

Drought in Southeast Arizona: Where are we now and where are we headed? (El Niño? Edition)

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Arizona Cooperative Extension
The University of Arizona**



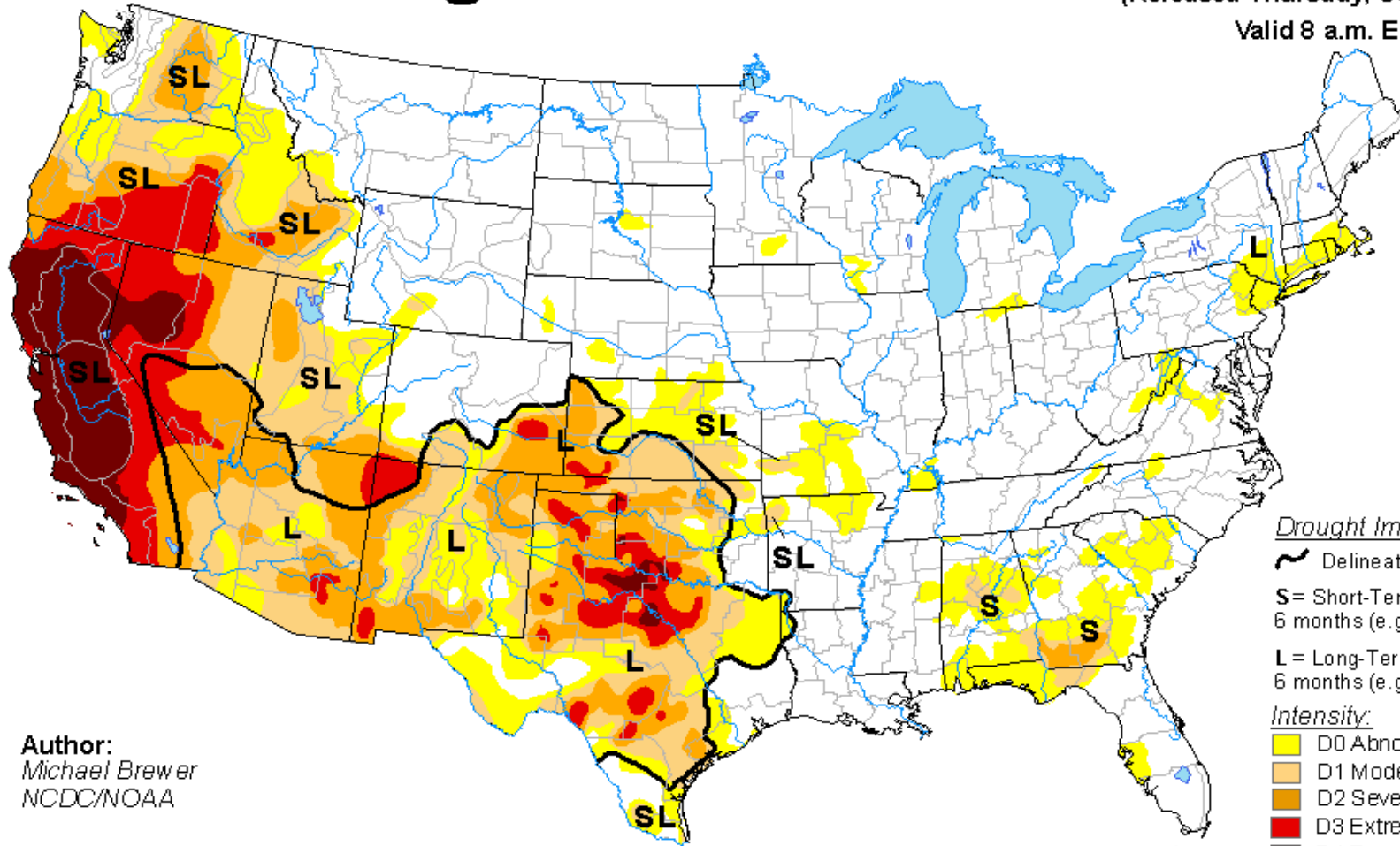
Presentation Overview

- Where are we now?
- Climatic Context
- Interannual Climate Variability
- El Niño 2014-15




U.S. Drought Monitor

September 16, 2014
(Released Thursday, Sep. 18, 2014)
Valid 8 a.m. EDT








Author:
Michael Brewer
NCDC/NOAA

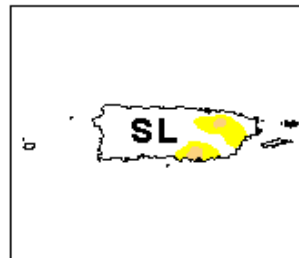
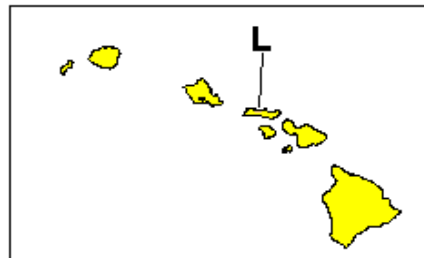
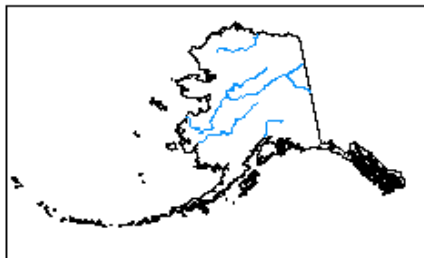
Drought Impact Types:

-  Delineates dominant impacts
- S** = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L** = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

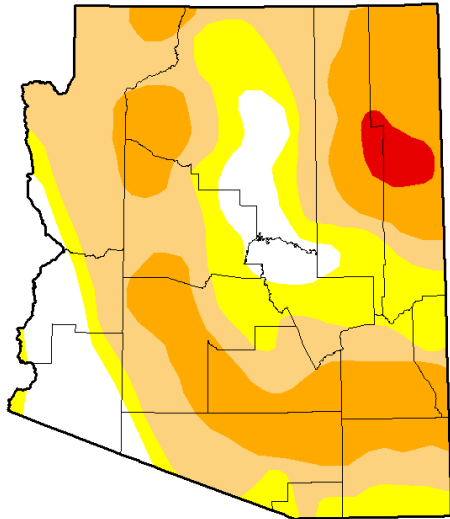
-  D0 Abnormally Dry
-  D1 Moderate Drought
-  D2 Severe Drought
-  D3 Extreme Drought
-  D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



<http://droughtmonitor.unl.edu/>

U.S. Drought Monitor Arizona



September 17, 2013
(Released Thursday, Sep. 19, 2013)
Valid 7 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	12.81	87.19	66.82	30.35	1.94	0.00
Last Week 8/10/2013	3.43	96.57	74.04	41.52	15.49	1.94
3 Months Ago 6/18/2013	0.00	100.00	92.49	72.23	22.25	0.00
Start of Calendar Year 1/1/2013	0.00	100.00	97.91	37.78	8.68	0.00
Start of Water Year 8/1/2012	0.00	100.00	100.00	31.93	5.67	0.00
One Year Ago 8/16/2012	0.00	100.00	100.00	31.93	5.67	0.00

Intensity:
■ D0 Abnormally Dry ■ D3 Extreme Drought
■ D1 Moderate Drought ■ D4 Exceptional Drought
■ D2 Severe Drought

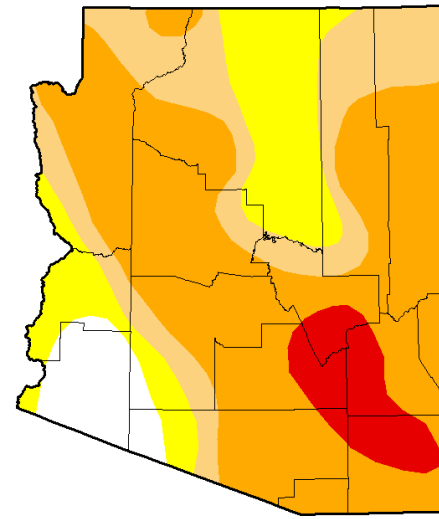
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
David Miskus
NOAA/NWS/NCEP/CPC



<http://droughtmonitor.unl.edu/>

U.S. Drought Monitor Arizona



February 25, 2014
(Released Thursday, Feb. 27, 2014)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	6.18	93.82	77.24	57.20	7.04	0.00
Last Week 2/18/2014	6.18	93.82	77.09	57.20	7.04	0.00
3 Months Ago 11/26/2013	20.72	79.28	53.58	16.32	0.00	0.00
Start of Calendar Year 12/1/2013	20.72	79.28	53.58	14.73	0.00	0.00
Start of Water Year 10/1/2013	14.83	85.17	61.91	25.28	0.00	0.00
One Year Ago 2/26/2013	0.00	100.00	83.08	29.45	2.03	0.00

Intensity:
■ D0 Abnormally Dry ■ D3 Extreme Drought
■ D1 Moderate Drought ■ D4 Exceptional Drought
■ D2 Severe Drought

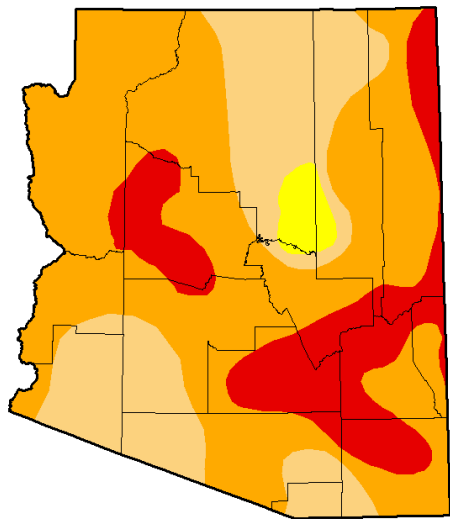
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Brad Rippey
U.S. Department of Agriculture



<http://droughtmonitor.unl.edu/>

U.S. Drought Monitor Arizona



July 22, 2014
(Released Thursday, Jul. 24, 2014)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	97.88	72.30	17.59	0.00
Last Week 7/15/2014	0.00	100.00	97.88	72.30	15.64	0.00
3 Months Ago 4/22/2014	0.00	100.00	98.17	61.20	7.31	0.00
Start of Calendar Year 12/1/2013	20.72	79.28	53.58	14.73	0.00	0.00
Start of Water Year 10/1/2013	14.83	85.17	61.91	25.28	0.00	0.00
One Year Ago 7/23/2013	0.00	100.00	91.13	63.58	22.81	3.04

Intensity:
■ D0 Abnormally Dry ■ D3 Extreme Drought
■ D1 Moderate Drought ■ D4 Exceptional Drought
■ D2 Severe Drought

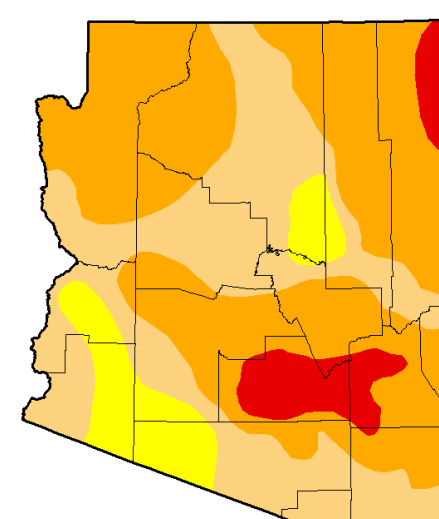
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
David Miskus
NOAA/NWS/NCEP/CPC



<http://droughtmonitor.unl.edu/>

U.S. Drought Monitor Arizona



September 2, 2014
(Released Thursday, Sep. 4, 2014)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	90.74	56.60	6.71	0.00
Last Week 8/28/2014	0.00	100.00	90.75	56.60	6.71	0.00
3 Months Ago 6/3/2014	0.00	100.00	98.17	76.28	7.69	0.00
Start of Calendar Year 12/1/2013	20.72	79.28	53.58	14.73	0.00	0.00
Start of Water Year 10/1/2013	14.83	85.17	61.91	25.28	0.00	0.00
One Year Ago 8/2/2013	0.00	100.00	78.23	42.31	15.55	1.94

Intensity:
■ D0 Abnormally Dry ■ D3 Extreme Drought
■ D1 Moderate Drought ■ D4 Exceptional Drought
■ D2 Severe Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

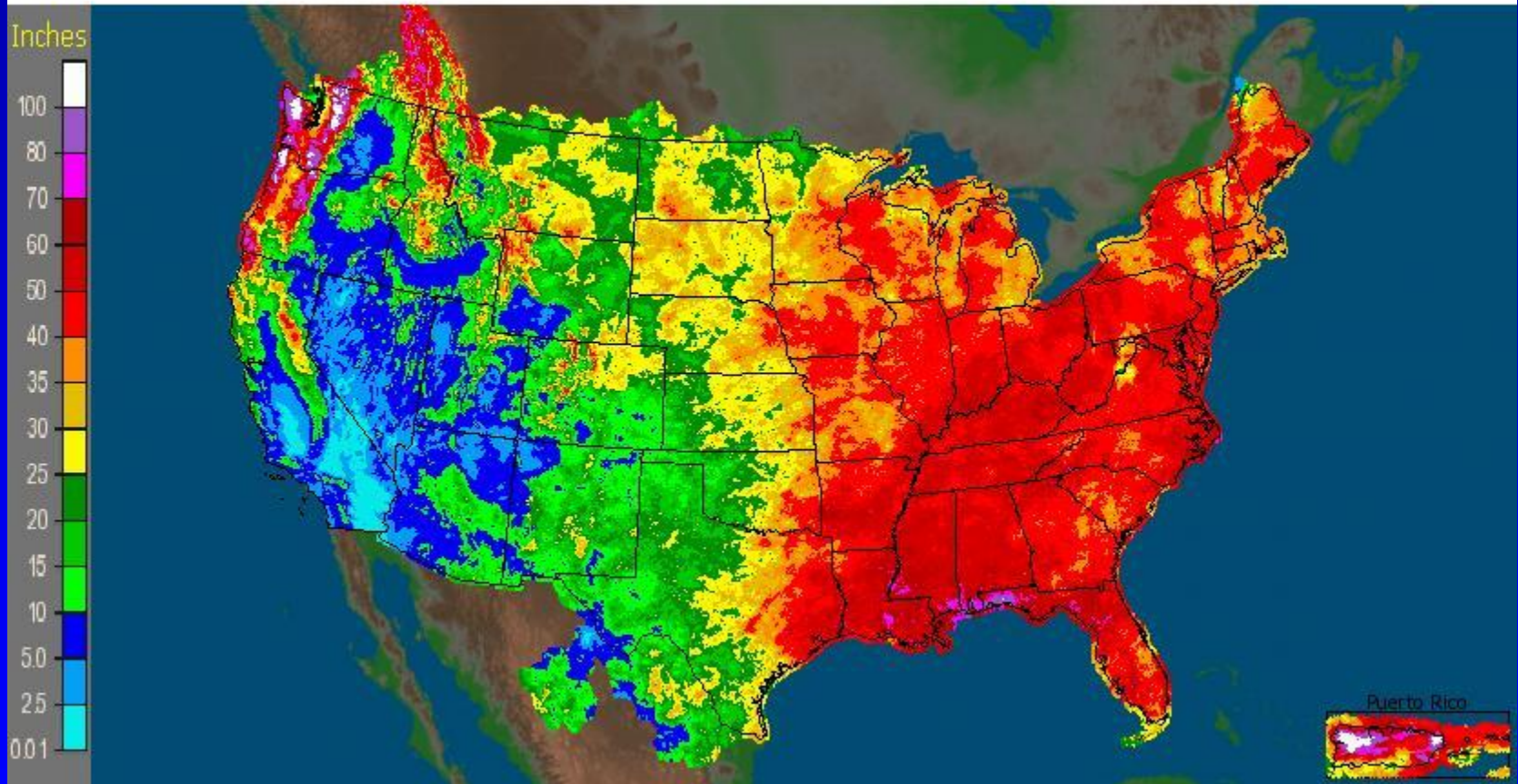
Author:
David Simeral
Western Regional Climate Center



<http://droughtmonitor.unl.edu/>

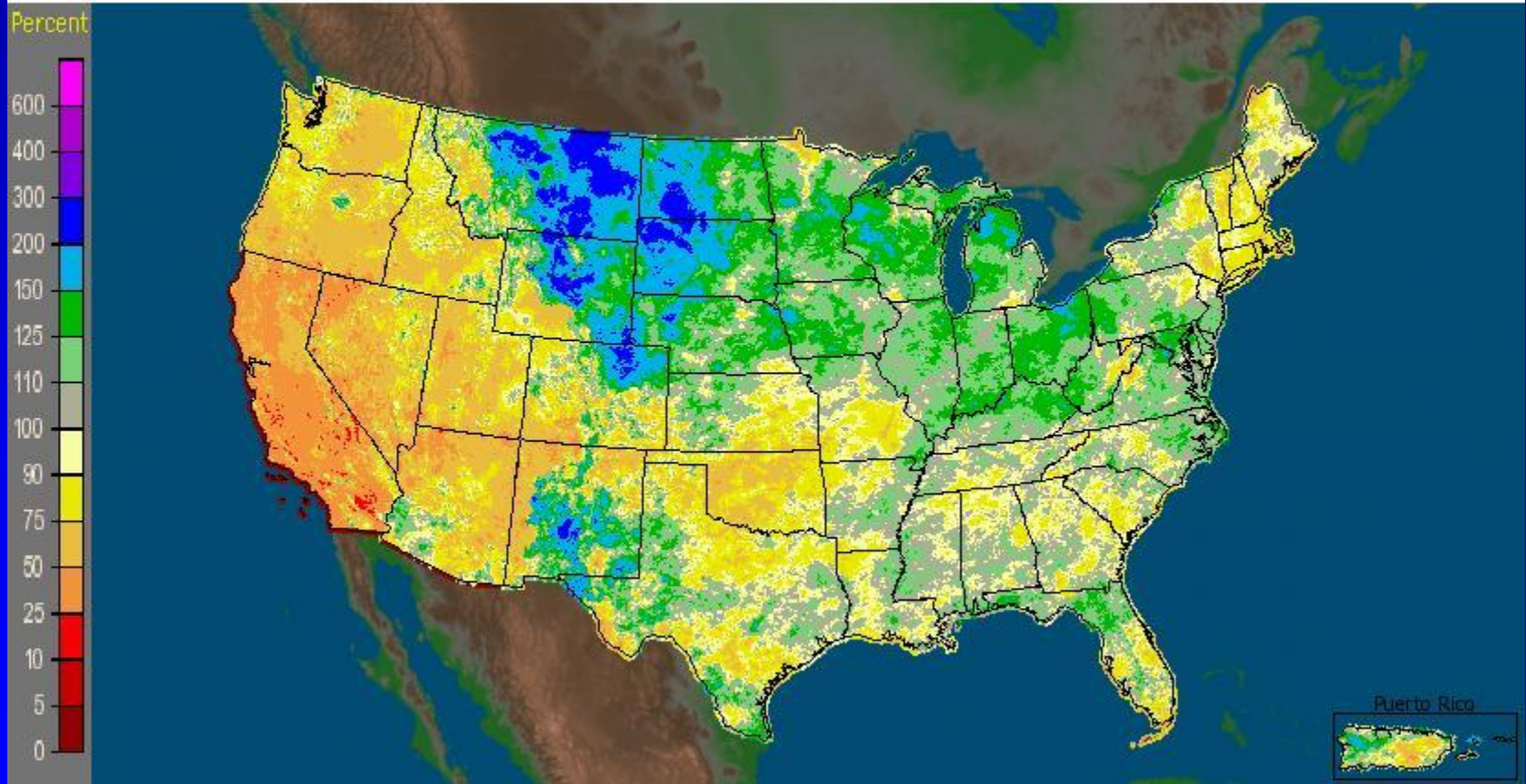
Water-year Precipitation

CONUS + Puerto Rico: Current Water-Year (Oct 1) Observed Precipitation
Valid at 9/18/2014 1200 UTC- Created 9/18/14 15:52 UTC



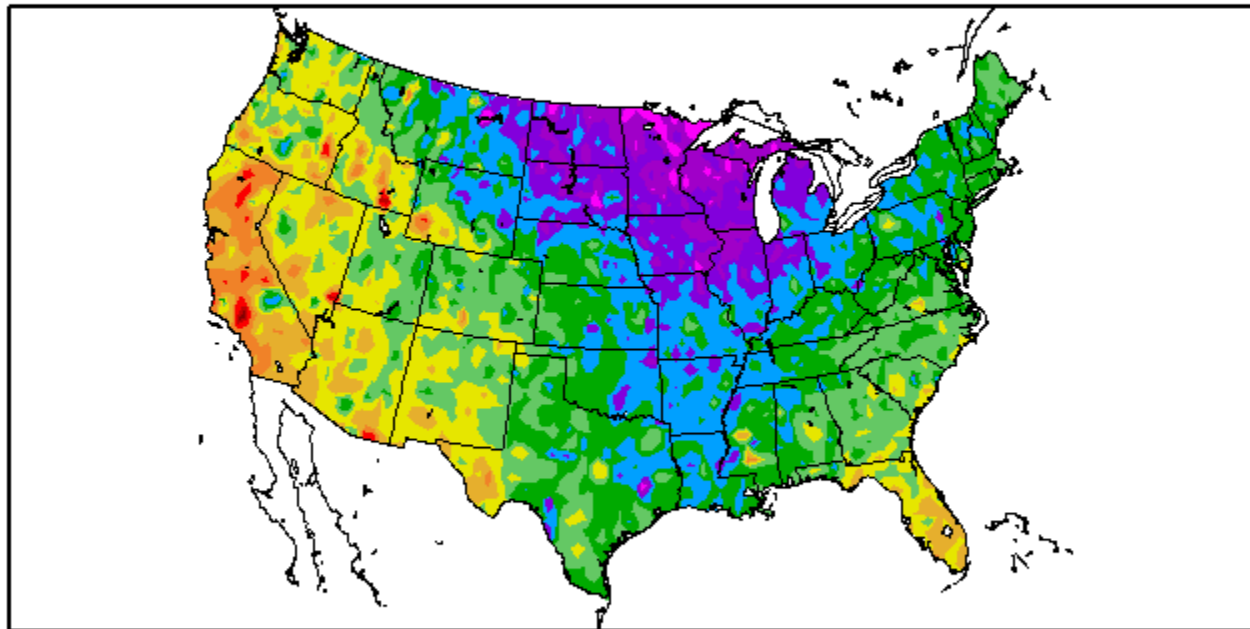
Water-year Precipitation

CONUS + Puerto Rico: Current Water-Year (Oct 1) Percent of Normal Precipitation
Valid at 9/18/2014 1200 UTC- Created 9/18/14 15:52 UTC



