

# Climate Change: Recent News from the Journals

Brad Udall, Colorado Water Institute

*Brad Udall is a Senior Water and Climate Research Scientist/Scholar at Colorado State University's Colorado Water Institute. His expertise includes hydrology and related policy issues of the American West. He has researched water problems on all major Southwestern US rivers including the Rio Grande, Colorado, Sacramento-San Joaquin and Klamath, and has spent six months in Australia studying their recent water reforms. Brad has written extensively on the impacts of climate change on water resources. He was a contributing author to the 2014 IPCC climate change report, the lead author of the water sector chapter of the 2009 Global Climate Change Impacts in the United States, and was an author of the 2008 Climate Change in Colorado Report. He has provided congressional testimony, input to several National Academy of Science panels, and has given hundreds of talks on climate change impacts. Brad was formerly the Director of the Getches-Wilkinson Center for Natural Resources, Energy and Environment at the University of Colorado Law School, Director of the CU-NOAA Western Water Assessment, and a consulting engineer and principal with Hydrosphere Resource Consultants.*



Figure 1. Introduction.

## 2015 a Pivot Year for Climate

- Increasingly Clear that Climate Change is Water Change
- Major Climate Events
  - Globally Hottest Year Since Records Kept
  - California Drought
  - Miracle May in US
  - S. Carolina Rain and Floods
- Stronger & More Compelling Science by the Day
  - California Drought Causes
  - Southwest Megadrought Risk
  - Rio Grande Climate Change Studies
- Reasons for Optimism
  - Major Climate Commitments
  - Technology and Hope for the Future
  - Just like we switched from analog world to digital world, we can switch to non-fossil fuel energy world

Figure 2. Climate change in 2015.

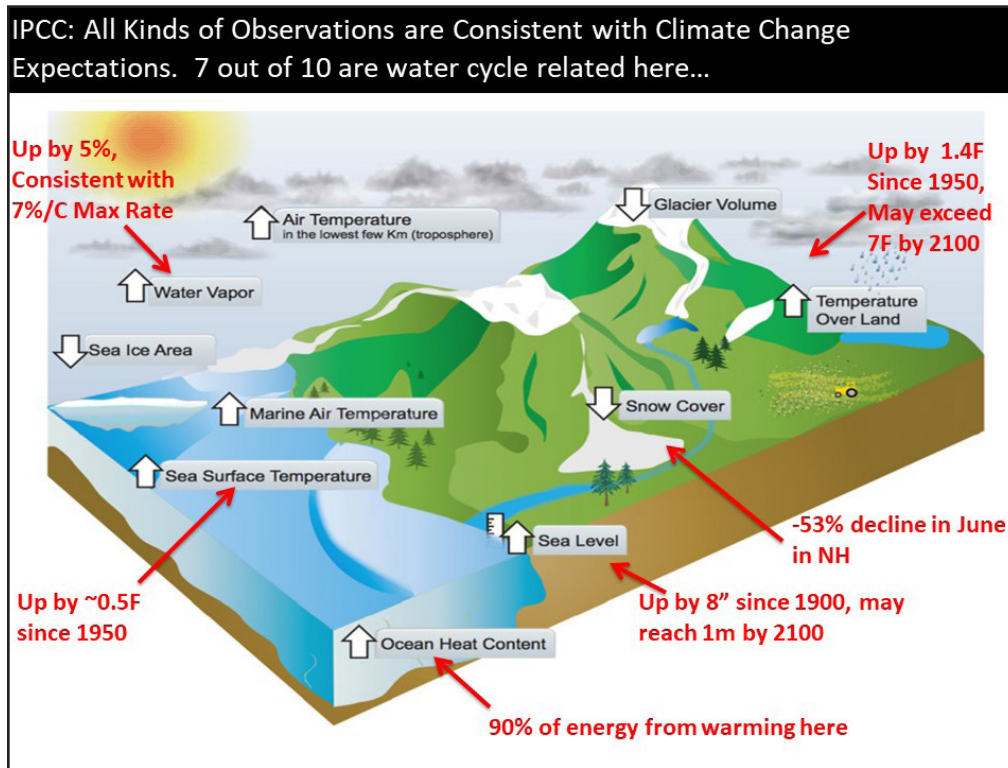


Figure 3. Observations consistent with climate change expectations.

## Climate Change is Water Change

- Heat Drives the Water Cycle – 1000 km<sup>3</sup> evaporates daily from the oceans
- The Water Cycle mixes heat from areas of too much to too little
- As the Atmosphere Warms it Holds More Moisture: ~5F warming is 20% increase
- Heating Up the Earth (and uneven heating) results in Water Cycle changes
  - More Evaporation, More Precipitation, More Moisture
  - Changes in weather patterns
  - Wet Wetter, Dry Drier Standard Rule
  - More Intense Floods and Droughts
- All Kinds of Water Changes Already Noted
  - More rain/less snow, Earlier Runoff, Higher Water Temps, More Intense Rain
- Many of the most critical impacts of climate change will arise through water cycle changes driven by higher temps, not just higher temps rising temperatures

Figure 4. Climate change's effect on water.

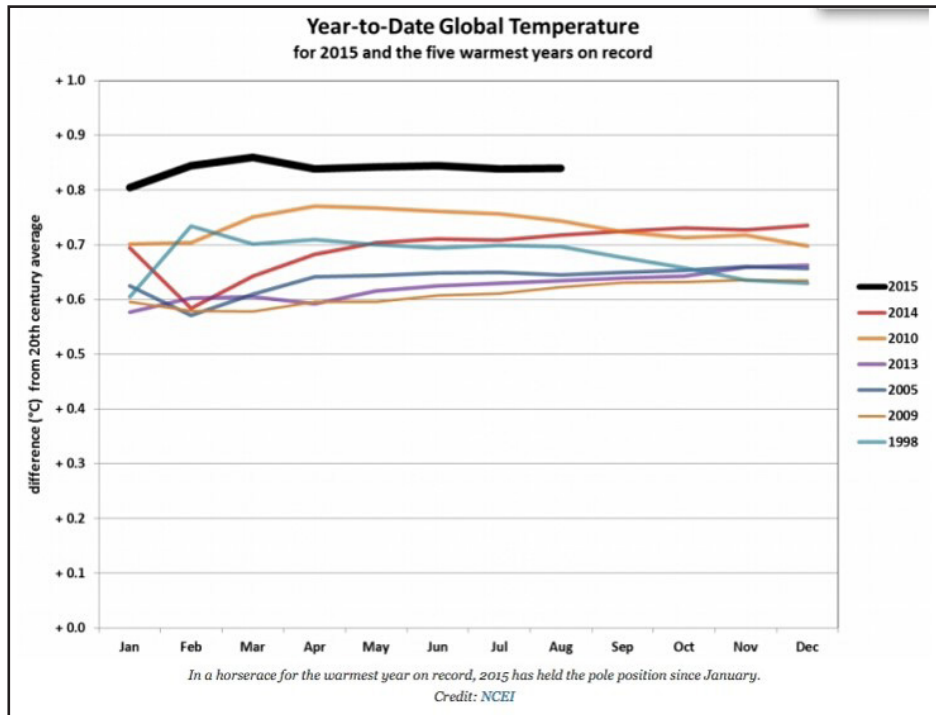


Figure 5. Global temperature from 1998 to 2015.

