CLIMAS
Climate Assessment for the Southwest

CSAP

An Overview of the North American Monsoon and Seasonal Outlook for 2008

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UA Climate Science Applications Program (CSAP) and
Climate Assessment for the Southwest (CLIMAS) Web Briefing

June 4, 2008

THE UNIVERSITY OF ARIZONA

ATMOSPHERIC SCIENCES
UASCIENCE

Presentation Outline

Overview of the North American Monsoon and what it means for Arizona

Current state of monsoon forecasting

Outlook for the 2008 monsoon

Department of Atmospheric Science Monsoon Briefings

A definition of “monsoon”

A seasonal reversal of the atmospheric circulation, accompanied by dramatic shifts in winds and precipitation. Caused by the heat differential between a continent and the surrounding ocean.

Classic example: Indian monsoon

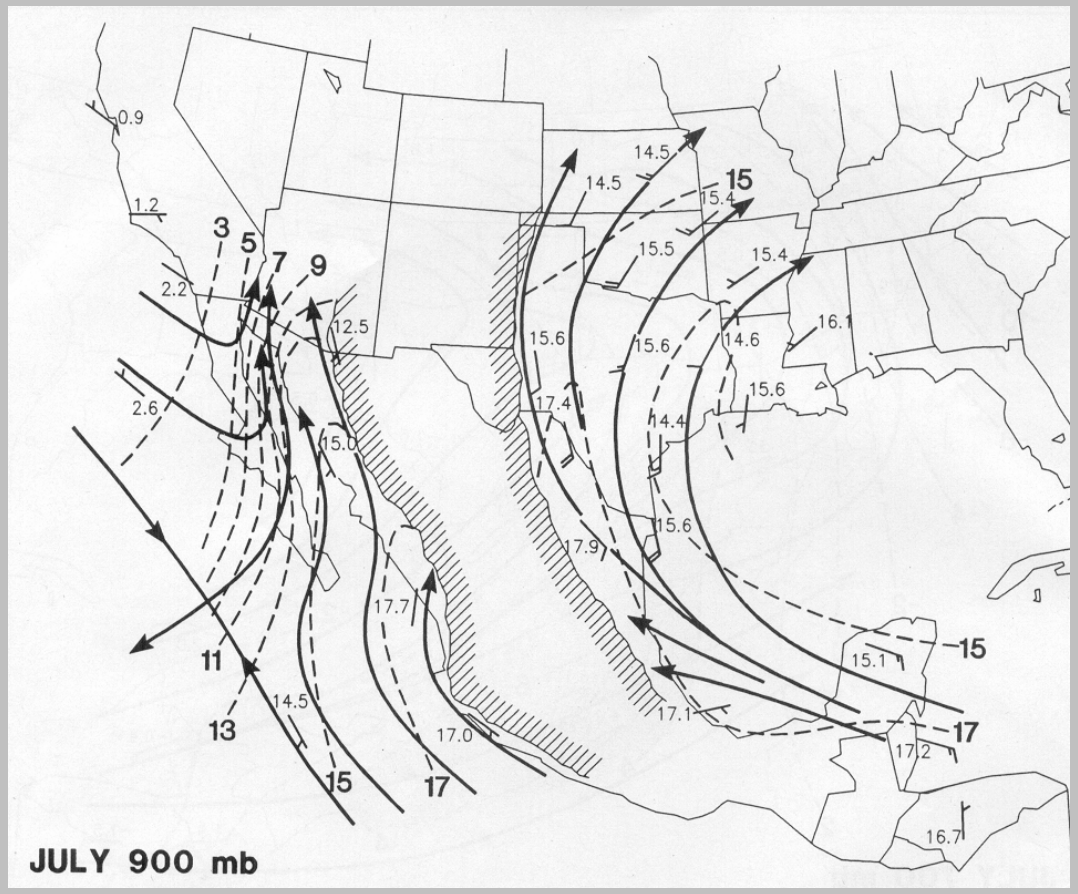
Why a North American Monsoon?

Similar to Asia, North America has a giant elevated plateau in the western U.S. and Mexico.

Mexican plateau is only about 4000-7000 ft. in elevation.

Though it is not as high as Tibet, it IS high enough that there is a regular seasonal reversal of circulation.

Average Low-Level Flow: July



Low level winds (900-mb) are directed onshore.

East of the Rockies, moisture is transported at low-levels from the Gulf of Mexico

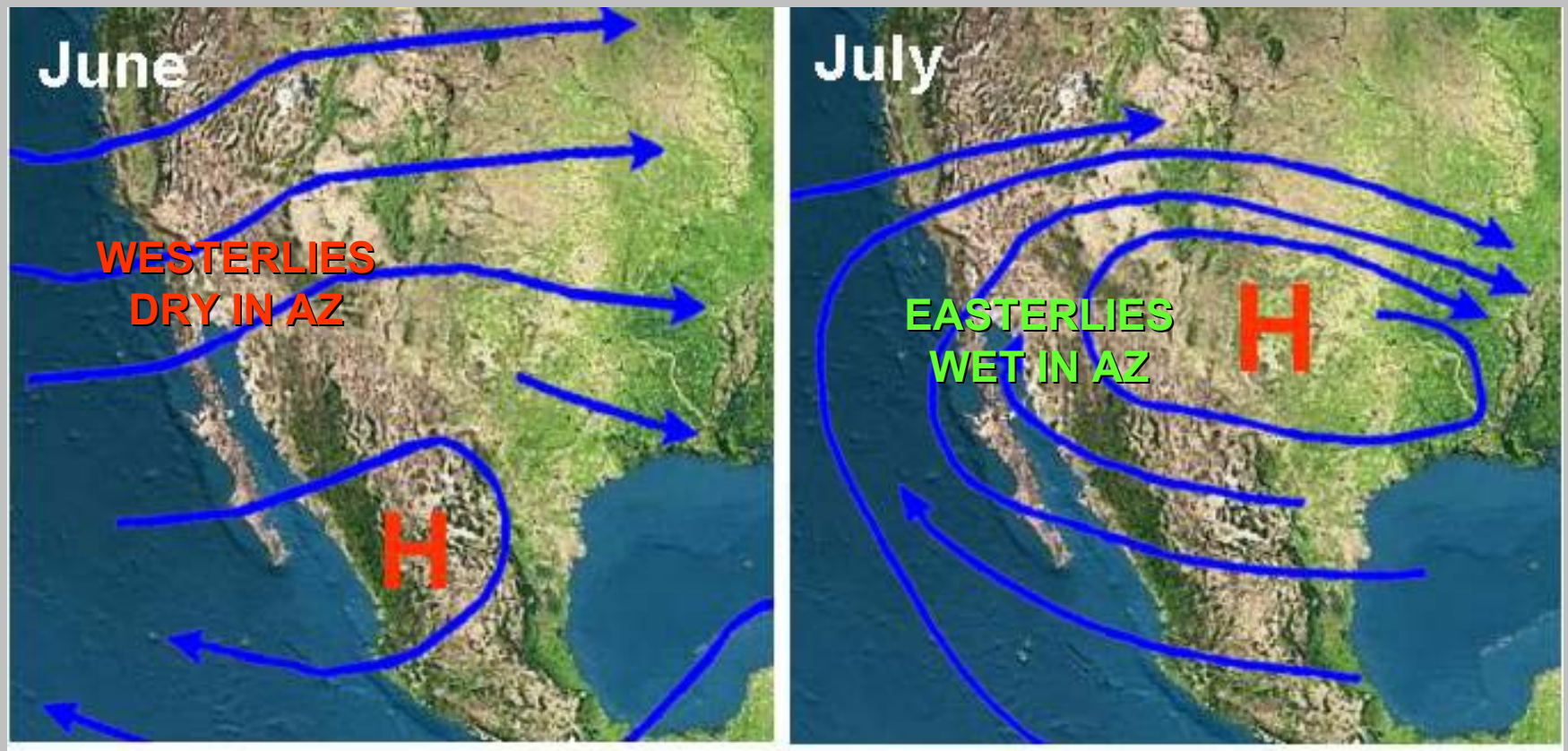
West of the continental divide, low-level moisture transport from the Gulf of California and East Pacific.

(Douglas et al. 1993)

Upper-level flow (~18,000 ft.)

