2014 Water Supply Verification Webinar

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Colorado Basin River Forecast Center

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2014 Water Supply Verification Webinar

Why Do Verification? It's a path to improvement

Setting the stage: Fall and Winter Weather

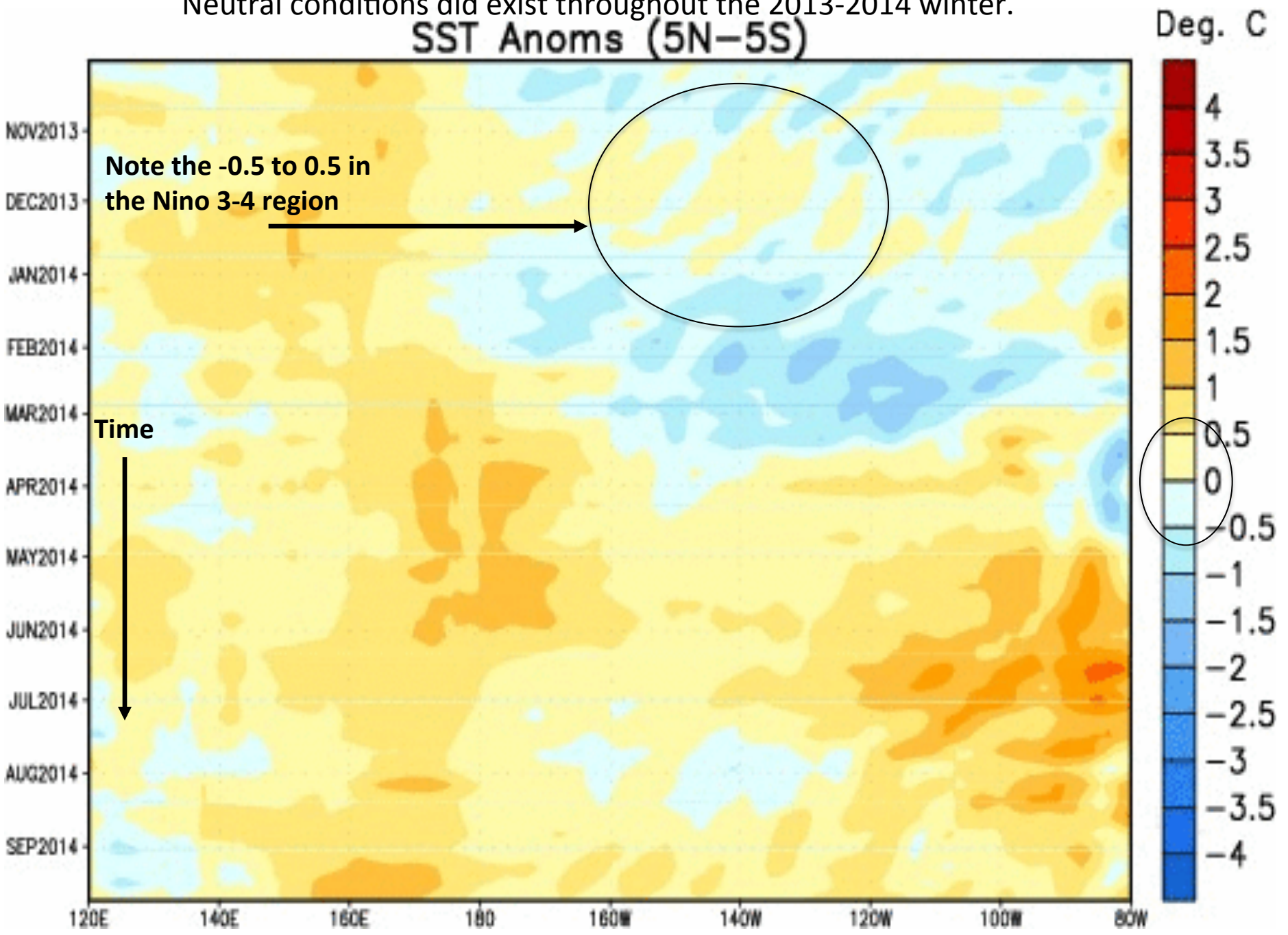
Primary drivers of the 2014 forecasts

Verification: Forecasts and Observed Volumes

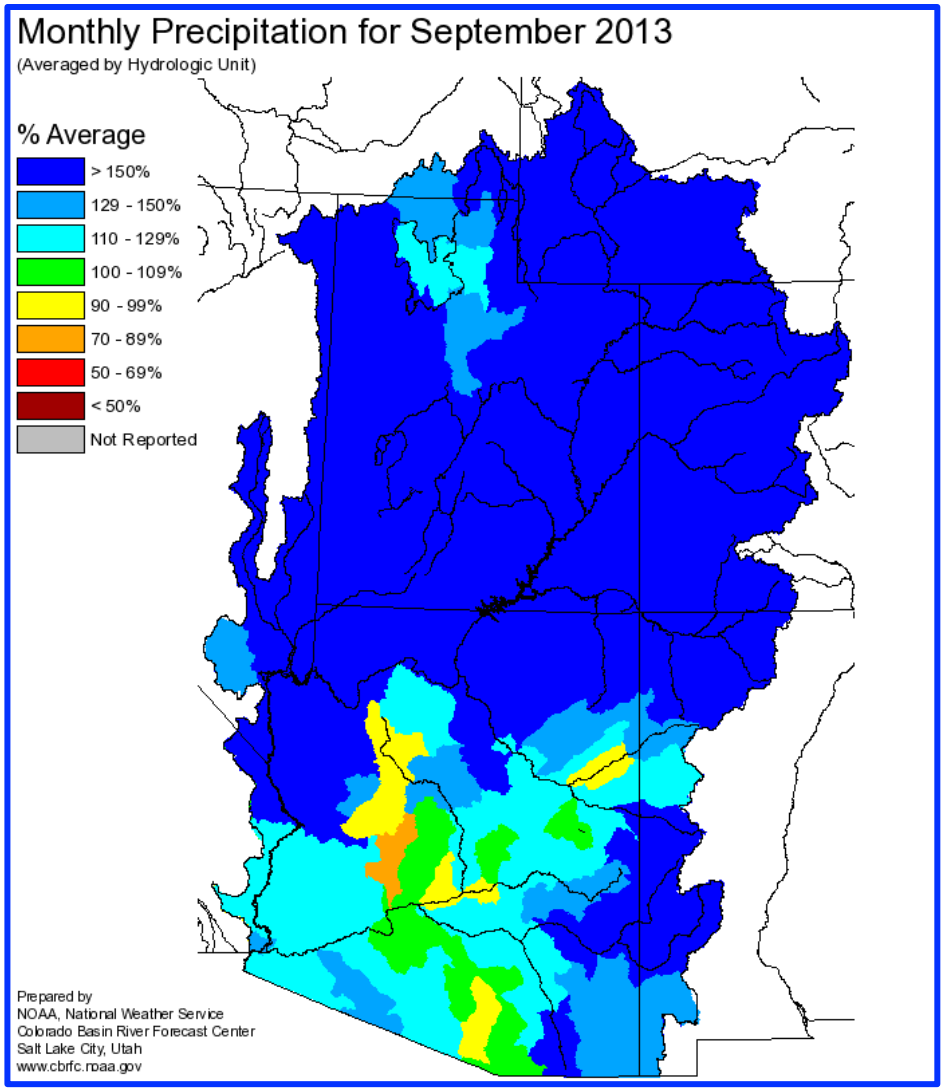
Verification: Take-a-ways from 2014

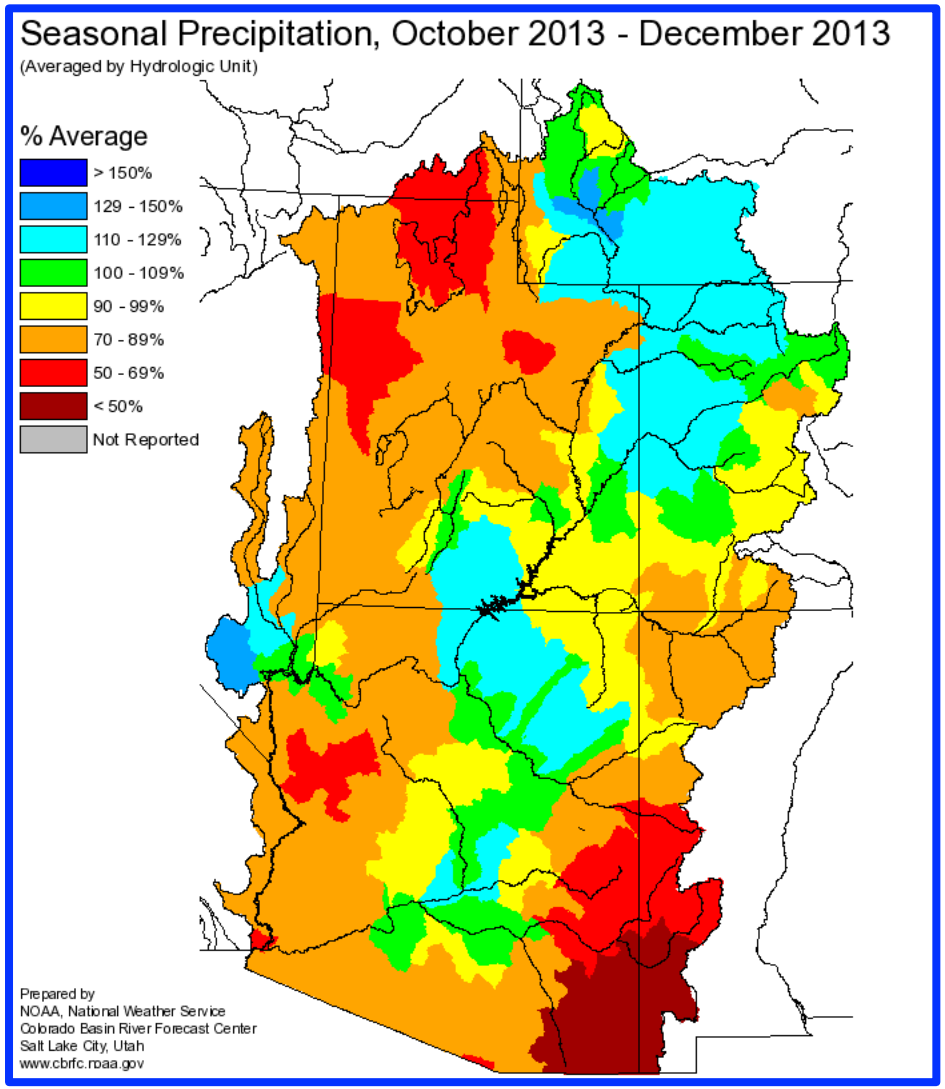
Future water supply webinar schedule

Neutral conditions did exist throughout the 2013-2014 winter.



A very wet September boosted soil moisture conditions in many areas

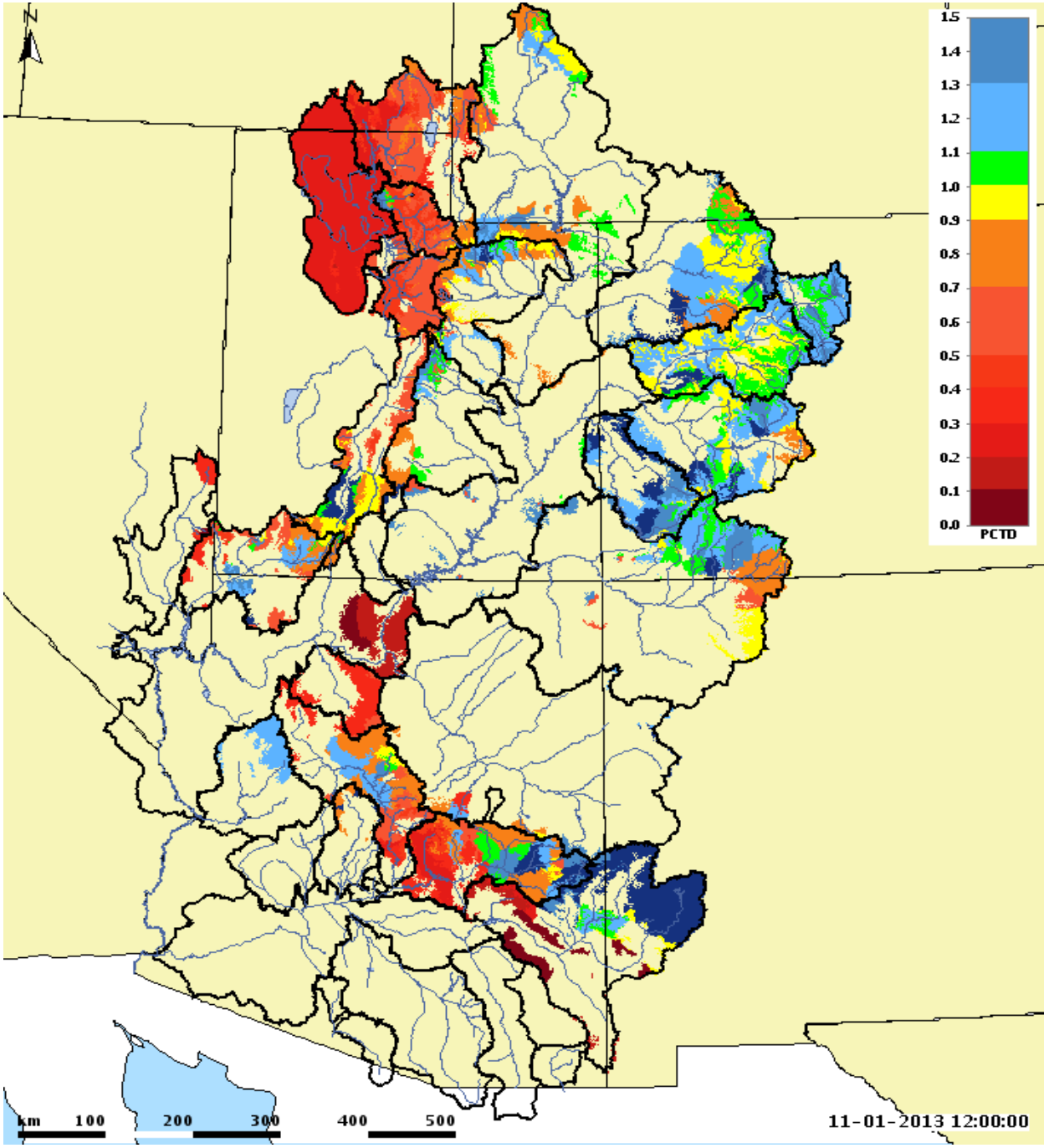




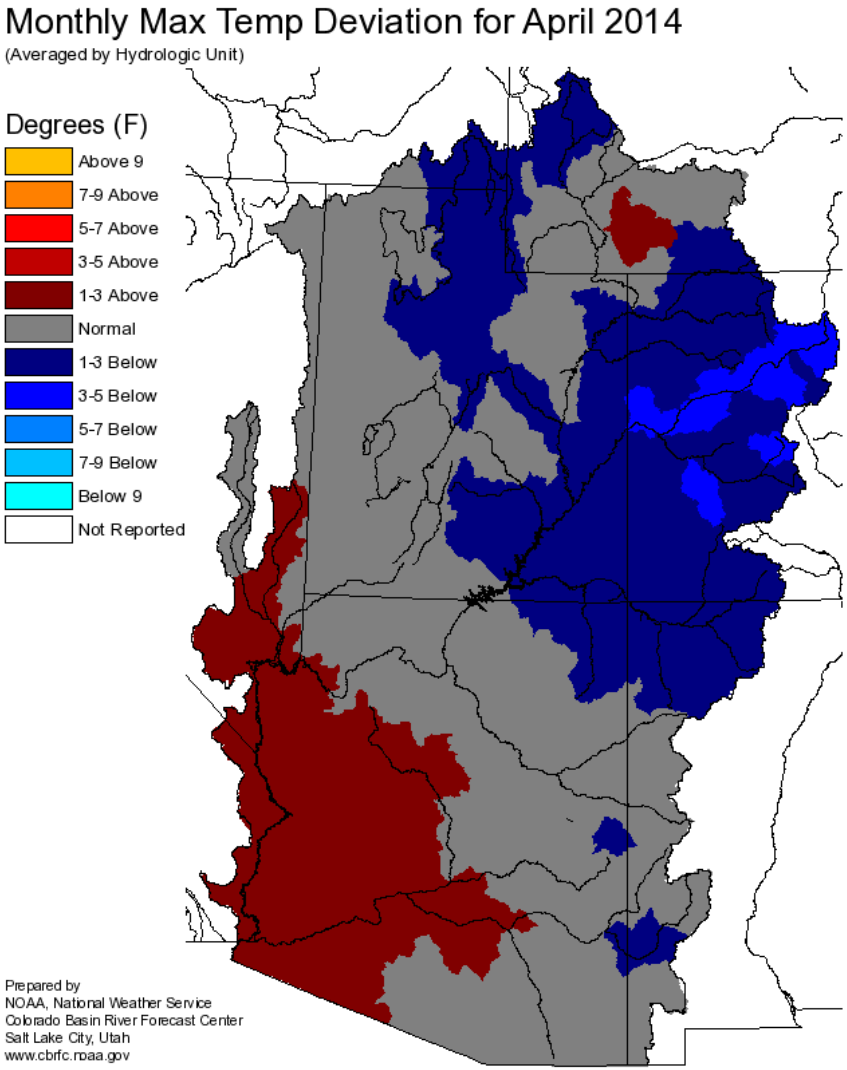
Soil Moisture Entering the 2013-2014 Winter Season

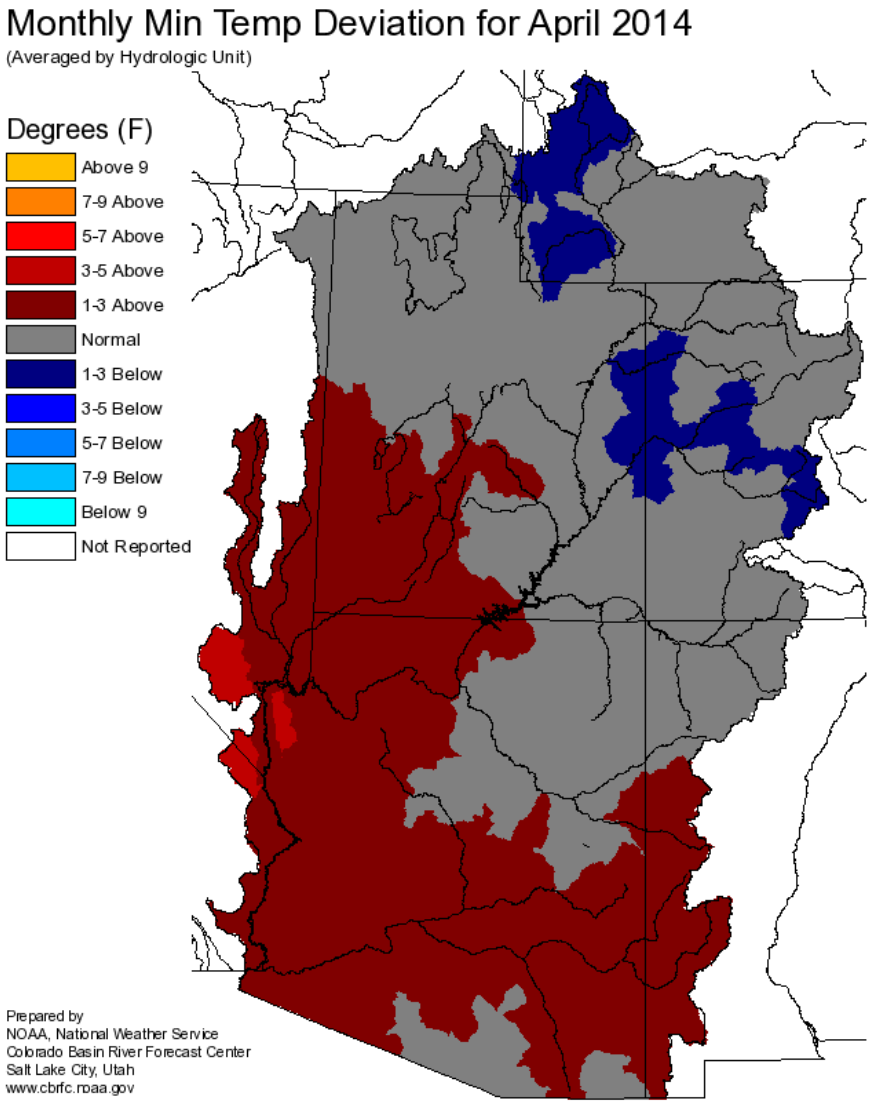
<u>Positive effect:</u>
Colorado River Headwaters
Yampa
Upper Gunnison
Upper Dolores
part of San Juan Basin.

<u>Negative effect:</u>
Great Basin
Virgin River
Lower Colorado (Salt, Verde)

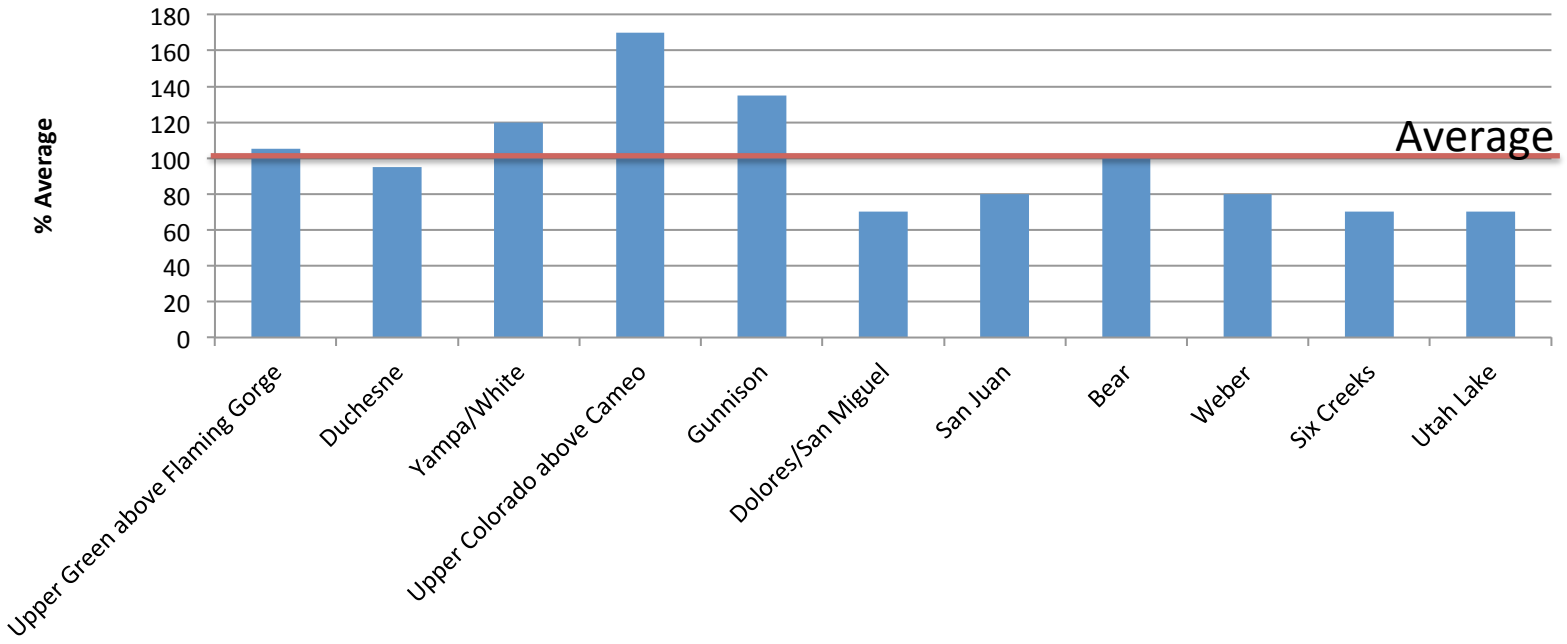


April 2014 Temperatures



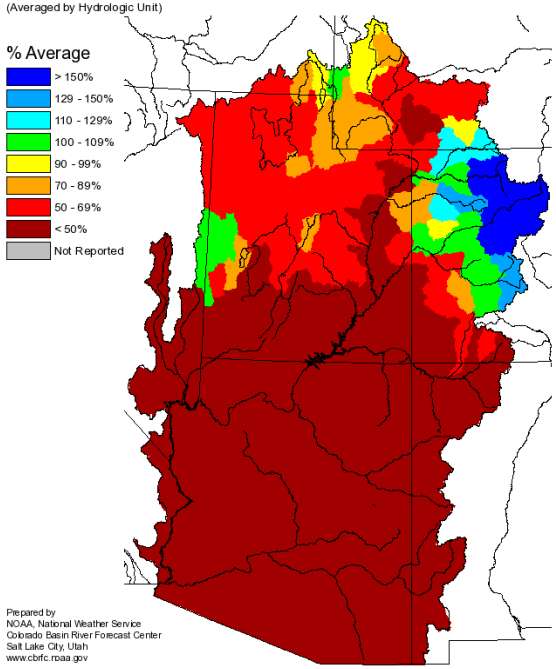


APRIL 2014
%AVERAGE UNREGULATED VOLUMES



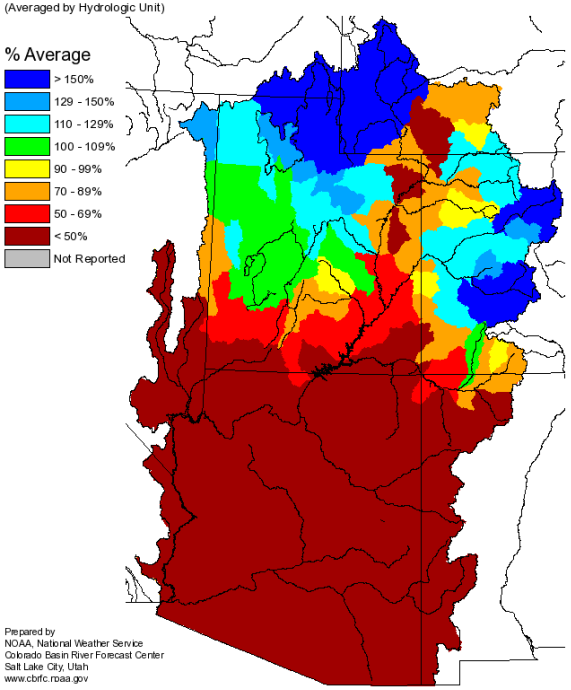
Monthly Precipitation for January 2014

(Averaged by Hydrologic Unit)



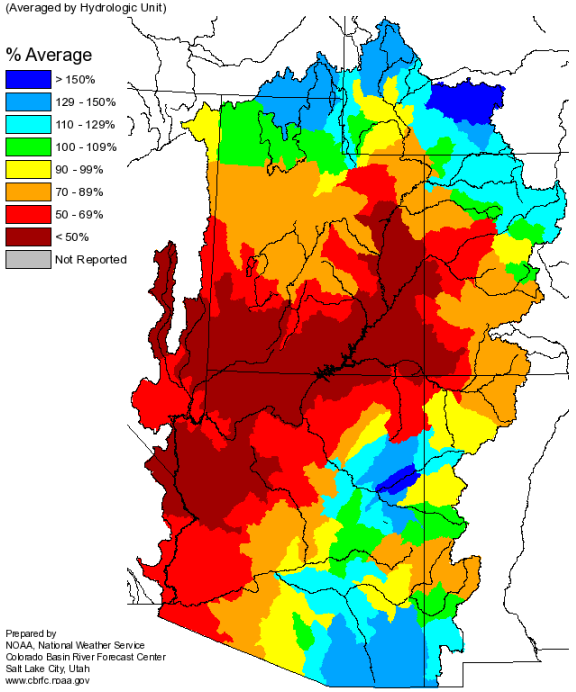
Monthly Precipitation for February 2014

(Averaged by Hydrologic Unit)



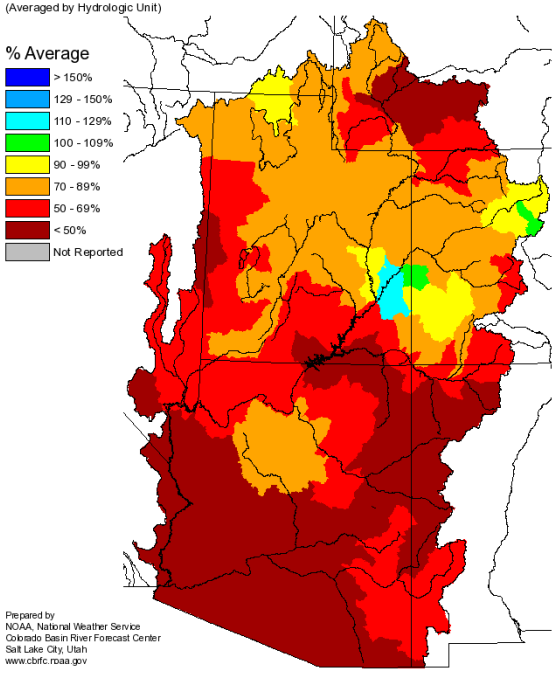
Monthly Precipitation for March 2014

(Averaged by Hydrologic Unit)



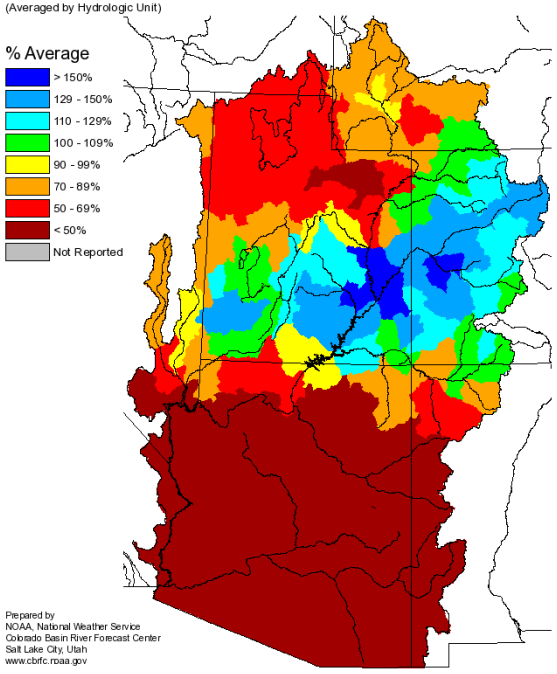
Monthly Precipitation for April 2014

(Averaged by Hydrologic Unit)



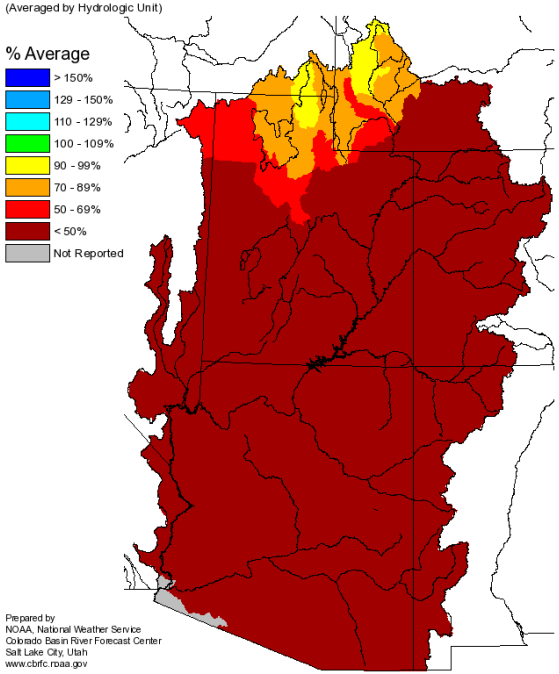
Monthly Precipitation for May 2014

(Averaged by Hydrologic Unit)

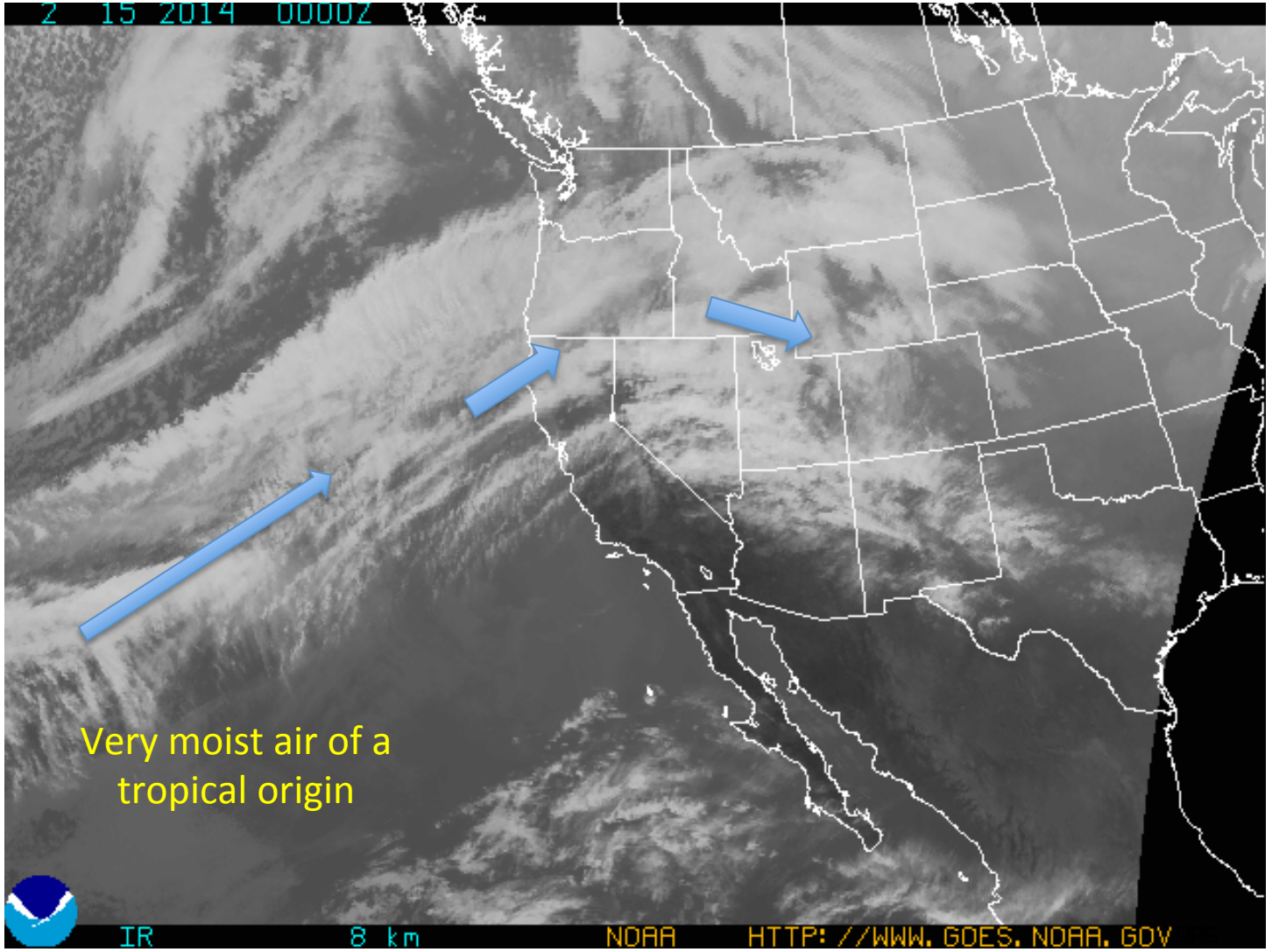


Monthly Precipitation for June 2014

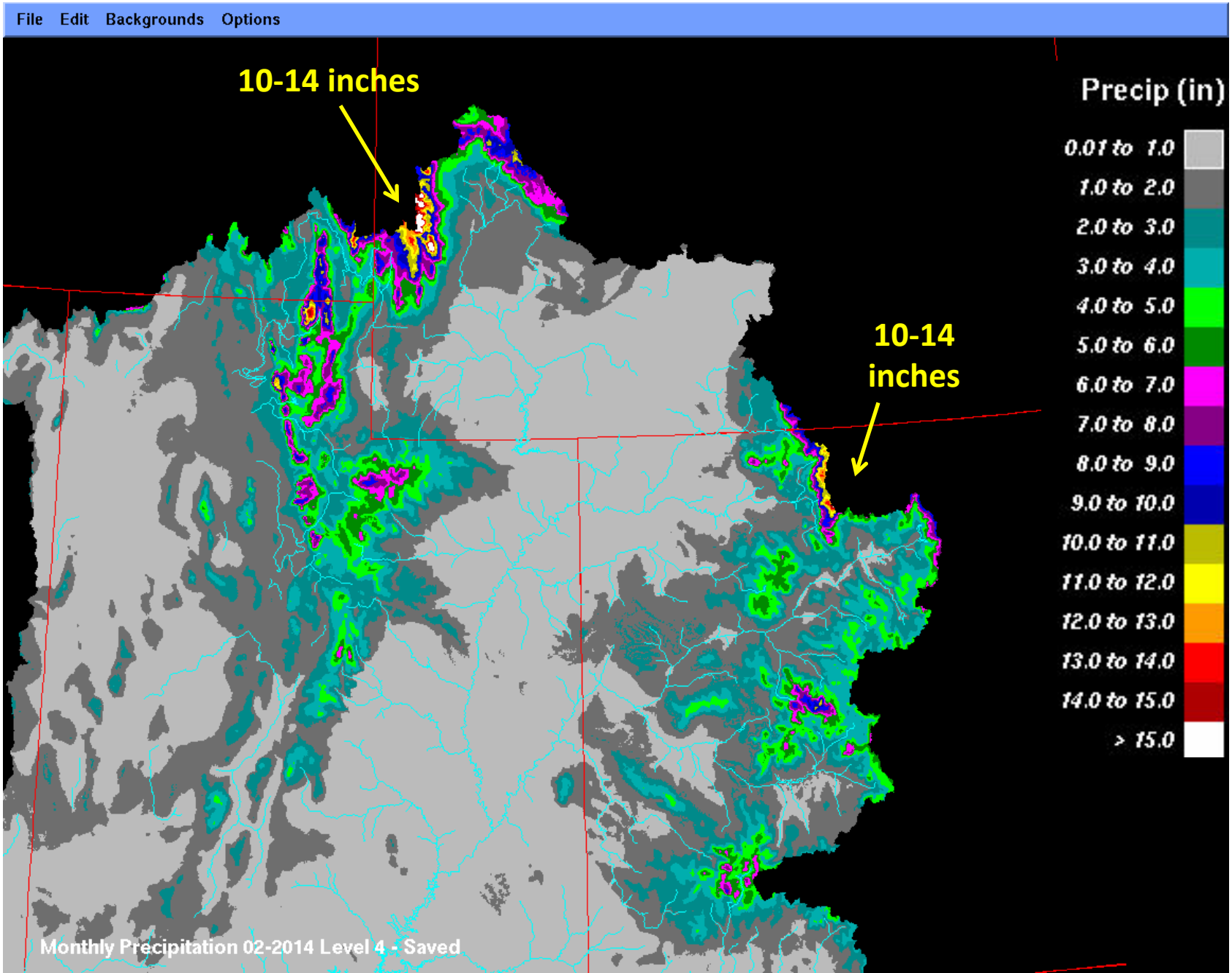
(Averaged by Hydrologic Unit)



