2014 Verification Recap & Early Look At 2015

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Colorado Basin River Forecast Center

Dec 9th 2014

Webinar Outline

2014 verification recap (from Nov Webinar)

Conditions entering the winter season
- Fall Precipitation
- Soil Moisture
- Stream flow
- Snow

Early look at 2015 Apr-July runoff (model guidance)

Weather Outlook

Water supply webinar schedule

Why Verify ?

Allows us to develop a path for improvement.

Identify where we need to follow up and improve forecast process, model calibration.

Annual review how the forecast error compares to the long term mean.

Can we identify the forecast error ?

Error Characterization :

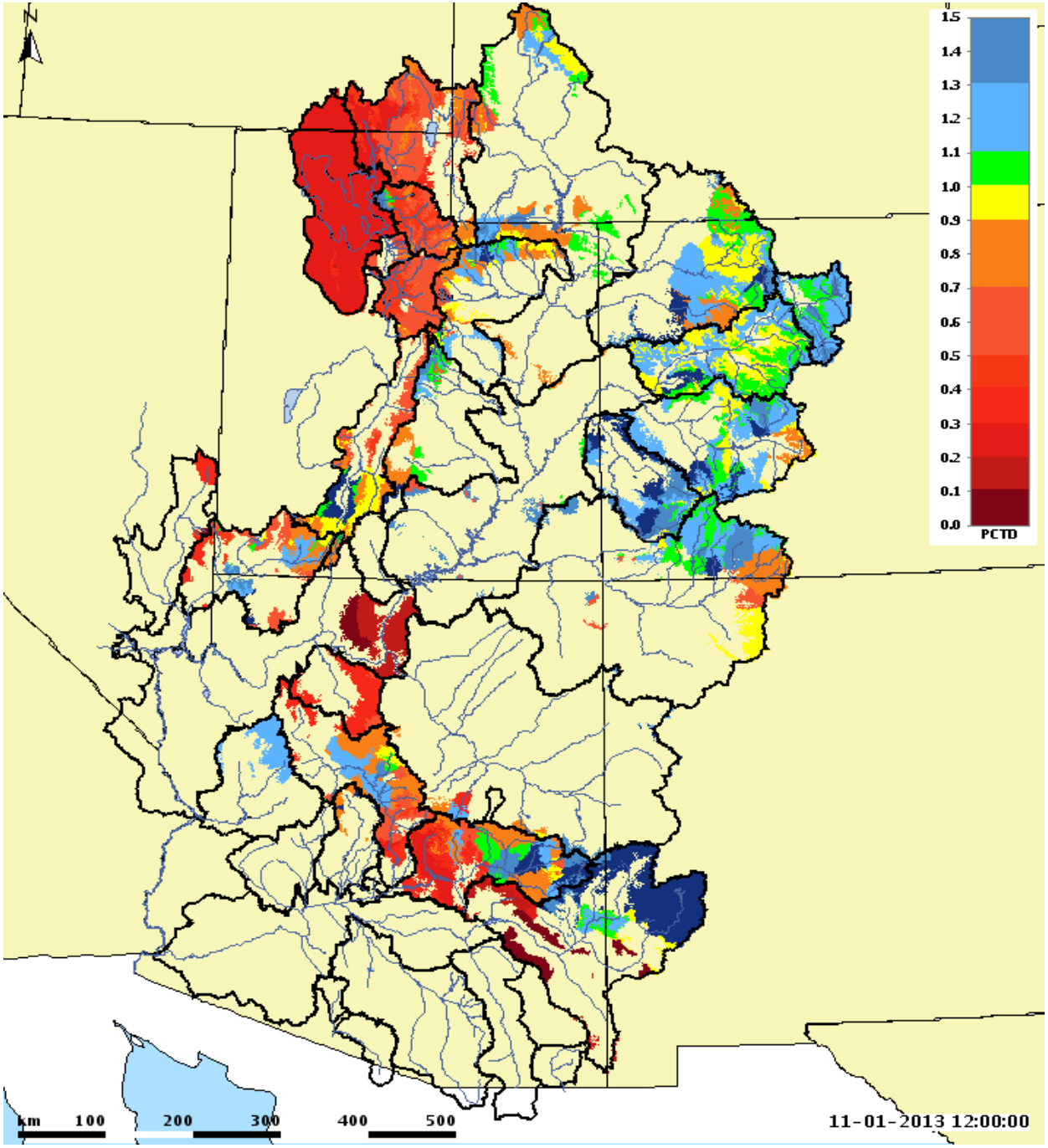
Some control – Model States (soil moisture, snow extent, data inputs), etc.

No control – future weather, data network density, changing climate, etc.

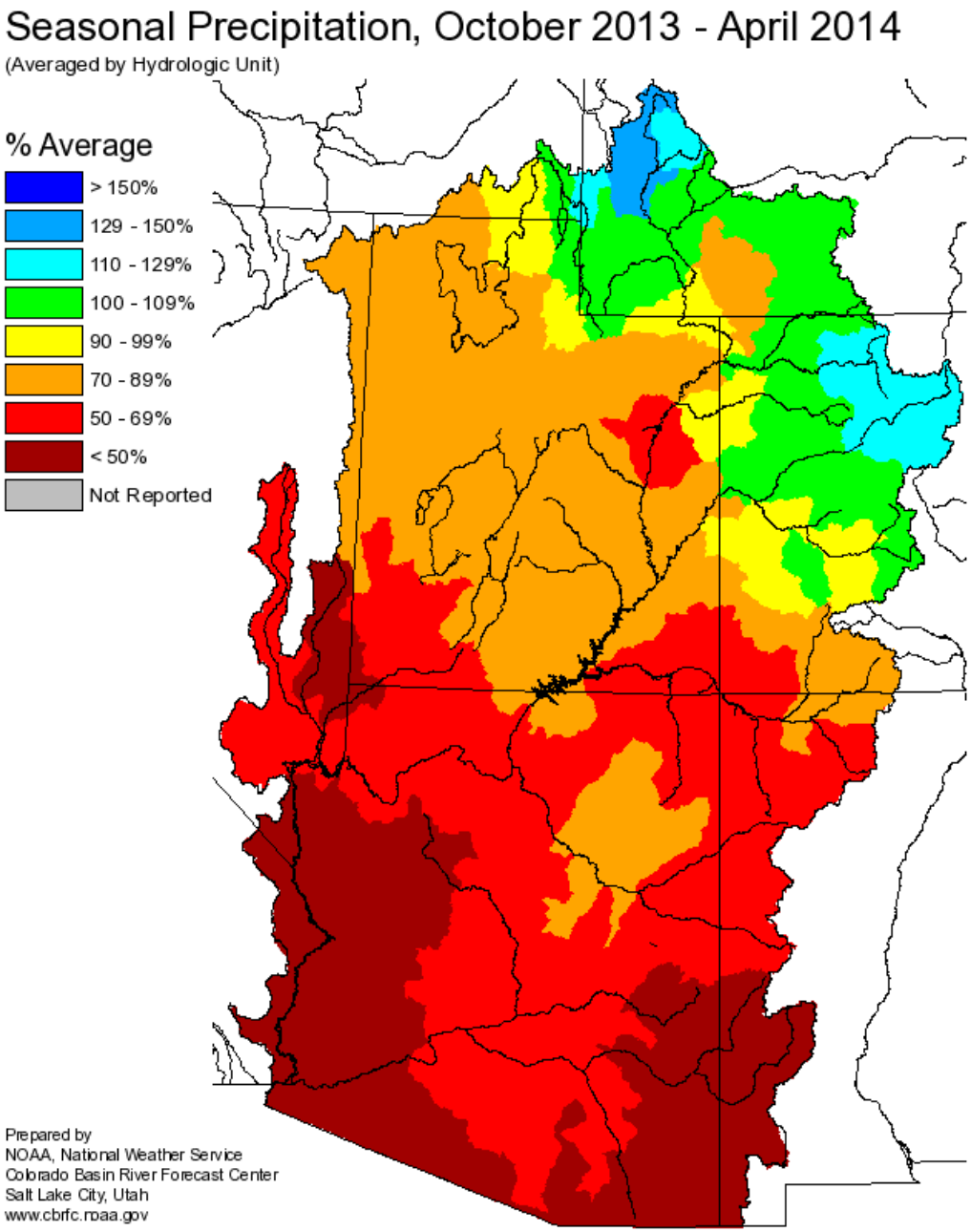
Soil Moisture Entering the 2013-2014 Winter Season

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

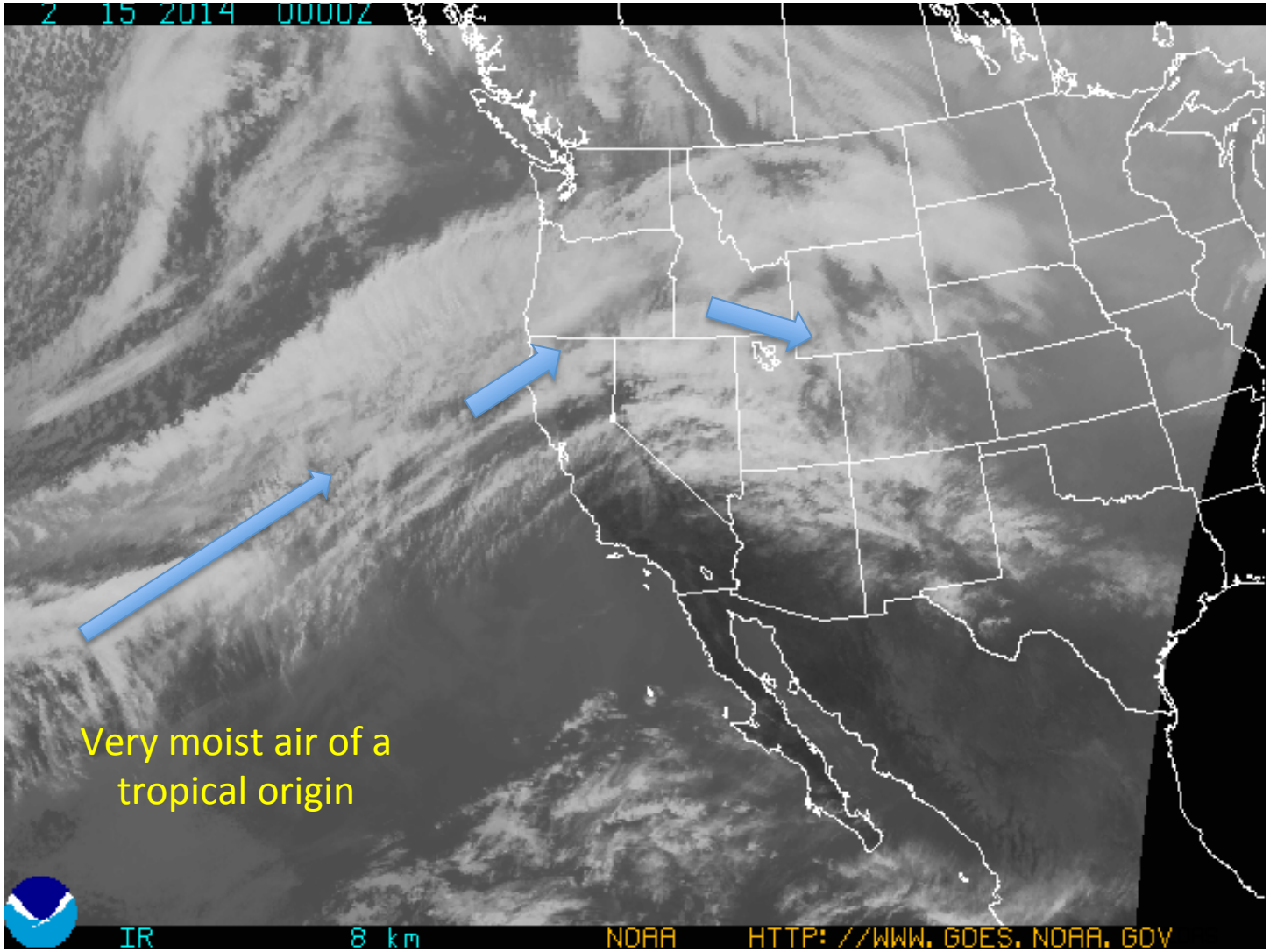
<u>Negative effect:</u>
Great Basin
Virgin River
Lower Colorado (Salt, Verde)



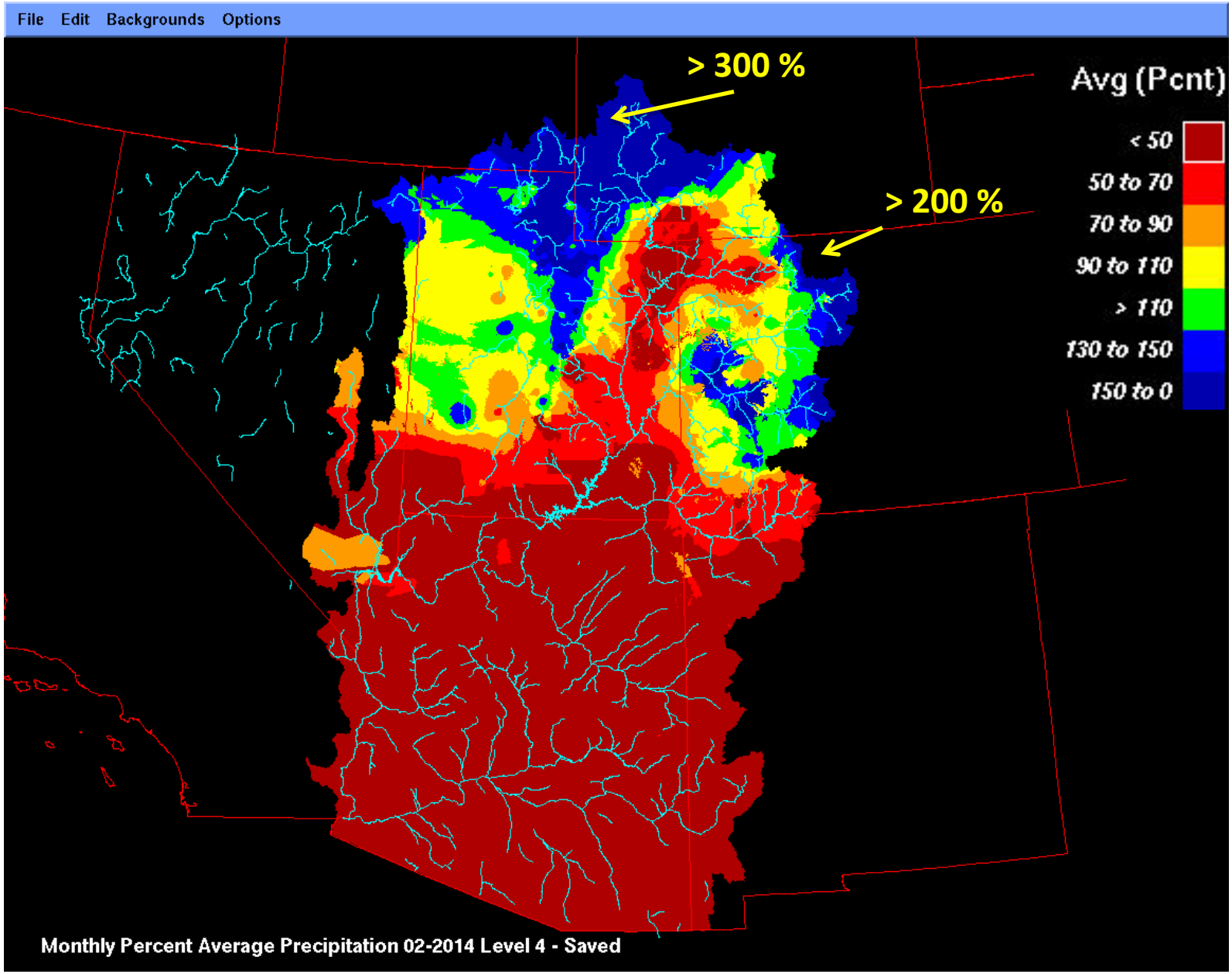
Precipitation



February 2014 had a large impact on forecasts

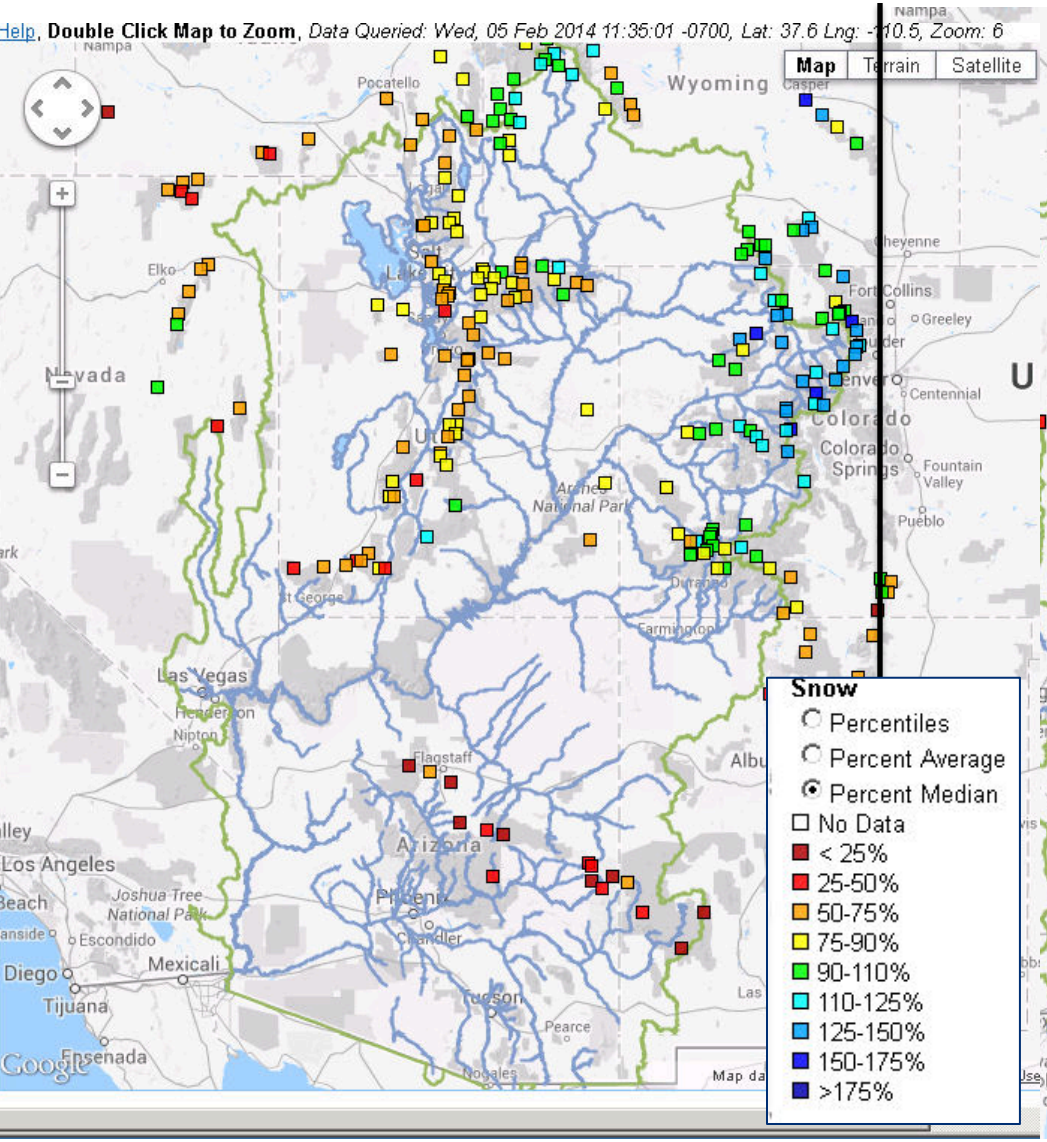


February 2014 Precipitation Percent of Average

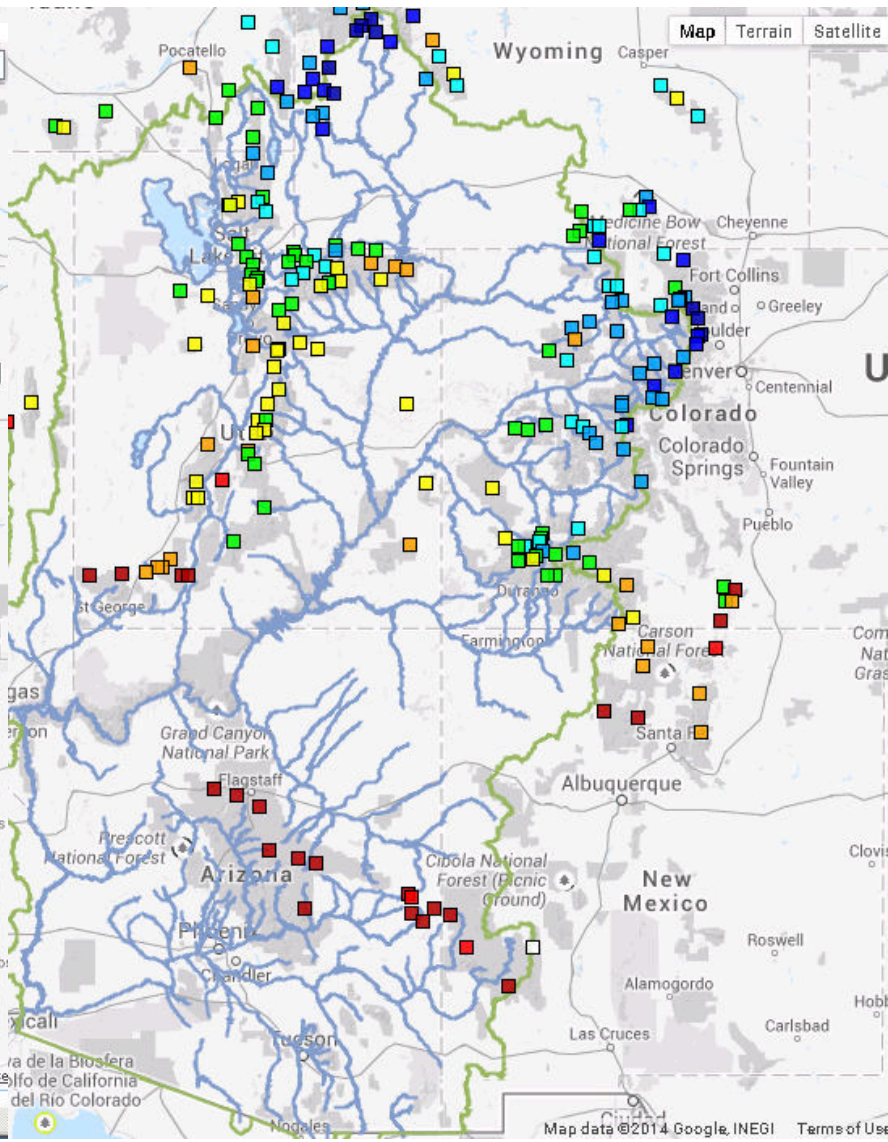


Snow (note the increase in the upper Green, Bear, and parts of Colorado)

