Arizona Climate

An Overview for the Master Watershed Steward Program

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Overview

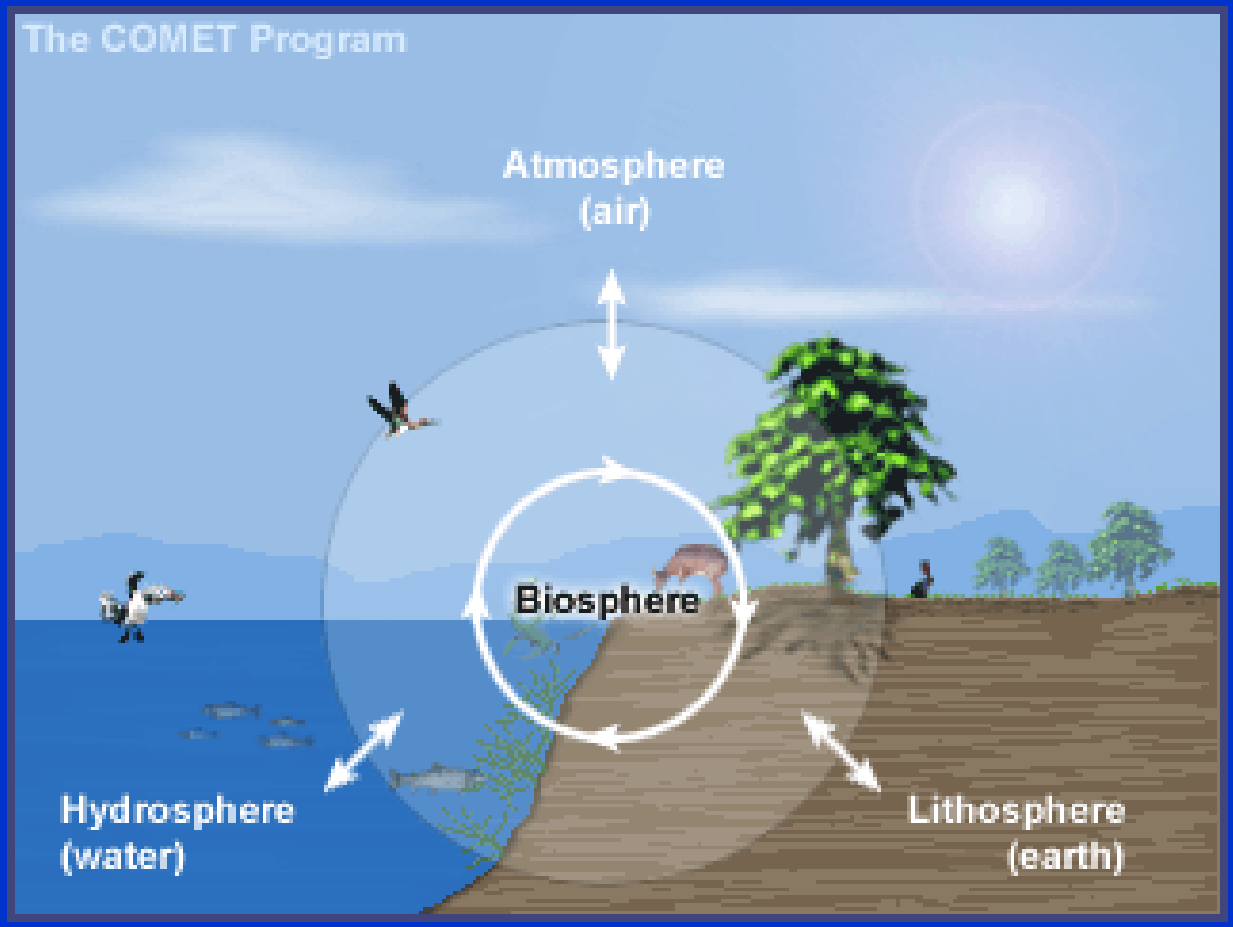
- Intro to Climatology
- Climatic Controls
- Regional Climate Variability and ENSO
- Climate Monitoring and Forecasts

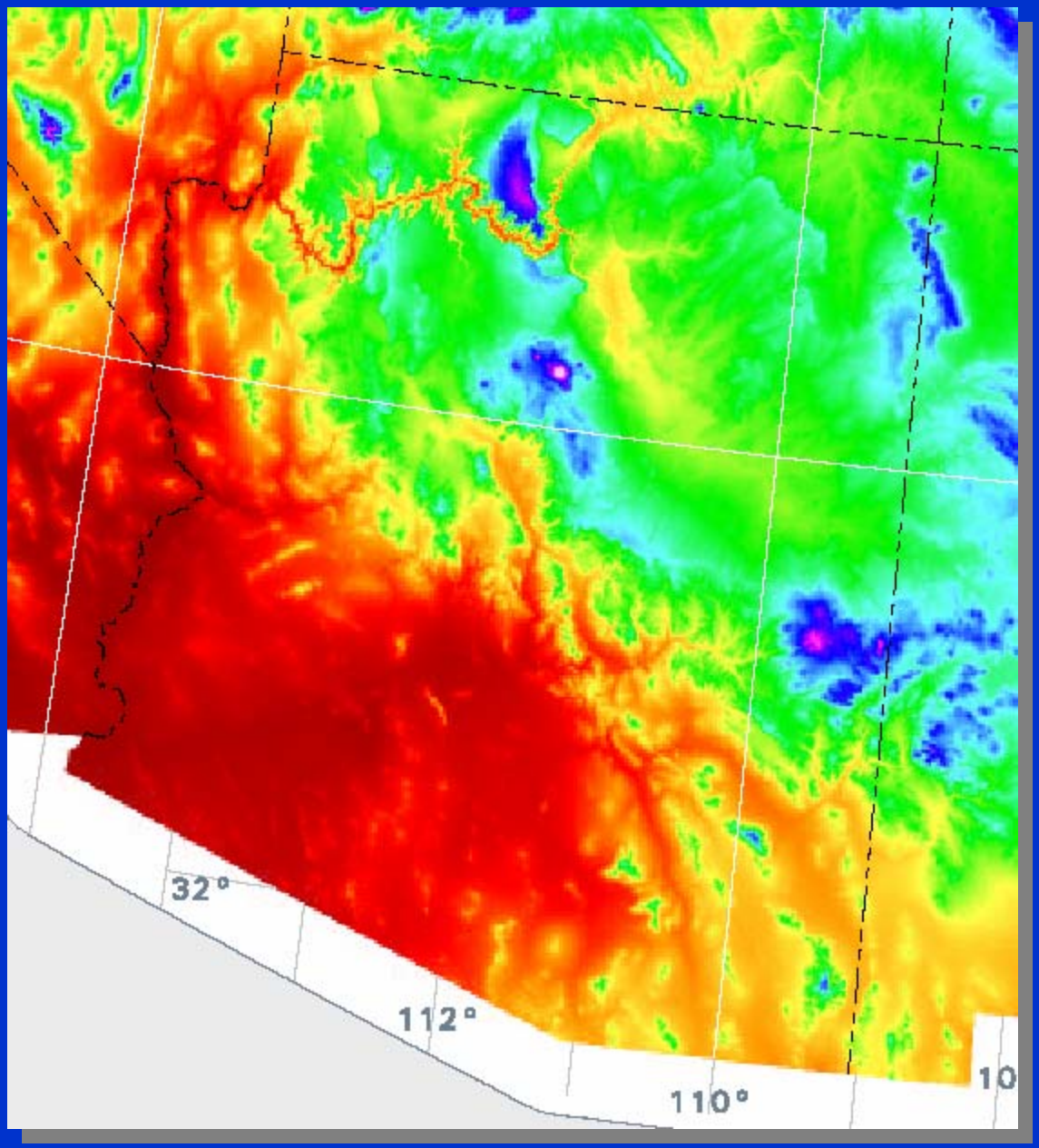
Climatology

"Climate is what you expect, weather is what you get."
-Robert Heinlein

- Climatology: analyzes long-term weather patterns over time or space.
- Climate is a strong determinant of where major ecosystems are found.
- Climate Components
  - insolation
  - temperature
  - air pressure
  - air masses
  - precipitation

Connections



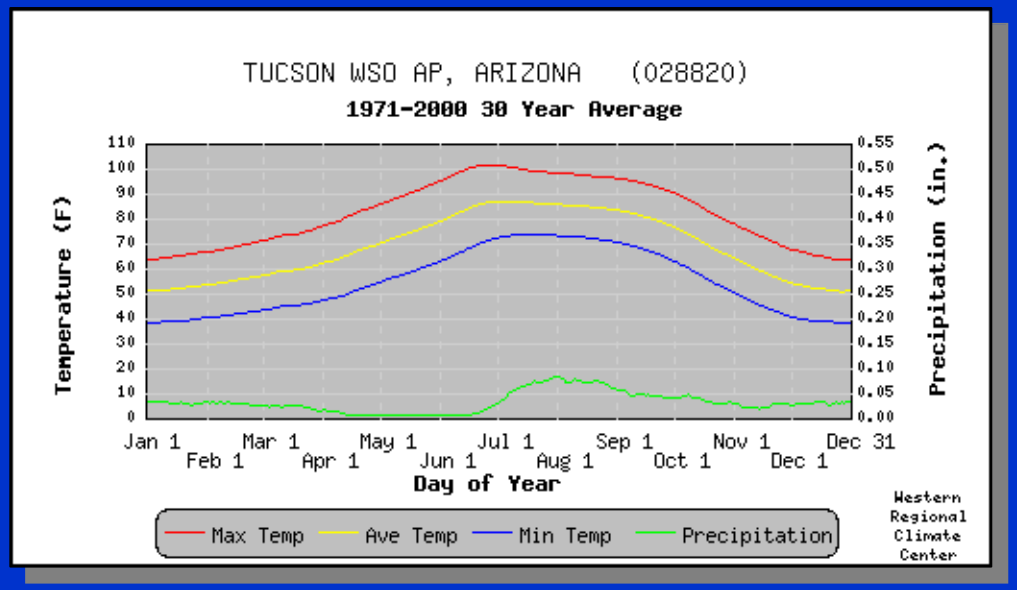


Average Arizona Temperatures

- Inland, continental location
- Subtropical high position
- Governed by elevation

