



Arizona Climate

**Mike Crimmins
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Dept. of Soil, Water, & Env. Science &
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The University of Arizona**

Presentation Overview

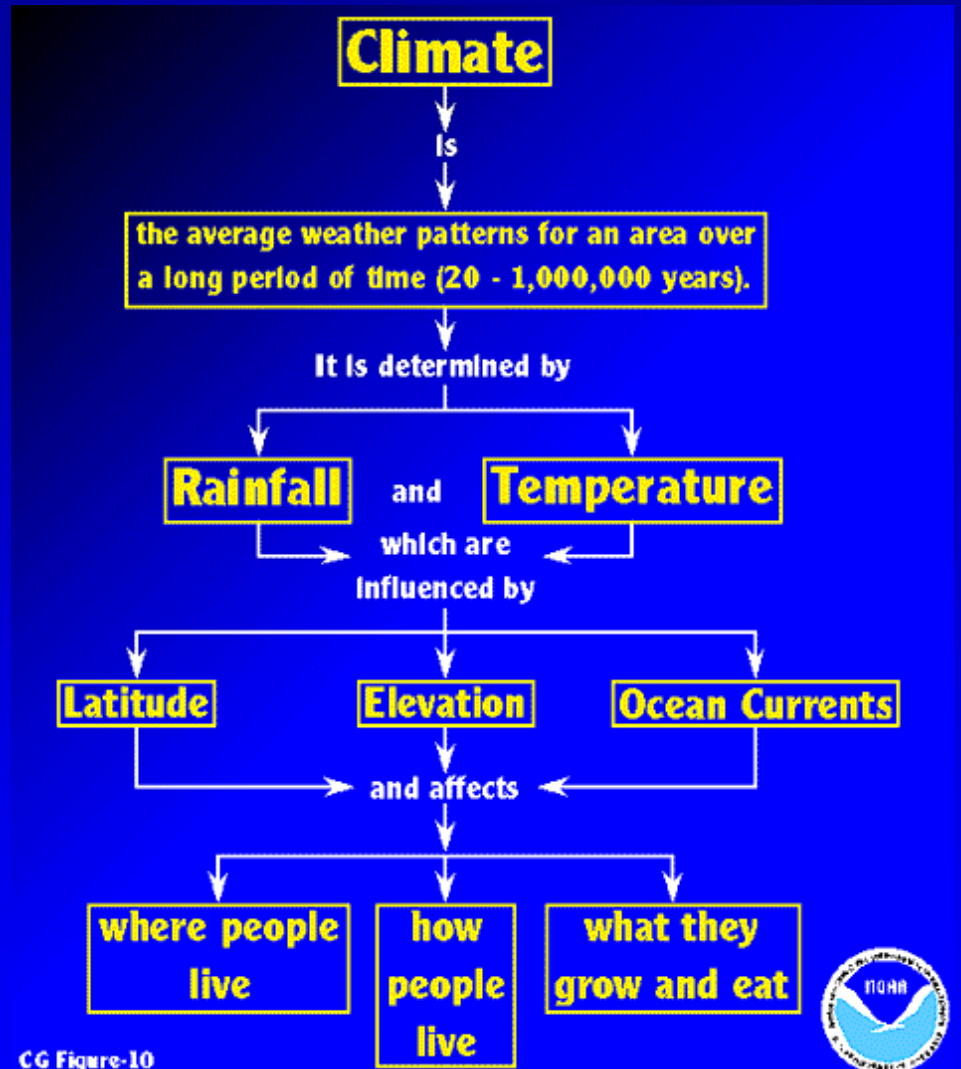
- The global climate system
- An overview of Arizona climate
- Why so much variability?
- Winter 2011/12
- Volunteer Opportunities



What is climate?

Climatology: analysis of long-term weather patterns over time or space

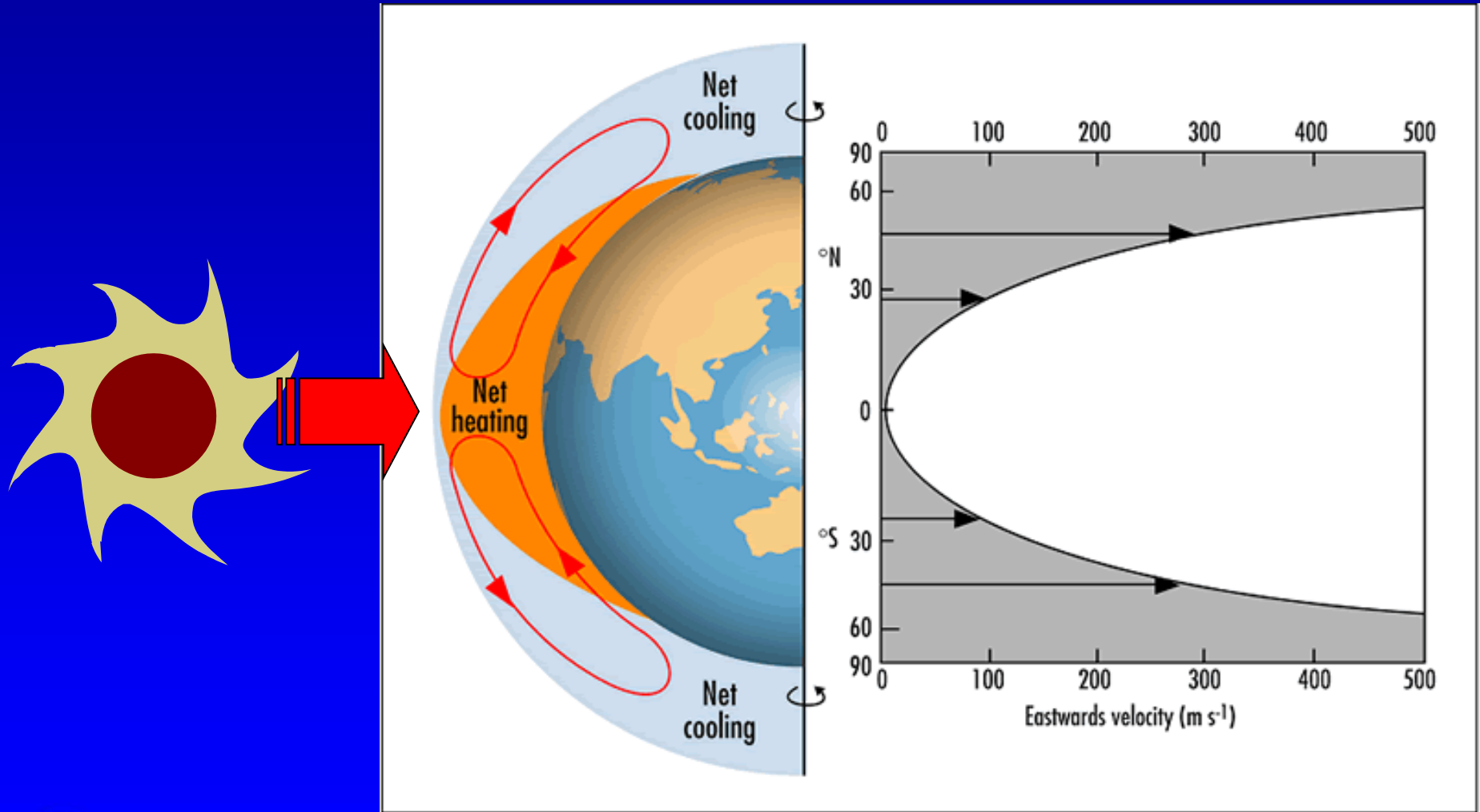
- The frequency of extreme events also important in climatic analyses (e.g. droughts & floods)
- Mean conditions AND variability