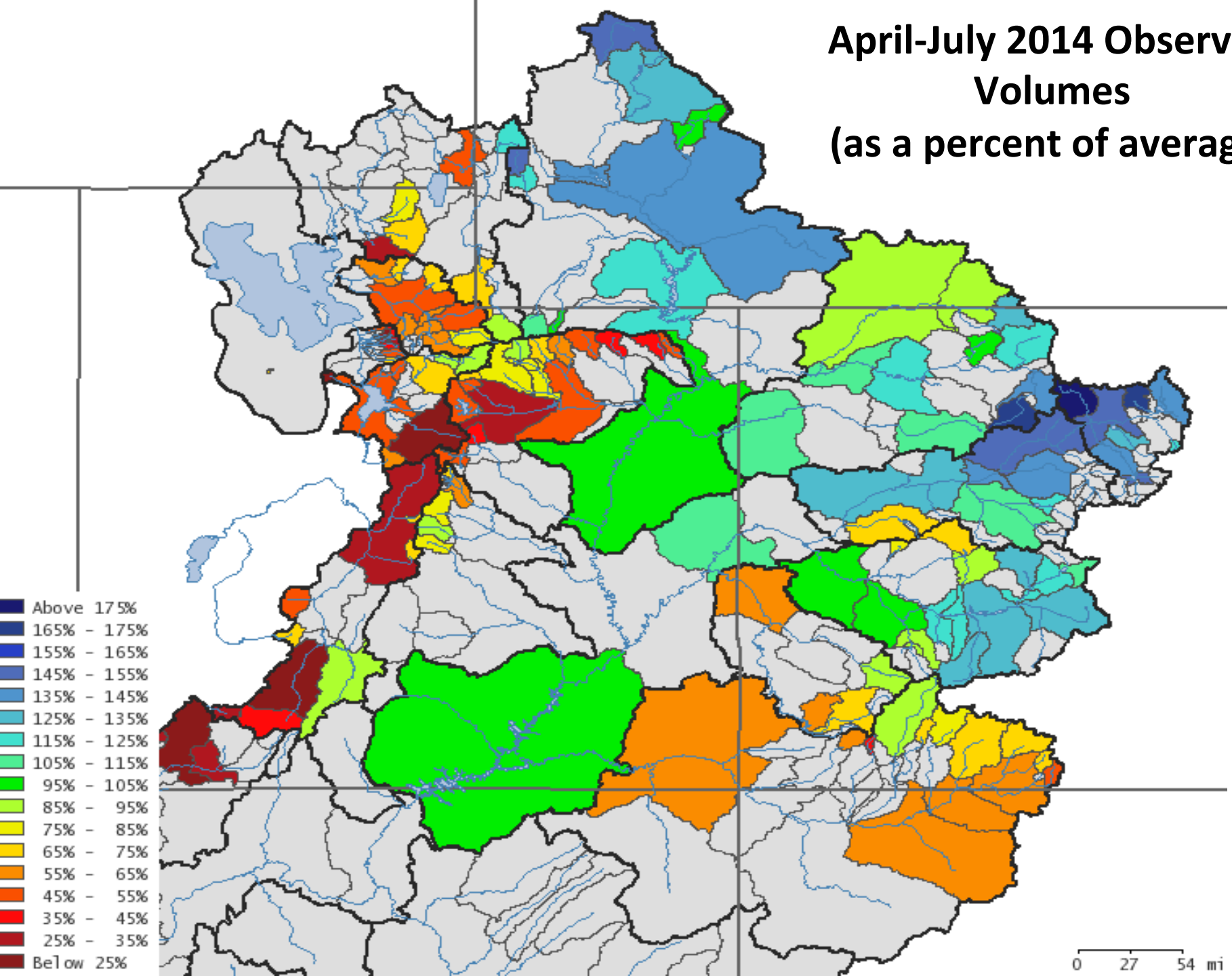
February 5th Snow



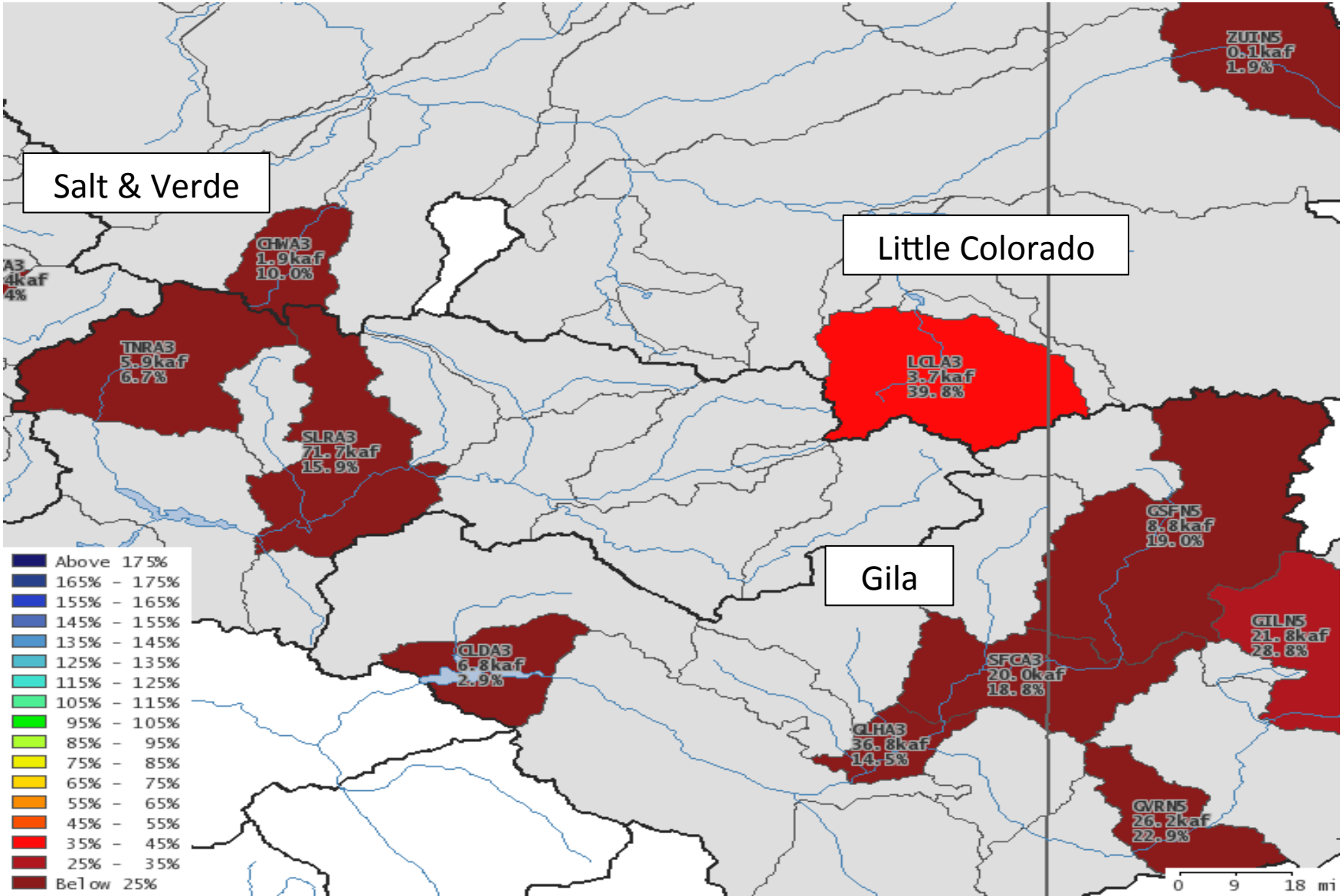
March 5th Snow



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

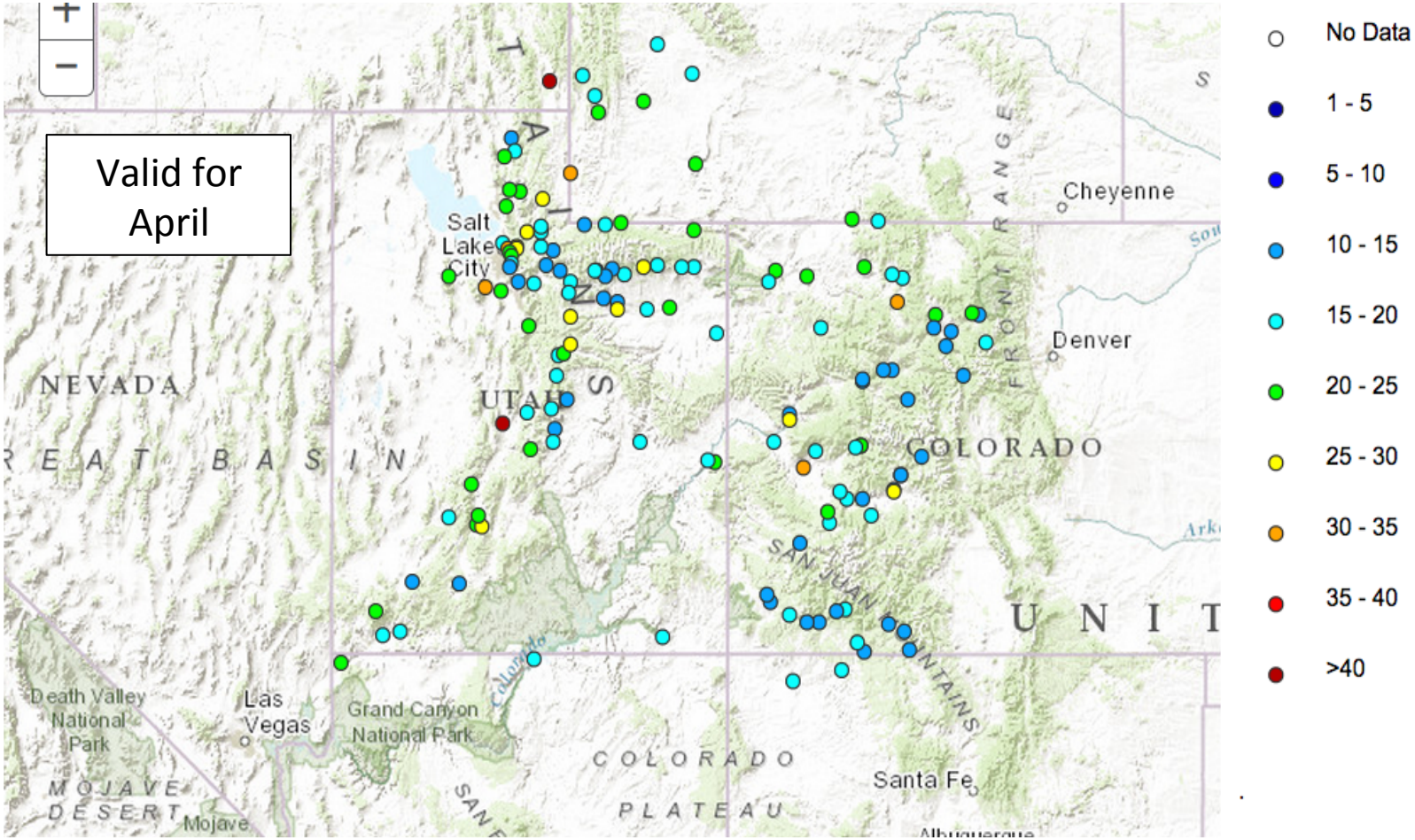


Jan-May 2014 Observed Volumes (as a percent of median)



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

Mar
Apr
May
Jun

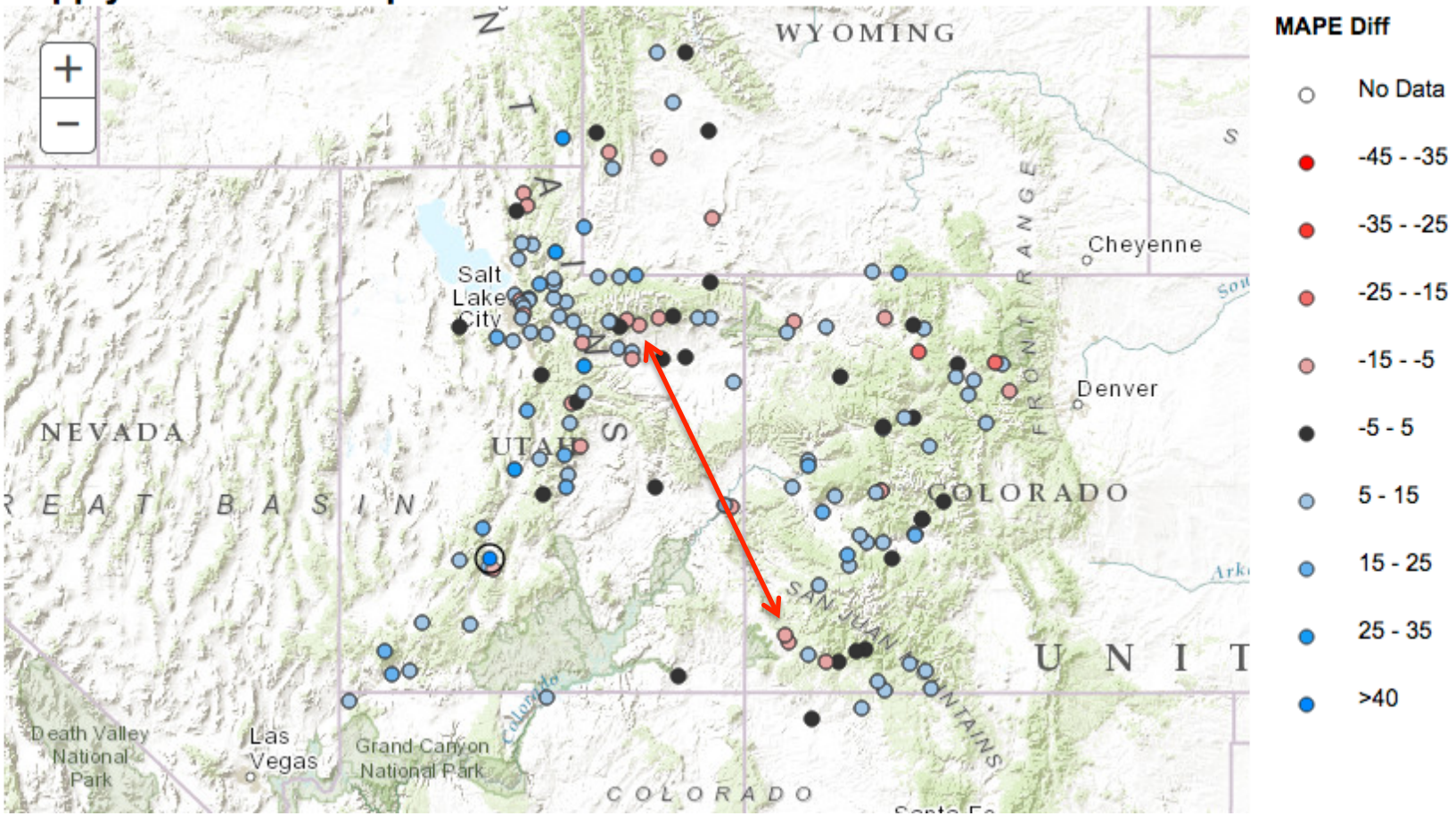


- Less error in higher elevation (i.e. headwater) locations
- Less error where snow melt is the primary source
- Less error where diversions are few or well known

New Verification Maps: 2014 Forecast Error vs Mean Model Error

2014 Water Supply Verification - Apr

Jan
Feb
Mar
Apr
May
Jun



Positive = 2014 Forecast performed BETTER

Negative = 2014 Forecasts performed WORSE

-5 to 5 = Normal

Untitled — Edited

CBRFC Conditions Map

www.cbrfc.noaa.gov

Apps | Customize Links | Imported

COLORADO BASIN RIVER FORECAST CENTER

NATIONAL WEATHER SERVICE / NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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News

Water Supply Webinar Nov 6th 11 AM MST. 2014 Year In Review. Read More...
CBRFC presentation are posted here. Read More...
CBRFC Webinars are posted here. Read More...

River Conditions

Data Queried: Wed, 05 Nov 2014 11:25:01 -0700

Help, **Double Click Map to Zoom**, *Lat: 37.6 Lng: -110.5, Zoom: 6*

Search Points

Forecast Group

All Points

Overlays

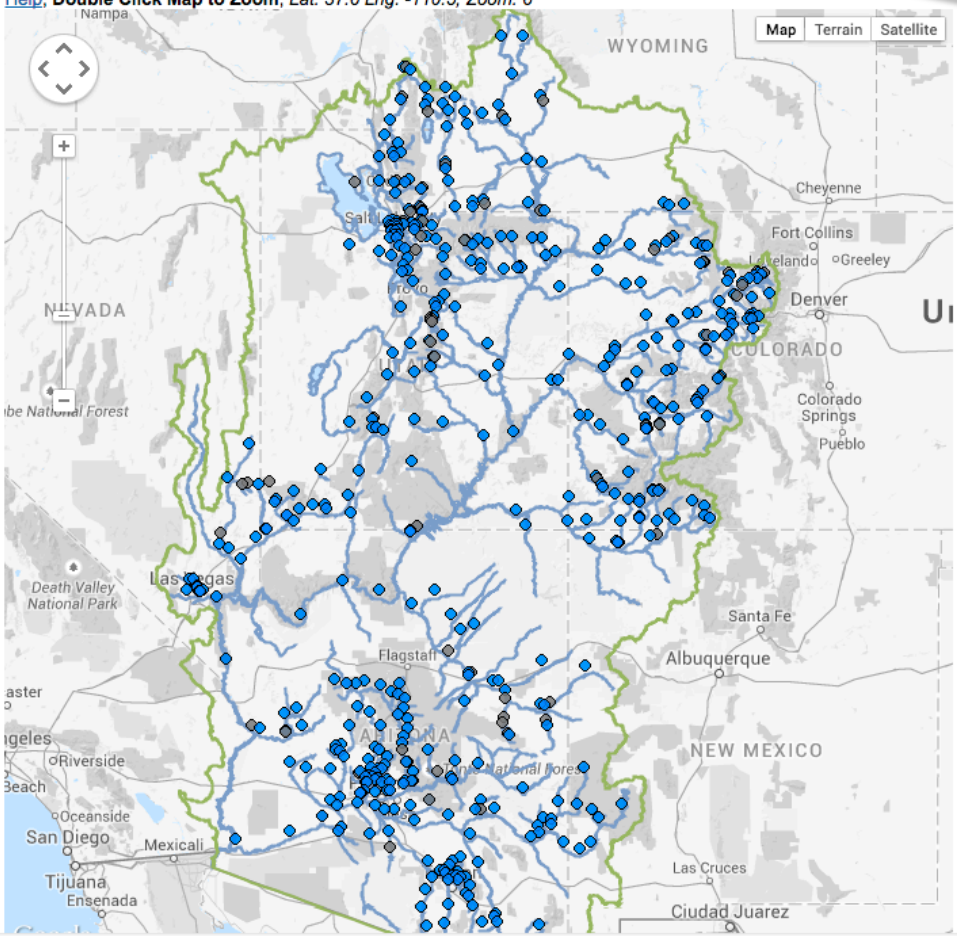
- [x] Rivers
- [x] RFC Boundary
- [ ] Forecast Group
- [ ] Basin
- [ ] County
- [ ] County Warning Area
- [ ] Hydrologic Service Area

River Points

- [ ] All
- [ ] Data
- [x] Forecast
- [x] Reservoir
- [x] Official Flood
- [x] Active

Snow Sites

- [ ] All
- [ ] No Data
- [ ] No Average
- [ ] < 7000 ft
- [ ] 7000-8000 ft
- [ ] 8000-9000 ft
- [ ] 9000-10000 ft
- [ ] > 10000 ft



River

- No Data
- Normal
- Significant Rise
- Near Bankfull
- Above Bankfull
- Above Flood Stage
- Outlook (> 3 days)

Snow

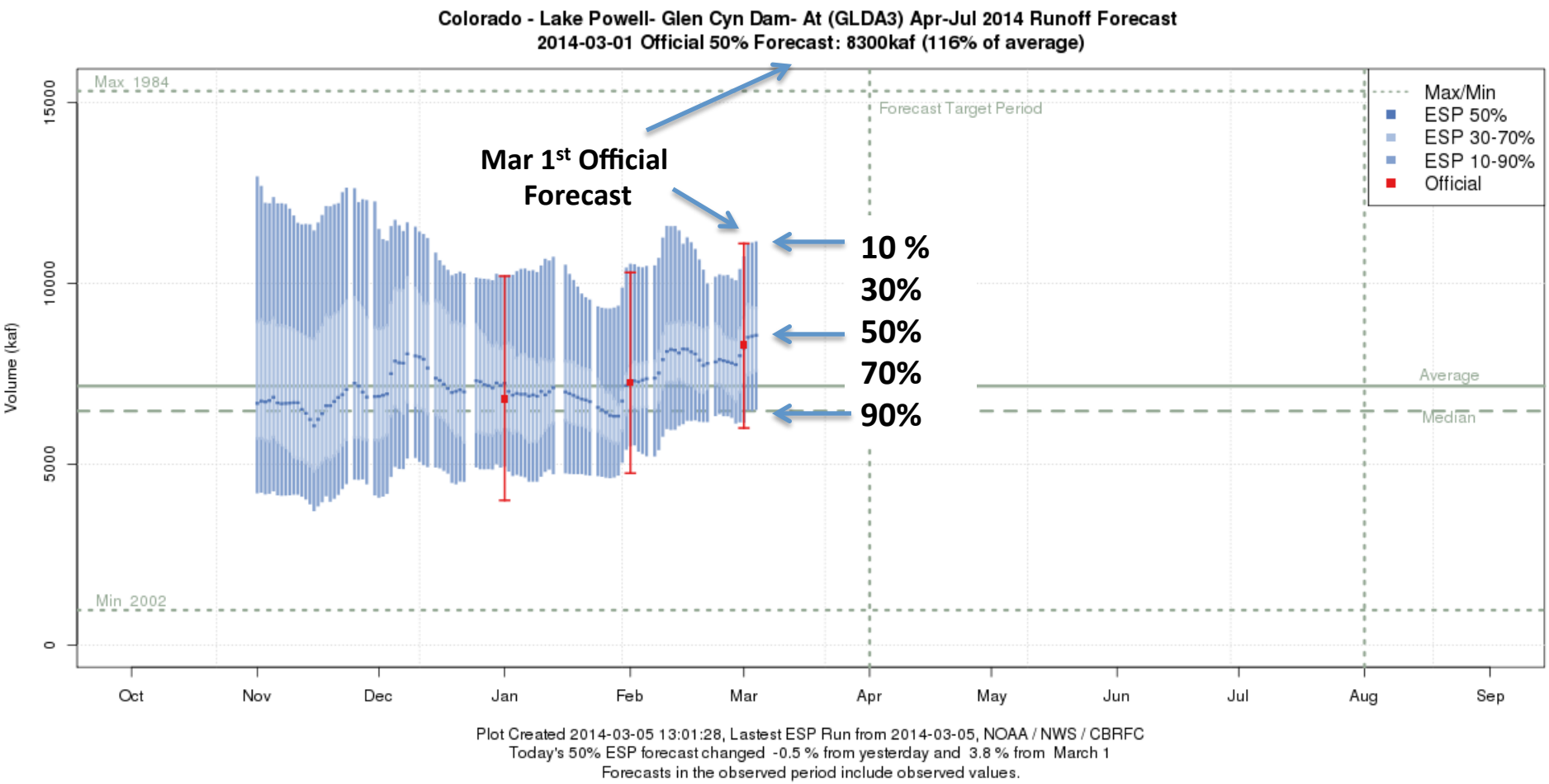
- Percentiles
- Percent Average
- Percent Median
- No Data
- < 25%
- 25-50%
- 50-75%
- 75-90%
- 90-110%
- 110-125%
- 125-150%
- 150-175%
- >175%

WATER SUPPLY

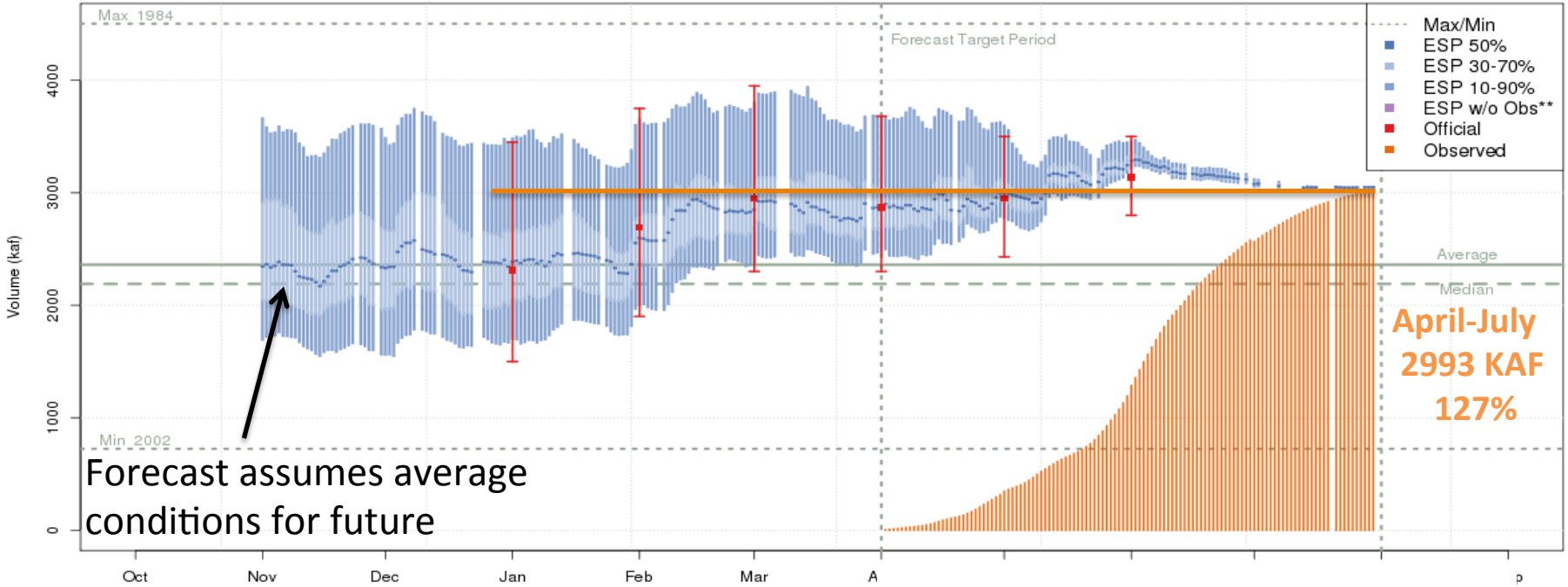
- 2014 Verification Map
- Historical Verification Map
- Forecast Map
- Forecast Map (Local)
- Forecast List
- Forecast List (Local)
- Discussion
- Discussion (Local)
- Discussion Archive
- Publication
- Publication (Local)
- Publication Archive
- Specific Site Archive
- Daily ESP
- Daily ESP (Local)
- Documentation
- Precipitation
- Temperature
- Soil Moisture
- Internal Tools

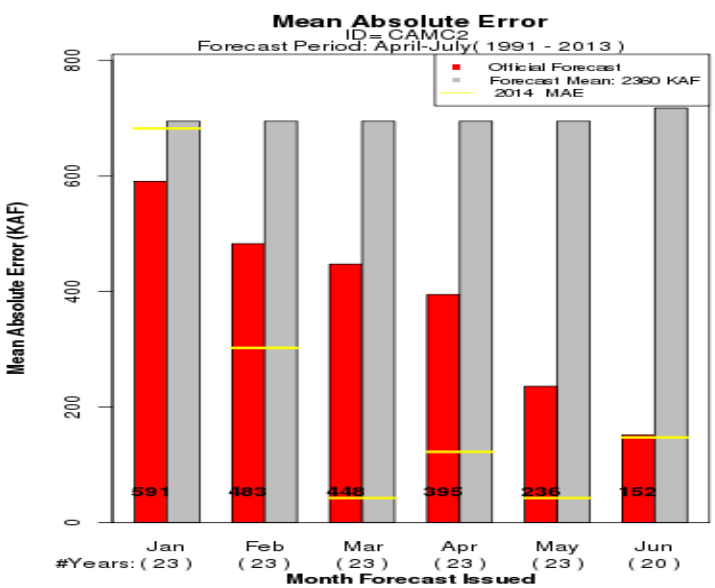
Daily Ensemble Streamflow Prediction (ESP) Model Run & Official Forecast

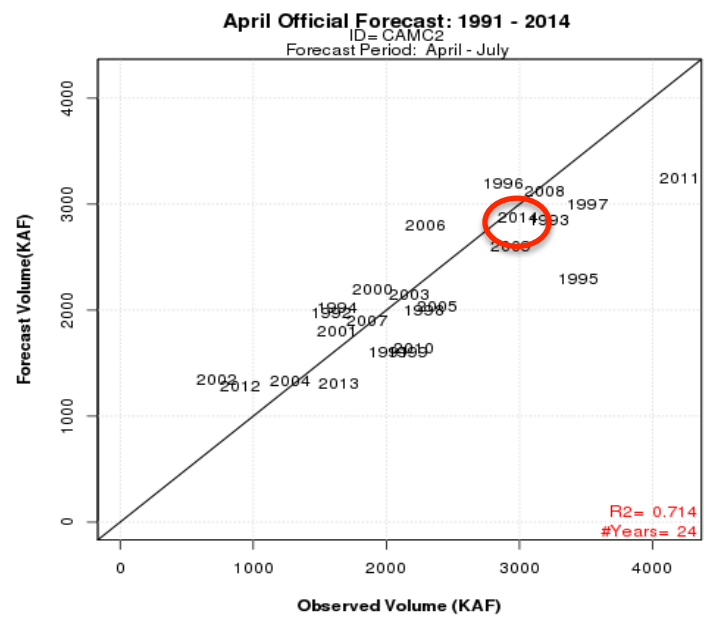
Will be available at: www.cbrfc.noaa.gov Select: Water Supply Click: Point of Interest