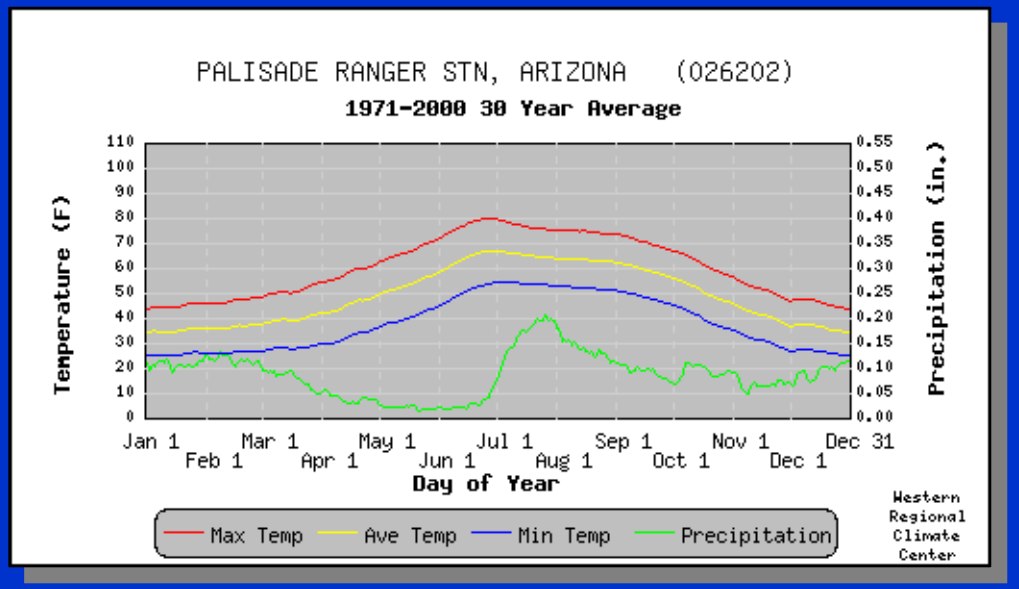
Map from http://www.daymet.org

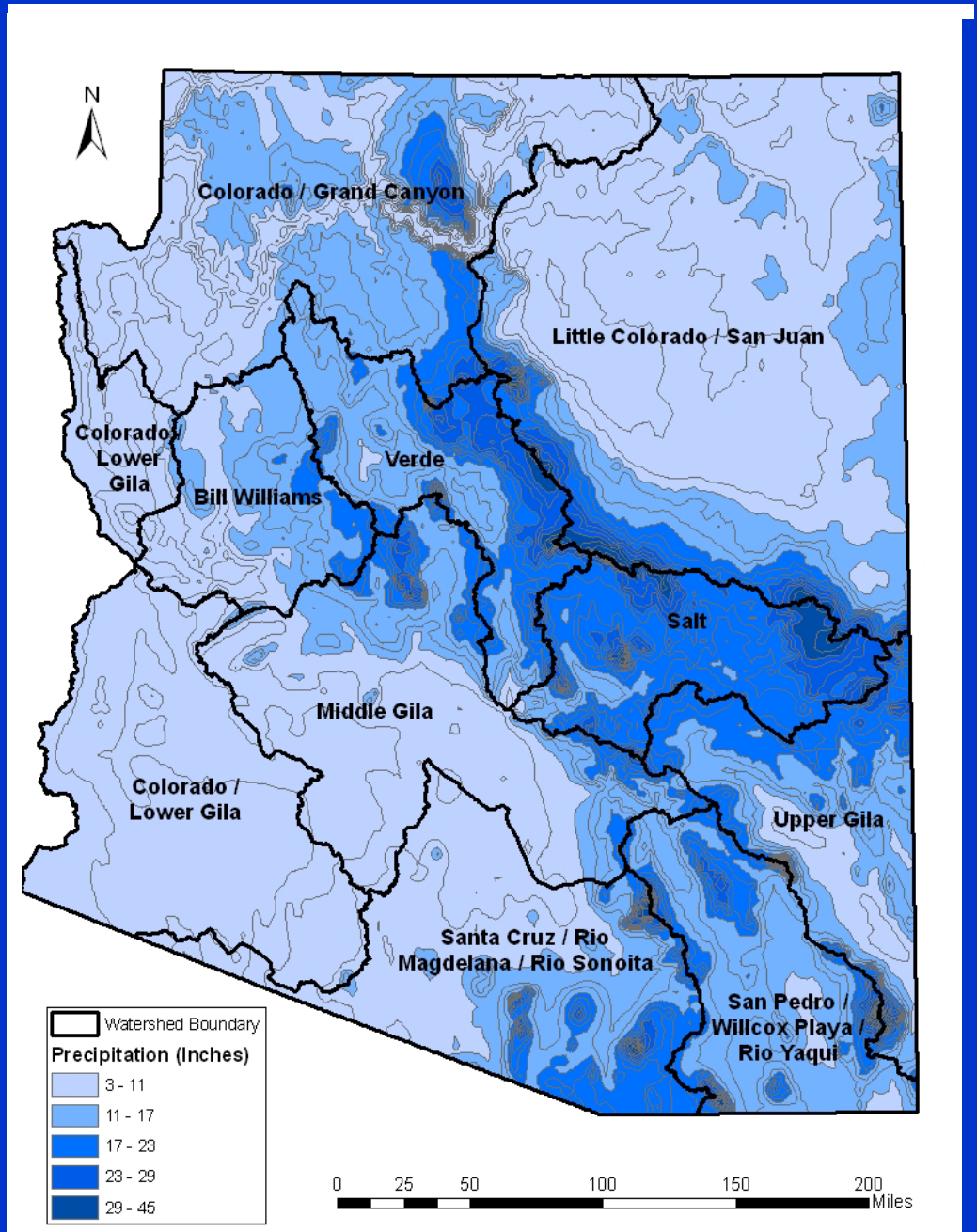
Elevation and Climate



Tucson: 2560 ft.

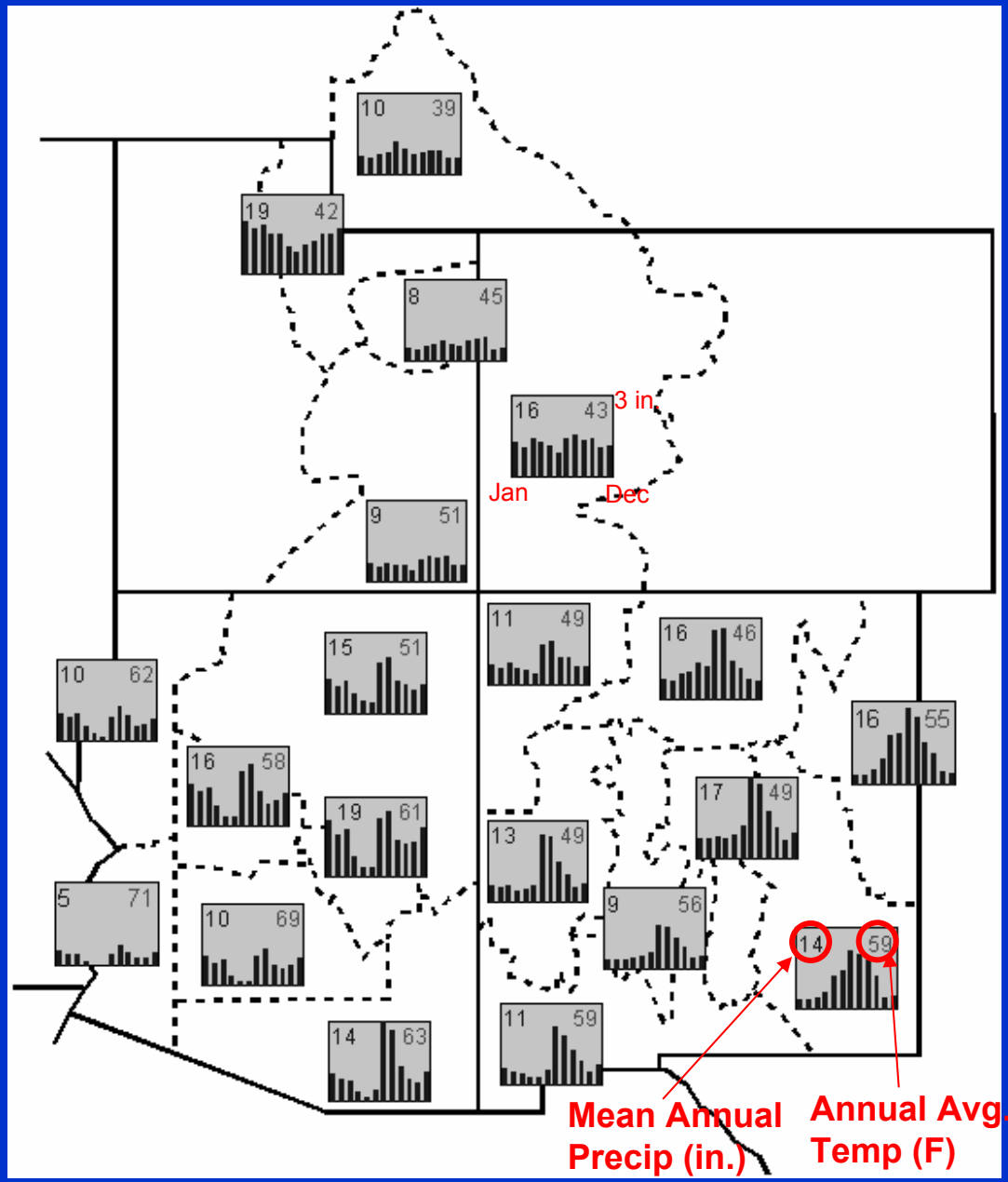
Palisades: 7960 ft.





Average Arizona Precipitation

Seasonal Distribution of Precipitation



- More winter precip in northern AZ
- Stronger monsoon signal in southeast AZ (more summer precip)

(graphic from Sheppard, et al. 2000)

Synoptic Circulation Patterns

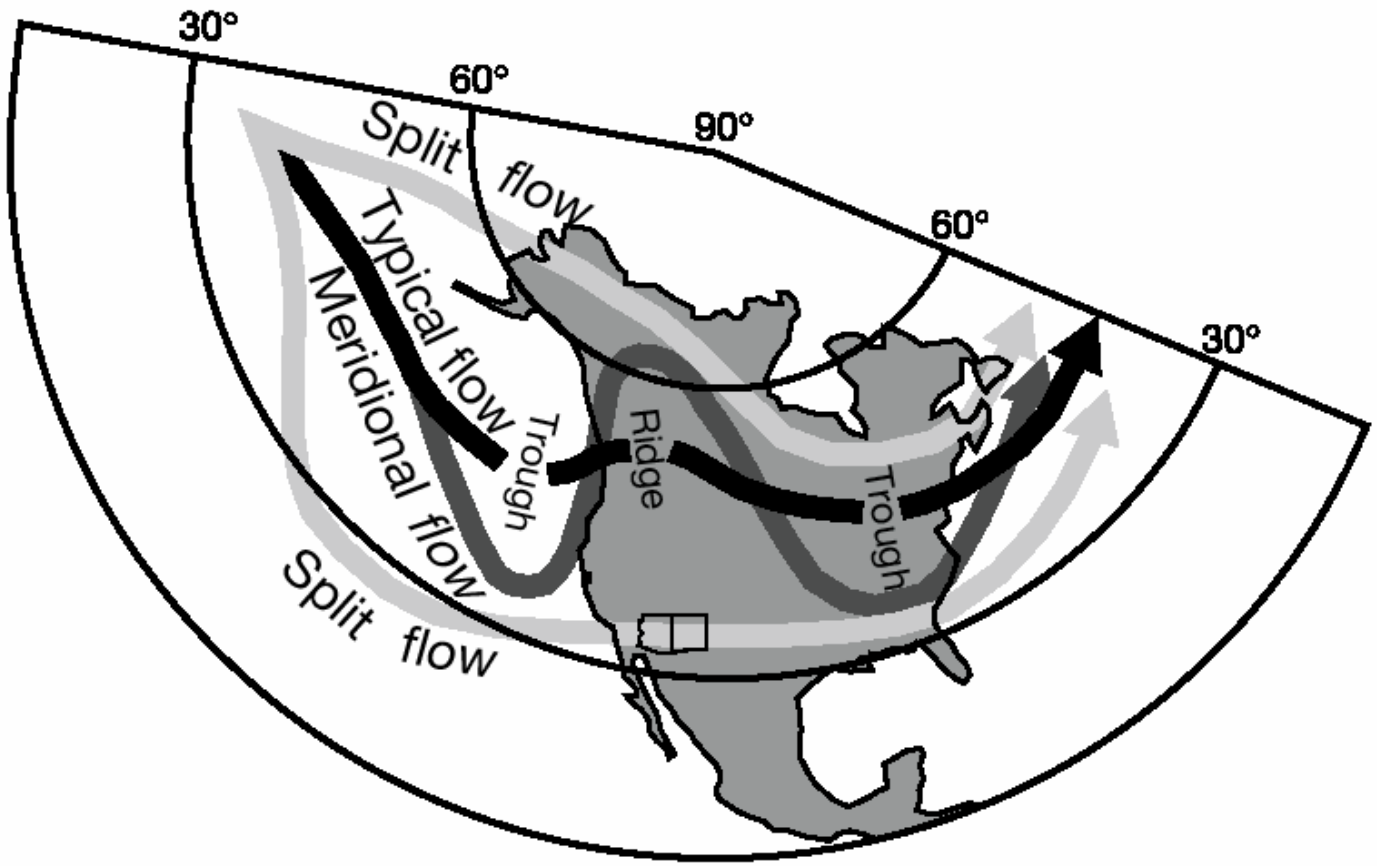


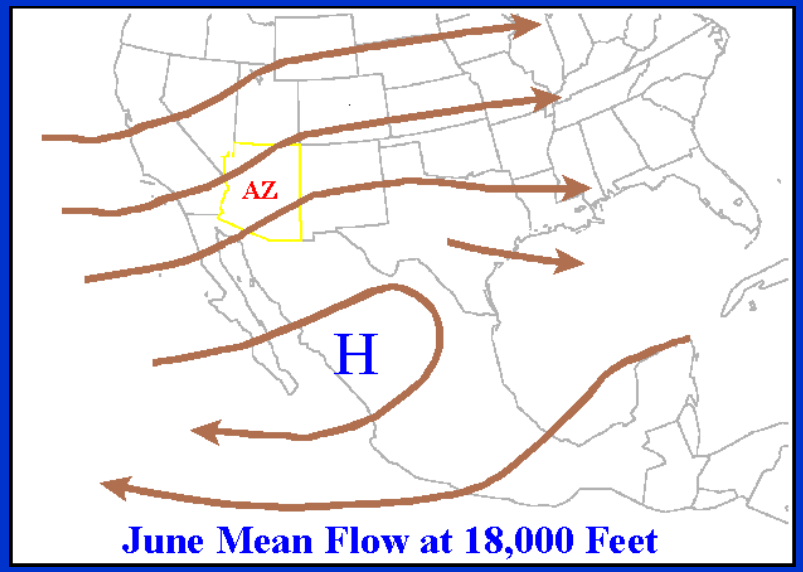
Fig. 6. Winter flow patterns drawn from circulation patterns at the 700 mb geopotential height, which relates well to the climate over North America (Jorgensen et al. 1967)

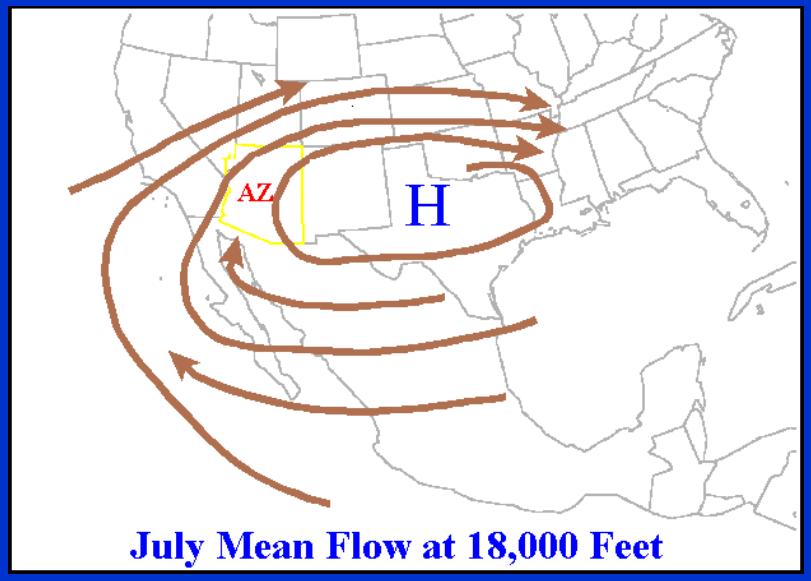
North American Monsoon

Monsoon

Monsoon start dates for Tucson

- Average start July 3rd
- Earliest start June 17 2000
- Latest start July 25 1987

