CBRFC Water Supply Webinar
November 10, 2009

Outline

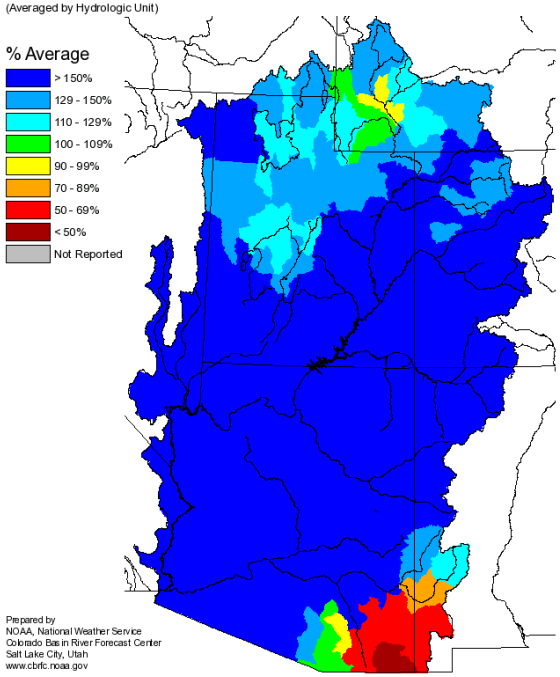
- 2009 Year in review
- 2010 Look ahead
  - Climate forecasts
  - CBRFC services
- Upper Colorado in detail

2009 Year in Review

- Precipitation, Temperature, and Snowfall Review
- Climate forecast verification
- Water Supply and Peak Flow Forecast Verification

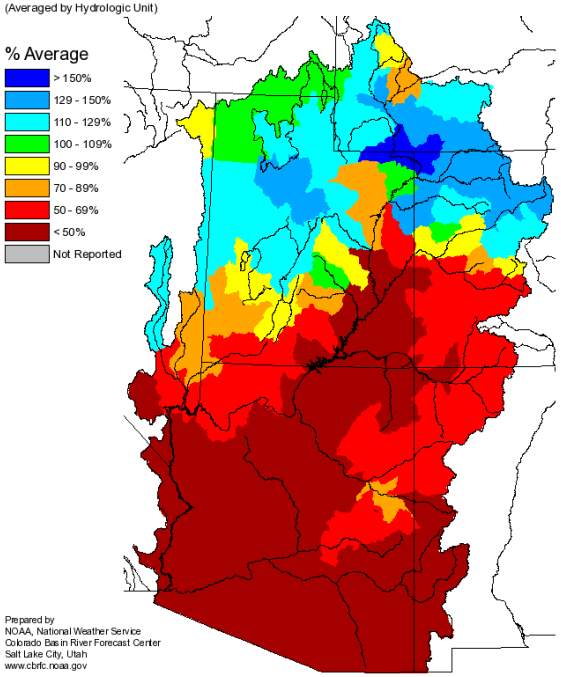
Monthly Precipitation for December 2008

(Averaged by Hydrologic Unit)



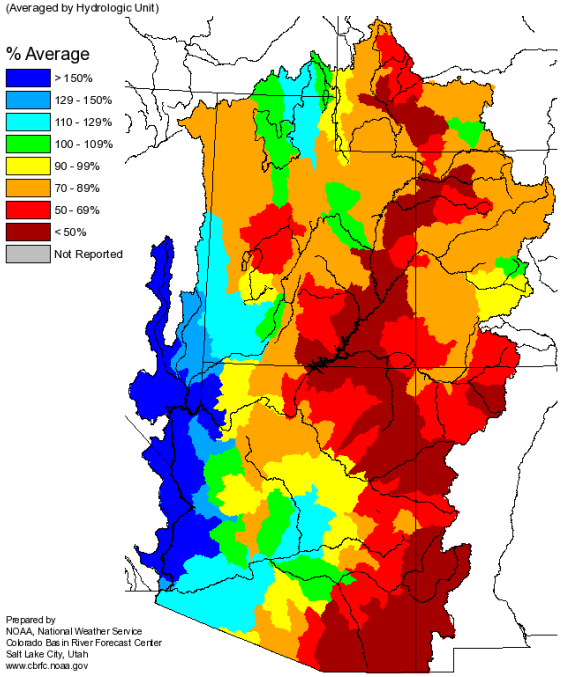
Monthly Precipitation for January 2009

(Averaged by Hydrologic Unit)



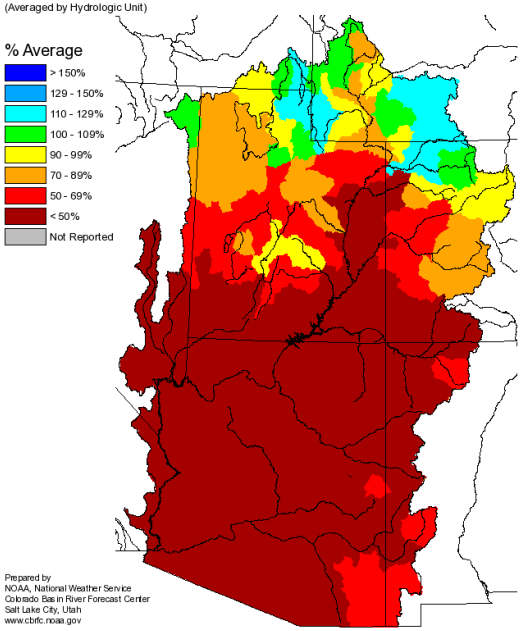
Monthly Precipitation for February 2009

(Averaged by Hydrologic Unit)



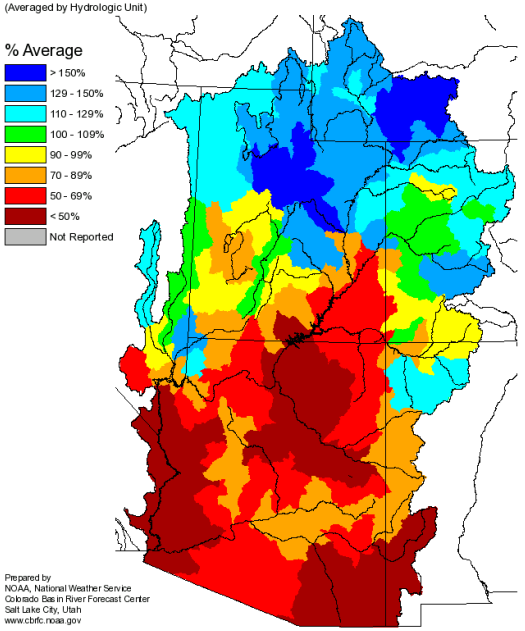
Monthly Precipitation for March 2009

(Averaged by Hydrologic Unit)



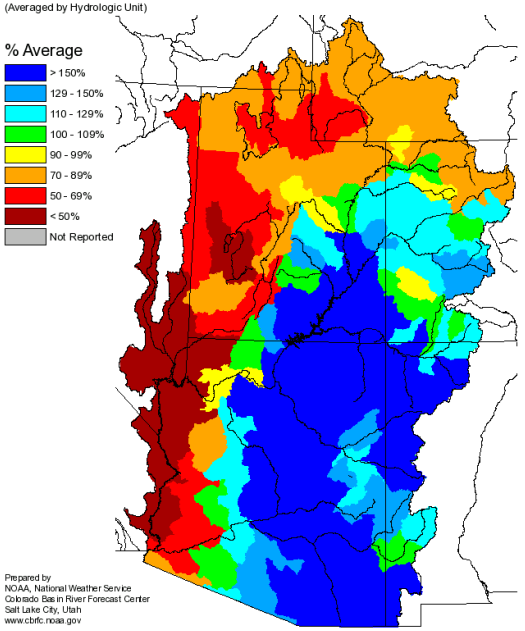
Monthly Precipitation for April 2009

(Averaged by Hydrologic Unit)



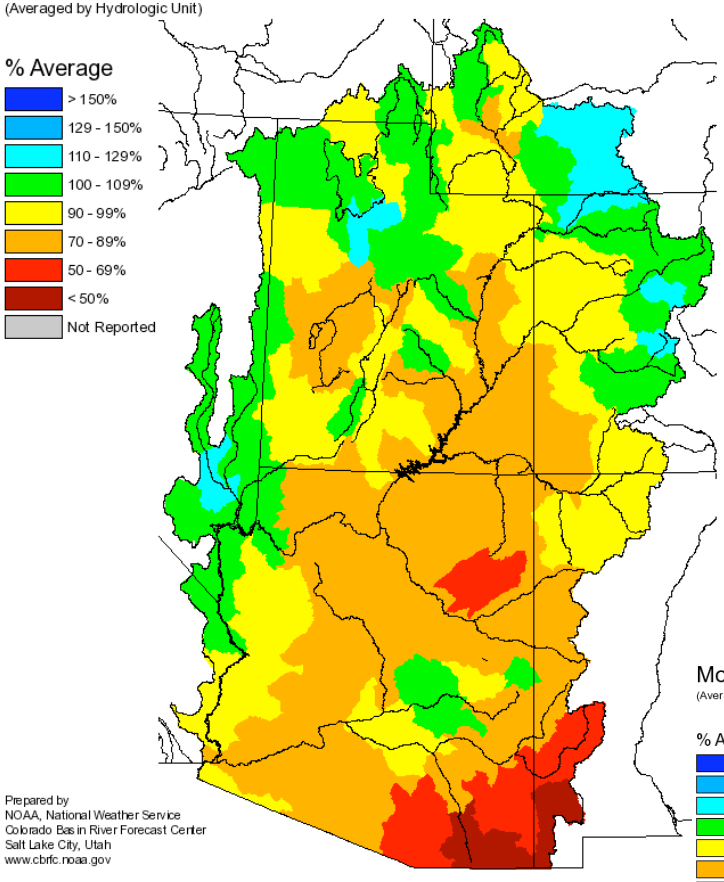
Monthly Precipitation for May 2009

(Averaged by Hydrologic Unit)



Seasonal Precipitation, October 2008 - May 2009

(Averaged by Hydrologic Unit)



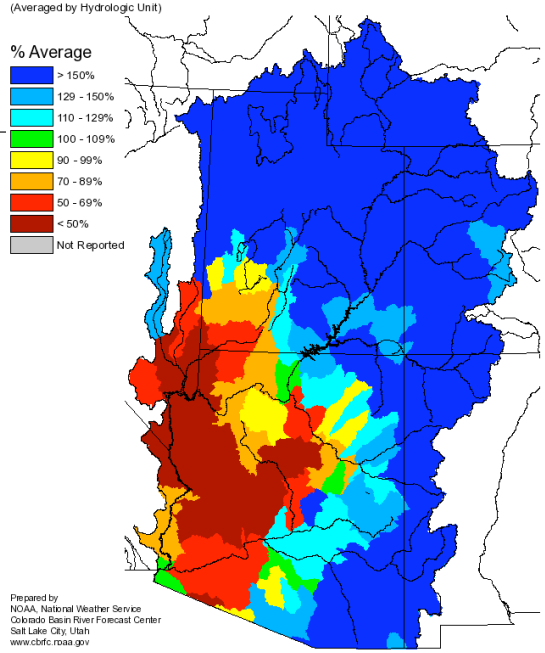
Prepared by
NOAA, National Weather Service
Colorado Basin River Forecast Center
Salt Lake City, Utah
www.cbrfc.noaa.gov

Seasonal Precipitation, October 2008 - June 2009

(Averaged by Hydrologic Unit)

Monthly Precipitation for June 2009

(Averaged by Hydrologic Unit)



Prepared by
NOAA, National Weather Service
Colorado Basin River Forecast Center
Salt Lake City, Utah
www.cbrfc.noaa.gov

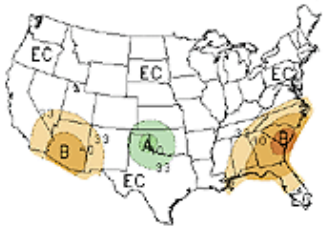
October, 2008 CPC climate outlooks

December - February 2008-09
Precipitation

Larger Map -- Show Legend

Type:	Precipitation
Season:	December-February 2008-09
Issue Date:	October 2008
Lead Time:	2 months

January - March 2009
Precipitation



Larger Map -- Show Legend

Type:	Precipitation
Season:	January-March 2009
Issue Date:	October 2008
Lead Time:	3 months

February - April 2009
Precipitation

Larger Map -- Show Legend

Type:	Precipitation
Season:	February-April 2009
Issue Date:	October 2008
Lead Time:	4 months

March - May 2009
Precipitation

Larger Map -- Show Legend

Type:	Precipitation
Season:	March-May 2009
Issue Date:	October 2008
Lead Time:	5 months

April - June 2009
Precipitation

Larger Map -- Show Legend

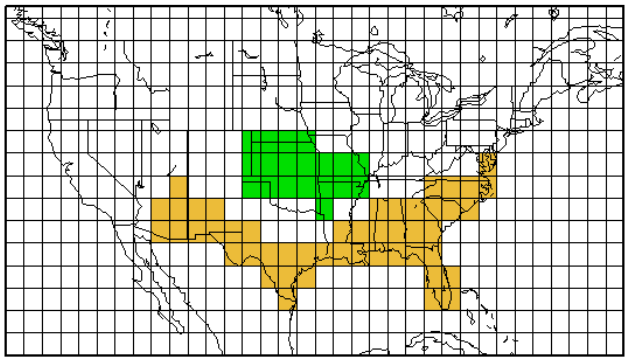
Type:	Precipitation
Season:	April-June 2009
Issue Date:	October 2008
Lead Time:	6 months

May - July 2009
Precipitation

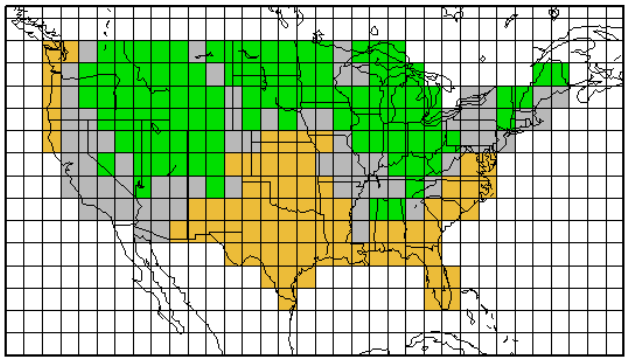
Larger Map -- Show Legend

Type:	Precipitation
Season:	May-July 2009
Issue Date:	October 2008
Lead Time:	7 months

Dec–Jan–Feb 2008–09 Prec Official_Forecast



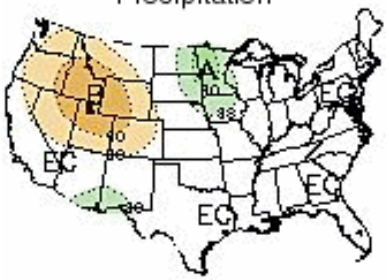
Dec–Jan–Feb 2008–09 Prec Obs_Categories



Sources: cpc.ncep.noaa.gov and fet.hwr.arizona.edu/ForecastEvaluationTool

April and May, 2009 CPC climate outlooks

May - July 2009
Precipitation



Larger Map -- Show Legend

Type:	Precipitation
Season:	May-July 2009
Issue Date:	April 2009
Lead Time:	1 month

June - August 2009
Precipitation

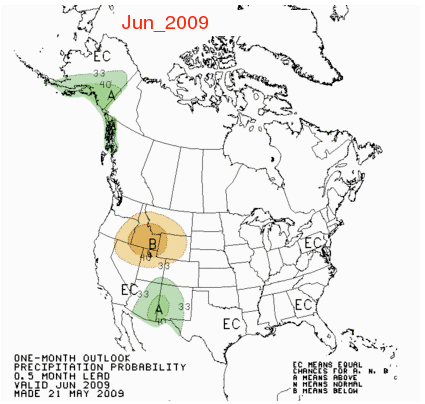
Larger Map -- Show Legend

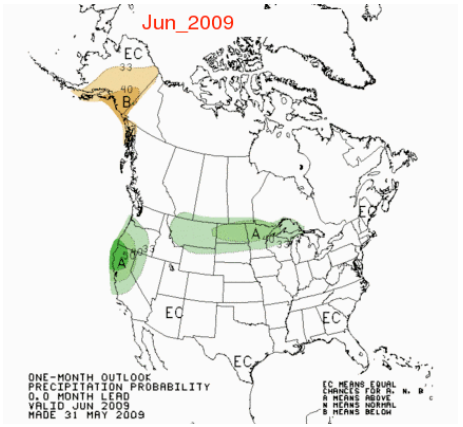
Type:	Precipitation
Season:	June-August 2009
Issue Date:	April 2009
Lead Time:	2 months

June - August 2009
Precipitation

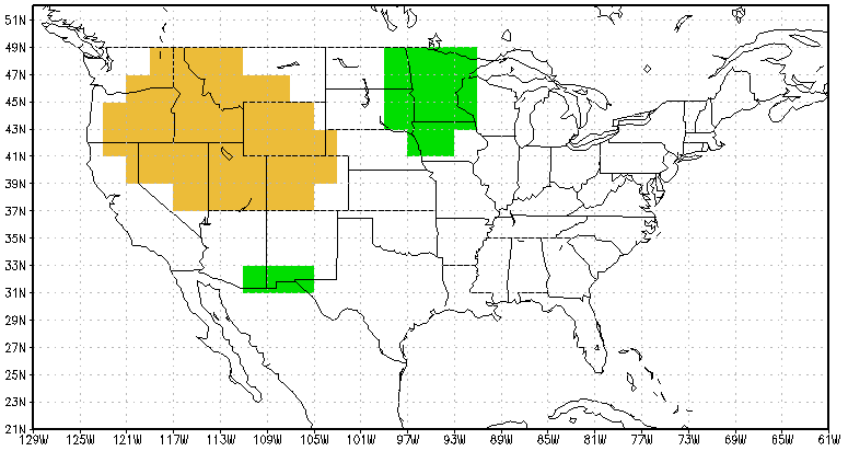
Larger Map -- Show Legend

Type:	Precipitation
Season:	June-August 2009
Issue Date:	May 2009
Lead Time:	1 month

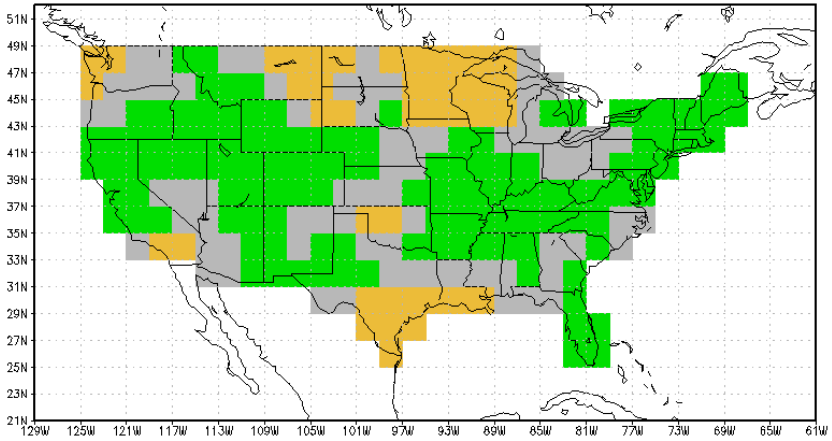




May-Jun-Jul 2009 Prec Official_Forecast



May-Jun-Jul 2009 Prec Obs_Categories

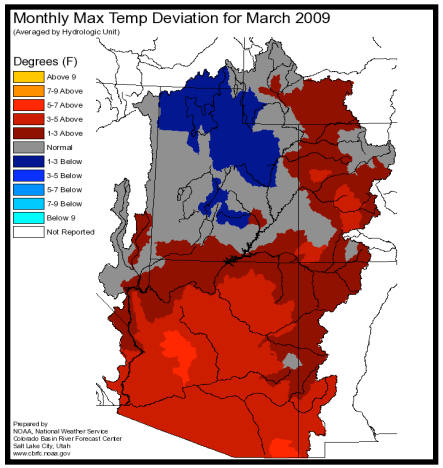


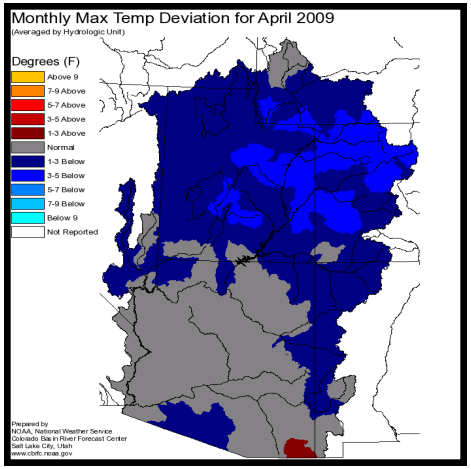
Spring Temperatures Deviations

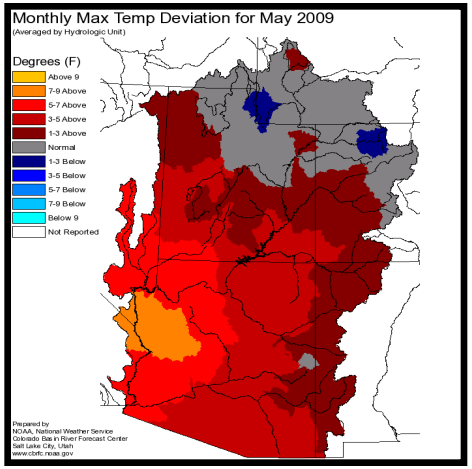
March: Warm – especially minimum temps

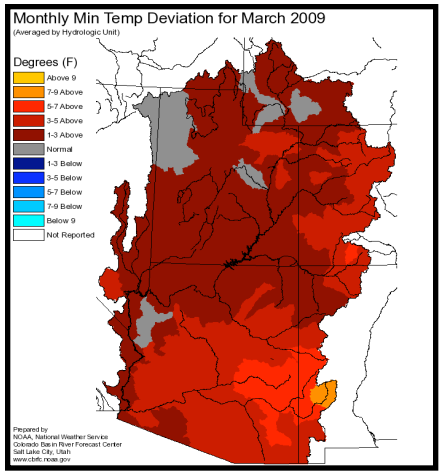
April: Variable

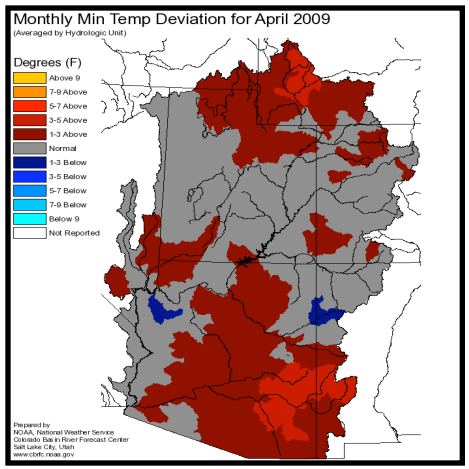
May: Very warm minimum temperatures

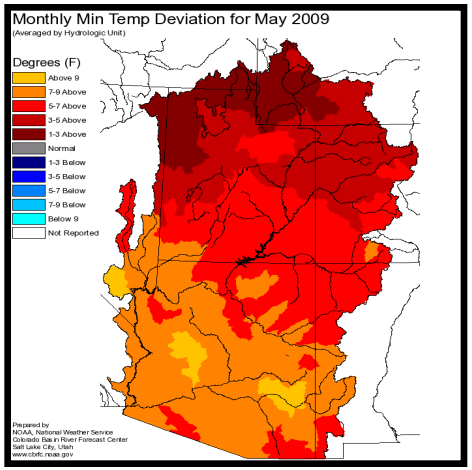






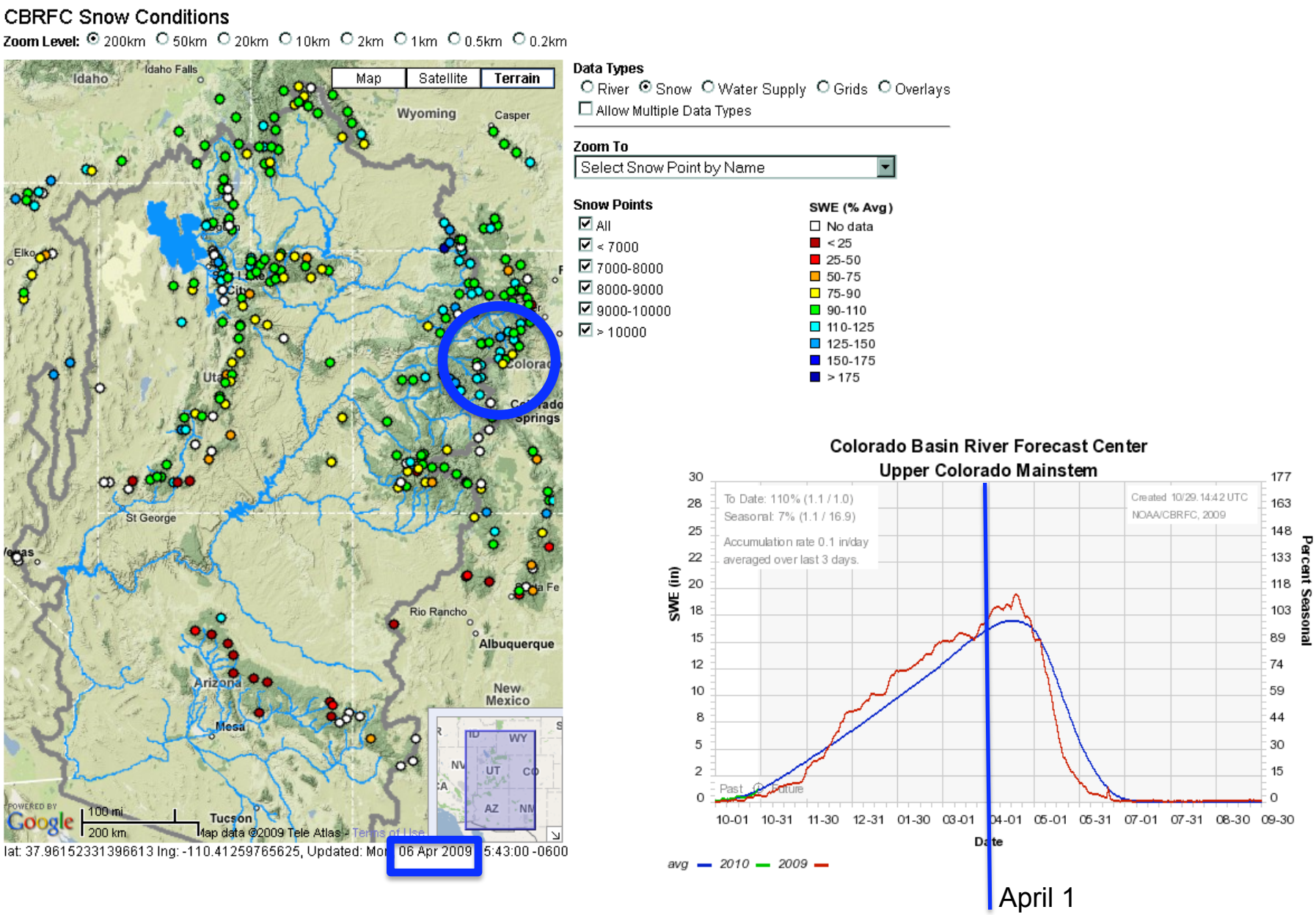




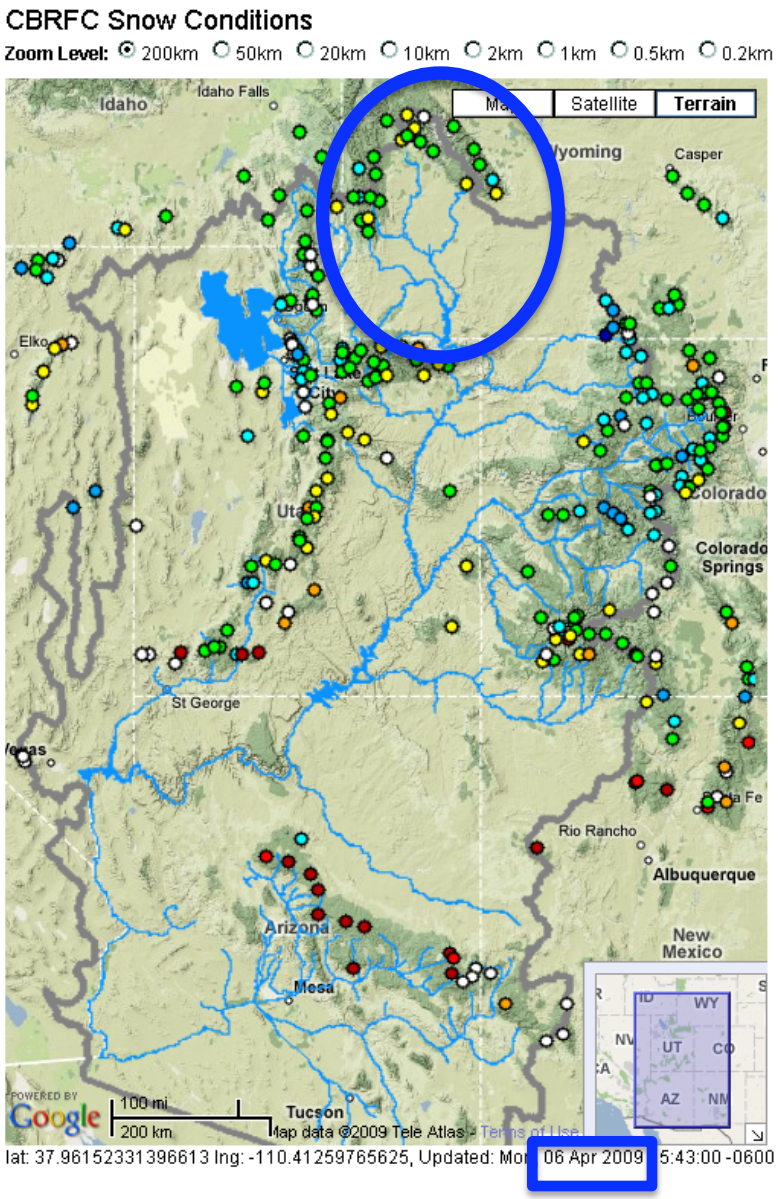


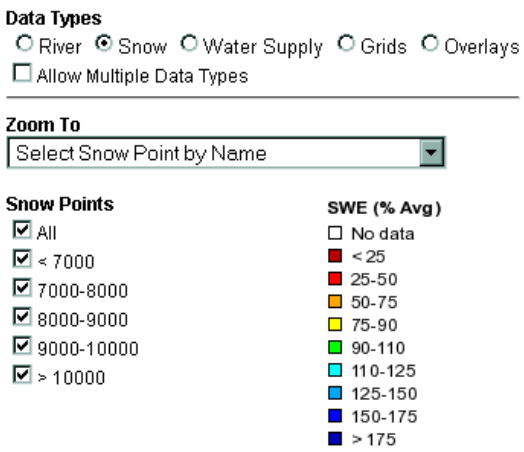
Temperature Deviation Source - http://www.cbrfc.noaa.gov/product/mapsum/mapsum.cgi?temp?cbrfc????2009

