# Climate, Change and Adaptation

**UCOP Ontario Workshop**

April 10, 2013

# Talk Overview

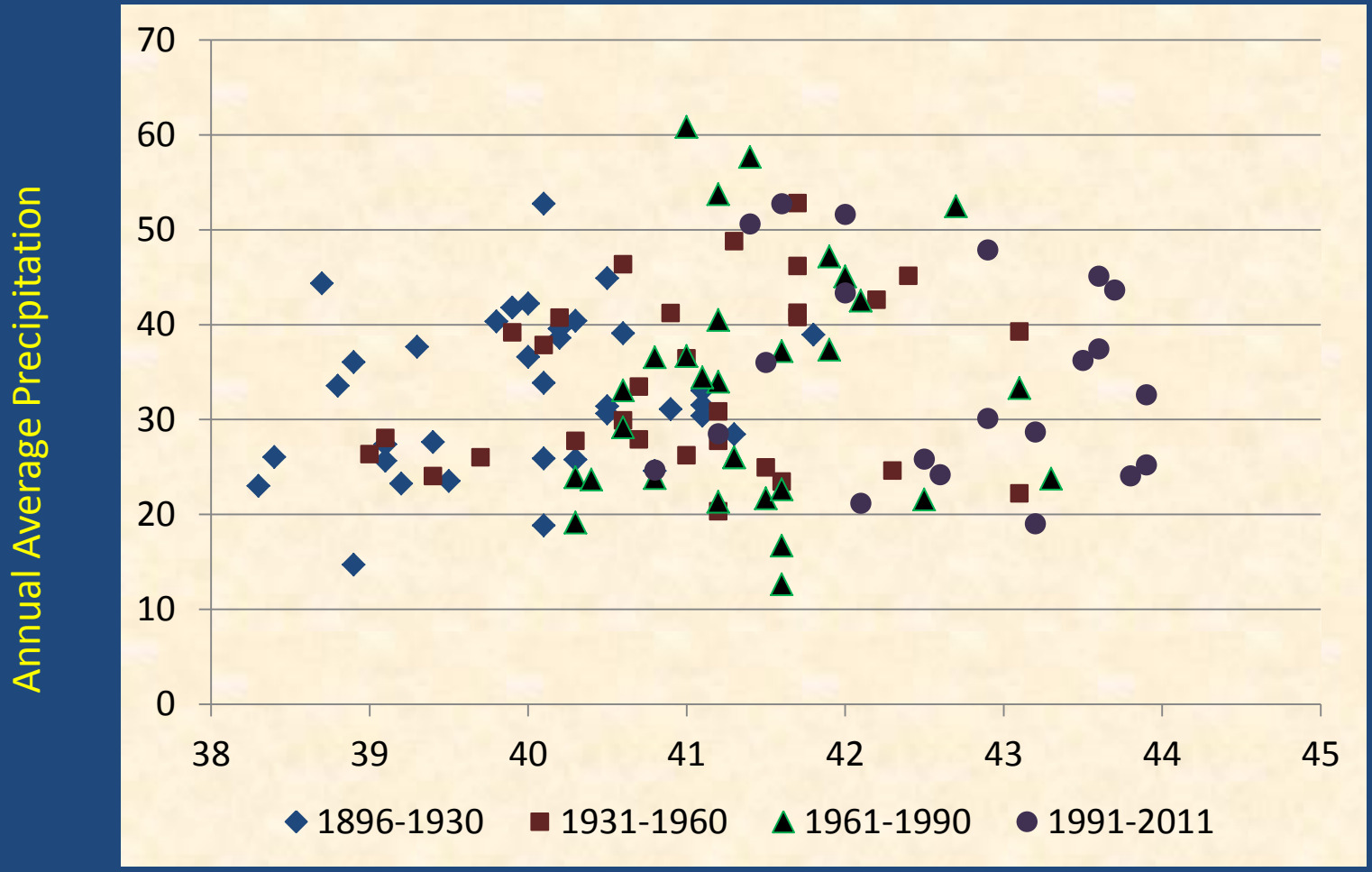
- Climate and Expectations for Change
- Variability, Vulnerability and Adaptation
- Available Resources

# Climate Change Variables

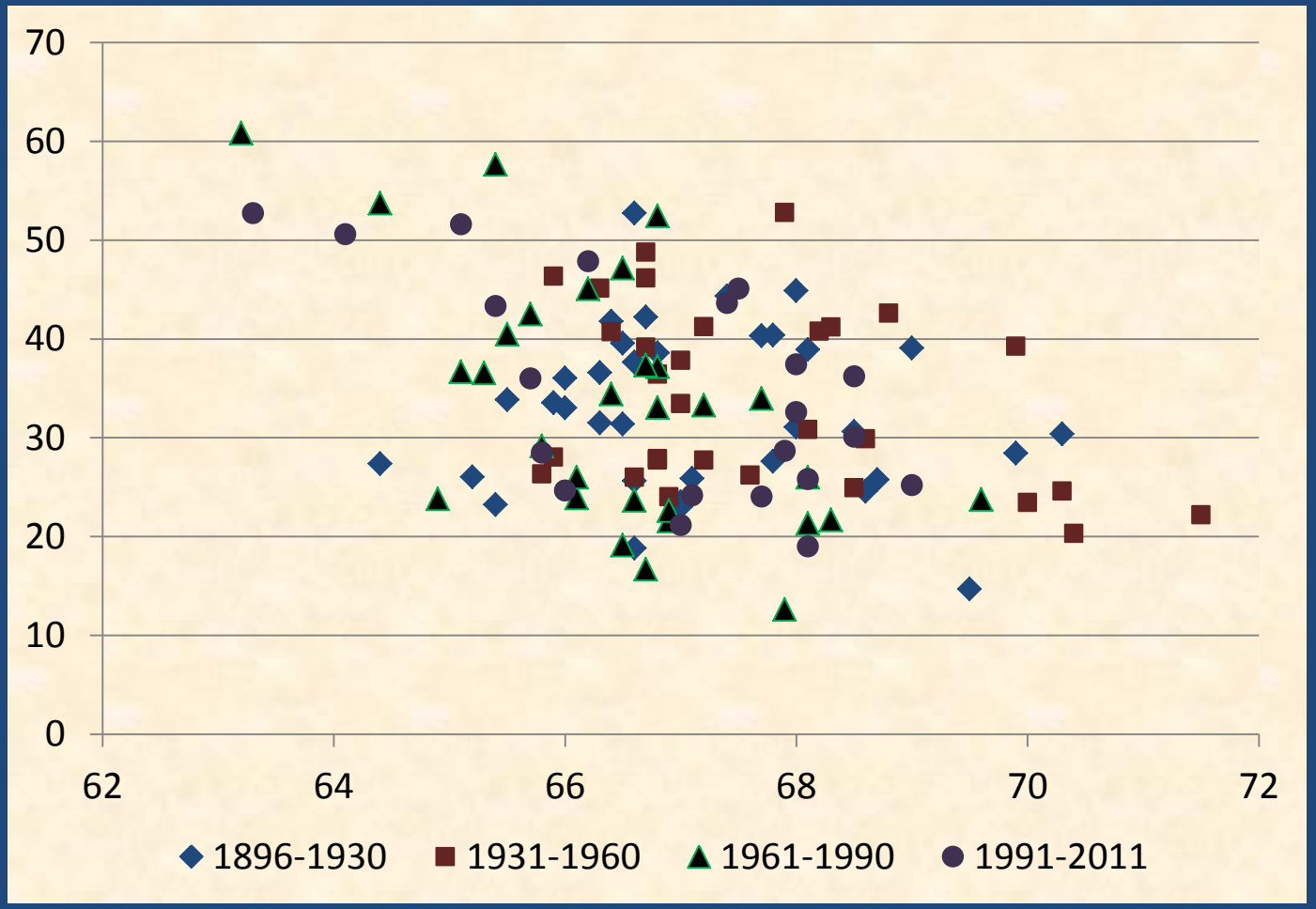
- Temperature
- Precipitation
- Snowpack
- Annual and Seasonal Runoff
- Peak River Flows (Amount and Timing)
- Mean Sea Level