Water-year Temperature

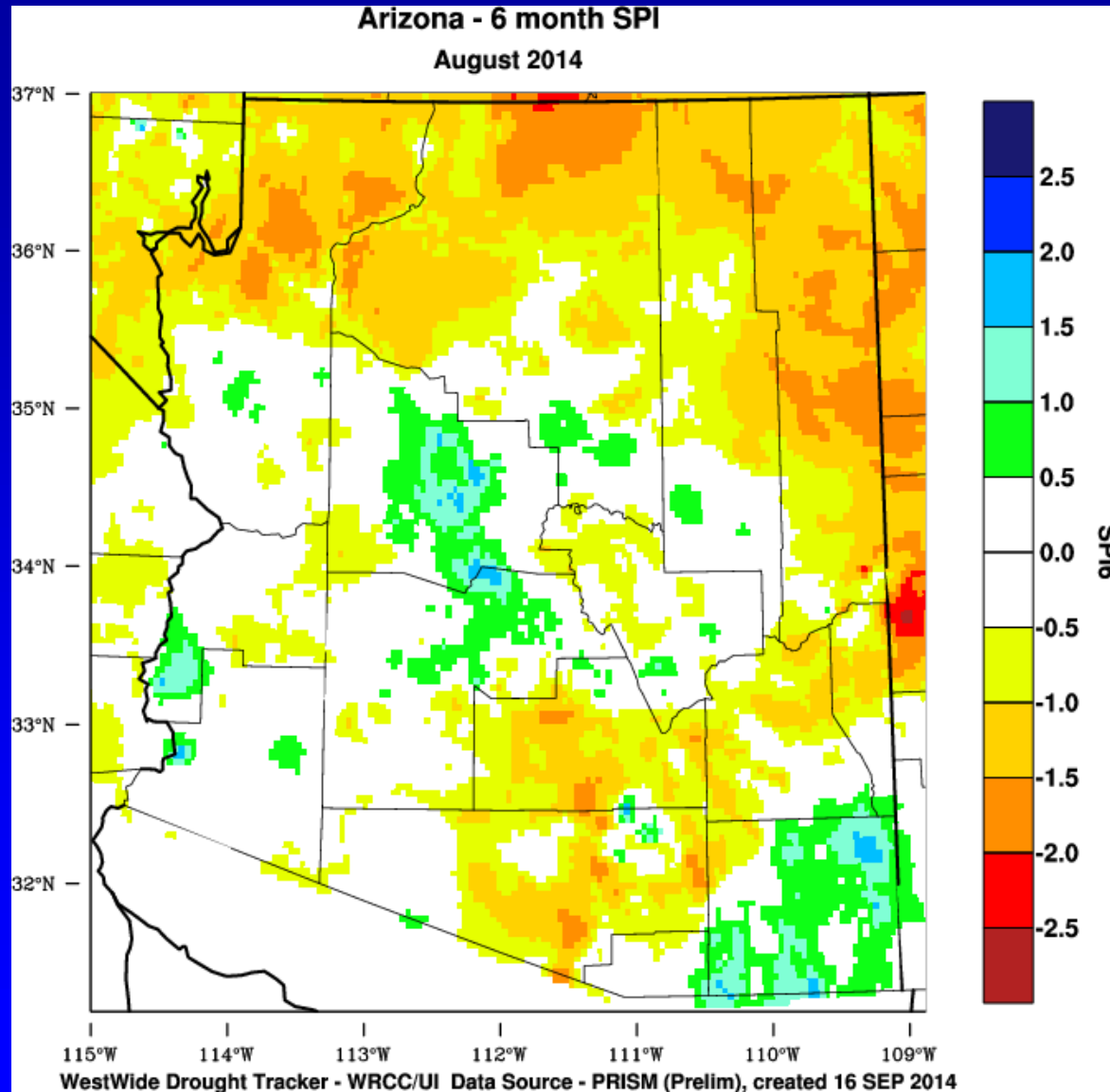
Departure from Normal Temperature (F)
10/1/2013 – 9/17/2014



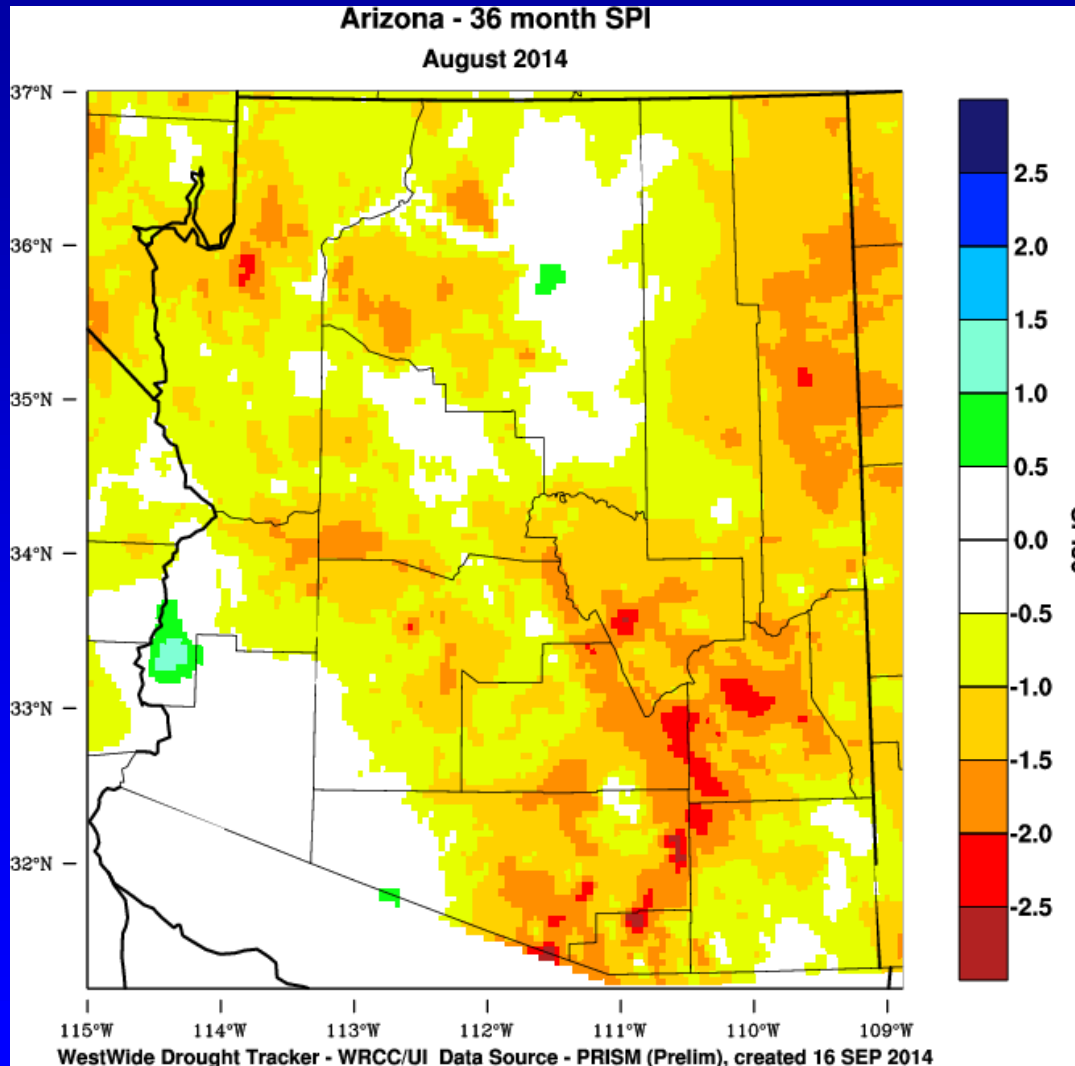
Generated 9/18/2014 at HPRCC using provisional data.

Regional Climate Centers

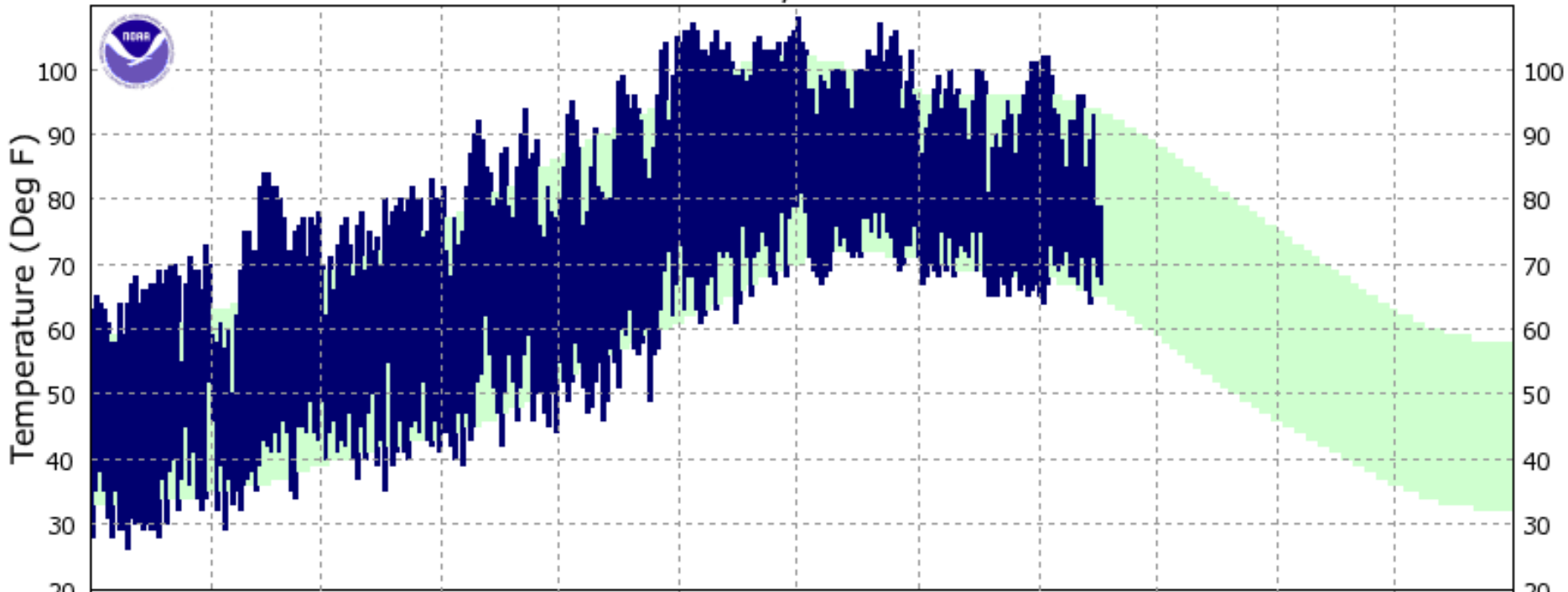
Short-term Drought Conditions



Long-term Drought Conditions



SAFFORD, AZ - 2014



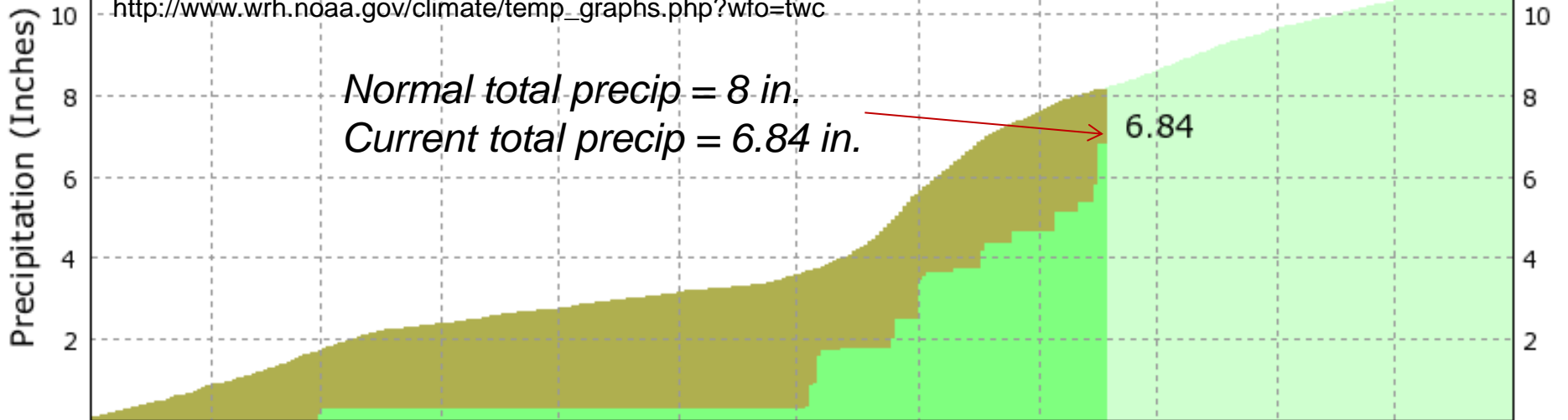
Safford daily temperature and precipitation Oct 2013 – Sep 2014

http://www.wrh.noaa.gov/climate/temp_graphs.php?wfo=twc

Normal total precip = 8 in.

Current total precip = 6.84 in.

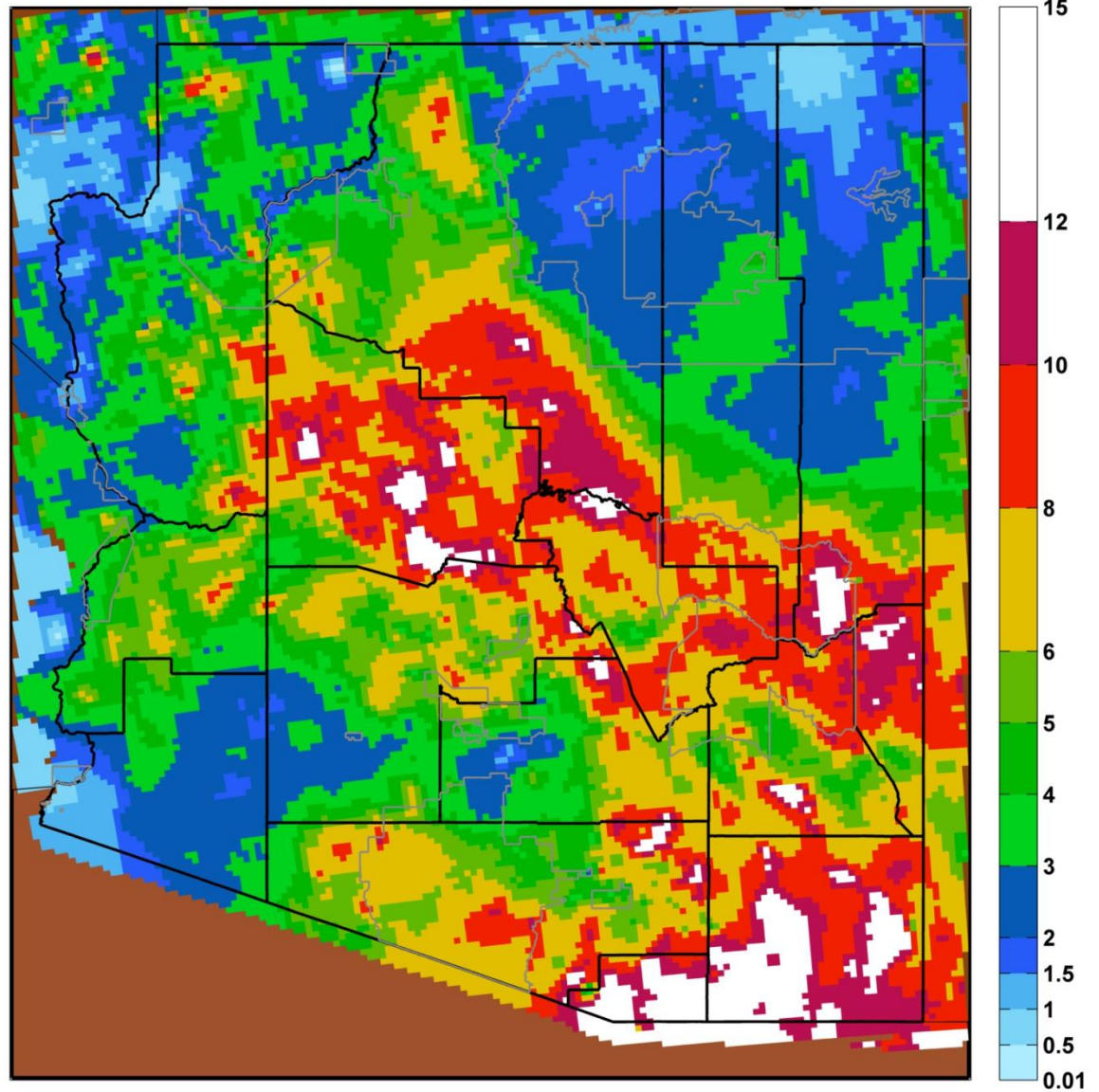
6.84



Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Record Min Record Max Normal Below Normal Above Normal

Monsoon Season Precip – total (in)

Total Precipitation (in): 06/15/14 to 09/17/14

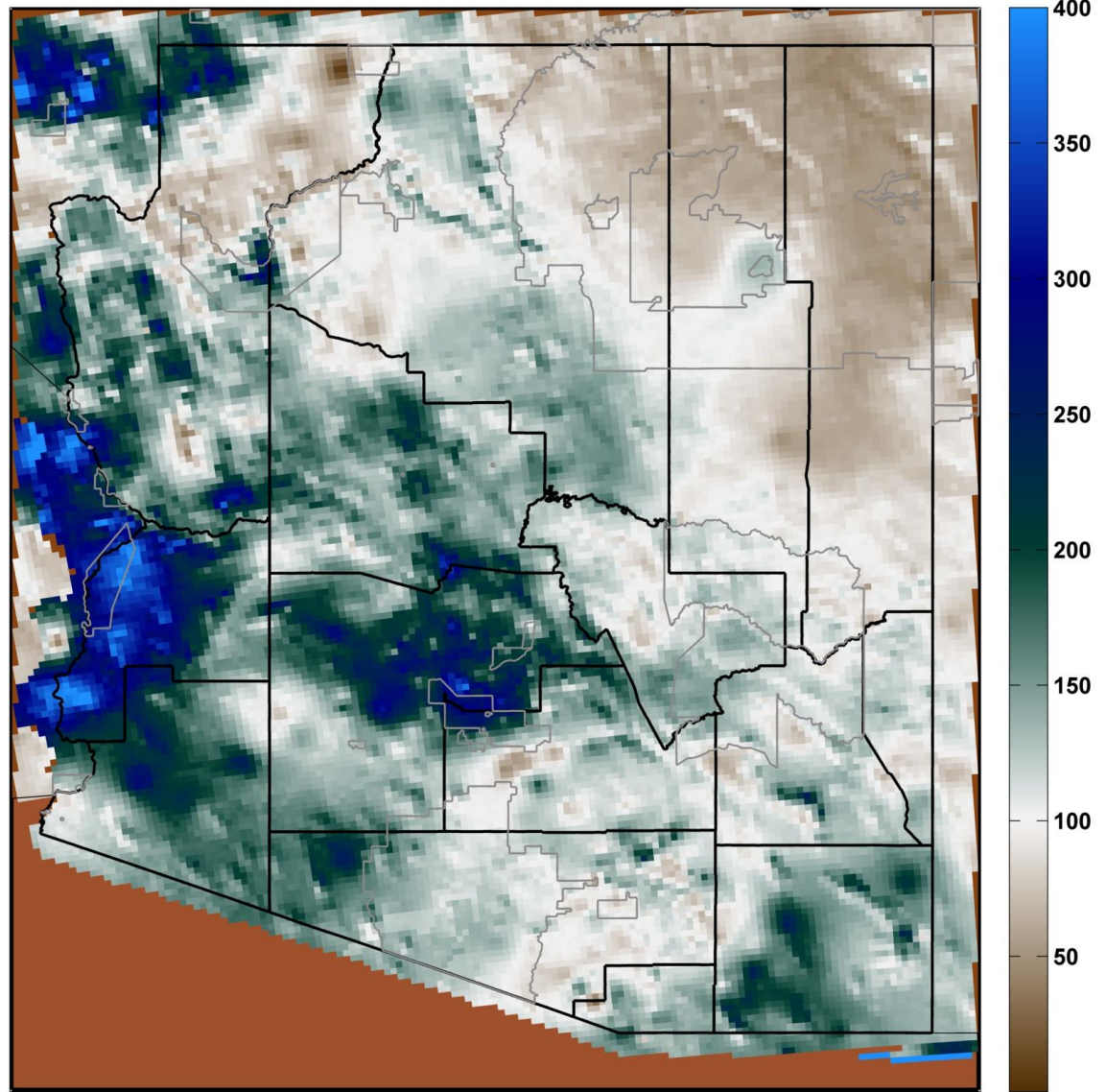


Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at <http://water.weather.gov/precip/about.php>. Date created: 18-Sep-2014
University of Arizona - <http://cals.arizona.edu/climate/>



Monsoon Season Precip – % of avg

Percent of Average Precipitation (%): 06/15/14 to 09/17/14

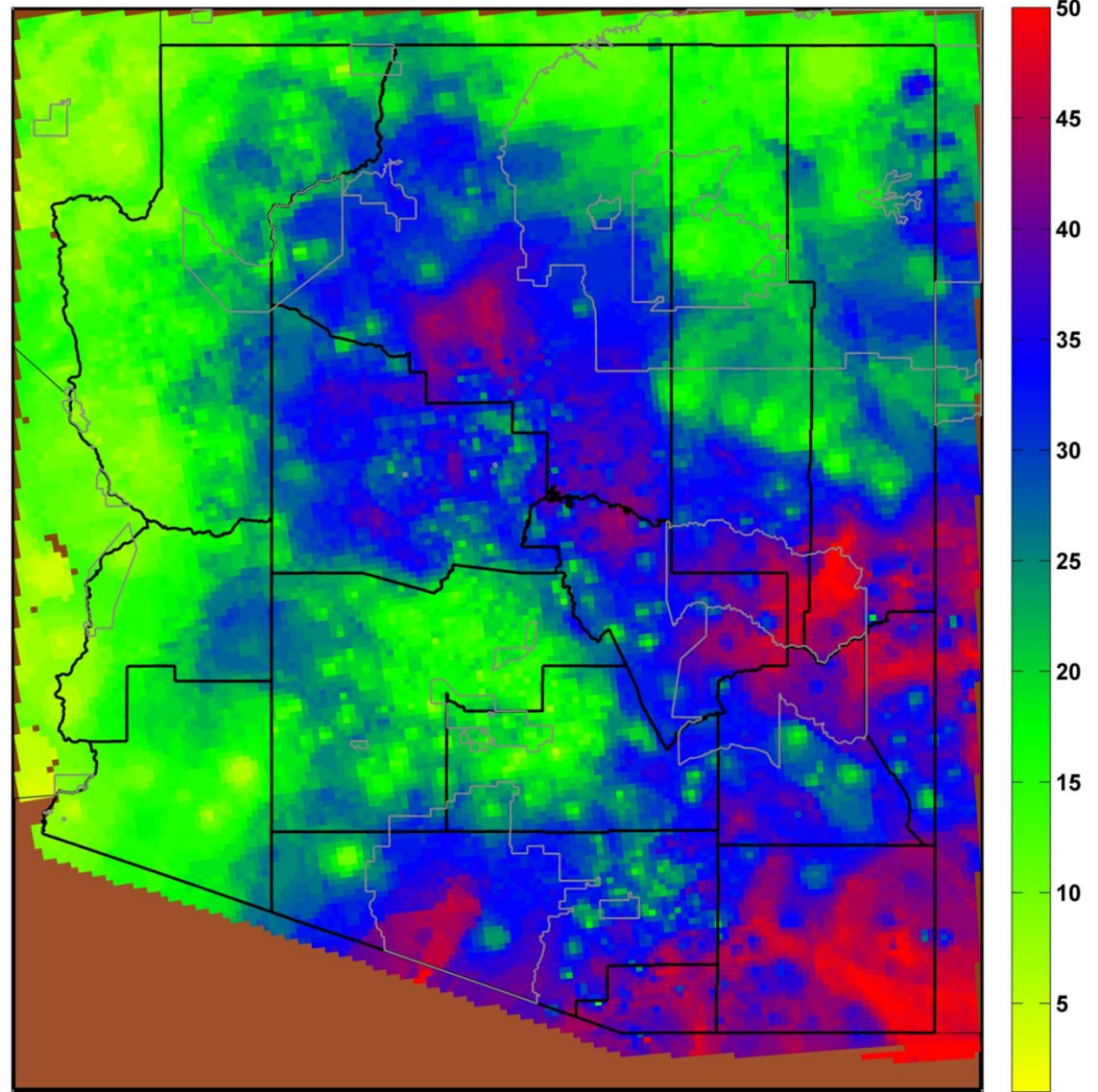


Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at <http://water.weather.gov/precip/about.php>. Date created: 18-Sep-2014
University of Arizona - <http://cals.arizona.edu/climate/>



