Summer and Fall Climate Outlook

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The University of Arizona

Presentation Overview

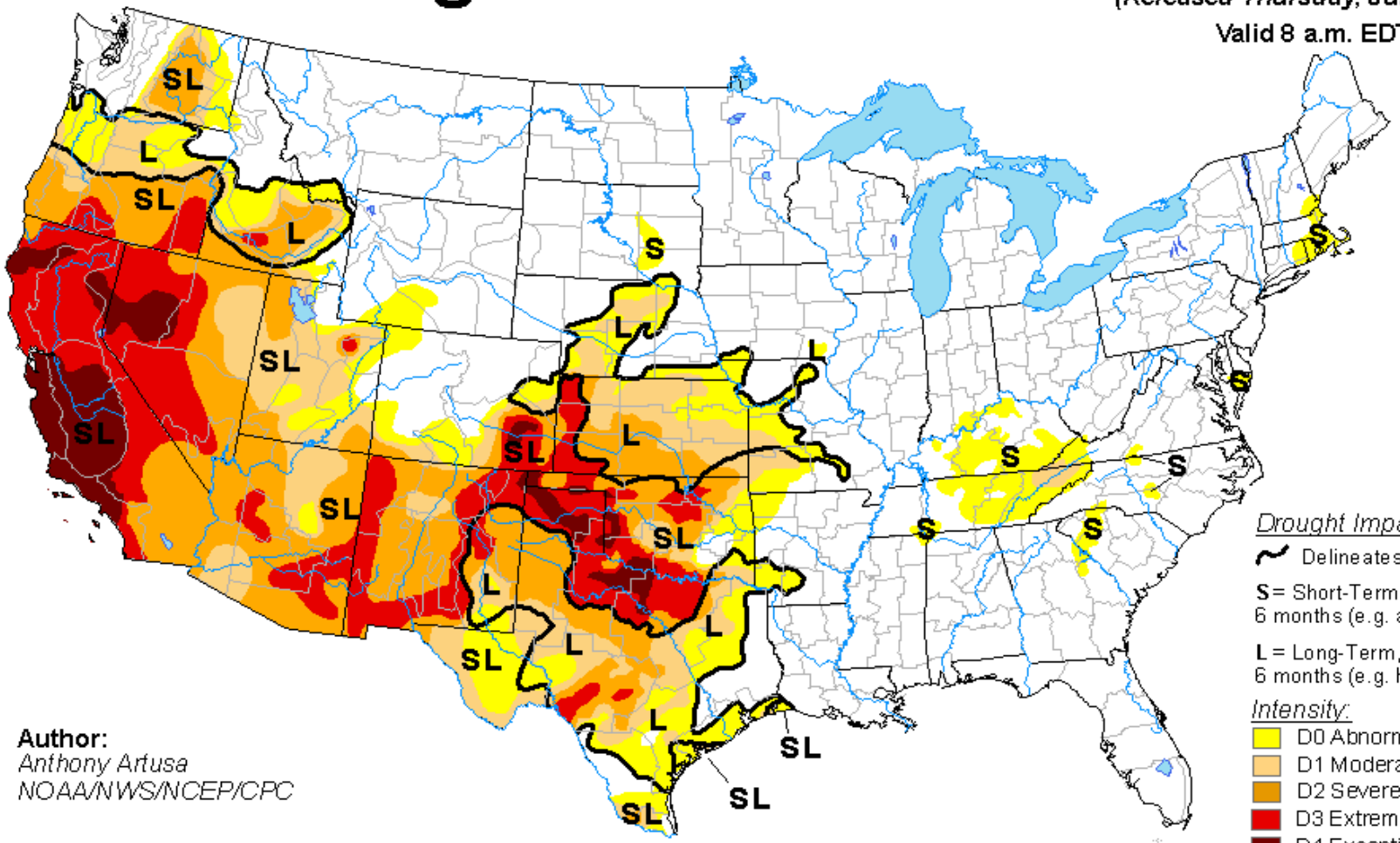
- Act I: The Drought
- Act II: The Monsoon
- Act III: The El Niño

U.S. Drought Monitor

July 1, 2014

(Released Thursday, Jul. 3, 2014)

Valid 8 a.m. EDT



Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC

Drought Impact Types:

~ Delineates dominant impacts

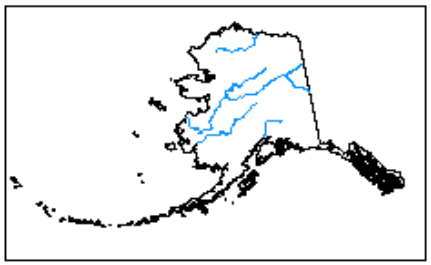
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

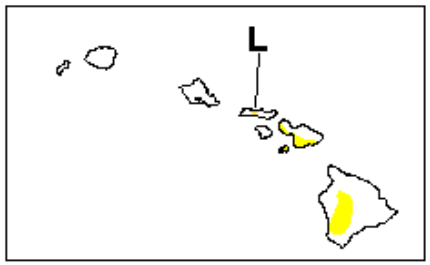
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

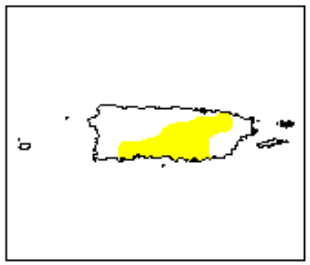
Intensity:

- 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.





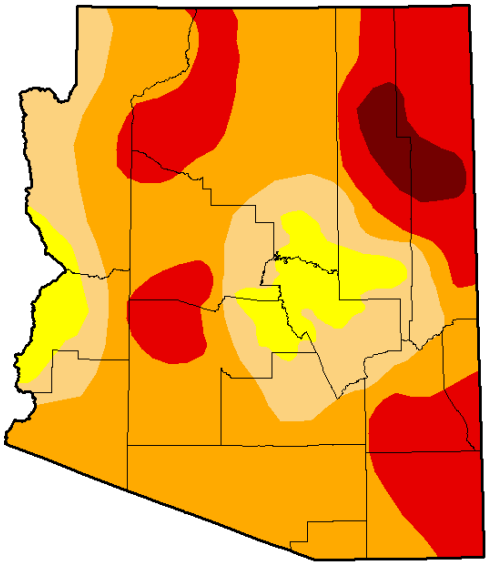


USDA National Drought Mitigation Center

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Arizona



July 2, 2013

(Released Thursday, Jul. 4, 2013)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	92.46	74.35	27.40	3.04
Last Week 6/25/2013	0.00	100.00	92.49	74.44	23.48	0.00
3 Months Ago 4/2/2013	3.06	96.94	80.11	29.72	2.03	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 9/25/2012	0.00	100.00	100.00	31.93	5.67	0.00
One Year Ago 7/3/2012	0.00	100.00	100.00	93.78	25.07	0.00

Intensity:

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

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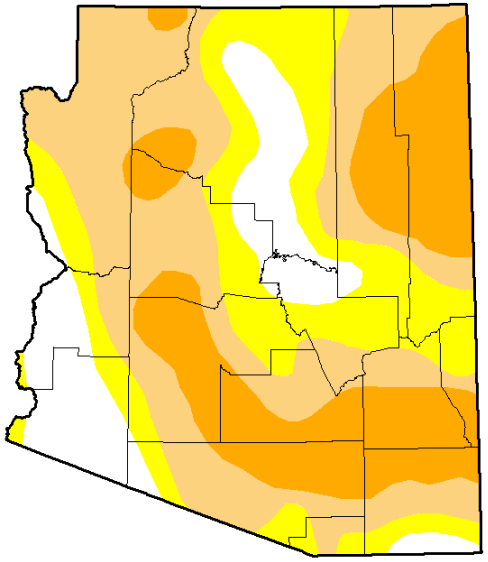
Author:
Matthew Rosencrans
CPC/NCEP/NWS/NOAA

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Arizona



October 1, 2013

(Released Thursday, Oct. 3, 2013)

Valid 7 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	14.83	85.17	61.91	25.28	0.00	0.00
Last Week 9/24/2013	14.83	85.17	61.91	25.28	0.00	0.00
3 Months Ago 7/2/2013	0.00	100.00	92.46	74.35	27.40	3.04
Start of Calendar Year 1/1/2013	0.00	100.00	97.91	37.78	8.68	0.00
Start of Water Year 10/1/2013	14.83	85.17	61.91	25.28	0.00	0.00
One Year Ago 10/2/2012	0.00	100.00	100.00	31.42	5.67	0.00

Intensity:

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

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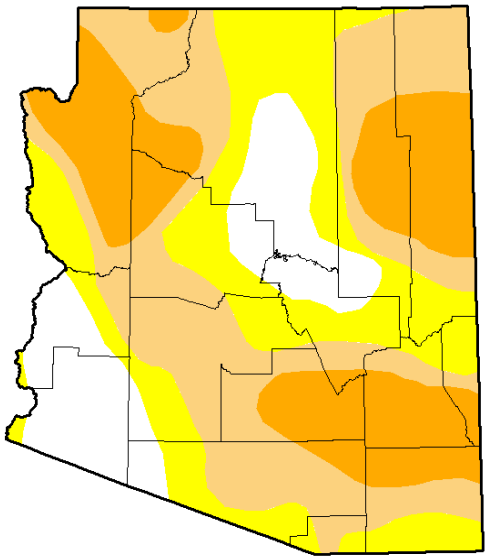
Author:
David Miskus
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Arizona



January 7, 2014

(Released Thursday, Jan. 9, 2014)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	16.08	83.92	57.19	24.66	0.00	0.00
Last Week 12/31/2013	20.72	79.28	53.58	14.73	0.00	0.00
3 Months Ago 10/8/2013	15.00	85.00	61.91	25.28	0.00	0.00
Start of Calendar Year 12/31/2013	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 1/8/2013	0.00	100.00	97.82	37.78	8.68	0.00

Intensity:

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

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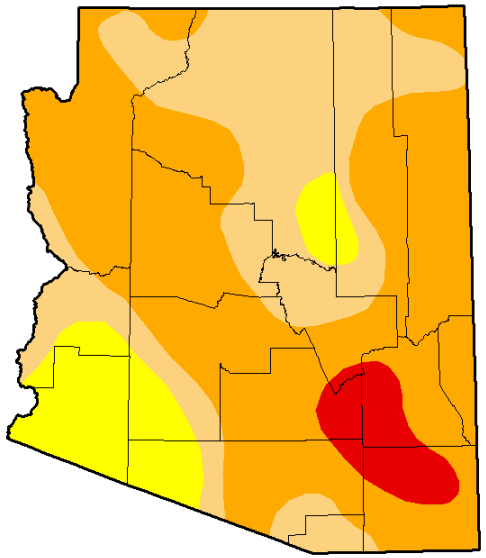
Author:
Mark Svoboda
National Drought Mitigation Center

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Arizona



April 8, 2014

(Released Thursday, Apr. 10, 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	88.56	57.06	5.18	0.00
Last Week 4/1/2014	0.00	100.00	87.99	57.01	5.18	0.00
3 Months Ago 1/7/2014	16.08	83.92	57.19	24.66	0.00	0.00
Start of Calendar Year 12/31/2013	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 4/9/2013	3.06	96.94	81.30	41.15	5.63	0.00

Intensity:

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

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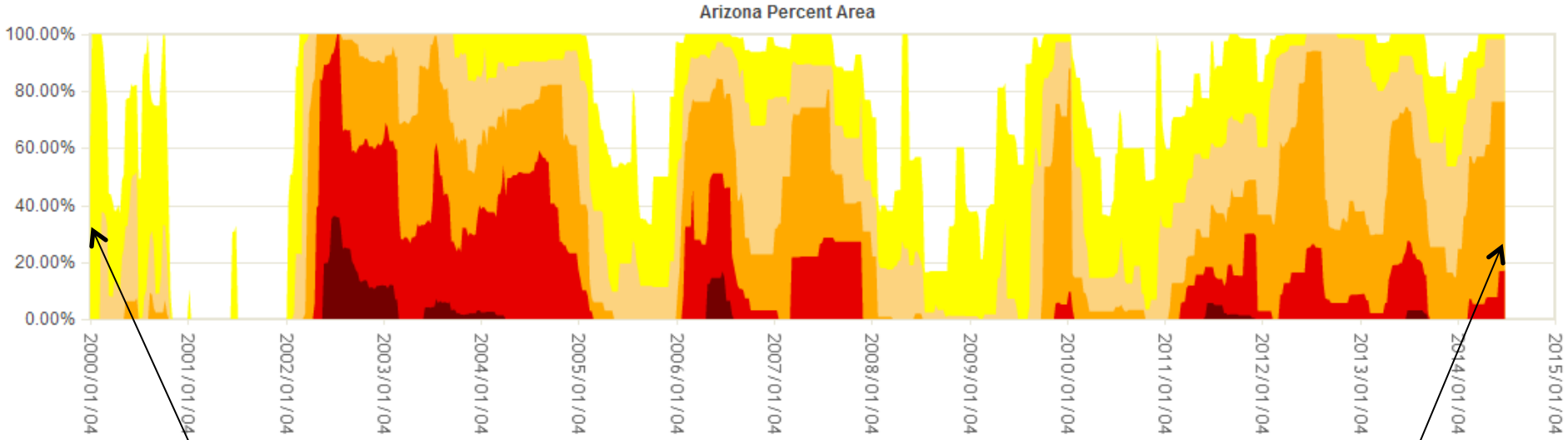
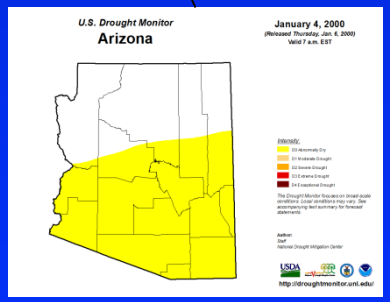
Author:
Brian Fuchs
National Drought Mitigation Center

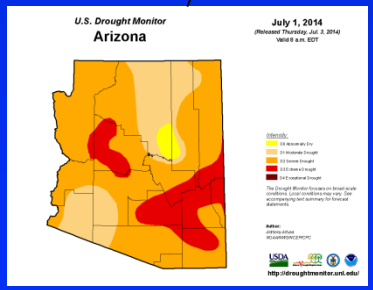
http://droughtmonitor.unl.edu/



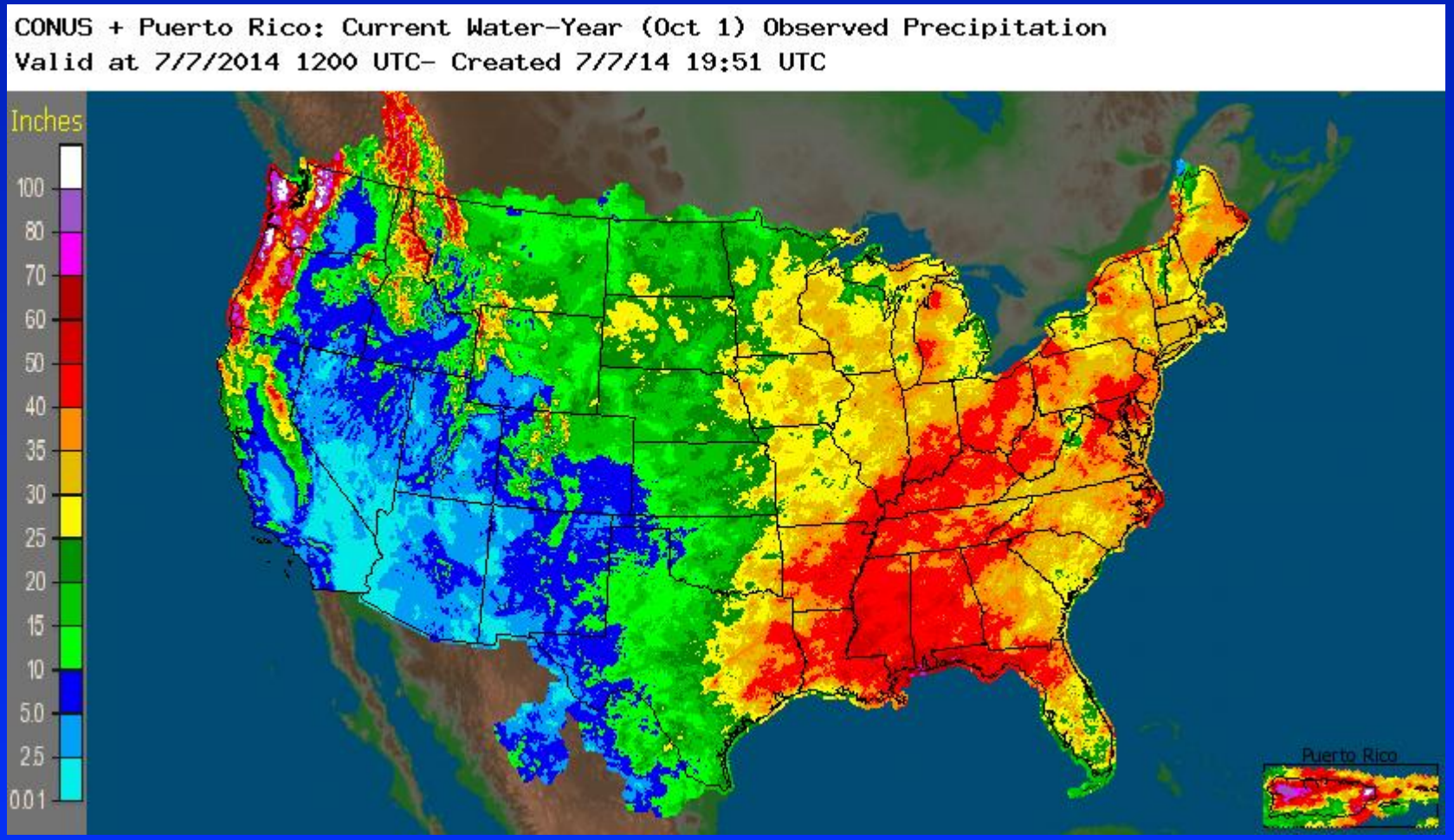
To zoom in, click and drag the cursor. To return to the full time series, double-click anywhere in the chart.

D0-D4 x:, y:
D1-D4 x:, y:
D2-D4 x:, y:
D3-D4 x:, y:
D4 x:, y:

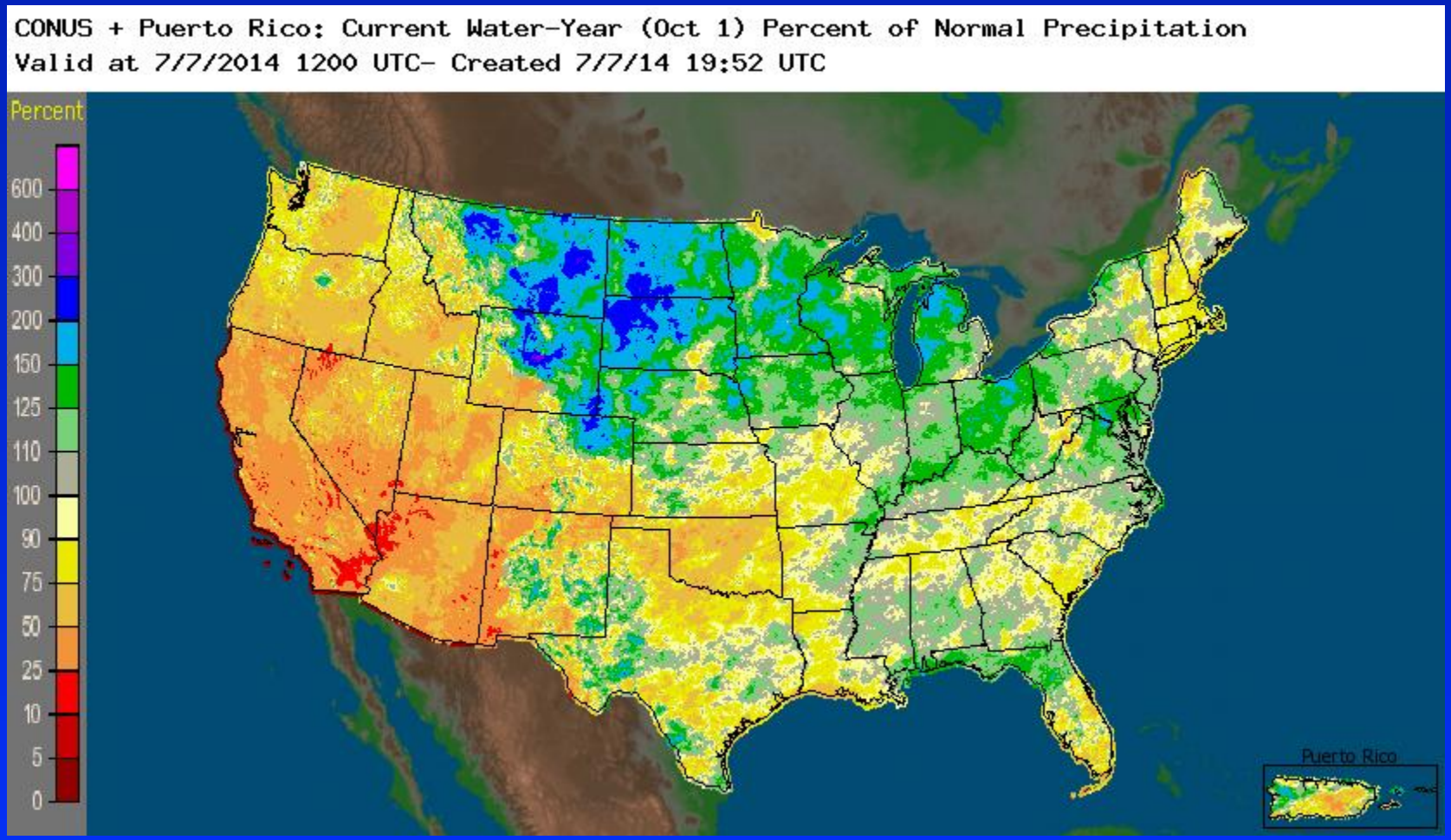




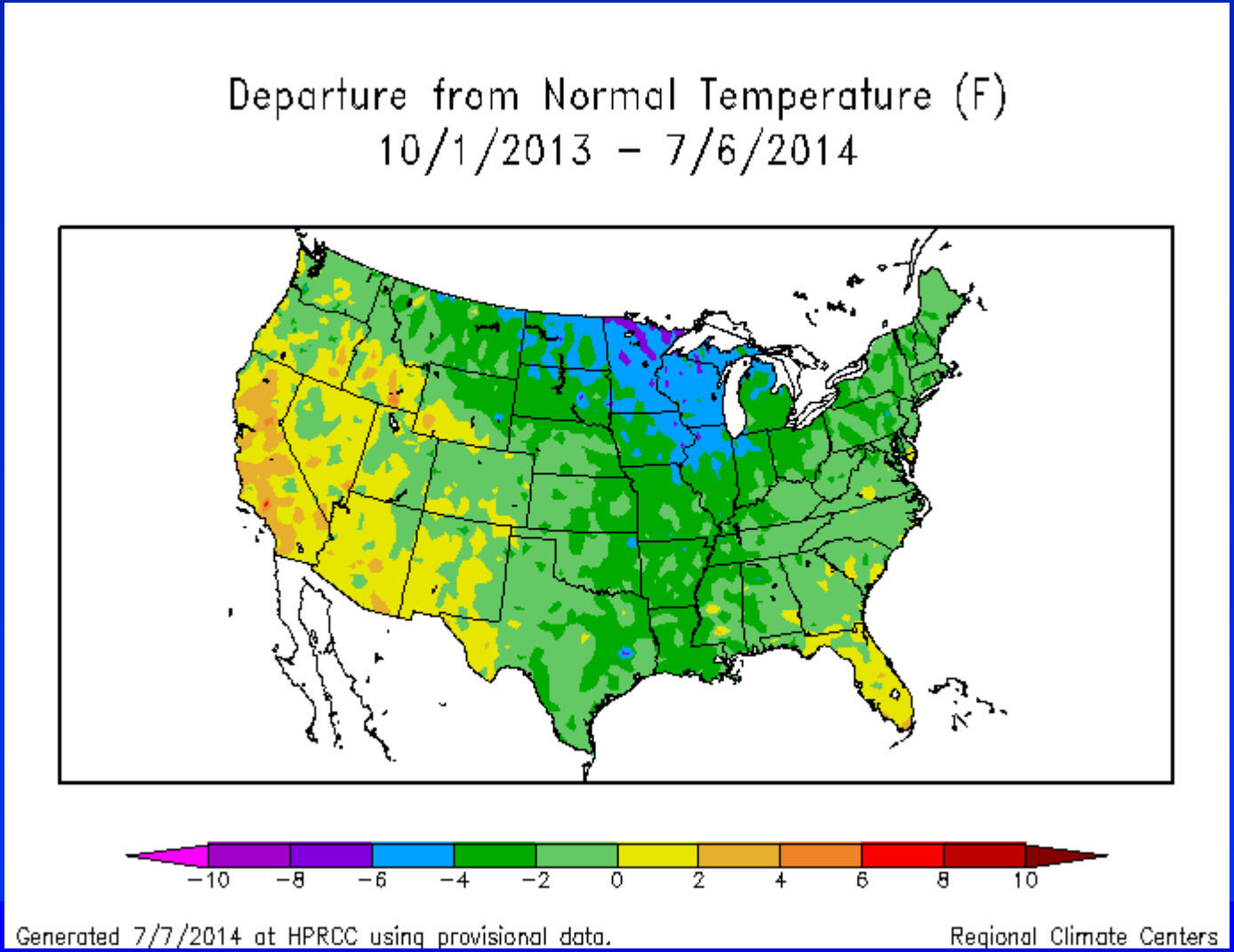
Water-year Precipitation

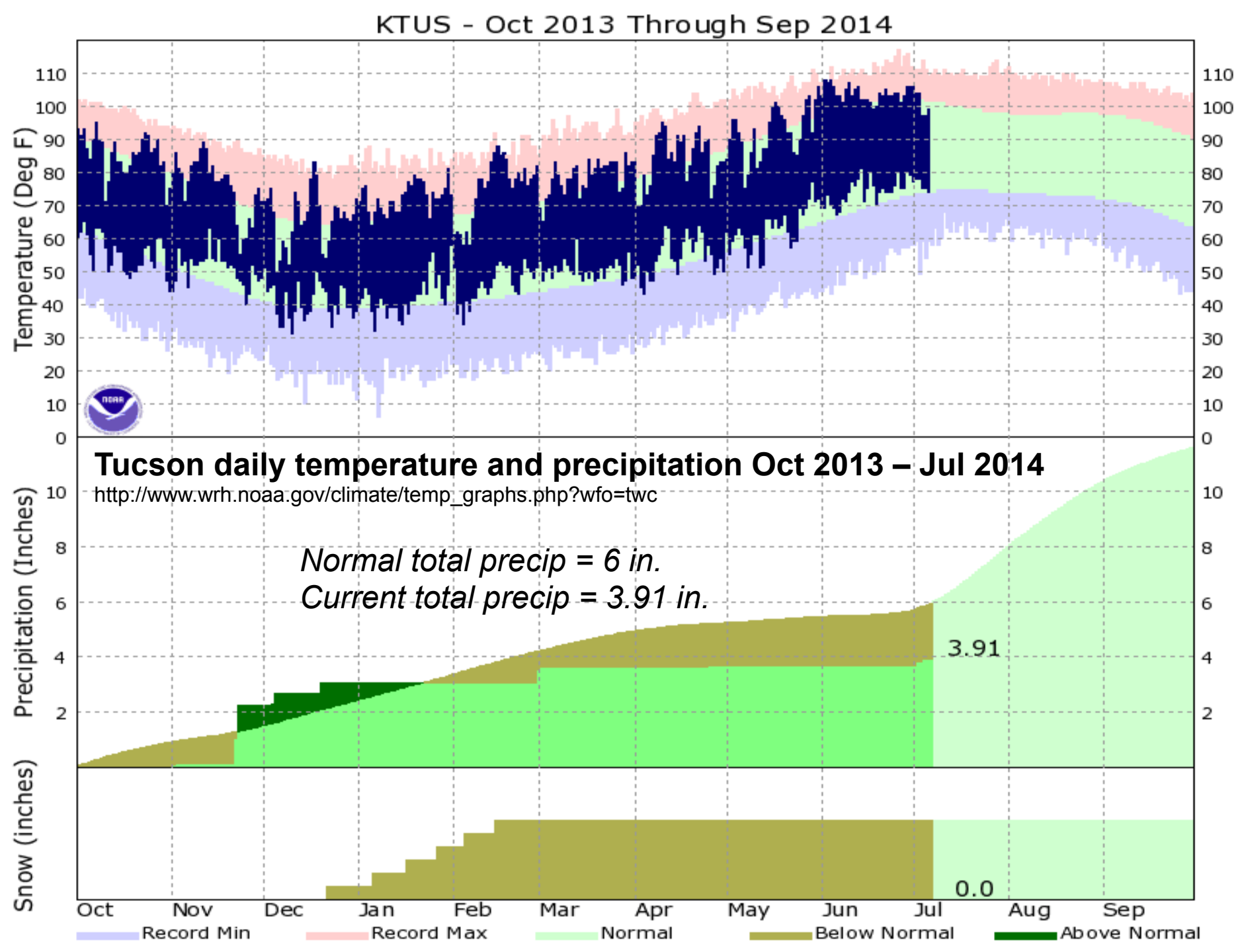


Water-year Precipitation

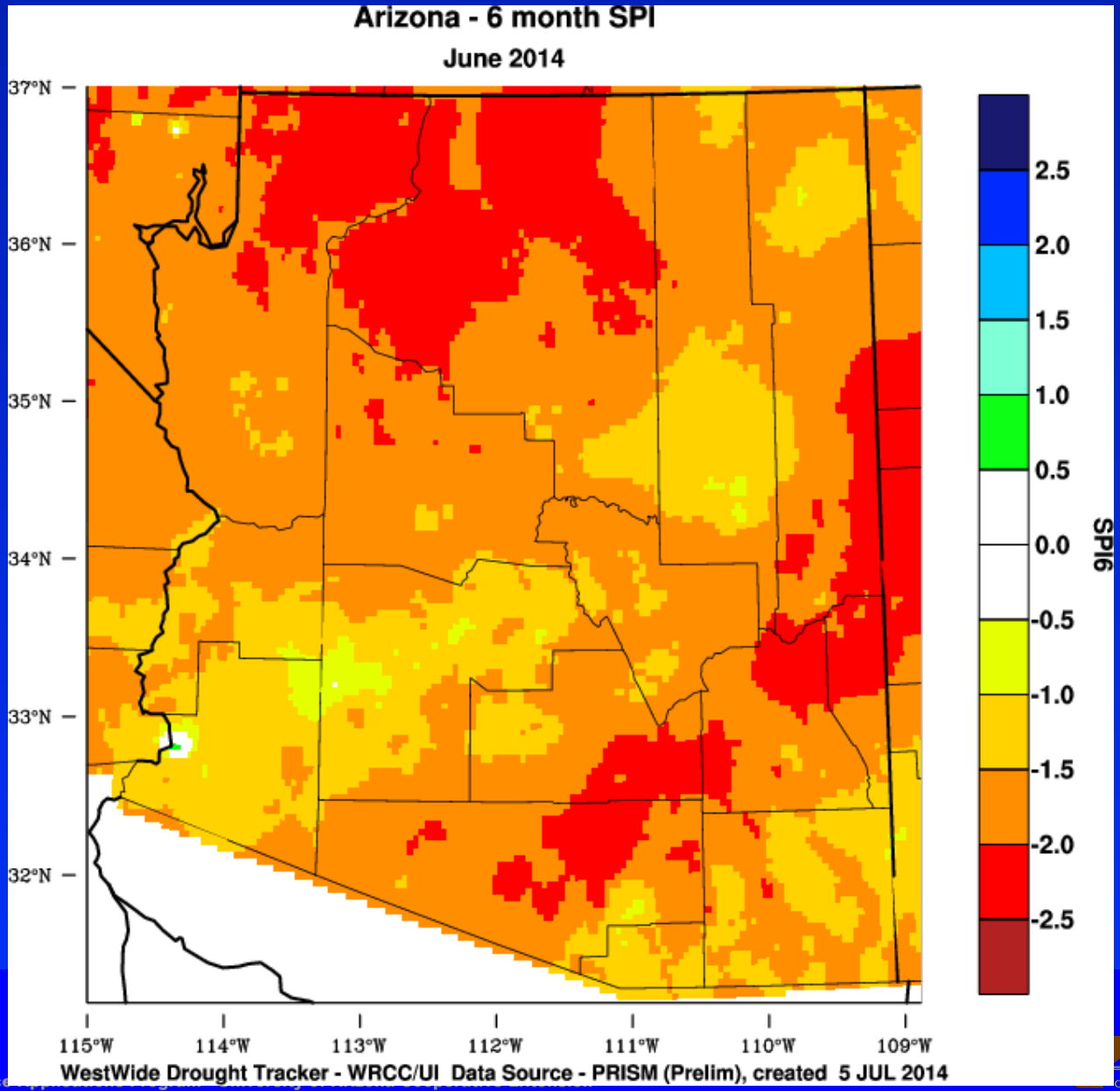


Water-year Temperature

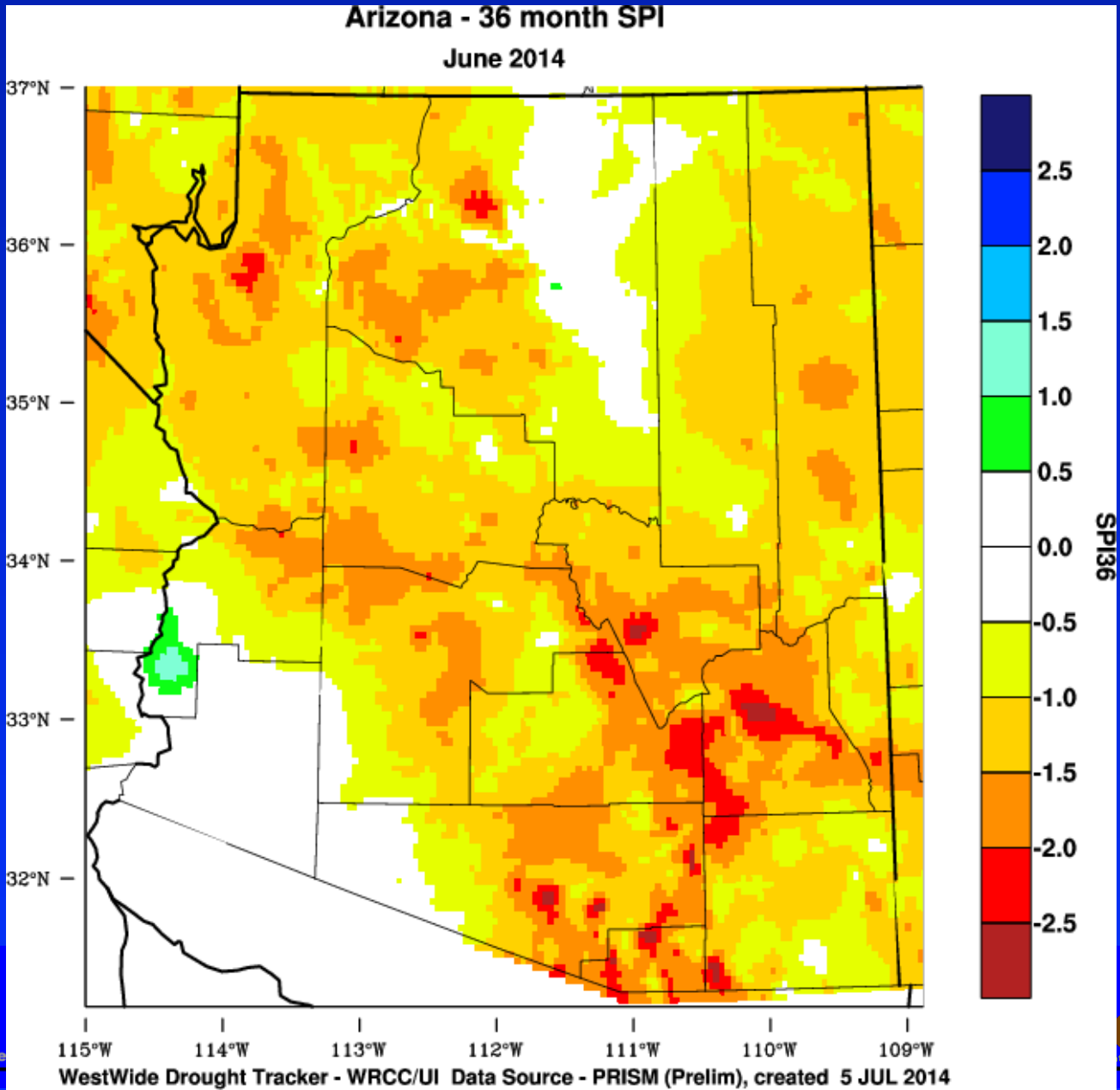


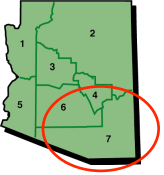

KTUS - Oct 2013 Through Sep 2014
Temperature (Deg F)
110
100
90
80
70
60
50
40
30
20
10
0
Tucson daily temperature and precipitation Oct 2013 – Jul 2014
http://www.wrh.noaa.gov/climate/temp_graphs.php?wfo=twc
Normal total precip = 6 in.
Current total precip = 3.91 in.
Precipitation (Inches)
10
8
6
4
2
3.91
Snow (inches)
0.0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Record Min
Record Max
Normal
Below Normal
Above Normal

