NOAA's Colorado Basin River Forecast Center

State Water and Climate Outlook

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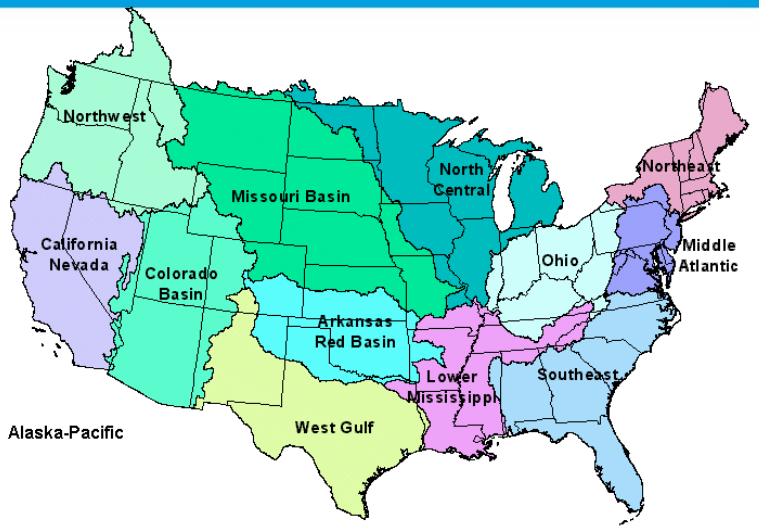
Service Coordination Hydrologist

Utah Water Conservation Forum
2017 Annual Spring Conference
May 12, 2017 – Jordan Valley Water Conservation District

Overview

- Who is the CBRFC and what is our role?
- Current State Water Outlook
- What does the future climate have in store for us?
- How do we move forward?

Who Are We?



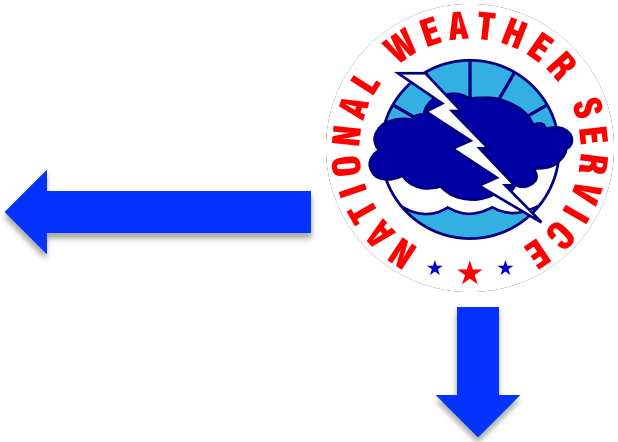
- Part of NOAA - NWS, one of 13 RFCs nationwide
- An operational field office located in Salt Lake City, UT
- Highly collaborative, reliant on partners and data
- All about decision-support!

Who We Are

- Work with a broad and diverse set of stakeholders
  - Weather Forecast Offices and Reclamation
  - Municipal and Agricultural Water Users
  - USGS, NRCS, and many other federal agencies
  - State agencies, Academics, NGOs, Tribes
- Receive data from many of these sources

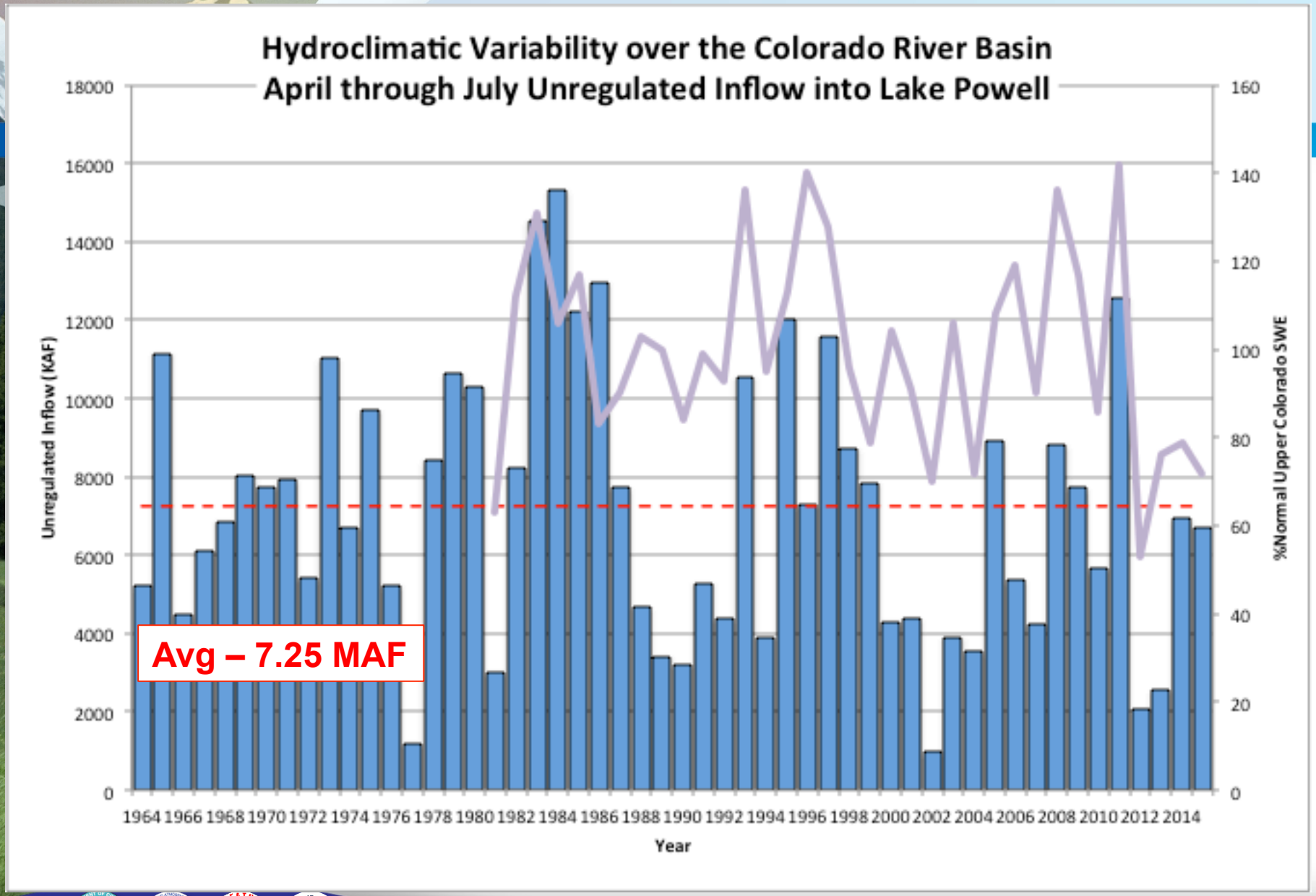
Colorado Basin River Forecast Center

- River Forecast Centers (RFCs)
  - –Support for WFOs
  - –River levels and flows
  - –Reservoir inflows
  - –Each RFC is unique
- CBRFC
  - –Seasonal Water Supply forecasts, in addition to many other products
    - Most advanced, involved
    - www.cbrfc.noaa.gov

