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<TIP> The hot links to the individual cruise documents are the BODC cruise mnemonics. These are used throughout the database to label data as belonging to that cruise.

CTD Data for Cruise Belgica 9309

(19 April - 6 May 1993)

1) Instrumentation

The CTD profiles were taken with a SeaBird SBE9S CTD system. The instrument has enclosed conductivity and temperature sensors supplied with water by a pump. The water inlet is at the base of the bottle rosette. When not in use, the sensors were bathed in MilliQ water. SeaBird temperature sensors are high performance, pressure protected thermistors. A non-pulsed membrane dissolved oxygen sensor was also included on the rig.

The CTD was periodically sent for calibration to SeaBird's NWRCC facility in Washington State. An average of 4 salinity samples were taken per cast, stored in crown-corked beer bottles, and determined on Beckman salinometer using OSI standard seawater. The procedure has come out well in ICES intercalibration exercises. Nevertheless, the salinometer is not considered as accurate as the SeaBird CTD. Consequently, the bottle data were used as a check for instrument malfunction but not for recalibration. Similarly, the performance of the temperature sensor was monitored against digital reversing thermometers but not recalibrated.

Dissolved oxygen performance was monitored against Winkler titration, done by MUMM or University of Liege, and recalibrated by polynomial, usually linear, if required.

A SeaBird rosette sampler fitted with 12, 10 litre Niskin or Go-Flo bottles was mounted around the CTD cage. The bases of the bottles were level with the pressure sensor with their tops 0.8 m above it. Digital thermometers on water bottles were placed 0.63 m above the CTD temperature sensor.

Note that an SBE19 SeaCat backup system was carried on this cruise and used for three profiles. However, the data from these are poor quality and have not been included in the data set.

2) Data Acquisition

The CTD sampled at 24Hz but this was automatically reduced to 2Hz by the deck unit. The data were logged on a PC using SeaBird's SEASAVE program.

The CTD was lowered at 0.8-1 m/s. On the upcast, the hauling rate is approximately the same, but was reduced on approach to a bottle firing depth to minimise wake interference.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from raw binary data into calibrated data in ASCII format that were supplied to BODC.

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Time was converted from Belgian local time to GMT.

Temperature has been converted from ITS68 to ITS90 by dividing the values by 1.00024.

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by:

$$(1000 + \text{sigma-theta})/1000.0.$$

Both depth and pressure channels were included in the original data. Pressure was taken as the independent variable to provide consistency with other OMEX data sets.

3.2) Editing

The reformatted CTD data were transferred onto a high speed graphics workstation and the downcasts inspected using an in-house interactive graphical editor. The downcasts were topped/tailed and any obvious spikes were manually flagged 'suspect'. In this way quality control was achieved with none of the original data values edited or deleted.

Once screened on the workstation, the CTD downcasts (**41**) were loaded into a database under the Oracle relational database management system.

3.3) Calibration

The pressures, temperatures and salinities supplied are believed to be accurate.

MUMM reported that the dissolved oxygen data showed reasonable agreement with the bottle data set from University of Liege. However, for the sake of internal consistency, the dissolved oxygen sensor performance was calibrated against 26 water bottle samples analysed following the classical Winkler titration procedure.

The calibration equation obtained was:

$$O_{corrected} = O_{observed} * 1.03 + 4.24 \quad (R^2 = 0.98)$$

and this has been applied to the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2db (casts deeper than 100db) or 1db (casts shallower than 100db). Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

4) References

Benson, B.B., Krause D. (1984). The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol.Oceanogr.*** 29 pp.620-632.

CTD Data for Cruise Poseidon 200-7

(23 June - 04 July 1993)

1) Instrumentation

The CTD profiles were taken with a Neil Brown CTD, probably a Mk3, incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. On most of the casts a SeaTech red light (661 nm) 25 cm path length transmissometer was fitted to the CTD package. The CTD unit was mounted vertically in the centre of a protective cage and the rig was fitted with a rosette sampler equipped with 12 Niskin bottles.

2) Data Acquisition and IfM Data Processing

The data were logged at 16 Hz on a PC running the standard EG&G data acquisition software. The downcasts were processed by the marine physics group at IfM Kiel and the calibrated data were transferred as ASCII files to BODC. The data have been worked up by an experienced team and are therefore believed to be of good quality.

3) BODC Processing, Screening and Calibration

3.1) Reformatting

The data in ASCII format were then transferred to the BODC internal format (PXF). This allowed the data to be quality assured using in-house software tools, notably the workstation graphics editor.

3.2) Editing

Using a custom in-house graphics editor, the limits of the downcasts were manually delimited and any spikes flagged suspect.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

During screening a salinity offset of -0.028 was observed on cast 486 between 1931 and 1959 decibars. This was corrected by applying a manual edit once the data had been loaded into the database.

3.3) Calibration

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from salinity). The following corrections were determined and have been applied to the data:

Casts 458, 461, 462, 465, 471, 473, 475, 486, 487, 488, 489, 490, 491, 492

$$P_{corrected} = P_{observed} - 0.73$$

Casts 459, 467, 469, 477, 480, 482, 484,

$$P_{corrected} = P_{observed} - 0.60$$

Cast 481

$$P_{corrected} = P_{observed} - 0.50$$

Salinity and temperature

The CTD data were accompanied by log sheets containing digital reversing thermometer data. These showed excellent agreement with the CTD temperatures inspiring confidence in the CTD temperature calibration. Therefore no adjustments have been made to the data by BODC.

The log sheets included the bottle references for the salinity samples but not the salinometer determinations. Subsequent attempts to obtain these data failed and consequently it was not possible to check out the salinity calibration. However, the T/S curves from the deep OMEX 3 station show excellent agreement with other cruises known to be of good quality.

Attenuance

Consideration of the clear water values from the transmissometer data showed that the instrument had problems. On cast 458 the instrument failed part way down and on the next few casts the clear water data were below pure water values. Between cast 465 and 471, the clear water data values suddenly increased by over 0.1 per m. Subsequent values were relatively stable until the instrument was removed after cast 486.

The following corrections, determined by normalising the clear water attenuance to 0.35, have been applied to the data to correct for the problems described above:

458	None	459	+0.085	461	+0.087
462	+0.080	465	+0.088	467	No data
469	No data	471	-0.050	475	-0.040
477	No data	480	-0.040	481	-0.050
482	-0.045	484	-0.045	486	-0.050

Please note that as a result of this procedure proving necessary, these data should not be used for purposes where accurate intercomparison between profiles is required.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

CTD Data for Cruise Valdivia 137

(23 June - 16 July 1993)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk2 CTD incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. The CTD unit was mounted vertically in the centre of a protective cage. Attached to the bars of the frame was a Chelsea fluorometer. However, this failed to return any useful data.

A rosette sampler fitted with 12, 2.5 litre Niskin bottles was mounted above the frame.

2) Data Acquisition

The data were logged using the EG&G CTDACQ program running on a PC.

3) On-Board Data Processing

The raw data logged by CTDACQ were written onto Quarter Inch Cartridge tapes using the Everex tape streamer backup facility.

4) Post-Cruise Processing

4.1) Reformatting

The raw data were extracted from the Quarter Inch Cartridge tapes on a PC running the Everex software at the British Antarctic Survey in Cambridge and transferred to BODC as compressed files on floppy disk. The Chelsea Instruments CTDPOST program, which is compatible with the EG&G format, was used to convert the binary files into 1db binned calibrated files in ASCII. These were transferred to a UNIX workstation and converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor.

4.2) Editing

Using a custom in-house graphics editor, the limits of the downcasts were manually flagged. In addition, spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system.

4.3) Calibration

<u>Pressure</u>

The pressure offset is usually determined by looking at the pressures recorded when the CTD was clearly logging in air. Few data points were logged in air and therefore the minimum pressure of each cast was used to derive a pressure correction. Using the logic that at the start of the cast the pressure should read about 1.5db a consistent pressure offset was observed throughout the cruise thus:

$$P_{corrected} = P_{observed} - 1.72$$

<u>Temperature</u>

A CTD temperature calibration exercise was carried out using data from the deep sea classical reversing thermometers included with the CTD data. The following offsets were determined:

Calibration 1: CTDs 100, 101, 1C1, 200C1, 200C2, 201C1, 201C2, 300C1, 300C2, 301C1, 301C2, 400C1, 400C2, 401C1, 401C2

$$T_{corrected} = T_{observed} + 0.11$$

Calibration 2: CTDs 110, 111, 112, 113, 115, 600C1, 600C2, 610C1, 610C2, 611C1, 611C2, 620C1, 620C2, 700C1, 700C2, 710C1, 710C2, 720C1, 720C2, 800C1, 800C2

$$T_{corrected} = T_{observed} + 0.034$$

Calibration 3: CTDs 210C1, 210C2, 211, 212, 213, 214, 215, 310C1, 310C2, 311, 312, 313, 314, 315, 410C1, 410C2, 411,412, 413, 414, 415, 500C1, 500C2, 510C1, 510C2, 511, 512, 513, 514, 515

$$T_{corrected} = T_{observed} + 0.048$$

However, comparison of the profiles from the deep casts with data from other cruises known to be of good quality showed that the temperatures as recorded were much nearer the true values than the data with the corrections described above applied. **Consequently, the reversing thermometer data have been deemed unreliable and no corrections have been applied to the temperature data.**

Salinity

In order to calibrate the conductivity sensor of the probe, water samples were taken at selected stations and analysed on board using a salinometer. From these, the following offsets were determined for the CTD salinity data:

Group 1: $S_{corrected} = S_{observed} + 0.034$
Group 2: $S_{corrected} = S_{observed} + 0.079$
Group 3: $S_{corrected} = S_{observed} + 0.050$

However, a comparison of deep station T/S curves with other cruises known to be of good quality showed the CTD on this cruise to be reading 0.016 PSU high, not low as implied by the corrections above. It has therefore been concluded that the bottle salinity data from this cruise are unreliable and a correction of -0.016 PSU has been applied to all CTD salinities from this cruise.

Chlorophyll

It has not been feasible to retrieve the fluorometer data. The Chelsea Instruments processing software refused to recognise the presence of a fluorometer channel in the raw data. Data were only available for a small number of casts due to the instrument flooding when the top plate deformed under a pressure of 6000 db. Consequently, it was not deemed cost effective to pursue the only options open (purchasing the EG&G software or writing custom software) to recover such a small amount of data.

4.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

CTD Data for Auriga Cruise PLUTUR1

(26 - 30 July 1993)

1) Instrumentation and Shipboard Protocols

The CTD profiles were taken with a Hydropolytester/Nephelometer ZULLIG probe, including pressure, temperature, salinity, dissolved oxygen, pH and optical backscatter sensors. No water bottle rosette was included in the package.

2) BODC Data Processing and Quality Control

2.1) Reformatting

ASCII files were supplied to BODC and contained temperature (C), depth (m), pH (pH units), conductivity (mmho/cm), oxygen (units unknown), turbidity (standard turbidity units (ftu)) and salinity (PSU). The data were converted into the BODC internal format (PXF). In addition to reformatting, the transfer program computed a sigma-theta channel (using the standard UNESCO subroutines POTEMP and SVAN) and converted depths to pressures (using the inverse of UNESCO function PTODEP).

2.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The pH and dissolved oxygen channels contained values that were either all zero or obviously erroneous. After consultation with the data originator, these channels were deleted. The salinity data were very noisy in parts, particularly on temperature gradients, and sometimes required heavy flagging. The temperature and nephelometer data were much cleaner.

2.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of originator's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

2.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

3) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The absolute accuracy of these channels is therefore unknown.

The temperature and salinity data were supplied to 2 decimal places, implying low accuracy. Visual inspection of the salinity channel supported this impression. Users are advised not to use the salinity data from this cruise for applications requiring high (>0.05 PSU) accuracy.

CTD Data for Cruise NAOMEX 1

(2 - 5 September 1993)

1) Instrumentation and Shipboard Protocols

NAOMEX 1 (BODC mnemonic NAOX1) was a University of Bordeaux cruise on the research vessel Cote d'Acquitaine. The CTD profiles were taken with the SeaBird SBE25 system fitted with a Chelsea Instruments fluorometer, a nephelometer and an oxygen membrane of the Beckman (non-pulsed) type.

2) Data Acquisition

The SBE25 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV software. The raw data files are converted into ASCII files with the data in oceanographic units on the basis of coefficients held in a calibration file.

3) Post-Cruise Processing

ASCII DATCNV output files were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 0.25 db with temperature, practical salinity, chlorophyll (nominal units), oxygen (ml/l) and optical backscatter (nominal units).

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66.

The chlorophyll was converted back to a voltage by a natural log transform to conform to the requirements of the BODC CTD data handling system. On retrieval, the data as supplied are reproduced.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were manually flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The manual inspection procedures revealed that there were serious problems with the salinity data. The data were plagued by frequent oscillations with an amplitude of up to 0.5 PSU. This, combined with the fact that the calibration accuracy of the salinity is totally unknown, led to the decision to delete the entire salinity channel from the data set.

The form of the dissolved oxygen profiles, with the exception of the upper 50m of the first cast, looked perfectly reasonable. However, the absolute values were obviously seriously low with saturations of below 80% at the surface. No water bottle data were available with which to correct the CTD oxygen data. Consequently, this channel was also deleted.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

The salinity data were subject to severe oscillations and have been deleted.

The absolute dissolved oxygen data were obviously wrong and no sample data were available for their calibration. Consequently, the oxygen data have also been deleted.

No independent checks, such as reversing thermometer data, were available for the verification of the temperature data. The accuracy of this channel is therefore unknown.

The fluorometer has not been calibrated against extracted chlorophyll data. The absolute values may therefore be meaningless.

The nephelometer data are in arbitrary units and their absolute values have no meaning.

CTD Data for Cruise Belgica 9322 (Leg A)

(21 - 29 September 1993)

1) Instrumentation

The CTD profiles were taken with the SeaBird SBE9 SCTD system. The instrument has enclosed conductivity and temperature sensors supplied with water by a pump. The water inlet was at the base of the bottle rosette. When not in use, the sensors were bathed in MilliQ water. SeaBird temperature sensors are high performance, pressure protected thermistors. A dissolved oxygen sensor was also included on the rig (non-pulsed membrane).

The CTD was periodically sent for calibration to SeaBird's NWRCC facility in Washington State. An average of 4 salinity samples were taken per cast, stored in crown-corked beer bottles, and determined on Beckman salinometer using IOSDL standard seawater. The procedure has come out well in ICES intercalibration exercises. Nevertheless, the Beckman is not considered as accurate as the SeaBird: the bottle data were used as a check for instrument malfunction but not for recalibration. Similarly, temperature sensor performance was monitored against digital reversing thermometers but not recalibrated.

Dissolved oxygen performance was monitored against Winkler titration, done by MUMM or University of Liege, and recalibrated by polynomial - usually linear - if required.

A SeaBird rosette sampler fitted with 12, 10 litre Niskin or Go/Flo bottles was mounted above the frame. The bases of the bottles were level with the pressure sensor with their tops 0.8 m above it. Digital thermometers on water bottles were placed 0.63 m above the CTD temperature sensor.

2) Data Acquisition

The CTD sampled at 24Hz but this was automatically reduced to 2Hz by the deck unit. The data were logged on a PC using the SeaBird SEASAVE program.

The CTD was lowered at 0.8-1 m/s. On the upcast, the hauling rate was approximately the same, but is reduced on approach to a bottle firing depth to minimise wake interference.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from raw binary data into calibrated data in ASCII format that were supplied to BODC.

3.1) Reformatting

Data supplied to BODC were binned to 1 m with an independent variable of depth in metres. This was converted to decibars using an inverse (by iteration) of the Saunders and Fofonoff algorithm. The algorithm was checked against data from cruise BG9412 that were supplied with both pressure and depth channels. An empirical examination showed that pressure could be computed from the depth to an accuracy of 0.0001db assuming a latitude of 50°N. This latitude was therefore assumed from the conversion of the BG9322 depths to pressures.

