DYNAMIC RESERVOIR SIMULATION MODEL DYRESM v4

v4.0 User Guide

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Introduction

1.1 Introduction

1.1.1 The DYRESM model

DYRESM (**DY**namic **RES**ervoir **S**imulation **M**odel) is a one-dimensional hydrodynamics model for predicting the vertical distribution of temperature, salinity and density in lakes and reservoirs satisfying the one-dimensional approximation.

The one-dimensional approximation is valid when the forces acting to destabilize a water body (wind stress, surface cooling or plunging inflows) do not act over prolonged periods of time. The dynamics of many lakes and reservoirs, viewed over time scales longer than those of extreme events such as storms and floods, are well described using this approximation. DYRESM provides quantifiably verifiable predictions of the thermal characteristics in such systems over time scales ranging from several weeks to tens of years. The model thus provides a means of predicting seasonal and inter-annual variability of lakes and reservoirs as well as sensitivity testing to long-term changes in environmental factors or watershed properties. DYRESM can be run either in isolation for purely hydrodynamic studies or coupled to CAEDYM (**C**omputational **A**quatic **E**cosystem **DY**namics **M** odel) for investigations involving biological and/or chemical processes. The computational demands of DYRESM are quite modest and multi-year simulations can be carried out on PC platforms under Linux, Mac OS X, Windows 95/98/Me/2000/XP or NT.

The DYRESM computer model parameterizes the important physical processes leading to temporal changes in the temperature, salinity and density distributions in lakes and reservoirs. The model relies on parameterizations derived from detailed process studies (both from the field and in the laboratory) and thus draws on the internationally recognized strengths of the Centre for Water Research in analytical, laboratory and field measurement of density-stratified flows. The resulting model is unique in that reliable predictions are obtained without calibration of model parameters.

1.1.2 The program

Implementation Language:	Fortran 95
Current Development Platform:	Linux
Target Platforms:	Any that have a Fortran 95 compiler. Downloadable executables are available from this site for Linux and Windows machines.
Program Architecture:	DYRESM has a layered program architecture. The science routines are abstracted from the data structure details as much as is feasible.

An object-oriented (OO) approach was taken in the computational engine as this supports future program growth and naturally represents the abstraction hierarchy of the model. (Even though Fortran 95 is an object-based (rather than object-oriented) language, an OO design can still be implemented albeit with more effort.) Hence, the science core of DYRESM is OO. DYRESM in whole is of hybrid design.

Overview of File Preparation and Use

2.1 Overview of File Preparation and Use

2.1.1 Data input & output

For the creation of input to DYRESM a number of text files are required. The forcing and morphometry file information are placed into a *netCDF* file (called the Reference File or abbreviated to 'RefFile'), which will contain all the static and forcing data obtained from an external source, and covers all the possible days of the simulation. The Reference File (RefFile) and the remaining text files are translated into another *netCDF* file (called the Simulation File or 'SimFile') and configured under the control of the graphical user interface (Modeller). DYRESM takes input from the SimFile only. Output from DYRESM is written back to the SimFile. This data can be visualized after the simulation completes using *Modeller* or any other program that reads *netCDF* files. Packaging the input data and resulting output data in one file greatly assists long-term archiving of simulation runs and project management.

netCDF is an information rich, machine independent binary file format which is commonly used for the storage of field and simulation data in the oceanography and atmospheric science communities. Standardized file formats maximize the value of computational data files over time as information about the data and the data itself may be contained within the one file.

The data of the input text files described above are placed into the Ref and SimFiles via the programs *createDYref*, *createDYsim* and *extractDYinfo*. All the text files must have a file name with the format of <name>.<ext> The extension for each type of file is fixed. For details see the following chapter.

Figure 2.1 below illustrates the data preparation and simulation process.

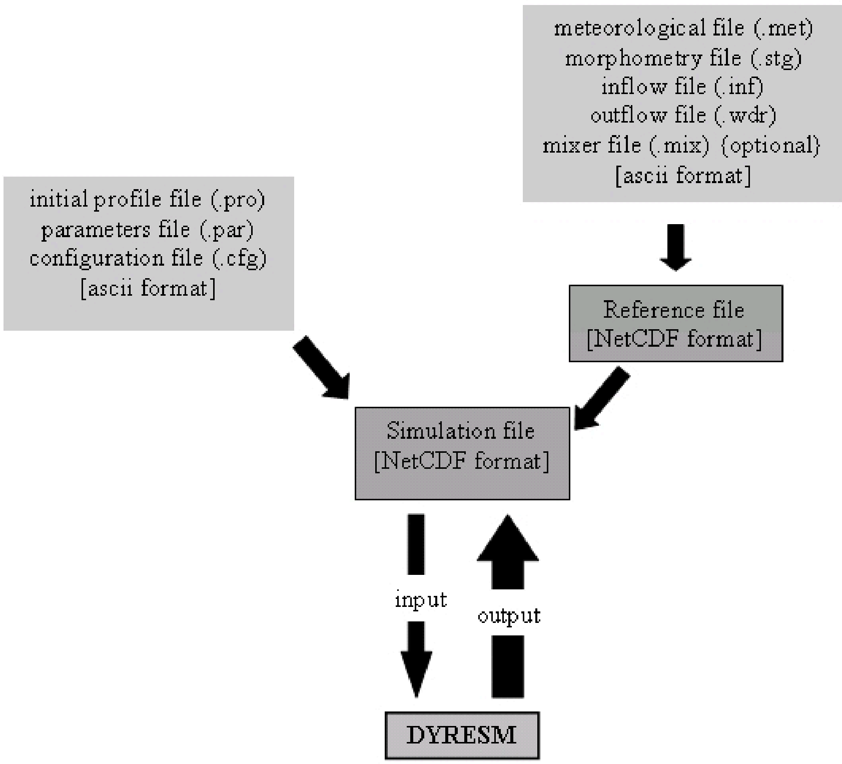

Figure 2.1 DYRESM simulation process

Input text files

3.1 Input text files

3.1.1 Introduction

This section describes the required format of the input text files. (See the appendices for example files.)

3.1.2 DYRESM configuration file (.cfg)

This text file contains configuration information for a particular simulation. This file must have the extension "cfg".

An example of DYRESM configuration file is shown in Appendix A.

The file has the following set up data:

- Simulation start day
- Number of days of simulation
- CAEDYM switch {.TRUE. or .FALSE.}
- Output interval in days (put -9999 to output every timestep)
- Light extinction coefficient [m-1]
- Minimum layer thickness [m]
- Maximum layer thickness [m]
- Time step [s]
- Number of output selections
- List of output selections
- Artificial mixing switch {.TRUE. or .FALSE.} and operation period indicator {**DAYTIME_OP**, **NIGHTTIME_OP** or **CONTINUOUS_OP**}
- Non-neutral atmospheric stability correction switch {.TRUE. or .FALSE.}

3.1.3 Physical data and lake morphometry file (.stg)

This text file contains a description of the morphometric characteristics of the water body. This file must have the extension "stg".