Monsoon Season Precip – % days

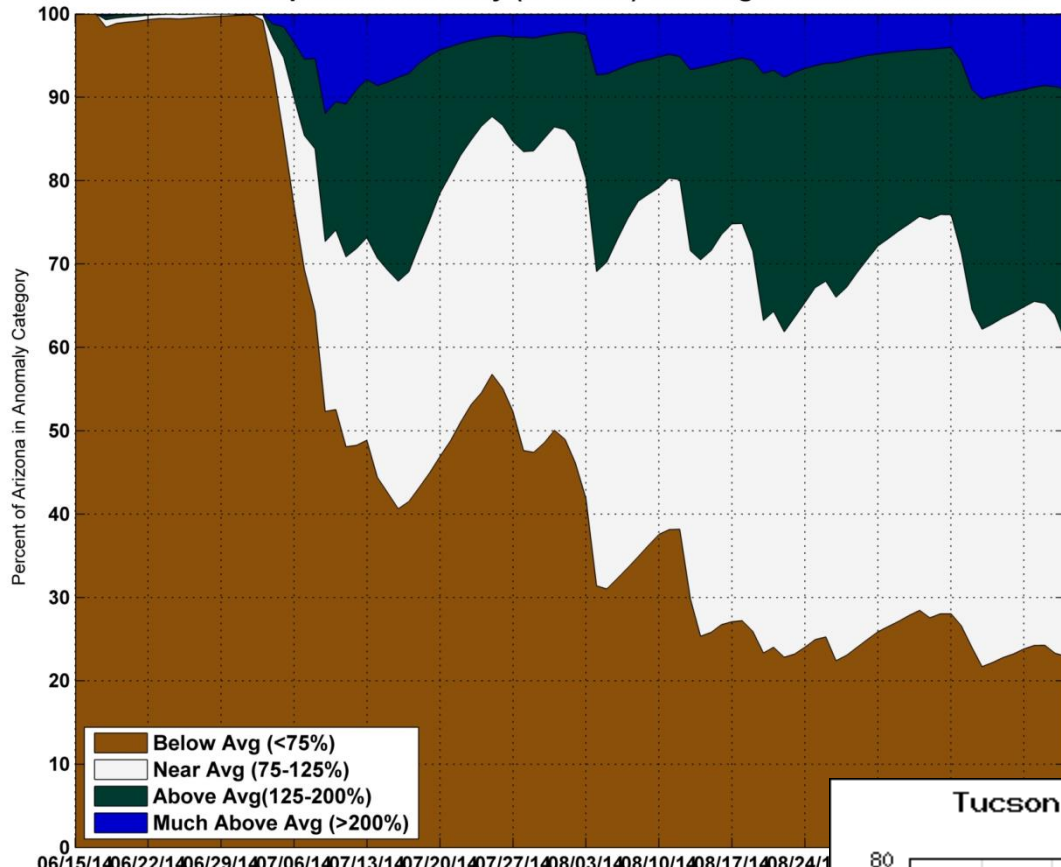
Percent of days with rain (>0.01"): 06/15/14 to 09/17/14



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: 18-Sep-2014
University of Arizona - <http://cals.arizona.edu/climate/>



Arizona Precipitation Anomaly (% of ave) Coverage: 06/15/14 to 09/17/14

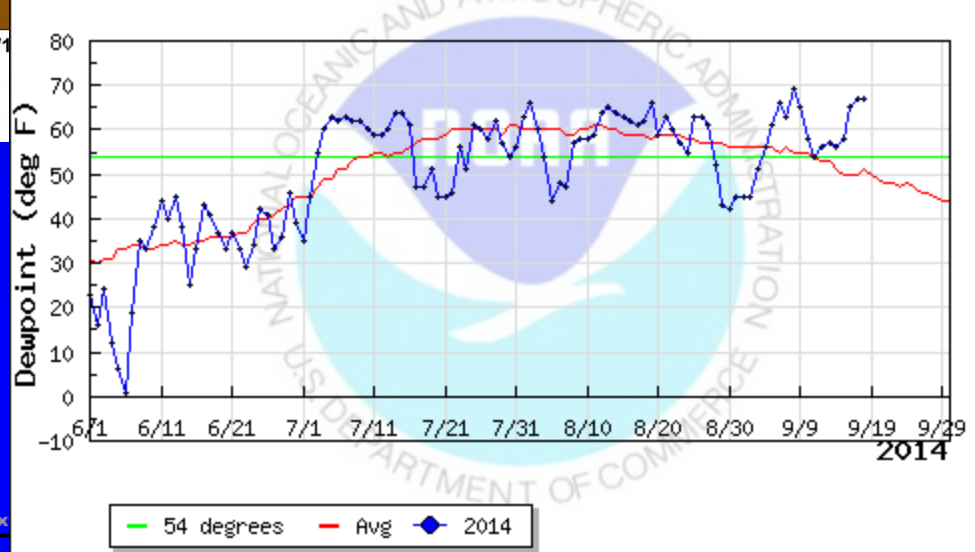


AZ Monsoon Precip and Dewpoints

06/15/14 06/22/14 06/29/14 07/06/14 07/13/14 07/20/14 07/27/14 08/03/14 08/10/14 08/17/14 08/24/14

Figure 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: 18-Sep-2014
University of Arizona - <http://cals.arizona.edu/climate/>

Tucson Airport Avg. Daily Dewpoint Tracker



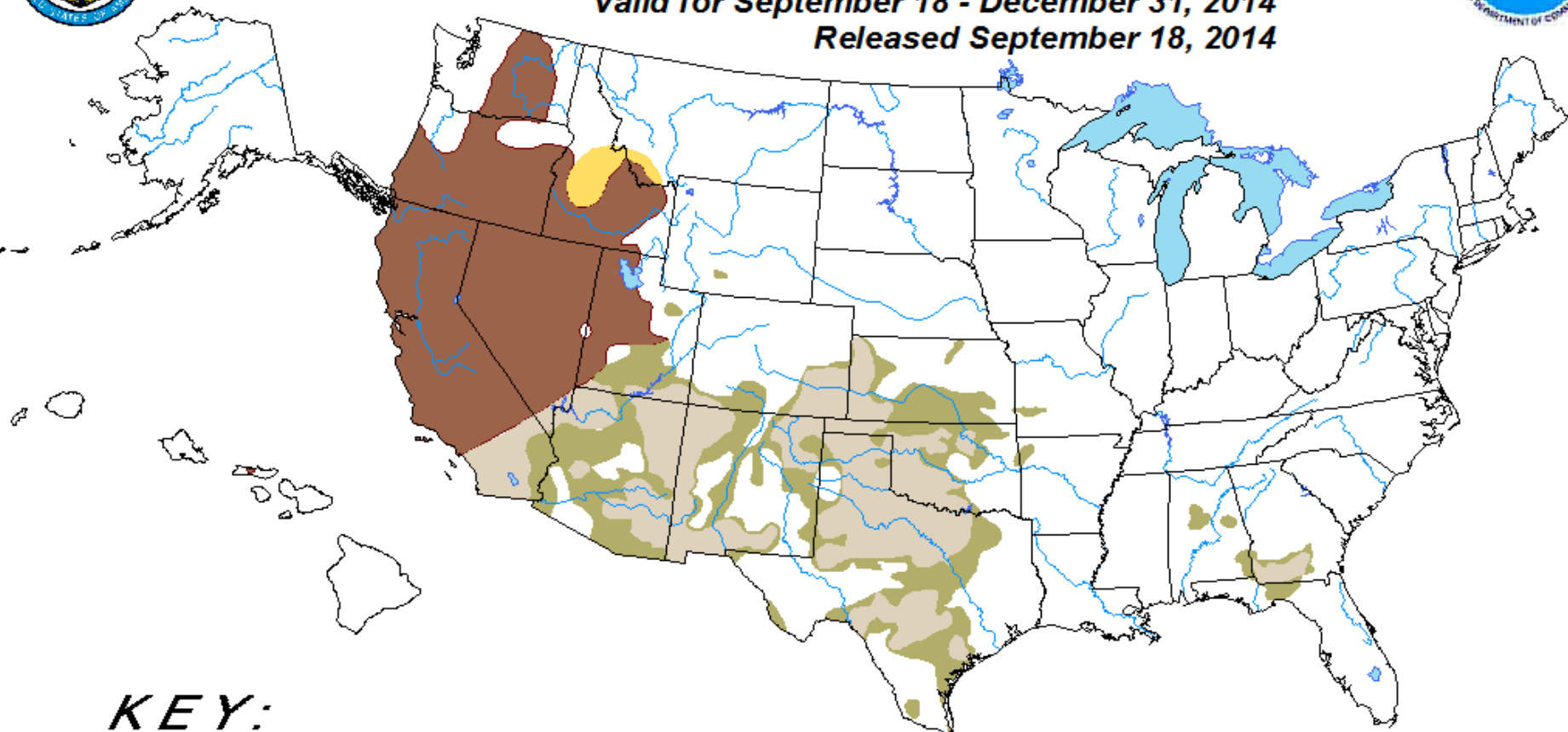


U.S. Seasonal Drought Outlook


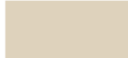


Drought Tendency During the Valid Period

Valid for September 18 - December 31, 2014

Released September 18, 2014



KEY:

-  Drought persists or intensifies
-  Drought remains but improves
-  Drought removal likely
-  Drought development likely

Author: Anthony Artusa, Climate Prediction Center, NOAA

http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.html

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity).

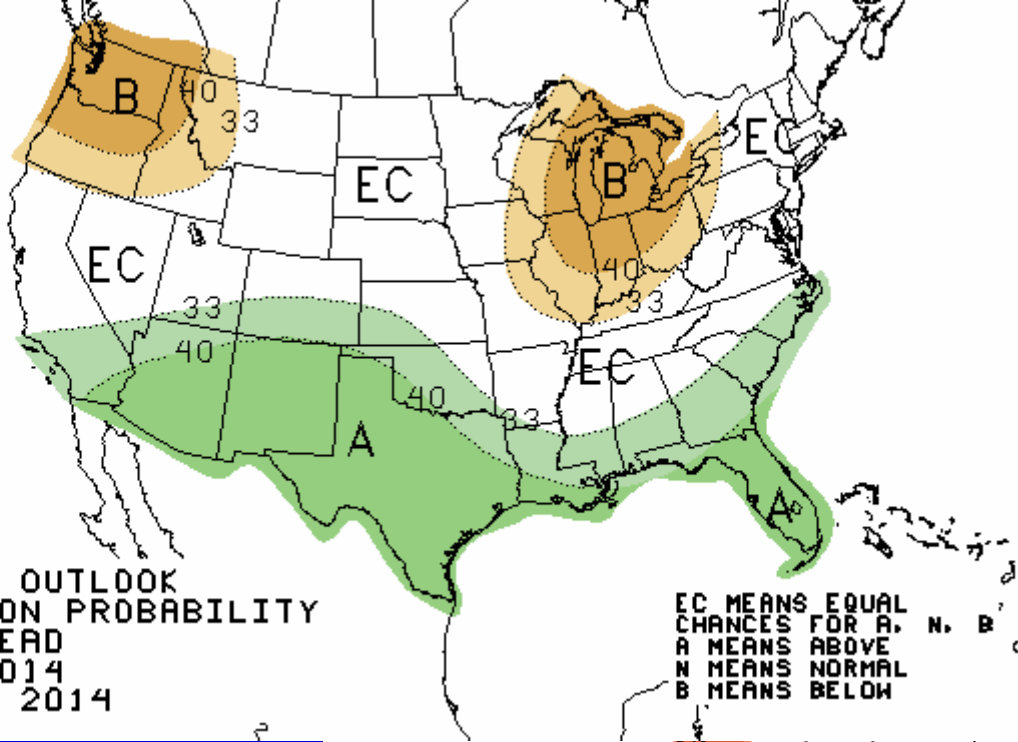
For weekly drought updates, see the latest U.S. Drought Monitor.

NOTE: The tan area areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period although drought will remain.

The Green areas imply drought removal by the end of the period (D0 or none)