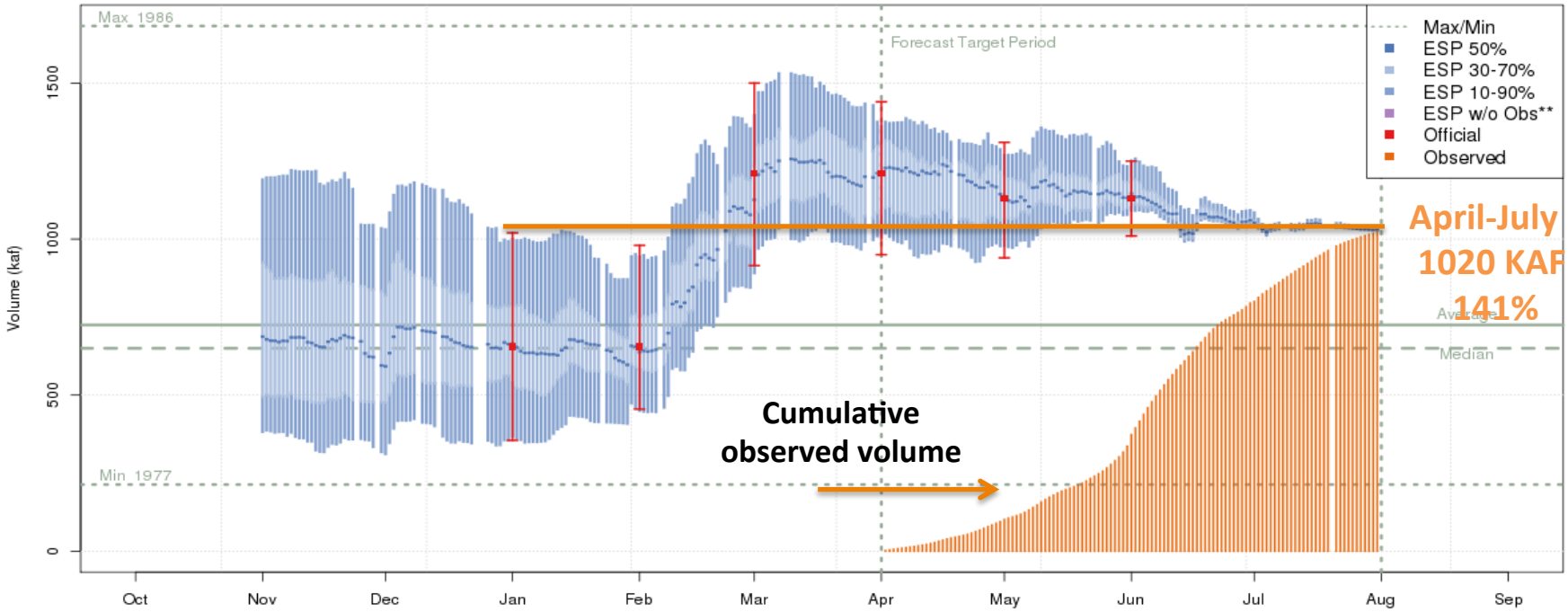
Upper Colorado: Colorado near Cameo

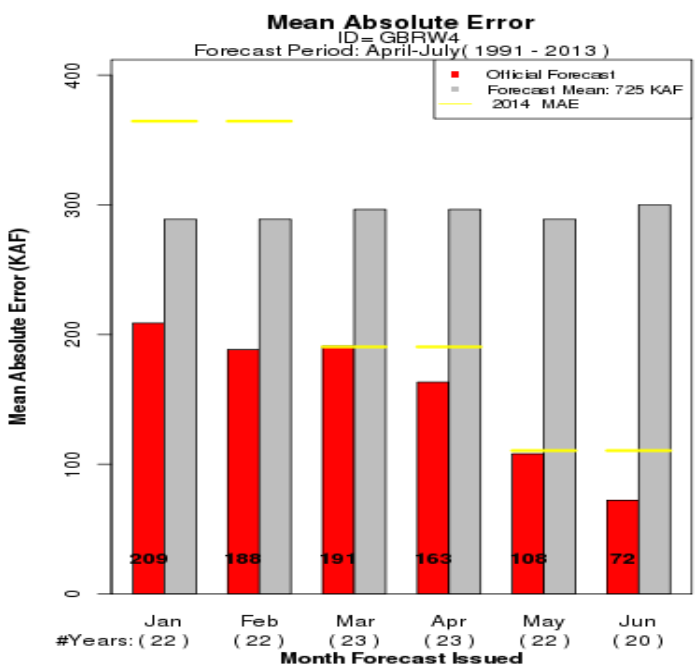


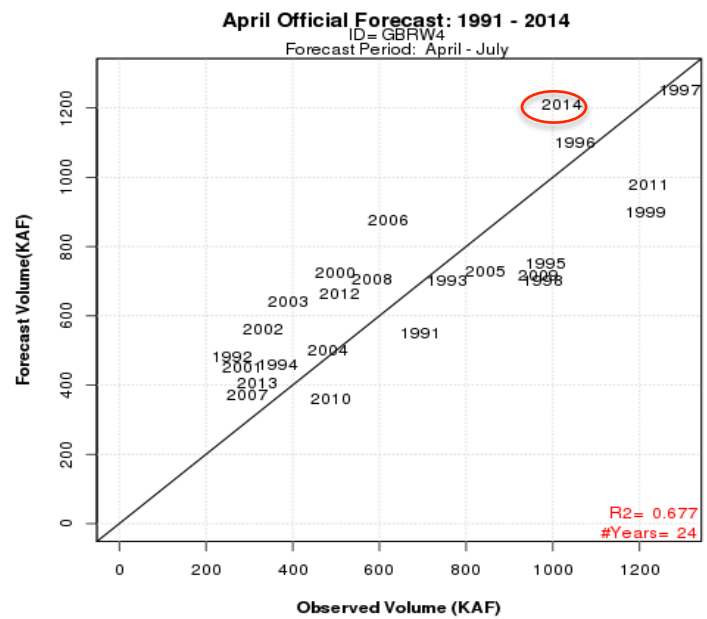




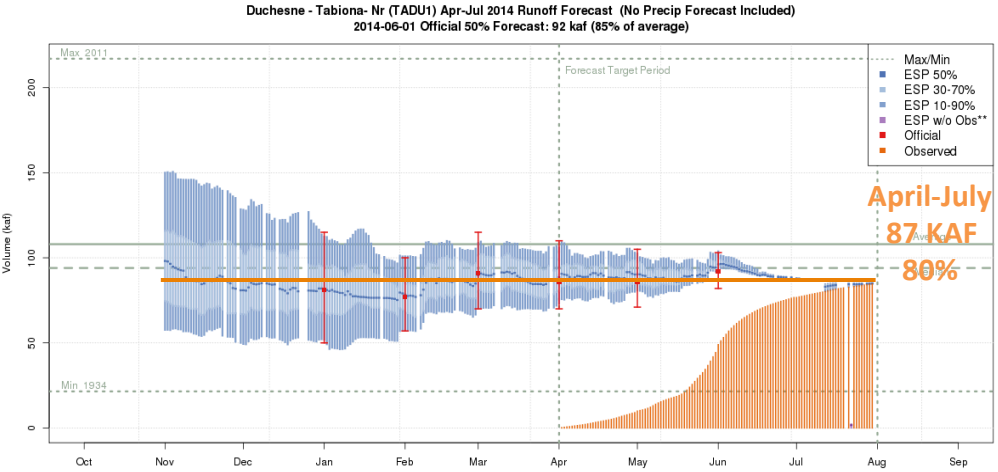
Upper Green: Fontenelle Inflow





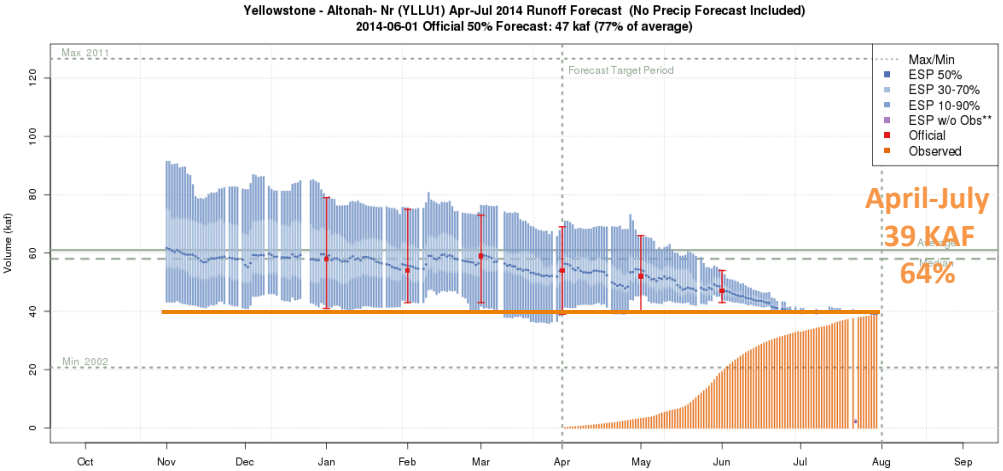


West to East Look At Duchesne River



Duchesne near Tabiona

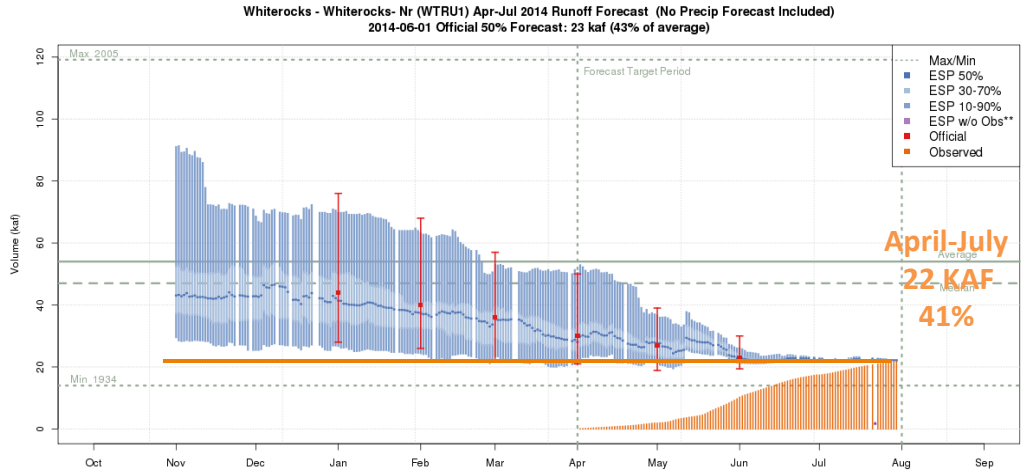
April MAE=1 KAF (1%)
May MAE= 1 KAF (1%)
June MAE= 5 KAF (6%)



Yellowstone River nr Altonah

- Missed 90% Exceedance

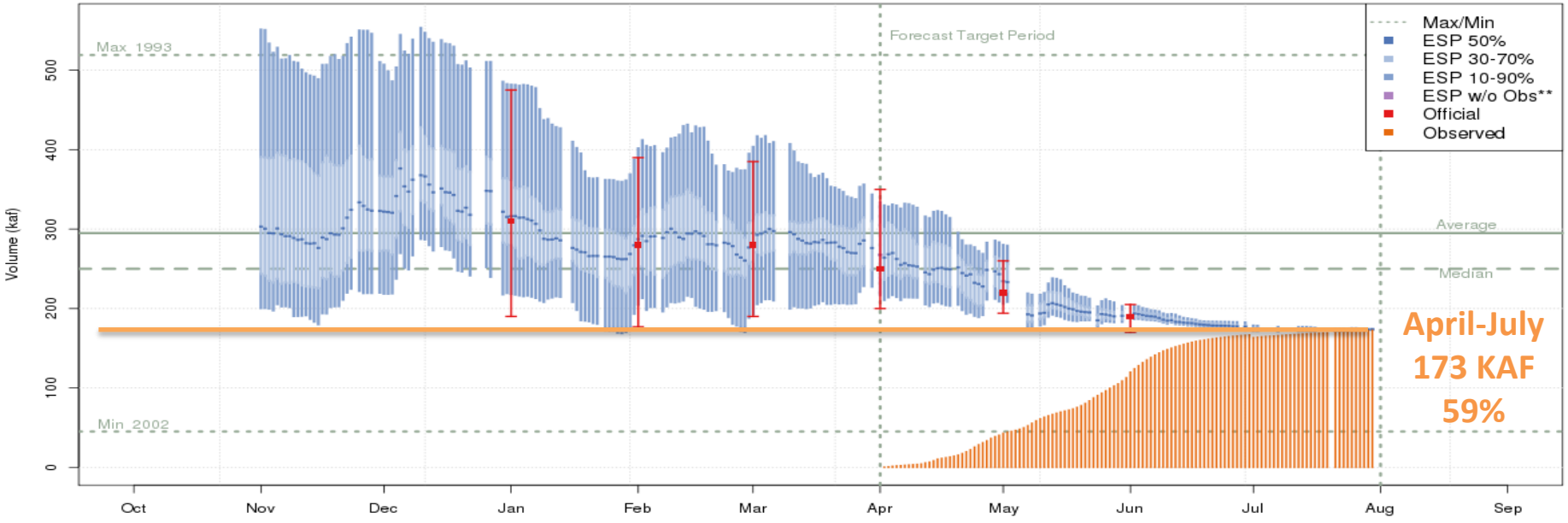
April MAE= 15 KAF (38%)
May MAE= 13 KAF (33%)
June MAE= 18 KAF (20%)

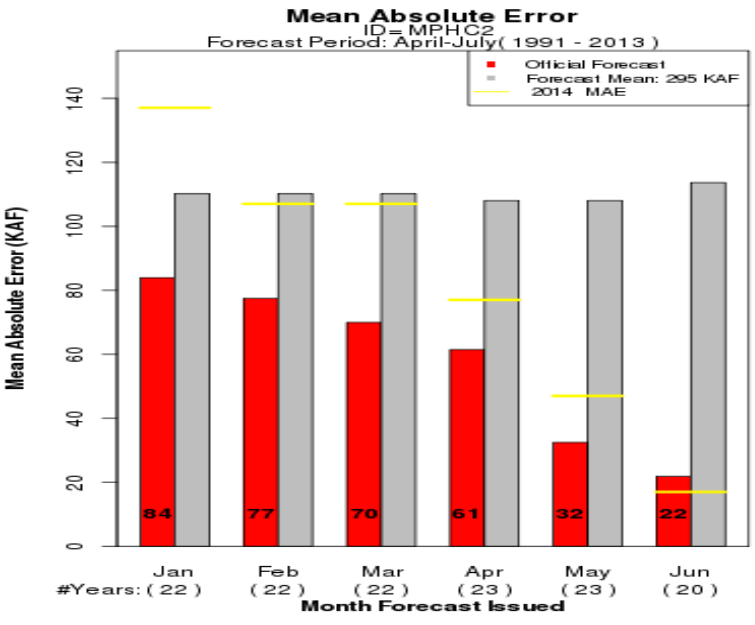


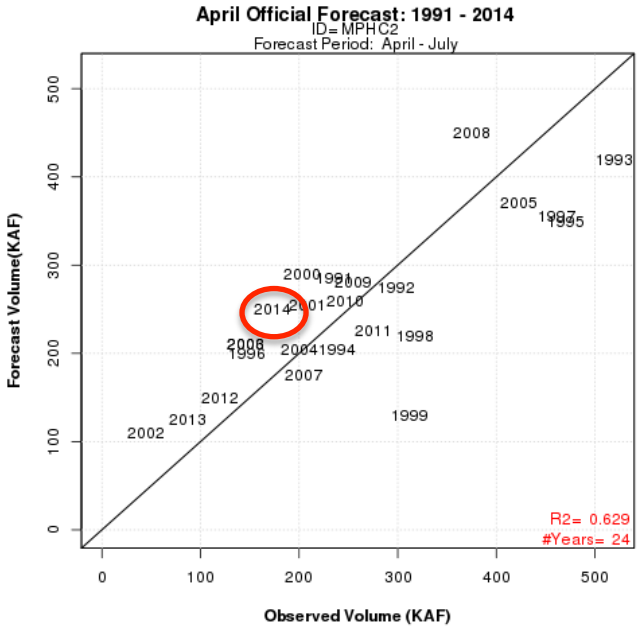
Whiterocks River

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

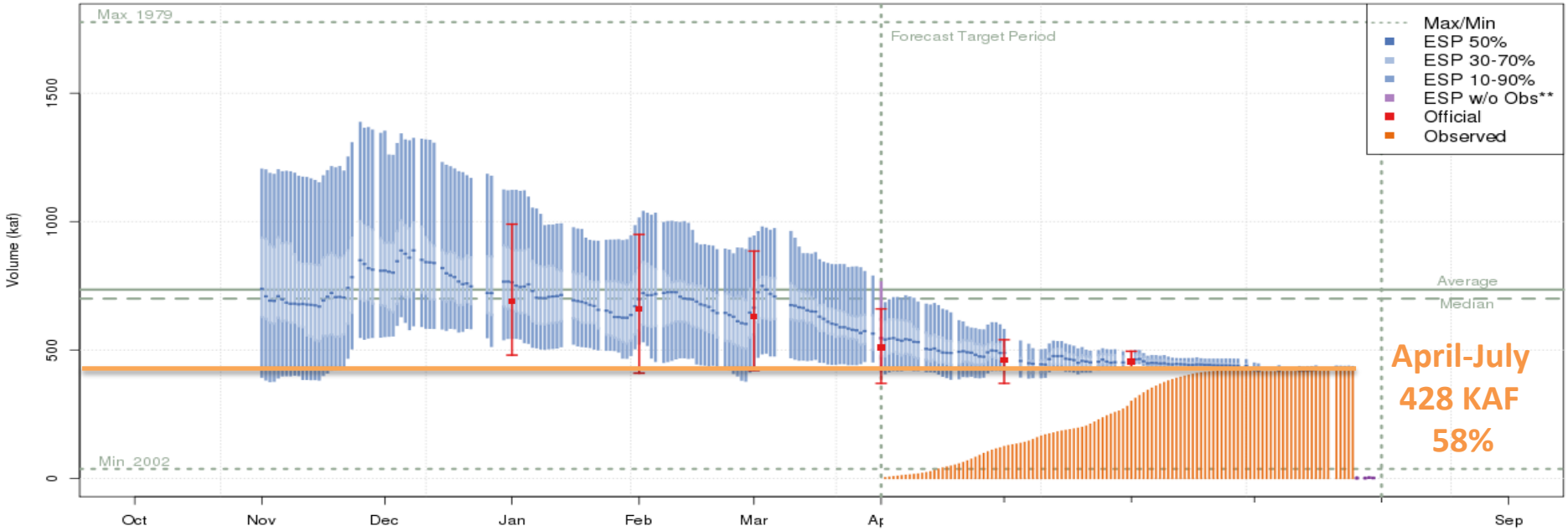
Dolores: McPhee Reservoir Inflow

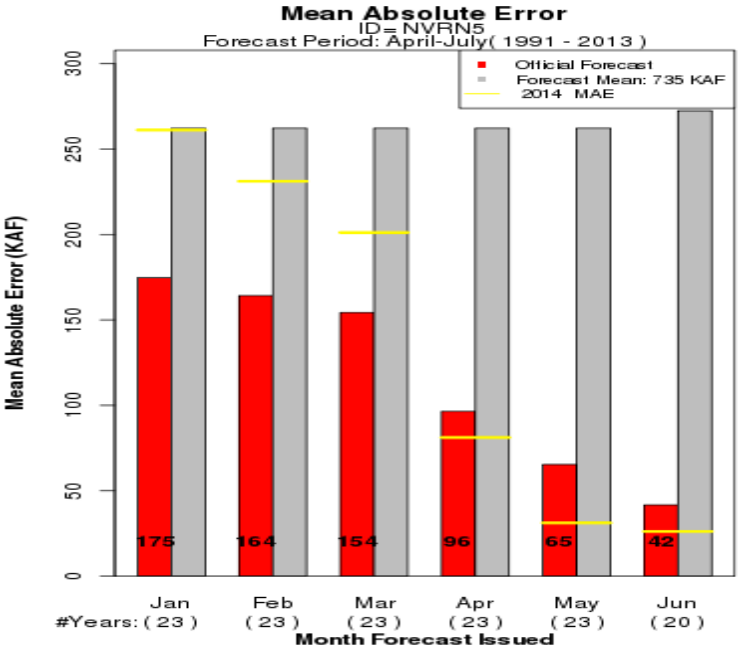


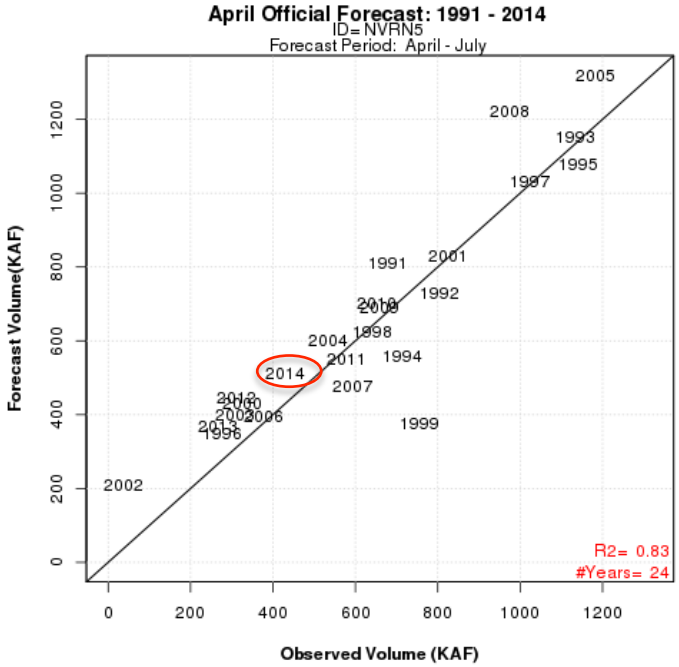




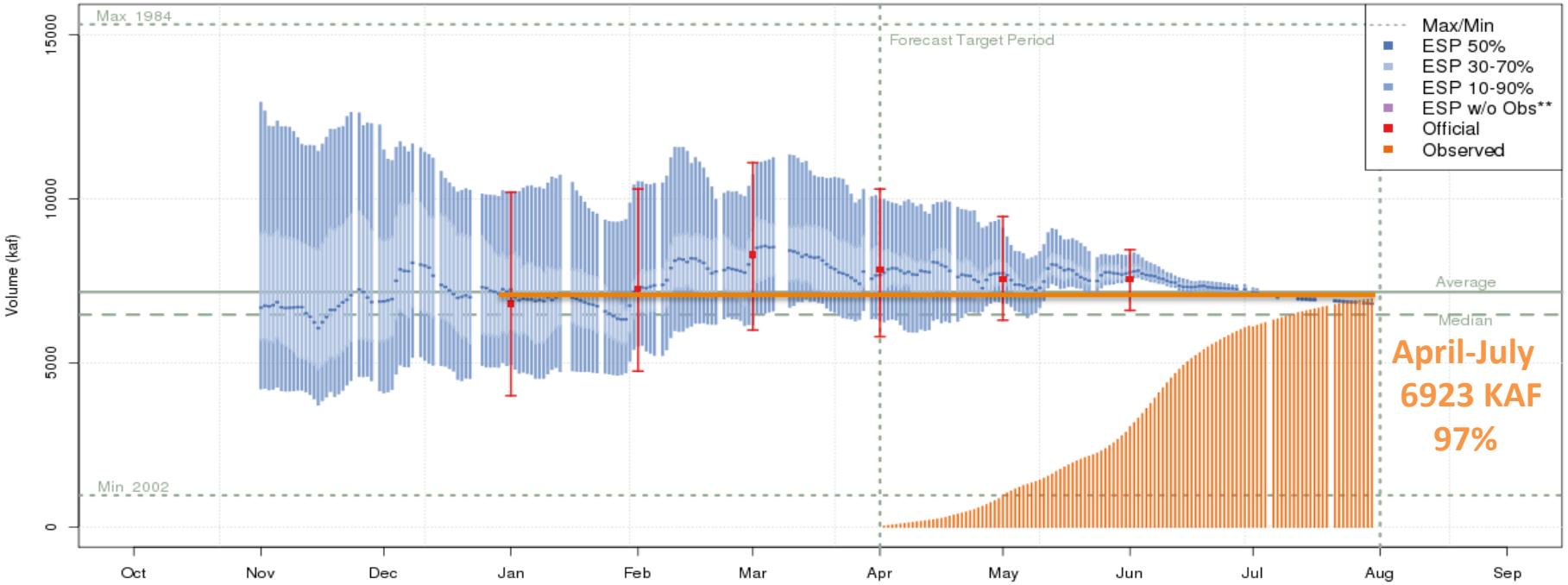
San Juan: Navajo Reservoir Inflow

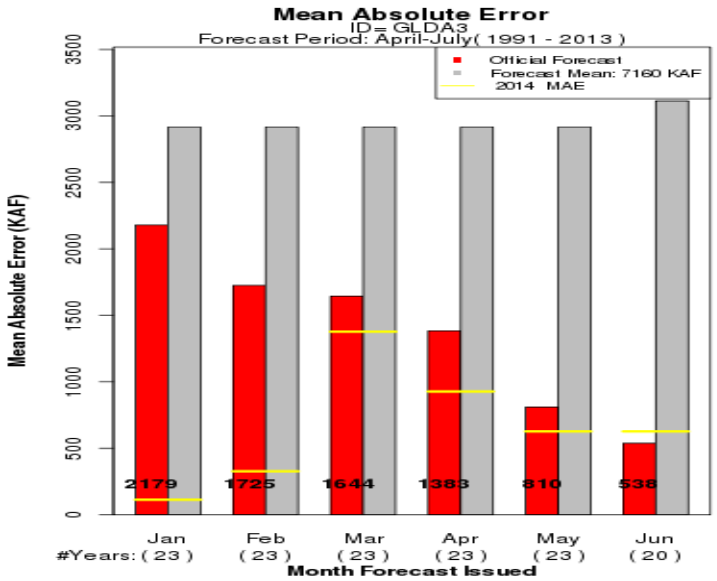


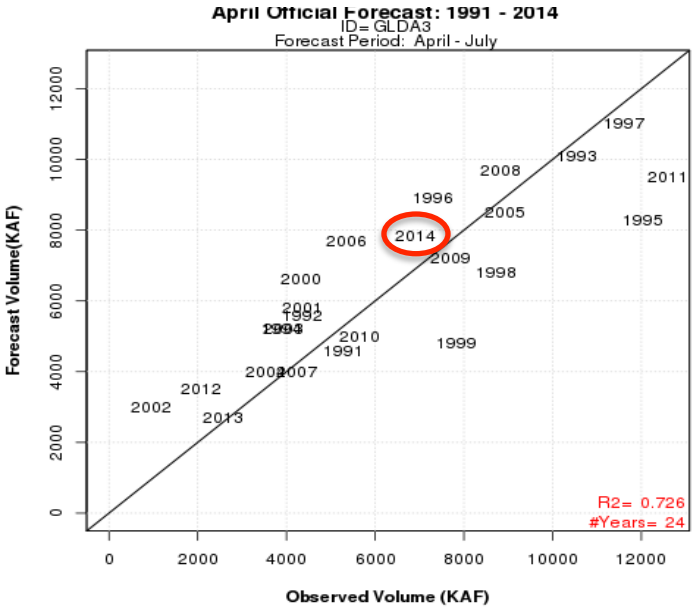




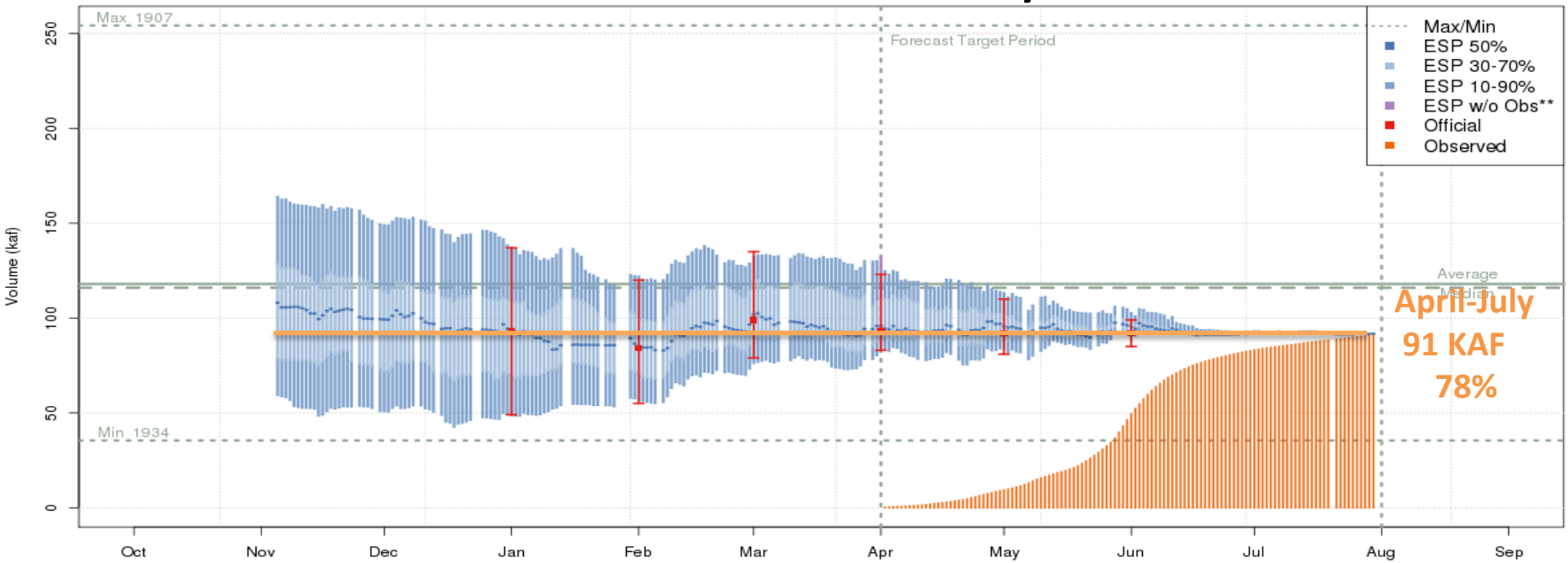
Lake Powell

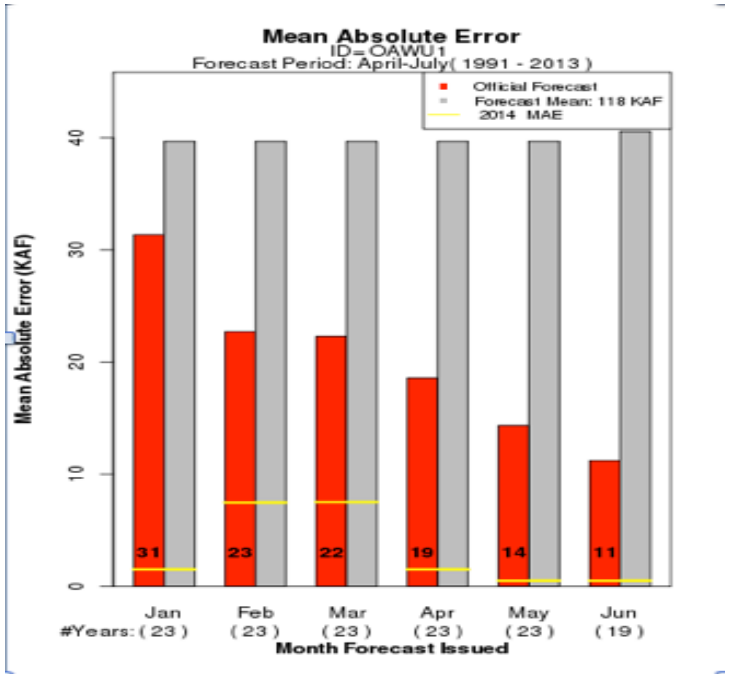

Max 1984
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
ESP w/o Obs**
Official
Observed
Average
Median
Min 2002
Volume (kaf)
0
5000
10000
15000
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
April-July
6923 KAF
97%