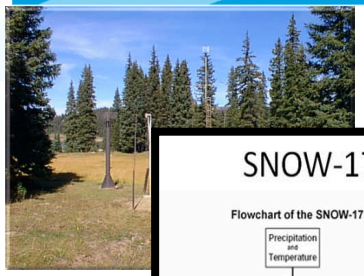


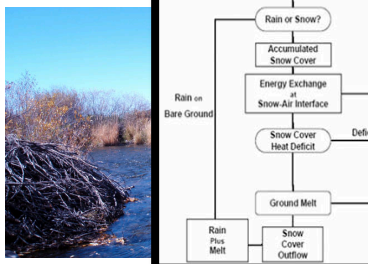
Weather Forecast Offices (WFOs)

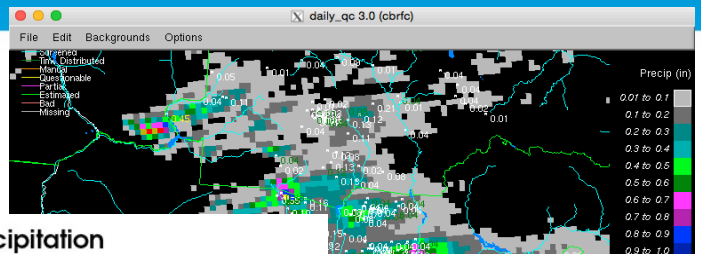
- **Everyday weather**
- **Extreme weather**
- **Warnings, watches, and advisories**
- **Floods, tornadoes, heat, etc…**

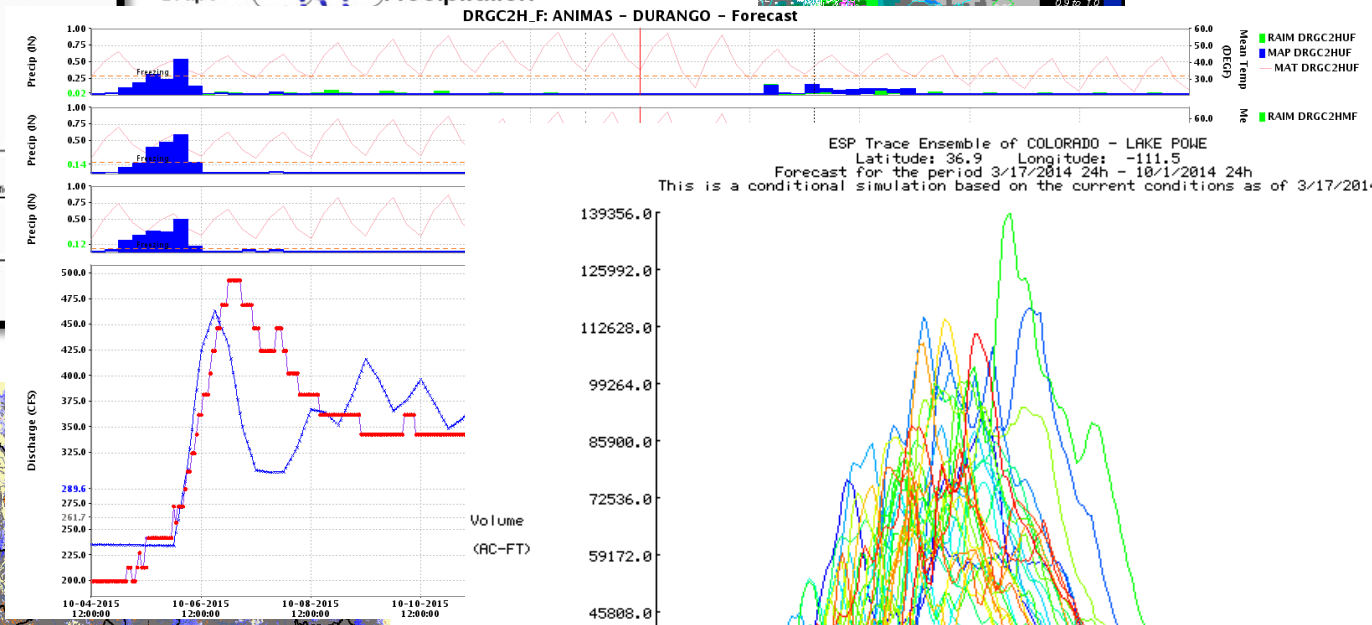

Hydroclimatic Variability over the Colorado River Basin
April through July Unregulated Inflow into Lake Powell
Unregulated Inflow (KAF)
%Normal Upper Colorado SWE
Year
Avg – 7.25 MAF
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
160
140
120
100
80
60
40
20
0
1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014

