SECTION 1: CRUISE SUMMARY

PRE-WOCE ISS01, RRS DISCOVERY CRUISE 164
SEASOAR AND CTD SECTIONS IN THE SOUTHWEST INDIAN AND SOUTHERN OCEANS FROM 22S TO 52S

Expedition Designation (EXPOCODE) 74DI164_1

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Ship: RRS Discovery owned and operated by the Natural Environment Research Council, UK.

Ports of Call: Port Louis, Mauritius to Port Louis, Mauritius.

Cruise Dates: 19 December 1986 to 21 January 1987.

CRUISE OVERVIEW

Cruise Track
The station locations are available in the accompanying summary file.

Number of Stations
A total of 61 CTD/Rosette stations were occupied employing a 12 place 2 litre Niskin Bottle Rosette with a Neil Brown CTD.

Sampling
Water samples measurements were made for salinity and oxygen. Although CTD data were carefully reconciled with the sample values the latter are no longer available.

XBTs
39 Deep Blue XBTs were deployed during the cruise. Their fate is unknown.

Table 1 CRUISE PERSONNEL & TASKS

Pollard, Raymond T.	IOS	Principal Scientist
Diddams, Paul D.	IOS	XBTs
Goy, Keith M.	IOS	XBTs
Griffiths, Gwyn	IOS	ADCP
Grohman, Dave	IOS	Winches
Hooker, Nigel J.	IOS	CTD
King, Brian A.	IOS	Hydrography/Navigation
Moorey, John A.	IOS	Salinity/Oxygen
Read, Jane F.	IOS	Hydrography
Smithers, John	IOS	CTD/Rosette
Stirling, Moragh W.	IOS	Biology
Wild, Roy A.	IOS	Winches
Brook, Andrew J.	RVS	Computing
Lewis, Derek	RVS	Computing
May, Stephen J.	UCNW	Biology

IOS   Institute of Oceanographic Sciences, Wormley UK
RVS   Research Vessel Services, Barry UK
UCNW University College of North Wales, Bangor UK

SECTION 2: SCIENTIFIC PROGRAMME

1. To document the incidence and nature of frontal structures in the Southern Ocean. Can the Subantarctic front be identified on all transects? How do upper ocean properties change across each front? Are the Polar, Subantarctic and Subtropical Fronts the only ones?

2. To document downstream (zonal) variations in the structure of the Antarctic Circumpolar Current (ACC). Is the ACC banded in mid-0cean as it is in the Drake Passage, with geostrophic currents concentrated in frontal zones?

3. To estimate the transport of the ACC.

4. To observe spatial variations in the T/S properties of mode waters and compare the observations with theories of mode water formation.

5. To explore the potential of the SeaSoar and Acoustic Doppler Profiler to quantify the scales and meridional transport of mesoscale eddies in the Subantarctic Zone.

SECTION 3: UNDERWAY MEASUREMENTS

A) NAVIGATION

Only GPS and transit satellites could provide absolute position fixes in the area of operation. The track plot was therefore computed in the standard way perfected on Discovery, using the two-component EM log to interpolate between satellite fixes, assuming a constant current between each pair of transit fixes. The EM log had been calibrated on Cruise 162 (Pollard, Swallow and Saunders), and these recent calibrations were used on Cruise 164, namely

Misalignment angle

of EM log = 1.7deg clockwise from ship's head

vFA(tru) = 0.1955 + 0.93145 vFA(est) (knots)

vSP(tru) = 0.015 + 0.962 vSP(est) (knots)

Transit satellite fixes were transferred from the Level C to the PDP11/34 via magnetic tape, eliminating all duplicate and suspect fixes. These were further culled to eliminate all fixes with elevations less than 10deg or greater than 70deg, with more than 3 or occasionally 4 iterations, and closer together than about one hour. About 400 fixes remained over the 33 day cruise, an average of about one fix every two hours. The currents calculated from these fixes and the EM log DR can be seen in Fig. 3 of Pollard et al. (1987).

The GPS system provided position fixes for between 3 and 5 hours per day throughout the cruise, typically for periods of one to two hours duration. Once per minute during these periods, fixes were typed on a dedicated printer and time, latitude, longitude and number of space vehicles were logged onto the ship's level A/B/C system.

The GPS user has some control over how the system chooses which space vehicles (SVs) are used to calculate position:

(1) The minimum angle of elevation of a good SV. This was kept at 10deg throughout the cruise.

(2) The maximum acceptable value of PDOP (Position Dilution of Precision) for a group of SVs, which is a function of the relative positions of the SVs. The default value for this is 7.0. However, a value of 15 was used for most of the cruise and the fixes obtained when PDOP was greater that 7.0 were not obviously worse that when PDOP was less than 7.0.

(3) At certain times during the cruise, four or more SVs were visible. If permitted, the system will calculate a horizontal and vertical position from four SVs. However, the resulting fixes had a high value of PDOP (which may or may not matter). When four SVs were available, the receiver was programmed to calculate a 2-D fix from the best combination of three SVs; the choice of SVs was made by the system.

It is recommended that when a group of SVs comes into view, the system is initialised with a position correct to within half a degree. After initial experimentation, the receiver was left unattended throughout the day and periods of GPS fixes were initialised with the previous GPS fix, which was up to 13 hours earlier and 1.5 degrees distant. This method of operation seems to have been quite adequate.

Accuracy A preliminary analysis of the position fixes shows that even with values of PDOP up to 15, differences between GPS and SATNAV/DR were usually less than 500m, which is the limiting accuracy of the transit fixes themselves.