Before monsoon

During Monsoon

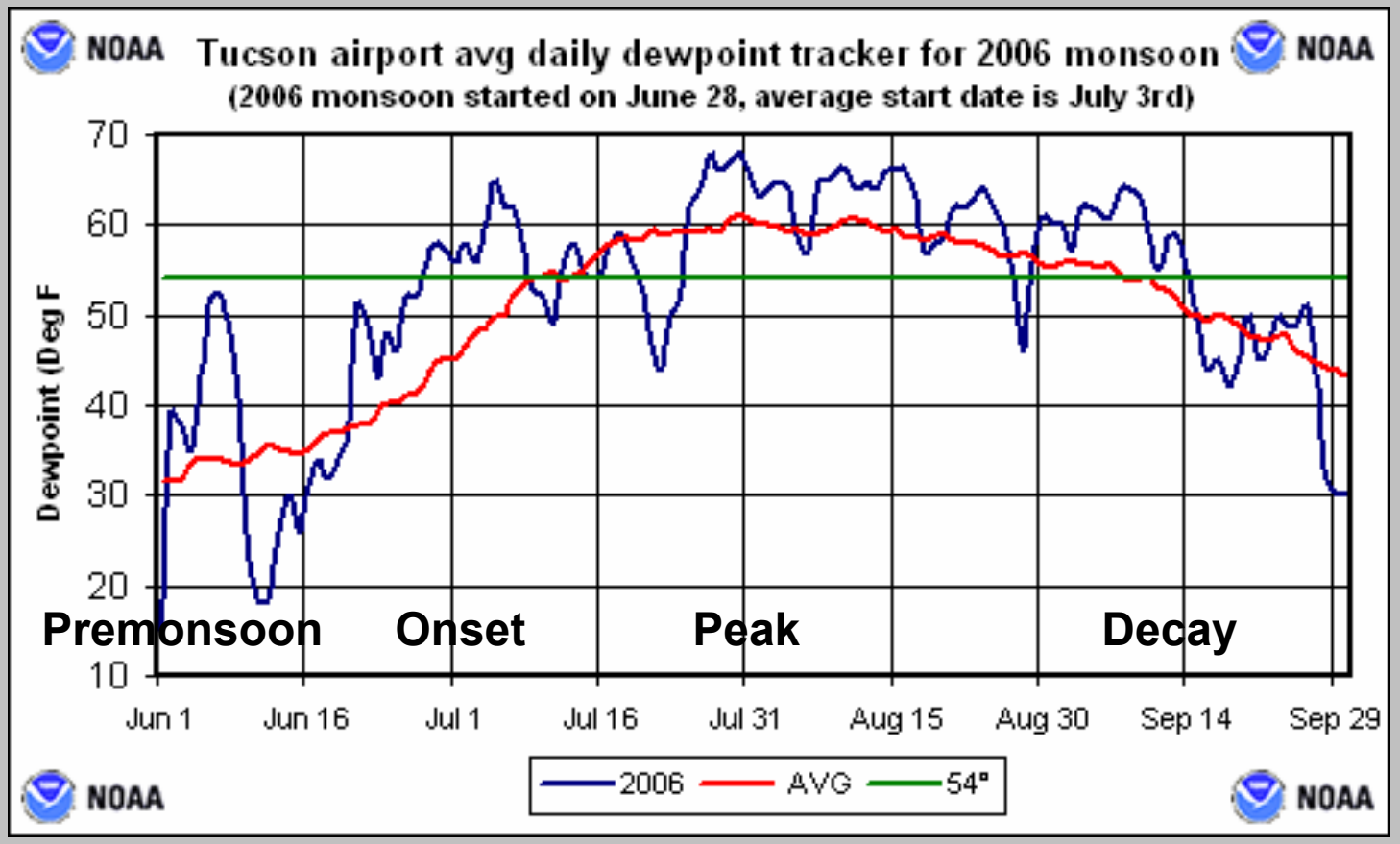


Mean 50 kPa Flow Patterns over SW North America

Westerlies
High pressure ridge to the south.
Little moisture at upper levels.

Easterlies
High pressure ridge to north (and east)
Moisture transport from Gulf of Mexico

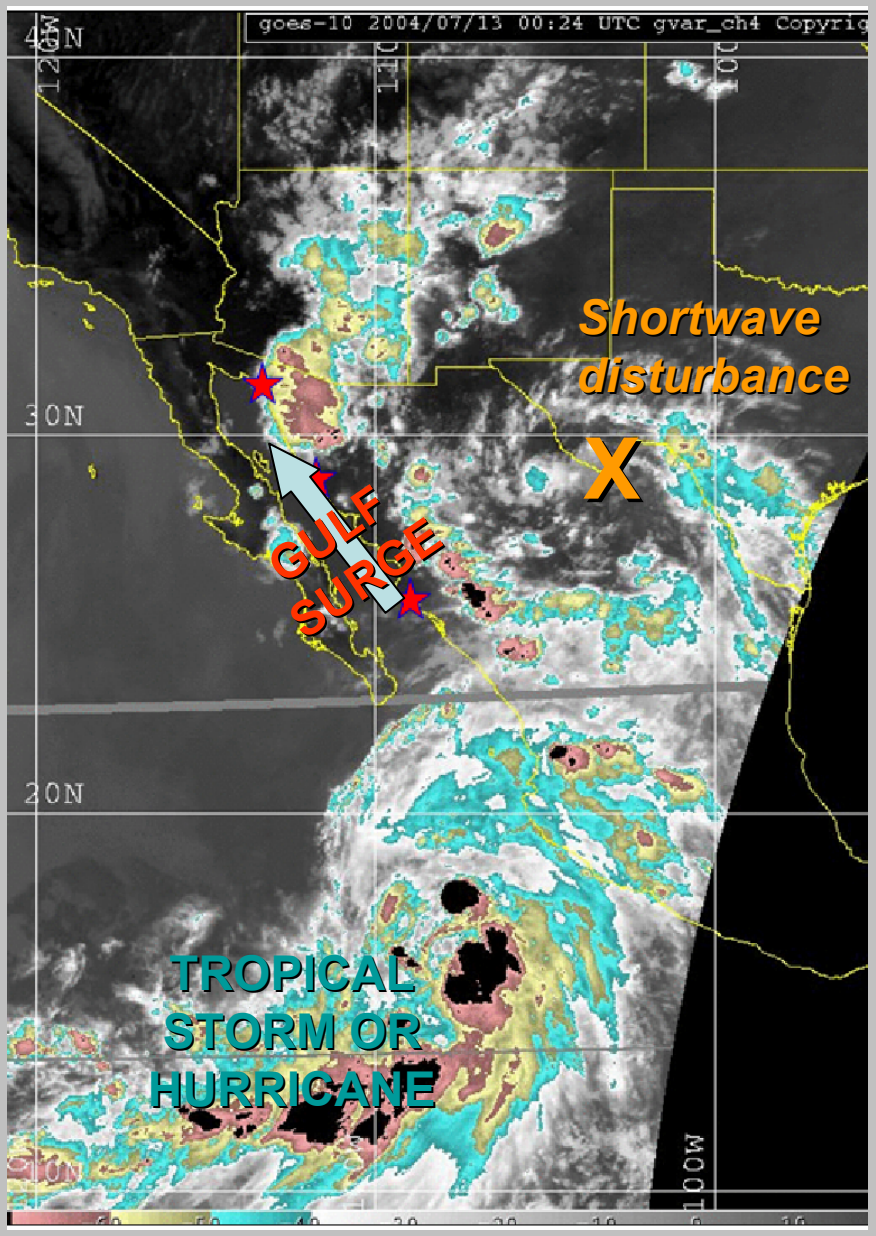
Monsoon in Tucson



Monsoon onset used to be defined as when dew point exceeds 54°F for three consecutive days.

The daily cycle of thunderstorm development: central to monsoon rainfall

Imagery from CuPido Experiment



Conditions for enhanced monsoon thunderstorms

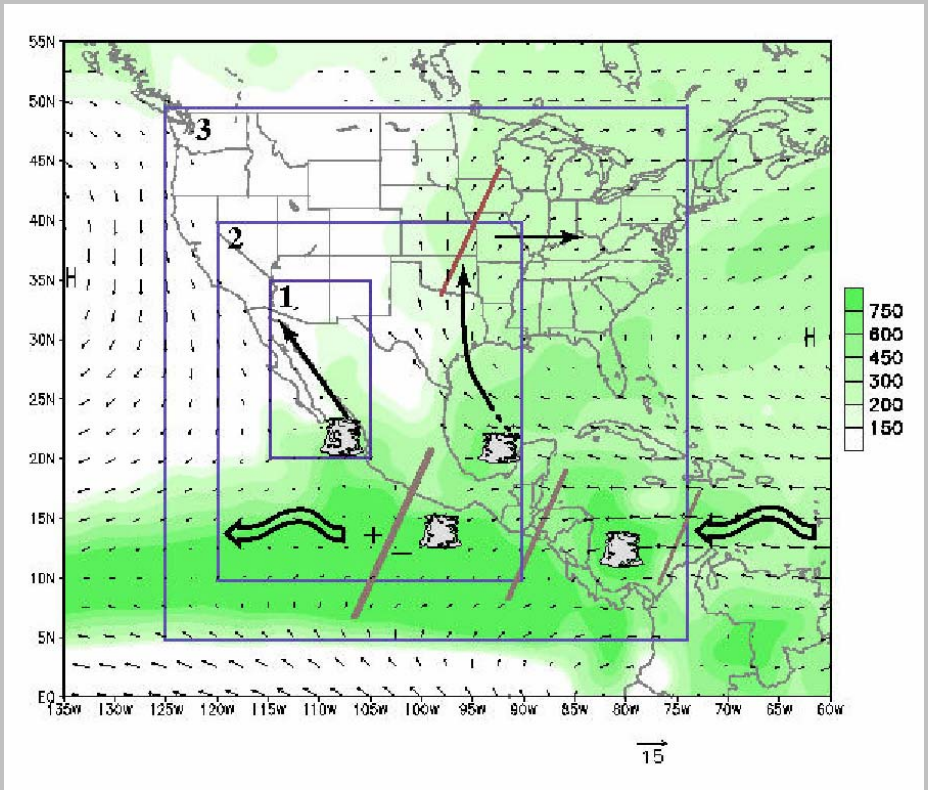
An upper-level disturbance (X) traveling around the monsoon ridge.

Low level-moisture surging up the Gulf of California

RESULT

Thunderstorms which originate on the Mogollon Rim intensify and move westward toward low deserts and the Colorado River Valley.

Principal factors to consider with respect to monsoon variability



Mid-latitude teleconnections, or alterations to the climatological circulation patterns, related principally to Pacific SST variability

Variation of tropical rainfall patterns within a given season

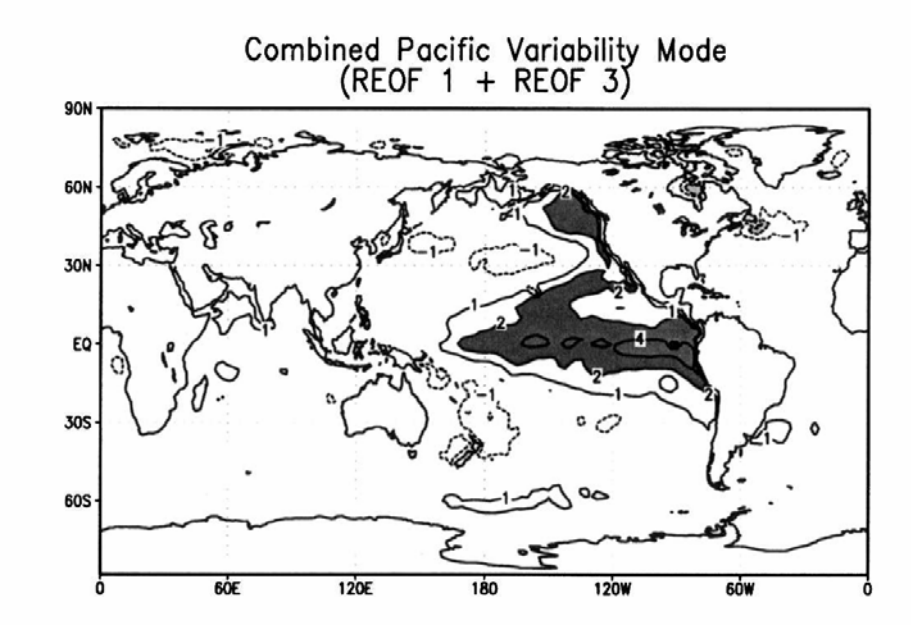
Occasional passage of weather disturbances

