

What Is the ENSO Climatology Tool?¹

Caroline Staub, Clyde Fraise, Eduardo Gelcer, and Daniel Dourte²

Introduction

Increasing climate extremes, including multiyear droughts, intense precipitation, prolonged dry spells, and heat waves, are rapidly emerging as one of the more serious problems affecting the agricultural industry around the world. In 2012, extremes in nighttime temperature resulted in \$220 million in damage to the cherry industry in Michigan (Hatfield et al. 2015). That same year, the combination of drought and heat stress reduced corn production in the US Midwest by 13% compared to the previous year (NASS 2013). Projected increases in the risk of extreme events suggest that producers will face even greater uncertainties in upcoming decades.

Many factors play a role in the variability of weather conditions across space and over time. Mountain–valley winds and seasonal changes in prevailing winds are associated with rainfall over regions ranging from a few miles to approximately 60 miles (Ahrens 2007). High- and low-pressure areas and associated weather fronts influence the spatial distribution of rainfall over larger regions (60–600 square miles) (Nicholson 1996). On a global scale, periodic anomalies in sea surface temperatures coupled with shifts in atmospheric pressure and winds, such as those associated with the El Niño Southern Oscillation (ENSO), can have severe impacts on weather conditions. ENSO affects atmospheric circulation patterns well into the midlatitudes and is the leading driver of seasonal climate variability in the United States. Tremendous advances have been made in predicting the occurrence of ENSO events with confidence

three to six months in advance. An advance warning of seasonal climate anomalies is pertinent to farmers and farming decisions including crop and variety selection, plant population, acreage allocation, and purchase of inputs and crop insurance (Fraise et al. 2015).

Seasonal rainfall and temperature forecasts and outlooks, while useful to farmers, often fail to result in changes in behavior (Dilling and Lemos 2011). One reason for this is that forecasts often fail to represent the nature of the relationship between ENSO events and weather conditions at a scale that is pertinent to farming operations. Another reason is the lack of clarity in communicating the probability of observing ENSO-related variations in rainfall and/or temperature in a particular area. This is particularly important because no ENSO event is the same in magnitude, and the rainfall and temperature response to ENSO varies across geographic regions as well as over time. These concerns limit the user's willingness and ability to make or change a decision based on the information provided in a forecast. The ENSO climatology tool, available free of charge on the AgroClimate website (<http://agroclimate.org/tools/Climate-Anomalies/>) (Fraise et al. 2006), was designed as an educational tool to be used to facilitate the assessment of risk ENSO forecasts.

1. This document is AE522, one of a series of the Department of Agricultural and Biological Engineering, UF/IFAS Extension. Original publication date March 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Caroline Staub, postdoctoral research associate; Clyde Fraise, associate professor; Eduardo Gelcer, PhD candidate, Department of Agricultural and Biological Engineering; UF/IFAS Extension, Gainesville, FL 32611; and Daniel Dourte, agricultural engineer, The Balmoral Group.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

How does the ENSO climatology tool work?

This tool allows the user to explore historical average monthly rainfall totals, minimum temperature, and maximum temperature associated with ENSO events relative to a long-term average. It also includes the frequency at which these have been observed since 1950.

First, the user selects the weather variable of interest: rainfall (monthly total) or temperature (monthly mean minimum or maximum), the ENSO phase of interest (El Niño, La Niña, or ENSO-neutral, which can be displayed simultaneously and relative to all years for comparison purposes), and a month during which weather-sensitive decisions are usually made. The resulting maps (Figure 1) represent the average rainfall total for March during all years as well as all years classified as either El Niño, La Niña or ENSO-neutral for the period 1950–2013. These phases are categorized using the multivariate ENSO index (MEI), an index based on multiple aspects of the ocean atmospheric system including sea level pressure, winds, sea surface temperature, and surface air temperature (Wolter and Timlin 2011; Wolter and Timlin 1993).

The user can also access rainfall and temperature anomaly maps by selecting the “Deviation from Average” tab. These maps represent the departure (or deviation) of rainfall or temperature from long-term average (1950–2013) conditions in the month of interest (Figure 2, left). The frequency or number of years that the departure was observed out of all El Niño, La Niña or ENSO-neutral years since 1950 is also provided (Figure 2, right). In areas shaded in blue on the frequency map, 70–100% of years were wetter than normal, while in areas shaded in red, 70–100% of years were drier than normal.

