USER'S MANUAL FOR THE ENVIRONMENTAL FLUID DYNAMICS COMPUTER CODE

by

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Preface

This document comprises Volume I of the first release of a user's manual for the Environmental Fluid Dynamic Code. Volume I, comprised of 12 chapters and two appendices discusses the general structure of the EFDC model, grid generation and preprocessing, construction of input files, and post processing of output files. Volume II of the manual contains Appendix C , which is devoted to a specific model application. There will be various versions of Volume II representing different model applications. It is anticipated that Volume I of the user's manual will be continually evolving and numerous application specific versions of Volume II will also be created. To assure that users have access to the most recent version of the EFDC source code, input file templates and the User's Manual, future versions of the manual will be posted as self-extracting Microsoft Word for Macintosh documents on the author's Internet FTP server. To obtain current releases, anonymous ftp to 139.70.10.75 and cd to pub/efdc. Three sub-directories (efdcman, efdccode, and efdcinp) will contain the user's manual, the EFDC FORTRAN source code, and input file templates. A fourth directory (efdcsample) will contain a complete sample problem. By early 1996, it is anticipated that the Microsoft Word version of the user's manual will be replaced by a Framemaker document for better cross platform access. The Framemaker version will be an interactive on-line document and require Frameview (available from Frame Technology) for accessing the document.

Acknowledgment

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Disclaimer

The EFDC model is capable of simulating a diverse range of environment flow and transport problems, often addressing critical questions related to both human health and safety and the health of natural ecosystems. However since the EFDC model is considered public domain and freely distributed, the author, the Virginia Institute of Marine Science, and the College of William and Mary disclaim any and all liability which may be incurred by the use of the EFDC code for engineering, environment assessment and management purposes.

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1. Introduction

The EFDC (Environmental Fluid Dynamics Code) model was developed at the Virginia Institute of Marine Science (Hamrick, 1992a). The model has been applied to Virginia's James and York River estuaries (Hamrick, 1992b, 1995a) and the entire Chesapeake Bay estuarine system (Hamrick, 1994a). It is currently being used for a wide range of environmental studies in the Chesapeake Bay system including: simulations of pollutant and pathogenic organism transport and fate from point and nonpoint sources (Hamrick, 1991, 1992c), simulation of power plant cooling water discharges (Kuo and Hamrick, 1995), simulation of oyster and crab larvae transport, and evaluation of dredging and dredge spoil disposal alternatives (Hamrick, 1992b, 1994b, 1995b). The EFDC model has been used for a study of high fresh water inflow events in the northern portion of the Indian River Lagoon, Florida, (Moustafa and Hamrick, 1994, Moustafa, *et. al.*, 1995) and a flow through high vegetation density-controlled wetland systems in the Florida Everglades (Hamrick and Moustafa, 1995a,b; Moustafa and Hamrick, 1995).

The physics of the EFDC model and many aspects of the computational scheme are equivalent to the widely used Blumberg-Mellor model (Blumberg & Mellor, 1987) and U. S. Army Corps of Engineers' Chesapeake Bay model (Johnson, *et al*, 1993). The EFDC model solves the three-dimensional, vertically hydrostatic, free surface, turbulent averaged equations of motions for a variable density fluid. The model uses a stretched or sigma vertical coordinate and Cartesian or curvilinear, orthogonal horizontal coordinates. Dynamically coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity and temperature are also solved. The two turbulence parameter transport equations implement the Mellor-Yamada level 2.5 turbulence closure scheme (Mellor & Yamada, 1982) as modified by Galperin *et al* (1988). An optional bottom boundary layer submodel allows for wave-current boundary layer interaction using an externally specified high frequency surface gravity wave field. The EFDC model also simultaneously solves an arbitrary number of Eulerian transport-transformation equations for dissolved and suspended materials. A complimentary Lagrangian particle transport-transformation scheme is also implemented in the model. The EFDC model also allows for drying and wetting in shallow areas by a mass conservative scheme. A number of alternatives are in place in the model to simulate general discharge control structures such as weirs, spillways and culverts. For nearshore surf zone simulation, the EFDC model can incorporate externally specified radiation stresses due to high frequency surface gravity waves. Externally specified wave dissipation due to wave breaking and bottom friction can also be incorporated in the turbulence closure model as source terms. For the simulation of flow in vegetated environments, the EFDC model incorporates both two and three-dimensional vegetation resistance formulations (Hamrick and Moustafa, 1995a). The model provides output formatted to yield transport fields for water quality models, including WASP5 (Ambrose, *et. al*., 1993) and CE-QUAL-IC (Cerco and Cole, 1993).

The numerical scheme employed in EFDC to solve the equations of motion uses second order accurate spatial finite difference on a staggered or C grid. The model's time integration employs a second order accurate three time level, finite difference scheme with an internal-external mode splitting procedure to separate the internal shear or baroclinic mode from the external free surface gravity wave or barotropic mode. The external mode solution is semi-implicit, and simultaneously computes the two-dimensional surface elevation field by a preconditioned conjugate gradient procedure. The external solution is completed by the calculation of the depth averaged barotropic velocities using the new surface elevation field. The model's semi-implicit external solution allows large time steps which are constrained only by the stability criteria of the explicit central difference or upwind advection scheme used for the nonlinear accelerations. Horizontal boundary conditions for the external mode solution include options for simultaneously specifying the surface elevation only, the characteristic of an incoming wave (Bennett & McIntosh, 1982), free radiation of an outgoing wave (Bennett, 1976; Blumberg & Kantha, 1985) or the normal volumetric flux on arbitrary portions of the boundary. The EFDC model's internal momentum equation solution, at the same time step as the external, is implicit with respect to vertical diffusion. The internal solution of the momentum equations is in terms of the vertical profile of shear stress and velocity shear, which results in the simplest and most accurate form of the baroclinic pressure gradients and eliminates the over determined character of alternate internal mode formulations. Time splitting inherent in the three time level scheme is controlled by periodic insertion of a second order accurate two time level trapezoidal step. The EFDC model is also readily configured as a two-dimensional model in either the horizontal or vertical planes.

The EFDC model implements a second order accurate in space and time, mass conservation fractional step solution scheme for the Eulerian transport equations at the same time step or twice the time step of the momentum equation solution (Smolarkiewicz and Margolin, 1993). The advective step of the transport solution uses either the central difference scheme used in the Blumberg-Mellor model or a hierarchy of positive definite upwind difference schemes. The highest accuracy upwind scheme, second order accurate in space and time, is based on a flux corrected transport version of Smolarkiewicz's multidimensional positive definite advection transport algorithm (Smolarkiewicz, 1984; Smolarkiewicz & Clark, 1986; Smolarkiewicz & Grabowski, 1990) which is monotone and minimizes numerical diffusion. The horizontal diffusion step, if required, is explicit in time, while the vertical diffusion step is implicit. Horizontal boundary conditions include time variable material inflow concentrations, upwinded outflow, and a damping relaxation specification of climatological boundary concentration. For the heat transport equation, the NOAA Geophysical Fluid Dynamics Laboratory's atmospheric heat exchange model (Rosati & Miyakoda, 1988) is implemented. The Lagrangian particle transport-transformation scheme implemented in the model utilizes an implicit trilinear interpolation scheme (Bennett & Clites, 1987). To interface the Eulerian and Lagrangian transport-transformation equation solutions with near field plume dilution models, internal time varying volumetric and mass sources may be arbitrarily distributed over the depth in a specified horizontal grid cell. The EFDC model can be used to drive a number of external water quality models using internal linkage processing procedures described in Hamrick (1994a).

The EFDC model is implemented in a generic form requiring no internal source code modifications for application to specific study sites. The model includes a preprocessor system which generates a Cartesian or curvilinear-orthogonal grid (Mobley and Stewart, 1980; Ryskin & Leal, 1983), and interpolates bathymetry and initial salinity and temperature input fields from observed data. The model's input system features an interactive user's manual with extensive on-line documentation of input variables, files and formats. A menu driven, windows based, implementation of the input system is under development. The model produces a variety of real time messages and outputs for diagnostic and monitoring purposes as well as a restart file. For postprocessing, the model has the capability for inplace harmonic and time series analysis at user specified locations. A number of options exist for saving time series and creating time sequenced files for horizontal and vertical sliced contour, color shaded and vector plots. The model also outputs a variety of array file formats for three-dimensional vector and scalar field visualization and animation using a number of public and inexpensive private domain data visualization packages (Rennie and Hamrick, 1992). The EFDC model is coded in standard FORTRAN 77, and is designed to economize mass storage by storing only active water cell variables in memory. Particular attention has also been given to minimizing logical operations with the code being 99.8 per cent vectorizable for floating point operations and benchmarked at a sustained performance of 380 MFLOPS on a single Cray Y-MP C90 processor. The EFDC model is currently operational on VAX-VMS systems, Sun, HP-Apollo, Silicon Graphics, Convex, and Cray UNIX systems, IBM PC compatible DOS systems (Lahey EM32 FORTRAN) and Macintosh 68K and Power PC systems (LSI and Absoft FORTRAN).

The theoretical and computational basis for the model is documented in Hamrick (1992a). Extensions to the model formulation for the simulation of vegetated wetlands are documented in Hamrick and Moustafa (1995a,b) and Hamrick and Moustafa and Hamrick (1995a). Model formulations for computation of Lagrangian particle trajectories and Lagrangian mean transport fields are described in Hamrick (1994a) and Hamrick and Yang (1995).

The general organization of this manual is as follows. Chapter 2 presents the general structure of the EFDC modeling system focusing on the structure of the EFDC code and the sequence of steps in setting up and executing the model and processing and interpreting the computational results. Chapters 3 through 10 essentially follow the sequence of steps in the application of the model to a specific environmental flow system. Chapter 3 describes the specification of the horizontal spatial configuration of the system being modeled using the GEFDC grid generating preprocessor code. Chapter 4 describes the configuration of the master input file efdc.inp which controls the overall execution of a model simulation. Chapter 5 documents additional input files necessary to specify the simulation. Guidelines for compiling and executing the model on UNIX workstations and super computers, IBM compatible PC systems and Macintosh systems are presented in Chapter 6. Chapter 7 describes options for diagnosing execution failures using EFDC's internal diagnostic options and a number of compiler option diagnostic tools. Chapter 8 describes time series output options and formats as well a number of generic and custom, application specific, time series analysis techniques. Two-dimensional horizontal and vertical plane graphics output and visualization options are presented in Chapter 9, while Chapter 10 presents similar material for three-dimensional graphics and visualization. Appendix A contain a list of the source code subroutines and their functions. Appendix B contains a number of example grids and input files for the *gefdc.f* grid generating preprocessor.

2. General Structure of the EFDC Modeling System

The primary component of the EFDC modeling system is the FORTRAN 77 source code *efdc.f* and two include files: *efdc.com*, which contains common block declarations and arrayed variable dimensions, and *efdc.par*, which contains a parameter statement specifying the dimensions of arrayed variables. The source code *efdc.f* and the common file, *efdc.com*, are universal for all model applications or configurations. The parameter file, *efdc.par*, is configured for a particular model application to minimize memory requirements during model execution. Details of configuring the parameter file, *efdc.par*, and compiling the source code *efdc.f* are presented in Chapter 6. The source code, *efdc.f*, is comprised of a main program and 110 subroutines. A list of the subroutines and a brief description of their functions is found in Appendix A.

Model configuration and environmental data for a particular application are provided in the following sequence of input files (in alphabetical order).

File Name	Type of Input Data
aser.inp	Atmospheric forcing time series file.
cell.inp	Horizontal cell type identifier file.
celllt.inp	Horizontal cell type identifier file for saving mean mass transport.
depth.inp	File specifying depth, bottom elevation, and bottom roughness for Cartesian grids only.
dser.inp	Dye concentration time series file.
dxdy.inp	File specifying horizontal grid spacing or metrics, depth, bottom elevation, bottom roughness and vegetation classes for either Cartesian or curvilinear-orthogonal horizontal grids.

dye.inp File with initial dye distribution for cold start simulations.

efdc.inp Master input file.

fldang.inp File specifying the CCW angle to the flood axis of the local M2 tidal ellipses.

gcellmap.inp File specifying a Cartesian grid overlay for a curvilinear-orthogonal grid.

gwater.inp File specifying the characteristic of a simple soil moisture model.

lxly.inp File specifying horizontal cell center coordinates and cell orientations for either Cartesian or curvilinear-orthogonal grids.

mappgns.inp Specifies configuration of the model grid to represent a periodic region in the north-south or computational y direction.

mask.inp File specifying thin barriers to block flow across specified cell faces.

modchan.inp Subgrid scale channel model specification file.

moddxdy.inp File specifying modification to cell sizes. (used primarily for calibration adjustment of subgrid scale channel widths)

pser.inp Open boundary water surface elevation time series file.

qctl.inp Hydraulic control structure characterization file.

qser.inp Volumetric source-sink time series file.

restart.inp File for restarting a simulation.

restran.inp File with arbitrary time interval averaged transport fields used to drive mass transport only simulations.

salt.inp File with initial salinity distribution for cold start, salinity stratified flow

	simulations.
sdser.inp	Suspended sediment concentration time series file.
show.inp	File controlling screen print of conditions in a specified cell during simulation runs.
sser.inp	Salinity time series file.
sfser.inp	Shellfish release time series file.
sfbser.inp	Shellfish behavior time series file.
tser.inp	Temperature time series file.
vege.inp	Vegetation resistance characterization file.
wave.inp	Specifies a high frequency surface gravity wave field require to activate the wave-current boundary layer model and/or wave induced current model.

Table 1. Input files for the efdc.f code.

The above listed input files can be classified in four groups as follows.

1. Horizontal grid specification files:

cell.inp	celllt.inp
depth.inp	dxdy.inp
gcellmap.inp	lxly.inp
mappgns.inp	mask.inp

2. General data and run control files:

efdc.inp	show.inp

3. Initialization and restart files:

salt.inp	dye.inp
restart.inp	restran.inp

4. Physical process specification files:

gwater.inp	modchan.inp
moddxdy.inp	qctl.inp
vege.inp	wave.inp

5. Time series forcing and boundary condition files:

aser.inp	dser.inp
pser.inp	qser.inp
sdser.inp	sfser.inp
sfbser.inp	sser.inp
sser.inp	

Table 2. Input files grouped by function.

The recommended sequence for the construction of the input files for configuration of the model and set up for a simulation generally corresponds to the above file group classes. The files, *dxdy.inp* and *lxly.inp*, which specify the model grid geometry and topography or bathymetry, and the file, *gcellmap.inp,* which specifies an optional graphics overlay grid, can be automatically generated by an auxiliary grid generating preprocessor code GEFDC (FORTRAN 77 source file *gefdc.f*). The use of GEFDC is discussed in Chapter 3. The master input file, *efdc.inp*, is discussed in detail in Chapter 4, while the structure of the remaining input files are described in Chapter 5.

The EFDC modeling system produces five classes of output: 1) diagnostic output files; 2) restart and transport field files; 3) time series, point samples and least squares harmonic analysis output files; 4) two-dimensional graphics and visualization files; and 5) three-dimensional graphics and visualization files. The activation and control of these output classes is specified in the master input file *efdc.inp*, as will be discussed in Chapter 4. Guidance for activating and analyzing diagnostic output options is discussed in Chapter 7, while Chapters 8, 9, and 10 describe the formats and processing procedures for time series, two-dimensional and three-dimensional model outputs.

3. Grid Generation and PreProcessing

The first step in the setup or configuration of the EFDC modeling system is defining the horizontal plane domain of the region being modeled. The horizontal plane domain is approximated by a set of discrete quadrilateral and optional triangular cells. The terminology grid or grid lines refers to the lines defining the faces of the quadrilateral cells. (Triangular cells are defined by one of four possible regions resulting from diagonal division of a quadrilateral cell.) Since the EFDC model solves the hydrodynamic equations in a horizontal coordinate system that is curvilinear and orthogonal, the grid lines also correspond to lines having a constant value of one of the horizontal coordinates. In the following discussions, x and y, as well as I and J will be used to identify the two horizontal coordinate directions in the so-called computation domain. The terminology east and north, when associated with the curvilinear x and y coordinates respectively, will also be used to specify relative locations. The terminology true east and true north will be associated with a set of horizontal map coordinates, x* and y*, respectively, which may represent longitude-latitude, east and north state plane (SP) or universal transverse mercator (UTM) coordinates, or any local set of map coordinates defined by the user. Since the *efdc.f* code uses the MKS (meters, kilograms and seconds unit system internally), the writer tends to favor the use of localized UTM coordinates (true zonal UTM coordinates localized to an origin southwest of the region to be modeled).

The horizontal grid of cells is defined by a cell type array which is specified by the file *cell.inp*. To illustrate the definition of the horizontal model domain and the form of the *cell.inp* file, consider a simple circular basin with an entrance channel to the East, as shown in Figure 1. The region is coarsely approximated by 18 square cells and 4 right triangular cells as shown in Figure 1. The *cell.inp* file corresponding to the 22 water cell grid is shown in Figure 2. The *cell.inp* file has four header lines, followed by an image of the cell type array, IJCT(I,J), where I and J are the cell indexes in the computational or curvilinear x and y directions respectively. In the lines following the header lines, the first three columns (I3 format) specify the value of J decreasing from a maximum of 6 to 1, followed by two blank spaces (2X format). The remaining columns across the row specify the cell type identification number entered in the array, IJCT(I,J) for I increasing from 1 to 9. Seven identification numbers are used to define the cell type. They are as follows:

0	dry land cell not bordering a water cell on a side or corner.
1	triangular water cell with land to the northeast
2	triangular water cell with land to the southeast
3	triangular water cell with land to the southwest
4	triangular water cell with land to the northwest
5	quadrilateral water cell
9	dry land cell bordering a water cell on a side or corner or a fictitious dry land cell bordering an open boundary water cell on a side or a corner.

Table 3. Definition of cell types in the *cell.inp* file.

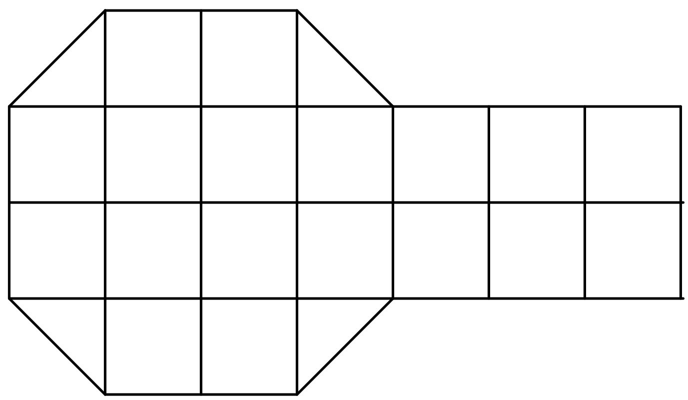

Figure 1. Representation of a circular basin and entrance channel by a 22 water cell grid.

```
C cell.inp file, i columns and j rows, for Figure 1
C    0        1
C    1234567890
C
  6  999999000
  5  945519999
  4  955555559
  3  955555559
  2  935529999
  1  999999000
C
C    1234567890
```

```
C    0        1
```

Figure 2. File *cell.inp* corresponding to the grid shown in Figure 1.

```
C celllt.inp file, i columns and j rows, for Figure 1
C    0        1
C    1234567890
C
  6  999999000
  5  945519900
  4  955555900
  3  955555900
  2  935529900
  1  999999000
C
C    1234567890
C    0        1
```

Figure 3. File *celllt.inp* corresponding to the *cell.inp* file shown in Figure 1, with four entry channel cells removed.

The type 9 dry land or fictitious dry land cell type is used in the specification of no flow boundary conditions and in graphics masking operations. For purposes of assigning adjacent type 9 cells, triangular water cells are treated identically to quadrilateral water cells. The file *celllt.inp* may be identical to the file *cell.inp* or specify a subset of the water cells in the *cell.inp* file. In specifying the subset, the following rules apply. Type 0 cells remain unchanged, type 9 cells may be changed only to type 0, and type 1-5 cells may be changed only to types 0 or 9. Figure 3 illustrates a *celllt.inp* file corresponding to the *cell.inp* file in Figure 2 with four of the entry channel cells removed.

To specify the horizontal geometric and topographic properties and other related characteristics of the region, the files *dxdy.inp* and *lxly.inp* are preferably used. (An older model option used the *depth.inp* file for this purpose. However this is not recommended). For this simple grid, these files, shown in Figure 4 and 5, can be readily constructed by hand. Both files, which are read into the model execution in free format, begin with four header lines defining the columns. The file *dxdy.inp* provides the physical *x* and *y* dimensions of a cell, *dx* and *dy*, the initial water depth, the bottom elevation, and the roughness height (log law z_o). These quantities should generally be specified in meters, although units conversion options can be specified in the master input file, *efdc.inp*. The last column contains an integer vegetation type class identifier. This column is read only when the vegetation resistance option is activated in the master input file *efdc.inp*. The file *lxly.inp* provides cell center coordinates and the components of a rotation matrix. The cell center coordinates are used only in graphics output and can be specified in the most convenient units for graphical display such as decimal degrees, feet, miles, meters or kilometers. The rotation matrix is used to convert pseudo east and north (curvilinear x and y) horizontal velocities to true east and north for graphics vector plotting, according to:

$$\begin{Bmatrix} u_{te} \\ v_{tn} \end{Bmatrix} = \begin{bmatrix} C_{cue} & C_{cve} \\ C_{cun} & C_{cvn} \end{bmatrix} \begin{Bmatrix} u_{co} \\ v_{co} \end{Bmatrix} \quad (1)$$

where the subscripts *te* and *tn* denote true east and true north, while the subscripts *co* denote the curvilinear-orthogonal horizontal velocity components. The inverse of the rotation matrix is used to compute horizontal curvilinear components of the surface wind stress from true east and north components, according to:

$$\begin{Bmatrix} \tau_{sx,co} \\ \tau_{sy,co} \end{Bmatrix} = \begin{bmatrix} C_{cue} & C_{cve} \\ C_{cun} & C_{cvn} \end{bmatrix}^{-1} \begin{Bmatrix} \tau_{sx,te} \\ \tau_{sy,tn} \end{Bmatrix} \quad (2)$$

For the example shown in Figure 4, the horizontal grid is Cartesian and aligns with true east and north.

```
C dxdy.inp file, in free format across columns
C
C   I   J   DX      DY      DEPTH   BOTTOM ELEV  ZROUGH   VEG TYPE
```

```
C
    2   2   100.0   100.0   5.0     -5.0         0.02     0
    3   2   100.0   100.0   5.0     -5.0         0.02     0
    4   2   100.0   100.0   5.0     -5.0         0.02     0
    5   2   100.0   100.0   5.0     -5.0         0.02     0
    6   2   100.0   100.0   5.0     -5.0         0.02     0
    7   2   100.0   100.0   5.0     -5.0         0.02     0
    8   2   100.0   100.0   5.0     -5.0         0.02     0
    2   3   100.0   100.0   5.0     -5.0         0.02     0
    3   3   100.0   100.0   5.0     -5.0         0.02     0
    4   3   100.0   100.0   5.0     -5.0         0.02     0
    5   3   100.0   100.0   5.0     -5.0         0.02     0
    6   3   100.0   100.0   5.0     -5.0         0.02     0
    7   3   100.0   100.0   5.0     -5.0         0.02     0
    8   3   100.0   100.0   5.0     -5.0         0.02     0
    2   4   100.0   100.0   5.0     -5.0         0.02     0
    3   4   100.0   100.0   5.0     -5.0         0.02     0
    4   4   100.0   100.0   5.0     -5.0         0.02     0
    5   4   100.0   100.0   5.0     -5.0         0.02     0
    6   4   100.0   100.0   5.0     -5.0         0.02     0
    7   4   100.0   100.0   5.0     -5.0         0.02     0
    8   4   100.0   100.0   5.0     -5.0         0.02     0
    2   5   100.0   100.0   5.0     -5.0         0.02     0
    3   5   100.0   100.0   5.0     -5.0         0.02     0
    4   5   100.0   100.0   5.0     -5.0         0.02     0
    5   5   100.0   100.0   5.0     -5.0         0.02     0
    6   5   100.0   100.0   5.0     -5.0         0.02     0
    7   5   100.0   100.0   5.0     -5.0         0.02     0
    8   5   100.0   100.0   5.0     -5.0         0.02     0
C
C   I            ARRAY INDEX IN X DIRECTION
C   J            ARRAY INDEX IN Y DIRECTION
C   DX           CELL DIMENSION IN X DIRECTION, METERS
C   DY           CELL DIMENSION IN Y DIRECTION, METERS
C   DEPTH        INITIAL WATER DEPTH, METERS
C   BOTTOM ELEV  BOTTOM BED ELEVATION, METERS
C   ZROUGH       LOG LAW ROUGHNESS HEIGHT, ZO, METERS
C   VEG TYPE     VEGETATION TYPE CLASS, INTEGER VALUE
C
```

Figure 4. File *dxdy.inp* for grid shown in Figure 1.

```
C lxly.inp file, in free format across columns
C
C   I   J   XLNUTME   YLTUTMN   CCUE   CCVE   CCUN   CCVN
C
    2   2   250.0     250.0     1.0    0.0    0.0    1.0
    3   2   350.0     250.0     1.0    0.0    0.0    1.0
    4   2   450.0     250.0     1.0    0.0    0.0    1.0
    5   2   550.0     250.0     1.0    0.0    0.0    1.0
```

```
    6   2   650.0     250.0     1.0    0.0    0.0    1.0
    7   2   750.0     250.0     1.0    0.0    0.0    1.0
    8   2   850.0     250.0     1.0    0.0    0.0    1.0
    2   3   250.0     350.0     1.0    0.0    0.0    1.0
    3   3   350.0     350.0     1.0    0.0    0.0    1.0
    4   3   450.0     350.0     1.0    0.0    0.0    1.0
    5   3   550.0     350.0     1.0    0.0    0.0    1.0
    6   3   650.0     350.0     1.0    0.0    0.0    1.0
    7   3   750.0     350.0     1.0    0.0    0.0    1.0
    8   3   850.0     350.0     1.0    0.0    0.0    1.0
    2   4   250.0     450.0     1.0    0.0    0.0    1.0
    3   4   350.0     450.0     1.0    0.0    0.0    1.0
    4   4   450.0     450.0     1.0    0.0    0.0    1.0
    5   4   550.0     450.0     1.0    0.0    0.0    1.0
    6   4   650.0     450.0     1.0    0.0    0.0    1.0
    7   4   750.0     450.0     1.0    0.0    0.0    1.0
    8   4   850.0     450.0     1.0    0.0    0.0    1.0
    2   5   250.0     550.0     1.0    0.0    0.0    1.0
    3   5   350.0     550.0     1.0    0.0    0.0    1.0
    4   5   450.0     550.0     1.0    0.0    0.0    1.0
    5   5   550.0     550.0     1.0    0.0    0.0    1.0
    6   5   650.0     550.0     1.0    0.0    0.0    1.0
    7   5   750.0     550.0     1.0    0.0    0.0    1.0
    8   5   850.0     550.0     1.0    0.0    0.0    1.0
C
C
C   I            ARRAY INDEX IN X DIRECTION
C   J            ARRAY INDEX IN Y DIRECTION
C   XLNUTME      X CELL CENTER COORDINATE, LONGITUDE, METERS, OR KM
C   YLTUTMN      Y CELL CENTER COORDINATE, LONGITUDE, METERS, OR KM
C   CCUE         ROTATION MATRIX COMPONENT
C   CCVE         ROTATION MATRIX COMPONENT
C   CCUN         ROTATION MATRIX COMPONENT
C   CCVN         ROTATION MATRIX COMPONENT
C
```

Figure 5. File *lxly.inp* for grid shown in Figure 1.

For realistic model applications, the grid generating preprocessor code, *gefdc.f*, is used to generate the horizontal grid and form the *dxdy.inp* and *lxly.inp* files. The *gefdc.f* code requires the following input files:

cell.inp — Cell type file as in Figure 2.

depdat.inp — File specifying depth or bottom topography (optional if depth interpolation is not specified).

gcell.inp	Optional auxiliary file with *cell.inp* format which specifies an auxiliary square Cartesian grid for rectangular array graphics when the actual computational grid is curvilinear.
gridext.inp	File of water cell corner coordinates for used with NTYPE = 0 grid generation option.
gefdc.inp	Master input file for *gefdc.f.*
vege.inp	File specifying vegetation type classes.
zrough.inp	File specifying bottom roughness (log law z_o).

Table 4. Input files for the *gefdc.f* grid generating preprocessor.

The format of the *cell.inp* file has already been discussed. The *depdat.inp* file is a three column ASCII text file with no header, as shown in Figure 6. The first two columns are true east and true north coordinates, in meters or kilometers, with the depth or bottom elevation given in the third column. The origin of the true east and north coordinates is arbitrary, but should generally be related to an accepted geographic coordinate system such as longitude-latitude, state plane, or universal transverse mercator. The optional file *gcell.inp* has the same format as the cell.inp file, but specifies an auxiliary, square cell, Cartesian grid corresponding to the curvilinear grid specified by the *cell.inp* file. When the option to process the *gcell.inp* file is activated in the *gefdc.inp* file, a correspondence table between the curvilinear grid and the auxiliary, square cell, Cartesian grid is generated. The correspondence table, output as file *gcellmap.inp*, is used by the *efdc.f* code to generated two and three-dimensional rectangular arrays of graphics visualization, as will be subsequently discussed. The file *gridext.inp* is used for generation of a grid constructed external to the *gefdc.f* code. This file is a four column free format ASCII text file with no header. The four columns correspond to the I indices, J indices, true east coordinates, and true north coordinates of the water cell corners. The lower left (pseudo southwest relative to the cell center) cell corners carry the same I and J indices as the cell. The *gridext.inp* file corresponding to the simple grid in Figure 1 is shown in Figure 7. Triangular cells must be specified as equivalent quadrilaterals in the *gridext.inp* file. The files *vege.inp* and *zrough.inp* have the same format as the *depdat.inp* file, with the exception that the third column of the *vege.inp* file has an integer value corresponding to a vegetation class. The third column of the *zrough.inp* file has values of the log law bottom roughness height, z_o, (preferably in meters, however unit conversion may be specified in the master input file *efdc.f*).

4.2798	6.9175	3.2309
4.2785	6.9175	3.2309
4.4509	6.7880	3.1090
4.4409	6.7927	3.1090
4.4222	6.7995	3.1090
4.4133	6.8028	3.1090

Figure 6. Format of the file *depdat.inp*.

2	2	200.	200.
3	2	300.	200.
4	2	400.	200.
5	2	500.	200.
6	2	600.	200.
2	3	200.	300.
3	3	300.	300.
4	3	400.	300.
5	3	500.	300.
6	3	600.	300.
7	3	700.	300.
8	3	800.	300.
9	3	900.	300.
2	4	200.	400.
3	4	300.	400.
4	4	400.	400.
5	4	500.	400.
6	4	600.	400.
7	4	700.	400.
8	4	800.	400.
9	4	900.	400.
2	5	200.	500.
3	5	300.	500.

```
          4    5      400.      500.
          5    5      500.      500.
          6    5      600.      500.
          7    5      700.      500.
          8    5      800.      500.
          9    5      900.      500.
          2    6      200.      600.
          3    6      300.      600.
          4    6      400.      600.
          5    6      500.      600.
          6    6      600.      600.
```

Figure 7. File *gridext.inp* for grid shown in Figure 1.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
    'gefdc.inp corresponding to example in figure 1'
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     9     1     6     9    6
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     0    0    0.    0.    1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
      0.      0.      0.      0.      0.      0.
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
     100    100    100    100    4000   1.0
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1.      1.      15.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFID INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFID INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
```

```
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    0      0       2.  .5    2        4.0     0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
    1   1   0.          0.
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure 8. Example of the *gefdc.inp*, master input file for the *gefdc.f* code.

The execution of the *gefdc.f* code is controlled by its master input file, *gefdc.inp*. An example of the *gefdc.inp* file for the grid in Figure 1 is shown in Figure 8. The file is essentially a sequence of 'card images' or input lines. Each input line is preceded by card number lines beginning with 'C' followed by a number corresponding the card image or data input line and text defining the data type and the actual data parameters. To fully discuss the options in the execution of the *gefdc.f* code, it is useful to consider each 'card image' or input line sequence. The following discussion will sequentially present the header and data lines in Monaco text with definitions of data parameters following in Monaco text. Additional discussion then follows in plain text. In the discussions, reference will be made to six grid generation examples in Appendix B, which illustrate specific options as well as showing the resulting grid.

Card Image 1

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
    'ENR GRID'
```

The 80 character title simply serves to identify the particular application.

Card Image 2

```
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     50    1     55    50   55
```

Card Image 2 Parameter Definitions

```
     NTYPE = PROBLEM TYPE
             0, READ IN FILE 'cell.inp' AND WATER GRID CELL CORNER
                COORDINATES FROM FILE 'gridext.inp' TO GENERATE
                INPUT FILES FOR AN EXTERNALLY GENERATED
                ORTHOGONAL GRID
             1-
              5 GENERATE AN ORTHOGONAL GRID AND INPUT FILES
                USING THE METHOD OF RYSKIN AND LEAL,
                J. OF COMP. PHYS. V50, 71-100 (1983)
                WITH SYMMETRIC REFLECTIONS AS SUGGESTED BY
                CHIKHLIWALA AND YORTSOS,
                J. OF COMP. PHYS. V57, 391-402 (1985).
             1, RL-CY EAST REFLECTION
             2, RL-CY NORTH REFLECTION
             3, RL-CY WEST REFLECTION
             4, RL-CY SOUTH REFLECTION
             5, RL NO REFLECTION
             6, GENERATE GRID AND INPUT FILES USING
                THE AREA-ORTHOGONALITY METHOD OF KNUPP,
                J. OF COMP PHYS. V100, 409-418 (1993)
                ORTHOGONALITY IS NOT GUARANTEED
             7, GENERATE GRID ORTHOGONAL GRID
                AND INPUT FILES USING THE QUASI-CONFORMAL
                METHOD OF MOBLEY AND STEWART,
                J. OF COMP PHYS. V24, 124-135 (1980)
                REQUIRES USER SUPPLIED FUNCTION SUBROUTINES
                FIB,FIE,GJB,GJE
             8, DEPTH INTERPOLATION TO CARTESIAN GRID SPECIFIED
                BY cell.inp AND GENERATE dxdy.inp AND lxly.inp
                FILES
             9, DEPTH INTERPOLATION TO CARTESIAN GRID AS FOR 8
                CONVERTING INPUT COORDINATE SYSTEM FROM
                LONG,LAT TO UTMBAY (VIMS PHYS OCEAN CHES BAY REF)
     NBPP = NUMBER OF INPUT BOUNDARY POINTS (NTYPE = 1-6)
     IMIN,IMAX = RANGE OF I GRID INDICES
     JMIN,JMAX = RANGE OF J GRID INDICES
     IC = NUMBER OF CELLS IN I DIRECTION
     JC = NUMBER OF CELLS IN J DIRECTION
```

The NTYPE parameter controls the type of grid generated by the *gefdc.f* code. NTYPE = 0 corresponds to an external specification of the grid by the *gridext.inp* file, see Figure 7, with *gefdc.f* only generating input files for the *efdc.f* code. Example of NTYPE = 0 grids are given in Appendices B.1, B.2, and B.4. The NTYPE options 1-5 generate curvilinear-orthogonal grids using the method or Ryskin and Leal (1983). NTYPE options 1-4 require that one of the boundaries of the grid to be a straight line and use reflection extensions of Ryskin and Leal's method proposed by Chikhliwala and Yortsos (1985). The NTYPE = 5 option is generally recommended. A simple NTYPE = 2 grid generation example is given in Appendix B.3. A more complicated composite grid composed of NTYPE 0 and 5 subgrids is discussed in Appendix B.4. The NTYPE = 7 option generates a quasi-conformal grid using the method of Mobley and Stewart (1980). When the NTYPE = 7 option is used, the computational domain must be rectangular (i.e. the physical domain is mapped into a rectangular region). An example of a NTYPE = 7 grid is presented in Appendix B.5. The NTYPE = 8 option generates a square cell Cartesian grid using only the *cell.inp* file and information on Card Image 4. The NTYPE = 9 option generates an approximately square cell Cartesian grid using the *cell.inp* file and information on Card Image 4. However, the coordinate information on Card Image 4 must correspond to longitude and latitude, which is internally converted to a universal transverse mercator (UTM) coordinate system localized to the Chesapeake Bay region. An example NTYPE = 9 grid is presented in Appendix B.6. The NTYPE = 6 option implements the area-orthogonal method of Knupp (1992). Since this method does not guarantee an orthogonal grid, it should be used with extreme care. For NTYPE = 1-6, NBPP coordinate pairs specifying the grid points (water cell corner points) around the boundary of the domain must be specified (see Card Images 12 and 13).

Card Image 3

```
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     0    0    1.    1.    1
```

Card Image 3 Parameter Definitions

```
ISGG = 1, READ IN gcell.inp WHICH DEFINES THE CARTESIAN OR
          GRAPHICS GRID OVERLAY
IGM    MAXIMUM X OR I CELLS IN CARTESIAN OR GRAPHICS GRID
JGM    MAXIMUM Y OF J CELLS IN CARTESIAN OR GRAPHICS GRID
DXCG   X GRID SIZE OF CARTESIAN OR GRAPHICS GRID
DYCG   Y GRID SIZE OF CARTESIAN OF GRAPHICS GRID
NWTGG  NUMBER OF WEIGHTED COMP CELLS USED TO INTERPOLATE
       TO THE GRAPHICS GRID (MUST EQUAL 1)
```

Activation of ISGG = 1, allows for a square cell Cartesian grid to be simultaneously generated when NTYPE = 1-7. This Cartesian grid is used by *efdc.f* to output the results of a 3D curvilinear coordinate computation in a 3D rectangular array for visualization and graphics. The relation between the I and J indices of the Cartesian grid, specified by *gcell.inp*, and the global coordinates (true east and true north) defining the curvilinear grid in physical space are defined by input on Card Image 4. The *gcell.inp* file has the same format as the *cell.inp* file. The *gefdc.inp* files shown in Figure B14 and B27 are examples where the ISGG = 1 option is activated.

Card Image 4

```
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     -77.5   1.25    -0.625  36.7    1.0     -0.5
```

Card Image 4 Parameter Definitions

```
CDLON1:  6 CONSTANTS TO GIVE CELL CENTER LAT AND LON OR OTHER
CDLON2:    COORDINATES FOR CARTESIAN GRIDS USING THE FORMULAE
CDLON3:    DLON(L)=CDLON1+(CDLON2*FLOAT(I)+CDLON3)/60.
```

```
CDLAT1:    DLAT(L)=CDLAT1+(CDLAT2*FLOAT(J)+CDLAT3)/60.
CDLAT2:
CDLAT3:
```

The information on this card image defines the global coordinates (true east and true north) of Cartesian cell centers corresponding to the I and J indices in the *gcell.inp* file for the Cartesian graphics grid overlay when NTYPE = 1-7 is specified (see *gefdc.inp* files in Figure B14 and B27). When NTYPE = 8 or 9 is specified, the information defines the cell center coordinates corresponding to I and J indices in the *cell.inp* file (see the *gefdc.inp* file in Figure B34). When NTYPE = 9, DLON and DLAT must correspond to longitude and latitude, otherwise DLON and DLAT can also correspond to a true east and true north coordinate system in meters or kilometers.

Card Image 5

```
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
     500    500    500    500    4000   1.0
```

Card Image 5 Parameter Definitions

```
ITRXM = MAXIMUM NUMBER OF X,Y SOLUTION ITERATIONS
ITRHM = MAXIMUM NUMBER OF HI,HJ SOLUTION ITERATIONS
ITRKM = MAXIMUM NUMBER OF KJ/KI SOLUTION ITERATIONS
ITRGM = MAXIMUM NUMBER OF GRID SOLUTION ITERATIONS
NDEPSM = NUMBER SMOOTHING PASSES TO FILL MISSING DEP DAT
DEPMIN = MINIMUM DEPTH PASSING DEPDAT.INP DATA
```

The first four parameters on Card Image 5 control the number of iterations for the various curvilinear grid generation schemes, based on successive over relaxation (SOR) solutions of elliptic equations, in *gefdc.f*. The value of 500 is recommended as a maximum for each of the these parameters based on the writer's experience that if the successive over relaxation (SOR) solution schemes do not converge after 500 iterations they are not converging at all. The value of 4000 for NDEPSM is the recommended number of smoothing passes used to fill in missing depth or bottom elevation data when the ISIDEP = 1 option on Card Image 11 is activated.

Card Image 6

```
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
```

Card Image 6 Parameter Definitions

```
     RPX,RPK,RPH = RELAXATION PARAMETERS FOR X,Y; KI/KJ; AND HI,HJ
                   SOR SOLUTIONS
     RSQXM,RSQKM,RSQHM = MAXIMUM RESIDUAL SQUARED ERROR IN SOR
                         SOLUTION FOR X,Y; KJ/KI; AND HI,HJ
     RSQKIM = CONVERGENCE CRITERIA BASED ON KI/KJ (NOT ACTIVE)
     RSQHIM = CONVERGENCE CRITERIA BASED ON HI (NOT ACTIVE)
     RSQHJM = CONVERGENCE CRITERIA BASED ON HJ (NOT ACTIVE)
```

The values of the first three parameters should not be changed, since they have been determined to the near optimum for the SOR solution schemes in gefdc.f. The remaining parameters are residual squared error criteria for stopping the SOR solutions. The values shown are rough estimates. For very large grids they can be decreased in magnitude to approximately 1.E-6.

Card Image 7