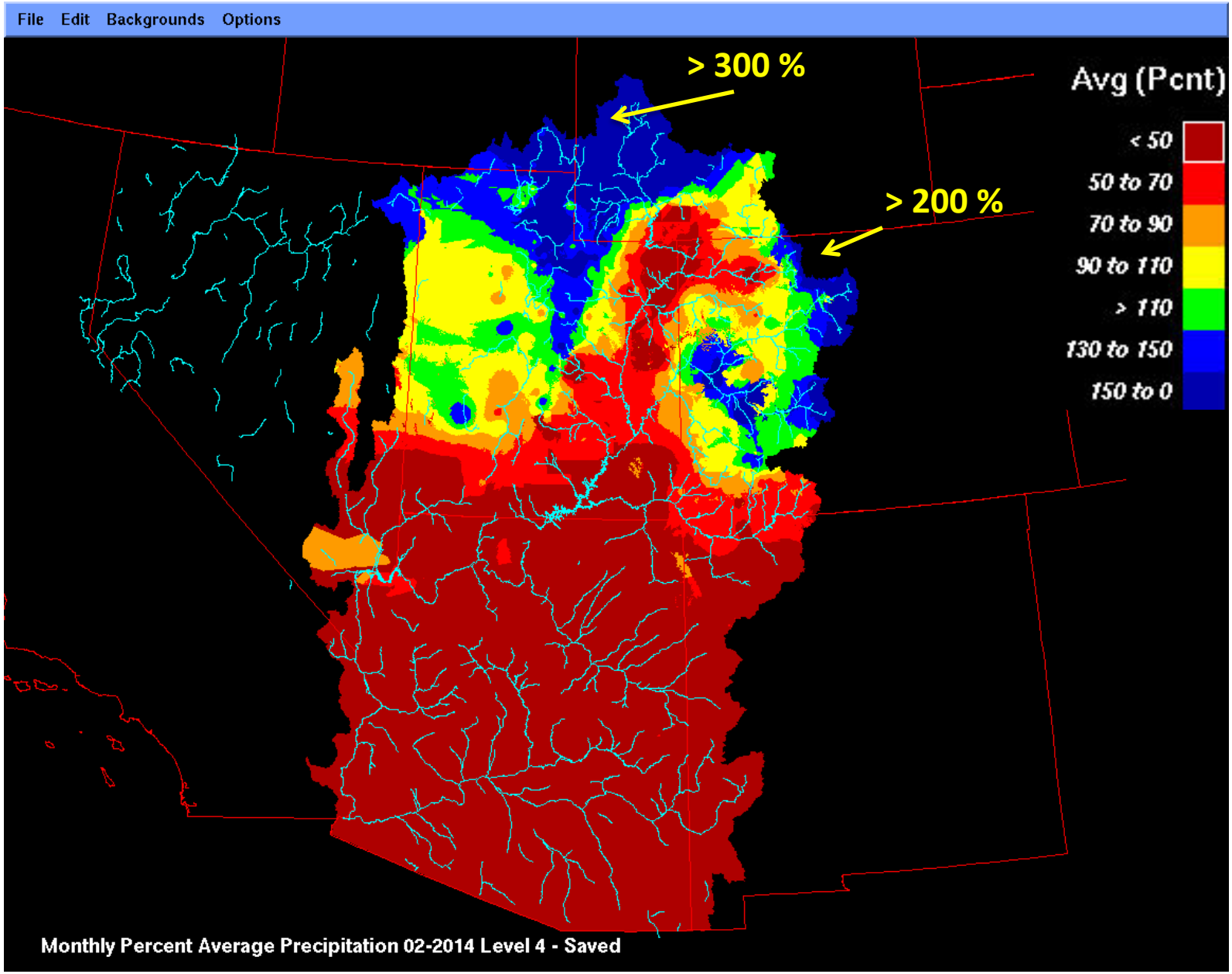
February 2014 had a large impact on forecasts



February 2014 Precipitation Observed



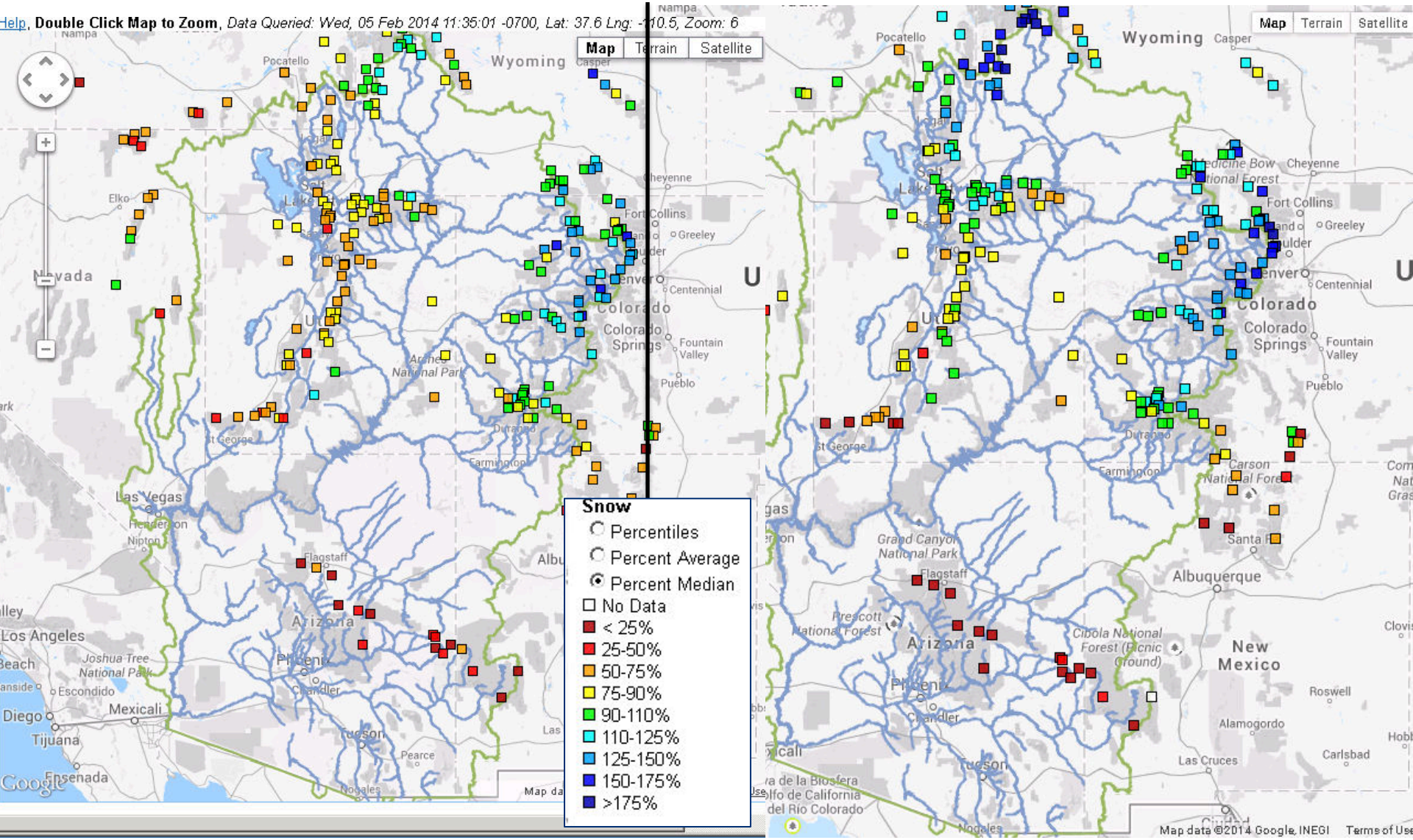
February 2014 Precipitation Percent of Average



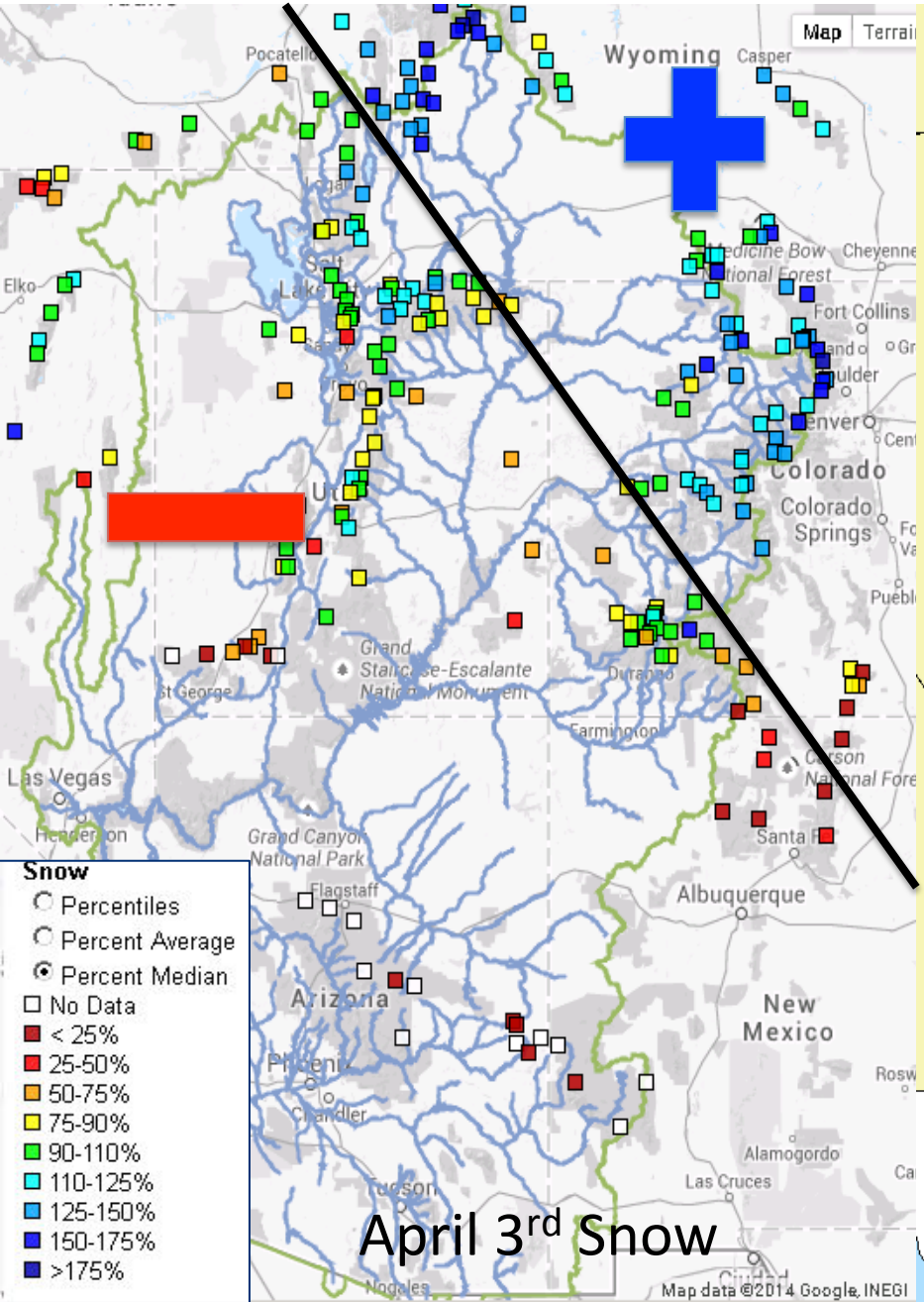
Snow (note the increase in the upper Green, Bear, and parts of Colorado)

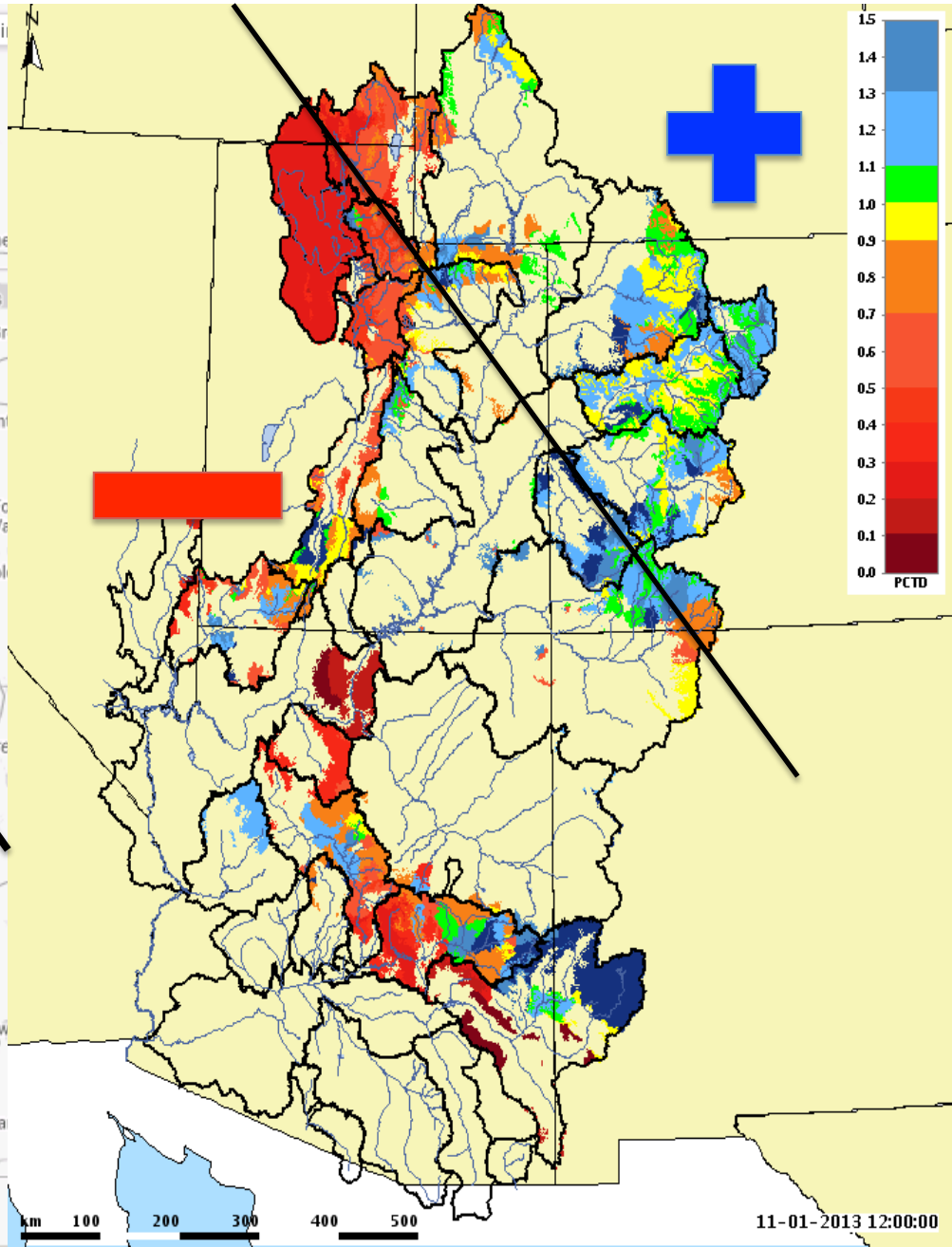
February 5th Snow

March 5th Snow

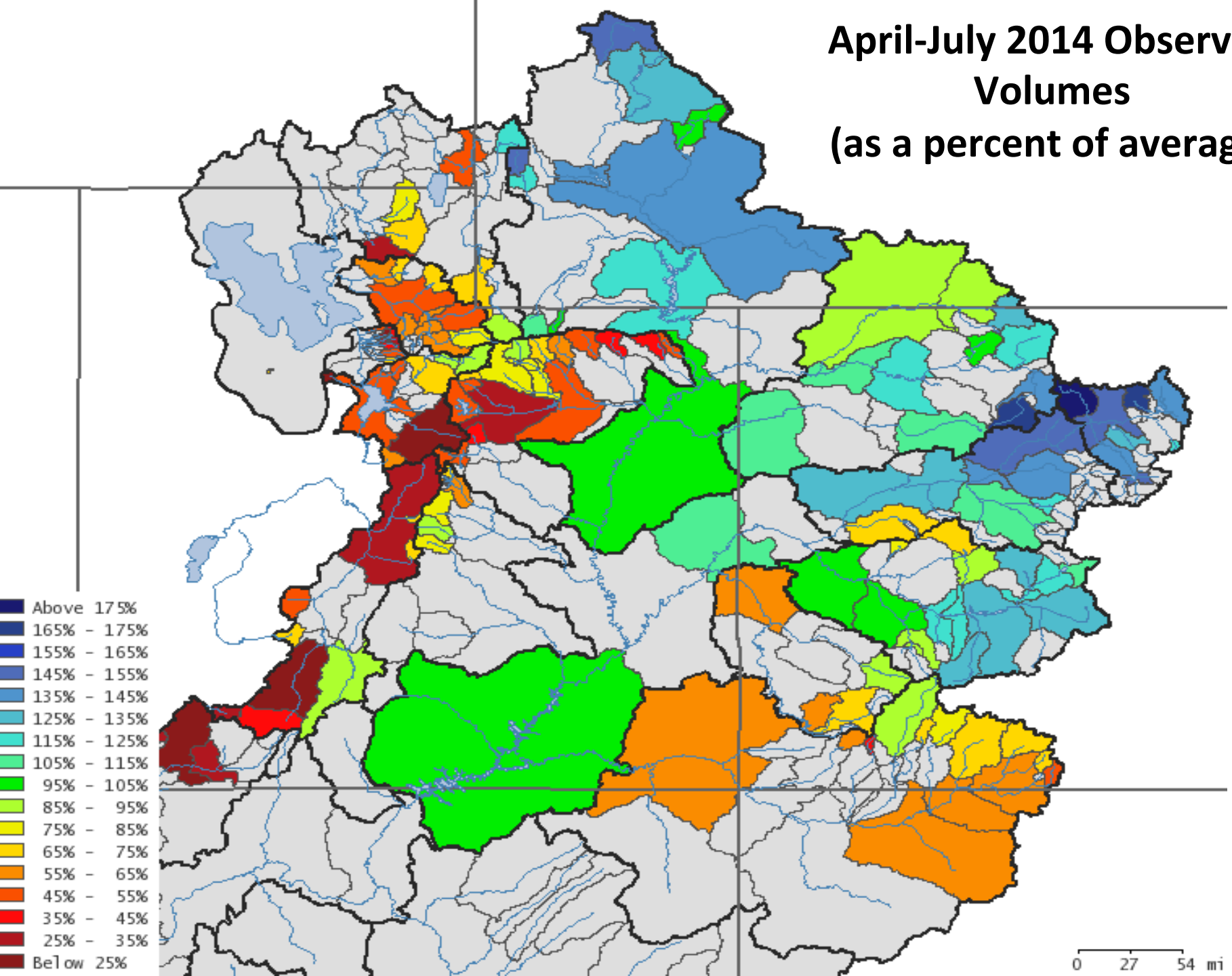


The dividing line (fairly consistent messagefrom March onward)

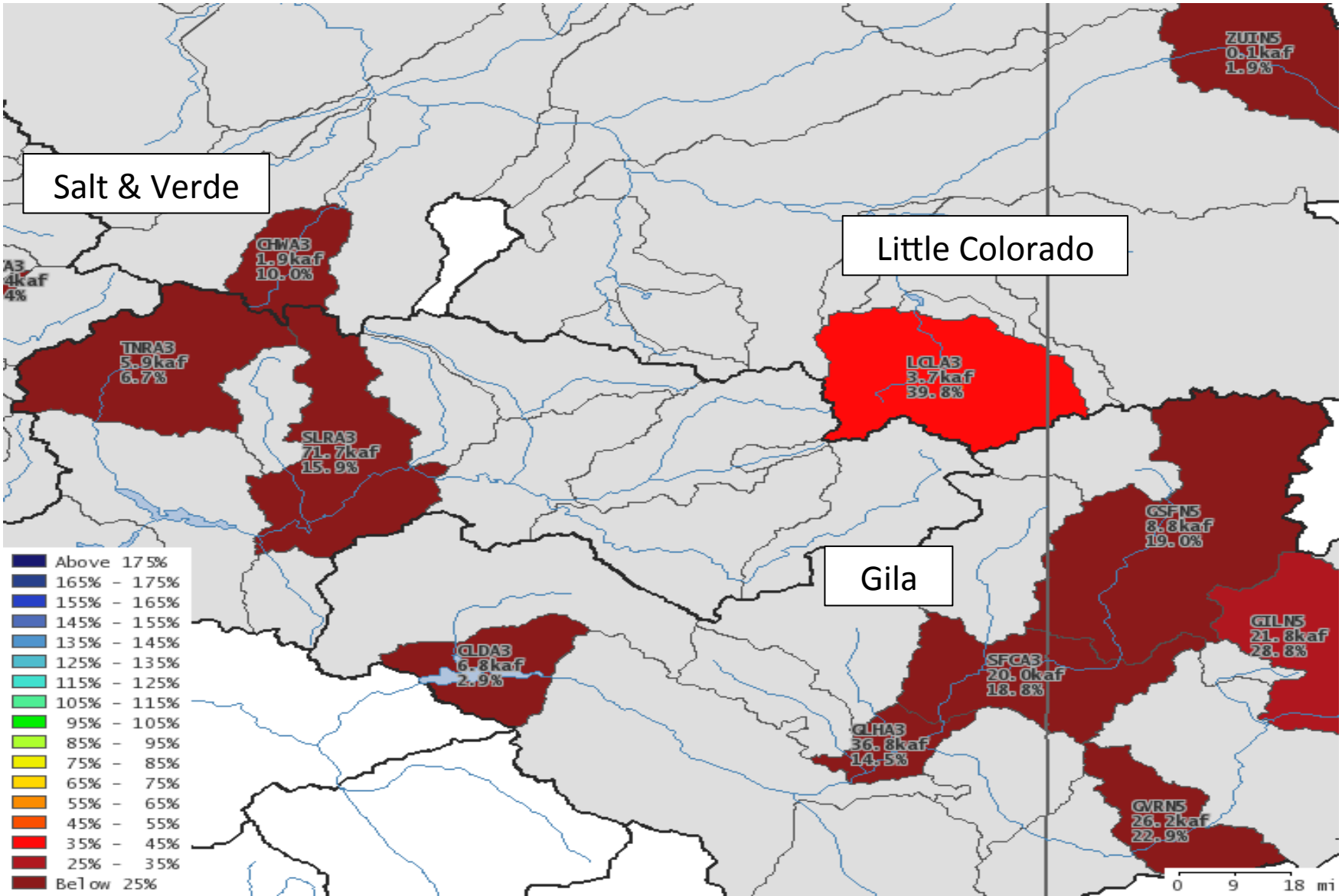




April-July 2014 Observed Volumes (as a percent of average)



Jan-May 2014 Observed Volumes (as a percent of median)



Generating the Forecasts: (Model Guidance Driven)

ESP: Ensemble Streamflow Prediction (primary model used)

Initial Model States of Streamflow, Snow, Soil Moisture Critical
Inputs include short term precipitation and temperature forecasts
Long term – use historical average (calibration period 1981-2010)

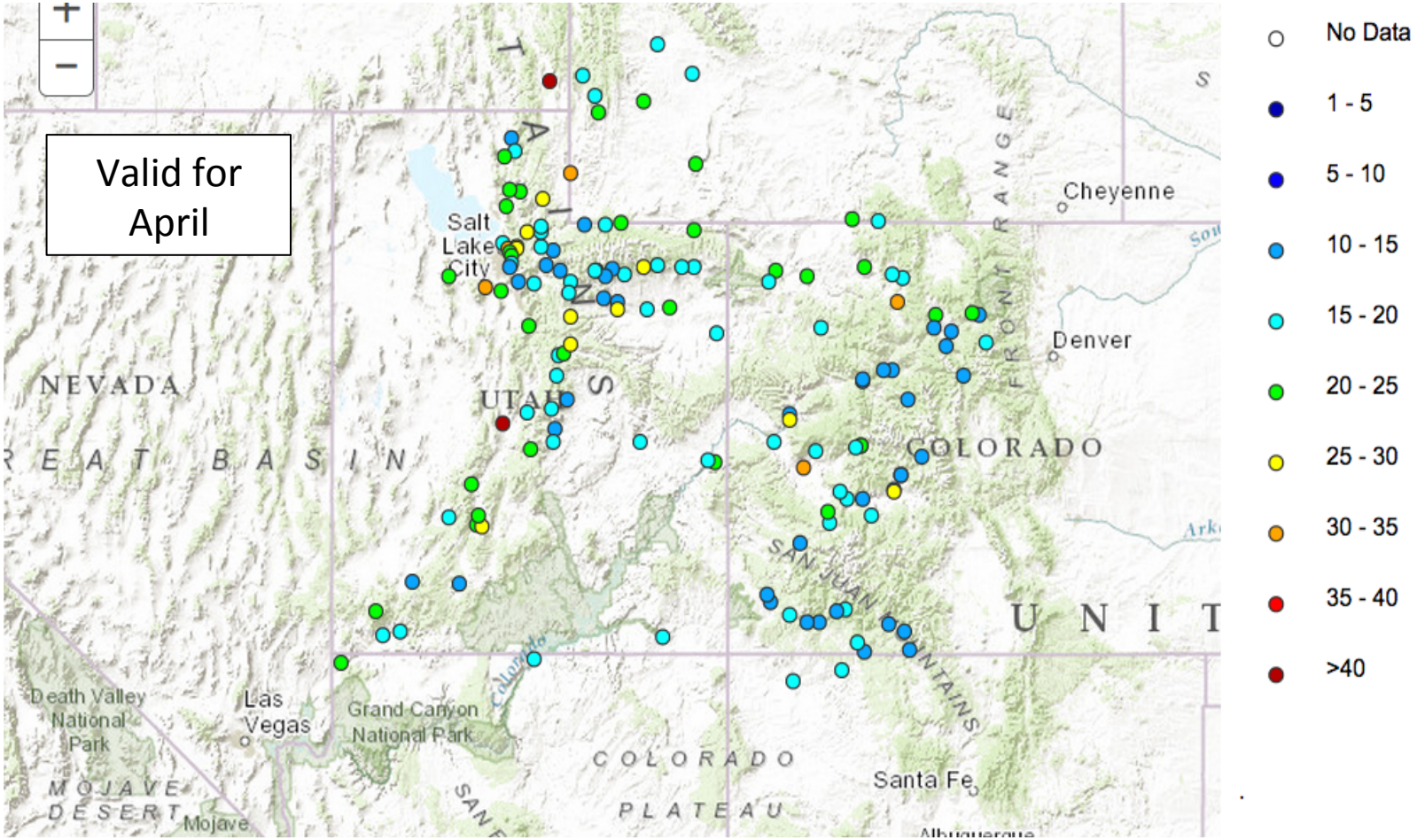
SWS: Statistical regression method exist for many points

Primary inputs are SWE and Precipitation
Primary use is for routing of upstream forecasts to downstream points

- We consider analog years – similar snow / runoff patterns in analysis
- We can incorporate El Nino / La Nino events (primarily for Lower Colorado)
- We track model states throughout the season, adjust obvious errors
- Collaboration with colleagues including the NRCS

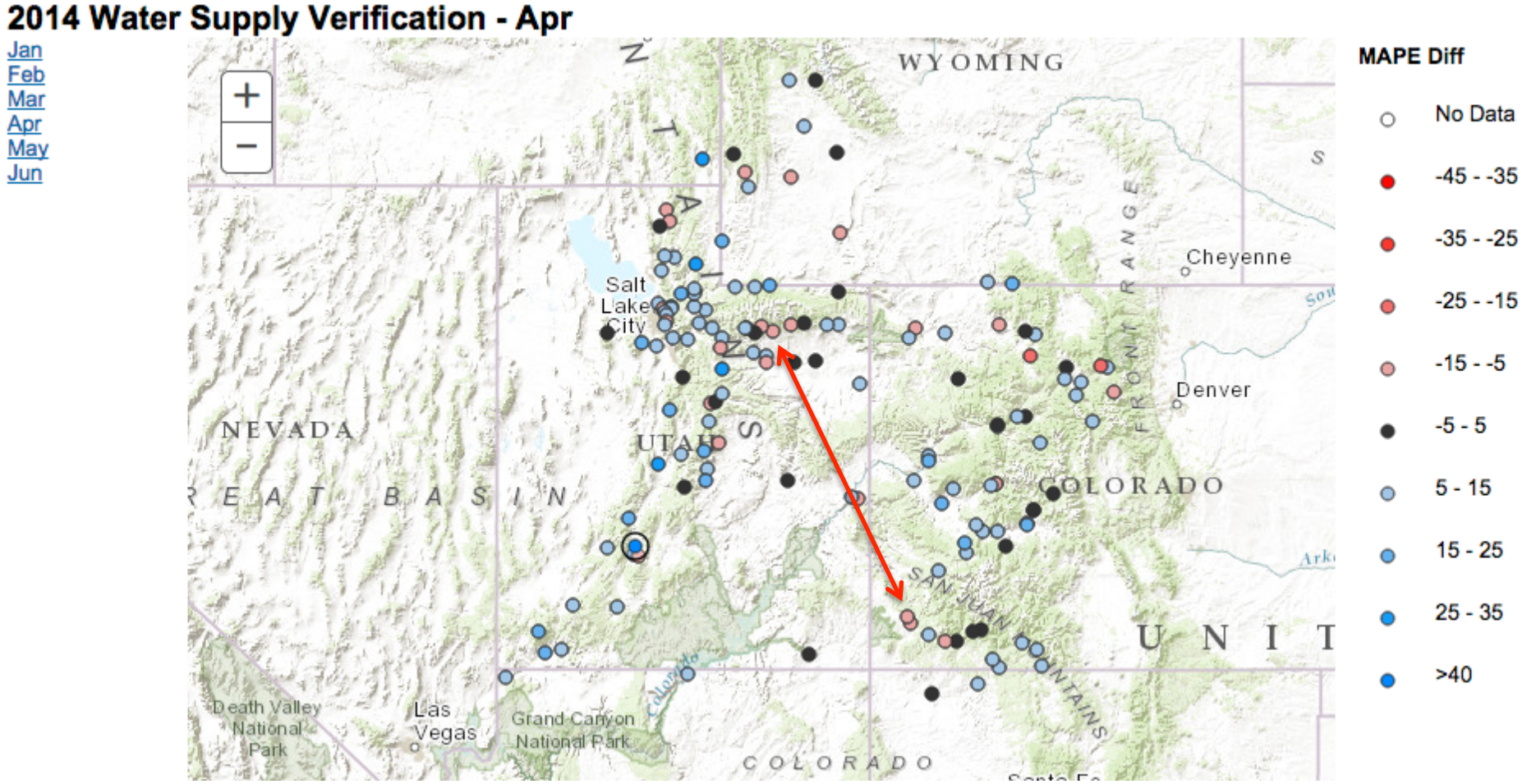
New Verification Maps: Model Mean Absolute Percent Error based on 30 years of re-forecasts.