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Temperature has been converted from ITS68 to ITS90 by dividing the values by 1.00024.

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66.

3.2) Editing

Reformatted CTD data were transferred onto a high speed graphics workstation. Using a custom in-house graphics editor, the downcasts was manually flagged. The flagging involved marking the top and the bottom of the downcast. The top was set to the point where salinity increased from near zero value to a realistic value for sea water. Additionally, any obvious spikes were manually flagged 'suspect'. In this way none of the original data values were edited or deleted.

Once screened on the workstation, the CTD downcasts (**25**) were loaded into a database under the Oracle relational database management system.

3.3) Calibration

The pressures, temperatures and salinities supplied are believed to be accurate.

MUMM reported that the dissolved oxygen data showed reasonable agreement with the bottle data set from University of Liege. However, for the sake of internal consistency, the dissolved oxygen sensor performance was calibrated against 97 water bottle samples analysed following the classical Winkler titration procedure.

The recalibration equation obtained was:

$$O_{corrected} = O_{observed} * 0.83 + 52.78 \quad (r_2 = 0.89)$$

and this has been applied to the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set were binned to 2db (casts deeper than 100db) or 1db (casts shallower than 100db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

4) References

Benson, B.B., Krause D. (1984). The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol.Oceanogr.*** 29 pp.620-632.

Fofonoff, N.P., Millard, R.C. (1982). Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science***. 44.

CTD Data for Cruise Pelagia 93

(11 - 31 October 1993)

1) Instrumentation and Shipboard Protocols

The CTD profiles were taken with the SeaBird SBE9 system fitted with a 25 cm path length red light SeaTech transmissometer, a Chelsea Instruments Aquatracka fluorometer and an oxygen membrane of the Beckman (non-pulsed) type.

A rosette sampler fitted with 22, 12 litre NOEX bottles was mounted with the bottles forming a ring around the CTD cage. The bases of the bottles were approximately 0.5 m below the pressure sensor with their tops about 0.5 m above it. Digital thermometers on water bottles were placed 0.3 m above the CTD temperature sensor. Salinity samples were collected from 2-3 bottles on most deep casts (water depth in excess of 1000 m).

Operational procedure was to lower the CTD continuously to the bottom and then raise it in increments, firing the water bottles at the required depths.

2) Data Acquisition

The data were logged on a PC using the SeaBird data acquisition software.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from binary raw data files to ASCII format in engineering units (PSU, °C, etc.). The data were then passed to Dr. Hendrik van Aken's group at NIOZ who worked up the temperature, salinity and oxygen channels. Details of the procedures used are not known but this group are associated with the collection of WOCE data and there is every reason to believe that the work was done to a very high standard.

The processed data were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 1db with temperature (ITS90), practical salinity, chlorophyll (expressed as µg/l), oxygen (µmol/kg) and attenuance (per m).

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by (1000+sigma-theta)/1000.

The chlorophyll was converted back to a voltage by applying a natural log transform to conform to the requirements of the BODC CTD data handling system. On retrieval, the data as supplied are reproduced.

3.2) Editing

Using custom in-house graphics editors, the limits of the downcast were manually flagged. Any obvious spikes identified were manually flagged 'suspect'. The data from this cruise were very clean and the only flagging required were some near-surface oxygen data where the sensor had obviously not equilibrated.

Once screened on the workstation, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

3.3) Calibrations

The salinity and temperature data had been calibrated prior to submission to BODC. The only additional check was a comparison of the salinity/potential temperature plot for a deep cast off the Goban Spur with other OMEX data known to be of good quality. The agreement was excellent.

On screening the oxygen data it was noticed that one cast (CP1) showed a significant offset in oxygen saturation from the rest of the data. This prompted a check of the CTD oxygen data against bottle data obtained following the Winkler titration protocols similar to those described in Carpenter (1965).

The results showed good agreement for all casts except CP1. The following recalibration was obtained for this cast and has been applied to the data:

$$O_{2\ \mathrm{corrected}} = (0.456 * O_{2\ \mathrm{observed}}) + 156$$

No additional calibration was applied to the other casts.

During screening it was observed that significant deviations, in the form of a smooth peak, were present in the oxygen profiles at the depth of the thermocline. No attempt was made to flag these data but users should be aware that this feature may be an artefact.

The attenuance values were higher than expected (0.5-0.6) at clear water depths. This was corrected in Oracle by normalising the clear water data (away from the surface and from the bottom and avoiding any mid-water nepheloid features) to the expected value for the clear water minimum (0.35) in the Goban Spur area. The correction has been applied as follows:

Cast	Correction
CP1	-0.30
CP2	-0.29
CP3	-0.27
CP4	-0.24
CP5	-0.22
CP6	-0.20
CP7	-0.20
CP8	-0.18
CP9	-0.17
CP10	-0.18
CP11	-0.21

No extracted chlorophyll data were available for this cruise and consequently the data presented are the result of a nominal calibration. **More heed should therefore be paid to the relative, rather than absolute, chlorophyll values.**

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

4) Data Warnings

The attenuance values supplied were characteristic of SeaTech data which have not been air corrected. The data have been normalised to a clear water minimum value of 0.35. **The resulting absolute attenuance values should**

be used with some caution and no attempt should be made to ascertain differences in clear water particle concentration across the shelf break using these data.

The fluorometer has not been calibrated against extracted chlorophyll data. The absolute values may therefore be meaningless.

5) Bibliography

Benson, B.B., Krause, D., 1984. The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol.Oceanogr.*** 29 pp.620-632.

Carpenter, J.H., 1965. The Chesapeake Bay Institute techniques for the Winkler dissolved oxygen method. ***Limnol. Oceanogr.*** 10 pp.141-143.

CTD Data for Auriga Cruise PLUTUR2

(22 November - 03 December 1993)

1) Instrumentation and Shipboard Protocols

The CTD profiles were taken with a Hydropolytester/Nephelometer ZULLIG probe, including pressure, temperature, salinity, dissolved oxygen, pH and optical backscatter sensors. No water bottle rosette was included in the package.

2) BODC Data Processing and Quality Control

2.1) Reformatting

ASCII files were supplied to BODC and contained temperature (C), depth (m), pH (pH units), conductivity (mmho/cm), oxygen (units unknown), turbidity (standard turbidity units (ftu)) and salinity (PSU). The data were converted into the BODC internal format (PXF). In addition to reformatting, the transfer program computed a sigma-theta channel (using the standard UNESCO subroutines POTEMP and SVAN) and converted depths to pressures (using the inverse of UNESCO function PTODEP).

2.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The pH and dissolved oxygen channels contained values that were either all zero or obviously erroneous. After consultation with the data originator, these channels were deleted. The salinity data were very noisy in parts, particularly on temperature gradients, and sometimes required heavy flagging. The temperature and nephelometer data were much cleaner.

2.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of originator's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

2.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

3) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The absolute accuracy of these channels is therefore unknown.

The temperature and salinity data were supplied to 2 decimal places, implying low accuracy. Visual inspection of the salinity channel supported this impression. Users are advised not to use the salinity data from this cruise for applications requiring high (>0.05 PSU) accuracy.

CTD Data for Cruise Charles Darwin 83

(13 December 1993 - 13 January 1994)

1) Instrumentation

The CTD profiles were taken with an RVS Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckman dissolved oxygen sensor. The CTD unit was mounted vertically in the centre of a protective cage approximately 1.5 m square. Attached to the bars of the frame was a Chelsea Instruments Aquatracka fluorometer, a Chelsea Instruments Aquatracka configured as a nephelometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

A General Oceanics rosette sampler fitted with 12, 10 litre Niskin or GoFlo bottles was mounted above the frame. The bases of the bottles were 0.75 m above the pressure head with their tops 1.55 m above it.

Lowering rates were generally in the range of 0.5-1.0 m/sec but could be up to 1.5 m/sec. Bottle samples were acquired during the upcast.

2) Data Acquisition

CTD data were sampled at a frequency of 32 Hz. Data reduction in real time, converting the 32 Hz data to a 1-second time series, was done by the RVS Level A microcomputer system. These were then logged as digital counts by the Level C workstation via the Level B data buffer.

3) On-Board Data Processing

RVS software on the Level C (a SUN workstation) was used to convert the raw counts into engineering units (Volts for transmissometer and fluorometer, ml/l for oxygen, mmho cm^{-1} for conductivity and °C for temperature). A nominal calibration (a simple antilog) was also applied to the chlorophyll channel by this program.

Salinity (Practical Salinity Units, as defined by the Practical Salinity Scale (Fofonoff and Millard 1982)) was calculated from the conductivity ratio (conductivity / 42.914) and a time lagged temperature using the function described in UNESCO Report 37 (1981).

The data were written onto Quarter Inch Cartridge tapes in RVS internal format and submitted to BODC for post-cruise processing and data-banking.

4) Post-Cruise Processing

4.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66.

The raw transmissometer voltages were corrected for light source decay using a correction ratio computed from light reading in air taken during the cruise (4.675V) and the manufacturer's figure for the new instrument (4.738V). Transmissometer voltages were converted to percentage transmission by multiplying them by 20 and then to attenuance by applying the formula:

$$\text{attenuance} = -4 * \ln(\text{percent transmittance} / 100)$$

The nominal calibration applied to the fluorometer was removed.

4.2) Editing

The reformatted CTD data were transferred onto a high speed graphics workstation. Using a custom in-house graphics editor, the downcasts were manually delimited and any spikes flagged suspect.

Once screened on the workstation, the CTD downcasts were loaded into a database under the Oracle relational database management system.

Visual inspection showed that the attenuance data from this cruise had severe problems. There was a strong hysteresis between the up and downcasts and clear water values were drifting from cast to cast anywhere between 0.5 and 1.0 per m. Consequently, these data have been discarded.

4.3) Calibration

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from the conductivity channel). No pressure correction proved necessary.

Temperature

Since no reversing thermometer readings were available for this cruise the offset has been taken to be zero. The instrument was calibrated in the RVS base facility just prior to the cruise and experience from previous cruises has shown the Neil Brown Mk3 thermometer to be a very stable and accurate instrument.

Salinity

The data originator determined that the CTD was reading 0.078 PSU low when compared with salinometer determinations on bottle samples. This correction has been applied to the data.

Oxygen

The dissolved oxygen sensor was calibrated by the data originator against water bottle samples analysed following the Winkler titration procedures. The calibration obtained was:

$$\text{oxygen(cal)} = 3.394 + 1.146 * \text{oxygen(CTD)}$$

This has been applied to the data. Note the intercept has been adjusted from the value in the cruise report to allow for the conversion from ml/l to µM.

Chlorophyll

A calibration was done against 87 **fluorometrically assayed,** extracted chlorophyll samples. The resulting equation was:

$$\text{chlorophyll (mg/m}^3\text{)} = \exp(3.71 * \text{raw\_voltage} - 6.39)$$

This has been applied to the data.

4.4) Data reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Oxygen saturations were calculated using the algorithm of Benson and Krause (1984).

5) Bibliography

Benson, B.B. and Krause D. jnr., 1984. The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol. Oceanogr.*** 29 pp.620.632.

Fofonoff, N.P. and Millard, R.C., 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science***, 44.

CTD Data for Cruise Meteor 27-1

(29 December 1993 - 17 January 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometers, dissolved oxygen sensor and a rosette sampler equipped with 12 Niskin bottles (12 litre). The CTD unit was mounted vertically in the centre of a protective cage. A 25cm path length transmissometer was attached to the rig.

Please note that neither the oxygen sensor nor the transmissometer functioned properly on this cruise. This was mentioned in the cruise report and has been confirmed by BODC inspection of the data. These channels have therefore been jettisoned.

2) Data Acquisition and On-Board Data Processing

The data were logged at 16 Hz on a PC running the standard EG&G data acquisition software. The CTDPOST software was used to apply nominal calibrations and output the data at full resolution as ASCII files. These were supplied to BODC.

3) Post-Cruise Processing

3.1) Reformatting

The ASCII data were transferred onto BODC's UNIX environment. The 16 Hz data were reduced to 1 Hz resolution by averaging the data from groups of 16 datacycles. A spike elimination algorithm prevented corruption of the generated 1 Hz data by any data dropout.

The output from the averaging program was combined with a time channel. The time channel was generated using the time in the file header as a base and assuming a 1 m/second lowering rate. Any gaps in the data stream could be detected and the time adjusted accordingly by monitoring the pressure channel.

Oxygen concentration was computed from the oxygen current and corrected for temperature and salinity using the standard Neil Brown algorithm. CTD temperature had to be used as the oxygen temperature channel data appeared corrupted. The resultant dissolved oxygen data were converted from ml/l to µM by multiplying the values by 44.66. However, as stated above, this was a vain effort and the oxygen data were discarded.

The data in ASCII format were then transferred to the BODC internal format (PXF). This allows the data to be quality assured using in-house software tools, notably the workstation graphics editor.

3.2) Editing

Using a custom in-house graphics editor, the limits of the downcasts were manually flagged. Upcasts were not saved. In addition, spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were changed or lost.

Once screened on the workstation, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from the salinity channel). A consistent value was observed throughout the cruise and the following correction has been applied to the eight CTDs:

$$P_{corrected} = P_{observed} + 1.04$$

with the exception of cast 029401 (002-94/1) where the applied correction was 1.1 db.

Salinity and temperature

The salinity was calibrated against 34 water bottle samples taken on 7 out of 16 casts. The bottle data for two of the casts (049401 and 069401) showed a significantly different offset from the other casts (approximately 0.02 rise in CTD salinity). After careful cross checking between these casts and other casts on the same station (OMEX 3) from other cruises it has been concluded that this apparent difference is the result of an error in the bottle data for these two casts.

Consequently, a single mean offset of -0.027 (standard deviation 0.0065) was determined for the whole cruise and this has been applied to the data.

No reversing thermometer readings were taken during the cruise due to the bad weather making the risk of smashing them too high. However, the temperature data from this CTD is reported as good quality and not usually in need of further calibration.

Oxygen

The oxygen converted to µM proved to be of suspicious quality, this probably being due to a corrupted current signal. The calibration against 45 water bottle samples was a total failure giving a correlation coefficient of 0.12. Therefore all the CTD oxygen data under ORACLE for this cruise were flagged as suspect.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

CTD Data for Cruise Charles Darwin 84

(18 January - 2 February 1994)

1) Instrumentation

The CTD profiles were taken with an RVS Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckman dissolved oxygen sensor. The CTD unit was mounted vertically in the centre of a protective cage approximately 1.5 m square. Attached to the bars of the frame were a Chelsea Instruments Aquatracka fluorometer, a Chelsea Instruments Aquatracka configured as a nephelometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

A General Oceanics rosette sampler fitted with 12, 10 litre Niskin or GoFlo bottles was mounted above the frame. The bases of the bottles were 0.75 m above the pressure head with their tops 1.55 m above it. One of the bottles was fitted with a holder for up to three digital reversing thermometers mounted 1.38 m above the CTD temperature sensor.

Below the rosette sampler, fitted to the bottom of the cage, was a PML 2-pi PAR (photosynthetically available radiation) sensor pointing downwards to measure upwelling irradiance. A second such sensor was fitted above the rosette pointing upwards to measure downwelling irradiance. Both sensors were pressure hardened to 1000 db. It should be noted that the PAR sensors were vertically separated by approximately 2 m. These instruments were only attached for a small number of casts (CTD1, CTD2, CTD3).

Lowering rates were generally in the range of 0.5-1.0 m/sec but could be up to 1.5 m/sec. Bottle samples and reversing thermometer measurements were acquired on the upcast.

2) Data Acquisition

CTD data were sampled at a frequency of 32 Hz. Data reduction was done in real time by the RVS Level A microcomputer system producing a 1-second time series. This was logged as digital counts on the Level C workstation via the Level B data buffer.