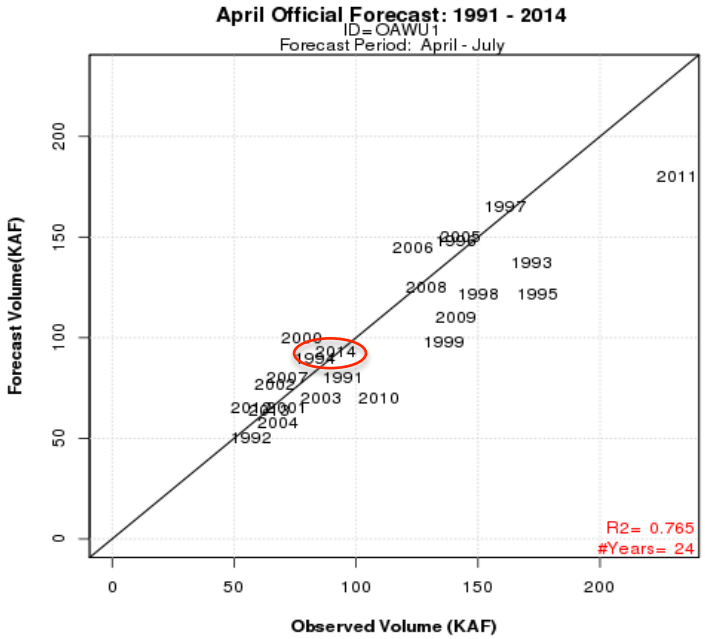

Mean Absolute Error
ID= GLDA3
Forecast Period: April-July(1991 - 2013)
Official Forecast
Forecast Mean: 7160 KAF
2014 MAE
Mean Absolute Error (KAF)
0
500
1000
1500
2000
2500
3000
3500
2179
1725
1644
1383
810
538
Jan
Feb
Mar
Apr
May
Jun
#Years: (23)
(23)
(23)
(23)
(23)
(20)
Month Forecast Issued


April Official Forecast: 1991 - 2014
ID= GLDA3
Forecast Period: April - July
Forecast Volume(KAF)
Observed Volume (KAF)
0
2000
4000
6000
8000
10000
12000
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

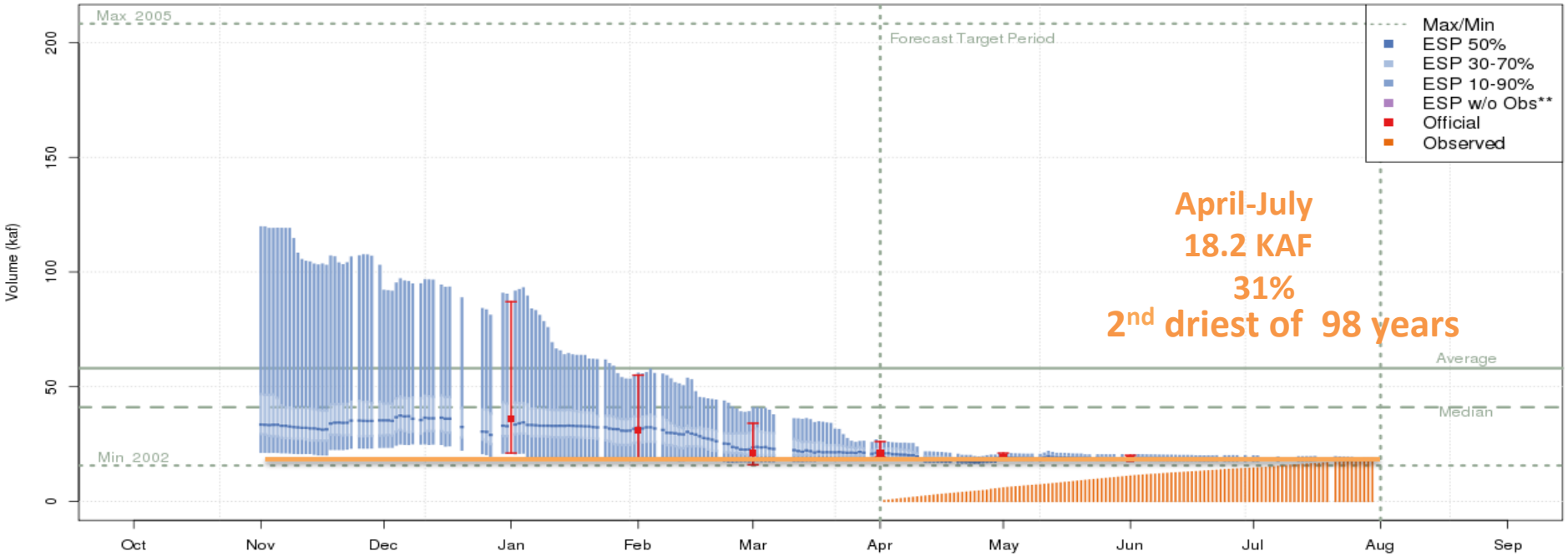
Great Basin: Weber River at Oakley

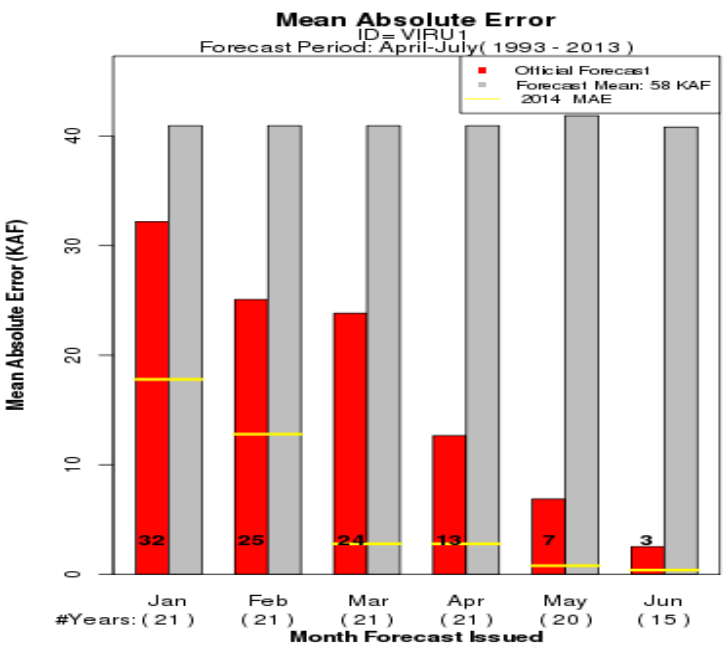


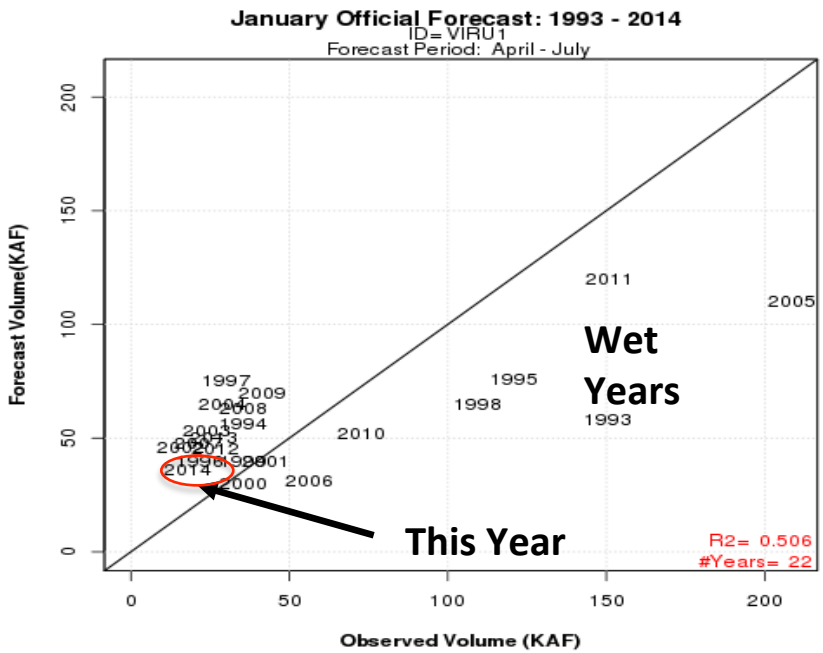




Virgin: Virgin at Virgin







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)

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

- Yellowstone Drainage (Uinta Range)
- Dolores River Basin

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

- Taylor Park (Upper Gunnison)

Initial model state issues & possibly snow extent issues

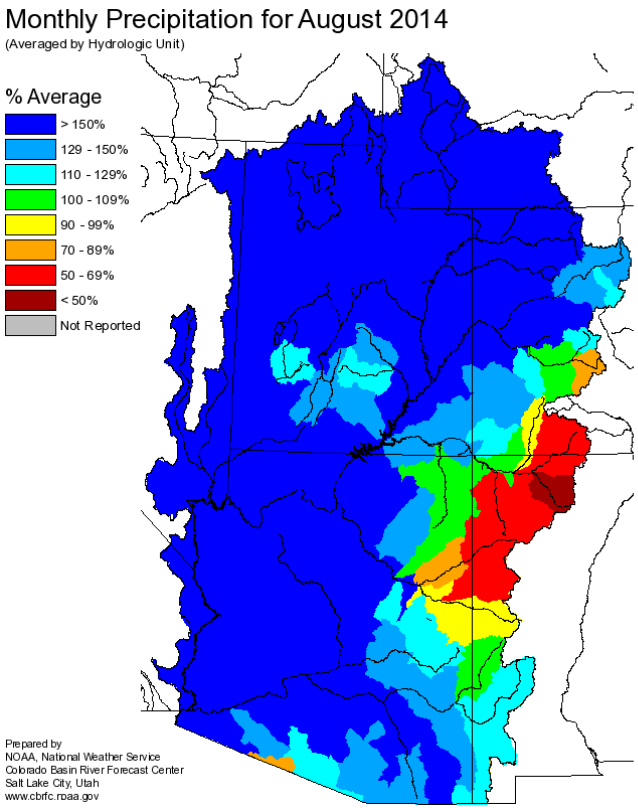
- Dolores River Basin
- Taylor Park

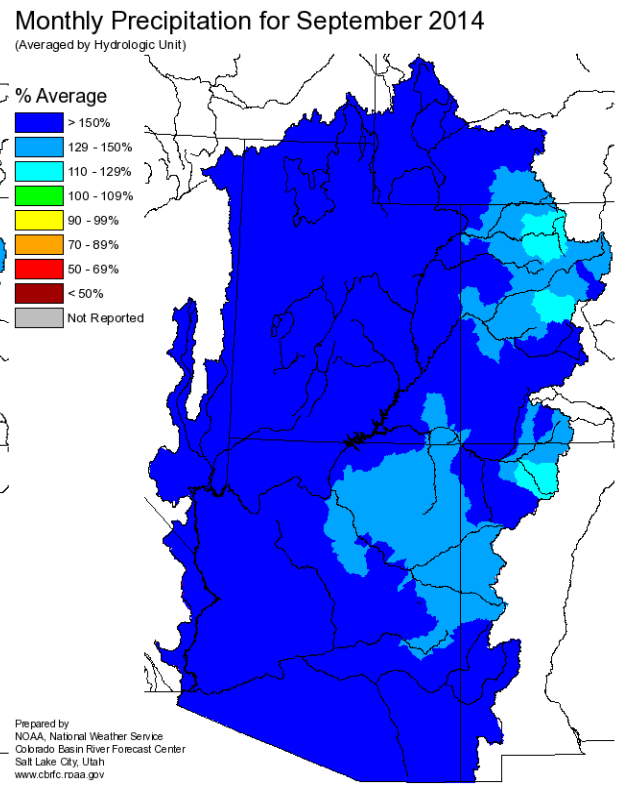
San Juan generally too high early in the season (10 of last 12 years) – Drier springs?

