THE OMEX II UNDERWAY DATA SET

Introduction

During the OMEX II cruises operated by RRS Charles Darwin, RV Belgica or FS Meteor, the ship's computers automatically logged a range of surface physical, chemical and biological parameters together with navigation meteorology and bathymetry. In addition, an instrumented Continuous Plankton Recorder was towed through the OMEX II area either by merchant ships or a research vessel. The files described in this section, termed the underway data set, contain these data merged on a common time base with a sampling interval of between 30 seconds and 15 minutes.

The data files may be found in the UNDERWAY directory on the CD-ROM. This contains one file per cruise leg that are named using the convention:

cruise_leg_mnemonic.BMM

The data are stored in BODC's Binary Merge Format. This is a binary format that may not be listed or printed. However, a software interface, the BODC Underway Explorer, is provided for *Windows* users and a format specification is given to allow users of other operating systems to develop applications to access the data.

Each data file is accompanied by a data document that is included in this *Acrobat* manual.

A fundamental principle of Binary Merge Format, and BODC's management of underway data files, is that each data value is assigned a single character quality control flag. This provides the only quality control mechanism: any suspect data values, including total garbage, are labelled by a quality control flag set to 'S'. Problem data are not deleted. Consequently, **these flags must not be ignored.**

The underway section of this manual includes the following information:

Data Set Contents

A summary table is provided listing the cruise legs for which data are available, including their start and end dates and the parameters measured.

Database Data Documentation

A data document has been prepared for each cruise leg. This describes the instrumentation, the data processing and calibration protocols employed and any problems with the data noted by either the originators or BODC. The burden of deciding whether the data you extract is 'fit for purpose' for your application is placed on you, the user. **Ignore this documentation at your peril.**

Using the BODC Underway Explorer

The BODC Underway Explorer is a *Windows95* application that allows data from the underway files to be presented as time series plots and listed in a data grid that may be exported to other applications. The program also provides an indication of the spatial context of the data through a map of the cruise track overlaid on a coastline and bathymetric contours.

Binary Merge Format Specification

This section provides a technical specification of the Binary Merge Format used for the data files. It provides sufficient information for users to be able to write their own applications for handling data in this format.

OMEX II Underway Data Set Contents

The OMEX II underway data set contains data from the following cruise legs and instrumented CPR tows. Note that the hieroglyphics in the 'Channels' section are Binary Merge Format parameter codes that may be found in the format specification.

Cruise Legs

Cruise leg:	Charles Darwin CD105A
Dates:	29/05/1997 14:24 to 09/06/1997 08:01
Sampling:	1 minute
Channels:	ABCF?KL

Cruise leg:	Charles Darwin CD105B
Dates:	10/06/1997 06:12 to 22/06/1997 17:15
Sampling:	1 minute
Channels:	ABCFJL?!ITUVW

Cruise leg:	Belgica BG9714B
Dates:	18/06/1997 07:54 to 20/06/1997 08:48
Sampling:	30 seconds
Channels:	ABJKCFDOa1ZYGQME

Cruise leg:	Belgica BG9714C
Dates:	21/06/1997 06:59 to 30/06/1997 07:52
Sampling:	30 seconds
Channels:	ABJKCFDOaZY1GQME

Cruise leg:	Belgica BG9714D
Dates:	02/07/1997 06:58 to 07/07/1997 08:05
Sampling:	30 seconds
Channels:	ABJKCFDOa1ZYGQME

Cruise leg:	Charles Darwin CD110A
Dates:	23/12/1997 13:00 to 05/01/1998 08:00
Sampling:	1 minute
Channels:	ABCFJK?IL

Cruise leg:	Charles Darwin CD110B
Dates:	06/01/1998 11:00 to 19/01/1999 12:00
Sampling:	1 minute
Channels:	ABCFJK?Ia1dcYZLEu!

Cruise leg: Belgica BG9815B
Dates: 25/06/1998 09:28 to 26/06/1998 16:23
Sampling: 30 seconds
Channels: ABJdCFDOa1ZYNMQEu

Cruise leg: Belgica BG9815C
Dates: 27/06/1998 13:24 to 07/07/1998 12:01
Sampling: 30 seconds
Channels: ABJdCFDOa1ZYGNMQEu

Cruise leg: Belgica BG9815D
Dates: 10/07/1998 06:28 to 14/07/1998 07:15
Sampling: 30 seconds
Channels: ABJdCFDOa1ZYGNEuMQ