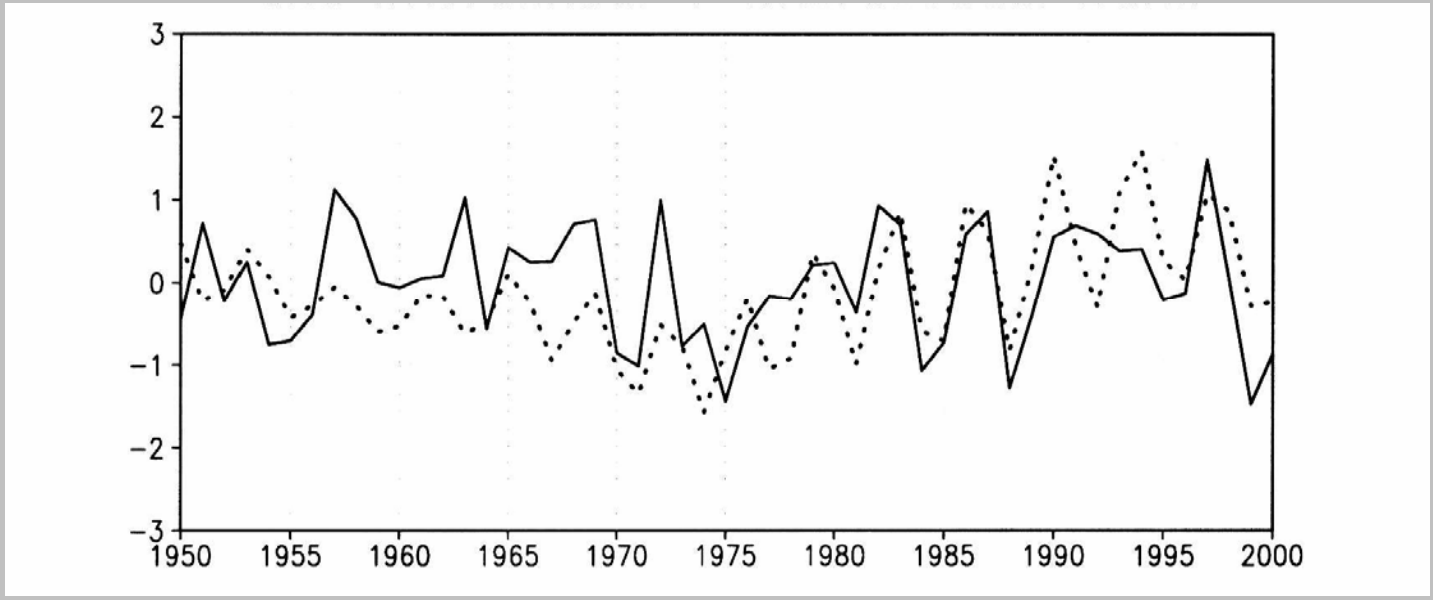
Moisture transport and possible teleconnections from Atlantic and inter-American seas

Land surface feedback processes

Anthropogenic climate change

Combined Pacific Variability Mode (CPVM)





(Castro et al. 2007)

Monsoon Ridge Position at Onset (Late June, July)

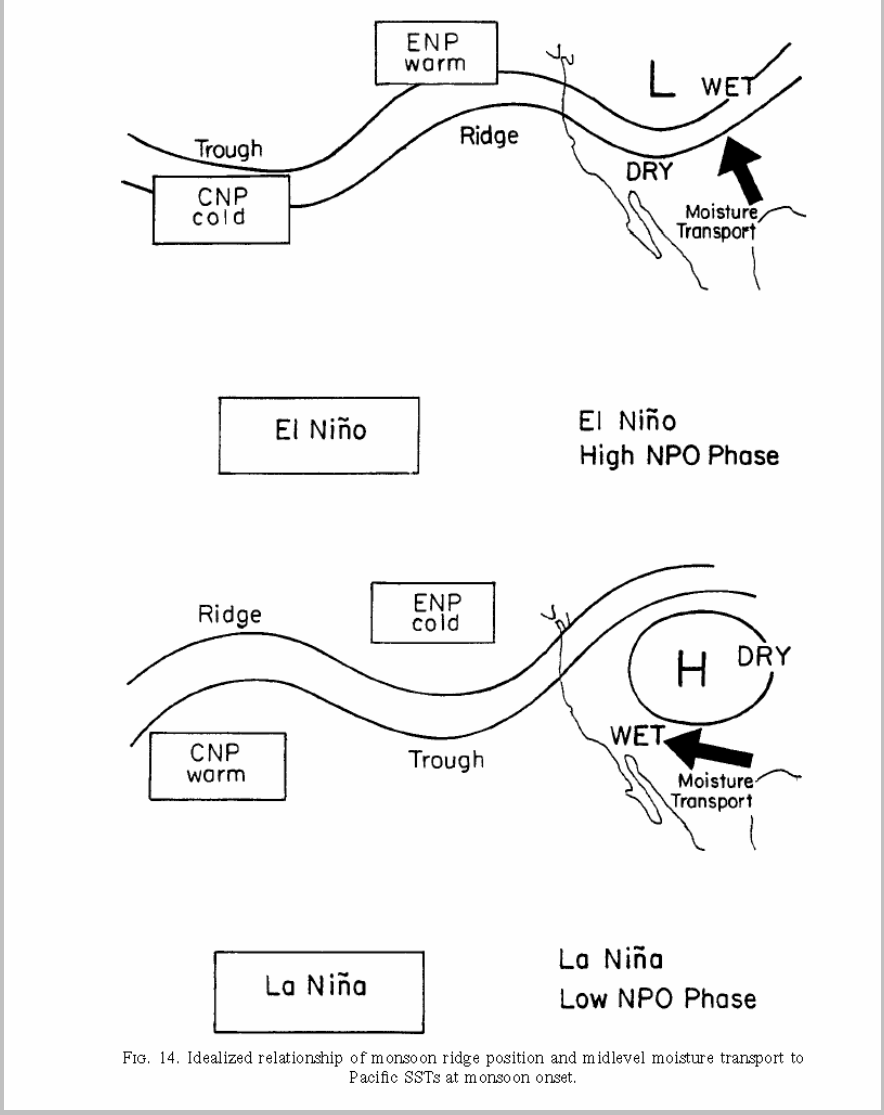


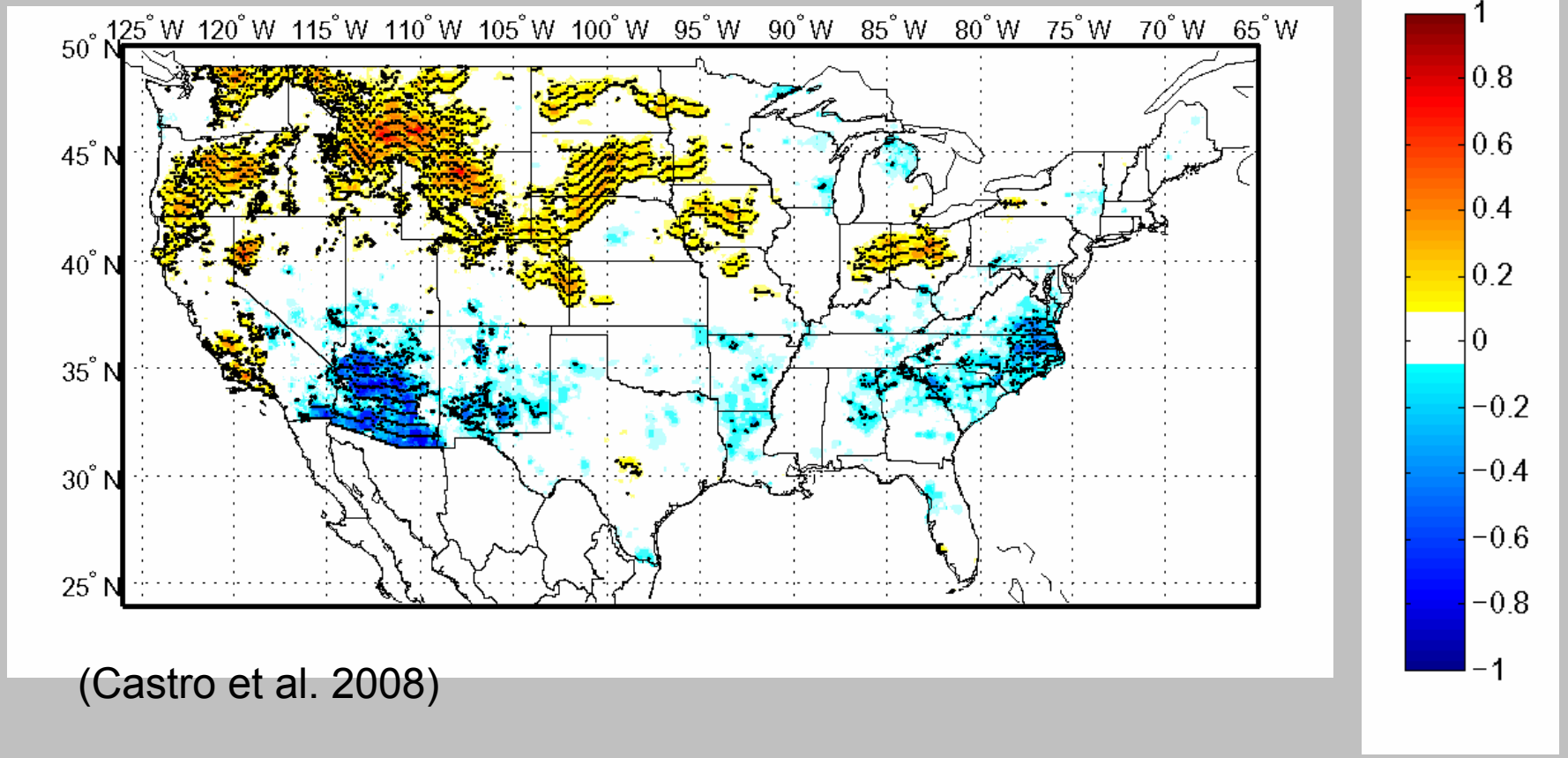
FIG. 14. Idealized relationship of monsoon ridge position and midlevel moisture transport to Pacific SSTs at monsoon onset.

