NOAA's Colorado Basin River Forecast Center

Hydrology 2014 -2015: Where Have We Been? Where Are We Going?

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Basin States Technical Committee Meeting

October 16, 2014

Las Vegas, NV – McCarran International Airport

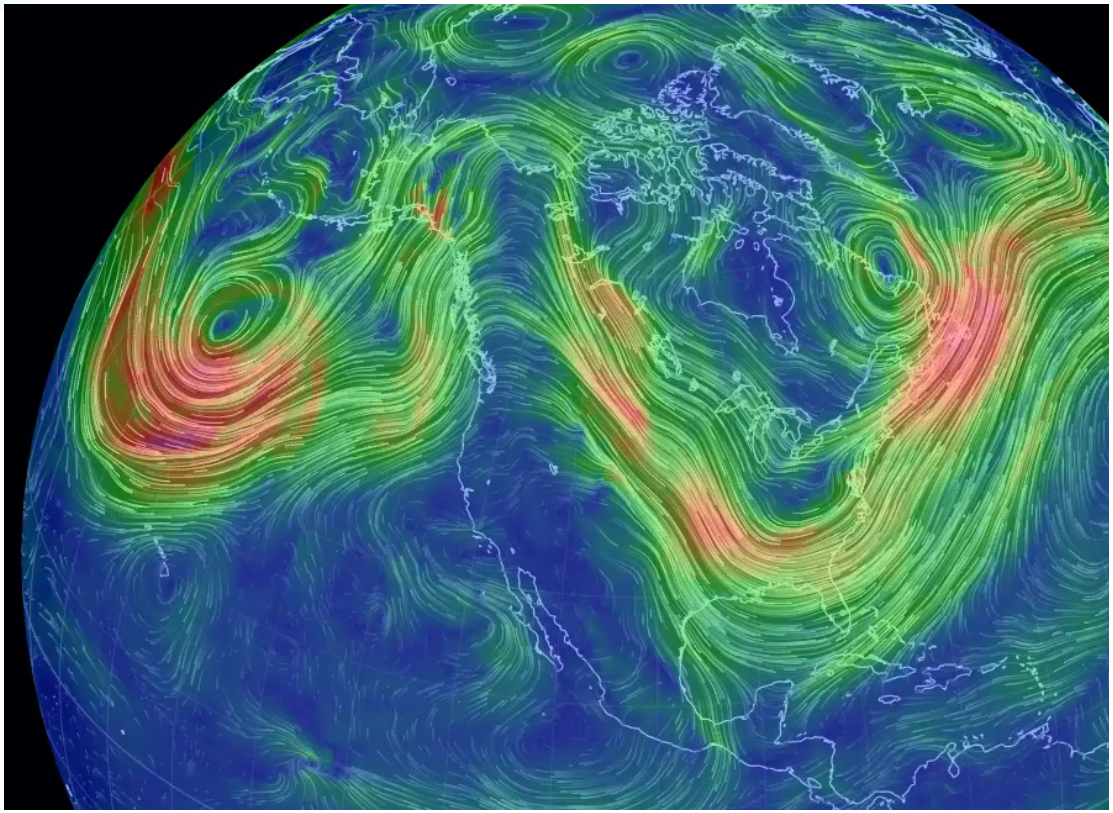
The Take Away

- WY 2014 water supply was near average, mostly due to high snowpack in the Green and Colorado Headwater River Basins
- Increased precipitation in August and September contributed to high flows throughout the Lower Basin, but did not contribute much to LC mainstem flow
- WY 2015 forecasted unregulated inflow to Lake Powell is 10.6 MAF (98% of average)

Overview

- Last season's hydroclimatic conditions
  - Winter precipitation
  - April through July streamflow
  - Hurricane activity and late water year monsoon precipitation and streamflow
- Looking ahead to water year 2015
  - Soil moisture conditions
  - Climate outlook
- Questions and comments

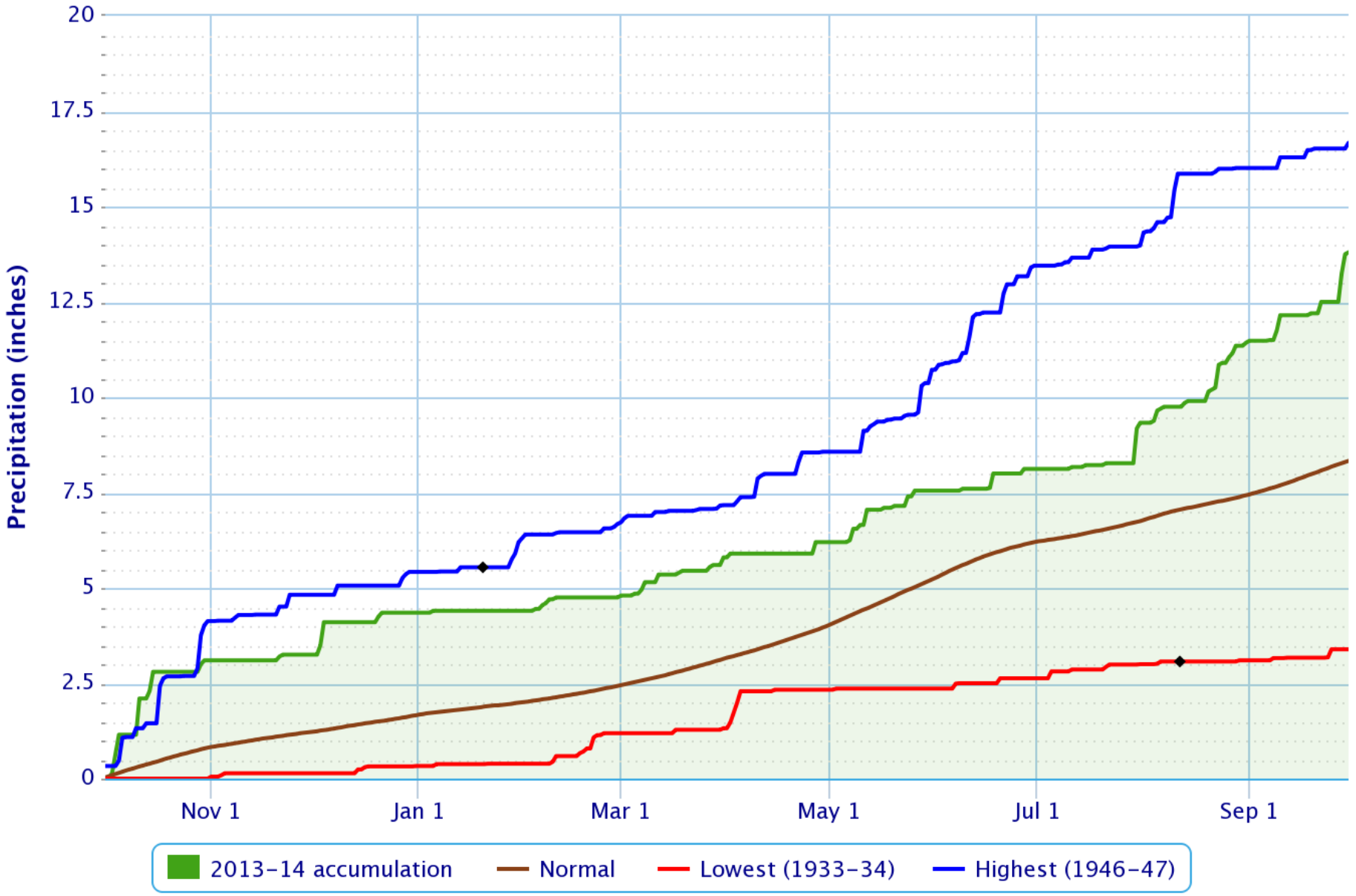
Early Winter Precipitation



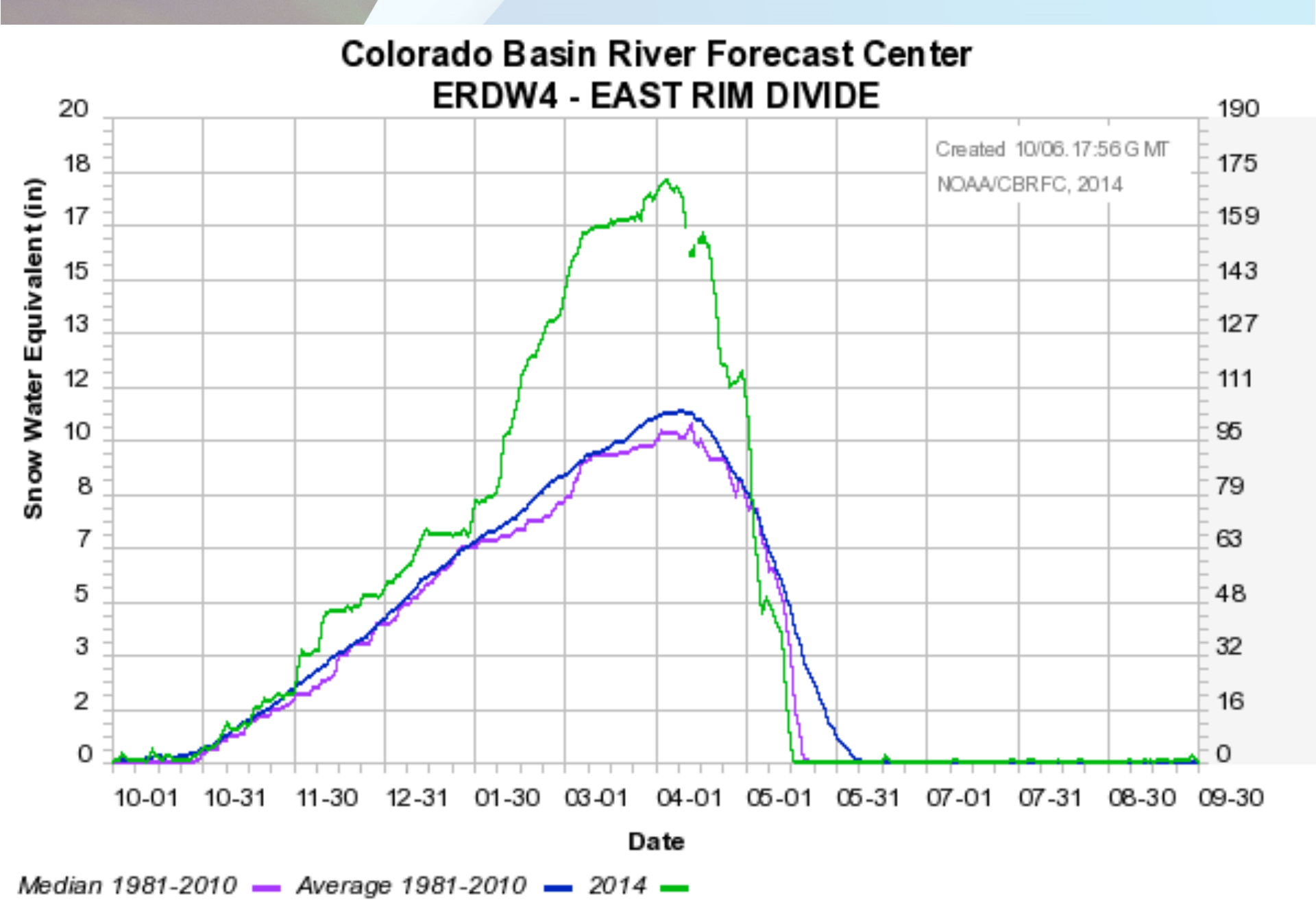
By the middle of January, a ridge had built up along the Western United States, exacerbating drought conditions in California and diverting moisture away from much of the Colorado River Basin and Great Basin regions, although the Upper Green River Basin and portions of the Colorado headwaters benefitted from the ridge.

Accumulated Precipitation – GREEN RIVER, WY

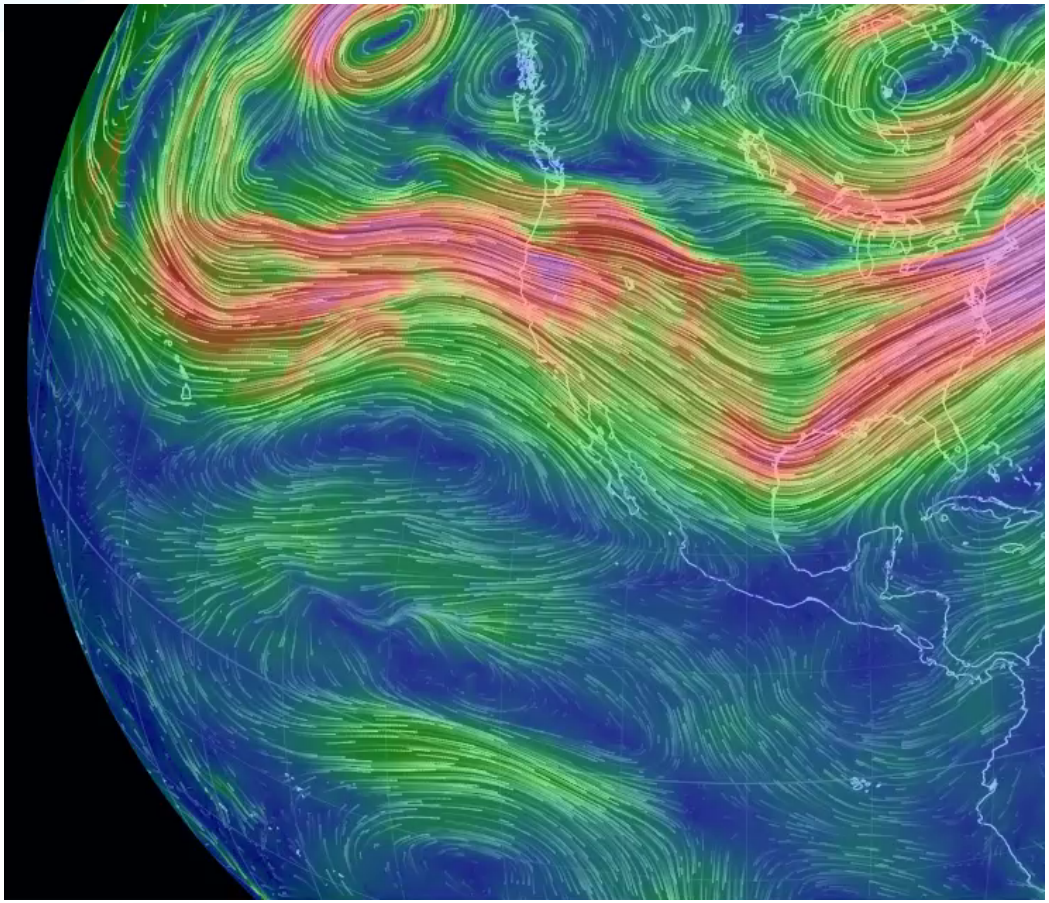
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS


Colorado Basin River Forecast Center
ERDW4 - EAST RIM DIVIDE
Created 10/06.17:56 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
20
18
17
15
13
12
10
8
7
5
3
2
0
190
175
159
143
127
111
95
79
63
48
32
16
0
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
Date
Median 1981-2010
Average 1981-2010
2014

