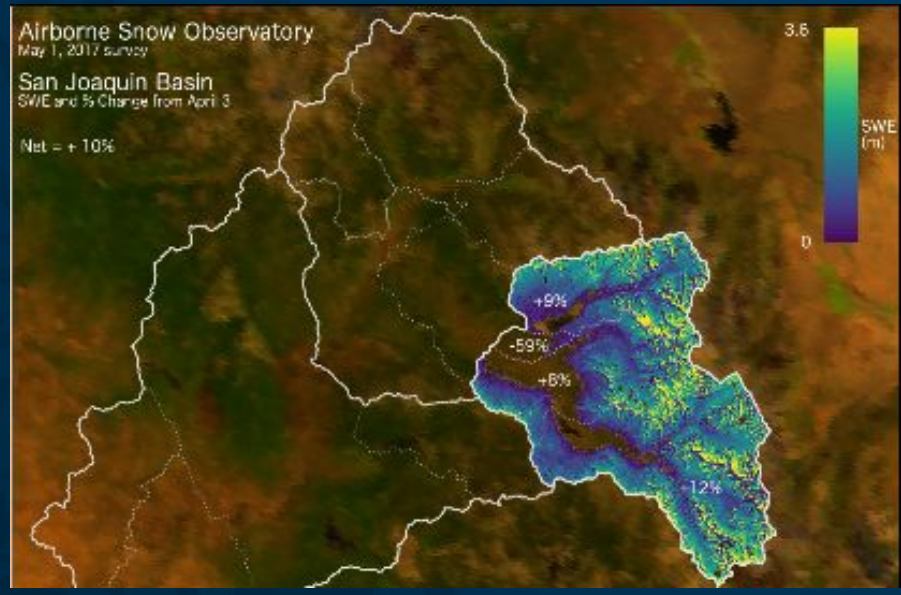


Atmospheric Rivers and Water Management in California

Dr. Michael Anderson, State Climatologist

2nd IARC, La Jolla

June 25, 2018

Summary Thoughts

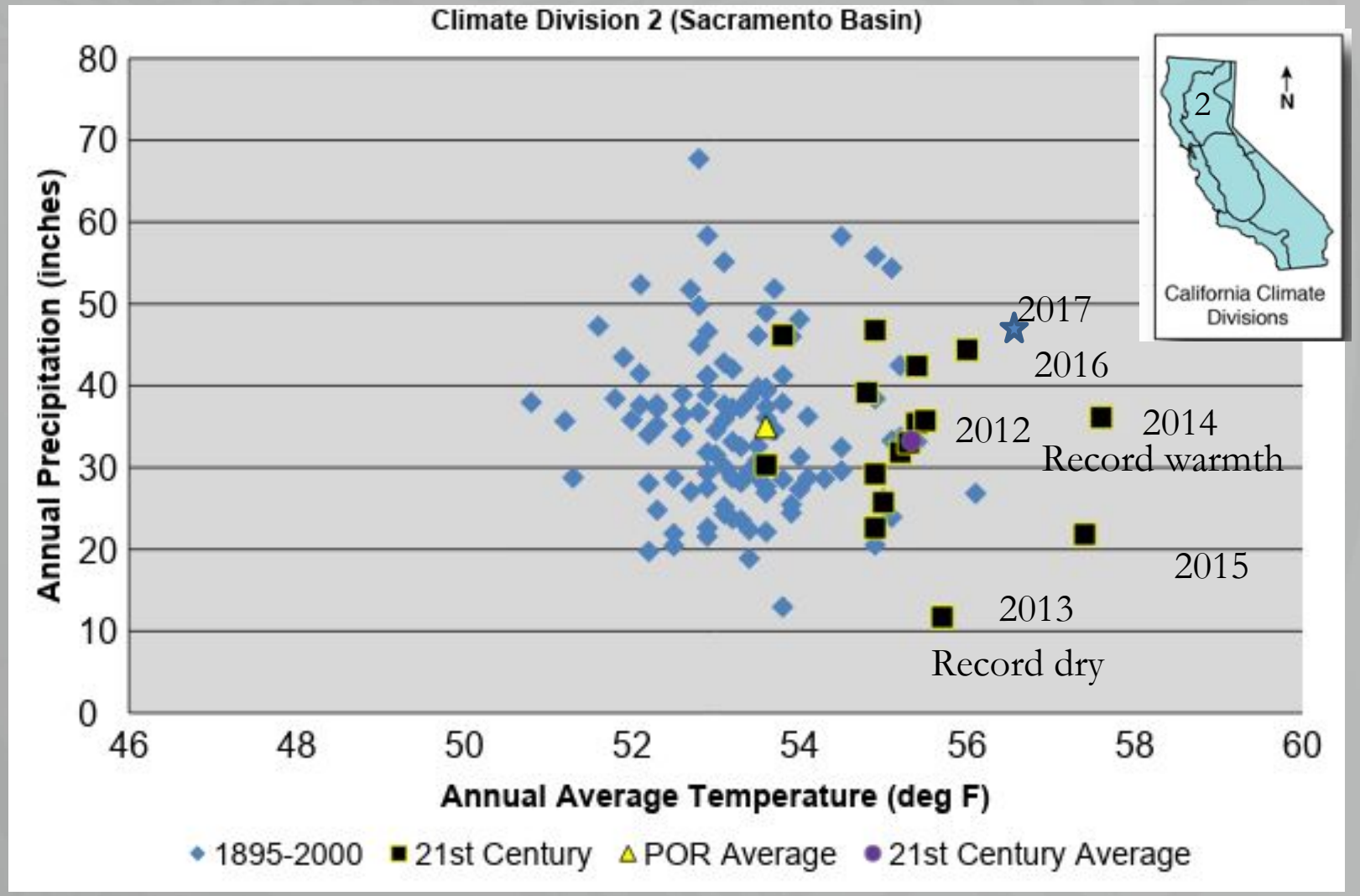
- Atmospheric Rivers are a key component to California's water supply and flood risk. The character, size, number, and timing of atmospheric rivers play a key role in seasonal hydrologic outcomes for California including the size and distribution of the snowpack.
- Improved observations and forecasting are key elements for enabling more options for integrated water management in California.
- As the world warms, capabilities in observations and forecasting must adapt for water management to keep up with changing conditions.