## What matters, when, and why?

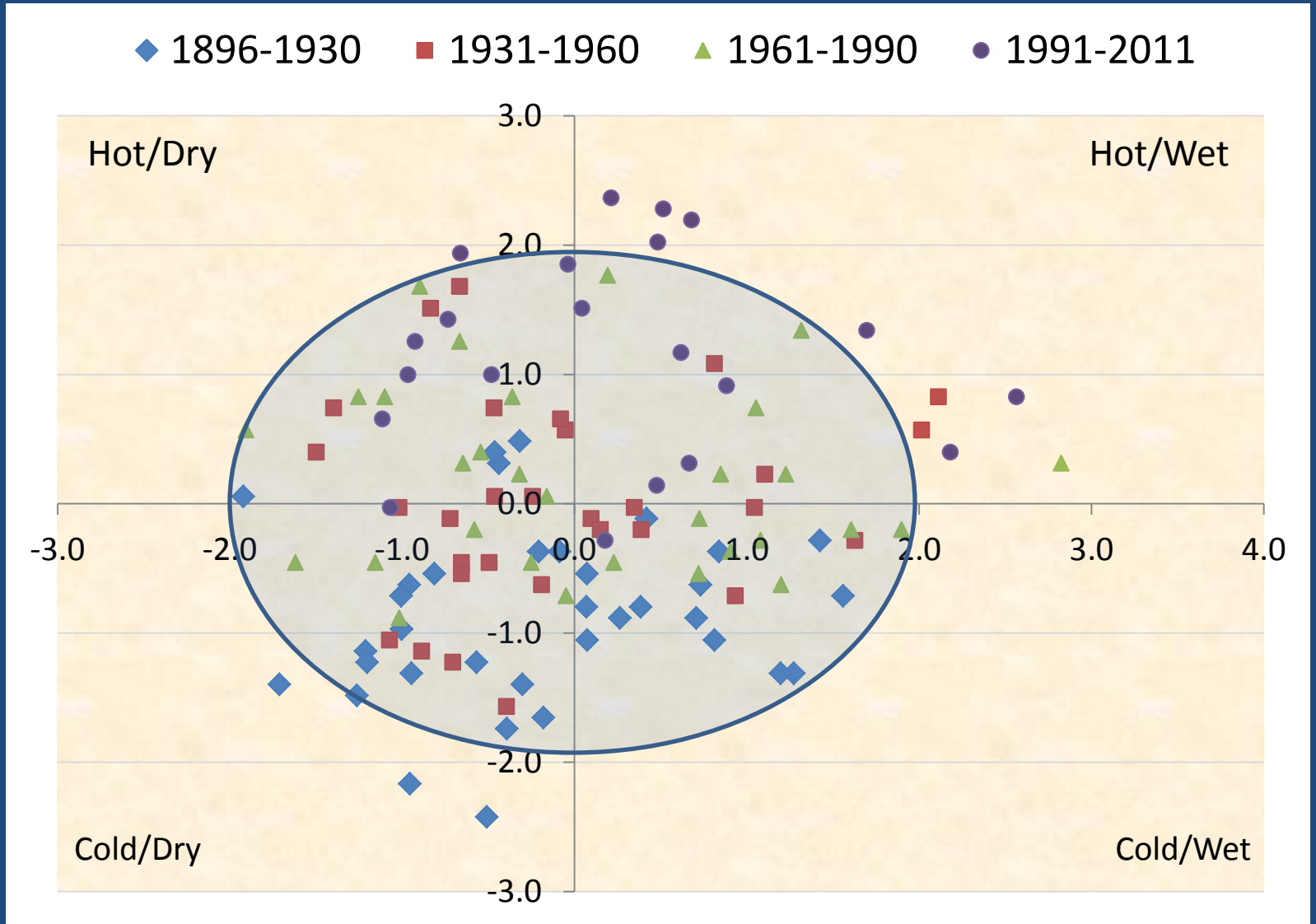
# Mariposa County West Map Data



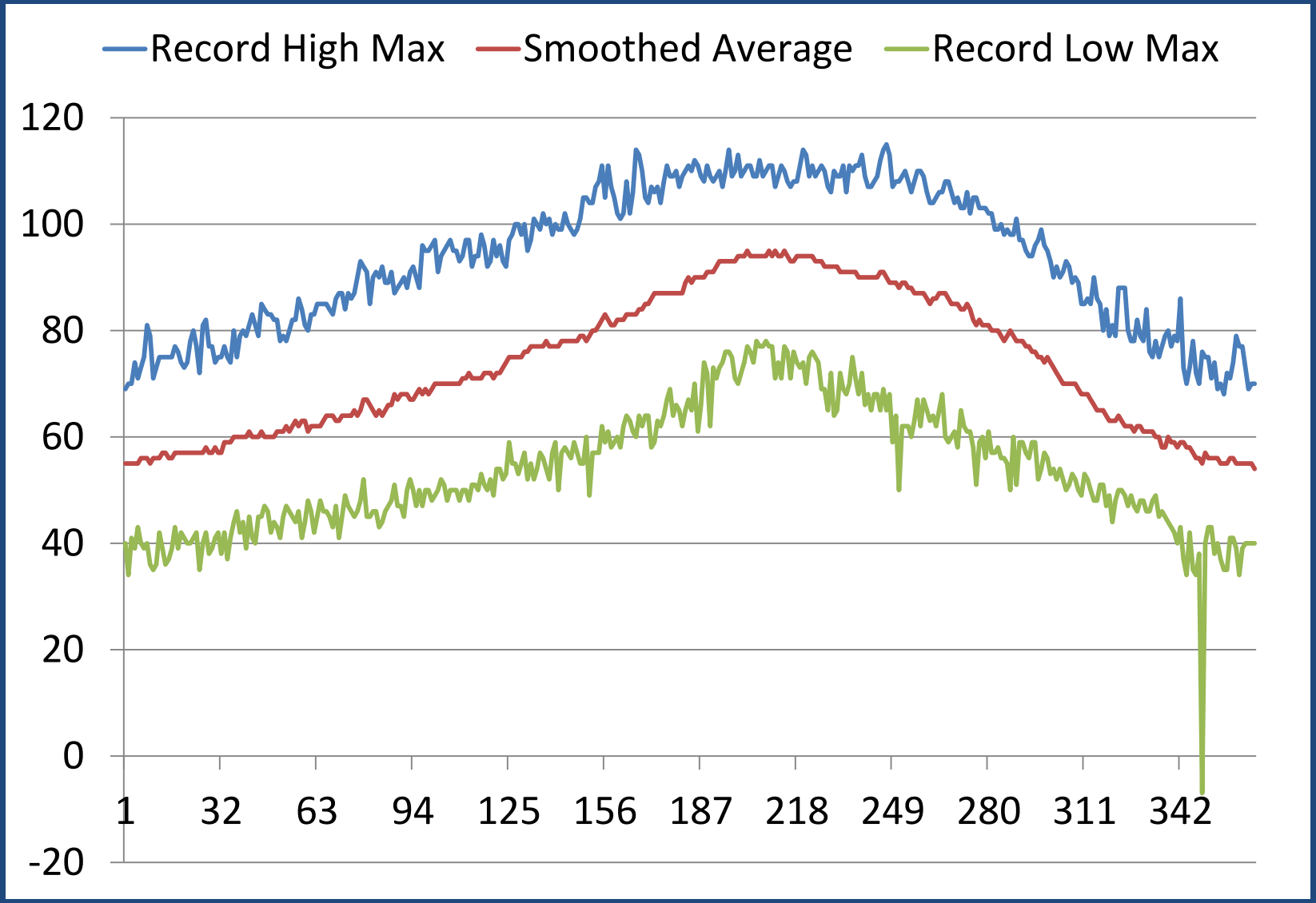
# Mariposa County West Map Data



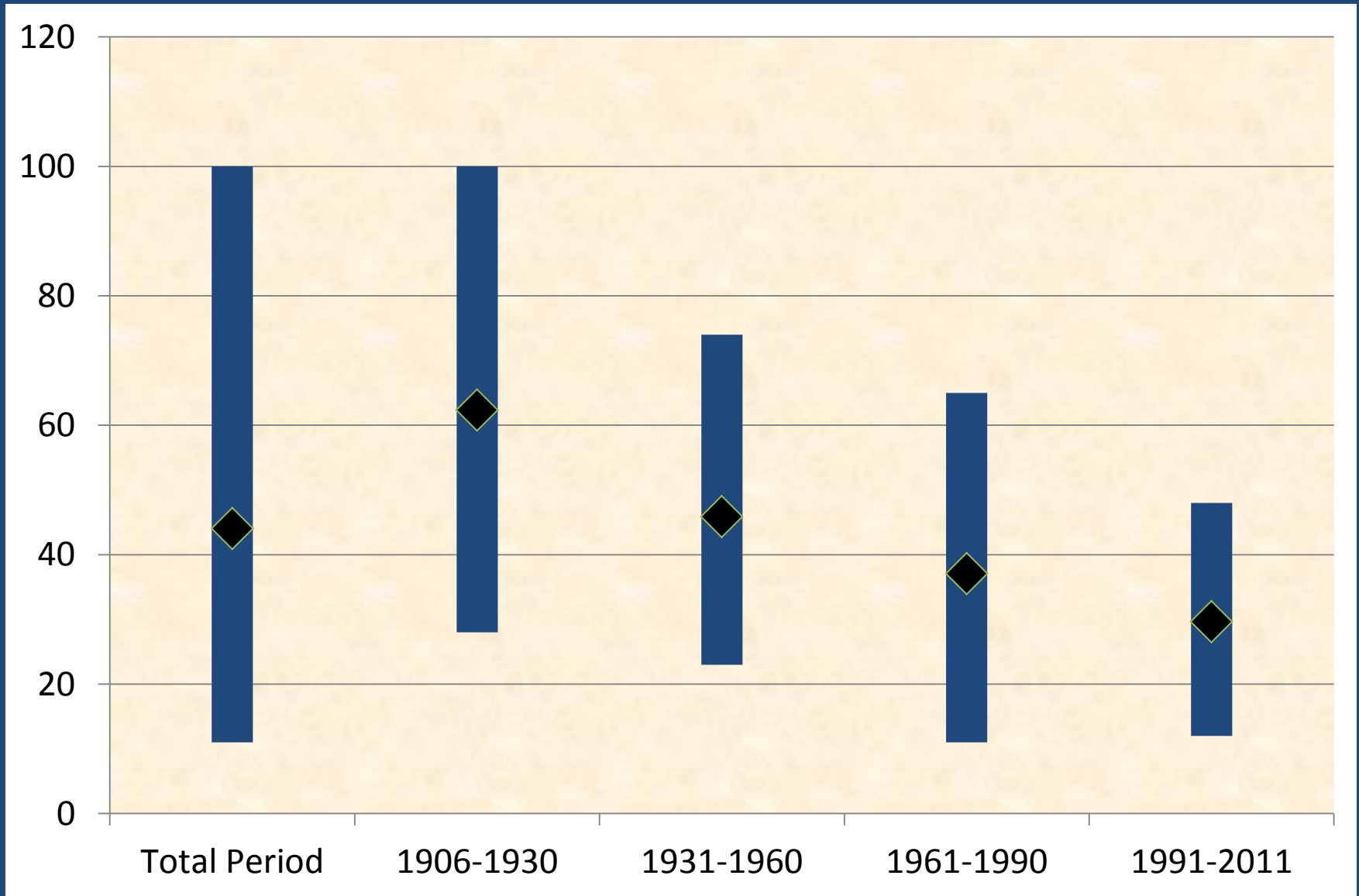
# Precipitation/Temperature Distribution Sonoma County



