21st Century Climate Change, Sustained Droughts and Human – Environmental Impacts

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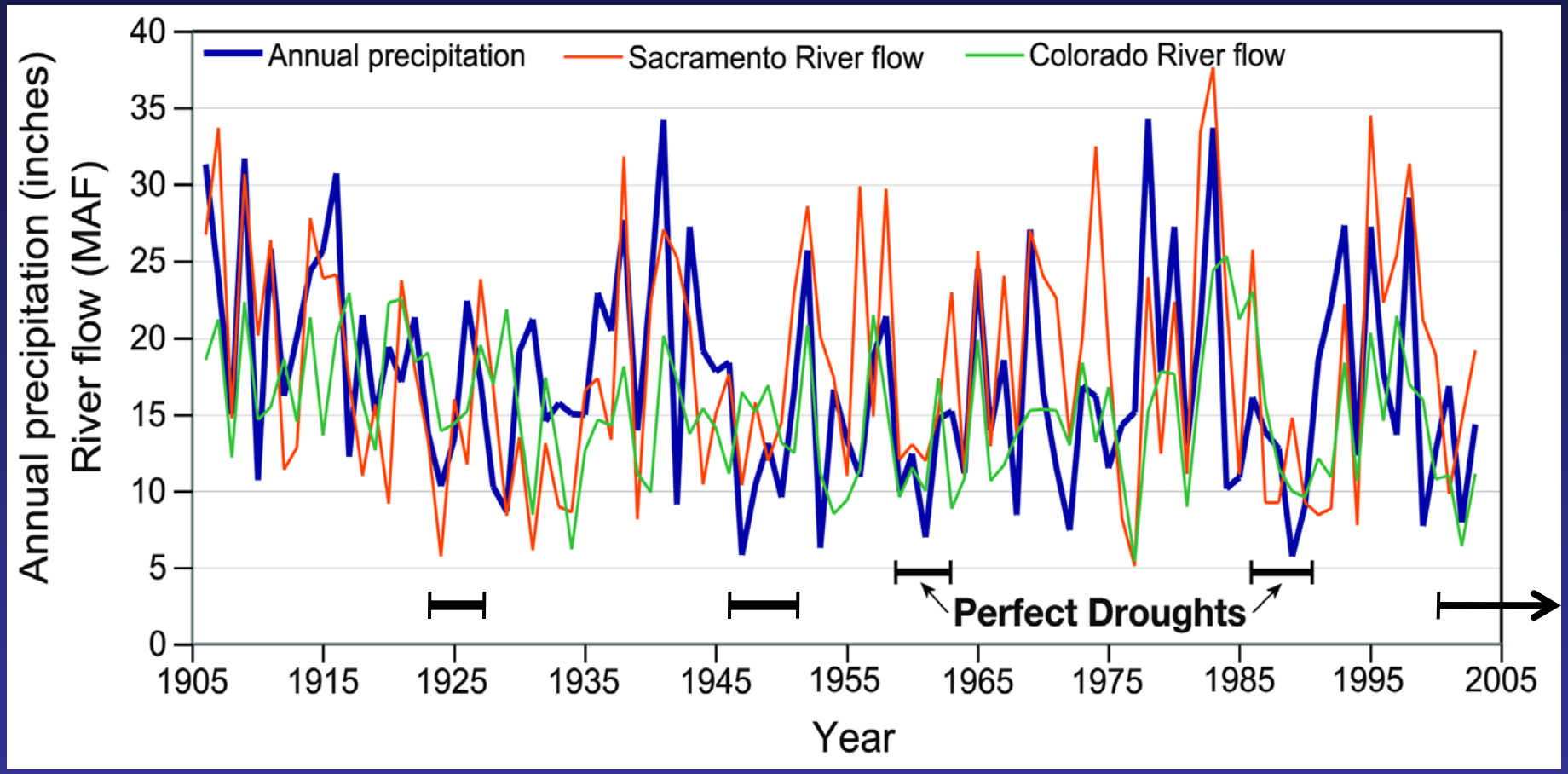
PERFECT DROUGHTS – Synchronous Droughts in Southern California, Northern California and Colorado River Basin from Observational Data.

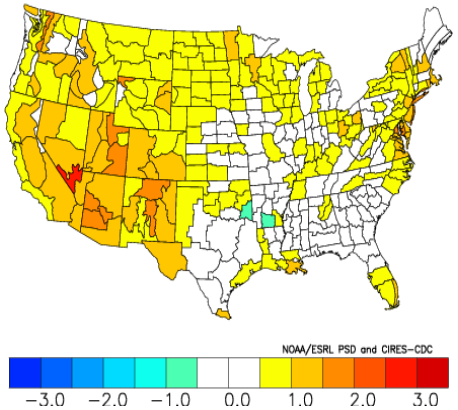


MacDonald, G.M., Rian, S. and Hidalgo, H. 2005. Southern California and the perfect drought. Colorado Basin Climate, California Department of Water Resources, pp 50-57.

MacDonald, G.M., Kremenetski, K.V. and Hidalgo, H. 2008. Southern California and the Perfect Drought: simultaneous prolonged drought in Southern California and the Sacramento and Colorado River systems. Quaternary International 188, 11-23 doi:10.1016/j.quaint.2007.06.027