An example of lake morphometry file is shown in Appendix B

The file contains the following:

1. **Text Header**: this provides information on the file
2. **Latitude** : of the lake or reservoir. Positive values for Northern Hemisphere, negative values for Southern Hemisphere.
3. **Vertical distance**: of crest of the lake above Mean Sea Level (MSL) in metres (*i.e.*, height above MSL).
4. **Number of inflows**: the number of streams/rivers that are flowing into the water body. If you specify three inflows in the morphometry (.stg) file then you must have three inflows in your inflow (.inf) file.
5. **Inflow type** : this can be either **SURF** for a surface inflow (such as a river), or the **height** of a submerged inflow (groundwater or pipe) in metres above the base of the lake
6. **Streambed half angle**: for each inflow is given by the value of A, in degrees, as in figure 3.1.

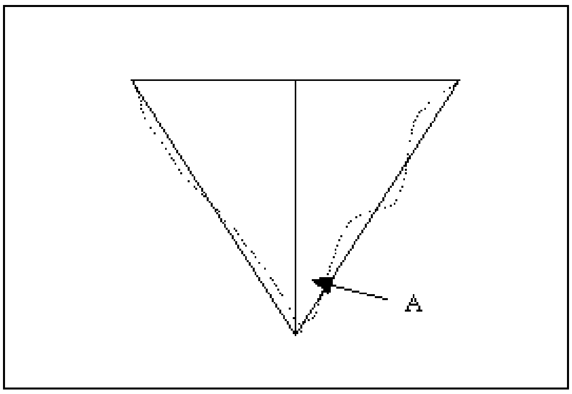

Figure 3.1 Streambed half-angle

7. **Streambed slope**: this is given by the value of B, in degrees, in figure 3.2, and represents the average stream gradient prior to entering the water body.
8. **Streambed drag coefficient**: typically assumes a value of CD = 0.015.
9. **Name of river**: the name of the river or stream must be included.

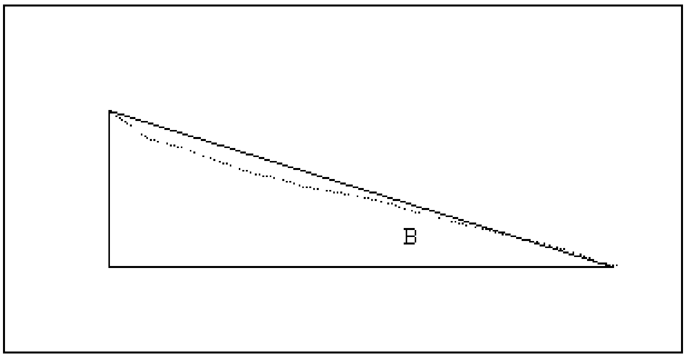

Figure 3.2 Streambed slope

10. **Zero height Elevation**: the elevation of the reservoir bottom above some arbitrary datum. The datum is irrelevant as long as consistency is maintained throughout the file. In Australia, a common datum that is used is the Australian Height Datum. The units are metres.

11. **Crest Elevation**: in the case of a dam this is the elevation of the level of the spillway above the reference datum. The datum used for this elevation must be consistent with the datum used for the zero height elevation. The units are metres.

12. **Number of outlets**: this is simply the number of outlets from the water body (excluding the overflow/spill). If you specify three outlets in this file then you must have three outlets in your withdrawal (.wdr) file.

13. **Outlet elevations**: the elevations of the individual outlets with respect to the datum.

14. **Lake morphometry**: this consists of a matrix of height-area values which describe the hypsographic curves of the water body. That is, a storage table of elevations (above the datum) versus (horizonatal) cross-sectional surface areas at those elevations. If these data are not available it may be estimated using a planimeter and a bathymetric map. The elevation for the bottom of the reservoir must be identical with that specified above for the zero elevation height of the water body. Storage table data will need to extend above the spillway (*i.e.*, crest) level if there are large inflows. The heights are in metres and the surface areas in square metres.

Figure 3.3 summarizes the morphometry-data reference and Table 3.1 summarizes the units adopted by the morphometry variables adopted in DYRESM. .

Table 3.1: Morphometry: Units

Attributes	**Units**
1/2-angle	degrees
slope	degrees

Table 3.1 – continued from previous page

Attributes	**Units**
drag coefficient	dimensionless
elevation	m
area	m^2

Notes:

"Elevation" refers to height above the datum, whereas "height" refers to height above the zero height elevation (the bottom of the water body). A diagrammatic representation of the specification required for the morphometry file is shown below.

DYRESM assumes A(z=0) = 0 and V(z=0) = 0. Hence, no height of 0 value should be present in the morphometry file.

