

Summary of hydrographic observations in Drake Passage

Stuart Cunningham, March 1, 2005

XBT Programme

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The Drake Passage XBT program has been operational since September 1996, and there are 57 transects to date (Figure 1).

Funding for the Drake Passage XBT/XCTD program has recently been renewed by NSF Office of Polar Programs through June 2009. The sampling will be undertaken on an approximately bimonthly schedule, with 6-7 sections per year (as has been done in the past). Approximately 70 XBTs are dropped per transect every 5-15 km (closer sampling over the major fronts), beginning and ending at the 200 m isobath. The XBTs measure temperature to 800 m. The number of XCTDs dropped per cruise was recently increased from 6 to 12 casts, with spatial separation of 25-50 km. The XCTDs return temperature and salinity data to ~ 1000 m. Increased XCTD sampling is expected to lead to better transport estimates and help better resolve the salinity structure and variability of the region (Sprintall, J., 2003).

Future plan is to maintain the XBT/XCTD programme. Once the deeper (2000 m) T12 probes become more reliable, I would like to use these along the transect.

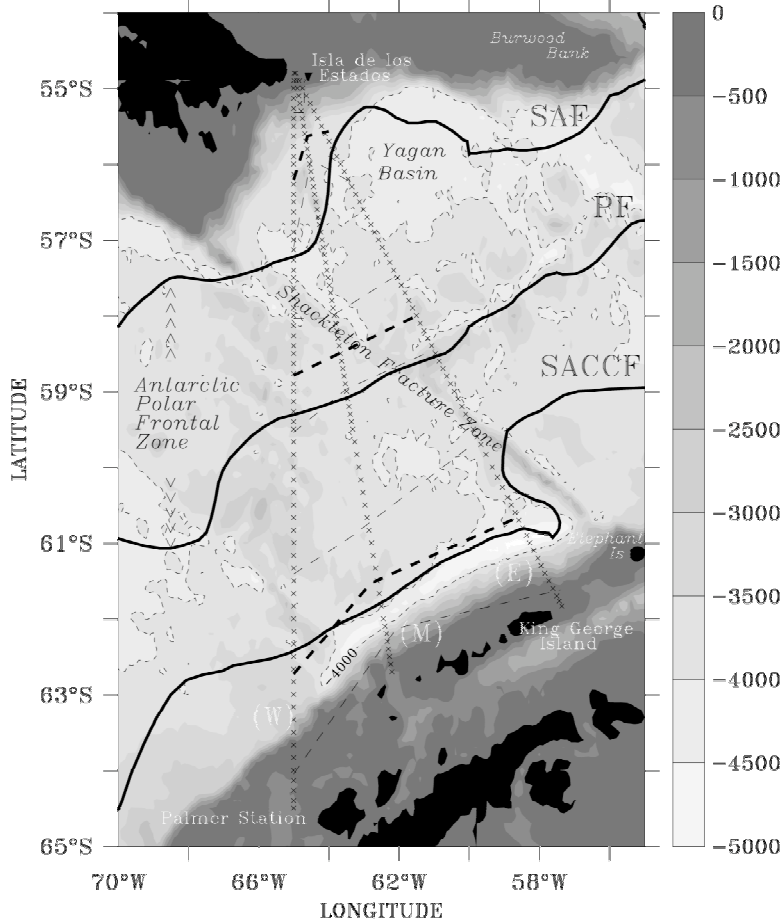


Figure 1: The 3 main cruise tracks that the Gould takes across Drake Passage when undertaking XBT/XCTD and ADCP surveys.

Near Surface Currents measured by shipboard ADCP

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Currently in year six [2005] of a ten year program to measure ocean currents in Drake Passage from shipboard ADCP observation on the U.S. Antarctic supply vessel Laurence M. Gould. We have about 125 crossings to date (Figure 1).

Beginning in September 1999, we installed an RDI narrowband 150 kHz on the Gould. It profiles to about 300-350 m. In November 2004, we added an RDI Ocean Surveyor, 38 kHz. From limited data that I've looked at so far, we are profiling to 1000m.