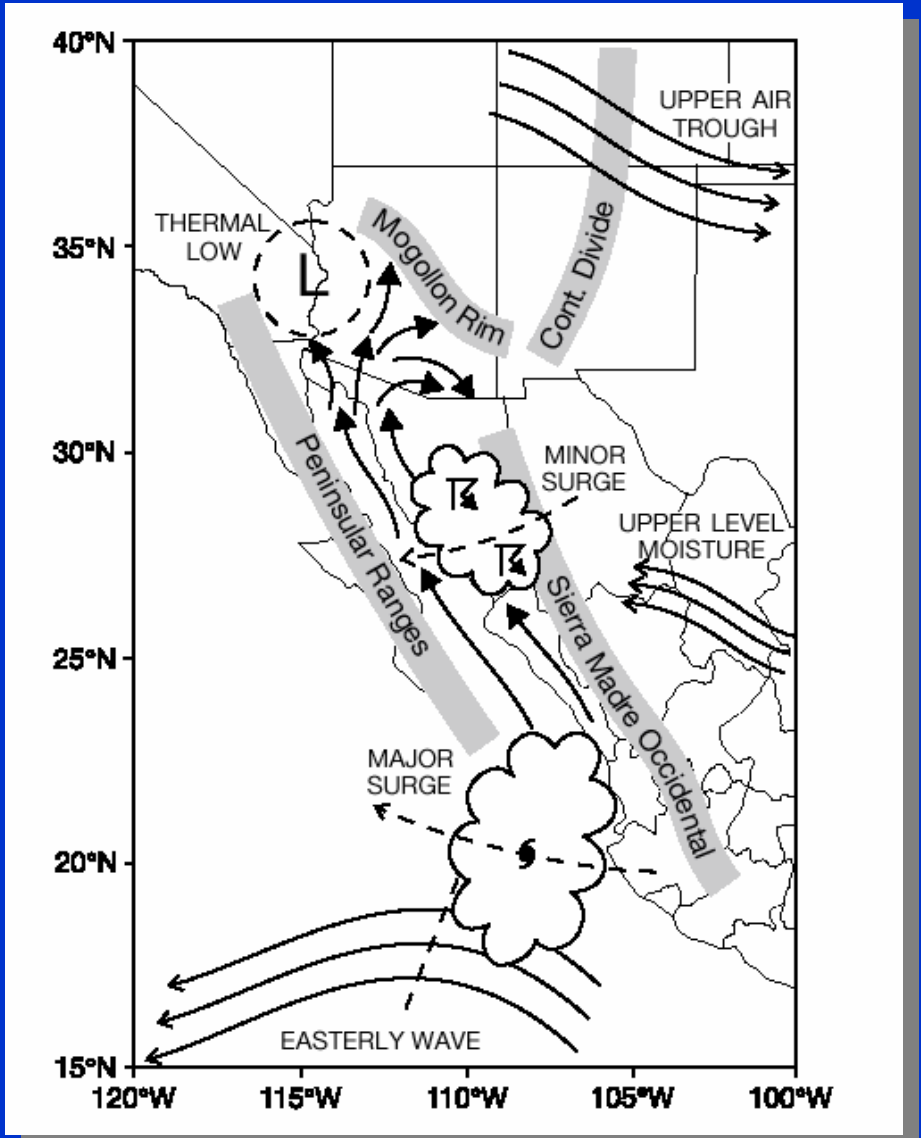




Monsoon season rainfall (June 15th to September 30th)

- Average monsoon season rainfall 6.06”
- Driest monsoon season 1.59” in 1924
- Wettest monsoon season 13.84” in 1964

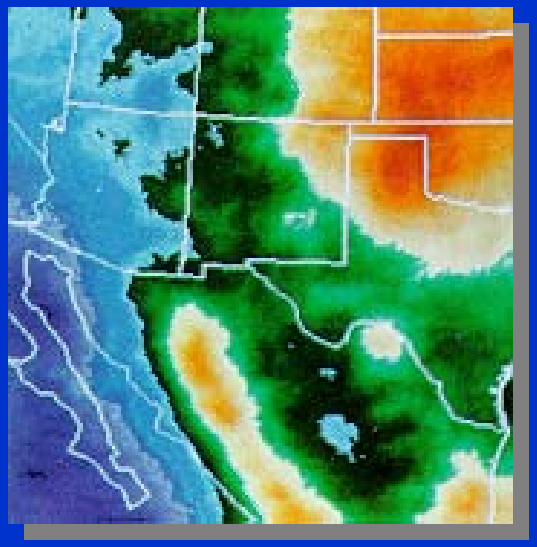
Monsoon Dynamics



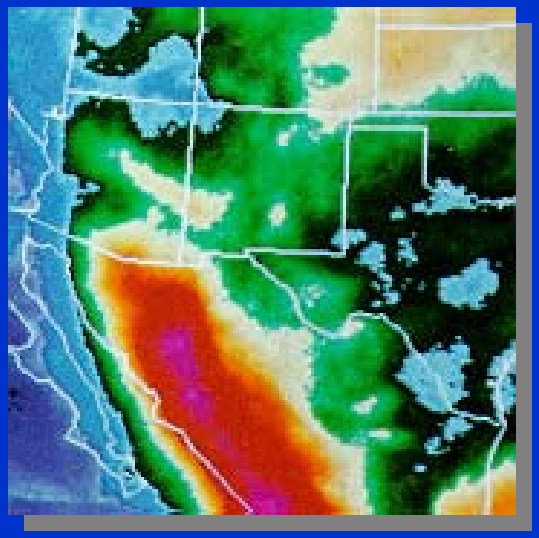
From Adams & Comrie 1997

Satellite View of Monsoon

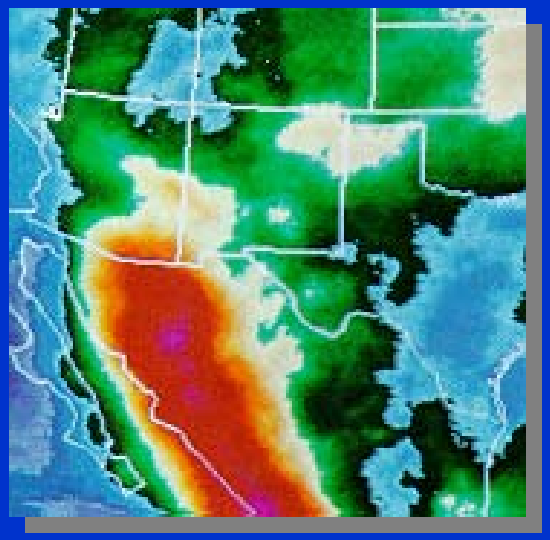
June



July



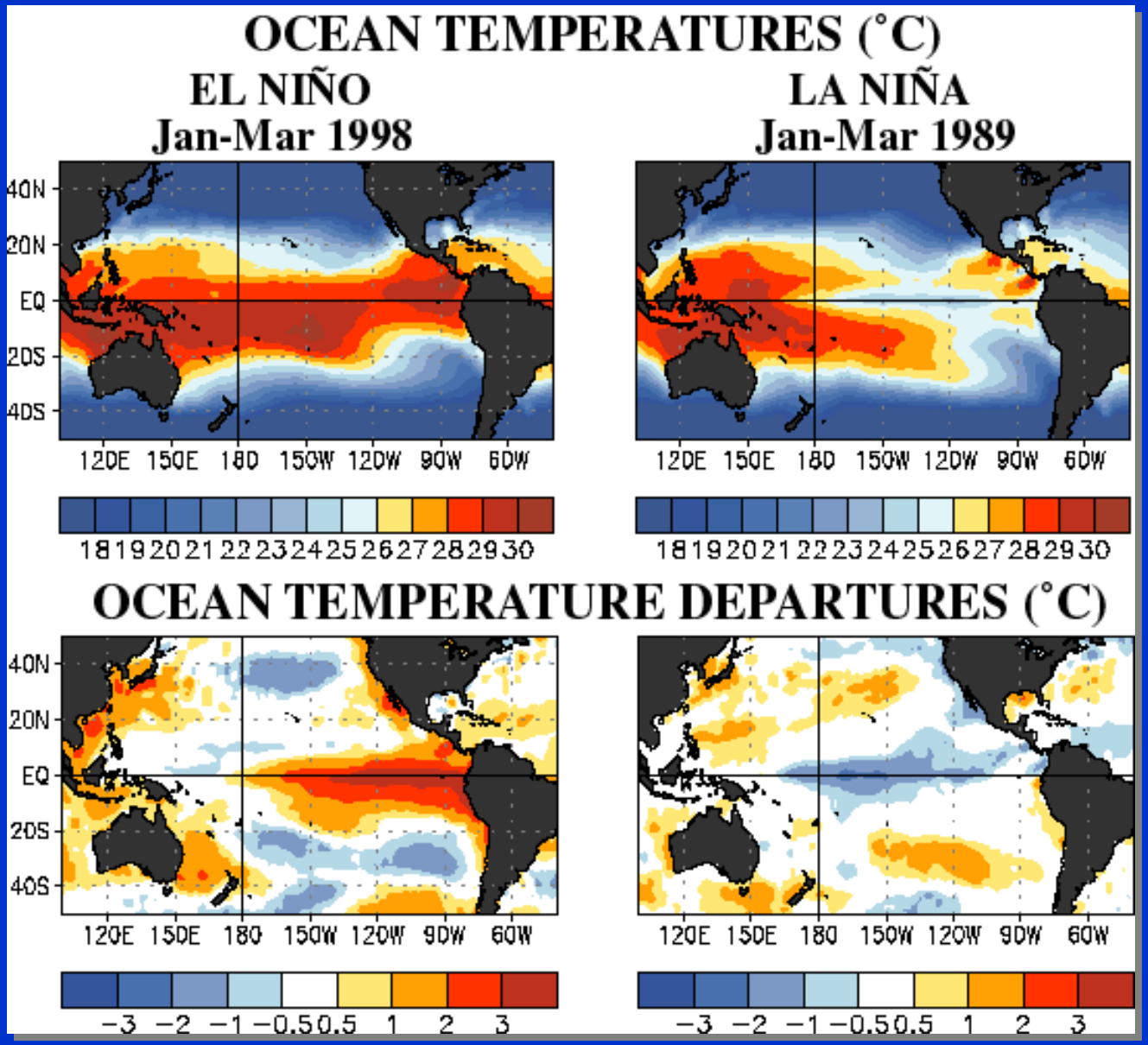
August



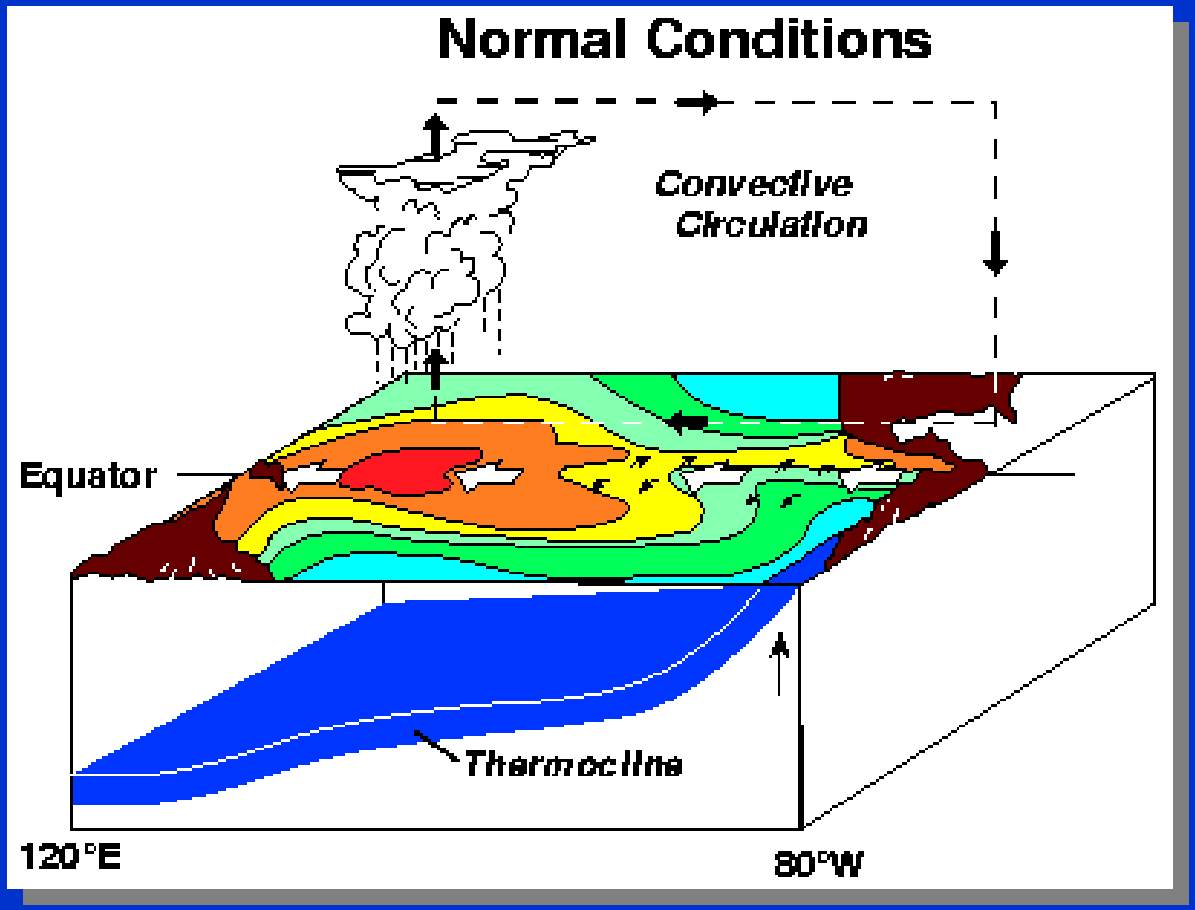
- Colors indicate cloud top heights (reds:high, greens:low)
- Higher the clouds, the more intense the convection

