Evaluating Forecast Reference Evapotranspiration For Florida

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Abstract.
The National Weather Service has released a product that estimates forecast reference evapotranspiration (FRET) at a 2.5 km resolution. The objective of this study was to compare FRET data to calculated Florida reference evapotranspiration (ETo) data and evaluate their differences. Daily ETo values were calculated with data from 42 UF/IFAS Florida Automated Weather Network (FAWN) locations using two methods, FAO56 and ASCE-EWRI. These values were then compared to FRET data for one week during September 2017. Results from this limited data analysis showed FRET data were similar to measured data, with differences between values decreasing as the number of days between forecasted and calculated values decreased. In addition, FRET data were similar to both calculated data sets with ASCE-EWRI values being more similar than FAO56 values. Similarity between FRET predictions and calculated data suggests that FRET data could be used to help water managers anticipate future water demand and improve irrigation management. Additional work is needed with a larger data set to confirm these results over time and space in Florida.

Keywords. Reference evapotranspiration, web-based tools, forecast, FRET (forecasted reference evapotranspiration)

Introduction

Irrigation decisions can be made using a variety of information. Example information used in irrigation scheduling decisions includes near real-time data collected at the irrigation site, historical trends, and/or weather forecasts. With the advancement in data acquisition methods, the Internet, and the proliferation of handheld Internet-enabled devices; greater opportunities exist to connect data to irrigation decision makers in a useful way.

The National Weather Service (NWS) has developed datasets of several forecasted weather parameters that can be used in irrigation decision making. For example, a gridded product that provides forecasted reference evapotranspiration (FRET) was released in 2014 on an experimental basis. This product provides daily 7-day FRET forecasts on a 2.5-km resolution. The values are calculated using the

Penman-Monteith Reference Evapotranspiration Equations from ACSE-EWRI for a short canopy (12 cm grass; ASCE-EWRI, 2004) and NWS gridded forecasts of temperature, relative humidity, wind, and cloud or sky cover. Solar radiation is derived using day length, sun angle and eccentricity and is based on the method established by Doorenbos and Pruitt (1977). The methodology used by the NWS to create FRET originated with Richard Snyder form University of California – Davis.

Evapotranspiration (ET) is one method that can be used to estimate the water consumptive use of a system. Irrigation schedules based on ET methods have been shown to provide greater water use efficiency than scheduling methods that do not use real-time data (Singh et al., 2009; Kisekka et al., 2010; Migliaccio et al., 2010). Thus, using real-time ET with FRET has the potential to further improve irrigation scheduling and water use efficiency.

Little has been published in literature regarding the accuracy of FRET and its potential to be used in irrigation decision making. Our objective was to compare measured reference ET (ETo) to predicted ETo at the 42 weather stations operated by the UF/IFAS (FAWN). Results of this comparison will help guide potential integration of FRET data into irrigation scheduling decision-making tools.

Methods

Reference ET (ETo) can be calculated using different methods. The two methods used in this study were the FAO56 Penman Monteith ETo (Allen et al., 1998) and the ASCE-EWRI method (ASCE-EWRI, 2004). Daily temperature, relative humidity, solar radiation, and wind speed from the 42 FAWN stations were used with both FAO56 and ASCE-EWRI methods to generate daily ETo values. The R package "Evapotranspiration" was used to calculate daily ETo for these two methods. R is publicly available and has wide application for data analysis, model simulation, and statistical comparisons. A relatively short data set, which covered the one-week period from September 20 through September 26, 2017, was used for this analysis.

During the one-week time-period, FRET data were collected daily via the public open API at preview.weather.gov using a corresponding list of FAWN station latitudes and longitudes. Grid cells corresponding to the FAWN station locations were then identified and used for comparison purposes. An R script was scheduled using Crontab to run automatically daily to update information from the dev endpoint XML (eXtensible Markup Language). Each day, FRET data for the following 6 days were used in the analysis. Data were evaluated visually using box plot comparisons.

