How do Global Weather Patterns Influence Days Suitable for Fieldwork?

Tyler B. Mark, Assistant Professor
Department of Agricultural Economics
University of Kentucky
Lexington, KY, 40546
(859) 257-7283
Tyler.Mark@uky.edu

Jeremy M. D'Antoni, Research Economist[1]
Economic Research Service, USDA
Washington DC
JMDANTONI@ers.usda.gov

Terry W. Griffin, Ph.D., CCA
(501) 249-6360
Terry.Griffin@comcast.com

Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014

[1] The views expressed herein are those of the authors and do not necessarily represent those of the Economic Research Service or the US Department of Agriculture.

How Do Global Weather Patterns Influence Days Suitable for Fieldwork?

Tyler Mark, Jeremy D'Antoni, and Terry Griffin
University of Kentucky, USDA-ERS, Griffin Consulting

Abstract:

Weather can play a significant role in a producer's decision making process. However, the literature is void of research estimating the impact of weather patterns on days suitable for field work. The probability of having enough days available to do field work drives the machinery investment decisions, timing of field operations, and optimal risk management strategies. This study shows that when either an El Nino or La Nina cycle are present then the days available decrease. The number of days that decrease is dependent upon the location of the state and the specific cycle present. This model also shows that Arctic Oscillation cycles, specifically a negative cycle, do not impact days available.

Background:

- Days suitable for fieldwork (DSFW) influences timing of agricultural field operations, equipment purchases, and risk management.
- An unexplored area of the literature is the influence of global weather patterns on DSFW. Specifically, we investigate the influence El Niño Southern Oscillation (ENSO) and Artic Oscillations (AO) on DSFW.
- ENSO is a global weather pattern that takes place in the Equatorial Pacific Ocean. Within the ENSO cycle there are three phenomenon observed: 1) El Niño, 2) Neutral or Normal and 3) La Niña.
- During El Nino the Equatorial Pacific ocean waters warm to temperatures above their neutral or normal temperatures as opposed to La Niña where the waters cool below normal temperatures.
- Warming and cooling of these waters influences global weather patterns (Ropelewski, 1987) (Adams, 1999) (Zhang, 2012).
- El Niño cycles typically increase rainfall across the southern tier, especially from Texas to Florida. Additionally, brings more intense storms across the southeastern United States (Cook-Anderson, 2008).
- La Niña cycles, typically there is below normal precipitation across the southeast and higher than normal temperatures across the southeast (Graham, 1999).
- AO is a global weather pattern that has two different and distinct modes. These patterns determine how pressure patterns are distributed over the Artic and change the circulation in the atmosphere.
- Positive AO the jet stream controlling weather in the United States shifts north and a warmer and drier pattern.
- Negative AO the jet stream is pushed south and stronger winter storms to the eastern United States

Data and Methods:

- Weekly data for DSFW, Palmer Drought Index, Crop Moisture Index, Precipitation, and Temperature were collected from 1996-2013.
- Monthly data for El Nino, La Nina, and Arctic Oscillations were collected. These monthly estimates were then decomposed into a weekly dummy variable to indicate the specific cycle present
- Figure 1 is a map of all of the states that are include in the data set. Some states are left out either because they do not collect DSFW or weather data for the state was missing. The descriptive statistics for all variables included in the model can be seen in table 1.
- An Unbalanced Random Effects model is used to estimate the impact of El Nino, La Nina and Arctic Oscillations on DSFW
- The general specification to the model is below:

$$y_{ij} = x_{it}'\beta + (a_i + e_{ij})$$
$$j = 1, \dots, n_i, i = 1, \dots, k$$
$$where\ a_i \sim (\alpha, \sigma_a^2) \text{ and } \varepsilon_{ij} \sim (0, \sigma_u^2)$$

$$u_{it} = (a_i + e_{ij})\ where\ Corr(u_{it}, u_{is}) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_\varepsilon^2}\ for\ all\ s \neq t$$

