

Extreme events – heat and drought

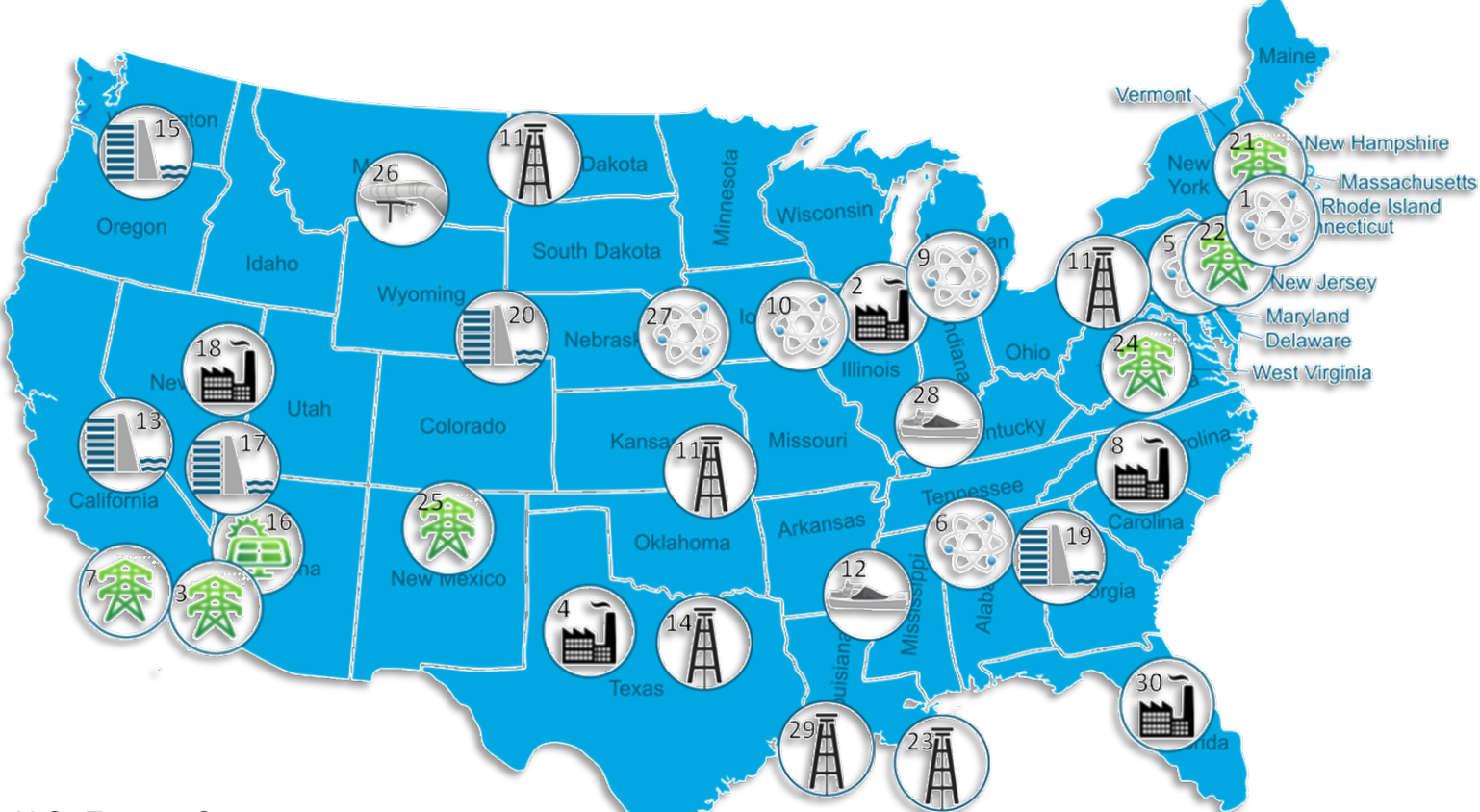
Benjamin L. Preston
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Infrastructure Resilience and
Environmental Policy