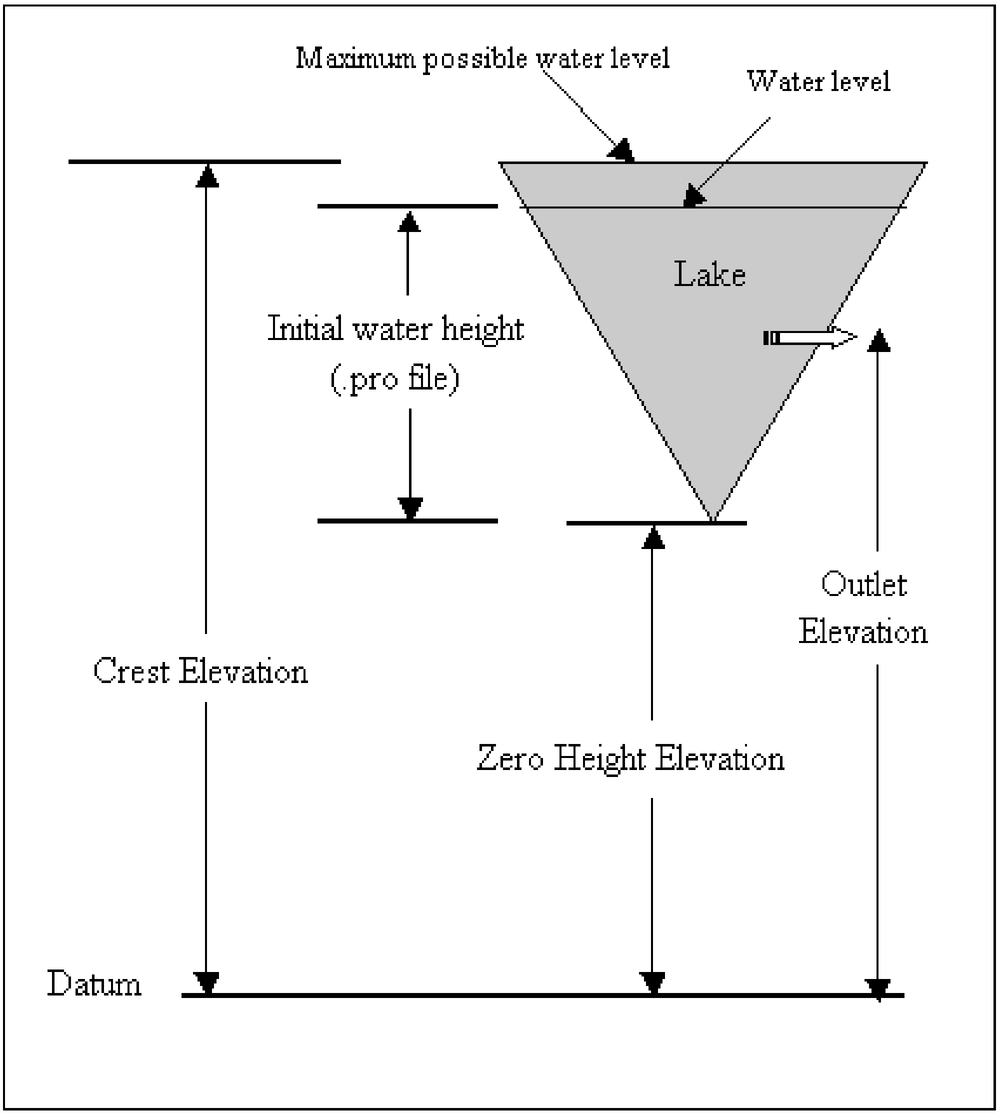

Figure 3.3 Morphometry data convention used in DYRESM

3.1.4 Initial Profile (.pro)

The first line of the file is a comment

The next three lines give the initial values of blue ice depth, white ice depth and snow depth.

Following this the text file contains the initial vertical profile, of the water temperature and salinity. The initial profile must be specified at the deepest point in the water body. The initial values for the simulation should be at the start of the first simulation day (*i.e.*, midnight).

The initial profile consists of a table where there are different columns for each state variable and different rows for the different heights in the reservoir. The height of each layer in the initial profile is specified by its height above the reservoir zero height elevation.

Note:

Water quality parameters are initialised via the *CAEDYM*.int file

The final height listed represents the initial height of the water surface.

3.1.5 Meteorological data (.met)

This text file contains meteorological data which at least covers the simulation period. The file can either contain daily average values or sub-daily average values. If sub-daily values are used the model uses sub-daily forcing for all meteorological variables. (Note then that the time step of the simulation is then constrained to be that of the meteorological data.)

An example of a daily meteorological data file is available on Appendix C.

An example of a sub-daily meteorological data file is available on Appendix D.

The header of the file must contain the timestep of the input data in units of seconds. When using the sub-daily meteorological forcing the input file timestep MUST MATCH the simulation timestep, entered via the configuration file or the GUI. Sub-daily meteorological forcing timesteps must be in the range [10, 180] minutes.

The meteorological file must contain (86400/timestep) data points per day. For example, if a 3-hour (10800 sec) timestep is used each day of the data file must have $86400/10800 = 8$ data points.

Also contained in the header of the file is a keyword describing the type of longwave radiation data provided

3.2:

Table 3.2: Long Wave Radiation Indicator Strings

STRING LITERAL	MEANING
INCIDENT_LW	long wave incident (*i.e.*, incoming) measured in W m^{-2}
NETT_LW	long wave nett (defined as Qin - Qout) measured in W m^{-2}
CLOUD_COVER	cloud cover fraction (valid range is [0,1])

The last line of the file header contains information as to whether the sensor is at a fixed height (**FIXED_HT** – with respect to the bottom of the water body) or floating on the water surface (**FLOATING** – *i.e.*, a constant fixed height above the water surface). For a fixed height sensor, the height of the sensor above the lake bottom (*i.e.*,, where z = 0) must be given. For a floating sensor, the height of the sensor above the water surface must be given. *Please note that this information is only used if the non-neutral atmospheric stability correction is invoked (see the configuration file).*

The file must have a "met" extension. The meteorological data include short wave and longwave radiation (or cloud cover), air temperature, vapour pressure, wind speed, rainfall, snowfall. The eight columns of the met file are:

1. **Ordinal Date**: Format is <year><calendar_day_number>, where <year> is the 4-digit year and <calendar_day_num> is the 3-digit number of the day in the year. For example, the calendar date *05 January 1987* is 1987005 written as an ordinal date.

2. **Short Wave Radiation**: the short wave radiation power flux density averaged over the input timestep, expressed in W m^{-2}.

3. **Long Wave Radiation**: the long wave radiation power flux density averaged over the input timestep, expressed either in W m^{-2} (if measured directly) or as a decimal fraction of cloud over (the fraction of the sky covered by cloud). If cloud cover is entered, the model estimates long wave radiation based on this and the water surface temperature calculated during the simulation.

4. **Air Temperature**: this is the average temperature over the input timestep in units of degrees Celcius.

For daily input data this value is often determined from an average based on the maximum and minimum daily air temperatures.

5. **Average Water Vapour Pressure**: this is the average over the input timestep expressed in hPa. This value can be approximated from average wet and dry bulb temperatures or average relative humidity and average air temperature.

Vapour Pressure Based on Wet and Dry Bulb Temperatures:

$$e_a = e'_{as} - 0.00066(1 + 0.00115q_W).P.(q_D - q_W)$$

(Eqn. C5 of (TVA,1972))

where

e_a = partial water vapour pressure of the air [hPa]
e'_{as} = saturation vapour pressure at wet bulb temperature [hPa]

e'_{as} is given by the *Magnus-Tetens* formula:

$$e'_{as} = exp[2.303((a.q_W/(q_W + b)) + c)]$$

(Eqn. C1 of (TVA,1972), but as modified by section 2 following it.)

where the coefficients for over-water calculations are

$a = 7.5$
$b = 237.3$
$c = 0.7858$

and

q_W = wet bulb air temperature [°C]

q_D = dry bulb air temperature [°C]

P = atmospheric pressure [hPa]

Vapour Pressure Based on Relative Humidity and Air Temperature:

$$e_a = (h/100)exp[2.303((a.q_D/(q_D + b)) + c)]$$

(Eqn. C2 of (TVA,1972))

where

e_a = vapour pressure [hPa]
h = relative humidity of air [%]
q_D = dry bulb air temperature [°C]
where the coefficients for over-water calculations are
$a = 7.5$
$b = 237.3$
$c = 0.7858$

6. **Average Wind Speed**: this is the average wind speed over the time step in m s-1. In the model wind data are assumed to be collected from the height of the wind speed sensor.

7. **Rainfall**: total rainfall measured over the timstep in **metres**.

8. **Snowfall**: total snowfall measured over the timstep in **metres**.

Table 3.3 summarizes the meteorological data input in DYRESM.

Table 3.3: Meteorological Data: Units

Attributes	**Units**
short wave	W m^{-2}
long wave	W m^{-2} if rad^{n} is given **or** dimensionless if cloud cover is given
air temp	°C
vapour pressure	hPa
wind speed	m s^{-1}
rainfall	m
snowfall	m

3.1.6 Stream Inflow (.inf)

This text file contains daily average inflow data (volume, temperature, salinity and, if required, WQ data) for the duration of the simulation.