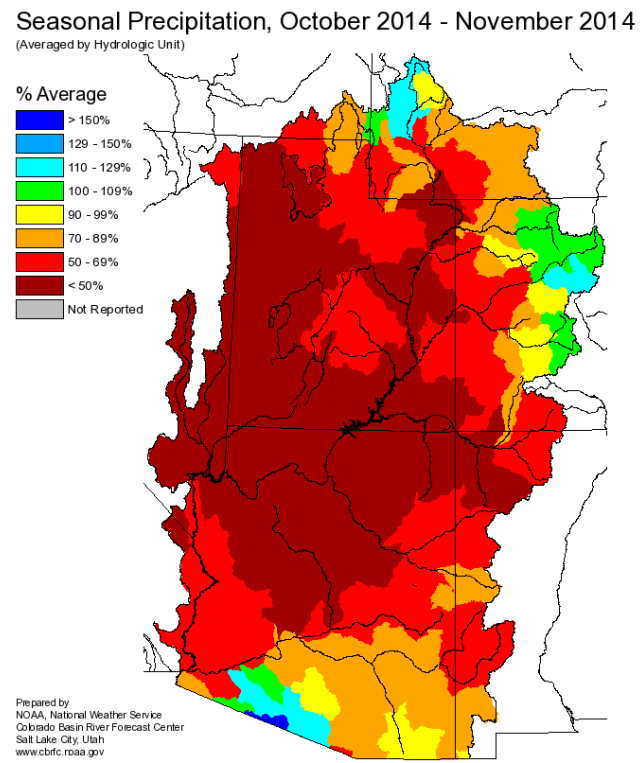
2015 Water Supply

Initial Conditions & Early Guidance

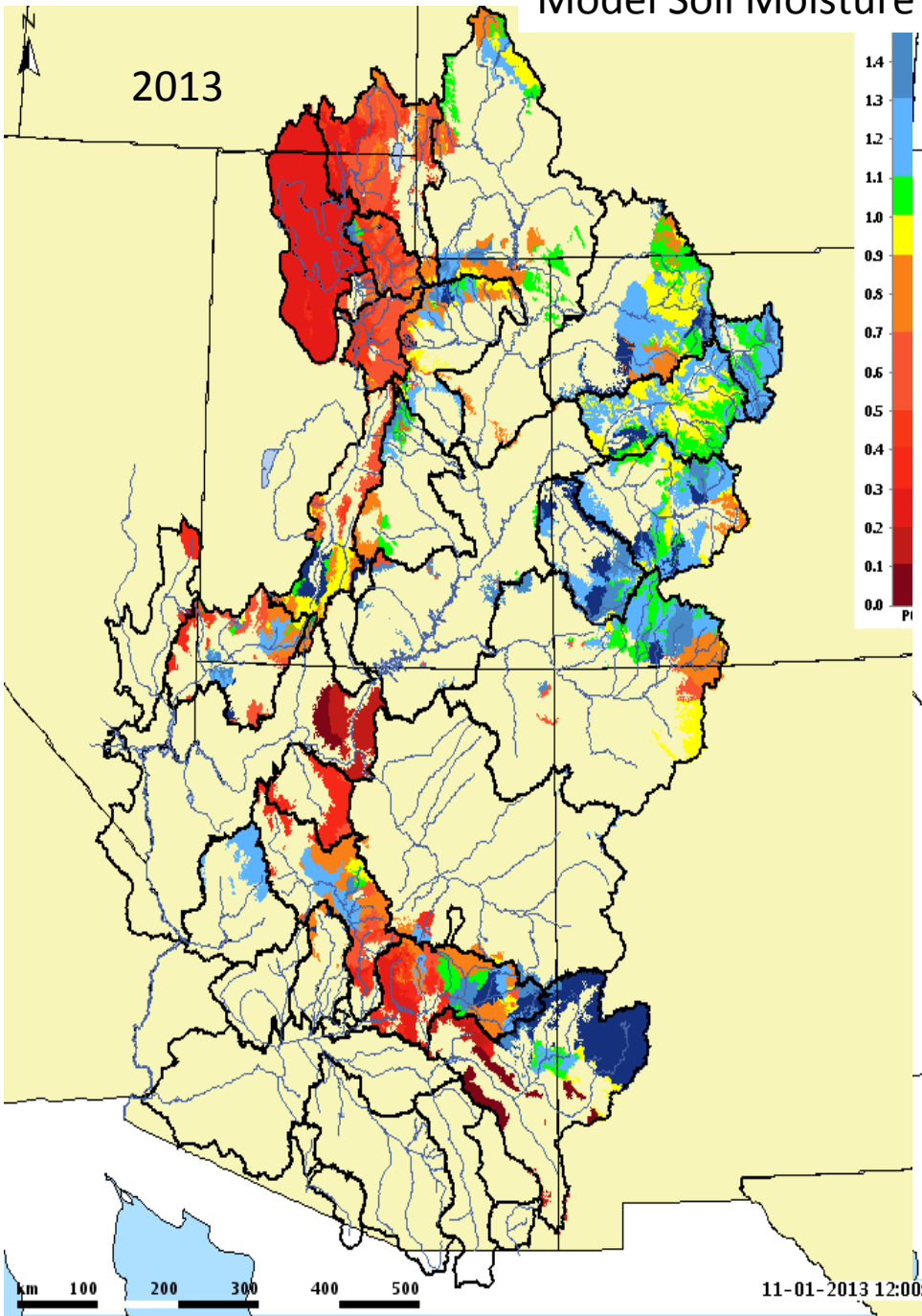
Late Summer / Fall Precipitation

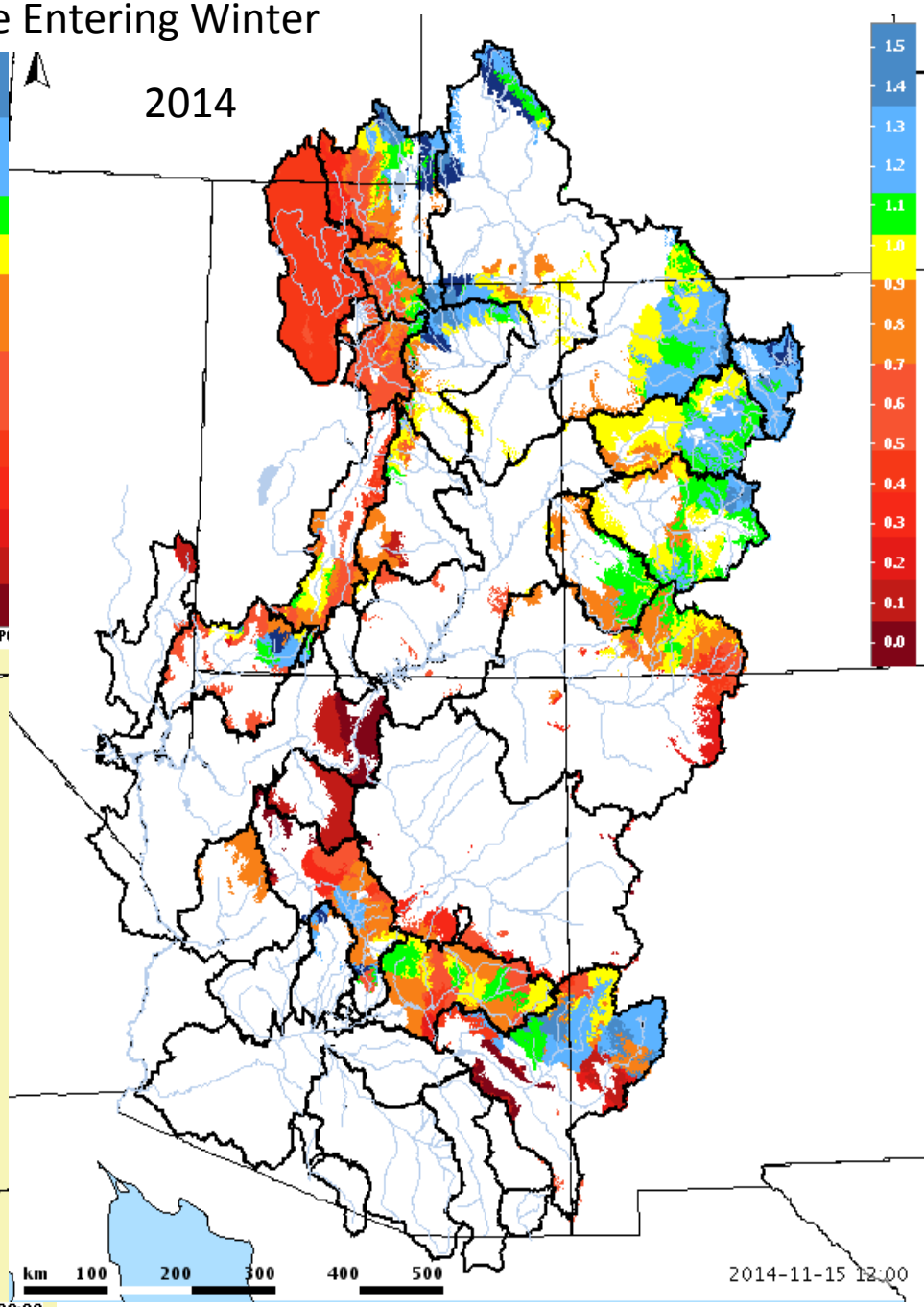






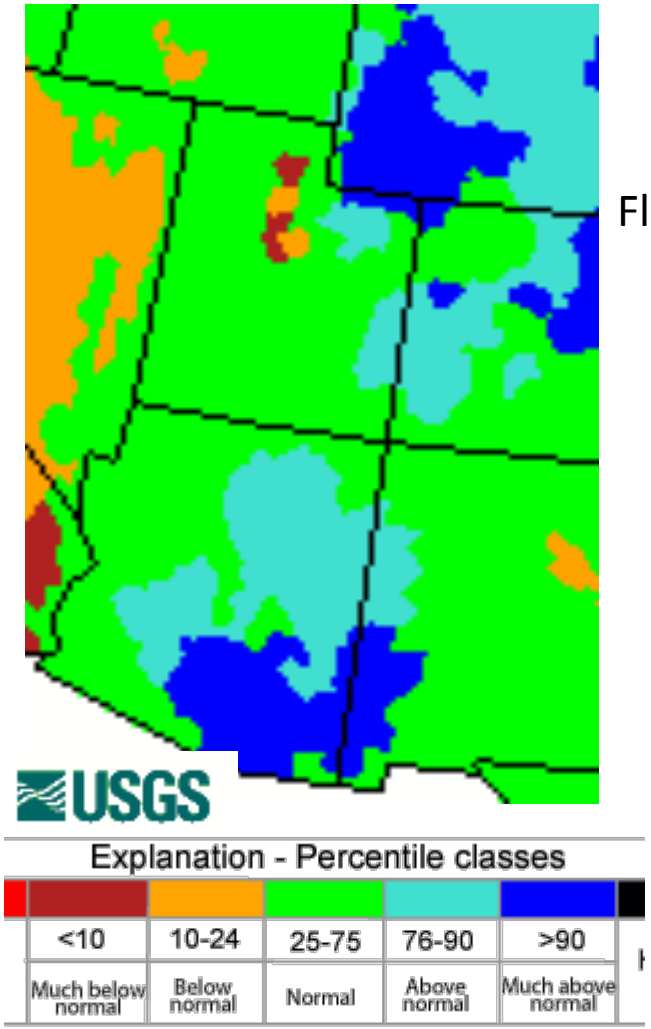
Model Soil Moisture Entering Winter



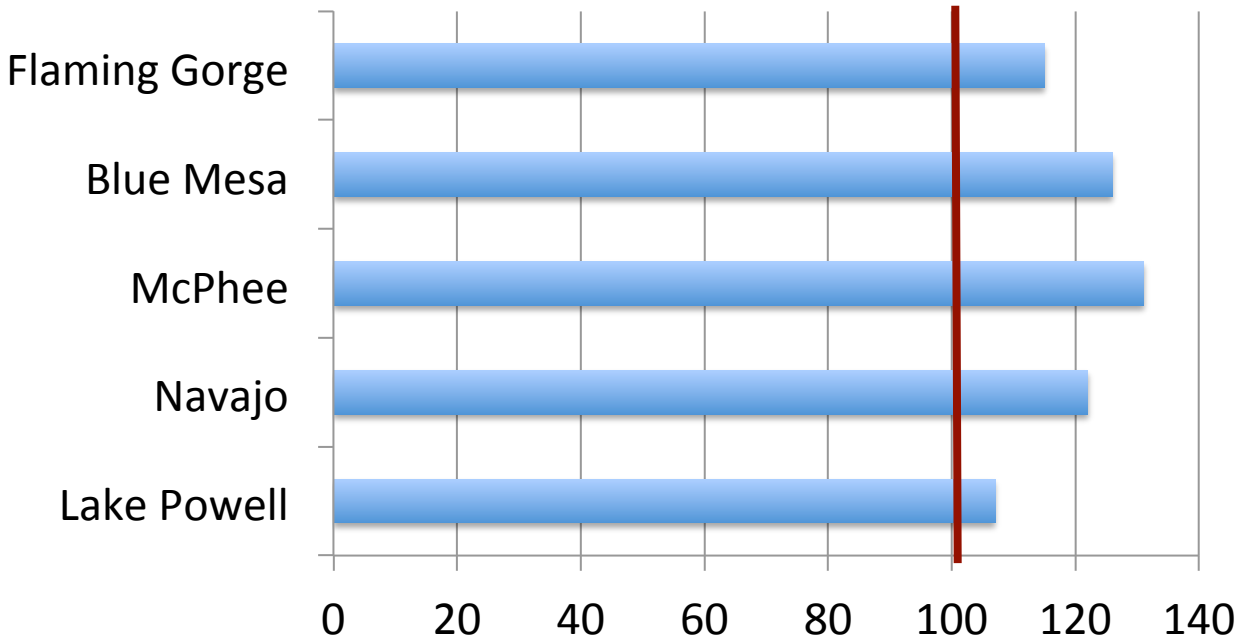


FALL FLOWS

October Regulated Flows

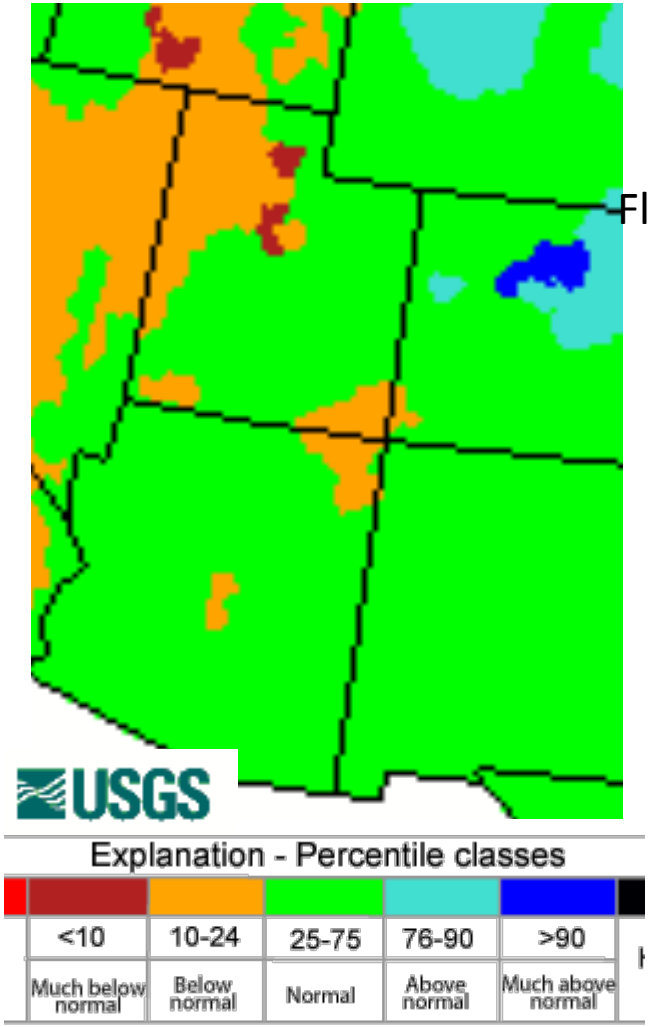


October %Average Unregulated Flows

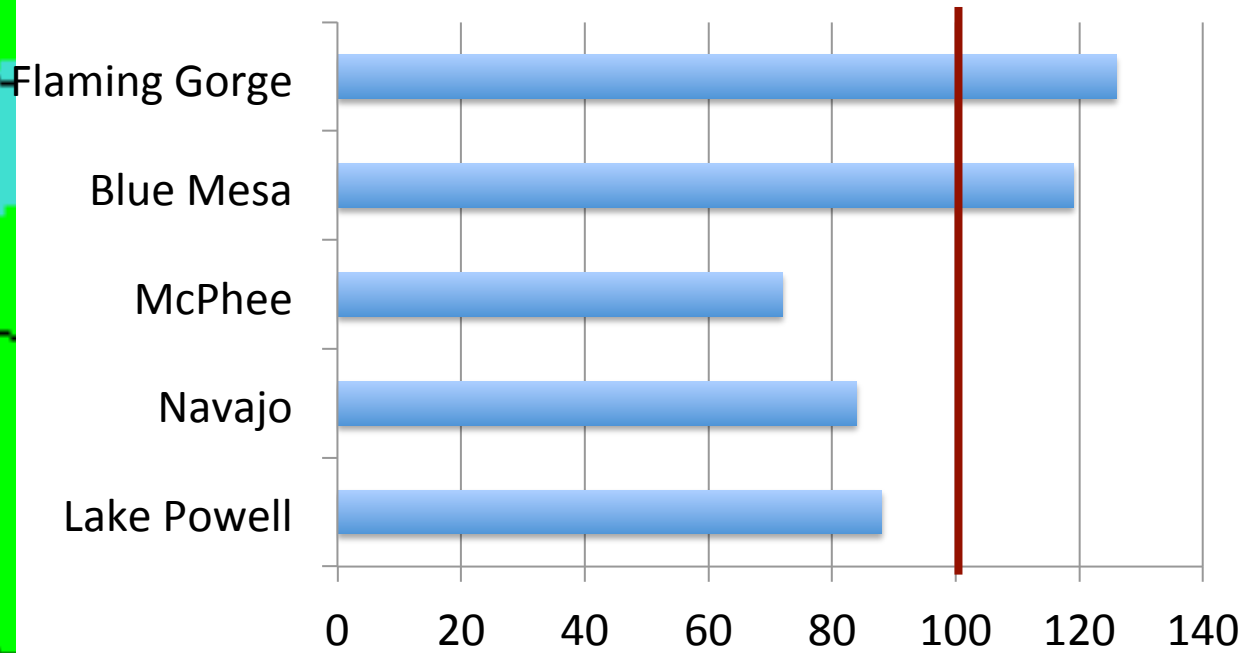


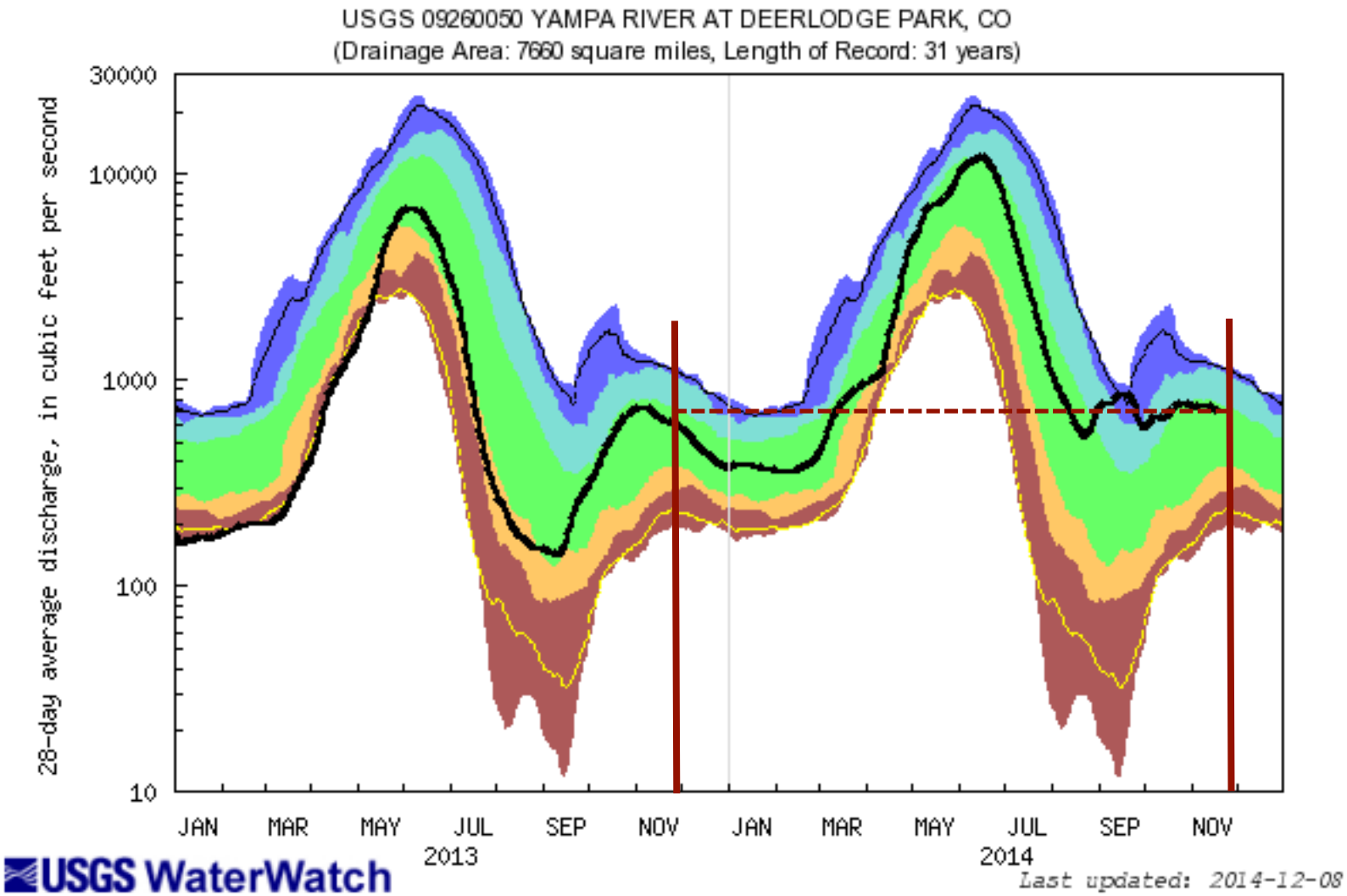
FALL FLOWS

November Regulated Flows



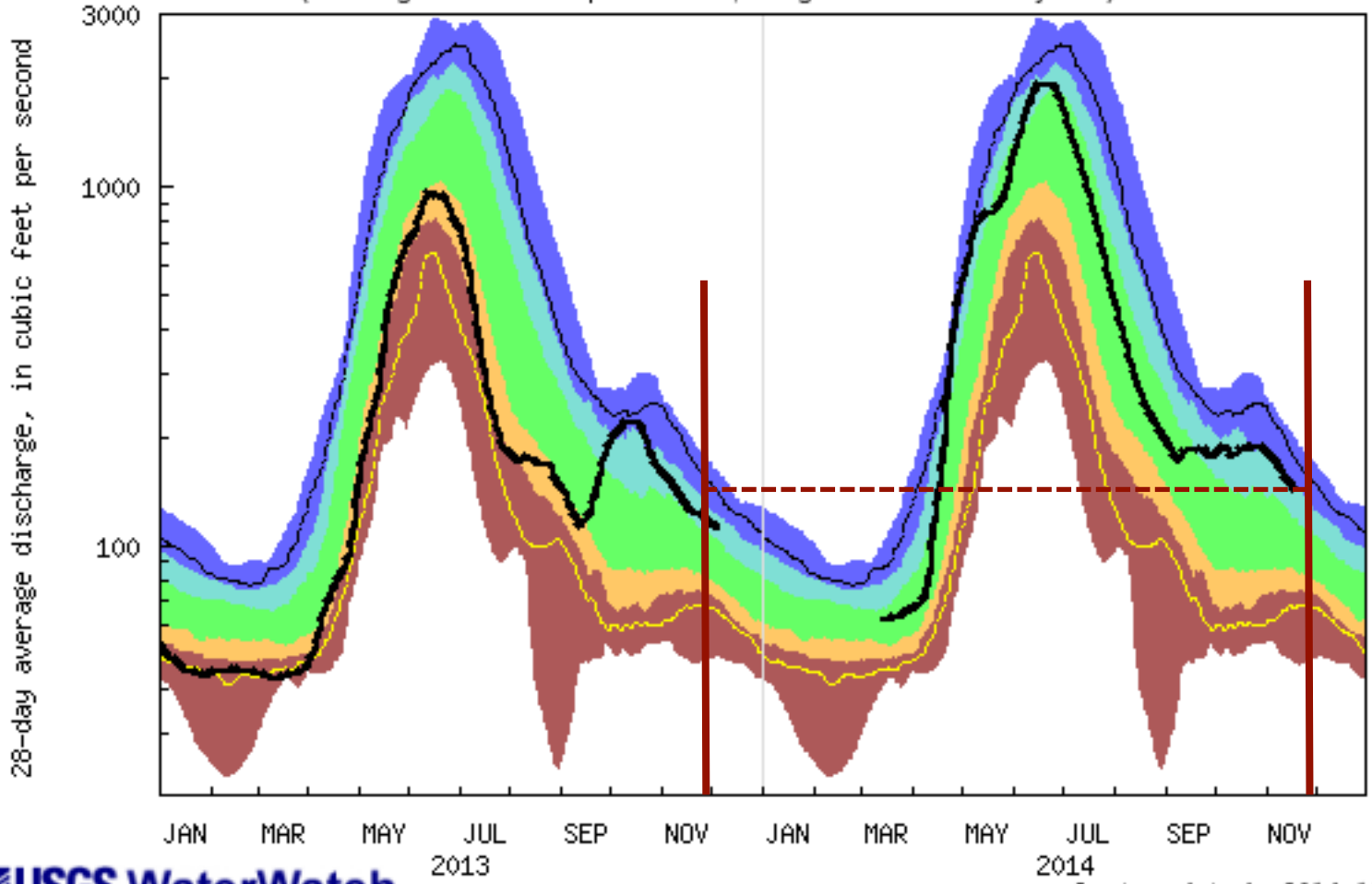
November %Average Unregulated Flows





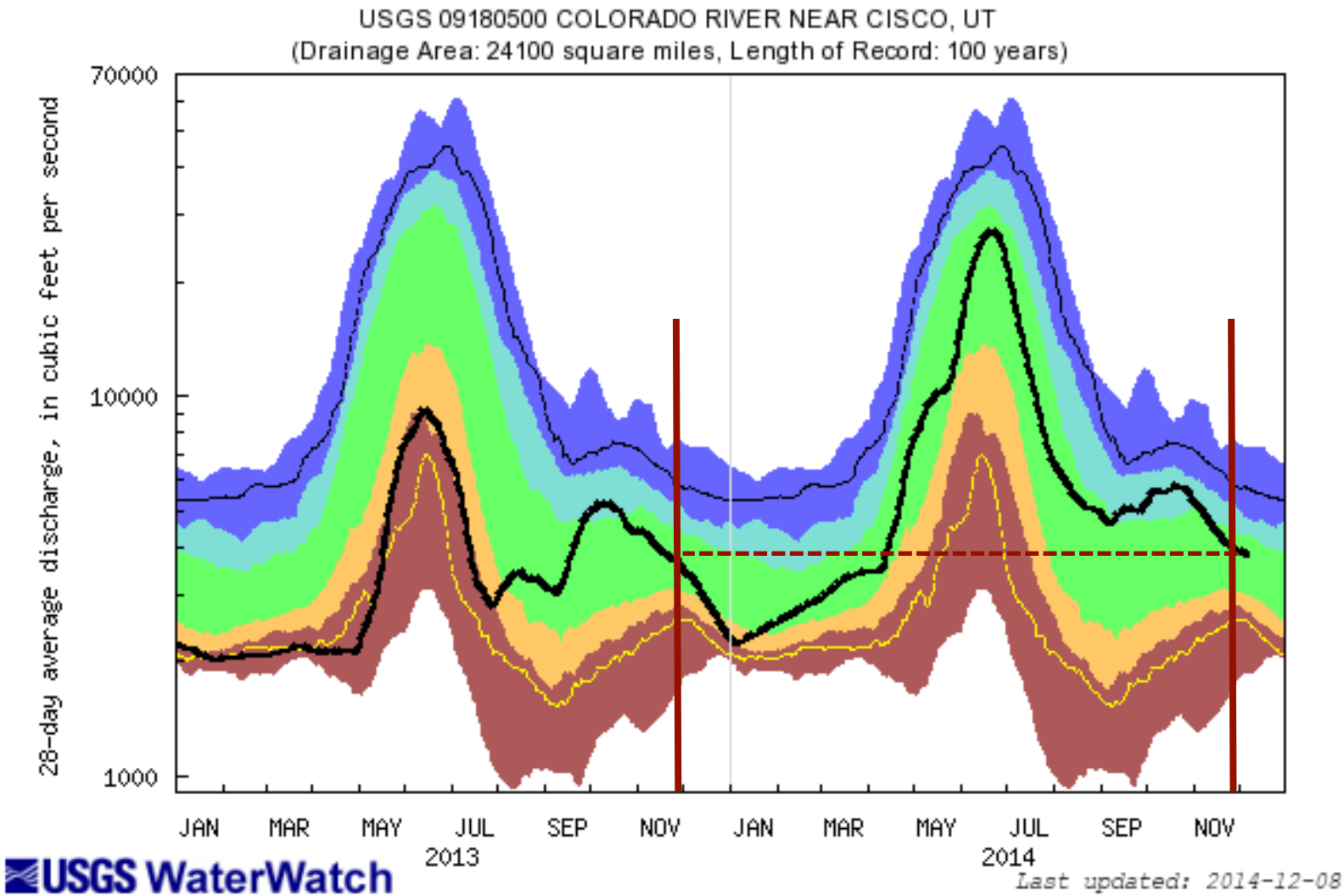
Explanation - Percentile classes							
lowest-10th percentile	5	10-24	25-75	76-90	95	90th percentile -highest	Flow
Much below Normal		Below normal	Normal	Above normal	Much above normal		

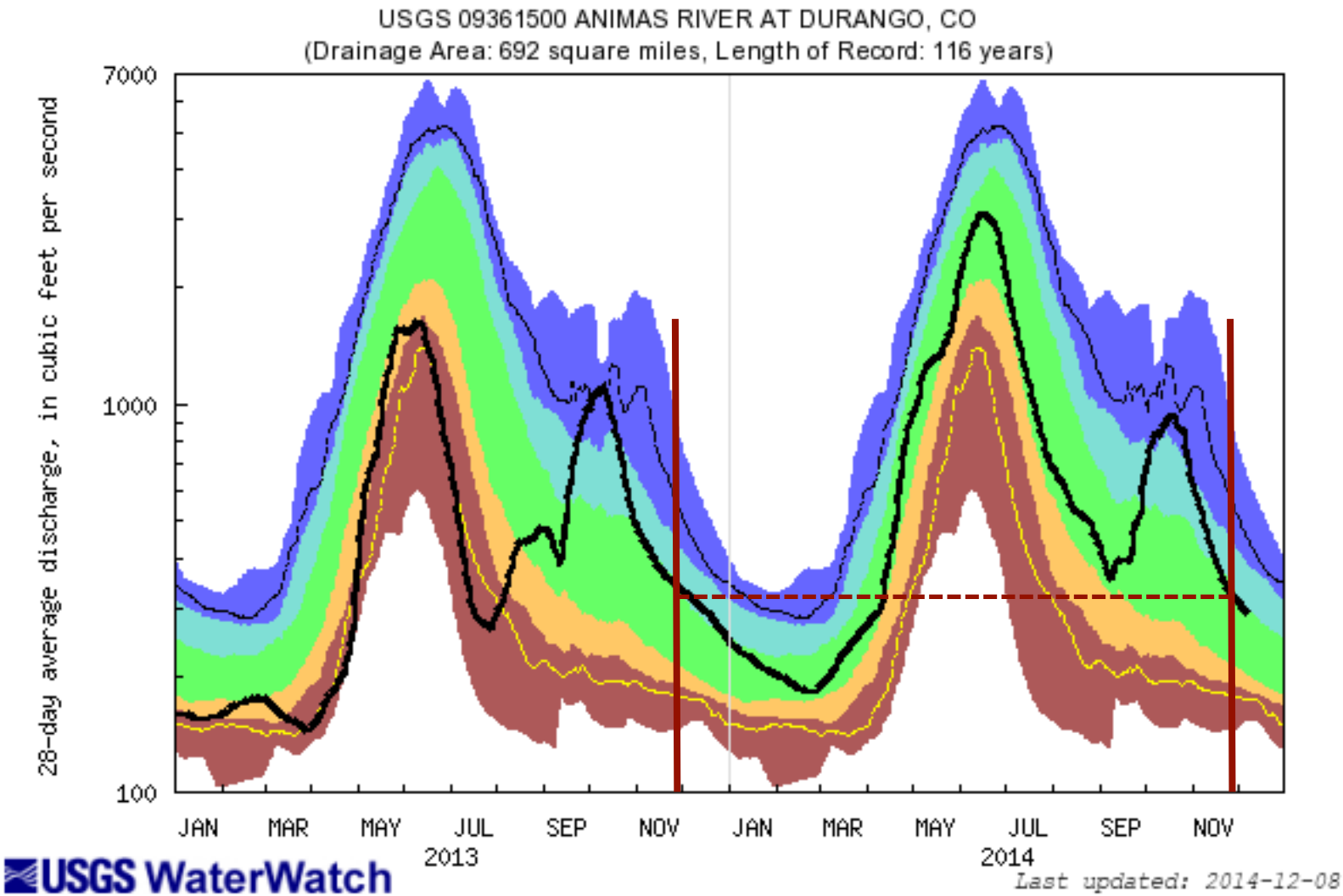
USGS 09112500 EAST RIVER AT ALMONT, CO
(Drainage Area: 289 square miles, Length of Record: 103 years)

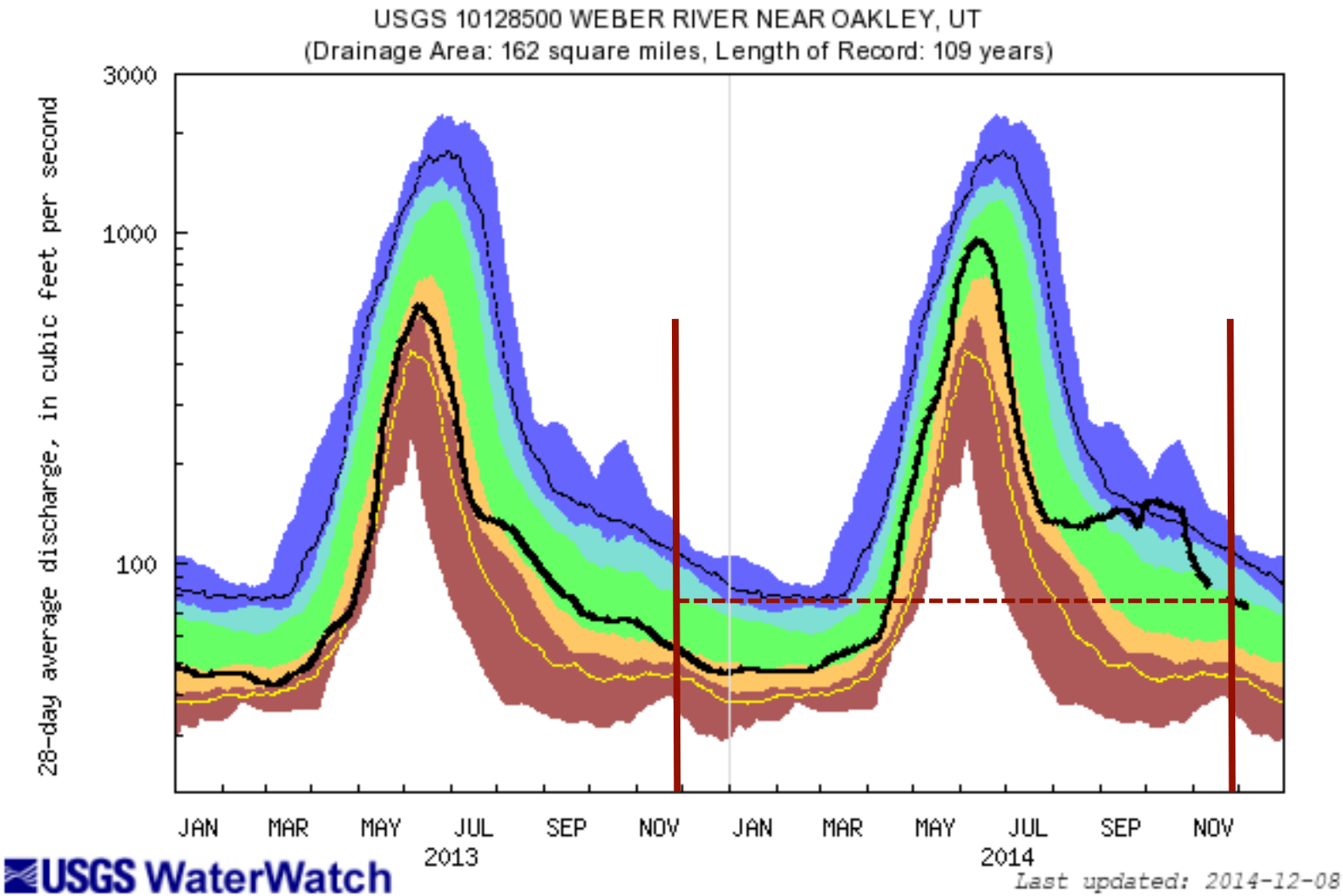


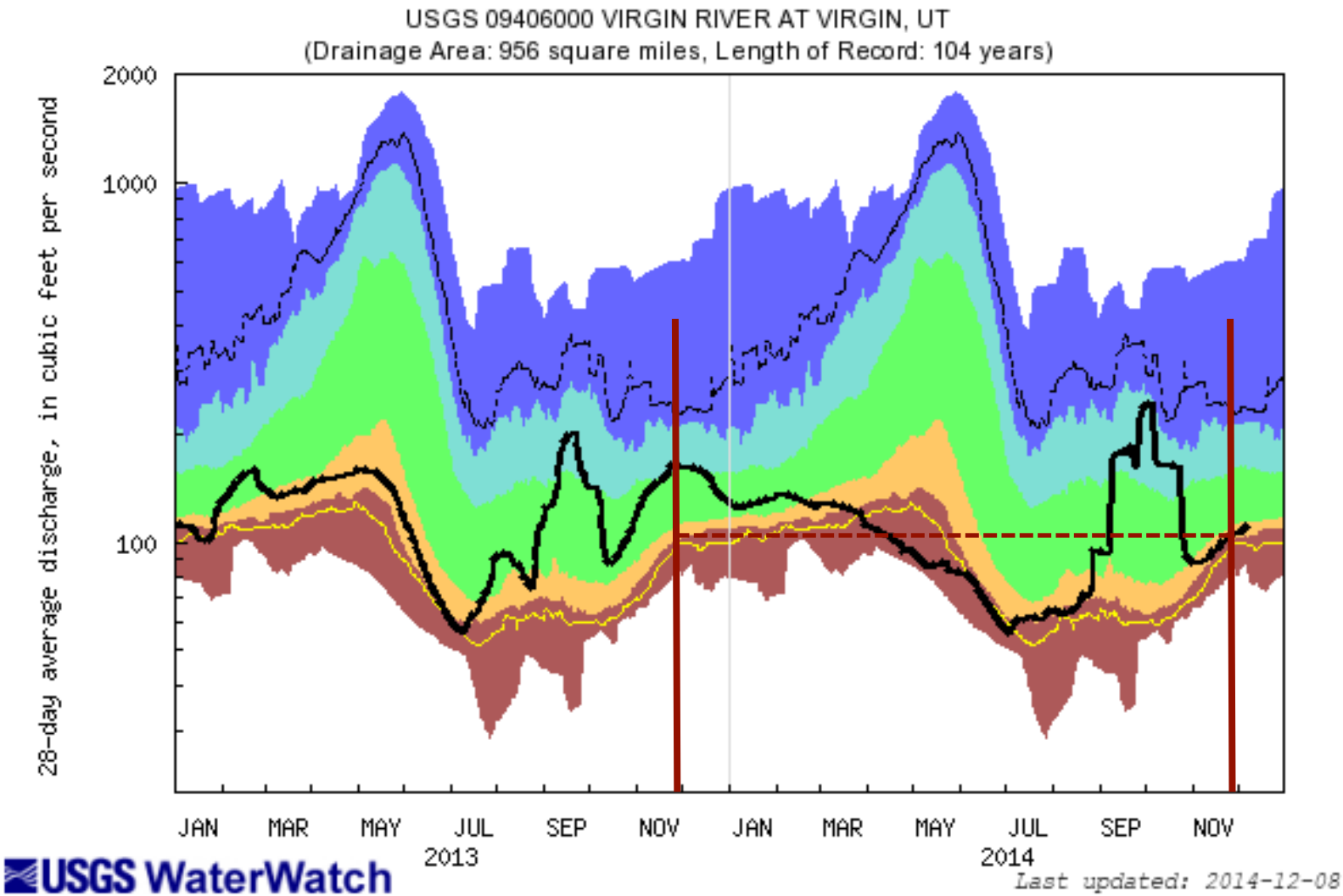
USGS WaterWatch

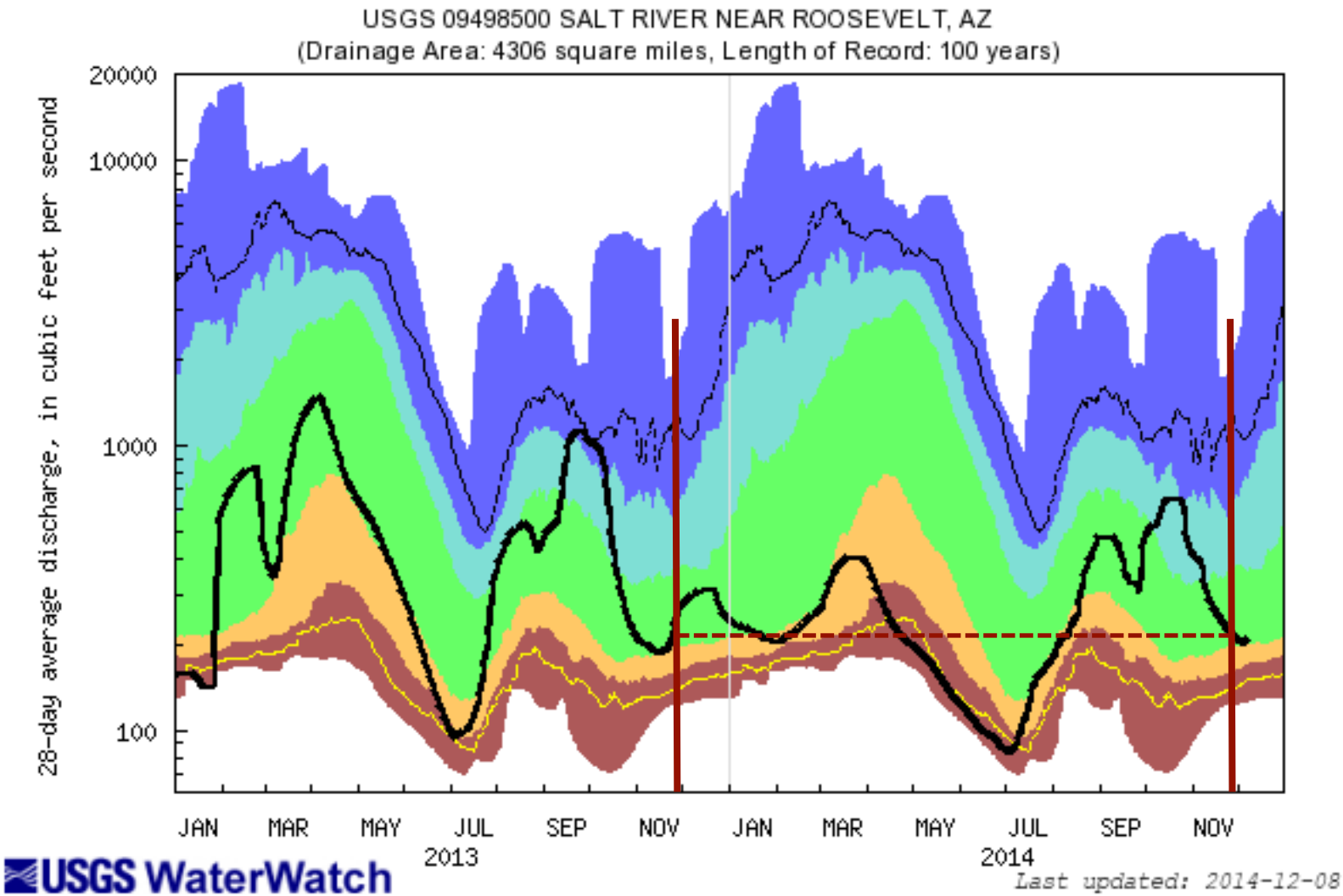
Last updated: 2014-12-08


USGS 09180500 COLORADO RIVER NEAR CISCO, UT
(Drainage Area: 24100 square miles, Length of Record: 100 years)
28-day average discharge, in cubic feet per second
70000
10000
1000
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
2013
2014
USGS WaterWatch
Last updated: 2014-12-08