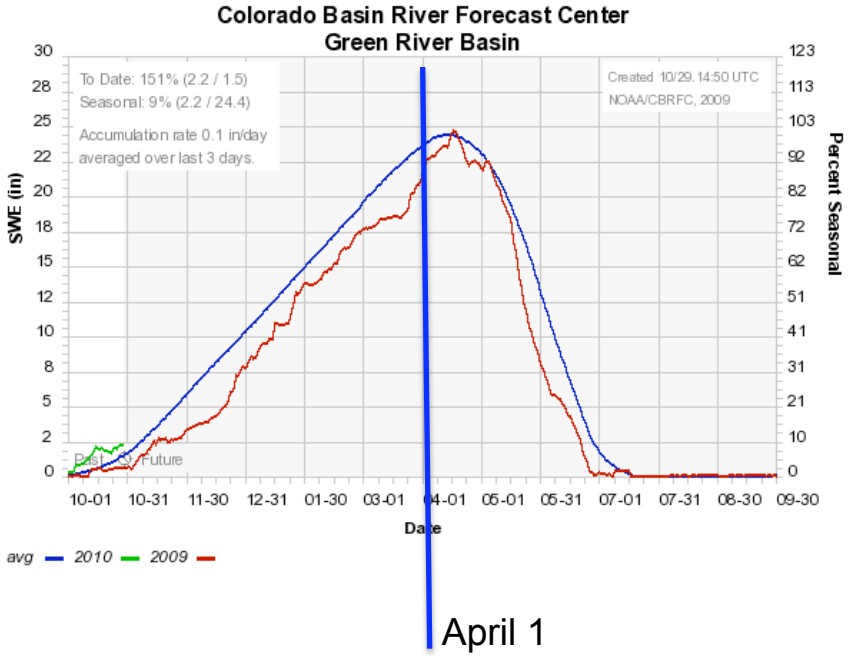
April 6, 2009 Snow Conditions



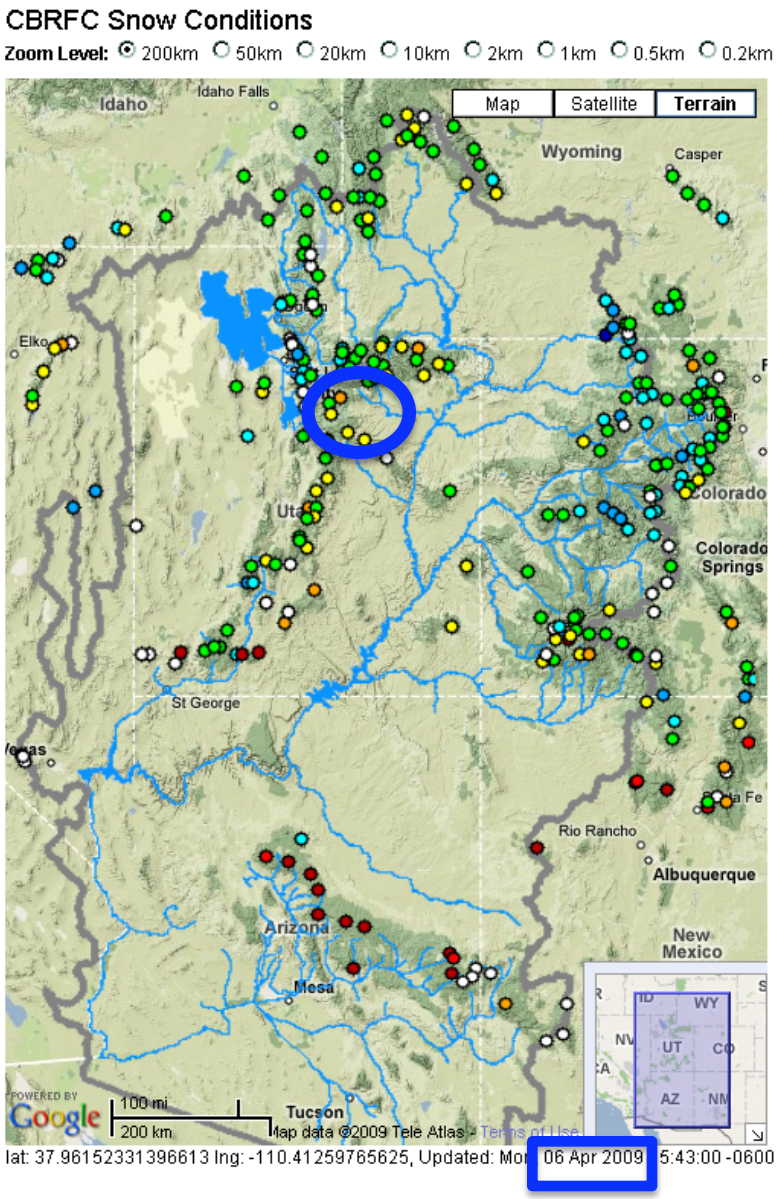
April 6, 2009 Snow Conditions

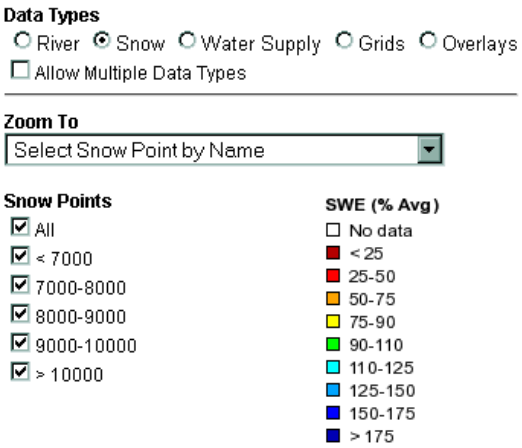


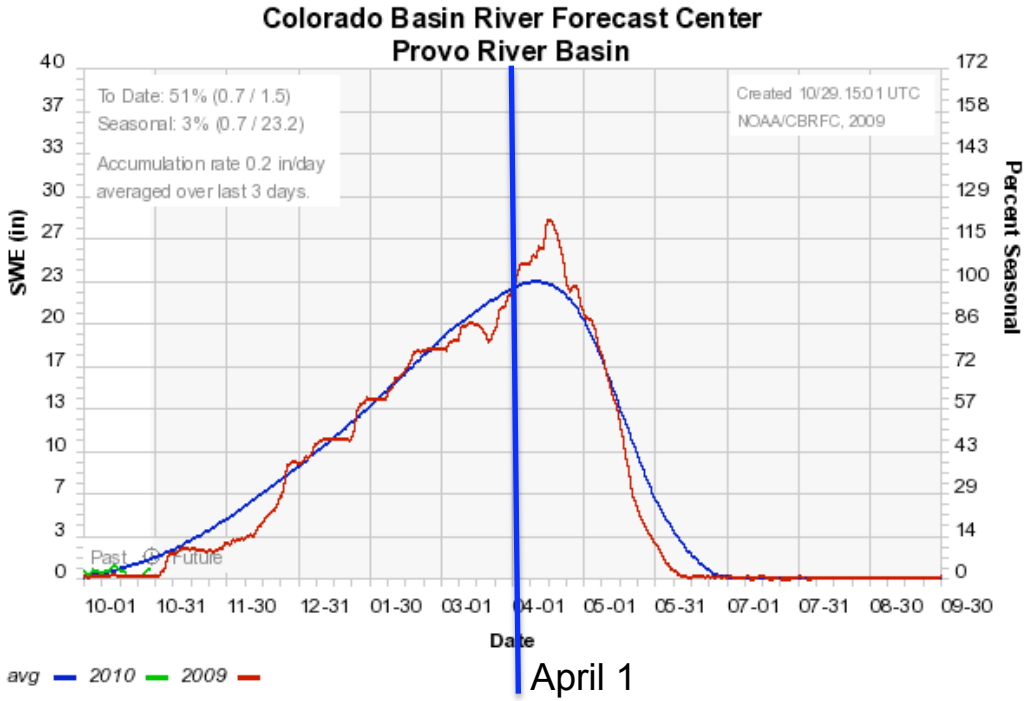




April 6, 2009 Snow Conditions

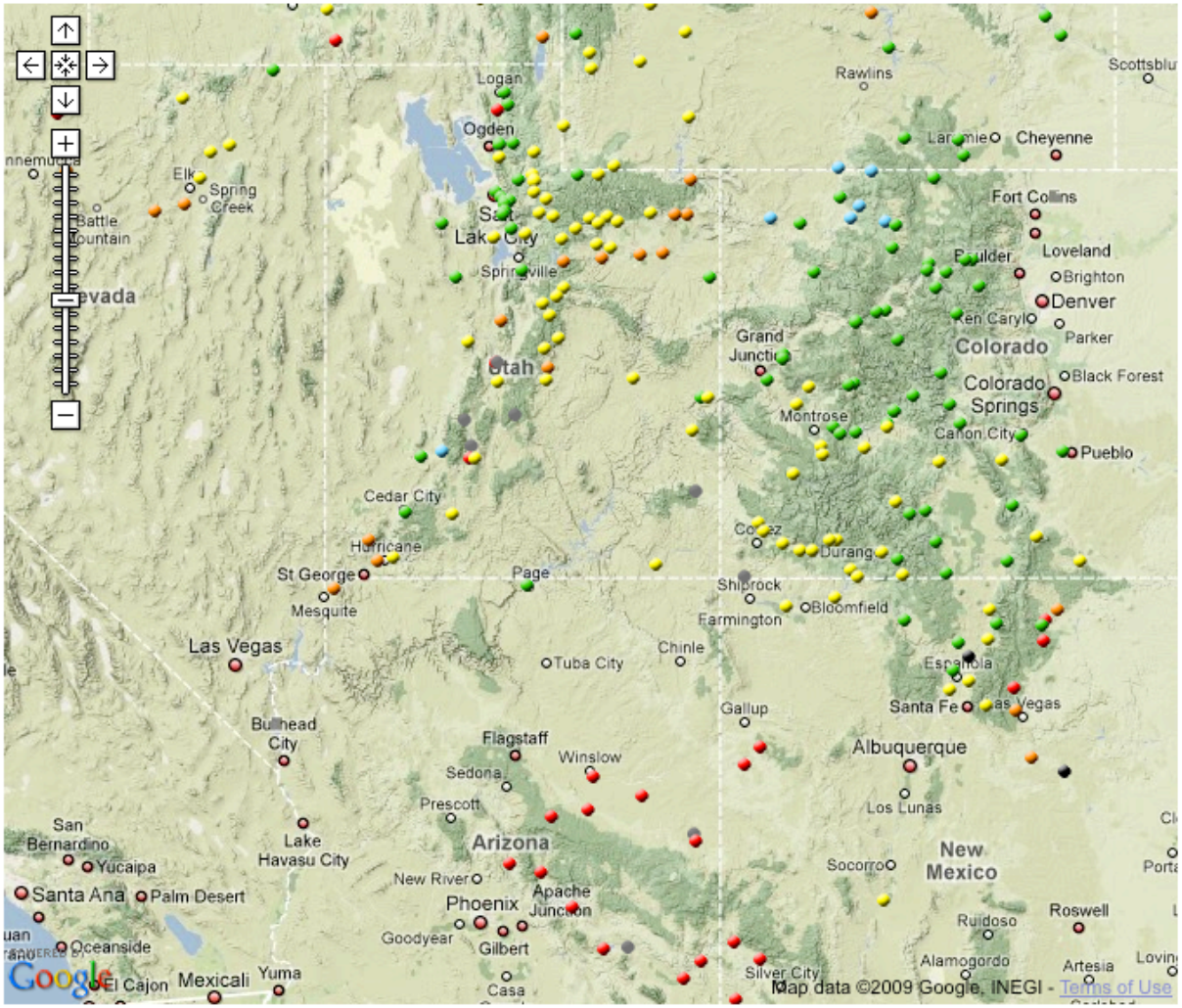






2009 Water Supply Forecasts

Water Supply Forecasts Map



Options

Map Display

- (•) Water Supply Forecast
  - (•) Mean
  - ( ) Median
  - April 2009
- ( ) Water Resources Outlook
- ( ) Monthly 'Observed' Streamflow
- ( ) Climate Change Scenarios

Map Options

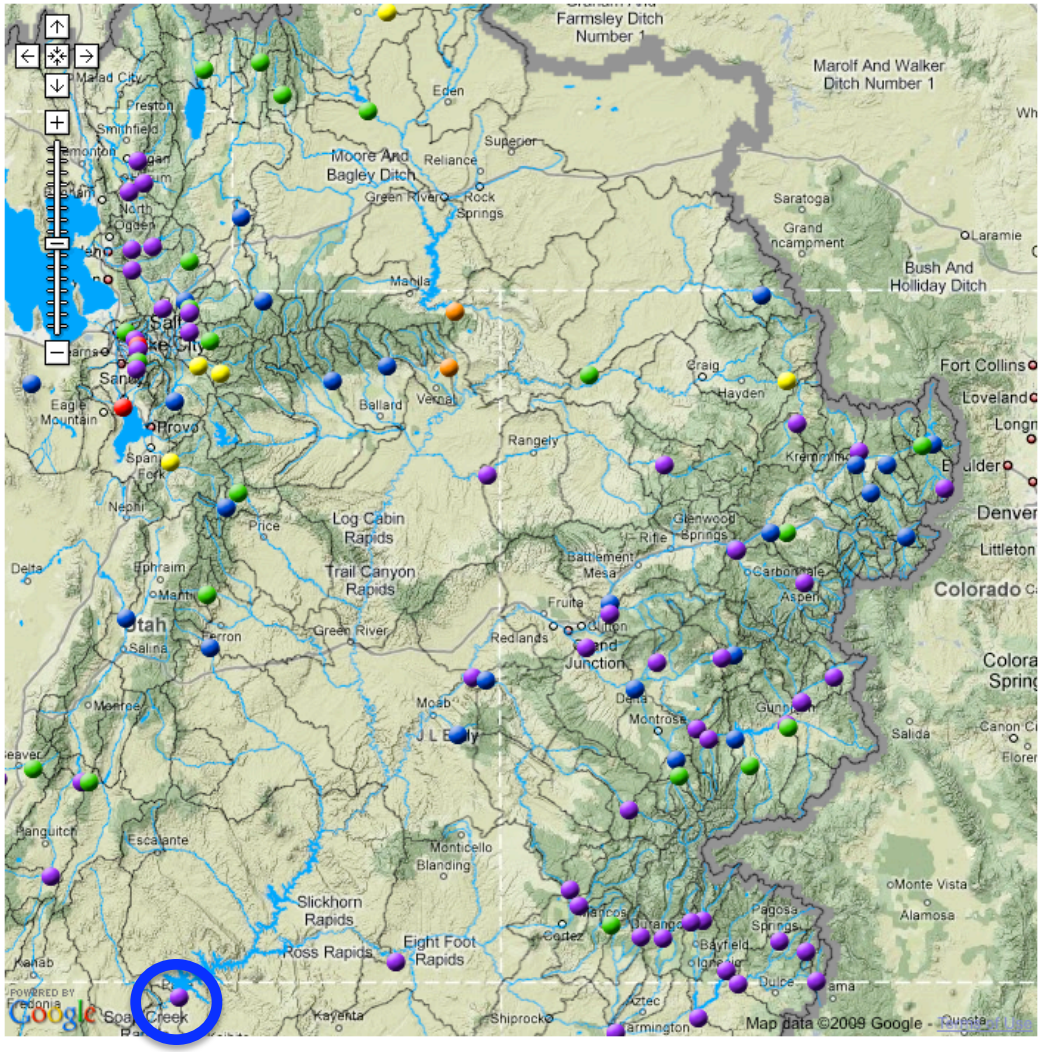
Legend

- > 150% of Average
- 130% - 150% of Average
- 110% - 130% of Average
- 90% - 110% of Average
- 70% - 90% of Average
- 50% - 70% of Average
- < 50 % of Average
- No Average
- No Forecast Available

2009 Water Supply Forecasts

Water Supply Forecast Evaluation

Colorado Basin River Forecast Center



Normalized MAE
April Forecast

- 0% - 10%
- 10% - 20%
- 20% - 30%
- 30% - 40%
- 40% - 50%
- > 50%

Month: April

Year: 2009

Statistic: Mean Absolute Error

Display

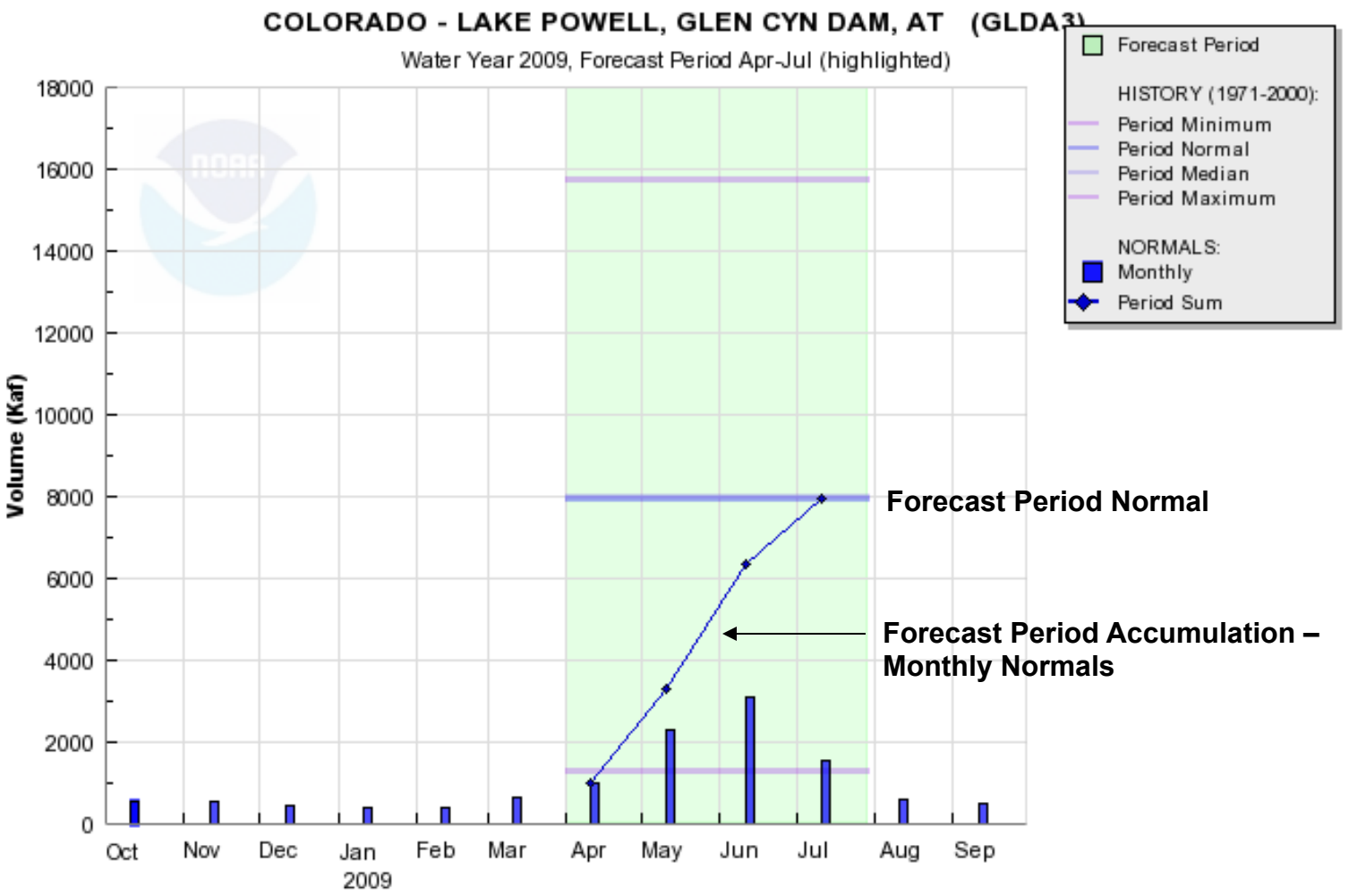
April 2009 Forecast Error

- |(Forecast – Observed)/Observed |
- Lower is better

www.cbrfc.noaa.gov -> Water Supply -> Verification

2009 Water Supply Forecasts: Lake Powell Inflow

1971-2000 History and Normals



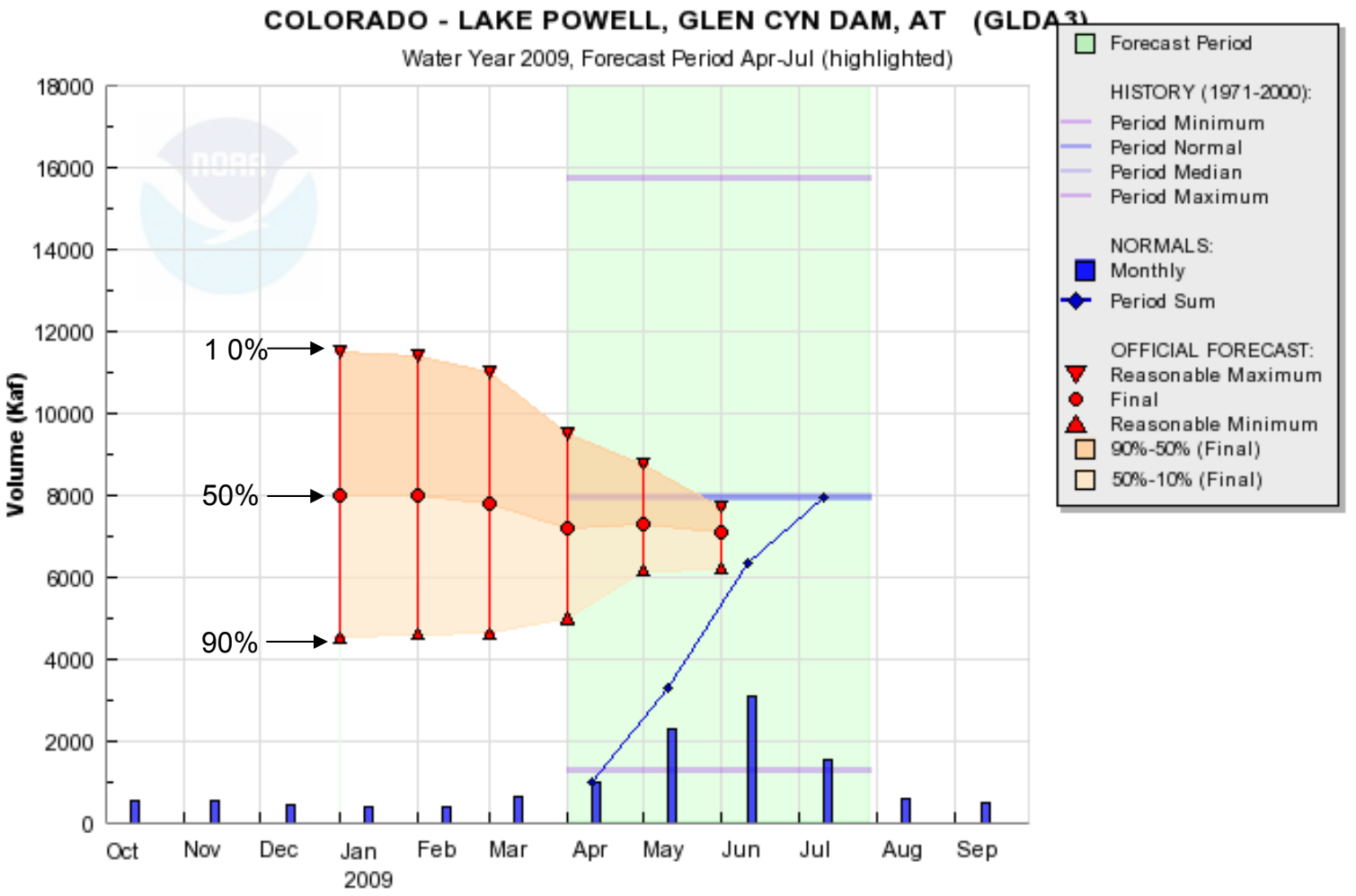
www.nwrfc.noaa.gov/westernwater
CBRFC/NWS/NOAA 09/09/09 21:00:29 UTC