Climatology delayed

Climatology accelerated

(Castro et al., 2001)

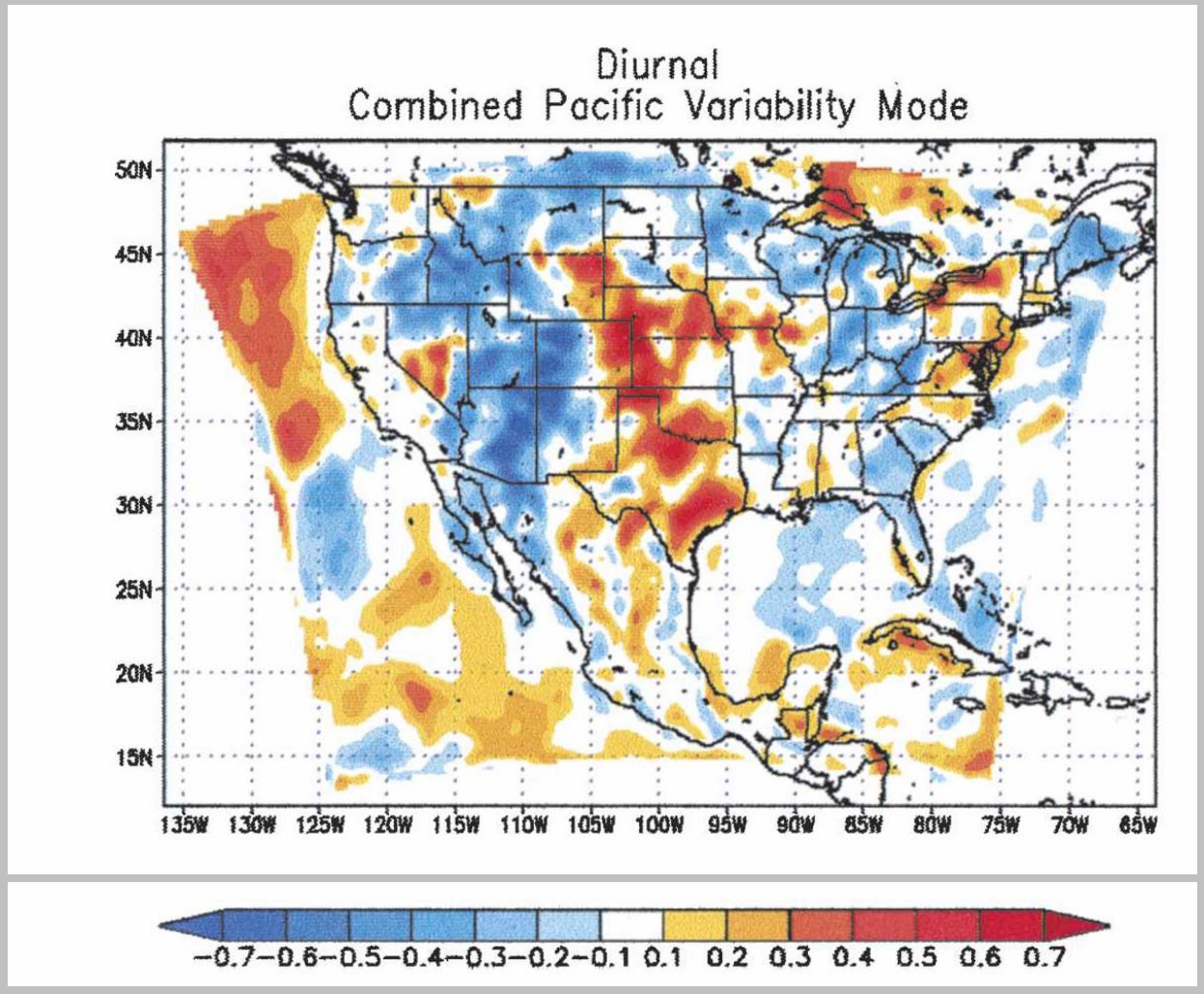
Correlation of JJ 2mo. PRISM-derived SPI with antecedent MAM CPVM (onset period)



(Castro et al. 2008)

For Arizona → Negative phase of the mode = more rainfall

Regional model simulated change in development of diurnal thunderstorms associated with CPVM



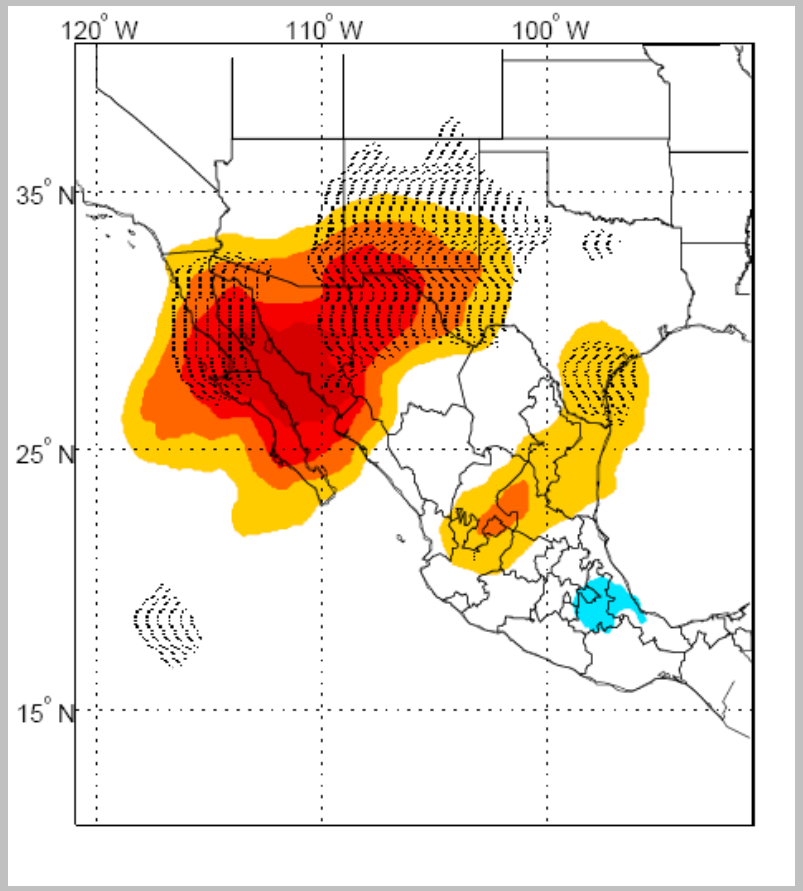
Note:

Occurs during monsoon onset

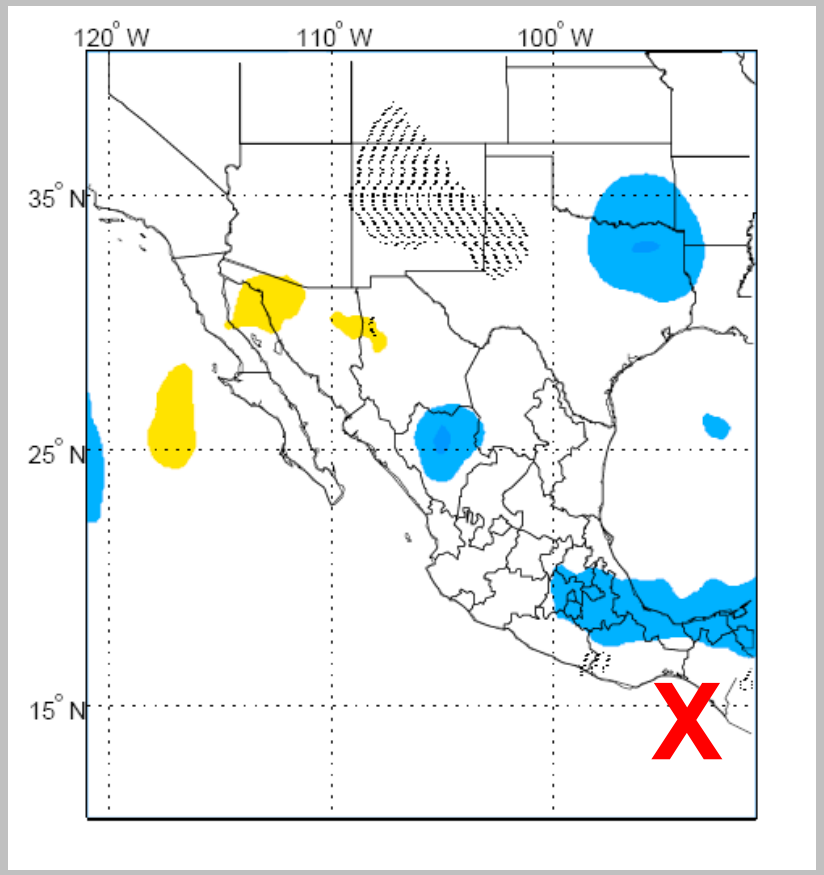
(Castro et al. 2007)

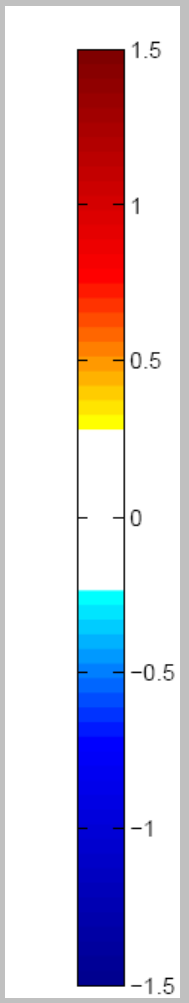
Change in frequency of upper level disturbances: negative minus positive CPVM years (1979-2003)