Summary:

September 1999- 2004 - ocean currents in the upper 350 m, shipboard ADCP (125 crossings to date).

2005 - 2009 - ocean currents in the upper 1000 m, shipboard ADCPs

DIMES, Diapycnal/Isopycnal Mixing Experiment

There are plans (DIMES, Diapycnal/Isopycnal Mixing Experiment) to inject tracer early in 2008 at about 110 W, 60 S, and watch it for three years as it passes through the Drake Passage, Scotia Sea and into the SW Atlantic. Jim Ledwell is the lead PI for DIMES. As part of DIMES, Teri Chereskin and Jim Ledwell are thinking about proposing three winter CTD/LADCP transects from the Gould in 2008, 2009, 2010.

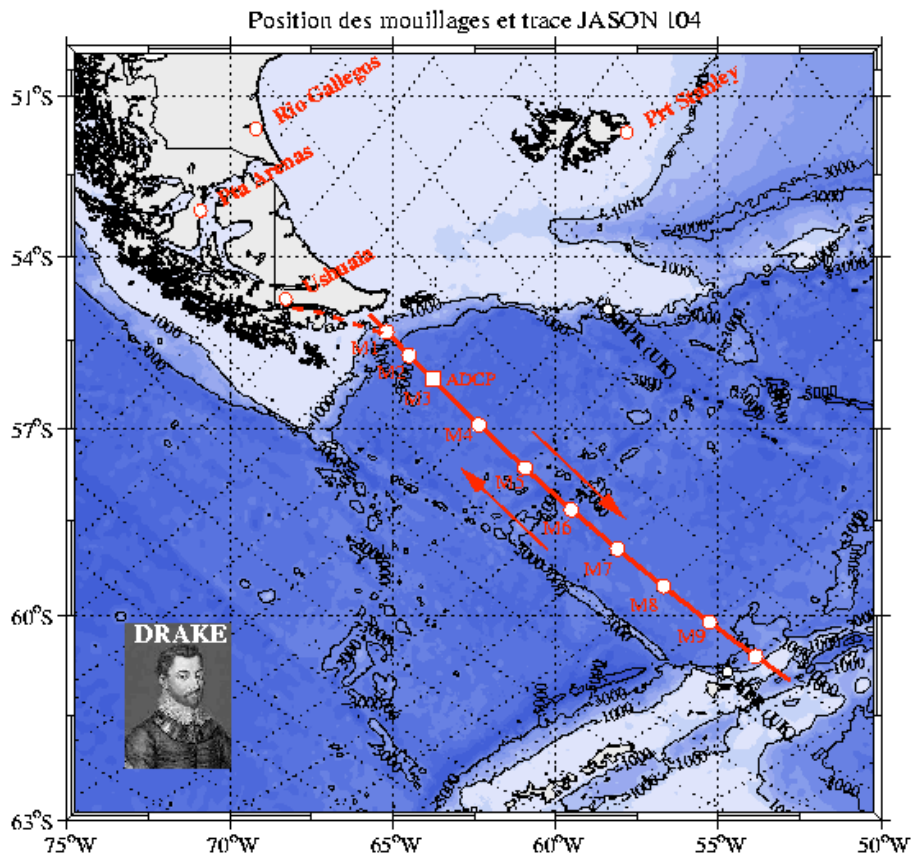
Current Meter Array

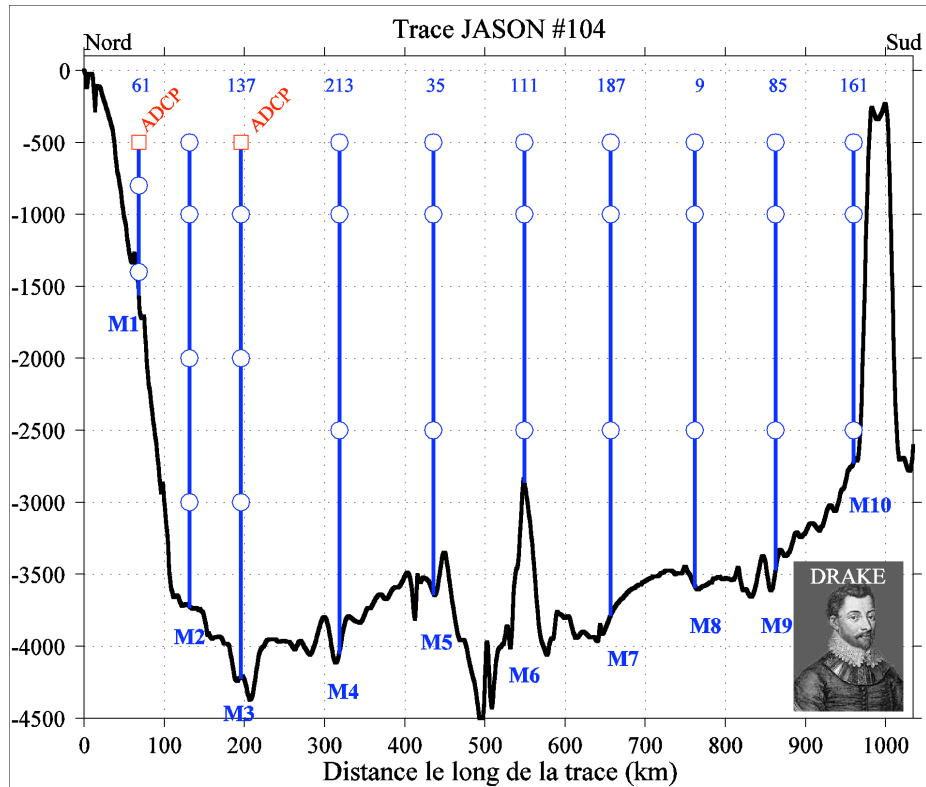
Christine Provost (Christine.Provost@lodyc.jussieu.fr)

Feb 2005: six argo floats to be launched in northern DP (RV Puerto Deseado, Arg)
Jan-Feb 2006: Polarstern funded observations: - array of 10 current meter moorings across DP- a line of closely spaced CTD/LADCP with tracers , and a few GEOTRACE stations.

Mooring and CTD performed from the Polarstern early 2006 and deployment of a further six argo floats.

Attached a map of the cruises and moorings.





Tide Gauges and Bottom Pressure Recorders

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1. Proudman Oceanographic Laboratories: BPRs at northern and southern end of SR1b (1000m, Burdwood Bank to Elephant Island).

Have been operating since 1988 with no planned end date. BPRs now fitted with SeaBird CTDs, to enable time series of T & S to be compiled (very useful for studying downslope convection from Antarctic shelf). One BPR is currently deployed in middle of section SR1b also, primarily for test purposes. MYRTLE deployment planned for next season (2005/6), deep at southern end (possibly 2000-2500m). One BPR being loaned to French group at LODYC, for them to deploy at northern end of their current meter/JASON section (Cape Horn to Elephant Island), deployment due in January 2006, for around 18 months duration.

2. Tide gauge measurements

Continuing at Rothera, Faraday and Signy. Faraday extremely useful: now several decades of data, which are providing the best measure of interannual variability in ACC transport. Plans to recover data from Rothera and Faraday in near-realtime via orbcomm, iridium or BAS real time internet.