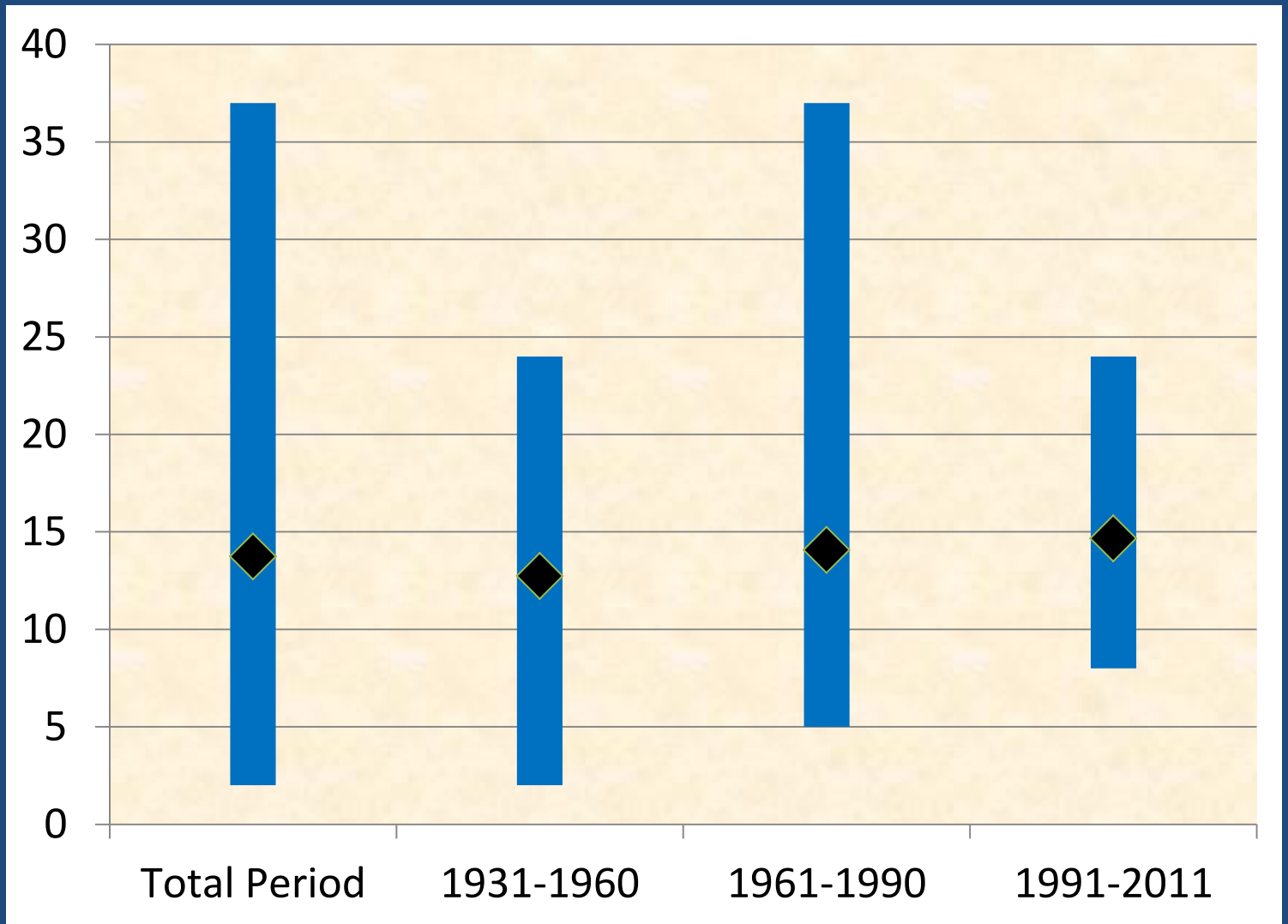
# Current Daily Extremes – Tmax Ukiah



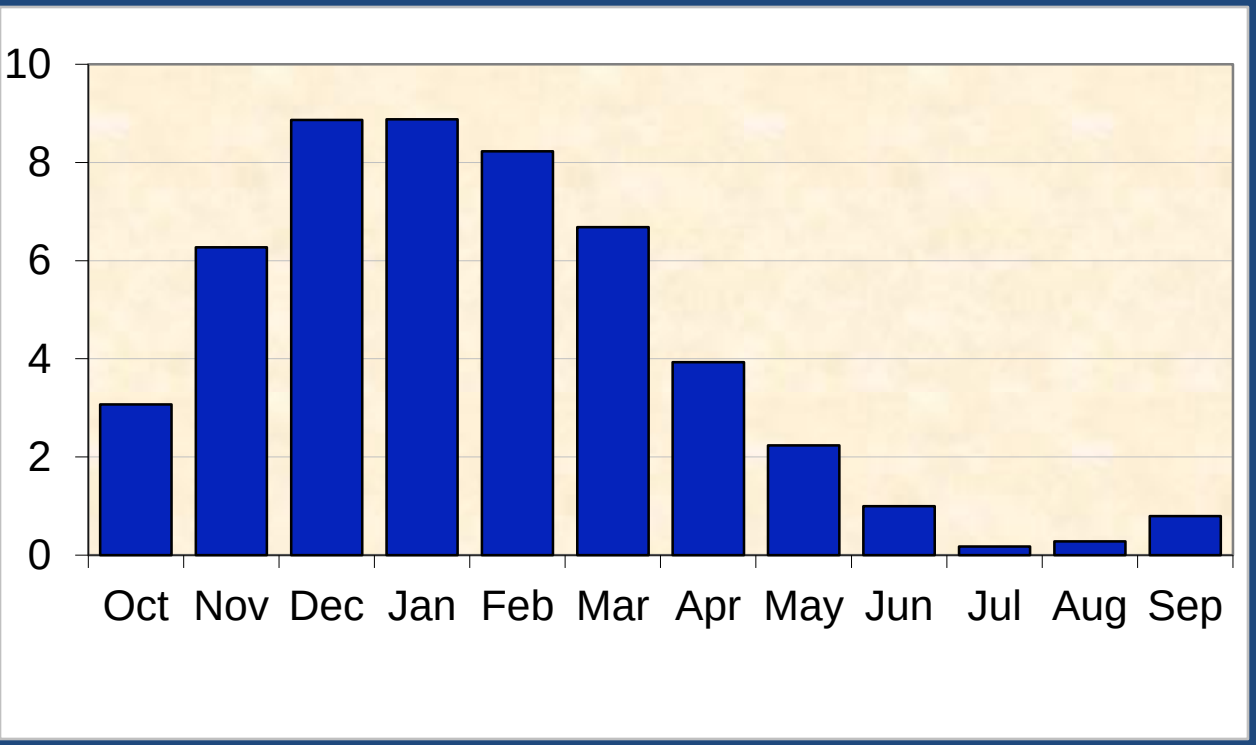
# Event Above Threshold Tracking
# Ukiah Tmin below 32 °F