Climate Variability and ENSO

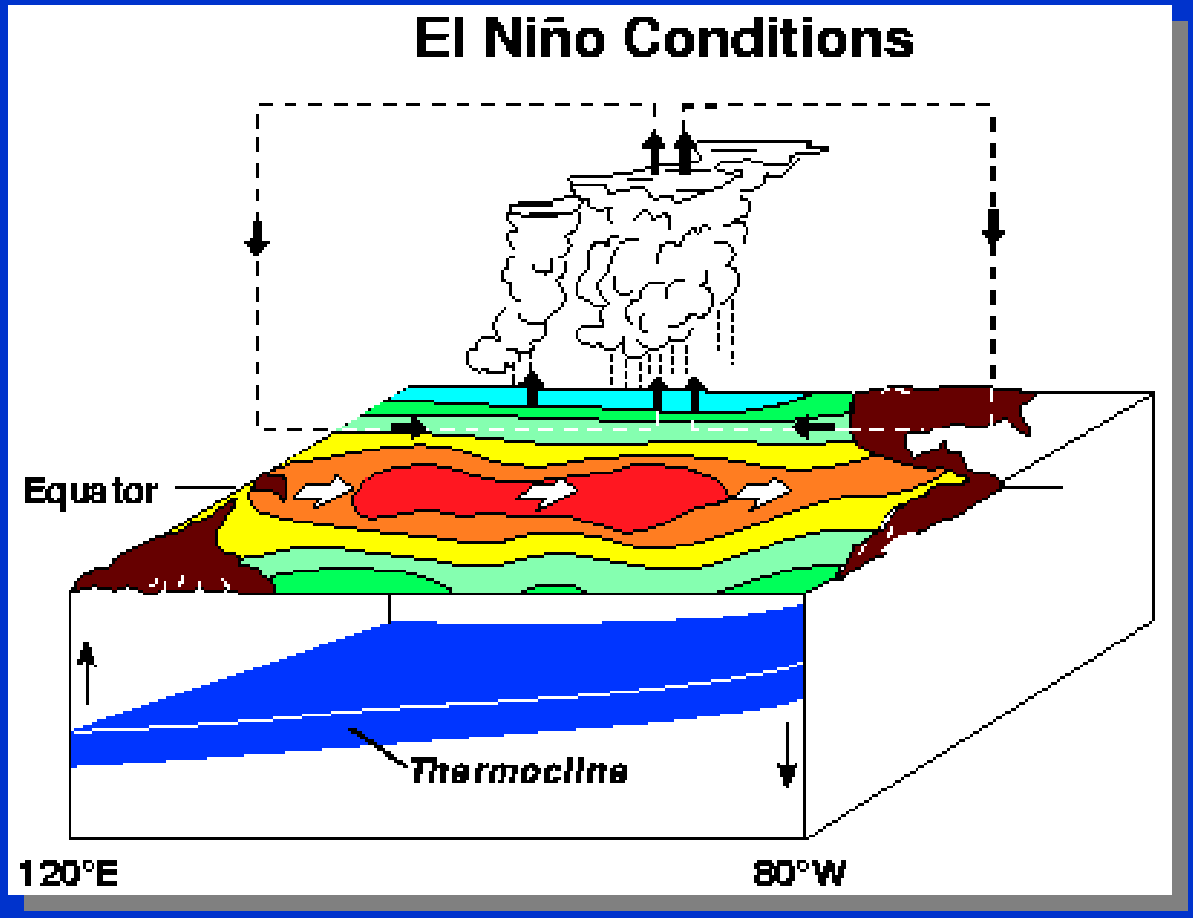
What are El Nino and La Nina?



Atmosphere-Ocean Coupling



Atmosphere-Ocean Coupling



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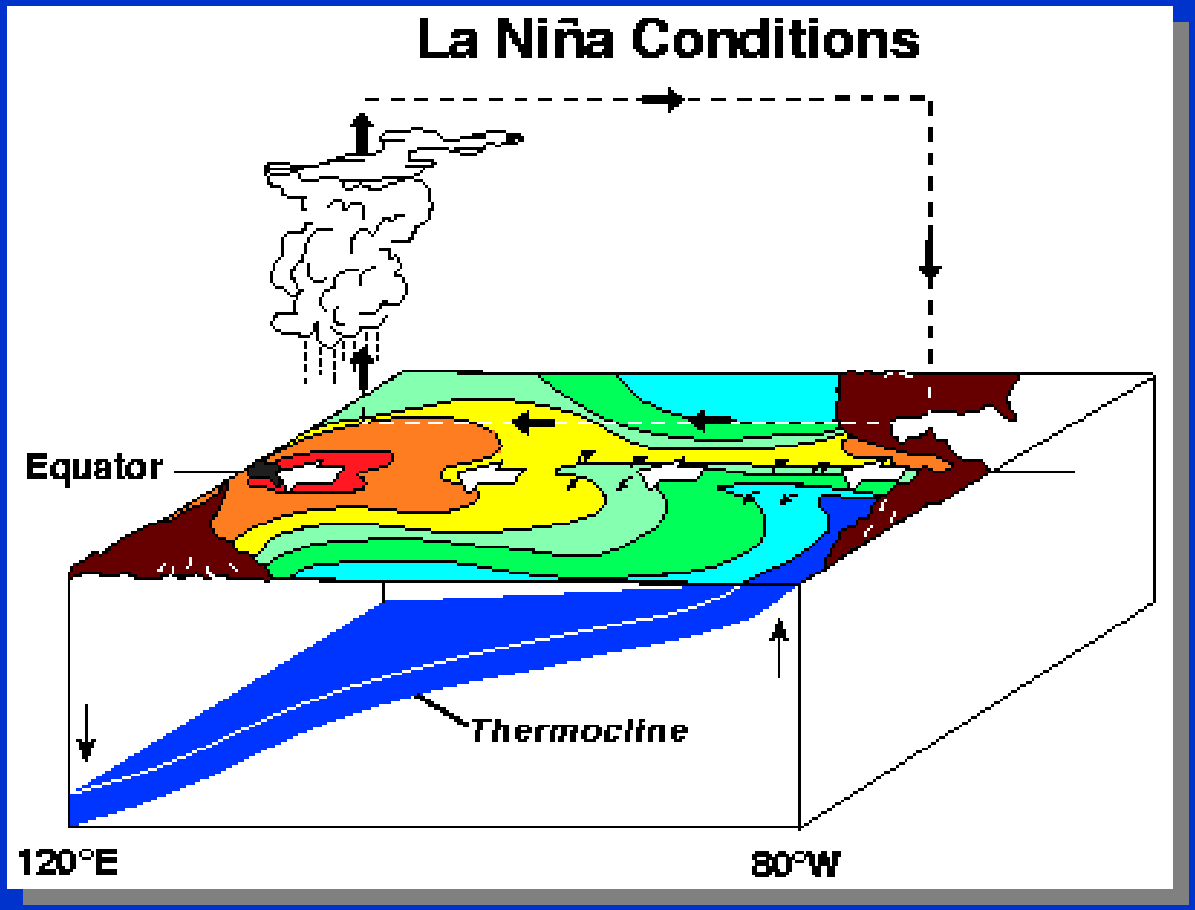
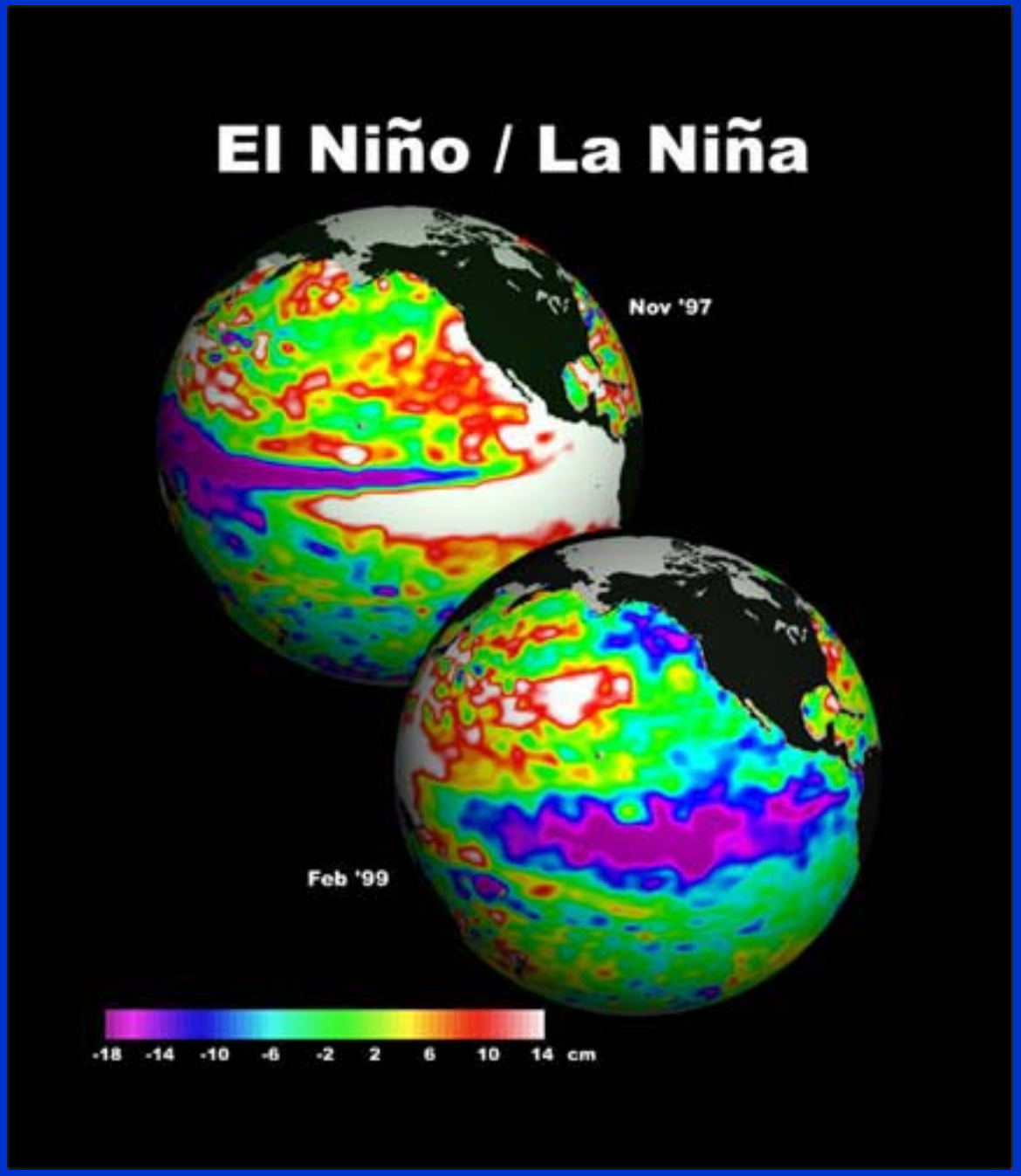
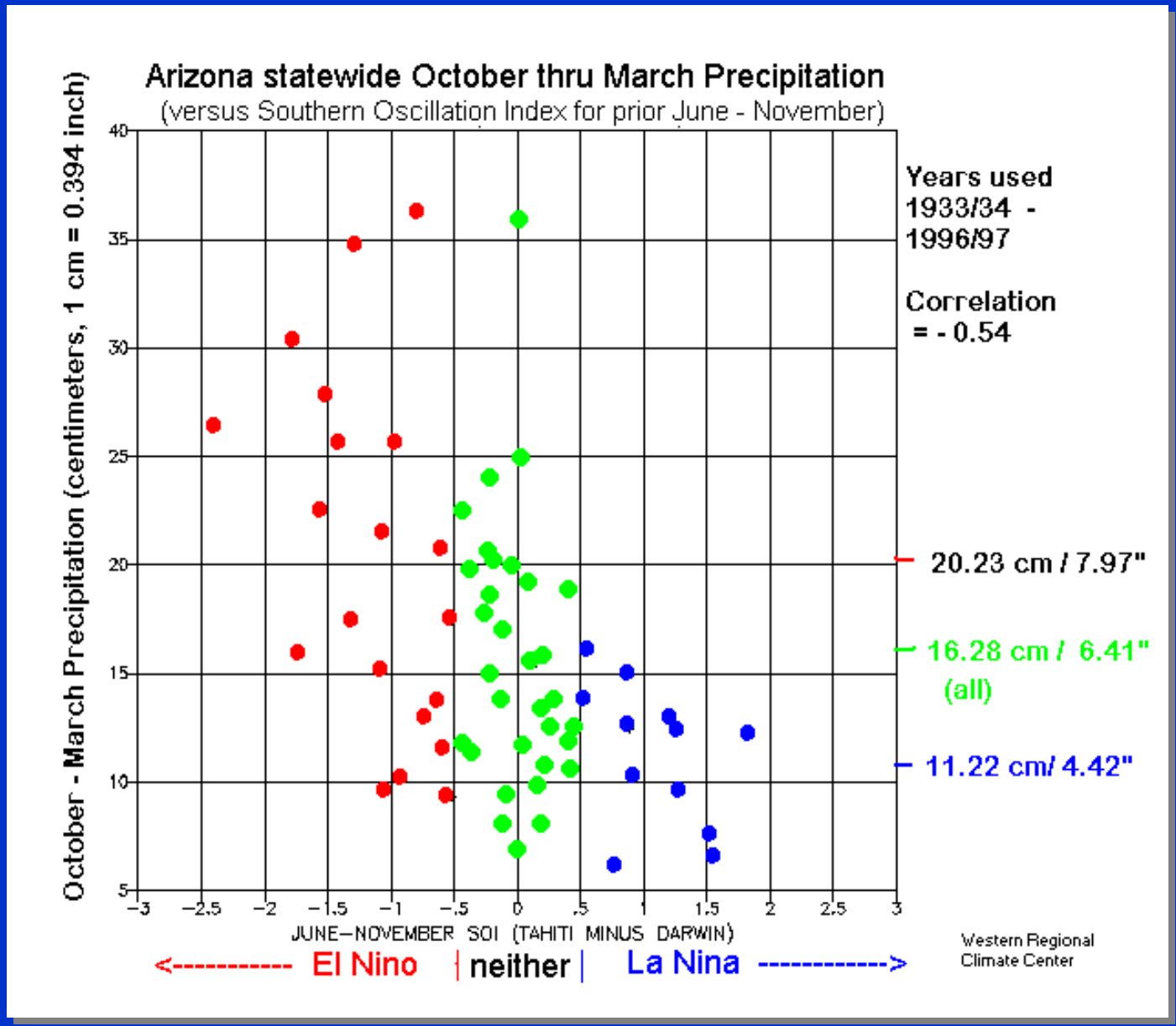