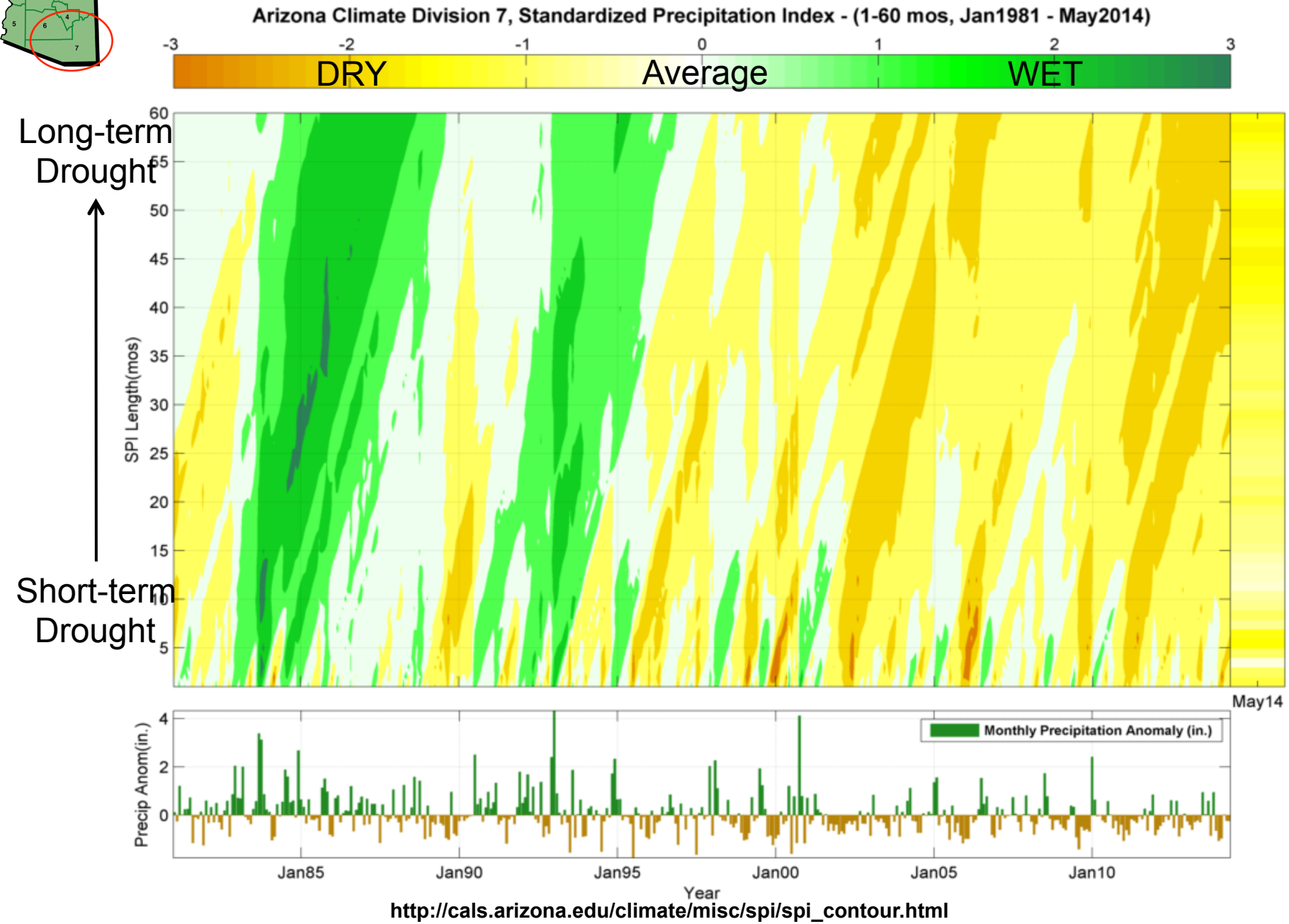
Short-term Drought Conditions



Long-term Drought Conditions





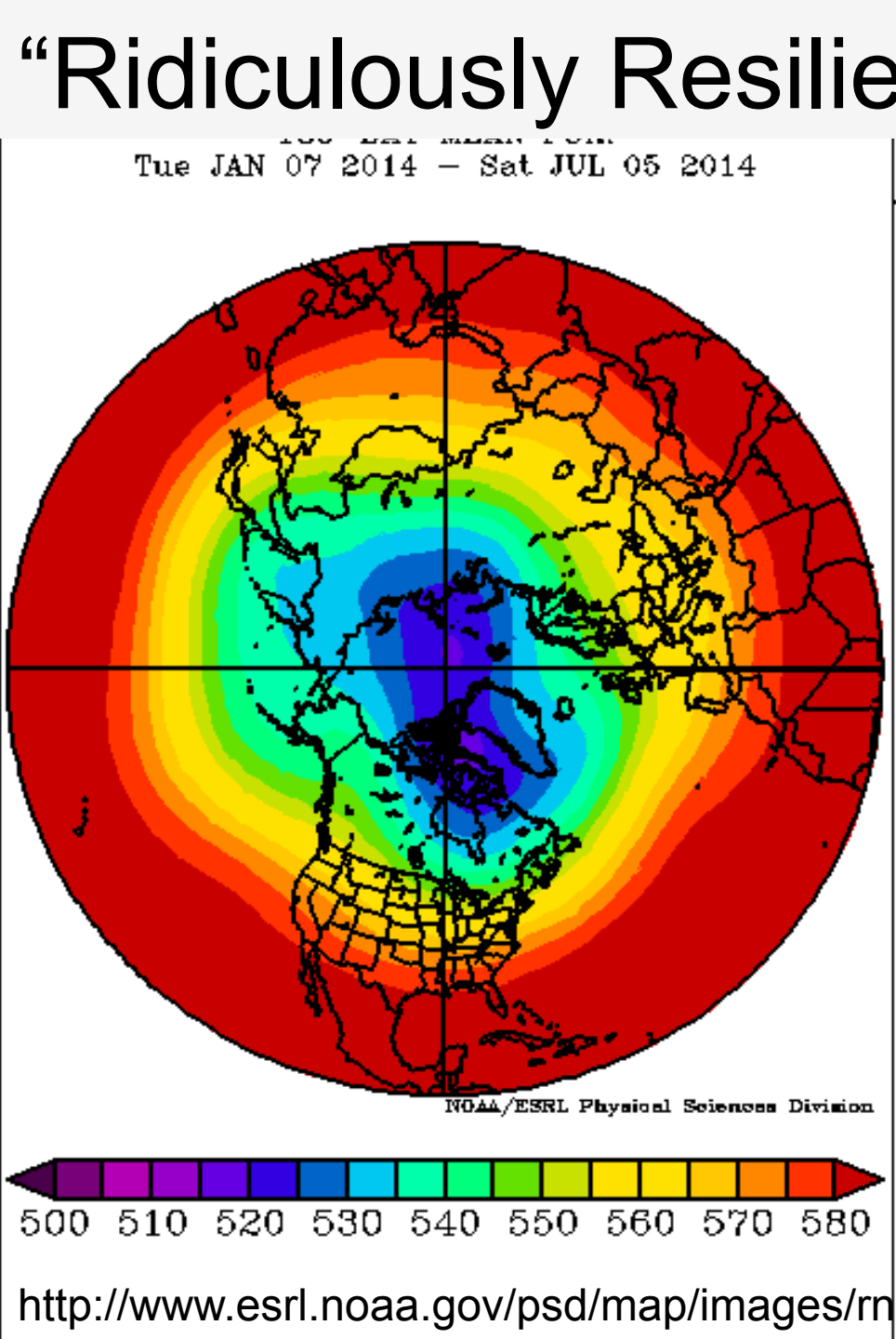


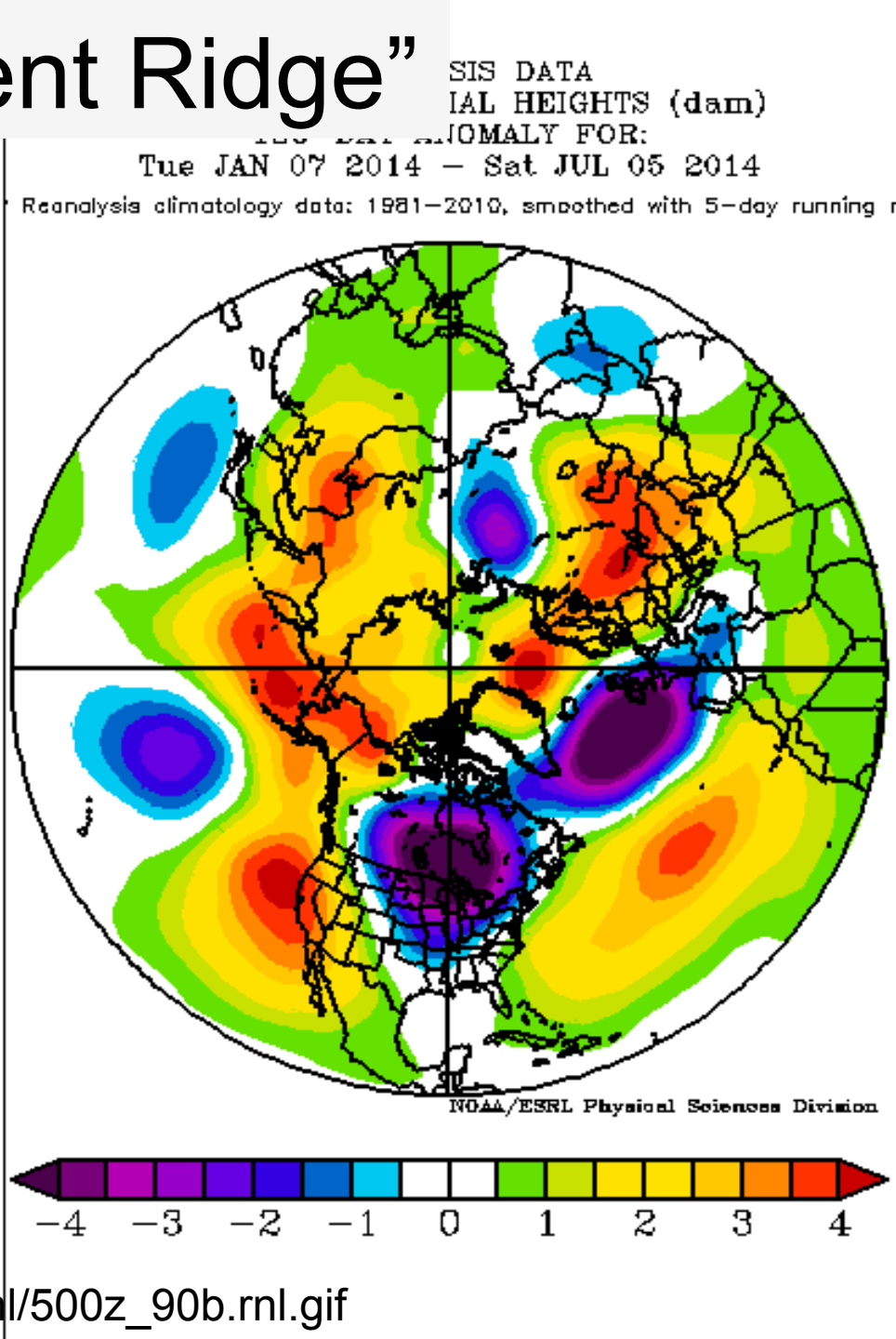
http://cals.arizona.edu/climate/misc/spi/spi_contour.html

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

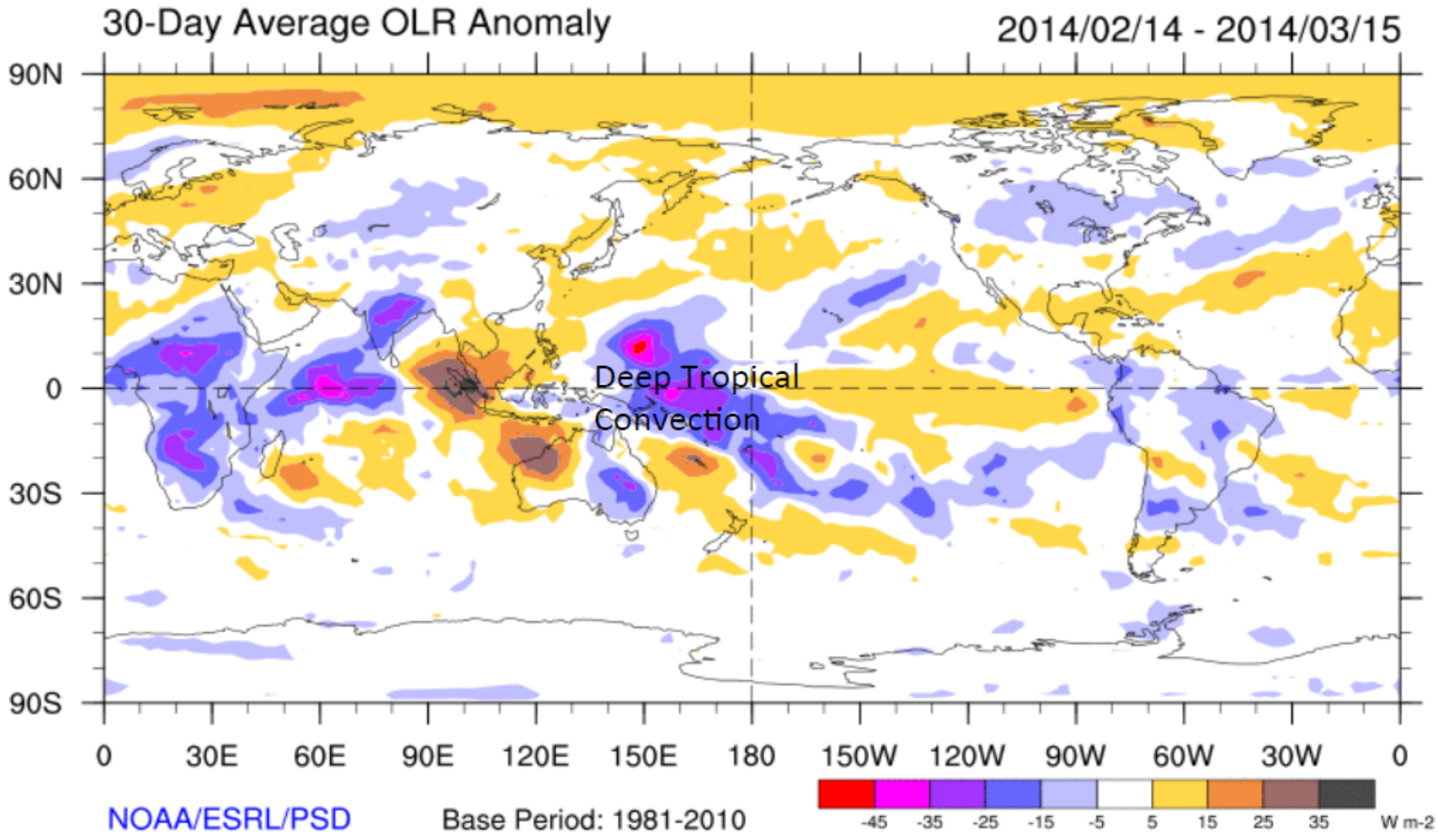
Data source: NOAA National Climatic Data Center
ftp://ftp.ncdc.noaa.gov/pub/data/cirs/climdiv
Base Period= 1900-2014 Date created: 30-Jun-2014

“Ridiculously Resilient Ridge”

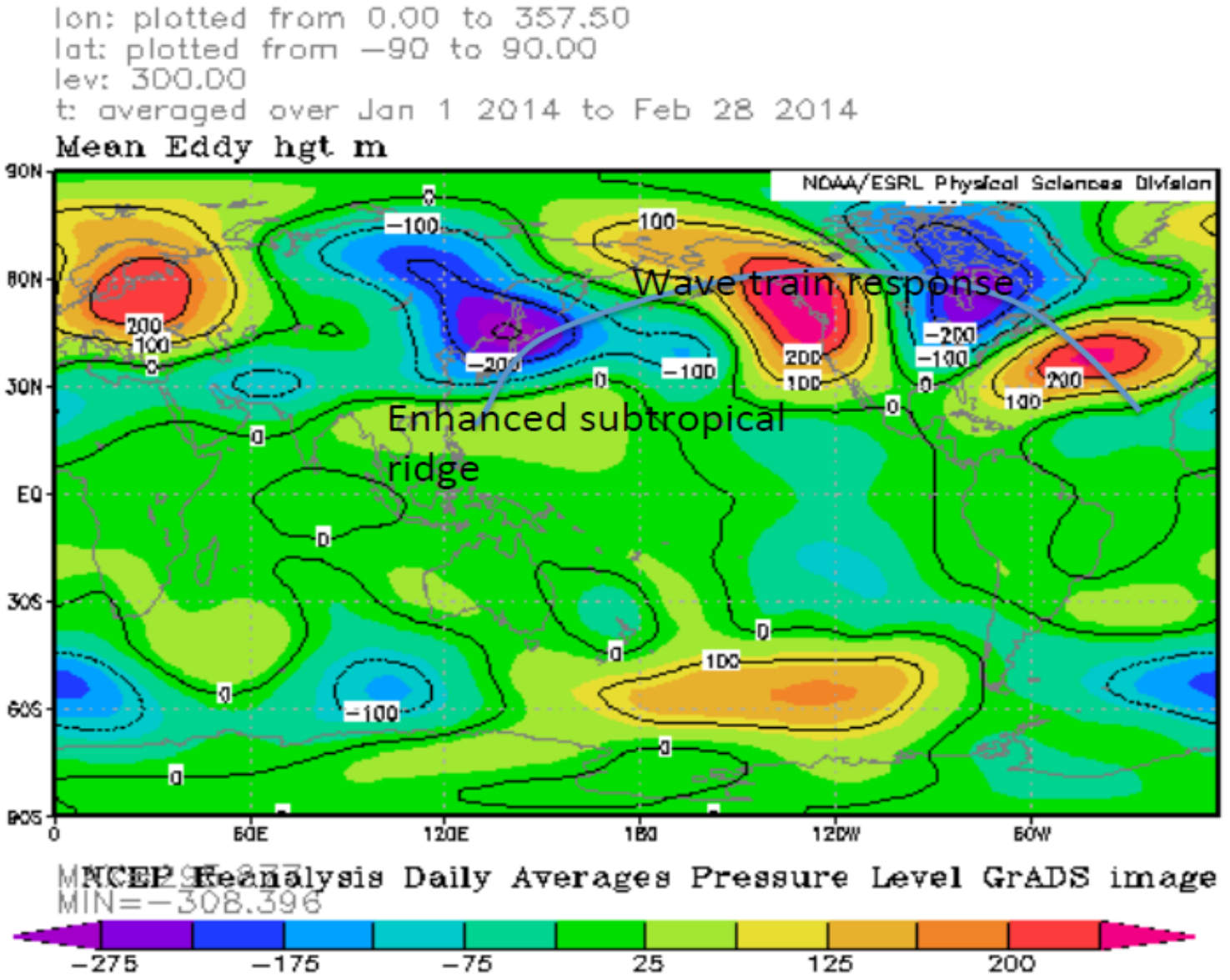




http://www.esrl.noaa.gov/psd/map/images/rnl/500z_90b.rnl.gif



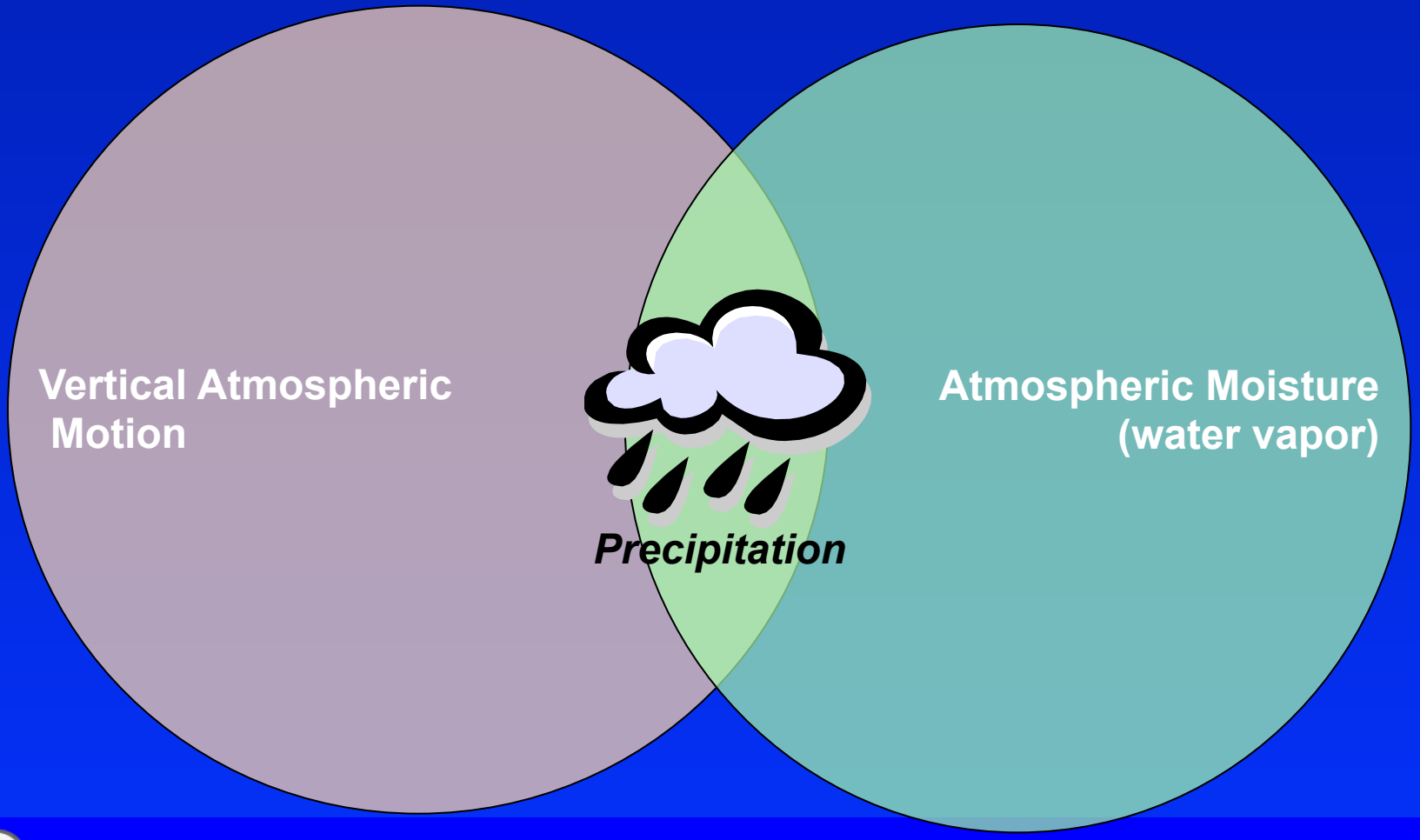
From P. Roundy



From P. Roundy

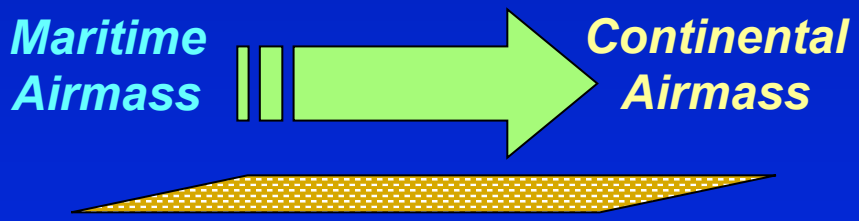
Hydroclimatology 101

What does it take to produce precipitation?



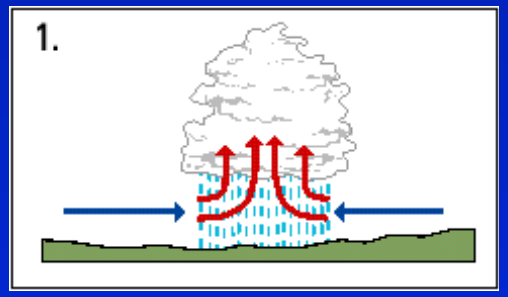
Where does Arizona's atmospheric moisture come from?

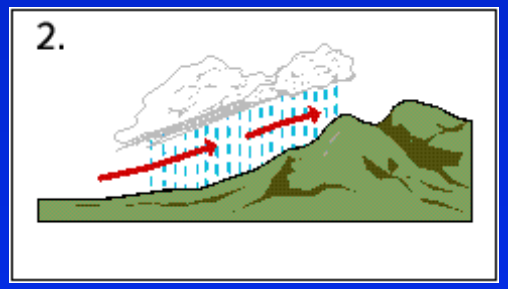
- Moisture Advection: Water evaporates into atmosphere over ocean areas and moves over continental areas
- Moisture Recycling: Precipitation initially from advection re-enters atmosphere from evapotranspiration

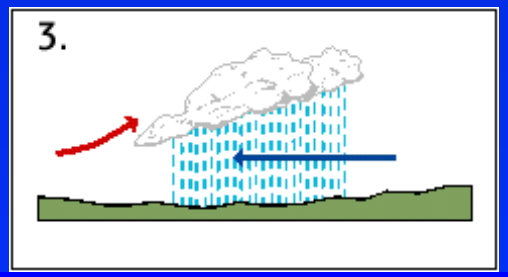


Lifting Mechanisms

1. **Convection**: Intense heating at surface causes buoyancy
2. **Orographic Lifting**: Air is forced up and over physical barrier
3. **Frontal Lifting**: Air masses of different temperature/moisture levels force vertical motion





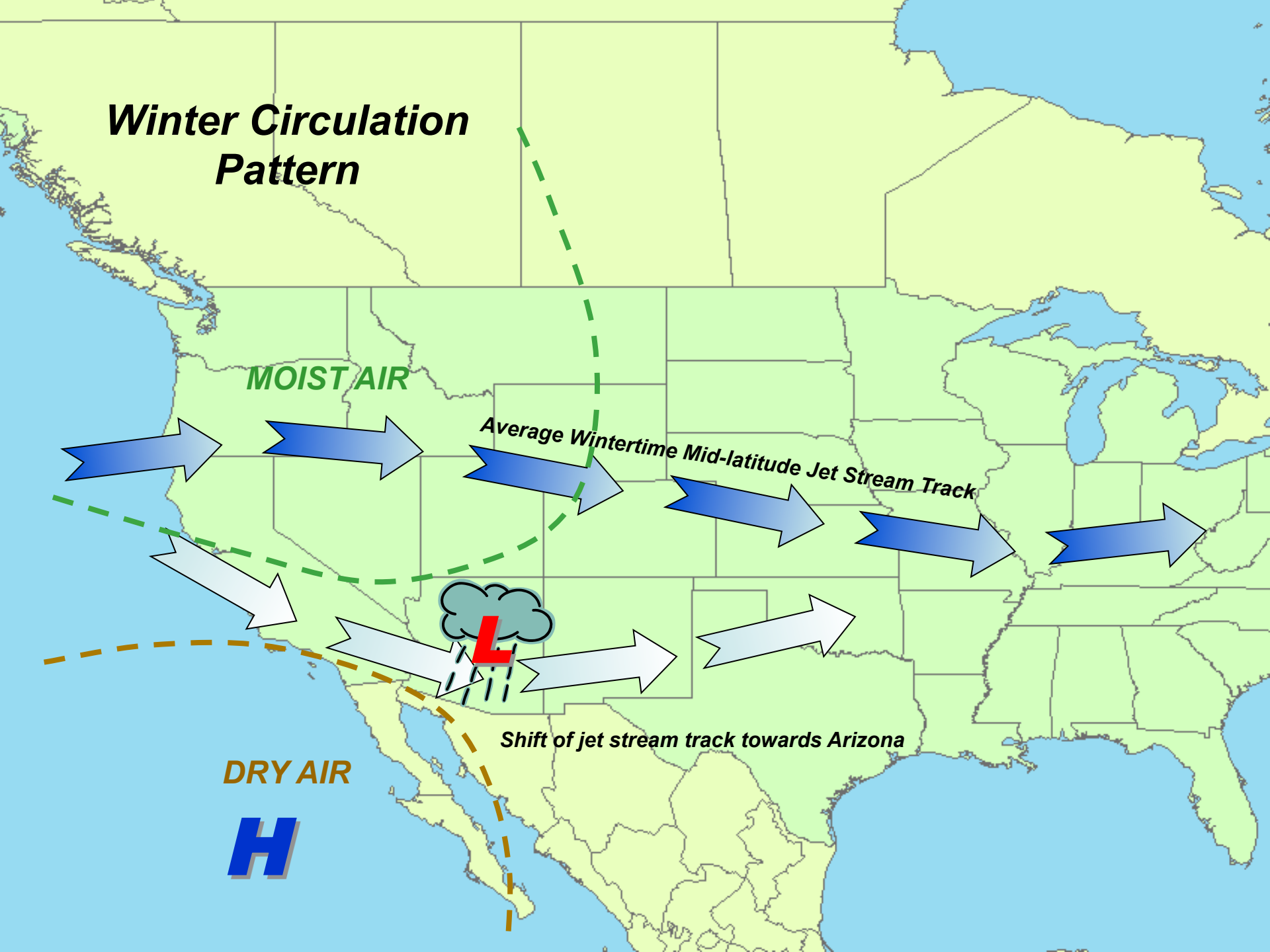


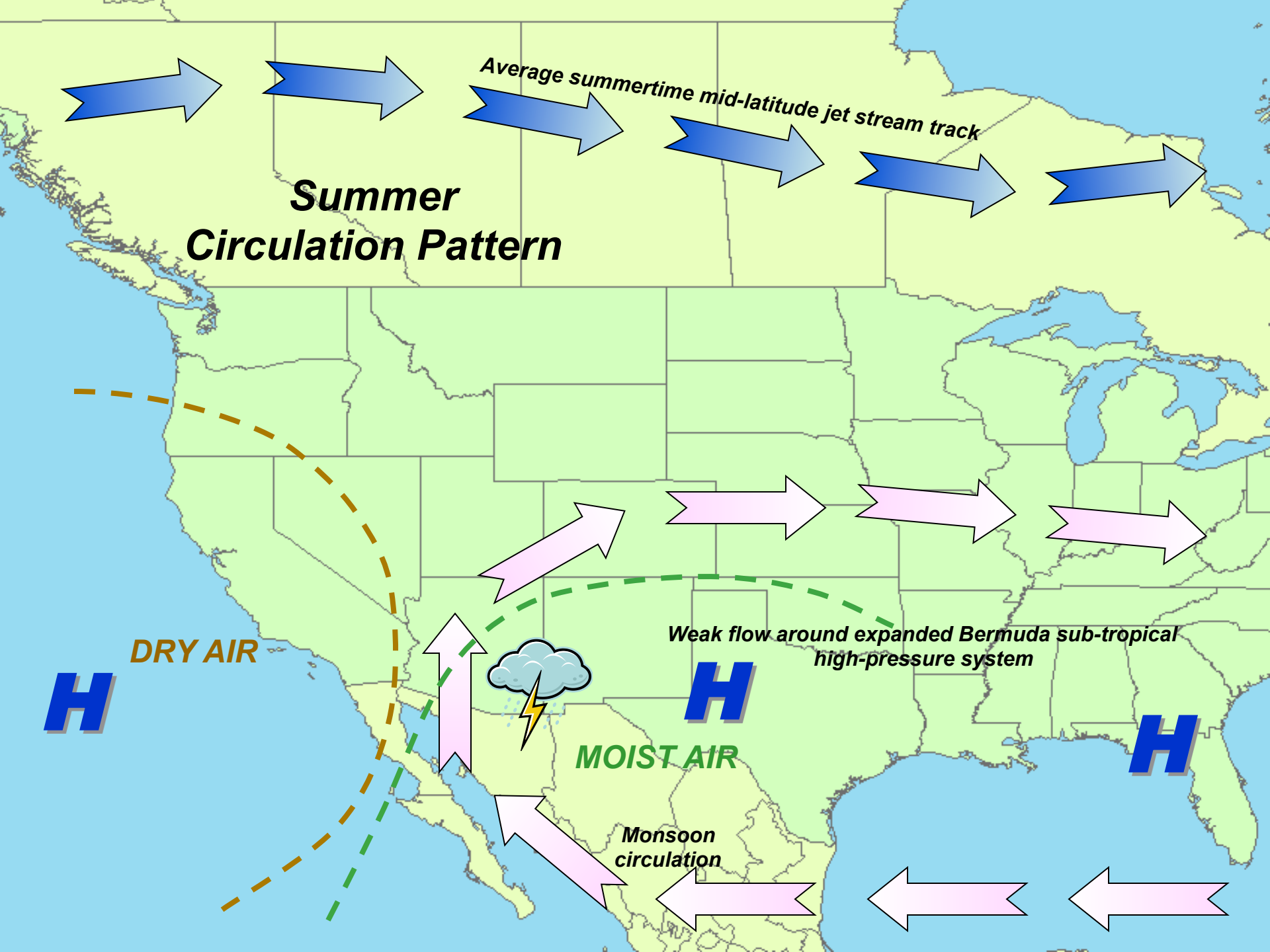
http://www.angliacampus.com/public/pri/geog/rivers/page04a.htm

North American Monsoon System

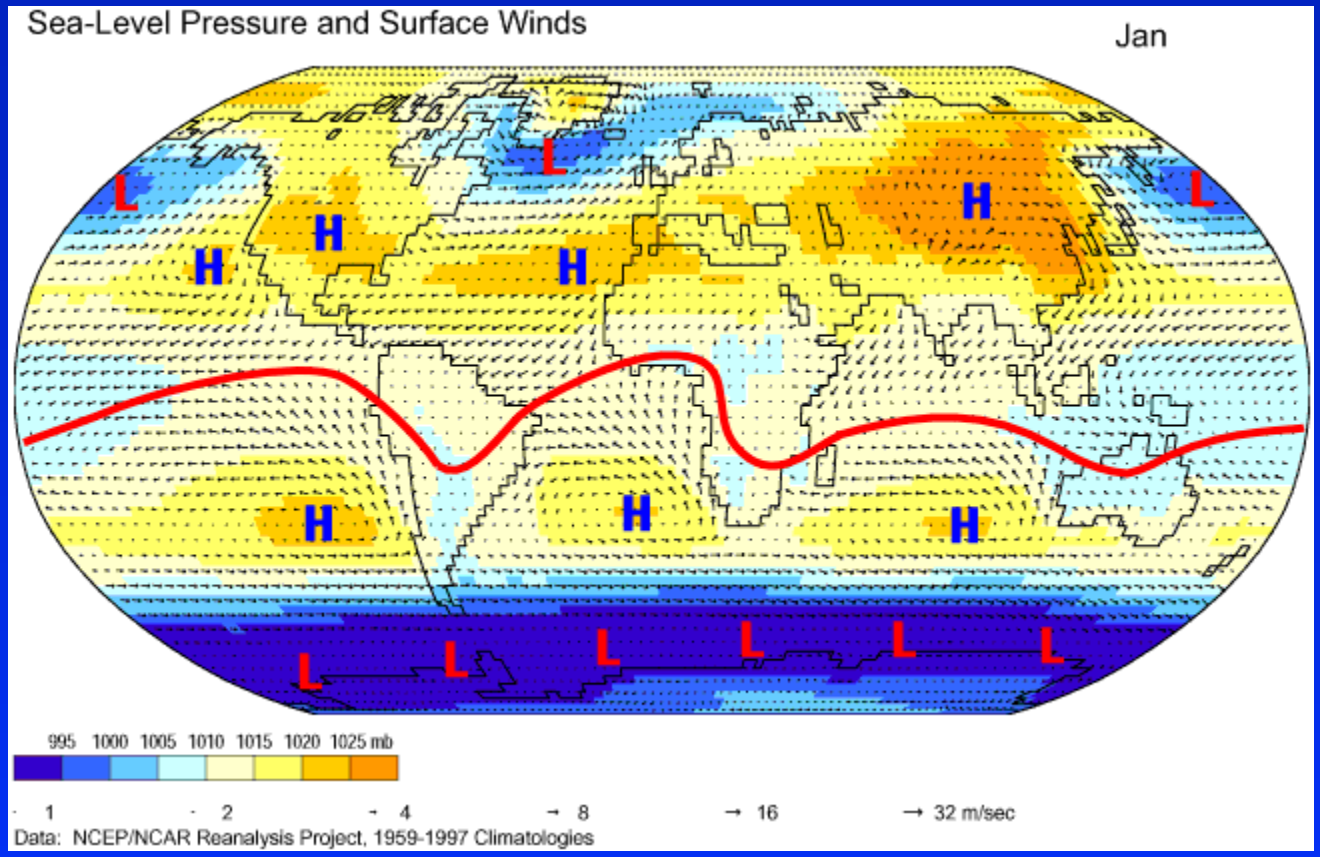
North American Monsoon & Arizona

- **Monsoon:** from Arabic *mawsim* meaning season, refers to seasonal change in wind direction
- **Start of Monsoon in AZ (*now 6-15 through 9/30*)**
  - Tucson NWS: 3 consecutive days of average daily dew point >= 54 °F
  - Phoenix NWS: 3 consecutive days of average daily dew point >= 55 °F
- **Monsoon start dates for Tucson**
  - Average start July 3rd
  - Earliest start June 17 2000
  - Latest start July 25 1987
- No official criteria for end of monsoon in AZ; typically Sept 30th is used in Tucson

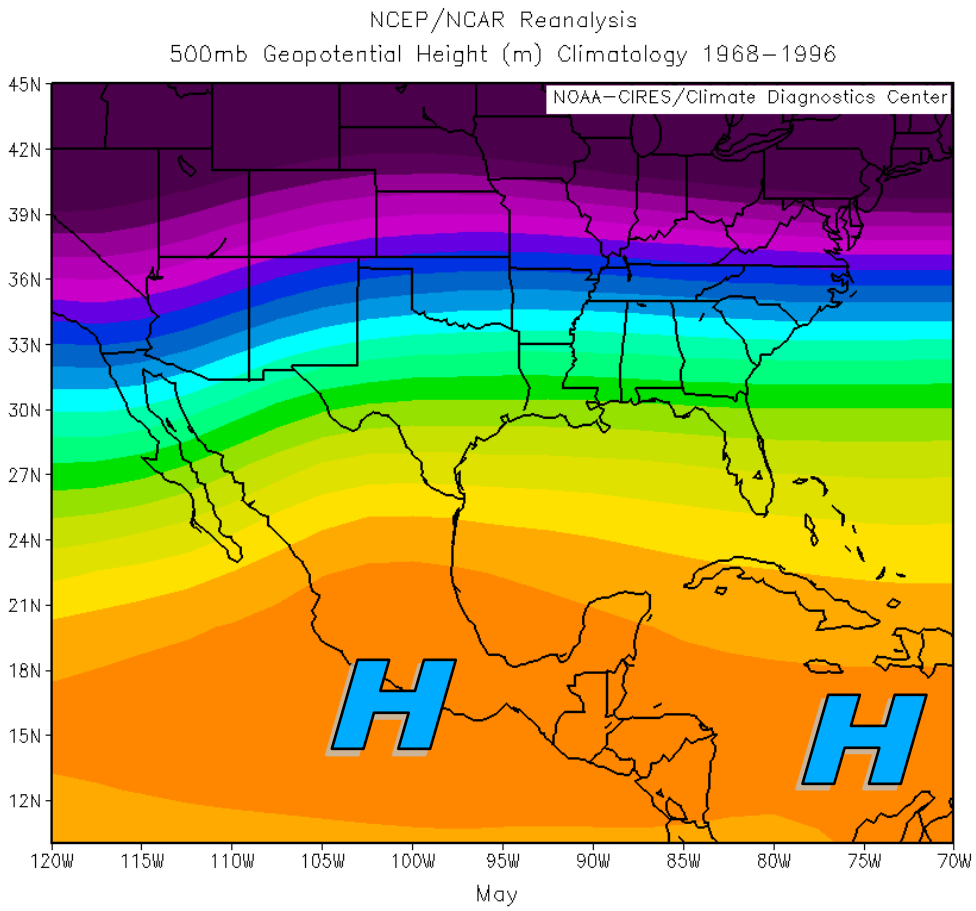

Winter Circulation Pattern
MOIST AIR
Average Wintertime Mid-latitude Jet Stream Track
L
Shift of jet stream track towards Arizona
DRY AIR
H