Late June, early July



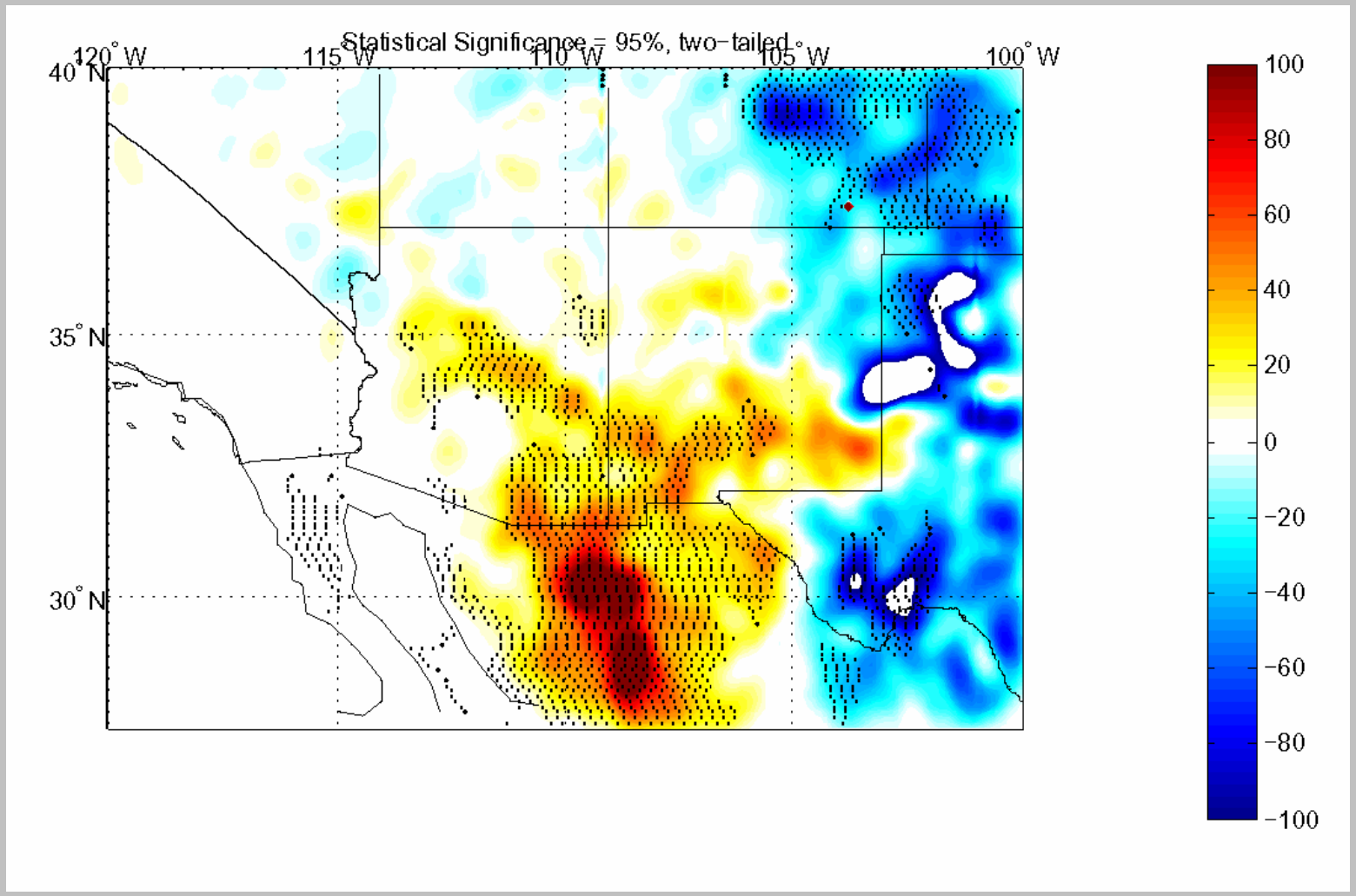
August

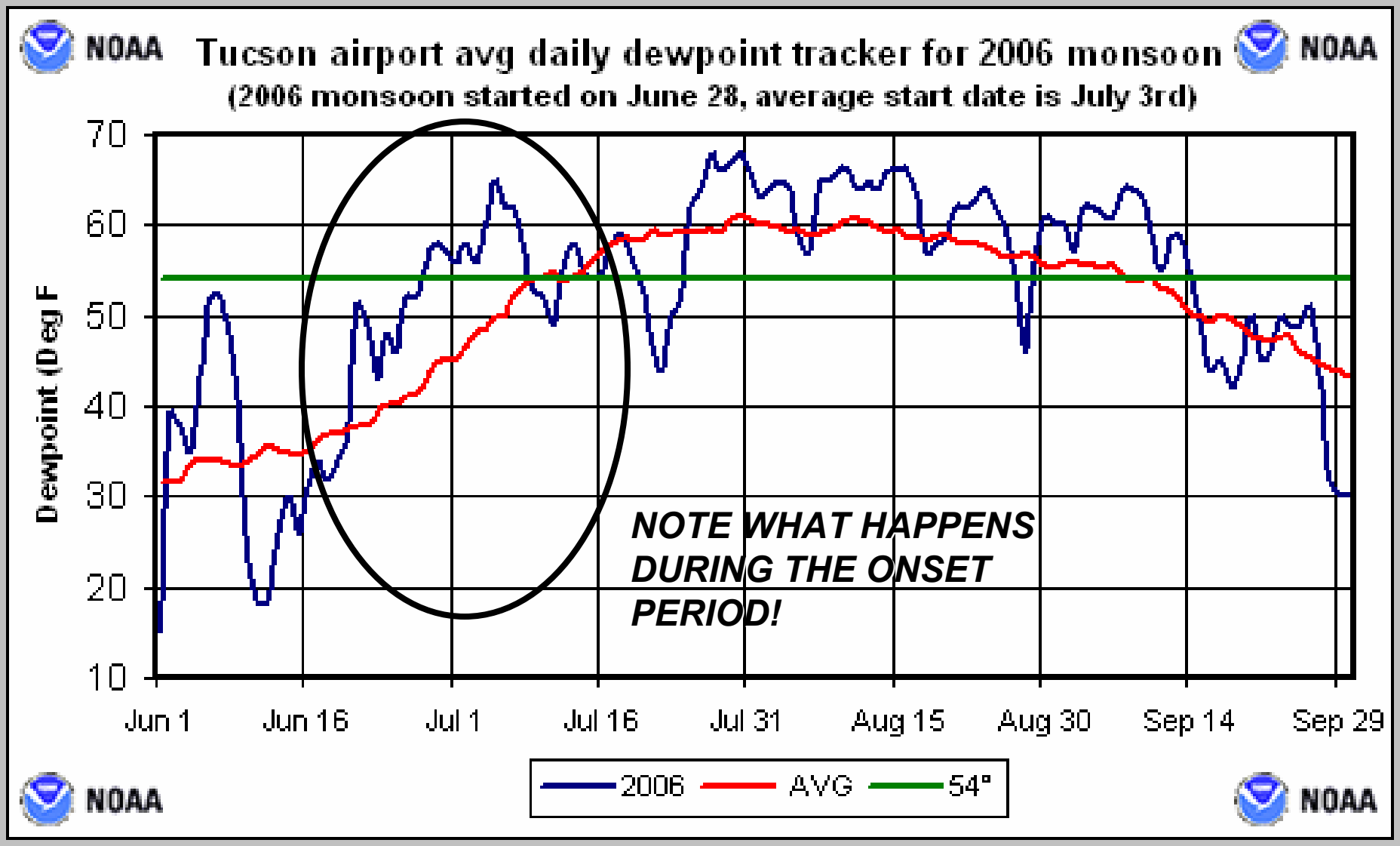




(Bieda et al., submitted)

Change in lightning counts (1996-2005) associated with negative phase of CPVM in June




NOAA
Tucson airport avg daily dewpoint tracker for 2006 monsoon
(2006 monsoon started on June 28, average start date is July 3rd)
NOAA
Dewpoint (Deg F
70
60
50
40
30
20
10
Jun 1
Jun 16
Jul 1
Jul 16
Jul 31
Aug 15
Aug 30
Sep 14
Sep 29
NOTE WHAT HAPPENS DURING THE ONSET PERIOD!
2006
AVG
54°
NOAA
NOAA

Tools used in seasonal forecasting

Current:

General circulation models (e.g. Climate Forecast System model)

Statistical analogs, or compositing

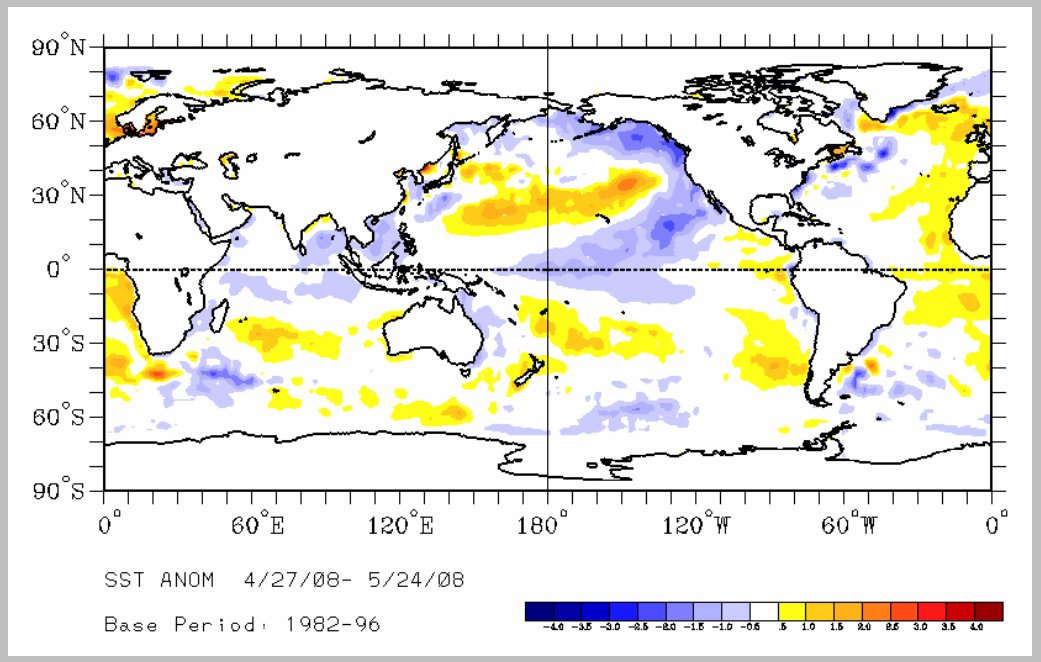
Multiple regression using large-scale climate signals as predictors

Pattern recognition (e.g. Canonical correlation analysis)