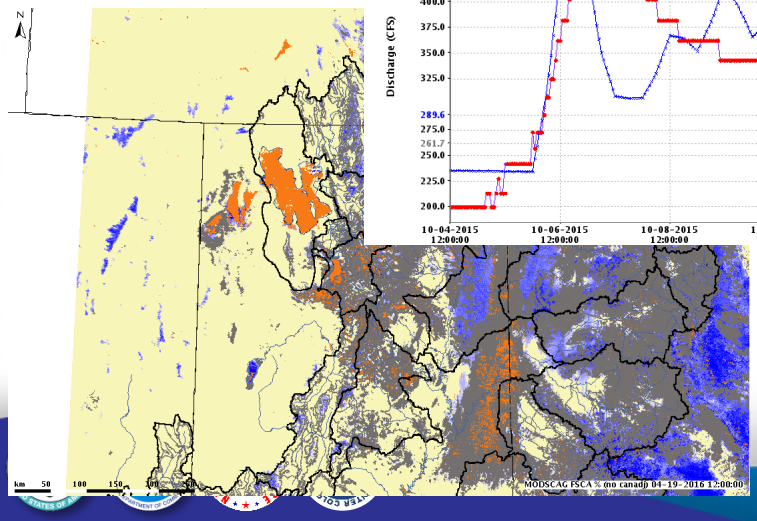
Providing Decision Support







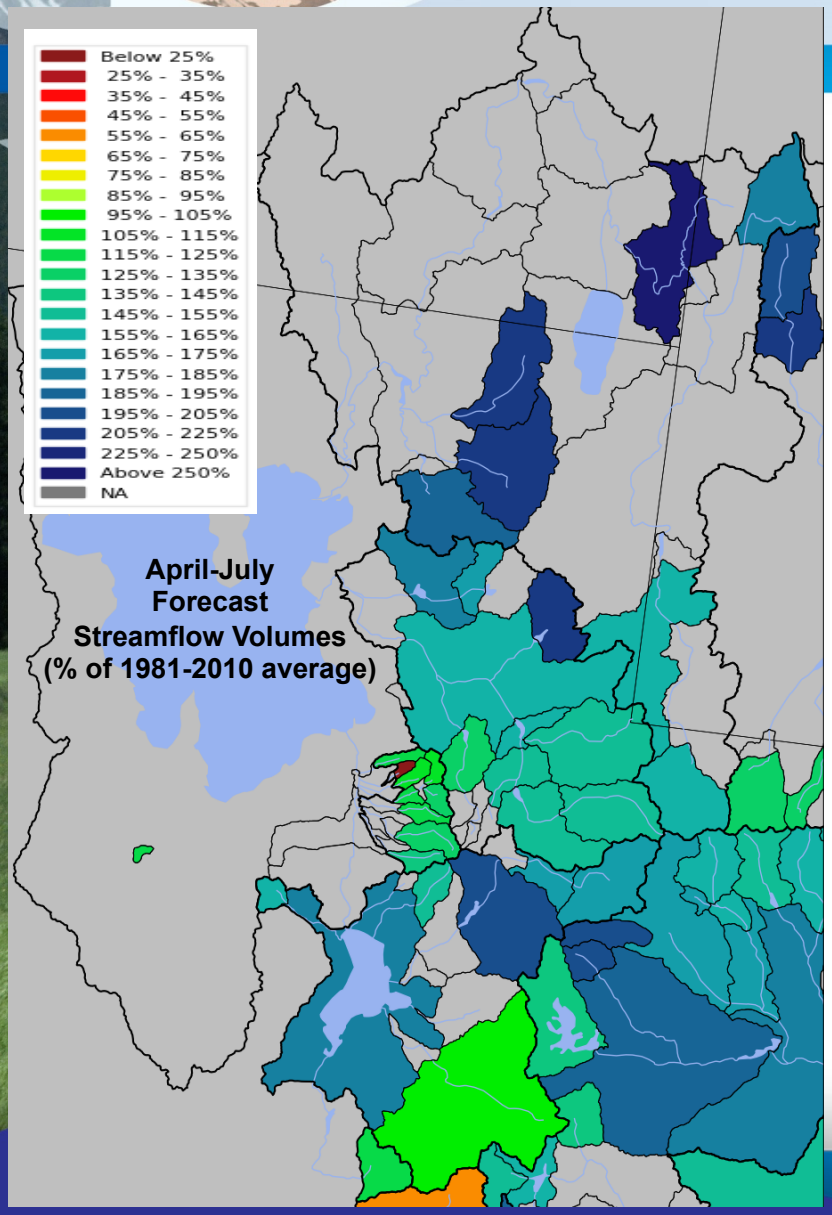




Update on Current Conditions

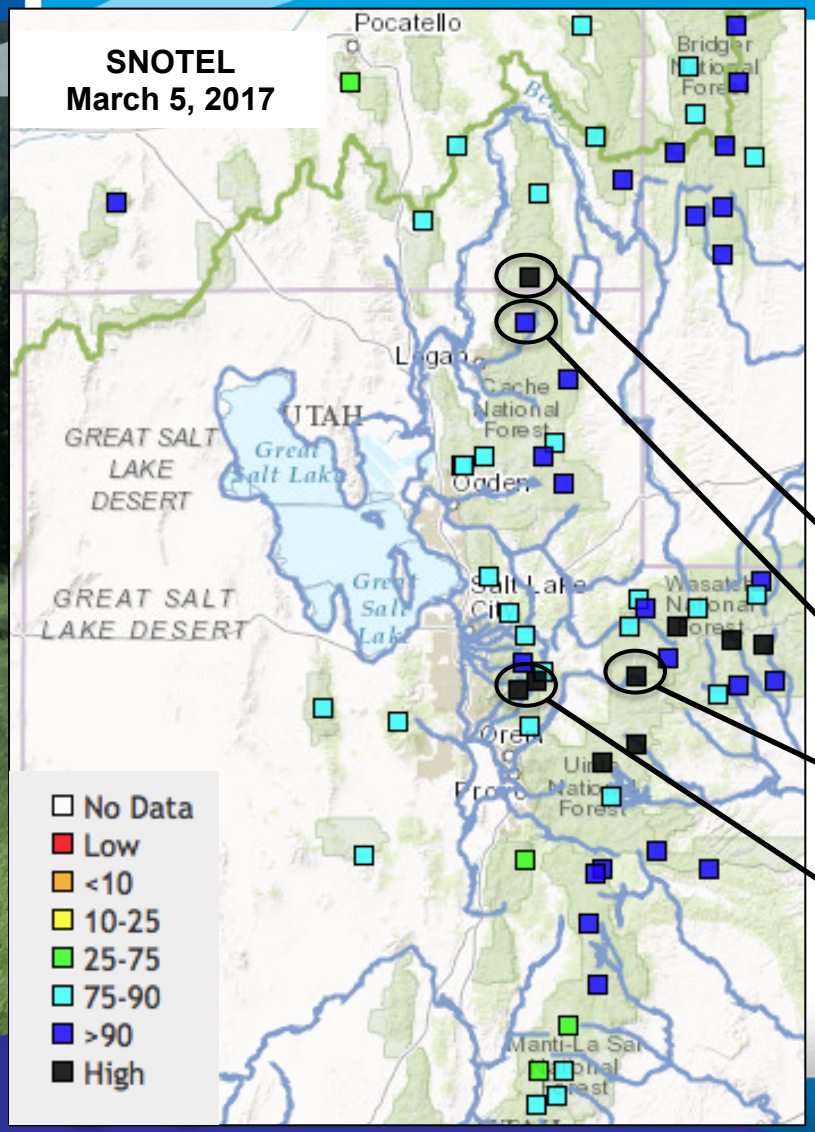
- Well above normal precipitation in the Great Basin
  - Multiple Atmospheric River Events
  - Seasonal snow peaks at some areas attained in February, some records set
- Forecasts still generally well above average
- A very warm March reduced expected seasonal volumes

Update on Current Conditions



- Highlights:
  - Blacksmith's Fork, 233%
  - East Canyon 130%
  - Echo Reservoir 158%
  - Little Cottonwood 133%
  - Big Cottonwood 139%
  - Provo near Woodland 167%
  - Spanish Fork 113%
  - Utah Lake 171%

Snow Conditions



Ranking based on where current observation falls in the historical record:

- **Black squares indicate record SWE on March 5th.**
- **Dark blue squares indicate SWE in top 2-3.**
- **Aqua squares are generally ranked 4th on record.**

Most SNOTEL sites have historical records of 34-39 years, but some are shorter.

