	B3	Randy Watts and Andy Greene
2094	7/1/2005	21:53	32 22.74	148 21.23	H6	Andy Greene and Scott Hiller
2101	7/2/2005	6:45	33 11.45	148 47.25	G6	Andy Greene and David Lishego
2100	7/4/2005	5:05	37 48.518	147 51.94	A2	Randy Watts and David Lishego
2085	7/4/2005	14:29	38 31.02	148 20.67	N1	Randy Watts and David Lishego
2086	7/4/2005	17:42	38 42.04	148 27.97	N1-N2	Andy Greene and Scott Hiller
2084	7/4/2005	18:24	38 48.00	148 31.81	N1-N2	Andy Greene and Scott Hiller
2087	7/4/2005	19:05	38 48.03	148 22.94	N1-N2	Andy Greene and Scott Hiller

Table 8: Argo Floats Launch Information

2.4 NOAA Surface Drifters

ID #	Date	Time (Z)	Launch Latit (N)	Launch Long (E)
54688	6/19/2005	1:38	30 01.19	143 18.35
54676	6/22/2005	1:52	34 49.56	145 02.35
54673	6/25/2005	15:50	34 00.61	145 30.19
54674	6/29/2005	18:22	36 20.78	147 53.23
54690	7/1/2005	23:57	32 22.74	148 21.23
54675	7/3/2005	20:47	37 06.13	148 20.89
54691	7/4/2005	19:05	38 48.01	148 22.91
54677	7/8/2005	17:12	37 06.11	148 21.16
54689	7/11/2005	16:06	35 59.99	145 59.25
54692	7/15/2005	23:11	34 00.37	143 19.231

Table 9: NOAA Surface Drifters Launch Information

3 Figures

3.1 Feature Survey

3.1.1 Potential temperature

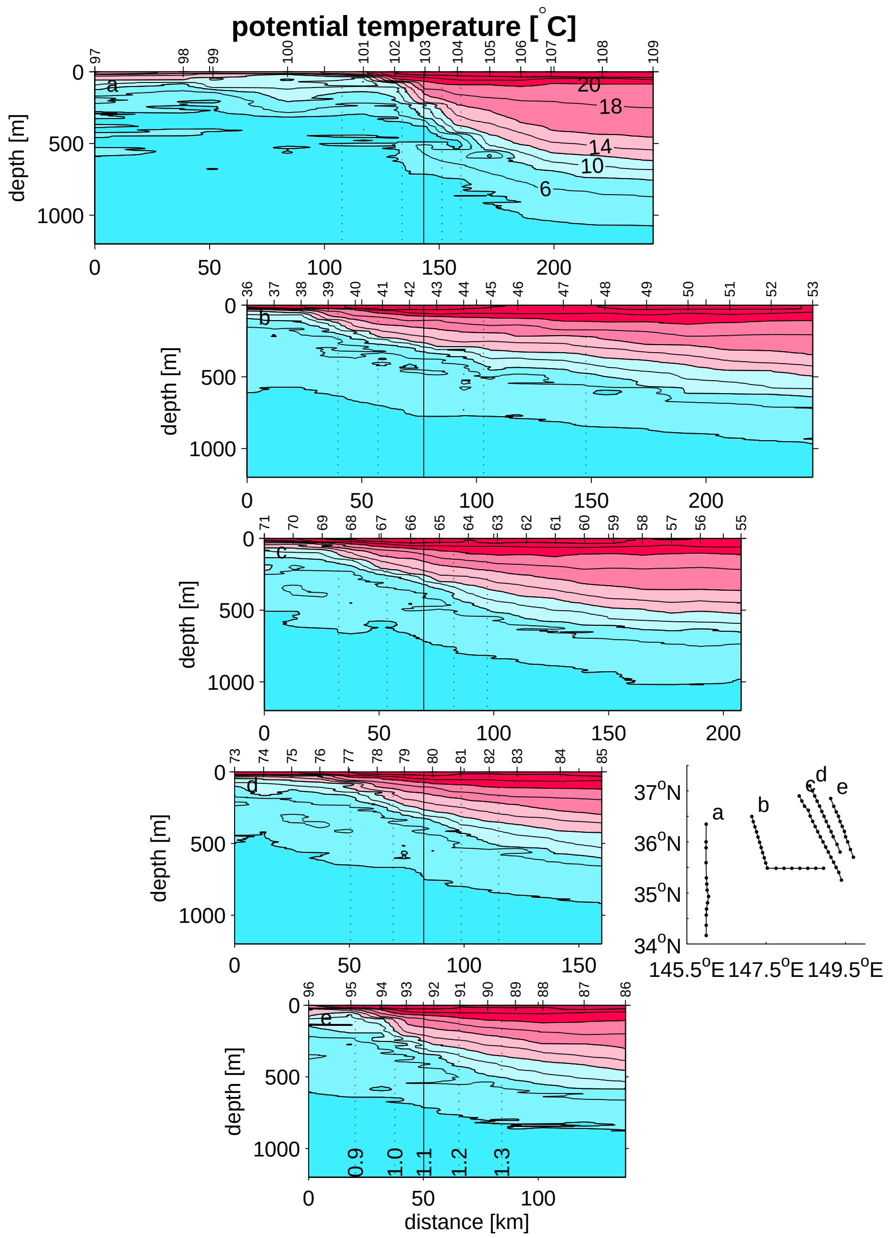

Figure 1: Potential temperature (°C) contoured against depth and latitude (left panel) for the five survey sections (a) through (e) shown in the map (right panel). Dashed and solid vertical lines superimposed on the contour plots are dynamic height values at 100 m referenced to 1000 m in dynamic meters.

3.1.2 Salinity

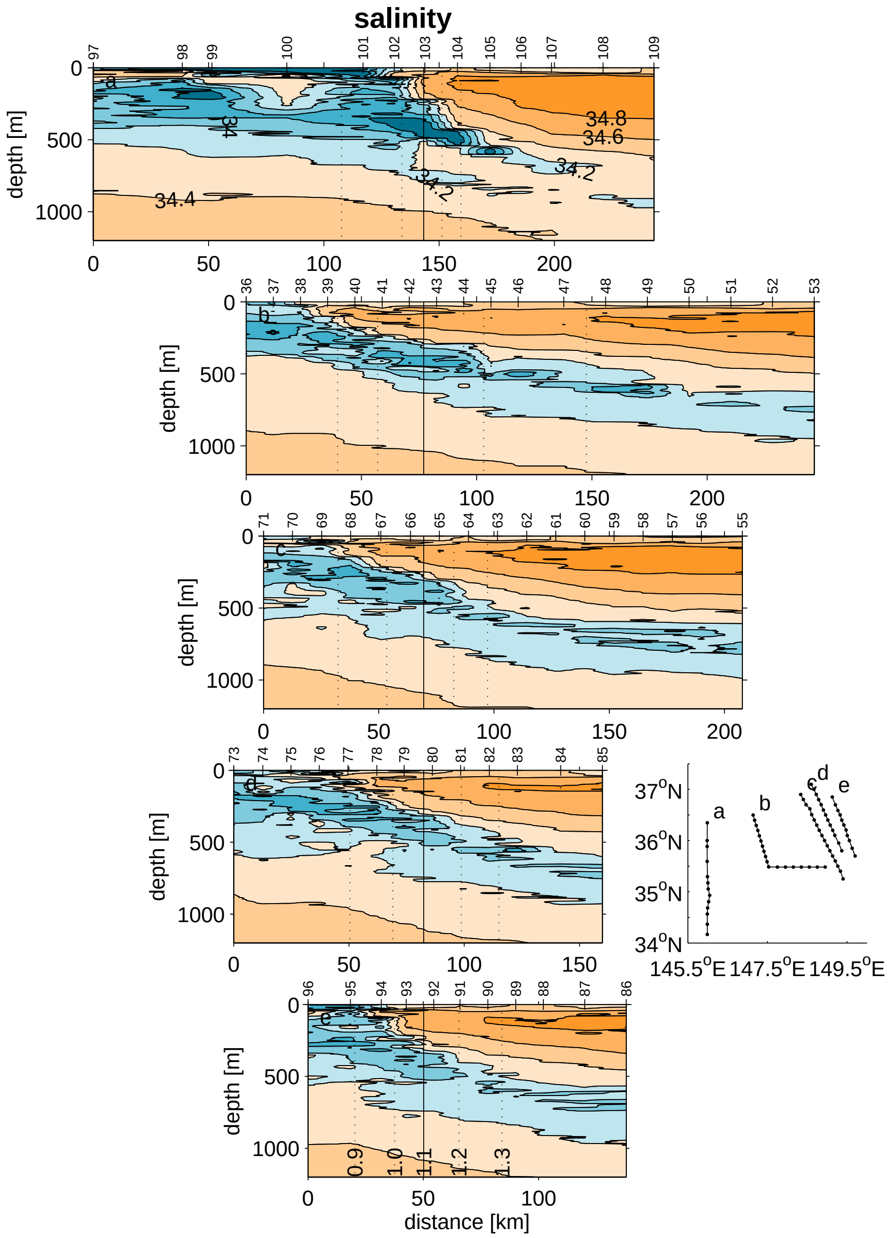

Figure 2: Salinity contoured against depth and latitude (left panel) for the five survey sections (a) through (e) shown in the map (right panel). Dashed and solid vertical lines superimposed on the contour plots are dynamic height values at 100 m referenced to 1000 m in dynamic meters.

3.1.3 Zonal velocity

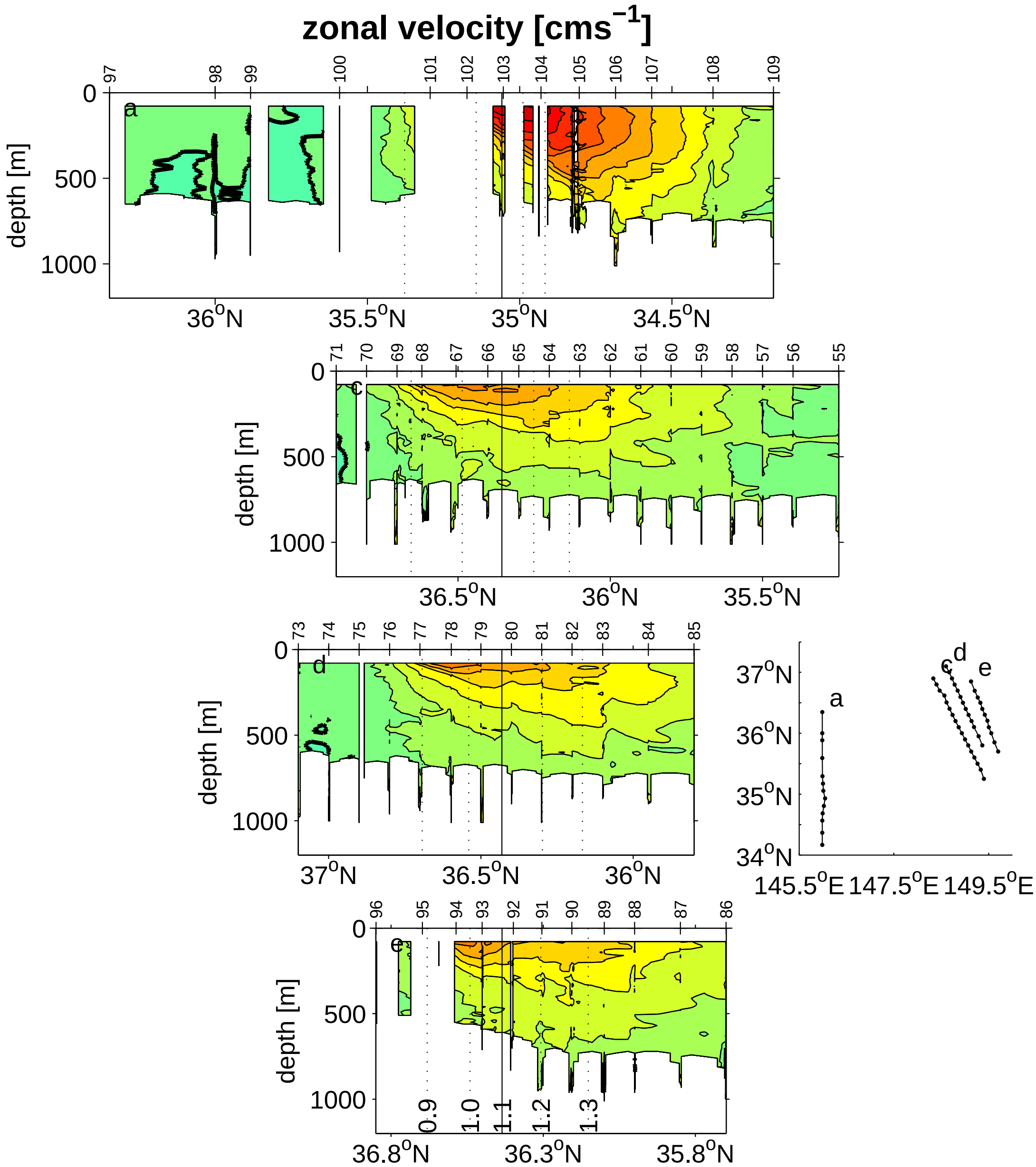

Figure 3: Zonal velocity (cm s^{-1}) contoured against depth and latitude (left panel) for the four survey sections (a) and (c) through (e) shown in the map (right panel). Dashed and solid vertical lines superimposed on the contour plots are dynamic height values at 100 m referenced to 1000 m in dynamic meters. Note that CI = 20 cm s^{-1}.

