Florida Evapotranspiration Network

D.M. Sumner[1], A. Swancar[2], J.W. Grubbs[3], and W.B. Shoemaker[4]
[1]U.S. Geological Survey, Florida Integrated Science Center, Orlando, Florida
[2]U.S. Geological Survey, Florida Integrated Science Center, Tampa, Florida
[3]U.S. Geological Survey, Florida Integrated Science Center, Tallahassee, Florida
[4]U.S. Geological Survey, Florida Integrated Science Center, Miami, Florida

Evapotranspiration (ET) returns to the atmosphere anywhere from 50 to 100 percent of average, annual rainfall in Florida, depending on location and surface cover. The relative magnitude of ET in Florida suggests the importance of temporal and spatial quantification of this atmospheric water flux for water resources management and analysis. However, ET traditionally has been the most difficult water budget term to quantify and has frequently been estimated through inference, rather than through direct measurement. This shortcoming in hydrologic knowledge limits construction of reliable hydrologic models for use as water management tools.

In response to the need for direct measurements of ET, the United States Geological Survey (USGS) began developing a network of micrometeorological stations for direct measurement of ET in 2000. The 11 stations operating as of March 2005 are located in four of the five State of Florida Water Management Districts (WMDs) and are funded cooperatively between the USGS and the WMDs. The primary objective of the network is to develop a database of long-term ET measurements at daily (at least) resolution in a variety of geographic and environmental settings in Florida. Two micrometeorological methods have been used for ET measurement: eddy correlation and Bowen-ratio energy-budget approaches. A secondary objective is to define the cause-and-effect relation between the environment and ET. Toward this goal, meteorological (air temperature, relative humidity, net radiation, solar insolation, soil/water temperature, and wind speed and direction), vegetative (leaf-area index and speciation), and hydrologic (soil moisture and water-table depth) measurements are made to develop links between the environment and ET.

The available data indicate a wide range in ET rates both temporally and spatially. Most variability in ET can be explained by variations in available energy and moisture status. For example, annual ET from a site on the Lake Wales Ridge with droughty sandy soils, a deep water-table, and shallow-rooted grass was 680 mm, roughly half of the average 1,470 mm of evaporation from a nearby lake. Strong diurnal and seasonal patterns in ET from vegetated sites were the result of corresponding variations in available energy primarily related to varying solar angle and cloud cover. Diurnal variations in open water evaporation were modest because of the buffering effect of changes in stored heat energy in the water body, whereas seasonal variations in evaporation were large (for example, 2- to 3-fold change from winter to late-spring at a lake in central Florida).

Remote sensing methods offer the potential to estimate ET “everywhere” in the State. Towards this goal, the database developed during this study is serving as ground-truthing for an on-going effort managed by the USGS, executed by research personnel at University of New Hampshire, University of Alabama, and Tufts University, and funded by all five WMDs to estimate Statewide potential and reference ET from 1995 through 2004 at 2-kilometer spatial and daily temporal resolution. Statewide estimation of actual ET is scheduled to begin in a follow-up phase of this effort. The approach relies on measurements of incoming solar radiation derived from Geostationary Operational Environmental Satellites (GOES) data, along with ground-based meteorological measurements to provide input for Priestley-Taylor and Penman-Monteith ET equations. The USGS is scheduled to assume complete operation of this effort for 2005 and beyond. The availability of the resulting database will establish a major milepost – potential and reference ET will be based on an approach shared by all of the State of Florida WMDs, allowing for a more unified and coherent approach to simulating, interpreting, and allocating the State’s water resources.