Preludes to Drought

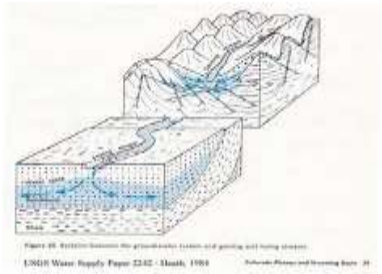
Good News (and Other News)

Martin Hoerling, NOAA

Workshop on Improving Drought Prediction at Seasonal to Inter-Annual Timescales
Sponsored by Western States Water Council and California Department of Water Resources
April 29-May 1 2013

Things to *Know* as Preludes to Drought

° ***Know Your Basin***



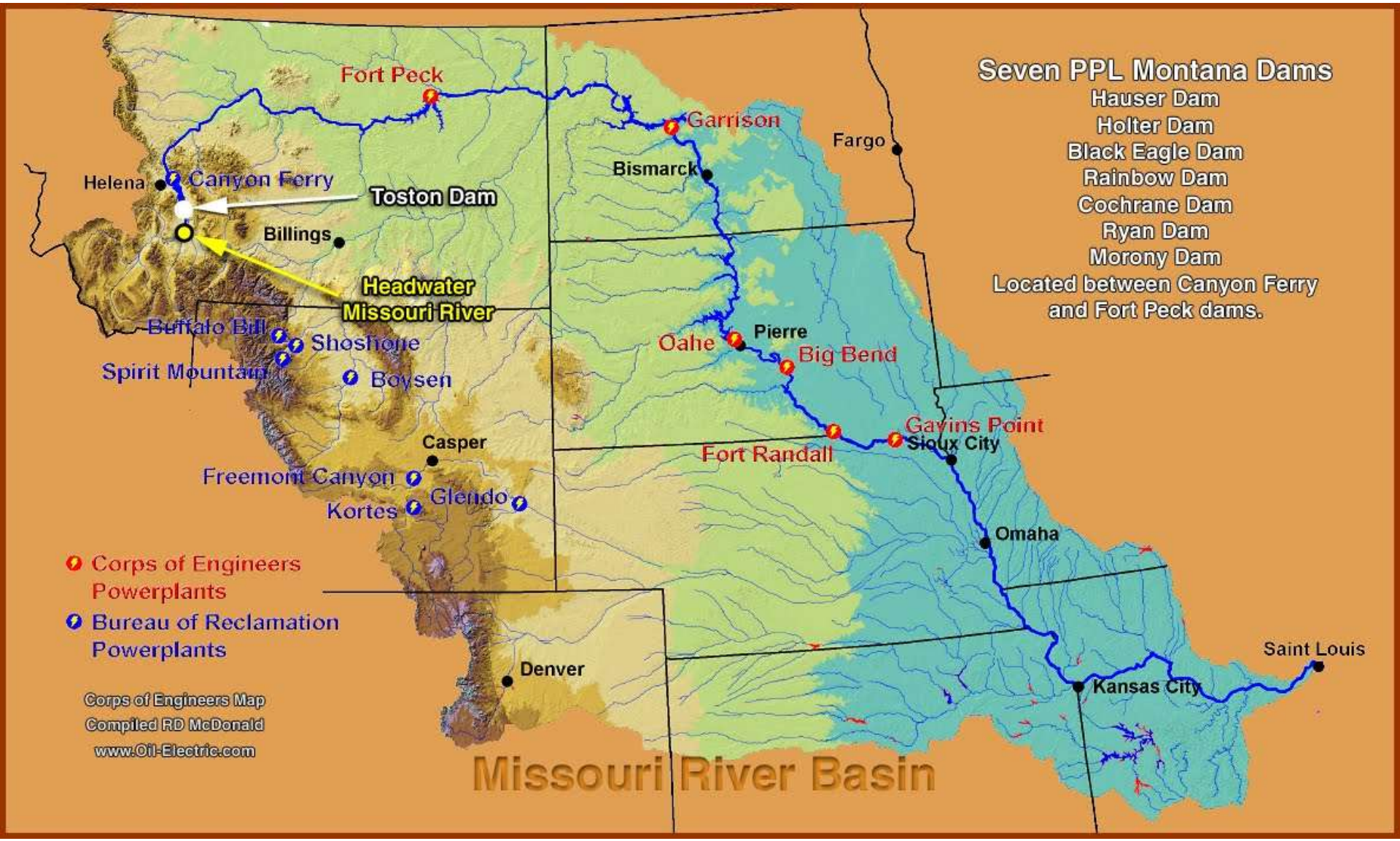
° ***Know Your Dirt***

° ***Know Your Oceans***

° ***Know Your Trees***

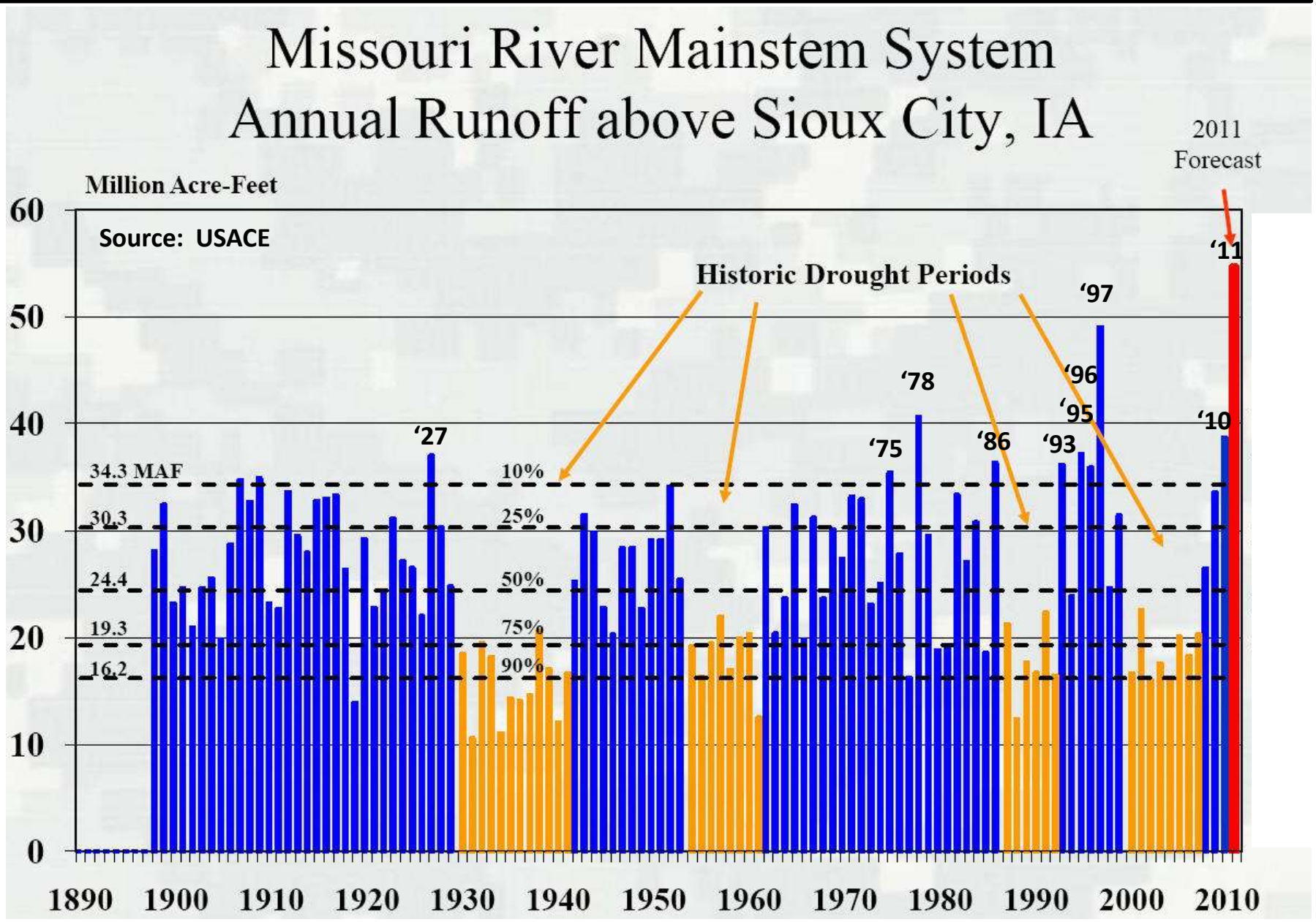
° ***Know Your Where You're Go'ng***

The Curious Case of Drought in the Missouri River Basin

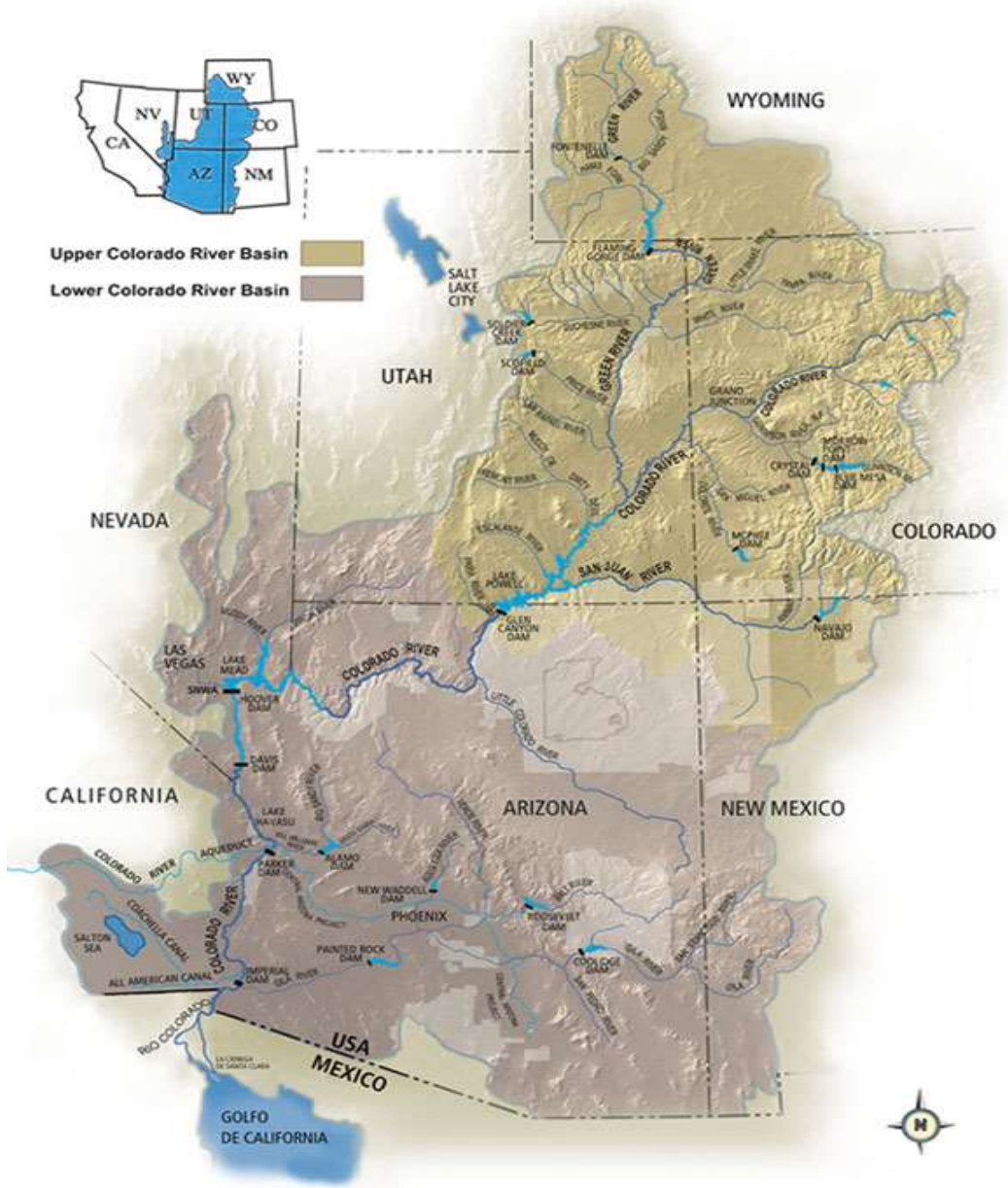


Prelude for Missouri Basin Drought: A Prior Year's Drought

One Year Lag Correlation is 0.35….. (Good News!)