- Bootstrapped standard errors with 500 replications

Descriptive Statistics and Variable Descriptions

Variable			Mean	Std. Dev	Min	Max	Observations	
DSFW	Days Suitable for Fieldwork (deviations from the mean by state)	overall		1.298	-6.015	2.465	N	21500
		between	-1.31E-08	1.44E-07	-2.25E-07	2.34E-07	n	37
		within		1.298	-6.015	2.465		
PDI	Modified Palmer's Drought Index	overall		0.471	-1.210	4.73	N	20712
		between	0.034	0.024	-0.026	0.068	n	37
		within		0.470	-1.224	4.702		
CI	Crop Moisture Index	overall		0.660	-4.053	8.510	N	20712
		between	0.023	0.021	-0.023	0.063	n	37
		within		0.660	-4.069	8.484		
PRECIP	Total precipitation for the week	overall		0.779	0	9.940	N	21500
		between	0.763	0.267	0.141	1.111	n	37
		within		0.737	-0.348	9.737		
$PRECIP_{T-1}$	Lag of weekly precipitation	overall		0.779	0	9.940	N	21500
		between	0.763	0.267	0.141	1.112	n	37
		within		0.737	-0.349	9.738		
TEMP	Average weekly temperature	overall		18.361	-13.333	91.844	N	21500
		between	56.902	6.133	46.013	69.582	n	37
		within		17.303	-2.443	89.501		
EL NINO	El Nino cycle	overall		0.497	0	1	N	21500
		between	0.558	0.008	0.533	0.591	n	37
		within		0.497	-0.033	1.024		
LA NINA	La Nina cycle	overall		0.490	0	1	N	21500
		between	0.401	0.005	0.383	0.413	n	37
		within		0.490	-0.012	1.018		
AOSC(-)	Negative arctic oscillation cycle	overall		0.500	0	1	N	21500
		between	0.519	0.014	0.511	0.597	n	37
		within		0.500	-0.079	1.008		

Results Random Effects Model for Days Suitable for Fieldwork

Variable	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]	
PDI	0.921	0.131	7.04	0.000	0.665	1.178
CI	0.453	0.040	11.28	0.000	0.375	0.532
PRECIP	-0.873	0.105	-8.28	0.000	-1.080	-0.667
$PRECIP_{T-1}$	0.123	0.011	11.11	0.000	0.101	0.145
TEMP	-0.0004	0.001	-0.4	0.687	-0.002	0.001
EL NINO	-0.258	0.048	-5.4	0.000	-0.352	-0.165
LA NINA	-0.300	0.033	-9.18	0.000	-0.364	-0.236
AOSC(-)	0.004	0.022	0.17	0.865	-0.040	0.048
CONST	0.851	0.103	8.26	0.000	0.649	1.053
N	20,712		Wald chi^2	493.26		
n	37		Prob. Chi^2	0.0000		

References:

Adams, R. C. (1999). The Economic Consequences of ENSO Events for Agriculture. *Climate Research, 13*(3), 165-172.

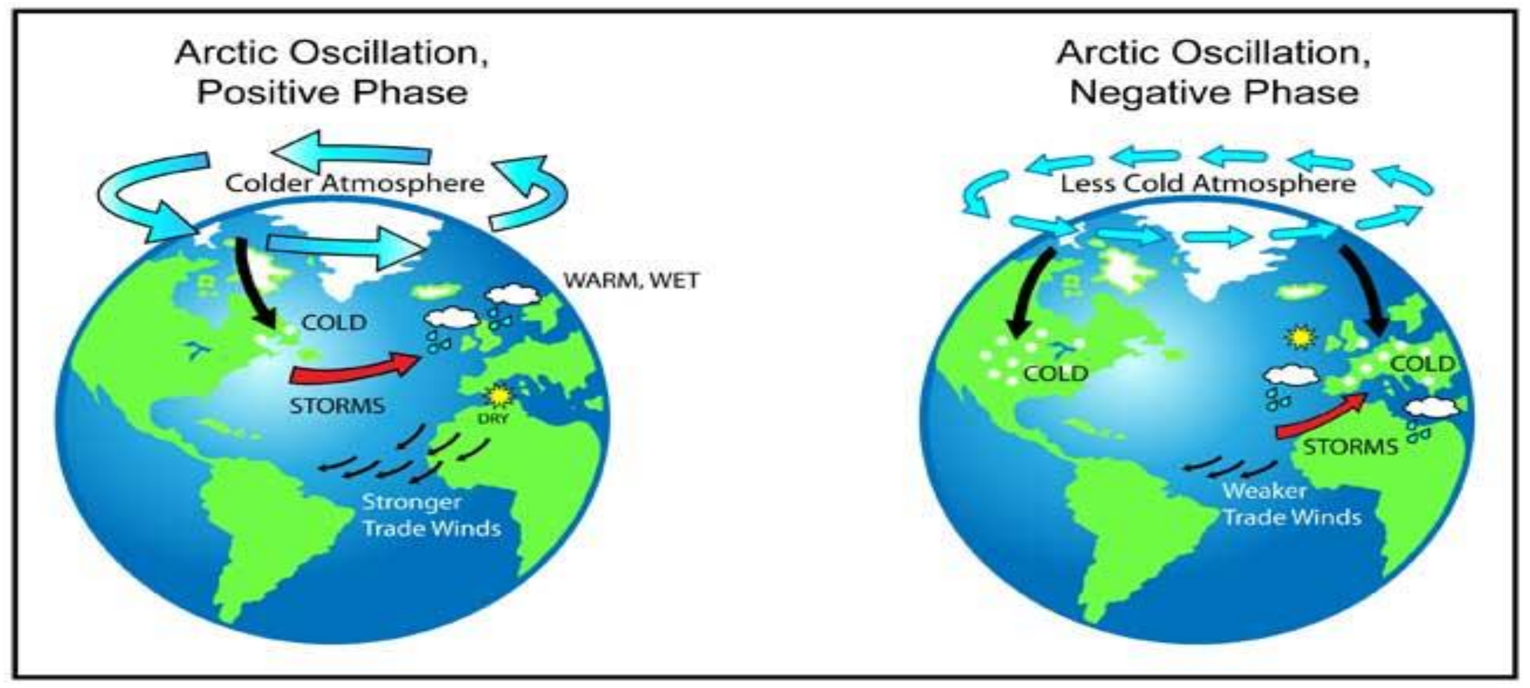
Cook-Anderson, G. (2008, January 28). *El Nino at Play as Source of More Intense Regional U.S. Wintertime Storms.* Retrieved from NASA's Goddard Space Flight Center: http://www.nasa.gov/centers/goddard/news/topstory/2008/elnino_winter.html

