Final Report

REVISION OF AFSIRS CROP WATER USE SIMULATION MODEL AFSIRS TASK 13 CLIMATE DATABASE IMPLEMENTATION

By

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GWRAPPS Climate Database

a. AFSIRS Climate Database Background

The original AFSIRS climate database provides daily evapotranspiration (ET) and rainfall (P) data from eight locations in and near Florida. The locations are Mobile, Tallahassee, Jacksonville, Daytona Beach, Orlando, Tampa, West Palm Beach, and Miami. The record lengths at these locations range from 18-24 years. Task 9a extended the record for these stations and an additional station at Gainesville to include data from 1970 to 1990. The updated AFSIRS climate data were used to generate 30 years of daily climate data at 368 locations covering the state of Florida. These locations are spaced at a 20-km resolution. The database was generated using the GWRAPPS climate interpolation utility. Task 9a employed the spline interpolation technique and, for each location, stored the interpolated data in a separate Microsoft Access database.

Task 9b compared four interpolation methods, Inverse Distance Weighting (IDW), spline, kriging, and trend surface to estimate ET and precipitation at ungaged sites. The results show that the IDW method performed best for ET interpolation. No method gave reasonable results using the 12 station precipitation data. However, the prediction accuracy was significantly improved by using a denser network of 80 stations. IDW performed best for the denser precipitation dataset. The final recommendation was to make efficient use of the available data by using separate datasets to develop the regional ET and precipitation databases. IDW is recommended for both ET and precipitation interpolations.

b. Update AFSIRS Climate Database

The final AFSIRS 1970-1999 climate database includes daily ET data generated from the nine stations used in Task 9a (Table 1) and the 80 daily precipitation stations used in Task 9b (totaling 80 stations) as shown in Figure 1. The locations and station details are provided in the clim_all_pt ArcGIS point feature class and provided in Appendix A. The updated reference ET database was generated using the FAO Penman-Monteith method (Allen et al., 1998). A complete overview of the steps used to develop the updated climate database is provided in this paper.

Table 1. NOAA weather stations included in the updated AFSIRS climate database

Location	Latitude	Longitude	Elevation Above Mean Sea Level (m)
Daytona Beach, FL	29° 11′	W 83° 03′	2.0
Gainesville, FL	29° 38′	W 82° 22′	29.3
Jacksonville, FL	30° 30′	W 81° 42′	9.0
Key West, FL	24° 33′	W 81° 45′	1.0
Miami, FL	25° 48′	W 80° 16′	2.0
Mobile, AL	30° 41′	W 88° 15′	7.0
Tallahassee, FL	30° 23′	W 84° 22′	11.0
Tampa, FL	27° 58′	W 82° 32′	3.0
West Palm Beach, FL	26° 41′	W 80° 06′	6.0

