

NOAA's Colorado Basin River Forecast Center

Decision Support in the Cadillac Desert: *Water Supply Data and Tools in the Water Stressed and Politically Charged Colorado River Basin*

W. Paul Miller, Service Coordination Hydrologist

Arizona Hydrological Society Annual Symposium

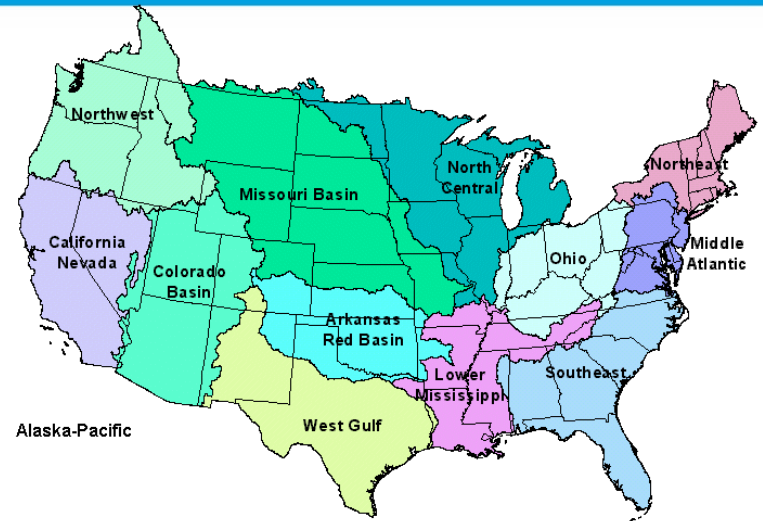
September 16, 2016

Tucson, AZ – Casino Del Sol Resort





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!

Colorado Basin River Forecast Center

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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
 - Reclamation is a key stakeholder
 - www.cbrfc.noaa.gov



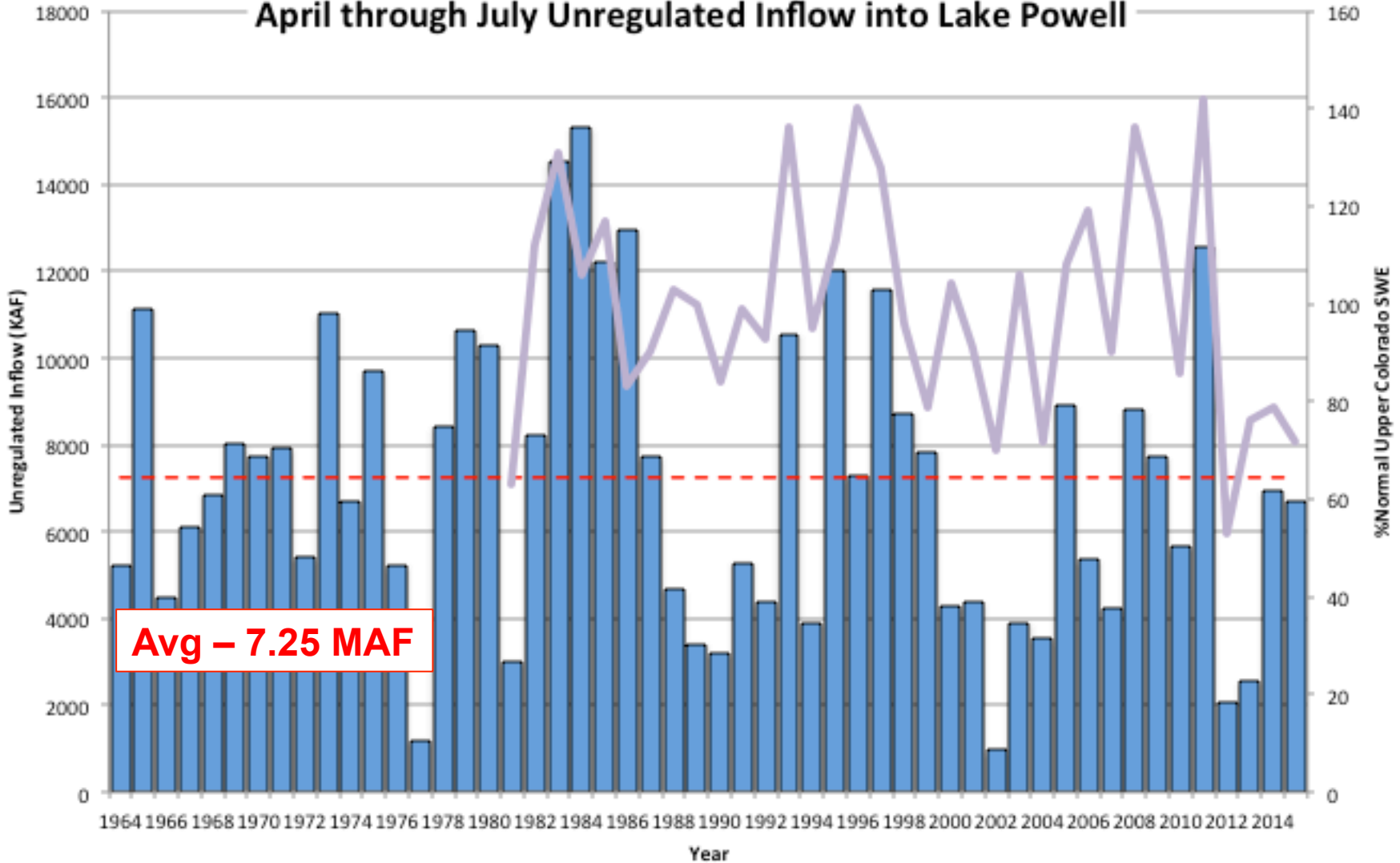
Weather Forecast Offices (WFOs)

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



Hydroclimatic Variability over the Colorado River Basin

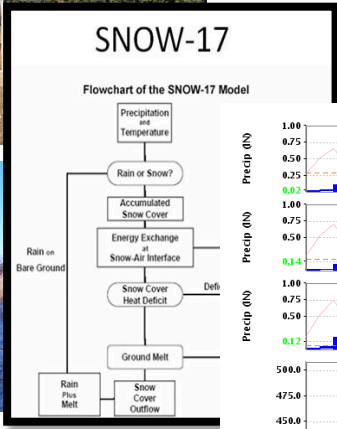
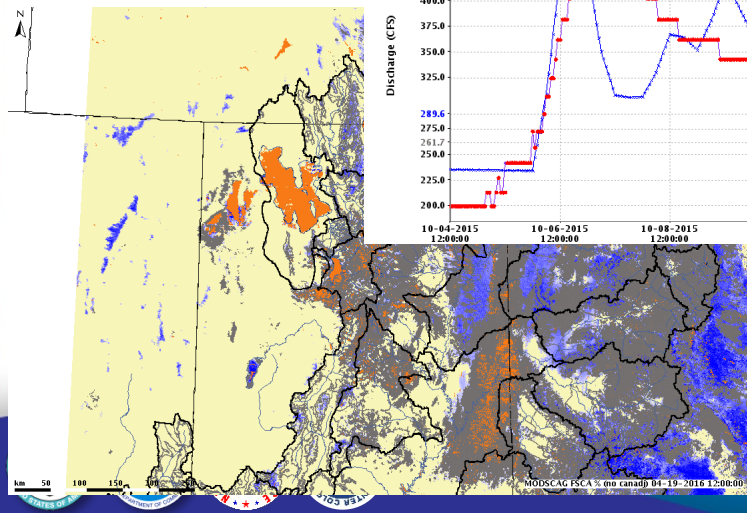
April through July Unregulated Inflow into Lake Powell