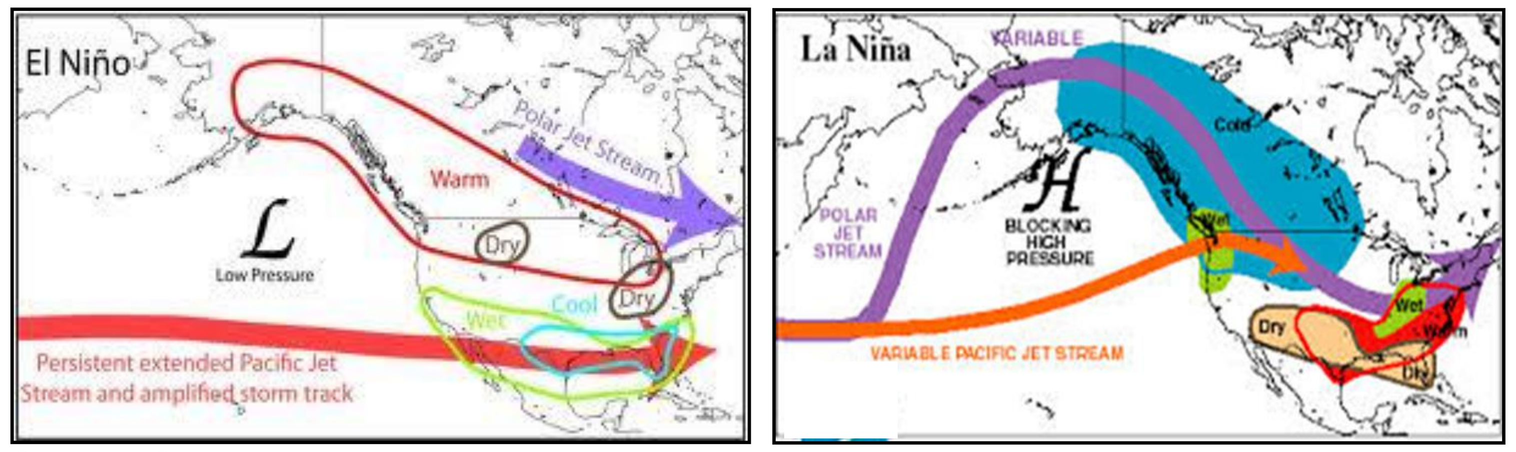
Graham, S. (1999, April 27). *The Cold Counterpart to El Nino is Known as La Nina.* Retrieved from NASA Earth Observatory: http://earthobservatory.nasa.gov/Features/LaNina/

National Weather Service. (2014, January 6). *Cold & Warm Episodes by Season*. Retrieved from NOAA/National Weather Service: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

Ropelewski, C. a. (1987). Global and Regional Scale Precipitation Patterns Associated with El Nino/Southern Oscillation. *Monthly Weather Review, 115*(8), 1606-1626.