3) On-Board Data Processing

RVS software on the Level C (a SUN workstation) was used to convert the raw counts into engineering units (Volts for the PAR sensor, transmissometer and fluorometer, ml/l for oxygen, mmho cm^{-1} for conductivity and °C for temperature).

Salinity (Practical Salinity Units, as defined by the Practical Salinity Scale (Fofonoff and Millard 1982)) was calculated from the conductivity ratio (conductivity / 42.914) and a time lagged temperature using the function described in UNESCO Report 37 (1981).

Data were written onto Quarter Inch Cartridge tapes in RVS internal format and submitted to BODC for post-cruise processing and data-banking.

4) Post-Cruise Processing

4.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66.

The raw transmissometer voltages were corrected for light source decay using a correction ratio computed from light readings in air taken during the cruise and the manufacturer's figure for the new instrument (4.738V). The correction was applied as follows:

From	To	Air Reading(V)
18/01/94 18:13	22/01/94 14:00	4.683
22/01/94 14:01	23/01/94 15:00	4.670
23/01/94 15:01	24/01/94 09:00	4.673
24/01/94 09:01	25/01/94 11:00	4.705
25/01/94 11:01	26/01/94 10:30	4.700
26/01/94 10:31	27/01/94 10:00	4.761
27/01/94 10:01	28/01/94 10:00	4.763
28/01/94 10:01	29/01/94 14:00	4.739
29/01/94 14:01	30/01/94 04:30	4.683
30/01/94 04:31	31/01/94 13:00	4.763
31/01/94 13:01	02/02/94 09:00	4.775

Transmissometer voltages were converted to percentage transmission by multiplying them by 20 and then to attenuance using the algorithm:-

attenuance = $-4 * \ln$ (percent transmittance / 100)

The 2-pi PAR voltages were converted to W/m2 using the equations:

Downwelling:	PAR = exp (-5.060 * V + 6.5746)
Upwelling:	PAR = exp (-4.978 * V + 6.7770)

4.2) Editing

Using a custom in-house graphics editor, the downcasts and upcasts were differentiated and the limits of the downcasts were marked by flags in the cycle number channel. In addition, spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

The pressure ranges over which the bottle samples were taken were logged using the editor. Usually, the marked reaction of the oxygen sensor to the bottle firing signal was used to determine this. These pressure ranges were subsequently used, in conjunction with a geometrical correction for the position of the water bottles with respect to the CTD pressure transducer, to determine the pressure range of data to be averaged to obtain values for calibration.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system and the following manual edits applied:

> A salinity offset of -0.08 PSU (from the depth of 955.4db downwards) was noticed during the screening of cast CTD18. This was corrected in ORACLE by adding 0.08 PSU to all affected salinity values.
>
> The PAR meters were attached to the CTD on only three casts. The PAR channels for all other casts were set to null.

4.3) Calibration

With the exception of pressure, calibrations were done by comparison of CTD data against measurements made on water bottle samples or from the reversing thermometers mounted on the water bottles in the case of temperature. In general, values were averaged from the CTD downcasts but where inspection on a graphics workstation showed significant hysteresis, values were manually extracted from the CTD upcasts.

All calibrations described here have been applied to the data.

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from the conductivity channel). A consistent value was observed throughout the cruise thus:

$$P_{corrected} = P_{observed} - 0.675$$

Temperature

The CTD temperature readings were in excellent agreement with digital reversing thermometer readings. Hence no temperature calibration was applied.

Salinity

Salinity was calibrated against 49 water bottle samples measured using a Guildline 55358 Autolab salinometer during the cruise. Samples were taken from the bottles fired on 20 casts. Usually 1 sample was taken per cast except for casts CTD7, CTD16 and CTD17 where 12, 11 and 10 water bottle samples were taken respectively.

Samples were collected in glass bottles filled to just below the neck and sealed with plastic stoppers. Batches of samples were left for at least 24 hours to reach thermal equilibrium in the constant temperature laboratory containing the salinometer before analysis.

The correction determined for all casts from this cruise was:

$$S_{corrected} = S_{observed} + 0.076$$

Oxygen

The dissolved oxygen sensor was calibrated against 83 water bottle samples analysed following the Winkler titration procedures outlined in Carpenter (1965). The samples were taken from 19 casts (except CTD11). Sensor drift during the cruise was apparent. Therefore the calibration was applied in segments thus:

Cast	Slope	Intercept	R^2
CTD1-CTD4	1.20	-16.3	94.9%
CTD5	1.18	-18.2	92.4%
CTD6, CTD7	0.88	45.4	90.2%
CTD8	0.93	34.9	88.4%
CTD9	0.99	26.5	96.8%
CTD10, CTD11	0.90	39.7	99.1%
CTD12-CTD15	1.01	20.5	95.9%
CTD16	1.68	-110.0	77.2%
CTD17-CTD20	0.73	88.7	75.8%

Oxygen saturations present in the data files were computed using the algorithm presented in Benson and Krause (1984).

Chlorophyll

An attempt was made to calibrate the fluorometer using a regression against extracted chlorophyll. However, due to a large baseline drift of the instrument throughout the cruise it was not possible to obtain a satisfactory calibration. Therefore all of the voltages stored in ORACLE were marked suspect.

4.4) Data Reduction

The final data set were produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

5) Data Warnings

All chlorophyll data were flagged suspect as the fluorometer baseline drift significantly exceeded the signal.

6) Bibliography

Benson, B.B. and Krause D. jnr. 1984.The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol. Oceanogr.*** 29 pp.620-632.

Carpenter J.H. 1965. The Chesapeake Bay Institute techniques for the Winkler dissolved oxygen method. ***Limnol.Oceanogr.*** 10 pp.141-143.

Fofonoff, N.P. and Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater**.** ***UNESCO Technical Papers in Marine Science****.* 44.

CTD Data for Cruise Jan Mayen 1

(12 - 16 March 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was a relatively new instrument and the manufacturer's temperature and conductivity calibrations were used.

2) Data Acquisition and Originator Processing

Data were logged at 16 Hz on a PC running EG&G data acquisition software and subsequently incorporated into the Tromsø data system. Data were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect. **Temperature and salinity were noted as being unusually noisy.**

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data. The originator's calibration was as supplied by the manufacturer and, as this was a relatively new instrument when used on this cruise, is believed by the originator to be reliable.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

$$\text{chlorophyll (mg/m}^3\text{)} = \exp(\text{raw voltage} * 1.19 - 0.722) \quad (n=119\text{: } R^2=79\%)$$

This has been applied to the data held in the database.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gap were set null.

4) Data Warnings

The temperature and salinity data were unusually noisy. For a number of the casts, the noise level was considered excessive and the entire channel has been deleted. The casts affected were:

0039	Temperature and salinity
0043	Salinity
0045	Temperature and salinity
0046	Temperature and salinity
0047	Salinity
0071	Salinity
0072	Temperature and salinity
0074	Temperature and salinity

CTD Data for Cruise Charles Darwin 85

(11 April - 7 May 1994)

1) Instrumentation

The CTD profiles were taken with an RVS Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell and a platinum resistance thermometer. The CTD unit was mounted in a protective cage to which a Chelsea Instruments Aquatracka fluorometer was attached.

A General Oceanics rosette sampler fitted with 6, 1.7 and 6, 2.4 litre Go-Flo bottles was mounted above the frame. The bottles were fired in pairs to give 4 litres of water per sample. The bases of the larger bottles were approximately 40 cm above the CTD and their tops 1 m above it. The 1.7 litre bottles were fitted with a holder for up to three SIS digital reversing thermometers and/or pressure devices with their sensors approximately 85 cm above the CTD in their triggered position.

Lowering rates were in the range of 0.5-1.0 m/sec. Bottle samples and reversing thermometer measurements were acquired on the upcast.

2) Data Acquisition

The CTD data were sampled at a frequency of 32 Hz and reduced in real time by the RVS Level A microcomputer system to produce a 1-second time series. This was logged as digital counts on the Level C workstation via a Level B data buffer.

3) On-Board Data Processing

RVS software on the Level C (a SUN workstation) was used to convert the raw counts into engineering units (Volts for the fluorometer, mmho cm^{-1} for conductivity and °C for temperature). A nominal calibration (a simple antilog) was also applied to the chlorophyll channel by this program.

Data were written onto Quarter Inch Cartridge tapes in RVS internal format and submitted to BODC for post-cruise processing and data-banking.

4) Post-Cruise Processing

4.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the graphics editor. The nominal calibration applied to the fluorometer data was removed, returning the data to raw voltages.

4.2) Editing

Using the graphics editor, the limits of the downcast were manually delimited. Any spikes on the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

The pressure ranges over which the bottle samples were taken were logged by manual interaction with the editor. These were subsequently used, in conjunction with a geometrical correction for the position of the water bottles with respect to the CTD pressure transducer, to determine the pressure range of data to be averaged for calibration purposes.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system.

4.3) BODC Quality Control and Calibrations

Pressure

No pressure data logged in air was available for this cruise. However, many of the casts gave negative pressures at the surface. A pressure correction was determined on the basis that the lowest pressure logged at the surface represented zero which gave:

$$P_{corrected} = P_{observed} + 1.45$$

This correction has been applied to the data.

Temperature

The Neil Brown temperatures were in good agreement with digital reversing thermometer readings, hence no temperature calibration was applied.

Salinity

Salinity was calibrated against 23 water bottle samples measured on a Guildline Autosal salinometer. Samples were taken from the bottles fired on five casts. Usually 4-6 samples were taken per cast.

The samples were collected in glass bottles and sealed with plastic stoppers. The temperature at which the samples were measured was 21°C.

The salinity correction determined was:

$$S_{corrected} = S_{observed} - 0.066$$

The salinity signal from two of the casts (03-01 and 18-12) was excessively noisy and the salinity data from these casts have been deleted.

Chlorophyll

An attempt was made to calibrate the fluorometer against chlorophyll measured by HPLC. However, the concentration range of the samples was inadequate to cover the full voltage range, resulting in the calibration being inaccurate for higher chlorophyll concentrations. **Instead, the calibration was done against the sum of fluorometrically measured chlorophylls done on size-fractionated samples.**

These samples were taken from GoFlo hydrocasts taken within an hour of the CTD casts. The samples were filtered through a membrane filter cascade and extracted in acetone. Chlorophyll was determined on board using a Turner Design bench fluorometer calibrated against absolute chlorophyll standards. The resulting regression equation was:

$$\text{chlorophyll (mg/m}^3\text{)} = \exp(4.03 * \text{raw\_voltage} - 8.83)$$

From graphical examination of the data, the fluorometer was obviously malfunctioning on the casts 03-01, 04-11, 04-46, 04-48, 04-53 and 05-13. The chlorophyll data from these casts have been deleted.

4.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

CTD Data for Cruise Jan Mayen 2

(11 - 16 April 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was a relatively new instrument and the manufacturer's temperature and conductivity calibrations have been used.

2) Data Acquisition and Originator Processing

Data were logged at 16 Hz on a PC running EG&G data acquisition software and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and a natural log transform was applied to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect. **Temperature and salinity were noted as being unusually noisy.**

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data. The originator's calibration was as supplied by the manufacturer and, as this was a relatively new instrument when used on this cruise, is believed by the originator to be reliable.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.0555 - 0.711) (n=129: R^2=72%)

This has been applied to the data held in the database. Note that near-surface data points affected by quenching were excluded from the calibration.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gap were set null.

4) Data Warnings

The temperature and salinity data were unusually noisy. For a number of the casts, the noise level was considered excessive and the entire channel has been deleted. The casts affected were:

0189	Temperature and salinity
0190	Salinity
0217	Temperature and salinity

The fluorometer data exhibited clear examples of 'quenching' where photo-adaptive reactions of the phytoplankton caused a variation in fluorescence yield as a function of depth near the surface. Consequently, calibrated fluorometer values in the top 10-15 m should be regarded as possible underestimates of the true chlorophyll calibration.

The fluorometer data from three casts (0154, 0213 and 0214) exhibited clear instrumental problems and have been deleted from the data set.

CTD Data for Cruise An Cappall Ban CAPB1

(12 - 14 April 1994)

1) Instrumentation

The CTD profiles were taken with an Applied Microsystems STD 12 plus CTD system incorporating a Keller stainless steel pressure transducer, a precision thermistor and a four platinised electrode conductivity cell.

Prior to use, a check of the sensors was done by running the instrument in a water bath. A single Niskin bottle was sometimes clamped to the wire above the CTD to take calibration samples. On other SEFOS cruises the package was mounted in a CTD rosette frame allowing a more thorough calibration to be undertaken.

2) Data Acquisition and UCG Processing

The instrument included an internal data logger that sampled at up to 8 Hz. However, internal memory restrictions (7,500 record capacity at the time of this cruise) dictated that lower sampling rates be used. Data from the CTD were downloaded onto a PC, binned to 1db and converted into engineering units in ASCII format using software supplied with the instrument.

A calibration offset of -0.015 has been applied to the salinity data by UCG based upon an extensive calibration against bottle data during SEFOS cruise Heinke 71 in May 1995.

3) BODC Data Processing and Quality Control

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the graphics editor.

3.2) Editing

Using a custom in-house graphics editor, the limits of the downcasts were manually flagged. In addition, spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

Once screened on the workstation, the CTD downcasts were loaded into a database under the Oracle relational database management system.

3.3) Calibration

No additional calibrations have been applied to the data by BODC.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 m) or 1 db (casts shallower than 100 m). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

CTD Data for Cruise Belgica 9412

(20 April - 5 May 1994)

1) Instrumentation and Shipboard Procedures

The CTD profiles were taken with a SeaBird SBE 911 *plus* system. The instrument was fitted with duplicate sensor sets, each including a conductivity and temperature sensor. Each sensor set was supplied with water by a separate pump. The water inlet was at the base of the bottle rosette. The CTD had a temperature and salinity (TC) duct with an inertia balanced pump flow to improve the quality of salinity measurements.

When not in use, the sensors were bathed in MilliQ water. SeaBird temperature sensors are high performance, pressure protected thermistors. Other sensors on the rig were a non-pulsed membrane dissolved oxygen cell and an Aqutracka fluorometer.

The CTD was periodically sent for calibration to SeaBird's NWRCC facility in Washington State. An average of 4 salinity samples were taken per cast, stored in crown-corked beer bottles, and determined on Beckman RB7 laboratory salinometer, calibrated using OSI standard seawater. The procedure has come out well in ICES intercalibration exercises. Nevertheless, the Beckman was not considered as accurate as the SeaBird: the bottle data were used as a check for instrument malfunction but not for recalibration. Similarly, temperature sensor performance was monitored against digital reversing thermometers but not recalibrated.

A SeaBird rosette sampler fitted with 12, 10 litre Niskin or Go-Flo bottles was mounted above the frame. The bases of the bottles were level with the pressure sensor with their tops 0.8m above it. Digital thermometers on water bottles were placed 0.63 m above the CTD temperature sensor.

2) Data Acquisition

The CTD sampled at 24 Hz but this was automatically reduced to 2 Hz by the deck unit. The data were logged on a PC using SeaBird's SEASAVE program.

The CTD was lowered at 0.8-1 m/s. On the upcast, the hauling rate is approximately the same, but was reduced on approach to a bottle firing depth to minimise wake interference.

3) Post-Cruise Processing

The SeaBird DATCNV software was used to convert the binary raw data files into calibrated ASCII data that were supplied to BODC.

The salinity computation algorithm in the software is based on Fofonoff and Millard (1982). Salinity spiking on thermal gradients was minimised through software realignment of the temperature and conductivity channels.

The fluorometer data were calibrated to give nominal chlorophyll using the manufacturer's calibration.

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Temperature has been converted from ITS68 to ITS90 by dividing the values by 1.00024.