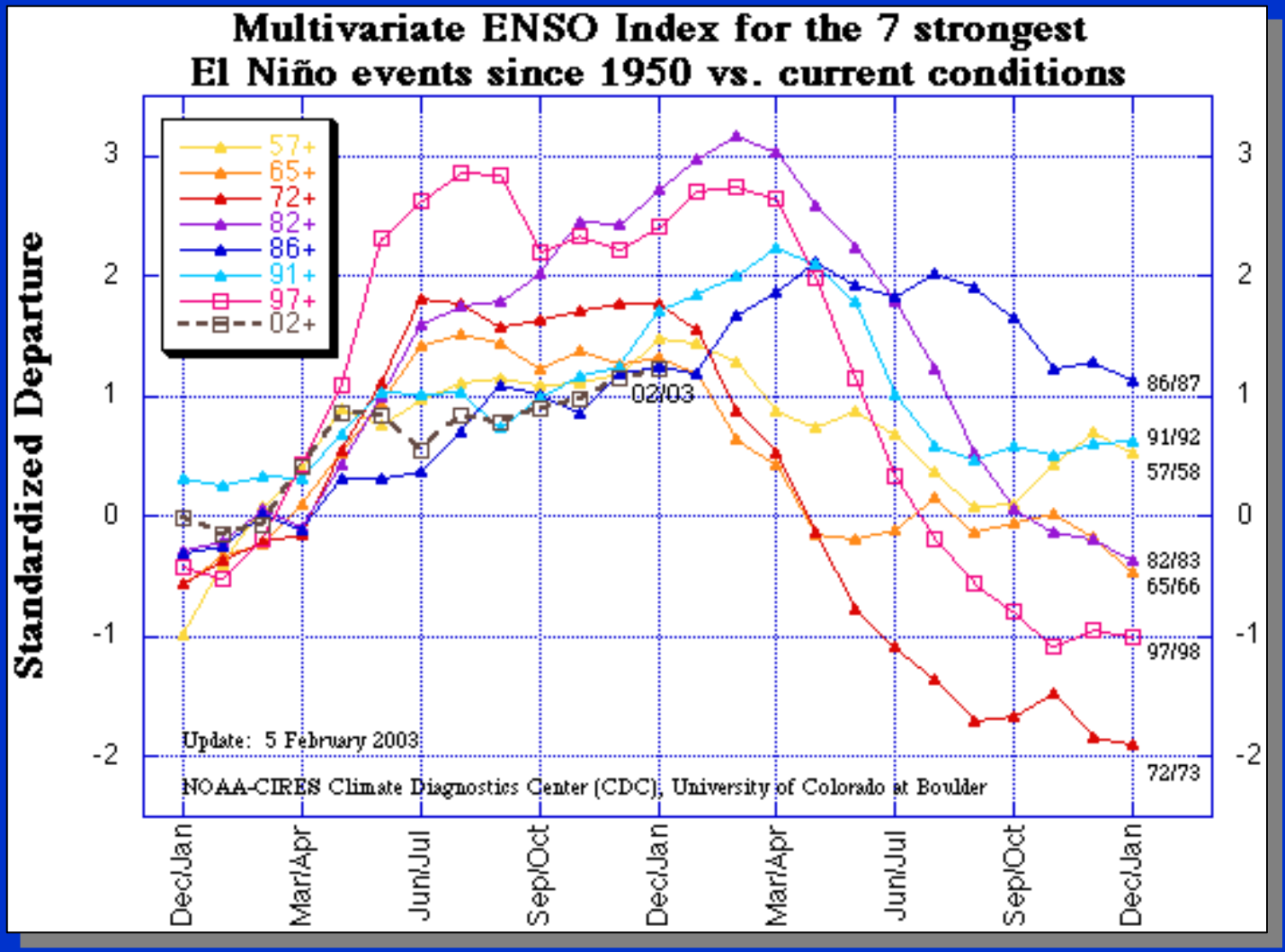


Sea Surface Height

Local ENSO Connection

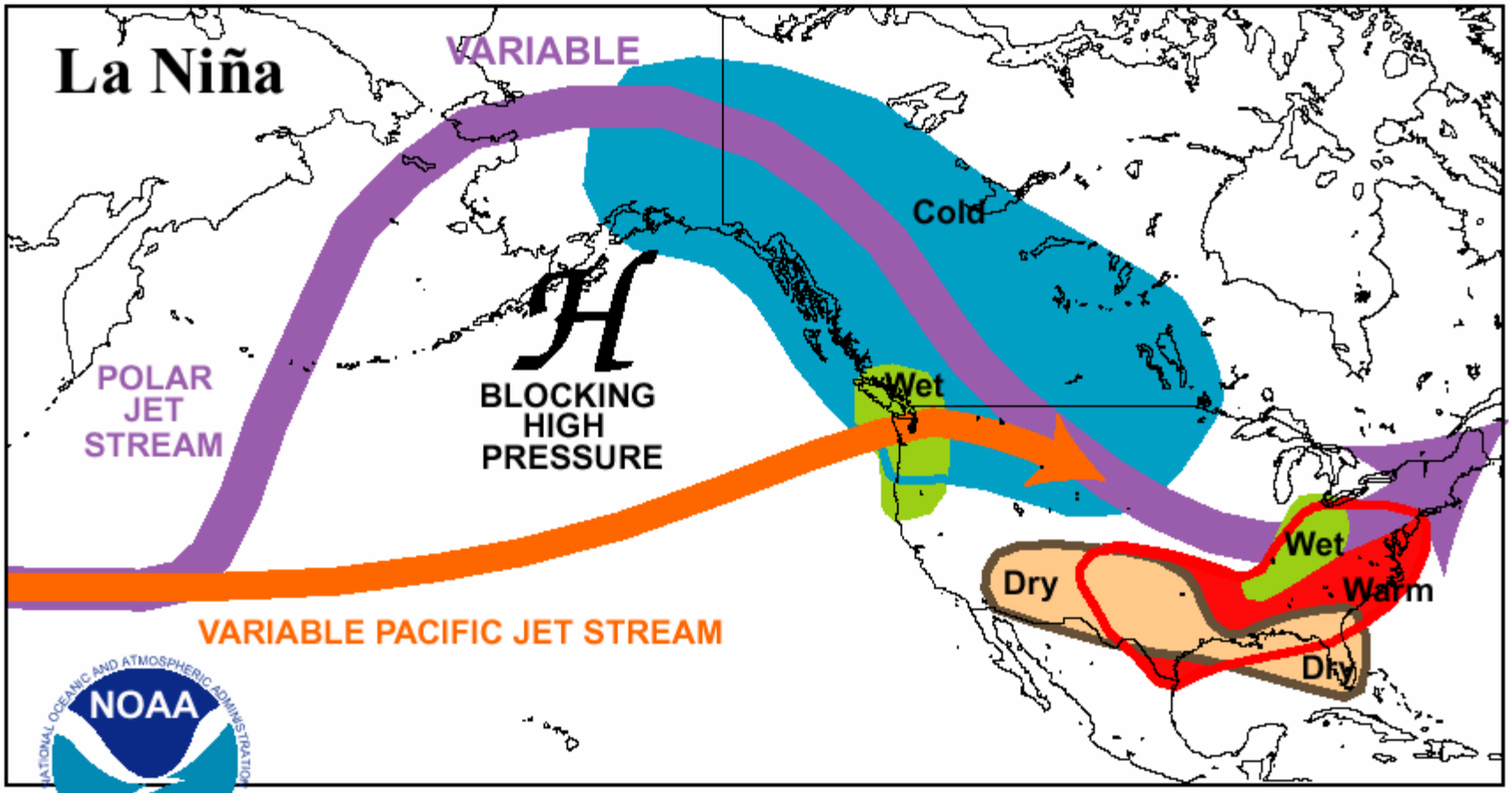


El Nino Comparisons

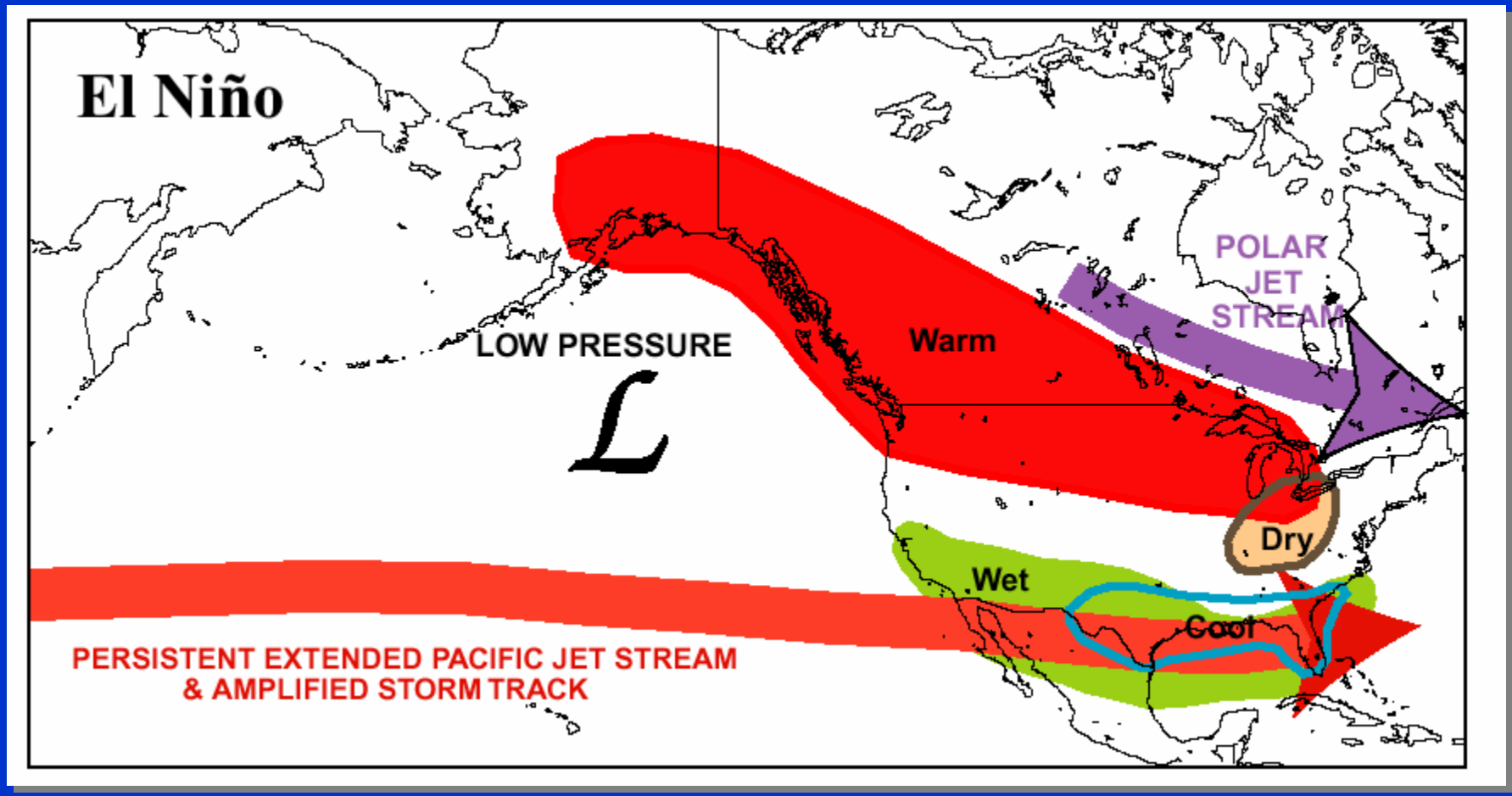


(From http://www.cdc.noaa.gov/)