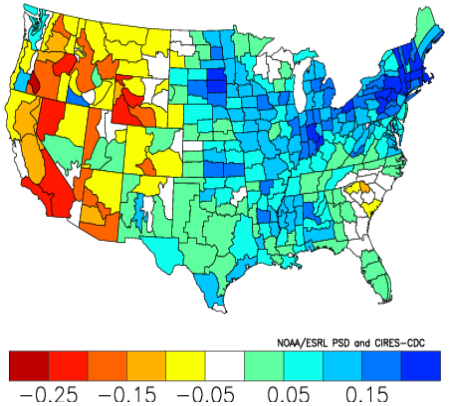
2001-2009

Temperature



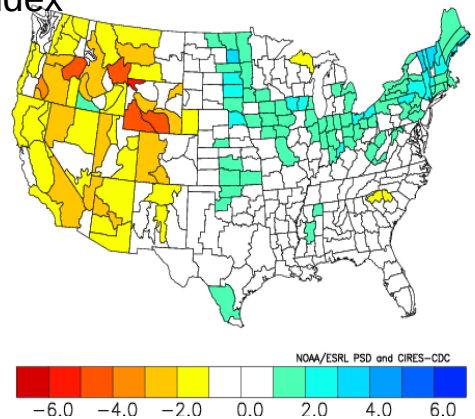
a

Precipitation

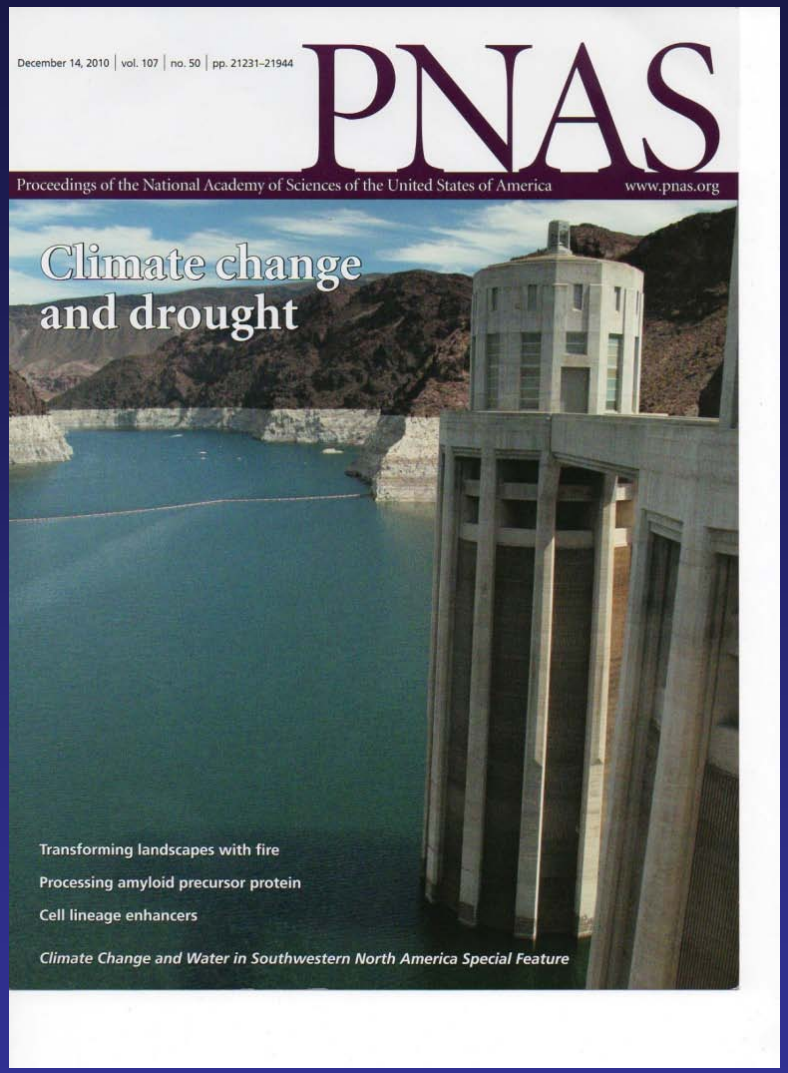


b

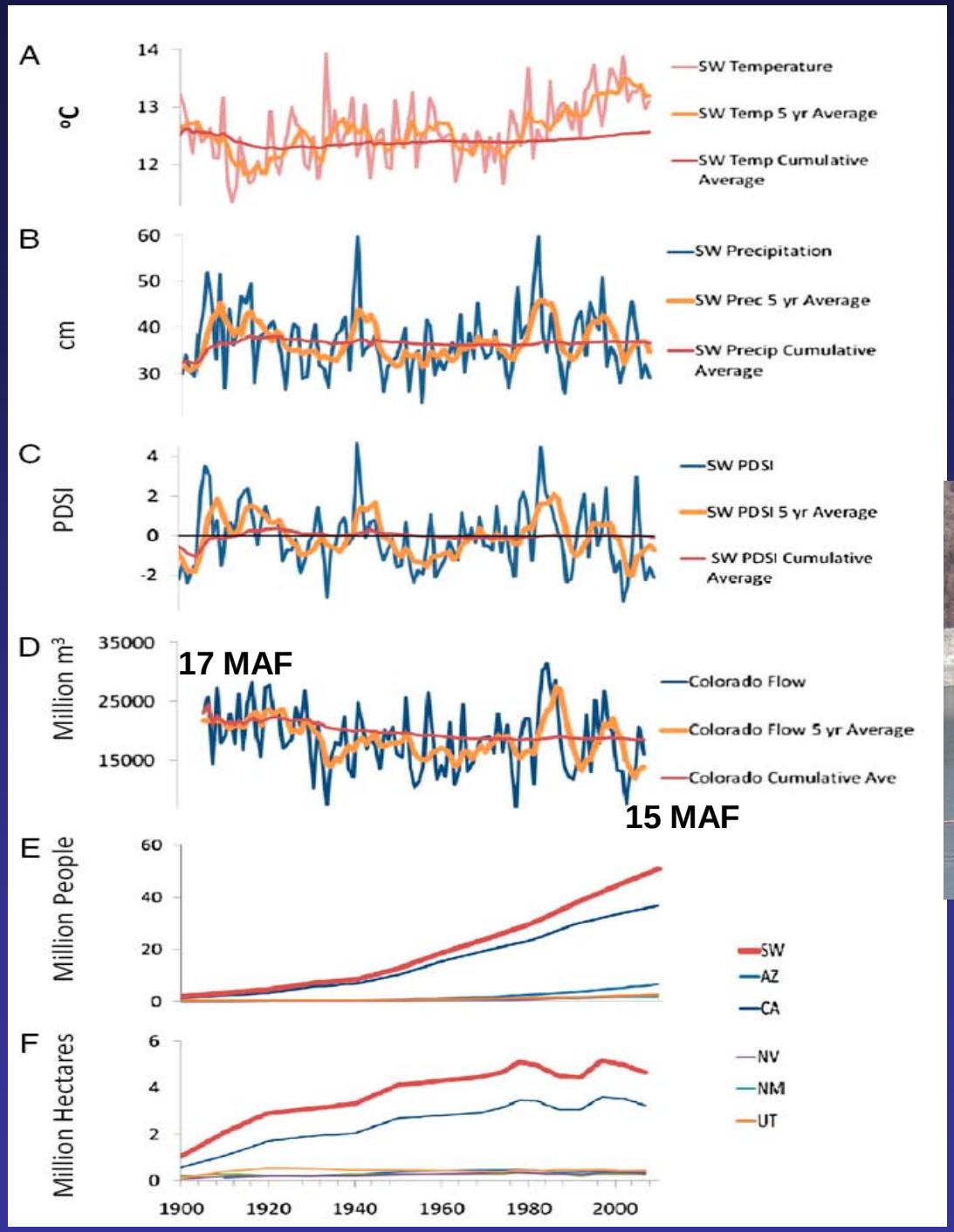
Drought Index