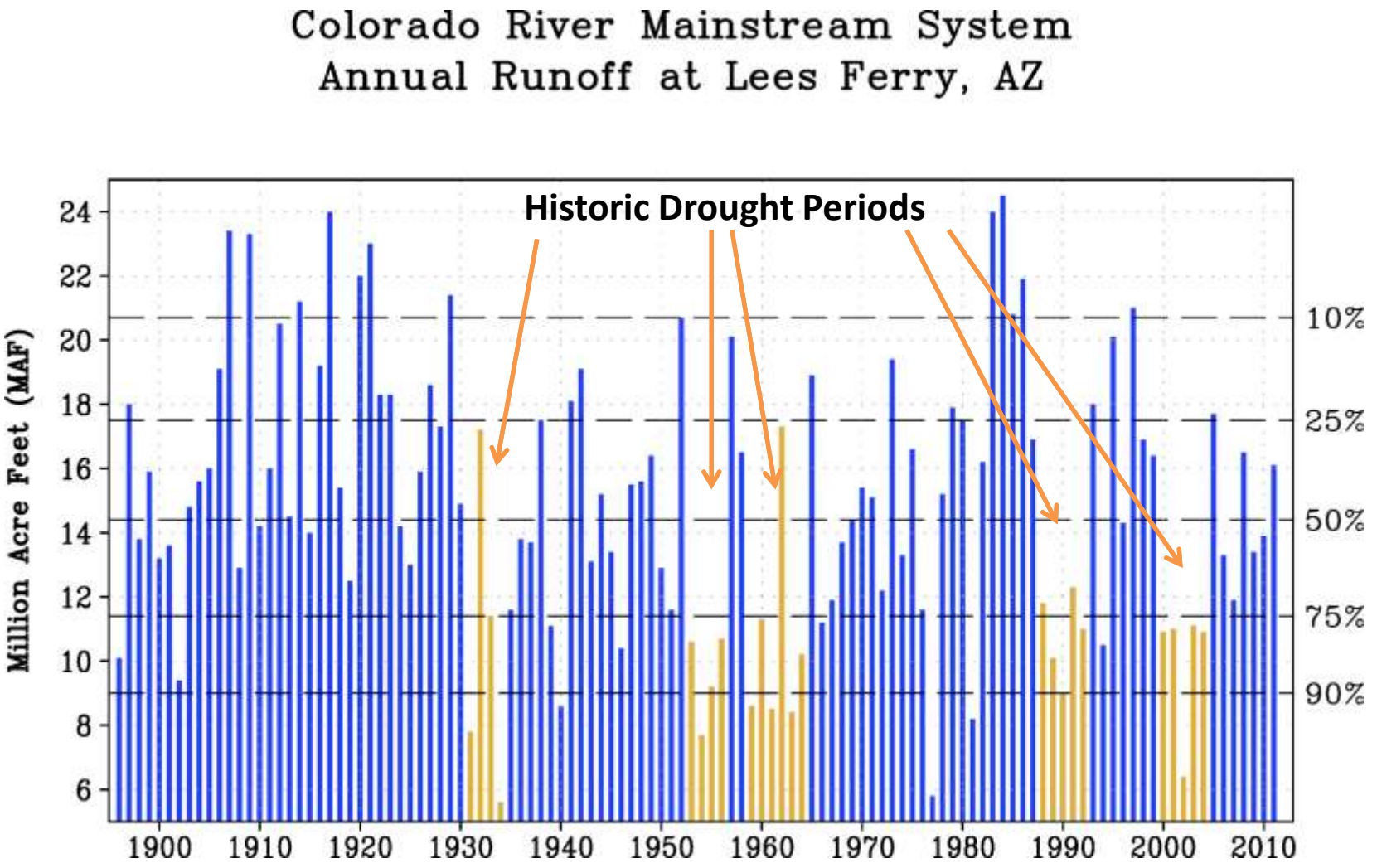


The Colorado River Basin

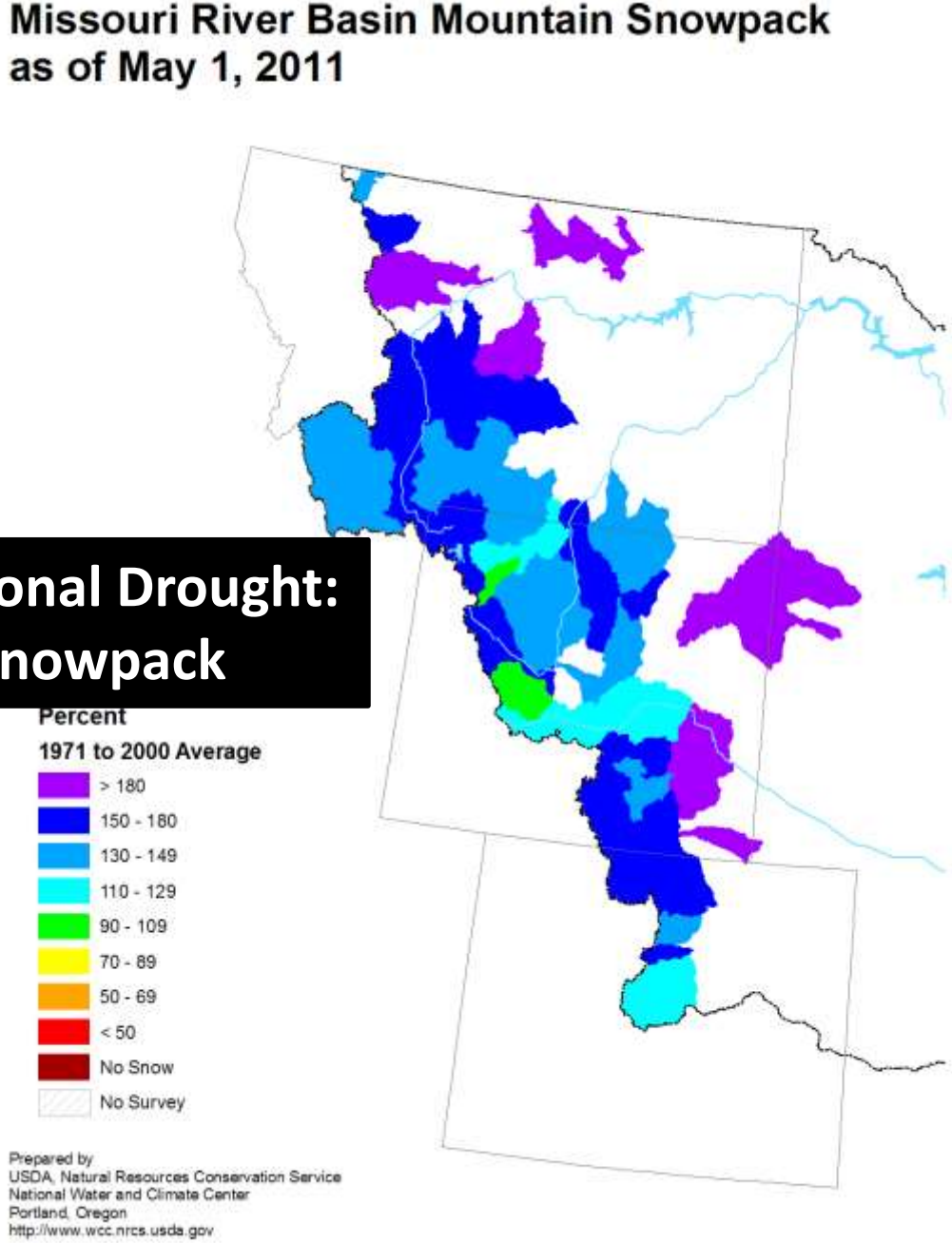


Prelude for UCRB Basin Drought: A Prior Year's Drought

One Year Lag Correlation is 0.25….. (Decent News)



Prelude to Seasonal Drought: Monitored Snowpack



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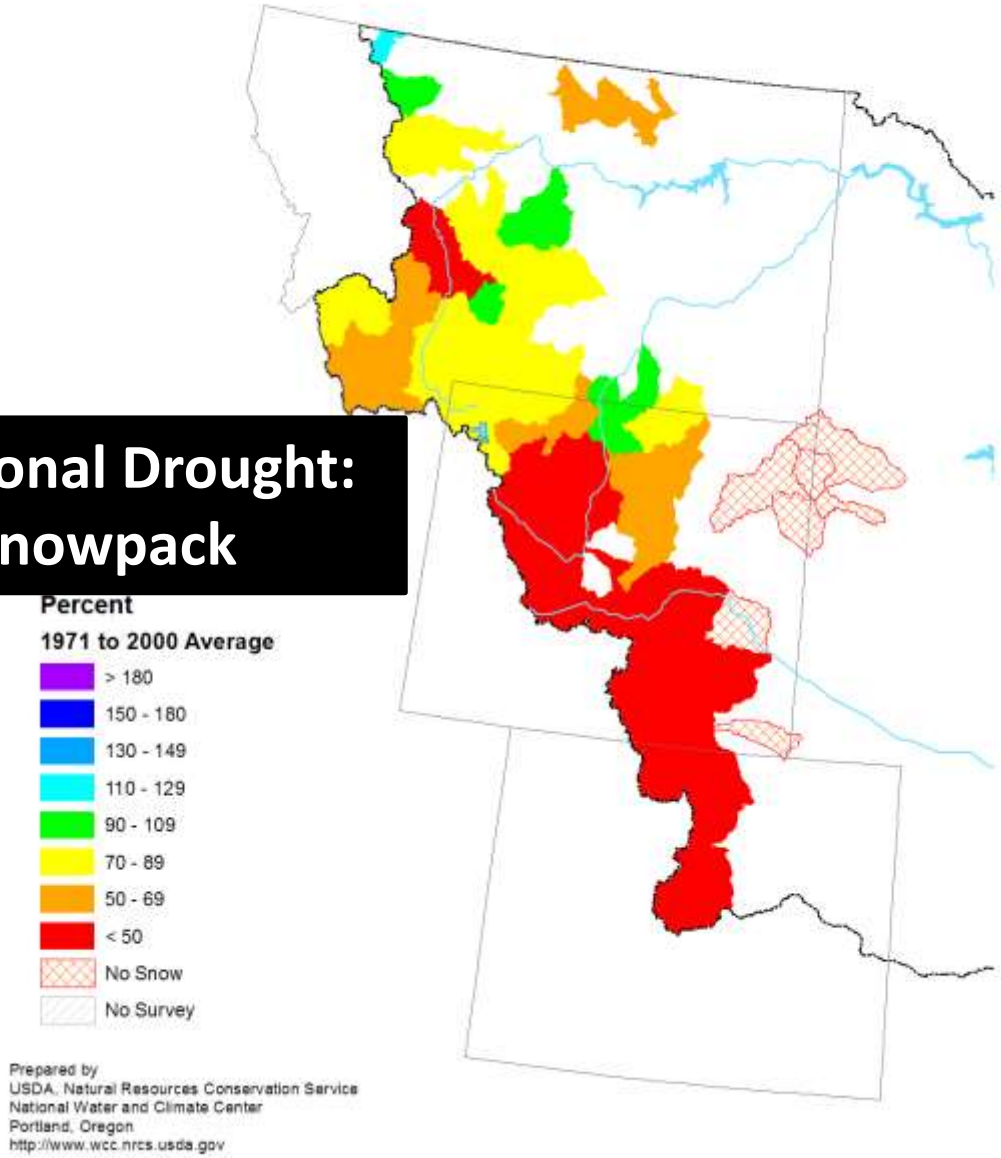
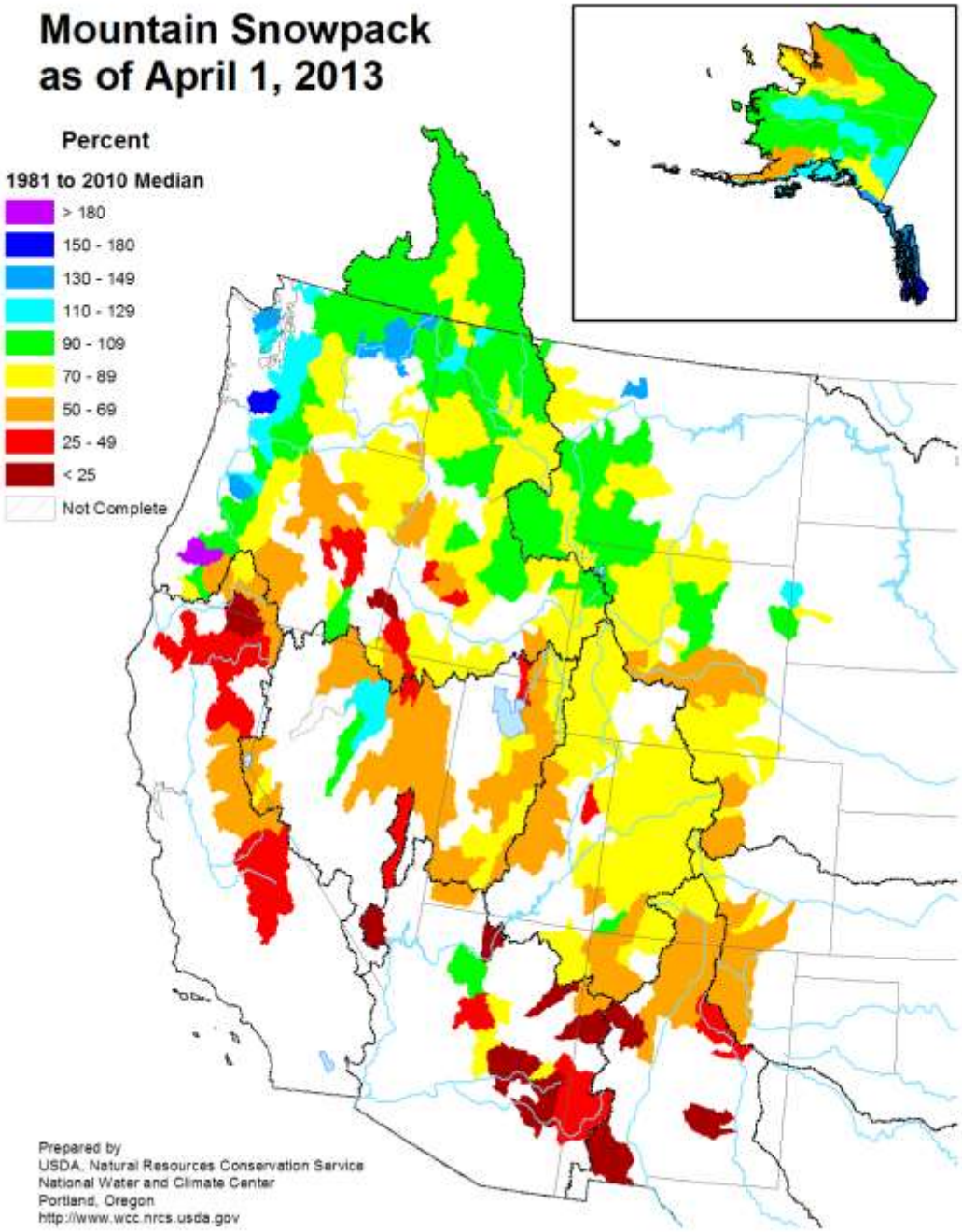


