Southampton Oceanography Centre

Cruise Report No.***

RRS *James Clark Ross*

JR27

17 DEC 1997 - 08 JAN 1998

WOCE SR1 IN DRAKE PASSAGE

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Lowered Acoustic Doppler Current Profiler Measurements on JR27

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14, January 1998

Physical Location and Use

The 150 kHz RDI Broadband ADCP with a nnn° transducer head was mounted in SOC CTD frame nnn. The ADCP was situated centrally with the transducer heads approximately 10 cm inside the frame. The ADCP was powered by a battery pack located in a pressure case mounted horizontally on one side of the CTD frame.

The data lead, a nnn type, with male connectors on the end away from the ADCP was fixed to a convenient upright on the CTD frame. At the end of each cast the blanking plug was removed and an extension cable running to a pc fixed in the Chemistry Lab. was fitted. Via this cable the ADCP receives power on deck so that data can be transferred from its internal memory. The extension cable was run through the window facing aft then draped over the top of the CTD frame. This relieves strain on the connectors and reduces the chances of the cable being pulled apart when there is power on it and data transfer is taking place.

Battery Packs

*** Will have to get all the details from Nick ***

NNN type voltage batteries were mounted in parallel and voltage and current protected by a diode. The packs give 50 V off load.

Statistics for hours of operation and voltage changes per cast are given in Table nnn. Each battery pack lasted approximately 40 hours of operation, dropping 10 V before being changed. One pack which was left to rest for 2 days was retried. After this rest time the voltage increased by 6 V to 42.1 V and was used for a further 6 hours, a significant extra usage of the batteries.

Instrument Parameters

Deployment and Recovery

*** this is Nicks operation notes ***

Processing

Navigation

Navigation is important for converting the LADCP shear profiles to absolute water velocities. Because the cruise spanned a year

boundary the processing became complicated. Bestnav was used to provide navigation, the main contribution to bestnav is differential gps and is accurate to approximately 1 m. The bestnav data are split across the year boundary, time in seconds is converted into day of year ensuring that the 1998 portion starts with day of year equal one. ASCII listings of doy, lon, lat are then made. These can be read by matlab and saved as a mat file, e.g.

>matlab

run matlab

>load nav271.1997.ascii -ascii

read ascii navigation file

>sm=nav271;

save navigation to a new matrix called sm

>save sm.mat sm -mat

save the matrix sm to a mat file sm.mat

This is repeated for the 1998 portion saving the navigation data to sm.mat.1998. For processing profiles 001 to 014 navigation is from 1997 for 016-054 navigation is from 1998. e.g. cp sm.mat.1997 sm.mat then within matlab do_absN will work. For profile 015 which spans the year boundary the processing has not yet been sorted. The navigation files should reside in

/data/jr27/ladcp/socproc/data/jr9712/DEVA

Water Track

Processing of the water track data follows the University of Hawaii processing software based on perl scripts and matlab. The following processing was done immediately after each cast. Station number_cast number sss_cc.

> perl -S scanbb.prl sss_cc

to make a preliminary examination of the data

> edit mag_var.tab

enter new line with magnetic variation and position e.g. jnnn,7,dd mm.mm S,dd mm.mm W where jnnn is the station number, 7 is the magnetic variation, dd is degrees and mm.mm is decimal minutes.

> edit stations.asc

enter new line with position and date e.g. nnn dd mm.mm -1 dd mm.mm -1 yyyy mn day where nnn is station number, dd is degrees mm.mm is decimal minutes, -1 represents south and west hemispheres, yyyy is year, mn is month, day is day of month.

> perl -S loadbb.prl sss_cc

load data into the self contained codas database. If this step needs to be repeated then the databases for this file must be deleted.

```
> perl -S domerge.prl -c0 sss_cc
-c0 for no CTD data
*** can't remember what this does ***
> matlab
plist=nnn.01
do_abs
```

produces profile plots which are saved as postscript files.