California's topography affects our weather and climate.

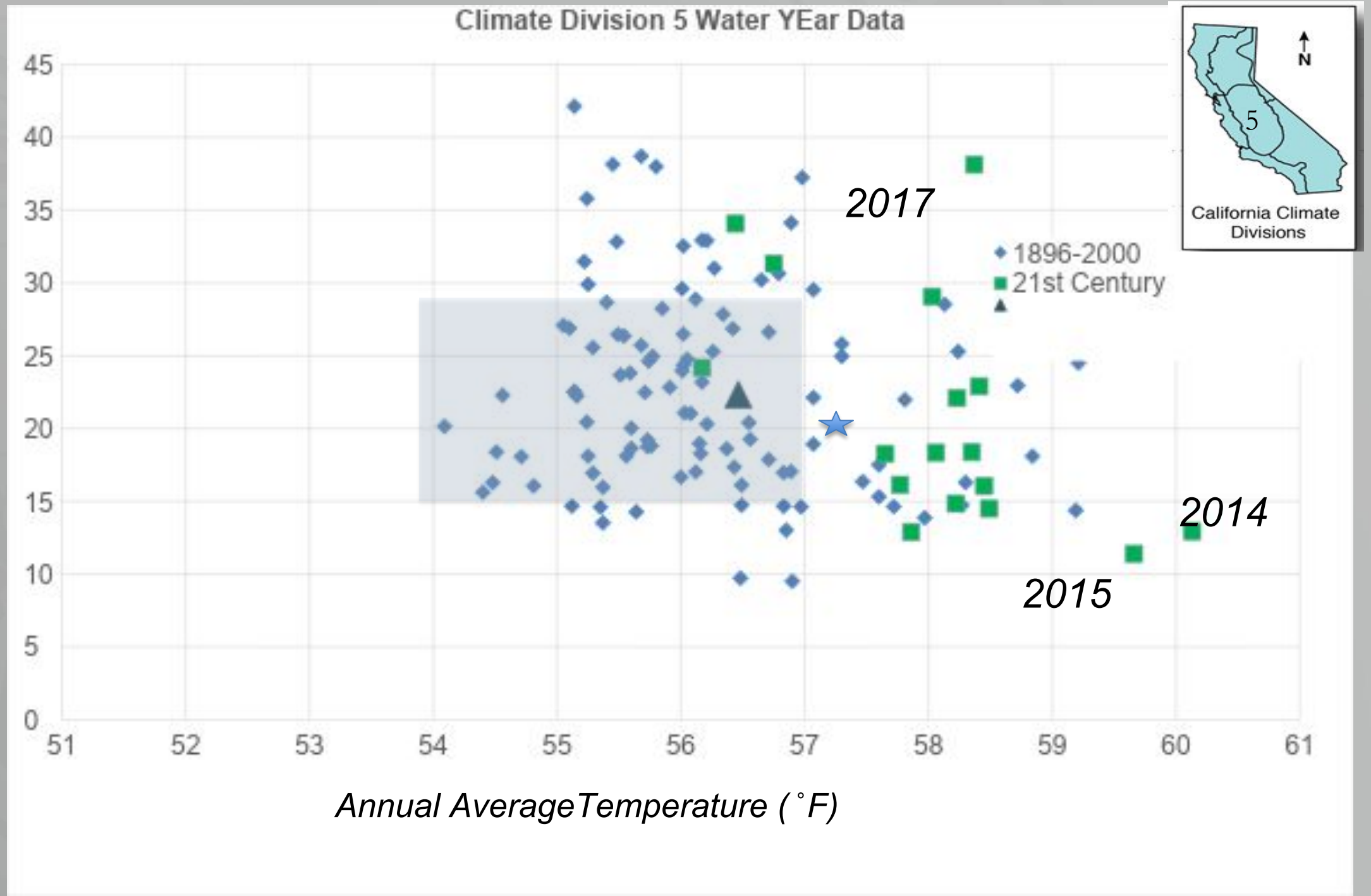
High-elevation observations are challenged by land use restrictions and by extreme weather conditions, but play a critical role in water and resource management.