3.1.4 Meridional velocity

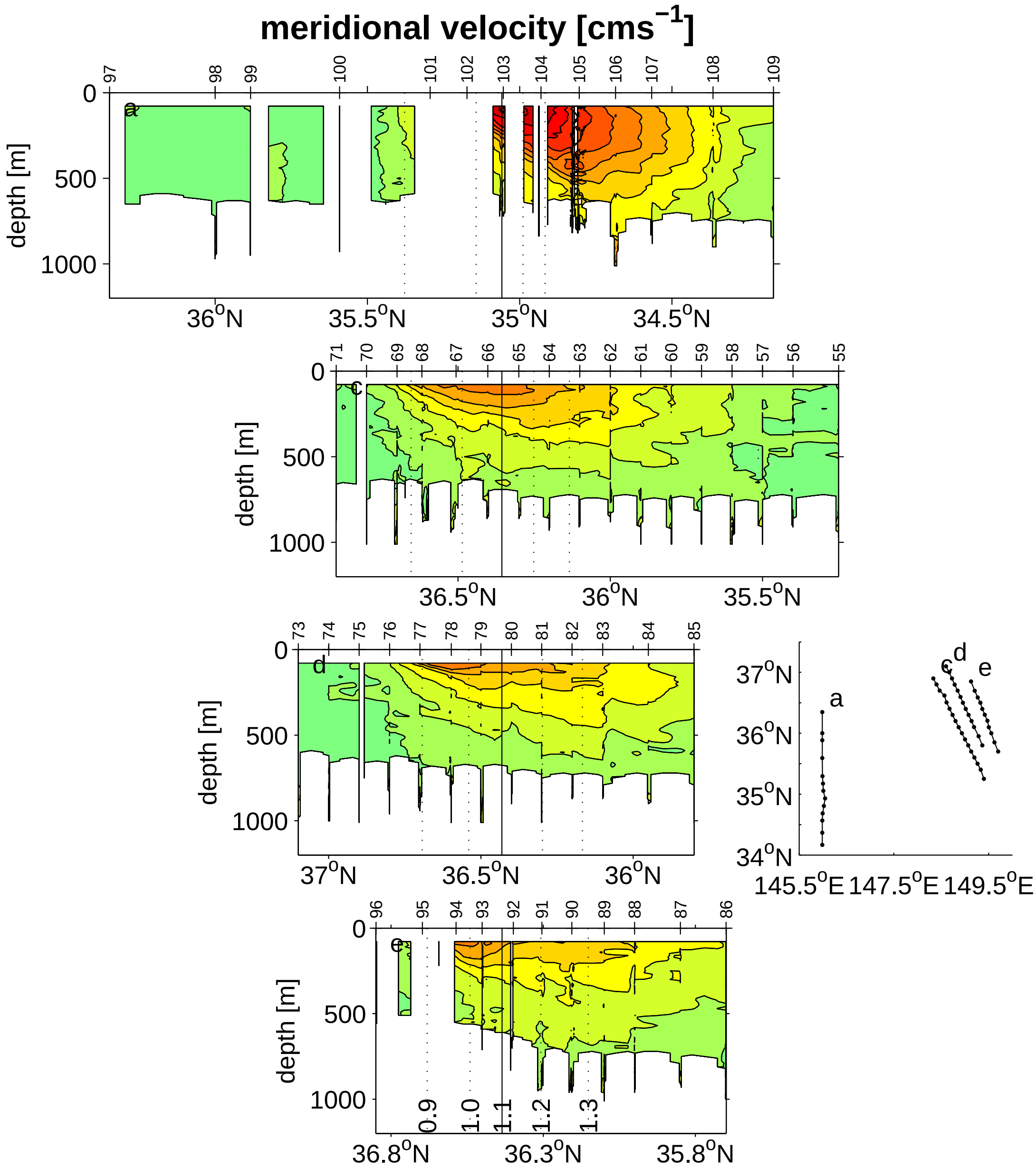

Figure 4: Meridional velocity (cm s^{-1}) contoured against depth and latitude (left panel) for the four survey sections (a) and (c) through (e) shown in the map (right panel). Dashed and solid vertical lines superimposed on the contour plots are dynamic height values at 100 m referenced to 1000 m in dynamic meters. Note that CI = 20 cm s^{-1}.

3.2 CPIES Data

3.2.1 Taus

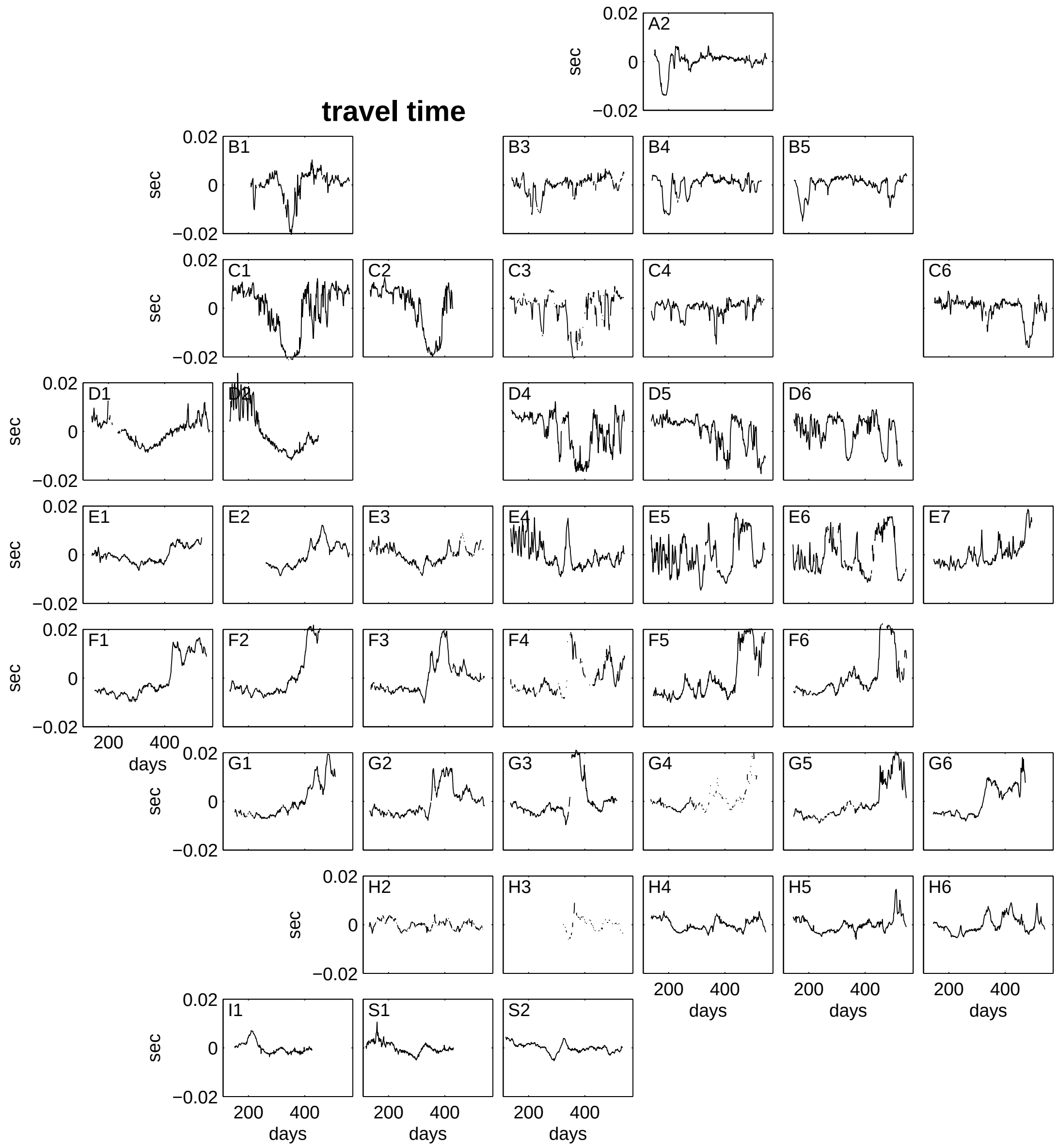

Figure 5: Time series of τ anomaly in seconds plotted according to approximate geographic location. Site number noted in the upper left corner of each subplot.