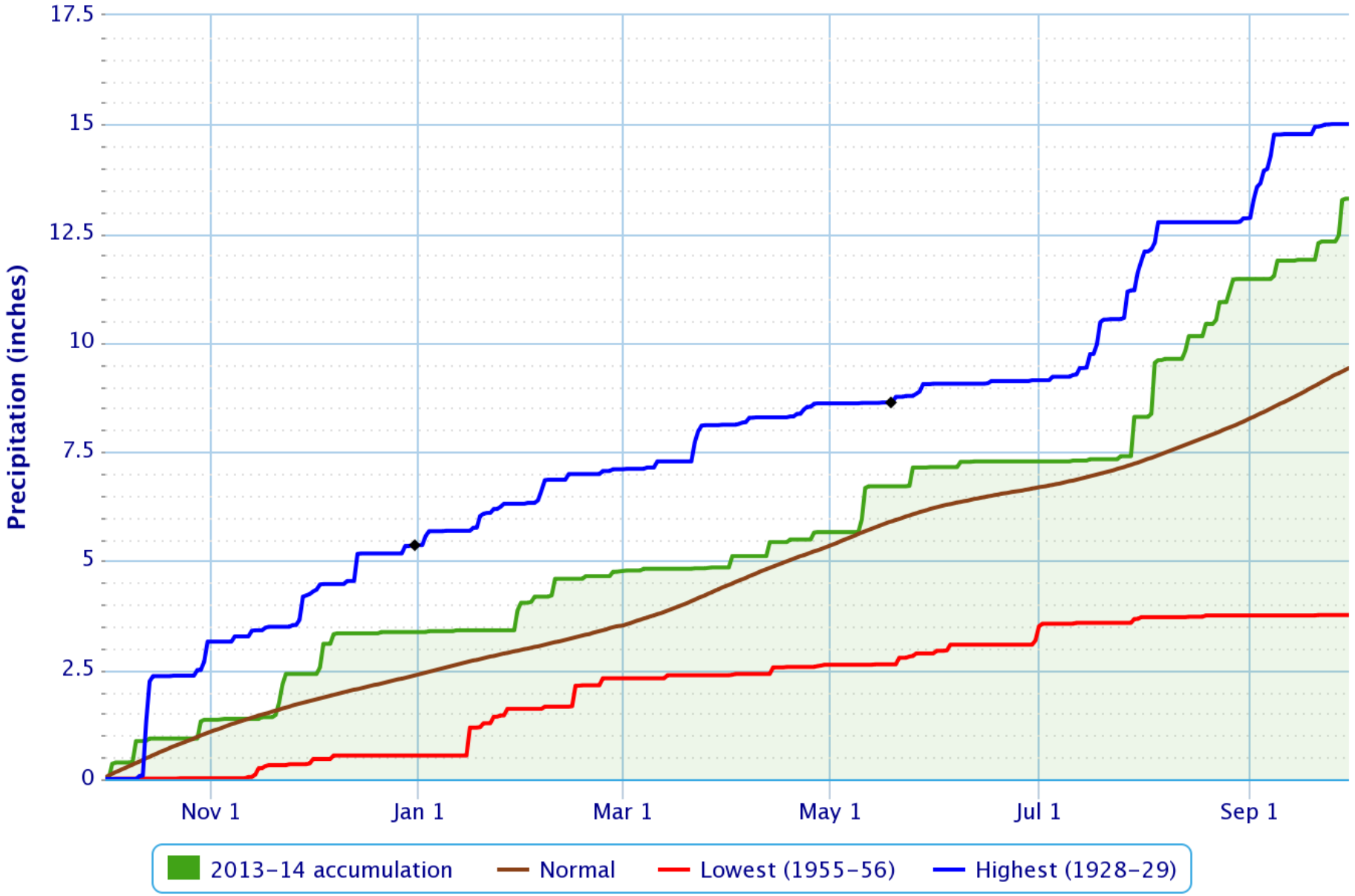
Early Winter Precipitation

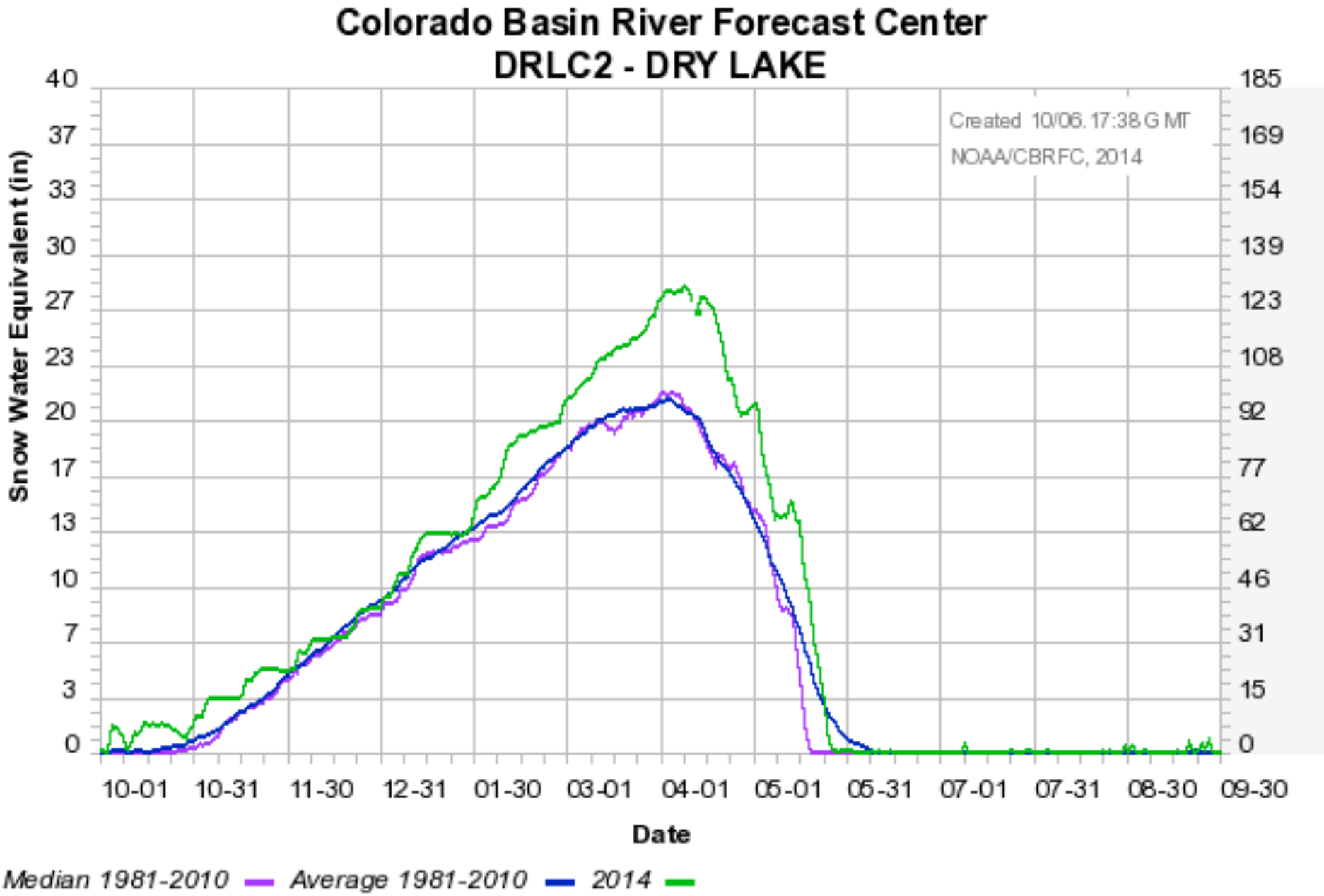


About a week into February, the weather pattern changed and the ridge broke down, allowing moisture to cross over much of the Colorado River Basin and Great Basin regions.

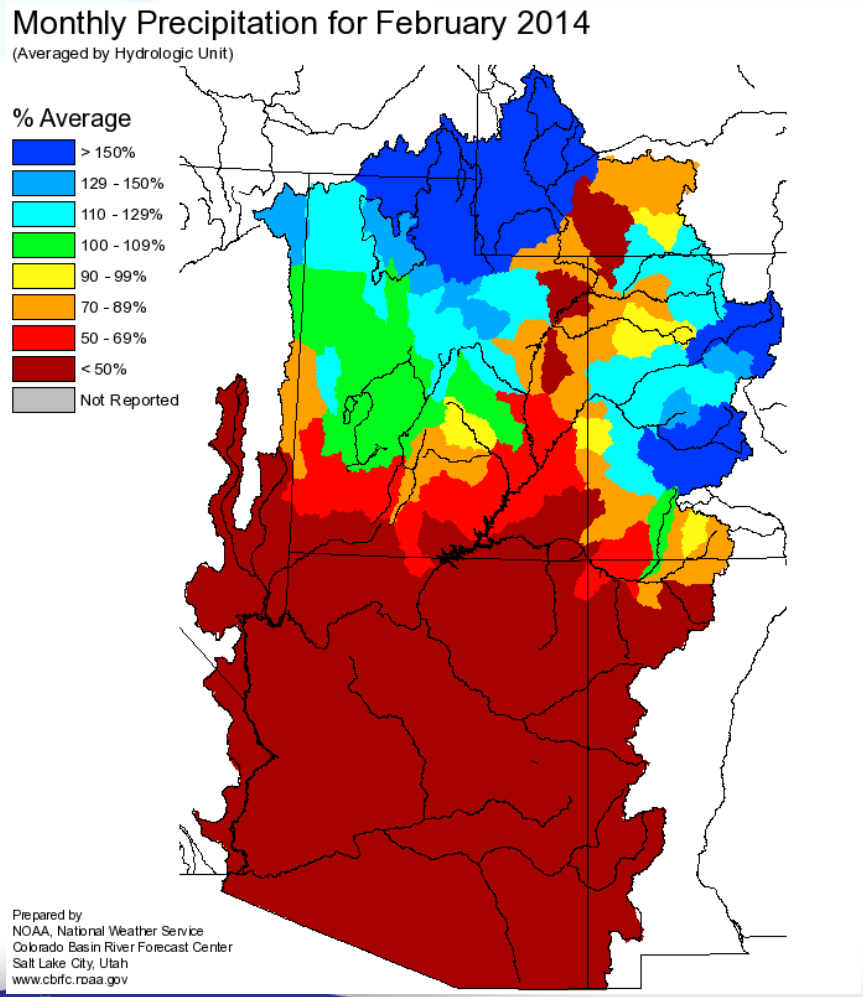
Accumulated Precipitation – Grand Junction Area, CO (ThreadEx)

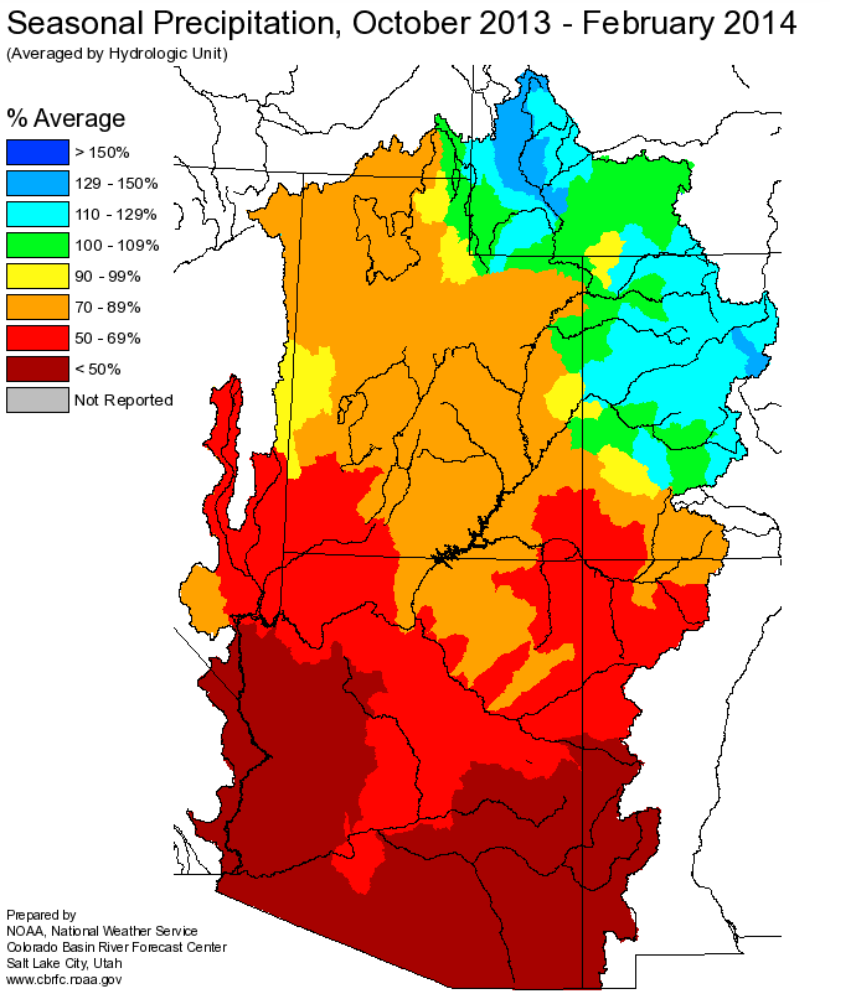
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



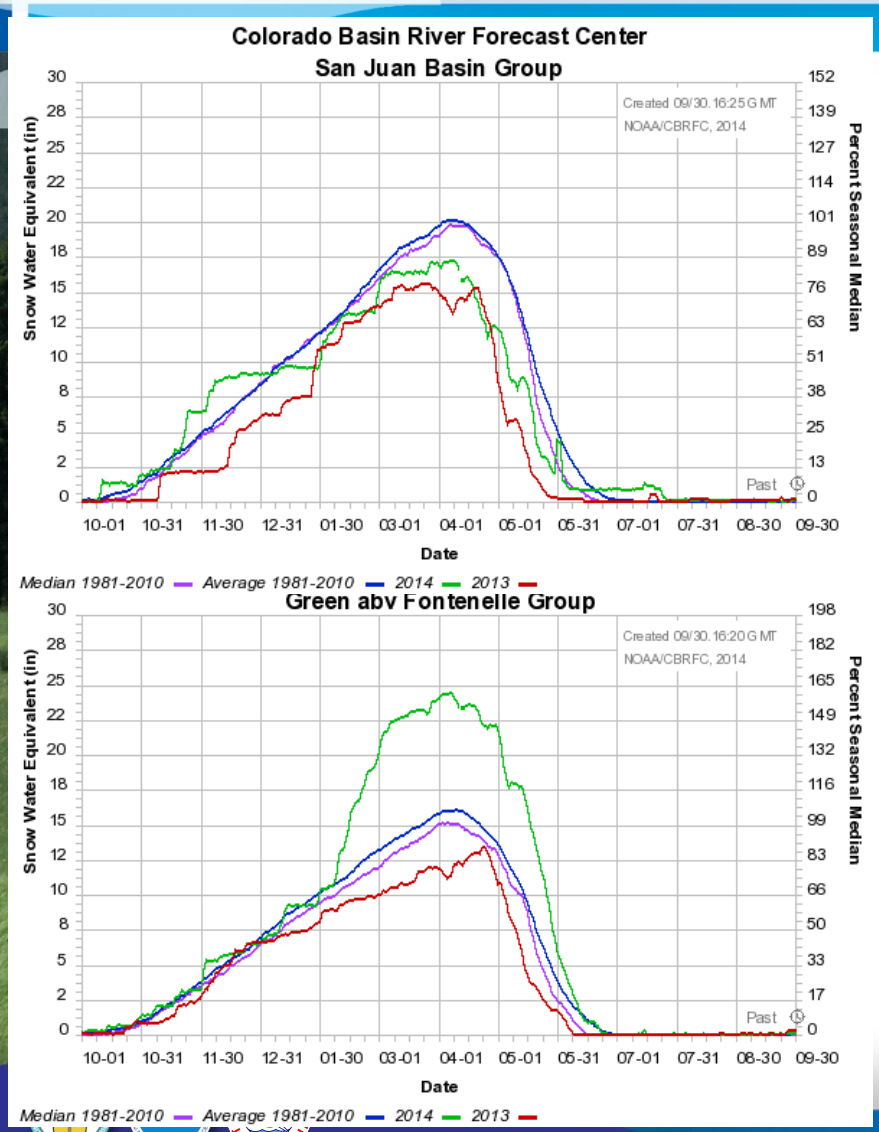

Colorado Basin River Forecast Center
DRLC2 - DRY LAKE
Created 10/06. 17:38 G MT
NOAA/CBRFC, 2014
Snow Water Equivalent (in)
40
37
33
30
27
23
20
17
13
10
7
3
0
185
169
154
139
123
108
92
77
62
46
31
15
0
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
Date
Median 1981-2010
Average 1981-2010
2014

