OMEX II Moored Instrument Data Set

The OMEX II moored instrument data set includes the following elements:

- Aanderaa RCM data from the sediment trap moorings (6 series)
- Aanderaa RCM (19 series) and thermistor chain (1 series) from the Portuguese Hydrographic Institute moorings on the shelf and slope.
- S4 current meter (1 series) and temperature mini-logger data (9 series) from a short term mooring deployed on the shelf during Charles Darwin cruise CD114.
- Temperature data (1 series) from the Galway ADCP deployment at OMEX II station P200.
- Mean time series (3 series) and burst recorded data from the Proudman Oceanographic Laboratory STABLE II lander deployments during Charles Darwin cruises CD110 and CD114.
- Near-bottom current and hydrographic data (3 series) from the Netherlands Institute for Sea Research BOBO lander.

Details of precise locations, times and instrument types may be found in either spreadsheet inventories supplied with the data or from the OMEX II database.

The data are subdivided into two groups. The first of these are conventional time series where the instrument sampled at pre-set regular intervals of the order of several minutes to an hour. The second are burst recorded data where the instrument sampled at high frequency for a period of several minutes followed by a period of inactivity. This latter category is confined to the STABLE II lander deployments.

Conventional Time Series Data

The conventional time series data may be found in the Time series subdirectories of the MOORINGS directory. These are:

CMD	Aanderaa RCM, S4 and Galway ADCP data
TEMP	Thermistor chain data and mini-logger data
LANDER	BOBO and STABLE II time series

A spreadsheet in ASCII comma separated variable format and *Excel* 8.0 format (MOORINV.CSV and MOORINV.XLS) is included in the MOORINGS directory, which provides an index to the data files. The data filenames are of the form Bnnnnnnn.LST or Bnnnnnnn.QXF where nnnnnnnn is the BODC series reference number. This number is used to refer to the data in the file throughout the data documentation and may also be found in the MOORINDX table in the OMEX II database. It is well worth making a note of it when using the data.

The data files are in one of two formats as indicated by their file extension. The .LST files are in a simple ASCII format, termed BODC Request Format Version 1.0. This format will be familiar to users who have received data from the BODC National Oceanographic Database. The .QXF files are in QXF format, a derivative of the NetCDF binary exchange format. The introduction of this format was necessary to handle the structural complexity of thermistor chain data. Both formats are handled transparently and output in a common grid format by the BODC Mooring Explorer software. It is strongly recommended that all users with access to a *Windows* system should use this program as the interface to the OMEX II moored instrument data.

These data have been through the standard BODC moored instrument quality control procedures, during which data documentation has been compiled. This describes the instrumentation and data processing procedures applied to the data by the originators and BODC. The documentation also describes any problems or abnormalities with the data reported by the originator or detected by BODC quality control. In some cases, vital information may only be found in the data documentation. **Therefore, ignore this document at your peril.**

Burst Recorded Data

Introduction

The STABLE II lander was deployed twice for OMEX II, during Charles Darwin cruises CD110 and CD114. Both deployments were at site P200 (42° 41'N, 9° 30.5' W) in approximately 200 m of water. The instrument was fitted with a range of sensors and two data loggers. The mean data logger stored a cycle of averaged data once a minute for currents, pressure and temperature or once per hour for the OBS. The data from this are included as part of the conventional time-series data set on the CD-ROM. The second data logger collected approximately 9500 scans at a frequency of 8 Hz once an hour. These data are documented here.

Instrument Description

STABLE II lander (Humphery and Moores, 1994) consisted of a large aluminium frame standing on tripod legs fitted with syntactic foam buoyancy, two Benthos transponding releases, mechanical releases and disposable ballast.

The following sensors on the STABLE II platform were logged in burst mode:

> Three electromagnetic current meter arrays (Valeport 800 series), termed Array A (300 mm above seabed), Array B (598 mm above seabed) and Array C (897 mm above sea bed). Each array comprised two heads mounted on Y-shaped arms with a horizontal separation of 230 mm. The arrays were mounted such that the heads were at identical angles to port and starboard of the lander centre-line facing its bow (the reference point on the lander for the heading channel in the mean data set).
>
> A Digiquartz pressure sensor capable of operating at depths of up to 1400 m was mounted 1950 mm above the sea floor. Note that the mean data logger used a separate sensor.

Data File Location

The burst recorded data files may be found in the CD-ROM directory MOORINGS\STABURST. The data are located under the appropriate cruise directory (CD110 or CD114). There are over 400 files from each cruise, each containing the data from a single burst.

