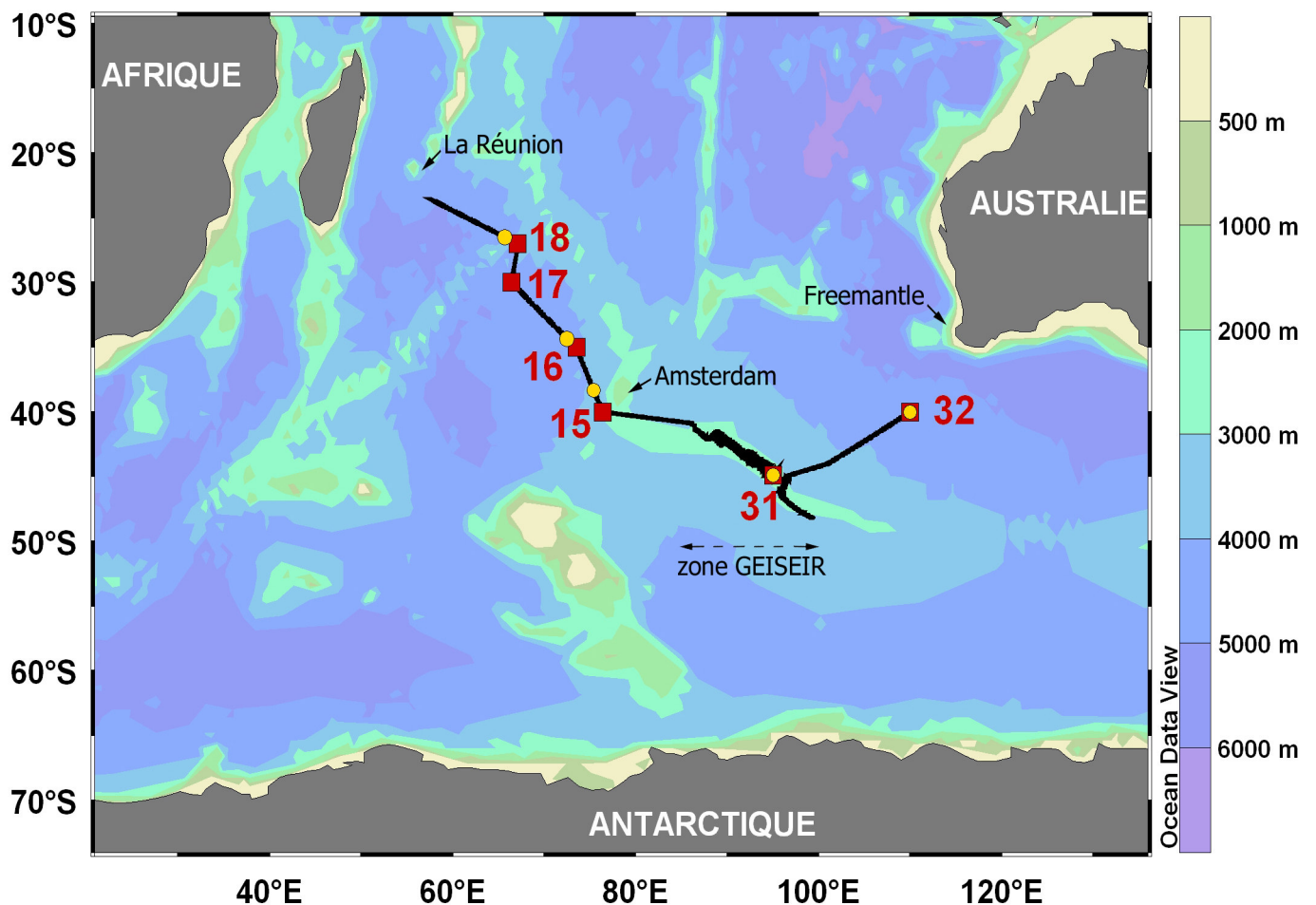


OISO17 cruise
conducted in Jan/Feb 2009
on board *R.V. Marion Dufresne*



Map locating the observations collected during the OISO17 cruise conducted in 2009 (Jan, 3 -Feb, 12). Water column samples were collected at the six CTD-Hydro stations shown in red (CTD and bottle data). Also indicated are the surface underway measurements (in black, CO₂ and related parameters) and the CTD-Light stations (yellow dots, CTD and PAR data)

