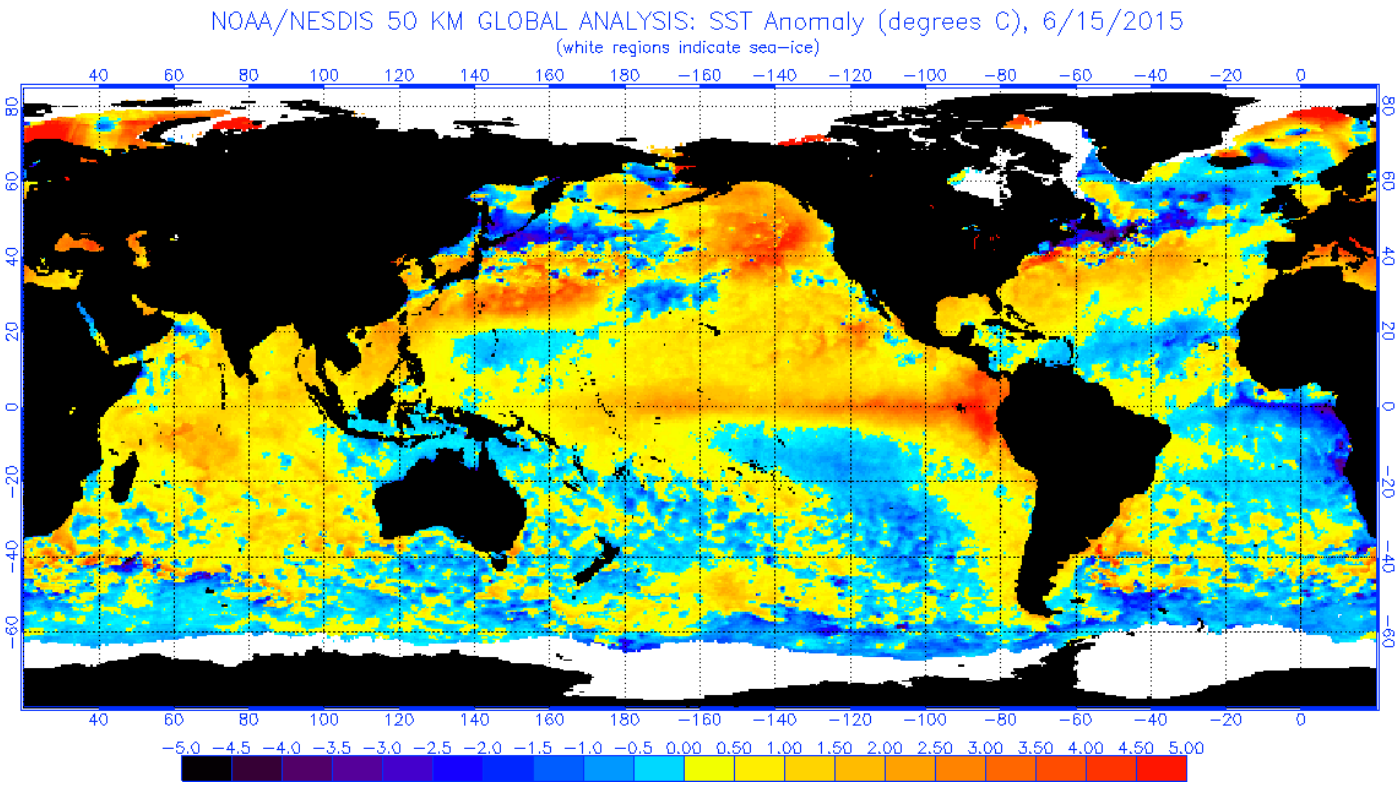
Recap 2014 / 2015 Winter & What if it Doesn't Snow Next Winter



IWUA Summer Water Law & Resource Issues Seminar
June 22, 2015 Sun Valley, Idaho

This talk will be posted on Idaho Snow Survey web page:
http://www.nrcs.usda.gov/wps/portal/nrcs/main/id/snow/
Water Supply Presentations by Year

Ron Abramovich
Water Supply Specialist
USDA NRCS Snow Survey Boise, Idaho

USDA
United States Department of Agriculture

Topics:

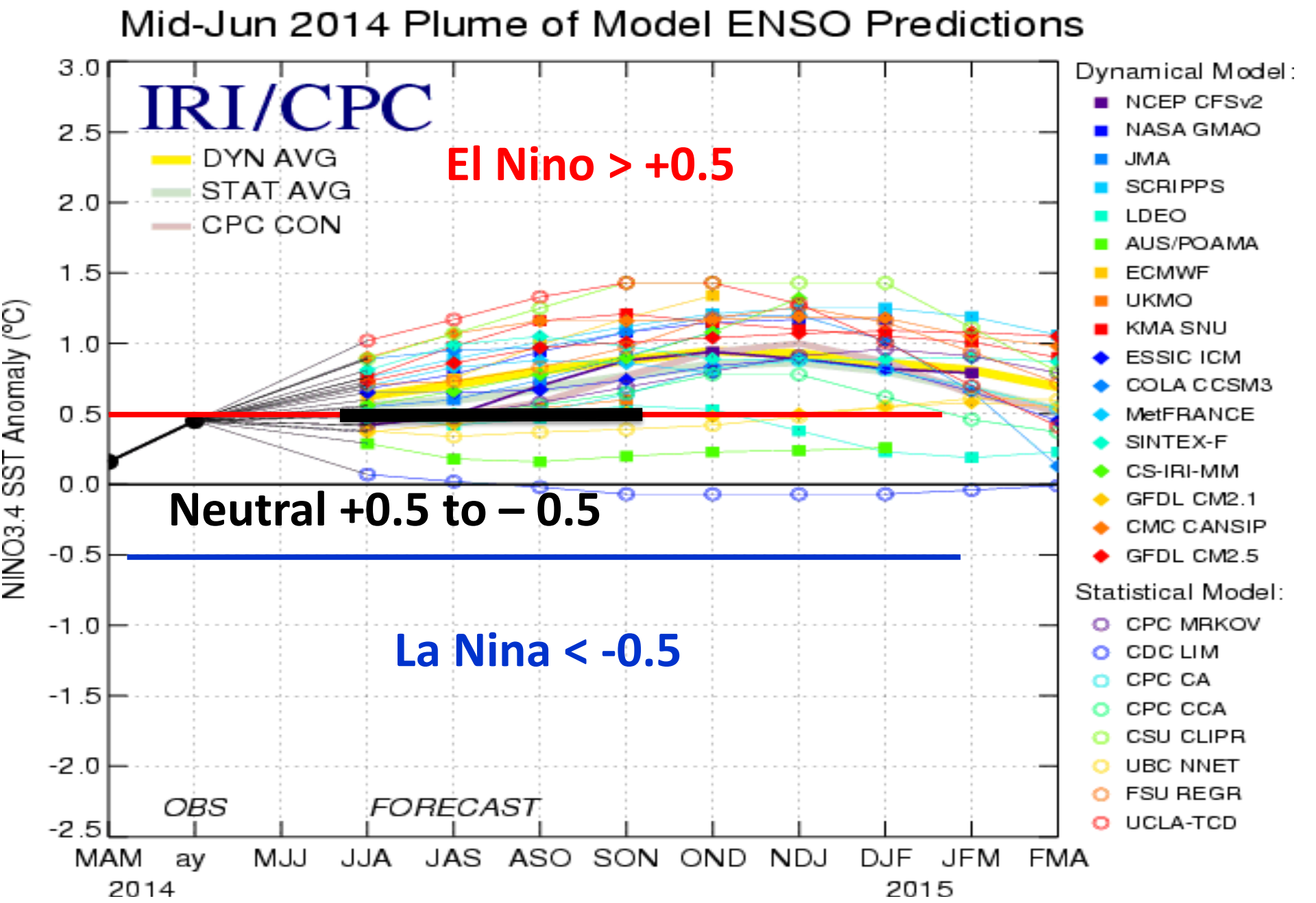
- **Review of 2014 / 2015 Winter's Weather Forecasts**
  - **Winter 2014 / 2015 - what happened & when did we learn what we now know?**
  - **Which forecasts worked, and why**
  - **Two atmospheric river events**

- **Current ENSO Conditions (El Nino Southern Oscillation)**
  - **Status of Pacific Decadal Oscillation (PDO)**
  - **El Nino conditions setting up for 2015/2016**
  - **Current Sea Surface Ocean Temperatures –**
    - **influence of the warm ocean temperatures on last winter's storm track**

- **2014 / 2015 Snow Drought vs Rain Drought**
  - **Lessons learned about lack of snow fall and influence of rain on runoff**
  - **Stream baseflow level and why they are important to understand in years like this**
  - **2015 Streamflow forecast accuracy review, a tough year to forecast with the increase in spring precipitation variability**

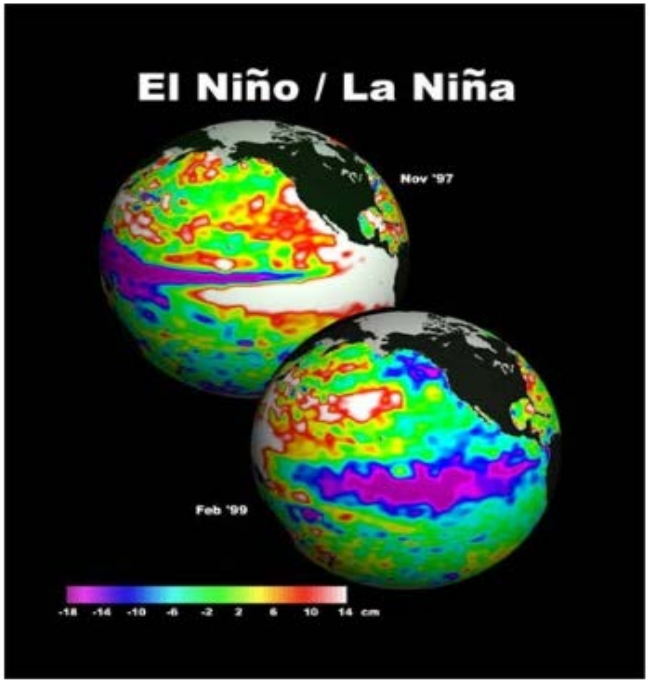
- **Any early Fall / Winter Forecasts for 2015 / 2016 Winter?**

Recap for 2014/2015 --- from mid JUN 2104



Spring 2014 **El Nino Watch: 75% Chance El Nino will develop by Summer or Fall**

June 2015 : **90% Chance that El Niño conditions will continue through summer, and > 80% chance it will last through 2015**

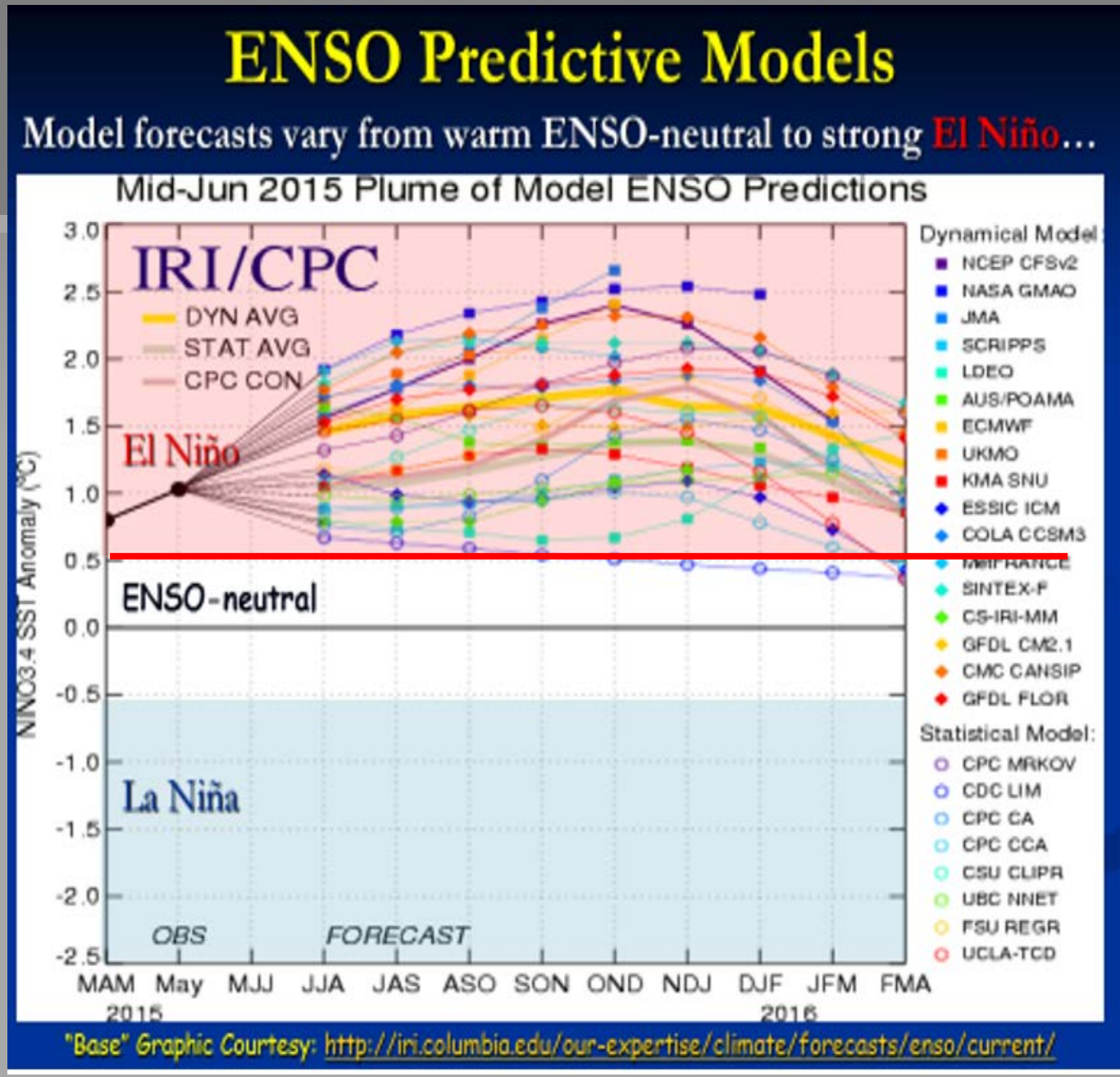


From Mid- Jun 2105

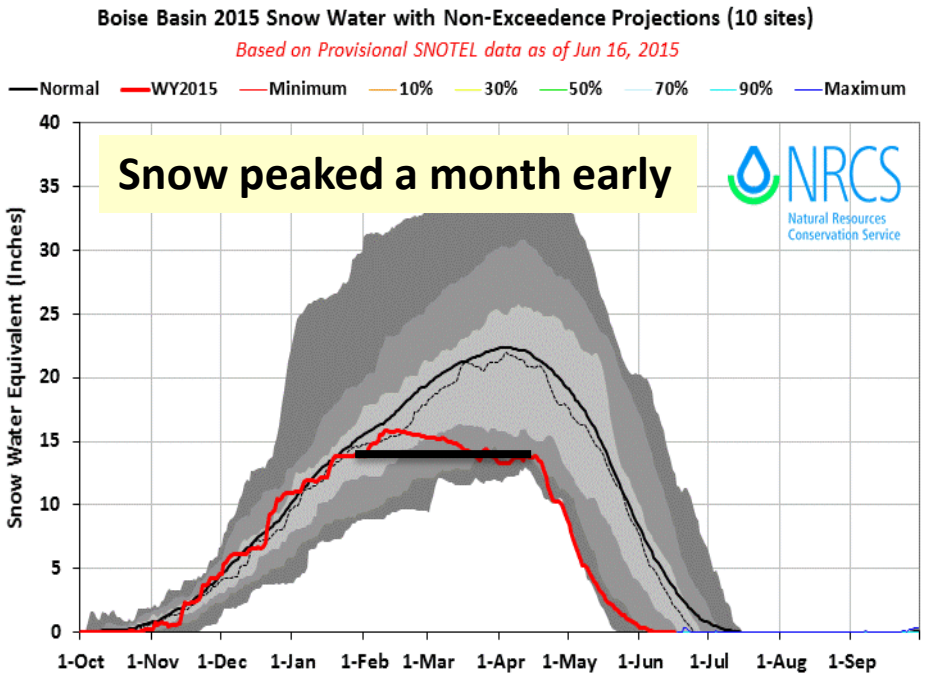
IRI/CPC Pacific Niño 3.4 SST Model Outlook

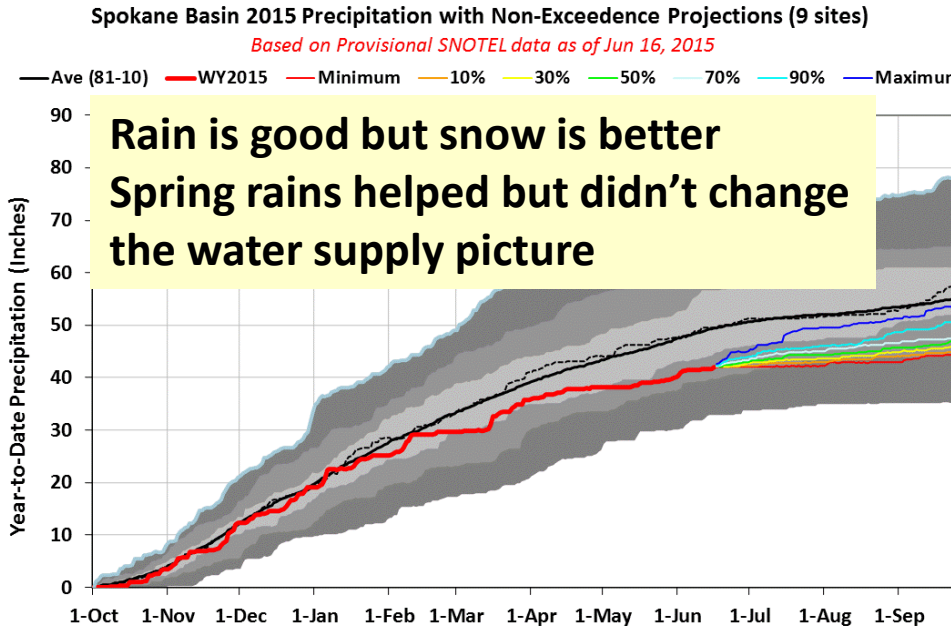
Almost all of the models indicate Niño 3.4 SST anomalies will remain greater than or equal to +0.5C through the end of 2015.

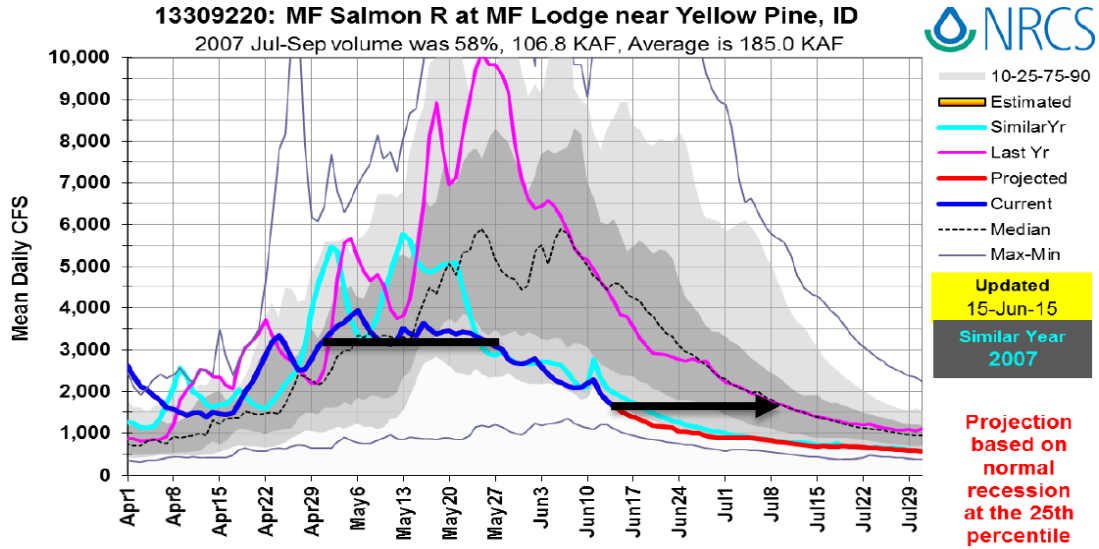
However, there is a large amount of spread in the potential strength of El Niño.



Recap of Last Winter & Forecasts





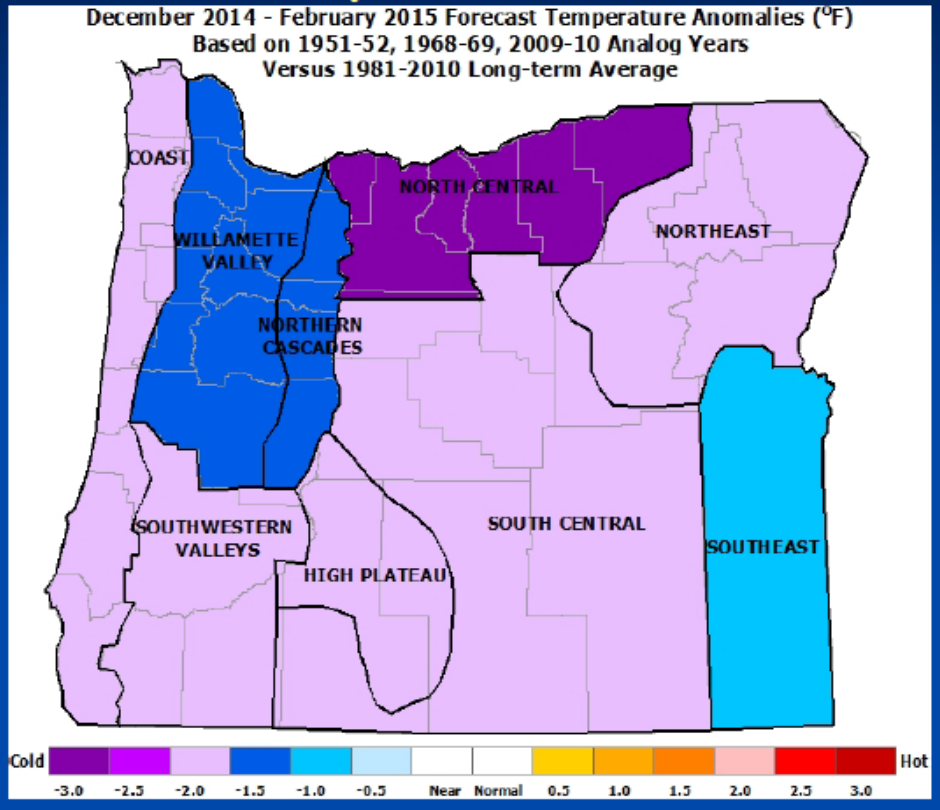


Peak streamflow were low and they are currently flowing where they typical are a month from now

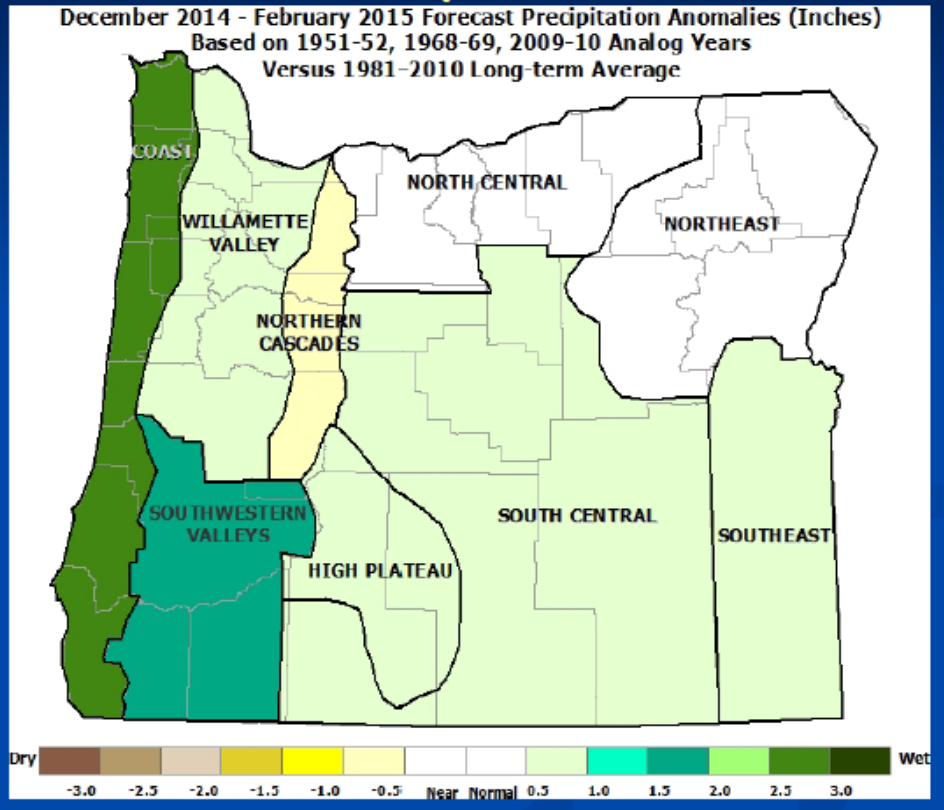
From Pete Parsons OR Meteorologist Analog Years 1952, 1969, 2010

Dec. 2014 – Feb. 2015 Forecast

Temperatures



Precipitation



- Tremendous variation among analog years for December and January increases forecast uncertainty. A "classic" El Niño produces warmer and drier than average weather, but the opposite extremes can occur…

Dec. 2014 – Feb. 2015 Highlights

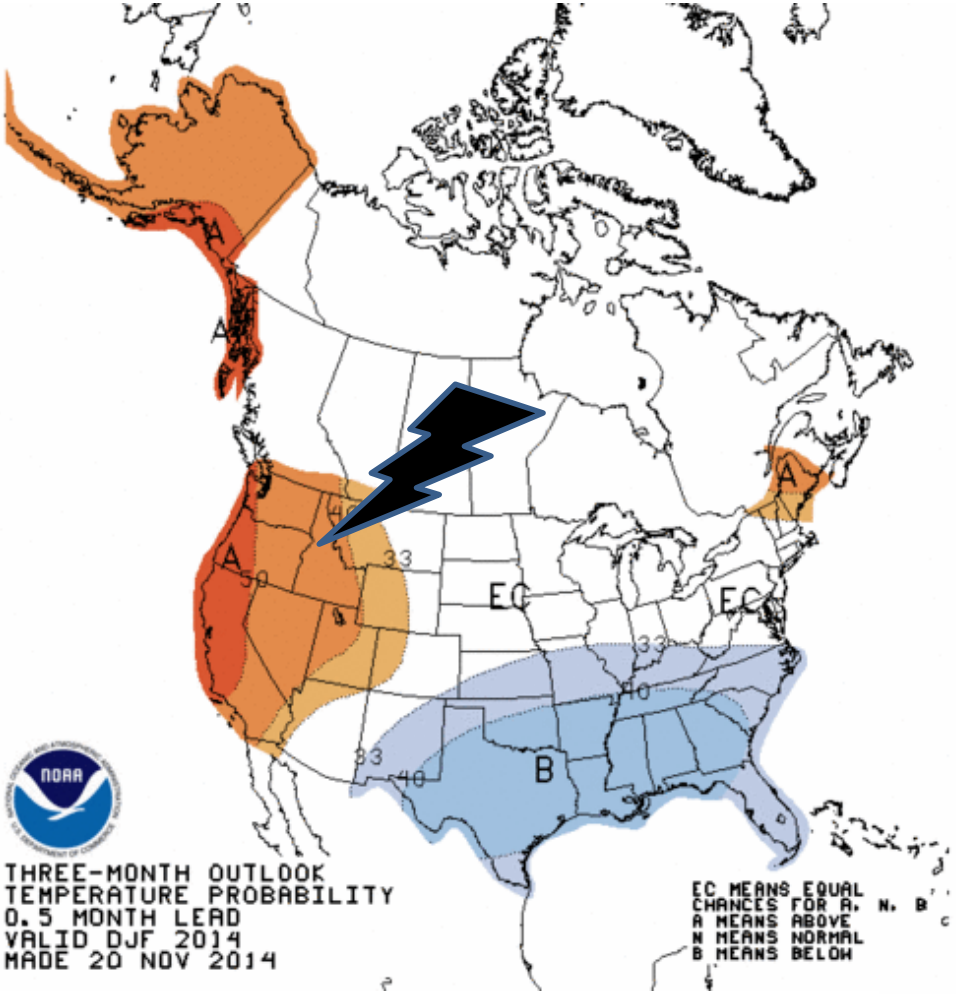
- A weak or moderate El Niño is likely this winter, which commonly produces cool and stormy conditions in late-autumn, but relatively mild and dry weather in mid-winter.
- Mountain snowfall (relative to average) is typically greater across southern Oregon than across northern Oregon.
- However, there are other possibilities…
- In stark contrast to the current Climate Prediction Center (CPC) Forecasts, the analog method used here shows that extremely cold and wet weather can't be ruled out for December and January.
- Dec. 1968 – Jan. 1969, (one of the top analog years) produced multiple Arctic outbreaks with heavy snowfall across much of the state, especially for northern Oregon.
- Extremely cold weather becomes unlikely after January, but generally cool temperatures may prevail into February.