3.2.2 Dedrifted Bottom Pressures

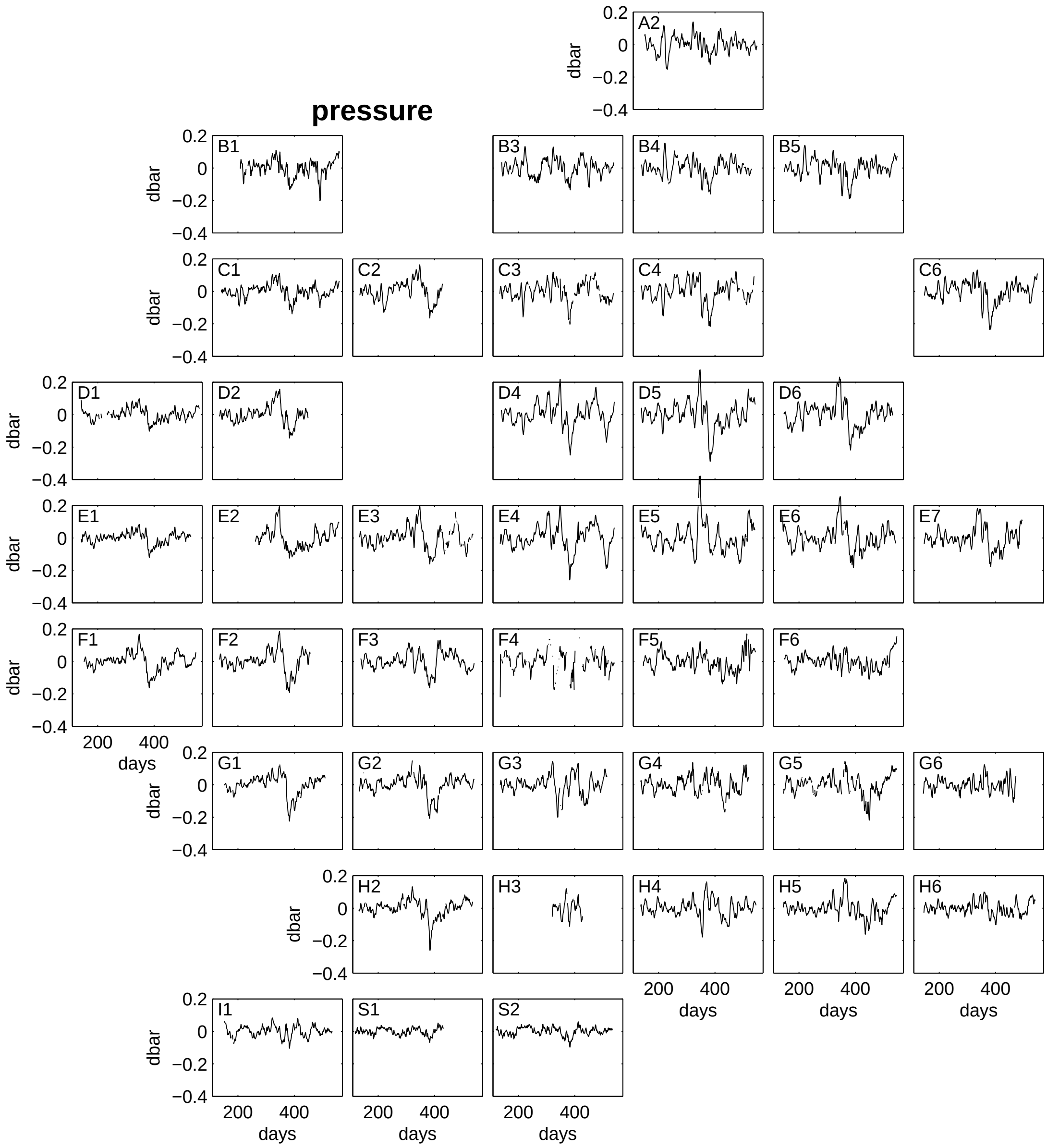

Figure 6: Time series of dedrifted bottom pressure anomaly in dbars plotted according to approximate geographic location. Site number noted in the upper left corner of each subplot.

3.2.3 Bottom Currents

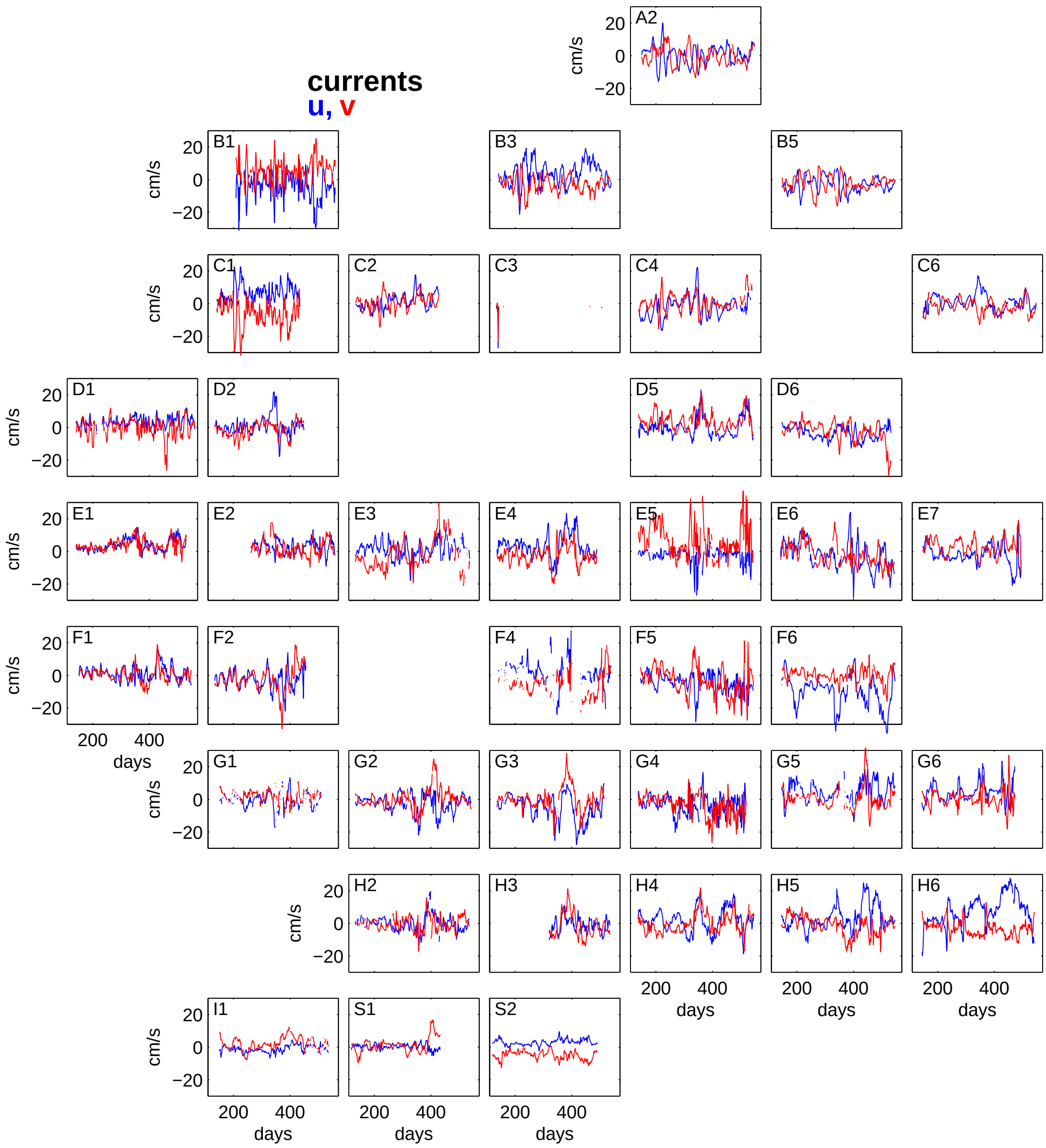

Figure 7: Time series of bottom currents, u and v, in centimeters per second plotted according to approximate geographic location. Site number noted in the upper left corner of each subplot.

3.3 External Data on Kuroshio Paths

3.3.1 Satellite SST Tohoku Model

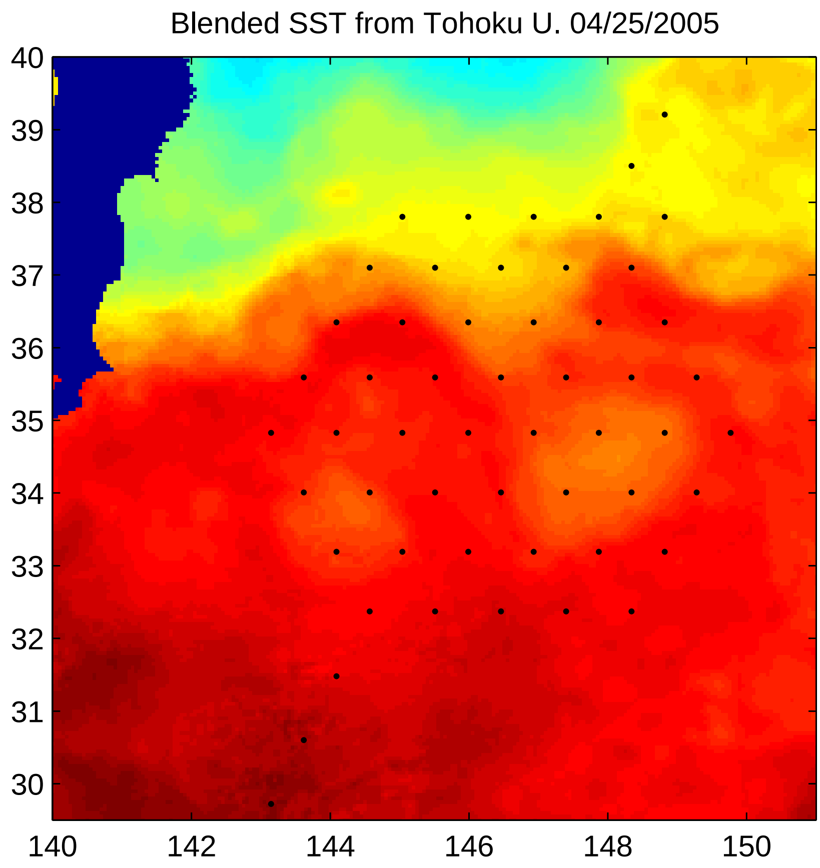

Figure 8: Merged SST (MODIS, AVHRR, and AMSR-E) generated by Tohoku University, http://www.ocean.caos.tohoku.ac.jp/merge/sstbinary/actvalbm.cgi

3.3.2 SSH for 7/1/2005 from NLOM model output

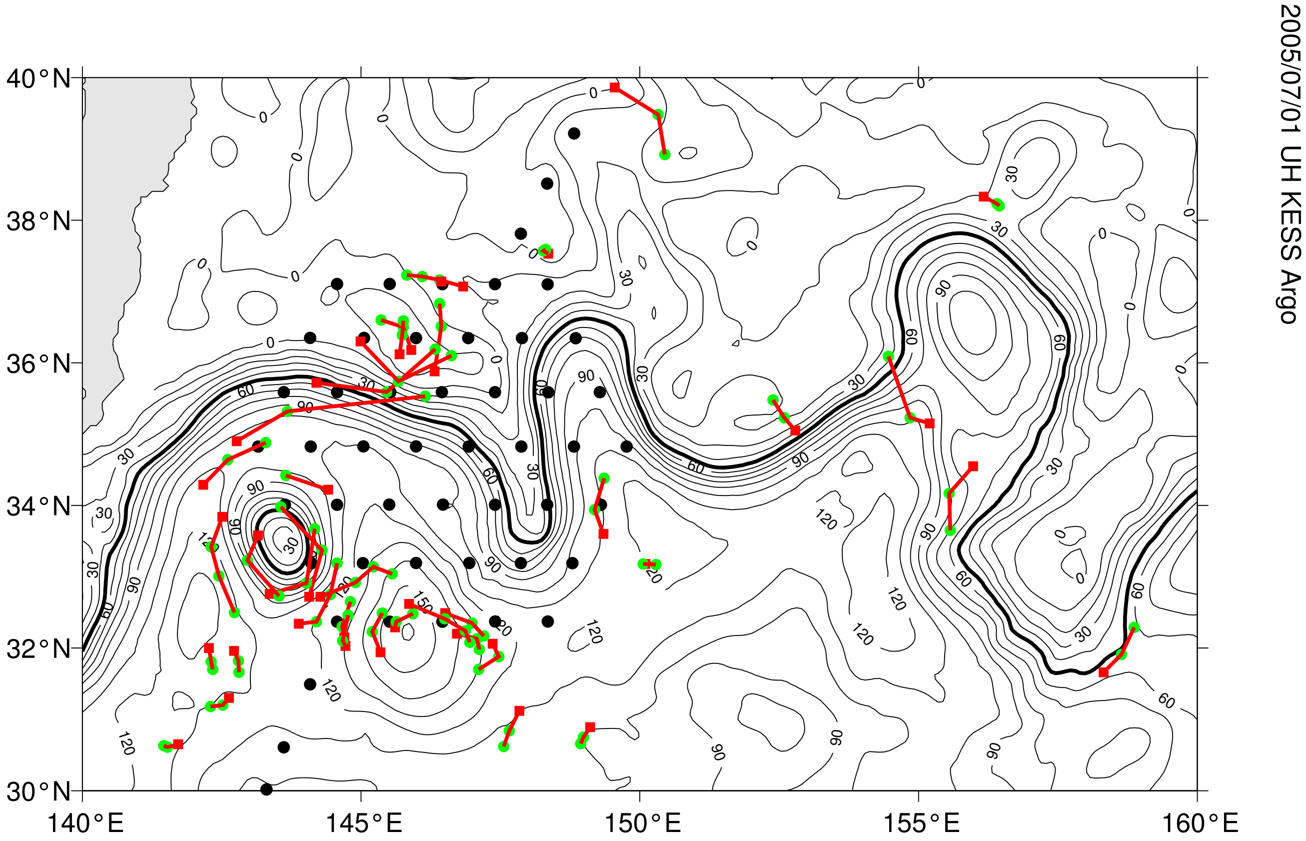

Figure 9: SSH for 7/1/2005 from NLOM model output with KESS array and ARGO float displacements added by Bo Qiu.