Finally, the user can visualize and compare variations in the average rainfall total, maximum or minimum temperature across months, and ENSO phases on a county-by-county basis across the conterminous US by selecting the “Interactive Map, Average” tab and moving the cursor over the map to select the county of interest (Figure 3).

Equipped with this tool, growers can find out whether to expect a wetter, drier, cooler, or warmer season than usual in their area or in other production regions that influence market conditions during a particular ENSO phase. This information may act as a trigger to make or change particular management decisions related to crop or variety selection, plant population, acreage allocation, and purchase of inputs and crop insurance (Table 1).

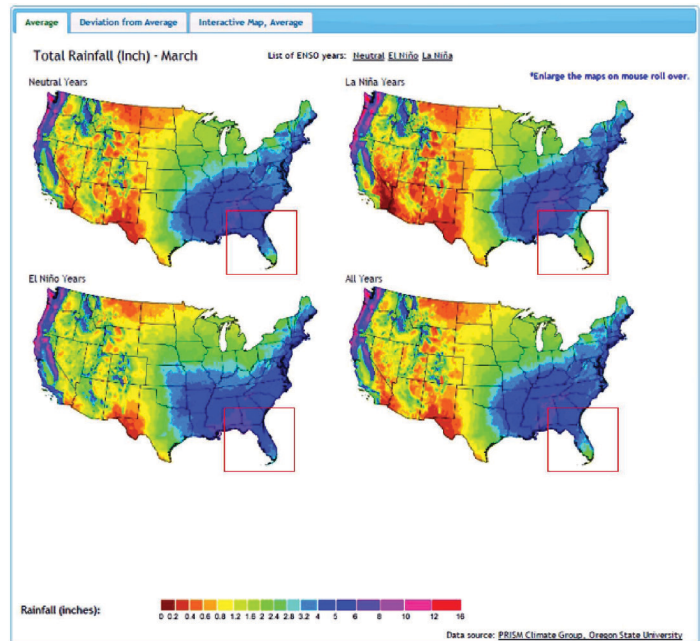


Figure 1. Average rainfall total for March during all years and all years classified as either El Niño, La Niña or ENSO-neutral during the period 1950–2013. A red box is included to highlight the ENSO/rainfall relationship in the Southeast. The maps can be enlarged when rolled over to provide focused viewing. Credits: Southeast Climate Consortium

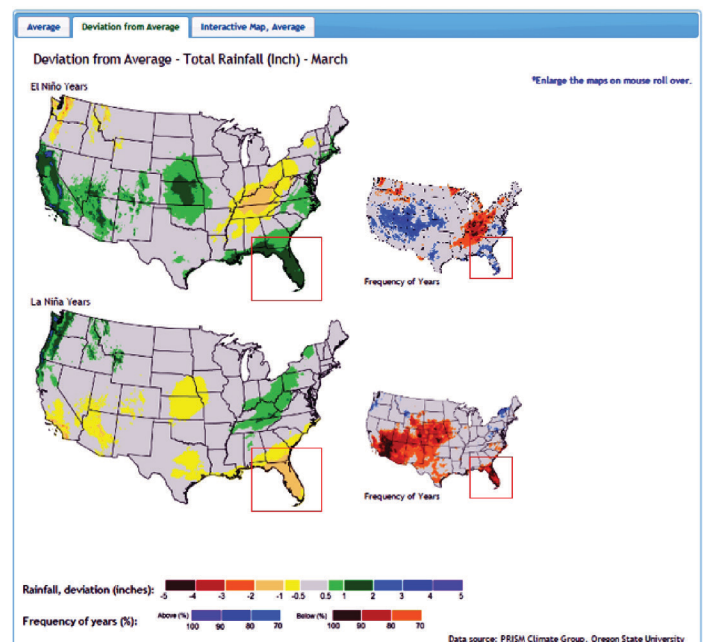


Figure 2. Deviation from average rainfall total for March during all years classified as either El Niño or La Niña for the period 1950–2013 (left) and frequency of years during which the departure was observed out of all El Niño and La Niña years since 1950 (right). A red box is included to highlight the ENSO/rainfall relationship in the Southeast.