Nov Artic outbreak

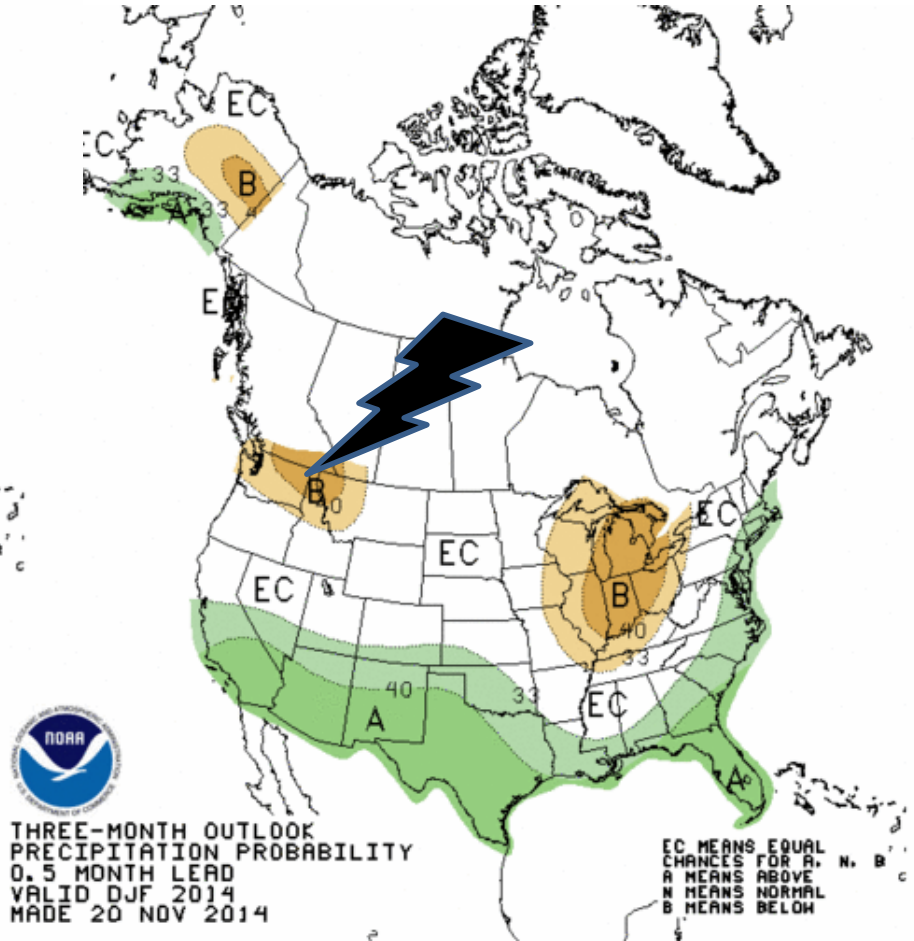
Warm winter Feb -Apr

Recap 2014/2015 Forecasts

Three-Month Outlooks
OFFICIAL Forecasts
Dec-Jan-Feb 2014-15



Dec-Jan-Feb Temperature
Forecast made Nov 20, 2104

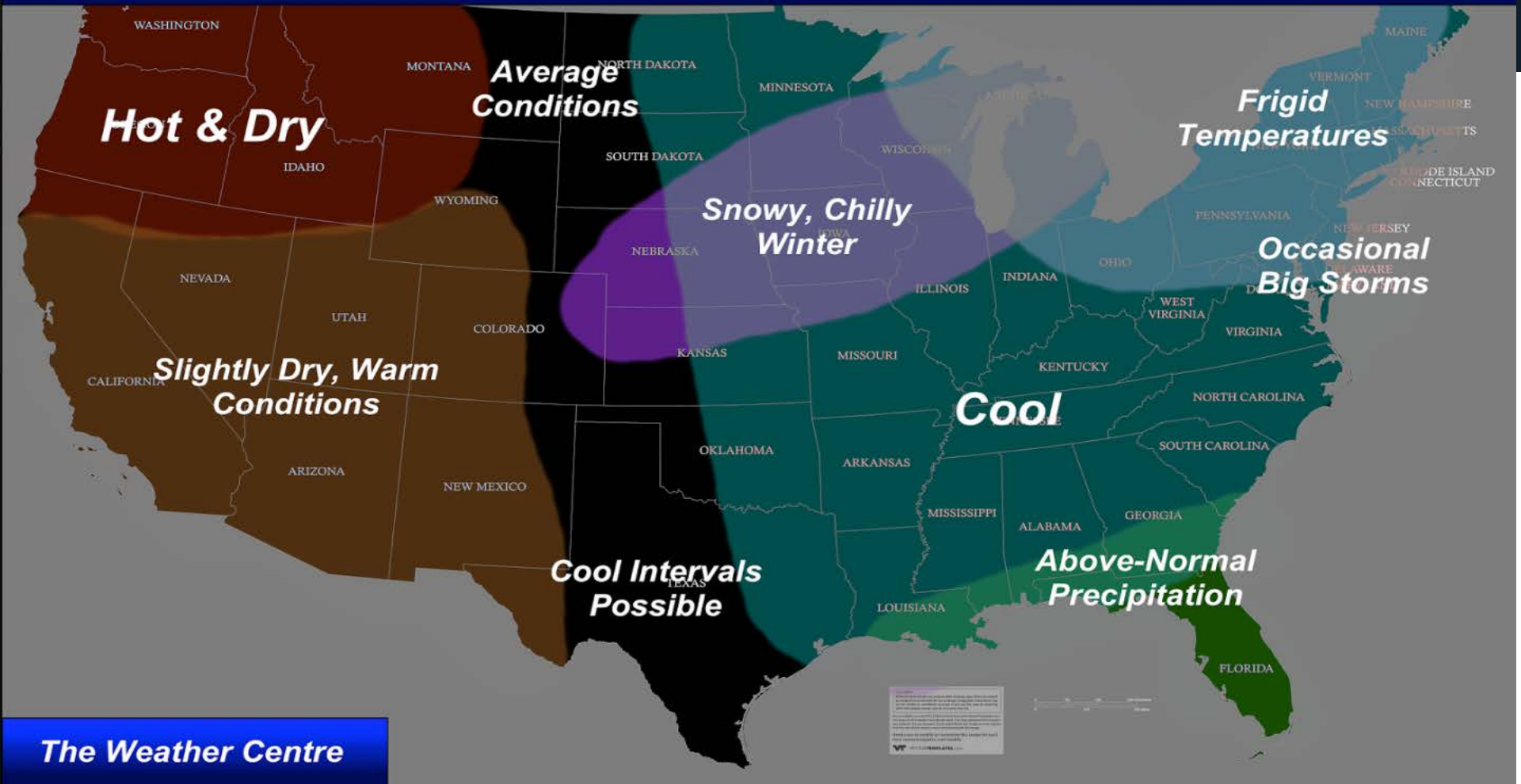


Dec-Jan-Feb Precipitation
Forecast made Nov 20, 2104

From OCT 2105

The Weather Centre

Official 2014-2015 Winter Forecast

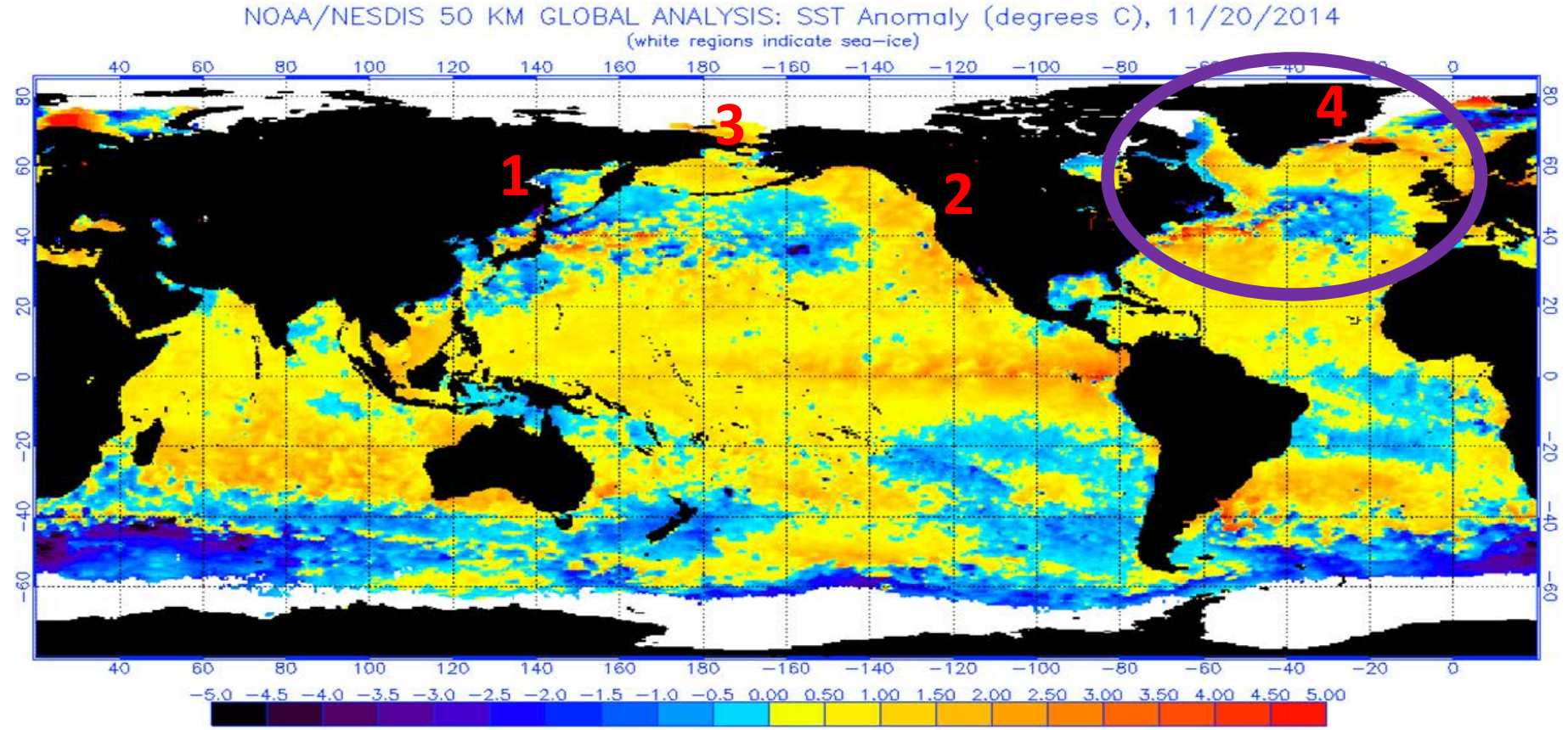


The Weather Centre

Sea Surface Temperatures
Nov 11, 2014

The Weather Centre

EXPECT THE UNEXPECTED



1. Below Normal SST Anomalies in the Sea of Japan

In the Sea of Japan, located to the west of Japan, we see a swath of below-normal to well below-normal sea surface temperature anomalies (henceforth abbreviated as SSTAs). These below-normal water temperatures were recently stirred up by the passage of a Typhoon Halong in early August, making quick work of what had previously been a rather

2. Well Above-Normal Water Temperatures in the Gulf of Alaska

3. Well-Above Normal SST Anomalies in the Bering Sea

4. Above-Normal SST Anomalies Near Greenland


Think Snow!!

Review of Key Climate Indicators

Teleconnections **– climatic indexes - key is understanding their correlations and influence on current weather (and snow, flow & more).**

Primary Ones:

PDO	**Pacific Decadal Oscillation – larger cycle**
ENSO	**El Nino Southern Oscillation – short cycle**
	El Nino Neutral La Nina measure of Sea Surface Temperature SST
SOI	**Southern Oscillation Index measure of barometric pressure difference between Darwin & Tahiti**

Key to 2014 winter/spring – went negative Feb – Apr and sent meteorologists & weather enthusiasts into a frenzy… May 2014 declared AMO back to a + phase

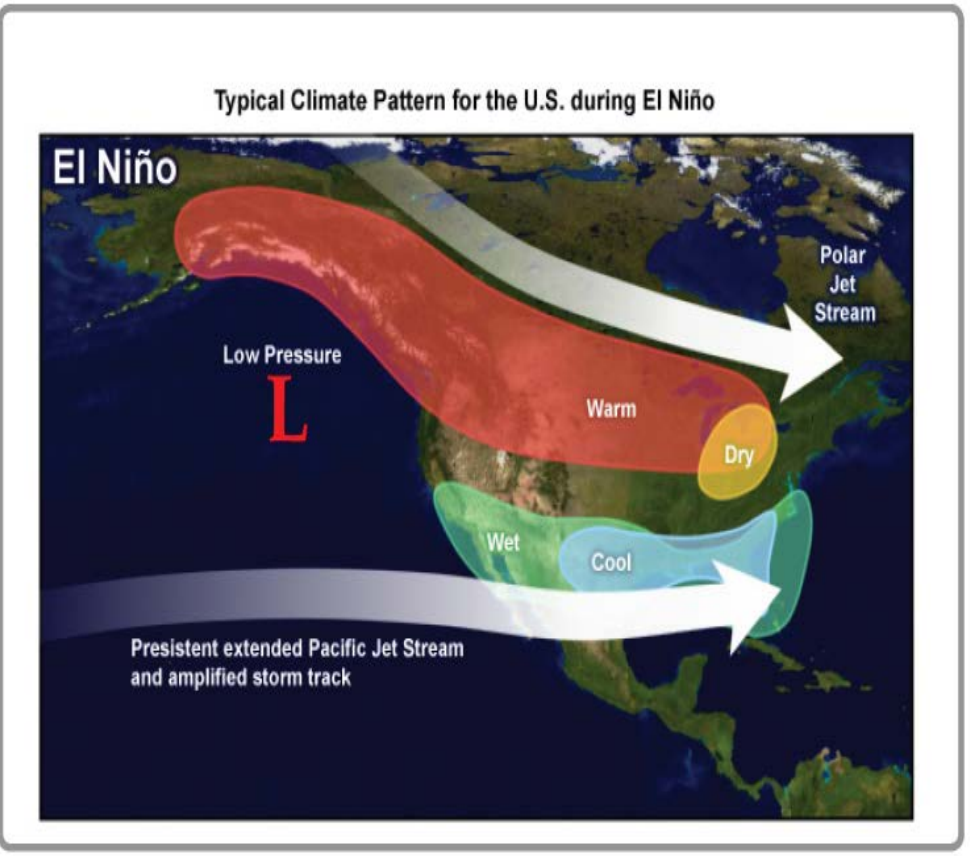
AMO	**Atlantic Multidecadal Oscillation**

Additional climate indices:

NAO	**North Atlantic Oscillation**
AO	**Artic Oscillation**
SSW	**Sudden Stratospheric Warming**

Sun Spots, Solar Activity, Polar Vortex, and more…..

Typical El Niño Winter Pattern



Typical El Niño jet stream patterns across the U.S. include a stronger than usual storm track across the southern U.S., leaving the northern U.S. removed from the average storm track. Image courtesy of NOAA.

Teleconnections **Primary Ones:**

- **PDO Pacific Decadal Oscillation**
  20 to 30 year cycle

*** ENSO 3 to 5 year cycle**
El Nino/Neutral/La Nina - measure of Sea Surface Temperature (SST)

SOI Southern Oscillation Index measure of barometric pressure difference between in south Pacific

La Nina and Pacific Decadal Oscillation (PDO)

Cooling in the Pacific Ocean

Don J. Easterbrook, Dept. of Geology, Western Washington University, Bellingh

The announcement by NASA's Jet Propulsion Laboratory that the Pacific Decadal Os
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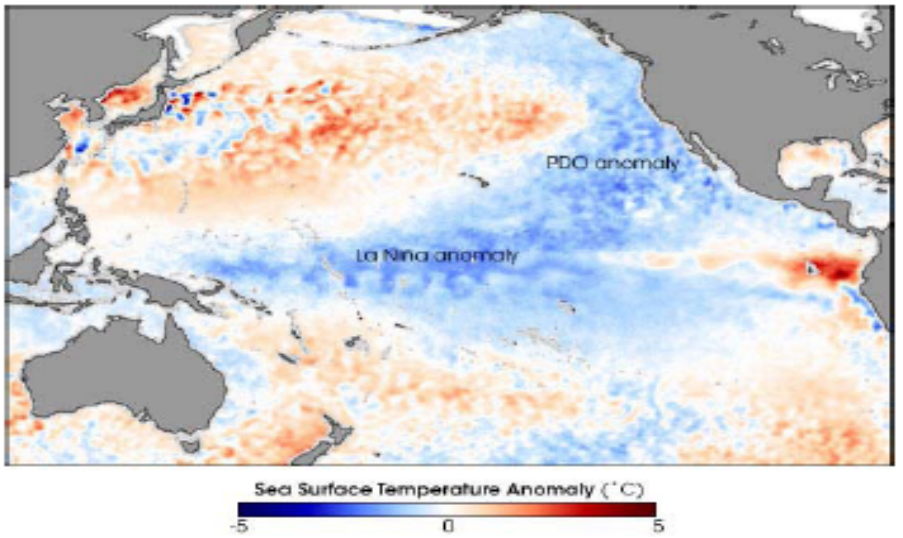


Figure 1. Cooling of the Pacific Ocean and setting up of the PDO. Sea surface tem

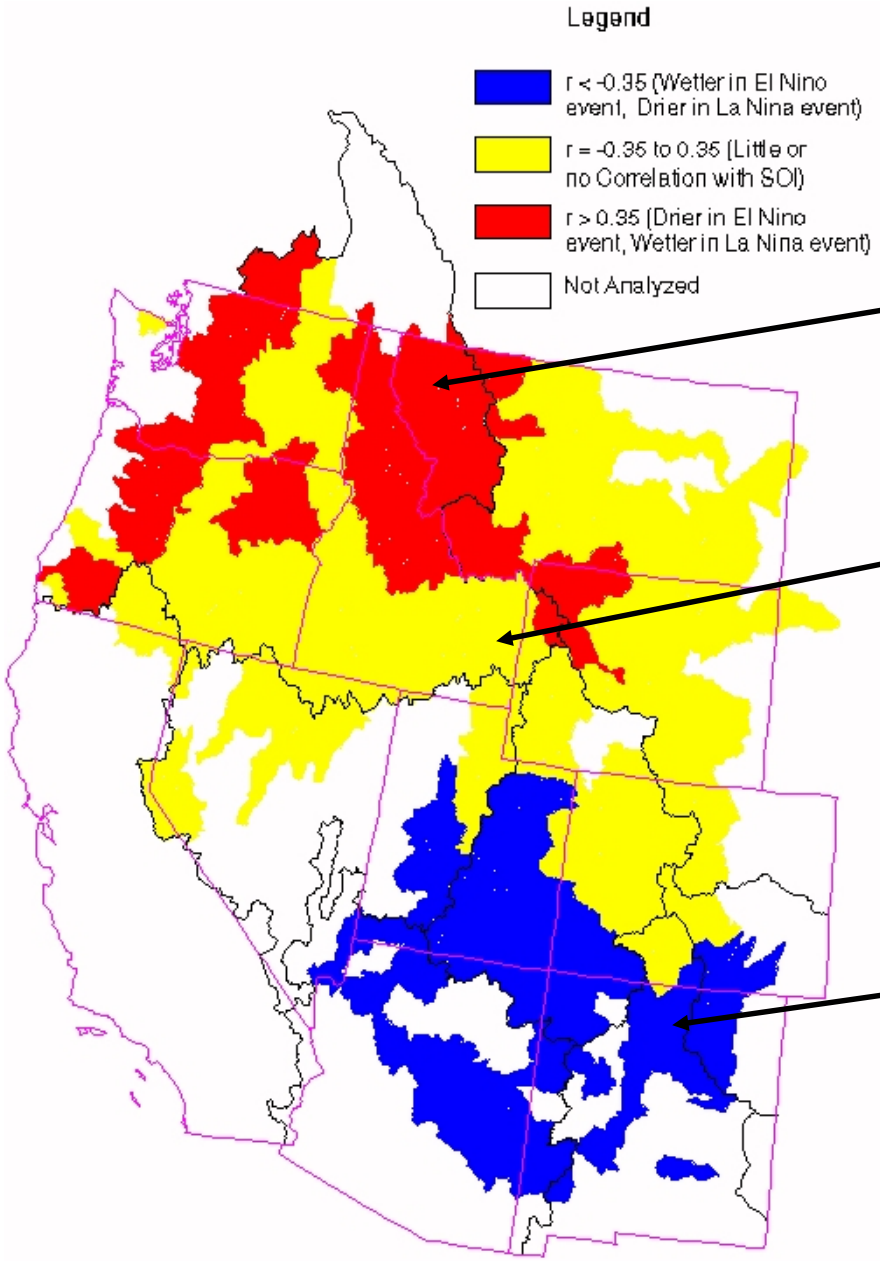
Teleconnection Relationships

Correlation Map of the Southern Oscillation Index (SOI) with spring and summer streamflow

Key is what happens during the July – Nov period

Winter 2014-2015: Slight El Nino & SOI

Winter 2015/2016: Stronger El Nino ?



La Nina and Pacific Decadal Oscillation (PDO)

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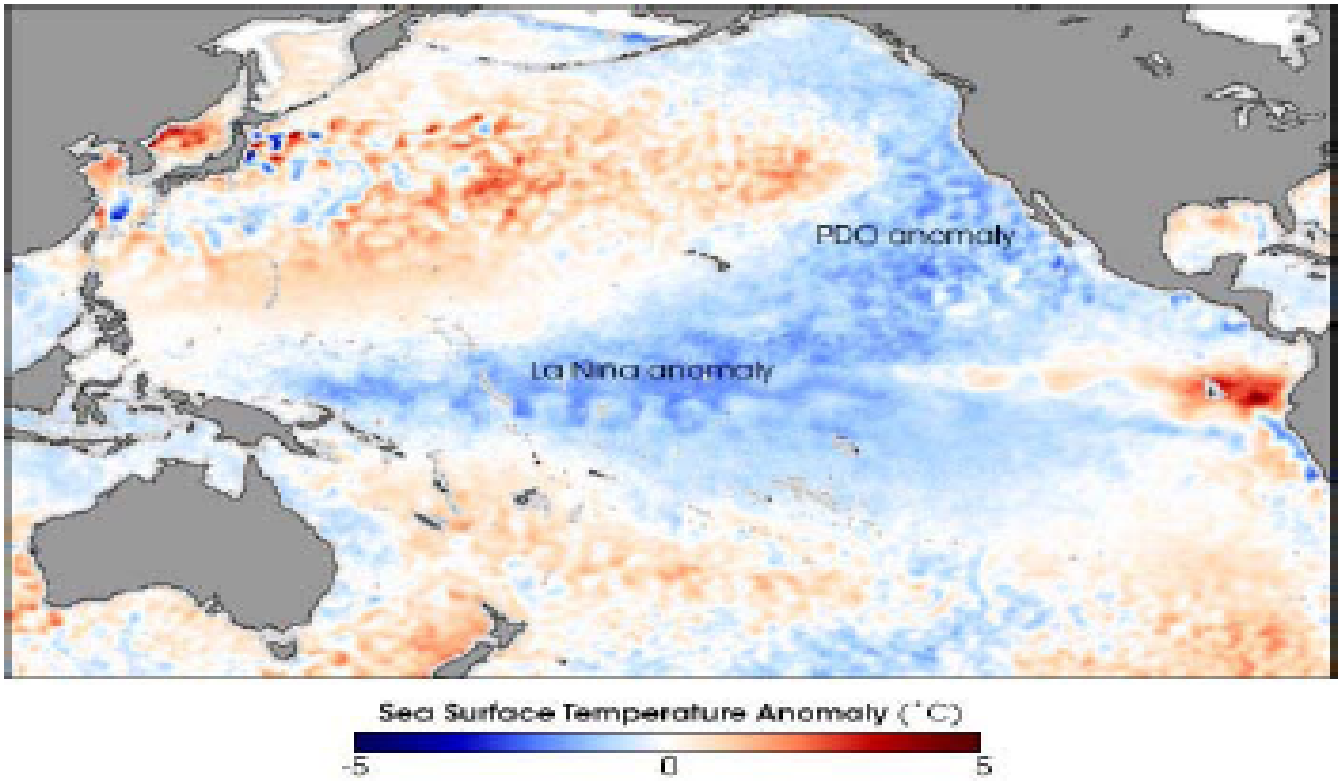


Figure 1. Cooling of the Pacific Ocean and setting up of the PDO. Sea surface temperature anomaly in the Pacific Ocean from April 14–21, 2008. The anomaly compares the recent temperatures measured by the Advanced Microwave Scanning Radiometer for EOS (AMSR-E) on NASA's Aqua satellite with

As shown by the historic pattern of PDOs over the past century (Fig. 2) and by corresponding global warming and cooling, the pattern is part of ongoing warm/cool cycles that last 25-30 years.

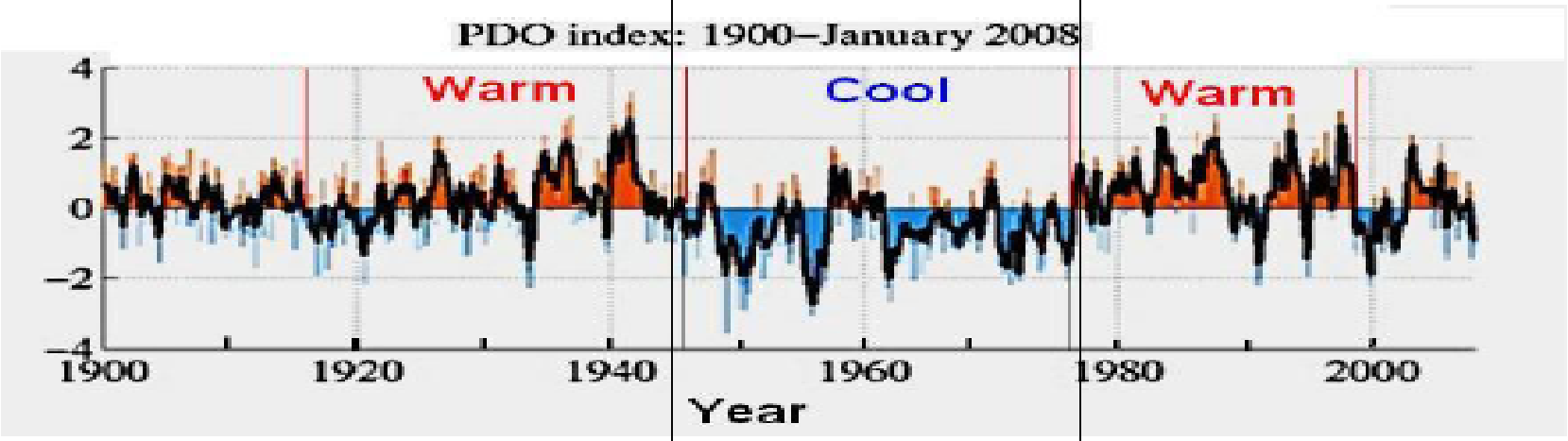
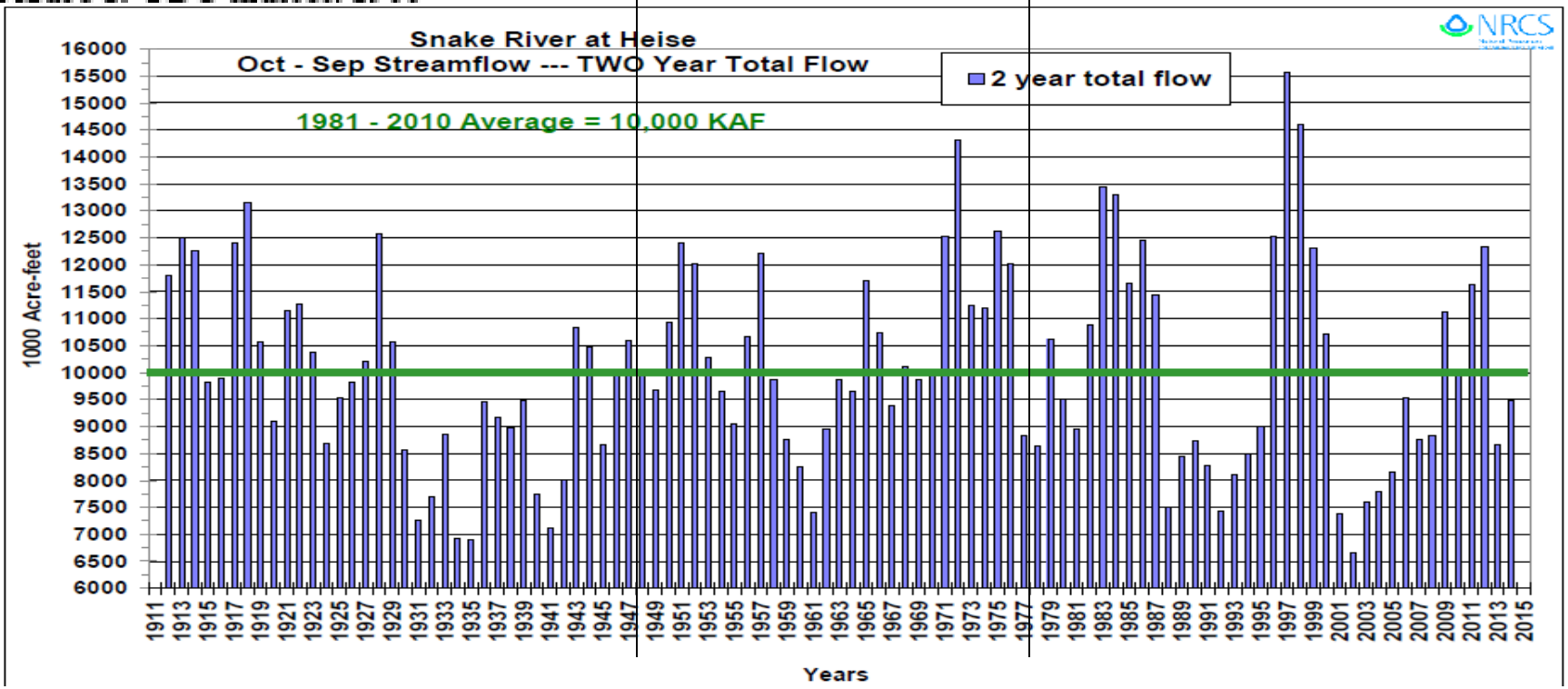
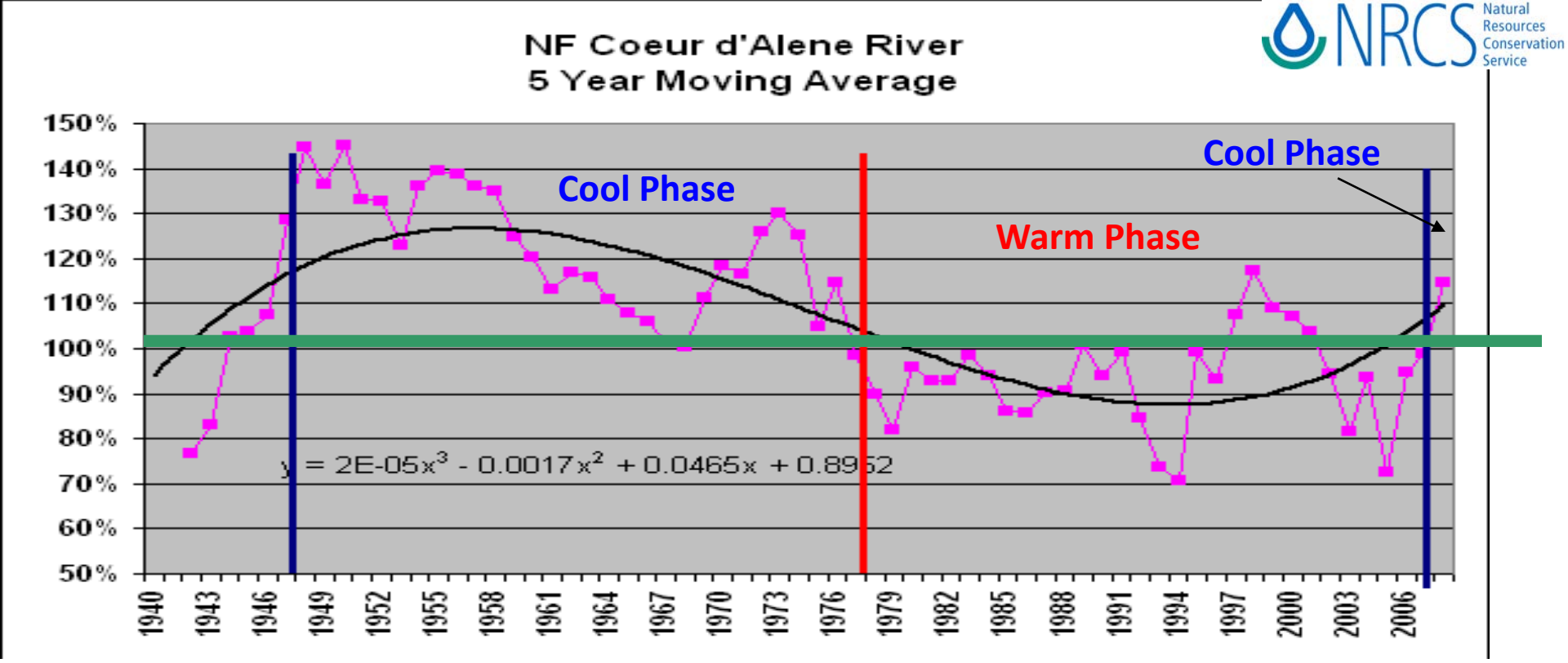