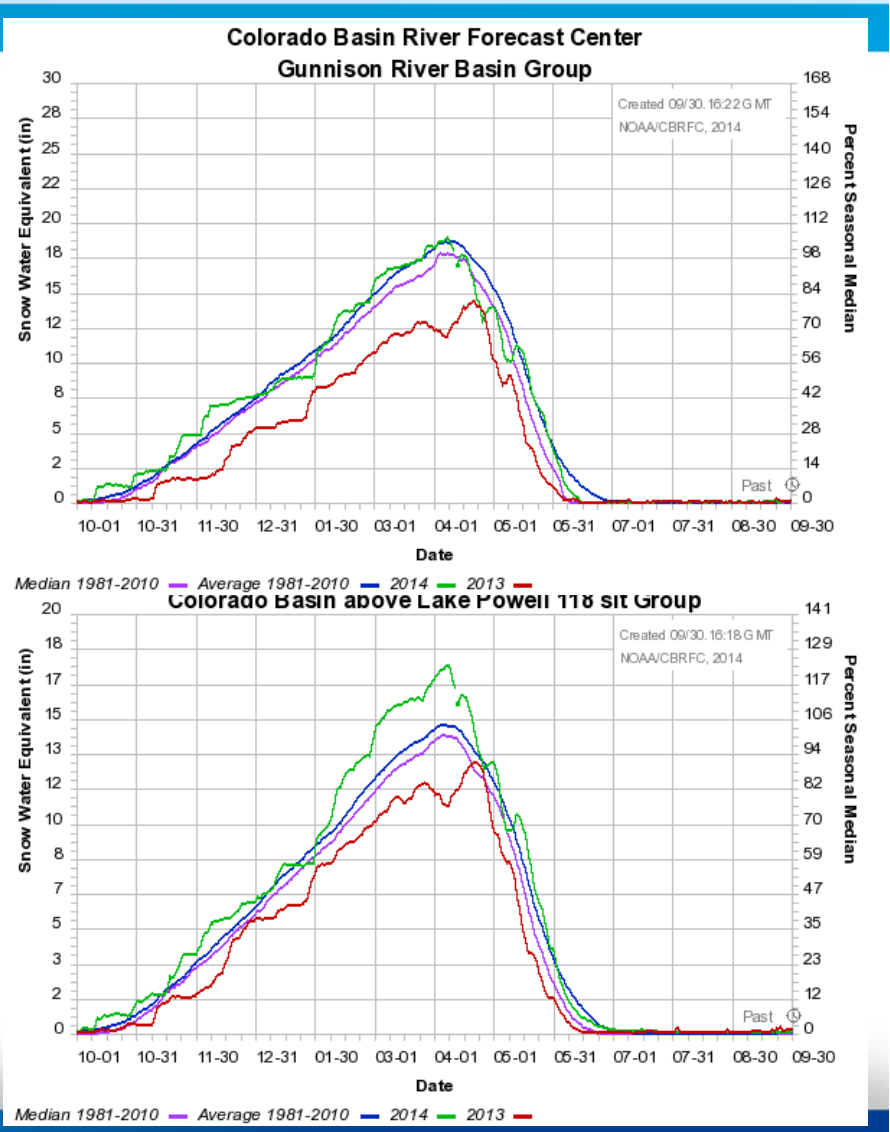
Early Winter Precipitation





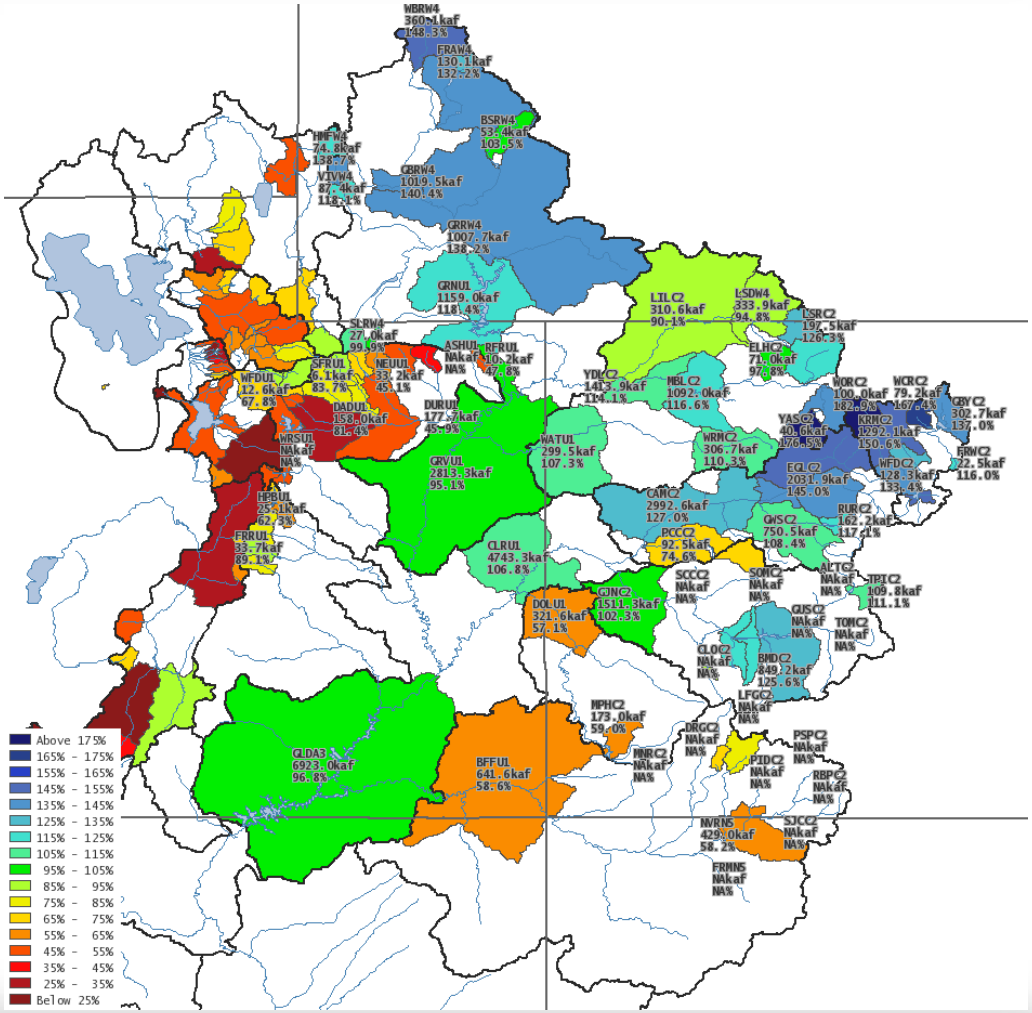
Overall Snowpack Conditions



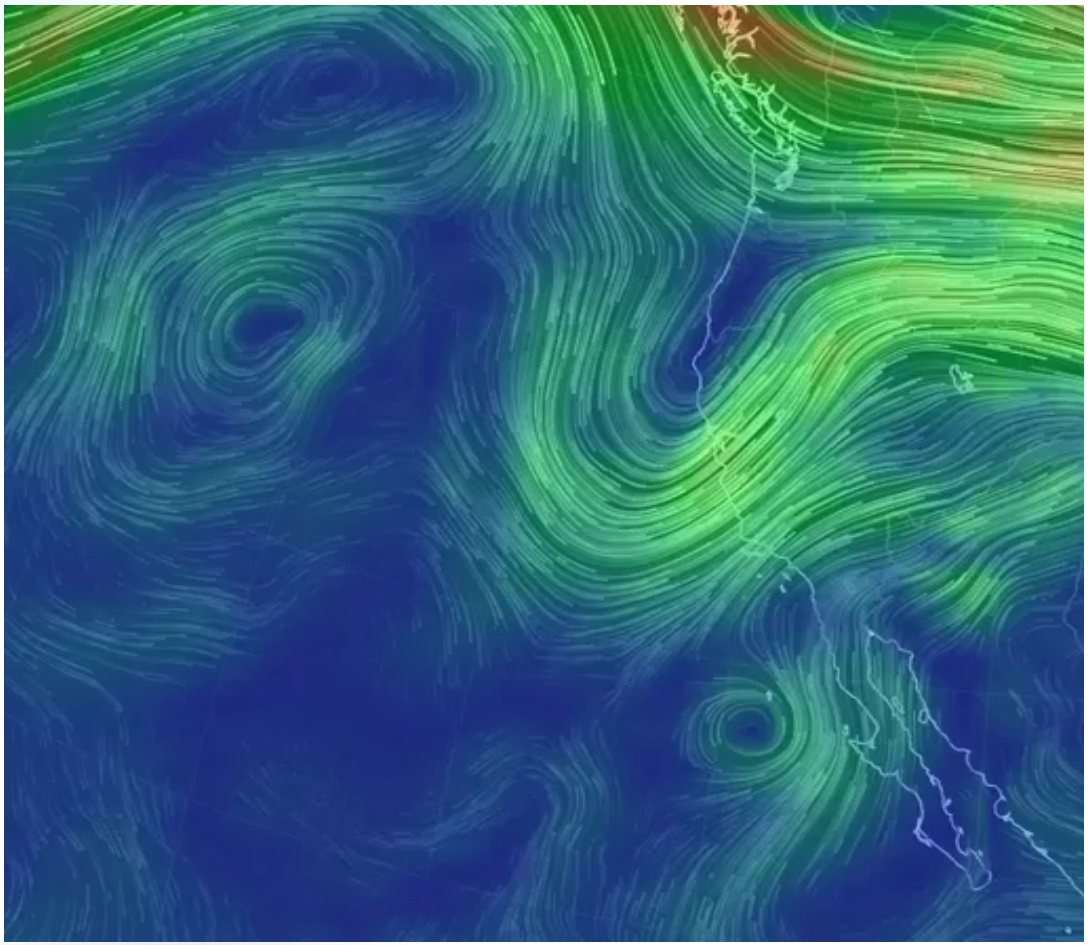


April through July Runoff

- Powell – 97% of average, 6.92 MAF
- Flaming Gorge – 118%, 1.16 MAF
- Blue Mesa – 126%, 850 KAF
- Navajo – 58%, 430 KAF



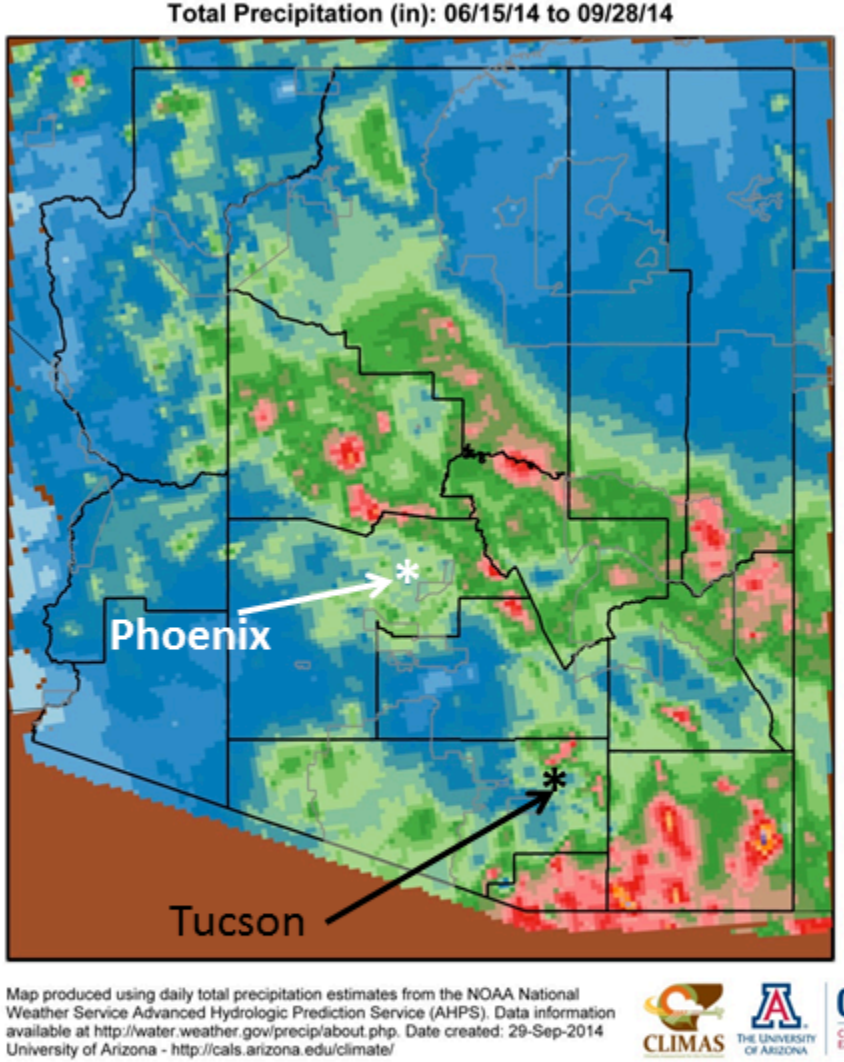
Late Summer Precipitation

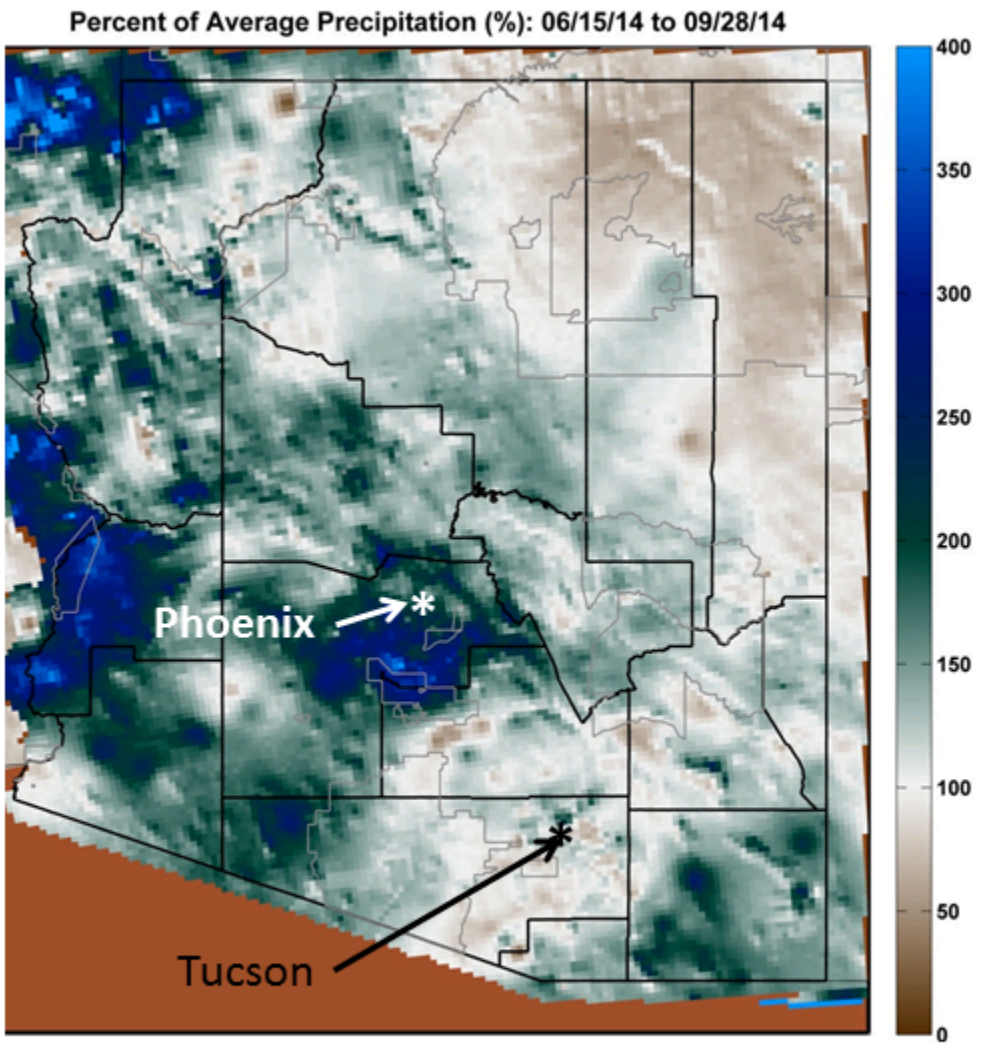


An active monsoon season, coupled with an active Pacific hurricane season, brought frequent, intense, storm events and flash flooding to the Lower Colorado River Basin. Remnants of Hurricane Norbert impacted the Upper Colorado River Basin as well.