3.4 Ship Track Segments

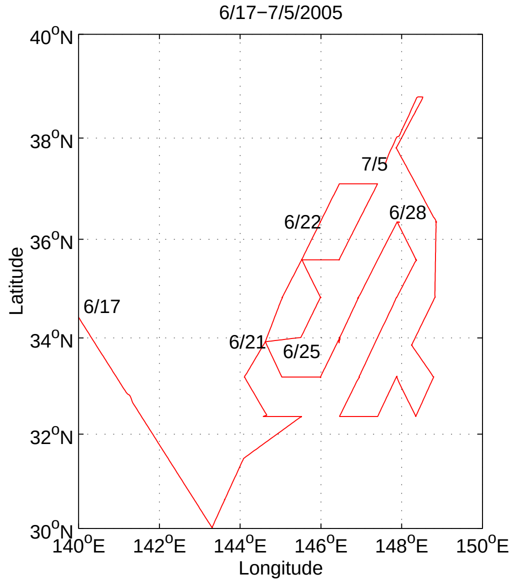

Figure 10: R/V Roger Revelle: Watts/Donohue KESS cruise track for June 17–July 5, 2005

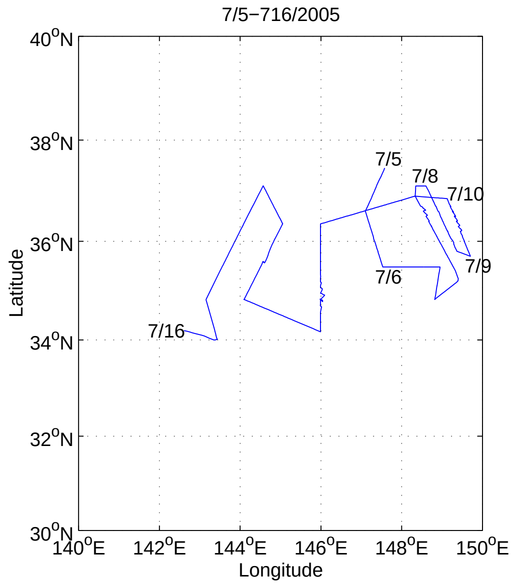

Figure 11: R/V Roger Revelle: Watts/Donohue KESS cruise track for July 5–16, 2005

3.5 ADCP Plots

3.5.1 Along Track

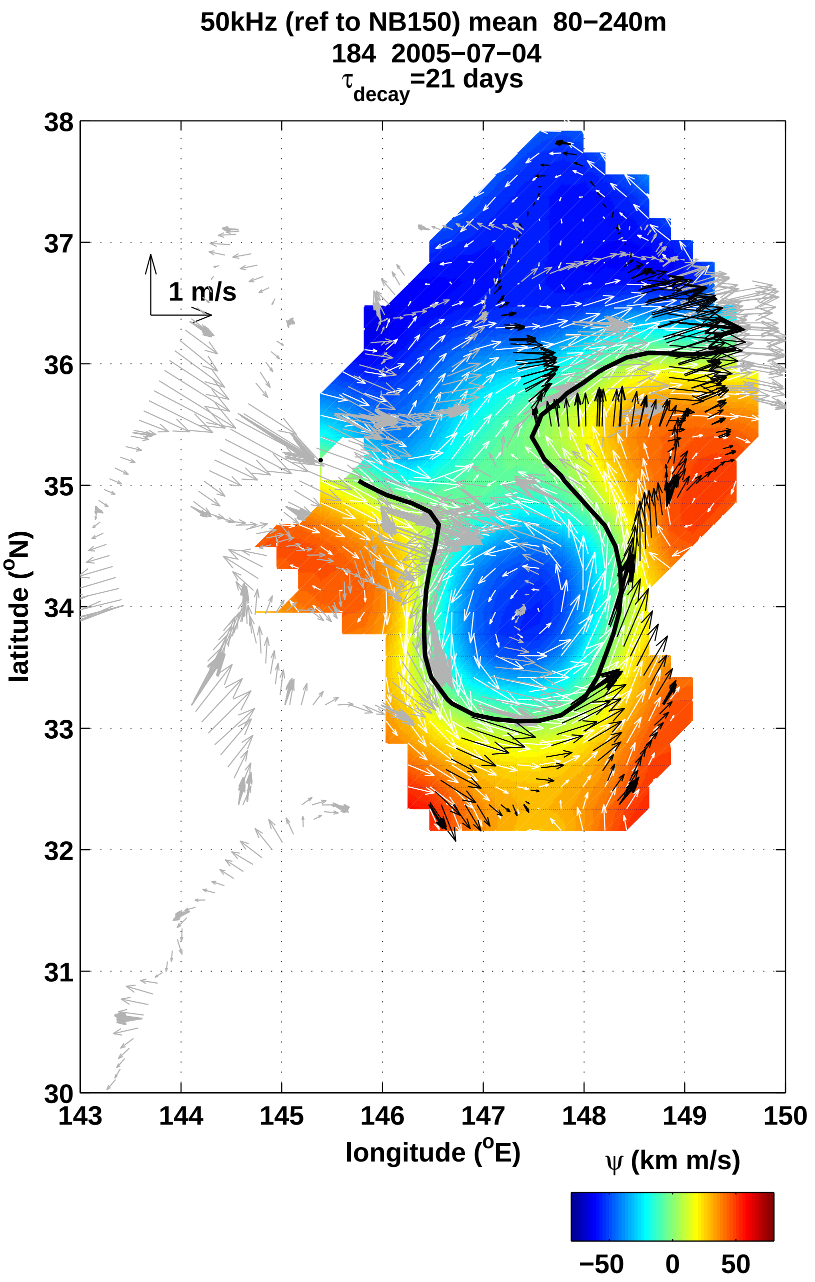

Figure 12: Along track ADCP vector plots (black and grey arrows) with OI mapped streamfunctions and velocity vectors (white arrows).

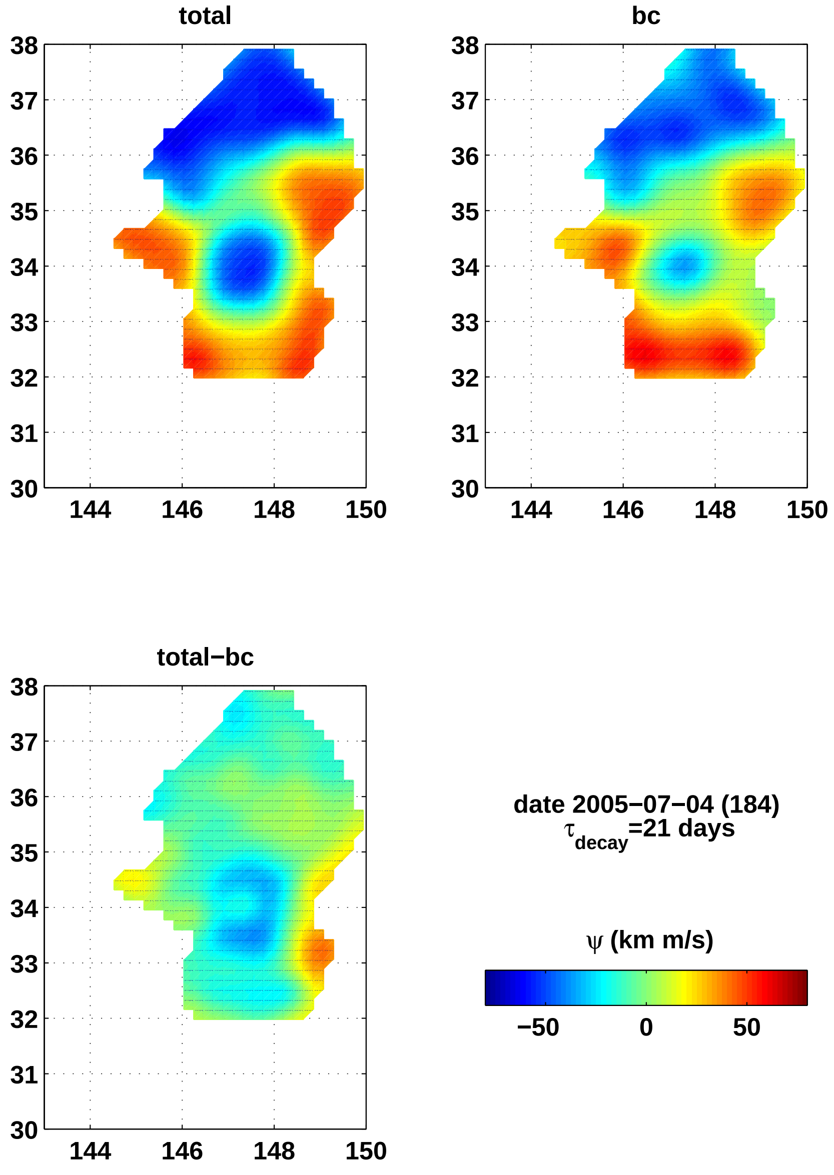

Figure 13: Total, baroclinic, and barotropic streamfunctions. The total streamfunction was calculated from an OI of shipboard ADCP, the baroclinic portions were derived from CTD data, and the barotropic is the difference of the two.

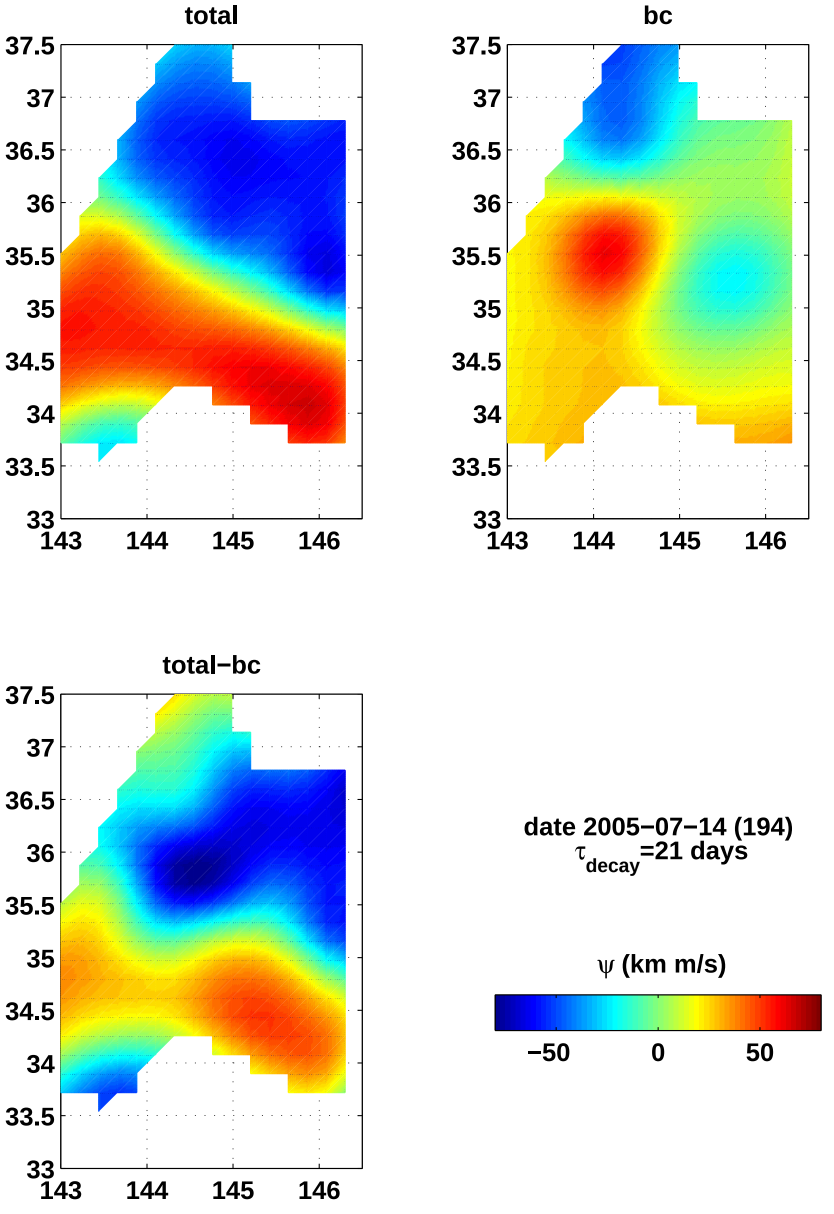

Figure 14: Total, baroclinic, and barotropic streamfunctions. The total streamfunction was calculated from an OI of shipboard ADCP, the baroclinic portions were derived from CTD data, and the barotropic is the difference of the two.