Bottom Track

Bottom track data were obtained in a manor different to previous cruises. A batch process was used, limiting the amount of manual intervention required. The RDI utility bbbatch was use to provide an ascii listing of required variables from the binary profiles. This was done using a DOS batch file called bt.bat with the following line,

```
for %%i in (j*.000) do bbbatch %%i bt2.fmt b%%i
```

which used a pattern match for the input file to bbbatch writing the output variables as listed in bt2.fmt to the ascii output file which is prefixed by "b". The following 23 variables are read from the binary file and output to ascii: binnum, ensemble, yy, mm, dd, hh, mm, ss, range1, range2, range3, range4, bote, botn, botvert, boterr, botpcgd, wate, watn, watvert, waterr, watpcgd. The ascii files on the pc can then be ftp'd to the UNIX system.

ladbexec0

Read the ascii data into pstar.

```
input:  bjnnn_01.000
output: bjnnn.pst
```

ladbexec1

Edit ranges between 1 and 35774 cm. Not sure why this number is chosen but Brian and Mike used it in 1996. Compute the average of the four ranges and select data where the average range is between 0 and 35774 cm. At this point only data where bottom track data exist remain. Swap the absent data value to one recognised by pstar, calibrate ranges to be in m, velocities in cm/s, compute time in seconds, compute absolute velocities by subtracting bottom track velocities from water track velocities.

```
input:  bjnnn.pst
output: bjnnn.bt
```

ladbexec2

Merge press and depth from CTD data onto LADCP profiles using time as the merging variable, calculate depth of the bins (=ctd depth + (16+16*binnum)), sort and average to give data in 16 m bins.

input: bjnnn.bt

output: btnnn

ladbexec3

Apply the magnetic variation correction to profiles

input: btnnn

output: btnnn

ladbctdexec

Copy time and pressure from a CTD 1hz file and calculate depth using latitude in the header of the CTD file. The 1 hz file must be down and up casts.

input: ctd27nnn.1hz

output: ctd27nnn

Notes

Profile 015 spans 1997 and 1998, bottom track data all in 1998 and there is no problem processing this data, however there is a problem processing the water track data so that do_absN will not run as there is a mismatch between the navigation time and time in the file. Somehow it is complicated to process across a year boundary and there is some problem with the UoH software.

Profiles 021 and 022 are not full depth and have no bottom track data. They cause the bottom track execs to crash.

JR27 Cruise report, Tim Jickells and Richard Sanders, University of East Anglia, Norwich, Norfolk, U.K.

Objectives

This work was funded by an NERC small grant number to T. Jickells. The objectives of the work were twofold. Firstly to provide a high quality dissolved inorganic nutrient and dissolved oxygen data set to enable fluxes of these components to be generated in association with the heat, momentum and salt fluxes derived from the physical measurements. In addition these parameters, particularly dissolved xygen and, in this area, dissolved silicate will be valuable in water mass characterisation, in support of the temperature and salinity measurements. The second component of the project involved analyses for dissolved organic nitrogen and phosphorus in the water column. These components have been rarely analysed for before on major oceanographic cruises and the data collected on this trip may represent the first available from Antarctic waters.

Location of equipment

The oxygen analyses were conducted in the Chemistry Lab, which was very convenient for easy access to the water bottle sampling operation, though the lab did become crowded briefly after casts because of the necessity to also operate the LADCP computer in this location.

The autoanalyser for the nutrient analyses was set up in the Main Lab. On the previous cruise we participated in on the JCR this instrument was set up in the Biology Lab but this was unavailable on this trip due to equipment left installed from the previous cruise. The Main Lab proved a perfectly satisfactory alternative location though was further from the Prep Lab and had no sink.

The UV system used to oxidise organic nitrogen and phosphorus to inorganic phosphate and nitrate was set up in the fume cupboard in the Prep Lab with freshwater cooling supply run to the sink. This arrangement worked very well and allowed us to safely shield and vent the UV source.

Facilities on the JCR for these chemical analyses proved very satisfactory, with provision of high purity MilliQ water in both the Prep and Chemistry labs a real asset, along with the stability of the ship as a platform, a function no doubt both of the quality of the ship itself and the very good weather we enjoyed. One small point is that the oven in the prep lab was

almost impossible to operate satisfactorily in the absence of an instruction manual.

The passage leg south to Rothera provided an excellent opportunity to optimise the analytical methods and equipment function

Methods

The oxygen and inorganic nutrient analyses methods were those used on the A23 cruise on the JCR (Heywood and King, 199). All samples were unfiltered but we follow accepted practice and define our results as dissolved concentrations.