Late Summer Precipitation

- Highlights of the 2014 Monsoon Season
  - Highest totals were in SE Arizona, where observations of 10” – 15” was common
  - Rainfall total in Prescott, AZ was 18.23”, wettest monsoon on record (since 1898)
  - Rainfall total at the Flagstaff airport was 12.73”, 5th wettest on record (since 1898)
  - The Phoenix area saw 6.34”, 5.11” fell in September. Average total is about 2.71”





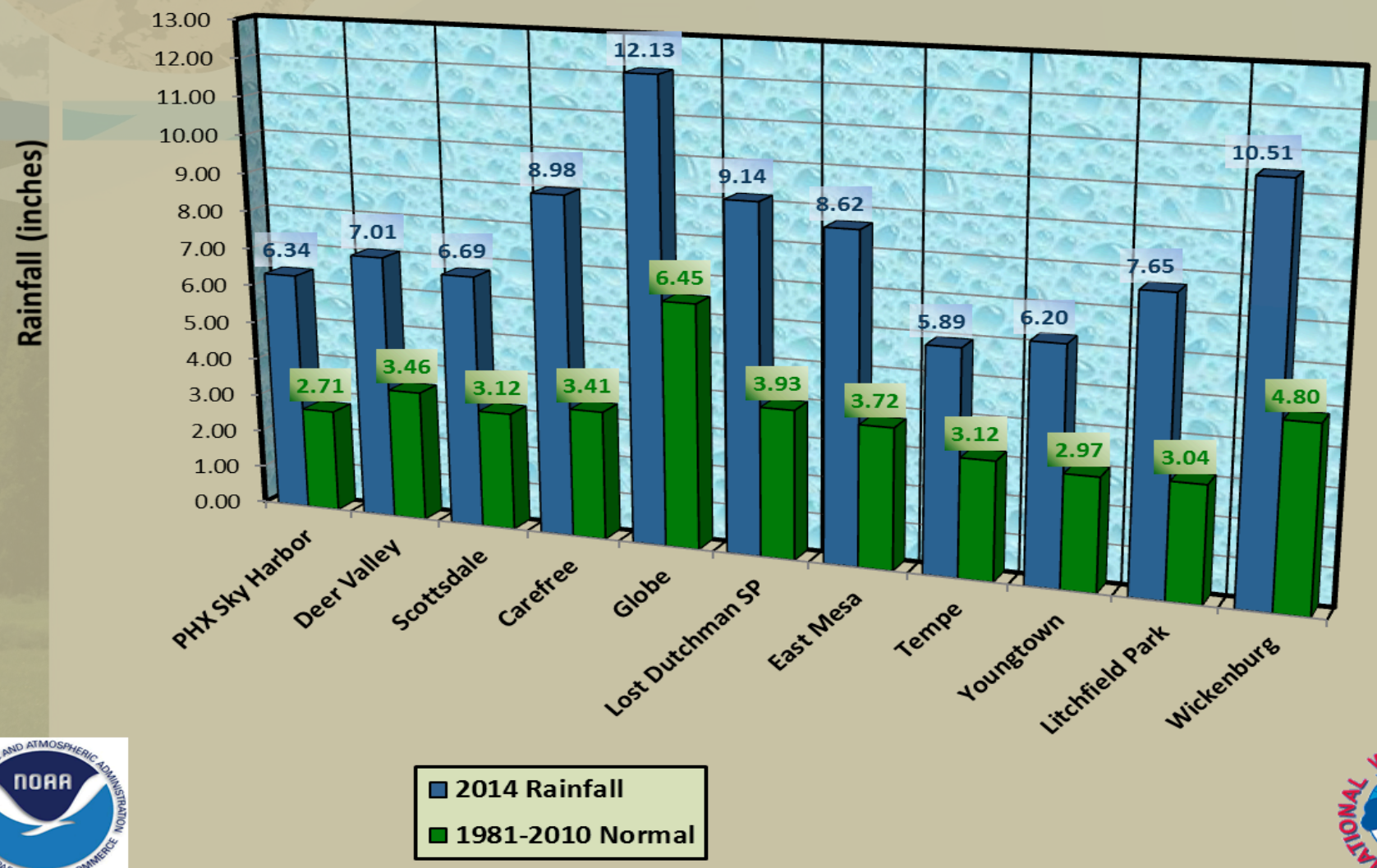
Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 29-Sep-2014
University of Arizona - http://cals.arizona.edu/climate/

CLIMAS | THE UNIVERSITY OF ARIZONA | CALS COOPERATIVE EXTENSION

- ✓ Tucson airport had 6.08" which is normal. Tucson metro area totals ranged from 2" to 11" with 20" on Mt. Lemmon.
- ✓ The highest totals were in Santa Cruz and Cochise Counties with 10 to 15" common.
- ✓ Phoenix had 6.34" of which 5.11" was in September. The normal monsoon rainfall for Phoenix is about 2.71".

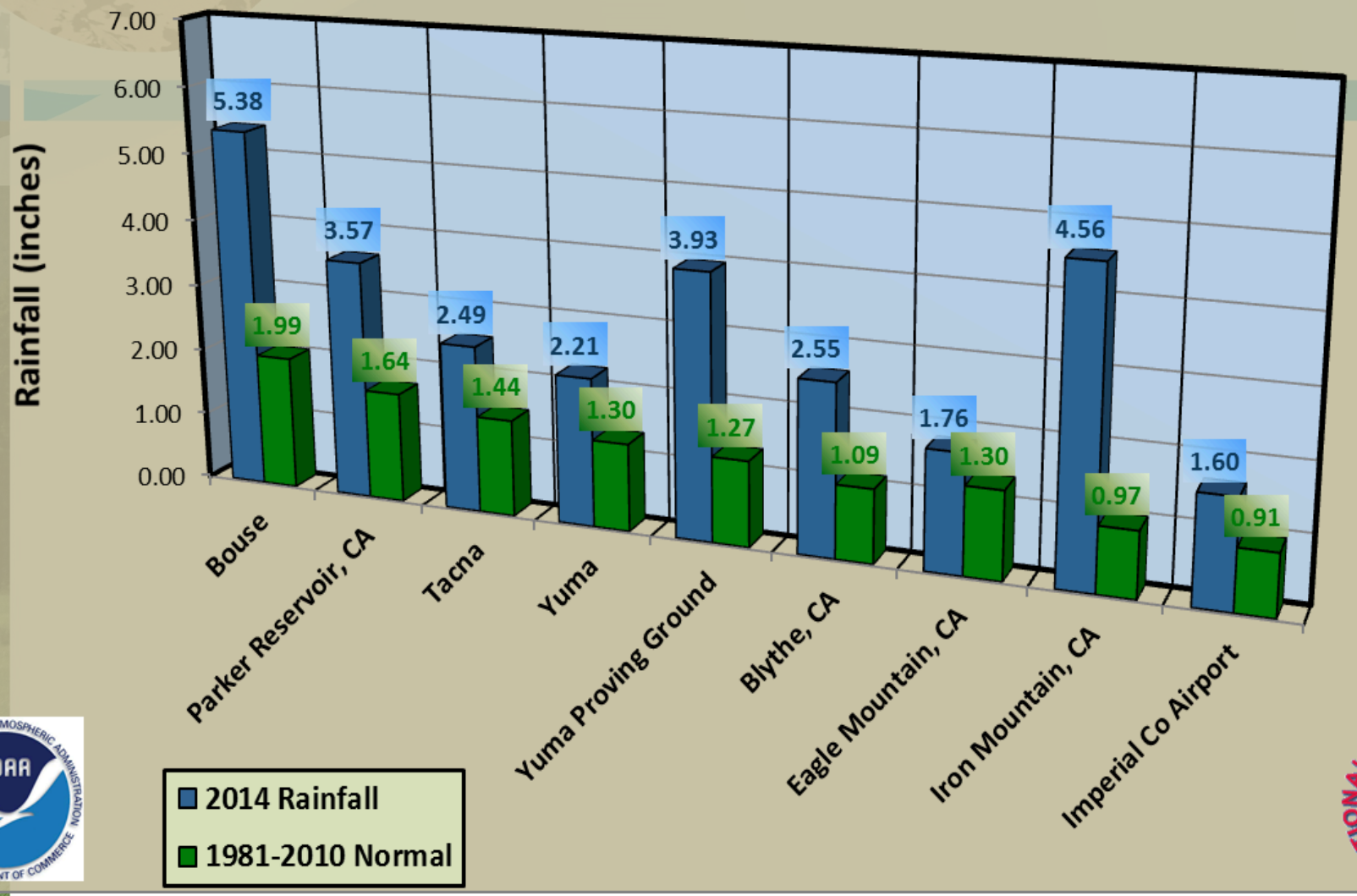
Graphic courtesy of Tucson Weather Forecast Office

Preliminary 2014 Monsoon Rainfall Totals versus Normal for Select Maricopa and Gila County locations (June 15th-Sept 30th)



Graphic courtesy of Phoenix Weather Forecast Office

Preliminary 2014 Monsoon Rainfall Totals versus Normal for Western Arizona and Southeast California locations (June 15th-Sept 30th)



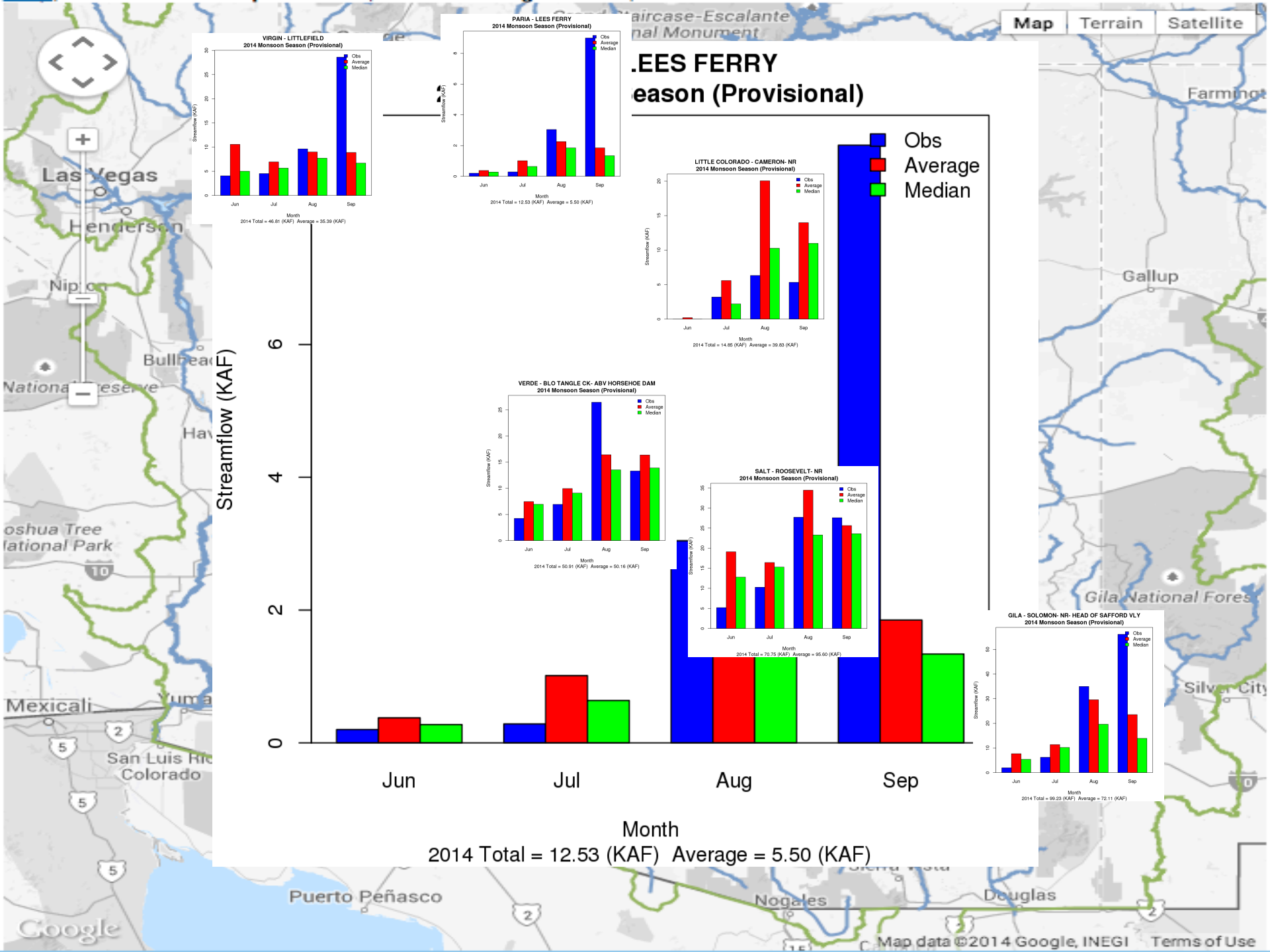
Graphic courtesy of Phoenix Weather Forecast Office

Monsoon Season Wrap Up

	2014 Jun-Sept Total	Normal	Percent of Normal
Las Vegas	1.21″	1.05″	115%
Kingman	4.83″*	2.83″	171%
Bishop	0.51″	0.64″	80%
Needles	5.30″	1.10″	482%
Barstow-Daggett	0.83″	0.99″	84%
Pahrump	1.48″	1.24″	119%
Lake Havasu City	3.65″	0.85″	429%

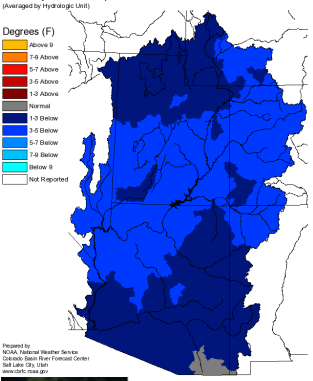
*Kingman Precipitation data valid through 9/26