Mountain Snowpack as of April 1, 2013



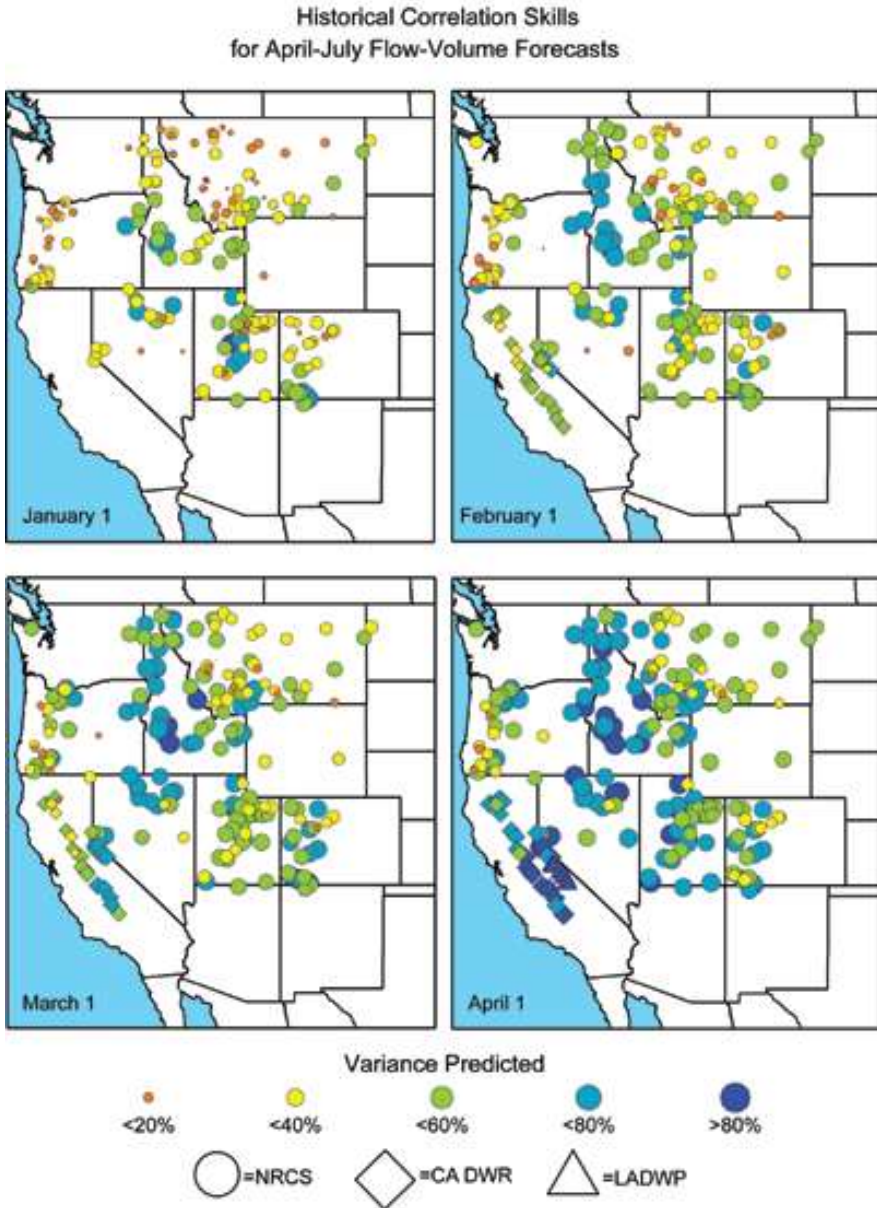


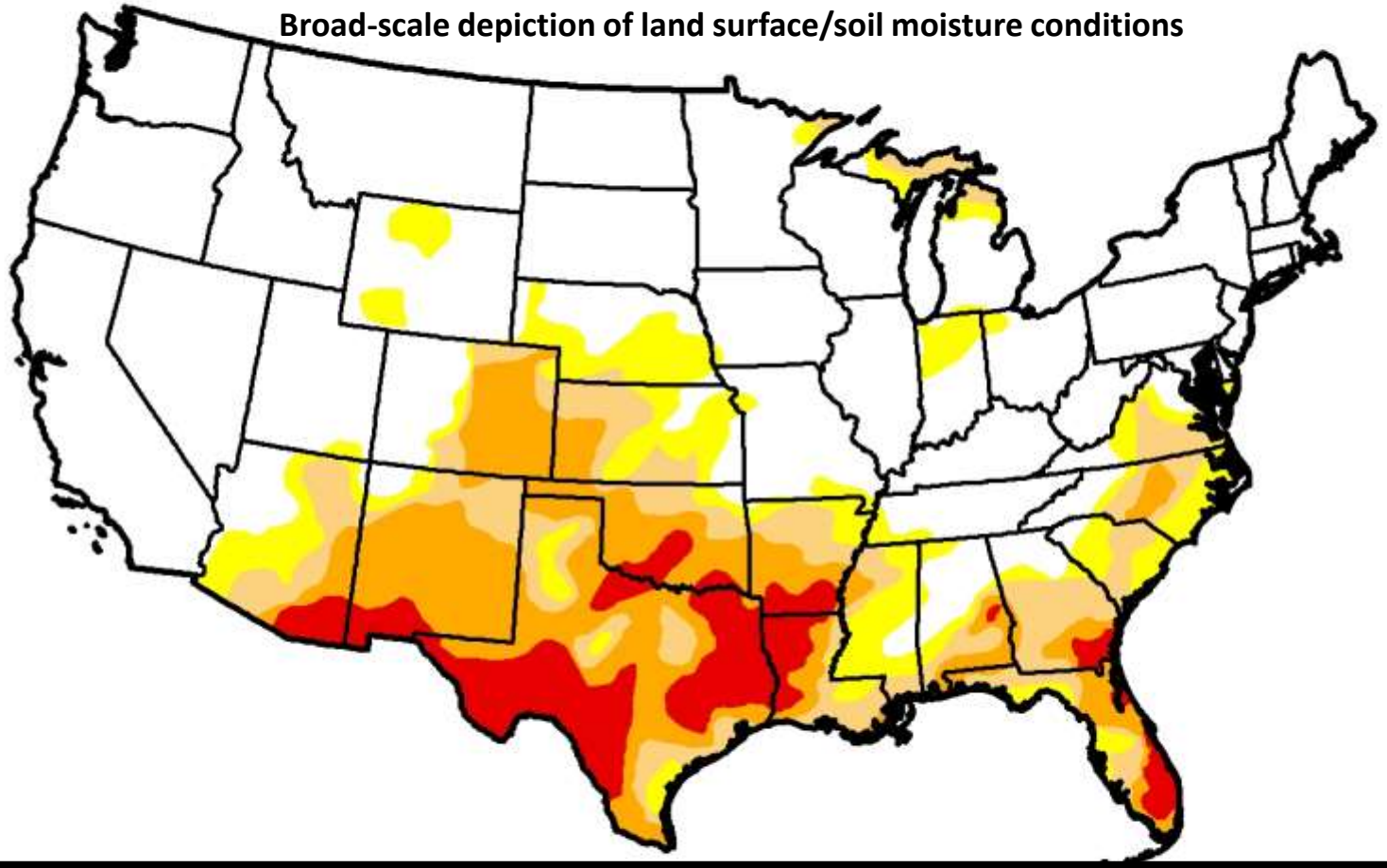
Figure 2.12 , in Ch 2 of SAP5.3:

Decision support experiments and evaluations using seasonal to interannual forecasts & observational data

