Generation of Daily Weather Data Conditioned on ENSO Phase

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ABSTRACT

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The purpose of this research is to evaluate and compare methods for generating daily weather data for use by SECC researchers. We have begun by testing a weather generator recently described by SECC researchers Schoof, Arguez, Brolley & O'Brien (2005). In particular, this work examines a version of that generator that was developed specifically to work with weather data in the format used by DSSAT crop models. The weather generator was parameterized with observed weather data previously processed to include daily solar radiation data and to eliminate gaps. To obtain ENSO-conditioned parameters for the weather generator, the daily observed data from 11 S.E. USA weather stations were classified according to ENSO phase using a modified JMA index. Parameters, and then 100 years of data were generated for each the Niño, Niña, and Neutral phases plus climatology for each site. Since this work has only recently begun, the results are preliminary, but encouraging. The weather generator's parameterization apparently functions normally using the ENSO-classified observed data. Throughout the first level of assessment, the generated data shows no glaring defects. However, much remains to be done to evaluate thoroughly the quality and suitability of the generated data for the purposes of the SECC.

OBJECTIVE

The objective of this research to evaluate alternative weather generators using criteria and tests that will answer questions relevant to SECC researchers who are considering using generated data. This particular effort is just beginning, and therefore a principal objective of this poster presentation is to elicit suggestions from you, the potential consumers of generated weather data. What characteristics of the generated weather would you find most useful to evaluate?

METHODS & MATERIALS

Observed Weather Data

The daily solar radiation, maximum temperature, minimum temperature and rainfall data used to parameterize the weather generator were obtained from the SECC FTP website (secc.coaps.fsu.edu /pub/dssat Weather_Files). As the directory name implies, these data have been formatted and gaps filled to enable their direct use with the DSSAT crop simulation models. Since solar radiation data are frequently absent from observed weather series, those missing data were estimated using a solar radiation generator developed by Garcia y Garcia and Hoogenboom (2005). Since it is expected that one use of generated weather data will be with DSSAT crop models, we decided to use processed, "DSSAT ready" data to parameterize the weather generator. For this first round of tests, three stations in each of the current SECC states, plus two extra in Florida were selected (Table 1). The extra southern Florida stations were included specifically to help test how well the weather generator captures the ENSO signal previously found in that area.

Table 1: Weather stations selected to parameterize the weather generator.

State	County	DSSAT ID	Coop ID	Years
AL	Escambia	AL09	011084	1926-2004
AL	Hale	AL23	013511	1900-2004
AL	Colbert	AL39	015749	1940-2004
FL	Palm Beach	FL06	080611	1924-2004
FL	Walton	FL19	082220	1900-2004
FL	Marion	FL61	086414	1900-2004
FL	Hillsborough	FL68	087205	1900-2004
FL	Dade	FL78	088780	1940-2004
GA	Lee	GA01	090140	1900-2004
GA	Tattnall	GA35	093754	1904-2004
GA	Colquitt	GA48	096087	1911-2004

Note: Only the highlighted sites were examined in time for this presentation.

ENSO Classification

By parameterizing the weather generator using weather station data that correspond to a single ENSO phase, the generated weather may acquire characteristics of weather occurring during that ENSO phase, at that location. In order to detect a clearer ENSO "signal", meteorologists continue to test new methods of classifying weather data according to ENSO phase. One such new method has recently been developed by SECC collaborating scientist David Zierden. His method is based on the venerable Japan Meteorological Agency (JMA) system, and is referred to as the "modified JMA index". This modified JMA index breaks with the conventional Oct – Sep ENSO year, and provides a monthly ENSO classification. One possible complication from this new classification is that, during a selected time period, each month is not necessarily equally represented in a given ENSO phase (Fig 1). To sort the weather data by ENSO phase, the daily data were entered into a database that included a field for the modified JMA monthly ENSO index. Weather data occurring during each phase was used independently to parameterize the generator. But how would the spectral weather generator's parameterization process respond to a fragmented weather data series?

