The ATLSS High Resolution Topology and High Resolution Hydrology Models

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There are many factors affecting individual growth and reproduction and population dynamics in South Florida (SF). The influence of hydrology upon the fauna and flora is among the more significant factors. Hydrology has a wide range of effects upon these species, including the creation and loss of suitable habitat, modifying the availability of food resources and influencing mating success. The range of effect and number of species influenced by hydrology makes it a critical part of the Across Trophic Level System Simulation (ATLSS) models. An important part of these models is their spatially explicit nature and particularly the fine spatial resolution at which they simulate biological processes. Many of the models simulate processes at a 500x500 meter or a 100x100 meter resolution. The accepted hydrology data for most of SF, the South Florida Water Management Model (SFWMM), provides hydrology at a much coarser 2x2 mile resolution. To bridge the gap between the SFWMM hydrology data and the ATLSS models, the ATLSS High Resolution Topography (HRT) model and High Resolution Hydrology (HRH) model have been created. These models modify SFWMM hydrology to provide spatial variation in water depths at sub-2x2 mile resolutions, in particular they provide spatial variation at both a 500x500 meter and 100x100 meter resolution.

The HRT model is the basic element in the operation of the HRH model. The HRT model generates elevation values at resolutions as fine as 28.5x28.5 meters. It does this by combining habitat type information for each locale across the landscape, hydrology data for the landscape, and expected hyroperiod values for the habitat types. The main assumption is that plant associations are located in places where the elevation provides suitable range of hydroperiods. Currently the habitat type data is provided by the Florida GAP analysis map (FGAP v2.1), the hydrology data is provided by the Calibration/Validation run of the SFWMM and the hydroperiod values are drawn from available literature. The hydrology data is processed into a hydroperiod histogram which provides the number of days the water surface is at or above a certain elevation as a function of elevation. The HRT model can be used to create elevation maps at any resolution from 28.5x28.5 meters to 2x2 miles. These maps are collectively referred to as ATLSS HRT maps.

The ATLSS HRH model is used to create hydrology at resolutions which are appropriate for the various ATLSS models. The HRH model modifies local water depths across the landscape by redistributing the SFWMD water depth values over an ATLSS HRT map. The redistribution process is carried out on a cell by cell basis at the 2x2 mile resolution and preserves the volume of water in each 2x2 mile cell for each day.

The USGS has initiated a High Accuracy Elevation Data (HEAD) collection program aimed at collecting elevation data for SF at a high spatial resolution and with a high degree of vertical accuracy. This data is available for a number of regions, eleven of which are covered by the ATLSS HRT model. The data from the HEAD project has been compared to the ATLSS HRT model output. These comparisons have demonstrated a number of strengths and weaknesses in the ATLSS HRT maps. At a regional scale the ATLSS HRT model generates elevation means and variations which are similar to the USGS HEAD data. At a local scale the current ATLSS HRT model does not accurately predict ground surface elevations.

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Regional Evaluation of Evapotranspiration In The Everglades

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Nine sites in the Florida Everglades were selected and instrumented for collection of data necessary for evapotranspiration (ET) determination using the Bowen-ratio energy-budget method. The sites were selected to represent the sawgrass or cattail marshes, wet prairie, and open-water areas that comprise most of the natural Everglades system. Site characteristics are given in the following table.

Site number	Community	Latitude-Longitude	Comments
1	Cattails	263910 0802432	Never dry
2	Open water	263740 0802612	Never dry
3	Open water	263120 0802013	Never dry
4	Dense sawgrass	261900 0802307	Dry part of most years
5	Medium sawgrass	261541 0804356	Dry part of some years
6	Medium sawgrass	254450 0803007	Never dry
7	Sparse sawgrass	253655 0804211	Never dry
8	Sparse rushes	252112 0803807	Dry part of every year
9	Sparse sawgrass	252135 0804600	Dry part of every year

At each site, measurements necessary for ET calculation and modeling were automatically made and stored on-site at 15- or 30-minute intervals. Data collected included air temperature, humidity, wind speed and direction, incoming solar radiation, net solar radiation, water level and temperature, soil moisture content, soil temperature, soil heat flux, and rainfall. Data are available for 8 of the 9 sites for January 1996 through December 1997, and for one site January-December 1997. Four sites were continued through September 1999 and 2 sites are still being operated in May 2000. Plans are to install additional sites in the summer of 2000 in Shark Valley Slough, to provide ET and meteorological data for development of hydrologic models, and to confirm regional models of ET developed using data from the original network of 9 ET sites.

Modified Priestley-Taylor models of latent heat (ET) as a function of selected independent variables were developed at each of the 9 sites, using data for January 1996 through December 1997. These models were used to fill in periods of missing latent-heat measurement, and to develop a regional model of the entire Everglades region. The individual site models were combined and used to formulate regional models of ET that may be used to estimate ET in wet prairie, sawgrass or cattail marsh, and open-water portions of the natural Everglades system. The models are not applicable to forested areas or to the brackish areas adjacent to Florida Bay.

Two types of regional models were developed. One type of model uses measurements of the energy budget at a site, together with incoming solar energy and water depth, to estimate ET for 30-minute intervals. This energy-based model requires site data for net radiation, water heat storage, and soil heat flux, as well as data for incoming solar radiation and water depth. A second type of model was developed that does not require site energy-budget data and uses only incoming solar energy, air temperature, and water depth data to provide estimates of ET at 30-minute intervals. The second

model thus uses data that are more readily available than the data required for the available-energy model, but does not give as precise an estimate ET as the model using energy-budget measurement.

Precision of the site models and the regional models was evaluated for each site. Precision of the individual site models is only slightly better than the regional model based on energy-budget measurement. The difference in precision of the two types of regional models is most noticeable for 30-minute ET totals. For 30-minute ET totals, the energy-based model has a standard error of about 32 percent and the non-energy-based model has a standard error of about 58 percent. For monthly ET totals, both types of models are much more precise, and have standard errors of about 7 percent for the energy-based model and about 9 percent for the non-energy-based model.

Computed ET mean annual totals for all nine sites for the 1996-97 period range from 42.4 inches per year at Site 9, where the water level is below land surface for several months each year to 57.4 inches per year at Site 2, an open-water with no emergent vegetation. The variation in ET follows a seasonal pattern, with lowest monthly ET totals occurring in December through February, and highest ET occurring in May through August. The monthly total ET among all nine sites for the 2-year period ranged from 1.81 inches in December 1997 to 6.84 inches in July 1996.

Although the density of photosynthetically-active plant leaves has been shown to relate directly to ET in some studies, it does not appear to relate directly to ET in the Everglades, based on comparison of annual ET data with leaf-area index data from satellite imagery (NDVI). In fact, NDVI and ET appear to be inversely related in the Everglades. The greatest ET rates occurred at open-water sites where the NDVI data indicated the lowest leaf-area index. Among the remaining vegetated sites, there is no clear relation between ET and NDVI, though the highest ET rate (Site 2) corresponded to the lowest NDVI and one of the lowest ET rates (Site 1) corresponded to the highest NDVI value.

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