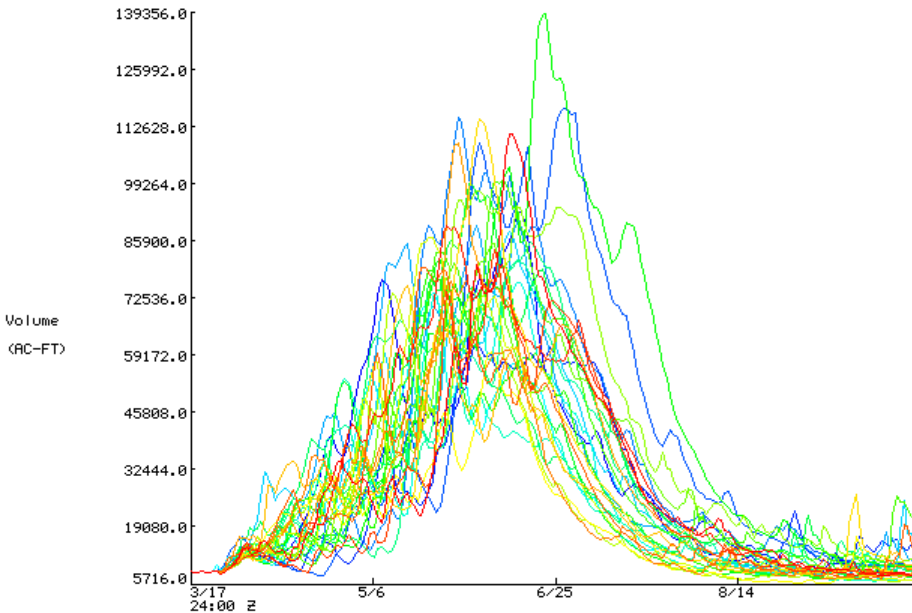
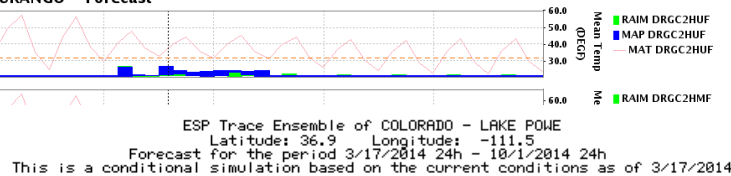
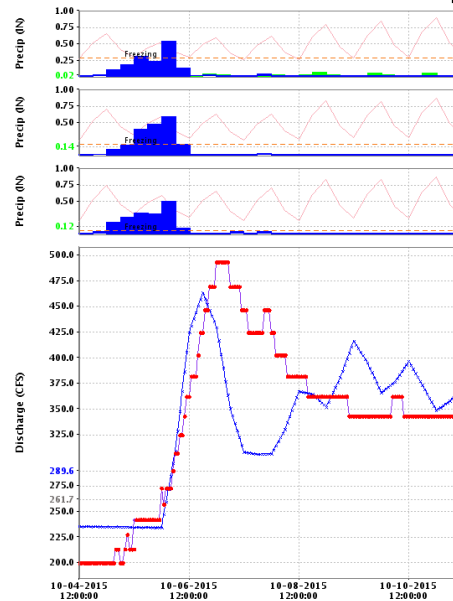
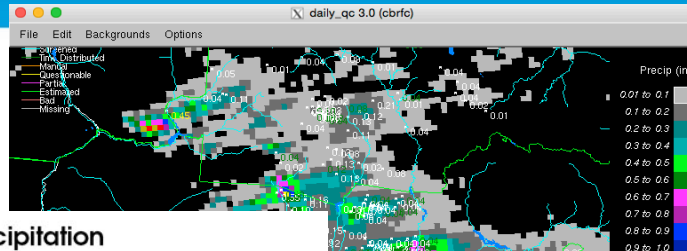
Avg - 7.25 MAF

Providing Decision Support

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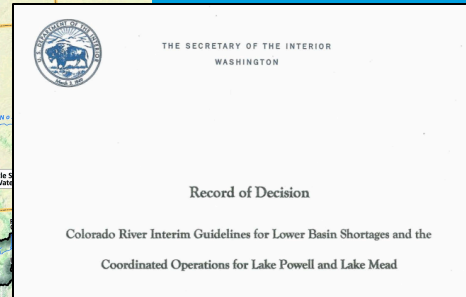
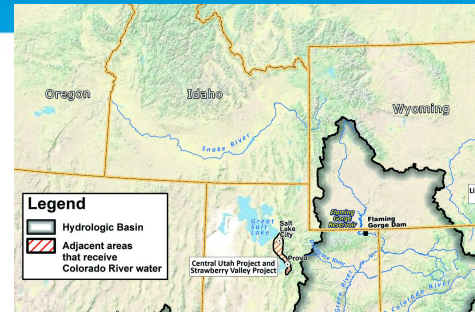
Evapo-  Precipitation



Providing Decision Support

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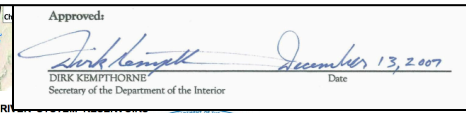
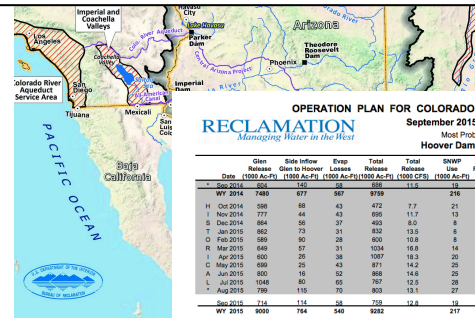
- CBRFC's water supply forecasts drive Reclamation's model that