Mar
Apr
May
Jun



- Less error in higher elevation (i.e. headwater) locations
- Less error where snow melt is the primary source
- Less error where diversions are few or well known

New Verification Maps: 2014 Forecast Error vs Mean Model Error



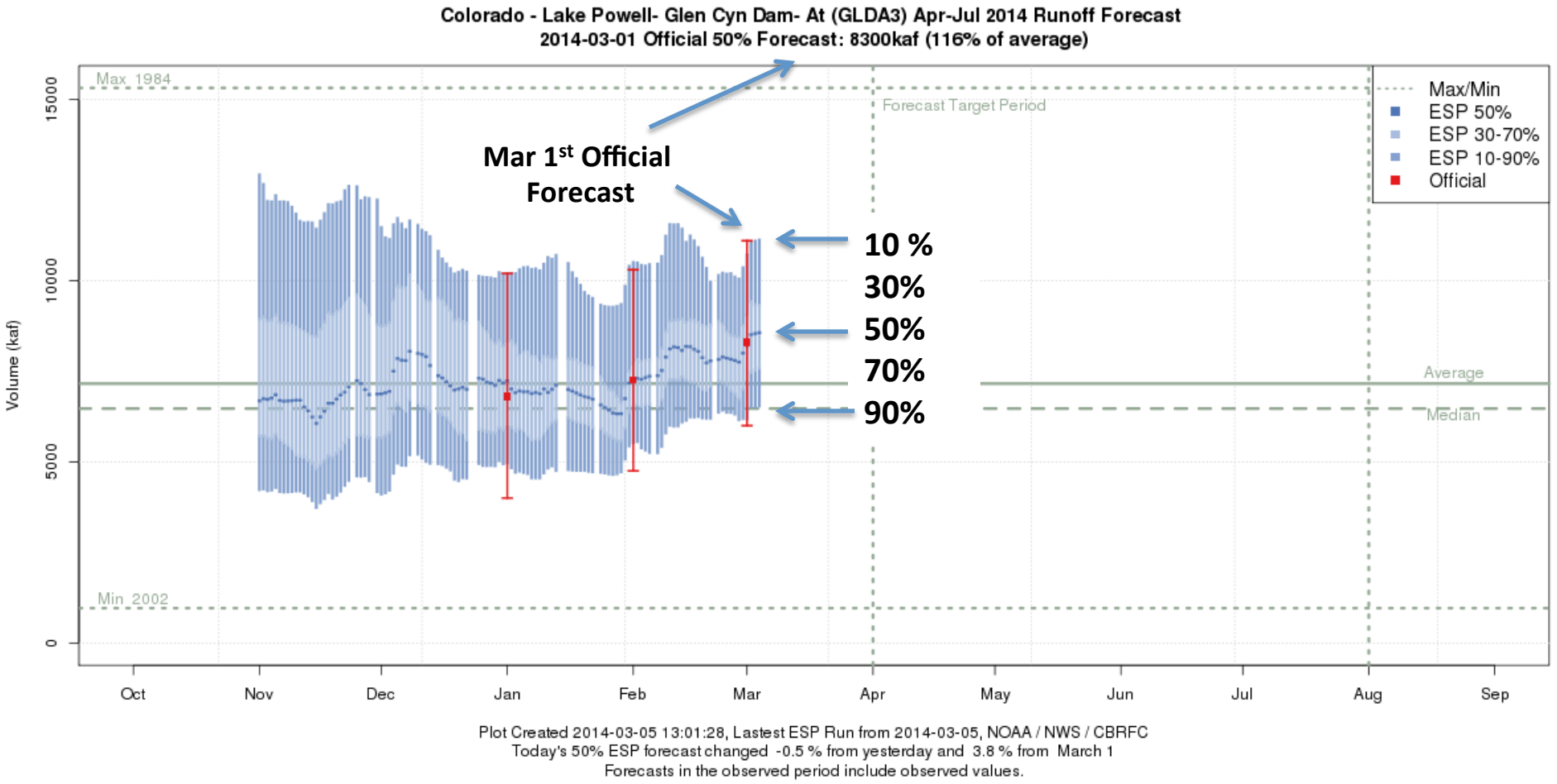
Positive = 2014 Forecast performed BETTER

Negative = 2014 Forecasts performed WORSE

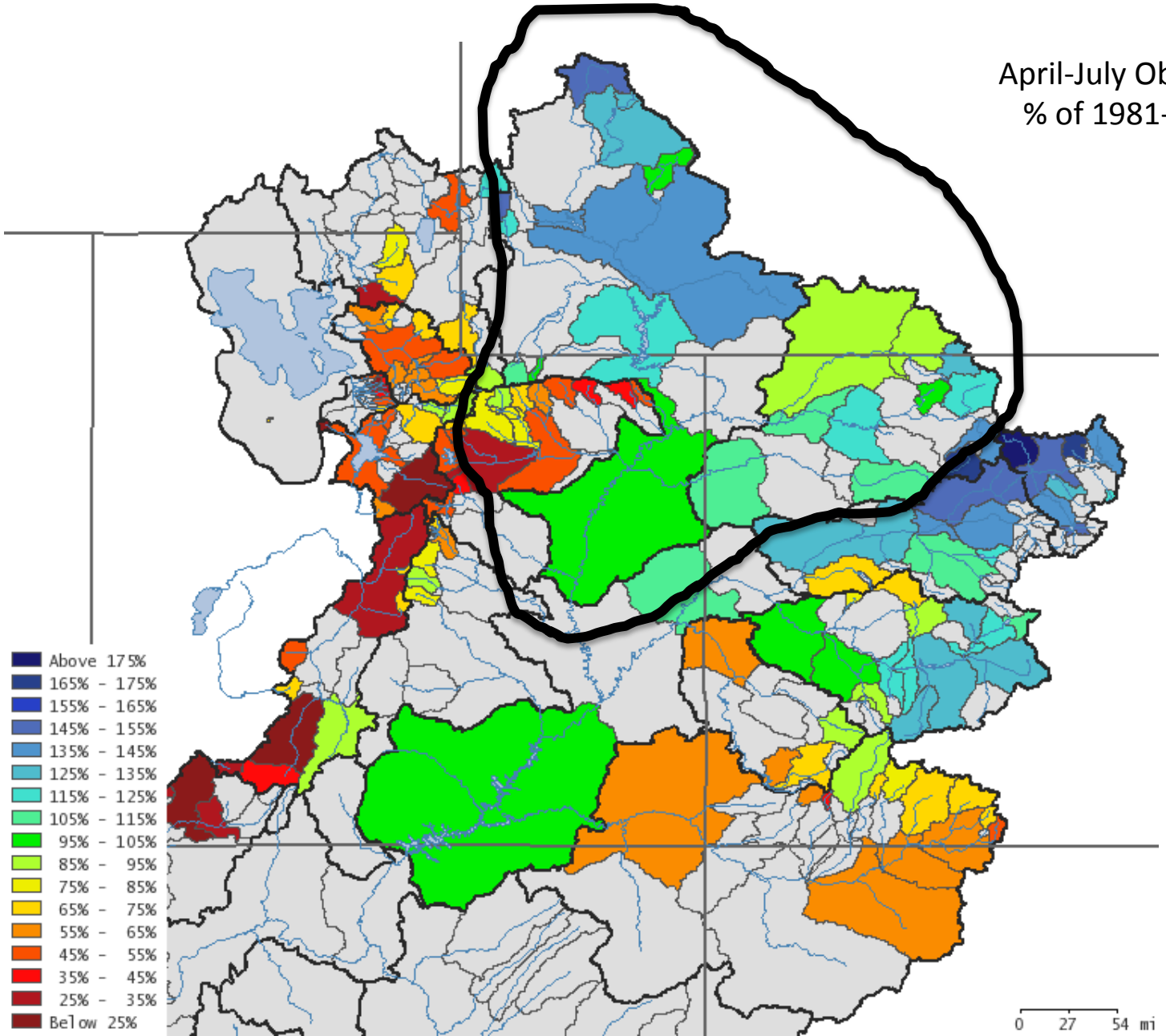
-5 to 5 = Normal

Daily Ensemble Streamflow Prediction (ESP) Model Run & Official Forecast

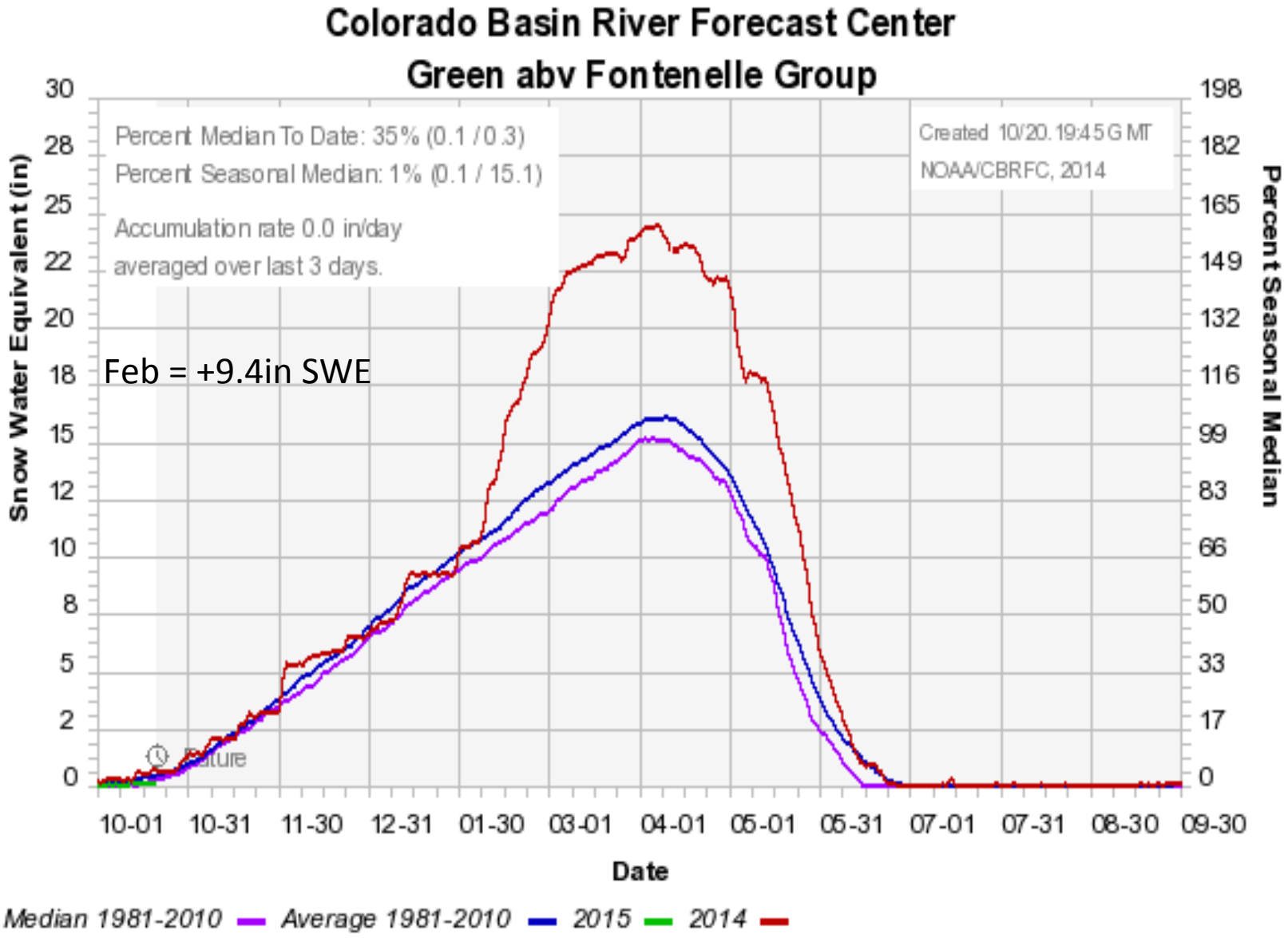
Will be available at: www.cbrfc.noaa.gov Select: Water Supply Click: Point of Interest



Forecast Performance: Green River Basin

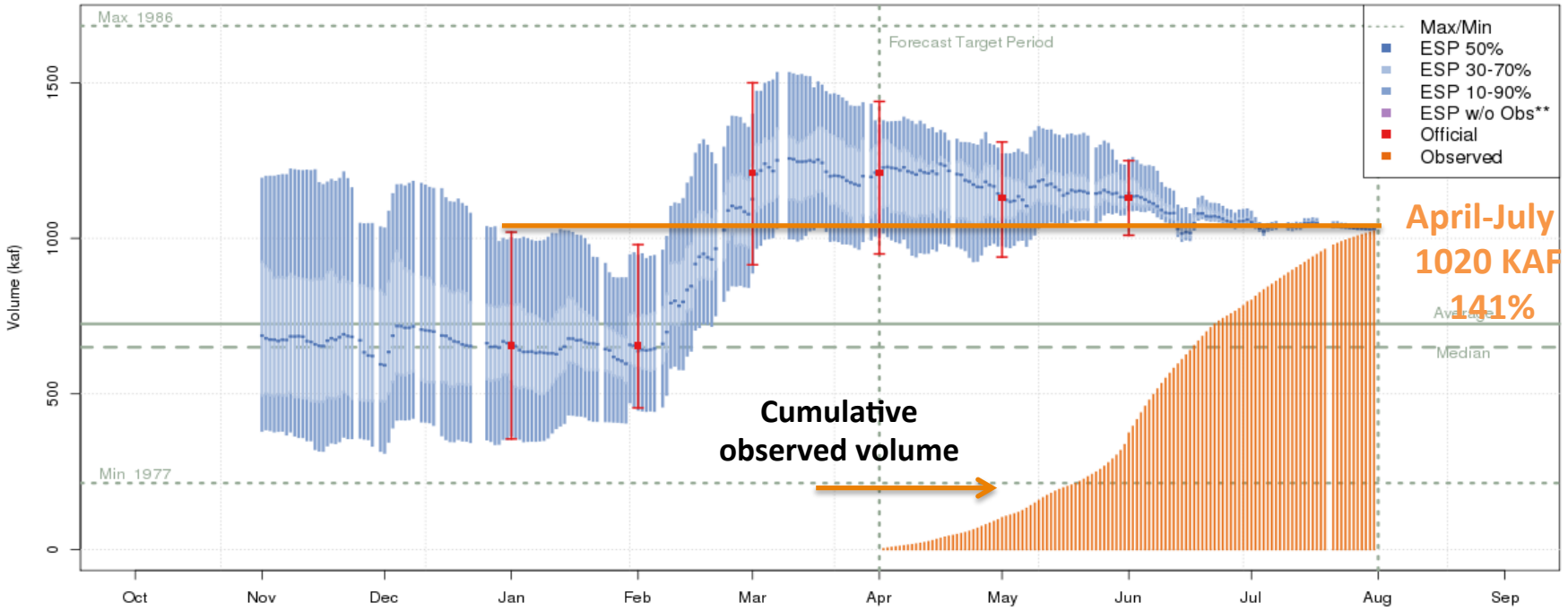


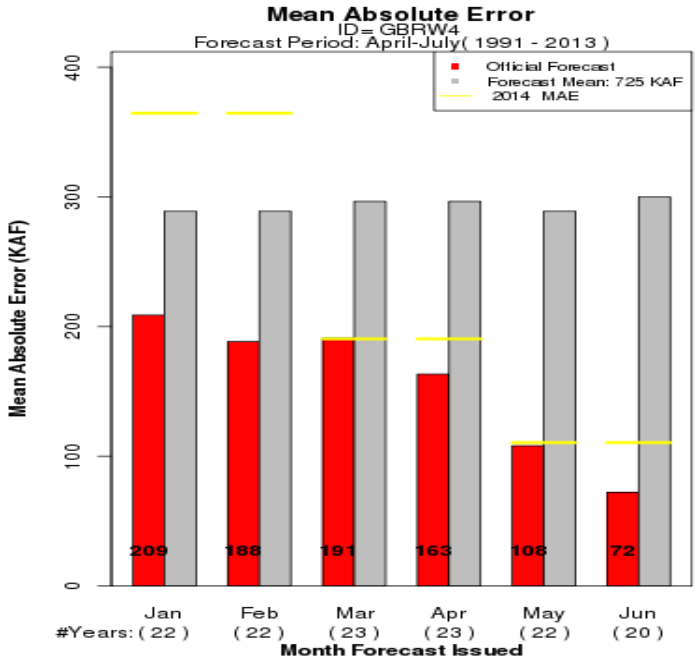
Upper Green: Snow Conditions

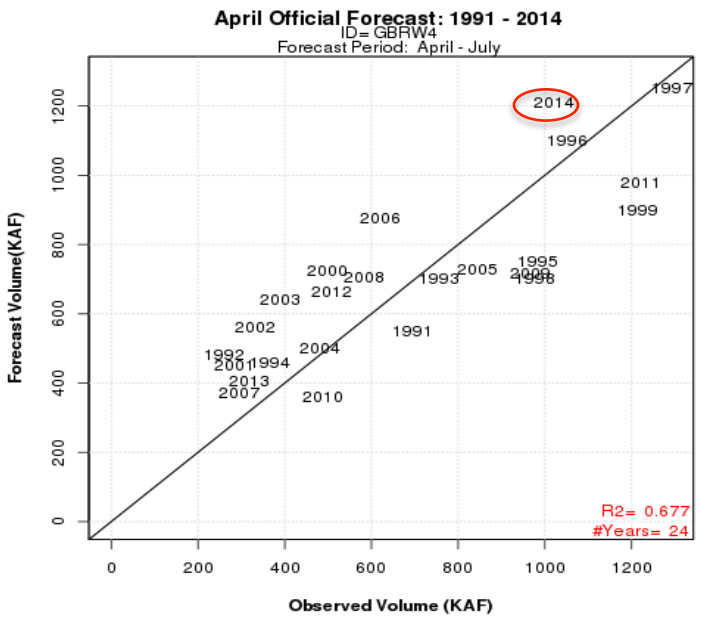


February precipitation for all the SNOTELs was 2nd highest on record!

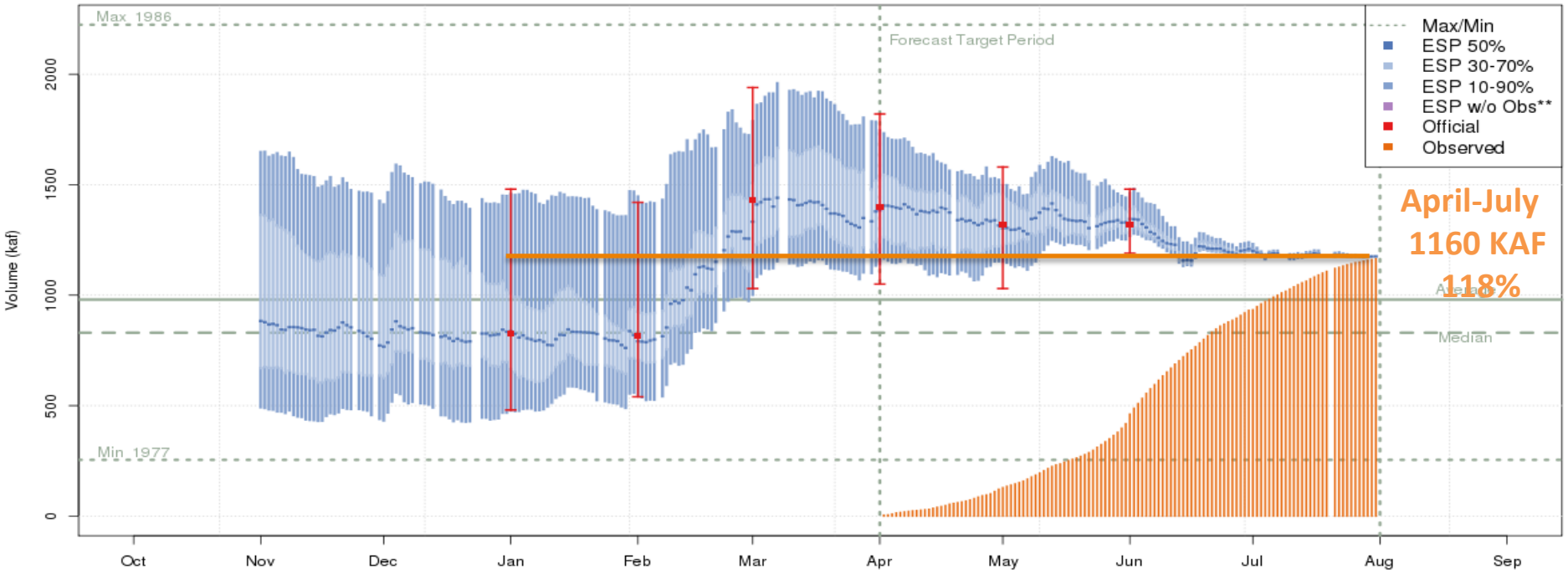
Upper Green: Fontenelle Inflow

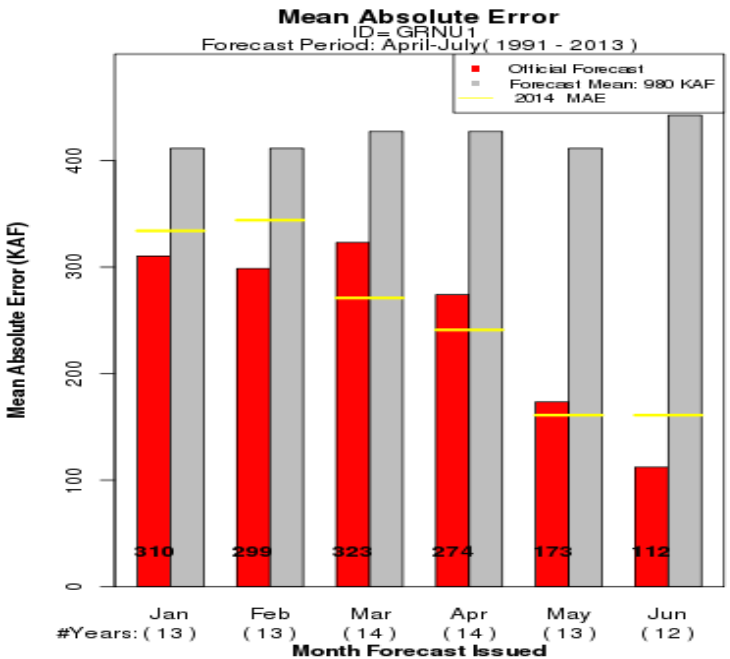


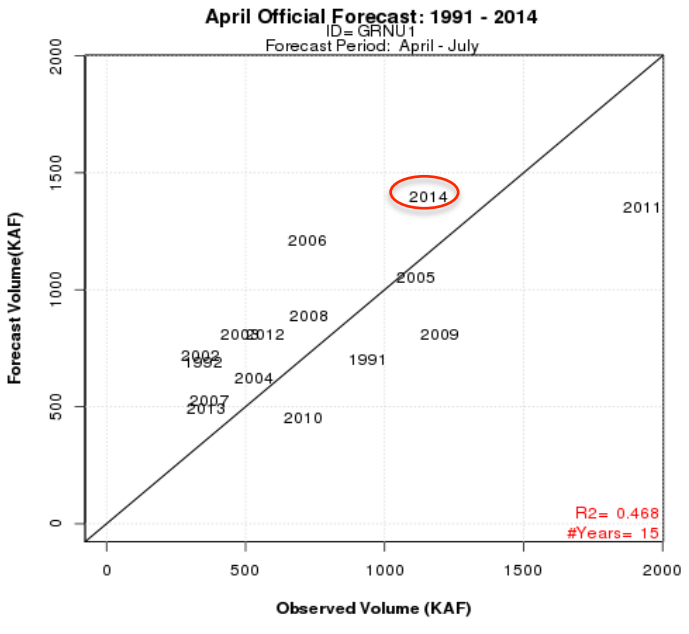




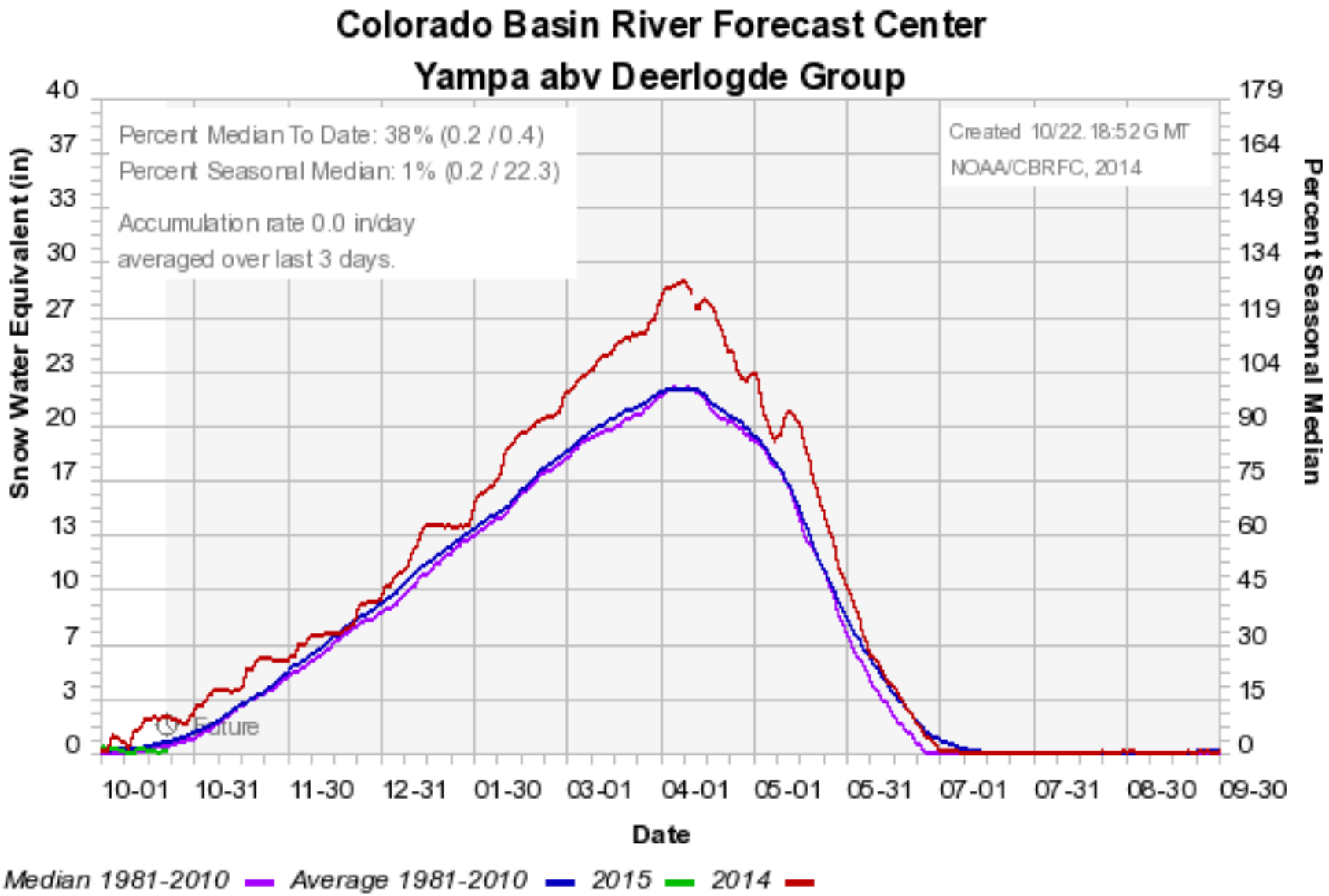
Upper Green: Flaming Gorge Inflow



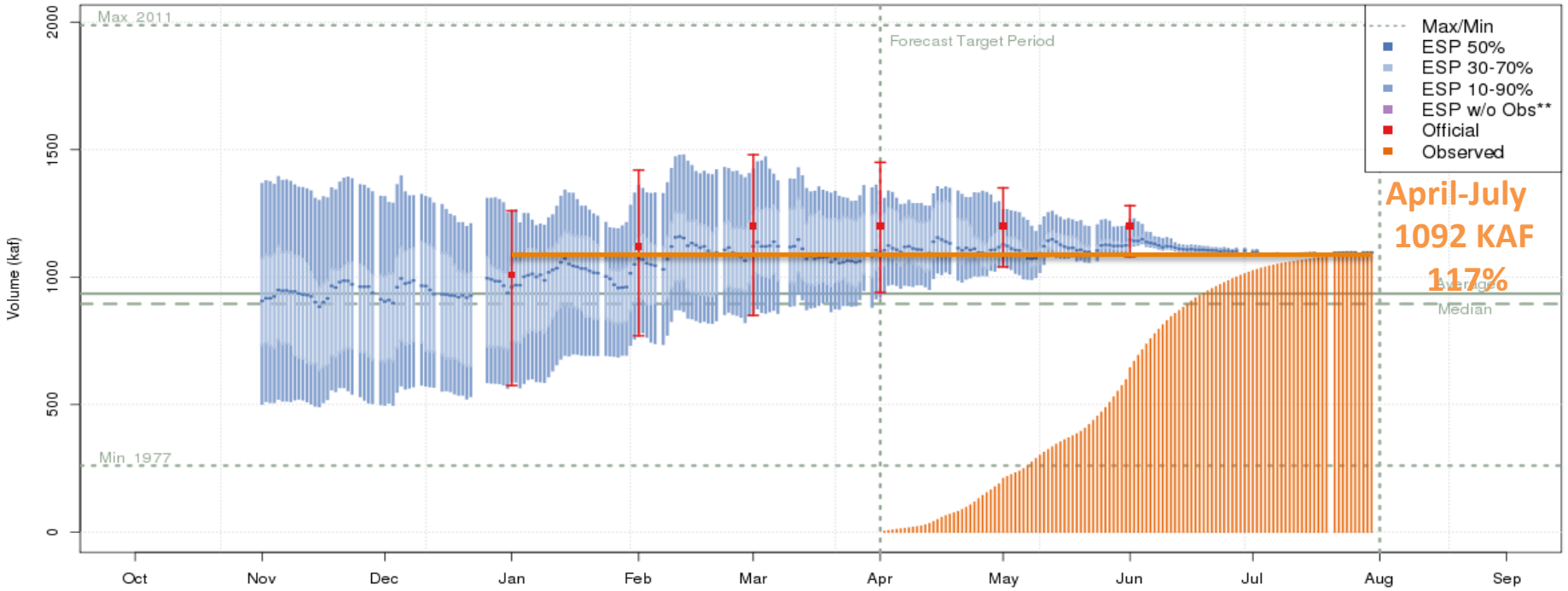


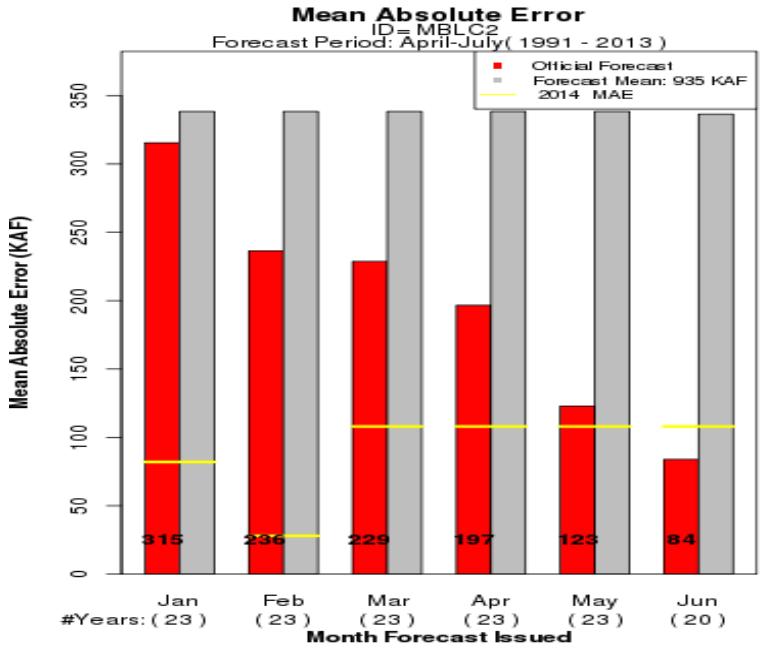


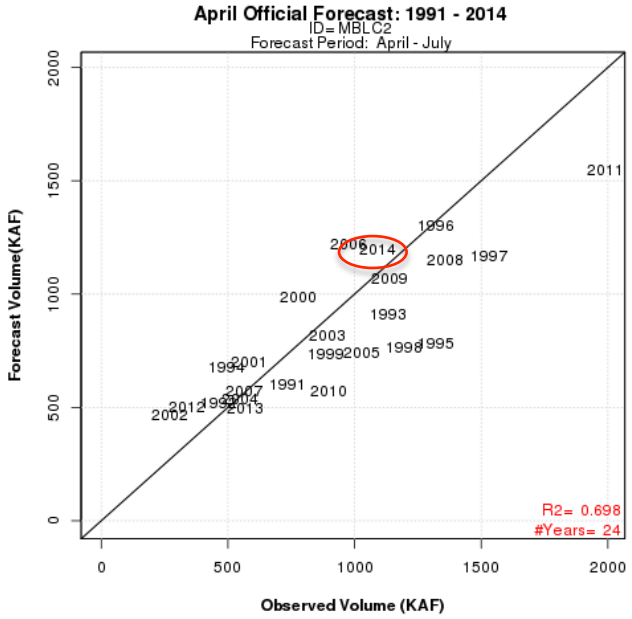
Yampa: Snow Conditions



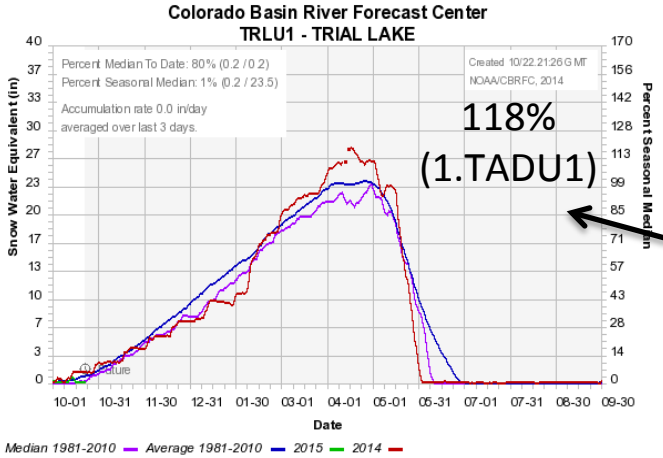
Yampa: Yampa River near Maybell

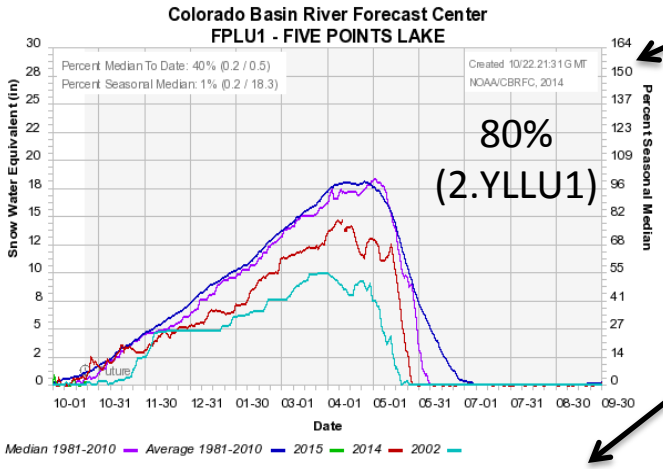


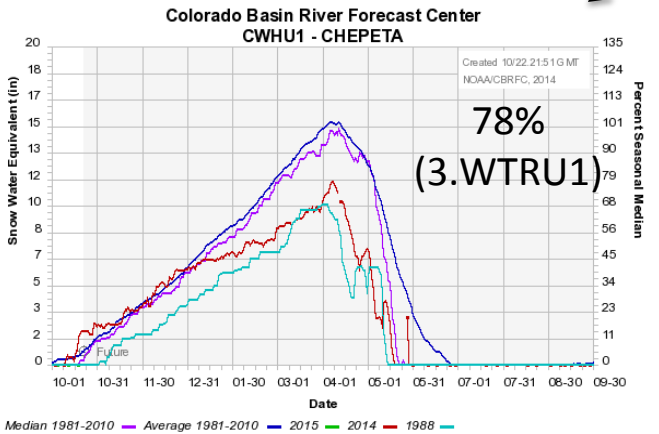


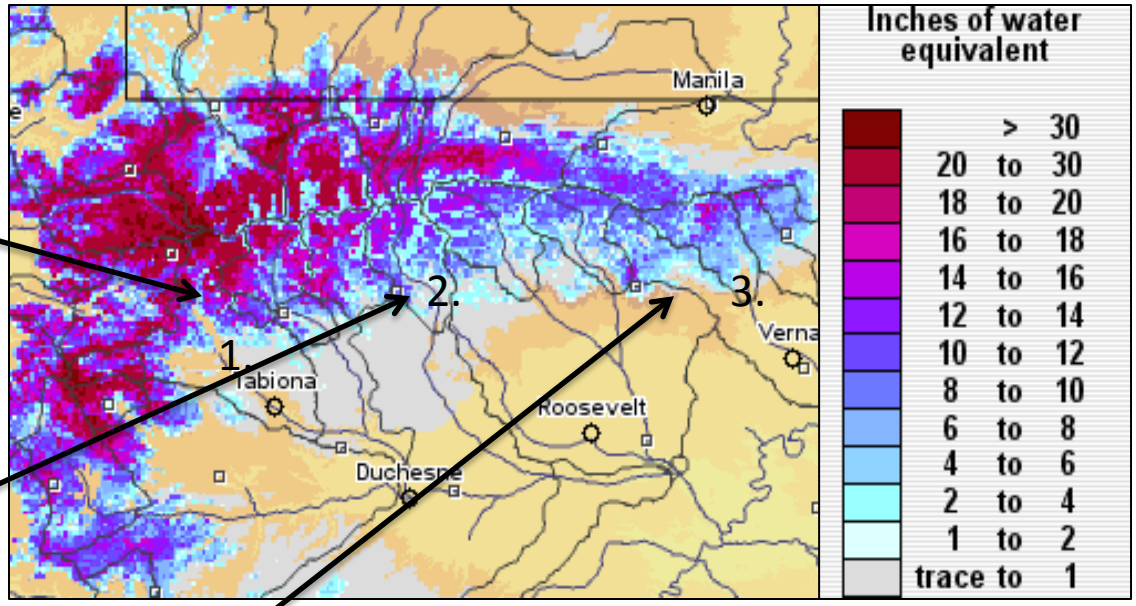


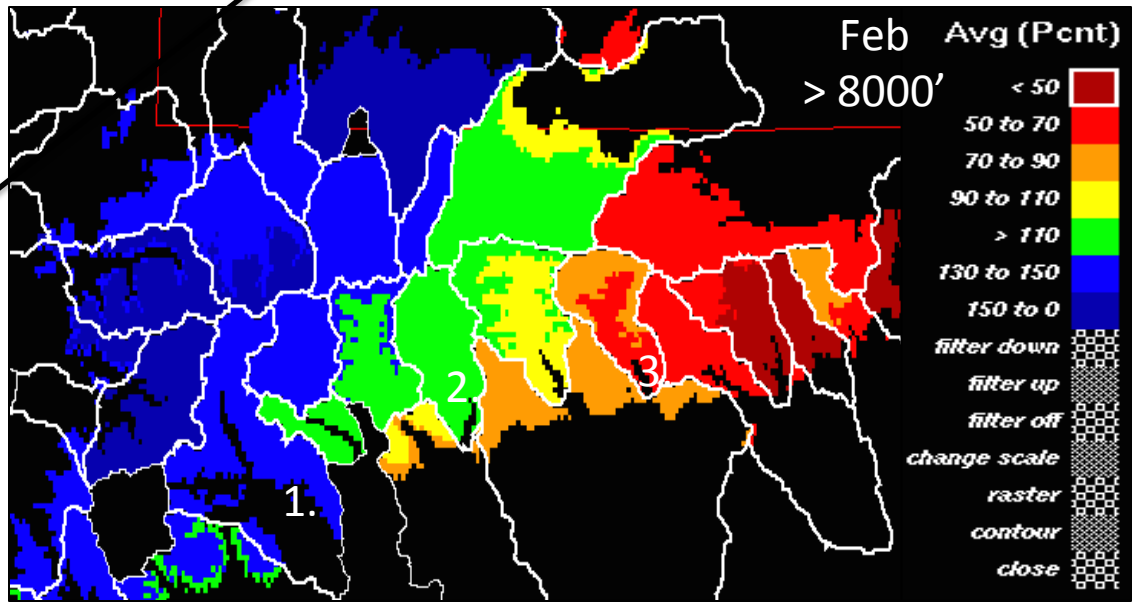
Duchesne: Basin Conditions





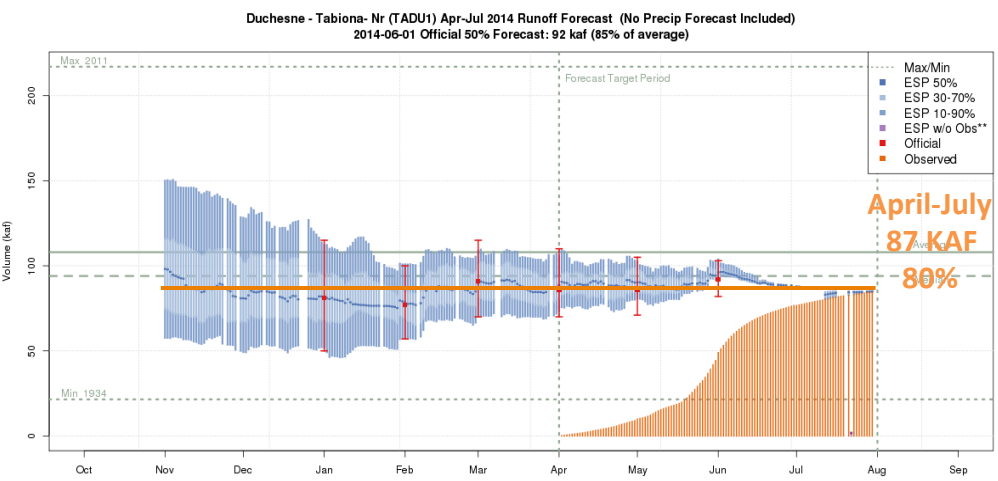






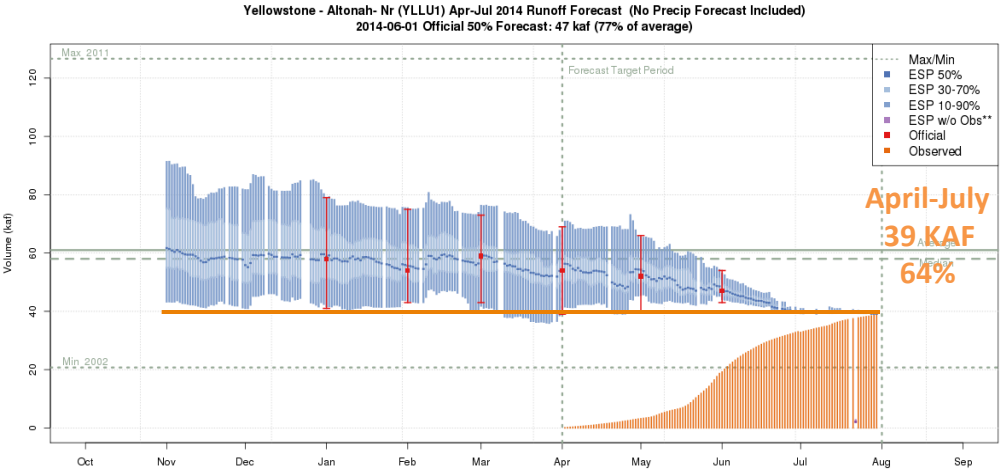
- Drying trend West to East

West to East Look At Duchesne River



Duchesne near Tabiona

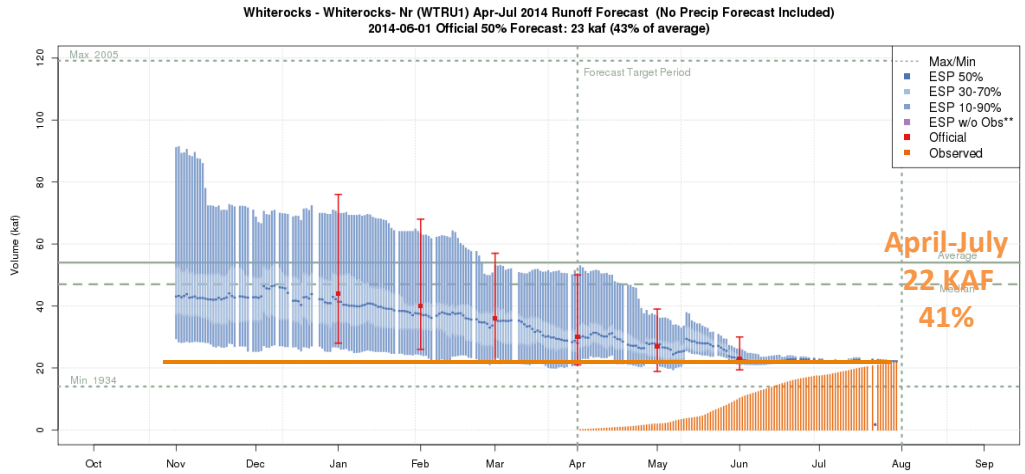
April MAE=1 KAF (1%)
May MAE= 1 KAF (1%)
June MAE= 5 KAF (6%)