Metadata for water column observations - OISO17

Principal Investigators

Name : Dr. Nicolas Metzl
Organization: LOCEAN-IPSL
Address: Univ. Pierre et Marie Curie - Case 100 - 4 place Jussieu
75252 Paris cedex 5 - France
Phone: +33 (0)1 44 27 33 94
Email: nicolas.metzl@locean-ipsl.upmc.fr

Name : Dr. Claire Lo Monaco
Organization: LOCEAN-IPSL
Address: Univ. Pierre et Marie Curie - Case 100 - 4 place Jussieu
75252 Paris cedex 5 - France
Phone: +33 (0)1 44 27 33 94
Email: claire.lomonaco@locean-ipsl.upmc.fr

Cruise Info

Project Name: Océan Indien Service d'Observation (OISO)
Objectives: The OISO program, started in 1998, aims at monitoring observations of the CO₂ system and associated properties (hydrology, biogeochemistry) in both sea surface and water column in the Southern Indian Ocean.
Cruise Name : OISO17
Expocode: 35MF20090103
Region: South Indian Ocean
Spatial Coverage: 23°S-48°S, 57°E-110°E
Temporal Coverage: 2009, Jan, 3 – 2009, Feb, 12
Ports of Call: Le Port, Reunion Island - Freemantle, Australia
Vessel, Country: Marion Dufresne (IPEV), France

Dataset Info

Submission Date: 2012, April

- Temperature CTD:

Units : Degree Celsius

Method: Temperature sensor Sea-Bird SBE3, calibrated in June 2009.

Quality Control: Temperature data are in good agreement with previous observations collected at the same locations (GEOSECS, INDIGO, WOCE and OISO data).

- Salinity CTD:

Method: Conductivity sensor Sea-Bird SBE04, calibrated in June 2009.

Quality Control: A shift in the conductivity sensor occurred at station 32 after the deep cast, resulting in unrealistic high values during the next shallow cast (cast 1). The latter were corrected by +0.05, based on the difference between CTD and bottle data during the shallow cast (0.053 ± 0.003). The corrected data are in good agreement with salinity CTD data from the deep cast. A good agreement is also obtained between CTD and bottle data at stations 15 and 31. For the other stations (16, 17 and 18), we found significant differences between CTD and bottle data which we attributed to bad salinity measurements (see below Measured Salinity).

- Measured Salinity:

Method: Water samples were collected from the Niskin bottles in 150 ml salinity bottles (Ocean Scientific International Ltd) and properly stored. Measurements were performed at LOCEAN using a Salinometer Guidline AutoSal 8400.

Standardization: IAPSO standards were used (Ocean Scientific International Ltd).

Accuracy: ± 0.005 , based on the analysis of replicate samples.

Quality Control: A random bias is detected in salinity measurements at stations 16, 17 and 18 (all depths), and at station 15 between the surface and 20m. These bad measurements were clearly identified by comparison with CTD data and salinity measurements from previous cruises. Consequently these data are flagged bad. On the contrary, a good agreement is obtained between CTD data, bottle measurements and previous observations at station 15 below 20m and at stations 31 and 32 (corrected CTD salinity for cast 1, see Salinity CTD above).

- Measured Oxygen

Units: $\mu\text{mol/kg}$

Method: Water samples were collected from the Niskin bottles in calibrated glass bottles (150-200ml). Measurements were performed onboard following Winkler's titration technique (Williams and Jenkinson, 1982).

Standardization: Iodate standards were used (Ocean Scientific International Ltd).

Field Replicate: Deep replicate samples were collected from two different Niskin bottles (usually 1000m or bottom). The mean difference between two deep replicates was $1.0 \mu\text{mol/kg}$ ($n=7$), with a maximum difference of $2.3 \mu\text{mol/kg}$.

Accuracy: $\pm 1 \mu\text{mol/kg}$ based on the analysis of deep replicate samples.

