LOIS SES DATABASE
DATA DOCUMENTATION INDEX

Introduction

The database data documentation is structured in a series of sections that each cover data held in one or more of the data tables in the database. A brief description of each of these is given in the index that follows. Click on the red headings to access the appropriate section.

ADCP Data (Table ADCP)

Vertical current velocity profiles measured by underway acoustic doppler current profiler, including signal return amplitude that provides an indication of zooplankton biomass.

Drifting Buoy Data (Table ARGOS)

Tracks of drogued buoys released from SES cruises.

CTD Profiles (Table BINCTD)

Vertical profiles of temperature and salinity. Some of the profiles also include dissolved oxygen, chlorophyll, optical attenuance and light channels.

Marine Snow Camera Profiles (Table MSP)

Profiles of particle size distribution and concentration collected by analysis of photographs taken by a CTD-mounted camera.

Instrument Vertical Profiles (Table PRDATA)

Table PRDATA is a general purpose profile storage table containing data from various types of vertical profilers, other than CTDs. PRDATA in the SES database contains optical profiles (radiance and vector irradiance), FLY turbulence profiles, XBTs and sound velocity profiles.

SeaSoar Data (Table BINCTD)

Data from a towed undulating fish containing a CTD and a fluorometer. The data are presented in the database as a series of vertical profiles.

Water Bottle Data (Table BOTDATA)

A wide range of physical, chemical and biological parameters measured on discrete water and air samples collected using bottles and pumps. This table also includes CTD data at bottle firing depths and averaged data collected by an instrumented Continuous Plankton Recorder.

Production Data (Table C14DAT)

Data from long (usually 24-hour) on-deck production experiments. Note that results from P:I experiments are stored in table BOTDATA.

Benthic Data (Tables CORETOT and COREPROF)

Parameters measured on bulk core samples or grab samples and profiles of a wide range of chemical and sedimentological parameters along cores.

Sediment Trap Data (Table TRAPDATA)

Parameters measured on the samples collected by the SES sediment traps.

Settling Velocity Tube Experiments (Tables SVTOTAL and SVDATA)

The results of settling velocity tube experiments looking at the sinking rates of both suspended matter and pigments.

Tidal Constituent Data

The results of tidal analyses on moored acoustic doppler current profilers (ADCPs).

Underway ADCP Data

Introduction

Underway acoustic doppler current profiler data were collected during all the SES cruises on RRS Challenger. The data were processed and quality controlled at BODC.

Instrumentation

Challenger was fitted with an RDI 150 kHz ADCP mounted on the hull approximately 4m below the water line. Bin widths were fixed at 8m, but various settings were used for the data acquisition period. The appropriate values for each profile may be found in table ADCPINDX.

Data Acquisition

The data were logged by a PC running the RDI Transect software. GPS navigation was input directly into the ADCP PC and logged with the data on a common time base (the PC clock). The data were dumped onto floppy disk at the end of each cruise and transferred to BODC.

BODC ADCP Processing Procedures

The ship's 'processed' files were aggregated into, typically, three or four files per SES cruise. These ADCP files or series were each uniform in respect of their sampling characteristics and bin size.

The series were checked for timing errors by correlating positional data within the file with the corresponding data logged by the RVS ABC system, which has a time channel derived from the ship's master clock. On occasion, as a preliminary, it was necessary to modify the ADCP files for gross errors in the recorded day number. This is common, as Transect knows nothing of leap years.

Once the correct timing had been established, a calibration relating to velocity scaling and heading misalignment angle was determined for each series that carried a sufficient sampling of bottom track velocity. Where no bottom tracking was available, an educated guess based on neighbouring values was made.

The calibration algorithm integrated bottom track velocity over segments of up to two hours and compared the results with the net displacement recorded through GPS. The results for each series were determined by combining each segment's results weighted by the straight-line distance between the beginning and end of the segment.

Data below the seafloor, as determined by the average of the four ADCP beam depths, were removed.

The calibrated values were then screened using BODC's ADCP visualisation software and loaded, after appropriate flagging, into Oracle.

Comments on Data Quality

With one exception, CH126A, the residual timing corrections after the day number correction (1440 minutes) had been applied were of the order of a minute or less. The sampling interval was generally 5 minutes but values of 1, 2 and 10 minutes were also encountered.

The higher frequency data (1-2 minute sampling) data were visibly of lower quality, exhibiting high-frequency variation about a low-frequency mean. This aspect was present within the velocities measured relative to the ship as well as the absolute velocities and is therefore not an artefact of subsequent processing. It was also noticeable that larger (counterbalanced) spikes were present in the absolute trace for 1 and 2 minute data and these coincided with abrupt changes in ship's velocity. No data smoothing has been undertaken though as indicated above some degree of smoothing is required for 1 and 2 minute data.

The corrections for scaling and misalignment angle had averages and standard deviations as follows (with anomalous values from CH125A and CH125B omitted):

Scaling:	Mean 0.9733	Standard deviation 0.00081
Misalignment:	Mean 1.87°	Standard deviation 0.50°

No manual flagging of individual profiles was undertaken. Current velocity data having an absolute error velocity in excess of 9 cm/s have automatically been flagged suspect. Absolute current velocities in excess of 200 cm/s were also flagged.

Latitudes recorded by Transect exhibit dips in value on a random basis that are not mirrored by corresponding changes in longitude. The cause is currently unknown. The frequency of incidence and magnitude changed somewhat between the cruises. Affected values have been substituted from the RVS ABC data stream.

Profiles tended towards uniformity of velocity through the water column. However, near the bottom and sometimes near the top there were large departures from the mean by several standard deviations. These were always associated with low values for the percentage good parameter. Profiles of percentage good rarely deviated from 100% except at the extremes of the profile. All current data from bins where the percentage good fell below 85% have been automatically flagged suspect.

The following observations were made during the processing of the specified cruises.