CG Figure-10

From: http://www.fsl.noaa.gov/visitors/education/climgraph/CG_Figure_10.gif.html

Global Energy Balance

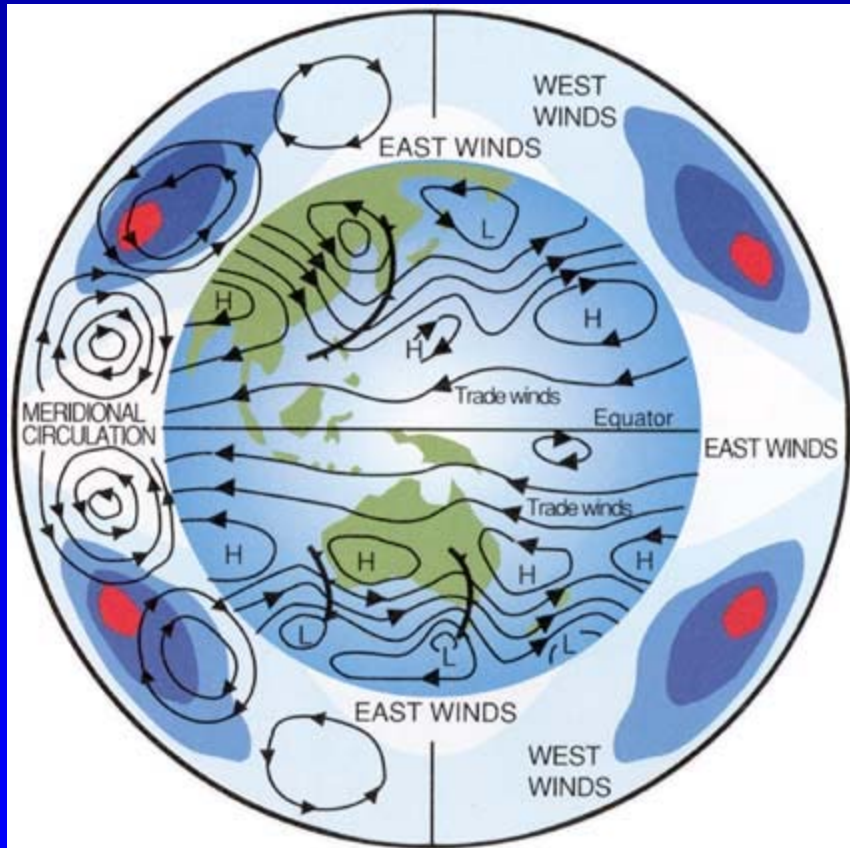


From <http://www.bom.gov.au>



Global Circulations: Flows of Mass & Energy

Atmosphere



Ocean

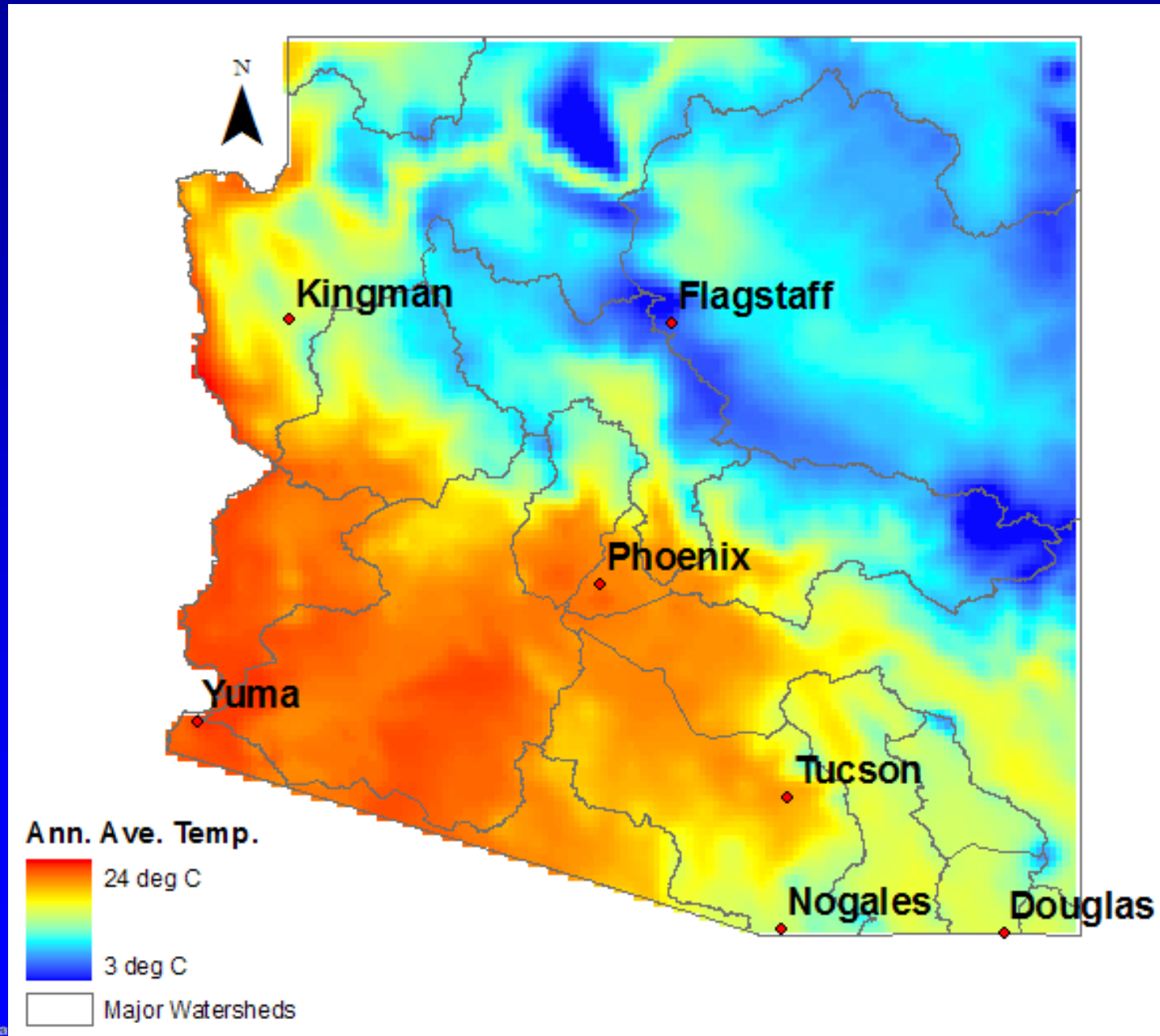


From <http://www.bom.gov.au>

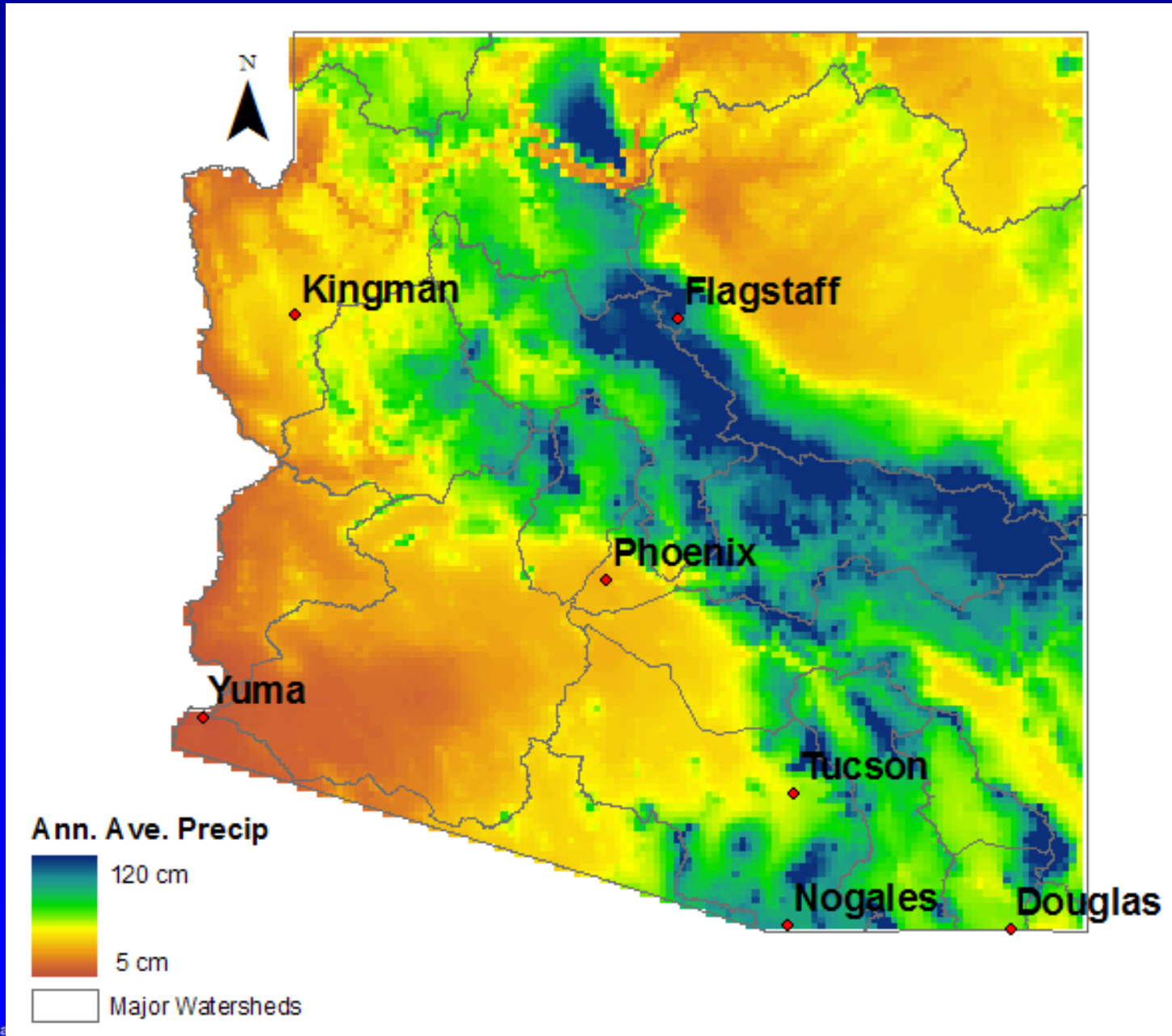
Background on AZ Climate



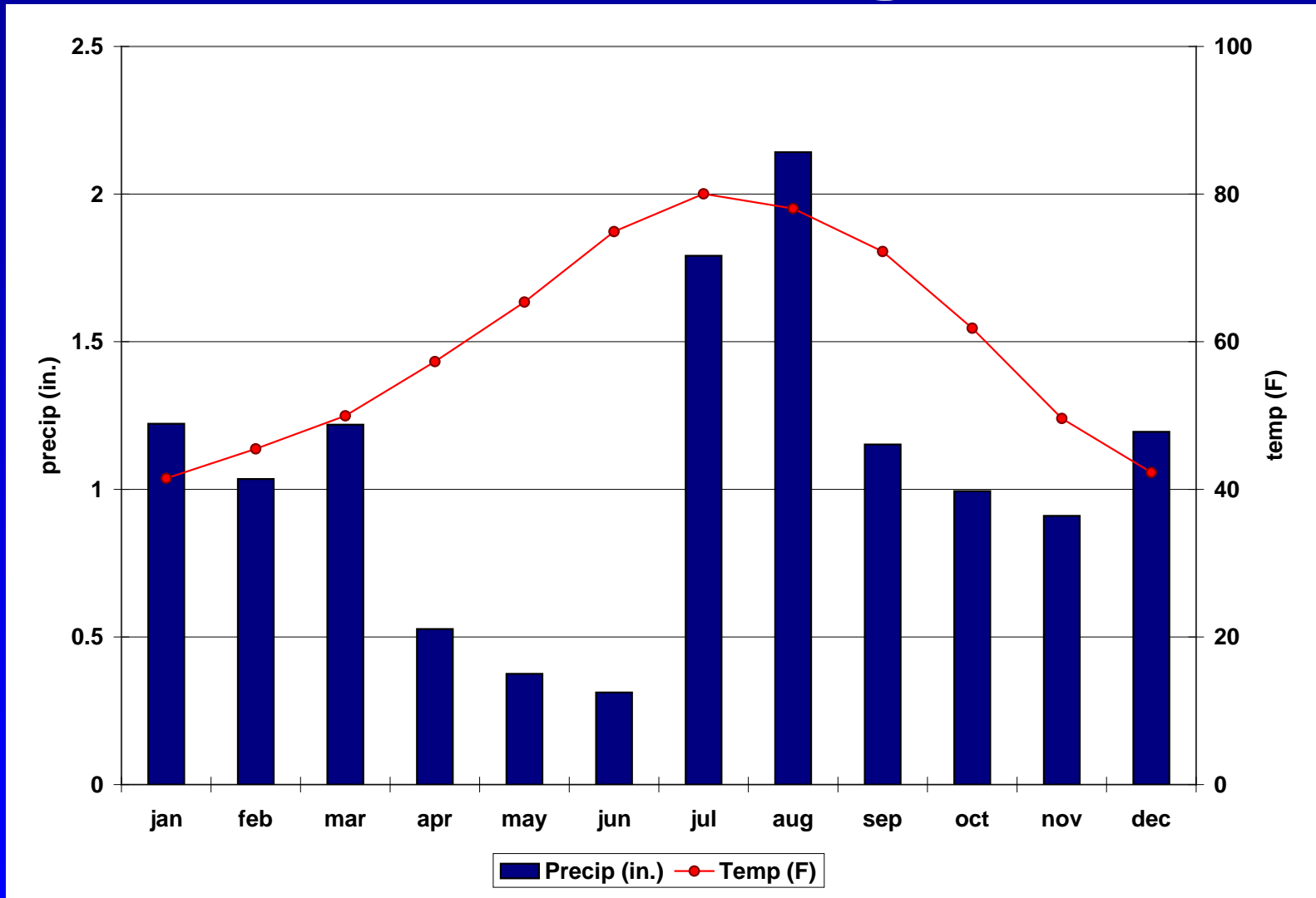
Annual Average Arizona Temperatures



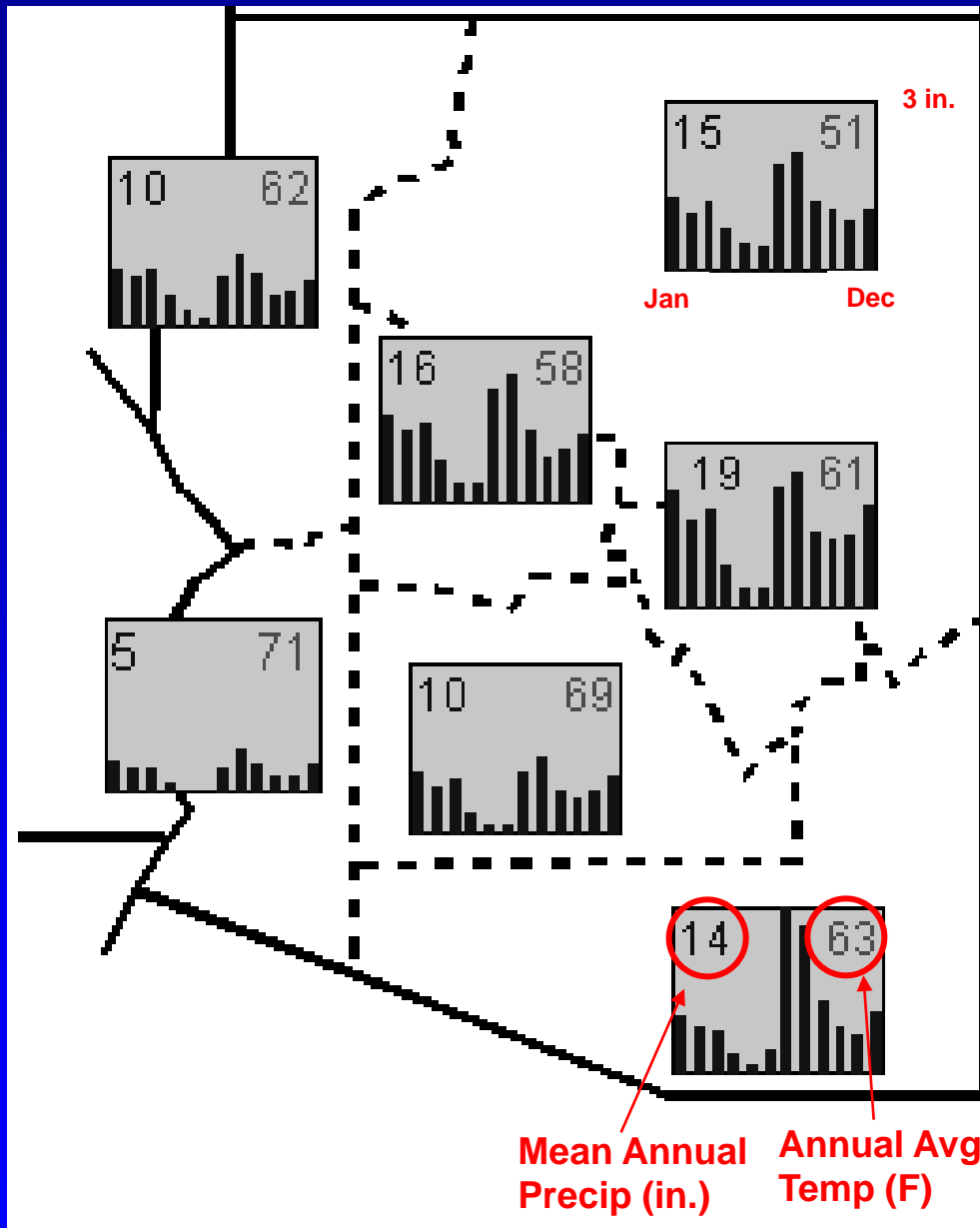
Annual Average Arizona Precipitation



Arizona Climograph



Seasonal Distribution of Precipitation



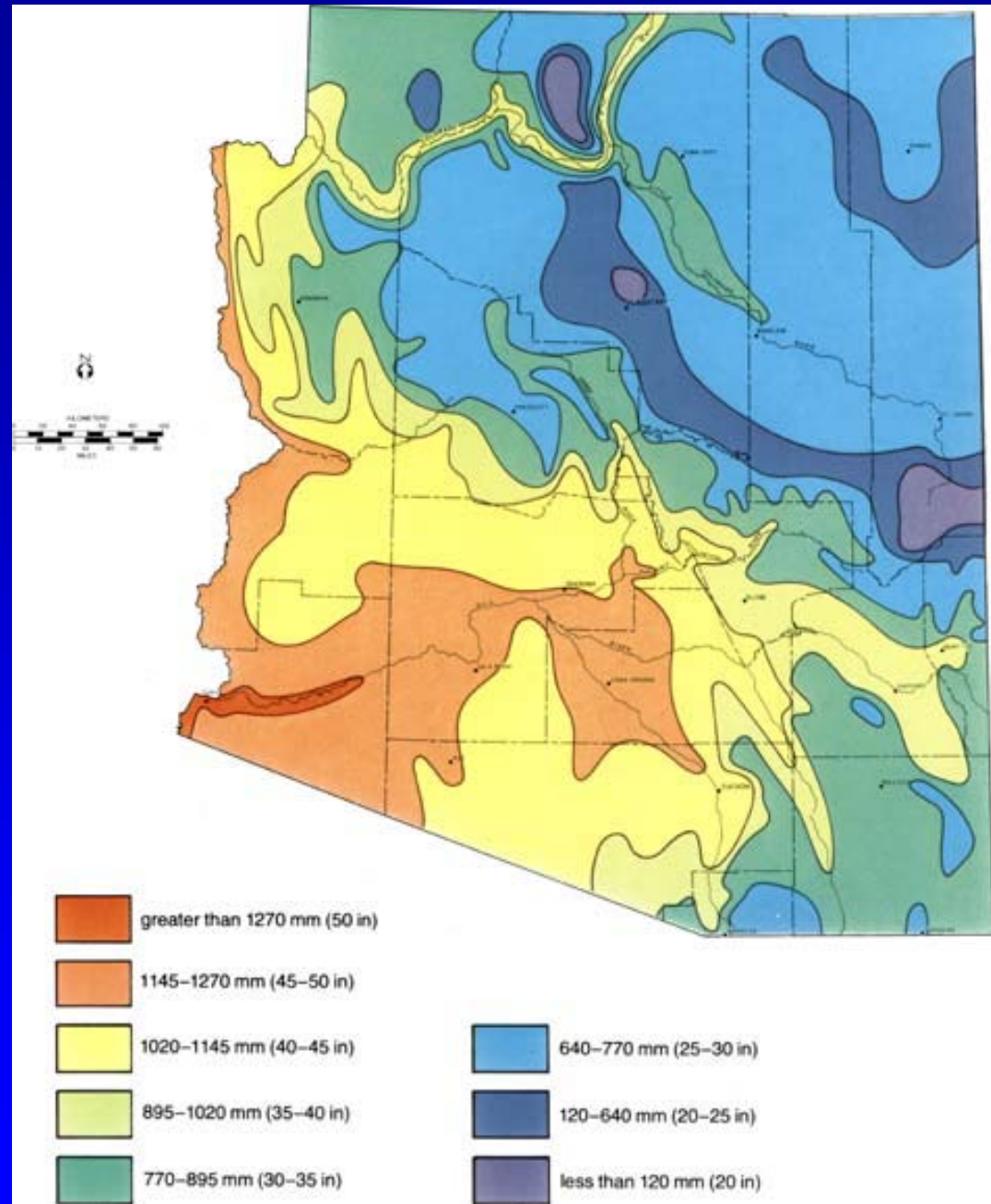
- More winter precip in northern AZ
- Stronger monsoon signal in southeast AZ (more summer precip)

(graphic from Sheppard, et al. 2000)