Average summertime mid-latitude jet stream track
Summer
Circulation Pattern
DRY AIR
H
Weak flow around expanded Bermuda sub-tropical
high-pressure system
H
H
MOIST AIR
Monsoon
circulation

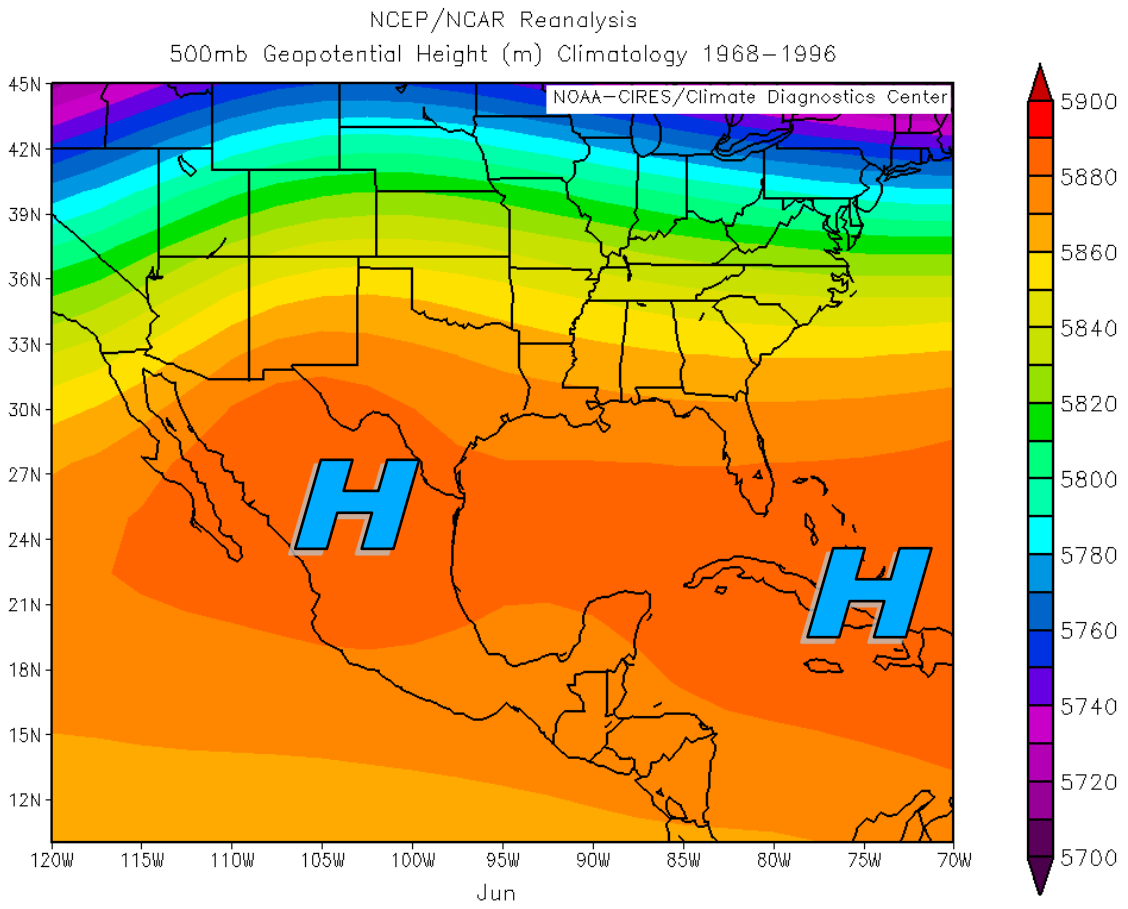
Seasonality of Circulation Patterns



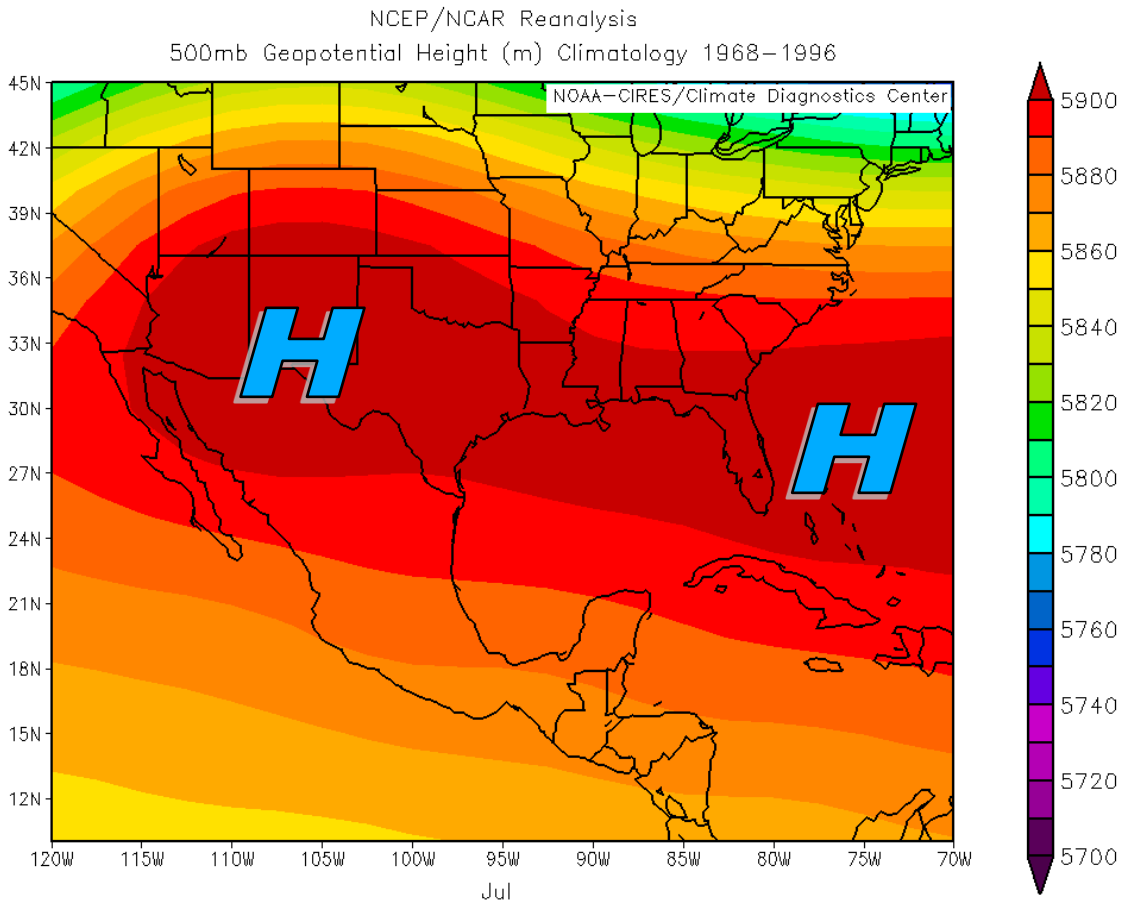
Upper Level Flow - May



Upper Level Flow - June

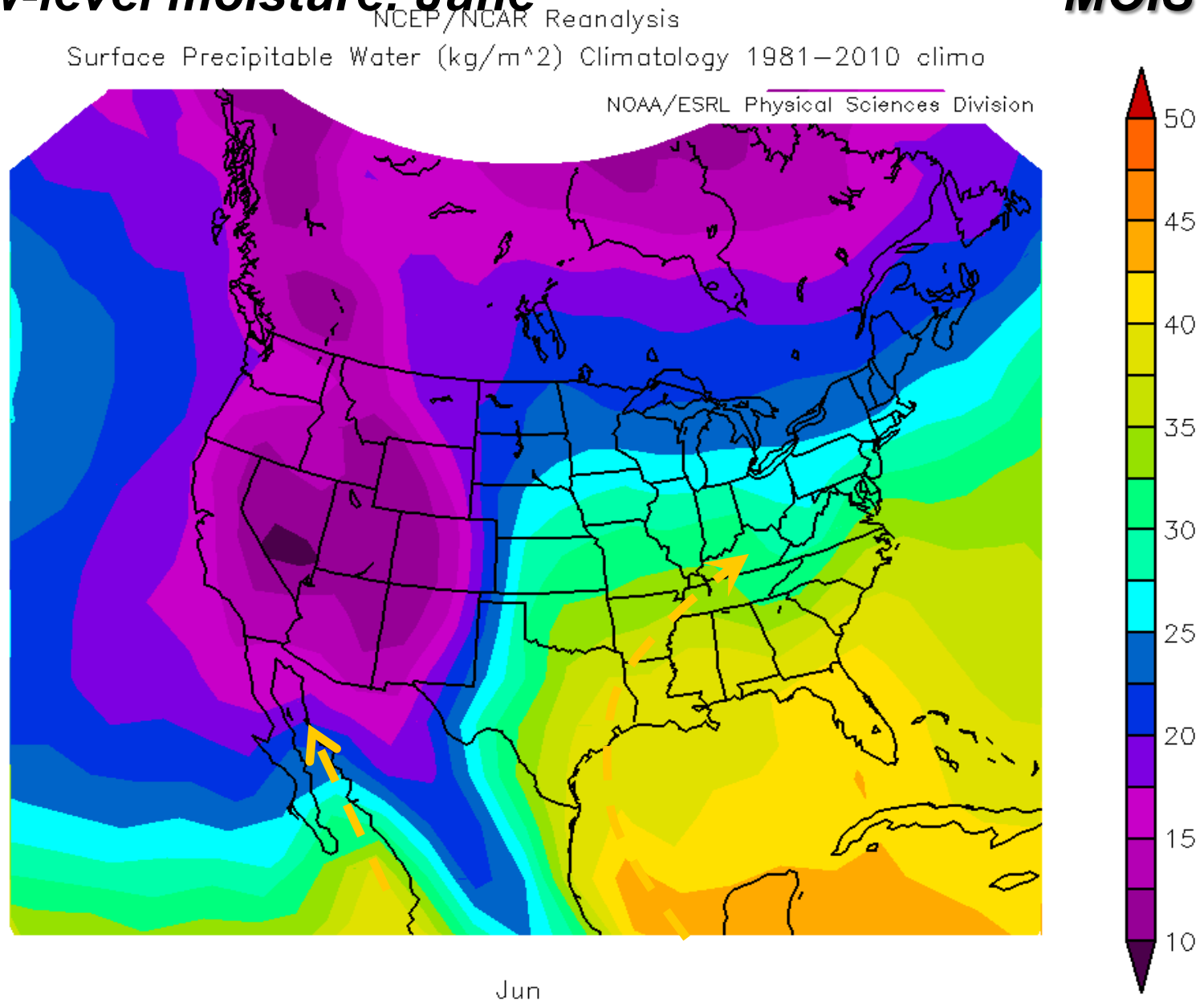


Upper Level Flow - July



Average low-level moisture: June

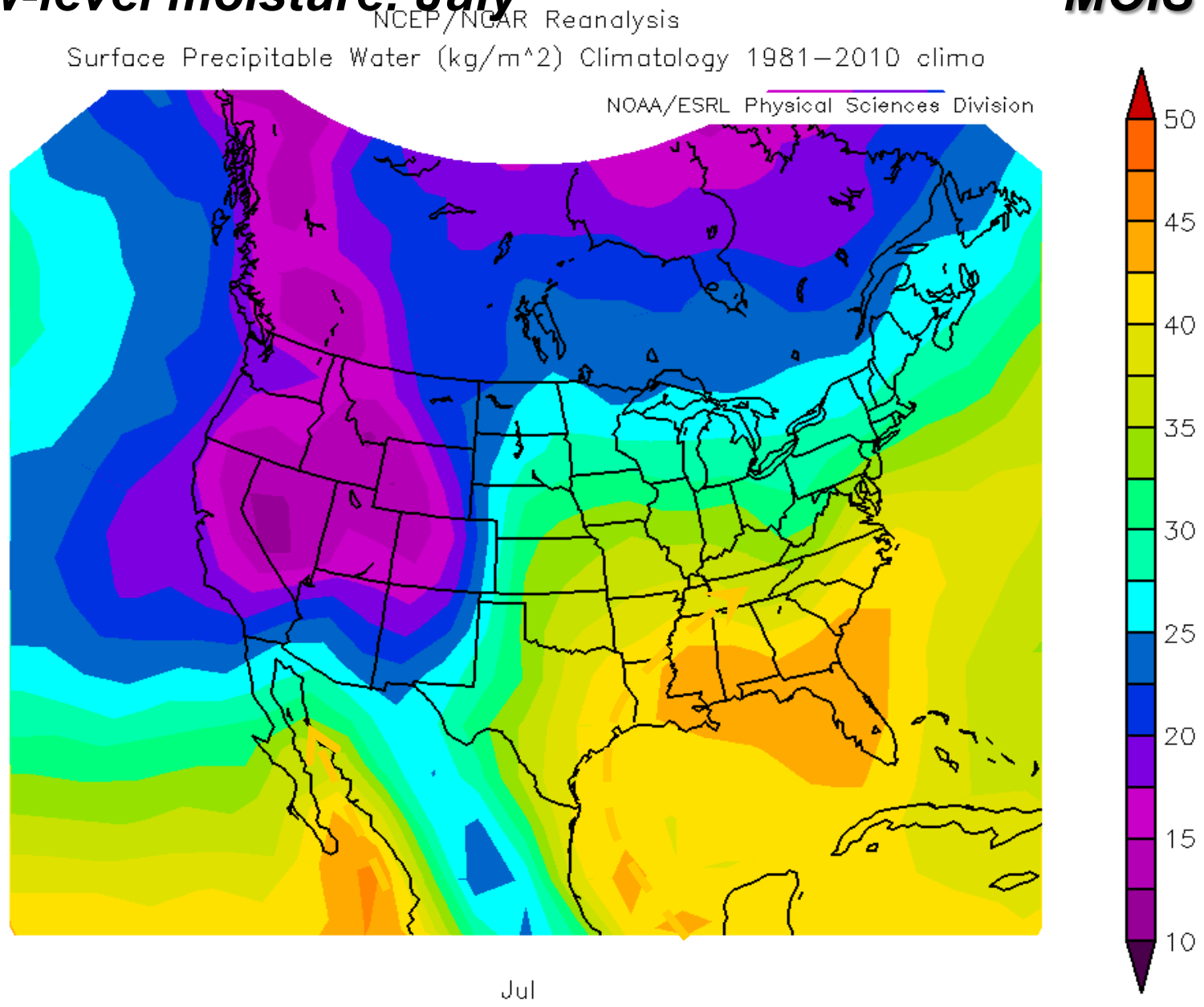
MOIST



DRY

Average low-level moisture: July

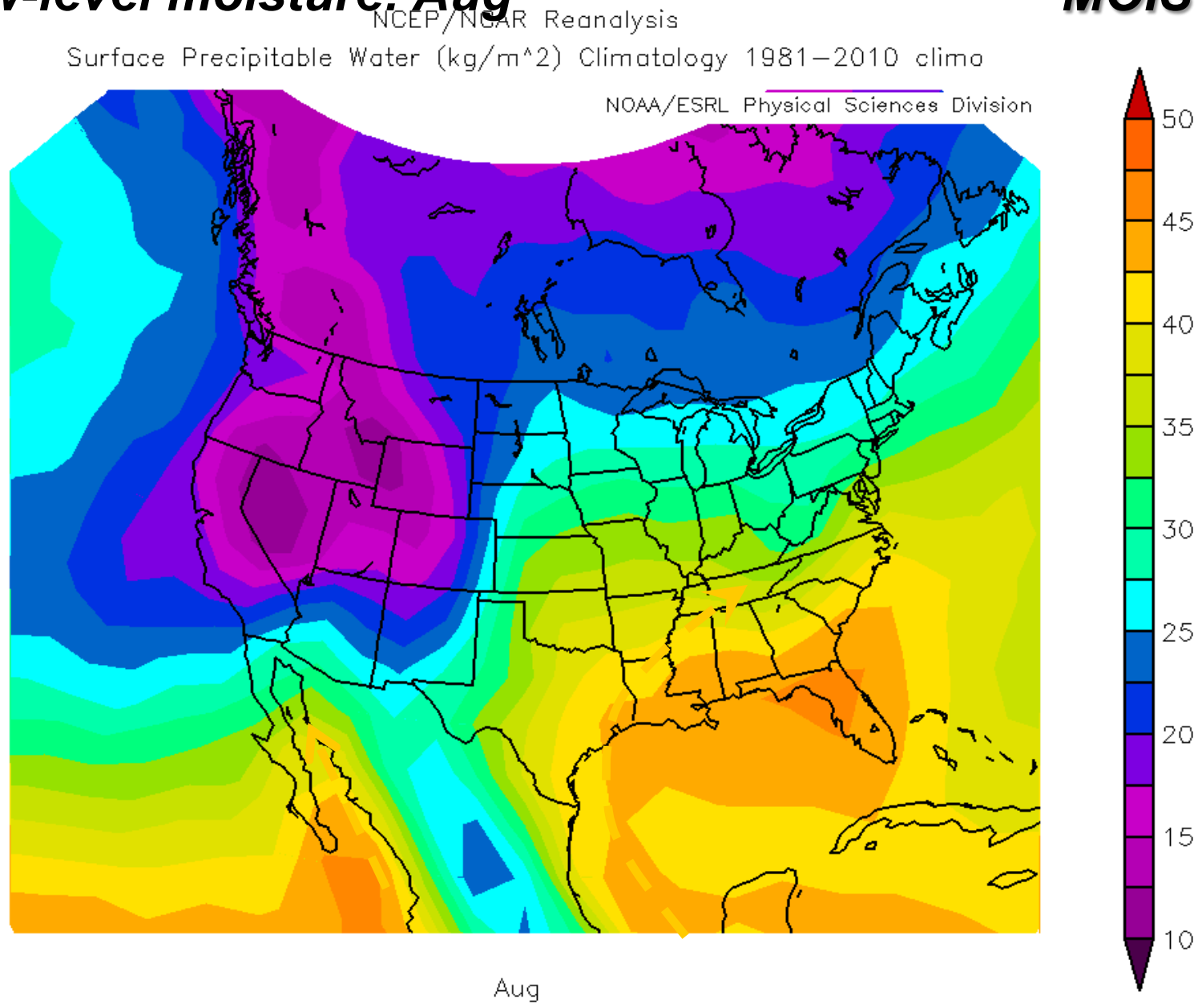
MOIST



DRY

Average low-level moisture: Aug

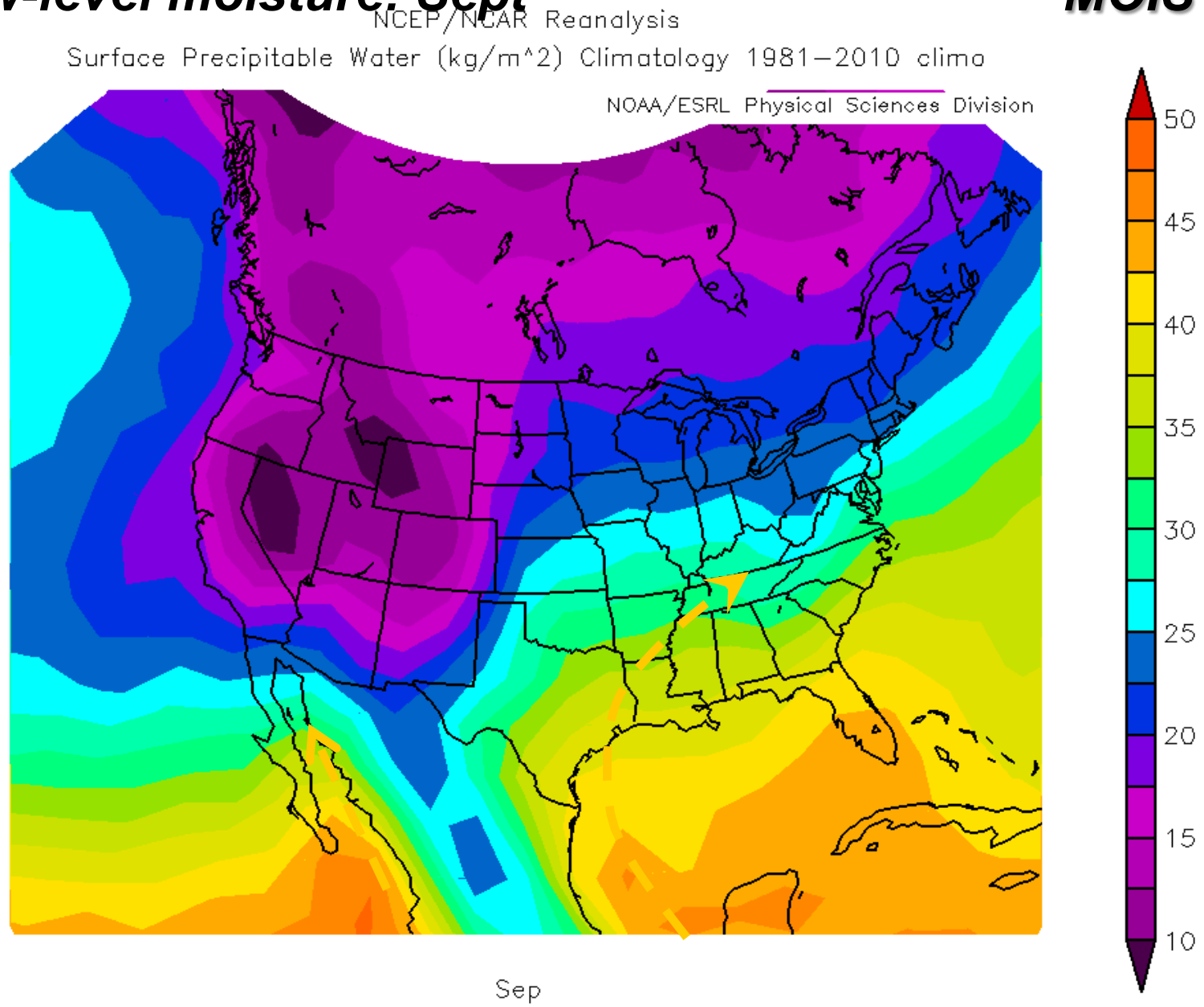
MOIST



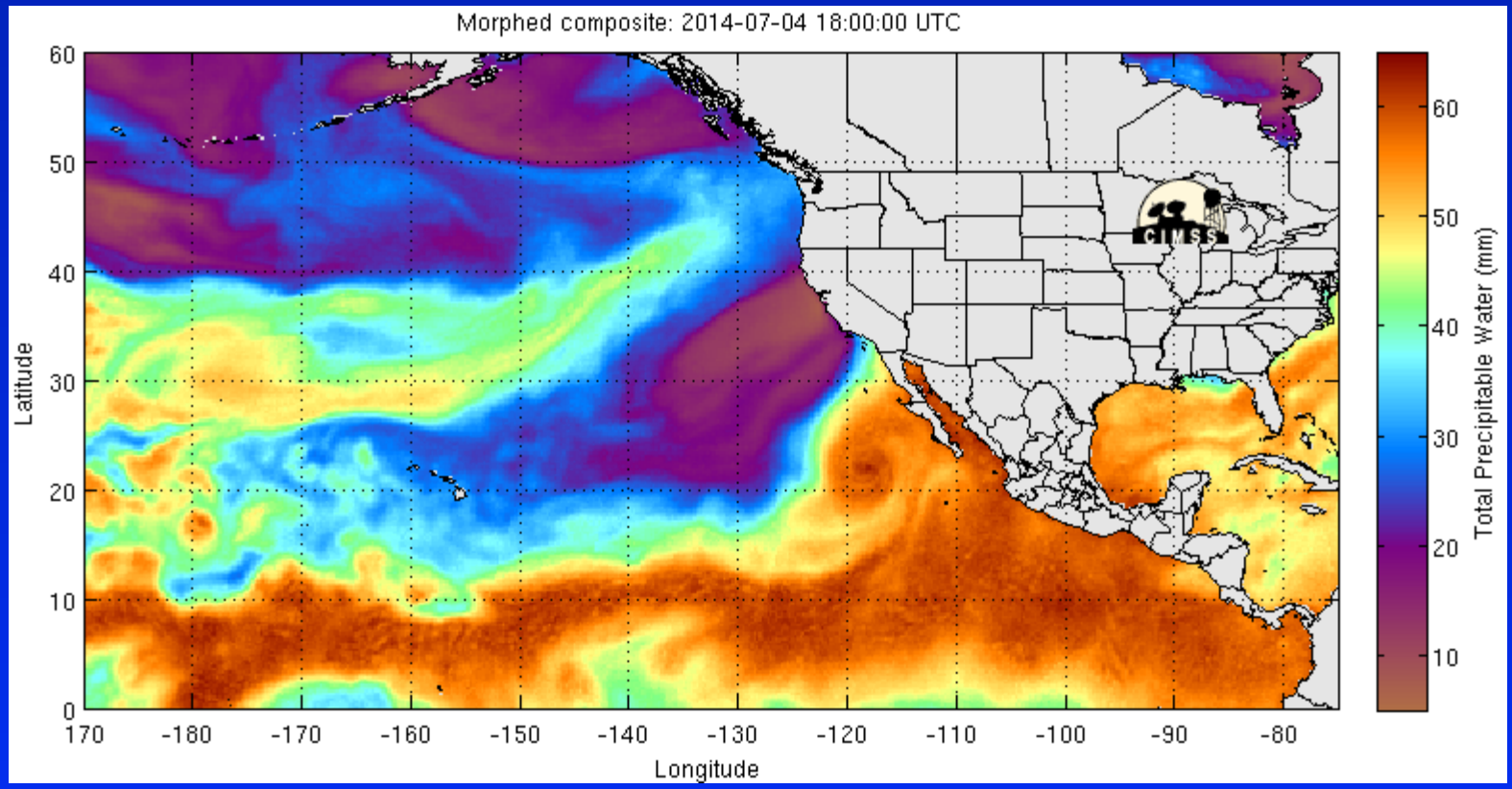
DRY

Average low-level moisture: Sept

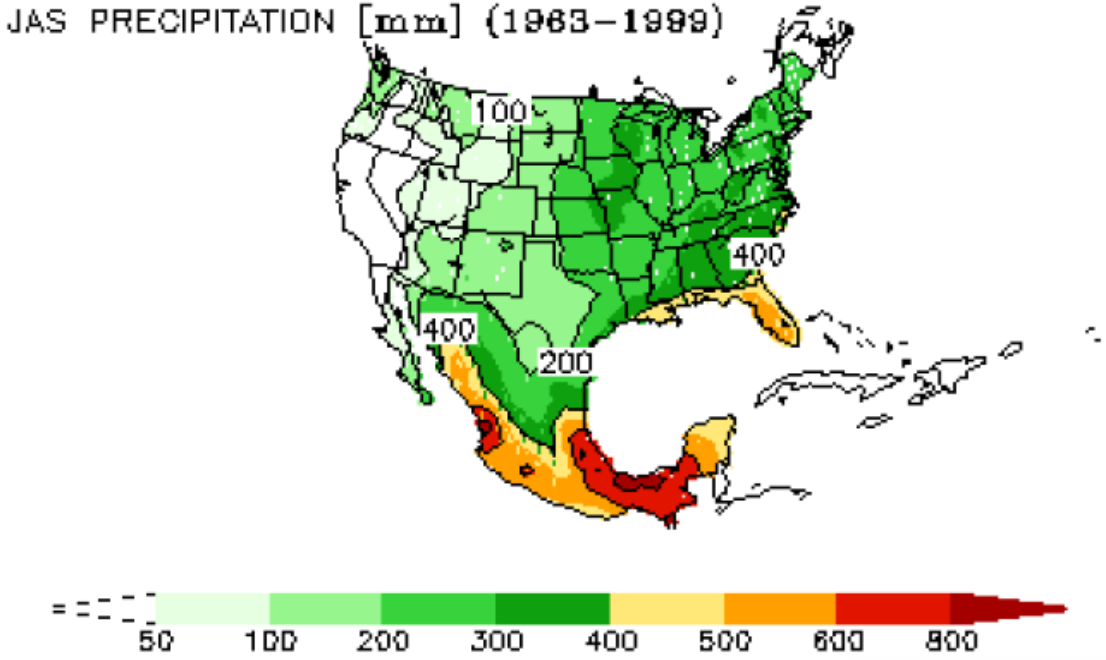
MOIST



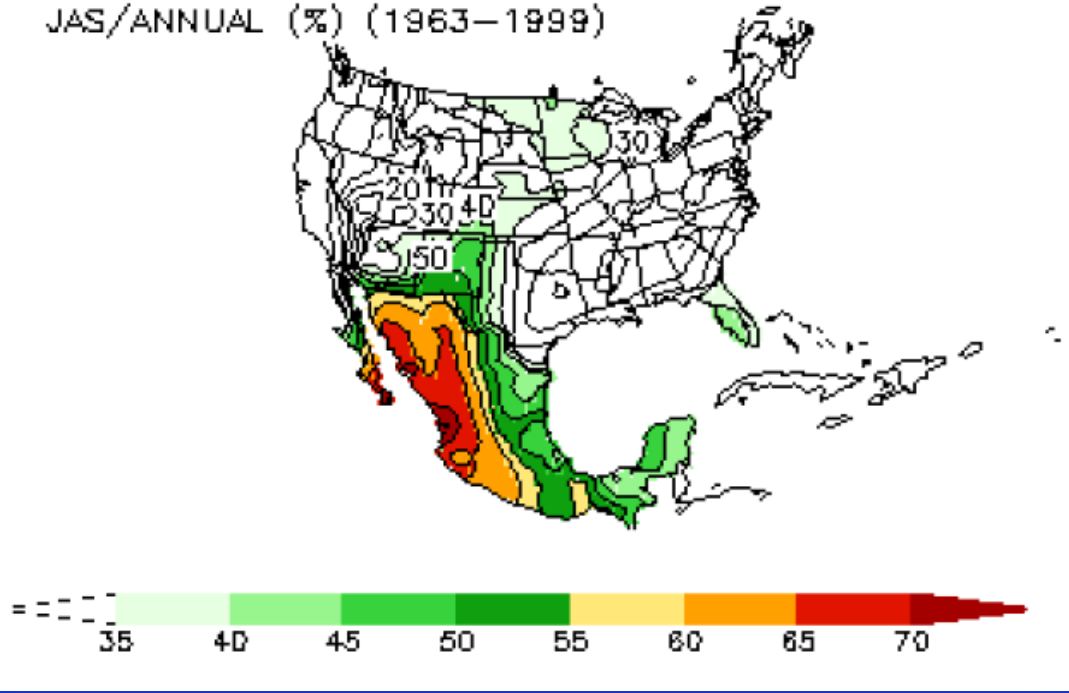
DRY



http://tropic.ssec.wisc.edu/real-time/mimic-tpw/epac/main.html

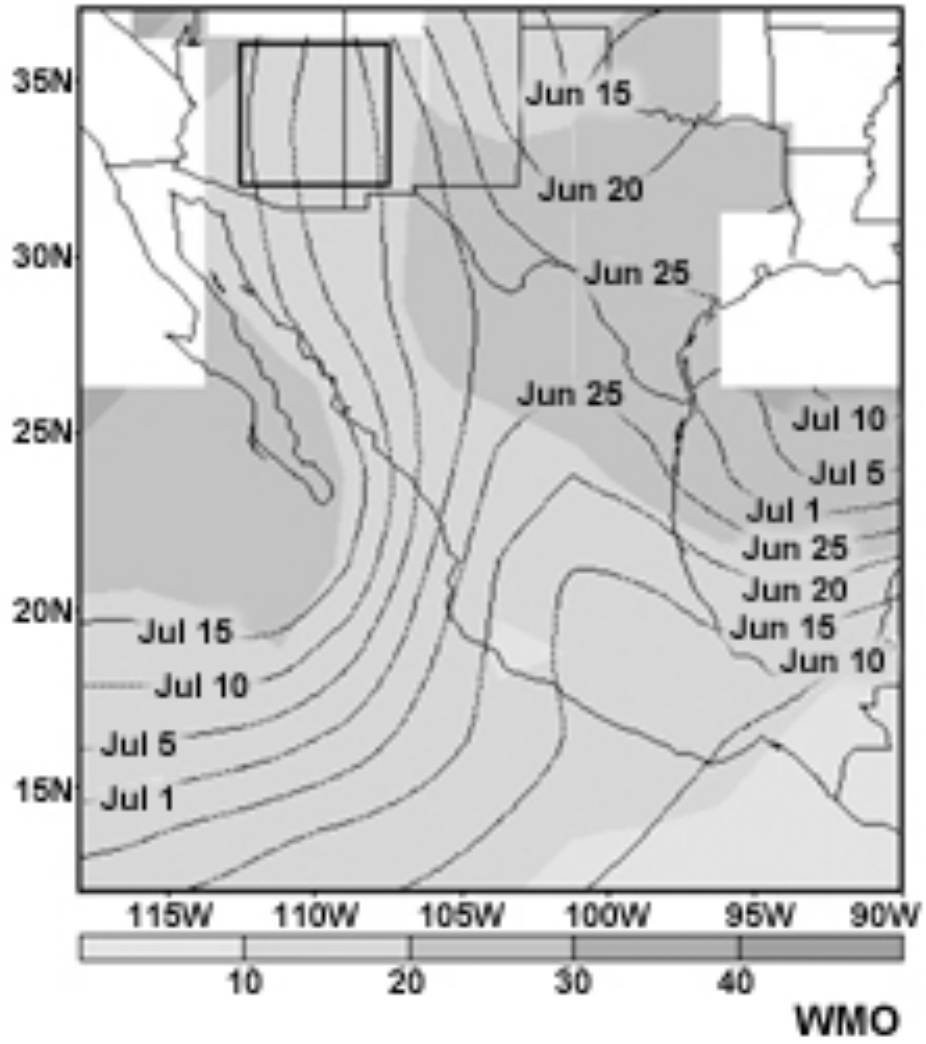


Summer Precip (July-Aug-Sep)



a

Monsoon Onset based on Satellite-derived Rainfall



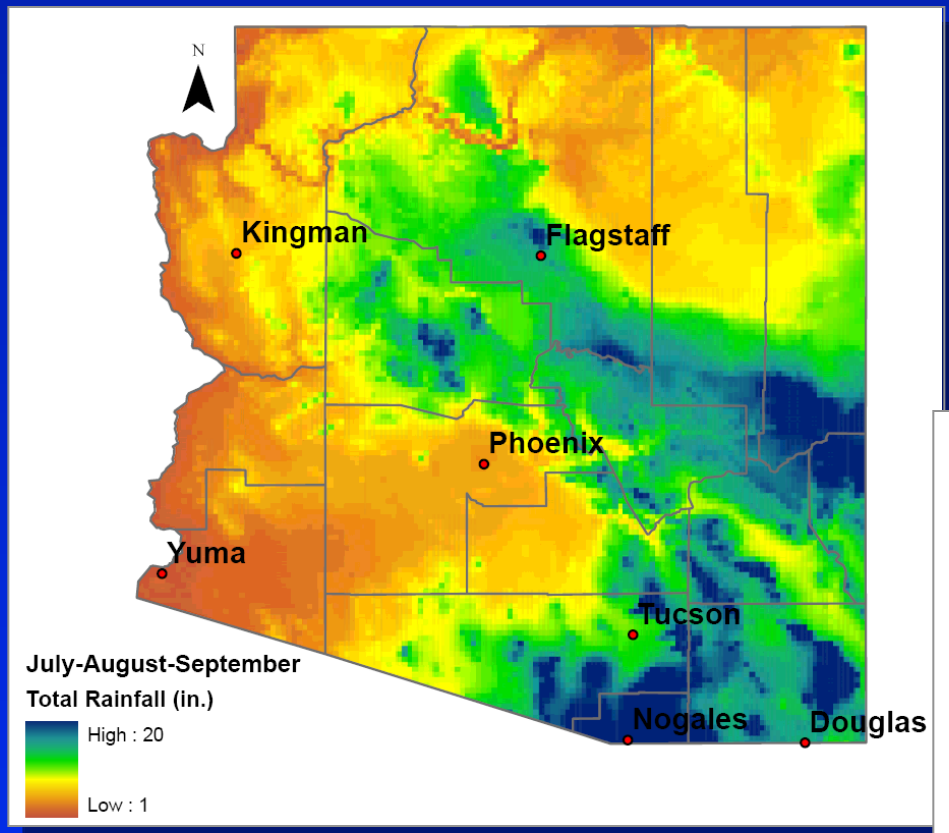
b

North American Monsoon

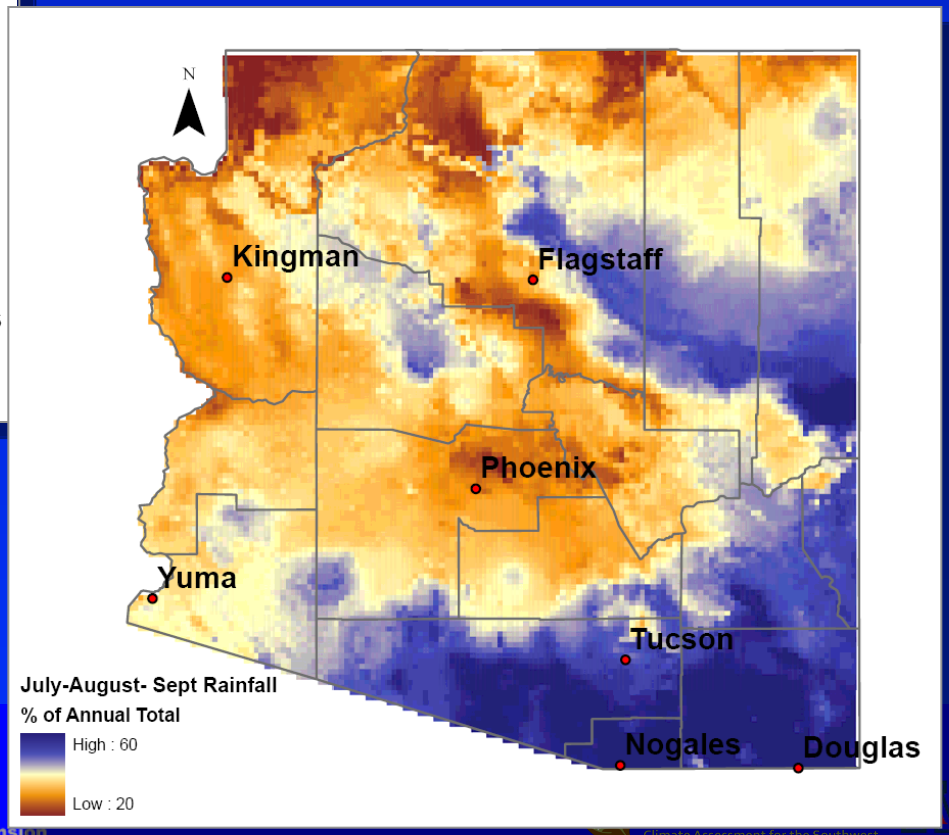
David Gochis / UCAR

Arizona Monsoon

Total Monsoon Rainfall

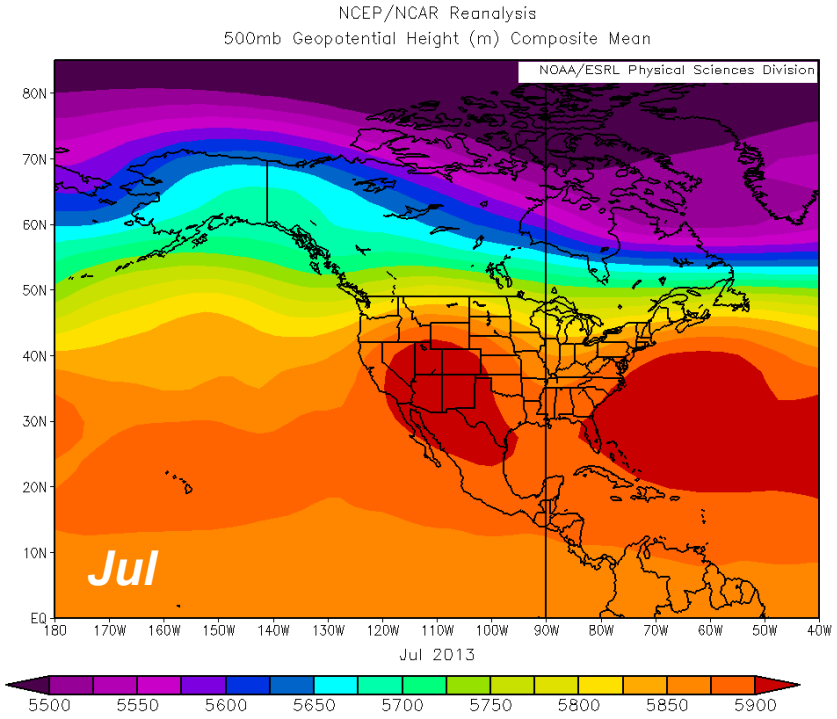


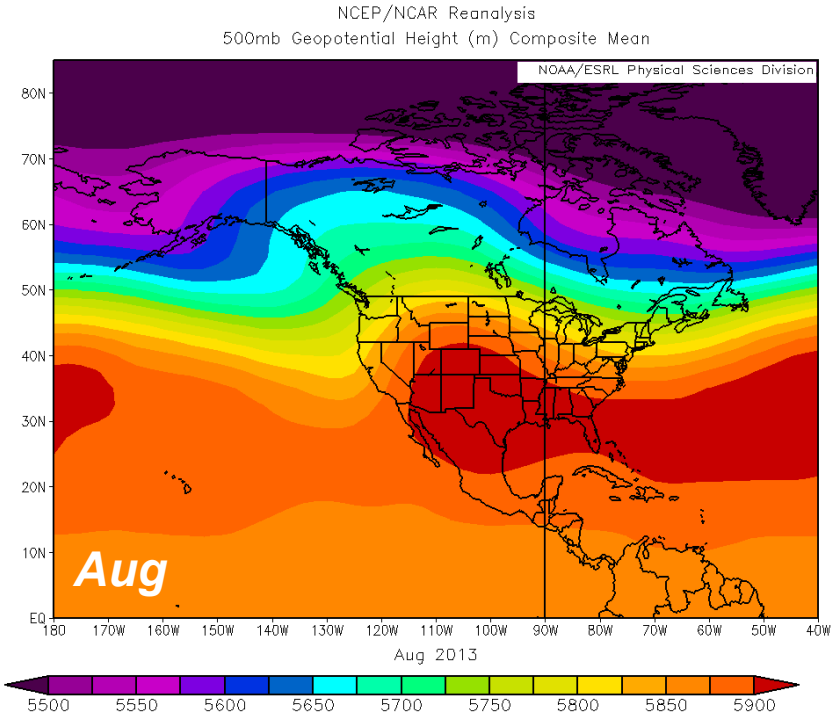
JAS Percent of Annual Rainfall



Conceptual diagram of key circulation features of the North American Monsoon System