## California Drought Lessons

- Temperatures
  - Sierra Winter Above 32 F, (1<sup>st</sup> in 120 years)
- Sierra Precipitation
  - Rain, not Snow
  - Not the driest! (40% to 90% of normal)
- Snowpack
  - Lowest Ever - 5% on April 1, (1977 at 25%)
  - 500 Year Return Period
- Drought
  - Worst in 1200 Years
- Water Deliveries
  - Record Low to CVP Contractors
- El Nino no guarantee of salvation
  - N. Cal precip critical




Figure 6. California drought lessons in 2013 compared to 2015.

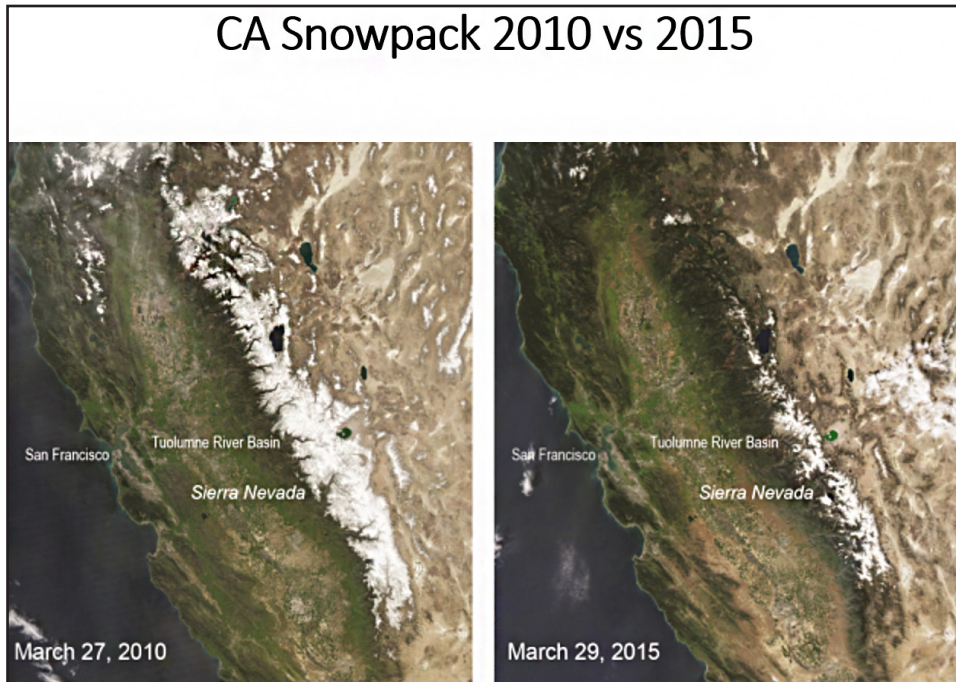


Figure 7. California snowpack in 2010 compared to 2015.

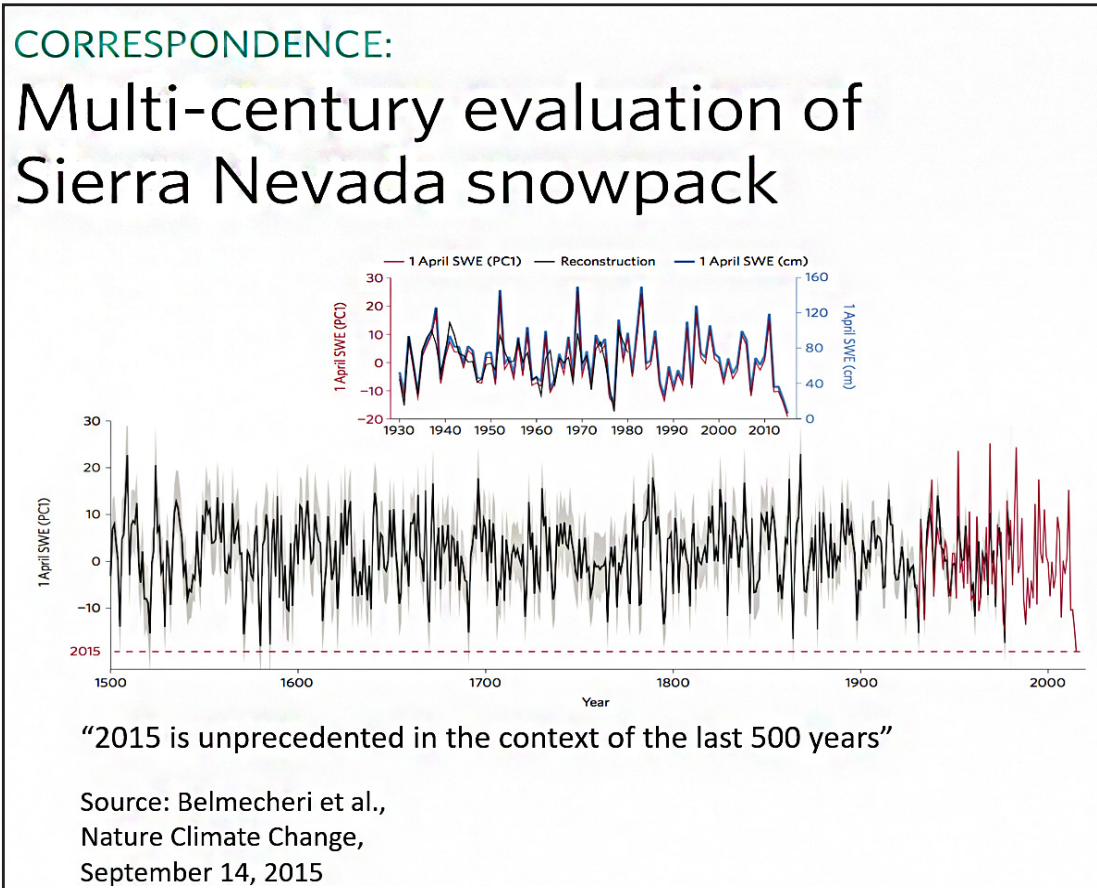


Figure 8. Multi-century evaluation of Sierra Nevada snowpack.