2009 Water Supply Forecasts

2009 Beginning Of Month

Exceedence Forecasts

For April-July Runoff Volume



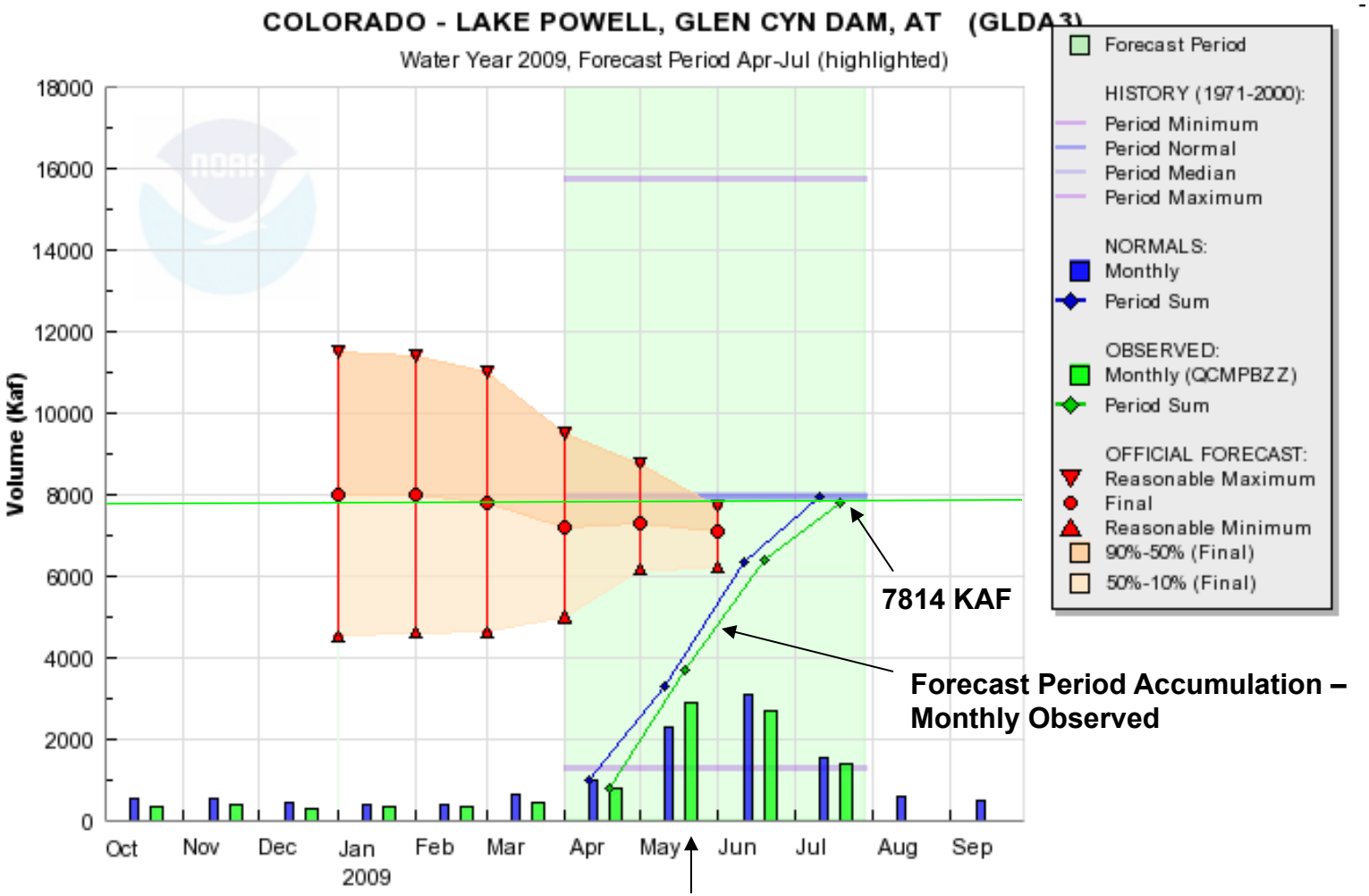
www.nwrfc.noaa.gov/westernwater

CBRFC/NWS/NOAA 09/09/09 21:04:36 UTC

2009 Water Supply Forecasts

2009 Observed Values:

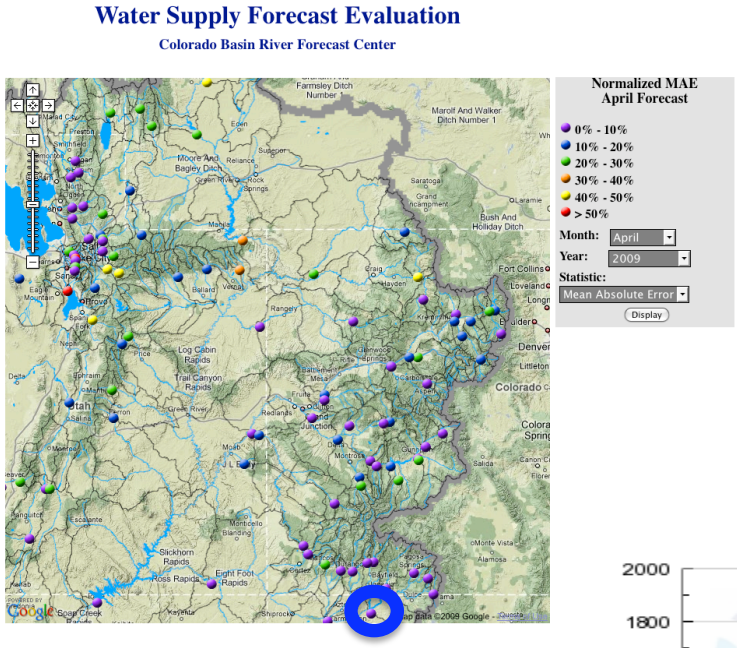
2009 Observed (7814 KAF) Slightly Above June 1st 10% Exceedence Forecast (7720 KAF)

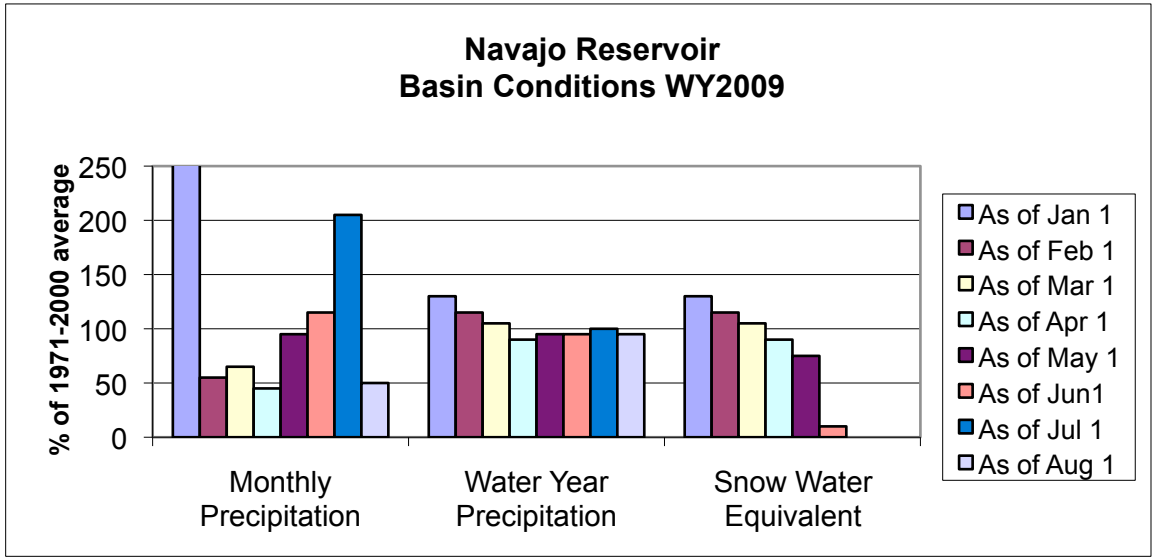


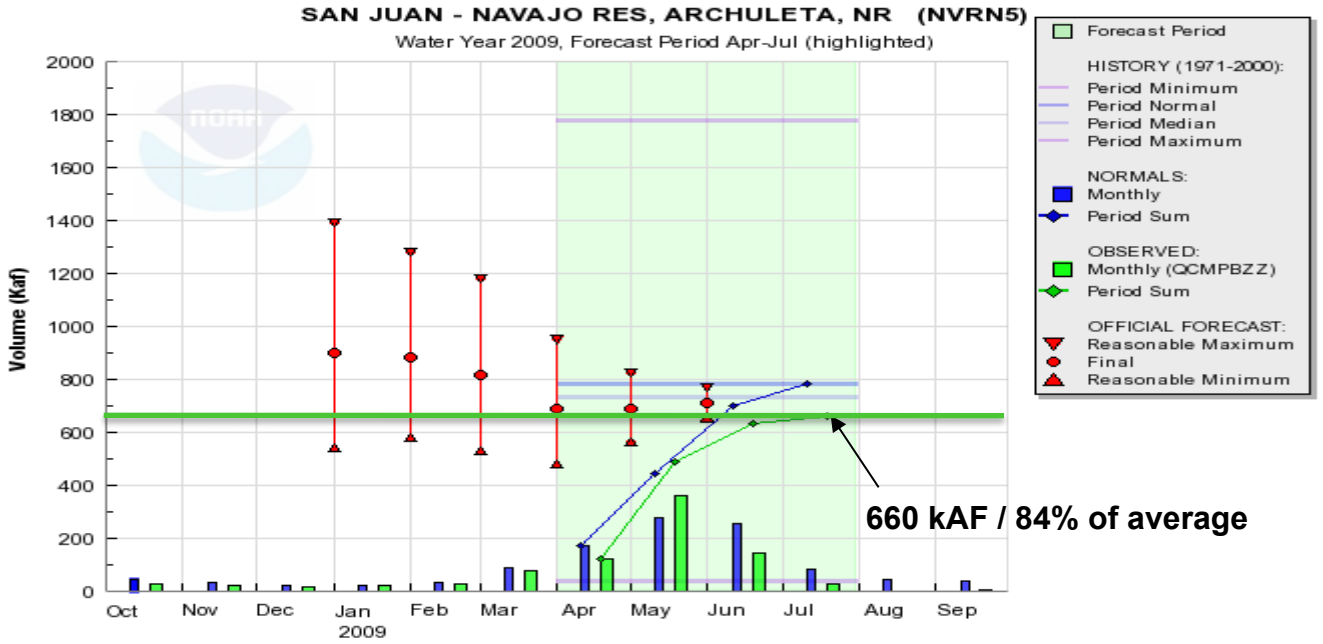
www.nwrfc.noaa.gov/westernwater

CBRFC/NWS/NOAA 09/09/09 21:09:45 UTC

2009 Water Supply Forecasts: San Juan above Navajo, NM

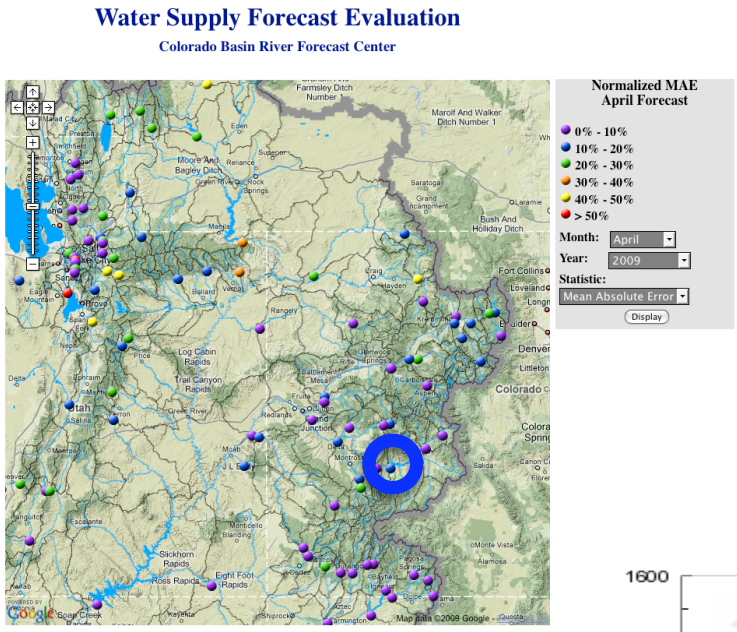


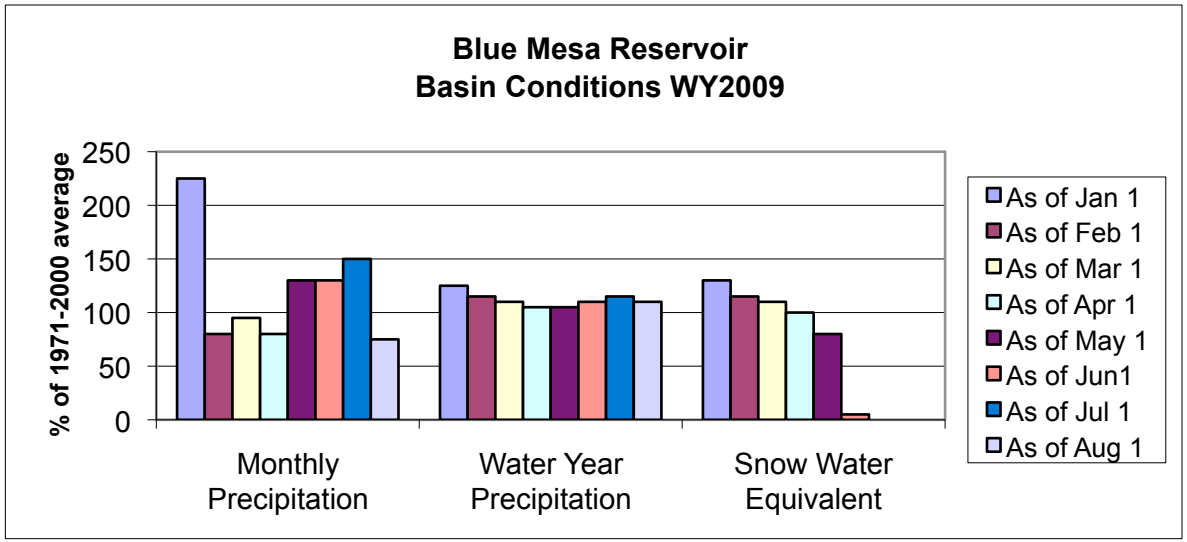


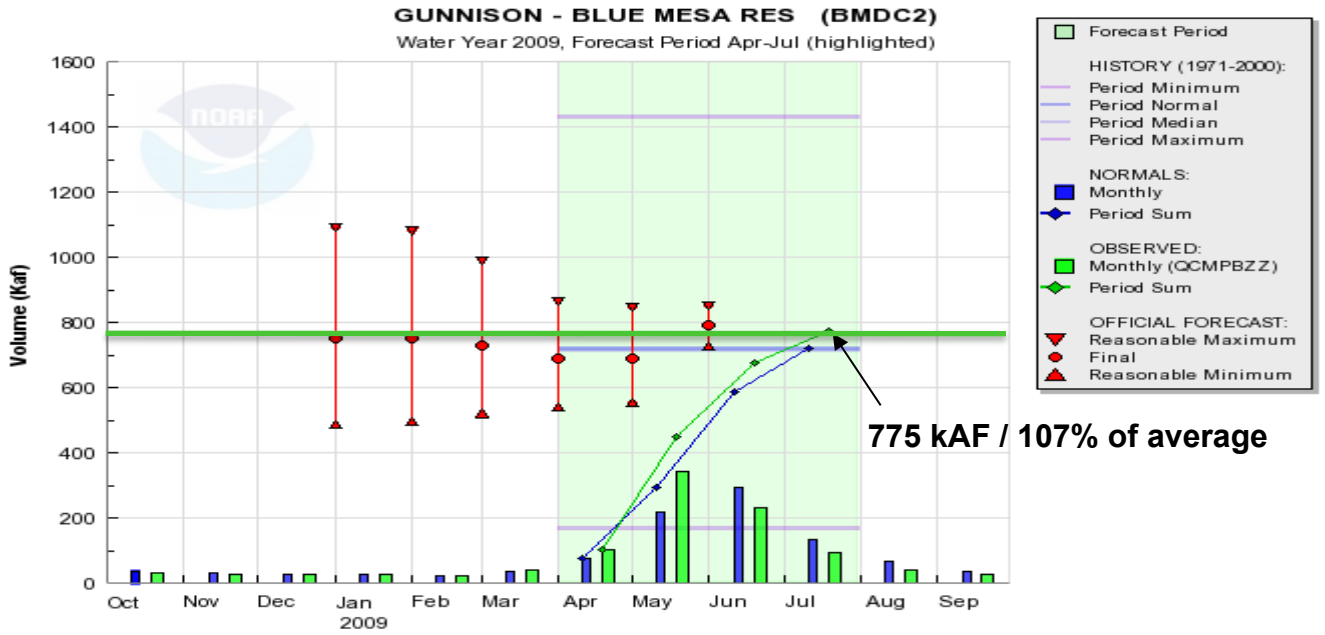


CBRFC/NWS/NOAA 10/21/09 15:44:35 UTC

2009 Water Supply Forecasts: Gunnison above Blue Mesa, CO

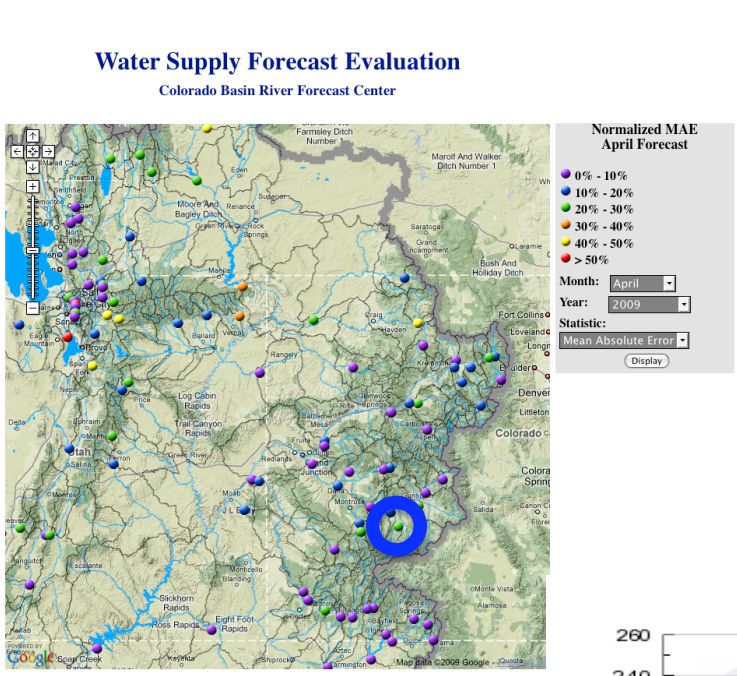


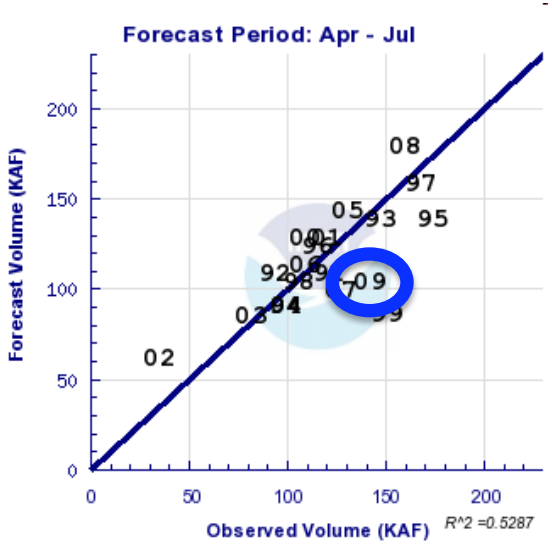


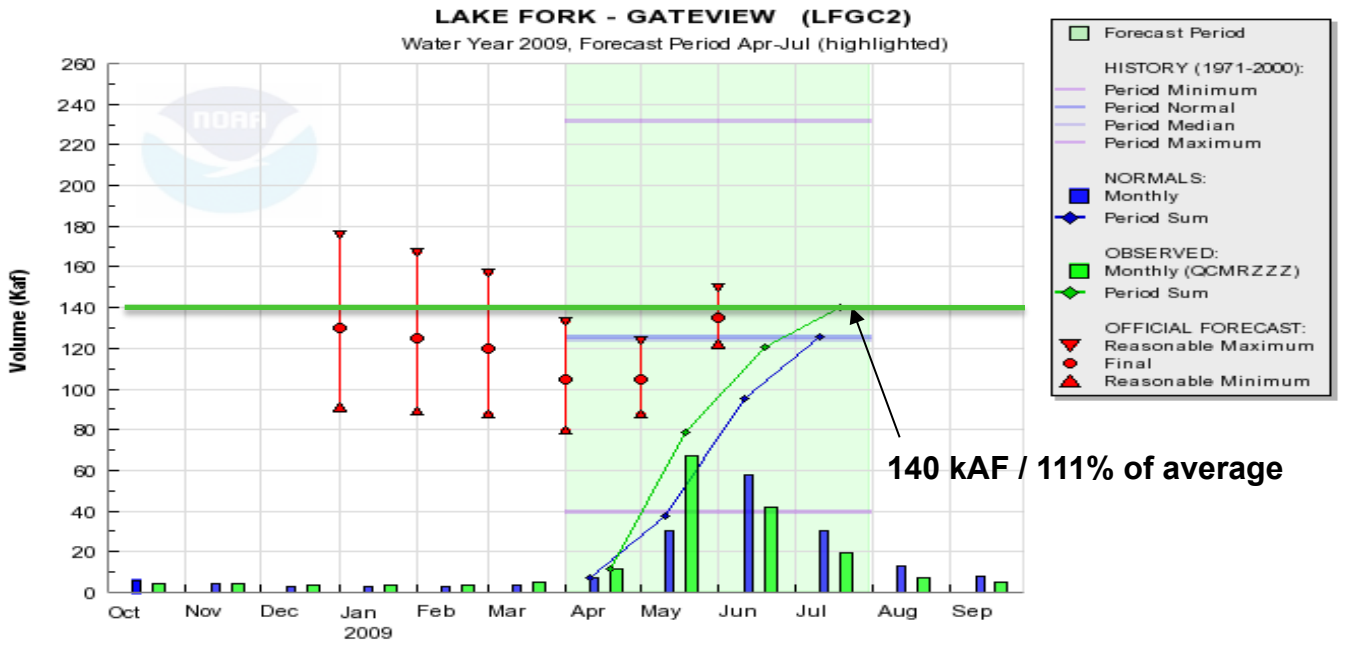


CBRFC/NWS/NOAA 10/21/09 14:51:00 UTC

2009 Water Supply Forecasts: Lake Fork at Gateview, CO

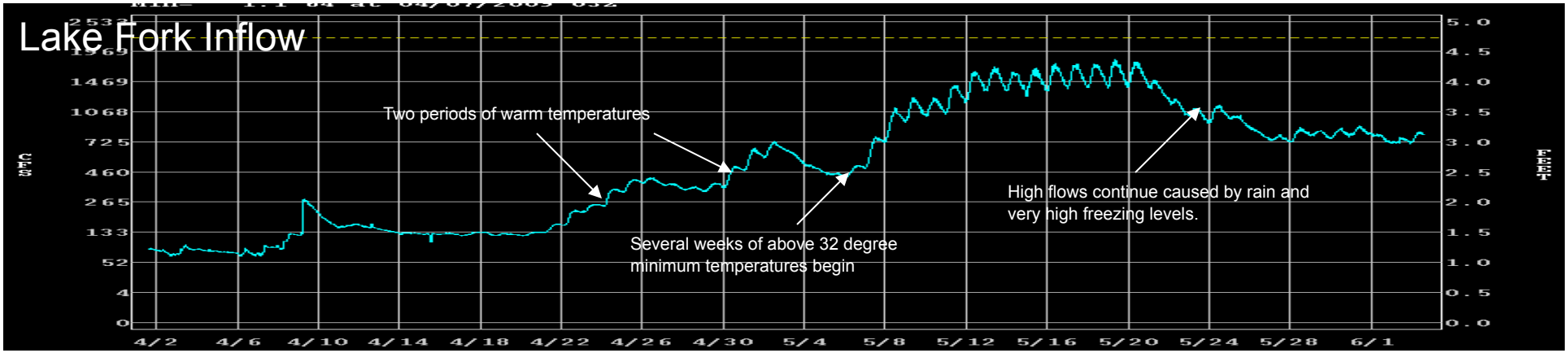


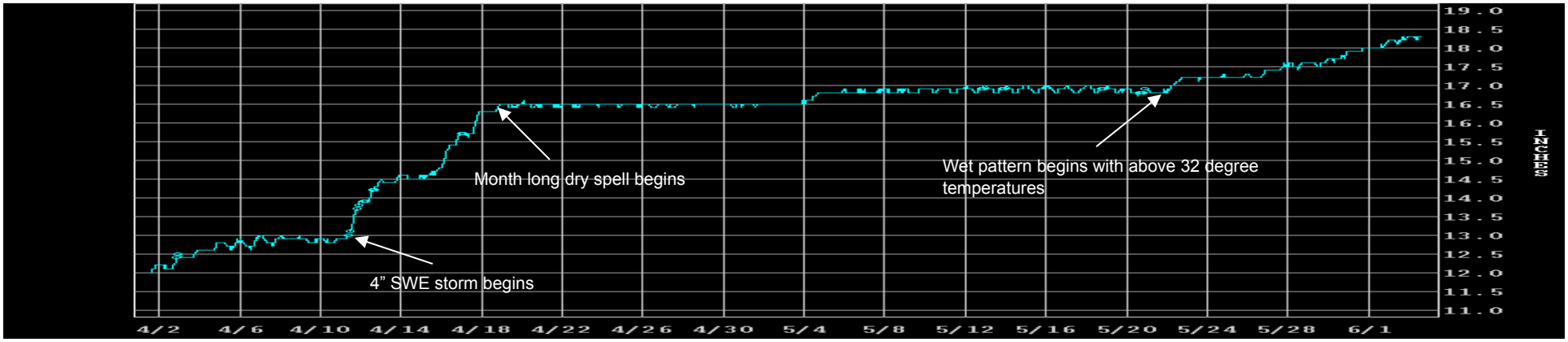


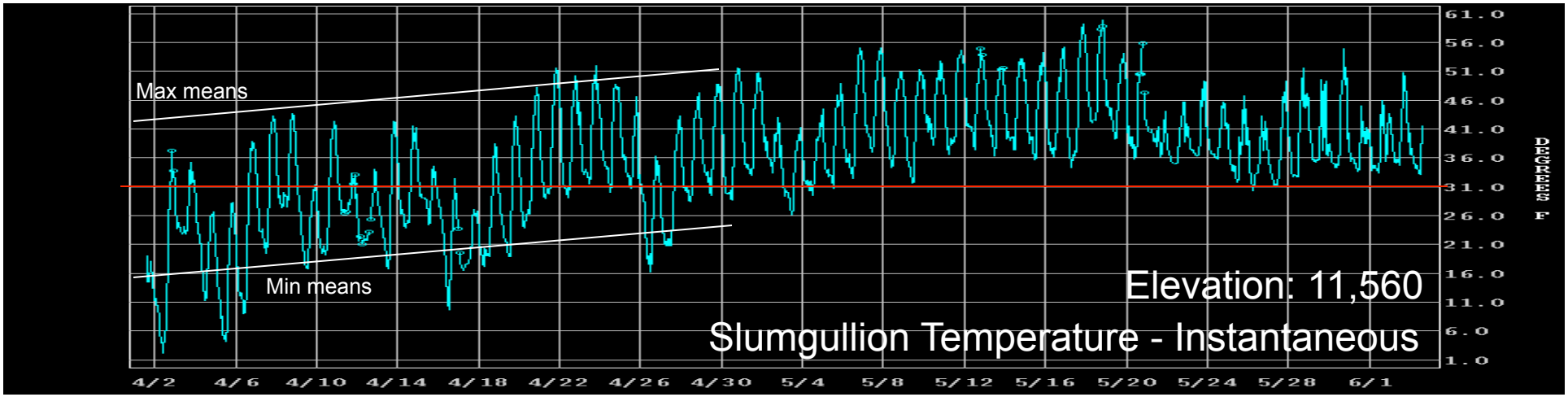


CBRFC/NWS/NOAA 10/21/09 15:19:57 UTC

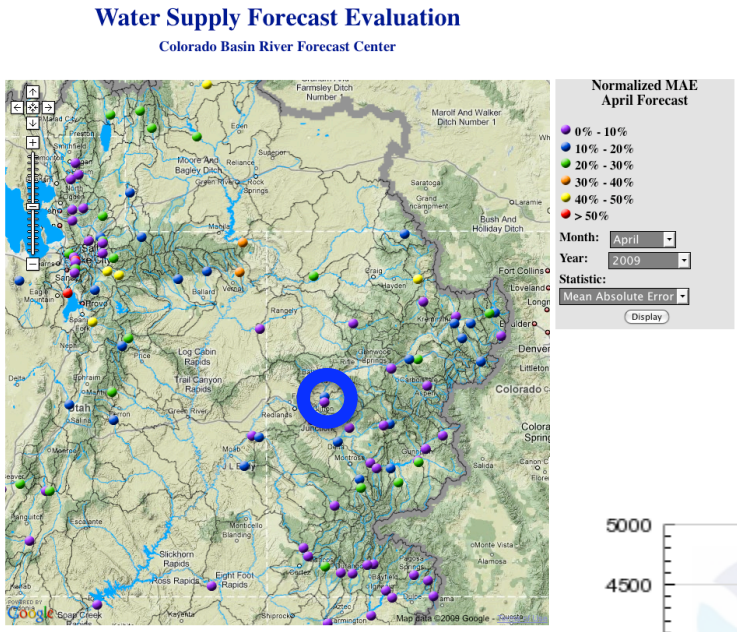
Time Series 04/01-06/03 2009

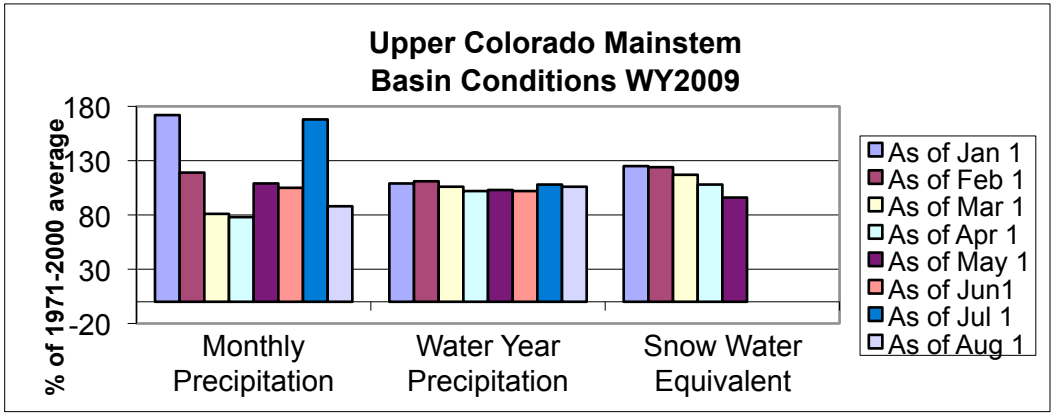


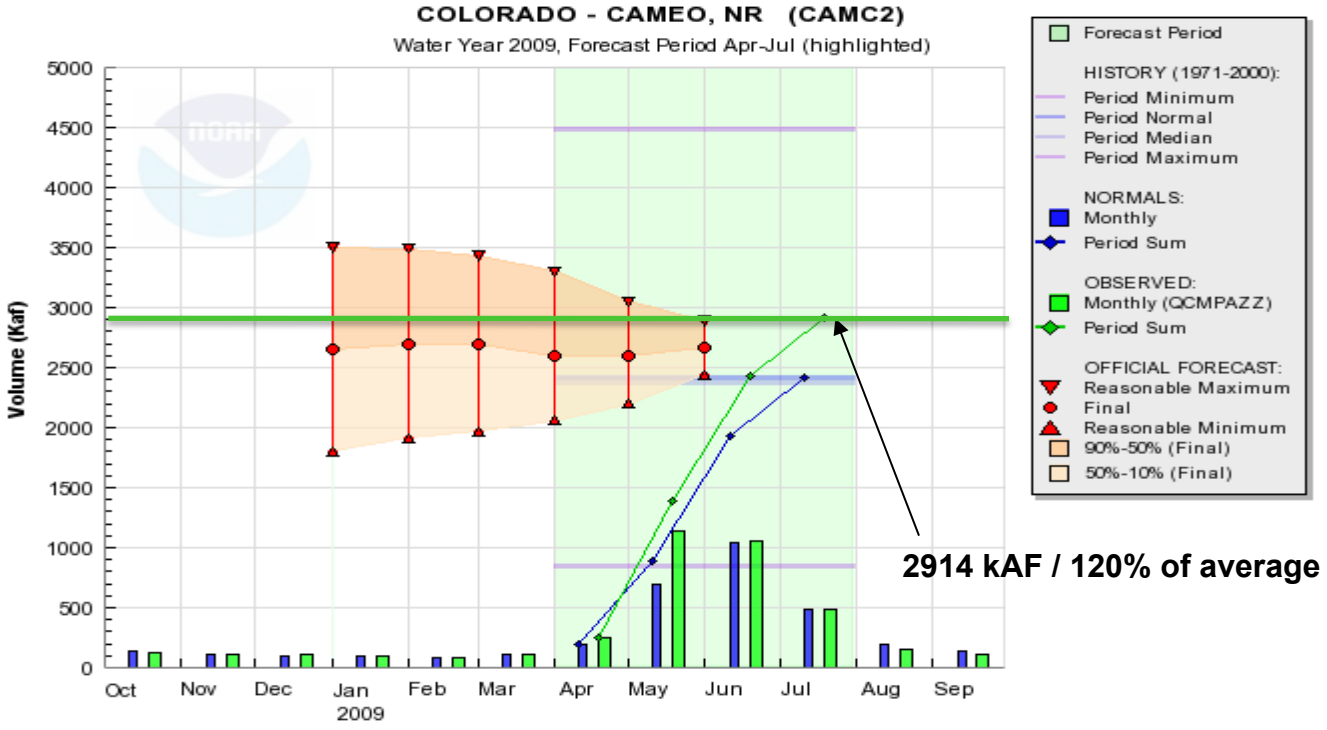




2009 Water Supply Forecasts: Colorado above Cameo, CO







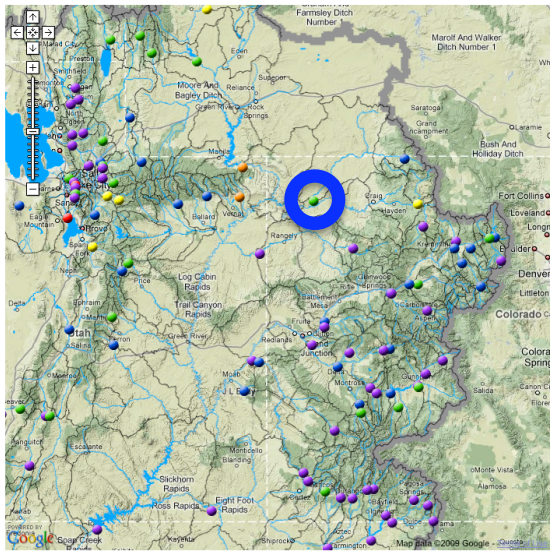
More details on Upper Colorado in second hour