c



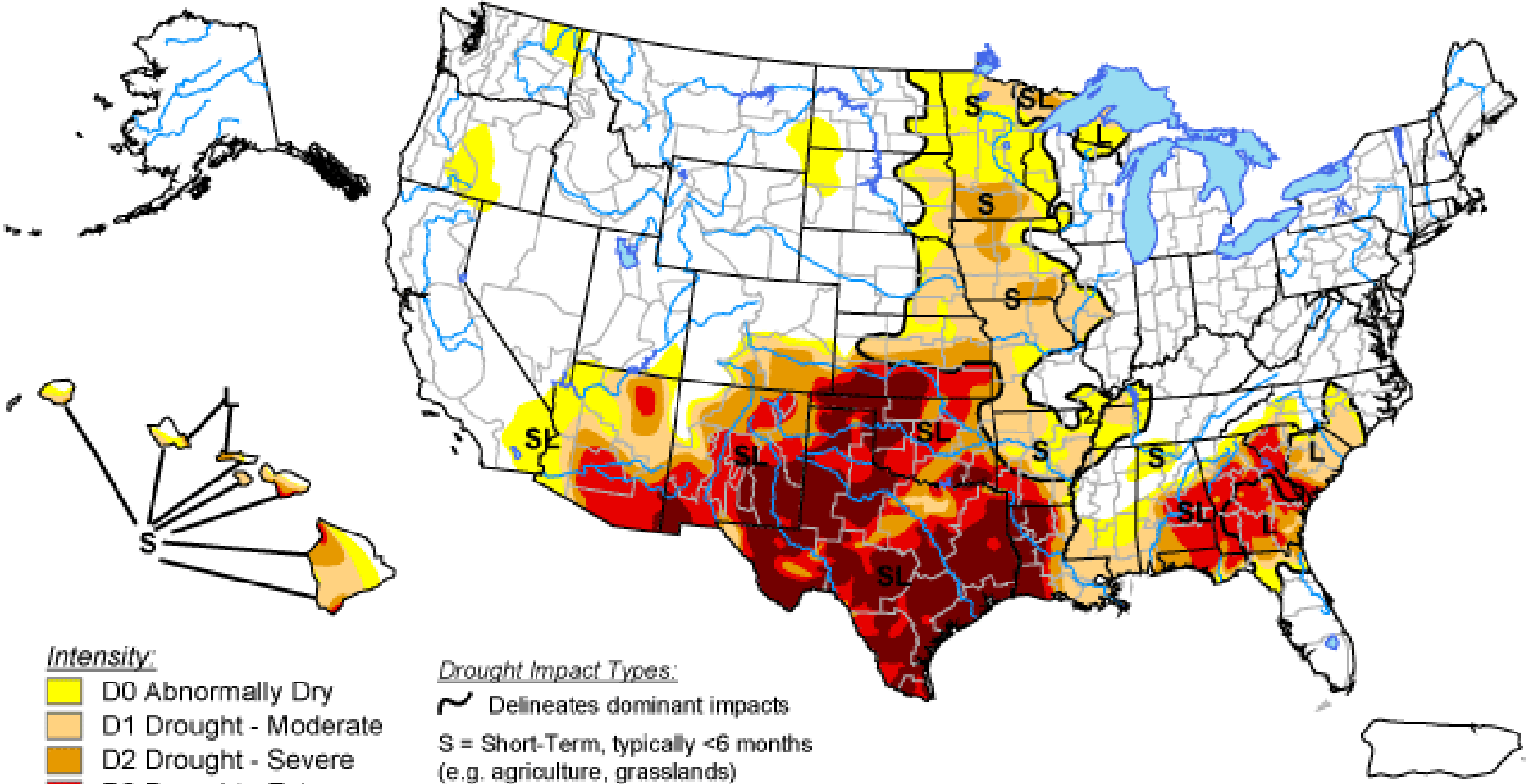
MacDonald 2010 PNAS



MacDonald 2010 PNAS

U.S. Drought Monitor

November 8, 2011
Valid 7 a.m. EST



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