U.S. Drought Monitor

29 March 2011

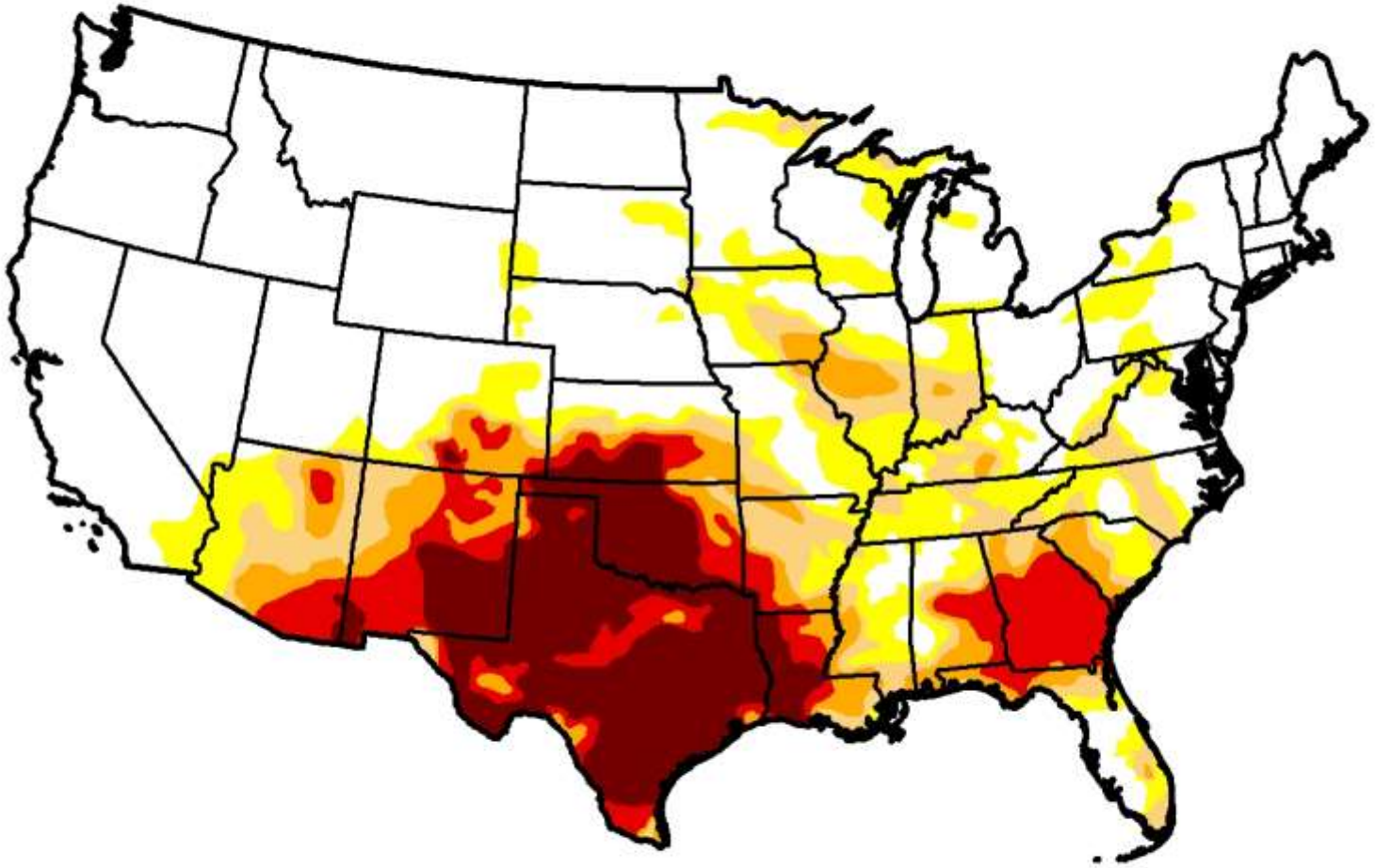
Broad-scale depiction of land surface/soil moisture conditions



Prelude to Seasonal Drought: Antecedent Drought

U.S. Drought Monitor

30 August 2011

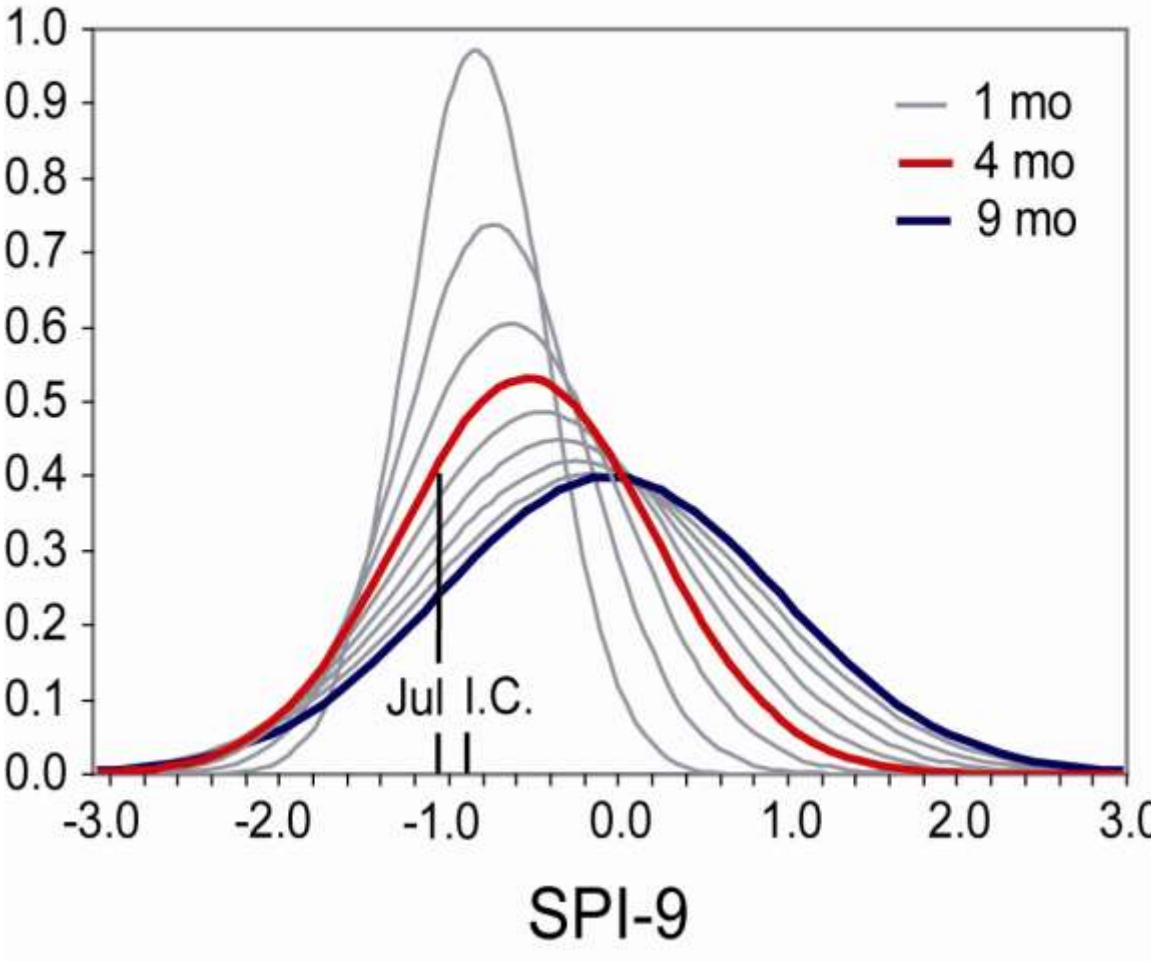


Persistence of Soil Moisture Conditions : Skill Source for Seasonal Drought Forecasts

Good News!

Probability Distributions of Future Drought, Given Initial Dryness

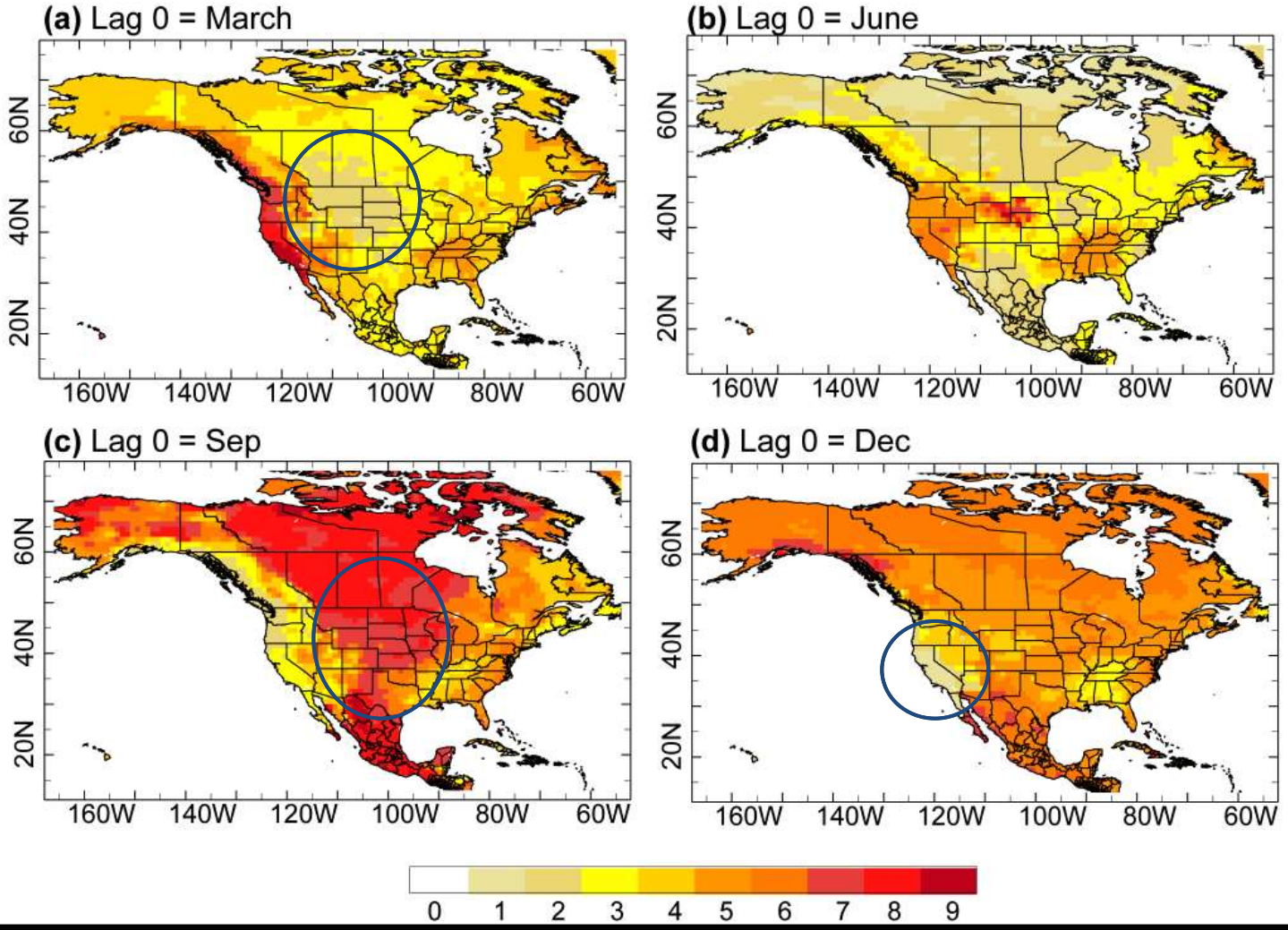
An illustrative example using March 1999 i.c. in the Hudson River Valley…. (Lyon et al. 2012)



Inherent persistence of drought makes possible useful predictive information out to several months lead time…..*Good News*!

The Memory of Drought

Unconditional Persistance of SPI-12, from Lyon et al. (2012)

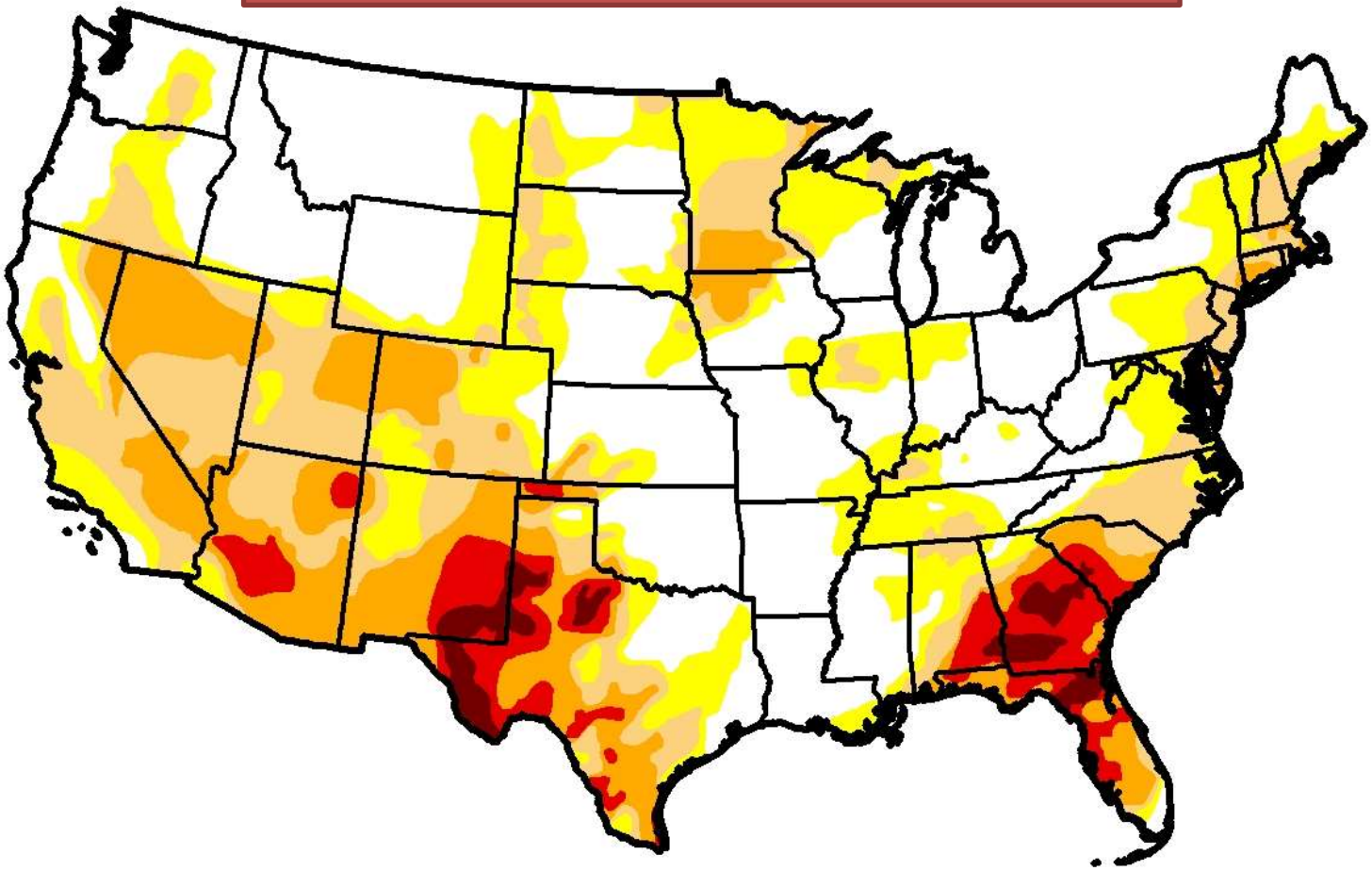


Drought Memory Fails When You Most Need It: in Advance of Climatological Rainy Seasons

Bad News!