Yellowstone River nr Altonah

- Missed 90% Exceedance

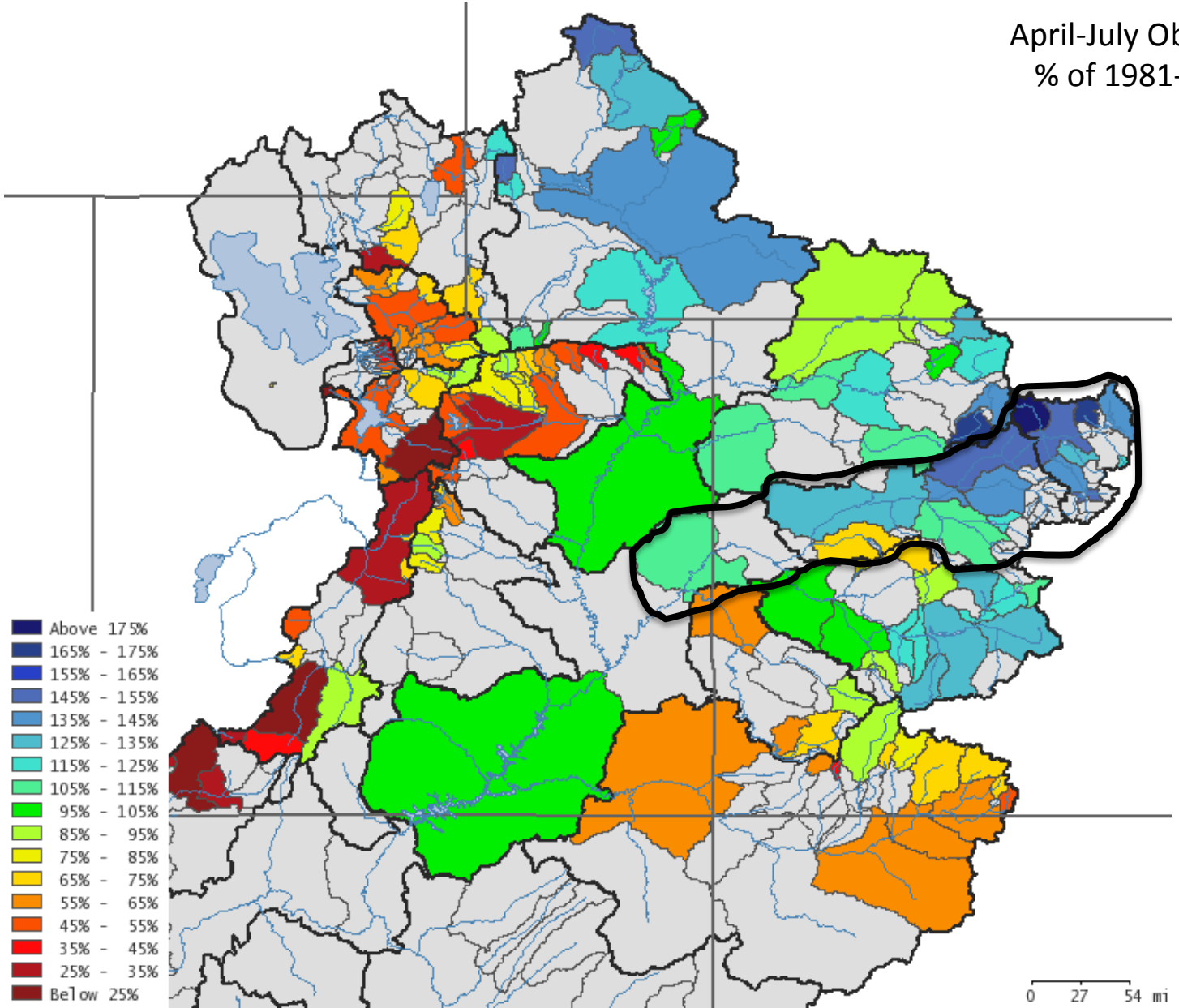
April MAE= 15 KAF (38%)
May MAE= 13 KAF (33%)
June MAE= 18 KAF (20%)



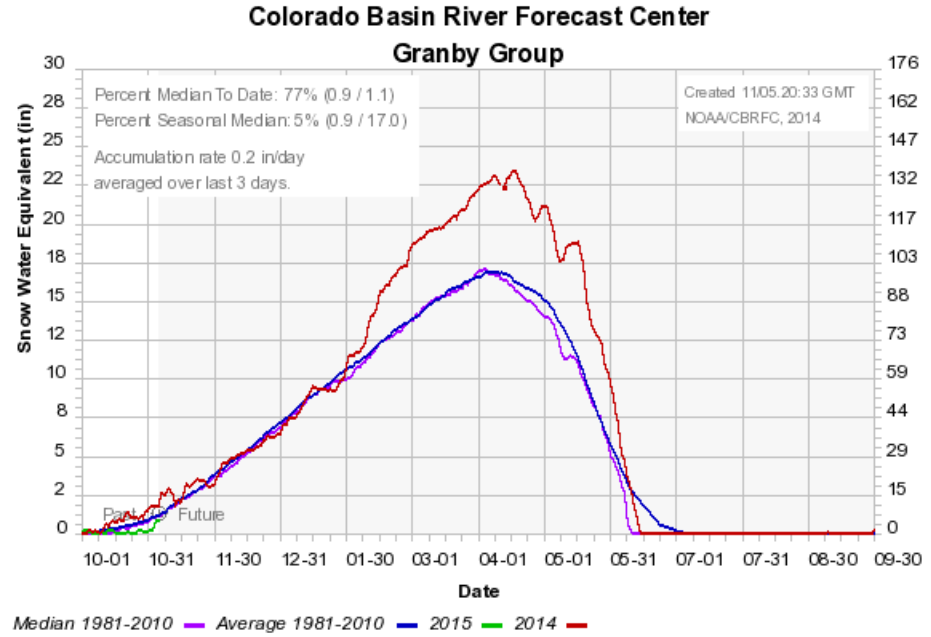
Whiterocks River

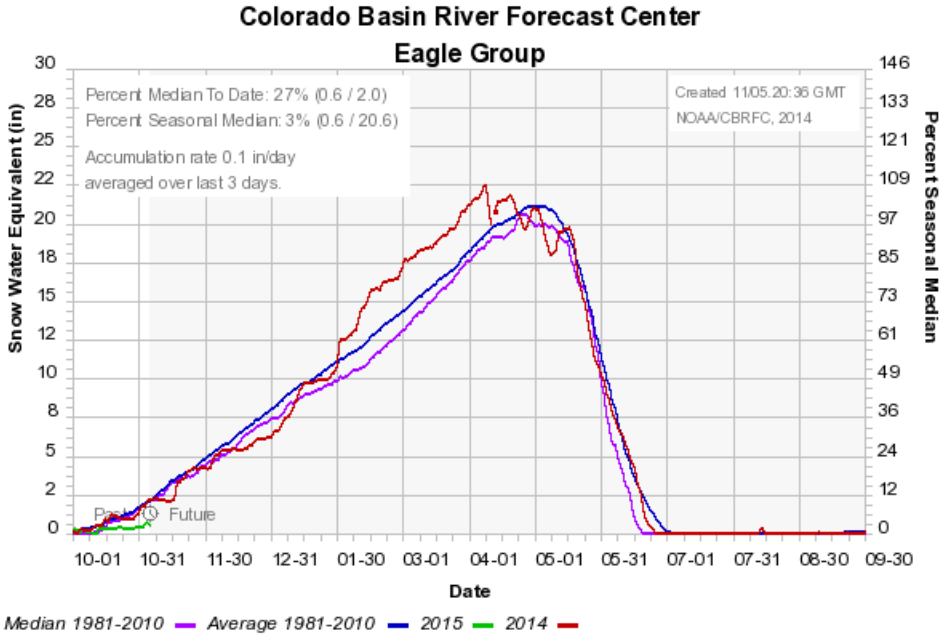
April MAE= 8 KAF (36%)
May MAE= 13KAF (22%)
June MAE= 1 KAF (4%)

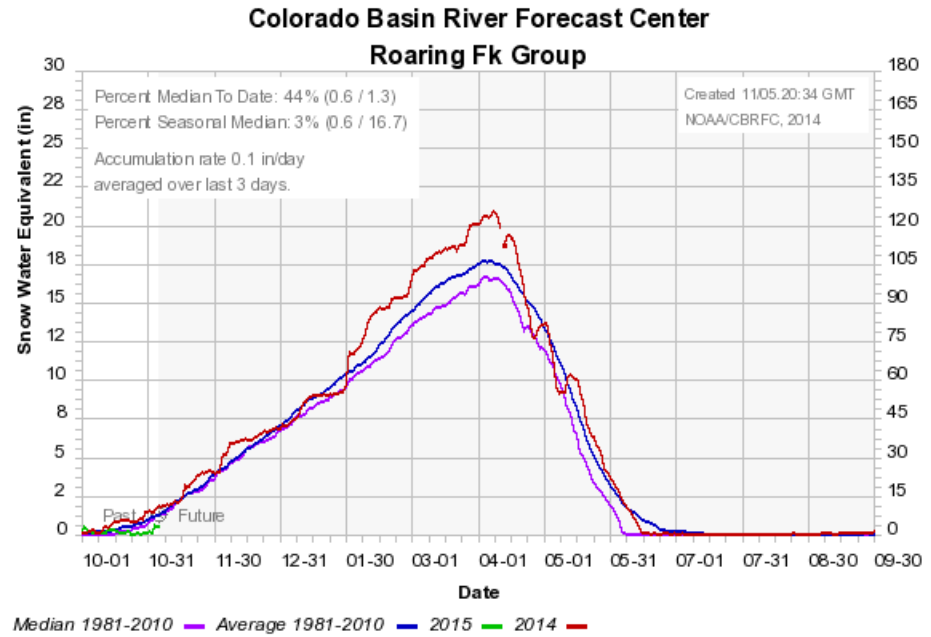
Forecast Performance: Upper Colorado

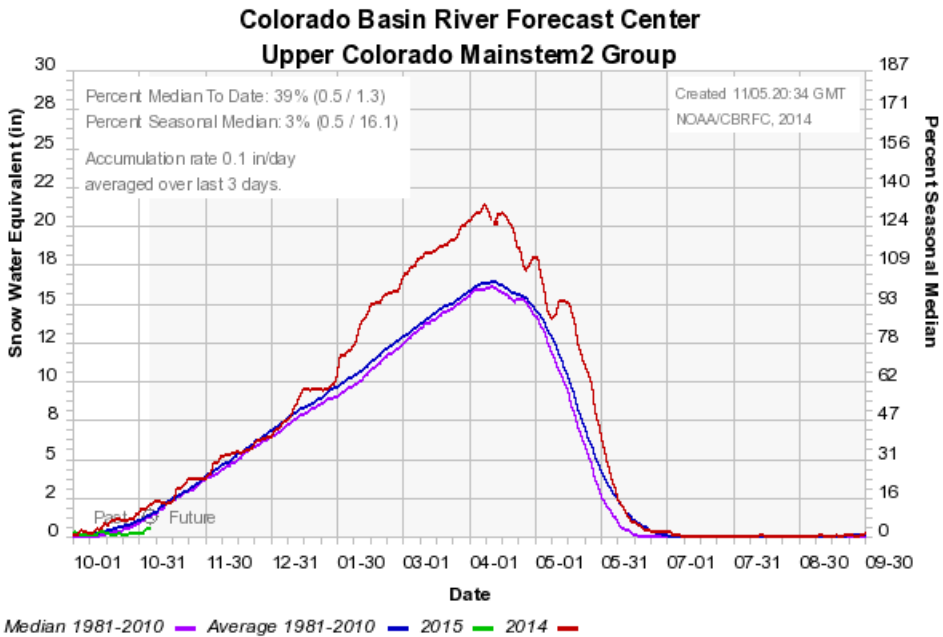


Upper Colorado: Snow Conditions

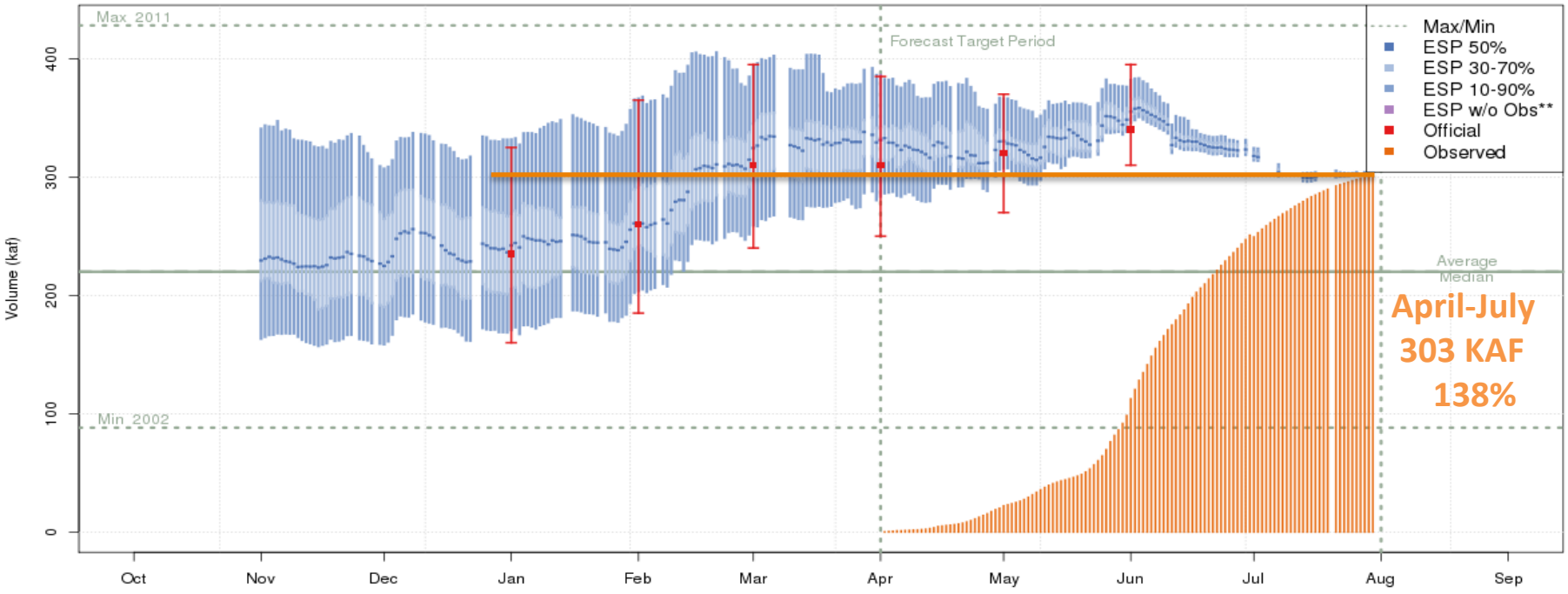


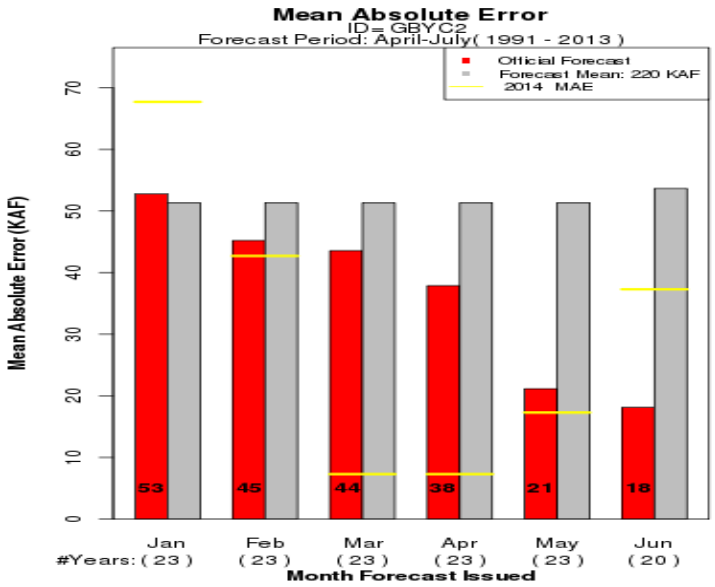


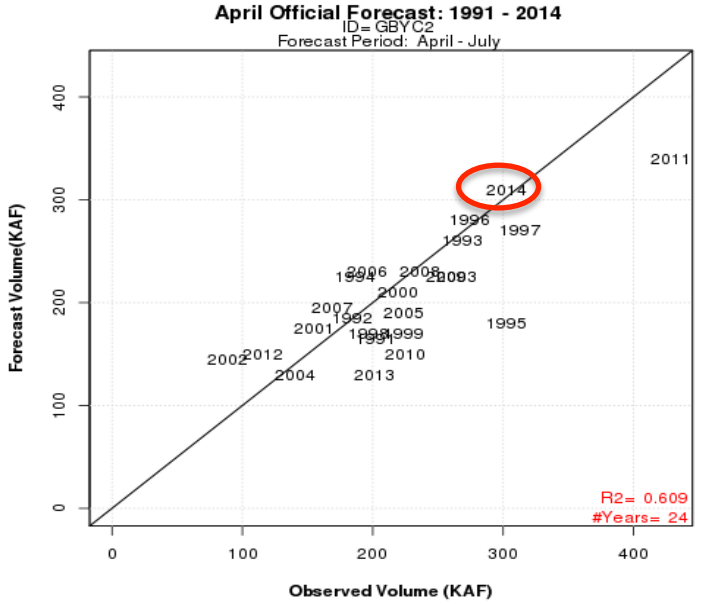




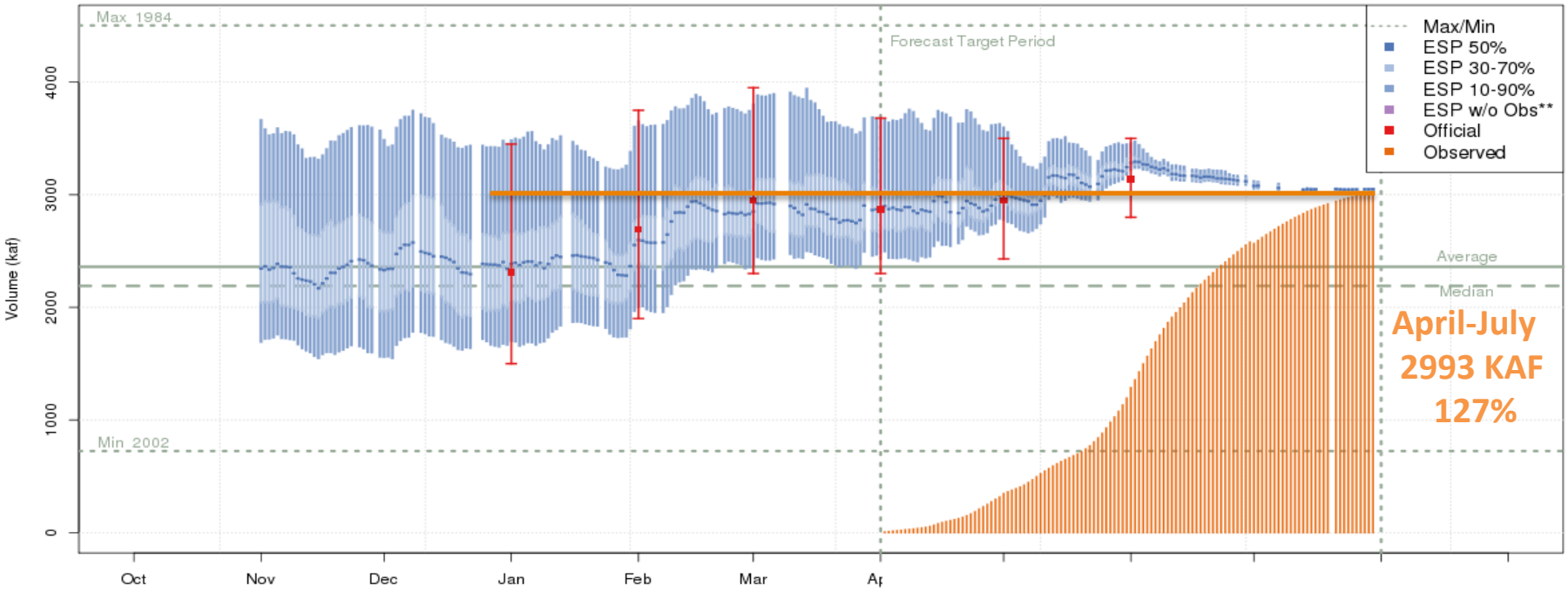
Upper Colorado: Granby Inflow

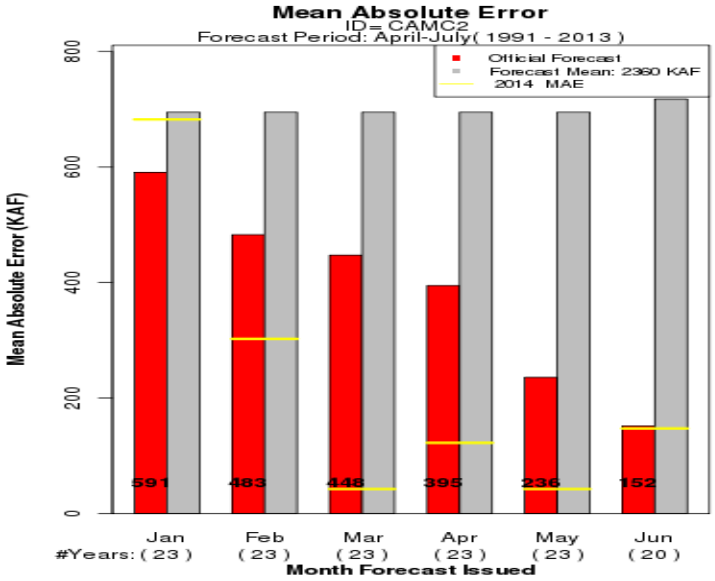


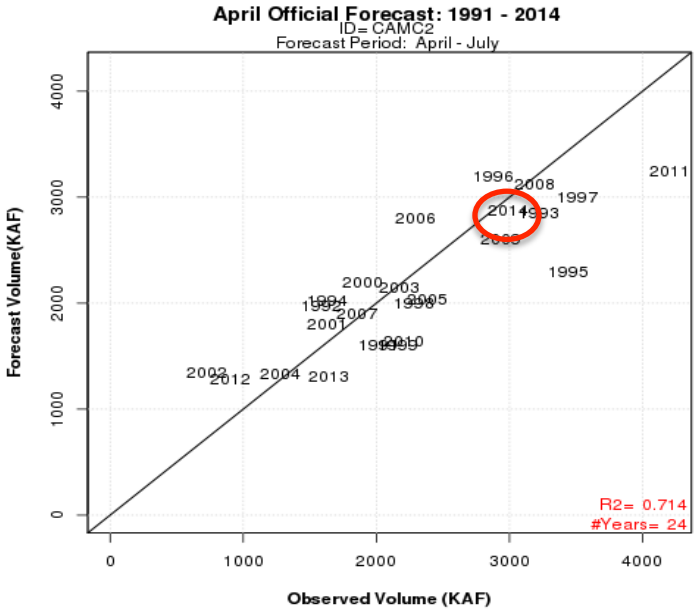




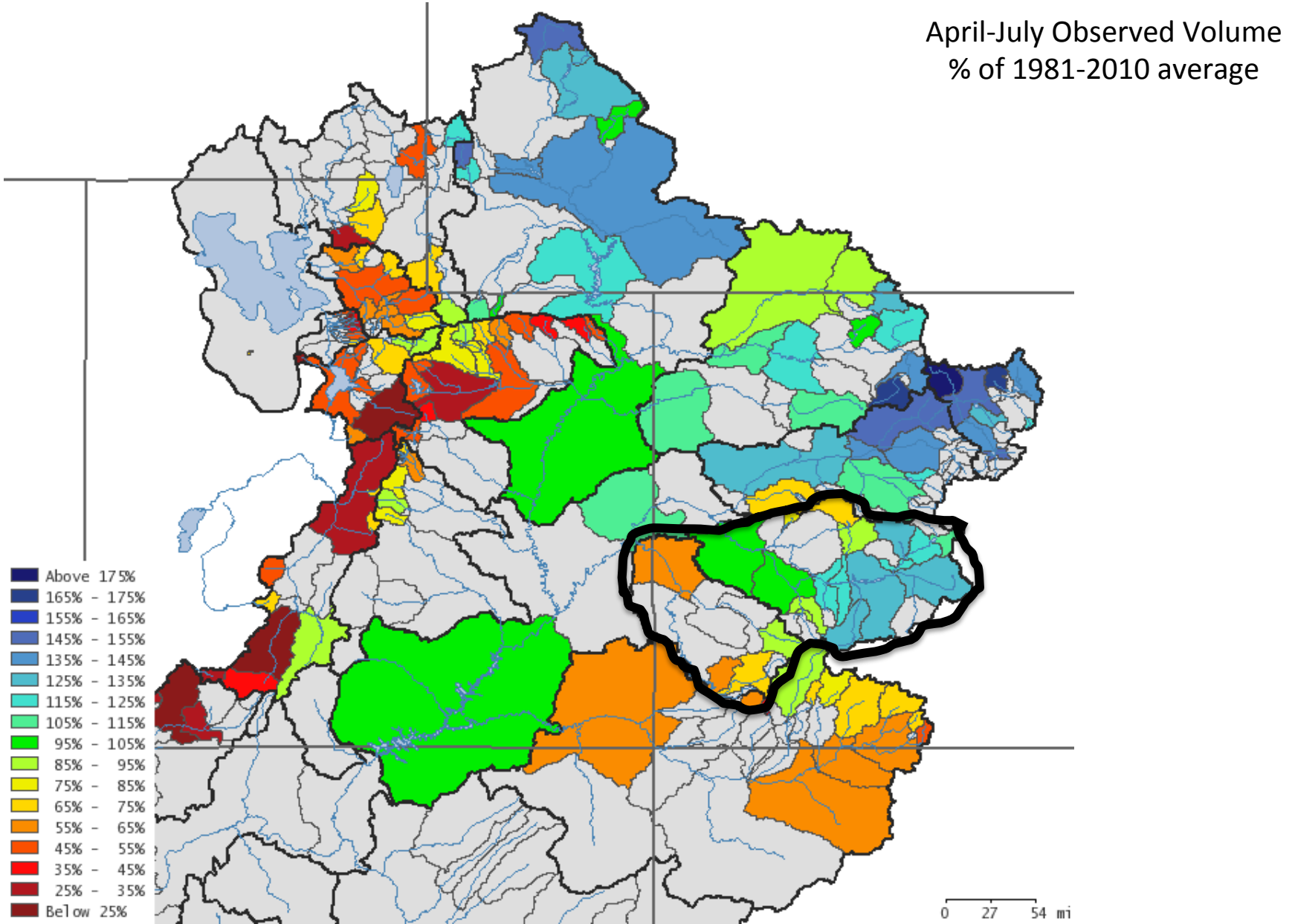
Upper Colorado: Colorado near Cameo



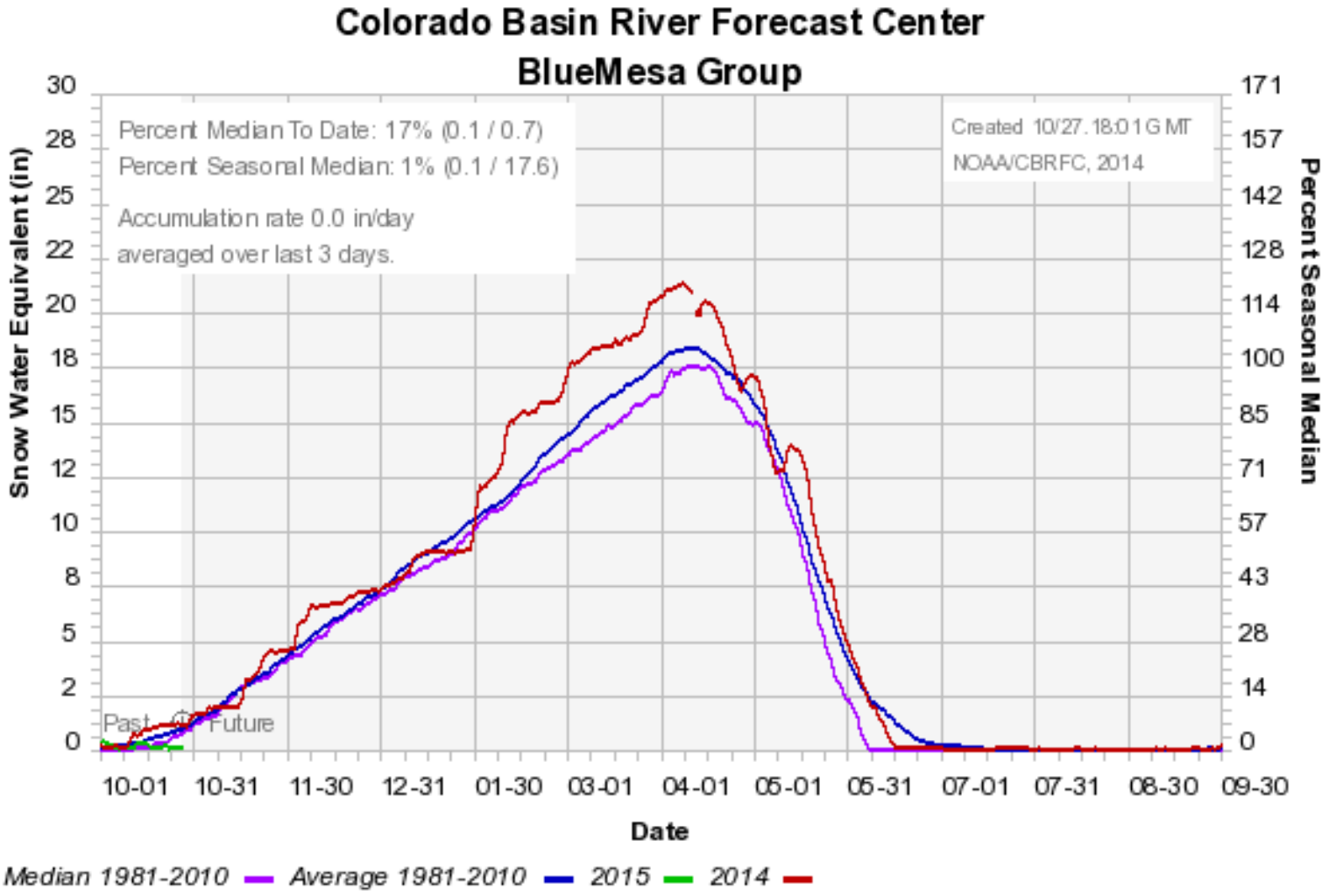




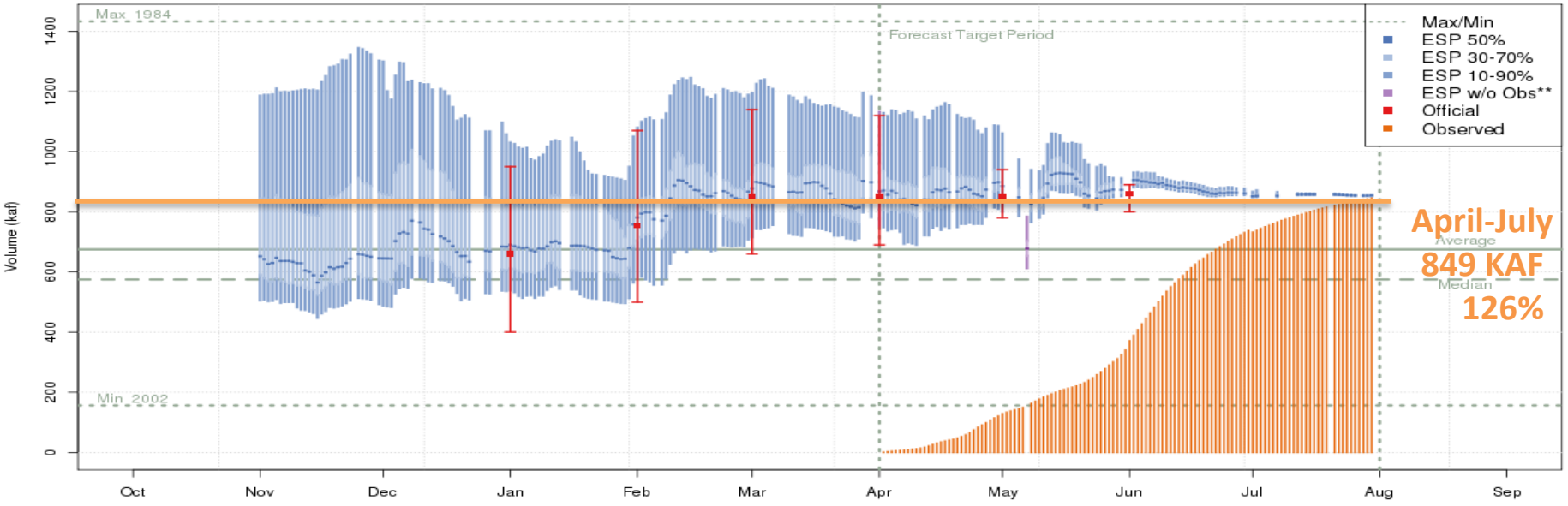
Forecast Performance: Gunnison and Dolores

