Pacific Northwest Weather and Climate Recap for Winter 2015-16 and Climate Outlook

Kelly T. Redmond

Western Regional Climate Center
Desert Research Institute
Reno Nevada

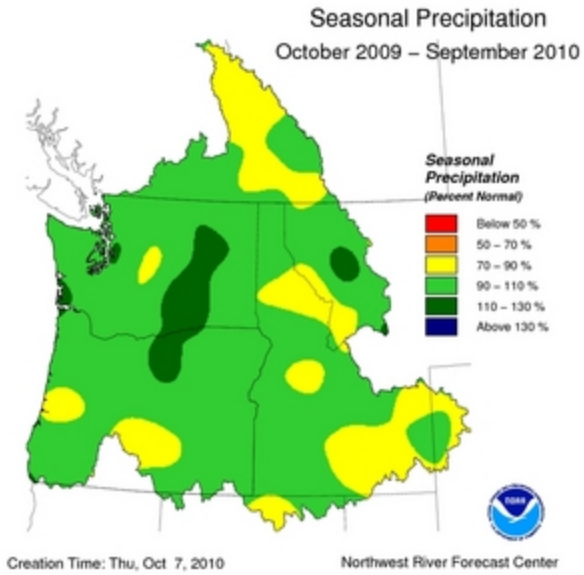
Pacific Northwest Drought Early Warning System
Marriott Downtown
Portland Oregon 2-3 February 2016

Western Regional Climate Center

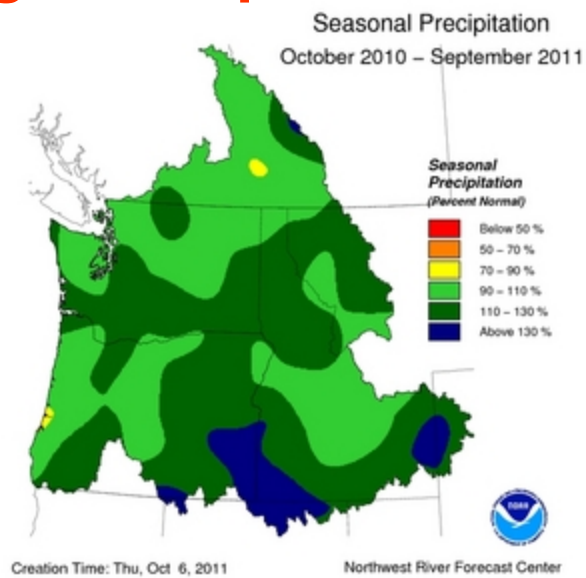
Southwest Climate Science Center

California-Nevada Climate Applications Program

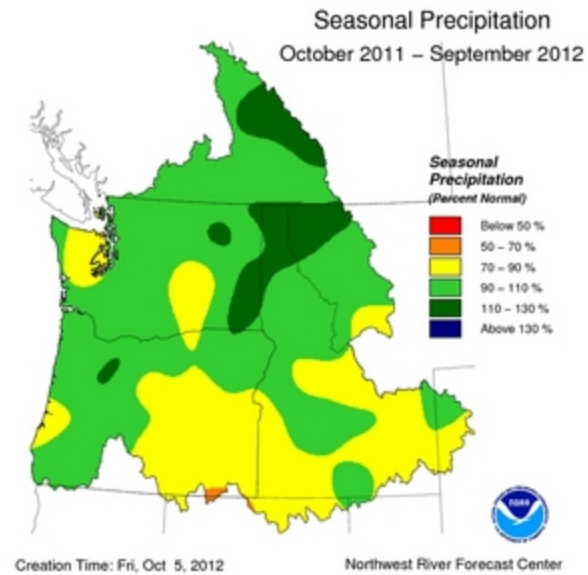
Percent of Average Precipitation Past Six Water Years



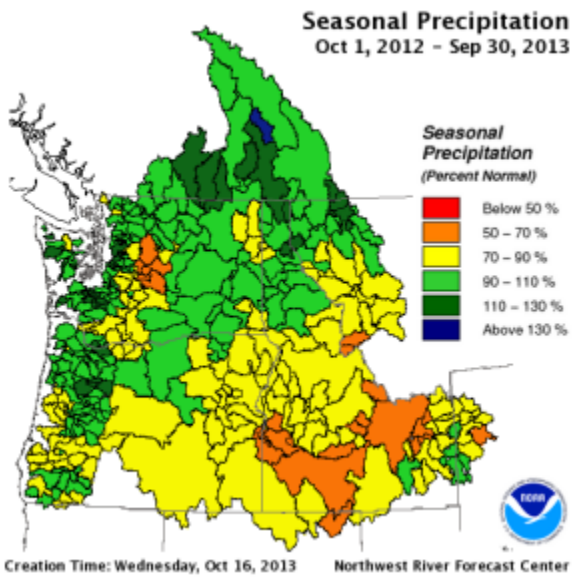
WY 2009-2010



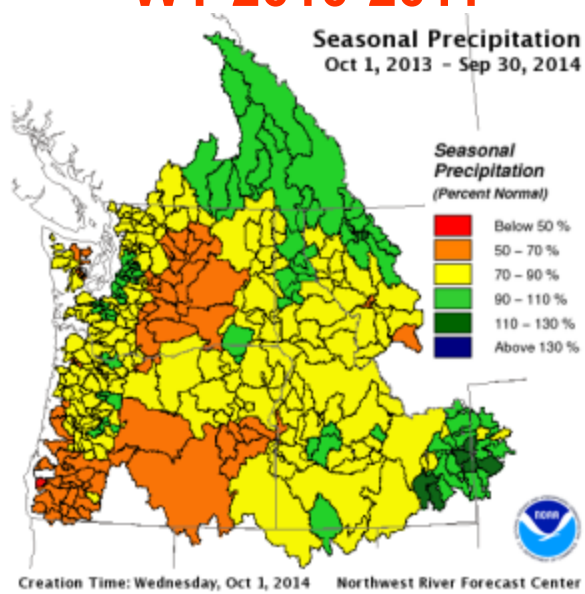
WY 2010-2011



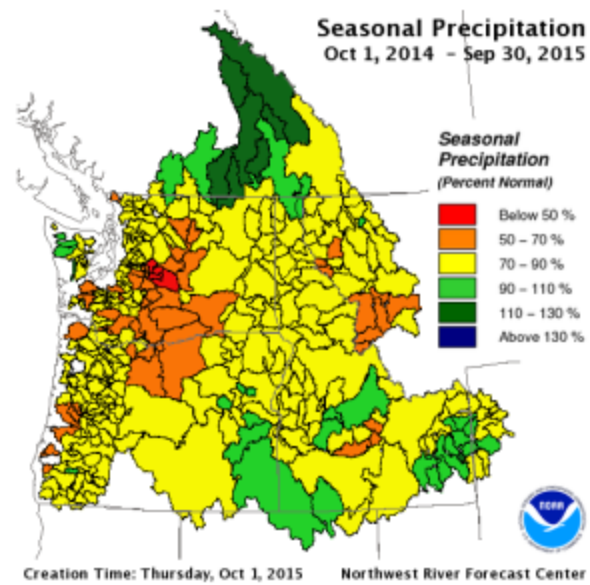
WY 2011-2012



WY 2012-2013



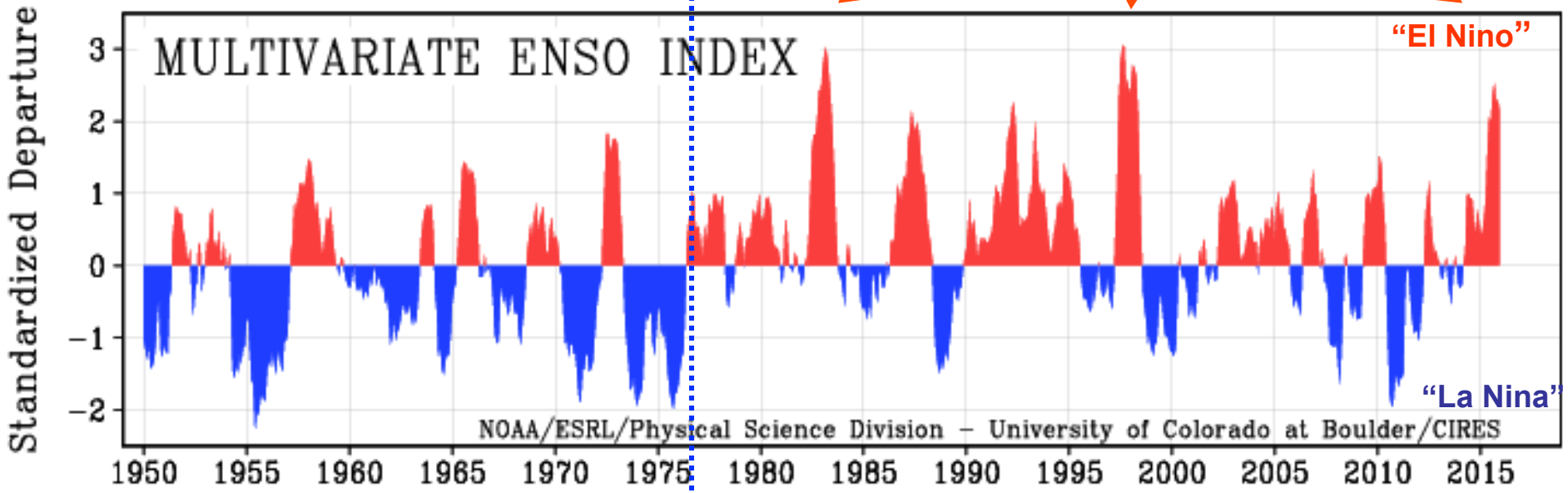
WY 2013-2014



WY 2014-2015

3 largest El Nino Events of Past Century
(All in 1/3 century)

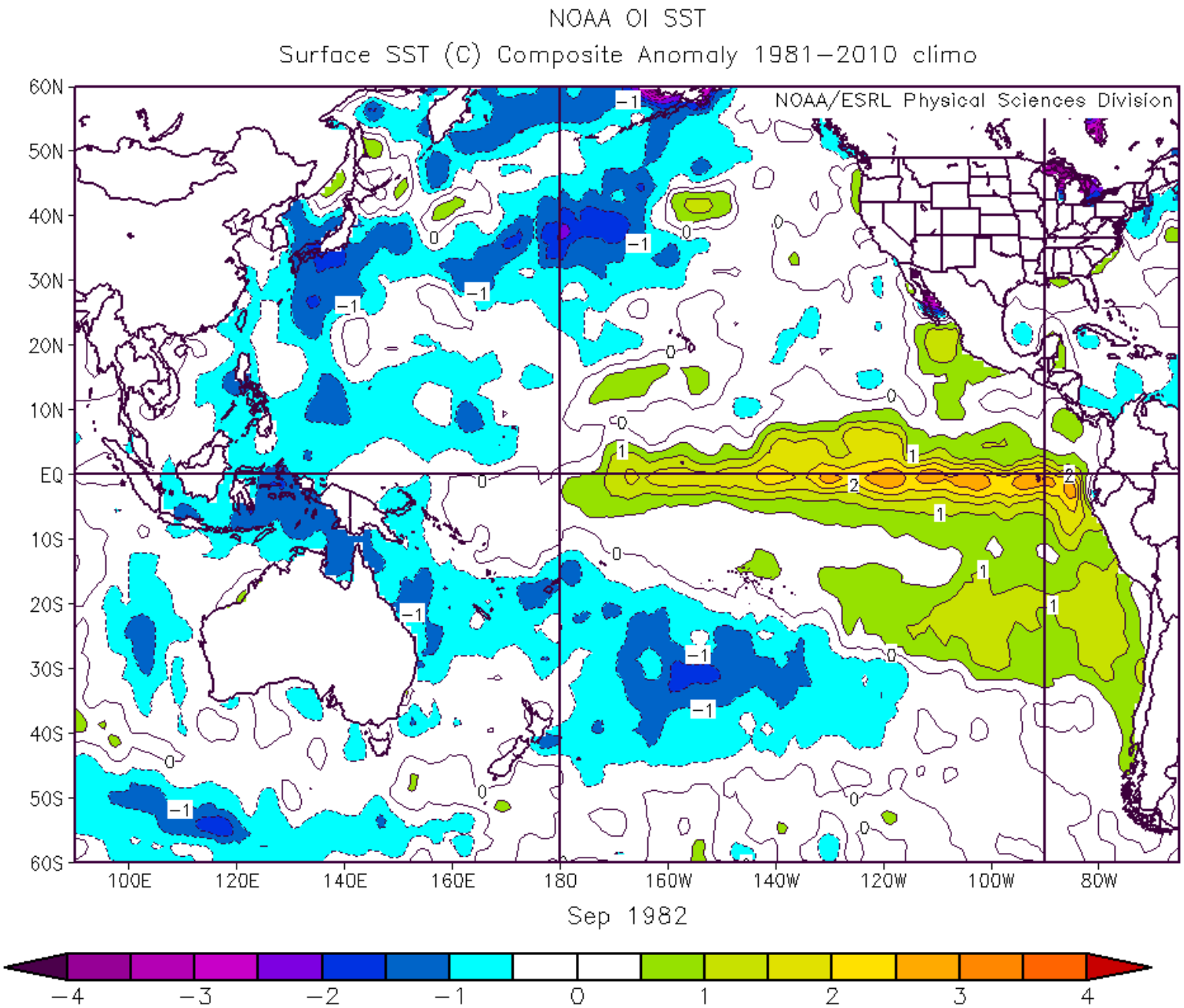
Through December 2015



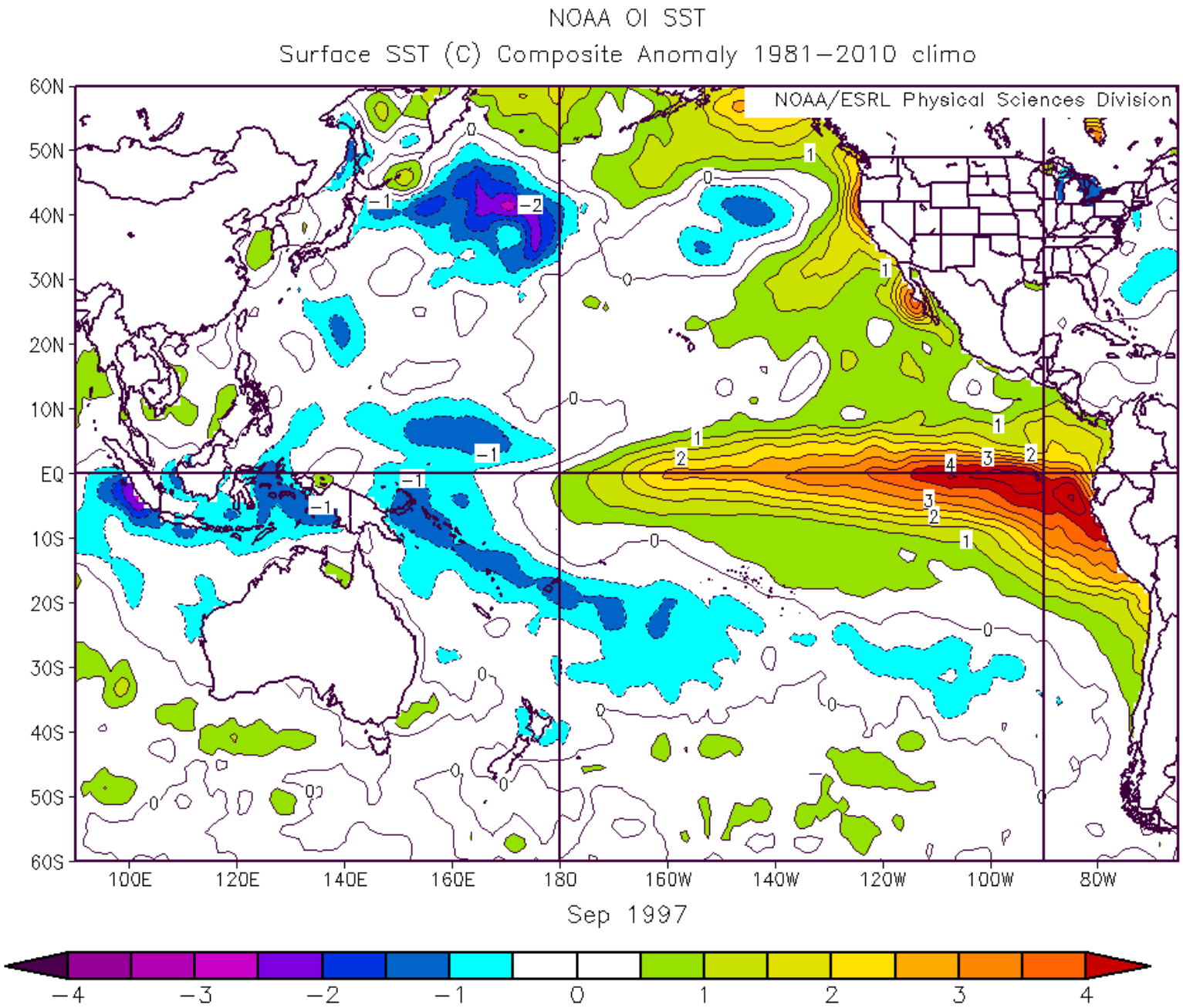
NOAA ESRL ("CDC"), Wolter and Timlin

The "1976 Shift"

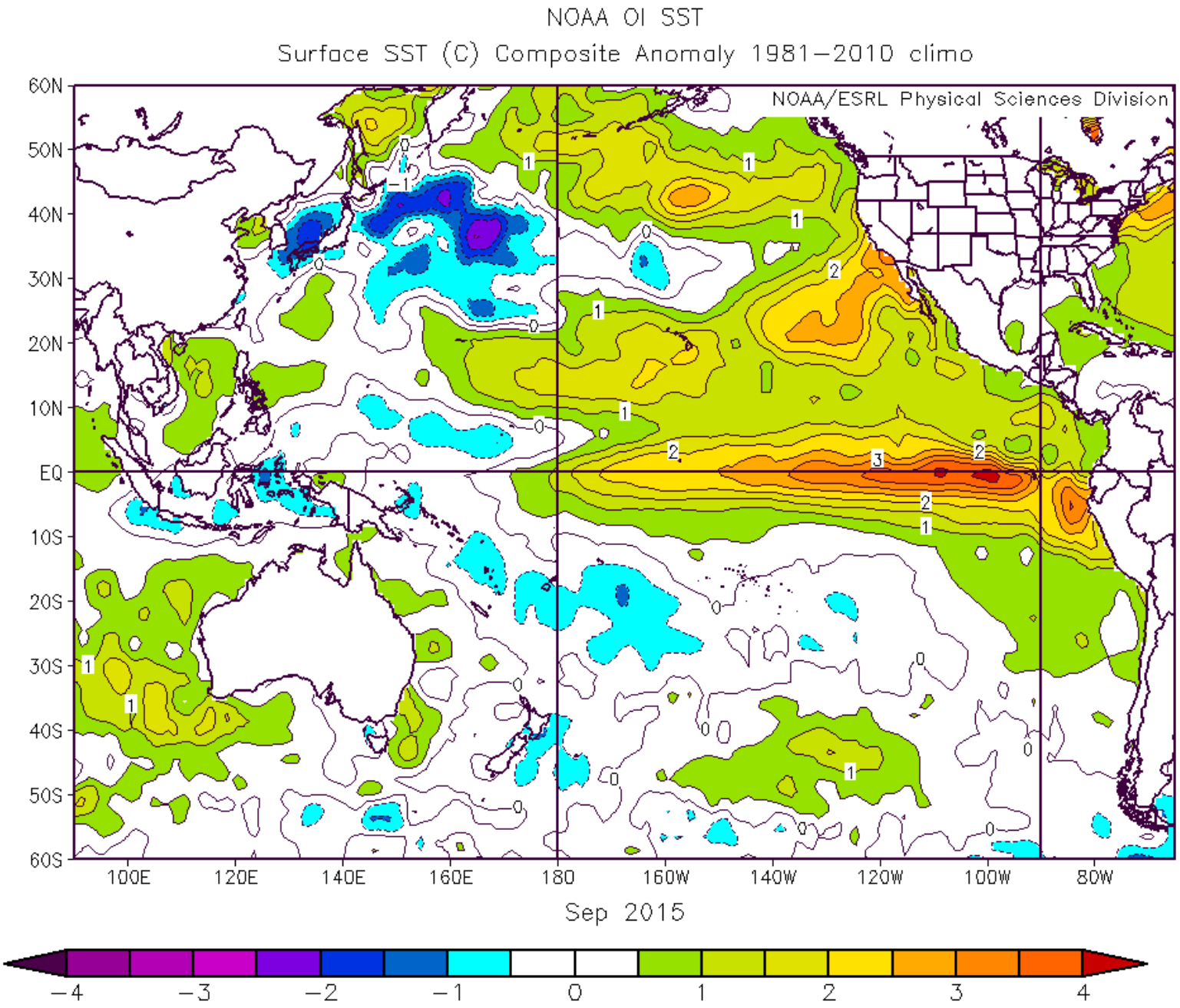
Ocean Surface Temperature Departure from Average. Sep 1982.



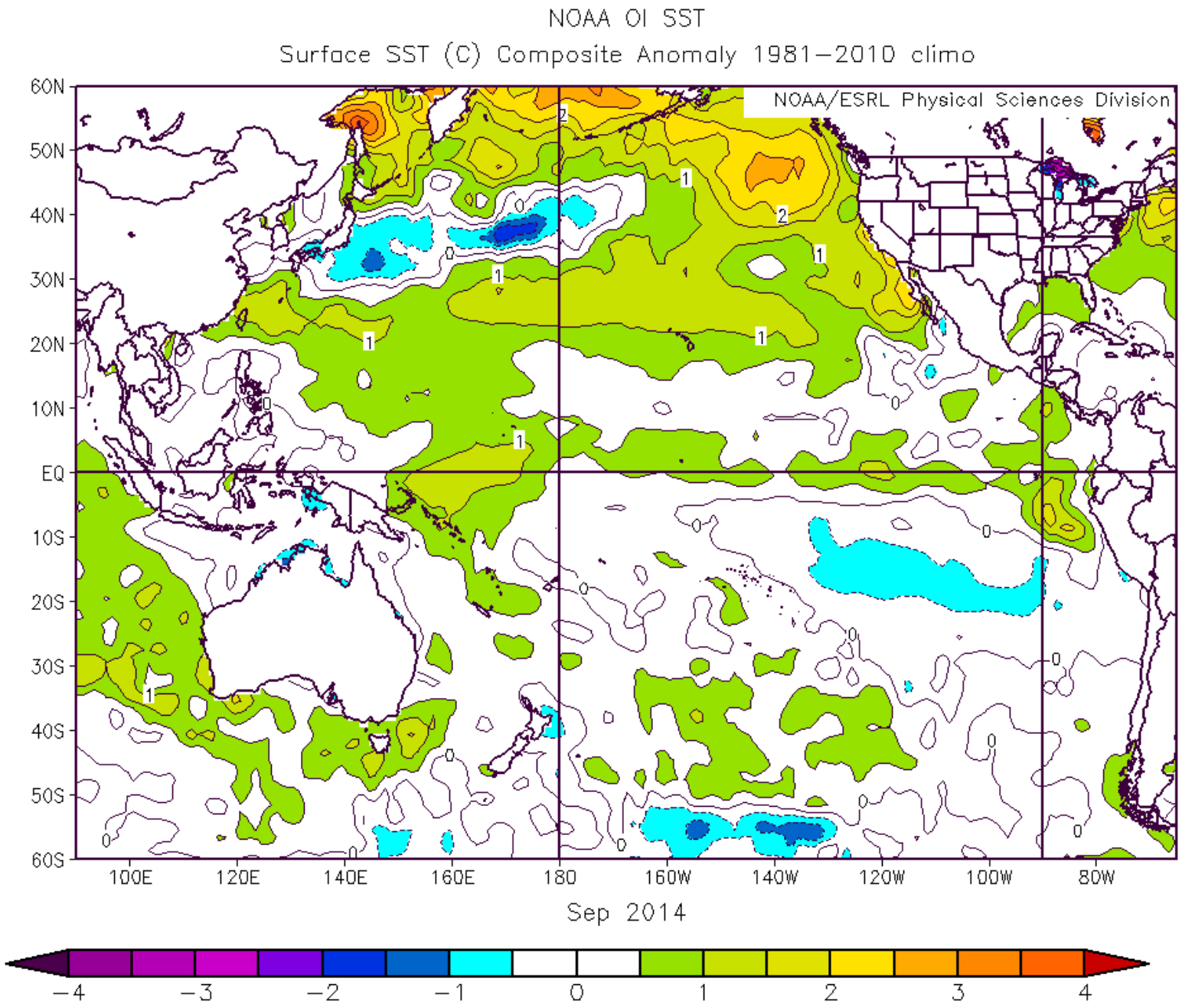
Ocean Surface Temperature, Departure from Average. Sep 1997.



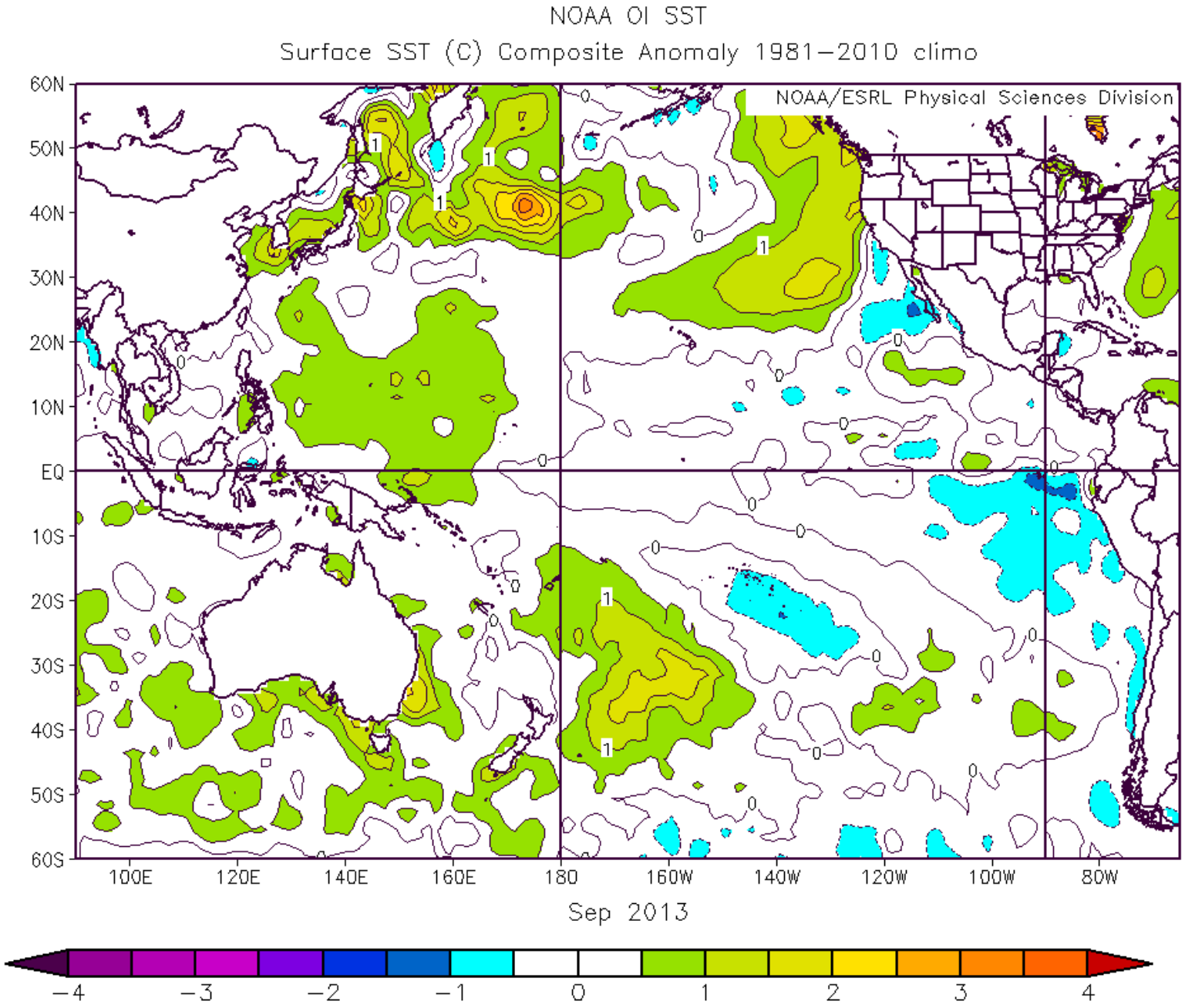
Ocean Surface Temperature, Departure from Average. Sep 2015.