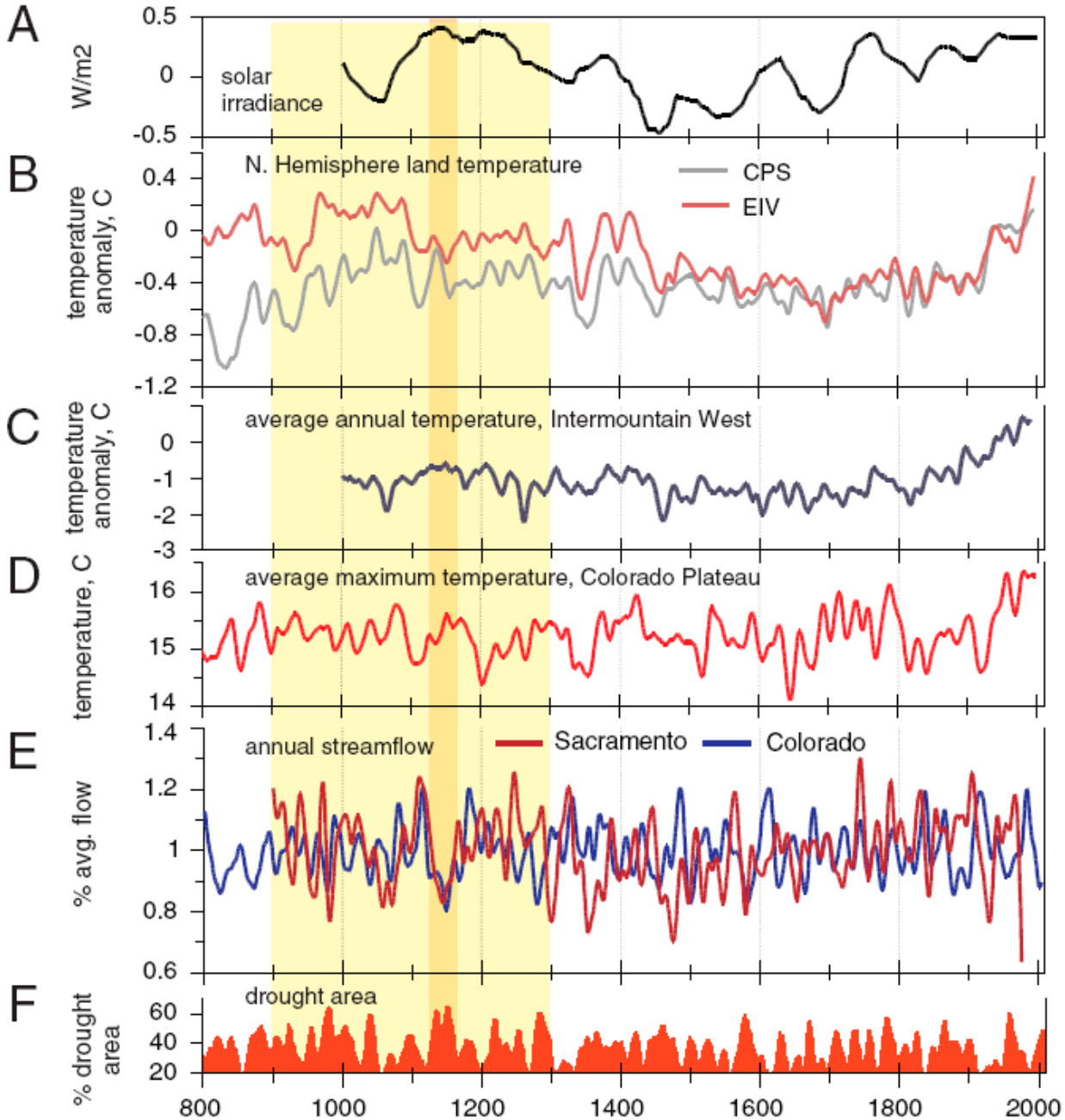
Released Thursday, November 10, 2011

Author: Brian Fuchs, National Drought Mitigation Center

How Bad is the Early 21st Century?

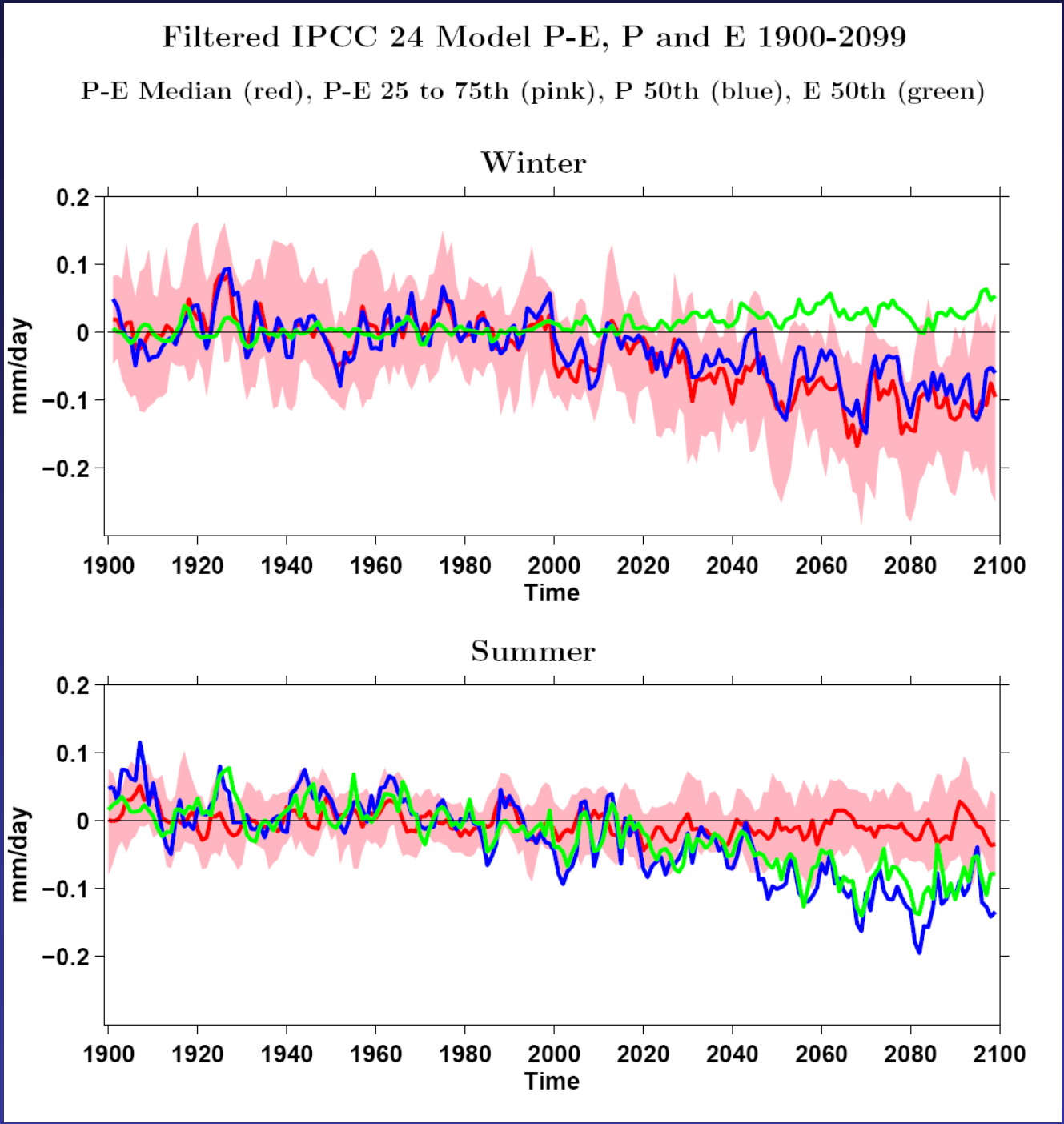
Is it Anthropogenic?