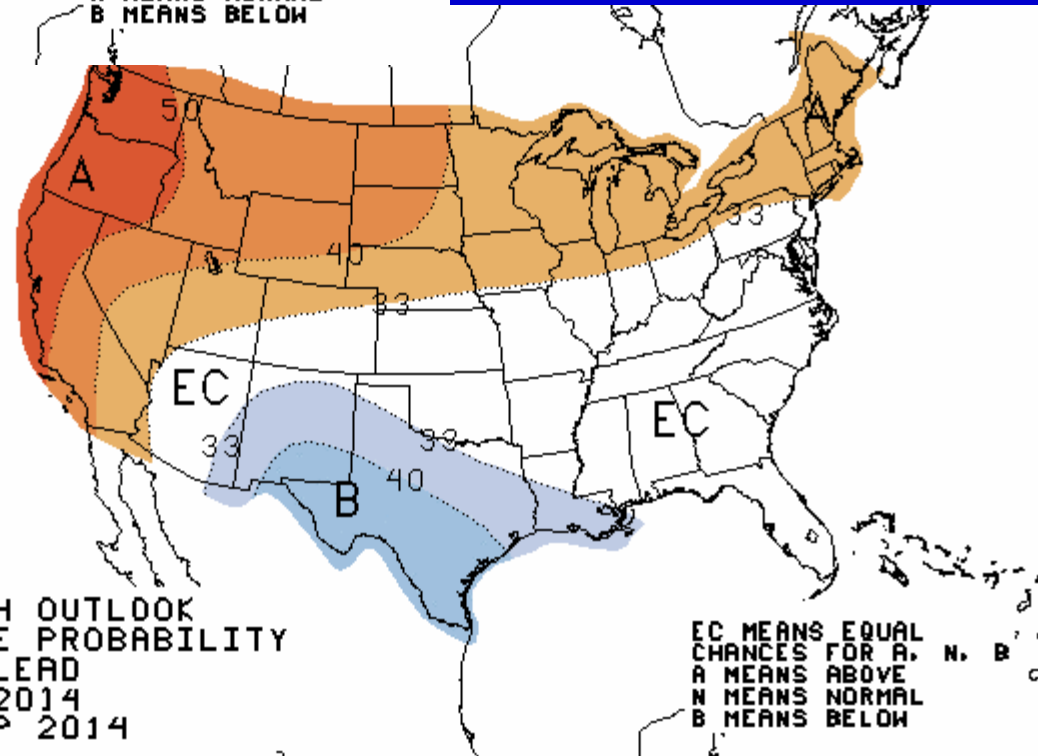
Seasonal Forecasts



EC MEANS EQUAL CHANCES FOR A, N, B
 A MEANS ABOVE
 N MEANS NORMAL
 B MEANS BELOW

THREE-MONTH OUTLOOK
 PRECIPITATION PROBABILITY
 2.5 MONTH LEAD
 VALID DJF 2014
 MADE 18 SEP 2014

http://www.cpc.ncep.noa.gov/products/predictions/long_range/lead03

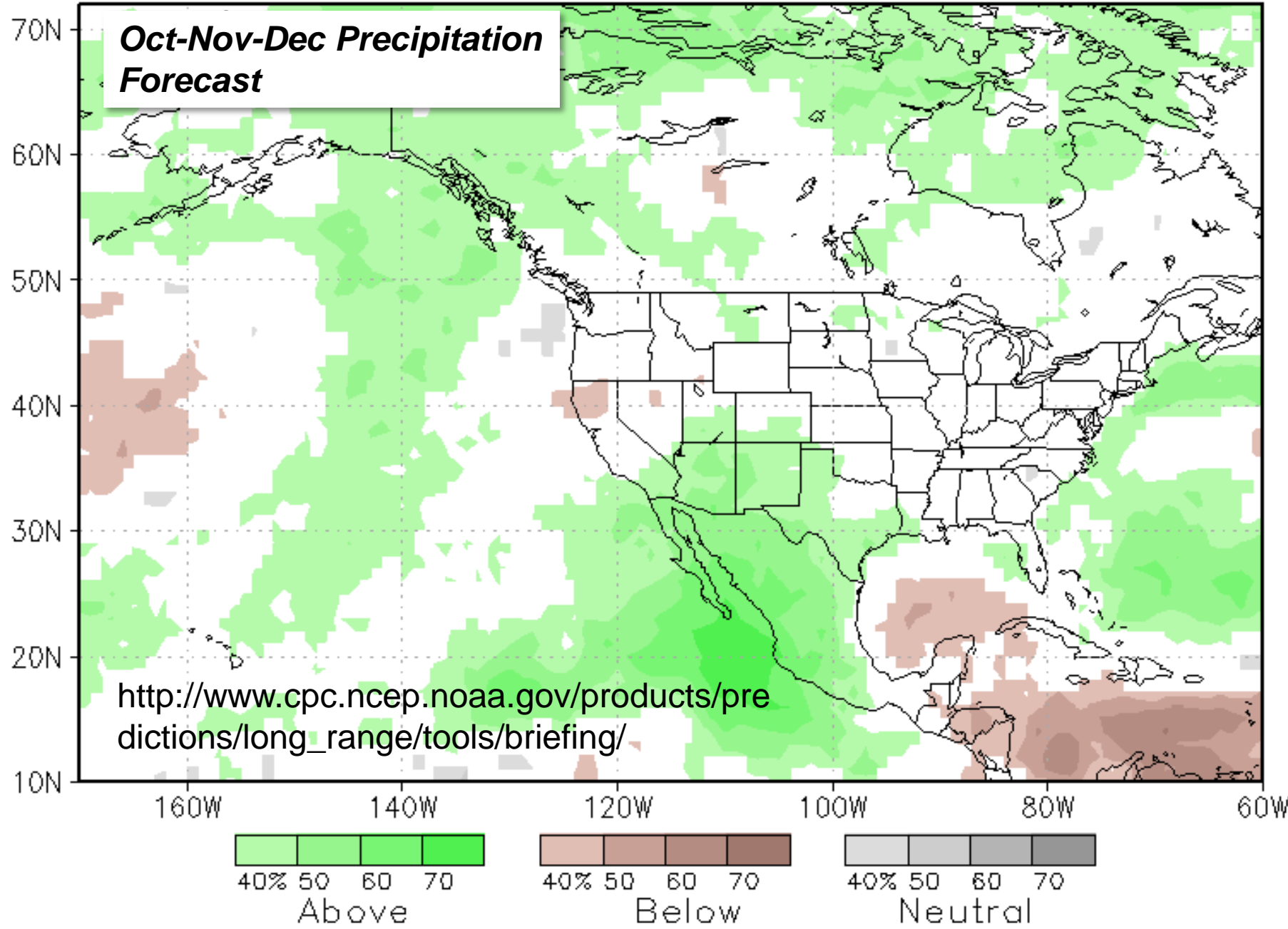


EC MEANS EQUAL CHANCES FOR A, N, B
 A MEANS ABOVE
 N MEANS NORMAL
 B MEANS BELOW

THREE-MONTH OUTLOOK
 TEMPERATURE PROBABILITY
 2.5 MONTH LEAD
 VALID DJF 2014
 MADE 18 SEP 2014

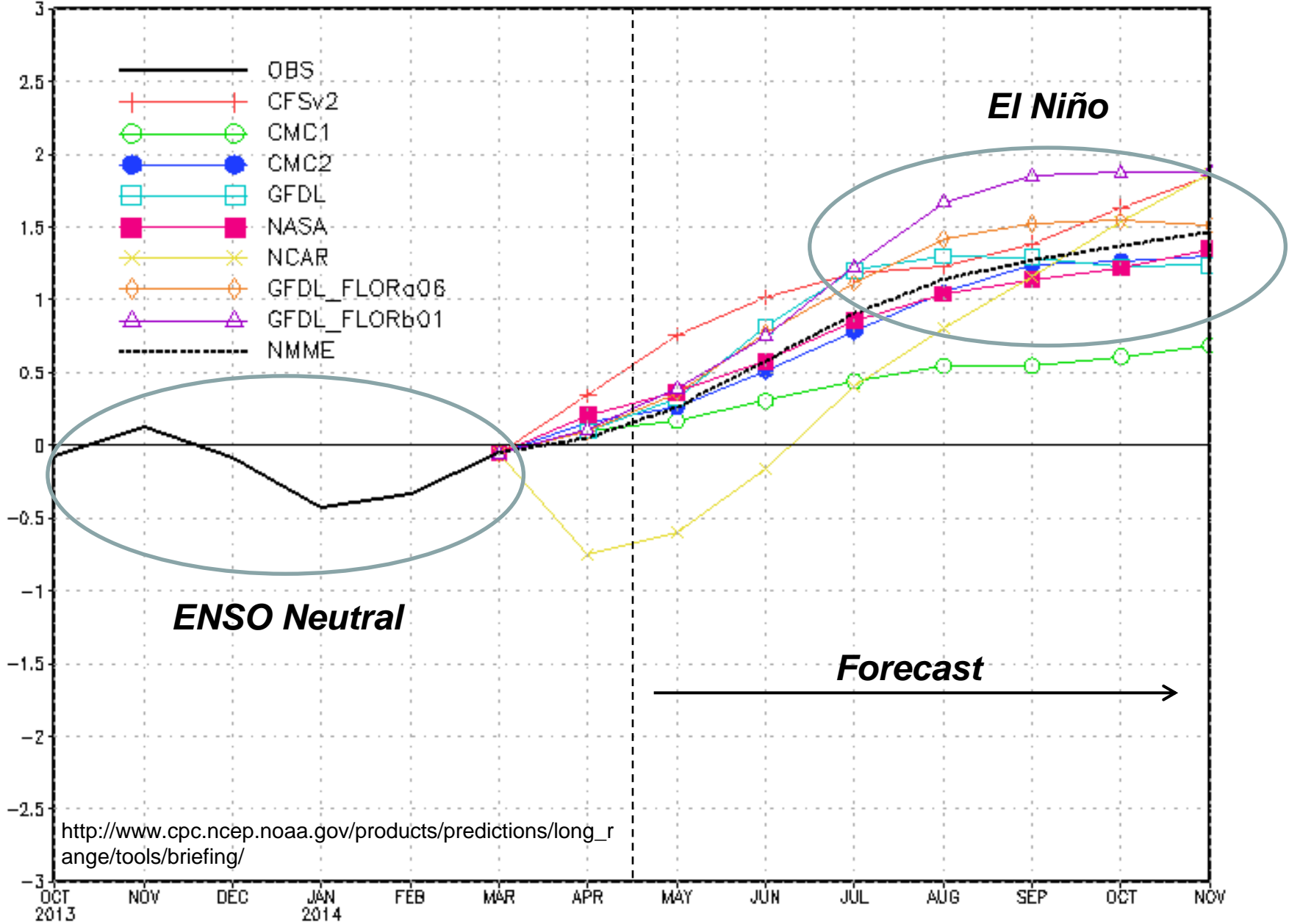


NMME prob fcst Prate IC=201409 for lead 1 2014 OND

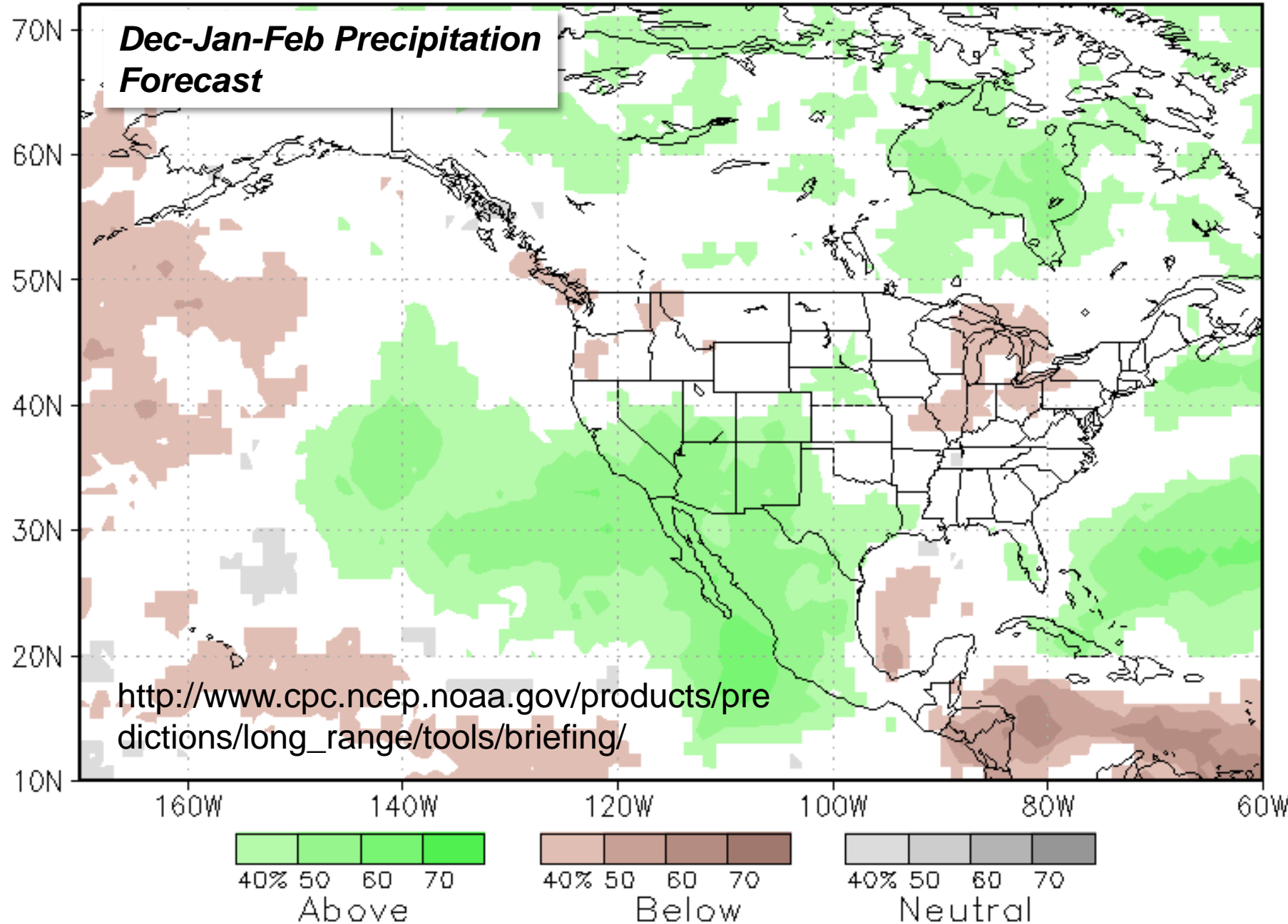


April Forecast

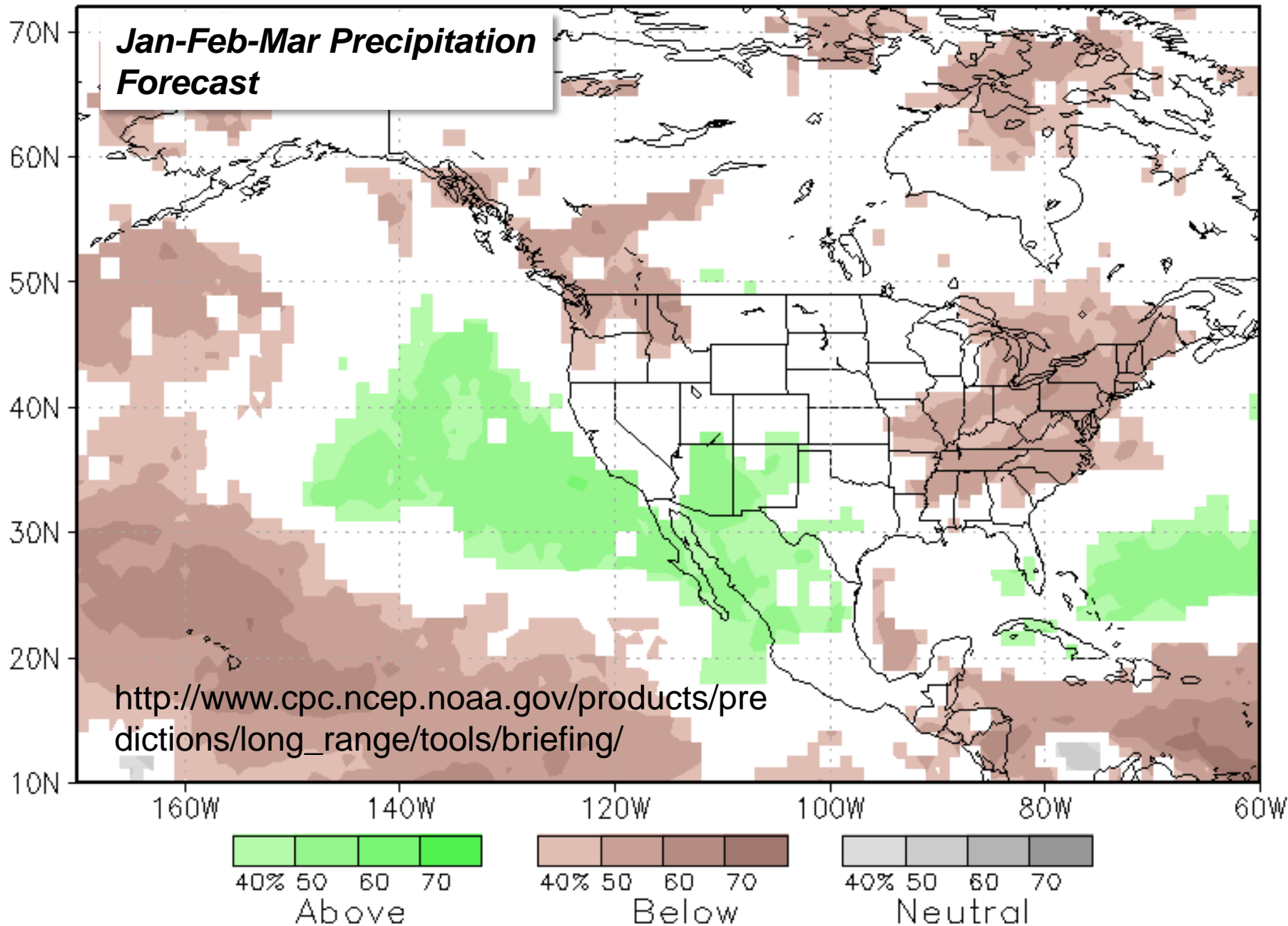
NMME Forecast for Nino 3.4 IC= 201404



NMME prob fcst Prate IC=201409 for lead 3 2014 DJF



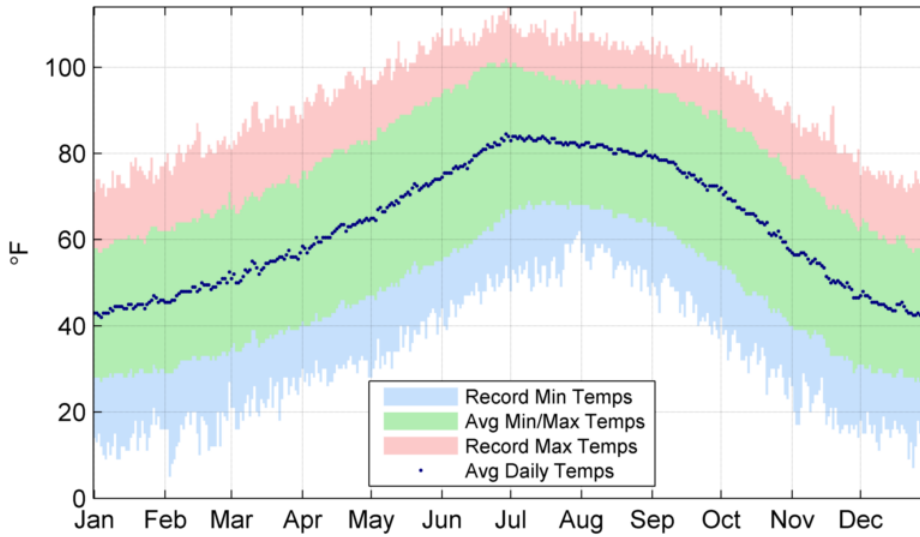
NMME prob fcst Prate IC=201409 for lead 4 2015 JFM



Climatic Context

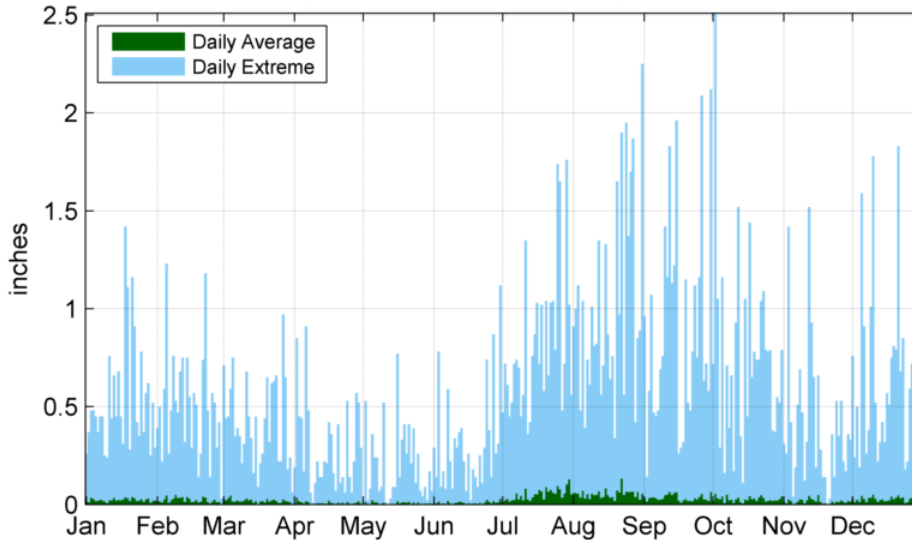


SAFFORD AGRICULTRL CTR, (1948-2012)
Average and Record Extreme Daily Temperature

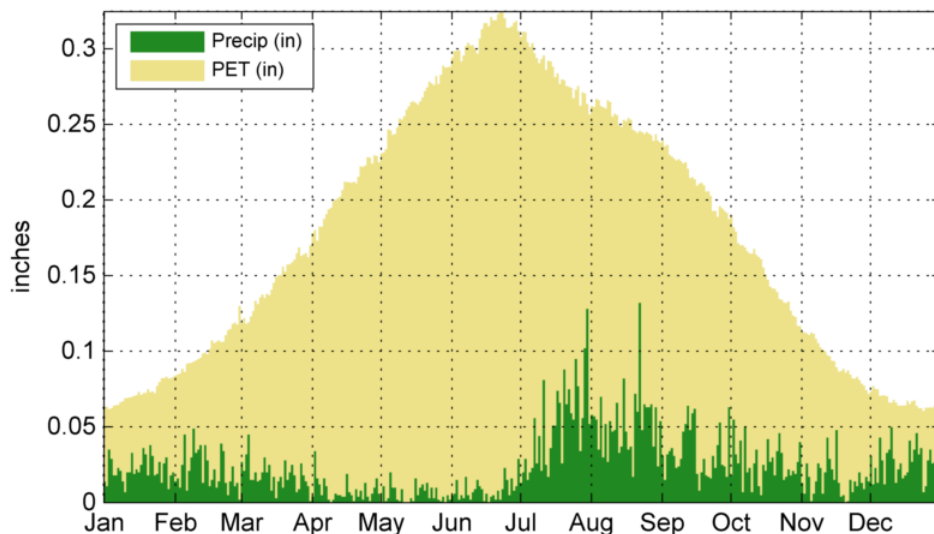


Climate of Safford

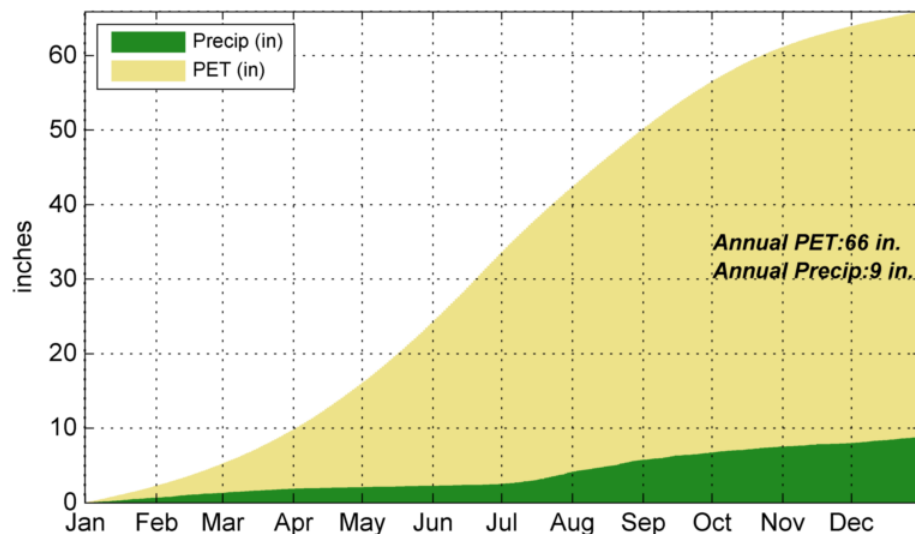
Average and Record Extreme Daily Precipitation



SAFFORD AGRICULTURAL CTR, (1948-2012)
Average Daily Precipitation and Potential Evapotranspiration (PET)

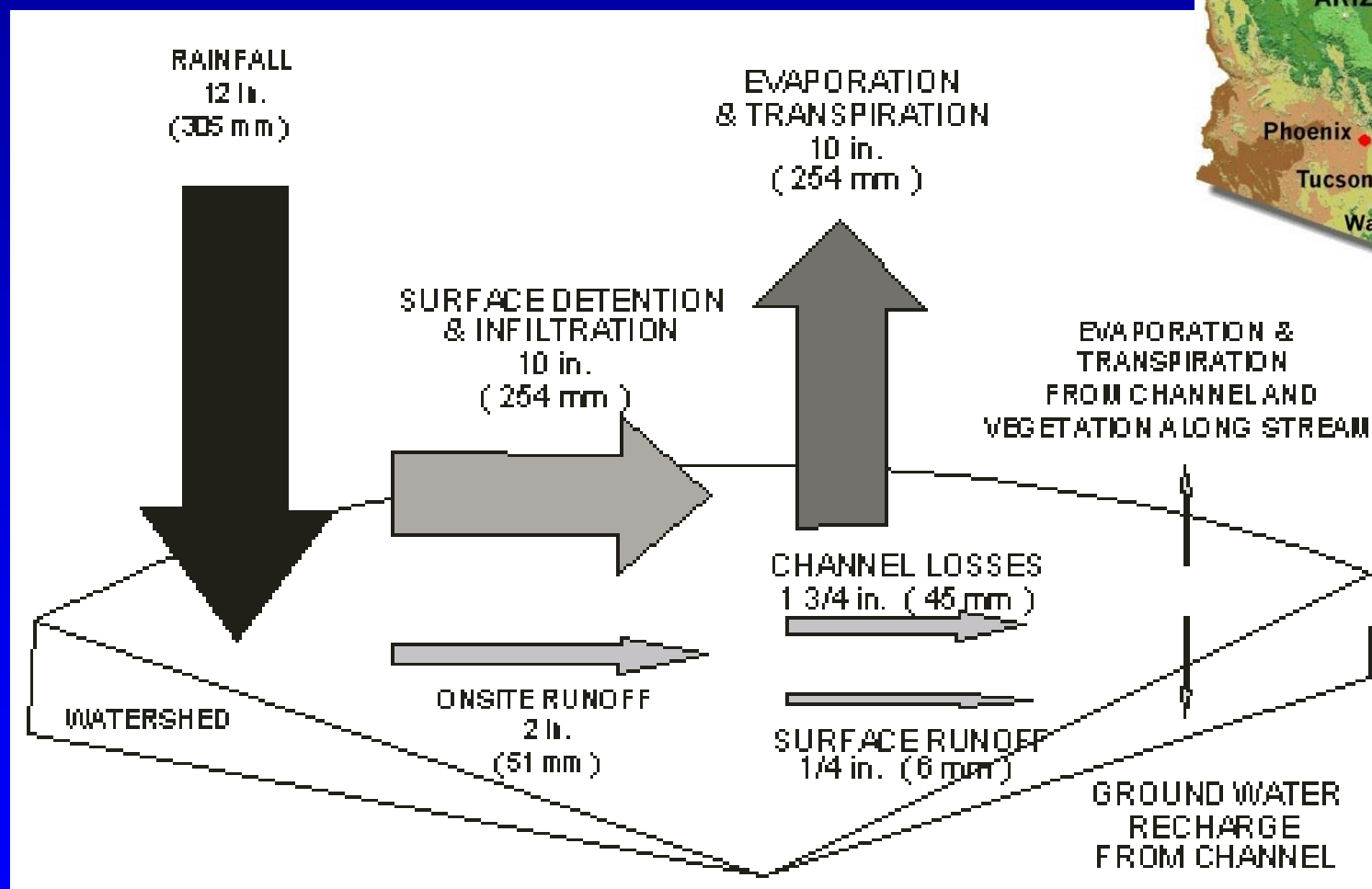


Cumulative Daily Precipitation and Potential Evapotranspiration (PET)



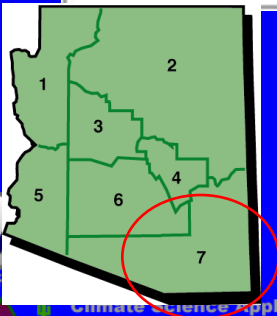
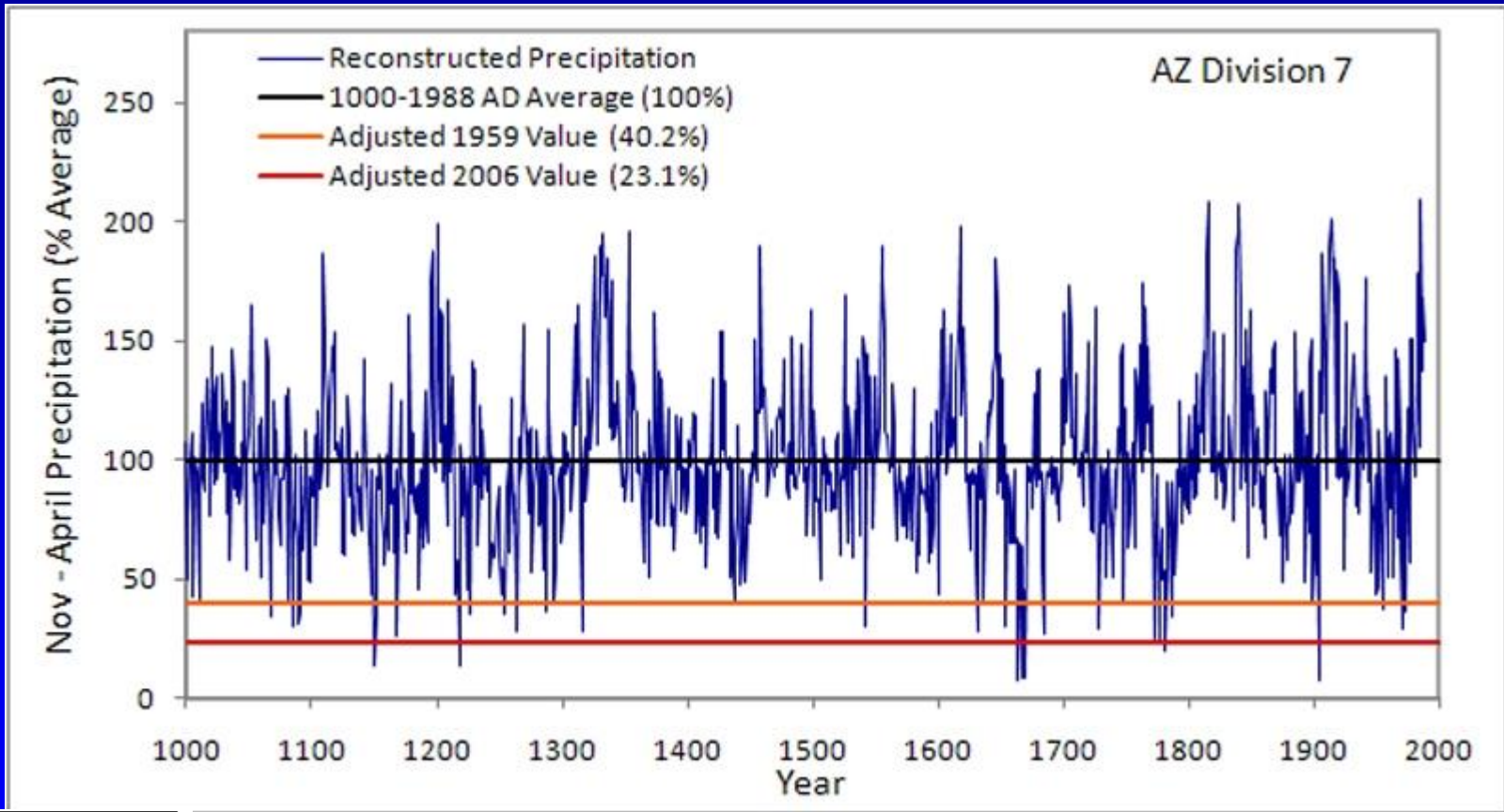
Climate of Safford