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by

$$(1000 + \text{sigma-theta}) / 1000$$

3.2) Editing

Reformatted CTD data were transferred onto a high speed graphics workstation for manual inspection using a custom in-house graphics editor. The top and bottom of the downcast were marked to eliminate noisy data logged whilst the instrument was stabilising.

The data were examined point by point and any obvious spikes were flagged 'suspect'.

Once screened on the workstation, the CTD downcasts (**17**) were loaded into a database under the Oracle relational database management system. Note that the loader only included data from the downcast marked during screening.

3.3) Calibration

The temperature and salinity data are believed to be accurate as supplied and no further calibrations have been applied.

The fluorometer supplied values in terms of nominal chlorophyll. An empirical investigation of the CTD data against a set of extracted chlorophyll data (**spectrophotometrically assayed using the SCOR equation**, Strickland and Parsons, 1975) showed these values to have a strong linear relationship with chlorophyll described by the equation:

True chlorophyll = Nominal chlorophyll * 395.15 - 3.988 (n=30: R^2=94%)

This posed a problem for the BODC CTD data management system which includes the hard wired assumption that chlorophyll is exponentially related to the raw fluorometer value. The problem was overcome by applying the equation given above to the raw data tables, applying a natural log transform to the data and setting the calibration coefficients held in the system to 1 and zero. In this way, the true calibrated values are retrieved by the BODC software.

On many of the casts, the chlorophyll data are missing from the top 20-30 m. This comprised obviously spurious values several orders of magnitude higher than the rest of the cast, dropping over a couple of records to the 'normal' magnitude. These caused problems when calibrated due to value overflow and had to be eliminated from the data set.

The data were supplied to BODC by MUMM before any oxygen bottle data became available. Consequently, the oxygen calibration could not be checked. Once bottle data were obtained, BODC undertook a calibration against 96 water bottle samples analysed by Winkler titration (University of Liege data).

The calibration equation obtained was:

$$O_{corrected} = O_{observed} * 0.879 + 58.493 \quad (R^2 = 97.1\%)$$

This has been applied to the data.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Bibliography

Fofonoff, N.P., Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science.*** 44.

Strickland, J.D.H., Parsons, T.R. (1975). A practical handbook of seawater analysis. ***Fish. Res. Bd. Can***. pp.167-311.

CTD Data for Cruise Jan Mayen 3

(16 - 20 May 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was a relatively new instrument and the manufacturer's temperature and conductivity calibrations were used.

2) Data Acquisition and Originator Processing

Data were logged at 16 Hz on a PC running EG&G data acquisition software and subsequently incorporated into the Tromsø data system. Data were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect. **Temperature and salinity were noted as being unusually noisy.**

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data. The originator's calibration was as supplied by the manufacturer and, as this was a relatively new instrument when used on this cruise, is believed by the originator to be reliable.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

$$\text{chlorophyll (mg/m}^3\text{)} = \exp(\text{raw voltage} * 1.3676 - 0.915) \quad (n=106\text{: } R^2=90\%)$$

This has been applied to the data held in the database. Note that near-surface data points affected by quenching were excluded from the calibration.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

The temperature and salinity data were unusually noisy. For one cast (0428), the temperature noise level was considered excessive and the entire channel has been deleted.

The fluorometer data exhibited clear examples of 'quenching' where photo-adaptive reactions of the phytoplankton caused a variation in fluorescence yield as a function of depth near the surface. Consequently, calibrated fluorometer values in the top 10-15 m should be regarded as possible underestimates of the true chlorophyll concentration.

CTD Data for Cruise Charles Darwin 86

(18 May - 13 June 1994)

1) Instrumentation

The CTD profiles of the water column and water samples at discrete horizons were taken with a Seabird SBE 911 *plus* CTD mounted inside a 22 bottle rosette array. The CTD probe incorporated a pressure sensor, conductivity cell, pressure protected high quality thermistor and a membrane dissolved oxygen sensor. In addition, attached to the CTD frame, were a Chelsea Instruments Mk III Aquatracka fluorometer, a Chelsea Instruments Mk III Aquatracka nephelometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

The rosette frame was equipped with twenty-two 12 litre NOEX bottles. The bases of the bottles were 0.5 m above the pressure head with their tops 0.5 m above it. One of the bottles was fitted with a holder for up to three digital reversing thermometers mounted 0.3 m above the CTD temperature sensor. As usual, there were intermittent problems with the NOEX bottles from contamination by leakage.

An underway CTD routine check station was held on 20th May. This was followed by a programme of CTD profiles of the water column along the OMEX transect with consecutive water sampling at discrete horizons.

Lowering rates were generally in the range of 0.5-1.0 m sec^{-1} but could be up to 1.5 m sec^{-1}. Bottle samples and reversing thermometer measurements were acquired on the ascent of the CTD casts. Salinity determinations of bottle samples were partially done on board ship with the remainder being completed at the laboratory after the cruise. Oxygen concentrations from the majority of the bottle samples were also obtained on board by Winkler titration.

2) Data Acquisition

The data were logged on a PC using the SeaBird data acquisition software.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from binary raw data files to ASCII format in engineering units (PSU, °C, etc.). The data were then passed to Dr. Hendrik van Aken's group at NIOZ who worked up the temperature, salinity and oxygen channels. Details of the procedures used are not known but this group are associated with the collection of WOCE data and there is every reason to believe that the work was done to a very high standard.

The processed data were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 1db with temperature (ITS90), practical salinity, chlorophyll (calibrated to µg/l), oxygen (µmol/kg), attenuance (per m) and nephelometer output (arbitraty units).

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by (1000+sigma-theta)/1000.

The chlorophyll was converted back to a voltage by a natural log transform to conform to the requirements of the BODC CTD data handling system. On retrieval, the data as supplied are reproduced.

3.2) Editing

Using a custom in-house graphics editor, the limits of the downcasts were delimited by manually applying flags to the cycle number channel.

No flagging of data other than garbage in the attenuance channel at depths greater than 2000 m on a couple of casts were required.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system

3.3) Calibration

The salinity and temperature data had been calibrated prior to submission to BODC. No further calibration was required.

Inspection of the attenuance data showed the values in clear water to be too high, typically about 0.5. This is probably because no air correction had been applied to the data. Analysis of the data showed that the transmissometer was exceptionally stable and therefore a uniform correction factor (-0.132) was applied to all casts to normalise the data to a clear water value of 0.35.

The oxygen data were checked against the bottle data and this confirmed that the oxygen data had been calibrated against the bottle data set.

No extracted chlorophyll data were available for this cruise and consequently the data presented are the result of a nominal calibration. **More heed should therefore be paid to the relative, rather than absolute, chlorophyll values.**

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

4) Data Warnings

The fluorometer has not been calibrated against extracted chlorophyll data. The absolute values may therefore be meaningless.

5) Bibliography

Benson, B.B. and Krause, D. 1984. The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol. Oceanogr.*** 29 pp.620-632.

CTD Data for Cruise NAOMEX 2

(6 - 13 June 1994)

1) Instrumentation and Shipboard Protocols

NAOMEX 2 (BODC mnemonic NAOX2) was a University of Bordeaux cruise on the research vessel Cote d'Acquitaine. The CTD profiles were taken with the SeaBird SBE25 system fitted with a Chelsea Instruments fluorometer, a nephelometer and an oxygen membrane of the Beckman (non-pulsed) type.

2) Data Acquisition

The SBE25 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV software. The raw data files are converted into ASCII files with the data in oceanographic units on the basis of coefficients held in a calibration file.

3) Post-Cruise Processing

ASCII DATCNV output files were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 0.25db with temperature, practical salinity, chlorophyll (nominal units), oxygen (ml/l) and optical backscatter (nominal units).

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66.

The chlorophyll was converted back to a voltage by a natural log transform to conform to the requirements of the BODC CTD data handling system. On retrieval, the data as supplied are reproduced.

3.2) Editing and Quality Control

Using custom in-house graphics editors, the limits of the downcast were manually flagged. Any obvious spikes identified were manually flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data showed none of the problems noted in the data from the previous NAOMEX cruise, indicating that either a different CTD was used or that the instrument had been serviced.

The nephelometer data gave some cause for concern. With the exception of the first cast, CTD07, the data were extremely noisy, with the noise centred on the value returned by CTD07 in clear water. We are convinced that this was an instrument malfunction and have only loaded the data from the one profile into the database.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

The form of the dissolved oxygen profiles looked perfectly reasonable. However, the absolute values were slightly low with saturations of between 85-95% at the surface. There was also obvious drift from cast to cast. No water bottle oxygen measurements were made on this cruise.

The data from this cruise were collected from a relatively limited area, over a short period of time and the fluorometer data indicate limited phytoplankton activity at the surface. On the basis of this, it was considered justified to 'calibrate' the oxygen data by constraining the surface saturation to the range 99-101%. The following scaling factors were determined and have been applied to the data.

CTD01	1.15
CTD02	1.10
CTD03	1.11
CTD04	1.15
CTD05	1.11
CTD06	1.15
CTD07	1.16
CTD08	1.15
CTD09	1.12
CTD10	1.15
CTD11	1.17
CTD12	1.12

Users should be aware of the possibility that the corrected absolute values will be in error should the assumption that the surface waters were saturated with oxygen prove invalid.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

The absolute dissolved oxygen values have been empirically 'calibrated' to enforce saturation at the surface and may be incorrect if this assumption is invalid.

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown. Checks against known stable water masses were not possible because there were no casts deeper than 500 m.

The fluorometer has not been calibrated against extracted chlorophyll data. The absolute values may therefore be meaningless.

The nephelometer data are in arbitrary units and their absolute values have no meaning. Only one CTD cast returned sensible nephelometer data.

CTD Data for Cruise Jan Mayen 4

(13 - 18 June 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was a relatively new instrument and the manufacturer's temperature and conductivity calibrations were used.

2) Data Acquisition and Originator Processing

Data were logged at 16 Hz on a PC running EG&G data acquisition software and subsequently incorporated into the Tromsø data system. Data were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect. **Temperature and salinity were noted as being unusually noisy.**

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data. The originator's calibration was as supplied by the manufacturer and, as this was a relatively new instrument when used on this cruise, is believed by the originator to be reliable.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.453 - 0.5786) (n=124: R^2=90%)

This has been applied to the data held in the database. Note that near-surface data points affected by quenching were excluded from the calibration.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

The temperature and salinity data were unusually noisy.

The fluorometer data exhibited clear examples of 'quenching' where photo-adaptive reactions of the phytoplankton caused a variation in fluorescence yield as a function of depth near the surface. Consequently, calibrated fluorometer values in the top 10-15 m should be regarded as possible underestimates of the true chlorophyll concentration.

CTD Data for Auriga Cruise PLUTUR3

(28 June - 07 July 1994)

1) Instrumentation and Shipboard Protocols

The CTD profiles were taken with a Hydropolytester/Nephelometer ZULLIG probe, including pressure, temperature, salinity, dissolved oxygen, pH and optical backscatter sensors. No water bottle rosette was included in the package.

2) BODC Data Processing and Quality Control

2.1) Reformatting

ASCII files were supplied to BODC and contained temperature (C), depth (m), pH (pH units), conductivity (mmho/cm), oxygen (units unknown), turbidity (standard turbidity units (ftu)) and salinity (PSU). The data were converted into the BODC internal format (PXF). In addition to reformatting, the transfer program computed a sigma-theta channel (using the standard UNESCO subroutines POTEMP and SVAN) and converted depths to pressures (using the inverse of UNESCO function PTODEP).

2.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The pH and dissolved oxygen channels contained values that were either all zero or obviously erroneous. After consultation with the data originator, these channels were deleted. The salinity data were very noisy in parts, particularly on temperature gradients, and sometimes required heavy flagging. The temperature and nephelometer data were much cleaner.

2.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of originator's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

2.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

3) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The absolute accuracy of these channels is therefore unknown.

The temperature and salinity data were supplied to 2 decimal places, implying low accuracy. Visual inspection of the salinity channel supported this impression. Users are advised not to use the salinity data from this cruise for applications requiring high (>0.05 PSU) accuracy.

CTD Data for Cruise Jan Mayen 5

(15 - 20 July 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell and platinum resistance thermometer. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was a relatively new instrument and the manufacturer's temperature and conductivity calibrations were used.

2) Data Acquisition and Originator Processing

Data were logged at 16 Hz on a PC running EG&G data acquisition software and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect. **Temperature and salinity were noted as being unusually noisy.**

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data. The originator's calibration was as supplied by the manufacturer and, as this was a relatively new instrument when used on this cruise, is believed by the originator to be reliable.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.384 - 0.2301) (n=116: R^2=65%)

This has been applied to the data held in the database.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

The temperature and salinity data were unusually noisy.

CTD Data for Cruise Jan Mayen 6

(8 - 12 August 1994)

1) Instrumentation

The CTD profiles were taken with a Meerestechnik OTS-1200 CTD incorporating pressure, conductivity and temperature sensors. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was calibrated on a regular basis (approximately twice per year) using the facility at the University of Bergen. Additional salinity checks were made against OSI standard sea water.

2) Data Acquisition and Originator Processing

Data were logged on a PC and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data, supplied in ASCII format, were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.2512 - 0.9252) (n=135: R^2=84%)

This has been applied to the data held in the database.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

None.

CTD Data for Cruise Jan Mayen 7

(5 - 10 September 1994)

1) Instrumentation

The CTD profiles were taken with a Meerestechnik OTS-1200 CTD incorporating pressure, conductivity and temperature sensors. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was calibrated on a regular basis (approximately twice per year) using the facility at the University of Bergen. Additional salinity checks were made against OSI standard sea water.

2) Data Acquisition and Originator Processing

Data were logged on a PC and subsequently incorporated into the Tromsø data system. Data were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.6665 - 0.9322) (n=92: R^2=75%)

This has been applied to the data held in the database.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

None.

Madorniña Cruise MD0994

(26 September 1994)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV software. The raw data files are converted into ASCII files with the data converted into oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.

CTD Data for Cruise Meteor 30-1

(6 - 20 September 1994)

1) Instrumentation

The CTD profiles were taken with a Neil Brown Mk3 CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometers, dissolved oxygen sensor, fluorometer and a rosette sampler equipped with 12 Niskin bottles (12 litre). The CTD unit was mounted vertically in the centre of a protective cage. For the duration of the cruise, the rosette attached to the CTD frame remained inoperative. Calibration data were obtained from bottles lowered on a different rosette directly after the CTD cast.

2) Data Acquisition

Data were logged at 16 Hz on a PC running EG&G data acquisition software. The channels logged were: pressure, depth, temperature, salinity, sigma-theta, fluorometer volts, oxygen current, oxygen temperature, conductivity and fast temperature (for salinity computation from conductivity).

3) On-Board Data Processing

The above data channels were converted to ASCII using the EG&G CTDPOST software and supplied to BODC together with the calibration files used.

4) Post-Cruise Processing

4.1) Reformatting

The ASCII data were transferred to BODC's UNIX environment. The 16 Hz data was reduced to 1 Hz resolution by averaging the data from groups of 16 datacycles. A spike elimination algorithm prevented corruption of the generated 1 Hz data by any data dropout.

The output from the averaging program was combined with a time channel. This was generated using the time in the file header as a base and assuming a 1 m/second lowering rate. Any gaps in the data stream were detected and the time adjusted accordingly by monitoring the pressure channel.

Oxygen concentration was computed from the oxygen current and corrected for temperature and salinity using the standard Neil Brown algorithm. CTD temperature had to be used as the oxygen temperature channel data appeared corrupted. The resultant dissolved oxygen data was converted from ml/l to µM by multiplying the values by 44.66.

The data in ASCII format were then transferred to the BODC internal format (PXF). This allowed the data to be quality assured using in-house software tools, notably the workstation graphics editor.