*20th Energy and Climate Research Seminar
May 10, 2017, Washington, DC*



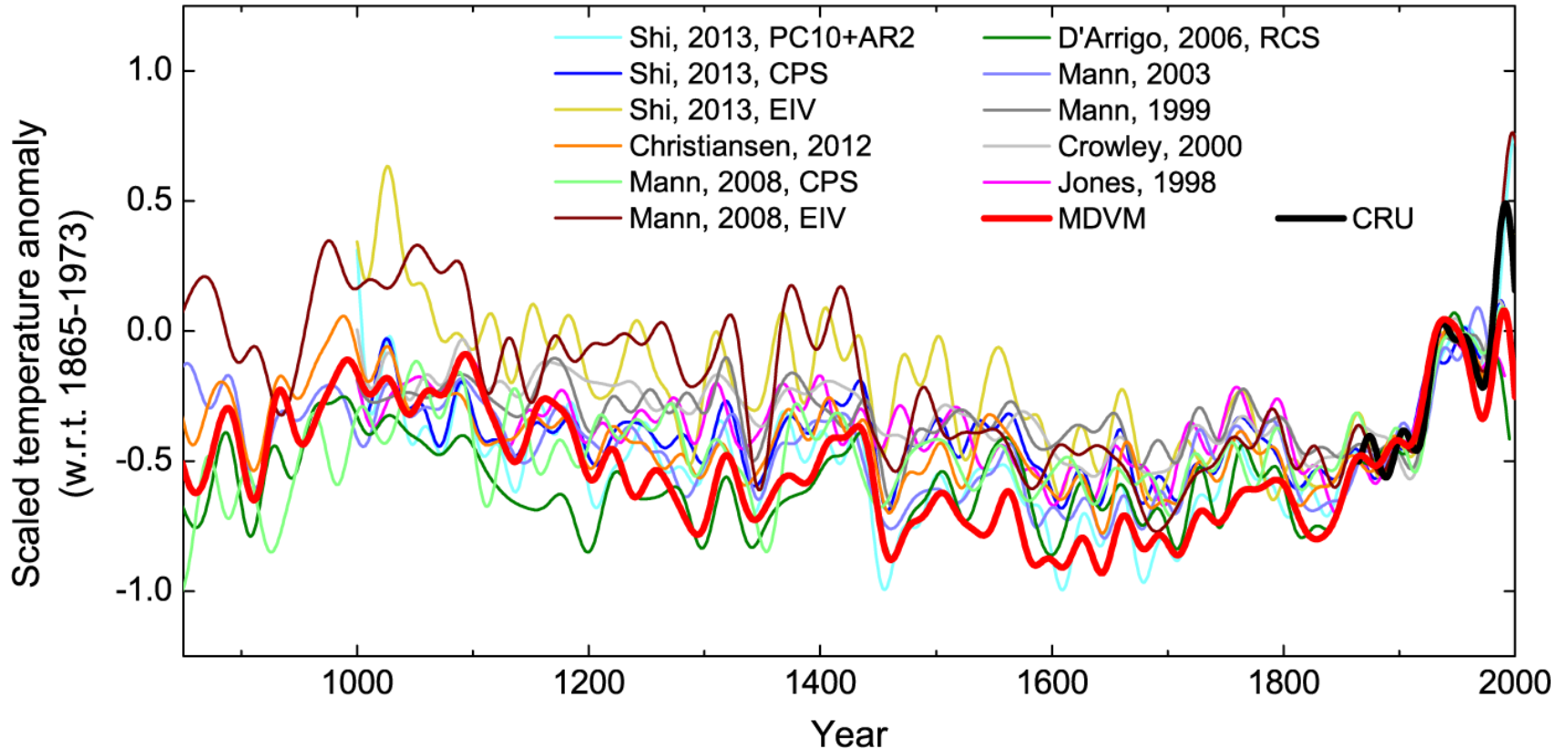
Vulnerability of the U.S. Energy System



DOE (2013) U.S. Energy Sector Vulnerabilities to Climate Change

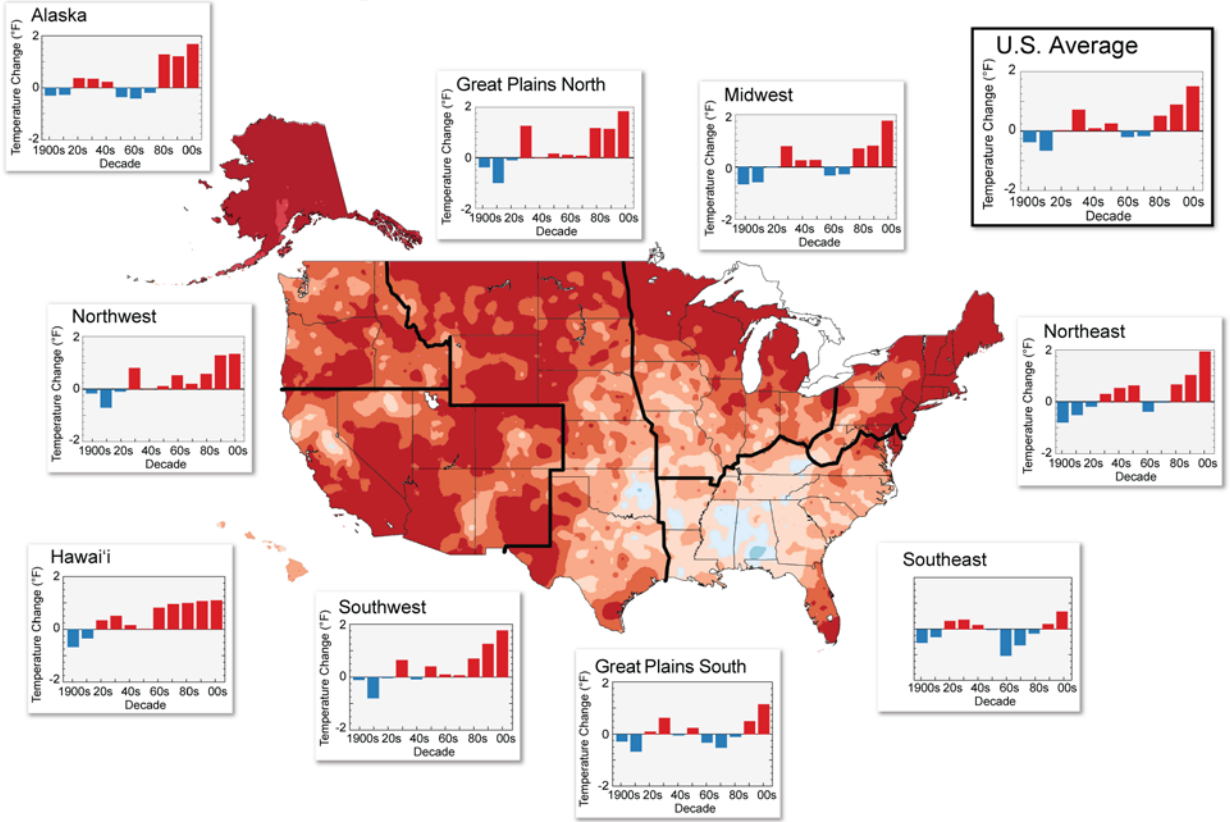


Temperature Trends Since 800 AD

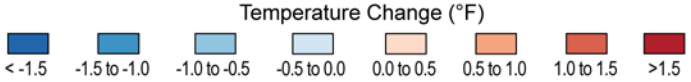


Xing et al. (2016) The extratropical Northern Hemisphere temperature reconstruction during the last millennium based on a novel method.