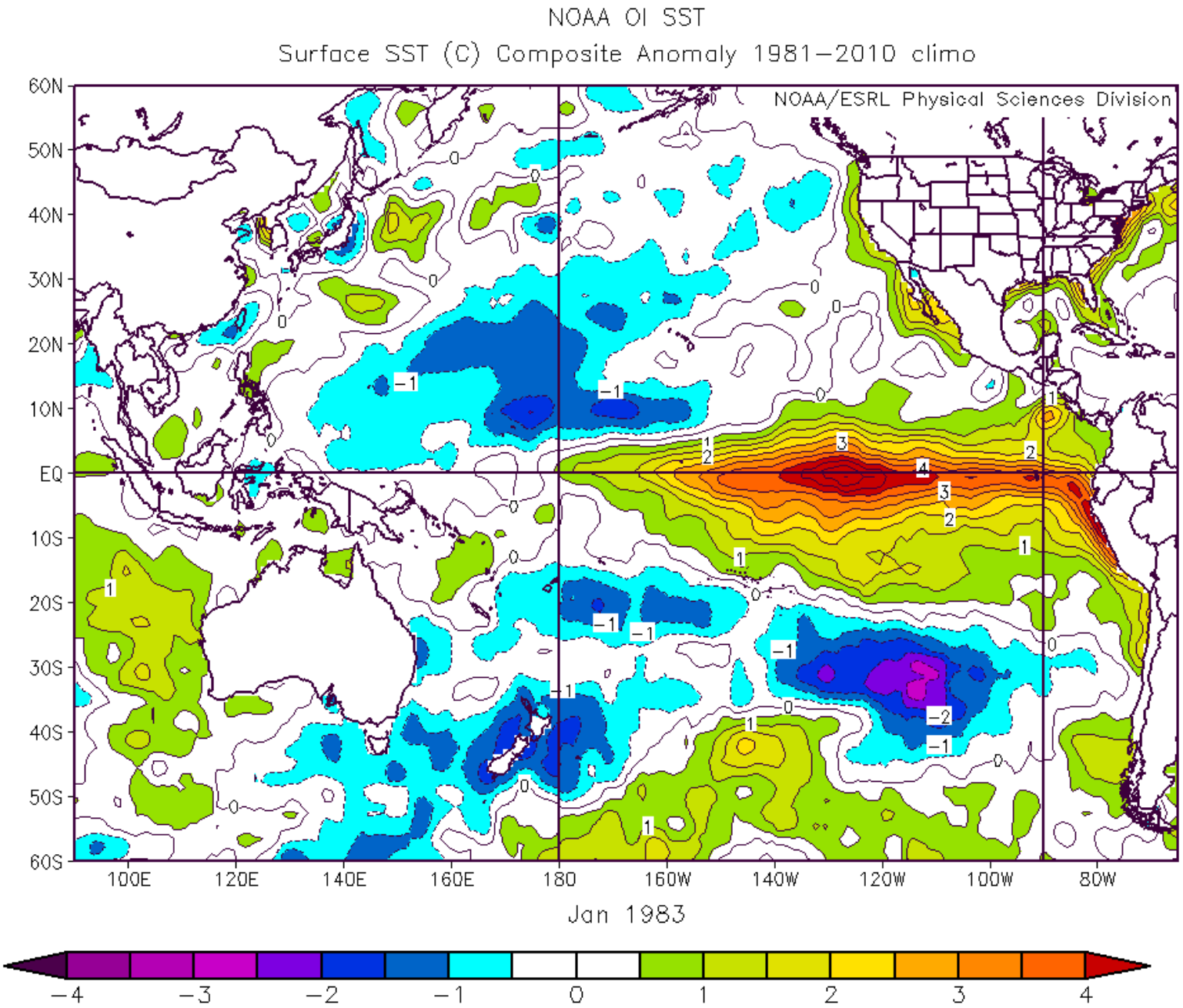
Ocean Surface Temperature, Departure from Average. Sep 2014.



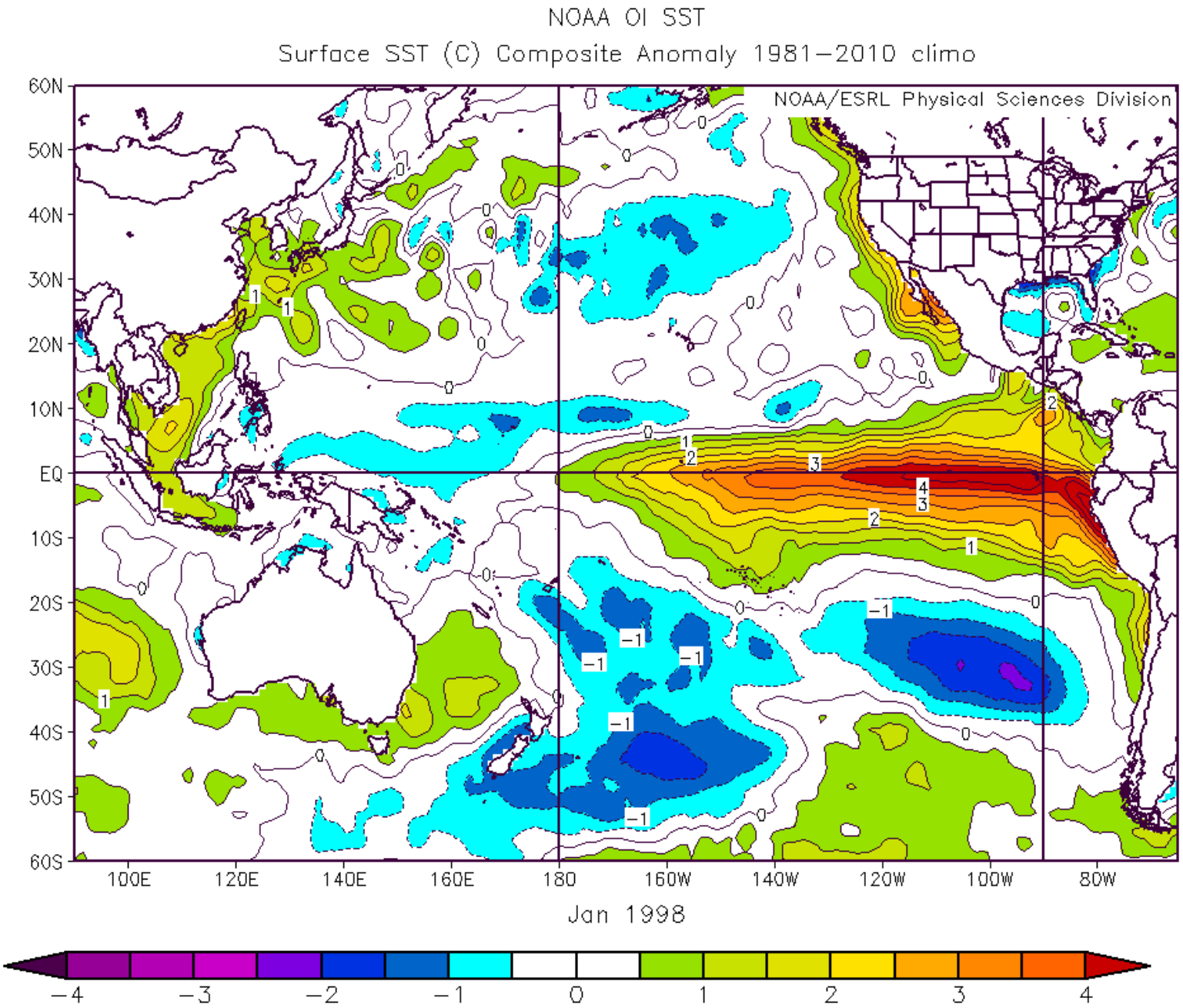
Ocean Surface Temperature, Departure from Average. Sep 2013.



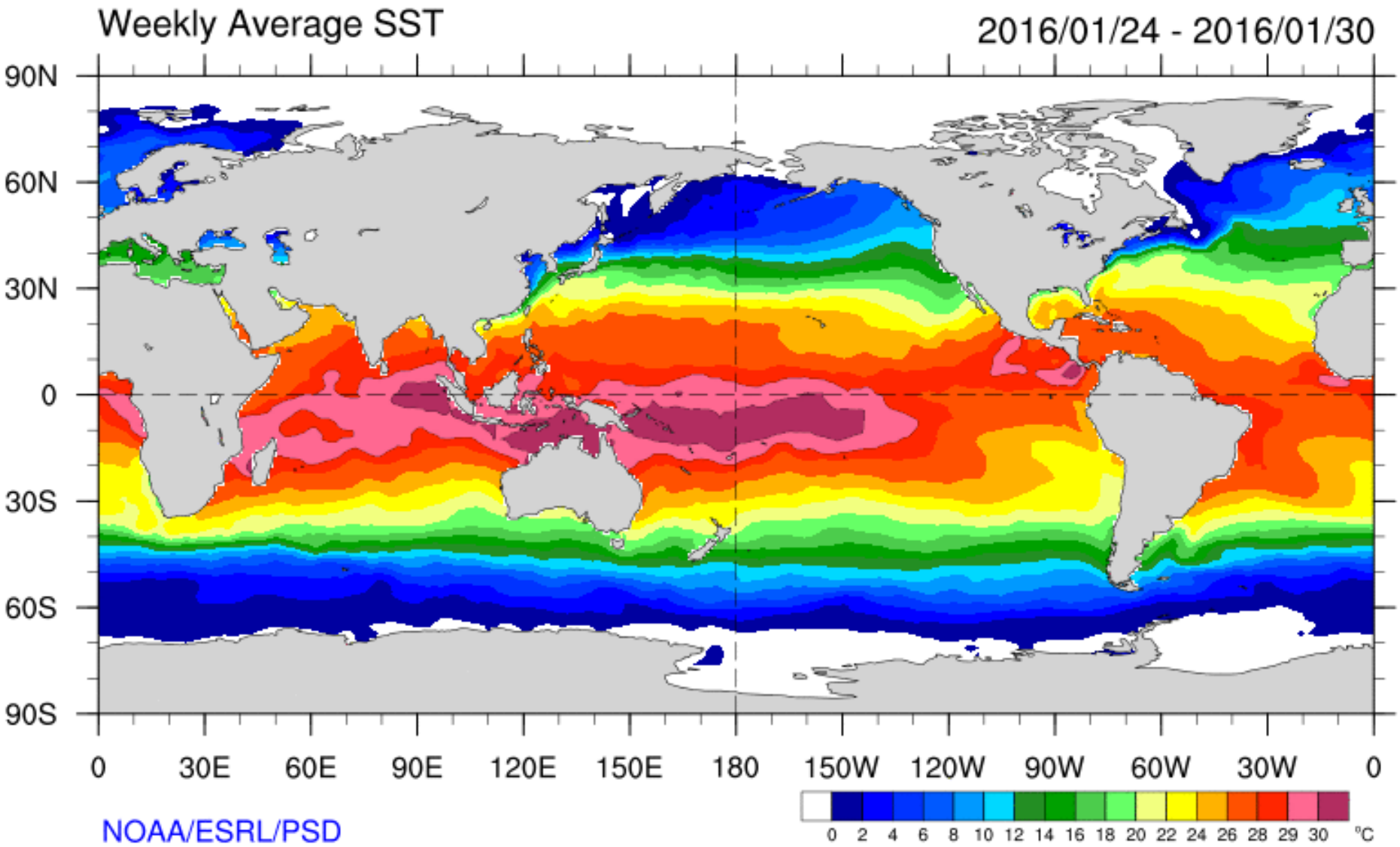
Ocean Surface Temperature, Departure from Average. Jan 1983.



Ocean Surface Temperature, Departure from Average. Jan 1998.

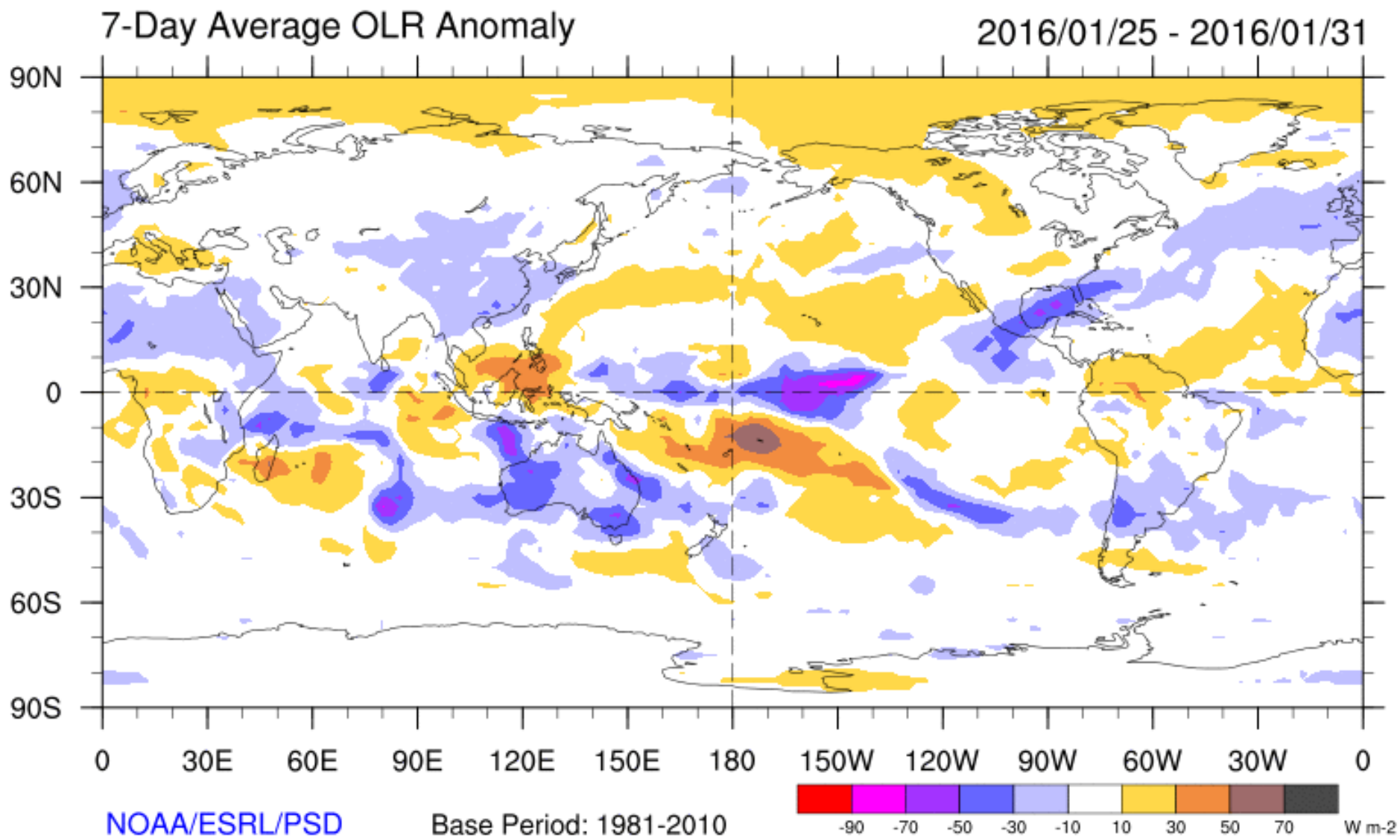


Ocean Surface Temperature (C) 2016 Jan 24 - 30

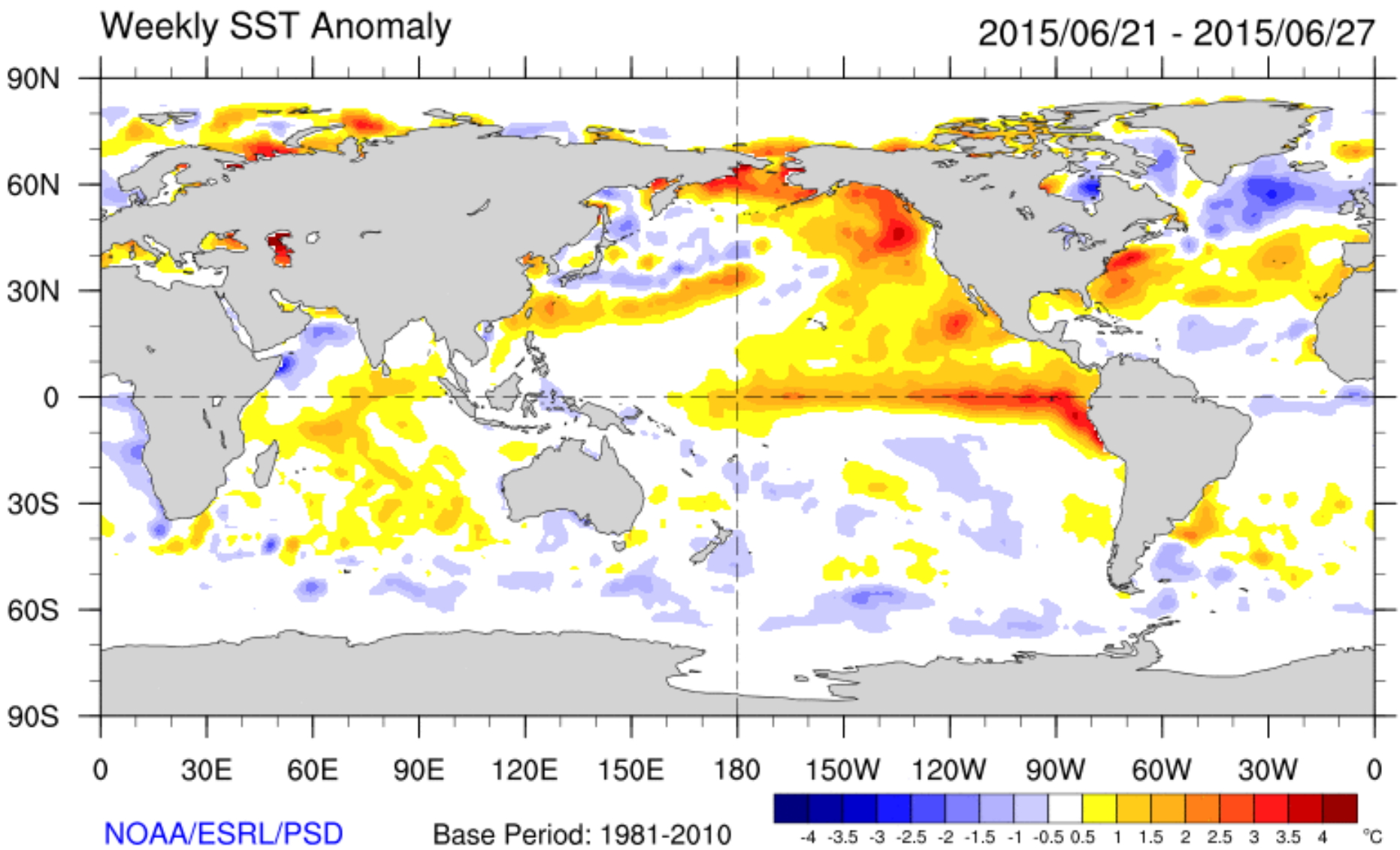


Cloudiness Departures (W/m**2) 2016 Jan 25 - 31

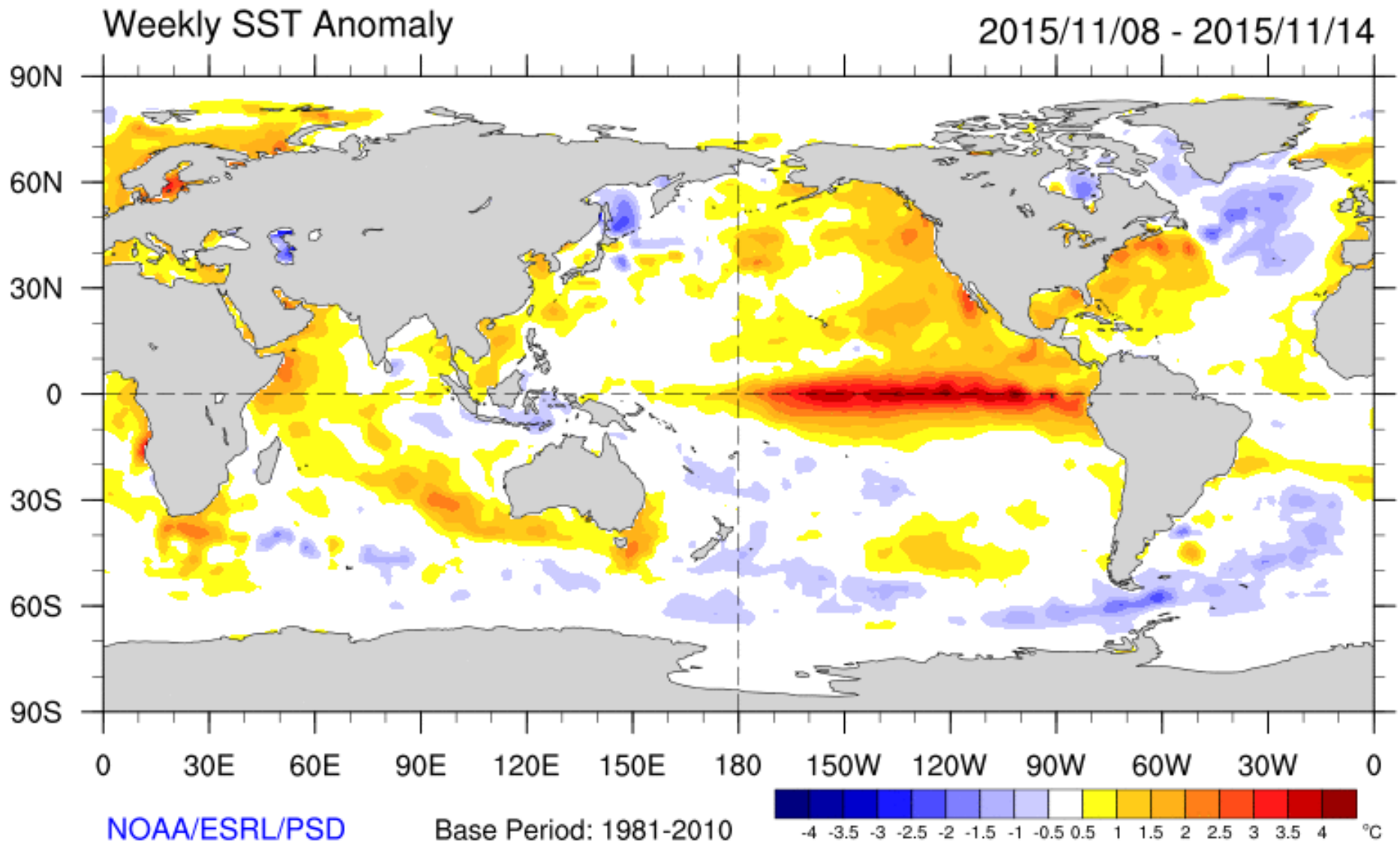
Less Cloudy than Usual. More Cloudy than Usual.



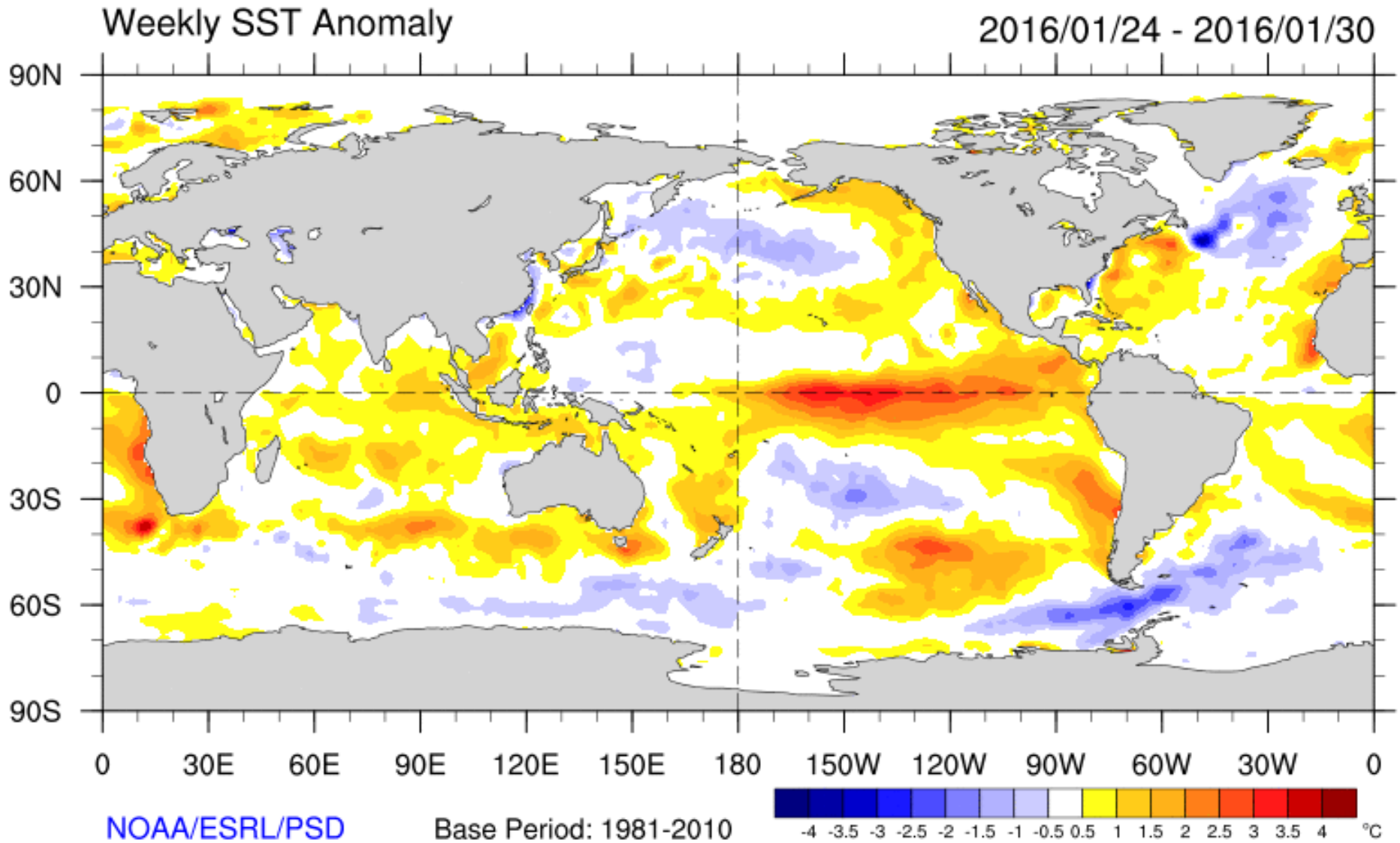
Ocean Departures from Average Temperature (C) 2015 Jun 21 - 27



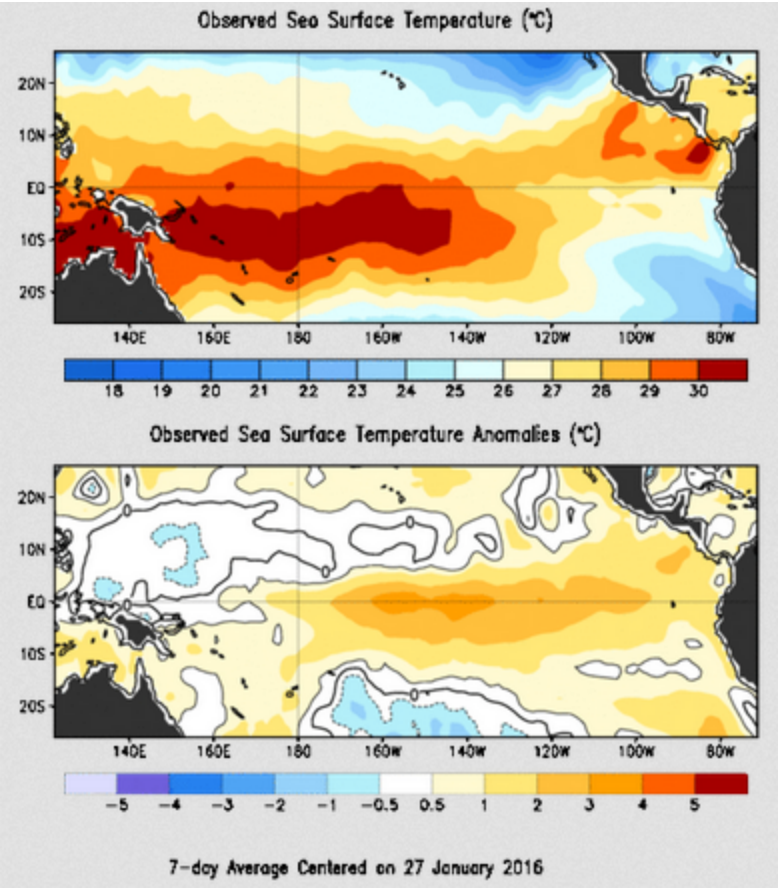
Ocean Departures from Average Temperature (C) 2015 Nov 8 - 14