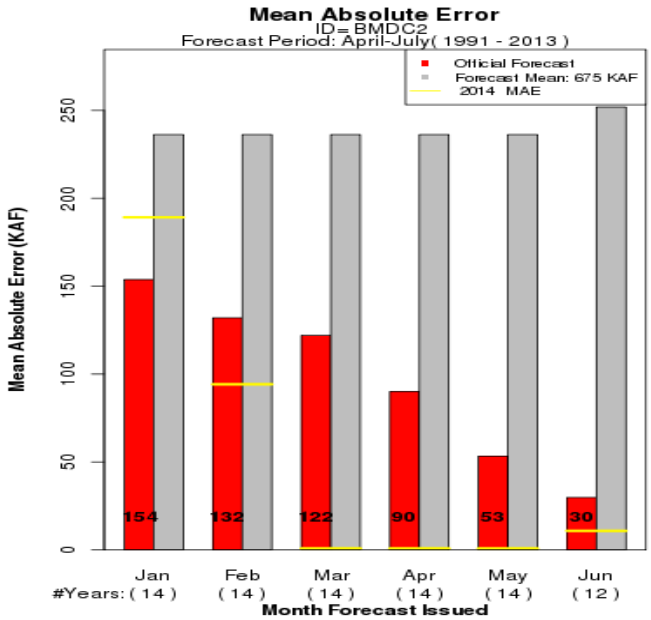


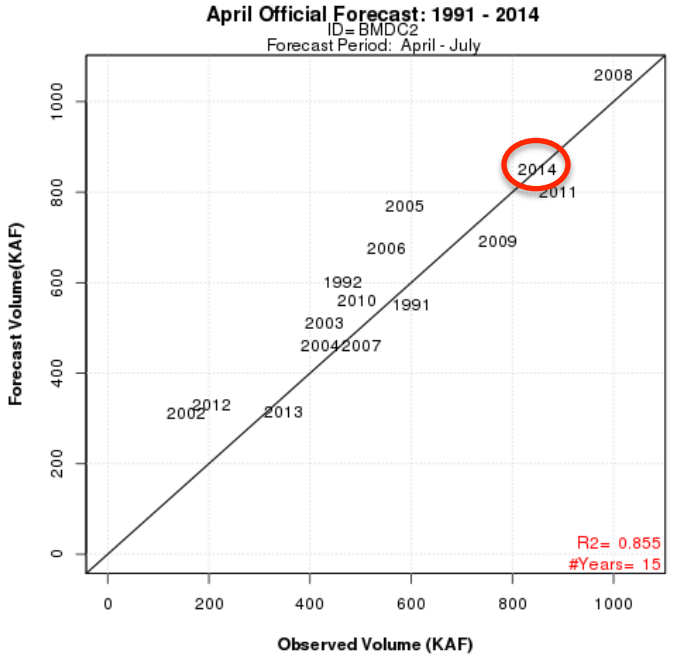
Upper Gunnison: Snow Conditions



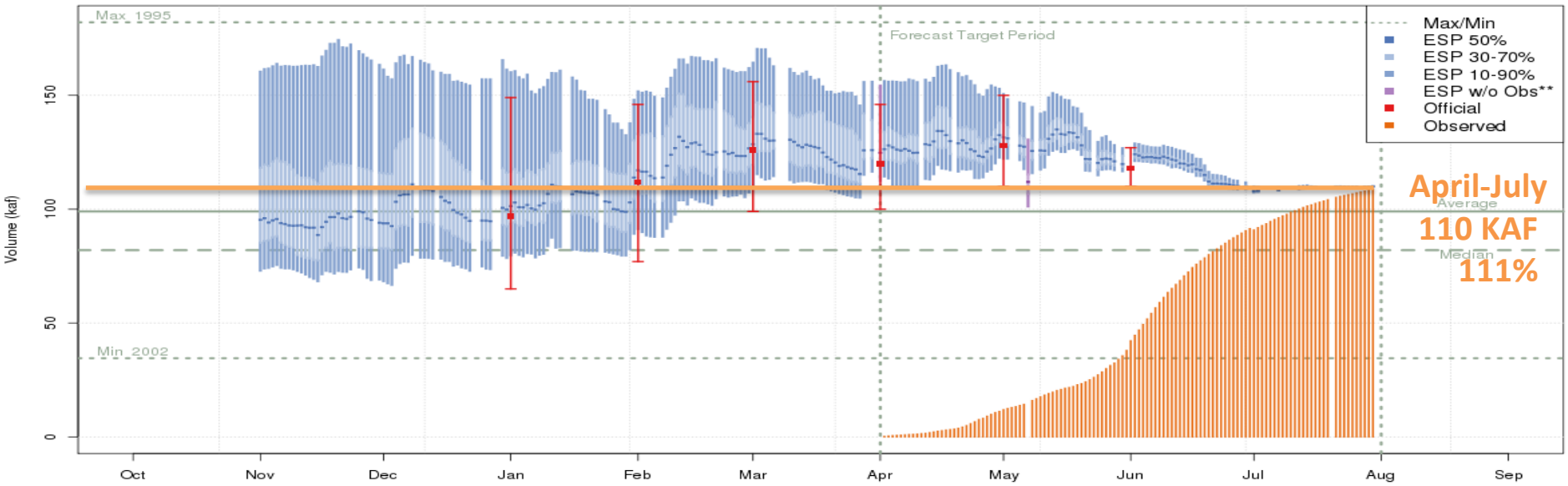
Gunnison: Blue Mesa Inflow

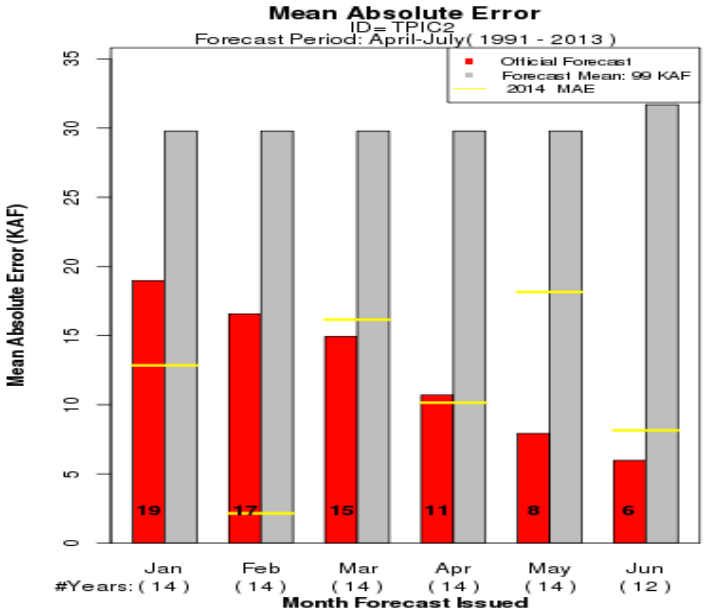


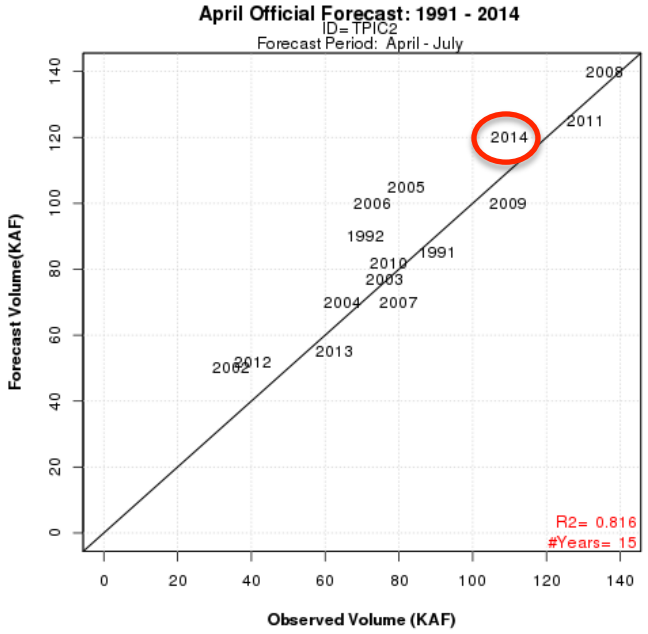




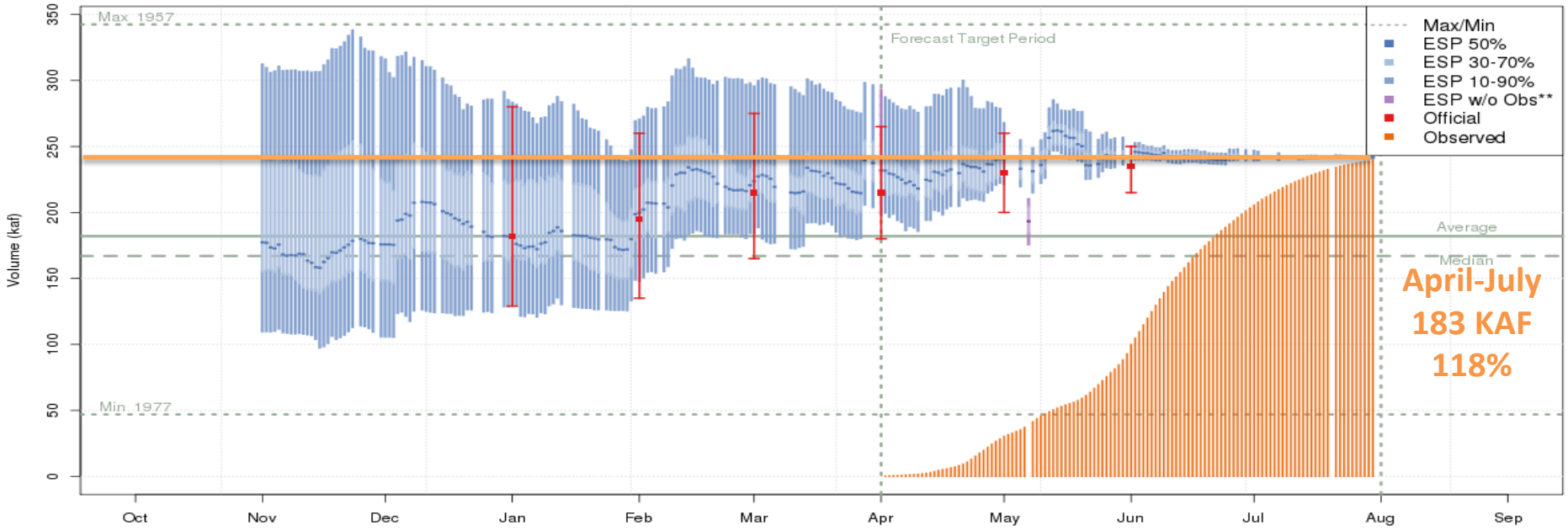
Gunnison: Taylor Park Inflow

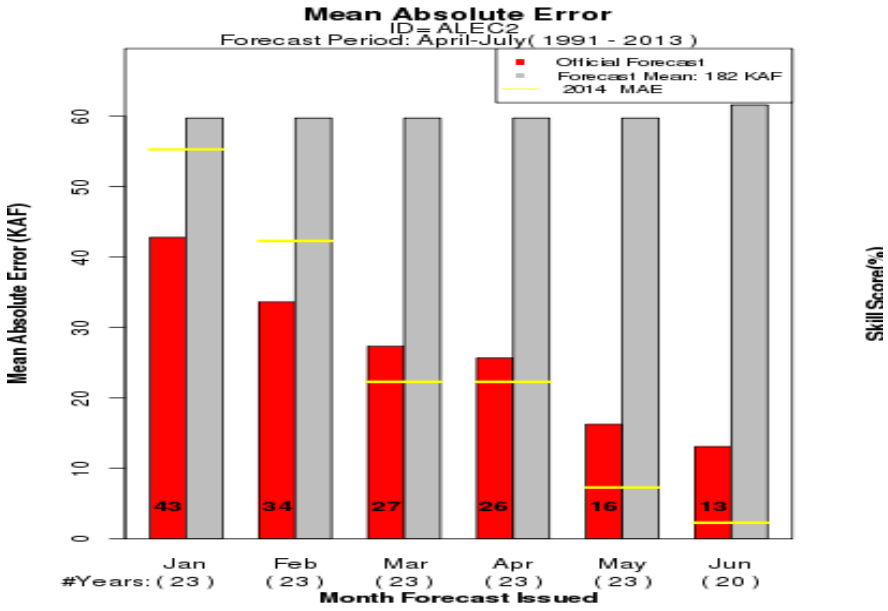


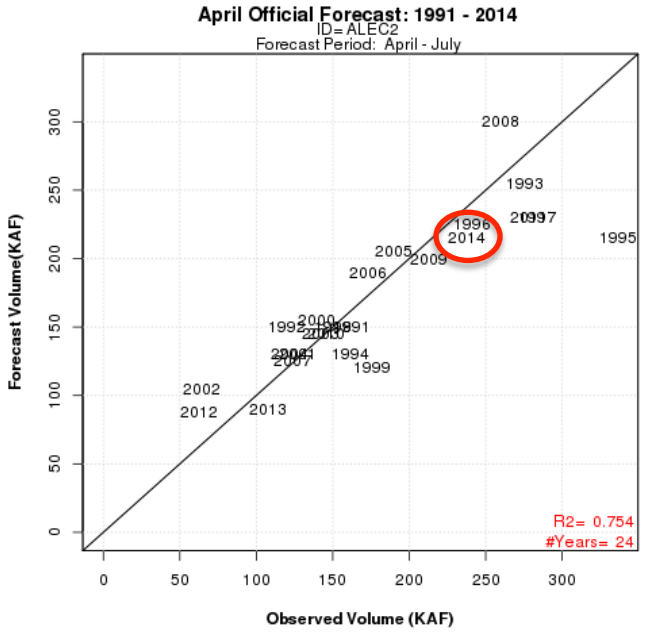




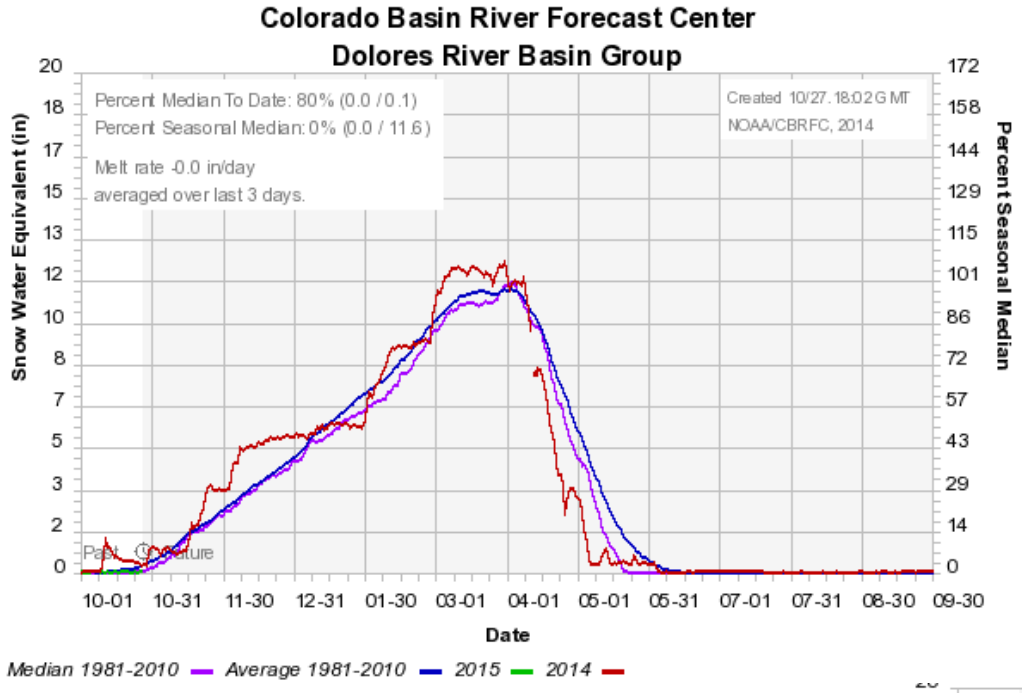
Gunnison: East River at Almont

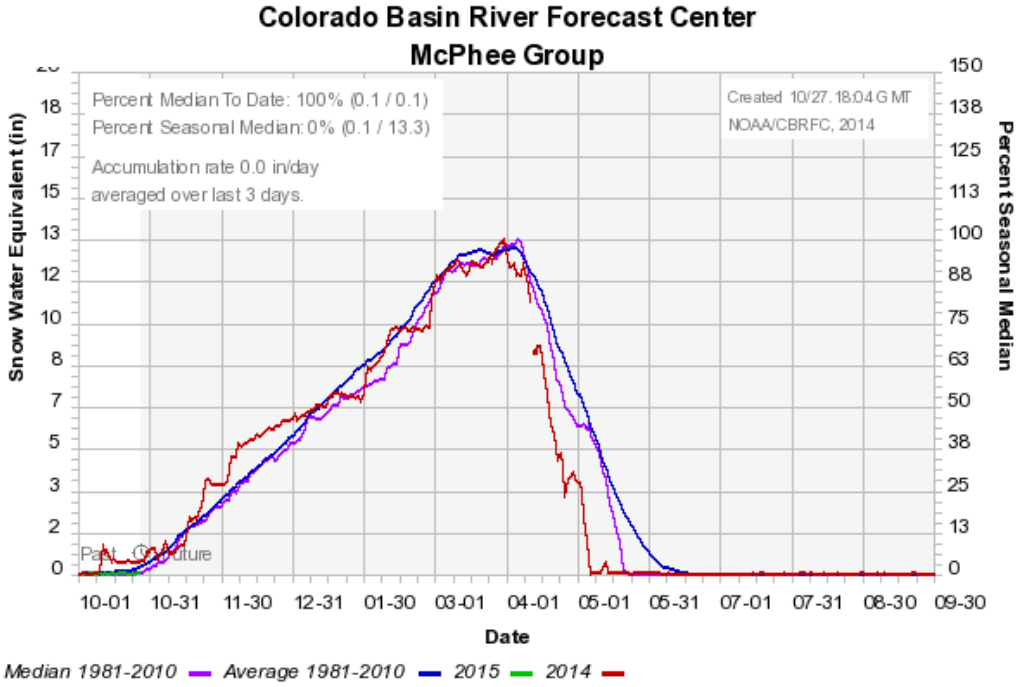




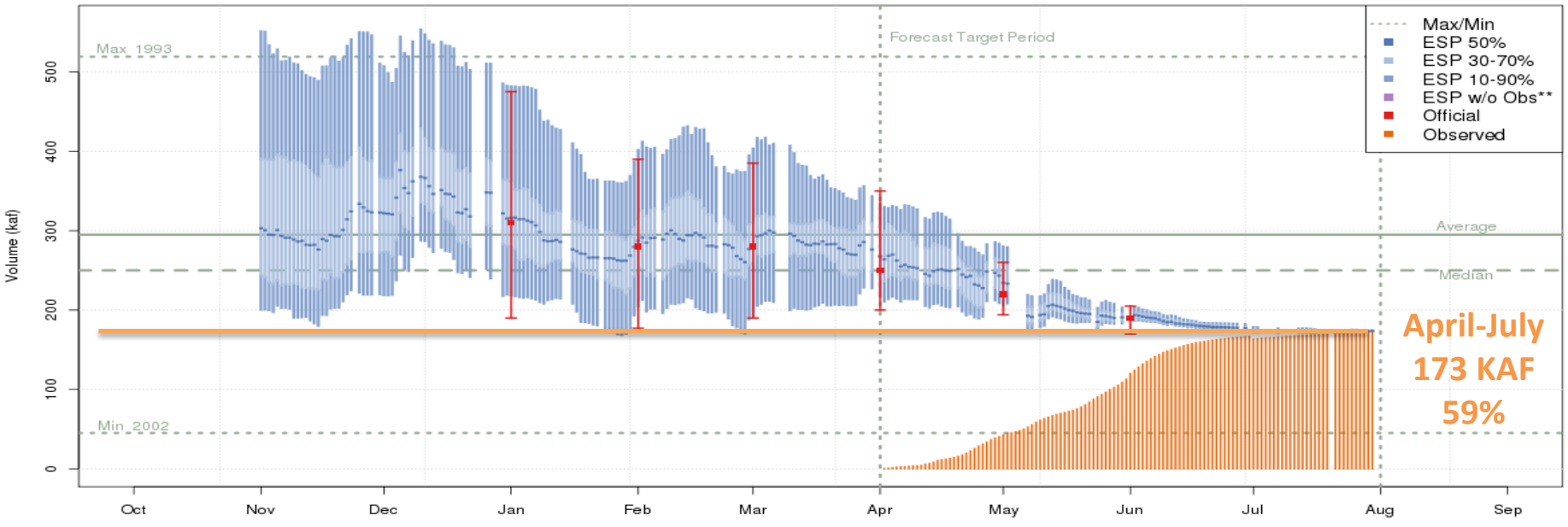


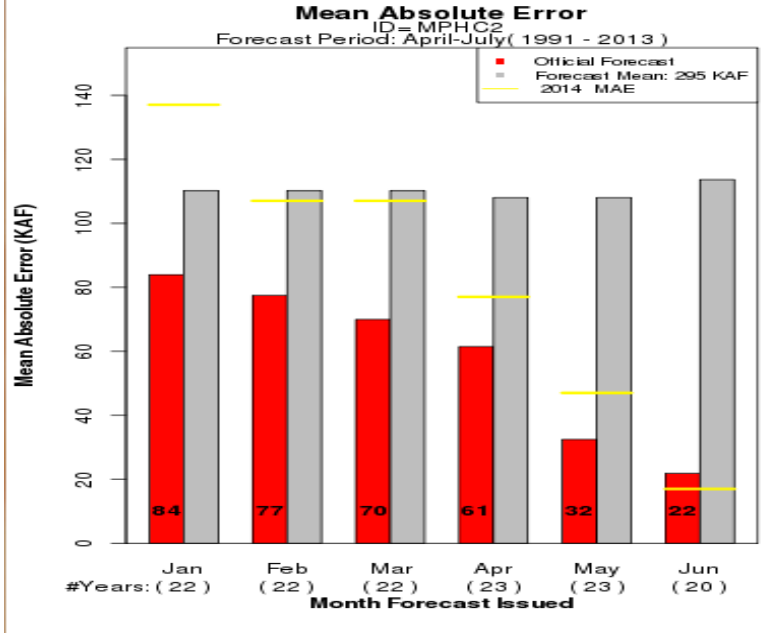
Dolores River Basin: Snow Conditions

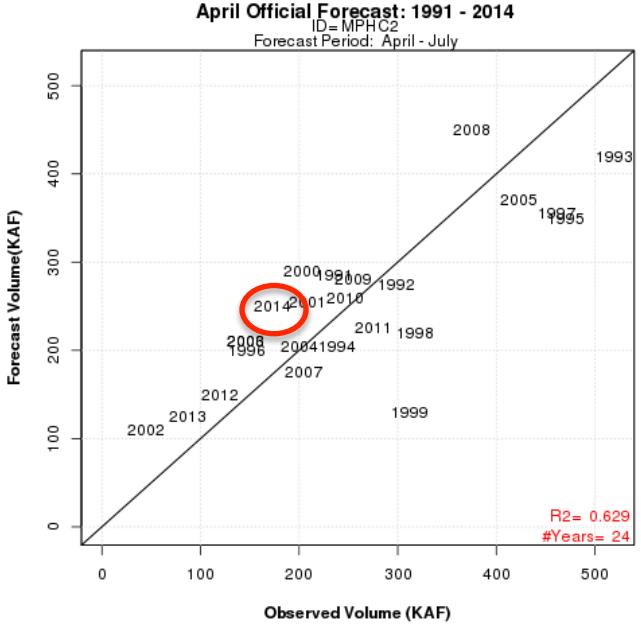




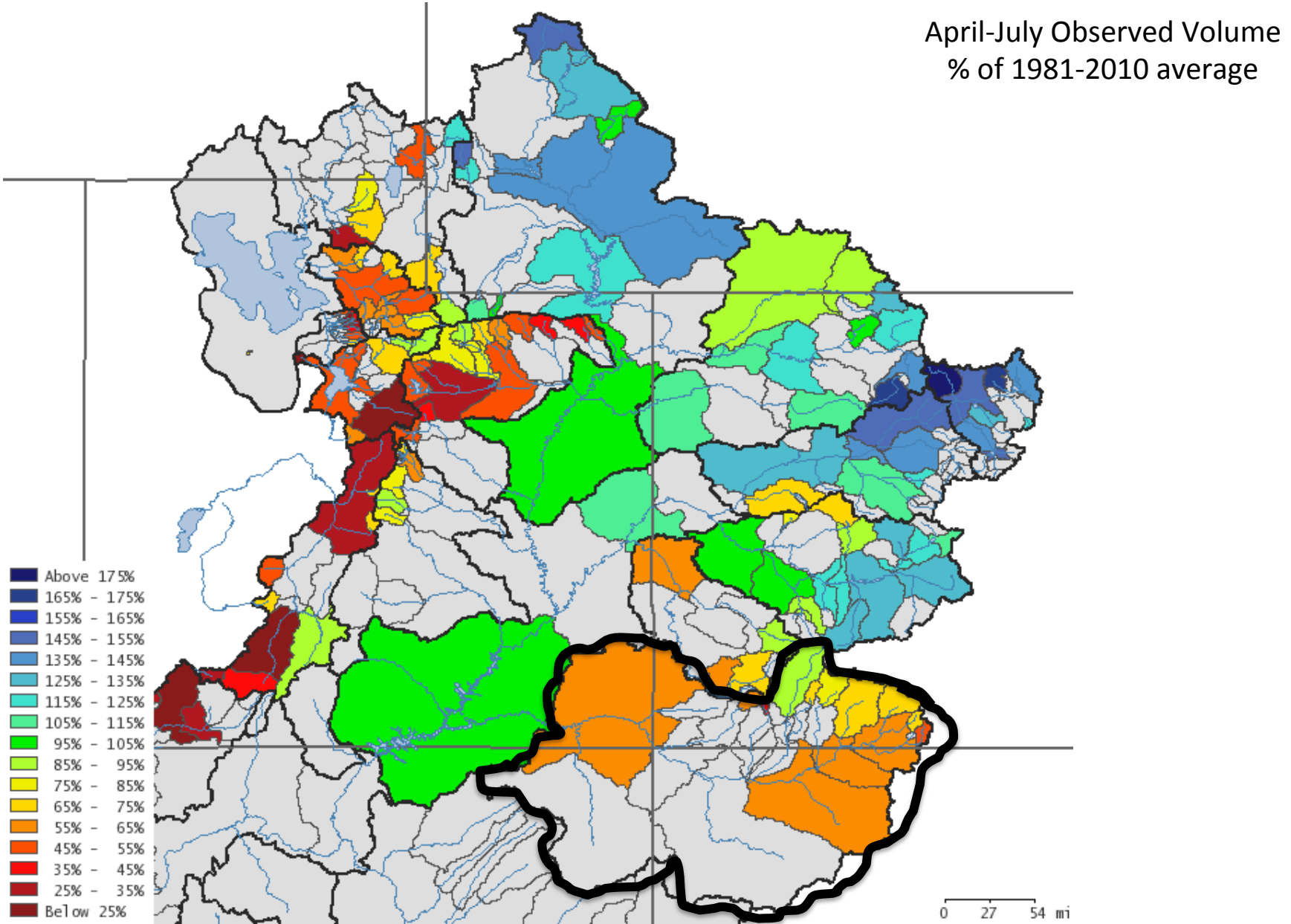
Dolores: McPhee Reservoir Inflow



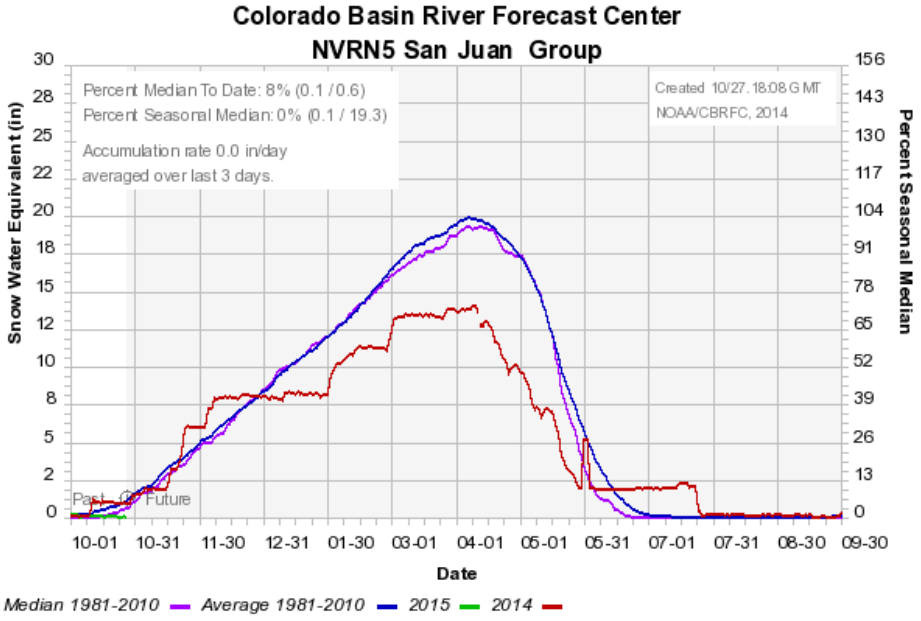


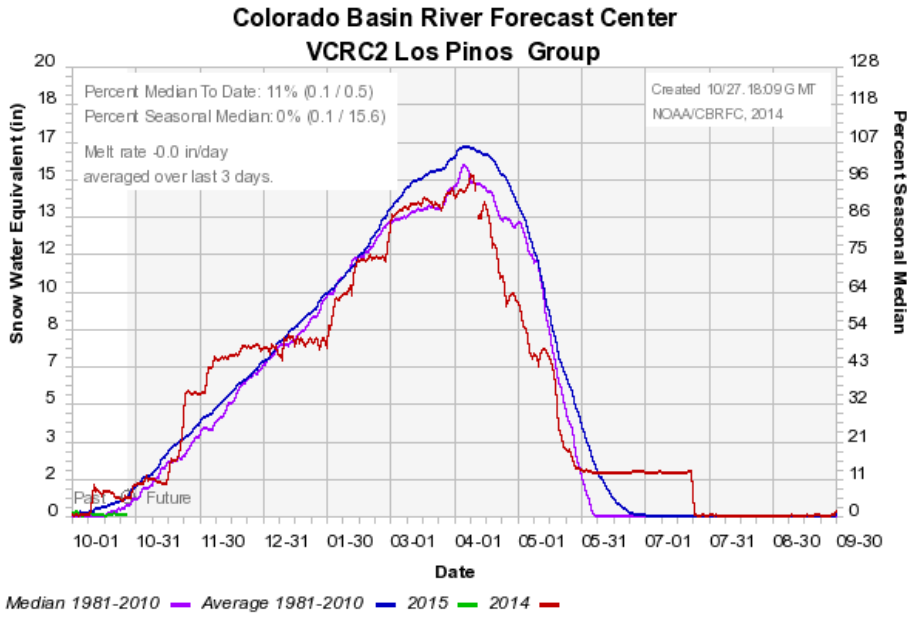


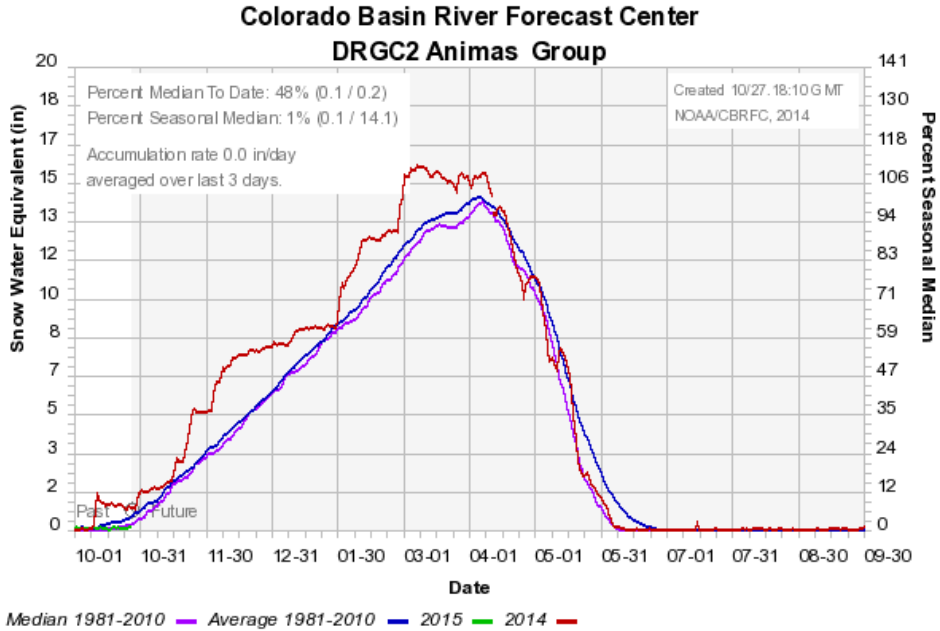
Forecast Performance: San Juan



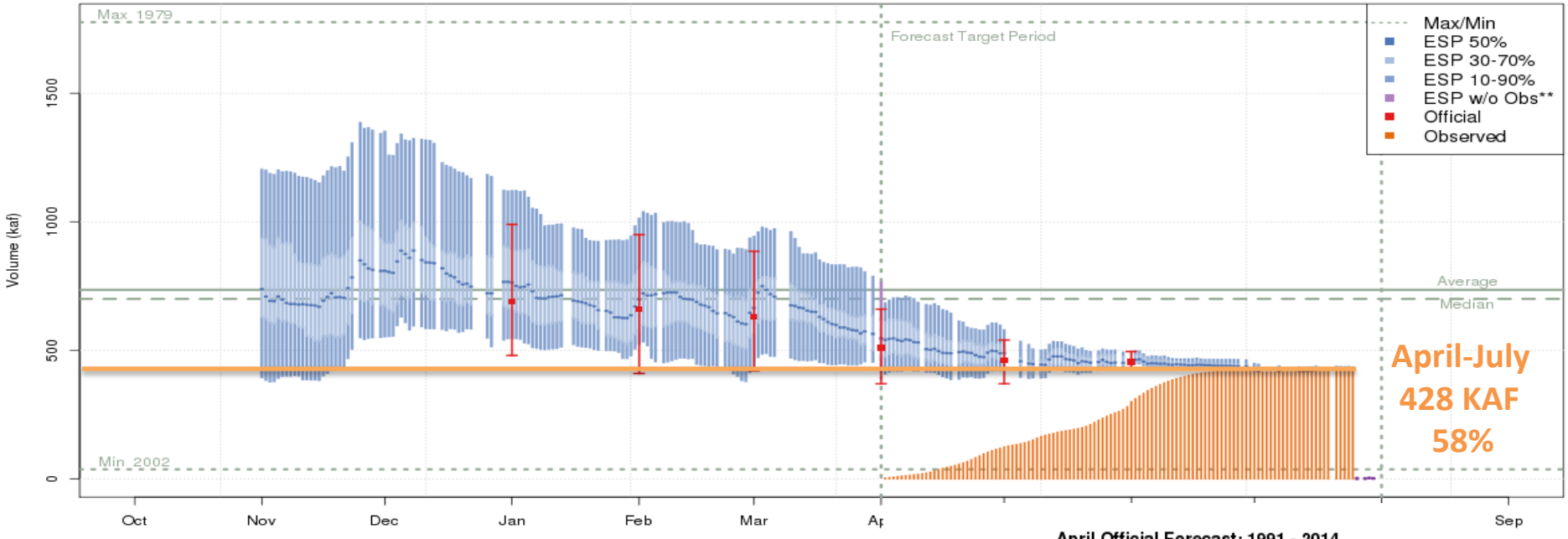
San Juan River Basin: Snow Conditions

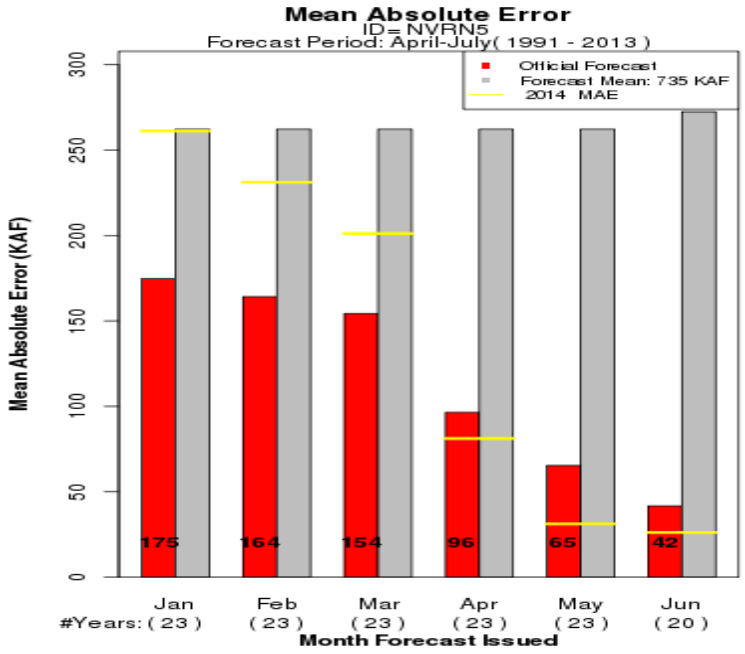


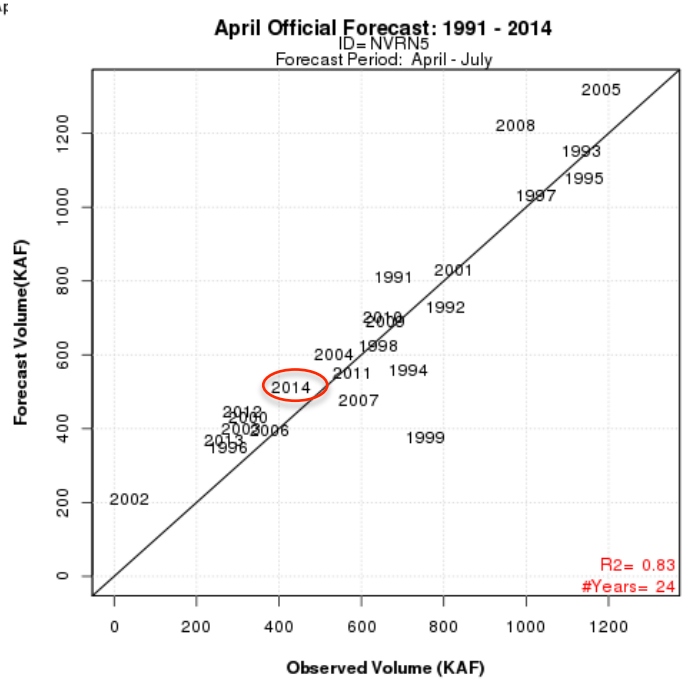




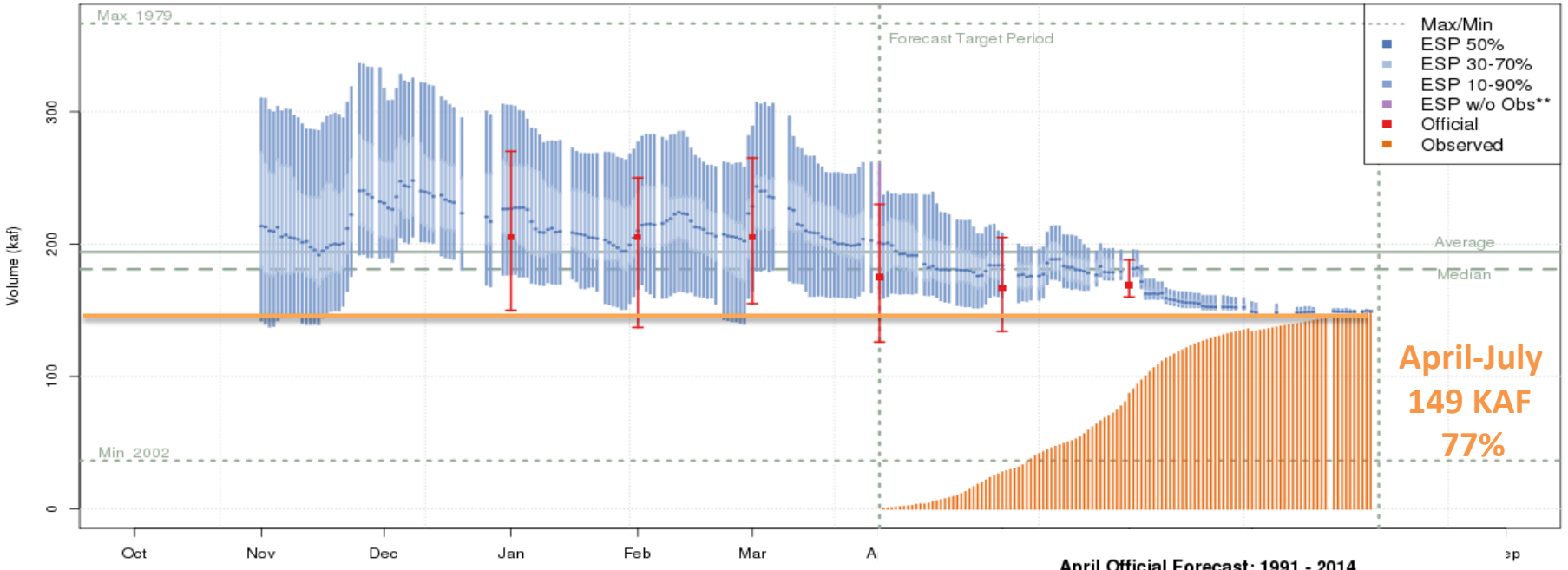
San Juan: Navajo Reservoir Inflow

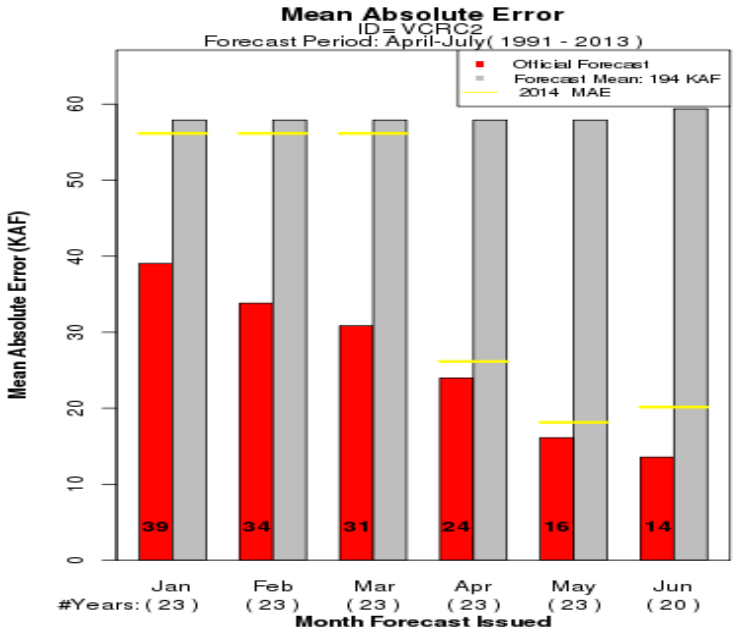


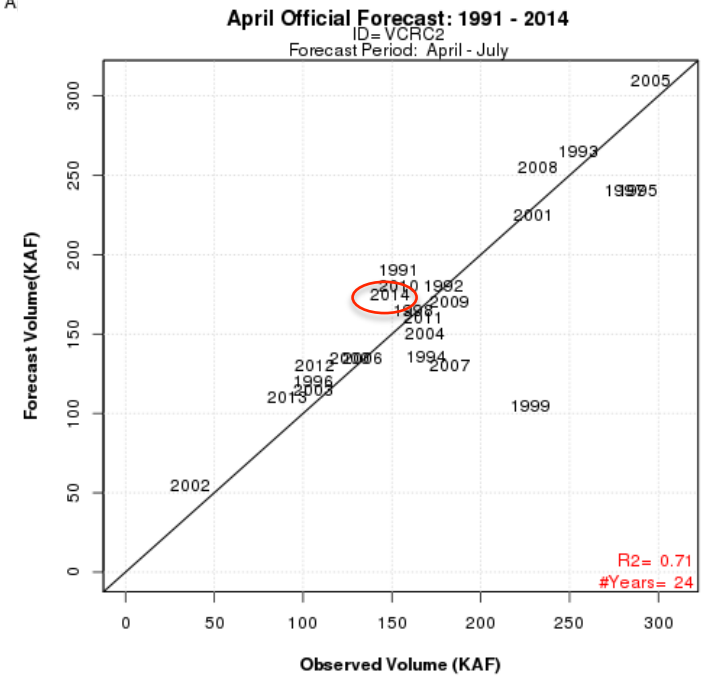




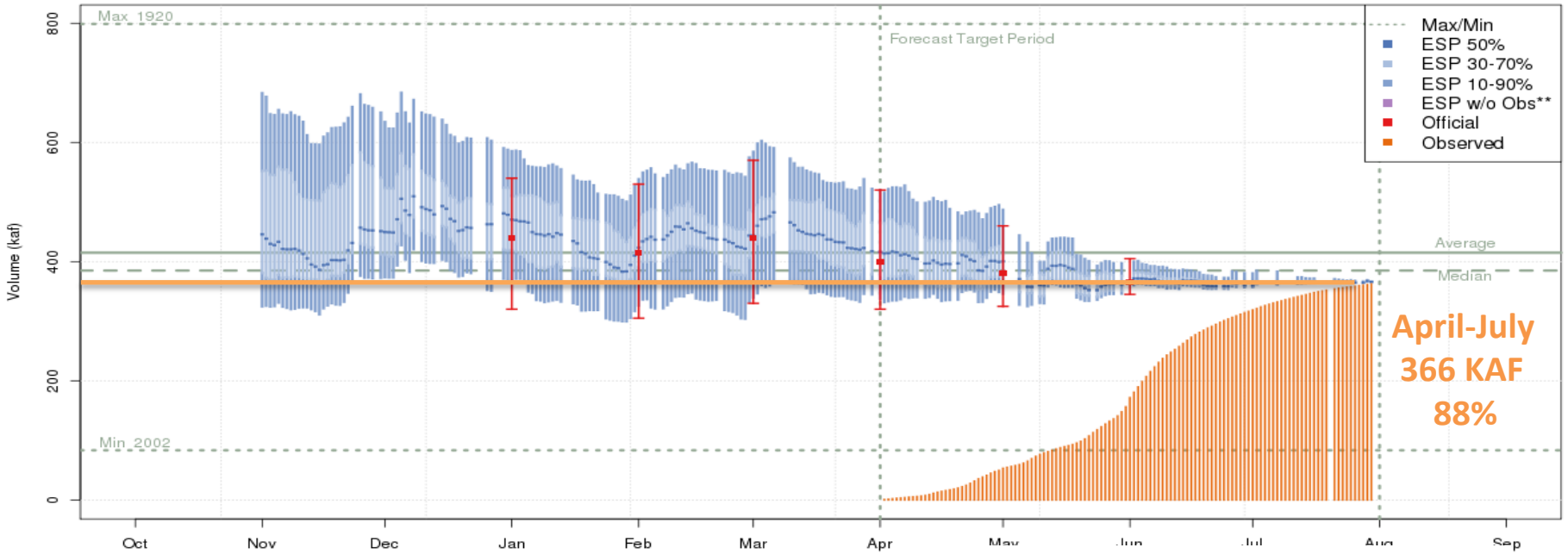
San Juan: Vallecito Reservoir Inflow