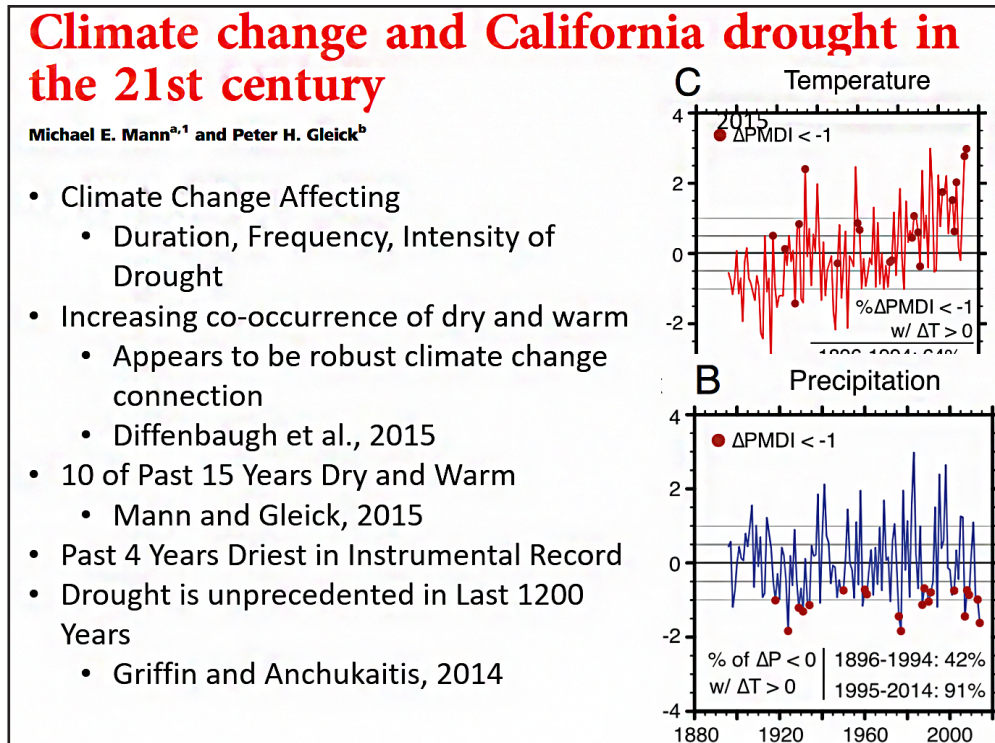


Figure 9. Climate change and California drought in the 21st century.

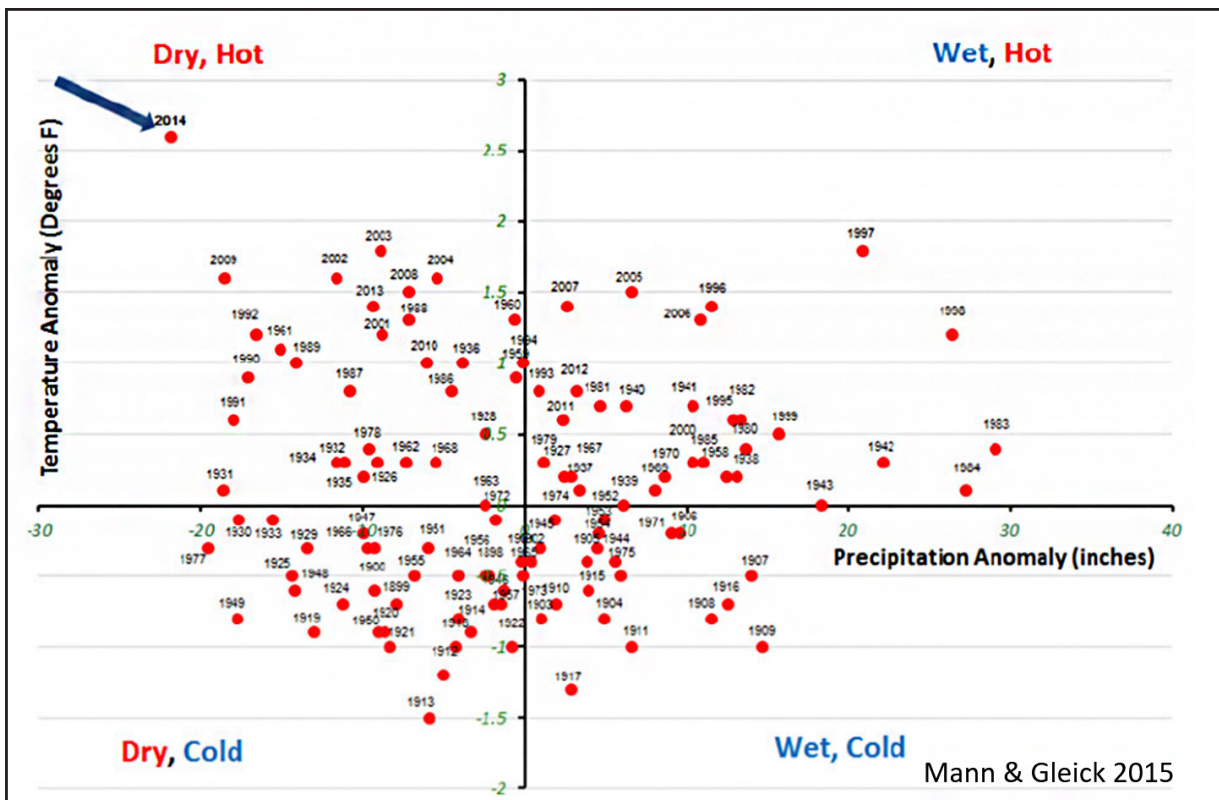


Figure 10. California temperatures and precipitation anomalies.