AOP consultation process. In making these projections, the Secretary shall utilize the April 1 final forecast of the April through July runoff, currently provided by the National Weather Service's Colorado Basin River Forecast Center.

declarations

- Direct impact to State, municipal, agricultural, water and energy managers and Mexico



OPERATION PLAN FOR COLORADO RIVER
RECLAMATION
 Managing Water in the West
 September 2015 24-Month Study
 Most Probable Inflow*
 Hoover Dam - Lake Mead

Scenario	Gen. Release (1000 Ac-Ft)	Side Inflow (1000 Ac-Ft)	Evap. Losses (1000 Ac-Ft)	Total Release (1000 CFS)	SNWP (1000 Ac-Ft)	Downstream Use (1000 Ac-Ft)	Reservoir Storage (1000 Ac-Ft)	Bank Storage (1000 Ac-Ft)	ECM (1000 Ac-Ft)
WY 2014	7480	677	367	8799	216	9716			
1 Oct-2014	586	61	42	605	7.7	21	481	868	1062.78
1 Nov-2014	777	44	43	695	11.7	13	692	670	1063.57
1 Dec-2014	864	36	37	452	8.0	8	482	803	1061.78
1 Jan-2015	864	73	21	812	13.5	8	632	697	1066.51
1 Feb-2015	589	90	28	600	10.8	8	580	700	1066.98
1 Mar-2015	649	57	31	1026	16.8	14	1033	877	1066.87
1 Apr-2015	800	26	38	1007	18.3	20	1066	646	1079.03
1 May-2015	699	25	43	871	14.2	25	862	632	1058.87
1 Jun-2015	800	16	52	868	14.6	25	868	624	1075.08
1 Jul-2015	1048	80	65	797	12.5	28	786	641	1059.15
1 Aug-2015	799	116	70	803	13.1	27	802	642	1078.31
2015	714	113	36	739	34.8	18	739	681	1033.21
WY 2015	8000	784	540	9262	217	9263			
1 Oct-2015	800	61	42	809	9.9	24	609	640	1079.06
1 Nov-2015	800	50	42	622	10.5	14	622	636	1075.74
1 Dec-2015	800	96	38	612	8.3	11	512	699	1061.56
1 Jan-2016	800	72	30	862	11.3	8	662	688	1065.16
1 Feb-2016	690	77	28	623	10.8	7	623	672	1063.93
1 Mar-2016	800	68	31	1017	16.5	15	1017	651	1059.88
1 Apr-2016	800	78	38	1090	18.3	21	1090	622	1074.58
1 May-2016	800	68	42	996	16.2	20	996	599	1055.24
1 Jun-2016	800	23	51	924	15.5	30	924	688	1068.09
1 Jul-2016	1000	67	63	874	14.2	31	874	584	1060.27
1 Aug-2016	1050	127	68	776	12.7	29	779	613	1052.82
2016	800	114	58	718	52.1	16	718	620	1032.25
WY 2016	8000	874	637	9497	337	9497			
1 Oct-2016	600	61	41	478	7.8	20	478	628	1075.06
1 Nov-2016	600	50	41	623	10.5	11	623	626	1075.37
1 Dec-2016	800	96	38	582	9.0	7	582	644	1078.81
1 Jan-2017	800	72	30	699	11.4	8	699	663	1065.24
1 Feb-2017	600	77	27	627	11.3	7	627	667	1061.08
1 Mar-2017	800	61	31	1025	16.7	15	1025	635	1075.98
1 Apr-2017	800	37	37	1098	18.1	21	1098	605	1057.40
1 May-2017	800	49	42	1004	18.3	30	1004	582	1066.94
1 Jun-2017	1000	23	50	931	15.7	30	931	571	1064.67
1 Jul-2017	1000	67	62	881	14.3	31	881	576	1060.79
1 Aug-2017	1050	127	67	786	12.8	29	786	584	1059.32

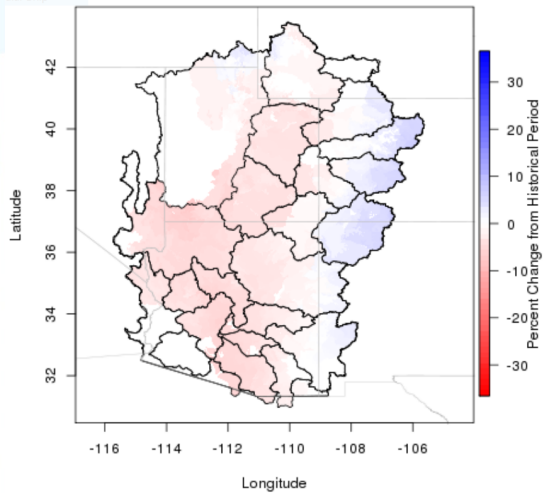
* Based on the Colorado River Basin Forecast Center's Most Probable Water Supply Forecast
 Model Run ID: 2266
 Processed On 9/9/2015 9:26:12AM