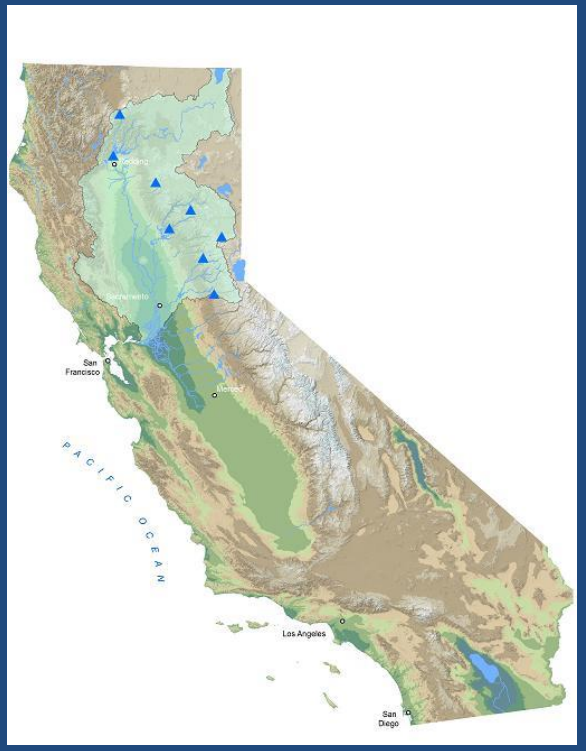


# Event Above Threshold Tracking Healdsburg Precipitation Above 1 inch/day



# Northern Sierra 8 Station Index

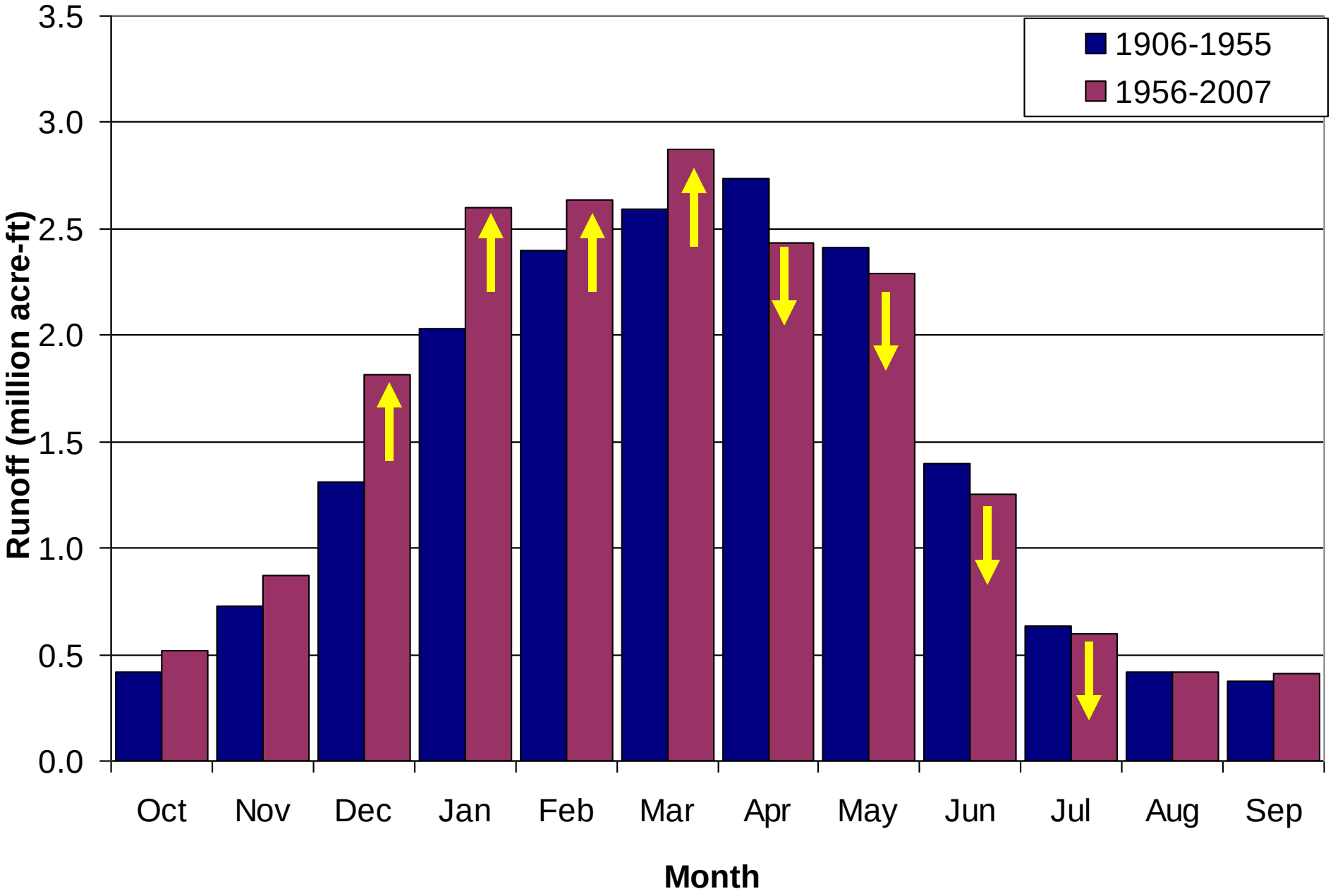


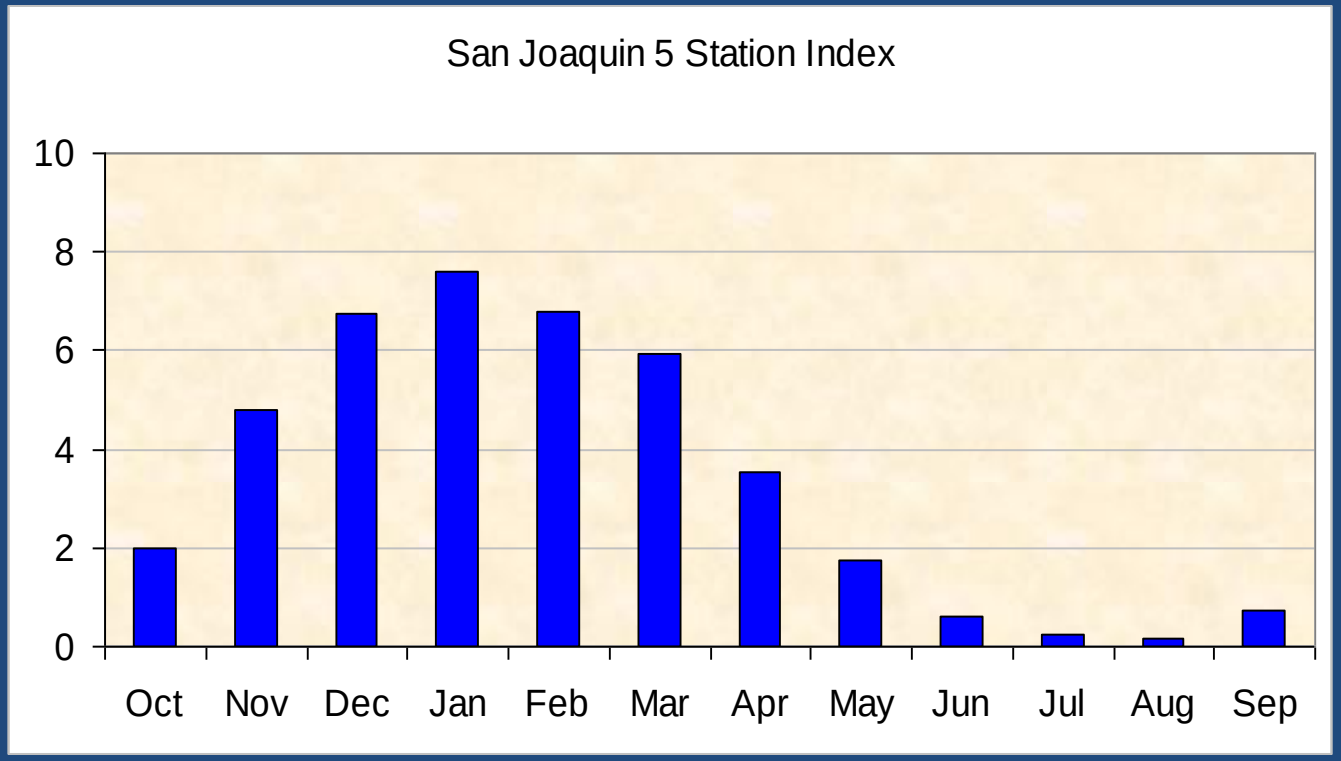

Annual Average: 50 inches
Maximum Year (1983): 88.5 inches
Minimum Year (1924): 17.1 inches
Period of Record 1921- Present

Average of:

| | |
|---|---|
| Mt. Shasta City | Quincy |
| Shasta Dam | Sierraville RS |
| Mineral | Pacific House |
| Brush Creek RS | Blue Canyon |


Monthly Average Runoff of Sacramento River System
1906-1955
1956-2007
Runoff (million acre-ft)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month

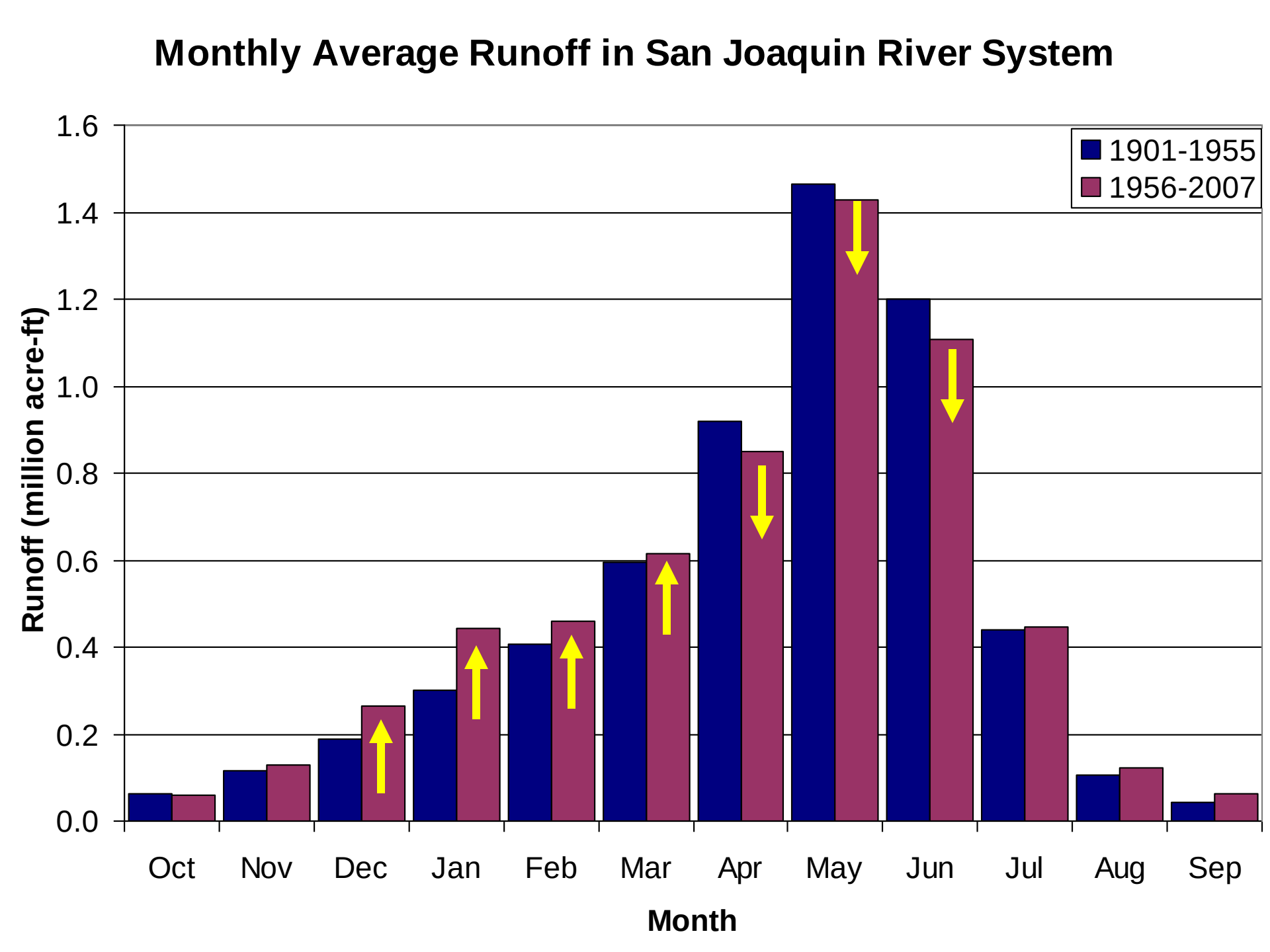
# San Joaquin 5-Station Index

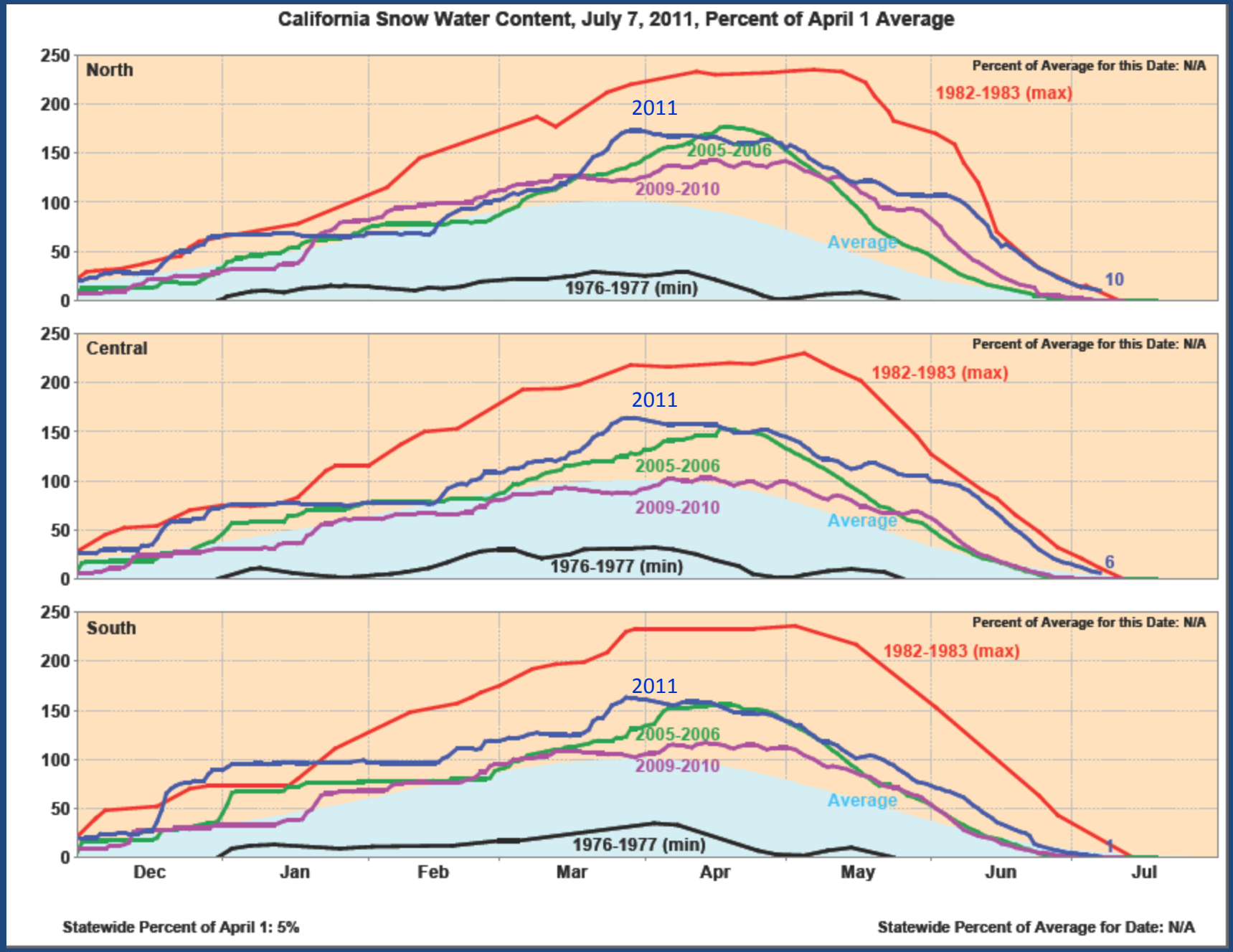




Annual Average: 40 inches
Maximum Year (1983) 77.4 inches
Minimum Year (1924) 14.8 inches
Period of Record 1949 - Present