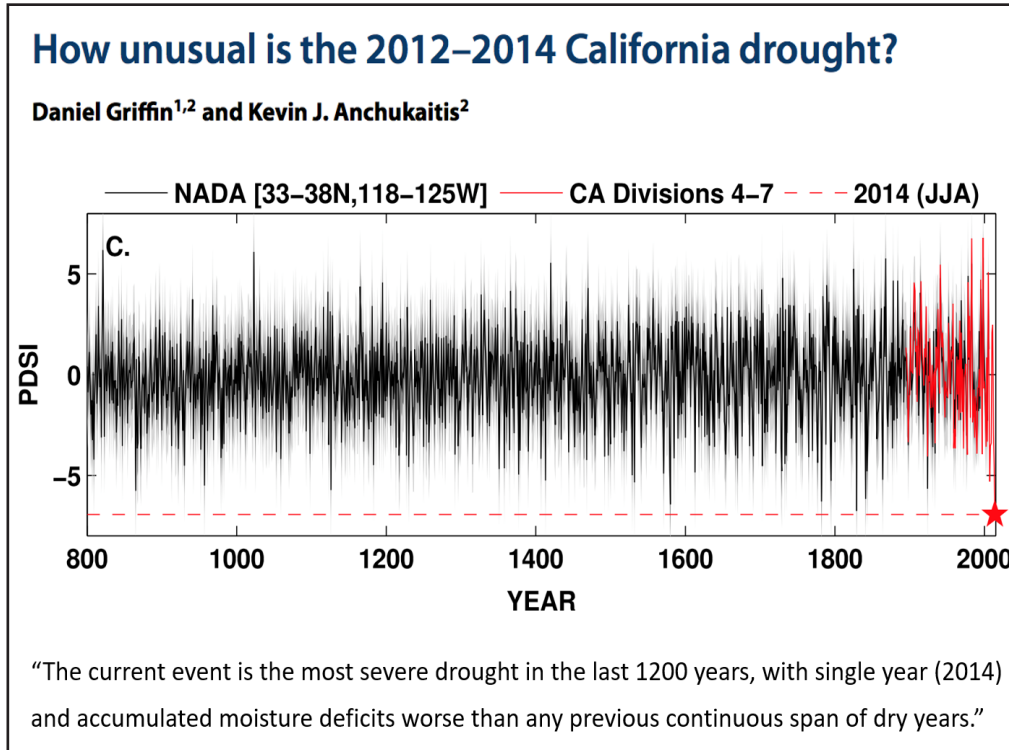


Figure 11. Palmer drought severity index (PDSI) California drought measurements from 2012-2014.

## May 2015 was wettest month ever recorded in U.S.

*Friday, June 12, 2015*

Last month, much of the United States was wet. How wet? When climate scientists at NOAA’s National Centers for Environmental Information averaged the observations of rain, snow, and other precipitation from across the country, they found out **it was the country’s wettest May since records began 121 years ago. In fact, it was the wettest month ever recorded!**

percent of average precipitation

5 10 25 50 75 100 125 150 200 300 500

NOAA Climate.gov  
Data: NCEI

<https://www.climate.gov/news-features/featured-images/may-2015-was-wettest-month-ever-recorded-us>

Figure 12. Wettest month ever recorded in the United States.

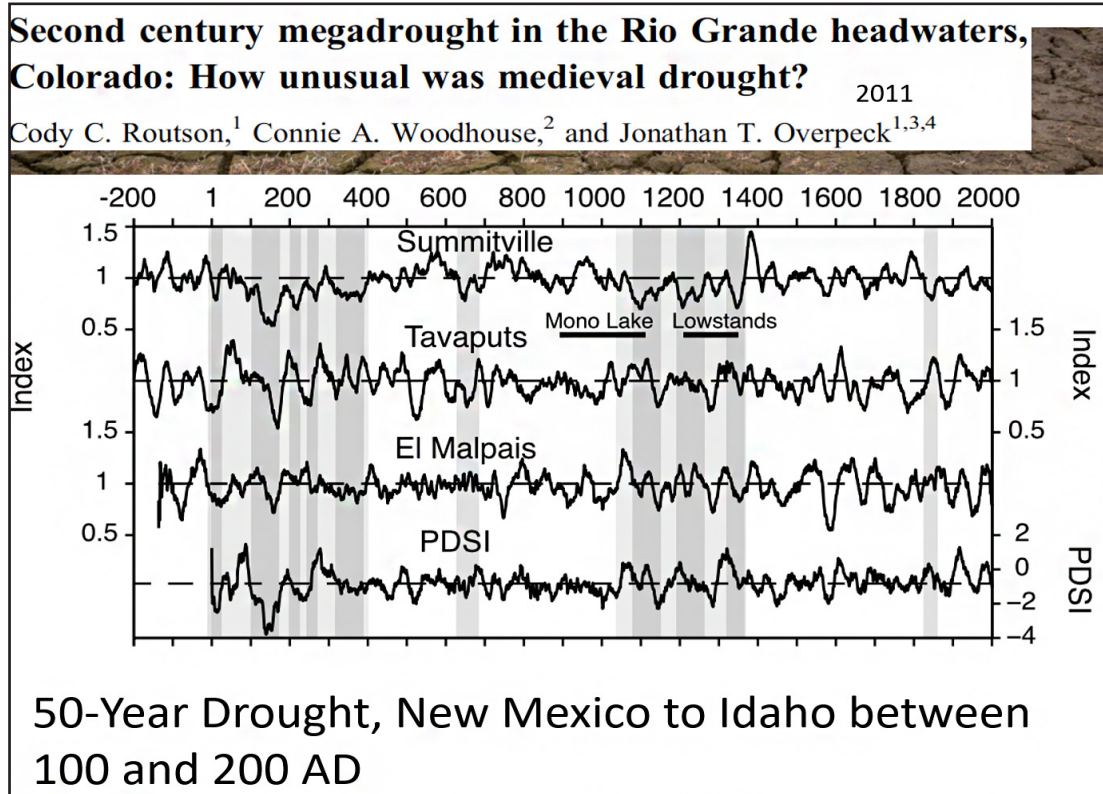


Figure 13. Century-long megadrought in the Rio Grande headwaters.