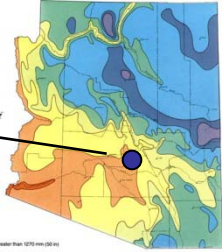


Annual Average Arizona Potential Evapotranspiration

<http://southwest.library.arizona.edu/>

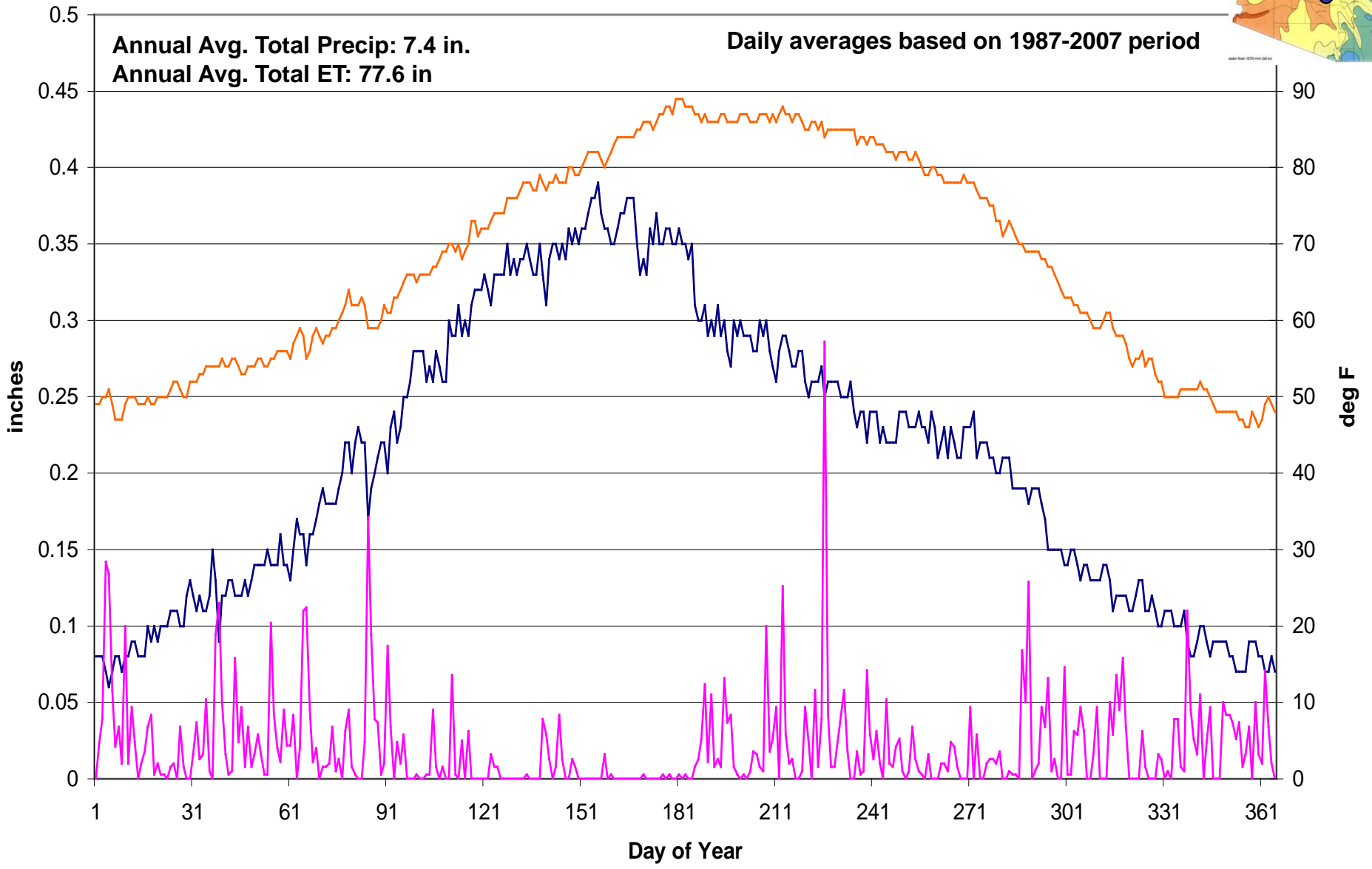


Average Daily Observations: Coolidge-AZMET



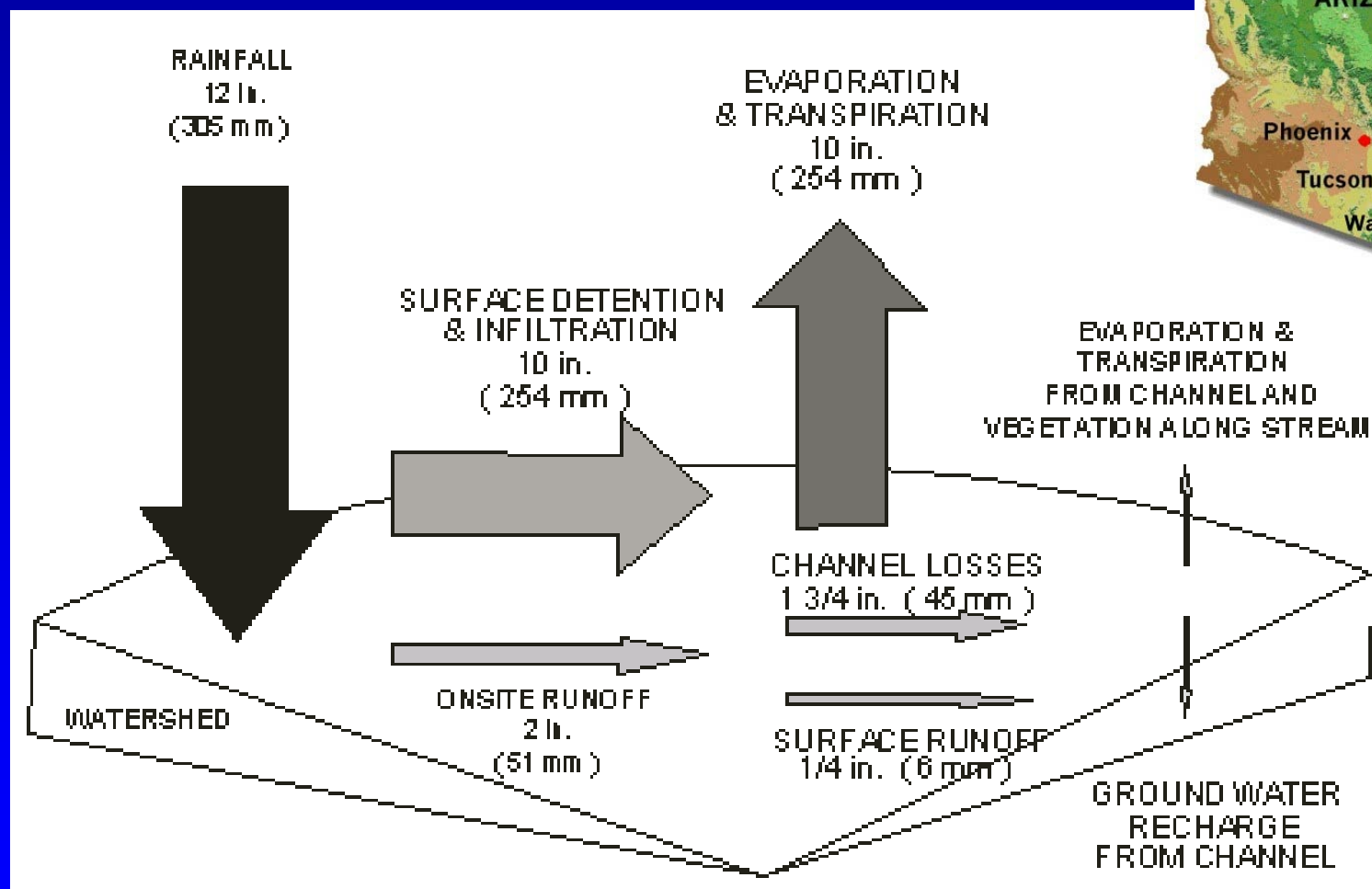
Annual Avg. Total Precip: 7.4 in.
Annual Avg. Total ET: 77.6 in

Daily averages based on 1987-2007 period



— Ref ET (in) — Total Precip (in) — Avg Temp (F)

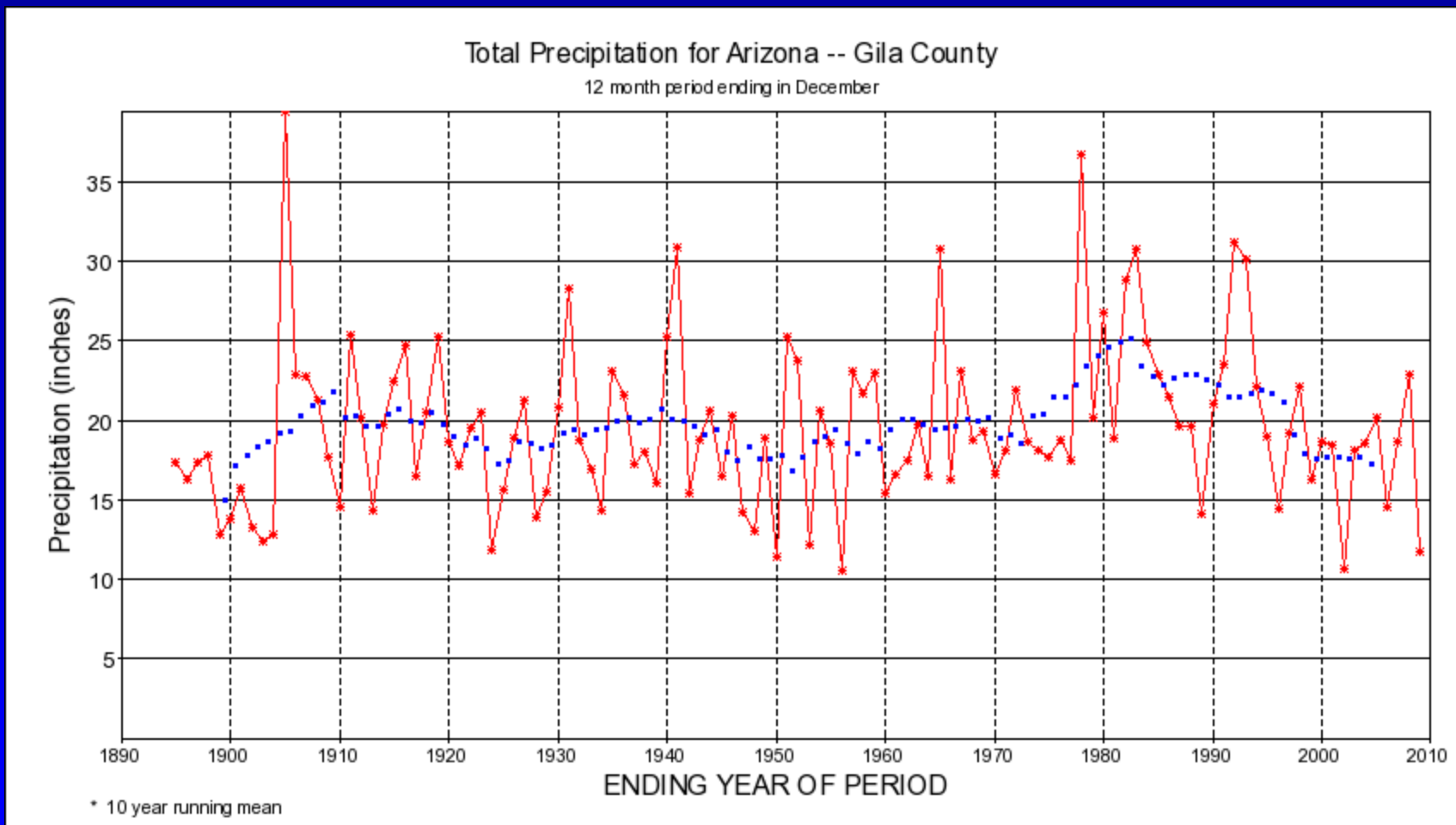
Example Water Balance: Walnut Gulch, Arizona



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



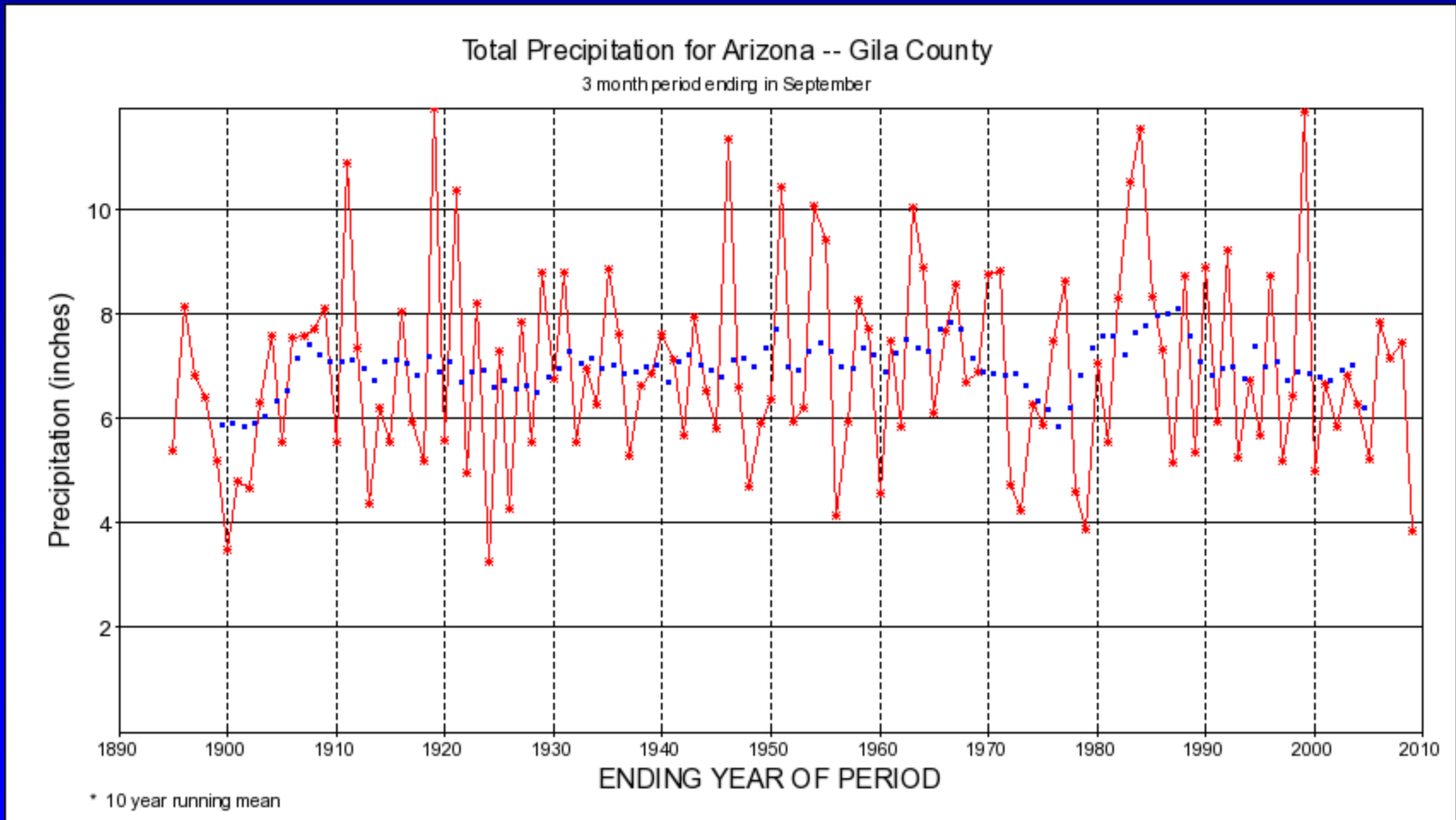
Gila County – Annual Total Precipitation



<http://www.cefa.dri.edu/Westmap/>



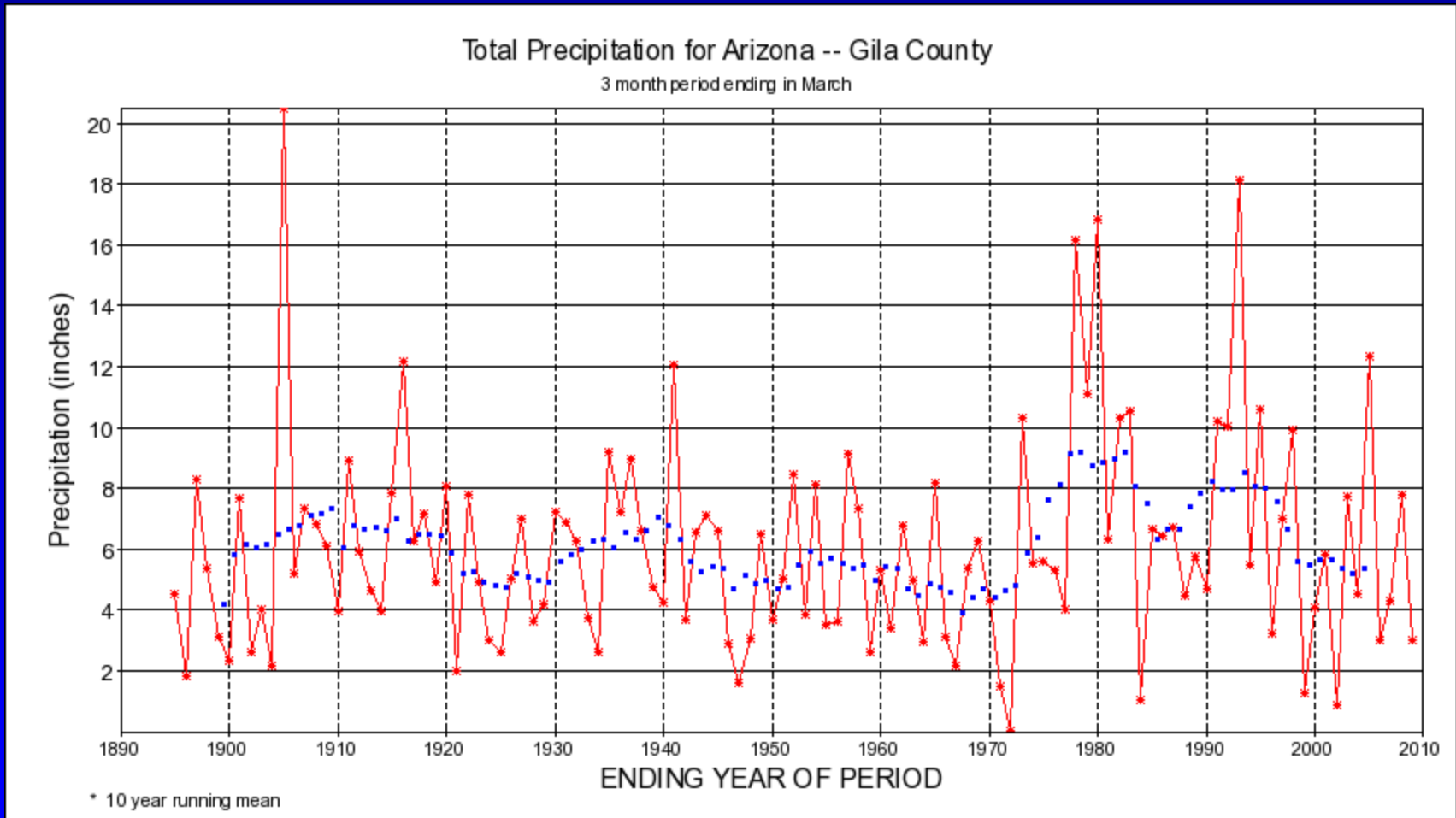
Gila County – Summer Total Precipitation