Figure 2. PDO indices, 1900




NF Coeur d'Alene River
5 Year Moving Average
NRCS Natural Resources Conservation Service
Cool Phase
Warm Phase
Cool Phase
y = 2E-05x³ - 0.0017x² + 0.0465x + 0.8952
150%
140%
130%
120%
110%
100%
90%
80%
70%
60%
50%
1940
1943
1946
1949
1952
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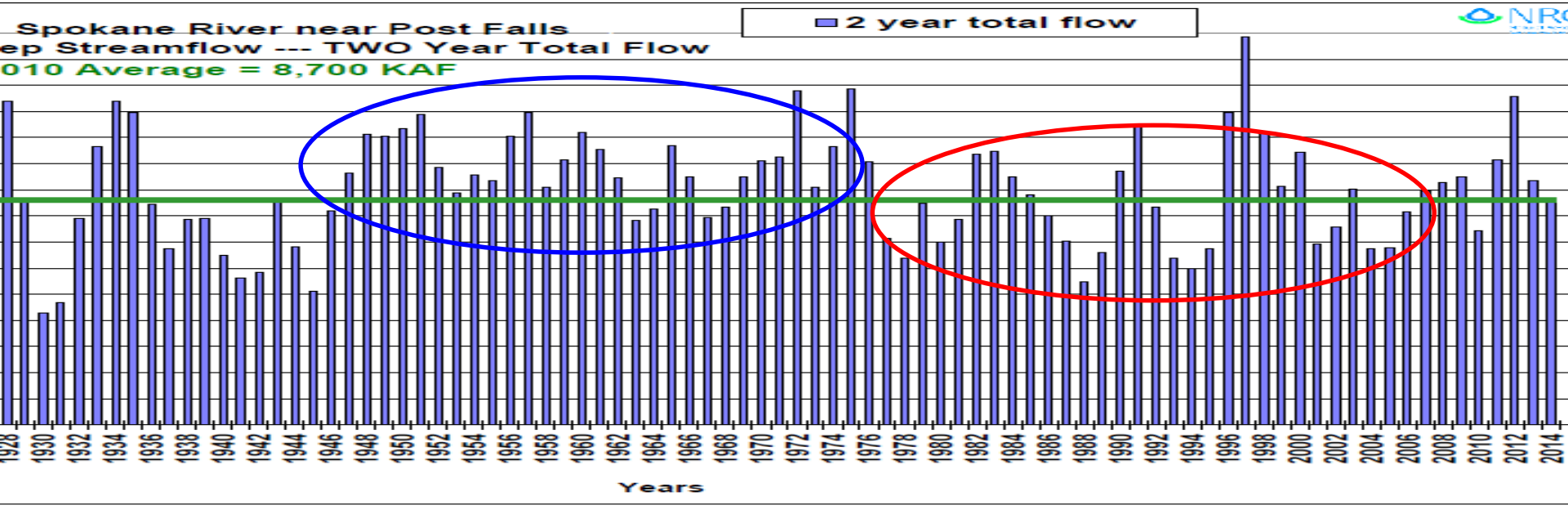
2006


Spokane River near Post Falls
ep Streamflow --- TWO Year Total Flow
010 Average = 8,700 KAF
2 year total flow
1928
1930
1932
1934
1936
1938
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
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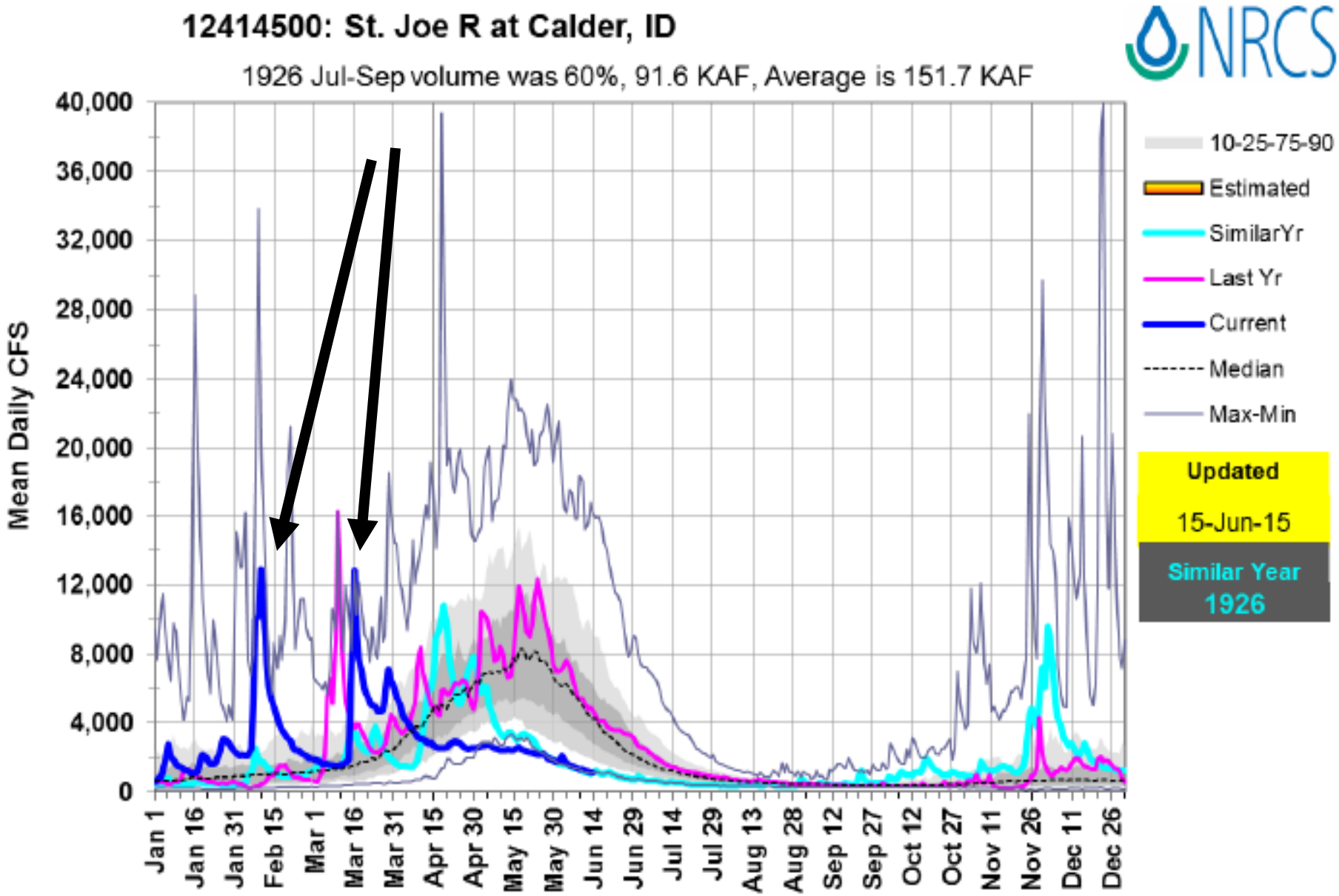
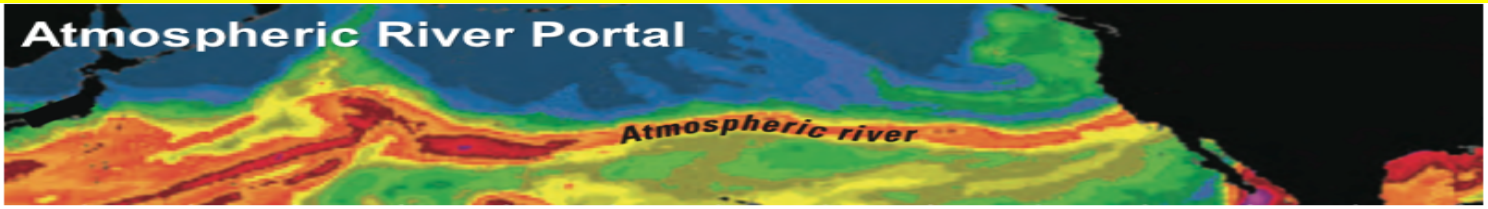
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Years

Winter 2015 - Two Atmospheric River Precipitation Events - Feb 9 & Mar 16

If not for these events, total runoff in northern Idaho would have be much less…



New Tools to Forecast Atmospheric Rivers From Feb 3, 2015



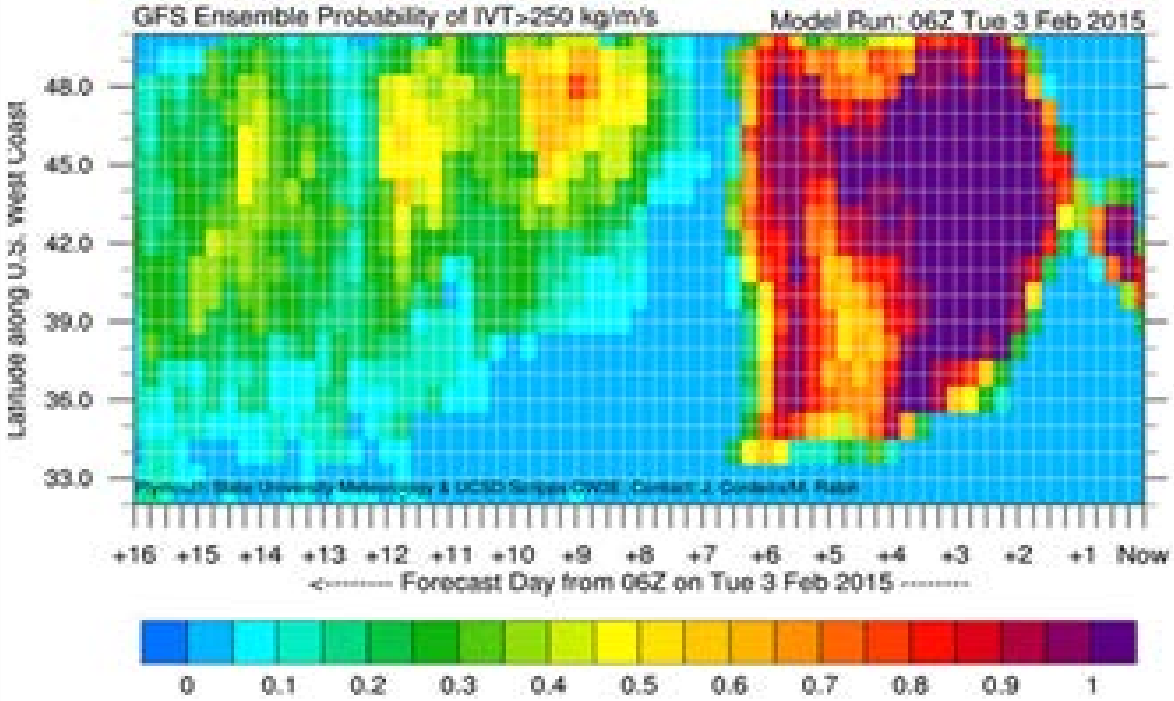
Plymouth State University

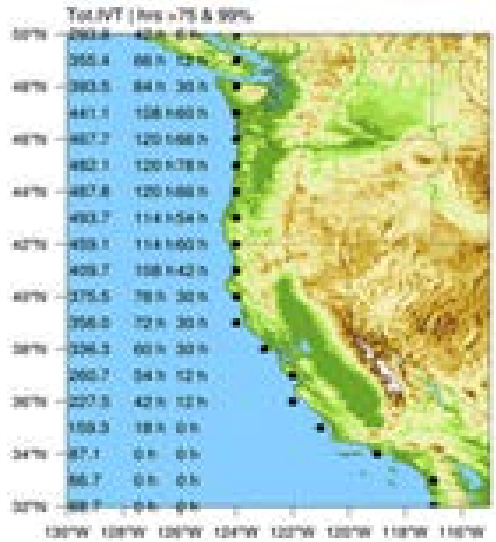
Center for Western Weather and Water Extremes (CW3E)

Introduction: The purpose of this website is to provide a portal for atmospheric river forecasts and diagnostics from the NCEP GFS

U.S. West Coast AR Landfall Tool

Control IVT	Probability IVT>250 kg/m/s	Probability IVT>500 kg/m/s
7-d dProg/dt Loop	7-d dProg/dt Loop	7-d dProg/dt Loop

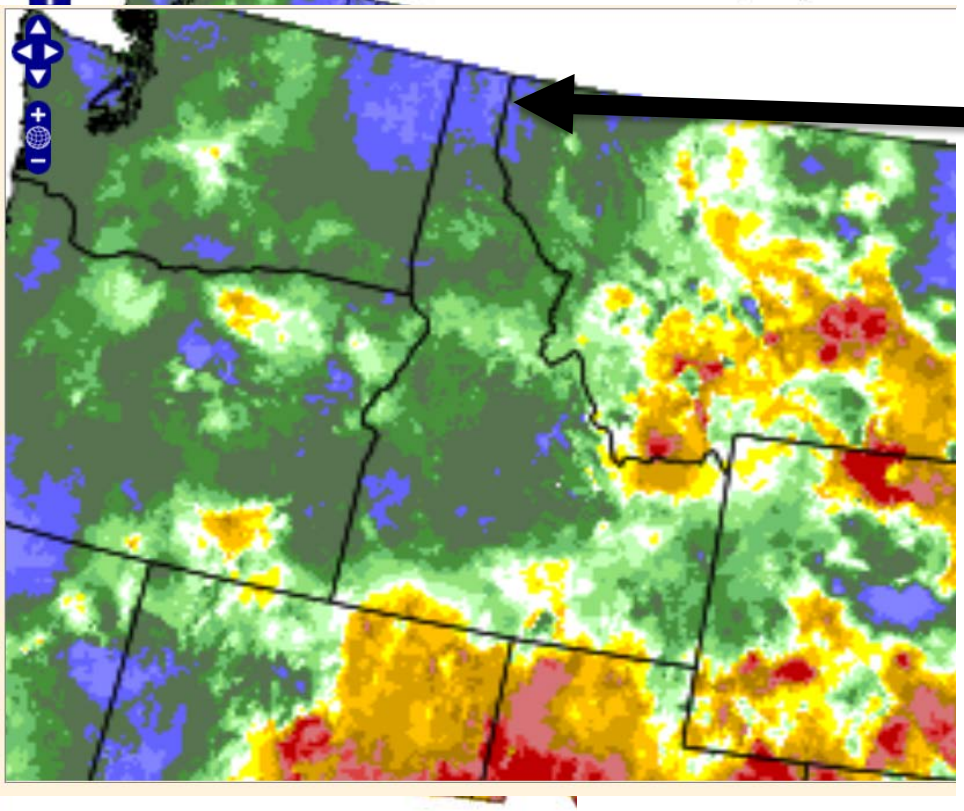


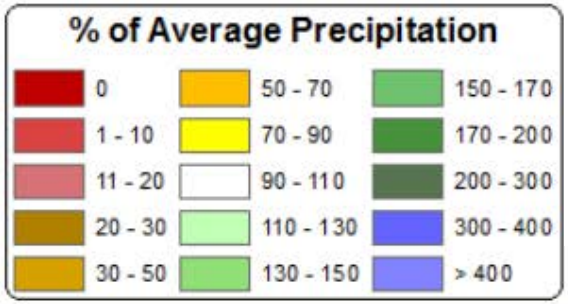


Click on each image for additional information

Total Precipitation Anomaly: 01 February 2015 - 10 February 2015

Period ending 7 AM EST 10 Feb 2015
Base period: 1981-2010
(Map created 11 Feb 2015)





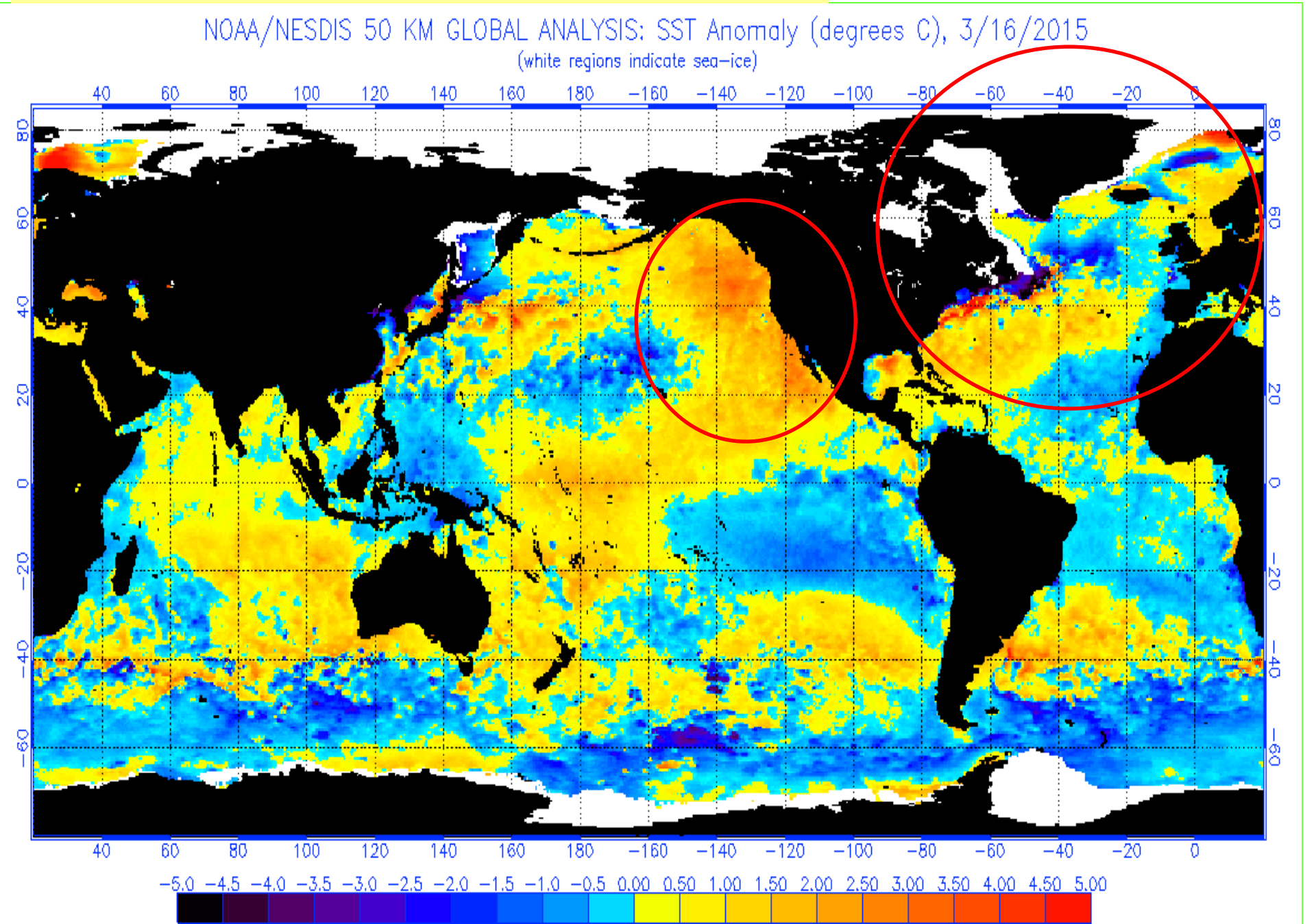
February Precipitation:

One Atmospheric River event brought 200% of normal to two SNOTEL sites near Canadian border,

125% of average to the Panhandle

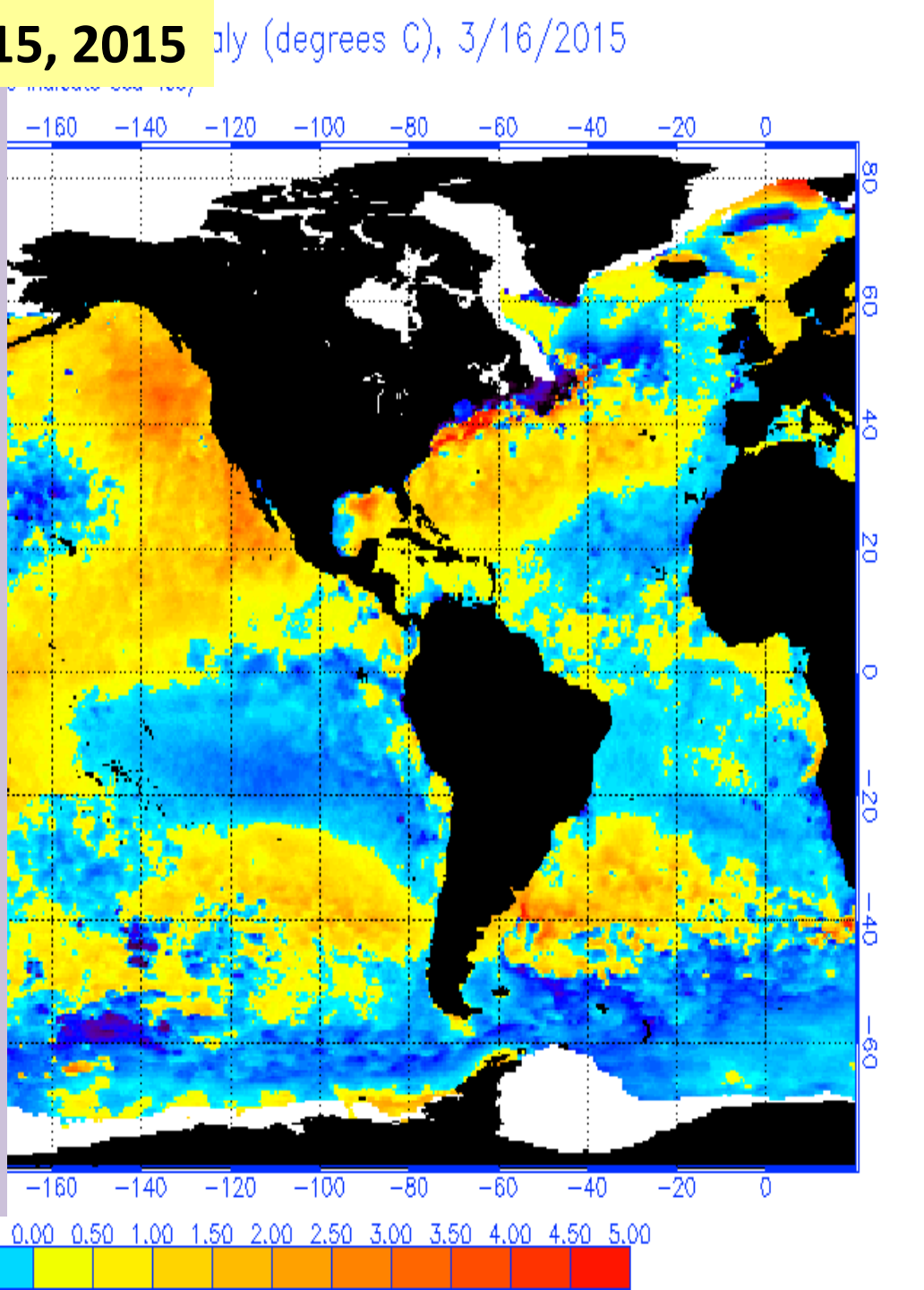
while rest of Idaho received 50 - 90% for month of February

Sea Surface Temperatures March 16, 2015

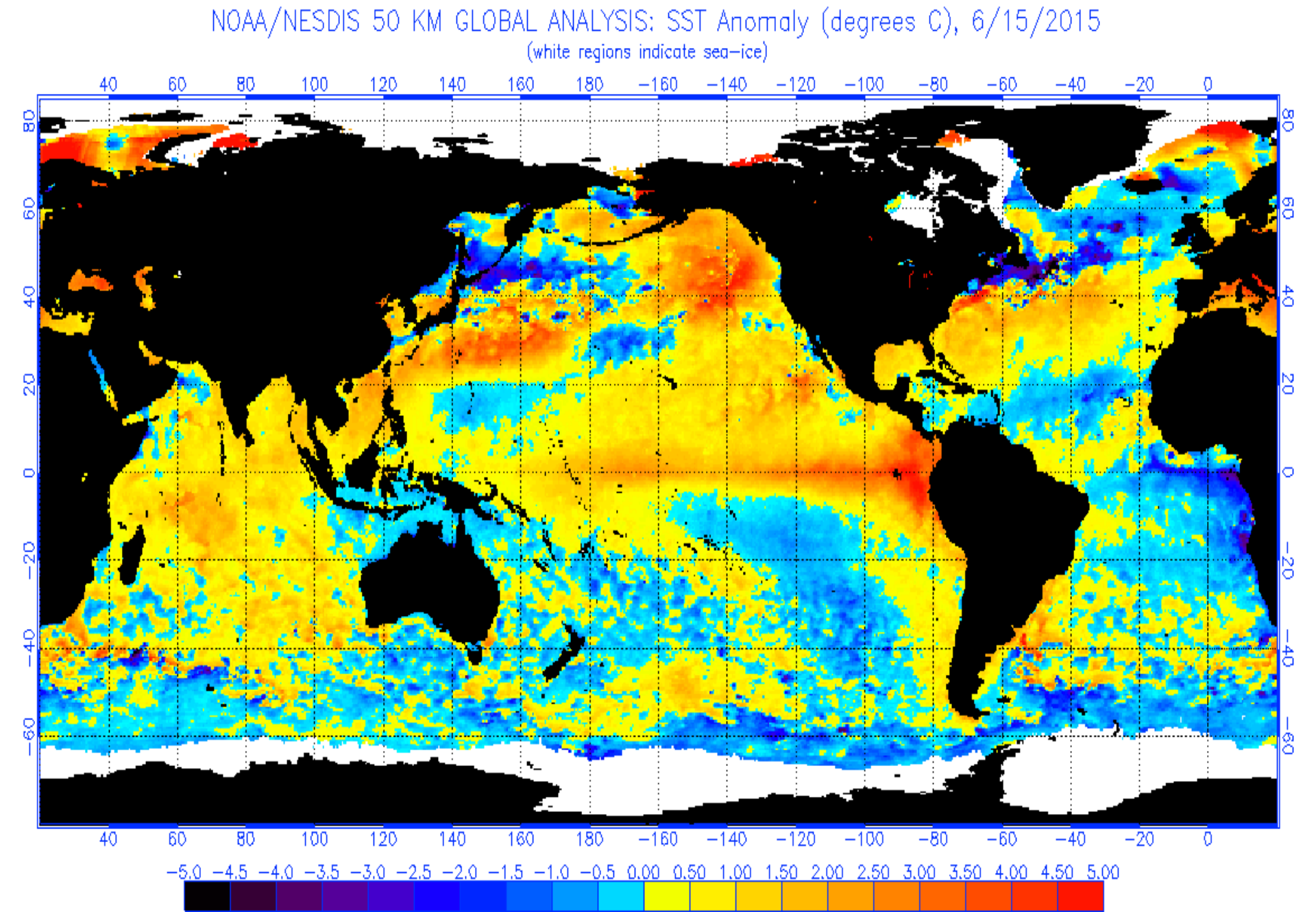


Sea Surface Temperatures June 15, 2015

- Warm waters off west coast: warmest in 60-70 years
- Flipped to positive PDO in January 2014
- Temperatures were ~6 F above normal, similar to Seattle's winter temperature
- NOAA / Clearing Up - mentioned warm waters have extended to depths of 60-100 meters – impacts of future salmon runs