```
C7  COORDINATE SHIFT PARAMETERS AND ANGULAR ERROR
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      5.0
```

Card Image 7 Parameter Definitions

```
     XSHIFT,YSHIFT = X,Y COORDINATE SHIFT X,Y=X,Y+XSHIFT,YSHIFT
     HSCALE = SCALE FACTOR FOR HII AND HJJ WHEN PRINTED TO dxdy.out
     RKJDKI = ANISOTROPIC STRETCHING OF J COORDINATE (USE 1.)
     ANGORO = ANGULAR DEVIATION FROM ORTHOGONALITY IN DEG USED
              AS CONVERGENCE CRITERIA
```

The first two parameters allow for a coordinate translation of input coordinate data, which is generally not recommended. The scale factor is used to convert the input coordinate units to meters. For example, if the input coordinates are in kilometers, 1000 is necessary for DX and DY in the *dxdy.inp* file to be properly specified in meters. Note the cell center coordinates in the *lxly.inp* file will remain in the same units as the input coordinates. The final parameter, ANGORO, specifies the maximum deviation from orthogonal in the final grid. If the specified maximum deviation is not achieved, the generation procedure will execute the maximum number of iterations.

Card Image 8

```
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
```

Card Image 8 Parameter Definitions

```
     ISIRKI = 1, SOLUTION BASED ON INTERPOLATION OF KJ/KI TO
              INTERIOR
     JSIRKI = 1, INTERPOLATE KJ/KI TO INTERIOR WITH CONSTANT
              COEFFICIENT DIFFUSION EQUATION
     ISIHIHJ =1, SOLUTION BASED ON INTERPOLATION OF HI AND HJ TO
              INTERIOR, AND THEN DETERMINING KJ/KI=HI/HJ
     JSIHIHJ = 1, INTERPOLATE HI AND HJ TO INTERIOR WITH CONSTANT
              COEFFICIENT DIFFUSION EQUATION
```

The shown configuration for this Card Image is recommended.

Card Image 9

```
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7 SERRMAX
```

Card Image 9 Parameter Definitions

```
     IB     = BEGINNING I INDEX MS METHOD
     IE     = ENDING I INDEX MS METHOD
     JB     = BEGINNING J INDEX MS METHOD
     JE     = ENDING J INDEX MS METHOD
     N7RELAX= MAXIMUM RELAXATION PER INIT LOOP, NTYPE = 7
     NXYIT  = NUMBER OF ITERS ON EACH X,Y SWEEP, NTYPE = 7
     ITN7MAX= MAXIMUM GENERATION ITERS, NTYPE = 7
     IJSMD  = 1, CALCULATE GLOBAL CONFORMAL MODULE
     ISMD   = A VALUE IB.LE.ISMD.LE.IE, CALCULATE CONFORMAL
              MODULE ALONG LINE I=ISMD
     JSMD   = A VALUE JB.LE.JSMD.LE.JE, CALCULATE CONFORMAL
              MODULE ALONG LINE J=JSMD
     RP7    = SOR RELAXATION PARAMETER, NTYPE = 7
     SERRMAX= MAXIMUM CONFORMAL MODULE ERROR, NTYPE = 7
```

Data is necessary on this line only if NTYPE = 7. The indices IB and IE define the beginning and ending I grid lines of the rectangular (in the computational domain) grid generated by the quasi-conformal mapping technique implemented for NTYPE = 7. The indices JB and JE likewise define the beginning and ending J indices. Recommended values for the remaining parameter in this card image are shown in Figure B27 in Appendix B.

Card Image 10

```
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
```

Card Image 10 Parameter Definitions

```
     XIBJB,YIBJB = IB,JB COORDINATES
     XIEJB,YIEJB = IE,JB COORDINATES
     XIBJE,YIBJE = IB,JE COORDINATES
     XIEJE,YIEJE = IE,JE COORDINATES
```

Data is necessary on this line only if NTYPE = 7, with the x and y coordinates specified corresponding to the true east and north physical domain coordinates of the four corners of the rectangular region in the computational domain.

Card Image 11

```
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      11564    2.  .5    2         4.0     0     0       0
```

Card Image 11 Parameter Definitions

```
     ISIDEP   = 1, READ depdat.inp FILE AND INTERPOLATE DEPTH, BOTTOM
                ELEVATION AND BOTTOM ROUGHNESS DATA IN THE dxdy.inp FILE
     NDEPDAT  = NUMBER OF X, Y, DEPTH FIELDS IN DEPDAT.INP FILE
     CDEP     = WEIGHTING COEFFICIENT IN DEPTH INTERPOLATION SCHEME
     RADM     = CONSTANT MULTIPLIER FOR DEPTH INTERPOLATION RADIUS
     ISIDPTYP = 1, ASSUMES DEPDAT.INP CONTAINS POSITIVE DEPTHS
                TO A BOTTOM BELOW A SEA LEVEL DATUM AND THE BOTTOM
                ELEVATION IS THE NEGATIVE OF THE DEPTH
                2, ASSUMES DEPDAT.INP CONTAINS POSITIVE BOTTOM
                ELEVATIONS, LOCAL INITIAL DEPTH IS THEN DETERMINED
                BY DEPTH=SURFELV-BELB
                3, ASSUMES DEPDAT.INP CONTAINS POSITIVE BOTTOM
                ELEVATIONS WHICH ARE CONVERTED TO NEGATIVE VALUES,
                LOCAL INITIAL DEPTH IS THEN DETERMINED
                BY DEPTH=SURFELV-BELB
     SURFELV  = INITIALLY FLAT SURFACE ELEVATION FOR USE WHEN
                ISIDPTYP = 2 OR 3.
     ISVEG    = 1, READ AND INTERPOLATE VEGETATION DATA
     NVEGDAT  = NUMBER OF X,Y,VEGETATION CLASS DATA POINTS
     NVEGTYP  = NUMBER OF VEGETATION TYPES OR CLASSES
```

Setting ISIDEP = 1 activates depth or bottom elevation interpolation to the grid using NDEPDAT depth or bottom elevation data points. The depth or bottom elevation data within a radius of RDM*Min(dx,dy) of a cell center to determine a weighted average cell center or cell mean depth using an inverse distance weighting if CDEP = 1 or an inverse square weighting is CDEP = 2. If no data is within RDM*Min(dx,dy) of the cell center, the cell is flagged as having missing depth or bottom elevation data. Missing depth or bottom elevation data is determined using a Laplace equation filling technique which preserves values of the depth and bottom elevation in the unflagged cells. Vegetation class interpolation is activated by ISVEG = 1. For vegetation class interpolation, the predominant class is selected if more than on vegetation class data point falls within a cell. Since there is no fill option for the vegetation class interpolation, cells not having vegetation data points within their boundaries are assigned the null class 0. The null class is then replaced by hand in the *dxdy.inp* file, using class information from surrounding cells.

Card Image 12

```
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
    1   1   0.          0.
```

Card Image 12 Parameter Definitions

```
     LAST PAIR OF GRID COORDINATES ON BOUNDARY
     USED FOR NTYPE = 1 through 6
```

The last I,J index and true east and north coordinates X,Y for the last point in the clockwise sequence of grid points around the domain is specified. See the example in Appendix B.

Card Image 13

```
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Card Image 13 Parameter Definitions

```
     SEQUENCE OF GRID COORDINATES CLOCKWISE
     AROUND THE BOUNDARY
     USED FOR NTYPE = 1 THROUGH 6
```

The sequence of I,J index and true east and north coordinates X,Y clockwise around the domain is specified with one set of I,J,X,Y points per line, see the example in Appendix B. In the NTYPE = 1-4 options are specified, grid reflection occurs about the line joining the first and last points.

The *gefdc.f* code generates a number of output files, including the *dxdy.inp* and lxly.inp files for input into the *efdc.f* code. (These files are actually output as *dxdy.out* and *lxly.out* and must be renamed for use by *efdc.f*. The other output files and their purposes and content are as follows:

depint.log A file containing the I,J indices and true x,y coordinates of cells having no depth or bottom elevation data in their immediate vicinity (depths and bottom elevations are determined by a smoothing interpolation).

dxdy.diag A file containing diagnostics for curvilinear-orthogonal grids. See following text and Figure 9.

gefdc.log A file containing a log of the execution of the gefdc.f code. The contents of this file are also written to the screen during execution. See following text and Figure 10.

gefdc.out This contain a listing of the *cell.inp* file, the KSGI array specifying interior grid points, the initial x,y grid coordinates, and the final x,y grid coordinates.

grid.cord A file containing sequence of grid line coordinates with character variables separating sequences of constant I or J lines. Contents can be used for plotting grid.

grid.dxf A dxf (CADD drawing exchange file) of the final grid which can be plotted with any CADD or graphics software capable of importing the dxf format.

grid.init A dxf (CADD drawing exchange file) of the initial grid which can be plotted with any

CADD or graphics software capable of importing the dxf format.

grid.ixy	Similar to grid.cord, but contains only constant I lines
grid.jxy	Similar to grid.cord, but contains only constant J lines
grid.mask	A file containing a clockwise sequence of the true x,y coordinates of grid points along the land-water boundary. This file can be used in masking or defining the region for horizontal plane contour plotting by contouring software such as NCAR Graphic or Surfer.
gridext.out	A file containing the I,J indices and true x,y coordinates of all water cell grid points. This file can be renamed gridext.inp and used for NTYPE = 0 grid generation. A number of gridext.out files form subgrids that can be combined into a single gridext.inp to generate a composite grid. See example in Section B.4 of Appendix B.
salt.inp	This file is a template of the salt.inp input file for the *efdc.f* code. Salinity values are set to zero and may be filled with data. See Chapter 5.

Table 5. Output files from the *gefdc.f* code.

```
  I   J    HII          HJJ          HIIHJJ       JACOBIAN     ANG ERROR

 39   6  0.1968E+02  0.2962E+02  0.5827E+03   0.5827E+03   0.3120E+00
  .   .   .           .           .            .             .
  .   .   .           .           .            .             .
  .   .   .           .           .            .             .
  .   .   .           .           .            .             .

ASQRTG=   0.3305E+06  ASHIHJ=   0.3311E+06  AERR=   0.1973E-02
NWCELLS=       325
```

Figure 9. Sample output in the *dxdy.diag* file.

```
DIFF INITIAL X&Y, ITER = 100 RSX,RSY =   0.4439E-10   0.4383E-11

DIFFUSE RKI, ITERATION =  69 RSK =   0.9475E-12

DIFF X & Y, ITER =  81 RSX,RSY =   0.9747E-12   0.8887E-12

GRID GENERATION LOOP ITERATION =        1

GLOBAL RES SQ DIFF IN RKI=  0.3978E+00

MIN AND MAX DEVIATION FROM ORTHO =    0.3837E-02    0.1008E+02

  .     .        .      .                .
  .     .        .      .                .

NWCELLS=       325
N999 =         0
DEPMAX =  0.30678E+01
```

Figure 10. Sample output in the *gefdc.log* file.

The file *dxdy.diag*, Figure 9, contains the primary diagnostics of the curvilinear-orthogonal grid generation process. For each water cell, the file lists the computed orthogonal metric factors HI and HG (which are also dx and dy, the curvilinear cell dimensions). For true orthogonality, the product HII*HJJ is the horizontal area of the cell. The actual area of the cell, which is also the Jacobian of the general curvilinear coordinate transformation, is also shown, and should agree with HII*HJJ to within a few percent. The angular error for each cell is a measure of deviation from numerical orthogonality, and should be small. The orthogonality of the grid can be improved by identifying cells along the land water boundary with the largest angular errors and adjusting their land bounding grid corner coordinate points on Card Image 13 in the *gefdc.inp* file. At the end of the *dxdy.diag* file, the exact area of the grid, ASQRTG, is printed for comparison with the sum of the HII*HJJ product for all water cells. The relative error between these two quantities, AERR, is also printed, as well as the total number of water cells in the grid. The *gefdc.log* file, shown in Figure 10, summarizes the computational steps in the grid generation. The initialization of the grid, referred to as diffuse x and y, since the generation scheme is similar to the solution of a steady state diffusion or elliptic equation, is followed by a summary of each grid generation iteration. The iteration involves diffusing the boundary metric ratios, RKI, to the interior and then the diffusion of the x and y coordinates to the interior. The residuals for these diffusion or elliptic equation solutions by successive over relaxation are the small quantities beginning with R. The minimum and maximum deviations from orthogonality, in degree, at the end of the iteration is then printed. After the grid generation has converged or executed the specified number of maximum iterations, the equivalent contents of the *dxdy.out* (inp) file is also written in *gefdc.log*. The file ends with a summary of the number of water cells, the number of cells where depth or bottom topography failed to be determined, and the maximum initial water depth in the grid.

4. The Master Input File

This chapter describes the master input, *efdc.inp*, for the *efdc.f* code. The information in efdc.inp provides run control parameters, output control and physical information describing the model domain and external forcing functions. The file is internally documented, in essence providing a template or menu for setting up a simulation. The file consists of card image sections, with each section having header lines which define the relevant input parameter in that section. The function of the various card image sections is best illustrated by a sequential discussion of each section. Card Image sections and input parameters which are judged to be clearly explained in the *efdc.inp* files internal documentation will not be discussed specifically. Before proceeding, a number of conventions should be discussed. Many options in the code are activated by integer switches (most beginning with either IS or JS). Unless otherwise noted, setting theses switches to zero deactivates the option. Options are normally activated by specifying nonzero integer values. A number of options described in the file are classified as for research purposes. This classification indicates that the option may involve an experimental and not fully tested numerical scheme or that it involves rather complex internal analysis or flow field data extraction. Detail information on the function and current status of these options may be obtained from the writer. A complete listing of the *efdc.inp* file for an actual application can be found in Appendix C, and may be used as the template for setting up a new model application.

Card Image 1

```
--------------------------------------------------------------------
C1  TITLE FOR RUN
C
      TITLE OR IDENTIFIER FOR THIS INPUT FILE AND RUN
C
C1  (LIMIT TO 80 CHARACTERS LENGTH)
 'JAMES RIVER 6 LAYERS, FINAL CALIBRATION RUN '
--------------------------------------------------------------------
```

Card Image 2

```
--------------------------------------------------------------------
C2  RESTART, GENERAL CONTROL AND DIAGNOSTIC SWITCHES
C
      ISRESTI: 1 FOR READING INITIAL CONDITIONS FROM FILE
                 restart.inp
              -1 AS ABOVE BUT ADJUST FOR CHANGING BOTTOM ELEVATION
               2 INITIALIZES A KC LAYER RUN FROM A KC/2 LAYER RUN
                 FOR KC.GE.4
              10 FOR READING IC'S FROM restart.inp WRITTEN BEFORE 8
                 SEPT 1992
      ISRESTO:-1 FOR WRITING RESTART FILE restart.out AT END OF RUN
               N INTEGER.GE.0 FOR WRITING restart.out EVERY N REF
                 TIME PERIODS
      ISRESTR: 1 FOR WRITING RESIDUAL TRANSPORT FILE restran.out
      ISPAR:   0 FOR EXECUTION OF CODE ON A SINGLE PROCESSOR MACHINE
               1 FOR PARALLEL EXE, PARALLELIZING PRIMARILY OVER LAYERS
```

```
              2 FOR PARALLEL EXE, PARALLELIZING PRIMARILY OVER
                NDM HORIZONTAL GRID SUBDOMAINS, SEE CARD C9
      ISLOG:   1 FOR WRITING LOG TO SCREEN AND FILE efdc.log
               2 FOR WRITING TO FILE efdc.log ONLY
      ISDIVEX: 1 FOR WRITING EXTERNAL MODE DIVERGENCE TO SCREEN
      ISNEGH:  1 FOR SEARCHING FOR NEGATIVE DEPTHS AND WRITING TO
                 SCREEN
      ISMMC:   1 FOR WRITING MIN AND MAX VALUES OF SALT AND DYE
                 CONCENTRATION TO SCREEN
      ISBAL:   1 FOR ACTIVATING MASS, MOMENTUM AND ENERGY BALANCES
                 AND WRITING RESULTS TO FILE bal.out
      ISHP:    1 FOR CALLING HP 9000 S700 VERSIONS OF CERTAIN
                 SUBROUTINES
      ISHOW:   1 TO SHOW PUV&S ON SCREEN, SEE INSTRUCTIONS FOR FILE
                 show.inp
C
C2 ISRESTI ISRESTO ISRESTR ISPAR ISLOG ISDIVEX ISNEGH ISMMC ISBAL ISHP ISHOW
    1       4       0      0     2     0       0      0     0     0    0
--------------------------------------------------------------------
```

Card Image 2, specifies the mode of model startup, either a cold start, with the flow field initialized to zero, or a restart.inp using initial conditions corresponding to the conditions at the end of a previous simulation. The ISRESTO switch controls the frequency of outputting restart information to the file restart.out (which is renamed restart.inp to launch a run). The file restran.out contains the time averaged transport file, which may be used to execute the efdc.f code in a transport only mode. The switch ISPAR allows implementation of internal code options for execution on multiple processor or parallel machines. These options are currently supported on multiple vector processor Cray supercomputers, and on Silicon Graphic and Sparc (Sun and clones) based symmetric multiprocessor UNIX workstations. The choice of ISPAR equal to 1 or 2, depends on both the grid structure and the number of processors on which the code will execute. Portions of the code capable of being parallelized over vertical layers or horizontal grid subdomains are parallelized over vertical layers when ISPAR is set to 1. For layer parallelization, the number of layers must be an integer multiple of the number of processors on which the code will execute. For grids consistent with layer parallelization, portions of the code allowing either mode of parallelization are generally more efficient in the layer parallelization mode. Certain portions of the code may be parallelized only overly horizontal subdomains, with this mode being active for ISPAR equal 1 or 2. For ISPAR = 2, all parallelization is over horizontal subdomains. See Card C9 and chapter 6 for additional details regarding parallel execution of EFDC. The switch ISLOG activates the creation of a log file (ISLOG = 2, recommended) which is deleted and reopened after each reference time period. The contents and interpretation of the material in file efdc.log will be discussed in the diagnostics chapter. The switches, ISDIVEX, ISNEGH, and

ISMMC, activate diagnostic checks on volume conservation, identify negative solution depths, and check mass conservation of transport materials, activation of these switches (IS=1) produces identical output to the screen and efdc.log file. The use of these options for diagnostic purposes is discussed in the diagnostics chapter. The switch ISHP allows use of Hewlett-Packard 9000 series 700 vector libraries. The vector library calls are currently commented out with CDHP in the source code. The procedure for activating this option and accessing the HP vector library may be obtained from the writer. The switch ISBAL activates an internal volume, mass, momentum and energy balance procedure. The switch ISHOW activates a screen print of flow field conditions in a specified horizontal location during the run, with more details given with the description of the file show.inp in the next chapter.

Card Image 3

```
--------------------------------------------------------------------
C3  EXTERNAL MODE SOLUTION OPTION PARAMETERS AND SWITCHES
C
      RP:          OVER RELAXATION PARAMETER
      RSQM:        TARGET SQUARE RESIDUAL OF ITERATIVE SOLUTION SCHEME
      ITERM:       MAXIMUN NUMBER OF ITERATIONS
      IRVEC:     0 STANDARD RED-BLACK SOR SOLUTION
                 1 MORE VECTORIZABLE RED-BLACK SOR
                   (FOR RESEARCH PURPOSES)
                 2 RED-BLACK ORDERED CONJUGATE GRADIENT SOLUTION
                 3 REDUCED SYSTEM R-B CONJUGATE GRADIENT SOLUTION
      RPADJ:       RELAXATION PARAMETER FOR AUXILLARY POTENTIAL
                   ADJUSTMENT OF THE MEAN MASS TRANSPORT ADVECTION
                   FIELD (FOR RESEARCH PURPOSES)
      RSQMADJ:     TARGET SQUARED RESIDUAL ERROR FOR ADJUSTMENT
                   (FOR RESEARCH PURPOSES)
      ITRMADJ:     MAXIMUM ITERARTIONS FOR ADJUSTMENT
                   (FOR RESEARCH PURPOSES)
      ITERHPM:     MAXIMUM ITERATIONS FOR STRONGLY NONLINEAR DRYING AND
                   WETTING SCHEME (ISDRY=3 OR OR 4) ITERHPM.LE.4
      IDRYCK:      ITERATIONS PER DRYING CHECK (ISDRY.GE.1)
                   2.LE.IDRYCK.LE.20
      ISDSOLV:   1 TO WRITE DIAGNOSTICS FILES FOR EXTERNAL MODE SOLVER
C
C3  RP  RSQM  ITERM IRVEC RPADJ RSQMADJ ITRMADJ ITERHPM IDRYCK ISDSOLV
   1.8  1.E-8  100   3    1.8   1.E-16  1000    0       20     0
--------------------------------------------------------------------
```

The information input on Card Image 4 primarily controls the external or barotropic mode solution in *efdc.f*. The relaxation parameter of 1.8 should not be changed. The RSQM parameter is the residual squared error in the external mode solution. It is generally set between 1E-6 and 1E-15, with the small values corresponding several hundred cells and a small time step (10-100 seconds) and the larger value corresponding a large number of cells (1000-10,000) and a large time step (100-1000 seconds). It RSQM is set to a small value, a simulation may crash due to accumulated roundoff error. RSQM should be adjusted such that the number of iterations shown in the efdc.log file is between approximately 10 and 40. The maximum iteration count in the external solution ITERM is set such that execution stops if the external solution does not converge in the maximum number of iterations. The parameter IRVEC controls the type of linear equation solver used in the external mode solution. The original successive over relaxation solver has been supplemented with two conjugate gradient solvers, a diagonally preconditioned solver, IRVEC = 2, and a red-black ordered, reduced system, conjugate gradient solver, IRVEC = 3. The options IRVEC = 0 or IRVEC = 3 is recommended if drying and wetting is not active, while the option, IRVEC = 2, is required when drying and wetting is activated. The remaining parameters are for research purposes, and generally not used in standard applications, or are self-explanatory.

Card Image 4

```
--------------------------------------------------------------------
C4  LONGTERM MASS TRANSPORT INTEGRATION ONLY SWITCHES
C
      ISLTMT:  1 FOR LONG-TERM MASS TRANSPORT ONLY (FOR RESEARCH
               PURPOSES)
      ISSSMMT: 0 WRITES MEAN MASS TRANSPORT TO restran.out AFTER
                 EACH AVERAGING PERIOD  (FOR RESEARCH PURPOSES)
               1 WRITES MEAN MASS TRANSPORT TO restran.out AFTER
                 LAST AVERAGING PERIOD  (FOR RESEARCH PURPOSES)
      ISLTMTS: 0 ASSUMES LONG-TERM TRANSPORT SOLUTION IS TRANSIENT
                  (FOR RESEARCH PURPOSES)
                1 ASSUMES LONG-TERM TRANSPORT SOLUTION IS ITERATED
                 TOWARD STEADY STATE (FOR RESEARCH PURPOSES)
      ISIA:    1 FOR IMPLICIT LONG-TERM ADVECTION INTEGRATION FOR
                 ZEBRA VERTICAL LINE R-B SOR (FOR RESEARCH PURPOSES)
      RPIA:      RELAXATION PARAMETER FOR ZEBRA SOR (FOR RESEARCH
                 PURPOSES)
      RSQMIA:    TARGET RESIDUAL ERROR FOR ZEBRA SOR (FOR RESEARCH
                 PURPOSES)
      ITRMIA:    MAXIMUM ITERATIONS FOR ZEBRA SOR (FOR RESEARCH
                 PURPOSES)
C
C4  ISLTMT  ISSSMMT ISLTMTS  ISIA  RPIA  RSQMIA   ITRMIA
    0       1       0        0     1.8   1.E-10   100
--------------------------------------------------------------------
```

The EFDC model has the capability to function in a transport only mode using advective and diffusive transport specified in the file restran.inp. The first parameter, ISLTMT, actives this mode. The second parameter ISSSMMT controls the creation of the restran.inp file, output as restran.out, during normal execution. The frequency of graphical output of residual fields is also controlled by this parameter. The third parameter determines whether the transport only mode with be integrated to steady state or integrated for a transient residual transport field. The remaining four parameters are for research purposes, however, ISIA should be set to zero.

Card Image 5

```
--------------------------------------------------------------------
C5   MOMENTUM ADVEC AND HORIZ DIFF SWITCHES AND MISC SWITCHES
C
      ISCDMA:  1 FOR CENTRAL DIFFERENCE MOMENTUM ADVECTION
               0 FOR UPWIND DIFFERENCE MOMENTUM ADVECTION
               2 FOR EXPERIMENTAL UPWIND DIFF MOM ADV
                 (FOR RESEARCH PURPOSES)
      ISAHMF:  1 TO ACTIVATE HORIZONTAL MOMENTUM DIFFUSION
```

```
                 ISDISP:  1 CALCULATE MEAN HORIZONTAL SHEAR DISPERSION
                 TENSOR OVER LAST MEAN MASS TRANSPORT AVERAGING PERIOD
      ISWASP: 4 or 5 TO WRITE FILES FOR WASP4 or WASP5 MODEL LINKAGE
      ISDRY:     GREATER THAN 0 TO ACTIVE WETTING & DRYING OF
S                HALLOW AREAS
               1 CONSTANT WETTING DEPTH SPECIFIED BY HWET ON CARD 11
                 WITH NONLINEAR ITERATIONS SPECIFIED BY ITERHPM
                 ON CARD C3
               2 VARIABLE WETTING DEPTH CALCULATED INTERNALLY IN
                 CODE WITH NONLINEAR ITERATIONS SPECIFIED BY
                 ITERHPM ON CARD C3
              11 SAME AS 1, WITHOUT NONLINEAR ITERATION
              12 SAME AS 2, WITHOUT NONLINEAR ITERATION
               3 DIFFUSION WAVE APPROX, CONSTANT WETTING DEPTH (NOT
                 ACTIVE)
               4 DIFFUSION WAVE APPROX, VARIABLE WETTING DEPTH (NOT
                 ACTIVE)
      ISQQ:    1 TO USE STANDARD TURBULENT INTENSITY ADVECTION SCHEME
      ISRLID:  1 TO RUN IN RIGID LID MODE (NO FREE SURFACE)
      ISVEG:   1 TO IMPLEMENT VEGETATION RESISTANCE
               2 IMPLEMENT WITH DIAGNOSTICS TO FILE cbot.log
      ISVEGL:  1 TO INCLUDE LAMINAR FLOW OPTION IN VEGETATION
                 RESISTANCE
      ISITB:   1 FOR IMPLICIT BOTTOM & VEGETATION RESISTANCE IN
                 EXTERNAL MODE FOR SINGLE LAYER APPLICATIONS (KC=1)
      ISWAVE   1 FOR WAVE CURRENT BOUNDARY LAYER
               2 FOR WC BL AND WAVE INDUCED CURRENTS
                 BOTH OPTIONS REQUIRE FILE wave.inp
 C
 C5 ISCDMA ISAHMF ISDISP ISWASP ISDRY ISQQ ISRLID ISVEG ISVEGL ISITB ISWAVE
    0      0      0      0      0     1    0      0     0      0     0
 -------------------------------------------------------------------
```

This card image controls various options for integration of the advective and diffusive portions of the momentum equations as well as the activation of additional physical process representations and optional output processing. The parameter ISCDMA controls the finite difference representation of momentum advection, with the zero default value corresponding to upwind difference, and the values of 1 and 2 corresponding respectively to central differencing and an experimental upwind difference scheme. The central difference option is generally recommended only for smooth or idealized bottom topography and lateral boundaries. The second parameter ISAHMF activates horizontal moment diffusion. It should be activated when using central difference advection or when simulating wave induced currents. For wave induced currents, the horizontal diffusion is specified in terms of the wave energy dissipation due to wave breaking in the surf zone. The options ISDISP and ISWASP respectively control the creation of shear dispersion coefficient file disp.out and a WASP water quality model transport files waspX.out. The parameter ISDRY activates drying and wetting and the value 11 is recommended. The parameter ISQQ should remain set to unity. The parameter ISRLID implements a rigid free surface simulation and is generally used only for research purposes. The next three parameters activate the vegetation resistance model. The last parameter ISITB should be activated only in single layer or depth integrated simulations. The remaining parameter ISWAVE activates the wave-current boundary layer model and the wave induced current model, using an external specification of high frequency surface wave conditions in the input file wave.inp.

Card Image 6

```
--------------------------------------------------------------------
C6  DISSOLVED AND SUSPENDED CONSTITUENT TRANSPORT SWITCHES
C6  TURB INT=0, SALT=1, TEMP=2, DYEC=3, SEDC=4, SFL=5, CWQ=6
C
      ISTRAN:  1 TO ACTIVATE TRANSPORT
      ISTOPT:    CONSTITUENT SPECIFIC TRANSPORT OPTIONS
      ISCDCA:  0 FOR STANDARD DONOR CELL UPWIND DIFFERENCE ADVECTION
               1 FOR CENTRAL DIFFERENCE ADVECTION FOR THREE TIME
                 LEVEL STEPS
               2 FOR EXPERIMENTAL UPWIND DIFFERENCE ADVECTION (FOR
                 RESEARCH PURPOSES)
      ISADAC:  1 TO ACTIVATE ANTI-NUMERICAL DIFFUSION CORRECTION TO
                 STANDARD DONOR CELL SCHEME
      ISFCT:   1 TO ADD FLUX LIMITING TO ANTI-NUMERICAL DIFFUSION
                 CORRECTION
      ISPLIT:  1 TO OPERATOR SPLIT HORIZONTAL AND VERTICAL ADVECTION
                 (FOR RESEARCH PURPOSES)
      ISADAH:  1 TO ACTIVATE ANTI-NUM DIFFUSION CORRECTION TO
                 HORIZONTAL SPLIT ADVECTION STANDARD DONOR CELL
                 SCHEME (FOR RESEARCH PURPOSES)
      ISADAV:  1 TO ACTIVATE ANTI-NUM DIFFUSION CORRECTION TO
                 VERTICAL (FOR RESEARCH PURPOSES)
                 SPLIT ADVECTION STANDARD DONOR CELL SCHEME
                 (FOR RESEARCH PURPOSES)
      ISCI:    1 TO READ CONCENTRATION FROM FILE restart.inp
      ISCO:    1 TO WRITE CONCENTRATION TO FILE restart.out
```

```
C
C6 ISTRAN ISTOPT ISCDCA ISADAC ISFCT ISPLIT ISADAH ISADAV ISCI ISCO
   1      0      0      0      0     0      0      0      0    0  !turb
   1      0      0      1      1     0      0      0      1    1  !salt
   1      0      0      1      1     0      0      0      1    1  !temp
   0      0      0      1      1     0      0      0      0    0  !dye
   0      0      0      1      1     0      0      0      0    0  !sed
   0      0      0      1      1     0      0      0      0    0  !tsfl
   0      0      0      1      1     0      0      0      0    0  !cwq
-------------------------------------------------------------------
```

Card Image 6 controls the advective transport and source sink options for transported scalar fields. The seven lines of active input represent in order, turbulent intensity, salinity, temperature, a dye tracer, suspended sediment, shellfish larvae, and water quality variables. The first switch, ISTRAN activates advective transport and sources and sinks. On the first line, corresponding to the turbulence model, only ISTRAN should be set to unity with the remaining parameters set to zero. For water quality, ISTRAN=1, activates the embedded water quality model WQ3D (Park, 1995) which has additional input files not documented in this manual. The second parameter ISTOPT sets options for a number of the transport scalar fields. Current active options are:

Salinity

ISTOPT=1: Read initial salinity distribution from file
salt.inp (ISRESTI=0, only)

Temperature

ISTOPT=1: Full surface and internal heat transfer
calculation using data from file aser.inp.

ISTOPT=2: Transient equililibrium surface heat transfer
calculation using external equilibrium
temperature and heat transfer coefficient
data from file aser.inp.

ISTOPT=3: Equilibrium surface heat transfer
calculation using constant equilibrium
temperature and heat transfer coefficients
from Card Image 30.

Initial isothermal temperature for cold starts (ISRESTI=0)
is read on Card Image 30. See Cerco and Cole (1993) for
a discussion of the equilibrium temperature surface
head transfer approach.

Dye Tracer

ISTOPT=1: Read initial dye tracer distribution from file dye.inp (ISRESTI=0, only).

Linear or first order dye decay specified on Card Image 30.

Suspended Sediment

ISTOPT=1: Suspended sediment is cohesive. Settling, deposition and resuspension calculated in subroutine CALSED

ISTOPT=2: Suspended sediment is cohesive. Settling, deposition and resuspension calculated in subroutine CALSED2

ISTOPT=3: Suspended sediment is noncohesive. Settling, deposition and resuspension calculated in subroutine CALSED3

ISTOPT=4: Suspended sediment is noncohesive. Settling, deposition and resuspension calculated in subroutine CALSED3 after wave wave-current boundary layer or wave induced forcing have been gradually introduced.

Sediment settling, resuspension, and deposition data is read on CARD Image 29.

Shellfish Larvae

No options available

Water Quality Constituents

ISTOPT=1: Specifies 20 water column state variables.

ISTOPT=2: Specifies 14 water column state variables.

ISTOPT=3: Specifies 8 water column state variables.

The third parameter, ISCDCA, specifies the advection scheme with the zero default values corresponding to donor cell upwind difference. Values of 1 and 2 specify central difference (not recommended) and an experimental first order upwind difference scheme, respectively. The parameter ISADAC=1 activates an antidiffusion advective flux correction (Smolarkiewicz and Clark, 1986) for ISCDCA equals 0 or 1. The parameter ISFCT=1, implements the antidiffusion correction in the flux corrected transport form (Smolarkiewicz and Grabowski, 1990). The three parameters ISPLIT, ISADAH, and ISADAV activate an experimentally operated split antidiffusive upwind difference scheme and should remain set to 0. The parameters ISCI and ISCO when set to 1 read and write, respectively, the specified field from and to the files restart.inp and restart.out. Turbulence quantities are by default read from and written to the restart files.

Card Image 7

```
-------------------------------------------------------------------
C7  TIME-RELATED INTEGER PARAMETERS
C
      NTC:     NUMBER OF REFERENCE TIME PERIODS IN RUN
      NTSPTC:  NUMBER OF TIME STEPS PER REFERENCE TIME PERIOD
      NLTC:    NUMBER OF LINEARIZED REFERENCE TIME PERIODS
      NLTC:    NUMBER OF TRANSITION REF TIME PERIODS TO FULLY
               NONLINEAR
      NTCPP:   NUMBER OF REFERENCE TIME PERIODS BETWEEN FULL PRINTED
               OUTPUT TO FILE efdc.out
      NTSTBC:  NUMBER OF REFERENCE TIME PERIODS BETWEEN TWO
               TIME LEVEL TRAPEZOIDAL CORRECTION TIME STEP
      NTCNB:   NUMBER OF REFERENCE TIME PERIODS WITH N0 BUOYANCY
               FORCING
      NTCVB:   NUMBER OF REF TIME PERIODS WITH VARIABLE BUOYANCY
               FORCING
      NTCMMT:  NUMBER OF REF TIME TO AVERAGE OVER TO OBTAIN
               RESIDUAL OR MEAN MASS TRANSPORT VARIABLES
      NFLTMT:  USE 1 (FOR RESEARCH PURPOSES)
      NDRYSTP: MIN NO. OF TIME STEPS A CELL REMAINS DRY AFTER
               INITIAL DRYING
C
C7  NTC NTSPTC NLTC NTTC NTCPP NTSTBC NTCNB NTCVB NTSMMT NFLTMT NDRYSTP
    72  432    0    0    200   6      0     1     864    1      4
-------------------------------------------------------------------
```

Card Images 7 and 8 provide time controls for the simulation with Card Image 7 providing integer parameters. The EFDC code executes of a specified number of time cycles, NTC. The actual length of the time cycle in seconds is specified by TREF on Card Image 8. For example, a 30 day simulation would correspond to NTC = 30 and TREF = 86400 seconds. The example shown specifies 72 time cycles and TREF = 44714.16 seconds, the period of the M2 time. The time step is specified as the number of time steps per reference time period, NTSPTC. For the values shown, the actual time step is 103.505 seconds (44714.16 sec/432). The parameter NLTC allows for NLTC time periods with no nonlinear terms in the momentum equations, while NTTC allows for a gradual introduction of the nonlinear terms of NTCC reference time periods. These two options may be useful for cold starts (ISRESTI=0) or diagnostic purposes. The NTCPP controls the frequency of printed output to efdc.out. The printed output is primarily in the form of line printer contour plots which may be useful in situations where graphics postprocessing capabilities are not readily available. Given the extensive options currently available in the code to generate graphical output, NTCPP is usually specified large enough such that the printed output is not generated. The parameter, NTSTBC is extremely important in that it specifies the frequency of insertion of a two time level trapezoidal correction step into the three-time level integration (see Hamrick, 1992a). Generally NTSTBC should be between 4 and 12, increasing if NTSPTC increases. The parameters NTCNB and NTCVB control the introduction of buoyancy forcing into the momentum equations in a similar manner as described for NLTC and NTTC. The parameter NTSMMT specifies the number of time steps for the calculation of time averaged or residual output variables and also the output frequency to the "r" class output files. If NTSMMT is greater than or equal to NTSPTC, the averaging includes calculation of the Lagrangian mean transport fields (Hamrick, 1994a). The parameter NFLTMT should remain set to 1. The parameter NDRYSTP specifies the number of timesteps a cell must remain dry before wetting is allowed when the drying and wetting option is activated.

Card Image 8

```
-------------------------------------------------------------------
C8  TIME-RELATED REAL PARAMETERS
C
      TCON:     CONVERSION MULTIPLIER TO CHANGE TBEGIN TO SECONDS
      TBEGIN:   TIME ORIGIN OF RUN
      TREF:     REFERENCE TIME PERIOD IN SEC
                (i.e. 44714.16s or 86400s)
      CORIOLIS: CONSTANT CORIOLIS PARAMETER IN 1/SEC
      ISCCA:    WRITE DIAGNOSTICS FOR MAX CORIOLIS-CURV ACCEL TO
                FILE efdc.log
      ISCFL:    WRITE DIAGNOSTICS OF MAX THEORETICAL TIME STEP TO
                FILE cfl.out
C
C8   TCON    TBEGIN    TREF       CORIOLIS   ISDCCA   ISCFL
    3600.   3173.7166  44714.16   0.0001     0        0
-------------------------------------------------------------------
```

This card image specifies a number of real time related parameters as well as activating timestep related diagnostics. TBEGIN specifies the start time of the runs in units of seconds, minutes, hours, or days, with TCON being the multiplier factor which would convert TBEGIN to seconds. The reference time period must always be specified in seconds. The EFDC model currently is based on an f plane formulation for the Coriolis accelerations, with the variable CORIOLIS being the value of f in 1/seconds units. The maximum stable time step is constrained by the 0.5/f and the CFL criteria for advection (Hamrick, 1992a). Activation of ISDCCA causes the maximum effective Coriolis parameter to be printed to the log file efdc.log at each time step. Activation of ISCFL=1 writes the limiting time step, and the cell in which it occurs, based on the CFL condition to the file cfl out at each time step. Since the CFL condition is based on linear stability analysis of a constant coefficient, three-dimensional advection equation, a good rule for real world applications with spatial and temporal varying advective fields is to use a time step on the order of 1/4 to 1/2 the limiting CFL time step written to cfl.out. Since both of the time step diagnostics involve logic searches, they should only be activated during the start up of a new model application.