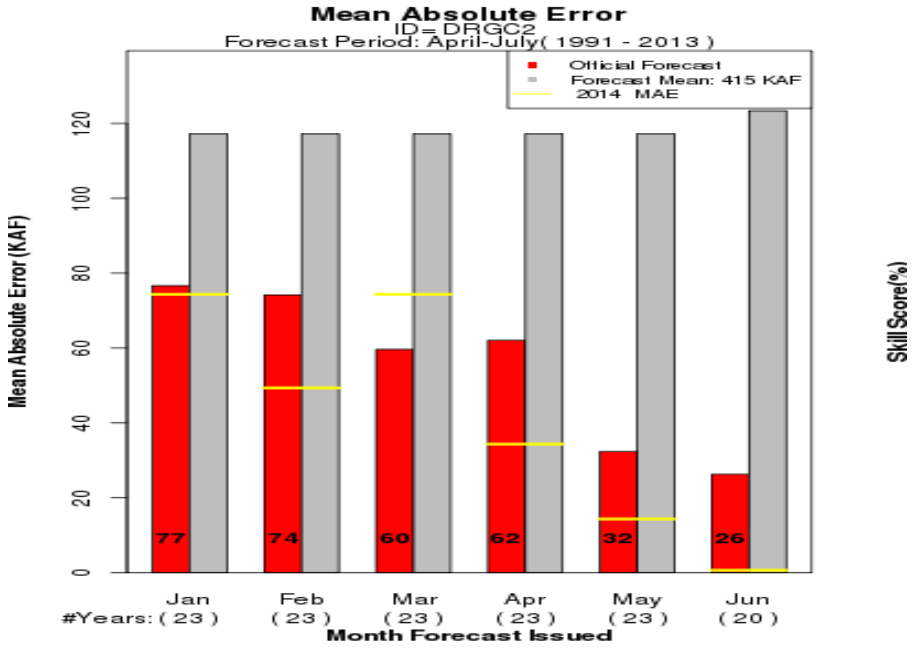


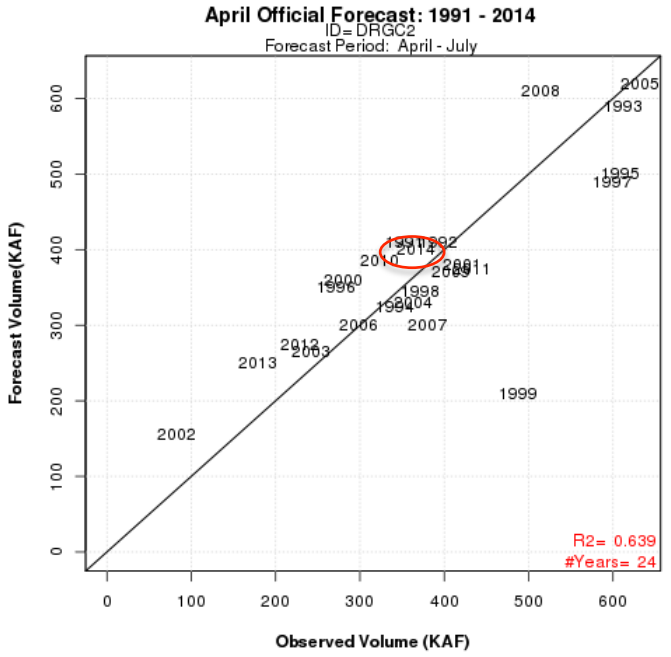




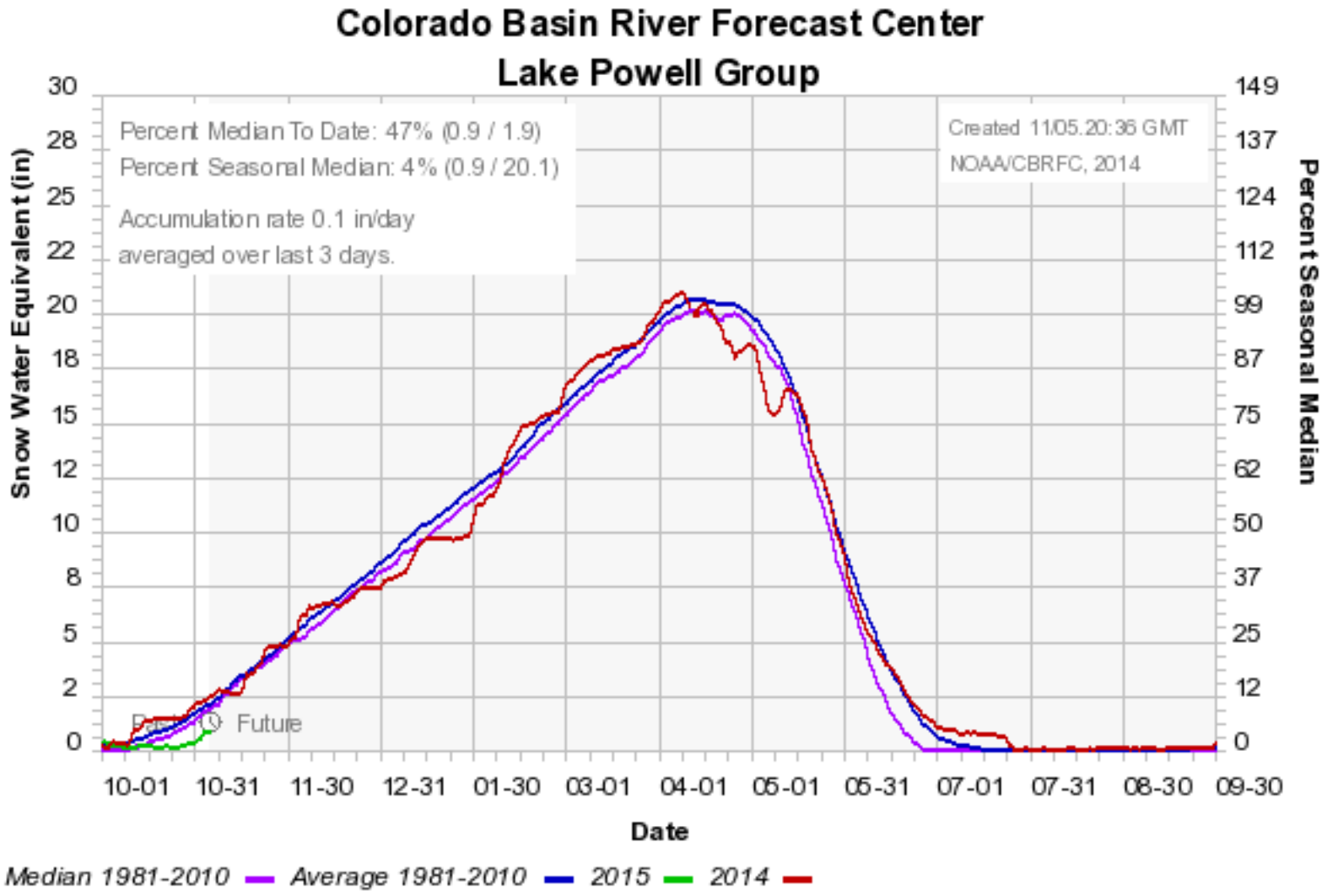
San Juan: Animas - Durango



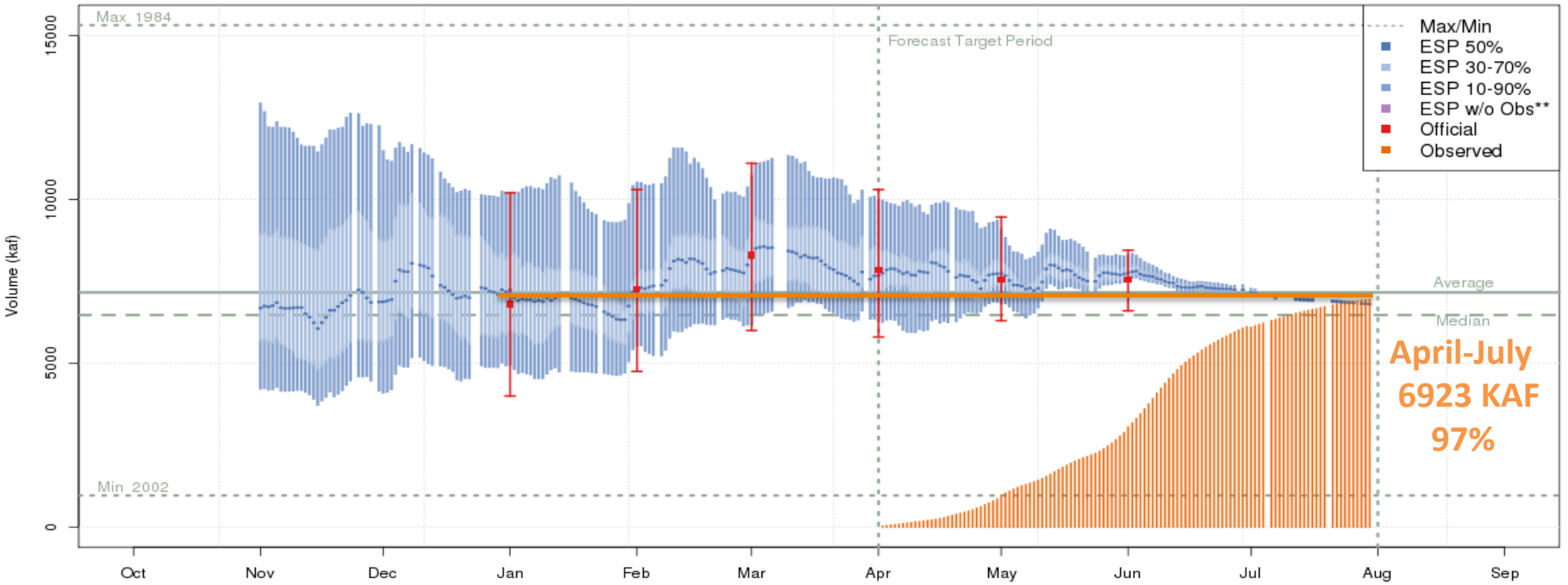


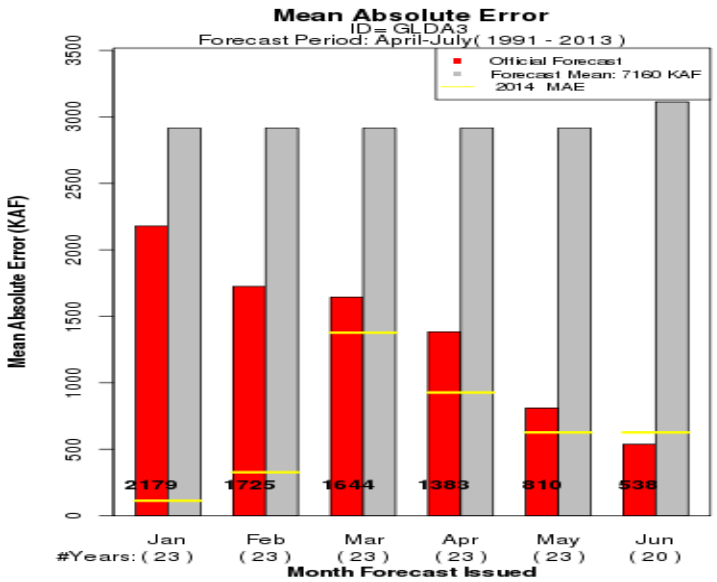


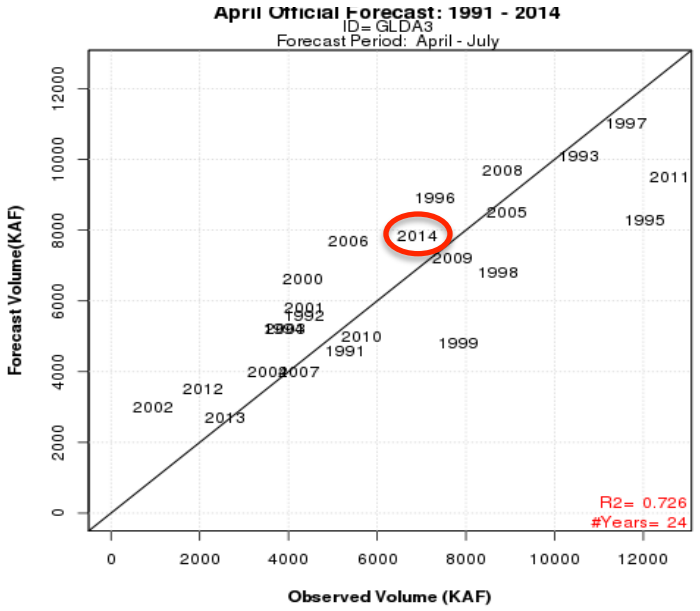
Lake Powell: Snow Conditions



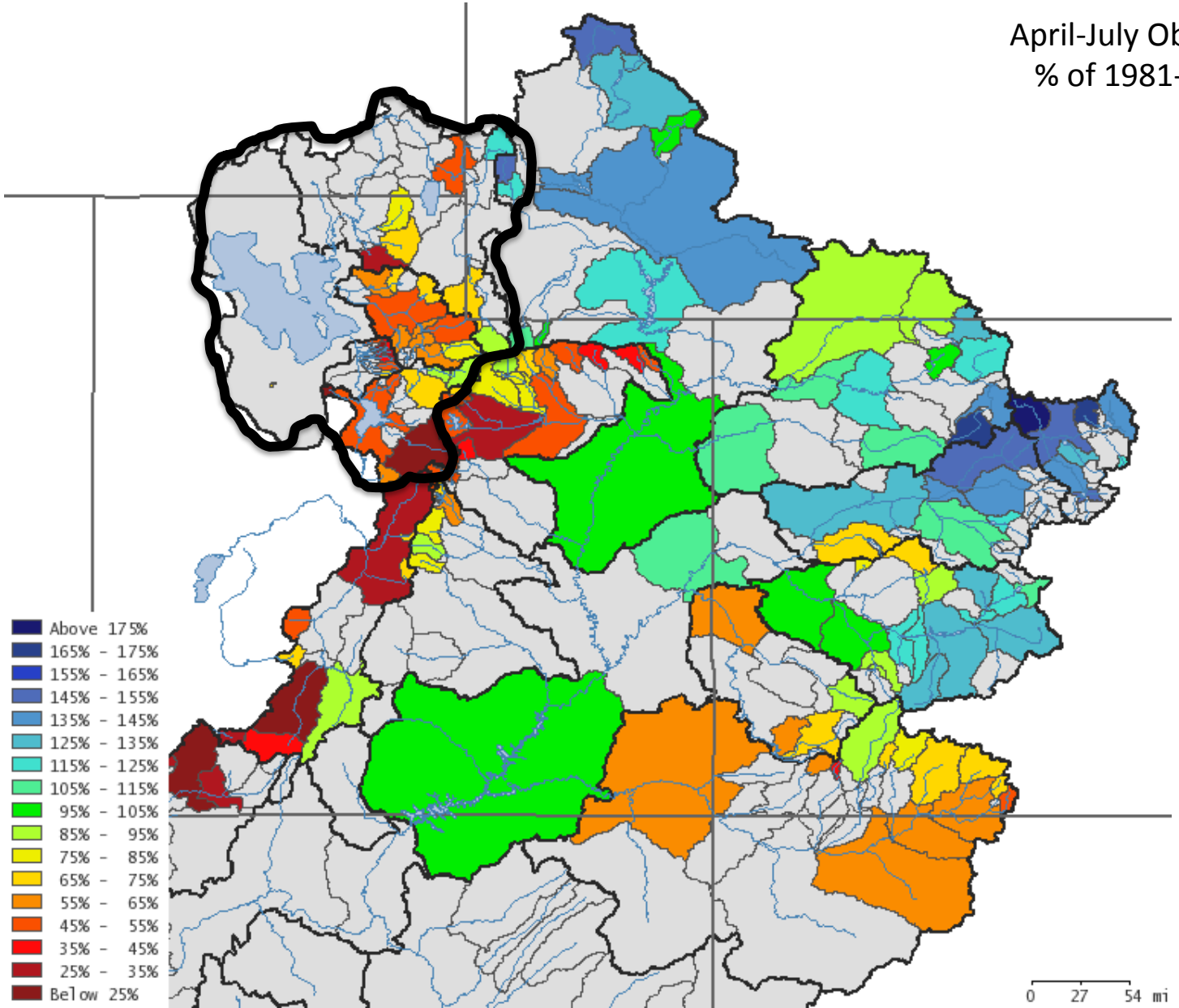
Lake Powell


Max 1984
Min 2002
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
ESP w/o Obs**
Official
Observed
Average
Median
April-July
6923 KAF
97%
Volume (kaf)
0
5000
10000
15000
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

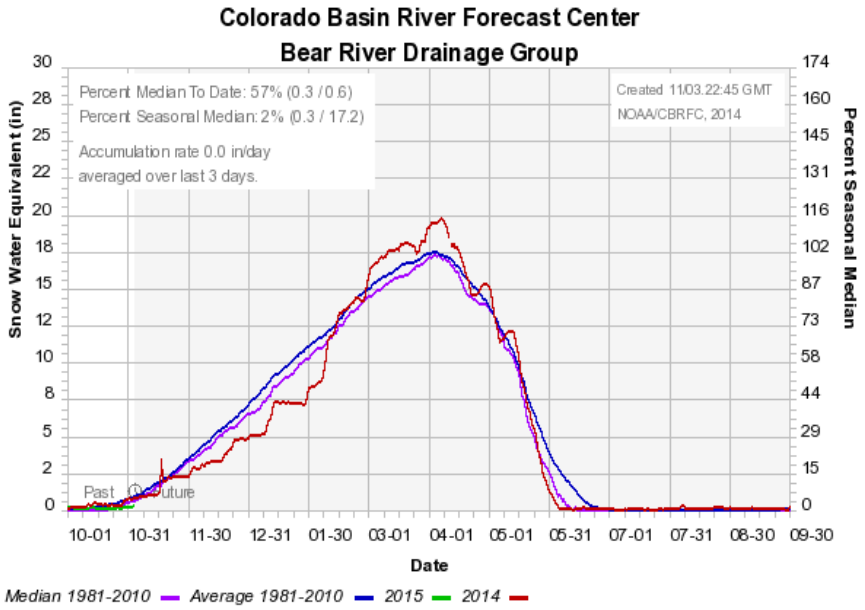

Mean Absolute Error
ID= GLDA3
Forecast Period: April-July(1991 - 2013)
Official Forecast
Forecast Mean: 7160 KAF
2014 MAE
Mean Absolute Error (KAF)
0
500
1000
1500
2000
2500
3000
3500
2179
1725
1644
1383
810
538
Jan
Feb
Mar
Apr
May
Jun
#Years: (23)
(23)
(23)
(23)
(23)
(20)
Month Forecast Issued

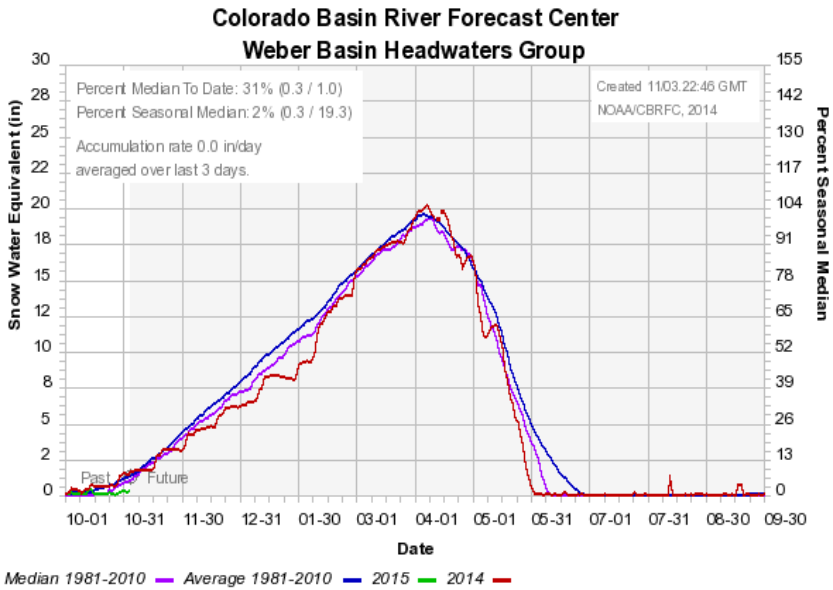

April Official Forecast: 1991 - 2014
ID= GLDA3
Forecast Period: April - July
Forecast Volume(KAF)
0
2000
4000
6000
8000
10000
12000
Observed Volume (KAF)
1997
1993
2008
2011
1996
2005
1995
2006
2014
2009
1998
2000
2001
1992
1994
2010
1991
1999
2003
2007
2012
2002
2013
R2= 0.726
#Years= 24

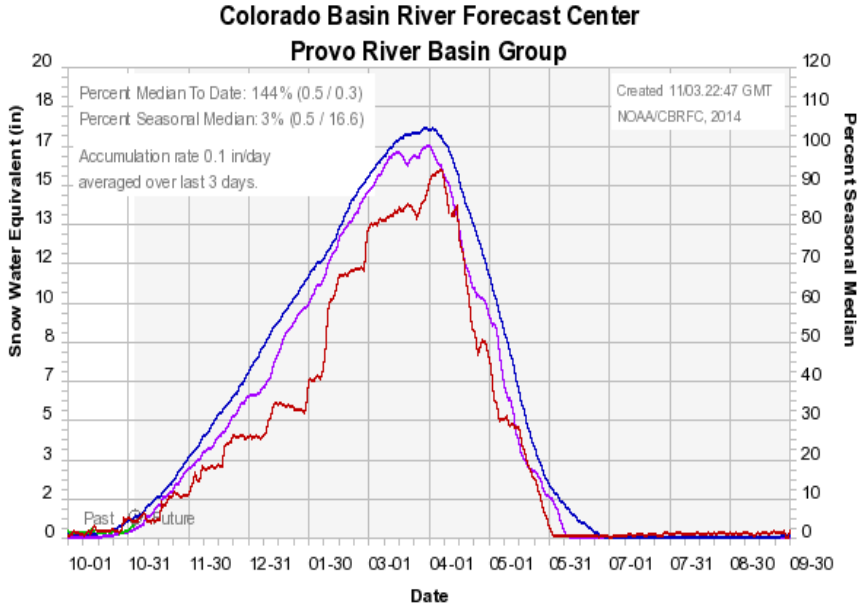
Forecast Performance: Bear, Weber, Provo & Six Creeks