How Bad Might it Get?



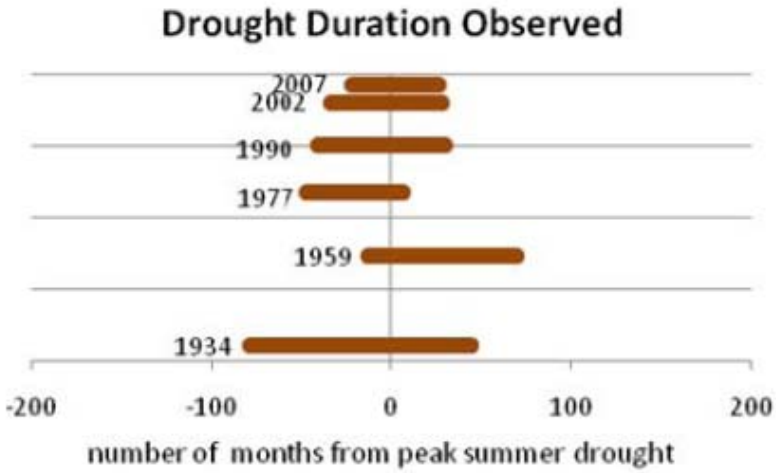
"The recent drought, thus far, pales hydrologically in comparison to the worst-case drought documented in the medieval period in both spatial extent (Fig. 3) and duration."

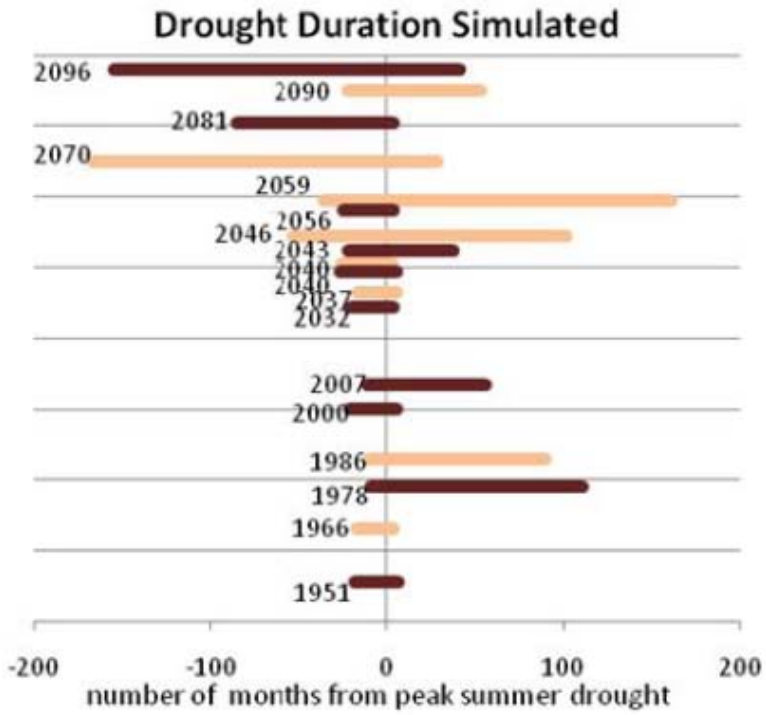
Woodhouse et al PNAS 2010



"Due to the presence of large amplitude decadal variations of presumed natural origin, observations to date cannot confirm that this transition to a drier climate is already underway,
but it is anticipated that the anthropogenic drying will reach the amplitude of natural decadal variability by midcentury."

Seager and Vecchi, PNAS 2010





Cayan et al. PNAS 2010

Duration of observed dry intervals associated with extreme drought, determined as those months with persistent negative soil moisture anomalies for Southwest region.

Simulated dry intervals over Southwest associated with extreme drought from VIC hydrological model runs from downscaled CNRM and GFDL simulations, historical period and projected from SRES A2 21st Century simulations. Drought duration determined as for Figure 1a. Light/dark bars designate CNRM and GFDL dry spells, respectively.

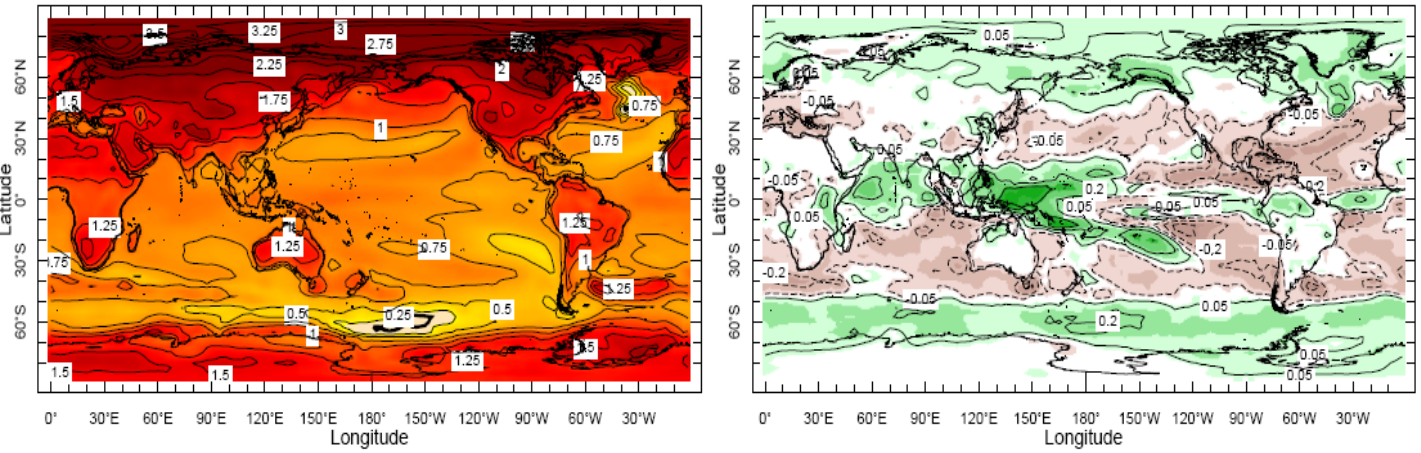
"At this point, it is not possible to say which mechanism (chance or warming) is responsible for the observed dryness in the Colorado basin during the first years of the 21st century."