Summer 2013


NCEP/NCAR Reanalysis
500mb Geopotential Height (m) Composite Mean
NOAA/ESRL Physical Sciences Division
Jul
Jul 2013
5500 5550 5600 5650 5700 5750 5800 5850 5900


NCEP/NCAR Reanalysis
500mb Geopotential Height (m) Composite Mean
NOAA/ESRL Physical Sciences Division
Aug
Aug 2013
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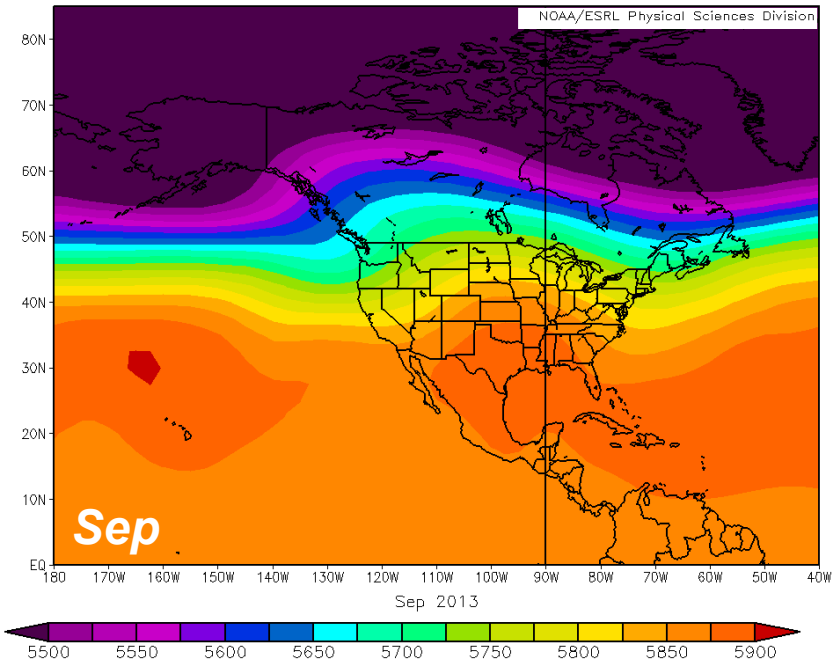
NOAA/ESRL Physical Sciences Division
Sep
Sep 2013
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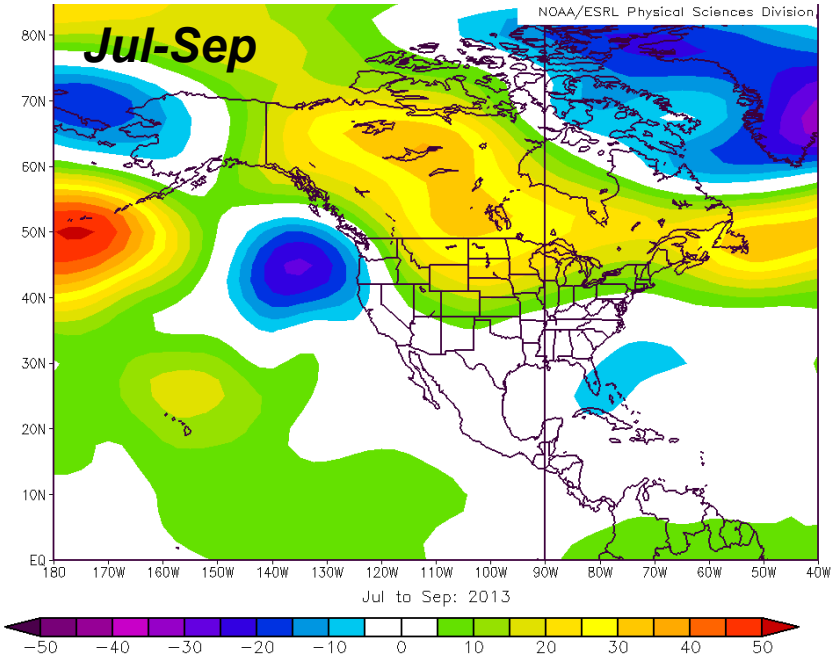
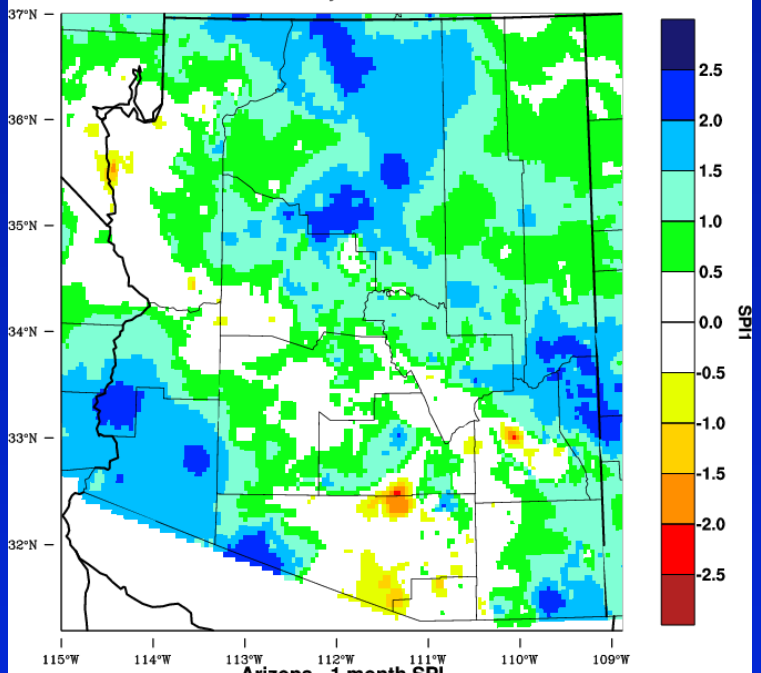

NOAA/ESRL Physical Sciences Division
Jul-Sep
Jul to Sep: 2013
−50 −40 −30 −20 −10 0 10 20 30 40 50

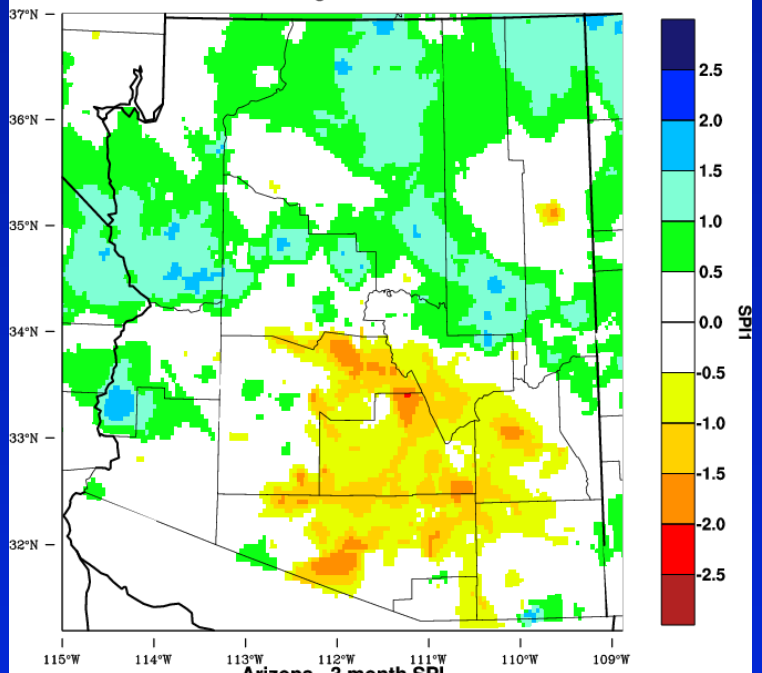
Arizona - 1 month SPI

July 2013



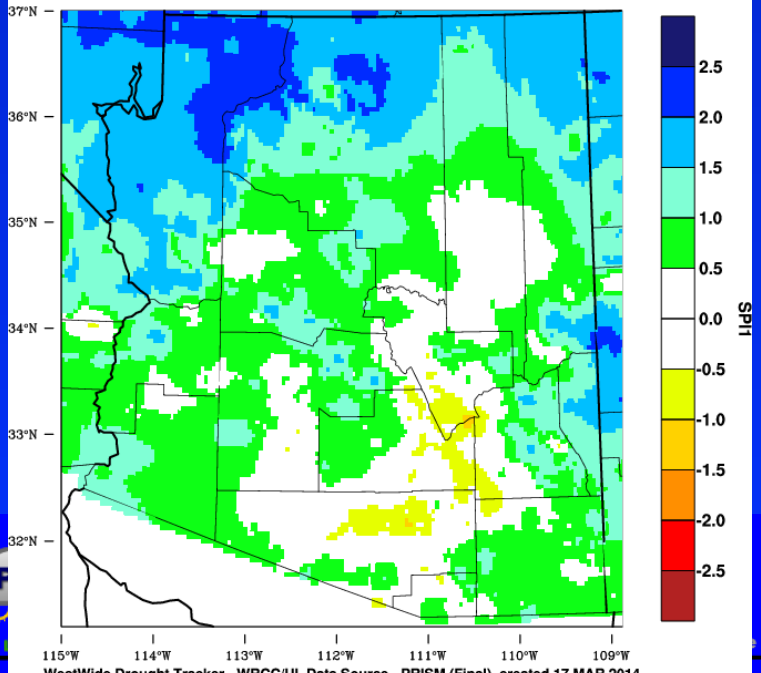
Arizona - 1 month SPI

August 2013



Arizona - 1 month SPI

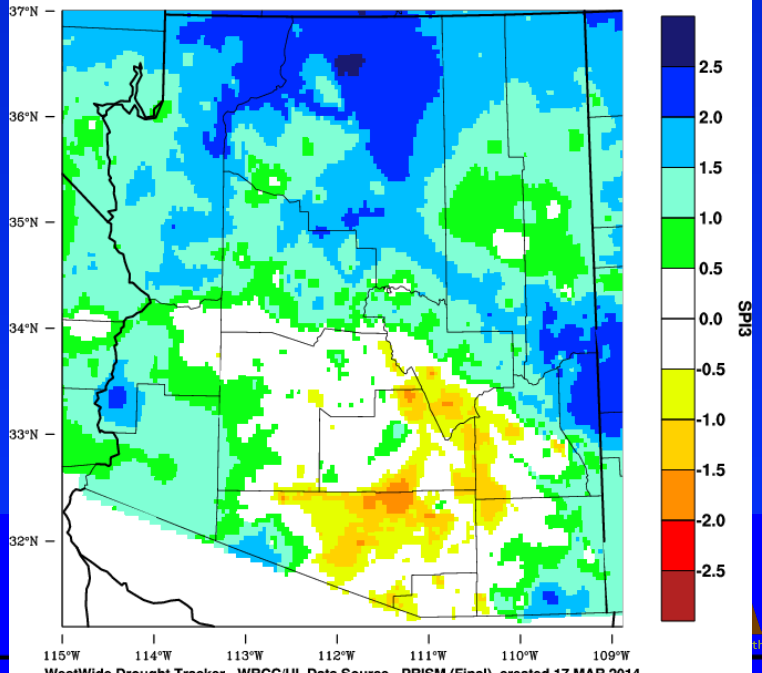
September 2013



WestWide Drought Tracker - WRCC/UI Data Source - PRISM (Final), created 17 MAR 2014

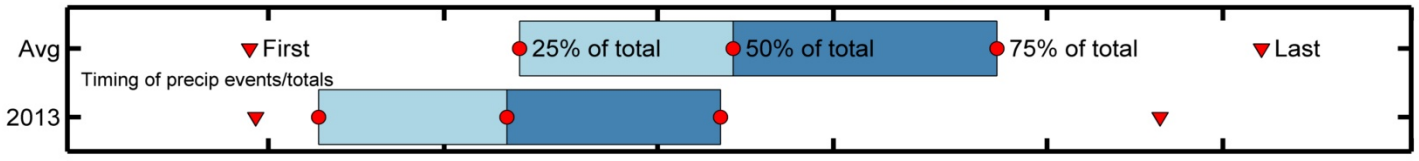
Arizona - 3 month SPI

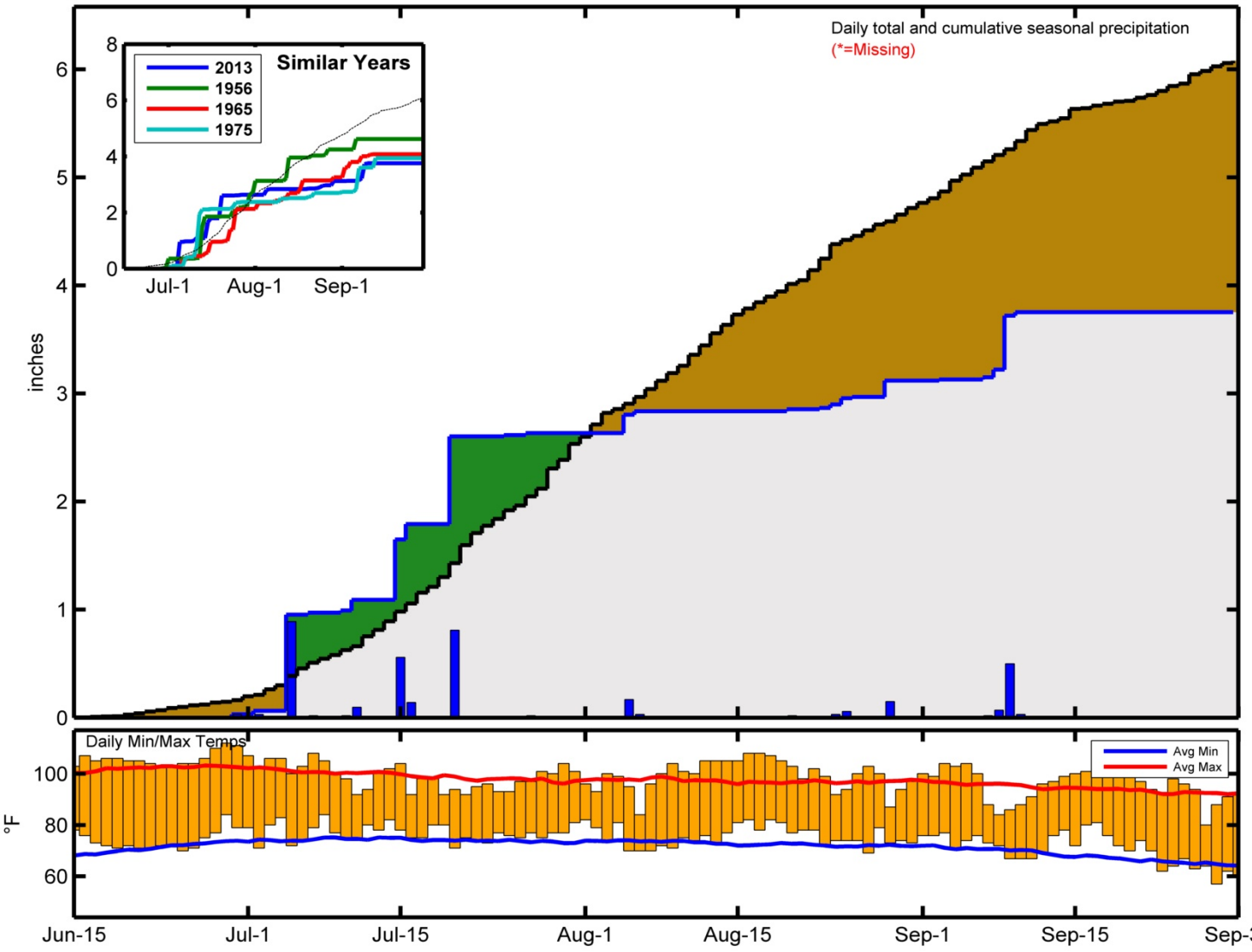
September 2013



WestWide Drought Tracker - WRCC/UI Data Source - PRISM (Final), created 17 MAR 2014

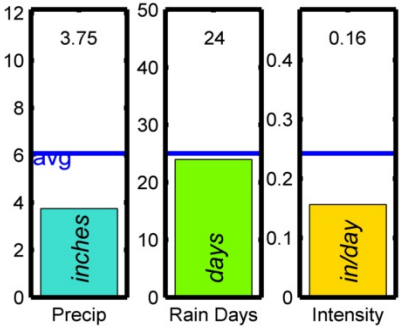
2013 Monsoon Summary

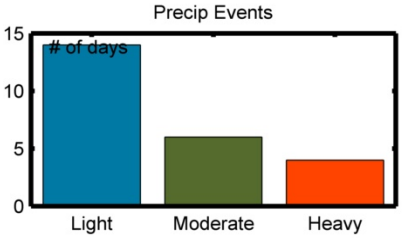




TUCSON INTL AP

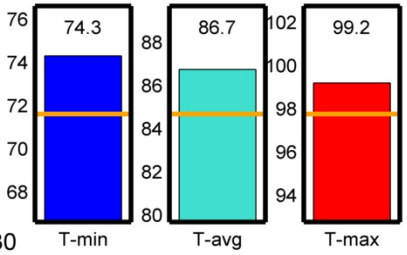
Elevation: 777m
Period of record: 1950-2013
Years in record: 64
Precip rank: 54 (1,wettest)
Temp rank: 6 (1,warmest)
Missing in 2013: 0 days





Dry Spells

Avg length: 4 days (avg: 5)
Max length: 13 days (avg: 14)

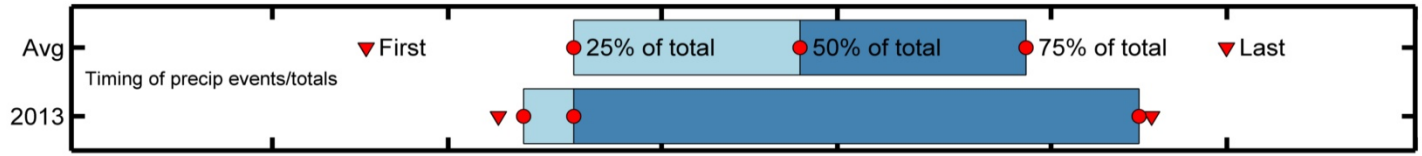


http://cals.arizona.edu/climate/misc/monsoon/monsoon_summaries.html

Climate Science Applications Program
University of Arizona Cooperative Extension
http://cals.arizona.edu/climate
Date created: 07-Nov-2013

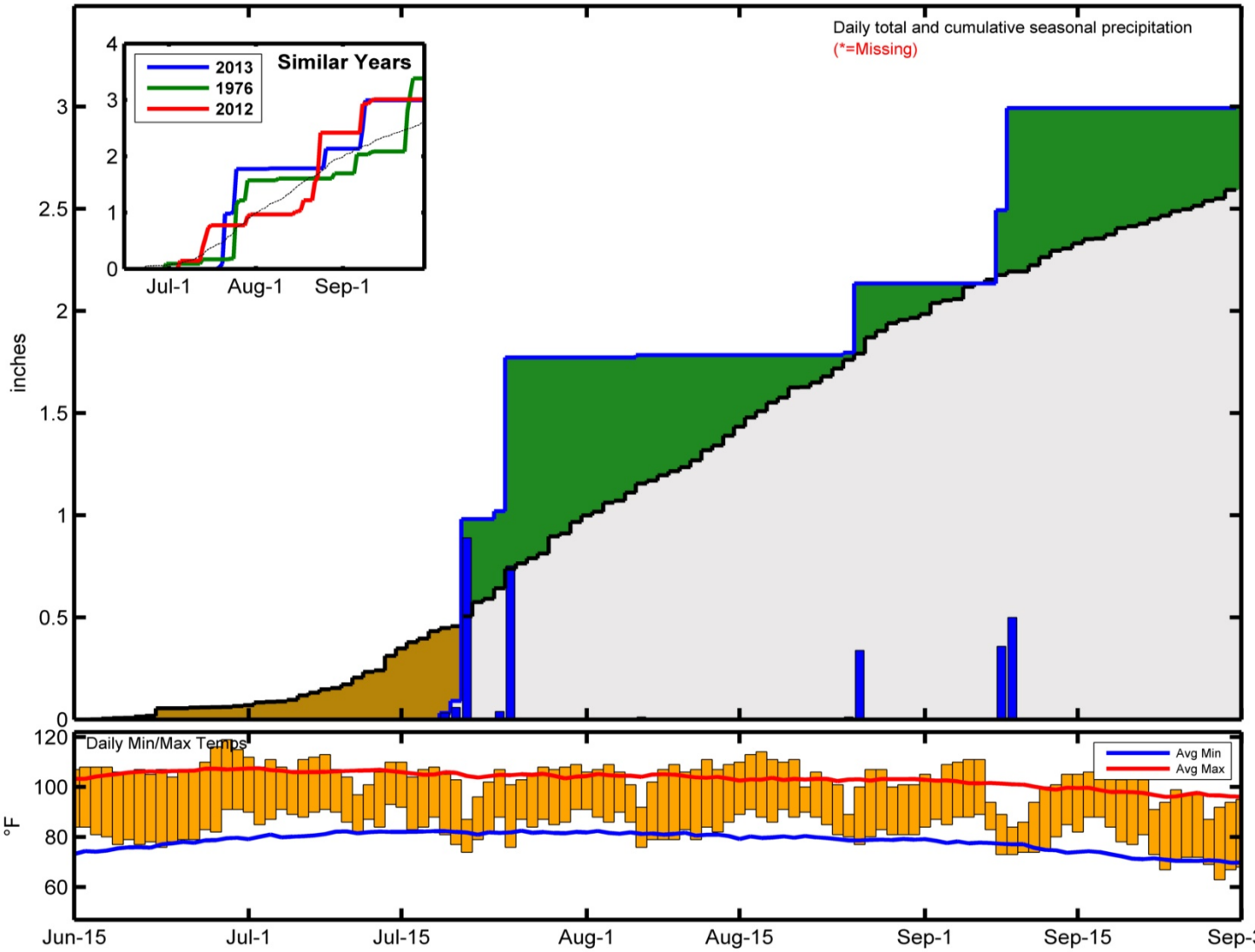
THE UNIVERSITY OF ARIZONA | CALS COOPERATIVE EXTENSION

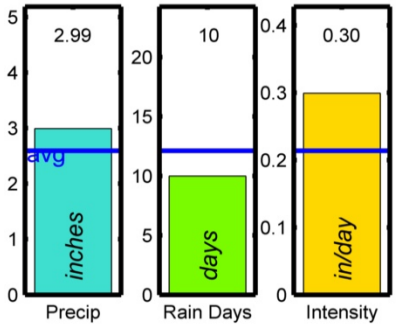
2013 Monsoon Summary

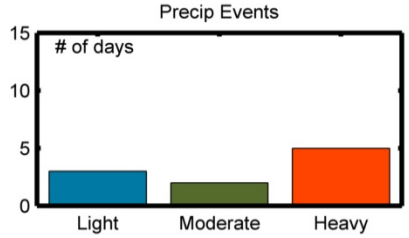


PHOENIX SKY HARBOR INTL AP

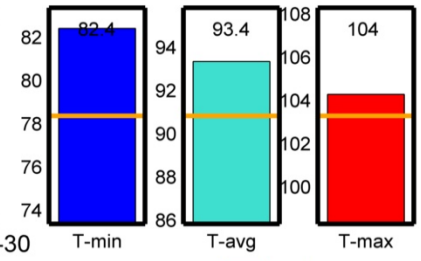
Elevation: 337m
Period of record: 1950-2013
Years in record: 64
Precip rank: 21 (1,wettest)
Temp rank: 11 (1,warmest)
Missing in 2013: 0 days







Dry Spells
Avg length: 15 days (avg: 11)
Max length: 18 days (avg: 21)



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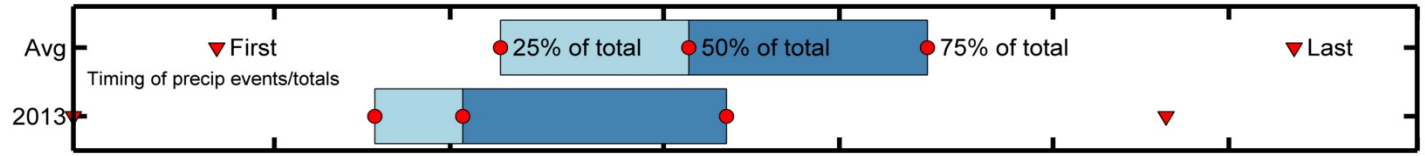
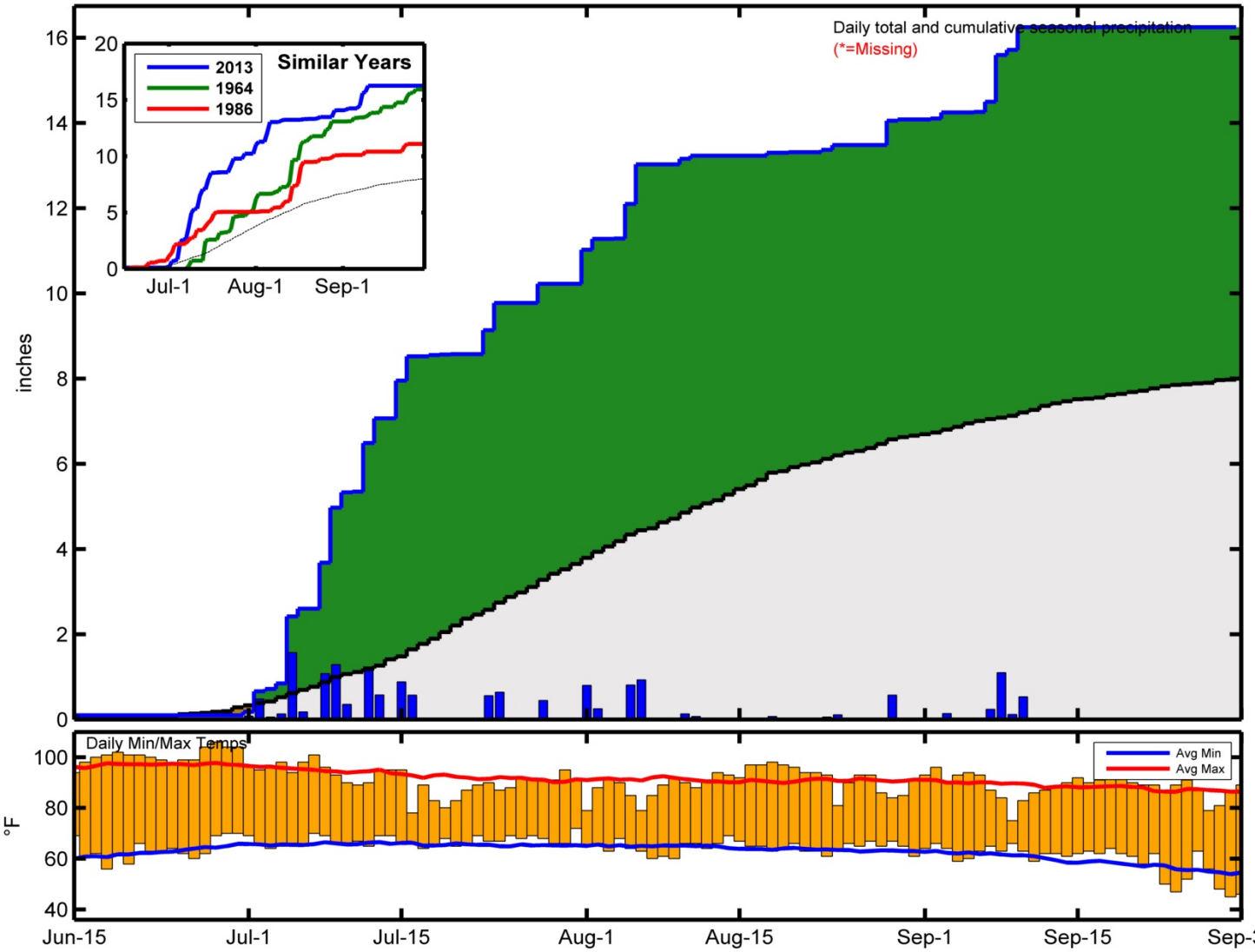
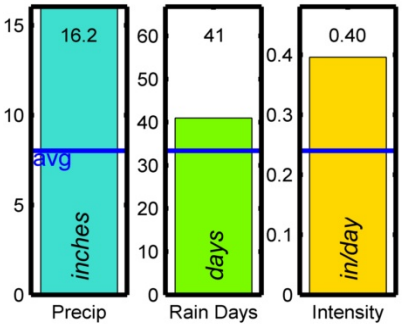
2013 Monsoon Summary

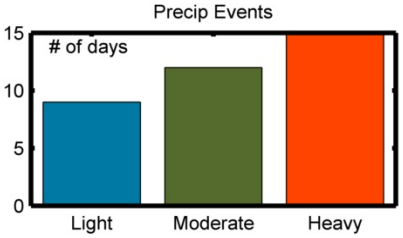




DOUGLAS BISBEE INL AP

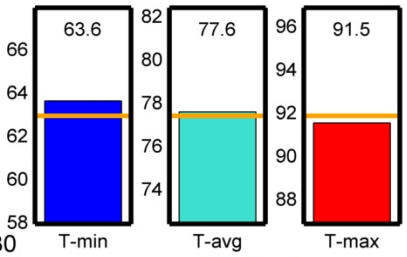
Elevation: 1251m
Period of record: 1950-2013
Years in record: 64
Precip rank: 1 (1,wettest)
Temp rank: 24 (1,warmest)
Missing in 2013: 0 days





Dry Spells

Avg length: 3 days (avg: 4)
Max length: 15 days (avg: 13)



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Date created: 07-Nov-2013

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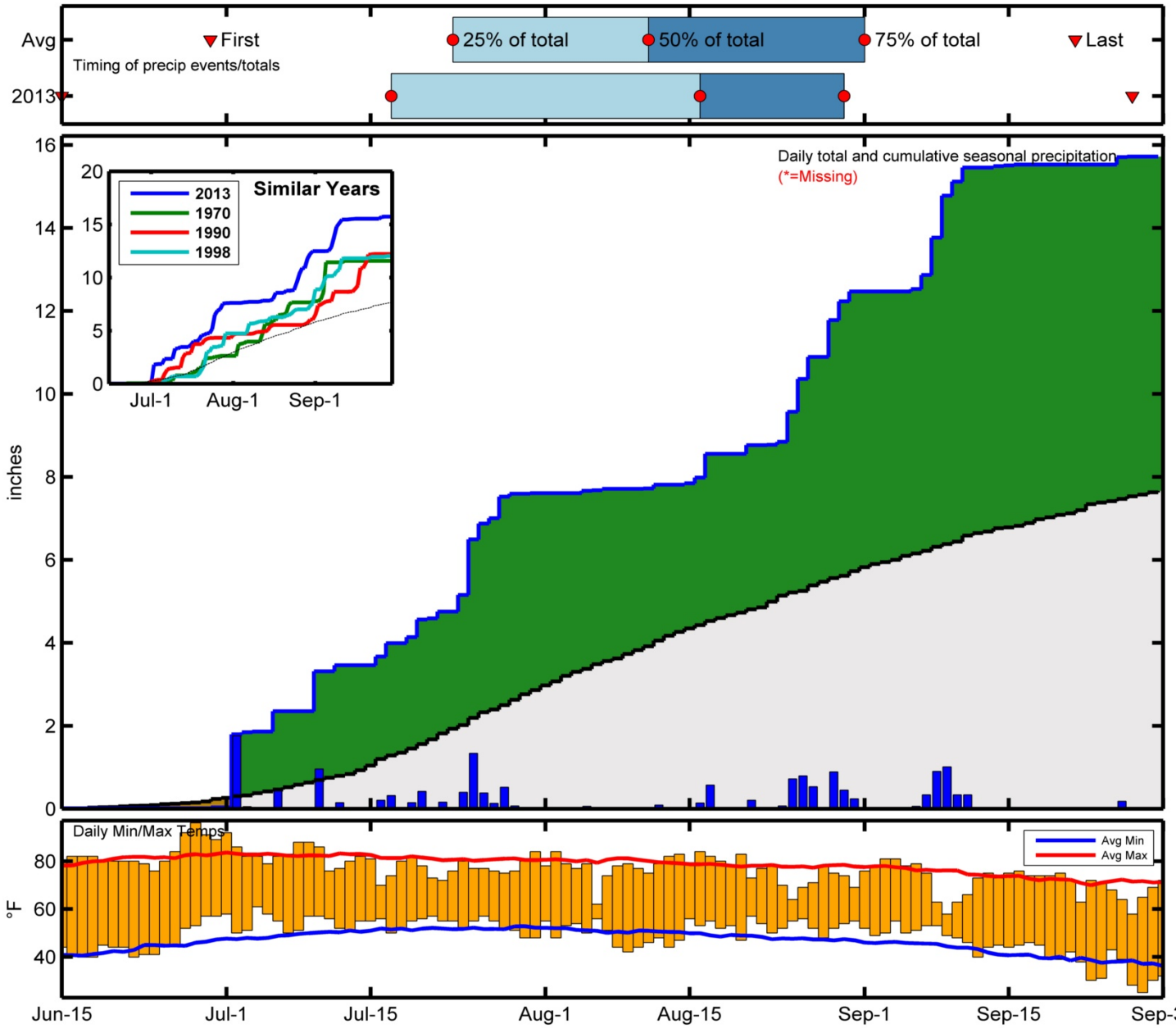
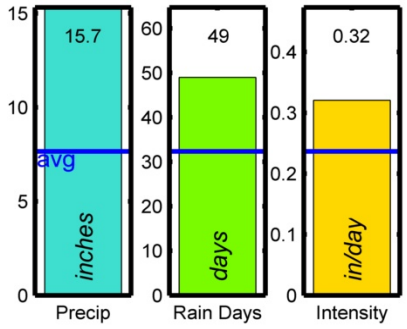
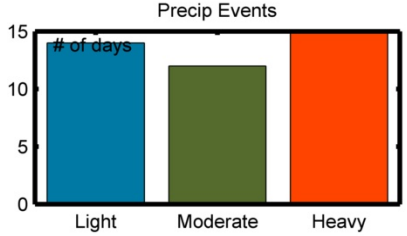
2013 Monsoon Summary



FLAGSTAFF PULLIAM AP

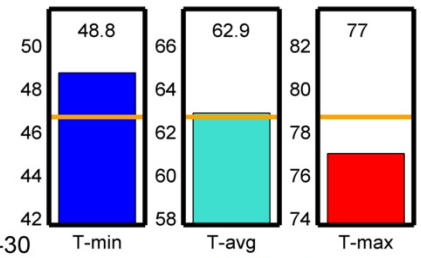
Elevation: 2135m
Period of record: 1950-2013
Years in record: 64
Precip rank: 2 (1,wettest)
Temp rank: 26 (1,warmest)
Missing in 2013: 0 days