Example Water Balance: Walnut Gulch, Arizona



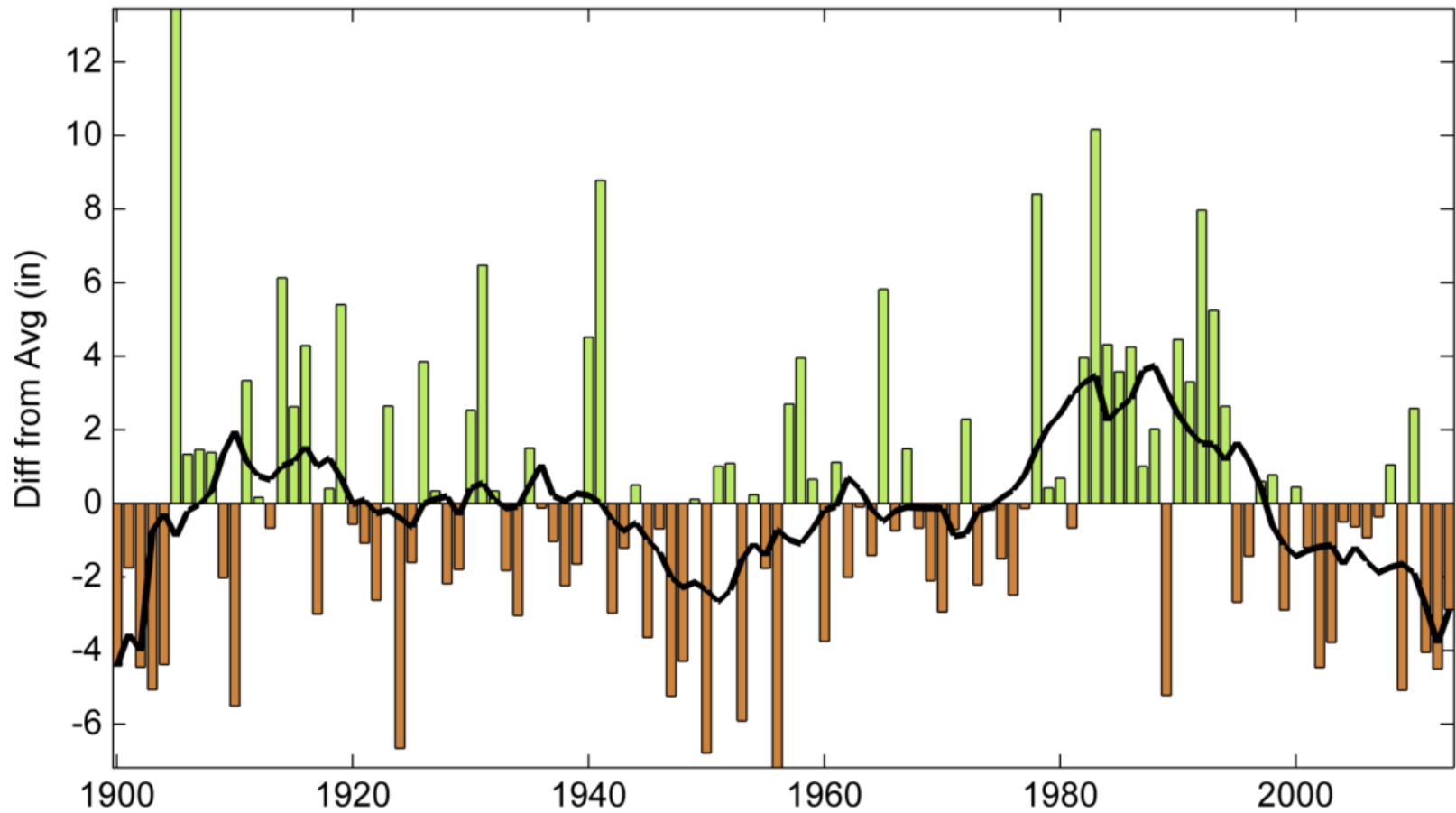
http://www.tucson.ars.ag.gov/dap/field_sites.htm

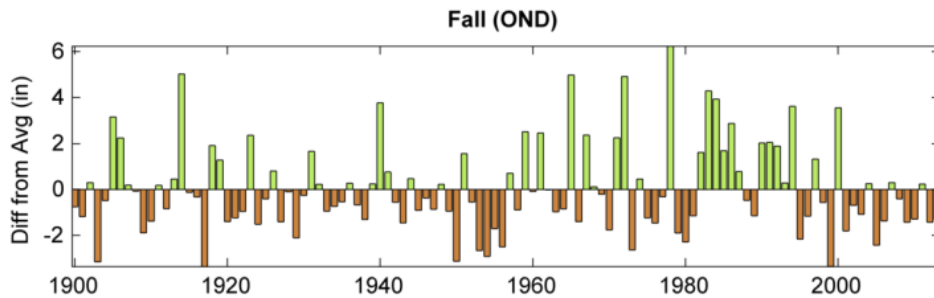
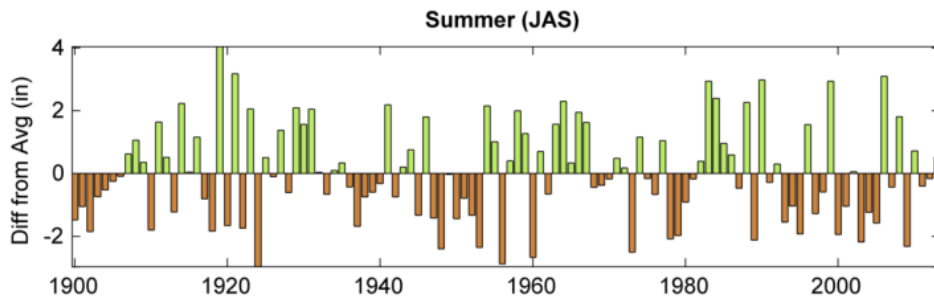
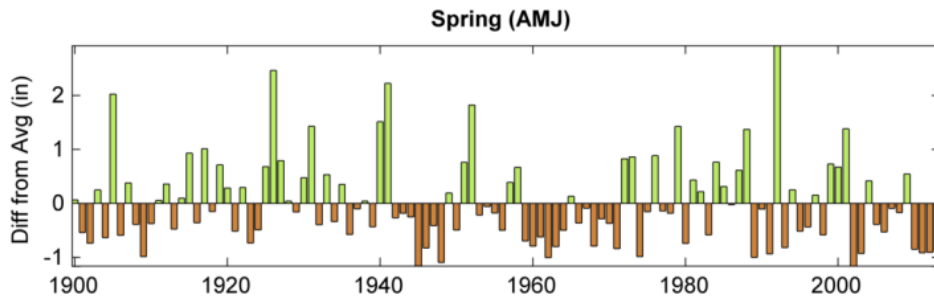
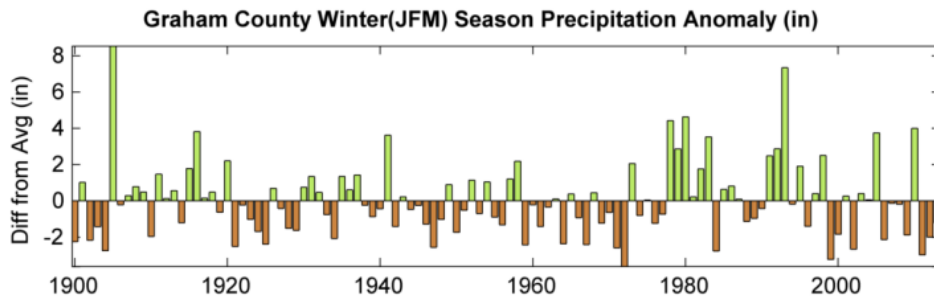
Precipitation: 1000-1988



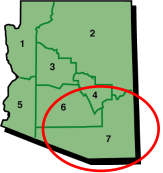
<http://www.climas.arizona.edu/research/paleoclimate/product.html>

Graham County Annual Precipitation Anomaly (in) 1900-2013

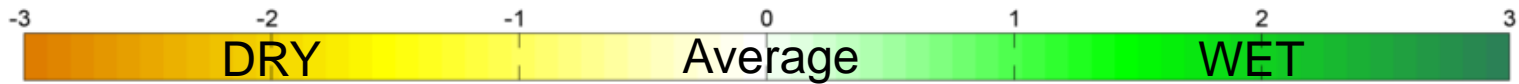




Seasonal Precipitation: 1900-2013



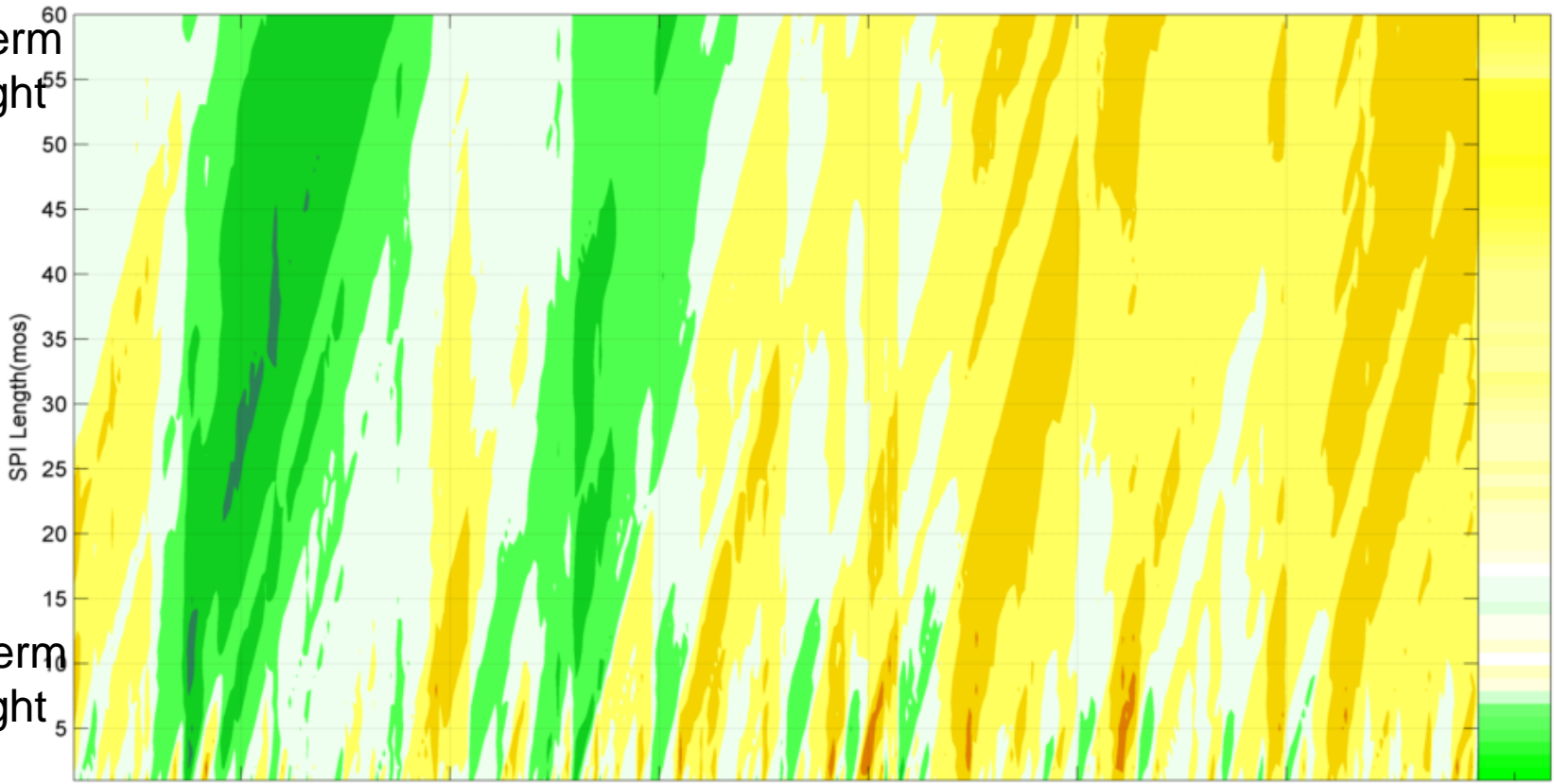
Arizona Climate Division 7, Standardized Precipitation Index - (1-60 mos, Jan1981 - Aug2014)



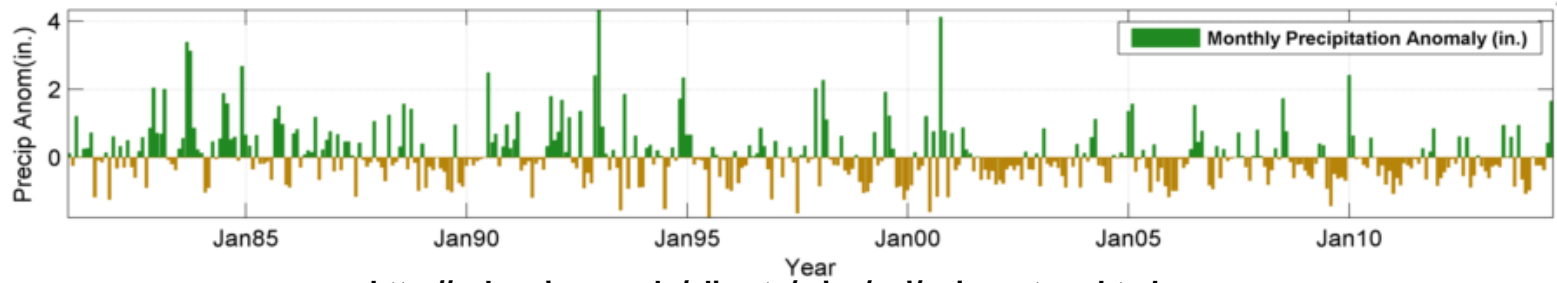
Long-term
Drought



Short-term
Drought



Aug14



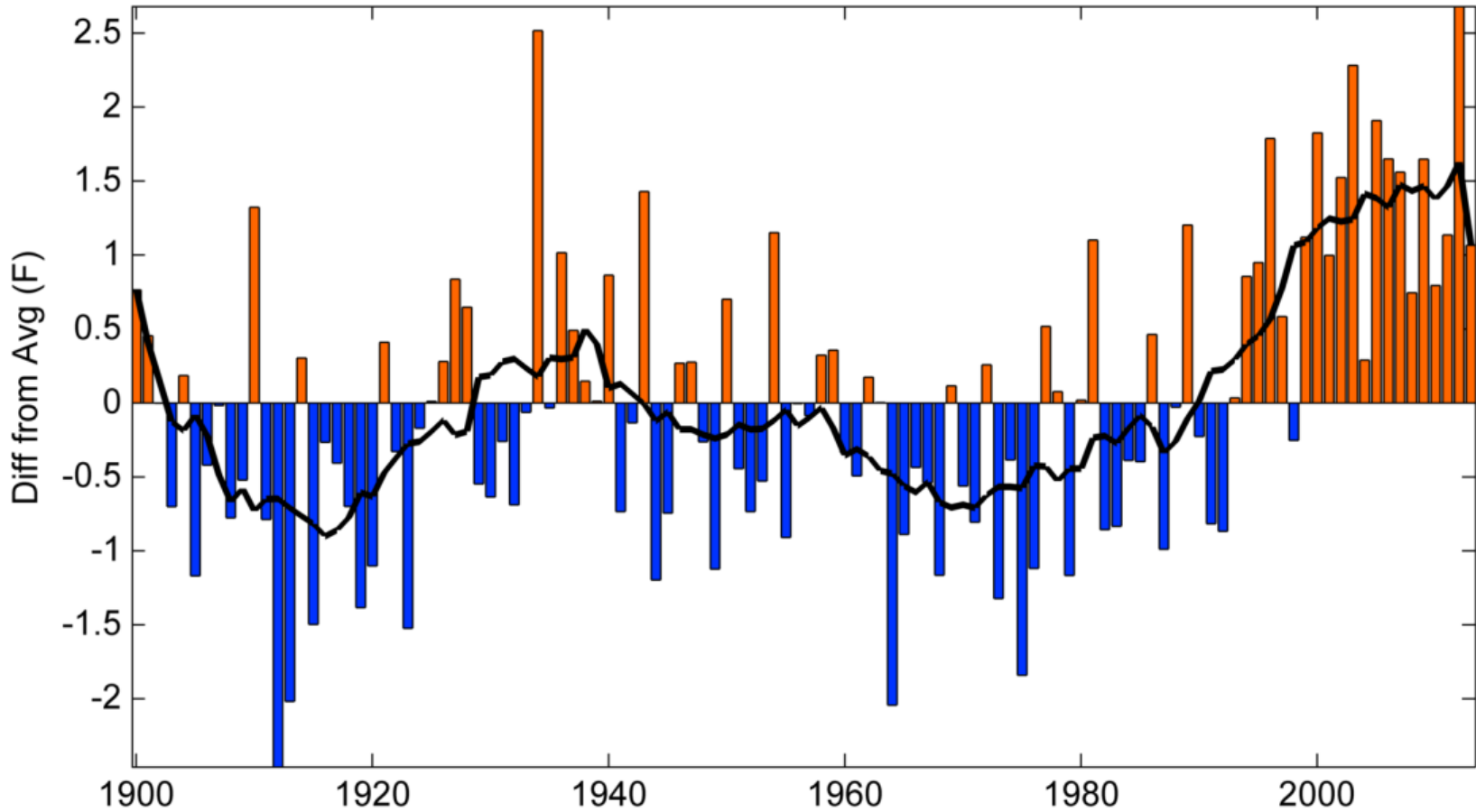
http://cals.arizona.edu/climate/misc/spi/spi_contour.html

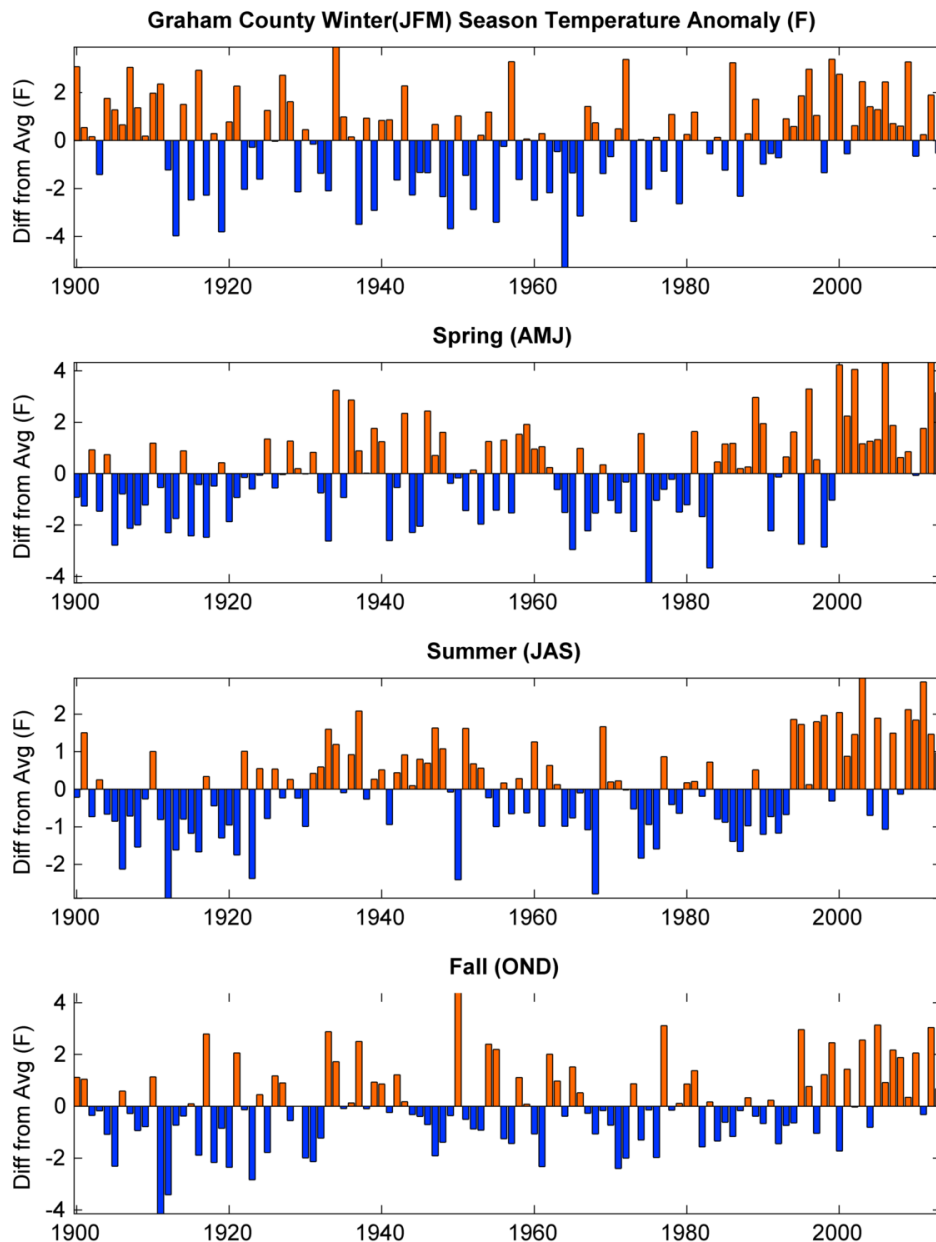


Climate Science Applications Program
University of Arizona Cooperative Extension
<http://cals.arizona.edu/climate>

Data source: NOAA National Climatic Data Center
<ftp://ftp.ncdc.noaa.gov/pub/data/cirs/climdiv>
Base Period= 1900-2014 Date created: 15-Sep-2014