An example of a stream inflow file is shown in Appendix E.

The file must have the extension "inf". This file contains daily flow volumes and physical (and, optionally, chemical and biological) characteristics of all of the inflows that are entering the water body. It contains the following information read from each record:

1. **Ordinal Date**: <*year*><*day_num*>. For example, 17 January 2007 is 2007017.
2. **Inflow Number**: this is a sequence number for each inflow and must be consistent with the information provided for the morphometry (.stg) file.
3. **Volume**: this is the inflow volume in cubic metres per day. If inflow volumes are not available it is possible to estimate the inflow by performing a volume balance on the water body, where

$$\mathbf{Inflow = \Delta storage + outflow + evaporation - rainfall/snowfall}$$

where

$$\mathbf{\Delta storage = storagefinal - storageinitial}$$

and outflow, evaporation and rainfall are all non-negative quantities.

Notes:

Evaporation is often determined as 0.7 * daily or long term average Pan measurements.

Where there is ungauged inflows, or where there is considerable overland flow, this inflow should be estimated and included as an additional "river" inflow stream.

4. **Temperature**: Inflow temperatures may be taken from continuous measurements, periodic measurements or estimated from average air temperatures. Linear interpolation is often used between periodically measured temperatures. If no inflow temperature measurements are available it may be possible to use an average air temperature for a period of about 4 days prior to the date of the inflow entering the water body as an estimate of the inflow temperature. Whenever possible, however, estimated water temperatures should be validated with actual measurements, particularly for large inflow

events.

5. **Salinity**: The salinity is expressed in the Practical Salinity Scale (PSS). In cases where reservoir density stratification is influenced solely by temperature, salinity is not considered important and is commonly entered in the inflow (*.inf) file and the initial profile (*.pro) file as a constant value.

Table 3.4 summarizes the inflow data input in DYRESM.

Table 3.4: Inflow Data: Units

Attributes	**Units**
daily volume	m^3
temperature	°C
salinity	Practical Salinity Scale
WQ parameters	as required by water quality module CAEDYM (refer to the CAEDYM documentation for this information)

The first 5 columns (*i.e.,* ordinal date to salinity, inclusive) are fixed in order and are **always** required. The water quality columns (if any) are identified by their header labels. These labels are exactly the same ones used by CAEDYM (*e.g.*, NO3) and are case-sensitive.

3.1.7 Withdrawals (.wdr)

subsec:wdl

This file contains daily values of withdrawal data covering at least the period of the simulation.

An example of a withdrawals file is shown in Appendix F.

The name given to the file must have the extension "wdr". The withdrawal file consists of a table of daily volumes of outflow from the lake or reservoir. Each row in the table contains withdrawal volumes for a particular day. Each column in the table represents a particular withdrwawal. The outflows must be in the order that they were specified in the morphometry (*.stg) input file. The outflows volumes are expressed in cubic metres per day.

Table 3.5 summarizes the inflow data input in DYRESM.

Table 3.5: Withdrawal: Units

Attributes	**Units**
daily withdrawal volume	m^3

Note:

the outflow names (*e.g.*, "Irrig_Canal") should only be composed of alpha-numeric characters and the underscore. There must not be any white space in the names.

3.1.8 Parameter file (.par)

The DYRESM parameter file contains 'parameters' of the simulation – or from a numerical modelling point of view 'pseudo-constants'. The lines of this file must ALL be present and be **in the specified order** (see the example file in Appendix G). The values in this file should only be changed by experienced users. (This file also contains the **time of day** of output of the model in seconds since midnight.)

An example of a parameters is shown in Appendix G

3.1.9 Artificial mixing file (.mix)

The DYRESM artificial mixing file specifies the operational set-up of an artificial destratification system, if there is one operating. Currently two destratification devices are possible: **DIFFUSER**, a bubble plume diffuser, and/or **IMPELLER**, a surface mounted mechanical mixer with a draft tube.

The file contains the following:

1. **Text Header**: this provides information on the file
2. **Number of Destratification Devices**: the number of destratification devices operating in the reservoir.

3. **Device Type, Draft Tube Length or Diffuser Height, Draft Tube Diameter or Number of Diffuser Ports.**

   All dimensions above are in metres, with height of the diffuser referring to distance of the bubbler tube above the base of the reservoir. (A height of 0 m indicates that it is lying on the bottom of the water body bed.)

4. **Volume Flow Rates**: indicates the volume flow rate of air (for bubblers) or water (for impellers) in $m^3\ s^{-1}$.

Note:

For bubble plume diffusers the volume flow rate is that at the ambient pressure at the level of the diffuser; *i.e.*, NOT AT THE FREE SURFACE. A free-air flow rate can be converted to a flow rate at the diffuser by assuming adiabatic compression of the air, via

$$Q_{diffuser} = Q_{air} * (P_{air}/P_{diffuser})\gamma$$

where Q_{air} is the free air flow rate of the compressor, P_{air} the atmospheric pressure, $P_{diffuser}$ the pressure at the level of the diffuser, and Qdiffuser is the volume flow rate at the level of the diffuser, which is the value to be entered into the .mix file. Gamma (γ) is the ratio of specific heat at constant volume to specific heat at constant pressure for an ideal diatomic gas (= 5/7).

An example of a artificial mixing file is shown in Appendix H.

3.1.10 Field data file (.fld)

The field data file is a text file containing measured field data. It is used **only** in the visualisation of field data results, and so is not necessary for running the model. It is important to compare field data with simulation results.

An example of field data file is shown in Appendix I.

The field data file contains a series of data blocks, one for each measurement period. Data are organised in vertical columns for measured variables. The fields required for each data block are as follows.

ORDINAL DATE	Number of depths		
ORDINALDATE_value	ndepths_value		
DEPTH	VARIABLE 1	VARIABLE 2	VARIABLE 3
$depth_1$	var_1_$value_1$	var_2_$value_1$	var_3_$value_1$
...	...	...	...
$depth_n$	var_1_$value_n$	var_2_$value_n$	var_3_$value_n$
EOF			

The field data file is not presently written to the SimFile, though this feature will be added in future releases.

Note:

The order of variables must not change from one measurement period to the next. This means that the all measured variables must be present in each data block. If no data is recorded, use a no data flag value such as -999.

Each data block must have the **same** number of columns, but the number of rows **can vary**, to allow for different depth resolutions to be included on different days

The file MUST end with the end-of-file keyword **EOF**.

Refs:

TVA - Tennessee Valley Authority, Division of Water Control Planning Engineering Laboratory 1972, *Heat and Mass Transfer Between a Water Surface and the Atmosphere*, Laboratory Report No. 14, Report No. 0-6803, Norris, Tennessee.

CHAPTER 4

Creating a DYRESM Reference and Simulation File

4.1 Creating a Reference and Simulation File

The graphical uiser interface ARMS lite can be used to configure and run DYRESM simulations. See the ARMS Lite User mamual for more information.