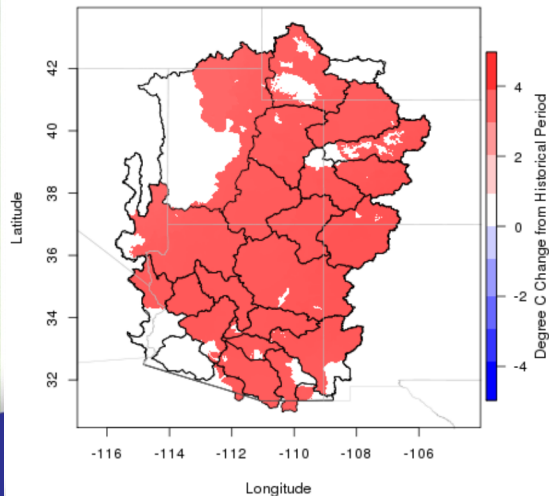
We Know The Climate Is Changing

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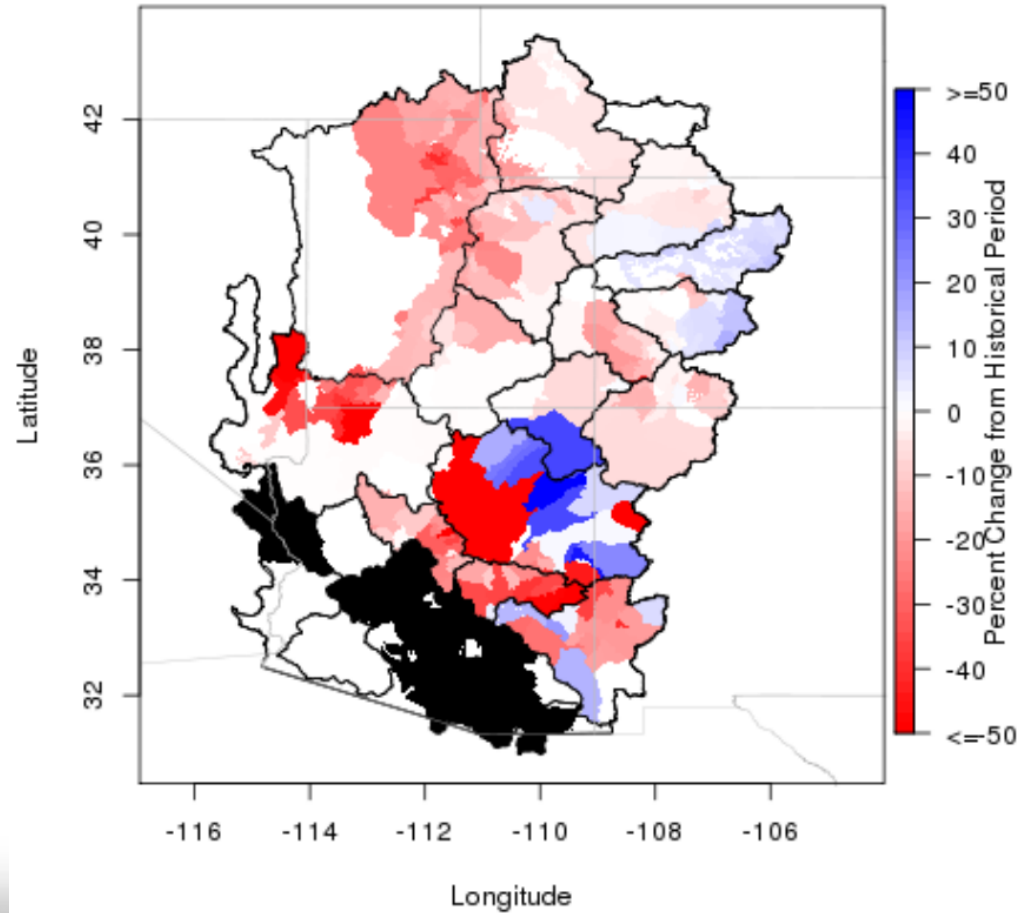
BCSD CMIP5 Ensemble Mean Precipitation Change from 1981-2010 to 2070-2099



BCSD CMIP5 Ensemble Mean Temperature Change from 1981-2010 to 2070-2099



Avg Seasonal CMIP5 Change from 1981-2010 to 2070-2099



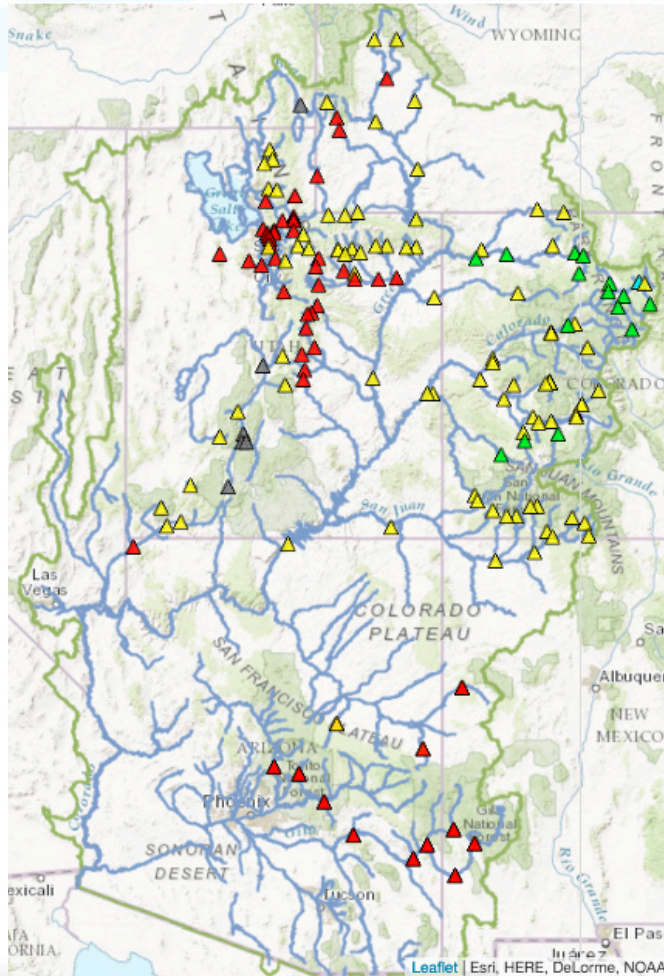
And Our Stakeholder's Needs Are Changing

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- Where we were:
 - What is THE forecast?
 - How much water is there?
 - How much snow is there?
 - Will there be flooding?
- Where we are going:
 - What is the range of forecasts?
 - What is the likelihood of reaching this flow?
 - What if it's a dry/wet year?
 - What is the risk to filling my reservoir?
 - What is your uncertainty?