Dry Spells

Avg length: 3 days (avg: 5)
Max length: 14 days (avg: 13)



Climate Science Applications Program
University of Arizona Cooperative Extension
http://cals.arizona.edu/climate
Date created: 07-Nov-2013

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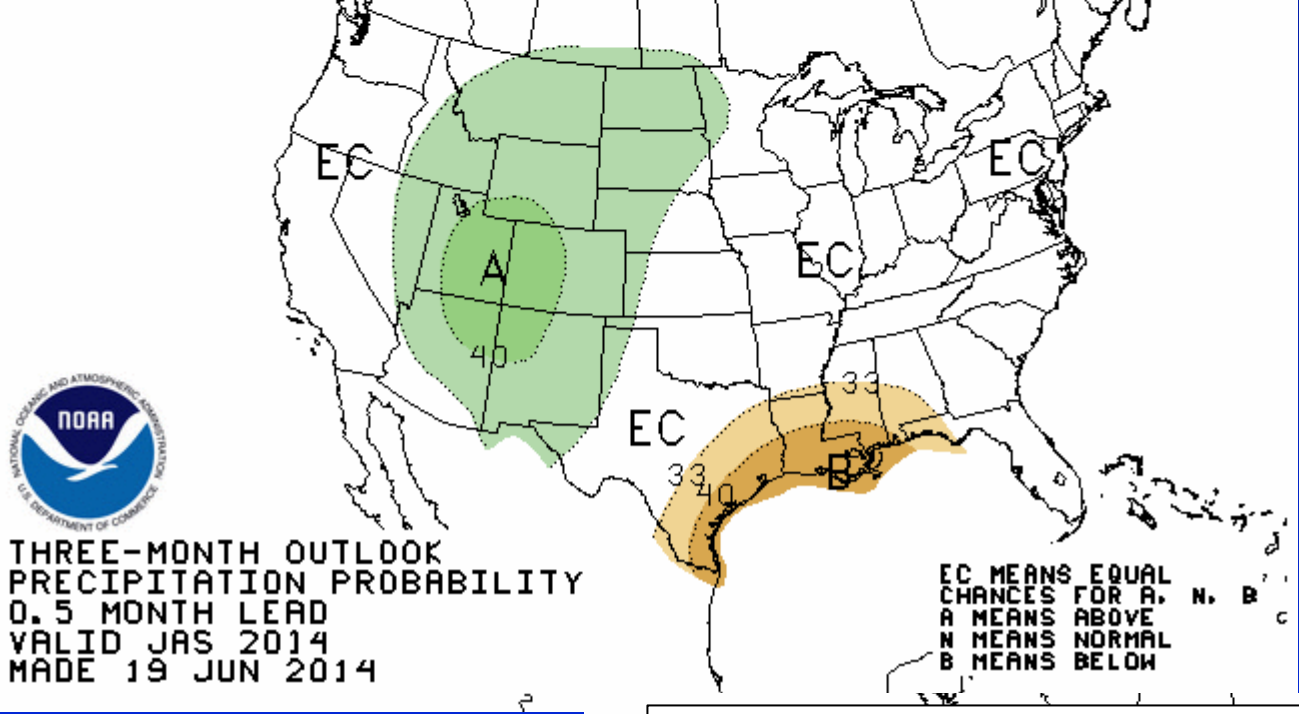
Climate Outlooks

Forecasting the monsoon season (don't try this at home)

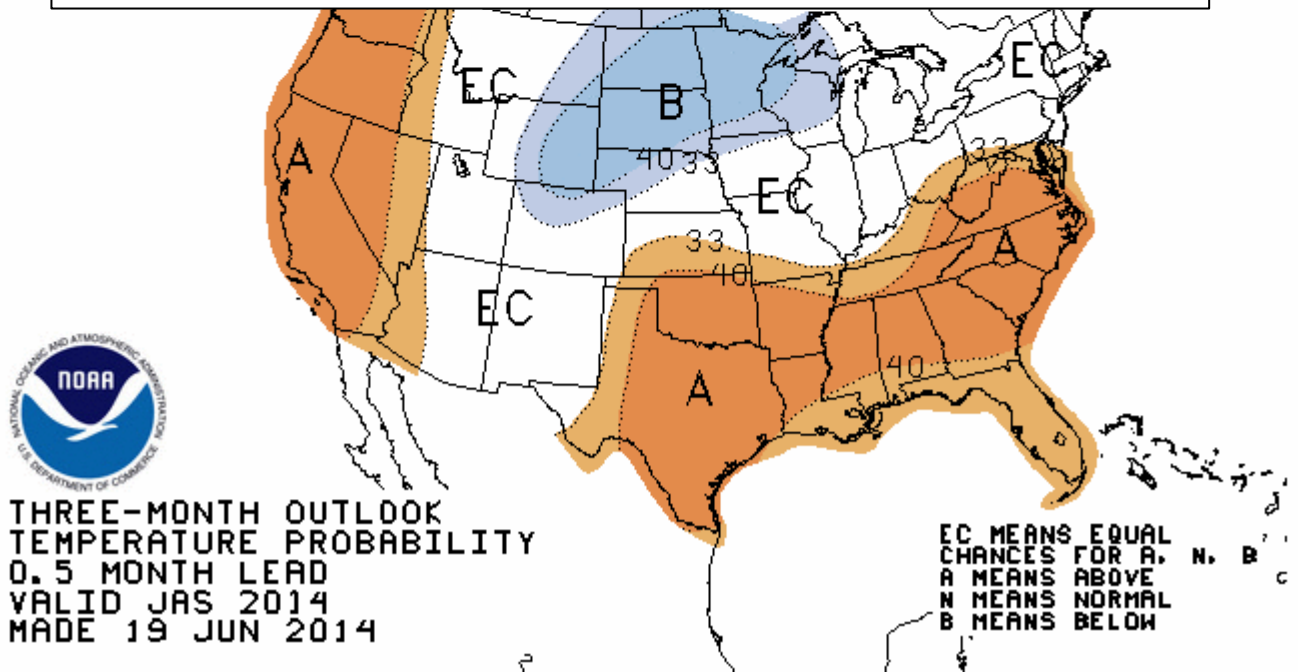
- Things to look for…
  - Position of the subtropical ridge
  - El Niño-Southern Oscillation
  - East Pacific SSTs
- Monthly to seasonal precipitation patterns are driven largely by day to day weather
- Tools include historical analogs and dynamical seasonal forecast models

Seasonal Forecasts



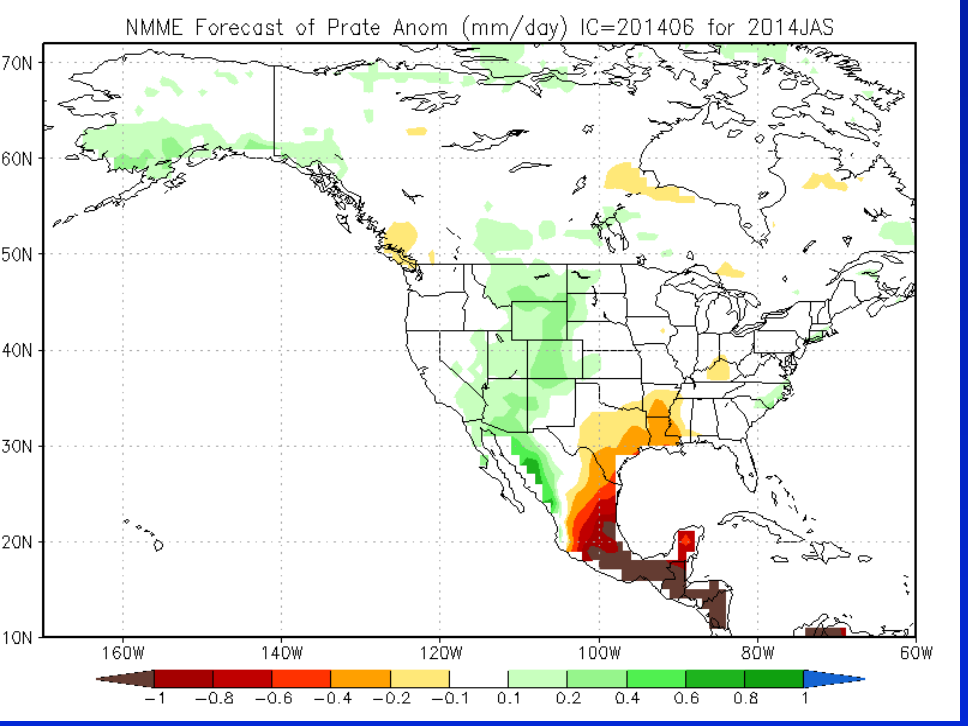
THREE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
0.5 MONTH LEAD
VALID JAS 2014
MADE 19 JUN 2014

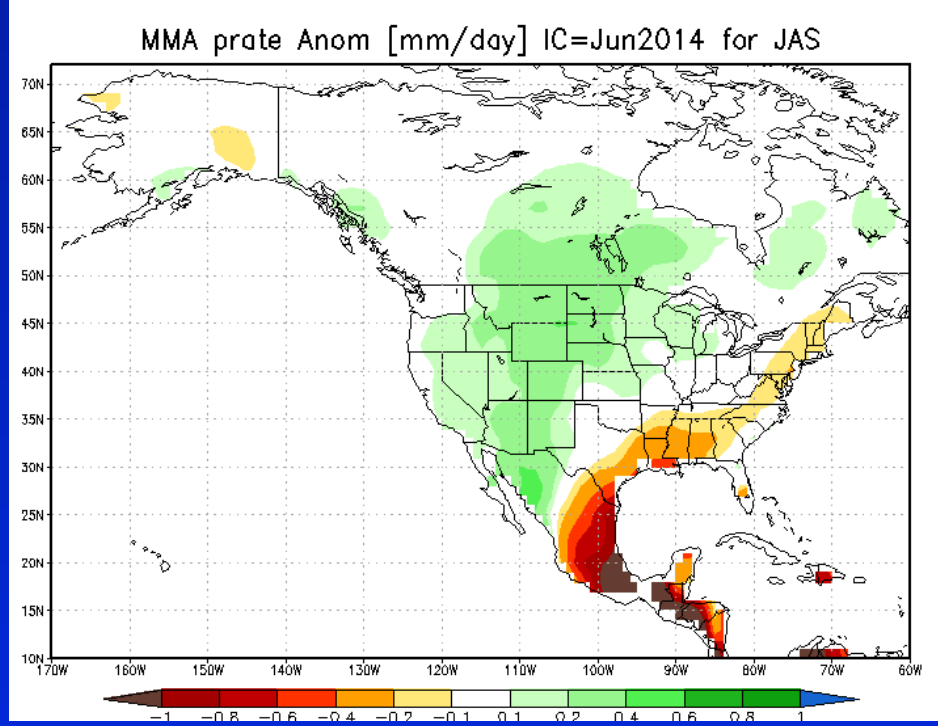
http://www.cpc.ncep.noaa.gov/products/predictions/90day/

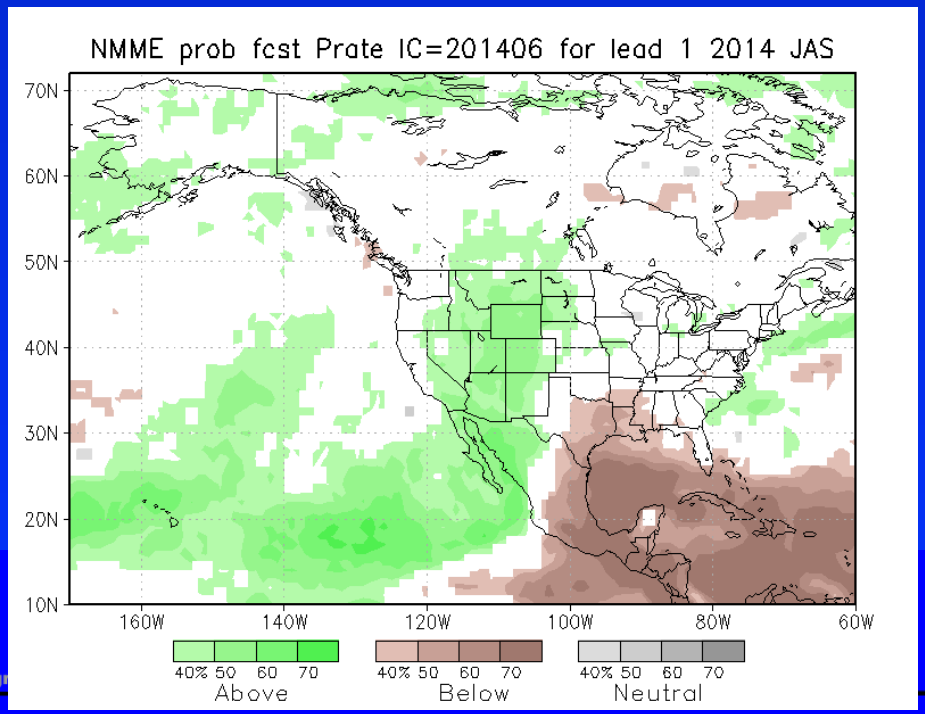


THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
0.5 MONTH LEAD
VALID JAS 2014
MADE 19 JUN 2014

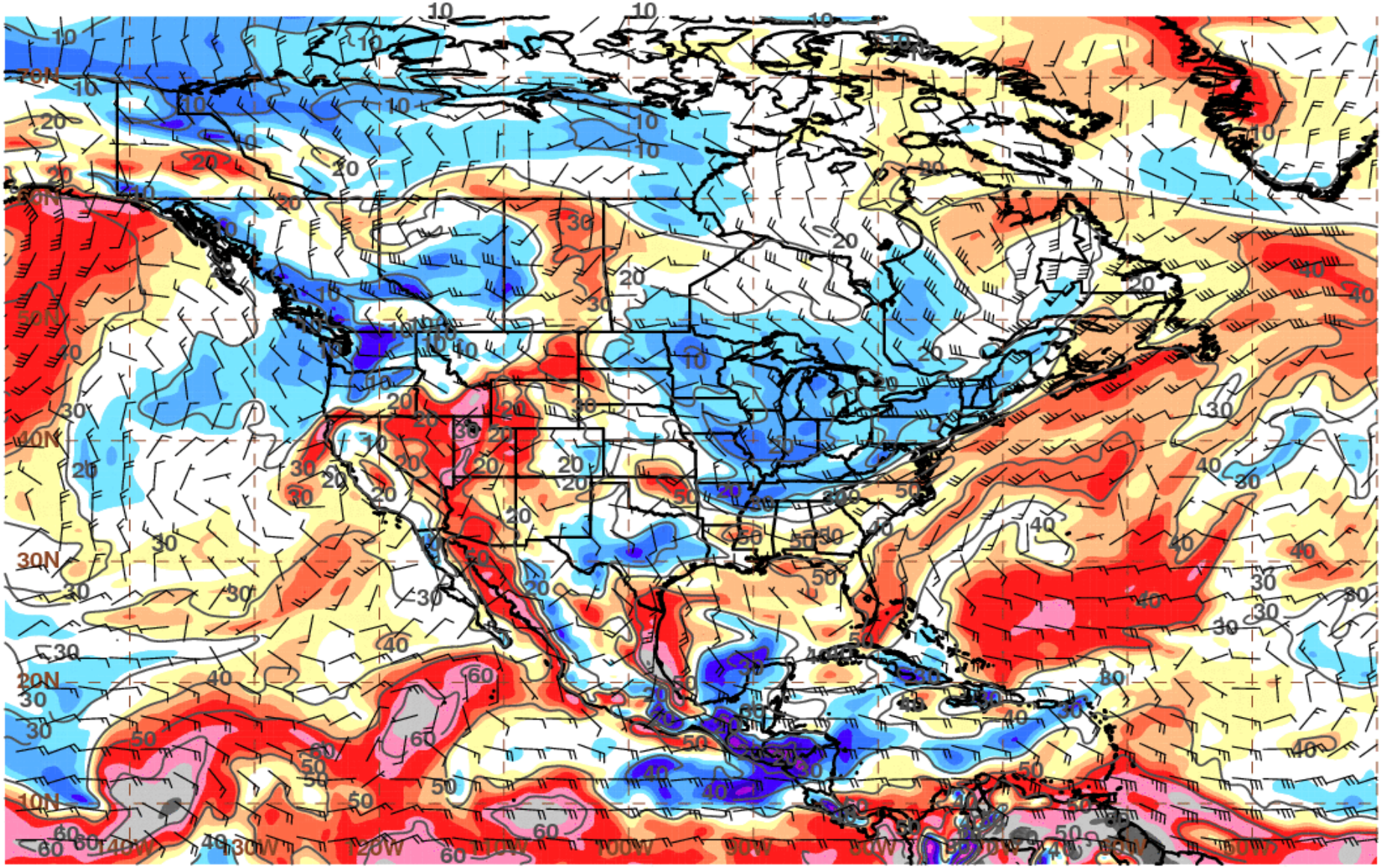
CSAP Climate Science Applications Program - Univ


NMME Forecast of Prate Anom (mm/day) IC=201406 for 2014JAS
70N
60N
50N
40N
30N
20N
10N
160W
140W
120W
100W
80W
60W
−1
−0.8
−0.6
−0.4
−0.2
−0.1
0.1
0.2
0.4
0.6
0.8
1


MMA prate Anom [mm/day] IC=Jun2014 for JAS
70N
65N
60N
55N
50N
45N
40N
35N
30N
25N
20N
15N
10N
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
70W
60W
−1
−0.8
−0.6
−0.4
−0.2
−0.1
0.1
0.2
0.4
0.6
0.8
1


NMME prob fcst Prate IC=201406 for lead 1 2014 JAS
70N
60N
50N
40N
30N
20N
10N
160W
140W
120W
100W
80W
60W
40% 50 60 70
Above
40% 50 60 70
Below
40% 50 60 70
Neutral

Snapshot current atmospheric moisture….



http://www.atmos.albany.edu/student/kgriffin/maps/pw_stdanom

El Niño, where are you!?!?

Monster El Nino May Be Brewing, Experts Say

BY JOHN ROACH

Stay informed. Sign up for breaking news alerts direct to your inbox.

Ready for a '90s El Niño flashback?

Researchers are keeping a close eye on a giant pool of abnormally warm water in the Pacific Ocean that some think could trigger another El Niño of epic proportions if it rises to the surface, sending weather patterns into a tizzy around the world.

future tense ASU | NEW AMERICA | SLATE

FUTURE TENSE | THE CITIZEN'S GUIDE TO THE FUTURE | APRIL 7 2014 11:23 AM

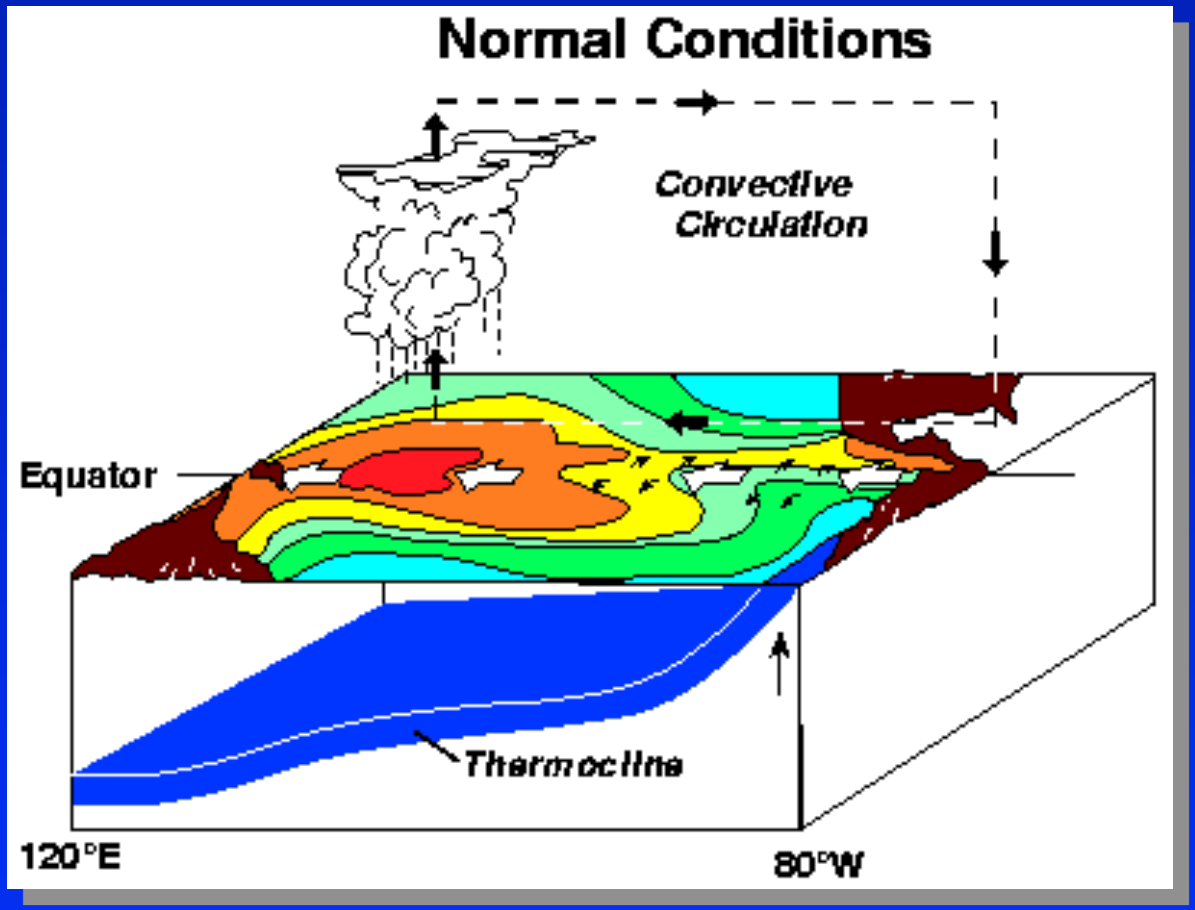
El Niño Could Grow Into a Monster, New Data Show

By Eric Holthaus

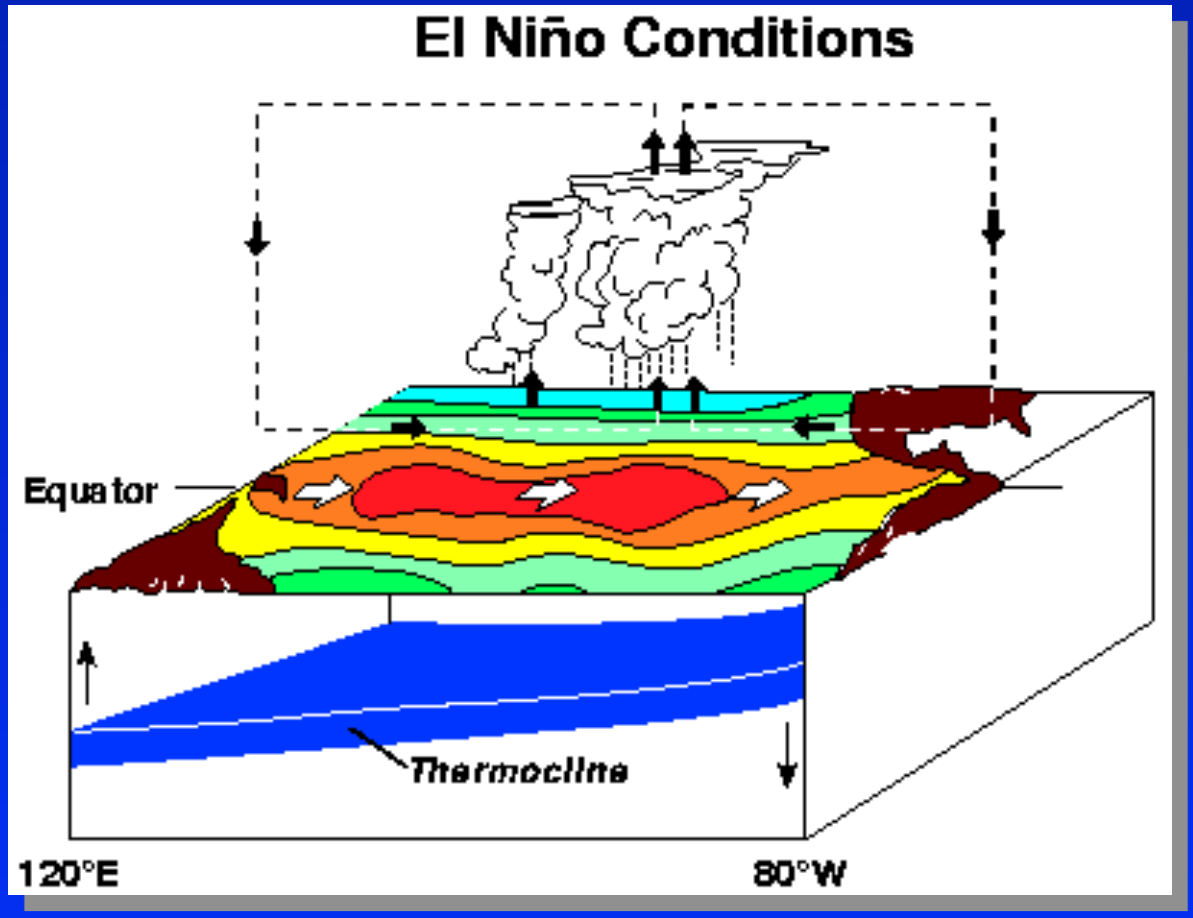
3.6k 1.3k 214

The odds are increasing that an El Niño is in the works for 2014—and **recent forecasts** show it might be a big one.

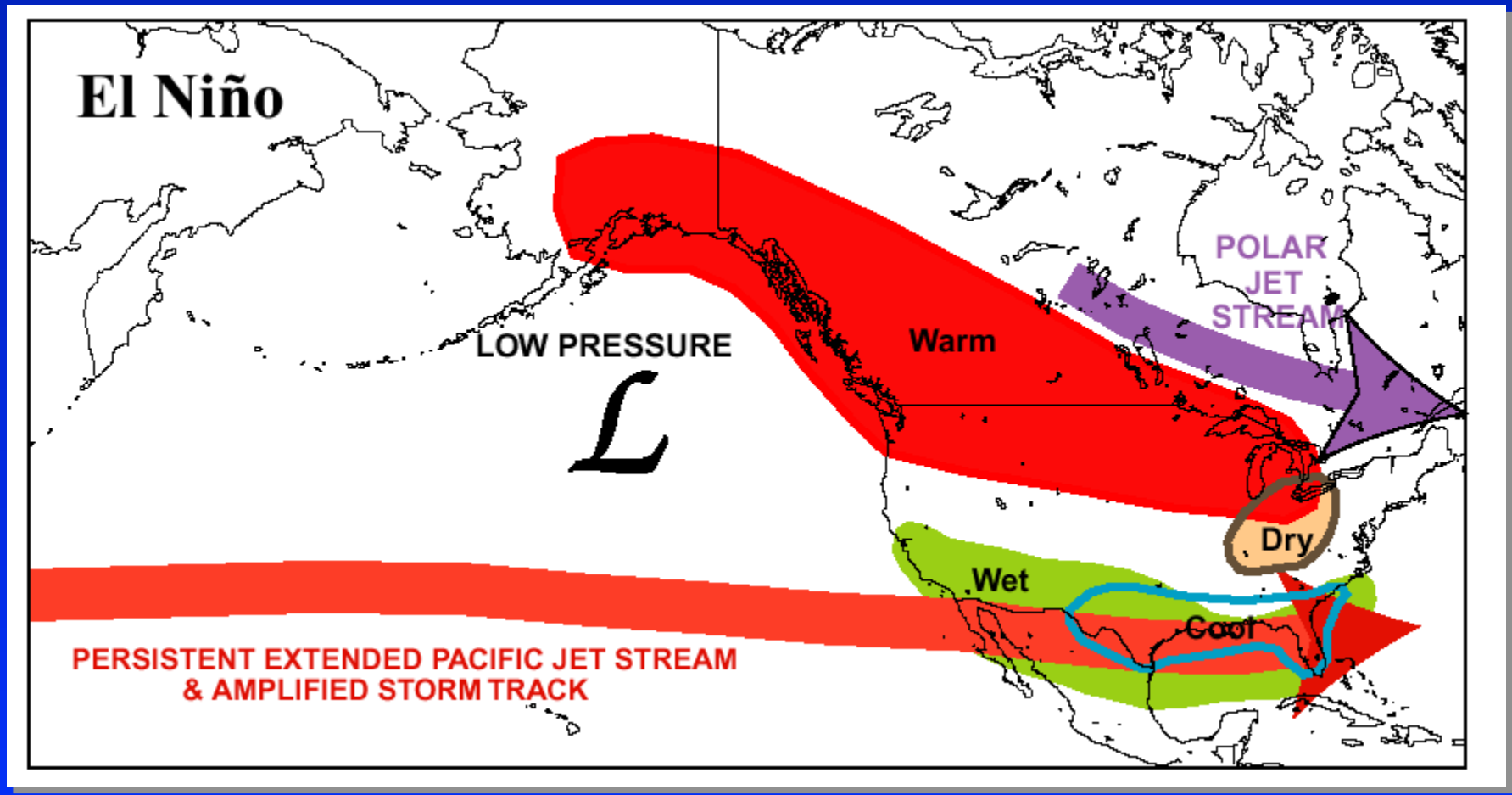
Atmosphere-Ocean Coupling



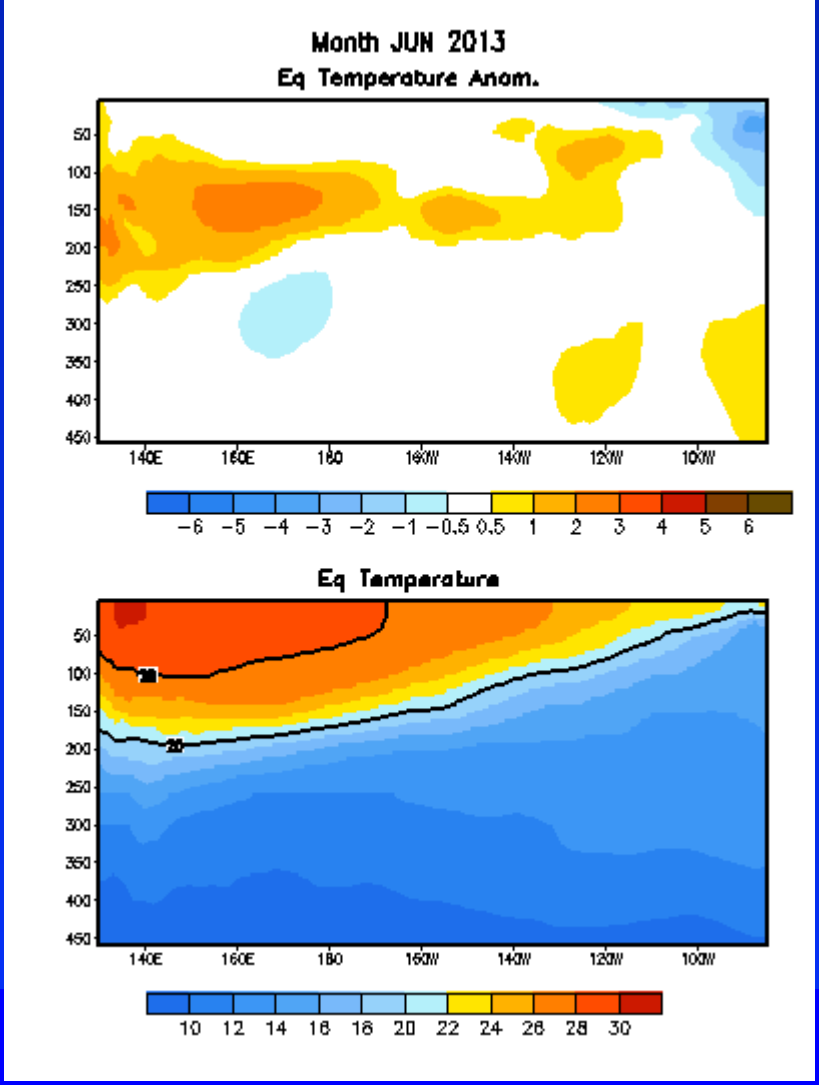
Atmosphere-Ocean Coupling

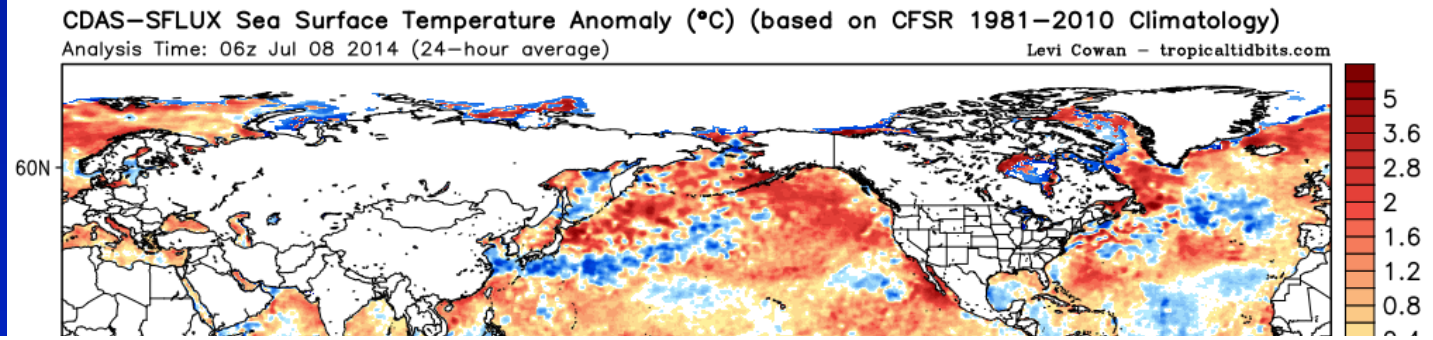


Dominant Circulation Pattern: El Niño Winter

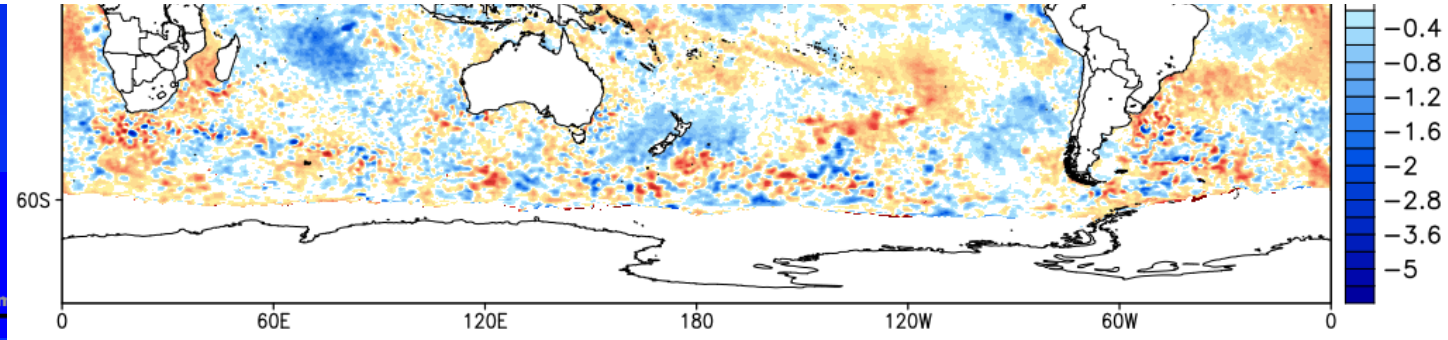


Subsurface water temperatures along equator…



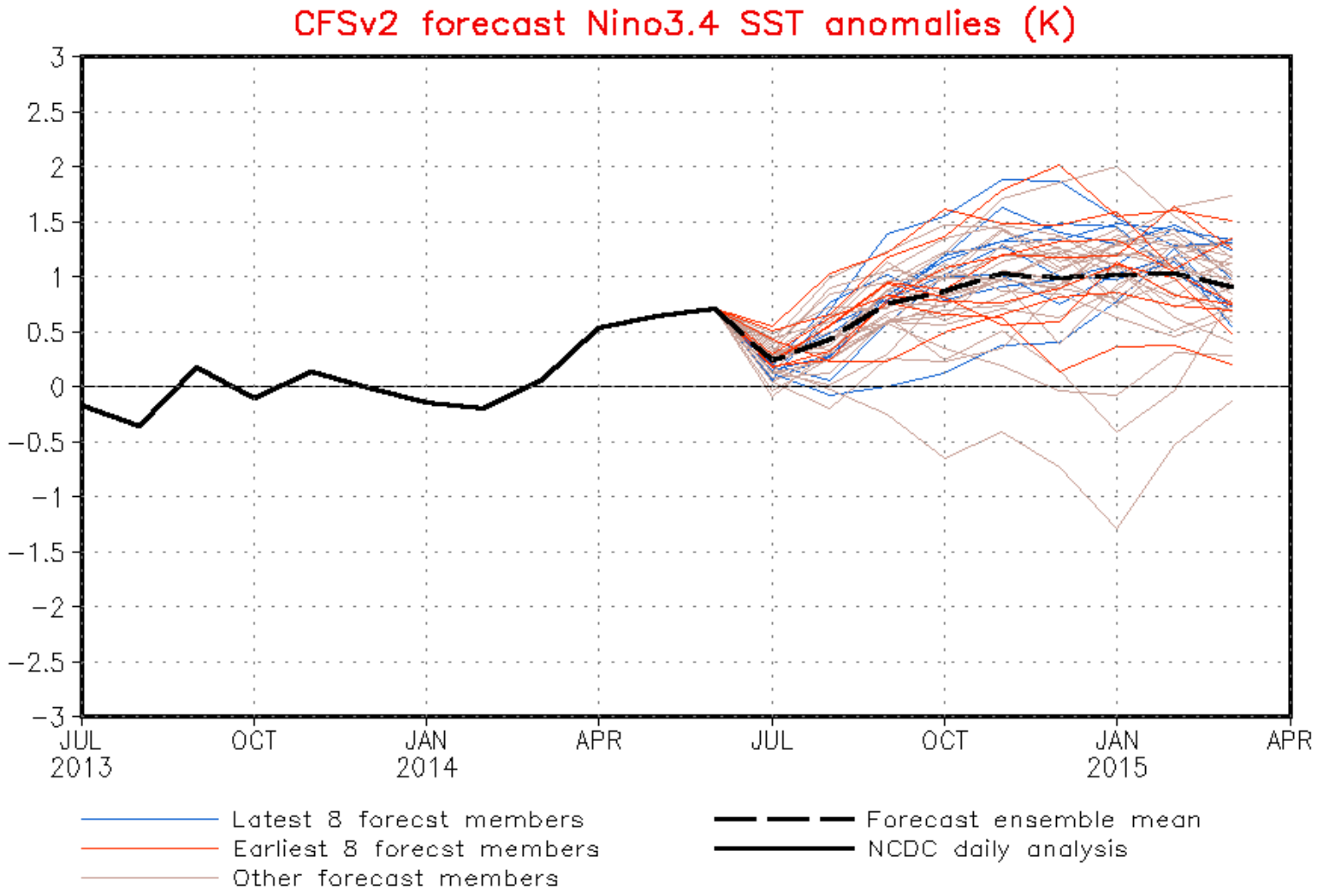

CDAS–SFLUX Sea Surface Temperature Anomaly (°C) (based on CFSR 1981–2010 Climatology)
Analysis Time: 06z Jul 08 2014 (24–hour average)
Levi Cowan – tropicaltidbits.com
60N
5
3.6
2.8
2
1.6
1.2
0.8