Results and Discussion

ETo was calculated daily at the 42 FAWN station locations using the FAO56 and ASCE-EWRI methods from September 20 to September 26, 2017, and then compared to FRET data for the same locations (Figure 1). Average values for FAO56, ASCE-EWRI, and FRET calculations for all sites were 3.9, 4.7, and 4.0 mm over the time-period. FRET data showed less variability compared to the calculated FAO PM and ASCE-EWRI values using FAWN data as input. Interestingly, FRET uses the ASCE-EWRI method, but values were closer to those estimated using the FAO PM method. Overall, values calculated using the FAO PM method were lower than those calculated using the ASCE EWRI method.

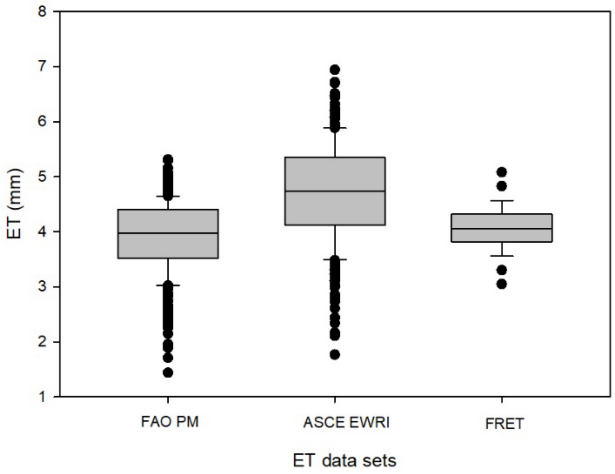

Figure 1. Box plots showing the distribution of ETo data for the three datasets.

FRET data were also evaluated at all FAWN station locations using the daily forecast starting six days prior, with the day 0 being September 26. Day -1 was the value forecasted on September 25th to occur September 26th (Figure 2). The ASCE-EWRI method was compared to the prediction to identify if predictions improved closer to event occurrence. Average absolute difference between FRET and the ASCE EWRI method decreased closer to the actual event occurrence. For example, average absolute difference six days in advance between the two ETo values was 0.67 mm, and then decreased to 0.52 mm one day in advance. Differences were less than 1 mm for 85% of the data for the 6 days prior to day 0 considering all weather stations.

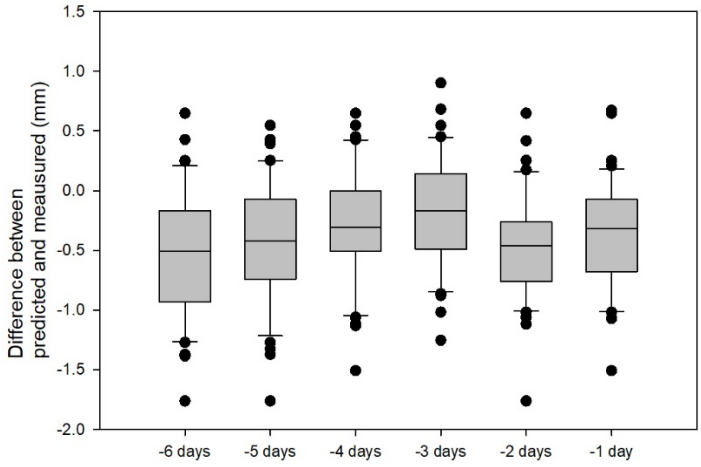

Figure 2. Box plots of differences between forecast FRET data and measured reference ETo for FAWN stations considering September 26, 2017 data.

Results suggest that the FRET data product could be used to predict ETo in Florida. However, additional evaluation is needed for a longer time series. Some quality control of the data may also be needed, as FRET data are considered experimental at this point. FRET provides a forecast data source for ETo that would be viable for FAWN and other irrigation decision making tools.

Conclusions

FRET data were obtained and compared to ETo calculations for 42 locations in Florida. Results showed that predictions were similar to measured data. Thus, FRET may provide additional information that can be used in water management tools in Florida. Further evaluation of a longer time series is needed to validate findings.

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