UK CTD and LADCP Sections at SR1b

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The World Ocean Circulation Experiment established a repeat hydrographic section across Drake Passage and designated it SR1. This section was occupied by the R/V *Meteor* in 1990 (Roether, W. R., Schilitzer, R., Putzka, A., Bening, P., and Bulsiewicz, K., 1993). Subsequently, the section was shifted to the east in order for it to lie on a satellite ground track. The endpoints were now at the south side of Burdwood Bank, south of the Falkland Islands, and off Elephant Island at the north end of the Antarctic Peninsula (Figure 1). This revised section location was designated SR1b and was first occupied by the R/V *Polarstern* in 1992 (Gersonde, R., 1993). The first UK occupation of SR1b followed on RRS *Discovery* later the same year, and was a SeaSoar (a profiler which undulates between the surface and ~400 m) tow (Turner, D. R., 1993; Read, J. F., Allen, J. T., Machin, P., Miller, G. W. J., Morrison, A. I., Pollard, R. T., and Taylor, P. G., 1993). Between that time and the time of writing of the present document (2005) there have been 10 UK occupations of SR1b at nearly one section per year, all on RRS *James Clark Ross*, all with full-depth CTDs and latterly with LADCP Table 1. On each section currents from the surface to approximately 300m were obtained with an RD Instruments 150kHz shipboard ADCP.

Table 1: List of UK occupations of Drake Passage section, WOCE designation SR1b (Cunningham, S. A., 2001, Bacon, S. and Cunningham, S. A., 2005, Bacon, S., 2002, Bacon, S., 2003),.

Notes: “Year” is the year of the start of the relevant southern season. “LADCP” shows which cruises carried that instrument (y=yes, n=no), noting that the most recent occupation (JR115) experienced some technical difficulties. All occupations aimed to occupy the standard station positions shown in Figure 1.1. D198 was occupied with an undulating profiling instrument, SeaSoar, with no full-depth CTDs. Extra stations were occupied on JR27, effectively doubling the mid-Passage resolution. JR47 happened to occupy the ‘geostrophic velocity’ positions, ie the mid-point between the standard positions.

Year	Start date	End date	Designator	LADCP	Comments
1992	11/11/1992	17/12/1992	D198	n	SeaSoar only; cruise called <i>Sterna</i>
1993	20/11/1993	18/12/1993	JR0a	n	Designator also JR00_1
1994	13/11/1994	12/12/1994	JR0b	n	Designator also JR00_2
1996	13/11/1996	07/12/1996	JR16	y	
1997	17/12/1997	08/01/1998	JR27	y	Extra stations
1999	12/02/2000	16/02/2000	JR47	n	Odd positions
2000	21/11/2000	14/12/2000	JR55	y	
2001	19/11/2001	17/12/2001	JR67	y	
2002	18/12/2002	02/01/2003	JR81	y	
2003	27/11/2003	17/12/2003	JR94	y	
2004	01/12/2004	19/12/2004	JR115	y	LADCP not on all stations

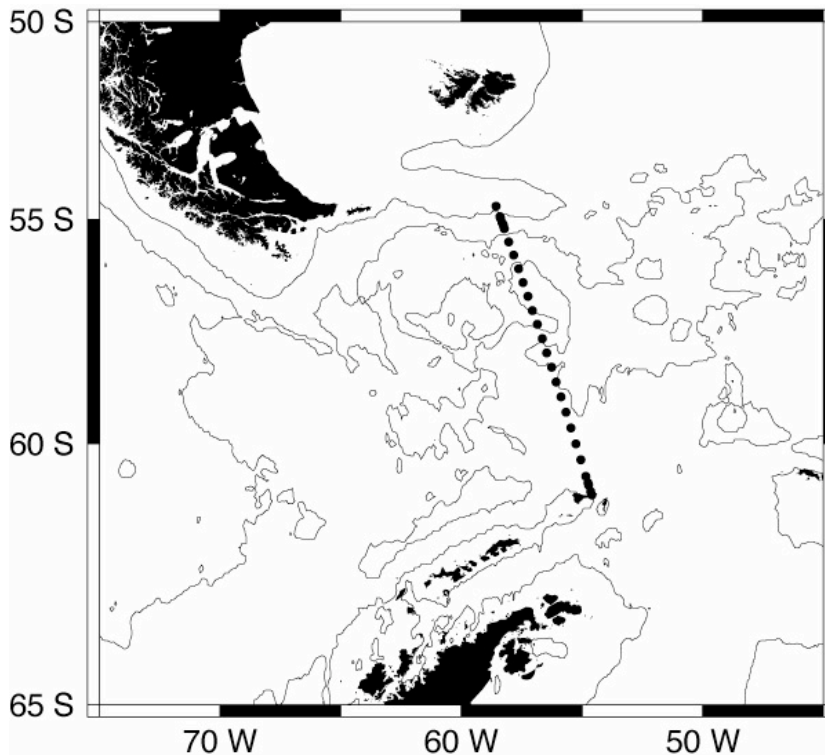


Figure 1.1: Drake Passage standard station positions, between Elephant Island in the south and Burdwood Bank in the north. Depth contours are 500 m and 4000 m.