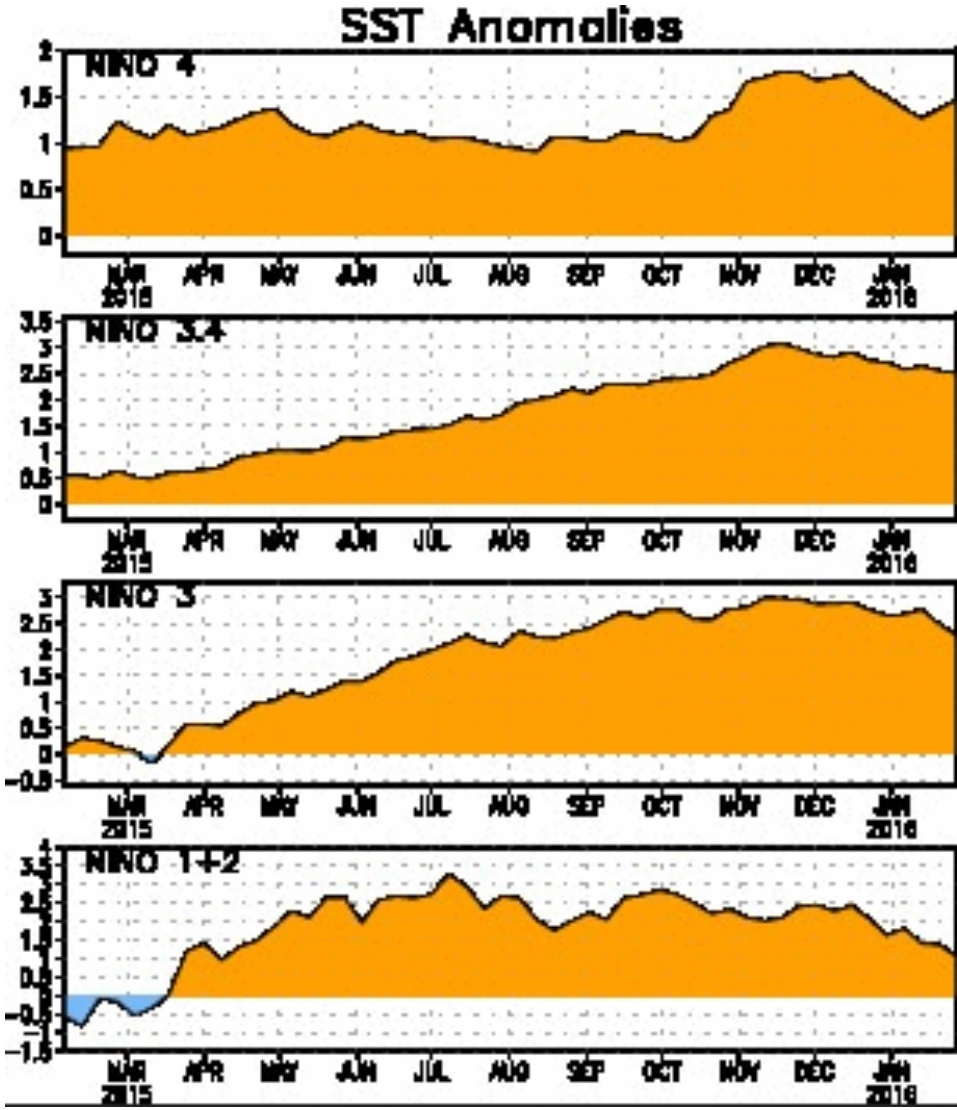


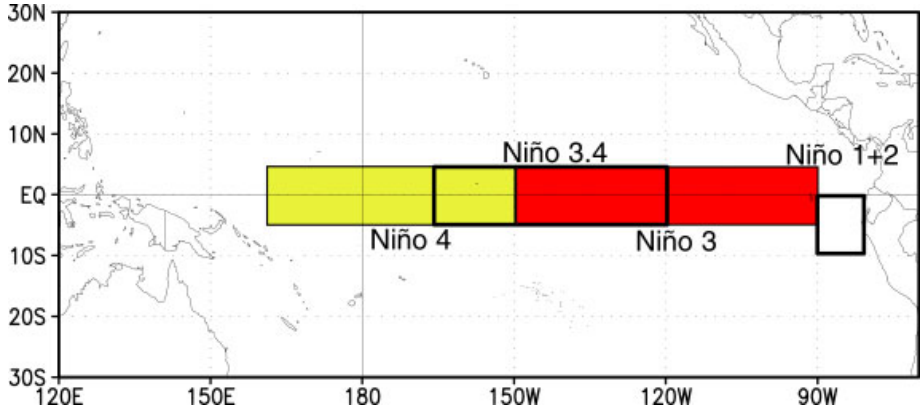
Ocean Departures from Average Temperature (C) 2016 Jan 24 - 30



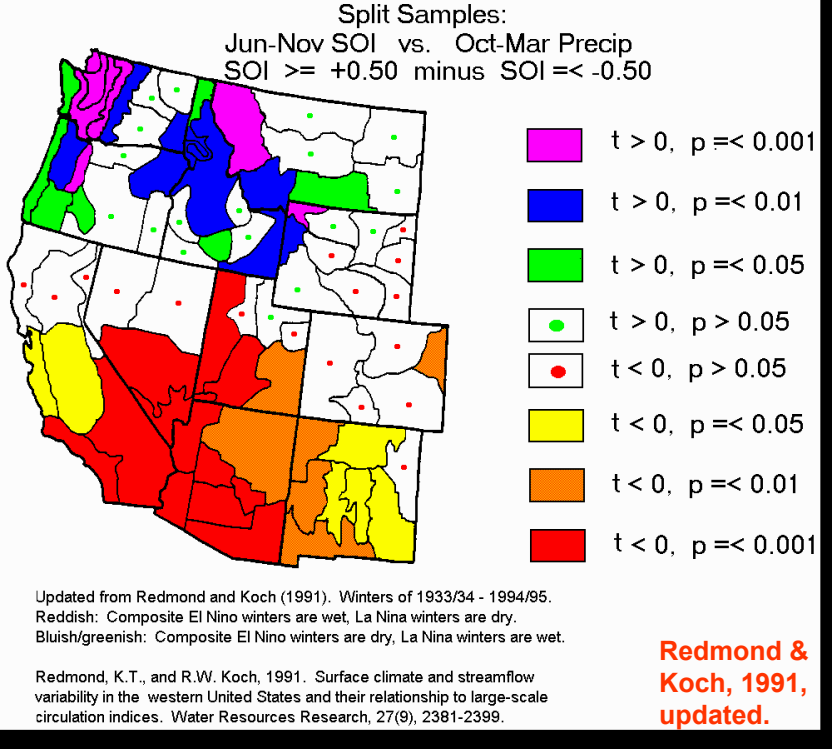
Recent Evolution of Equatorial Pacific SST Departures

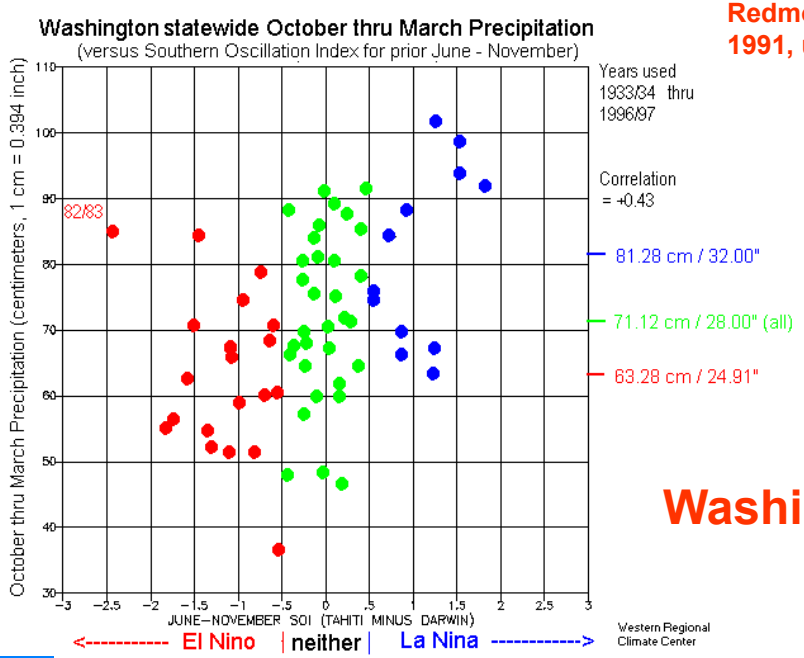




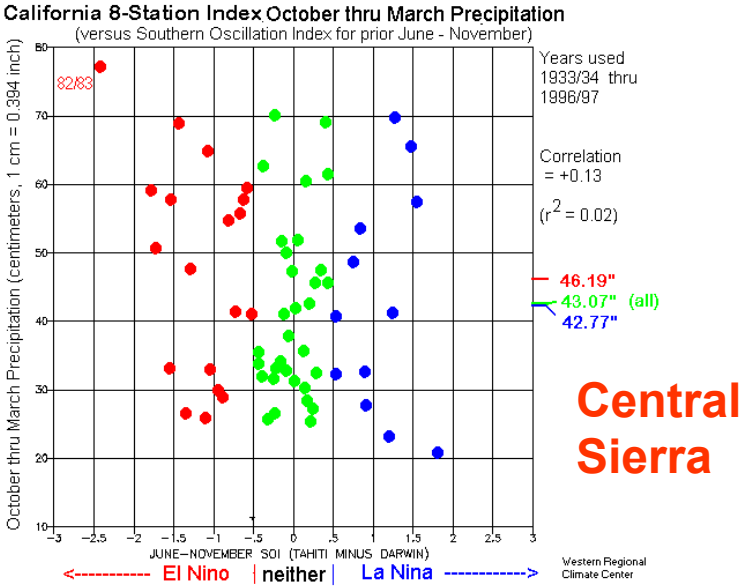


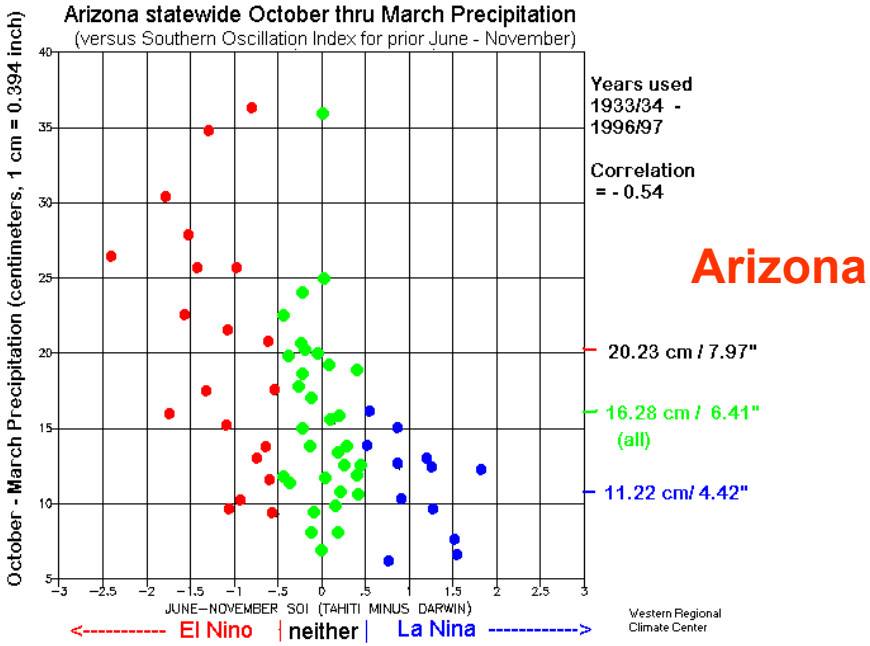
Updated through 2016 Jan 24 - 30

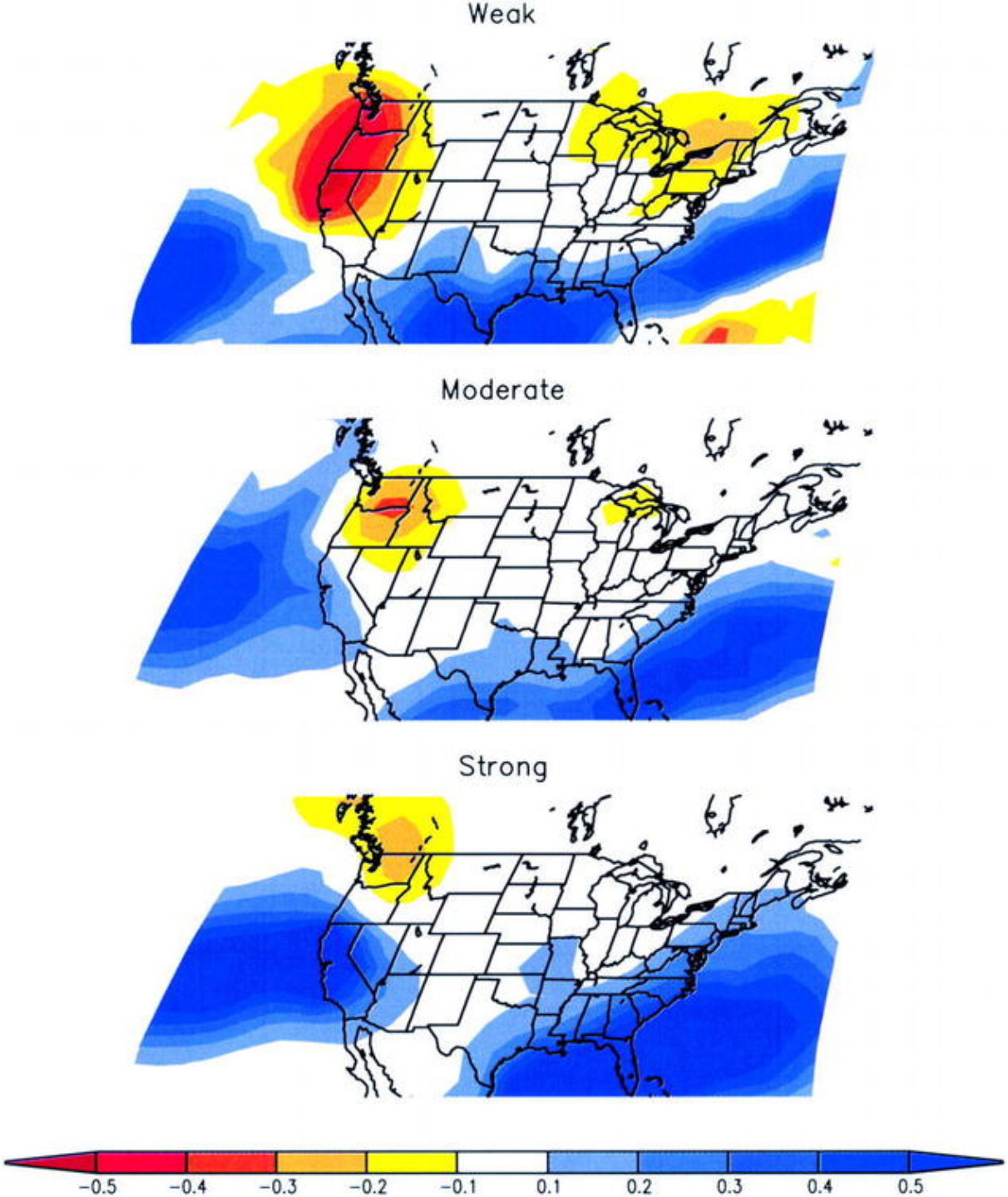

Split Samples:
Jun-Nov SOI vs. Oct-Mar Precip
SOI >= +0.50 minus SOI =< -0.50
t > 0, p =< 0.001
t > 0, p =< 0.01
t > 0, p =< 0.05
t > 0, p > 0.05
t < 0, p > 0.05
t < 0, p =< 0.05
t < 0, p =< 0.01
t < 0, p =< 0.001
Updated from Redmond and Koch (1991). Winters of 1933/34 - 1994/95.
Reddish: Composite El Nino winters are wet, La Nina winters are dry.
Bluish/greenish: Composite El Nino winters are dry, La Nina winters are wet.
Redmond, K.T., and R.W. Koch, 1991. Surface climate and streamflow variability in the western United States and their relationship to large-scale circulation indices. Water Resources Research, 27(9), 2381-2399.
Redmond & Koch, 1991, updated.


Washington statewide October thru March Precipitation
(versus Southern Oscillation Index for prior June - November)
Redmond & Koch, 1991, updated.
Years used 1933/34 thru 1996/97
Correlation = +0.43
82/83
81.28 cm / 32.00"
71.12 cm / 28.00" (all)
63.28 cm / 24.91"
October thru March Precipitation (centimeters, 1 cm = 0.394 inch)
JUNE–NOVEMBER SOI (TAHITI MINUS DARWIN)
<---------- El Nino | neither | La Nina ---------->
Western Regional Climate Center
Washington

ENSO


California 8-Station Index October thru March Precipitation
(versus Southern Oscillation Index for prior June - November)
Years used 1933/34 thru 1996/97
Correlation = +0.13
(r^2 = 0.02)
82/83
46.19"
43.07" (all)
42.77"
October thru March Precipitation (centimeters, 1 cm = 0.394 inch)
JUNE–NOVEMBER SOI (TAHITI MINUS DARWIN)
<---------- El Nino | neither | La Nina ---------->
Western Regional Climate Center
Central Sierra


Arizona statewide October thru March Precipitation
(versus Southern Oscillation Index for prior June - November)
Years used 1933/34 - 1996/97
Correlation = - 0.54
20.23 cm / 7.97"
16.28 cm / 6.41" (all)
11.22 cm/ 4.42"
October - March Precipitation (centimeters, 1 cm = 0.394 inch)
JUNE–NOVEMBER SOI (TAHITI MINUS DARWIN)
<---------- El Nino | neither | La Nina ---------->
Western Regional Climate Center
Arizona



DJF Precip

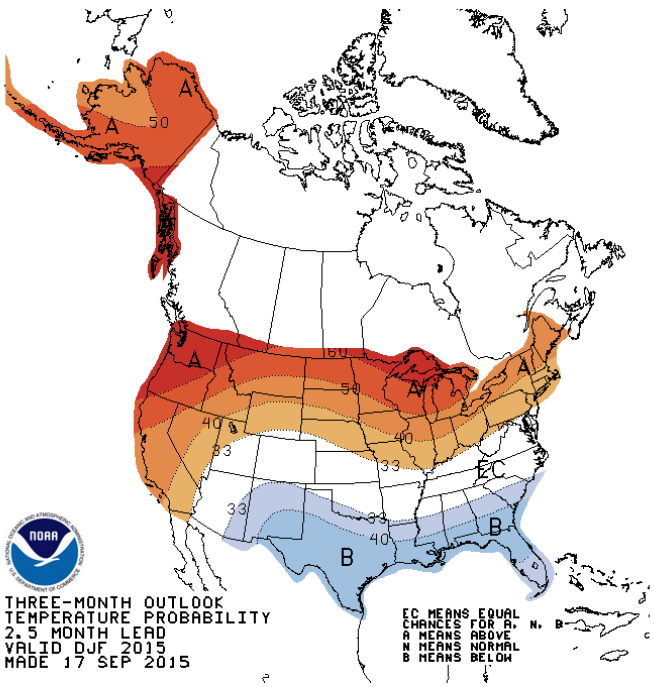
Hoerling and Kumar

2002

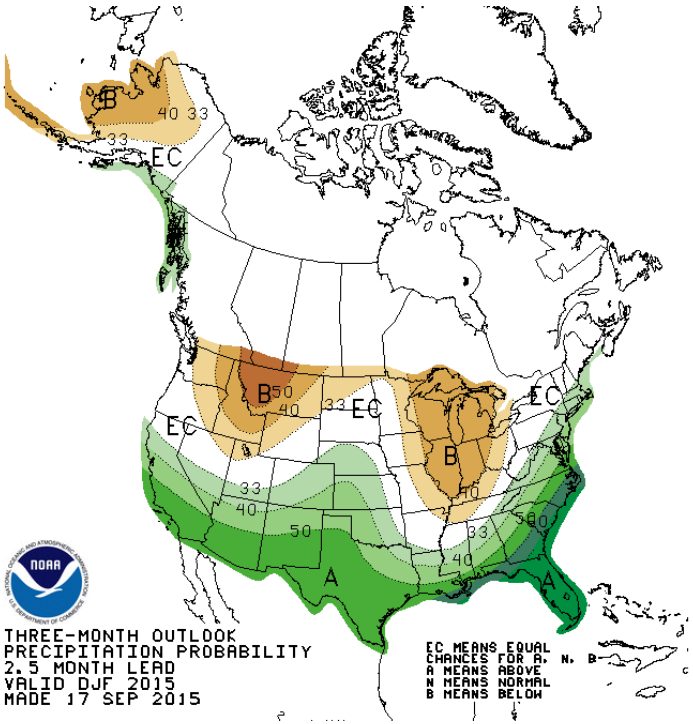
Journal of Climate

Temperature & Precipitation
2015-2016 Official Outlooks
Three Month Winter

Dec-Jan-Feb Temperature



Dec-Jan-Feb Precipitation

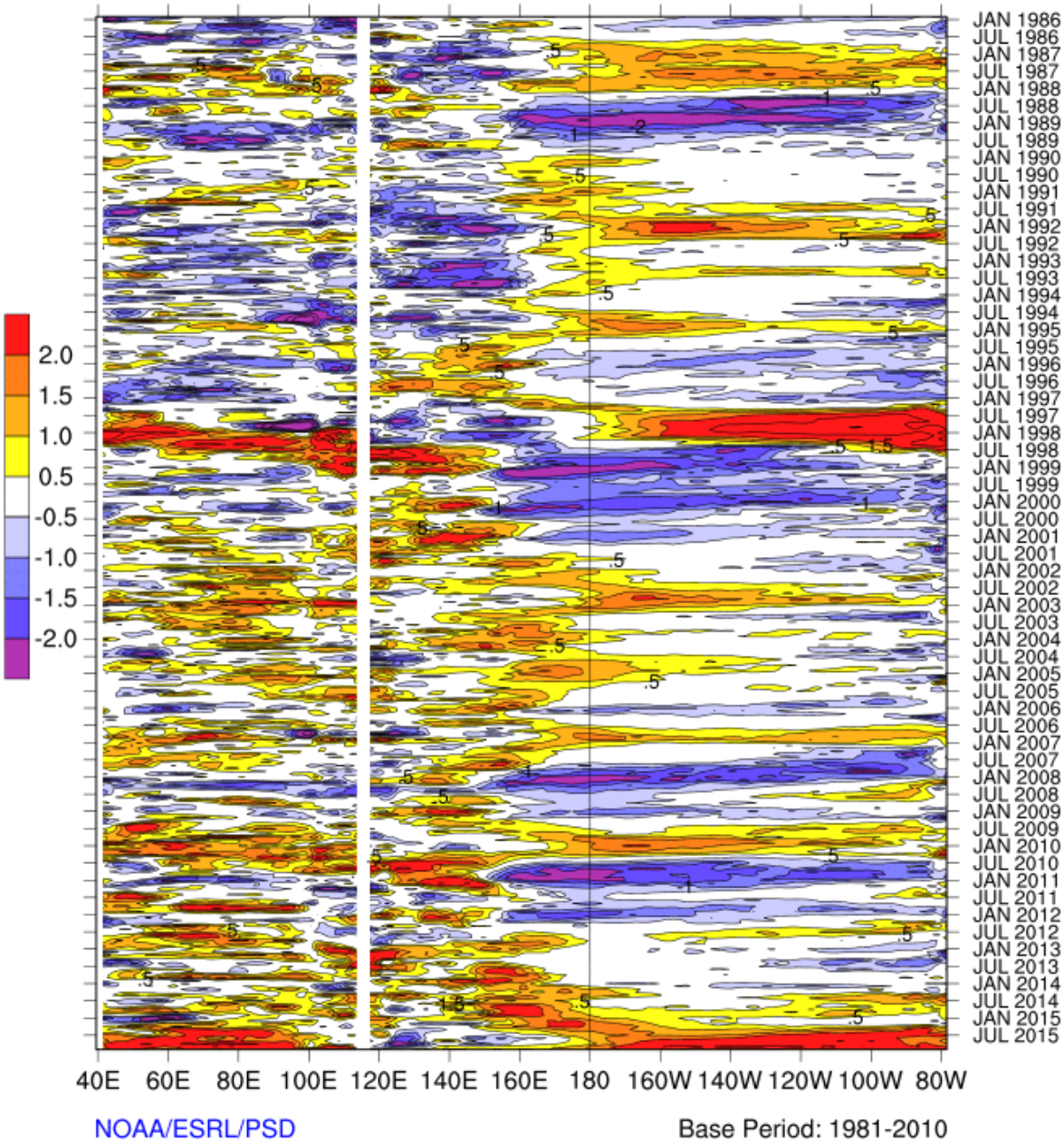


Orange / Red - Higher likelihood of warmer / drier than usual

Green / Blue - Higher likelihood of cooler / wetter than usual

NOAA Climate Prediction Center

30 Years of Equatorial Pacific Ocean Temperature Departures from Average



1986

87-88 Major El Nino

88-89 La Nina

97-98 Major El Nino

98-99 La Nina

2007-08 La Nina

2010-11 La Nina

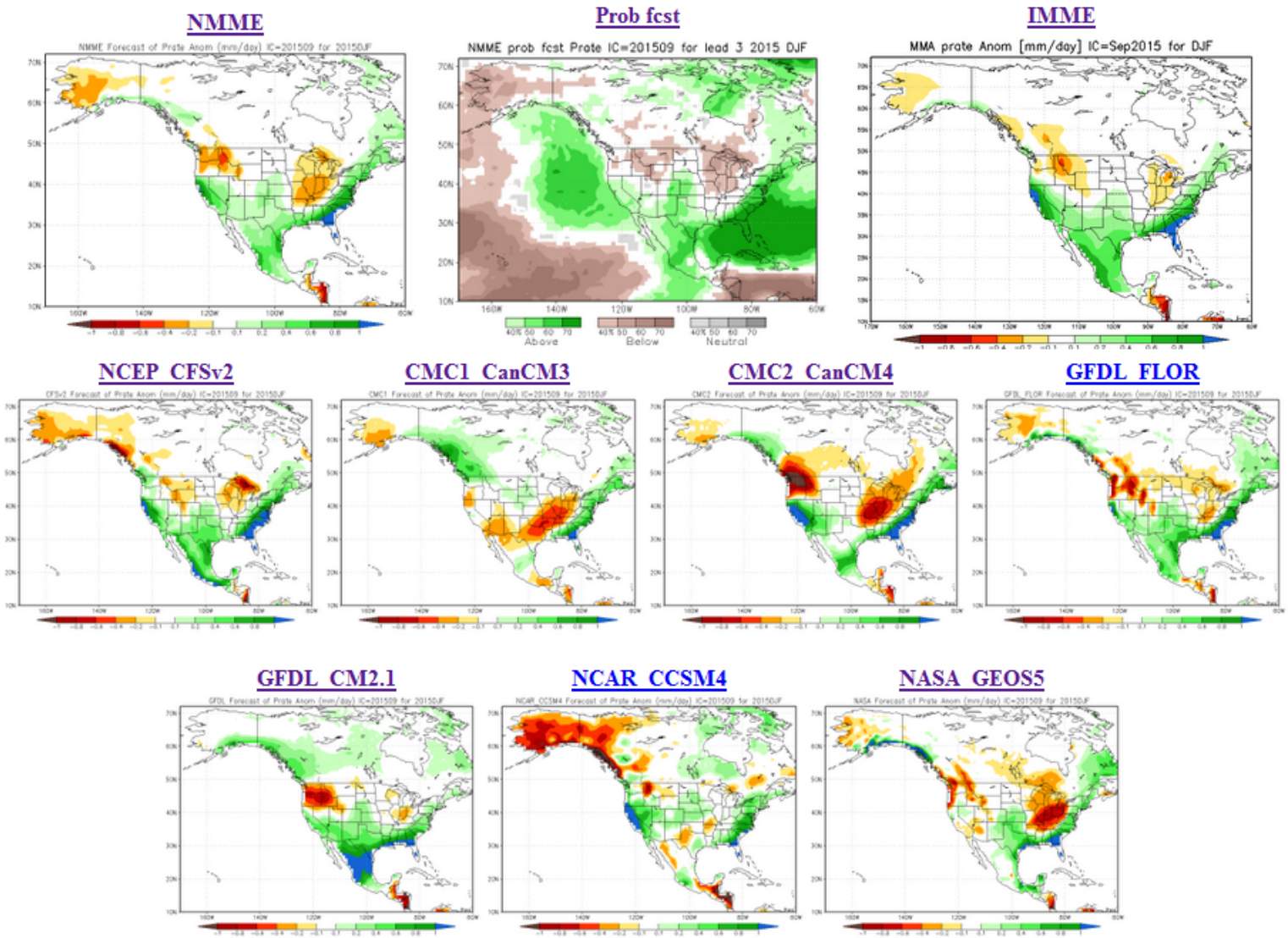
2015-16 Major El Nino

E Africa Indonesia Dateline W South America

Seven experiments in near-term climate forecasting Dec-Feb 2015-6. Precipitation.