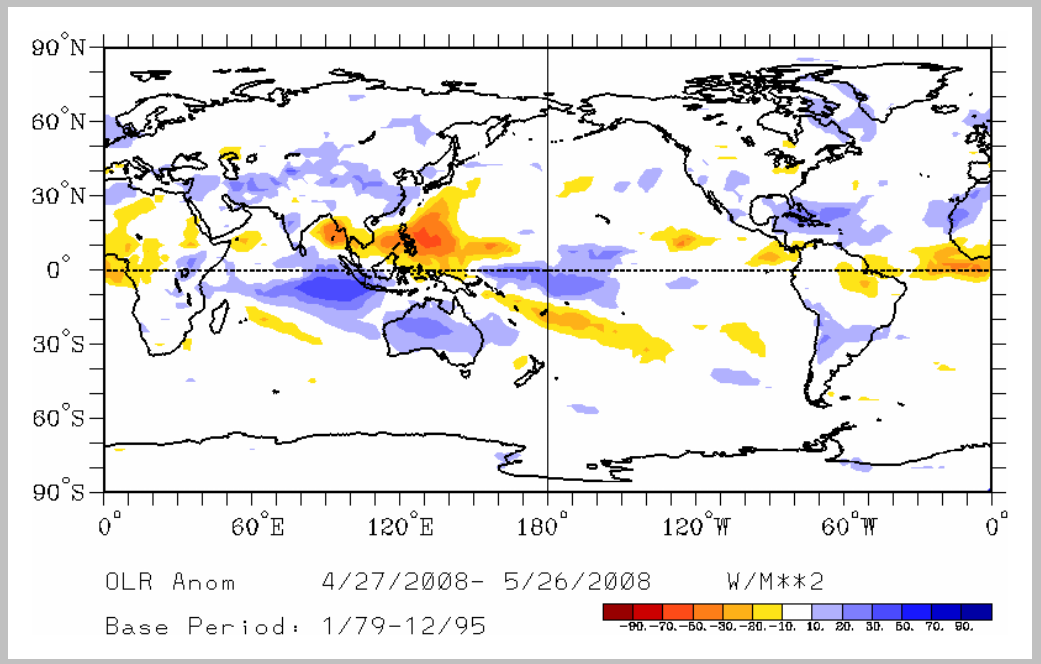
Statistical downscaling

Future:

Dynamical downscaling with a regional climate model (WRF)



Current Pacific Sea Surface Temperature Anomalies

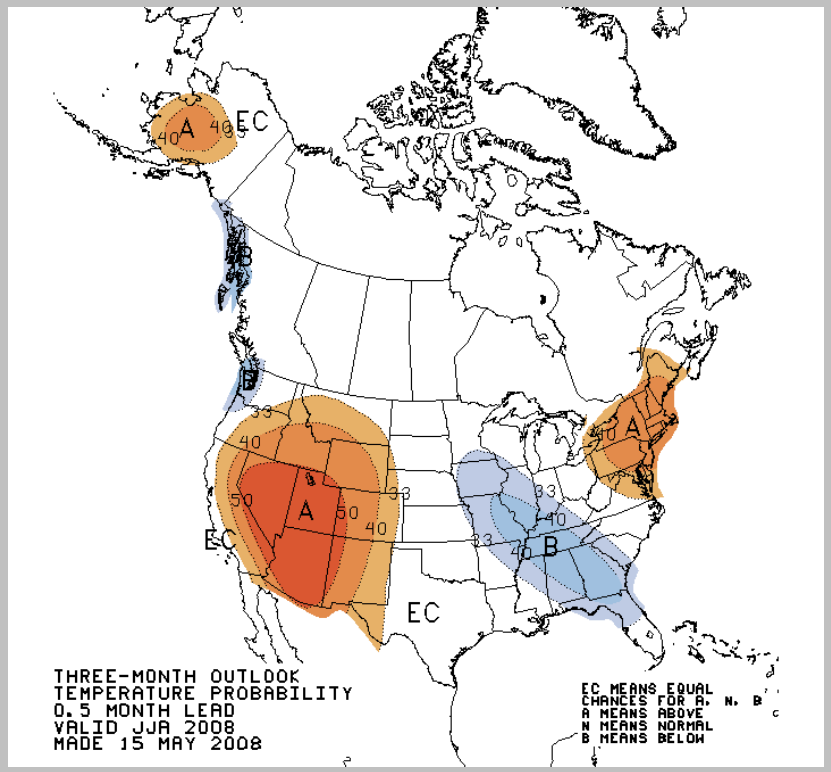


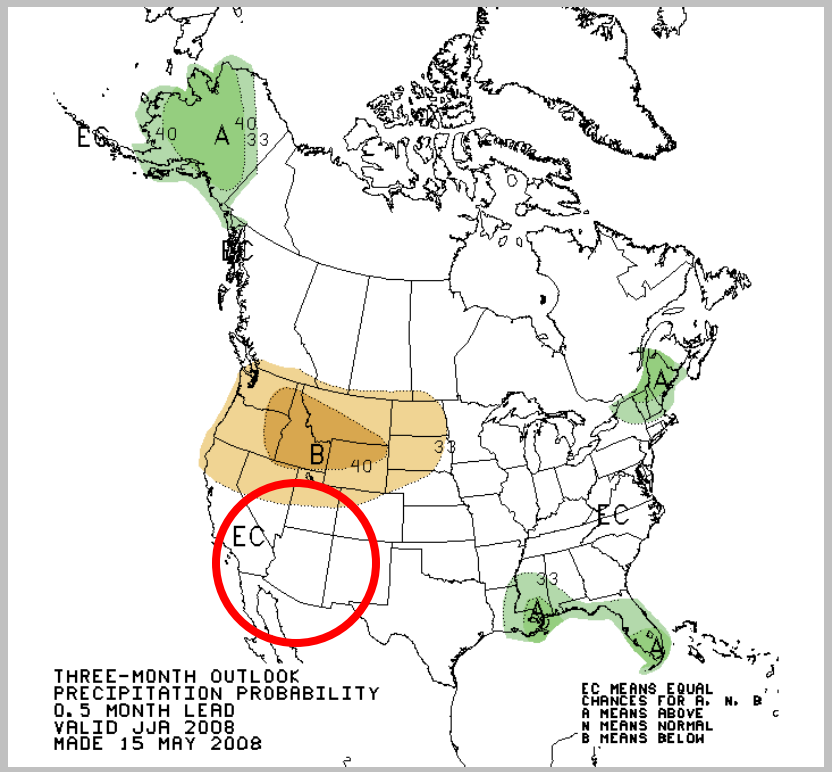
Current Outgoing Longwave Radiation (OLR) Anomalies

Warm colors = More Rainfall
Cool colors = Less Rainfall

http://www.cdc.noaa.gov/map/

Official Climate Prediction Center Forecast





Temperature forecasts are becoming more dominated by long-term trends, probably due to climate change.

“Equal chances” for monsoon precipitation in the Southwest.

http://www.cdc.noaa.gov

An “equal chances” monsoon CPC forecast is typical. Why??

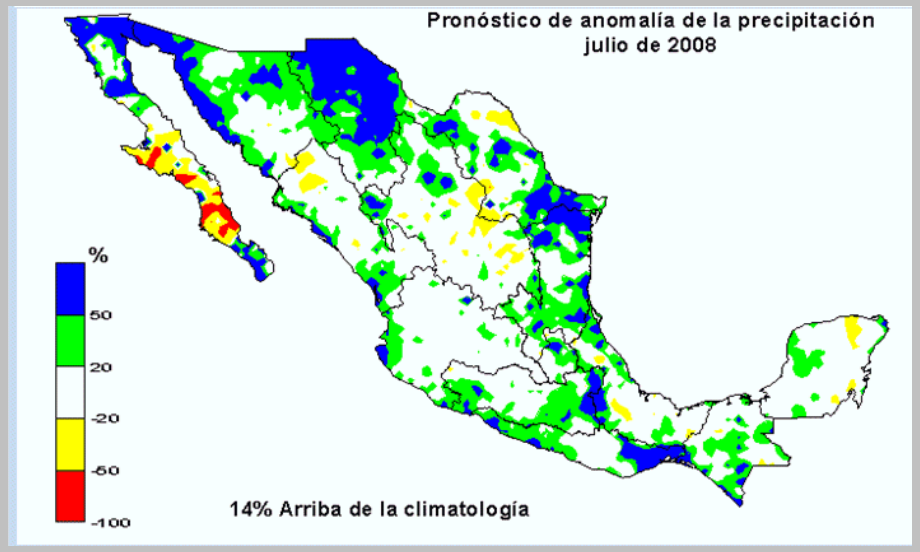
Likely reason: CPC forecasts are partly based on a global model (CFS). These models cannot resolve the local scale processes which lead monsoon rainfall very well.

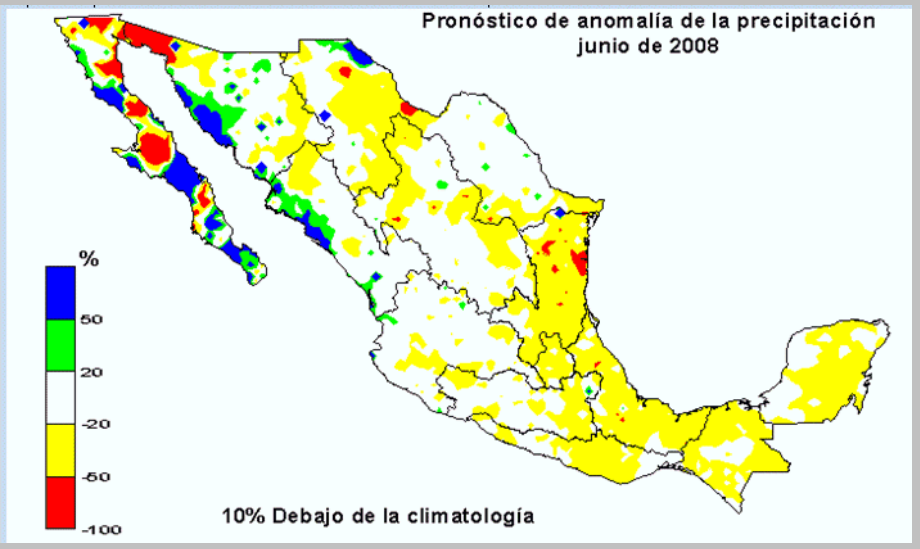
Also a major caveat in IPCC global warming projections for the Southwest!!