The UK are currently planning to continue annual occupations of SR1b. As part of IPY we will propose to occupy three sections to form a box around the Atlantic sector of the Southern Ocean. These will be undertaken in near-synoptic surveys in 2008, as a direct contribution to the IPY. We propose a western Drake Passage (DP) section, repeating the WOCE A21 line. Previous occupations in 1990 and 1999 included good transient tracer measurements which will facilitate estimates of decadal-timescale property changes. To provide an east-west section across the South Atlantic we will repeat the WOCE A10 section at 30°S previously occupied in January 1993. This avoids the Brazil-Falklands confluence at 45°S where transports would be difficult to estimate. It will provide direct observation of decadal changes in water mass properties (including carbon and transient tracers). The box will be closed by a section from Africa to Antarctica (AA), re-occupying the WOCE I6 line at 30°E (last undertaken in 1996), and connecting to Africa on the line of our Agulhas current moorings (by H. Bryden and L. Beal in 1995 and 2003-2005) and the line of high-quality hydrographic surveys in 1987, 1995, and 2002. To achieve near-synoptic closure will require the AA line to be occupied by a second (ice-capable) ship.

Non-UK SR1b summary

Occupations by R/V *Meteor* in 1990 and R/V *Polarstern* in 1992 are mentioned above. Additionally, there were three Spanish occupations on R/V *Hesperides* in the

month of February in 1995, 1996 and 1998. Results from these sections are reported in Garcia, M. A., Bande, I., Cruzado, A., Velasquez, Z., Garcia, H., Puigedegabregas, J., and Sospedra, J., 2002. In Garcia, M. A., Bande, I., Cruzado, A., Velasquez, Z., Garcia, H., Puigedegabregas, J., and Sospedra, J., 2002 3 CTD sections of 21 stations each in Feb. 95, 96 and 98 across Drake Passage are presented. According to Garcia et al. only the 1995 section has useable shipboard acoustic Doppler current profiler data because of differential GPS problems. Unfortunately, not long after the Garcia, M. A., Bande, I., Cruzado, A., Velasquez, Z., Garcia, H., Puigedegabregas, J., and Sospedra, J., 2002 paper was published M. Garcia left the field of oceanography, and the location and responsibility for managing these data was unclear. However, recently as part of a Ph.D. project the CTD data only have been obtained from Raquel Boza, UTM (Marine Technologies Unit), CSIC (Spanish Research Council), CMIMA – UTM, Paseo Marítimo de la Barceloneta 37-49, 08003 BARCELONA, SPAIN, (but not the 1995 data). There have also been regular Chilean occupations of the ‘old’ SR1 line from R/V *Vidal Gormaz* (ex-US *Thomas Washington*) in November-December of 1993, 1994, 1995, 1996 and 1998. Some of the data from these sections are presented in Rojas, R., Guerrero, Y., Calvete, T., and Garcia, W., 1998.

Aida Rios (Instituto de Investigaciones Marinas.CSIC aida@nautilus.iim.csic.es) is proposing a 28 station full depth CTD/tracer/carbon section along SR1b from the Hesperedes in April 2007

Extracts from SOP National Reports

The following extracts are from the Southern Ocean Panel national reports, where there is research or offers of collaboration in regions close to Drake Passage.