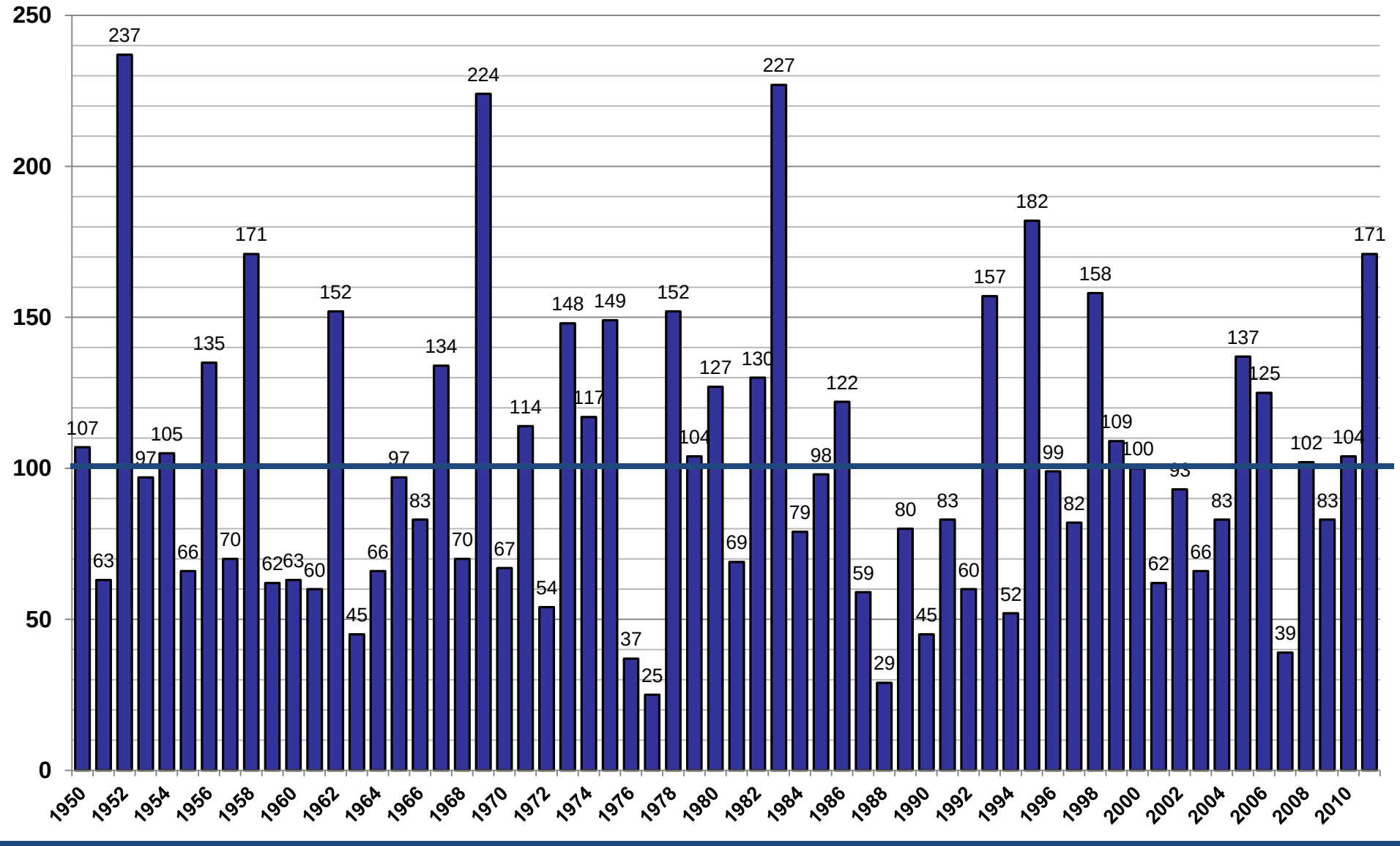
Average of:
Calaveras Big Trees
Hetch Hetchy
Yosemite HQ
North Fork Ranger Station
Huntington Lake


Monthly Average Runoff in San Joaquin River System
Runoff (million acre-ft)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1901-1955
1956-2007
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month

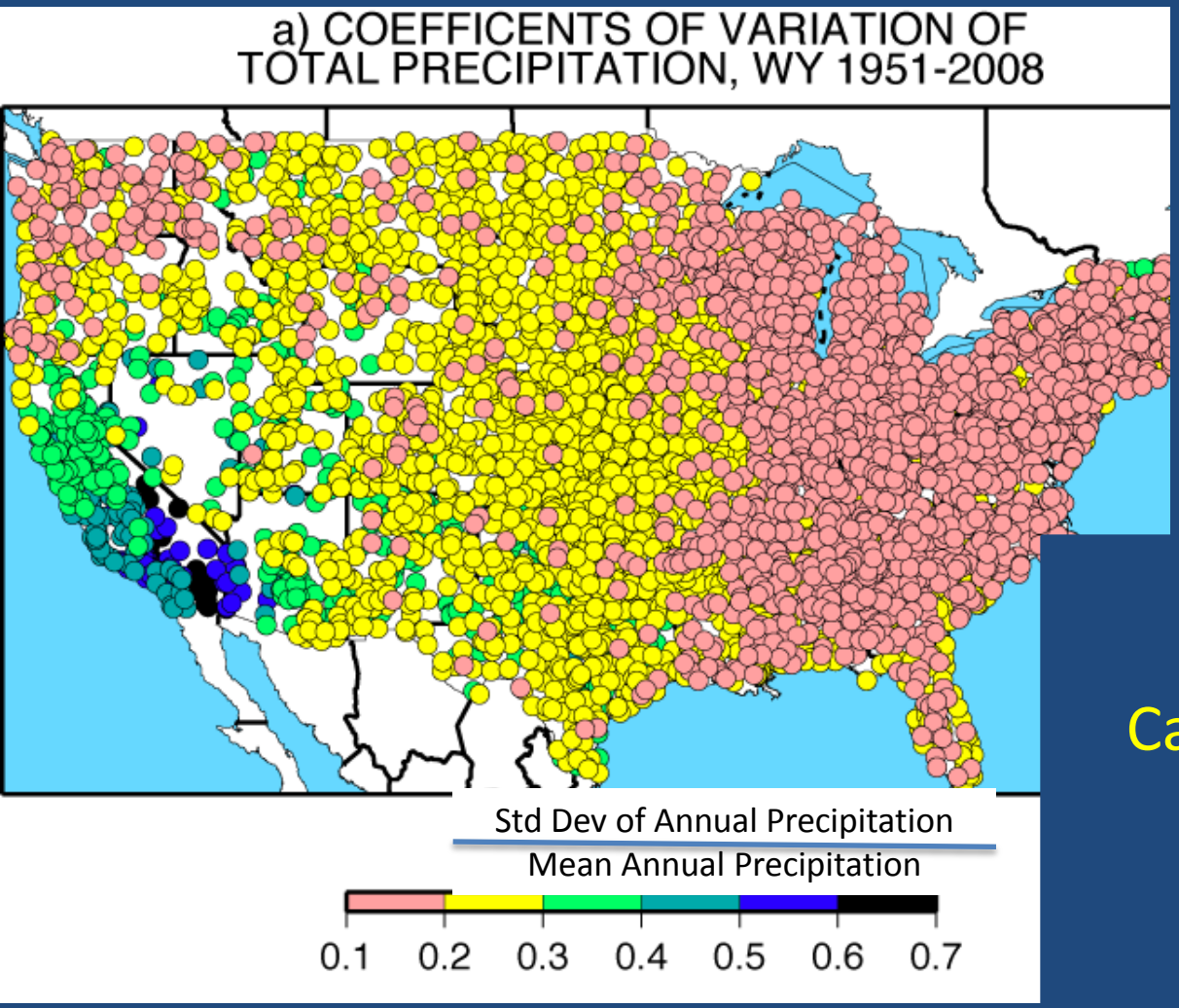

California Snow Water Content, July 7, 2011, Percent of April 1 Average
North
Percent of Average for this Date: N/A
1982-1983 (max)
2011
2005-2006
2009-2010
Average
1976-1977 (min)
10
Central
Percent of Average for this Date: N/A
1982-1983 (max)
2011
2005-2006
2009-2010
Average
1976-1977 (min)
6
South
Percent of Average for this Date: N/A
1982-1983 (max)
2011
2005-2006
2009-2010
Average
1976-1977 (min)
1
250
200
150
100
50
0
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Statewide Percent of April 1: 5%
Statewide Percent of Average for Date: N/A

# April 1 Snowpack Water Content

## Statewide Percent of Average



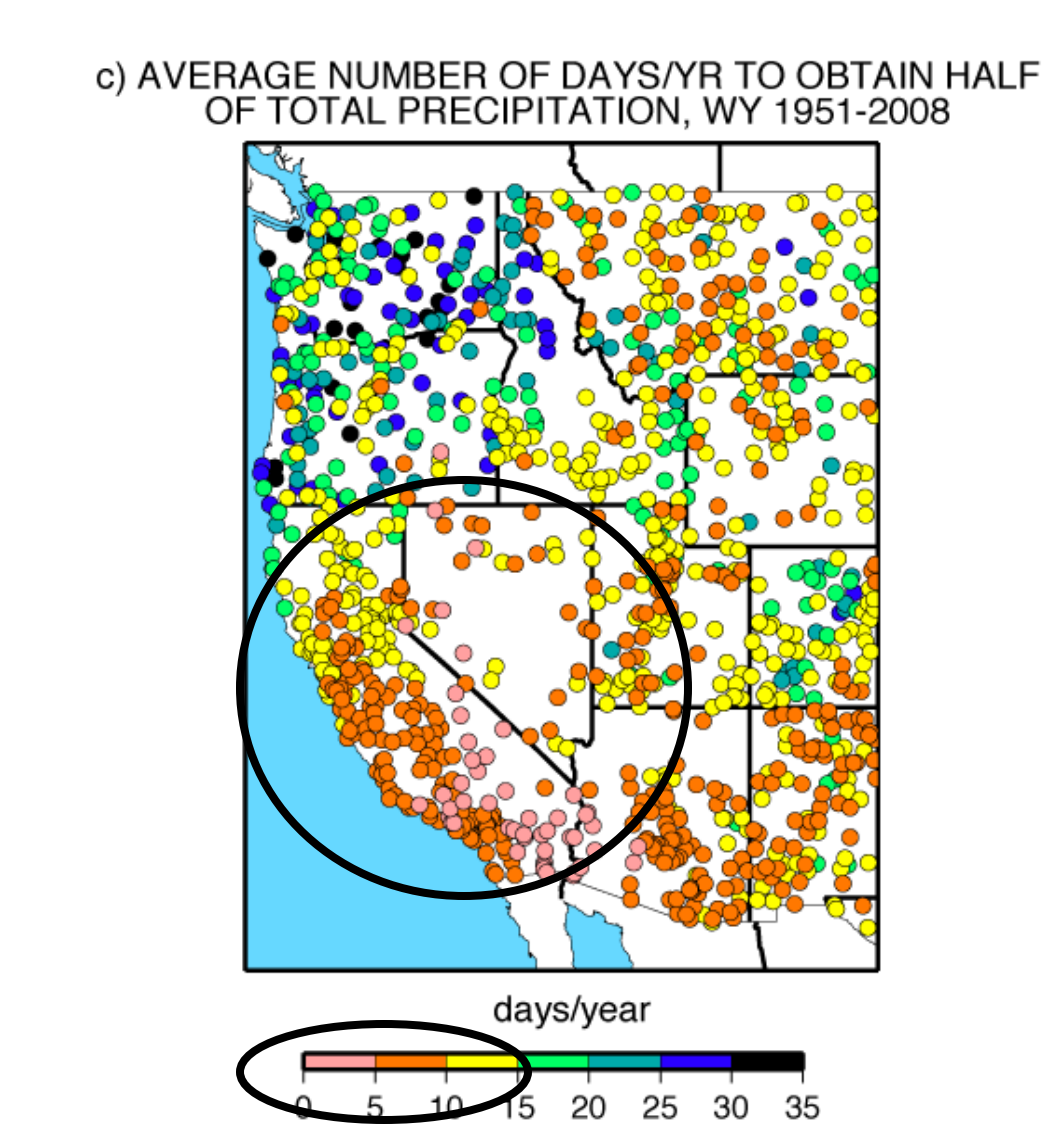
# Year to Year Precipitation Variability