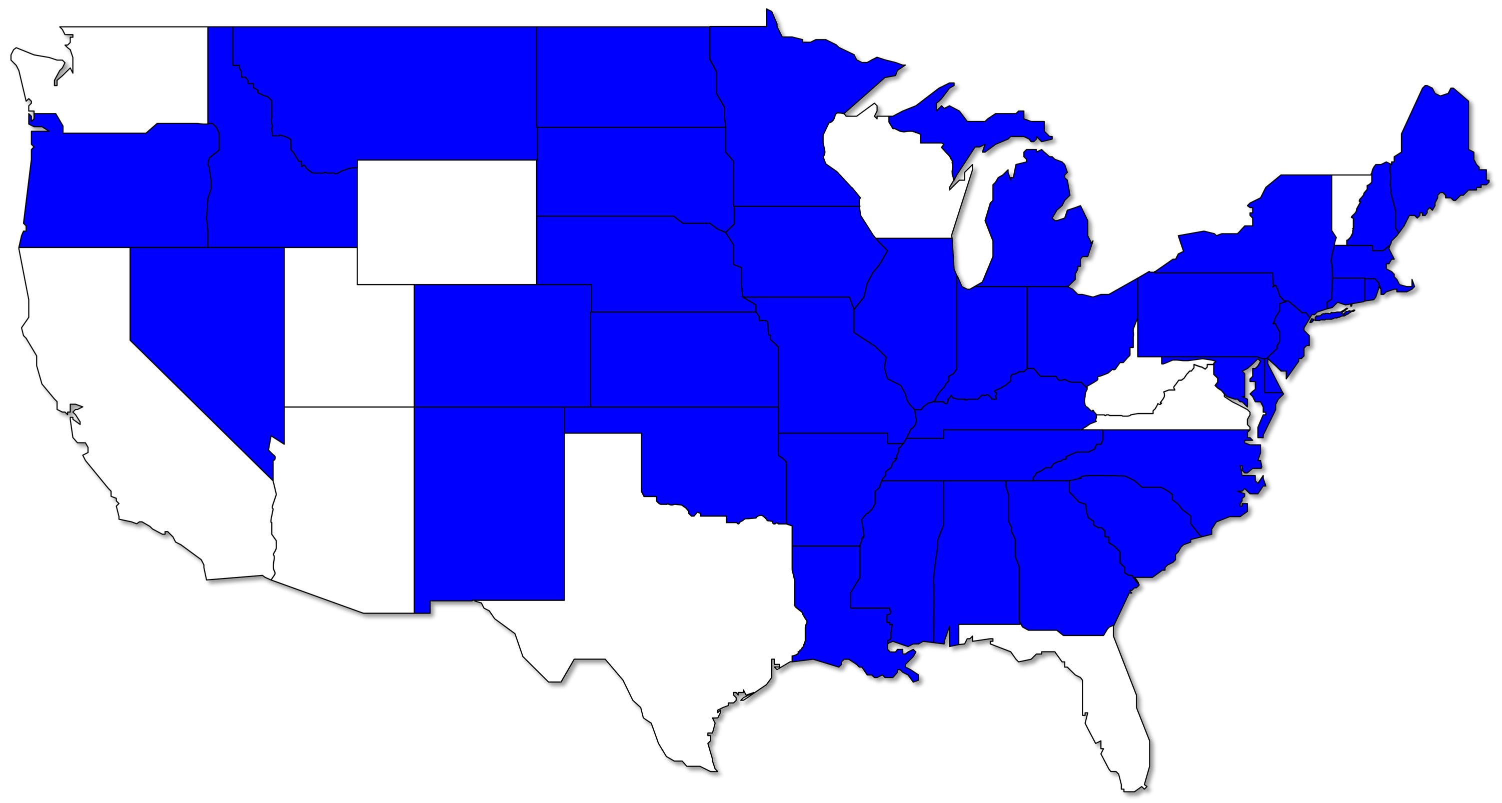
Zhang, Y. Y. (2012). ENSO Anomalies over the Weste4rn United States: Present and Future Patterns in Regional Climate Simulations. *Climatic Change, 110*(1), 315-346.





Sources: NOAA

Map of States Included in Analysis



Discussion:

- An unbalanced Random Effects Panel Model was estimated with the pooled data
- Larger increases in DSFW above the mean level occurred when:
  - The larger the increase in the modified Palmer Drought Index
  - The larger the increase in the crop moisture index
- As expected precipitation in the current week decreases DSFW
  - however, precipitation in the previous week increases DSFW
- When either an El Nino or La Nina cycle are present DSFW decreases. This is a function of the pooled data set utilized. It is expected that in years of El Nino that the southern portion of the United States would receive above average rain. Then the northern half above average temperatures increasing the DSFW. In periods of La Nina it is expected that the southern half of the United States would be very dry and potentially decrease DSFW as a result of lack of moisture in the fields for work to be preformed.
- Unexpectedly within the model a negative arctic oscillation cycle and average temperature did not have any impact on the model. Further work is being done to investigate.
- Future work will include estimating DSFW by state and decomposing the model to more clearly show the impacts of these weather patterns on DSFW