Graham County Annual Temperature Anomaly (F) 1900-2013



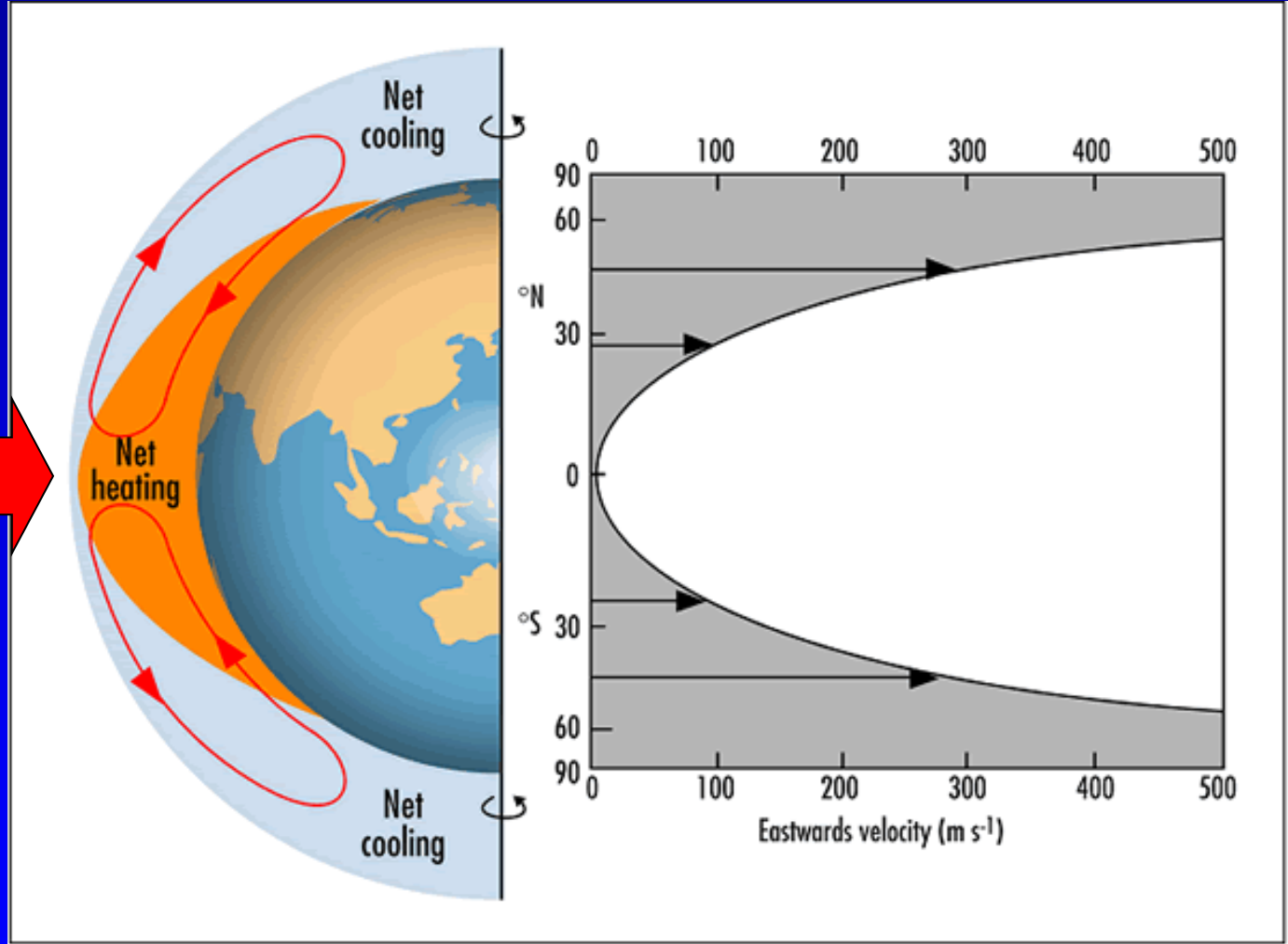
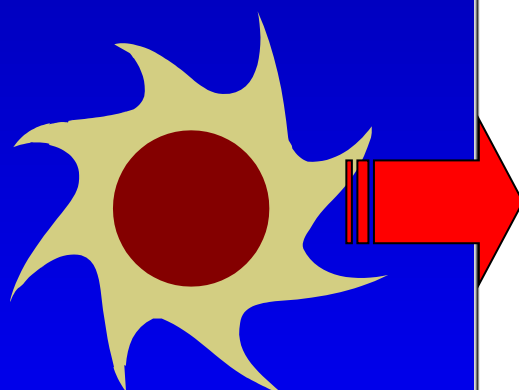


Seasonal Temperature: 1900-2013

Atmospheric Controls on Arizona Climate



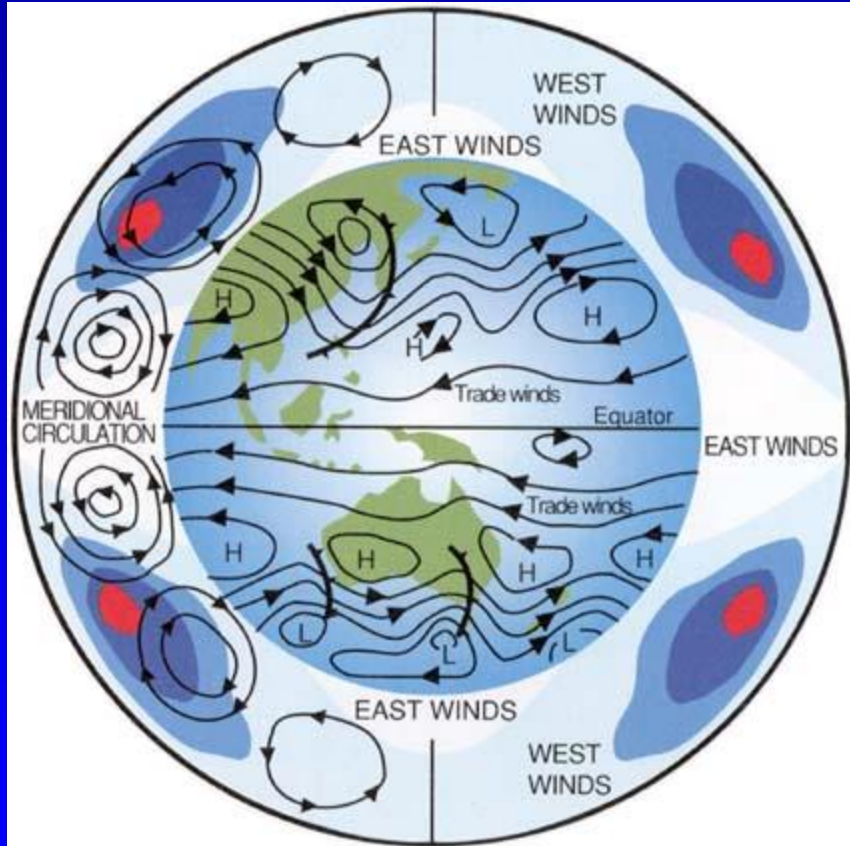
Global Energy Balance



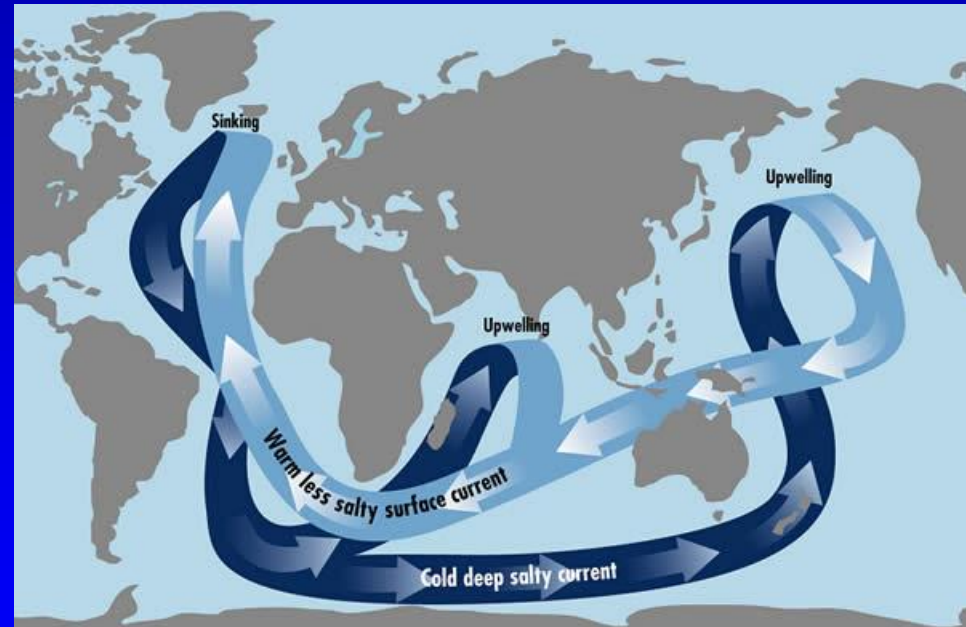
From <http://www.bom.gov.au>

Global Circulations: Flows of Mass & Energy

Atmosphere

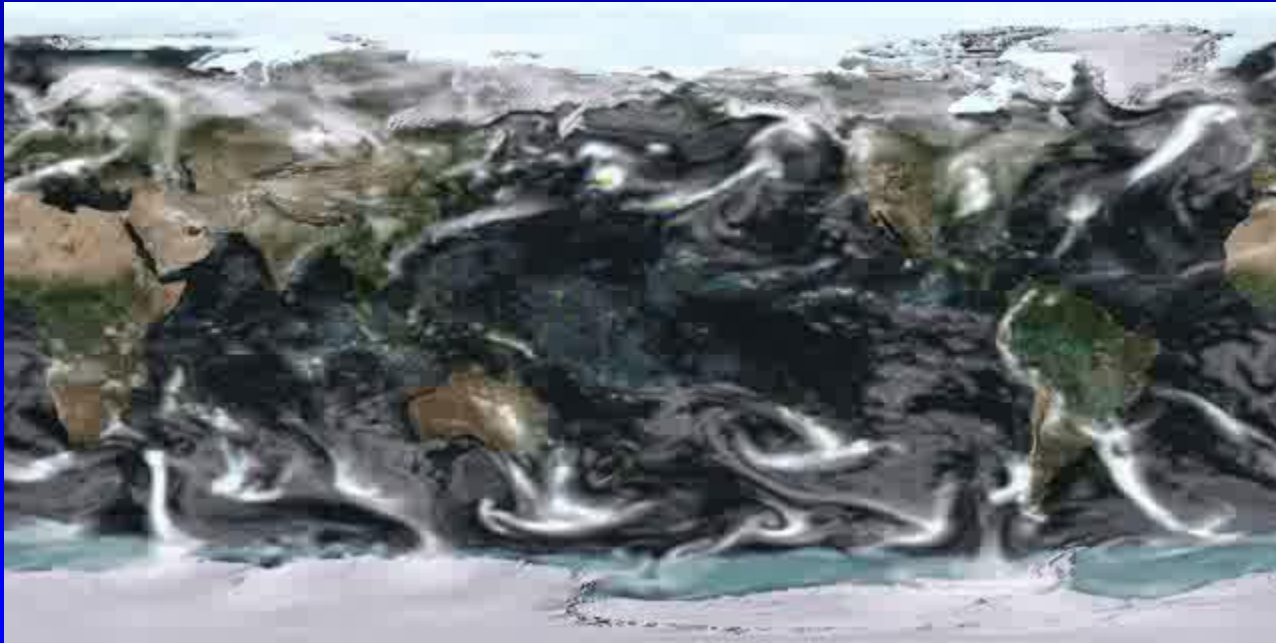


Ocean



From <http://www.bom.gov.au>

Global Circulation

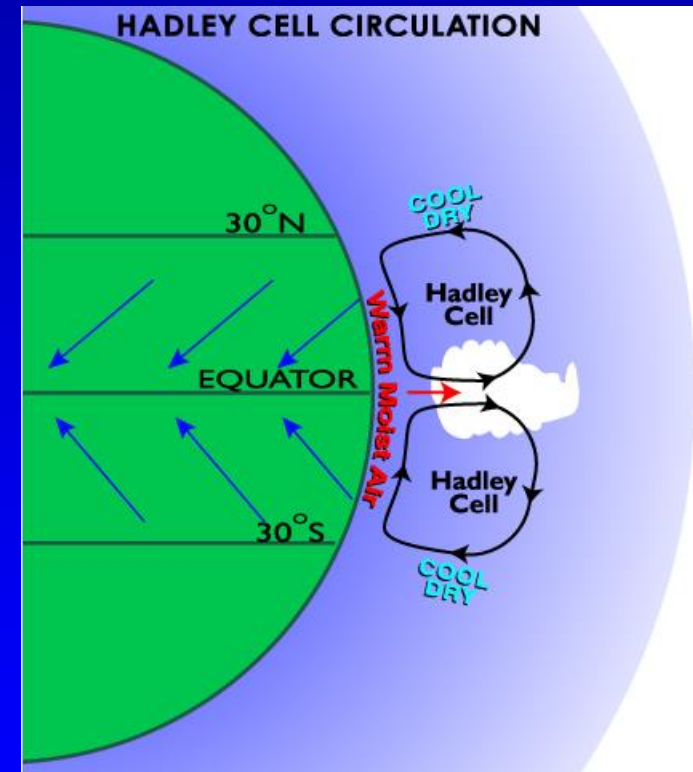


<http://www.cmmmap.org/learn/climate/gencirc.htm>

<http://earth.nullschool.net/>

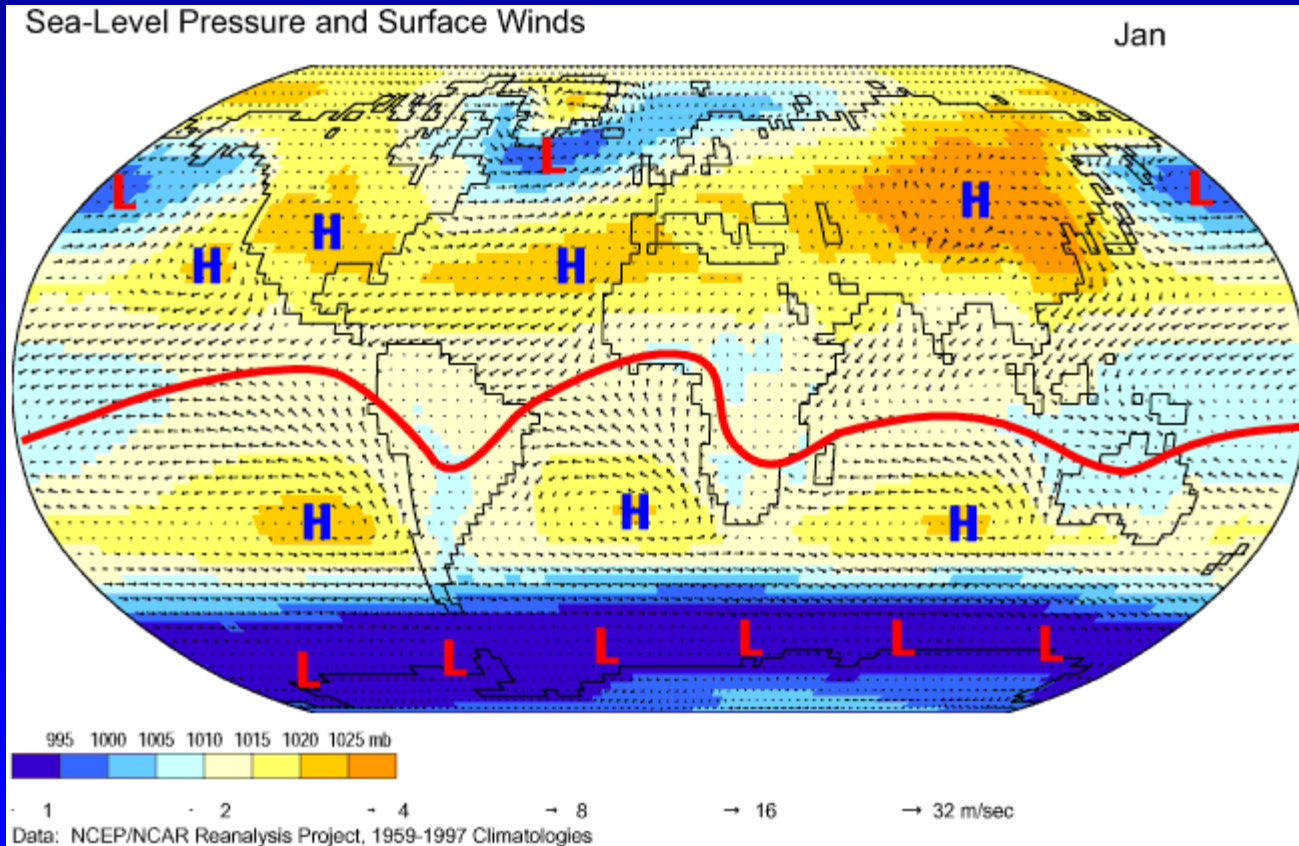
Atmospheric Circulation and Arizona Climate

- Large-scale circulation patterns are an important determinant of local climate
- Arizona has a unique geographic position in northern hemisphere
- Circulation patterns are tied to global ocean sea surface temperatures
- Patterns can persist for years and even decades

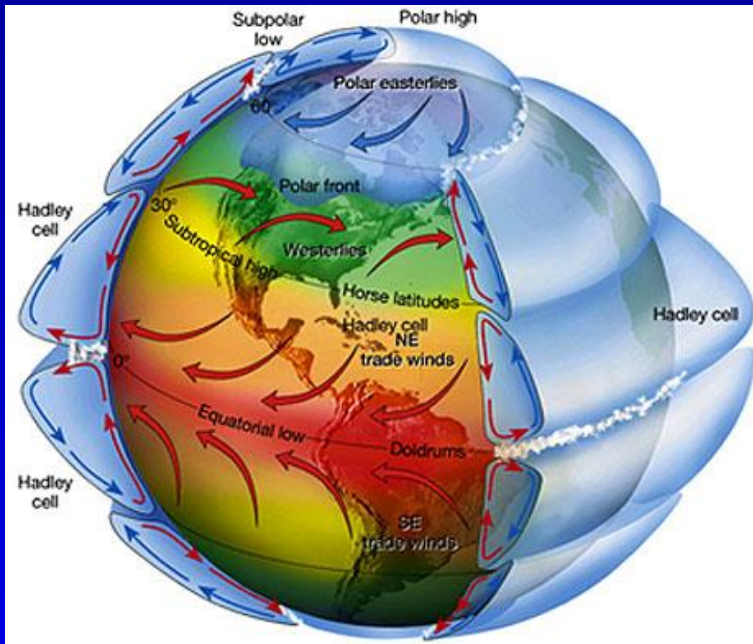


<http://www.geography.hunter.cuny.edu/~tbw/wc.notes/7.circ.atm/animations/GlobalWind.html>