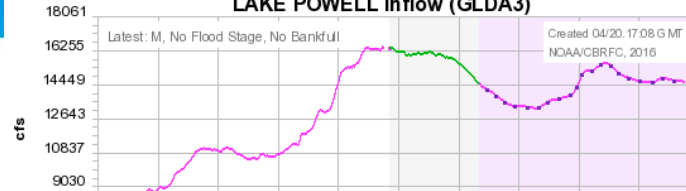


Reaching our Stakeholders

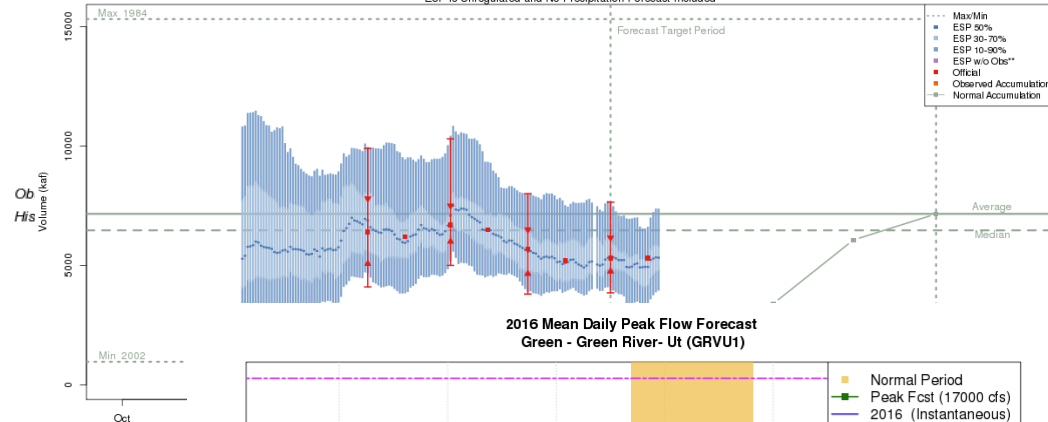


Colorado Basin River Forecast Center

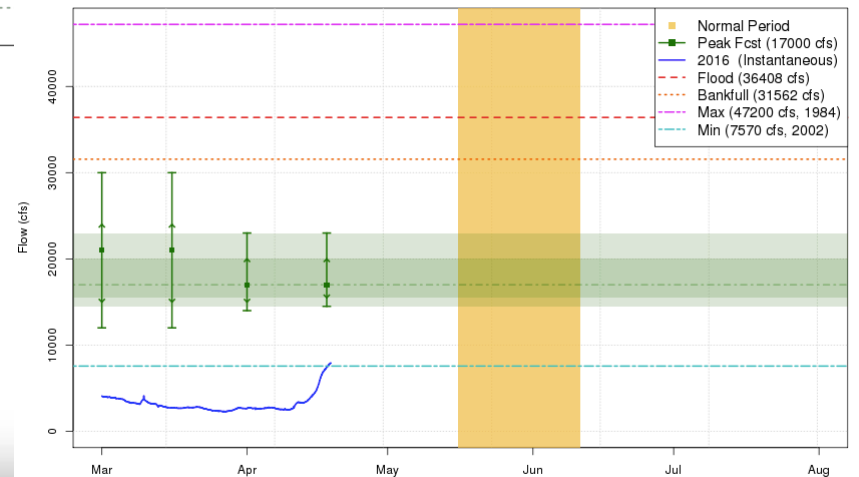
LAKE POWELL Inflow (GLDA3)



Colorado - Lake Powell- Glen Cyn Dam- At (GLDA3)
2016-04-15 Apr-Jul Official 50% Forecast: 5300 kaf (74% of average)
ESP is Unregulated and No Precipitation Forecast Included



2016 Mean Daily Peak Flow Forecast
Green - Green River- Ut (GRVU1)



These graphics are updated approximately every two weeks between 3/1 and 5/1

Plot Created 2016-04-18 15:23:43
CBRFC / NWS / NOAA



Challenges Ahead

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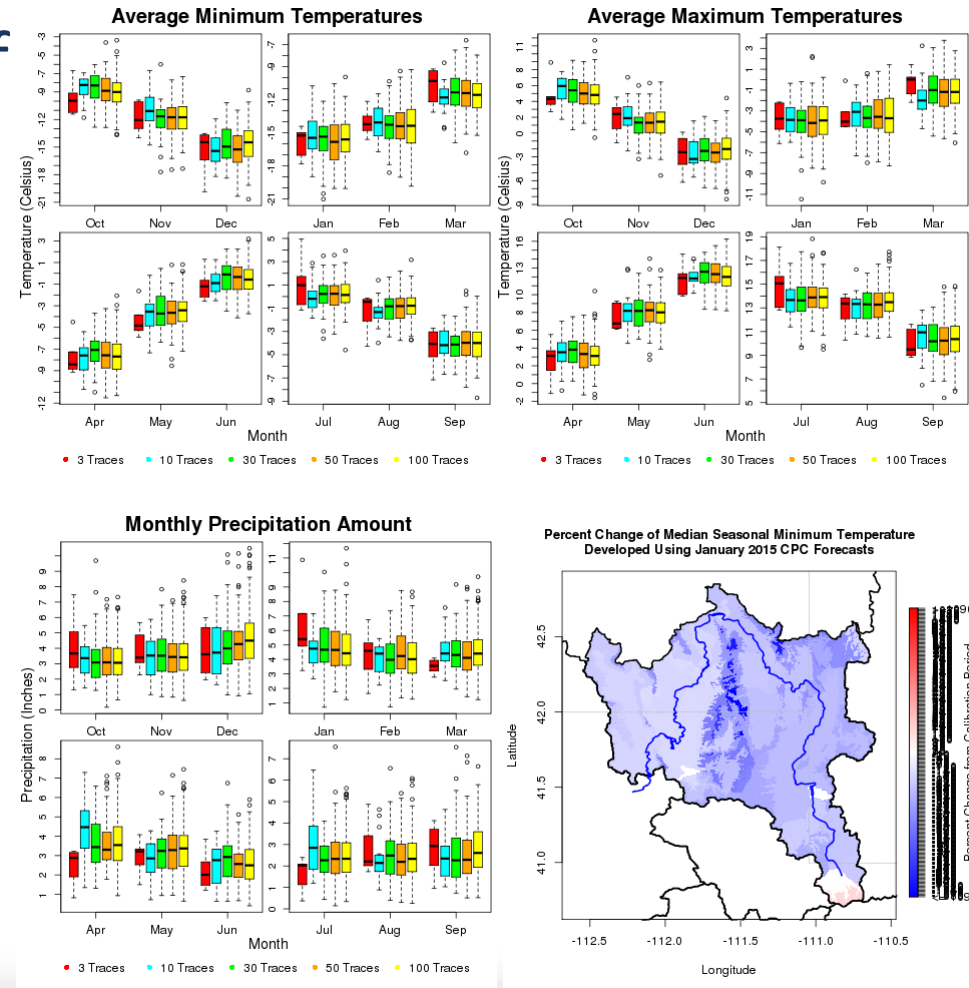
- Climate Change and its Impacts
 - Stationarity is in the past – but it's also how we look forward
 - Extreme Events – persistent drought and intense rains can impact our forecasts, and our stakeholder's ability to manage resources effectively
- Infrastructure and Operations
 - How do we continue to 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

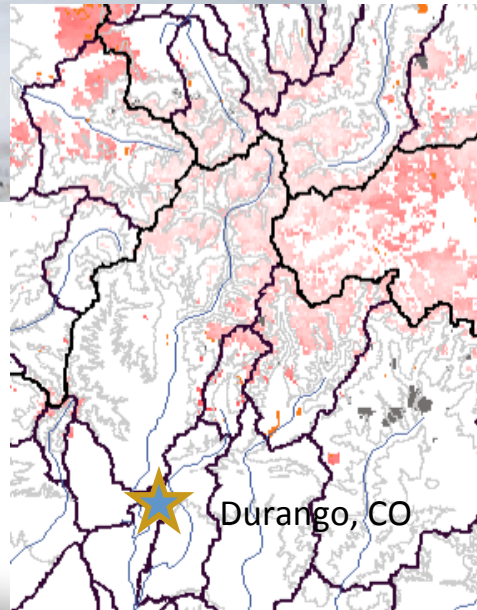
11

- Investigating the use of a Stochastic Weather Generator
 - Reduce reliance on historical weather and climate
 - Understand variability and risk better
 - Incorporate climate information