The oxygen analyses were based on the Winkler procedure using an automatic titration system with spectrophotometric end-point detection (Williams). Results were calculated using the Dickson equations as recommended by WOCE (WOCE manual). The reagent blank was determined as recommended by Dickson (WOCE manual) and were close to detection limit at. Based on analyses of replicate Niskin bottles fired at the same depth, the estimated short term precision of the analyses is (precision number of samples). Sagami standard iodate solutions were used for calibration and the results for this standard agreed with standards prepared from UEA within y%. Standards were analysed throughout the cruise at regular intervals and there was no evidence of systematic drift in the standardisation from day to day, but rather an apparently random variation of the order of x%. Oxygen concentrations on any particular day were calculated based on the most recent iodate standardisation. Thus we estimate the long term precision of the analyses to be approximately. An evaluation of the accuracy of the analyses will be undertaken via a comparison with historical data. Oxygen analyses were usually completed within 6 hours of sample collection.

Dissolved inorganic nutrients (phosphorus, silicon and nitrate+nitrite) were analysed using a Skalar San Plus autoanalyser as on A23. Artificial seawater (40g/L NaCl in milli-Q water) was used for baseline and wash purposes. Based on various criteria, we believe that blanks associated with the artificial seawater were less than the detection limits of each of the analyses (i.e. <). Due to the relatively high nitrate+nitrite and silicate concentrations encountered samples for both analyses were diluted with wash solution using in-line dilution loops to achieve dilutions of threefold and tenfold respectively. A brand new cadmium reduction column was fitted for nitrate+nitrite analyses at the start of the cruise. Standardisation was based on dried standards prepared at UEA made up as

stocks on the ship and diluted appropriately. Fresh dilute standards were generally prepared daily. Two independent standards prepared this way agreed within x%. Sagami standards were also analysed for each nutrient (Batch numbers). Nitrate and silicon results agreed with x% but our phosphorus analyses of the Sagami standard yielded values x% lower than the certified value. A similar problem occurred on the A23 cruise (Heywood and King) and as then we believe this reflects a problem with the Sagami standards rather than with UEA standards. To check for day to day variations in calibrations and blanks, we also analysed each day a bulk seawater sample collected on the A23 cruise which had been preserved with $HgCl_2$. The values obtained for this sample varied apparently randomly over the sampling programme by x%(N), y%(P),z%(Si) and were close to those obtained for the same sample on A23 x years earlier (Table). Thus we believe short and long term precision of our analyses to be . An evaluation of the accuracy of the analyses will be undertaken via a comparison with historical data.

The analytical systems for both oxygen and nutrients worked satisfactorily throughout the cruise, with the following problems encountered. Silicate analyses on stations 20 and 24 were subject to considerable drift for an unknown reason. The logging system generated data were discarded and a manual calculation of results undertaken using the chart recorder output which accompanied every analytical run. The compute logging system failed on station 28, all results from this cruise have been generated from the chart recorder output. The temperature control for the phosphate analyses was not switched on for station 30. Half of these samples were rerun in the next analytical run and the remainder corrected using an appropriate conversion factor. For nitrate+nitrite, ship rolling can induce bubbles to pass into the photocell generating erroneous peaks. These incidences were identified on the chart recorder and edited carefully. In most cases it was possible to extract usable peak information and these peaks were then processed using the computer integration system. A full evaluation of the implications of these problems on the data quality is beyond the scope of this short report, however it will be completed in the near future. In a small number of cases the bubble peaks coincided with the peak maximum and it was considered impossible to extract accurate information for this sample. In some cases these samples were reanalysed but in some cases there was insufficient sample remaining and in these cases no data are reported. In general inorganic nutrient analyses were started within 2 hours of sample collection and completed within another two hours.

Sampling Strategy

At the start of the cruise we were uncertain of the rate at which we could process samples for oxygen, dissolved inorganic and organic nutrients. It was therefore agreed that we would initially sample up to 16 samples for dissolved oxygen and both inorganic and organic nutrients from each station (with less at the shallow stations). Later in the cruise as we grew more familiar with the organic nutrient analyses we were able to increase sample processing to include all 24 water bottles, though this often included several samples collected at the same depth and thus provided some replication. This increased sample throughput allowed us to target some additional sampling effort in the near surface waters where interesting gradients in organic nutrient concentrations were evident. The number of samples analysed for oxygen, and inorganic and organic nutrients was reduced somewhat at the northern leg of the cruise to cope with the very dense sampling strategy adopted.

Preliminary inspections of the data suggest patterns consistent with expectations with relatively high nitrate+nitrite and phosphate concentrations present in surface waters throughout the section declining northwards. South of the polar front, surface water silicate concentrations are very high, but decline sharply across the front. Concentrations of all nutrients increase with depth, consistent with biological utilisation in surface waters and regeneration at depth. At depth in the southern half of the section, the presence of a very high dissolved silicon concentration layer was evident. At present there has not been time to compare the results obtained with previous data from this area, though such a comparison will be undertaken.