3.5.2 Cross Sections of the Kuroshio Extension

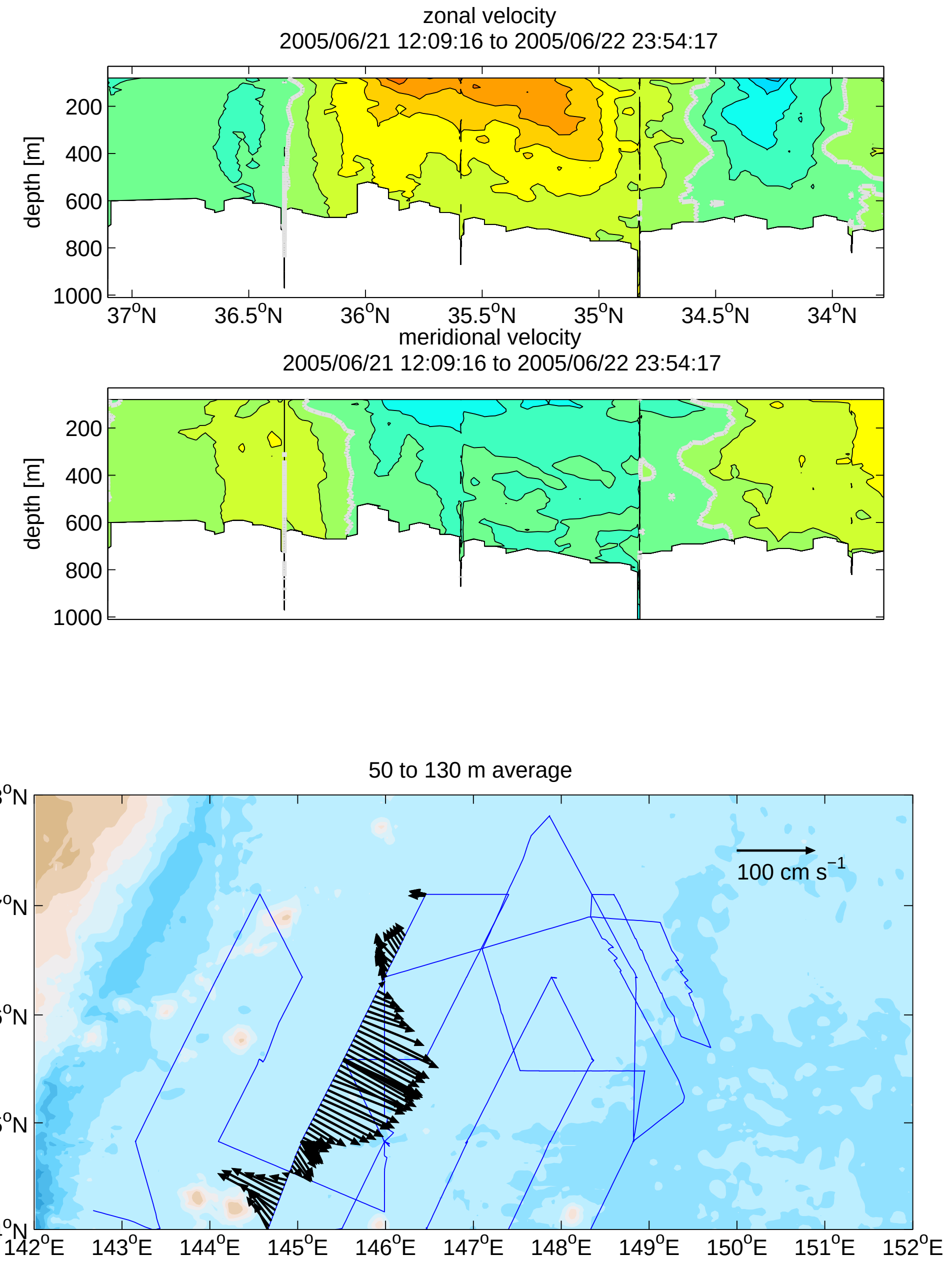

Figure 15: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

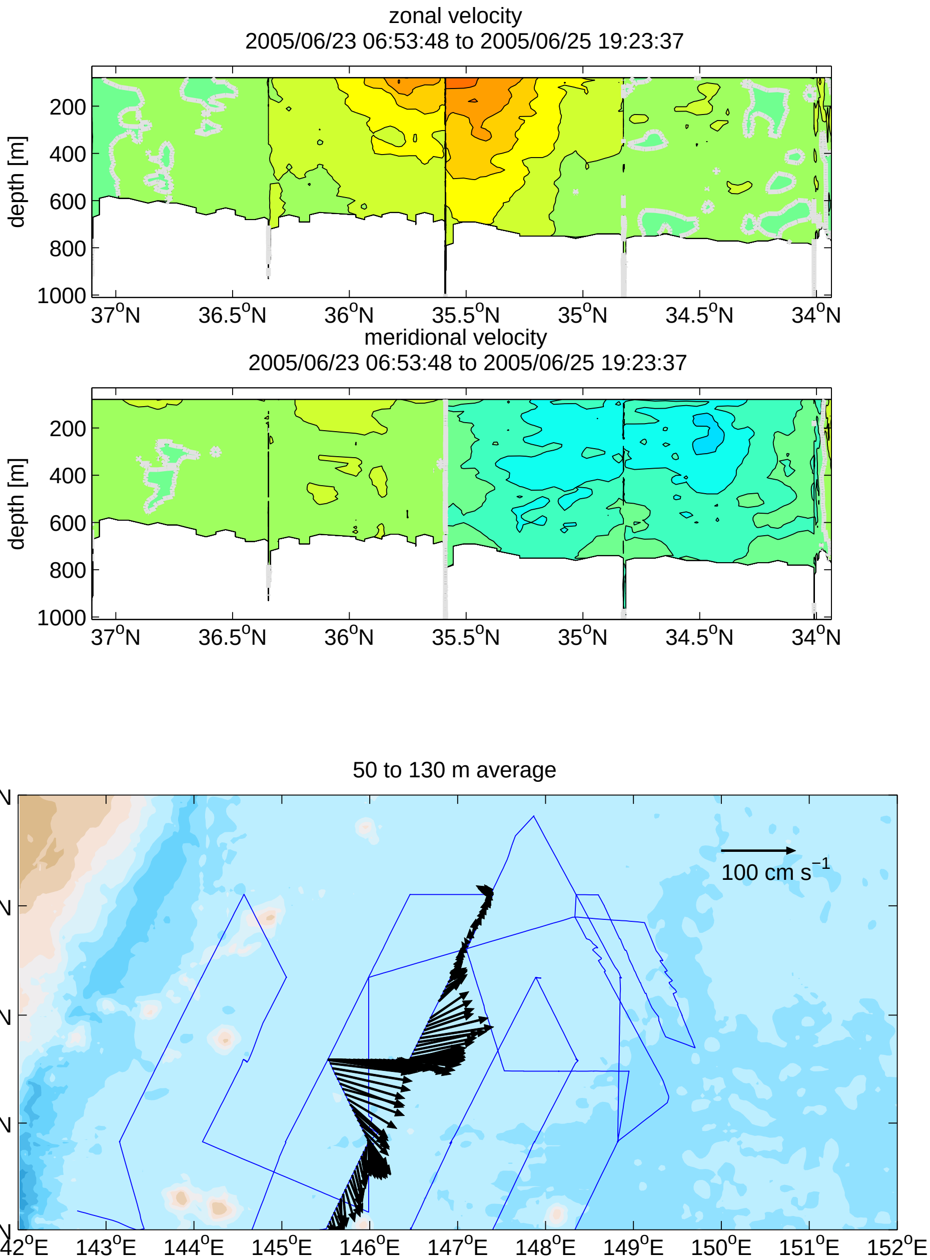

Figure 16: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

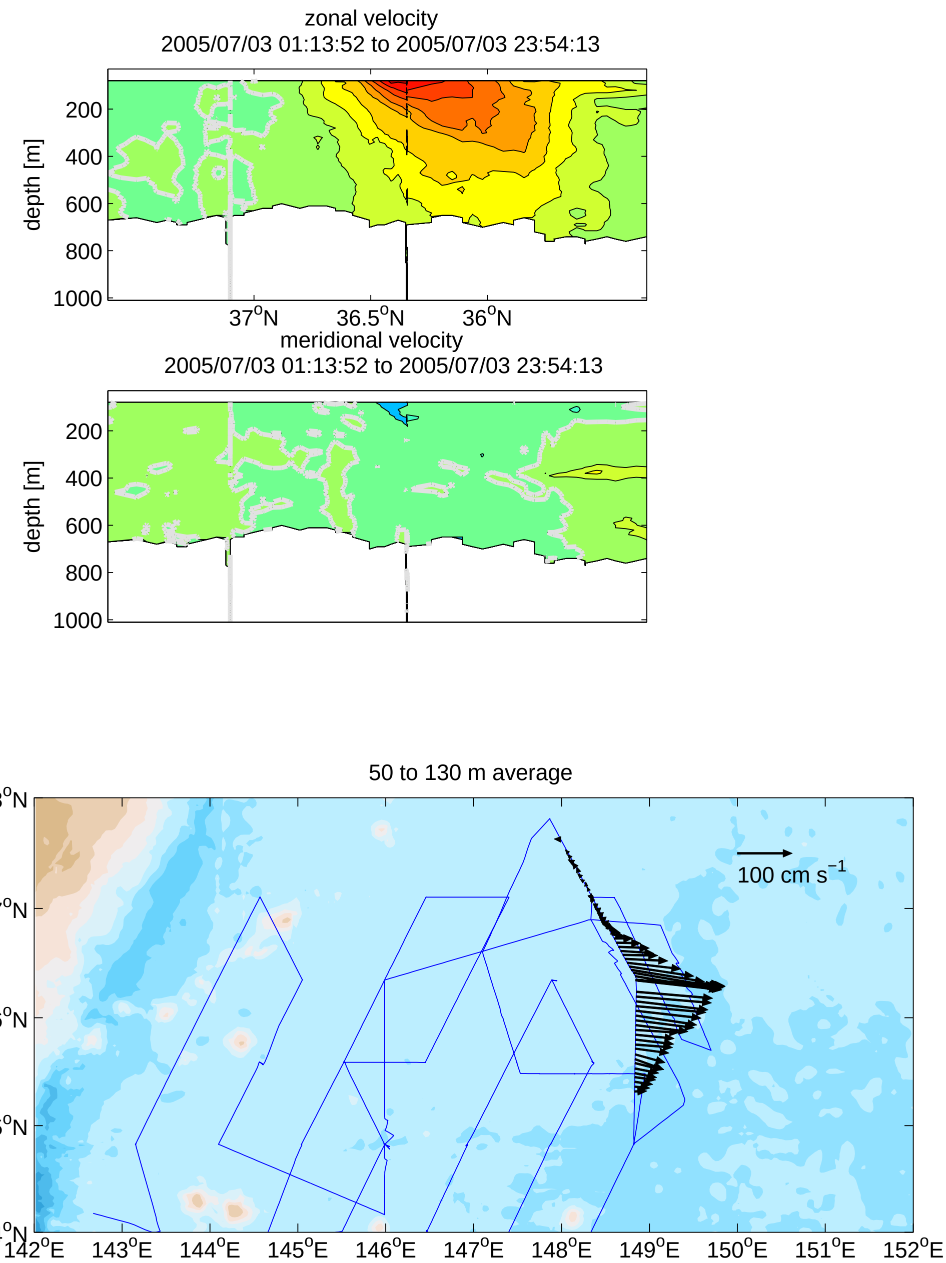

Figure 17: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

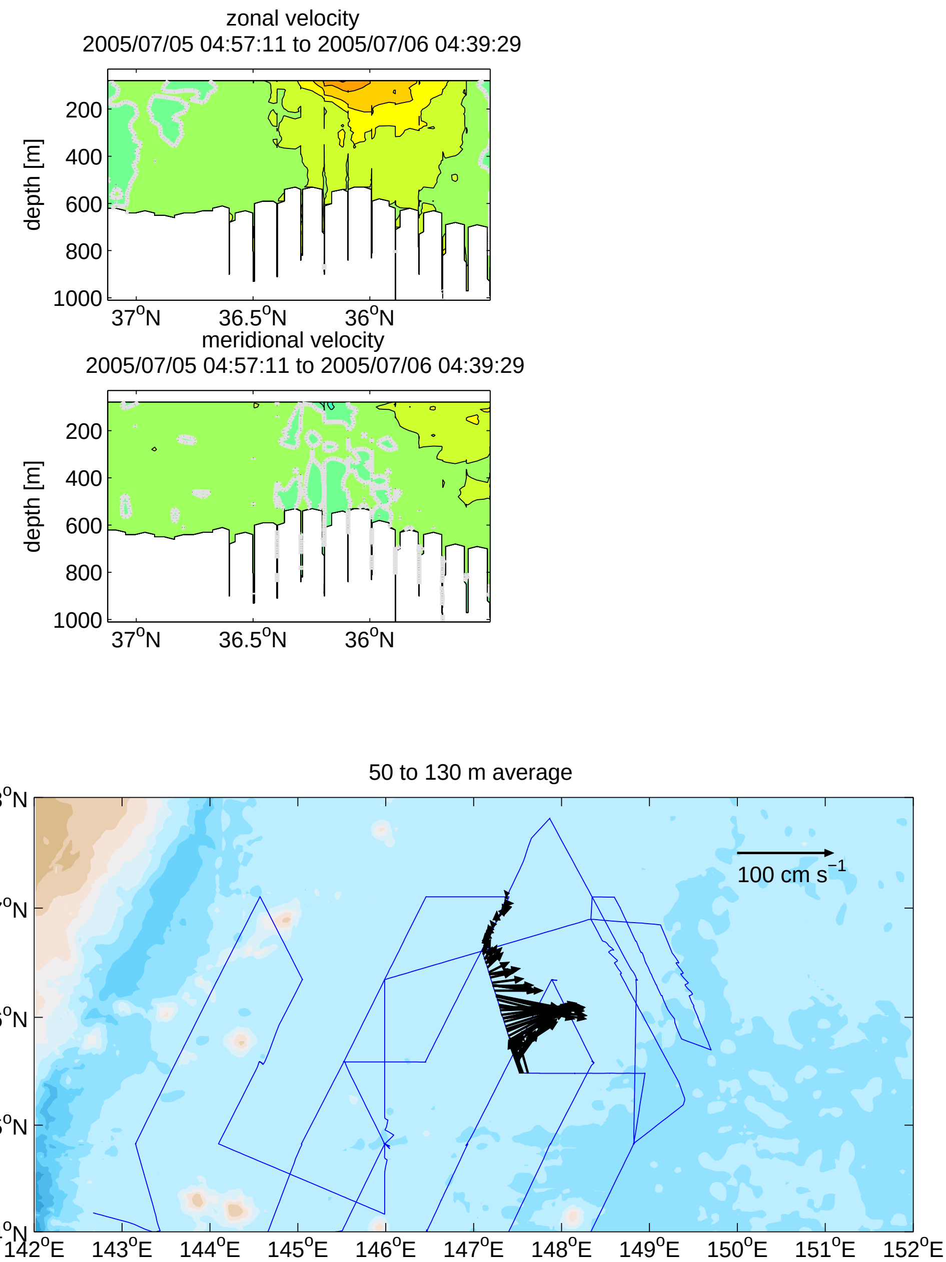