<http://www.cefa.dri.edu/Westmap/>



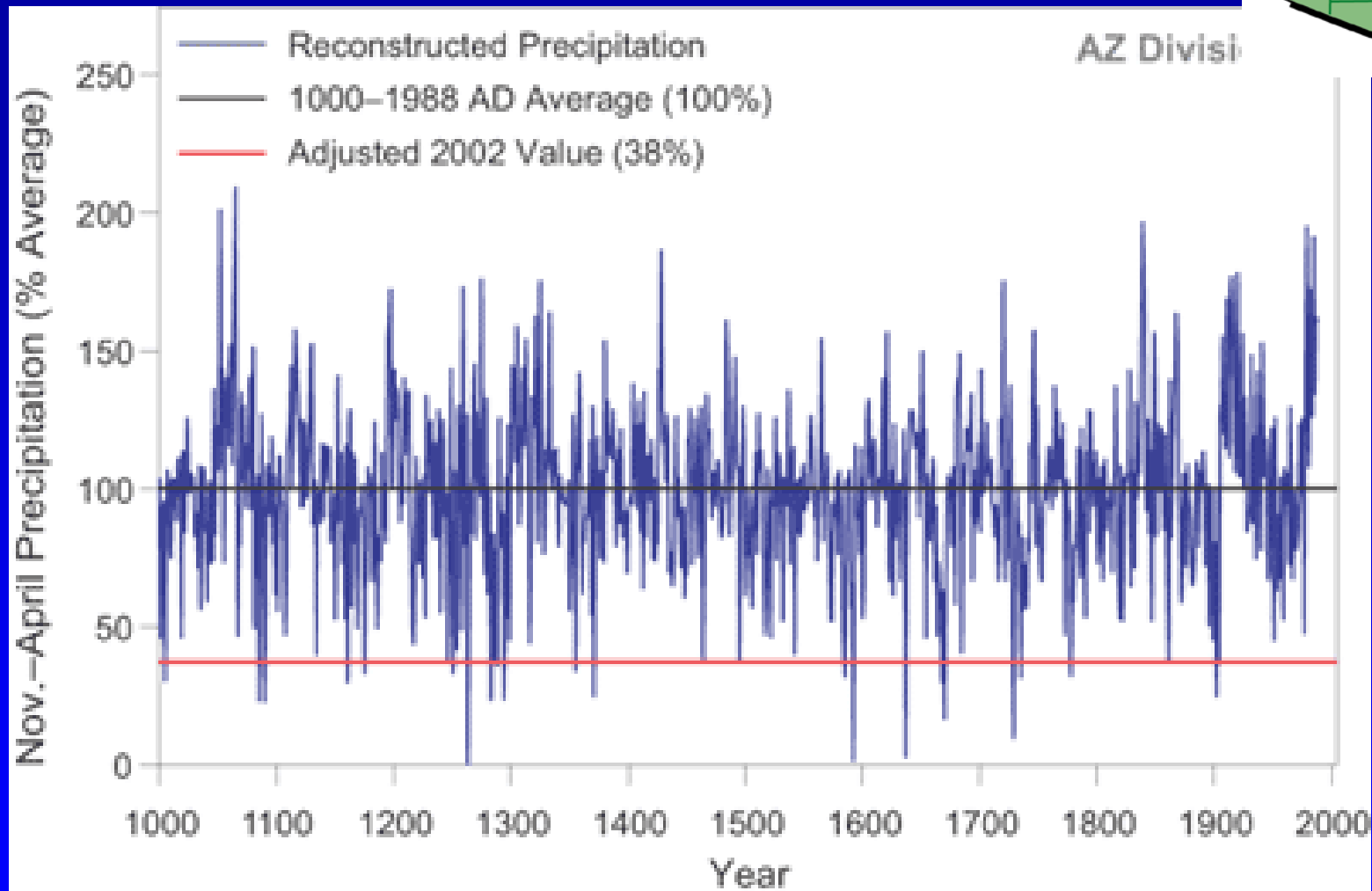
Gila County – Winter Total Precipitation



<http://www.cefa.dri.edu/Westmap/>



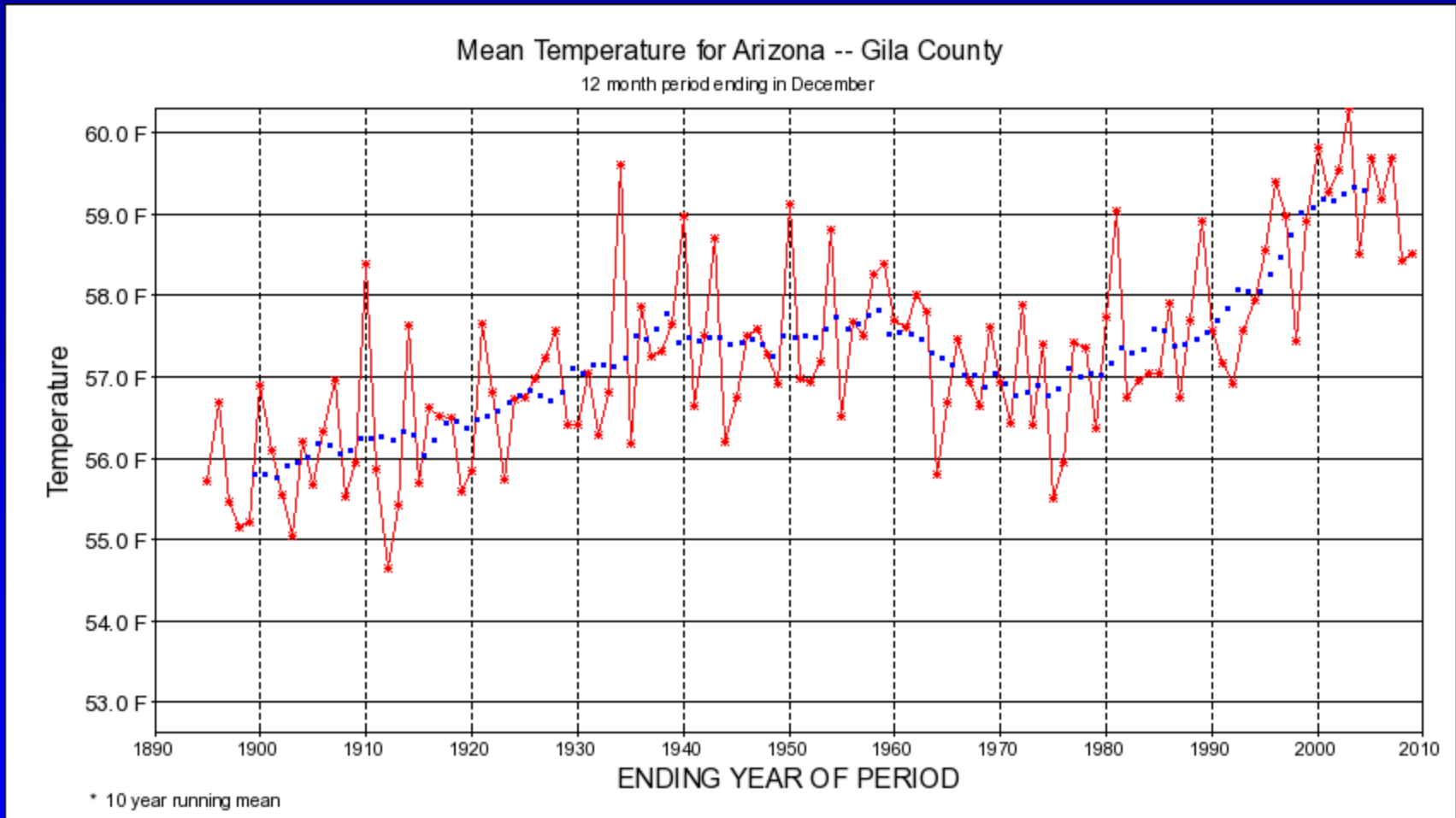
Long-term View



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



Gila County – Avg. Annual Temperature



<http://www.cefa.dri.edu/Westmap/>



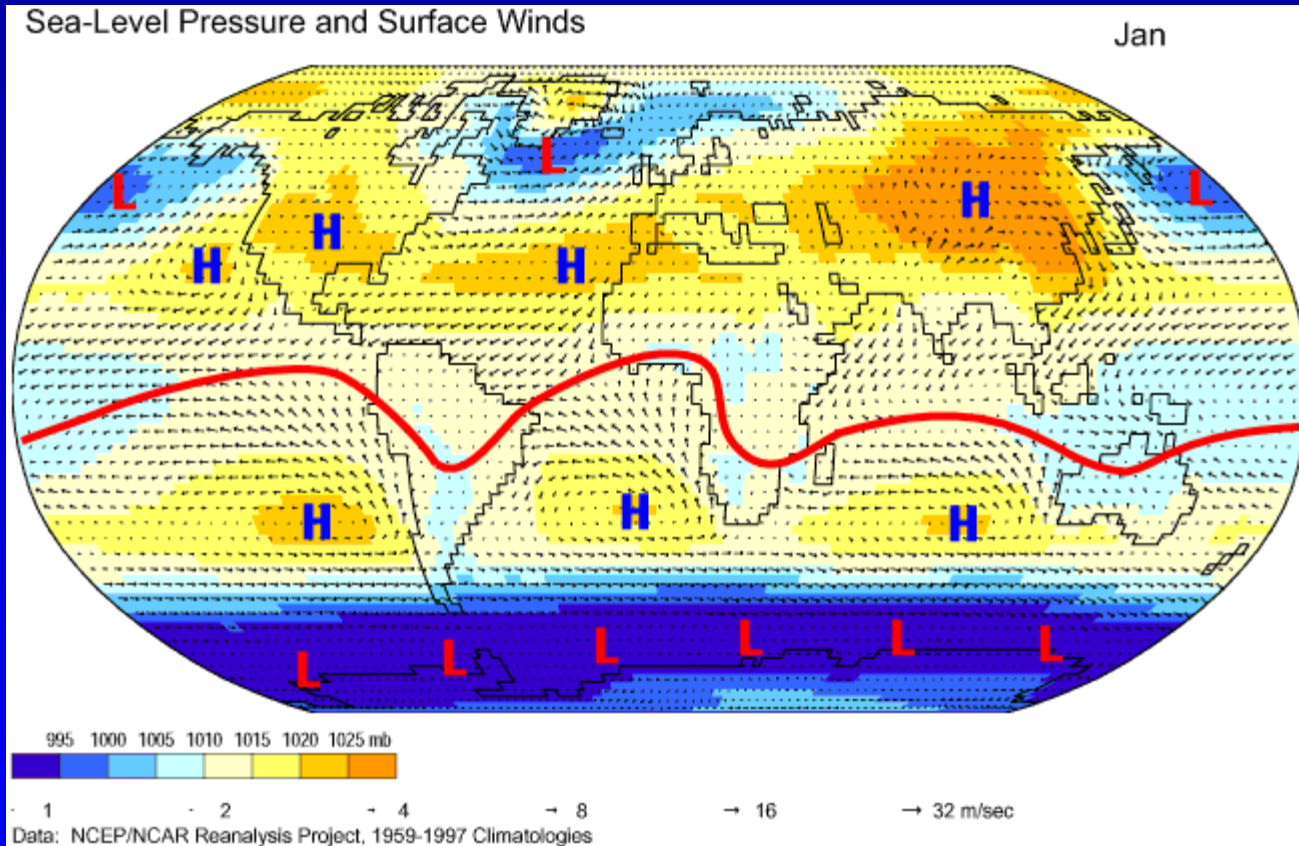
Changes in plant hardiness zones: 1990-2006

Loading maps...
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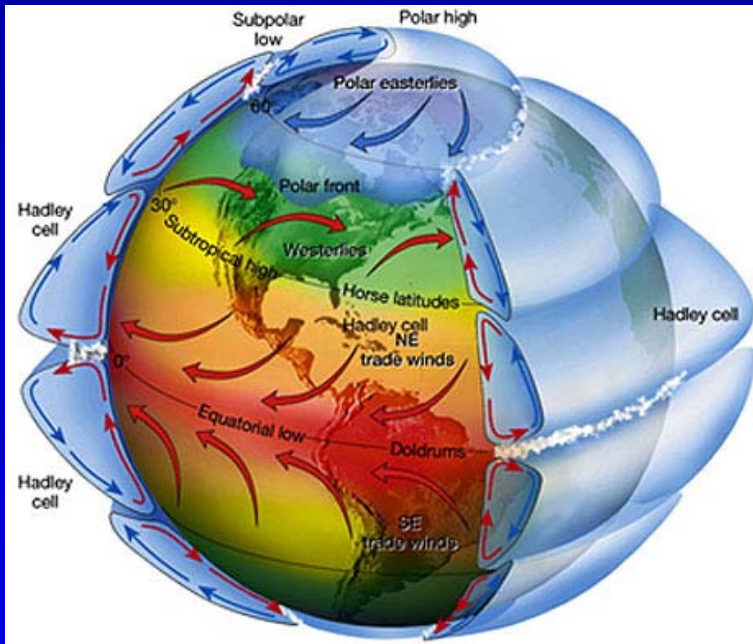
Atmospheric Controls on Arizona Climate