Graphic courtesy of Las Vegas Weather Forecast Office

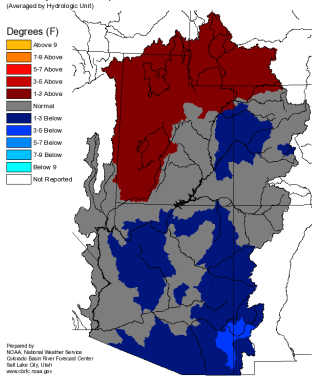

Map
Terrain
Satellite
Las Vegas
Henderson
Gallup
Mexicali
Puerto Peñasco
Nogales
Douglas
Silver City
Google
Map data ©2014 Google, INEGI
Terms of Use
VIRGIN - LITTLEFIELD
2014 Monsoon Season (Provisional)
Obs
Average
Median
Streamflow (KAF)
Jun
Jul
Aug
Sep
Month
2014 Total = 46.81 (KAF) Average = 35.39 (KAF)
PARIA - LEES FERRY
2014 Monsoon Season (Provisional)
2014 Total = 12.53 (KAF) Average = 5.50 (KAF)
LITTLE COLORADO - CAMERON- NR
2014 Monsoon Season (Provisional)
2014 Total = 14.85 (KAF) Average = 39.83 (KAF)
VERDE - BLO TANGLE CK- ABV HORSEHOE DAM
2014 Monsoon Season (Provisional)
2014 Total = 50.91 (KAF) Average = 50.16 (KAF)
SALT - ROOSEVELT- NR
2014 Monsoon Season (Provisional)
2014 Total = 70.75 (KAF) Average = 95.60 (KAF)
GILA - SOLOMON- NR- HEAD OF SAFFORD VLY
2014 Monsoon Season (Provisional)
2014 Total = 99.23 (KAF) Average = 72.11 (KAF)
.EES FERRY
eason (Provisional)
Obs
Average
Median
Streamflow (KAF)
0
2
4
6
Jun
Jul
Aug
Sep
Month
2014 Total = 12.53 (KAF) Average = 5.50 (KAF)

2014 Water Year Climate

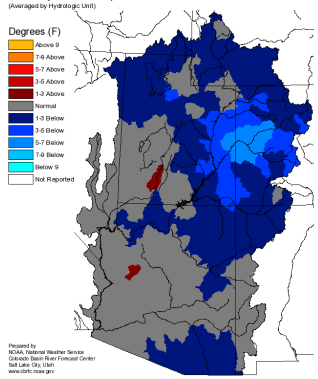
Monthly Max Temp Deviation for October 2013



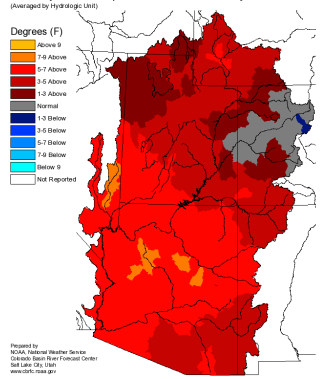
Monthly Max Temp Deviation for November 2013



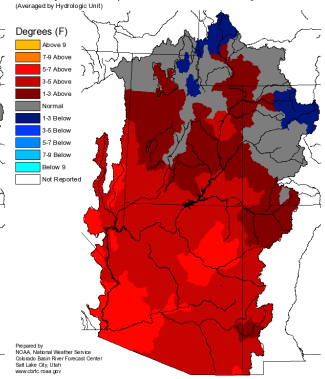
Monthly Max Temp Deviation for December 2013



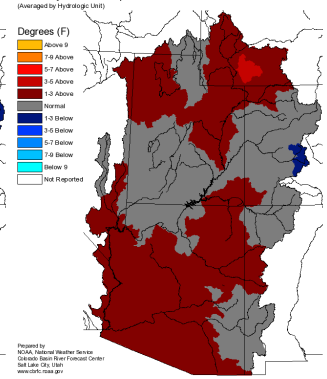
Monthly Max Temp Deviation for January 2014



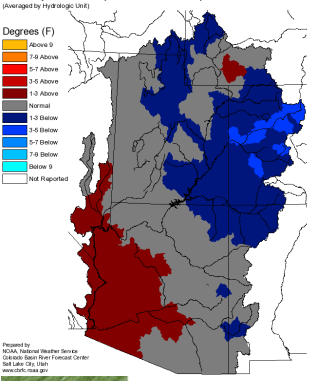
Monthly Max Temp Deviation for February 2014



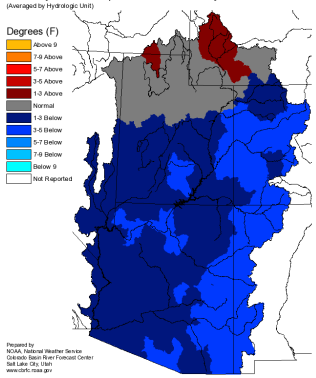
Monthly Max Temp Deviation for March 2014



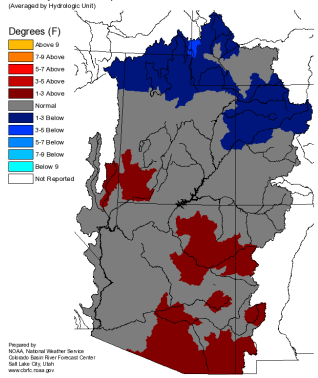
Monthly Max Temp Deviation for April 2014



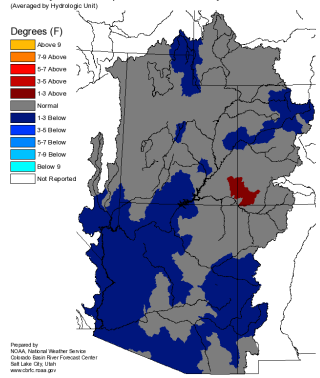
Monthly Max Temp Deviation for May 2014



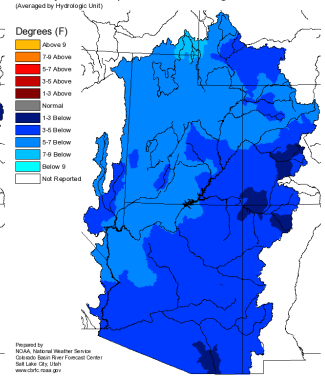
Monthly Max Temp Deviation for June 2014



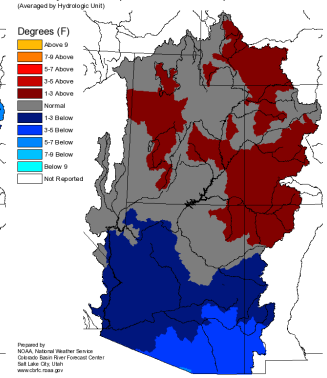
Monthly Max Temp Deviation for July 2014



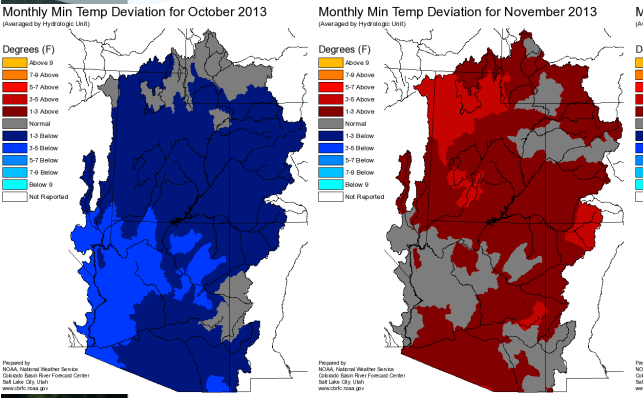
Monthly Max Temp Deviation for August 2014

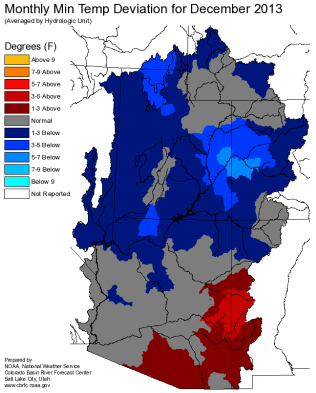


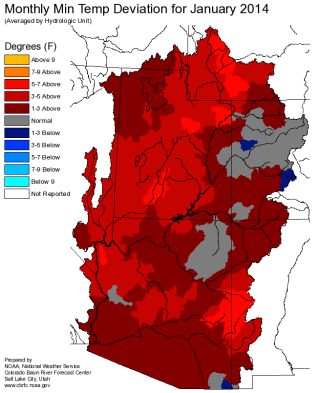
Monthly Max Temp Deviation for September 2014

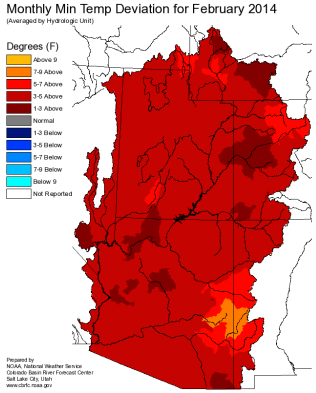


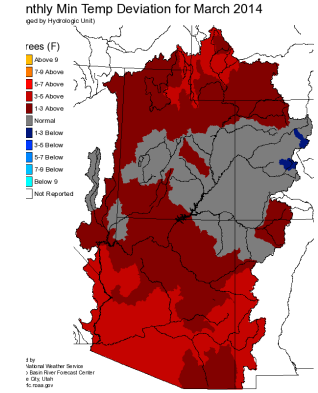
2014 Water Year Climate

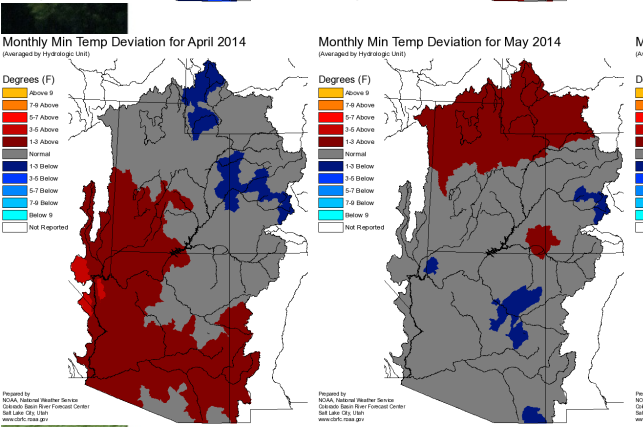


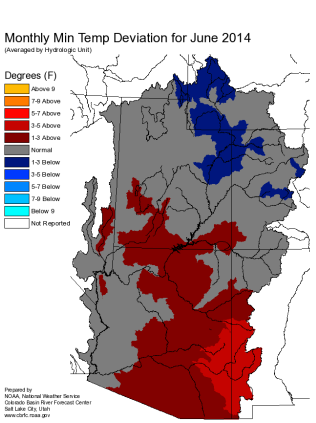


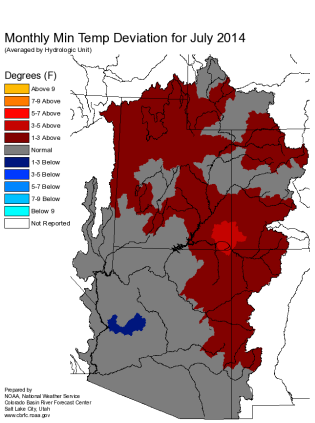


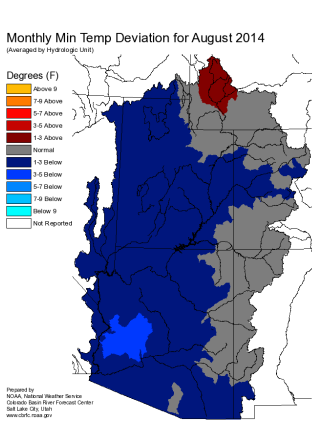


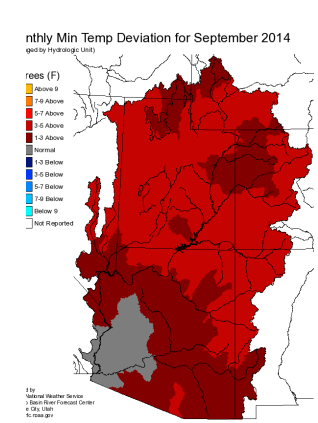












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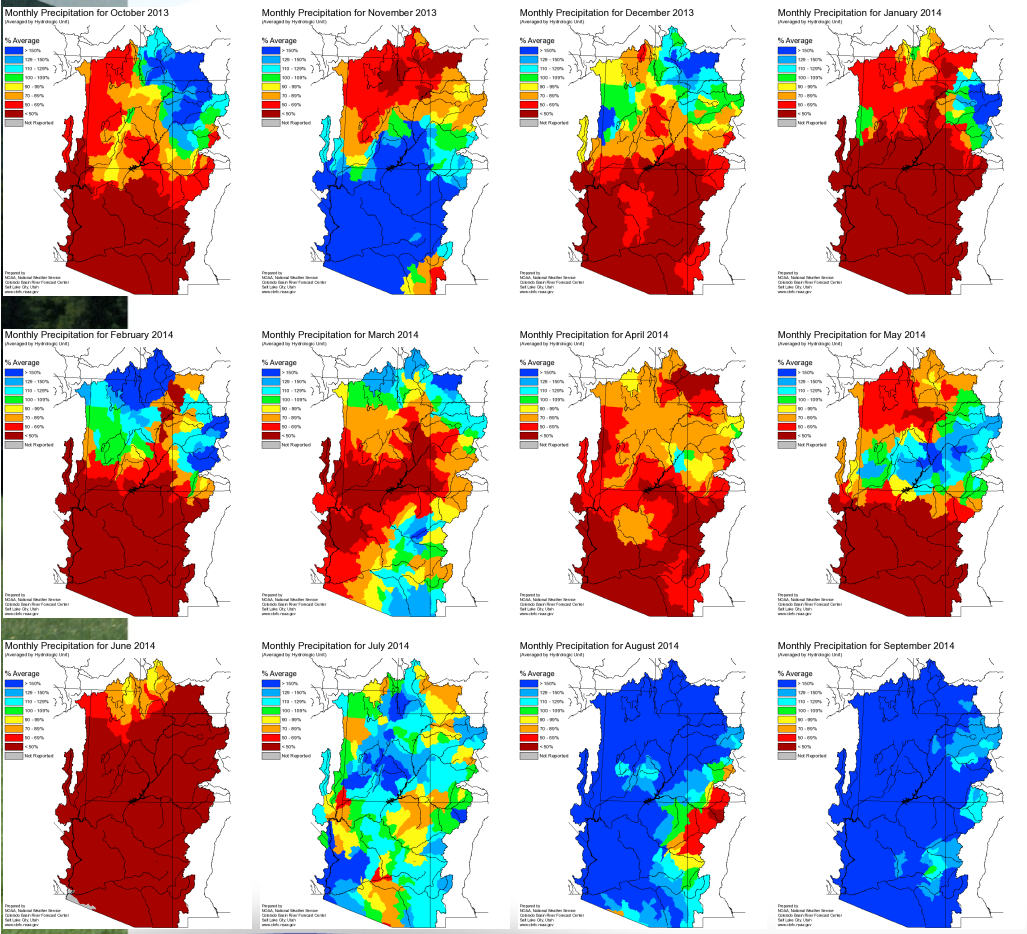
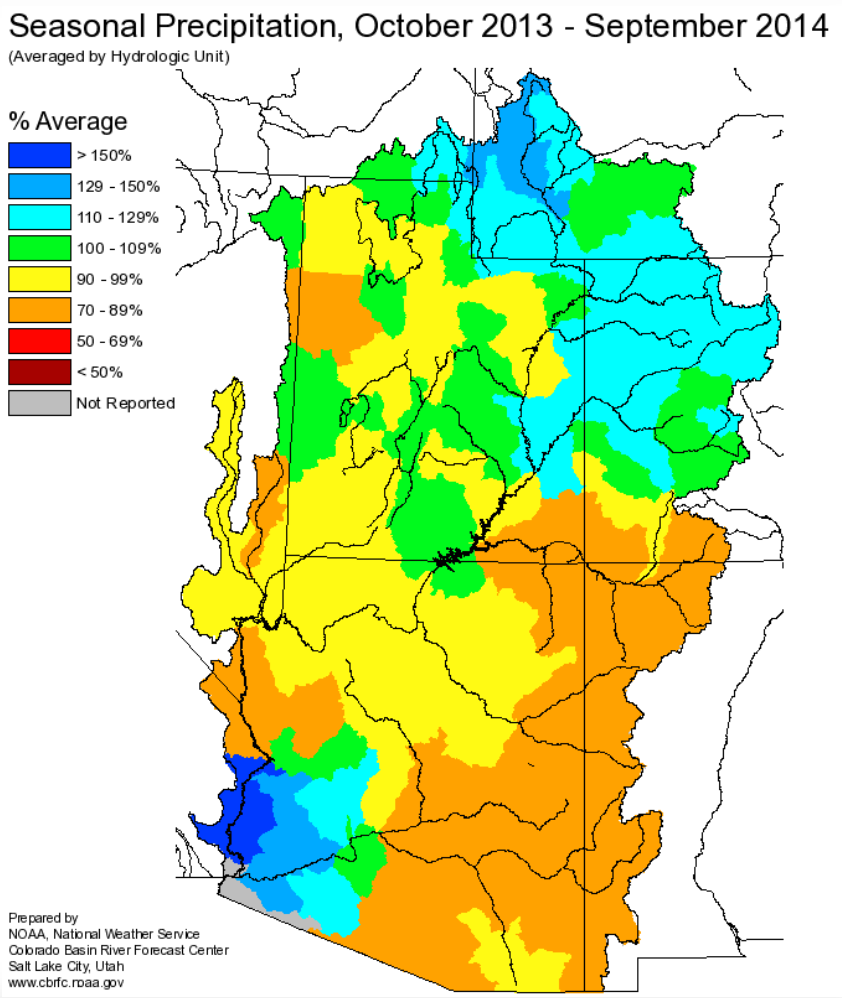