CH121B

Data prior to 15:43 on 18/08/1995 have been excluded due to a lack of navigation data. Part of the data has 5-minute sampling and these appear satisfactory. The remainder has 1-minute sampling and is therefore in need of smoothing (see comments above). A specific comparison with the S140 moored ADCP (30-31/08/1995) gave good agreement.

CH121C

The data collected between 15:18 on 01/09/1995 and 09:16 on 03/09/1995 were unacceptable with hugely exaggerated absolute current values. These have been excluded from the database. The remaining data from the cruise were satisfactory.

CH123A

The data appear to be satisfactory.

CH123B

The data appear reasonable but profile quality deteriorates with depth. The percentage of good returns should therefore be taken into account when using the data. The number of bins varied from one group of profiles to another. The misalignment angle and scaling factor (.97, 1.5°) were based on interpolation.

CH125A

There was some evidence of hardware malfunction in the data. The profiles of percentage good were not always 100% continuous (e.g. profiles 1040 and 1048). The computed misalignment angle for all data from this cruise had a magnitude of 5°. This was significantly different from the values from the other cruises (average 1.9°).

CH125B

The data between 12:16 on 13/02/1996 and 06:03 on 19/02/1996 had a misalignment angle of 5°. Hardware in the ADCP deck unit was replaced, after which the misalignment angle reduced to 1.9°. Part of the data set was sampled at 2 minutes and the quality of these data could be improved by smoothing.

CH126A

The timing correction for profiles collected between 08:20 on 14/04/1996 and 03:54 on 15/04/1996 was unusually large (>37 hours). The misalignment angle and scaling factor for profiles collected between 08:20 on 14/04/1996 and 11:19 on 19/04/1996 (2.3°, 0.969) was based on interpolation. Some profiles, associated with abrupt changes in ship's velocity, contained a high proportion of spikes.

CH126B

The misalignment angle and scaling factor for profiles collected between 07:23 on 27/04/1996 and 22:03 on 03/05/1996 (2.0°, 0.97) was based on interpolation.

CH128A

Parts of the data were sampled at 2-minute intervals and their quality may be improved through smoothing. Some profiles, associated with abrupt changes in ship's velocity, contain a high proportion of spikes.

CH128B

Some profiles, associated with abrupt changes in ship's velocity, contain a high proportion of spikes.

Drifting Buoy Data

Introduction

The SES drifting buoy data set includes the space/time co-ordinates of buoys deployed specifically to make Lagrangian current measurements. Buoy patterns were released in May and December to observe the slope current in both summer and winter. The scientific results of the drifter experiment are presented in Burrows et al. (1999).

Buoy Description

The drifters were of a standard design (Poulain et al., 1996) with a small surface buoy and a parachute drogue set at a depth of 50m. The buoys included a temperature sensor on the surface buoy and some were also fitted with a pressure sensor and a second temperature sensor at the top of the drogue. The absolute calibration of these sensors was unreliable and much of the data from them have been flagged as suspect by BODC.

Buoy Deployment

The buoys were deployed in groups of 6 or 7 in circular patterns. The ship steamed slowly around a pre-determined course. At each release point, the buoy was released first and the drogue carefully paid out to avoid tangling. The ship stood by to observe the drogue sink and acquire its initial transmissions.

References

Burrows M., Thorpe S.A. and Meldrum D.T., 1999. Dispersion over the Hebridean and Shetland shelves and slopes. *Continental Shelf Research*, 19, 49-55.

Poulain P.M., Warn-Varnas D. and Niiler P.P., 1996. Near-surface circulation of the Nordic seas as measured by Lagrangian drifters. *Journal of Geophysical Research*, 101, 18237-18258.

Marine Snow Profiler Data

Introduction

This document covers the acquisition of abundance profiles of the amorphous aggregates commonly known as marine snow by means of a photographic system mounted on a CTD frame.

The Marine Snow Profiler

The marine snow profiler is a system for quantification of the marine snow abundance by photographic means. The principle of the technique is similar to that reported by Honjo et al. (1984), but with the advantages gained from mounting the system on a CTD equipped with a transmissometer, fluorometer and rosette sampling system.

Some 40 litres of water (only part of which was used for analysis) were illuminated by a strobe light collimated by a set of Fresnel lenses. Great care was taken with the geometry of the system, to ensure that a truly parallel beam of light was produced.

Particles along 52 cm of the beam were photographed orthogonally every 15 or 30 seconds by an IOS Mk4 35mm camera with 400 frame capacity using Ilford XP2 film. Each frame included a time stamp, printed by an LED display in the camera, which was used to determine the depth of the exposure by cross-referencing with the CTD pressure channel.

The films were developed on board ship using a Bray film processor.

Image Analysis

The negatives produced were analysed using a Kontron Vidas image analyser. Each frame was analysed twice, once using 6.2 litres (13% of the photographed volume) to examine particles in the size range 0.4 to 5mm and then using 23 litres (48% of the volume) to quantify particles in the range 5 to 9.8mm.

Particle size was determined, based on the assumption that all of the particles lay in the mid-plane of the 30cm thick light slab and 80cm from the camera lens.

Each particle with an in-situ diameter >0.4mm was measured in two dimensions and the volume (V) computed using:

$$V = (r^2.R.p)(1.33+0.66C)$$

where: $C = (R-r)/R$
R = One half of the maximum particle dimension
r = One half of the minimum particle dimension

The factor C was chosen to give the best approximation of volume for various geometrical shapes.

On the very rare occasions that zooplankton were identifiable in the frames, their volume was excluded from the analysis.

The data are presented as the number and volume of particles for the following size classes (expressed in terms of equivalent spherical diameter):

0.60 to 0.98mm
0.98 to 1.56mm
1.56 to 2.48mm
2.48 to 3.94mm
3.94 to 6.25mm
6.25 to 9.93mm
>9.93mm

The total marine snow volume and abundance were estimated by summing the size fractionated data for all size classes except the >9.93mm class.