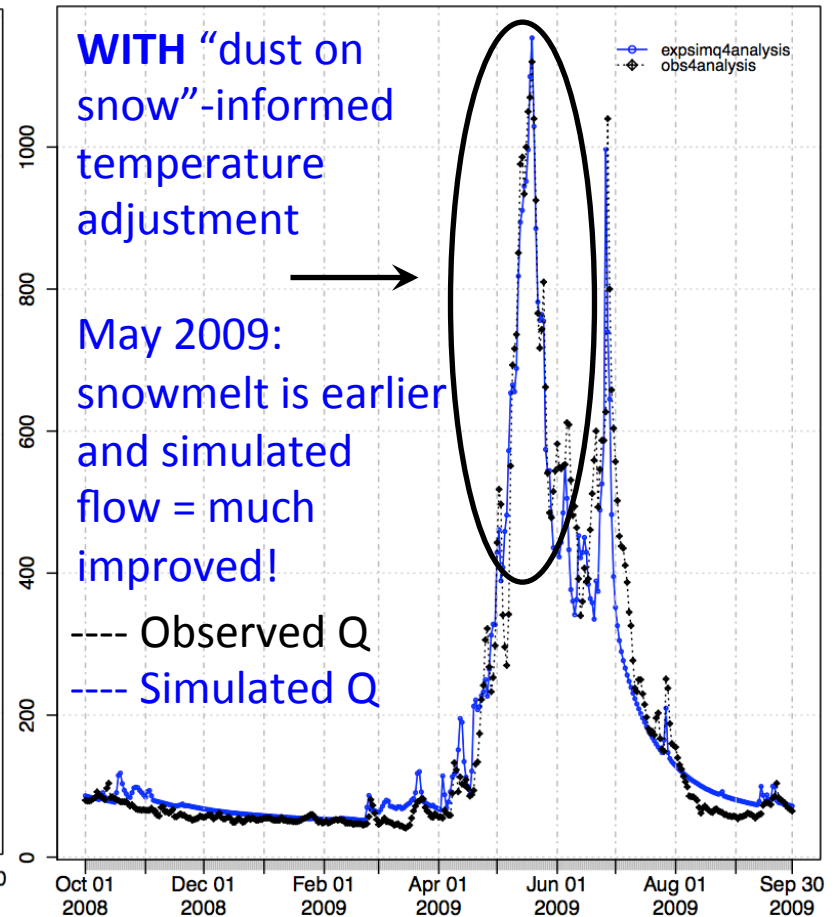
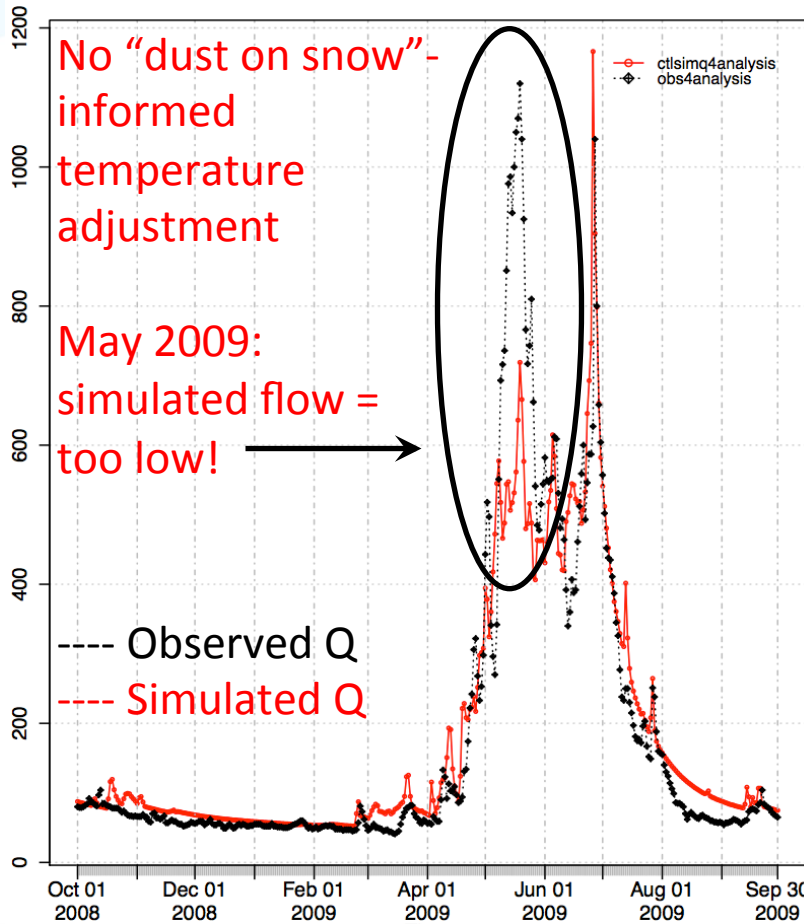
Moving Forward

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

Moving Forward



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 article about Colorado River water when I was seeing for many years now that it was "after 14 years of drought"

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 of rain in Colorado and Utah did provide a significant boost to the outlook for the river.

A terrible year became merely below average.

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

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

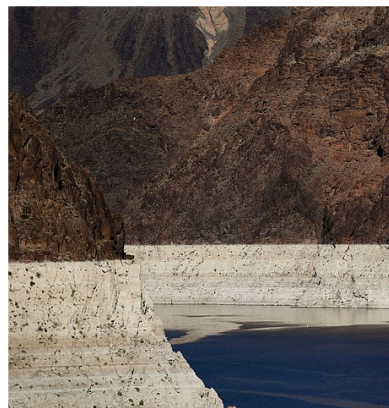
Lake Powell could dry up in as little as six years, study says

By Tony Davis Arizona Daily Star Updated Sep 4, 2016



Cracks in the rock formation indicate the extent of the drought in the Colorado River Basin. The cracks are a result of the severe consequences for the lake.