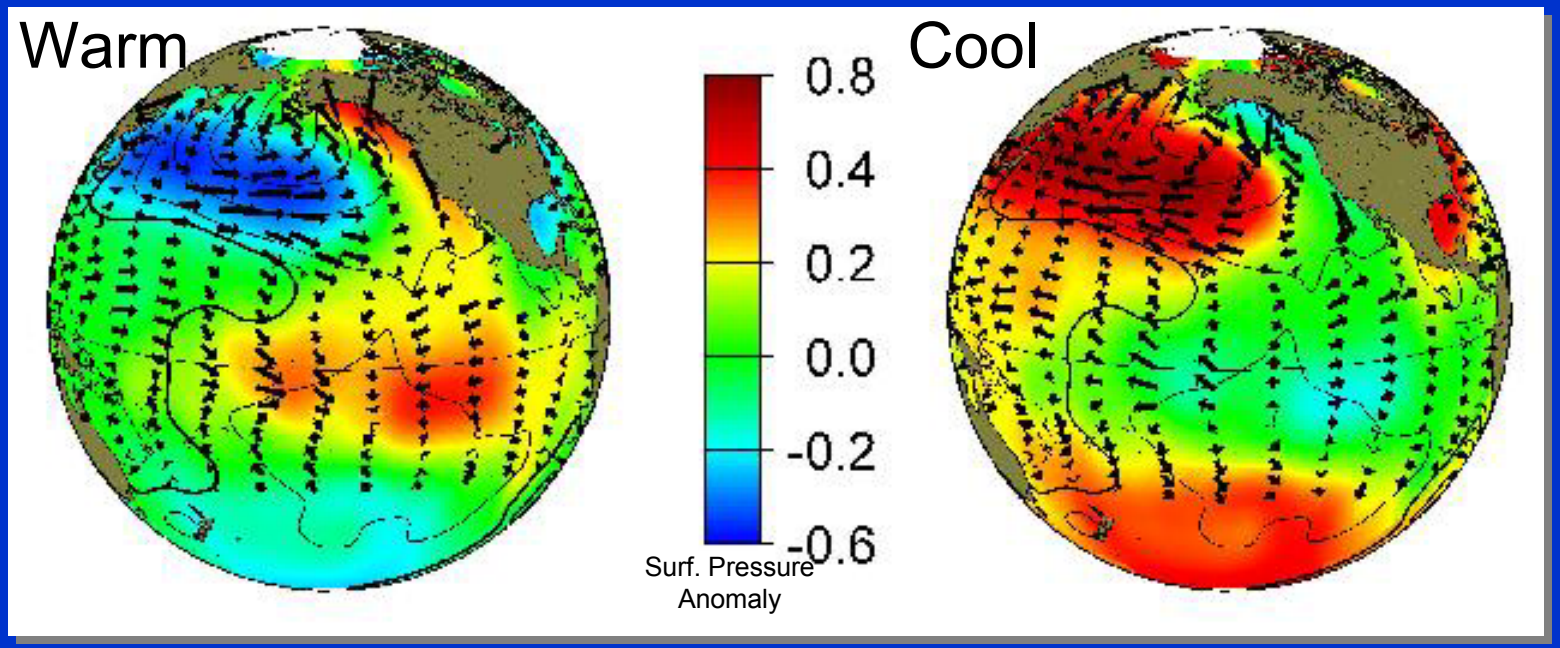
Dominant Circulation Pattern: La Nina Winter



Dominant Circulation Pattern: El Nino Winter



Pacific Decadal Oscillation

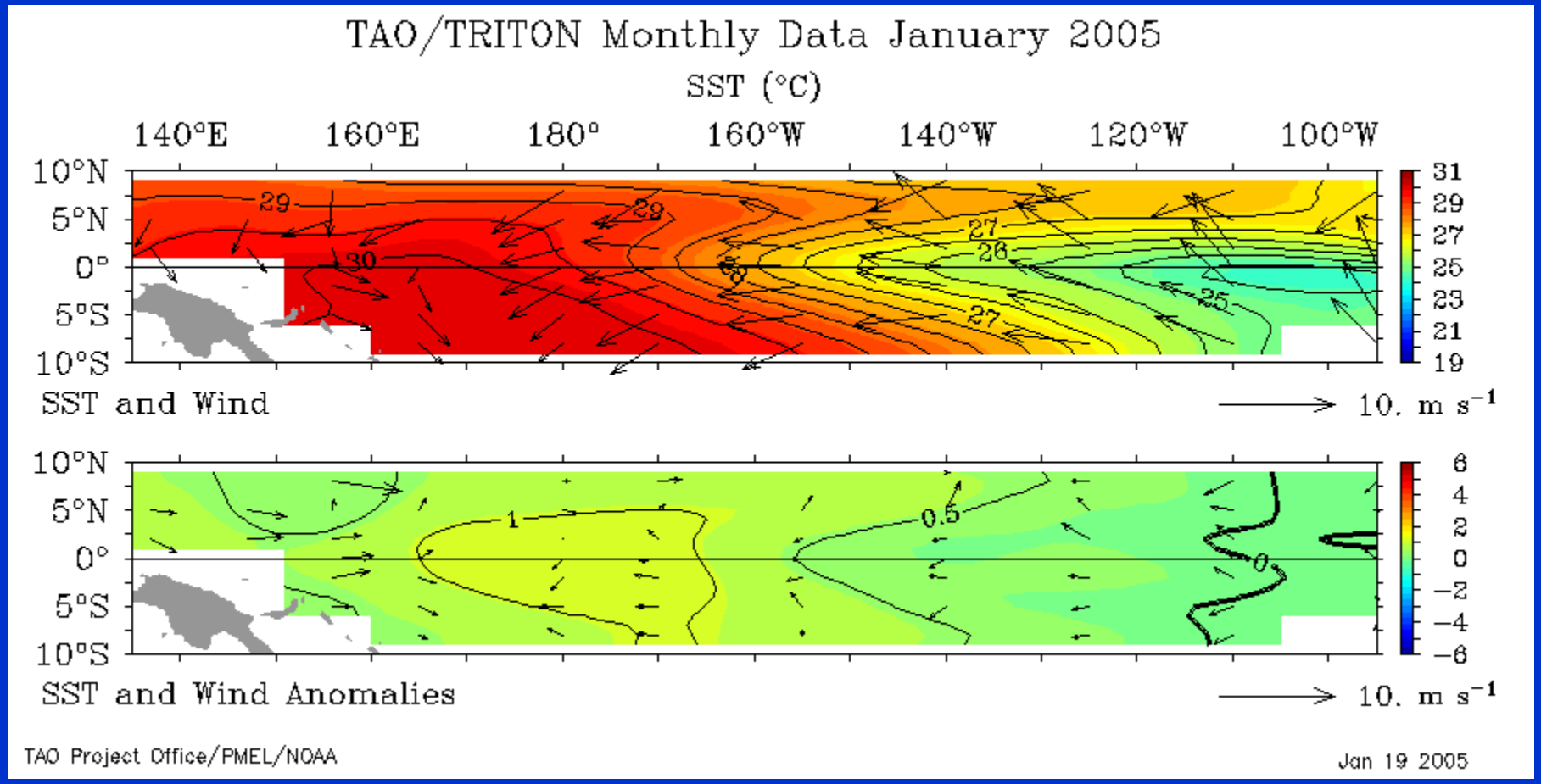


(from http://tao.atmos.washington.edu/pdo)

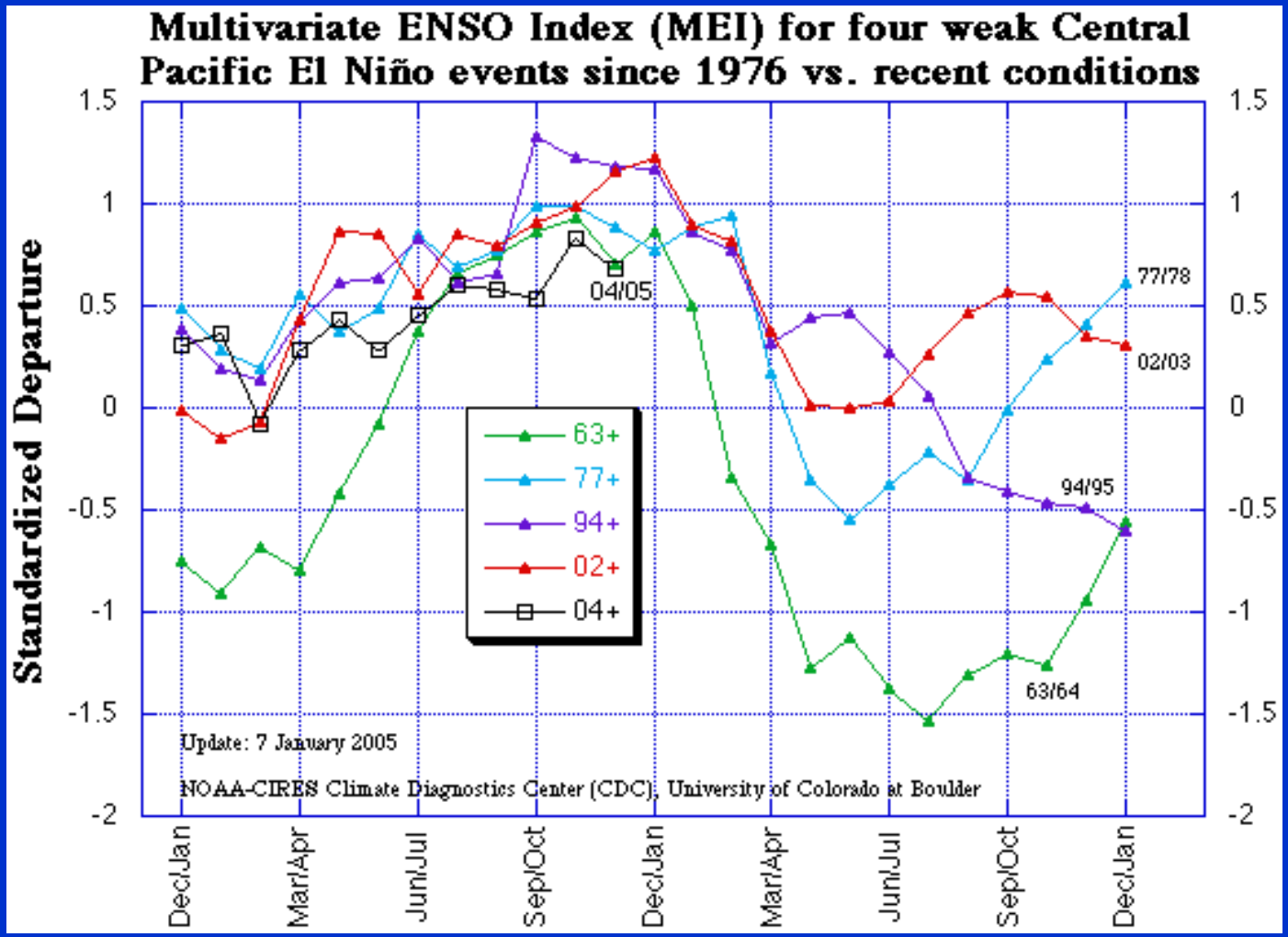
Period	North Pacific SSTs	Southwest Winters
1920s-1940s	Cold	Wetter
1940s-1970s	Warm	Drier
1970s-1990s	Cold	Wetter
1995-present	Warm	Drier?