To create a Simulation File without using ARMS Lite, open a DOS command window or terminal and change to your data directory. Firstly, an unconfigured Simulation File needs to be created, then a configured Simulation File.

To create an unconfigured Simulation File, you need to enter the following command:

```
createDYsim npine.pro npine.par DYsim.nc
```

That is, the name of the executable program, the *.pro file, the *.par file, and the Simulation File name.

To create a configured Simulation File, you need to enter the following command:

```
extractDYinfo DYref.nc DYsim.nc npine.cfg
```

That is, the name of the executable program, the Reference file, the Simulation file, and the configuration file name.

Once the Simulation File is created, the next step involves running DYRESM.

CHAPTER 5

Running DYRESM

5.1 Running DYRESM

The graphical uiser interface ARMS lite can be used to configure and run DYRESM simulations. See the ARMS Lite User mamual for more information.

To run DYRESM from the command line Open a DOS window or terminal, and change directory (folder) to where the input SimFile, DYsim.nc, is stored. Type

```
dycd > dycd.log
```

This will start DYRESM-CAEDYM and redirect all output to the screen to a file called *dycd.log* (use whatever file name you wish but note the restriction in the following paragraph). This file captures output from the CWR Common Library and CAEDYM. Its purpose is to help with any debugging. A command line prompt will be returned when the simulation is complete.

Note that DYRESM, by construction, writes to a log file called *dy.log* so be careful **NOT** to redirect data to a file of this name. *dy.log* is the simulation log file and contains a record of the data structure set up and numerical simulation of the water body. User errors/problems can sometimes be determined by investigation of this file (which is produced whether or not the run finished 'successfully'.) Information at the head of this file contains configuration information for the code you are running, followed by data structure set up and data input and, finally, a brief report for each day of the simulation. The simulation log is simply a text file so any editor will be able to read it. (Note, however, that it may get large so your editor may not be able to read it for large simulation runs.) To go from day to day search for the string "START OF NEW DAY" in *dy.log*.

Configuration File

```
<#5>
Dyresm Configuration File for DYCD
V4.0.0
1999244                             # Simulation start day
300                                 # Simulation length (days)
.FALSE.                             # Run CAEDYM (.TRUE. or .FALSE.)
1                                   # Output Interval (in days, or -9999 for every time step)
0.85                                # Light extinction coefficient [m^1]
1.5                                 # Min layer thickness [m]
3.0                                 # Max layer thickness [m]
3600                                # Time Step [s]
3                                   # Number of Output Selections
TEMPTURE SALINITY DENSITY           # List of Output Selections
.TRUE. CONTINUOUS_OP                # Activate bubbler (.TRUE. or .FALSE.)
.TRUE.                              # Activate non-neutral atmos.  stability (.TRUE. or .FALSE.)
```

Storage File

```
<#3>
Comment line:  Reservoir morphometry
-35                                   # latitude
100                                   # height above MSL
1                                     # number of inflows
SURF 88.8 0.24 0.016 Stream1          # entry height, 1/2-angle, slope, drag coeff, name
0.0                                   # zero-ht elevation (i.e., bottom elev.)
33.1                                  # crest elevation [m]
1                                     # number of outlets
19.31                                 # outlet heights
11                                    # number of stg survey points after header line

Elev_[m]                SurfArea_[m^2]
3                       127200
6                       205100
9                       289900
12                      389300
15                      501000
18                      641600
21                      839300
24                      1108000
27                      1448000
30                      1932000
33.1                    3200000
```

Initial Profile File

```
CWR DYRESM-CAEDYM Initial profile
0.0 # Initial Blue Ice Depth
0.0 # Initial White Ice Depth
0.0 # Initial Snow Depth
11 # number of initial profile points
Height (m)       T (Cel)          S (pss)
 1.3             16.08            0.717
 5.3             16.432           0.712
 6.3             16.975           0.714
 7.3             17.81            0.717
 11.3            17.991           0.710
 21.3            17.991           0.709
 26.3            17.993           0.713
 31.3            17.993           0.711
 36.3            17.998           0.712
 38.3            18.000           0.713
 41.3            18.014           0.714
```

Meteorological Data File

```
<#3>
Comment line:  dy_basic test case - daily met forcing
86400 # met data input time step (seconds)
CLOUD_COVER # longwave radiation type (NETT_LW, INCIDENT_LW, CLOUD_COVER)
FIXED_HT 10 # sensor type (FLOATING; FIXED_HT), height in m (above water surface; above lake bottom)
```

JulDay	SW_[W/m2]	Cloud	Tair_[C]	Vap_Press_[hPa]	Wind_Spd_[m/s]	Rain_[m]	Snow_[m]
1990001	293.055	0.25	29.45	19.99	0.78	0	0
1990002	309.259	0.59	24.13	14.54	1	0	0
1990003	370.254	0.08	33.8	18.71	1.28	0	0
1990004	107.638	0.8	20.85	13.75	2.58	0	0
1990005	281.134	0.41	22.9	12.48	3.6	0	0
1990006	240.162	0.63	26.13	17.76	1.28	0.0003	0
1990007	178.935	0.75	24.98	21.29	2.55	0.0024	0
1990008	61.805	0.75	19.07	18.21	1.03	0.022	0
1990009	43.402	0.75	19.93	19.77	1.7	0.0094	0
1990010	120.023	0.78	20.03	18.45	1	0.0142	0
1990011	208.217	0.68	23.78	20.54	1.13	0.0012	0
1990012	335.995	0.41	25.47	20.23	1.53	0.0002	0
1990013	286.342	0.6	25.68	22.27	0.63	0	0
1990014	64.583	0.8	20.28	17.72	0.63	0.0056	0
1990015	85.069	0.75	19.13	18.22	1.03	0.0008	0
1990016	239.351	0.66	19.33	13.4	3.23	0.0006	0
1990017	278.703	0.4	21.3	12.72	1.4	0	0
1990018	275.578	0.53	24.48	17.06	0.78	0	0
1990019	302.893	0.35	26.13	17.76	0.5	0	0
1990020	244.097	0.5	27.48	19.88	0.5	0	0
1990021	136.689	0.8	21.08	16.42	0.65	0.0156	0
1990022	228.819	0.75	20.97	14.15	1.53	0.0008	0

