APPENDIX G TIME V2.0 TECHNICAL CODE UPDATES

The TIME v2.0 model consists of the FTLOADDS code applied to the land domain of Everglades National Park. FTLOADDS has been modified in a number of ways since this original application in TIME v1.0 (Wang et al. (2007)). The modifications have several purposes, such as removing hardcoding of files and variables, reorganizing and streamlining the run process and file hierarchy, and resolving compile and run-time errors.

One goal of the revision process was to produce a 'package' of the model's input files, output files, and source code that compiled, ran, and could be easily modified by the end user. Other goals were to assign the model a version number, and produce a report associated with that version for purposes of accurate documentation, referencing, and future development.

For future use of the TIME model, it is recommended that the TIME code and input files be compared to this package to determine exactly what features have changed, and their potential influence on the model results.

Application improvements

Several initial organizational tasks produced substantial improvement in application portability and ease-of-use. The directory structure was made more intuitive and input files were simplified and converted to user-readable formats:

- Extraneous and unused files were removed. (Directories removed: ENPRoads, Flows, Rain, topography).
- Preprocessing programs were moved to a separate preprocessing directory.
- File structure was simplified to contain only two directories: input and output. The code was modified to only read from the input files, not modify them. Also changes were made to place all the output files in the output directory and to read all the input files from the input directory.
- The time.ghb file format was simplified to require only interpolation points, which reduced its large file size and therefore increased portability of the model.
- All input files were changed to ascii format, and the model code was updated to read the new files.

Other adjustments allowed more versatility in defining model inputs:

- A process was developed and code written to convert any SFWMM or NSM run to TIME input.
- Code was written to examine model input and output files, and convert output to NetCDF format.
- Code was changed to accept more than 40 input flow timeseries (especially needed for NSM simulations).

- Code was changed to accept beginning and ending offsets for sea level rise runs.
- Code was written to view and analyze the TIME model output from a MySQL database and in graphical form.

Compiler options

When received by NPS, the TIME model could not be compiled on our systems. The model was originally compiled at USGS using the Compaq FORTRAN compiler within the Microsoft Visual Studio environment. NPS had problems getting these two programs to work together, so USGS revised the code to compile on the Intel FORTRAN Compiler within the Microsoft Studio Development Environment (MSDE). Effort was needed to identify the required compiler options and settings for the model to be able to compile and run TIME v2.0 as it did at USGS. Problems were determined to be due to the fact that USGS used MSDE released in 2005 using the Intel Fortran Compiler Integration version 9.10 and NPS had MSDE version 7 (2003 release) using the Intel Fortran Compiler Integration version 8.10. The key change required was to set the flag for "Local Variable Storage - All Variables Save."

Run time for each 10-year simulation took about 14 hours to complete on a Dell Precision T7400 with two Intel Xeon E5430 CPUs at 2.66 GHz and 3.25 GB of RAM, divided up into eight virtual CPUs each running a model.

Removal of hardcoded parameters from code

In TIME v2.0, several hardcoded values were removed from the code. Some examples of hardcoded values that were in the TIME model are:

1. The location of inflow sources (subroutine SOURCEWATER)
2. Tidal boundary conditions (subroutines OPENBOUND and TIDAL)
3. Defined rainfall zones (subroutine SOURCEWATER)
4. Defined zones of potential evapotranspiration rates (SOURCEWATER)
5. Input filenames for inflow sources, rainfall, evapotranspiration, wind, and frictional resistance terms (subroutines SOURCEWATER, GETWIND, INDAT1, SIOFIL)
6. Surface water/groundwater leakage coefficients (subroutine LEAK).

The spatial location of inflow sources into the TIME v2.0 domain was coded into a separate subroutine (SOURCEWATER) while developing the TIME model, but was subsequently modified to be an input to the model, as described in Lohmann and Swain (written communication, 2009).

The input of tidal boundary conditions was modified to allow offshore water levels and salinity values generated by the EFDC Florida Bay model to be used as input (Wolfert et al. (2006)). This interface was hardcoded into a modified subroutine (TIDAL), replacing the standard tidal boundary input. The solution for standardizing this input was to simply convert this data into the standard SWIFT2D input format used in FTLOADDS (Swain, 2005). The modified TIDAL subroutine was discarded.

The rainfall data input and the potential evapotranspiration data input to TIME were both defined for specific zones in the model area. For the initial TIME model, the zonal boundaries were hardcoded in the SOURCEWATER subroutine and the data values were read from the input file. This was modified to have zonal locations for both rainfall and potential evapotranspiration read in from the input files, as described in Lohmann and Swain (written communication, 2009). When developing the FTLOADDS simulator for the TIME model, new input files were developed for inflow sources, rainfall, evapotranspiration, wind, and frictional resistance terms. The input filenames and locations for these had been hardcoded. In order to allow the user more versatility, these input files are now able to be declared. The modifications required to achieve this were in the SWIFT2D.MTR master file and the SIOFIL subroutine.

In TIME v1.0 (Wang et al. (2007)), the leakage coefficients for surface water and groundwater exchange were hardcoded into the LEAK subroutine. The leakage is represented as occurring across a thin surficial layer and the underlying aquifer, to the vertical center of the uppermost aquifer cell. The coefficients include the hydraulic conductivities of the thin layer and the aquifer, and the thickness of the thin layer. The TIME v2.0 code was modified to allow these values to be input from an input file as spatially variable or uniform values.

Code streamlining

The SEAWAT code incorporated into the FTLOADDS simulator was constructed in the modular fashion of its basic program, MODFLOW (McDonald and Harbaugh (1988)), but the SWIFT2D code used to represent the hydrodynamic surface water flow is not as modular. Substantial code streamlining was achieved by removing unused and outdated subroutines and code. Primary changes to TIME v2.0 include the removal of subroutines for:

- obsolete representation of flow sources (subroutine ADJSRC),
- obsolete representation of hydraulic barriers (subroutines BARENU, BARENV, SLUCEU, and SLUCEV),
- unused DIGS-GKS output graphics (subroutine DIGSGKS, GRQLC),
- the obsolete SWIFT.IDP preprocessor (subroutines GET012, GET_01, GET_CR, GETCHR, GETCHV, GETCRT, GETCVL, GETFLT, GETIFL, GETINT, GETIVL, GETNUM, GETOPT, GETRNM, GETRVL, GETSTR),
- unused simulation history output (subroutine HISTRY),
- unused plotting routine (subroutine PLTDAT),
- unused printout options (subroutine PRHOUT),
- unused smoothing routine (subroutines SMOOT, TIMESMO).

Use of modules

The versions of the FTLOADDS code up through version 3.2 used ‘common’ statements predominantly for passing information between subroutines, especially in the SWIFT2D portion. This created relatively bulky code, as the common statements and dimensions are repeated in each subroutine. In addition, the common statements needed to be repeated in all accessed routines or some compiled versions of the code will lose variable values.

The common statements were largely replaced with the FORTRAN Module function in TIME v2.0. Modules contain specifications and definitions that can be used in one or more program units and the module is accessed with a USE statement (Compaq Computer Corporation (1999)). For application in FTLOADDS, three modules were developed, SEAWATDIM, SWIFTDIM, and COUPLING, which contain the variables used in SEAWAT, SWIFT2D, and the FTLOADDS coupling respectively.

LITERATURE CITED

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