Cruise leg: Charles Darwin CD114A
Dates: 29/07/1998 08:48 to 11/08/1998 06:59
Sampling: 1 minute
Channels: ABKCFJD1adtONREuMQGYZ

Cruise leg: Charles Darwin CD114B
Dates: 11/08/1998 07:00 to 24/08/1998 05:20
Sampling: 1 minute
Channels: ABKCFJ1adtOWTVNREuMQYZ

Cruise leg: Meteor M43_2
Dates: 28/12/1998 00:00 to 14/01/1999 12:00
Sampling: 1 minute
Channels: ABCFJ1O/adYZNQMEu#(^]yz

Cruise leg: Belgica BG9919A
Dates: 30/08/1999 09:49 to 03/09/1999 11:28
Sampling: 1 minute
Channels: ABJCFDOaYZG

Cruise leg: Belgica BG9919B
Dates: 04/09/1999 08:55 to 11/09/1999 13:46
Sampling: 1 minute
Channels: ABJCFDOaZYMQEuG

Cruise leg: Belgica BG9919C
Dates: 14/09/1999 06:45 to 18/09/1999 15:54
Sampling: 1 minute
Channels: ABJCFDOaYZMQEuG

Cruise leg: Belgica BG9919D
Dates: 18/09/1999 19:56 to 21/09/1999 10:43
Sampling: 1 minute
Channels: ABJCFDOaYZG

Instrumented CPR Tows

Tow reference:	449SB
Dates:	26/05/1997 12:46 to 28/05/1997 02:46
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	451SB
Dates:	29/09/1997 04:32 to 01/10/1997 03:32
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	452SB
Dates:	26/10/1997 16:59 to 29/10/1997 02:59
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	453SB
Dates:	24/11/1997 10:24 to 27/11/1997 03:39
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	455SB
Dates:	22/02/1998 13:29 to 26/02/1998 01:44
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	456SB
Dates:	24/03/1998 00:23 to 25/03/1998 09:23
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	457SB
Dates:	21/04/1998 08:24 to 22/04/1998 15:39
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	458SB
Dates:	19/05/1998 14:52 to 20/05/1998 11:52
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	459SB
Dates:	29/06/1998 23:28 to 01/07/1998 10:28
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference:	CPR114A
Dates:	31/07/1998 19:05 to 01/08/1998 17:05
Sampling:	15 minute
Channels:	ABCF!KX

Tow reference: CPR114B
Dates: 21/08/1998 15:09 to 22/08/1998 11:54
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 462SB
Dates: 10/09/1998 10:49 to 11/09/1998 04:34
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 463SB
Dates: 18/10/1998 15:06 to 21/10/1998 00:51
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 464SB
Dates: 18/11/1998 07:01 to 19/11/1998 02:46
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 465SB
Dates: 14/12/1998 07:35 to 16/12/1998 02:50
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 466SB
Dates: 20/01/1999 14:36 to 21/01/1999 16:51
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 467SB
Dates: 14/02/1999 14:19 to 16/02/1999 09:04
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 468SB
Dates: 14/03/1999 14:54 to 17/03/1999 05:04
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 469SB
Dates: 26/04/1999 23:44 to 27/04/1999 15:44
Sampling: 15 minute
Channels: ABCF!KX

Tow reference: 470SB
Dates: 23/05/1999 10:29 to 25/05/1999 04:59
Sampling: 15 minute
Channels: ABCF!KX

Tow reference:	471SB
Dates:	20/06/1999 10:46 to 23/06/1999 00:16
Sampling:	15 minute
Channels:	ABCF!KX

Binary Merge Format Specification

Binary Merge Format is a binary format for the compact storage of high volume, time series data. The format was initially developed for use on an IBM mainframe and subsequently adapted for use on UNIX workstations and PCs.

The file structure comprises a single header record followed by the datacycles. All the data on the CD-ROM in Binary Merge Format have a regular time channel with a sampling interval ranging from 30 seconds to 15 minutes.

The structure of the header record is:

Cruise identifier	-	12-byte character
Pointer to first data record	-	4-byte integer
Pointer to last data record	-	4-byte integer
Number of data channels excluding date and time (always present)	-	4-byte integer
Processing status mask	-	4-byte integer
Data source indicator	-	4-byte integer
Project indicator word	-	4-byte integer
Padding	-	set to binary zero
Channel identifiers	-	1 byte per flagged channel

The cruise identifier is of the form cruise_mnemonic/yy where yy is the year in which the data were collected. It is stored in ASCII character code.