Figure 1: A portion of the modified JMA index used to parameterize the generator.
(**C**-cold-Niña; **W**-warm-Niño; **N**-neutral)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1950	C	C	C	C	C	C	C	N	N	N	N	N
1951	N	N	N	N	W	W	W	W	W	W	W	W
1952	W	W	N	N	N	N	N	N	N	N	N	N
1953	N	N	N	N	N	N	N	N	N	N	N	N
1954	N	N	C	C	C	C	C	C	C	C	C	C
1955	C	C	C	C	C	C	C	C	C	C	C	C
1956	C	C	C	N	C	C	C	C	C	C	C	C
1957	N	N	N	W	W	W	W	W	W	W	W	W
1958	W	W	W	W	N	N	N	N	N	N	N	N
1959	N	N	N	N	N	N	N	N	N	N	N	N
1960	N	N	N	N	N	N	N	N	N	N	N	N
1961	N	N	N	N	N	N	N	N	N	N	N	N
1962	N	N	N	N	N	N	N	N	N	N	N	N
1963	N	N	N	N	N	W	W	W	W	W	W	W
1964	W	N	N	C	C	C	C	C	C	C	C	C
1965	C	N	N	N	W	W	W	W	W	W	W	W
1966	W	W	N	N	N	N	N	N	N	N	N	N
1967	N	N	N	N	N	N	N	N	C	C	C	C
1968	C	C	C	C	N	N	N	N	N	N	W	W
1969	W	W	W	W	W	W	W	W	W	W	W	W
1970	W	W	N	N	C	C	C	C	C	C	C	C
1971	C	C	C	C	C	C	C	C	C	C	C	C
1972	C	N	N	N	W	W	W	W	W	W	W	W
1973	W	W	W	N	C	C	C	C	C	C	C	C
1974	C	C	C	N	N	N	N	N	N	C	C	C
1975	C	C	C	C	C	C	C	C	C	C	C	C
1976	C	C	C	N	N	W	W	W	W	W	W	W
1977	W	W	N	N	N	N	N	N	N	N	N	N
1978	N	N	N	N	N	N	N	N	N	N	N	N
1979	N	N	N	N	N	N	N	N	N	N	N	N
1980	N	N	N	N	N	N	N	N	N	N	N	N
1981	N	N	N	N	N	N	N	N	N	N	N	N
1982	N	N	N	W	W	W	W	W	W	W	W	W
1983	W	W	W	W	W	W	W	W	N	N	N	N
1984	N	N	N	N	N	N	N	N	N	N	C	C
1985	C	C	C	C	C	C	C	C	N	N	N	N
1986	N	N	N	N	N	N	N	N	W	W	W	W
1987	W	W	W	W	W	W	W	W	W	W	W	W
1988	W	N	N	C	C	C	C	C	C	C	C	C
1989	C	C	C	C	N	N	N	N	N	N	N	N
1990	N	N	N	N	N	N	N	N	N	N	N	N
1991	N	N	N	W	W	W	W	W	W	W	W	W
1992	W	W	W	W	W	W	W	N	N	N	N	N
1993	N	N	N	N	N	N	N	N	N	N	N	N
1994	N	N	N	N	N	N	N	N	N	N	N	N
1995	N	N	N	N	N	N	N	N	N	N	N	N
1996	N	N	N	N	N	N	N	N	N	N	N	N
1997	N	N	N	W	W	W	W	W	W	W	W	W
1998	W	W	W	W	W	W	N	N	N	C	C	C
1999	C	C	C	N	N	N	C	C	C	C	C	C
2000	C	C	C	N	N	N	N	N	N	N	N	N
2001	N	N	N	N	N	N	N	N	N	N	N	N
2002	N	N	N	W	W	W	W	W	W	W	W	W
2003	W	W	N	N	N	N	N	N	N	N	N	N
2004	N	N	N	N	N	N	N	N	N	N	N	N

Weather Generator

The weather generator was developed and well described by Schoof, Arguez, Brolley & O'Brien (2005). The authors refer to it as the "spectral weather generator". The specific version utilized here is a modification which both accepts inputs and generates outputs formatted for DSSAT crop-model use. Key aspects of the weather generator's performance were evaluated in the 2005 paper mentioned above, but that paper was not based on the DSSAT-specific version, nor did it use the particular ENSO classification we wanted to test. We decided to generate 100 years of daily data (solar radiation, maximum temperature, minimum temperature and rainfall) for each ENSO phase, plus 100 years for the full series (climatology), for each of the 11 sites. At the suggestion of the spectral weather generator's lead developer, Justin Schoof, the user-defined parameter, "iterations", was set at 1000 for all runs.