Card Image 9

```
-------------------------------------------------------------------
C9  SPACE-RELATED AND SMOOTHING  PARAMETERS
C
      KC:      NUMBER OF VERTICAL LAYER
      IC:      NUMBER OF CELLS IN I DIRECTION
      JC:      NUMBER OF CELLS IN J DIRECTION
      LC:      NUMBER OF ACTIVE CELLS IN HORIZONTAL + 2
      LVC:     NUMBER OF VARIABLE SIZE HORIZONTAL CELLS
      ISCO:    1 FOR CURVILINEAR-ORTHOGONAL GRID (LVC=LC-2)
```

```
      NDM:     NUMBER OF DOMAINS FOR HORIZONTAL DOMAIN DECOMPOSITION
               (NDM=1, FOR MODEL EXE ON A SINGLE PROCESSOR SYSTEM OR
                NDM=MM*NCPUS, WHERE MM IS AN INTEGER AND NCPUS IS THE
                NUMBER OF AVAILABLE CPU's FOR MODEL EXECUTION ON A
                PARALLEL MULTIPLE PROCESSOR SYSTEM)
      LDW:     NUMBER OF WATER CELLS PER DOMAIN
               (LDW=(LC-2)/NDM, FOR VECTOR PROCESSORS, LWD MUST BE AN
                INTEGER MULTIPLE OF THE VECTOR LENGTH OR STRIDE NVEC
                CONSTRAINING LC-2 TO BE AN INTEGER MULTIPLE OF NVEC)
      ISMASK:  1 FOR MASKING WATER CELL TO LAND OR ADDING THIN
                 BARRIERS USING INFORMATION IN FILE mask.inp
      ISPGNS:  1 FOR CONFIGURING GRID TO BE PERIODIC IN NORTH SOUTH
                 DIRECTION USING MAPPING DAT IN FILE mappgns.inp
      NSHMAX:  NUMBER OF DEPTH SMOOTHING PASSES
      NSBMAX:  NUMBER OF INITIAL SALINITY FIELD SMOOTHING PASSES
      WSMH:    DEPTH SMOOTHING WEIGHT
      WSMB:    SALINITY SMOOTHING WEIGHT
C
C9 KC IC JC   LC  LVC NDM LDM ISCLO ISMASK ISPGNS NSHMAX NSBMAX WSMH WSMB
   6  20 80 1026 1024  1 1024  1    1      0      1      0   0.03125  0.5
--------------------------------------------------------------------
```

Card image 9 specifies the spatial structure of the model grid, with KC denoting the number of layers and IC and JC denoting the number of cells in the computational x and y directions as discussed in the previous chapter on grid generation. Internally, the EFDC code uses a single horizontal index, L, rather than the two indices I and J. The use of the single index L allows only for computation on and storage of only active water cells. The parameter LC is the number of active or water cells in the grid plus 2. The two additions to the L sequence at L=1 and L=LC are used for boundary condition implementation with computational loops ranging from L=2,LC-1. The parameter LVC is equal to LC-2 if the ISCLO switch is set to 1. The ISCLO switch is set to 1 for curvilinear grids, variable spaced Cartesian grids and Cartesian grids which are specified entirely by the cell.inp, dxdy.inp and lxly.inp files. The parameters NDM and LDM specify a domain decomposition of the horizontal grid for execution of EFDC on parallel or multiple processor systems. For parallel execution, NDM should equal the number of processors the code will execute on. For multiple processor systems, such as symmetric multiprocessor UNIX work stations, with no vector capability, LDM should be equal to the number of water cells in the grid, LC - 2, divided by NDM, ensuring load balancing across the processors. The same rule should also be followed for parallel vector processors, however for optimum performance, LDM should also the an integer multiple of the vector stride (usually 64 or 128). This may require the additional cells to be added to the grid. The additional cells may be in the form of one-dimensional, in the horizontal, closed channels, which do not influence the solution of the actual problem. The input shown above could be modified for execution on a 4 processor system by setting NDM equal to 4 and LDM equal to 256, which is also an integer multiple of 64 and 128. The ISMASK switch activates the 'certain of no flow' barriers on cell faces specified in the file mask.inp. The switch ISPGNS configures all or portions of north and south open boundaries to represent periodic domains in the computational y direction, using information in the file mappgns.inp. This option is useful in shelf and nearshore applications. The parameter NSHMAX specifies the number of smoothing passes applied to the input depth and bottom elevation fields with WSMH being the smoothing parameter, which must be less than 0.25. The smoother has the form:

$$H_{new}(L) = H_{old}(L) + WSMH * \begin{pmatrix} H_{old}(LS) + H_{old}(LW) + H_{old}(LE) \\ +H_{old}(LN) - 4. * H_{old}(L) \end{pmatrix} \tag{3}$$

Likewise the parameter NSBMAX specifies the number of smoothing passes to be applied to a salinity field initialized by the salt.inp file. The salinity smoother can also be used to interpolate sparse salinity data to create a smooth initial salinity field. In this case, the vertical salinity profiles in the salt.inp file must be set with zero values, except at locations where nonzero values are supplied. Setting NSBMAX to a large number, which must be greater than 10, and should usually be on the order of 2000, interpolates the salinity over the entire grid with the nonzero input data unmodified. In an estuary application, specifying small values at the limit of salinity intrusion will prevent the diffusive interpolation scheme from progressing upstream.

Card Image 10

```
-------------------------------------------------------------------
C10 LAYER THICKNESS IN VERTICAL
C
      THICKNESS OF EACH VERTICAL LAYER, 1 = BOTTOM
      LAYER THICKNESSES MUST SUM TO 1.0
C
C10 LAYER NUMBER   DIMENSIONLESS LAYER THICKNESSES
        1            0.166
        2            0.167
        3            0.167
        4            0.167
        5            0.167
        6            0.166
-------------------------------------------------------------------
```

Card Image 10 (older versions)

```
-------------------------------------------------------------------
C10 LAYER THICKNESS IN VERTICAL
C
      THICKNESS OF EACH VERTICAL LAYER, 1 = BOTTOM
      LAYER THICKNESSES MUST SUM TO 1.0
C
C10 1     2     3     4     5     6     7     8
    0.166 0.167 0.167 0.167 0.167 0.166
-------------------------------------------------------------------
```

This card specifies the dimensional thickness of the vertical layers, which do not have to be equal.

Card Image 11

```
-------------------------------------------------------------------
C11 GRID, ROUGHNESS AND DEPTH PARAMETERS
C
      DX:       CARTESIAN CELL LENGTH IN X OR I DIRECTION (ISCO=0)
      DY:       CARTESIAN CELL LENGTH IN Y OR J DIRECTION (ISCO=0)
      DXYCVT:   MULTIPLY DX AND DY BY TO OBTAIN METERS
      ZBRADJ:   LOG BDRY LAYER CONST OR VARIABLE ROUGH HEIGHT ADJ IN
                METERS
      ZBRCVRT:  LOG BDRY LAYER VARIABLE ROUGHNESS HEIGHT CONVERT TO
                METERS
      HMIN:     MINIMUM DEPTH OF INPUTS DEPTHS IN METERS
      HADJ:     ADJUSTMENT TO DEPTH FIELD IN METERS
      HCVRT:    CONVERTS INPUT DEPTH FIELD TO METERS
      HDRY:     DEPTH AT WHICH CELL OR FLOW FACE BECOMES DRY
      HWET:     DEPTH AT WHICH CELL OR FLOW FACE BECOMES WET
      BEADJ:    ADJUSTMENT TO BOTTOM BED ELEVATION FIELD IN METERS
      BECVRT:   CONVERTS INPUT BOTTOM BED ELEVATION FIELD TO METERS
C
C11 DX DY DXYCVT ZBRADJ ZBRCVRT HMIN HADJ HCVRT HDRY HWET BEADJ BECVRT
   3.7 3.7  1.   0.0125  0.0    0.1  0.1  1.0  0.05  0.06  -0.1 -1.0
-------------------------------------------------------------------
```

Card image 11 specifies horizontal grid, bottom roughness and bathymetric parameters. The parameters DX and DY are used to specify constantly spaced Cartesian cell sizes for grids specified by the cell.inp and depth.inp files when ISCLO equals 0. The conversion factor DXYCVT can be used to convert the units of DX and DY in the dxdy.inp to the required internal unit of meters. The parameters ZBRADJ and ZBRCVRT are used to adjust and convert the log law, z_o, bottom roughness specified in either the dxdy.inp or depth.inp files. The conversion equation is of the form:

ZBR=ZBRADJ + ZBRCVRT*ZBR

The parameter HMIN is used to specify a minimum depth, over- riding input values. The parameters HADJ and HCVRT and BEADJ and BECVRT provide for adjustments and conversions to the initial depth and bottom elevation inputs in the same format as that for bottom roughness. The parameter HDRY specifies the water depth at which a cell becomes dry, while HWET specifies the depth at which the cell become wet.

Card Image 12

```
-------------------------------------------------------------------
C12 TURBULENT DIFFUSION PARAMETERS
C
      AHO:     CONSTANT HORIZONTAL MOMENTUM AND MASS DIFFUSIVITY M*M/S
      AHD:     DIMENSIONLESS HORIZONTAL MOMENTUM DIFFUSIVITY
      AVO:     MOLECULAR KINEMATIC VISCOSITY M*M/S
      ABO:     MOLECULAR DIFFUSIVITY M*M/S
      AVBCON:  EQUALS ZERO FOR CONSTANT VERTICAL VISCOSITY AND
               DIFFUSIVITY EQUAL TO AVO AND ABO
      ISFAVB:  SET TO 1 TO SQRT FILTER AVV AND AVB
C
C12  AHO   AHD     AVO      ABO      AVBCON  ISFAVB
     0.0   0.0     1.E-6    1.E-9    1.0     0
-------------------------------------------------------------------
```

Card image 12 provides information for horizontal and vertical momentum and mass diffusion. A spatially constant horizontal diffusion is specified by a constant value AHO. A variable horizontal diffusion may be added to the constant value by specifying a non-zero value of AHD, which is the dimensionless constant in the Smagorinsky subgrid scale horizontal diffusion formulation (Smagorinsky, 1963). The background molecular kinematic viscosity and diffusivity are specified by AVO and ABO respectively. When AVBCON is set to 0, the turbulence model is deactivated and the vertical viscosity and diffusivity are set to AVO and ABO respectively. Using this option and setting AVO and ABO to larger values representing turbulent flow readily allows model results to be compared with constant viscosity and diffusivity analytical solutions for vertical current structure. Setting the parameter ISFAVB to 1 activates a square root smoother for both the vertical turbulent viscosity and diffusivity of the form:

AVO(n+1)=SQRT(AVO(n+1)*AVO(n))

where n indicates the timestep. The smoother is particularly useful for flows having strong surface wind stress forcings.

Card Image 13

```
-----------------------------------------------------------------------
C13 TURBULENCE CLOSURE PARAMETERS
C
      VKC:    VON KARMAN CONSTANT
      CTURB:  TURBULENT CONSTANT (UNIVERSAL)
      CTE1:   TURBULENT CONSTANT (UNIVERSAL)
      CTE2:   TURBULENT CONSTANT (UNIVERSAL)
      CTE3:   TURBULENT CONSTANT (UNIVERSAL)
      QQMIN:  MINIMUM TURBULENT INTENSITY SQUARED
      QQLMIN: MINIMUM TURBULENT INTENSITY SQUARED TIME MACRO-SCALE
      DMLMIN: MINIMUM DIMENSIONLESS MACRO-SCALE
C
C13 VKC   CTURB   CTE1   CTE2   CTE3   QQMIN   QQLMIN   DMLMIN
    0.4   16.0    1.8    1.33   0.53   1.E-8   1.E-16   1.E-8
-----------------------------------------------------------------------
```

The turbulence closure parameters should not be modified without consulting the writer!

Card Image 14

```
-----------------------------------------------------------------------
C14 PERIODIC FORCING CONSTITUENT AND HARMONIC ANALYSIS PARAMETERS
C
      MTIDE:   NUMBER OF PERIOD FORCING CONSTITUENTS
      ISLSHA:  1 FOR IN PLACE LEAST SQUARES HARMONIC ANALYSIS
      MLLSHA:  NUMBER OF LOCATIONS FOR LSHA
      NTCLSHA: LENGTH OF LSHA IN INTEGER NUMBER OF REF TIME PERIODS
      ISLSTR:  1 FOR TREND REMOVAL
      ISHTA :  1 FOR SINGLE TREF PERIOD SURFACE ELEV ANALYSIS
C
C14 MTIDE  ISLSHA  MLLSHA   NTCLSHA  ISLSTR  ISHTA
    7      1        8       56       0       0
-----------------------------------------------------------------------
```

Card image 14 provides basic data for specifying periodic water surface elevation forcings on open boundaries as well as controlling inplace least squares harmonic analysis of modeling predictions. MTIDE specifies the number of periodic constituents. ISLSHA activates the least squares harmonic analysis at MLLSHA user specified horizontal locations over NTCLSHA reference time periods. The analysis assumes a steady component or a linear trend component if ISLSRT is set to 1. The switch ISHTA should only be activated if MTIDE is equal to 1, with a single period constituent least squares harmonic analysis activated for the entire free surface displacement and horizontal velocity field.

Card Image 15

```
-------------------------------------------------------------------
C15 PERIODIC FORCING (TIDAL) CONSTITUENT SYMBOLS AND PERIODS
C
      SYMBOL:  FORCING SYMBOL (CHARACTER VARIABLE) FOR TIDES, THE NOS
               SYMBOL
      PERIOD:  FORCING PERIOD IN SECONDS
C
C15 SYMBOL   PERIOD
      'M2'     44714.16
      'S2'     43200.00
      'N2'     45570.05
      'K1'     86164.09
      'M4'     22357.08
      'O1'     92949.63
      'M6'     14904.72
      'MSf'  1275721.39
      'Mm'   2380713.14
-------------------------------------------------------------------
```

Card image 15 specifies user defined symbols or standard NOAA tidal constituent symbols and forcing periods for the MTIDE constituents.

Card Image 16

```
-------------------------------------------------------------------
C16 HARMONIC ANALYSIS LOCATIONS AND SWITCHES
C
      ILLSHA:   I CELL INDEX
      JLLSHA:   J CELL INDEX
      LSHAP:  1 FOR ANALYSIS OF SURFACE ELEVATION
      LSHAB:  1 FOR ANALYSIS OF SALINITY
      LSHAUE: 1 FOR ANALYSIS OF EXTERNAL MODE HORIZONTAL VELOCITY
```

```
      LSHAU:  1 FOR ANALYSIS OF HORIZONTAL VELOCITY IN EVERY LAYER
      CLSL:      LOCATION AS A CHARACTER VARIABLE
C
C16 ILLSHA   JLLSHA   LSHAP  LSHAB  LSHAUE LSHAU  CLSL
     201       52       1      0      0      0    'OPEN BOUNDARY'
     166       44       1      0      0      0    'SEWELL'S POINT'
     168       55       1      0      0      0    'FORT MONROE'
     145       44       1      0      0      0    'NN POINT'
     138       30       1      0      0      0    'PIG POINT'
     124       69       1      0      0      0    'JR BRIDGE N'
     111       57       1      0      0      0    'JR BRIDGE S'
      85       80       1      0      0      0    'BURWELL BAY'
--------------------------------------------------------------------
```

Card image 16 specifies the I and J cell indices at which multiple constituent least squares harmonic analysis is to be performed. The following four switches activate the analysis for surface elevation, salinity, the barotropic or depth integrated horizontal velocity and the horizontal velocity in each layers. The character string identifies the analysis location in the output file lsha.out.

Card Image 17

```
--------------------------------------------------------------------
C17 SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITION PARAMETERS
C
      NPBS:    NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY
               CONDITIONS CELLS ON SOUTH OPEN BOUNDARIES
      NPBW:    NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY
               CONDITIONS CELLS ON WEST OPEN BOUNDARIES
      NPBE:    NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY
               CONDITIONS CELLS ON EAST OPEN BOUNDARIES
      NPBN:    NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY
               CONDITIONS CELLS ON NORTH OPEN BOUNDARIES
      NPFOR:   NUMBER OF HARMONIC FORCINGS
      NPSER:   NUMBER OF TIME SERIES FORCINGS
```

```
      PDGINIT: ADD THIS CONSTANT ADJUSTMENT GLOBALLY TO THE SURFACE
               ELEVATION
C
C17  NPBS NPBW NPBE NPBN  NPFOR  NPSER  PDGINIT
     0    0    10   0     2      0      0.0
--------------------------------------------------------------------
```

Card image 17 specifies the number of open boundary cells on south, west, east and north open boundaries in the computational grid, as well as the number of periodic forcing functions, the number of surface elevation time series to be used for open boundary forcings and an initial adjustment to the water surface elevation. If NPSER is greater than zero, NPSER surface elevation time series are read from the pser.inp file. The adjustment factor should in general not be used without consultation with the writer. Note that south and north boundary cells paired to implement the periodic domain configuration in the computation y direction should not be included in the NPBS and NPBN counts.

Card Image 18

```
--------------------------------------------------------------------
C18 PERIODIC FORCING SURF ELEV OR PRESSURE BOUNDARY COND. FORCINGS
C
      NPFOR:      FORCING NUMBER
      SYMBOL:     FORCING SYMBOL (FOR REFERENCE HERE ONLY)
      AMPLITUDE:  AMPLITUDE IN M (PRESSURE DIVIDED BY RHO*G)
      PHASE:      FORCING PHASE RELATIVE TO TIME ORIGIN OF TBEGIN IN
                     SECONDS
C
C18 NPFOR    SYMBOL   AMPLITUDE      PHASE
     1       'M2'      0.34200E+00    0.10855E+05
     1       'S2'      0.63000E-01   -0.13959E+05
     1       'N2'      0.76000E-01   -0.11331E+05
     1       'K1'      0.44000E-01    0.21641E+05
     1       'M4'      0.0            0.0
     1       'O1'      0.35798E-01   -0.23892E+04
     1       'M6'      0.0            0.0
     2       'M2'      0.0            0.0
     2       'S2'      0.0            0.0
     2       'N2'      0.0            0.0
```

```
     2       'K1'      0.0            0.0
     2       'M4'      0.0            0.0
     2       'O1'      0.0            0.0
     2       'M6'      0.0            0.0
--------------------------------------------------------------------
```

Card image 18 specifies NPFOR forcing functions, each having MTIDE constituents, with the first column set to the forcing number for user reference. Constituents for each forcing should be in the order sequence defined on card image 16. The phase is specified in seconds consistent with the representation:

$$\zeta_{tot}(t) = \sum_{n=1}^{N} \zeta_n \cos\left(\frac{2\pi}{T_n} (t - \tau_n) \right) + \zeta_{ser}(t) \qquad (4)$$

where ζ and τ are the amplitude and phase of the n constituent and ζ_{ser} is an additive time series specification of the surface elevation. The time origin for the phase should be consistent with the time origin for the simulation. For example TBEGIN on card image 8 is in Julian hours relative to midnight, January 1 of a given year. For this case, then the phase should also be relative to midnight January 1 of the same year. For the analysis of field records, to accomplish this synchronization, a stand alone least square harmonic analysis program lsqhs.f is available from the writer. The null forcing function 2 might be used on an open boundary with only outgoing wave propagation, to be discussed below.

Card Image 19

```
--------------------------------------------------------------------
C19 PERIODIC FORCING SURF ELEV OR PRESSURE ON SOUTH OPEN BOUNDARIES
C
      IPBS:      I CELL INDEX OF BOUNDARY CELL
      JPBS:      J CELL INDEX OF BOUNDARY CELL
      ISPBS:   1 FOR RADIATION-SEPARATION CONDITION
               0 FOR ELEVATION SPECIFIED
      NPFORS:    APPLY HARMONIC FORCING NUMBER NPFORS
      NPSERS:    APPLY TIME SERIES FORCING NUMBER NPSERS
C
C19   IPBS   JPBS   ISPBS    NPFORS  NPSERS
--------------------------------------------------------------------
```

Card Image 20

```
--------------------------------------------------------------------
C20 PERIODIC FORCING SURF ELEV OR PRESSURE ON WEST OPEN BOUNDARIES
C
```

```
      IPBW:   SEE CARD 19
      JPBW:
      ISPBW:
      NPFORW:
      NPSERW:
C
C20   IPBW   JPBW   ISPBW    NPFORW  NPSERW
--------------------------------------------------------------------
```

Card Image 21

```
--------------------------------------------------------------------
C21 PERIODIC FORCING SURF ELEV OR PRESSURE ON EAST OPEN BOUNDARIES
C
      IPBE:   SEE CARD 19
      JPBE:
      ISPBE:
      NPFORE:
      NPSERE:
C
C21  IPBE    JPBE   ISPBE    NPFORE  NPSERE

     201      46       1       1      0
     201      47       1       1      0
     201      48       1       1      0
     201      49       1       1      0
     201      50       1       1      0
     201      51       1       1      0
     201      52       1       1      0
     201      53       1       1      0
     201      54       1       1      0
     201      55       1       1      0
--------------------------------------------------------------------
```

Card Image 22

```
--------------------------------------------------------------------
C22 PERIODIC FORCING SURF ELEV OR PRESSURE ON NORTH OPEN BOUNDARIES
C
      IPBN:   SEE CARD 19
      JPBN:
      ISPBN:
      NPFORN:
      NPSERN:
```

```
C
C22 IPBN     JPBN   ISPBN    NPFORN  NPSERN
-------------------------------------------------------------------
```

Card images 19 through 22 specify the open boundary conditions for the four directional faces of the horizontal computational domain. Because of the similarity of the four data sets, they will be discussed in a generic fashion. To provide background on the discussion of the model's operation at open boundaries, it is useful to summarize the treatment of open boundary conditions in the EFDC model. The EFDC model provides for two types of hydrodynamic open boundary conditions. The first type is the standard specification of water surface elevation using combinations of harmonic constituents and time series. The second type of open boundary conditions is referred to as a radiation-separation boundary condition in that the incoming wave at an open boundary is separated from the outgoing wave (Bennett and McIntosh, 1982). For outgoing waves the condition functions as a radiation condition with a phase speed equal to the square root of gh, where h is the mean or undisturbed depth along the open boundary. For incoming waves, 1/2 of the characteristic of the incoming wave is specified. As an example, consider an east open boundary, with the model domain to the west in the negative *x* direction and the unmodeled region to the east in the positive *x* direction. The incoming characteristic for the linearized one-dimensional shallow water equation (Bennett, 1976), is:

$$\zeta - \frac{h\bar{u}}{\sqrt{gh}} \tag{5}$$

where ζ is the free surface displacement, h is the water depth and u is the x component of velocity, with the overbar denoting depth averaged or external mode velocity. For a purely progressive wave propagating in the negative x direction, incoming toward the east open boundary:

$$\zeta = \zeta_0 \cos\left(\omega\left(\frac{x}{\sqrt{gh}} + t\right)\right) \tag{6}$$

$$\frac{h\bar{u}}{\sqrt{gh}} = -\zeta_0 \cos\left(\omega\left(\frac{x}{\sqrt{gh}} + t\right)\right) \tag{7}$$

Inserting (6) and (7) into (5) gives

$$\zeta - \frac{h\bar{u}}{\sqrt{gh}} = 2\zeta_0 \cos\left(\omega\left(\frac{x}{\sqrt{gh}} + t \right) \right) = 2\zeta \tag{7}$$

Thus 1/2 of the characteristic of the purely progressive incoming wave is the wave surface displacement.

Open boundary cells are defined by the type 5 cell type in the cell.inp file but are presumed to be external to the computation in that the continuity equation is not solved in the open boundary cell. Tangential velocities (i.e. the u or x velocity component in a south or north open boundary cell and the v or y velocity component in an east or west open boundary cell) are also not currently computed in open boundary cells. Due to the placement definition of u on west cell faces and v on south cell faces, the u is computed for east open boundary cells and v is computed for north open boundary cells. The first two parameters on each card image specify the I and J indices of the open boundary cells. The I and J indices sequence does not need to be continuous since a model domain may have multiple opening on either of the four directional face normals. The ISBPS (ISPBW,E,N) switch is set to zero for direct specification of the open boundary cell surface elevation or to 1 for the implementation of a radiation-separation boundary condition. For ISPBS set to zero, the open boundary cell water surface elevation is directly specified by the sum of the periodic forcing function (NPFORS,W,E,N) and the surface elevation time series (NPSERS,W,E,N) where NPSER_ identifies one of the NPSER surface elevation time series in the pser.inp file. The radiation-separation boundary condition specifies the linear characteristic of an assumed normal incident incoming wave as twice the surface elevation specified by the sum of the periodic and time series forcing. By default, the outgoing characteristic is left undefined allowing waves generated interior to the model domain to pass outward across the boundary with no reflection. Since the normal incident criteria is somewhat idealized, care should be used in the use of the radiation separation boundary condition. A more sophisticated radiation-separation open boundary condition (relaxing the normal incident criteria the imposition of zero tangential velocity) is under development.

Card Image 23

- -

```
C23 VELOCITY, VOL SOURCE/SINK, FLOW CONTROL, & WITHDRAWAL/RETURN DATA
C
      NVBS:   NUMBER OF VELOCITY BC'S ON SOUTH OPEN BOUNDARIES
      NUBW:   NUMBER OF VELOCITY BC'S ON WEST OPEN BOUNDARIES
      NUBE:   NUMBER OF VELOCITY BC'S ON EAST OPEN BOUNDARIES
      NVBN:   NUMBER OF VELOCITY BC'S ON NORTH OPEN BOUNDARIES
      NQSIJ:  NUMBER OF CONSTANT AND/OR TIME SERIES SPECIFIED
              SOURCE/SINK LOCATIONS (RIVER INFLOWS,ETC)
      NQSER:  NUMBER OF VOLUME SOURCE/SINK TIME SERIES
      NQCTL:  NUMBER OF PRESSURE CONTROLLED WITHDRAWAL/RETURN PAIRS
      NQWR:   NUMBER OF CONSTANT OR TIME SERIES SPECIFIED
              WITHDRAWAL/RETURN PAIRS
      ISDIQ:  SET TO 1 TO WRITE DIAGNOSTIC FILE, diaq.out
C
C23 NVBS NUBW NUBE NVBN NQSIJ NQSER NQCTL NQWR  ISDIQ
    0    0    0    0    4     3     4     1     0
--------------------------------------------------------------------
```

Card image 23 specifies basic information on volumetric sources and sinks. The first four parameters on this card are currently inactive. Volumetric source and sink representation in the EFDC model falls within three classes. The first class is constant or time varying volumetric sources and sinks at NQSIJ horizontal grid locations. The second class is pressure or surface elevation controlled hydraulic structures occurring as NQCTL source and sink pairs. The third class is constant or time variable flow withdrawal and return sources and sinks occurring as NQWR pairs. The sources and sinks associated with NQSIJ and NQWR may have constant flow rates, specified in this file or time variable flow rates as specified by one of NQSER flow time series read from the qser.inp file. For positive NQSIJ sources, inflow concentrations of the various transported scalar constituents may be associated with the flow. For negative NQSIJ sinks, mass loss of transport scalar constituents is accounted for. The withdrawal-return source sink class provides for a constant or time variable concentration rise between the withdrawal and return cells. The NQWR options is designed to power plant and industrial cooling systems. The final switch ISDIQ activates diagnostics of allowable classes of volumetric source and sink flows to be written to the file diaq.out. Since this file can become quite large, this option is recommended to be used only for debugging. Generally when activated, the model should be allowed to run only a few timesteps and then killed.

Card Image 24

```
--------------------------------------------------------------------
C24 VOLUME SOURCE/SINK LOCATIONS, MAGNITUDES, AND CONCENTRATION SERIES
C
      IQS:     I CELL INDEX OF VOLUME SOURCE/SINK
```

```
      JQS:     J CELL INDEX OF VOLUME SOURCE/SINK
      QSSE:    CONSTANT INFLOW/OUTFLOW RATE IN M*M*M/S or M*M/S
      NQMUL:   MULTIPLIER SWITCH FOR CONSTANT AND TIME SERIES VOL S/S
               = 0  MULT BY 1. FOR NORMAL IN/OUTFLOW (L*L*L/T)
               = 1  MULT BY DY FOR LATERAL IN/OUTFLOW (L*L/T) ON
                    U FACE
               = 2  MULT BY DX FOR LATERAL IN/OUTFLOW (L*L/T) ON
                    V FACE
               = 3  MULT BY DX+DY FOR LATERAL IN/OUTFLOW (L*L/T)
                    ON U&V FACES
      NQMF:    IF NON ZERO ACCOUNT FOR VOL S/S MOMENTUM FLUX
               = 1  MOMENTUM FLUX ON NEG U FACE
               = 2  MOMENTUM FLUX ON NEG V FACE
               = 3  MOMENTUM FLUX ON POS U FACE
               = 4  MOMENTUM FLUX ON POS V FACE
      NQSERQ:   ID NUMBER OF ASSOCIATED VOLUMN FLOW TIME SERIES
      NSSERQ:   ID NUMBER OF ASSOCIATED SALINITY TIME SERIES
      NTSERQ:   ID NUMBER OF ASSOCIATED TEMPERATURE TIME SERIES
      NDSERQ:   ID NUMBER OF ASSOCIATED DYE CONC TIME SERIES
      NSDSERQ:  ID NUMBER OF ASSOCIATED SEDIMENT CONC TIME SERIES
      NSWSERQ:  ID NUMBER OF ASSOCIATED SAL WATER QUALITY TIME SERIES
C
C24 IQS JQS QSSE NQMUL NQMF NQSERQ NSSERQ NTSERQ NDSERQ NSDSERQ NSWSERQ
    191 144  0.0  0     0     1      0      1      0      0       0
    112   6  0.0  0     0     2      0      1      0      0       0
    112   7  0.0  0     0     3      0      1      0      0       0
    100 100  1.0  0     0     0      0      0      0      0       0
--------------------------------------------------------------------
```

Card image 24 provides information for the NQSIJ class of volumetric source sink flows, with the first two parameters specifying the location by I and J indices. The third parameter, QSSE is used to specify a time invariant inflow rate (outflows or sinks simply have negative signs) in either cubic meters per second or cubic meters per second per meter. The adjustment factor NQMUL specifies how volumetric flows per unit length are converted to true volumetric flows. The control parameter NQMF indicates if the volumetric source or sink is to have an associated momentum flux and which face of the source cell the momentum flux is assigned. Time variable flows are defined by entering a flow time series identifier number (less than or equal to NQSER) under NQSERQ. The remaining five columns allow the specification of a scalar constituent concentration time series associated with the flow time series only. Constant concentrations associated with the constant QSEE flows are defined on card image 25, below. The constant flowrate source and sinks are distributed uniformly over the vertical layers, while the time series specification of source and sink flows allows arbitrary distribution over the vertical layers.

Card Image 25

```
-------------------------------------------------------------------
C25 TIME CONSTANT INFLOW CONC FOR TIME CONSTANT VOLUMETRIC SOURCES
C
      SALT:  SALT CONCENTRATION CORRESPONDING TO INFLOW ABOVE
      TEMP:  TEMPERATURE CORRESPONDING TO INFLOW ABOVE
      DYEC:  DYE CONCENTRATION CORRESPONDING TO INFLOW ABOVE
      SEDC:  SEDIMENT CONCENTRATION CORRESPONDING TO INFLOW ABOVE
      SFL :  SFL CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C
C25 SALT   TEMP   DYEC   SEDC  SFL
    0.     0.     0.     0.    0.
    0.     0.     0.     0.    0.
    0.     0.     0.     0.    0.
    0.    20.     0.     0.    0.
-------------------------------------------------------------------
```

Card Image 26

```
-------------------------------------------------------------------
C26 SURF ELEV OR PRESSURE DEPENDENT FLOW CONTROL STRUCTURE INFORMATION
C
      IQLU:   I INDEX OF UPSTREAM OR WITHDRAWAL CELL (IQCTLU IN CODE)
      JQLU:   J INDEX OF UPSTREAM OR WITHDRAWAL CELL (JQCTLU IN CODE)
      IQLD:   I INDEX OF DOWNSTREAM OR RETURN CELL   (IQCTLD IN CODE)
      JQLD:   J INDEX OF DOWNSTREAM OR RETURN CELL   (JQCTLD IN CODE)
      NQCTYP:   CONTROL STRUCTURE TYPE
                = 0  FLOW DRIVEN BY ELEVATION OR PRESSURE DIFFERENCE
                = 1  FLOW DRIVEN BY SQ ELEVATION OR PRESSURE
                     DIFFERCENCE (NOT ACTIVE)
                = 2  SFWMD LEVEE SEEPAGE FUNCTION, REQUIRES AUX DNSRM
                     CELL  (NOT ACTIVE)
      NQCTLQ:   ID NUMBER OF CONTROL CHARACTERIZATION TABLE
      NQCMUL:   MULTIPLIER SWITCH FOR FLOWS FROM UPSTREAM CELL
                = 0  MULT BY 1. FOR CONTROL TABLE IN (L*L*L/T)
                = 1  MULT BY DY FOR CONTROL TABLE IN (L*L/T) ON
                     U FACE
                = 2  MULT BY DX FOR CONTROL TABLE IN (L*L/T) ON
                     V FACE
                = 3  MULT BY DX+DY FOR CONTROL TABLE IN (L*L/T) ON
                     U&V FACES
      NQCMFU:   IF NON-ZERO ACCOUNT FOR FLOW MOMENTUM FLUX IN UPSTREAM
                   CELL
                = 1  MOMENTUM FLUX ON NEG U FACE
                = 2  MOMENTUM FLUX ON NEG V FACE
```

```
                = 3  MOMENTUM FLUX ON POS U FACE
                = 4  MOMENTUM FLUX ON POS V FACE
      NQCMFD:  IF NON ZERO ACCOUNT FOR FLOW MOMENTUM FLUX IN
               DOWNSTREAM CELL
                = 1  MOMENTUM FLUX ON NEG U FACE
                = 2  MOMENTUM FLUX ON NEG V FACE
                = 3  MOMENTUM FLUX ON POS U FACE
                = 4  MOMENTUM FLUX ON POS V FACE
      IQCAX     AUXILLARY DOWNSTREAM CELL I INDEX FOR NOCTYP=2
      JQCAX     AUXILLARY DOWNSTREAM CELL J INDEX FOR NOCTYP=2
C
C26 IQCU JQCU IQCD JQCD NQCTYP NQCTLQ NQCMUL NQCMFU NQCMFD IQCAX JQCAX
      37    4   37    2   0      1     1       0      0     0     0
      37    5   37    2   0      2     1       0      0     0     0
      37    6   37    2   0      3     1       0      0     0     0
      37    7   37    2   0      4     1       0      0     0     0
-------------------------------------------------------------------
```

Card image 26 specifies the location and properties of source-sink pairs representing hydraulic control structures. The notation of upstream (sink) and downstream (source) is used for the hydraulic control structure pairs, which allow flow in only one direction. For structures such as culverts, which allow bi-directional flow, two control structure pairs are necessary to account for both flow directions. The first four parameters on this card image define the horizontal locations by the I and J indices of the upstream and downstream cells. Structures whose flowrates depend only on the surface elevation in the upstream cell (i.e., spillways and weirs) can discharge out of the computational domain by specifying the null indices 0,0 for the downstream cell. The parameter NQCTYP specifies the form of the flow dependence on the surface elevation difference between the upstream and downstream cell, (with only the 0 option currently active). The parameter NQCTLQ identifies control table number characterizing the structure. The control tables are input in the file qctl.inp. The options identifies NQCMUL and NQCMFU are similar to those discussed for the NQSIJ class sources and sinks. The remaining two indices, IQCAX and JQCAX are currently not used.

Card Image 27

```
-------------------------------------------------------------------
C27 FLOW WITHDRAWAL, HEAT OR MATERIAL ADDITION, AND RETURN DATA
C
      IWU:      I INDEX OF UPSTREAM OR WITHDRAWAL CELL (IWRU IN CODE)
      JWU:      J INDEX OF UPSTREAM OR WITHDRAWAL CELL (IWRU IN CODE)
      IWRD:     I INDEX OF DOWNSTREAM OR RETURN CELL  (IWRD IN CODE)
      JWRD:     J INDEX OF DOWNSTREAM OR RETURN CELL  (IWRD IN CODE)
      QWRE:     CONSTANT VOLUMN FLOW RATE FROM WITHDRAWAL TO RETURN
      NQSERW:   ID NUMBER OF ASSOCIATED VOLUMN FLOW TIME SERIES
      NSSERW:   ID NUMBER OF ASSOCIATED SALINITY INCREASE TIME SERIES
      NTSERW:   ID NUMBER OF ASSOCIATED TEMP INCREASE TIME SERIES
      NDSERW:   ID NUMBER OF ASSOCIATED DYE CONC INCREASE TIME SERIES
```

```
      NSDSERW:  ID NUMBER OF ASSOCIATED SED CONC INCREASE TIME SERIES
      NSFSERW:  ID NUMBER OF ASSOCIATED SFL CONC INCREASE TIME SERIES
C
C27 IWU JWU IWD JCWD QWRE NQSERW NSSERW NTSERW NDSERW NSDSERW NSFSERW
    84  102  75 107  88.3   0      0      0      0       0      0
--------------------------------------------------------------------
```

Card image 27 provides information for the NQWR volumetric source-sink class with the location of the upstream (withdrawal) and downstream (return) flow cell pairs specified by their I and J indices. The remaining parameters specify a constant flow rate and time series identified for variable flow rates and concentration rises. Time constant concentration rises associated with the constant flow rate are specified as shown below on card image 28.

Card Image 28

```
--------------------------------------------------------------------
C28 TIME CONSTANT WITHDRAWAL AND RETURN CONCENTRATION RISES
C
      SALT:    SALINITY RISE
      TEMP:    TEMPERATURE RISE
      DYE:     DYE CONCENTRATION RISE
      SEDC:    SEDIMENT CONCENTRATION RISE
      SFL:     SFL RISE
C
C28 SALT   TEMP   DYEC   SEDC   SFL
    0.     8.     0.     0.     0.
--------------------------------------------------------------------
```

Card Image 29

```
-------------------------------------------------------------------
C29 SUSPENDED SEDIMENT SOURCE/SINK PARAMETERS
C
      SEDO:    INITIAL SEDIMENT CONCENTRATION IN FLUID PHASE
      SEDBO:   INITIAL SEDIMENT PER UNIT AREA OR BOTTOM SURFACE
      SDEN:    SEDIMENT SPECIFIC VOLUMN
      SSG:     SEDIMENT SPECIFIC GRAVITY
      WSEDO:   CONSTANT OR REFERENCE SEDIMENT SETTLING VELOCITY
               IN FORMULA WSED=WSEDO*( (SED/SEDSN)**SEXP )
      SEDSN:   NORMALIZING SEDIMENT CONCENTRATION (COHESIVE SED)
               SED MASS/VOLUME IN BED (NONCOHESIVE SED TRANSPORT)
      SEXP:    EXPONENTIAL (COHESIVE SED TRANSPORT) OR DIMENSIONLESS
               RESUSPENSION PARAMETER GAMMA ZERO (NONCOHESIVE SED)
      TAUD:    BOUNDARY STRESS BELOW WHICH DEPOSITION TAKES PLACE
               ACCORDING TO (TAUD-TAU)/TAUD (COHES) OR DUNE BREAK PT
               STRESS (NONCOHES)
      WRSPO:   REFERENCE RESUSPENSION RATE IN FORMULA
               WRSP=WRSPO*( ((TAU-TAUR)/TAUN)**TEX ) (COHESIVE SED
               TRANS ONLY)
      TAUR:    BOUNDARY STRESS ABOVE WHICH RESUSPENSION TAKES PLACE
      TAUN:    NORMALIZING STRESS (EQUAL TO TAUR FOR NONCOHESIVE SED)
      TEX:     EXPONENTIAL (COH SED), CRITICAL SHIELDS PARM (NONCOH)
      SDBLV:   CONVERTS SEDIMENT FLUX AT BED TO CHANGE IN BED ELEVATION
               USING BELV(N+1)=BELV(N)-DT*SDBLV*SEDF(L,0) SDBLV=0.58E-6
C
C29 SEDO SEDBO SDEN SSG WSEDO SEDSN SEXP TAUD WRSPO TAUR TAUN TEX SDBLV
    40.  0.  0.4E-6 2.5 5.E-5 1.E-5 0.  7.5E-5 0.2 1.E-4 1.E-4 1.  0.
-------------------------------------------------------------------


C29 SEDO SEDBO SDEN SSG WSEDO SEDSN SEXP TAUD WRSPO TAUR TAUN TEX SDBLV
  .01  0.  0.4E-6 2.65 0.015 1.7E+6 .001 3.9E-4  0. 1.5E-4 1.5E-4 0.06 0.
-------------------------------------------------------------------
```

Card image 29 specifies information for the transport of suspended cohesive or non-cohesive sediment. The EFDC model currently allows for the transport of only one sediment class but may be easily modified for multiple sediment classes with the information of this card image repeated for each class. The various parameters on this card image have different meanings for cohesive and noncohesive sediment. The first example input line shows parameter values typical of estuarine cohesive sediment while the second shows values typical of 0.15 mm sand under combined current and wave action. For both types of sediment, the units are chosen such that sediment concentrations in the water column will have units of mg per liter and the mass per unit area of sediment on the bed will be grams per square meter. These units remain consistent if velocities are specified in meters per second and stresses are expressed in kinematic units of square meters per square seconds (i.e., stresses are squared shear velocities). The first two parameters for both sediment classes are the initial sediment concentration in the water column and the initial mass of sediment per unit area on the bed which are used to initialize the entire model domain for cold starts or when restarting with no sediment information in the restart.inp file for cold starts. The third parameter is the sediment specific volume and is used only to introduce the effect of suspended sediment into the buoyancy distribution by:

```
B(L,K)=B(L,K)*(1.-SDEN*SED(L,K))+(SSG-1.)*SDEN*SED(L,K)
```

where B is the buoyancy ((mixture density-ref water density)/ref water density) and SED is the sediment concentration in mg/l. The parameter SSG is the sediment specific gravity. For noncohesive sediment, WSEDO represents a constant settling velocity in m/s. For cohesive sediment, a concentration dependent settling velocity of the form:

```
WSED=WSDEO*( (SED/SEDN)**SEXP )
```

where SEDN is a reference or normalizing sediment concentration and SEXP is a dimensionless quantity. For noncohesive sediment SEDN is the maximum sediment concentration defined as the sediment mass per unit total volume in the bed (sediment density in mg/l times the bed porosity). For noncohesive sediment, SEXP is a dimensionless coefficient in an empirical formula for the reference near bed sediment concentration. For cohesive sediment, TAUD is a probability of deposition stress in the depositional flux expression:

```
FLUXD=WSED*SED*(TAUD-TAU)/TAUD:      TAU.LT.TAUD
FLUXD=0                              TAU.GE.TAUD
```

where TAU is the magnitude of the bottom boundary or bed stress. For noncohesive sediment, TAUD is the bottom boundary stress at which ripples or dunes begin to decay and is determined from a Shields' parameter ratio according to Grant and Madsen (1982) (also see Glenn and Grant, 1987). The parameter WRSPO is used only for cohesive sediment transport to specify the sediment resuspension rate according to:

```
WRSP=WRSPO*( ((TAU-TAUR)/TAUN)**TEX ):     TAU.GT.TAUR
WRSP=0                                     TAU.LE.TAUR
```

The units of WRSPO are (m/s)*(mg/liter). For cohesive sediment transport, the next three parameters are as defined in the above resuspension formula. For noncohesive sediment, TAUR and TAUN are both equal to the critical stress for incipient sediment motion and are determined from the critical Shields' parameter. For noncohesive sediment transport, TEX is the critical Shields' parameter. For both sediment classes, the parameter SDBLV is used to determine bottom bed elevation changes in response to deposition and resuspension according to:

```
BELV(N+1)=BELV(N)-DT*SDBLV*SEDF(L,0)
```

where BELV is the bed elevation at time level N+1 or N and SEDF is the bed flux defined as positive for resuspension. For fine sand, SDBLV=0.58E-6 in units such that BELV is in meters, DT is in seconds, and SEDF is in (m/s)*(mg/liter).