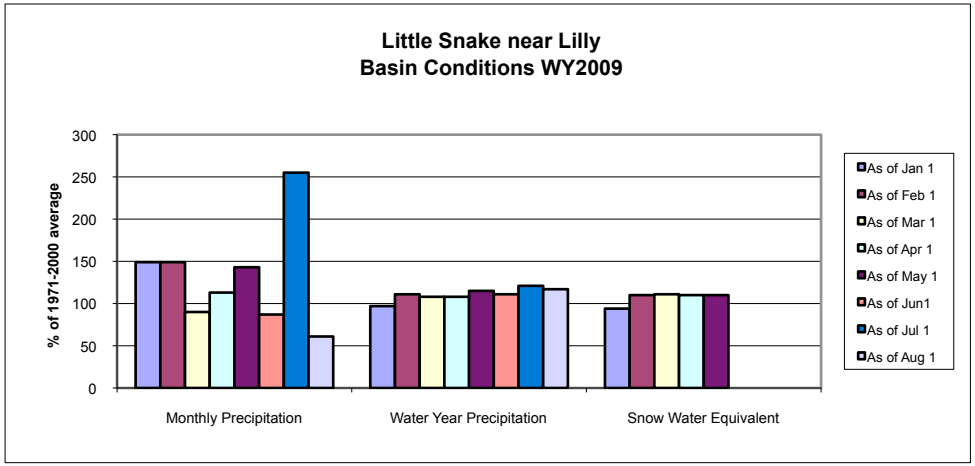
CBRFC/NWS/NOAA 10/29/09 23:17:00 UTC

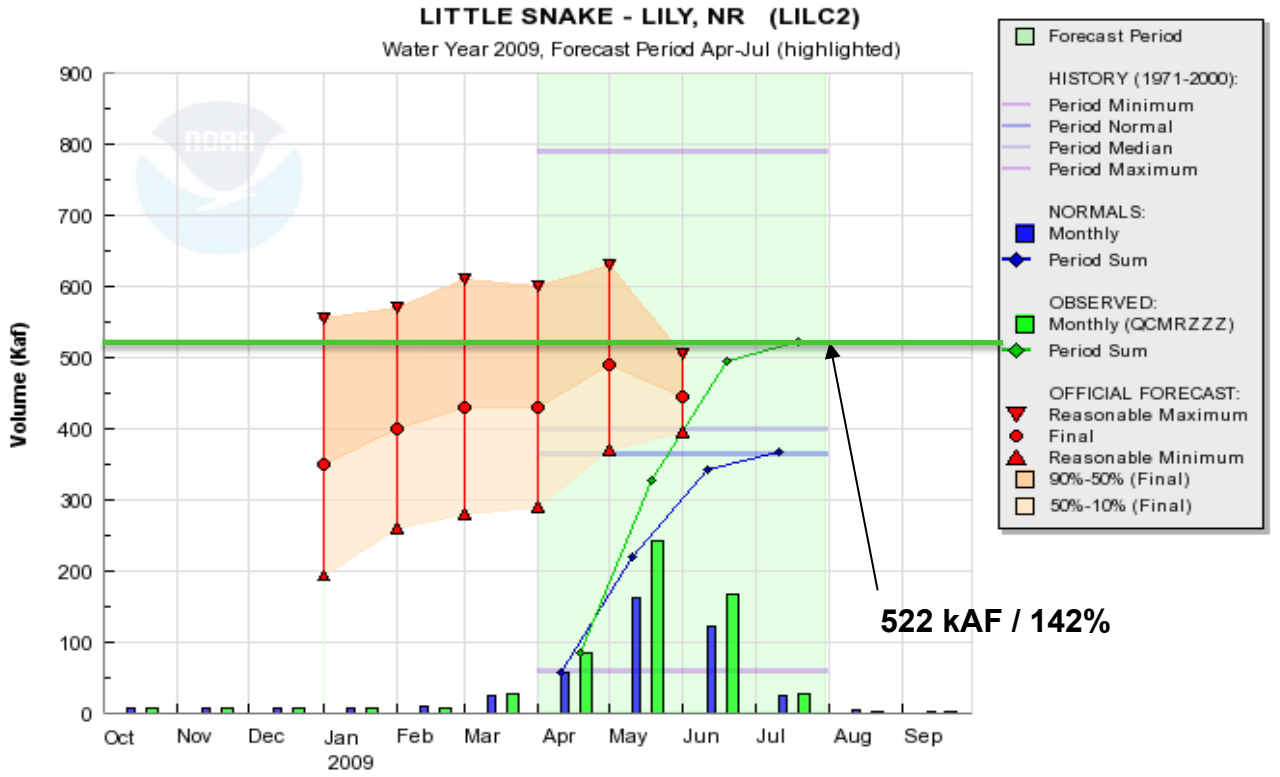
2009 Water Supply Forecasts: Little Snake near Lily, CO

Water Supply Forecast Evaluation

Colorado Basin River Forecast Center

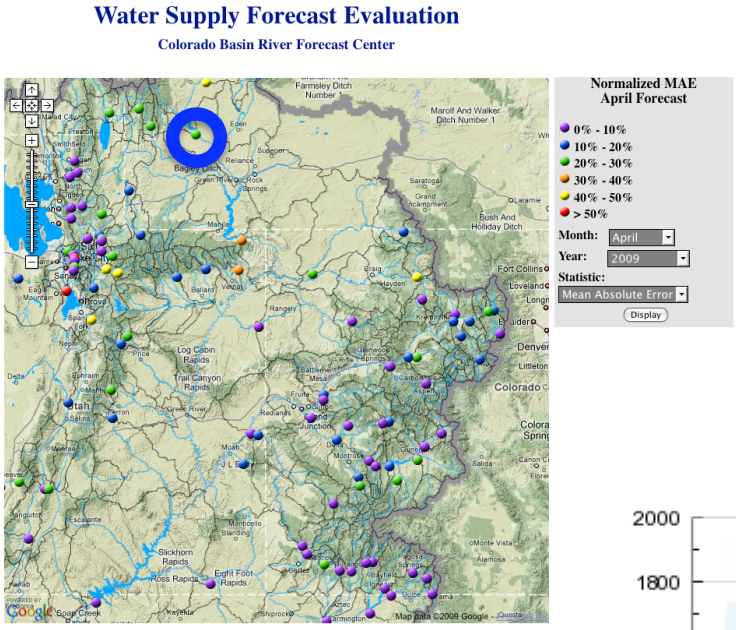


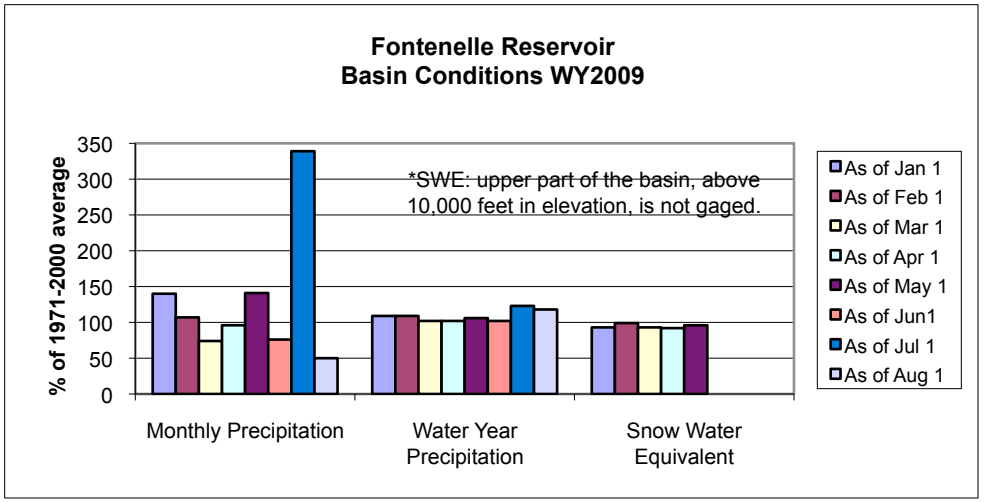


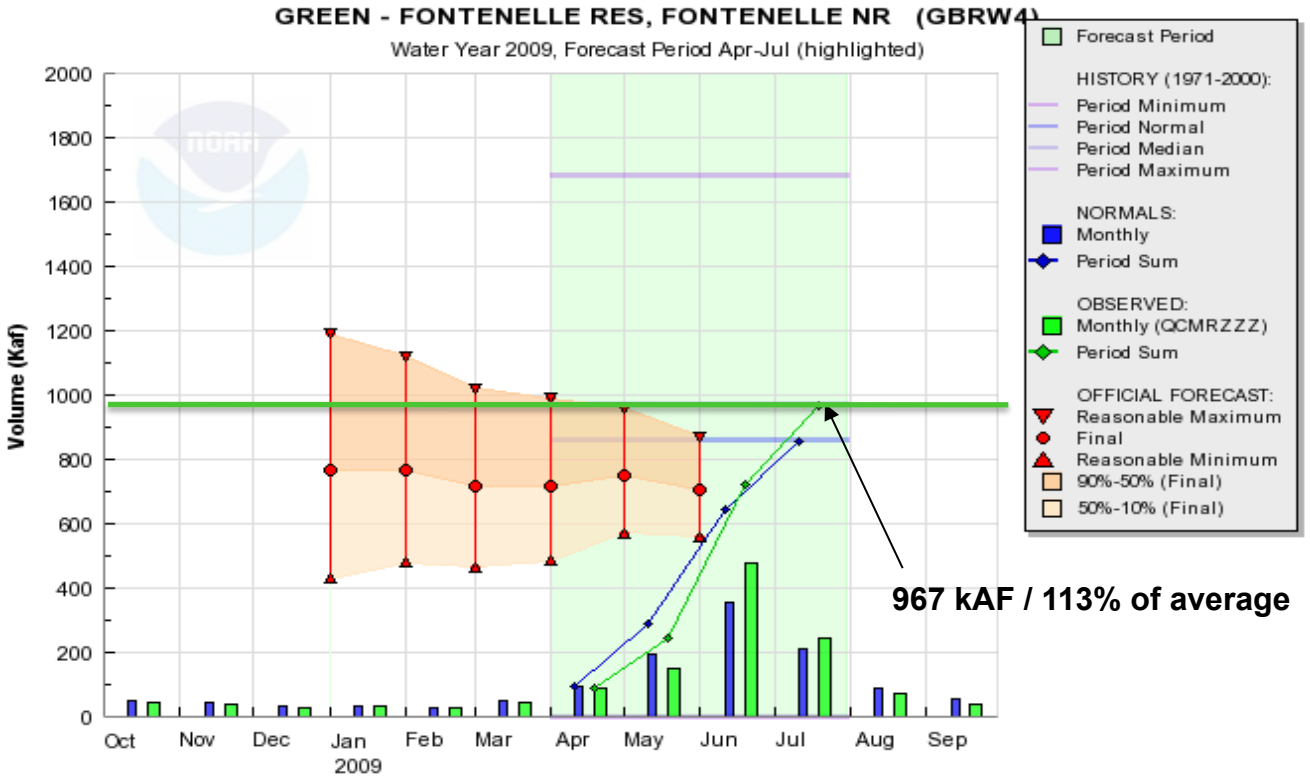


CBRFC/NWS/NOAA 10/29/09 23:22:58 UTC

2009 Water Supply Forecasts: Green above Fontenelle, WY

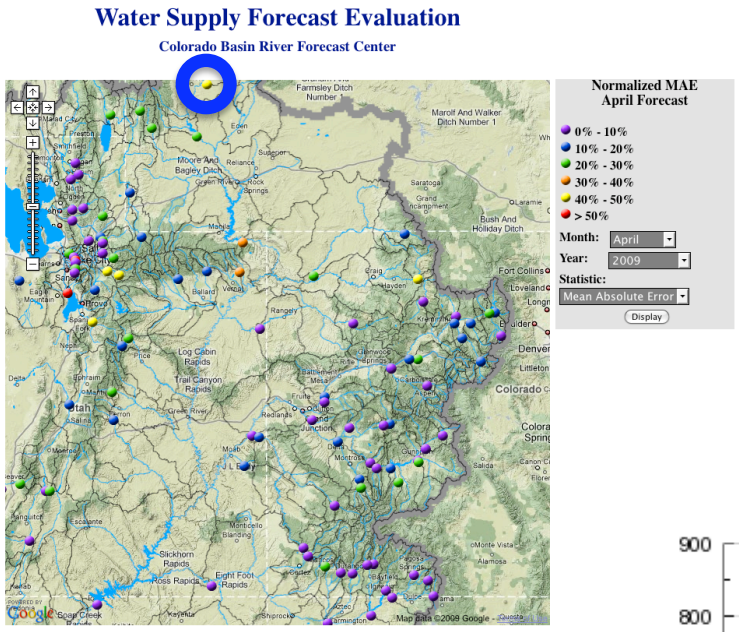


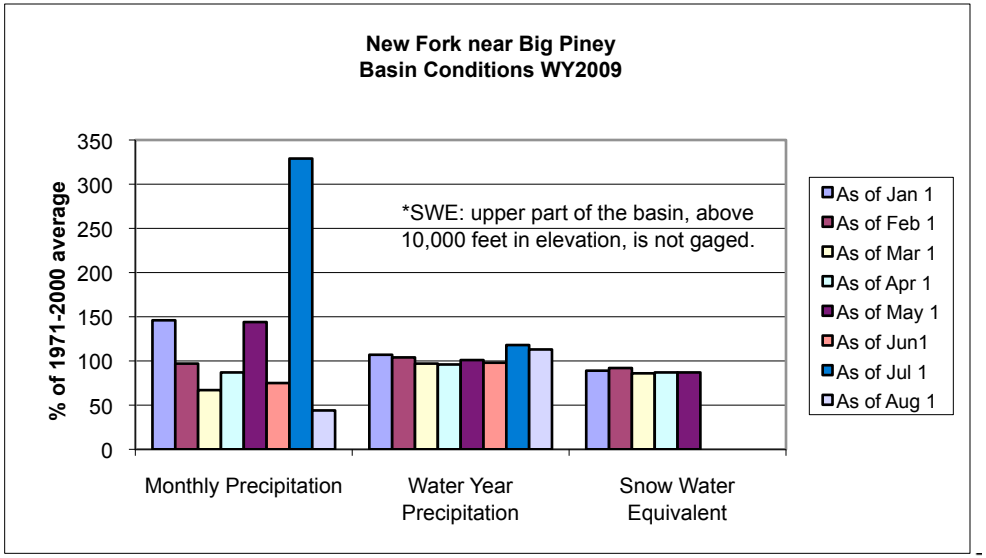


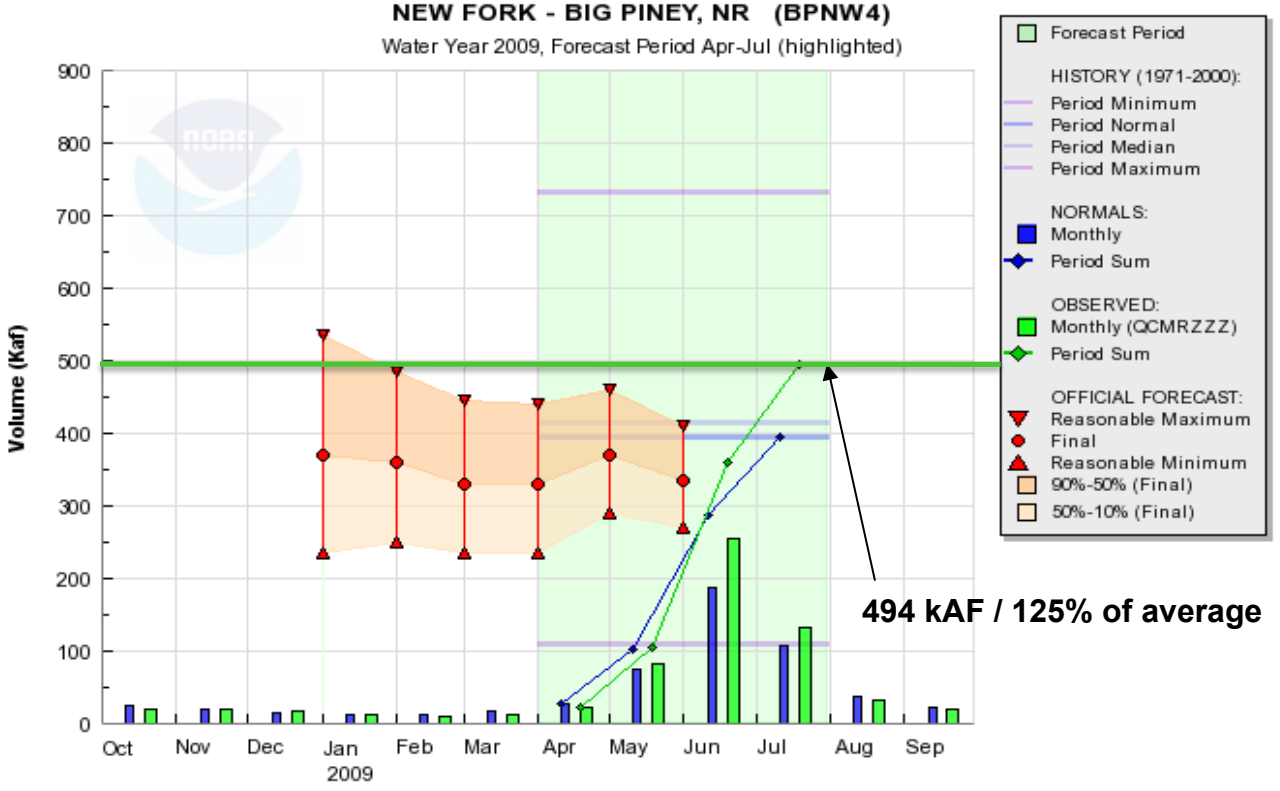


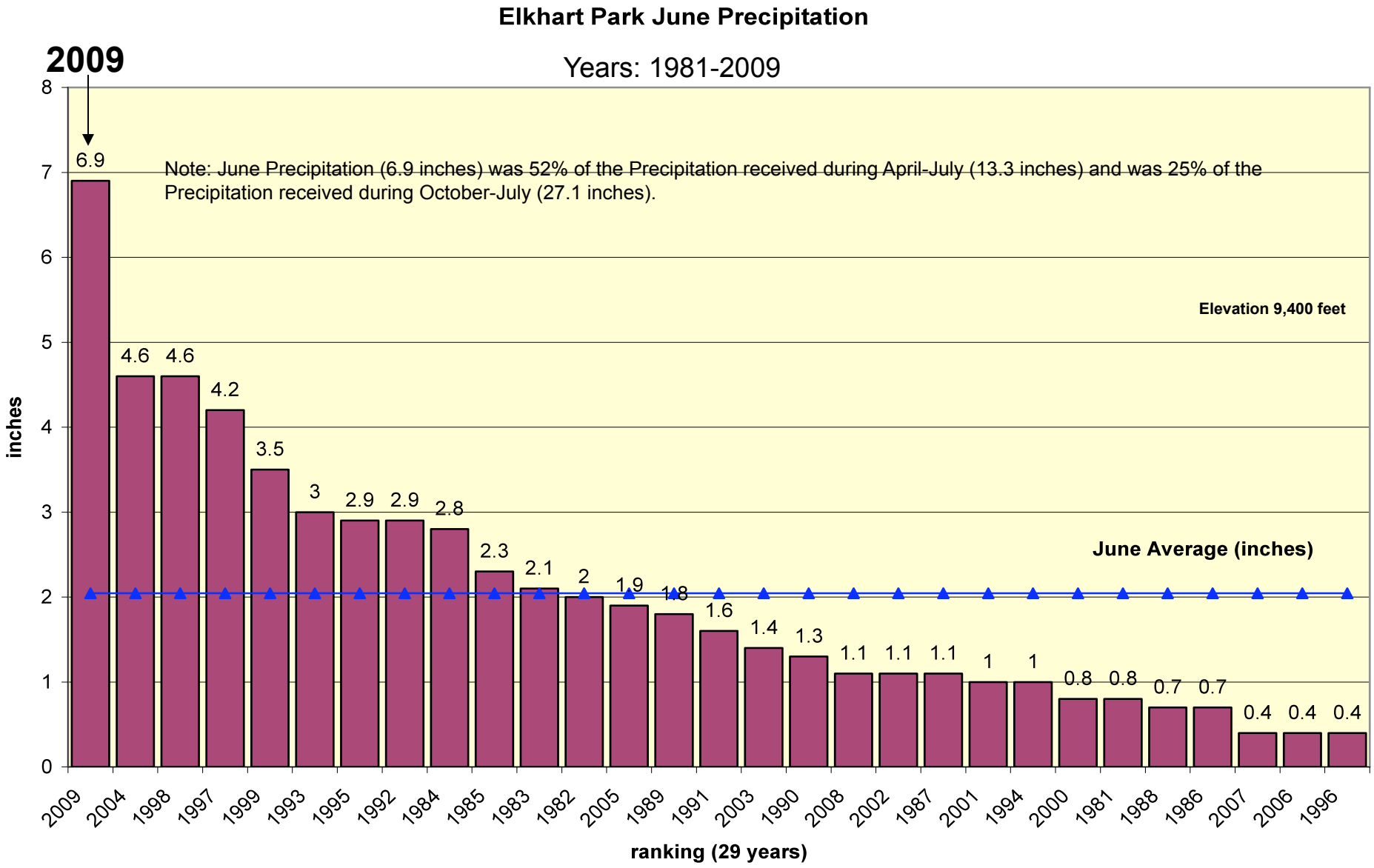
CBRFC/NWS/NOAA 10/29/09 23:20:43 UTC

2009 Water Supply Forecasts: New Fork near Big Piney, WY







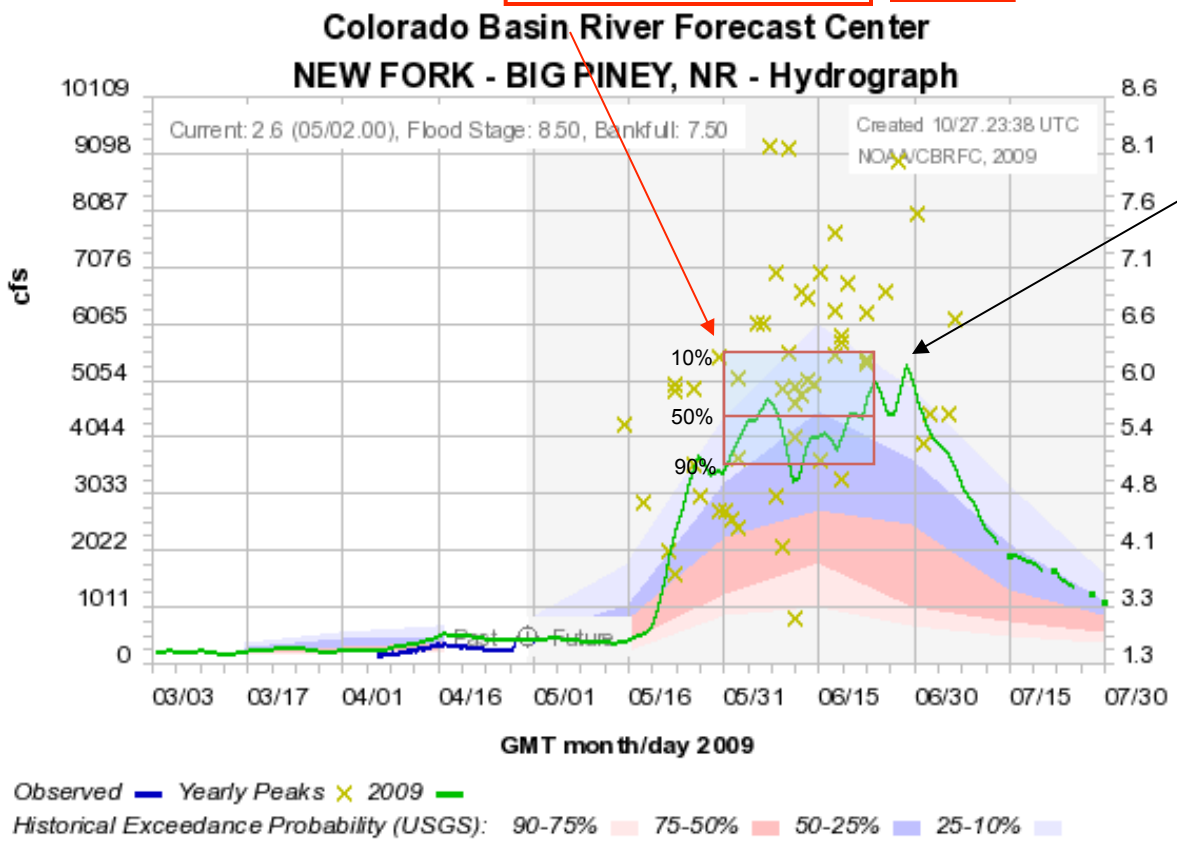

Elkhart Park June Precipitation
2009
Years: 1981-2009
Note: June Precipitation (6.9 inches) was 52% of the Precipitation received during April-July (13.3 inches) and was 25% of the Precipitation received during October-July (27.1 inches).
Elevation 9,400 feet
June Average (inches)
inches
ranking (29 years)
6.9
4.6 4.6
4.2
3.5
3 2.9 2.9 2.8
2.3 2.1 2 1.9 1.8 1.6 1.4 1.3 1.1 1.1 1.1 1 1 0.8 0.8 0.7 0.7 0.4 0.4 0.4
0 1 2 3 4 5 6 7 8
2009 2004 1998 1997 1999 1993 1995 1992 1984 1985 1983 1982 2005 1989 1991 2003 1990 2008 2002 1987 2001 1994 2000 1981 1988 1986 2007 2006 1996