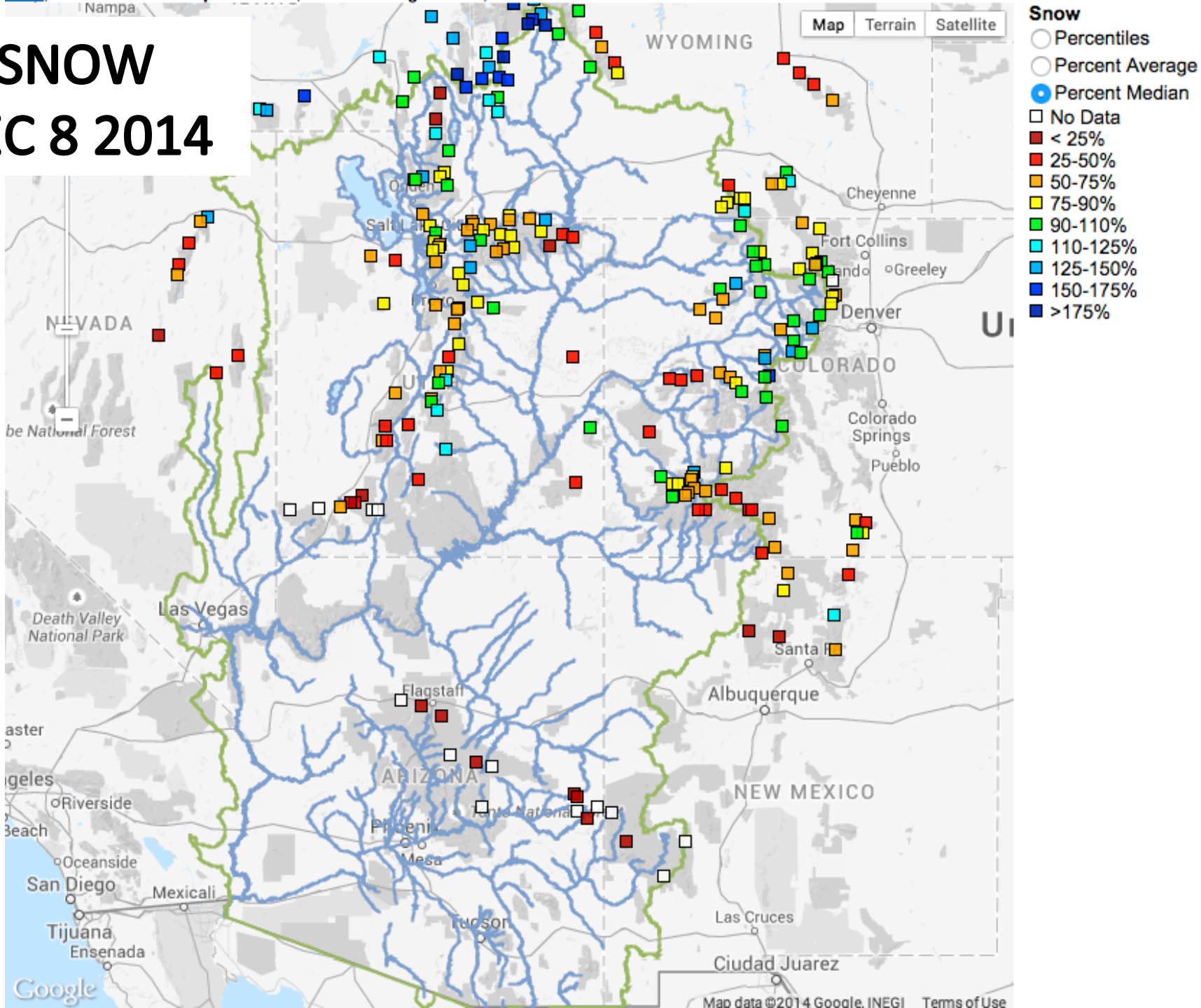

USGS 09361500 ANIMAS RIVER AT DURANGO, CO
(Drainage Area: 692 square miles, Length of Record: 116 years)
28-day average discharge, in cubic feet per second
7000
1000
100
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
2013
2014
USGS WaterWatch
Last updated: 2014-12-08

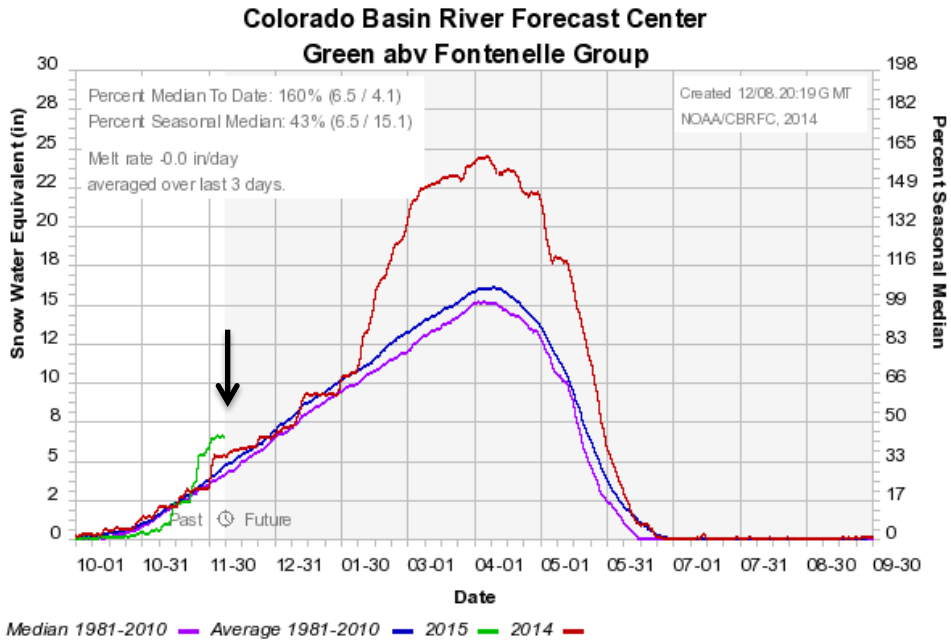

USGS 10128500 WEBER RIVER NEAR OAKLEY, UT
(Drainage Area: 162 square miles, Length of Record: 109 years)
28-day average discharge, in cubic feet per second
3000
1000
100
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
2013
2014
USGS WaterWatch
Last updated: 2014-12-08

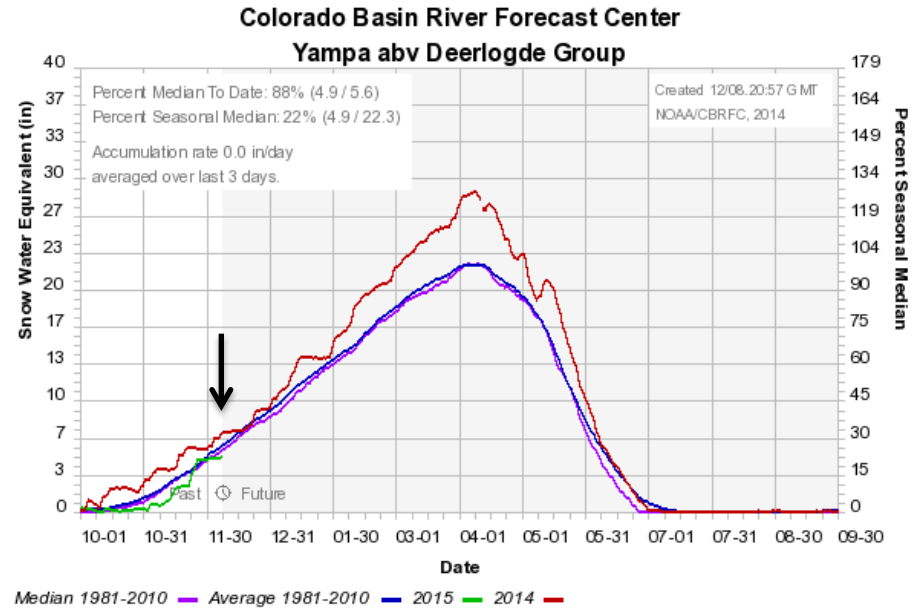

USGS 09406000 VIRGIN RIVER AT VIRGIN, UT
(Drainage Area: 956 square miles, Length of Record: 104 years)
28-day average discharge, in cubic feet per second
2000
1000
100
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
2013
2014
USGS WaterWatch
Last updated: 2014-12-08

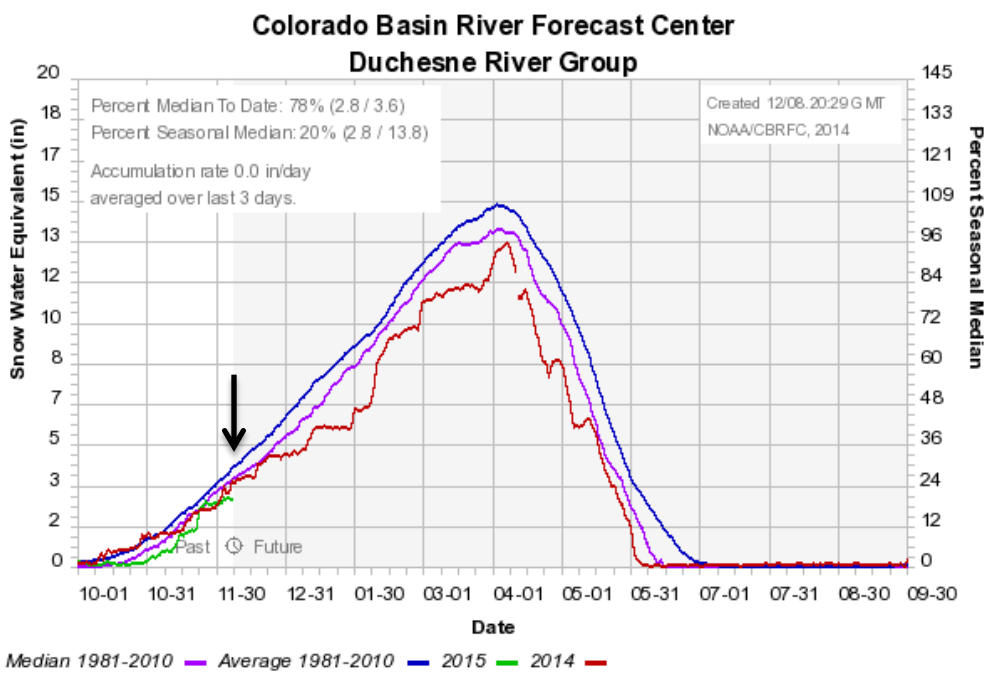

USGS 09498500 SALT RIVER NEAR ROOSEVELT, AZ
(Drainage Area: 4306 square miles, Length of Record: 100 years)
28-day average discharge, in cubic feet per second
20000
10000
1000
100
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
2013
2014
USGS WaterWatch
Last updated: 2014-12-08

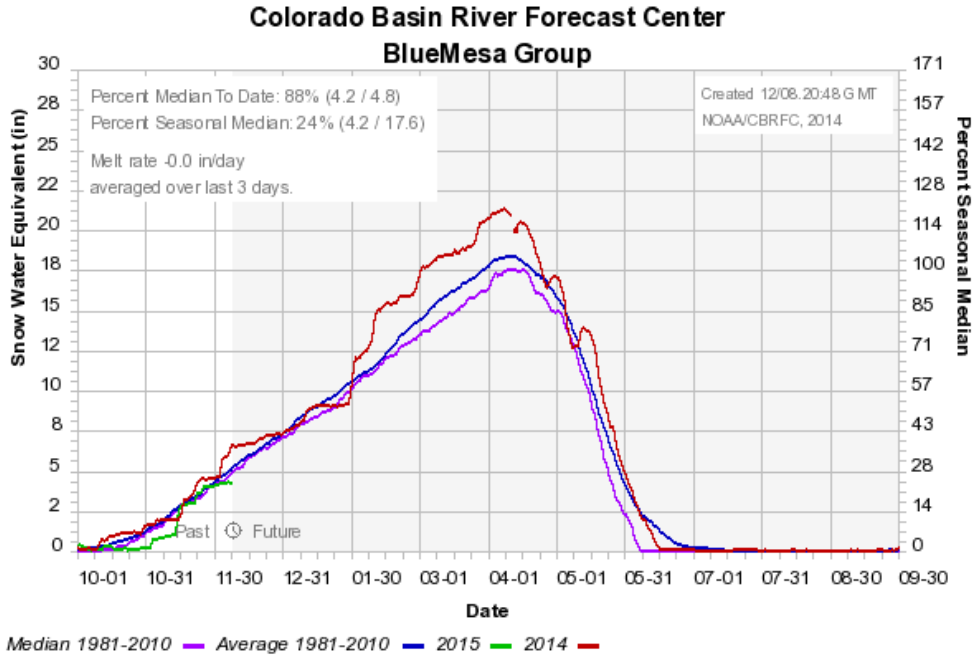
SNOW
DEC 8 2014

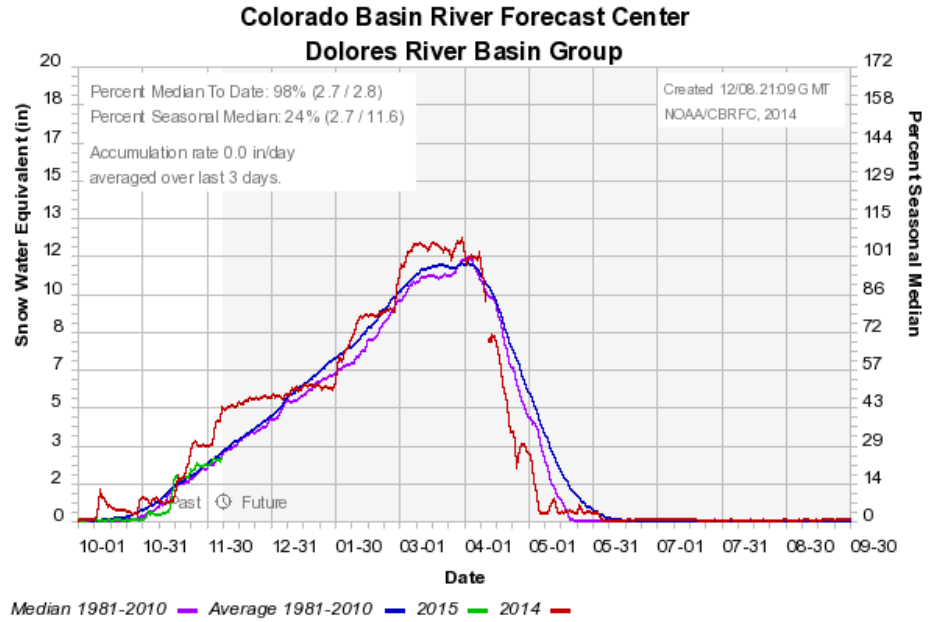


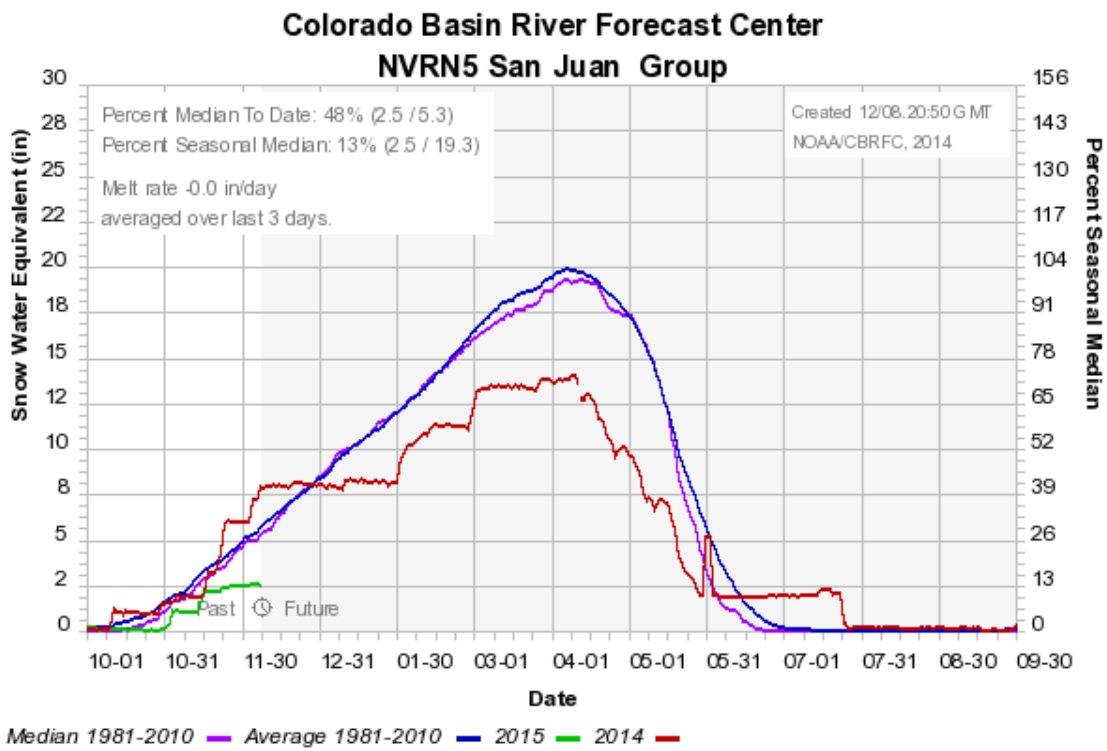

Colorado Basin River Forecast Center
Green abv Fontenelle Group
Percent Median To Date: 160% (6.5 / 4.1)
Percent Seasonal Median: 43% (6.5 / 15.1)
Melt rate -0.0 in/day
averaged over last 3 days.
Created 12/08.20:19 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
Median 1981-2010
Average 1981-2010
2015
2014

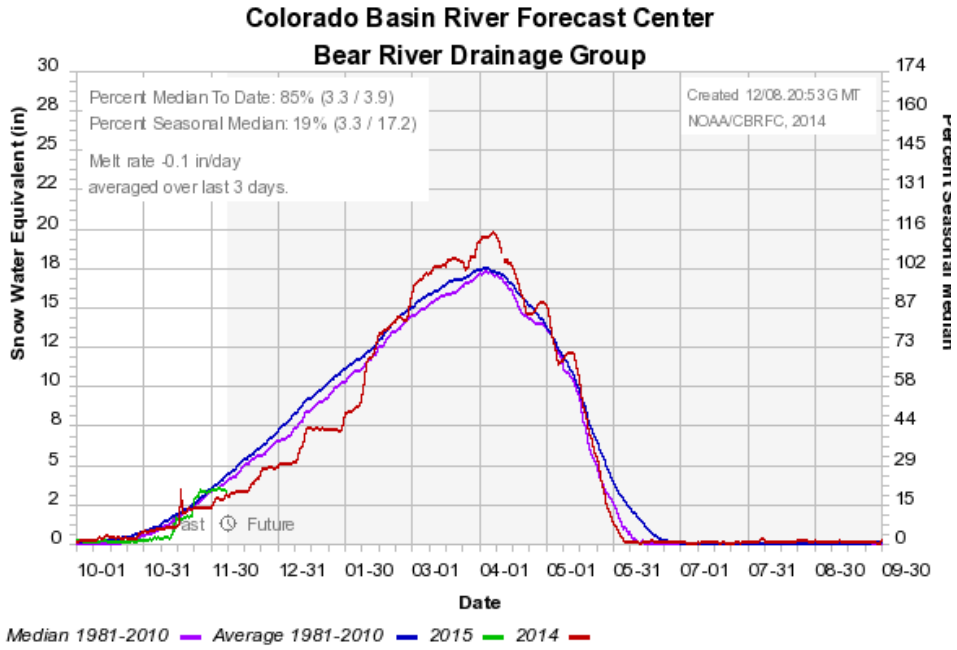

Colorado Basin River Forecast Center
Yampa abv Deerlogde Group
Percent Median To Date: 88% (4.9 / 5.6)
Percent Seasonal Median: 22% (4.9 / 22.3)
Accumulation rate 0.0 in/day
averaged over last 3 days.
Created 12/08.20:57 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
Median 1981-2010
Average 1981-2010
2015
2014

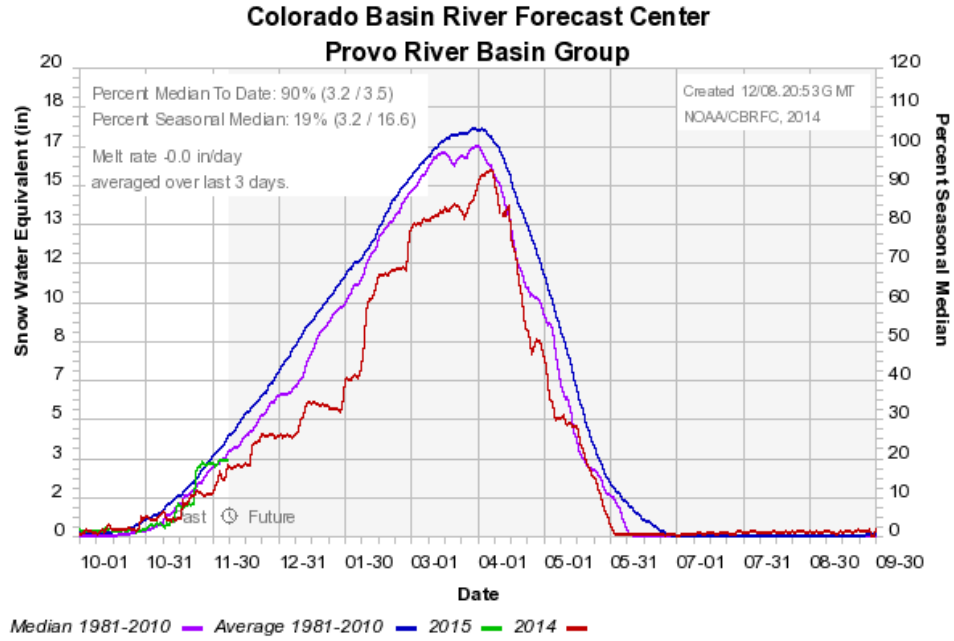

Colorado Basin River Forecast Center
Duchesne River Group
Percent Median To Date: 78% (2.8 / 3.6)
Percent Seasonal Median: 20% (2.8 / 13.8)
Accumulation rate 0.0 in/day
averaged over last 3 days.
Created 12/08.20:29 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
Median 1981-2010
Average 1981-2010
2015
2014

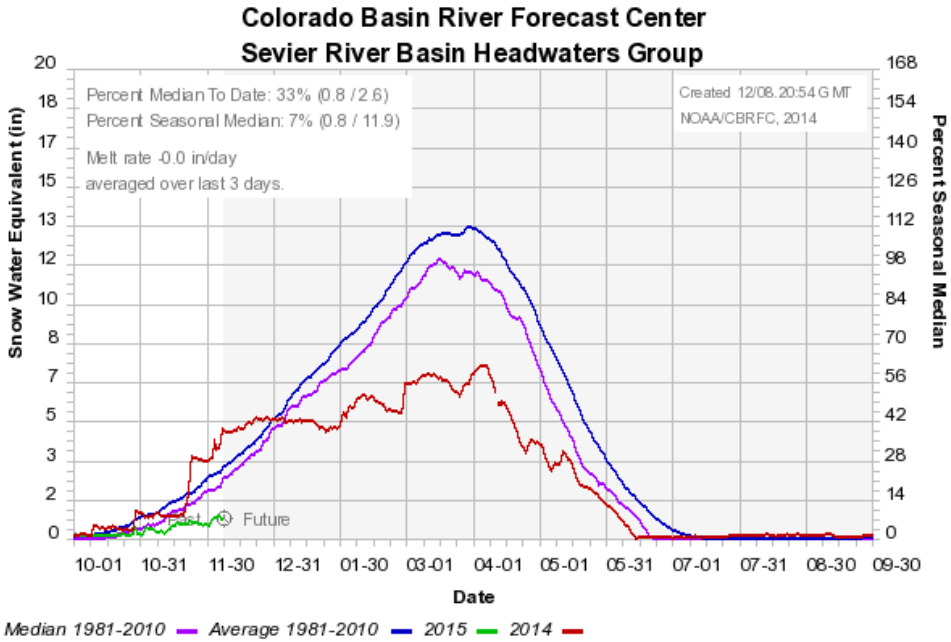

Colorado Basin River Forecast Center
BlueMesa Group
Percent Median To Date: 88% (4.2 / 4.8)
Percent Seasonal Median: 24% (4.2 / 17.6)
Melt rate -0.0 in/day
averaged over last 3 days.
Created 12/08. 20:48 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
Median 1981-2010
Average 1981-2010
2015
2014