U.S. Regional Temperature Trends

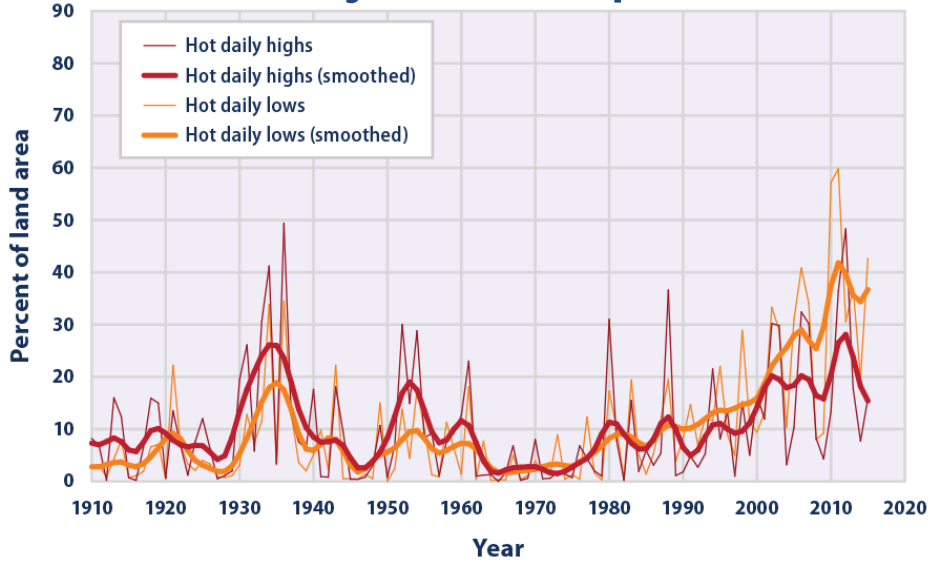


EPA (2016) Climate Change Indicators

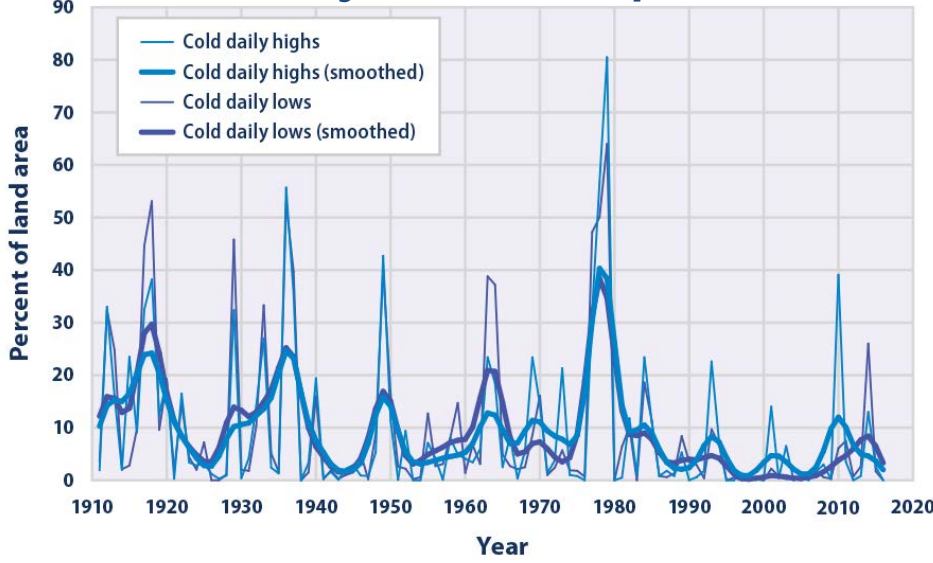


Trends in Extreme Temperature Anomalies

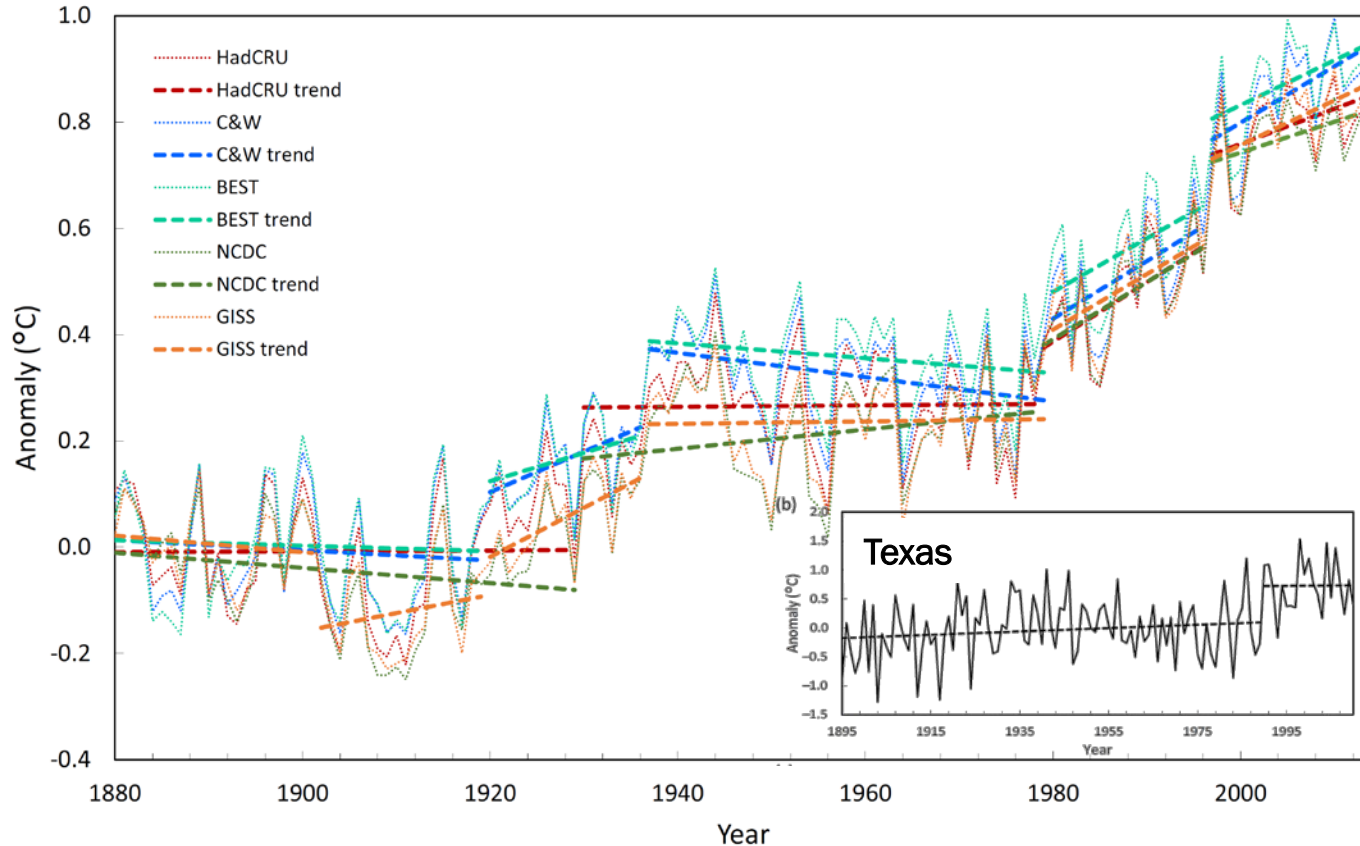
Unusually Hot Temperatures



Unusually Cold Temperatures



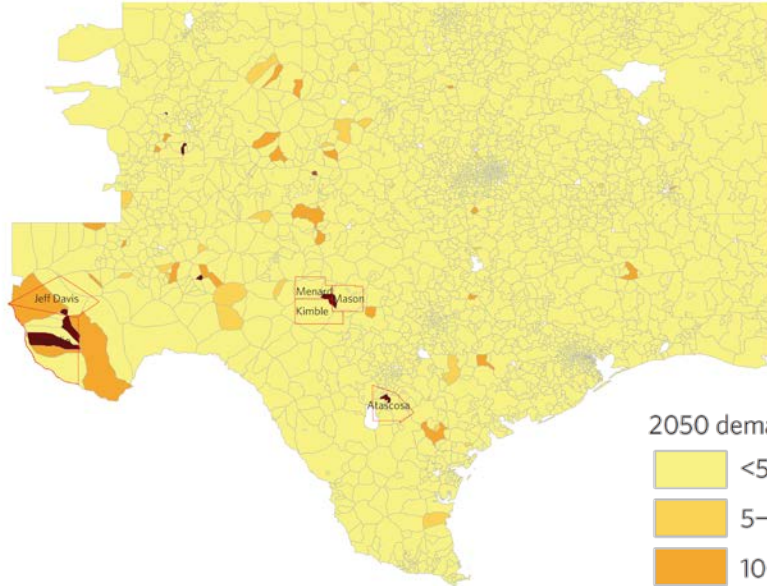