Seasonality of Circulation Patterns



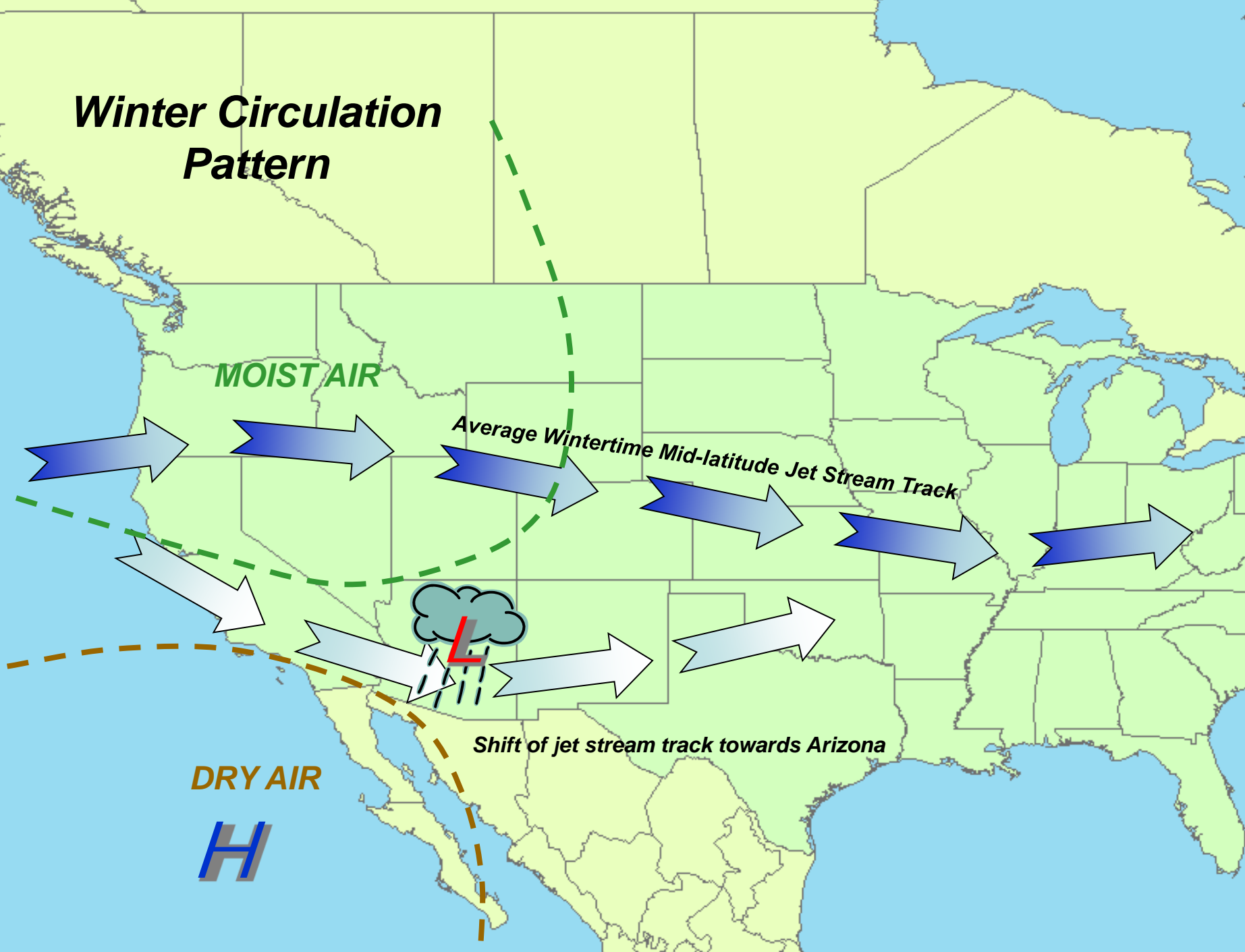
Global Circulations and Aridity



Deserts of the WORLD



Winter Circulation Pattern



MOIST AIR

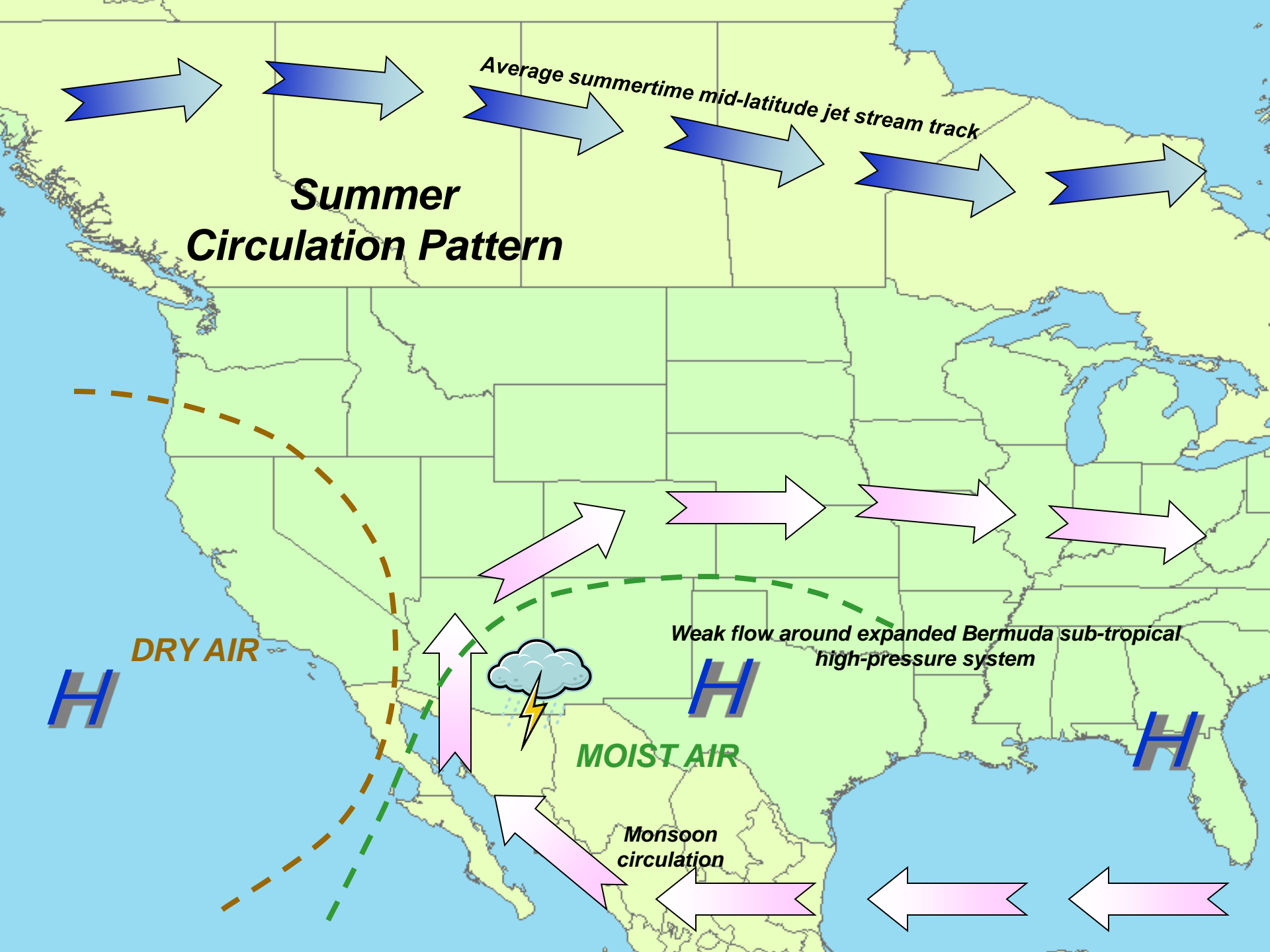
Average Wintertime Mid-latitude Jet Stream Track

DRY AIR

H

Shift of jet stream track towards Arizona





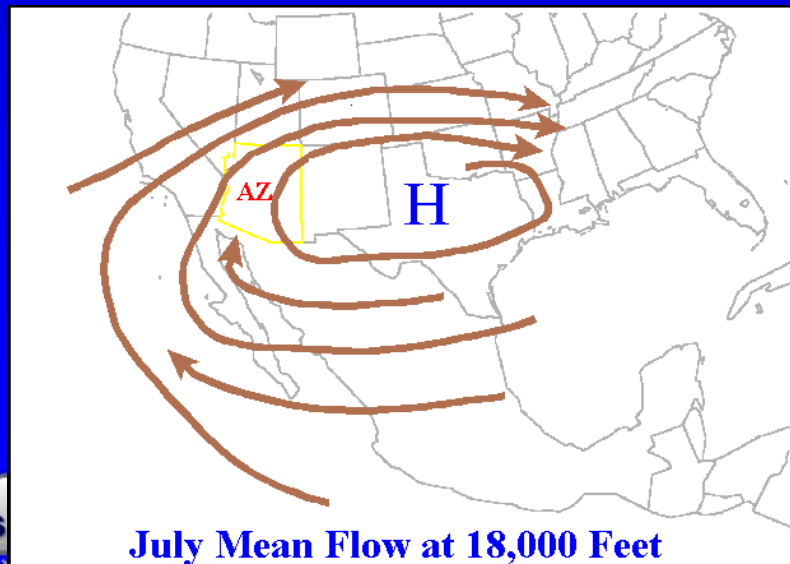
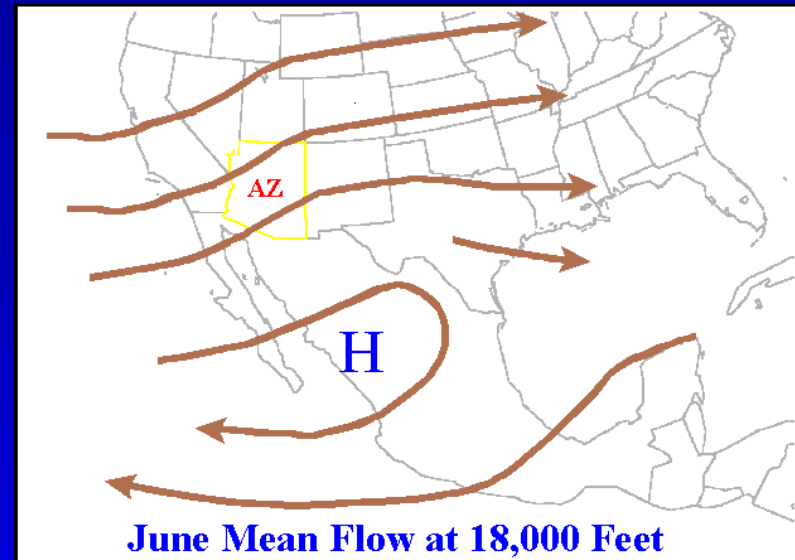
North American Monsoon



Monsoon

Monsoon start dates for Tucson

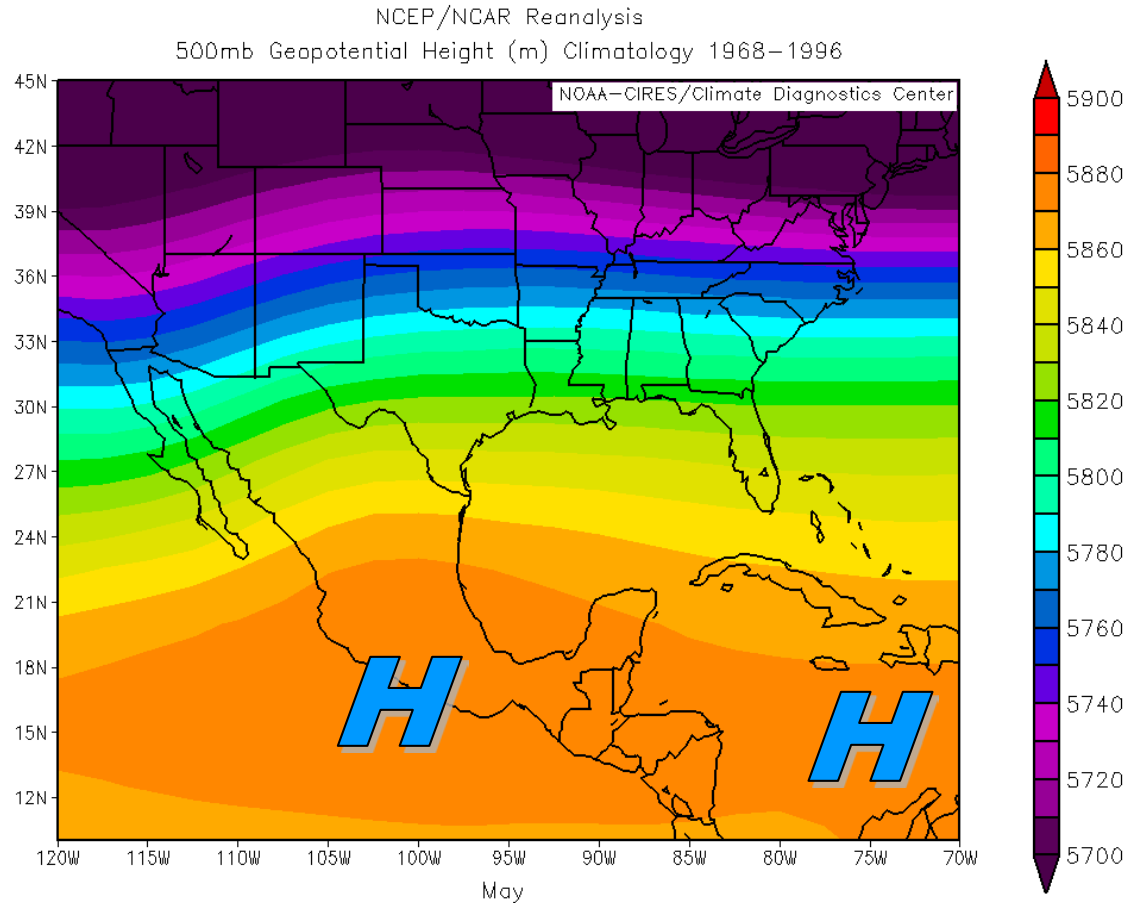
- Average start July 3rd
- Earliest start June 17 2000
- Latest start July 25 1987



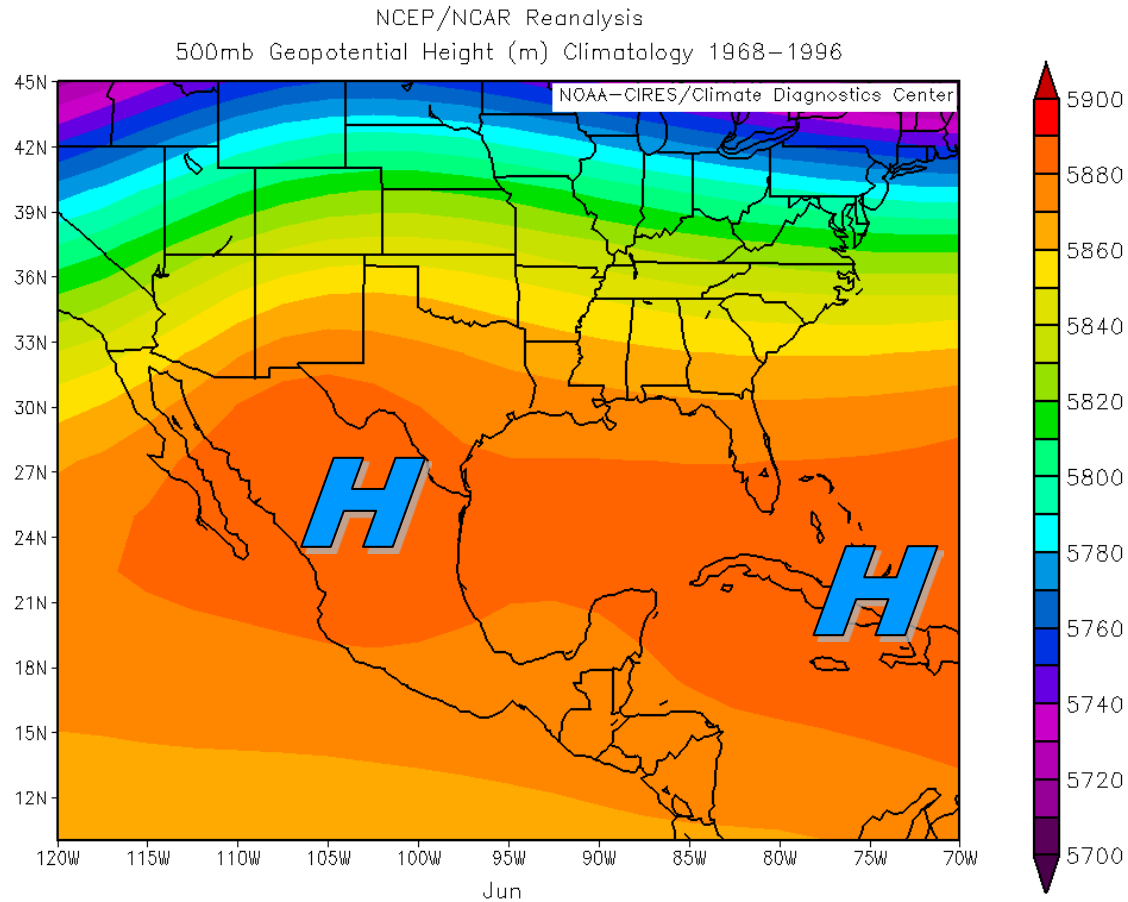
Monsoon season rainfall (June 15th to September 30th)

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

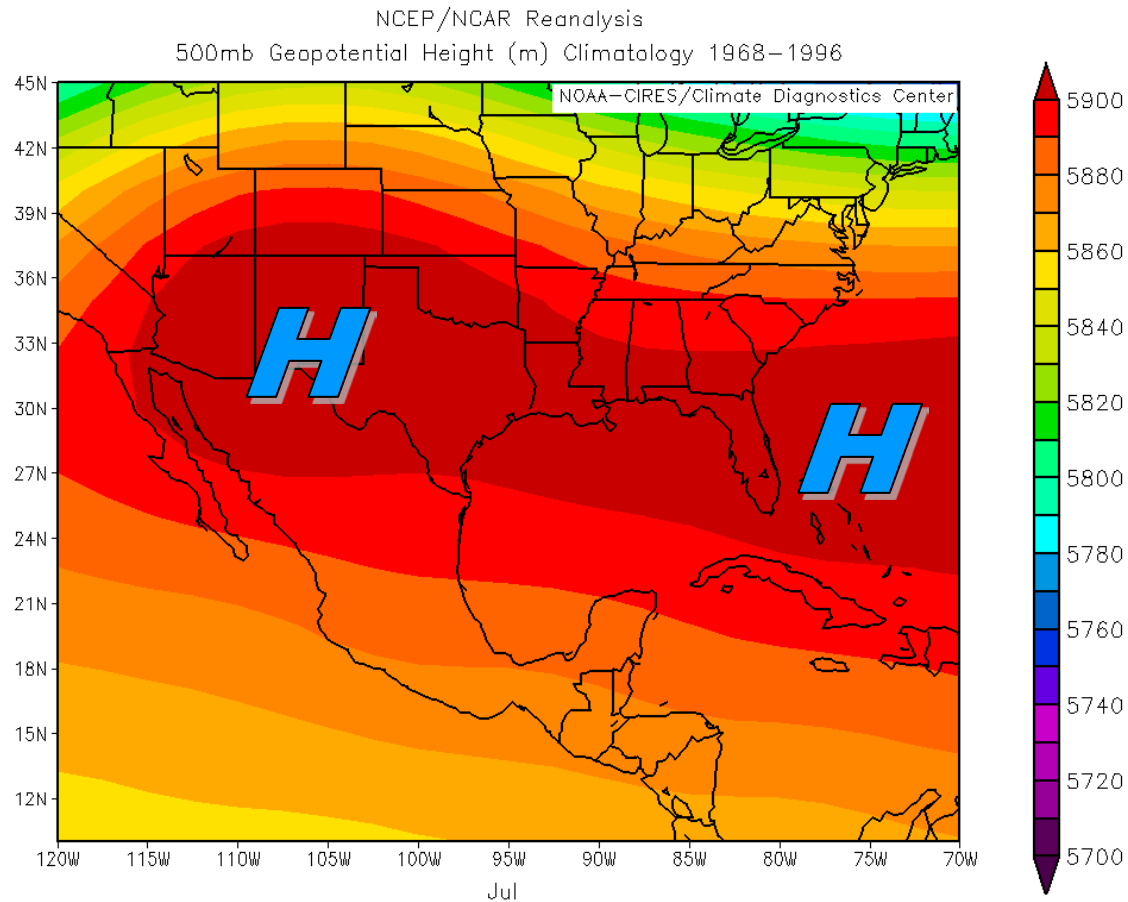
Upper Level Flow - May



Upper Level Flow - June



Upper Level Flow - July





westerly wind

NE

NV

UT

CO

Four Corners
High Pressure

KS

CA

TX

CO. River Valley
Thermal Low

AZ

NM

Mid-level moisture
from Gulf of Mexico

TX

Low-level moisture
from Gulf of California

Core Monsoon Area
(abundant tropical moisture,
frequent
thunderstorm activity)