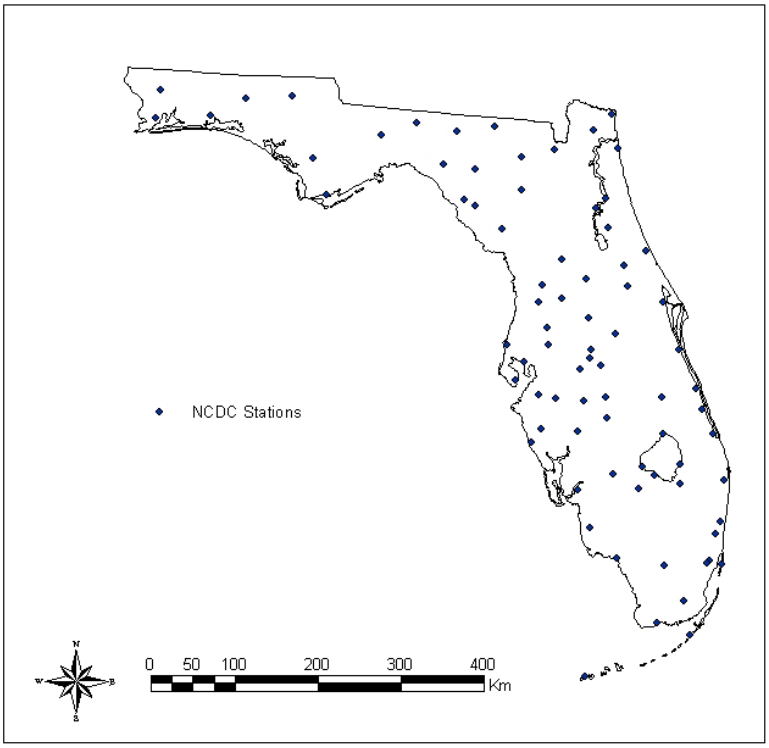

Figure 1. Precipitation network used in the interpolation study

Data Compilation

The FAO method requires daily measurements of incoming solar radiation, wind speed, minimum and maximum temperature, and relative humidity. These data are compiled from NOAA weather stations at the nine locations. A quality assurance procedure was applied to measured data. A threshold analysis was applied to limit the maximum relative humidity to 100%. The solar radiation accuracy was evaluated by comparing the daily average measured values against computed maximum solar radiation values that can reach the Earth under clear sky conditions. Temperature, solar radiation, or wind speed were assessed using graphical tools. The erroneous or missing values on a given day were replaced with average recorded values using the remaining years' observations on that day. Table 2 shows the variables used to estimate ET and their units of measure.

Table 2. Measured and calculated climate variables and their units

Climate Variable	Units
Incoming solar radiation	MJ m^2
Minimum temperature	°C
Maximum temperature	°C
Relative humidity	%
Height of relative humidity measurement	m
Wind speed	m s^{-1}
Height of wind speed measurement	m
Rainfall	mm
Evapotranspiration	mm day^{-1}

NOAA weather stations discontinued measuring incoming solar radiation from 1990 to present. As this variable is critical in estimating ET, a solar radiation product was used for the period 1990 to 1999. The solar radiation data were obtained from the long-term hydrologic dataset developed for the Variable Infiltration Capacity model (Maurer et al., 2002) (http://www.ce.washington.edu/pub/HYDRO/edm/VIC_retrospective/index.html). No statistically significant difference was found between the ET estimated using the solar radiation product and measured solar radiation for a 2-year period. The compiled data for the nine locations are provided on the CD in the **NOAA_Climate_Data** folder as a deliverable under Task 9.

ET Estimation

A FORTRAN program was used to calculate reference ET based on the climate dataset. The source code and sample input and output files are provided on the CD in the

ET_Estimation folder. Except for an additional column with ET data, the data format in the output file is identical to that of the input file. The ET units are mm day^{-1}.

Precipitation

The 12 National Climatic Data Center (NCDC) stations are not sufficient to represent the spatial distribution of precipitation over the entire state. In Florida, precipitation exhibits a particularly highly variable spatial distribution due to the local convective systems. A denser precipitation network was developed to provide meaningful spatial interpolation. The network of 80 NCDC stations having a long-term (1960-current) precipitation record was compiled as part of Task 9b (Figure 1). A quality assurance procedure was applied to identify outliers in rainfall data.

Climate Database

For each of the 80 locations, the estimated ET and rainfall data are stored in a Microsoft Access database (climateDB.mdb). Each location has a separate table in climateDB.mdb. The table name for each station is maintained in the clim_all_pt ArcGIS point feature class and a complete list of station name, county, database name, and location are provided in Appendix A. ET and rainfall units are inches. For those locations having not ET values, the ET values were set to –9999. Missing values of precipitation were set to -99999. This Access database is provided both with the GWRAPPS software and on the CD in the **Updated_AFSIRS_Climate** folder. Figure 2 shows a snapshot of a sample climate table.