Argentina

3. Requests or opportunities for collaboration with other nations

Unfortunately, few research groups are directly involved in Southern Ocean research. There is a long-term collaboration on diagnosis and simulations of Southern Hemisphere atmospheric variability between CIMA and LMD/CNRS. Similarly, recent initiatives to study the role of the Southern Ocean upper layer dynamics and biota on the ocean CO₂ uptake are possible through collaborations between IAA, SHN and LPCM. These efforts are funded by EC projects and by bilateral agreements between France and Argentina. With some minor modifications, the cruise track of icebreaker *ALMIRANTE IRIZAR* shown in Figure 1 is repeated on a yearly basis between November and May. Though *IRIZAR* has an oceanographic winch with conducting wire, oceanographic capabilities and time availability in summer are limited. Also shown in Figure 1 is the most frequent track of R/V *PUERTO DESEADO*, this is a fully equipped oceanographic vessel. Ancillary research projects in the area may be carried out on board any of these vessels. We envision CLIVAR as an excellent framework for further collaborations, both in modeling and experimental research.

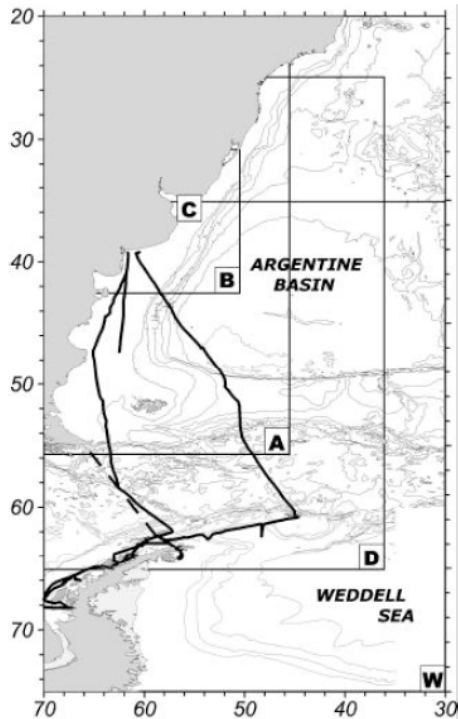


Figure 1: Cruise track of Argau Zero, carried out between 20 March and 14 May 2000 from icebreaker *ARA Almirante Irizar*, heavy solid line and *PUERTO DESEADO* heavy dashed line. Bathymetric contours are 200, 1000, 2000, 3000, 4000 and 5000 meters.

Germany

The observations consist of large-scale hydrographic sections of the prime meridian with a repeat cycle between 2 and 4 years and moored instruments to avoid effects of aliasing. To determine water mass properties and transports, temperature, salinity, CFCs, currents and ice thickness are measured. A moored observing system is maintained in the Weddell Sea Convection Control (WECCON) project since 1996 along the prime meridian. Current meter moorings were exchanged in 1998, 1999, 2001 and 2002/2003. A redeployment is planned for the austral summer 2005. Current meters in this array are also contributed by Norway.

In 1999, 2001, 2002/2003 hydrographic surveys were carried out along the Greenwich Meridian with a CTD-probe (Conductivity/Temperature/Depth) combined with a rosette water sampler). A repeat of this transect is planned for 2005. Previously this section had been sampled some times as part of the WOCE program. XBTs are deployed north of the CTD transect. The continuation is envisaged. In addition, in 2005 a reoccupation of a CTD section across the Weddell Sea basin between Kapp Norvegia and the tip of the Antarctic Peninsula is planned (Fig. 3). Previously this section was sampled completely in 1996, whilst parts of it were occupied in 1992 and 1998.

