

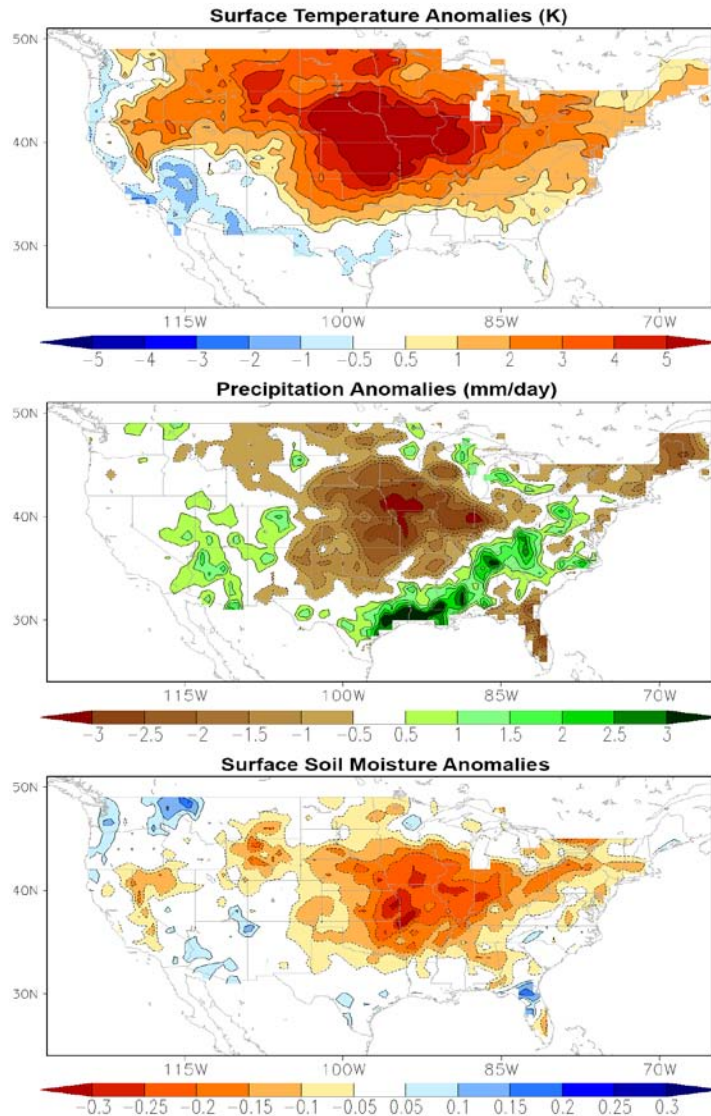


# Sea Surface Temperatures and North American Heat and Drought

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Regions of the U.S. experienced extreme drought and heat waves during the summers of 2011 and 2012. A series of simulations performed with GEOS-5 show that:

- Drought and heat waves across the Southern Plains in 2011 appear to have been a response to cool tropical Pacific sea surface temperatures (SSTs).
- GEOS-5 simulations initialized in May, June, and July of 2012 did not fully capture the severity of the 2012 drought and heat wave until the forecast initialized in July, suggesting the extreme hot and dry conditions of 2011 were not a precursor for the excessive heat and drought experienced in 2012. There is some evidence, however, that dry soils in 2011 played a role in the development of 2012 temperature anomalies through soil moisture feedbacks.
- Drought and heat waves across the Central Plains in 2012 cannot be attributed to SST anomalies, and were most likely a response to the development of a phase locked Rossby wave over the region.



The 2012 drought and heat wave, as represented by anomalies found in MERRA-Land. July 2012 anomalies are relative to the 1980-2010 climatology.



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Heat waves and drought were present in the U.S. during the summer months of 2011 and 2012. Analysis of MERRA data reveals that, in 2011, hot and dry conditions were most intense in the Southern Plains and peaked in June. In 2012, however, drought and heat waves were more prevalent in the Central Plains, and peaked in July. Both summers were characterized by cold phases of the Pacific Decadal Oscillation (PDO), and warm phases of the Atlantic Multi-decadal Oscillation (AMO). Cool SSTs were present in the equatorial Pacific (La Niña) in 2011, but not in 2012. To investigate what role, if any, SSTs played in forcing the extreme heat and drought experienced in the U.S. during the summers of 2011 and 2012, a series of simulations was conducted with GEOS-5.

### **Methods:**

For all simulations, GEOS-5 was run at a 1° horizontal resolution with 72 vertical levels, forced with prescribed SSTs. A 12-member ensemble baseline run was forced with observed SSTs from January 1979 to August 2012 to see if the model was capable of reproducing the magnitude and spatial distribution of the heat and drought experienced in the U.S. in 2011 and 2012. A series of 20-member ensemble simulations was initialized in November of 2010 or 2011 and forced with climatological SSTs except in either the tropical Pacific, the North Pacific, the tropical Atlantic, or the North Atlantic, where observed SSTs were used. Summer temperatures and precipitation were analyzed to determine which ocean(s) had the most impact on heat and dryness. See Wang et al. (2013) for full experimental details.

### **Results:**

Observed surface temperature, soil wetness, and precipitation were generally within the baseline ensemble spread for 2011, with the exception of June and July precipitation, suggesting the model is capable of reproducing the extreme heat and drought in the summer of 2011. The model was not able to reproduce the extreme heat and drought experienced in the Central Plains in the summer of 2012, however, and observations fell outside of the ensemble spread.

Results for simulations where SSTs were set to climatological values in all but specific basins were as follows:

- In 2011, abnormally warm temperatures experienced in the Southern Plains were mainly forced by SST anomalies in the tropical Pacific. Later in the summer of 2011, SST anomalies in the tropical and North Atlantic supported the spread of warmer conditions across more of the U.S.
- In 2012, SST anomalies in the tropical Pacific support warm surface temperature anomalies in spring, and SST anomalies in the Atlantic become more important to forcing warm temperatures in the Central and Western Plains later in the summer.
- The 2011 drought and heat waves in the Southern Plains appear to have been a classic response to cooler tropical Pacific SSTs.
- SSTs alone could not have forced the intense drought and heat waves experienced in the Central Plains during the summer of 2012, nor did the dry conditions of 2011 appear to be a precursor for drought of 2012. Phase-locked stationary Rossby waves over the Central Plains were most likely responsible for the extreme hot and dry conditions experienced in that region in the 2012 summer months.

For more information, see [http://gmao.gsfc.nasa.gov/research/climate/SST\\_heat\\_drought](http://gmao.gsfc.nasa.gov/research/climate/SST_heat_drought)

### **References:**

Wang, H., S. Schubert, R. Koster, Y.-G. Ham, M. Suarez, 2013: On the role of SST forcing in the 2011 and 2012 extreme U.S. heat and drought: A study in contrasts. *J. Hydrometeor.* Submitted.