Inflow File

```
CWR DYRESM-CAEDYM Inflow file
6 # number of inflow streams
Neger # stream 1
Yarmuch # stream 2
Jordan # stream 3
Ground_Water # stream 4
Misc # stream 5
Sald_Canal # stream 6
YrDayNum  InfNum VOL      TEMP  SALINITY NH4   NO3   TN    PO4   TP    DO    FBOD  SBOD  SSOL1 SSOL2 PH    DINOF CHLOR FDIAT
1997001   1   34732.8  15     0.33   0.01  2.45  1.07  0.02  0.05  10.04  1    1    3    57   8.2   0    0    0
1997001   2   142580   17.6   1.71   0.02  1.59  1.91  0.04  0.09  10.04  1    1    3    57   8.2   0    0    0
1997001   3   976320   15     0.33   0.02  1.59  1.91  0.04  0.09  10.04  1    1    3    57   8.2   0    0    0
1997001   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997001   5   12580    25     9.82   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997001   6   42500    25.4  19.64   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997002   1   34732.8  15     0.31   0.01  2.46  1.03  0.02  0.06  10.04  1    1    3    57   8.2   0    0    0
1997002   2   142580   17.6   1.64   0.03  1.73  1.94  0.05  0.11  10.04  1    1    3    57   8.2   0    0    0
1997002   3   924480   14.5   0.31   0.03  1.73  1.94  0.05  0.11  10.04  1    1    3    57   8.2   0    0    0
1997002   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997002   5   12580    25     9.82   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997002   6   42500    25.4  19.64   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997003   1   34732.8  15.0   0.31   0.01  2.31  1.08  0.02  0.04  10.04  1    1    3    57   8.2   0    0    0
1997003   2   142580   17.6   1.59   0.01  1.7   1.9   0.04  0.08  10.04  1    1    3    57   8.2   0    0    0
1997003   3   984960   14.5   0.31   0.01  1.7   1.9   0.04  0.08  10.04  1    1    3    57   8.2   0    0    0
1997003   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997003   5   12580    25     9.82   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997003   6   42500    25.4  19.64   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997004   1   34819.2  15.0   0.30   0.01  2.15  1.01  0.02  0.04  10.04  1    1    3    57   8.2   0    0    0
1997004   2   142580   17.6   1.57   0.02  1.64  1.89  0.03  0.08  10.04  1    1    3    57   8.2   0    0    0
1997004   3   924480   14     0.30   0.02  1.64  1.89  0.03  0.08  10.04  1    1    3    57   8.2   0    0    0
1997004   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997004   5   12580    25     9.82   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997004   6   42500    25.4  19.64   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997005   1   34862.4  15.0   0.31   0.01  2.13  0.97  0.02  0.04  10.04  1    1    3    57   8.2   0    0    0
1997005   2   142580   17.6   1.61   0.02  1.74  1.84  0.04  0.08  10.04  1    1    3    57   8.2   0    0    0
1997005   3   915840   13     0.31   0.02  1.74  1.84  0.04  0.08  10.04  1    1    3    57   8.2   0    0    0
1997005   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997005   5   12580    25     9.82   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997005   6   42500    25.4  19.64   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997006   1   34862.4  15.0   0.32   0.01  2.23  1.03  0.02  0.03  10.04  1    1    3    57   8.2   0    0    0
1997006   2   142580   17.6   1.69   0.03  1.79  1.97  0.04  0.07  10.04  1    1    3    57   8.2   0    0    0
1997006   3   907200   13.5   0.32   0.03  1.79  1.97  0.04  0.07  10.04  1    1    3    57   8.2   0    0    0
1997006   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997006   5   12580    25     9.82   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997006   6   42500    25.4  19.64   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997007   1   34862.4  15.0   0.33   0.02  2.08  1.00  0.02  0.04  10.04  1    1    3    57   8.2   0    0    0
1997007   2   142580   17.6   1.70   0.04  1.84  1.96  0.04  0.08  10.04  1    1    3    57   8.2   0    0    0
1997007   3   889920   13.5   0.33   0.04  1.84  1.96  0.04  0.08  10.04  1    1    3    57   8.2   0    0    0
1997007   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997007   5   12580    25     8.35   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997007   6   42500    25.4  16.70   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997008   1   34862.4  15.0   0.32   0.01  2.07  1.01  0.02  0.03  10.04  1    1    3    57   8.2   0    0    0
1997008   2   142580   17.6   1.672  0.03  1.77  1.94  0.04  0.06  10.04  1    1    3    57   8.2   0    0    0
1997008   3   907200   14     0.32   0.03  1.77  1.94  0.04  0.06  10.04  1    1    3    57   8.2   0    0    0
1997008   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997008   5   12580    25     8.35   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997008   6   42500    25.4  16.70   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997009   1   34862.4  15.0   0.31   0.00  2.12  0.98  0.02  0.05  10.04  1    1    3    57   8.2   0    0    0
1997009   2   142580   17.6   1.61   0.01  1.8   1.9   0.05  0.11  10.04  1    1    3    57   8.2   0    0    0
1997009   3   898560   14     0.31   0.01  1.8   1.9   0.05  0.11  10.04  1    1    3    57   8.2   0    0    0
1997009   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997009   5   12580    25     8.35   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997009   6   42500    25.4  16.70   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997010   1   34862.4  15.0   0.31   0.01  2     0.98  0.02  0.06  10.04  1    1    3    57   8.2   0    0    0
1997010   2   142580   17.6   1.63   0.02  1.69  1.87  0.04  0.11  10.04  1    1    3    57   8.2   0    0    0
1997010   3   907200   14     0.31   0.02  1.69  1.87  0.04  0.11  10.04  1    1    3    57   8.2   0    0    0
1997010   4   18710    35    12.36   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997010   5   12580    25     8.35   0     0     0     0     0     0      0    0    0    0    0     0    0    0
1997010   6   42500    25.4  16.70   0     0     0     0     0     0      0    0    0    0    0     0    0    0
```

Withdrawals File

```
Comment line:  Daily withdrawals [m^3/day]
3 # number of withdrawal outlets
YrDayNum     Drinking        Irrig_Canal        Hydro
1997001      806000          47741.9            10320
1997002      800000          47741.9            10320
1997003      800000          47741.9            10320
1997004      800000          47000.0            10320
1997005      800000          47000.0            10320
1997006      800000          47000.0            10320
1997007      800000          40500.0            10320
1997008      800000          40500.0            10320
1997009      800000          40500.0            10320
1997010      800000          40500.0            10320
```

Parameters File

```
<#7>
Dyresm Parameters File for DYCD V4.0.0
1.3E-3 # bulk aerodynamic mmt.  transport coeff.  (priv.  comm.  [Imberger, 1998])
0.08 # mean albedo of water
0.96 # emissivity of a water surface (Imberger & Patterson [1981,p316])
3.00 # critical wind speed [m s^-1]
54000 # time of day for output (secs from midnight) (54000 s = 15:00 HR)
0.012 # bubbler entrainment coefficient (priv.  comm.  [Alexander,2000])
0.083 # buoyant plume entrainment coefficient [Fischer et al.  1979]
0.06 # shear production efficiency (eta_K)
0.20 # potential energy mixing efficiency (eta_P)
0.4 # wind stirring efficiency (eta_S)
1.0E+7 # effective surf.  area coeff.  (priv.  com.  [Yeates,2002]
1.4E-5 # BBL detrainment diffusivity (priv.  com.  [Yeates,2002]
200 # vertical mix coeff.  (priv.  com.  [Yeates,2002]
==========================================================================================
```