Credits: Southeast Climate Consortium

What are the challenges?

When used in conjunction with a seasonal ENSO forecast, the ENSO climatology tool can inform users of the potential impacts of ENSO on rainfall and temperature

in their area. However, growers do not always have the ability to respond to ENSO-related information. The timing of forecast release is critical in determining whether or not it is usable. In some cases, the absence of additional

work with them to further incorporate weather and climate information into their management actions.

References

Ahrens, C. D. 2007. *Meteorology Today: An Introduction to Weather, Climate, and the Environment*. 8th ed. Independence, CA: Cengage Learning.

Broad, K., A. S. Pfaff, and M. H. Glantz. 2002. "Effective and equitable dissemination of seasonal-to-interannual climate forecasts: Policy implications from the Peruvian fishery during El Niño 1997–98." *Climatic Change* 54(4): 415–438.

Carbone, G. J., and K. Dow. 2005. "Water resources management and drought forecasts in South Carolina." *Wiley Online Library*. Accessed on March 10, 2017. <http://onlinelibrary.wiley.com/doi/10.1111/j.1752-1688.2005.tb03724.x/full>

Dilling, L., and M. C. Lemos. 2011. "Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy." *Global Environmental Change* 21(2): 680–689.

Fraisse, C. W., J. H. Andreis, T. Borba, T. Cerbaro, E. Gelcer, W. Pavan, D. Pequeno, et al. 2015. "AgroClimate: Tools for managing climate risk in agriculture." *Agrometeoros* 24(1): 121–129.

Fraisse, C. W., N. E. Breuer, D. Zierden, J. G. Bellow, J. Paz, V. E. Cabrera, A. Garcia y Garcia, et al. 2006. "AgClimate: A climate forecast information system for agricultural risk management in the southeastern USA." *Computers and Electronics in Agriculture* 53(1): 13–27. <https://doi.org/10.1016/j.compag.2006.03.002>

Hatfield, J., C. Swanston, M. Janowiak, and R. F. Steele. 2015. "USDA Midwest and Northern Forests Regional Climate Hub: Assessment of climate change vulnerability and adaptation and mitigation strategies." *Midwest Hub*. Accessed on March 10, 2017. http://www.nc-climate.org/app/download/7118330922/Midwest+Region+Vulnerability+Assessment+3_20_2015.pdf

Lemos, M. C., T. J. Finan, R. W. Fox, D. R. Nelson, and J. Tucker. 2002. "The use of seasonal climate forecasting in policymaking: Lessons from Northeast Brazil." *Climatic Change* 55(4): 479–507.

National Agricultural Statistics Service (NASS). 2013. *Crop Production 2012 Summary*. Washington, D.C.: US Department of Agriculture.

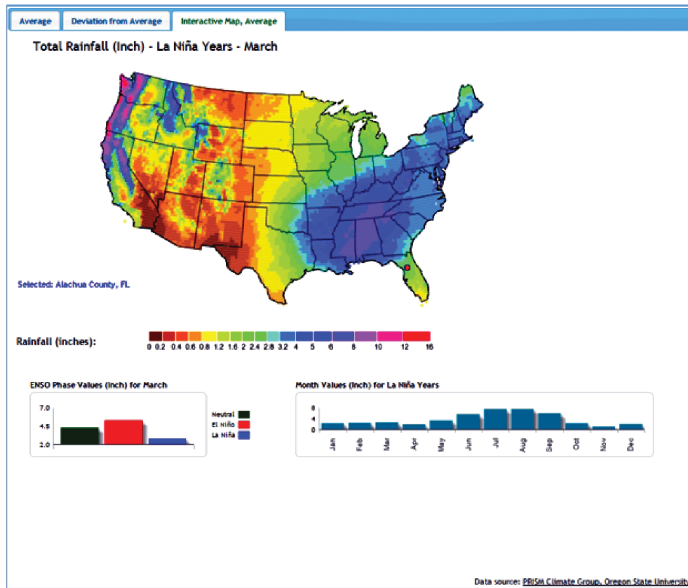


Figure 3. Average rainfall total during the month of March during La Niña years in Alachua County between 1950 and 2013, with additional month-by-month and cross-phase comparisons. Credits: Southeast Climate Consortium