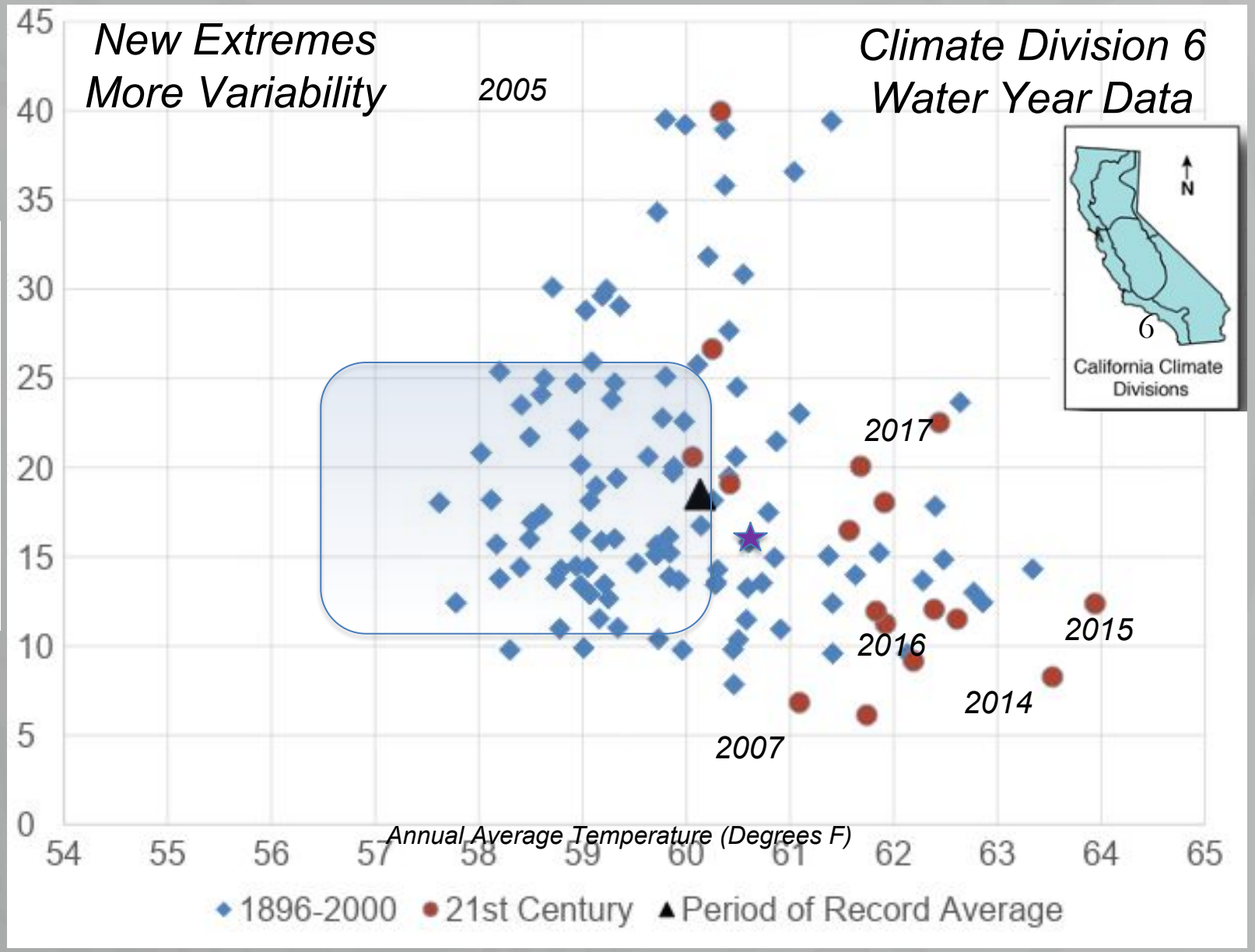
Elevation variability affects other observing systems like radar as well