Mixing File

```
<#2>
Comment line:  dy_destrat destratification system
3 # Number of destratification devices
IMPELLER 13 5 # length and diameter of draft tube
IMPELLER 13 5 # length and diameter of draft tube
DIFFUSER 0.0 160 # height and number of ports
YrDayNum     Drinking        Irrig_Canal        Hydro
1999244      3               3                  0
1999245      3               3                  0
1999246      3               3                  0
1999247      3               3                  0
1999248      3               3                  0
1999249      3               3                  0
1999250      3               3                  0
1999251      3               3                  0
1999252      3               3                  0
1999253      3               3                  0
1999254      3               3                  0
1999255      3               3                  0
1999256      3               3                  0
1999257      3               3                  0
1999258      0               0                  0
1999259      0               0                  0
1999260      0               0                  0
1999261      0               0                  0
1999262      0               0                  0
1999263      0               0                  0
1999264      0               0                  0
1999265      0               0                  0
1999266      0               0                  0
1999267      3               0                  0
1999268      3               0                  0
1999269      3               0                  0
1999270      3               0                  0
1999271      3               0                  0
1999272      3               0                  0.0468
1999273      3               0                  0.0468
1999274      3               0                  0.0468
1999275      3               0                  0.0468
1999276      3               0                  0.0468
1999277      3               0                  0.0468
1999278      3               0                  0.0468
```

Field Data File

Yr_Jul_day		layers												
1998126		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	17.2	8.5	8.44	0.036	0.103	0.064	1.320	1.490	9.9	7.0	10.7	-999.0	-999.0	-999
2.8	17.0	8.3	8.48	0.027	0.052	0.056	1.060	1.204	9.1	5.5	13.2	5.3	-999.0	-999
5.7	16.7	7.9	8.34	0.026	0.057	0.090	1.080	1.228	9.2	4.7	18.9	-999.0	-999.0	-999
Yr_Jul_day		layers												
1998140		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	19.4	7.5	7.88	0.029	0.068	0.092	1.000	1.236	10.6	3.4	9.4	-999.0	-999.0	0.18
2.8	18.1	7.4	7.86	0.033	0.144	0.090	1.020	1.098	11.4	3.4	10.9	6.6	-999.0	-999
5.7	17.9	6.3	7.68	0.019	0.088	0.132	1.040	1.524	12.4	2.7	16.1	-999.0	-999.0	0.27
Yr_Jul_day		layers												
1998154		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	23.2	8.9	7.97	0.041	0.062	0.098	0.720	1.524	11.3	10.1	13.4	-999.0	-999.0	-999
2.8	21.8	7.2	7.70	0.052	0.078	0.098	0.720	1.590	11.9	8.9	16.0	13.8	-999.0	-999
5.7	20.3	3.5	7.19	0.063	0.110	0.106	0.820	1.722	14.1	8.3	16.6	-999.0	-999.0	-999
Yr_Jul_day		layers												
1998168		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	24.8	6.9	7.60	0.076	0.099	0.112	0.700	1.188	11.5	5.4	16.7	-999.0	-999.0	0.05
2.8	22.9	5.3	7.26	0.056	0.084	0.166	0.760	1.130	11.0	5.6	15.7	6.4	-999.0	-999
5.7	22.2	3.7	6.98	0.067	0.083	0.244	0.860	1.072	12.1	5.3	16.5	-999.0	-999.0	0.06
Yr_Jul_day		layers												
1998185		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	28.7	7.3	6.90	0.060	0.053	0.100	0.120	0.274	10.5	0.4	6.2	-999.0	-999.0	-999
2.8	28.1	6.8	6.92	0.089	0.067	0.110	0.200	0.430	10.8	0.5	6.4	3.3	-999.0	-999
5.7	24.8	2.9	6.74	0.189	0.162	0.344	0.420	0.888	9.3	0.5	7.1	-999.0	-999.0	-999
Yr_Jul_day		layers												
1998200		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	25.7	8.9	8.22	0.101	0.388	0.218	0.380	0.826	15.8	3.1	52.7	6.7	3.7	0.12
2.8	25.6	8.5	8.18	0.084	0.442	0.148	0.500	1.268	14.5	2.9	52.9	11.7	4.7	-999
5.7	24.9	5.3	7.50	0.109	0.383	0.202	0.560	1.270	22.0	2.1	39.4	3.6	4.1	0.13
Yr_Jul_day		layers												
1998223		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	26.1	6.6	8.75	0.085	0.101	0.194	0.440	2.422	2.3	5.0	41.9	3.0	5.3	-999
2.8	26.0	6.0	8.72	0.092	0.102	0.224	0.500	2.240	5.4	3.9	49.7	4.7	5.8	-999
5.7	25.9	4.9	8.37	0.113	0.130	0.278	0.620	2.912	3.7	3.5	43.2	4.6	8.8	-999
Yr_Jul_day		layers												
1998236		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	26.2	9.1	8.18	0.095	0.117	0.390	0.320	1.792	14.8	2.9	17.5	-999.0	-999.0	0.06
2.8	25.7	7.7	7.94	0.112	0.130	0.365	0.100	1.598	13.6	2.7	21.8	-999.0	-999.0	-999
5.7	25.0	5.3	7.30	0.121	0.151	0.364	0.160	2.080	16.7	3.5	22.9	-999.0	-999.0	0.13
Yr_Jul_day		layers												
1998238		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	27.7	11.4	8.30	0.080	0.105	0.404	0.040	1.326	15.4	2.7	20.2	-999.0	-999.0	0.11
2.8	26.2	9.9	8.04	0.069	0.126	0.343	0.075	1.993	15.3	4.1	19.0	-999.0	-999.0	-999
5.7	24.6	4.4	7.59	0.112	0.118	0.360	0.133	1.747	14.1	3.0	15.2	-999.0	-999.0	0.42
Yr_Jul_day		layers												
1998244		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	24.7	6.8	7.77	0.130	0.159	0.438	0.160	1.882	14.3	3.9	19.9	5.2	6.5	-999
2.8	24.7	5.9	7.71	0.142	0.169	0.336	0.200	2.524	14.9	3.5	18.7	3.5	7.1	-999
5.7	25.4	5.1	6.84	0.106	0.146	0.348	0.240	1.952	14.6	2.9	20.3	6.4	6.0	-999
Yr_Jul_day		layers												
1998254		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	23.5	5.4	8.53	0.115	0.141	0.226	0.340	2.166	-999.0	3.9	-999.0	-999.0	-999.0	0.17
2.8	23.3	4.3	8.46	0.122	0.140	0.242	0.320	2.090	-999.0	3.3	-999.0	-999.0	-999.0	-999
5.7	23.2	3.8	8.01	0.102	0.136	0.410	0.420	1.742	-999.0	3.1	-999.0	-999.0	-999.0	0.25
Yr_Jul_day		layers												
1998276		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	19.8	6.5	8.34	0.088	0.166	0.224	0.620	8.096	-999.0	5.0	35.7	1.7	10.8	-999
2.8	19.7	6.3	8.24	0.083	0.147	0.226	0.600	7.116	-999.0	4.7	34.6	10.0	6.5	-999
5.7	19.7	5.2	8.02	0.073	0.140	0.354	0.760	7.430	-999.0	5.7	26.8	-999.0	50.9	-999
Yr_Jul_day		layers												
1998297		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	17.4	7.1	8.55	0.082	0.166	0.078	0.320	9.358	-999.0	4.6	56.1	4.1	18.2	0.19
2.8	17.4	6.6	8.49	0.101	0.228	0.088	0.420	9.462	-999.0	3.6	50.1	1.3	18.1	-999
5.7	17.3	5.0	8.18	0.100	0.235	0.148	0.540	9.456	-999.0	4.6	54.3	-999.0	46.7	0.22
Yr_Jul_day		layers												
1998325		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	11.2	7.5	8.25	0.047	0.138	0.178	0.220	7.852	14.3	3.3	18.4	3.8	9.8	0.09
2.8	11.1	7.4	8.25	0.045	0.076	0.166	0.160	7.674	14.6	2.8	33.6	15.4	16.3	-999
5.7	11.0	7.3	8.22	0.039	0.070	0.162	0.220	7.858	14.3	3.5	16.2	-999.0	12.5	0.14
Yr_Jul_day		layers												
1998339		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	9.8	7.0	7.98	0.037	0.085	0.208	0.280	2.576	5.6	1.7	9.3	3.9	7.9	-999
2.8	9.8	7.0	7.98	0.038	0.066	0.204	0.320	4.144	5.9	1.5	10.9	6.4	6.8	-999
5.7	9.8	6.9	7.97	0.038	0.072	0.208	0.300	3.914	7.6	2.1	-999.0	-999.0	51.0	-999
Yr_Jul_day		layers												
1998354		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	6.1	10.5	8.01	0.082	0.148	0.340	0.520	2.068	10.2	2.3	13.2	20.1	15.9	0.08
2.8	5.7	10.1	8.01	0.080	0.106	0.350	0.560	2.262	8.0	2.1	15.4	6.0	6.5	-999
5.7	5.6	10.1	8.00	0.084	0.175	0.426	0.660	2.628	7.7	2.2	20.3	-999.0	20.9	0.16
Yr_Jul_day		layers												
1999009		3												
DEPTH	WTR_TEMP	DO	PH	PO4	TP	NH4	NO3	TN	SiO2	FBOD	CHLA	SSOL1	SBOD	SIZE1
0.3	5.4	10.0	8.07	0.083	0.130	0.248	0.76	7.688	10.66	2.6	12.3	7.2	4.8	-999
2.8	5.4	10.0	8.07	0.072	0.117	0.334	0.700	7.114	9.7	2.3	6.4	3.5	2.9	-999
5.7	5.3	9.7	8.01	0.130	0.187	0.314	0.92	8.064	10.7	2.8	14.3	-999.0	14.3	-999
Yr_Jul_day		layers												
1999017		3												