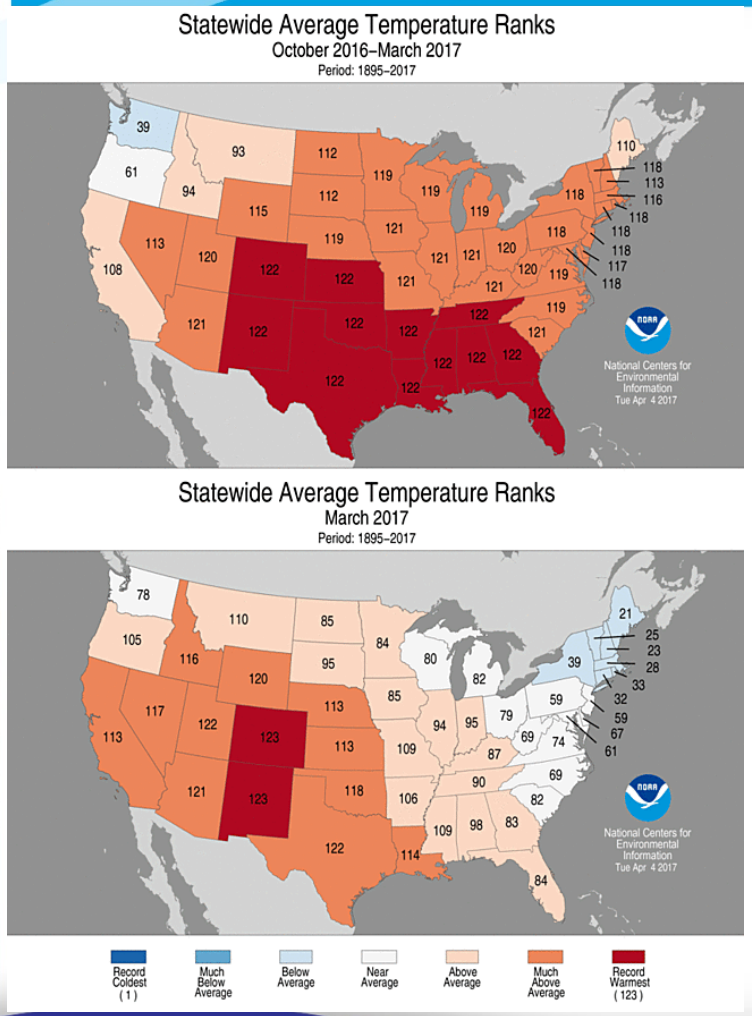
Franklin Basin SNOTEL record begins 1982

Tony Grove Lake SNOTEL record begins 1979

Beaver Divide SNOTEL record begins 1979

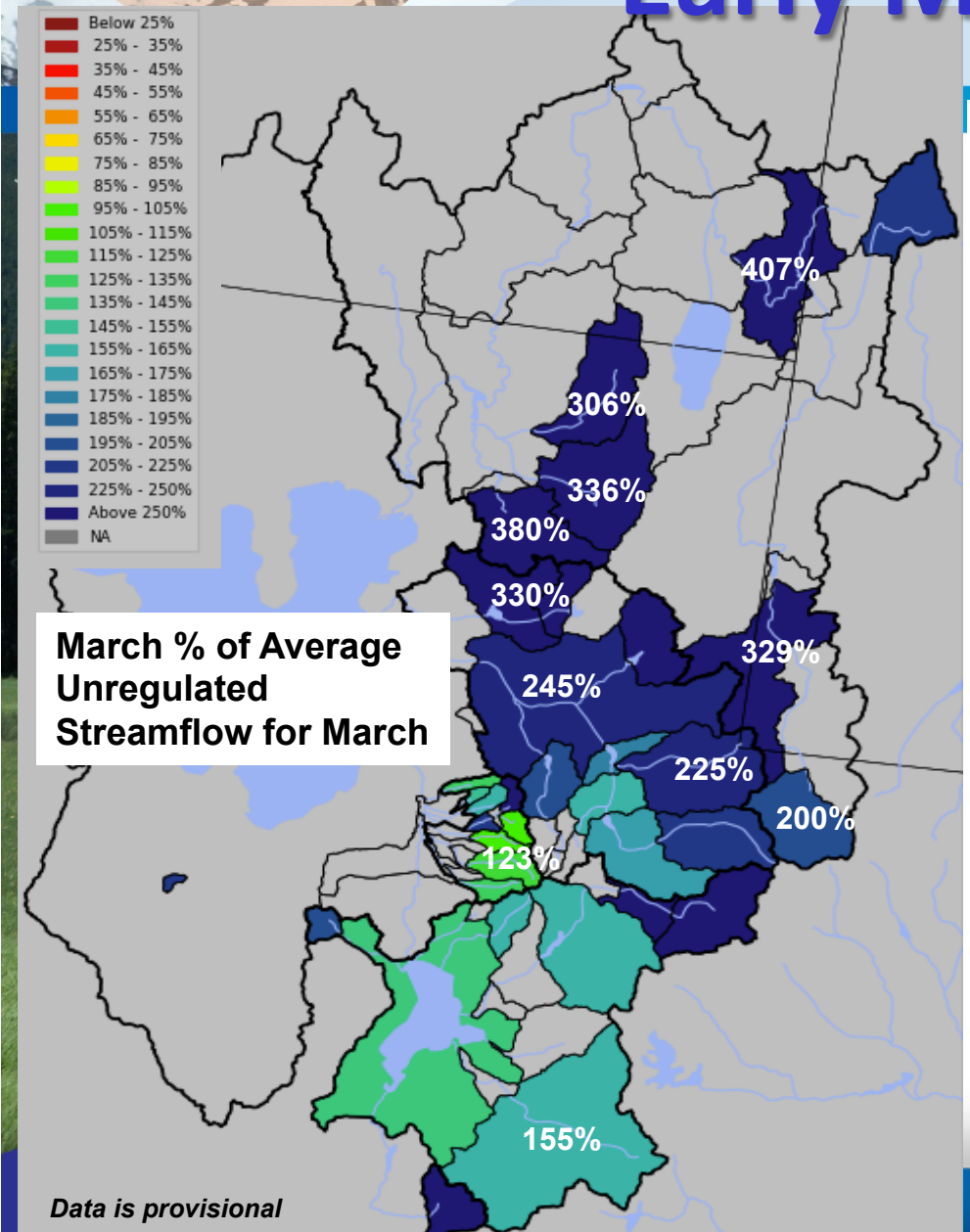
Brighton SNOTEL record begins 1987
Snowbird SNOTEL record begins 1990

A Warm Run-Up



- Despite the much above average precipitation, near record temperatures led to early snowmelt and early rises in streamflow
  - 2nd Warmest Utah March on Record!