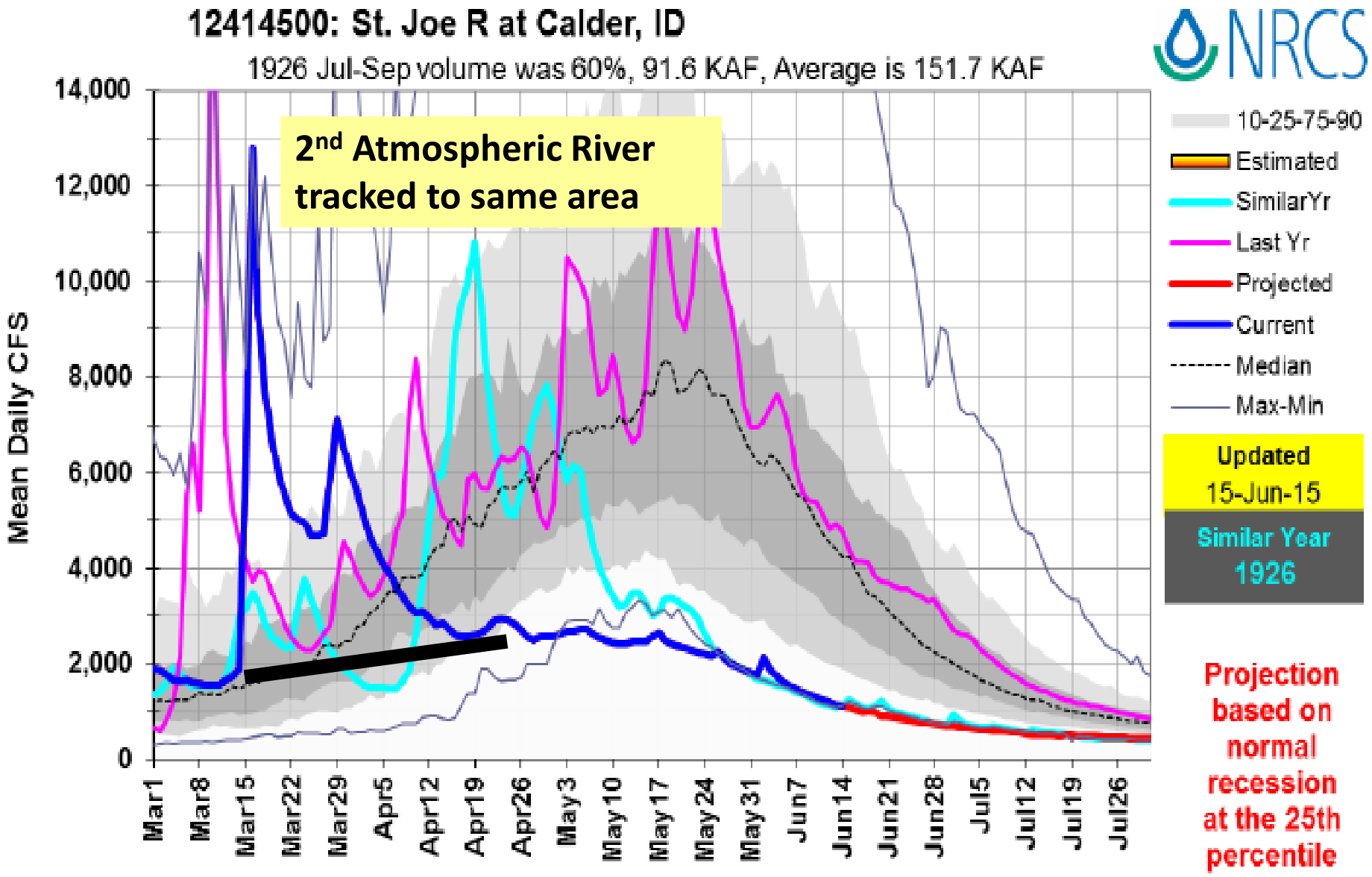


Sea Surface Temperatures June 15, 2015

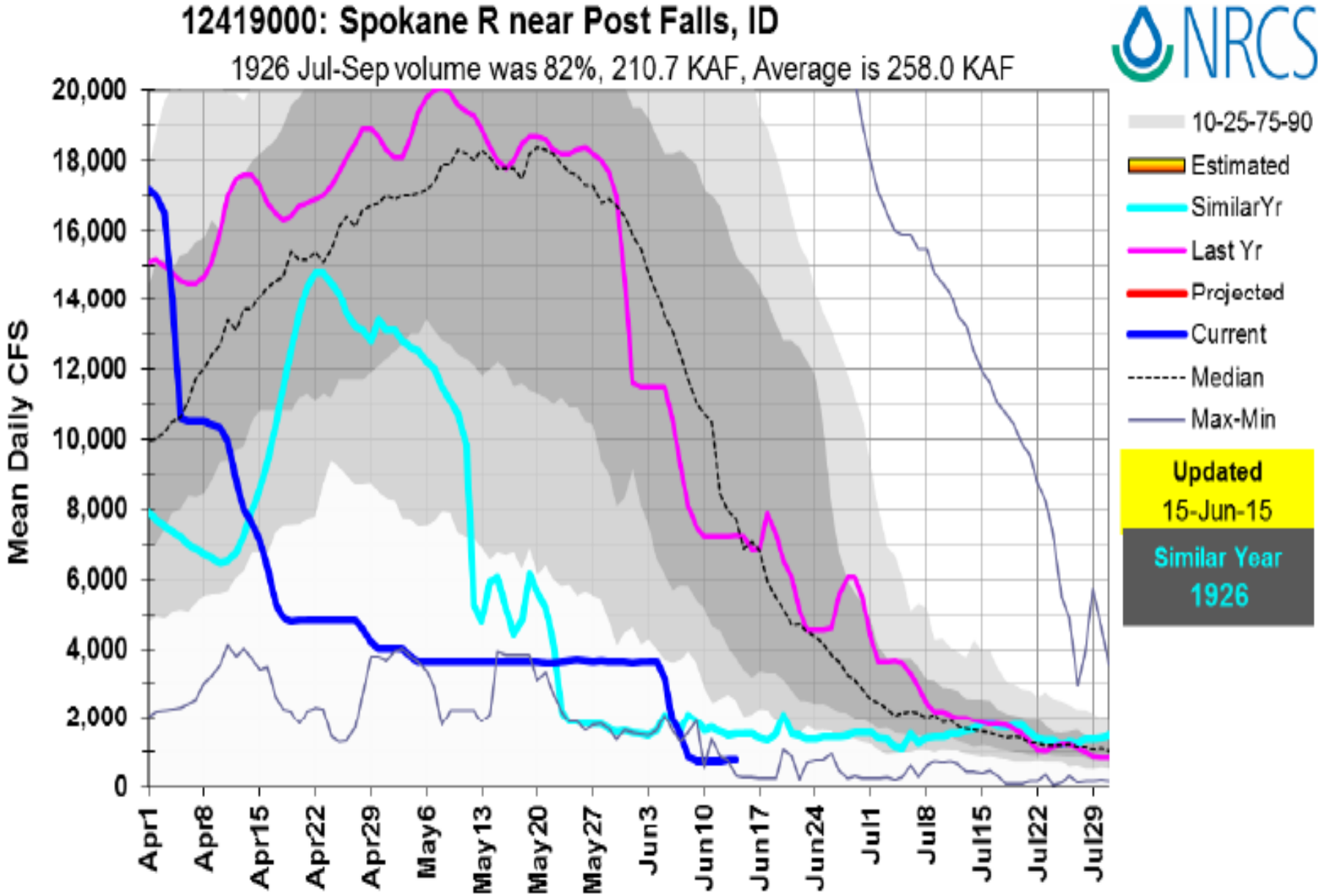


Summer 2015 - Idaho Panhandle rivers setting new record lows.

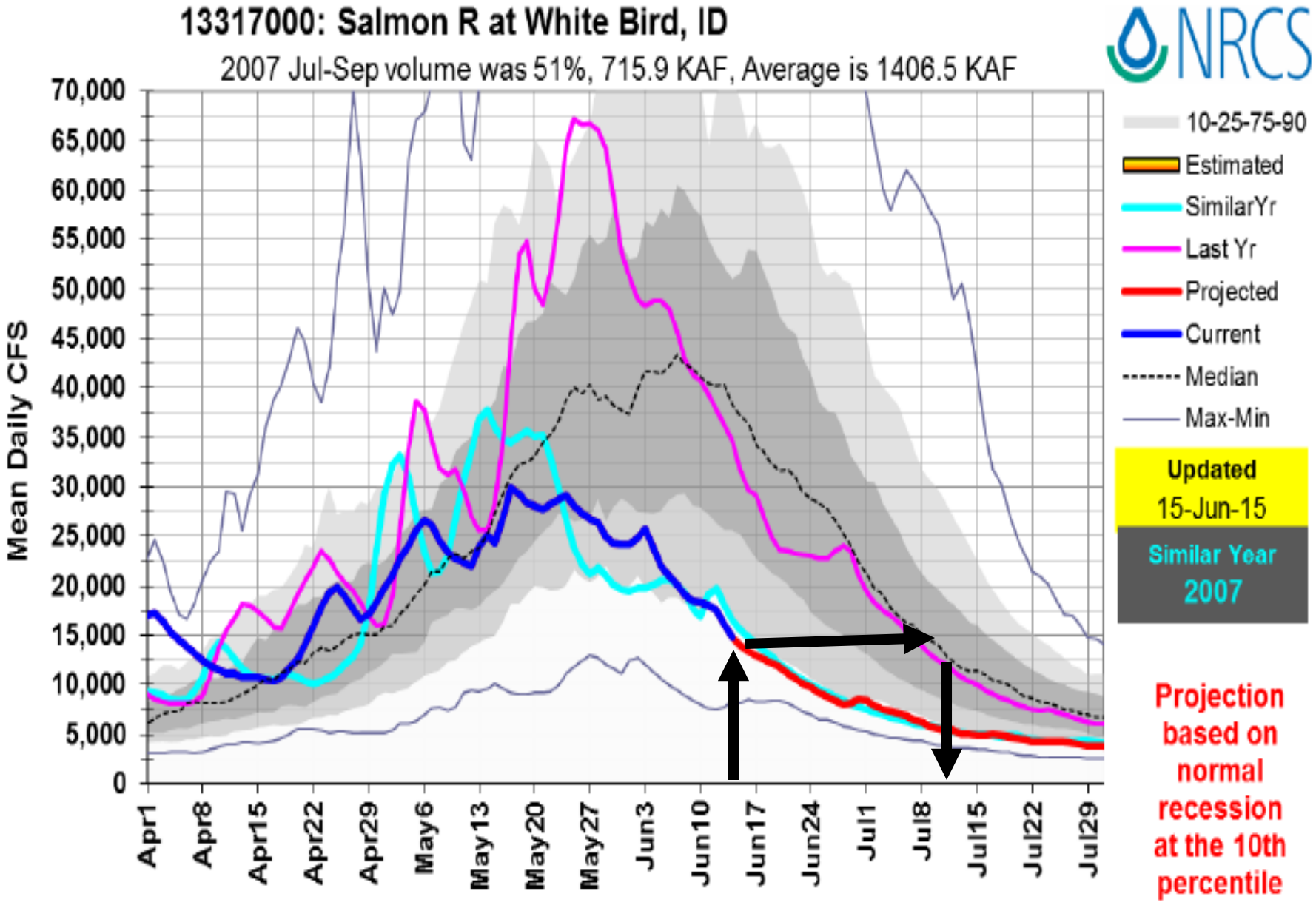
Without rain events – snow runoff was minimal when combined with dry spring

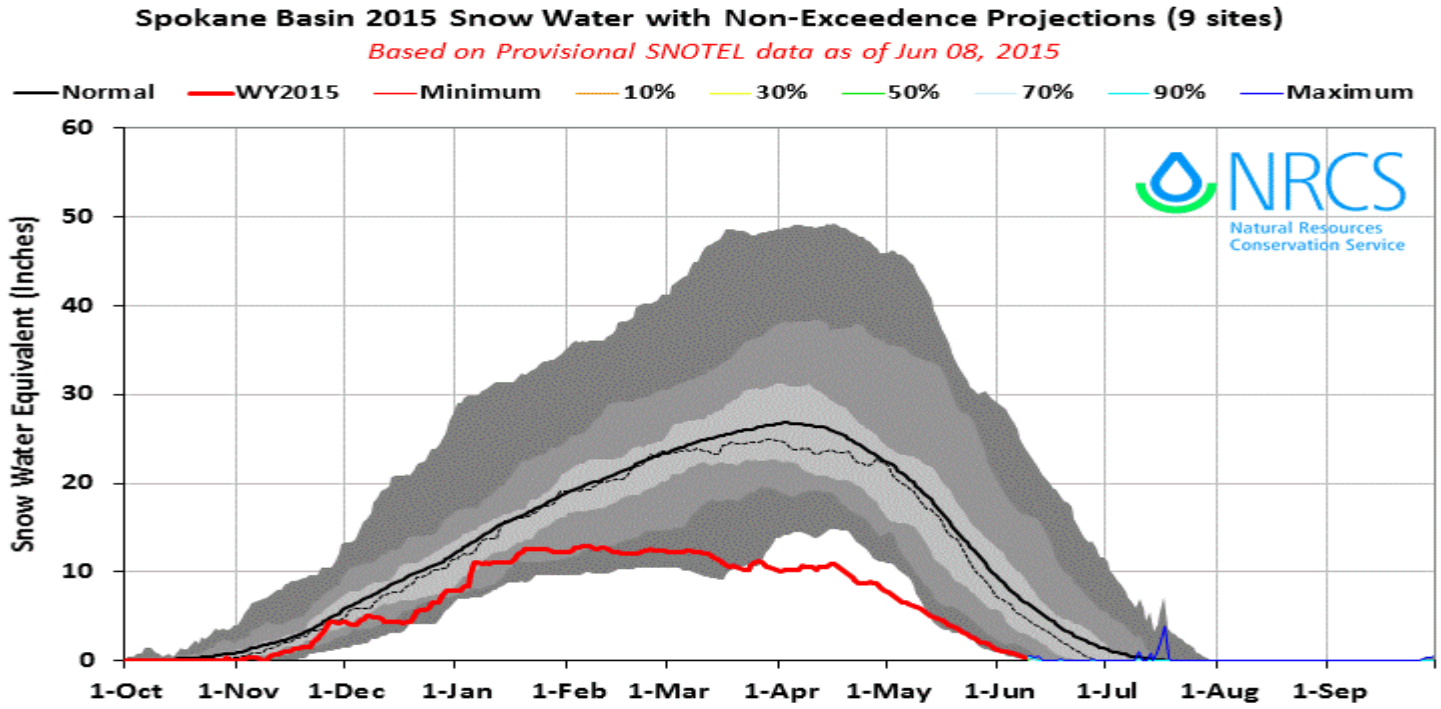


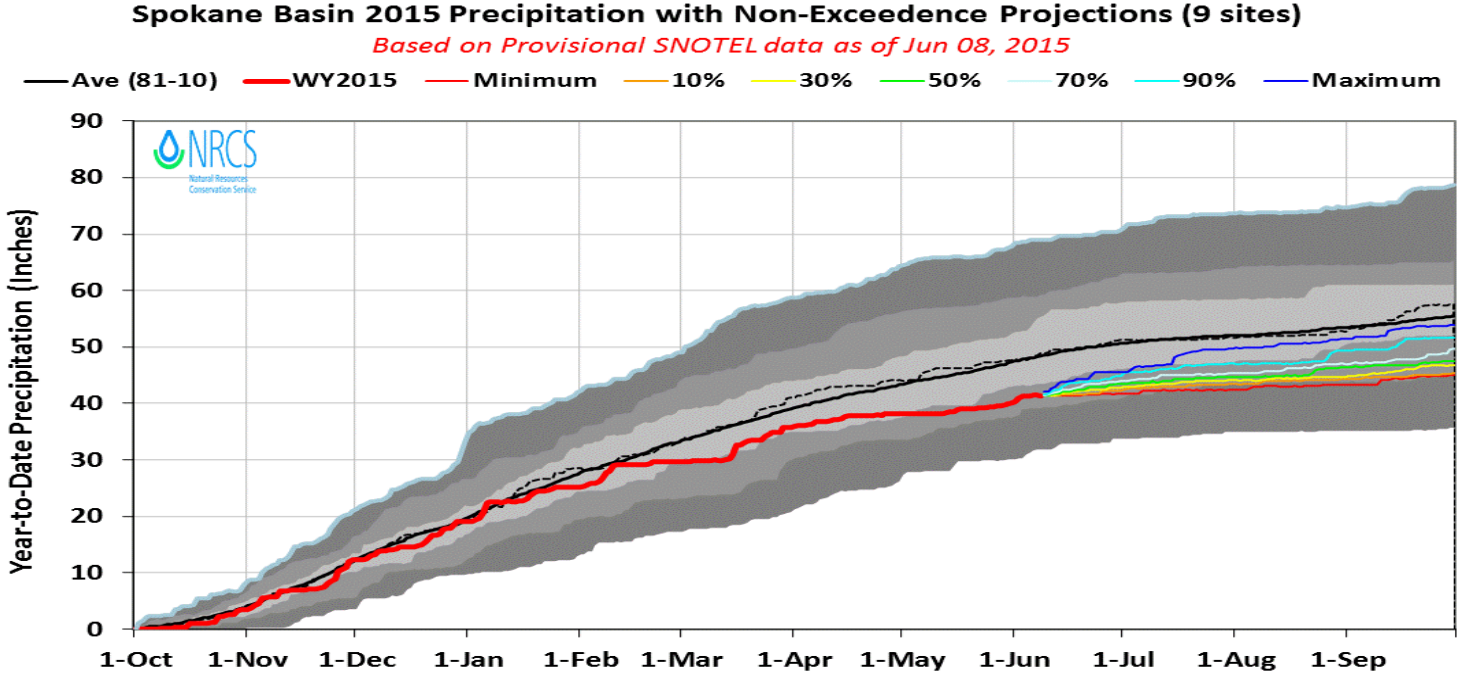
Summer 2015 - Idaho Panhandle rivers setting new record lows. Some stations start before 1900



Summer 2015 – moving south – current flows are where they are typically in mid-July, about 30 days earlier



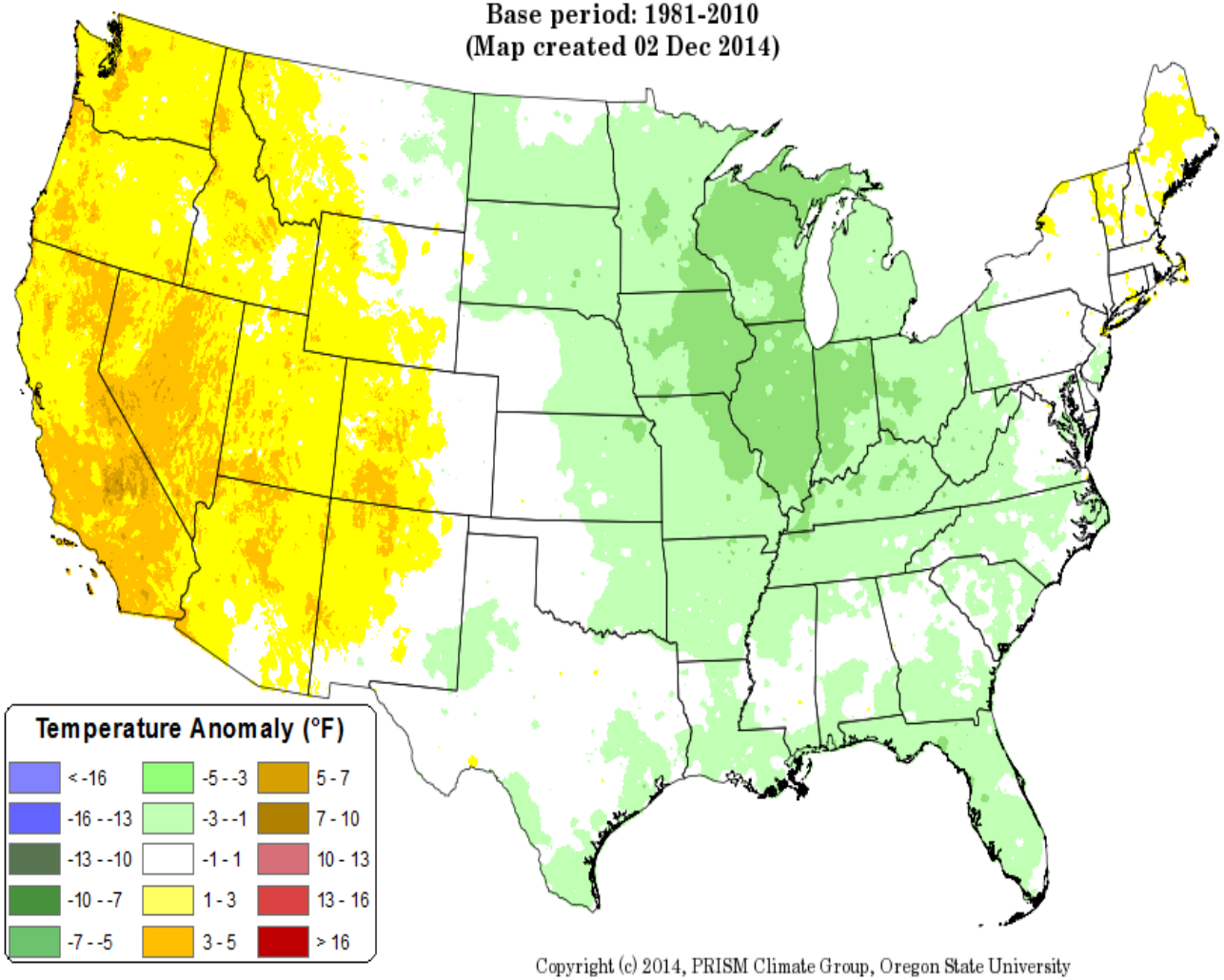




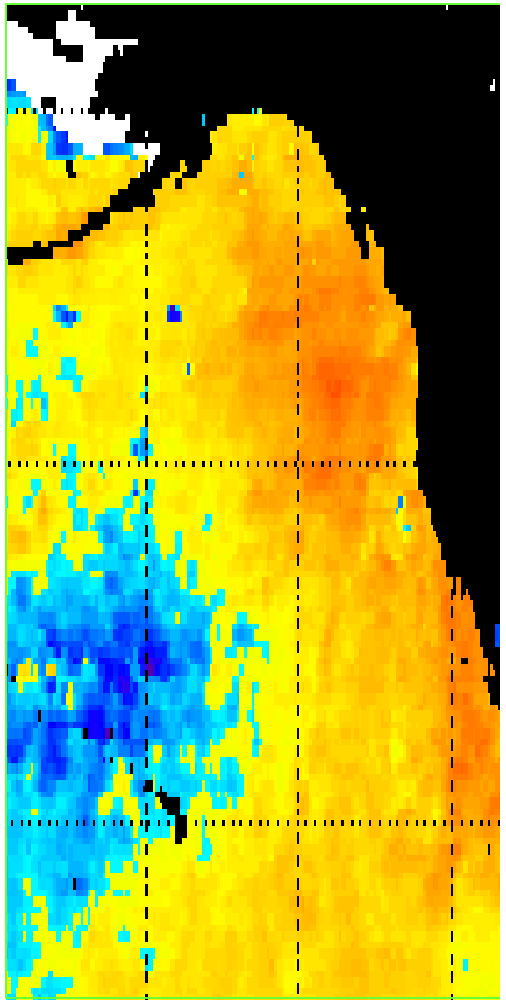
- **Snow Drought**
- **Water Year to Date Precipitation near normal**

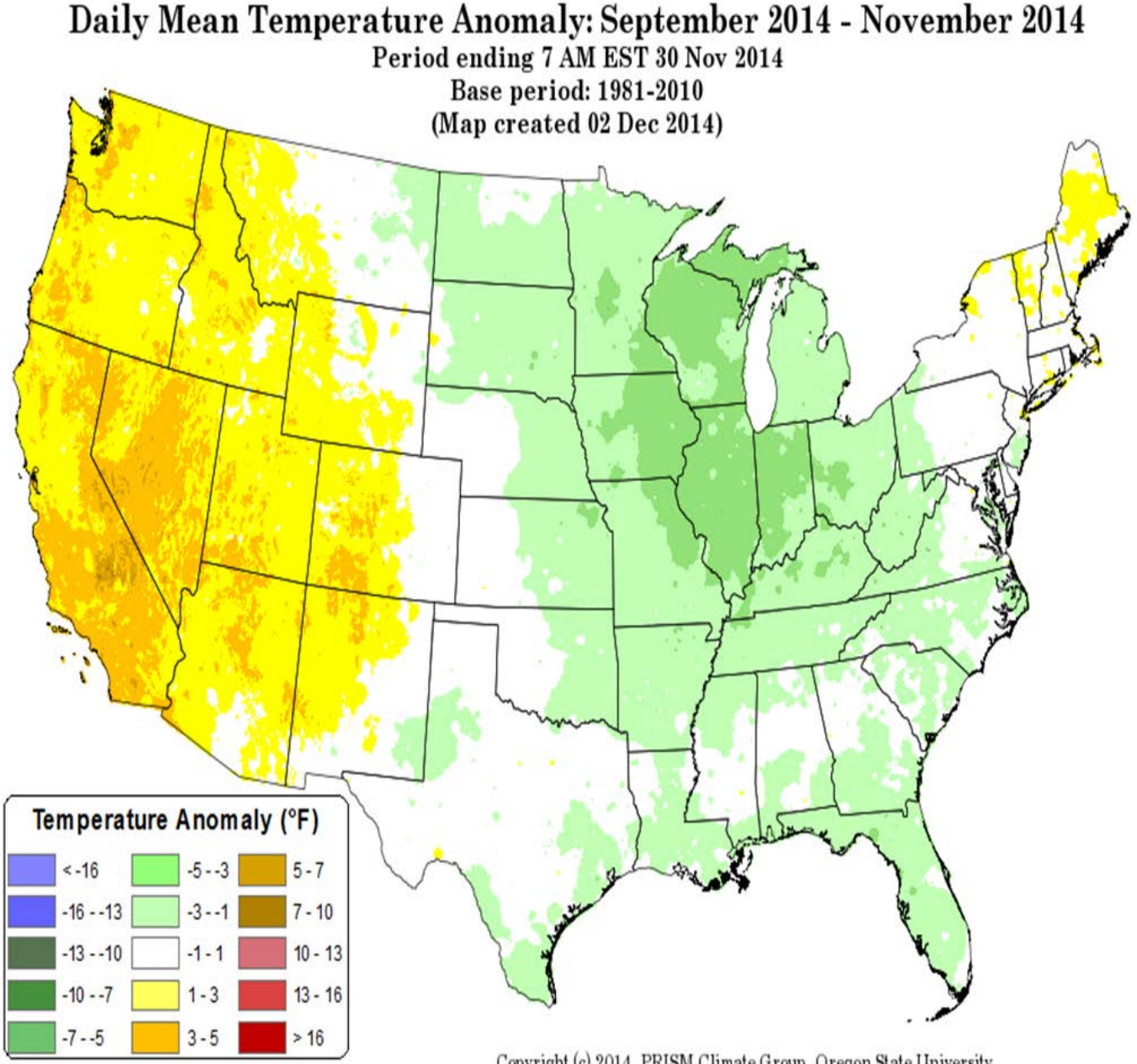
Daily Mean Temperature Anomaly: September 2014 - November 2014

Period ending 7 AM EST 30 Nov 2014
Base period: 1981-2010
(Map created 02 Dec 2014)