Organic nutrients

Samples were irradiated with a high intensity Hg UV lamp to destroy organic matter and hence liberate organic phosphorus and nitrogen as inorganic species. Organic nitrogen and phosphorus concentrations are thus the differences between the measured dissolved inorganic phosphorus and nitrogen concentrations before and after oxidation. This approach has been used by various people in the past most recently by Hansell and Whitehouse (DSR 1997), although these authors froze samples and analysed them in their home lab. We purchased a newly available small UV oxidation system (Metrohm) and were able to successfully use this on the ship allowing us to begin

oxidation of samples usually within an hour of sampling, hence minimising concerns over possible storage artefacts.

During the first leg of the cruise we concentrated on optimising analysis procedures, particularly in terms of oxidation times. The full results of these investigations are still being evaluated and will be published separately. In summary we selected a 2 hour photoxidation period at a temperature of about 80oC as adequate to destroy most of the organic nitrogen and phosphorus and short enough to prevent losses of phosphorus, which were evident with longer oxidation times. Earlier workers have added hydrogen peroxide to facilitate photoxidation, but we found this to be both unnecessary and liable to produce substantial blanks as reported by Cornell and Jickells ( ) in a different context, and consequently we did not use hydrogen peroxide. We found no evidence of ammonium formation during photoxidation and consequently subsequently only analysed for nitrate+nitrite. Added ammonium spikes were oxidised to nitrate+nitrite, but recoveries were less than 100%, though there was no residual ammonium after photo-oxidation, implying production of other nitrogen species not analysed by our methods such as N_2 or N_2O. Similarly urea oxidation efficiency was less than 100%, again broadly consistent with other studies (Cornell and Jickells). Thus we believe the results we report, represent lower limits since some species may not be completely oxidised to nitrate+nitrite by our procedures.

The quantification of these organic nutrients is done by difference as noted earlier and consequently in the nutrient rich waters of the southern ocean, this analysis is rather difficult, since it is necessary to calculate the *small* difference between two relatively large numbers. However, with the high precisions we were able to achieve with the inorganic nutrient analysis procedures we believe we have been able to achieve the best results possible for organic nitrogen and phosphorus concentrations using this analytical approach. We estimate precision of replicate samples drawn from different sample bottles triggered at the same depth to be n% yielding a detection limit of. With such a new technique we have decide to be cautious in our interpretation of results close to detection limits. Furthermore we have some concerns that ageing of the silica glass tubes used for photoxidation may have degraded the organic phosphorus methods and we have arbitrarily decided not to report results from any stations where more than 10% of the results obtained gave negative organic phosphorus concentrations outside the

allowable range based on detection limits. In practice this means that we do not report DOP on n stations.

The full interpretation of this novel data set will take some time but several obvious features are evident at this stage. DON is ubiquitous with deep water concentrations of the order of 4uM. These increase to 5-10uM in surface waters. At some stations deep water maxima in DON are also evident suggesting a benthic source or possibly high DON water flowing from shelf systems into the deep water. DOP concentrations in deep water are close to detection limits but generally increase in surface waters and at the same place as the deep DON maxima. Thus the two parameters appear quite well correlated though the relationship does not necessarily imply a simple Redfield relationship which can be applied throughout the section

Phytoplankton sampling

Samples for phytoplankton identification were collected for Dr.R.Raine U. Galway Eire. Samples were collected using a vertically towed very fine (?mm) mesh net over the upper 100m of the water column once a day at approximately midday. Samples were preserved with Lugols Iodine and will be shipped to Galway for subsequent analysis. The sampling operation was run off the small winch mounted below the main hydrographic winch gantry and thanks to the efficient work of the crew this operation was achieved safely and with minimum disruption to the main sampling programme.