Early March Streamflow

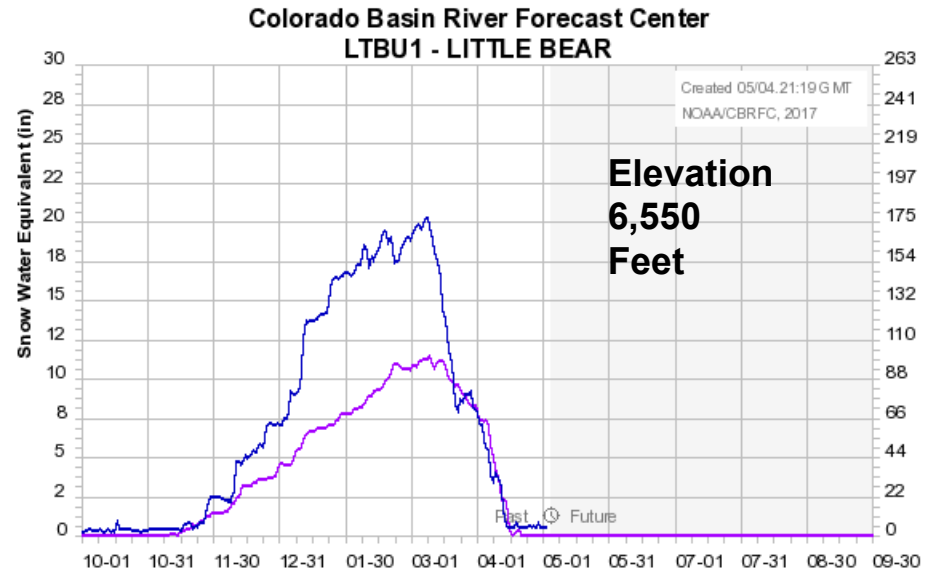


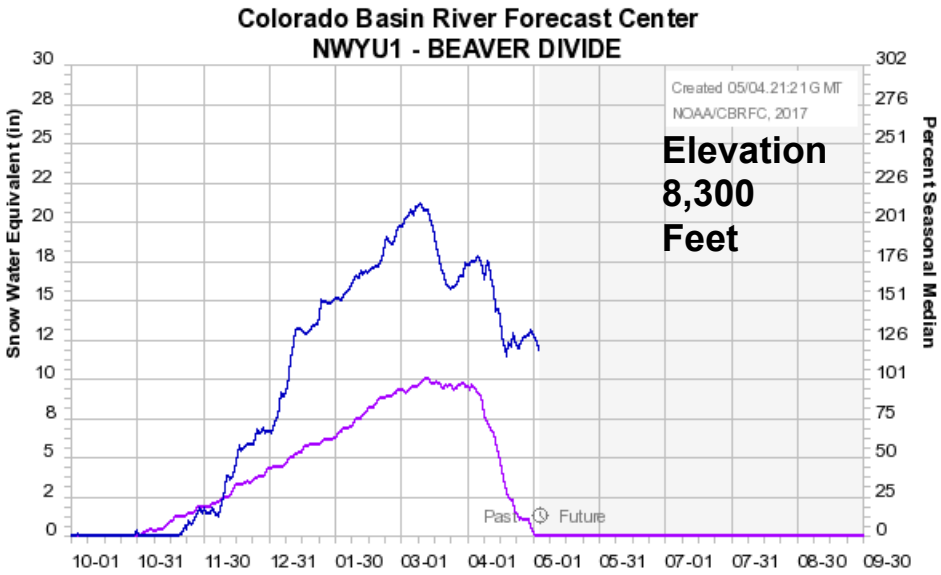
Site (Rank/POR) –	Mar Vol KAF / % Avg	– old record (year)
Bear-UT/WY (1/75)*	5.8 /200%	4.8 (2015)
Smiths Fork (1/75)*	8.8/224%	6.2 (2015)
Stewart Dam (1/89)*	98/407%	82 (1986)
Logan River (1/52)*	25/306%	23 (1986)
Blacksmith Fork (1/99)*	23/336%	22 (1986)
Little Bear River(1/73)*	29/380%	24 (1986)
South Fork Ogden (1/94)*	29/400%	25 (1986)
Pineview Inflow (1/79)*	80/330%	72 (1986)
Provo-Woodland(1/52)*	11.6/265%	11.4 (1986)
Provo-Hailstone(1/62)*	18.3/319%	16.5 (1986)

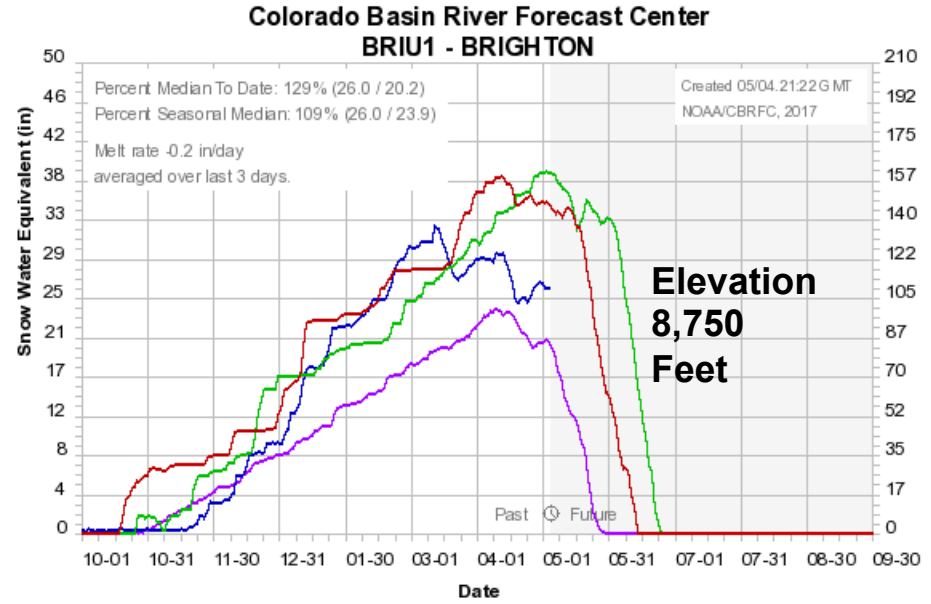
Saturated conditions, warm temperatures, low elevation snowmelt and precipitation resulted in record flows at many locations.