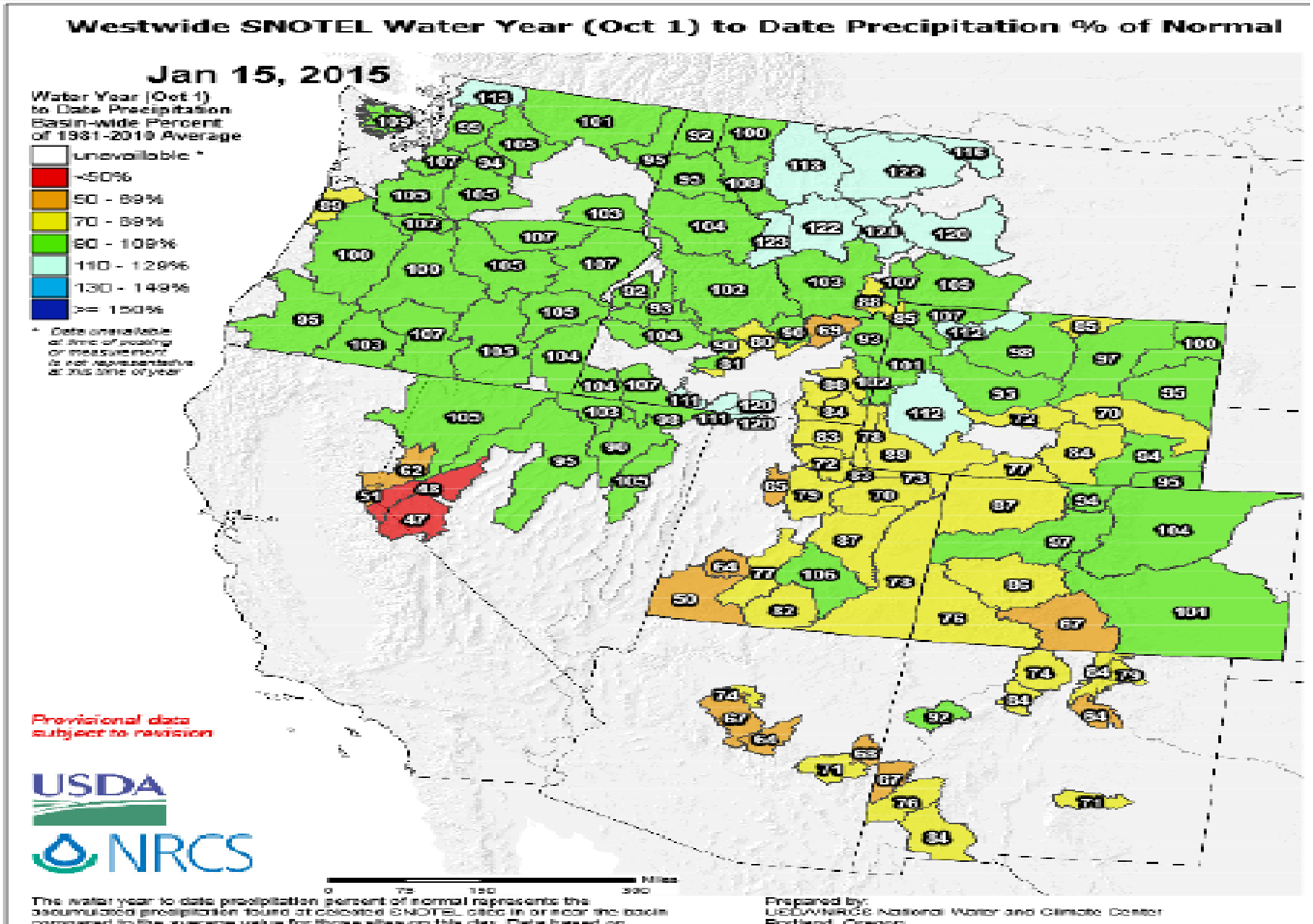


Sep–Nov 2014 Temperatures & Sea Surface Temperatures

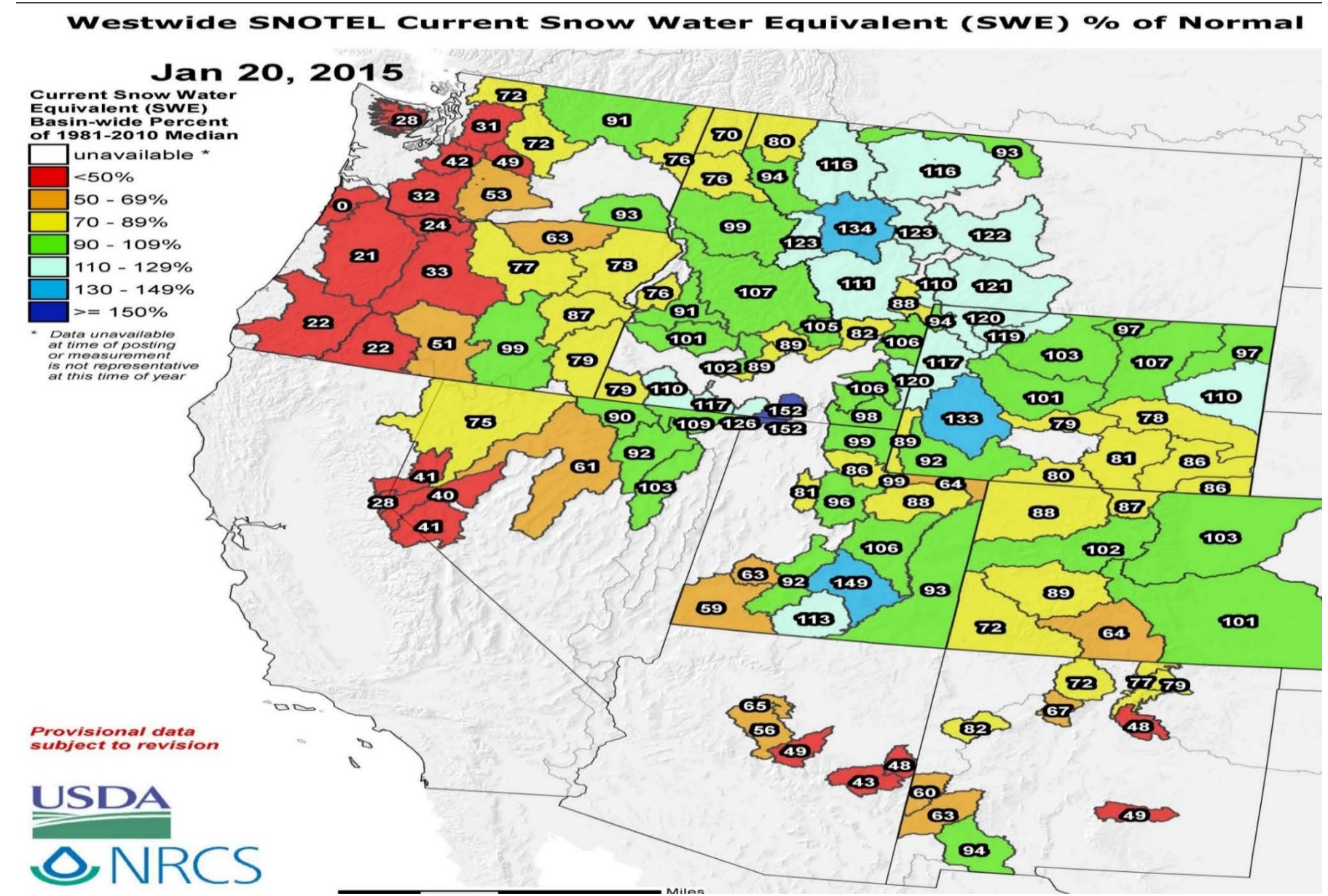


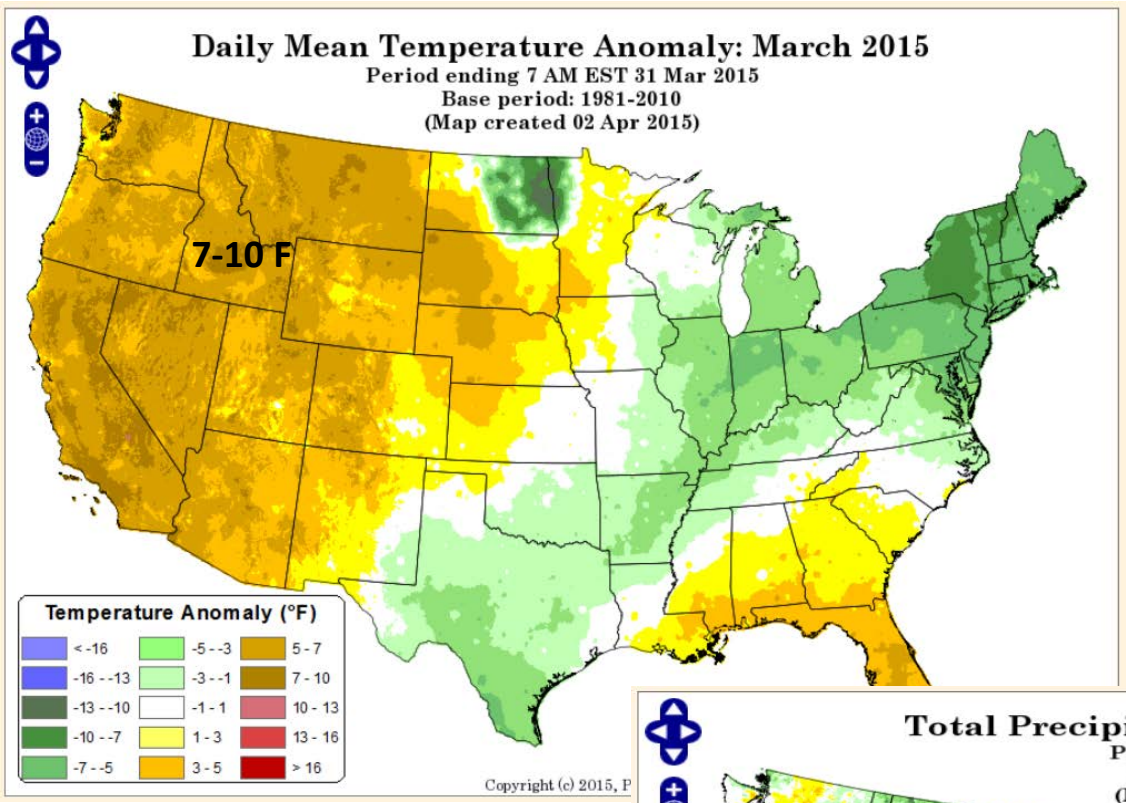


Water Year to Date Precipitation 90-120% of average across PNW

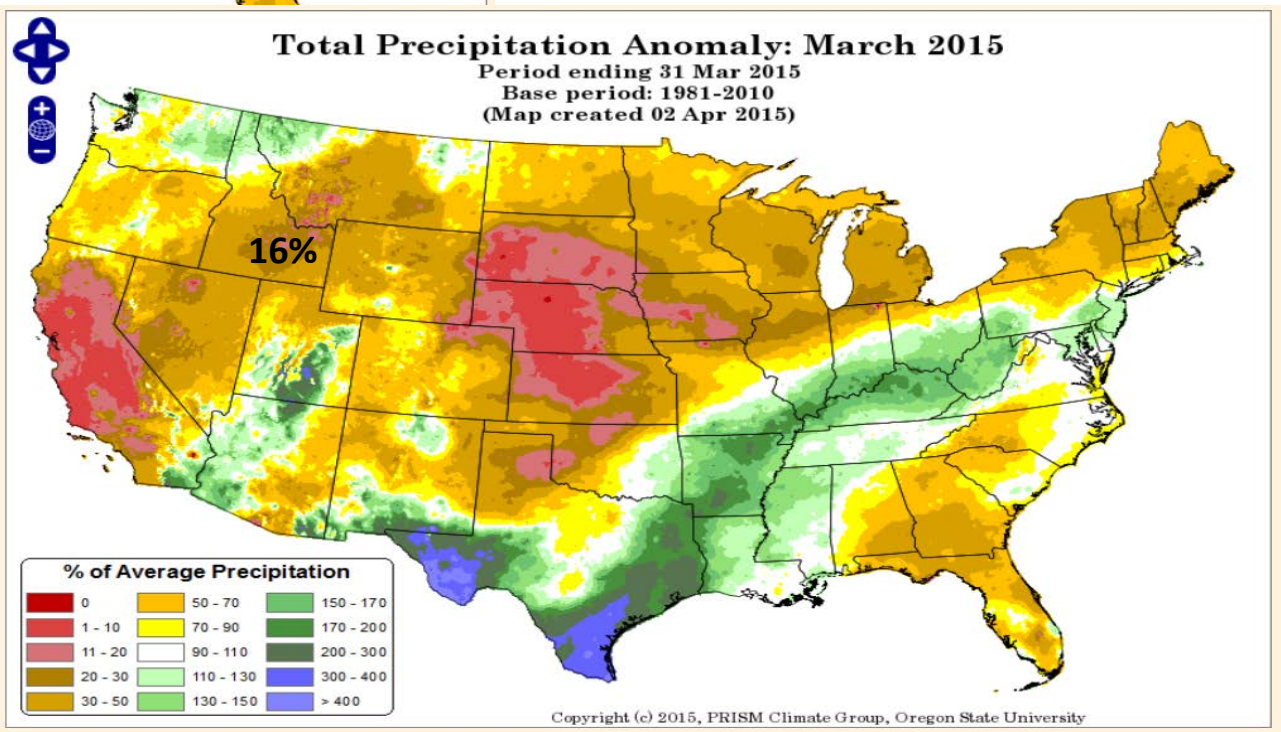


Jan 20, 2015 Snowpack mirrored Andrew's forecast for warm & dry in PNW



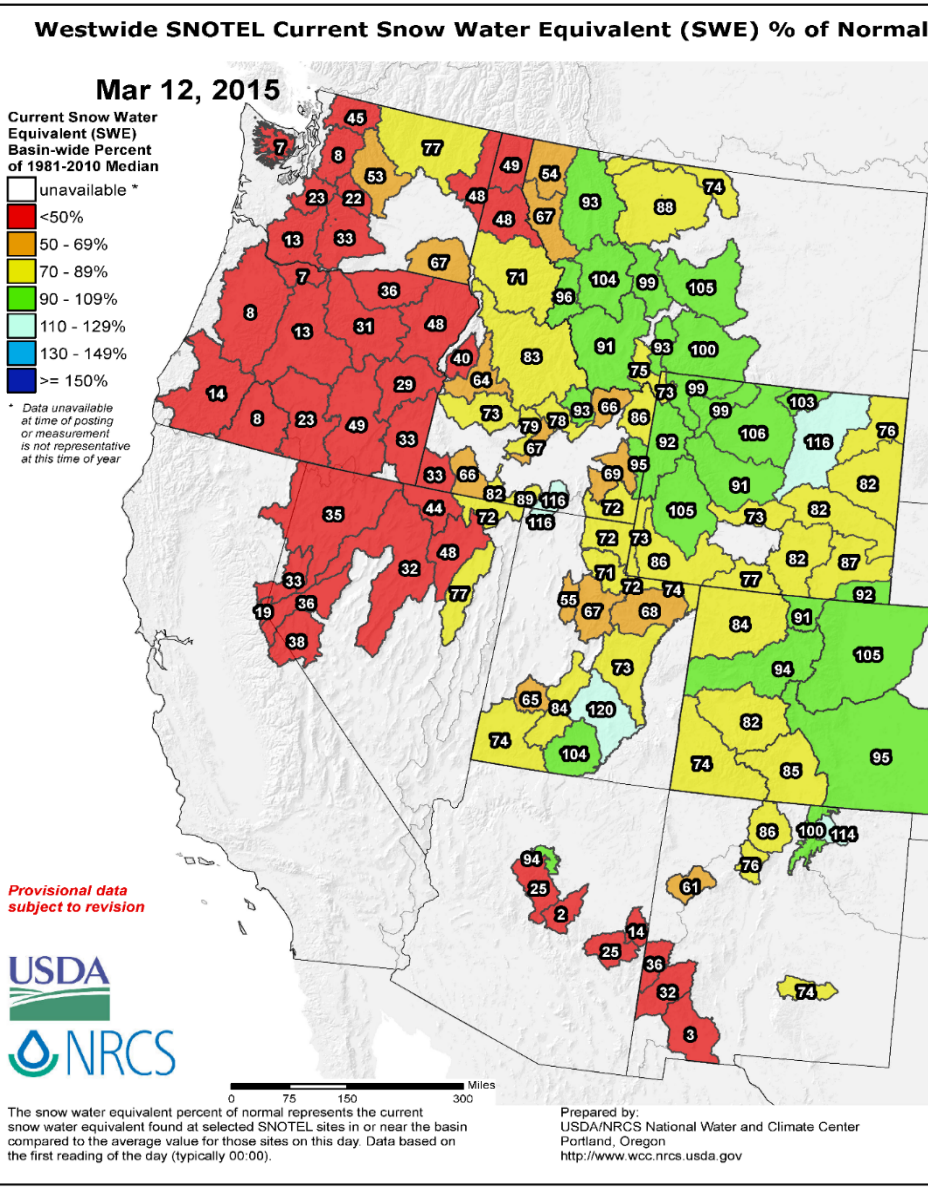


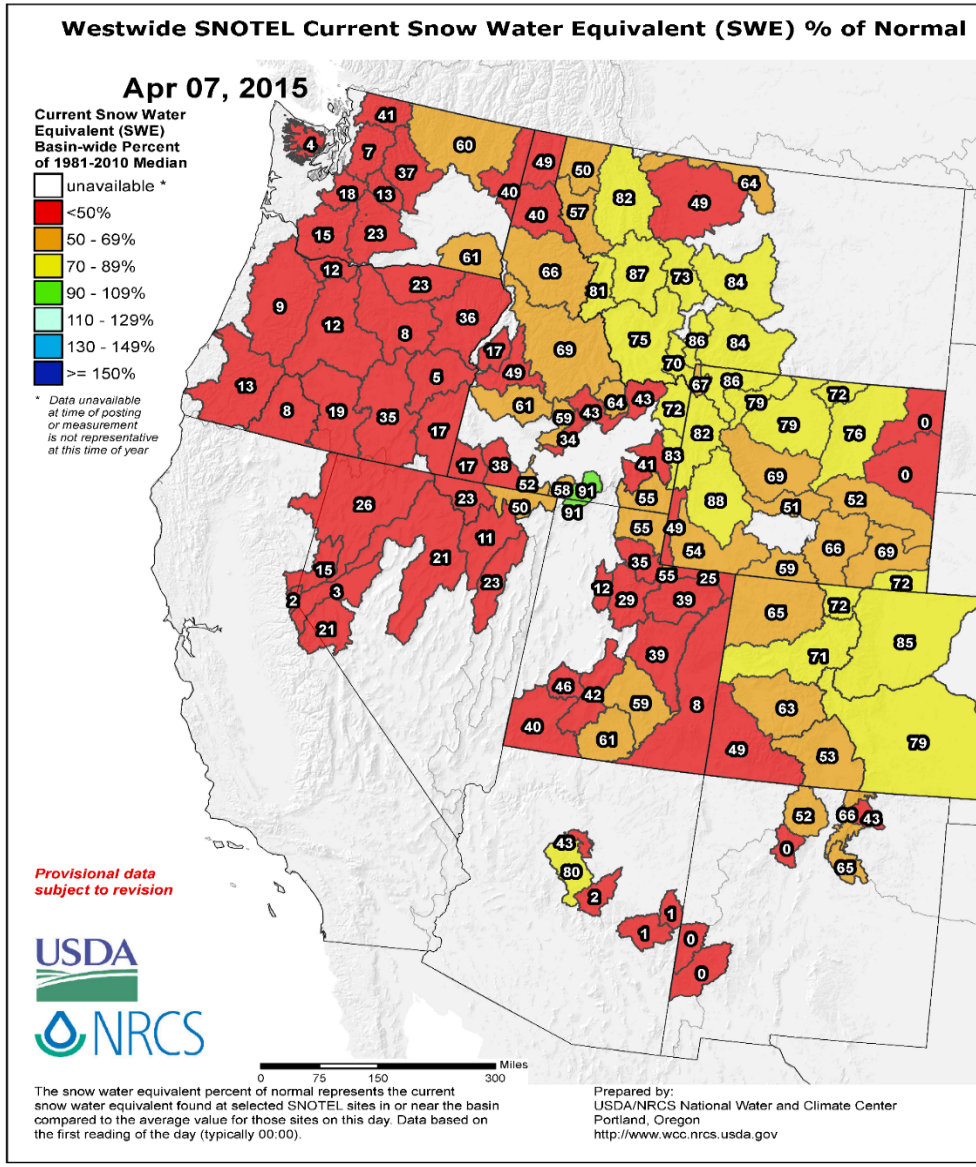
March weather with above normal temperature & below normal precipitation deteriorated Idaho's snowpack



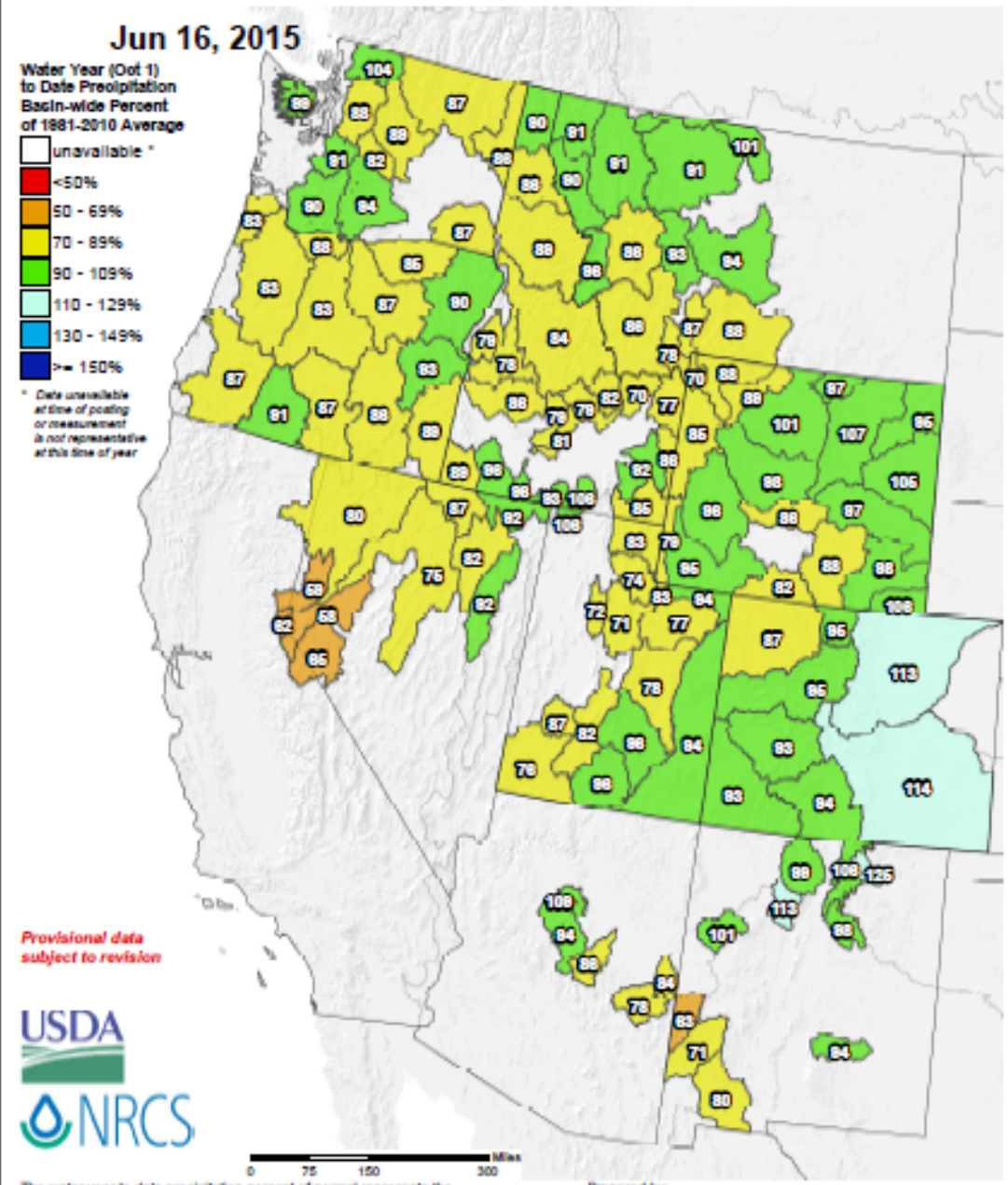
Jan 10 post by Andrew mentioned warmth 'bleeding east" Strong ridge cell then evolves in the West US and shifts east with the departure of the trough along the East Coast.

March 1 Peak SWE for this Year





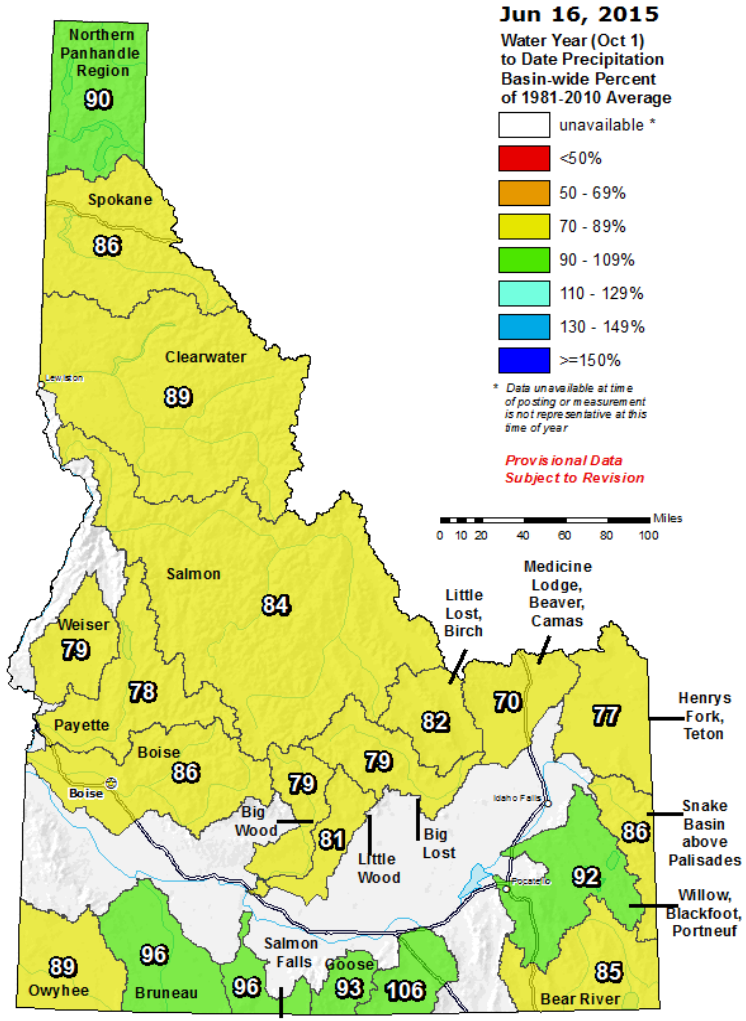
Westwide SNOTEL Water Year (Oct 1) to Date Precipitation % of Normal



The water year to date precipitation percent of normal represents the accumulated precipitation found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

Idaho SNOTEL Water Year (Oct 1) to Date Precipitation % of Normal



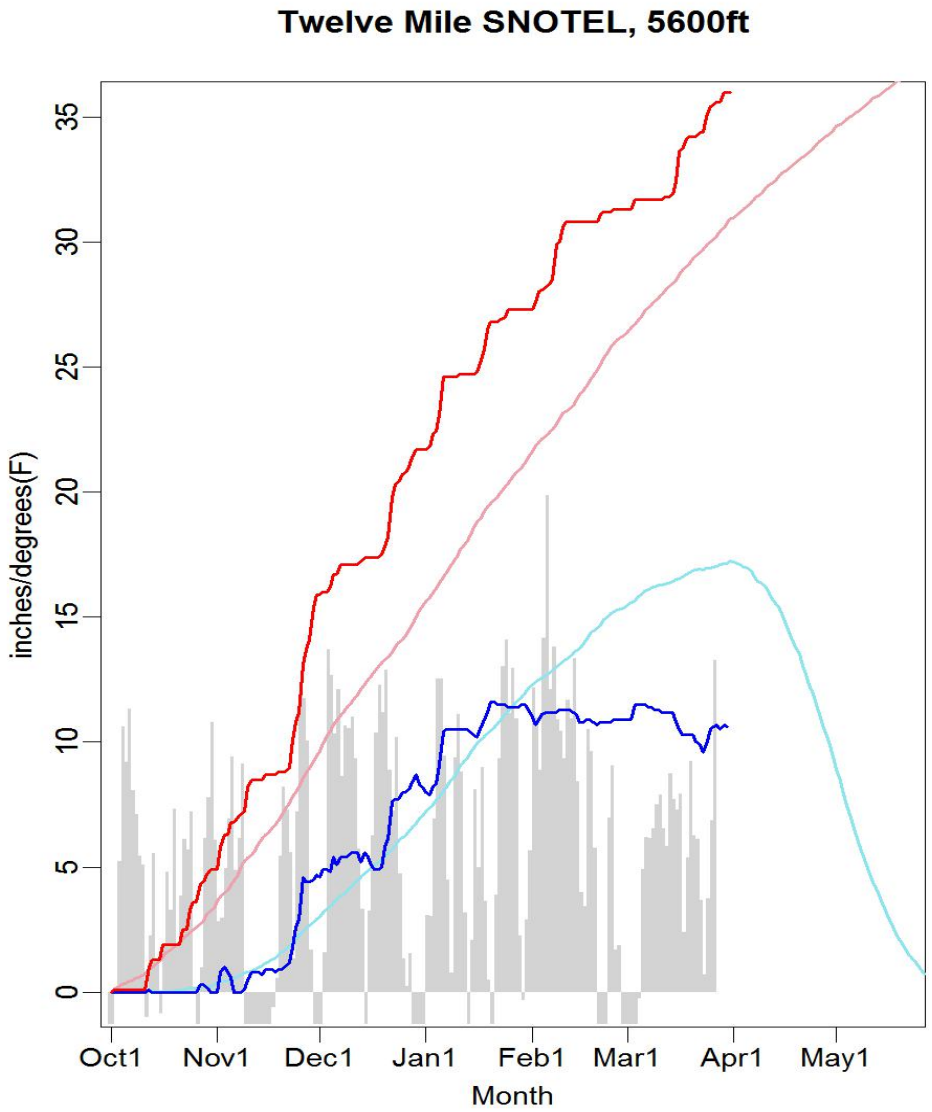
The water year to date precipitation percent of normal represents the accumulated precipitation found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