Card Image 30

```
--------------------------------------------------------------------
C30 CONCENTRATION BOUNDARY CONDITION AND SOURCE PARAMETERS AND REF TEMP
C
      NCBS:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON SOUTH OPEN
              BOUNDARIES
      NCBW:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON WEST OPEN
              BOUNDARIES
      NCBE:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON EAST OPEN
              BOUNDARIES
      NCBN:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON NORTH OPEN
              BOUNDARIES
```

```
      NSSER:  NUMBER OF SALINITY TIME SERIES
      NTSER:  NUMBER OF TEMPERATURE TIME SERIES
      NDSER:  NUMBER OF DYE CONCENTRATION TIME SERIES
      NSDSER: NUMBER OF SEDIMENT CONCENTRATION TIME SERIES
      NSFSER: NUMBER OF SHELLFISH LARVAE CONCENTRATION TIME SERIES
      BSC:    BUOYANCY INFLUENCE COEFFICIENT 0 TO 1, BSC=1. FOR REAL
              PHYSICS
      TEMO:   REFERENCE, INITIAL, EQUILIBRIUM AND/OR ISOTHERMAL TEMP
              IN DEG C
      HEQT:   EQUILIBRIUM TEMPERATURE TRANSFER COEFFICIENT M/SEC
      RKDYE:  FIRST ORDER DECAY RATE FOR DYE VARIABLE IN 1/SEC
C
C30 NCBS NCBW NCBE NCBN NSSR NTSER NDSR NSDSR NSfSR BSC TEMO HEQT RKDYE
    0    0    10   0    0    1     0    0     0     1. 13.6 9.2E-06  0.
--------------------------------------------------------------------
```

Card image 30 is used to specify scalar constituent concentration informative on open boundaries as well as to provide additional scalar variable information. The first four parameters specify the number of concentration open boundary cells on the four computational grid direction faces and are identical to the first four parameters on card image 17. The next five parameters specify the number of time series to be read from files sser.inp, tser.inp, dser.inp, sdser.inp, and sfser.inp, respectively. The parameter BSC controls the buoyancy forcing in the momentum equations. The temperature TEMO, in degrees C, is used as the initial temperature for cold starts or the isothermal temperature. When the temperature transport option ISTOPT on card image 6 is specified as 3, TEMO is the time invariant equilibrium temperature. The parameter HEQT is the equilibrium surface heat transfer coefficient, in square meters per second, and is used only when the ISTOPT equals 3 option is set. The remaining parameter RKDYE is a first order decay rate of the dye tracer variable and must have units of 1/seconds.

Card Image 31

```
--------------------------------------------------------------------
C31  LOCATION OF CONC BC'S ON SOUTH BOUNDARIES
C
      ICBS:    I CELL INDEX
      JCBS:    J CELL INDEX
      NTSCRS:  NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON
               CHANGE TO INFLOW FROM OUTFLOW
      NSSERS:  SOUTH BOUNDARY CELL SALINITY TIME SERIES ID NUMBER
      NTSERS:  SOUTH BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER
      NDSERS:  SOUTH BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER
      NSDSERS: SOUTH BOUNDARY CELL SED CONC TIME SERIES ID NUMBER
      NSWSERS: SOUTH BOUNDARY CELL SFL CONC TIME SERIES ID NUMBER
C
C31  IBBS   JBBS  NTSCRS NSSERS NTSERS NDSERS NSDSERS  NSWSERS
--------------------------------------------------------------------
```

Card Image 32

```
-----------------------------------------------------------------------
C32 TIME CONSTANT BOTTOM CONC ON SOUTH CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING BOTTOM LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING BOTTOM LAYER SFL CONCENTRATION
C
C32 SALT  TEMP  DYEC  SEDC   SFL
-----------------------------------------------------------------------
```

Card Image 33

```
-----------------------------------------------------------------------
C33 TIME CONSTANT SURFACE CONC ON SOUTH CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING SURFACE LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING SURFACE LAYER SFL CONCENTRATION
C
C33 SALT  TEMP  DYEC  SEDC   SFL
-----------------------------------------------------------------------
```

Card Image 34

```
-----------------------------------------------------------------------
C34 LOCATION OF CONC BC'S ON WEST BOUNDARIES AND SERIES IDENTIFIERS
C
      ICBW:   SEE CARD 27
      JCBW:
      NTSCRW: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON
              CHANGE TO INFLOW FROM OUTFLOW
C
C34 ICBW  JCBW  NTSCRW NSSERW NTSERW NDSERW NSDSERW  NSWERW
-----------------------------------------------------------------------
```

Card Image 35

```
-------------------------------------------------------------------
C35 TIME CONSTANT BOTTOM CONC ON WEST CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING BOTTOM LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING BOTTOM LAYER SFL CONCENTRATION
C
C35 SALT  TEMP  DYEC   SEDC   SFL
-------------------------------------------------------------------
```

Card Image 36

```
-------------------------------------------------------------------
C36 TIME CONSTANT SURFACE CONC ON WEST CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING SURFACE LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING SURFACE LAYER SFL CONCENTRATION
C
C36 SALT  TEMP  DYEC   SEDC   SFL
-------------------------------------------------------------------
```

Card Image 37

```
-------------------------------------------------------------------
C37 LOCATION OF CONC BC'S ON EAST BOUNDARIES AND SERIES IDENTIFIERS
C
      ICBE:   SEE CARD 27
      JCBE:
      NTSCRE: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON
              CHANGE TO INFLOW FROM OUTFLOW
C
C37 ICBE   JCBE  NTSCRE NSSERE NTSERE NDSERE NSDSERE  NSWSERE
    201    46    36     0      1      0      0        0
    201    47    36     0      1      0      0        0
    201    48    36     0      1      0      0        0
    201    49    36     0      1      0      0        0
    201    50    36     0      1      0      0        0
    201    51    36     0      1      0      0        0
    201    52    36     0      1      0      0        0
```

```
    201    53    36     0      1      0      0        0
    201    54    36     0      1      0      0        0
    201    55    36     0      1      0      0        0
--------------------------------------------------------------------
```

Card Image 38

```
--------------------------------------------------------------------
C38 TIME CONSTANT BOTTOM CONC ON EAST CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING BOTTOM LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING BOTTOM LAYER SFL CONCENTRATION
C
C38 SALT  TEMP  DYEC  SEDC   SFL
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
--------------------------------------------------------------------
```

Card Image 39

```
--------------------------------------------------------------------
C39 TIME CONSTANT SURFACE CONC ON EAST CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING SURFACE LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING SURFACE LAYER SFL CONCENTRATION
C
C39 SALT  TEMP  DYEC  SEDC   SFL
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
```

```
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
     30.  25.6     0.  0.    30.
--------------------------------------------------------------------
```

Card Image 40

```
--------------------------------------------------------------------
C40 LOCATION OF CONC BC'S ON NORTH BOUNDARIES AND SERIES IDENTIFIERS
C
      ICBN:    SEE CARD 27
      JCBN:
      NTSCRN: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON
              CHANGE TO INFLOW FROM OUTFLOW
C
C40 ICBN   JCBN  NTSCRN NSSERN NTSERN NDSERN NSDSERN  NSWERN
--------------------------------------------------------------------
```

Card Image 41

```
--------------------------------------------------------------------
C41 TIME CONSTANT BOTTOM CONC ON NORTH CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING BOTTOM LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING BOTTOM LAYER SFL CONCENTRATION
C41 SALT  TEMP  DYEC  SEDC  SFL
--------------------------------------------------------------------
```

Card Image 42

```
--------------------------------------------------------------------
C42 TIME CONSTANT SURFACE CONC ON NORTH CONC BOUNDARIES
C
      SALT:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
      TEMP:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
      DYEC:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
      SEDC:  ULTIMATE INFLOWING SURFACE LAYER SEDIMENT CONCENTRATION
      SFL:   ULTIMATE INFLOWING SURFACE LAYER SFL CONCENTRATION
C
C42 SALT  TEMP  DYEC  SEDC  SFL
--------------------------------------------------------------------
```

Card images 31 through 42 specify scalar inflowing concentrations on open boundaries. The open boundary condition for salinity, temperature and other transported constituents is based on the specification of inflowing values. The inflowing values may be specified as depth dependent and either time constant or time variable, if concentration time series are available at open boundaries. Outflowing values are calculated using upwinded values immediately inside the open boundary. When the flow at the open boundary changes from outflow to inflow, the model provides for a linear interpolation of inflowing concentration, over a user specified number of timesteps, (NTSCR_ on card images 31, 34, 37, and 40) between the last outflowing value and the ultimate inflowing value of concentration, which allows for a smooth transition of concentration values at the open boundary. The ultimate inflowing concentration is the sum of a time constant value and a time series specified inflowing concentration value (either of which may be zero). Card images 31, 34, 37, and 40 define the location of open boundary cells by the indices ICB_ and JCB_. The next parameter on these four card images, NTSCR_, defines the number of time steps to recover the specified boundary concentration value after the change from outflow to inflow. For tidal flows, NTSCR_ might typically be the number of time steps corresponding to one hour. Alternately NTSCR_ can be adjusted during model calibration. The remaining five parameters on these four cards specify scalar concentration time series identifier numbers if the inflow concentrations are to be specified by time series. The time series specification of inflowing concentrations allows a unique concentration in each layer of the boundary cell. When the open boundary inflow concentrations are specified by constant values, bottom layer values on the four computational domain face directions are specified on card images 32, 35, 38, and 41, while surface layer values are specified on card images 33, 36, 39, and 42. If the number of layers exceeds two, values for the interior layers are linearly interpolated between the bottom and surface layer values.

Card Image 43

```
-------------------------------------------------------------------
C43 DRIFTER DATA (1ST 4 DATA FOR SUB DRIFTER, 2ND 6 FOR SUB LAGRES)
C
     ISPD:   1 TO ACTIVATE SIMULTANEOUS RELEASE AND LAGRANGIAN
               TRANSPORT OF NEUTRALLY BUOYANT PARTICLE DRIFTERS AT
               LOCATIONS INPUT ON C44
     NPD:      NUMBER OF PARTICLE DRIFTERS
     NPDRT:    TIME STEP AT WHICH PARTICLES ARE RELEASED
     NWPD:     NUMBER OF TIME STEPS BETWEEN WRITING TO TRACKING FILE
               drifter.out
     ISLRD: 1  TO ACTIVATE CALCULATION OF LAGRANGIAN MEAN VELOCITY
               OVER TIME INTERVAL TREF AND SPATIAL INTERVAL
               ILRPD1<I<ILRPD2, JLRD1<J<JLRD2, 1<K<KC, WITH MLRPDRT
               RELEASES.  AN AVERAGE OVER ALL RELEASE TIMES IS ALSO
               CALCULATED
             2 SAME AS 1 BUT USES HIGHER ORDER TRAJECTORY INTEGRATION
             3 SAME AS 1 BUT AVERAGE OF RELEASES IS RELOCATED TO
               TRAJECTORY BARYCENTER
             4 SAME AS 3 BUT USES A HIGHER ORDER TRAJECTORY INTEGRATION
      ILRD1    WEST BOUNDARY OF REGION
      ILRD2    EAST BOUNDARY OF REGION
      JLRD1    NORTH BOUNDARY OF REGION
      JLRD2    SOUTH BOUNDARY OF REGION
      MLRDRT   NUMBER OF RELEASE TIMES
      IPLRD    1,2,3 WRITE FILES TO PLOT ALL, EVEN, OR
                ODD HORIZONTAL CELL LAG VEL VECTORS
C
C43 ISPD NPD NPDRT NWPD ISLRD ILRD1 ILRD2 JLRD1 JLRR2 MLRPDRT IPLRD
    1     4  1260  12    3     80    170   20    100    12     1
-------------------------------------------------------------------
```

Card image 43 activates and controls two types of Lagrangian particle trajectory calculations, which may be simultaneously activated. The first Lagrangian trajectory calculation, activated by ISPD=1, releases NPD particles at time step NPDRT. The released particles are then tracked for the remainder of the model simulation, with the nearest cell center positions (I,J,K) written to the file drifter.out every NWPD time steps. The initial position of the NPD particles is specified on card image 44, shown below. The second Lagrangian trajectory calculation, activated by ISLRD greater than zero, releases particles at active water cell centers for all vertical layers, in the region of the computational grid bound in the x or I direction by (ILRD1.LE.I.LE.ILRD2), and in the y or J direction by (JLRD1.LE.J.LE.JLRD2). MLRPDRT releases, evenly spaced in the reference time period, card 8, occur during the next to last reference time period of the model simulation (i.e., NTC.GE.2). Each group of particles is tracked for one reference time period and their net vector displacements from their release positions are determined. The net vector displacements are then divided by the reference time period to give Lagrangian mean velocity vectors (Hamrick, 1994a), which are written to the file lmvvech.out. The average Lagrangian mean of the MLRPDRT release times is also calculated and written to the file almvvech.out. For ISLRD equal to 1 or 2, the Lagrangian mean velocity vectors are associated with their release positions for plotting. For ISLRD equal to 3 or 4, the Lagrangian mean velocity vectors are associated with the mean position of the corresponding particle during its trajectory. To assure a uniform distribution of vectors for plotting, the trajectory centroid located vectors are interpolated back to the cell centers and the results written to the file lmvech.out for the MLRPDRT releases with the average of the releases written to the file almvech.out. Values of 1 or 3 for ISLRD implement first order explicit forward Euler integrator for the trajectory calculation, while values of 2 and 4 implement a second order implicit trapezoidal integrator (Bennett and Clites, 1987) incurring increased computational time. If the trajectory calculation is executed over the entire grid for 10 to 12 release times, the computational effort for the last two time cycles is increased by approximately 20 to 40 percent.

Card Image 44

```
-------------------------------------------------------------------
C44 INITIAL DRIFTER POSITIONS (FOR USE WITH SUB DRIFTER)
C
      RI:  I CELL INDEX IN WHICH PARTICLE IS RELEASED IN
      RJ:  J CELL INDEX IN WHICH PARTICLE IS RELEASED IN
      RK:  K CELL INDEX IN WHICH PARTICLE IS RELEASED IN
C
C44 RI      RJ   RK

    146     44   6
    147     45   6
-------------------------------------------------------------------
```

Card Image 45

```
-----------------------------------------------------------------
C45 CONSTANTS FOR CARTESIAN GRID CELL CENTER LONGITUDE AND LATITUDE
C
      CDLON1:  6 CONSTANTS TO GIVE CELL CENTER LAT AND LON OR OTHER
      CDLON2:    COORDINATES FOR CARTESIAN GRIDS USING THE FORMULAE
      CDLON3:    DLON(L)=CDLON1+(CDLON2*FLOAT(I)+CDLON3)/60.
      CDLAT1:    DLAT(L)=CDLAT1+(CDLAT2*FLOAT(J)+CDLAT3)/60.
      CDLAT2:
      CDLAT3:
C
C45 CDLON1  CDLON2   CDLON3   CDLAT1  CDLAT2   CDLAT3
     -77.0   0.25     -1.125   36.0    0.20     48.9
-----------------------------------------------------------------
```

This card image allows cell center coordinates for graphics output files to be generated for Cartesian grids where the grid, bathymetric and roughness are specified in the cell.inp and depth.inp files.

Card Image 46

```
-----------------------------------------------------------------
C46 CONTROLS FOR PRINTED OUTPUT
C
      ISPOP: 1 FOR PRINTER PLOT OF SURFACE ELEVATION
      ISPOU: 1 FOR PRINTER PLOT OF SURF AND BOTTOM LAYER U VELOCITY
      ISPOV: 1 FOR PRINTER PLOT OF SURF AND BOTTOM LAYER V VELOCITY
      ISPOS: 1 FOR PRINTER PLOT OF SURF AND BOTTOM LAYER S VELOCITY
C
C46 ISPOP   ISPOU  ISPOV  ISPOS
    0       0      0      0
-----------------------------------------------------------------
```

Options of this card image are currently inactive.

Card Image 47

```
-----------------------------------------------------------------
C47 CONTROLS FOR HORIZONTAL PLANE SCALAR FIELD CONTOURING
C
      ISSPH:  1 TO WRITE FILE FOR SCALAR FIELD CONTOURING IN
                HORIZONTAL PLANE
      NPSPH:    NUMBER OF WRITES PER REFERENCE TIME PERIOD
      ISRSPH: 1 TO WRITE FILE FOR RESIDUAL SCALAR FIELD
                CONTOURING IN THE HORIZONTAL PLANE
C
C47 ISSPH   NPSPH   ISRSPH
    1       12      1
-----------------------------------------------------------------
```

Card image 47 activates the creation of output files xxxconh.out and rxxxconh.out (where xxx is sal, tem, dye, sed, or sfl) for horizontal plane contour plotting of surface and bottom layer scalar field distributions. For sediment (sed) and shellfish larvae (sfl) bottom bed concentrations are also output. The switch ISSPH generated the non-r-prefixed files for transport scalar fields at NPSPH times during the last time cycle of the model run. The switch ISRSPH activates the output of time averaged or residual fields representing an average over NTSMMT time steps (see card image 7). If ISSSMMT on card image 4 is 0 residual fields are written for each averaging period in the model run, while a value of 1 results in writing the results of only the last averaging period.

Card Image 48

```
-------------------------------------------------------------------
C48 CONTROLS FOR HORIZONTAL SURFACE ELEVATION OR PRESSURE CONTOURING
C
      ISPPH:  1 TO WRITE FILE FOR SURFACE ELEVATION OR PRESSURE
                CONTOURING IN HORIZONTAL PLANE
      NPPPH:    NUMBER OF WRITES PER REFERENCE TIME PERIOD
      ISRPPH: 1 TO WRITE FILE FOR RESIDUAL SURFACE ELEVATION
                CONTOURING IN HORIZONTAL PLANE
C
C48 ISPPH   NPPPH   ISRPPH
    0       12      0
-------------------------------------------------------------------
```

Card image 48 controls output for contour plotting instantaneous and residual or averaged water surface elevation fields to files surfconh.out and rsurfconh.out. The control switches have similar definitions as those for card image 47.

Card Image 49

```
-------------------------------------------------------------------
C49 CONTROLS FOR HORIZONTAL PLANE VELOCITY VECTOR PLOTTING
C
      ISVPH:  1 TO WRITE FILE FOR VELOCITY PLOTTING IN HORIZONTAL
                PLANE
      NPVPH:    NUMBER OF WRITES PER REFERENCE TIME PERIOD
      ISRVPH: 1 TO WRITE FILE FOR RESIDUAL VELOCITY PLOTTING IN
                HORIZONTAL PLANE
C
C49 ISVPH   NPVPH   ISRVPH
    0       12      0
-------------------------------------------------------------------
```

Card image 49 activates the creation of the output file velvech.out, containing instantaneous surface and bottom horizontal velocity vectors for ISVPH = 1, 2, or 3 at NPVPH times during the last reference time period for vector plotting. The switch ISRVPH = 1, 2, or 3 activates the creation of three files, xvelconh.out (where x is r, p, or m) containing surface and bottom layer residual velocity vectors corresponding to the Eulerian mean transport velocity (r prefix), the nondivergent component of the Stokes' drift (p prefix) and the first order Lagrangian mean or mean mass transport velocity (m prefix) for horizontal plane vector plotting. If ISSSMMT on card image 4 is 0, residual fields are written for each averaging period in the model run, while a value of 1 results in writing the results of only the last averaging period. The choice of 1, 2, or 3 for ISVPH and ISRVPH writes all cell vectors, I+J is even vectors, or I+J is odd vectors. For grids with a large number of cells, the 2 or 3 options often result in less dense and more pleasing to the eye plots.

Card Image 50

```
-------------------------------------------------------------------
C50 CONTROLS FOR VERTICAL PLANE SCALAR FIELD CONTOURING
C
      ISECSPV:  AN INTEGER NUMBER OF VERTICAL SECTIONS (N.LE.99)
                TO WRITE ISECSPV FILES FOR SCALAR FIELD CONTOURING
      NPSPV:    NUMBER OF WRITES PER REFERENCE TIME PERIOD
      ISSPV:    1 TO ACTIVATE INSTANTANEOUS SCALAR FIELDS
      ISRSPV:   1 TO ACTIVATE FOR RESIDUAL SCALAR FIELDS
      ISHPLTV:  1 FOR VERTICAL PLANE PLOTTING FOR MSL DATUMS, ZERO
                OTHERWISE
C
C50 ISECSPV   NPSPV  ISSPV  ISRSPV  ISHPLTV
    2         12     1      1       1
-------------------------------------------------------------------
```

Card image 50 activates output of information for vertical plane scalar field contouring for ISCESPV vertical sections or transects. The switch ISSPV activates output of instantaneous values NPSPV times during the last reference time period to the files xxxcnvN.out (xxx equals sal, tem, dye, sed, or sfl, and N represents the section number currently limited to a maximum of 9). The switch ISRSPV activates output of time-averaged or residual variables to similar r-prefixed files after each averaging period (ISSSMMT = 0) or only the last averaging period (ISSMMT = 1) with the time steps in the averaging period defined by NTSMMT on card image 7. The last parameter configures the plotting information for tidal or other datums. Additional information is specified on card images 51 and 52.

Card Image 51

```
------------------------------------------------------------------
C51 MORE CONTROLS FOR VERTICAL PLANE SCALAR FIELD CONTOURING
C
      ISECSPV:  SECTION NUMBER
      NIJSPV:   NUMBER OF CELLS OR I,J PAIRS IN SECTION
      SEC ID:   CHARACTER FORMAT SECTION TITLE
C
C51 ISECSPV NIJSPV  SEC ID
     1       14      'JR BRIDGE'
     2       10      'NN PT 45'
------------------------------------------------------------------
```

Card image 51 provides information to define the vertical plane transects. A line of data is required for each vertical section. The maximum number of vertical sections is currently limited to 9. The first parameter identifies the section number, the second parameter specifies the number of cells comprising the section, and the last character string provides an identifier which is also written to the output files.

Card Image 52

```
-------------------------------------------------------------------
C52 I,J LOCATIONS FOR VERTICAL PLANE SCALAR FIELD CONTOURING
C
      ISECSPV: SECTION NUMBER
      ISPV:    I CELL
      JSPV:    J CELL
C
C52 ISECSPV ISPV    JSPV
     1        117     52
     1        118     53
     1        119     54
     1        120     55
     1        121     56
     1        122     57
     1        123     58
     1        124     59
     1        125     60
     1        126     61
     1        127     62
     1        128     63
     1        129     64
     1        130     65
     2        141     39
     2        142     40
     2        143     41
     2        144     42
     2        145     43
     2        146     44
     2        147     45
     2        148     46
     2        149     47
     2        150     48
-------------------------------------------------------------------
```

Card image 52 defines the sequence of cells comprising the section, with the first parameter being for user identification. The other two parameters define the section sequenced by I and J cell indices. It is noted that cells in the sequence do not need to be adjacent, nor do they need to follow a straight line. For example, they may represent instrument locations, longitudinal moving survey locations, or interesting cross sections of the flow field or a typical longitudinal section up an estuary.

Card Image 53

```
-----------------------------------------------------------------------
C53 CONTROLS FOR VERTICAL PLANE VELOCITY VECTOR PLOTTING
C
      ISECVPV:  AN INTEGER NUMBER (N.LE.9) OF VERTICAL SECTIONS
                TO WRITE ISECVPV FILES FOR VELOCITY PLOTTING
      NPVPV:      NUMBER OF WRITES PER REFERENCE TIME PERIOD
      ISVPV:    1 TO ACTIVATE INSTANTANEOUS VELOCITY
      ISRSPV:   1 TO ACTIVATE FOR RESIDUAL VELOCITY
C
C53 ISECVPV   NPVPV  ISVPV  ISRSPV
    2         12     0      1
-----------------------------------------------------------------------
```

Card image 53 activates output of information three types of vector plotting in ISECVPV (currently limited to 9) vertical planes. The switch ISVPV activates output of instantaneous data at NPVPV times during the reference time period, while ISRSPV activates output of time averaged or residual data after each averaging period (ISSSMMT = 0), defined by NTSMMT on card image 7, or the last averaging period (ISSSMMT = 1). The first class of output files provides data for plotting vectors tangential to the vertical plane. Instantaneous data are written to the files velvcvN.out, while residual data are written to the files rvelvcvN.out, pvelvcvN.out, mvelvcvN.out, lmvvcvN.out, and almvvcvN.out, where N indicates the second number. The last two files are written only if ISLRD is not zero. The second class of output files provides data for contour plotting the component of the horizontal velocity normal to the vertical planes. Instantaneous data are written to the files velcnvN.out, while residual data are written to the files rvelcnvN.out, pvelcnvN.out, mvelcnvN.out, lmvcnvN.out, and almvcnvN.out. The last two files are written only if ISLRD is not zero. The final class of output files provides data for contour plotting the component of the horizontal residual velocities tangential to the vertical plane. Time-averaged or residual data are written to the files rvelcvtN.out, pvelcvtN.out, mvelcvtN.out, lmvcvtN.out, and almvcvtN.out, again with the last two files written to as ISLRD is not zero.

Card Image 54

```
-----------------------------------------------------------------------
C54 MORE CONTROLS FOR VERTICAL PLANE VELOCITY VECTOR PLOTTING
C
      ISCEVPV:  SECTION NUMBER
      NIJVPV:   NUMBER IS CELLS OR I,J PAIRS IN SECTION
```

```
      ANGVPV:   CCW POSITIVE ANGLE FROM EAST TO SECTION NORMAL
      SEC ID:   CHARACTER FORMAT SECTION TITLE
C
C54 ISECVPV   NIJVPV  ANGVPV  SEC ID
     1         14      -45.0    'JR BRIDGE'
     2         10      -45.0    'NN PT 45'
-------------------------------------------------------------------
```

Card image 54 provides additional information to specify the vertical planes for plotting velocity vectors and contours, with the first parameter identifying the section number and the second parameter specifying the number of horizontal cells defining the section. The third parameter, ANGVPV defines the angle counterclockwise from east to the section normal. For meaningful results, the sequence of cells defining the vertical plane should approximate a straight line. For a section oriented at 45 degrees CC from east, the normal angle could be defined as 135 degrees or -45 degrees. For these two choices, the definitions of the positive normal and tangential directions are reversed. The remaining character parameter defines a title to be written on the output file headers.

Card Image 55

```
-------------------------------------------------------------------
C55 CONTROLS FOR VERTICAL PLANE VELOCITY PLOTTING
C
      ISECVPV:  SECTION NUMBER (REFERENCE USE HERE)
      IVPV:     I CELL INDEX
      JVPV:     J CELL INDEX
C
C55 ISECVPV IVPV    JVPV
     1        117     52
     1        118     53
     1        119     54
     1        120     55
```

```
      1        121     56
      1        122     57
      1        123     58
      1        124     59
      1        125     60
      1        126     61
      1        127     62
      1        128     63
      1        129     64
      1        130     65
      2        141     39
      2        142     40
      2        143     41
      2        144     42
      2        145     43
      2        146     44
      2        147     45
      2        148     46
      2        149     47
      2        150     48
-------------------------------------------------------------------
```

Card image 55 specifies the sequence of I and J indices defining the vertical plane sections.

Card Image 56

```
-------------------------------------------------------------------
C56 CONTROLS FOR 3D FIELD OUTPUT
C
      IS3D:    1 TO WRITE TO 3D ASCII INTEGER FORMAT FILES
               2 TO WRITE TO 3D CHARACTER ARRAY FORMAT FILES (NOT
                 ACTIVE)
               3 TO WRITE TO 3D HDF IMAGE FORMAT FILES (NOT ACTIVE)
               4 TO WRITE TO 3D HDF FLOATING POINT FORMAT FILES (NOT
                ACTIVE) (IS3D IS IS3DO IN CODE)
      ISR3D:    SAME AS IS3DO EXCEPT FOR RESIDUAL VARIABLES
                (ISR3D IS ISR3DO IN CODE)
      NP3D:     NUMBER OF WRITES PER LAST REF TIME PERIOD FOR INST
                VARIABLES (NP3D IS NP3DO IN CODE)
      KPC:      NUMBER OF UNSTRETCHED PHYSICAL VERTICAL LAYERS
      NWGG:     NUMBER OF WATER CELLS IN CARTESIAN 3D GRAPHICS GRID
                OVERLAY OF A CURVILINEAR GRID.  FOR EFDC RUNS ON A
                CURVILINEAR GRID, I3DMI,I3DMA,J3DMI,J3DMA REFER TO
```

```
                CELL INDICES ON THE ON THE CARTESIAN GRAPHICS GRID
                OVERLAY DEFINED BY FILE gcell.inp.  THE FILE gcell.inp
                IS NOT USED BY EFDC, BUT BY THE COMPANION GRID
                GENERATION CODE GEFDC.F.  INFORMATION DEFINING THE
                OVERLAY IS READ BY EFDC.FOR FROM FILE gcellmap.inp
      I3DMI:    MINIMUM OR BEGINNING I INDEX FOR 3D ARRAY OUTPUT
      I3DMA:    MAXIMUM OR ENDING I INDEX FOR 3D ARRAY OUTPUT
      J3DMI:    MINIMUM OR BEGINNING J INDEX FOR 3D ARRAY OUTPUT
      J3DMA:    MAXIMUM OR ENDING J INDEX FOR 3D ARRAY OUTPUT
      J3RW:   1 REWRITE FILES TO CORRECT ORIENTATION
      SELMX:    MAXIMUM SURFACE ELEVATION FOR UNSTRETCHING
      BELMN:    MINIMUM BOTTOM ELEVATION FOR UNSTRETCHING
C
C56 IS3D ISR3D NP3D KPC NWGG I3DMI I3DMA J3DMI J3DMA I3DRW SELMX BELMN
    0    0     6    1   0    2     3     2     3     1     4.0  -32.0
--------------------------------------------------------------------
```

Card image 56 controls the output of three-dimensional data for graphics and visualization. The switches IS3D and ISR3D activate output of instantaneous data at NP3D times during the last reference time period and time averaged or residual data respectively. The residual data is output after each averaging period (ISSSMMT = 0), defined by NTSMMT on card image 7, or only the last averaging period (ISSMMT = 1). However the current configuration allows only 24 averaged output files, and if the number of averaging periods for a run exceeds 24, only the last 24 periods are output. The only currently active option (IS3D=1 and ISR3D=1) writes output as eight bit ASCII integers (0 to 255). This choice was made for flexibility and the minimization of disk storage. A post processor is available via ftp to translate the 8 bit ASCII integer data to a number of alternate forms including 8 bit ASCII character data, 8 bit binary, and HDF image or floating point format for compatibility with various visualization software. Although the 8 bit three-dimensional integer array files may be very large, they can be efficiently compressed on most systems. On UNIX systems, the UNIX .Z compressed version of the output files may be up to a factor 10 times smaller.

The output format is a three-dimensional array which can be conceptualized as a stack of KPC layers, of equal thickness, which slice the model domain at constant elevation plane, progressing from above the maximum water surface elevation to below the minimum bottom elevation. Each layer (or plane) comprises a two-dimensional array with a true east-north alignment. The most rapid variation in the two-dimensional plane is from west to east analogous to the columns of a spread sheet. The sequence of columns is written from north to south analogous to the rows of a spread sheet. Thus if a layer of the 3 matrix is viewed in a spread sheet type form, it will have the proper geographic orientation. The KPC constant elevation slices are generated by constant elevation interpolation equivalent to an unstretching of the model's internal stretched or sigma coordinate system. The upper bounding elevation of the first layer is specified by elevation SELMX, which should be slightly larger than the maximum water surface elevation during the entire data sampling period. The lower bounding elevation of the last layer is specified by BELMN, which should correspond to an elevation slightly below the bottom of the deepest cell in the model domain. The values SELMX and BELMN shown in the example data line above are referenced to a sea level datum, hence the negative value of BELMN. For constant spacing Cartesian grids, the rectangular two-dimensional arrays or matrices corresponding to the constant elevation layers directly coincide with the model grid.

For curvilinear, or variable-spacing, Cartesian grids, a Cartesian graphics grid overlay, which can be generated by the preprocessor code GEFDC, and is input into EFDC by the file gcellmap.inp and is used to define the horizontal layers. The parameter NWGG defines the number of water cells in the Cartesian graphic grid. If NWGG is zero, the computation grid is assumed to be Cartesian, while a nonzero value indicates an overlay and activates the reading of the file gcellmap.inp. The input file gcellmap.inp includes information from interpolating the curvilinear grid data to the Cartesian graphic grid. The extent of the horizontal region over which three-dimensional data is to be extracted is defined by I3DMI<IG< I3DMA, and J3DMI<JG< J3DMA, where IG and JG are east and north indices in the Cartesian graphics grid overlay or the I and J indices of an equal spacing Cartesian computational grid. The parameter I3DRW allows the three-dimensional output to be written in a temporary compressed form. If I3DRW is set to 1, the output files are in the three-dimensional array structure described above. However, from many model applications to irregular regions, a large percent of the three-dimensional output matrix represents dry land. Setting I3DRW to zero results in output of information for active water cells in either the graphics overlay or computation grid. This output can later be expanded into the aforementioned fully three-dimensional format by a post processing utility, available via ftp.

Card Image 57

```
--------------------------------------------------------------------
C57 SCALES FOR 3D FIELD OUTPUT
C
      VARIABLE:      DUMMY VARIABLE ID (DO NOT CHANGE ORDER)
      IS3(VARID):  1 TO ACTIVATE THIS VARIABLES
      JS3(VARID):  0 FOR NO SCALING OF THIS VARIABLE
                   1 FOR AUTO SCALING OF THIS VARIABLE
                   2 FOR SCALING SPECIFIED IN NEXT TWO COLUMNS
C
C57 VARIABLE  IS3 (VARID) JS3 (VARID)  MAX SCALE VAL  MIN SCALE VAL
    'U VEL'     0           0              1.0            -1.0
    'V VEL'     0           0              1.0            -1.0
    'W VEL'     0           0              1.0E-3         -1.0E-3
    'SALINITY'  1           2             30.0             0.0
    'TEMP'      0           0             30.0            10.0
    'DYE'       0           0           1000.0             0.0
    'SEDIMENT'  0           0           1000.0             0.0
--------------------------------------------------------------------
```

Card image 57 controls the fields for three-dimensional data output. Current fields for output, corresponding to the data lines above include the true east and north horizontal velocity vectors, the physical vertical velocity vector, (as opposed to the internally used stretched coordinate vertical velocity), and the salinity, temperature, dye tracer and sediment concentration scalar fields. The switch IS3 activates the output of the particular variable, while the switch JS3 defines its conversion to 8 bit integer form. The option JS3 equals 2 which uses minimum and maximum values corresponding to 1 and 255 (recommended). Dry land positions in the three-dimensional array are by default set to 0. The output filenames corresponding to the data lines on card 57 are:

Output Variable	Instantaneous	Residual
U VEL	uuu3dNN.asc	ruuu3dNN.asc
V VEL	vvv3dNN.asc	rvvv3dNN.asc
W VEL	www3dNN.asc	rwww3dNN.asc
SALINITY	sal3dNN.asc	rsal3dNN.asc
TEMP	tem3dNN.asc	rtem3dNN.asc
DYE	dye3dNN.asc	rdye3dNN.asc
SEDIMENT	sed3dNN.asc	rsed3dNN.asc

where NN represents a two digit time sequence identified between 1 and 24. Two additional files, out3d.dia and rout3d.dia, provide summary information including the actual minimum and maximum values of each variable for the output files.

Card Image 58

```
--------------------------------------------------------------------
C58 CONTROLS FOR WRITING TO TIME SERIES FILES
C
      ISTMSR:  1 OR 2 TO WRITE TIME SERIES OF SURF ELEV, VELOCITY,
               NET INTERNAL AND EXTERNAL MODE VOLUME SOURCE-SINKS,
               AND CONCENTRATION VARIABLES, 2 APPENDS EXISTING TIME
               SERIES FILES
      MLTMSR:  NUMBER OF HORIZONTAL LOCATIONS TO WRITE TIME SERIES
               OF SURF ELEV, VELOCITY, AND CONCENTRATION VARIABLES,
               (MAXIMUM LOCATIONS = 99)
      NBTMSR:  TIME STEP TO BEGIN WRITING TO TIME SERIES FILES
      NSTMSR:  TIME STEP TO STOP WRITING TO TIME SERIES FILES
      NWTSER:  WRITE INTERVAL FOR WRITING TO TIME SERIES FILES
      TCTMSR:  UNIT CONVERSION FOR TIME SERIES TIME.  FOR SECONDS,
               MINUTES, HOURS,DAYS USE 1.0, 60.0, 3600.0, 86400.0
               RESPECTIVELY
C
C58 ISTMSR  MLTMSR  NBTMSR  NSTMSR  NWTMSR  TCTMSR
    1       3       1       32000   36       3600.
--------------------------------------------------------------------
```

Card image 58 activates and controls the writing of time series files. The parameter ISTMSR = 1 activates the creation of new time series files, while ISTMSR = 2 writes to the end of existing time series files and is useful in certain cases where the model is restarted to continue a long simulation. Instantaneous data for various model variables may be output at MLTMSR locations (the current limit is 99 locations). The parameters NBTMSR and NSTMSR specify the beginning and ending time steps of a time interval where data is output at every NWTMSR time steps. The conversion factor TCTMSR specifies the time units for the time column in the time series output files.

Card Image 59

```
--------------------------------------------------------------------
C59 CONTROLS FOR WRITING TO TIME SERIES FILES
C
      ILTS:    I CELL INDEX
      JLTS:    J CELL INDEX
      MTSP:  1 FOR TIME SERIES OF SURFACE ELEVATION
      MTSC:  1 FOR TIME SERIES OF TRANSPORTED CONCENTRATION VARIABLES
      MTSA:  1 FOR TIME SERIES OF EDDY VISCOSITY AND DIFFUSIVITY
      MTSUE: 1 FOR TIME SERIES OF EXTERNAL MODE HORIZONTAL VELOCITY
      MTSUT: 1 FOR TIME SERIES OF EXTERNAL MODE HORIZONTAL TRANSPORT
      MTSU:  1 FOR TIME SERIES OF HORIZONTAL VELOCITY IN EVERY LAYER
      MTSQE: 1 FOR TIME SERIES OF NET EXTERNAL MODE VOLUME SOURCE/SINK
      MTSQ:  1 FOR TIME SERIES OF NET EXTERNAL MODE VOLUME SOURCE/SINK
      CLTS:    LOCATION AS A CHARACTER VARIABLE
C
C59 ILTS JLTS  MTSP MTSC MTSA  MTSUE MTSUT MTSU MTSQE MTSQ    CLTS
     128   62   1    1    1     1     1     1     1    1     'JRB A'
     125   59   1    1    1     1     1     1     1    1     'JRB B'
     123   58   1    1    1     1     1     1     1    1     'JRB C'
--------------------------------------------------------------------
```

Card image 59 specifies the I and J indices of horizontal locations for writing time series data and the class of data. The generic file names created by the activation of the output switches are:

Switch	File Name
MTSP	seltmsrNN.out
MTSC	saltmsrNN.out

	temtmsrNN.out
	dyetmsrNN.out
	sedtmsrNN.out
	sfltmsrNN.out
MTSA	avvtmsrNN.out
	avbtmsrNN.out
MTSUE	uvetmsrNN.out
MTSUT	uvttmsrNN.out
MTSU	u3dtmsrNN.out
	v3dtmsrNN.out
MTSQE	qqetmsrNN.out
MTSQ	q3dtmsrNN.out

with NN, between 01 and 99, indicating the location. The last column provides a character string identifier for the location, which is written to the output file header.

Card Image 60

```
--------------------------------------------------------------------
C60 CONTROLS FOR EXTRACTING INSTANTANEOUS VERT SCALAR FIELD PROFILES
C
      ISVSFP: 1 FOR EXTRACTING INSTANTANEOUS VERTICAL FIELD PROFILES
      MDVSFP:   MAXIMUM NUMBER OF DEPTHS FOR SAMPLING VALUES
      MLVSFP:   NUMBER OF HORIZONTAL SPACE-TIME LOCATION PAIRS TO BE
```

```
                SAMPLED
      TMVSFP:   MULTIPLIER TO CONVERT SAMPLING TIMES TO SECONDS
      TAVSFP:   ADDITIVE ADJUSTMENT TO SAMPLING TIME BEFORE
                CONVERSION TO SEC
C
C60 ISVSFP  MDVSFP  MLVSFP  TMVSFP  TAVSFP
      1       8     10      3600.    0.0
--------------------------------------------------------------------
```

Card image 60 provides for the extraction of instantaneous vertical scalar field profiles at specified times an locations. This option is designed to mimic field sampling surveys and produce a smaller volume of output data than the time series output option. The switch ISVSFP = 1 activates the option. The parameter MDVSFP specifies the maximum number of depths (measured downward from the instantaneous free surface for sampling, while MLVSFP specifies the number of discrete time and space locations for sampling. The parameter TMVSFP converts the sampling times specified on card image 62 to seconds. The time origin for specifying sampling should be consistent with information specified on card image 8. The parameter TAVSFP is an additive adjustment to the sampling times on card image 63, and is useful for dealing with sampling times recorded during daylight savings conditions. Output for this option is written to the file vsfp.out.