U.S. Drought Monitor

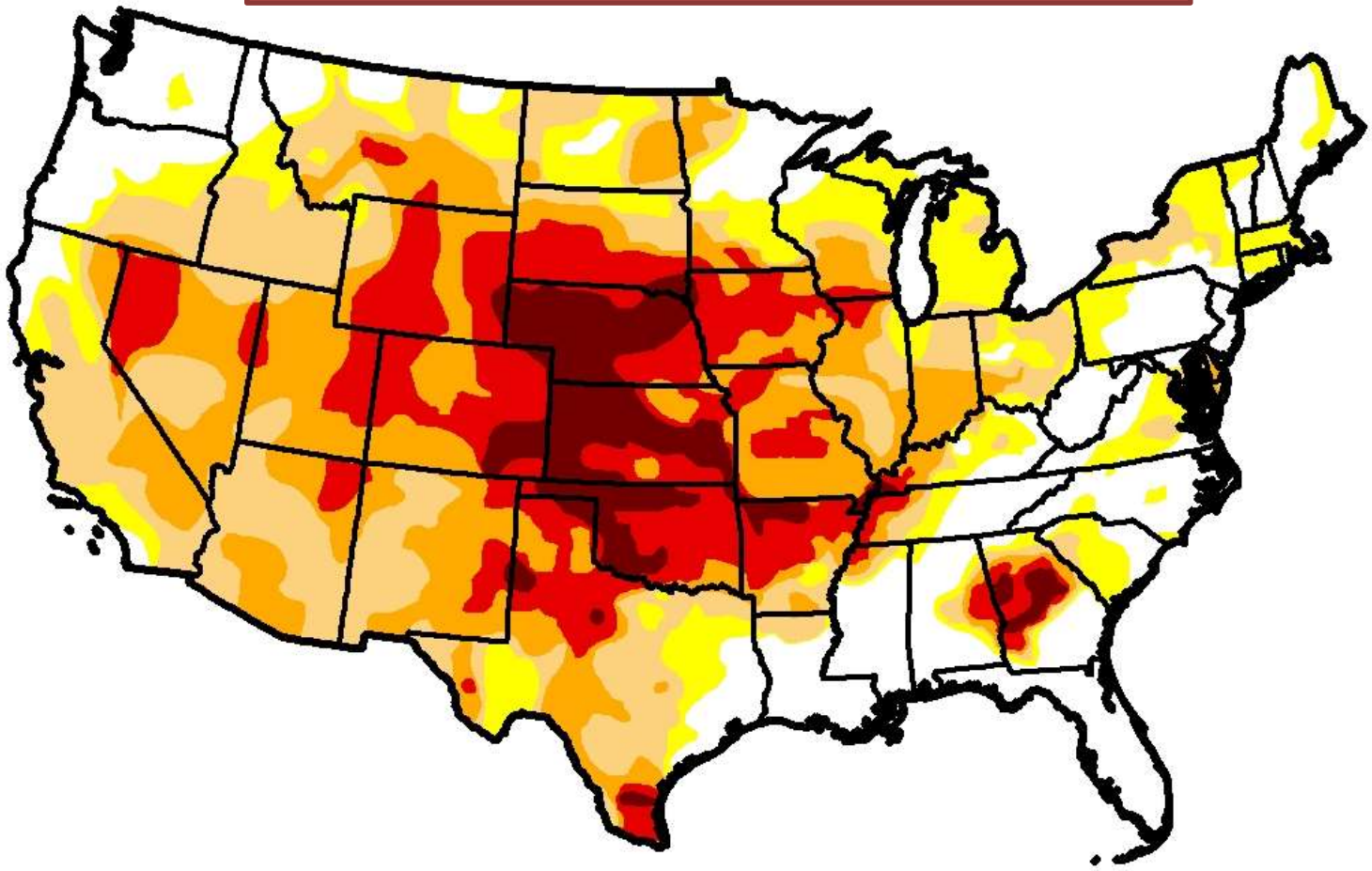
1 May 2012



Limited Antecedent Drought Coverage over the Central Great Plains on 1 May 2012

U.S. Drought Monitor

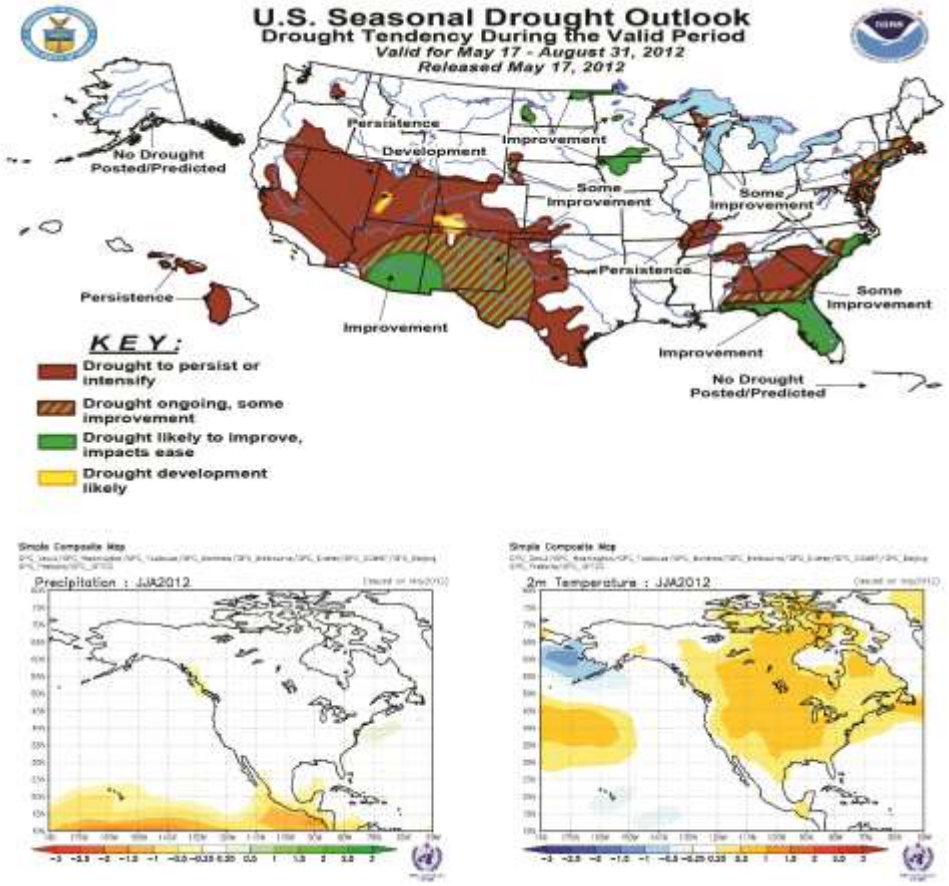
4 September 2012



Summer 2012 Witnessed a "Flash Drought" Having Limited Antecedents and Little Forewarning

see Report of the NOAA Drought Task Force: An Interpretation of the Origins of the 2012 Central Great Plains Drought, 20 March 2013

Why No Early Warning for the 2012 Drought?

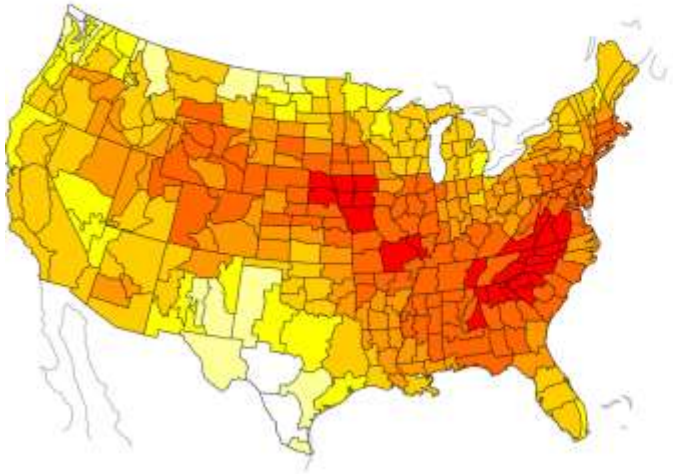


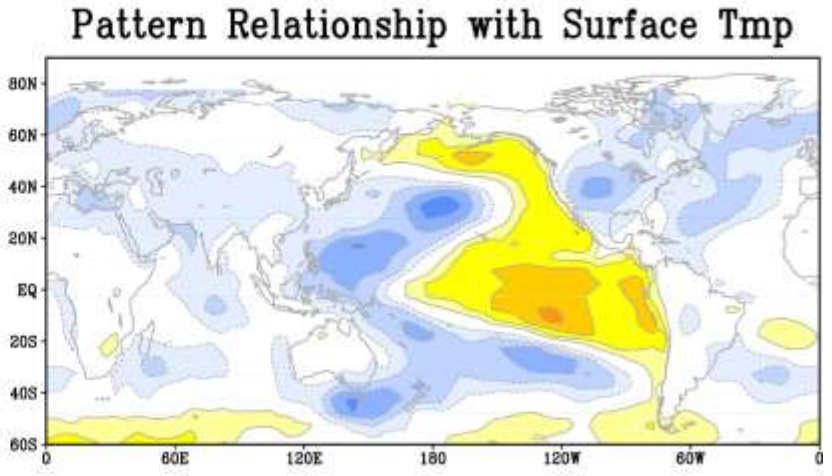
Neither ocean states nor human-induced climate change - factors that can provide long-lead predictability - appeared to play significant roles in causing severe rainfall deficits that were of record intensity over the Central Great Plains in summer 2012.