The Charles Darwin CD110 deployment was from 27 December 1997 until 14 January 1998. There are 830 files named in the range 005.ZIP to 836.ZIP

(uncompress to burst.005 to burst.836). No data were supplied for bursts 1-4 and the data files for bursts 29 and 31 were corrupted and therefore rejected. Bursts 005-146 were logged before the instrument was deployed.

The Charles Darwin CD114 deployment was from 01 August 1998 until 20 August 1998. There are 496 files named in the range 100.ZIP to 595.ZIP (uncompress to burst.100 to burst.595). No data were supplied for bursts 1-99. Bursts 100-152 were logged before STABLE was deployed.

Data Format

The data are stored in a simple ASCII format. Due to space constraints, the burst files have been compressed using the Unix 'zip' utility (using, zip –l to ensure PC-compatible record terminators). The files may be uncompressed using MS-DOS, UNIX or *Windows*-based software (e.g. Pkware). Note that if the UNIX 'unzip' command is used, the '-a' option must be specified to convert the PC record terminators to the UNIX form (unzip –a <*filename*>).

Each file has a standard 33 record header thus:

```
Rig:                      POP-UP STABLE2

Burst Number:             147

Start Date:               27:12:1997

Start Time ( GMT):        11:59:59

Deployment reference:     OMEX-CD110

Logging Frequency:        8Hz


Column information:
Columns 1 to 12 contain data for the Electromagnetic Current Meters
and give velocity in metres per second.

Column          EMCM Array      Head    Flow component

  1             A               Port    Horizontal
  2             A               Port    Vertical
  3             A               Stbd    Horizontal
  4             A               Stbd    Vertical
  5             B               Port    Horizontal
  6             B               Port    Vertical
  7             B               Stbd    Horizontal
  8             B               Stbd    Vertical
  9             C               Port    Horizontal
  10            C               Port    Vertical
  11            C               Stbd    Horizontal
  12            C               Stbd    Vertical

Column 13 contains wave induced pressure information in Bars.
```

After the header are three blank lines and then the data records. These contain 13 columns of decimal numbers, separated by at least one blank (usually two) as specified in the header. Each file contains 9600 scans.

The 'ECM Array' designations are defined in the Data Documentation section above. Vertical currents are positive when flowing from the bottom of the head to the top. Horizontal currents are positive when flowing from left to right (viewing the sensor from the front).

Data Quality

Each of the EMCM heads has a “warm up” time. This means that the first 20 seconds of every burst are suspect. A brief examination of the data showed the pressure data and the data from the port head of EMCM array A to be highly suspect for all bursts from the CD114 deployment.

References

Humphery J.D. and Moores S.P. 1994. STABLE II – An improved benthic lander for the study of turbulent wave-current-bed interactions and associated sediment transport. p170-174 *in* ***Sixth International Conference on Electronic Engineering in Oceanography***, 19-21 July 1994, Cambridge, UK. London: Institute of Electrical Engineers. 188 pp.

BODC Request Format
Version 1.0

This is a generalised output format to handle most types of data held in the BODC National Oceanographic Database.

The following is an example of a file listed in the format:

```
BODC Request Format Std. V1.0          Headers=  15 Data Cycles=   1247 BODC QC (a)
Series:   12050 Inv: CMD  1008          Produced:1993/07/07                     (b)
Id:   048/0          United Kingdom    Scottish Office Agric. & Fisheries Dept. (c)
 57d18.1mN001d54.6mW                    Start:19700831095800 End:19701022075800 (d)
Depth: floor  22.0  sensor  18.0        Nom. sample int.:   3600        secs    (e)
    2 Parameters included:                                                     (f)
Parameter  f  P  Q     Absent Data Value  Minimum Value  Maximum Value     Units
LCDAEL01   Y 30 37                -1.00           0.00         359.70     deg T (g)
Horizontal Current Direction           Eulerian method
LCSAEL01   Y 40 47                -1.00           0.14          72.07    cm/sec
Horizontal Current Speed               Eulerian method
    1 FORTRAN format record:                                                   (h)
(I7,A20,A1,1X,F8.2,A1,1X,F8.2,A1)
  Cycle    Date      Time    LCDAEL01  LCSAEL01                                (i)
 Number yyyy mm dd hh mi ssf          f         f
      1 1970/08/31 09.58.00    228.26     18.63                               (j)
      2 1970/08/31 10.58.00    209.69     36.14
      3 1970/08/31 11.58.00    206.74     44.23
      4 1970/08/31 12.58.00    204.33     40.06
      5 1970/08/31 13.58.00    207.48     27.95
```

Notes:

(a) The first record contains general information regarding the file. Std. indicates Standard format and V1.0 indicates version 1.0 of the format. Headers and Data Cycles are counts of the number of header records and data cycles in the file. BODC QC indicates that the data has been through BODC quality control procedures; this field is blank if this is not the case.