California precipitation is uniquely variable

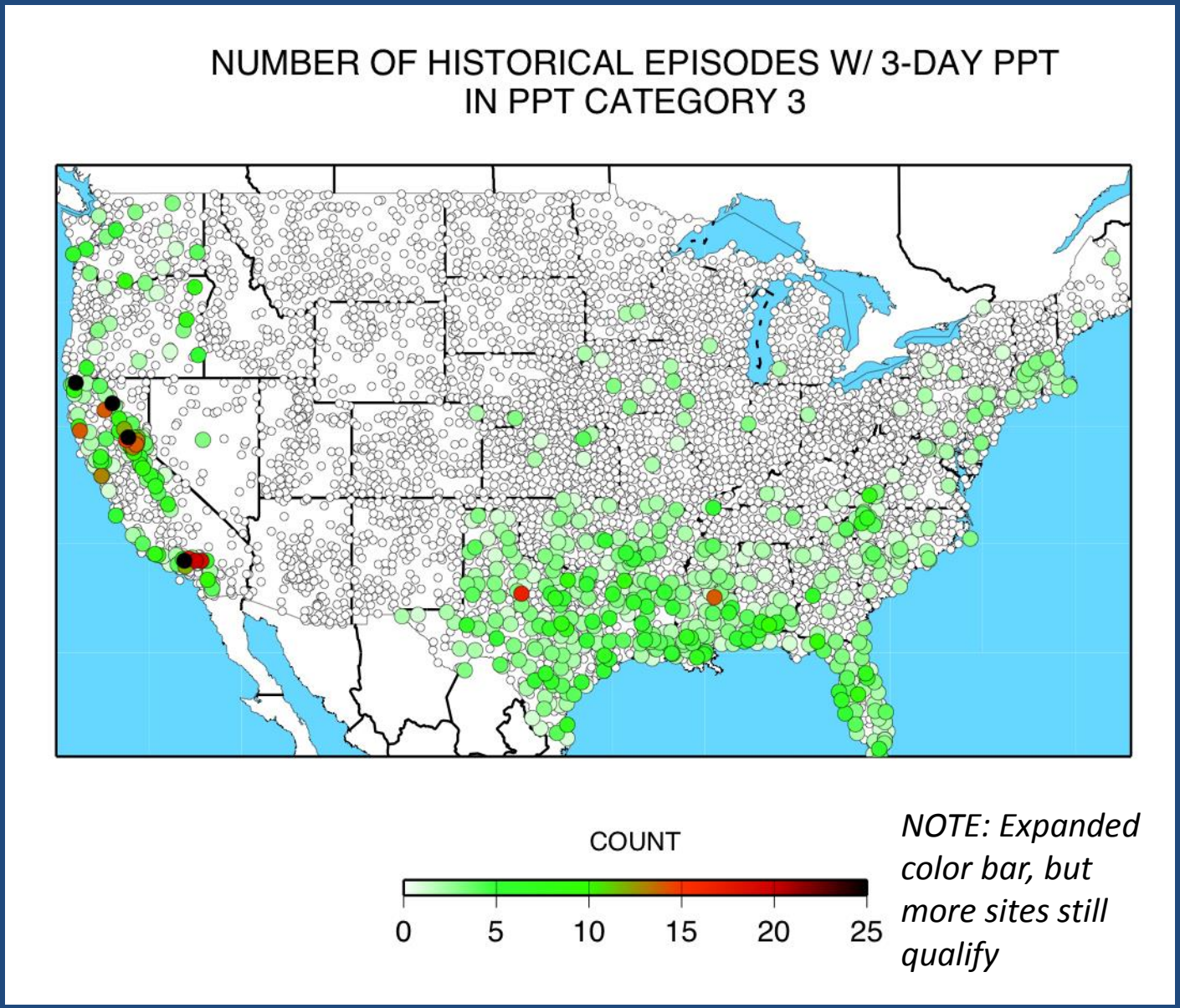
Dettinger et al, 2011

# Storms and California Water Supply




Just a few storms each year are the core of California's water supplies

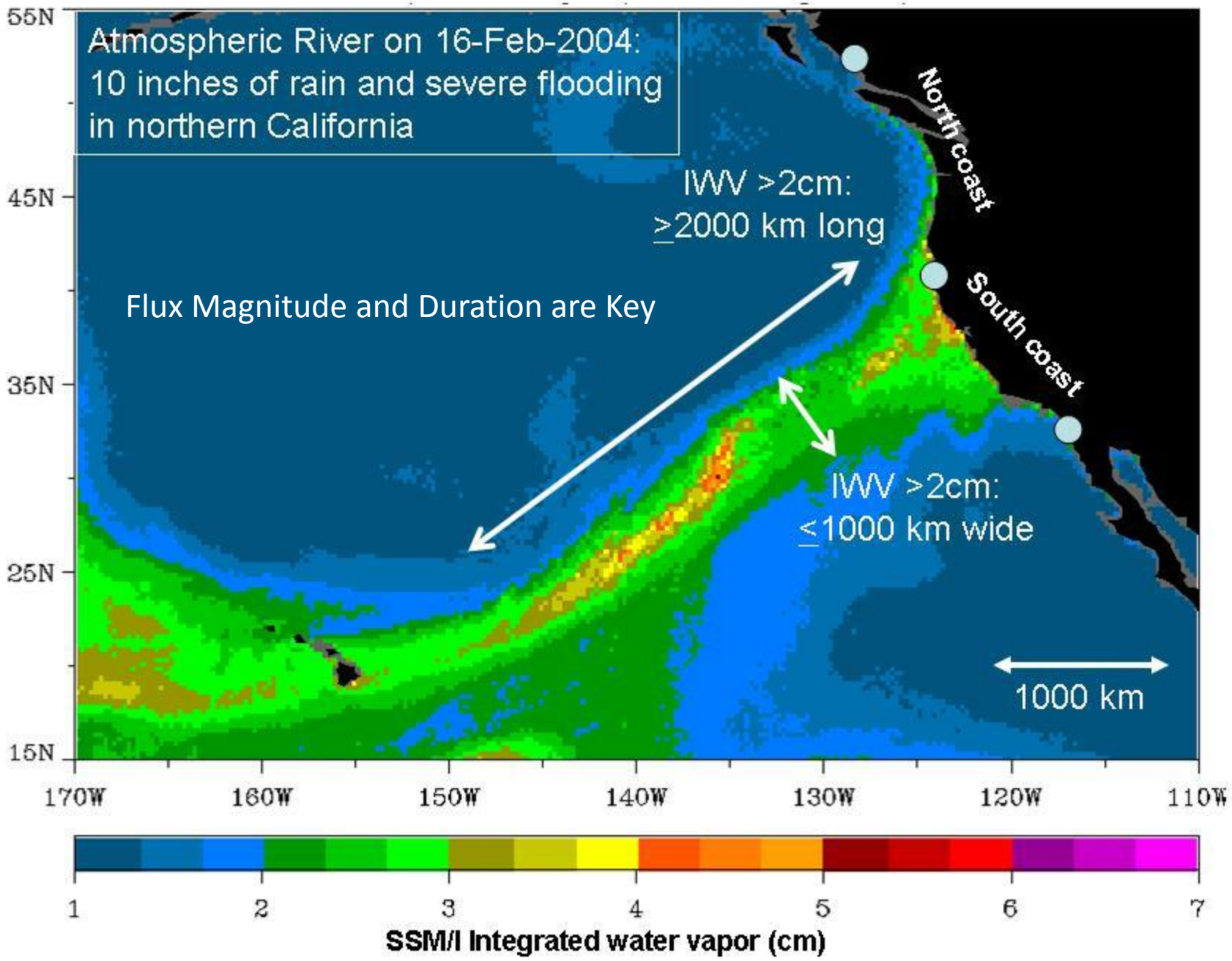
Dettinger et al, 2011



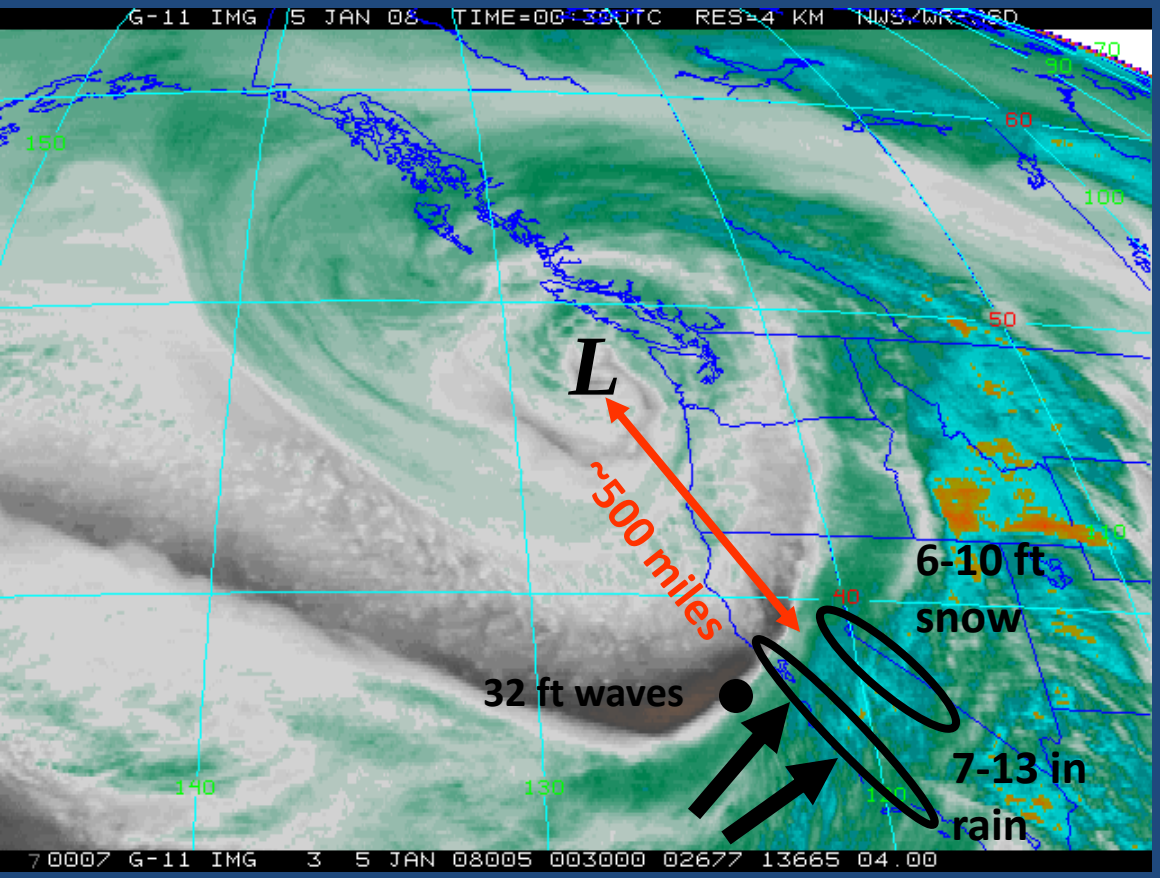

*NOTE: Expanded color bar, but more sites still qualify*

CAT 3 is > 30 cm (12 in) in 3 days

From M. Dettinger


Atmospheric River on 16-Feb-2004:
10 inches of rain and severe flooding
in northern California
IWV >2cm:
≥2000 km long
Flux Magnitude and Duration are Key
IWV >2cm:
≤1000 km wide
1000 km
North coast
South coast
55N
45N
35N
25N
15N
170W
160W
150W
140W
130W
120W
110W
1
2
3
4
5
6
7
SSM/I Integrated water vapor (cm)