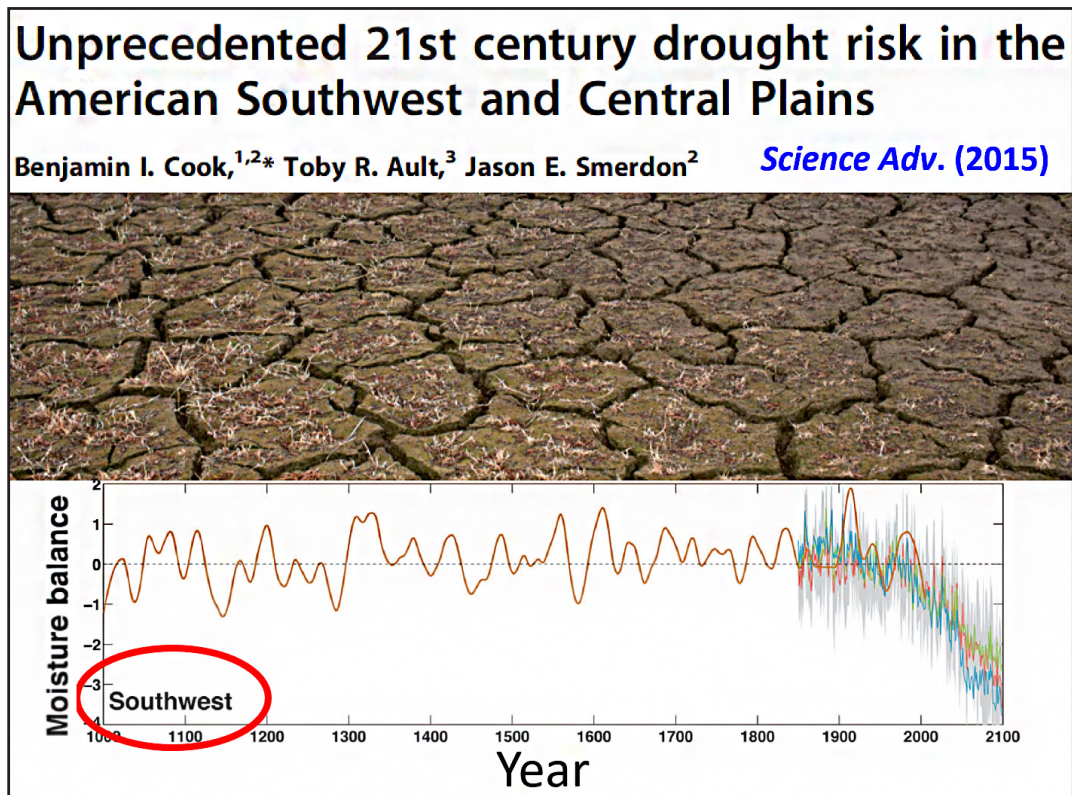


Figure 14. 21st century drought risk in the American Southwest.

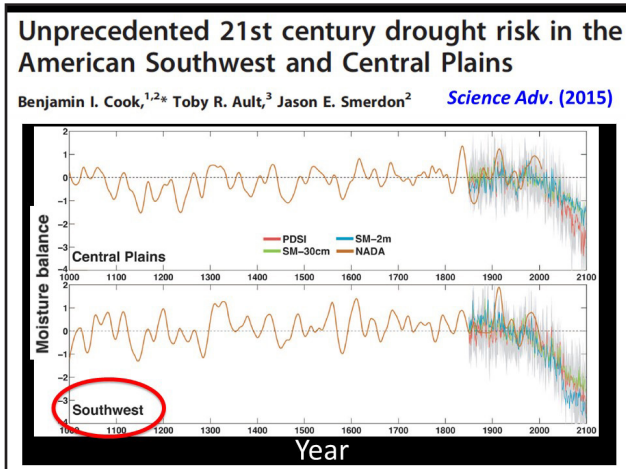


Figure 15. 21st century drought risk in the American Southwest and Central Plains.

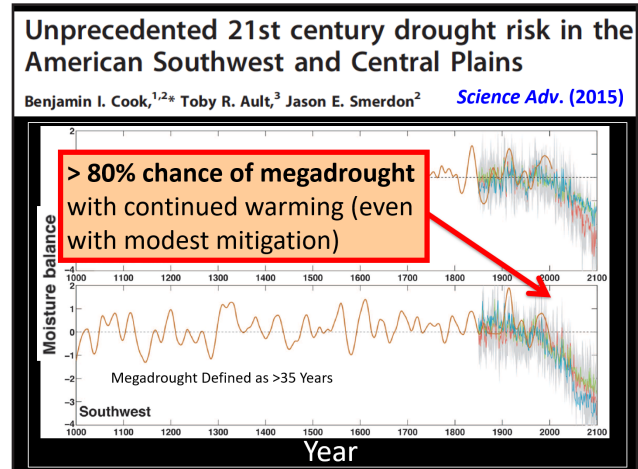


Figure 16. Greater than 80% chance of megadrought in the Southwest with continued warming.

## Upper Rio Grande Impact Assessment Report

- “URGRIA”
  - Acronym appropriate on many levels (-;-)
- Released December 2013
- Reclamation, USACE, Sandia Labs
- San Luis Valley to Caballo Reservoir
- Based on 2007 IPCC Models (‘CMIP3’)
  - Older but probably not that different from latest
- WaterSmart \$
- SECURE Water Act Westwide Climate Risk Assessment
- Not a ‘Basin Study’ but similar
- Utilized Upper Rio Grande Simulation Model (URGSiM) to get flows under realistic use and management unlike Hurd and Coonrod 2007 Economic Study from UNM, NMSU

**West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment**

Figure 17. Upper Rio Grande Impact Assessment Report.



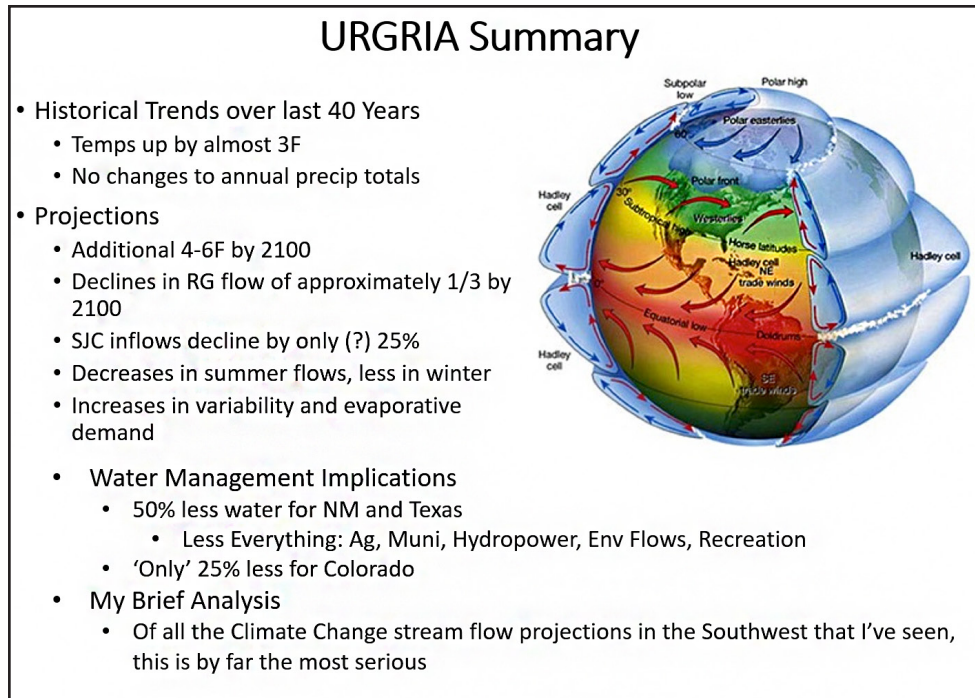


Figure 18. Upper Rio Grande Impact Assessment Summary.