Figure 18: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

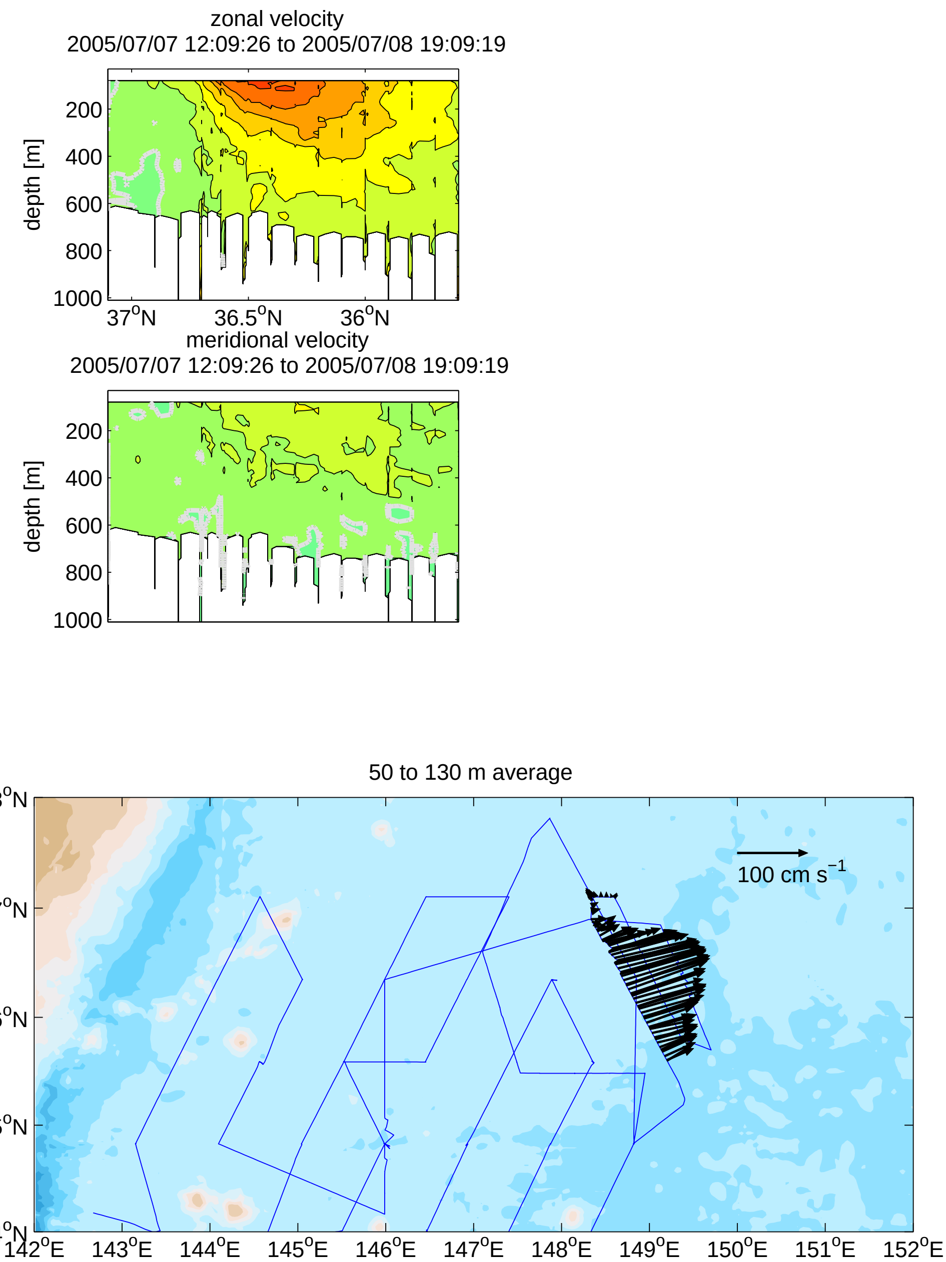

Figure 19: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

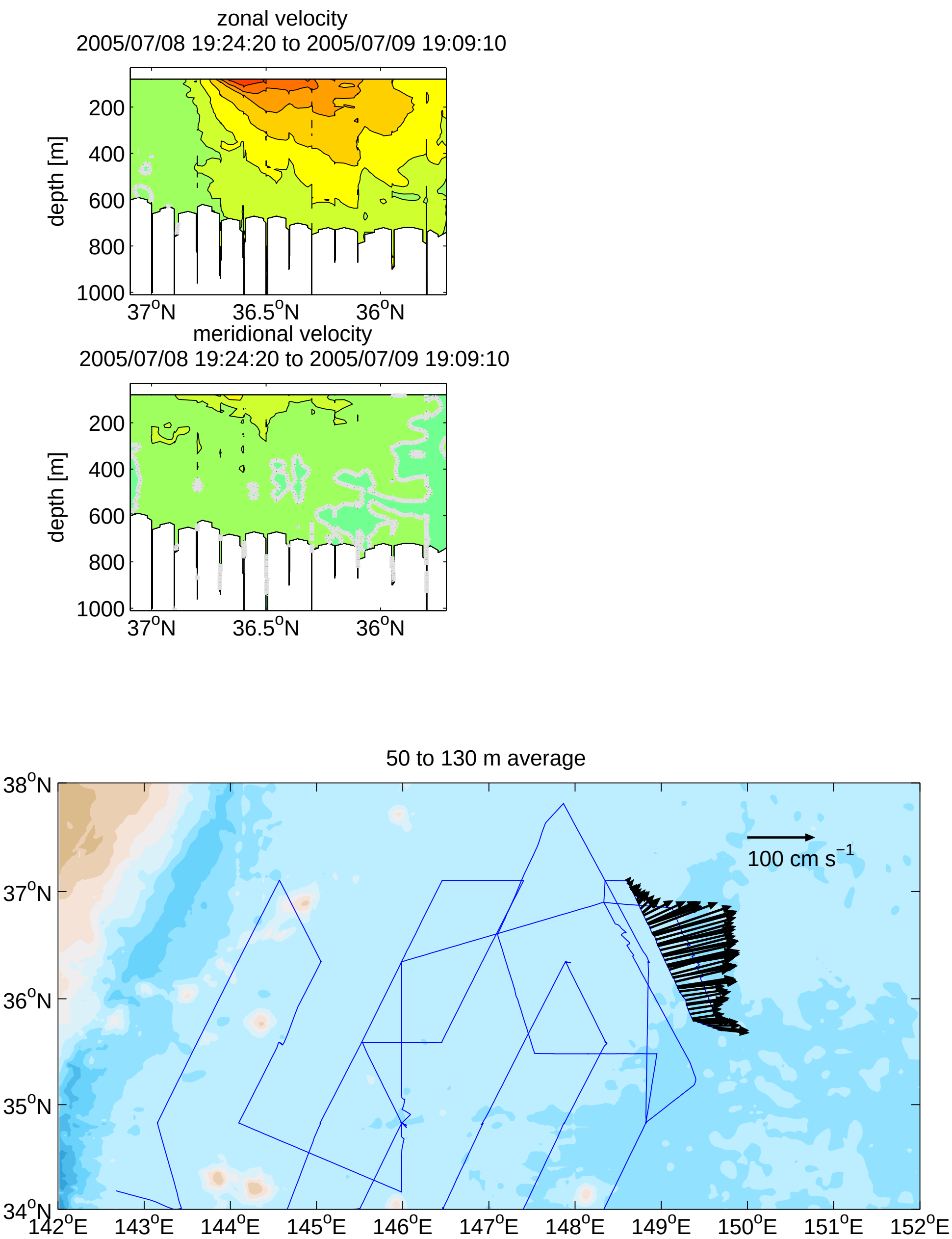

Figure 20: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

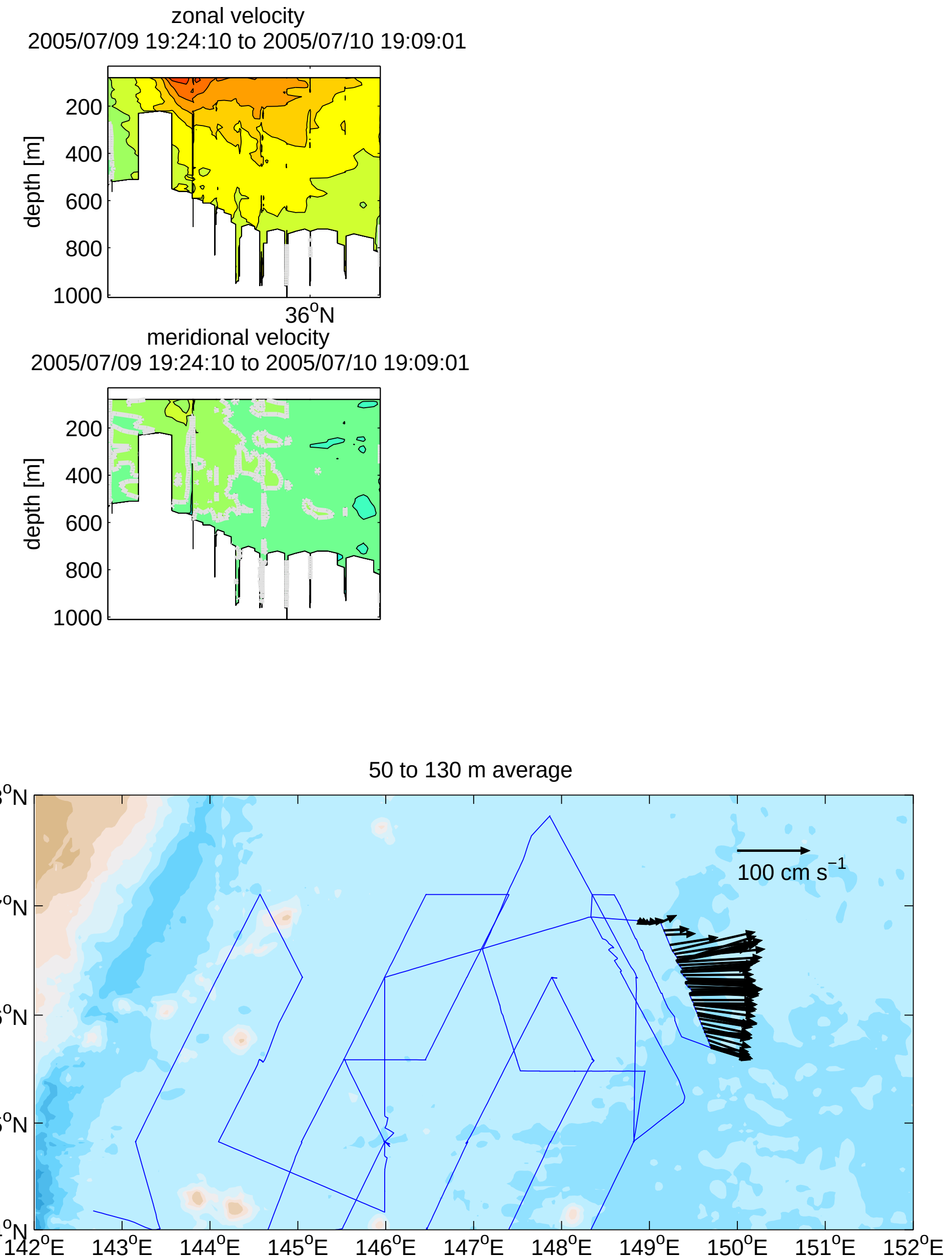

Figure 21: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