NMME (National Multi-Model Ensemble). 2-month lead time

IMME (International Multi-Model Ensemble).



Dynamical Models

CFSv2: US Climate Forecasting System version 2

CMC1: Canadian Meteorological Center version 1

CMC2: Canadian Meteorological Center version 2

GFDL: US Geophysical Fluid Dynamics Laboratory

NCAR: US National Center for Atmospheric Research

NASA: US National Aeronautics and Space Administration

NMME: National Multi-Model Ensemble

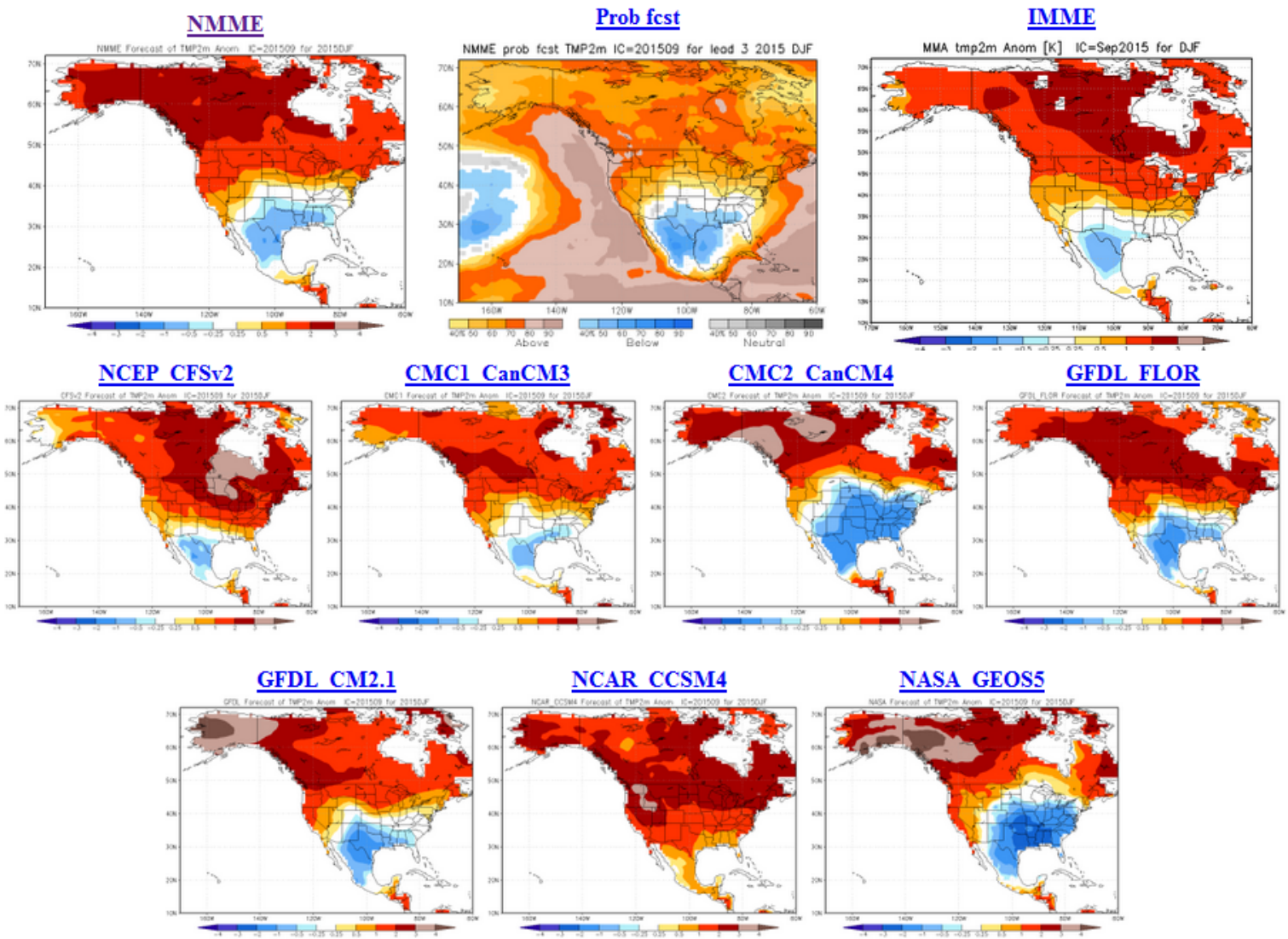
IMME: International Multi-Model Ensemble

2015 Sep 27

Seven experiments in near-term climate forecasting Dec-Feb 2015-16. Temperature.

NMME (National Multi-Model Ensemble). 2-month lead time

IMME (International Multi-Model Ensemble).



Dynamical Models

CFSv2: US Climate Forecasting System version 2

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NCAR: US National Center for Atmospheric Research

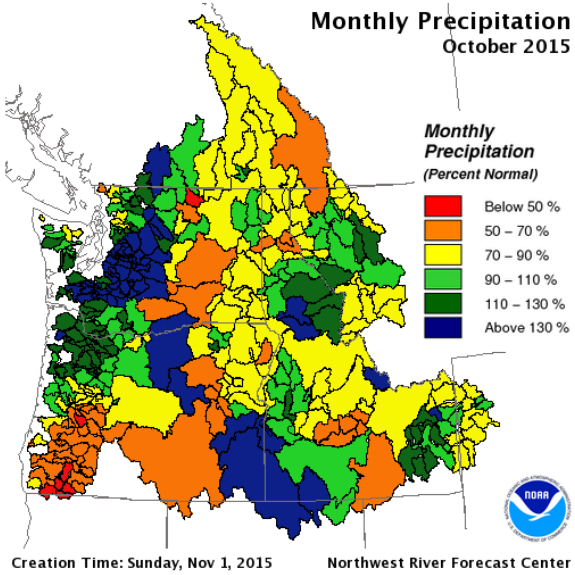
NASA: US National Aeronautics and Space Administration

NMME: National Multi-Model Ensemble

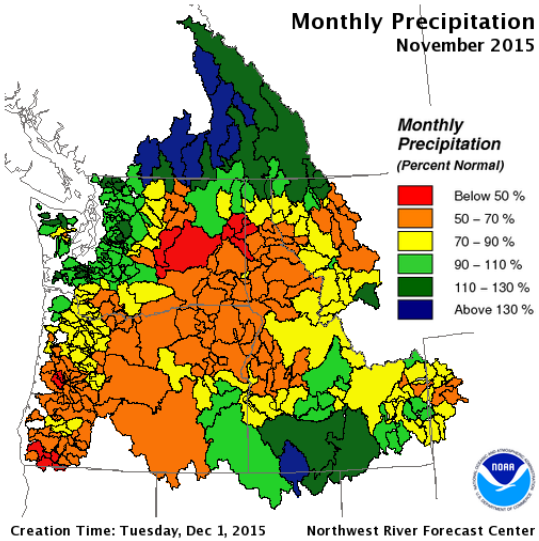
IMME: International Multi-Model Ensemble

2015 Sep 27

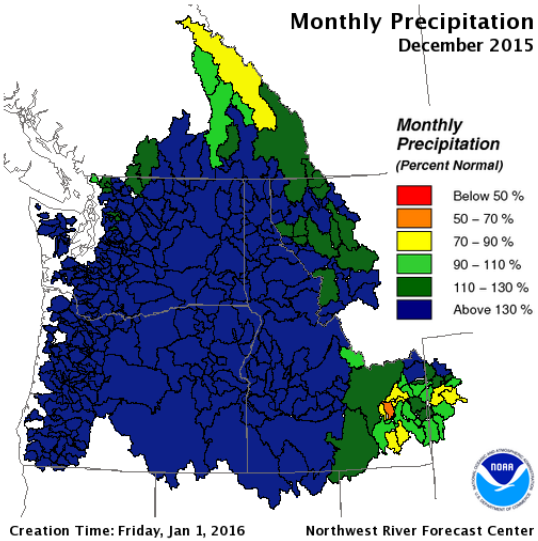
Percent of Average Precipitation



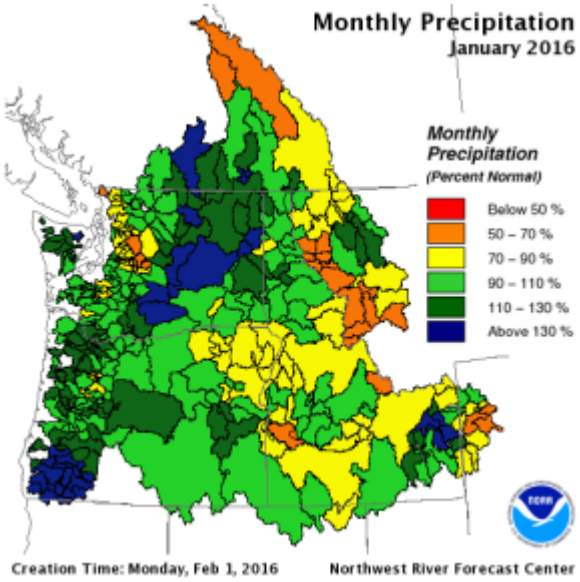
Oct 2015



Nov 2015



Dec 2015

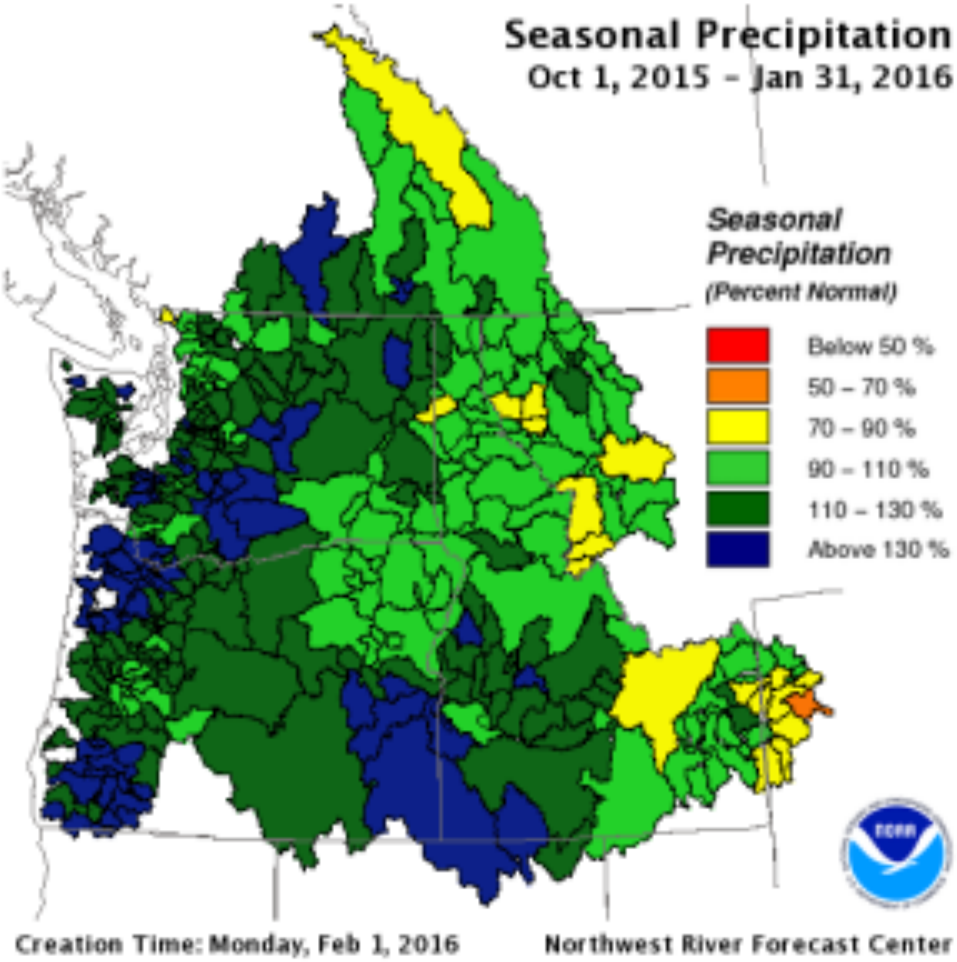


Jan 2016

Feb 2016

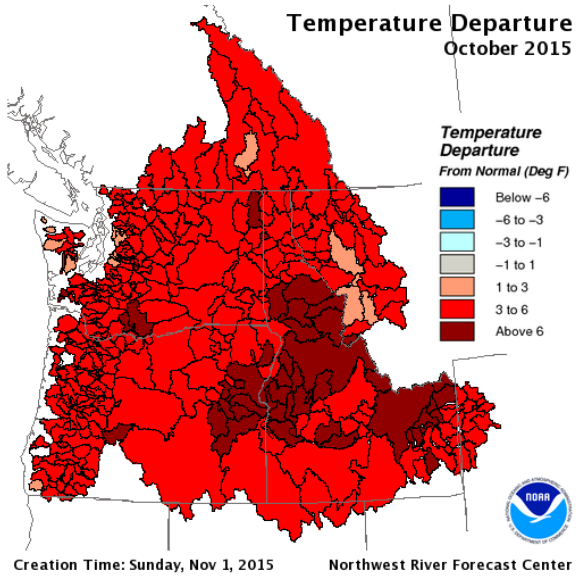
Mar 2016

PNW Precipitation Current Water Year

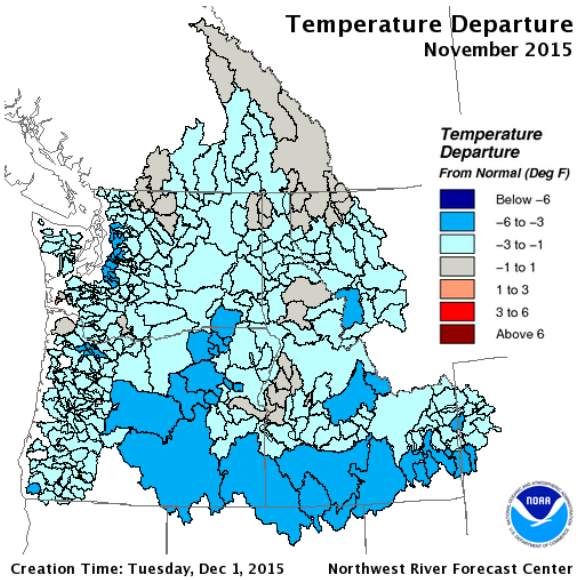


Oct 2015 - Jan 2016

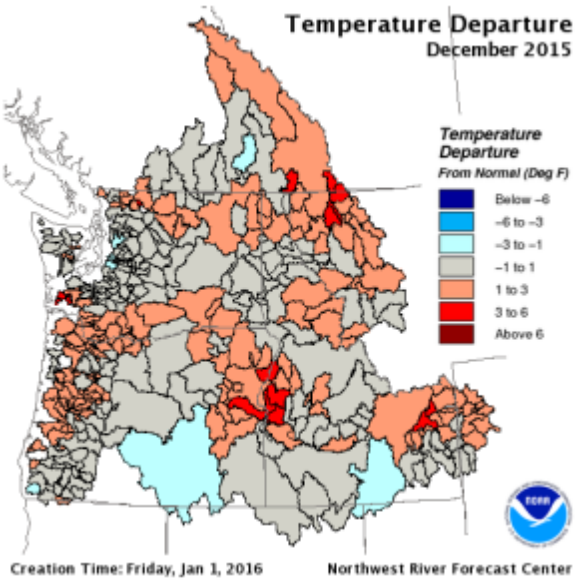
PNW Mean Temperature Departure from Normal



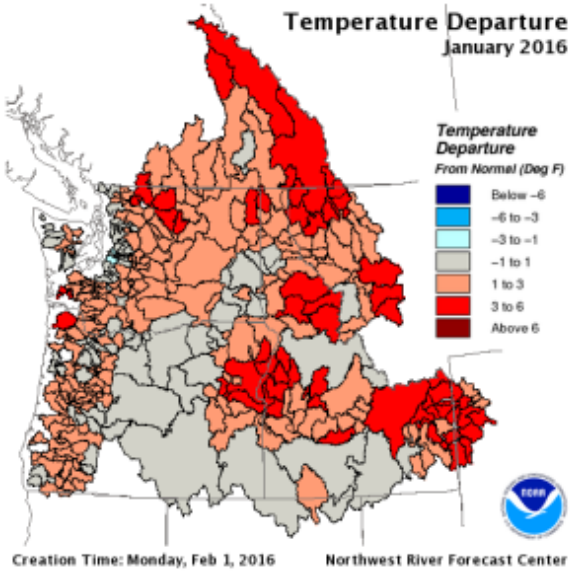
Oct 2015



Nov 2015



Dec 2015



Jan 2016

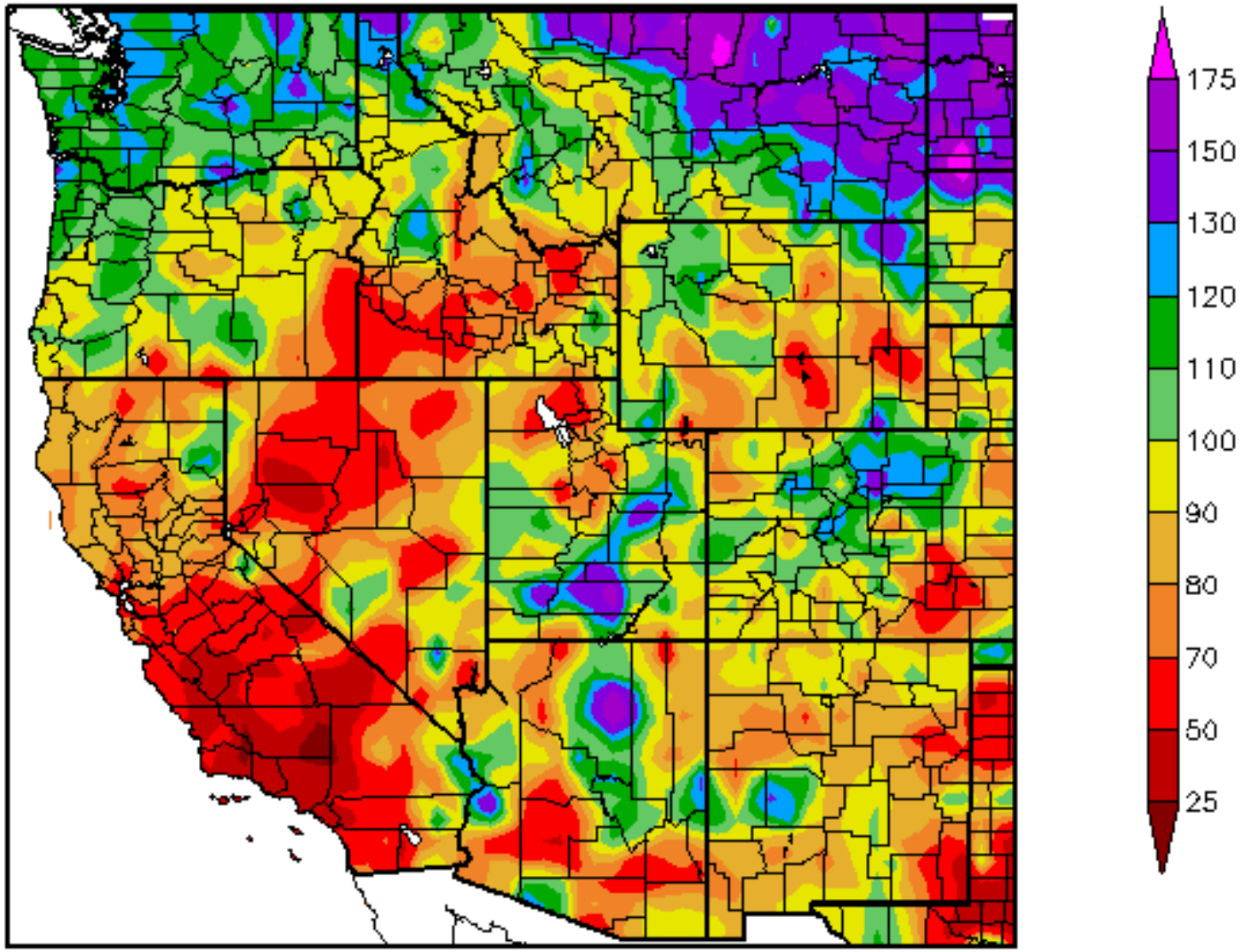
Feb 2016

Mar 2016

An Overlapping View using ACIS maps.
PNW and ACIS maps each have advantages.

Water Year
2012-13
01 Oct 2012
Thru
30 Sep 2013

Percent of Normal Precipitation (%)
10/1/2012 – 9/30/2013

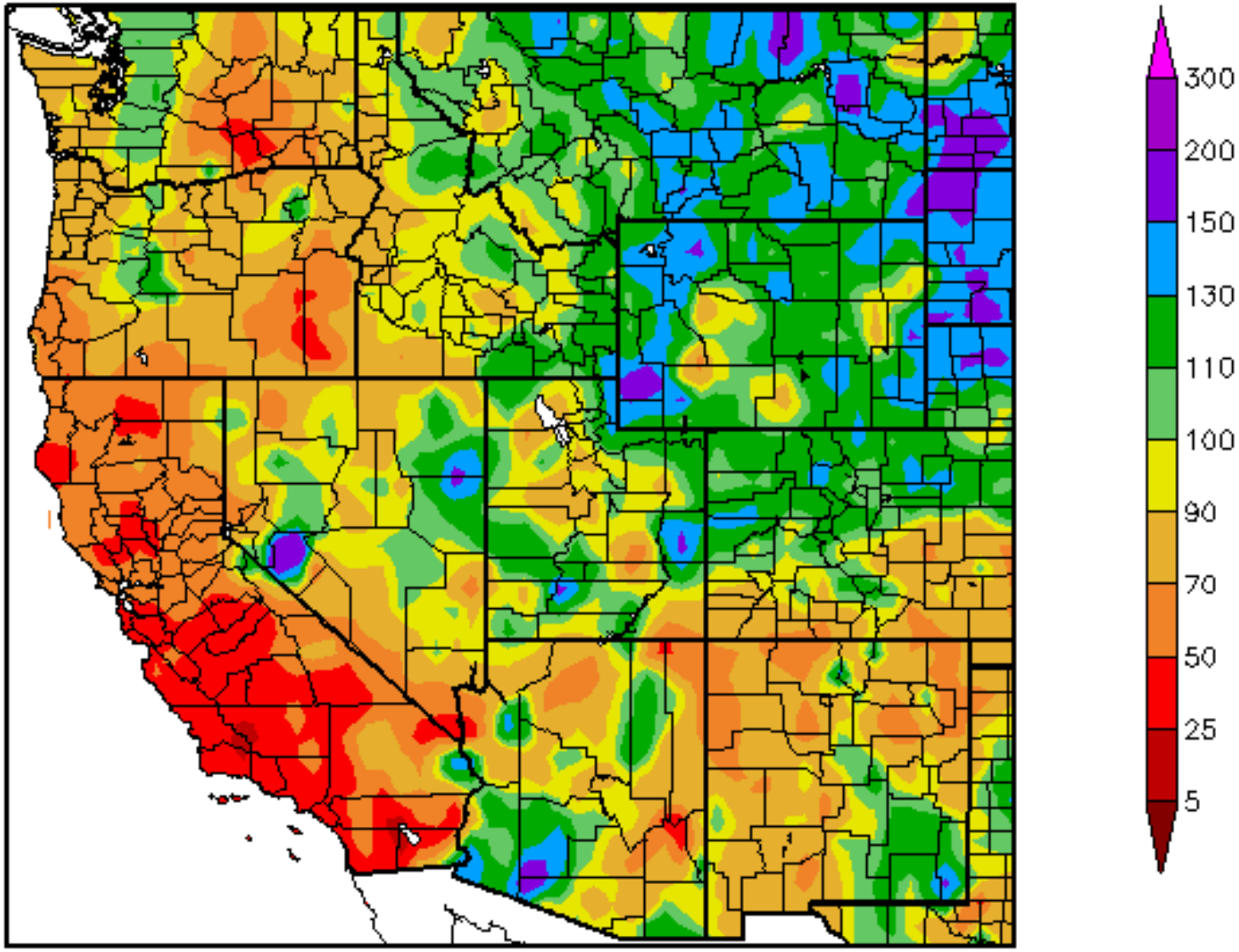


Generated 10/11/2013 at HPRCC using provisional data.