Reference

Honjo S., Doherty K.W., Agrawal Y.C., Asper V.L. 1984. Direct optical assessment of large amorphous aggregates (Marine Snow) in the deep ocean. *Deep Sea Res.* 31(1): 67-76.

Instrument Vertical Profiles

Introduction

Four types of profiling instrument, other than the CTD, were deployed during SES. Each of these is documented in a separate section.

These were:

Profiling Radiometer

Vertical profiles of upwelling radiance and downwelling irradiance at the SeaWiFs measurement bands and PAR together with synchronous surface irradiance measurements.

FLY Probe

Profiles of turbulent energy dissipation measured using the **F**ast, **L**ight, **Y**o-Yo turbulence probe.

XBT

Expendable bathythermograph temperature profiles.

Sound Velocity Profiler

Vertical profiles of the speed of sound in sea water.

Profiling Radiometer Data

Parameter Code Definitions

412ERXSD   Surface downwelling vector irradiance at 412 nm
Cosine-collector radiometer
Watts per square metre per nanometre

412ERXUD   Sub-surface downwelling vector irradiance at 412 nm
Cosine-collector radiometer
Watts per square metre per nanometre

412LRXUU   Sub-surface upwelling radiance at 412 nm
Radiance sensor array
Watts/sq m/nanometre/steradian

443ERXSD   Surface downwelling vector irradiance at 443 nm
Cosine-collector radiometer
Watts per square metre per nanometre

443ERXUD   Sub-surface downwelling vector irradiance at 443 nm
Cosine-collector radiometer
Watts per square metre per nanometre

443LRXUU   Sub-surface upwelling radiance at 443 nm
Radiance sensor array
Watts/sq m/nanometre/steradian

490ERXSD   Surface downwelling vector irradiance at 490 nm
Cosine-collector radiometer
Watts per square metre per nanometre

490ERXUD   Sub-surface downwelling vector irradiance at 490 nm
Cosine-collector radiometer
Watts per square metre per nanometre

490LRXUU   Sub-surface upwelling radiance at 490 nm
Radiance sensor array
Watts/sq m/nanometre/steradian

510ERXSD   Surface downwelling vector irradiance at 510 nm
Cosine-collector radiometer
Watts per square metre per nanometre

510ERXUD   Sub-surface downwelling vector irradiance at 510 nm
Cosine-collector radiometer
Watts per square metre per nanometre

510LRXUU   Sub-surface upwelling radiance at 510 nm
           Radiance sensor array
           Watts/sq m/nanometre/steradian

555ERXSD   Surface downwelling vector irradiance at 555 nm
           Cosine-collector radiometer
           Watts per square metre per nanometre

555ERXUD   Sub-surface downwelling vector irradiance at 555 nm
           Cosine-collector radiometer
           Watts per square metre per nanometre

555LRXUU   Sub-surface upwelling radiance at 555 nm
           Radiance sensor array
           Watts/sq m/nanometre/steradian

665ERXSD   Surface downwelling vector irradiance at 665 nm
           Cosine-collector radiometer
           Watts per square metre per nanometre

665ERXUD   Sub-surface downwelling vector irradiance at 665 nm
           Cosine-collector radiometer
           Watts per square metre per nanometre

665LRXUU   Sub-surface upwelling radiance at 665 nm
           Radiance sensor array
           Watts/sq m/nanometre/steradian

683LRXUU   Sub-surface upwelling radiance at 683 nm
           Radiance sensor array
           Watts/sq m/nanometre/steradian

PARERXSD   Surface downwelling PAR (400-700 nm) vector irradiance
           Cosine-collector radiometer
           MicroEinsteins/square metre/second

PARERXUD   Sub-surface downwelling PAR (400-700 nm) vector irradiance
           Cosine-collector radiometer
           MicroEinsteins/square metre/second

PRESPR01   Sea pressure (profile)
           Profiling pressure sensor (e.g. CTD)
           Decibars

TEMPST01   Sea temperature (CTD/STD)
           CTD or STD measurement
           Degrees Centigrade

Originator Code Definitions

Charles Darwin cruises CD93A and CD93B and Challenger cruises CH126A, CH126B and CH128A

24   Dr. Paul Tett   Napier University, Edinburgh

Originator Protocols

Dr. Paul Tett

Pelagic optical measurements were made following the SeaWiFs-compatible protocols developed by the University of Wales, Bangor Marine Optics Group. Up to four instruments were deployed at the optical stations but worked up data were only available from the PRR-600 Profiling Radiometer and associated surface data.

The instruments used were a Biospherical Instruments PRR-600 submarine reflectance radiometer and a PRR-610 surface reference sensor. These measured upwelling radiance at 412, 443, 490, 510, 555, 665 and 683 nm, downwelling vector irradiance at 412, 443, 490, 510, 555, 665 nm and PAR (Photosynthetically Active Radiation). The filter photodetectors used had a full-width half-maximum spectral width of 10 nm centred on the quoted wavelengths. The PAR sensors were sensitive to wavelengths from 400-700 nm. The irradiance sensors were covered by an acrylic-backed Teflon collector designed to give optimal cosine response in air (PRR-610) or water (PRR-600).

Temperature was measured using a platinum resistance transducer with a quoted accuracy of $\pm 0.1°C$ and a resolution of $\pm 0.03°C$. The pressure transducer had a quoted accuracy of $\pm 1\%$ full-scale (200 db).

The optics sensors were calibrated by the manufacturer using a NIST Standard of Spectral Irradiance. Radiance calibrations were performed using a 61cm integrating sphere tied to the NIST Standard of Spectral Irradiance with a calibrated transfer radiometer and reference reflectance plaque.

The sampling protocol involved keeping the ship stationary, head to wind, and then deploying the instrument from a location where the vessel's shadow was avoided using winches, cranes or manual lifting.