"Durations of depleted soil moisture over the historical record ranged from 4 to 10 years, but in the 21st Century simulations, some of the dry events persisted for 12 years or more."

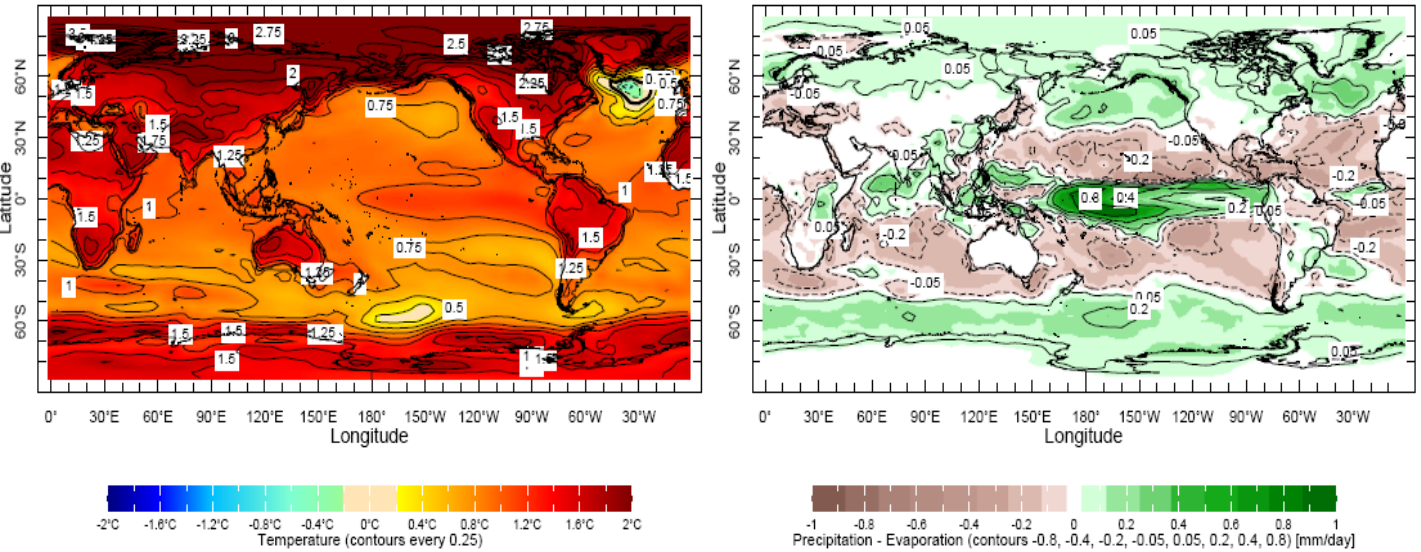
IPCC (2021 to 2040) - (1950 to 1999)