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 near

By Ken Ritter, The Associated Press



The Rise of Water Optimism

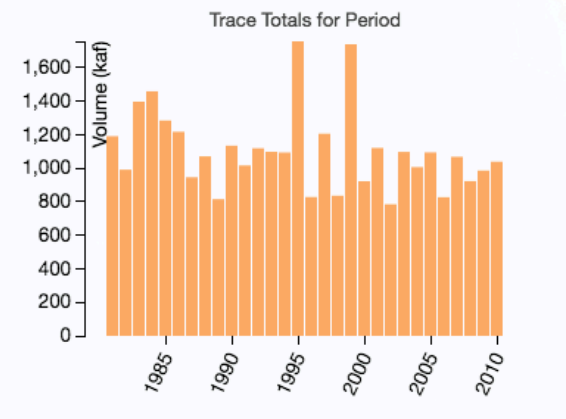
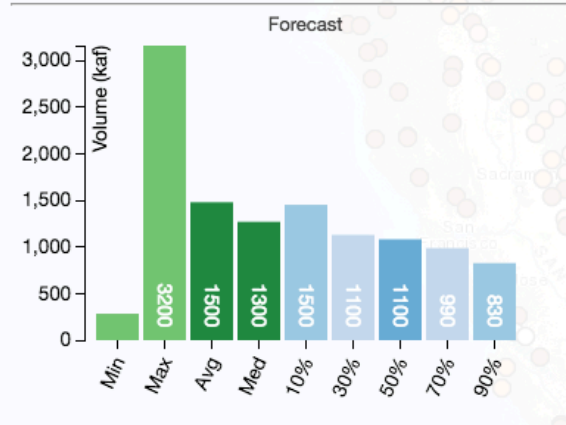
Two new books offer hope for our aquatic future.

By Ben Goldfarb

Moving Forward

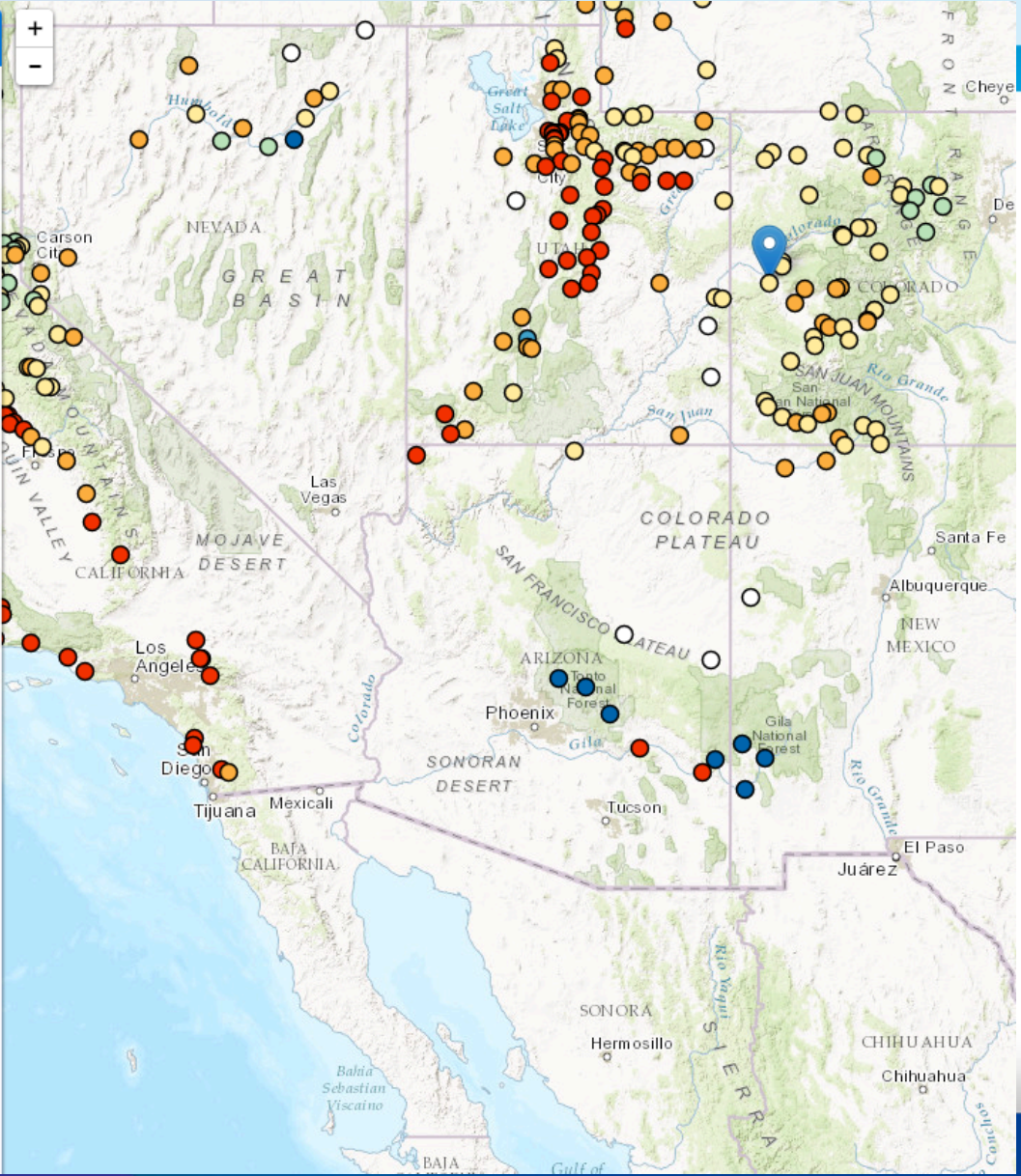
Forecast Point Details

Gunnison - Grand Junction, Nr



[View Forecast Evolution](#)

Station
ID GJNC2
Latitude 38.98
Longitude -108.45



National Water Center



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 gauges 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

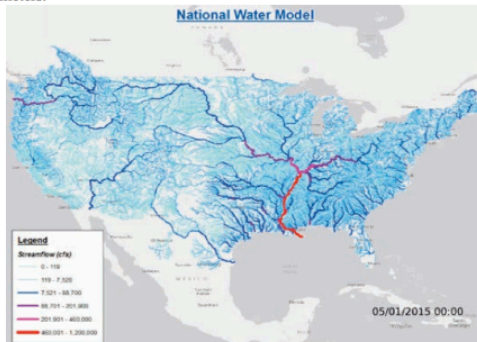
The new NWM improves the National Weather Service's ability to deliver impact-based decision support services nationwide by providing "street level" water information and guidance, as well as serve as the foundation for additional private sector water services. At a minimum, the NWM will immediately 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