Discrete wavelength data were supplied in units of $\mu W\ cm^{-2}\ nm^{-1}$ (irradiance) or $\mu W\ cm^{-2}\ nm^{-1}\ str^{-1}$ (radiance). These were scaled by BODC to $W\ m^{-2}\ nm^{-1}$ and $W\ m^{-2}\ nm^{-1}\ str^{-1}$ (divided by 100) to conform to database standard units. PAR was scaled for the same reason to $\mu E\ m^{-2}\ s^{-1}$ from $\mu E\ cm^{-2}\ s^{-1}$ by multiplying by 10,000.

FLY Probe Data

Parameter Code Definitions

DEPHPR01   Depth (computed from pressure)
Pressure converted using UNESCO PTODEP
Metres

EPSIFY01   FLY turbulent kinetic energy dissipation (sensor 1)
Fast Light Yo-Yo turbulence profiler (FLY probe)
Watts per cubic metre

EPSIFY02   FLY turbulent kinetic energy dissipation (sensor 2)
Fast Light Yo-Yo turbulence profiler (FLY probe)
Watts per cubic metre

TEMPPR01   Sea temperature (unspecified)
Unspecified temperature probe
Degrees Centigrade

Originator Code Definitions

Challenger CH121B and CH128A

126   Dr. Toby Sherwin   University College of Wales, Bangor

Originator Protocols

Dr. Toby Sherwin

The rapid, free-falling FLY (**F**ast, **L**ight, **Y**o-Yo) turbulence probe was used to measure the turbulent energy dissipation rate ($\in$). FLY II was used during cruise Challenger CH121B, while cruise Challenger CH128A deployed FLY IV. The sensor specifications of both instruments are the same but the electronics differ.

The FLY was deployed with the ship moving ahead at 1 knot relative to the water. Two sampling strategies were employed during the SES cruises: sampling across the shelf, from 140m to 300m, or along the shelf at the 140m or 200m contour. Both sampling techniques produced 12.5-25 hours of data and were complimented by the shipborne ADCP and CTD casts every two hours. Both cruises included sampling on neap and spring tides.

The SES FLY campaign resulted in 355 profiles of reliable data from cruise Challenger CH121B and 461 profiles from CH128A.

Sensor Specifications

The sensor and its specifications are described fully in Dewey et al. (1987).

The FLY probe consisted of two airfoil shear probes (measuring along sensor pressure differences 268 times per second), thermistors, a conductivity cell and a pressure gauge. A probe guard protected the thermistors and the shear probes, but prevented measurement in the bottom 15 cm of the water column.

The pressure case contained two tilt gauges, signal amplifiers, analogue to digital electronics and the power supply. Syntactic floats, used to control the fall velocity and ensure the profiler remains vertical, were attached to the top of the pressure case.

The probe was attached to the ship using a Kelvar multi-conductor cable. This permitted real-time output of the sensor readings, and a means of winching the FLY to the surface.

The sensor specifications for the FLY profiler (from Dewey et al., 1987) are:

Sensor	Range	Accuracy	Response Time
Conductivity	20 to 60 mmho/cm	±0.05 mmho/cm	0.34s
Fast thermistor	1.5°C to 13°C	±0.004°C	0.018s
Slow thermistor	1.8°C to 17°C	±0.006°C	0.3s
Pressure	0 to 250m	±0.5m	
Tilt	0 to 45°	±0.5°	
Shear probe	0 to 4s^{-1}	±5%	Resolution 1-2cm

Calculations of the Turbulent Dissipation Rate, $\hat{I}$

Dewey and Crawford (1988) give details of the calculation of the turbulent dissipation rate, $\in$, from the velocity gradients. The microstructure shear was calculated from the differentiated shear probe signal, using the fall speed (typically 80cm/s) calculated from the pressure record. The profile was subdivided into vertical sections of about 1.5cm and $\in$ was computed for each bin.

Sources of Error

The FLY system experiences low levels of noise, equivalent to a dissipation rate of $\approx 3.0 \times 10^{-7}$ Wm^{-3} (Dewey et al., 1987). There are two principal sources of noise: electronic noise and instrument vibration. There are reductions of probe performance at high frequencies, and noise from mechanical

instrument vibrations at low frequencies. Hence, low (2Hz) and high frequency limits were imposed on the frequency range. The choice of high frequency cut off was dependent on the dissipation levels observed.

There are two sources of instrument vibration, namely structural resonance of the probe guard-profiler system and vibration caused by the shedding of eddies from leading edges of the profiler. The profiler was designed to minimise the spread of such noise through the spectrum.

Uncertainties in the fall speed and other parameters (dynamic viscosity, shear probe sensitivity) led to an estimated $\in$ error of 20% (Dewey and Crawford, 1988). Random errors in the estimation of $\in$ were minimised by obtaining 6-10 dissipation profiles each time the probe was deployed. This approach assumed that the flow was stationary for the duration of the deployment.

Shear probe sensitivity is dependent on water temperature and on angle of descent. Generally, the sensitivity increases, approximately linearly, with temperature. Provided the probe angle with the vertical is less than 5° the change in probe sensitivity is small (Dewey et al., 1987). Tilt was usually greatest at the surface. However, surface measurements were influenced more by the turbulence generated by the ship's wake.

References

Dewey R.K., Crawford W.E., Gargett A.E. and Oakey N.S., 1987. A microstructure instrument for profiling oceanic turbulence in coastal bottom boundary layers. *Journal of Atmospheric and Oceanic Technology*, 4(2), 288-297.

Dewey R.K. and Crawford W.E., 1988. Bottom stress estimates from vertical dissipation rate profiles on the continental shelf. *Journal of Physical Oceanography*, 18(8), 1167-1177.