4.2) Editing

Using custom in-house graphics editors, the limits of the downcasts were manually flagged. Upcasts were not saved. In addition, spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

4.3) Calibration

With the exception of pressure, calibrations were done by comparison of CTD data against measurements made on water bottle samples and by classical reversing thermometers. As the CTD rosette was inoperative during this cruise, samples were obtained from a separate rosette frame which was lowered directly after the recovery of the CTD frame.

All calibrations described here have been applied to the data.

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from the conductivity channel). A consistent value was observed throughout the cruise and the following correction has been applied:

$$P_{corrected} = P_{observed} - 0.67$$

Temperature

The CTD temperature calibration of the data as supplied to BODC has been assumed to be correct. Three reversing thermometers were fired in the mixed layer. Two gave ridiculous readings (over 3 °C out). The third was within 0.1 °C of the corresponding CTD reading. The calibration could not, however, be checked in detail because below the mixed layer there is a strong gradient which only has to be displaced slightly by an internal wave to invalidate comparison.

Salinity

The bottle data were compared with the profiles displayed on a graphical workstation. In all cases the water column was stable and the deeper values differed by less than 0.005 PSU. Consequently, it was concluded that calibration of the data as received was good and no further calibration was required.

Chlorophyll

A nominal calibration (slope=4, intercept=-3) has been applied as there are no extracted chlorophyll data available. The calibration was chosen to give a chlorophyll signal in the range 0-5 **but it should be emphasised that the result is semi-quantitative at best**.

Oxygen

During screening severe hysteresis in oxygen between up and downcast was observed - this exceeded the ‘signal’ showed by the bottle data set. The fact that the oxygen temperature channel was unusable may well have contributed to the problem. Consequently, the oxygen data have been removed from the data set.

4.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the gaps were set null.

5) Data Warnings

Chlorophyll data only have a nominal calibration rendering the data set semi-quantitative at best.

The oxygen data have been deleted from the data set due to the massive hysteresis, in excess of the total signal in the bottle data, between up and downcast data.

Water bottle samples used in the salinity calibration were collected by a separate rosette lowered immediately after the CTD frame was recovered. This creates the potential for calibration errors resulting from changes in the water column structure between casts.

CTD Data for Cruise Jan Mayen 8

(10 - 14 October 1994)

1) Instrumentation

The CTD profiles were taken with a Meerestechnik OTS-1200 CTD incorporating pressure, conductivity and temperature sensors. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was calibrated on a regular basis (approximately twice per year) using the facility at the University of Bergen. Additional salinity checks were made against OSI standard sea water.

2) Data Acquisition and Originator Processing

Data were logged on a PC and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.7844 - 1.4716) (n=39: R^2=66%)

This has been applied to the data held in the database.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

None.

CTD Data for Auriga Cruise PLUTUR4

(23 November - 01 December 1994)

1) Instrumentation and Shipboard Protocols

The CTD profiles were taken with a Hydropolytester/Nephelometer ZULLIG probe, including pressure, temperature, salinity, dissolved oxygen, pH and optical backscatter sensors. No water bottle rosette was included in the package.

2) BODC Data Processing and Quality Control

2.1) Reformatting

ASCII files were supplied to BODC and contained temperature (C), depth (m), pH (pH units), conductivity (mmho/cm), oxygen (units unknown), turbidity (standard turbidity units (ftu)) and salinity (PSU). The data were converted into the BODC internal format (PXF). In addition to reformatting, the transfer program computed a sigma-theta channel (using the standard UNESCO subroutines POTEMP and SVAN) and converted depths to pressures (using the inverse of UNESCO function PTODEP).

2.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The pH and dissolved oxygen channels contained values that were either all zero or obviously erroneous. After consultation with the data originator, these channels were deleted. The salinity data were very noisy in parts, particularly on temperature gradients, and sometimes required heavy flagging. The temperature and nephelometer data were much cleaner.

2.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of originator's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

2.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

3) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The absolute accuracy of these channels is therefore unknown.

The temperature and salinity data were supplied to 2 decimal places, implying low accuracy. Visual inspection of the salinity channel supported this impression. Users are advised not to use the salinity data from this cruise for applications requiring high (>0.05 PSU) accuracy.

CTD Data for Cruise Belgica 9506

(3 - 17 March 1995)

1) Instrumentation and Shipboard Procedures

The CTD profiles were taken with a SeaBird SBE 911 *plus* system. The instrument had enclosed conductivity and temperature sensors supplied with water by a pump. The water inlet was at the base of the bottle rosette. The CTD had a temperature and salinity (TC) duct with an inertia balanced pump flow to improve the quality of salinity measurements.

When not in use, the sensors are bathed in MilliQ water. SeaBird temperature sensors are high performance, pressure protected thermistors. Other sensors on the rig were a dissolved oxygen cell (YSI SBE-13-Y polargraphic membrane) and a SeaTech red light (661 nm) 25 cm path length transmissometer loaned by NIOZ.

The CTD was periodically sent for calibration to SeaBird's NWRCC facility in Washington State. An average of 4 salinity samples were taken per cast, stored in crown-corked beer bottles, and determined on Beckman RB7 laboratory salinometer, calibrated using OSI standard seawater. The procedure has come out well in ICES intercalibration exercises. Nevertheless, the Beckman is not considered as accurate as the SeaBird: the bottle data were used as a check for instrument malfunction but not for recalibration. Similarly, temperature sensor performance was monitored against digital reversing thermometers but not recalibrated.

A SeaBird rosette sampler fitted with 12, 10 litre Niskin or GoFlo bottles was mounted above the frame. The bases of the bottles were level with the pressure sensor with their tops 0.8 m above it. Digital thermometers on water bottles were placed 0.63 m above the CTD temperature sensor.

2) Data Acquisition

The CTD sampled at 24 Hz but this was automatically reduced to 2 Hz by the deck unit. Data were logged on a PC using the SeaBird SEASAVE program.

The CTD was lowered at 0.8-1 m/s. On the upcast, the hauling rate was approximately the same, but was reduced on approach to a bottle firing depth to minimise wake interference.

3) Post-Cruise Processing

The SeaBird DATCNV software was used to convert the binary raw data files into the calibrated ASCII data files supplied to BODC.

The salinity computation algorithm in the software is based on Fofonoff and Millard (1982). Salinity spiking on thermal gradients was minimised through software realignment of the temperature and conductivity channels.

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Temperature has been converted from ITS68 to ITS90 by dividing the values by 1.00024.

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by

$$(1000 + \text{sigma-theta}) / 1000$$

Percentage transmission was converted to attenuance using the equation:

$$\text{Atten} = -4.0 \ln (\text{Percentage transmission} / 100)$$

3.2) Editing

Reformatted CTD data were transferred onto a high speed graphics workstation for manual inspection using a custom in-house graphics editor. The top and bottom of the downcast were marked to eliminate noisy data logged whilst the instrument was stabilising.

The data were examined point by point and any obvious spikes were flagged 'suspect'.

Once screened on the workstation, the CTD downcasts (**16**) were loaded into a database under the Oracle relational database management system. Note that the loader only included data from the downcast marked during screening.

3.3) Calibration

The temperature and salinity data are believed to be accurate as supplied and no further calibrations have been applied.

It is usual practice to calibrate the MUMM oxygen data against bottle data supplied by University of Liege. However, the bottle data from this cruise are systematically low by about 10 per cent whereas the CTD data appear about right. The following relationship was determined between the CTD data and the bottle data:

"Corrected oxygen" = Raw oxygen * 0.7811 + 31.967 (R^2 = 93%: n = 83)

This has not been applied to the data due to the concerns about the accuracy of the bottle data. Should the veracity of the bottle data be confirmed at some stage in the future then this equation may be applied to bring the CTD data into line.

Screening of the profiles revealed the deep water (~1500 m) minimum attenuance to be 0.564, 0.582 and 0.586 for the 3 deep casts OX02A, OX03A and OX04B respectively. Since attenuance in the clear ocean water should be about 0.35, an offset of -0.21 has been applied to the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set were binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

4) Bibliography

Fofonoff N.P., Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science***. 44.

CTD Data for Cruise Heincke 68

(27 March - 17 April 1995)

1) Instrumentation

The CTD profiles were taken with an Applied Microsystems STD 12 plus CTD system incorporating a Keller stainless steel pressure transducer, a precision thermistor and a four platinised electrode conductivity cell.

Prior to use, a check of the sensors was done by running the instrument in a water bath. The system was mounted on a water bottle rosette.

2) Data Acquisition and UCG Processing

The instrument included an internal data logger and sampled at up to 8 Hz. Internal memory restrictions (7,500 record capacity at the time of this cruise) dictated that lower sampling rates were used. Data from the CTD instrument were downloaded onto a PC, binned to 1db and converted into ASCII format in engineering units using software supplied with the instrument.

A calibration offset of -0.015 has been applied to the salinity data by UCG based upon an extensive calibration against bottle data during SEFOS cruise Heinke 71 in May 1995.

3) BODC Data Processing and Quality Control

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphical editor.

3.2) Editing

The reformatted CTD data were transferred onto a high speed graphics workstation. Using a custom in-house graphical editor, the limits of the downcasts were manually flagged. In addition, spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system.

3.3) Calibration

No additional calibrations have been applied to the data by BODC.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set were binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Madorniña Cruise MD0495

(10 April 1995)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV program. The raw data files are converted into ASCII files with the data converted into oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.

CTD Data for Cruise Jan Mayen 9

(16 - 17 May 1995)

1) Instrumentation

The CTD profiles were taken with a Meerestechnik OTS-1200 CTD incorporating pressure, conductivity and temperature sensors. A rosette fitted with 5 litre Niskin bottles was included in the package.

The CTD was calibrated on a regular basis (approximately twice per year) using the facility at the University of Bergen. Additional salinity checks were made against OSI standard sea water.

2) Data Acquisition and Originator Processing

Data were logged on a PC and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature and salinity.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

None.

Madorniña Cruise MD0695

(01 June 1995)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV software. The raw data files are converted into ASCII files with the data converted into oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.

CTD Data for Cruise Charles Darwin CD94

(3 - 20 June 1995)

1) Instrumentation

A total of 51 CTD casts returned data on this cruise. Of these, 11 (CTD3A, CTD3B, CTD8A, CTD8B, CTD15, CTD21, CTD26, CTD31, CTD35, CTD42 and CTD49) were taken with a CTD system belonging to the Institute of Oceanographic Sciences Deacon Laboratory (now part of the Southampton Oceanography Centre). The remaining casts were taken using a CTD supplied with the ship by Research Vessel Services. These are referred to in this document as the IOS CTD and RVS CTD respectively.

The IOS CTD was a Neil Brown Systems Mk3B instrument incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckman non-pulsed oxygen electrode. The package also included a Chelsea Instruments Aquatracka fluorometer and an experimental UV-absorption nitrate sensor. The primary purpose of the deployments of this package was the development and testing of the nitrate sensor.

The RVS system comprised a Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckman dissolved oxygen sensor. The oxygen sensor was supplied with water by a SeaBird submersible pump. The CTD unit was mounted vertically in the centre of a protective cage approximately 1.5 m square. Attached to the bars of the frame was a Chelsea Instruments Aquatracka fluorometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

A General Oceanics rosette sampler fitted with 12, 10 litre Niskin or lever-action Niskin (externally sprung for trace metal work) bottles was mounted above the frame. The bases of the bottles were 0.75 m above the pressure head with their tops 1.55 m above it. One of the bottles was fitted with a holder for up to three digital reversing thermometers mounted 1.38 m above the CTD temperature sensor.

Lowering rates were generally in the range of 0.5-1.0 m/sec but could be up to 1.5 m/sec. Bottle samples were acquired on the ascent of the package.

2) Data Acquisition

The CTD data were sampled at a frequency of 32 Hz. Real time data reduction to a 1-second time series was done by the RVS Level A microcomputer system. The resulting data stream was logged as digital counts on the Level C via a Level B data buffer.

3) On-Board Data Processing

RVS software on the Level C (a SUN workstation) was used to convert the raw counts into engineering units (Volts for the PAR sensor, transmissometer and fluorometer, ml/l for oxygen, mmho cm^{-1} for conductivity and °C for temperature).

Salinity (Practical Salinity Units, as defined by the Practical Salinity Scale (Fofonoff and Millard 1982)) was calculated from the conductivity ratios (conductivity / 42.914) and a time lagged temperature.

Data were written onto Quarter Inch Cartridge tapes in RVS internal format and submitted to BODC for post-cruise processing and data-banking.

4) Post-Cruise Processing

4.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66 for the IOS CTD casts. For the RVS CTD, dissolved oxygen was computed from the sensor current, sensor temperature and CTD temperature and salinity using algorithms taken from SeaBird CTD manuals appropriate for a pump-fed sensor. Calibration constants were included, derived using the full University of Hamburg Winkler data set, following the procedures established for this instrument during the LOIS Shelf Edge Study.

The raw transmissometer voltages from the RVS CTD were corrected for light source decay using a correction ratio computed from light readings in air taken during the cruise (4.787 V) and the manufacturer's figure for the new instrument (4.802 V). No transmissometer was fitted to the IOS package.

4.2) Editing

Using a custom in-house graphics editor, the downcasts and upcasts were defined by the manual insertion of flags into the cycle number channel. Any spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

The pressure ranges over which the bottle samples were taken were logged by manual interaction with the software. Usually, the marked reaction of the oxygen sensor to the bottle firing sequence was used to determine this. These pressure ranges were subsequently used, in conjunction with a geometrical correction for the position of the water bottles with respect to the CTD pressure transducer, to determine the pressure range of data to be averaged for calibration purposes.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system.

4.3) Calibration

With the exception of pressure, calibrations were done by comparison of CTD data against measurements made on water bottle samples or, in the case of temperature, from the reversing thermometers mounted on the water bottles. In general, values were averaged from the CTD downcasts but where inspection on a graphics workstation showed significant hysteresis, values were manually extracted from the CTD upcasts.

All calibrations described here have been applied to the data.

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from the conductivity channel). The pressure sensors on both instruments exhibited considerable drift. Consequently, corrections were determined for the individual casts as follows. IOS CTD casts are denoted by an asterisk appended to the cast number.

Cast	Pressure Correction
CTD1	+0.15
CTD2	-0.44
CTD3A*	-0.44
CTD3B*	-1.15
CTD4	-0.06
CTD5	-0.49
CTD6	-0.49
CTD7	-0.49
CTD8A*	-0.08
CTD8B*	-0.92
CTD9	-0.49
CTD10	-0.49
CTD11	-0.09
CTD12	-0.49
CTD13	-0.49

Cast	Pressure Correction
CTD14	-0.49
CTD15*	-0.01
CTD16	-0.01
CTD17	+0.71
CTD18	+0.71
CTD19	-1.06
CTD21*	-0.60
CTD22	+0.15
CTD23	-1.05
CTD24	-1.05
CTD25	-0.22
CTD26*	+0.95
CTD27	+0.08
CTD28	+0.08
CTD29	+0.07
CTD30	+0.07
CTD31*	+1.28
CTD32	+0.10
CTD33	+0.10
CTD34	+0.39
CTD35*	+1.28
CTD36	+0.47
CTD37	-0.85
CTD38	-0.51
CTD39	+0.32
CTD40	-0.38
CTD41	-0.18
CTD42*	+0.70
CTD43	+0.13
CTD44	-0.19
CTD45	-0.19
CTD47	-0.19
CTD48	-0.19
CTD49*	+0.70
CTD50	+0.36
CTD51	+0.36
CTD52	+0.36

The pressure corrections have been added to the raw pressures to effect the correction.

<u>Temperature</u>

The CTD temperature readings were in excellent agreement with digital reversing thermometer readings. Hence no temperature calibration was applied to either instrument.

Salinity

Salinity was calibrated against water bottle samples measured on the Guildline Autosal Salinometer during the cruise. Samples were usually obtained from several depths on each cast.