(b) Record two indicates the BODC series reference number and any inventory reference numbers by which the series is also known (in this case the inventory is the Moored Time Series Inventory that was originally known as the Current Meter Inventory: hence the mnemonic). A reference to a second inventory may occur on this line. If a series has not yet been allocated a BODC reference number this record will start with 'File:' followed by the full BODC file name. This record also indicates the date on which the output was produced (yyyy/mm/dd).

(c) Record three gives the data originator's identifier for the series, the source country and the source laboratory. If this information is not available the record will state 'Series header information not available' and the next two records will be blank.

(d) This record specifies one or two geographic positions; if a second position is given its purpose will be described in the accompanying documentation. Start date and end date (if available) are given in the format yyyymmddhhmiss (24 hour clock and GMT). If time is unavailable hhmiss will be blank.

(e) This record gives the sea floor depth and the sensor depth. If a second (greater) sensor depth is given the two sensor depths specify the range of depths over which measurements were made. The second half of this record gives the nominal sampling interval and units.

(f) This record and the following title record start the parameter section. There are two records per parameter present.

(g) The parameter information record gives the BODC parameter name, whether the channel has been flagged with quality control indicators (Y/N), byte pointers (P and Q) to the start and end of the parameter within each datacycle record, the absent data value, minimum and maximum values of the parameter within the series and parameter storage units. The next record gives the full parameter name and the sampling method.

(h) This line indicates the number of following records which together form the FORTRAN format used to write each data cycle record.

(i) This and the next record are the data cycle title lines. 'f' indicates a flag channel.

(j) Data cycles are listed one per line. The first seven characters are always a data cycle count. One of the following quality control flags may appear against an individual data value (if the remark 'BODC QC' is present in record 1, then a blank flag indicates that the value is good):

Flag	Description
	Unqualified
<	Below detection limit
>	In excess of quoted value
B	Beginning of CTD downcast
D	Thermometric depth
E	End of CTD downcast
K	Uncertain/suspect value
L	Improbable value - originator's quality control
M	Improbable value - BODC quality control
N	Null value
P	Trace/calm
Q	Indeterminate
R	Replacement value
S	Estimated value
T	Interpolated value
W	Control value
X	Excessive difference

QXF Format

Introduction

QXF is a binary format developed within BODC to handle multidimensional data such as wave spectra, ADCP data and thermistor chains. A concise definition of multidimensional data is those data that have more than one independent variable. For example, for a thermistor chain temperature to make any sense, it must be labelled with both its date/time and sensor depth. Due to the overheads involved in software maintenance, it is proposed that QXF will become the standard BODC binary format. It will replace PXF and its ASCII analogue (BODC Request Format) that has previously been used by BODC for the distribution of time series data. For operational reasons, the OMEX II CD-ROM represents a transitional stage and includes data in both QXF and BODC Request Format.

QXF is a customisation of Network Common Data Form (NetCDF) that was developed for data exchange within the atmospheric research community in the USA. Its purpose is to provide a vehicle for the platform-independent exchange of binary data. The format is well supported by the Unidata Program Center, managed by the University Corporation of Atmospheric Research on behalf of the US National Science Foundation. Interface software written in both C and FORTRAN is freely available on the Web. Users wishing to know more about NetCDF or wishing to write applications against QXF should consult the UCAR Web site (www.unidata.ucar.edu). Further support, in the form of C++ methods, is available to those wishing to program against QXF from BODC.

NetCDF Concepts and Terminology

NetCDF considers data to consist of a series of multidimensional arrays, each of which stores the values for a specified variable. Some arrays will have values for all dimensions, whilst other arrays have a lower number of dimensions. These may pertain to one or more dimensions of the multidimensional arrays. One of the dimensions, usually time, is unlimited in that the file may grow along that dimension. Fixed storage is allocated for the other dimensions.

Initially, this is a difficult concept to understand. The following example may help. Consider thermistor chain data where temperature is measured at a number of depths along a common time base. The minimum number of arrays required to store these data is three: temperature, time_stamp and sensor_depth. The temperature array is 2-dimensional (time, depth), time_stamp is 1-dimensional (time) and sensor_depth is also 1-dimensional but this time the dimension is depth. The time dimension is set to be

unlimited, whilst the depth dimension is fixed at the number of sensors on the thermistor chain.

In addition to the data arrays, NetCDF also stores attributes. These may be either global or variable-specific. Global attributes are used to store metadata that pertains to the entire data set. Variable-specific attributes are used to store such items as variables' names, absent data values, formats, minimum and maximum data values, etc.