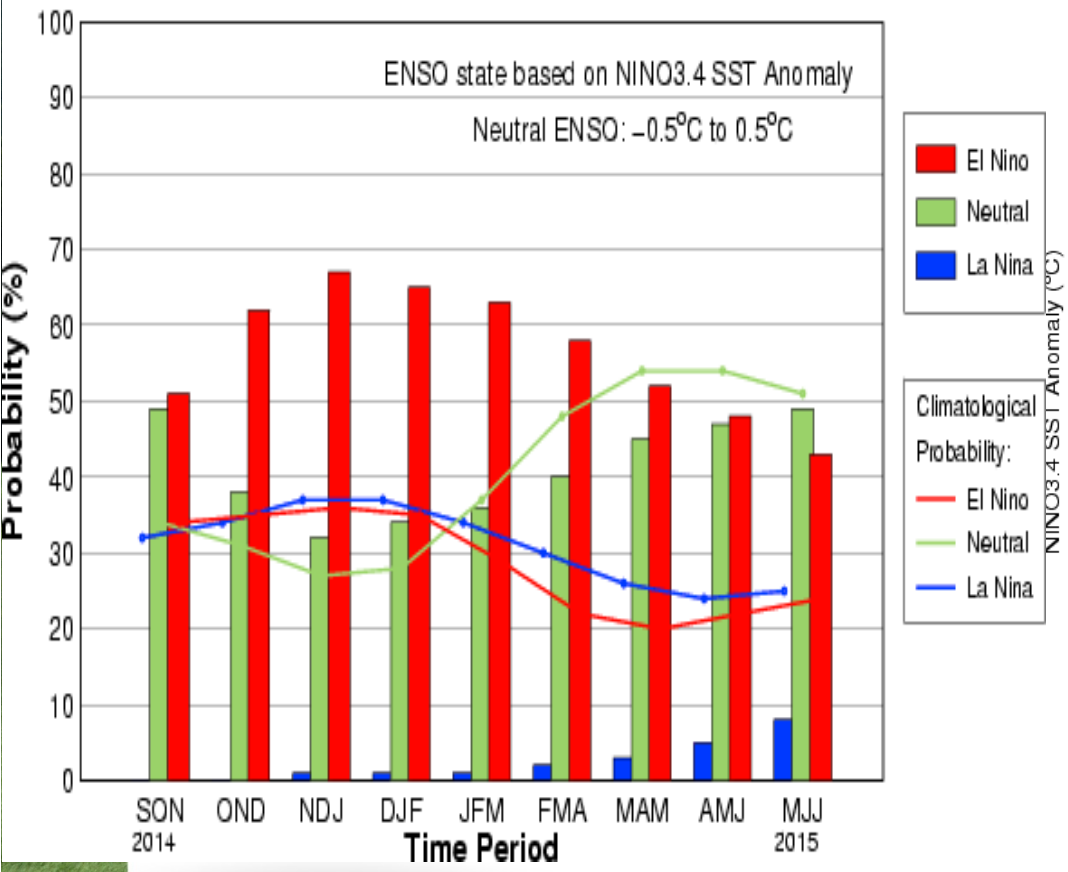


2014 Water Year Runoff

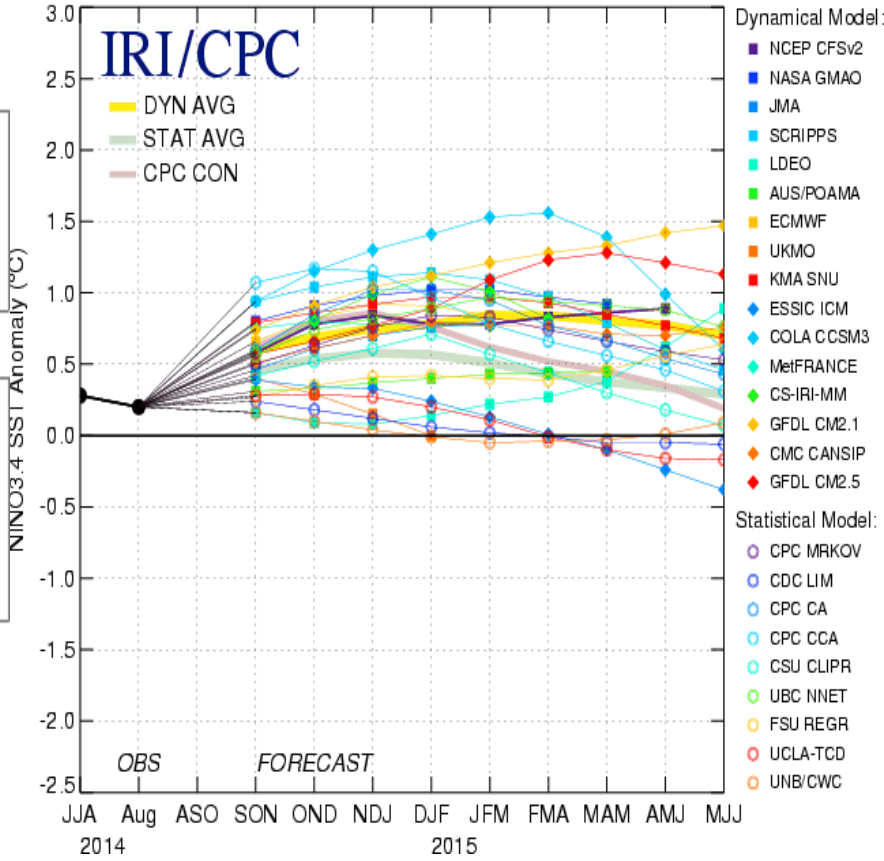
- Powell – 96% of average, 10.4 MAF
- Flaming Gorge – 116%, 1.69 MAF
- Blue Mesa – 120%, 1.14 MAF
- Navajo – 65%, 700 KAF

Looking ahead to 2015

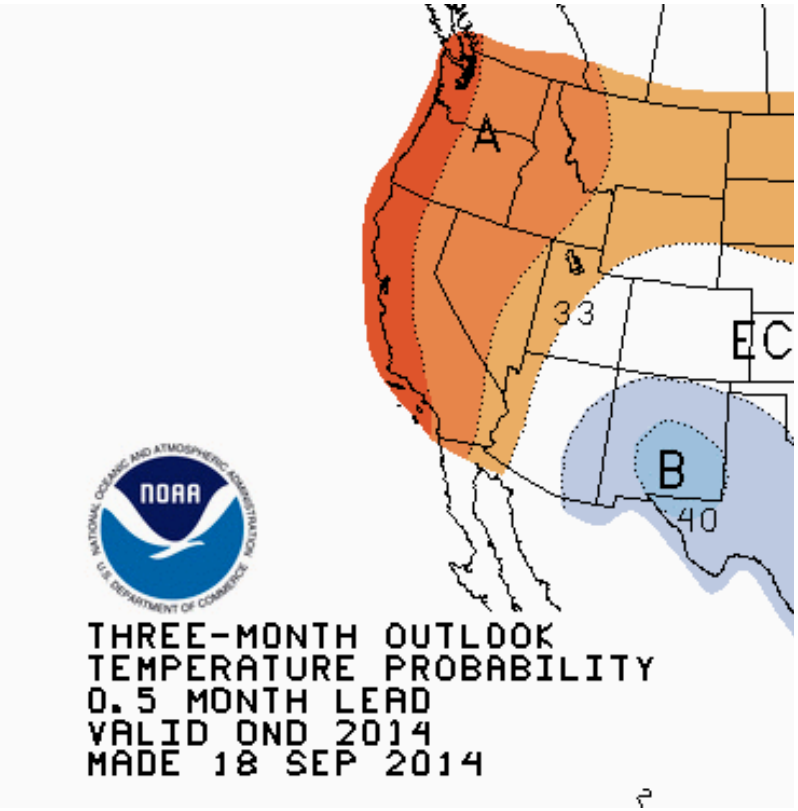
Early-Oct CPC/IRI Consensus Probabilistic ENSO Forecast