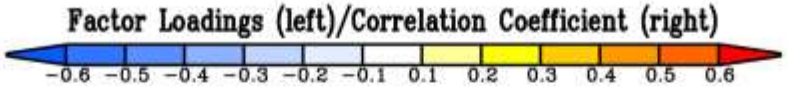
Hoerling et al. 2013 Bulletin of American Met. Society, in review

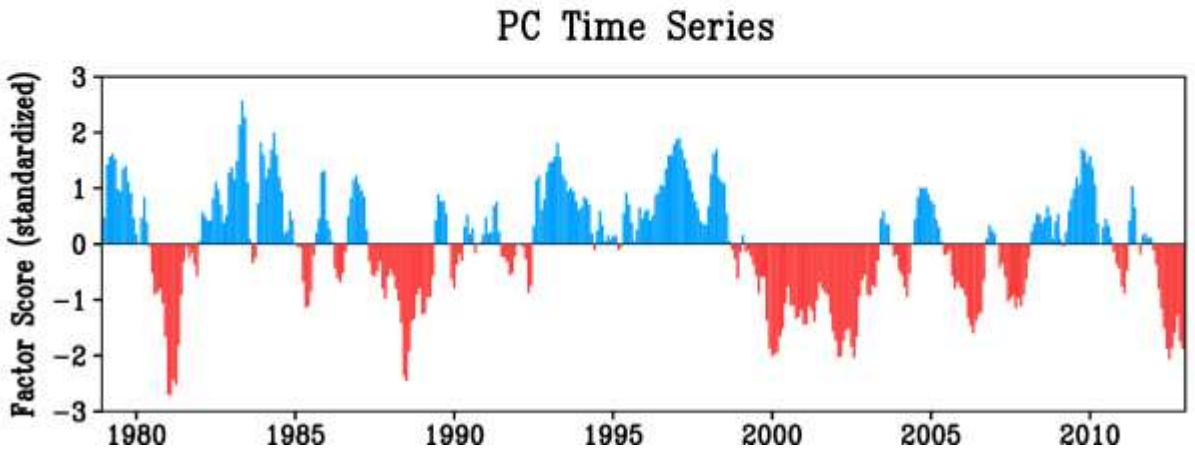
“Observed” US Soil Moisture Variability (EOF1) : 1979-2012

From Seager and Hoerling, 2013



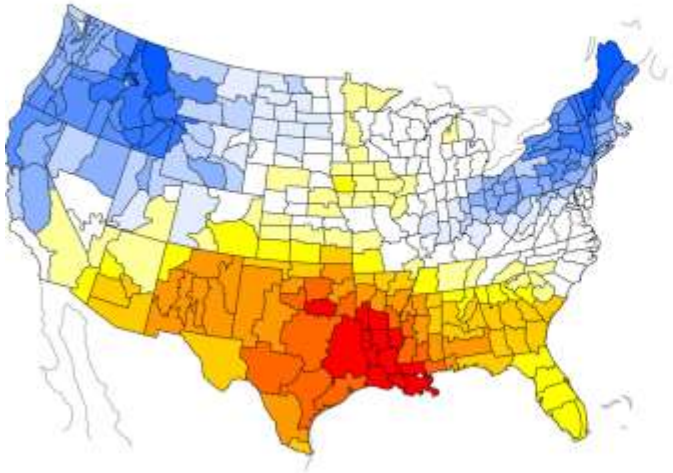


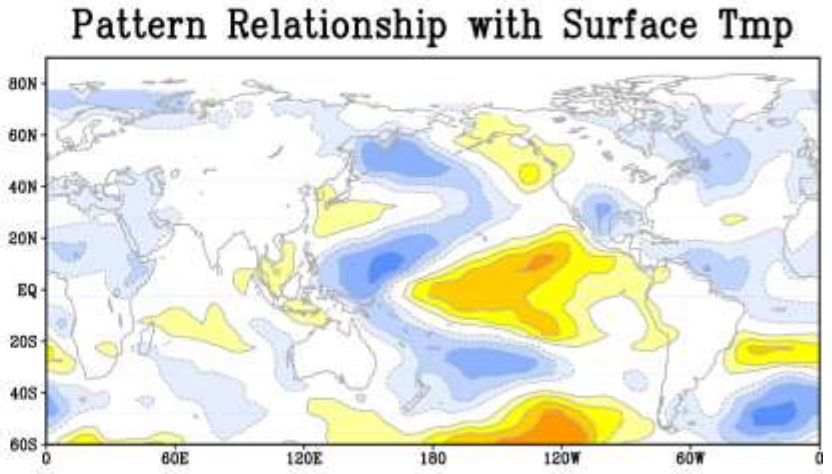


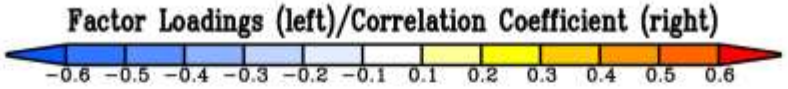


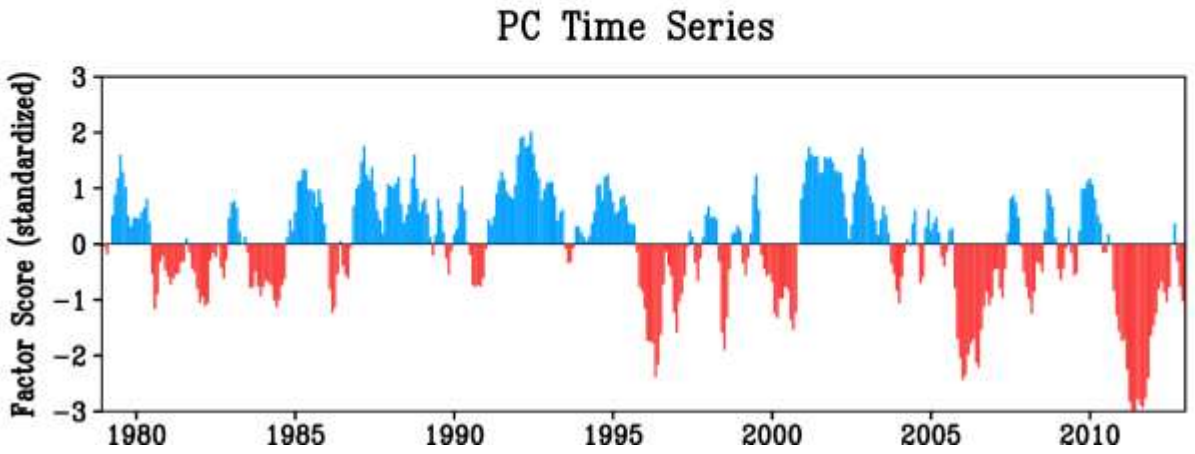
“Observed” US Soil Moisture Variability (EOF3) : 1979-2012

From Seager and Hoerling, 2013



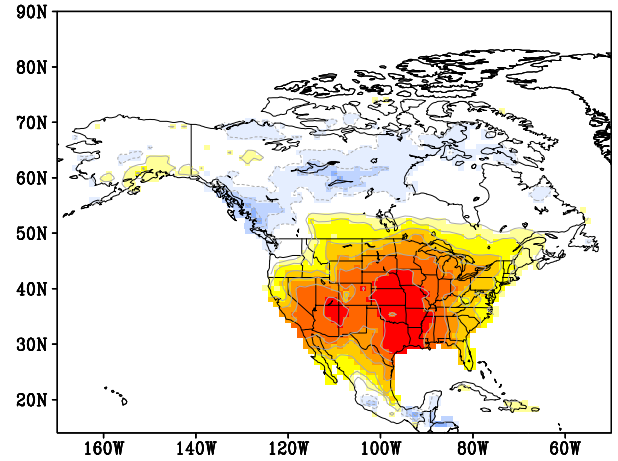


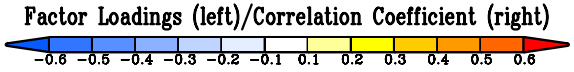


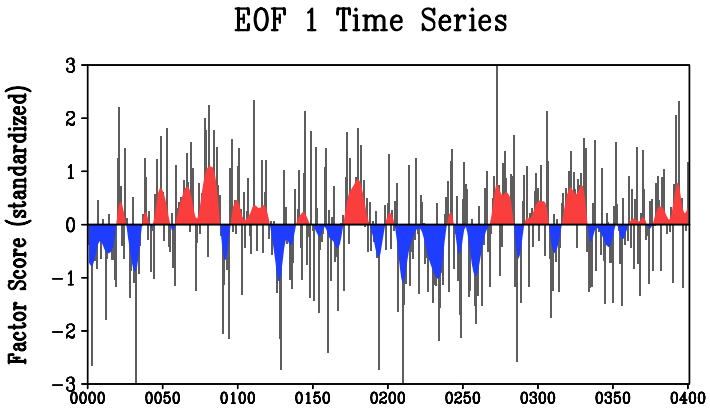


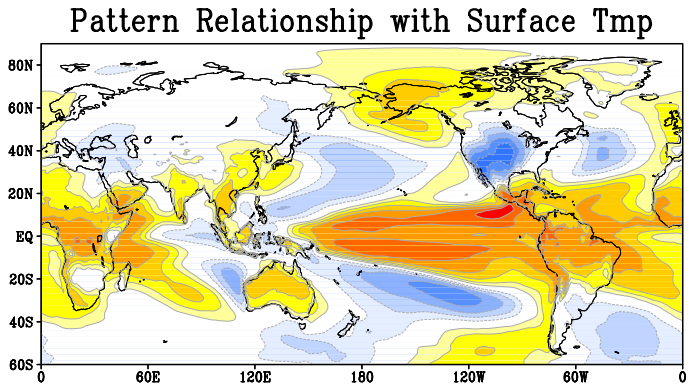
Coupled Model North American Soil Moisture Variability (EOF1)

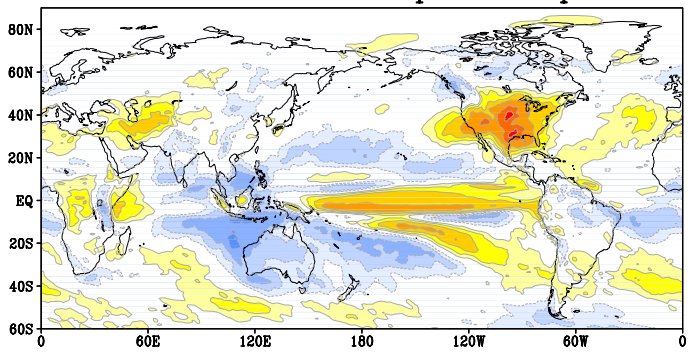
500-yr simulation of NCAR's CCSM4









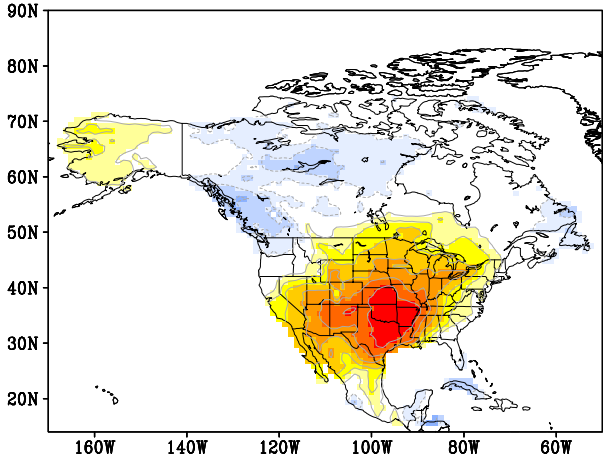


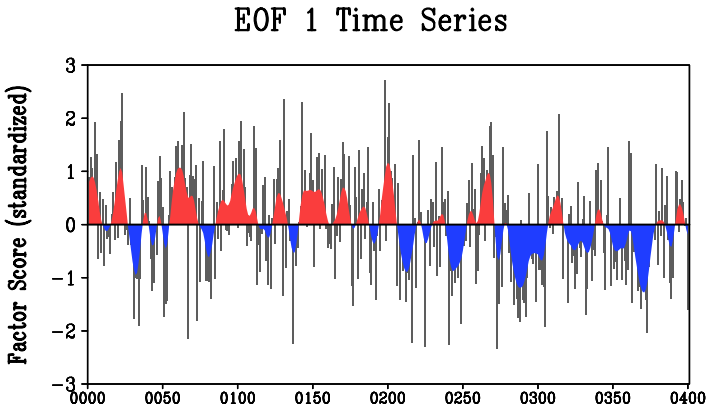
Confirming evidence for SST-link to a contiguous US scale soil moisture variability

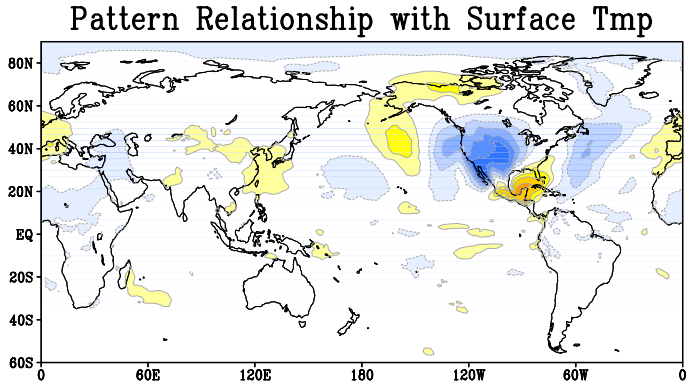
Good News!