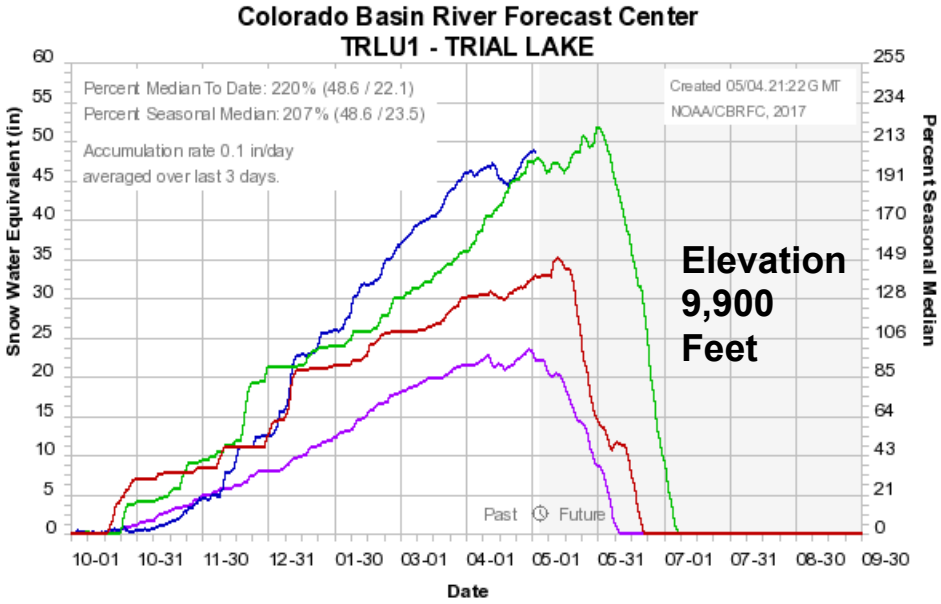
Many more sites in top 2 or 3 of record

Cooler April Temperatures Slow Melt









Median 1981-2010 2017 2011 2005

Median 1981-2010 2017 2011 2005

We Know The Climate Is Changing

Temperatures are rising and will continue to rise

Precipitation outlook is uncertain, but we do expect more extreme events

Decreased water supply, particularly for the Southwest and Colorado River Basin

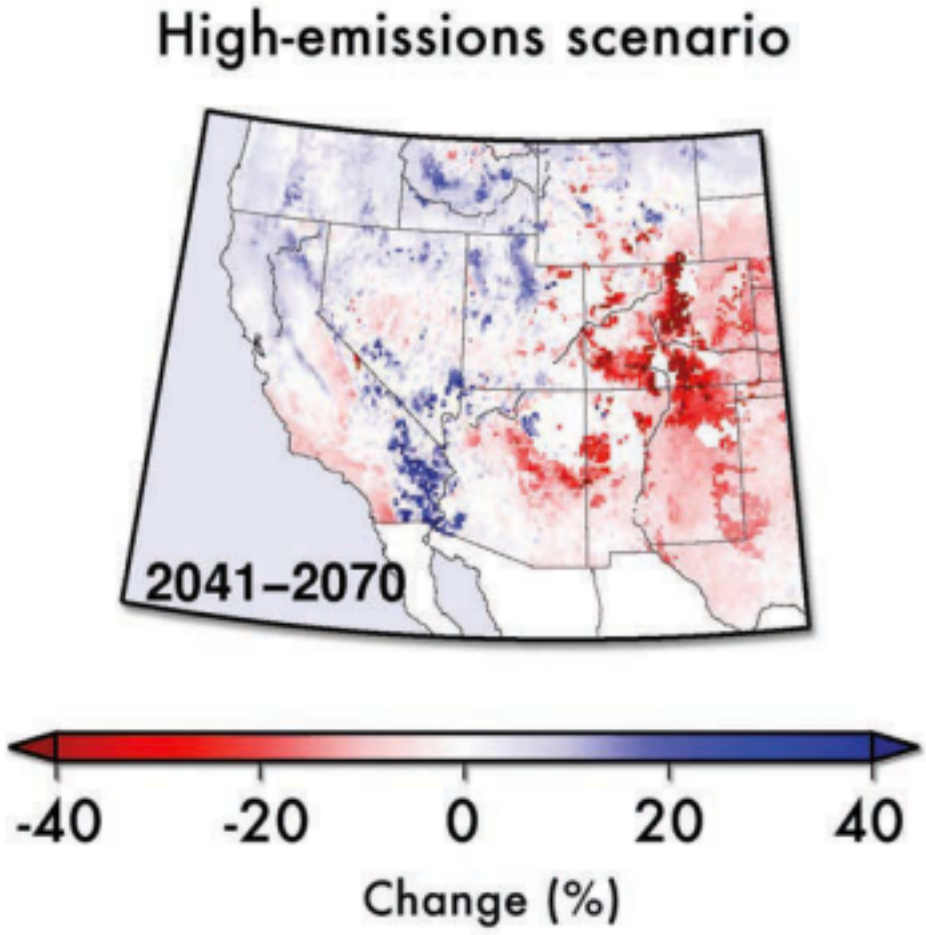


Figure from: Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy, eds. 2013. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

Impacts to Utah and the West

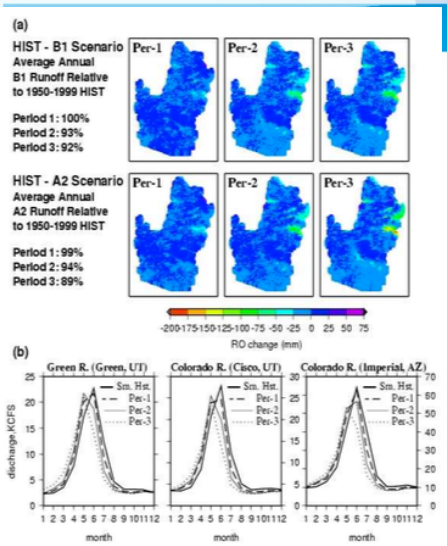


Figure from: Christensen and Lettenmaier, 2007. A multimodel ensemble approach to assessment of climate change impacts on the hydrology and water resources of the Colorado River Basin. Hydrology and Earth System Sciences.

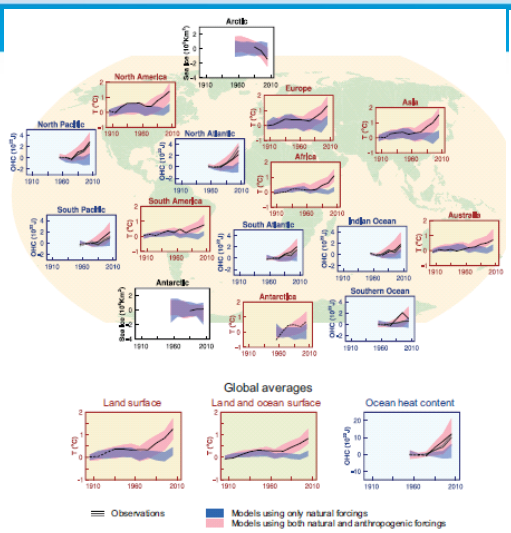
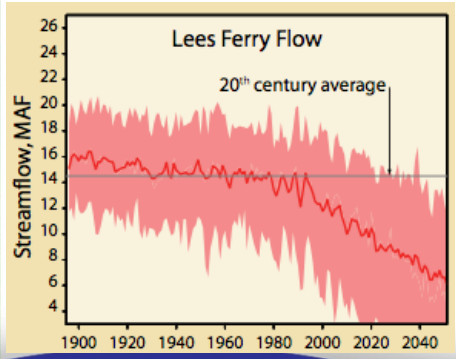
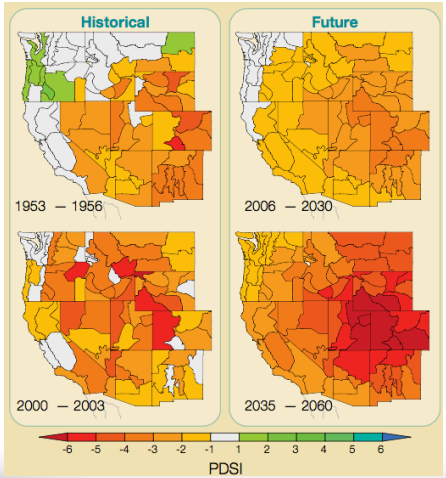
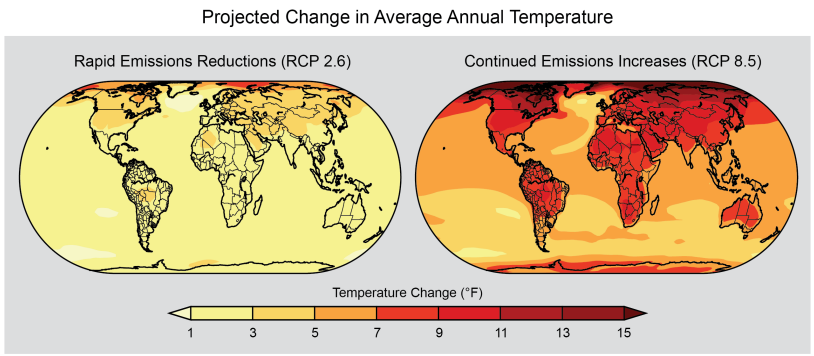


