

# Chapter 4

## fort.15 File - Parameter File

Once a good mesh is in place, the fort.14 file becomes essentially static and does not need to be altered from simulation to simulation. The fort.15 file, on the other hand, contains many simulation-specific parameters that may need to be adjusted frequently. For a complete description of the fort.15 file, the reader is referred to the ADCIRC documentation provided at <http://www.adcirc.org>. Only a few items will be covered in the present chapter.

### 4.1 General Parameters

First of all, the beginning of the fort.15 file contains many parameters that govern how ADCIRC will be run. Is the model to be run in two-dimensional or three-dimensional mode? Are spherical (longitude, latitude) coordinates being used, or projected (x, y) coordinates?

There are some important parameters that control how nonlinearity is dealt with. For example, linear wave theory essentially ignores the wave itself and ‘linearizes’ the equations by using only the mean bathymetric depth at a given location. In a location like Glacier Bay, where large tidal ranges are found in shallow waters, this approximation would be quite poor. Thus, the author has been considering finite-amplitude effect by setting NOLIFA to be nonzero.

In addition to simply considering finite-amplitude effects, the ADCIRC model has the distinct advantage of being able to model wetting and drying effects. In other words, as the tide ebbs, some elements will become ‘dry’ as

the water contact line moves away from shore. This feature of ADCIRC is turned on by setting NOLIFA to have a value of 2.

Next, the model time step must be selected. For the sake of expediency, it is tempting to set DT to be large. However, due to the explicit way in which time derivatives are handled in ADCIRC, a too-large DT will lead to severe numerical instability. The maximum model time step is set by the lowest CFL value in the domain. The CFL (Courant-Friedrichs-Levy) constraint states that

$$\frac{\Delta t}{\Delta x} \sqrt{gh} < CFL.$$

The maximum value that the parameter CFL may have is 1.0. Thus, it is clear that exceptionally small elements may lead to prohibitively expensive computer time (very small  $\Delta t$ ). As discussed in the previous chapter, the final Glacier Bay domain grid revealed a maximum  $\Delta t$  of 1 second.

## 4.2 Tidal Parameters

The middle section of the fort.15 file contains information about how the domain is to be forced with tides.

### 4.2.1 Interior Forcing

First, it is possible to force the interior of the domain via the tidal potential. In other words, a closed basin of sufficient size will generate its own tides. As the present model domain is quite small, it has been decided to use projected coordinates (x, y) and to turn off the interior forcing.

### 4.2.2 Boundary Forcing

Second, it is possible to force the domain by prescribing the tidal motion at the (two, in this case) open boundaries. The user has the ability to specify as many tidal constituents as desired. While there are several hundred recognized constituents, many are insignificant in amplitude and, from a practical modeling point of view, it is often sufficient to include only the top 5-10.

For each included constituent, several parameters must be specified. These include the frequency, amplitude, phase, nodal factor, and equilibrium argument. To help in explaining these terms, note that the water surface elevation

may, in general, be written as:

$$\eta(x, y, t) = \sum A_i(x, y) f_i(t_0) \cos \left[ \frac{2\pi}{T_i} (t - t_0) + V_i(t_0) - \Psi_i(x, y) \right].$$

In this equation, the summation symbol merely indicates that the water surface elevation (due to the tides) is made up a number of terms (constituents). The amplitude (of constituent  $i$ ) is given by  $A_i$ , the period by  $T_i$  (note that  $\frac{2\pi}{T_i}$  is the angular frequency), and the phase by  $\Psi_i$ . The nodal factor is given by  $f_i$  and the equilibrium argument by  $V_i$ .

Among these terms, only the period / frequency is an absolute constant for a given constituent. The amplitudes and phases are spatially variable, temporally constant values. The nodal factors and equilibrium arguments are spatially constant, temporally variable values. Most importantly, these latter two terms are essential to ‘starting the clock’ on an ADCIRC simulation. If the goal of the user is to produce time series of elevations and velocities, for the purposes of comparisons with data, these parameters must be calculated. Otherwise, the output, will not be properly synchronized in time.

### Determination of Nodal Factors and Equilibrium Arguments

The author has found two different methods for calculating these parameters.

1. The first is a Fortran program, called `tide_fac.f`, and available from the ADCIRC webpage at <http://www.adcirc.org>. When compiled and executed, this program prompts the user for a date and time (GMT). For example, if a start at 11 p.m. on January 25th, 2006 is desired, the time is entered as:

```
23 25 1 2006
```

Execution of the program yields the following output:

CONST	NODE	EQ ARG (ref GM)
NAME	FACTOR	(DEG)
K1	1.11206	19.09
O1	1.18191	34.73

P1	1.00000	309.89
Q1	1.18191	101.74
N2	0.96350	120.42
M2	0.96350	53.40
S2	1.00000	330.00
K2	1.31448	218.05

- The second is a Matlab program, called `compute_modulation.v2.m`, which is part of a Matlab package called `t_tide`, freely available online. When this program is executed, the user is, as with `tide_fac`, asked for the time (GMT) and date at which the nodal factor and equilibrium argument are desired. The output contains many more constituents than the `tide_fac` output. As just a single point of comparison it is found that:

K1	1.1124	19.0543
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While there are some very slight differences, it appears that the two programs yield essentially equivalent results.

### **Determination of Amplitudes and Phases**

Tidal constituents at the open boundaries may be extracted from the Eastern Pacific Database, found at <http://www.unc.edu/ims/ccats/tides/tides.htm>. In addition to the databases themselves, a fortran program for extracting information at requested points is provided. In brief, the fortran program requires an input file, entitled `tides.in`, whose first line is an integer specifying at how many points information is being requested. The following lines are simply the longitude and latitude coordinates of those points. The output file from the fortran program contains the amplitudes and phases of the M2, S2, N2, K2, O1, K1, P1, Q1, M4, and M6 constituents. Note that the amplitudes and phases for each constituent must be listed in the `fort.15` file in the exact order in which the open boundary points are specified in the `fort.14` file.

### 4.3 Output Specification

The last major portion of the fort.15 file has to do with user requests for output data. In general, the user may specify that data (including elevation, water velocity, and scalar concentration) be output either at specified nodes in the domain or at *all* nodes in the domain (global output). In addition, the user may specify at what times these data are output. Specifically, a start time, end time, and time step ‘skip’ may be specified. For example, consider an ADCIRC run that lasts for 14 days. The user may wish to specify that data are output beginning on the 10th day and ending on the 14th. Moreover he may wish to specify that the data be output at every 1000th model time step. Note that these ‘global’ output files (where data are written at every node) can become extremely large in their ASCII format. If needed, ADCIRC can be generate binary output files as well, which are more compact.

In addition to elevation and velocity time series data, it is possible to have ADCIRC perform harmonic analysis on model output. Harmonic analysis takes time series output and uses least-squares analysis to fit it to a specified number of constituents. As a result, the amplitudes and phases of the constituents can be determined. It is possible to request harmonic analysis output either at selected points or at every point in the domain.

Note that this is precisely how the Eastern Pacific (ENPAC) Database, as described above, was generated. In that case, tidal constituents at the open boundary of the ENPAC domain were extracted from global ocean models and were used to drive the ENPAC ADCIRC simulation. Subsequent harmonic analysis of the model output led to the tidal constituents in the ENPAC database. Now, the tidal constituents at the open boundaries of the (smaller) Glacier Bay domain are being extracted from the ENPAC database and used to drive an ADCIRC simulation of Glacier Bay. This ‘nested model’ approach is common and advantageous as it provides the desire resolution only in the regions where it is needed.