Step Changes in Global & Regional Temperatures?



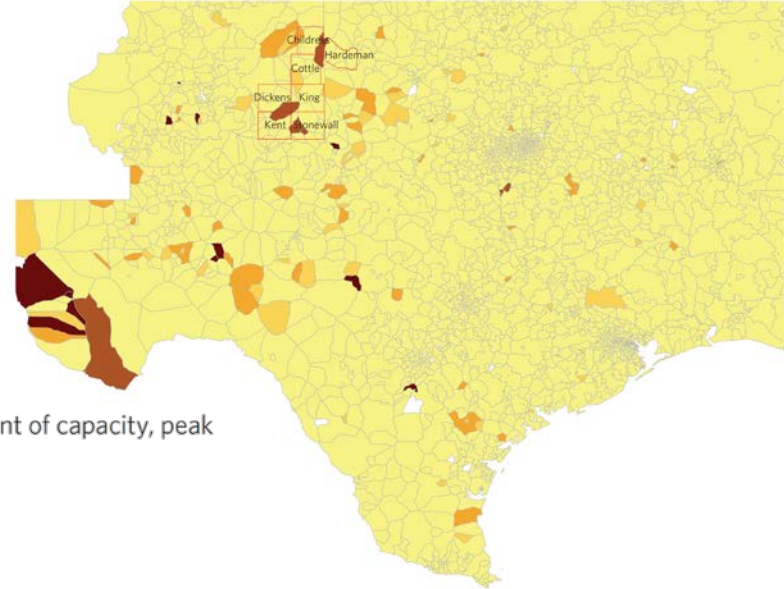
Jones, RN and Ricketts, JH (2017) Reconciling the signal and noise of atmospheric warming on decadal timescales

Climate change and Electricity Demand

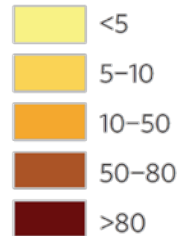
2030 Demand (% of Capacity)