Samples were collected in glass bottles filled to just below the neck and sealed with plastic stoppers. Batches of samples were left for at least 24 hours to reach thermal equilibrium in the constant temperature laboratory containing the salinometer before analysis.

The IOS CTD salinity calibration showed two distinct groupings giving the corrections:

$$S_{corrected} = S_{observed} + 0.327 \text{ (CTD8A, CTD8B, CTD15, CTD21)}$$
$$S_{corrected} = S_{observed} + 0.307 \text{ (CTD26, CTD31, CTD42, CTD49)}$$

Note that the salinity data from casts CTD3A, CTD3B and CTD35 exhibited severe hysteresis and they have not been included in the database. In general, the IOS salinity data are poorer quality than the data from the RVS CTD and data from the latter should be used in preference wherever possible.

The RVS CTD calibration was determined for batches of casts that were defined by empirical analysis of the differences between the bottle values and CTD values.

CTD Casts	Correction
CTD1-CTD10	0.030
CTD11	0.032
CTD12	0.033
CTD13	0.031
CTD14	0.035
CTD16	0.036
CTD17	0.031
CTD18	0.034
CTD19	0.037
CTD22	0.036
CTD23	0.038
CTD22	0.036
CTD23	0.038
CTD24, CTD25	0.037
CTD27	0.033
CTD28	0.034
CTD29	0.037
CTD30	0.035
CTD32	0.034

CTD Casts	Correction
CTD33, CTD34	0.038
CTD36-CTD39	0.037
CTD40	0.038
CTD41	0.032
CTD43	0.036
CTD44	0.035
CTD45	0.042
CTD47, CTD48	0.044
CTD50	0.039
CTD51	0.037
CTD52	0.036

The downcast salinity between 53 and 150db on cast CTD45 had a dramatic offset towards low salinity, indicative of biological fouling of the conductivity cell. The data from 100 to 150 db have been salvaged by adding an empirical correction of 0.03 PSU. The remaining affected data could not be corrected and have been deleted.

Oxygen

The dissolved oxygen sensor was calibrated against water bottle samples analysed following the Winkler titration procedures outlined in Carpenter (1965) by personnel from Hamburg University. The following calibration was determined for the IOS CTD.

$$O_{corrected} = O_{raw} * 2.2246 + 49.0 \ (R^2 = 67.0\%: n=22)$$

The RVS CTD oxygen data were initially calibrated as part of the reformatting procedure against the entire bottle data set. However, it was reported that the result was systematically high. As a result, the 'calibrated' values were recalibrated against a quality controlled bottle data set giving the following additional correction:

$$O_{corrected} = O_{raw} * 0.9926 - 2.38 \ (R^2 = 88.5\%: n=90)$$

It is appreciated that this methodology falls short of the ideal and had resources permitted the entire data set would have been reprocessed from scratch using the reduced bottle data set. However, the procedure has brought the deep data into line with other OMEX cruises sampling the same stations and has therefore been deemed successful.

Oxygen saturation present in the data files was computed using the algorithm presented in Benson and Krause (1984).

Chlorophyll

Chlorophyll was measured with a Chelsea Mk2 Aquatracka fluorometer calibrated against discrete samples taken from near-surface CTD bottles. Samples were filtered through Whatman GF/F filters and frozen in liquid nitrogen until analysed. The frozen filters were extracted in 2-5 ml of 90% acetone using sonification and centrifuged to remove cellular debris. **Analysis was carried by reverse phase HPLC**. The resultant regression equation is:

chlorophyll (mg/m^3) = exp (-2.8557 + 1.0966 * raw-voltage) (R^2 = 75.3%: n = 29)

4.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

5) Data Warnings

The salinity data from the IOS CTD are of poorer quality than the RVS CTD data. Wherever possible the latter data should be used to ascertain the salinity profile for a particular station.

The RVS CTD oxygen calibration appears empirically effective but an unconventional protocol was used. Users should bear this in mind when deciding whether to use the data. The calibrated results may also be slightly high due to a small systematic offset in the bottle data.

6) Bibliography

Benson B.B. and Krause D. jnr. 1984. The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol. Oceanogr.*** 29 pp.620-632.

Carpenter J.H. 1965. The Chesapeake Bay Institute techniques for the Winkler dissolved oxygen method. ***Limnol.Oceanogr.*** 10 pp.141-143.

Fofonoff N.P. and Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science.*** 44.

<u>CTD Data for Auriga Cruise PLUTUR5</u>

<u>(12 - 22 June 1995)</u>

1) Instrumentation and Shipboard Protocols

The CTD profiles were taken with a Hydropolytester/Nephelometer ZULLIG probe, including pressure, temperature, salinity, dissolved oxygen, pH and optical backscatter sensors. No water bottle rosette was included in the package.

2) BODC Data Processing and Quality Control

2.1) Reformatting

ASCII files were supplied to BODC and contained temperature (C), depth (m), pH (pH units), conductivity (mmho/cm), oxygen (units unknown), turbidity (standard turbidity units (ftu)) and salinity (PSU). The data were converted into the BODC internal format (PXF). In addition to reformatting, the transfer program computed a sigma-theta channel (using the standard UNESCO subroutines POTEMP and SVAN) and converted depths to pressures (using the inverse of UNESCO function PTODEP).

2.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The pH and dissolved oxygen channels contained values that were either all zero or obviously erroneous. After consultation with the data originator, these channels were deleted. The salinity data were very noisy in parts, particularly on temperature gradients, and sometimes required heavy flagging. The temperature and nephelometer data were much cleaner.

2.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of originator's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

2.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

3) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The absolute accuracy of these channels is therefore unknown.

The temperature and salinity data were supplied to 2 decimal places, implying low accuracy. Visual inspection of the salinity channel supported this impression. Users are advised not to use the salinity data from this cruise for applications requiring high (>0.05 PSU) accuracy.

CTD Data for Cruise Jan Mayen 10

(25 June - 1 July 1995)

1) Instrumentation

The CTD profiles were taken with a Meerestechnik OTS-1200 CTD incorporating pressure, conductivity and temperature sensors. A rosette fitted with 5 litre Niskin bottles was included in the package.

The CTD was calibrated on a regular basis (approximately twice per year) using the facility at the University of Bergen. Additional salinity checks were made against OSI standard sea water.

2) Data Acquisition and Originator Processing

Data were logged on a PC and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature and salinity.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect.

Once screened on the workstation, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

None.

CTD Data for Cruise Valdivia 154

(14-30 July 1995)

1) Instrumentation and Operational Practices

The CTD profiles of the water column and water samples at discrete horizons were taken with a Seabird SBE 911 CTD mounted inside a bottle rosette array. The CTD probe incorporated a pressure sensor, conductivity cell, pressure protected high quality thermistor and a membrane dissolved oxygen sensor.

Lowering rates were generally in the range of 0.5 - 1.0 m sec^{-1} but could be up to 1.5 m sec^{-1}. Bottle samples and reversing thermometer measurements were acquired on the ascent of the CTD casts. No dissolved oxygen measurements by Winkler titration were made on this cruise.

2) Data Acquisition

The data were logged on a PC using the SeaBird data acquisition software.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from binary raw data files to ASCII format in engineering units (PSU, °C, etc). The data were then passed to IFM Hamburg who worked up the temperature and salinity channels. Details of the procedures used are not known but they are believed to result in data of acceptable quality.

The processed downcast data were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 1db with temperature (ITS90), practical salinity, and oxygen (ml/l). The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program converted dissolved oxygen from ml/l to µM by multiplying the values by 44.66.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were topped and tailed and a few isolated spikes in temperature and salinity were flagged.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system

3.3) Calibration

The temperature data had been checked as accurate prior to submission to BODC. IFM Hamburg recommended a correction of -0.013 PSU to the salinity data. This has been applied.

Inspection of the dissolved oxygen data showed that whilst the form of the profiles was as expected, the absolute values were significantly low. No sample data were available for calibration and consequently the oxygen channel has been deleted from the final data set.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

Madorniña Cruise MD0795

(14 July 1995)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV software. The raw data files are converted into ASCII files with the data converted into oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.

CTD Data for Cruise Pelagia PLG95A

(14 August - 05 September 1995)

1) Instrumentation

The CTD profiles of the water column and water samples at discrete horizons were taken with a Seabird SBE 911 *plus* CTD mounted inside a 22 bottle rosette array. The CTD probe incorporated a pressure sensor, conductivity cell and a pressure protected high quality thermistor. In addition, attached to the CTD frame, were a Chelsea Instruments Mk III Aquatracka fluorometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

The rosette frame was equipped with twenty-two 12 litre NOEX bottles. The bases of the bottles were 0.5 m above the pressure head with their tops 0.5 m above it. One of the bottles was fitted with a holder for up to three digital reversing thermometers mounted 0.3 m above the CTD temperature sensor. As usual, there were intermittent problems with the NOEX bottles from contamination by leakage.

Lowering rates were generally in the range of 0.5 - 1.0 m sec^{-1} but could be up to 1.5 m sec^{-1}. Bottle samples and reversing thermometer measurements were acquired on the ascent of the CTD casts.

2) Data Acquisition

The data were logged on a PC using the SeaBird data acquisition software.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from binary raw data files to ASCII format in engineering units (PSU, °C, etc). The data were then passed to Dr. Hendrik van Aken’s group at NIOZ who worked up the temperature and salinity channels. An adjustment of +0.012 was applied to salinity to bring the deep T/S curves into line with data he has collected in the area. Further details of the procedures used are not known but this group are associated with the collection of WOCE data and there is every reason to believe that the work was done to a very high standard.

The processed data were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 1db with temperature (ITS90), practical salinity, chlorophyll (expressed as µg/l) and attenuance.

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program converted the chlorophyll back to a voltage by applying a natural log transform to conform to the requirements of the BODC CTD data handling system. On retrieval, the data as supplied are reproduced.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by applying flags manually to the cycle number channel. This was an exceptionally clean data set and no quality control flagging was required.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system

3.3) Calibration

The salinity and temperature data had been calibrated prior to submission to BODC. No further calibration was required. No modification has been made to the attenuance data.

No extracted chlorophyll data were available for this cruise and consequently the data presented are the result of a nominal calibration. **More heed should therefore be paid to the relative, rather than absolute, chlorophyll values.**

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

The fluorometer has not been calibrated against extracted chlorophyll data. The absolute values may therefore be meaningless.

The clear water minimum values of 0.39 are a little higher than the values of 0.35 to 0.36 normally returned by accurately calibrated transmissometers from the Goban Spur area.

CTD Data for Cruise Discovery DI216

(26 August - 12 September 1995)

1) Instrumentation

The 46 CTD profiles were taken with an RVS Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckman dissolved oxygen sensor. The CTD unit was mounted vertically in the centre of a protective cage approximately 1.5 m square. Attached to the bars of the frame was a Chelsea Instruments Aquatracka fluorometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

A General Oceanics rosette sampler fitted with 12, 10 litre Niskin or lever-action Niskin (externally sprung for trace metal work) bottles was mounted above the frame. The bases of the bottles were 0.75 m above the pressure head with their tops 1.55 m above it. One of the bottles was fitted with a holder for up to three digital reversing thermometers mounted 1.38 m above the CTD temperature sensor.

Lowering rates were generally in the range of 0.5-1.0 m/sec but could be up to 1.5 m/sec. Bottle samples were acquired on the ascent of all casts except CTD1, 2, and 33, and reversing thermometer readings taken on all except CTD1-4, 17, 25, 28 and 32-33.

2) Data Acquisition

The CTD sampled at a frequency of 32 Hz. These data were reduced in real time to a 1-second time series by the RVS Level A microcomputer system. These data were logged as raw counts on the Level C workstation via a Level B data buffer.

3) On-Board Data Processing

RVS software on the Level C (a SUN workstation) was used to convert the raw counts into engineering units (Volts for the transmissometer and fluorometer, ml/l for oxygen, mmho cm^{-1} for conductivity and °C for temperature,).

Salinity (Practical Salinity Units, as defined by the Practical Salinity Scale (Fofonoff and Millard 1982)) was calculated from the conductivity ratios (conductivity / 42.914) and a time lagged temperature.

Data were written onto Quarter Inch Cartridge tapes in RVS internal format and submitted to BODC for post-cruise processing and data-banking.

4) Post-Cruise Processing

4.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Dissolved oxygen was converted from ml/l to µM by multiplying the values by 44.66.

The raw transmissometer voltages were corrected for light source decay using a correction ratio computed from light readings in air taken during the cruise and the manufacturer's figure for the new instrument (4.802 V). The correction was applied as follows:

From	To	Air Reading (V)
28/08/95	31/08/95	4.780
01/09/95	12/09/95	4.788

Transmissometer voltages were converted to percentage transmission by multiplying them by 20 and attenuance computed using algorithm:-

$$\text{attenuance} = -4 * \ln(\text{percent transmittance} / 100)$$

4.2) Editing

Using a custom in-house graphics editor, the downcasts and upcasts were differentiated and the limits of the downcasts were manually flagged. Spikes on any of the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

The pressure ranges over which the bottle samples were taken were logged by manual interaction with the editor. Usually, the marked reaction of the oxygen sensor to the bottle firing sequence was used to determine this. These pressure ranges were subsequently used, in conjunction with a geometrical correction for the position of the water bottles with respect to the

CTD pressure transducer, to determine the pressure range of data to be averaged for calibration purposes.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system and further edited as follows:

> CTD5 had a series of false steps in the salinity channel of up to 0.01 PSU. Small affected depth intervals have been flagged out, but larger depth intervals have been salvaged by applying an offset correction.
>
> CTD8 was characterised by a very noisy transmissometer signal between the pressures of 120 db and 550 db. All attenuance values in excess of 0.365 within this pressure range have been flagged suspect.
>
> CTD19's salinity channel was a problem. Below 2012.4 db the downcast salinity was both noisy and unpredictably inaccurate. This affliction lasted until 3480 db on the upcast, but between 3480 db and 3800 db the upcast salinity was predictably inaccurate (0.009 PSU lower with respect to the rest of the cast). In order to correct the cast, the following actions were taken. Between 2012.4 db and 3480 db, upcast salinities and temperatures have been used and the downcast values rejected. Between 3480 db and 3800 db upcast salinities and temperatures have been used, but an offset correction of 0.009 PSU has been added to the salinities. Below 3800 db the upcast temperatures have been used but there are no salinities (all flagged suspect).
>
> CTD20 had an attenuance signal that was noisy. Between 908 db and 995 db 0.0239 has been subtracted from the signal. Between 1100 db and 1900 db the signal is extremely noisy and therefore heavy flagging has been applied.
>
> CTD25 required an empirical correction to the salinity channel of 0.014 PSU between 260 db and 1280.9 db.
>
> CTD44 had a step in the downcast transmissometer signal which was not replicated in the upcast. In order to correct this, 0.004 has been subtracted from the attenuance values at pressures greater than 675 db.

4.3) Calibration

With the exception of pressure, calibrations were done by comparison of CTD data against measurements made on water bottle samples or, in the case of temperature, against reversing thermometer data. In general, values were averaged from the CTD downcasts but where inspection on a graphics workstation showed significant hysteresis, values were manually extracted from the CTD upcasts.

All calibrations described here have been applied to the data.

Pressure

The pressure offset was determined by looking at the pressures recorded when the CTD was clearly logging in air (readily apparent from the conductivity channel). A mean air value (standard deviation of 0.29 db) was determined for all the data from the cruise, giving the correction:

$$P_{corrected} = P_{observed} - 0.99 \text{ db}$$

Temperature

The CTD temperatures were in excellent agreement with the digital reversing thermometer readings. Hence no temperature calibration has been applied.

Salinity

Salinity was calibrated against 262 water bottle samples measured on the Guildline 55358 Autolab Salinometer during the cruise. Samples were obtained from 43 of the 46 casts, usually at several depths on each cast.

Samples were collected in glass bottles filled to just below the neck and sealed with plastic stoppers. Batches of samples were left for at least 24 hours to reach thermal equilibrium in the constant temperature laboratory containing the salinometer before analysis.