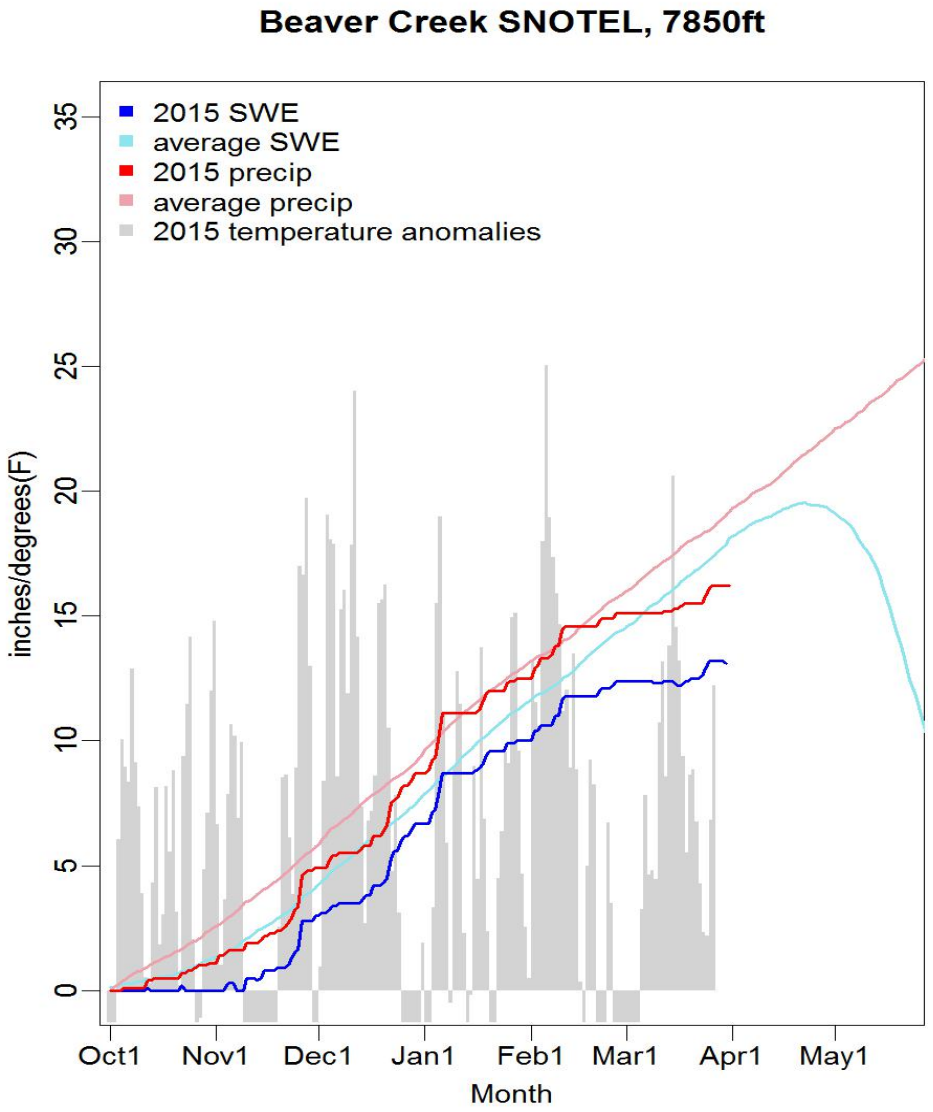
Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

Montana --- **Mean temperature departure & precipitation falling normal Nov 1 – Mar 31:**

Twelve Mile: 3.8F
Normally 70% precip falls as snow
2015 60% fell as snow

Beaver Creek: 5.1F
Normally 97% precip falls as snow
2015 92% fell as snow

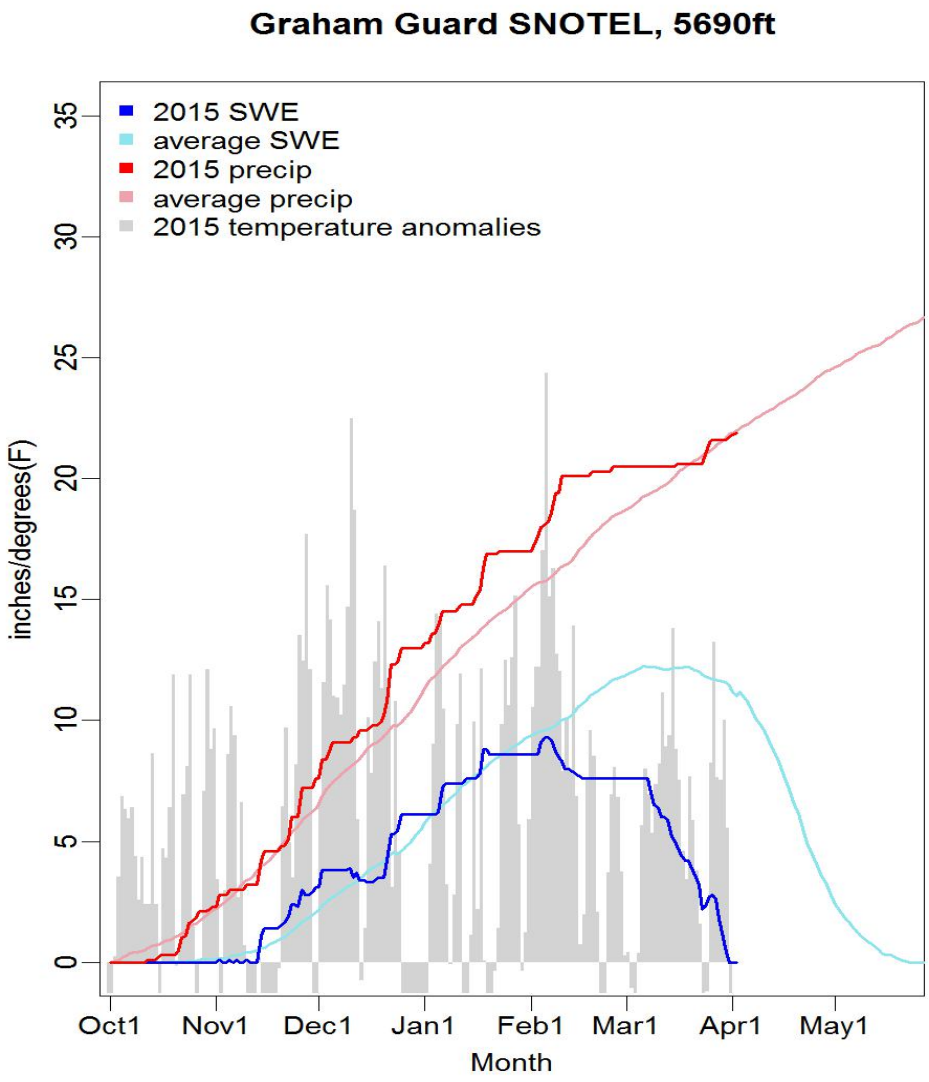


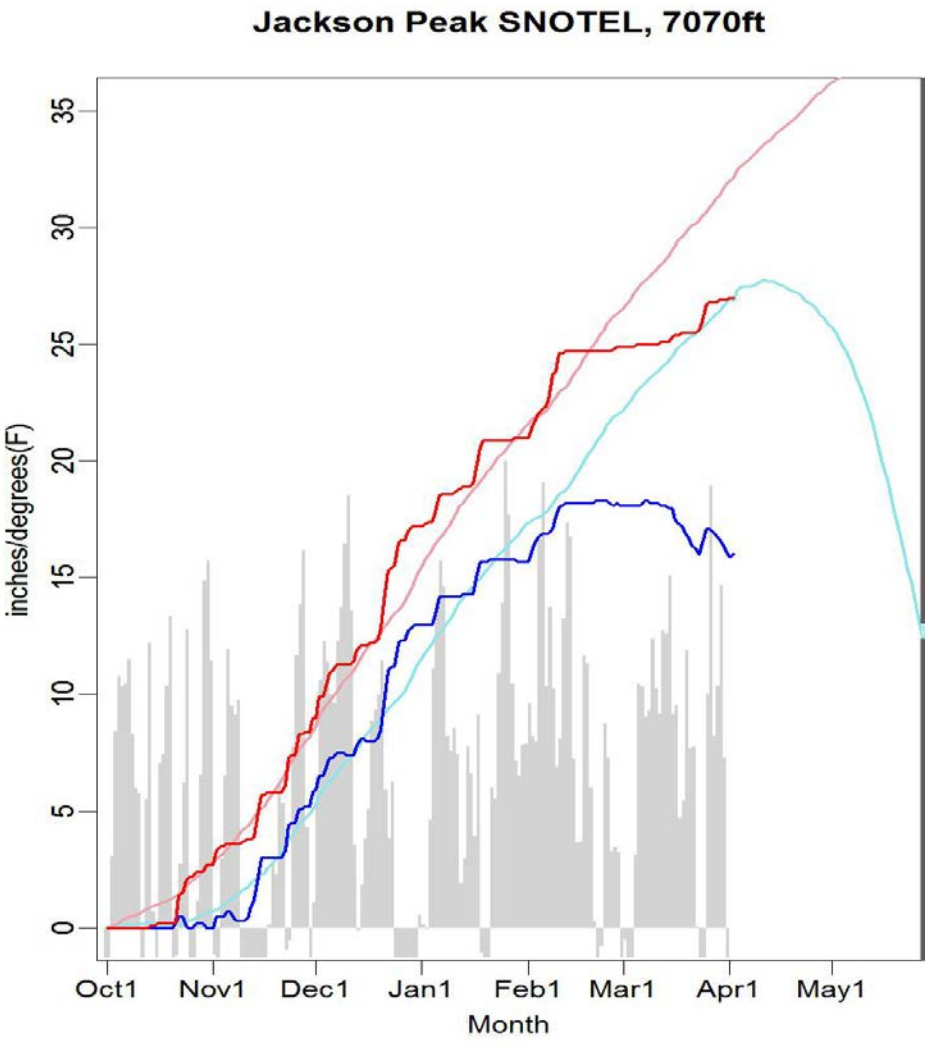


Idaho --- **Mean temperature departure & precipitation falling normal Nov 1 – Mar 31:**

Graham Guard: 4.9 F
Normally 75% precip falls as snow
2015 60% fell as snow

Jackson Peak: 5.1 F
Normally 92% precip falls as snow
2015 84% fell as snow

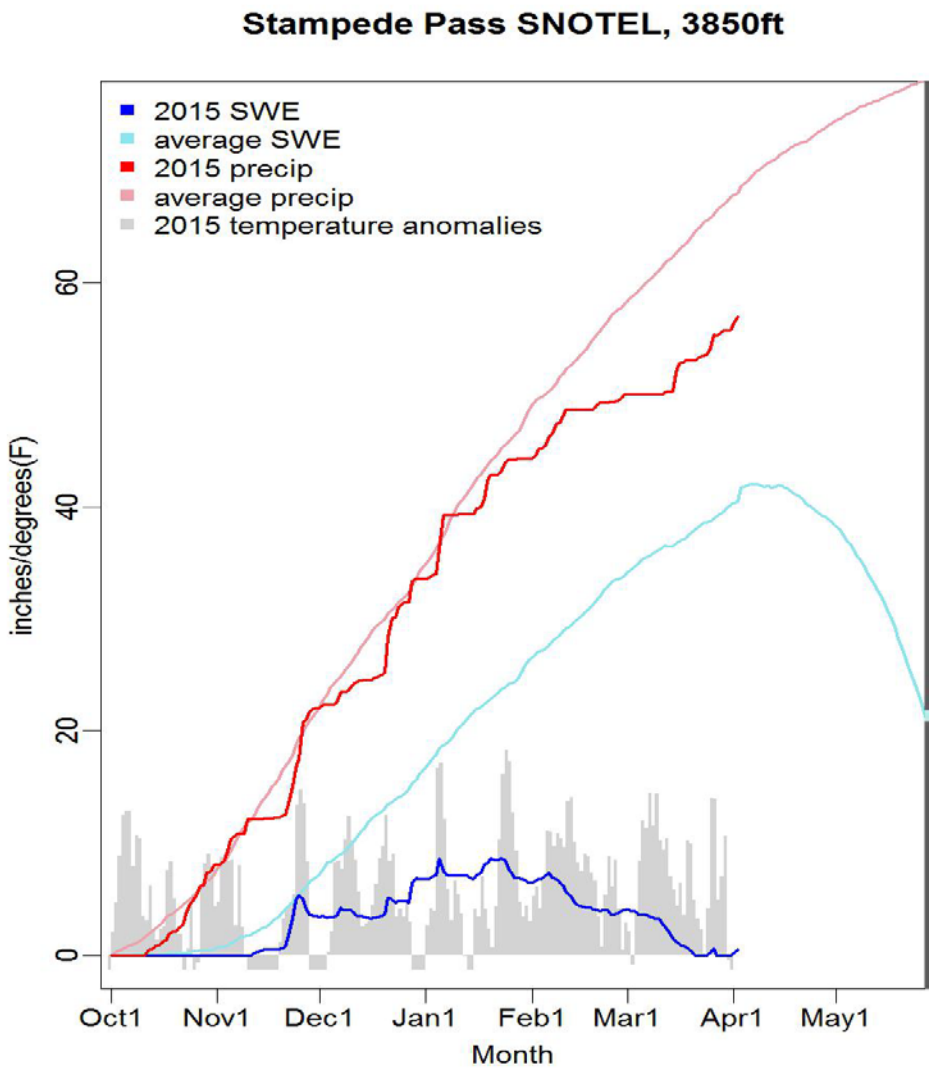


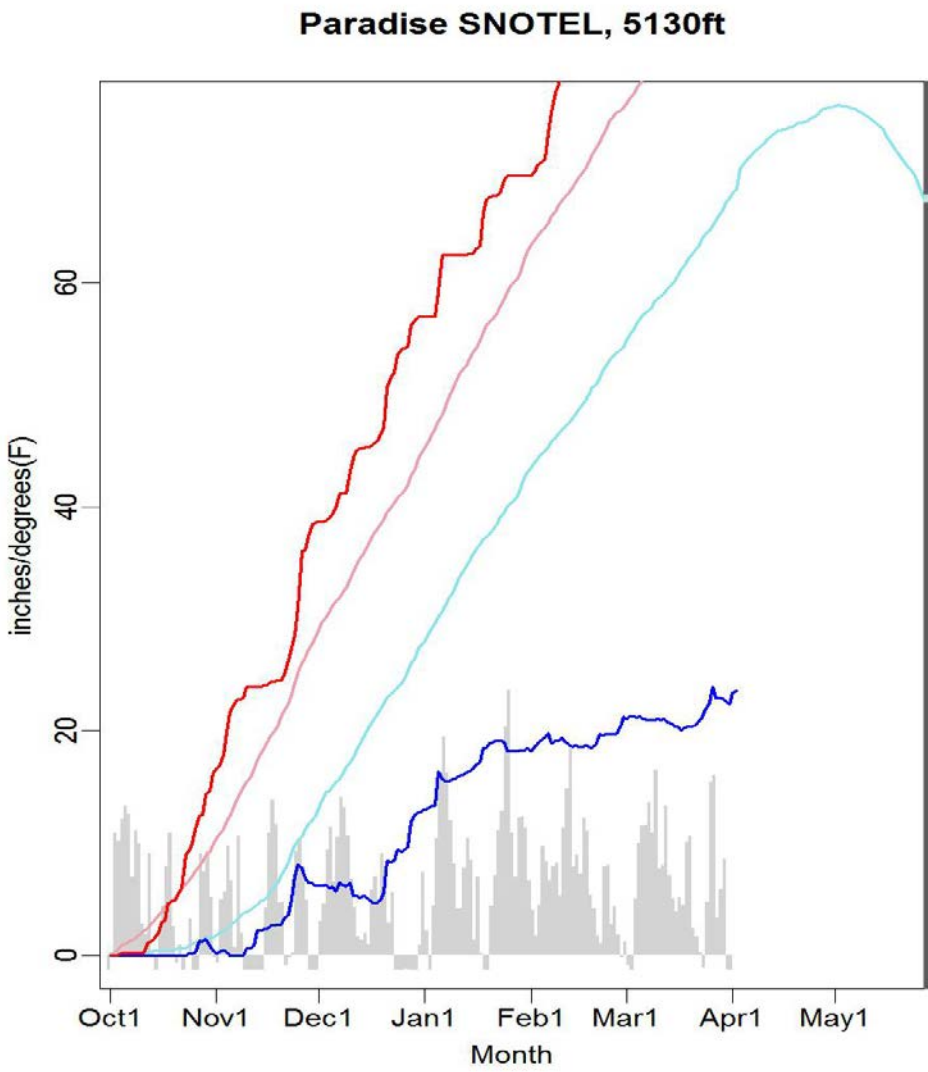


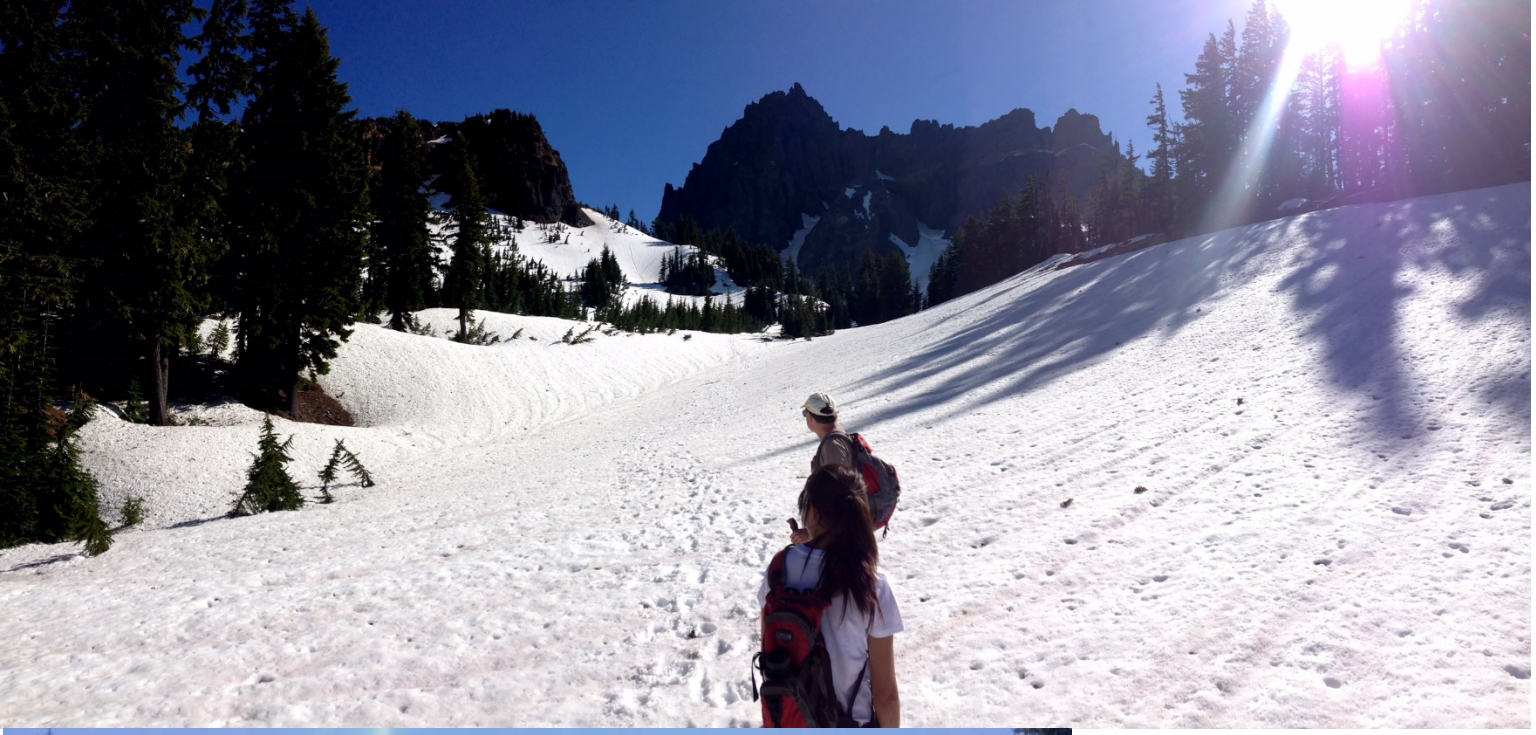
Washington --- **Mean temperature departure & precipitation falling normal Nov 1 – Mar 31:**

Stampede Pass: 5.0 F
Normally 80% precip falls as snow
2015 34% fell as snow

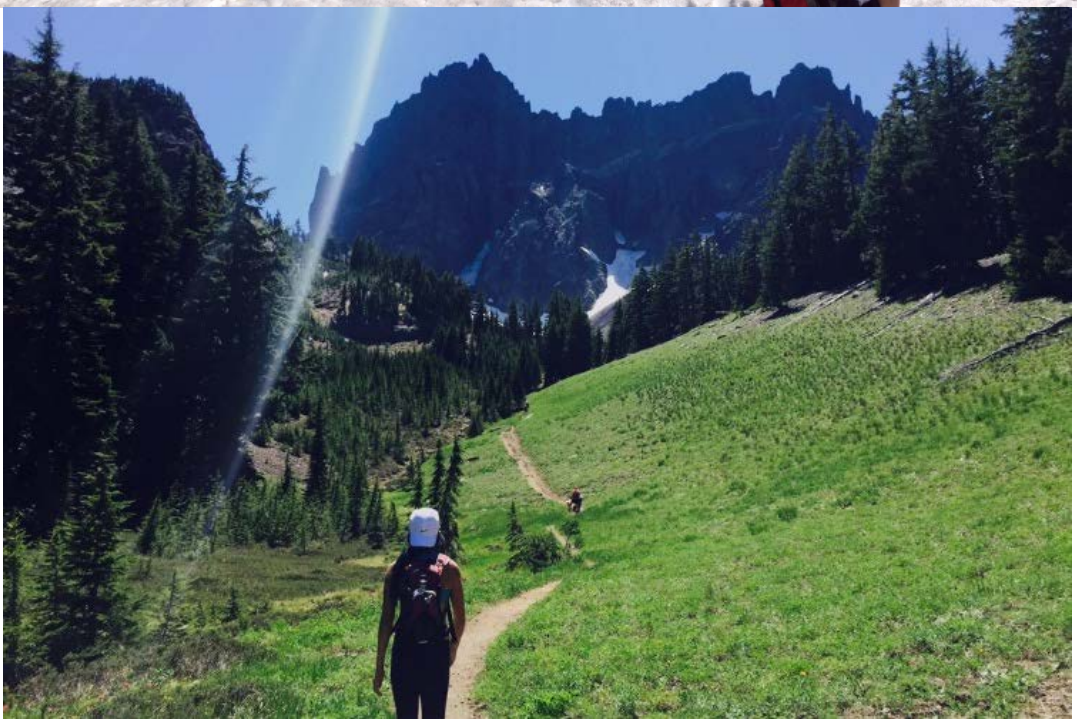
Paradise: 5.3 F
Normally 92% precip falls as snow
2015 46% fell as snow







June 21, 2014 with a near or a little below normal snowpack

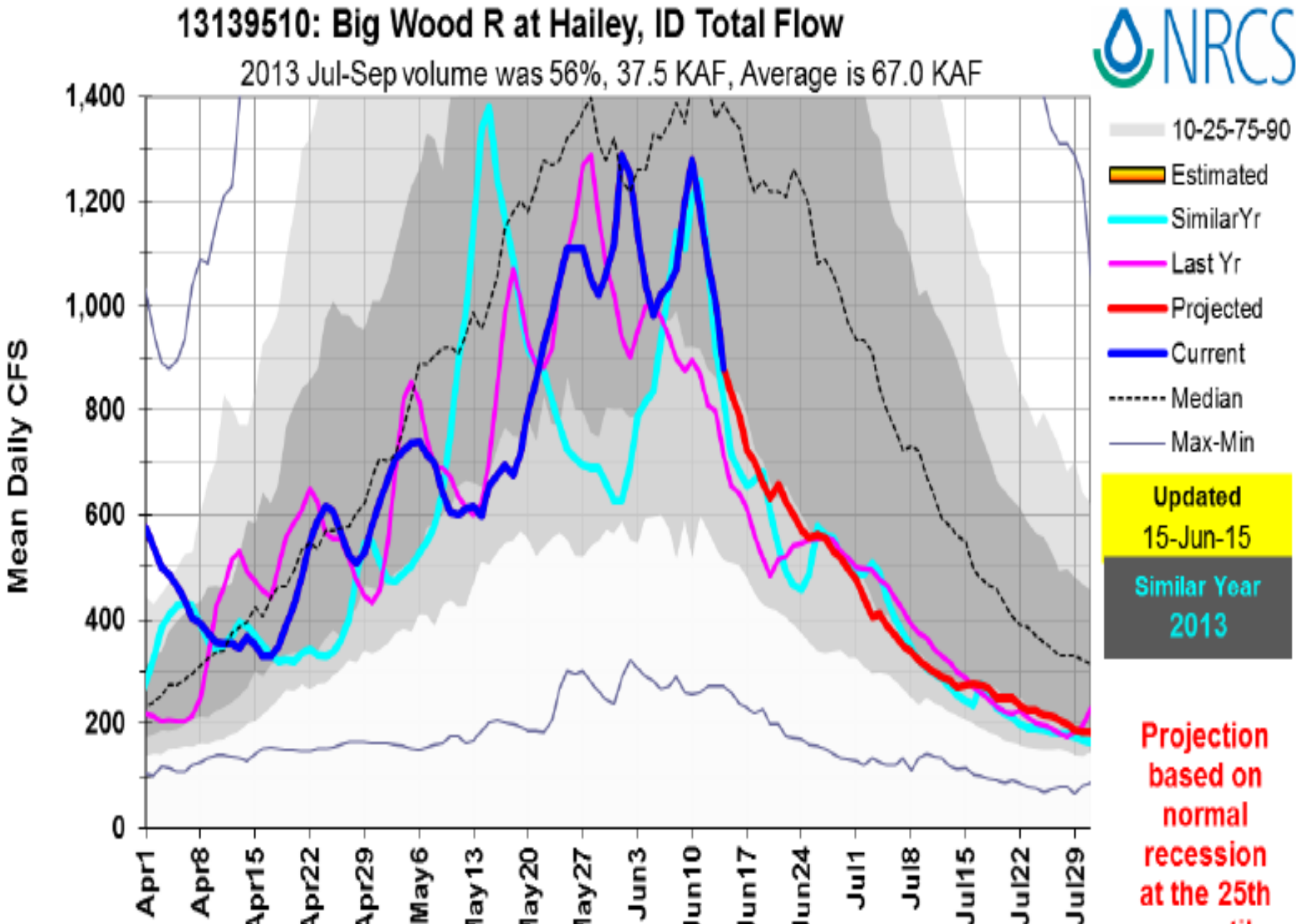


2014 snowpack vs. the nonexistent 2015 snowpack at Three Fingered Jack, taken from Canyon Creek Meadow north of the Santiam Pass, Oregon