Seasonality of Circulation Patterns



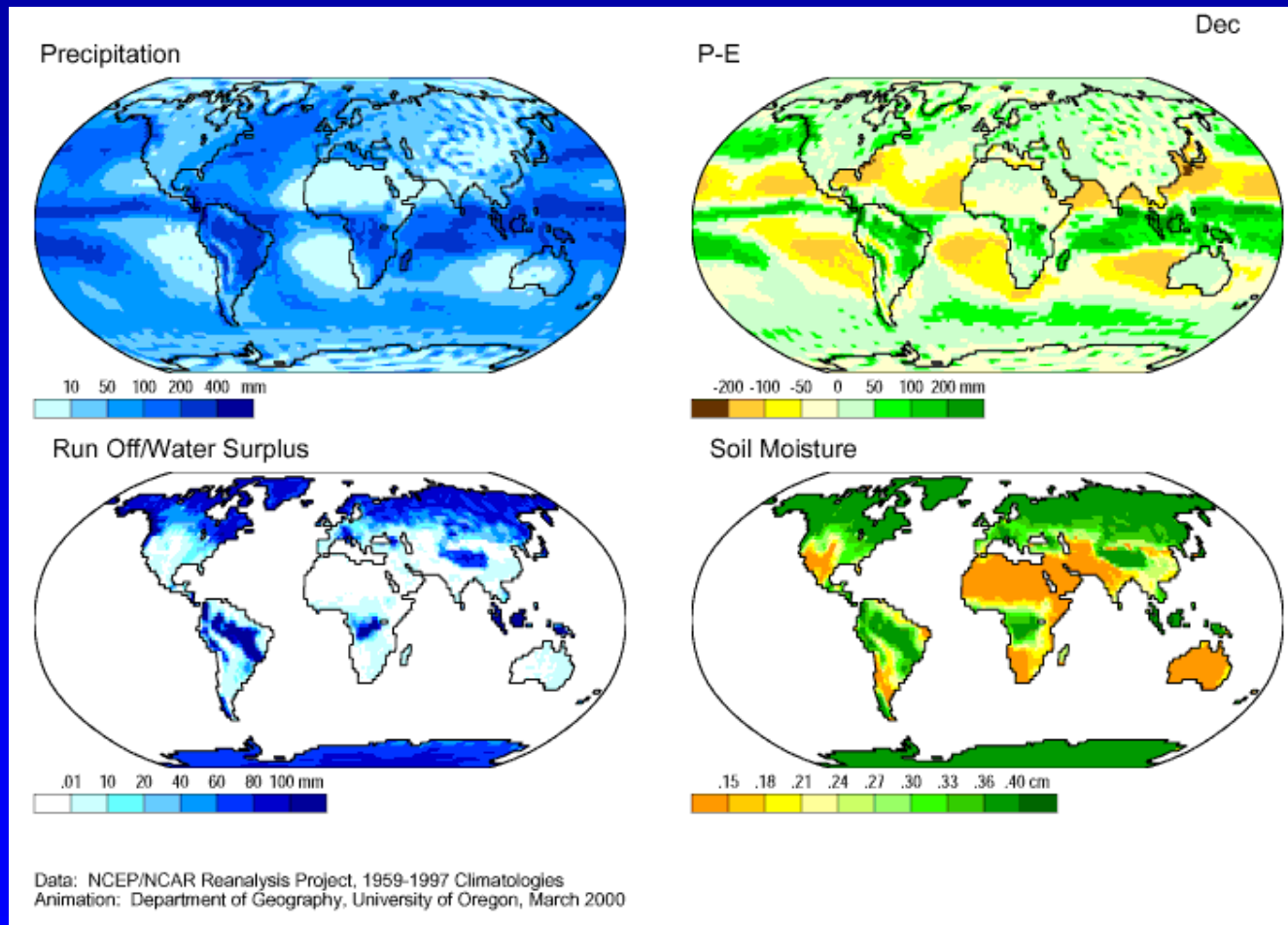
Global Circulations and Aridity



Deserts of the WORLD

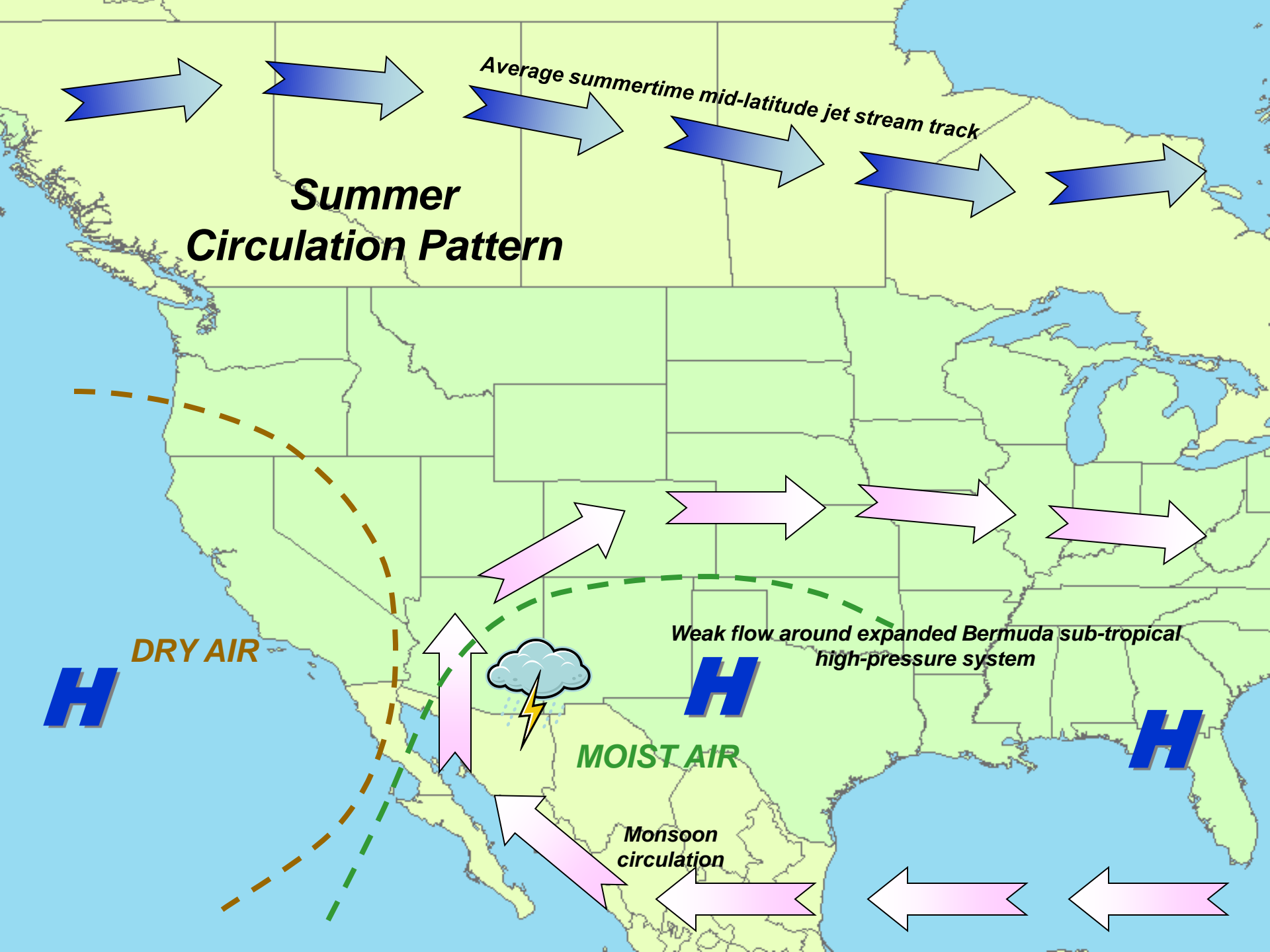


Global Hydroclimate



Winter Circulation Pattern





Summer Circulation Pattern

Average summertime mid-latitude jet stream track

DRY AIR

H

H

MOIST AIR

H

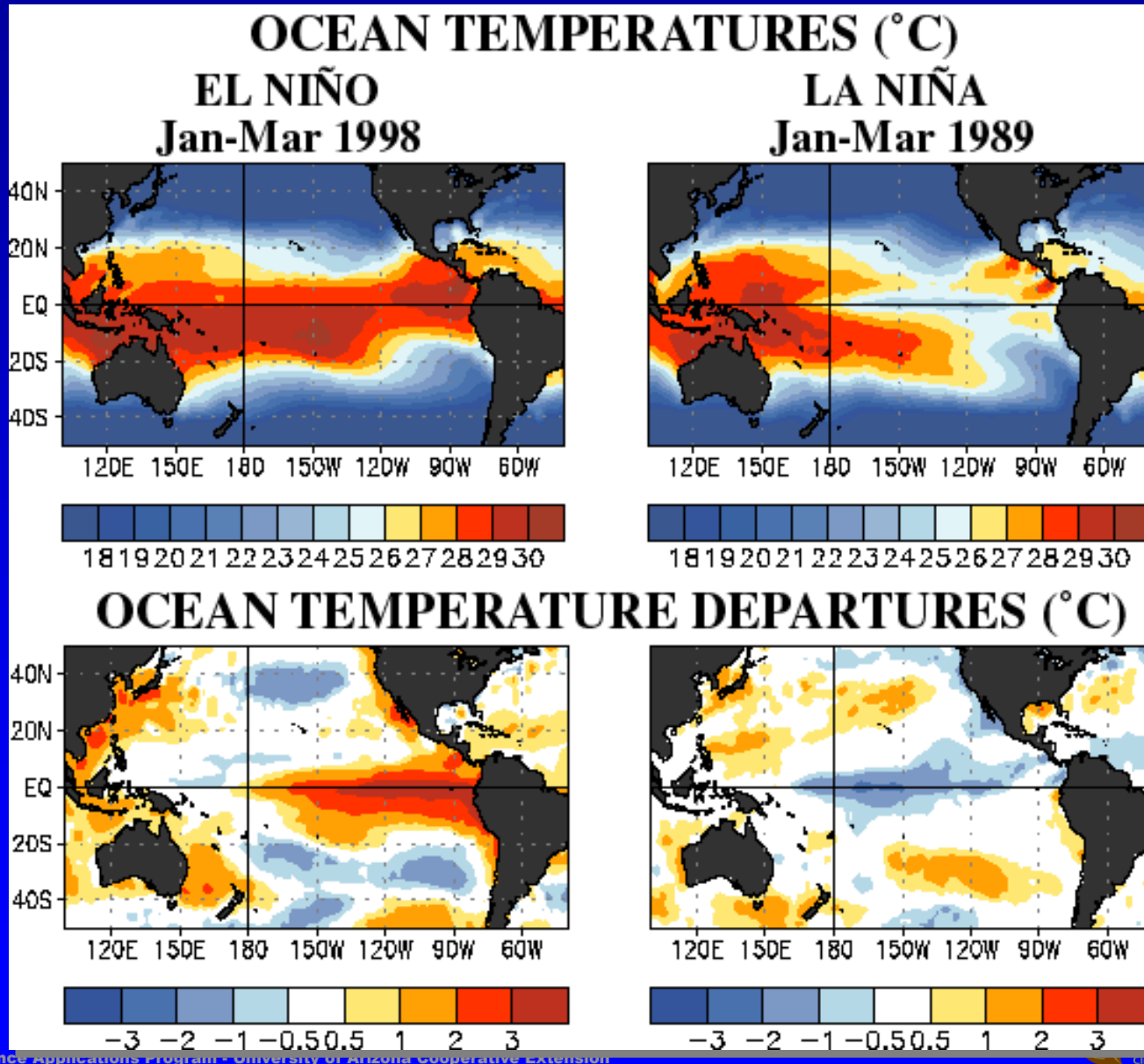
Weak flow around expanded Bermuda sub-tropical high-pressure system

Monsoon circulation

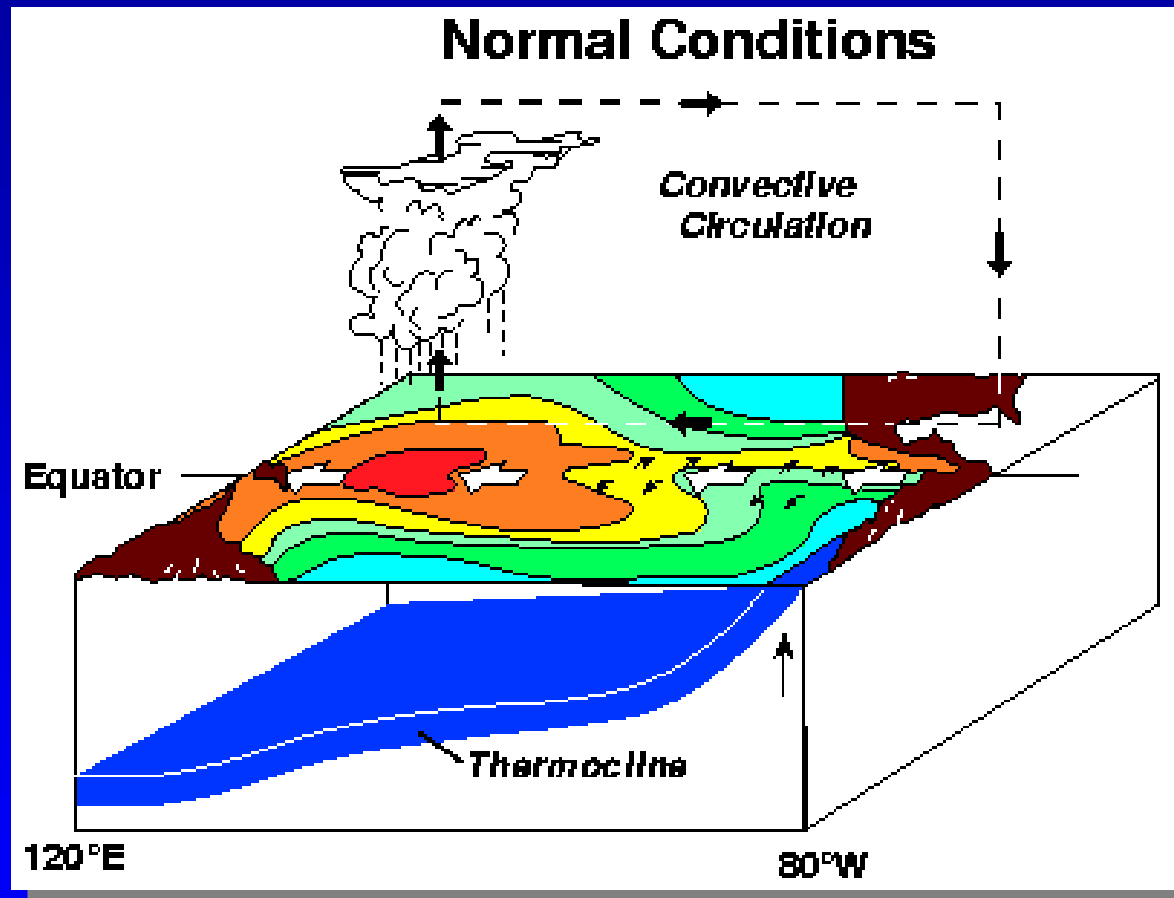
Interannual Climate Variability



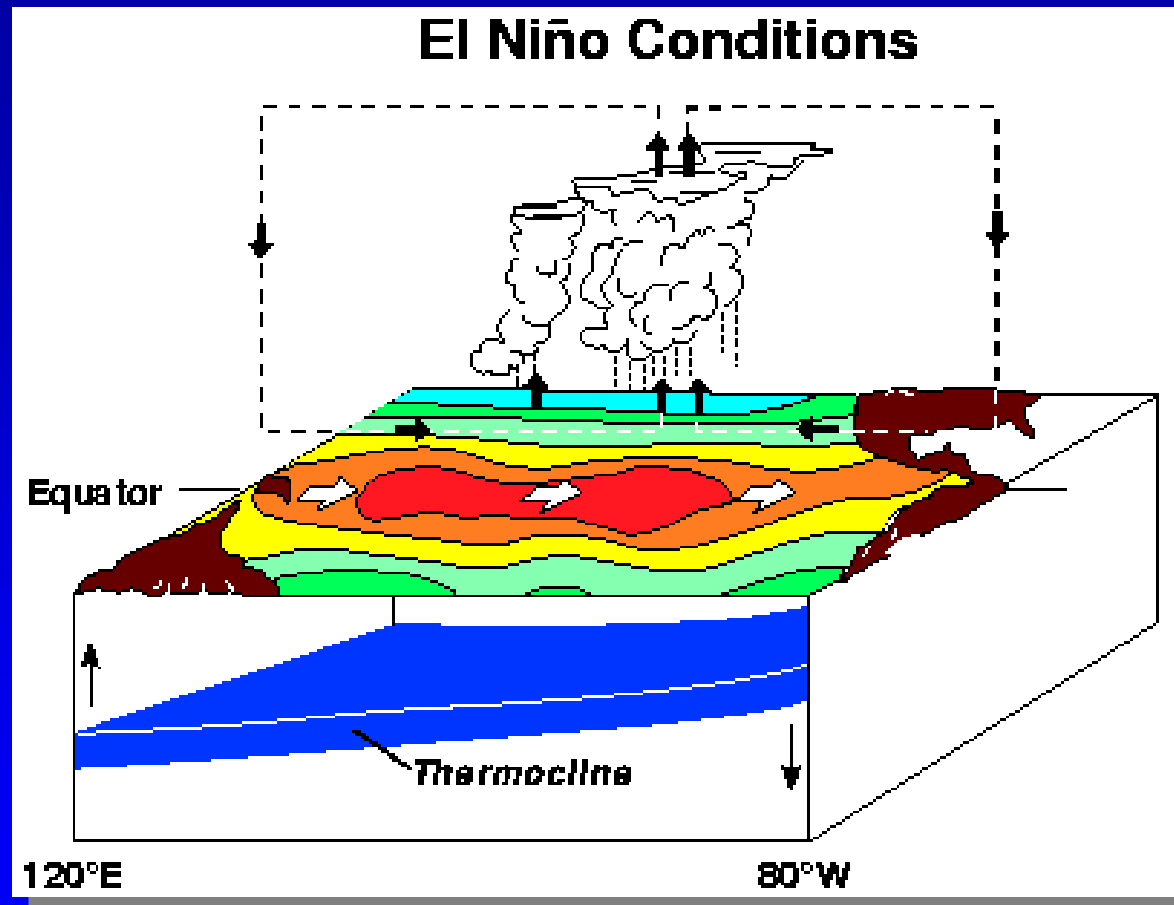
What are El Niño and La Niña?