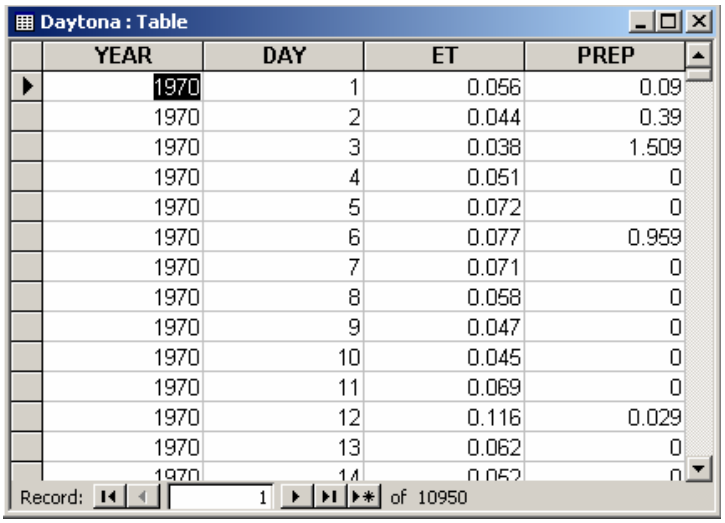

Figure 2. Access climate data table for Daytona Beach, Florida

c. Generate GWRAPPS Climate Database

The updated AFSIRS climate data were used to generate 30 years of daily climate data at 368 locations covering the state of Florida. These locations are spaced at a 20-km resolution. The database was generated using the GWRAPPS climate interpolation utility. This utility employs the inverse distance weighting technique and, for each location, stores the interpolated data in a separate Microsoft Access database. These databases are provided in the **GWRAPPS_Climate_Data** folder on the CD. The *Climate* ArcGIS shape feature class contains the location and database name corresponding to each location (provided in the **GIS_Data** folder on the CD).

References

Allen, R.G., L.S. Periera, D. Raes, and M. Smith. 1998. Crop evapotranspiration: Guidelines for computing crop requirements. *Irrigation and Drainage Paper No. 56*, FAO, Rome, Italy, 300 pp.

Maurer, E.P., A.W. Wood, J.C. Adam, D.P. Lettenmaier, and B. Nijssen. 2002. A long-term hydrologically-based data set of land surface fluxes and states for the conterminous United States. *J. Climate*, 15, 3237-3251.

Appendix A – Climate Stations

Location	County	DB Table	Latitude	Longitude
Gainesville	Alachua	Gainesville	29.674	-82.336
Jacksonville	Duval	Jacksonville	30.335	-81.658
Tallahassee	Leon	Tallahassee	30.457	-84.281
Daytona Beach	Volusia	Daytona	29.192	-81.053
Tampa	Hillsborough	Tampa	27.959	-82.482
West Palm Beach	Palm Beach	Westpalm	26.748	-80.126
Miami	Dade	Miami	25.776	-80.211
Key West	Monroe	Keywest	24.563	-81.775
Mobile	Mobile	Mobile	30.683	-88.250
Pensacola	Escambia	Pensacola	30.483	-87.183
Orlando	Orange	Orlando	28.433	-81.333
Ft. Myers	Lee	Ftmyers	26.583	-81.862
Key West Intl Ap	Monroe	4570	24.552	-81.758
Okeechobee	Okeechobee	6485	27.197	-80.832
Venice	Sarasota	9176	27.101	-82.436
Clewiston	Hendry	1654	26.742	-80.940
Hillsborough Rvr St Pk	Hillsborough	3986	28.150	-82.233
Mayo	Lafayette	5539	30.050	-83.167
Myakka River St Pk	Sarasota	6065	27.242	-82.316
Royal Palm Ranger Stn	Dade	7760	25.387	-80.594
Chipley 3 E	Washington	1544	30.783	-85.483
Clermont 7 S	Lake	1641	28.450	-81.748
Clewiston	Hendry	1654	26.742	-80.940
Cross City 2 Wnw	Dixie	2008	29.650	-83.167
Daytona Beach Intl Ap	Volusia	2158	29.183	-81.048
Fernandina Beach	Nassau	2944	30.659	-81.464
Fort Lauderdale	Broward	3163	26.102	-80.201
Hialeah	Dade	3909	25.817	-80.286
High Springs	Alachua	3956	29.829	-82.597
Inverness 3 Se	Citrus	4289	28.803	-82.313
Jacksonville Intl Ap	Duval	4358	30.495	-81.694
Jacksonville Beach	Duval	4366	30.290	-81.392
La Belle	Hendry	4662	26.752	-81.439
Melbourne Wfo	Brevard	5612	28.103	-80.646
Miami Beach	Dade	5658	25.780	-80.130
Miami Intl Ap	Dade	5663	25.791	-80.316
Milton Experiment Stn	Santa Rosa	5793	30.779	-87.141
Monticello 3 W	Jefferson	5879	30.533	-83.917
Mountain Lake	Polk	5973	27.935	-81.593
Naples	Collier	6078	26.169	-81.716
Niceville	Okaloosa	6240	30.531	-86.492
Ocala	Marion	6414	29.080	-82.078
Pensacola Regional Ap	Escambia	6997	30.478	-87.187