Regional Climate Centers

Water Year
2013-14
01 Oct 2013
Thru
30 Sep 2014

Percent of Normal Precipitation (%)
10/1/2013 – 9/30/2014

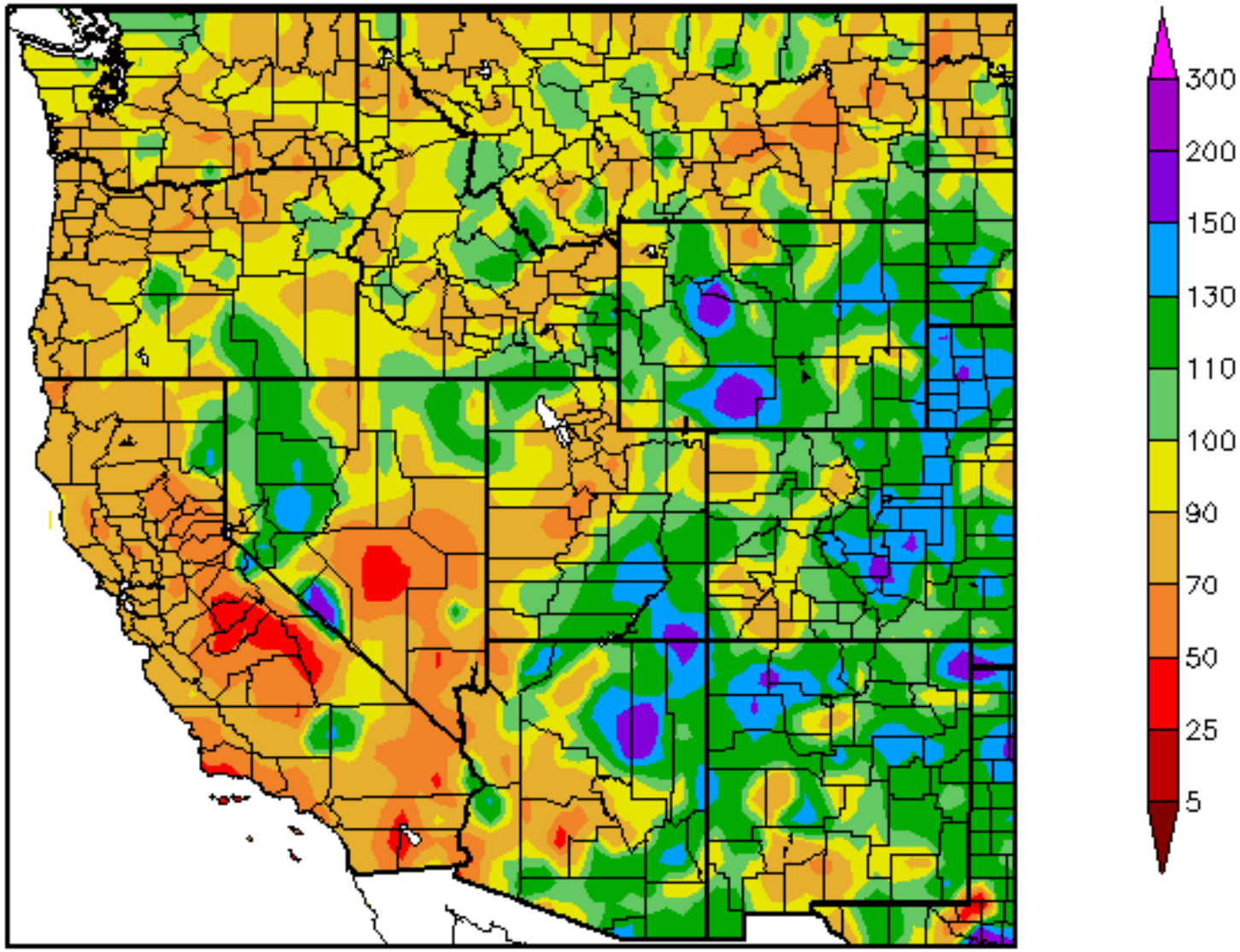


Generated 10/11/2014 at HPRCC using provisional data

Regional Climate Centers

Water Year
2014-15 to date
01 Oct 2014
Thru
30 Sep 2015

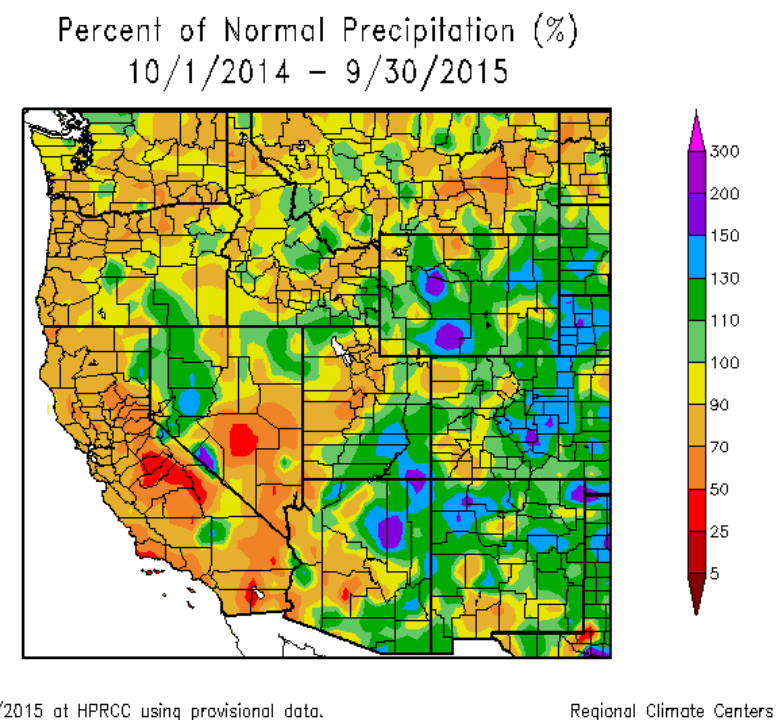
Percent of Normal Precipitation (%)
10/1/2014 – 9/30/2015

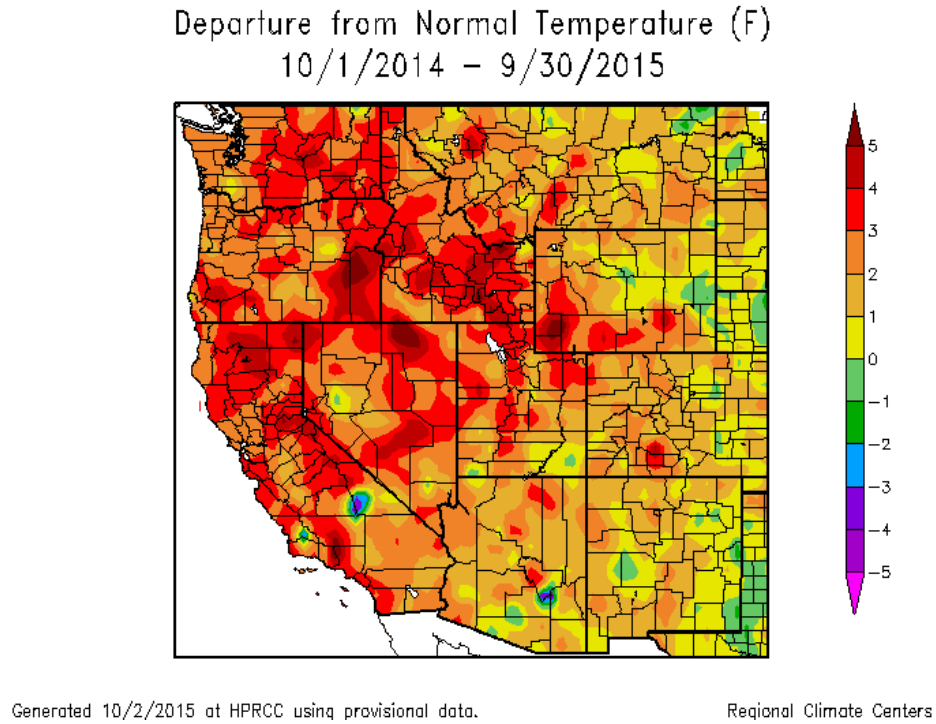


Generated 10/2/2015 at HPRCC using provisional data.

Regional Climate Centers

Water Year 2014-2015

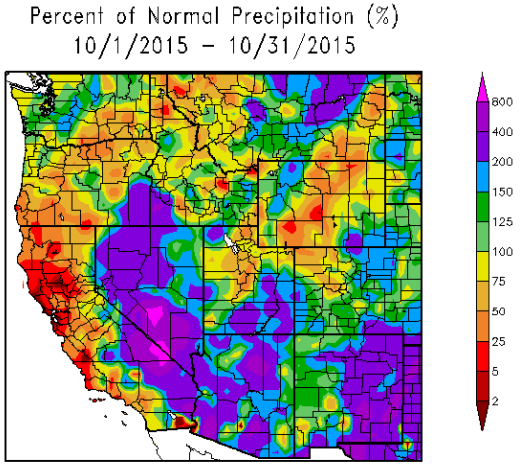




Precipitation Percent

Temperature Departure (F)

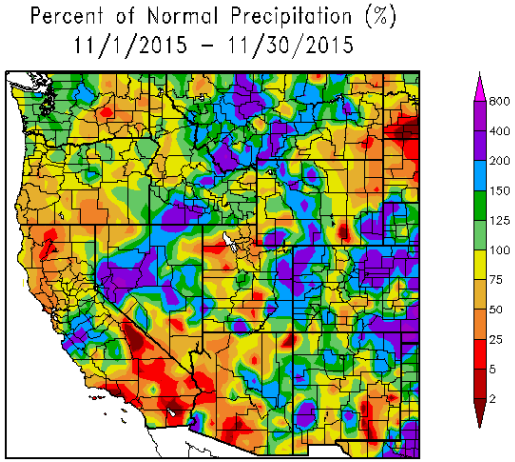
Precipitation Percent of Average



Generated 11/11/2015 at HPRCC using provisional data.

Regional Climate Cent.

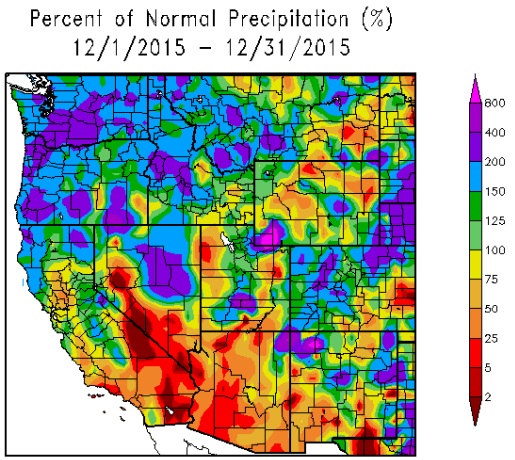
Oct 2015



Generated 12/11/2015 at HPRCC using provisional data.

Regional Climate Cent.

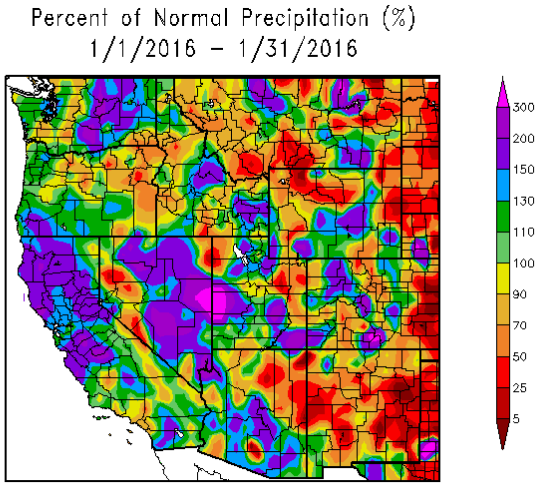
Nov 2015



Generated 1/11/2016 at HPRCC using provisional data.

Regional Climate Centers

Dec 2015

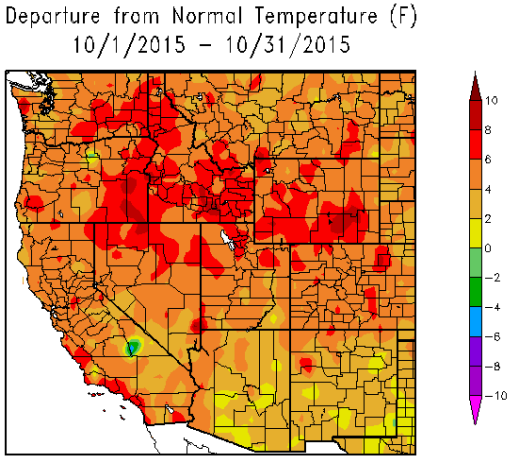


Generated 2/1/2016 at HPRCC using provisional data.

Regional Climate Centers

Jan 2016

Mean Temperature Departure from Normal



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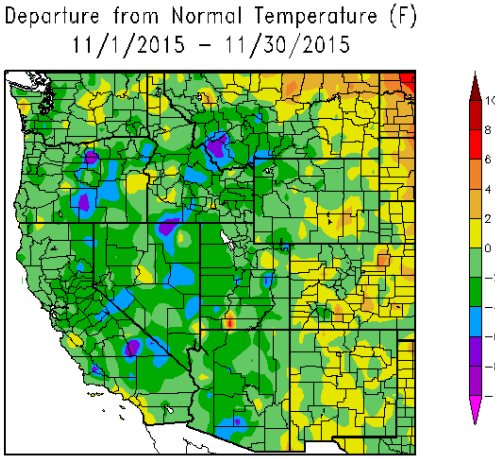
Oct 2015



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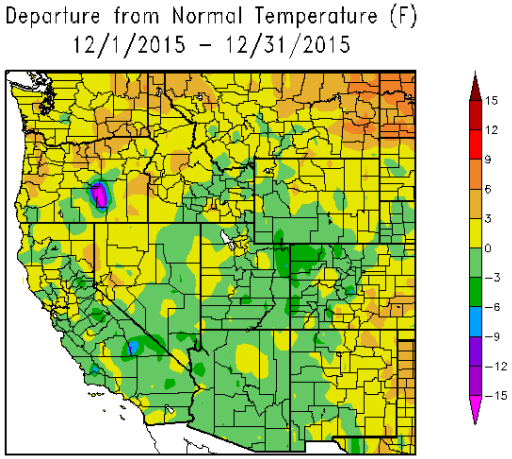
Nov 2015



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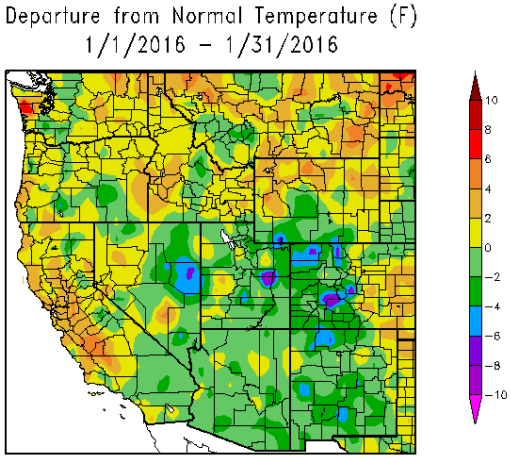
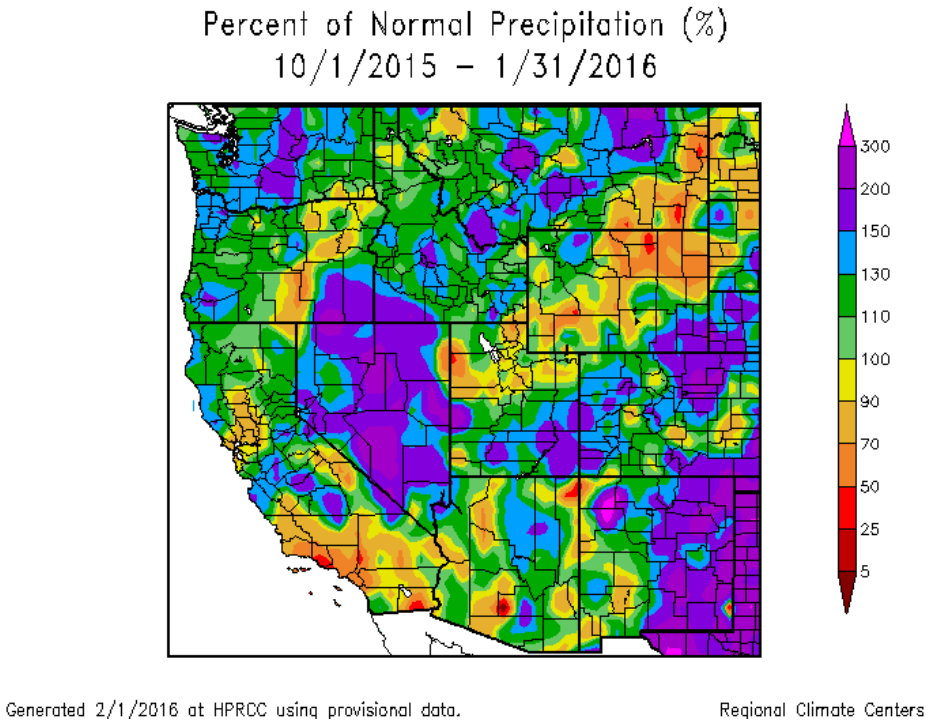
Dec 2015

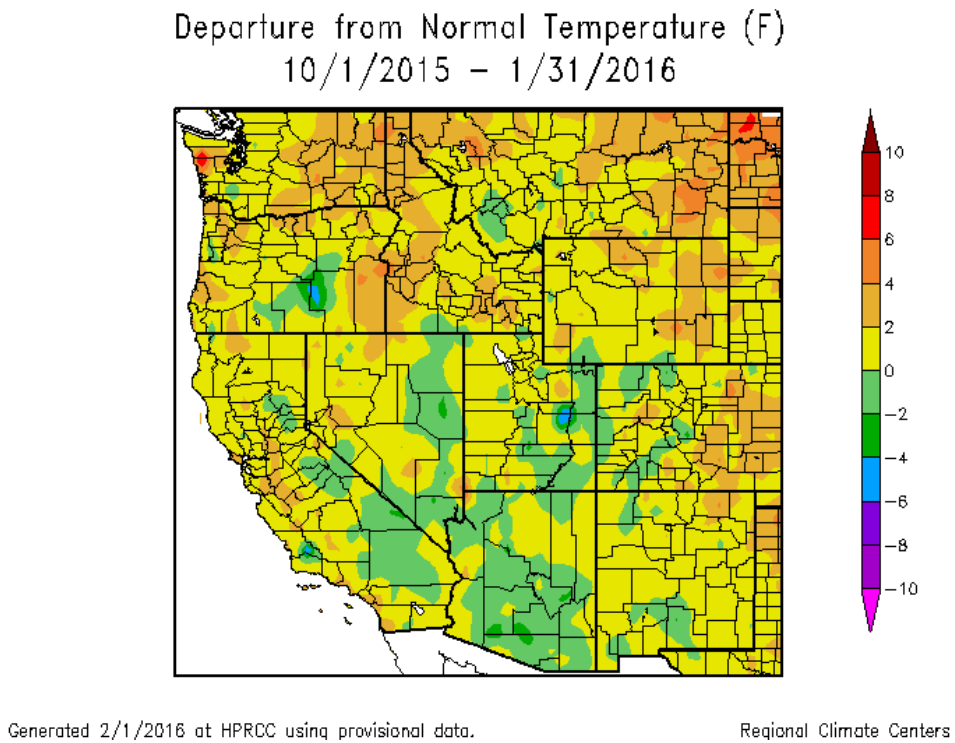


Generated 2/1/2016 at HPRCC using provisional data. Regional Climate Centers

Jan 2016

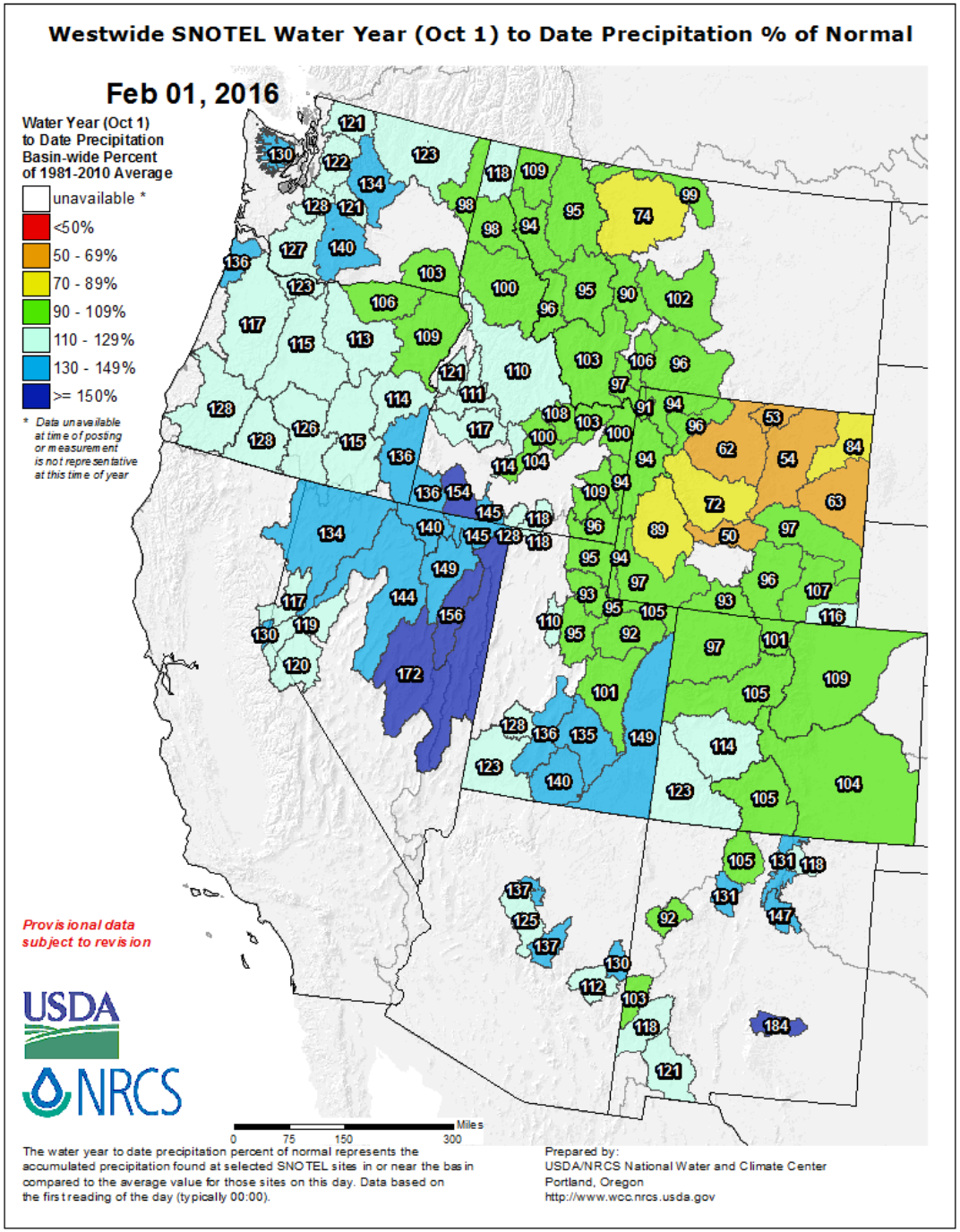
Water Year 2015-2016 Oct thru Jan





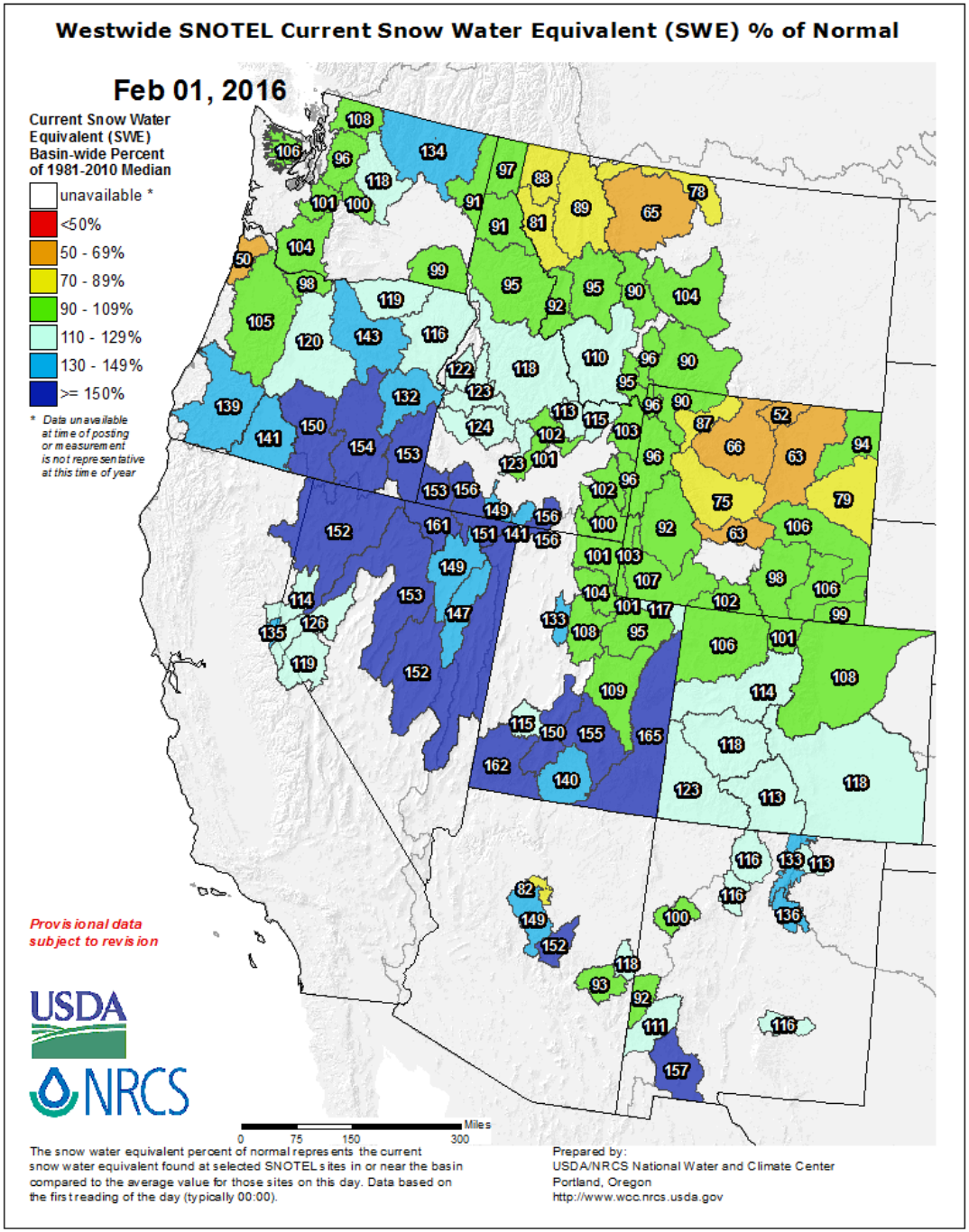
Precipitation Percent

Temperature Departure (F)



Snotel
Basin-Average
Water Year Precipitation

2015 Oct 1 thru 2016 Feb 01

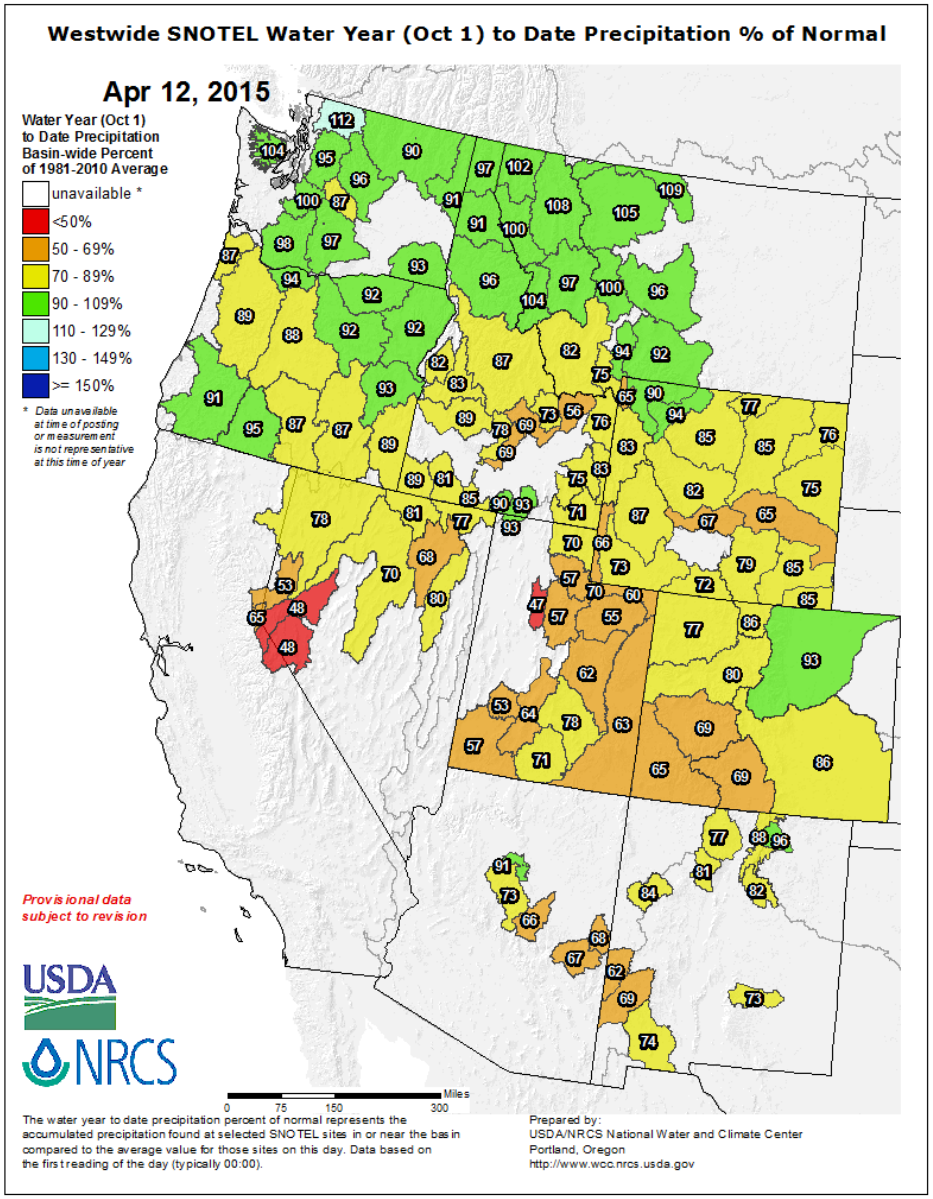


Snotel
Basin-Averaged
Snow Water Equivalent

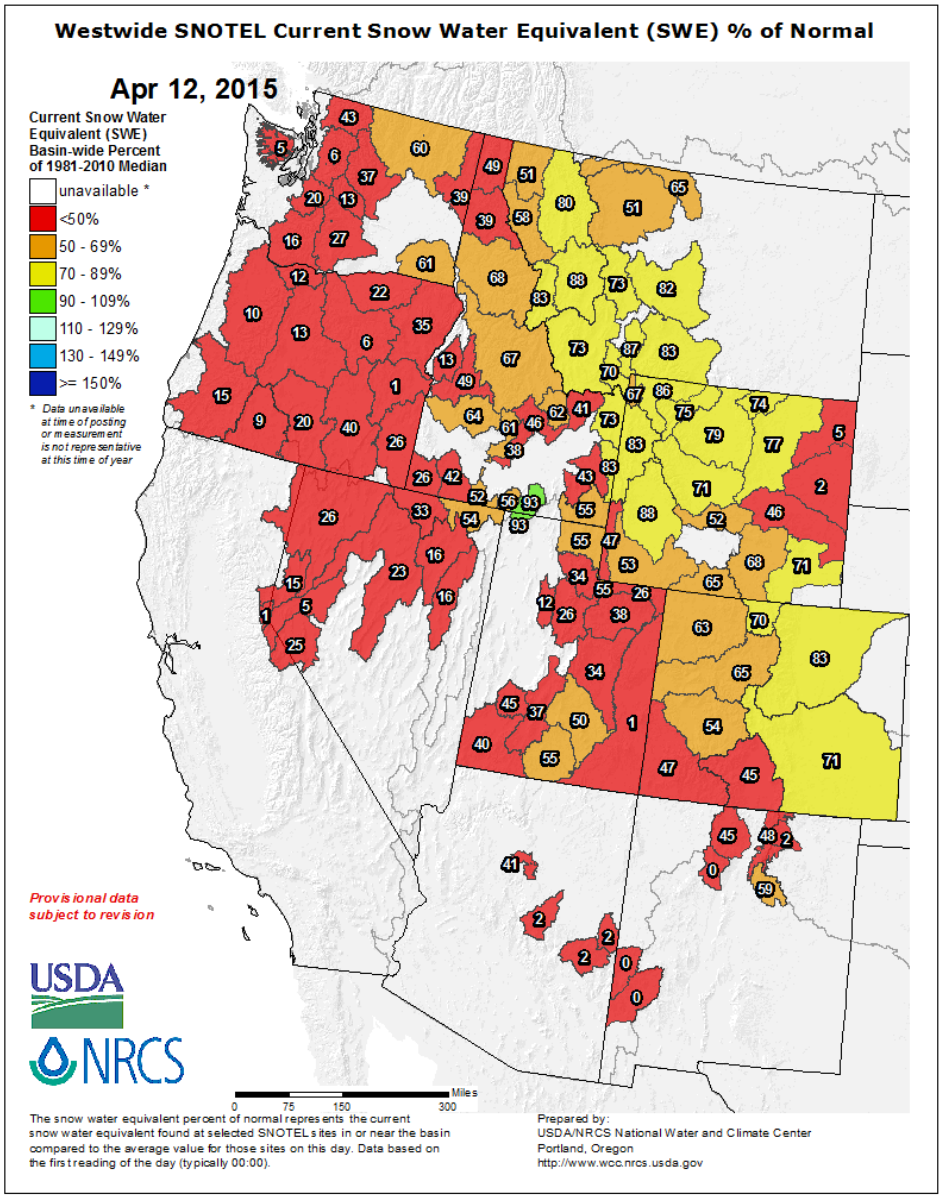
2016 February 1

The Great Snow Drought of 2014-15

Precipitation



Snowpack



Overall patterns matter.