(from Pagano 1999)

Recent Conditions

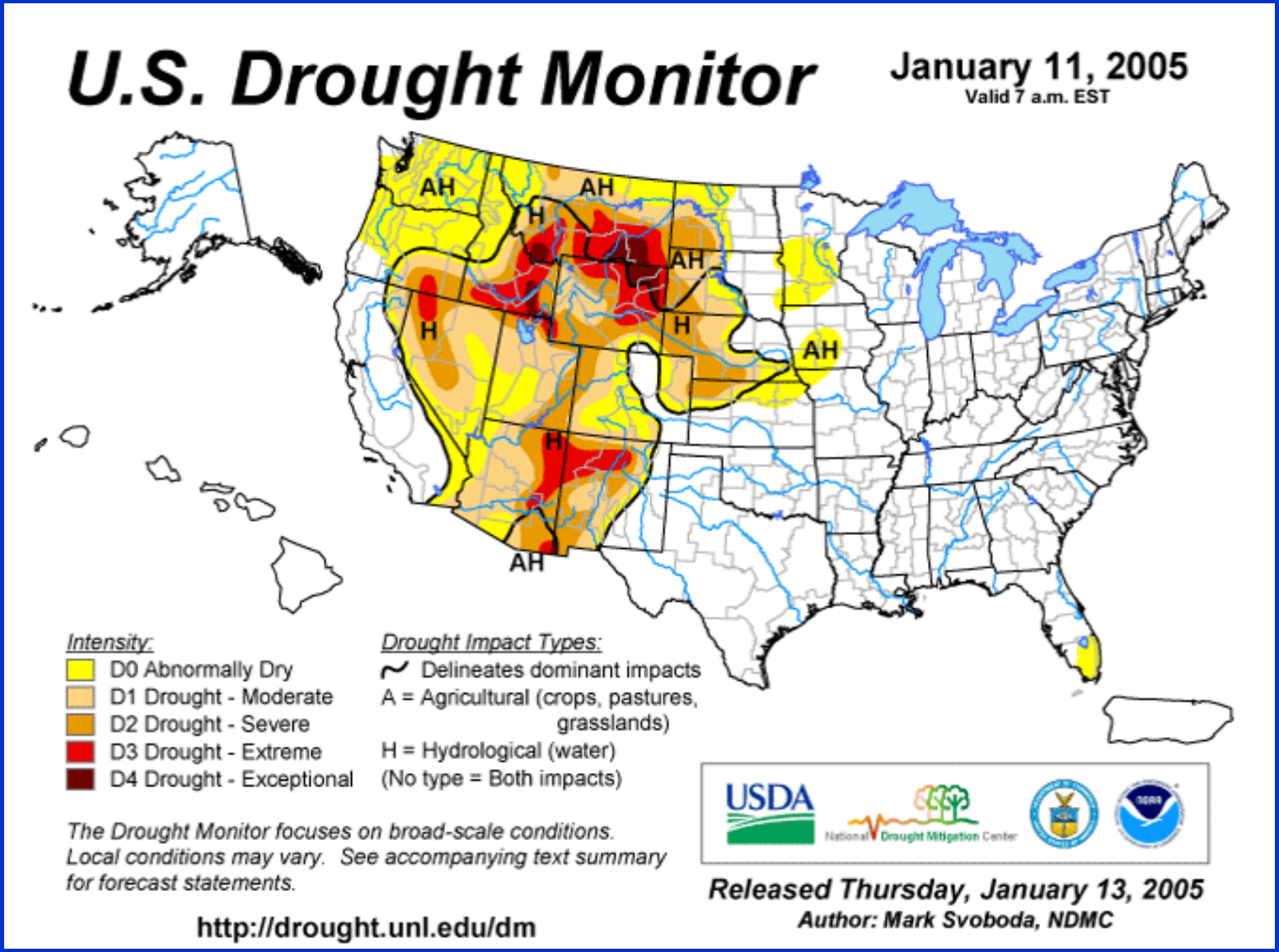


ENSO Comparison

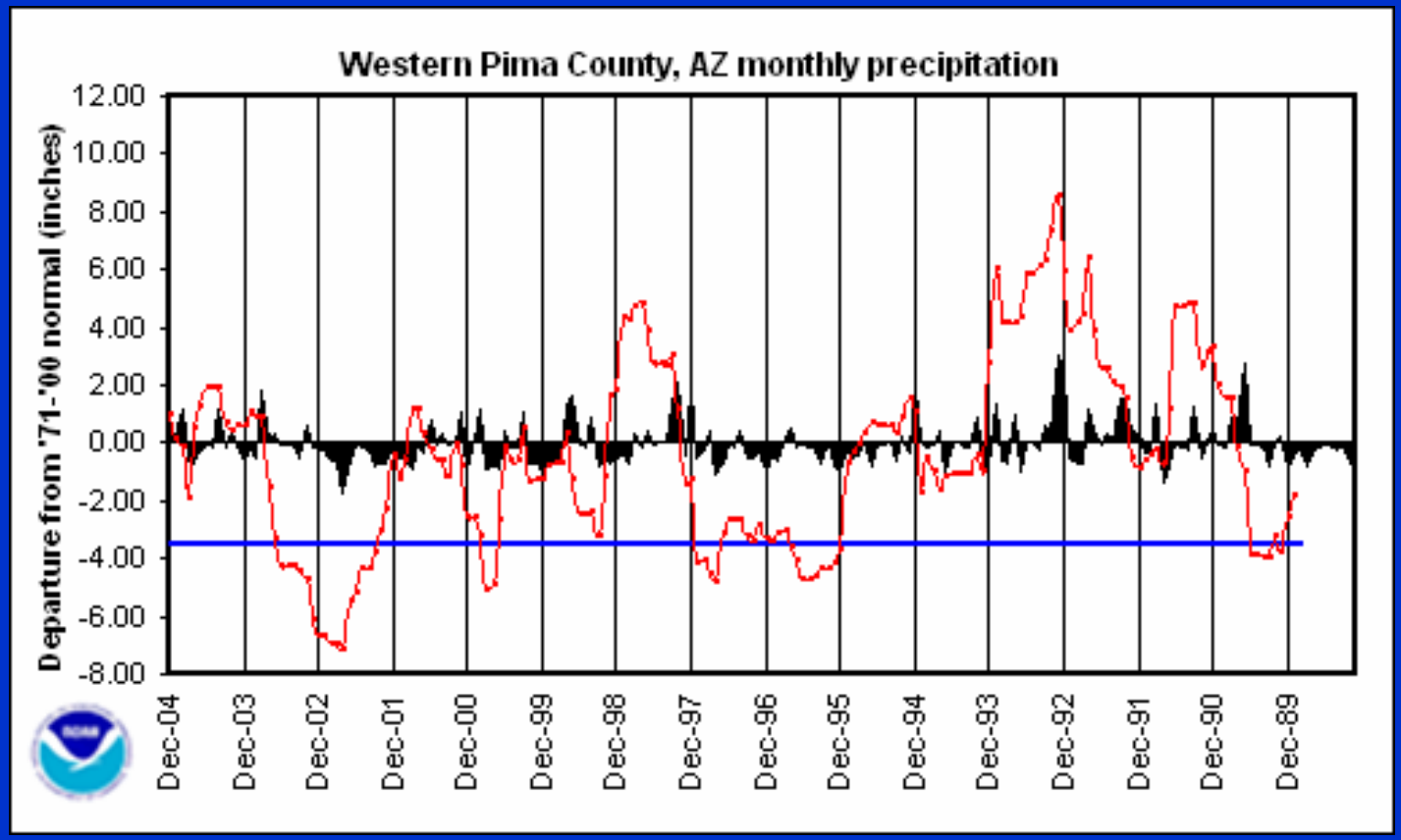


Climate Monitoring and Prediction

National Products

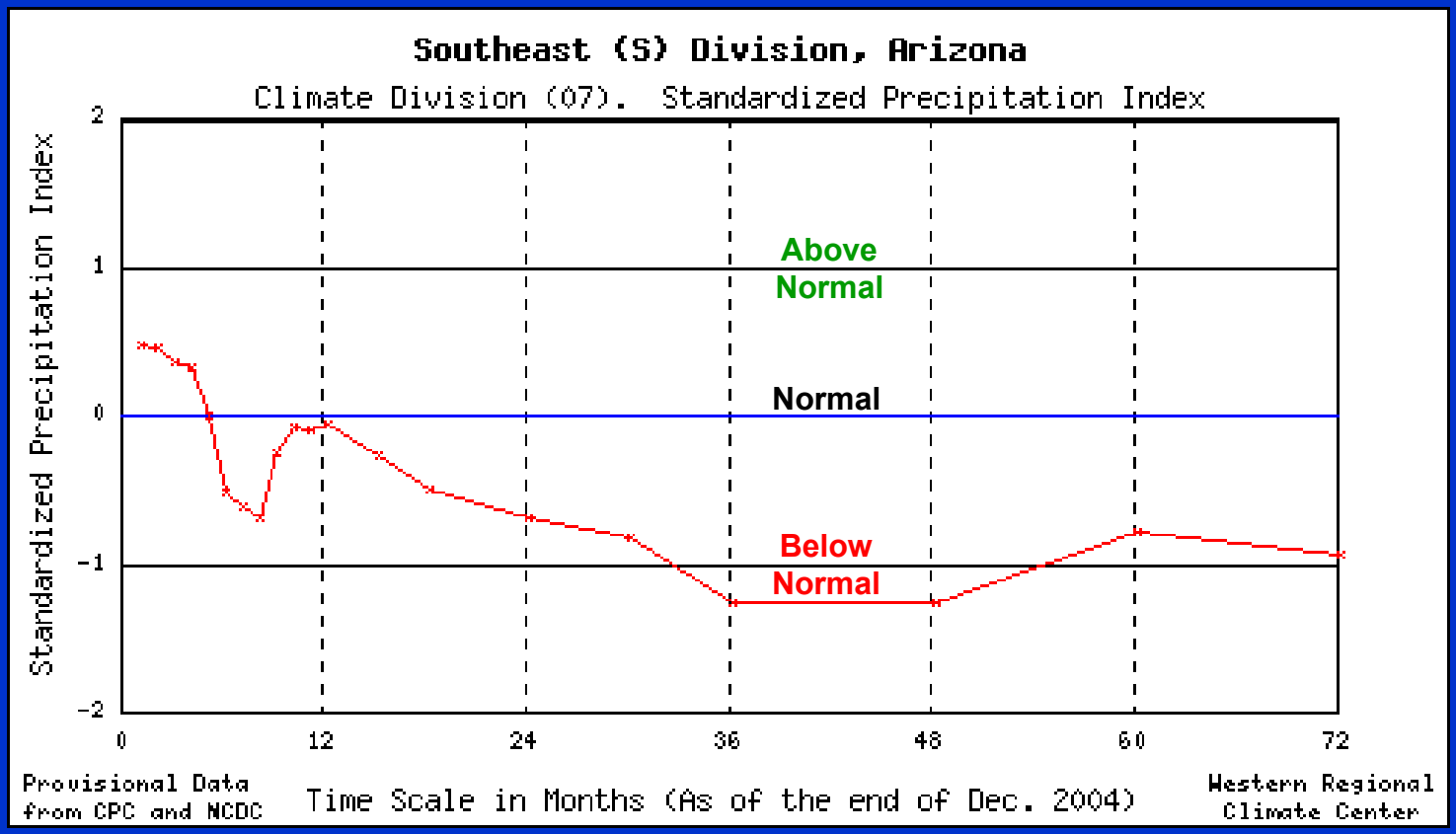


Accumulated Precipitation



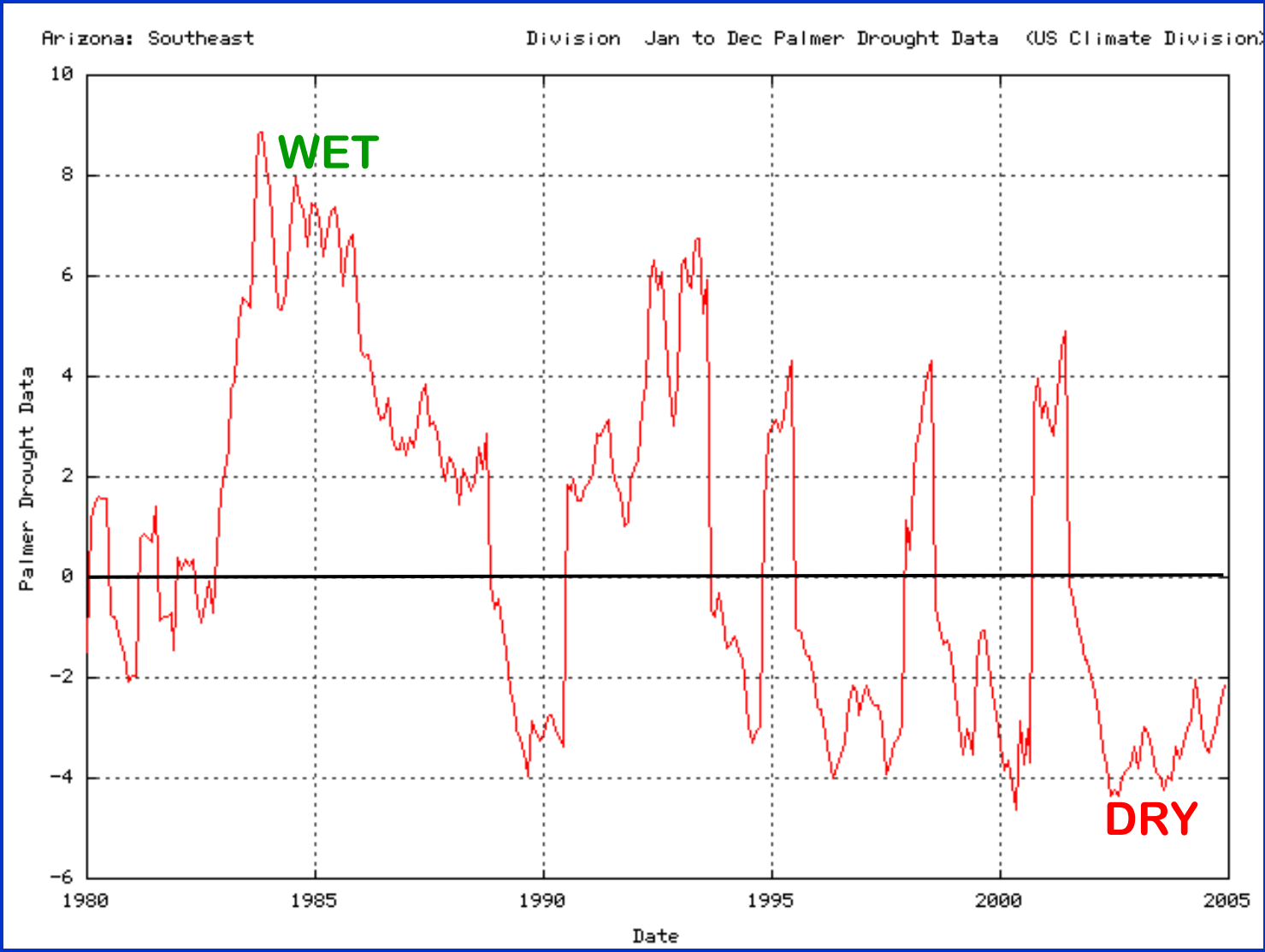
(from http://www.wrh.noaa.gov/twc)