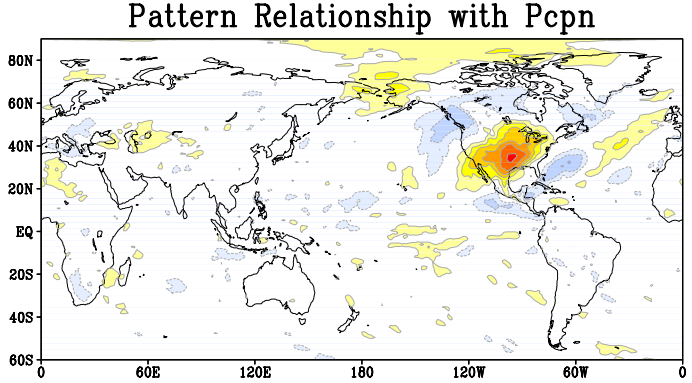
Atmospheric Model North American Soil Moisture Variability (EOF1)

500-yr simulation of NCAR's CAM4







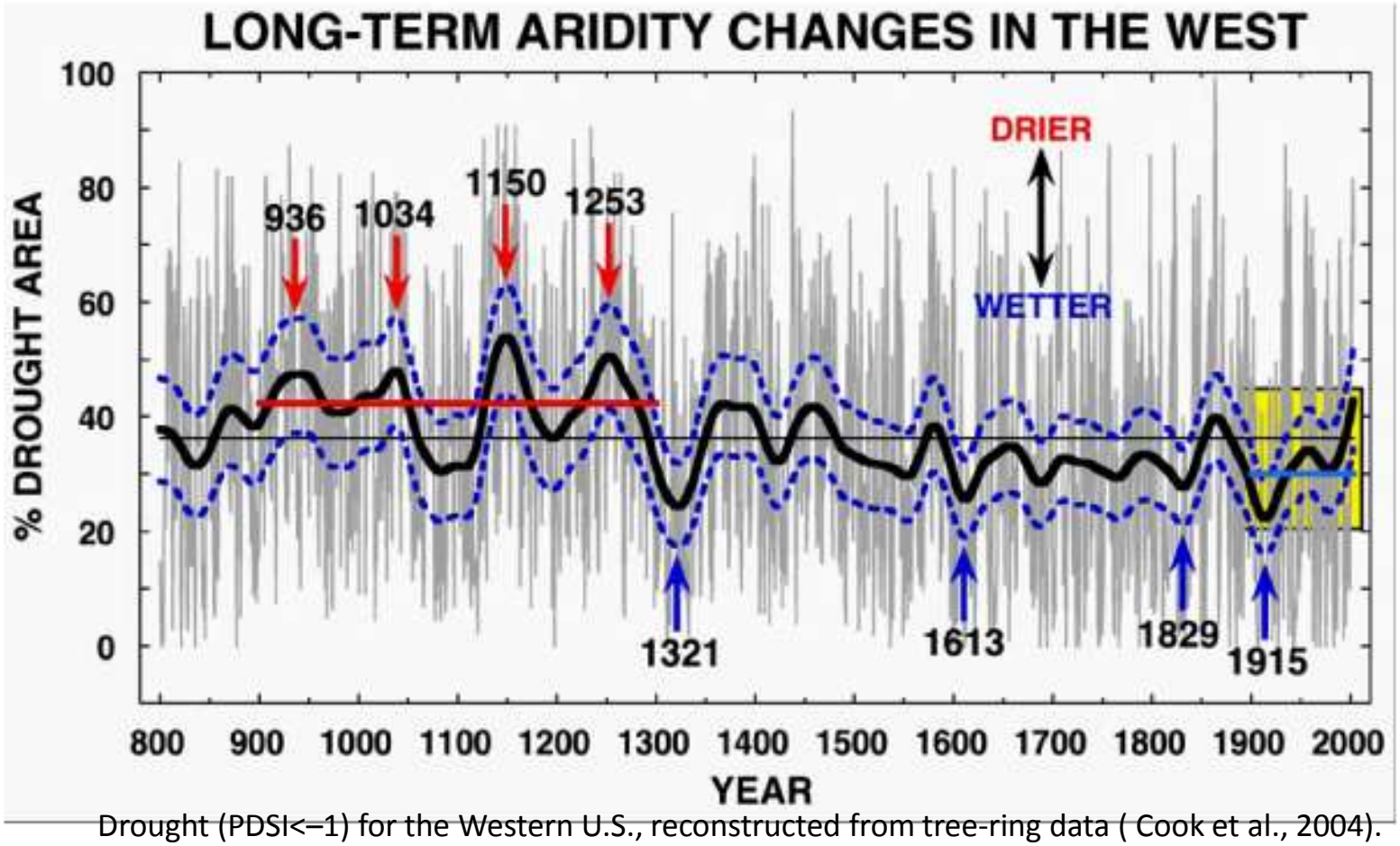


Long-lived US drought can arise due to random atmospheric variability alone

Terrible News for long-lead predictability!

The Story of the Rings

as told by the "Ents" (Trees)

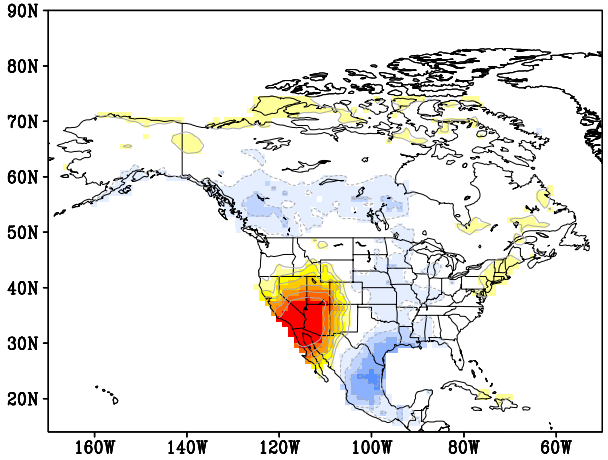


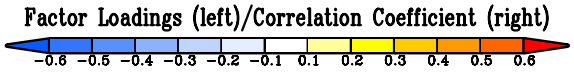
Drought (PDSI<=–1) for the Western U.S., reconstructed from tree-ring data (Cook et al., 2004).

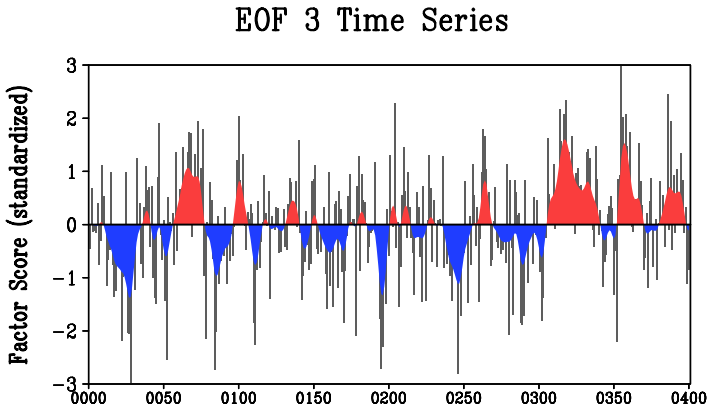
Paleo-droughts: But that was then, and this is now….*Right*?

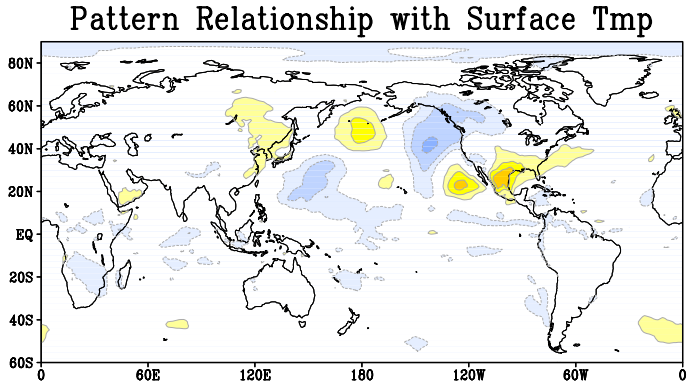
Atmospheric Model North American Soil Moisture Variability (EOF3)

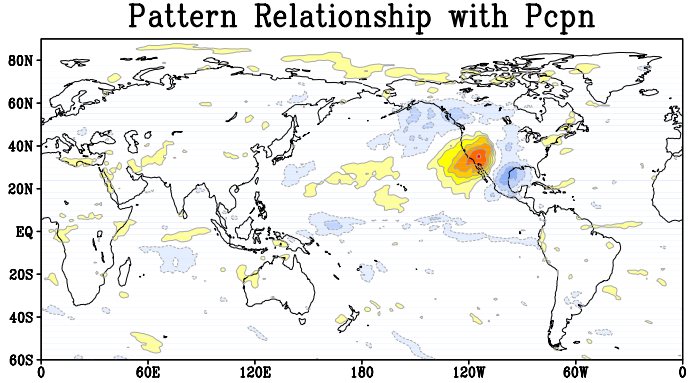
500-yr simulation of NCAR's CAM4









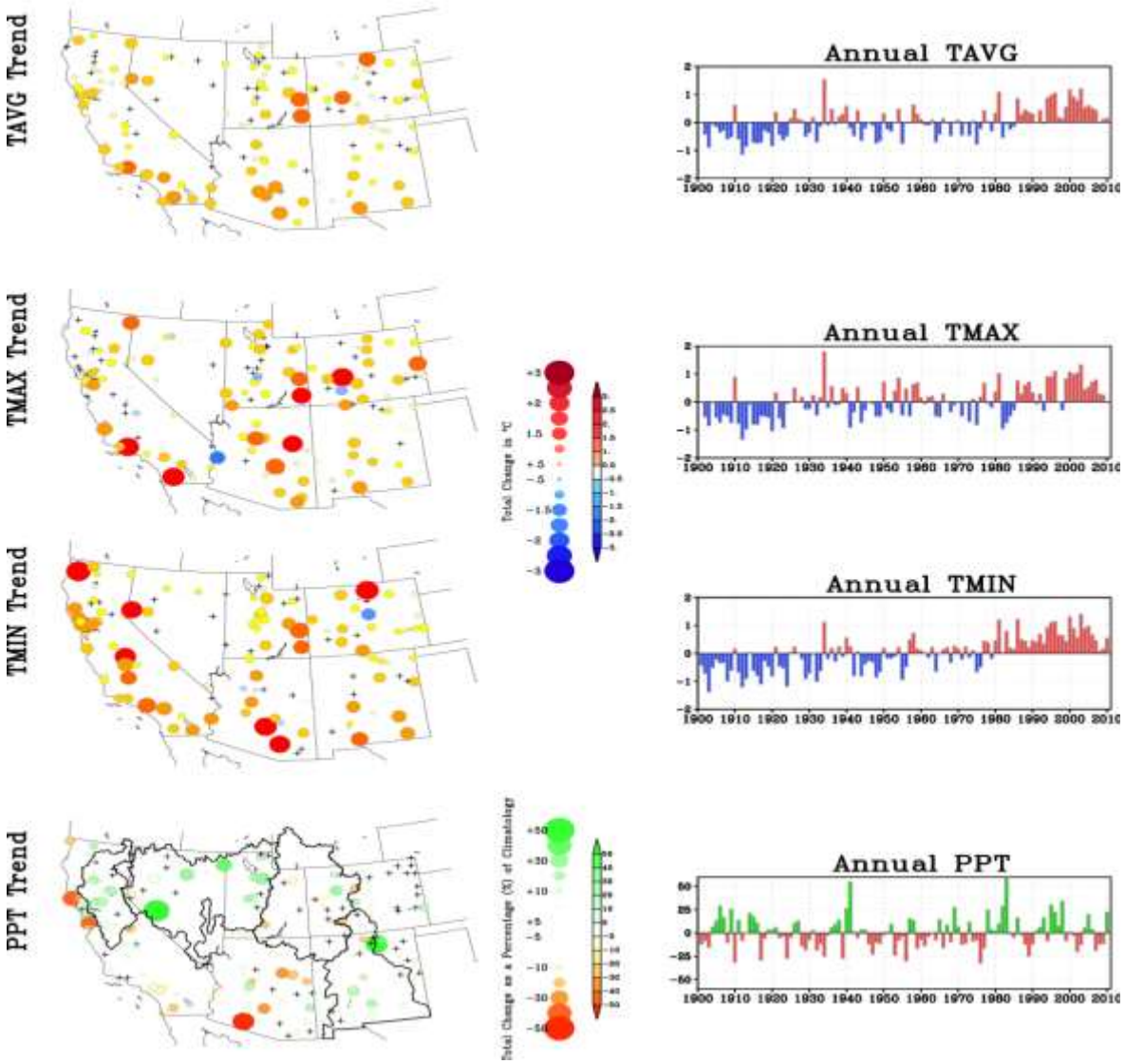


Decadal-centenial SW US pluvials & drought can arise from atmospheric noise alone