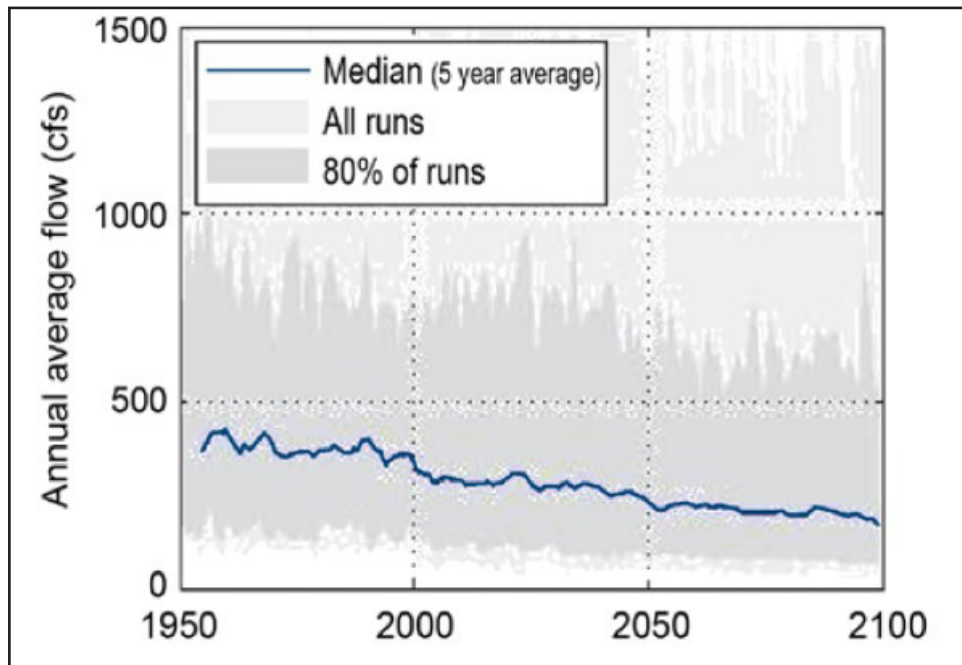


Figure 19. Annual average flow of Rio Grande near Lobatos.

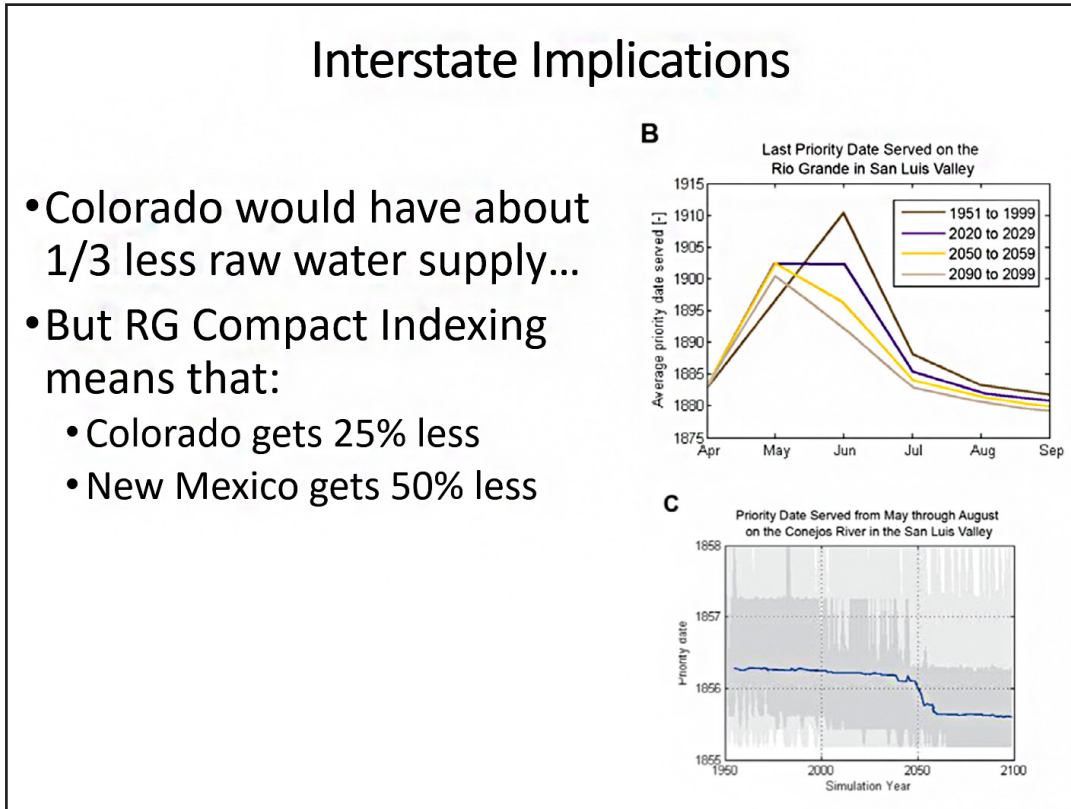


Figure 20. Interstate implications.