The processing status mask indicates the data processing operations to which the data have been subjected. In the case of the OMEX II some of the data have been calibrated using the BODC systems, which automatically set the bits. However, other data were supplied in a calibrated state and these will not have the bits set. Consequently, users are advised to ignore the processing status mask for the data on this CD-ROM.

The data source and project indicator words have no relevance to the data stored on the CD-ROM. They will always be set to zero and one respectively.

The padding words are included to ensure that the header contains the same number of bytes as the data records that follow. Consequently, the number of words of padding depends upon the number of data channels (it is in fact the number of data channels minus 7).

The channel identifiers are single characters, encoded in ASCII, which specify the channels (other than date and time which are always present) in the file. The order of the identifiers in the header specifies the order of the data channels in the data records.

The channel identifiers are defined as follows:

A = Latitude (deg +ve N)
B = Longitude (deg +ve E)
C = Temperature (°C)
D = Raw fluorescence from Turner Designs through-flow fluorometer
E = Aqueous pCO_2 determined by University of Liège (µatm)
F = Salinity (PSU)
G = Chlorophyll from Turner Designs (mg/m^3)
I = Optical attenuance (per m)
J = Bathymetric depth (m)
K = Distance run (km)
L = Photosynthetically available scalar irradiance (W/m^2)
M = pH (pH units)
N = Temperature of the pH determination (°C)
O = Solar vector irradiance (W/m^2)
Q = Dissolved oxygen at in-situ temperature and salinity (µM)
R = Oxygen saturation (%)
T = Nitrate + nitrite (µM)
U = Nitrite (µM)
V = Phosphate (µM)
W = Silicate (µM)
X = Null channel
Y = Absolute wind speed (knots)
Z = Absolute wind direction (degrees from which the wind blows)
1 = Barometric pressure (mb)
/ = Long wave radiation (W/m^2)
? = Raw signal from Chelsea Instruments Aquatracka fluorometer (V)
! = Chlorophyll from Aquatracka (mg/m^3)
= N-S component of ship's velocity (knots N)
(= E-W component of ship's velocity (knots E)
^ = Aqueous pCO_2 determined by GEOMAR (µatm)
] = Atmospheric pCO_2 determined by GEOMAR (µatm)
a = Combined dry bulb air temperature (°C)
c = Dew point (°C)
d = Relative humidity (%)
t = Photosynthetically available vector irradiance (W/m^2)
u = Atmospheric pCO_2 determined by University of Liège (µatm)
y = Atmospheric methane (nM)
z = Aqueous methane (nM)

At the right hand end of the header record are up to 3 blank padding bytes to ensure that the record length is a multiple of 4 bytes (to allow it to be specified in terms of words). The same number of padding bytes is also added to each datacycle record.

Each datacycle contains the date (word 1), time (word 2), the data values (words 3 to number of channels plus 2) and their flags. Date is stored in binary integer form as a 'Loch day number', defined as the number of days elapsed

since the start of the Gregorian calendar. Time is stored in IEEE binary floating point representation (as used on UNIX systems) as a day fraction (06:00 = 0.25, 12:00 = 0.5 etc.).

The data values are stored as IEEE binary floating point numbers in the order prescribed by the channel identifiers in the header. At the rightmost end of the record are the data quality control flags occupying one byte each. The flag definitions used are as follows:

B - Bad data
G - Good data
I - Interpolated data
N - Null data
S - Suspect data
U - Data outside range of calibration

The main problem awaiting those who wish to access the Binary Merge files without the assistance of the software interface provided is the conversion of 'Loch day numbers' into calendar dates. IEEE floating point structure is rapidly establishing itself as a de facto standard and therefore should not prove to be a problem.