Mapping Between QXF and NetCDF

The first consideration is the global attributes. The following global attributes have been included in QXF:

SERIDN	Series identifier
GOODFL	Flag character used to signify good data
NULLFL	Flag character used to signify null data
STOROP	Currently unused (set zero)
NSCHAN	Number of channels in the series
NSOFDA	Offset of free space within the series array
HEADSZ	Storage required besides data arrays
CYCLSZ	Storage required for one datacycle

The primary reason these variables are stored in the QXF file is that they are required by the BODC Series Class (see below). They may therefore be safely ignored by programmers developing applications outside the Series Class unless the information they contain proves useful.

The variable attributes stored are the absent data value (ABS), the minimum data value (MIN) and the maximum data value (MAX). Note that data units are not explicitly stored. The variable names used in QXF are BODC parameter codes. This implicitly specifies the storage unit because it is part of the parameter code definition. These definitions may be found in the OMEX II Database or in the moored instrument data documentation.

QXF also includes quality control flag variables in addition to the data variables. These may be recognised and linked to their related data variable through their variable name, which is 9 bytes long instead of 8. The first byte is always 'F' and the other 8 bytes are the name of the associated data channel.

The QXF data on the OMEX II CD-ROM have two dimensions specified: primary and secondary. The primary dimension is unlimited in size and represents time. The secondary dimension is limited to the number of measurement depths and represents measurement depth. Note that temperature probes have been implemented in QXF as if they were single-bead thermistor chains.

One final complication requires some explanation. The time stamp in QXF is implemented as two variables rather than one to reflect the way in which date and time are handled within BODC. The first variable, AADYAA01, defines the date in terms of what is known locally as a Loch day number. This is the number of days that have elapsed since the start of the Gregorian calendar. Source code (FORTRAN and Pascal) is provided in the Underway Data Set section of this manual, which converts a Loch day number into year month and day. The second variable, AAFDZZ01, stores time as a floating-point day fraction (06:00 = 0.25, 12:00 = 0.5 etc.).

Making use of data in QXF

The first message to users who have access to a *Windows* system is that the easiest way to use the QXF data on the OMEX II CD-ROM is via the BODC Moorings Explorer program. This handles both moored instrument data formats present on the CD-ROM with equal ease.

Users on other platforms will generally need to develop software if they wish to use the QXF data on the CD-ROM. Note that this is not restricted to conventional language programming: NetCDF data may be imported directly into packages such as *MatLab* and then manipulated through command language macros.

Another relatively simple route into the data is through the ‘ncdump’ utility. This general-purpose NetCDF to ASCII conversion utility is freely available for UNIX platforms.

BODC Mooring Explorer Software

The BODC Mooring Explorer is a *Windows* application that allows the moored instrument files on the CD-ROM to be plotted as stacked time series. The data may also be listed in a grid format that may be exported to other applications, such as spreadsheets. The mooring position may also be displayed overlaid on a map of GEBCO bathymetry.

The program has been tested successfully under *Windows95, Windows98* and *Windows NT 4.0*. It contains on-line help, including functional descriptions of all the menu options and control buttons. However, a brief description of how to get started is included here.

When the program is launched through either the BODC entry in the Start menu, a shortcut or *Windows Explorer*, a splash screen is briefly displayed followed by the opening of the program control window. The following actions are then required to display data.

- Select the Open Project option from the File menu and choose the project appropriate to the CD-ROM currently loaded.

- Click on the Select menu to open the Selection Dialog, which allows the series of interest to be specified. The form is in three parts. The top, 'Primary data selection criteria', allows various selection criteria to be specified. The result of this is to restrict the choices available in the other two sections to entries matching the selection. The selection may be refined, if desired through the 'Secondary data selection criterion' section. Once the number of series displayed in the bottom section of the form has been reduced to a manageable number, the series of interest may be chosen by a mouse left-click. Note that more than one series may be chosen at this stage.

- Press 'OK' to open the View Dialog. This controls the series, or part of a series, which is to be plotted or listed. The time interval, data channels and quality control flag values may all be used to restrict what is displayed. If you don't like working with parameter codes, right click in the Parameters Available window to get plain language definitions. This dialog may be opened at any time to update the selection criteria by selecting the Moorings option from the View menu.

- Click on one or more of the three large control buttons to open the plot window, data grid or mooring location map. The icons on the buttons clearly indicate which button does what.

This is all you need to do to access the data. Control over how the data are presented is provided through both the menus and the toolbar buttons. Consult the on-line help or simply experiment to discover what these can do.