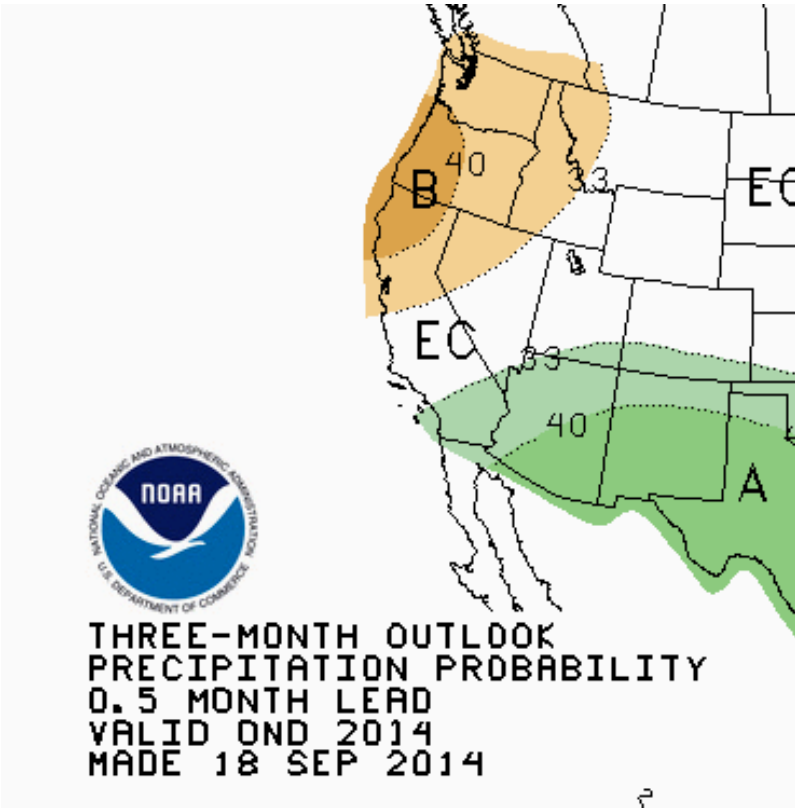


Mid-Sep 2014 Plume of Model ENSO Predictions

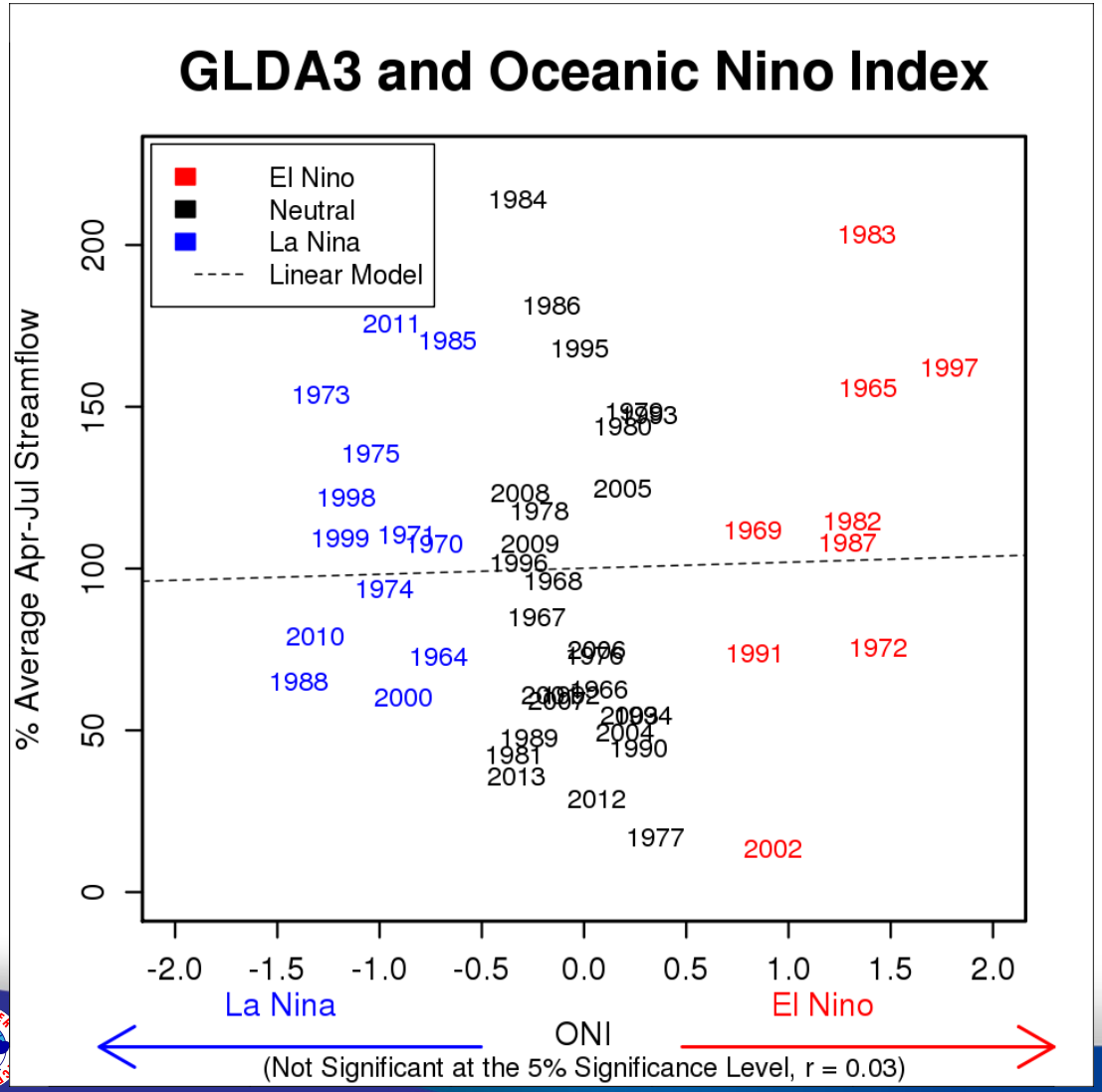


Looking ahead to 2015

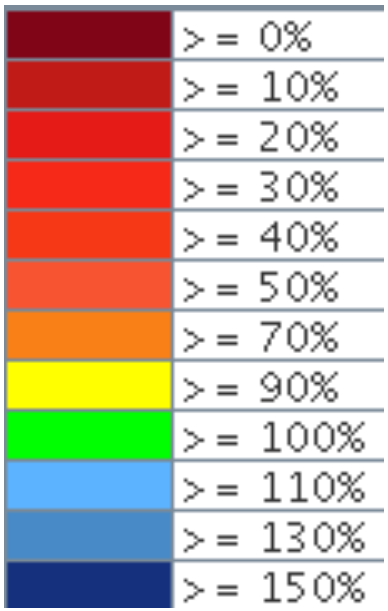


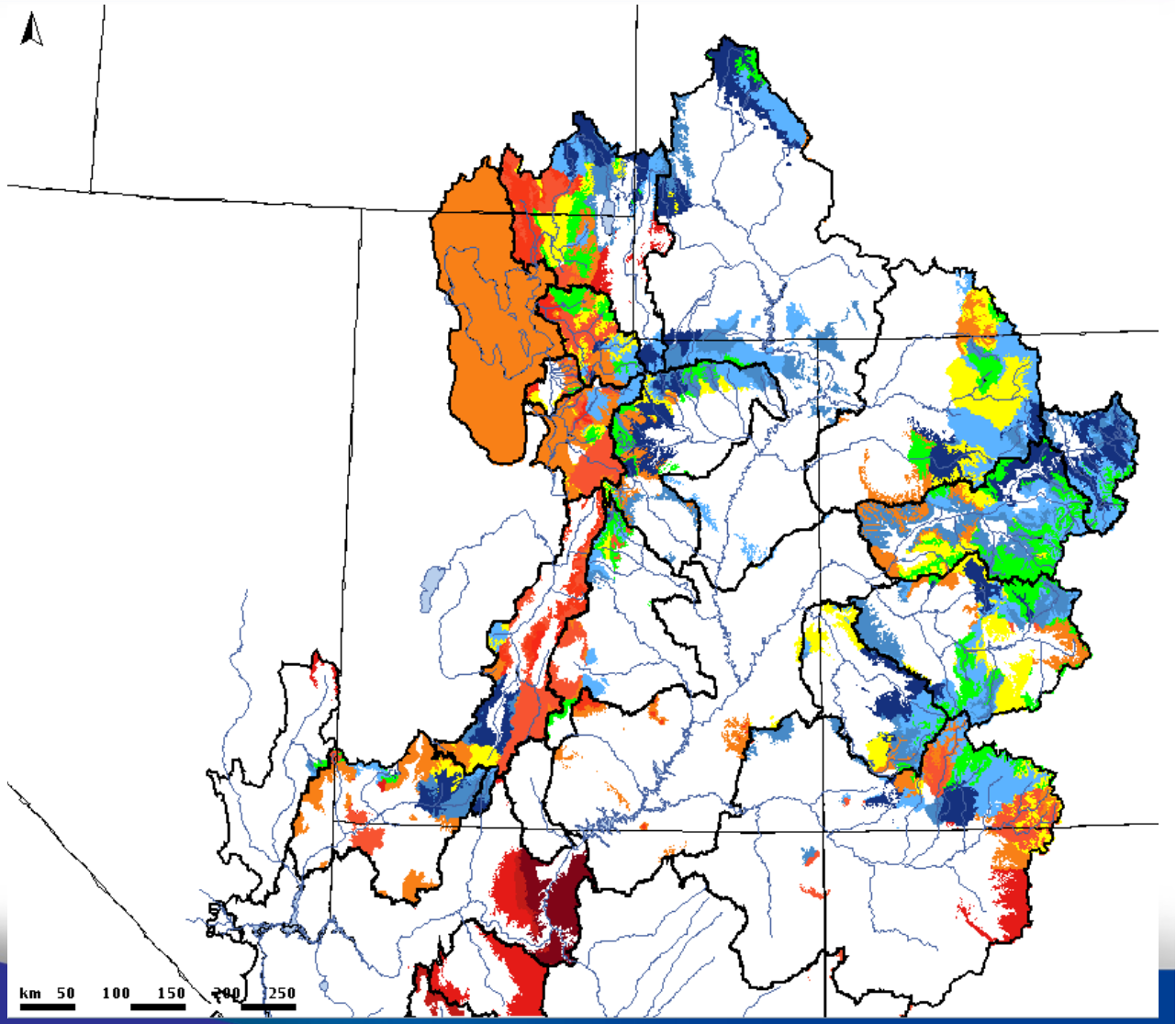


ENSO Impacts?



Soil Moisture





2015 Water Year Forecasts

- Powell – 98% of average, 10.6 MAF
- Flaming Gorge – 109%, 1.59 MAF
- Blue Mesa – 96%, 917 KAF
- Navajo – 81%, 874 KAF

News at the CBRFC

- Website improvements coming
  - New ESRI map
  - Verification statistics
- Working with Utah State University to understand possible benefits of an energy balance-based snow model
- Implementation of HEFS
- National Water Center starting to spin up

Contact us!

- Michelle Stokes – Hydrologist In Charge — michelle.stokes@noaa.gov
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- Ashley Nielson – Green River Basin Focal Point — ashley.nielson@noaa.gov
- Tracy Cox – Lower Colorado Basin Focal Point — tracy.cox@noaa.gov
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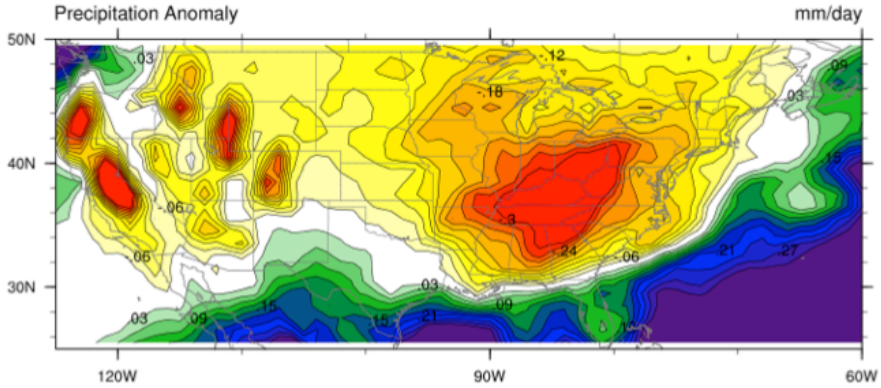
Questions?

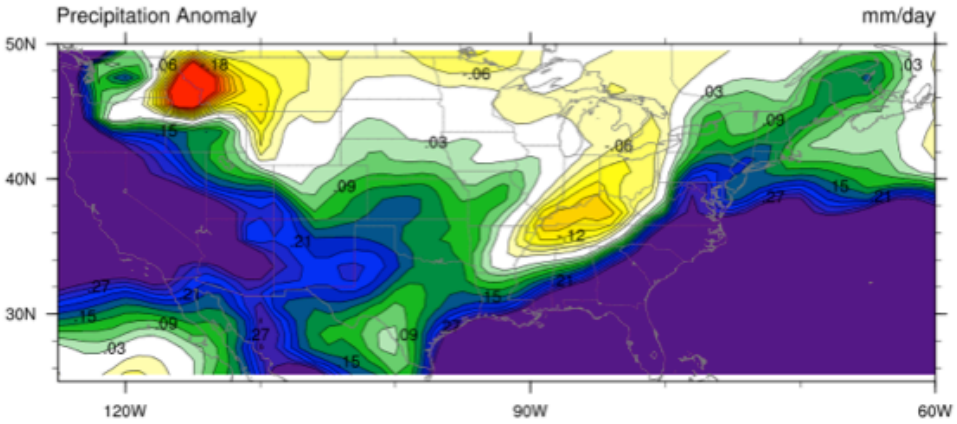
Extra Slides

ESRL Analysis of ENSO Correlation

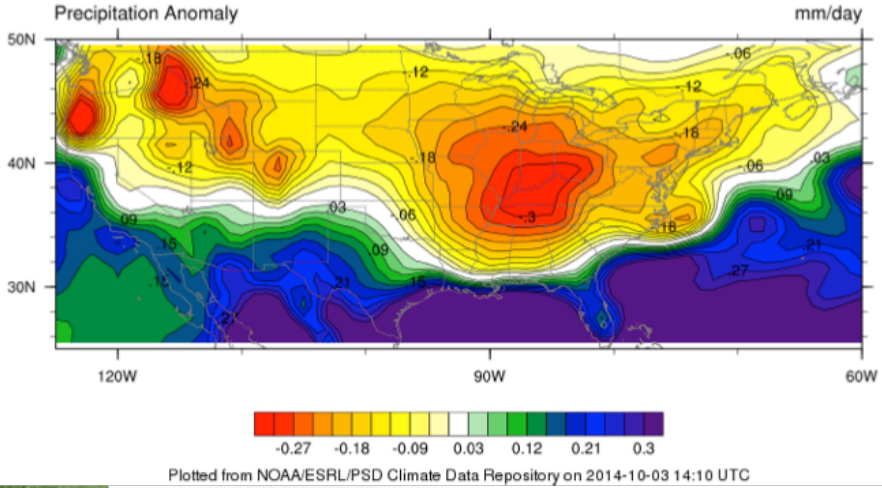
ECHAM5 amip_obs_rf ensmean Nov-Apr 1987, 1988, 1995, 2003, 2005, 2007, 2010



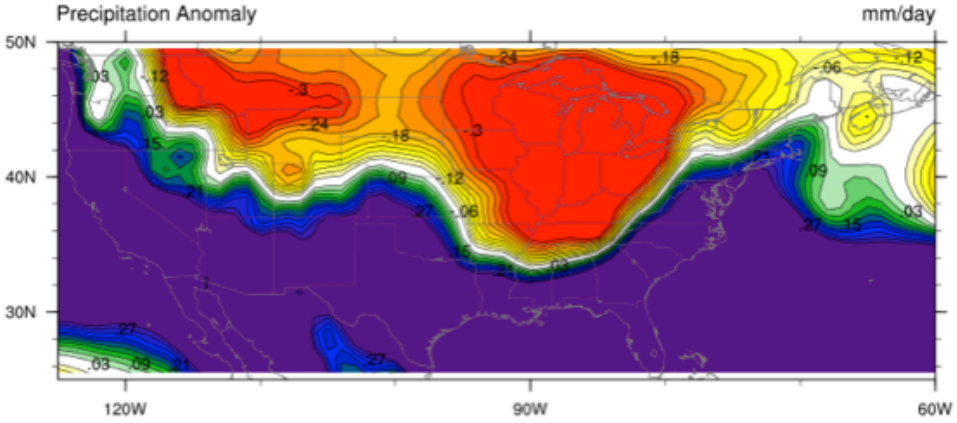
CAM4 amip_obs_rf ensmean Nov-Apr 1983, 1992, 1998



ESRL-GFSV2 amip_obs_rf ensmean Nov-Apr 1987, 1988, 1995, 2003, 2005, 2007, 2010



ESRL-GFSV2 amip_obs_rf ensmean Nov-Apr 1983, 1992, 1998



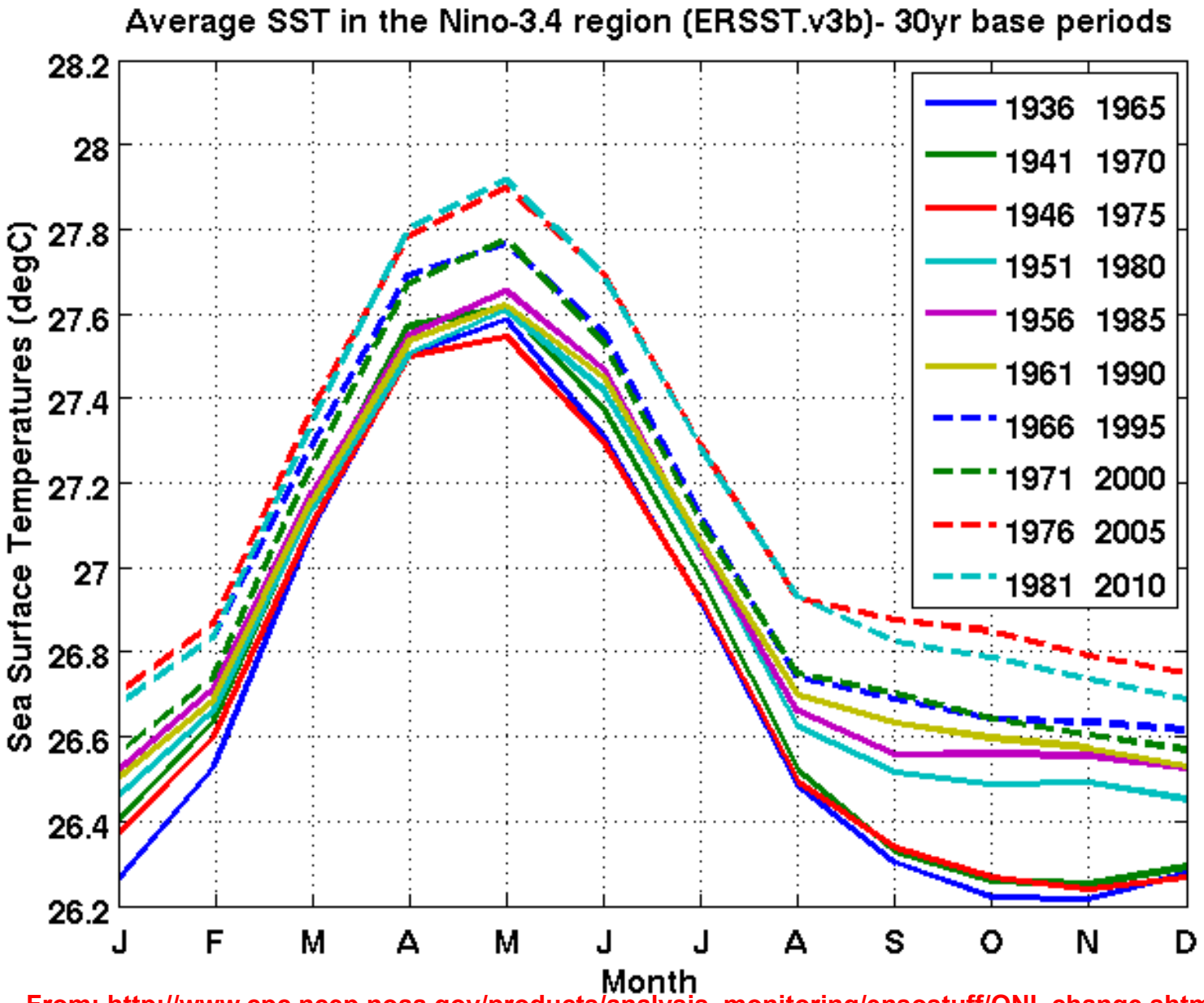
Figures by Marty Hoerling

How do we define ENSO?