CDAS Niño 3.4 Index
SST Anomaly (°C) (1981-2010 climatology)
+2.0
+1.5
+1.0
+0.5
0.0
-0.5
-1.0
-1.5
-2.0
Apr 15
Apr 29
May 13
May 27
Jun 10
Jun 24
Jul 08
Latest Value: +0.169
06z Jul 08
Levi Cowan - tropicaltidbits.com


60S
0
60E
120E
180
120W
60W
0
−0.4
−0.8
−1.2
−1.6
−2
−2.8
−3.6
−5

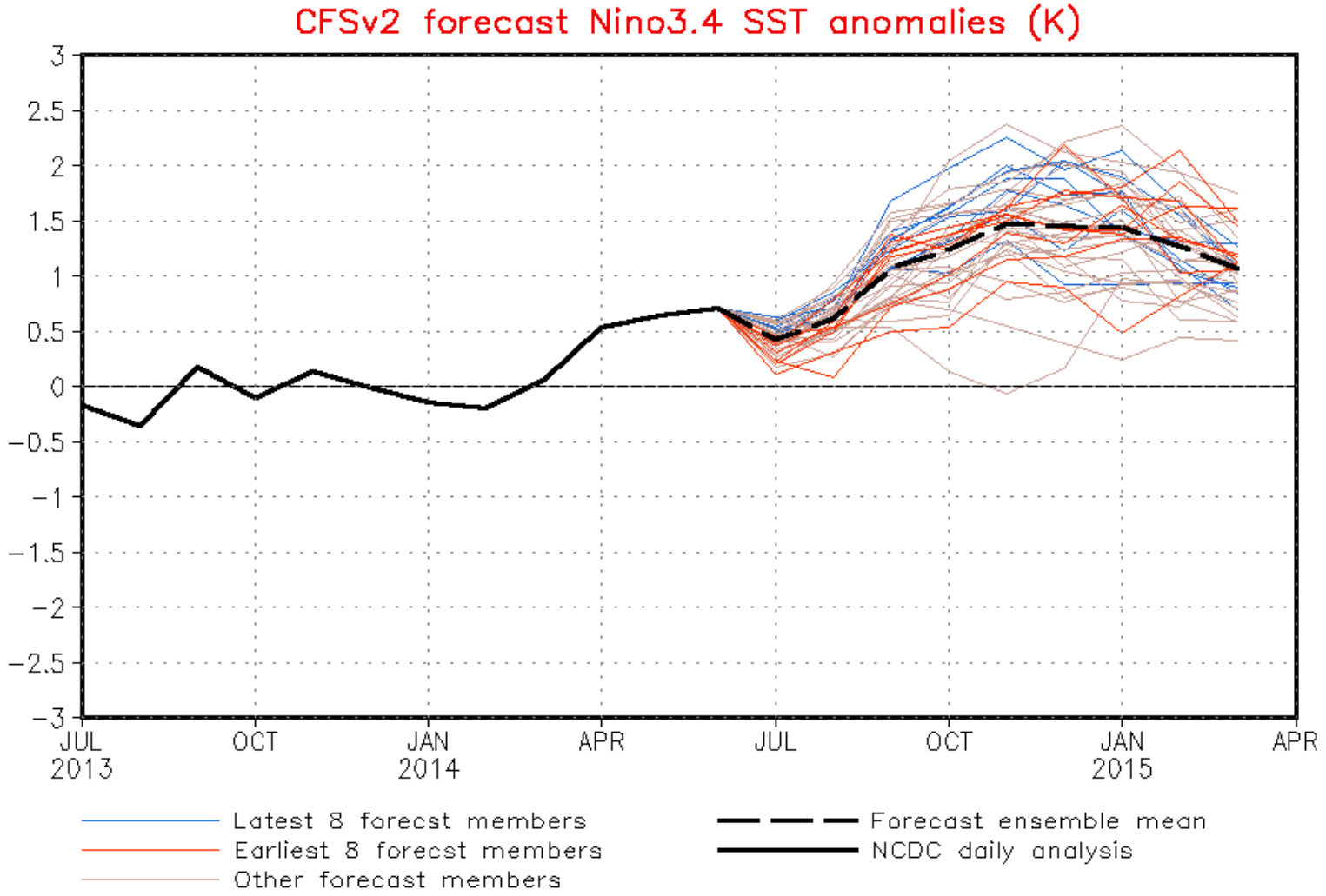
NWS/NCEP/CPC

Last update: Tue Jul 8 2014
Initial conditions: 7Jun2014–16Jun2014



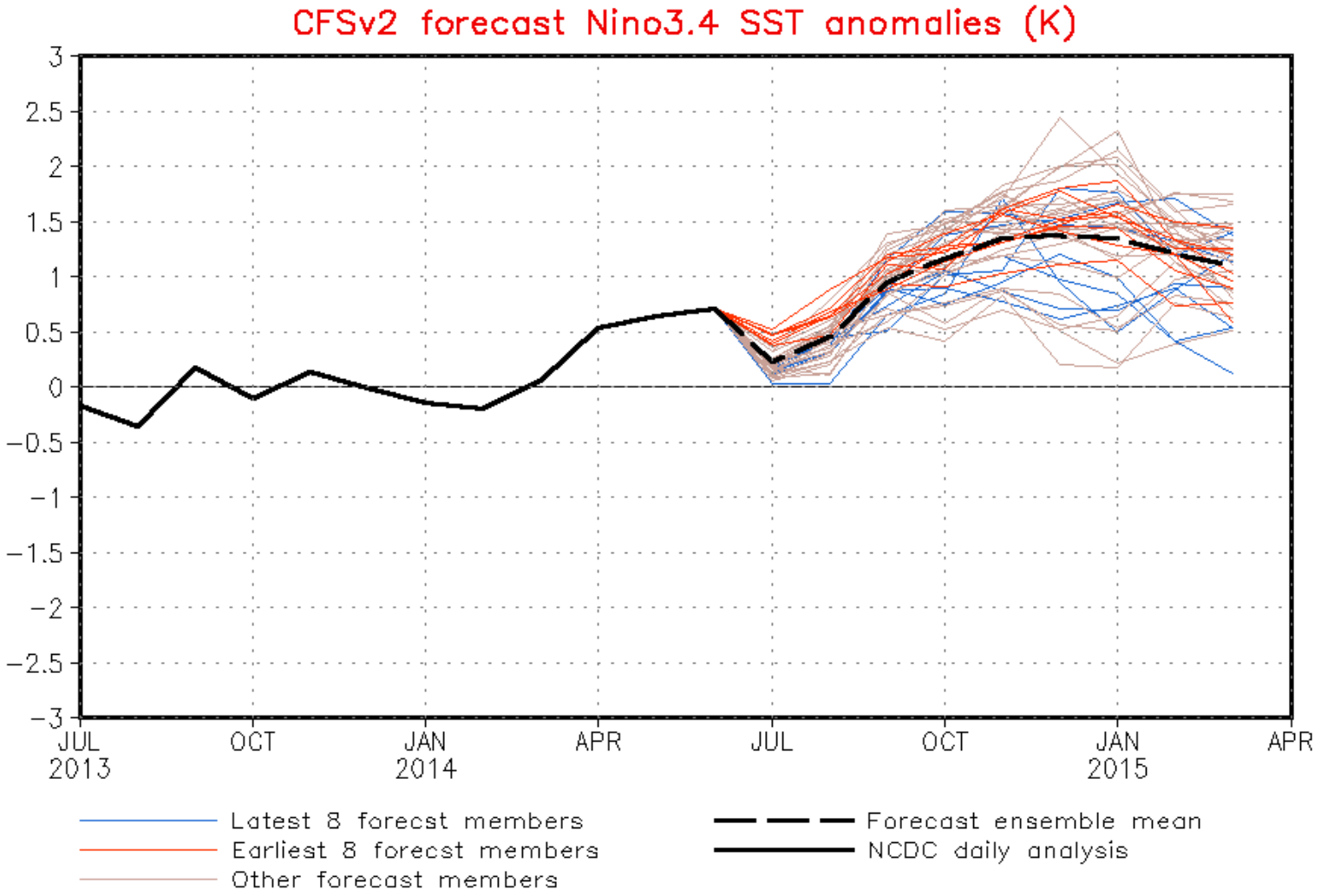
NWS/NCEP/CPC

Last update: Tue Jul 8 2014
Initial conditions: 17Jun2014–26Jun2014

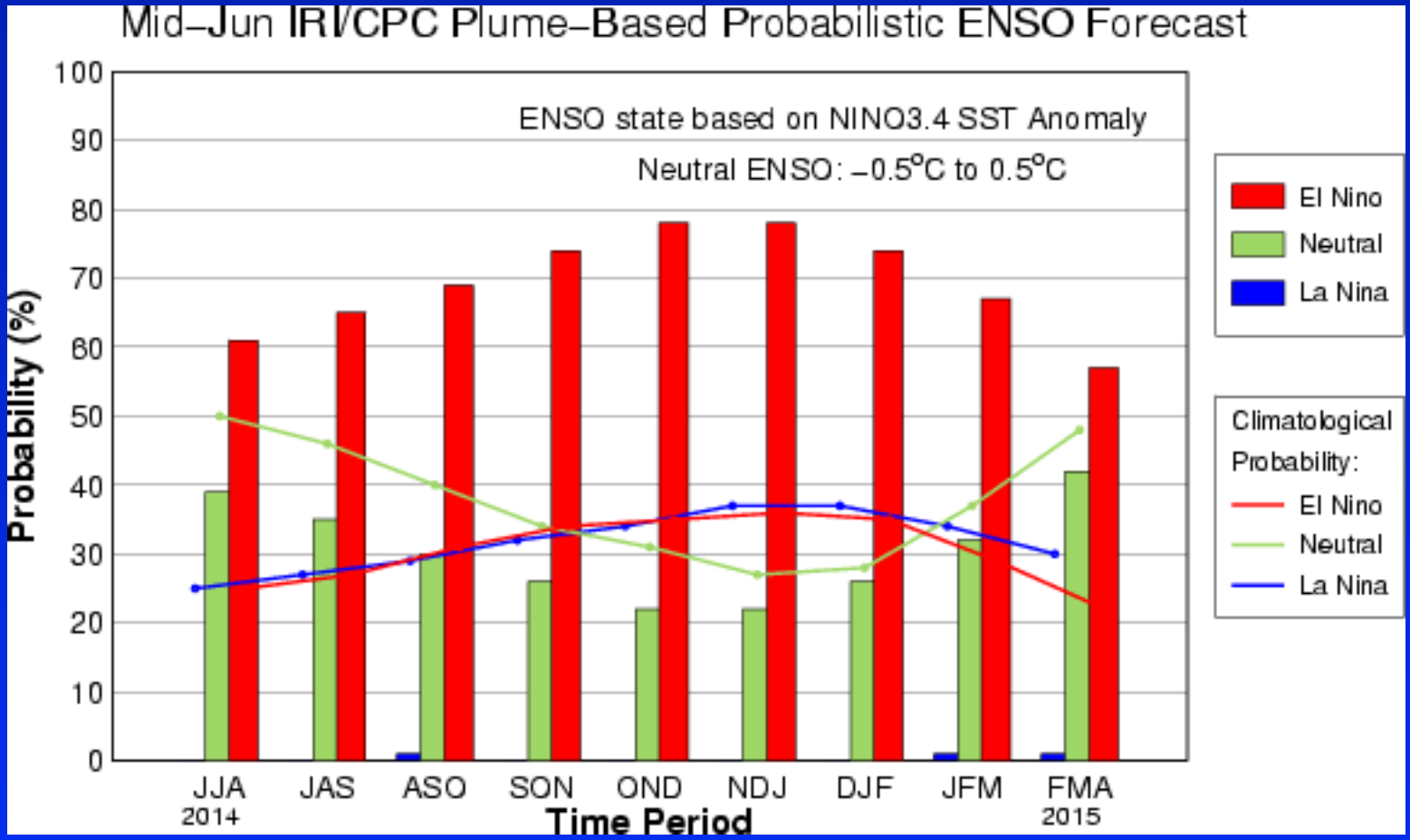


NWS/NCEP/CPC

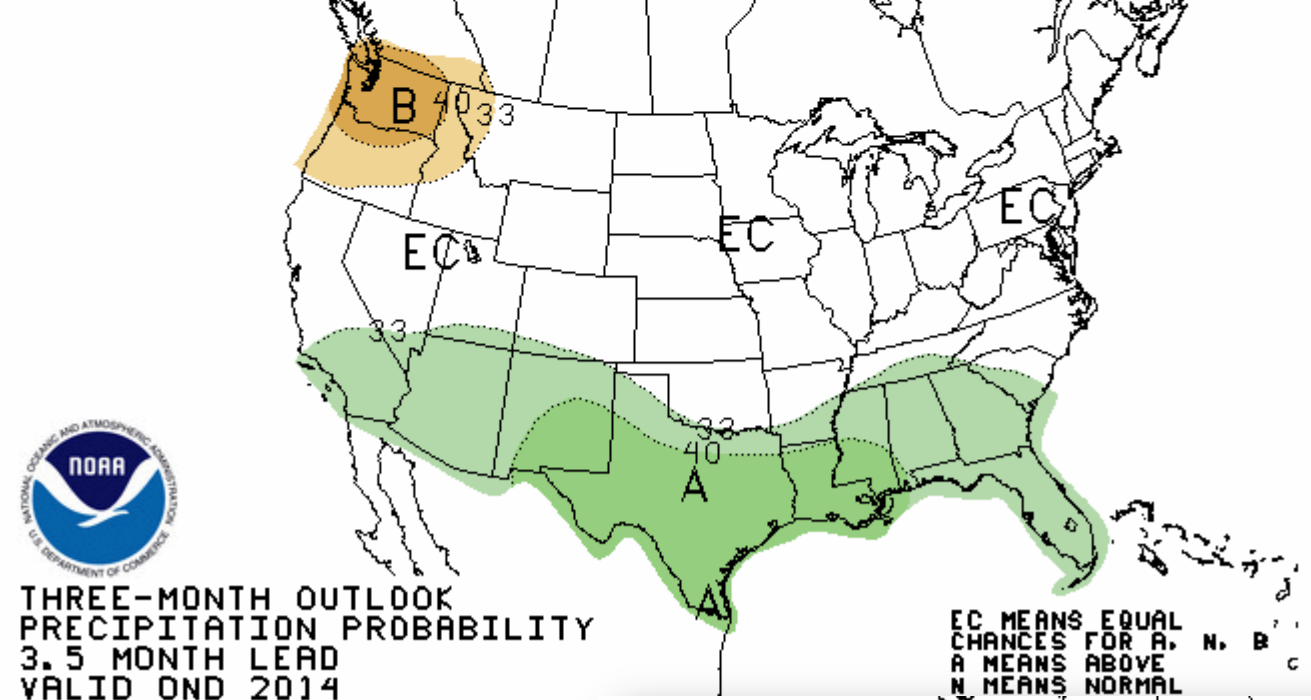
Last update: Tue Jul 8 2014
Initial conditions: 27Jun2014–6Jul2014



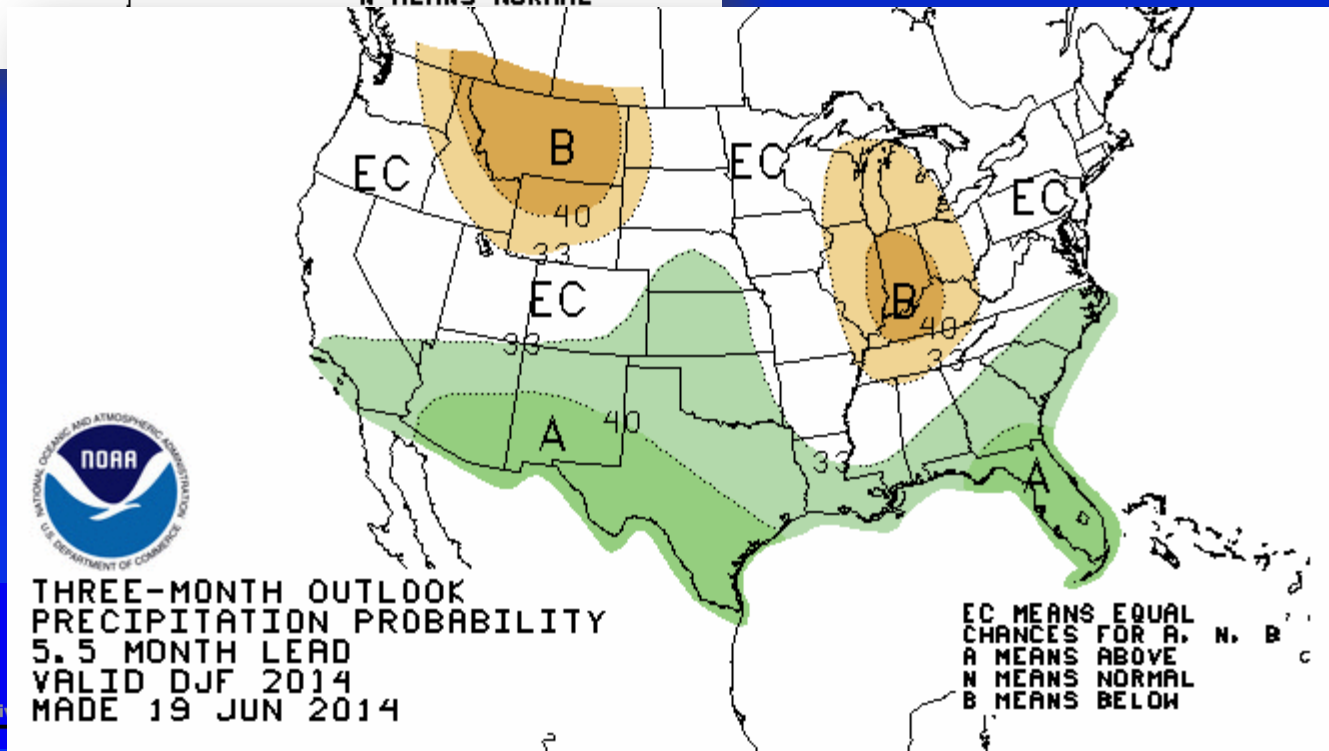
ENSO Forecast



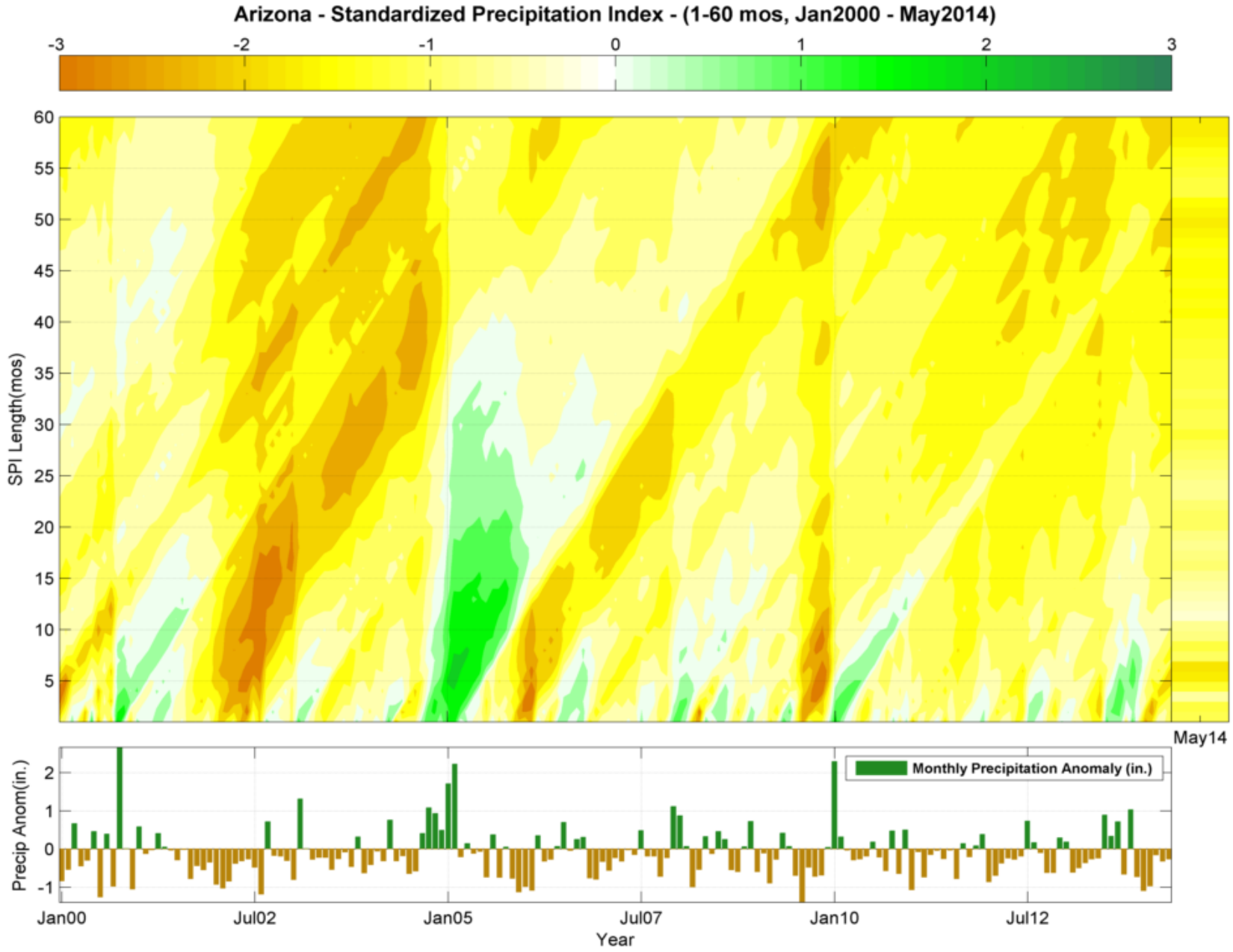
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/



Oct-Nov-Dec



Dec-Jan-Feb



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: 04-Jul-2014

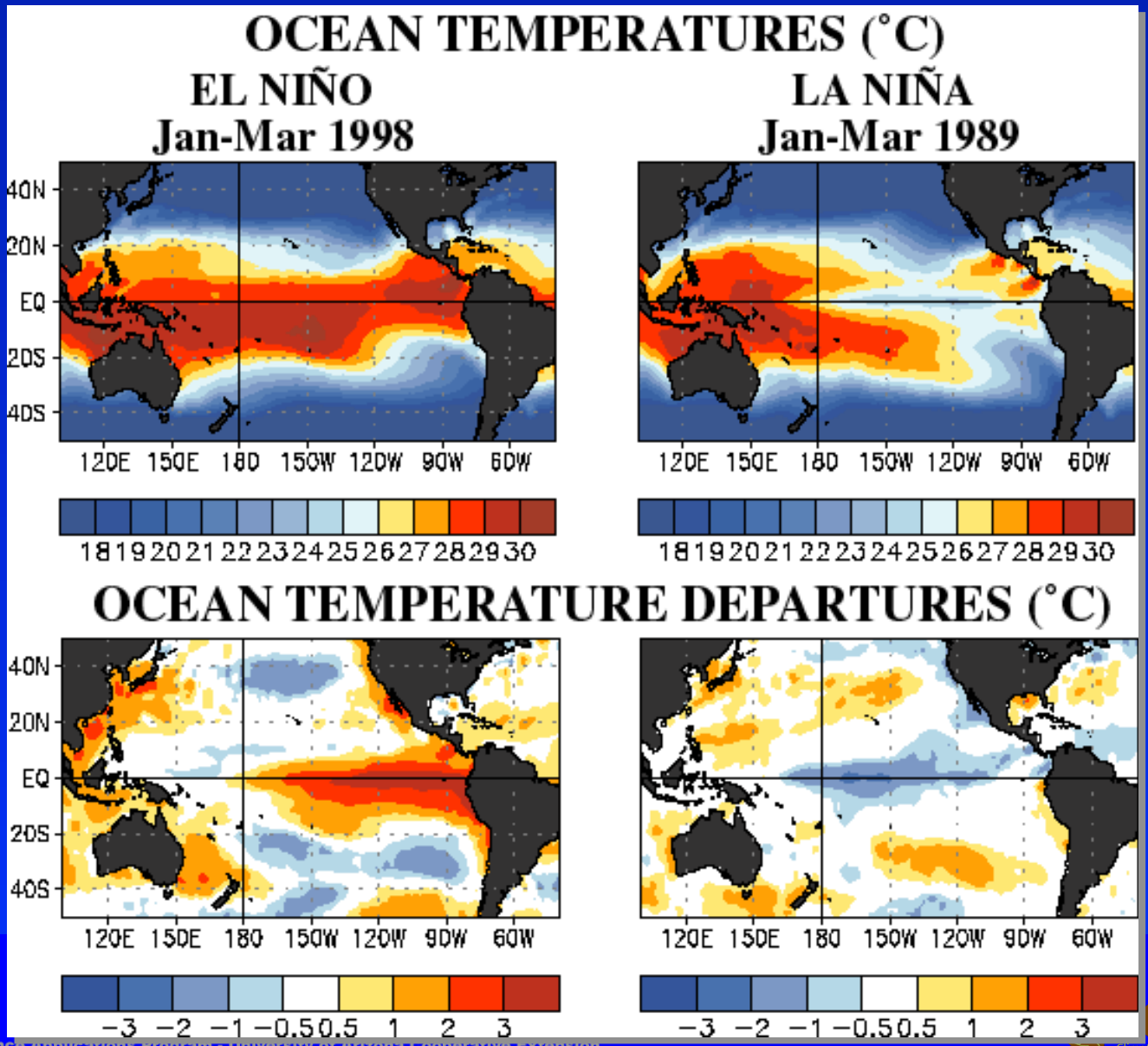
Thanks!

crimmins@u.arizona.edu

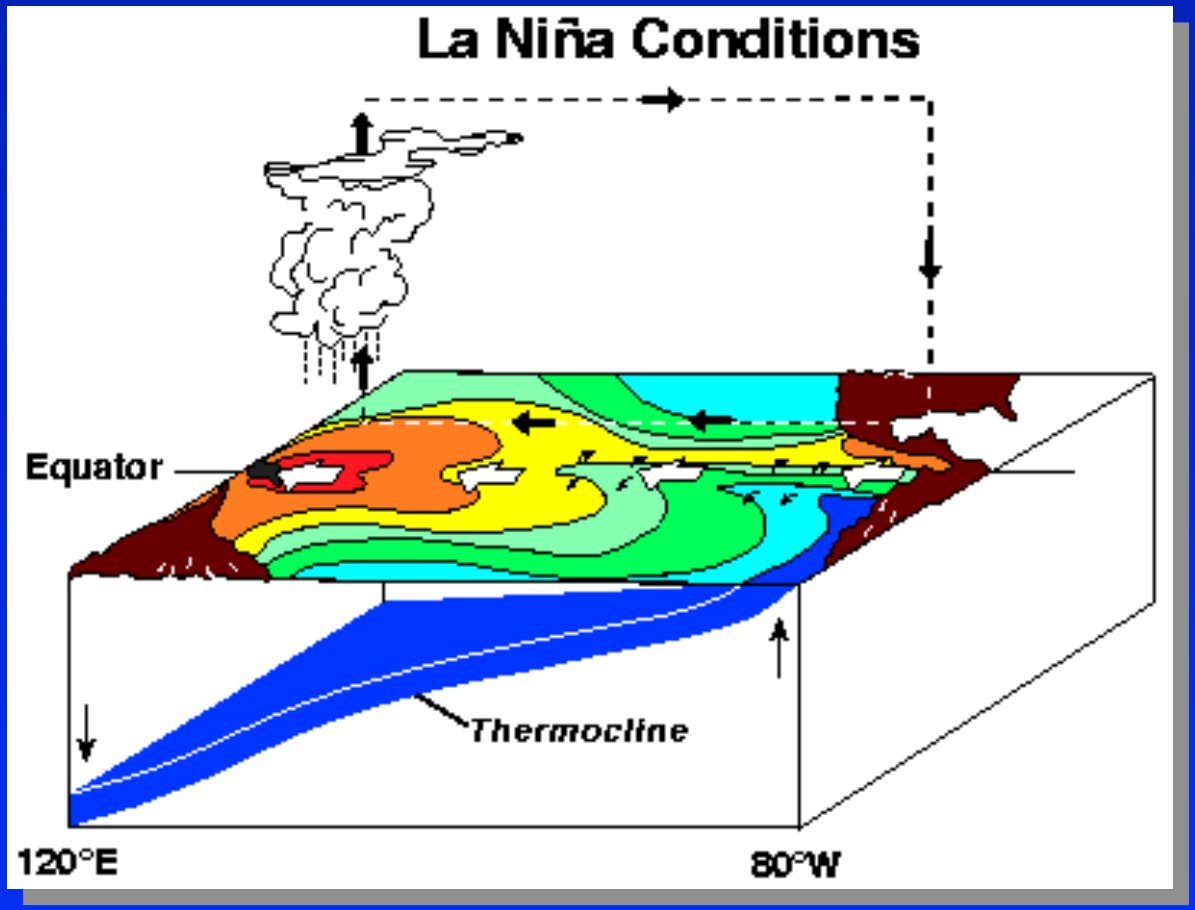
http://cals.arizona.edu/climate

Interannual Climate Variability

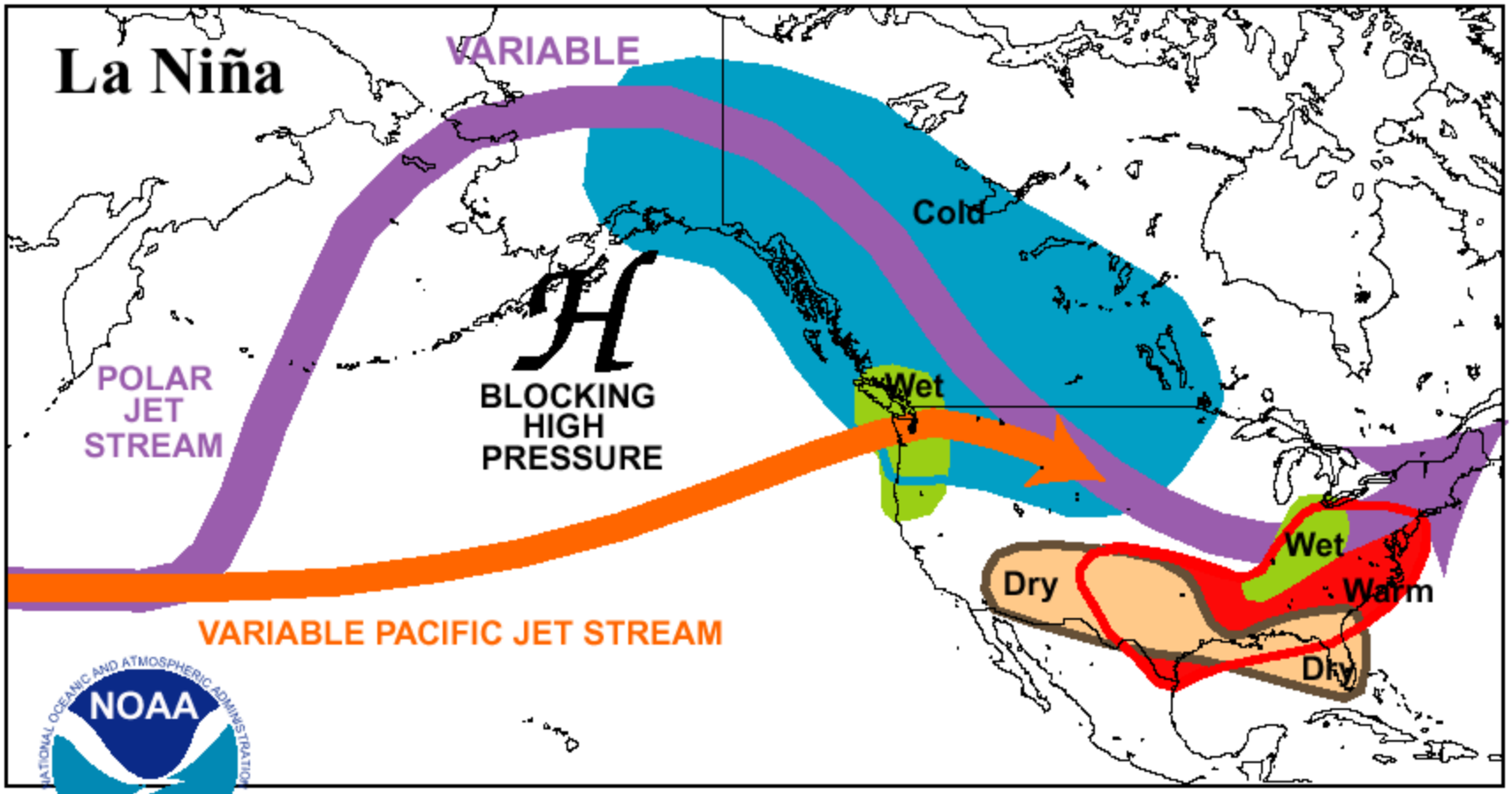
What are El Niño and La Niña?



