Could the 2012 drought have been anticipated?

NASA ENERGY AND WATER CYCLE STUDY
NEWS
Extremes Working Group

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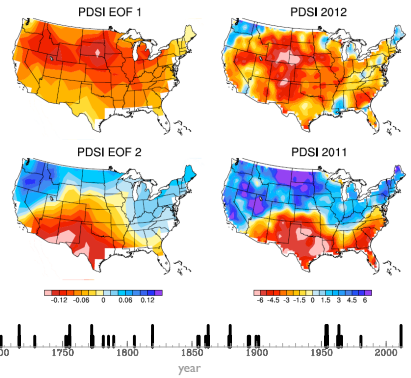
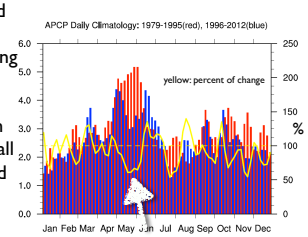
How rare was it?

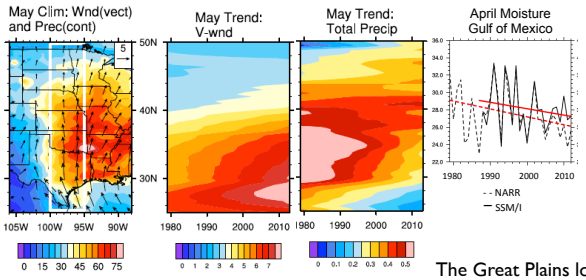
The spatial patterns of the 2011 and 2012 droughts resemble the prevailing patterns of past droughts. The sequential evolution of drought from 2011 to 2012 did happen sporadically in the past, according to PDSI data derived from tree rings. However it could go the other way as well and this appears to be the case from 2012 to 2013, with the latter experiencing a drought similar to EOF2, i.e. in southwest U.S.



Long-term changes

Beginning 1979, the drought stricken area of Oklahoma and northern Texas, whose rainy season is in the late spring, experienced a pronounced decrease in rainfall during the rainy season of May-June, in which rainfall has declined for ~50%!

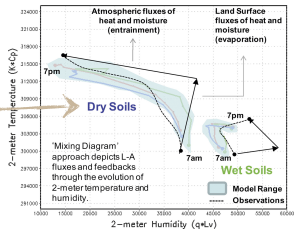




The Great Plains low-level jet (LLJ), exhibits an intensification and expansion since 1979, pushing late-spring rainfall into Nebraska and S.Dakota while reducing rainfall in Oklahoma and Texas. This corresponds to the rainfall reduction in late spring - i.e. the rainy/planting season. Precipitable water over the Gulf of Mexico also undergoes a marked decrease in April and partly in May, further reducing the source-region moisture.

Soil moisture

Soil moisture impacts are also felt via land–PBL interactions, where the atmosphere is more sensitive to dry soil anomalies and deep, dry PBL growth can lead to a persistent positive feedback on dry soils.

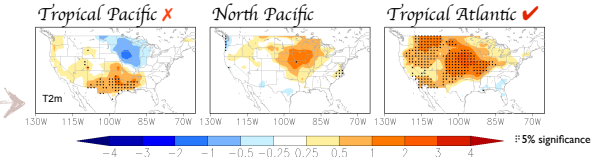


However, WRF experiments indicated that soil moisture could intensify the drought, but does not necessarily prolong the drought. GEOS-5 hindcasts also did not reveal any effect of dry soil in 2011 on the forecasting of 2012 drought. *If soil moisture didn't initiate the drought, what did?*

Ocean forcing

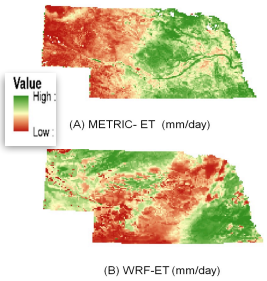
July 2012 surface temperature anomalies simulated with SSTs in:

Tropical Pacific ✗ *North Pacific* *Tropical Atlantic* ✔



GEOS-5 indicated that the Atlantic Ocean (widespread warming) contributed primarily to the 2012 summer heating, with a minor effect of the North Pacific on the Midwestern dryness.

Irrigation impact



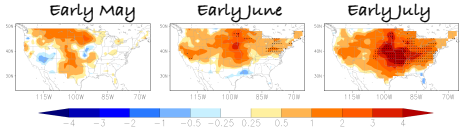
Comparison of ET between MODIS-based Metric model (with irrigation) and WRF-CLM (no irrigation) for Nebraska in August 2007. WRF-CLM does not consider irrigation so it undervalued the ET for irrigated land.

The implication is that, once drought takes place in early summer, the failing crop and the decrease in irrigation could and did modulate the ET, further exacerbating the drought.

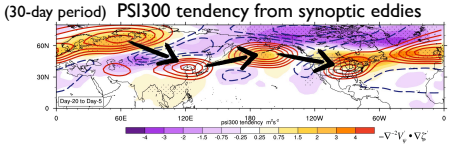
Predictability

July 2012 T2m (top) of GEOS-5 forecast initialized in

Early May Early June Early July



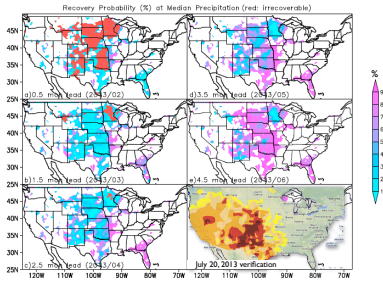
(30-day period) PSI300 tendency from synoptic eddies



The 2012 drought would not have benefited from long-lead prediction, as the full extent of the event was not forecasted until one month prior, suggested GEOS-5 modeling (top).

Which implies the forcing of stationary Rossby waves reinforcing the drought at intra-seasonal timescale.

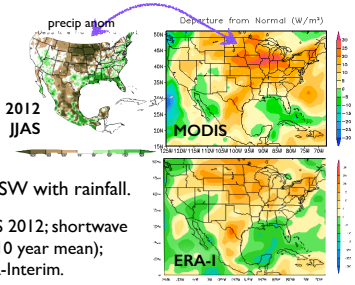
drought recovery



An ensemble streamflow prediction method was used to forecast drought recovery, i.e. when soil moisture percentile will fall back to climatology. However, drought recovery was uncertain even under the same precipitation conditions, signaling external forcing.

Radiative forcing

The rapid development of 2012 drought is associated with enhanced shortwave radiation input, as depicted by MODIS data and also seen in the ERA-I surface SW fluxes. Note the association of SW with rainfall.



clockwise: precipitation anomaly for JJAS 2012; shortwave radiation anomaly from MODIS (from 10 year mean); shortwave radiation anomaly from ERA-Interim.

Extremes Working Group References

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