2050 Demand (% of Capacity)

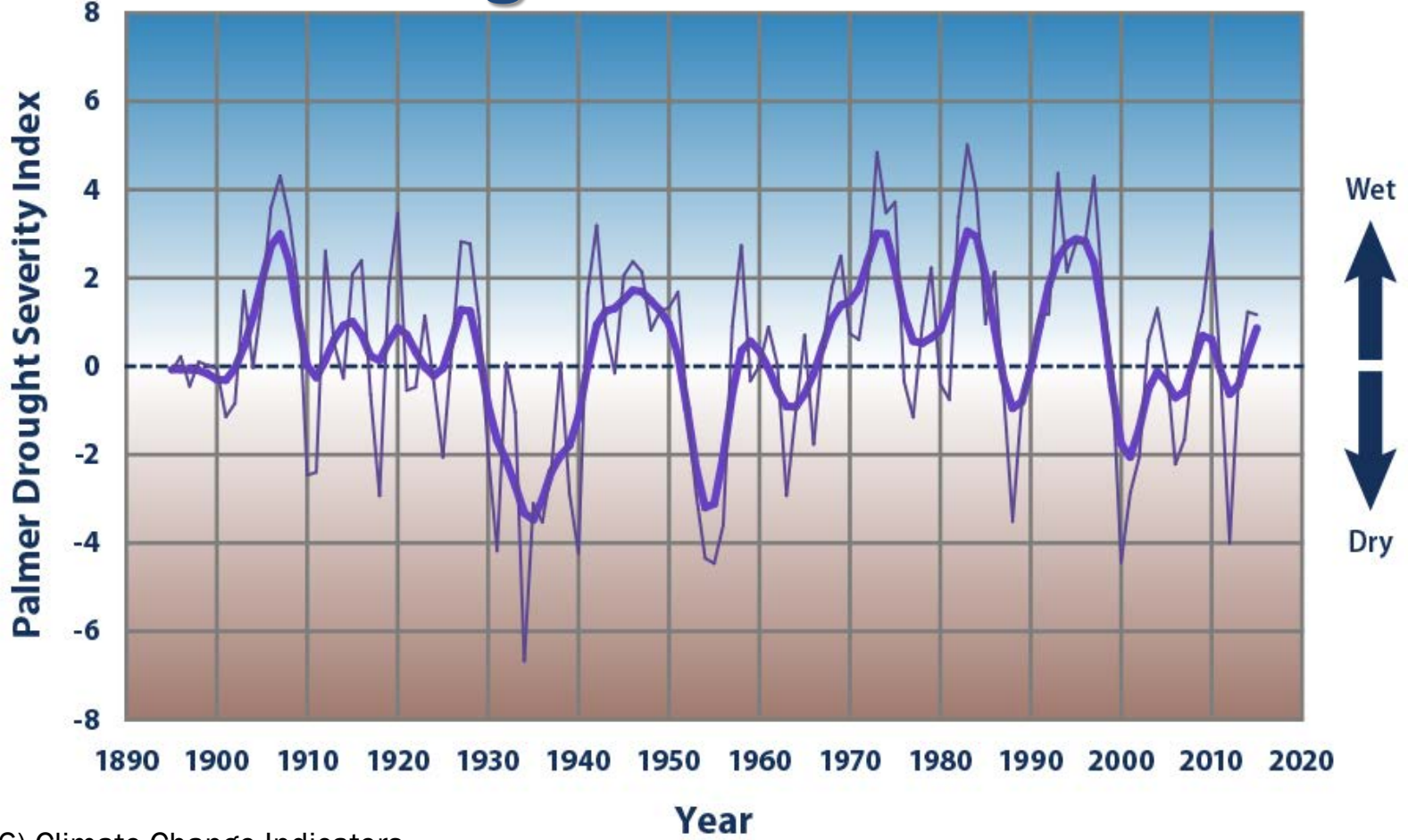


2050 demand per cent of capacity, peak

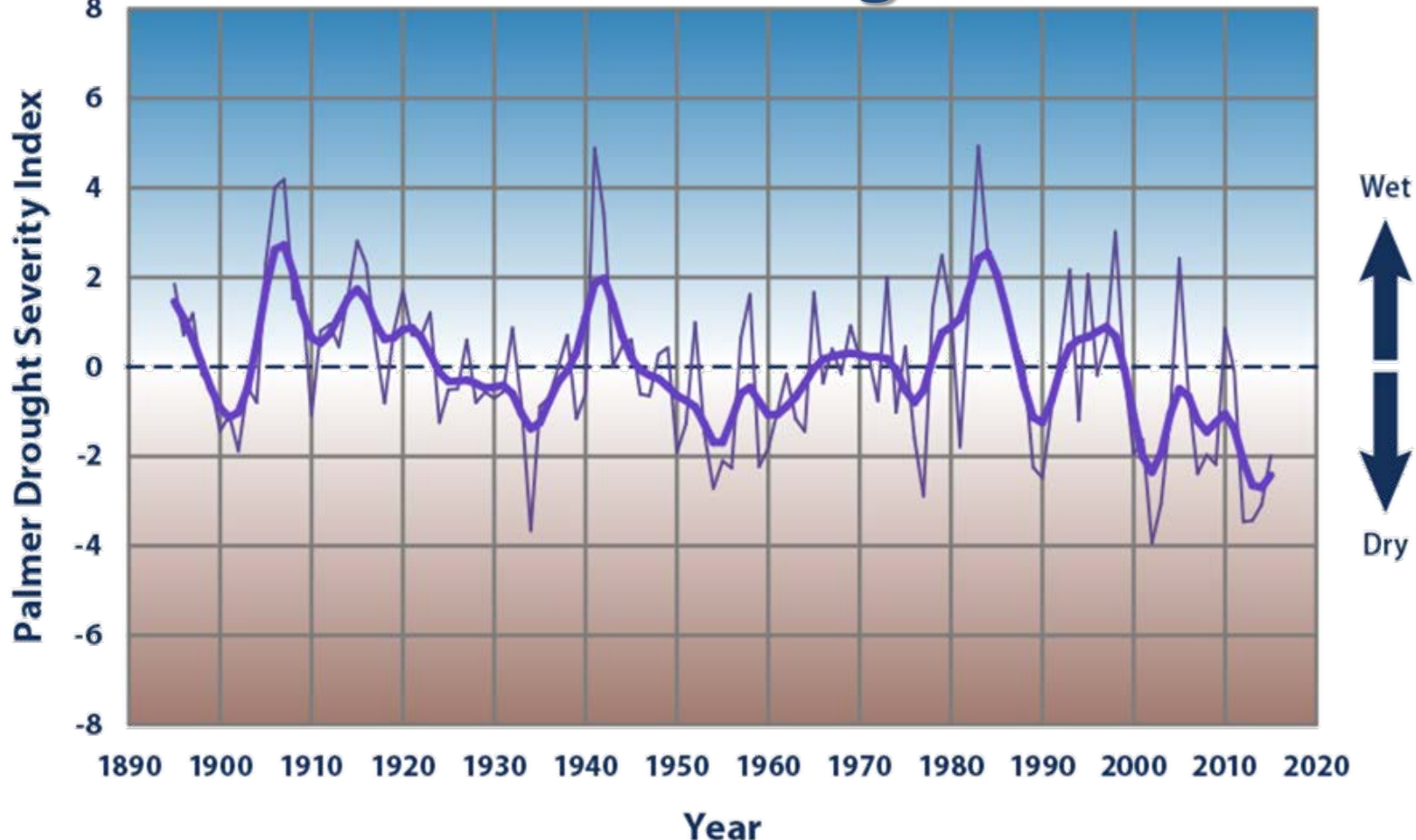




Trends in U.S. Drought

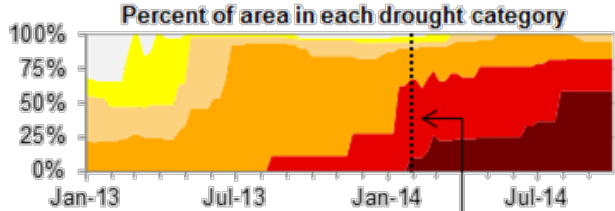
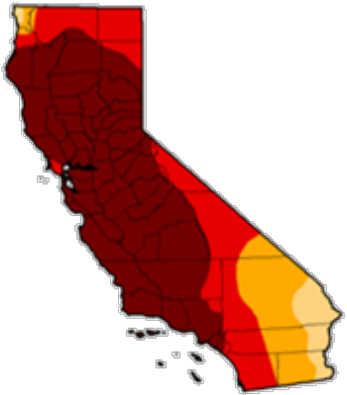