The following subroutine listings, one in FORTRAN and one in Pascal, convert a Loch day number into year, month and day.

```
    SUBROUTINE CMAADY(IDY,IDATE)
C#S   ************************************************************
C      TITLE  S CMAADY   VR  3.0   AUTHOR  MDBS/SGL   DATE 1979FEB01
C
C      S/R calculates date given the number of (complete) days since
C      1760.01.01  (= 0 days elapsed). Not valid for 22nd century
C
C      MODS – 2.0 adapted to be millennium compliant (1983FEB23sgl)
C             3.0 adapted for SG IRIX compiler (1990OCT15sgl)
C#E   ************************************************************
C
C  ARGUMENTS
C  ---------
C
C   IDY      -     No. of complete days elapsed
CO  IDATE    -     3 element array containing 1) year, 2) month
C                  and 3) day of month
C
      DIMENSION IDATE(3)
      INTEGER MONTH(12)/0,31,59,90,120,151,181,212,243,273,304,334/
      IC  =  0
C
      IDYC0 =  IDY - 51133
      ICEN  =  19
  10    IF(IDYC0.GT.0) GO TO 20
        ICEN  =  ICEN - 1
        IDYC0  =  IDYC0 + 36524
        GO TO 10
  20  IDYC  =  IDYC0 - 365
      IF(IDYC.GT.0) GO TO 30
      IDYC = IDYC0
      IDATE(1)  =  ICEN*100
      GO TO 40
C
C  NOW DETERMINE NO OF FULL LEAP YEAR CYCLES PRESENT
C
   30 NLPYR  =  (IDYC-1)/1461
      IYR  =  4*NLPYR
      IDYC  =  IDYC - NLPYR*1461
      IYRX  =  (IDYC-1)/365
      IF(IYRX.EQ.4) IYRX = 3
      IDYC  =  IDYC -  IYRX*365
      IDATE(1)  =  IYR + IYRX + ICEN*100 + 1
      IF(IYRX.EQ.3) IC = 1
C
C  NOW GET MONTH AND DAY
C
   40 L  =  13
      DO  50  I =1,12
        L  =  L - 1
        IF(L.EQ.2) IC = 0
        MN  =  MONTH(L) + IC
        IF(IDYC.GT.MN) GO TO 60
   50   CONTINUE
C
   60 IDATE(2) = L
      IDATE(3) = IDYC - MN
C
      RETURN
      END
```

```
Type
  IntArr = Record
             Y : Word;
             M,D : Byte
           End;
Const
  MonthSum : Array[1..12] of Word=(0,31,59,90,120,151,181,212,243,273,304,334);
Procedure Cmaady(Var Idy : LongInt; Var tDate : IntArr);
{     S/R calculates date given the number of (complete) days since  }
{     1760.01.01  (= 0 days elapsed). Not valid for 22nd century    }
Var
  iC,iCen,nLpYr,iYr : LongInt;
  mn,i,L,iYrx : LongInt;
  iDyc,iDyc0 : LongInt;
Begin
  IC := 0;
  IDYC0 :=  IDY - 51133;
  ICEN :=  19;
  While IDYC0 <= 0 Do
  Begin
    ICEN := ICEN - 1;
    IDYC0 := IDYC0 + 36524
  End;
  IDYC := IDYC0 - 365;
  IF IDYC<=0 Then
  Begin
    IDYC:= IDYC0;
    tDate.Y:= ICEN*100
  End
  Else
  Begin
    {  NOW DETERMINE NO OF FULL LEAP YEAR CYCLES PRESENT }
    NLPYR := Trunc((IDYC-1)/1461);
    IYR  :=  4*NLPYR;
    IDYC  :=  IDYC - NLPYR*1461;
    IYRX  :=  Trunc((iDYC-1)/365);
    IF IYRX=4 Then
      IYRX := 3;
    IDYC  :=  IDYC - IYRX*365;
    tDate.Y :=  IYR + IYRX + ICEN*100 + 1;
    IF IYRX=3 Then
      IC := 1
  End;
  { NOW GET MONTH AND DAY }
  L := 13;
  I:=1;
  While I<13 Do
  Begin
    L := L-1;
    IF L=2 Then
      IC:= 0;
    MN := MonthSum[L] + IC;
    IF IDYC>MN Then
      I:=13
    Else
      Inc(I)
  End;
  tDate.M:= L;
  tDate.D:= Integer(IDYC) - Mn
End;
```

The BODC Underway Explorer

The BODC Underway Explorer is a *Windows* application that allows data from the underway files to be presented as time series plots and listed in a data grid that may be exported to other applications. The program also provides an indication of the spatial context of the data through a map of the cruise track overlaid on a coastline and bathymetric contours. The program has been tested successfully under *Windows NT 4.0* and *Windows95/98*.

The content of all program windows, be it a plot, a map or a data grid may be saved onto disk or printed using any printer installed on the *Windows* system. It is designed to support one or more BODC CD-ROMs containing underway data files providing the project specific installation program has been run for each CD-ROM to be used.

The program includes full information on its use through an on-line help system, 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. Three 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. This may then be used to choose the cruise, time interval and up to 16 parameters of interest.

- Click on one or more of the three large control buttons to open the plot window, data grid or cruise track 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 and access to more advanced features such as zoom capabilities are provided through both the menus and the toolbar buttons. Consult the on-line help or simply experiment to discover what these can do.