But so does the way in which

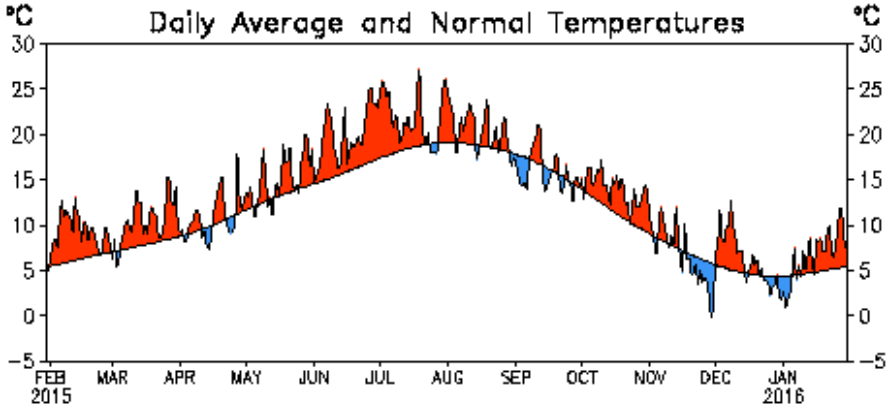
climate unfolds through day by day.

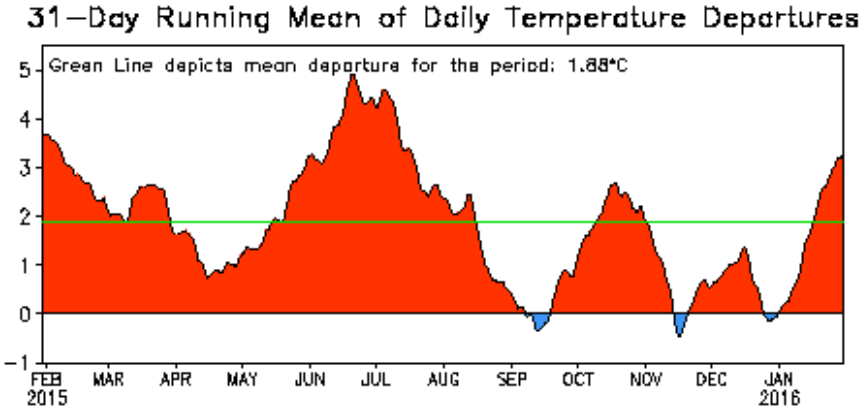
- - - - -

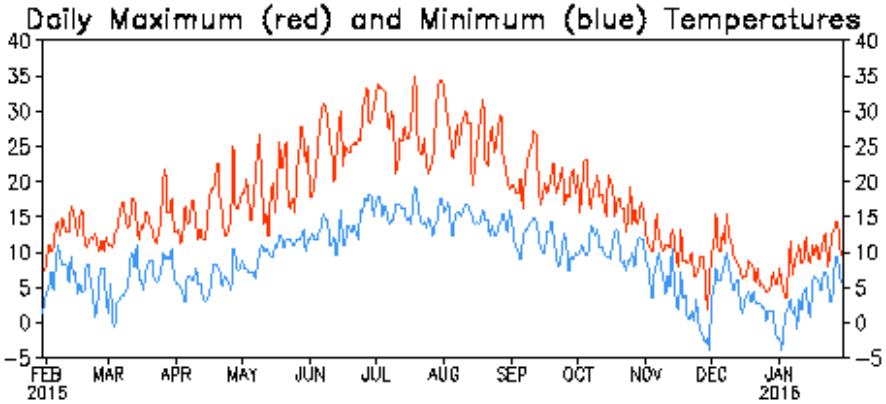
A few example sources.