NOAA Climate Division 2 Calendar Year Data 1895-2017



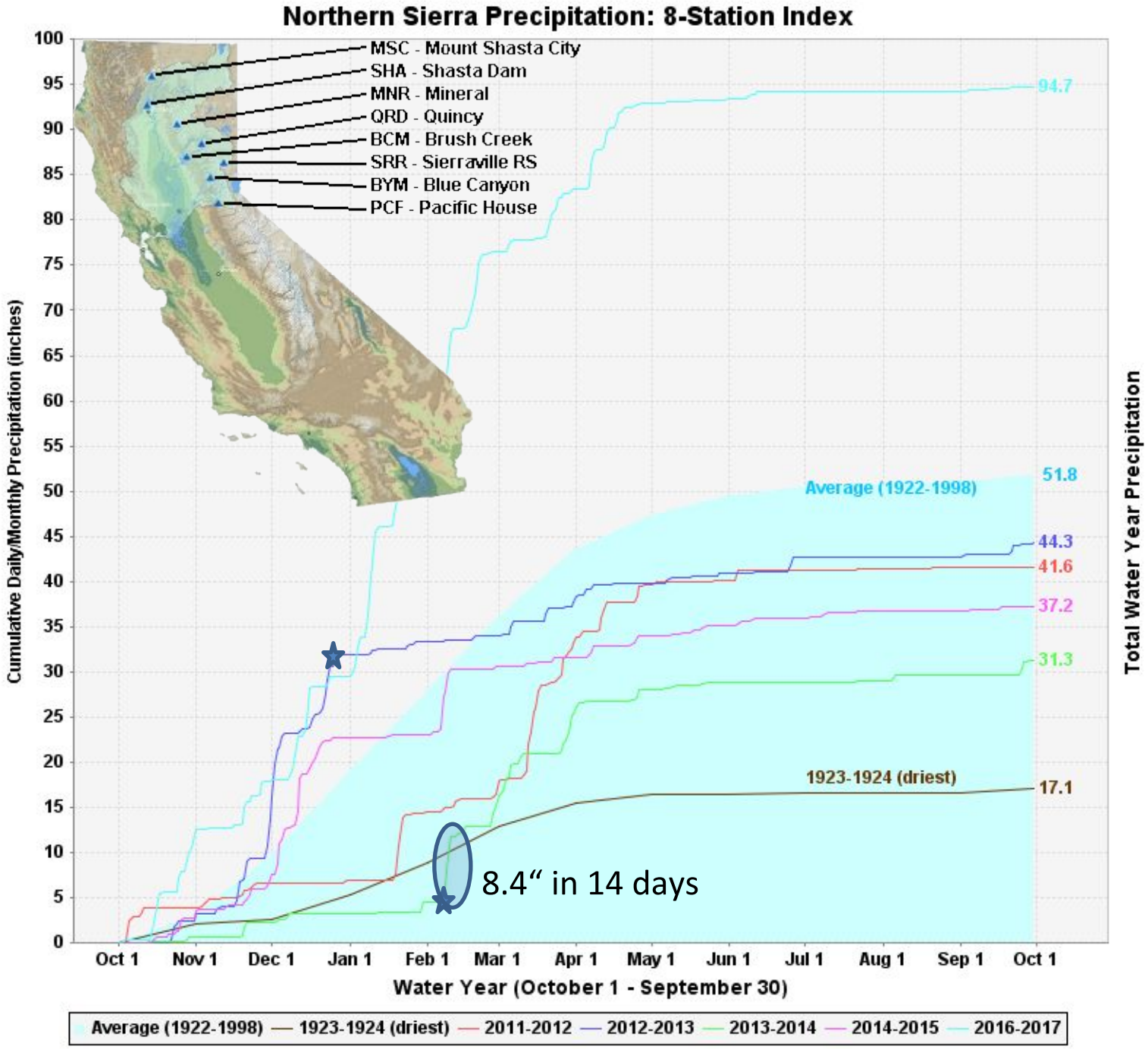
Source: NOAA Climate Division 2 Calendar Year Data