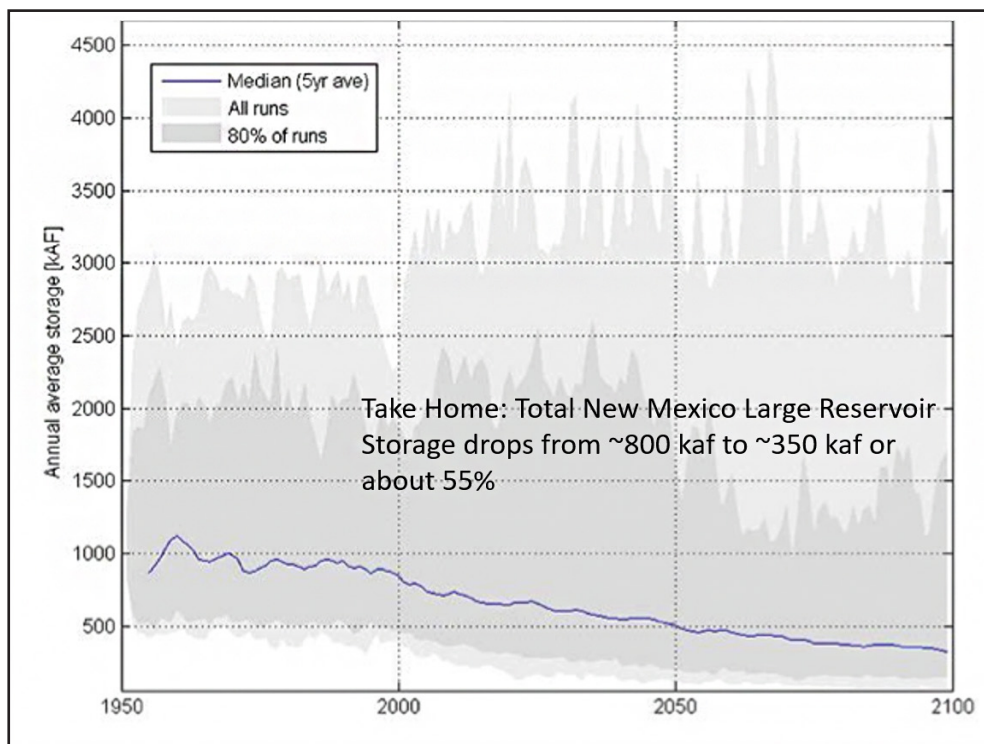


Figure 21. Total New Mexico reservoir storage.

- Technology
  - PV - \$10 to \$0.50 2 decades
  - Wind less than Gas Now
  - 200 Fewer Coal Plants (325 now)
  - LEDs
  - Nissan Leaf Battery \$15k to \$5k
  - Storage a top priority but not needed for a while
- International Commitments to Paris
  - China, Brazil, India, EU, Korea, others
- US Efforts
  - Clean Power Plan – no more coal built
  - 32% by 2032 relative to 2005
  - CO2 Electrical Generation Emissions may have peaked
- Science Implications
  - Will be able to rule out higher emissions soon
- Future still a challenge
  - Will blow by 2C warming most likely
  - We just spent 25 years wasting time on GHG reductions
  - We ultimately need to get totally off of fossil fuels

BloombergBusiness

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## Solar and Wind Just Passed Another Big Turning Point

It has never made less sense to build fossil fuel power plants.

**Latest Solar Costs by State**

Source: BNEF, Annotated by Bloomberg

**U.S. carbon dioxide emissions from the electric power sector (Jan 1988-Apr 2015)**

Source: U.S. Energy Information Administration, *Monthly Energy Review*  
Note: Data exclude emissions from biomass energy consumption.

Figure 22. Reasons for climate optimism.

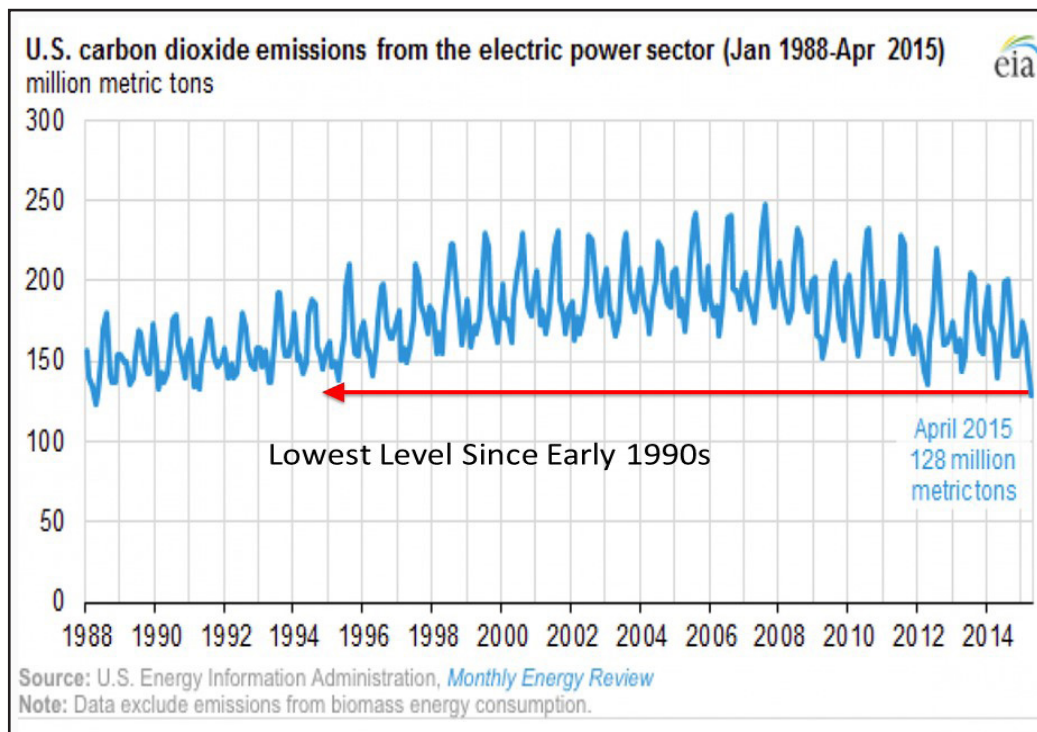


Figure 23. United States carbon dioxide emissions from the electric power sector.