Location	County	DB Table	Latitude	Longitude
Pompano Beach	Broward	7254	26.233	-80.141
St Petersburg	Pinellas	7886	27.763	-82.627
Stuart 1 S	Martin	8620	27.189	-80.226
Tallahassee Wso Ap	Leon	8758	30.393	-84.353
Tamiami Trail 40 Mi Ben	Dade	8780	25.761	-80.824
Tarpon Springs Swg Plnt	Pinellas	8824	28.150	-82.750
Tavernier	Monroe	8841	25.007	-80.521
Wauchula	Hardee	9401	27.550	-81.800
West Palm Beach Int Ap	Palm Beach	9525	26.685	-80.099
Winter Haven	Polk	9707	28.015	-81.733
Bushnell 2 E	Sumter	1163	28.662	-82.083
Fort Myers Faa/Ap	Lee	3186	26.586	-81.864
Crescent City	Putnam	1978	29.428	-81.508
Tampa Wscmo Ap	Hillsborough	8788	27.961	-82.540
Apalachicola Ap Fbo	Franklin	211	29.726	-85.021
Arcadia	Desoto	228	27.218	-81.874
Avon Park 2 W	Highlands	369	27.594	-81.525
Bartow	Polk	478	27.899	-81.843
Brooksville Chin Hill	Hernando	1046	28.616	-82.366
De Funiak Springs	Walton	2220	30.733	-86.067
Deland 1 Sse	Volusia	2229	29.018	-81.311
Everglades	Collier	2850	25.846	-81.387
Federal Point	Putnam	2915	29.755	-81.539
Fort Pierce	St. Lucie	3207	27.462	-80.354
Glen St Mary 1 W	Baker	3470	30.272	-82.186
Lake City 2 E	Columbia	4731	30.184	-82.593
Madison	Madison	5275	30.450	-83.417
Saint Leo	Pasco	7851	28.338	-82.260
Titusville	Brevard	8942	28.630	-80.833
Moore Haven Lock 1	Glades	5895	26.840	-81.087
Belle Glade Exp Stn	Palm Beach	611	26.657	-80.630
Lake Alfred Exp Stn	Polk	4707	28.104	-81.714
Vero Beach 4 W	Indian River	9219	27.686	-80.435
Flamingo Ranger Stn	Monroe	3020	25.142	-80.914
Palatka	Putnam	6753	29.644	-81.661
Lisbon	Lake	5076	28.873	-81.786
Steinhatchee 6 Ene	Dixie	8565	29.717	-83.300
Devils Garden	Hendry	2298	26.603	-81.129
Sanford	Seminole	7982	28.802	-81.269
Usher Tower	Levy	9120	29.408	-82.819
Wewahitchka	Gulf	9566	30.117	-85.200
Desoto City 8 Sw	Highlands	2288	27.370	-81.514
Fort Green 12 Wsw	Manatee	3153	27.571	-82.138
Kissimmee 2	Osceola	4625	28.280	-81.418
Perry	Taylor	7025	30.100	-83.567
Canal Point Usda	Palm Beach	1276	26.864	-80.626

Location	County	DB Table	Latitude	Longitude
Parrish	Manatee	6880	27.609	-82.348
Fort Drum 5 Nw	Okeechobee	3137	27.588	-80.843
Jasper	Hamilton	4394	30.523	-82.945