GULF OF
MEXICO

PACIFIC OCEAN

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

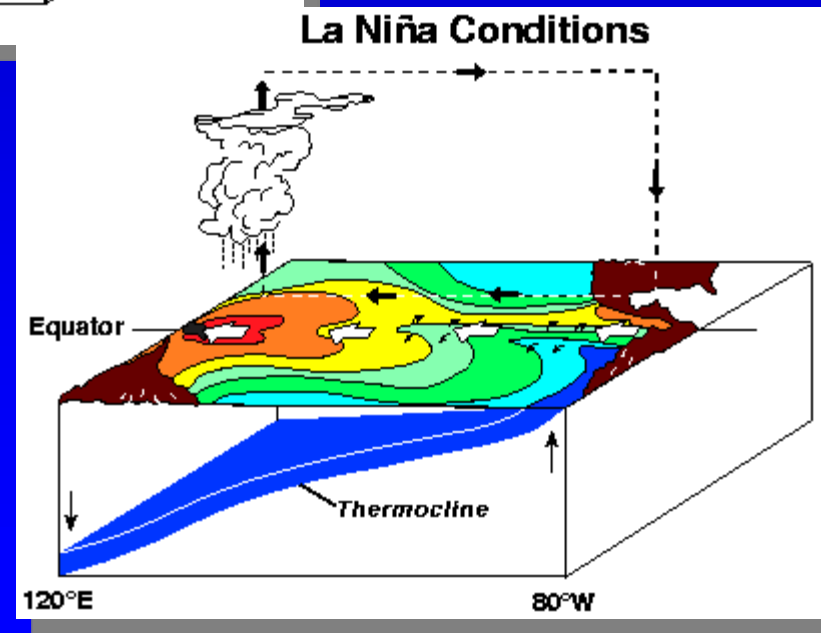
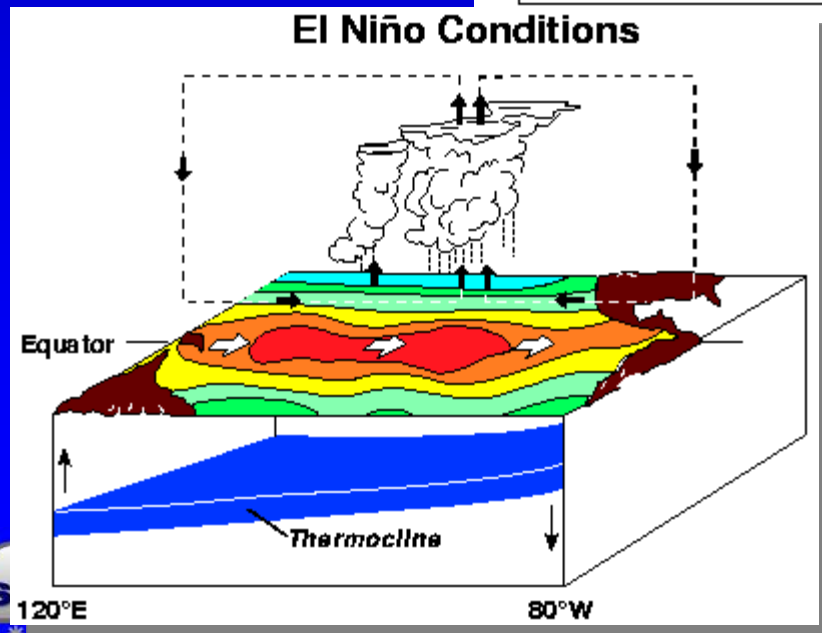
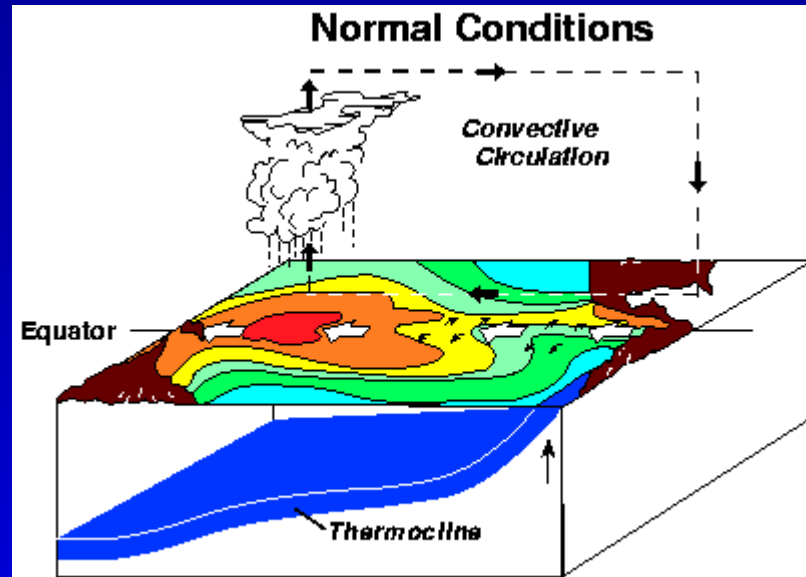
easterly wind