Quality Control: Oxygen data are in good agreement with previous observations collected at the same locations (GEOSECS, INDIGO, WOCE and OISO data). Note that, we detected significant differences in deep oxygen measurements at stations 31 and 32 between OISO17 and WOCE data, but no clear difference was observed between OISO17 and GEOSECS data.

Method References:

Williams, P. J. LeB, and N. W. Jenkinson, 1982. A transportable microprocessor-controlled precise Winkler titration suitable for field station and shipboard use. *Limnol. Oceanogr.*, 27, 576-585.

- Total CO₂ and Alkalinity

Units: $\mu\text{mol/kg}$

Method: Water samples were collected from the Niskin bottles in 500 ml glass bottles for the simultaneous analysis of total CO₂ and total alkalinity. Measurements were performed onboard following a potentiometric titration method (Edmond, 1970), using an automated system with a closed cell described by Goyet et al. (1991). The equivalence point is determined using a non-linear regression method (D.O.E., 1994).

Standardization: We used Certified Referenced Materials (CRMs), batch #83 and #91, provided by Dr. A. Dickson (SIO, University of California). The precision of the titration system, based on the analysis of CRMs, was $\pm 3.0 \mu\text{mol/kg}$ for both total CO₂ and alkalinity.

Field Replicate: Deep replicate samples were collected from two different Niskin bottles (usually 1000m or bottom). The mean difference between two deep replicates was

1.6 $\mu\text{mol/kg}$ for total CO_2 and 1.7 $\mu\text{mol/kg}$ for alkalinity ($n=7$), with a maximum difference of 3.8 $\mu\text{mol/kg}$ and 3.5 $\mu\text{mol/kg}$, respectively.

Accuracy: ± 3 $\mu\text{mol/kg}$ for both total CO_2 and alkalinity based on CRMs and deep replicate samples analyses.

Quality Control: Alkalinity data are in good agreement with previous observations collected at the same locations (GEOSECS, WOCE and OISO data). For Total CO_2 , we observed a good agreement with previous OISO observations at stations 16, 17 and 18, whereas measurements collected during the OISO17 cruise were higher than previous OISO observations at station 15 (by 5-10 $\mu\text{mol/kg}$ at 1000m) and higher than WOCE and GEOSECS data at stations 31 and 32 (by ~ 10 $\mu\text{mol/kg}$ below 1000m). However, since we also detected significant differences in oxygen, nitrate and $\delta^{13}\text{C}$ data at those stations, we attributed these differences to natural variability rather than a bias in total CO_2 measurements. Consequently, no correction was applied.

Method References:

D.O.E., 1994. Handbook of methods for 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.

Edmond J. M., 1970. High precision determination of titration of alkalinity and total CO_2 of seawater by potentiometric titration, *Deep-Sea Research*, 17, 737-750.

Goyet C., C. Beauverger, C. Brunet and A. Poisson, 1991. Distribution of carbon dioxide partial pressure in surface waters of the southwest Indian Ocean, *Tellus*, 43B, 1-11.

- Silicate, Nitrate, Nitrite and Phosphate

Units: $\mu\text{mol/kg}$

Method: Water samples were collected from the Niskin bottles in two plastic bottles of 20ml, and poisoned with 0.1ml of saturated HgCl_2 solution for storage. Measurements were performed at LOMIC (Banyuls, France) using an automated system (AA3, Bran+Luebbe), following the segmented flow method described by Aminot and K erouel (2007) and Coverly et al. (2009).

Standardization: Nutrients standard solutions (Ocean Scientific International Ltd) were diluted and used as reference samples.

Accuracy: $\pm 0.1 \mu\text{mol/kg}$ for silicate and nitrate, $\pm 0.01 \mu\text{mol/kg}$ for nitrite and $\pm 0.02 \mu\text{mol/kg}$ for phosphate, based on the analysis of 8 reference samples, each of them was measured twice (n=16). The accuracy was calculated as the standard deviation of the differences between measurements and the reference concentration. The maximum difference was $0.4 \mu\text{mol/kg}$ for silicate, $0.3 \mu\text{mol/kg}$ for nitrate, $0.02 \mu\text{mol/kg}$ for nitrite and $0.05 \mu\text{mol/kg}$ for phosphate.