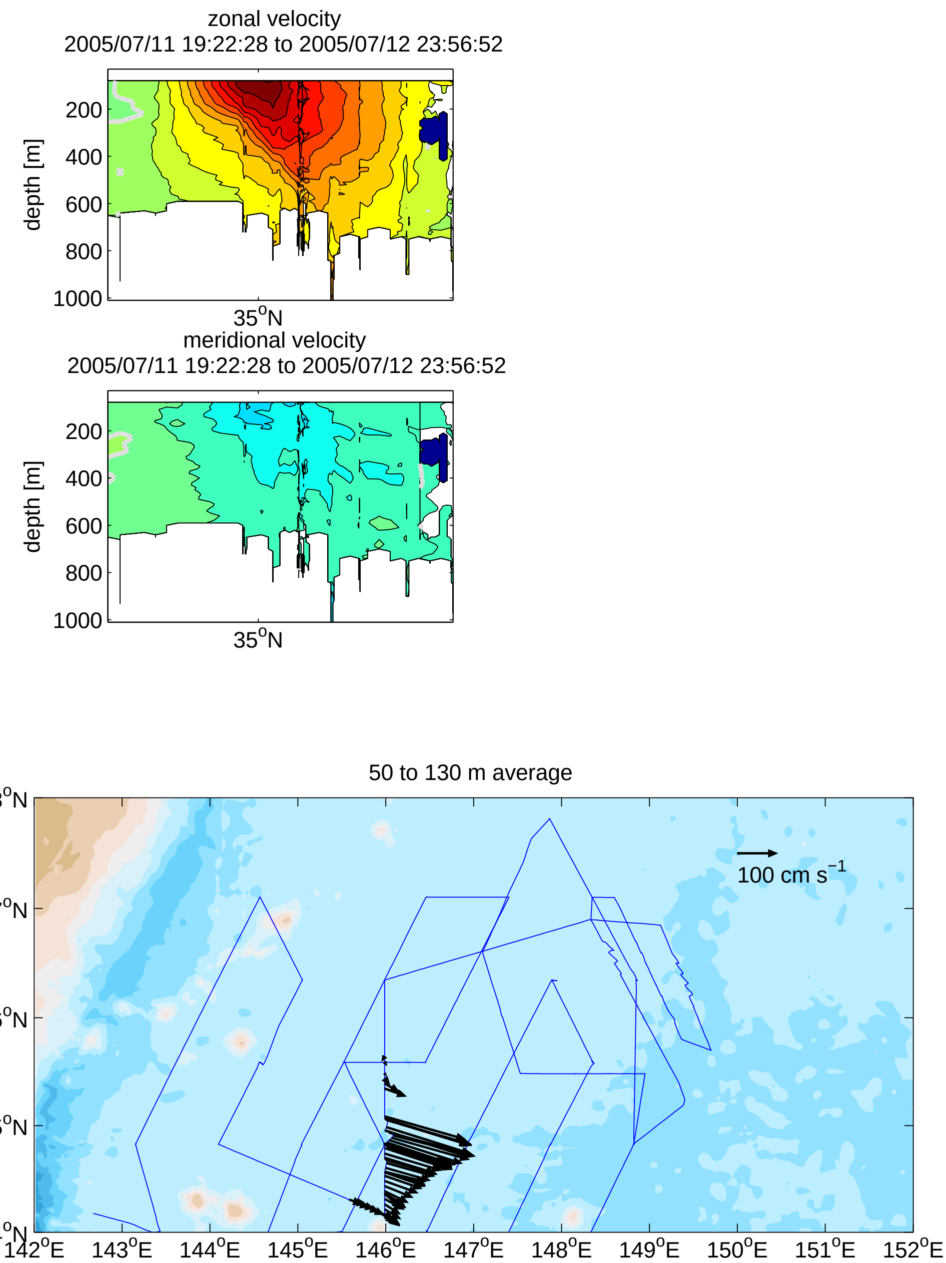

Figure 22: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

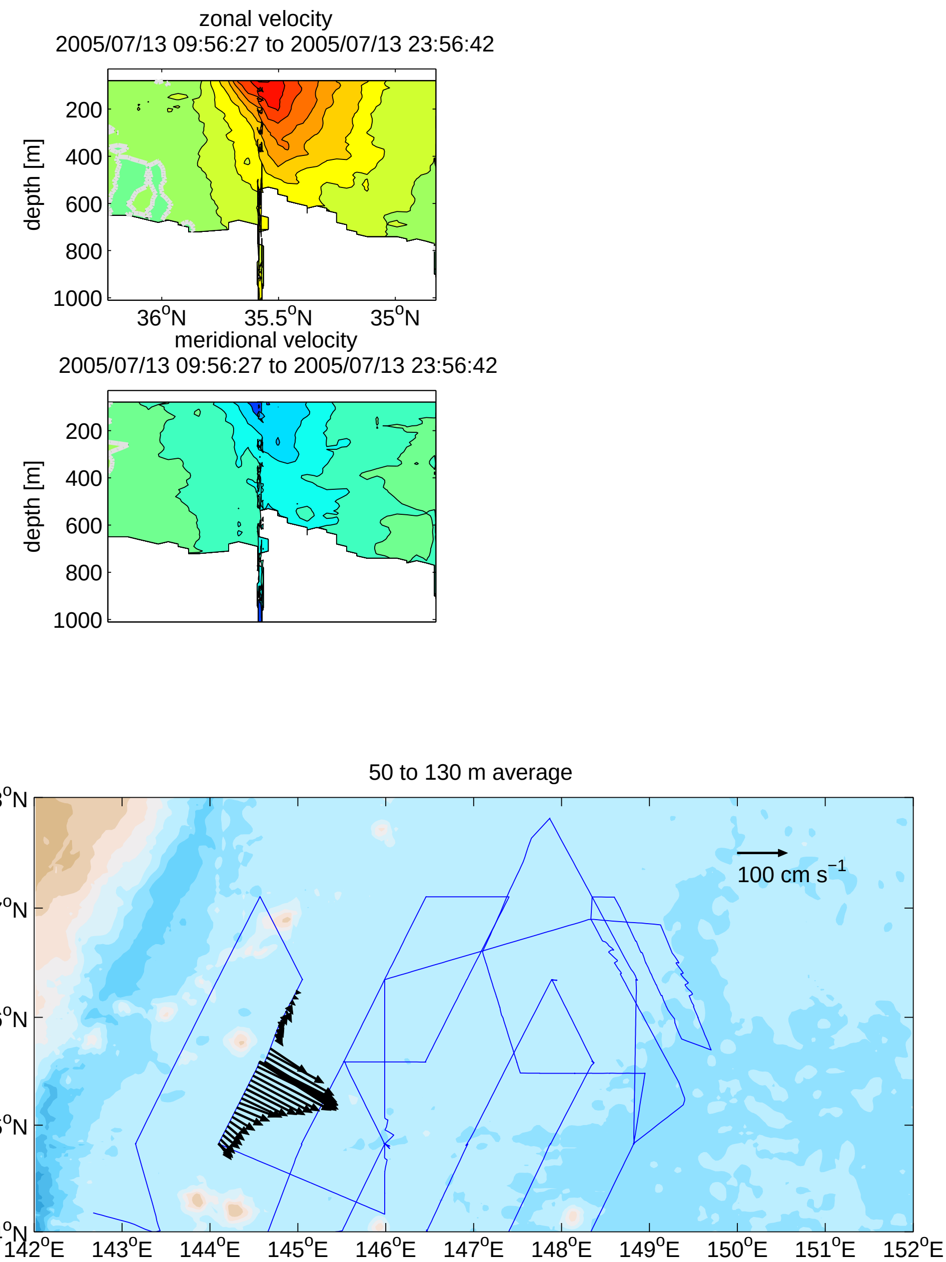

Figure 23: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

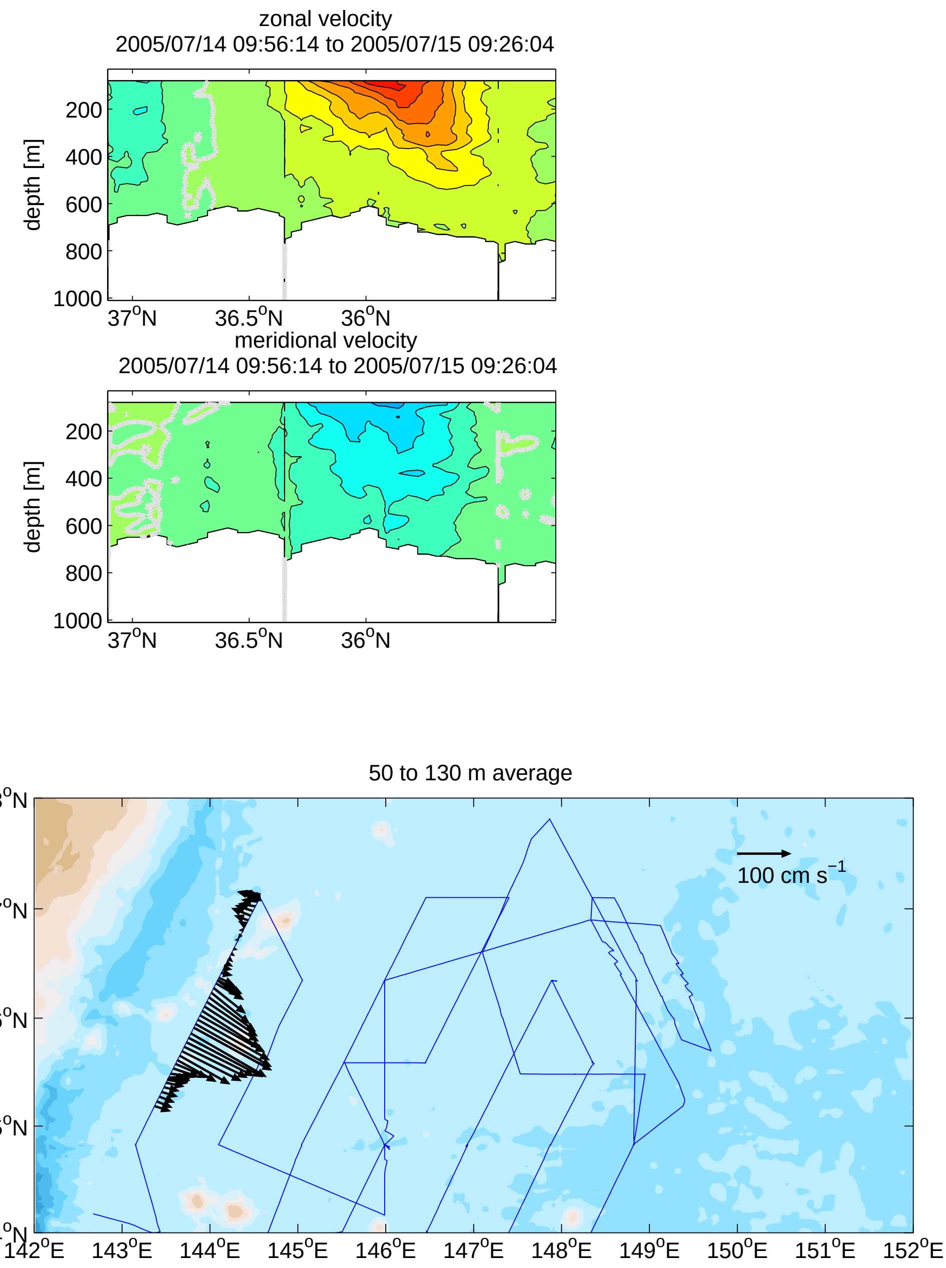

Figure 24: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

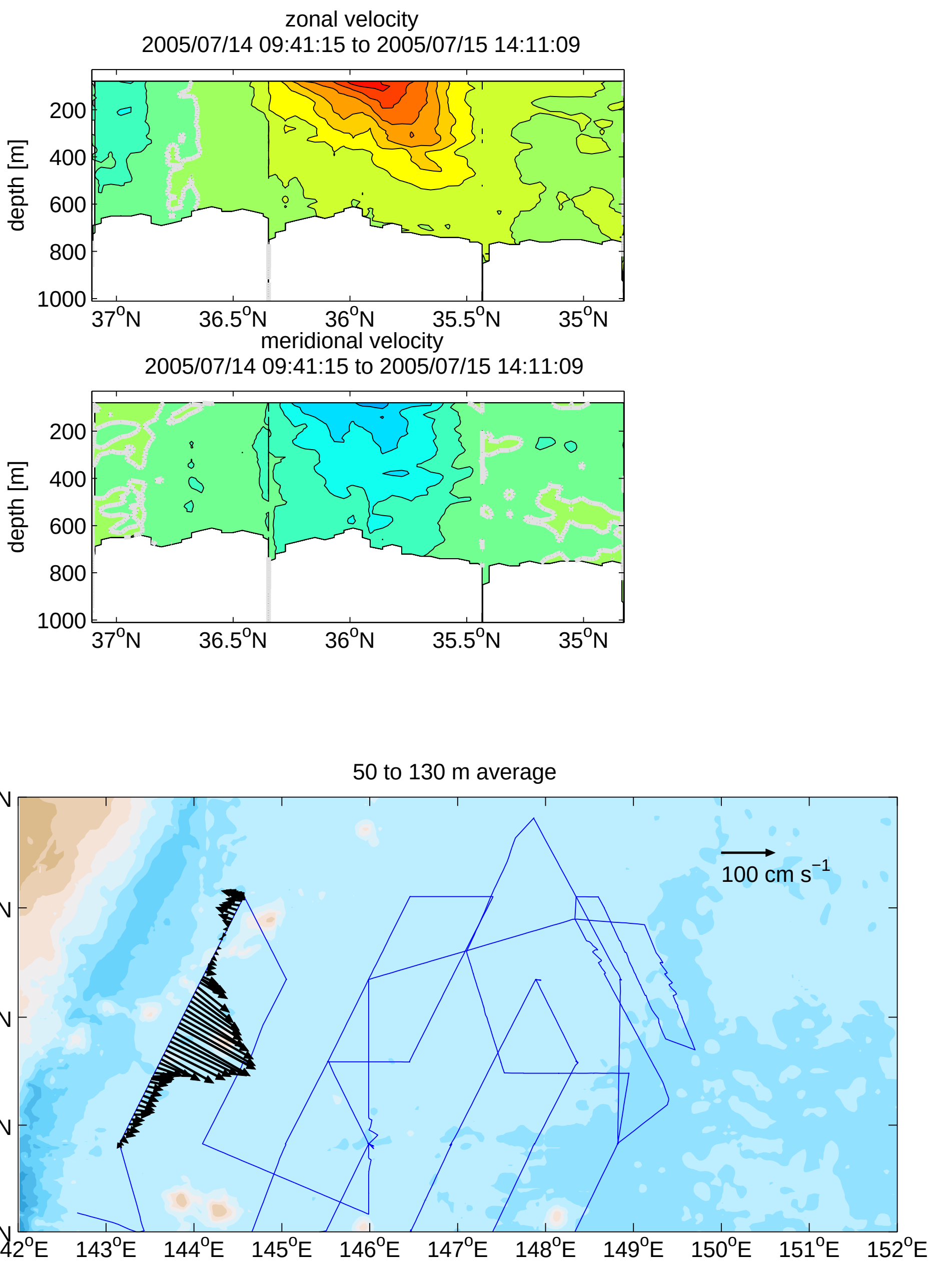