June 13, 2015 no-snow images

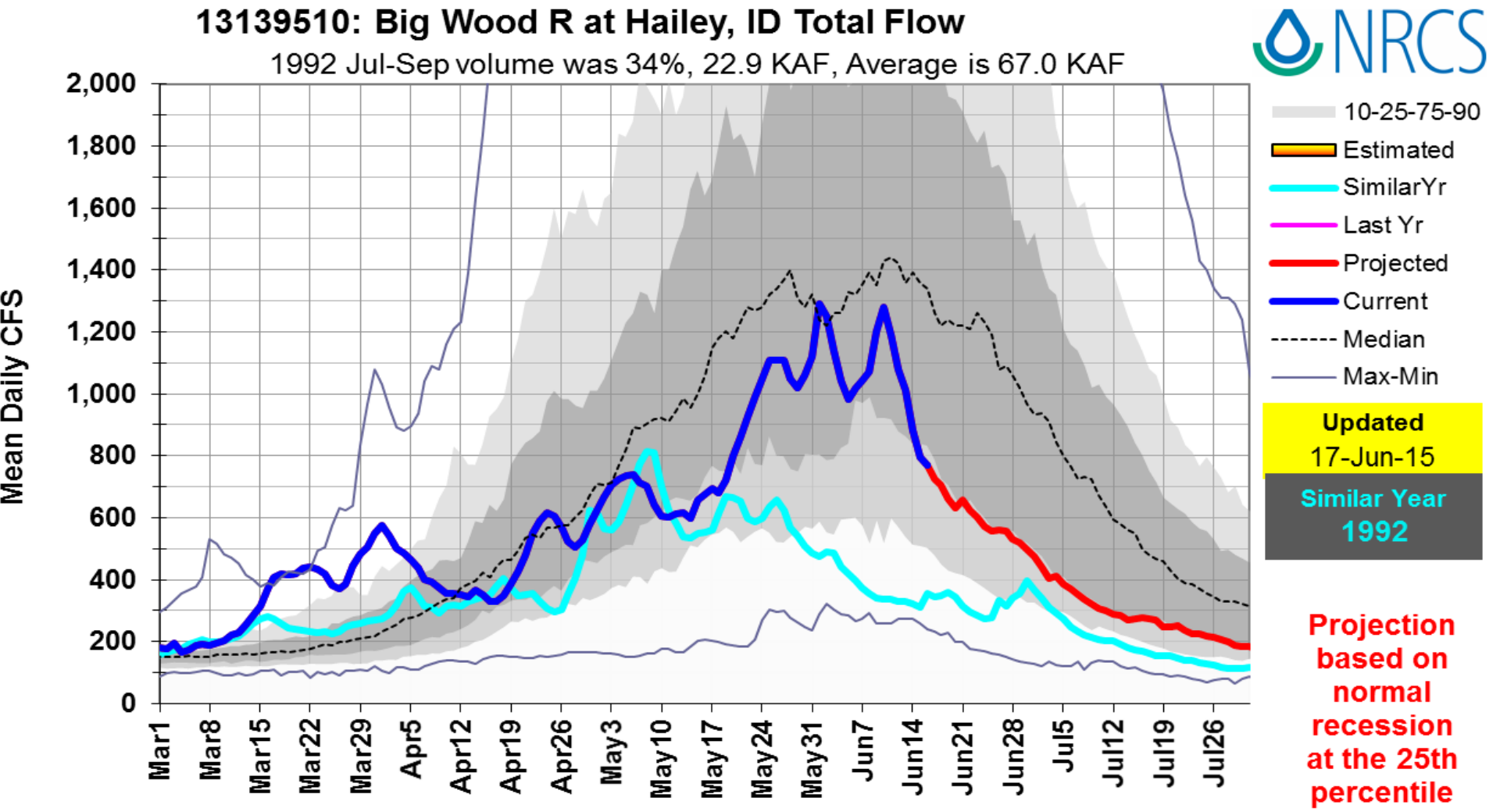
Pretty amazing…

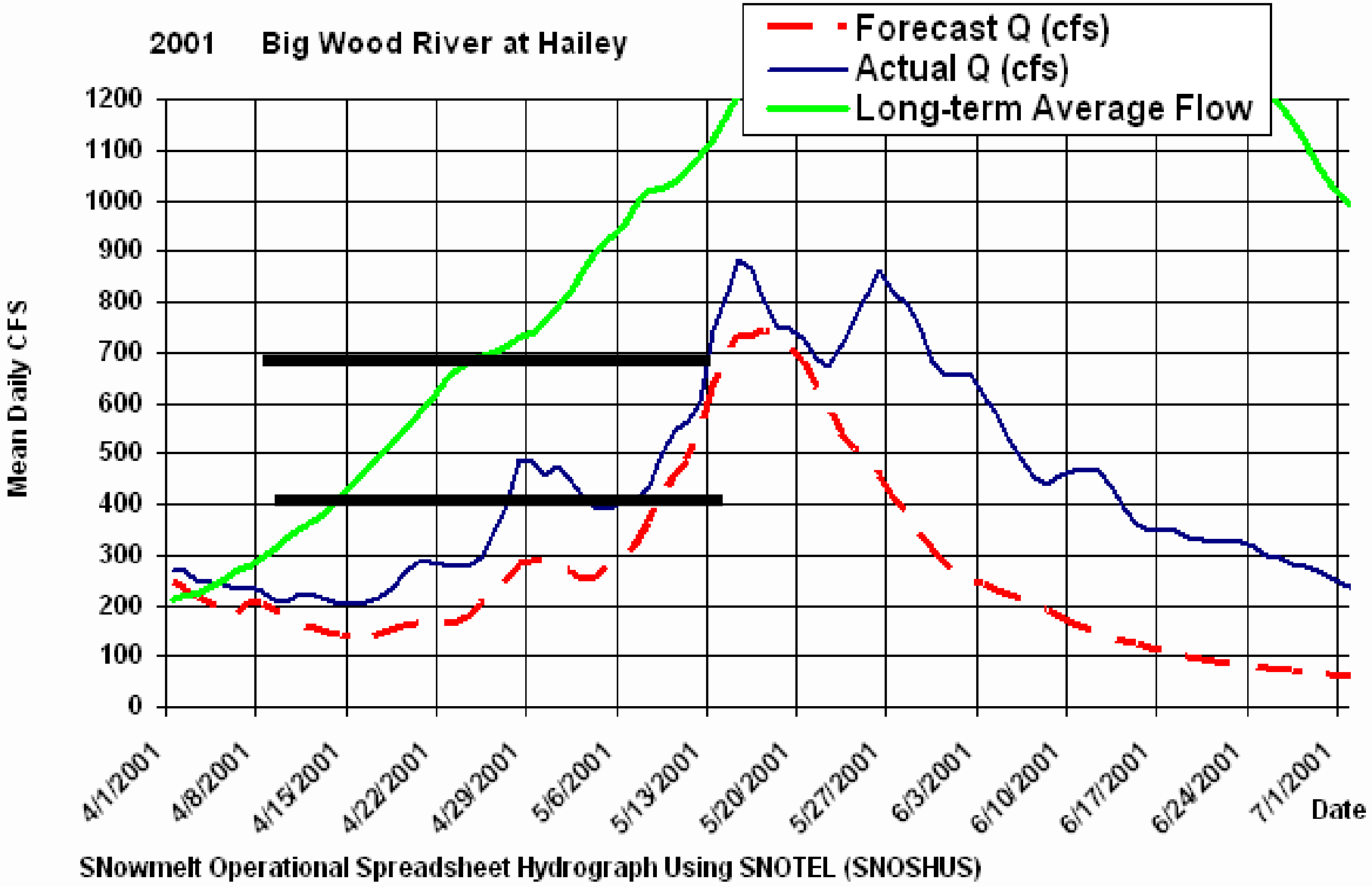
If it doesn't snow next year, must consider importance of baseflows



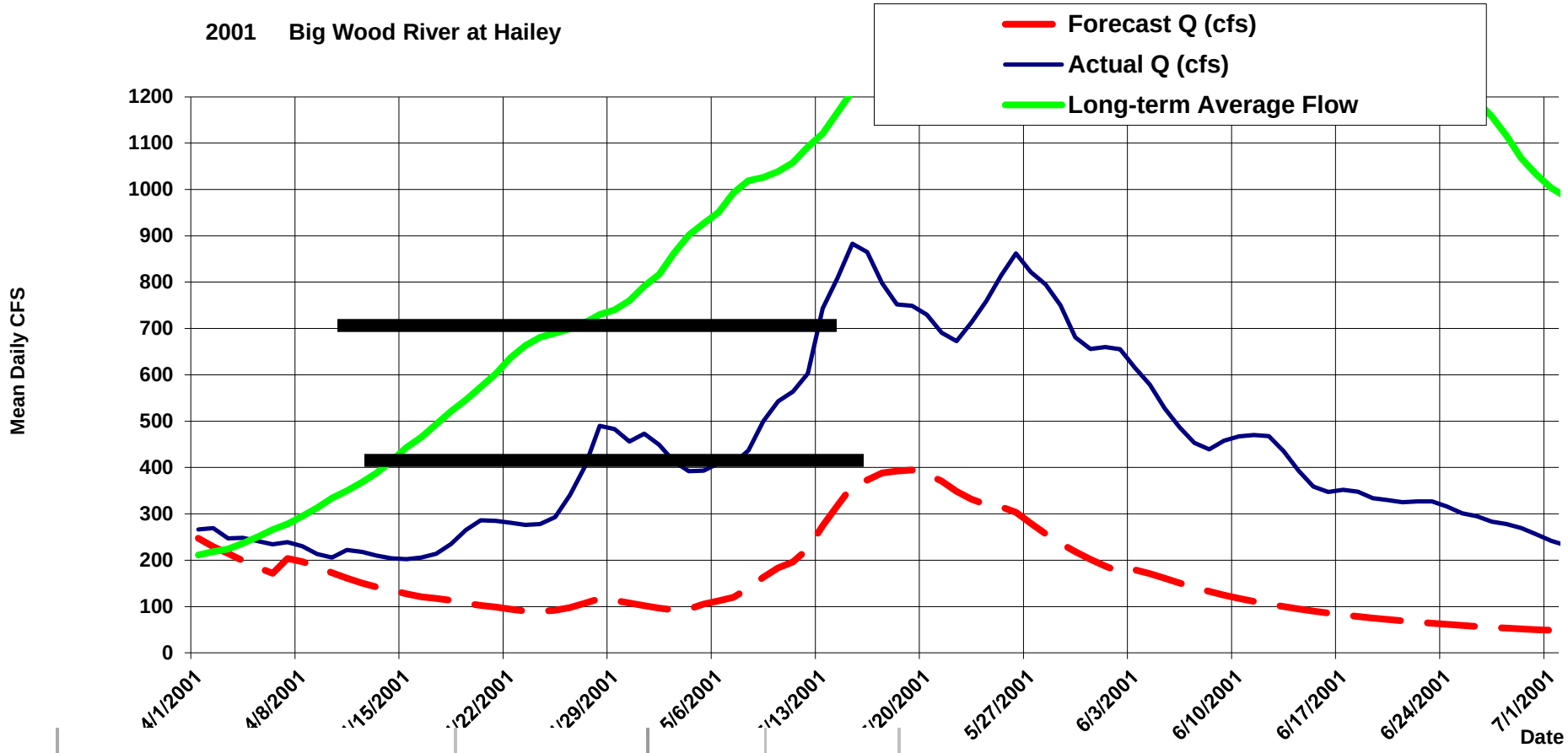
If it doesn't snow next year, must consider importance of baseflows & higher elevation is critical to storing the snowpack

- **1992 had much less snow & runoff**





SNowmelt Operational Spreadsheet Hydrograph Using SNOTEL (SNOSHUS)

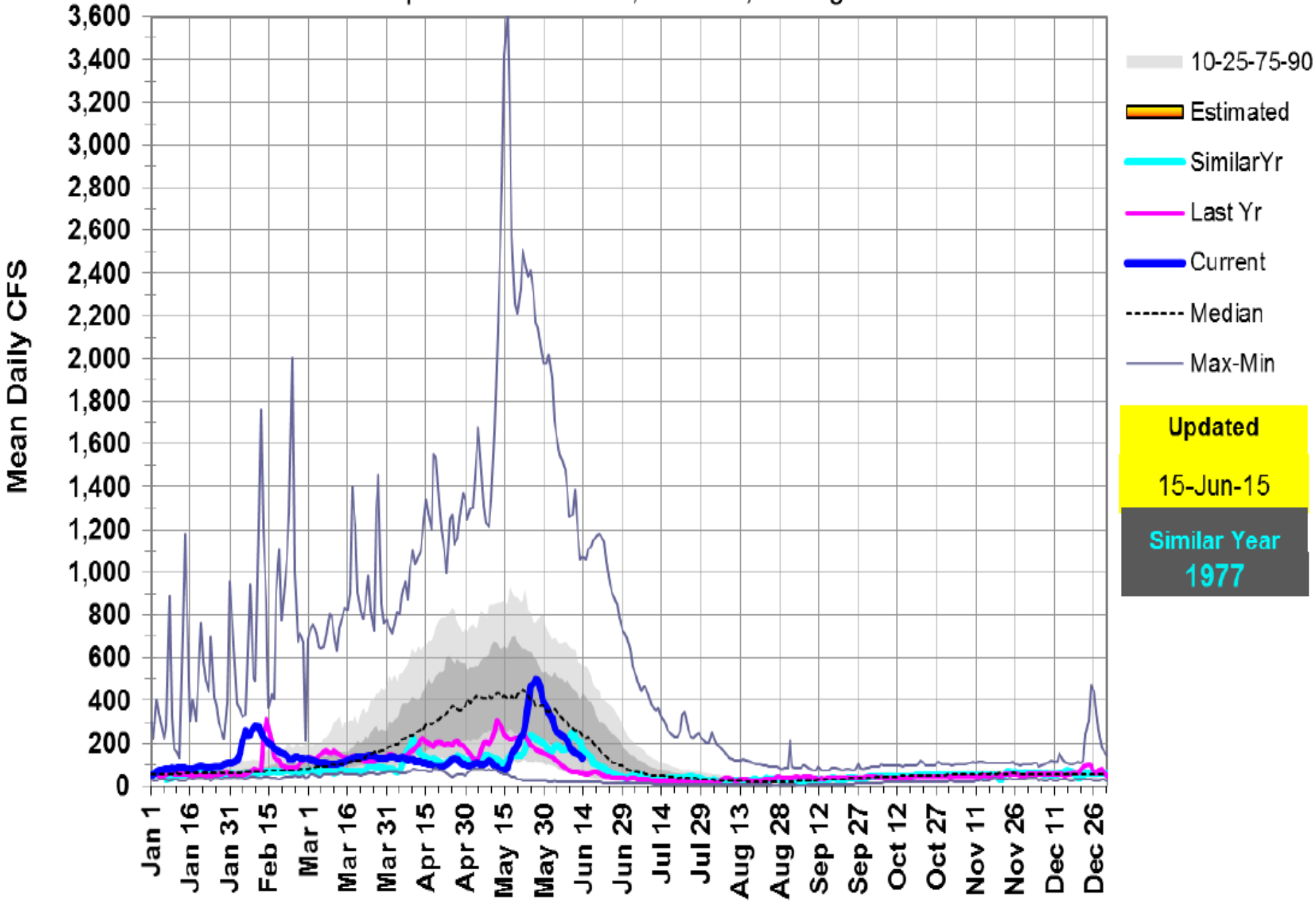


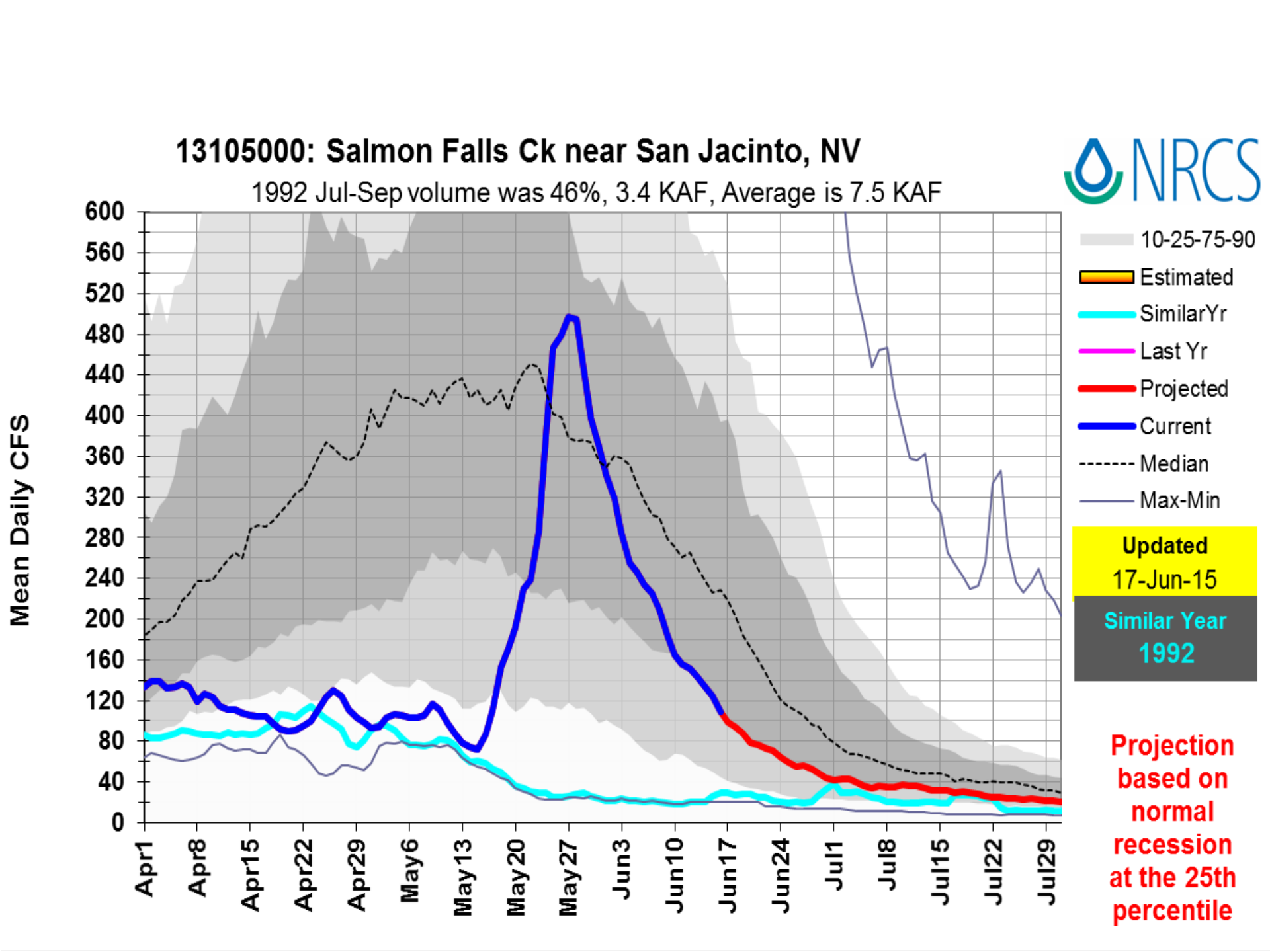
11		Zonal Area (mi^2)	Peak SWE	SWE percent of (cut-back)
12	Zone A – Chocolate G	10	0.0	0
13	Zone B – Galena	30	0.0	0
14	Zone C – Hyndman	11	0.0	0
15	Zone D – Lost-Wood D	30	0.0	0
16	Zone E – Dollarhide	160	15.7	58
17	Zone F – Galena Sumi	65	0.0	0
18	Zone G – Chocolate –	250	0.0	0

Example of runoff with no snow at 5 of the 6 SNOTEL sites on April 1

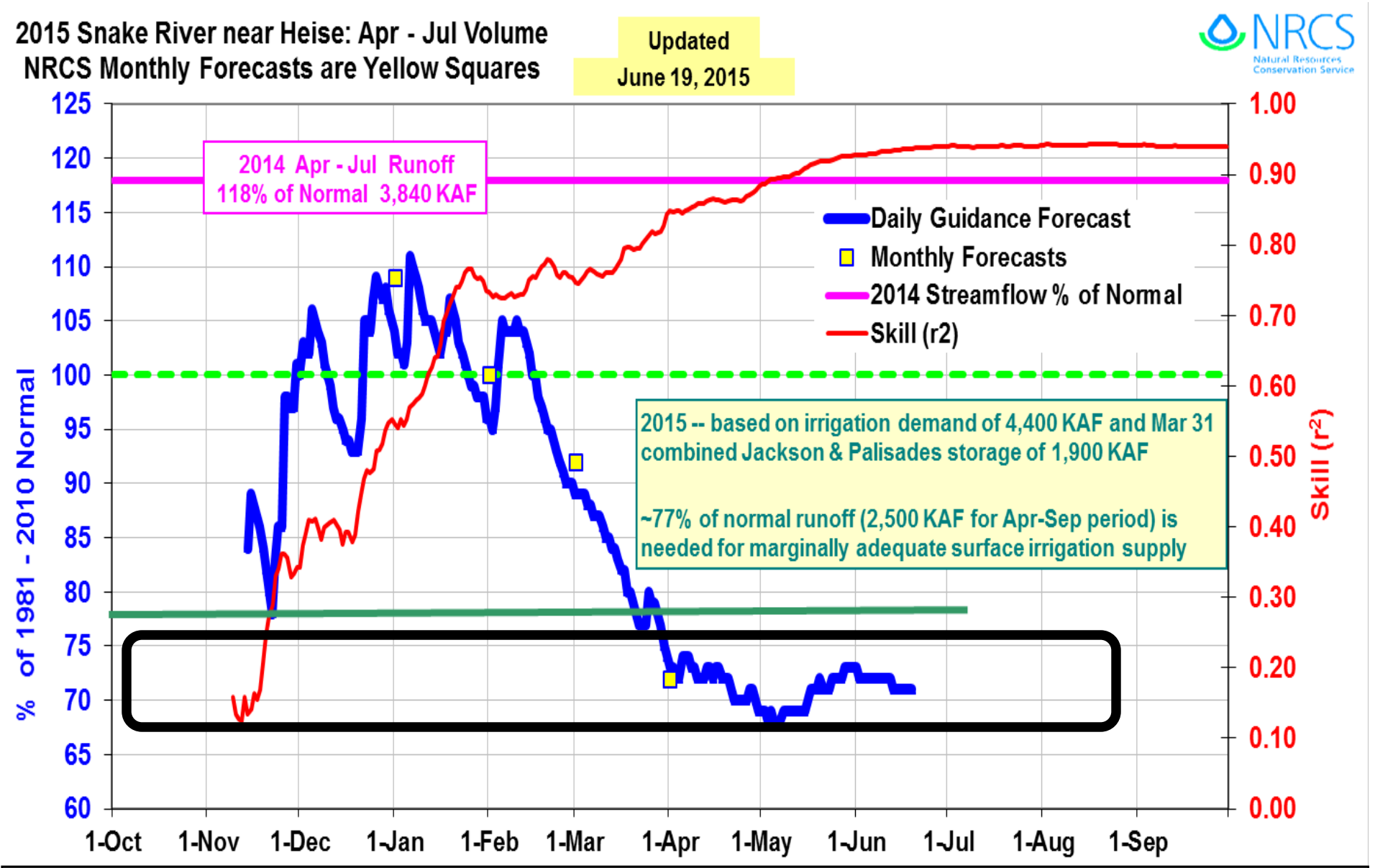
13105000: Salmon Falls Ck near San Jacinto, NV

1977 Jul-Sep volume was 80%, 5.9 KAF, Average is 7.5 KAF



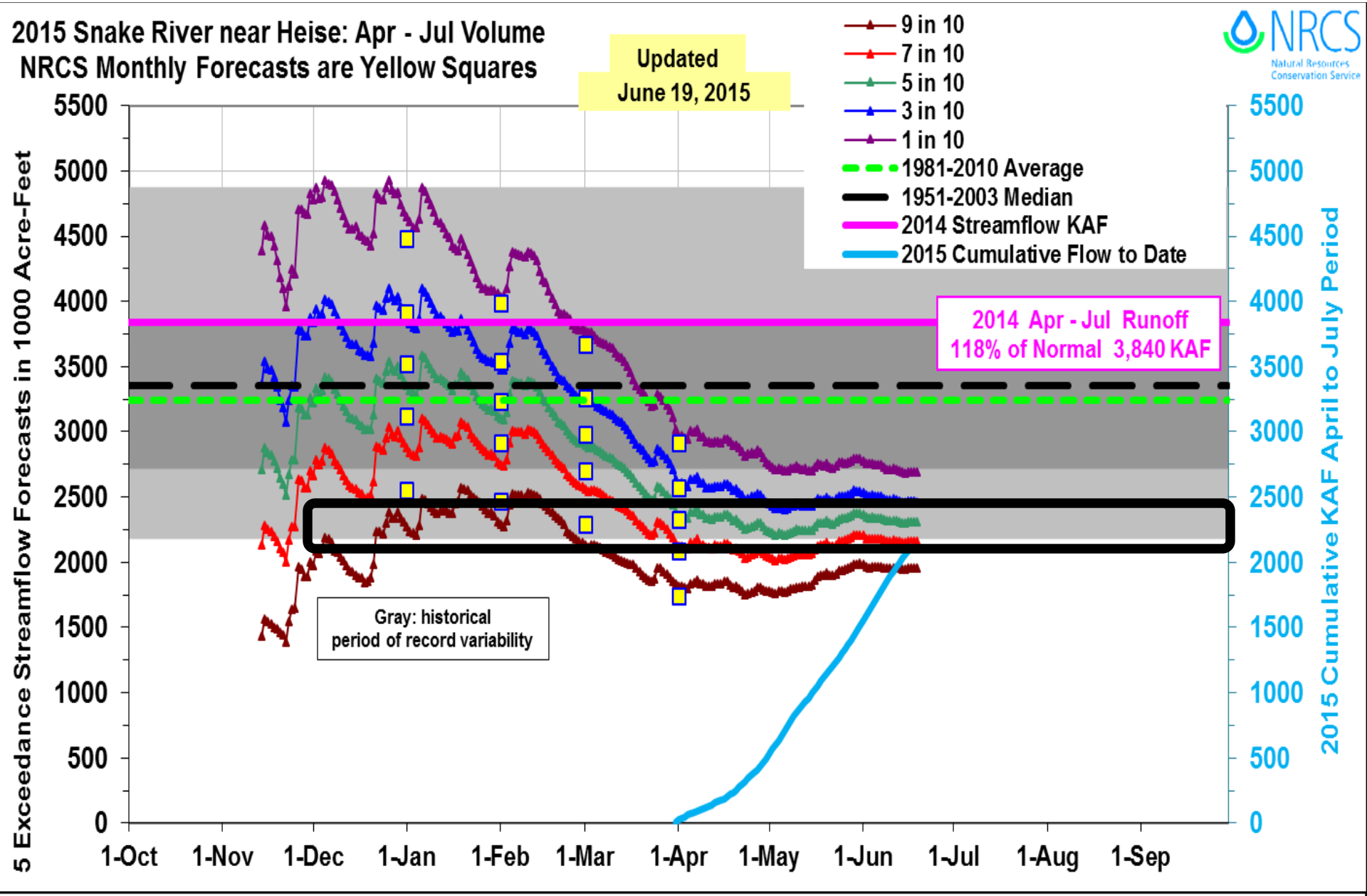

13105000: Salmon Falls Ck near San Jacinto, NV
1992 Jul-Sep volume was 46%, 3.4 KAF, Average is 7.5 KAF
NRCS
Mean Daily CFS
600
560
520
480
440
400
360
320
280
240
200
160
120
80
40
0
Apr1
Apr8
Apr15
Apr22
Apr29
May6
May13
May20
May27
Jun3
Jun10
Jun17
Jun24
Jul1
Jul8
Jul15
Jul22
Jul29
10-25-75-90
Estimated
SimilarYr
Last Yr
Projected
Current
Median
Max-Min
Updated
17-Jun-15
Similar Year
1992
Projection based on normal recession at the 25th percentile

2015 Forecast Accuracy – April – July runoff will be ~ 70-75% of average



SNOTELs used: Base Camp, Blind Bull, Cottonwood Ck, Lewis Lake, Snake River Station, Slug Ck, Thumb Div, Willow Ck

2015 Forecast Accuracy – near minimum Jan & Feb Forecasts



SNOTELs used: Base Camp, Blind Bull, Cottonwood Ck, Lewis Lake, Snake River Station, Slug Ck, Thumb Divide, Willow Ck

General Rule of Thumb to Keep in Mind:

Future precipitation is not included in NRCS streamflow forecasts

For April 1 Forecast:

50% Chance of Exceedance Forecast to occur:

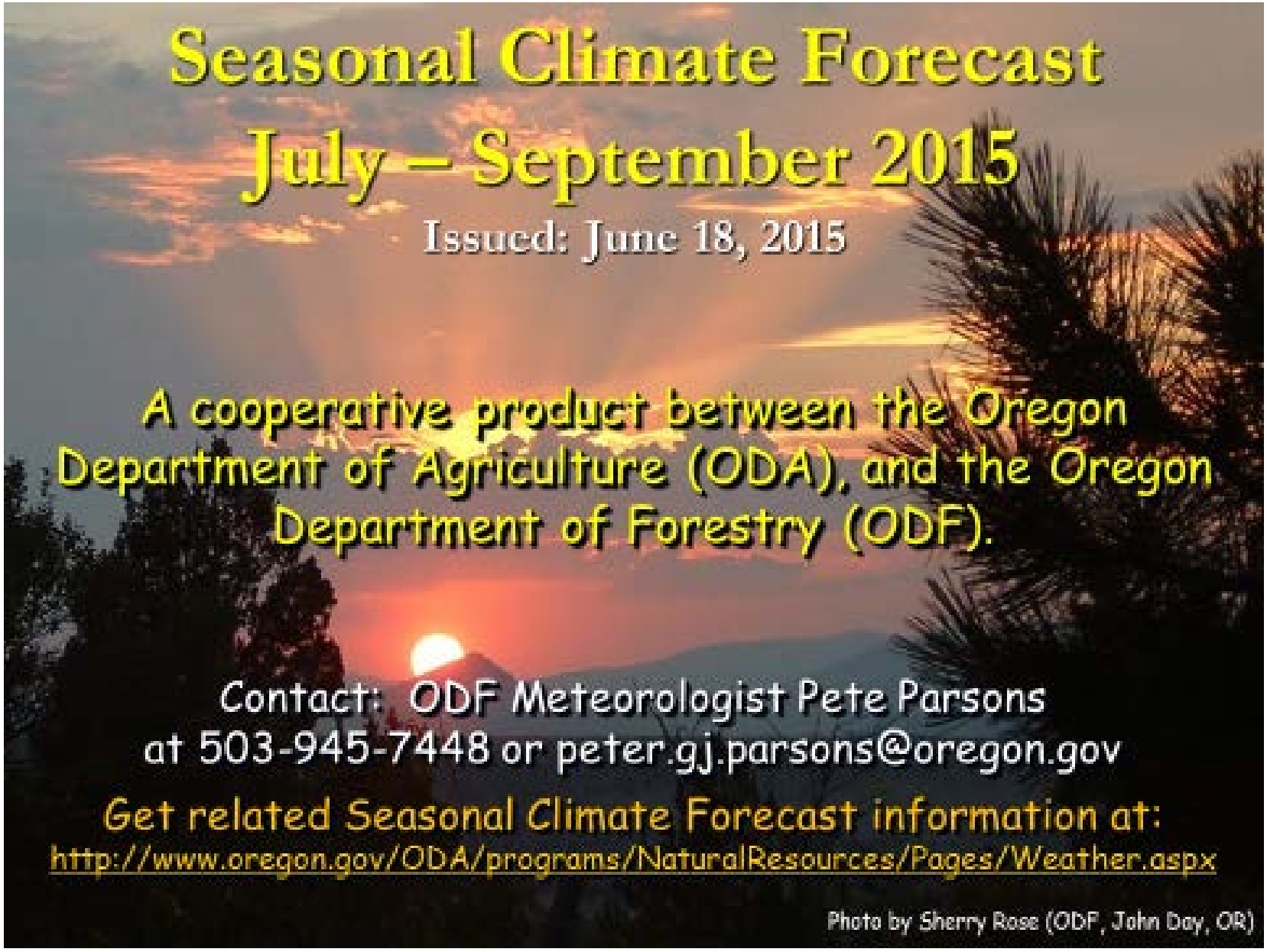
Need normal future precipitation

70% Chance of Exceedance Forecast to occur:

Future precipitation will be about 75% of average, similar to spring 2014

90% Chance of Exceedance Forecast to occur:

Future precipitation will be about 50% of average


Seasonal Climate Forecast
July – September 2015
Issued: June 18, 2015
A cooperative product between the Oregon Department of Agriculture (ODA), and the Oregon Department of Forestry (ODF).
Contact: ODF Meteorologist Pete Parsons
at 503-945-7448 or peter.gj.parsons@oregon.gov
Get related Seasonal Climate Forecast information at:
http://www.oregon.gov/ODA/programs/NaturalResources/Pages/Weather.aspx
Photo by Sherry Rose (ODF, John Day, OR)

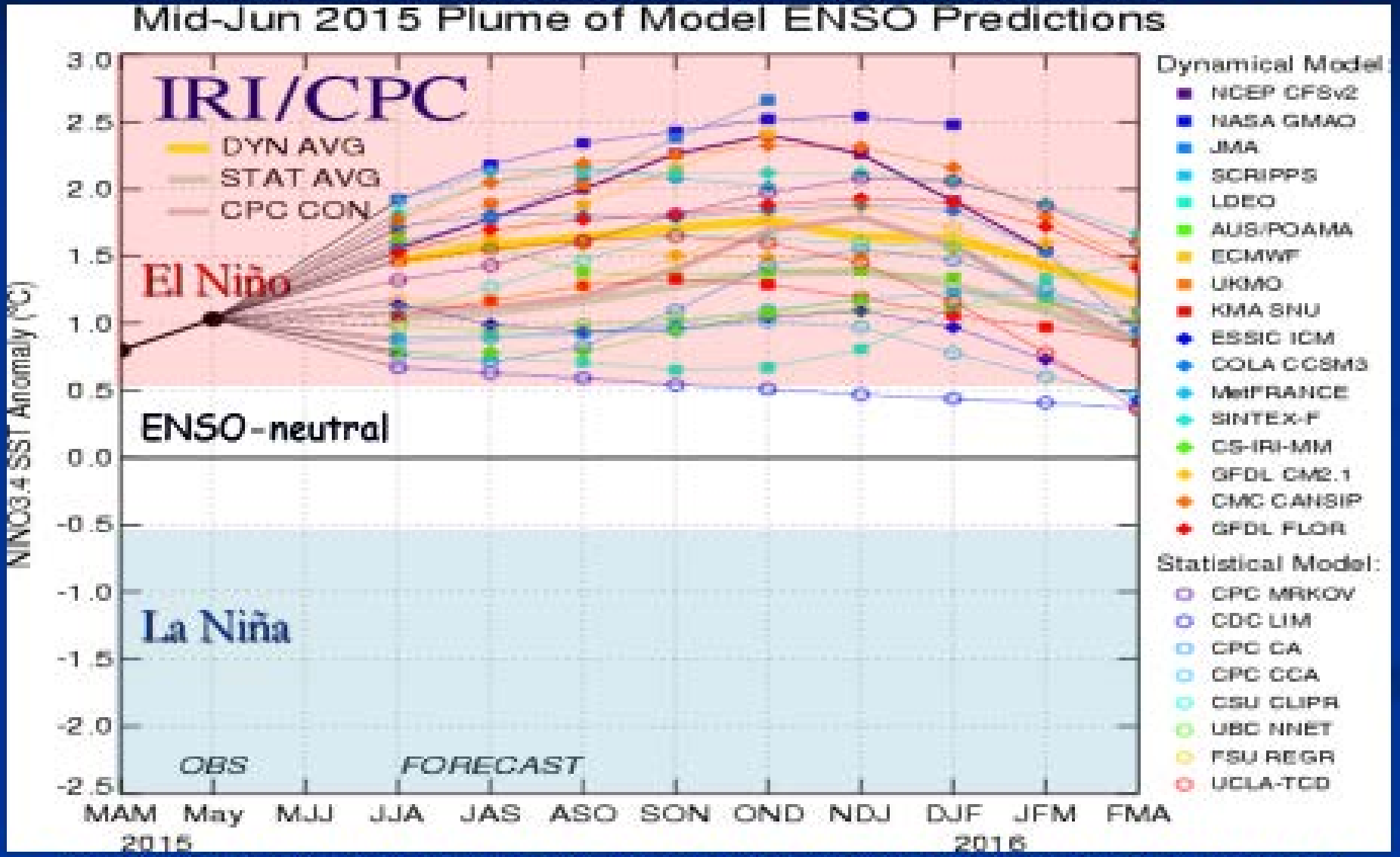
Forecast Method Notes…

- The top analog years (1977; 1980; 2005) used to create this forecast remain unchanged from last month. Of these years, only 1977 maintained El Niño conditions through the subsequent winter (1977-78), peaking at just weak intensity.

- El Niño has recently strengthened but has low predictability this time of year. This forecast is based solely on historical weather data and does not take dynamic model forecasts into account (see Forecasting Methods).

ENSO Predictive Models

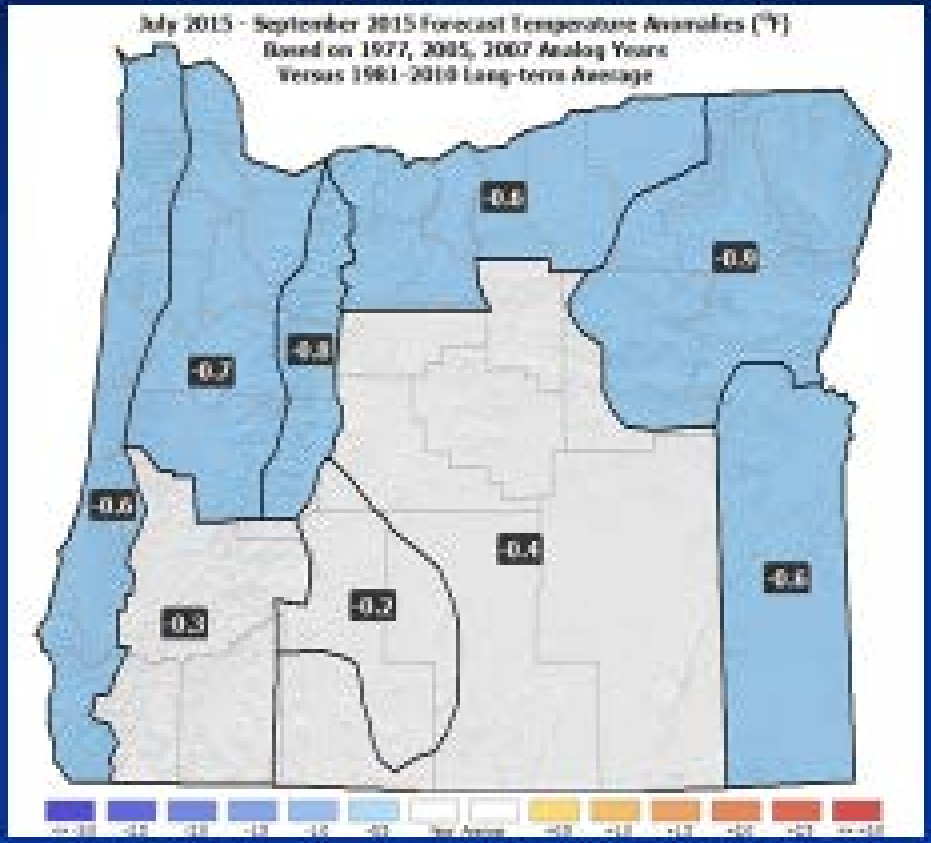
Model forecasts vary from warm ENSO-neutral to strong El Niño…



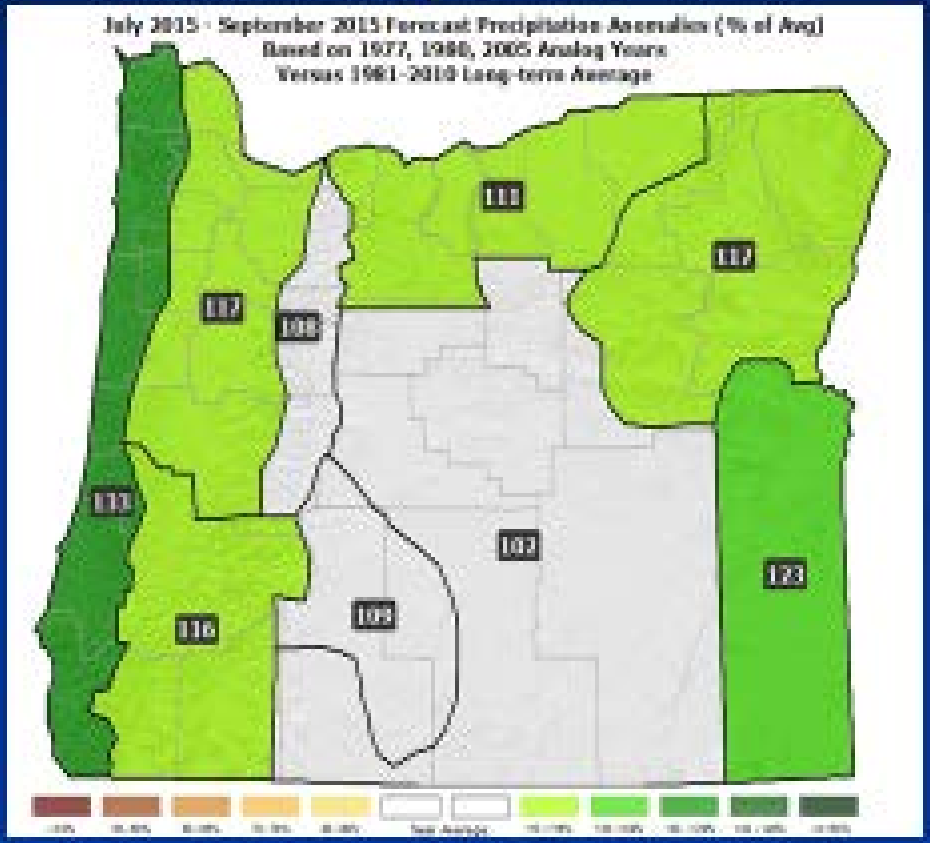
"Base" Graphic Courtesy: http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/

July – September 2015 Forecast

Temperatures



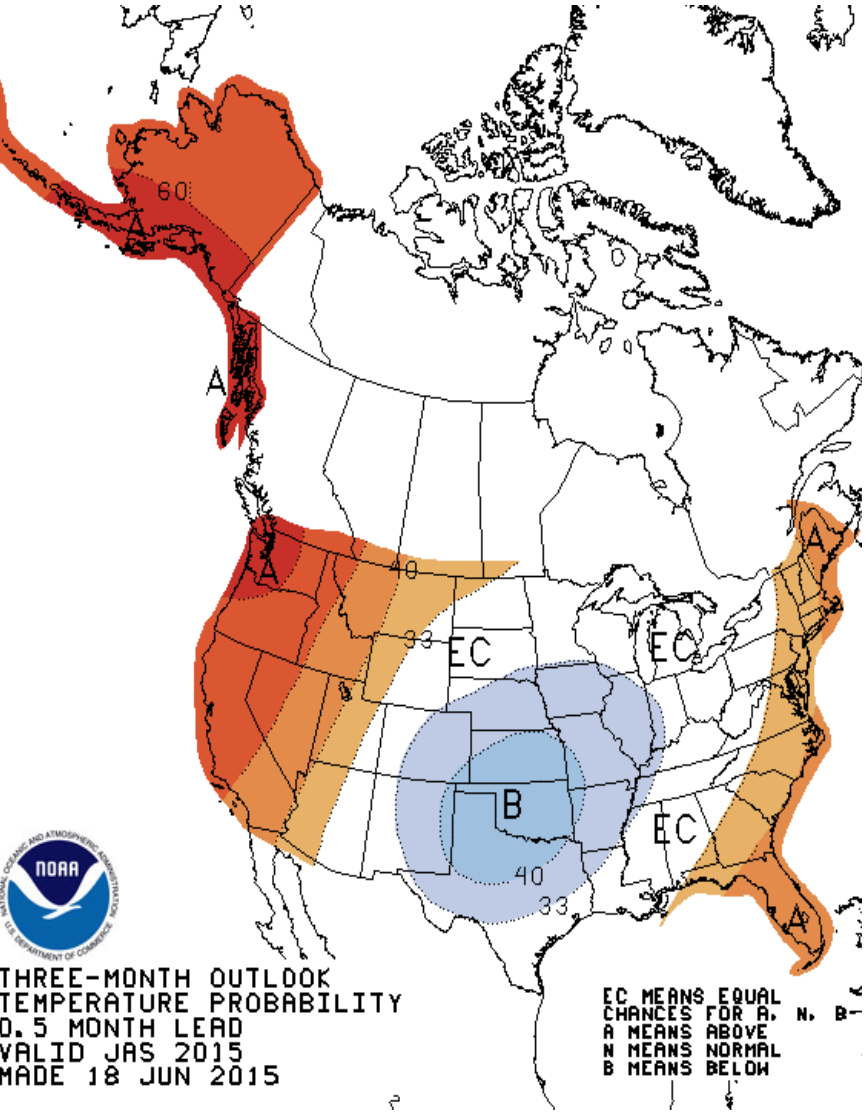
Precipitation

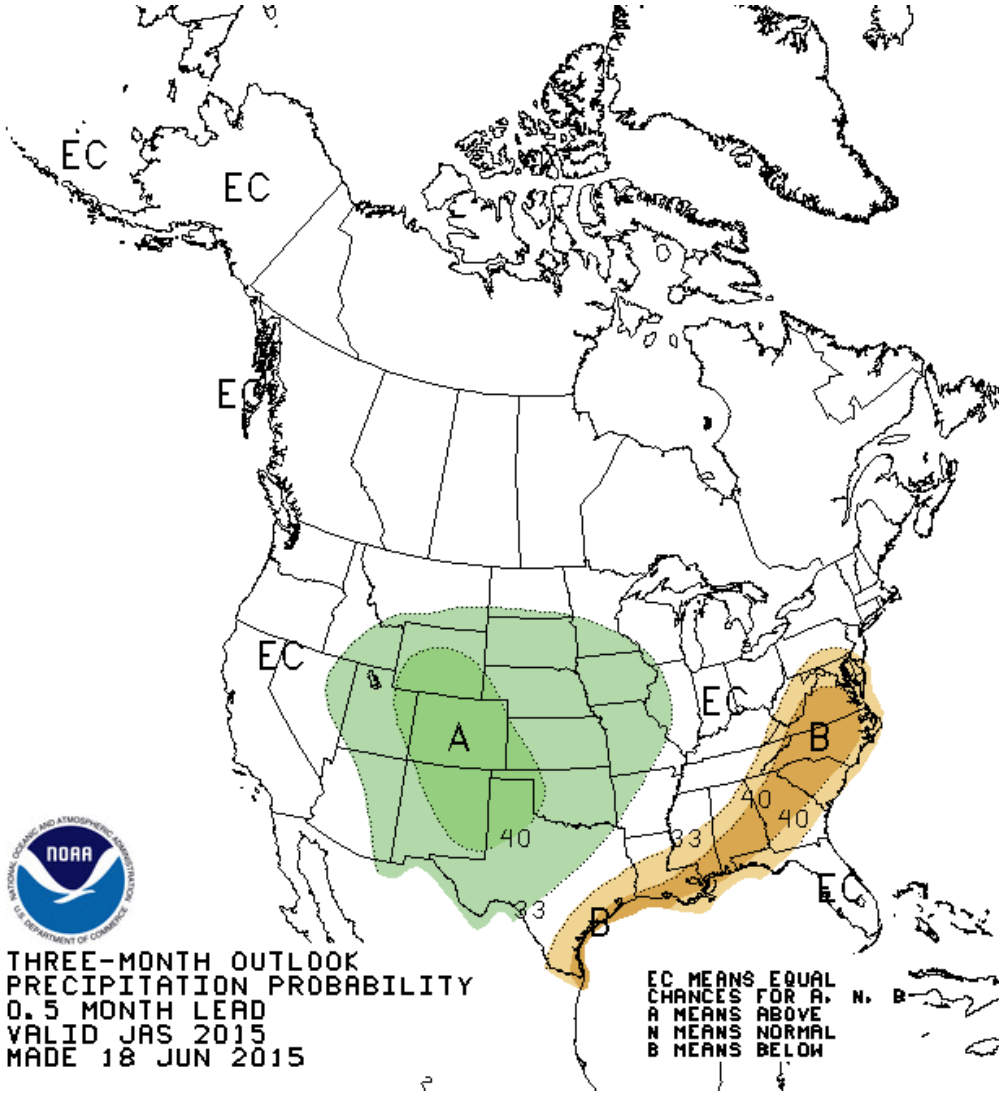


- No significant overall departures from average temperatures and precipitation are indicated.
- Analog years indicate a drier than average July, with a transition to a cooler and wetter pattern by late September.

Three-Month Outlooks
OFFICIAL Forecasts

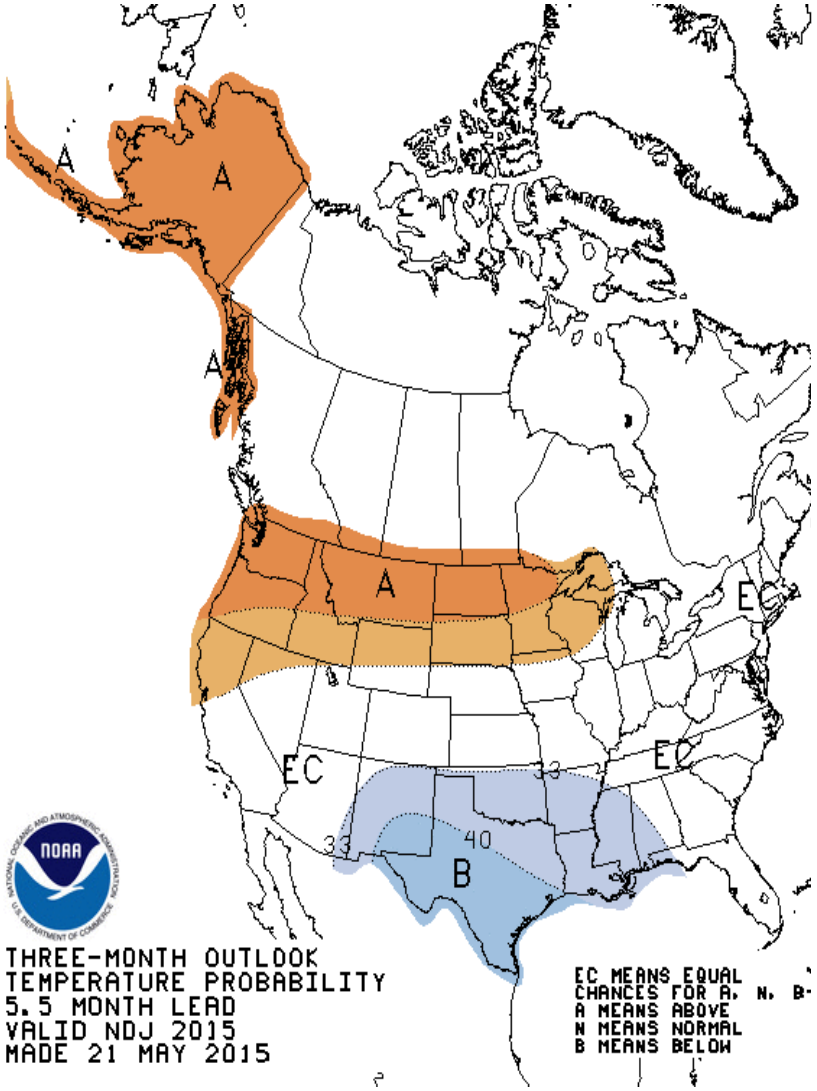
Made 18 June 2015 for Jul Aug Sep 2015

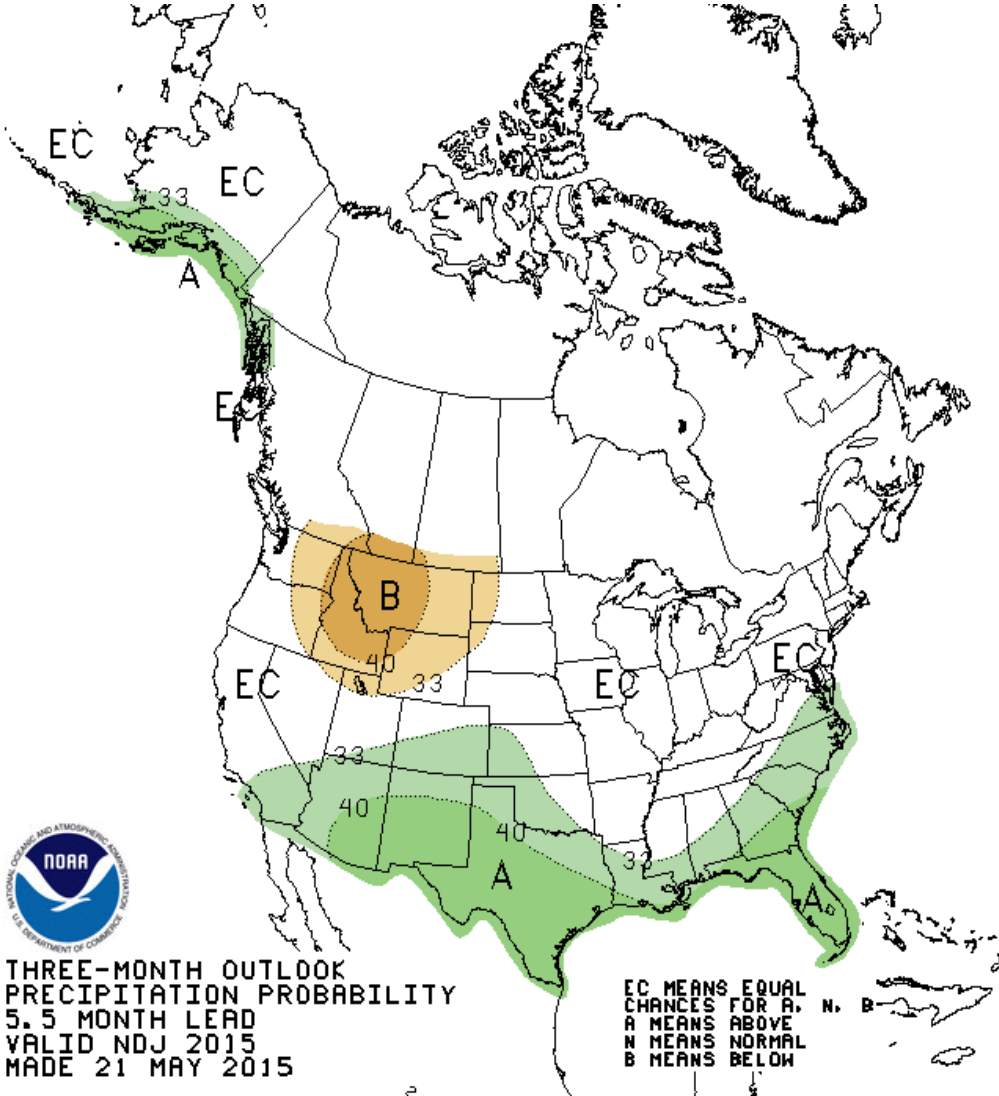




Three-Month Outlooks
OFFICIAL Forecasts

Made 21 May 2015 for Nov Dec Jan 2015



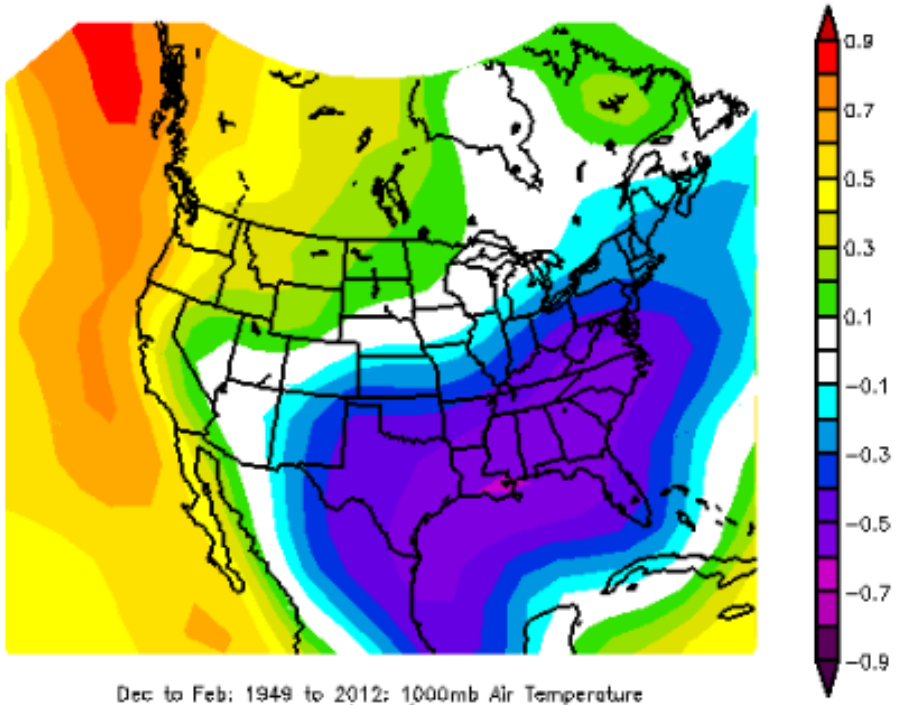


Long Range Climate Models Show Cold, Snowy SST Pattern for 2015-2016 Winter

Posted: 11 Apr 2015

I'll bite the bullet and be 'that one person' who starts discussing next winter far too early. Long range climate models are showing a sea surface temperature anomaly prognosis that could be conducive to another cold and snowy winter, particularly along the East US.

In the Gulf of Alaska, the models tells us that the warm pool we have seen the last two winters will only solidify itself for a third consecutive winter, with temperature anomalies definitively above normal in that area.



Streamflow April - September
as % of 1981-2010 Average

12 Years	ENSO	PDO					
Year	SE Strong El Nino	pos or neg	Owyhee River blw Dam	Salmon Falls Creek	Big Wood River blw Magic Dam	Snake River nr Heise	Spokane River nr Post Falls
1994	SE	pos	23	36	12	61	51
1966	SE	neg	28	48	51	78	90
1947	SE	pos / neg	44	50	59	108	90
1941	SE	pos	83	53	69	73	45
1988	SE	pos	30	65	24	70	71
1978	SE	pos	110	112	140	133	99
1973	SE	pos / neg	61	114	51	79	45
1995	SE	pos	124	135	195	118	70
1998	SE	pos	135	138	161	119	82
1983	SE	pos	221	157	282	132	91
1942	SE	pos	122	173	117	86	77
1952	SE	neg	247	178	263	116	123
2016	SE ?	pos ?	?	?	?	?	?

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1942	SE	pos	122	173	117	86	77
1952	SE	neg	247	178	263	116	123
2016	SE ?	pos ?	?	?	?	?	?

I am coming back to The Weather Centre.

Sunday, June 14, 2015

- Over the next few weeks, I will publish my Preliminary 2015-2016 Winter Forecast. I will announce a publication date in coming days, but as I've always done, you can expect it to be at high noon on a Saturday.

- I will publish an Official 2015-2016 Winter Forecast further down the road.

- I will publish extended discussions on winter storm systems, cold air outbreaks, and other winter phenomena.

- See more at: http://theweathercentre.blogspot.com/#sthash.R8aorbr7.dpuf


Think Snow!!