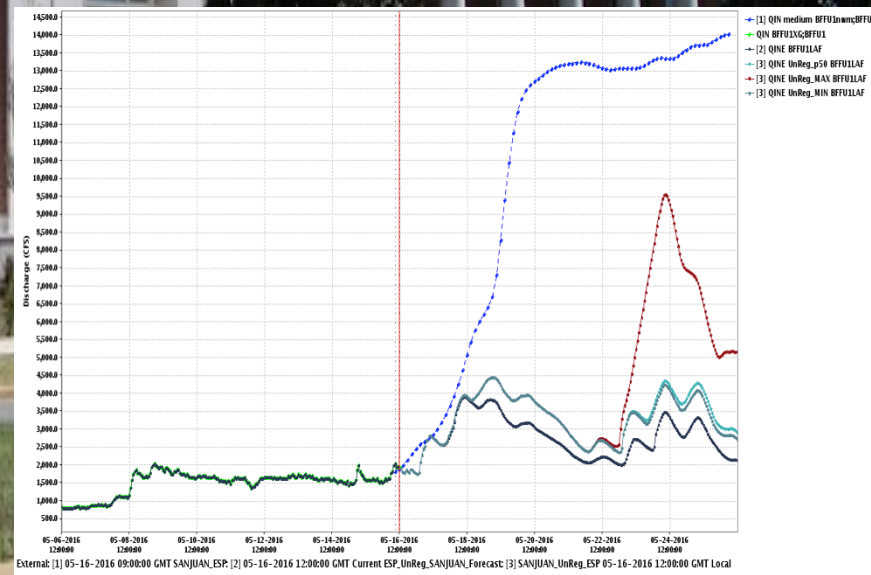
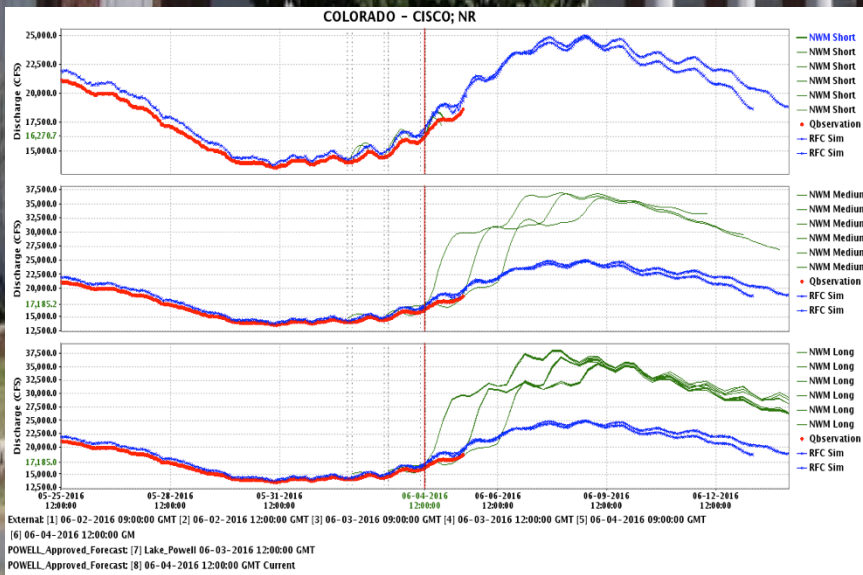
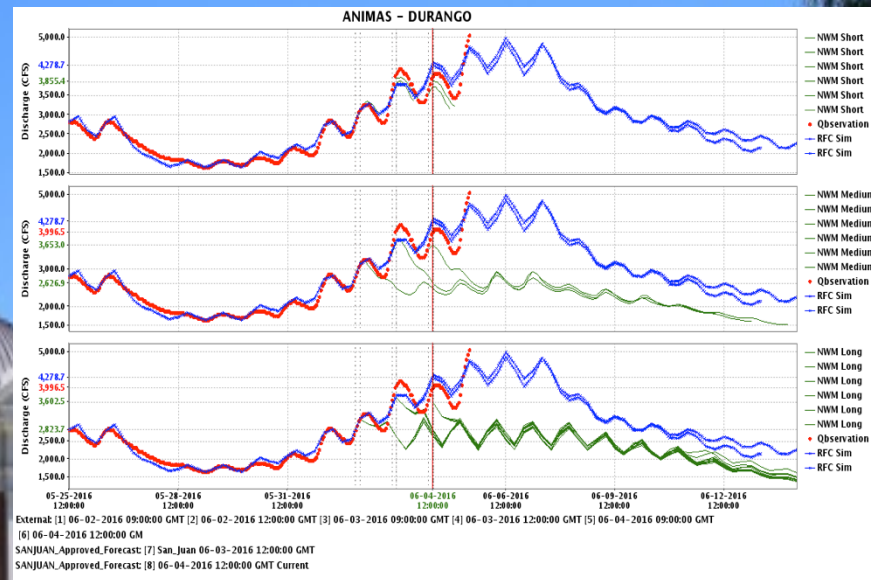
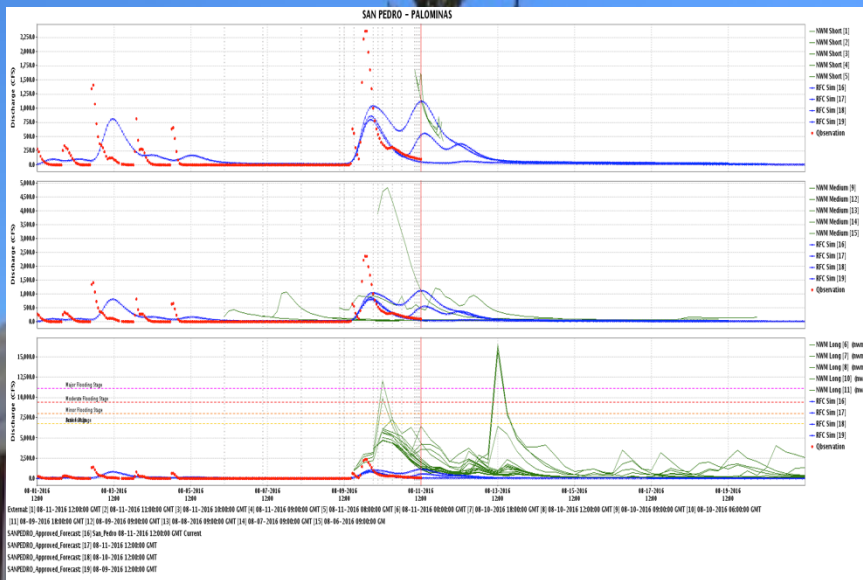
National Water Model Image Viewer

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

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
2016-09-10 06:00:00 UTC
2016-09-10 12:00:00 UTC
2016-09-10 18:00:00 UTC
2016-09-11 00:00:00 UTC
2016-09-11 06:00:00 UTC
2016-09-11 12:00:00 UTC
2016-09-11 18:00:00 UTC
2016-09-12 00:00:00 UTC
2016-09-12 06:00:00 UTC

National Water Center



Moving Forward

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CADILLAC DESERT

THE AMERICAN WEST AND ITS
DISAPPEARING WATER



MARC REISNER

"A savagely witty history of America's reckless depletion of its water resources"
—Newsday

If we want to continue to thrive in a Cadillac Desert, we have to carpool!

We need to facilitate and champion the notion of a hydrologic community – we're one basin.

New partnerships, new voices, and new ideas are going to be needed – we can help!