Climate Division 5 Water YEar Data
45
40
35
30
25
20
15
10
5
0
51
52
53
54
55
56
57
58
59
60
61
2017
2014
2015
1896-2000
21st Century
N
5
California Climate Divisions
Annual AverageTemperature (˚F)



Source: NOAA Climate Division 6 Water Year Data

Variability at multiple scales



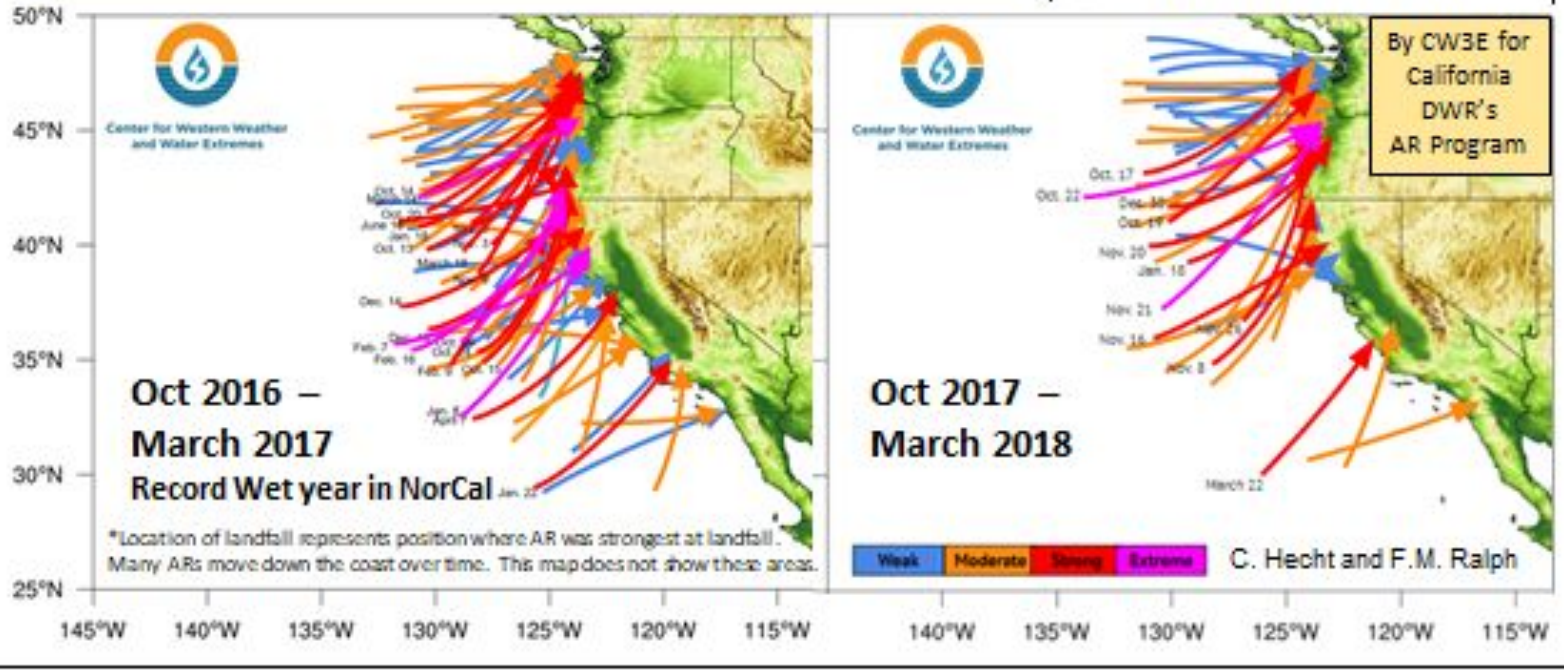
16.8”
404 Days

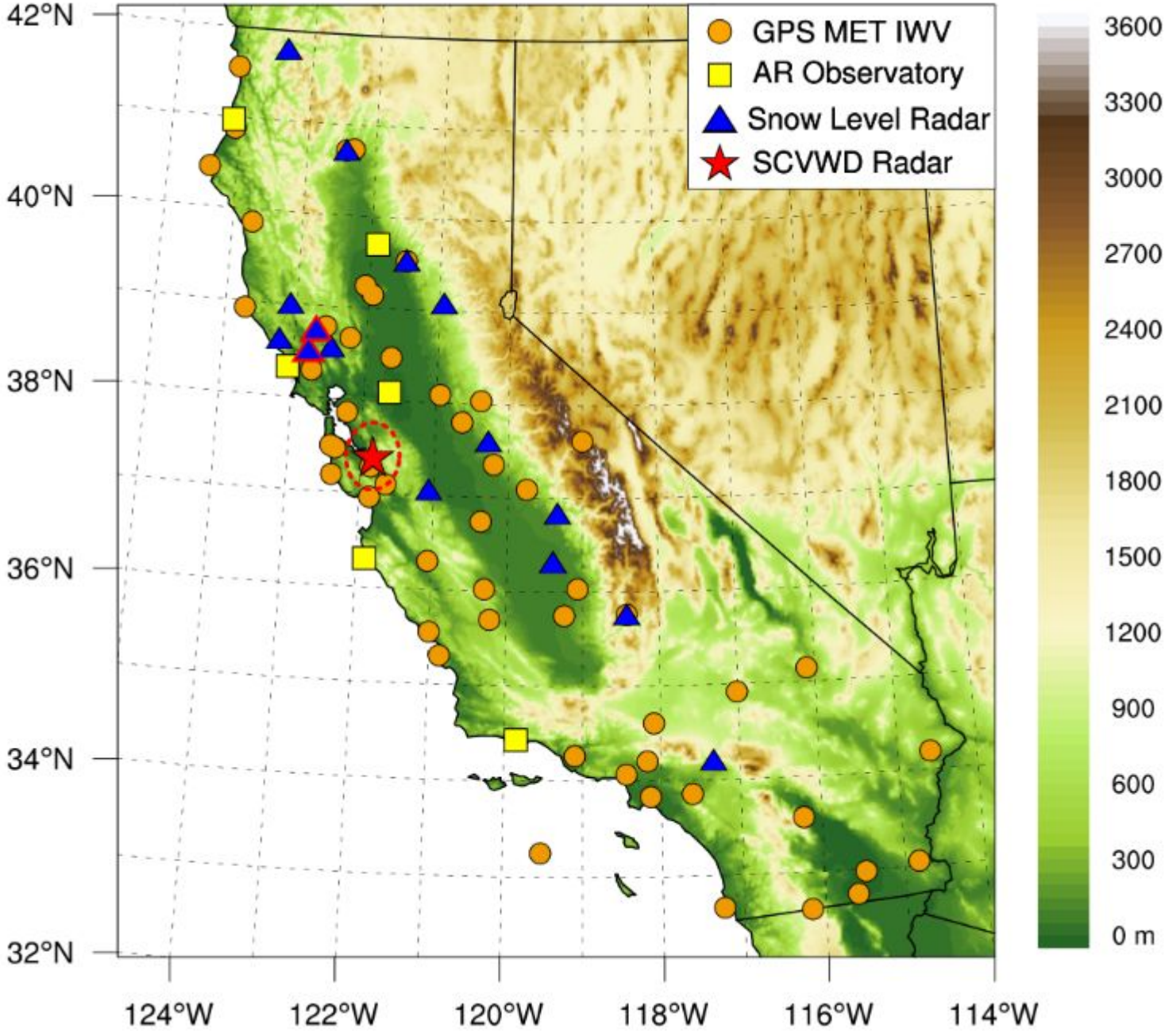
Map of Landfalling* Atmospheric Rivers on the U.S. West Coast Through 31 March: Comparison of Water Years 2017 and 2018