XBT Data

Parameter Code Definitions

DEPHCV01 Depth
Computed from probe free-fall time
Metres

TEMPET01 Sea temperature (XBT)
Expendable bathythermograph
Degrees centigrade

Originator Code Definitions

Charles Darwin cruise CD91A

124   Dr. Brian McCartney   CCMS Proudman Oceanographic
Laboratory

Challenger cruise CH121B

126   Dr. Toby Sherwin   University College of Wales, Bangor

Originator Protocols

Dr. Brian McCartney and Dr. Toby Sherwin

Standard T7 shallow XBTs were deployed from a Sippican SA810 launcher with Bathy Systems 'SEAS' software. Data were transferred by floppy disk onto the RVS Level C computer where launch times were corrected for delay between entering the header information and actual launch and major transients in the data were flagged using a graphics editor.

At BODC, the data were converted from RVS format into the BODC internal format, and screened using an interactive graphical editor. Any additional data spikes not flagged by RVS were flagged as suspect. The data were then loaded into the Oracle relational database.

Sound Velocity Profiles

Paramater Code Definitions

PRESPR01   Sea pressure (profile)
Profiling pressure sensor (e.g. CTD)
Decibars

SVELVP01   Sound velocity
Sound velocity profiler
metres/sec

TEMPPR01   Sea temperature (unspecified)
Unspecified temperature probe
Degrees Centigrade

Originator Code Definitions

Cruise Charles Darwin CD91A

124   Dr. Brian McCartney   CCMS Proudman Oceanographic Laboratory

Originator Protocols

Dr. Brian McCartney

During cruise Charles Darwin CD91A, two sound velocity profiles to 1500m depth were obtained to provide calibration data for swath bathymetry. The data were gathered using a self-logging Applied Microsystems Sound Velocity Probe (SVP16) supplied by Ocean Scientific Instruments. The probe was calibrated and modified to operate to 5000m by the manufacturers prior to the cruise. The instrument (serial number 3102) had a temperature accuracy of $\pm$ 0.1 °C and resolution of 0.001°C. The sound velocity accuracy was $\pm$0.25m/s, with a 0.13 m/s resolution. Throughout the depth capabilities of the instrument the pressure accuracy was $\pm$0.1%.

SeaSoar Data

Instrument Description

The SeaSoar is a hydrodynamic fish towed behind the ship travelling at 8-9 knots linked by a faired cable. The usual cable length is 800m, which allows the fish to oscillate between the surface and a depth of 500m.

The unit has two stub wings whose angle of attack may be set by hydraulic servo motors. Thus the fish is able to climb or dive under the control of command signals from the ship or, more usually, by automatic command signals driven by the on-board pressure sensor. The wavelength and amplitude of the locus of the fish through the water depend upon the cable length, the ship's speed and the angle of attack selected for the wings.

The fish can carry a range of sensors. Invariably, a CTD is fitted but fluorometers, transmissometers, light sensors and plankton counters may also be included.

The instrument was developed by the Institute of Oceanographic Sciences, Wormley (now Southampton Oceanographic Centre) and was subsequently made available commercially.

SeaSoar Data Processing for RRS Challenger Cruise CH123A

The SeaSoar for this cruise was fitted with a Neil Brown MkIIIB CTD and a Chelsea Instruments Aquatracka fluorometer. Although the CTD unit included a Beckmann dissolved oxygen sensor the data have not been included in the final data set as no calibration samples were taken.

The data were logged by a Research Vessel Services Level 'A' microcomputer that dynamically reduced the sampling frequency to 1Hz and applied a time stamp from the ship's master clock. The reduced data were logged on the Level 'C' (a Sun workstation) via the Level 'B' disk buffer. Initial calibrations were applied to convert the raw counts into engineering units.

Further processing of the data was undertaken at BODC. Pressure was calibrated by considering the mean pressure logged in air (detected by salinity values <1 PSU). The following corrections were applied:

Series BSR507587 (SST1)   1.9 decibars
Series BSR507599 (SST2)   2.4 decibars
Series BSR507606 (SST3)   2.1 decibars

Temperature was checked by comparing SeaSoar data from the depth range 3-6 decibars with calibrated, contemporaneous thermosalinograph data. There was no significant difference between the two data sets and consequently the SeaSoar temperature data were left unchanged.

Salinity was calibrated using three water samples collected from the ship's non-toxic seawater supply to coincide with the fish reaching the surface. The samples were analysed on a Guildline Autosal bench salinometer calibrated against OSI standard seawater. A correction of +0.015 PSU was applied to the data. The calibrated SeaSoar data from the depth range of 3-6 decibars was compared with calibrated, contemporaneous thermosalinograph data to check for instrument drift. No significant drift was detected.

The underway fluorometer malfunctioned on this cruise. Consequently, the only calibration data that were available were four fluorometric extracted chlorophyll values taken from the non-toxic seawater supply. These were sampled over a voltage range from 1.26 to 1.35 volts whereas the good SeaSoar fluorometer data spanned the range 0.23 to 1.81 volts. Using the four calibration points available gave a very unusual calibration with a slope over 11 (1-3 is what one would expect). When applied to the SeaSoar data this gave the totally ridiculous answer of 63 mg/m^3 for the maximum SeaSoar chlorophyll.

To overcome this problem, an extra 'calibration' data point was added. This was based on the assumption that the highest extracted chlorophyll value from the entire cruise was responsible for the highest SeaSoar fluorometer voltage. This assumption may be defended for a cruise working in a limited geographic area (the SES box) at a time of relatively low biological activity (November).

This produced a modified calibration of:

Chl = exp (V*2.18 – 4.53) (R^2=68%, n=5)

Adopting this calibration reduced the maximum chlorophyll measured by SeaSoar to 0.55 mg/m^3. The calibration has been applied to the data. Note that this 'calibration' will cause the SeaSoar to underestimate chlorophyll if the assumption used to derive the extra calibration point is invalid.

Navigation was added to the calibrated SeaSoar data by matching on time. Both data sets were logged using a common clock. Consequently, timing errors were not a problem. The navigation data were logged with a sampling interval of 30 seconds. Consequently, only one SeaSoar data point in thirty could be matched to a position. The remaining positions were determined by linear interpolation.