Mexico

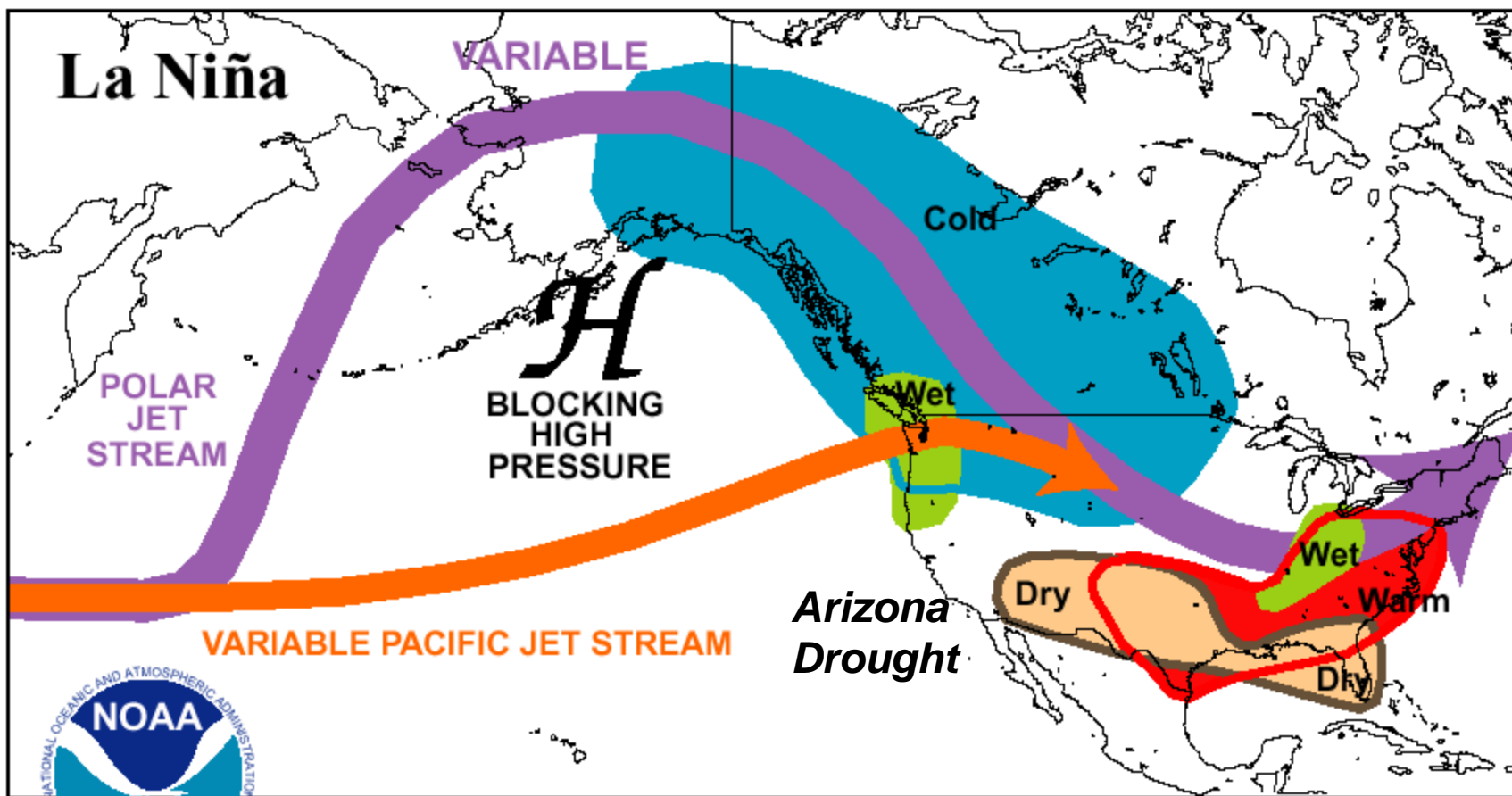
Interannual Climate Variability



El Nino – Southern Oscillation

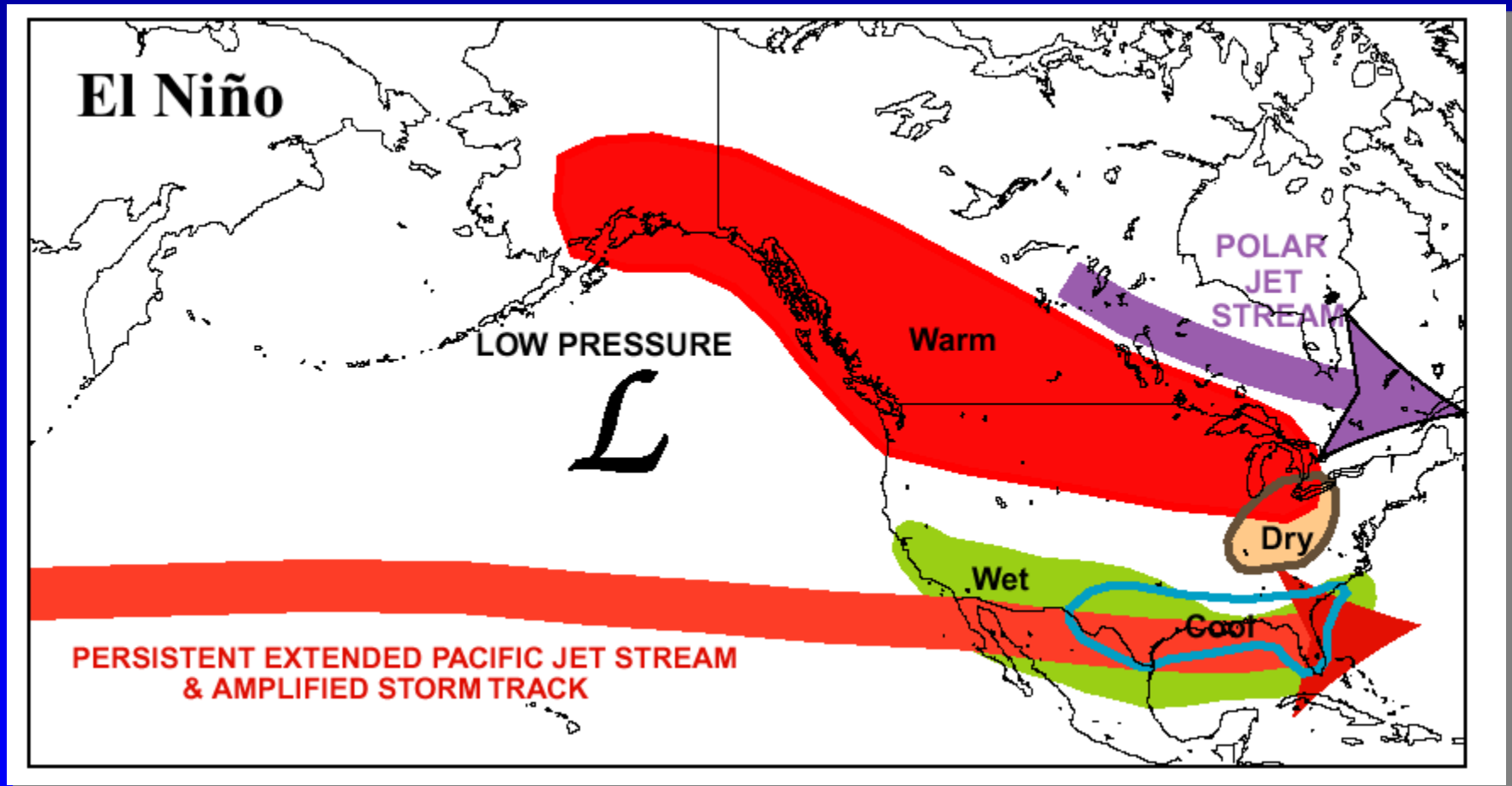


Dominant Circulation Pattern: La Nina Winter

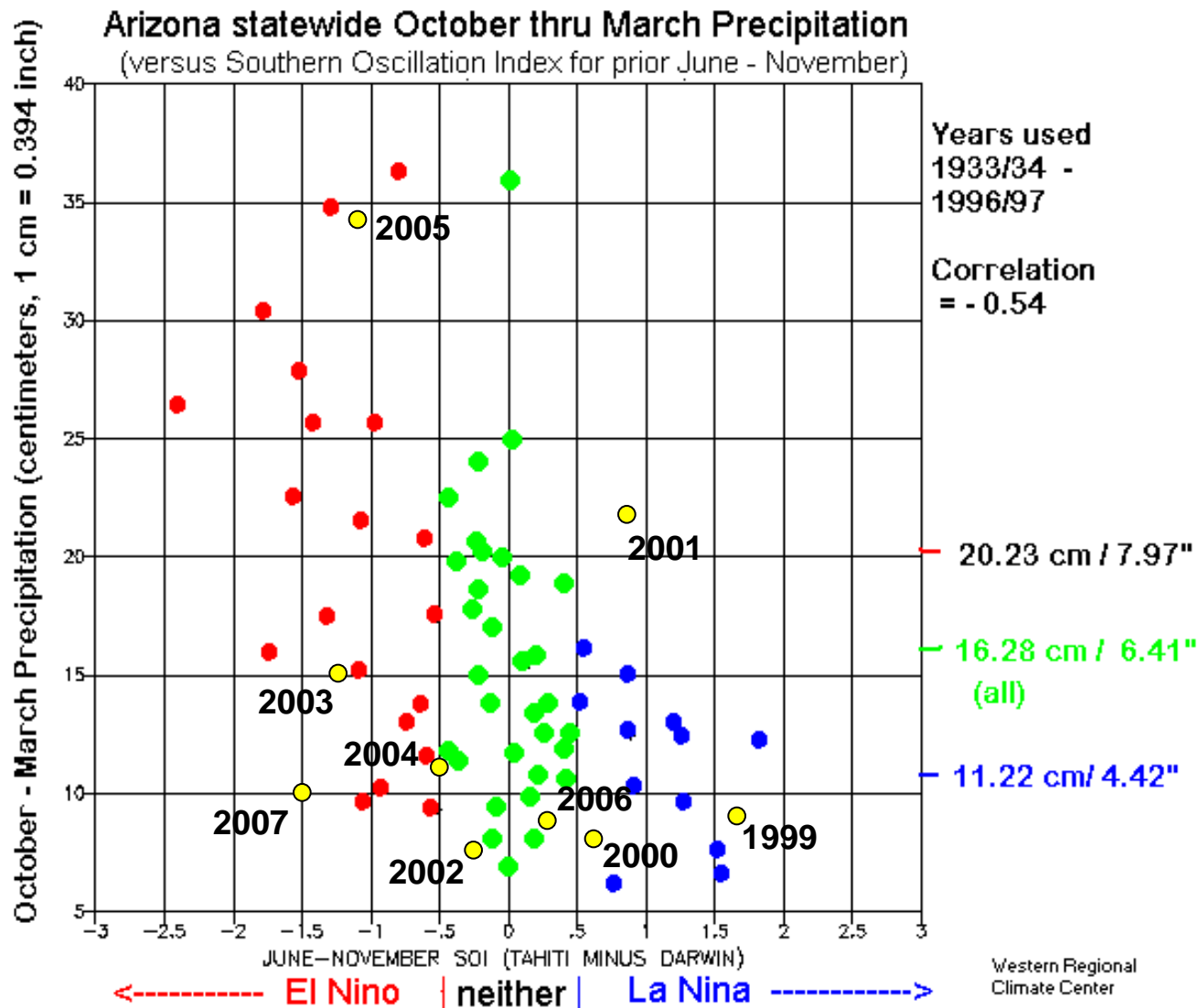


Climate Prediction Center/NCEP/NWS

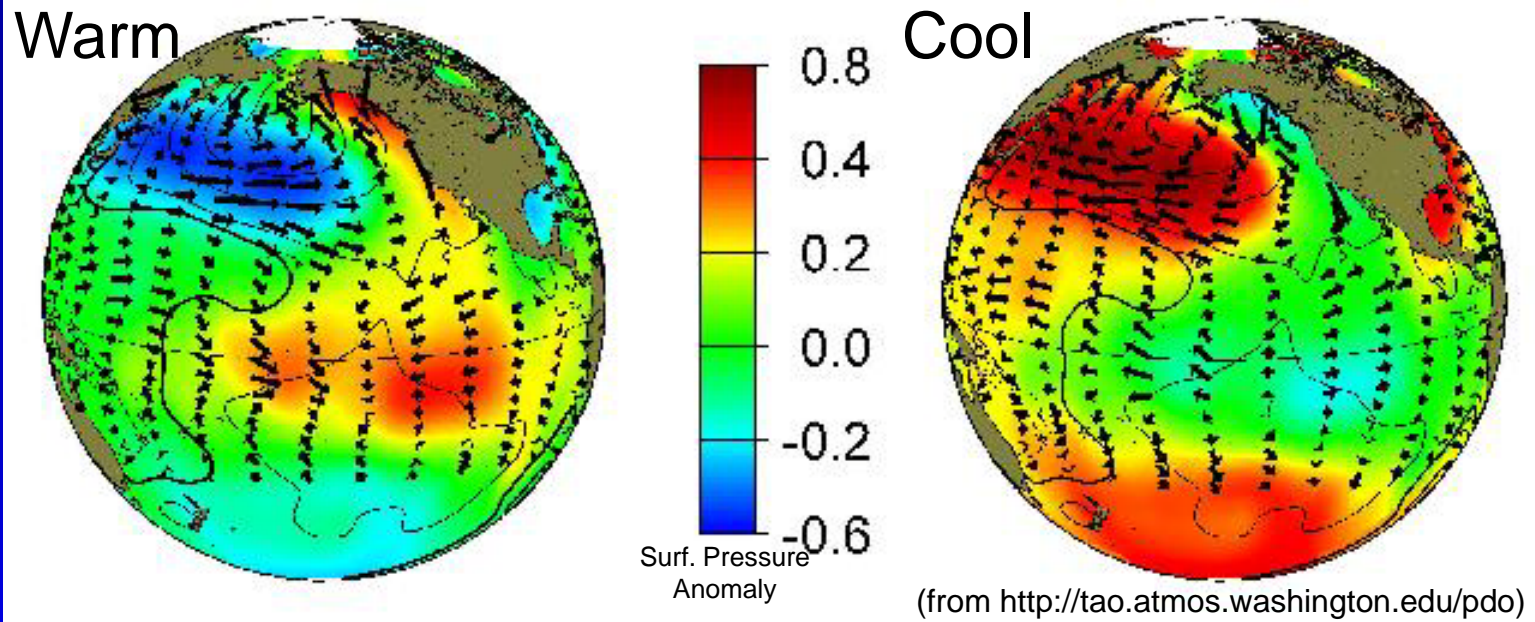
Dominant Circulation Pattern: El Niño Winter



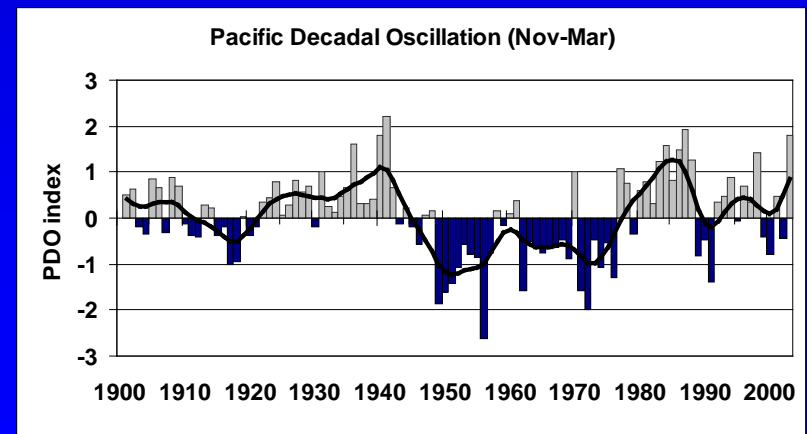
Arizona ENSO Connection



Pacific Decadal Oscillation



Period	North Pacific SSTs	Southwest Winters
1920s-1940s	Cold	Wetter
1940s-1970s	Warm	Drier
1970s-20??	Cold	Wetter
20??-????	Warm	Drier?



(from Pagano 1999)



Weather.gov Forecast

[» GO](#)
[» Active Weather Alerts](#)
[» NOAA Organizations](#)
[» Working With NOAA](#)
[» Media & Constituents](#)
[» NOAA In Your State](#)
[» Emergency Information
for NOAA Employees](#)

Related Links

[» Winter Outlook Conference
Call \(mp3\)](#)
[» U.S. Drought Monitor](#)
[» National Integrated Drought
Information System - U.S.
Drought Portal](#)
[» U.S. Winter Outlook](#)
[» Hydrometeorological
Prediction Center](#)

Media Contact

U.S. dealt another La Niña winter but 'wild card' could trump it

Devastating drought in Southern Plains likely to continue

October 20, 2011

The Southern Plains should prepare for continued drier and warmer than average weather, while the Pacific Northwest is likely to be colder and wetter than average from December through February, according to the annual [Winter Outlook](#) released today by NOAA.

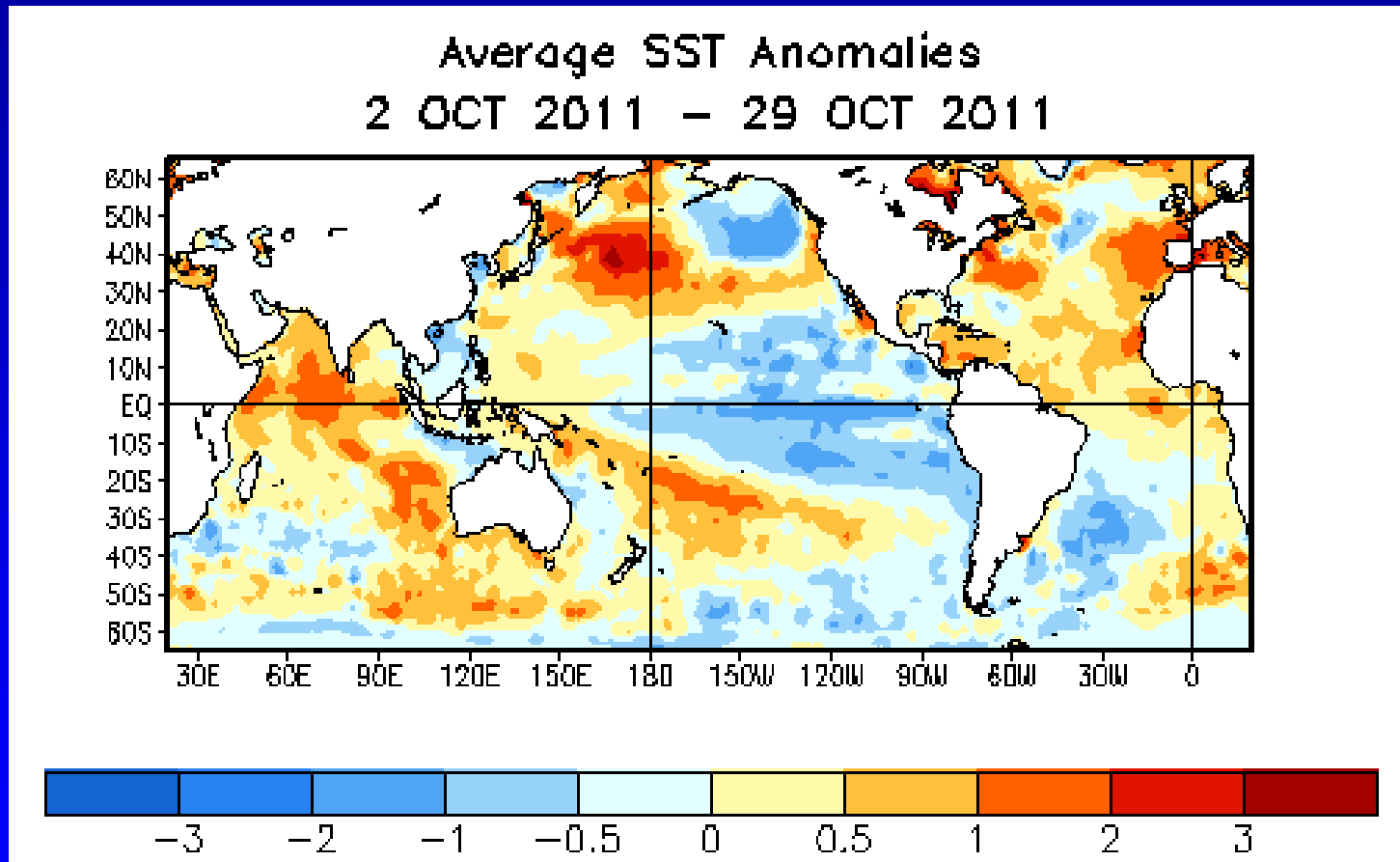
For the second winter in a row, La Niña will influence weather patterns across the country, but as usual, it's not the only climate factor at play. The 'wild card' is the lesser-known and less predictable Arctic Oscillation that could produce dramatic short-term swings in temperatures this winter.

NOAA expects La Niña, which returned in August, to gradually strengthen and continue through the upcoming winter. It is associated with cooler than normal water temperatures in the tropical Pacific Ocean and influences weather throughout the world.

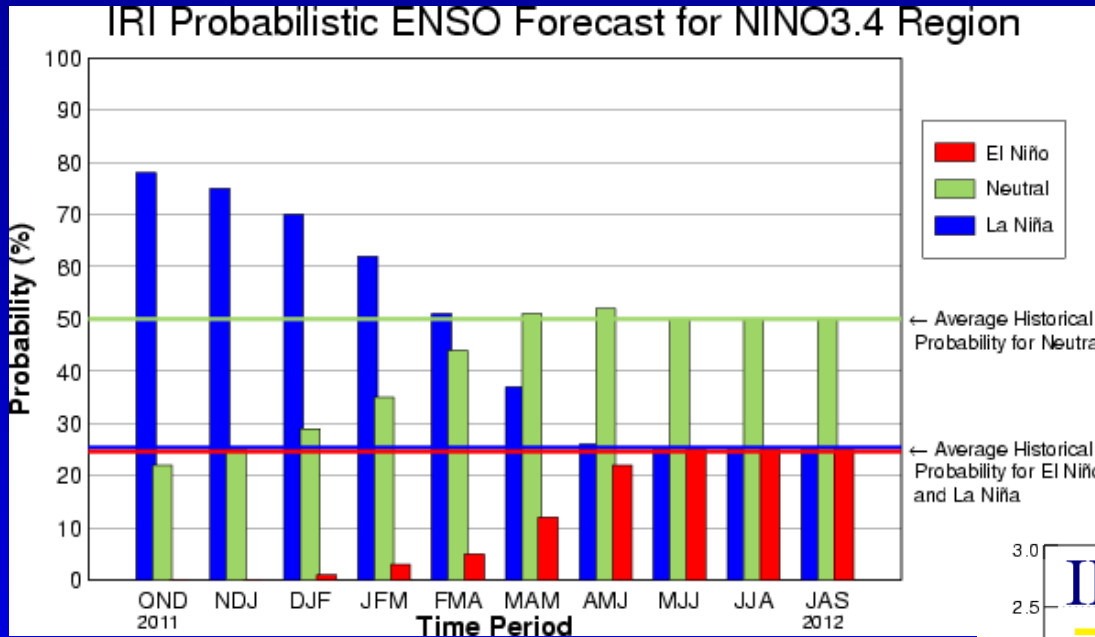
"The evolving La Niña will shape this winter," said Mike Halpert, deputy director of NOAA's Climate Prediction Center. "There is a wild card, though. The erratic Arctic Oscillation can generate strong shifts in the climate patterns that could overwhelm or amplify La Niña's typical impacts."


[High Resolution](#) (Credit: NOAA)

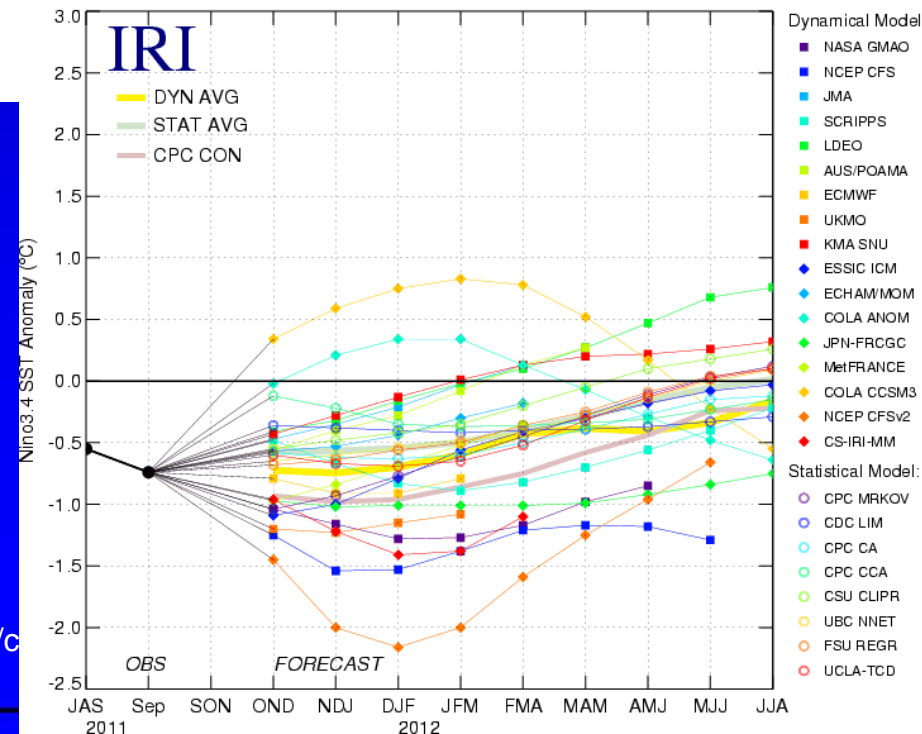
La Niña – Recent Conditions



Where are we headed?