RESULTS

The spectral weather generator, DSSAT version, was found to be capable of processing up to 100 years of observed data for parameterization. For parameterizations based on ENSO phases this is more than sufficient capacity, although when generating parameters for complete weather series longer than 100 years, some years must unfortunately be dropped to stay within that limit. There are currently some minor incompatibilities between DSSAT weather file formats, and the spectral weather generator. These are not difficult to work around, and along with another bug which results in the very occasional output of TMIN>TMAX, are all being addressed by Justin Schoof.

First indications are that as expected, the generator reproduces mean monthly rainfall, and captures that aspect of an ENSO signal at Palm Beach Co. (Figs 2 & 3).

Figure 2: Palm Beach Co., Fla. Observed Mean Monthly Rainfall by ENSO Phase

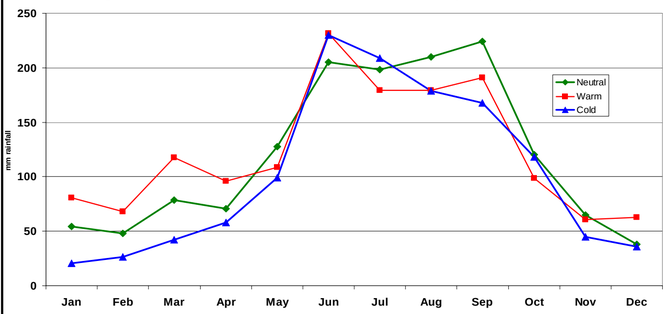
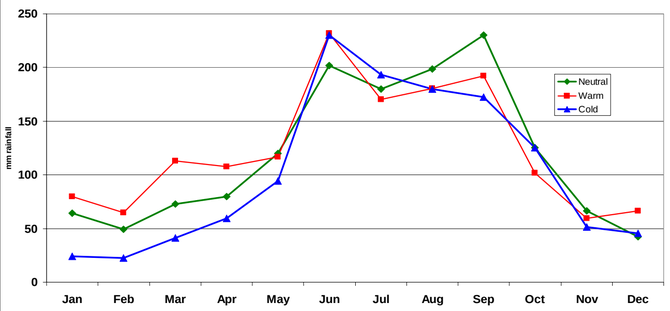
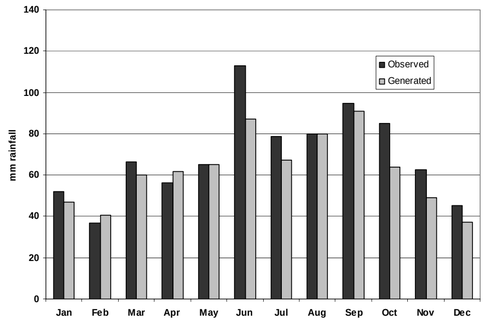


Figure 3: Palm Beach Co., Fla. Generated Mean Monthly Rainfall by ENSO Phase



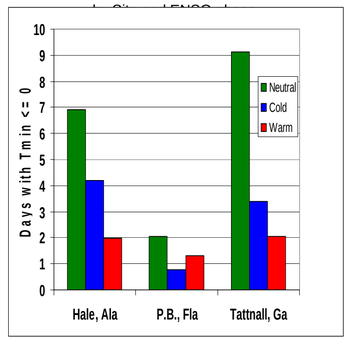
Comparing monthly standard deviations for Palm Beach Co., the generator is underestimating the year-to-year variability of each month's rainfall totals (Fig 4).

Figure 4: Standard Deviation for each month across complete observed and generated weather series at Palm Beach County, Fla



For all three locations, the generated weather underestimates the average number of days per year with minimum temps at or below freezing (Fig 5). This is particularly noticeable during the neutral phase; a result for which I have no explanation yet. Although the absolute error is smallest for Palm Beach County, it may be most important there, since crops grown in southern Florida can be very sensitive to these occasional freezes. Thus, the lower frequency of freezes in the generated data (0.56 vs. 1.94 per year) for that area could make those data unreliable for use in crop simulations.

Figure 5: Difference in Average Number of Freeze Days (Observed-Generated)



CONCLUSIONS

Too soon for conclusions, but stay tuned and please send us your suggestions:

- What characteristics of the weather series would you like to see examined (multi-month seasons, drought periods, ENSO phase correlations)?
- Any weather sites of special interest?
- Is there a particular weather generator that we should include in comparisons?

For comments or additional information please contact:

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Particular thanks to **Guillermo Baigorria, Justin Schoof, Gerrit Hoogenboom, Oxana Uryasev and David Zierden** *for their suggestions and support on this work.*

References:

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