365 Day Temperature Departures thru 2016 January 29

SEATTLE–TACOMA, WASHINGTON



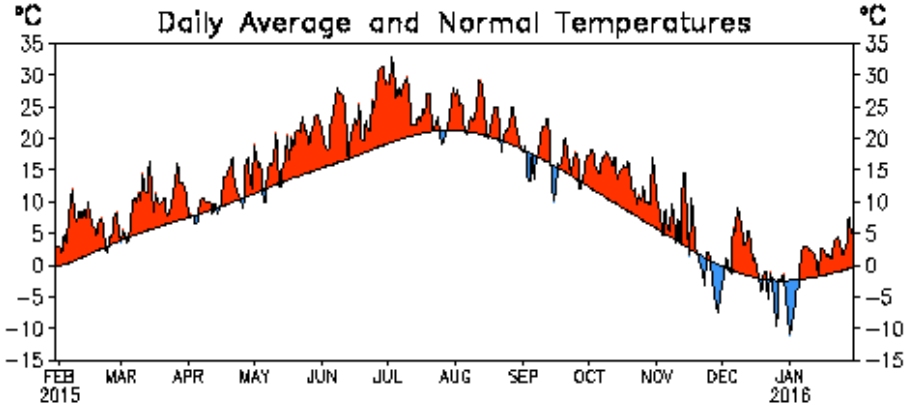


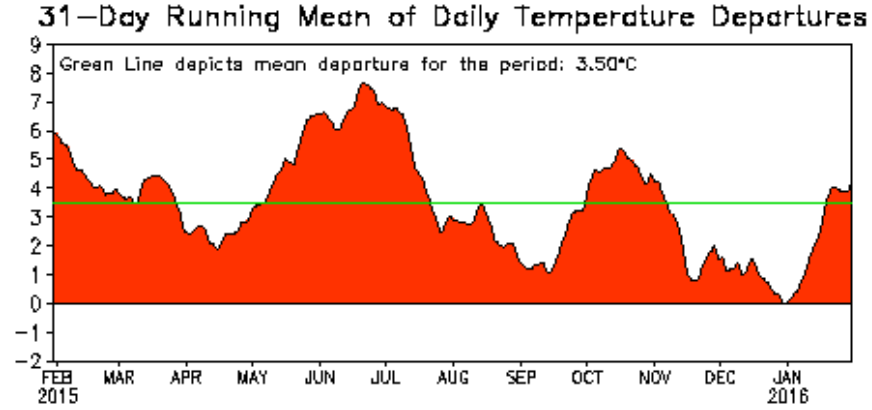


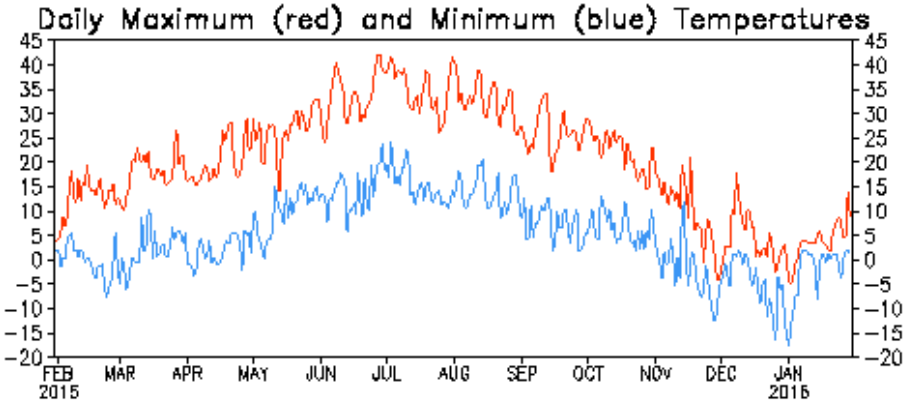
Data updated through 29 JAN 2016

CLIMATE PREDICTION CENTER/NCEP

YAKIMA, WASHINGTON





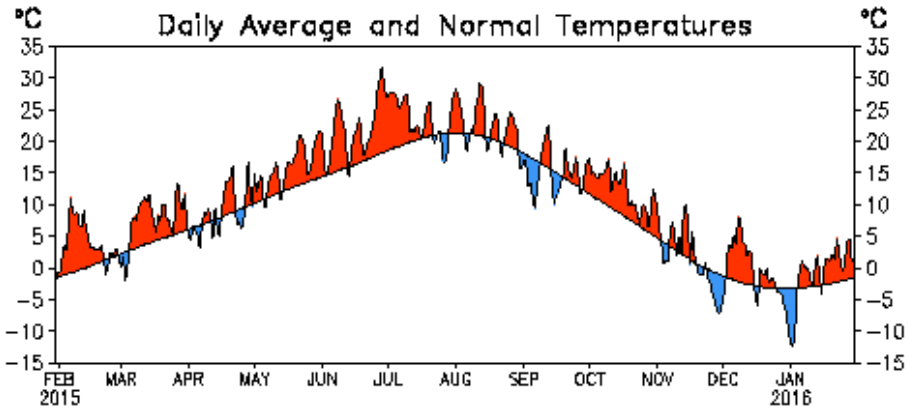


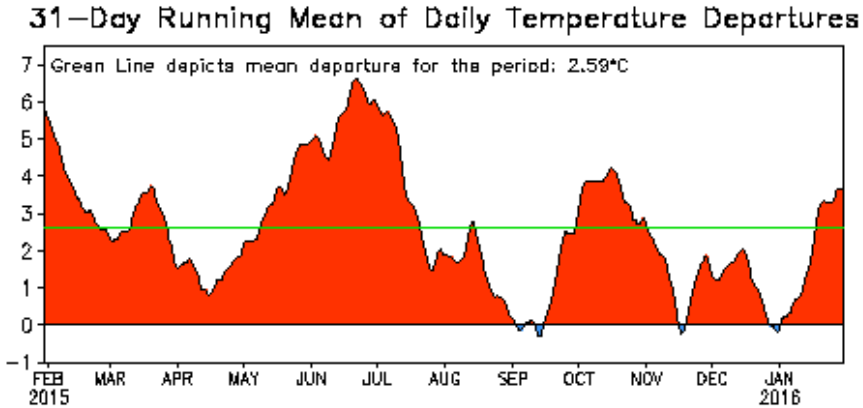
Data updated through 29 JAN 2016

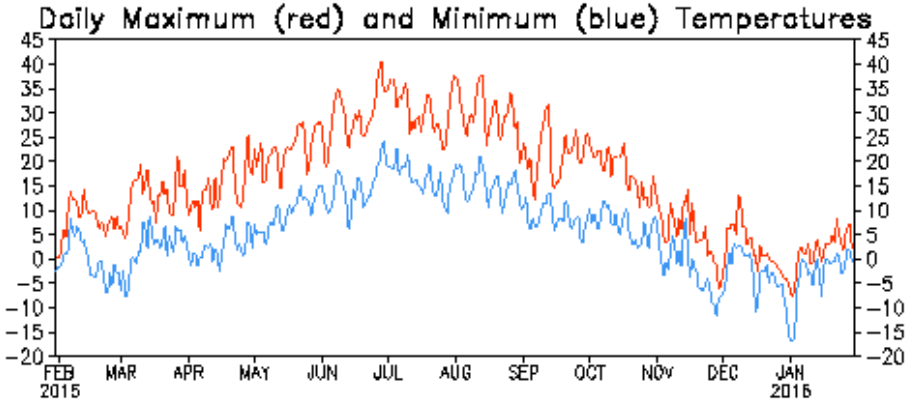
CLIMATE PREDICTION CENTER/NCEP

365 Day Temperature Departures thru 2016 January 29

SPOKANE, WASHINGTON



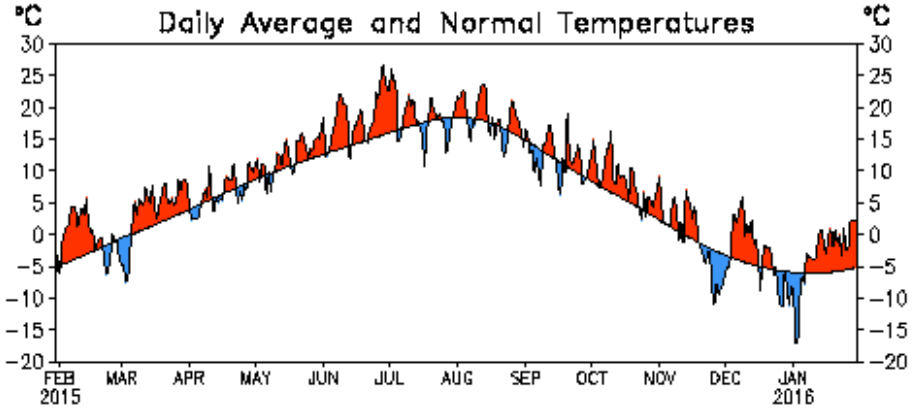


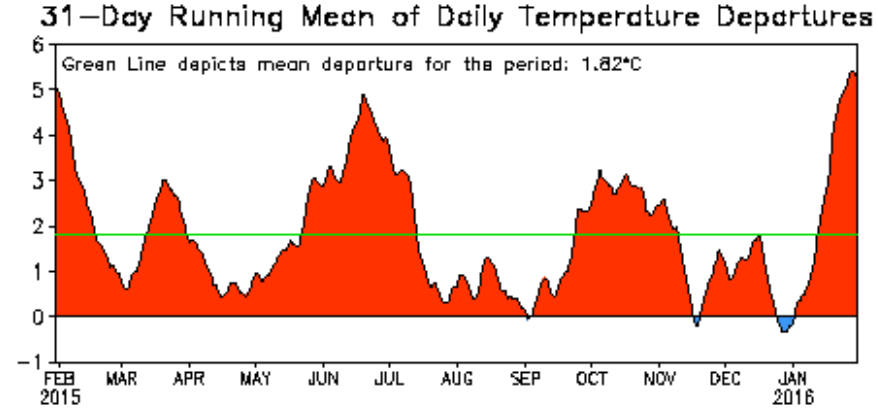


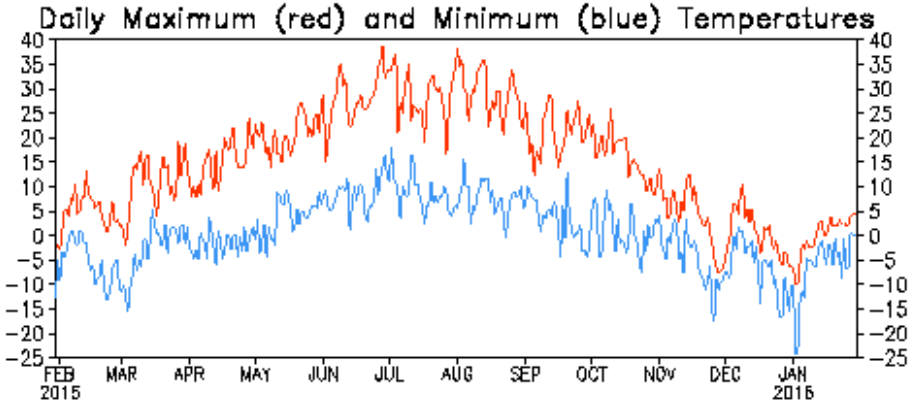
Data updated through 29 JAN 2016

CLIMATE PREDICTION CENTER/NCEP

KALISPELL, MONTANA





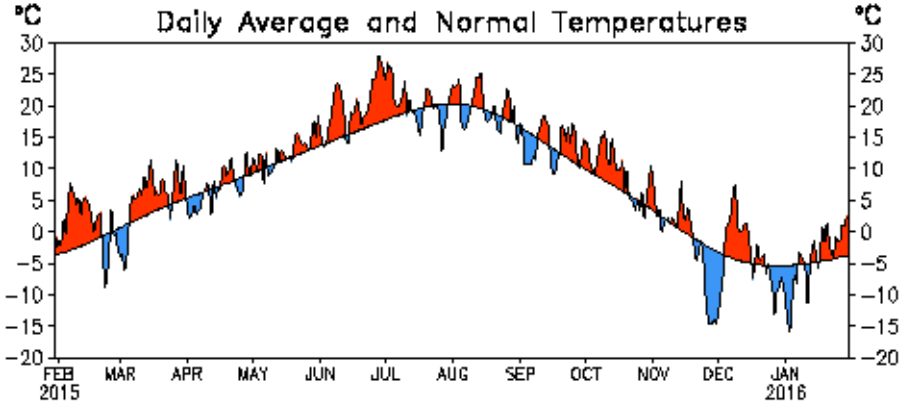


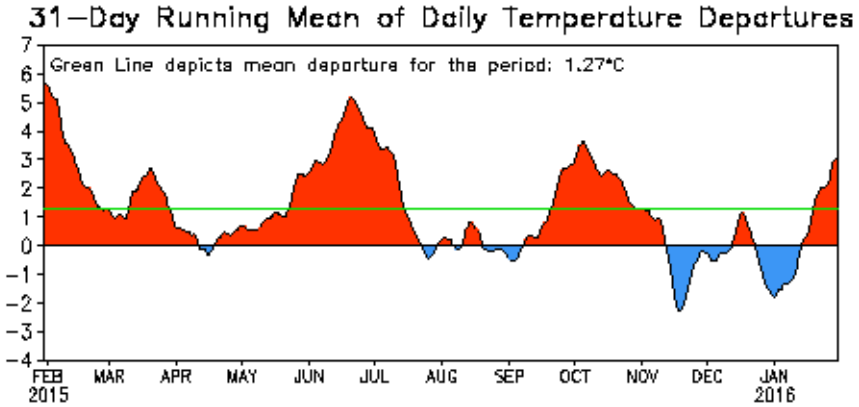
Data updated through 29 JAN 2016

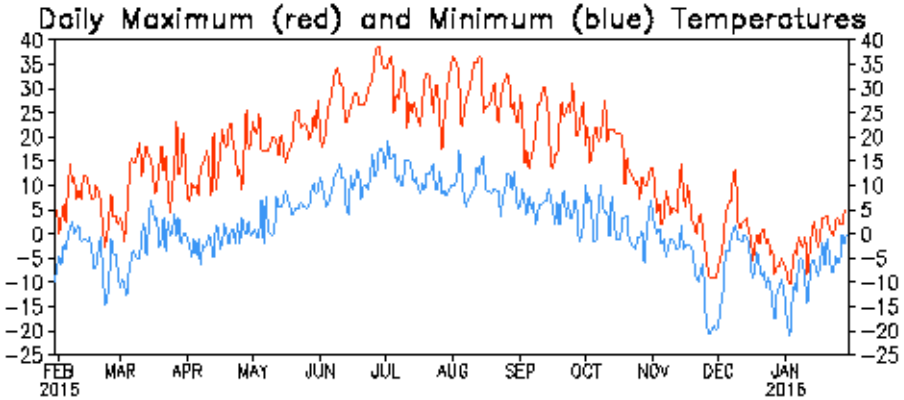
CLIMATE PREDICTION CENTER/NCEP

365 Day Temperature Departures thru 2016 January 29

MISSOULA, MONTANA



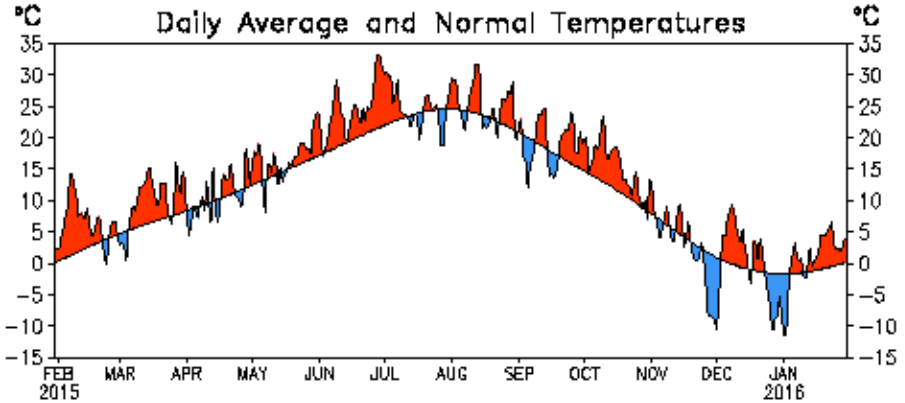


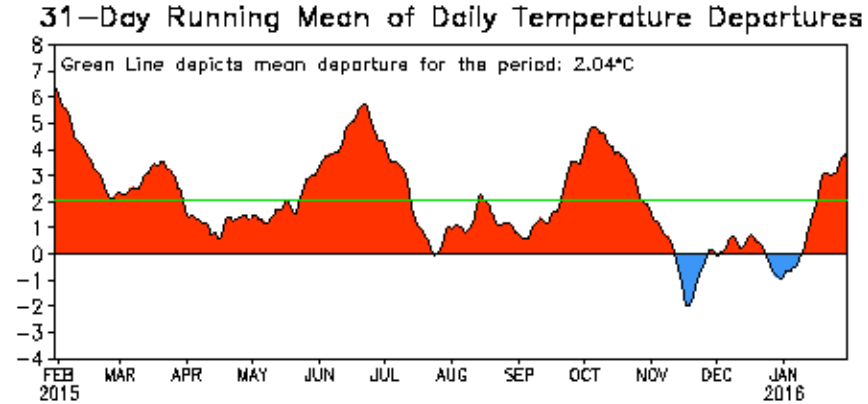


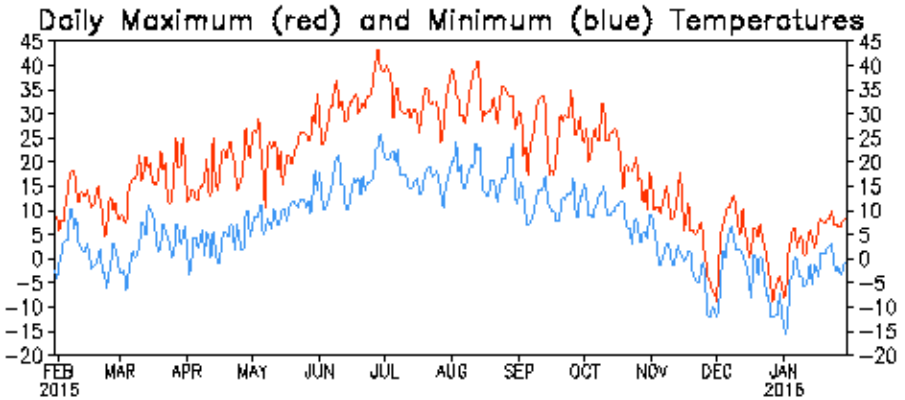
Data updated through 29 JAN 2016

CLIMATE PREDICTION CENTER/NCEP

BOISE, IDAHO





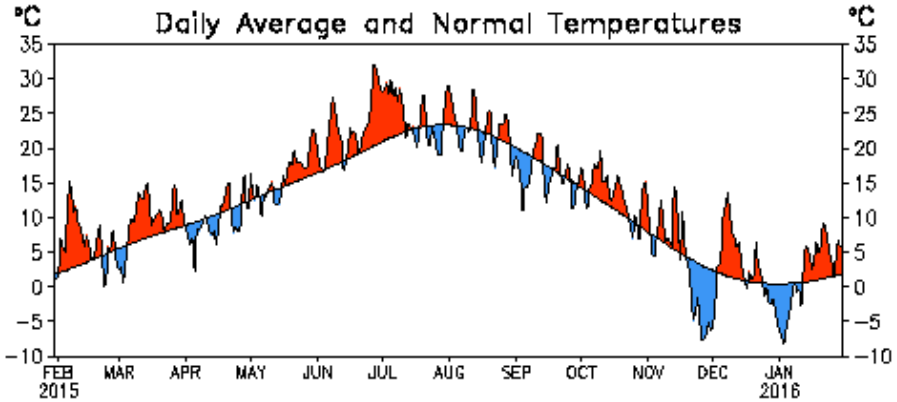


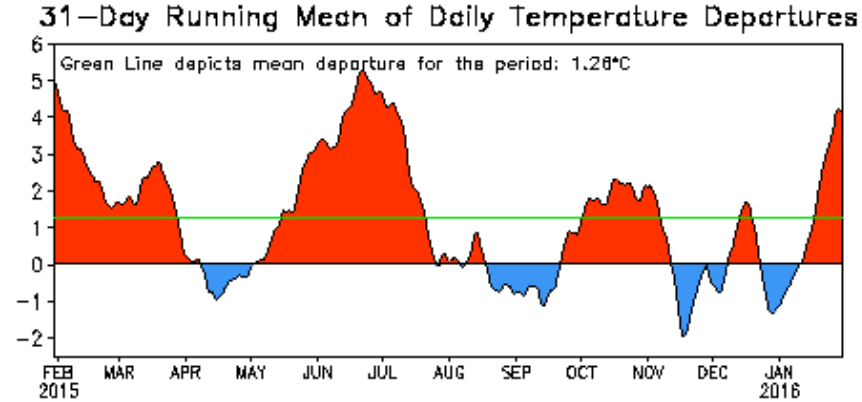
Data updated through 29 JAN 2016

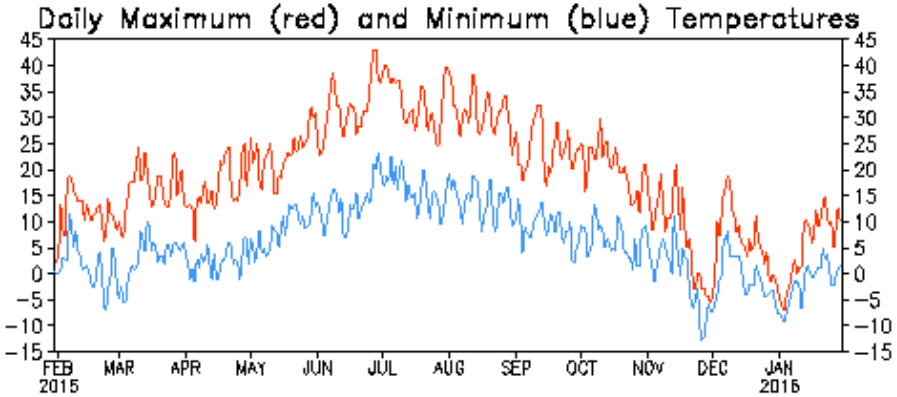
CLIMATE PREDICTION CENTER/NCEP

365 Day Temperature Departures thru 2016 January 29

PENDLETON, OREGON



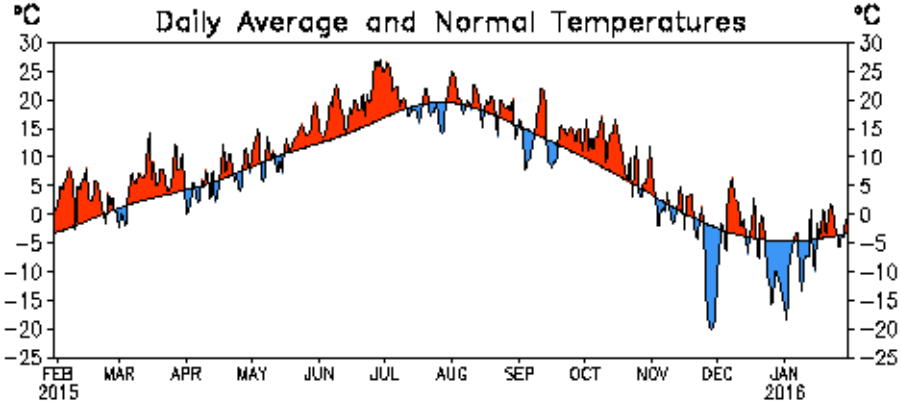


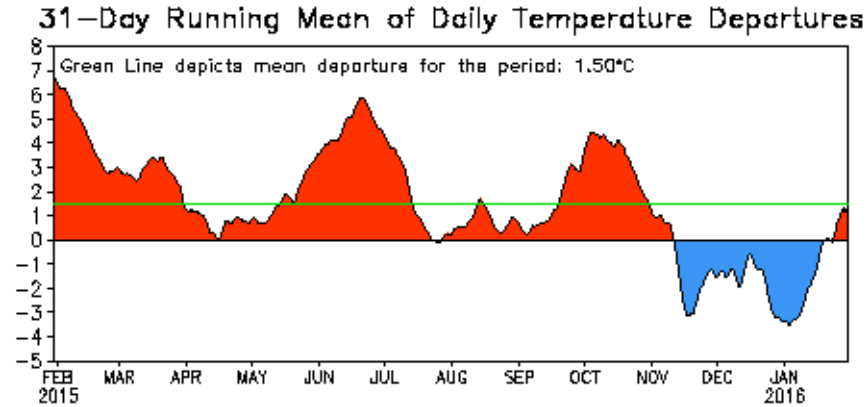


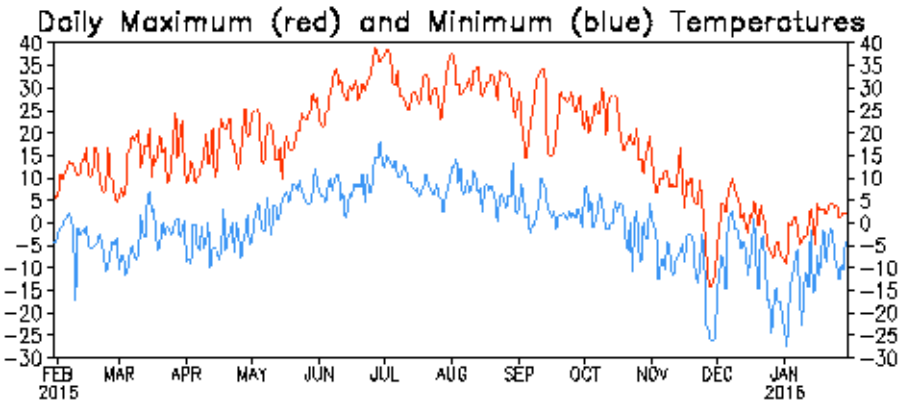
Data updated through 29 JAN 2016

CLIMATE PREDICTION CENTER/NCEP

BURNS (AMOS), OREGON



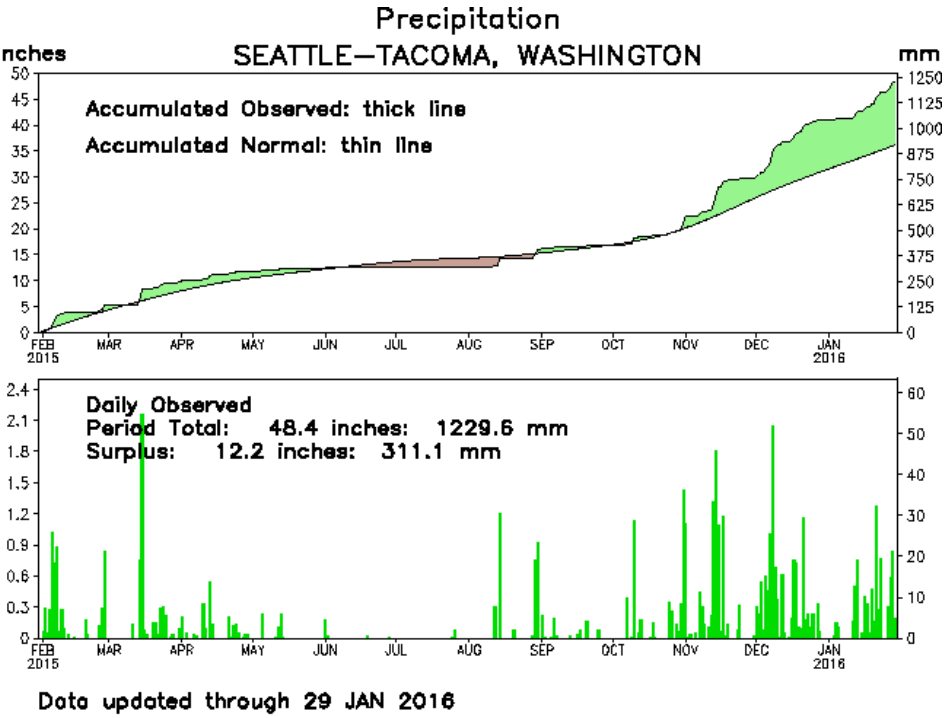




Data updated through 29 JAN 2016

CLIMATE PREDICTION CENTER/NCEP

365 Day precipitation Departures thru 2016 January 29



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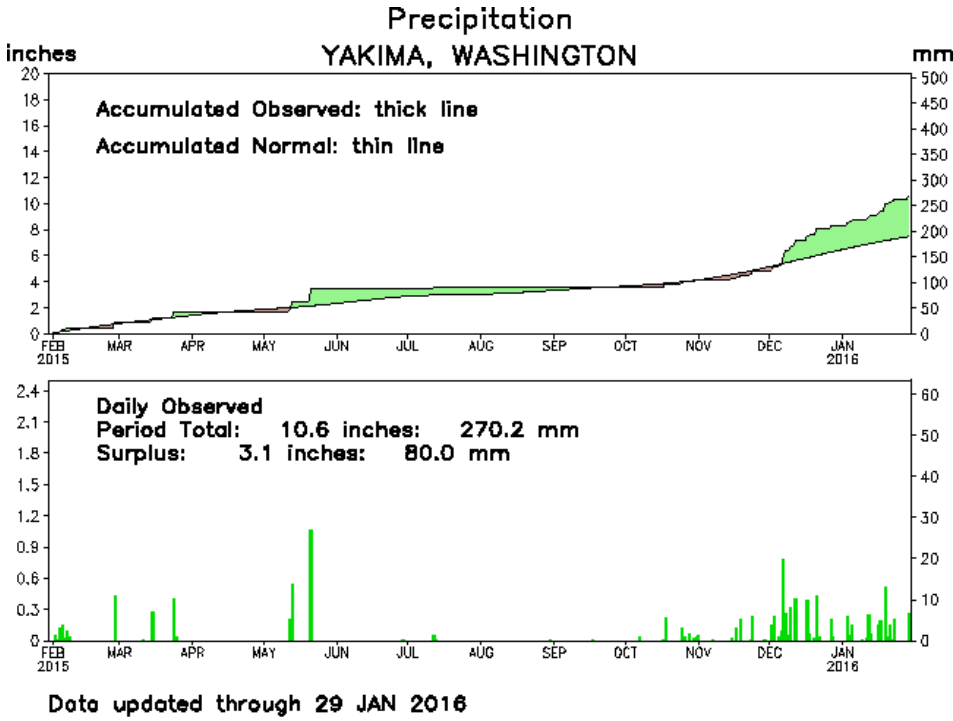
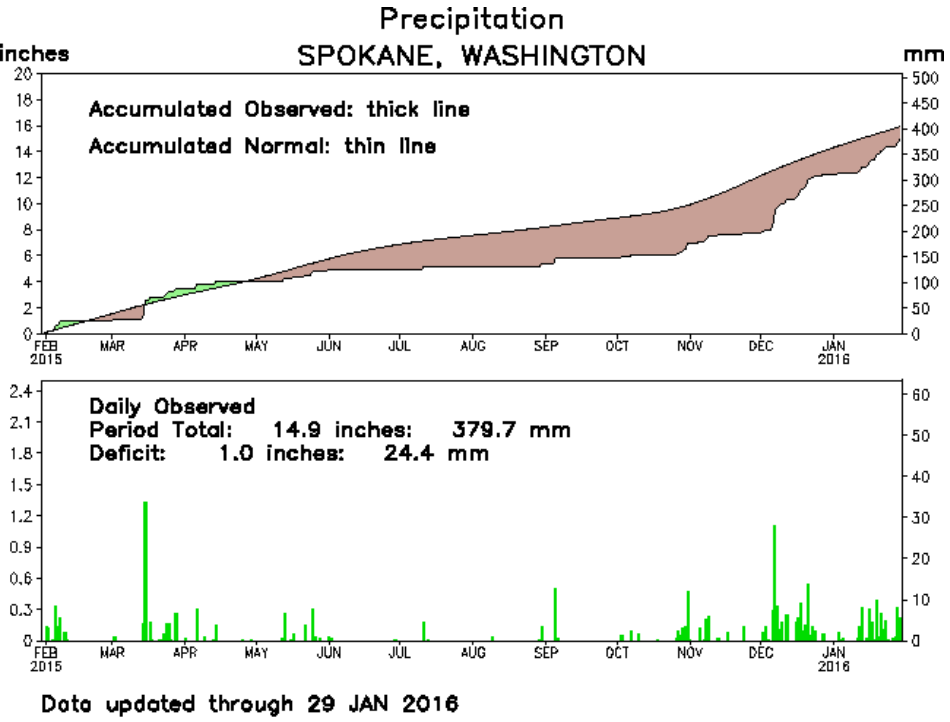
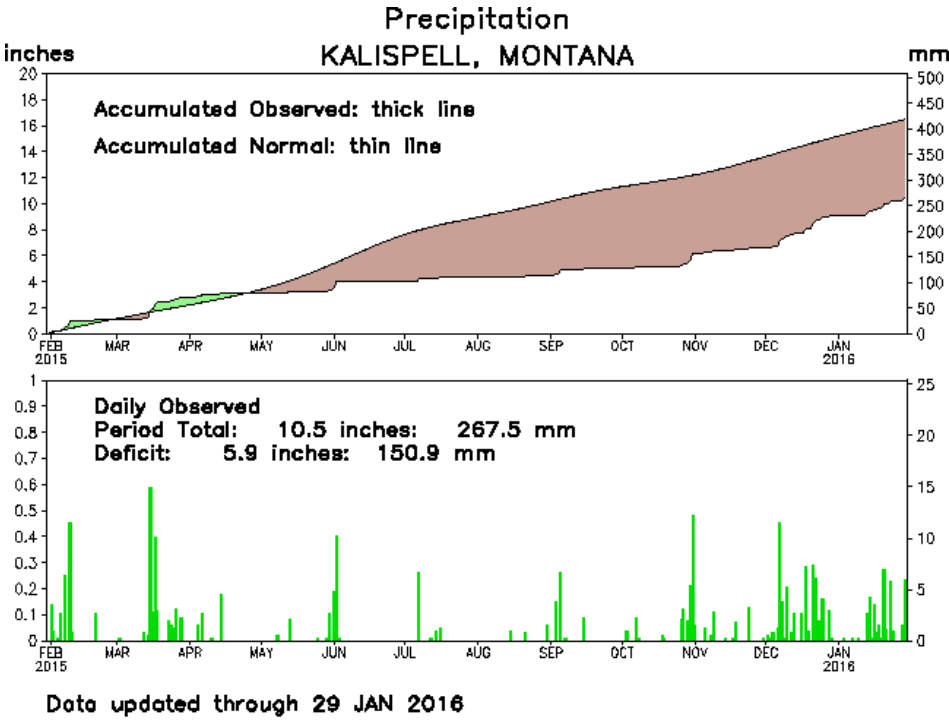


Data updated through 29 JAN 2016

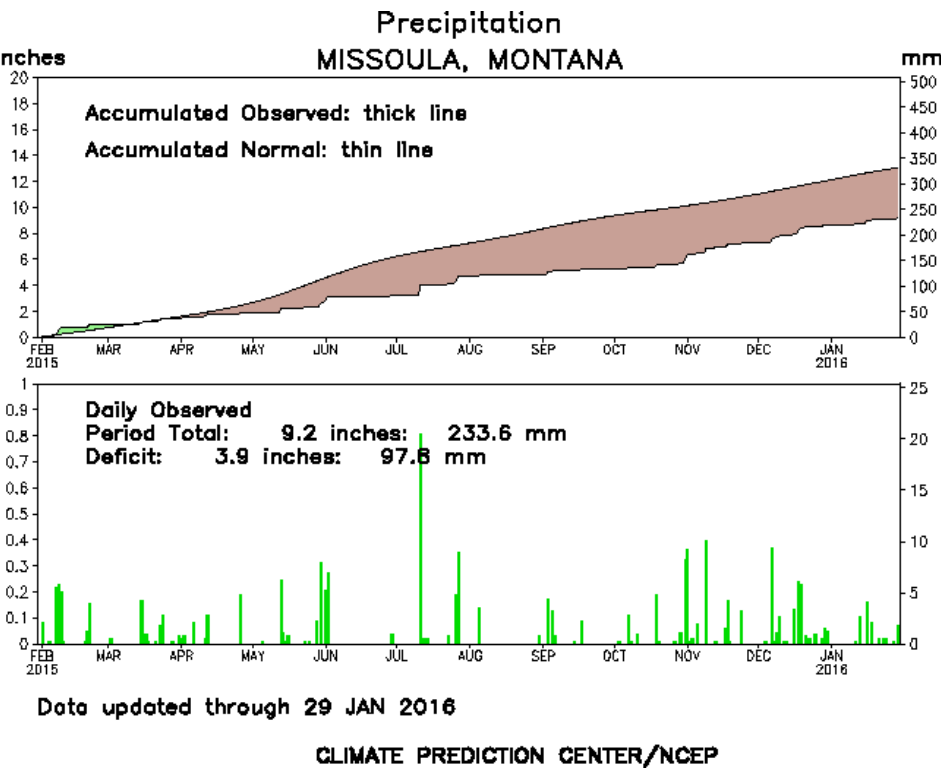
CLIMATE PREDICTION CENTER/NCEP

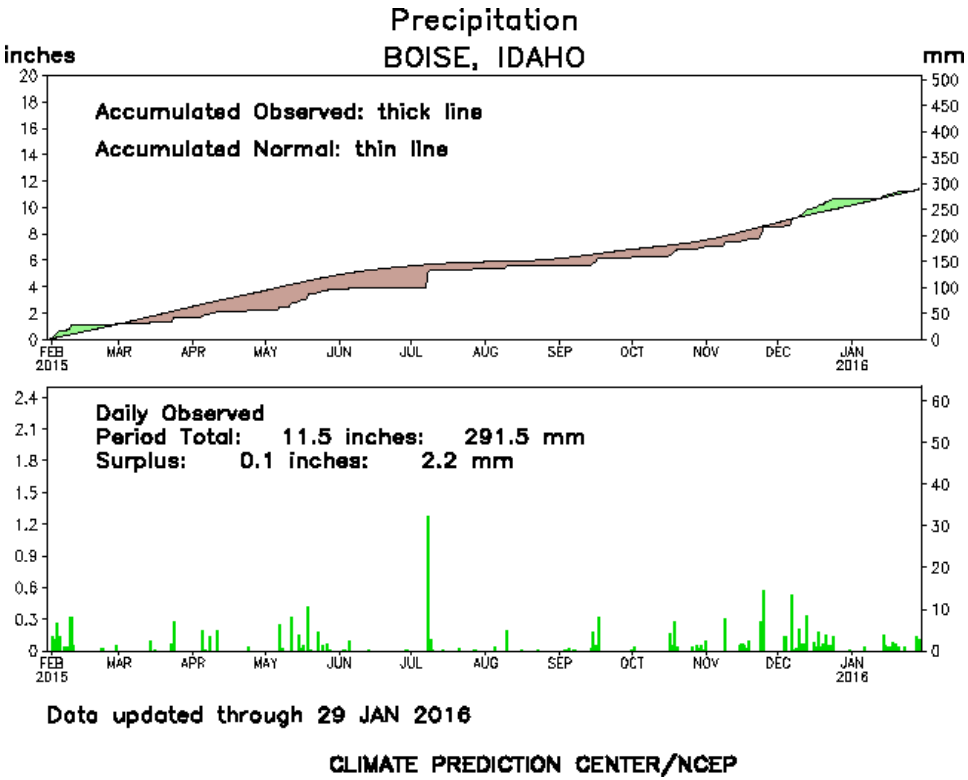
365 Day precipitation Departures thru 2016 January 29



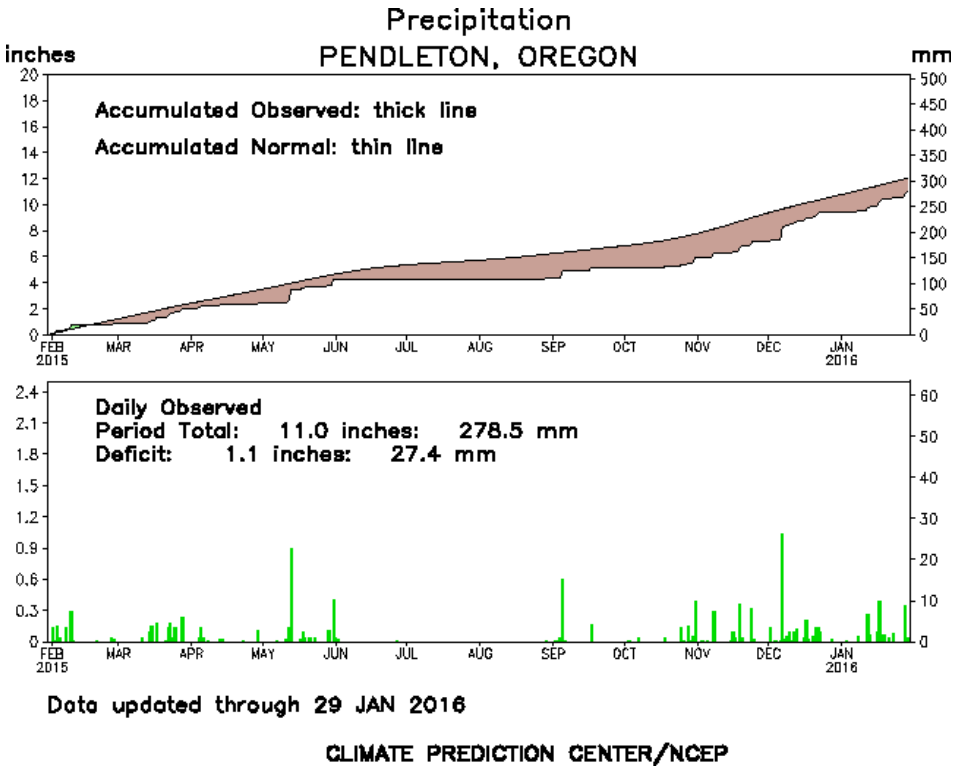


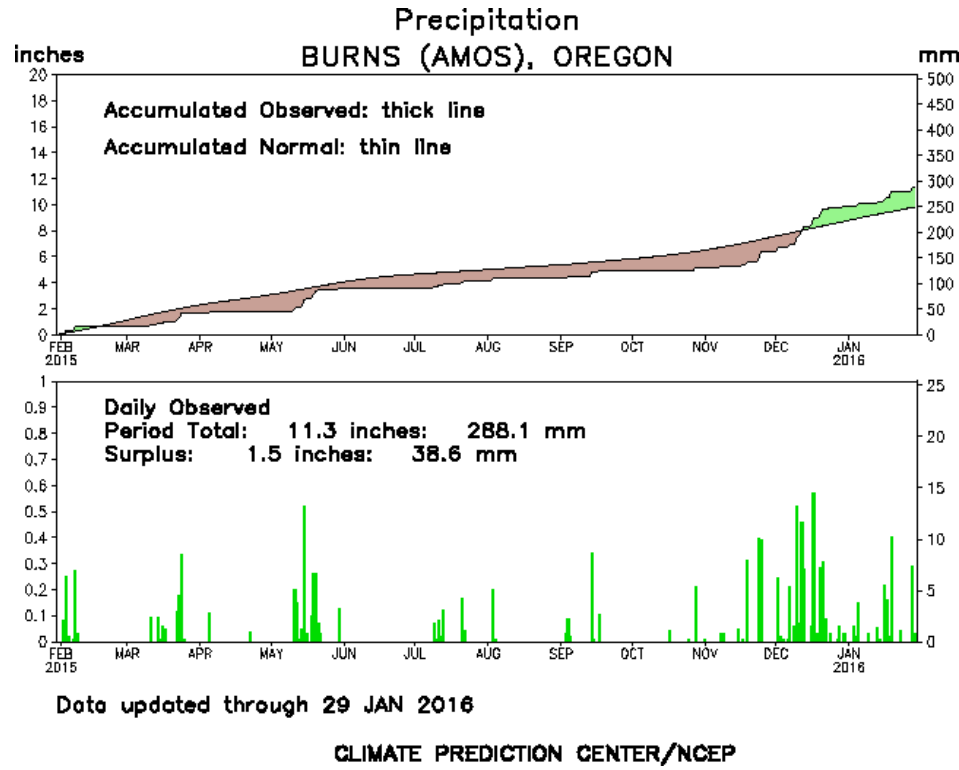
365 Day precipitation Departures thru 2016 January 29





365 Day precipitation Departures thru 2016 January 29





Select: near Castlegar BC, Winter Oct-Mar, Temperature 0 C, 9-year running mean.

North American Freezing Level Tracker

About

Introduction

This analysis tool allows one to track through time the height of the freezing level (0 C or 32 F) above sea level. Freezing level has important effects on hydrology in mountain environments. This level affects 1) the elevation of the rain/snow line, 2) whether precipitation at a specified level falls as rain or as snow, 3) whether the ground is frozen or thawed when the first autumn snows fall, 4) the efficiency of snowpack accumulation through the winter months, 5) the internal temperature and rate of "ripening" and melting of the snowpack in the spring, and 6) the length of the snow free season at different elevations. Freezing level also affects ecological function through biological growth rates (both plants and animals) at different elevations. Other temperature thresholds of interest are available (10 C, 20 C, 30 C / 50 F, 68 F, 86 F) as well. These temperatures can be substituted for the term "freezing level" below.

Definition

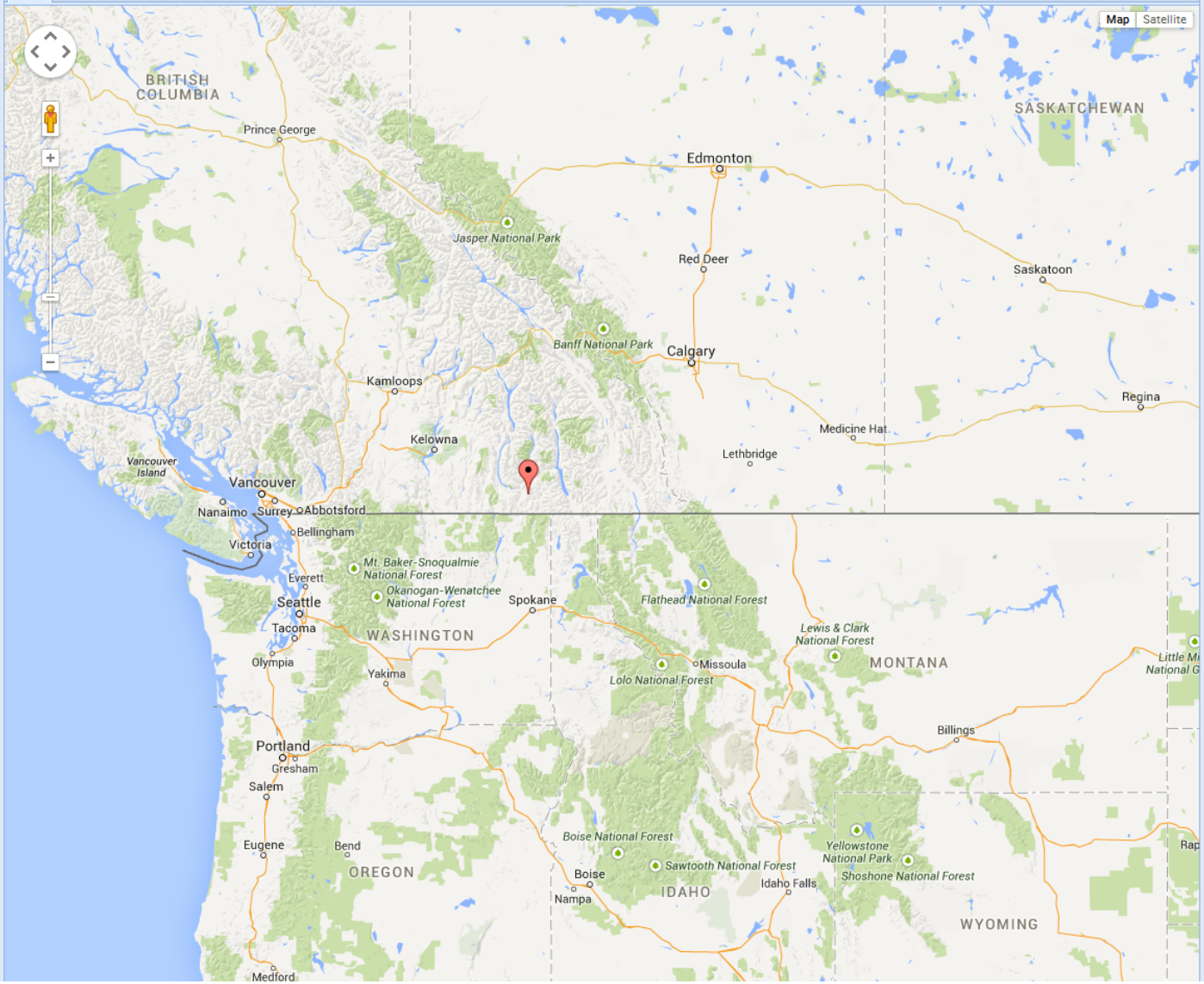
In the upper atmosphere temperatures are always below freezing everywhere on earth. Starting from the upper atmosphere and working down, the freezing level is taken to be the elevation above sea level in the free atmosphere at which a temperature of 0 C (or 32 F) is first encountered. The mean daily temperature profile used for this process is formed from the four six-hour averages available from Global Reanalysis (see below).

Monthly and seasonal means

Freezing level heights are found for each day. When the entire atmosphere is cooler than freezing, values are set to zero meters above sea level for that day. Monthly and seasonal values are the mean of all the daily values during that interval. Topographic information is not included in the determination of freezing level. This allows freezing level in mountainous or elevated regions to often be found below the topography. Below the topography, the vertical rate of change of temperature ("lapse rate") is calculated by the Reanalysis, and is generally between 4.5 and 6.5 degrees C per kilometer.