During Water Year 2018 (thru 31 March), California had received about half as many landfalling ARs as in Water Year 2017 (thru 31 March)

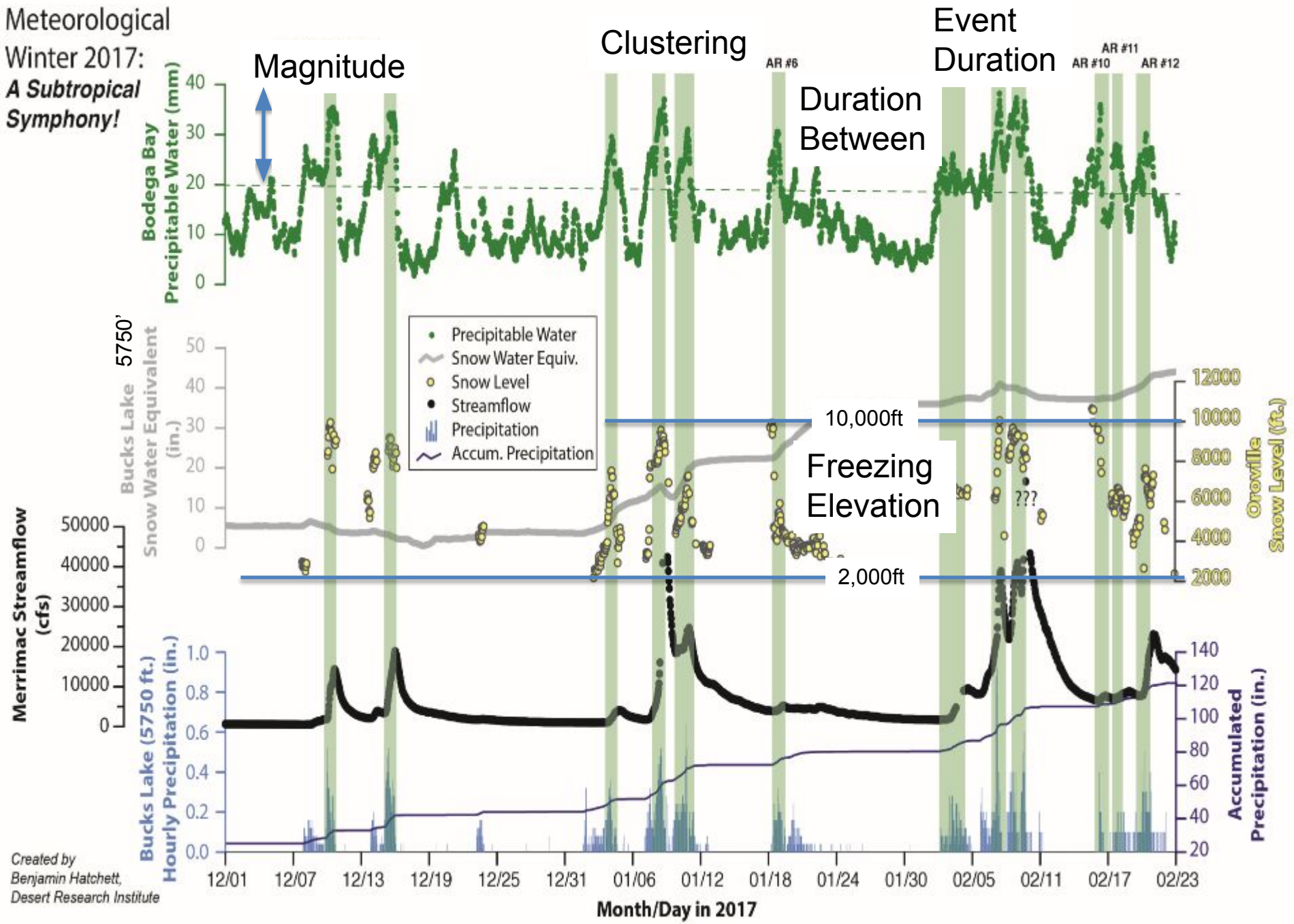
Ralph/CW3E AR Strength Scale