May 1st Peak Flow Forecasts

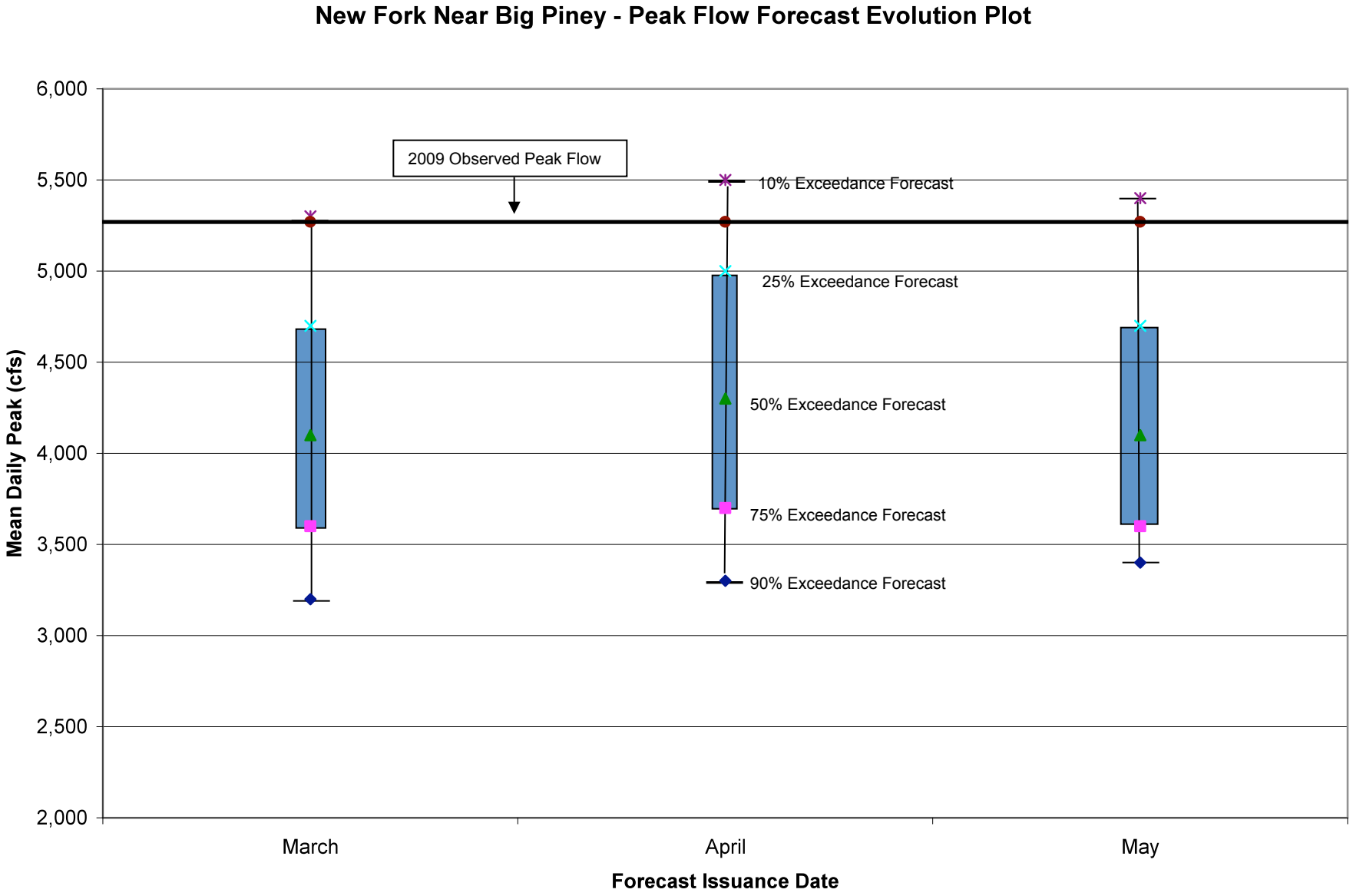
Upper Colorado Peak Flow Forecasts (mean daily cfs)

Prepared by: Alcorn, Cox, Reed

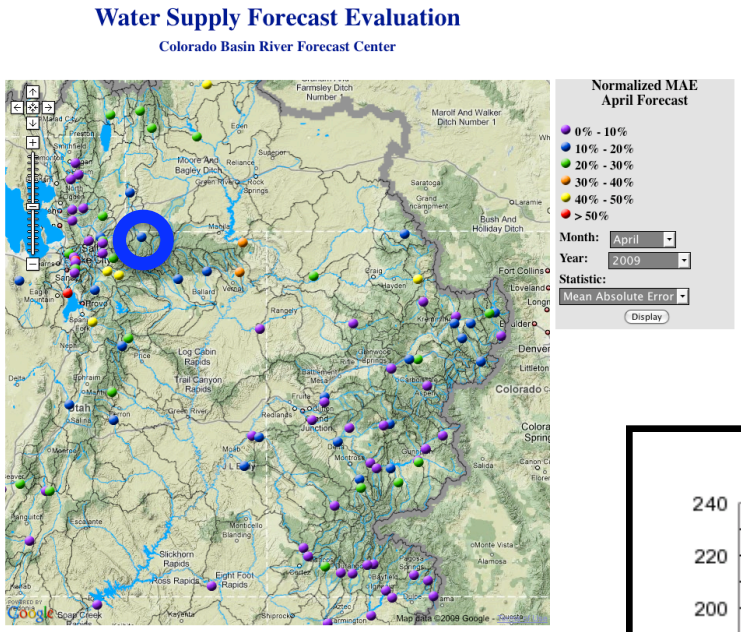
Historic Peak	Average Peak	Flood* Flow	2008 Peak	2008 Date	2009 Forecast Exceedance Probability 90%	75%	50%	25%	10%	Normal time of Peak	Issuance Date	Observed Peak	Observed Date
9,110	5,285	9,870	3,530	6/21	3,400	3,600	**4,100**	4,700	5,400	5/31 - 6/24	5/7		

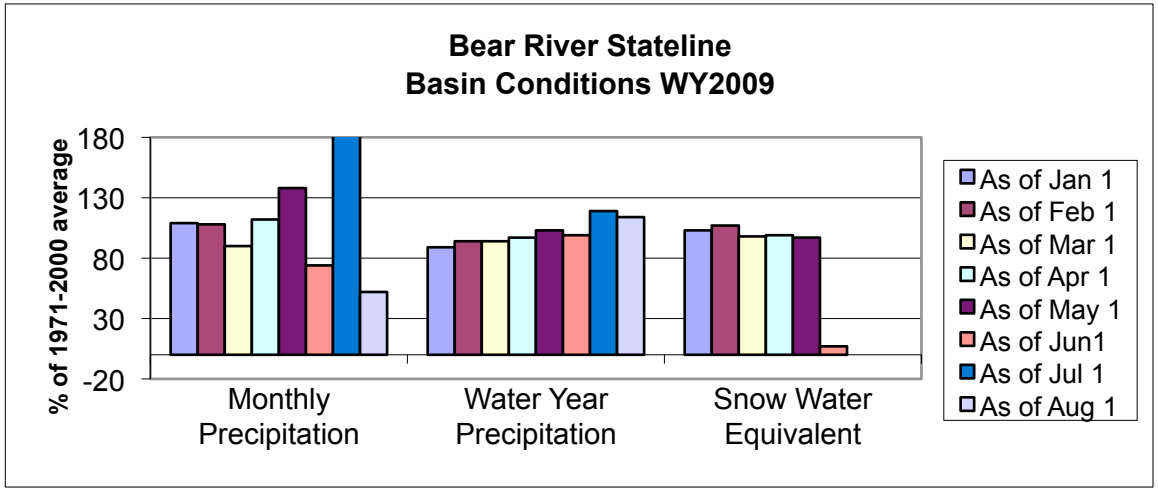


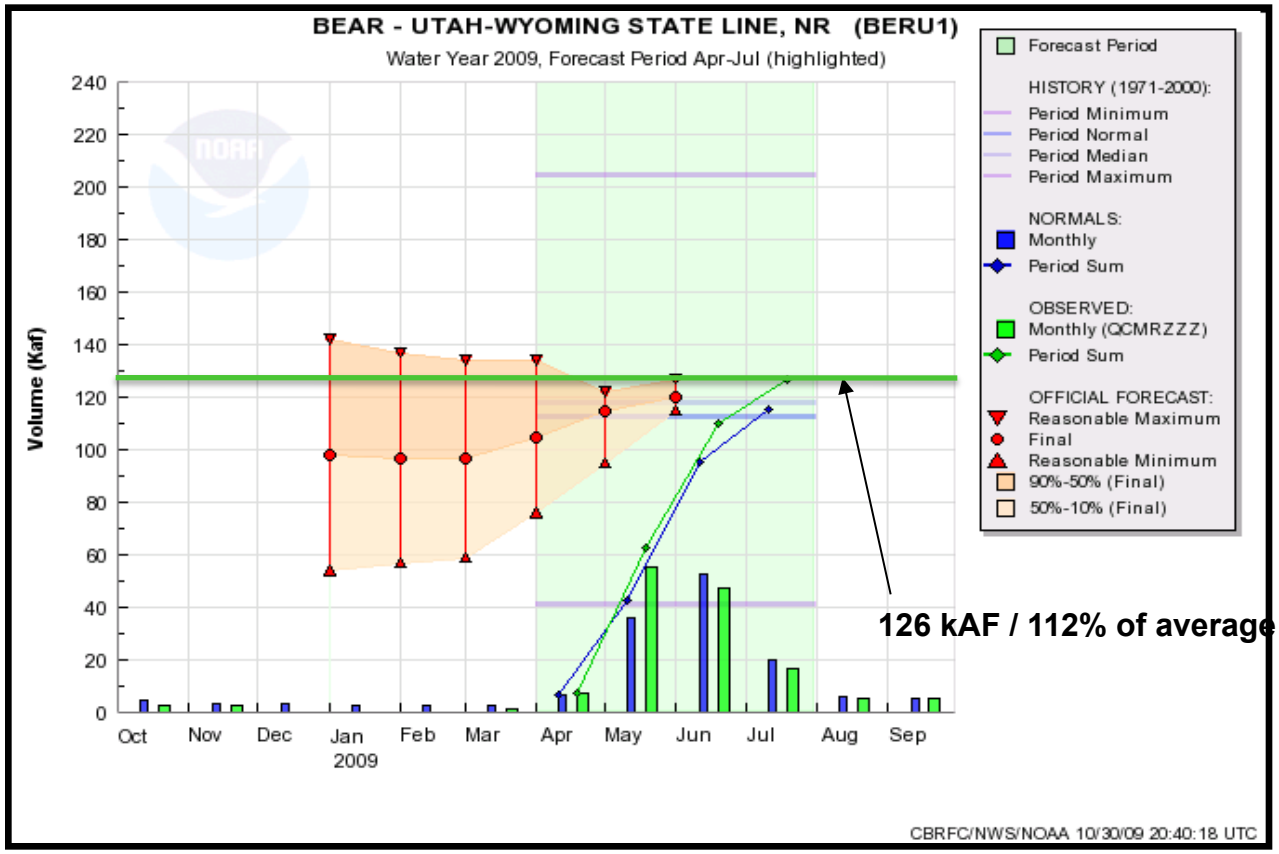
Last Peak outside of normal time (5270 cfs on 6/29) .


New Fork Near Big Piney - Peak Flow Forecast Evolution Plot
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
Mean Daily Peak (cfs)
2009 Observed Peak Flow
10% Exceedance Forecast
25% Exceedance Forecast
50% Exceedance Forecast
75% Exceedance Forecast
90% Exceedance Forecast
March
April
May
Forecast Issuance Date

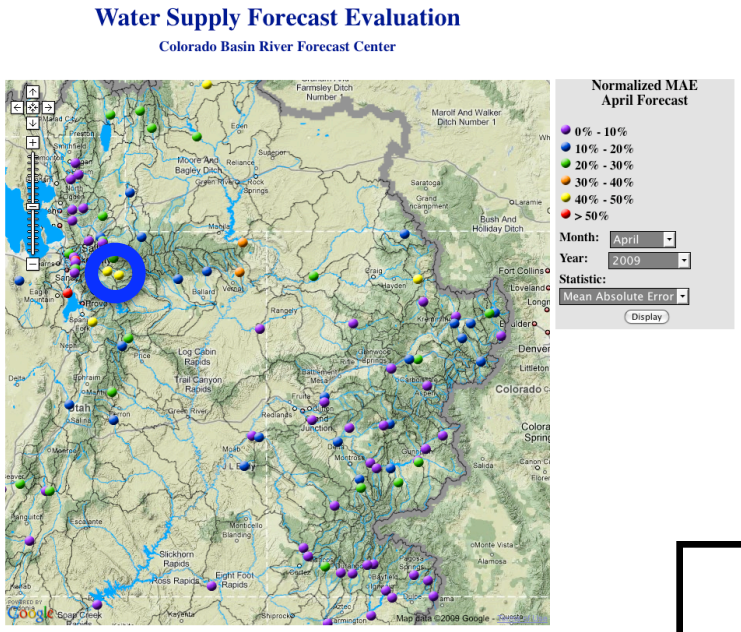
2009 Water Supply Forecasts: Bear at UT/WY Stateline

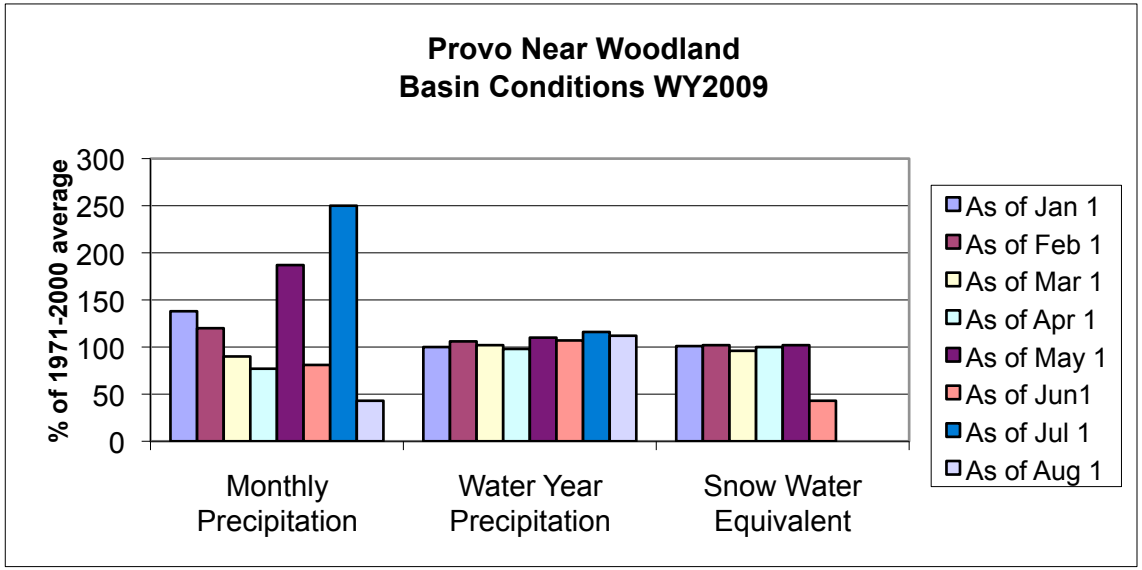




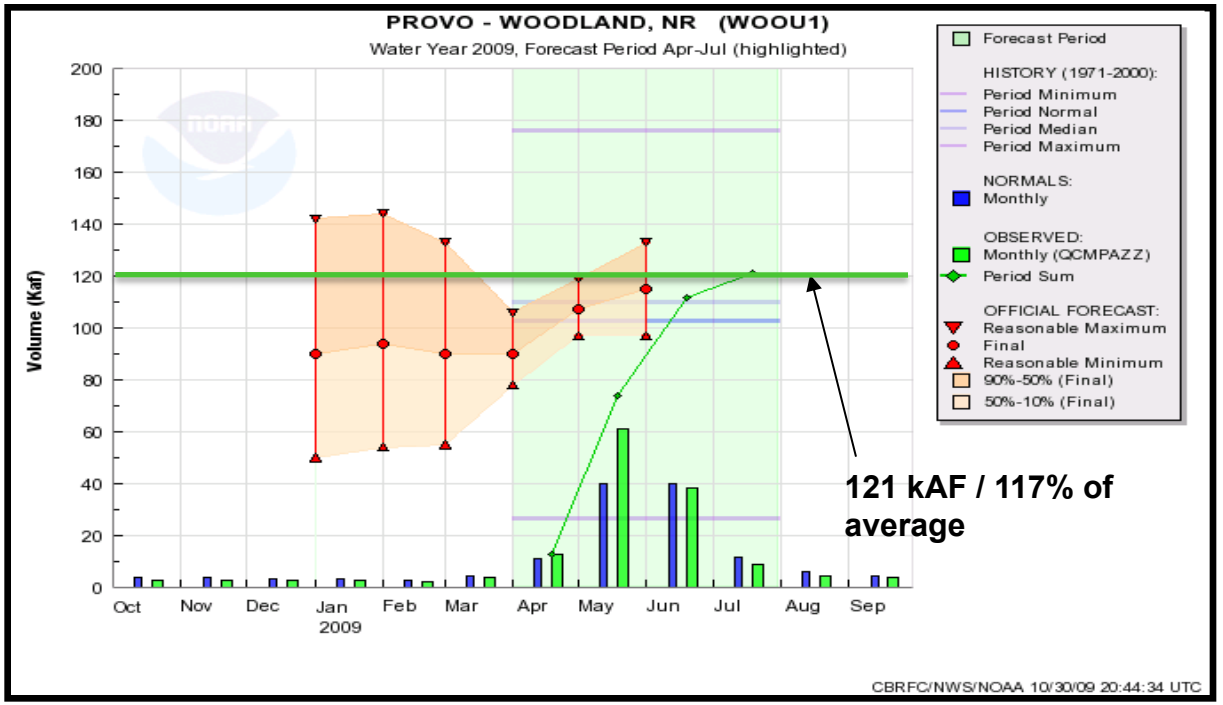


2009 Water Supply Forecasts: Provo near Woodland, UT

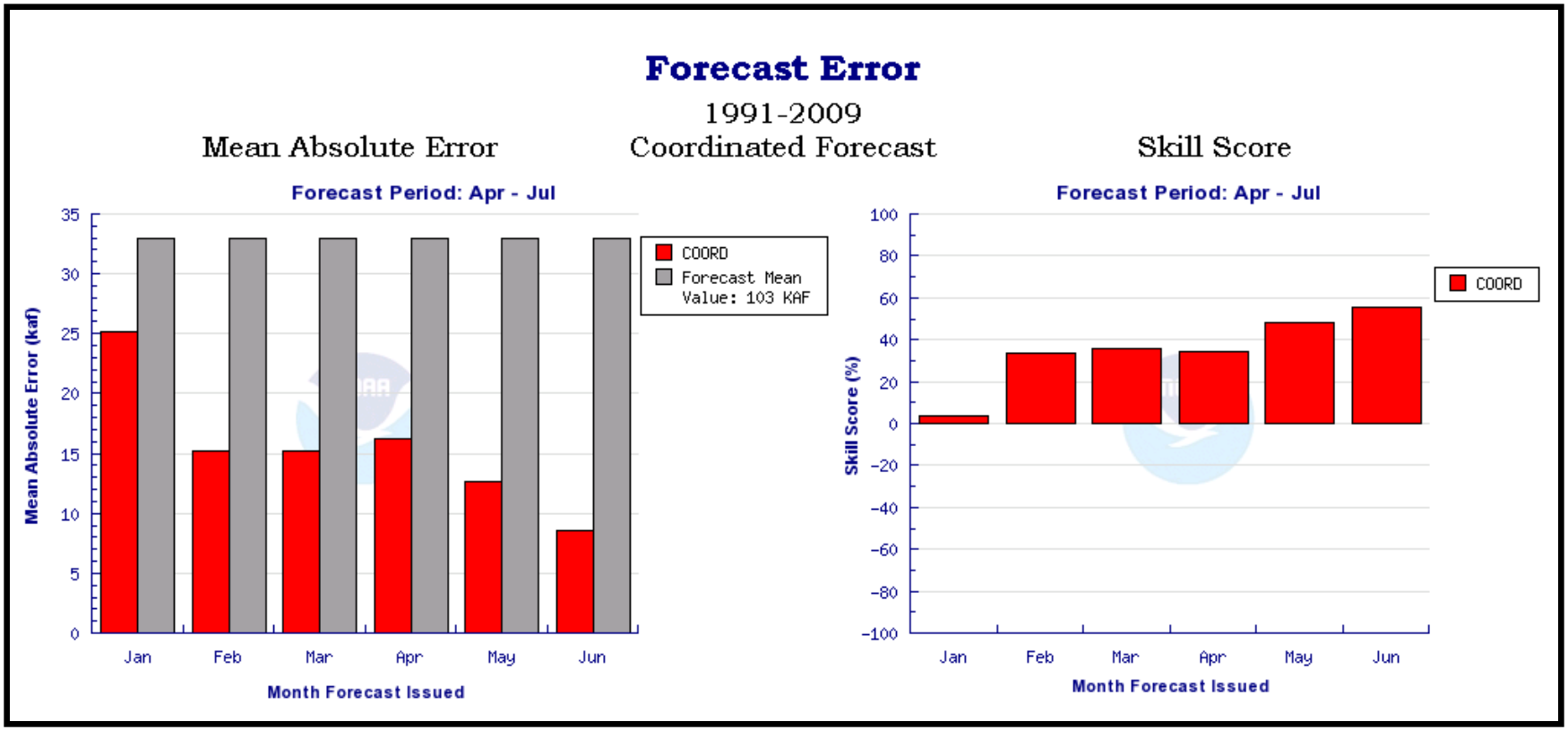




April 1 forecast error:
30 kAF

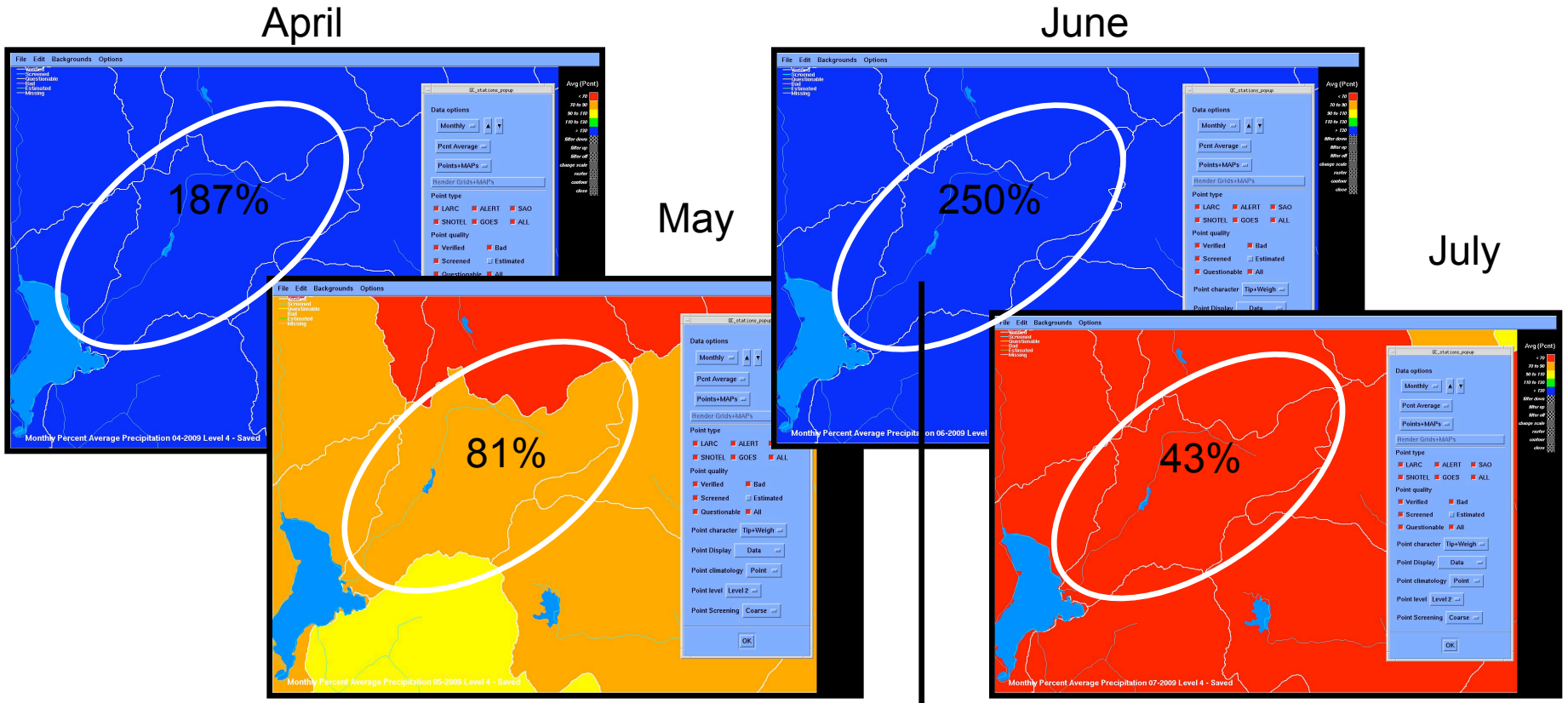


Skill Score and MAE ~ Provo, Woodland



April 1 forecast error:
30 kAF

Upper Provo River, April – July
HUC Percent of Normal Precipitation

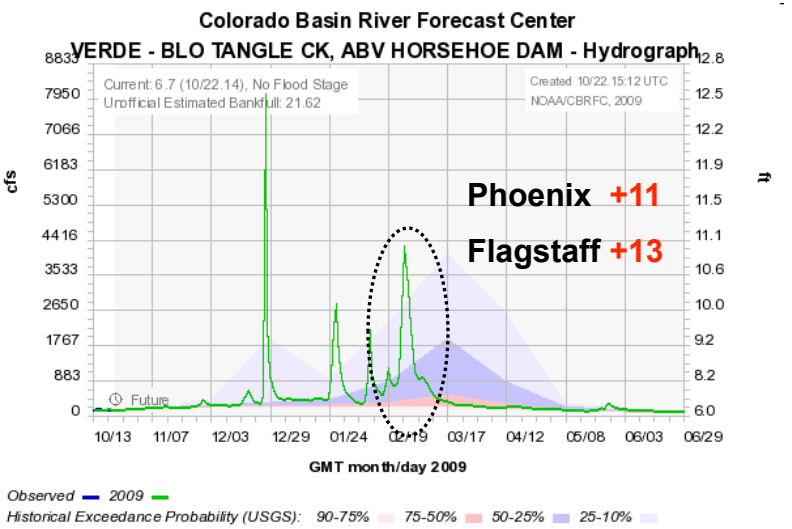


CBRFC Monthly Precipitation Calculations for the Upper Provo River

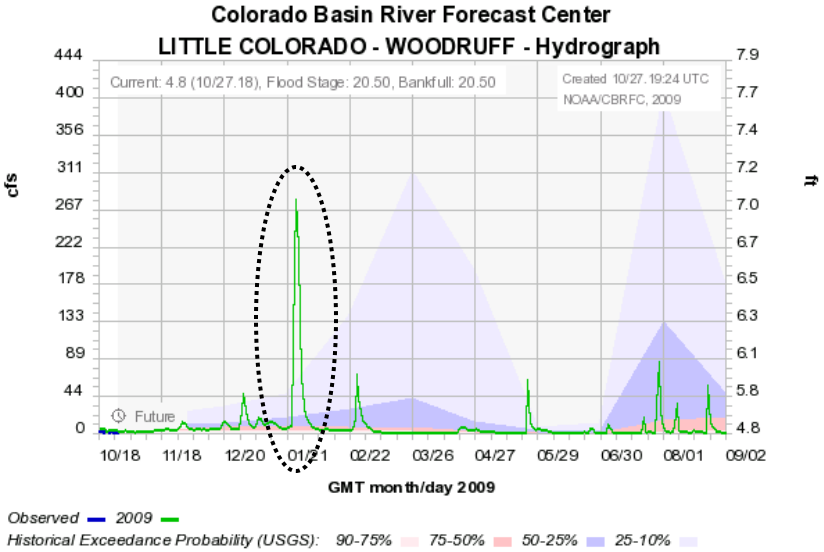
The Trial Lake SNOTEL gage for June ranked as the 2nd wettest during the pervious 31 years of record

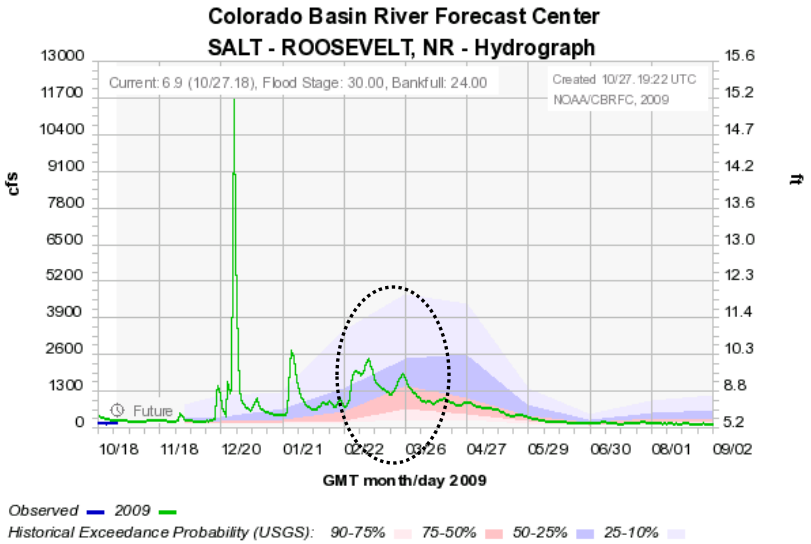
Arizona / New Mexico Basins – Impacts to Forecasts and Runoff Volumes

- **Gila Basin:** started dry, stayed dry – game over.
- **Salt River and LC Basins** streams near/above median early.
- **Little Colorado Basin**
  - Basin wide snow 275% Jan 1st and 120% March 1st
  - January Melt – High elevation snow persisted / limited area
- **Salt River Basin (Verde & Tonto)**
  - Early season rainfall-runoff response suggested moist soil
  - Significant snow in the Verde / Upper Salt (coverage ?)
  - Below Average precipitation except Feb Verde/Lower Salt
  - Feb & Mar 'storms on the horizon' – never materialized.
  - Largest forecast error (as a % of observed) – mid Feb.