agricultural technologies such as plows, storage equipment, new crop varieties, and fertilizers limit the user’s ability to take preventative measures before an unusually wet or dry season. In some cases, ENSO-related information may seem relevant and useful in a general context but prove to be less usable as it competes with other factors in the grower’s decision-making process. As an example, commodity prices normally have a stronger influence on the choice of crops to plant even if expected weather patterns based on the ENSO phase forecast may not be favorable for the selected crops. Last but not least, the level of trust that users have in seasonal climate forecasts and climate information in general is paramount in determining the likelihood of adoption. User networks in which researchers, Extension agents, and/or other brokers of climate information have built trust with growers and provided evidence of the accuracy and legitimacy of this type of climate information are likely to adopt this tool more readily (Broad, Pfaff, and Glantz 2002; Lemos et al. 2002; Carbone and Dow 2005).

Looking Forward

Ensuring the usability and benefit of the ENSO climatology tool requires purposeful and strategic interaction between providers and users of climate data. Researchers and Extension agents must endeavor to appreciate the complexity of the decision-making process faced by growers and

Nicholson, S. E. 1996. "A review of climate dynamics and climate variability in East Africa." In *The Limnology, Climatology and Paleoclimatology of the East African Lakes*. Amsterdam, Netherlands: Gordon and Breach Publishers.

Nicholson, S. E., and J. Kim. 1997. "The relationship of the El Niño-Southern Oscillation to African rainfall." *International Journal of Climatology* 17(2): 117–135.

Woli, P., B. V. Ortiz, K. Flanders, A. Hagan, B. Kemerait, and D. Wright. (2013b). "Adapting wheat production to climate in the Southeast." *Southeast Climate Extension*. Accessed on March 13, 2017. <http://agroclimate.org/management/Wheat-climate-variability.pdf>

Wolter, K., and M. S. Timlin. 2011. "El Niño/Southern Oscillation behaviour since 1871 as diagnosed in an extended multivariate ENSO index (MEI.ext)." *International Journal of Climatology* 31: 1074–1087.

Wolter, K., and M. S. Timlin. 1993. "Monitoring ENSO in COADS with a seasonally adjusted principal component index." Proc. of the 17th Climate Diagnostics Workshop, Norman, OK, NOAA/NMC/CAC, NSSL, Oklahoma Clim. Survey, CIMMS and the School of Meteor., Univ. of Oklahoma: 52–57.

Table 1. Key climate impacts and management strategies for wheat in the Southeast US (Woli et al. 2013b).

Impact	Strategy
Drier or warmer winter and spring	
Yield	
Late planting results in yield losses. Higher losses for late than early maturity varieties are mainly due to the lack of vernalization.	Avoid planting later than the recommended date for your area.
Yield losses, especially in coastal areas, if grown on sandy loam soils with low water holding capacity.	Reduce the area planted in these locations.
Yield losses due to shorter growing season and grain-filling period, lack of vernalization, and increased leaf senescence.	The yield loss is associated mainly with late planting. Plant early maturity varieties.
Early planting of early maturity varieties results in lower yields due to accelerated growth and development and spring freeze injury. Late planting of late varieties causes lower yields due to insufficient vernalization. Long-day photoperiod varieties have low yield and grain quality due to early flowering and short grain-filling period. Late heading results in grain filling under hot and dry conditions, which leads to lower yields.	Plant late maturity varieties first and early maturity varieties last.
Insect pests	
Higher likelihood of larger Hessian fly populations.	Avoid early planting. Plant at the recommended time for your location. Plant Hessian fly-resistant varieties. Avoid planting wheat after wheat. More intense scouting for Hessian fly is needed.
Increased populations of grain aphids.	More intense scouting for aphids is needed.
Diseases	
Increased outbreak of barley yellow dwarf virus (BYDV) due to more aphids.	Avoid early planting. Extra scouting is needed for aphids.
Reduced risk of rust diseases and glume blotch.	Scout at jointing to flag leaf emergence to assess disease risk.