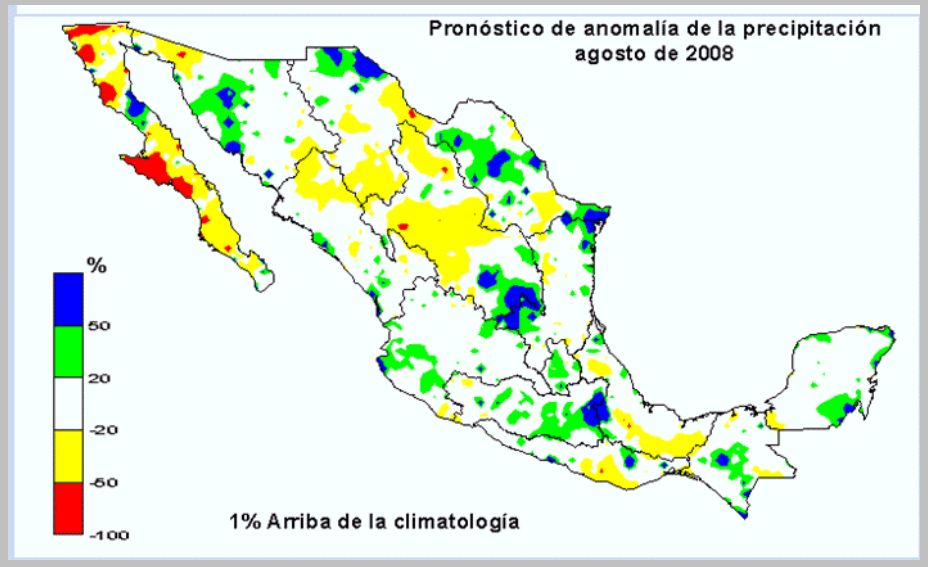
Alternatives to the official CPC forecast?

SMN Seasonal Forecast

CON BASE A LOS AÑOS
1950, 1951, 1955, 1975, 1999 Y 2001







http://smn.cna.gob.mx/productos/map-lluv/hmproduc.html

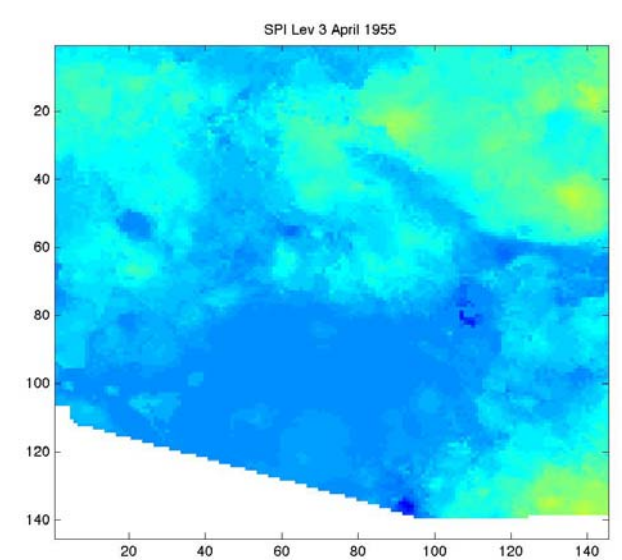
1955

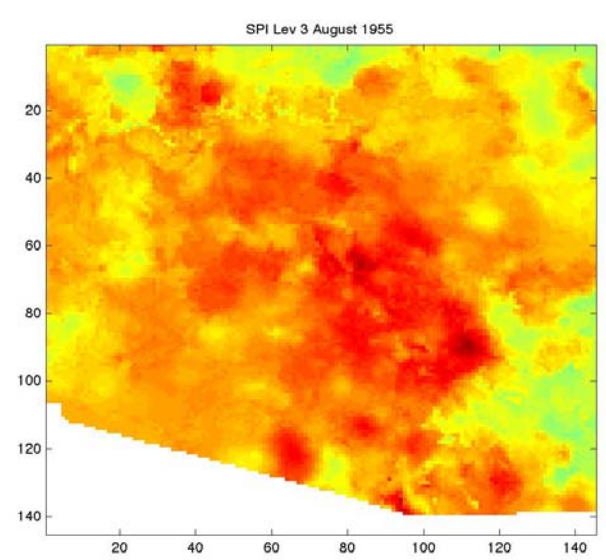
April

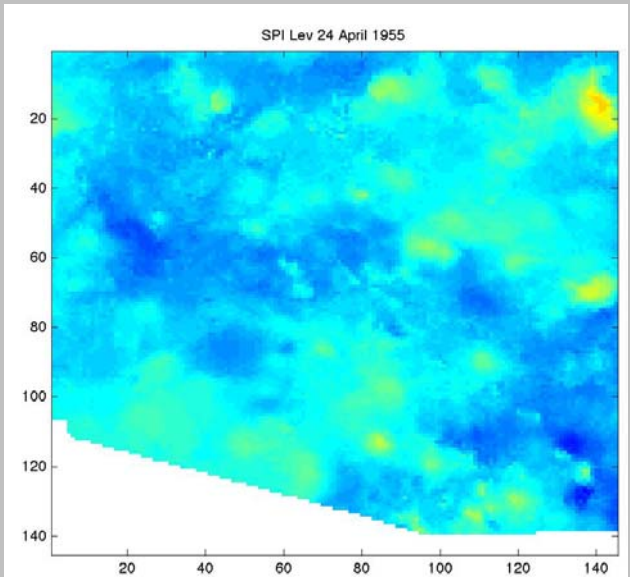
August

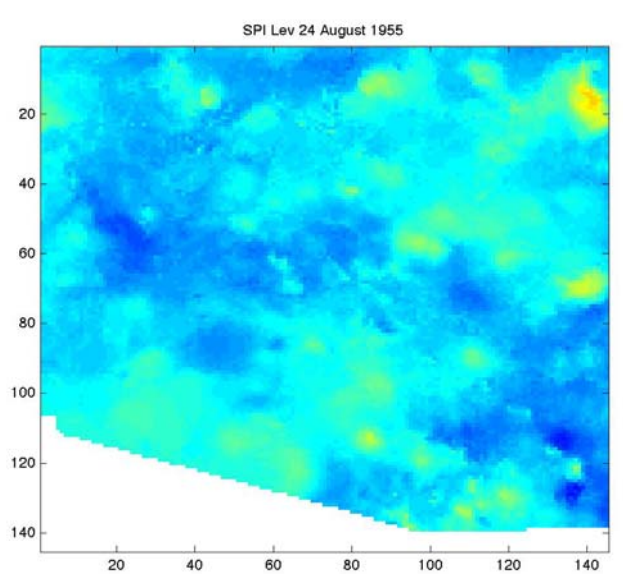
Short term (3 mo SPI)

Long term (2 yr SPI)

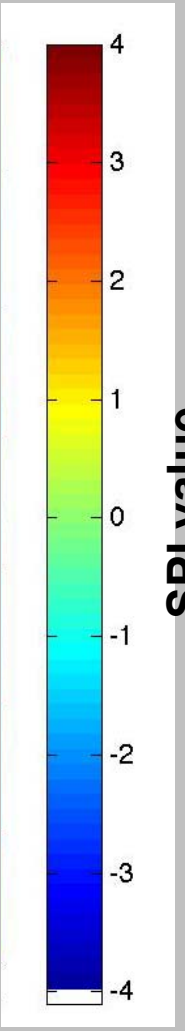






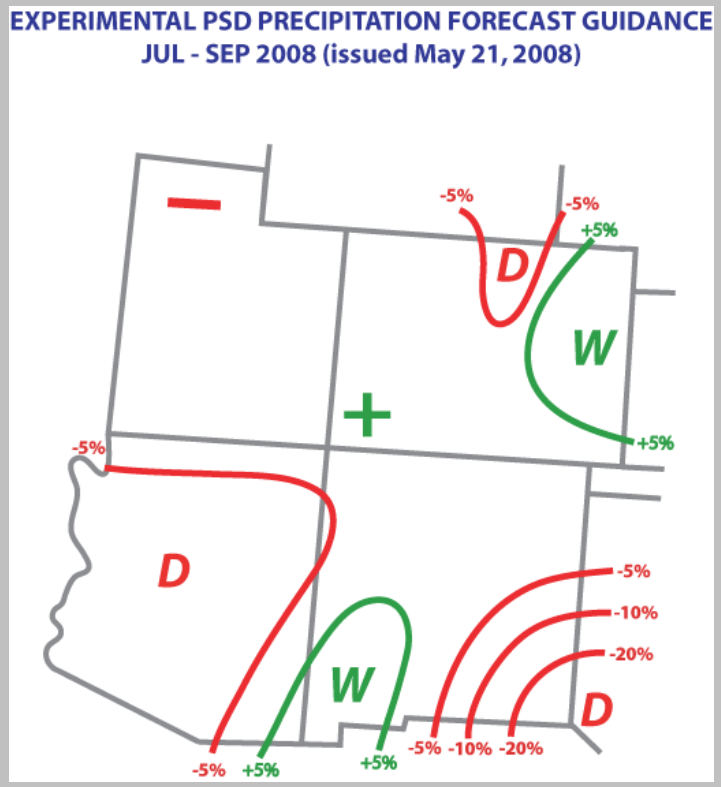


WET



DRY

Experimental Forecast by Dr. Klaus Wolter of NOAA CDC

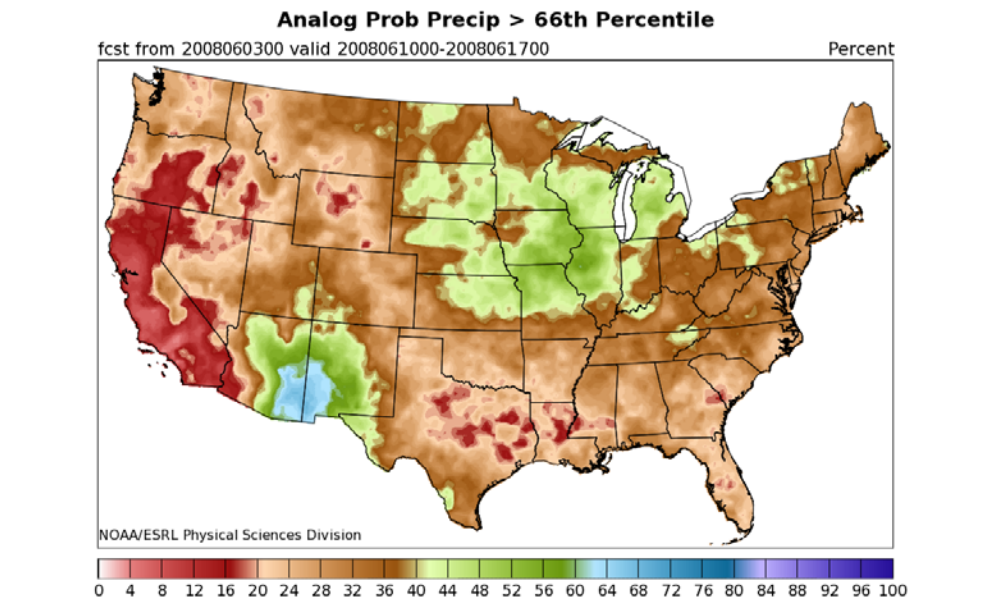


The forecast guidance based on a screening stepwise multiple regression procedure that requires that each new predictor explains at least an additional 10% of the predictand's variance.