Card Image 61

```
--------------------------------------------------------------------
C61 SAMPLING DEPTHS FOR EXTRACTING INST VERT SCALAR FIELD PROFILES
C
      MMDVSFP:  Mth SAMPLING DEPTH
      DMSFP:    SAMPLING DEPTH BELOW SURFACE, IN METERS
C
C61 MMDVSFP  DMVSFP
      1        1.0
      2        3.0
      3        5.0
      4        7.0
      5        9.0
      6       11.0
      7       13.0
```

```
      8      15.0
-------------------------------------------------------------------
```

Card image 61 specifies the MDVSFP sampling depths below the water surface at the specified times and locations. If the local depth to the bottom is less than a sample depth, output data is not written for that depth.

Card Image 62

```
-------------------------------------------------------------------
C62 HORIZONTAL SPACE-TIME LOCATIONS FOR SAMPLING
C
      MMLVSFP:  Mth SPACE TIME SAMPLING LOCATION
      TIMVSFP:  MAXIMUM NUMBER OF DEPTHS FOR SAMPLING VALUES
      IVSFP:    I HORIZONTAL LOCATION INDEX
      JVSFP:    J HORIZONTAL LOCATION INDEX
C
C62 MMLVSFP  TIMVSFP  IVSFP  JVSFP
      1      3221.60   151     42
      2      3222.00   140     46
      3      3222.40   124     59
      4      3222.60   102     72
      5      3223.00    94     86
      6      3223.30    87    102
      7      3221.60    88    117
      8      3223.90    70    112
      9      3224.10    54    120
     10      3224.50    37    121
-------------------------------------------------------------------
```

Card image 62 specifies the times and I and J cell indices for sampling.

5. Additional Input Files

This chapter describes additional input files required to run the EFDC model. Before describing the various files, it is useful to re- summarize them, noting the conditions and model options under which the model will need the file to execute.

File Name	Comments
aser.inp	Required for all model runs
cell.inp	Required for all model runs
cellllt.inp	Required for all model runs
depth.inp	Required if ISCLO = 0 on card image 9 of file efdc.inp

dser.inp	Required if NDSER .GE.1 on card image 30 of file efdc.inp
dxdy.inp	Required if ISCLO = 1 or if ISCLO = 0 and LC-LVC GT.2 on card image 9 of file efdc.inp
dye.inp	Required if ISTOPT = 1 on line 4, card image 9 of file efdc.inp
efdc.inp	Required for all model runs
efdc.wsp	Required if ISWASP .GE.1 on card image 5 of file efdc.inp
fldang.inp	Required if ISSFLFE = 1 on file sfbser.inp
gcellmap.inp	Not Required if ISCLO = 0 on card image 9 OR if NWGG = 0 on card image 56 of file efdc.inp
gwater.inp	Required for all model runs
lxly.inp	Required if ISCLO = 1 or if ISCLO = 0 and LC-LVC GT.2 on card image 9 of file efdc.inp
mappns.inp	Required if ISPGNS = 1 on card image 9 of file efdc.inp
mask.inp	Required if ISMASK = 1 on card image 9 of file efdc.inp
modchan.inp	Required for all model runs

moddxdy.inp Required for all model runs

pser.inp Required if NPSER .GE.1 on card image 17 of file efdc.inp

qctl.inp Required if NQCTL .GE.1 on card image 23 of file efdc.inp

qser.inp Required if NQSER .GE.1 on card image 23 of file efdc.inp

restart.inp Required if ISRESTI =1 on card image 1 of file efdc.inp

restran.inp Required if ISLTMT = 1 on card image 4 of file efdc.inp

salt.inp Required if ISTOPT = 1 on line 2, card image 9 of file efdc.inp

sdser.inp Required if NSDSER .GE.1 on card image 30 of file efdc.inp

show.inp Required if ISHOW = 1 on card image 2 of file efdc.inp

sser.inp Required if NSSER .GE.1 on card image 30 of file efdc.inp

sfser.inp Required if NSFSER .GE.1 on card image 30 of file efdc.inp

sfbser.inp Required if ISTRAN .EQ. 1 on data line 6, card image 6 of file efdc.inp tser.inp Required if NSSER .GE.1 on card image 30 of file efdc.inp

vege.inp Required if ISVEG .GE.1 on card image 9 of file efdc.inp

wave.inp Required if ISWAVE .GE.1 on card image 5 of file efdc.inp

The files cell.inp, celllt.inp, dxdy.inp and lxly.inp have been discussed and illustrated in Chapter 2, and reference is made to that chapter. The field depth.inp was used in early versions of the model and its functions has been superseded by the dxdy.inp; therefore it will not be discussed. Examples of the remaining input files will now be presented and discussed in alphabetical order.

Input file aser.inp

The input file aser.inp specifies atmospheric, wind and thermal forcings as well as precipitation and evapotranspiration. For ISTOPT = 1 on line 3 of card image 6, the full set of environmental parameters for an internal-to-the-model calculation of thermal sources and sinks is specified in the file. An example of the aser.inp file for this case is:

```
C aser.inp file, in free format across line, repeats naser=1 times
C
C  MASER   TCASER   TAASER   WINDSCT  RAINCVT  EVAPCVT
C
C TASER   WINDS   WINDD   PATM    TDRY   TWET   RAIN      EVAP   SOLSWR
C
   4       86400.   0.0      1.0      1.0      1.0
  73.46   4.13    161.   1000.    25.    20.   .28E-08   .29E-07   500.
  73.50   3.96    148.   1000.    25.    20.   .00E+00   .29E-07   500.
  73.54   4.25    144.   1000.    25.    20.   .56E-08   .29E-07   500.
  73.58   3.82    132.   1000.    25.    20.   .17E-07   .29E-07   500.
```

Parameters on the first data line specify the number of time points (MASER), a factor to convert the time units to seconds (TCASER), a constant time to be added before unit conversion (TAASER), a factor to convert wind speed to meters/second (WINDSCT), and factors to convert rainfall and evapotranspiration rates to meters per second (RAINCVT, EVAPCVT). Each time lines data has in order: time (TASER), wind speed

(WINDS), wind direction (WINDD) in bearing angle to the direction the wind is blowing (oceanographic as opposed to meteorological convention), atmospheric pressure (PATM) in millibars, dry and wet bulb temperature (TDRY, TWET) in degrees C, rainfall rate (RAIN), evapotranspiration rate (EVAP) and incident solar short-wave radiation (SOLSWR) in Joules per seconds per square meter. For ISTOPT = 2 on line 3 of card image 6, a time variable equilibrium temperature surface heat exchange formulation is implemented in the model. The form of the aser.inp file for this case is identical to that above, except that now the equilibrium temperature (degrees C) is entered under the TDRY column and the net surface heat exchange coefficient in square meters per second is entered under the SOLSWR column. Data entered under PATM and TWET are not used for this case. For ISTOPT = 3 on line 3 of card image 6, a time-invariant equilibrium temperature surface heat exchange formulation is implemented with a constant equilibrium temperature and heat exchange coefficient provided on card image 30 of the file efdc.inp. In this case, wind speed and direction data and rainfall and evapotranspiration data form the aser.inp file used by the model. If no atmospheric forcings are used to drive the model, a null aser.inp file of the form:

```
C aser.inp file, in free format across line, repeats naser=1 times
C
C  MASER   TCASER   TAASER   WINDSCT  RAINCVT  EVAPCVT
C
C TASER   WINDS   WINDD   PATM    TDRY   TWET   RAIN      EVAP   SOLSWR
C
   2       86400.   0.0      1.0      1.0      1.0
 -1.E+6   0.      0.      0.      0.     0.     0.        0.     0.
  1.E+6   0.      0.      0.      0.     0.     0.        0.     0.
```

should be provided.

Input files dser.inp, sser.inp, sdser.inp, sfser.inp, and tser.inp

The scalar constituent time series files have identical formats, and thus it suffices to discuss them in a generic sense. An example of the sser.inp time series file containing one time series is shown below.

```
C  sser.inp file, salt is nc=1 conc, in free format across line,
C  repeats ncser(1) times, test case
C
C ISTYP MCSER(NS,1) TCCSER(NS,1) TACSER(NS,1) RMULADJ(NS,1) ADDADJ(NS,1)
C
C if istyp.eq.1 then read depth weights and single value of CSER
C
C (WKQ(K),K=1,KC)
C
C TCSER(M,NS,1) CSER(M,NS,1) !(mcser(ns,1) sets ns=1,ncser(1) series)
C
C  else read a value of qser for each layer
C
C  TCSER(M,NS,1)   (CSER(M,K,NS,1),K=1,KC) !(mcser(ns,1) pairs)
C
  0      7        86400.       0.0         1.0           0.0
  35.791668   29.57  29.57  29.57  29.57  29.57  29.57  29.57  29.57
  35.833336   29.93  29.93  29.93  29.93  29.93  29.93  29.93  29.93
  35.875000   29.88  29.88  29.88  29.88  29.88  29.88  29.88  29.88
  35.916668   30.89  30.89  30.89  30.89  30.89  30.89  30.89  30.89
  35.958336   31.24  31.24  31.24  31.24  31.24  31.24  31.24  31.24
  36.000000   31.12  31.12  31.12  31.12  31.12  31.12  31.12  31.12
  36.041668   31.28  31.28  31.28  31.28  31.28  31.28  31.28  31.28
```

A concentration time series input file may contain multiple time series. Each time series set begins with the single data line specifying ISTYP (the time series format identifier), MCSER (the number of time data points), TCCSER (a multiplying conversion factor changing the input time units to seconds), TACSER (an additive time adjustment, applied before unit conversion), RMULADJ (a multiplying conversion for the concentration), and ADDADJ (an additive conversion for concentration, applied before the multiplier). If the ISTYP parameter is 0, the MCSER time data points must have a concentration value for each layer. If ISTYP is 1, an additional line of data providing interpolating factors is read, and the time data lines should have only one concentration value. An example of an ISTYP=1 dser.inp file is shown below:

```
C  dser.inp file, dye is nc=3 conc, in free format across line,
C  repeats ncser(3) times, test case
C
C ISTYP MCSER(NS,3) TCCSER(NS,3) TACSER(NS,3) RMULADJ(NS,3) ADDADJ(NS,3)
C
C if istyp.eq.1 then read depth weights and single value of CSER
C
C (WKQ(K),K=1,KC)
C
C TCSER(M,NS,3) CSER(M,NS,3) !(mcser(ns,3) sets ns=3,ncser(3) serseries)
C
C  else read a value of dser for each layer
C
C  TCSER(M,NS,3)   (CSER(M,K,NS,3),K=1,KC) !(mcser(ns,3) pairs)
C
   1    10      3600.0     0.     1.    0.
    0.0     0.00   0.00   0.00   0.00   1.00
-2000.0000         0.00
  713.39           0.00
  713.41         2263374.5
  726.89         2263374.5
  726.91           0.00
 7076.49           0.00
 7076.51         2657004.85
 7087.99         2657004.85
 7088.01           0.00
 10000.00          0.00
```

This example specifies 6 weights (for a 6 layer model) on the second data line, which is read when ISTYP=1. The weights are read from the bottom to the top layer. For the example shown above, the dye is being released into the surface layer. (see the qser.inp file for the corresponding dye release flow rate formulation).

Input files dye.inp and salt.inp

The input files dye.inp and salt.inp are used to initialize the dye and salinity fields for cold start runs if an appropriate ISTOPT switch is set on card image 6 of the efdc.inp file. An example of a portion of the salt.inp field is shown below.

```
C salt.inp file, in free format across line, for IRLTC Final Grid
C first data line ISALTYP =0 no L,I,J  =1 read L,I,J
C L=2,LA rows of SALINIT(L,K),K=1,KC across columns
C
    1
    1   40    2   30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
    2   41    2   30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
    3   42    2   30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
    4   43    2   30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
    5   40    3    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
    6   41    3    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
    7   42    3    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
    8   43    3    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
```

The file has four header lines, followed by a line specifying the format type switch, ISALTYP. If ISALTYP is equal to 1, LC-2 data lines follow in the order L=2,LA, which is the single index sequence of active water cells. For ISALTYP=1, the first three columns give L (the single horizontal internal cell index), and I and J (the two external indices). These are then followed by KC (the number of model layers) values of salinity read from the bottom to the surface. For ISALTYP=0, the L, I, and J indices are absent from the data lines. A template for the salt.inp file, of ISALTYP=1 form, is generated by GEFDC. However, the four header lines and ISALTYP=1 must be manually added. The ISALTYP=0 format is carried over from older versions of the model. To allow conversion from older versions, the EFDC model outputs a file, newsalt.inp, of the ISALTYP=1, form.

Input file efdc.wsp

The file efdc.wsp provides data for controlling the linkage of EFDC and the WASPS series of water quality models (Ambrose, *et. al*. 1993) writing WASP format input files specifying cell volumes, flow and diffusion linkages and flow files in either generic or DYNHYD format. An example of the efdc.wsp input file is shown below.

```
C1    CELL VOLUME PARAMETERS for WASP-EFDC Linkage
C1    IVOPT IBDEV SCALV CONVV VMULT VEXP DMULT DEXP
      2     0     1.0   1.0   1.0   0.   1.0   0.
C2    DIFFUSION AND DISPERSION PARAMETERS
C2    NRFLD SCALR CONVR ISNKH
      2     1.0   1.0   1
C3    ADVECTION PARAMETERS (iqopt=3 ASCII HYD, =4 for binary HYD file)
C3    IQOPT NFIELD SCALQ CONVQ  HYDFIL           ISWASPD   ISDHD
      3     5      1.0   1.0    'NORWALK.HYD'     0         0
C4    DEPTH OF SEDIMENT LAYER (METERS)
C4    DEPSED  TDINTS   SEDIFF         WSS1       WSS2       WSS3
      0.1     366      2.315E-09      0.05       0.10       0.15
```

The parameters on card images 1 and 2 are identical to those defined in the WASP user's manuals. Card images 3 and 4 provide information for the flow and diffusive transport fields and the sediment submodel. EFDC users considering activating the WASP linkage option should contact the author for further information and guidance.

Input file fldang.inp

The file fldang.inp is used to specify the direction of tidal flood flow and is used in shellfish larvae transport simulations (see file sfbser.inp) to cue larvae swimming behavior. It is a headerless file with LC-2 lines of data. The first few lines of an example are shown below.

```
  98    3    131.46    133.67
  99    3    166.15    165.82
 100    3    173.50    175.51
 101    3    210.48    211.48
  96    4    148.08    144.86
```

```
   97    4    166.50    161.98
   98    4    149.75    145.43
   99    4    169.05    167.36
```

The data on each line correspond to the I and J horizontal cell indices, followed by a bottom and surface layer flood direction angle. The angles, measured counter clockwise (CCW) from east specify the maximum tidal flood flow direction determined by an analysis of bottom and surface layer tidal velocity ellipses for a single dominant tidal constituent (usually M2 on the U. S. east coast). Tidal ellipse directions are obtained from the output files tidelkb.out and tidelkc.out generated by a preliminary model run. Contact the author for software to generate the fldang.inp file from the tidelkb.out and tidelkc.out files.

Input file gcellmap.inp

The input file gcellmap.inp is read if NWGG on card image 56 of the efdc.inp file is greater than zero. The gcellmap.inp file specifies a square cell Cartesian graphic grid overlay of a horizontal curvilinear grid. The file is used in the generation of three-dimensional graphics and visualization output in 3D array form. The file is optionally generated by GEFDC (also see efdc.inp file, card image 56 description). The file has four header lines, followed by a single data line specifying IG and JG, the number of I and J cells in the Cartesian graphics grid. This line is then followed by NWGG lines of data specifying the water cell indices IGRAPHIC and JGRAPHIC, in the graphics grid and the corresponding indices ICOMP and JCOMP in the curvilinear computational grid. An example of a portion of the gcellmap.inp file is shown below.

```
C gcellmap.inp file, in free format across columns
C
```

```
C IGRAPHIC  JGRAPHIC     ICOMP     JCOMP
C
        50        92
        40         3        16         2
        41         3        17         2
        39         4        16         2
        40         4        16         2
        41         4        17         2
        42         4        18         2
        43         4        19         2
```

Input file gwater.inp

A simple soil moisture model (Hamrick and Moustafa, 1995a) is activated by the input file gwater.inp, shown below.

```
C gwater.inp file, in free format across columns
C   ISGWIE
C     gt.1 for on
C   DAGWZ       RNPOR          RIFTRM
C dep act gw  eff porosity  max infilt rate
C
    1
    0.4          0.3           0.0001
```

The soil moisture model is generally implemented for wetland simulations (Moustafa and Hamrick, 1995). The switch ISGWIE activates a simple soil moisture mass balance, which does not include horizontal flow. The soil moisture mass balance is calculated in an active zone which extends to a depth DAGWZ (in meters) below the bottom of each horizontal cell. The maximum available soil water, in volume of soil water per unit total volume is specified by the effective porosity, RNPOR, which is the physical porosity reduced by a factor accounting for capillary retention under unsaturated conditions. If the overlying water cell is wet, and the soil moisture is less than its maximum available value, infiltration occurs at a maximum rate RIFTRM (in meters per second). If the overlying water cell is dry, and soil moisture is available, the soil moisture is reduced at each time step by evapotranspiration. For a cold start run, the soil moisture is set to its maximum available value below wet cells. Below dry cells, an initial value is set using the mean of the water surface elevation in the wet cells of the simulated region.

Input file mappgns.inp

The input file mappgns.inp is used to configure the EFDC model for the simulations of regions presumed to be periodic or infinite in the computational y or north-south direction, the prime example being an infinite continental shelf or nearshore region, or the same region under the assumption of spatially periodic forcing. An example of a portion of the file is shown below.

```
C  ISPNS,JSPNS =  I,J INDICES OF A SOUTH CELL
C  INPNS,JNPNS =  I,J INDICES OF A CORRESPONDING NORTH CELL
C   NPNSBP
C   ISPNS    JSPNS   INPNS    JNPNS  (REPEATED NPNSBP TIMES)
C
    4
       2        2       2      126
       3        2       3      126
       4        2       4      126
       5        2       5      126
```

The parameter NPNSBP specifies the number of north-south pairs. This is followed by NPNSBP pairs of south and north I and J indices. North and south open boundary conditions must not be specified for these cell pairs in the efdc.inp files.

Input file mask.inp

The file mask.inp is used to insert thin barriers, which block flow across specified cell faces. This option is useful to simulate structural obstacles such as breakwaters and causeways locally aligning with the model grid, but have widths much less than the cell size or grid spacing in one direction. An example of the mask.inp file is shown below.

```
C  mask.inp file, in free format across line, MMASK LINES
C
C  MMASK
C
C  I      J      MTYPE
C
    3
   53      5     1  ! Block flow across west ( u face )
   38     28     2  ! Block flow across south ( v face )
   36     56     3  ! Block flow across all four cell faces
```

The parameter MMASK identifies the number of data lines. Each data line consists of the I and J indices of the cell to be masked, while the parameter MTYPE identifies the face to be blocked. The mask option can be activated on both cold starts and restarts (with no previous masking).

Input file modchan.inp

The input file modchan.inp is used to activate and specify data for a subgrid scale channel model. The subgrid scale channel model (Hamrick and Moustafa, 1995a,b; Moustafa and Hamrick, 1995) allows narrow, one-dimensional in the horizontal plane, channels to pass through larger scale, two-dimensional in the horizontal, cells, referred to as host cells. Up to two subgrid channels at arbitrary orientations may pass through a host cell. The two channels are referred to as u and v channel (the u and v notation is arbitrary and does not define the alignment of the subgrid channels in an arbitrary direction). The subgrid scale channels interact with the host cells through an exchange flow. If the host cell is wet, the exchange flows are determined such that the water surface elevations in the host cell and the channel cells are identical. If the host cell becomes dry, flow is allowed to continue in the subgrid scale channels. An example of the modchan.inp file is shown below for 4 channel sections passing through 4 host cells.

```
C modchan.inp file, in free format across columns
C # host cells  MDCHHD=1 wet host from chan  MDCHHD2=1 dry ck first
C MDCHH         MDCHHD            MDCHHD2
C max iters     MDCHHQ=1 int Q=0   QCHERR= abs error for flow cms
C MDCITM        MDCHHQ            QCHERR
C type     i host  j host  i uchan  j uchan  i vchan  j vchan
C MDCHTYP  IMDCHH  JMDCHH  IMDCHU   JMDCHU   IMDCHV   JMDCHH
C
    4           1                  1
   40           2                  0.001
    1      2       4       6       31       1      1
    1      3       4       7       31       1      1
    1      4       4       8       31       1      1
    1      5       4       9       31       1      1
```

The parameter MDCHH specifies the number of host cells, MDCHHD switches on wetting of a dry host cell when the water surface elevation in the channel exceeds the bottom elevation in the host. MDCHHD2 specifies a drying iteration before the solution for the exchange flows. The maximum number of iterations allowed in the solution for the exchange flows is specified by MDCITM. MDCHHQ = 0 initializes the iterative exchange flow with its value at the previous time step, while MDCHHQ =1 initializes the iteration with zero values for the exchange flows. QCHERR is the convergence criteria for determining the exchange flows. The two lines of control parameters are followed by MDCHH lines of data defining the host cell and subgrid channel linkage mapping. The first parameter MDCHTYP equals 1, 2, or 3 for a single u orientation channel, a single v orientation channel, or two channels. IMDCHH and JMDCHH are the I and J indices of the host cell. IMDCHU and JMDCHU are the I and J indices of the u type channel. IMDCHV and JMDCHV are the I and J indices of the v type channel. For MDCHTYP equals 1 or 2, the indices 1,1 specified either null u or v type channels. The flow example data lines show a set of host cells running for I equals 2 to 5 at a constant J of 4. These cells host a u type channel running from I equal 6 to 9 at a constant J equal to 31. The u type subgrid channels are generally located along a constant J index line in the computational grid, while the v type channels are located along a constant I index line in the computation grid.

Input file moddxdy.inp

The file moddxdy.inp allows for quick modification of cell sizes, specified as dx and dy in the dxdy.inp file. Its primary use is for the quick adjustment of subgrid channel sections lengths and widths. The example below is self-explanatory.

```
C moddxdy.inp file, in free format across columns
C  NMDXDY = # of cells for DX(I,J)=RMDX*DX(I,J) & DY(I,J)=RMDX*DX(I,J)
C    I     J      RMDX       RMDY
C
     4
     6    31      1.0       2.5
     7    31      1.0       2.5
     8    31      1.0       2.5
     9    31      1.0       2.5
```

Input file pser.inp

The input file pser.inp is used to specify surface elevation time series primarily for use at open boundaries. The file may contain multiple time series, each having a single control and conversion data line followed by a sequence of MPSER time data lines. An example is shown below.

```
C  pser.inp file, in free format across line, repeats npser times
C
C  MPSER(NS)   TCPSER(NS)   TAPSER(NS)   RMULADJ(NS)     ADDADJ(NS)
C
C  TPSER(M,NS)  PSER(M,NS)   !(mpser(ns) pairs for ns=1,npser series)
C
    4          86400.       0.           1.0              0.0
    265.00      4.90
    270.00      4.90
    273.00      4.90
    275.00      2.06
```

The parameter MPSER specifies the number of time data lines. TCPSER and TAPSER provide for adjustment and conversion of the time data units to seconds. RMULADJ and ADDADJ provide for conversion and adjustment of the elevation data to meters.

Input file qctl.inp

The input file qctl.inp specifies data to implement flow between pairs of cells controlled by hydraulic structures. The flow is unidirectional between an upstream and downstream cell. Bi-directional flow is implemented by a control structure for each direction. An example of the file, which contains data sequences for an arbitrary number of structures is shown below:

```
C  qctl.inp file, in free format across line, repeats nqctl times
C
C  ISTYP MQCTL(NS) HCTLUA HCTLUM HCTLDA HCTLDM RMULADJ ADDADJ
C
C if istyp.eq.1 then read depth weights and single value of QCTL
C
C (WKQ(K),K=1,KC)
C
C HDIFCTL(M,NS)  QCTL(M,1,NS)  !(mqctl(ns) pairs for ns=1,nqser series)
C
C  else read a value of qser for each layer
C
C  HDIFCTL(M,NS)    (QCTL(M,K,NS),K=1,KC) !(mqctl(ns) pairs)
C
  1      5        0.0     1.0     0.0    1.0    1.76E-05     0.0
  1.0
   0.0       0.0
   0.0001    2.0
   5.0      12.485
   5.0001    0.0
   1.E+12    0.0
```

The parameter ISTYPE is either zero or one, corresponding to a flow for each model layer or a set of layer weights used to distribute a single flow over the layers. MQCTL specifies the number of data point in the control table, which is essentially a flow versus head difference rating curve. HCTLUA and HCTLDA are additive adjustments to the surface elevation in the upstream and downstream cells respectively. HCTLUM and HCTLDM are multiplying factors applied to the adjusted upstream and downstream water surface elevations respectively. ADDADJ and RMULADJ are additive and multiplier conversions applied directly to the flow data and are useful for unit conversion. MQCTL data lines follow the one or two control data lines. The data pairs are elevation difference and flow. The data in the above example implements the formula

$$\frac{Q}{L} = (1.7595E-5)\left(2.0 + 0.9(0.3048)(H_u + B_u - H_d - B_d)\right) \qquad \text{(x)}$$

$$H_u + B_u > H_d + B_d$$

where Q/L is discharge or flow per unit length and H and B are the water depth and bottom elevations in the upstream and downstream cells:

To illustrate the capabilities of the surface elevation or pressure flow control option it is convenient to summarize the sequence of steps involved in calculating the flow between the upstream and downstream cells. The FORTRAN statement sequence involves looping over all control structure pairs, NQCTL, and is shown in Table 6. The flow from the upstream cell to the downstream cell is determined by the difference, DELH, between the upstream pressure plus elevation head, HUP relative to -HCTLUA, adjusted by multiplying by HCTLUM, and the downstream pressure plus elevation head, HDW relative to -HCTLDA, adjusted by multiplying by HCTLDM. For flows controlled entirely by surface elevation differences, HCTLUA and HCTLDA would both be zero. For a spillway or weir, -HCTLUA would be the spillway or weir crest elevation. For upstream only control, HCTLDM would be set to zero. Given the adjusted head difference, DELH, which must be greater than zero, the discharge or discharge per unit width, QCTLT, is determined from an interpolation table. A final multiplying adjustment, by RQCMUL, is applied to convert discharge per unit width to discharge if required. The hydraulic control structure option is also suitable for simulating water surface elevation controlled pump station operation.

```
      DO NCTL=1,NQCTL
      RQDW=1.
      IU=IQCTLU(NCTL)                     ! I CELL INDEX UPSTREAM
      JU=JQCTLU(NCTL)                     ! J CELL INDEX UPSTREAM
      LU=LIJ(IU,JU)                       ! L CELL INDEX UPSTREAM
      HUP=HP(LU)+BELV(LU)+HCTLUA(NCTL)    ! UPSTREAM SUF ELEV + HCTLUA
      ID=IQCTLD(NCTL)                     ! I CELL INDEX DOWNSTREAM
      JD=JQCTLD(NCTL)                     ! J CELL INDEX DOWNSTREAM
      IF (ID.EQ.0.AND.JD.EQ.0) THEN
        LD=LC                             ! FLOW OUT OF MODEL DOMAIN
        HDW=0.                            !  WITH UPSTREAM FLOW
        RQDW=0.                           !  CONTROL
       ELSE
        LD=LIJ(ID,JD)                     ! L CELL INDEX DOWNSTREAM
        HDW=HP(LD)+BELV(LD)+HCTLDA(NCTL)  ! UPSTREAM SUF ELEV + HCTLDA
      END IF
      DELH=HCTLUM(NCTL)*HUP-HCTLDM(NCTL)*HDW ! ADJUSTED DIFFERENCE
      IF (DELH.LE.0.) THEN                ! NO FLOW
        DO K=1,KC
        QCTLT(K,NCTL)=0.
        END DO
       ELSE                               ! ENTER INTERPOLATION TABLE
        M1=0                              !  TO DETERMINE FLOW IN
        M2=1                              !  EACH LAYER AS A FUNCTION
 500    M1=M1+1                           !  OF DELH
        M2=M2+1
        IF(DELH.GE.HDIFCTL(M1,NCTL).AND.DELH.LE.HDIFCTL(M2,NCTL))THEN
          TDIFF=HDIFCTL(M2,NCTL)-HDIFCTL(M1,NCTL)
          WTM1=(HDIFCTL(M2,NCTL)-DELH)/TDIFF
          WTM2=(DELH-HDIFCTL(M1,NCTL))/TDIFF
          DO K=1,KC
           QCTLT(K,NCTL)=WTM1*QCTL(M1,K,NCTL)+WTM2*QCTL(M2,K,NCTL)
          END DO                          ! FLOW ASSIGNED TO LAYERS,K
         ELSE
          GO TO 500
        END IF
      END IF
       DO K=1,KC                          ! ADD CONTROL FLOW TO OTHERS
       QSUM(LU,K)=QSUM(LU,K)-RQCMUL(NCTL)*QCTLT(K,NCTL)
       QSUM(LD,K)=QSUM(LD,K)+RQCMUL(NCTL)*RQDW*QCTLT(K,NCTL)
       END DO
      END DO
C
       HP( ):   CELL CENTER DEPTH
       BELV( ): CELL CENTER BOTTOM ELEVATION
       NQCTL:   NUMBER OF CONTROLLED FLOW SETS
       MQCTL:   NUMBER OF DEPTH FLOW PAIRS IN SET NS
       HCTLUA:  CONSTANT ADDED TO UPSTREAM ELEVATION
       HCTLUM:  UPSTREAM MULTIPLIER
       HCTLDA:  CONSTANT ADDED TO UPSTREAM ELEVATION
       HCTLDM:  DONWSTREAM MULTIPLIER
       HDIFCTL: DEPTH AND
       QCTL:    VOLUMETRIC FLOW PAIRS
       RQCMUL:  CONVERTS DISCHARGE/LENGTH TO DISCHARGE, =1 FOR
                DISCHARGE, = DX OR DY FOR DISCHARGE PER LENGTH
```

Table 6. FORTRAN Implementation of Control Structures

Input file qser.inp

An example of the qser.inp file is shown below.

```
C  qser.inp file, in free format across line, repeats nqser times
C
C  ISTYP   MQSER(NS)   TCQSER(NS)  TAQSER(NS)  RMULADJ(NS)  ADDADJ(NS)
C
C  if istyp.eq.1 then read depth weights and single value of QSER
C
C  (WKQ(K),K=1,KC)
C
C  TQSER(M,NS)  QSER(M,1,NS)  !(mqser(ns) pairs for ns=1,nqser series)
C
C  else read a value of qser for each layer
C
C  TQSER(M,NS)    (QSER(M,K,NS),K=1,KC) !(mqser(ns) pairs)
C
   1    10     3600.0     0.     1.    0.     0
   0.166  0.167  0.167  0.167  0.167  0.166
-2000.0000         0.00
  713.39           0.00
  713.41           0.001
  726.89           0.001
  726.91           0.00
 7076.49           0.00
 7076.51           0.001
 7087.99           0.001
 7088.01           0.00
 10000.00          0.00
  1     9    3600.0    0.0   1.0    0.     0
   0.166  0.167   0.167  0.167  0.167  0.166
    708.0    260.3
    732.0    243.3
    756.0    230.2
    780.0    215.9
    804.0    202.3
    828.0    192.9
    852.0    181.1
    876.0    182.9
    900.0    173.5
```

Input file restart.inp

The file restart.inp is used to specify initial conditions for running the EFDC model in the restart mode. The file is obtained by renaming the restart.out file.

Input file restran.inp

The file restran.inp is used to specify advective and diffusive transport files when the EFDC model is executed in the transport only mode. The file is obtained by renaming the restran.out file.

Input file show.inp

The file show.inp, shown below, is used to control screen writing of information at the horizontal location specified by the horizontal cell indices ISHOW and JSHOW. The parameter NSTYPE determines the type of screen displace. For NSTYPE equal to 1, the screen display emulates

```
C  show.inp file, in free format across line
C
C  NSTYPE    NSHOWR    ISHOWC   JSHOWC
C
C  ZSSMIN    ZSSMAX    SSALMAX
C
   2         30       7       65
  -3.        3.        8.
```

a strip chart recording of water surface elevation and surface and bottom salinity. In this mode, and lower and upper scale for the surface elevation, ZSSMIN and ZSSMAX and an upper scale for salinity, SSALMAX must be specified on the third data line. The file is reread every NSHOWR time steps. Between the rereads of the file, it may be edited (only on multiple window UNIX systems) to move locations and the type of display. For NSTYPE equal 2, 3, or 4, column format data on time or timestep, surface and bottom layer velocity, salinity or sediment concentration, and vertical diffusion coefficients are displayed. NSTYPE = 2 displays timestep and salinity. NSTYPE = 3 displays time in days and salinity. NSTYPE = 4 displays timestep and sediment concentration. Activating this option is generally recommended for diagnostics of new applications and may result in noticeable decreases in model execution speeds on systems with slow IO capabilities.

Input file sfbser.inp

The file sfbser.inp specifies behavioral information for shellfish larvae when the shellfish larvae transport is activated. The header lines explain the meaning to the various time dependent behavior control information.

```
C  sfbser.inp file, shellfish larvae behavior time series in free format
C  MSFSER=no of time data points.  TCSFSER=converts time values to sec
C  TASFSER=additive adjustment to time values
C  TSRSF,TSSSF=times of sunrise and sun set as a fraction of 24 hours
C  ISSFLDN=1 to activate daylight,darkness dependent behavior
C  ISSFLFE=1 to activate flood,ebb dependent behavior
C  TSFSER=time of data   RKDSFL=first order decay rate in 1/sec
C  WSFLST=settling velocity in m/s  WSFLSM=vert swim velocity in m/s
C  DSFLMN=minimum depth below surface in daylight, meters
C  DSFLMX=maximum depth below surface in daylight, meters
C  SFNTBE=restricts advection in bottom layer during ebb
C          0. equals full restriction, 1. equals no restriction
C  SFATBT=1. allows larvae to settle to bottom and attach
C
C  MSFSER   TCSFSER   TASFSER  TSRSF   TSSSF  ISSFLDN  ISSFLFE
C
C  TSFSER RKDSFL WSFLST WSFLSM DSFLMN DSFLMX SFNTBE SFATBT
C
   4        86400.    0.       0.25    0.84    1       1
 -10000.  0.     0.    0.        0.        0.        0.        0.
  0.      0.     0.    0.        0.        0.        0.        0.
  0.01    0.     0.    0.        0.        0.        0.        0.
  10000.  0.     0.    0.        0.        0.        0.        0.
```

Input file vege.inp

The input file vege.inp specifies information on vegetation resistance. An example is shown below.

```
C  vege.inp file, in free format across line,  WCA2A
C
C  MVEGTYP(# vege classes) MVEGOW(open water class) UVEGSCL(vel scale)
C
C  after reading MVEGTYP, MVEGOW and UVEGVSCL read MVEGTYP lines of vars
C
C    M   RDLPSQ   BPVEG     HPVEG   ALPVEG   BETVEG   GAMVEG   SCVEG
C  typ#  1/m**2   meters    meters  no dim   no dim   no dim   nodim
C
    20     17       0.01
     1    32.0    0.1E-0     2.5    0.7854    1.0      0.0     0.50
     2    18.0    0.1E-0     2.5    0.7854    1.0      0.0     0.50
     3     8.0    0.1E-0     2.5    0.7854    1.0      0.0     0.50
```

```
  4    26.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
  5    12.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
  6    32.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
  7    32.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
  8    18.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
  9    12.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 10    32.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 11    18.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 12     8.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 13    26.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 14    18.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 15    26.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 16    32.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 17    0.25    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 18    32.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 19    32.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
 20     8.0    0.1E-0     2.5    0.7854    1.0       0.0     0.50
```

The parameter MVEGTYP specifies the number of vegetation types. The vegetation is represented as cylindrical elements of height HPVEG and width or diameter BPVEG having a spatial density of RDLPSQ resistance elements per square meter. The parameter ALPVEG, BETVEG, GAMVEG, and SCVEG are dimensionless shape factors (see Hamrick and Moustafa, 1995a) with the values shown being typical of cattail and sawgrass.

Input file wave.inp

The file wave.inp is used to specify forcings for modeling wave induced currents and wave-current boundary layers. The definitions on the header lines define and explain the various data types. A preprocessor is available from the author to generate the two layer data sets required in this file using the output of various wave prediction and transformation models.

```
c  file wave.inp to specify information for wave-current boundary layer
c  and wave induced flow
c
c  *first line data
c  NWVDAT=number of cells receiving wave data
c  WVPRD=wave period in secs
c  CVTWHA=mult convert wave height to amplidute in m
c  ISWCBL=1 activates wave current boundary layer model
c  ISWRSR=1 activates inclusion of rotational component of rad stress
c  ISWRSI=1 activates inclusion of irrotational component of rad stress
c  NWUPDT=number of time steps between updating wave forcing
c  NTSWV=number of time steps for gradual introduction of wave forcing
c  WVDISV=fraction of wave dissipation as source in vertical TKE closure
c  WVDISH=fraction of wave dissipation as source in horiz SSG closure
c  WVLSH=weight for depth as the horiz SSG eddy viscosity length scale
c  WVLSX=weight for sqrt(dxdy) as the horiz SSG eddy vis length scale
c  ISWVSD=1, include nondiverg wave stokes drift in mass transport
c  ISDZBR=1,write diagnos for effect wave current bndry layer roughness
c
c  *second NWVDAT lines data
c  I,J cell indices
c  HMP,HMC cell center & corner depths for consistent disper evaluation
c  WVENE wave energy 0.5*g*abs(amp)*abs(amp)
c  SXX rotational depth integrated wave radiation stress <huu>
c  SYY rotational depth integrated wave radiation stress <hvv>
c  SXY rotational depth integrated wave radiation stress <huv>
c  WVDISP wave energy dissipation in (m/s)**3
c
c  *third NWVDAT lines data
c  I,J cell indices
c  HMU,HMV cell u and v face depths for consistent disper evaluation
c  UWVRE real part of u component of wave orbital velocity magnitude
```

```
c  UWVIM imag part of u component of wave orbital velocity magnitude
c  VWVRE real part of v component of wave orbital velocity magnitude
c  VWVIM imag part of v component of wave orbital velocity magnitude
c
c NWVDAT WVPRD CVTWHA ISWCBL ISWRSR ISWRSI NWUPDT NTSWV WVDISV WVDISH
continuation of first head (not sep line)\  WVLSH WVLSX ISWVSD ISDZBR
c I  J    HMP   HMC     WVENE      SXX       SYY       SXY     WVDISP
c I  J    HMU   HMV     UWVRE      UWVIM     VWVRE     VWVIM
c
  5500  10.9  1.0     1      1      1    1000000  120    1.0    1.0
continuation of first head (not sep line)\  0.0  1.0    0     1
  2  2  .001  .001  .5845E-05  .0000E+00 .1288E-09  .0000E+00 .0000E+00
  3  2  .001  .001  .2276E-04  .1472E-04 .9844E-09  .8752E-07 .0000E+00
  4  2  .001  .001  .2367E-04  .3217E-05 .7498E-09  .8203E-06 .6821E-07
  .  .   .    .     .         .        .         .        .
  .  .   .    .     .         .        .         .        .
  .  .   .    .     .         .        .         .        .
  2  2  .001  .001  .0000E+00  .0000E+00  .282849E-03  .773267E-03
  3  2  .001  .001  .6392E-01 -.1561E+00  .184260E-02  .212868E-03
  4  2  .001  .001 -.1471E+00 -.2958E+00 -.566360E-03 -.154184E-02
```

6. Compiling and Executing the Code

To compile the EFDC model, the FORTRAN 77 source code efdc.f and the include files efdc.com, which contains global common blocks, and efdc.par, which contains a global parameter statement are necessary and should reside in the same directory. Extensive efforts have been made to ensure cross-platform compatibility of the EFDC model, however, a number of minor modifications are required for various platforms. The source code efdc.f contains calls to the VMS time utility secnds. For compilers which support the secnds function through systems libraries, (DEC and Hewlett-Packard UNIX systems and Absoft and LSI Macintosh FORTRAN compilers), no modifications to the standard source efdc.f are required if appropriate compiler options are specified. (To determine if your compiler supports the secnds functions, look for secnds or VMS compatibility in the compiler reference manuals.) For compilers which do not support the secnds function, (Cray cf77, Sun UNIX) the real function subroutine secnds.f should be appended to the end of the standard source code. A somewhat less desirable fix is to comment out calls to the secnds function. Many of the IO operations in the efdc.f source code use the open file statement form:

OPEN(1,FILE='fname', STATUS='UNKNOWN',ACCESS='APPEND')

To the writer's knowledge, the only systems which do not support the ACCESS='APPEND' modifier are Cray and IBM Risc6000 UNIX Systems. For Cray compilation, the ACCESS='APPEND' should be globally replaced by POSITION='APPEND'. A Cray-compatible version of the source, cefdc.f is continually maintained and available by ftp as described in the foreword of this report.