Trends in U.S. Southwest Drought



Drought and Energy Production in California

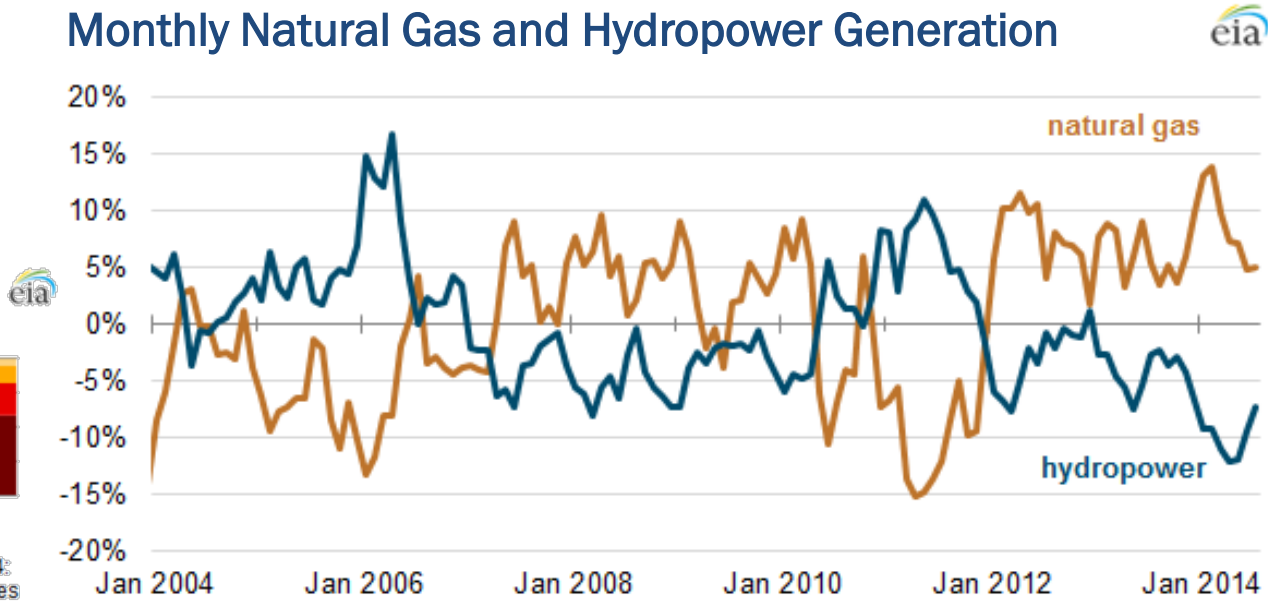
California Drought Status
(September 30, 2014)



- None
- Abnormally Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

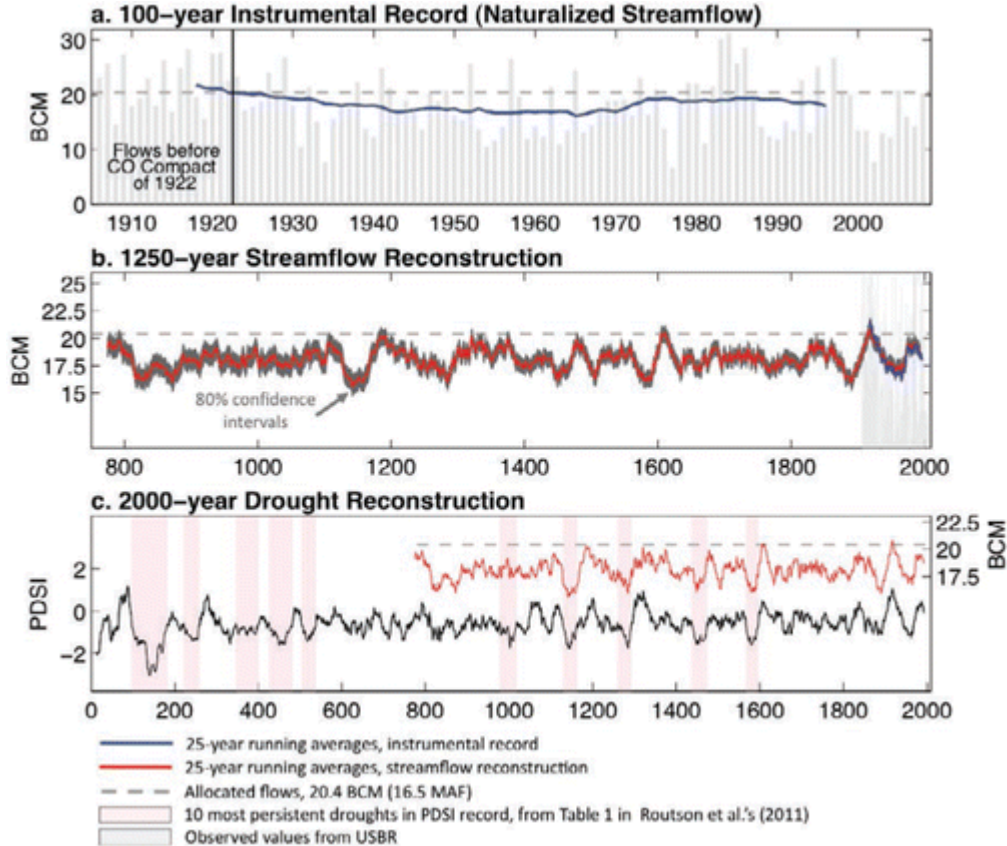
January 17, 2014:
California declares
state of drought
emergency

Monthly Natural Gas and Hydropower Generation



EIA (2014) California drought leads to less hydropower, increased natural gas generation

Drought in a Long-Term Context



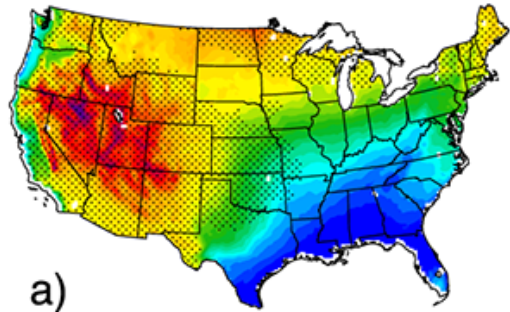
“Paleoclimate reconstructions clearly indicate that there have been prolonged multidecadal dry periods . . . not seen in approximately 100 years of instrumental record.”