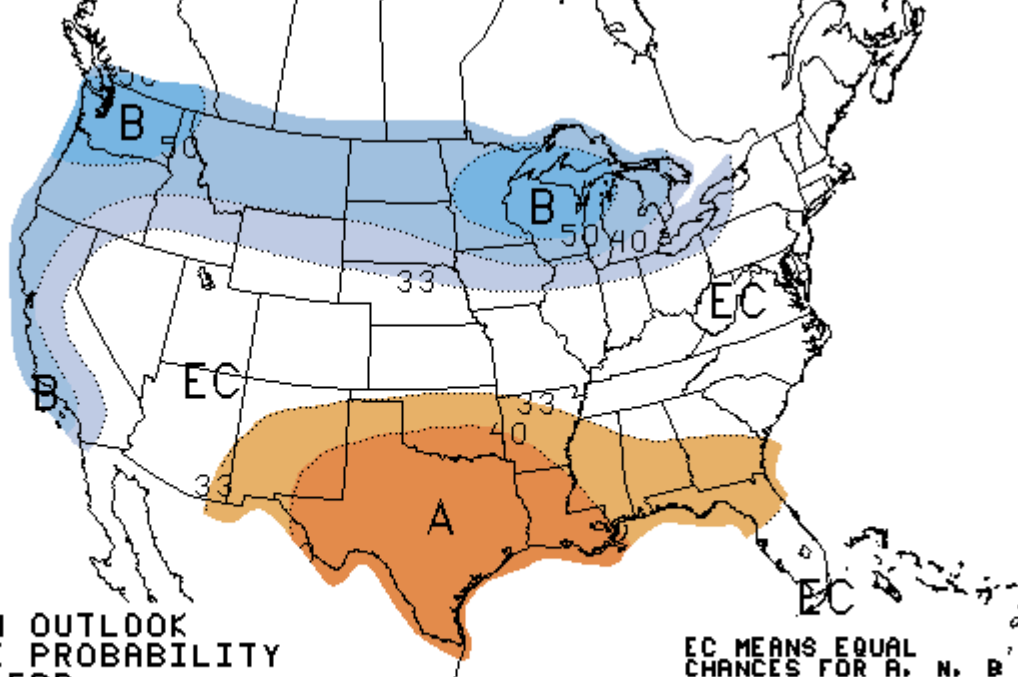
Model Predictions of ENSO from Oct 2011



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

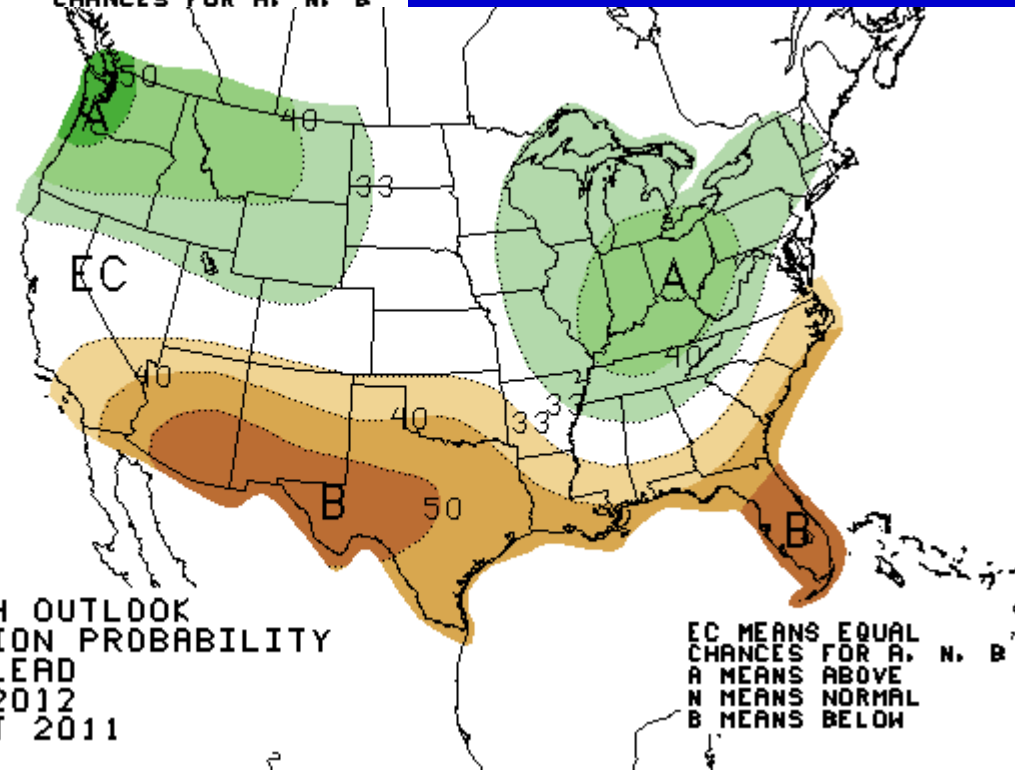


Winter 2011/12 Forecasts (Jan-Feb- Mar)



EC MEANS EQUAL CHANCES FOR A, N, B

THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
2.5 MONTH LEAD
VALID JFM 2012
MADE 20 OCT 2011



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 JFM 2012
MADE 20 OCT 2011



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

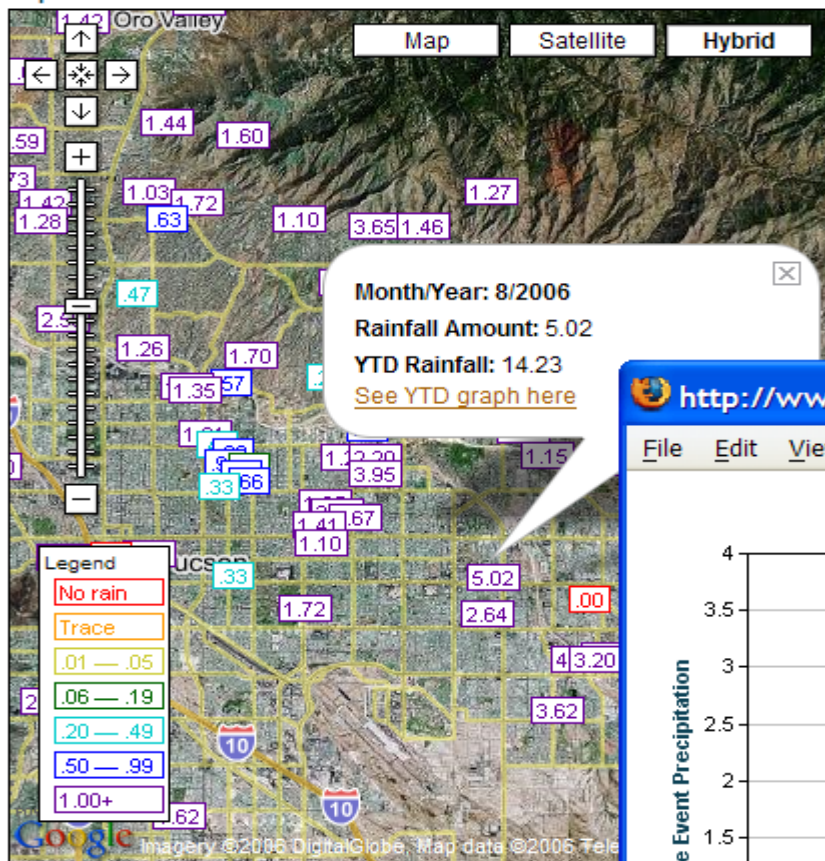


RainLog: Volunteer Precipitation Monitoring Network for Arizona

- Network developed by SAHRA and Arizona Cooperative Extension in support of state drought monitoring needs
- Has over 1700 volunteers and is continuing to grow
- Complementary to existing observing networks
- Opportunity to collect and share precipitation data across ungauged rural areas



Report of Rainfall Data for 8/2006



Select predefined region:

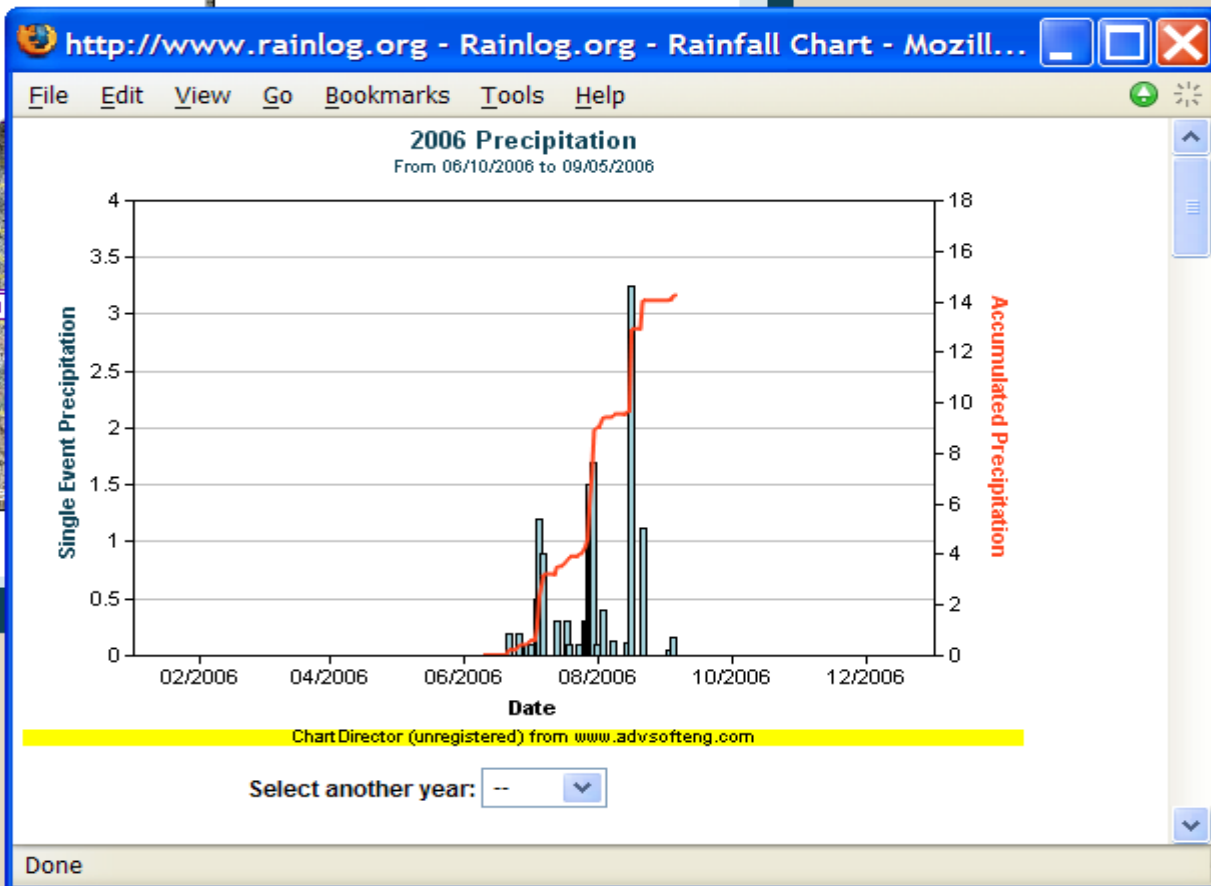
Tucson

Select a report type:

- Single day
- Date range
- Monthly totals

August 2006

Get report



My RainLog

- Encouraging volunteers to submit, store, and manage their own historical data
- Special functions and tools to create reports and graphics
- Historical data allows for calculations of averages and percentiles useful in drought monitoring
- Many detailed records submitted, ongoing solicitation for more historical data

rainlog.org home data add data handbook my profile partners Log out Mike Crimmins | Learn more

daily month grid monthly entries

< Previous month
Next month >
jump to: ▾

Monthly Rain Data for August, 2006

Enter your rain gauge data below. Red columns are required. Dates in the future are not presented.

Gauge	Will Read On	Report On	Check to Save	Total Precipitation	Reading Time 00-23 : 00-59	Quality	Comments
			<input type="checkbox"/> Check all	0.0	07 : 00	Good ▾	
08/01	07/31		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/02	08/01		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/03	08/02		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/04	08/03		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/05	08/04		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/06	08/05		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/07	08/06		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/08	08/07		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/09	08/08		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/10	08/09		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/11	08/10		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/12	08/11		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/13	08/12		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/14	08/13		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/15	08/14		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/16	08/15		<input type="checkbox"/>	0.0	07 : 00	Good ▾	
08/17	08/16		<input type="checkbox"/>	0.0	07 : 00	Good ▾	

Check out <http://www.rainlog.org> for more information!

CSAP

AZ DroughtWatch

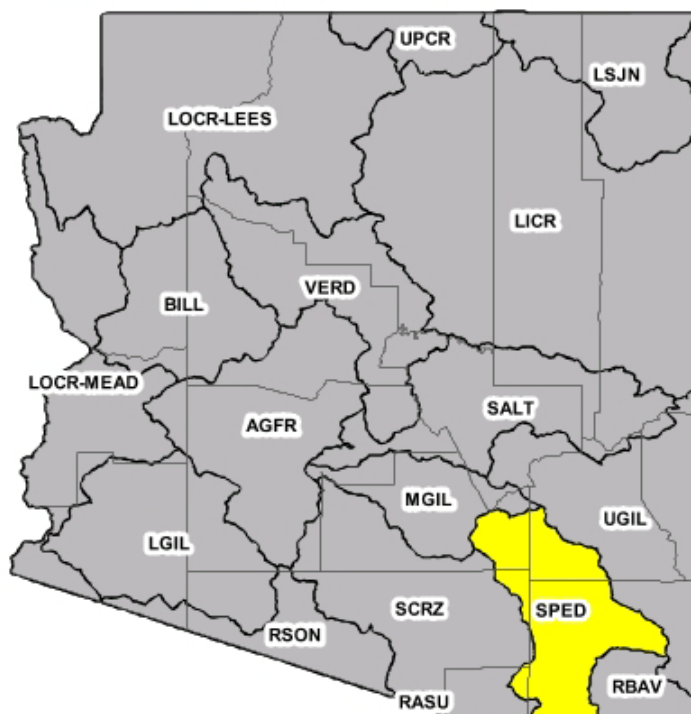


AZ DroughtWatch
Arizona's Drought Impact Reporting System

AZ DroughtWatch beta release

[Home](#) [My DroughtWatch](#) [User Guide](#) [Register](#) [About AZ DroughtWatch](#)

Drought Impacts: January-2009



Summary Reports

[County and watershed summary tables](#)

[Detailed impact reports \(requires registration and login\)](#)

Impacts Reported

- in 0 of 6 categories
- in 1 of 6 categories
- in 2 of 6 categories
- in 3 of 6 categories
- in 4 of 6 categories
- in 5 of 6 categories
- in 6 of 6 categories

Categories

-  Water
-  Agriculture
-  Livestock
-  Society
-  Tourism
-  Ecology

Watershed Abbreviations

AGFR	Agua Fria River-Lower Gila River
BILL	Bill Williams River
LGIL	Lower Gila River below Painted Rock Dam
LICR	Little Colorado River
LOCR-LEES	Lower Colorado River, Lees Ferry to Lake Mead
LOCR-MEAD	Lower Colorado River below Lake Mead
LSJN	Lower San Juan River

About AZ DroughtWatch

AZ DroughtWatch is a tool designed to collect qualitative reports of drought impacts across Arizona. This impact information is used in conjunction with meteorological and hydrological data to characterize drought conditions.

[Access recent drought status reports compiled by the Governor's Drought Task Force Monitoring Technical Committee](#)

[Find out more about AZ DroughtWatch](#)

[What's new at AZ DroughtWatch](#)

Arizona Drought Links

[AZ Dept. of Water Resources - Drought Program](#)

[Rainlog Precipitation Monitoring Network](#)


[U of A Climate Science Applications Program](#)

CSAP

Climate Science Applications Program - Arizona Cooperative Extension

<http://azdroughtwatch.org>


Qualitative Impact Reports

 Water Resources and Hydrology

SURFACE WATER IMPACTS

A1 Unusually low water levels in reservoirs, lakes, and ponds

Please provide more information about this drought impact

Provide details about the impact: Upload an image: 

How is this impact different this month than last month? Falling ▾

If applicable, provide a monetary cost of this impact (\$):

A2 Unusually low flows in streams, rivers, and springs


A3 Poor water quality due to low levels/low flows


A4 Impacts on hydro-electric power generation


A5 Need for supplemental water due to drought impacts on local surface water resources (e.g. hauling water)


Add an impact for this category not listed above:


GROUNDWATER IMPACTS

 Agricultural Impacts (food crops, cash crops, and aquaculture)

 Livestock Production and Grazing Land Impacts

 Societal and Community Impacts

 Tourism and Recreation

 Ecological Impacts

Resources

- Climate Assessment for the Southwest
(<http://www.climas.arizona.edu/>)
- 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>)