Except for the optional function subroutine secnds.f, the source code consisting of approximately 112 subroutines at last count is maintained as a single text file, efdc.f or cefdc.f. A number of compilers, including the Cray and Silicon Graphics UNIX compilers and the Lahey Intel based PC compiler, are able to produce optimized executable code by operating the entire source using, for example, the Cray and SGI commands:

```
cf77 -Zv cefdc.f
f77 -O3 efdc.f
```

which produce the executable a.out. (Note the option -Zv for the Cray compilation produces optimum vectorization, using -Zp would produce both optimum vectorization and autotasking). Other compilers, such as the HP and SUN UNIX compilers and the Absoft and LSI Macintosh compilers, are capable of producing only nonoptimized executables working with the entire source code. An example command line for the HP is:

```
f77 -K +E1 -C -o hpefdcnopt efdc.f
```

which produces the nonoptimized executable hpefdcnopt. The options -K +E1 invoke support of the secnds function, while -C implements array range checking. To produce optimized code on these systems, recourse to makefiles or batch command files which compile each subroutine separately is necessary. Batch command files for HP and SUN UNIX compilers and Makefiles for Absoft and LSI Macintosh compilers are available via ftp.

To achieve minimum memory requirements for running a specific application, it is recommended that the parameter file be customized for that application. The parameter file is of the form:

```
C
C     EFDC PARAMETER FILE
C     LAST MODIFIED ON 7 FEBRUARY 1995
C
C     IMPLICIT REAL*8 (A-H,O-Z)
C
      PARAMETER (KSM=7,KCM=8,KGM=8,LCM=5502,ICM=52,JCM=112,
     $      IGM=52,JGM=112,KPCM=1,NWGGM=5502,NTSM=12000,NPDM=10,
     $      NPBSM=50,NPBWM=2,NPBEM=110,NPBNM=50,LCMW=5502,
     $      NVBSM=1,NVBNM=1,NUBWM=1,NUBEM=1,NGLM=2,LCGLM=2,
     $      NQSIJM=20,NQSERM=20,NCSERM=20,NQCTLM=20,
     $      NQWRM=2,NPSERM=20,NDQSER=2000,NVEGTPM=2,
     $      NBBSM=50,NBBWM=2,NBBEM=110,NBBNM=50,
     $      MTM=12,MLM=10,MGM=24,NPFORM=12,MLTMSRM=99)
C
C      ICM= MAXIMUM X OR I CELL INDEX TO SPECIFIC GRID IN
C            FILE cell.inp
C      IGM= MAXIMUM I CELL INDEX FOR GRAPHICS GRID SPECIFIED
C           BY GCELLMAP.INP
C      JCM= MAXIMUM Y OR J CELL INDEX TO SPECIFIC GRID IN
C            FILE cell.inp
C      JGM= MAXIMUM J CELL INDEX FOR GRAPHICS GRID SPECIFIED
C           BY GCELLMAP.INP
C      KCM= MAXIMUM NUMBER OF LAYERS, MAX LOOP INDEX KC
C      KGM= KCM
C      KSM= KCM-1
C     KPCM= MAXIMUM NUMBER OF CONSTANT ELEVATION LEVEL FOR
C            THREE DIMENSION GRAPHIC OUTPUT
C      LCM= MAXIMUM NUMBER OF WATER CELLS + 2
C            OR 1 + THE MAX LOOP INDEX LA
C     LCMW= SET TO LCM IF ISWAVE.GE.1 OTHERWISE =2
C    LCGLM= SET TO LCM IF ISLRD.GE.1 OTHERWISE =2
C      MGM= 2*MTM
C      MLM= MAXIMUN NUMBER OF HARMONIC ANALYSIS LOCATION
C      MTM= MAXIMUM NUMBER OF PERIODIC FORCING CONSTITUENTS
C  MLTMSRM= MAXIMUM NUMBER OF TIME SERIES SAVE LOCATIONS
C   NCSERM= MAXIMUM NUMBER OF CONCENTRATION TIME SERIES FOR
C            ANY CONCENTRATION VARIABLE
C     NGLM= NUMBER OF ISLRD PARTICLE RELEASE TIMES
C    NBBEM= NPBEM
C    NBBNM= NPBNM
C    NBBSM= NPBSM
C    NBBWM= NPBWM
C   NDQSER= MAXIMUM NUMBER OF TIME POINTS IN THE LONGEST TIME SERIES
C    NPBEM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C    NPBNM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C    NPBSM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C    NPBWM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
```

```
C     NPDM= MAXIMUM NUMBER OF ISPD TYPE PARTICLE DRIFTERS
C   NPFORM= MAXIMUM NUMBER OF PERIODIC FORCING FUNCTIONS
C   NPSERM= MAXIMUM NUMBER OF SURFACE ELEVATION TIME SERIES
C   NQCTLM= MAXIMUM NUMBER OF FLOW CONTROL STRUCTURES
C   NQSERM= MAXIMUM NUMBER OF FLOW TIME SERIES
C   NQSIJM= MAXIMUM NUMBER OF NQSIJ VOLUMETRIC SOURCE-SINKS
C    NQWRM= MAXIMUM NUMBER OF FLOW WITH-RETURN PAIRS
C     NTSM= MAXIMUM NUMBER OF TIME STEP PER REFERENCE TIME PERIOD
C    NUBEM= 1
C    NUBWM= 1
C    NVBNM= 1
C    NVBSM= 1
C  NVEGTPM= MAXIMUM NUMBER OF VEGETATION TYPE CLASSES
C    NWGGM= NUMBER OF WATER CELLS IN CARTESIAN GRAPHIC OVERLAY
C           GRID, EQUAL TO LCM-2 FOR CARTESIAN GRIDS
C
```

For a given model application, the parameters, which dimension arrays in efdc.com, should be set to the lowest value that accommodates the grid and data for the application. When starting to run a new application, it is recommended to use a nonoptimized executable compiled with the range checking option (usually -C on UNIX compilers) to determine if arrayed variables are within the range specified by the parameter dimensioned arrays.

7. Diagnostic Options and Output

adjmmt.dia
bal.out
balo.out
bale.out
buoy.dia
disdia.out
modchan.dia
rbcm.dia
sinval.out
efdc.log
time.log
drywet.log
lijmap.out
zvolbal.out
cfl.out
eqcoef.out
eqterm.out
fp.out
eqcoef1.out
diaq.out

8. Time Series Output and Analysis

lsha.out
saltmsr01.out
temtmsr01.out
dyetmsr01.out
sedtmsr01.out
sfltmsr01.out
avvtmsr01.out
avbtmsr01.out
uvetmsr01.out
uvttmsr01.out
u3dtmsr01.out
v3dtmsr01.out
qqetmsr01.out
q3dtmsr01.out
vsfp.out

```
INSTANTANEOUS VERTICAL SCALAR FIELD PROFILES


TIME =    3221.6001 N =   1665  I,J =    151    42
DEPTH BELOW SURFACE    MODEL SALINITY

        1.00               16.70
        3.00               17.27
        5.00               17.79
        7.00               18.09
        9.00               18.21
       11.00               18.24
       13.00               18.25


TIME =    3222.0000 N =   1679  I,J =    140    46
DEPTH BELOW SURFACE    MODEL SALINITY

        1.00               17.36
        3.00               17.37
        5.00               17.37
        7.00               17.37
        9.00               17.39
       11.00               17.42
       13.00               17.43
       15.00               17.44
       17.00               17.44
       19.00               17.45


TIME =    3222.3999 N =   1693  I,J =    124    59
DEPTH BELOW SURFACE    MODEL SALINITY

        1.00               13.51
        3.00               13.51
        5.00               14.53
        7.00               14.93

        9.00               14.93
```

9. Two-Dimensional Graphics Output and Visualization

9.1 Two-Dimensional Horizontal Plane Scalar Format

belvcon.out
wcustrh.out wave current shear velocity
ccustrh.out current shear velocity
zbreffh.out
surfamp.out
surfpha.out
majaxis.out
majapha.out
salconh.out
temconh.out
dyeconh.out
sedconh.out
sflconh.out
rsalconh.out
rtemconh.out
rdyeconh.out
rsedconh.out
rsflconh.out
surfcon.out
rsurfcon.out

9.2 Two-Dimensional Horizontal Plane Vector Format

tstvech.out

stvech.out

tauvech.out

tidelkc.out

tidelkb.out

velvech.out

rvelvech.out

pvelvech.out

mvelvech.out

lmvvech.out

almvvech.out

9.3 Two-Dimensional Vertical Plane Scalar Format

salcnv1.out

temcnv1.out
dyecnv1.out
sedcnv1.out
sflcnv1.out
rsalcnv1.out
rviscnv1.out
rvefcnv1.out
rsflcnv1.out
velcnv1.out
rvelcnv1.out
pvelcnv1.out
mvelcnv1.out
lmvcnv1.out
almvcnv1.out
rvelcvt1.out
pvelcvt1.out
mvelcvt1.out
lmvcvt1.out
almvcvt1.out

9.4 Two-Dimensional Vertical Plane Vector Format

velvcv1.out
rvelvcv1.out
pvelvcv1.out
mvelvcv1.out
lmvvcv1.out
almvvcv1.out

10. Three-Dimensional Graphics Output and Visualization

sal3d01.asc up to 24 files
tem3d01.asc
dye3d01.asc
sed3d01.asc
uuu3d01.asc
vvv3d01.asc
www3d01.asc
out3d.dia
rsal3d01.asc up to 24 files
rtem3d01.asc
rdye3d01.asc
rsed3d01.asc
ruuu3d01.asc
rvvv3d01.asc
rwww3d01.asc
rout3d.dia

11. Miscellaneous Output

efdc.out

avsel.out
gwelv.out
cell9.out
drifter.out
restran.out
restart.out
waspp.out
waspc.out
waspb.out
waspd.out
waspdhd.out
waspdh.out
waspdhu.out
advmod.wsp
disten.out
uvtsc.out
uverv.out

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Appendix A. EFDC Source Code Subroutines and Their Functions.

Subroutine	Function
ADJMMT.f	Adjust mean transport field for transport only simulations
AINIT.f	Initializes Variables
ASOLVE.f	Utility solver for bi-conjugate gradient solver
ATIMES.f	Utility sparse matrix multiplier for bi-conjugate gradient solver
CALAVB.f	Calculates vertical turbulent viscosity and diffusivity
CALBAL1.f	Calculates mass, momentum and energy balances
CALBAL2.f	Calculates mass, momentum and energy balances
CALBAL3.f	Calculates mass, momentum and energy balances
CALBAL4.f	Calculates mass, momentum and energy balances
CALBAL5.f	Calculates mass, momentum and energy balances
CALBUOY.f	Calculates buoyancy or density anomaly using UNESCO equation of state
CALCONC.f	Calculates scalar field (concentration) transport
CALCSER.f	Concentration time series processor
CALDIFF.f	Calculates horizontal diffusion of scalar fields

CALDISP2.f Calculates time average horizontal shear dispersion tensor

CALDISP3.f Calculates time average horizontal shear dispersion tensor

CALEBI.f Calculates buoyancy integral in external mode equations

CALEXP.f Calculates explicit terms in momentum equations

CALFQC.f Calculates mass (scalar concentration field) sources and sinks

CALHDMF.f Calculates horizontal diffusion in momentum equations

CALHEAT.f Calculates surface and internal heat sources and sinks

CALHTA.f Performs harmonic analysis for single frequency periodically forced flow

CALMMT.f Calculates time mean mass transport field including Stokes' drift

CALPSER.f Processes surface elevation time series

CALPUV.f External mode solver for rigid lid or small surface displacement flows

CALPUV2.f External mode solver for larger surface displacements, but no drying or wetting

CALPUV5.f External mode solver for flows with drying and wetting and subgrid scale channels

CALPUV7.f External mode solver for kinematic wave approximation

CALQQ1.f Calculates transport of turbulent kinetic energy and length scale

CALQQ2.f Calculates transport of turbulent kinetic energy and length scale (research version)

CALQVS.f — Processes volumetric source and sink time series

CALSED.f — Calculates cohesive sediment settling, deposition and resuspension

CALSED2.f — Calculates cohesive sediment settling, deposition and resuspension

CALSED3.f — Calculates noncohesive sediment settling, deposition and resuspension

CALSFT.f — Calculates diffusion, sources and sinks and vertical migration of shellfish larvae.

CALTBXY.f — Calculates bottom drag coefficients for bottom stress calculation and calculates certain vegetation resistance parameters.

CALTRAN.f — Calculates explicitly advective transport of scalar field concentration) variables

CALTRANI.f — Calculates implicit advective transport of scalar field concentration) variables

CALTRANQ.f — Calculates advective transport of turbulent kinetic energy and length scale

CALTRWQ.f — Calculates explicit advection of water quality variables

CALTSXY.f — Processes wind and atmospheric condition time series and calculates surface wind stress.

CALUVW.f — Solves the internal mode momentum equations and continuity equation

CALWQC.f — Calculates diffusion and sources and sinks of water quality variables

CBALEV1.f — Calculates mass, momentum and energy balances for even time steps

CBALEV2.f — Calculates mass, momentum and energy balances for even time steps

CBALEV3.f Calculates mass, momentum and energy balances for even time steps

CBALEV4.f Calculates mass, momentum and energy balances for even time steps

CBALEV5.f Calculates mass, momentum and energy balances for even time steps

CBALOD1.f Calculates mass, momentum and energy balances for odd time steps

CBALOD2.f Calculates mass, momentum and energy balances for odd time steps

CBALOD3.f Calculates mass, momentum and energy balances for odd time steps

CBALOD4.f Calculates mass, momentum and energy balances for odd time steps

CBALOD5.f Calculates mass, momentum and energy balances for odd time steps

CELLMAP.f Maps I,J horizontal indexes to single L index

CELLMASK.f Inserts barriers across cell flow faces

CGRS.f Red-Black reduced system conjugated gradient solver for two-dimensional Helmholtz equation

CONGRAD.f Diagonally preconditioned conjugated gradient solver for two-dimensional Helmholtz equation

DEPPLT.f Generates file for bathymetry contouring in ASCII column format

DEPSMTH.f Smoothes bottom elevation and initial depth fields

DRIFTER.f Releases and tracks Lagrangian drifters at specified times and locations

EFDC.f	Main program
FILTRAN.f	Performs vertical filtering of mean mass transport field
GLMRES.f	Calculates generalized Lagrangian mean velocities
HDMT.f	Controls hydrodynamic and mass transport solution
INPUT.f	Processes input files
LAGRES.f	Calculates Lagrangian mean velocities by forward trajectories
LINBCG.f	Bi-conjugate gradient linear equation solver
LSQHARM.f	Performs least squares harmonic analysis
LTMT.f	Controls mass transport only solution
LUBKSB.f	Back substitution utility for LU decomposition equation solver
LUDCMP.f	LU decomposition equation solver
LVELPLTH.f	Writes ASCII column files for visualization of Lagrangian mean velocity field in horizontal stretched layer
LVELPLTV.f	Writes ASCII column files for visualization of Lagrangian mean velocity field in vertical transects
OUT3D.f	Writes files for two-dimensional slice and three-dimensional volume visualization of vector and scalar fields in 8 bit ASCII integer format or 8 bit HDF integer format
OUTPUT1.f	Writes printer output files in crude printer character contouring form
OUTPUT2.f	Writes printer output files in crude printer character contouring form
PPLOT.f	Processes printer character contour plots

REDKC.f	Reduces layers by 1/2 in mass transport only simulations (not active)
RELAX.f	Solve two-dimensional Helmholtz equation by Red-Black SOR (successive over relaxation)
RELAXV.f	A more vectorizabe version of RELAX.f
RESTIN1.f	Reads restart.inp file for restarting a run
RESTIN10.f	Reads older versions of restart.inp
RESTIN2.f	Reads a K layer restart.inp file to initialize a 2*K layer simulation
RESTMOD.f	Reads restart.inp field and deactivates specified horizontal cell
RESTOUT.f	Writes restart file restart.out
RESTRAN.f	Reads transport file restran.inp for transport only simulations
ROUT3D.f	Writes files for two-dimensional slice and three-dimensional volume visualization of time mean vector and scalar fields in 8 bit ASCII integer format or 8 bit HDF integer format
RSALPLTH.f	Writes ASCII column files for time means scalar field visualization in horizontal stretched layers
RSALPLTV.f	Writes ASCII column files for time mean scalar field visualization in vertical transects
RSURFPLT.f	Writes ASCII column file for visualization of time mean surface displacement field
RVELPLTH.f	Writes ASCII column files for visualization of time mean velocity field in horizontal stretched layers

RVELPLTV.f Writes ASCII column files for visualization of time mean velocity field in vertical transects

SALPLTH.f Writes ASCII column files for instantaneous scalar field visualization in horizontal stretched layers

SALPLTV.f Writes ASCII column files for instantaneous scalar field visualization in vertical transects

SALTSMTH.f Smoothes or interpolates an initial salinity field for cold start runs

SECNDS.f Emulates VMS library function secnds on compilers not supporting this function. This is the only optional subroutine in the code and is normally appended to the end of the efdc.f file for compilation on certain UNIX and Intel based PC compilers.

SETBCS.f Set horizontal boundary conditions

SHOWVAL.f Writes screen display of instantaneous conditions at a specified horizontal location

SNRM.f Computes error norm for bi-conjugate gradient equation solver

SURFPLT.f Writes ASCII column files for instantaneous surface displacement visualization

SVBKSB.f Back substitution utility of SVD equation solver

SVDCMP.f SVD (Singular value decomposition) linear equation solver

TMSR.f Writes time series files

VALKH.f Real function subroutine to solve high frequency surface gravity wave dispersion relationship for kh.

VELPLTH.f Writes ASCII column files for visualization of instantaneous velocity field in horizontal stretched layer

VELPLTV.f Writes ASCII column files for visualization of instantaneous velocity field in vertical transects

VMSLIB.f Library of VMS system subroutines for the function SECNDS (required for compiling code on Power Macintosh Systems using Absoft FORTRAN compiler)

VSFP.f Extracts and writes files of vertical scalar field profiles at specified times and locations to mimic field sampling

WASP4.f Writes grid and transport files to drive the WASP4 water quality simulation model

WASP5.f Writes grid and transport files to drive the WASP5 water quality simulation model

WASP6.f Writes grid and transport files to drive the WASP5 water quality simulation model as modified by Tetra Tech, Inc. Fairfax, VA.

WAVE.f Processes input high frequency surface gravity field specified in file wave.inp for calculating near bottom wave velocities for the wave-current bottom boundary layer formulation and/or calculating the three-dimensional wave Reynolds' stress and wave Stokes' drift for wave induced current simulation.

Appendix B: Grid Generation Examples

This appendix contains a number of example grids generated by the gefdc.f grid generating preprocessor code. Each sub section contains a plot of the grid in physical space and images of the cell.inp and gefdc.inp files.

B.1. Lake Okeechobee, Florida

This section describes a 1 kilometer square cell Cartesian grid of Lake Okeechobee, Florida. The physical domain grid is shown in Figure B1, the cell.inp file in Figure B2, and the gefdc.inp file in Figure B3. The grid was generated with the NTYPE = 0, option by gefdc.f. A FORTRAN program for the generation of the gridext.inp file is shown if Figure B4. It is noted that for square cell grids, the physical and computational domains are geometrically identical and differ by a scale factor equal to the cell side length, which in this case is 1 kilometer.

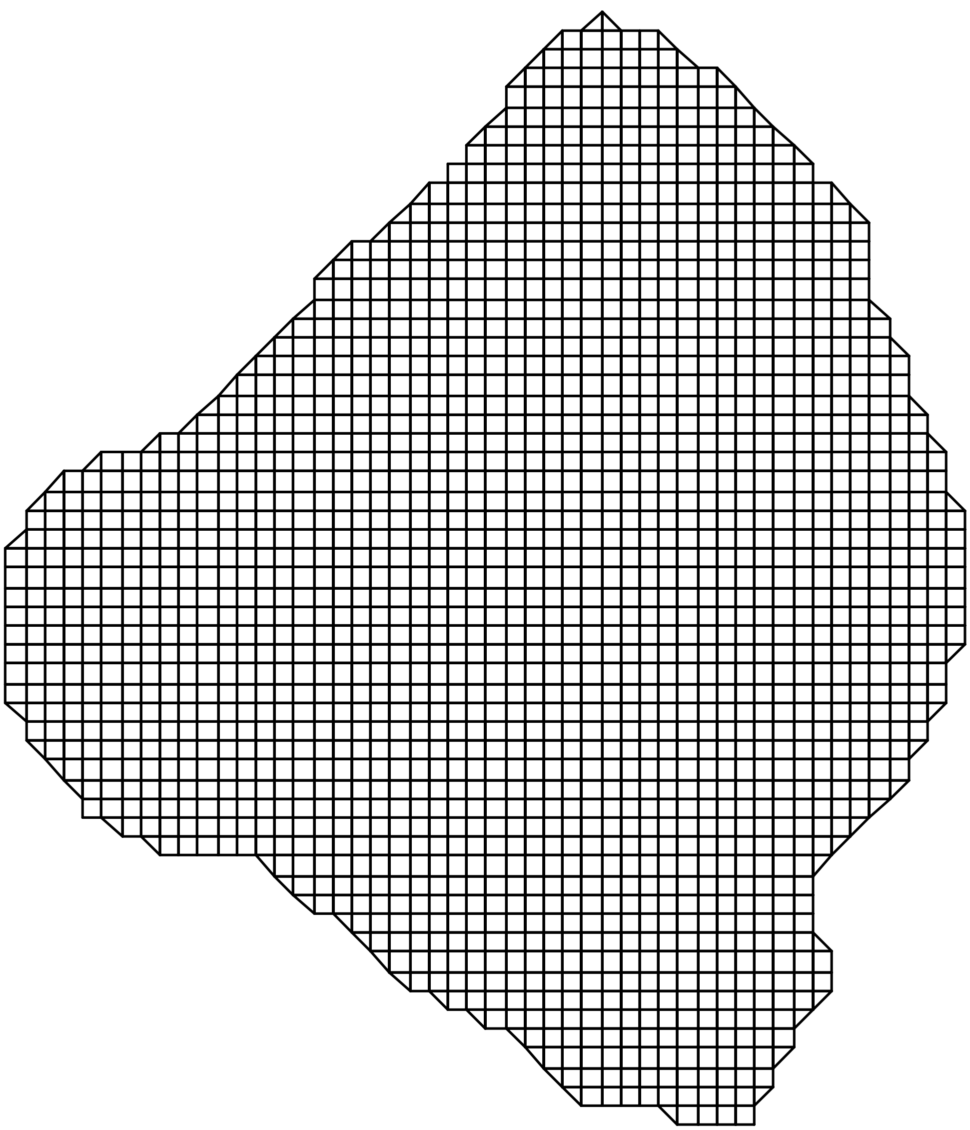

Figure B1. Physical and computational domain grid of Lake Okeechobee, Florida. Grid spacing is 1000 meters.

```
C cell.inp file, i columns and j rows, for LAKE OKEE
C             1         2         3         4         5
C    123456789012345678901234567890123456789012345678901234
C
 62  000000000000000000000000000000000000000000000000000000
 61  000000000000000000000000000000099990000000000000000000
 60  000000000000000000000000000099941999900000000000000000
 59  000000000000000000000000000099455555199000000000000000
 58  000000000000000000000000000994555555519990000000000000
 57  000000000000000000000000000945555555555199000000000000
 56  000000000000000000000000009955555555555519900000000000
 55  000000000000000000000000099455555555555551990000000000
 54  000000000000000000000000094555555555555555199000000000
 53  000000000000000000000000995555555555555555519000000000
 52  000000000000000000000099955555555555555555559990000000
 51  000000000000000000009945555555555555555555555199000000
 50  000000000000000000009945555555555555555555555519000000
 49  000000000000000000999455555555555555555555555559000000
 48  000000000000000009945555555555555555555555555559000000
 47  000000000000000009455555555555555555555555555559000000
 46  000000000000000099555555555555555555555555555559900000
 45  000000000000000994555555555555555555555555555551900000
 44  000000000000009945555555555555555555555555555555990000
 43  000000000000099455555555555555555555555555555555190000
 42  000000000000994555555555555555555555555555555555590000
 41  000000000009945555555555555555555555555555555555599000
 40  000000000099455555555555555555555555555555555555519000
 39  000000009994555555555555555555555555555555555555559900
 38  000009999455555555555555555555555555555555555555551900
 37  000999455555555555555555555555555555555555555555555900
 36  009945555555555555555555555555555555555555555555555990
 35  009455555555555555555555555555555555555555555555555190
 34  099555555555555555555555555555555555555555555555555590
 33  094555555555555555555555555555555555555555555555555590
 32  095555555555555555555555555555555555555555555555555590
 31  095555555555555555555555555555555555555555555555555590
 30  095555555555555555555555555555555555555555555555555590
 29  095555555555555555555555555555555555555555555555555590
 28  095555555555555555555555555555555555555555555555555590
 27  095555555555555555555555555555555555555555555555555290
 26  095555555555555555555555555555555555555555555555555990
 25  095555555555555555555555555555555555555555555555555900
 24  093555555555555555555555555555555555555555555555552900
 23  099555555555555555555555555555555555555555555555559900
 22  009355555555555555555555555555555555555555555555529000
 21  009935555555555555555555555555555555555555555555599000
```

Figure B2a. File cell.inp for Lake Okeechobee Grid.

```
 20  000993555555555555555555555555555555555555555555290000
 19  000099555555555555555555555555555555555555555552990000
 18  000009935555555555555555555555555555555555555529900000
 17  000000999355555555555555555555555555555555555299000000
 16  000000009999999355555555555555555555555555552990000000
 15  000000000000009935555555555555555555555555559900000000
 14  000000000000000993555555555555555555555555559000000000
 13  000000000000000099935555555555555555555555559900000000
 12  000000000000000000993555555555555555555555551900000000
 11  000000000000000000099355555555555555555555559000000000
 10  000000000000000000009935555555555555555555559000000000
  9  000000000000000000000999355555555555555555552900000000
  8  000000000000000000000000999355555555555555529900000000
  7  000000000000000000000000099935555555555555599000000000
  6  000000000000000000000000000993555555555555290000000000
  5  000000000000000000000000000099355555555555990000000000
  4  000000000000000000000000000009935555555552900000000000
  3  000000000000000000000000000000999999355559900000000000
  2  000000000000000000000000000000000099999999000000000000
  1  000000000000000000000000000000000000000000000000000000
C             1         2         3         4         5
C    123456789012345678901234567890123456789012345678901234
```

Figure B2b. Continuation of file cell.inp for Lake Okeechobee Grid.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     lake okeechobee
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     54    1     62    54   62
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     96   180  1850. 1850.  1
C4  CARTESION AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     -77.5   1.25    -0.625  36.7    1.0     -0.5
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
     100    100    100    100    4000   1.0
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      15.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFID INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      1799    2.  .5    2        5.0     0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
     0   0   0.0         0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure B3. File gefdc.inp for Lake Okeechobee.

```
            PROGRAM GENGRID
            OPEN(1,FILE='gridext.inp',STATUS='UNKNOWN')
```

```
      DO J=1,62
      DO I=1,54
      X=FLOAT(I-1)
      Y=FLOAT(J-1)
      WRITE(1,100)I,J,X,Y
      END DO
      END DO
  100 FORMAT(2I5,2(2X,F12.3))
      CLOSE(1)
      STOP
      END
```

Figure B4. FORTRAN program for generation of the gridext.inp file for the Lake Okeechobee grid shown in Figure B1.

B.2. Kings Creek and Cherry Stone Inlet, Virginia

This section describes a rectangular Cartesian grid of Kings Creek and Cherry Stone Inlet, located on the Eastern Shore of the Chesapeake Bay, north of Cape Charles, Virginia. The physical domain grid is shown in Figure B5, the cell.inp file in Figure B6, and the gefdc.inp file, Figure B7. The grid was generated with the NTYPE = 0, option by gefdc.f. The FORTRAN program for generation of the gridext.inp file is shown in Figure B8.

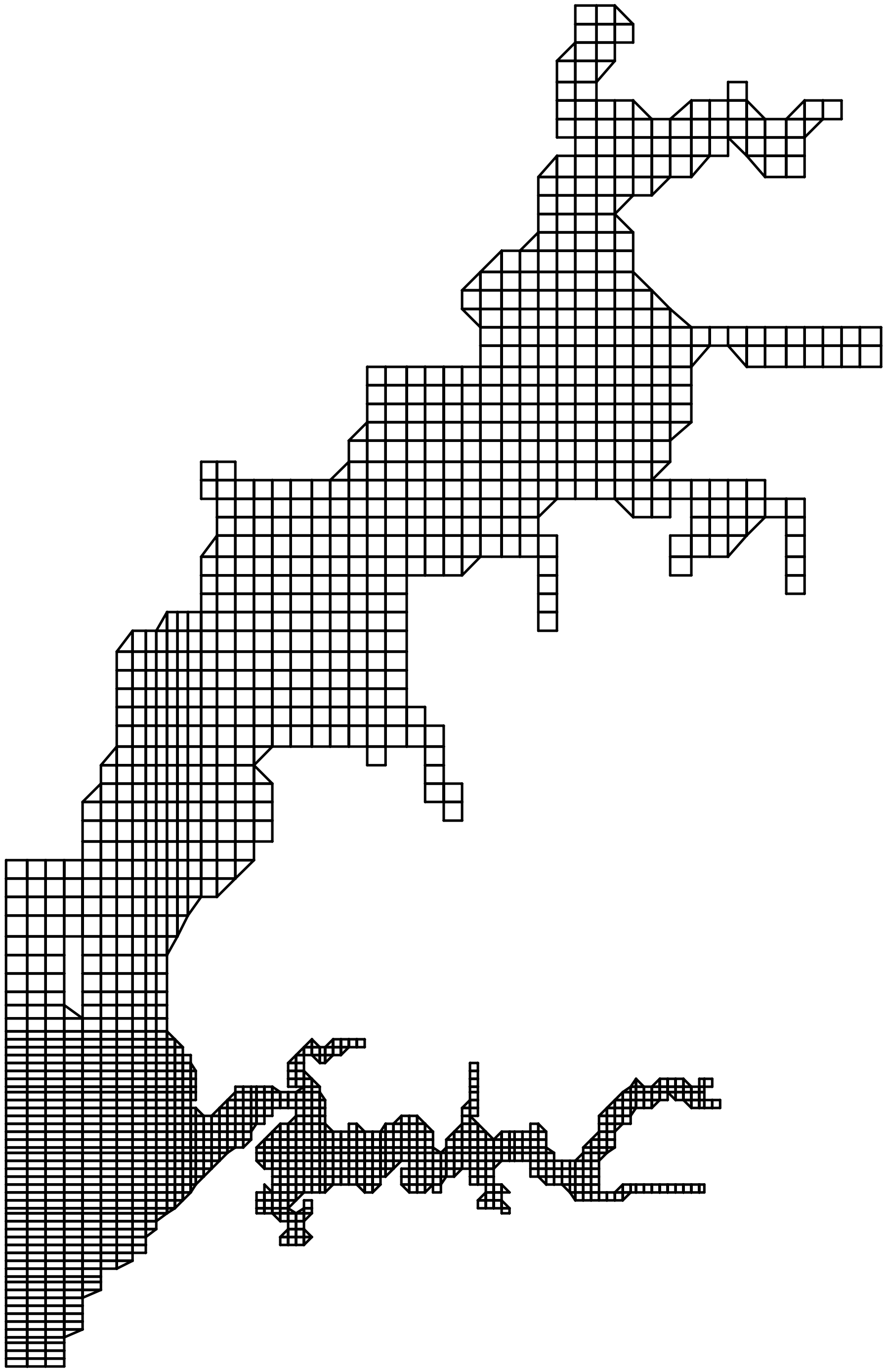

Figure B5. Physical domain grid of Kings Creek and Cherry Stone Inlet, Virginia. Grid spacing ranges from 40 to 100 Meters.

```
C cell.inp file, i columns and j rows, for Kings Creek and Cherry Stone Inlet
C             1         2         3         4         5         6         7         7         9
```

```
C     123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123
C
109  000000000000000000000000000000000000000099990000000000000000000000000000000000000000000000000
108  000000000000000000000000000000000000000095519000000000000000000000000000000000000000000000000
107  000000000000000000000000000000000000000099555900000000000000000000000000000000000000000000000
106  000000000000000000000000000000000000000094559900000000000000000000000000000000000000000000000
105  000000000000000000000000000000000000000095529000099900000000000000000000000000000000000000000
104  000000000000000000000000000000000000000095599999995999999000000000000000000000000000000000000
103  000000000000000000000000000000000000000095551945551945590000000000000000000000000000000000000
102  000000000000000000000000000000000000000095555555555555299000000000000000000000000000000000000
101  000000000000000000000000000000000000000999555555553555990000000000000000000000000000000000000
100  000000000000000000000000000000000000000945555555299355900000000000000000000000000000000000000
 99  000000000000000000000000000000000000000955555529999999900000000000000000000000000000000000000
 98  000000000000000000000000000000000000000955552999000000000000000000000000000000000000000000000
 97  000000000000000000000000000000000000009955551900000000000000000000000000000000000000000000000
 96  000000000000000000000000000000000000999455555900000000000000000000000000000000000000000000000
 95  000000000000000000000000000000000009945555555599000000000000000000000000000000000000000000000
 94  000000000000000000000000000000000009455555555199000000000000000000000000000000000000000000000
 93  000000000000000000000000000000000009555555555519900000000000000000000000000000000000000000000
 92  000000000000000000000000000000000009355555555551999999999900000000000000000000000000000000000
 91  000000000000000000000000000000000009955555555555555555555559000000000000000000000000000000000
 90  000000000000000000000000000000999999955555555555552935555559000000000000000000000000000000000
 89  000000000000000000000000000009555555555555555555555599999999999900000000000000000000000000000
 88  000000000000000000000000000009555555555555555555900000000000000000000000000000000000000000000
 87  000000000000000000000000000099555555555555555555900000000000000000000000000000000000000000000
 86  000000000000000000000000000094555555555555555552900000000000000000000000000000000000000000000
 85  000000000000000000000999900099555555555555555559900000000000000000000000000000000000000000000
 84  000000000000000000000955999994555555555555555529999900000000000000000000000000000000000000000
 83  000000000000000000000955555555555555555555555555555555555999000000000000000000000000000000000
 82  000000000000000000000995555555555555555529993559555555555590000000000000000000000000000000000
 81  000000000000000000000995555555555555555990999995552959000000000000000000000000000000000000000
 80  000000000000000000000945555555555555555555900095552995900000000000000000000000000000000000000
 79  000000000000000000000955555555555555299959000095999995900000000000000000000000000000000000000
 78  000000000000000000000955555555555999990959000099900095900000000000000000000000000000000000000
 77  000000000000000099999555555555555900000959000000000099900000000000000000000000000000000000000
 76  000000000000099994555555555555555900000959000000000000000000000000000000000000000000000000000
 75  000000000000094555555555555555555900000999000000000000000000000000000000000000000000000000000
 74  000000000000095555555555555555555900000000000000000000000000000000000000000000000000000000000
 73  000000000000095555555555555555555900000000000000000000000000000000000000000000000000000000000
 72  000000000000095555555555555555555990000000000000000000000000000000000000000000000000000000000
 71  000000000000095555555555555555555599000000000000000000000000000000000000000000000000000000000
 70  000000000000099555555555555555555559000000000000000000000000000000000000000000000000000000000
 69  000000000000094555555555529999959959000000000000000000000000000000000000000000000000000000000
 68  000000000000099555555555551000999959900000000000000000000000000000000000000000000000000000000
 67  000000000000094555555555559000009559000000000000000000000000000000000000000000000000000000000
 66  000000000000955555555555559000000995900000000000000000000000000000000000000000000000000000000
 65  000000000000955555555555559000000099900000000000000000000000000000000000000000000000000000000
 64  000099999999995555555555555990000000000000000000000000000000000000000000000000000000000000000
 63  000095555555555555555555552900000000000000000000000000000000000000000000000000000000000000000
 62  000095555555555555555555529900000000000000000000000000000000000000000000000000000000000000000
 61  000095555555555555555555299900000000000000000000000000000000000000000000000000000000000000000
 60  000095555555555555555529900000000000000000000000000000000000000000000000000000000000000000000
 59  000095555555955555552990000000000000000000000000000000000000000000000000000000000000000000000
 58  000095555555955555559900000000000000000000000000000000000000000000000000000000000000000000000
 57  000095555555955555559000000000000000000000000000000000000000000000000000000000000000000000000
 56  000095555555955555559000000000000000000000000000000000000000000000000000000000000000000000000
 55  000095555555155555559000000000000000000000000000000000000000000000000000000000000000000000000
```

Figure B6a. File cell.inp for Kings Creek and Cherry Stone Inlet.

```
 54  000095555555555555599000000000000000000000000000000000000000000000000000000000000000000000000
 53  000095555555555555519900000000000000009999999999900000000000000000000000000000000000000000000
 52  000095555555555555551900000000000000009941945555900000000000000000000000000000000000000000000
 51  000095555555555555555990000000000000009945555529990000000000000000000000000000000000000000000
 50  000095555555555555555599000000000000094593529990000000000000099900000000000000000000000000000
 49  000095555555555555555551900000000000009559999900000000000000095900000000000000000000000000000
 48  000095555555555555555555900000000000009551990000000000000000095900000000000000099999999999990
 47  000095555555555555555555900099999999999555190000000000000000095900000000000000994194555195590
 46  000095555555555555555555900995555519945599000000000000000000095900000000000099455555555555990
 45  000095555555555555555555909945555555555551900000000000000000995900000000000099455555535555999
 44  000095555555555555555555999945555555555555900000000000000000945900000000000994555552999355559
 43  000095555555555555555555519455555559995555900000000099999900095590000000000094555299990999999
 42  000095555555555555555555555555555599945555999999999999455199099519900009999000009555599000000
 41  000095555555555555555555555552994555551995199455555199945519999995190000995529900000000000000
 40  000095555555555555555555555555555994555555555555555994555514555555900099455990000000000000000
 39  000095555555555555555555555555555294555555555555555599555555555555559900945559000000000000000
 38  000095555555555555555555555555299955555555555555555514555555555555551909955529000000000000000
```

```
 37  000095555555555555555555552990955555555555555555555555555555555555555999455299000000000000000
 36  000095555555555555555555529900935555555555555555529555555555555299995555555599000000000000000
 35  000095555555555555555555299000999555555555555555295555555529555990095555555590000000000000000
 34  000095555555555555555552990000099555555555555559995555529995559990993555555599999999999999900
 33  000095555555555555555529900000991555555529993529093552559909999551900999935559945555555555900
 32  000095555555555555555299000000955552999990999990999999990009455990000009935555529999999999900
 31  000095555555555555552990000000955552959000000000000000000009555190000009999999999000000000000
 30  000095555555555555529900000000955551459000000000000000000000999959000000000000000000000000000
 29  000095555555555555299000000000009993555290000000000000000000009990000000000000000000000000000
 28  000095555555555555990000000000000999559900000000000000000000000000000000000000000000000000000
 27  000095555555555555290000000000000945519000000000000000000000000000000000000000000000000000000
 26  000095555555555555990000000000000955529000000000000000000000000000000000000000000000000000000
 25  000095555555555555900000000000000999999000000000000000000000000000000000000000000000000000000
 24  000095555555555555990000000000000000000000000000000000000000000000000000000000000000000000000
 23  000095555555555529000000000000000000000000000000000000000000000000000000000000000000000000000
 22  000095555555555599900000000000000000000000000000000000000000000000000000000000000000000000000
 21  000095555555555900000000000000000000000000000000000000000000000000000000000000000000000000000
 20  000095555555555900000000000000000000000000000000000000000000000000000000000000000000000000000
 19  000095555555552900000000000000000000000000000000000000000000000000000000000000000000000000000
 18  000095555555559900000000000000000000000000000000000000000000000000000000000000000000000000000
 17  000095555555559000000000000000000000000000000000000000000000000000000000000000000000000000000
 16  000095555555559000000000000000000000000000000000000000000000000000000000000000000000000000000
 15  000095555555559000000000000000000000000000000000000000000000000000000000000000000000000000000
 14  000095555555529000000000000000000000000000000000000000000000000000000000000000000000000000000
 13  000095555555599000000000000000000000000000000000000000000000000000000000000000000000000000000
 12  000095555555590000000000000000000000000000000000000000000000000000000000000000000000000000000
 11  000095555555590000000000000000000000000000000000000000000000000000000000000000000000000000000
 10  000095555555900000000000000000000000000000000000000000000000000000000000000000000000000000000
  9  000099999999990000000000000000000000000000000000000000000000000000000000000000000000000000000
  8  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  7  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  6  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  5  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  4  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  3  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  2  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
  1  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
C
C             1         2         3         4         5         6         7         7         9
C    123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123
```

Figure B6b. Continuation of File cell.inp for Kings Creek and Cherry Stone Inlet.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Kings Creek and Cherry Stone Inlet
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     93    1     109    93  109
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     0     50   92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
     100    100    100    100    4000   0.2
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      5.0
```

```
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      545    2.  .5    1        0.0     0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
    1   1   0.0         0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure B7. File gefdc.inp for Kings Creek and Cherry Stone Inlet.

```
      PROGRAM GVARCGRID
C
      DIMENSION X(93,109),Y(93,109)
C
      DO J=1,53
      DO I=1,93
      Y(I,J)=40.*FLOAT(J)+630.
      END DO
      END DO
C
      DO I=1,93
      Y(I,54)=2800.
      Y(I,55)=2860.
      Y(I,56)=2930.
      Y(I,57)=3010.
      END DO
C
      DO J=58,109
      DO I=1,93
      Y(I,J)=100.*FLOAT(J-58)+3100.
      END DO
      END DO
C
      DO J=1,109
      DO I=1,14
      X(I,J)=100.*FLOAT(I)
      END DO
      X(15,J)=1490.
      X(16,J)=1580.
      X(17,J)=1660.
      X(18,J)=1730.
      X(19,J)=1790.
```

```
      X(20,J)=1840.
      END DO
C
      DO J=1,54
      DO I=21,93
      X(I,J)=40.*FLOAT(I-21)+1880.
      END DO
      END DO
C
      DO J=55,109
      X(21,J)=1890.
      X(22,J)=1950.
      X(23,J)=2020.
      DO I=24,93
      X(I,J)=100.*FLOAT(I-24)+2100.
      END DO
      END DO
```

Figure B8a. FORTRAN program for generation of gridext.inp file.

```
C
      OPEN (1,FILE='gridext.inp',STATUS='UNKNOWN')
      DO J=1,109
      DO I=1,93
      X(I,J)=(X(I,J)/1000.)+408.
      Y(I,J)=(Y(I,J)/1000.)+124.
      WRITE(1,20)I,J,X(I,J),Y(I,J)
      END DO
      END DO
      CLOSE(1)
C
      OPEN (1,FILE='maskij.dat',STATUS='UNKNOWN')
      OPEN (2,FILE='shoremask',STATUS='UNKNOWN')
      OPEN (3,FILE='shoredep',STATUS='UNKNOWN')
      DEP=0.1
      DO N=1,337
      READ(1,*)J,I
      WRITE(2,2000)X(I,J),Y(I,J)
      IF(I.NE.6.OR.J.NE.10) THEN
        WRITE(3,3000)X(I,J),Y(I,J),DEP
        XTMP=X(I,J)+.01
        YTMP=Y(I,J)+.01
        WRITE(3,3000)X(I,J),YTMP,DEP
        WRITE(3,3000)XTMP,Y(I,J),DEP
        XTMP=X(I,J)-.01
        YTMP=Y(I,J)-.01
        WRITE(3,3000)X(I,J),YTMP,DEP
        WRITE(3,3000)XTMP,Y(I,J),DEP
      END IF
      END DO
      CLOSE(1)
      CLOSE(2)
      CLOSE(3)
C
   20 FORMAT(2I5,2X,F12.6,2X,F12.6)
 2000 FORMAT(2X,F12.6,2X,F12.6)
 3000 FORMAT(2X,F12.6,2X,F12.6,2X,F6.2)
C
      STOP
```

```
          END
C
```

Figure B8b. Continuation of FORTRAN program for generation of gridext.inp file.