- **All areas:** Below average precip (Jan, Mar, Apr, May) primary driver affecting final observed volumes

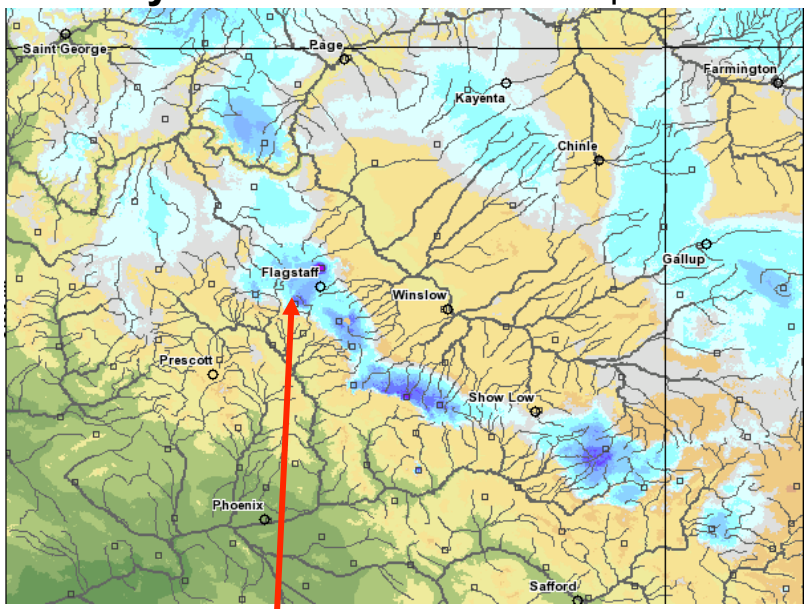


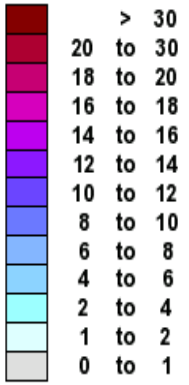


Snow Maps: www.nohrsc.noaa.gov

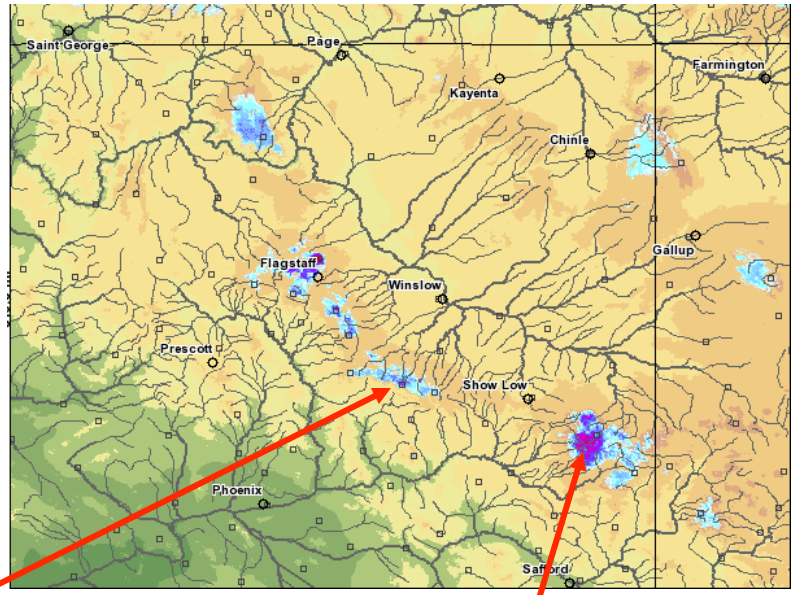
Arizona Basins – 2009 Snow Impacts

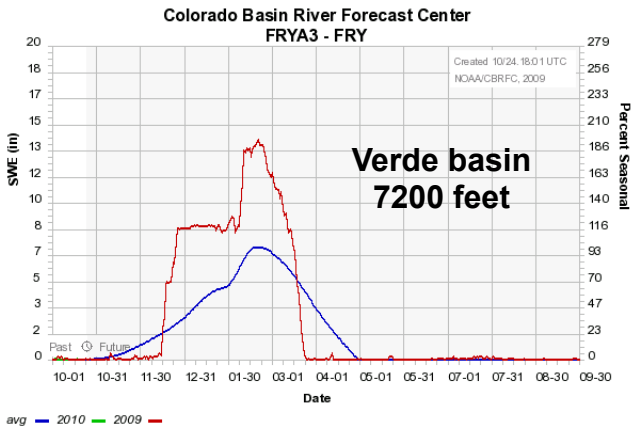
January 1 2009 – Snow Water Equivalent

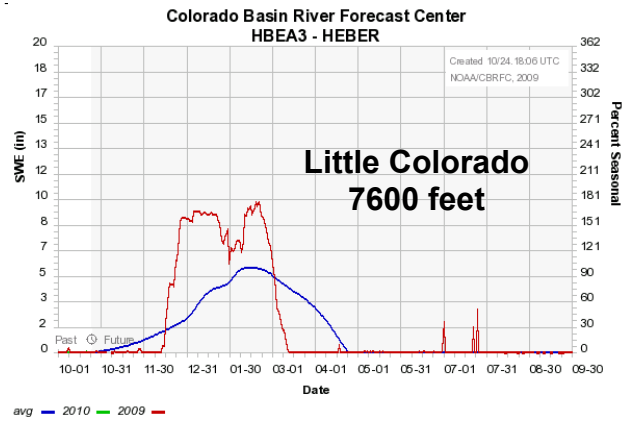


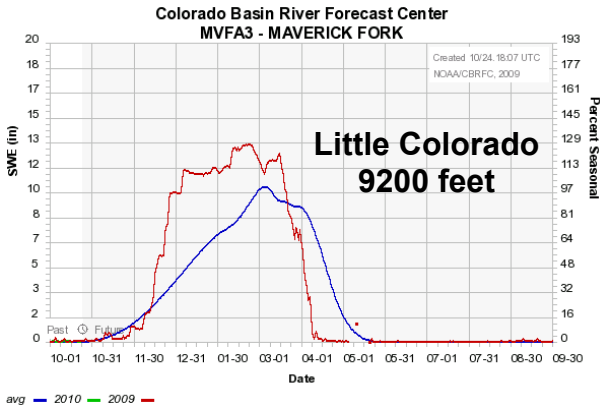


March 1 2009 – Snow Water Equivalent









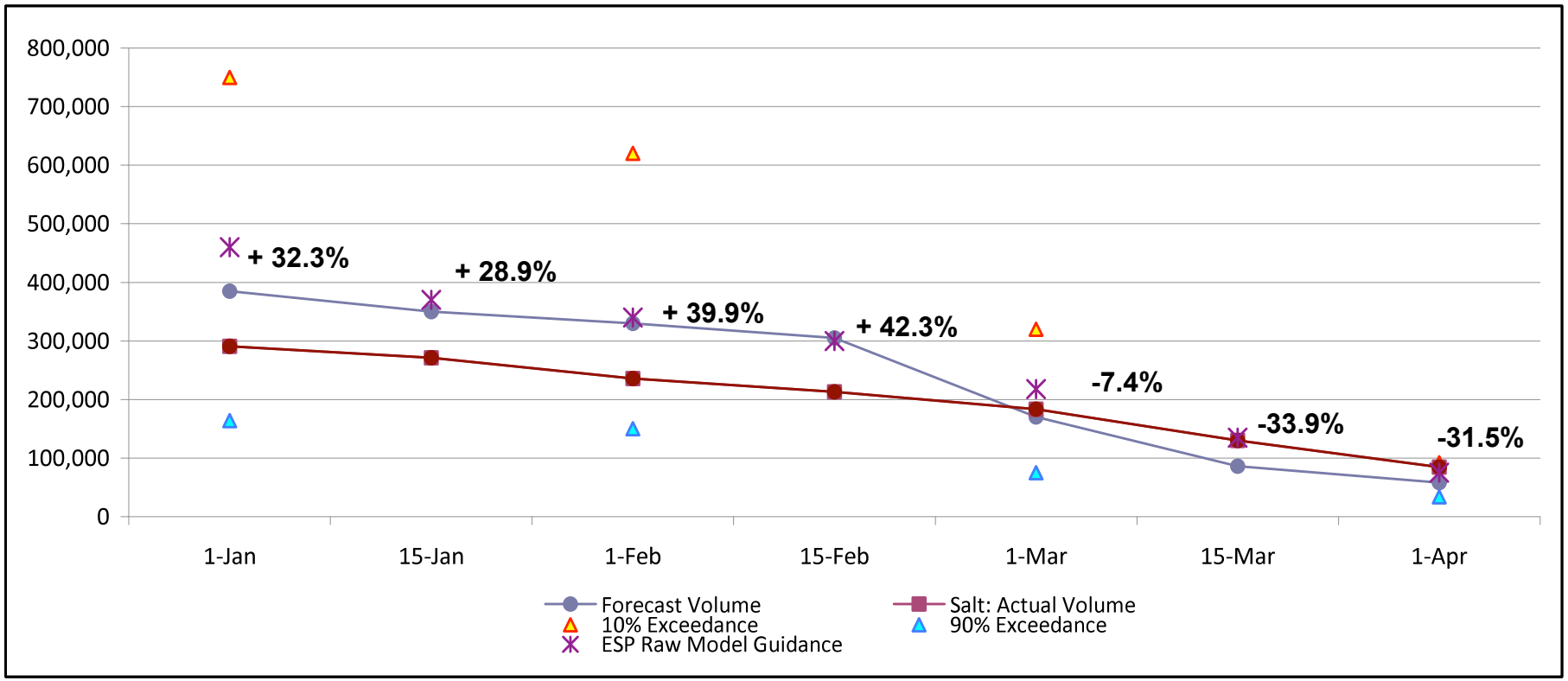
2009 observed

Average

SALT – ROOSEVELT:

CBRFC-NRCS-SRP COORDINATED FORECASTS

Progressive Forecast Period (Forecast Issue Date through May)

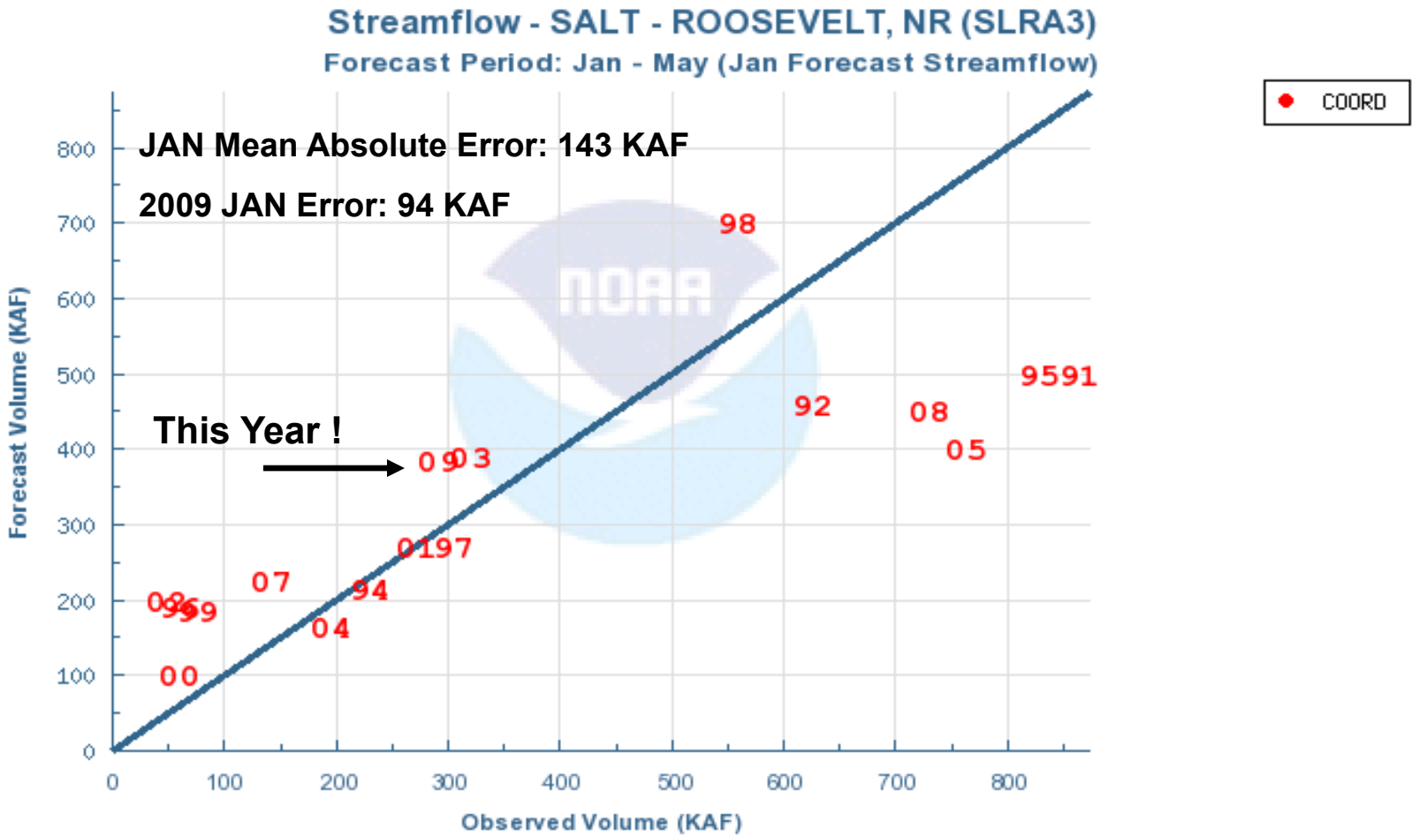


Volume in acre-feet

SALT RIVER – Forecast Performance the Last 20 Yrs

How did this year Compare ?

1991-2009: Exclude 1993



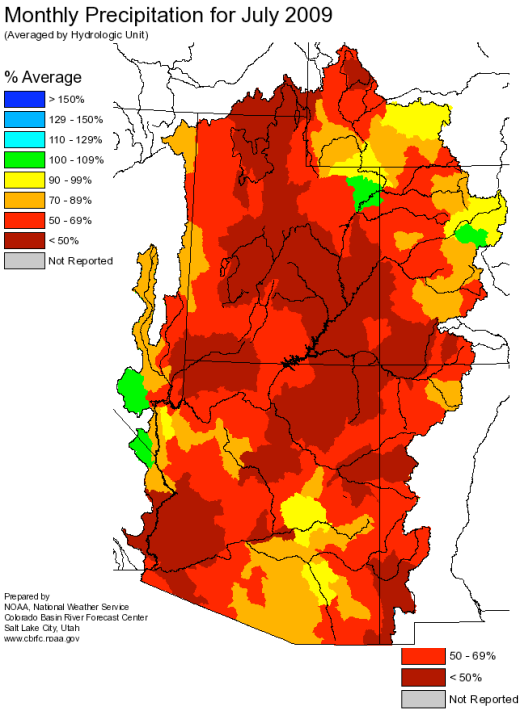
Verification Conclusions

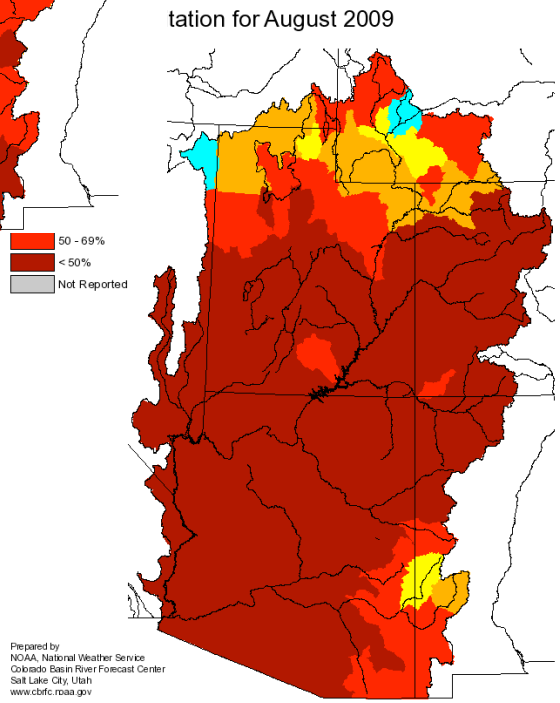
- 2009 had several important anomalies that were important for water supply:
  - Warm March
  - Warm May with very warm minimum temperatures
  - Dust on Snow in some areas
  - Very wet June
  - Beatle kill affecting forests
- Climate forecasts had marginal skill at best in the upper basin
- Results vary sometimes dramatically between basins depending on physical characteristics including elevation and location among others
- Forecast range (10 and 90% values in published forecasts) are generally reliable and more representative than the single 50% number.

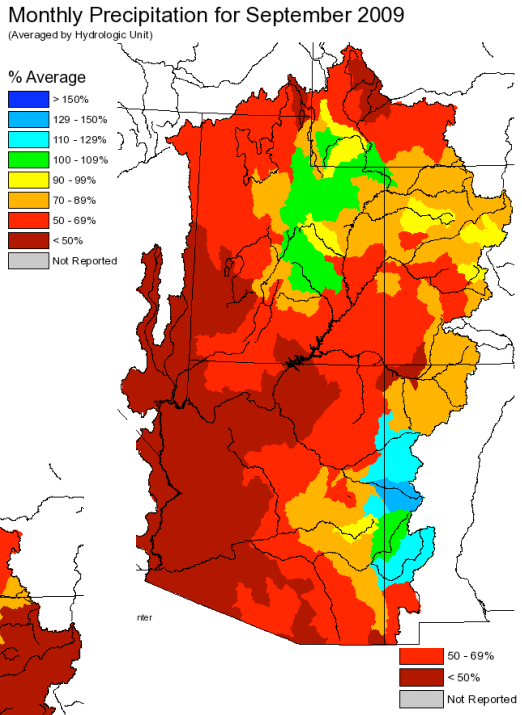
2010 Look Ahead

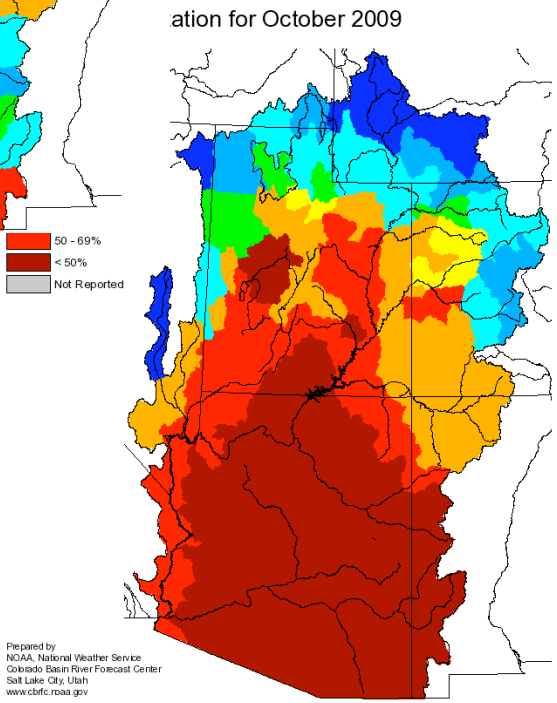
- Outlook and current situation:
  - Summer / Fall Precip
  - Soil Moisture States
  - Snow States
  - Climate Forecasts and ENSO
- New CBRFC Services
  - Weekly ESP
  - Lake Powell Probability of Exceedence
  - WS/WRO version 4 (including ENSO plots)
  - Webinars
  - Govdelivery
  - NIDIS focus on Upper Colorado

Summer / Fall 2009 Precipitation



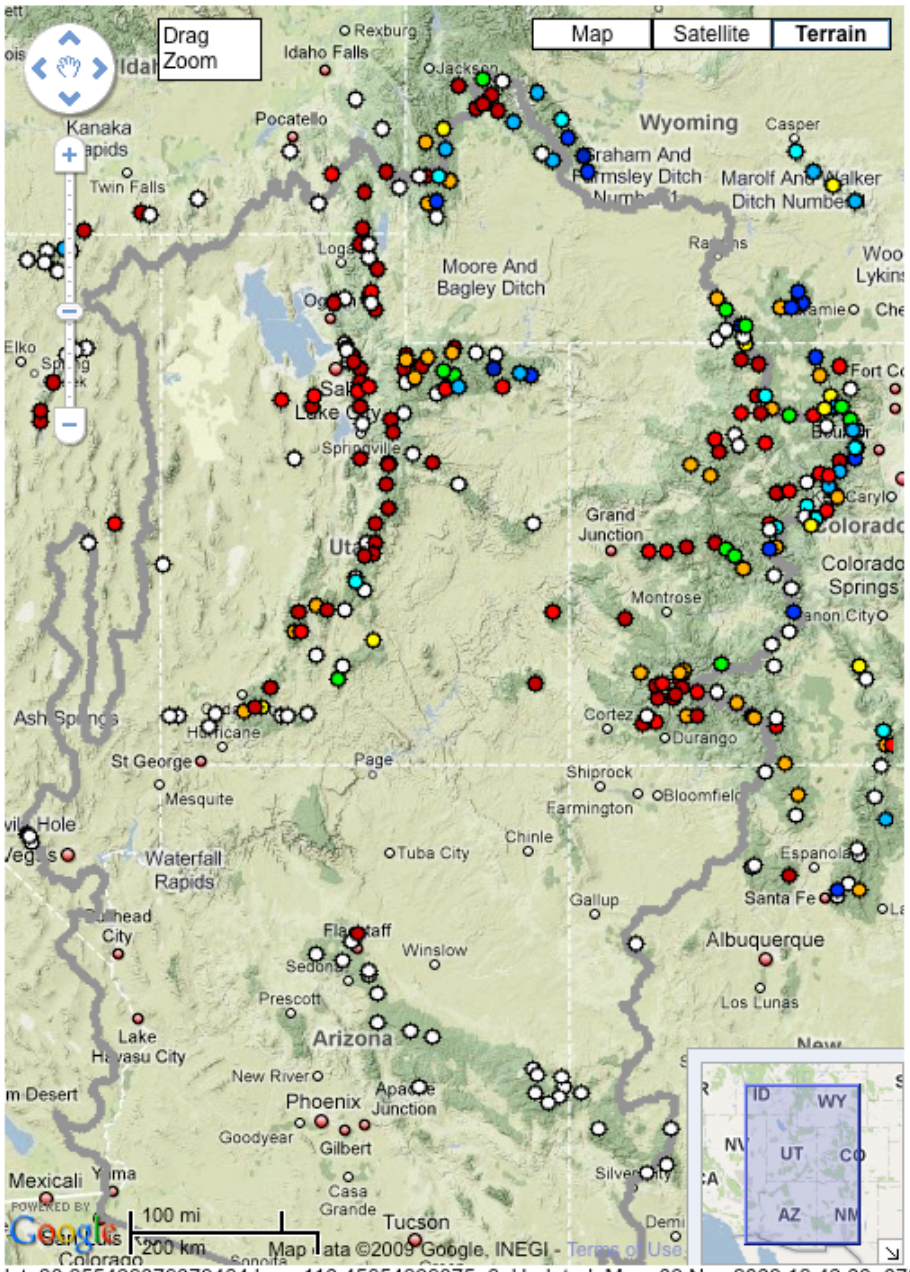






CBRFC Snow Conditions

Goto the Old Map or Give Feedback on New Map.



lat: 38.255436376379464 lng: -110.45654296875, 6, Updated: Mon, 09 Nov 2009 12:43:00 -0700

Data Type Controls

River | Snow | Water Supply | Peaks | Grids

Allow Multiple Data Types

Zoom To

Select Snow Point by Name

Snow Points

- All
- < 7000
- 7000-8000
- 8000-9000
- 9000-10000
- > 10000

SWE (% Avg)

- No data
- < 25
- 25-50
- 50-75
- 75-90
- 90-110
- 110-125
- 125-150
- 150-175
- > 175