Atmosphere-Ocean Coupling

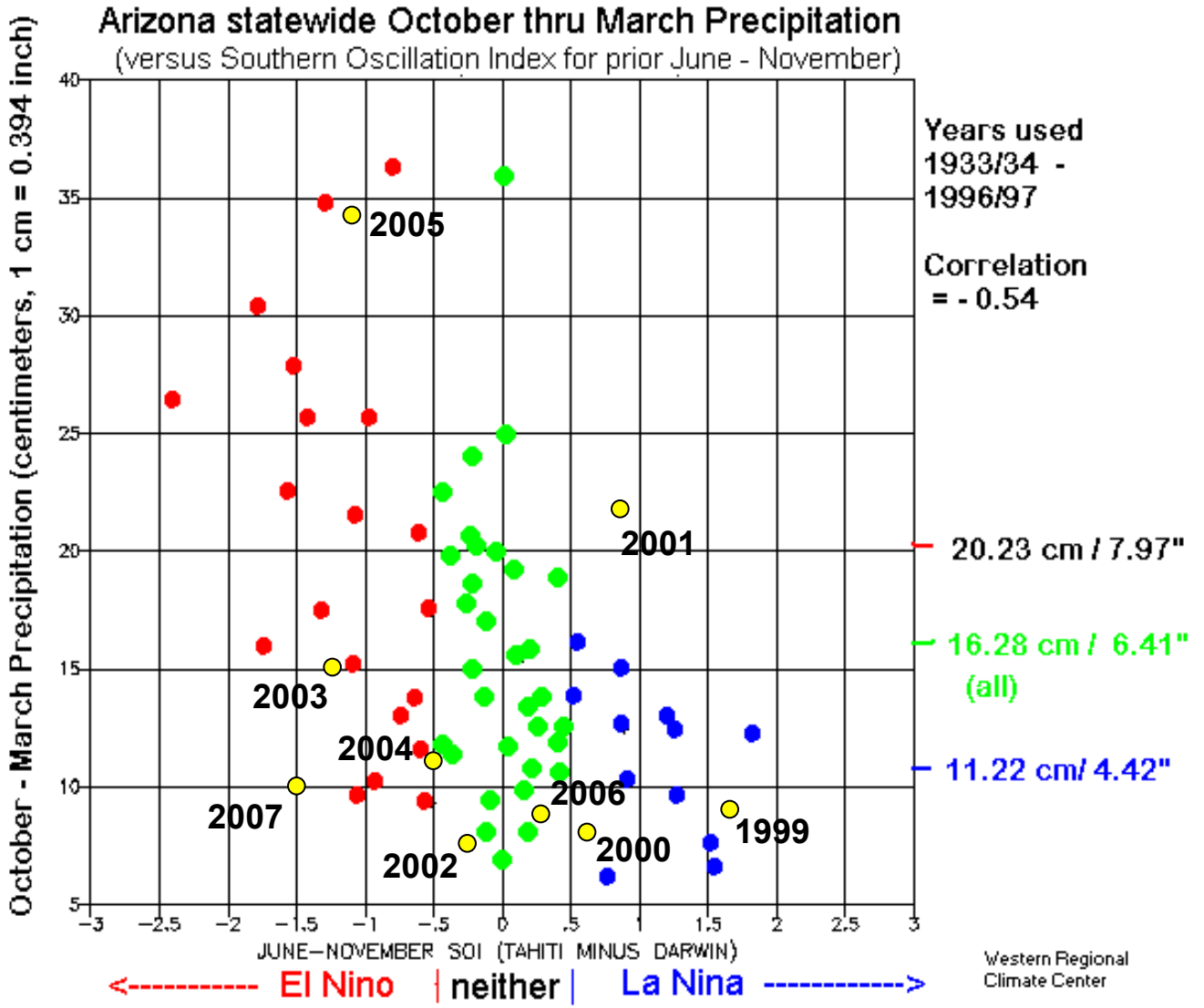


Dominant Circulation Pattern: La Niña Winter

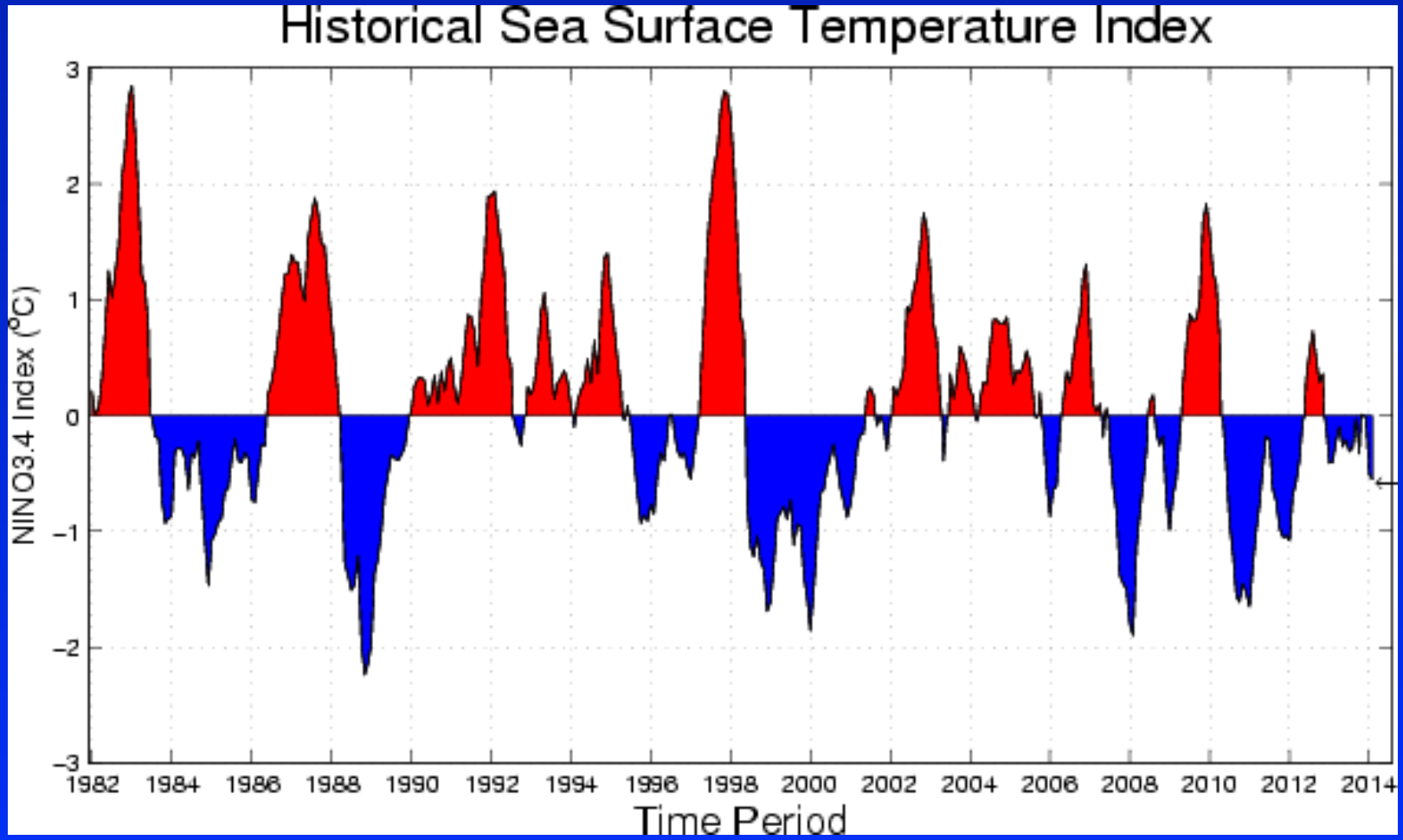


Climate Prediction Center/NCEP/NWS

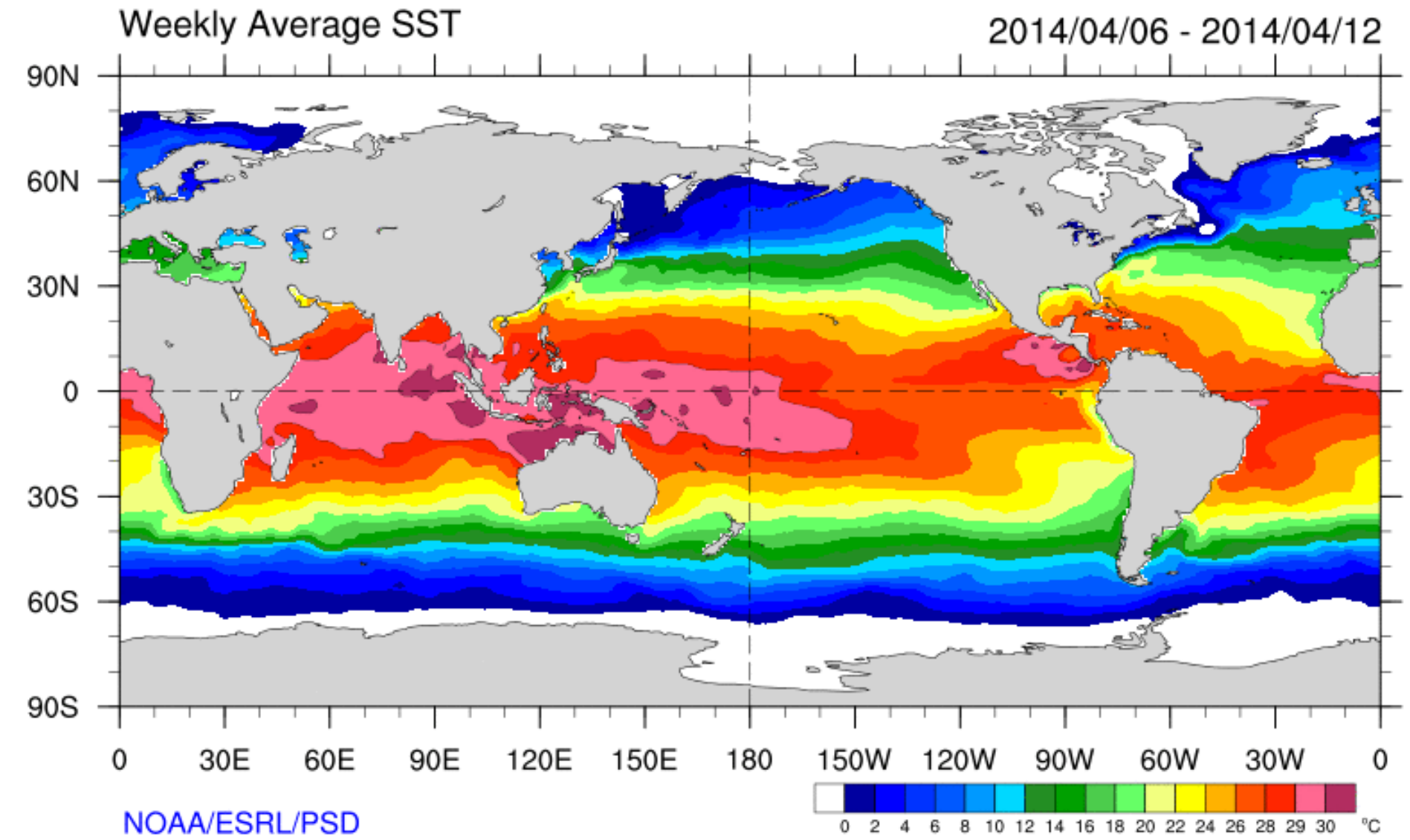
Arizona ENSO Connection

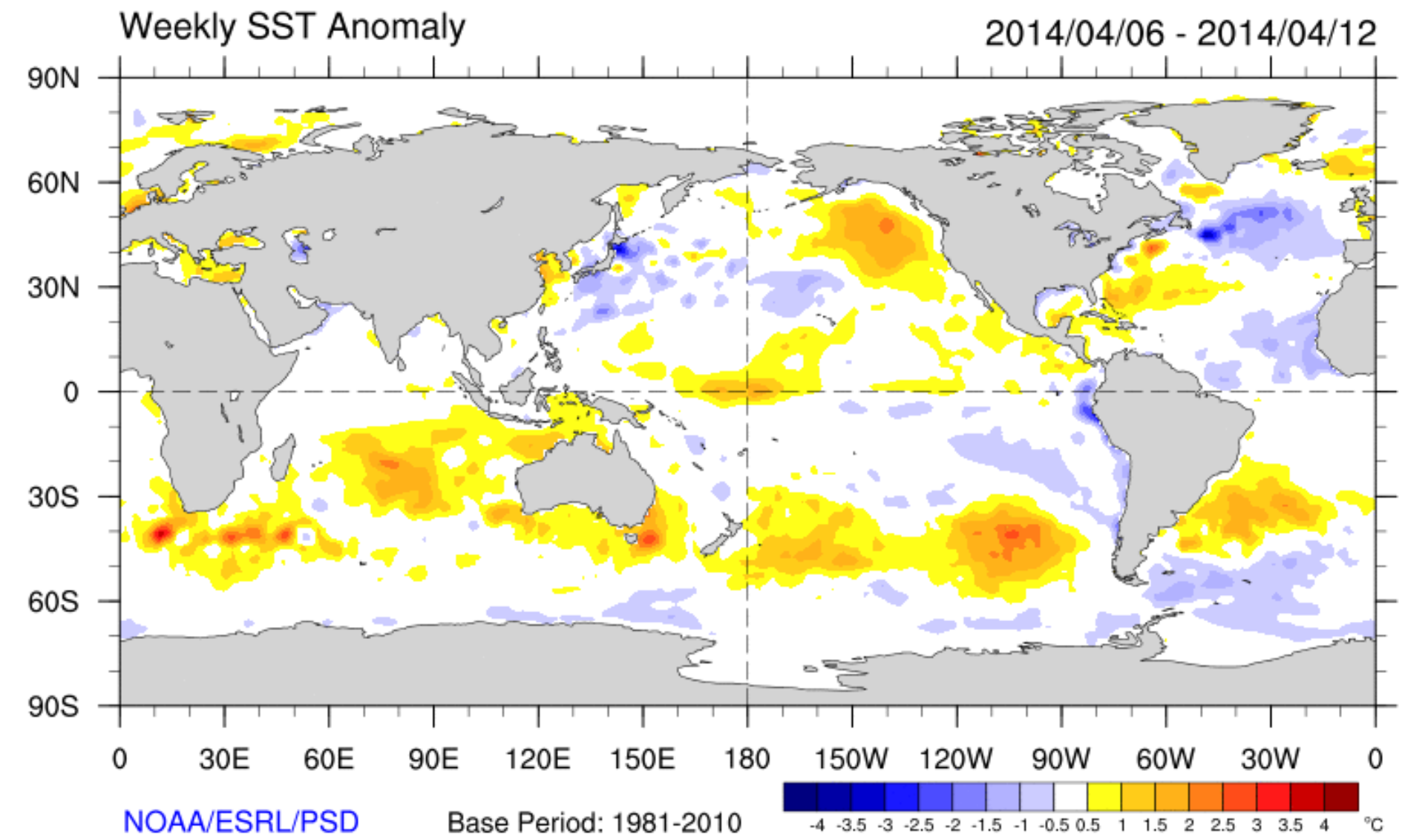


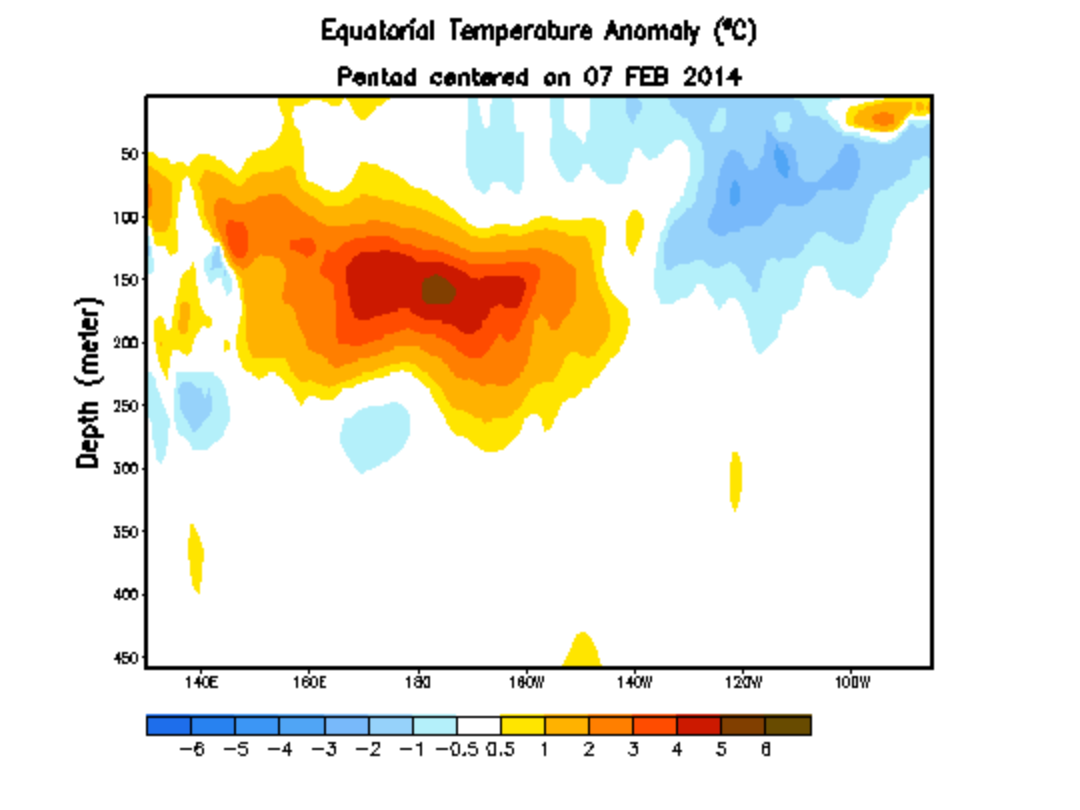
ENSO: 1982-2014

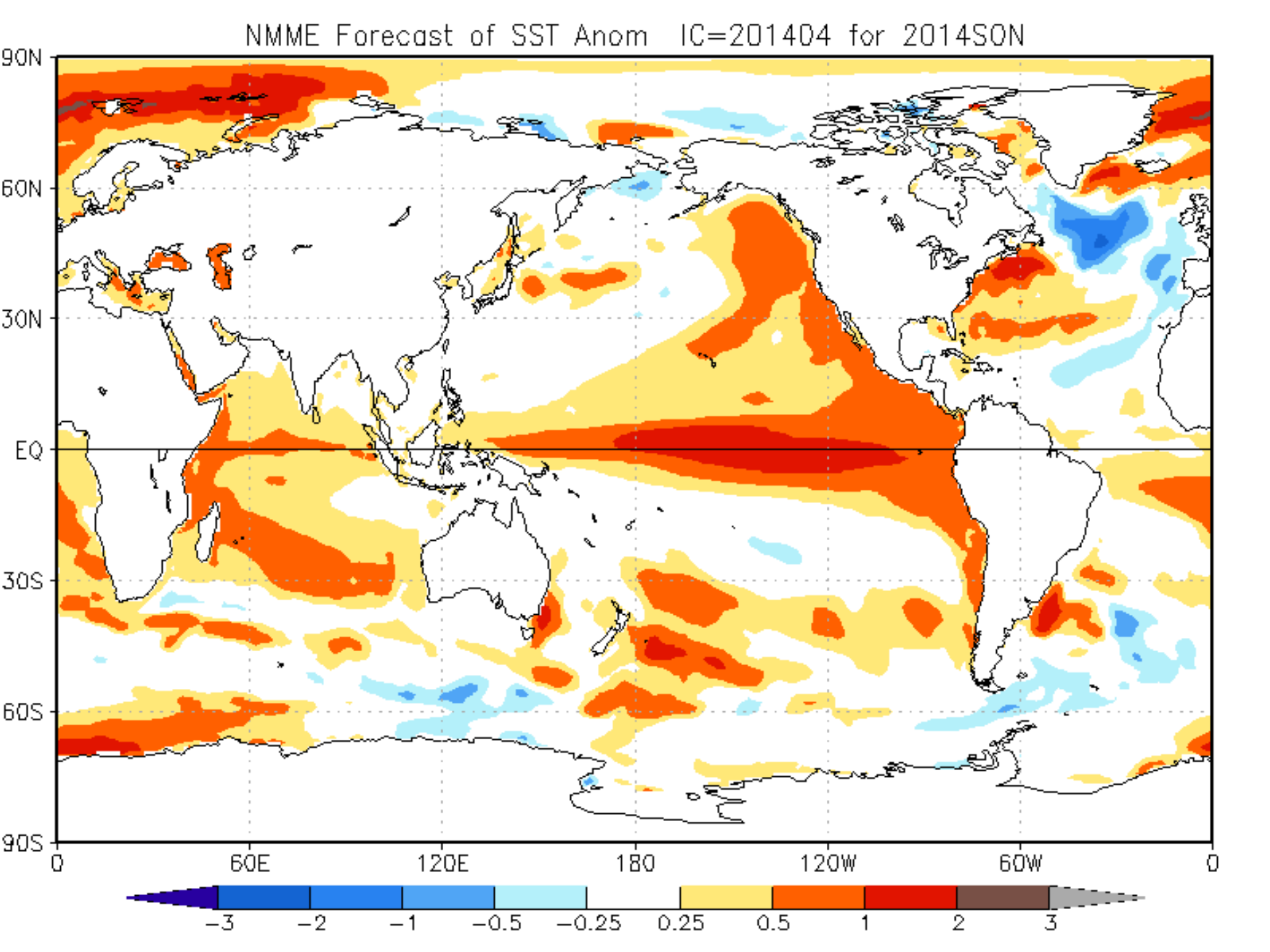


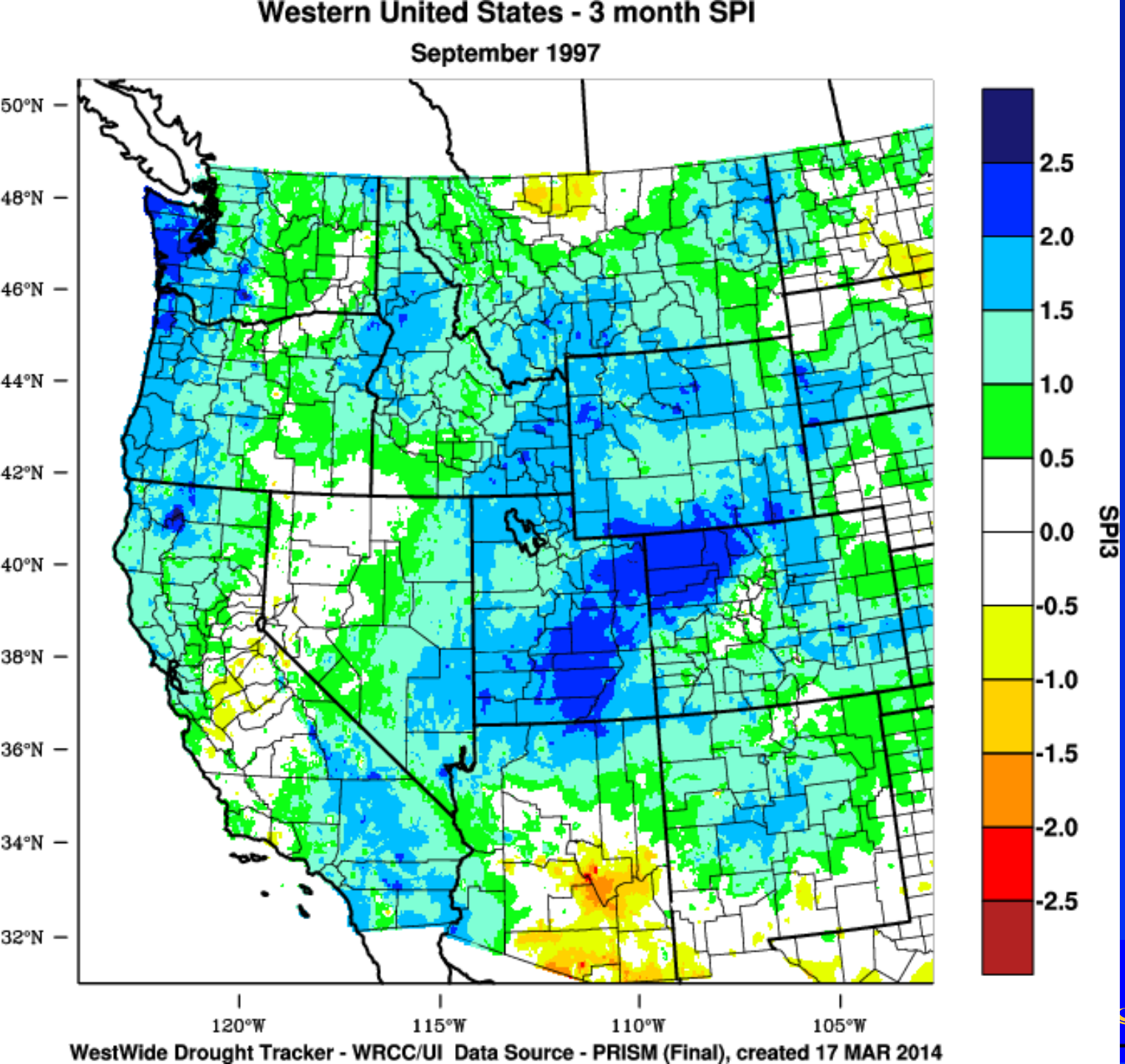
http://iri.columbia.edu/climate/ENSO


Weekly Average SST
2014/04/06 - 2014/04/12
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
NOAA/ESRL/PSD
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 29 30 °C


Weekly SST Anomaly
2014/04/06 - 2014/04/12
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
NOAA/ESRL/PSD
Base Period: 1981-2010
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0.5 1 1.5 2 2.5 3 3.5 4
°C

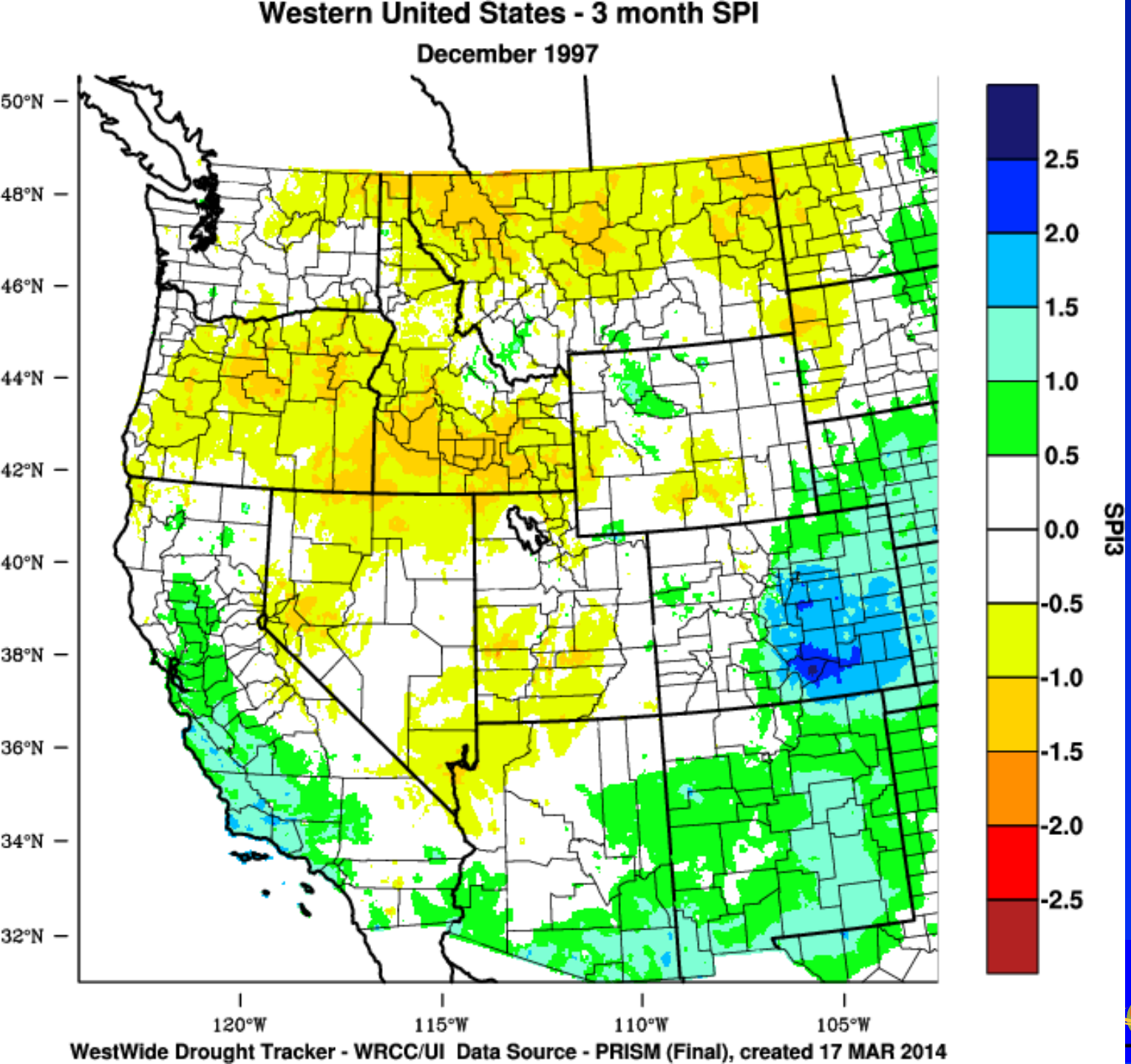

Equatorial Temperature Anomaly (°C)
Pentad centered on 07 FEB 2014
Depth (meter)
50
100
150
200
250
300
350
400
450
140E
160E
180
160W
140W
120W
100W
−6 −5 −4 −3 −2 −1 −0.5 0.5 1 2 3 4 5 6


NMME Forecast of SST Anom IC=201404 for 2014SON
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−3
−2
−1
−0.5
−0.25
0.25
0.5
1
2
3



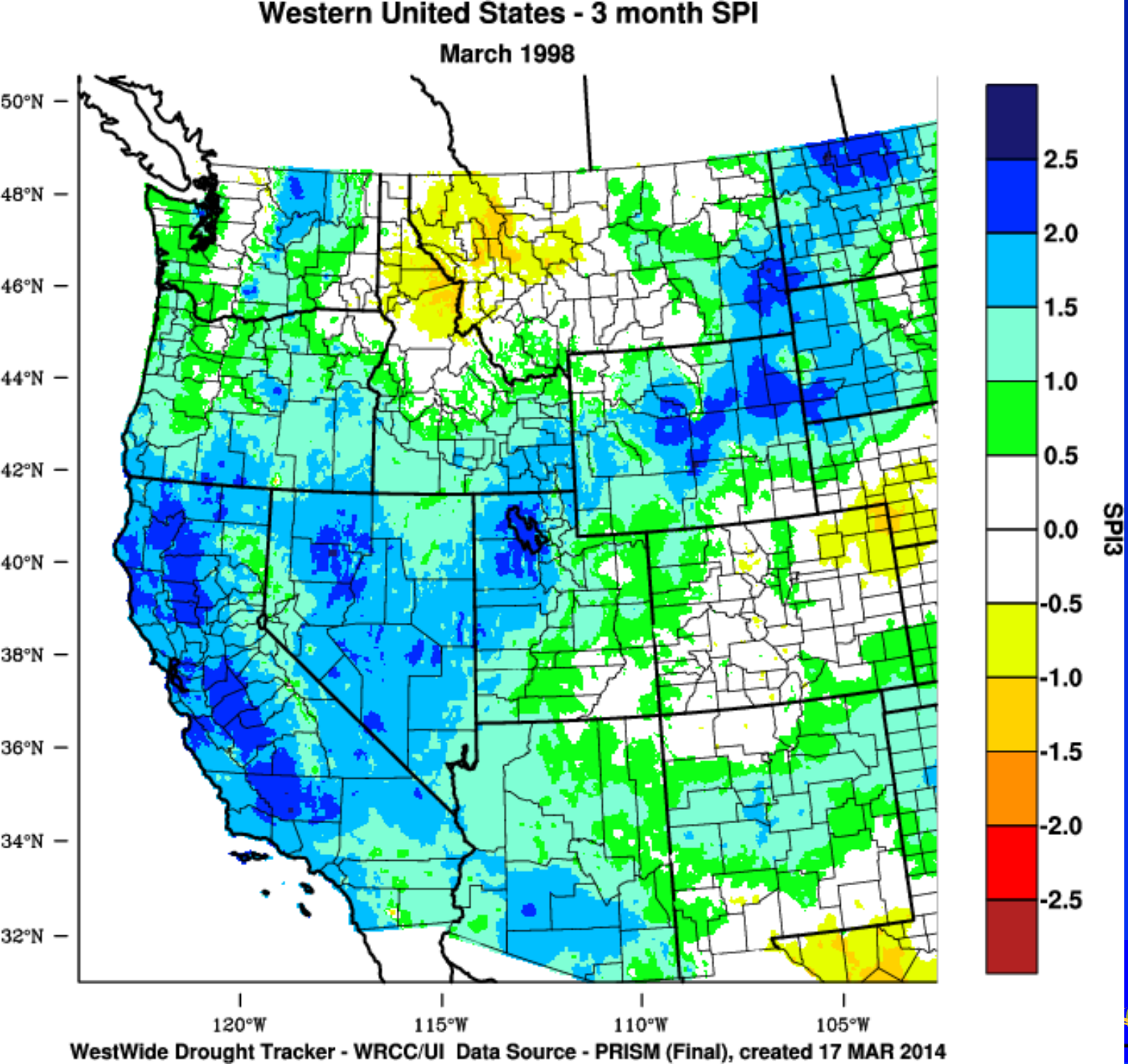
July-Aug-Sep 1997

CLIMAS
Climate Assessment for the Southwest



Oct-Nov-Dec 1997

CLIMAS
Climate Assessment for the Southwest



Jan-Feb-Mar 1998

CLIMAS
Climate Assessment for the Southwest

Closing Points

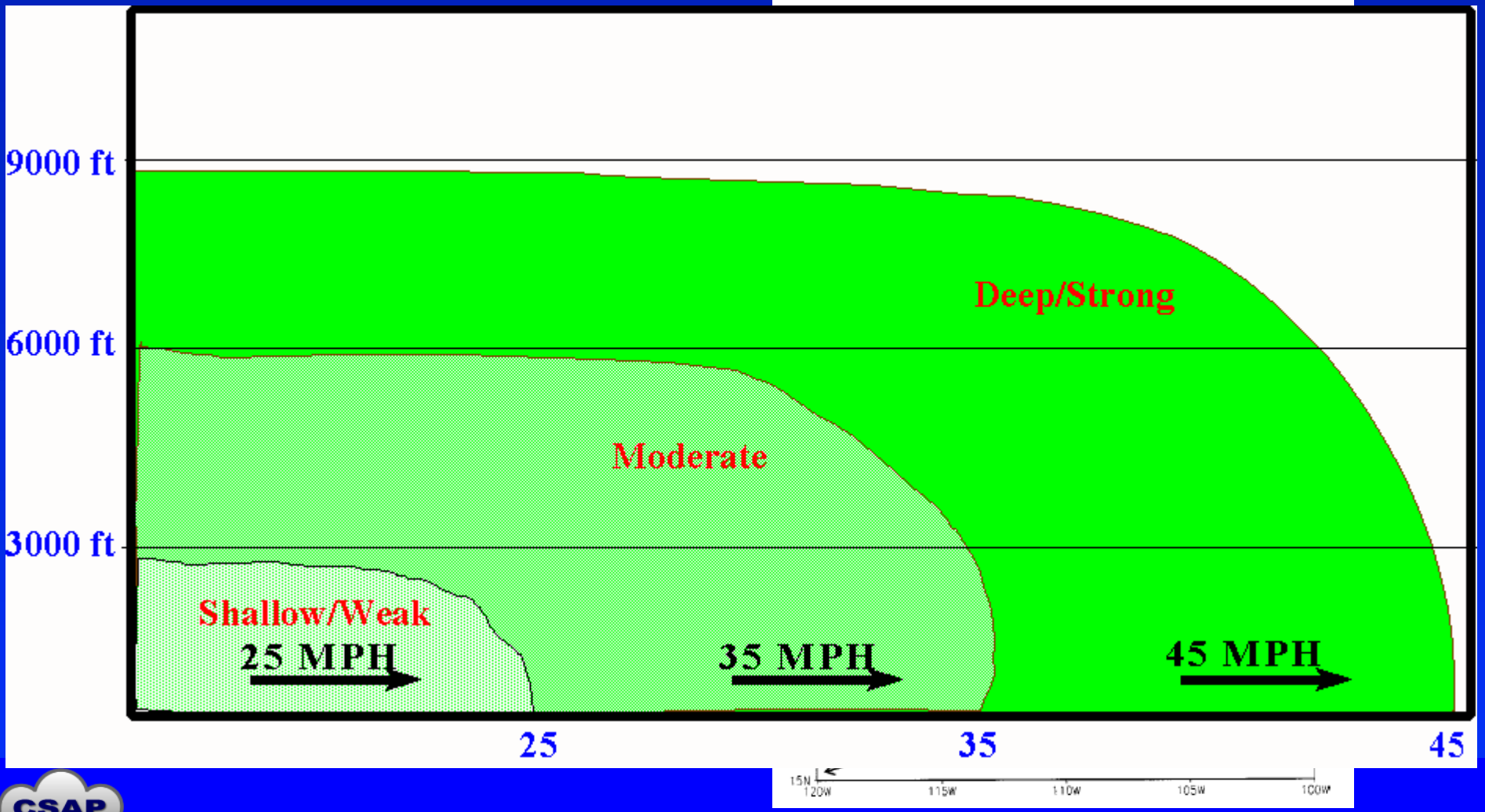
- Elevation, latitude, and ocean sea-surface temperatures create a complex Arizona climate
- Different mechanisms create summer versus winter precipitation
- Lots of opportunity for variability (spatially and temporally)
- Climate change is real and a reason for concern in Arizona

Conceptual diagram of key circulation features of the North American Monsoon System