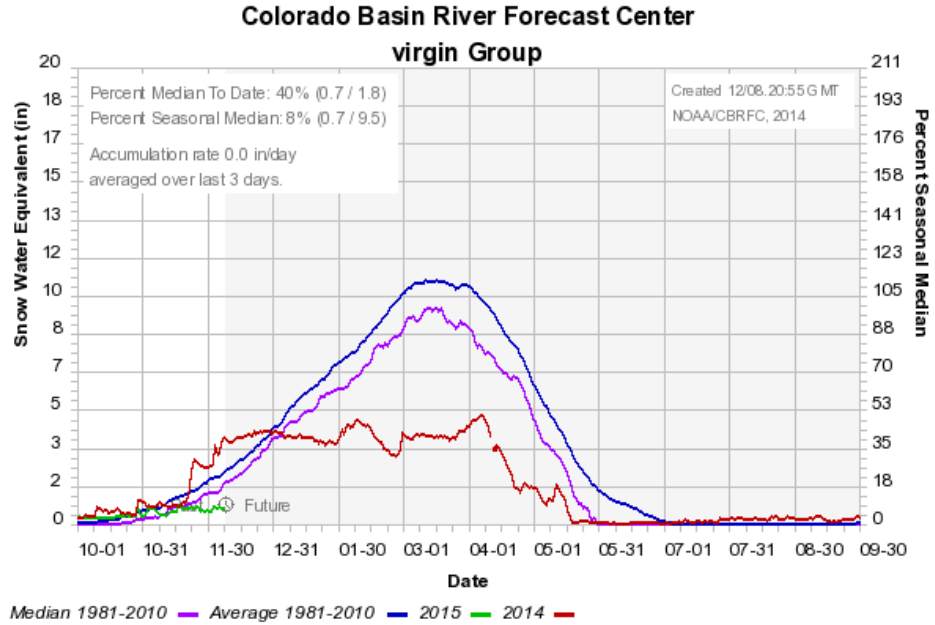

Colorado Basin River Forecast Center
Dolores River Basin Group
Percent Median To Date: 98% (2.7 / 2.8)
Percent Seasonal Median: 24% (2.7 / 11.6)
Accumulation rate 0.0 in/day
averaged over last 3 days.
Created 12/08. 21:09 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
Median 1981-2010
Average 1981-2010
2015
2014


Colorado Basin River Forecast Center
NVRN5 San Juan Group
Percent Median To Date: 48% (2.5 / 5.3)
Percent Seasonal Median: 13% (2.5 / 19.3)
Melt rate -0.0 in/day
averaged over last 3 days.
Created 12/08. 20:50 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
Median 1981-2010
Average 1981-2010
2015
2014


Colorado Basin River Forecast Center
Bear River Drainage Group
Percent Median To Date: 85% (3.3 / 3.9)
Percent Seasonal Median: 19% (3.3 / 17.2)
Melt rate -0.1 in/day
averaged over last 3 days.
Created 12/08.20:53 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Date
Past
Future
Median 1981-2010
Average 1981-2010
2015
2014


Colorado Basin River Forecast Center
Provo River Basin Group
Percent Median To Date: 90% (3.2 / 3.5)
Percent Seasonal Median: 19% (3.2 / 16.6)
Melt rate -0.0 in/day
averaged over last 3 days.
Created 12/08.20:53 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Date
Past
Future
Median 1981-2010
Average 1981-2010
2015
2014

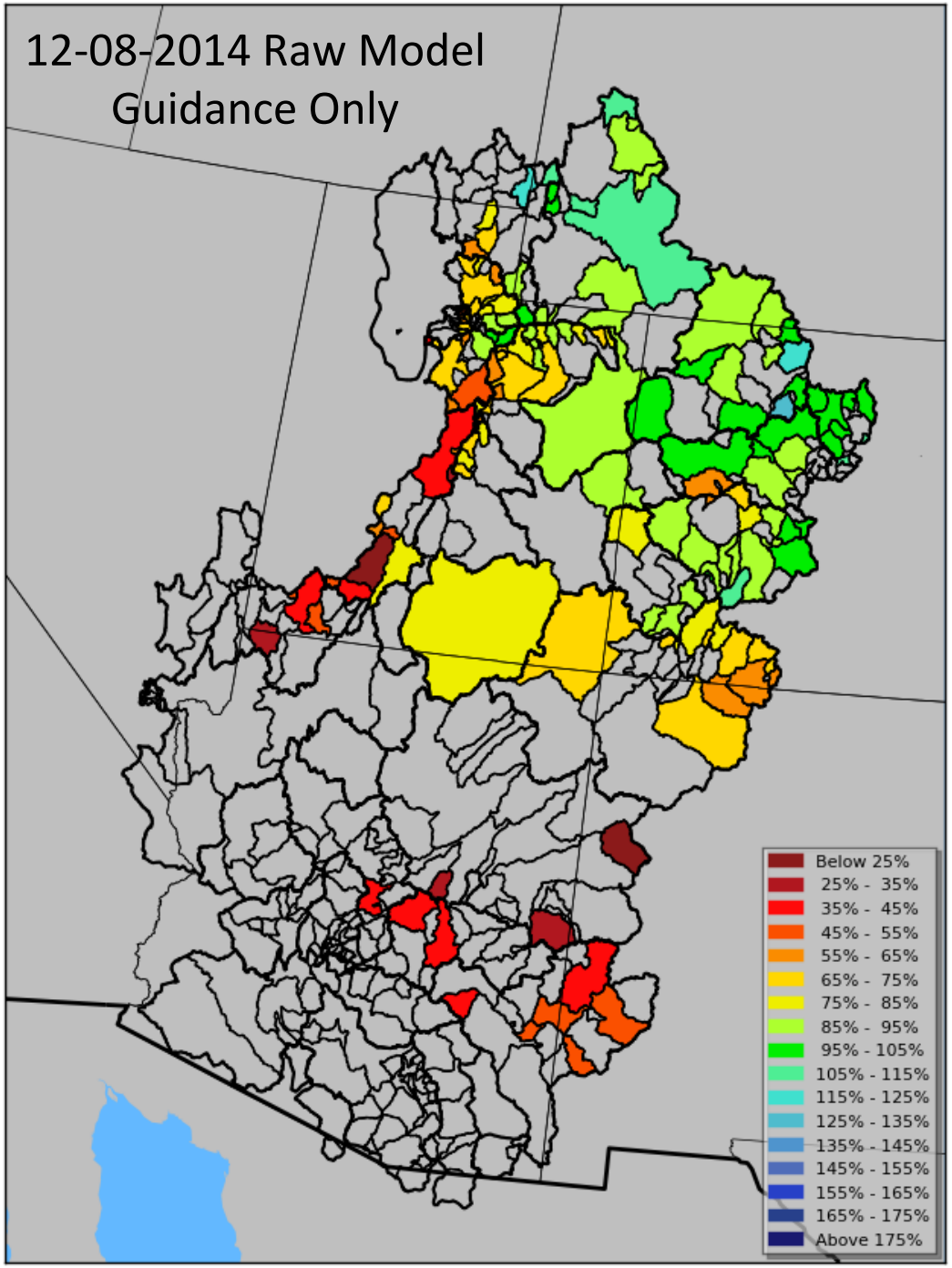

Colorado Basin River Forecast Center
Sevier River Basin Headwaters Group
Percent Median To Date: 33% (0.8 / 2.6)
Percent Seasonal Median: 7% (0.8 / 11.9)
Melt rate -0.0 in/day
averaged over last 3 days.
Created 12/08.20:54 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Date
Future
Median 1981-2010
Average 1981-2010
2015
2014

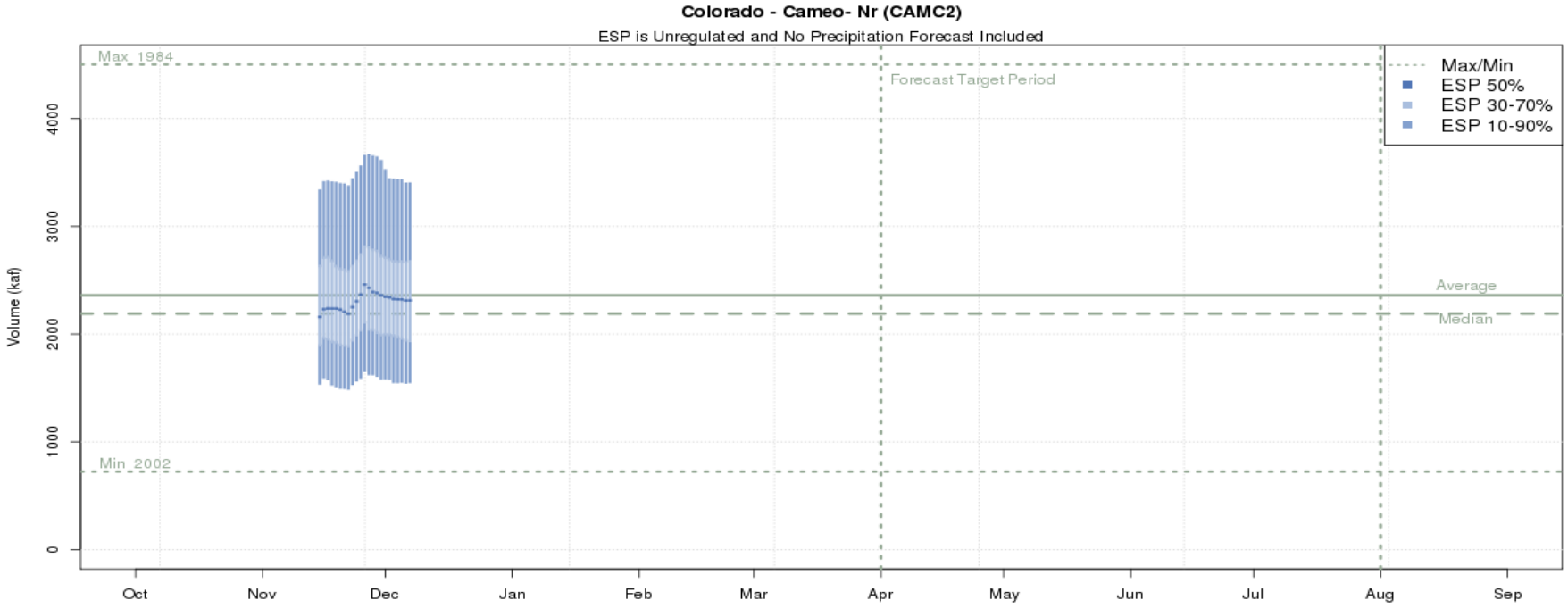

Colorado Basin River Forecast Center
virgin Group
Percent Median To Date: 40% (0.7 / 1.8)
Percent Seasonal Median: 8% (0.7 / 9.5)
Accumulation rate 0.0 in/day
averaged over last 3 days.
Created 12/08.20:55 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
Percent Seasonal Median
Date
Future
Median 1981-2010
Average 1981-2010
2015
2014

How is the model trending ?

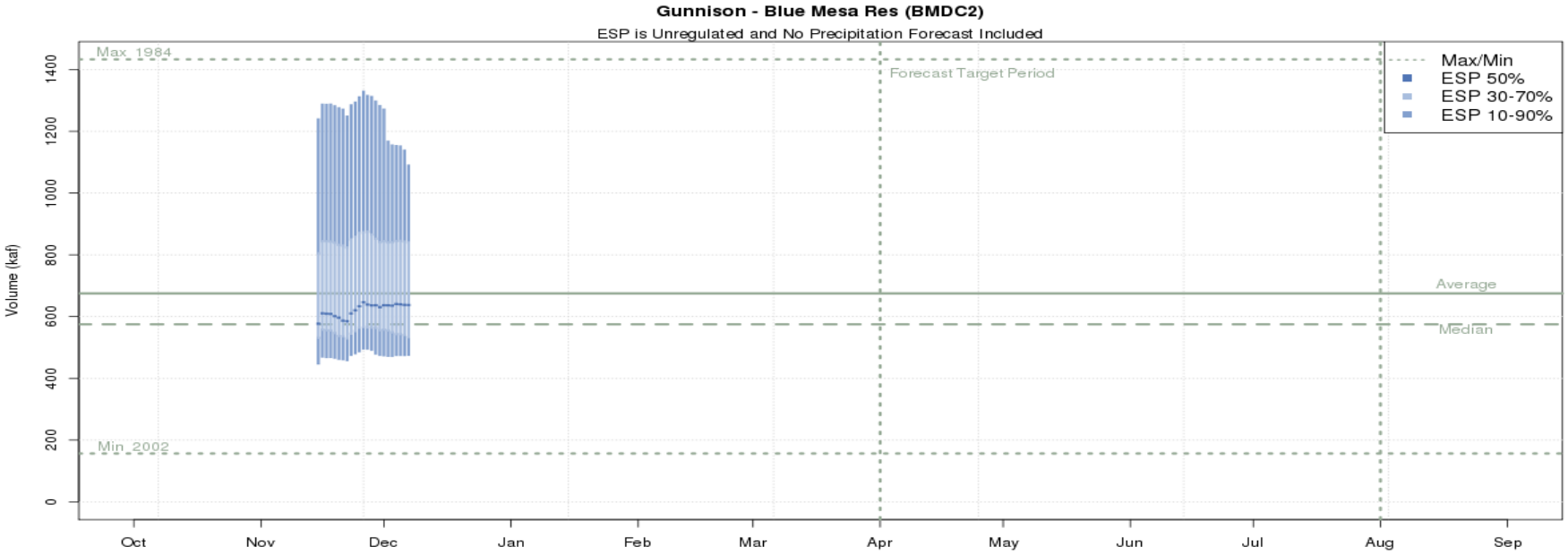
April-July Runoff Volumes

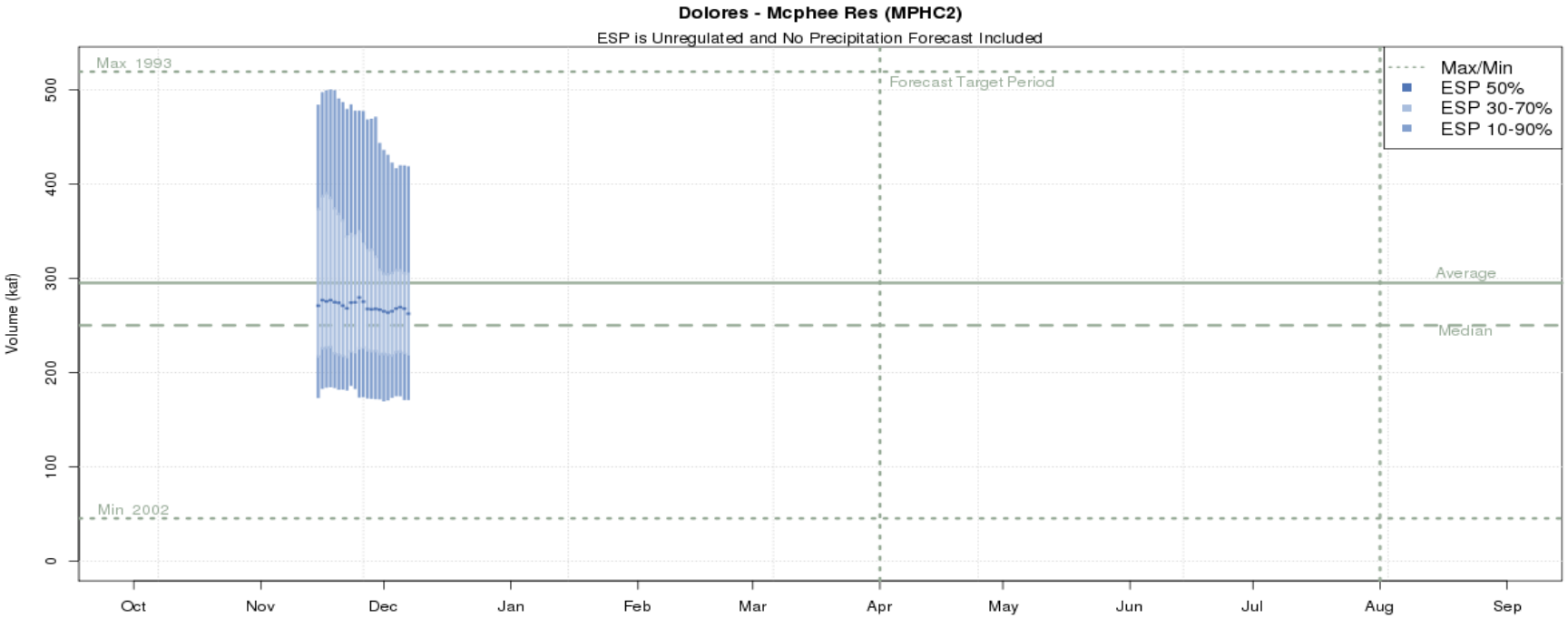
Jan-May Runoff Volumes Salt-Verde-Gila



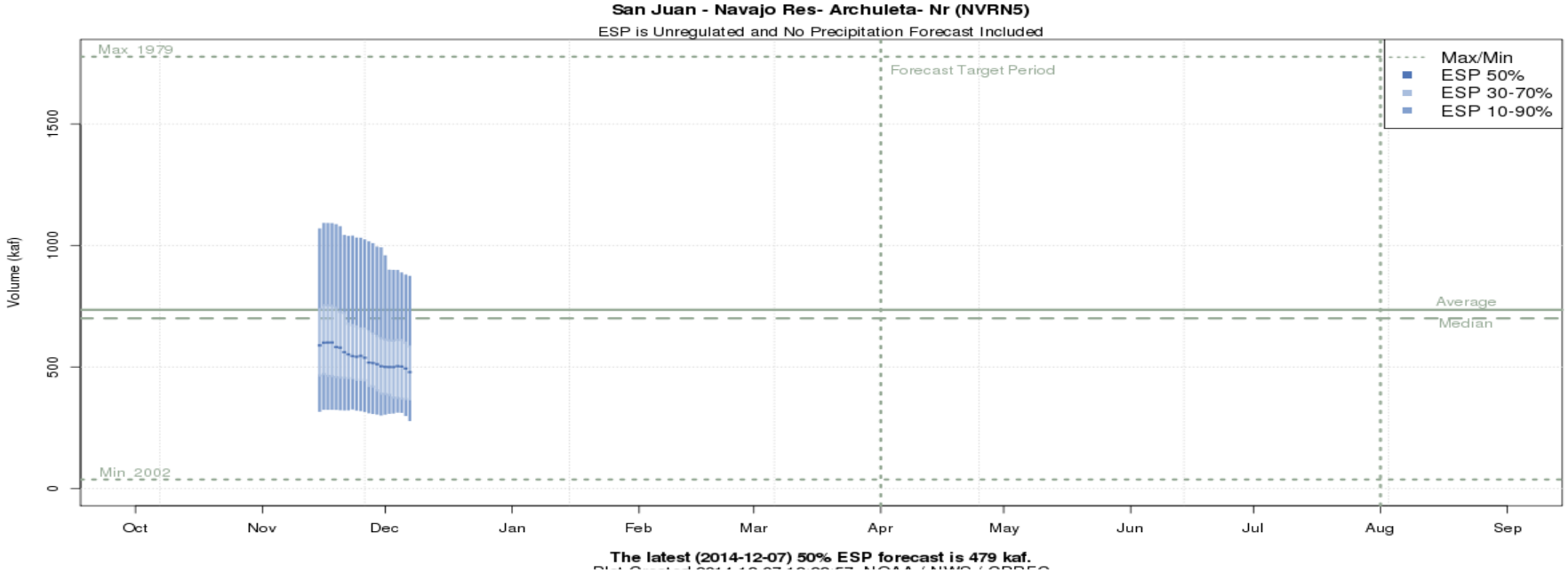


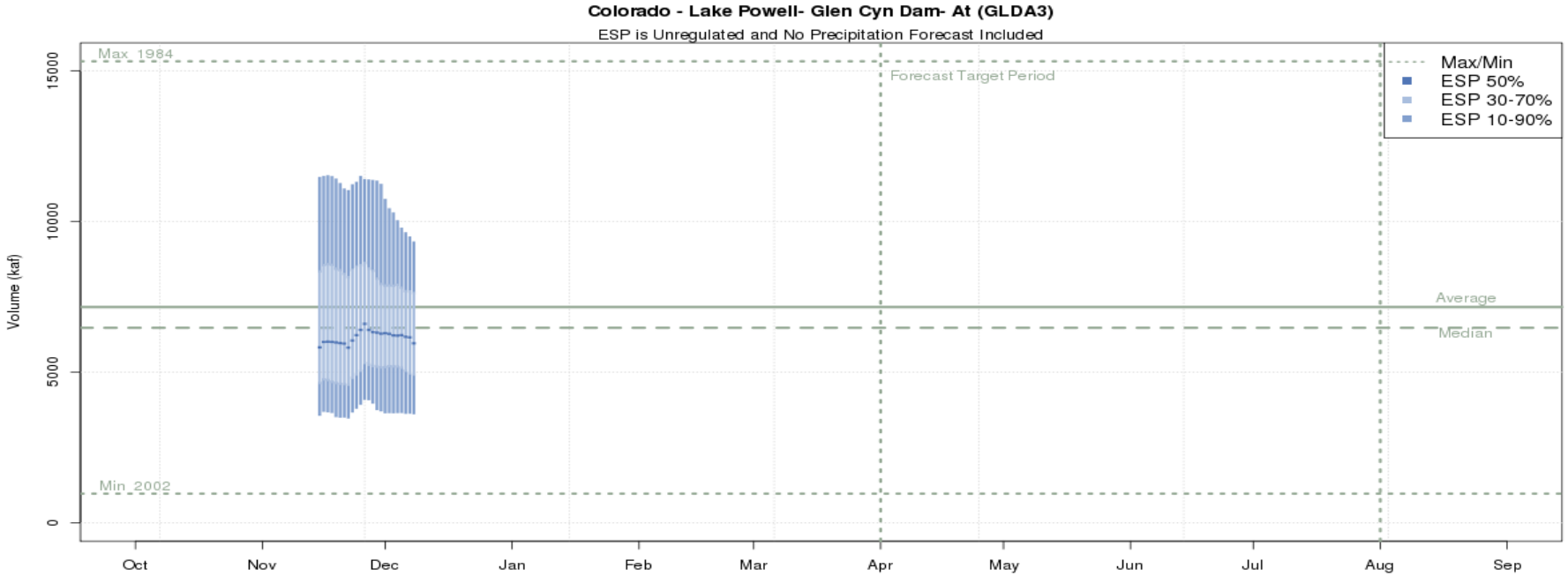
The latest (2014-12-07) 50% ESP forecast is 2313 kaf.
Plot Created 2014-12-07 12:04:51, NOAA / NWS / CBRFC



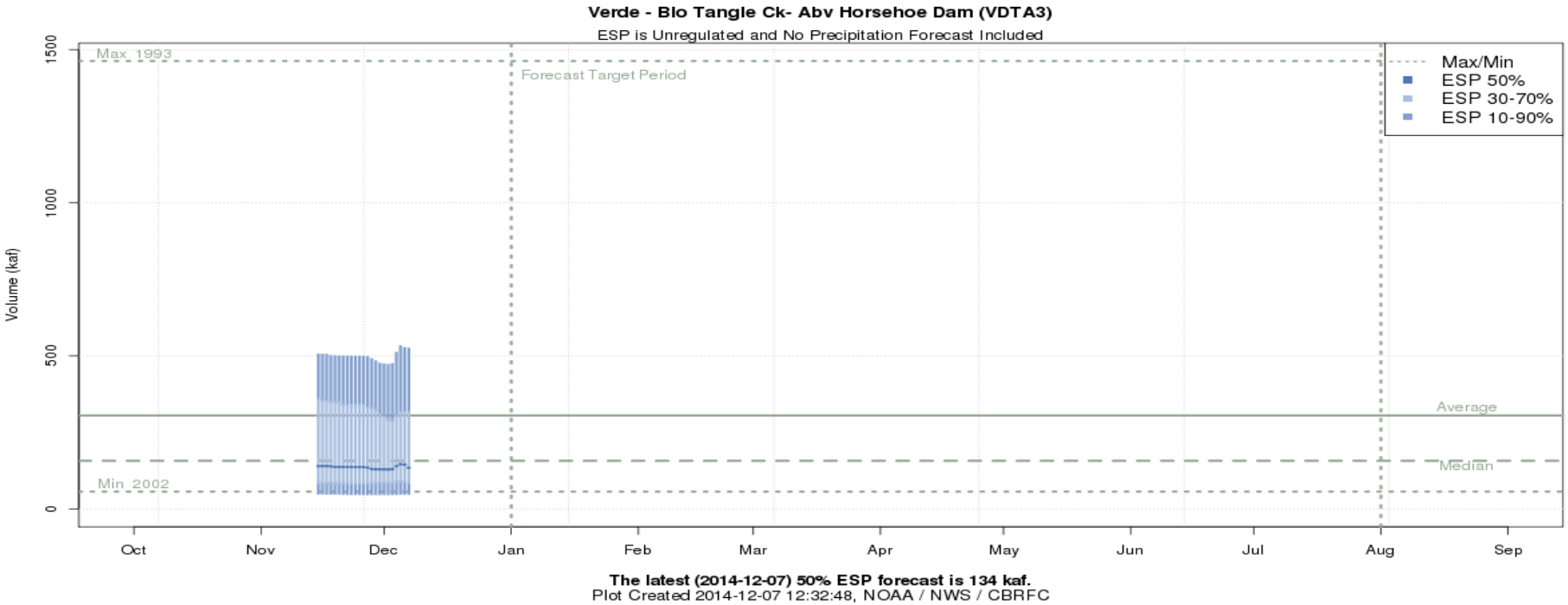


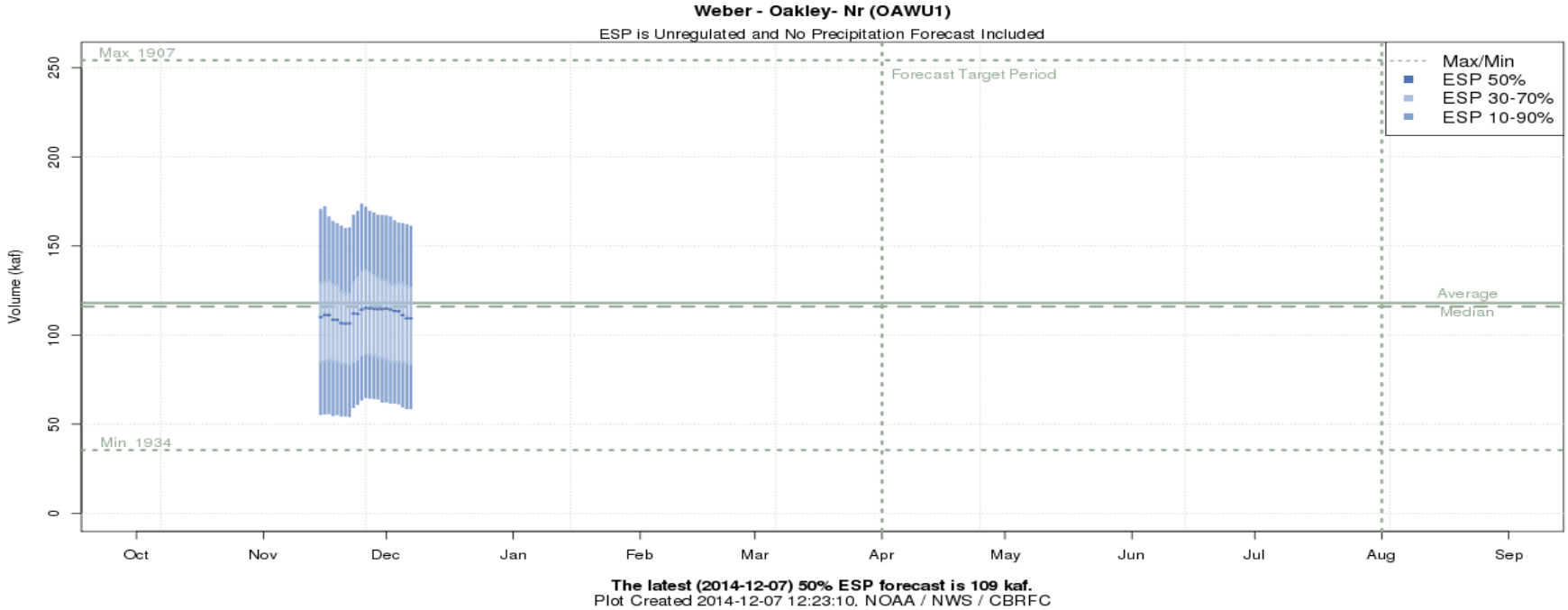
The latest (2014-12-07) 50% ESP forecast is 262 kaf.
Plot Created 2014-12-07 12:21:51, NOAA / NWS / CBRFC