Monthly Precip as Snow

Map



How to use

Monthly/Seasonal Listings

Monthly/seasonal Time Series

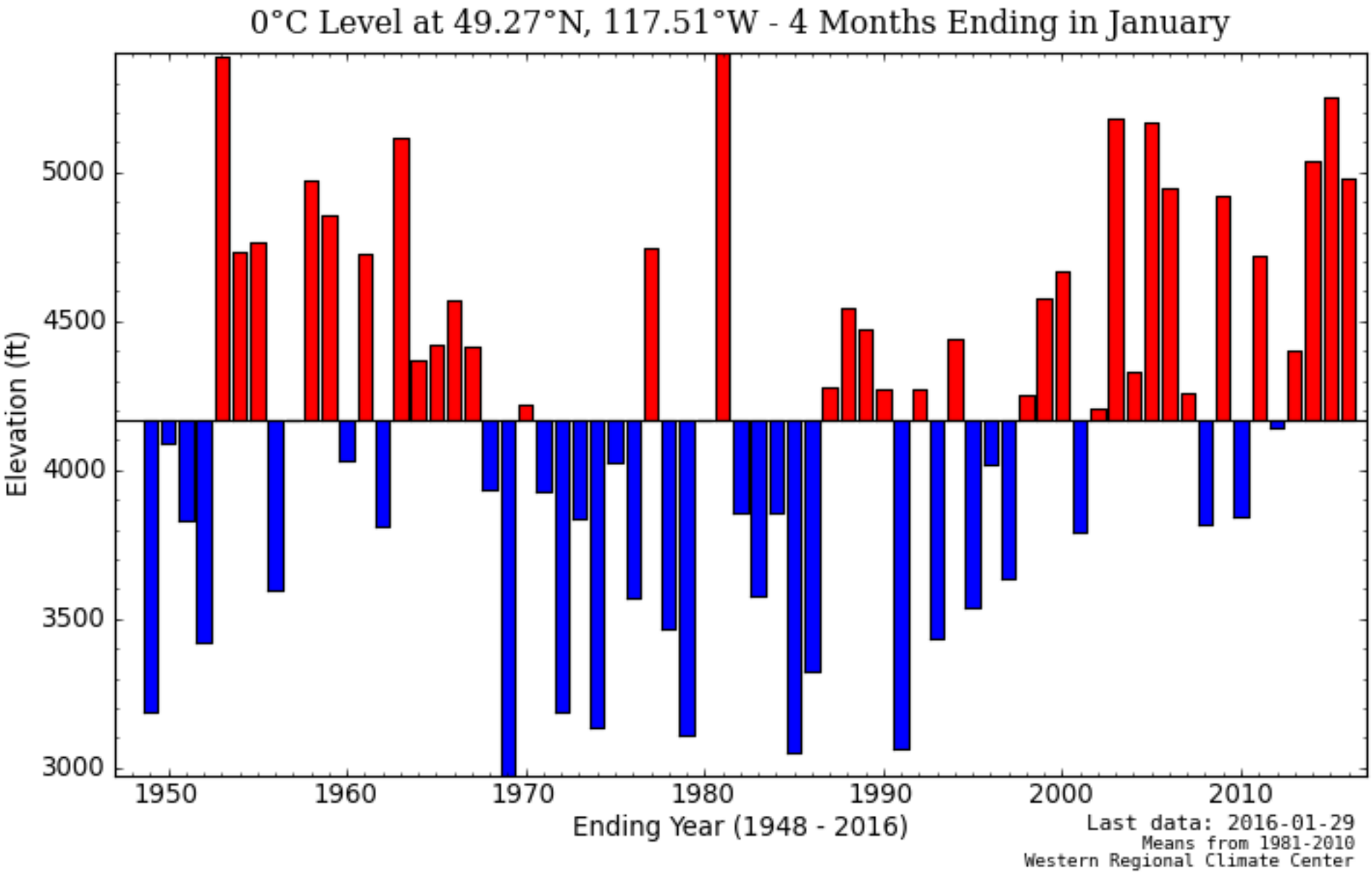
This product shows the mean height of the s

Lat:	49.26780455063753
Lon:	-117.509765625
Span:	1 Month
End Month:	Jan
Level:	0 C
Running average:	None
Units:	meters

Go

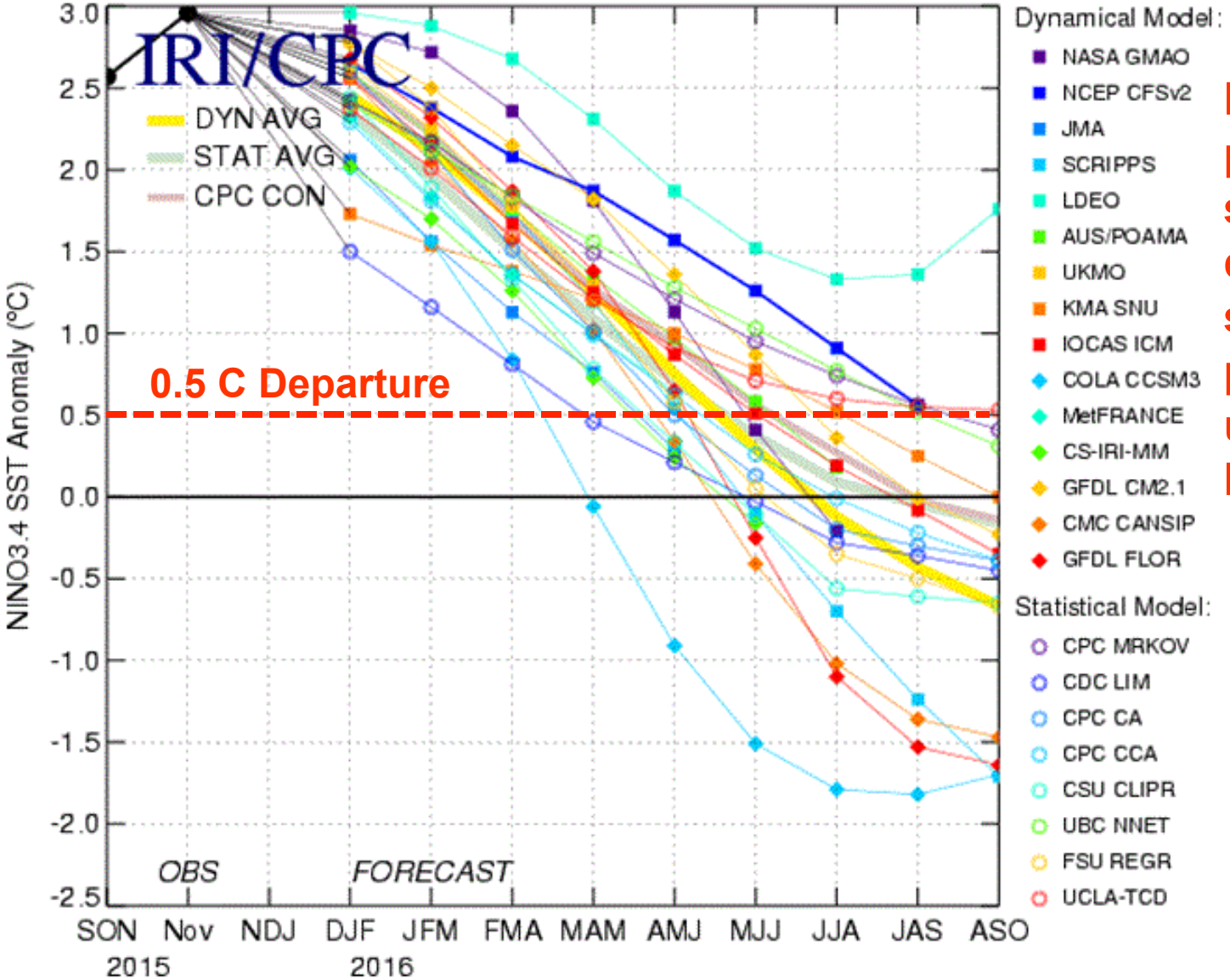
Western Regional Climate Center

Oct-Jan Freezing Level Near Castlegar, British Columbia
1948-49 thru 2015-16



Mid-Dec 2015 Plume of Model ENSO Predictions

? Where To ?



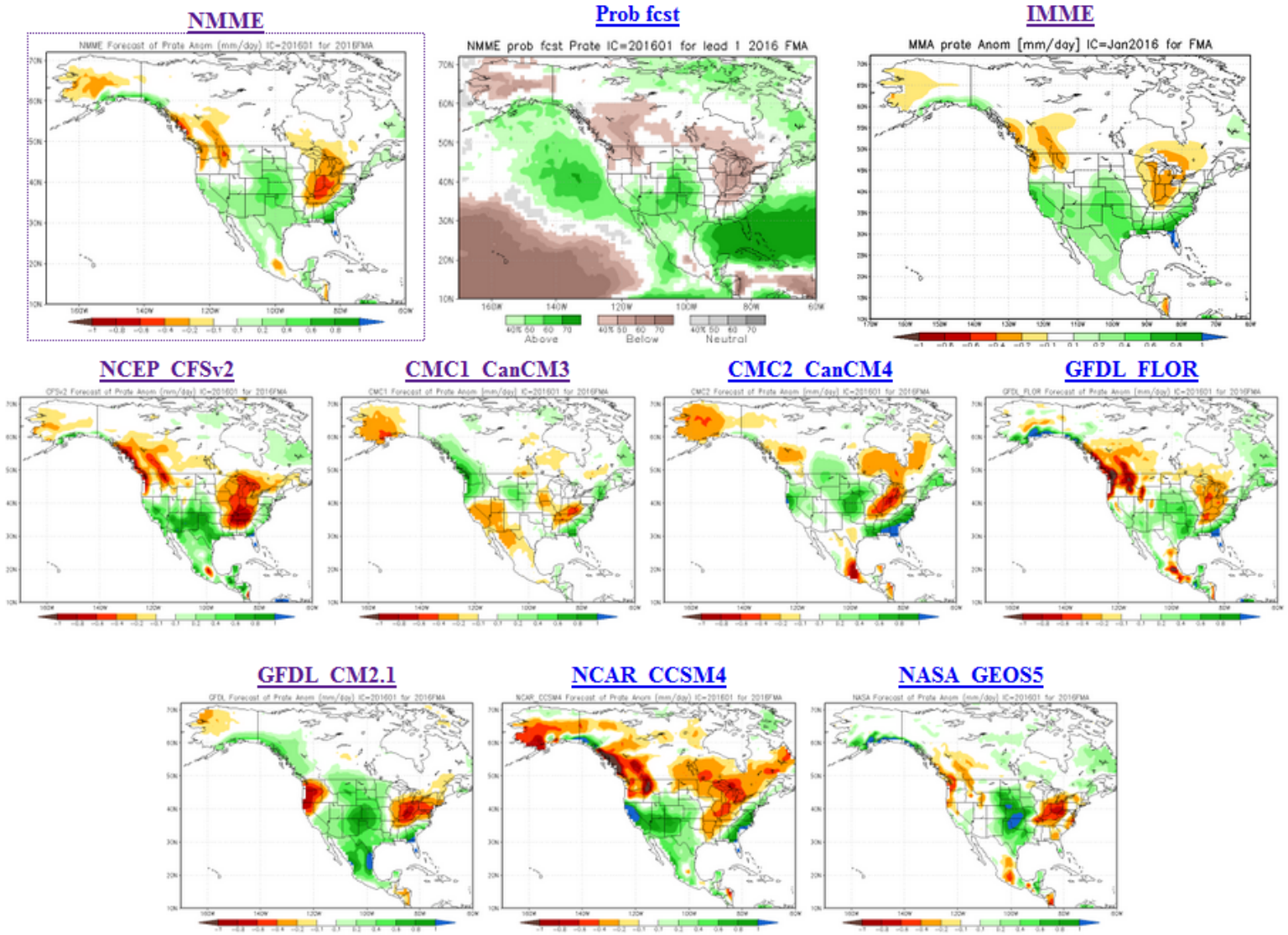
El Nino projected to slowly diminish but still be present until about May 2016.

Figure 6. Forecasts of sea surface temperature (SST) anomalies for the Niño 3.4 region (5°N-5°S, 120°W-170°W). Figure updated 15 December 2015.

Seven experiments in near-term climate forecasting Feb-Mar-Apr 2016. Precipitation.

NMME (National Multi-Model Ensemble). 1-month lead time (Jan initial conditions)

IMME (International Multi-Model Ensemble).



Dynamical Models

CFSv2: US Climate Forecasting System version 2

CMC1: Canadian Meteorological Center version 1

CMC2: Canadian Meteorological Center version 2

GFDL: US Geophysical Fluid Dynamics Laboratory

NCAR: US National Center for Atmospheric Research

NASA: US National Aeronautics and Space Administration

NMME: National Multi-Model Ensemble

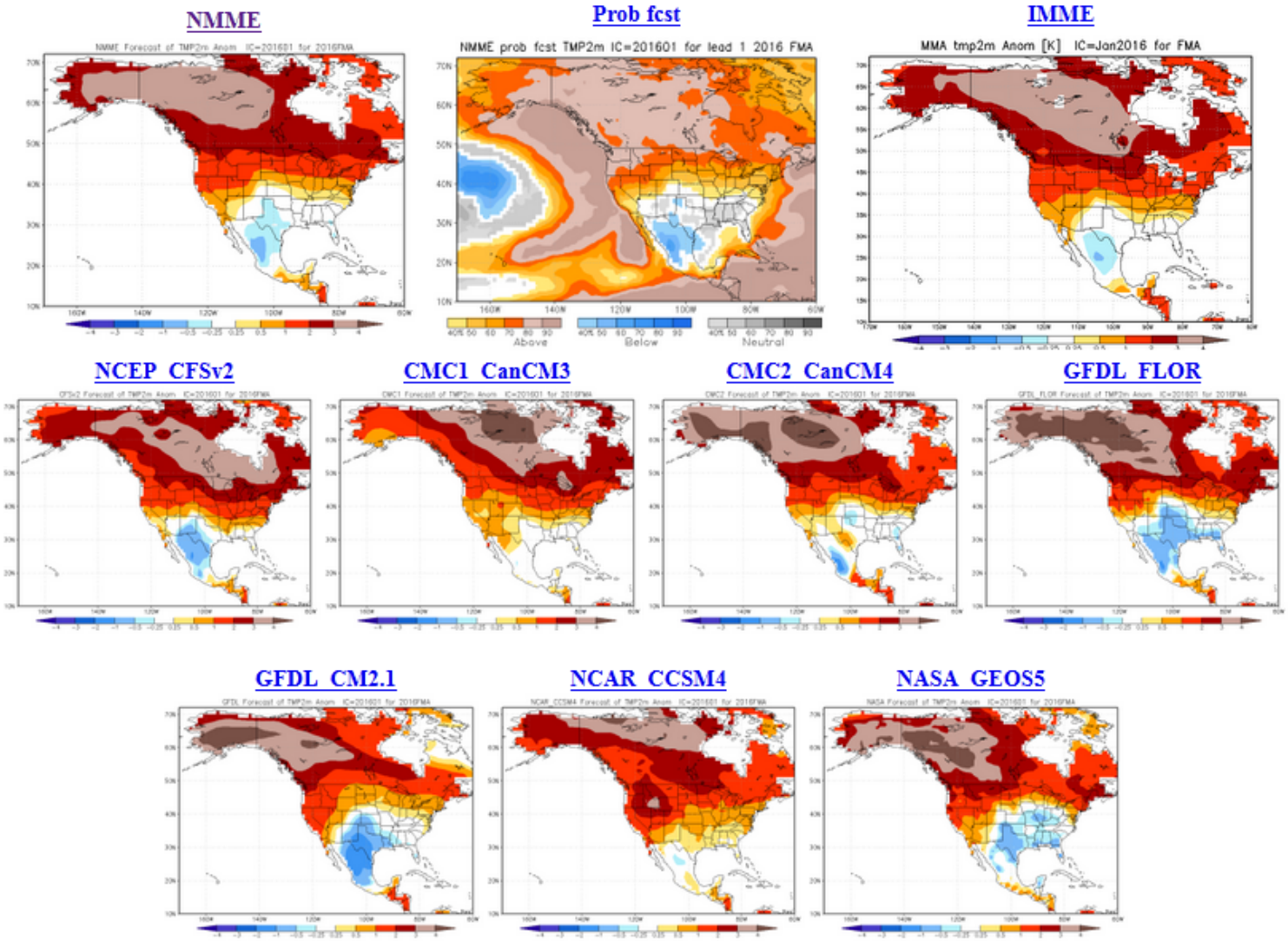
IMME: International Multi-Model Ensemble

2016 Jan 29

Seven experiments in near-term climate forecasting Feb-Mar-Apr 2016. Temperature.

NMME (National Multi-Model Ensemble). **1-month lead time (Jan initial conditions)**

IMME (International Multi-Model Ensemble).



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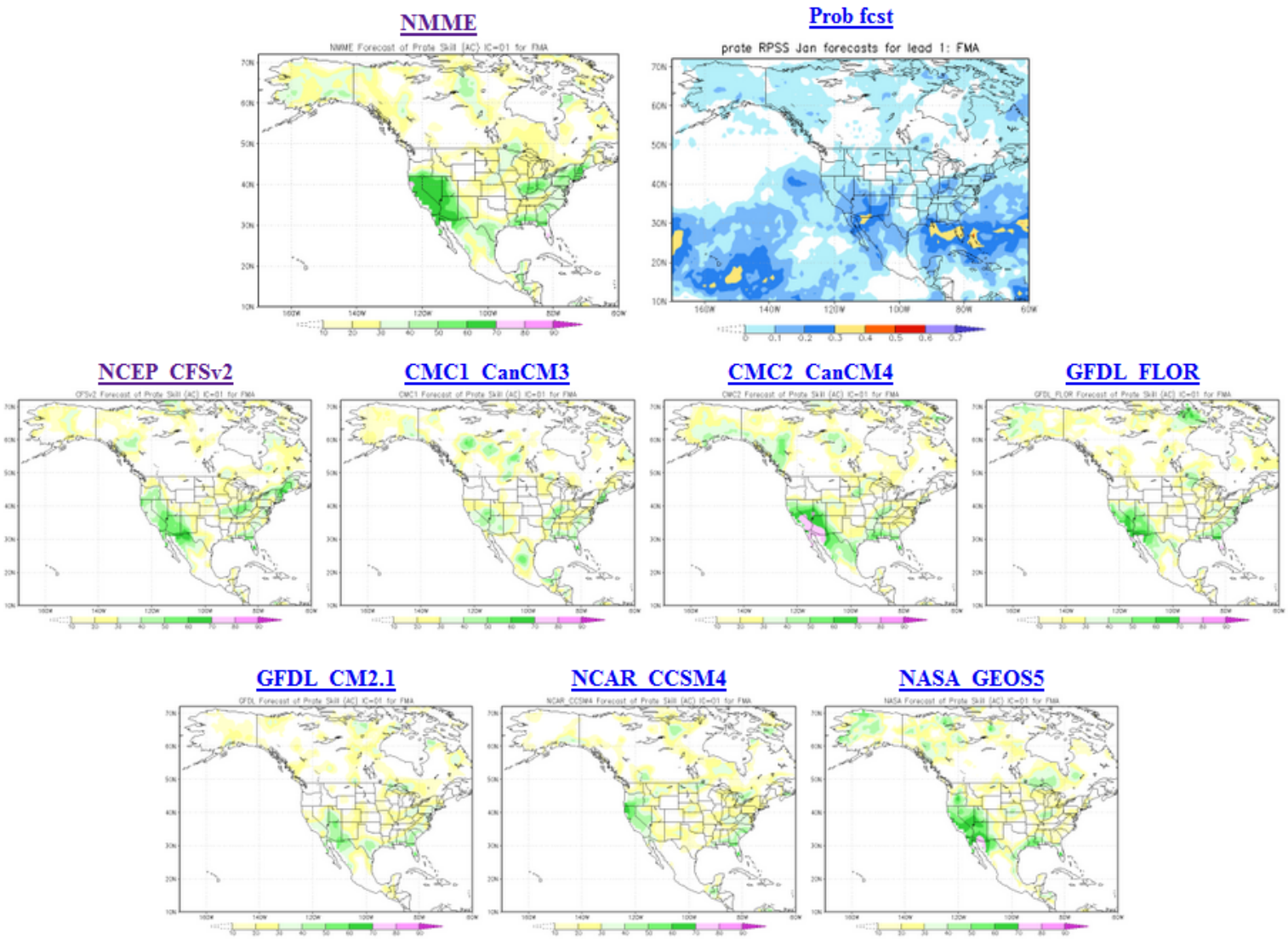
2016 Jan 29

Seven experiments in near-term climate forecasting Feb-Mar-Apr 2016. Precipitation.

NMME (National Multi-Model Ensemble). 1-month lead time *** Skill Map

IMME (International Multi-Model Ensemble).



Dynamical Models

CFSv2: US Climate Forecasting System version 2

CMC1: Canadian Meteorological Center version 1

CMC2: Canadian Meteorological Center version 2

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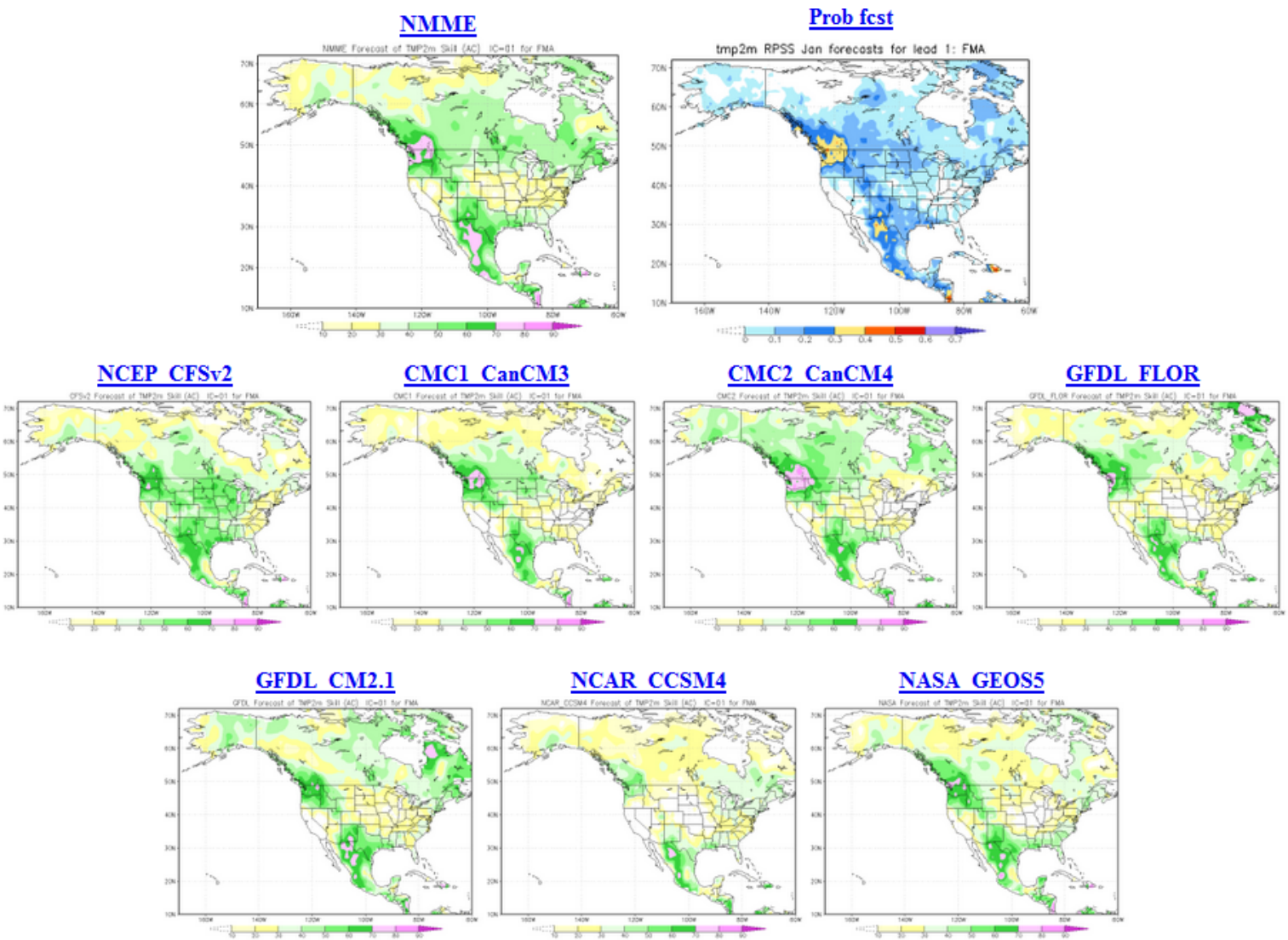

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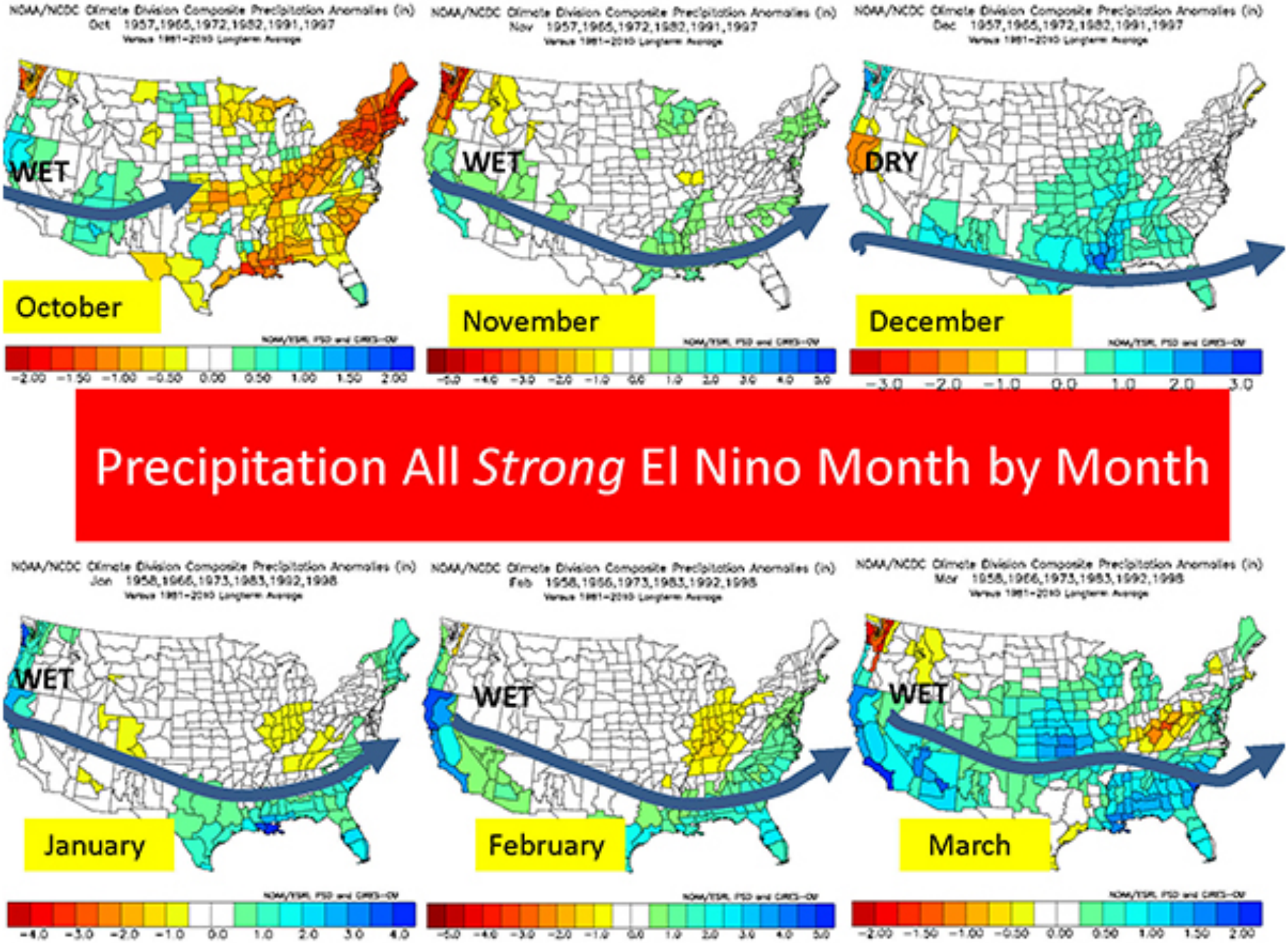

Figure prepared courtesy NWS San Diego

A few finishing comments (add)

So far, cool-season forecasts do not seem to have been all that great

Unusually strong ocean temperature patterns

But, western atmospheric response has not been outlandishly unusual

Helpful: Daily updates to PNW RFC seasonal temperature graphics

Winter is still not over

Tantalizing hints of potential La Nina *next* winter (2016-17)

Given the unexpected climate response ...

Potential for a learning opportunity, new research directions

Thank You !
Mather RAWS Station
Great Basin Nat Park

DISCARDS
and
EXTRAS
and
ELABORATIONS