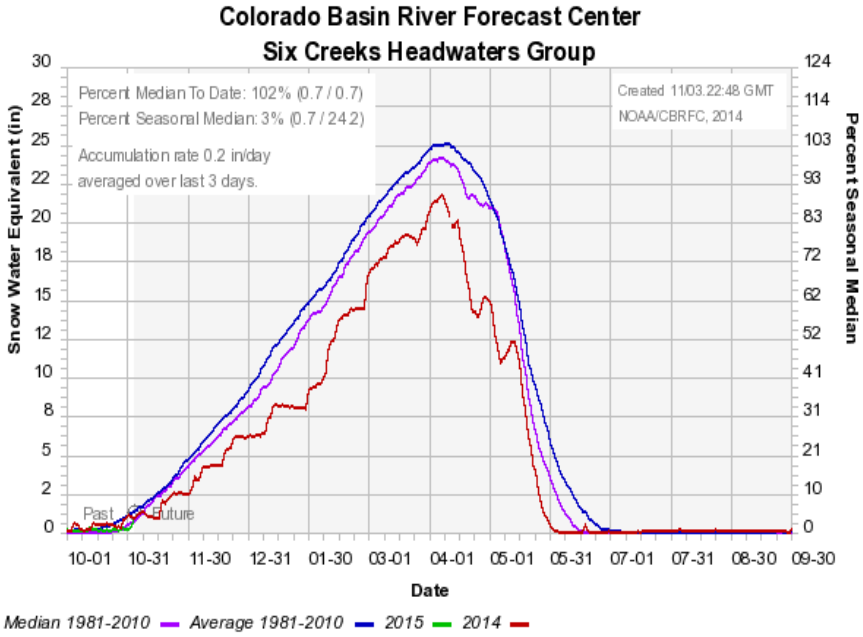


Great Basin: Snow Conditions

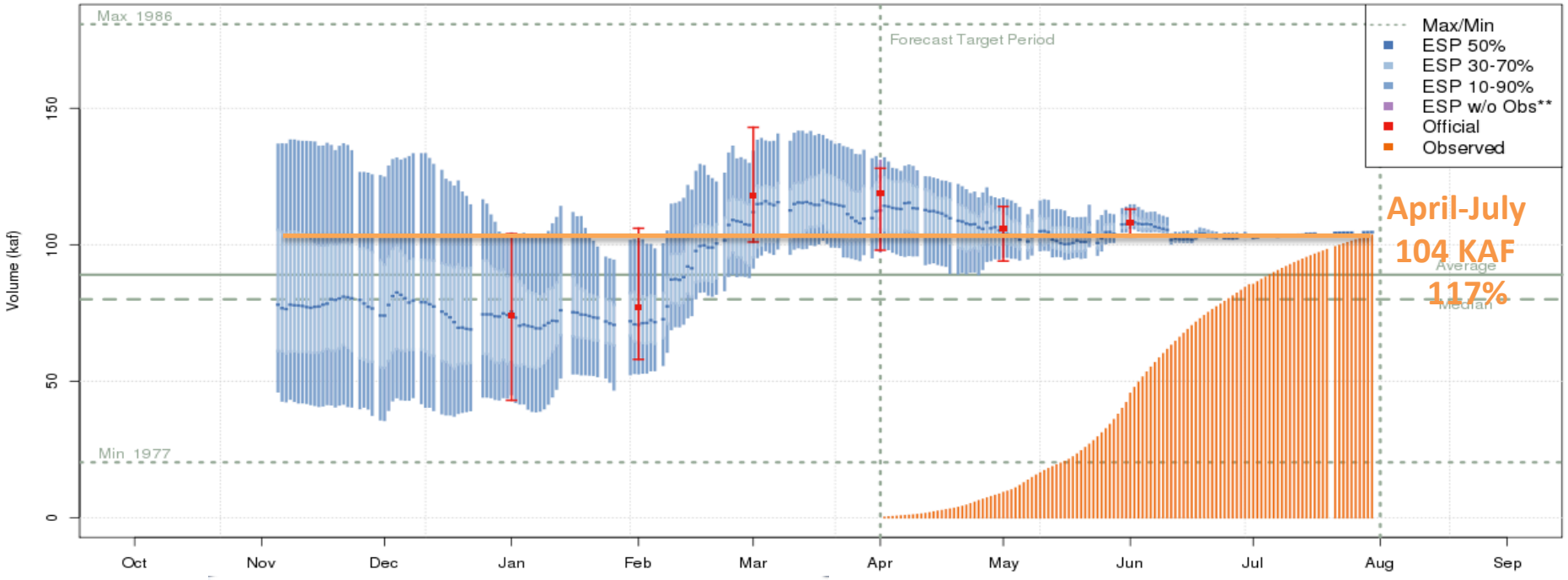


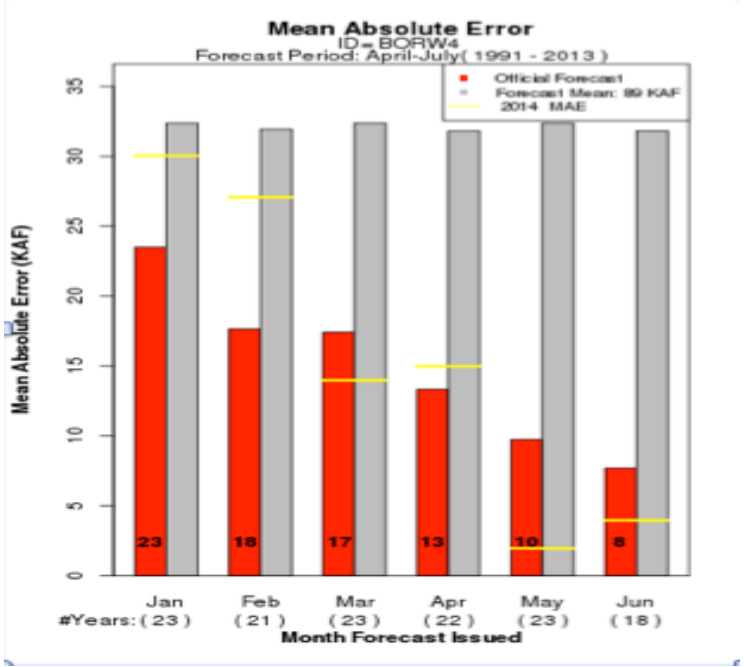


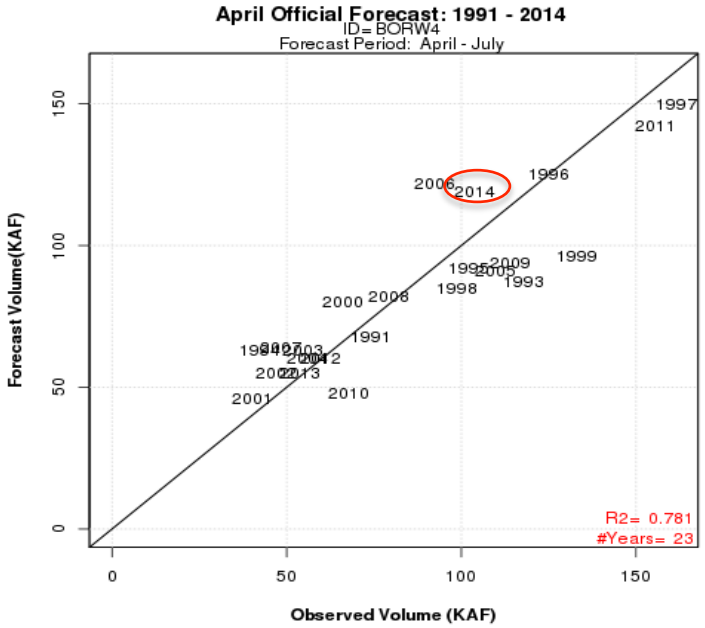




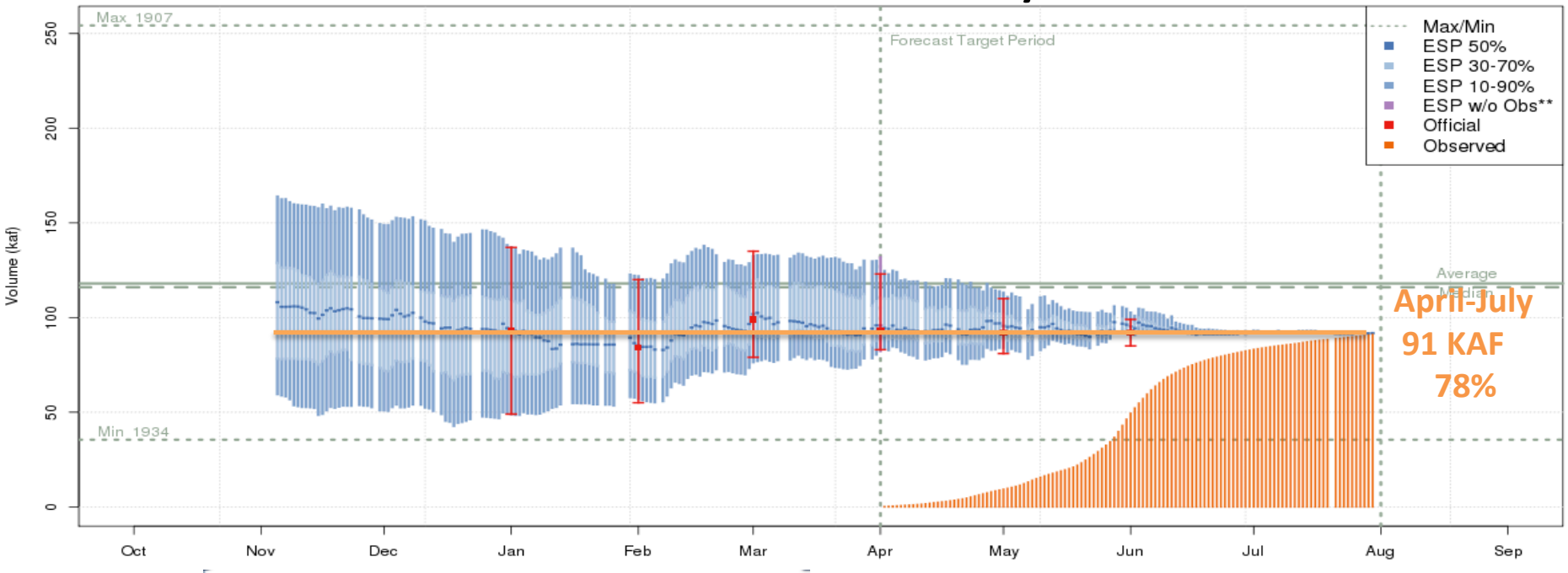
Great Basin: Smiths Fork near Border

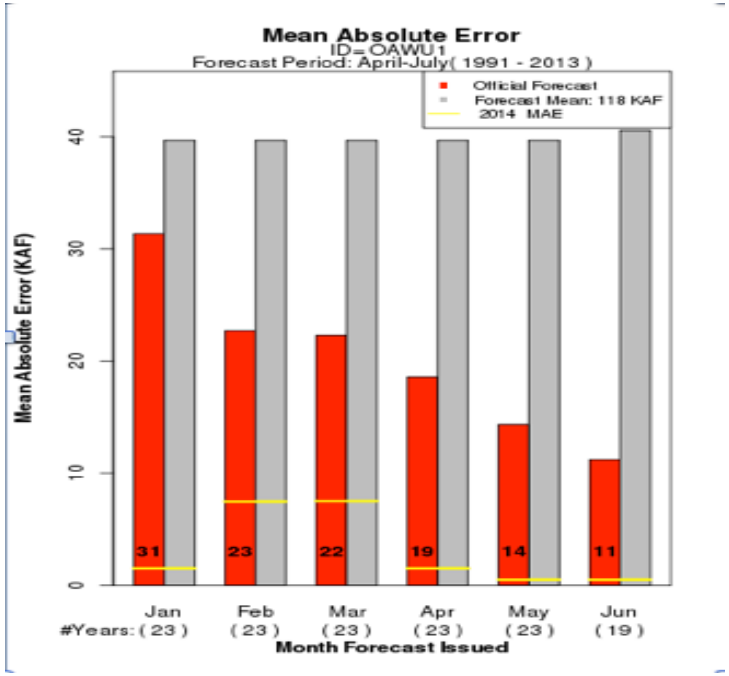


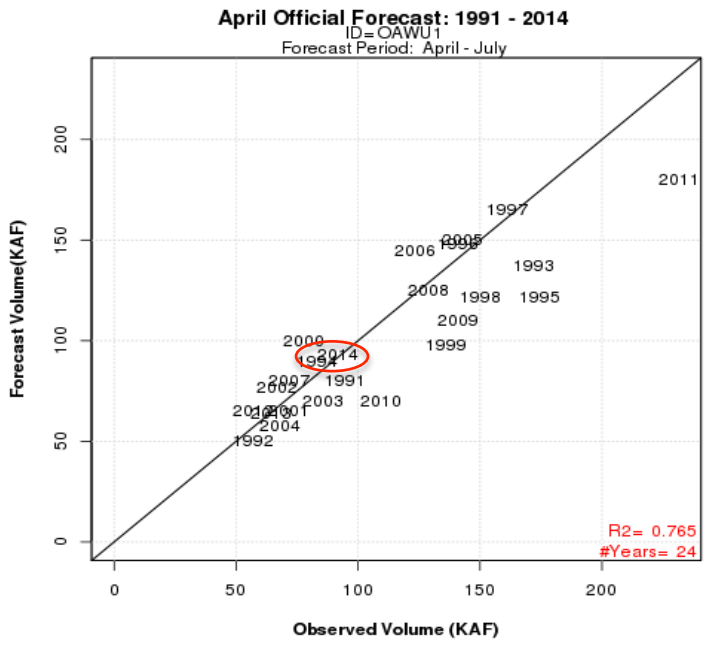




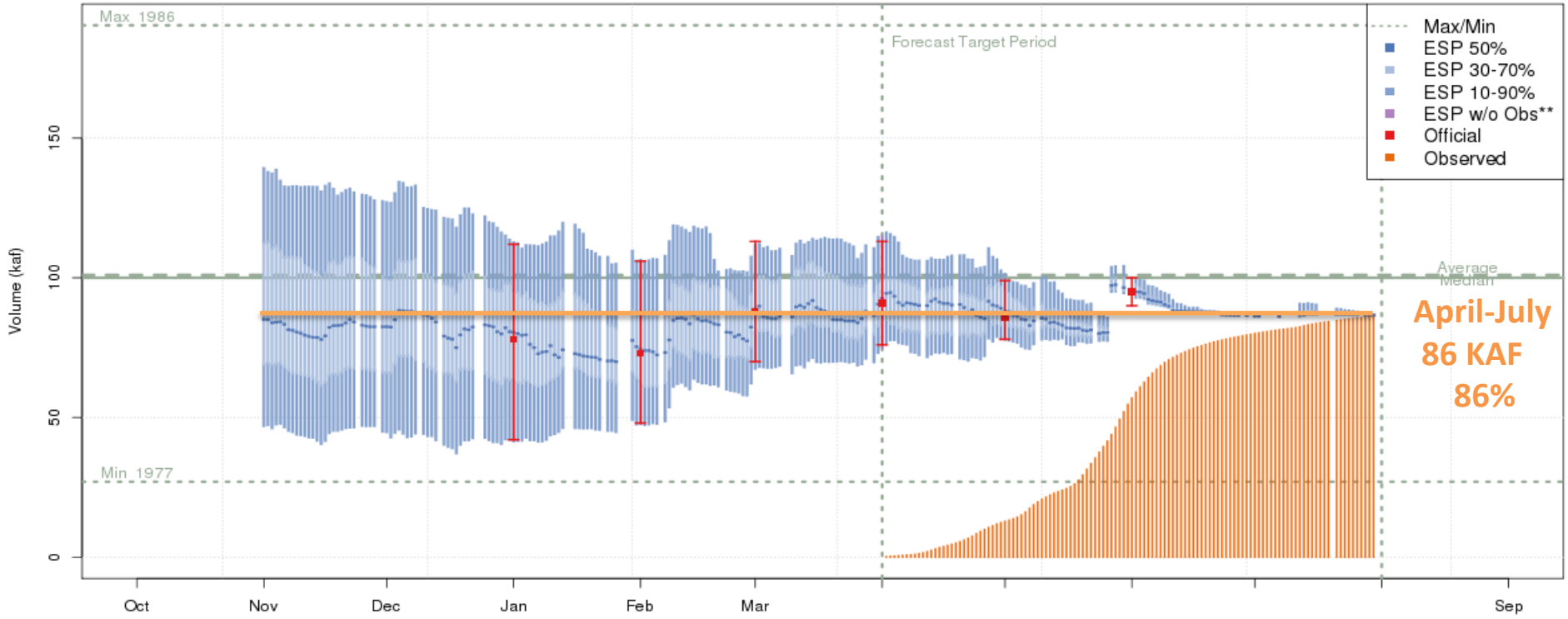
Great Basin: Weber River at Oakley

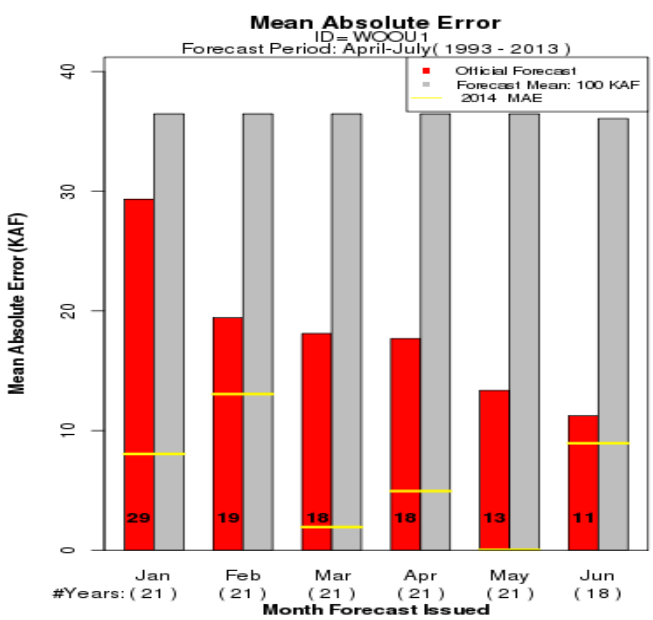


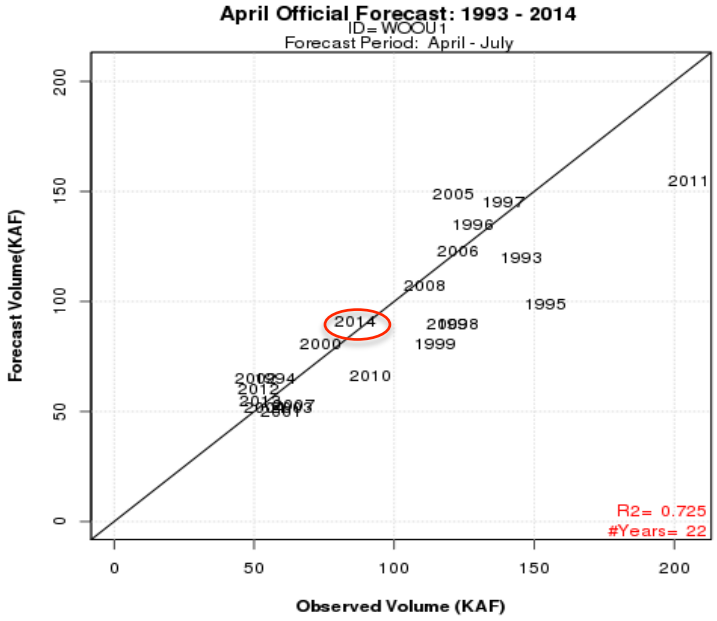




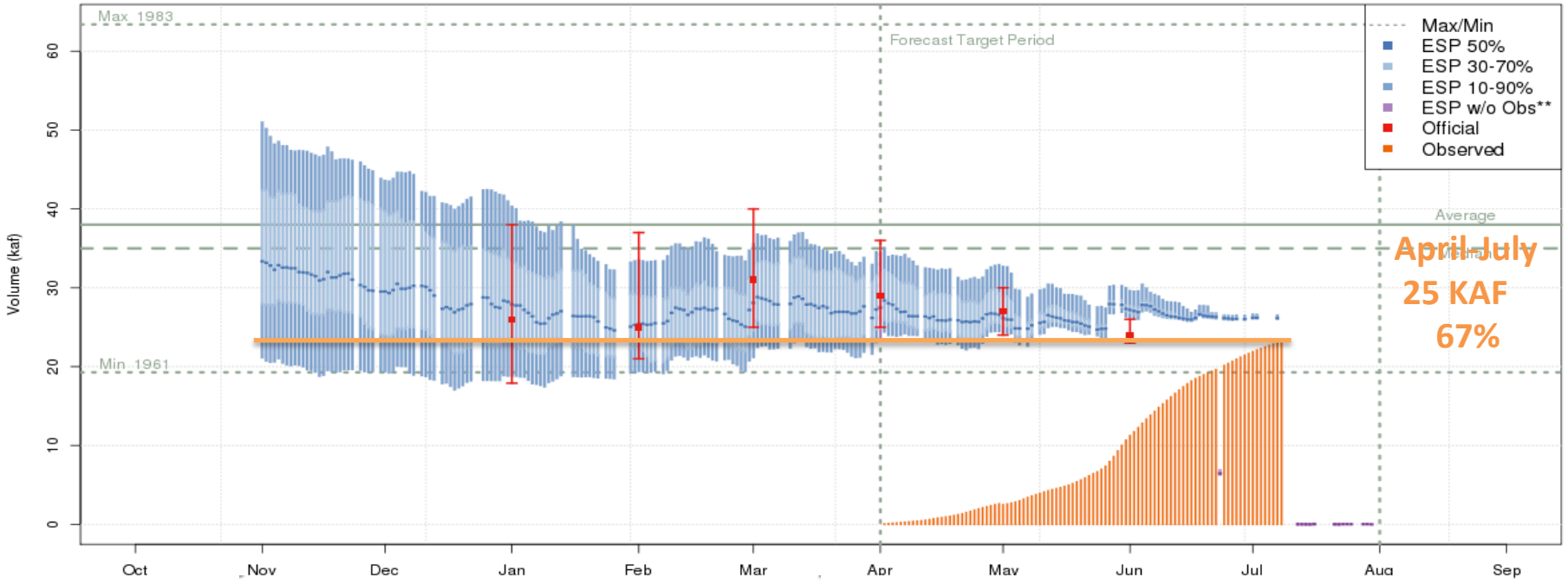
Great Basin: Provo near Woodland

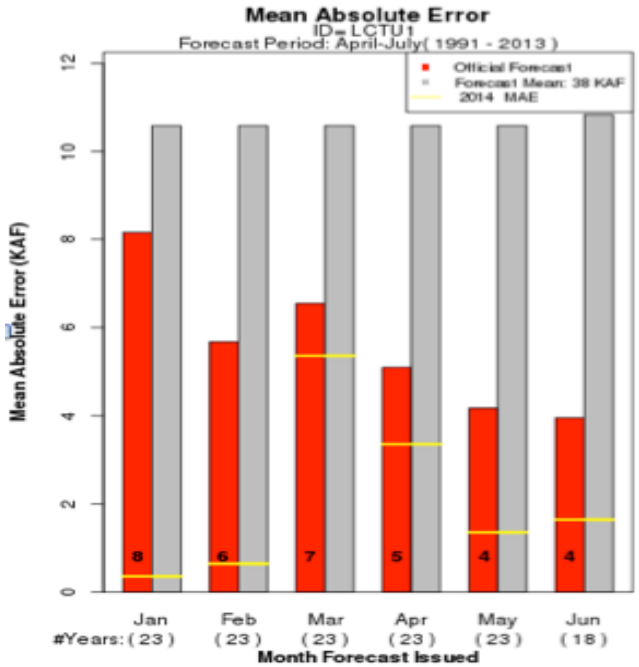


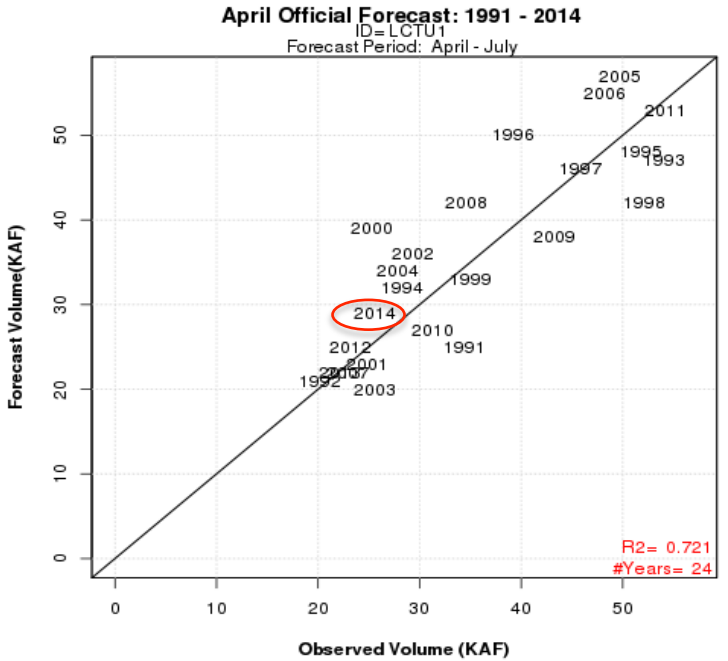




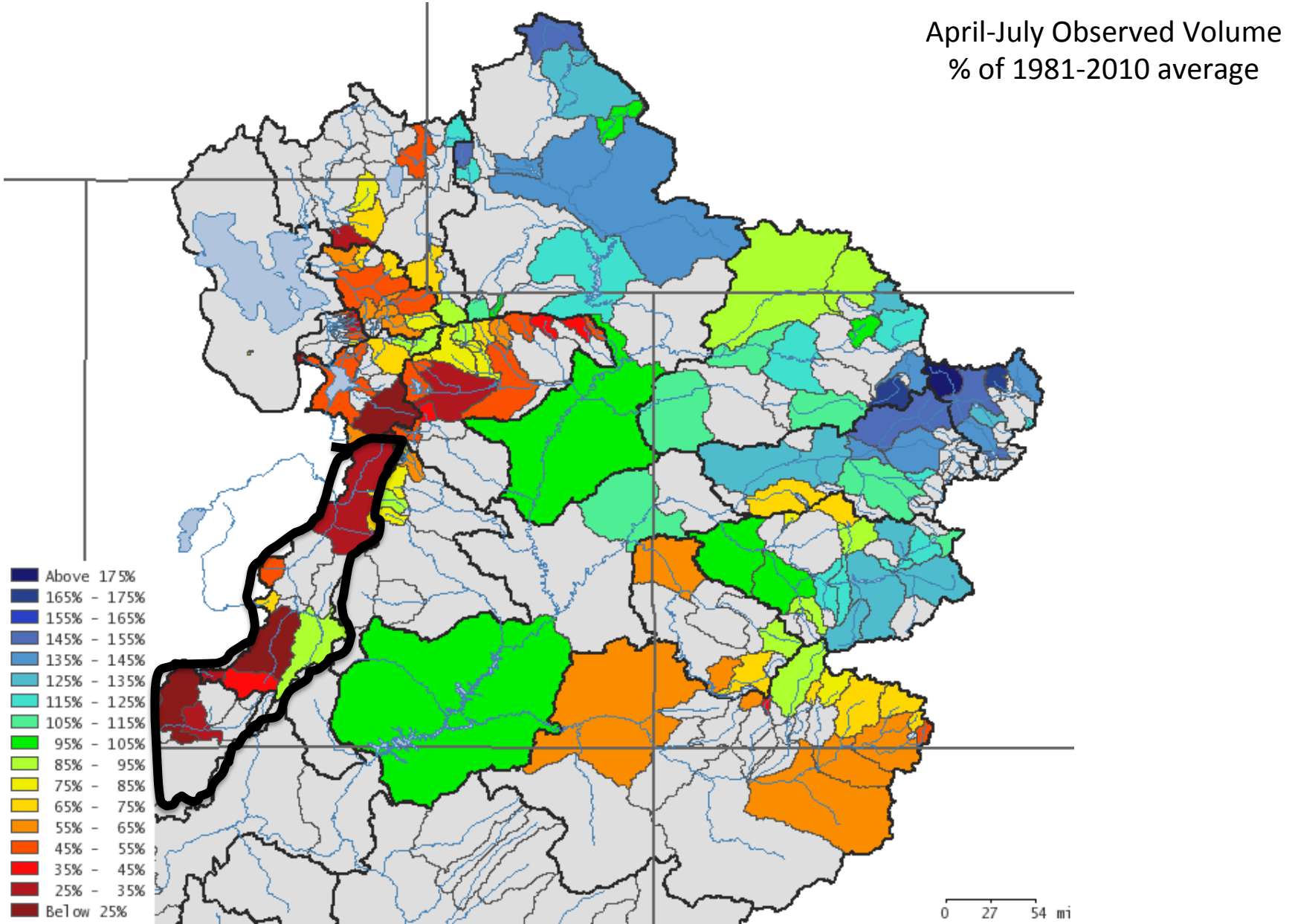
Great Basin: Little Cottonwood Creek near SLC