Nov 9 Snow pack
Very Early – 0-5%
of seasonal
precipitation

General Controls

Zoom To Select Area

Overlays

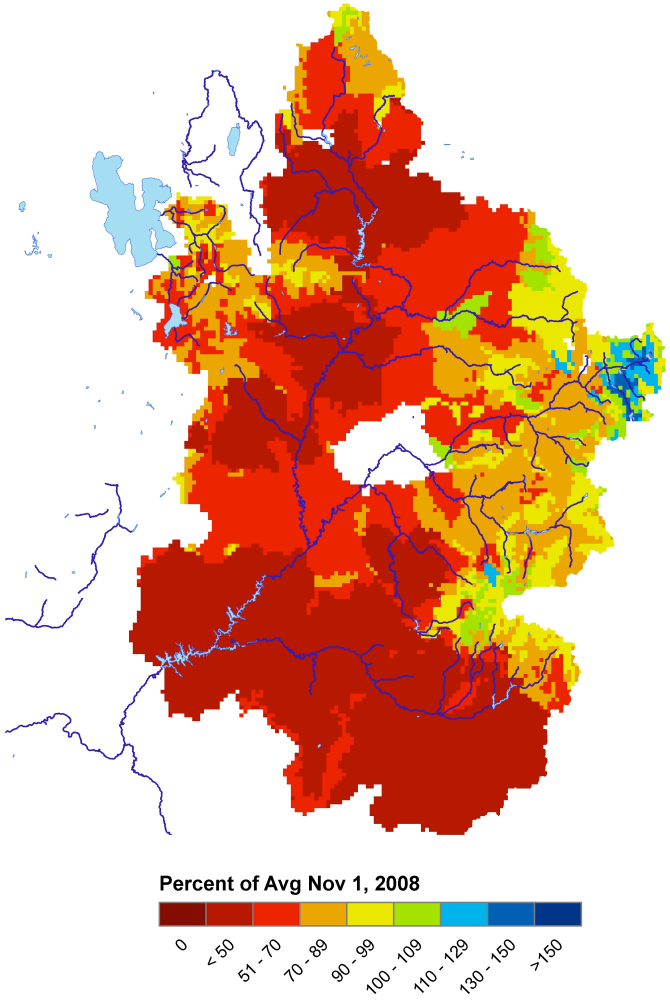
- Rivers
- RFC
- Basins

Display Options

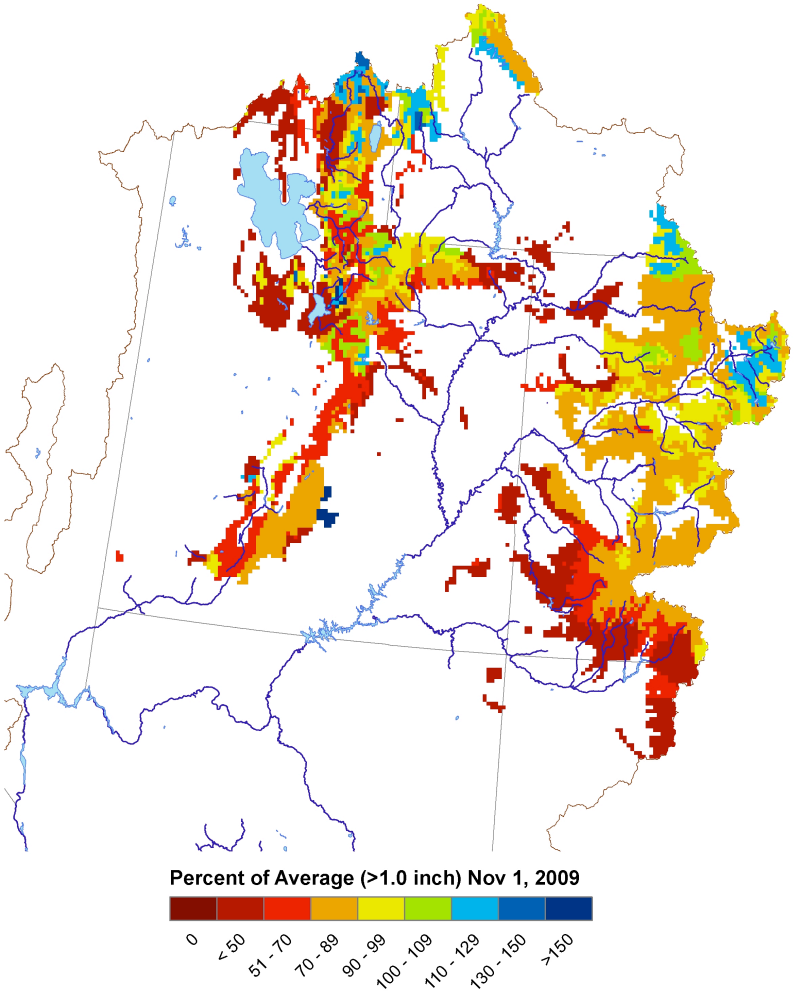
- Show NWS ID
- Show Data

Soil Moisture

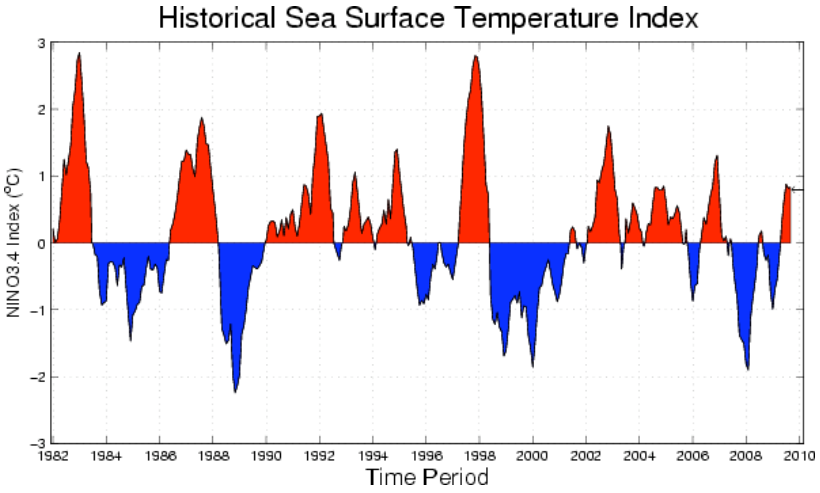
Upper Colorado
NWSRFS Modeled Lower Zone Soil Moisture

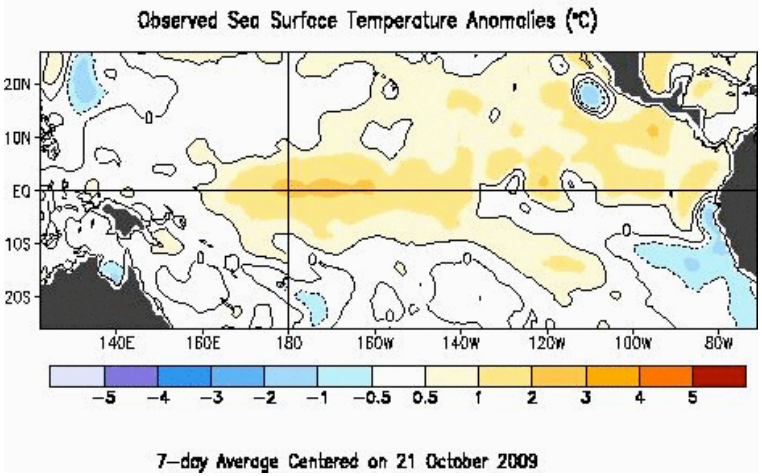


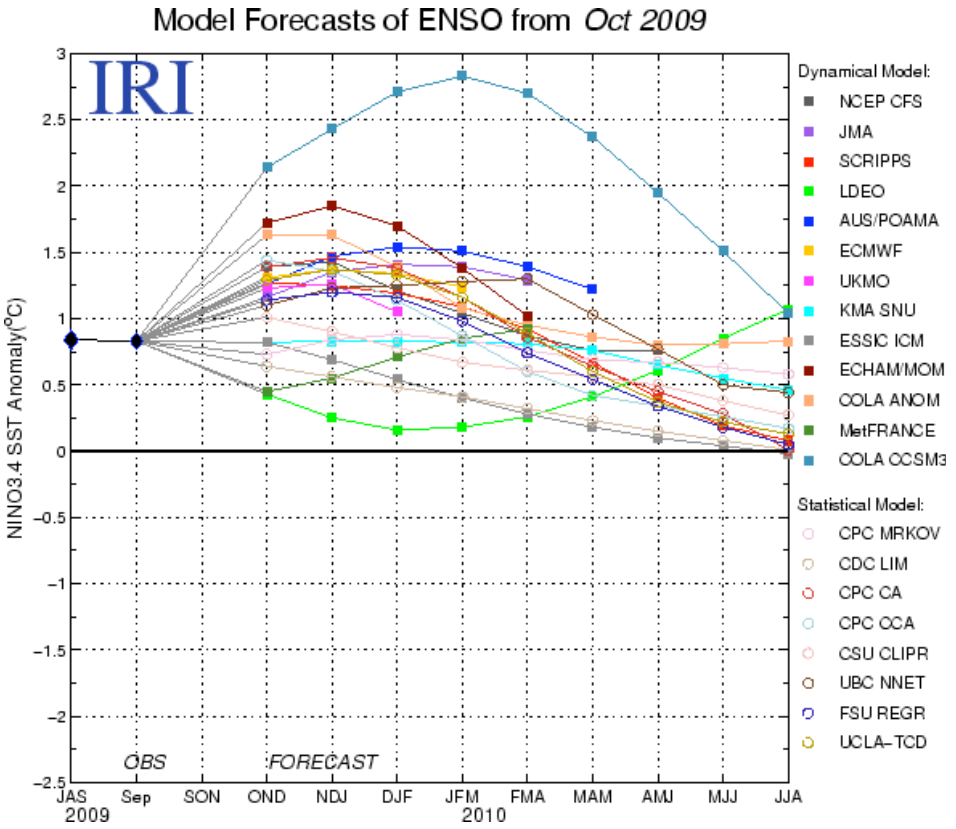
Upper Colorado
NWSRFS Modeled Lower Zone Soil Moisture



El Nino

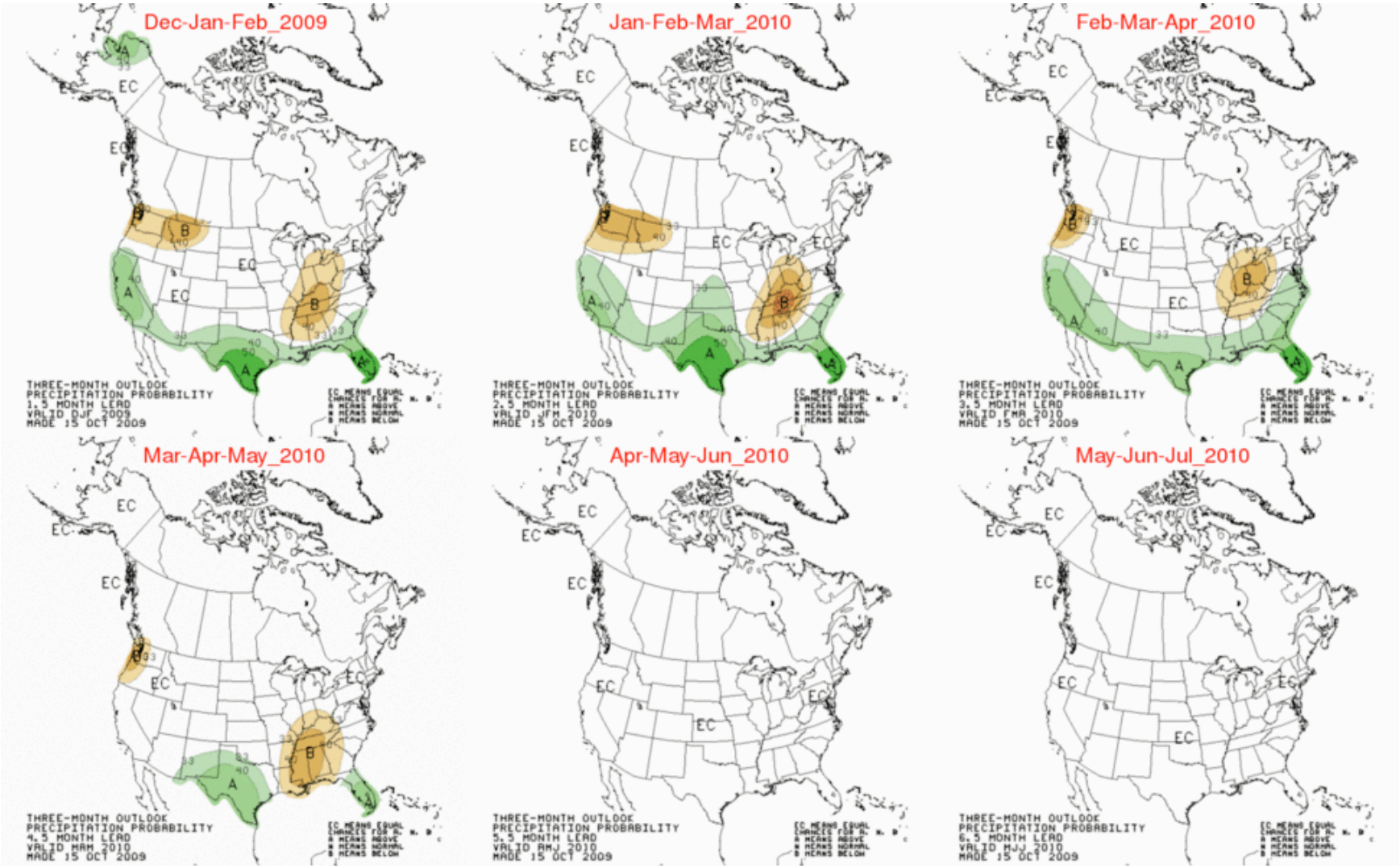




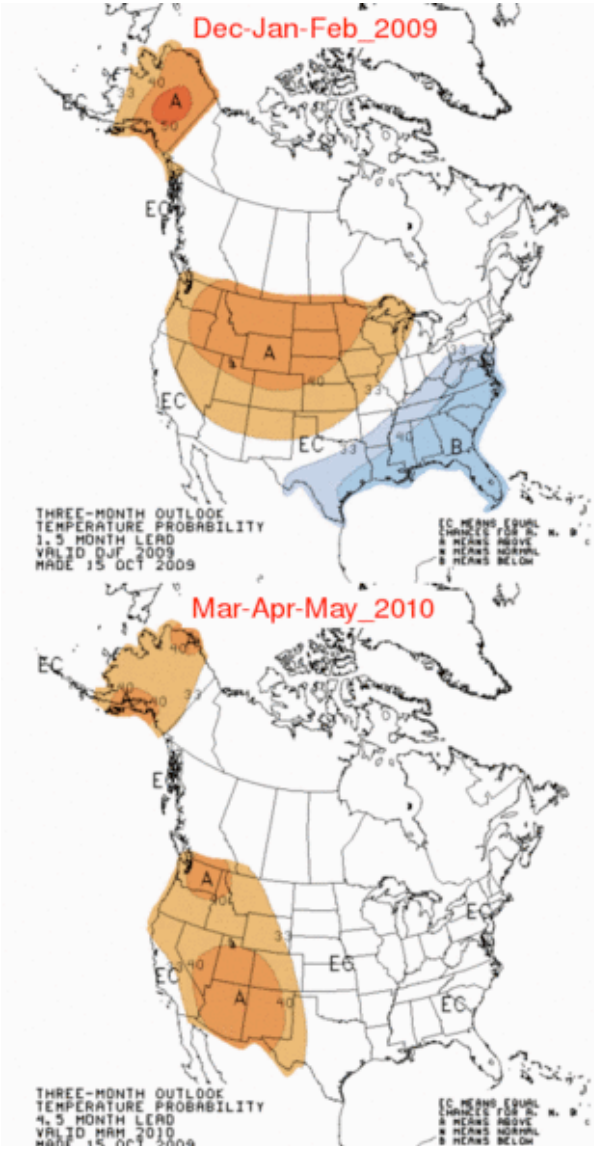


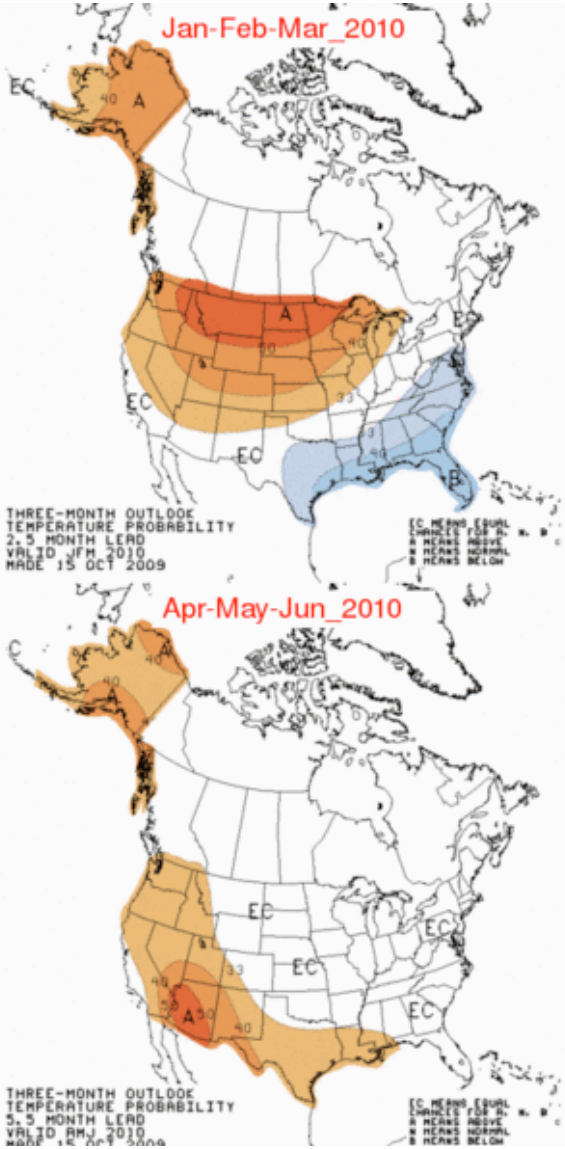
Sources: cpc.ncep.noaa.gov and iri.columbia.edu/climate/ENSO

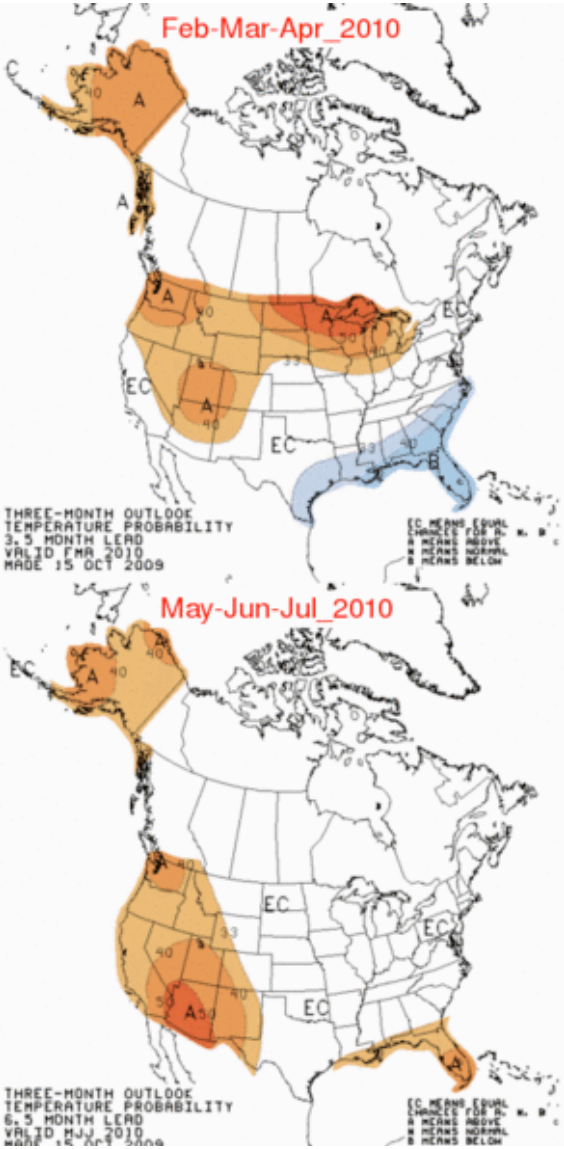
CPC Precipitation Outlooks



CPC Temperature Outlooks





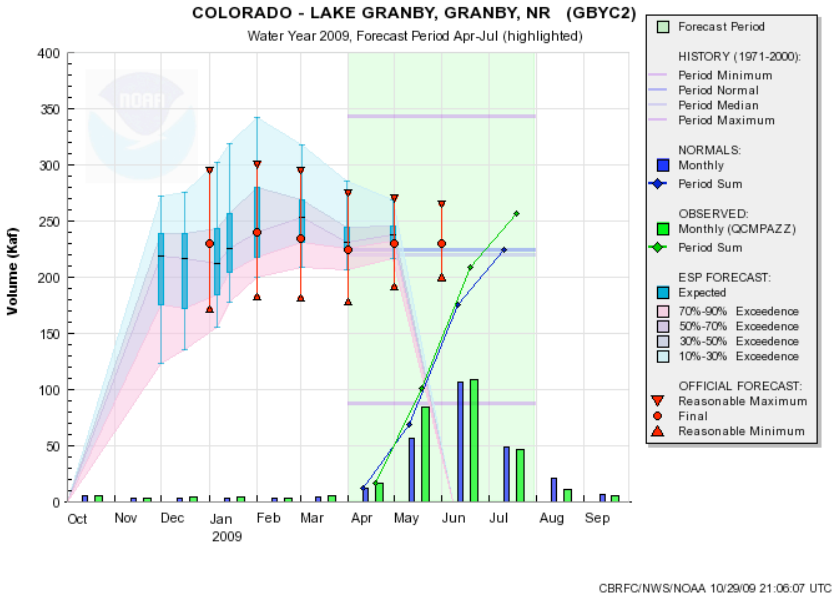


What's New at CBRFC

- Basin focal points / forecasters same as last year:
  - Brenda Alcorn (Upper Colorado)
  - Bill Reed (Green + Yampa / White)
  - Tracy Cox (San Juan + Gunnison)
  - Brent Bernard (Great Basin)
  - Greg Smith (Lower Colorado)
- Other key staff members:
  - Michelle Schmidt (Hydrologist In Charge)
  - Kevin Werner (Service Coordination Hydrologist)
  - Craig Peterson (Calibrations, Operations lead, etc)
  - Cass Goodman (IT Support, web development, etc)
  - Ed Clark (Distributed model development)
  - John Lhotak (New model development focal point)
  - Ashley Nielson (new hydrologist)
  - Drew Peterson (student)
  - Mike Hobbins (post-doc)

Weekly ESP

- CBRFC will run ESP weekly for water supply forecast points beginning Jan 2010
- ESP forecasts will be uncoordinated and with much less forecaster analysis than the first of the month official forecasts
- ESP forecasts will be accessible from CBRFC and NWS water supply websites

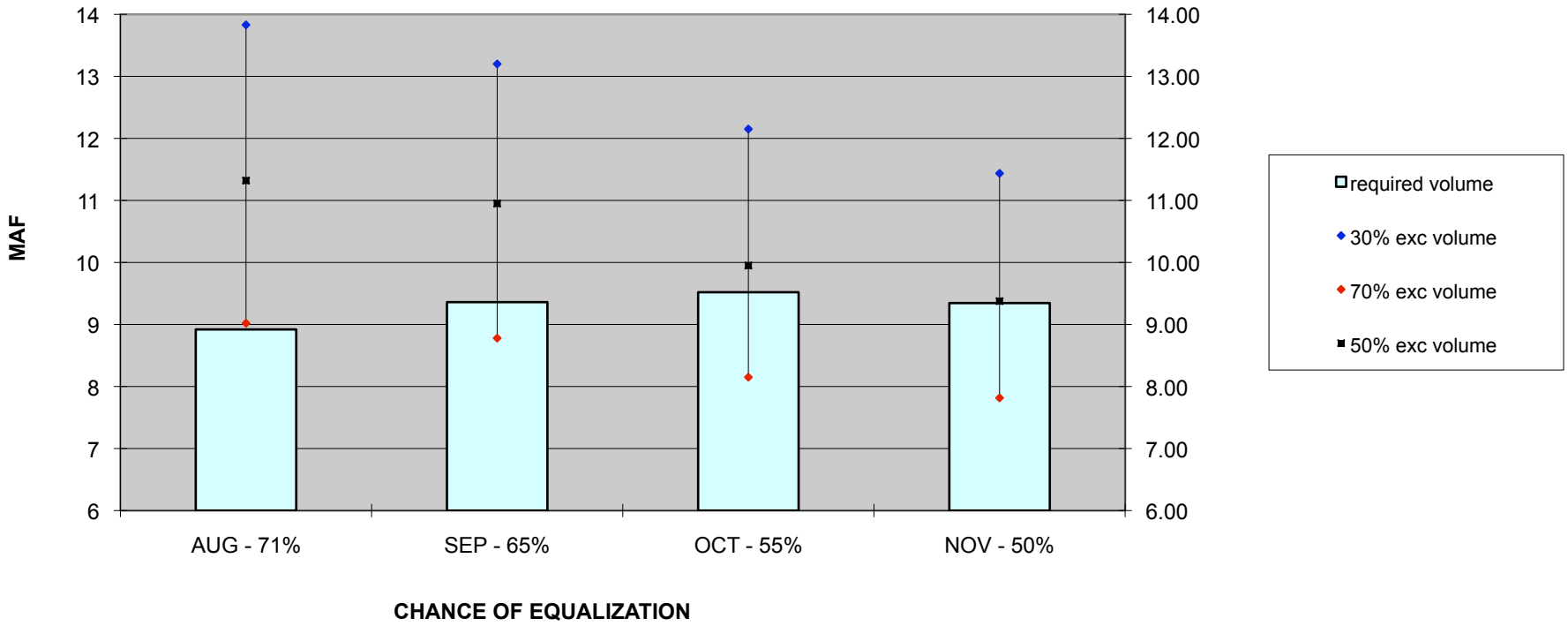


ESP RAW MODEL GUIDANCE							OFFICIAL COORDINATED FORECAST				
Date Issued	Forecast Period	90% Exceedance	70% Exceedance	50% Exceedance	30% Exceedance	10% Exceedance	Date Issued	Forecast Period	90% Exceedance	50% Exceedance	10% Exceedance
1/1/2010	April-July	150	190	**235**	278	350	1/1/2010	April-July		**240**	
1/7/2010	April-July	170	200	**255**	310	410					
1/14/2010	April-July	195	210	**260**	310	420	1/14/2010	April-July		**240**	
1/21/2010	April-July	180	200	**255**	290	370					
1/28/2010	April-July	160	180	**230**	260	310					
2/3/2010	April-July	145	165	**210**	255	300	2/3/2010	April-July		**215**	

Lake Powell
Probability of Equalization Forecast

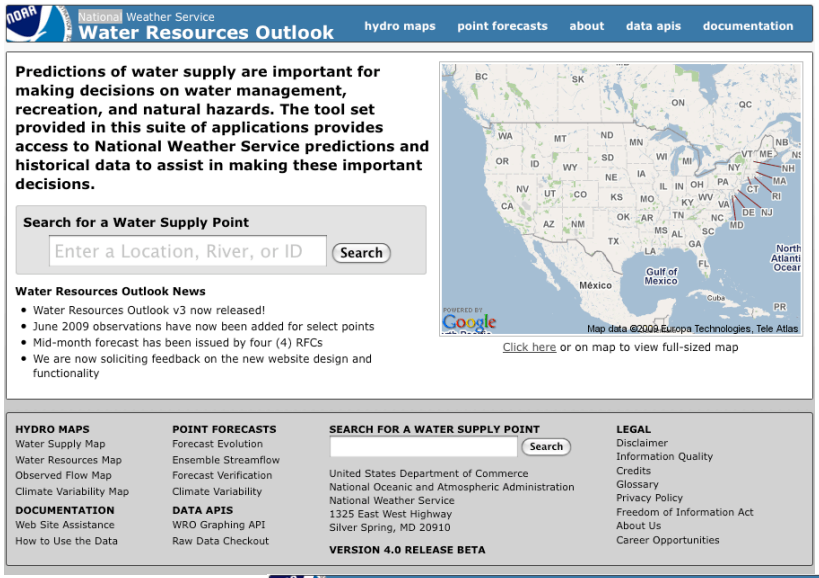
- CBRFC uses ESP to create a forecast probability distribution of regulated (observed) inflow volumes for the rest of the water year (Oct - Sep):
  - Water Supply forecasts are for unregulated volumes; this is what would be observed if there were no upstream reservoirs and diversions.
  - ESP knows how the reservoirs and diversions operated in past years and uses this information and reservoir rule curves to make (rough) assumptions about how they will operate in the future based on the forecast flows/volumes.
- USBR provides the threshold observed inflow volume for the rest of the water year that would trigger equalization from the latest 24-month study.
- CBRFC plugs that threshold value into the forecast probability distribution to determine the probability of equalization.