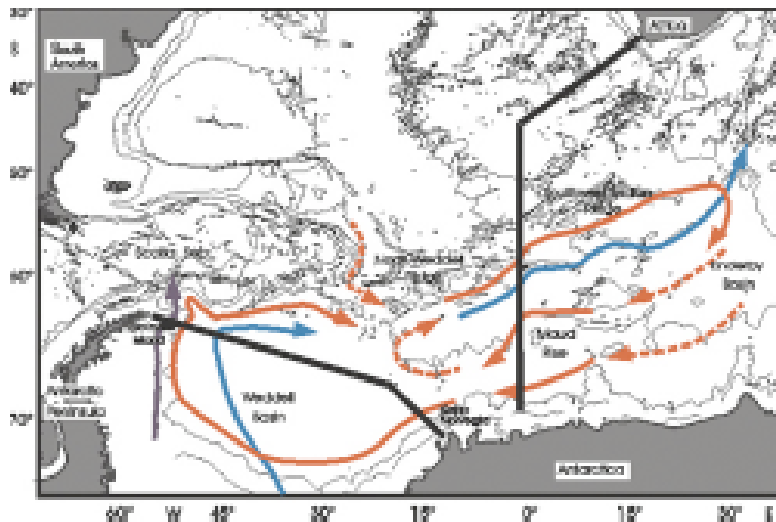


Fig. 3: Weddell Sea transects to be sampled in 2003

Russia

Antarctic Research Institute (AARI) is responsible for Russian logistic operations and research studies in the Southern Ocean. The research and support icebreaker Akademik Fedorov of the Russian Antarctic Expedition, operates annually in the ice-covered zone of the Southern Ocean. The AARI activity in the Antarctic Zone of the Southern Ocean comprises mainly oceanographic, meteorological and ice data collection during oceanographic surveys and along ship tracks during transport operations and from the fast ice near Russian coastal bases. Akademik Fedorov is equipped with the SeaBird 911plus unit.

For logistical and financial reasons future Russian research will concentrate in the East Antarctica seas. We expect to carry out oceanographic surveys each austral summer (most likely in February) in the area between Novolazarevskaya base at 12°E and Mirny base at 90°E with particular focus on Cosmonaut Sea and Prydz Bay areas.

References

- Bacon, S., 2002: RRS Jame Clark Ross cruise 67 19 Nov - 17 Dec 2001. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island Cruise Report No. 38, 118 pp.
- , 2003: RRS Jame Clark Ross cruise 81 18 Dec 2002 - 02 Jan 2003. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Cruise Report No. 43, 86 pp.
- Bacon, S. and S. A. Cunningham, 2005: Drake Passage Summary Report: Cruises on RRS James Clark Ross, 1993–2000. Cruise Report 44, 151 pp.

Cunningham, S. A., 2001: RRS James Clark Ross Cruise JR55 21 NOV - 14 DEC 2000. Drake Passage repeat hydrography: WOCE Southern Repeat Section 1b - Burdwood Bank to Elephant Island. Cruise Report 35, 75 pp.

Garcia, M. A., I. Bande, A. Cruzado, Z. Velasquez, H. Garcia, J. Puigedegabregas, and J. Sospedra, 2002: Observed variability of water properties and transports on the World Ocean Circulation Experiment SR1b section across the Antarctic Circumpolar Current. *J. Geophys. Res.*, **107**, doi: 1029/2000JC000277.

Gersonde, R., 1993: The expedition Antarktix X/5 of RV Polarstern in 1992. *Berichte zur Polarforschung* 131.

Read, J. F., J. T. Allen, P. Machin, G. W. J. Miller, A. I. Morrison, R. T. Pollard, and P. G. Taylor, 1993: SeaSoar data collected on RRS Discovery Cruise 198 (Sterna) across Drake Passage and in the Bellingshausen Sea. Internal Document No 320, 57 pp.

Roether, W. R., R. Schilitzer, A. Putzka, P. Bening, and K. Bulsiewicz, 1993: A chlorofluoromethane and hydrographic section across Drake Passage: Deep water ventilation and meridional property transport. *J. Geophys. Res.*, **98**, 14423-14435.

Rojas, R., Y. Guerrero, T. Calvete, and W. Garcia, 1998: WHP repeated hydrography section SR1, Drake Passage. *International WOCE newsletter*, **32**, 38-40.

Sprintall, J., 2003: Seasonal to interannual upper-ocean variability in Drake Passage. *J. Mar. Res.*, **61**, 27-57.

Turner, D. R., 1993: BOFS 'Sterna 92' Cruise REport, Discovery 198 11/11/92-17/12/92, 85 pp.