Quality Control: Nutrients data are in good agreement with previous observations collected at the same locations (GEOSECS, INDIGO, WOCE and OISO data), with the exception of nitrate measured in deep waters at stations 31 and 32. However, similarly as for total CO_2 , oxygen and $\delta^{13}\text{C}$ data, we attributed this anomaly to natural variability.

Method References:

Aminot, A., and R. K  rouel, 2007. Dosage automatique des nutriments dans les eaux marines : M  thodes en flux continu. Ed. Quae / Ifremer, 2007, 188pp.

Coverly, S. C., Aminot, A., and R. K  rouel, 2009. Nutrients in Seawater Using Segmented Flow Analysis, In *Practical Guidelines for the Analysis of Seawater*, Ed. Oliver Wurl, CRC Press, June 2009, doi: 10.1201/9781420073072.ch8.

- Isotopic composition: $\delta^{13}\text{C}_{\text{DIC}}$

Units: ‰ (vs. Vienna-Pee Dee Belemnite)

Method: Water samples were collected from the Niskin bottles in 125 ml glass bottles and poisoned with 1 ml of saturated HgCl_2 solution for storage. Measurements were performed at LOCEAN using a dual inlet-isotopic ratio mass spectrometer (SIRA9-VG), following the method described by Racap   et al. (2010), adapted from Kroopnick (1974). The precision and the reproducibility of this method are respectively close to $\pm 0.01 \text{‰}$ and 0.02‰ (Vangriesheim et al., 2009; Racap   et al., 2010).

Standardization: The isotopic composition is expressed in the δ -unit defined by Craig (1957) by comparing the $^{13}\text{C}/^{12}\text{C}$ ratio of the sample (R) to the $^{13}\text{C}/^{12}\text{C}$ ratio of a reference material (R*), the Vienna-Pee Dee Belemnite (V-PDB), as follows:
$$\delta^{13}\text{C}_{\text{DIC}} = [(R/R^*) - 1] \times 1000.$$

Accuracy: $\pm 0.01 \text{‰}$ based on the analysis of replicate samples.

Quality Control: $\delta^{13}\text{C}_{\text{DIC}}$ data are in good agreement with previous observations collected at the same locations (GEOSECS, WOCE and OISO data), with the exception of

deep measurements collected at stations 31 and 32. However, similarly as for total CO₂, oxygen and nitrate data, we attributed this anomaly to natural variability.

Method References:

- Craig, H. 1957. Isotopic standards for carbon and oxygen and correction factor for mass-spectrometric analysis of carbon dioxide. *Geochimica Cosmochimica Acta*, 12, 133-149.
- Kroopnick, P. 1985. The distribution of ¹³C of ΣCO₂ in the world oceans. *Deep-Sea Research*, 32 (1), 57-84.
- Racapé, V., C. Lo Monaco, N. Metzl, and C. Pierre, 2010. Summer and winter distribution of δ¹³C_{DIC} in surface waters of the South Indian Ocean (20°S-60°S). *Tellus B*, 62 (5), 660-673, doi: 10.1111/j.1600-0889.2010.00504.x
- Vangriesheim, A., Pierre, C., Aminot, A., Metzl, N., Baurand, F. and co-authors. 2009. The influence of Congo river discharges in the surface and deep layers of the Gulf of Guinea. *Deep-Sea Res. II*, doi:10.1016/j.dsr2.2009.04.002.

Additional information:

Acknowledgments: The OISO program is supported by the French agency INSU, IPEV and IPSL. We are grateful to the captain and crew of R.V. *Marion Dufresne*, the cruises participants, as well as on-land technicians for their help in producing these data.

Other data: More parameters were measured during the OISO17 cruise: (contact PIs above)

- Water column measurements of δ¹⁸O_{H2O}, chlorophyll-a, light attenuation (PAR).
- Incubation for measurements of primary production and N₂ fixation.
- Underway surface measurements of temperature, salinity, pCO₂ and related parameters.
- Atmospheric p CO₂ and meteorological observations
- Underway Current Profiler (ADCP)

Project URL: <http://caraus.ipsl.jussieu.fr/oiso-accueil.html>

Note: Website in French, the English version is under construction