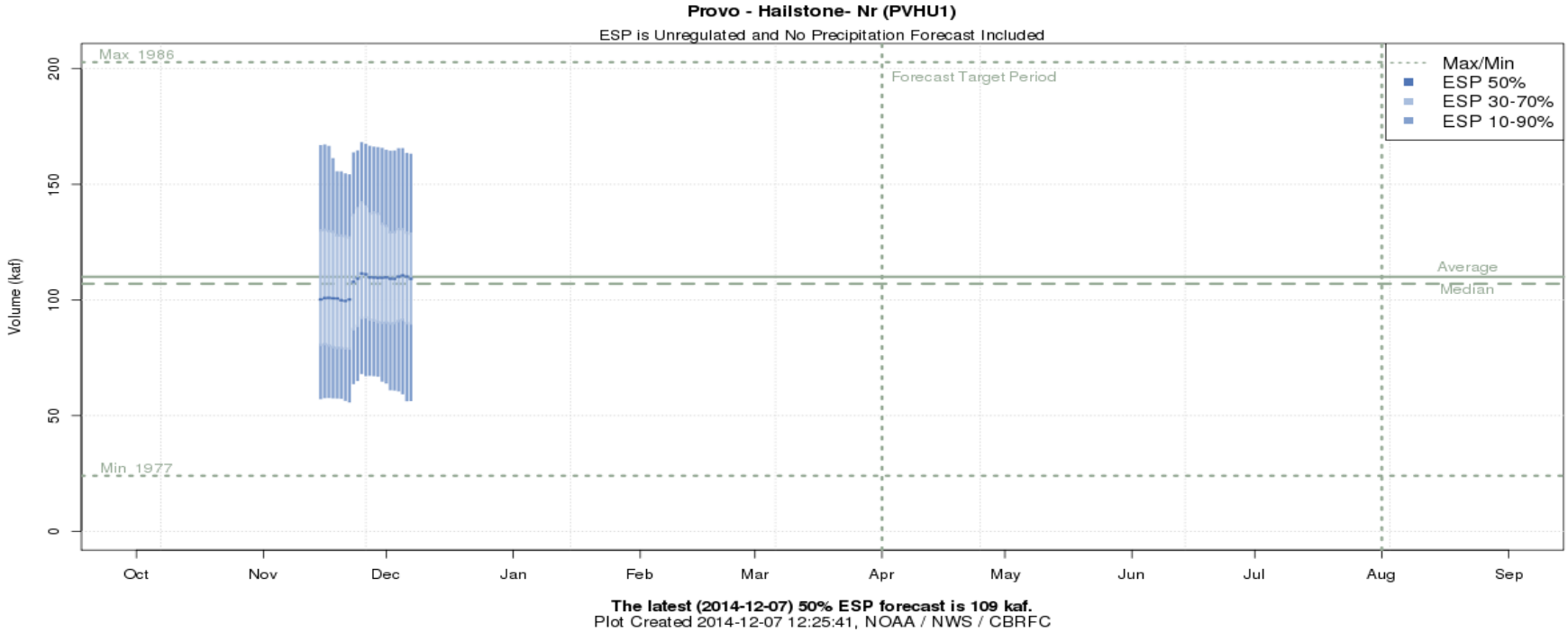

San Juan - Navajo Res- Archuleta- Nr (NVRN5)
ESP is Unregulated and No Precipitation Forecast Included
Max 1979
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
Average
Median
Min 2002
Volume (kaf)
0
500
1000
1500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
The latest (2014-12-07) 50% ESP forecast is 479 kaf.


Colorado - Lake Powell- Glen Cyn Dam- At (GLDA3)
ESP is Unregulated and No Precipitation Forecast Included
Max 1984
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
Average
Median
Min 2002
Volume (kaf)
0
5000
10000
15000
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
The latest (2014-12-08) 50% ESP forecast is 5954 kaf.
Plot Created 2014-12-09 07:21:55, NOAA / NWS / CBRFC

Virgin - Virgin (VIRU1)
ESP is Unregulated and No Precipitation Forecast Included
Max 2005
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
Average
Median
Min 2002
Volume (kaf)
0
50
100
150
200
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
The latest (2014-12-07) 50% ESP forecast is 31 kaf.
Plot Created 2014-12-07 12:33:01, NOAA / NWS / CBRFC


Verde - Blo Tangle Ck- Abv Horsehoe Dam (VDTA3)
ESP is Unregulated and No Precipitation Forecast Included
Max 1993
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
Average
Median
Min 2002
Volume (kaf)
0
500
1000
1500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
The latest (2014-12-07) 50% ESP forecast is 134 kaf.
Plot Created 2014-12-07 12:32:48, NOAA / NWS / CBRFC


Weber - Oakley- Nr (OAWU1)
ESP is Unregulated and No Precipitation Forecast Included
Max 1907
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
Average
Median
Min 1934
Volume (kaf)
0
50
100
150
200
250
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
The latest (2014-12-07) 50% ESP forecast is 109 kaf.
Plot Created 2014-12-07 12:23:10, NOAA / NWS / CBRFC


Provo - Hailstone- Nr (PVHU1)
ESP is Unregulated and No Precipitation Forecast Included
Max 1986
Forecast Target Period
Max/Min
ESP 50%
ESP 30-70%
ESP 10-90%
Average
Median
Min 1977
Volume (kaf)
0
50
100
150
200
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
The latest (2014-12-07) 50% ESP forecast is 109 kaf.
Plot Created 2014-12-07 12:25:41, NOAA / NWS / CBRFC

Short Term Weather Outlook
&
Long Term Winter Outlook

El Nino: 65% chance of a weak El Nino

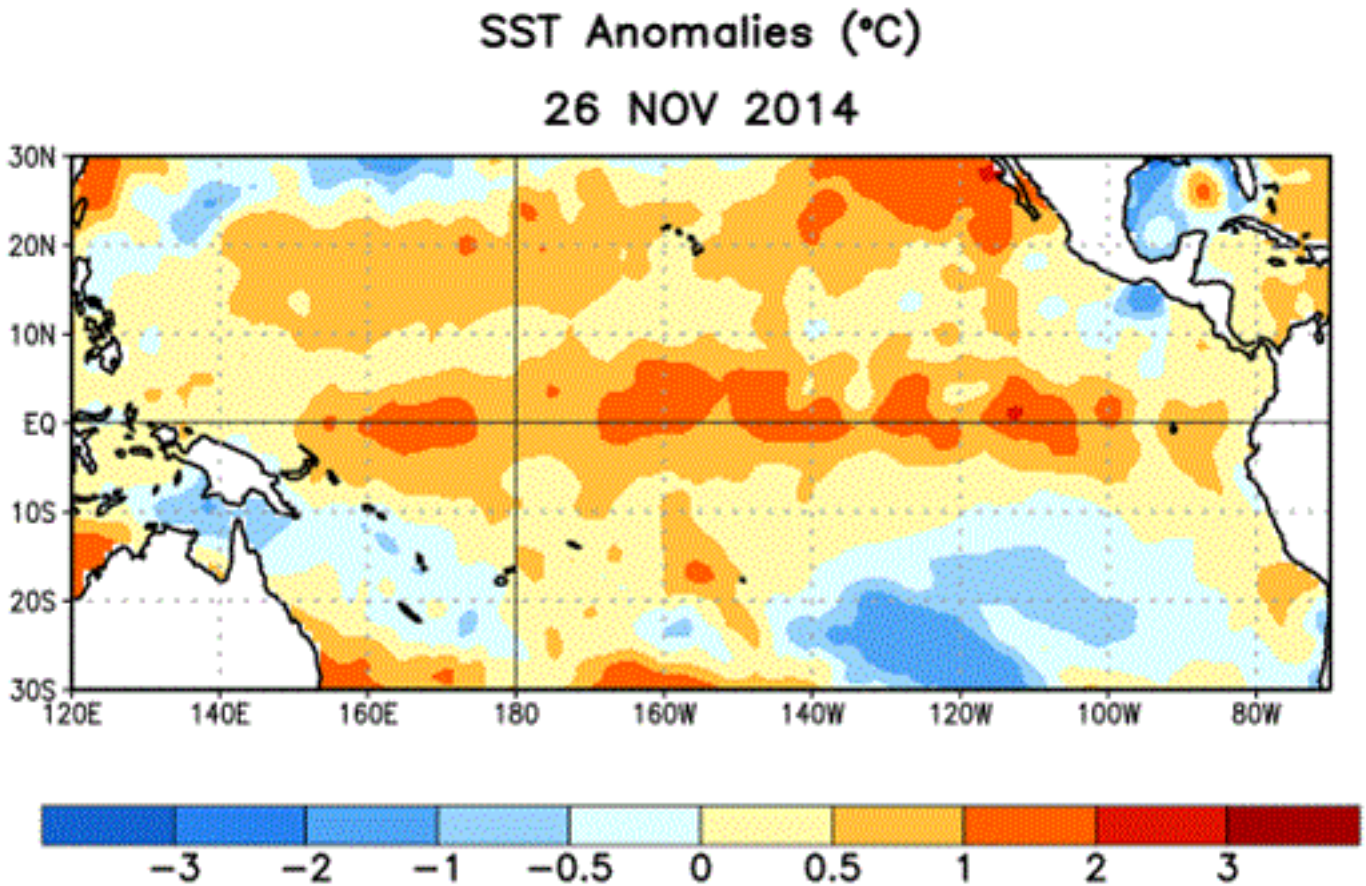
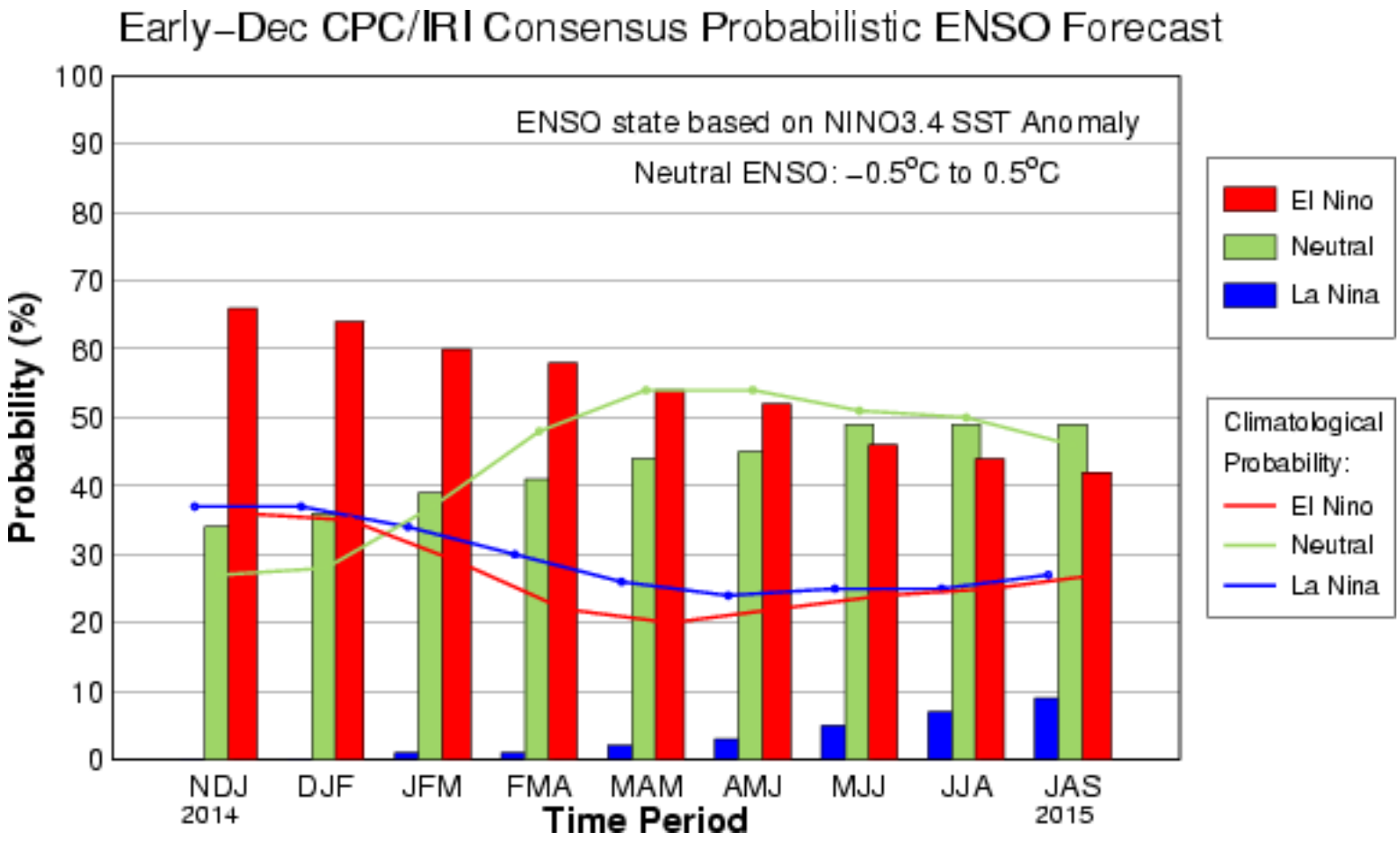
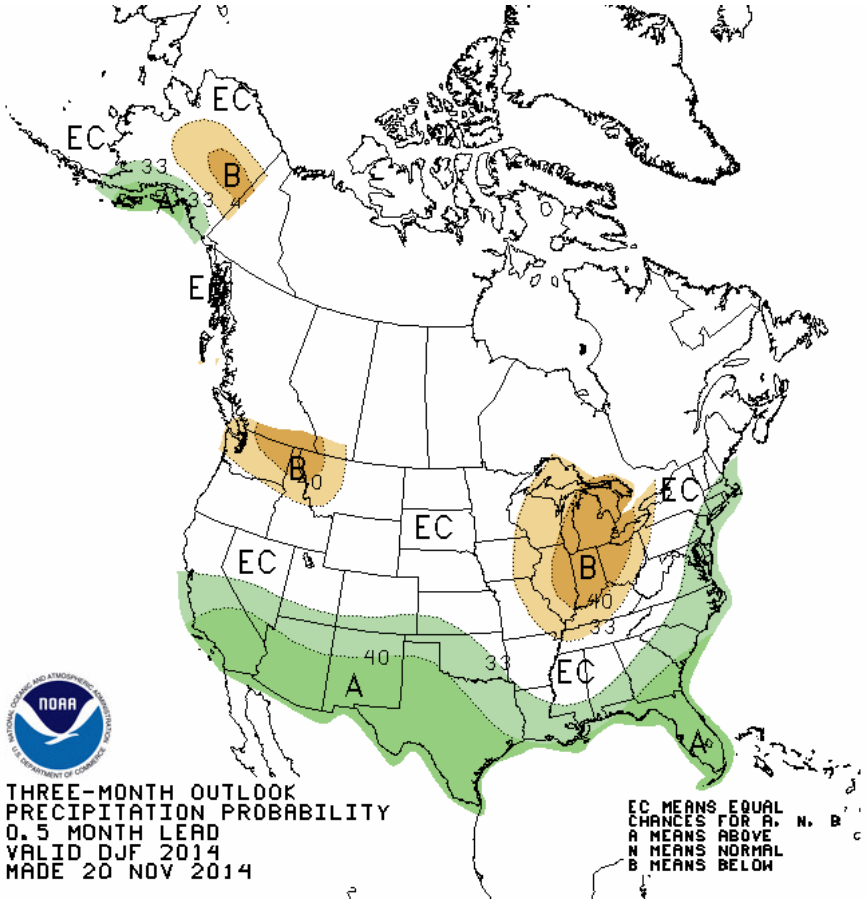
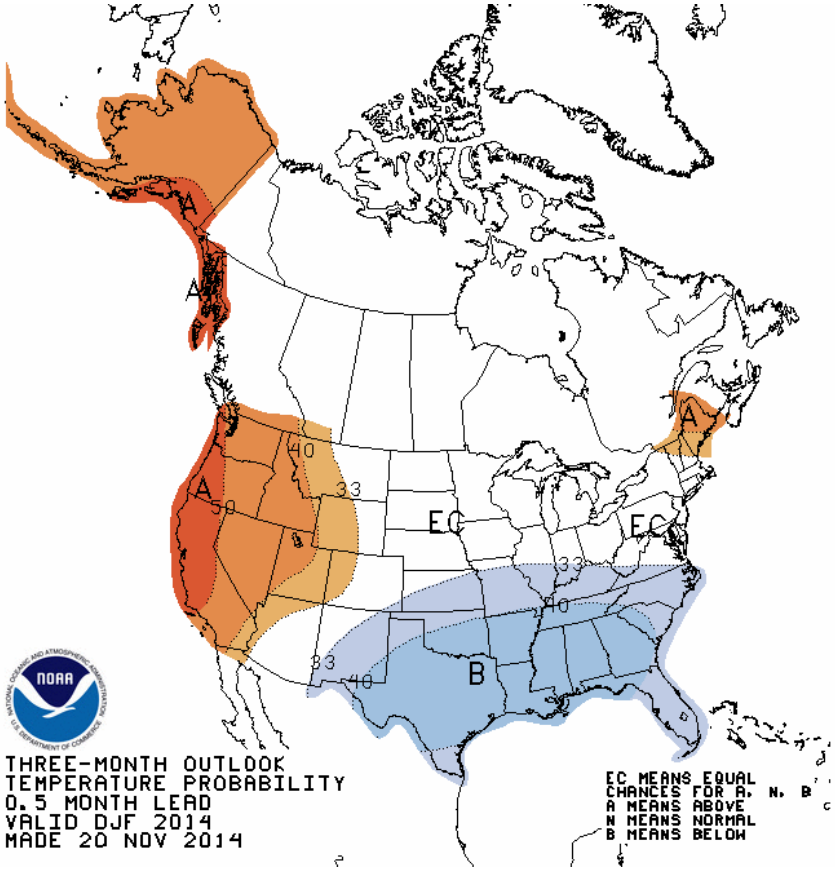


Figure 1. Average sea surface temperature (SST) anomalies (°C) for the week centered on 26 November 2014. Anomalies are computed with respect to the 1981-2010 base period weekly means.

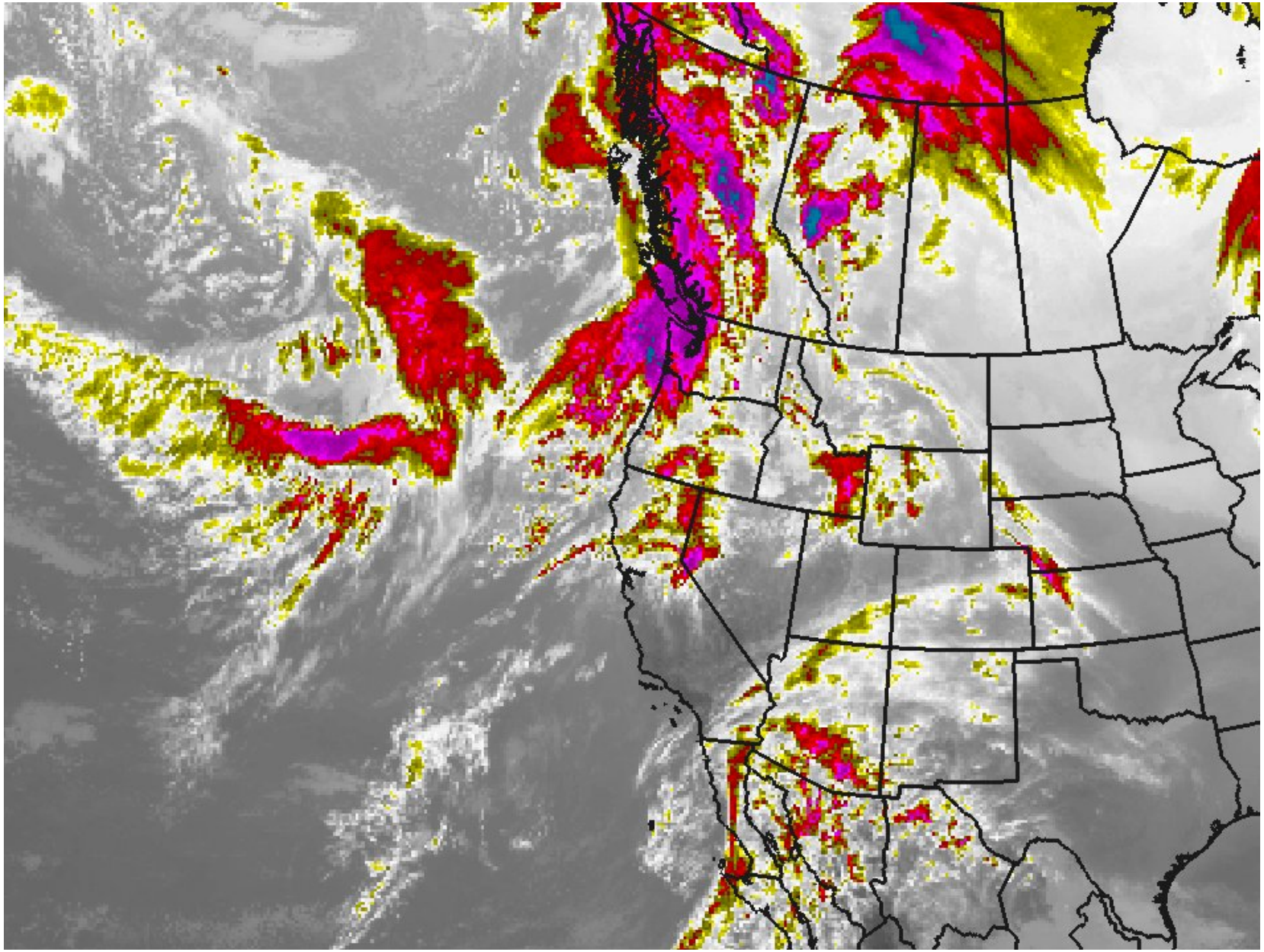

Early–Dec CPC/IRI Consensus Probabilistic ENSO Forecast
ENSO state based on NINO3.4 SST Anomaly
Neutral ENSO: –0.5°C to 0.5°C
Probability (%)
100
90
80
70
60
50
40
30
20
10
0
NDJ
2014
DJF
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
2015
Time Period
El Nino
Neutral
La Nina
Climatological Probability:
El Nino
Neutral
La Nina

Winter Precipitation and Temperature Outlook

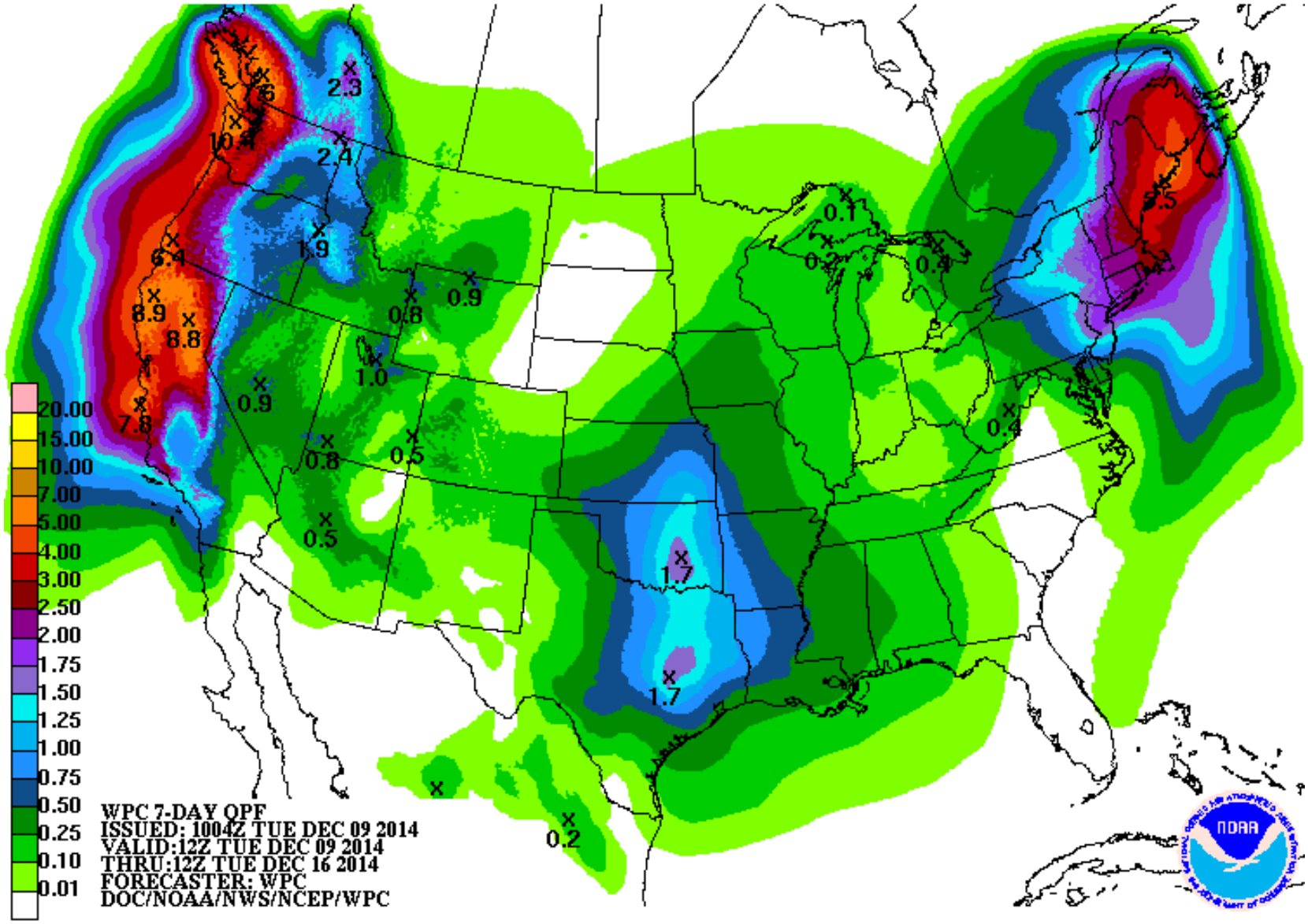




Short Term: Progressive Pattern but weak storm systems



Weather Prediction Center: 7-Day Precipitation Forecast



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

2015 Water Supply Forecasters

Green River Basin	Ashley Nielson
Upper Colorado/Lake Powell	Brenda Alcorn
Gunnison/Dolores/San Juan	Greg Smith
Great Basin (Bear, Weber, Provo)	Paul Miller
Sevier /Virgin River / Arizona	Tracy Cox