- It is important to remember that these departures are basically compared to 30-year averages updated every 10 years*
  - Important due to the impacts of climate change
  - As oceans warm, weak El Niño events may no longer qualify; cold events previously not defined as La Niña may now qualify
  - Currently using the 1981-2010 average

*It's actually slightly more complicated than that, with departures also being developed relative to recent 5-year periods. But for most purposes, it is probably okay to use the data as derived by the most recent 30-year period. For those interested in the details please take a look at: "In Watching for El Niño and La Niña, NOAA adapts to Global Warming at: http://www.climate.gov/news-features/understanding-climate/watching-el-ni%C3%B1o-and-la-ni%C3%B1a-noaa-adapts-global-warming. Also, see "Linear trends in sea surface temperature of the tropical Pacific Ocean and Implications for the El Niño-Southern Oscillation" by L'Heureux et al. 2012 in *Climate Dynamics.*

How do we define ENSO?



From: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_change.shtml

How do we define ENSO?

Seasonal temperature anomalies since 2000

La Niña, El Niño, neutral — relative to 1971-2000

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.6	-1.4	-1.0	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0.0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.1	1.3	1.5	1.4
2003	1.2	0.9	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.9	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.1	1.1
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1.0	-1.1	-1.3
2008	-1.4	-1.4	-1.1	-0.8	-0.6	-0.4	-0.1	0.0	0.0	0.0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6	0.7	0.8	0.9	1.2	1.5	1.8
2010	1.7	1.5	1.2	0.8	0.3	-0.2	-0.6	-1.0	-1.3	-1.4	-1.4	-1.4
2011	-1.3	-1.2	-0.9	-0.6	-0.2	0.0	0.0	-0.2	-0.4	-0.7	-0.8	-0.9
2012	-0.8	-0.6										

relative to 1981-2010

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.5	-1.2	-0.9	-0.8	-0.7	-0.6	-0.5	-0.6	-0.6	-0.8	-0.8
2001	-0.7	-0.6	-0.5	-0.4	-0.2	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.3
2002	-0.2	0.0	0.1	0.3	0.5	0.7	0.8	0.8	0.9	1.2	1.3	1.3
2003	1.1	0.8	0.4	0.0	-0.2	-0.1	0.2	0.4	0.4	0.4	0.4	0.3
2004	0.3	0.2	0.1	0.1	0.2	0.3	0.5	0.7	0.8	0.7	0.7	0.7
2005	0.6	0.4	0.3	0.3	0.3	0.3	0.2	0.1	0.0	-0.2	-0.5	-0.8
2006	-0.9	-0.7	-0.5	-0.3	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.0
2007	0.7	0.3	-0.1	-0.2	-0.3	-0.3	-0.4	-0.6	-0.8	-1.1	-1.2	-1.4
2008	-1.5	-1.5	-1.2	-0.9	-0.7	-0.5	-0.3	-0.2	-0.1	-0.2	-0.5	-0.7
2009	-0.8	-0.7	-0.5	-0.2	0.2	0.4	0.5	0.6	0.8	1.1	1.4	1.6
2010	1.6	1.3	1.0	0.6	0.1	-0.4	-0.9	-1.2	-1.4	-1.5	-1.5	-1.5
2011	-1.4	-1.2	-0.9	-0.6	-0.3	-0.2	-0.2	-0.4	-0.6	-0.8	-1.0	-1.0
2012	-0.9	-0.6	-0.5	-0.3	-0.2	0.0	0.1	0.4	0.5	0.6	0.2	-0.3

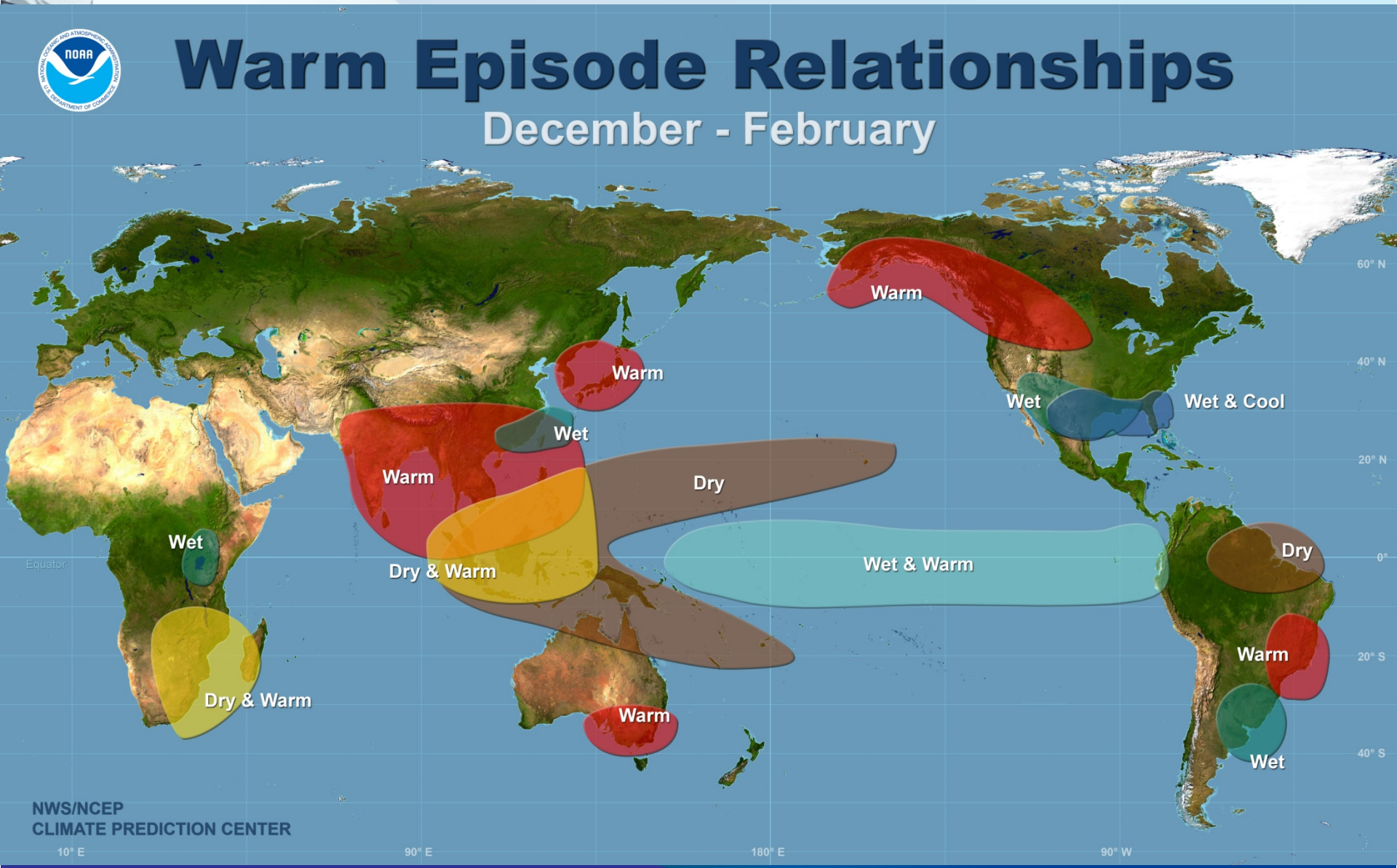
La Niñas that we didn't know we had when using the 1971-2000 average!

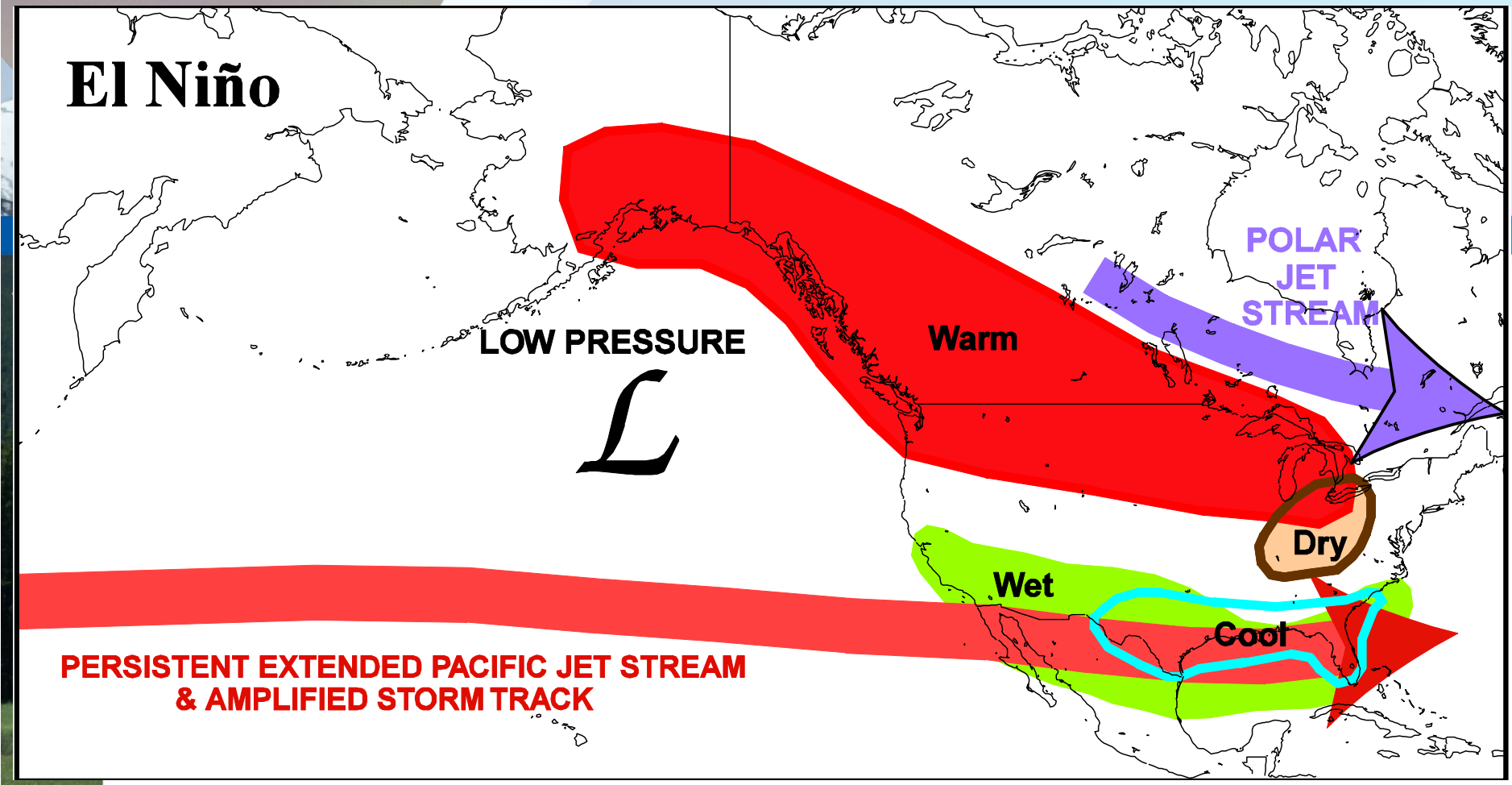
Blue = La Niña event

Red = El Niño event

Figure from: http://www.climate.gov/news-features/understanding-climate/watching-el-ni%C3%B1o-and-la-ni%C3%B1a-noaa-adapts-global-warming

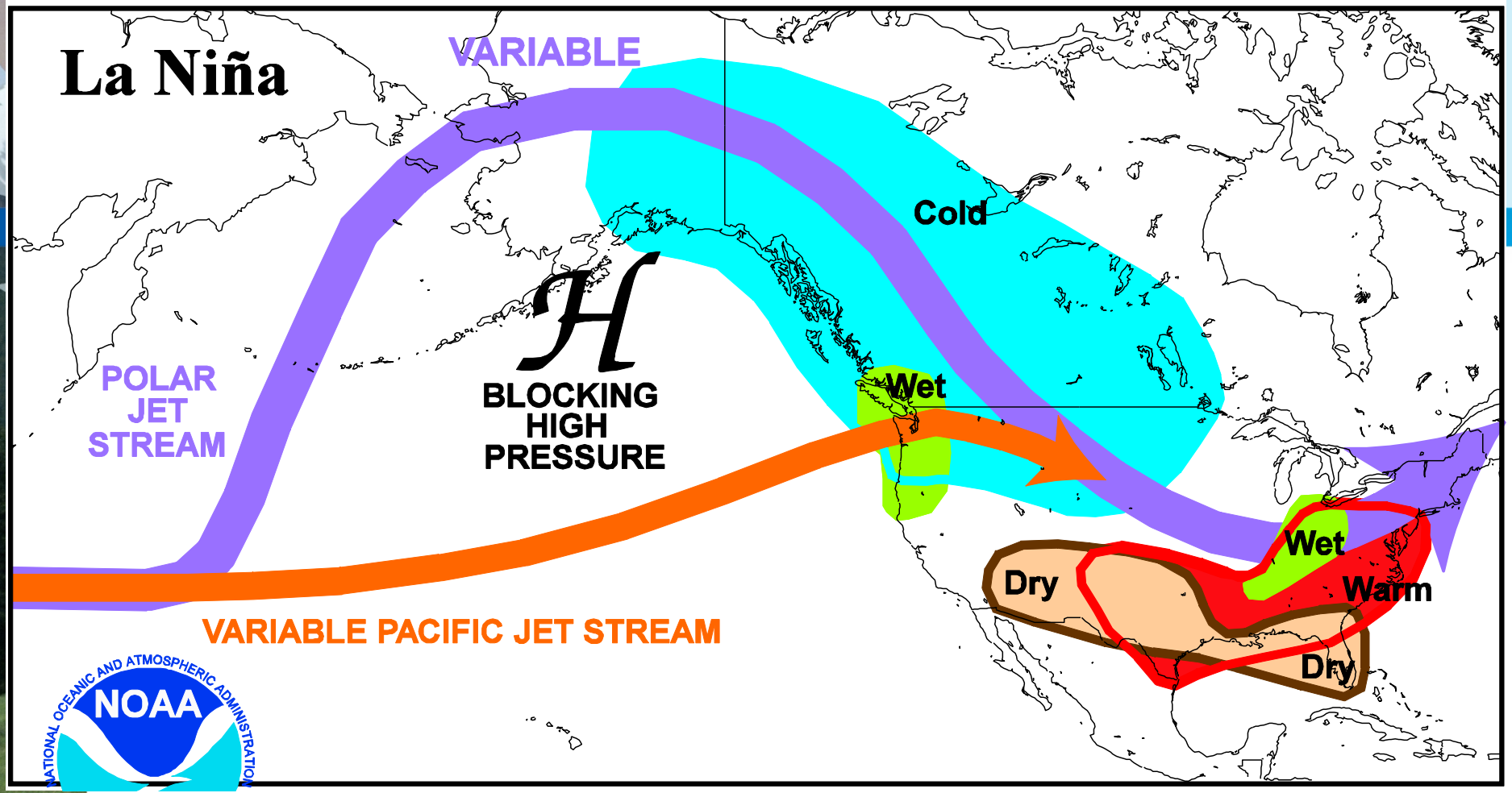
ENSO Impacts





- Over the winter months, cooler, wetter conditions typically form along southern latitudes in the U.S. during an El Niño

Figure from: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/nawinter.shtml



- Over the winter months, drier, sometimes warmer, conditions typically form along southern latitudes in the U.S. during a La Niña

Figure from: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/nawinter.shtml