Latitude (nominal)			Longitude (nominal)	
Degrees	Minutes		Degrees	Minutes
-61	3.00		-54	36.22
-60	59.00		-54	38.70
-60	51.00		-54	43.65
-60	50.00		-54	44.27
-60	49.00		-54	44.89
-60	48.00		-54	45.51
-60	44.00		-54	47.99
-60	40.00		-54	50.47
-60	30.00		-54	56.66
-60	20.00		-55	2.85
-60	10.00		-55	9.04
-60	0.00		-55	15.23
-59	50.00		-55	21.43
-59	40.00		-55	27.62
-59	30.00		-55	33.81
-59	20.00		-55	40.00
-59	10.00		-55	46.19
-59	0.00		-55	52.39
-58	50.50		-55	58.27
-58	41.00		-56	4.15
-58	31.50		-56	10.03
-58	22.00		-56	15.92
-58	12.50		-56	21.80
-58	3.00		-56	27.68
-57	53.50		-56	33.56
-57	44.00		-56	39.45
-57	35.00		-56	45.02
-57	26.00		-56	50.59
-57	15.50		-56	57.09
-57	5.00		-57	3.59
-56	56.00		-57	9.17
-56	47.00		-57	14.74
-56	37.50		-57	20.62
-56	28.00		-57	26.50
-56	18.00		-57	32.70
-56	8.00		-57	38.89
-55	58.50		-57	44.77
-55	49.00		-57	50.65
-55	40.00		-57	56.23
-55	31.00		-58	1.80
-55	22.00		-58	7.37
-55	13.00		-58	12.94
-55	10.00		-58	14.80
-55	7.00		-58	16.66
-55	4.00		-58	18.52
-54	58.00		-58	22.23
-54	57.00		-58	22.85
-54	55.00		-58	24.09

-54	39.00	-58	34.00

LADCP Statistics

Station No.	No. of Ensembles	V start	V end	Battery Pack no.	minutes of operation
01	1906		46.7	1	63.5
02	3300	47.6	44.8	1	110.0
03	1665	46.1	44.2	1	55.5
04	2083	45.1	43.6	1	69.4
05	2486	44.5	43.0	1	82.9
06	3477	43.9	42.4	1	115.9
07	3767	43.0	41.4	1	125.6
08	3713	40.8	39.3	1	123.8
09	4896	41.8	39.9	1	163.2
10	4569	41.1	39.3	1	152.3
11	4550	40.8	39.0	1	151.7
12	5366	40.5	38.7	1	178.9
13	4851	39.6	38.1	1	161.7
14	5002	39.6	37.8	1	166.7
15	4700	39.0	38.1	1	156.7
16	4811	38.4	36.8	1	160.4
17	4819	38.1	36.5	1	160.6
18	5235		35.9	1	174.5
19	4915	48.5	45.1	2	163.8
20	5092	46.1	43.6	2	169.7
21	2562	44.2	43.3	2	85.4
22	2583	44.2	43.0	2	86.1
23	5162	43.9	41.4	2	172.1
24	5670	42.7	40.5	2	189.0
25	4466	41.8	39.9	2	148.9
26	5190	41.1	39.0	2	173.0
27	4844	41.8	39.0	2	161.5
28	5310	40.5	38.4	2	177.0
29	5114	39.9	37.8	2	170.5
30	4341	39.3	37.5	2	144.7
31	4406	39.0	36.8	2	146.9
32	5259	38.7	36.8	2	175.3
33	4995	38.1	36.2	2	166.5
34	6159	48.8	44.8	3	205.3
35	5431	45.4	43.3	3	181.0
36	4600	43.9	42.1	3	153.3
37	5401	43.3	41.1	3	180.0
38	5106	42.4	40.5	3	170.2
39	4851	42.1	39.9	3	161.7
40	5119	41.1	39.3	3	170.6
41	5213	40.8	38.7	3	173.8
42	6213	40.2	38.4	3	207.1
43	5778	39.6	37.8	3	192.6
44	5642	39.3	37.8	3	188.1
45	5267	38.1	37.1	3	175.6
46	5300	38.7	36.5	3	176.7

47	4144	42.1	39.6	2	138.1
48	3539	40.2	38.4	2	118.0
49	3132	39.3	38.1	2	104.4
50	2639	49.1	46.7	4	88.0
51	2701	47.0	45.4	4	90.0
52	1788	45.7	44.5	4	59.6
53	1322	41.4	44.5	4	44.1
54	1062	44.5	43.9	4	35.4

accumulated hours of operation
1.1
2.9
3.8
5.0
6.4
8.3
10.4
12.4
15.2
17.7
20.2
23.2
25.9
28.7
31.3
34.0
36.6
39.6
2.7
5.6
7.0
8.4
11.3
14.4
16.9
19.8
22.5
25.4
28.3
30.7
33.1
36.1
38.8
3.4
6.4
9.0
12.0
14.8
17.5
20.4
23.3
26.7
29.9
33.1
36.0
38.9

2.3
4.3
6.0
1.5
3.0
4.0
4.7
5.3