The calibrated data were screened using the BODC SERPLO interactive graphical editor. All suspect data were flagged by setting the quality control byte to 'M'. The limits of the individual profiles contained in the data set were

marked by setting the pressure channel flag to 'B' and 'E' to signify 'beginning' and 'end' respectively.

The data series were 'topped and tailed' to eliminate corrupt data collected during deployment and recovery of the fish.

Each series was split into individual casts once all screening and calibration of the data was completed and these were loaded into Oracle as 'pseudo-CTDs'. The method used was to extract each profile defined by the 'B' and 'E' flags on the pressure channel (both upcasts and downcasts). The data for each cast were pressure sorted and the data flagged 'good' were binned to two decibars. If no good data were available for a specified bin then that bin was either filled by linear interpolation (for gaps up to 6 db) or set null. The result is a high spatial resolution CTD section with a vertical resolution of 2 decibars.

The entries in the EVENT table were prepared as follows. The start and end times are the actual times accurate to the nearest second. Latitude, longitude and water depth were determined by averaging data from the ship's underway systems between these times. The variance of latitude and longitude from the mean values were also stored.

Production Data

Introduction

The production data tables hold the results of uptake experiments that cannot sensibly be mapped into the water bottle data table (BOTDATA) because the amount of supporting information required exceeds what can be included in an 8-byte parameter code. The data in these tables result from a series of on-deck. 24-hour ^{14}C experiments carried out by QUB.

Method

Water samples were collected from ten depths in the euphotic zone from pre-dawn CTD casts. The depths were selected to represent 97, 55, 32.6, 19.9, 13.8, 6.9, 4.6, 3, 2 and 1 Per cent of surface incident irradiance.

The samples were treated in accordance with the JGOFS Level 1 protocols and triplicate 60ml samples plus a dark bottle were inoculated with ^{14}C bicarbonate. They were then placed in an on-deck incubator set up to simulate the in-situ light levels and spectral quality for each collection depth. Samples were held at surface seawater temperature by continuously flushing the incubators with surface seawater.

Following incubation, the samples were fractionated using 18, 2 and 0.25 micron polycarbonate filters. The particulate incorporation of labelled bicarbonate was measured by scintillation.

Sediment Trap Data

Parameter Code Definitions

DENSDWTM Particle density (trap material)
Sediment trap sample dry weight divided by sample volume
Grams per cubic centimetre

ICCNCNTM Inorganic carbon content (trap material)
Difference between C/N analyser results on total and acidified
sediment trap material samples
Per cent

ICFXCNXX Inorganic carbon flux
Difference between C/N analyser results on total and acidified
sediment trap material samples
Milligrams/m^2/day

MSFXDWXX Mass flux
Weighing dry trap material
Milligrams/m^2/day

OCCNCATM Organic carbon content (trap material)
Acidification then carbon/nitrogen analyser on sediment trap
material
Per cent

OCFXCAXX Particulate organic carbon (POC) flux (acidified)
Carbon/nitrogen analyser on acidified trap material
Milligrams/m^2/day

OPCNWOTM Opaline silica content (trap material)
Wet chemical oxidation of trap material
Per cent

OPFXWOXX Biogenic silica (opal) flux
Wet chemical oxidation of trap material
Milligrams/m^2/day

TCCNCNTM Total carbon content (trap material)
Carbon/nitrogen analyser on trap material
Per cent

TCFXCNXX   Total carbon flux
              Carbon/nitrogen analyser on trap material
              Milligrams/m^2/day

TNCNCNTM   Total nitrogen content (trap material)
              Carbon/nitrogen analyser on trap material
              Per cent

TNFXCNXX   Total particulate nitrogen ('PON') flux
              Carbon/nitrogen analyser on trap material
              Milligrams/m^2/day

Originator Code Definitions

Charles Darwin cruises CD91B and CD93A and Challenger cruises CH121C, CH125A and CH126A

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Originator Protocols

Dr. Paul Tett

<u>Trap moorings</u>

The trap moorings included two Parflux MK7G-21 sediment traps plus a single Aanderaa recording current meter. Each trap included a turret containing 22 bottles, identified by an engraved sample reference number (as included in the database STINDX table).

Approximately three days prior to deployment the bottles were washed with Decon-90 and rinsed with Decon-90. Preservative (GF/C filtered seawater, 5% formaldehyde, NaCl and borax) was then added to the bottles and they were mounted in the trap turret. The traps were programmed to collect for seven days in each bottle.

The mooring configuration used was as follows:

960m   Sub-surface buoy with Argos transmitter
980m   12 glass buoyancy spheres
1000m   Sediment trap
1380m   12 glass buoyancy spheres
1400m   Sediment trap
1483m   6 glass buoyancy spheres
1493m   Aanderaa current meter with a SeaTech transmissometer in the
                  fin
1496m   Acoustic release

During deployment on the first cruise (Charles Darwin CD91B) the rope between the upper trap and the 1380m spheres parted and only the bottom part of the mooring was deployed.

Sample handling

On trap recovery, 30ml of supernatant were immediately decanted from each sample and 1.0 ml buffered 40% formaldehyde added to give a formaldehyde concentration supplement of 0.15%. Samples were stored refrigerated in the dark until further manipulation on land. Decanted supernatants were stored frozen for subsequent analysis. Sample bottles and solutions contacted only plastic surfaces pre-cleaned using 10% HCl and then soaked with high quality deionised water (MilliQ).

Sample Pre-treatment

Each sample was resuspended in its remaining supernatant and qualitatively described under x6 to x50 magnification. Swimmers were identified and removed during this descriptive step using plastic forceps and preserved in formalin. Samples were split using a rotary splitter.

About 100ml of supernatant were decanted from each sample just prior to splitting and were used in rinsing procedures to effect quantitative transfer of sample through the splitting process. All manipulations were conducted in filtered air laminar flow environments. Sample splits were stored refrigerated until analysis.