# The Storm of 4-5 Jan 2008




***Atmospheric river***

GOES IR image of major West Coast storm

- Time = 0030 UTC 5 January 2008
- Low pressure center is off WA coast

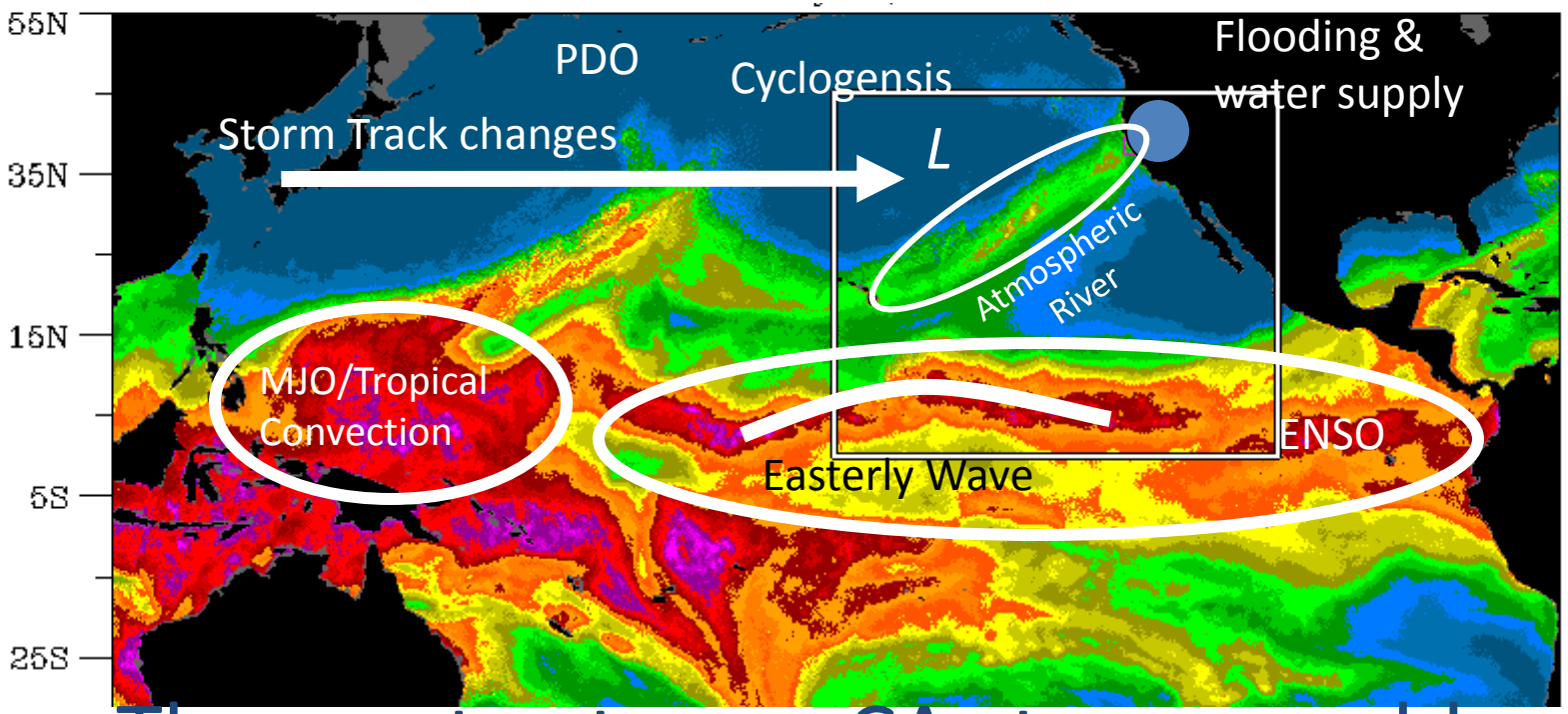
Note that major impacts were focused >500 miles south of the Low pressure center in this storm.

This differs significantly from hurricanes, but the impacts are enormous and spread over a large area

***Many major impacts are associated with the landfall of the "atmospheric river" element of the storm, the precise characteristics of which are not operationally monitored offshore or onshore.***

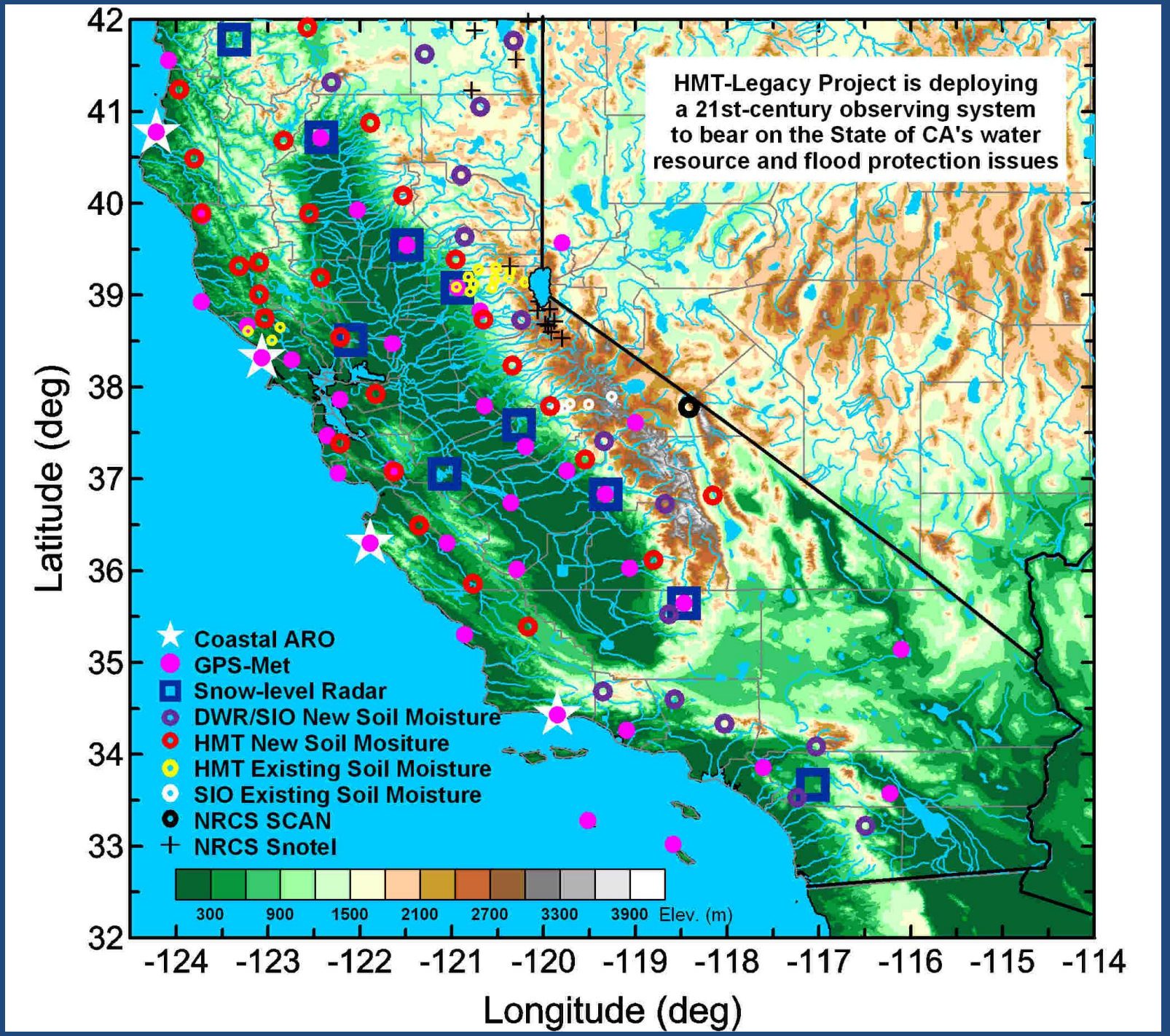
Slide from Marty Ralph, NOAA ESRL

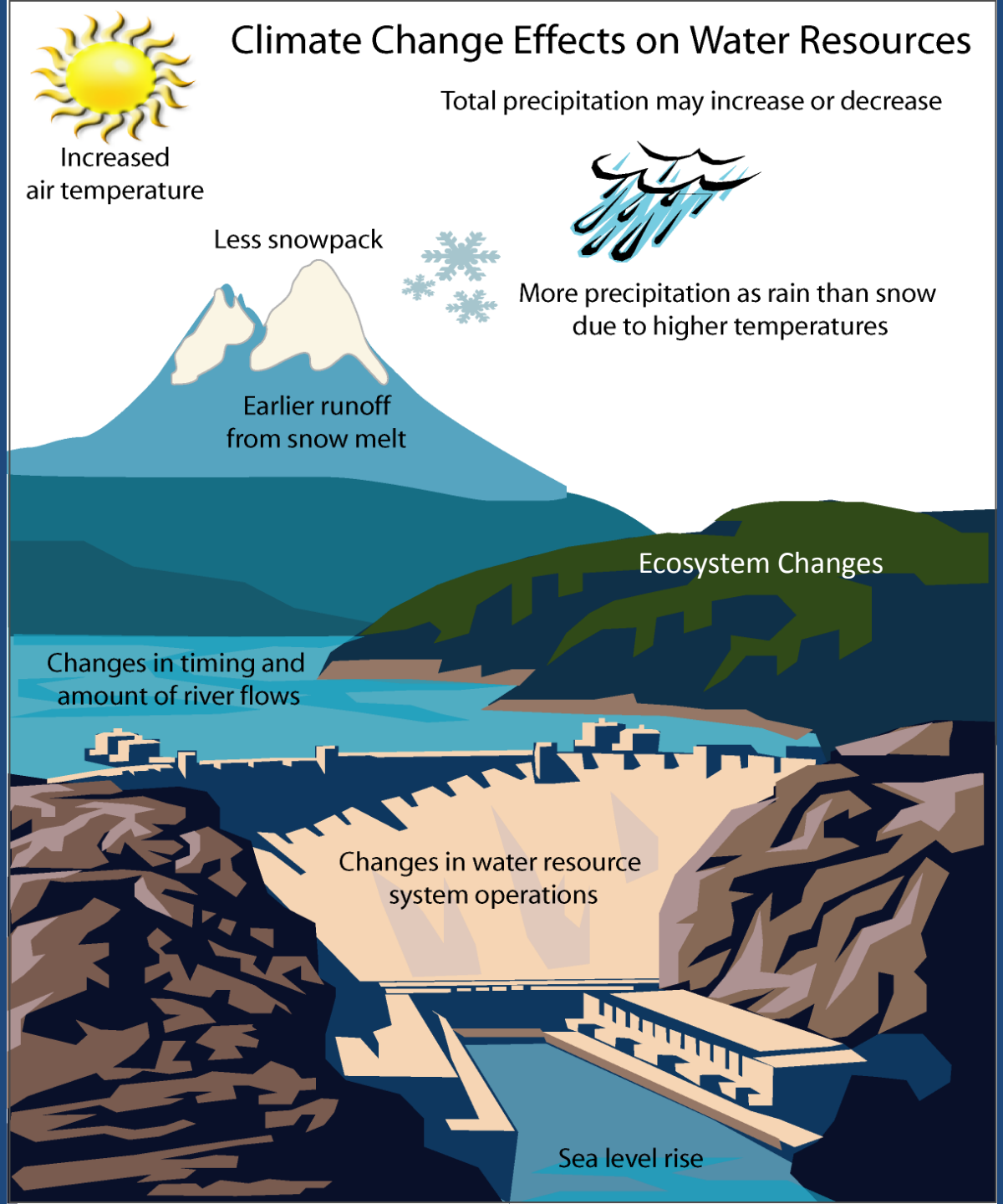
# Key Phenomena Affecting California Water Supply/Flooding:



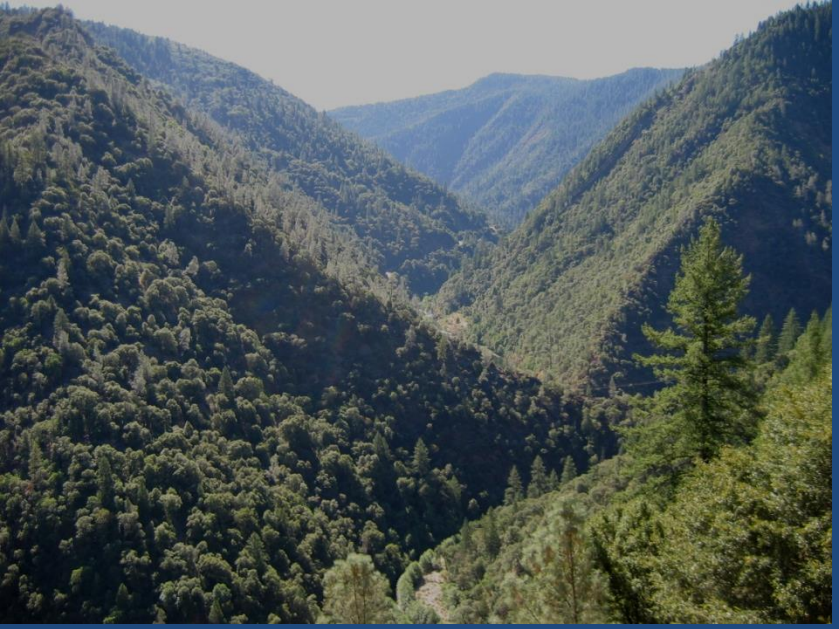

The most extreme CA storm would result from a rare alignment of key processes

Slide from Marty Ralph, NOAA ESRL

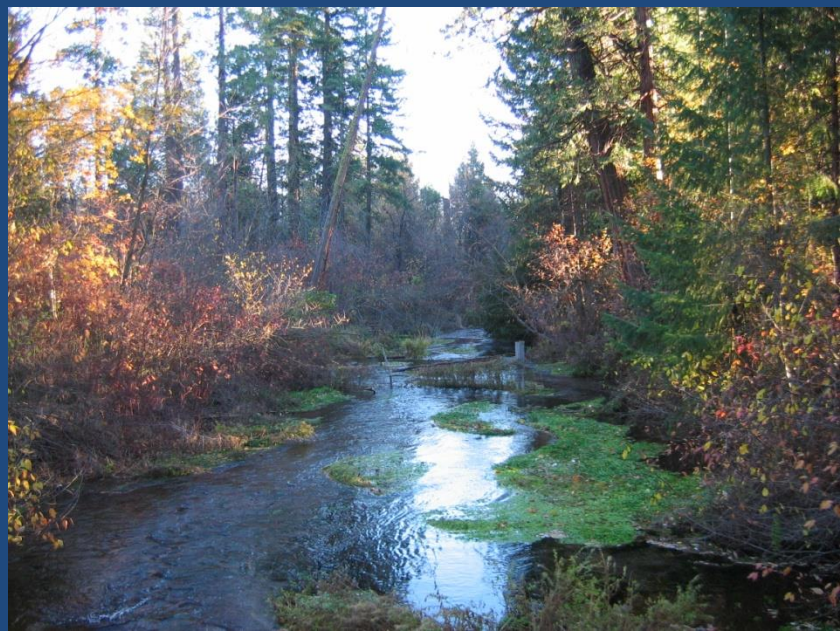

HMT-Legacy Project is deploying a 21st-century observing system to bear on the State of CA's water resource and flood protection issues
Coastal ARO
GPS-Met
Snow-level Radar
DWR/SIO New Soil Moisture
HMT New Soil Mositure
HMT Existing Soil Moisture
SIO Existing Soil Moisture
NRCS SCAN
NRCS Snotel
300
900
1500
2100
2700
3300
3900
Elev. (m)
Latitude (deg)
Longitude (deg)
42
41
40
39
38
37
36
35
34
33
32
-124
-123
-122
-121
-120
-119
-118
-117
-116
-115
-114




Slide from
Jamie Anderson
DWR- Bay Delta



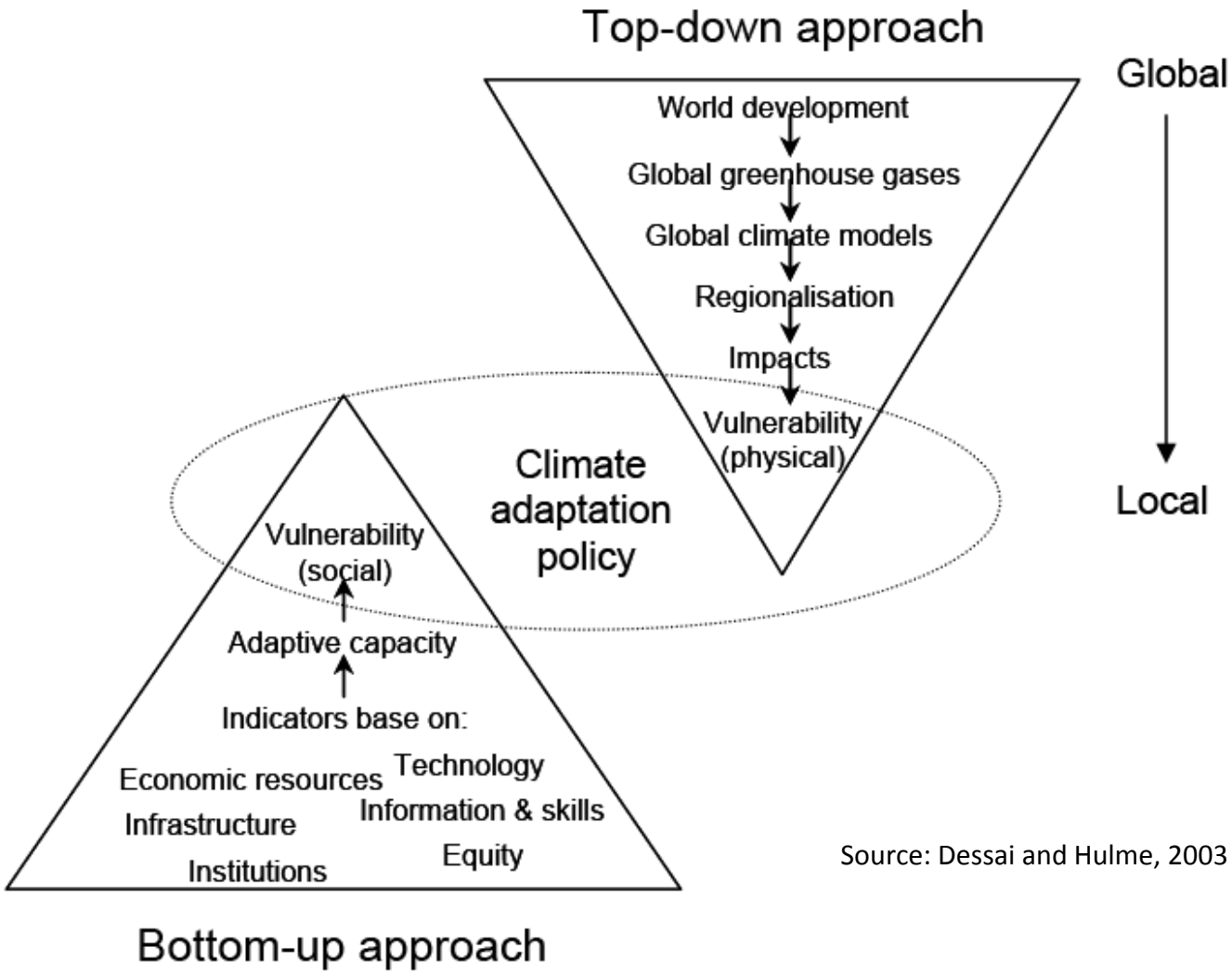
# Know Your Watershed!



# Climate Change Considerations

- How will atmospheric river/winter storm characteristics change in a warmer atmosphere?
- How will ocean temperature and circulation patterns impact storm tracks and storm number, size, intensity?
- How will temperature changes impact the land surface/watershed condition?
- Are we observing what we should for tracking climate change and its potential impacts?

# Determining Vulnerability




Source: Dessai and Hulme, 2003

# Assessing Adaptation Capacity

- Where , when, and how am I vulnerable?
- How does the level and timing of vulnerability intersect with land use activities and infrastructure?
- How will climate change impact water resources at my location? (thresholds and consequences)
- What action or investment changes the answer to any of the above and to what extent?

# Climate Data

- California Climate Tracker (Western Region Climate Center)
- West Map (Western Region Climate Center)
- California Climate Data Archive (Western Region Climate Center)

# Resources to Inform

- Integrated Water Resources Management Handbook
  http://www.water.ca.gov/climatechange/CCHandbook.cfm

- Cal Adapt Tools
  http://cal-adapt.org/

# Take Home Points

- Atmospheric Rivers are a fundamental element of California water resources
- Time and location are important
- Climate signals like PDO, ENSO, and MJO are important for inter-annual variability – all years are not the same
- Climate change has possible impacts to magnitude, timing, and frequency of events through changes to land surface, atmosphere, and oceans

# Take Home Points

- Climate change adaptation starts with vulnerability assessments
- Consequence and timing of adaptation measures are important – can phased implementation work?
- Resources to facilitate adaptation planning are available


Questions?
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