Standardized Precipitation Index



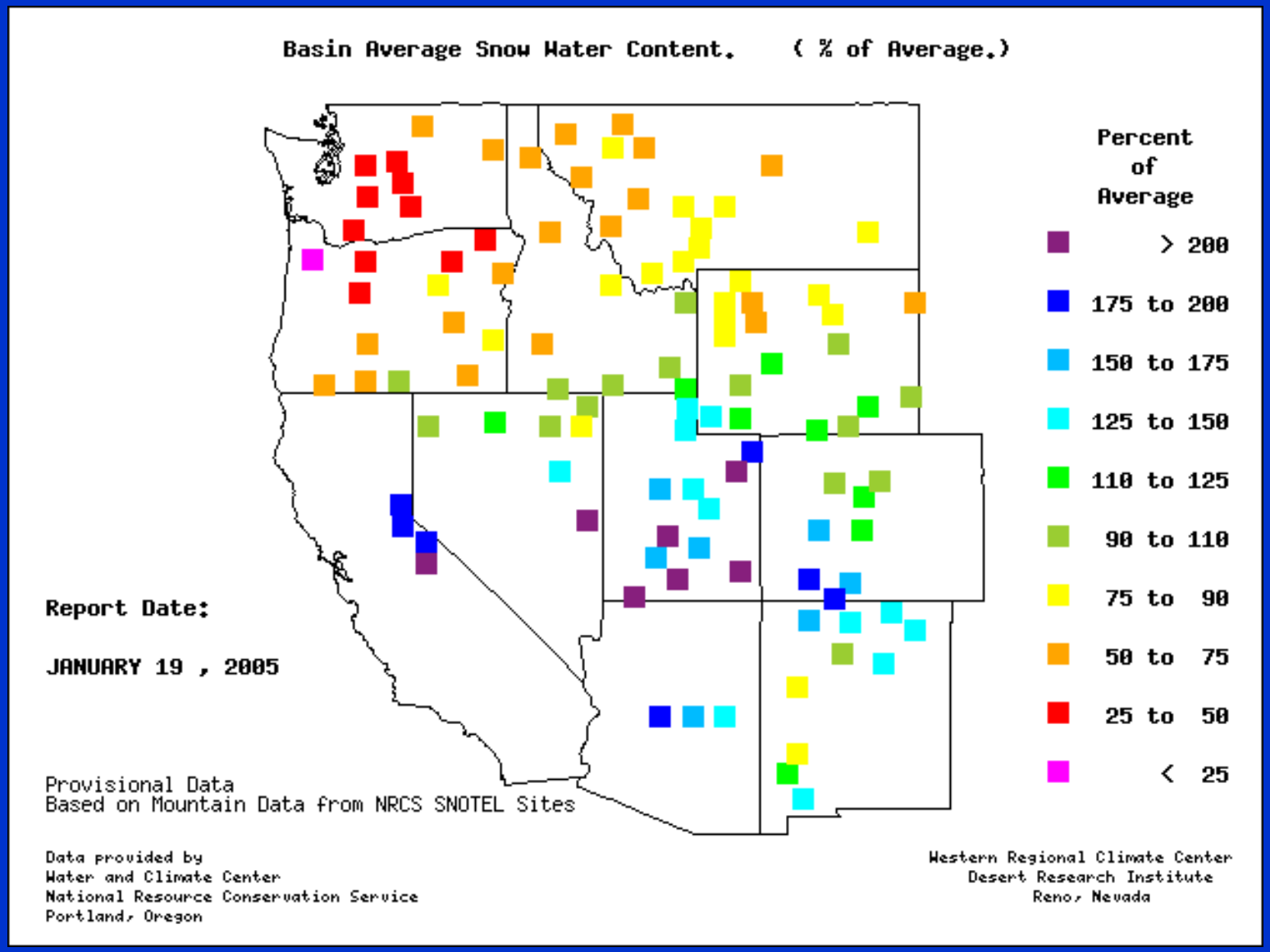
- Drought index like the Palmer Severity Drought Index
- More responsive to short term changes in precipitation
- Evaluates precip. deviations at different timescales (short-term and long-term)

Palmer Drought Severity Index



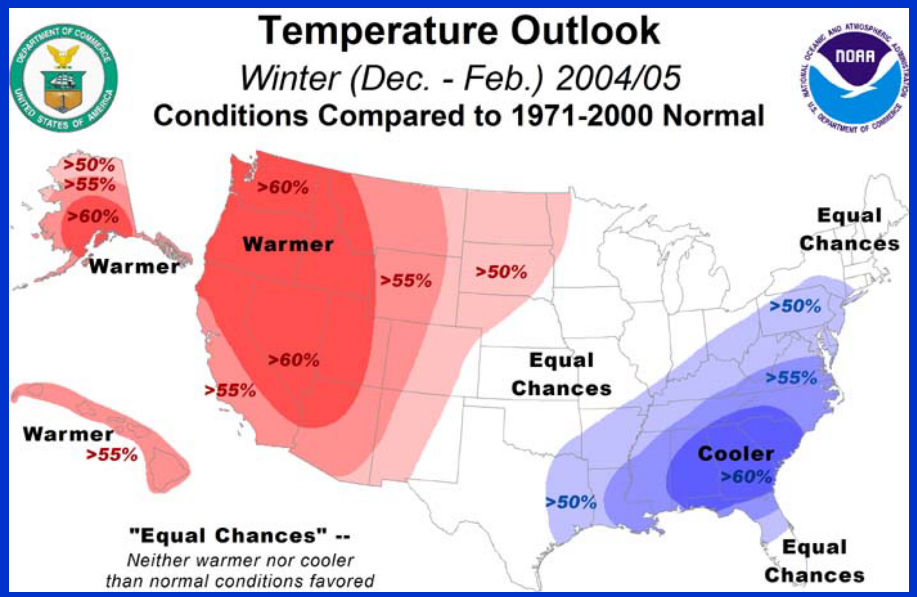
(From http://www.cdc.noaa.gov/)

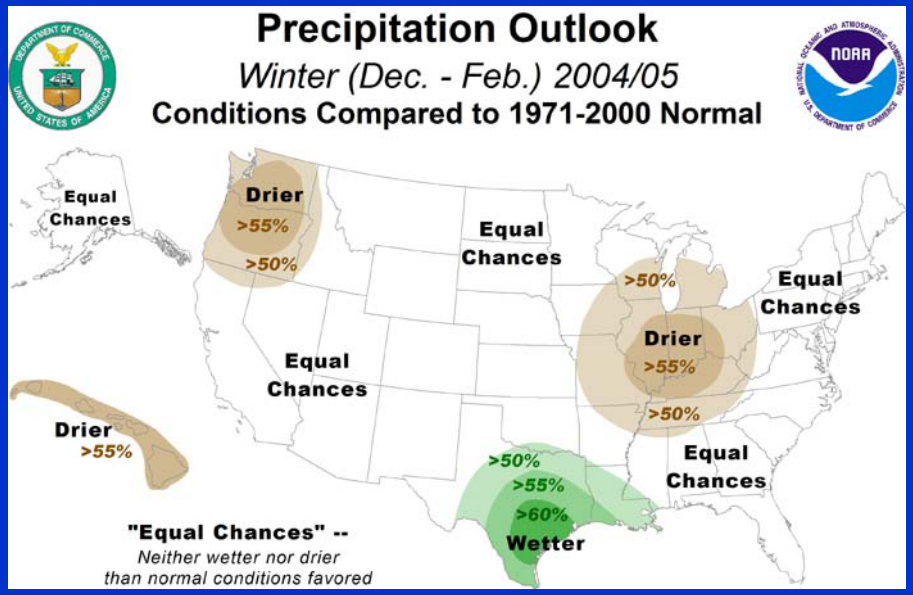
Snowpack



(From http://www.wcc.nrcs.usda.gov/cgibin/westsnow.pl)

Forecasts for this Winter: Dec-Feb '05





(From http://www.cpc.noaa.gov)

- Forecasts are based on statistical/dynamical models and expert assessment
- Greater forecast confidence during strong El Nino/La Nina conditions

Climate Change

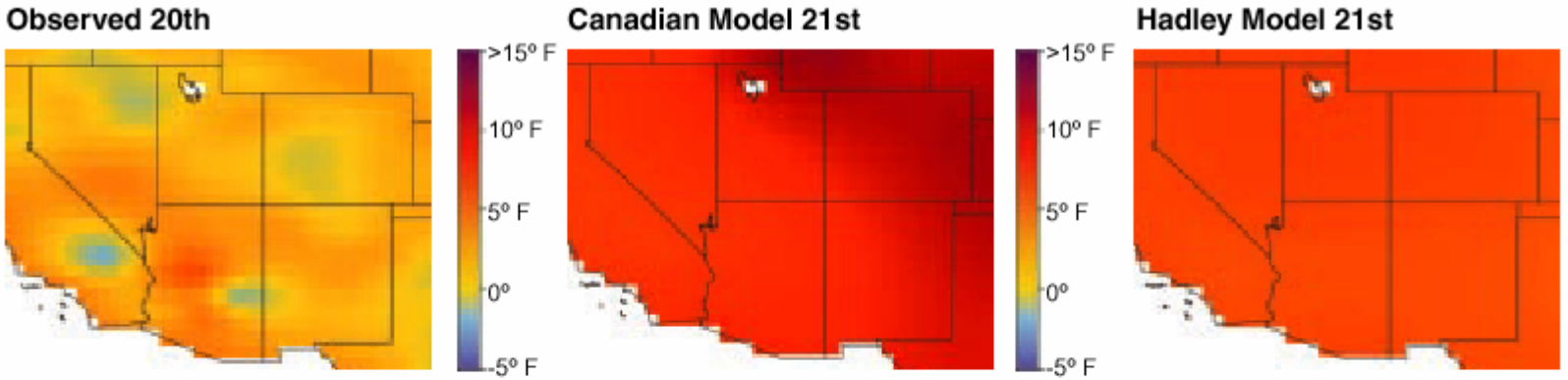


Figure 12. Temperature trend comparisons between 20th century observation and modeled scenarios of the 21st century.
Compiled by: Benjamin Felzer, National Center for Atmospheric Research

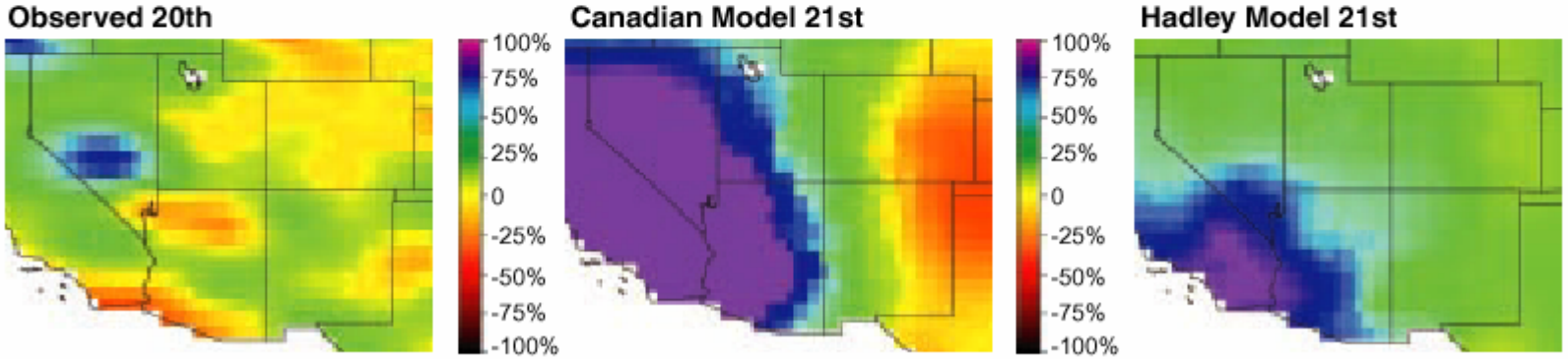


Figure 13. Precipitation trend comparisons between 20th century observation and modeled scenarios of the 21st century.
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From: ISPE Southwest Regional Assessment

Key Summary Points

- Southeast AZ and seasonal precip
  - Winter storms and summer monsoon
  - Different mechanisms and variability
- El Nino and La Nina teleconnections with AZ
  - El Nino usually means above normal winter precip (not always consistent)
  - La Nina means below normal
  - PDO?
- Many monitoring products are available on the web; precipitation still difficult to find
- Use climate forecasts carefully

Resources

- Climate Assessment for the Southwest (http://www.ispe.arizona.edu/climas)
- National Weather Service
- (http://www.weather.gov)
- Climate Prediction Center (http://www.cpc.noaa.gov/)
- Western Regional Climate Center (http://wrcc.dri.edu/)
- National Drought Monitor (http://www.drought.unl.edu/dm/index.html)
- **Climate Science Applications Program (http://cals.arizona.edu/climate)**