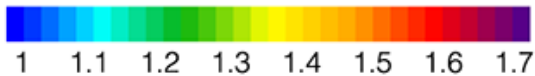
U.S. Temperatures Projected to Continue to Rise

Projected changes (2011-2050 minus 1981-2005)

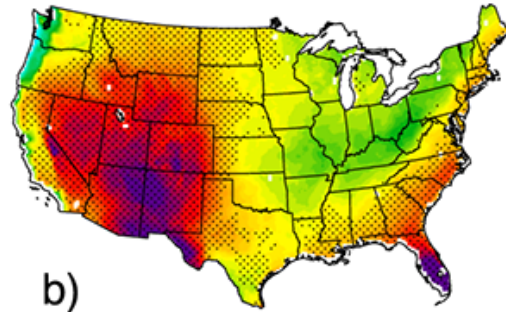
Annual Mean Temperature



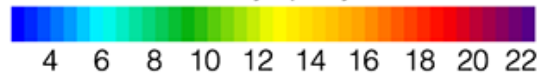
°C



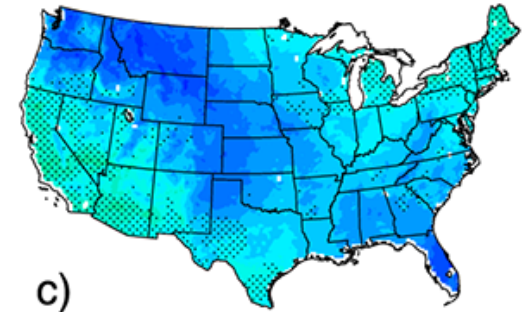
Extreme Hot Days



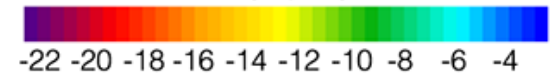
days per year



Extreme Cold Days

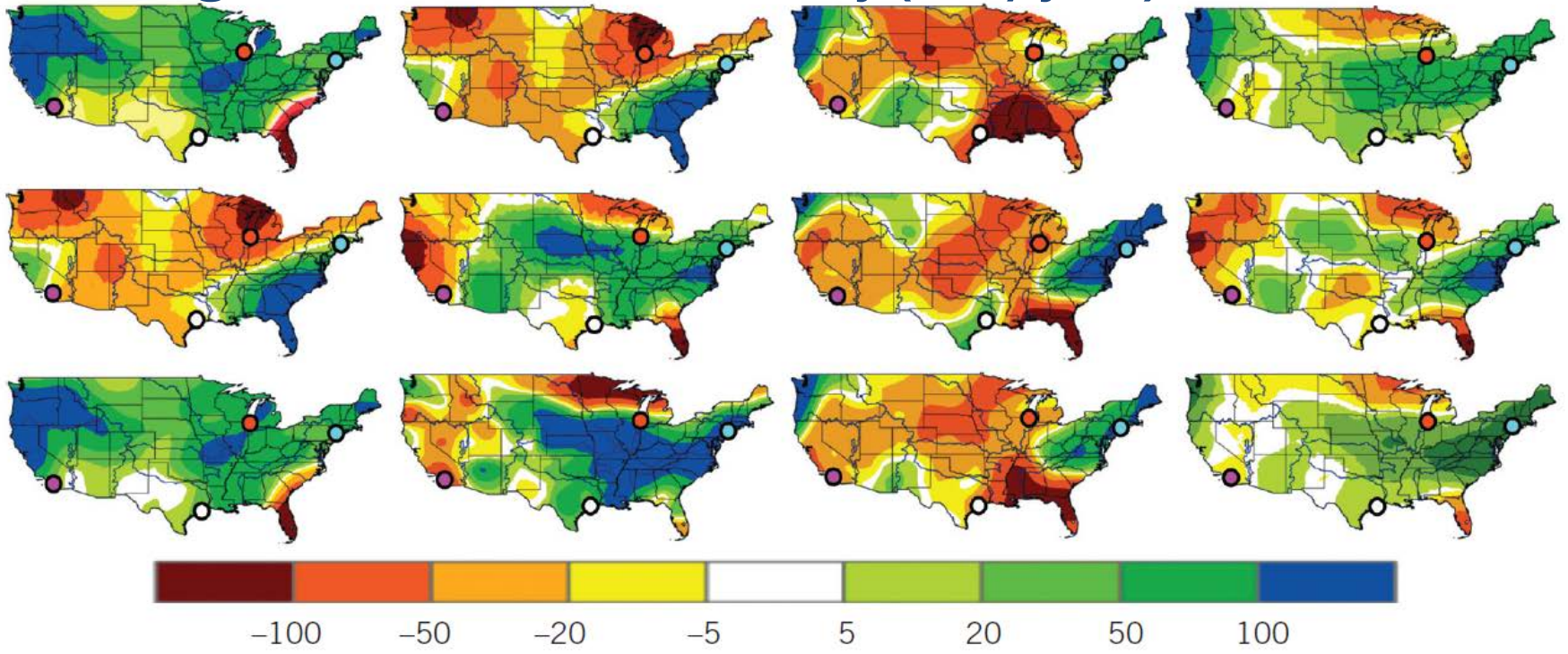


days per year



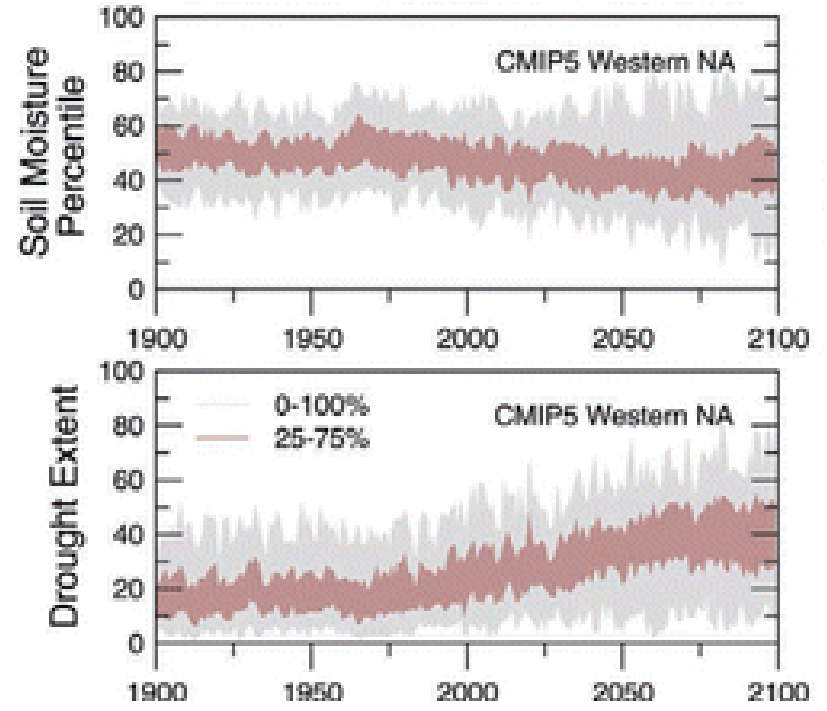
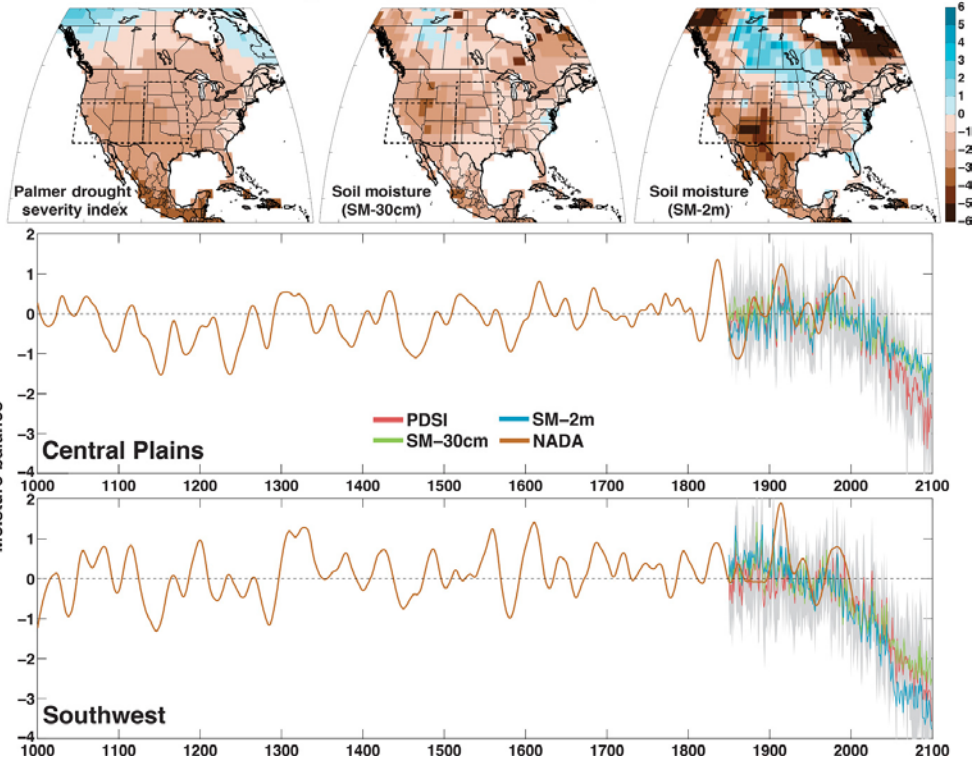
Model Projections of Future Water Availability

Change in Freshwater Availability (mm/year) in the 2030s



Projecting Trends in U.S. Drought

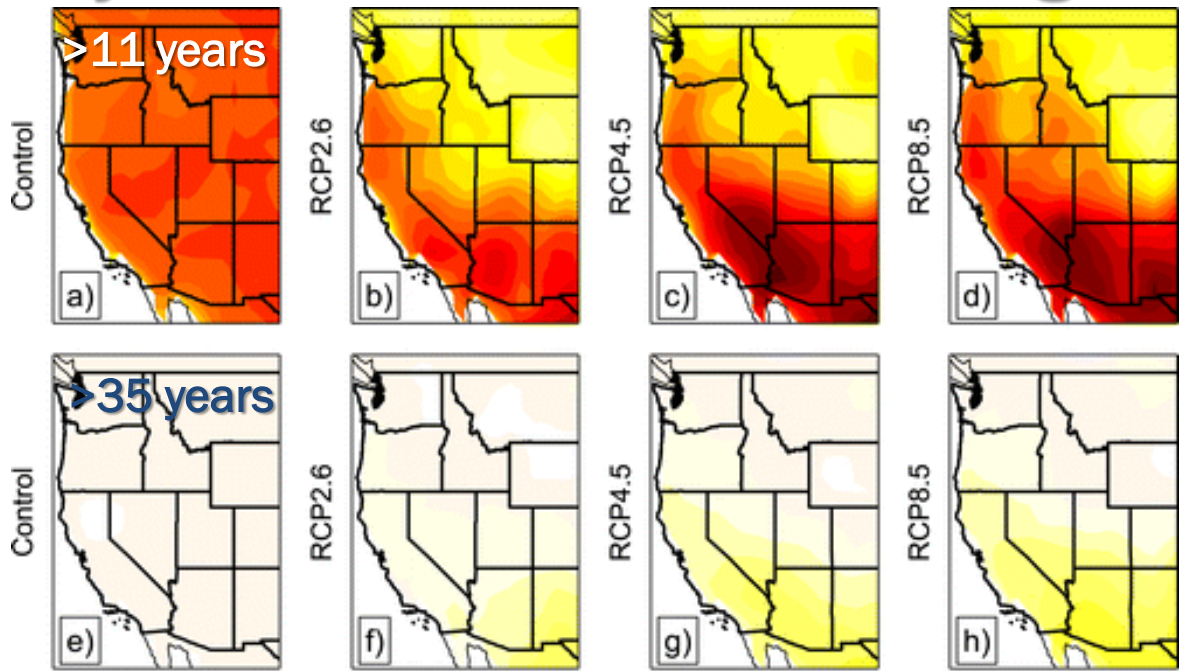
CMIP5 Drought Projections (RCP 8.5, 2050-2099 CE)



Cook et al (2015) Unprecedented 21st century drought risk in the American Southwest and Central Plains

Wuebbles et al (2014) CMIP5 Climate Model Analyses: Climate Extremes in the United States 21

Projections of Extended Drought Events



“The increasing risk of consecutive warm-dry years raises the possibility of extended drought periods such as those found in the paleoclimate record” Diffenbaugh et al. (2015)

0 0.5 1 1.5 2
CMIP5 prolonged drought rate (events/century)

Implications for Climate Risk Management

- **Climate risk is increasing from multiple sources**
- **Observations and projections of the future should be placed in their long-term climate context**
- **Future climate conditions are unlikely to evolve along smooth, predictable trajectories**
- **There may be value in testing the robustness of energy systems against a broader range of climatic conditions**

Thank You



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