The casts were subdivided into groups for the purpose of the salinity calibration. The correction applied was of the form:

$$S_{corrected} = S_{observed} + X$$

with the following values used for the correction factor (X):

CTD Casts	**Correction (X)**
CTD1, 2, 3	0.033
CTD4,	0.034
CTD5,	0.036
CTD6,	0.037
CTD10,	0.038
CTD7, 11, 15, 40, 41, 45	0.039
CTD14	0.040
CTD18, 21, 24, 26, 32, 37	0.041
CTD38, 39, 42	0.041

CTD Casts	Correction (X)
CTD8, 9, 33, 35, 44	0.042
CTD12, 23, 27, 34, 36, 43	0.043
CTD13, 16, 17, 19, 20, 25, 30, 31	0.044
CTD22	0.045
CTD29	0.046
CTD28	0.047

Oxygen

The dissolved oxygen sensor was calibrated against 222 water bottle samples analysed following the Winkler titration procedures outlined in Carpenter (1965). The samples were taken from 39 of the 46 casts, normally at several depths. The probe was extremely stable throughout the cruise and therefore a single calibration has been applied to the data:

$$O_{corrected} = O_{raw} * 21.8 + 13.8 \ (R^2 = 89.2\%: n=222)$$

Oxygen saturation present in the data files was computed using the algorithm presented in Benson and Krause (1984).

Chlorophyll

Chlorophyll was measured with a Chelsea Mk2 Aquatracka fluorometer calibrated against discrete samples taken from 109 near-surface CTD bottles. Samples were filtered through Whatman GF/F filters and frozen in liquid nitrogen until analysed on board. The frozen filters were extracted in 2-5 ml of 90% acetone using sonification and centrifuged to remove cellular debris. **Analysis was carried by reverse phase HPLC**. The resulting calibration equation is:

$$\text{chlorophyll (mg/m}^3\text{)} = \exp(-3.1336 + 1.1987 * \text{raw-voltage}) \ (R^2 = 85.35\%)$$

4.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

5) Data Warnings

None.

6) Bibliography

Benson B.B. and Krause D. jnr. 1984. The concentration and isotopic fractionation of oxygen dissolved in fresh water and sea water in equilibrium with the atmosphere. ***Limnol. Oceanogr.*** 29 pp.620-632.

Carpenter J.H. 1965. The Chesapeake Bay Institute techniques for the Winkler dissolved oxygen method. ***Limnol.Oceanogr.*** 10 pp.141-143.

Fofonoff N.P. and Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science.*** 44.

Madorniña Cruise MD0995

(01 September 1995)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV program. The raw data files are converted into ASCII files with the data in oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.

CTD Data for Cruise Pelagia PLG95B

(5 - 24 September 1995)

1) Instrumentation

The CTD profiles of the water column and water samples at discrete horizons were taken with a Seabird SBE 911 *plus* CTD mounted inside a 22 bottle rosette array. The CTD probe incorporated a pressure sensor, conductivity cell, dissolved oxygen sensor and a pressure protected high quality thermistor. In addition, and attached to the CTD frame, were a Chelsea Instruments Mk III Aquatracka fluorometer and a SeaTech red light (661 nm) transmissometer with a 25 cm path length.

The rosette frame was equipped with twenty-two 12 litre NOEX bottles. The bases of the bottles were 0.5 m above the pressure head with their tops 0.5 m above it. One of the bottles was fitted with a holder for up to three digital reversing thermometers mounted 0.3 m above the CTD temperature sensor. As usual, there were intermittent problems with the NOEX bottles from contamination by leakage.

Lowering rates were generally in the range of 0.5 - 1.0 m sec^{-1} but could be up to 1.5 m sec^{-1}. Bottle samples and reversing thermometer measurements were acquired on the ascent of the CTD casts.

2) Data Acquisition

The data were logged on a PC using the SeaBird data acquisition software.

3) Post-Cruise Processing

The SeaBird DATCNV program was used for the conversion from binary raw data files to ASCII format in engineering units (PSU, °C, etc). The data were then passed to Dr. Hendrik van Aken’s group at NIOZ who worked up the temperature and salinity channels. A salinity adjustment of +0.004 (stations 1 and 2), +0.008 (stations 3-5) or +0.011 (station 6) was required to bring the deep T/S profiles into line with data collected in the area by the NIOZ marine physics group. Further details of the procedures used are not known but this group are associated with the collection of WOCE data and there is every reason to believe that the work was done to a very high standard.

The processed data were supplied to BODC.

3.1) Reformatting

The data as supplied had been binned to 1db with temperature (ITS90), practical salinity, dissolved oxygen (µmol/kg), chlorophyll (calibrated to µg/l) and attenuance.

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program converted the chlorophyll back to a voltage by applying a natural log transform to conform to the requirements of the BODC CTD data handling system. On retrieval, the data as supplied are reproduced.

The dissolved oxygen data were converted from µmol/kg to µM.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by applying flags manually to the cycle number channel. This was an exceptionally clean data set and no quality control flagging was required.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system

3.3) Calibration

The salinity and temperature data had been calibrated prior to submission to BODC. No further calibration was required. No modification has been made to the attenuance data.

The dissolved oxygen sensor was calibrated at NIOZ against bottle data and no further corrections have been made by BODC.

No extracted chlorophyll data were available for this cruise and consequently the data presented are the result of a nominal calibration. **More heed should therefore be paid to the relative, rather than absolute, chlorophyll values.**

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

The fluorometer has not been calibrated against extracted chlorophyll data. The absolute values may therefore be meaningless.

The clear water minimum values of 0.39 are a little higher than the values of 0.35 to 0.36 normally returned by accurately calibrated transmissometers from the Goban Spur area.

CTD Data for Cruise Belgica 9521

(11 - 20 September, 1995)

1) Instrumentation and Shipboard Procedures

The CTD profiles were taken with the SeaBird SBE 911 *plus* system. The instrument had enclosed conductivity and temperature sensors supplied with water by a pump with an inlet at the base of the bottle rosette. The CTD had a temperature and salinity (TC) duct with an inertia balanced pump flow to improve the quality of salinity measurements.

When not in use, the sensors were bathed in MilliQ water. SeaBird temperature sensors are high performance, pressure protected thermistors. Other sensors on the rig were a dissolved oxygen (YSI SBE-13-Y polargraphic membrane) and a SeaBird optical backscatter nephelometer.

The CTD temperature and salinity sensors were sent in January 1995 to SeaBird's NWRCC facility in Washington State for calibration.

A SeaBird rosette sampler fitted with 12, 10 litre Niskin or GoFlo bottles was mounted above the frame. The bases of the bottles were level with the pressure sensor with their tops 0.8m above it.

The CTD was lowered at 0.8-1 m/s. On the upcast, the hauling rate was approximately the same, but was reduced on approach to a bottle firing depth to minimise wake interference.

2) Data Acquisition

Data were logged at 24 Hz but this was automatically reduced to 2 Hz by the deck unit. The resulting data were logged on a PC using the SeaBird SEASAVE program.

3) Post-Cruise Processing

The SeaBird DATCNV program was used to convert the binary raw data files into ASCII data in engineering units (PSU, °C, µmol/kg , etc).

The salinity computation algorithm in the software is based on Fofonoff and Millard (1982). Salinity spiking on thermal gradients was minimised through software realignment of the temperature and conductivity channels.

BODC were supplied with the ASCII output produced by DATCNV.

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Temperature was converted from ITS68 to ITS90 by dividing the values by 1.00024.

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by (1000 + sigma-theta) / 1000.

3.2) Editing

Using a custom in-house graphics editor, the top and bottom of the downcast were marked to eliminate noisy data logged whilst the instrument was stabilising.

The data were examined point by point and any obvious spikes were flagged 'suspect'. The salinity data from cast 01A showed severe problems between 30 and 50 metres with the salinity value oscillating wildly. The data from this interval have all been flagged suspect.

Once screened, the CTD downcasts (**19**) were loaded into a database under the Oracle relational database management system. Note that the loader only included data from the downcast marked during screening.

3.3) Calibration

The temperature data are believed to be accurate (within 0.01 °C according to the manufacturer's specification) as supplied and no further calibrations have been applied.

An average of 4 salinity samples were taken per cast, stored in crown-corked beer bottles, and determined on a Beckman RB7 laboratory salinometer, calibrated using OSI standard seawater. This procedure has come out well in ICES intercalibration exercises.

In the MUMM cruise report, a comparison between the CTD salinity data and these salinometer determinations was given. This revealed a systematic difference (mean for cruises BG9521 and BG9521 was 0.016 PSU with a standard deviation of 0.004 PSU) between the two data sets. No corrective action was taken by MUMM but a correction of +0.016 has been applied to the CTD data by BODC.

A comparison between the CTD oxygen data and bottle data supplied by the University of Liege showed that the oxygen sensor had significant problems on this cruise. Trouble of some sort was suspected during visual inspection because the signal was unusually noisy but the true extent of the problem did not become apparent until the bottle data were available.

The difference between CTD and bottle values in the upper 250 m varied from virtually zero to up to 20 μM. On some casts, there was good agreement at the surface, which increased systematically with depth. On other casts, this trend was reversed. A small group of casts showed good agreement at all depths.

Deeper than 250 m, a significant linear relationship could be established between the two data sets from all deep casts.

A complex empirical calibration exercise was undertaken to bring the CTD data into line with the bottle data. The criterion for success was taken to be the reduction of the maximum difference between all points in a given bottle and CTD downcast profile to below 10 μM. Where this could not be achieved, the CTD data were flagged suspect. In many cases, the agreement obtained was significantly better than this.

The first stage in the calibration exercise was to look at the deep casts where bottles were fired between 250 and 1200m. This gave the following calibration:

$$O_{corrected} = O_{observed} * 0.882 + 13.237 \quad (R^2 = 91\%)$$

This calibration is obviously only valid for depths >250m and consequently all data shallower than this for these casts have been flagged out. The casts involved are 04B, 05B, 06A, 07B, 09B and 10B.

Secondly, a calibration was obtained by combining the data from the shallow casts 01A and 04A. The equation obtained was:

$$O_{corrected} = O_{observed} * 1.027 + 8.234 \quad (R^2 = 73\%)$$

The following shallow casts were individually calibrated:

07A	$O_{corrected} = O_{observed} * 1.156 - 52.672$	($R^2 = 65\%$)
09A	$O_{corrected} = O_{observed} * 0.822 + 46.530$	($R^2 = 64\%$)
10A	$O_{corrected} = O_{observed} * 1.564 - 139.84$	($R^2 = 87\%$)
11A	$O_{corrected} = O_{observed} * 1.316 - 83.337$	($R^2 = 65\%$)

Casts 02A, 03A, 05C and 05D required no adjustment.

Casts 05A and 05E had no bottle data available and no sensible relationship could be obtained for the data from cast 08A. All oxygen values from these casts have been flagged suspect.

The calibrations specified above have all been applied to the data. The calibration exercise has significantly improved the fit of the CTD data to the bottle data. Nevertheless, the CTD oxygen data should be used with caution and should not be used for any purpose where an accuracy better than ±10 μM is required.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

A complex empirical calibration was required to obtain anything approaching a reasonable fit between the CTD dissolved oxygen data and the corresponding bottle data. The CTD oxygen data, especially those from the upper 250 m, should therefore be used with caution and should not be used for any purpose where an accuracy better than ±10 μM is required.

5) Bibliography

Fofonoff, N.P., Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science.*** 44.

CTD Data for Cruise Jan Mayen 11

(19 - 22 September 1995)

1) Instrumentation

The CTD profiles were taken with a Meerestechnik OTS-1200 CTD incorporating pressure, conductivity and temperature sensors. An in-situ fluorometer and a rosette fitted with 5 litre Niskin bottles were included in the package.

The CTD was calibrated on a regular basis (approximately twice per year) using the facility at the University of Bergen. Additional salinity checks were made against OSI standard sea water.

2) Data Acquisition and Originator Processing

Data were logged on a PC and subsequently incorporated into the Tromsø data system. They were delivered to BODC binned to 1 metre with the channels temperature, salinity and nominal chlorophyll.

3) Post-Cruise Processing

3.1) Reformatting

The data supplied were transferred to the BODC internal format (PXF). The translation program also converted depths to pressures using an inverse of the standard UNESCO algorithm and applied a natural log transform to the nominal chlorophyll data to make them compatible with BODC's CTD processing system.

3.2) Editing

Using a custom in-house graphics editor, the downcasts were delimited by manually applying flags to the cycle number channel. In addition, any dubious data (such as equilibration artefacts at the surface) or spikes in the downcast channels were manually flagged suspect.

Once screened, the CTD downcasts were loaded into the OMEX database under the Oracle relational database management system.

3.3) Calibration

The data were supplied to BODC calibrated and no further modifications have been made to the temperature and salinity data.

The fluorometer was calibrated against **fluorometrically assayed** extracted chlorophyll data and the following relationship obtained:

chlorophyll (mg/m^3) = exp (raw voltage * 1.4545 - 0.0455) (n=316: R^2=77%)

This has been applied to the data held in the database.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

4) Data Warnings

None.

<u>CTD Data for Cruise Belgica 9522</u>

<u>(21 - 30 September, 1995)</u>

1) Instrumentation and Shipboard Procedures

The CTD profiles were taken with the SeaBird SBE 911 *plus* system. The instrument had enclosed conductivity and temperature sensors supplied with water by a pump with an inlet at the base of the bottle rosette. The CTD had a temperature and salinity (TC) duct with an inertia balanced pump flow to improve the quality of salinity measurements.

When not in use, the sensors were bathed in MilliQ water. SeaBird temperature sensors are high performance, pressure protected thermistors. Other sensors on the rig were a dissolved oxygen (YSI SBE-13-Y polargraphic membrane) and a SeaBird optical backscatter nephelometer.

The CTD temperature and salinity sensors were sent in January 1995 to SeaBird's NWRCC facility in Washington State for calibration.

A SeaBird rosette sampler fitted with 12, 10 litre Niskin or GoFlo bottles was mounted above the frame. The bases of the bottles were level with the pressure sensor with their tops 0.8m above it.

The CTD was lowered at 0.8-1 m/s. On the upcast, the hauling rate was approximately the same, but was reduced on approach to a bottle firing depth to minimise wake interference.

2) Data Acquisition

Data were logged at 24 Hz but this was automatically reduced to 2 Hz by the deck unit. The resulting data were logged on a PC using the SeaBird SEASAVE program.

3) Post-Cruise Processing

The SeaBird DATCNV program was used to convert the binary raw data files into ASCII data in engineering units (PSU, °C, µmol/kg , etc).

The salinity computation algorithm in the software is based on Fofonoff and Millard (1982). Salinity spiking on thermal gradients was minimised through software realignment of the temperature and conductivity channels.

BODC were supplied with the ASCII output produced by DATCNV.

3.1) Reformatting

The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

Temperature has been converted from ITS68 to ITS90 by dividing the values by 1.00024.

Dissolved oxygen was converted from µmol/kg to µM by multiplying the values by (1000 + sigma-theta) / 1000.

3.2) Editing

Using a custom in-house graphics editor, the top and bottom of the downcast were marked to eliminate noisy data logged whilst the instrument was stabilising.

The data were examined point by point and any obvious spikes were flagged 'suspect'.

Once screened on the workstation, the CTD downcasts (**17**) were loaded into a database under the Oracle relational database management system. Note that the loader only included data from the downcast marked during screening.

3.3) Calibration

The temperature data are believed to be accurate (within 0.01 °C according to the manufacturer's specification) as supplied and no further calibrations have been applied.

An average of 4 salinity samples were taken per cast, stored in crown-corked beer bottles, and determined on a Beckman RB7 laboratory salinometer, calibrated using OSI standard seawater. This procedure has come out well in ICES intercalibration exercises.