Temperature — Precipitation - Evaporation

Positive Temperature Gradient Composite

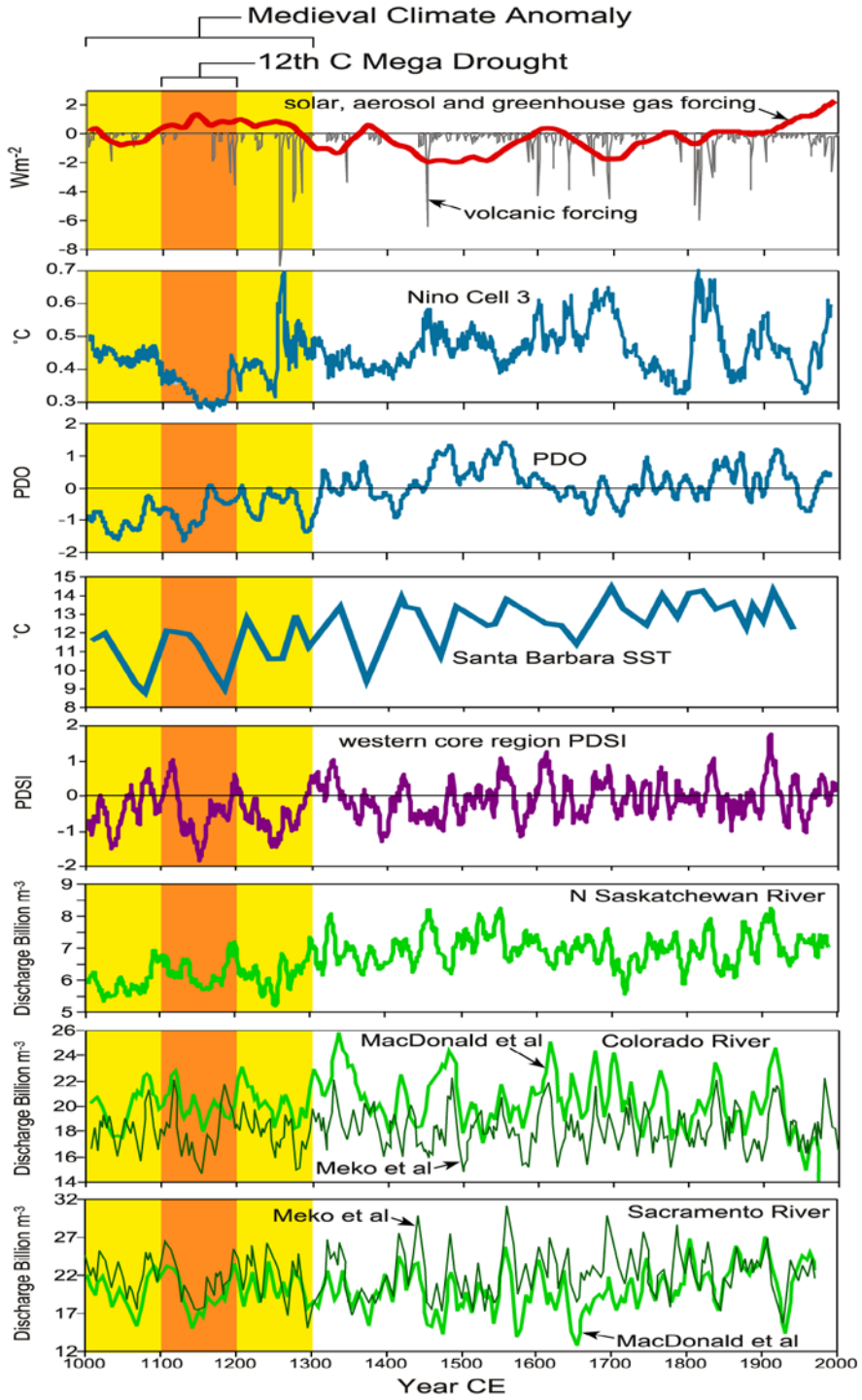


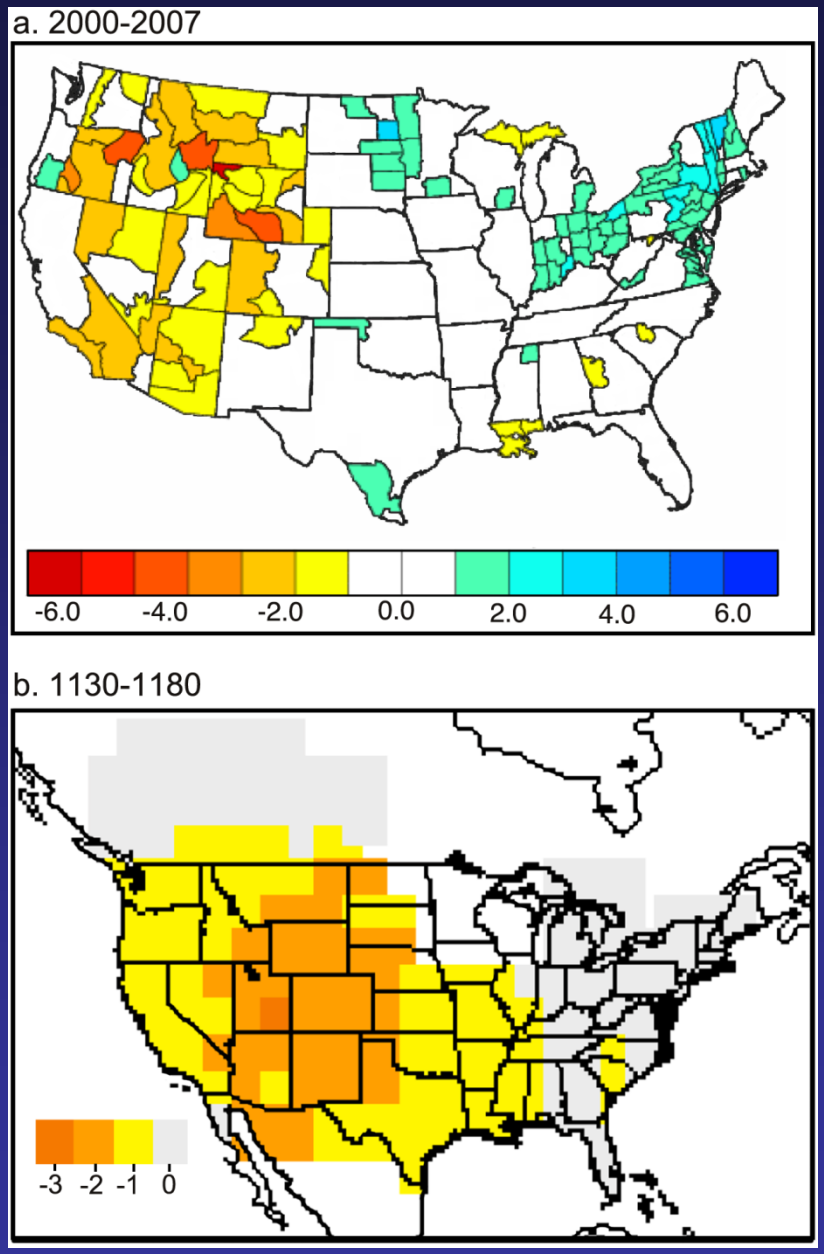
Negative Temperature Gradient Composite



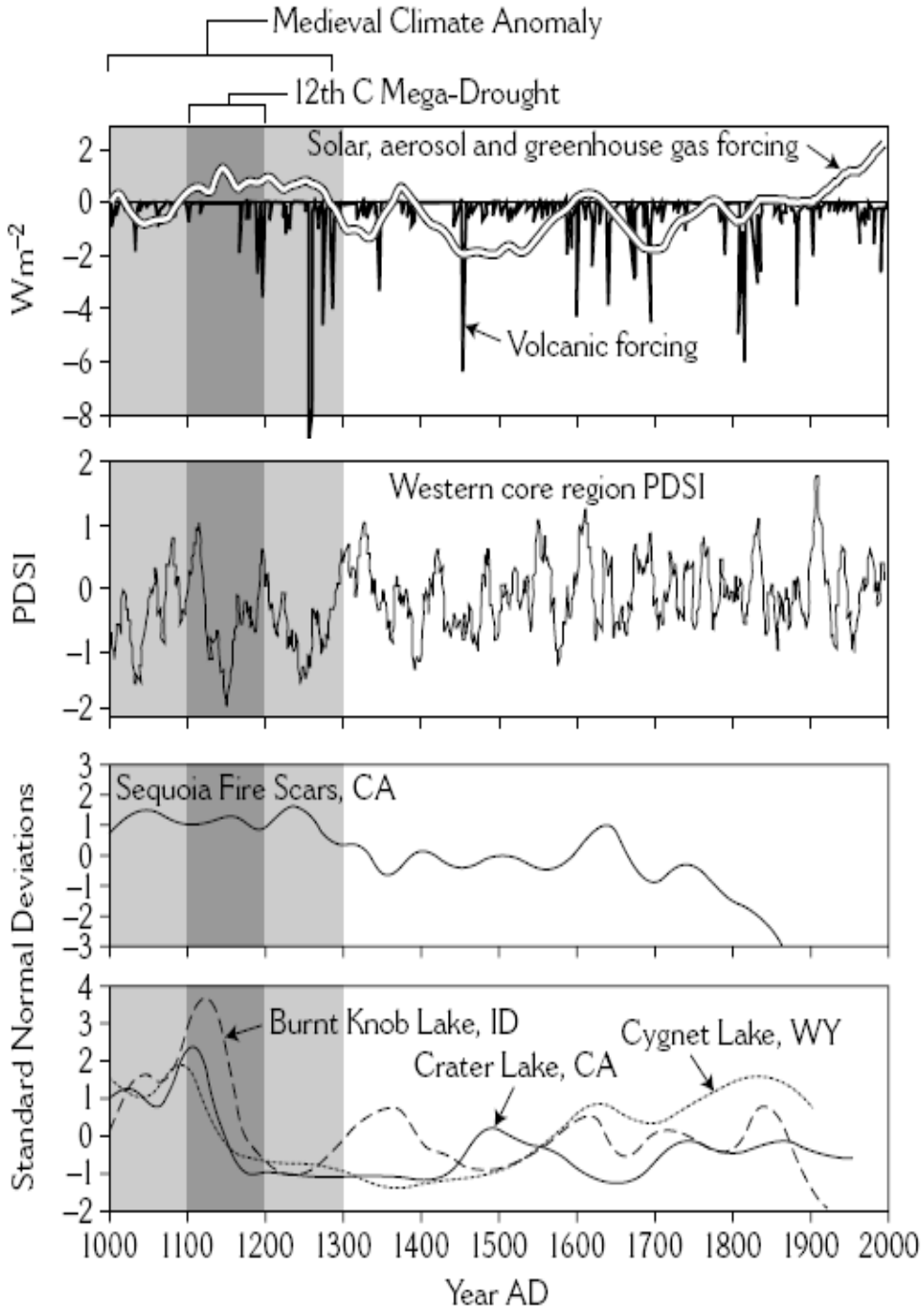
"This result is quite alarming, because the severity of the drying of SWNA that will occur in the near term future will depend on tropical Pacific climate change, but the current generation of climate models simulate the tropical Pacific very poorly (30). We have little confidence in their widely