Analytical methods

Opal

The opal measurement procedure involved extracting biogenic silica from a dry sample with an alkaline solution and measuring the dissolved silicon concentration in the extract following the molybdate-blue spectrophotometric method using a LACHAT QuikChem® 8000 Autoanalyser (QuikChem® method 31-114-27-1-A). This method can measure concentrations between 0.5 to 100 µM.

Before the opal extraction, organic matter and carbonates were removed from the samples as follows:

Samples were dried at $60°C$ overnight in an oven and then weighed on a microbalance. An aliquot ranging from 20-40mg was weighed into a 15ml plastic centrifuge tube, with pinholes to allow gas expansion. 2ml of 10% H_2O_2 solution (technical grade) was added to the tube and left for 30 minutes. Subsequently, 2ml of a 1N HCl solution (Analar grade) was added. At this stage, the sample was sonicated for 2 minutes, capped and placed in a metal rack for about 30 minutes. Immediately after that time, 10ml of deionised water was added to the tube and centrifuged for 10 minutes at 4300*g*.

Subsequently, the supernatant was carefully decanted with a micropipette to remove residual acid and peroxide and the tube was placed in an oven at 60°C to dry overnight.

Details of the opal extraction method used are:

Exactly 10ml of a 2M Na_2CO_3 analytical grade solution was added with a Whatman7 high-precision 10ml micropipette (accuracy 0.3%; precision on 30 readings 0.20%) to the sample tube. The tube was capped, mixed well, sonified for 2 minutes and placed in a pre-heated oven at 85°C. After 2 hours and again at 4 hours the sample was removed from the oven and mixed vigorously to resuspend the solids and quickly returned to the water bath. After a total of five hours, the tube was removed and immediately centrifuged for 10 minutes at 4300*g*. Finally, 13 ml of the clear supernatant was then quickly transferred to a polyethylene scintillation vial and stored in the freezer for further dissolved silica analysis. All steps after removing the tube from the oven were made quickly before cooling to minimise irreversible loss of dissolved silica to solid surfaces.

Carbon and nitrogen

The POC samples were placed into a pre-cleaned hermetic plastic container inside a pre-cleaned open plastic dish. Using an excess quantity of Analar concentrated HCl in a 50ml beaker, the samples were exposed directly to HCl vapour for 30-48 hours at room temperature. This acidification procedure removed inorganic carbon present as carbonate. The samples were removed and heated in an oven for 1 hour at 60°C to drive off residual HCl and water before they were analysed. Untreated and acidified samples were handled separately to avoid residual acid vapours in the HCl-treated samples reacting with carbonates in untreated samples.

Each TPC and POC sample was folded carefully into a rectangular shape, using sterilised forceps, inside a 30x30 mm square pre-cleaned tin foil. This maximised the oxidation reaction in the combustion chamber and allowed the sample to pass through the CHN analyser oxidation furnace entrance.

The carbon and nitrogen analyses were carried out at Dunstaffnage Marine Laboratory using a LECO CHN-900 Elemental Analyser with helium as the carrier gas and pure oxygen for combustion. Simultaneous determination of the carbon and nitrogen content of the samples was achieved by measuring the products of combustion using non-dispersive infrared detection and thermal conductivity.

The CHN analyser was calibrated using a known weight of a suitable standard organic compound having a known carbon and nitrogen content: acetanilide ($CH_3CONHC_6H_5$) containing 71.09% of carbon and 10.36% of nitrogen. Between 1995 and 1997 five visits were made to DML to analyse the samples. To avoid any errors resulting from changes in instrument

settings, a separate calibration was made on each visit. Each calibration involved analyses of standards on each day of use

Settling Velocity Tube Data

Parameter Code Definitions

CPHLFLP1 Fluorometric chlorophyll-a
Fluo. assay acetone extract. (GFF filtered)
milligrams/cubic metre

MDSVSVCL Median setting velocity of chlorophyll
SVT experiment plus analysis of cumulative SV curve
Millimetres/second

MDSVSVCP Median setting velocity of chlorophyll + phaeopigments
SVT experiment plus analysis of cumulative SV curve
Millimetres/second

MDSVSVPH Median setting velocity of phaeopigments
SVT experiment plus analysis of cumulative SV curve
Millimetres/second

MDSVSVSP Median setting velocity of total SPM
SVT experiment plus analysis of cumulative SV curve
Millimetres/second

MNSVSVCL Folk mean setting velocity of chlorophyll
SVT experiment plus Folk & Ward (1957) analysis of cumulative
SV curve
Millimetres/second

MNSVSVCP Folk mean setting velocity of chlorophyll + phaeopigments
SVT experiment plus Folk & Ward (1957) analysis of cumulative
SV curve
Millimetres/second

MNSVSVPH Folk mean setting velocity of phaeopigments
SVT experiment plus Folk & Ward (1957) analysis of cumulative
SV curve
Millimetres/second

MNSVSVSP Folk mean setting velocity of total SPM
SVT experiment plus Folk & Ward (1957) analysis of cumulative
SV curve
Millimetres/second

PHAEFLP1   Fluorometric phaeopigments
Fluo. assay of acetone extraction (GFF filtered)
milligrams/cubic metre

PSVASVCL   Wt percentage of chlorophyll settling slower than 0.1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVASVCP   Wt percentage of chlorophyll+phaeopigments settling slower than 0.1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVASVPH   Wt percentage of phaeopigments settling slower than 0.1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVASVSP   Wt percentage of total SPM settling slower than 0.1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVBSVCL   Wt percentage of chlorophyll settling slower than 1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVBSVCP   Wt percentage of chlorophyll+phaeopigments settling slower than 1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVBSVPH   Wt percentage of phaeopigments settling slower than 1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVBSVSP   Wt percentage of total SPM settling slower than 1 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVCSVCL   Wt percentage of chlorophyll settling slower than 10 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVCSVCP   Wt percentage of chlorophyll+phaeopigments settling slower than 10 m/day
SVT experiment plus analysis of cumulative SV curve
Per cent