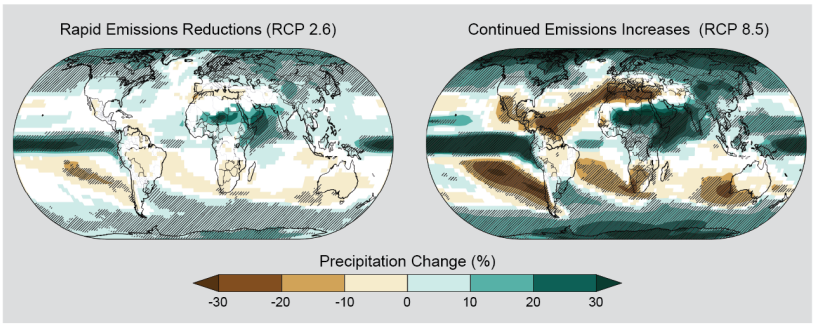
Figure from the IPCC 5th Assessment Report.

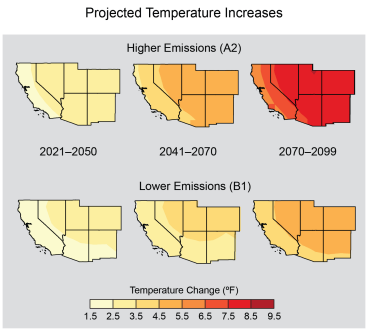


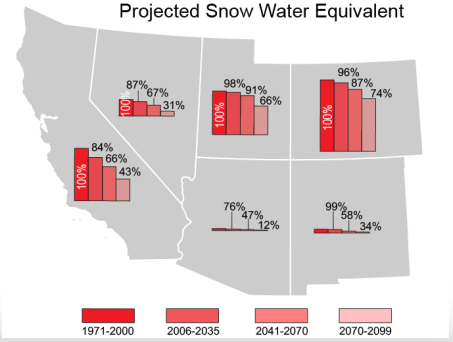


Figures from: Hoerling and Eischeid, 2007. Past Peak Water in the Southwest. Southwest Hydrology.









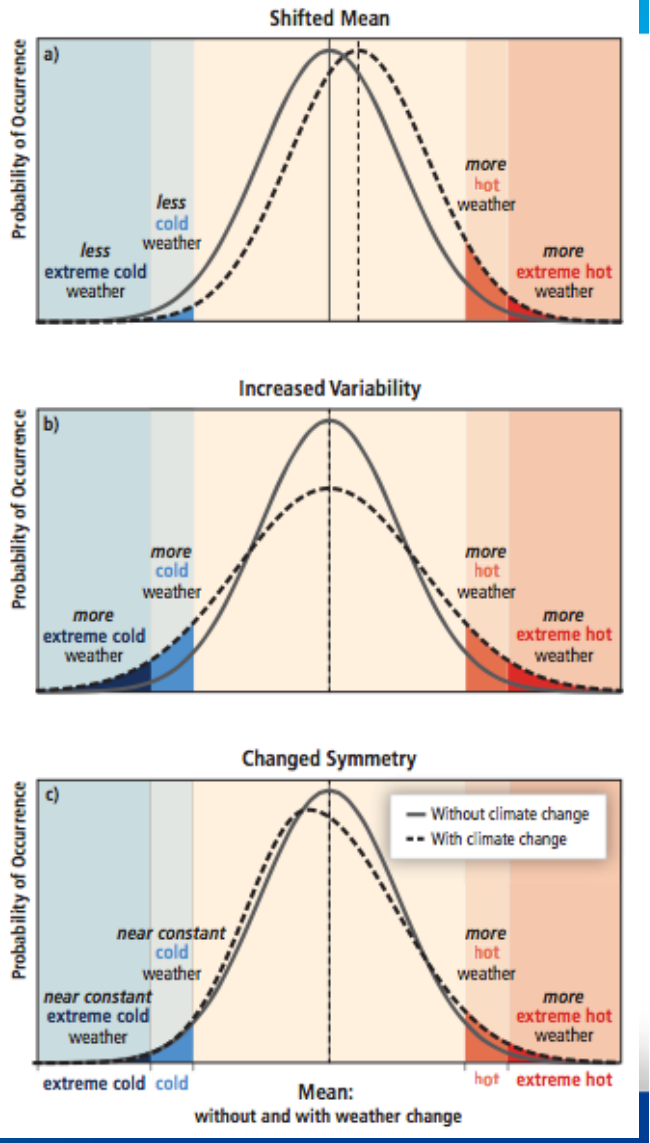
Figures from the 2014 National Climate Assessment

Impacts to the Colorado River Basin

- Temperatures are going to increase
  - About 3 ^{o}F to 10 ^{o}F over the next 20 – 80 years
  - Southwest is particularly effected
- Precipitation
  - More uncertainty
  - Locally and orographically influenced
  - West could see little change to about a 20% decrease
- Impacts to Streamflow
  - Locally variant, but overall decrease in water supply
  - More rainfall events, less snowfall
  - Earlier runoff
  - Increased evapotranspiration
  - Consensus seems to hover around 8% to 10% decrease over the next 20 – 80 years
  - Extreme events still possible, more likely

The Science Ahead

- Climate change attribution
  - Can we start to quantify how much climate change contributes to a particular event?
  - Difficult, but the science is rapidly advancing
    - Comparison with the observational record
    - Comparison to model simulations without anthropogenic climate change



Challenges Ahead

- Climate Change and its Impacts
  - Stationarity is in the past – but it's also how we look forward
  - Extreme Events – persistent drought and intense rains can impact our forecasts, and our stakeholder's ability to manage resources effectively
- Infrastructure and Operations
  - How do we continue to bridge the research to operations gap? AND the operations to research gap?
  - Our model from the 1970s was not built for the data we have access to now, so we have to be innovative
- Outreach
  - Facilitating cooperative and continued decision support
  - Reaching those partners we haven't met yet
  - A diverse area with diverse needs! Great Basin, Lower Basin, Upper Basin… and the users within those areas...

Moving Forward

Sixteen years of drought in the Colorado River Basin: Reality or talking point?