B.3. Rose Bay, Florida

This section describes a curvilinear orthogonal grid of Rose Bay, on the Halifax River, near New Smyrna Beach, Florida. The physical domain grid is shown in Figure B9, the cell.inp file in Figure B10, and the gefdc.inp file in Figure B11. The grid was generated with the NTYPE = 5, option by gefdc.f.

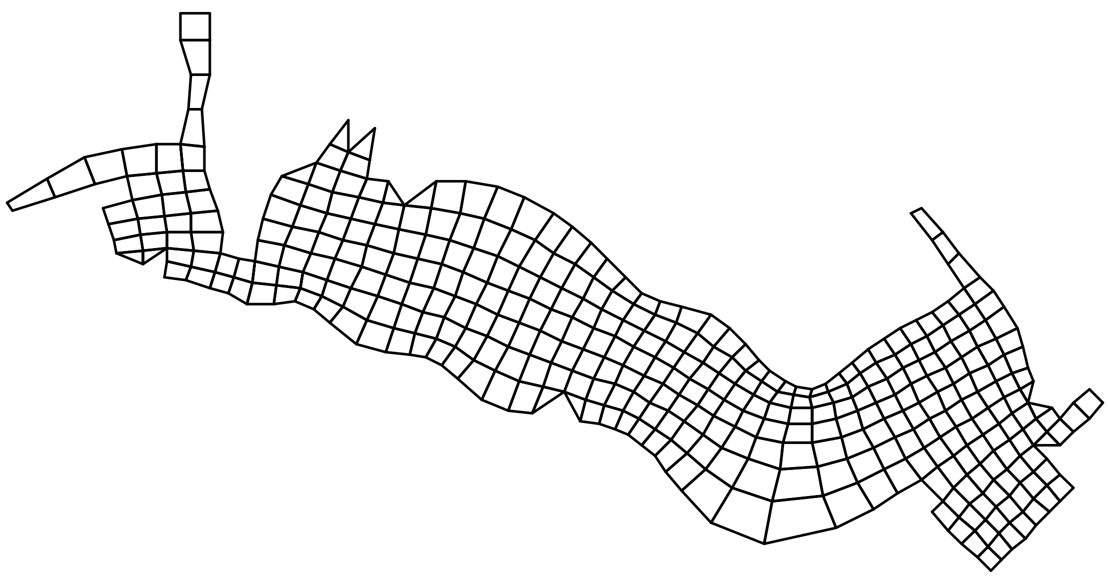

Figure B9. Physical domain grid of Rose Bay, Florida. Grid spacing ranges between approximately 20 and 90 meters.

```
C cell.inp file, i columns and j rows, for Rose Bay
C             1         2         3         4         5
C    12345678901234567890123456789012345678901234567890
C
 25  00000000000000000000000000000000000000000000000000
 24  00000000000000000000000000000000000000000000000000
 23  00000000000000000000000000000000000000000000000000
 22  00000009900000000000000000000000000000000000000000
 21  00000009590000000000000000000000000000000000099900
 20  00000009590999900000000000000000000000000000095900
 19  00000009590914900000000000000000000000000000095900
 18  00999999599955999999999999999999999999999999995900
 17  00955555599455514555555555555555555555555555555900
 16  00999955599555555555555555555555555555555555555900
 15  00009555599555555555555555555555555555555555555900
 14  00009555599555555555555555555555555555555555555900
 13  00009555599555555555555555555555555555555555555900
 12  00009325555555555555555555555555555555555555555900
 11  00009995555555555555555523555555555555555555552900
 10  00000099999999999999999999999999999999955555551900
  9  00000000000000000000000000000000000009555555555999
  8  00000000000000000000000000000000000009555555535559
  7  00000000000000000000000000000000000009555555599999
  6  00000000000000000000000000000000000009555555590000
  5  00000000000000000000000000000000000009999999990000
  4  00000000000000000000000000000000000000000000000000
  3  00000000000000000000000000000000000000000000000000
  2  00000000000000000000000000000000000000000000000000
  1  00000000000000000000000000000000000000000000000000
C
C             1         2         3         4         5
C    12345678901234567890123456789012345678901234567895
```

Figure B10. File cell.inp for Rose Bay.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     rose bay
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
    5      148    1     50    1     25    50   25
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     96   180  1850. 1850.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     -77.5   1.25    -0.625  36.7    1.0     -0.5
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
     100    100    100    100    1000   1.0
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1.     1.      9.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      62      2.  .5    1        5.0     0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
   40    6      1456.   16.
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
   39    6      1440.000        0.000
   39    7      1420.000       20.000
   39    8      1400.000       40.000
   39    9      1380.000       60.000
   39   10      1356.000       84.000
   40   10      1372.000      100.000
   40   11      1340.000      132.000
   39   11      1308.480      112.080
   38   11      1270.640       89.200
   37   11      1218.480       60.400
```

Figure B11a. File gefdc.inp for Rose Bay.

```
   36   11      1116.000       40.000
   35   11      1038.720       67.680
   34   11       995.840      114.320
```

33	11	976.240	143.280
32	11	957.520	165.680
31	11	942.080	182.160
30	11	920.000	196.320
29	11	901.760	203.600
28	11	877.920	209.440
27	11	850.480	216.640
26	11	818.080	220.400
25	11	784.960	226.800
24	11	750.480	228.480
23	11	712.080	244.160
22	11	677.040	276.400
21	11	654.320	293.520
20	11	631.200	304.720
19	11	607.600	309.200
18	11	575.040	315.600
17	11	532.160	326.640
16	11	494.080	356.960
15	11	468.960	376.400
14	11	444.720	385.040
13	11	413.680	384.320
12	11	375.920	384.240
11	11	348.020	397.000
10	11	320.160	406.240
9	11	288.800	416.480
8	11	256.480	421.120
8	12	259.440	442.720
7	12	226.720	440.400
6	12	192.400	434.160
6	13	187.760	453.920
6	14	182.080	476.000
6	15	178.080	497.040
6	16	169.360	520.080
7	16	212.240	530.880
7	17	203.360	566.720
6	17	156.000	556.000
5	17	100.000	536.000
4	17	40.000	516.000
4	18	32.000	528.000
5	18	87.000	562.000
6	18	142.000	594.000
7	18	194.320	605.600
8	18	243.520	611.000

Figure B11b. Continuation of file gefdc.inp for Rose Bay.

9	18	280.000	611.000
9	19	290.000	660.000
9	20	294.000	710.000
9	21	280.000	760.000
9	22	280.000	800.000
10	22	320.000	800.000
10	21	320.000	760.000
10	20	320.000	710.000
10	19	310.000	660.000
10	18	312.000	610.000

10	17	315.440	573.680
10	16	321.840	547.200
10	15	331.440	516.880
10	14	338.800	487.040
10	13	336.480	456.960
11	13	362.960	447.280
12	13	384.560	442.880
12	14	389.120	473.280
12	15	396.720	504.720
12	16	408.320	538.480
12	17	423.920	567.040
12	18	441.600	598.960
13	18	475.000	585.000
13	19	492.000	612.000
13	20	520.000	647.000
14	20	540.000	640.000
15	20	560.000	633.000
15	19	552.000	590.000
15	18	547.000	564.000
16	18	575.920	559.360
17	18	605.520	558.400
18	18	644.800	557.360
19	18	689.200	558.000
20	18	734.800	551.120
21	18	773.280	536.080
22	18	812.560	512.800
23	18	840.080	493.440
24	18	866.880	470.800
25	18	891.920	447.920
26	18	915.920	422.080
27	18	941.200	399.840
28	18	967.200	386.160
29	18	998.400	378.960
30	18	1038.000	366.880
31	18	1066.320	348.640
32	18	1088.480	326.880

Figure B11c. Continuation of file gefdc.inp for Rose Bay.

33	18	1107.040	302.640
34	18	1124.320	285.680
35	18	1144.560	272.320
36	18	1162.480	264.800
37	18	1182.800	260.560
38	18	1204.640	266.640
39	18	1224.720	284.400
40	18	1240.640	298.880
41	18	1265.440	316.240
42	18	1289.040	333.440
43	18	1311.280	348.960
44	18	1332.960	360.480
45	18	1356.800	372.560
46	18	1379.280	388.240
47	18	1403.000	404.000
47	19	1380.000	440.000
47	20	1355.000	475.000

```
   47   21      1326.000        512.000
   48   21      1340.000        520.000
   48   20      1370.000        485.000
   48   19      1395.000        455.000
   48   18      1425.920        422.800
   48   17      1444.000        401.120
   48   16      1460.880        379.840
   48   15      1477.200        349.440
   48   14      1488.240        320.480
   48   13      1494.800        293.040
   48   12      1501.680        272.640
   48   11      1512.560        253.920
   48   10      1528.400        235.040
   48    9      1540.000        220.000
   49    9      1560.000        240.000
   50    9      1580.000        260.000
   50    8      1600.000        240.000
   49    8      1580.000        220.000
   48    8      1560.000        200.000
   47    8      1540.000        180.000
   46    8      1520.000        160.000
   46    7      1540.000        140.000
   46    6      1560.000        120.000
   45    6      1541.000        101.000
   44    6      1523.000         83.000
   43    6      1505.500         65.500
   42    6      1488.500         48.500
   41    6      1470.000         32.000
   40    6      1456.000         16.000
```

Figure B11d. Continuation of file gefdc.inp for Rose Bay.

B.4. Indian River Lagoon, Florida

This section describes the construction of a composite grid of a section of the Indian River Lagoon, near Melborne, Florida, from five subgrids. Figures B12-B14 show the composite grid, and the corresponding cell.inp and gefdc.inp files. The composite grid was generated with the NTYPE = 0 option by gefdc.f. The input file, gridext.inp, specifying the composite grid was formed by combining the five gridext.out files generated for the five subgrid regions. Figure B15&B16, B17&B18, B19&B20, B21&B22, and B23&B24 show the subgrids and the corresponding gefdc.inp files. The cell.inp file for each sub grid is similar to the cell.inp file shown in Figure B13, with only the water cells in the particular subgrid activated. The first subgrid, Figures B15&B16, and the fourth subgrid, Figure B21&B22, were generated with the NTYPE = 0 option. The remaining subgrids are curvilinear-orthogonal and were generated with the NTYPE = 5 option.

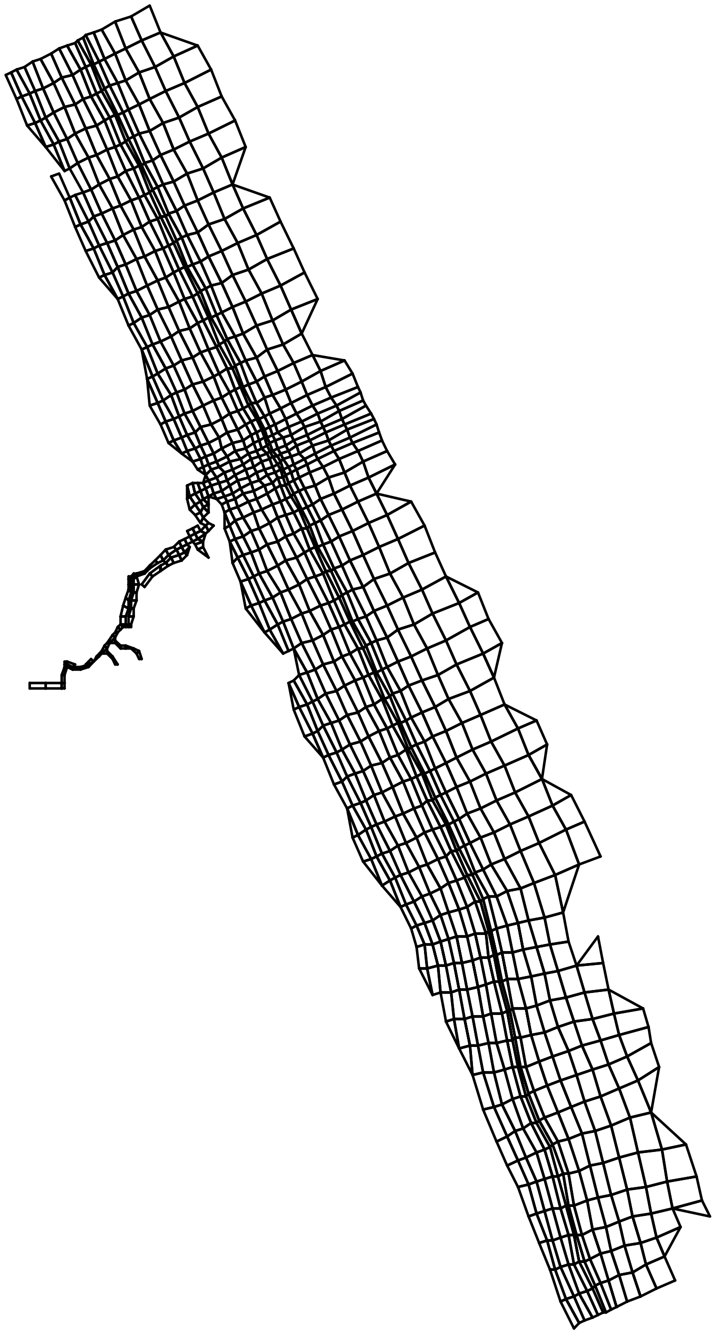

Figure B12. Grid of a section of the Indian River Lagoon near Melbourne, FL. Grid is a composite of five subgrids.

```
C cell.inp file, i columns and j rows, for Indian River Lag
C             1         2         3         4         5
```

```
C     123456789012345678901234567890123456789012345678901234
C
 60   000000000000000000000000000000000999999999999999999900
 59   000000000000000000000000000000000955555555555555555990
 58   000000000000000000000000000000000955555555555555555190
 57   000000000000000000000000000000000935555555555555555590
 56   000000000000000000000000000000000993555555555555555590
 55   000000000000000000000000000000000959955555555555555590
 54   000000000000000000000000000000000955555555555555555590
 53   000000000000000000000000000000000955555555555555555290
 52   000000000000000000000000000000000955555555555555555190
 51   000000000000000000000000000000000935555555555555555590
 50   000000000000000000000000000000000995555555555555555590
 49   000000000000000000000000000000000995555555555555555590
 48   000000000000000000000000000000009945555555555555555590
 47   000000000000000000000000000000009455555555555555555290
 46   000000000000000000000000000000009555555555555555555990
 45   000000000000000000000000000000009555555555555555555190
 44   000000000000000000000000000000009355555555555555555590
 43   000000000000000000000000000000009935555555555555555590
 42   000000000000000000000000000000000995555555555555555590
 41   000000000000000000000000000000000093555555555555555590
 40   000000000000000000000000000000999994555555555555555590
 39   000000000000000000000000000000945555555555555555555590
 38   000000000000000000000000000000955555555555555555555590
 37   000000000000000000000000000000955523555555555555555590
 36   000000000000000000000000000999955299555555555555555590
 35   000000000000000999999999999955959999555555555555555590
 34   000000000000000955555555555555559094555555555555555590
 33   000000000000000959599995555952999995555555555555555590
 32   000000000000000959595555552959900945555555555555555290
 31   000000000000000959599999999939009955555555555555555190
 30   000000000000000959590000000999009455555555555555555590
 29   009999999000000959590000000000009355555555555555555590
 28   009559959999999959590000000000009935555555555555555599
 27   009555555555555555590000000000009999455555555555555519
 26   009599999995959999990000000000009455555555555555555559
 25   999590000095959000000000000000009555555555555555555559
 24   955590000095959000000000000000009355555555555555555529
 23   999990000099959000000000000000009955555555555555555599
 22   000000000000959000000000000000009955555555555555555519
 21   000000000000959000000000000000009455555555555555555559
```

Figure B13a. File cell.inp for the Indian River Lagoon grid shown in Figure B12.

```
 20   000000000000999000000000000000009555555555555555555529
 19   000000000000000000000000000000009355555555555555555519
 18   000000000000000000000000000000009935555555555555555559
 17   000000000000000000000000000000009955555555555555555559
 16   000000000000000000000000000000000955555555555555555299
```

```
15  000000000000000000000000000000000095555555555555555990
14  000000000000000000000000000000000093555555555555555490
13  000000000000000000000000000000000099955555555555555599
12  000000000000000000000000000000000000935555555555555519
11  000000000000000000000000000000000000993555555555555559
10  000000000000000000000000000000000000999555555555555559
 9  000000000000000000000000000000000000009555555555555559
 8  000000000000000000000000000000000000009555555555555529
 7  000000000000000000000000000000000000009555555555555519
 6  000000000000000000000000000000000000009555555555555559
 5  000000000000000000000000000000000000009555555555555559
 4  000000000000000000000000000000000000009555555555555539
 3  000000000000000000000000000000000000009555555555555299
 2  000000000000000000000000000000000000009555555555555990
 1  000000000000000000000000000000000000009999999999999900
```

Figure B13b. Continuation of File cell.inp for the Indian River Lagoon grid shown in Figure B12.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Indian River Lagoon
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     54    1     60    54   60
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     1     50   92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
```

```
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     100    100    100    100    1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
     1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      5.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      995     2.  .5    3        0.3517   0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
     1   1   0          0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure B14. File gefdc.inp for the Indian River Lagoon grid shown in Figure B12.

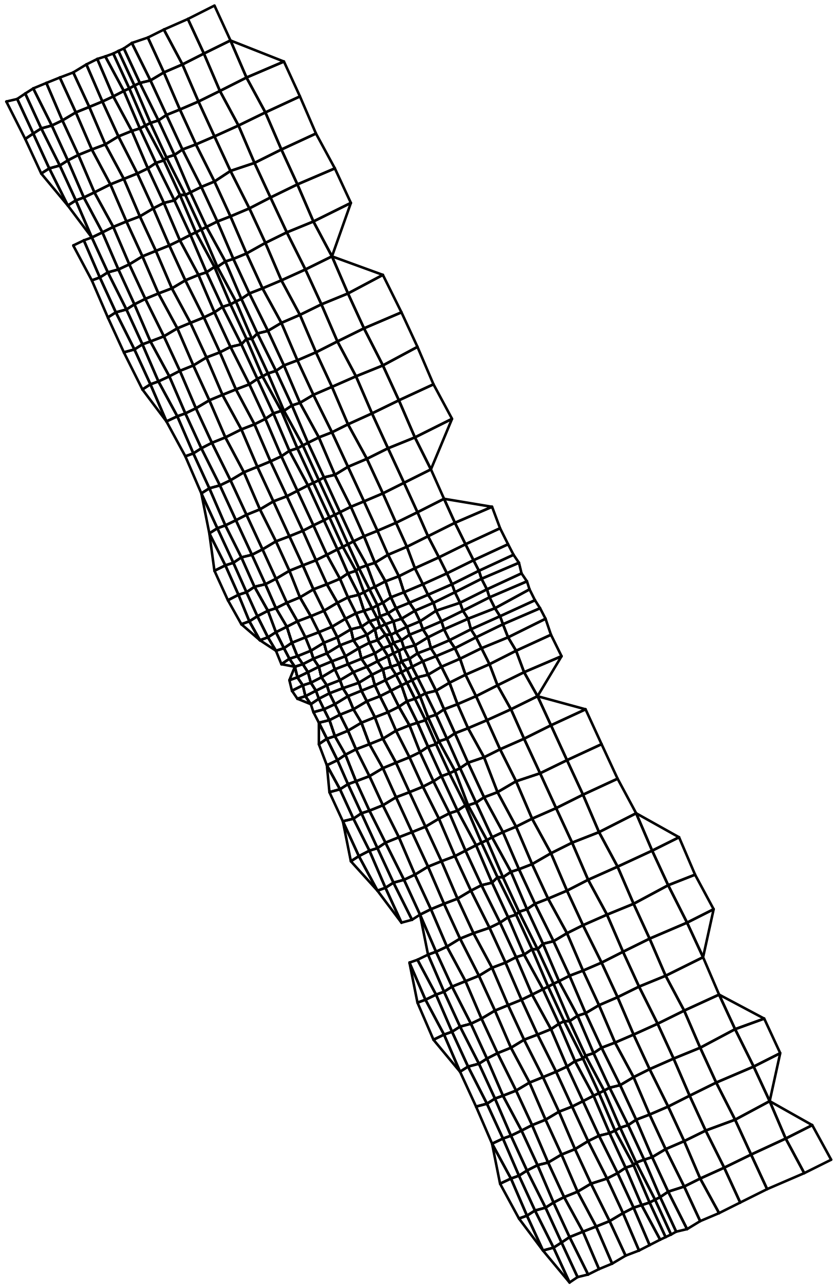

Figure B15. Subgrid 1 of the Indian River Lagoon grid shown in Figure B12. This grid is a variable spacing Cartesian grid generated with NTYPE = 0, option by gefdc.f.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Indian River Lagoon, sub grid 1
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     0      146    1     54    1     60   54   60
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     0     50    92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     100    100    100    100    1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
    0.        0.       1000.   1.      1.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
    0       0       1        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    0      896     2.  .5    3        0.35    0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
     0   0   0.0         0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure B16. File gefdc.inp for subgrid 1, shown in Figure B15.

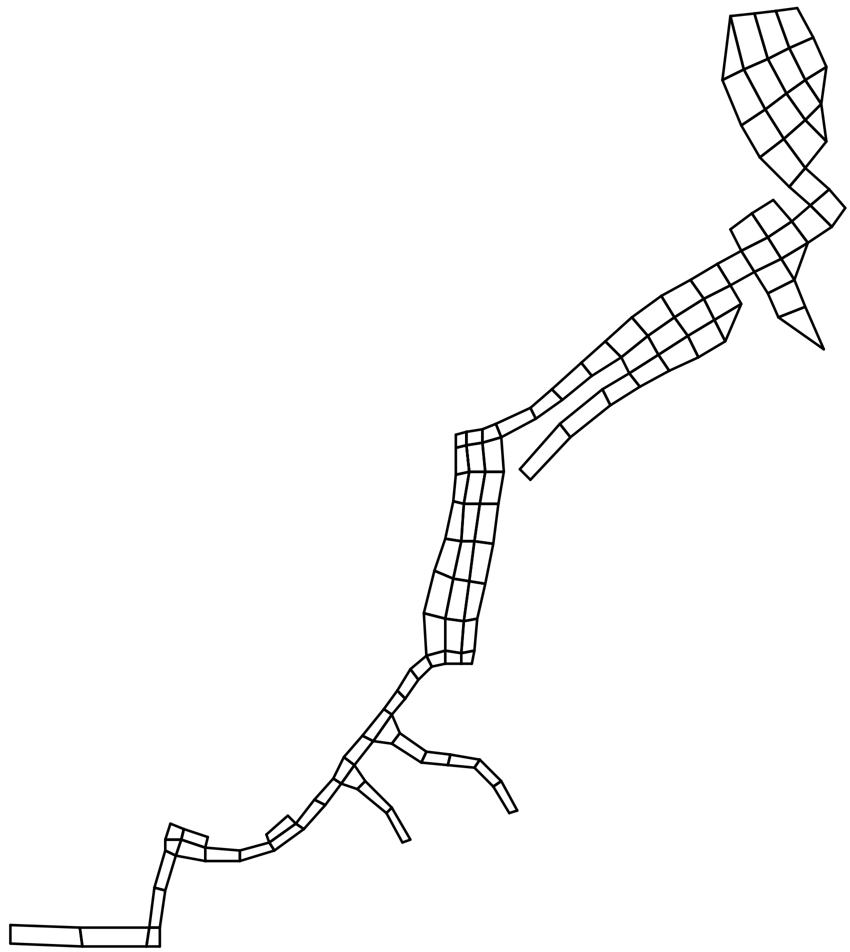

Figure B17. Subgrid 2 of the Indian River Lagoon grid shown in Figure B10. This grid is a curvilinear-orthogonal grid generated with NTYPE = 5.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Indian River Lagoon, Subgrid 2
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     5      140    1     54    1     60    54   60
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     0     50    92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
C5  INTEGER INPUT
```

```
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     100    100    100    100    1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
     1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.     10.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    0      1054    2.  .5    3        0.167   0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
    36   39   5.416584   32.868687
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
   36   38    5.458846   32.778057
   36   37    5.501108   32.687428
   35   37    5.446730   32.662067
   35   36    5.514679   32.611004
   34   36    5.459079   32.540939
   33   36    5.396529   32.462120
   33   35    5.468399   32.390812
   33   34    5.520639   32.337936
   32   34    5.476520   32.278748
```

Figure B18a. File gefdc.inp for subgrid 2, shown in Figure B17.

```
   31   34    5.403405   32.222584
   31   33    5.452924   32.151886
   30   33    5.364405   32.105095
   30   32    5.395795   32.025944
   30   31    5.452544   31.892416
   29   31    5.370976   31.854382
   29   32    5.312114   31.992439
   29   33    5.276192   32.069473
   29   34    5.239964   32.135338
   28   34    5.165042   32.094883
   28   33    5.199157   32.033554
   28   32    5.235079   31.956518
   27   32    5.148980   31.916368
   26   32    5.060462   31.869576
   25   32    4.971944   31.822783
   24   32    4.878895   31.773876
   23   32    4.790073   31.715906
   22   32    4.664386   31.618679
   21   32    4.537784   31.487925
   21   33    4.500639   31.520256
```

22	33	4.625128	31.655542
23	33	4.762297	31.763639
24	33	4.846588	31.819498
24	34	4.818812	31.867229
23	34	4.725458	31.807148
22	34	4.636329	31.738003
21	34	4.549620	31.675501
20	34	4.440557	31.613609
20	33	4.451099	31.508188
20	32	4.437174	31.407907
20	31	4.415995	31.287693
20	30	4.396928	31.162949
20	29	4.373633	31.047266
20	28	4.360015	30.948162
20	27	4.355037	30.905406
19	27	4.318927	30.908500
18	27	4.269384	30.905899
17	27	4.226488	30.901413
16	27	4.189625	30.862158
15	27	4.145506	30.802967
14	27	4.103806	30.750420
14	26	4.131277	30.691509
14	25	4.207983	30.633492
14	24	4.287153	30.627129
14	23	4.375015	30.606558

Figure B18b. Continuation of file gefdc.inp for subgrid 2, shown in Figure B17.

14	22	4.447190	30.546427
14	21	4.496096	30.453379
13	21	4.473438	30.442812
13	22	4.424227	30.524685
13	23	4.358696	30.582397
13	24	4.280768	30.595711
13	25	4.198070	30.602991
13	26	4.103477	30.656477
13	27	4.043370	30.667067
12	27	3.989883	30.592476
12	26	4.019771	30.540209
12	25	4.100399	30.461952
12	24	4.158063	30.361954
11	24	4.135406	30.351387
11	25	4.086499	30.444435
11	26	3.996809	30.518467
11	27	3.945765	30.533283
10	27	3.894697	30.465336
9	27	3.830034	30.391047
8	27	3.734261	30.324322
7	27	3.626115	30.295958
6	27	3.518578	30.289949
5	27	3.425249	30.312630
5	26	3.393198	30.203899
5	25	3.376549	30.085796
5	24	3.377136	30.025385
4	24	3.339077	30.024187
3	24	3.133373	30.027571
2	24	2.909850	30.033678
2	25	2.909263	30.094091

3	25	3.128256	30.085871
4	25	3.345134	30.082182
4	26	3.362088	30.211458
4	27	3.392026	30.324722
4	28	3.397473	30.360365
4	29	3.414402	30.406878
5	29	3.451852	30.390721
6	29	3.531892	30.367876
6	28	3.521913	30.330122
7	28	3.629143	30.324955
8	28	3.723696	30.346979
8	29	3.711017	30.374166
9	29	3.775374	30.437279
9	28	3.805872	30.407366
10	28	3.863892	30.484074
11	28	3.919492	30.554134

Figure B18c. Continuation of file gefdc.inp for subgrid 2, shown in Figure B17.

12	28	3.956964	30.615744
13	28	4.008034	30.683691
14	28	4.077534	30.771271
15	28	4.117120	30.828348
16	28	4.159126	30.892069
17	28	4.209583	30.937666
17	29	4.204185	31.067553
17	30	4.236845	31.198639
17	31	4.273123	31.298307
17	32	4.296415	31.413992
17	33	4.300971	31.498867
17	34	4.302171	31.581327
17	35	4.301000	31.623074
18	35	4.338164	31.632065
19	35	4.384400	31.645300
20	35	4.430603	31.658621
21	35	4.532715	31.711754
22	35	4.605831	31.767914
23	35	4.695264	31.848236
24	35	4.773217	31.917688
25	35	4.855700	31.989252
26	35	4.944829	32.058399
27	35	5.035765	32.111835
28	35	5.124283	32.158630
29	35	5.199204	32.199085
29	36	5.160864	32.269474
30	36	5.227030	32.316879
31	36	5.295308	32.359753
31	35	5.356001	32.288750
32	35	5.408877	32.340988
32	36	5.347880	32.400818
32	37	5.254269	32.495087
32	38	5.196604	32.595085
32	39	5.135629	32.737679
32	40	5.082215	32.911377
33	40	5.163478	32.938236

```
34   40    5.232954   32.943050
35   40    5.306961   32.949978
36   40    5.374322   32.959320
36   39    5.416584   32.868687
```

Figure B18d. Continuation of file gefdc.inp for subgrid 2, shown in Figure B17.

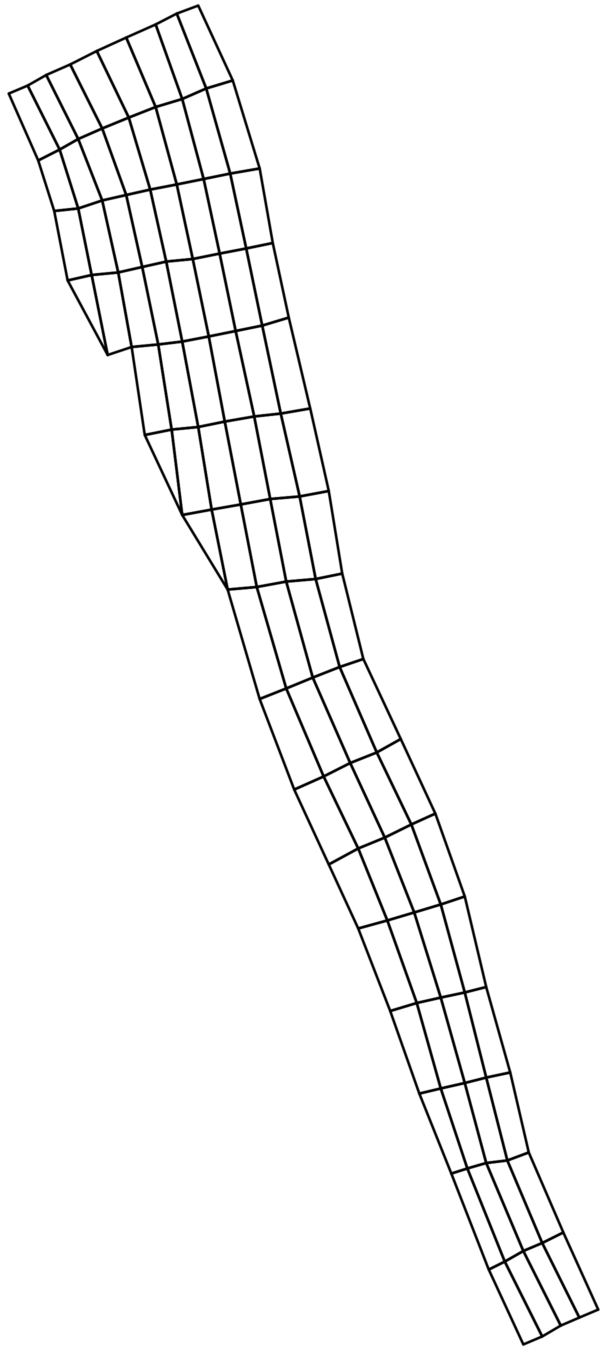

Figure B19. Subgrid 3 of the Indian River Lagoon grid shown in Figure B12. This grid is a curvilinear-orthogonal grid generated with NTYPE = 5.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Indian River Lagoon, Sub Grid 3
C2  INTEGER INPUT
```

```
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     5     48     1     54    1     60    54   60
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     0     50    92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     200    200    200    200    1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
     1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.     5.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    0      896     2.  .5    3        0.167   0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
   41    2   10.771623   20.911531
C13 BOUNDARY POINT INFORMATION
C13 I    J   X(I,J)  Y(I,J)
   40    2   10.680992   20.869270
   40    3   10.511944   21.231794
   40    4   10.332051   21.688562
   40    5   10.185966   22.072828
   40    6   10.044719   22.470383
   40    7    9.894407   22.863710
   40    8    9.746491   23.180916
   40    9    9.581670   23.534378
   40   10    9.410230   23.973021
   40   11    9.254519   24.496237
```

Figure B20a. File gefdc.inp for subgrid 3, shown in Figure B19.

```
   39   11    9.088380   24.473932
   39   12    9.040770   24.859980
   38   12    8.901817   24.850355
   38   13    8.859043   25.249693
   38   14    8.798752   25.662931
   37   14    8.681543   25.630342
   36   14    8.573397   25.601980
   36   15    8.490144   25.993475
   36   16    8.427410   26.317305
   36   17    8.353781   26.569849
   36   18    8.205865   26.887056
```

```
   37   18    8.296495   26.929317
   38   18    8.387127   26.971581
   39   18    8.500415   27.024408
   40   18    8.636361   27.087799
   41   18    8.772307   27.151192
   42   18    8.908255   27.214586
   43   18    9.021543   27.267414
   44   18    9.112172   27.309675
   44   17    9.281219   26.947151
   44   16    9.412794   26.523020
   44   15    9.479142   26.167774
   44   14    9.558780   25.807695
   44   13    9.654101   25.366657
   44   12    9.746417   24.979389
   44   11    9.811546   24.579441
   44   10    9.916542   24.164982
   44    9   10.098267   23.775270
   44    8   10.263088   23.421810
   44    7   10.404335   23.024256
   44    6   10.508718   22.587444
   44    5   10.613714   22.172985
   44    4   10.706031   21.785717
   44    3   10.874467   21.400841
   44    2   11.043514   21.038317
   43    2   10.952884   20.996056
   42    2   10.862254   20.953794
   41    2   10.771623   20.911531
```

Figure B20b. Continuation of file gefdc.inp for sub grid 3, shown in Figure B19.

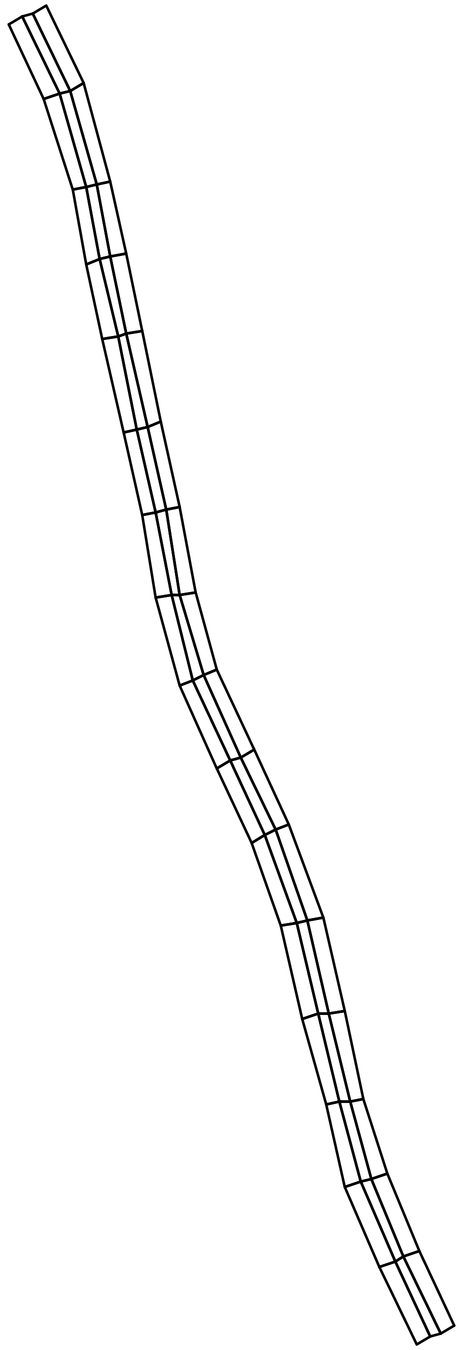

Figure B21. Subgrid 4 of the Indian River Lagoon grid shown in Figure B12. This grid is a curvilinear-orthogonal grid generated with NTYPE = 0.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Indian River Lagoon, Subgrid 4
C2  INTEGER INPUT
```

```
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     0      0     1     54    1     60    54   60
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     0     50    92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     100    100    100    100    1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
     1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      7.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    0      1054    2.  .5    3        0.167   0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
     1   1    0.0         0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure B22. File gefdc.inp for subgrid 4, shown in Figure B21, generated with NTYPE = 0.

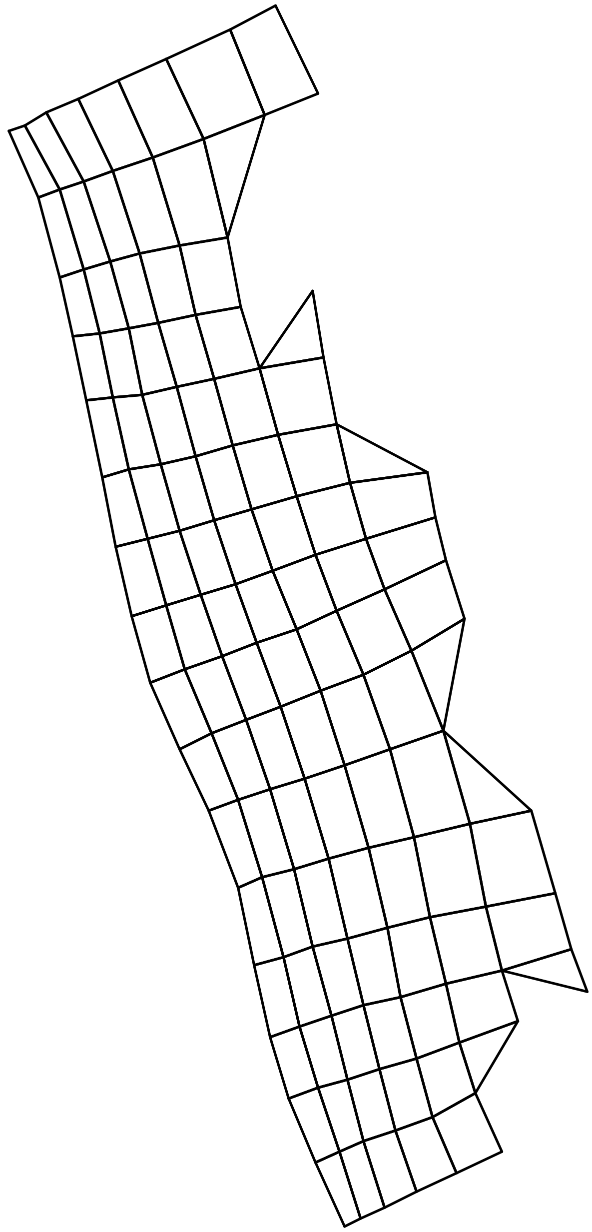

Figure B23. Subgrid 5 of the Indian River Lagoon grid shown in Figure B12. This grid is a curvilinear-orthogonal grid generated with NTYPE = 5.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     Indian River Lagoon, Subgrid 5
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     5      50    1     54    1     60    54   60
```

```
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     0     50    92  250.  250.  1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     1.875   15.0    0.0     17.875  15.0    0.0
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     100    100    100    100    1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
     1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      5.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    0      1054    2.  .5    3        0.167   0     0       0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
   48    2   11.315408   21.165104
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
   47    2   11.224776   21.122841
   47    3   11.055729   21.485365
   47    4   10.909035   21.847277
   47    5   10.797980   22.203743
   47    6   10.702049   22.622427
   47    7   10.606728   23.063465
   47    8   10.444349   23.506332
   47    9   10.279528   23.859795
   47   10   10.102028   24.240444
```

Figure B24a. File gefdc.inp for subgrid 5, shown in Figure B23, generated with NTYPE = 5.

```
   47   11    9.995811   24.610197
   47   12    9.917395   25.014980
   47   13    9.829916   25.415539
   47   14    9.738821   25.847515
   47   15    9.664020   26.220884
   47   16    9.592834   26.562840
   47   17    9.466708   27.022612
   47   18    9.293435   27.394197
   48   18    9.384066   27.436460
   49   18    9.520012   27.499853
   50   18    9.701274   27.584377
   51   18    9.927851   27.690031
```

52	18	10.199742	27.816816
53	18	10.562265	27.985865
54	18	10.834159	28.112650
54	17	11.070825	27.605118
53	17	10.763290	27.483780
53	16	10.961871	26.892284
52	16	10.556476	26.791515
52	15	10.621604	26.391569
53	15	11.044516	26.478437
53	14	11.101190	26.096615
54	14	11.559133	26.155685
54	13	11.637548	25.750900
54	12	11.696055	25.436136
54	11	11.747332	25.184202
54	10	11.807670	24.936493
54	9	11.919335	24.602381
54	8	12.111296	24.096069
54	7	12.300815	23.500349
54	6	12.431167	23.031511
54	5	12.529542	22.702236
54	4	12.621296	22.458145
53	4	12.223131	22.294544
53	3	12.324560	22.077030
52	3	11.974715	21.880795
52	2	12.131084	21.545460
51	2	11.859191	21.418674
50	2	11.632614	21.313019
49	2	11.451354	21.228497
48	2	11.315408	21.165104

Figure B24b. Continuation of file gefdc.inp for subgrid 5, shown in Figure B23, generated with NTYPE = 5.