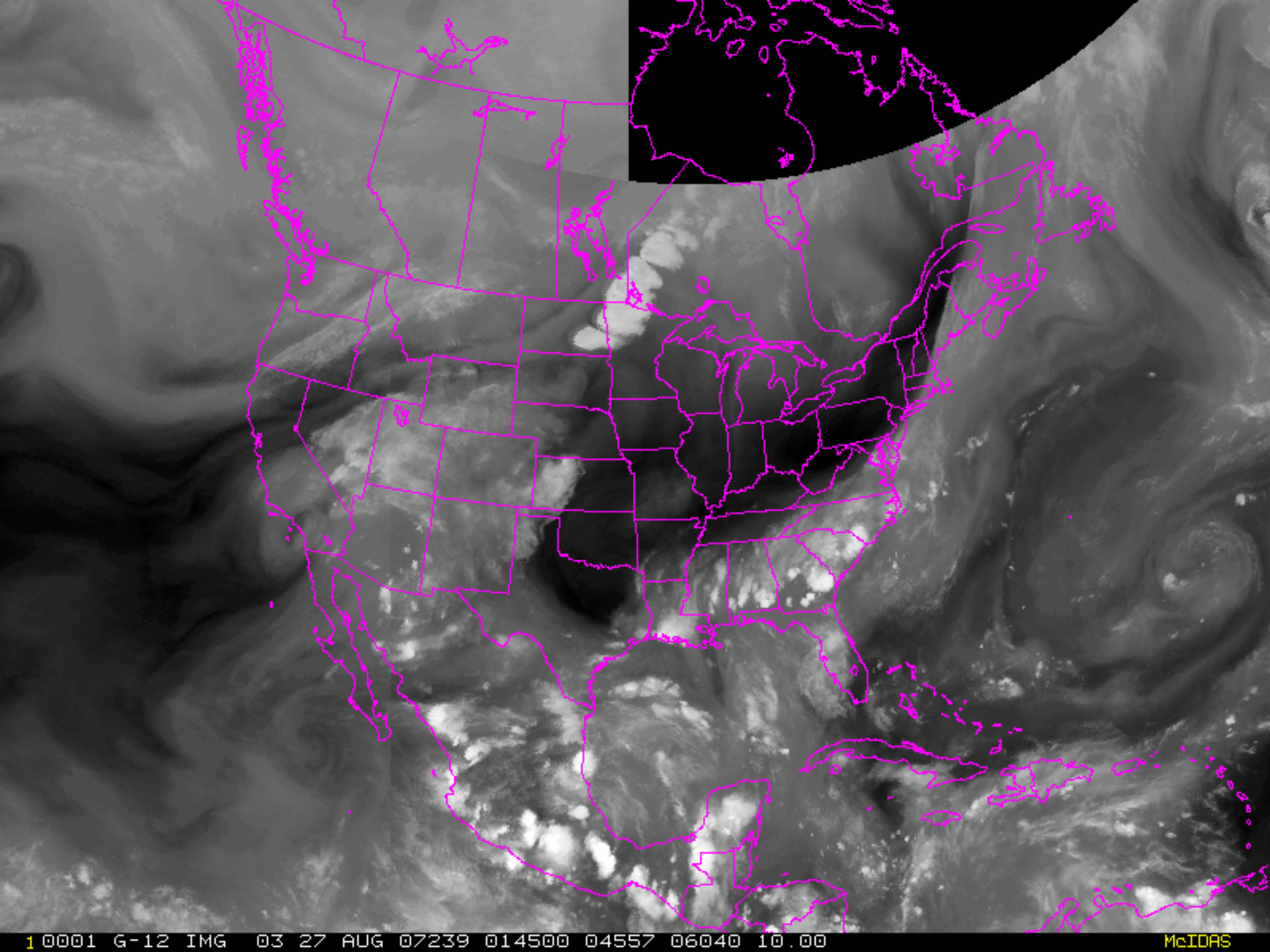
Monsoon Day in Tucson

- UofA Cloud Convection Experiment

Triggers of Thunderstorm Events

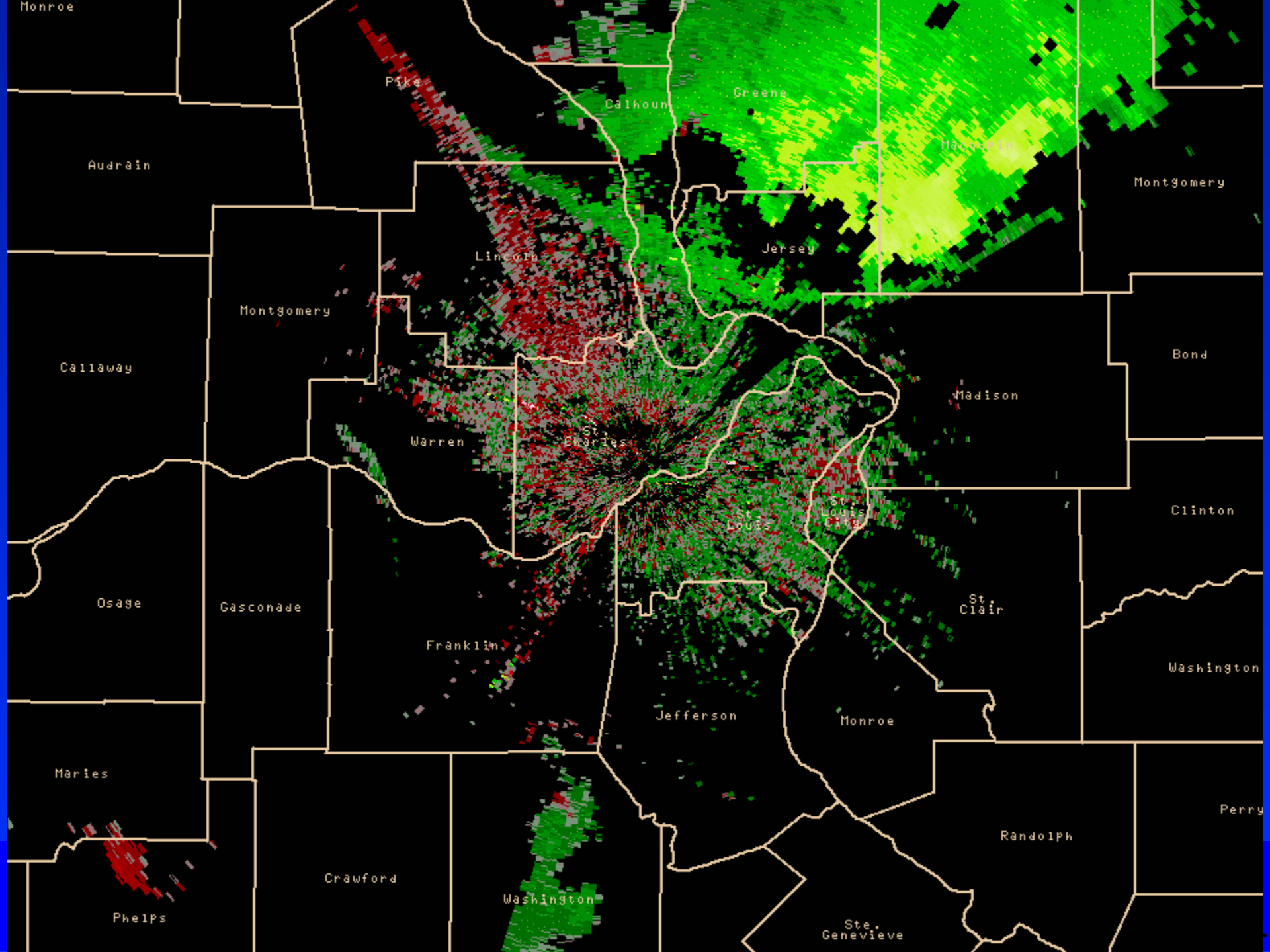


Adams and Comrie 1997


1 0001 G-12 IMG 03 27 AUG 07239 014500 04557 06040 10.00
McIDAS

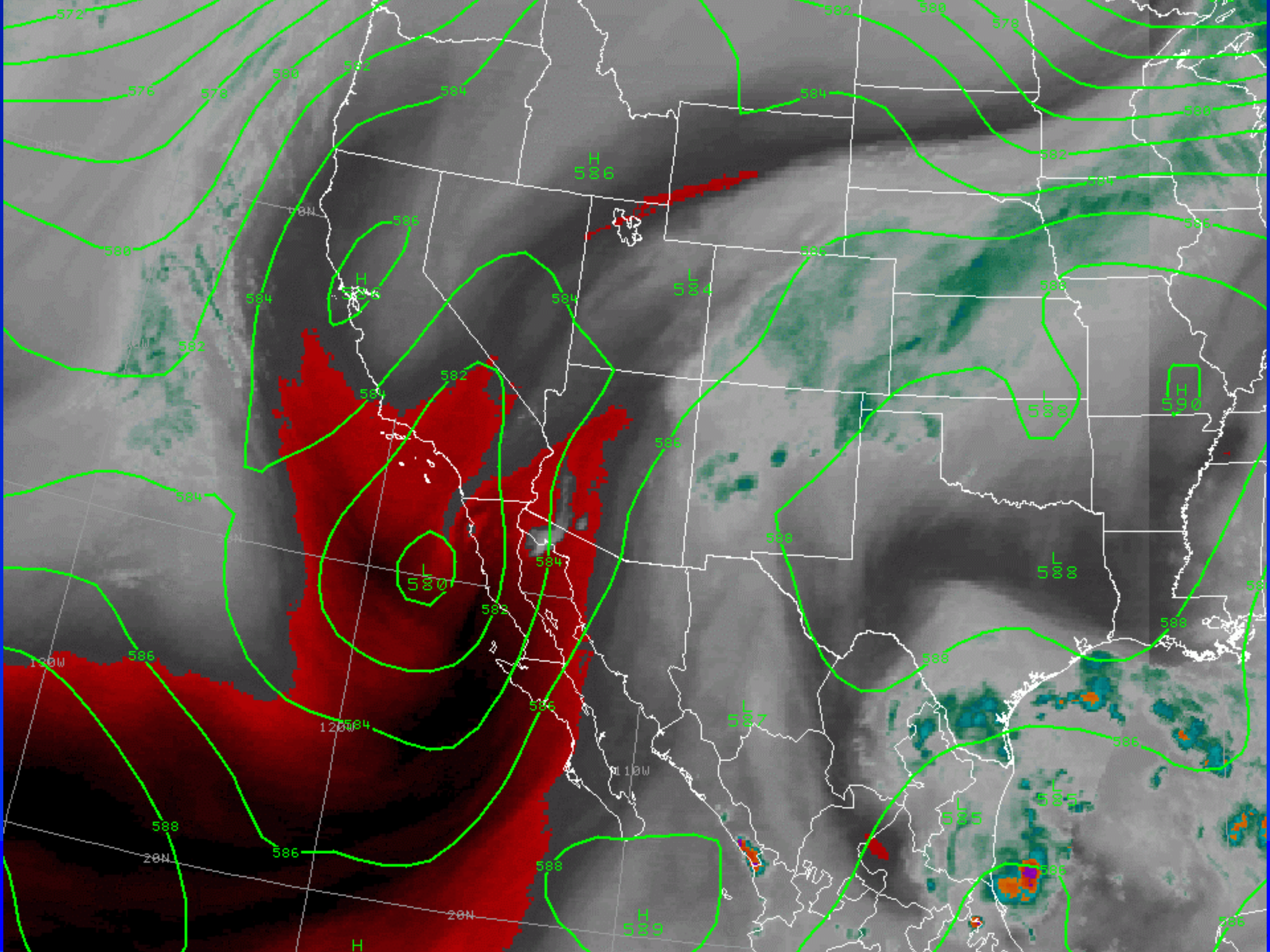
Triggers of Thunderstorm Events

- Thunderstorm Outflows


Monroe
Pike
Calhoun
Greene
Audrain
Montgomery
Lincoln
Jersey
Montgomery
Callaway
Bond
Madison
Warren
St. Charles
St. Louis
Clinton
Osage
Gasconade
Franklin
St. Clair
Washington
Jefferson
Monroe
Maries
Perry
Randolph
Crawford
Washington
Phelps
Ste. Genevieve

Triggers of Thunderstorm Events

- Frontal Storms

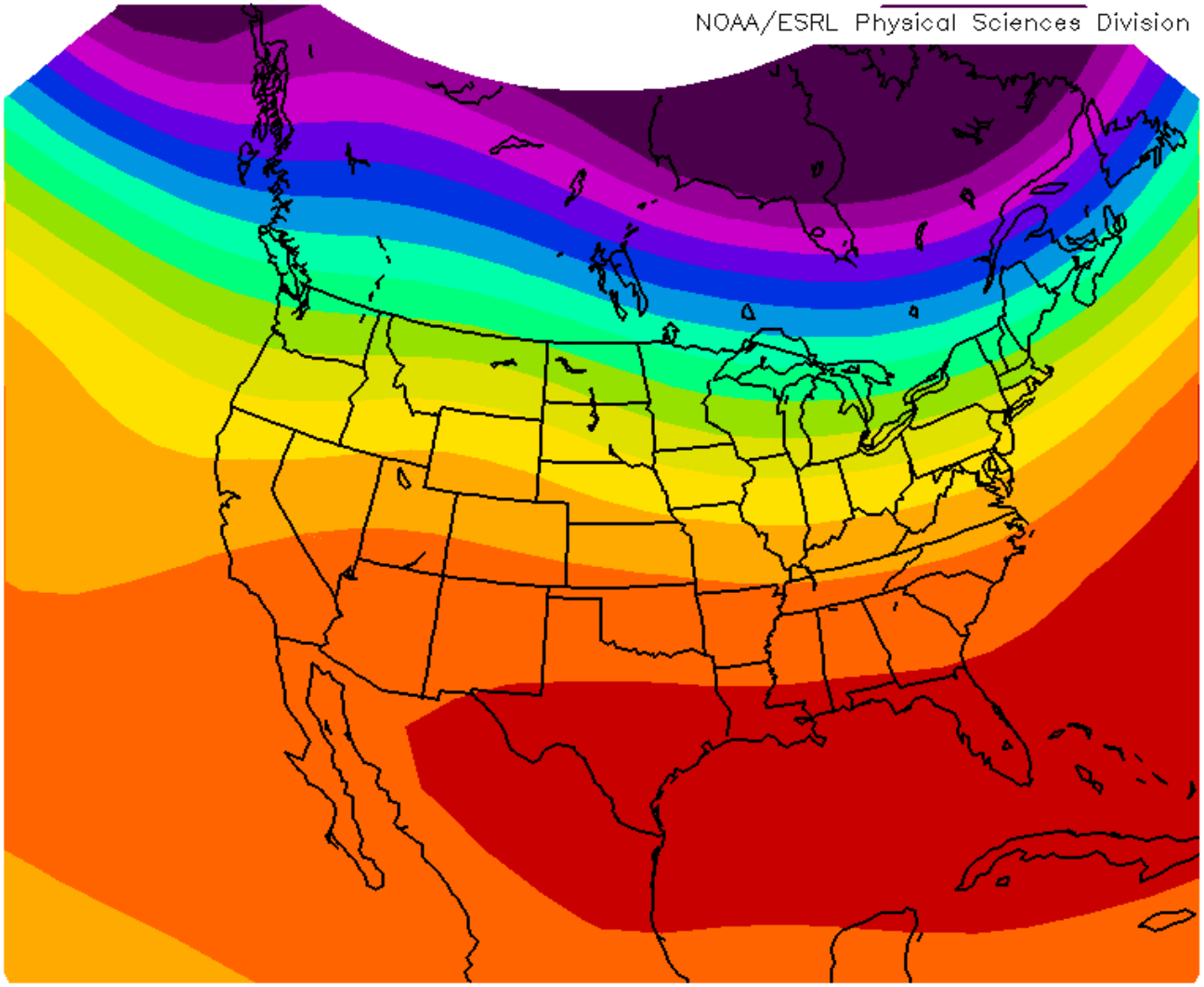


H
586
L
584
L
580
L
588
H
590
L
588
L
587
L
585
585
H
589
H
120W
120W
110W
20N
20N

NCEP/NCAR Reanalysis

500mb Geopotential Height (m) Composite Mean

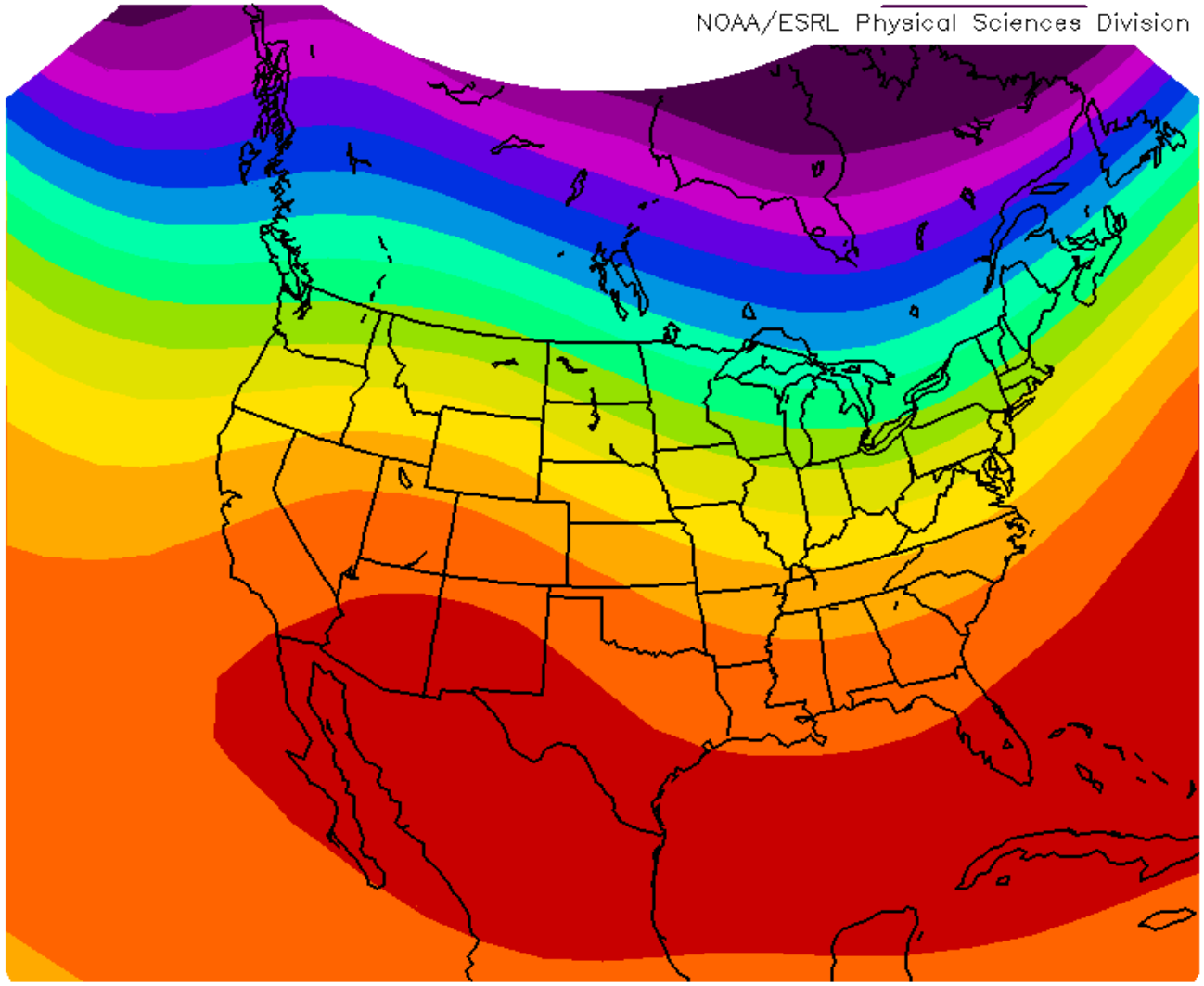
NOAA/ESRL Physical Sciences Division



Jul to Sep: 2006

NCEP/NCAR Reanalysis

500mb Geopotential Height (m) Composite Mean

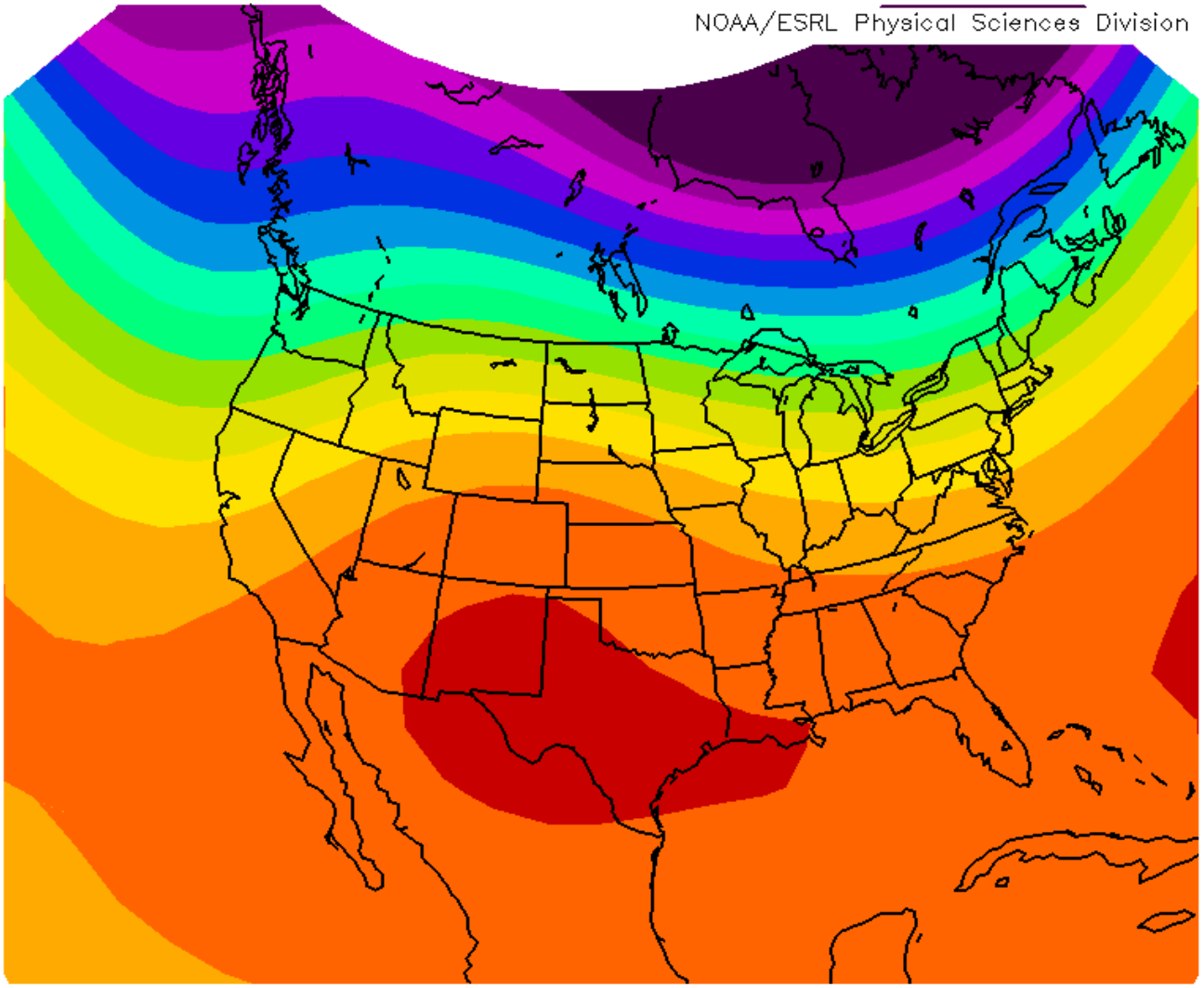


Jul to Sep: 2009

NCEP/NCAR Reanalysis

500mb Geopotential Height (m) Composite Mean

NOAA/ESRL Physical Sciences Division



Jul to Sep: 2013

Extent of NAMS

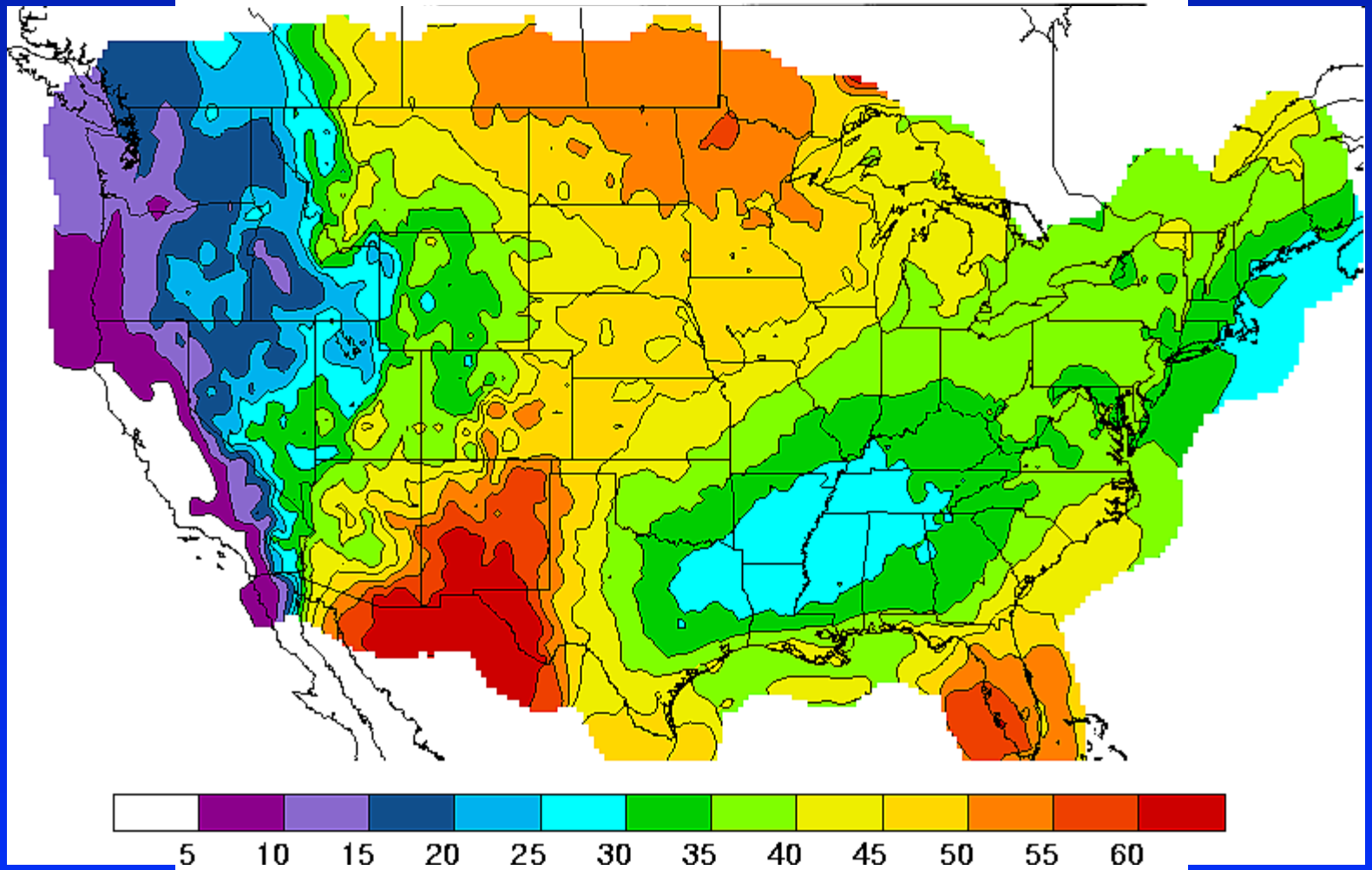
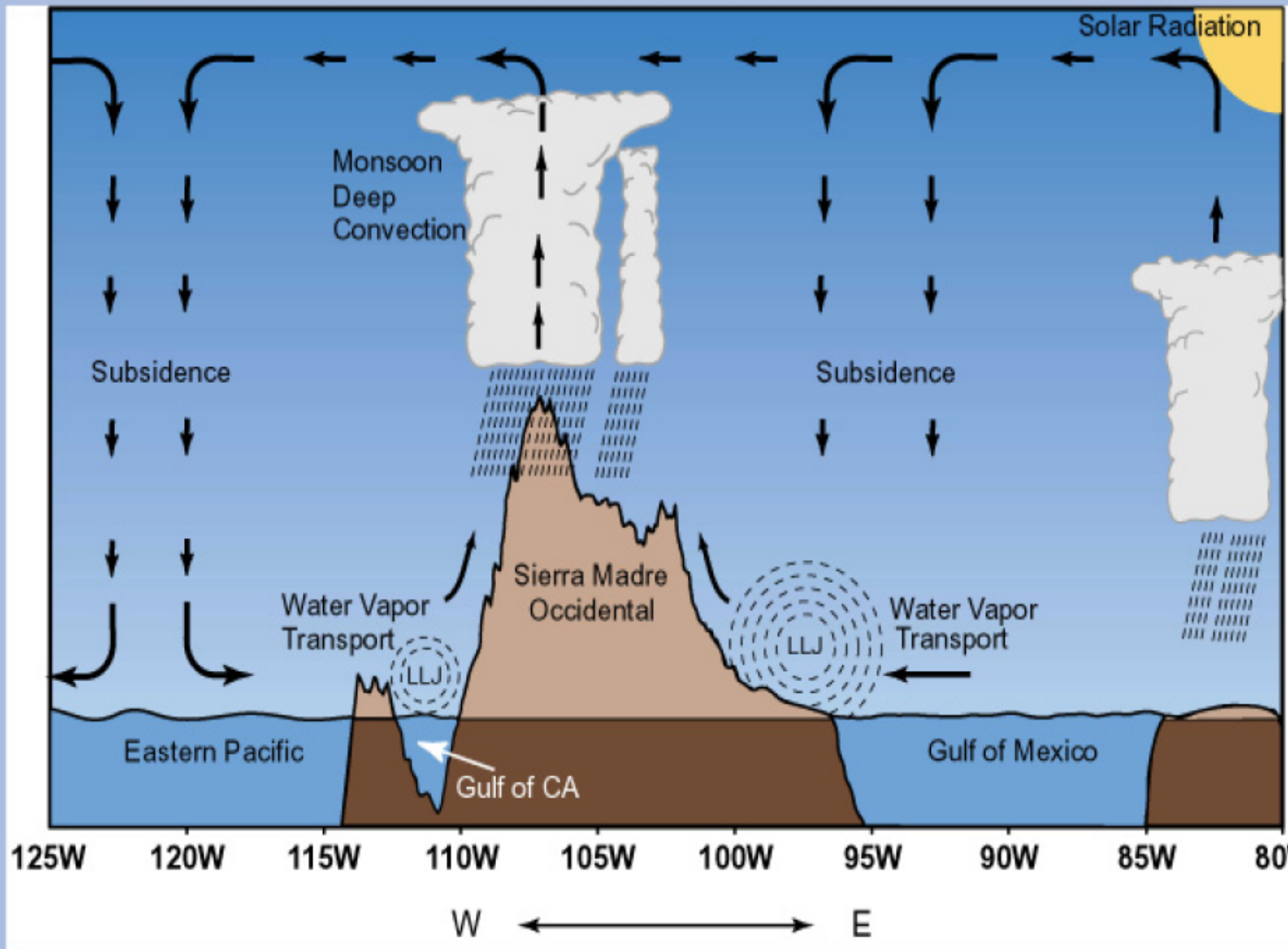


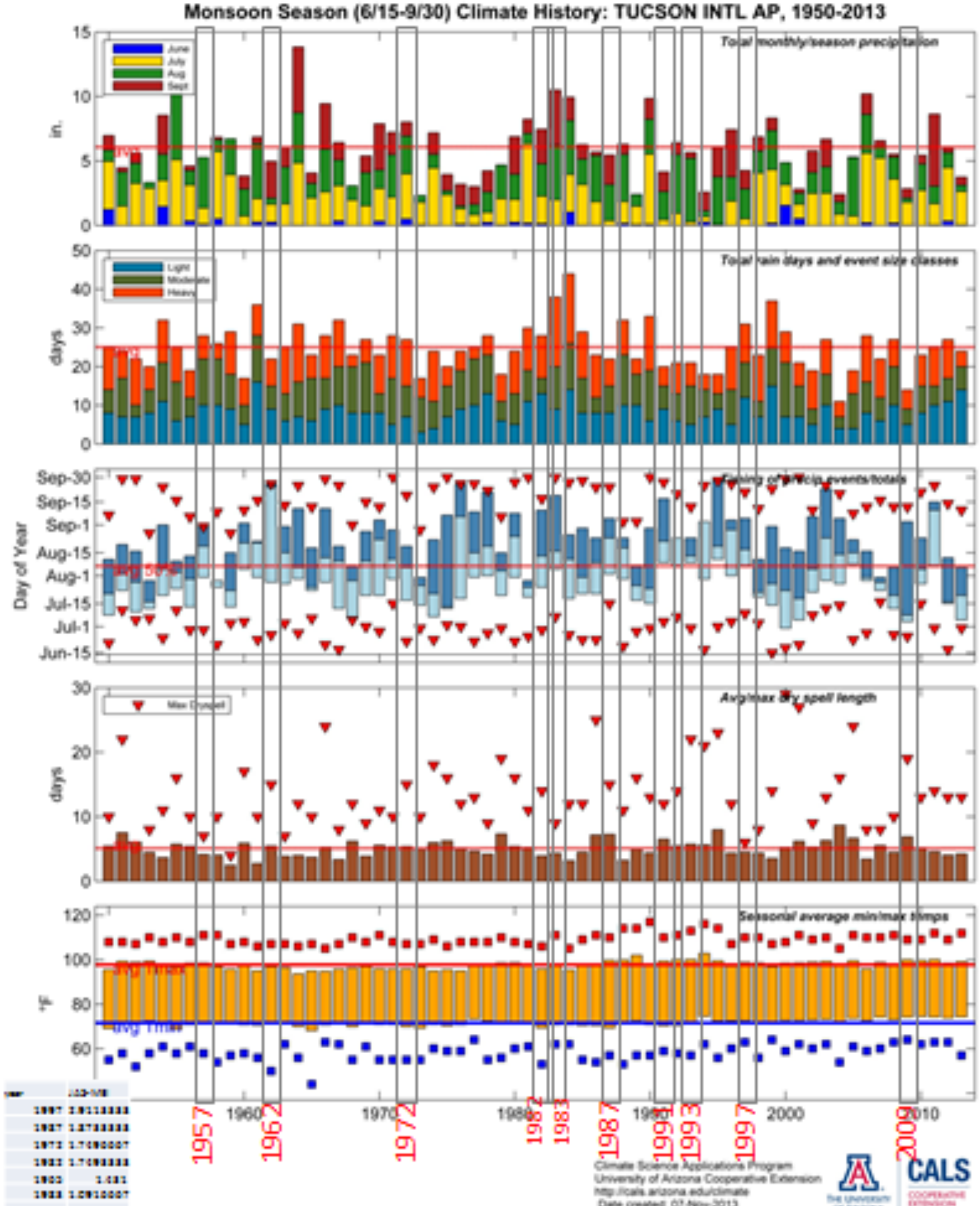
FIG. 3. Analysis of the contribution of the precipitation during July, August, and September to the annual total, expressed in percent. Greater than 70% is crosshatched. Stations used in the analysis are shown as dots.

Douglas et al. 1993

Elements of the North American Monsoon over Northern Mexico



courtesy W. Higgings **http://www.cpc.noaa.gov/products/outreach/Report-to-the-Nation-Monsoon_aug04.pdf** AV/G3/0101



year	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
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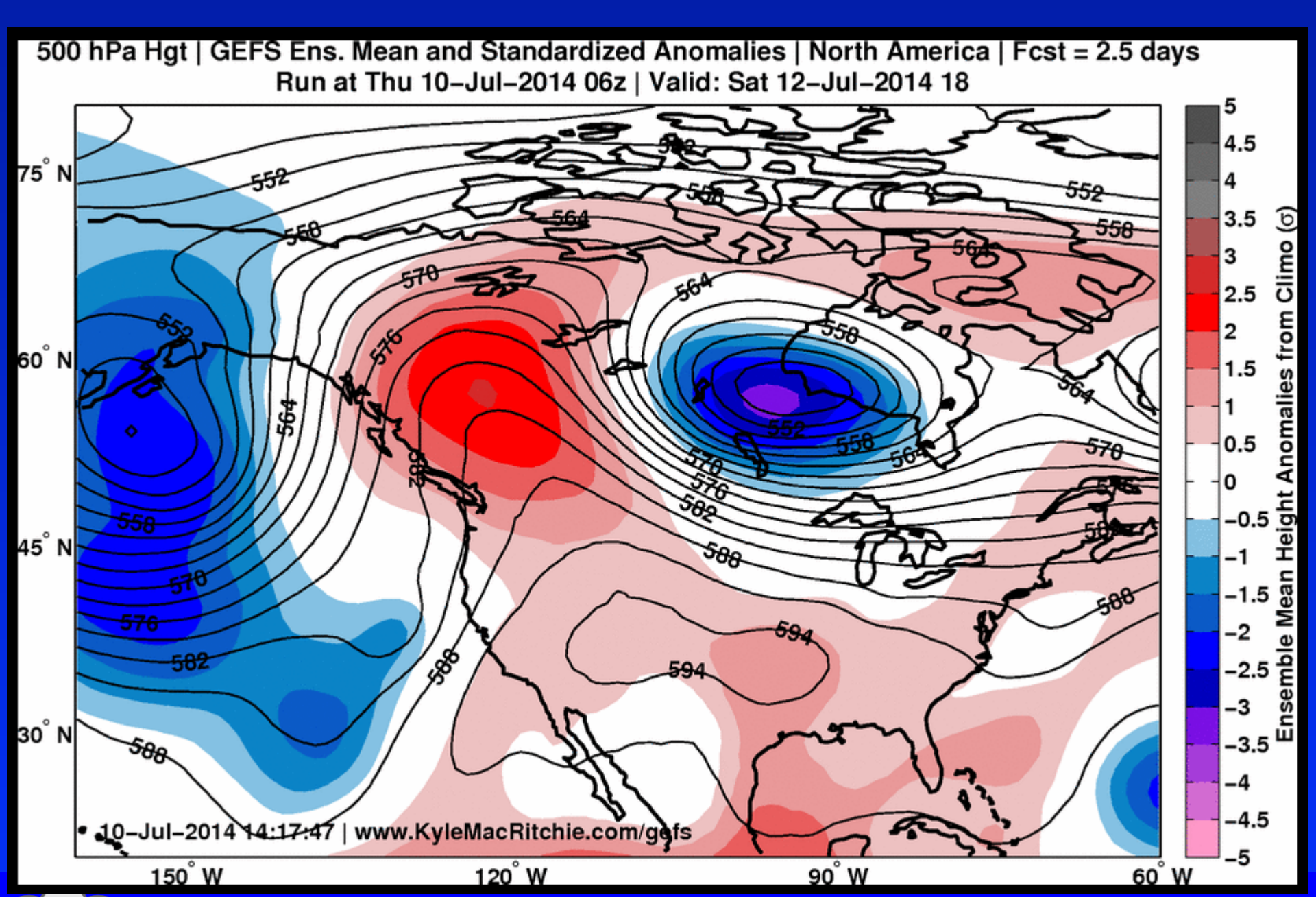
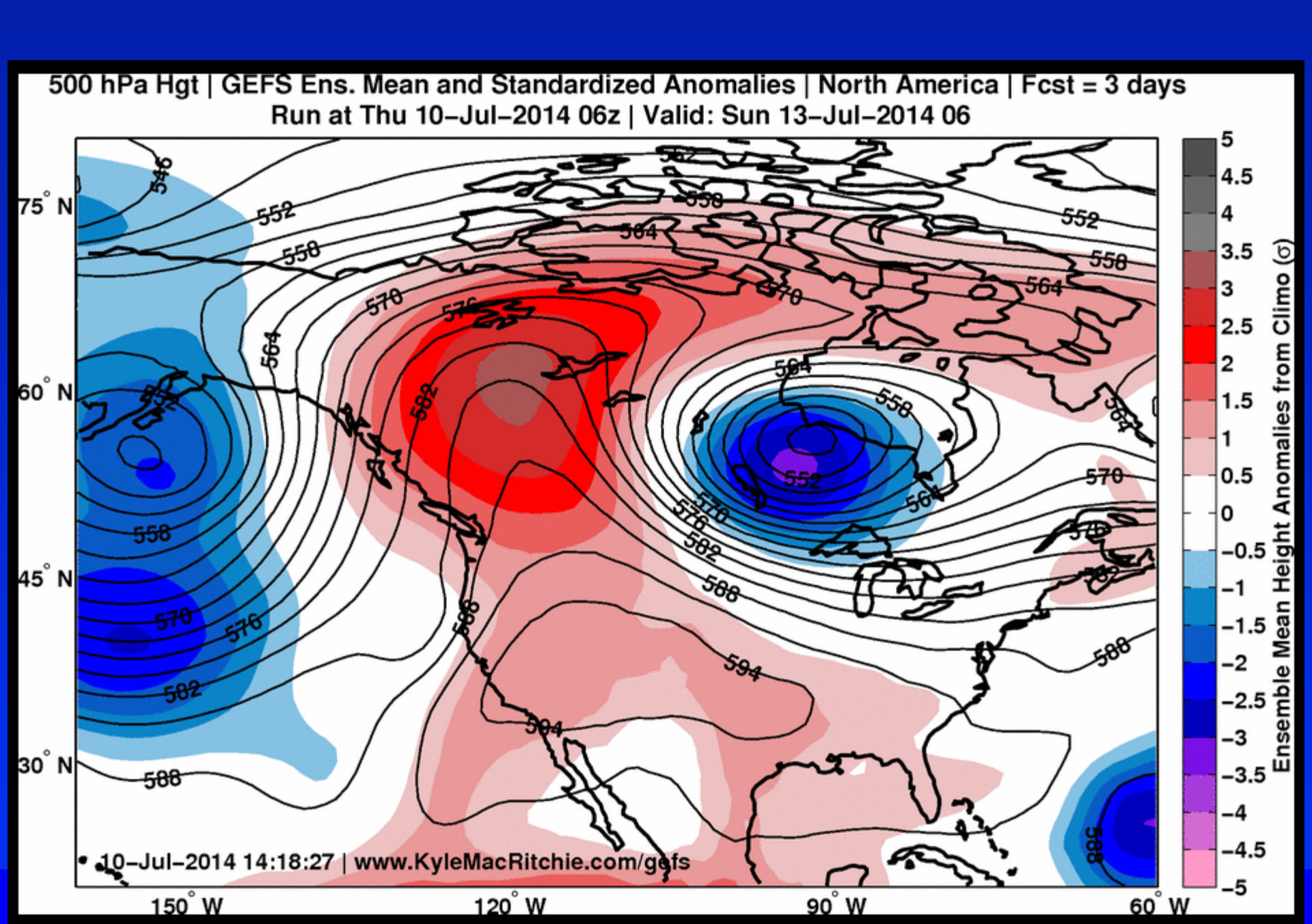
CLIMAS Climate Assessment for the Southwest


500 hPa Hgt | GEFS Ens. Mean and Standardized Anomalies | North America | Fcst = 2.5 days
Run at Thu 10–Jul–2014 06z | Valid: Sat 12–Jul–2014 18
75° N
60° N
45° N
30° N
150° W
120° W
90° W
60° W
Ensemble Mean Height Anomalies from Climo (σ)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
−3.5
−4
−4.5
−5
• 10–Jul–2014 14:17:47 | www.KyleMacRitchie.com/gefs


500 hPa Hgt | GEFS Ens. Mean and Standardized Anomalies | North America | Fcst = 3 days
Run at Thu 10–Jul–2014 06z | Valid: Sun 13–Jul–2014 06
75° N
60° N
45° N
30° N
150° W
120° W
90° W
60° W
10–Jul–2014 14:18:27 | www.KyleMacRitchie.com/gefs
Ensemble Mean Height Anomalies from Climo (σ)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
−3.5
−4
−4.5
−5