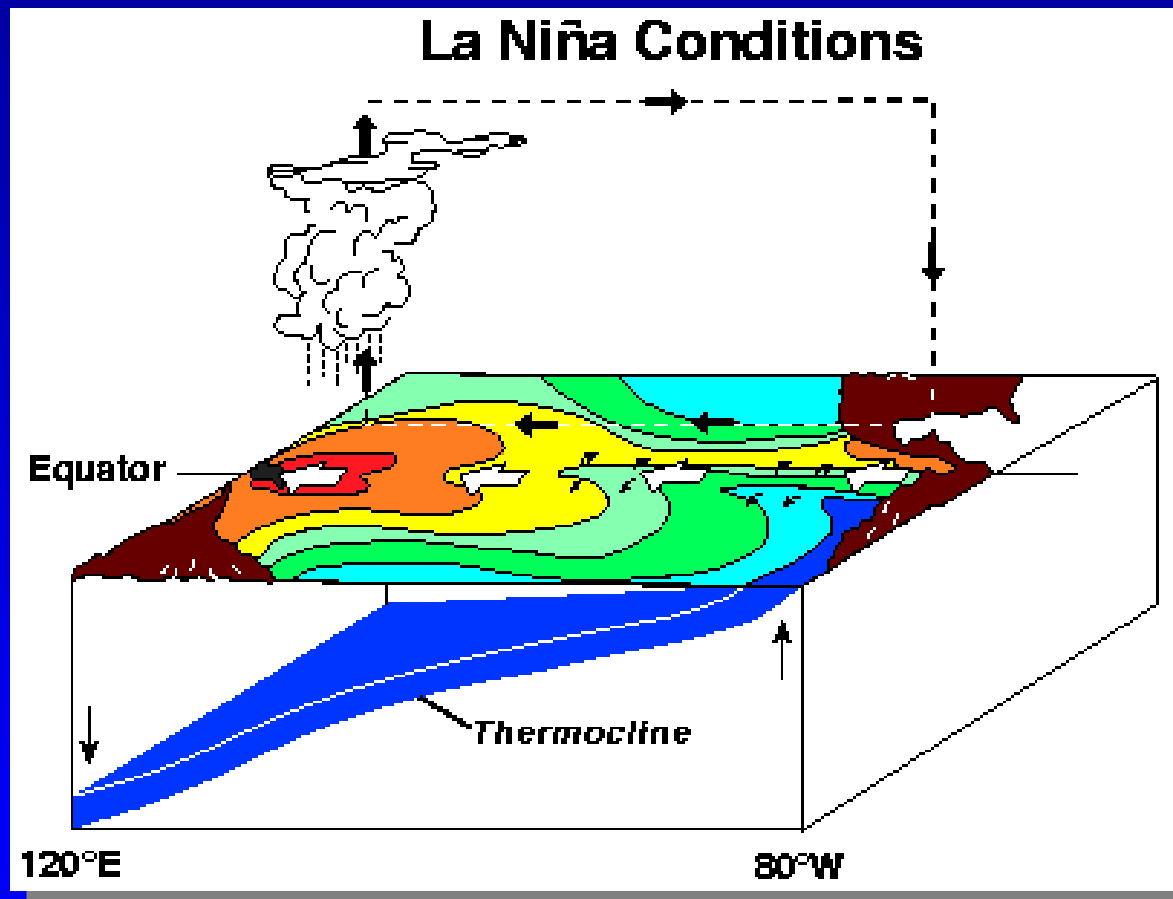
Atmosphere-Ocean Coupling



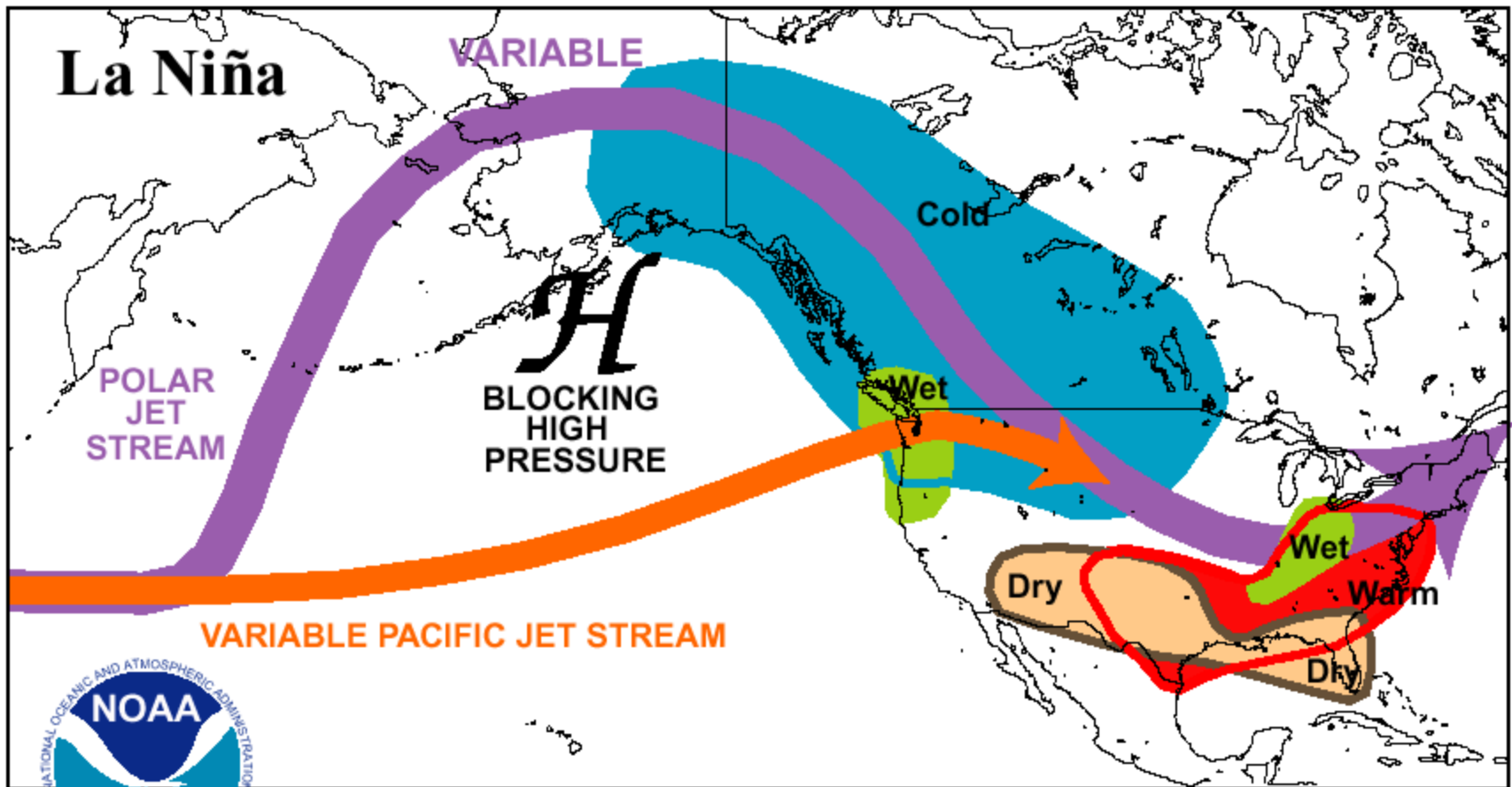
Atmosphere-Ocean Coupling



Atmosphere-Ocean Coupling

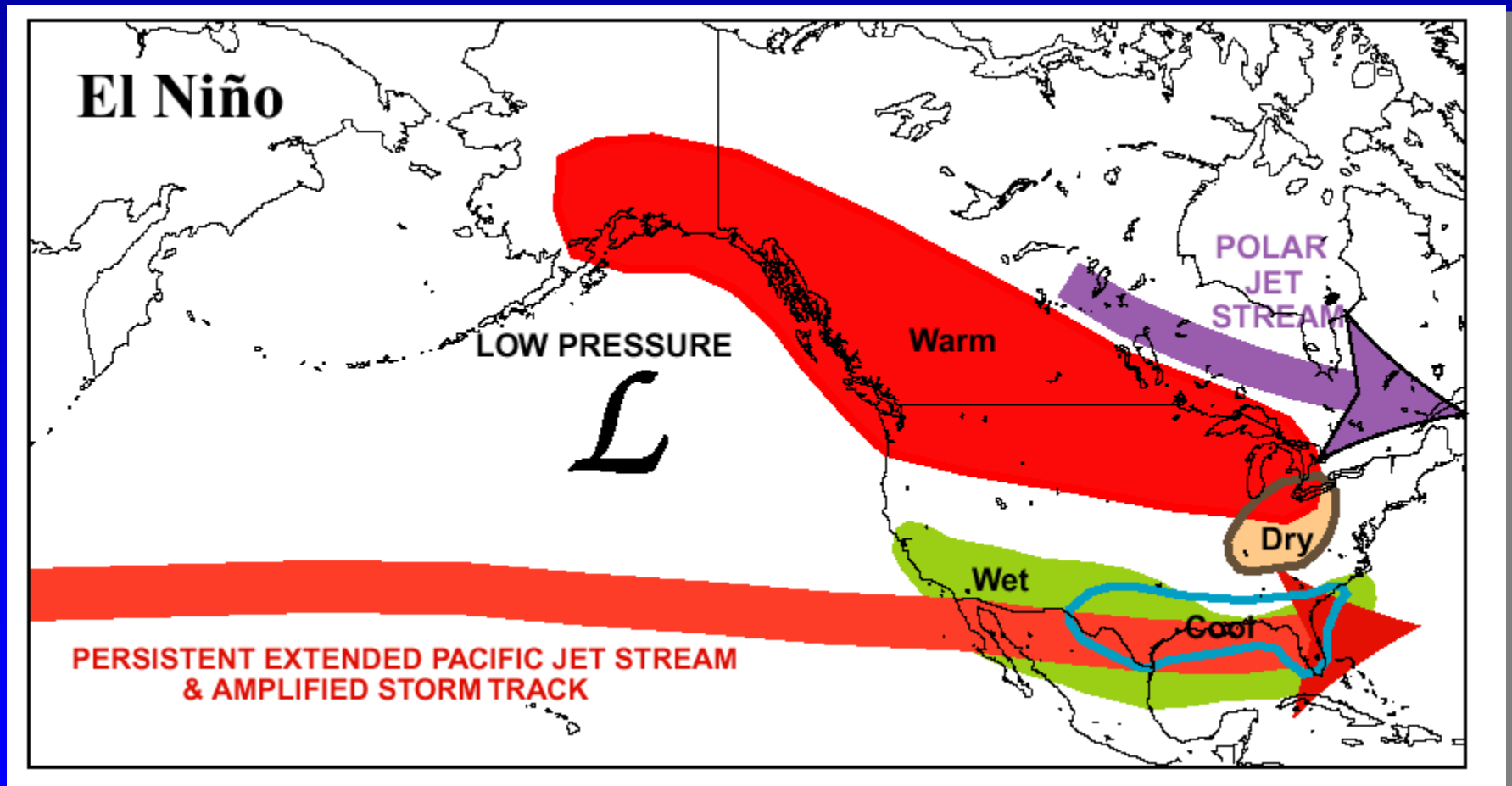


Dominant Circulation Pattern: La Niña Winter

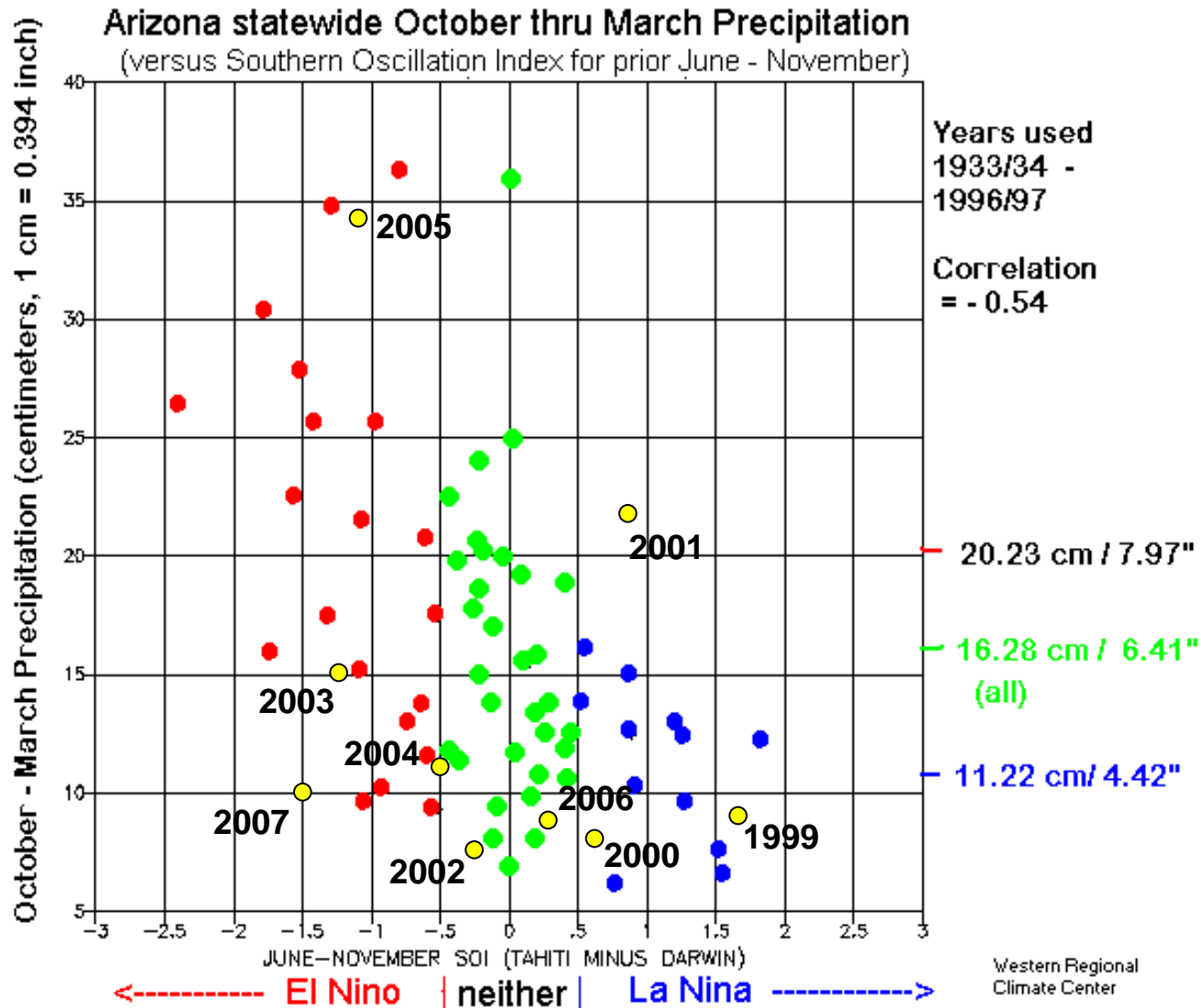


Climate Prediction Center/NCEP/NWS

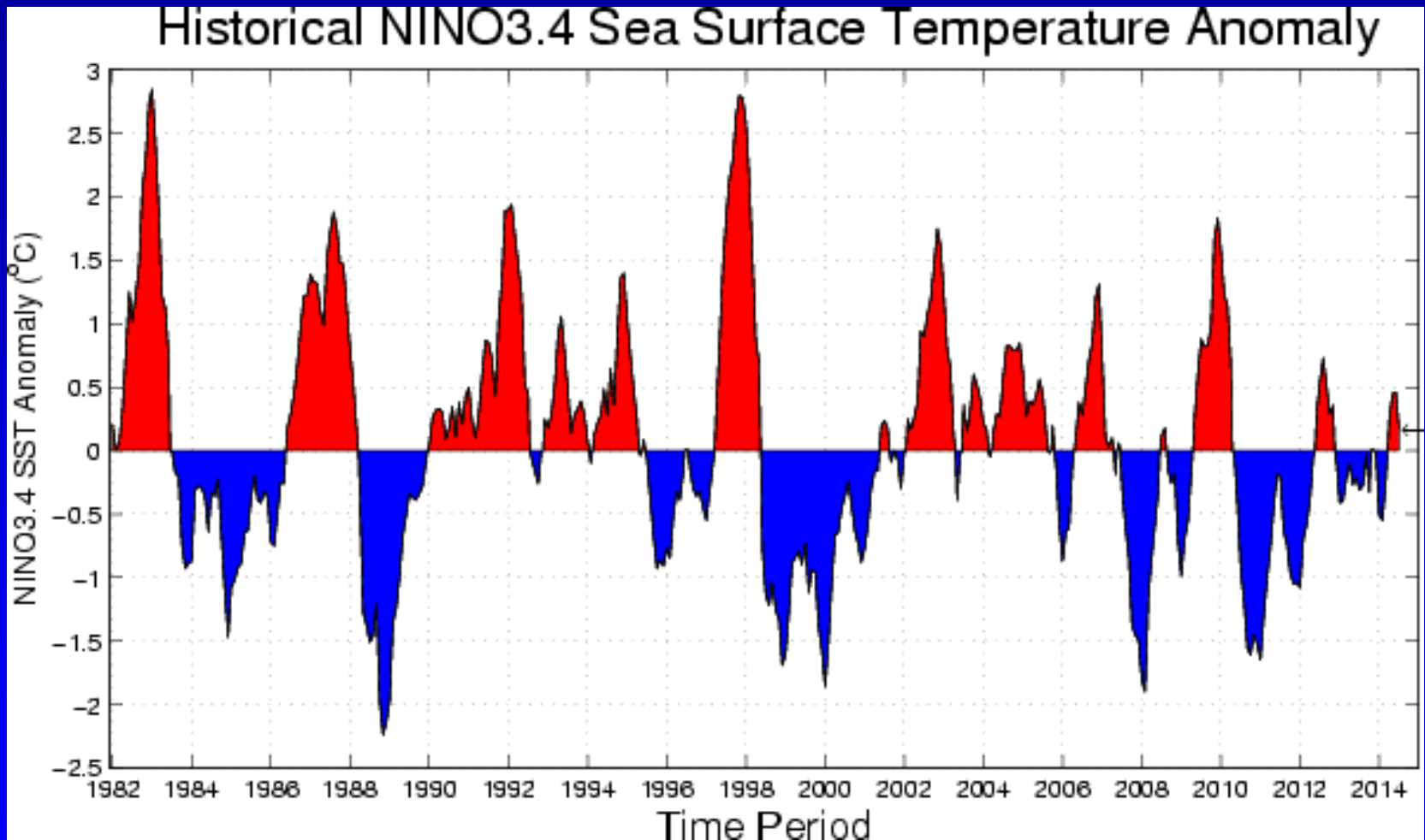
Dominant Circulation Pattern: El Niño Winter



Arizona ENSO Connection



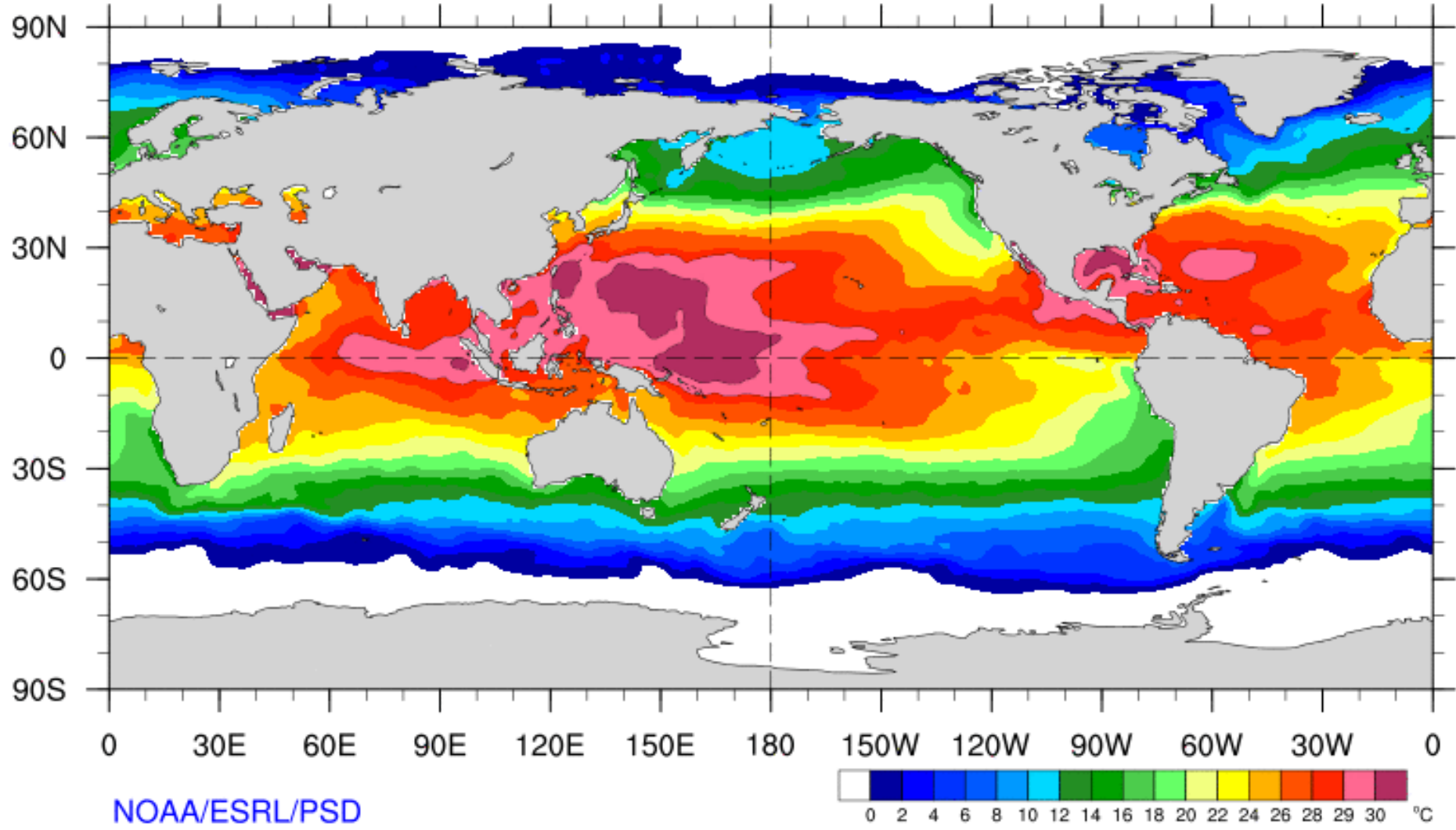
ENSO: 1982-2014



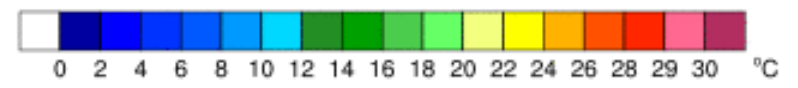
<http://iri.columbia.edu/climate/ENSO>

Weekly Average SST

2014/09/07 - 2014/09/13

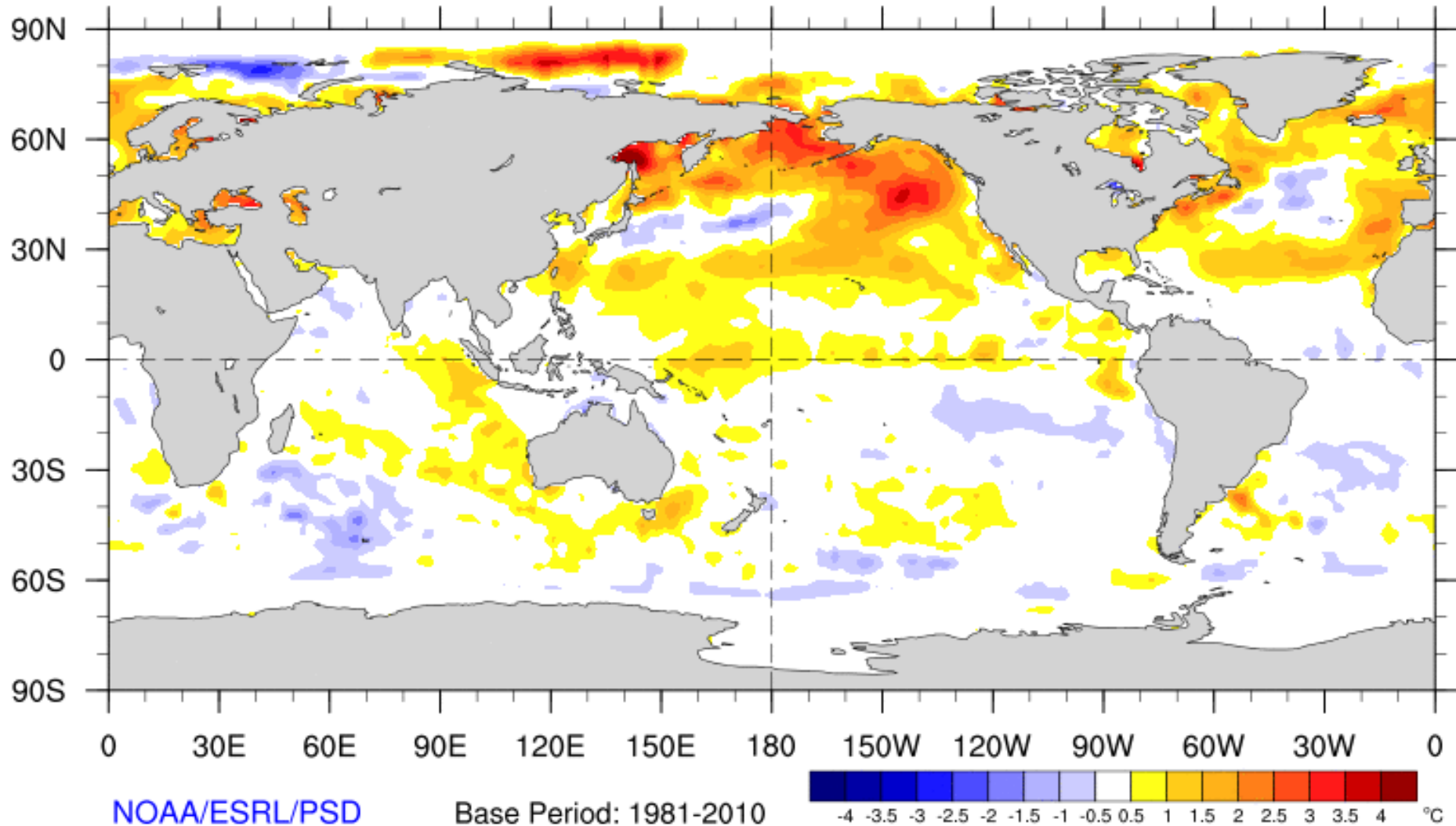


NOAA/ESRL/PSD

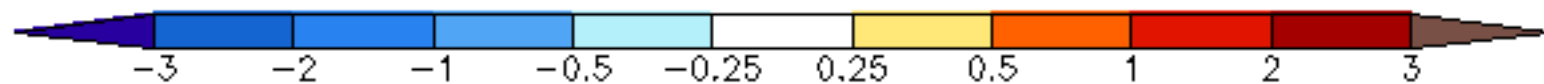
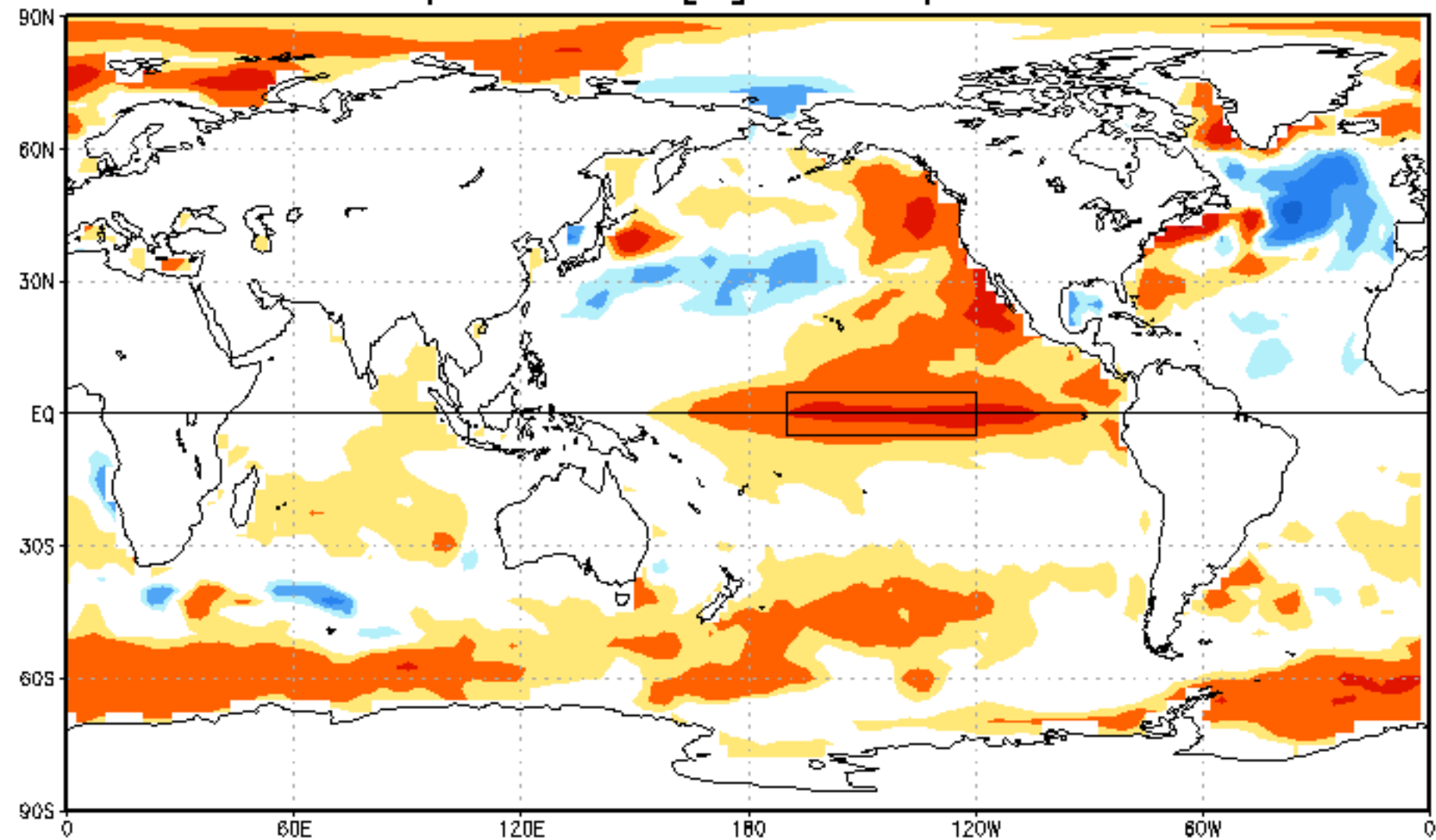


Weekly SST Anomaly

2014/09/07 - 2014/09/13



MMA tmpsfc Anom [K] IC=Sep2014 for DJF



Closing Points

- Elevation, latitude, and ocean sea-surface temperatures create a complex Arizona climate
- Different mechanisms create summer versus winter precipitation
- Lots of opportunity for variability (spatially and temporally)
- Climate change is real and a reason for concern in Arizona



Thanks!

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<http://cals.arizona.edu/climate>