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 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       6.9       11.9    8.30    0.072   0.104   0.526   0.44    8.472   15.08   3.8     -999.0  -999.0  -999.0  -999
 2.8       6.6       12.2    8.27    0.079   0.107   0.524   0.400   7.456   12.2    3.3     -999.0  -999.0  -999.0  -999
 5.7       6.2       11.3    8.21    0.068   0.094   0.530   0.36    6.416   9.2     4.1     -999.0  -999.0  -999.0  -999
 Yr_Jul_day           layers
 1999030             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       5.9       14.0    8.97    0.085   0.119   0.198   0.5     7.998   4.96    3.1     36.9    5.6     3.6     0.07
 2.8       5.7       13.8    8.98    0.079   0.107   0.190   0.440   7.340   4.7     3.1     32.5    1.22    2.0     -999
 5.7       5.6       13.4    8.90    0.124   0.159   0.282   0.52    7.522   5.1     3.6     -999.0  -999.0  25.4    0.19
 Yr_Jul_day           layers
 1999044             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       5.6       12.1    8.81    0.046   0.065   0.378   0.42    5.260   4.08    3.2     2.5     2.6     3.7     -999
 2.8       5.5       12.1    8.80    0.048   0.061   0.370   0.400   5.198   5.4     3.3     6.9     6.28    2.6     -999
 5.7       5.4       11.9    8.73    0.059   0.113   0.422   0.42    5.792   6.7     3.6     4.6     -999.0  13.8    -999
 Yr_Jul_day           layers
 1999045             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       5.7       12.2    8.67    0.038   0.059   0.316   0.14    5.672   4.32    3.0     14.0    -999.0  -999.0  -999
 2.8       5.5       12.1    8.64    0.042   0.063   0.384   0.180   5.564   5.0     3.2     11.1    -999.0  -999.0  -999
 5.7       5.3       11.8    8.59    0.047   0.065   0.362   0.16    5.594   5.4     3.5     11.7    -999.0  -999.0  -999
 Yr_Jul_day           layers
 1999058             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       7.3       9.4     8.24    0.028   0.043   0.302   0.18    5.430   2.58    3.1     19.1    1.4     1.8     0.15
 2.8       6.8       9.4     8.20    0.037   0.058   0.368   0.180   5.592   2.8     3.1     12.7    0.78    2.1     -999
 5.7       6.2       8.8     8.11    0.038   0.056   0.340   0.16    5.640   3.4     3.2     -999.0  -999.0  7.6     0.22
 Yr_Jul_day           layers
 1999072             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       11.5      9.8     8.26    0.048   0.057   0.208   1.16    6.112   2.76    2.7     21.2    1.8     2.2     -999
 2.8       10.9      9.7     8.10    0.044   0.052   0.258   1.120   5.990   3.4     2.8     24.1    2.28    1.7     -999
 5.7       9.3       8.1     7.96    0.062   0.079   0.234   1.16    6.062   2.9     2.68    -999.0  -999.0  6.4     -999
 Yr_Jul_day           layers
 1999086             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       12.0      9.5     8.26    0.055   0.070   0.242   0.82    5.464   3.32    3.7     23.4    1.4     1.5     0.06
 2.8       10.5      9.0     8.24    0.066   0.084   0.236   0.900   5.644   3.3     3.4     17.3    1.2     2.6     -999
 5.7       9.8       8.4     7.99    0.069   0.087   0.232   0.74    5.238   3.6     3.9     17.1    -999.0  8.7     0.04
 Yr_Jul_day           layers
 1999126             3
 DEPTH     WTR_TEMP  DO      PH      PO4     TP      NH4     NO3     TN      SiO2    FBOD    CHLA    SSOL1   SBOD    SIZE1
 0.3       17.2      8.5     8.44    0.036   0.103   0.064   1.320   1.490   9.9     7.0     10.7    -999.0  -999.0  -999.00
 2.8       17.0      8.3     8.48    0.027   0.052   0.056   1.060   1.204   9.1     5.5     13.2    5.3     -999.0  -999.00
 5.7       16.7      7.9     8.34    0.026   0.057   0.090   1.080   1.228   9.2     4.7     18.9    -999.0  -999.0  -999.00
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