B.5. SFWMD Water Conservation Area 2A, Florida

This section describes a curvilinear-orthogonal grid of the South Florida Water Management District's Water Conservation Area 2A southwest of West Palm Beach, Florida. The physical domain grid is shown in Figure B25, the cell.inp file in Figure B26, and the gefdc.inp file in Figure B27. The Cartesian graphic grid overlay file, gcell.inp, is shown in Figure B28, and its equivalent square cell Cartesian grid is shown in Figure B29. The main portion of the curvilinear grid, excluding the lower four cells is based on a quasi-conformal mapping using the NTYPE = 7, option by gefdc.f. The four lower cells were then appended to the grid by hand. The four boundary function subroutines required by the NTYPE = 7, option are shown in Figure B30-B33.

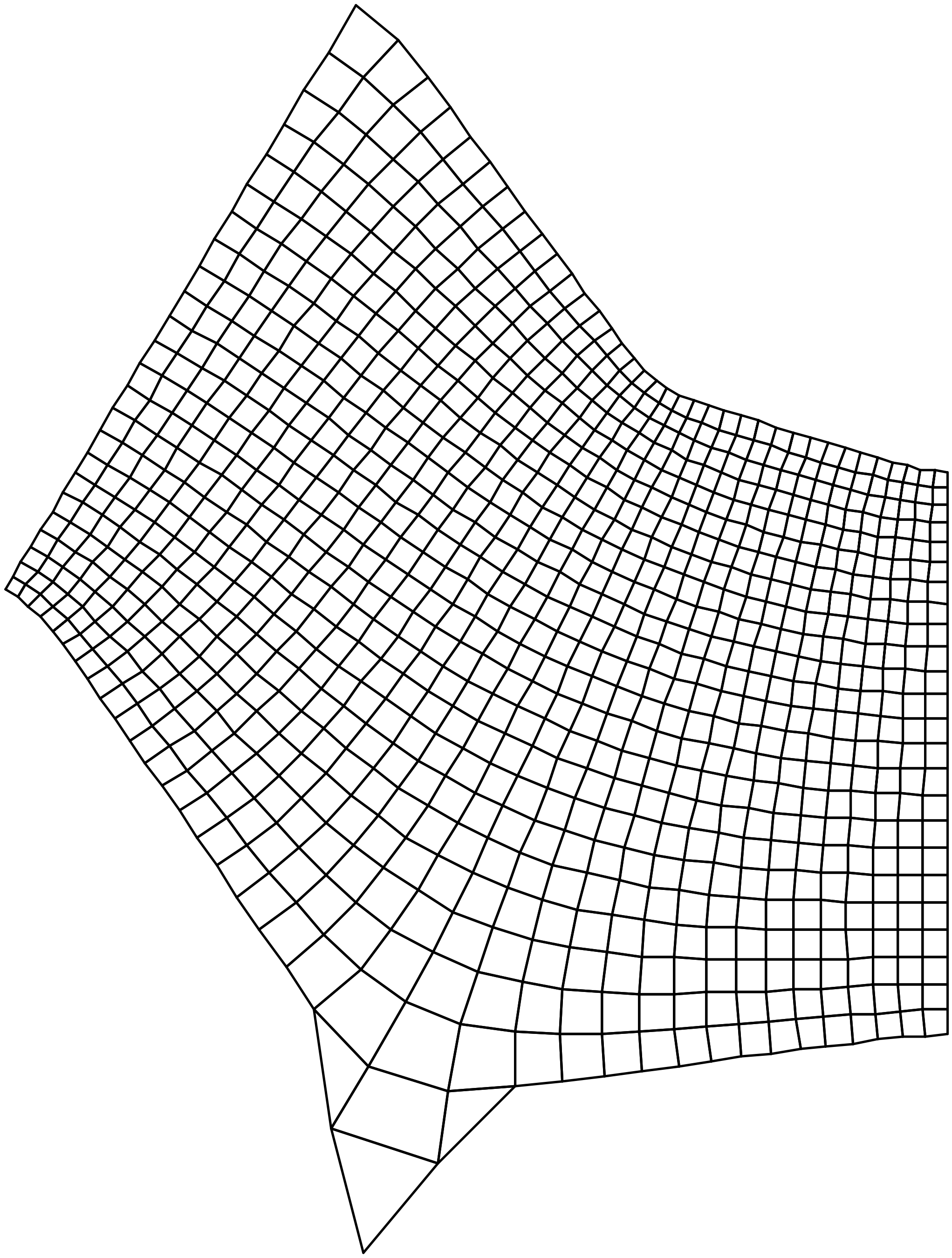

Figure B25. Physical domain grid of SFWMD's Water Conservation Area 2A. Grid spacing ranges from approximately 400 to 2500 meters.

```
C cell.inp file, i columns and j rows, for WCA2A
C            1         2         3         4
C   1234567890123456789012345678901234567890
C
```

```
     32  99999999999999999999999999999999999999
     31  95555555555555555555555555555555555559
     30  99999999999999999999999999999999999999
     29  00000000000009555555555555555555555559
     28  99999999999999999999999999999999999999
     27  95555555555555555555555555555555555559
     26  95555555555555555555555555555555555559
     25  95555555555555555555555555555555555559
     24  95555555555555555555555555555555555559
     23  95555555555555555555555555555555555559
     22  95555555555555555555555555555555555559
     21  95555555555555555555555555555555555559
     20  95555555555555555555555555555555555559
     19  95555555555555555555555555555555555559
     18  95555555555555555555555555555555555559
     17  95555555555555555555555555555555555559
     16  95555555555555555555555555555555555559
     15  95555555555555555555555555555555555559
     14  95555555555555555555555555555555555559
     13  95555555555555555555555555555555555559
     12  95555555555555555555555555555555555559
     11  95555555555555555555555555555555555559
     10  95555555555555555555555555555555555559
      9  95555555555555555555555555555555555559
      8  95555555555555555555555555555555555559
      7  95555555555555555555555555555555555559
      6  95555555555555555555555555555555555559
      5  95555555555555555555555555555555555559
      4  95555555555555555555555555555555555559
      3  99999999999999999999352999999999999999
      2  00000000000000000009939900000000000959
      1  00000000000000000000999000000000000999
    C             1         2         3         4
    C    1234567890123456789012345678901234567890
```

Figure B26. File cell.inp for WCA2A Grid Shown in Figure B25.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
     SWFWMD WCA2A
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     7      106   1     38    1     28    38   28
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
     1     44   55  600.  600. 1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
    5.1     36.0    0.0     3.9     36.0    0.0
```

```
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
     100    100    100    100   1000
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      5.04
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     0       0       1        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB  IE  JB  JE  N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7  SERRMAX
     2  38   4  28  1000  1     500   0     0    26   1.0  1.E-8
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
    6.76  20.6
    31.   9.1
    31.   23.6
   15.76  35.6
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      783     2.   .5   2        4.00    1     10710   12
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
    1   1  0.0         0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)
```

Figure B27. File gefdc.inp for WCA2A Grid Shown in Figure B25.

```
C gcell.inp file, i columns and j rows, for WCA2A
C           1         2         3         4         5
C    12345678901234567890123456789012345678901234567890
C
 55  00000000000000000000000000000000000000000000
 54  00000000000000099990000000000000000000000000
 53  00000000000000095599000000000000000000000000
 52  00000000000000995559900000000000000000000000
 51  00000000000000955555900000000000000000000000
 50  00000000000009955555990000000000000000000000
 49  00000000000099555555599000000000000000000000
 48  00000000000095555555559900000000000000000000
 47  00000000000995555555555900000000000000000000
 46  00000000000955555555555990000000000000000000
 45  00000000009955555555555590000000000000000000
 44  00000000009555555555555599000000000000000000
 43  00000000099555555555555559000000000000000000
 42  00000000095555555555555555990000000000000000
 41  00000000995555555555555555599000000000000000
 40  00000009955555555555555555599000000000000000
 39  00000009555555555555555555599000000000000000
```

```
 38  00000099555555555555555555555590000000000000
 37  00000995555555555555555555555599990000000000
 36  00000955555555555555555555555555999990000000
 35  00009955555555555555555555555555555599990000
 34  00009555555555555555555555555555555555999990
 33  00099555555555555555555555555555555555555590
 32  00095555555555555555555555555555555555555590
 31  00995555555555555555555555555555555555555590
 30  09955555555555555555555555555555555555555590
 29  09555555555555555555555555555555555555555590
 28  99555555555555555555555555555555555555555590
 27  00995555555555555555555555555555555555555590
 26  00095555555555555555555555555555555555555590
 25  00099555555555555555555555555555555555555590
 24  00009955555555555555555555555555555555555590
 23  00000995555555555555555555555555555555555590
 22  00000955555555555555555555555555555555555590
 21  00000099555555555555555555555555555555555590
 20  00000009955555555555555555555555555555555590
 19  00000000955555555555555555555555555555555590
 18  00000000995555555555555555555555555555555590
 17  00000000099555555555555555555555555555555590
 16  00000000009555555555555555555555555555555590
```

Figure B28a. File cell.inp for WCA2A Grid Shown in Figure B25.

```
 15  00000000009955555555555555555555555555555590
 14  00000000000995555555555555555555555555555590
 13  00000000000095555555555555555555555555555590
 12  00000000000099555555555555555555555555555590
 11  00000000000009955555555555555555555555555590
 10  00000000000000955555555555555555555555555590
  9  00000000000000955555555555555555555599999990
  8  00000000000000995555555555559999999900000000
  7  00000000000000095555555999999000000000000000
  6  00000000000000095555559900000000000000000000
  5  00000000000000095555599000000000000000000000
  4  00000000000000095555990000000000000000000000
  3  00000000000000099555900000000000000000000000
  2  00000000000000009999900000000000000000000000
  1  00000000000000000000000000000000000000000000
C
C    12345678901234567890123456789012345678901234567890
C             1         2         3         4         5
```

Figure B28b. Continuation of file cell.inp for WCA2A Grid Shown in Figure B25.

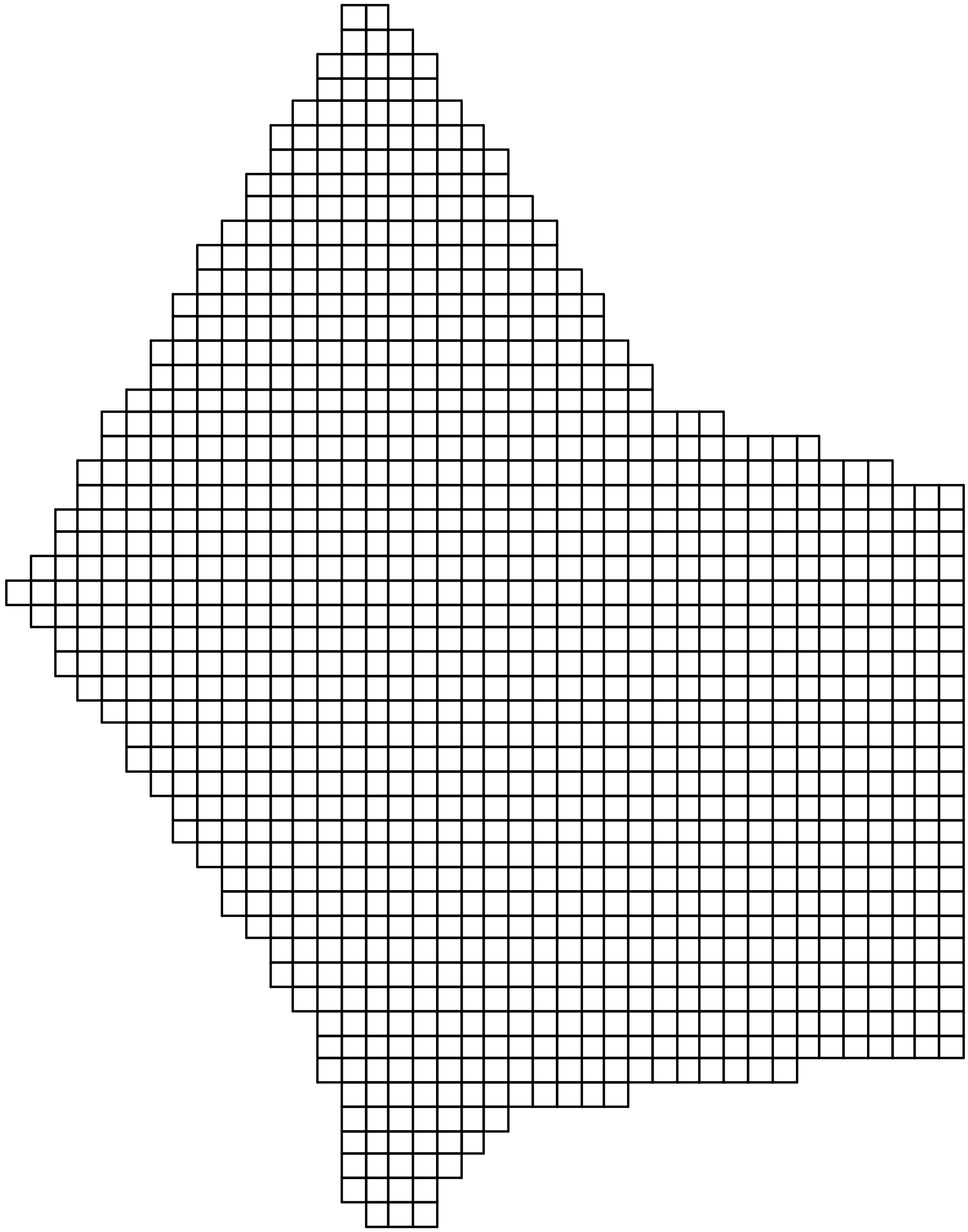

Figure B29. Square cell Cartesian grid representing same region as shown in Figure B25. This grid corresponds to the file gcell.inp in Figure B28.

```
C
      REAL*8 FUNCTION FIB(YY,J)
      IMPLICIT REAL*8 (A-H,O-Z)
```

```
      REAL*8 YY
C
      IF(YY.GE.20.6.AND.YY.LE.35.6) THEN
       FIB=9.*(YY-21.)/15. + 7.
       RETURN
      END IF
C
      WRITE(6,601) YY,J
  601 FORMAT(' FUNCTION FIB OUT OF BOUNDS YY,J = ',F10.4,I8/)
C
      RETURN
      END
C
```

Figure B30. FORTRAN function subroutine for physical domain true east or X coordinate (FIB), along beginning I boundary as a function of physical domain true north or Y coordinate (YY) on that boundary.

```
C
      REAL*8 FUNCTION FIE(YY,J)
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 YY
C
      IF(YY.GE.9.1.AND.YY.LE.23.6) THEN
       FIE=31.
       RETURN
      END IF
C
      WRITE(6,601) YY,J
  601 FORMAT(' FUNCTION FIE OUT OF BOUNDS YY,J = ',F10.4,I8/)
C
      RETURN
      END
C
```

Figure B31. FORTRAN function subroutine for physical domain true east or X coordinate (FIE), along ending I boundary as a function of physical domain true north or Y coordinate (YY) on that boundary.

```
C
      REAL*8 FUNCTION GJB(XX,I)
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 XX
C
      IF(XX.GE.6.76.AND.XX.LT.8.76) THEN
       X=XX-6.76
```

```
        GJB=20.6-0.6*X-(2.254-0.203*X)*X*X/7.7
        RETURN
       END IF
C
       IF(XX.GE.8.76.AND.XX.LT.14.7) THEN
        GJB=-11.2*(XX-7.)/7.7 + 21.
        RETURN
       END IF
C
       IF(XX.GE.14.7.AND.XX.LT.19.4) THEN
C       GJB=-2.1*(XX-14.7)/4.7 + 9.8
        X=XX-14.7
        CTMP=6.764968/(4.7*4.7)
        DTMP=-2.028605/(4.7*4.7*4.7)
        GJB=9.8-11.2*X/7.7+(CTMP+DTMP*X)*X*X
        RETURN
       END IF
C
       IF(XX.GE.19.4.AND.XX.LE.29.0) THEN
        GJB=1.5*(XX-19.4)/11.6 + 7.7
        RETURN
       END IF
C
       IF(XX.GE.29.0.AND.XX.LE.31.) THEN
        X=XX-31.
        GJB=9.1-(0.63+0.085*X)*X*X/11.6
        RETURN
       END IF
C
       WRITE(6,601) XX,I
   601 FORMAT(' FUNCTION GJB OUT OF BOUNDS XX,I = ',F10.4,I8/)
C
       RETURN
       END
C
```

Figure B32. FORTRAN function subroutine for physical domain true north or Y coordinate (GJB), along beginning J boundary as a function of physical domain true east or X coordinate (XX) on that boundary.

```
C
       REAL*8 FUNCTION GJE(XX,I)
       IMPLICIT REAL*8 (A-H,O-Z)
       REAL*8 XX
C
       IF(XX.GE.15.76.AND.XX.LT.17.76) THEN
        X=XX-15.76
        GJE=35.6-0.6*X-(1.696-0.082*X)*X*X/7.5
        RETURN
       END IF
C
       IF(XX.GE.17.76.AND.XX.LT.22.5) THEN
        GJE=-10.3*(XX-16.)/7.5 + 36.
```

```
         RETURN
        END IF
C
        IF(XX.GE.22.5.AND.XX.LT.24.5) THEN
         X=XX-22.5
         GJE=(203.05-10.3*X+2.*X*X)/7.5
         RETURN
        END IF
C
        IF(XX.GE.24.5.AND.XX.LT.29.0) THEN
         GJE=-2.3*(XX-23.5)/7.5 + 25.7
         RETURN
        END IF
C
        IF(XX.GE.29.0.AND.XX.LE.31.0) THEN
         X=XX-31.
         GJE=23.6+(1.175+0.2*X)*X*X/7.5
         RETURN
        END IF
C
        WRITE(6,601) XX,I
    601 FORMAT(' FUNCTION GJE OUT OF BOUNDS XX,I = ',F10.4,I8/)
C
C
        RETURN
        END
C
```

Figure B33. FORTRAN function subroutine for physical domain true north or Y coordinate (GJE), along ending J boundary as a function of physical domain true east or X coordinate (XX) on that boundary.

B.6. Chesapeake Bay

This section describes a square cell Cartesian grid of the Chesapeake Bay. The physical domain grid is shown in Figure B34, the cell.inp file, Figure B35, and the gefdc.inp file, Figure B36. The grid was generated with the NTYPE = 9, option by gefdc.f.

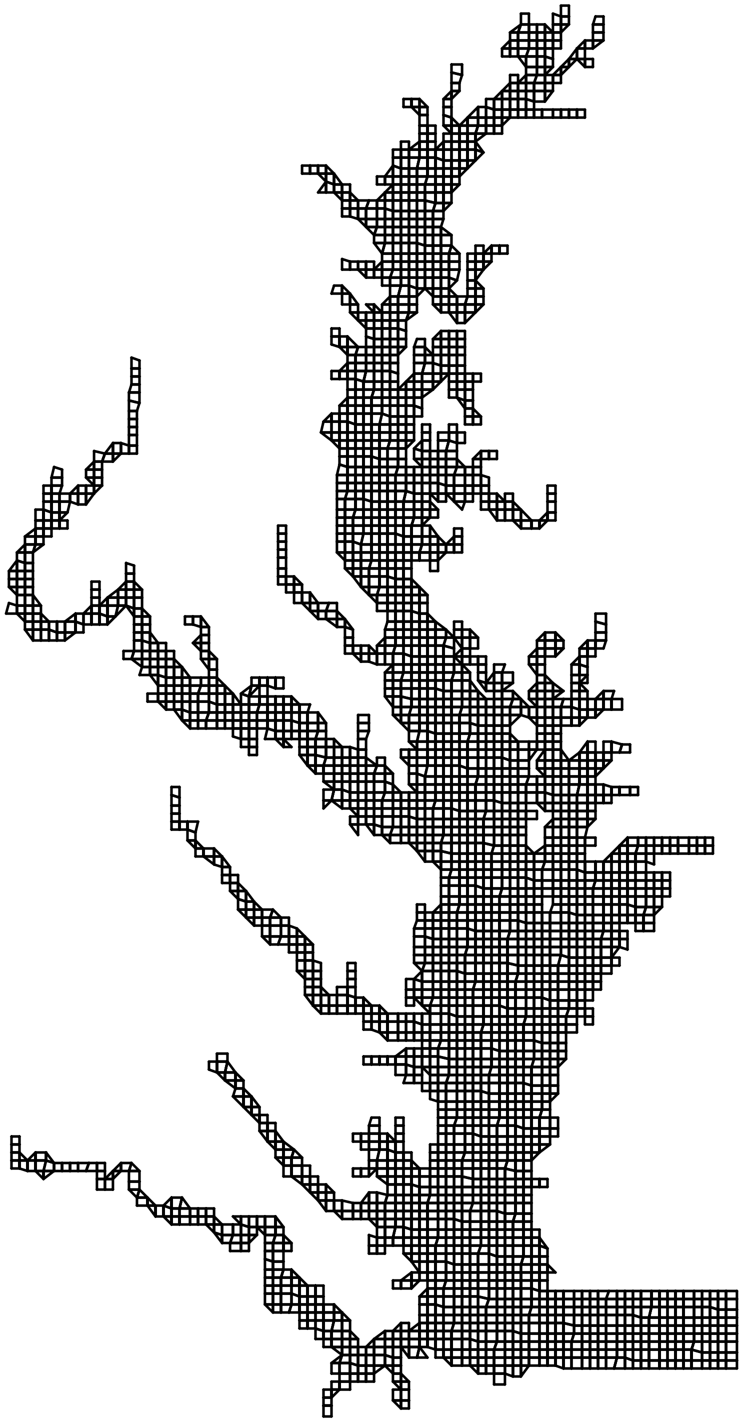

Figure B34. Physical and computational domain grid of the Chesapeake Bay. Grid spacing is approximately 1850 meters.

```
C cell.inp file, i across and j up, for ches bay
```

```
C    0         1         2         3         4         5         6         7         8         9
C    123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456
C
180  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
179  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
178  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
177  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
176  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
175  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
174  000000000000000000000000000000000000000000000000000000000000000009990000000000000000000000000000
173  000000000000000000000000000000000000000000000000000000000000000099909959099900000000000000000000
172  000000000000000000000000000000000000000000000000000000000000000009959995590959000000000000000000
171  000000000000000000000000000000000000000000000000000000000000000009455515290959000000000000000000
170  000000000000000000000000000000000000000000000000000000000000000009955555999959000000000000000000
169  000000000000000000000000000000000000000000000000000000000000000009455555994529000000000000000000
168  000000000000000000000000000000000000000000000000000000000000000009555555994599900000000000000000
167  000000000000000000000000000000000000000000000000000000000000000099900099935559423590000000000000
166  000000000000000000000000000000000000000000000000000000000000000095900009995524299990000000000000
165  000000000000000000000000000000000000000000000000000000000000000095900099545555900000000000000000
164  000000000000000000000000000000000000000000000000000000000000000099590099455555990000000000000000
163  000000000000000000000000000000000000000000000000000000000000000999999429099455555290000000000000
162  000000000000000000000000000000000000000000000000000009551995999955555599999990000000000000000000
161  000000000000000000000000000000000000000000000000000009935995994555555555555590000000000000000000
160  000000000000000000000000000000000000000000000000000009959951455552999999999990000000000000000000
159  000000000000000000000000000000000000000000000000000000955935555559900000000000000000000000000000
158  000000000000000000000000000000000000000000000000000009995595555299900000000000000000000000000000
157  000000000000000000000000000000000000000000000000000099545545555190000000000000000000000000000000
156  000000000000000000000000000000000000000000000000000099555555555529000000000000000000000000000000
155  000000000000000000000000000000000000000000000009999900009955555555552990000000000000000000000000
154  000000000000000000000000000000000000000000000009555199009945555555552990000000000000000000000000
153  000000000000000000000000000000000000000000000099935199095555555555990000000000000000000000000000
152  000000000000000000000000000000000000000000094555999945555552900000000000000000000000000000000000
151  000000000000000000000000000000000000000000099935199455555559900000000000000000000000000000000000
150  000000000000000000000000000000000000000000009955555555555552900000000000000000000000000000000000
149  000000000000000000000000000000000000000000009555555555555599000000000000000000000000000000000000
148  000000000000000000000000000000000000000000009993555555555559900000000000000000000000000000000000
147  000000000000000000000000000000000000000000000000993555555551900000000000000000000000000000000000
146  000000000000000000000000000000000000000000000000995555555555599999990000000000000000000000000000
145  000000000000000000000000000000000000000000000000093555555555199545590000000000000000000000000000
144  000000000000000000000000000000000000000000000009999995555555559555599900000000000000000000000000
143  000000000000000000000000000000000000000000000000955554555555555559552900000000000000000000000000
142  000000000000000000000000000000000000000000000000999355555555555559529900000000000000000000000000
141  000000000000000000000000000000000000000000000000999999955555555552951900000000000000000000000000
140  000000000000000000000000000000000000000000009519909955523551955900000000000000000000000000000000
139  000000000000000000000000000000000000000000009951999455995555559000000000000000000000000000000000
138  000000000000000000000000000000000000000000009959315555993555529000000000000000000000000000000000
137  000000000000000000000000000000000000000000000935555529999352990000000000000000000000000000000000
136  000000000000000000000000000000000000000000009993555559999999990000000000000000000000000000000000
135  000000000000000000000000000000000000000000009599955555999455590000000000000000000000000000000000
134  000000000000000000000000000000000000000000009551955555959555590000000000000000000000000000000000
133  000000000000000000000000000000000000000000009935555529515555900000000000000000000000000000000000
132  000000000000000000000999000000000000000000009955555599555555900000000000000000000000000000000000
131  000000000000000000000959000000000000000000009945555559955555599900000000000000000000000000000000
130  000000000000000000000959000000000000000000009555555559455525555900000000000000000000000000000000
129  000000000000000000000959000000000000000000009995555554555295559900000000000000000000000000000000
128  000000000000000000000959000000000000000000009955555555552995559000000000000000000000000000000000
127  000000000000000000000959000000000000000000009455555555555999935990000000000000000000000000000000
126  000000000000000000000959000000000000000000009995555555555900995190000000000000000000000000000000
125  000000000000000000000959000000000000000000009455555555559999995590000000000000000000000000000000
124  000000000000000000000959000000000000000000009555555555555959959990000000000000000000000000000000
123  000000000000000000000959000000000000000000009355555555555959555590000000000000000000000000000000
```

Figure B35a. File cell.inp for Chesapeake Bay Grid Shown in Figure B34.

```
122  000000000000000000999959000000000000000000009935555555524595599999990000000000000000000000000000
121  000000000000000009945559000000000000000000009955555555955555599455900000000000000000000000000000
120  000000000000000009955299900000000000000000000955555555935555195999000000000000000000000000000000
119  000000000000999094599900000000000000000000000955555555555555555990000000000000000000000000000000
118  000000000000959095590000000000000000000000000955555555555555559000009990000000000000000000000000
117  000000000009959993590000000000000000000000000955555555555555599990095900000000000000000000000000
116  000000000009559455290000000000000000000000000955555555353559551599095900000000000000000000000000
115  000000000009555552990000000000000000000000000955555555199399555519995900000000000000000000000000
114  000000000099555999900000000000000000000000000955555555999999355519459000000000000000000000000000
113  000000000095552900000000000000000000000099900009555555555529999909999355299000000000000000000000
112  000000000995555900000000000000000000000095900009555555555551995900099999000000000000000000000000
111  000000000945599900000000000000000000000095900009555555555555145900000000000000000000000000000000
110  000000009955990000000000000000000000000959000095555555555555555900000000000000000000000000000000
109  000000009452900000000000000000000000000959000093555555555552999000000000000000000000000000000000
108  000000099559900000009990000000000000000959000099555555559959900000000000000000000000000000000000
107  000000094559000000009590000000000000000959990009355555555999900000000000000000000000000000000000
```

```
106  000000095559000000999995990000000000000000095519000993555555199000000000000000000000000000000000000000000
105  000000095559000000959945190000000000000000995599900993555555190000000000000000000000000000000000000000000
104  000000093559900000959455590000000000000000995519990993555555900000000000000000000000000000000000000000000
103  000000099551900099545555990000000000000000993555990995555559900000000000000000000099900000000000000000000
102  000000095555999994555235190099999000000000099355199099555551999900000000000000000095900000000000000000000
101  000000099355199455552995590095519000000000009993519009555555195999000000999990095900000000000000000000000
100  000000009955555559999995599099959000000000000099959099555555515519000000945199995900000000000000000000000
 99  000000000935555299000009551990945900000000000000095999455555555355900000995559945590000000000000000000000
 98  000000000999999990000995555999359900000000000000095551555555555459990009455299559900000000000000000000000
 97  000000000000000000009555555999519000000000000000993555555555553555999095599945990000000000000000000000000
 96  000000000000000000000993555519935900000000000000009999945555555519595999359995590000000000000000000000000
 95  000000000000000000000995555519959909999990000000000009555555555595459999519954900000000000000000000000000
 94  000000000000000000000099355555551999555590000000000000955555555551355299455195199990000000000000000000000
 93  000000000000000000000099555555551942599999000000000009555555555551955195552955945990000000000000000000000
 92  000000000000000000000009555555555515555551990000000009355555555555555135555555555900000000000000000000000
 91  000000000000000000000009935555555555555555999009999955555555555555555555555555299900000000000000000000000
 90  000000000000000000000000999355555555555555519009590935555555555555529355555299900000000000000000000000000
 89  000000000000000000000000009935555555555555555900959099355555555555599955599990000000000000000000000000000
 88  000000000000000000000000000999999955595555555999959009955555555555519955599999999990000000000000000000000
 87  000000000000000000000000000000995599319555519959009935555555555555555994595559000000000000000000000000000
 86  000000000000000000000000000000995999995555555999955555555555555524551455559990000000000000000000000000000
 85  000000000000000000000000000000000999000935555555159935555555555555559555555552900000000000000000000000000
 84  000000000000000000000000000000000000993555555551995555555555555593555555299000000000000000000000000000000
 83  000000000000000000000000000000000000999555555559955555555555555555555555599999900000000000000000000000000
 82  000000000000000000000000000999000000000000000093555555519355555555555555555555555555900000000000000000000
 81  000000000000000000000000000959000000000000000009555555555555555555555555555555555599990000000000000000000
 80  000000000000000000000000000959000000000000000009235555555555555555555555935555559990000000000000000000000
 79  000000000000000000000000000959000000000000000009999355555555555555555555995555590000000000000000000000000
 78  000000000000000000000000000959990000000000000000009555555555555555555555994555529000000000000000000000000
 77  000000000000000000000000000955590000000000000000000939355555555555555555599555559909999999999999999000000
 76  000000000000000000000000000999599000000000000000000099999355555555555555599555555999455555555555559000000
 75  000000000000000000000000000093199900000000000000000000999935555555555555514555559994555555555555559000000
 74  000000000000000000000000000099551990000000000000000000000993555555555555555555599455555999999999000000000
 73  000000000000000000000000000009935190000000000000000000000999355555555555555555555555555599990000000000000
 72  000000000000000000000000000000999599000000000000000000000000995555555555555555555555555555590000000000000
 71  000000000000000000000000000000095599000000000000000000000000955555555555555555555555555555590000000000000
 70  000000000000000000000000000000009951990000000000000000000000095555555555555555555555555555590000000000000
 69  000000000000000000000000000000000935199000000000000000000999955555555555555955555555555555990000000000000
 68  000000000000000000000000000000000995519990000000000000000959455555555555559555555555555552900000000000000
 67  000000000000000000000000000000000093555199000000000000000955555555555555555555555555555559900000000000000
 66  000000000000000000000000000000000099355559990000000000000955555555555555555555555555555995590000000000000
 65  000000000000000000000000000000000099955551990000000000000955555555555555555555555555555599990000000000000
 64  000000000000000000000000000000000000935555190000000000009555555555555555555555555555555900000000000000000
 63  000000000000000000000000000000000000999955590000000000009555555555555555555555555529900000000000000000000
 62  000000000000000000000000000000000000009955990999000009555555555555555555555555555590000000000000000000000
 61  000000000000000000000000000000000000009555909590000093555555555555555555555555559900000000000000000000000
```

Figure B35b. Continuation of file cell.inp for Chesapeake Bay Grid Shown in Figure B34.

```
 60  000000000000000000000000000000000000009355909590000099455555555555555555555555599000000000000000000000000
 59  000000000000000000000000000000000000009955999590000955555555555555555555555555590000000000000000000000000
 58  000000000000000000000000000000000000009551955999009555555555555555555555555555990000000000000000000000000
 57  000000000000000000000000000000000000009355555199995355555555555555555555555599000000000000000000000000000
 56  000000000000000000000000000000000000009935555551999935555555555555555555555559000000000000000000000000000
 55  000000000000000000000000000000000000000999999955555555555555555555555555555959000000000000000000000000000
 54  000000000000000000000000000000000000000000955555555555555555555555555555559990000000000000000000000000000
 53  000000000000000000000000000000000000000000999355555555555555555555555555990000000000000000000000000000000
 52  000000000000000000000000000000000000000000099999955555555555555555555555590000000000000000000000000000000
 51  000000000000000000000000000000000999000000000000000099999455555555555555555559000000000000000000000000000
 50  000000000000000000000000000000000995990000000000000009555555555555555555555552900000000000000000000000000
 49  000000000000000000000000000000000955199000000000000009999955535555555555555555990000000000000000000000000
 48  000000000000000000000000000000000993519000000000000000009955955555555555555559000000000000000000000000000
 47  000000000000000000000000000000000993599000000000000000009995555555555555555559000000000000000000000000000
 46  000000000000000000000000000000000099519900000000000000000099555555555555552900000000000000000000000000000
 45  000000000000000000000000000000000009351900000000000000000009955555555555555990000000000000000000000000000
 44  000000000000000000000000000000000099359900000000000099999900955555555555555990000000000000000000000000000
 43  000000000000000000000000000000000099359900000000000959959009555555555555555900000000000000000000000000000
 42  000000000000000000000000000000000009955990000000099959959009555555555555555900000000000000000000000000000
 41  000000000999000000000000000000000009351990000009555515909955555555555555599000000000000000000000000000000
 40  000000000959000000000000000000000009935199000099555559995555555555555552900000000000000000000000000000000
 39  000000000959999900000000000000000009955190000099555559955555555555555299000000000000000000000000000000000
 38  000000000951451999999999999000000000000000935590009995555519555555555555599000000000000000000000000000000
 37  000000000955555555555945190000000000000000995559900955255555555555555555999000000000000000000000000000000
 36  000000000999329999954295900000000000000000993559999999355555555555555555555900000000000000000000000000000
 35  000000000000999000955995990000000000000000099355190999995555555555555555559990000000000000000000000000000
 34  000000000000000000999993199999900000000000099355999455555555555555555555590000000000000000000000000000000
 33  000000000000000000000099519451999900000000000993555555555555555555555555555900000000000000000000000000000
 32  000000000000000000000000993555555599999999900999355555555555555555555555590000000000000000000000000000000
 31  000000000000000000000000999355555193555519000099999355555555555555555555599000000000000000000000000000000
```

```
30  0000000000000000000000000000999999355553559900000009955555555555555555555990000000000000000000000
29  00000000000000000000000000000000099355529551900000009555555555555555555551900000000000000000000000
28  00000000000000000000000000000000099955995559000000095599555555555555555555900000000000000000000000
27  00000000000000000000000000000000000099999559900000099999355555555555555555990000000000000000000000
26  00000000000000000000000000000000000000009559990000000000993555555555555555190000000000000000000000
25  00000000000000000000000000000000000000009555190000000099455555555555555555990000000000000000000000
24  00000000000000000000000000000000000000009555199900000009552955555555555555999999999999999999999999
23  00000000000000000000000000000000000000009555555590000009999455555555555555555555555555555555555559
22  00000000000000000000000000000000000000009555555599900000009555555555555555555555555555555555555559
21  00000000000000000000000000000000000000009355555551990000009555555555555555555555555555555555555559
20  00000000000000000000000000000000000000009999955555190009999555555555555555555555555555555555555559
19  00000000000000000000000000000000000000000000955555599999454555555555555555555555555555555555555559
18  00000000000000000000000000000000000000000000999555519945555555555555555555555555555555555555555559
17  00000000000000000000000000000000000000000000099555594555555555555555555555555555555555555555555559
16  00000000000000000000000000000000000000000000009935555555535195555555555555555555555555555555555559
15  00000000000000000000000000000000000000000000000094555555599999355555555555555555555555555555555559
14  00000000000000000000000000000000000000000000000095555523599009999935555529999999999999999999999999
13  00000000000000000000000000000000000000000000000099555599519000009999599990000000000000000000000000
12  00000000000000000000000000000000000000000000000995599999359000000009990000000000000000000000000000
11  00000000000000000000000000000000000000000000000952990009559000000000000000000000000000000000000000
10  00000000000000000000000000000000000000000000000959900009359000000000000000000000000000000000000000
 9  00000000000000000000000000000000000000000000000959000009999000000000000000000000000000000000000000
 8  00000000000000000000000000000000000000000000000999000000000000000000000000000000000000000000000000
 7  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 6  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 5  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 4  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 3  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 2  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
 1  000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
```

Figure B35c. Continuation of file cell.inp for Chesapeake Bay Grid Shown in Figure B34.

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
    chesapeake bay cartesian, ll input, utm output
C2  INTEGER INPUT
C2  NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
     9      0      1     97    1     181   96   180
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG nwtgg
     1     96   180  1850. 1850. 1
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
     -77.5   1.25    -0.625  36.7    1.0     -0.5
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM
     100    100    100    100    4000  1.0
C6  REAL INPUT
C6  RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
     1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7  COORDINATE SHIFT PARAMETERS
C7  XSHIFT    YSHIFT   HSCALE  RKJDKI  ANGORO
     0.        0.       1000.   1.      7.0
C8  INTERPOLATION SWITCHES
C8  ISIRKI  JSIRKI  ISIHIHJ  JSIHIHJ
     1       0       0        0
C9  NTYPE = 7 SPECIFIED INPUT
C9  IB    IE    JB    JE  NINITM N7RELAX ITN7MAX  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
```

```
C10 X    Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT   CDEP  RADM  isidptyp  surfelv
     0       79431       2.    1.  1         0.      0    0    0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT)  Y(ILT,JLT)
     1   1   1           1
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)    Y(I,J)
```

Figure B36. File gefdc.inp for Chesapeake Bay Grid Shown in Figure B34.