In the MUMM cruise report, a comparison between the CTD salinity data and these salinometer determinations was given. This revealed a systematic difference (mean for cruises BG9521 and BG9521 was 0.016 PSU with a standard deviation of 0.004 PSU) between the two data sets. No corrective action was taken by MUMM but a correction of +0.016 has been applied to the CTD data by BODC.

A comparison between the CTD oxygen data and bottle data supplied by the University of Liege (available for two of the 17 casts) showed that the oxygen sensor had significant problems on this cruise. In the upper 200 m, the bottle data showed the dissolved oxygen levels to be virtually constant but the CTD profile displayed a strong, complex oscillating signal. Below 200 m there was a strong linear relationship between the CTD and bottle oxygen concentrations.

As so little bottle data are available, the empirical correction procedure adopted for Belgica 9521 proved impossible. Consequently, all CTD oxygen data from shallower than 200 m have been flagged suspect. The following calibration was determined from data collected deeper than 200 m:

$$O_{corrected} = O_{observed} * 1.271 - 84.472 \quad (R^2 = 96\%: n=16)$$

This calibration has been applied to the data.

3.4) Data Reduction

The final data set was produced by binning the calibrated data to 1 (casts shallower than 100 m) or 2 decibars. The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the gaps were set null.

4) Data Warnings

Oxygen data are only available from depths >200 m.

5) Bibliography

Fofonoff, N.P., Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science.*** 44.

CTD Data for Cruise Discovery 217 (DI217)

(27 September - 22 October 1995)

1) Instrumentation

The 39 CTD profiles were taken with a Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell and a platinum resistance thermometer. The CTD unit was mounted vertically in the centre of a protective cage approximately 1.5 m square. Attached to the bars of the frame was a Chelsea Instruments Aquatracka fluorometer and an IOS SeaTech red light (661 nm) transmissometer with a 1 m path length.

On some casts, a PML 2-pi PAR irradiance meter was fitted to measure downwelling irradiance. On other casts, a Kiel University nephelometer was attached. Note that this was connected to the same CTD channel as the light meter, but has been extracted and processed as a separate channel at BODC. A UV nitrate sensor was fitted on most casts for testing and development work.

A General Oceanics rosette sampler fitted with 24, 10 litre Niskin bottles was mounted above the frame. The bases of the bottles were 0.75 m above the pressure head with their tops 1.55 m above it. Some of the bottles were fitted with holders for up to three digital reversing thermometers mounted 1.38 m above the CTD temperature sensor.

Lowering rates were generally in the range of 0.5-1.0 m/sec but could be up to 1.5 m/sec. Salinity bottle samples were acquired on the ascent of all casts except 12810-1, and reversing thermometer readings taken on 5 out of 39 casts (12833-1, 12834-3, 12835-2, 12836-1, 12838-1).

Considerable technical problems were encountered with the CTD on this cruise. The pressure sensor was found to drift with time to such an extent as to make it unusable. The backup instrument couldn't be used because the new multiplexed analogue channels could not be used with it. Stations prior to 12796 were therefore worked with no operational pressure sensor. Manually logged wire out values provided the only source of instrument depth information.

The ship put into Falmouth where a new pressure sensor and interface board were delivered. The pressure sensor functioned well until station 12830 when the instrument developed a problem with discrete jumps of up to 30 decibars appearing in the pressure channel during upcasts. This problem continued until the end of the cruise.

After station 12793, the CTD rosette top plate was snagged by the hydrographic winch wire and wrecked. A replacement was obtained when the ship put into Falmouth. The CTD rosette was therefore not operational for cast 12794.

The conductivity sensor was snapped off prior to cast 12837. No salinity data are available for this cast. A replacement sensor was fitted for cast 12838.

2) Data Acquisition

CTD data were sampled at a frequency of 32 Hz. Data reduction, in real time, to a 1-second time series was done by the RVS Level A microcomputer system. This was logged as raw counts on the Level C workstation via a Level B data buffer.

3) SOC Data Processing

The raw data were passed to a Sun workstation running the P-EXEC data processing software. Using this system, the following calibrations and data processing procedures were applied.

Pressure

Stations 12791-1, 12793-1 and 12794-1 were deployed with no pressure sensor. For these casts, a data channel containing manually logged wire out values was merged into the data. This is subject to obvious errors such as no allowance for wire angle. As pressure was used as a term in the computation of salinity and sigma-theta, the quality of these channels will also be compromised. Users should be aware that the data from these three casts are therefore of comparatively poor quality.

All the subsequent casts were processed using a linear calibration:

Pressure (db) = A + (B * Raw pressure)

where A is the intercept and B is the pre-cruise determined slope (1.002348; SOC).

Stations 12796-1 to 12829-1 have been treated as one group, with a constant intercept of -3.5 applied. At station 12830-1 **the pressure sensor started drifting** on the upcast and that erratic behaviour continued through to the last station. These stations have had their *downcast* intercept adjusted individually as follows:

Station	Intercept
12830-1	-3.5
12831-1	0.4
12832-1	2.3
12833-1	-1.4
12834-3	3.6
12835-2	6.5
12836-1	3.0
12837-5	6.0
12838-1	2.0

After the initial calibration was completed, various obvious jumps were removed from the upcast pressure, using a comparison with wire-out at the bottle firing depths. The intercept (A) and slope (B) were then adjusted thus to bring the pressure at the start and end of each cast to zero.

Station	Jump offset(s) (db)	A	B
12830-1	20	8.1	0.9970
12831-1	17	4.4	0.9988
12832-1	20	13.8	0.9908
12833-1	5	13.5	0.9962
12834-3	8	23.4	0.9909
12835-2	4 + 3	12.3	0.9893
12836-1	0	9.1	0.9883
12837-5	4 + 6	11.8	0.9820
12838-1	0	1.0	0.9907

Temperature

The temperature was calibrated based on a pre-cruise tank calibration with slope of 0.998564 and intercept of -0.01655.

Conductivity - Salinity Conversion

The conductivity ratio was corrected by a factor of 0.9966263, to bring the CTD salinity data in line with the water bottle salinities. Salinity (Practical Salinity Units, as defined by the Practical Salinity Scale; Fofonoff and Millard, 1982) was then computed from the adjusted conductivity ratio and a time lagged temperature using SAL78 function described in UNESCO Report 37 (UNESCO, 1981).

Attenuance

Raw counts were converted to volts by multiplying them by 0.00122.

Correction of voltage and conversion to transmission were then computed as follows:

$$\%transmission = 4.35/4.25 * 0.9963 * (Volts - 0.001) * 20$$

4.35/4.25	-	Ratio of manufacturers voltage for in-air reading and average cruise air reading.
0.9963	-	Additional correction which accounts for the difference in refractive index between air and water (supplied by SeaTech).
0.001	-	Transmissometer reading with the light path blocked.
20	-	Factor to convert from voltage (5V full scale deflection) to percentage.

The attenuance value was computed from the % transmission using the equation:

$$Attenuance = -1.0 * \ln(\% transmission/100)$$

Chlorophyll

A chlorophyll calibration was determined using PML **fluorometric** extracted chlorophyll data by linear regression of the log of chlorophyll against fluorometer voltage. The resulting equation was obtained:

$$chlorophyll\ (mg/m^3) = \exp(0.7005 * raw\_voltage - 3.1409)$$

Downwelling Irradiance

The 2-pi PAR data were converted from Volts to W/m^2 using the equation:

$$PAR = \exp(4.965 * Volts - 7.570)$$

4) BODC Data Processing and Quality Control

The data were submitted to BODC in P-star format for incorporation into the OMEX database.

4.1) Reformatting

The BODC Transfer System was used to convert the data into the BODC internal format (PXF). In addition to the reformatting, the program carried out the following additional processing on the data.

For the three casts with no pressure data the wire depths were converted to pressure using the inverse of the UNESCO algorithm. All the values in excess of 10000, caused by wrap-round of the cable meter, were set null.

For the remaining casts, the salinity data in the source file had been computed at SOC using the raw pressure data. To correct this, the conductivity ratio was computed using SAL78 function in inverse mode (UNESCO, 1981) and raw pressure data. Salinity was then recomputed with respect to corrected pressure, using SAL78 in normal mode. The difference was significant. For example a change in pressure of 30 db produced a difference in salinity of 0.012.

Sigma-theta was recomputed for all casts.

4.2) Editing

Using a custom in-house graphics editor, the limits of the downcasts were manually flagged. Any spikes on all the downcast channels were manually flagged 'suspect' by modification of the associated quality control flag.

Once screened, the CTD downcasts were loaded into a database under the Oracle relational database management system. The Kiel nephelometer data were loaded into Oracle using a 'one off' program written specifically for the purpose.

4.3) Calibration

With the exception of pressure, the BODC calibration checks were done by comparison of CTD values, extracted manually using the graphical editor, against measurements made on water bottle samples.

All calibrations described here have been applied to the data.

Pressure

A check was run at BODC to ensure the pressure was consistently zero when the instrument was logging in air (readily apparent from the conductivity channel). This verified the corrections applied by SOC but the following additional calibrations were applied to some of the casts where no correction had been applied:

Station	Correction (db)
12796-1	1.50
12797-1	1.99
12798-1	2.09

Station	Correction (db)
12799-1	0.87
12800-1	-1.91
12802-1	0.84
12815-1	0.89
12816-1	-0.61
12817-1	-0.53
12822-1	0.72

Temperature

A very limited number of reversing thermometer measurements (11 readings in all) were available. Comparing these to the CTD data was inconclusive to say the least with absolute differences ranging from 0.003 °C to 1.313 °C and no consistency in the sign of the difference. Previous experience with Neil Brown Mk 3B CTD data gives more confidence in the CTD data than the RT data. Consequently, the RT data have been ignored and the CTD temperatures assumed correct. Users should be therefore be aware that there is no independent verification of the temperature data from this cruise.

Salinity

The salinity calibration was carefully checked at BODC. Whilst the general agreement between CTD and bottle data was excellent (within 0.005 PSU), a number of casts were noticed where the overall cruise calibration applied did not give such good results. The following additional, individual cast corrections have been applied:

Cast 12803-1	+0.008 PSU
Cast 12806-1	+0.008 PSU
Cast 12808-1	+0.008 PSU
Cast 12815-1	+0.008 PSU
Cast 12823-1	+0.039 PSU
Cast 12831-1	-0.008 PSU
Cast 12838-1	-0.256 PSU

4.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database. Oxygen saturations have been computed using the algorithm of Benson and Krause (1984).

5) Data Warnings

The pressure sensor failed on the first three casts (12791-1, 12793-1, 12794-1) and the pressure was derived using the wire-out. This introduced a significant error in the pressure channel.. Therefore all the data related to these casts should be treated with <u>extreme caution</u>.

Users should also be aware that for casts 12830-1 through to 12838-1, the pressure channel required significant additional processing to correct sensor problems.

No reliable, independent verification of the temperature data is available. However, there is no reason to suspect these data.

6) Bibliography

Fofonoff N.P., Millard R.C. 1982. Algorithms for computation of fundamental properties of seawater. ***UNESCO Technical Papers in Marine Science.*** <u>44</u>.

UNESCO 1981. Background papers ad supporting data on the Practical Salinity Scale, 1978. ***UNESCO Technical Papers in Marine Science.*** <u>37</u>.

Madorniña Cruise MD1095

(20 October 1995)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV program. The raw data files are converted into ASCII files with the data in oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened on the workstation, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.

CTD Data for Andromeda Cruise PLUTUR6

(20 November - 02 December 1995)

1) Instrumentation and Shipboard Protocols

The CTD profiles on this cruise were obviously collected by two different instruments. The first group, identified by the prefix 'PT' or 'SA' in the originator's identifier, were supplied in the same format as data from the previous PLUTUR cruises. These are presumed to have been taken with the Hydropolytester/Nephelometer ZULLIG probe used on the previous cruises. This instrument included pressure, temperature, salinity, dissolved oxygen, pH and optical backscatter sensors.

The second group, identified by the prefix 'F' in the originator's identifier, were collected by a very different instrument. The Hydropolytester profiles on this and all previous cruises were limited to a maximum profile depth of 250 m, no matter how deep the water, indicating the operational limit of the instrument. This second instrument achieved profiles to over 1000 m and produced much cleaner salinity profiles. No information was available concerning the make of the instrument (or indeed that an alternative had been used) but the data give a strong impression that it is a higher quality instrument. No pH or dissolved oxygen data were included from this instrument.

No water bottle rosette was included in the package for either instrument.

2) BODC Data Processing and Quality Control

2.1) Reformatting

ASCII files were supplied to BODC in two formats. The Hydropolytester data contained temperature (C), depth (m), pH (pH units), conductivity (mmho/cm), oxygen (units unknown), turbidity (standard turbidity units (ftu)) and salinity (PSU). The remaining data simply contained depth (m), temperature (C), salinity (PSU) and turbidity (ftu).

The data were converted into the BODC internal format (PXF). In addition to reformatting, the transfer program computed a sigma-theta channel (using the standard UNESCO subroutines POTEMP and SVAN) and converted depths to pressures (using the inverse of UNESCO function PTODEP).

2.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The pH and dissolved oxygen channels from the Hydropolytester contained values that were either all zero or obviously erroneous. After consultation with the data originator, these channels were deleted. The Hydropolytester salinity data were very noisy in parts, particularly on temperature gradients, and sometimes required heavy flagging. The temperature and nephelometer data were much cleaner.

All channels from the second instrument were relatively clean.

2.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of originator's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

2.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

3) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The absolute accuracy of these channels is therefore unknown. This comment applies to both instruments.

The temperature and salinity data for the Hydropolytester were supplied to 2 decimal places, implying low accuracy. Visual inspection of the salinity channel supported this impression. Users are advised not to use the salinity data from this cruise for applications requiring high (>0.05 PSU) accuracy. This comment may not apply to the second instrument used.

Madorniña Cruise MD1195

(30 November 1995)

1) Instrumentation and Shipboard Protocols

The Madorniña cruises undertook a repeated section across the shelf off Vigo in northern Spain. The CTD profiles were taken with the SeaBird SBE19 system fitted with a rosette holding General Oceanics 1.4 litre water bottles.

2) Data Acquisition

The SBE19 is normally a self-logging instrument with the data downloaded onto a PC running the SeaBird DATCNV program. The raw data files are converted into ASCII files with the data converted into oceanographic units on the basis of coefficients held in a calibration file. The data were subsequently loaded into the Lotus 1-2-3 spreadsheet package.

3) Post-Cruise Processing

3.1) Reformatting

Lotus WK3 files were supplied to BODC and contained pressure, temperature, conductivity and salinity. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notably the workstation graphics editor. In addition to reformatting, the transfer program computed a sigma-theta channel using the standard UNESCO subroutines POTEMP and SVAN.

3.2) Editing and Quality Control

Using a custom in-house graphics editor, the limits of the downcast were manually flagged and any obvious spikes identified were flagged 'suspect'.

Once screened, the CTD downcasts (between the flagged limits) were loaded into a database under the Oracle relational database management system.

The salinity data were very noisy in parts, particularly on temperature gradients, and required heavy flagging. The temperature data were remarkably clean.

3.3) Calibrations

No sample data were available to calibrate any of the channels. All data are therefore the result of manufacturer's calibrations of unknown date and no guarantee can be given as to the accuracy of the data.

3.4) Data Reduction

Once all screening and calibration procedures were completed, the data set was binned to 2 db (casts deeper than 100 db) or 1 db (casts shallower than 100 db). The binning algorithm excluded any data points flagged suspect and attempted linear interpolation over gaps up to 3 bins wide. If any gaps larger than this were encountered, the data in the gaps were set null.

Downcast values corresponding to the bottle firing depths were incorporated into the database.

4) Data Warnings

No independent checks, such as reversing thermometer data or salinity bottle data, were available for the verification of the temperature and salinity data. The accuracy of these channels is therefore unknown.