varying projections of how the tropical Pacific climate system will respond to radiative forcing."

Seager and Vecchi, PNAS 2010

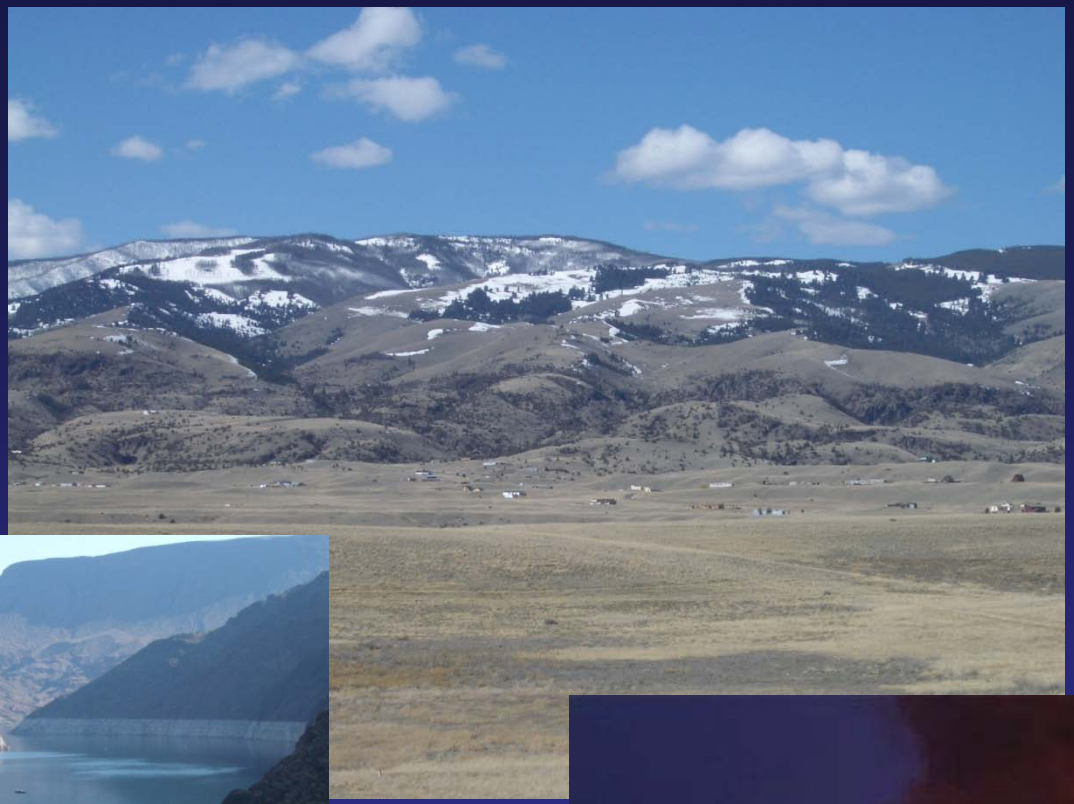




MacDonald et al 2008 EOS



G.M. MacDonald, G.M., Bennett, K.D., Jackson, S.T., Parducci, L., Smith, F.A., Smol, J.P. and Willis, K.J. 2008. Impacts of climate change on species, populations and communities: palaeobiogeographical insights and frontiers Progress in Physical Geography 32, 139-172. **DATA from Crowley; Cook, Swetnam, Whitlock and Colleagues**



Thank you -