Figure 25: Upper panels: zonal (top) and meridional (middle) velocity from the ADCP. Lower panel: ADCP average velocity vectors superimposed on Smith & Sandwell bathymetry contoured every 1000 m.

3.5.3 BT Correction to HDSS

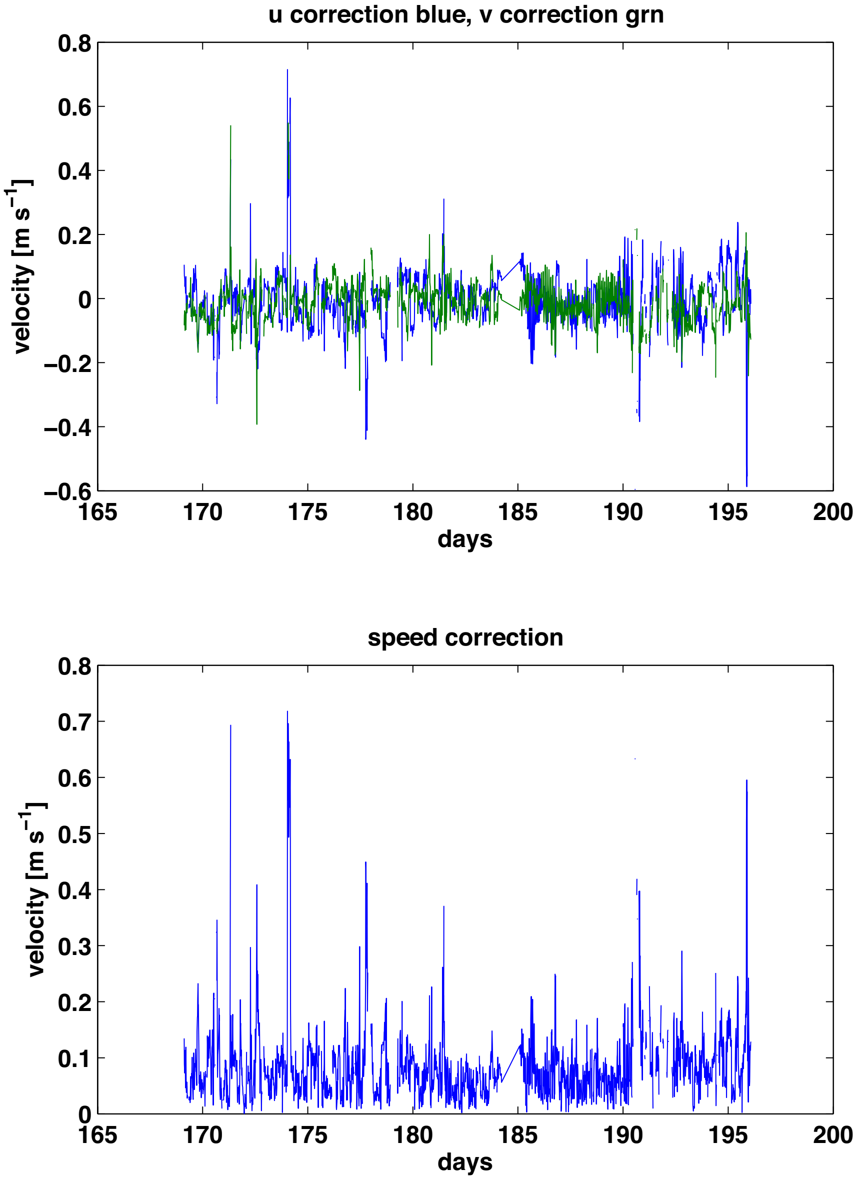

Figure 26: Barotropic correction applied to the HDSS 50. Upper panel: zonal (blue) and meridional (green) velocity. Lower panel: speed.