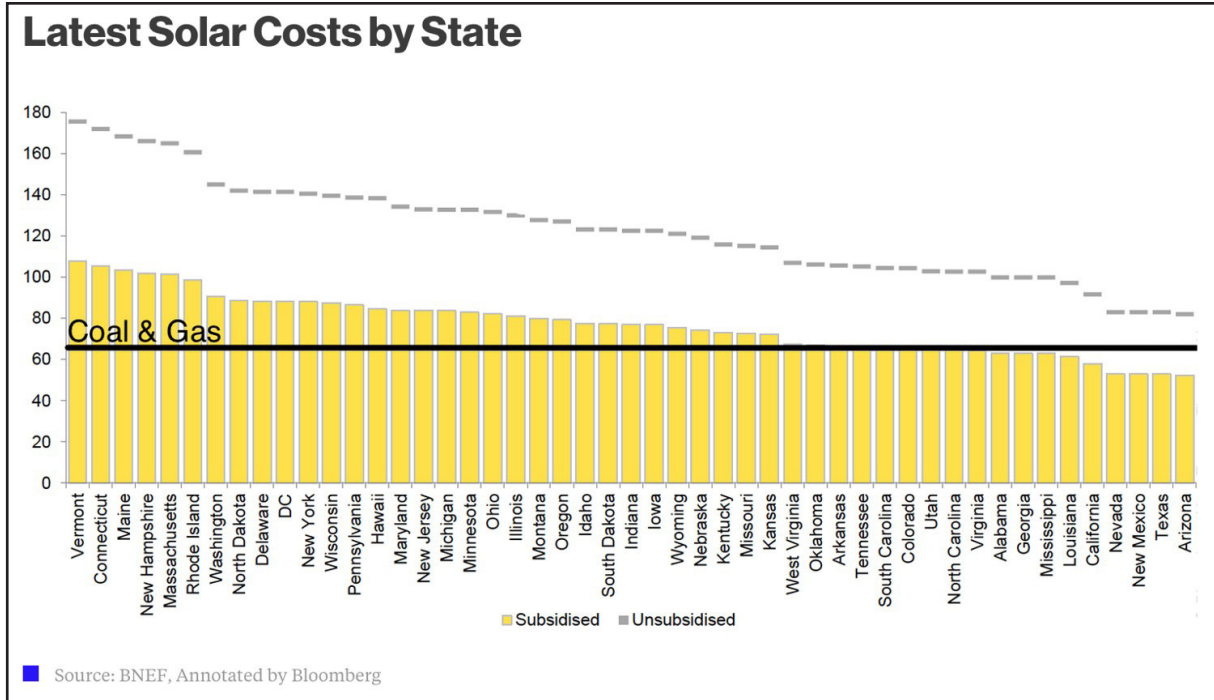


Figure 24. Solar costs compared to coal and gas costs for each state.

## Closing Thoughts

- Climate Change is here, now, all around us
- It is primarily a threat to our water supplies
- “Coloring Outside the Lines” is all about Climate Change
  - Hydrologic Lines – Stationarity
  - Policy Lines
- Climate Change a Common Enemy that can be (mostly) defeated
  - Need to acknowledge this
  - We have much of the technology we need already
  - Ultimately must stop burning carbon
  - **Color Outside the Lines: OK for Water Community to Push for GHG Mitigation**
- Climate Change is Water Change
  - It is all about water..
  - Drought, Snow, Temps, Floods, all connected by climate change thread
  - Stationarity is Truly Dead..

Figure 25. Conclusion.

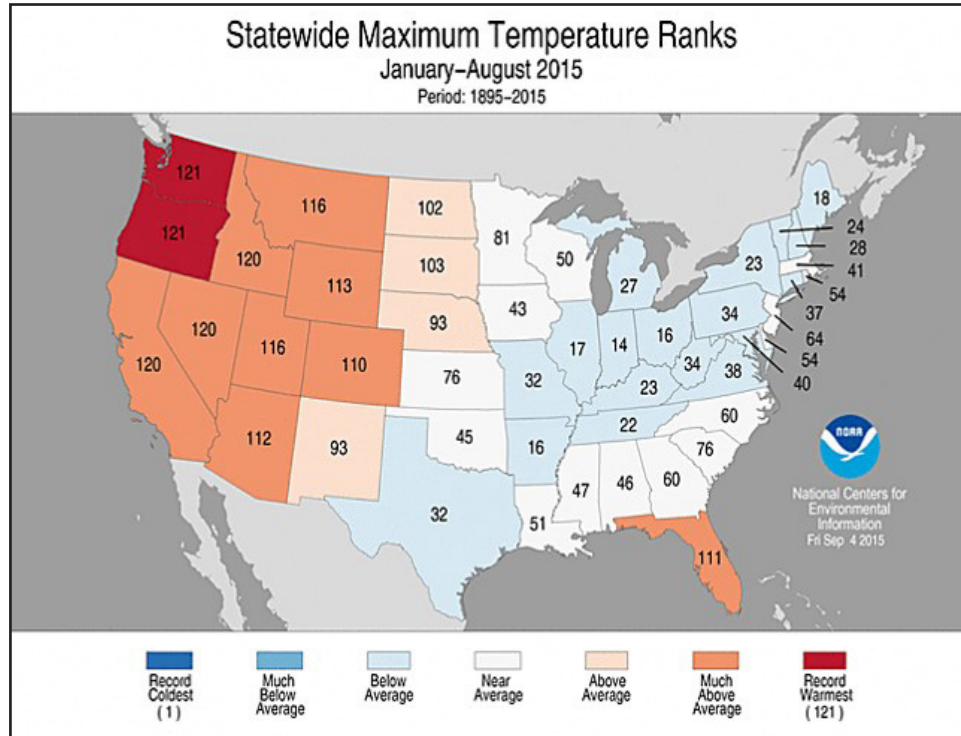


Figure 26. Statewide maximum temperature ranks from January to August in 2015.

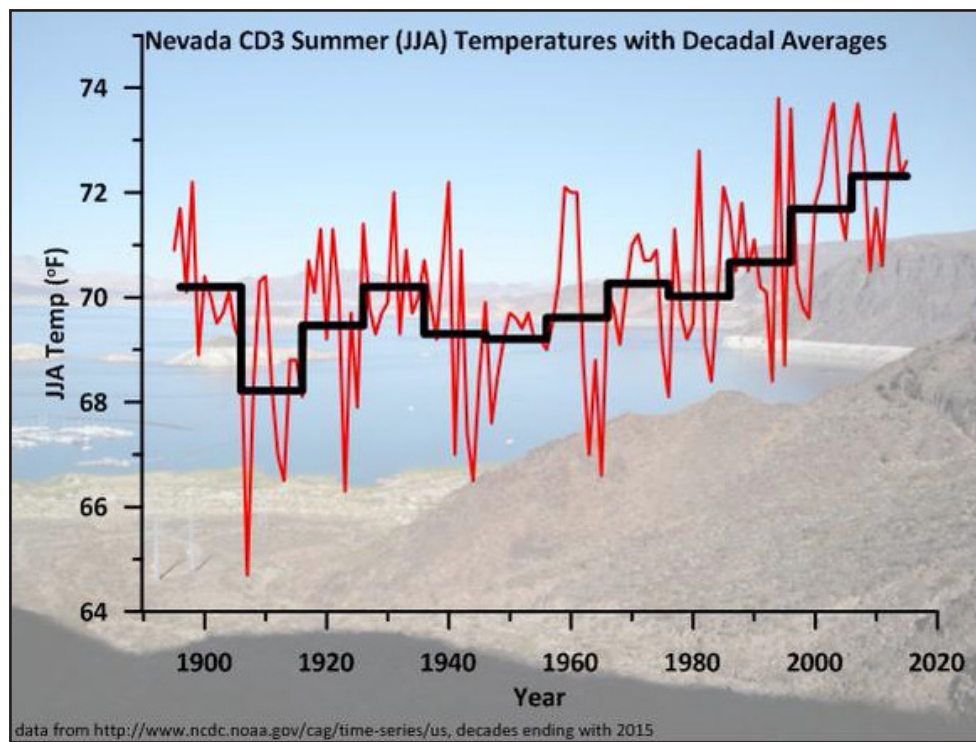


Figure 27. Nevada CD3 summer temperatures with decadal averages.