The predictors include a variety of large-scale climate indices and regional precipitation anomalies.

http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/

Medium Range Statistical Downscaling of MRF Reforecasts at NOAA CDC



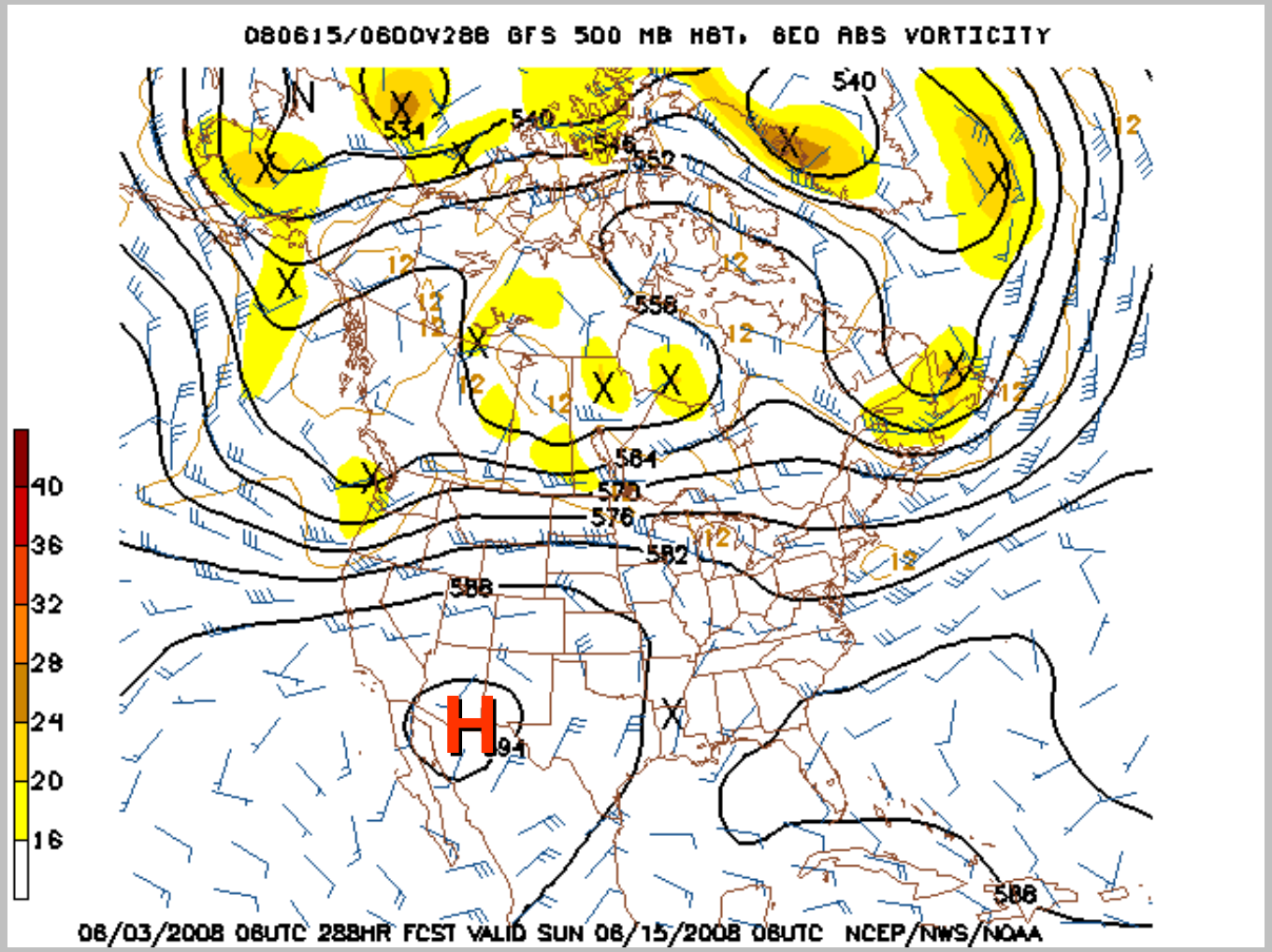
Probability that precipitation in the next 8-14 days (June 10th-17th) will be in upper tercile of the climatological distribution (i.e. above normal)

Use MRF reforecasts to find days in the past where the old forecasts were similar to the current forecast, and note the analyzed conditions associated with those forecasts.

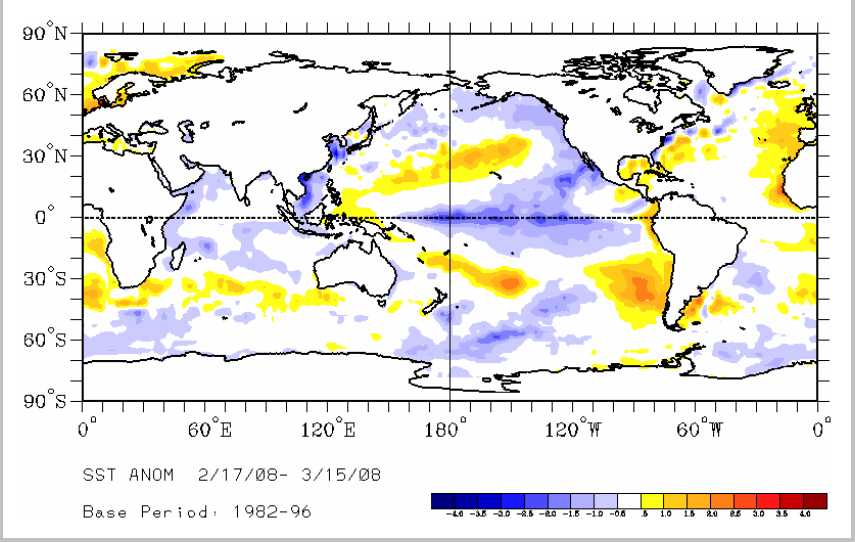
With knowledge of the dates of the similar forecasts, collect an ensemble of high-resolution analyzed precipitation conditions from the North American Regional Reanalysis (NARR)

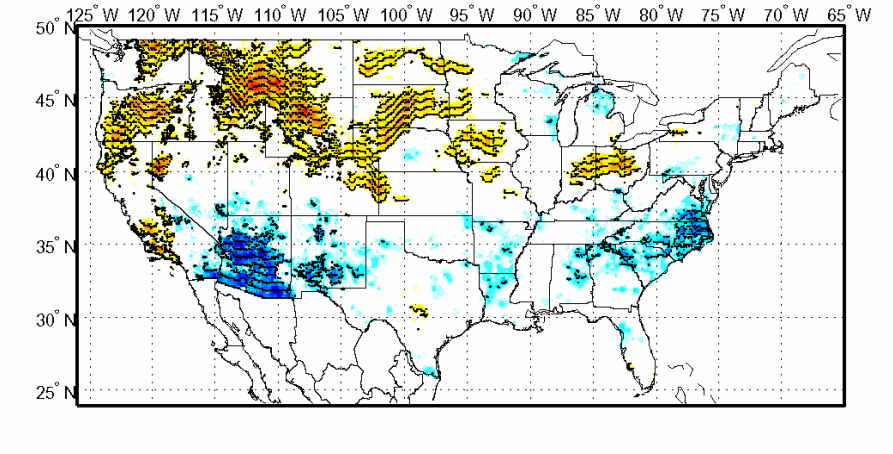
http://www.cdc.noaa.gov/reforecast/narr/

500-mb Height Forecast for June 14 (from NCEP)



What happens this summer, according to CPVM?





Antecedent spring CPVM relationship to monsoon onset SPI

A stronger, more north to northeastward positioning of monsoon ridge during onset period.

Hotter than average conditions before the monsoon arrives, with more lightning strikes and increased fire danger.

A greater frequency of weather disturbances and stronger diurnal cycle of thunderstorms

BOTTOM LINE: Above average rainfall in Arizona during late June to July period, below normal rainfall in Great Plains.

Other notes

What forecast guidance <u>cannot</u> provide:

A precise estimate of monsoon onset date at a given location, such as the previous Tucson NWS definition. All that can be said is that the onset is likely to be in late June to early July (before July 7 in Tucson).

Where exactly the most rain will fall. Depending on where the monsoon ridge is located will determine which specific regions in the Southwest will be the wettest. In general, though, the present scenario favors above normal precipitation for western new Mexico and most of Arizona.

Department of Atmospheric Science Monsoon Forecast Discussions

Start June 15

Physics and Atmospheric Sciences Building Rm. 488 at 1 pm.

Will utilize high resolution WRF model output for Arizona (1.8 km)

If interested contact Mike Leuthold in ATMO (leuthold@atmo.arizona.edu)

Daily forecast summaries will be posted and available through the Department of Atmospheric Sciences website.

Updated Monsoon Weather Pages from Tucson NWS

http://www.wrh.noaa.gov/twc/monsoon/monsoon_tracker.php

Topics:

Monsoon statistics
Dewpoint data
Monsoon rainfall
What is the monsoon?
Tracking the monsoon

Information on monsoon background updated with latest "state of the science" from North American Monsoon Experiment.