Factors that may explain SW paleo-droughts are likely still in play today

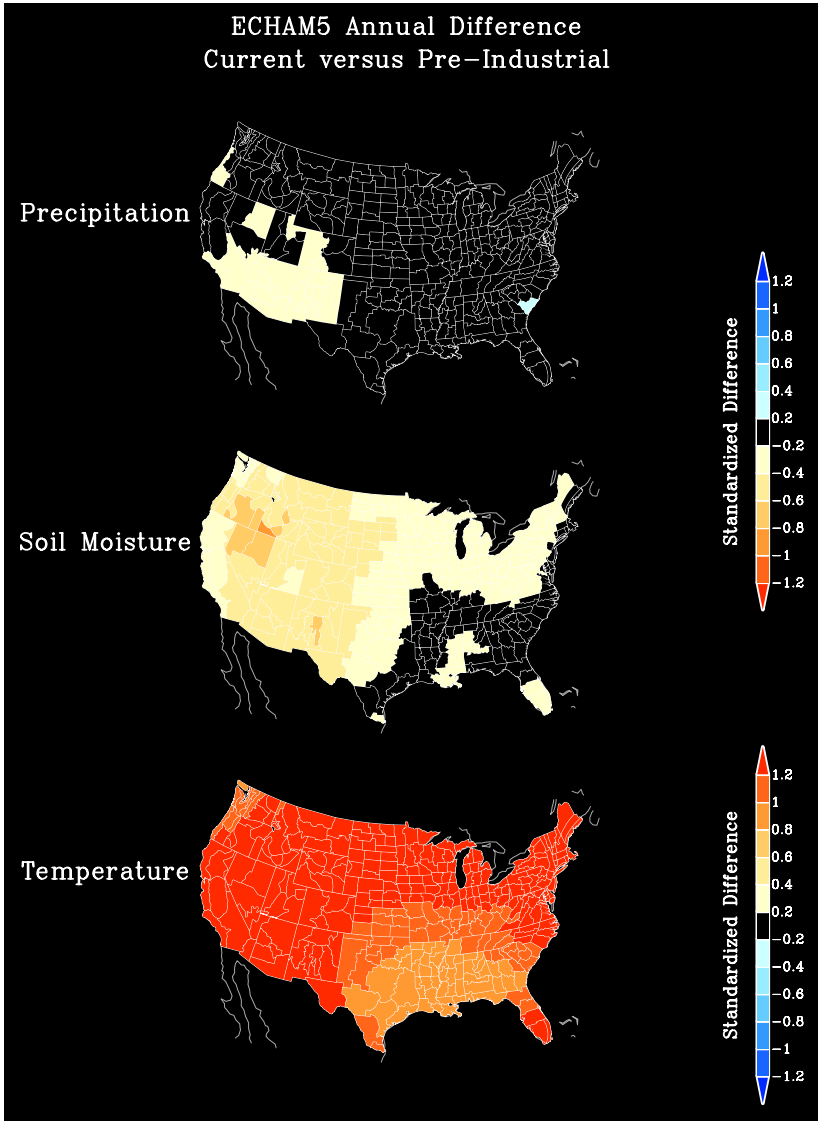
Observations of How Climate Has Changed since 1900

Annual sfcT for the 6-state SW region has warmed about 0.9°C during 1901-2010



Hoerling, M. P., Dettinger, M., Wolter, K., Lukas, J., Eischeid, J., Nemani, R., Liebmann, B., & Kunkel, K. E., 2013: Chapter 5: Present Weather and Climate: Evolving Conditions . In: Garfin, G., Jardine, A., Merideth, R., Black, M., & LeRoy, S. (Eds.), *Assessment of Climate Change in the Southwest United States: a Report Prepared for the National Climate Assessment*. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

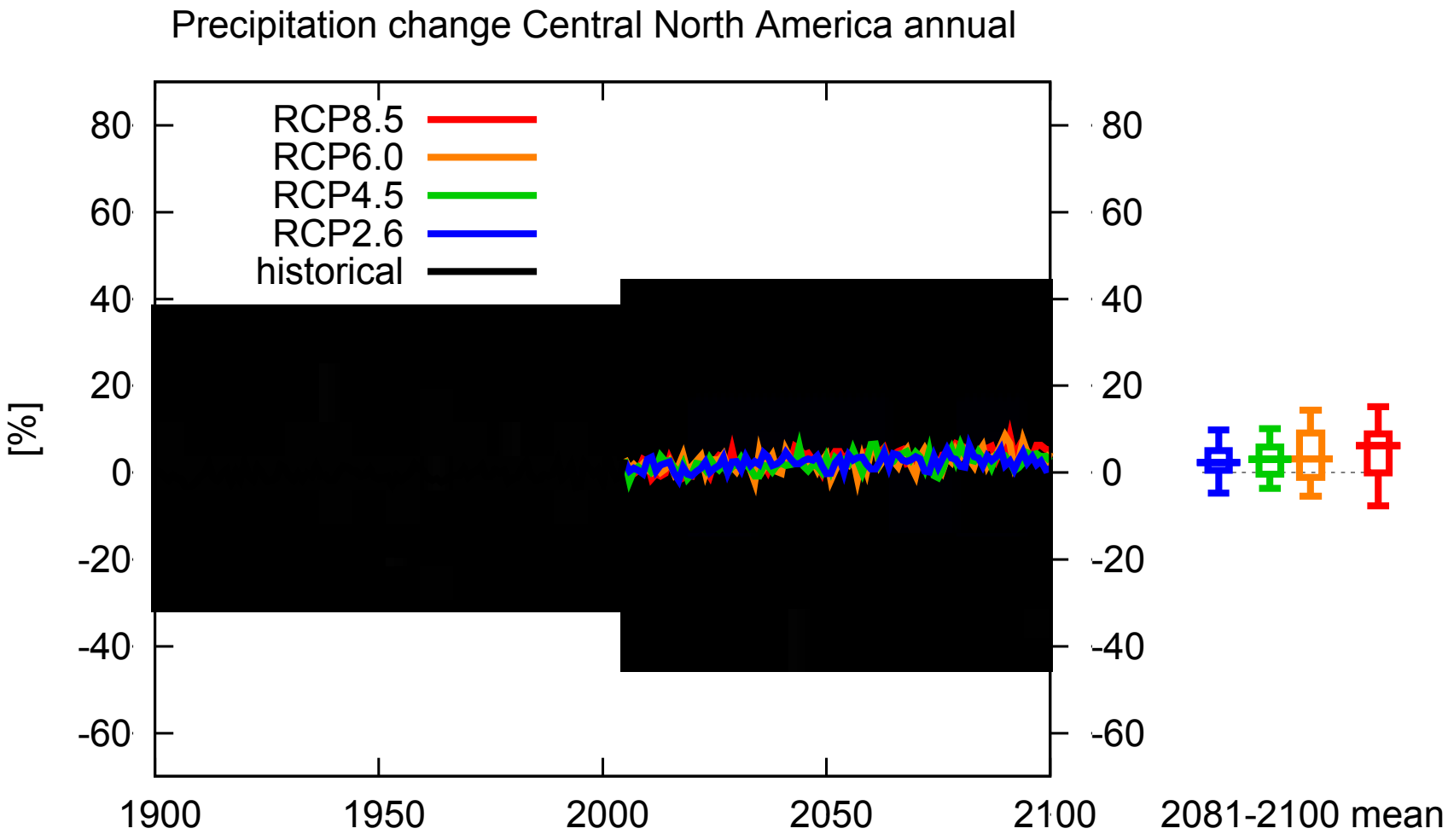
Century-long Warming of the West Has Likely Reduced Soil Moisture
But by How Much?



For particular rainfall deficits, drought is now entered more quickly & exited more slowly

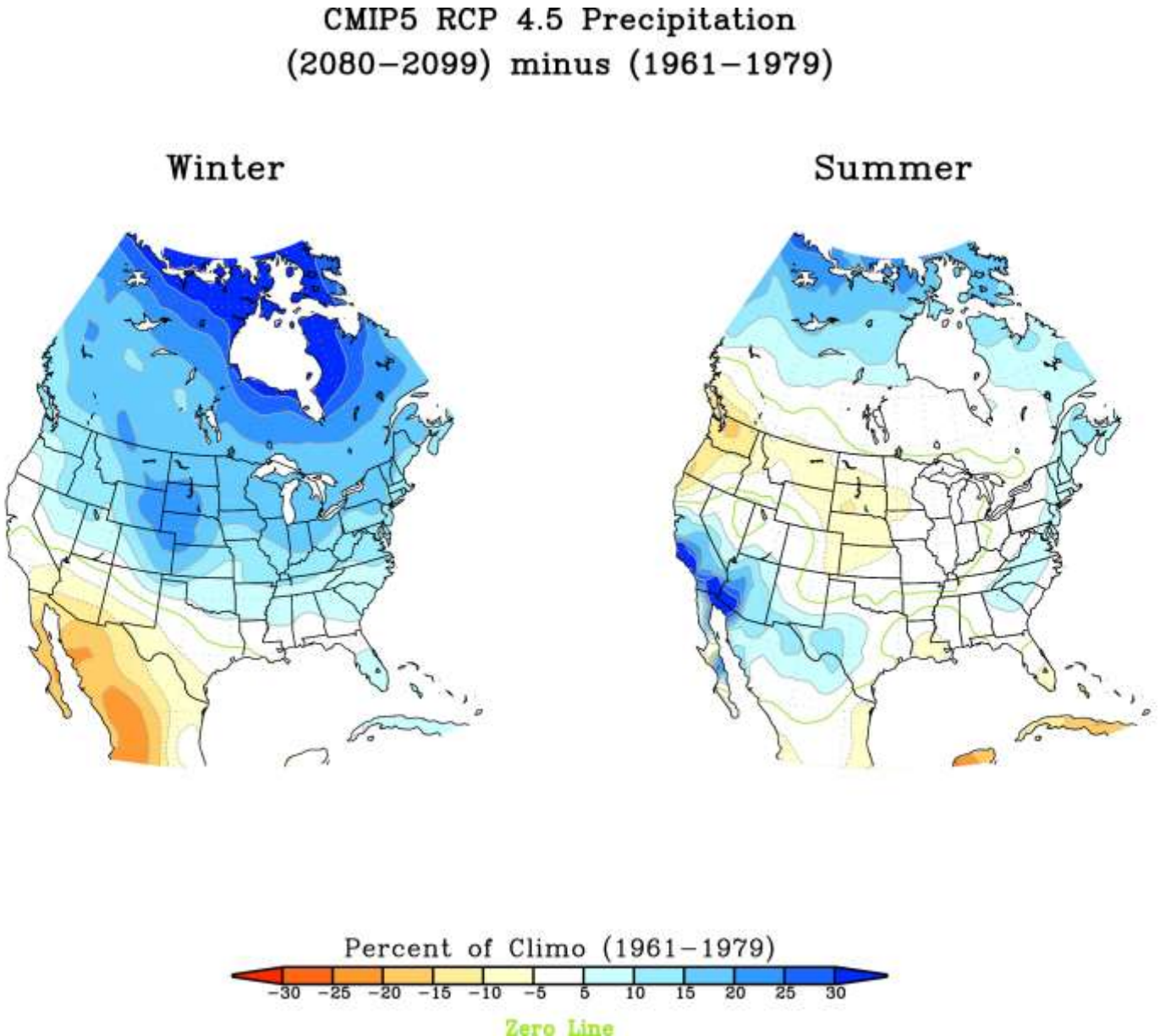
Is Semi-Permanent Drought Imminent for the Great Plains?

(See discussion in Hoerling et al. 2013, JClimate)



Suites of CMIP5 models do not reveal strong signals of Great Plains precipitation change, and they exhibit little sensitivity of the regions pcpn to future rates of GHG emissions.

Favorable Projections for Future Pcpn for Upper Colorado River Basin?



Favorable Projections for Future Pcpn for Upper Colorado River Basin?