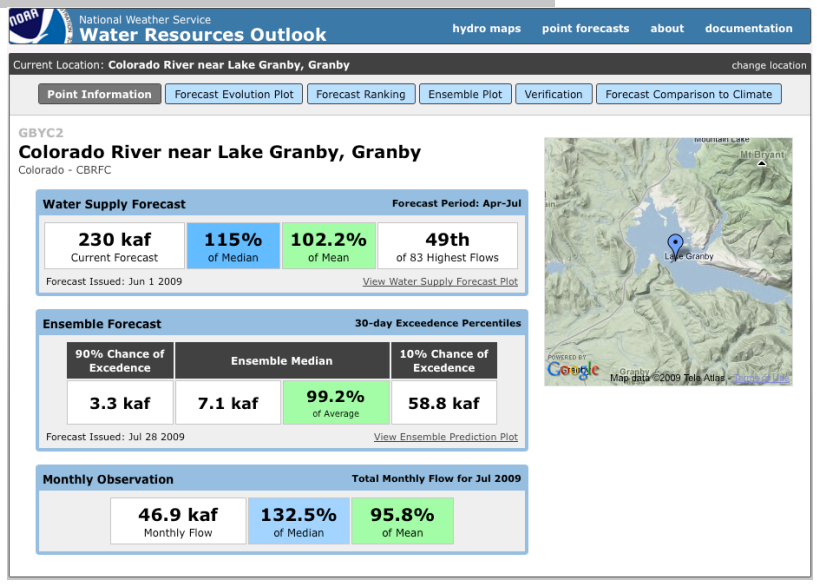
LAKE POWELL
FORECAST PROBABILITY DISTRIBUTION
OBSERVED INFLOW VOLUME
WATER YEAR 2010



NWS Water Supply Website

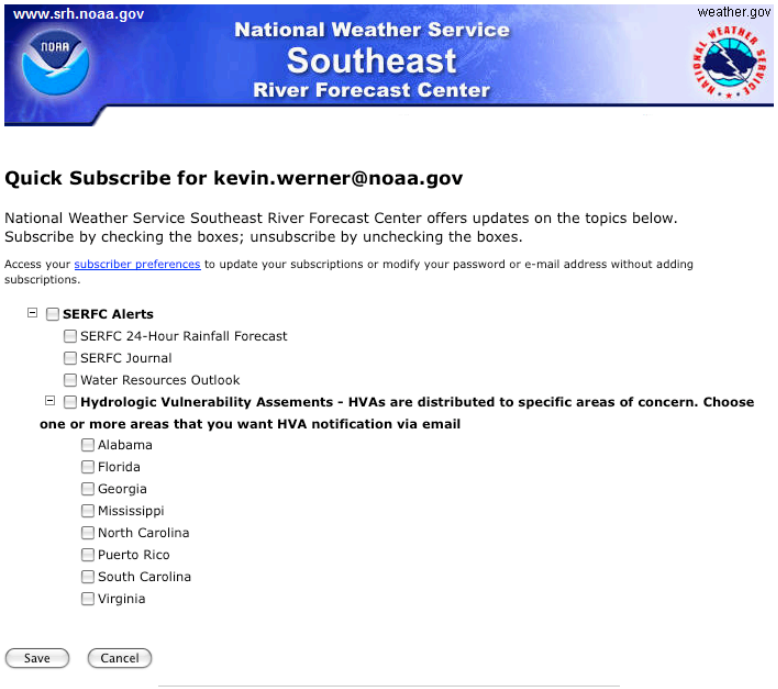
- Version 4 coming soon (by Dec 2009)
- Improved performance and data summaries
- Access to ENSO – streamflow relationships
- Forecast verification
- ESP forecast access and visualization





Govdelivery.com

- Transitioning to govdelivery.com to manage email announcements, forecast releases, and web page updates
- Individual users will be able to specify specific products that they would like to receive email notification updates when something new is available
- Details coming soon (hopefully before January 2010)



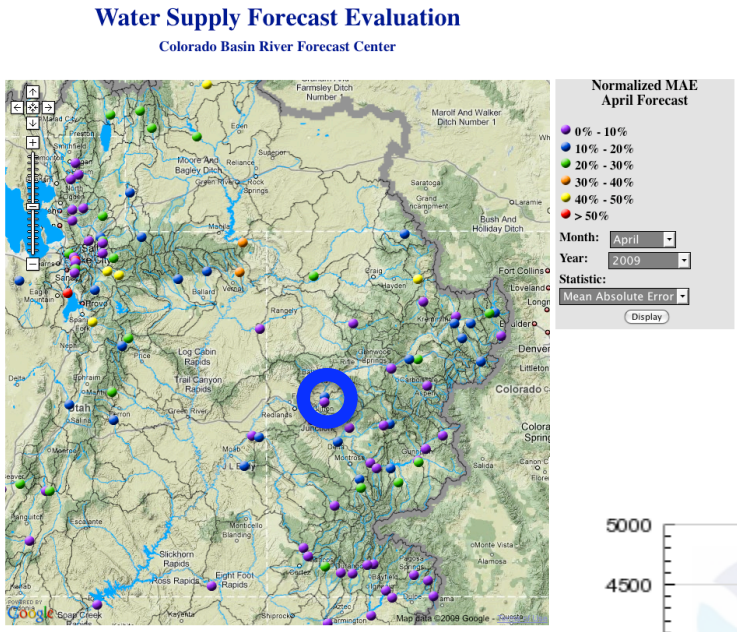
CBRFC Forecast Schedule

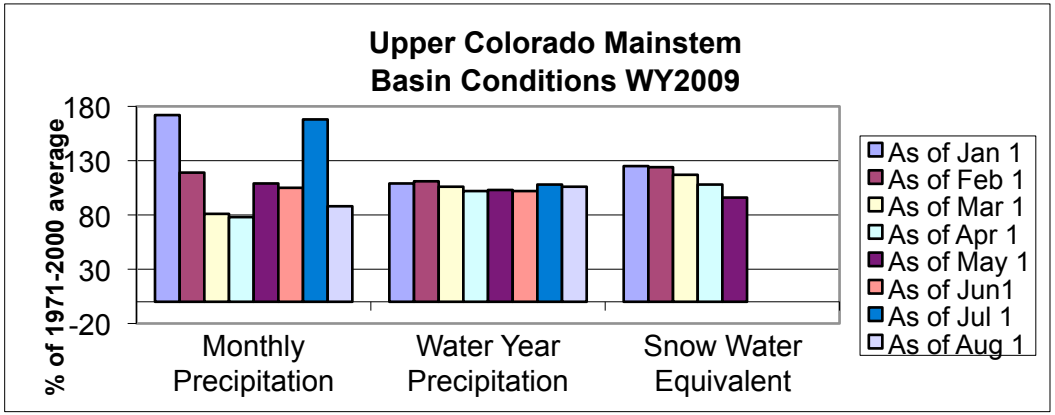
- Water supply forecasts
  - Monthly January through June
  - Final forecasts published by 5th working day of the month
  - Webinar follows shortly afterwards
  - January 11 at 1pm MT
- Peak flow forecasts
  - Monthly or as needed March through June
  - Webinars as needed
- Others
  - Verification (today), more detailed briefings on particular basins, etc as needed
  - Podcast for lower basin verification
  - Please contact us with suggestions, ideas, etc.

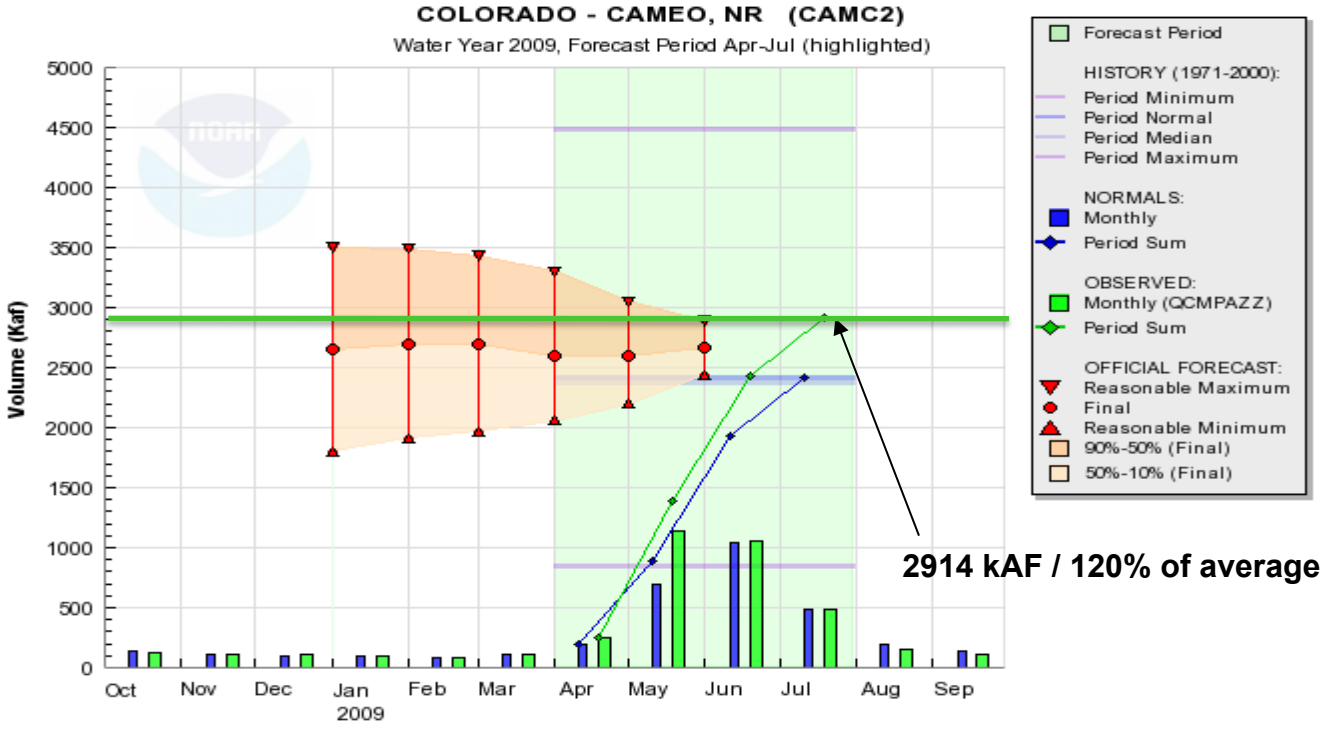
Upper Colorado in Detail

- CBRFC forecast verification
- CO climate center products and services
- NIDIS

2009 Water Supply Forecasts







More details on Upper Colorado in second hour

CBRFC/NWS/NOAA 10/29/09 23:17:00 UTC

May 1st Peak Flow Forecasts

Upper Colorado Peak Flow Forecasts (mean daily cfs)

Prepared by: Alcorn, Cox, Reed

Historic Peak	Average Peak	Flood* Flow	2008 Peak	2008 Date	2009 Forecast Exceedance Probability 90%	75%	50%	25%	10%	Normal time of Peak	Issuance Date	Observed Peak	Observed Date
38,000	17,500	23,700	22,500	6/04	16,000	17,000	**19,000**	22,000	24,000	5/29 - 6/18	5/7		

Peak was early, 18,700 on 5/25.

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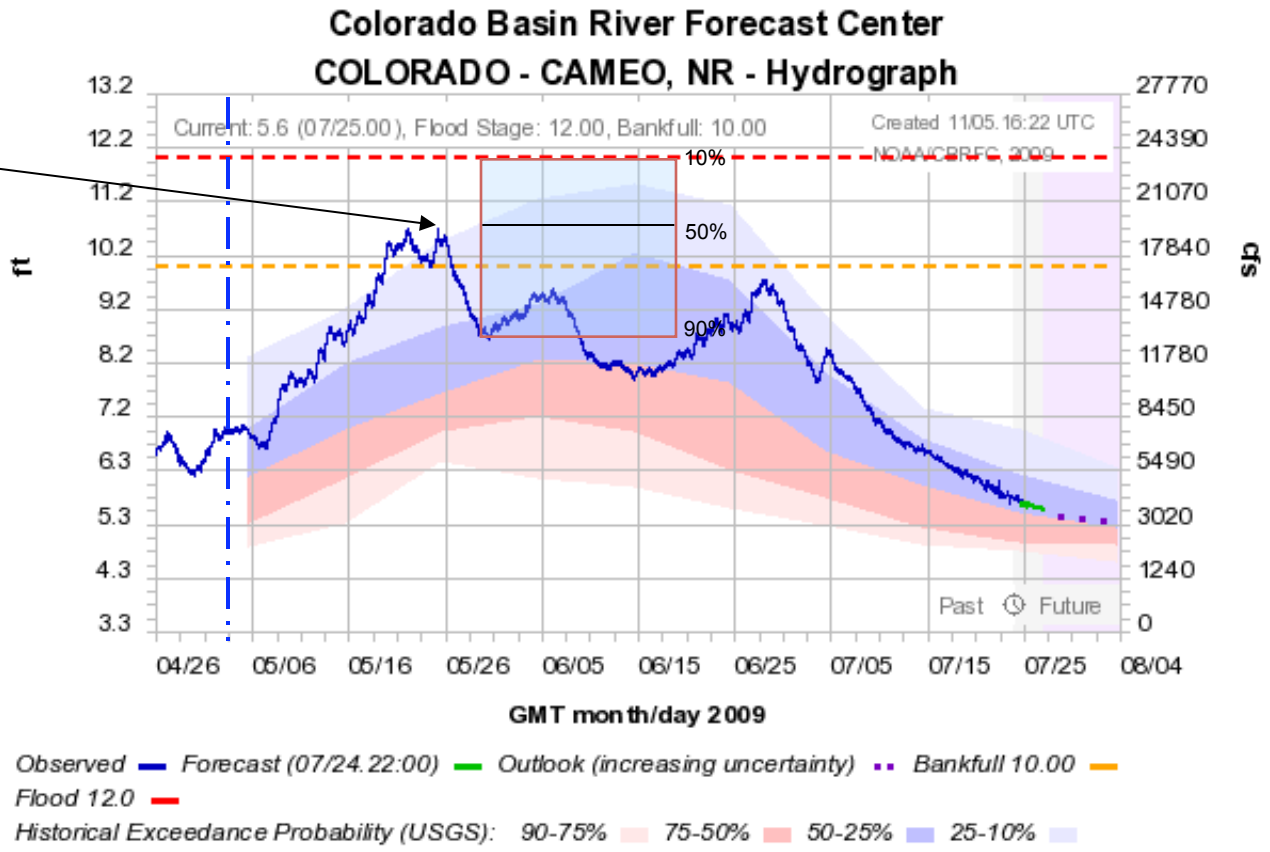
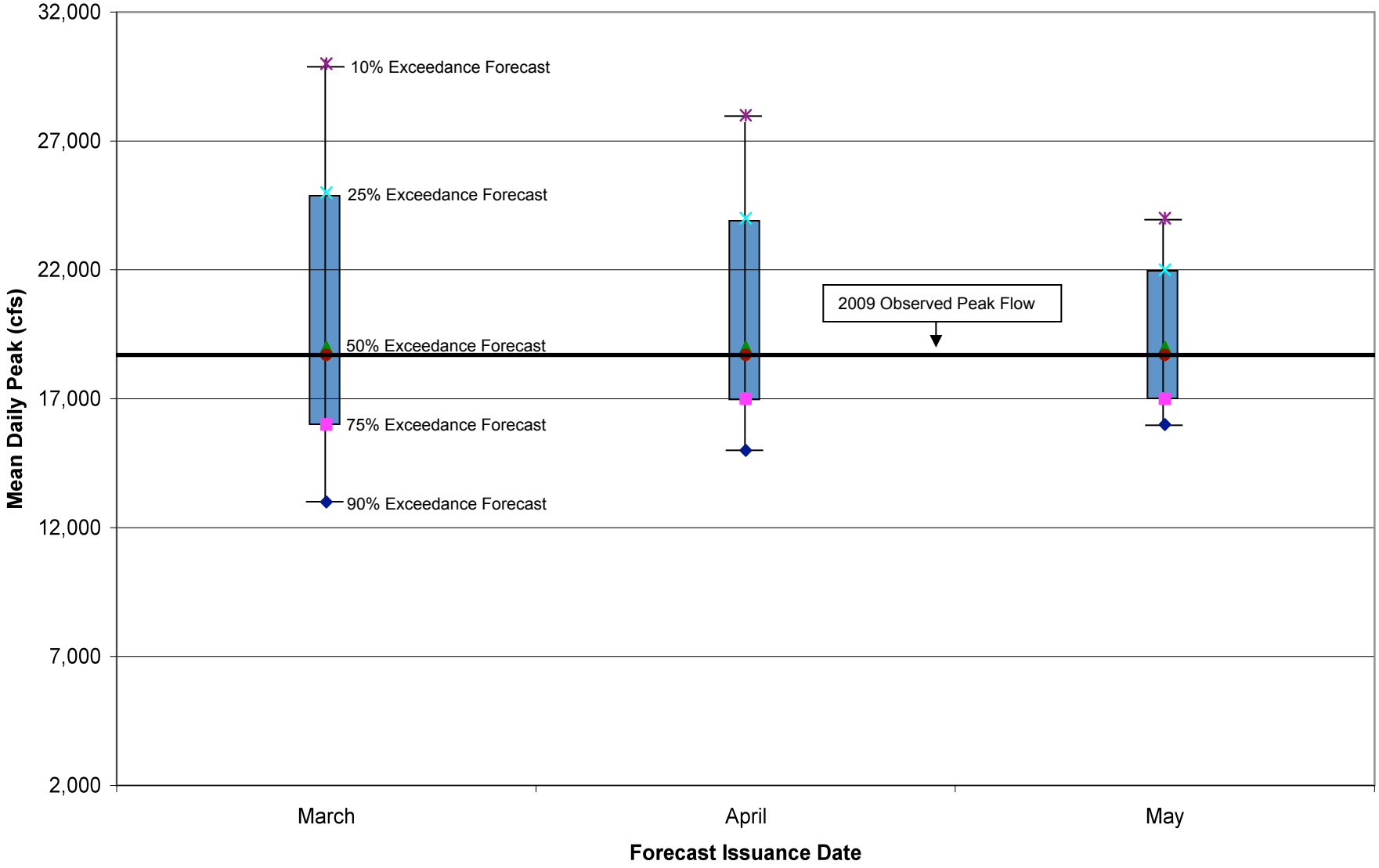
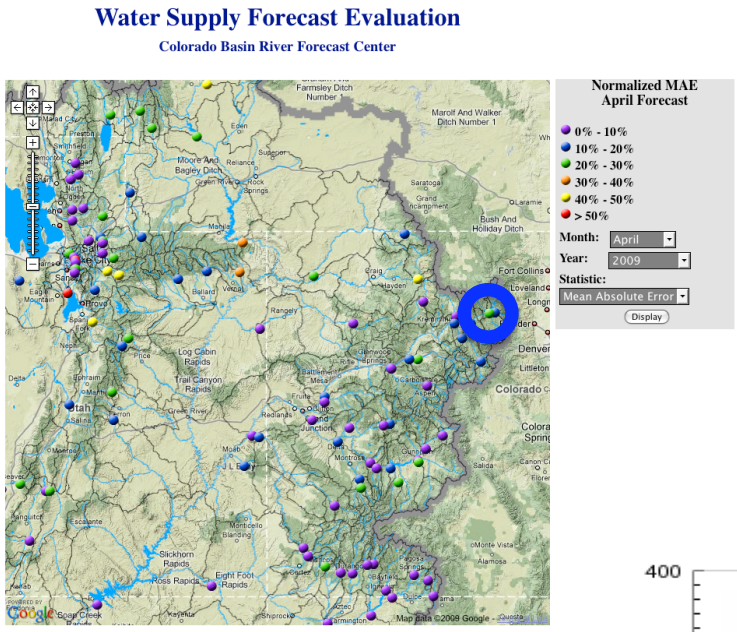
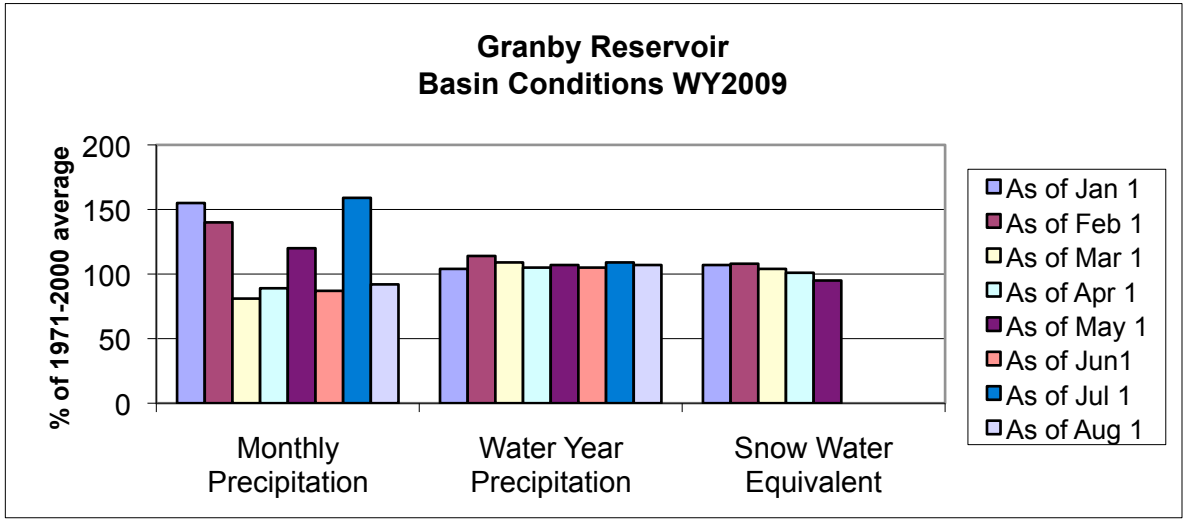


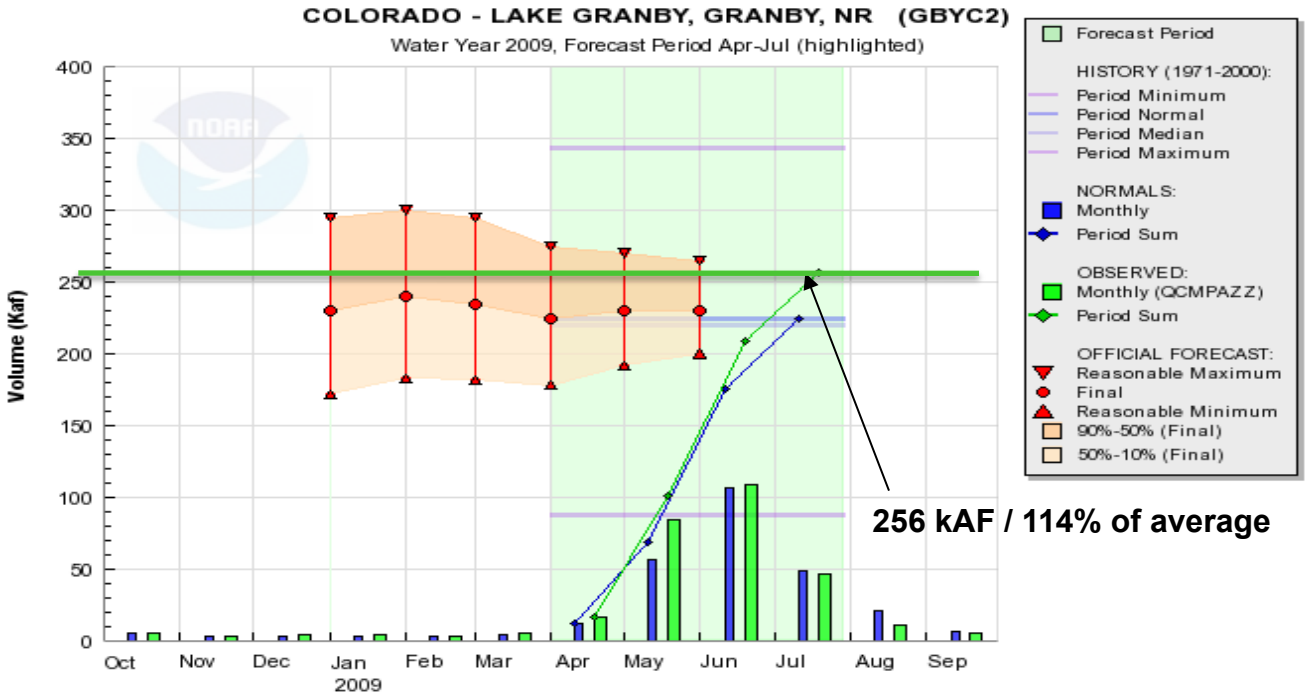
Colorado Near Cameo - Peak Flow Forecast Evolution Plot



2009 Water Supply Forecasts: Colorado at Granby

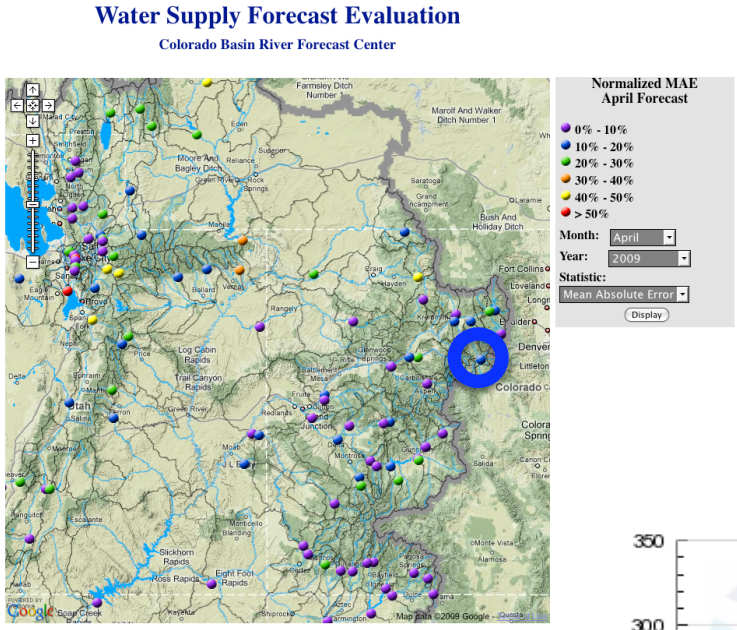


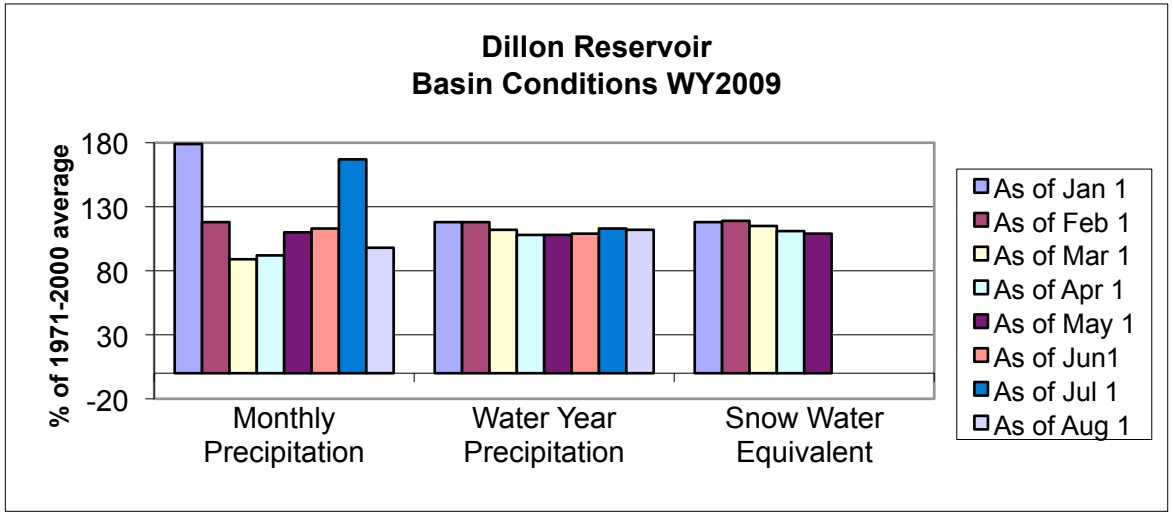


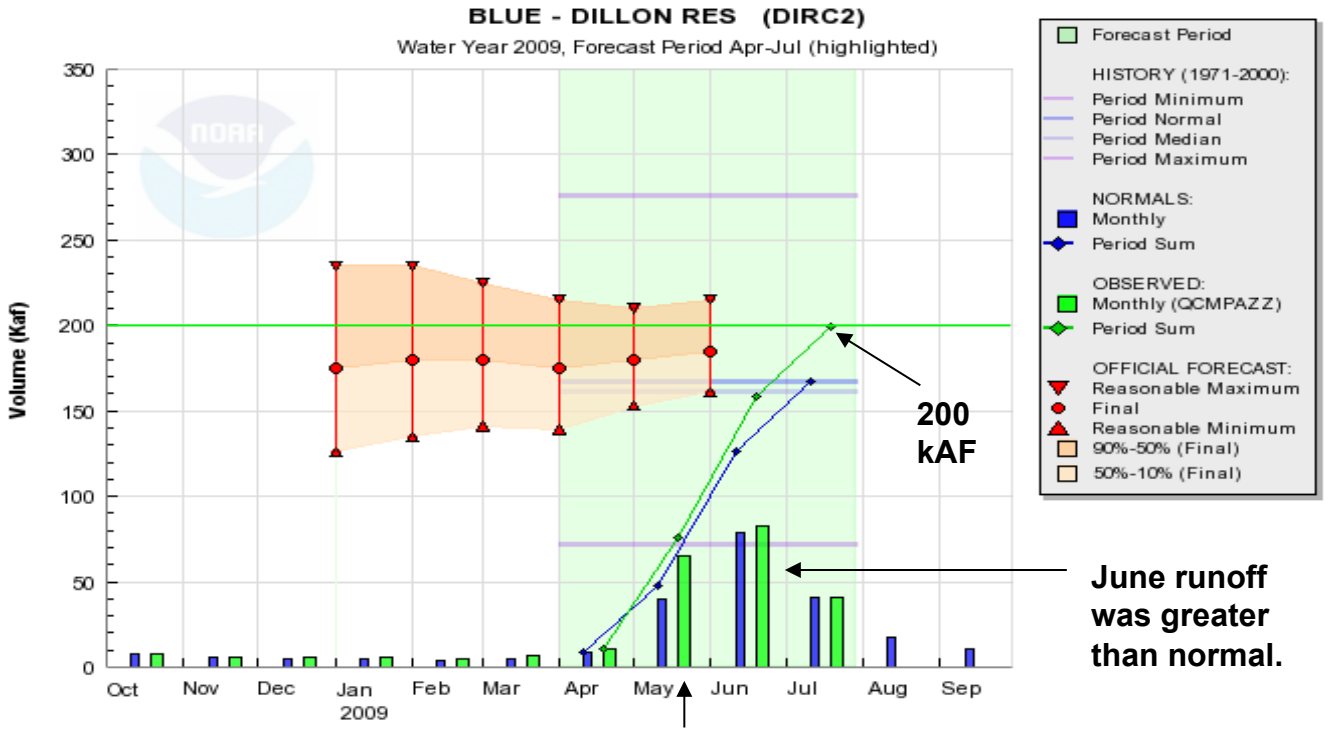


CBRFC/NWS/NOAA 11/03/09 19:00:38 UTC

2009 Water Supply Forecasts: Dillon Reservoir







June runoff was greater than normal.

May runoff was greater than normal.

CBRFC/NWS/NOAA 09/09/09 21:21:19 UTC