By Guest Columnist

Thursday, May 12, 2016

By Eric Kuhn

I was recently reading an a
Colorado River water when
seeing for many years now
was "after 14 years of drou

Energy and Environment

'Climate change is water change' — why the Colorado River system is headed for major trouble

By Chelsea Harvey August 19

Cutbacks in Arizona Water deliveries possible

Lake Powell could dry up in as little as six years, study says

By Tony Davis Arizona Daily Star Updated Sep 4, 2016 (5)

May showers bring better outlook for Colorado River, but no miracle

A group of kayakers prepare to head down river while paddling the Black Canyon Water Trail on the lower Colorado River in Lake Mead National Recreation Area on the Nevada and Arizona border east of Las Vegas on Thursday, July 3, 2014. There are 16 routes within the National Water Trail system, and the Black Canyon Water Trail is the first water trail in the Southwest and the only water trail that traverses through a desert. (Jason Bean/Las Vegas Review-Journal)

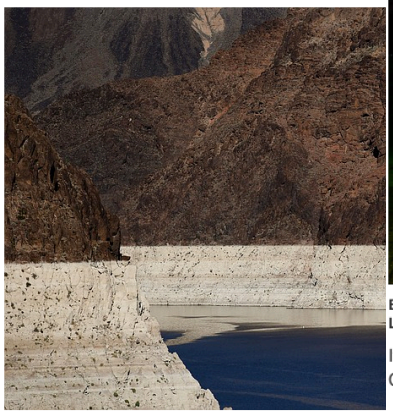
By HENRY BREAN
LAS VEGAS REVIEW-JOURNAL

It wasn't the "Miracle May" that some observers called it, but a month
Colorado and Utah did provide a significant boost to the outlook for th

A terrible year became merely below average.

"'Miracle' is probably a bit of an overstatement, but the unusually wet
impact on water supply," said Paul Miller, a senior hydrologist with the
Service's Colorado Basin River Forecast Center in Salt Lake City.

Lake Mead shows extent of drought: Feds see 2



Jae C. Hong/The Associated Press, file
A riverboat glides through Lake Mead on the Colorado River at Hoover Dam ne

By Ken Ritter, The Associated Press

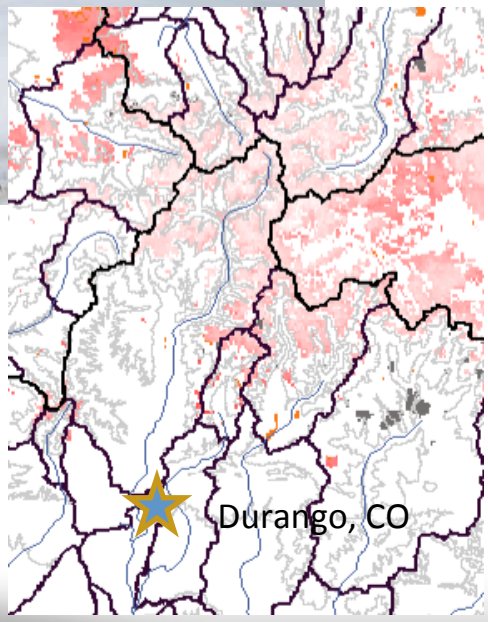
The Rise of Water Optimism

Two new books offer hope for our aquatic future.

By Ben Goldfarb

re indicated by white marks
lake.

Moving Forward



- Incorporation of remotely sensed snow information
  - Aerial extent
  - Dust on snow impacts
- An innovative way to get new information into an old model

National Water Center

Weather-Ready Nation
National Oceanic and Atmospheric Administration

National Water Model

Improving NOAA's Water Prediction Services

In August 2016, NOAA took a giant leap forward in its ability to forecast the flow of rivers and streams throughout the entire continental United States with the launch of the new high resolution National Water Model (NWM).

The NWM will enhance and expand NOAA's water flow forecasts, which to date have been available for approximately 4,000 river locations with stream gages operated by the U.S. Geological Survey. This new model will expand forecasts to 2.7 million stream locations nationwide. Leveraging the full network of nearly 8,000 U.S. Geological Service stream gauges and NOAA's investment in atmospheric modeling, the NWM will provide high-resolution forecasts of soil moisture, surface runoff, snow water equivalent, and other parameters.

We all recognize that water is an essential component of sustainable and resilient communities. But its also a stressed natural resource and potential threat to life, property, and livelihoods during extreme weather events.

Improved Water Information Services

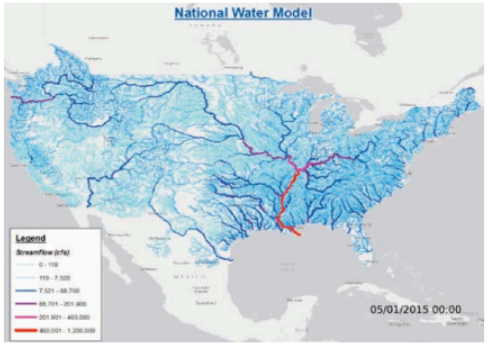
The new NWM improves the National Weather Service's ability to deliver impact-based decision support services nationwide by providing "street level" water information and guidance, as well as serve as the foundation for additional private sector water services. At a minimum, the NWM will immediately provide predictive water information for many locations where none previously existed.

Initially, this new NWM-based information will be particularly useful in headwater areas in support of NOAA's flash flood mission.

How it Works

The NWM simulates the water cycle with mathematical representations of the different processes and how they fit together. This complex representation of physical processes such as snowmelt and infiltration and water movement through the soil layers varies significantly with changing elevations, soils, vegetation types and a host of other variables.

Additionally, extreme variability in precipitation over short distances and times can cause the response on rivers and streams to change very quickly. Overall, the processes are so complex that to simulate it with a mathematical model means that it needs a "supercomputer" in order to run in the time frame needed to support decision makers when flooding is threatening.



National Water Model is a new forecasting tool that will help forecasters predict when and where flooding can be expected.

www.water.noaa.gov

National Water Model Image Viewer

The viewer below has been made available to view the pre-generated imagery depicting output from the National Water Model. For direct access to the imagery shown in the viewer, visit the following location: http://www.nohrsc.noaa.gov/pub/staff/keicher/WRFH_ppd/web/static_images/

Dataset: Stream Flow

Forecast Type: Long Range

5.0 s Apply

2016-09-09 06:00:00 UTC

- 2016-09-09 06:00:00 UTC
- 2016-09-09 12:00:00 UTC
- 2016-09-09 18:00:00 UTC
- 2016-09-10 00:00:00 UTC
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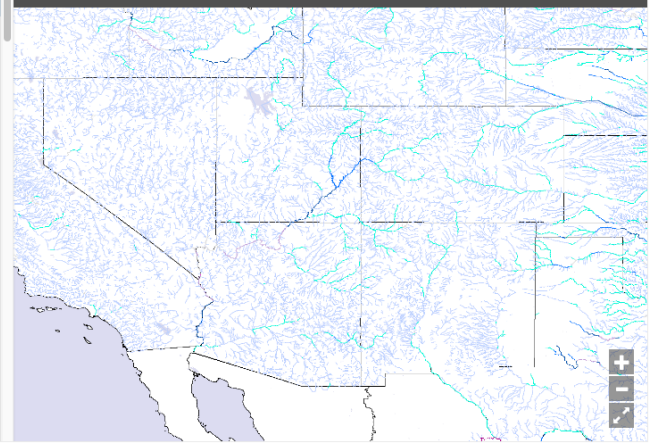

Questions?

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- 801-524-5130 x335

- www.cbrfc.noaa.gov