Note After a mains power failure, the GPS receiver had to be reset to the required mode of operation. Some fixes were lost before it was discovered that the receiver had not recovered to its state before the loss of power.

Navigation data resides at the British Oceanographic Data Centre (BODC).

(Brook, King, Pollard)

B) SEASOAR

Seasoar - towed yoyo CTD measurements were made between the surface and a nominal 400m depth along 3000km of track. These data can be recovered from the British Oceanographic Data Centre (BODC) and information concerning them can be found in Pollard et al. (1987).

C) ADCP MEASUREMENTS

These were early days for the RD Acoustic Doppler Current Measurements (ADCP) and considering this and given the lack of precision in the navigation, the data has large error estimates. See Pollard et al. (1987) for further details.

D) DEPTH MEASUREMENTS

The Precision Echo-Sounder was run throughout the cruise.

Depths every 6 minutes were logged and corrected using Carter tables. The data resides at the British Oceanographic Data Centre (BODC).

E) XBT OBSERVATIONS

See the section on Cruise Overview.

SECTION 4: STATION MEASUREMENTS - CTDS

A CTD station list can be seen in Table 1 of Pollard et al. (1987) and in the Summary file. All casts except 11399 and 11400 were made with the IOS Neil Brown Instrument Systems "New Deep CTD", and were made to full ocean depth. A transponder attached to the CTD frame was used to make casts to within 20m of the bottom whenever a good bottom echo could be seen.

The earth connection was found to be faulty and the cable termination was remade prior to station 11418. The oxygen sensor failed for station 11430. For all other stations it was found to drift way off calibration, but reasonable oxygen profiles could be recovered using oxygen samples. Only once did a station have to be delayed with the vessel hove to in rough weather, prior to 11450, when winds up to 45kt were recorded.

On station 11452, it was found that the wire on the midships winch did not lay properly at about 4600m, and some time was lost on that and subsequent casts trying to achieve a perfect lay.

The conductivity cell failed after cast 11458 and had to be replaced.

All casts were logged on a Digidata tape deck interfaced to the NBIS deck unit and displayed in real time on a BBC micro computer system. Indeed, for the first ten casts no other data recording was possible, because source code for the CTD Level A computers was not on board so the CTD data cycle definition could not be modified. This was later patched, and data were averaged to one second values by a Level A micro computer, and transferred to both the Level C and PDP11/34 computers. It proved useful to have all three routes, as two out of three paths failed on a number of occasions, when either the Digidata tape was inadvertently not started, or the logging program to the PDP timed out, or the Level C failed. Consequently, no data were lost.
(Smithers, Hooker, Brook)

CTD CALIBRATION

The 12 bottle multisampler was used to collect samples for calibration on all CTD casts. On occasion, the multisampler does not trip the sample bottle, but this can be detected by the CTD recovering rather quickly from the firing signal. Thermometer frames were placed on bottles one and four, to keep a check on the NBIS calibration. The CTD reads high by a few millidegrees compared to thermometers throughout the cruise, so was taken to be correct.

Salinities were drawn at 12 levels for the first six deep casts. The first-guess CTD calibration appeared to be stable, and about 0.050psu too low at all depths, so salinities were only drawn at three levels thereafter, to keep the number of samples to be analysed to reasonable levels. The Guildline salinometer did not function properly from the start of the cruise. The fault was diagnosed to be a faulty cell, and the Autolab salinometer had to be used for the rest of the cruise. Because it is not as repeatable as the Guildline (when working properly), triplicate samples were drawn at each level. If the duplicate samples proved inconsistent, the triplicate was analysed to decide the matter.

The Beckman oxygen sensor on the NBIS CTD is known to be unstable and hard to calibrate. For this reason, 9 to 12 samples were drawn on casts 11401-15. However, it became apparent that reagents for oxygen titration would run out, as significantly more CTD casts were being made than originally planned. Oxygen samples had therefore to be drawn from a restricted number of levels, namely the bottom, 2500m, oxygen minimum, oxygen maximum, thermocline and near surface, six in all. These proved barely adequate to fit the exponential temperature and pressure coefficients, as the sensor calibration drifted wildly during the course of the cruise. Further details will be given in the CTD data report (Pollard, Read and Smithers, 1987).

Two shallow casts were made at the start of the cruise to provide an approximate calibration for the conductivity ration of the shallow CTD to be used in the SeaSoar. In the absence of daily deep CTD casts during the week long SeaSoar runs, high priority was given to surface salinity samples drawn half hourly from the non-toxic supply. These were entered on the PSTAR computer system and differenced from 6m SeaSoar values after careful correction of the latter for obvious offsets in the T/S relation. It was found that the SeaSoar was within 0.03psu of the samples, with long term drifts (over days) or order 0.01psu, which can be corrected later. The technique is thus a satisfactory way of maintaining the salinity calibration within 0.01psu.

(Moorey, Read, Smithers)

REFERENCES

Pollard, R.T., et al. 1987 RRS Discovery Cruise 164, 19 December 1986 - 21 January 1987. SeaSoar and CTD sections in the Southwest Indian and Southern Oceans from 22 S to 52 S. Institute of Oceanographic Sciences, Cruise Report, No. 191, 31pp.

Pollard, R.T., Read, J.F., and Smithers, J. 1987 CTD sections across the Southwest Indian Ocean and Antarctic Circumpolar Current in southern summer 1986/7. Institute of Oceanographic Sciences, Report, No. 243, 161pp.