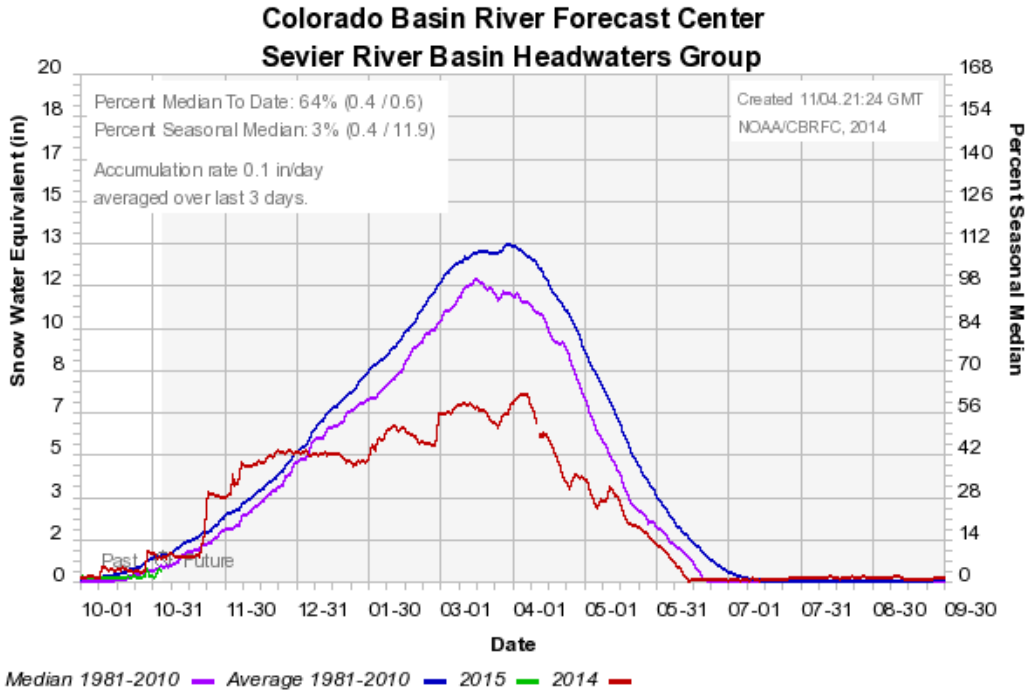


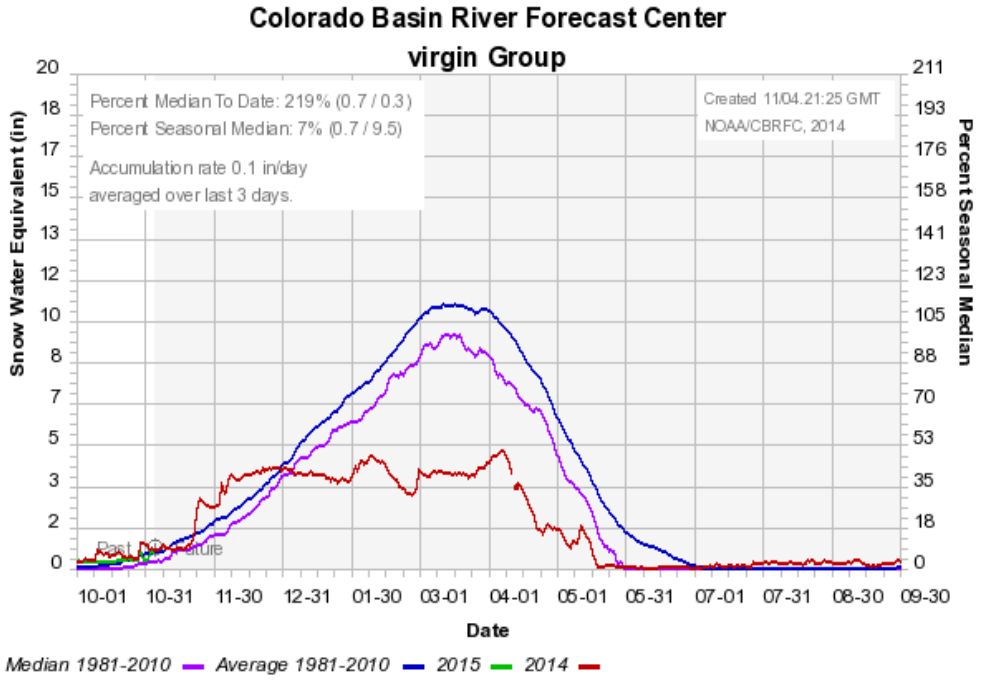


Forecast Performance: Sevier & Virgin

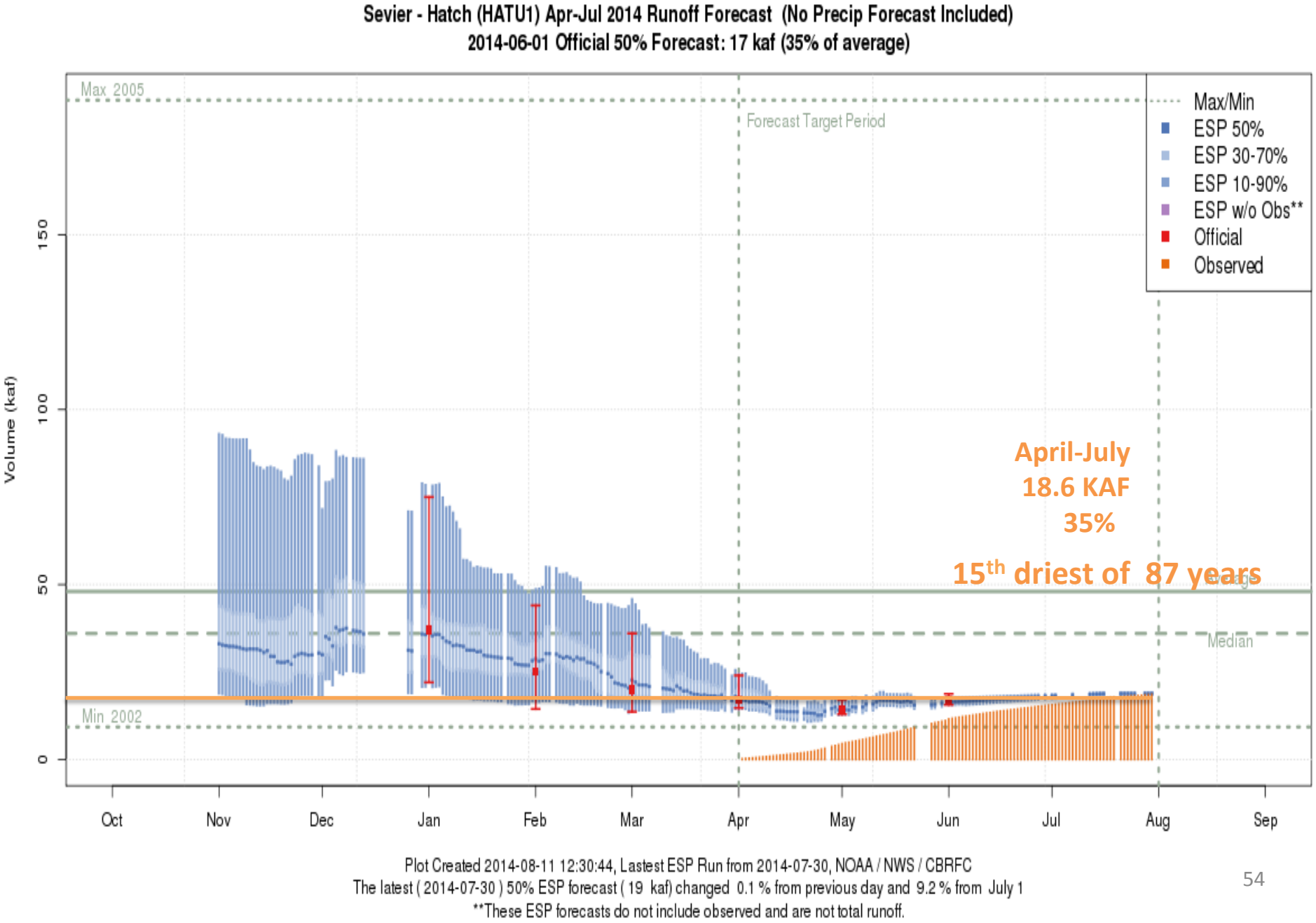


Sevier/Virgin River: Snow Conditions

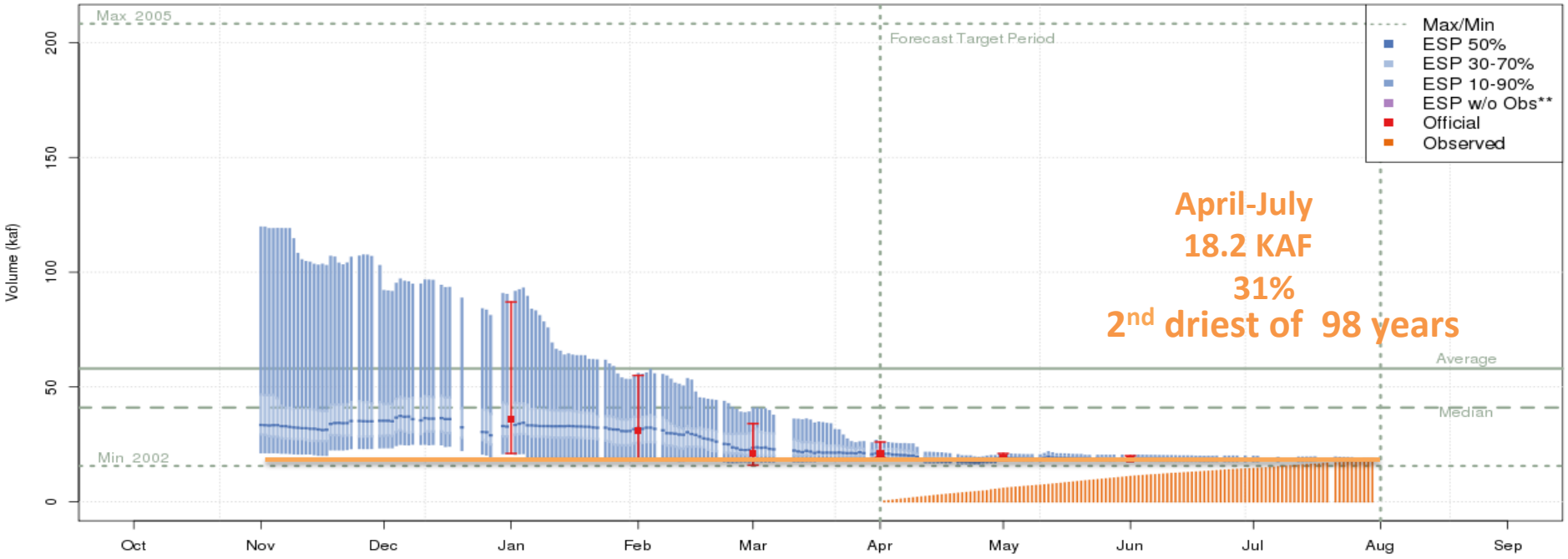




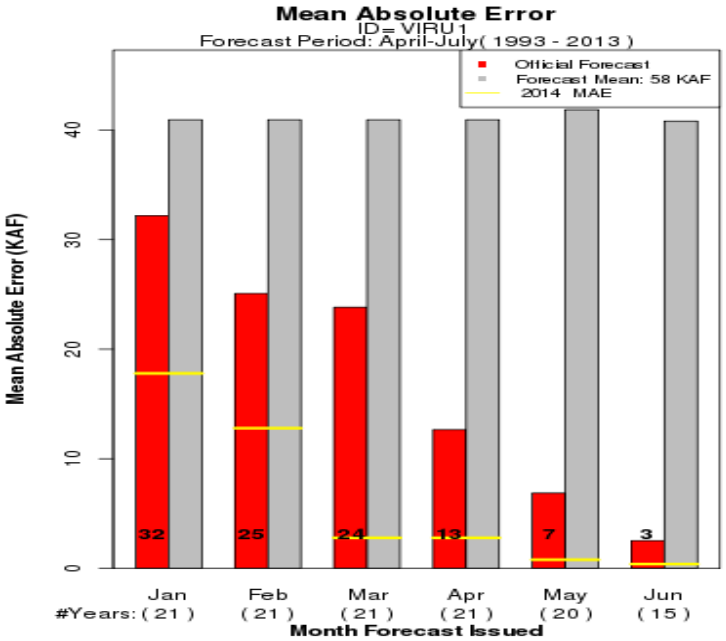
Sevier: Sevier at Hatch

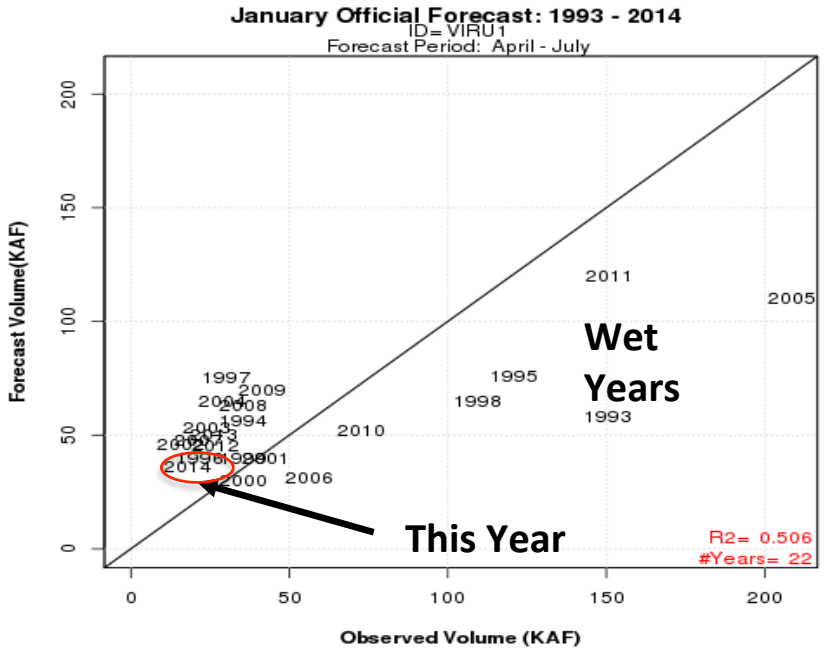


Virgin: Virgin at Virgin

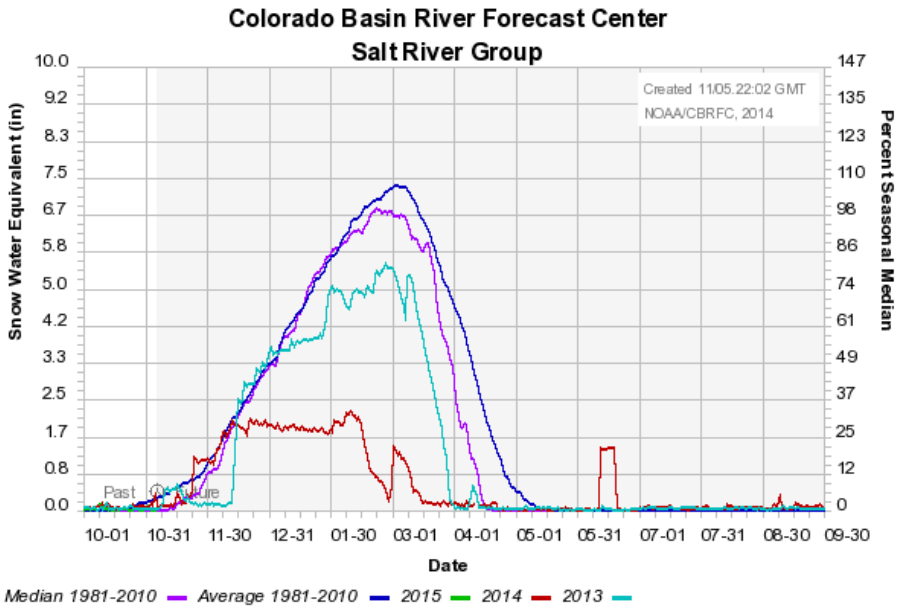


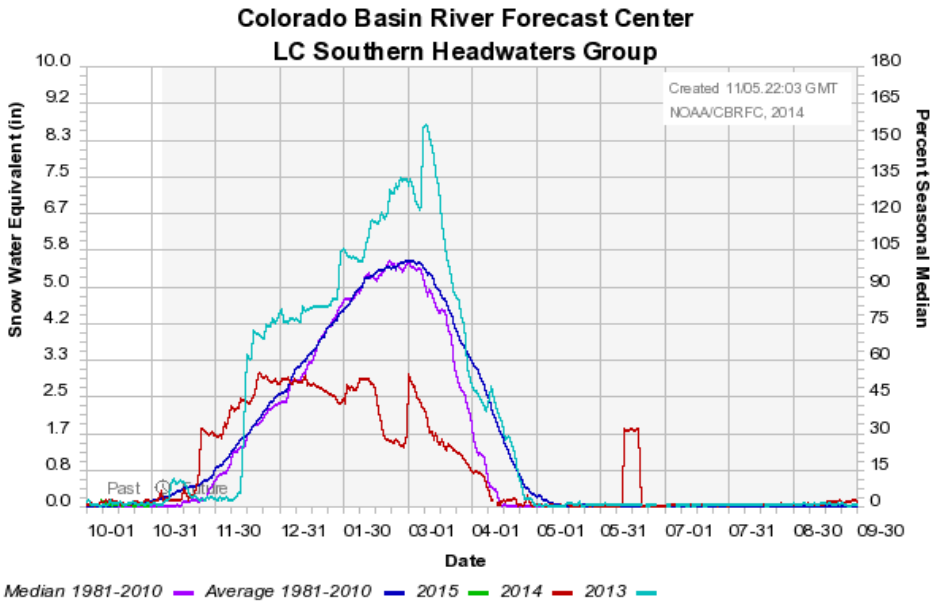
April-July
18.2 KAF
31%
2nd driest of 98 years

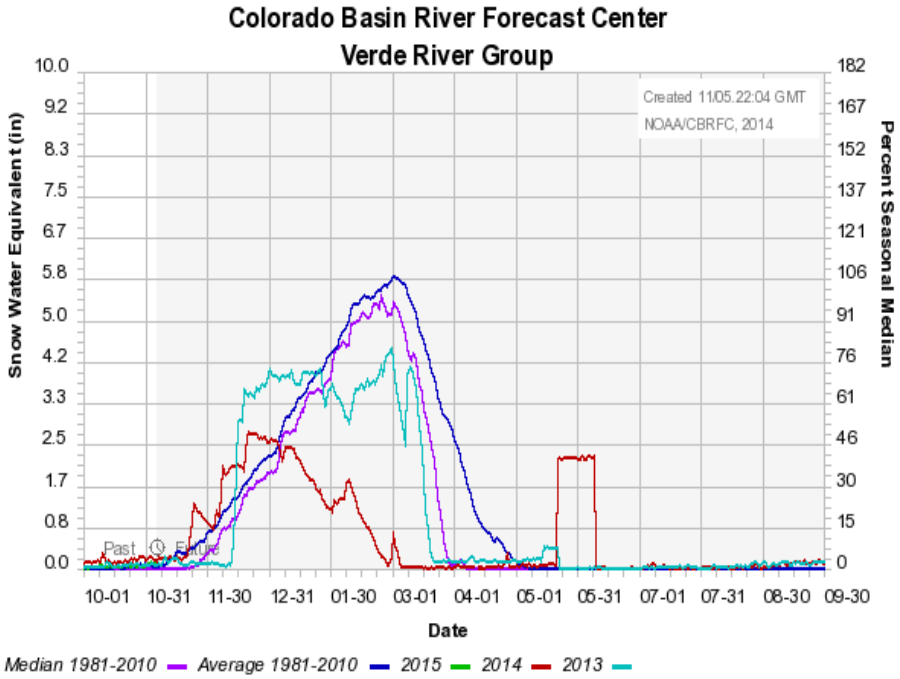


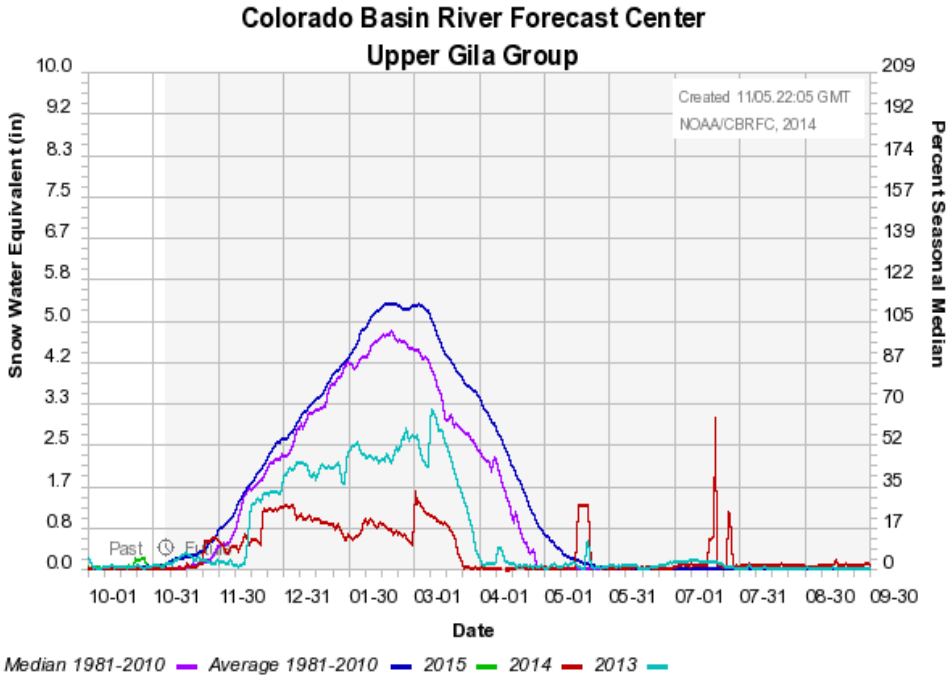


Lower Colorado River Basin: Snow Conditions



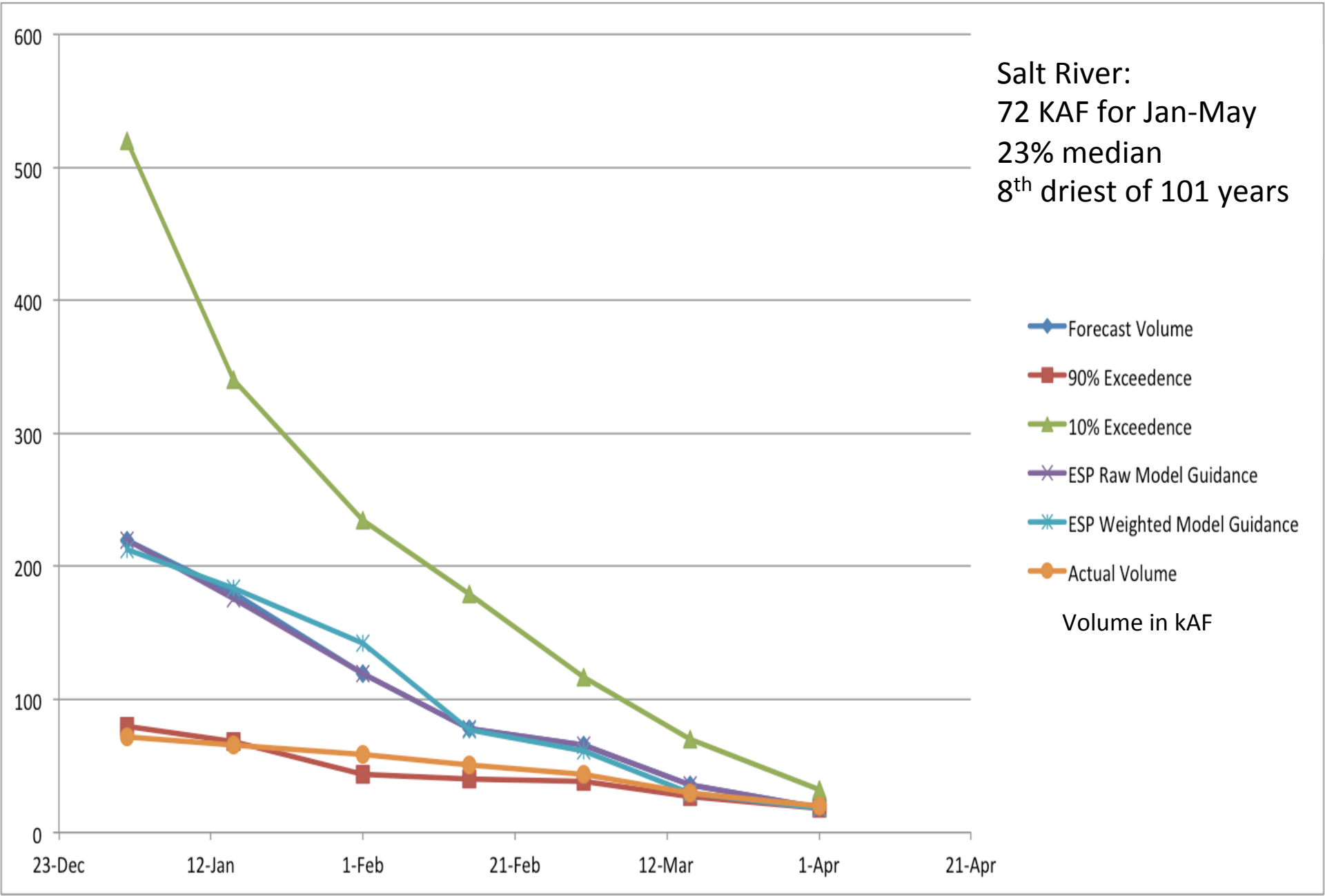






SALT – ROOSEVELT: 2014 CBRFC-NRCS COORDINATED FORECASTS

Progressive Forecast Period (Forecast Issue Date through May)



2014 Verification Takeaways:

Forecast signal was generally correct (Below, Above average)

Majority of April 1st forecasts beat the historical error (Nailed some: Granby, Blue Mesa, etc.)

High soil moisture areas were more problematic (missed some 90% exceedance levels)

Some forecasts errors increased between April to May and June (why?)

San Juan generally too high early in the season (10 of last 12 years)

Purpose of Verification Process:

Follow up where we did worse than the mean error

Identify those forecast errors over which we have control

Develop a path for improvement

Forecast Errors – What parameters can we identify and improve upon?

Errors we have some control over (Initial Model States)

Soil Moisture – Was it too high in some areas ?

- Taylor Park (Upper Gunnison)
- Yellowstone Drainage (Uinta Range)
- Dolores River Basin
- Parts of the San Juan

Snow Areal Extent (How accurate at mid/low elevations?)

- Taylor Park (Upper Gunnison)
- Dolores River Basin

Quality of Data Inputs – (Network Dependent, Impact snow model states accuracy)

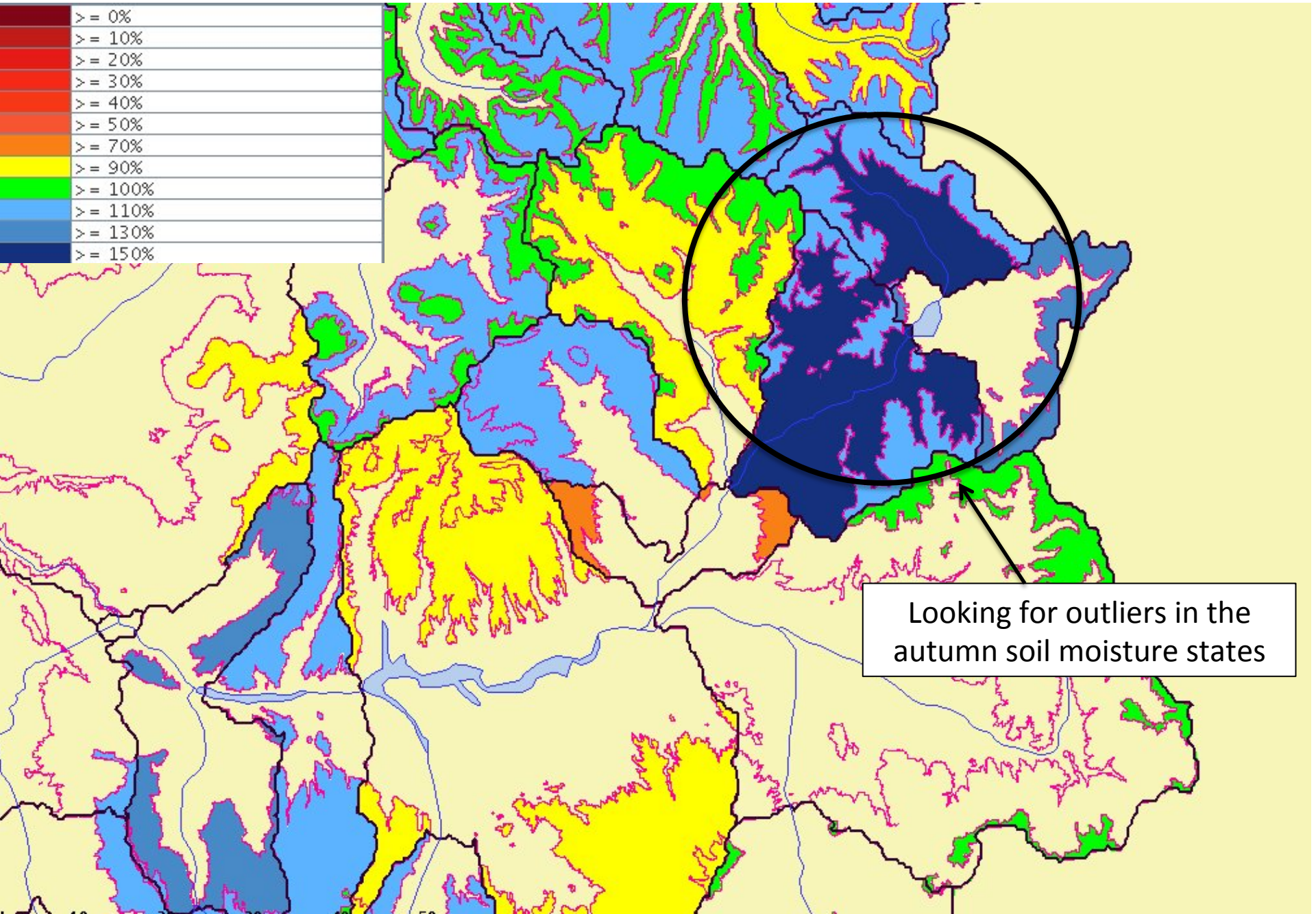
Errors we have little or no control over (Future events)

Dust in some areas (investigating impacts and possible application)

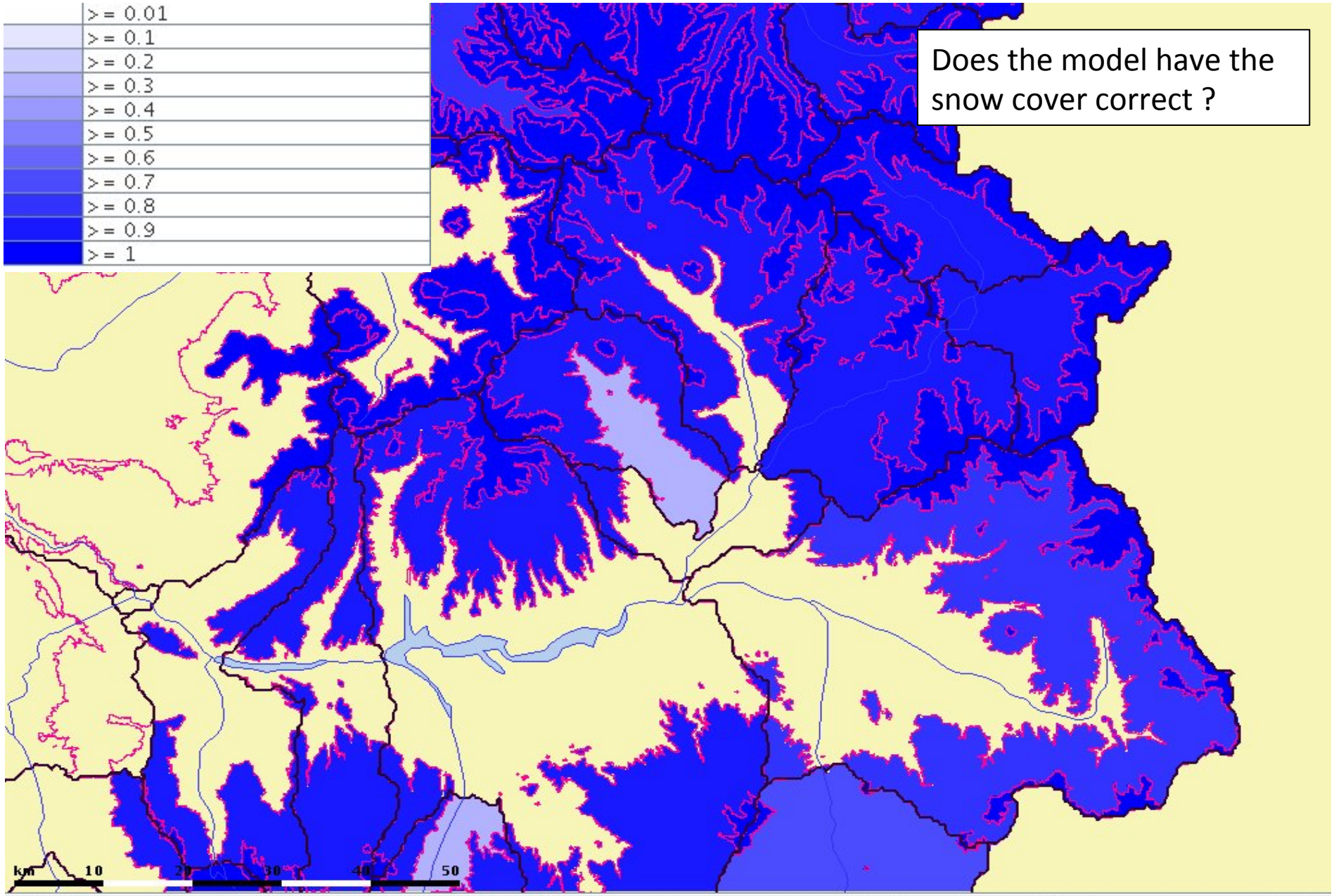
Paradigm shift in the San Juan ? (Higher frequency of dry spring weather?)

Future Weather (can be a large error source if initial states correct)

Initial Base-Flow (Lower Soil Moisture) conditions in the fall season



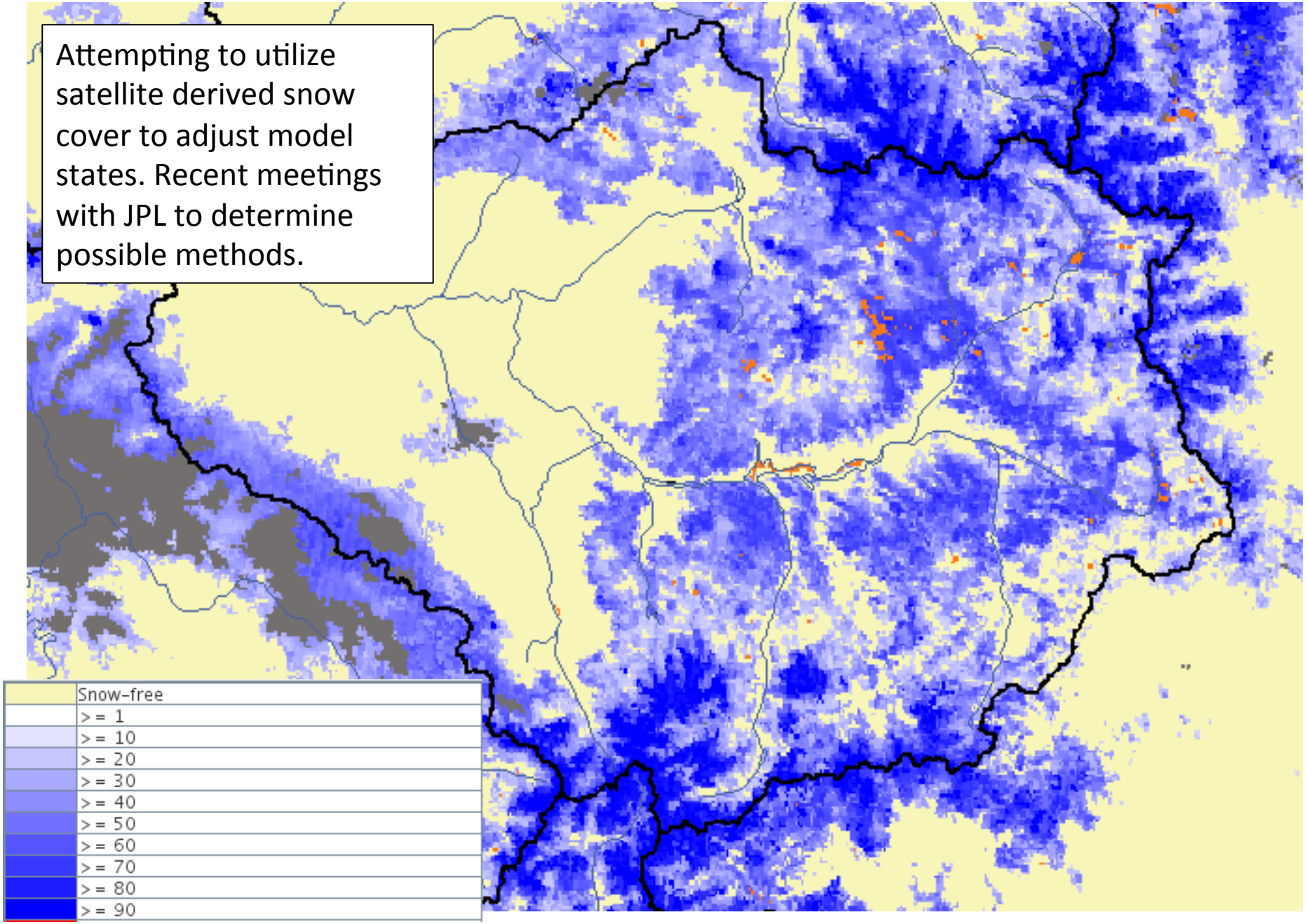
Model snow cover (100% coverage)

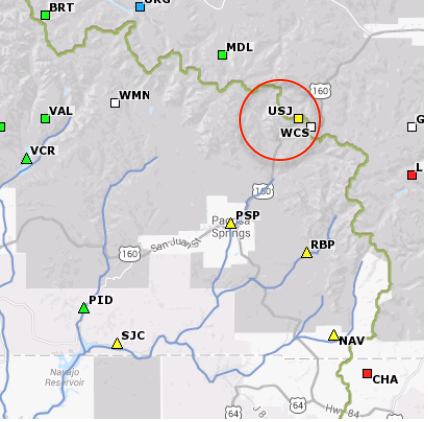


Satellite Derived Snow Cover

April 9 2014

Attempting to utilize satellite derived snow cover to adjust model states. Recent meetings with JPL to determine possible methods.

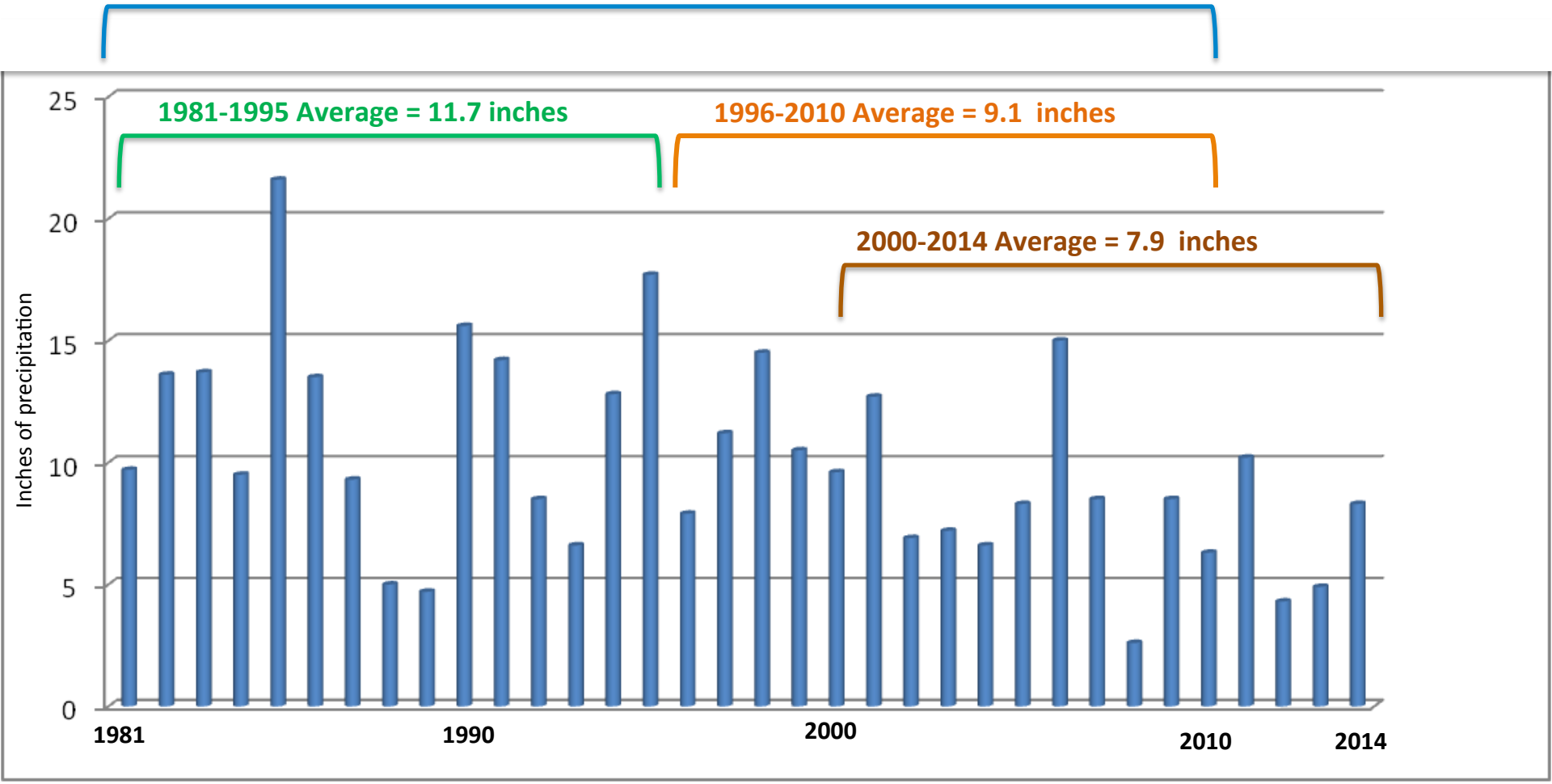


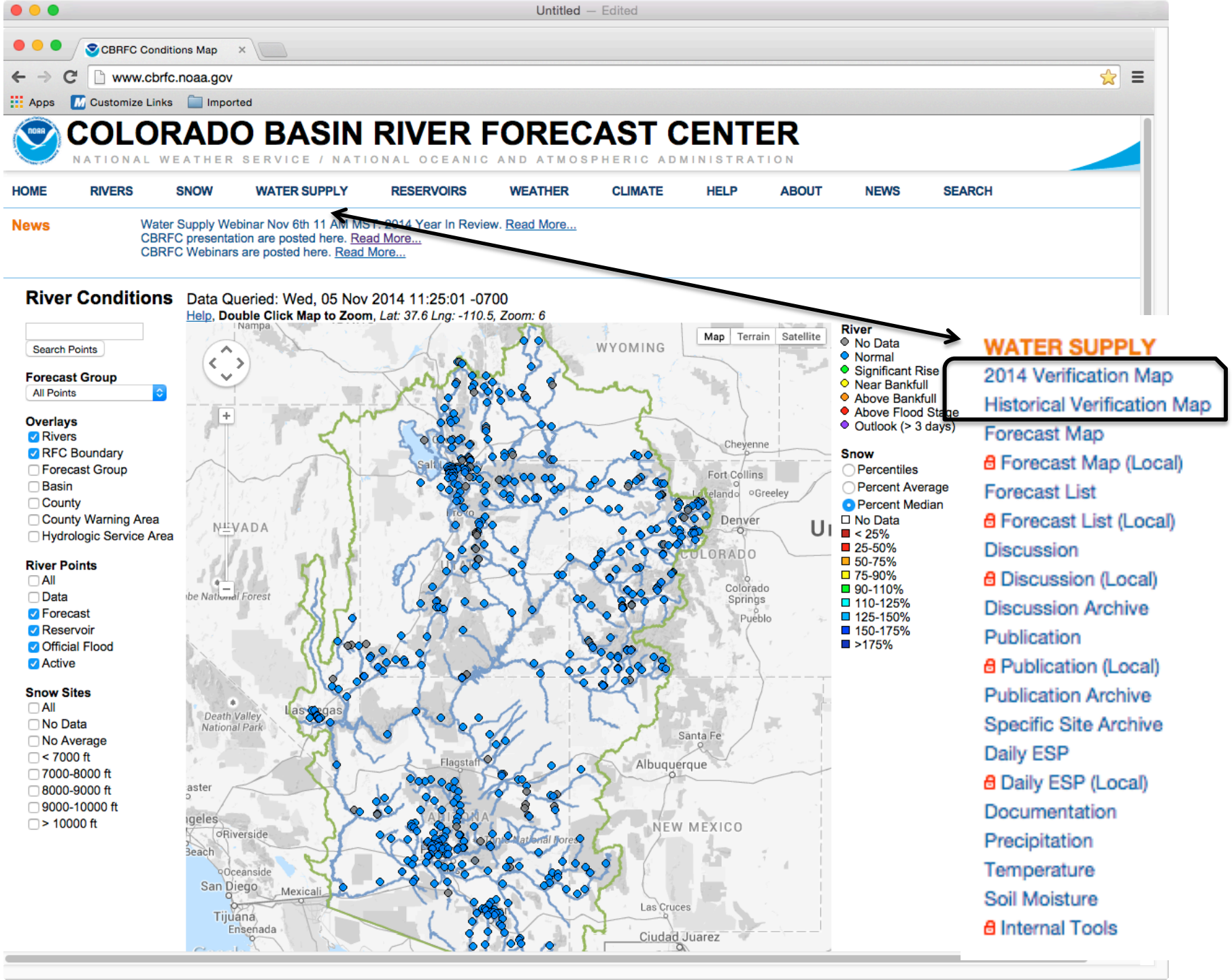


Upper San Juan SNOTEL
March-April Precipitation
1981-2014

How do you account for dryer spring weather if that is the trend ?

1981-2010 Average = 10.4 inches

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CBRFC Conditions Map
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NATIONAL WEATHER SERVICE / NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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SNOW
WATER SUPPLY
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Water Supply Webinar Nov 6th 11 AM MST. 2014 Year In Review. Read More...
CBRFC presentation are posted here. Read More...
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River Conditions
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Forecast Group
All Points
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RFC Boundary
Forecast Group
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County Warning Area
Hydrologic Service Area
River Points
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Forecast
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Official Flood
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Snow Sites
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Map
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Satellite
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COLORADO
NEW MEXICO
Cheyenne
Fort Collins
Greeley
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Colorado Springs
Pueblo
Las Vegas
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Flagstaff
Santa Fe
Albuquerque
Riverside
Oceanside
San Diego
Mexicali
Tijuana
Ensenada
Las Cruces
Ciudad Juarez
River
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Above Bankfull
Above Flood Stage
Outlook (> 3 days)
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Percent Median
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25-50%
50-75%
75-90%
90-110%
110-125%
125-150%
150-175%
>175%
WATER SUPPLY
2014 Verification Map
Historical Verification Map
Forecast Map
Forecast Map (Local)
Forecast List
Forecast List (Local)
Discussion
Discussion (Local)
Discussion Archive
Publication
Publication (Local)
Publication Archive
Specific Site Archive
Daily ESP
Daily ESP (Local)
Documentation
Precipitation
Temperature
Soil Moisture
Internal Tools

Upcoming Webinars

December 9th – Brief Verification Recap
Initial Water Supply Conditions
Early Outlook (General)
Any changes to our web page

2015 Water Supply Webinars

Thursday January 8th	11 am MT
Thursday February 5th	1 pm MT
Thursday March 5th	1 pm MT
Tuesday April 7th	11 am MT
Thursday May 7th	11 am MT