PSVCSVPH   Wt percentage of phaeopigments settling slower than 10 m/day
           SVT experiment plus analysis of cumulative SV curve
           Per cent

PSVCSVSP   Wt percentage of total SPM settling slower than 10 m/day
           SVT experiment plus analysis of cumulative SV curve
           Per cent

TCPEFLP1   Total chloroplastic pigment
           Fluorometric assay of acetone extract (GF/F filtered)
           milligrams/cubic metre

TSEDGVP2   Total spm (gravimetry)
           Gravimetric analysis (0.45 um pore filtered)
           Milligrams per litre

Originator Code Definitions

Charles Darwin cruises CD93B and Challenger cruises CH123B, CH125B, CH126B and CH128A

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Originator Protocols

Dr. Sarah Jones

The settling velocity data were collected using the QUISSET (QUasi In-Situ SETtling velocity) tube. The tube was developed, at the University of Wales, Bangor, specifically for deployment in SPM concentration ranges of 1 to 50 mg l^{-1}. Since concentrations at the shelf edge were typically an order of magnitude lower, the tubes were deployed as pairs, allowing double the sample volume to be obtained.

The QUISSET tube comprised a 2m stainless steel frame, which supported the sampling tube. This was held at one end in the open position against stretched elastic cords. The frame was lowered horizontally into the water from the ship's winch. The tube was triggered either automatically at 1m above the seabed when a suspended weight came into contract with the bed, or (at any depth in the water column) by means of an acoustic release system. The latter was more appropriate for obtaining samples at the shelf edge since it allowed firing of the tubes at any specified depth.

On triggering, the tubes moved horizontally past a piston to seal at a 60° conical tap end. This closure mechanism, combined with the large tube diameter, ensured a more natural turbulent environment at the moment of sampling (Jones and Jago, 1996). The steep cone angle, combined with

relatively fast withdrawal rates, was designed to minimise settlement of SPM onto the cone sides during analysis.

The tubes were deployed after a transmission profile had been obtained from a CTD cast that was used to determine the sampling depths. The tubes were lowered horizontally, as an attached pair, from the side of the ship using the hydrographic winch, which had a depth gauge accurate to 1m. The transponder, used to communicate with the acoustic release, also gave a readout of the depth of the instrument. When the specified depth was reached, a signal was sent via the transponder to the release, which fired the tubes. After triggering, the tubes were recovered as rapidly as possible and set vertically on a stand. They were encased in insulating neoprene jackets to avoid the effects of sunlight on the temperature of the sample and on the phytoplankton population.

Sub-samples were collected from the tap at ten specified intervals. For this study, the sample times were at longer intervals than those used in shelf waters because of the low SPM concentrations and high proportion of very fine material present. Generally, the sample times used were 2, 10, 20, 40, 80, 160, 300, 420 and 600 minutes. Sub-sample volumes were approximately 550 cm^3 from each tube, so the total sub-sample obtained for filtration was approximately 1.1 litres.

For determination of the settling rates of total SPM the entire sub-sample was filtered through a pre-weighed 47mm Cyclopore etched polycarbonate membrane filter of pore size 0.4μm. Membranes were rinsed using 50 cm^3 of distilled water, then air-dried before storage. After each set of ten sub-samples, an additional membrane was inserted beneath the last one before filtering and rinsing, thereby providing a blank. In the laboratory, the membranes were oven dried at 40°C for 8 hours, then brought to room temperature at ambient humidity before re-weighing. The mean blank weight was subtracted from the weight on the filters to correct for the "handling" error. Correction using the mean blank weight resulted in negative weights, which have been marked suspect.

In spring and summer, sub-samples were also used to determine the settling rates of the phytoplankton population. Between 0.1 and 0.25 litres of sub-sample was filtered through a 25mm Whatman GF/F glass-fibre filter with a nominal pore size of 0.7μm. The pigments on the filter were extracted for a minimum of 18 hours and a maximum of 72 hours (Tett, 1987) in 8ml 90% acetone (nine parts Analar grade acetone, one part distilled water and neutralised with sodium bicarbonate). The extractions took place in a refrigerator in darkness. After extraction, the sample was shaken, centrifuged for 5 minutes, re-shaken and re-centrifuged for a further 5 minutes to ensure complete dissolution of the pigments. The chlorophyll-a and phaeopigments of the supernatant were measured using a Turner Design Model 10 fluorometer. The fluorescence was measured before and after acidification with 2N HCl (approximately 8% concentrated HCl by volume). Blanks were

also measured to give correction factors and the fluorescence measured was corrected for the appropriate blanks and range used.

The raw data were analysed and interpreted using an interactive computerised procedure developed at the University of Wales, Bangor. The procedure produced a cumulative weight (%) versus log settling velocity curve. Median settling velocity was interpolated directly from the curve, and an estimate of mean settling velocity was obtained from percentiles using the technique of Folk and Ward (1957). Total SPM or pigment concentration and concentrations within each of 3 settling velocity classes (partitioned on a log-scale), were also determined.

References

Folk R.L. and Ward W.C., 1957. Brazos River Bar, a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, 27, 3-26.

Jones S.E. and Jago C.F., 1996. Determination of settling velocity in the Elbe Estuary using QUISSET tubes. *Journal of Sea Research*, 36 (1/2),   63-67.

Tett P., 1987. Plankton. In: *Biological Survey of Estuaries and Coasts*. Ed: Baker J. and Wolff W. J., 280-341. Cambridge University Press.

Tidal Constituents

The tidal constituent data in the database were determined from moored RDI Acoustic Doppler Current Profiler (ADCP) records. The constituents were derived using the standard harmonic analysis methods developed by the Proudman Oceanographic Laboratory (Murray, 1963).

Detailed information on the source data is provided in the moored instrument data documentation.

Reference

Murray M.T., 1963. Tidal analysis with an electronic digital computer. Extrait des *Cahires Oceanographiques*, Xve anee 10, December 1963.