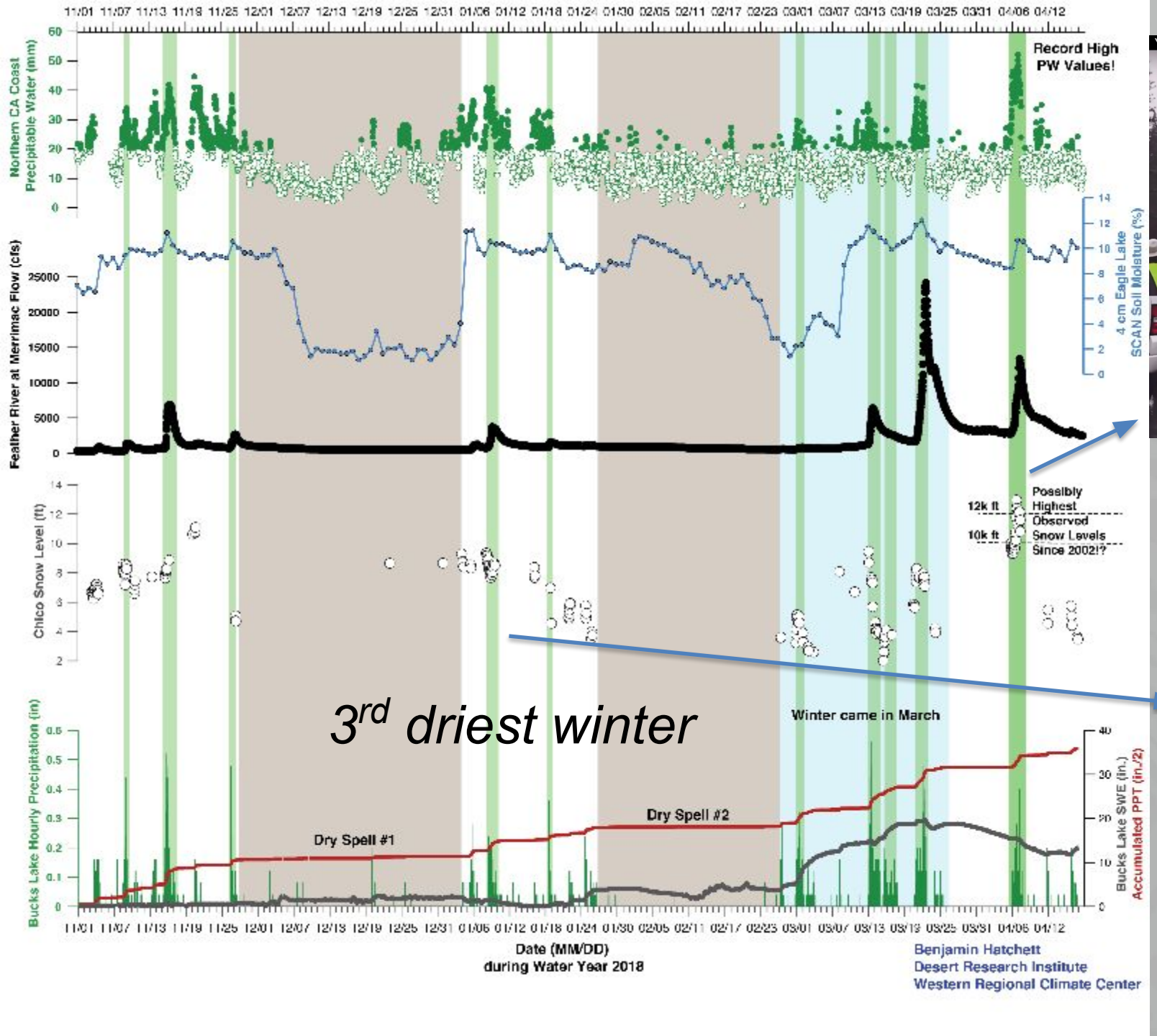
- Weak: IVT=250–500 kg m^{-1} s^{-1}
- Moderate: IVT=500–750 kg m^{-1} s^{-1}
- Strong: IVT=750–1000 kg m^{-1} s^{-1}
- Extreme: IVT=1000–1250 kg m^{-1} s^{-1}
- Exceptional: IVT>1250 kg m^{-1} s^{-1}





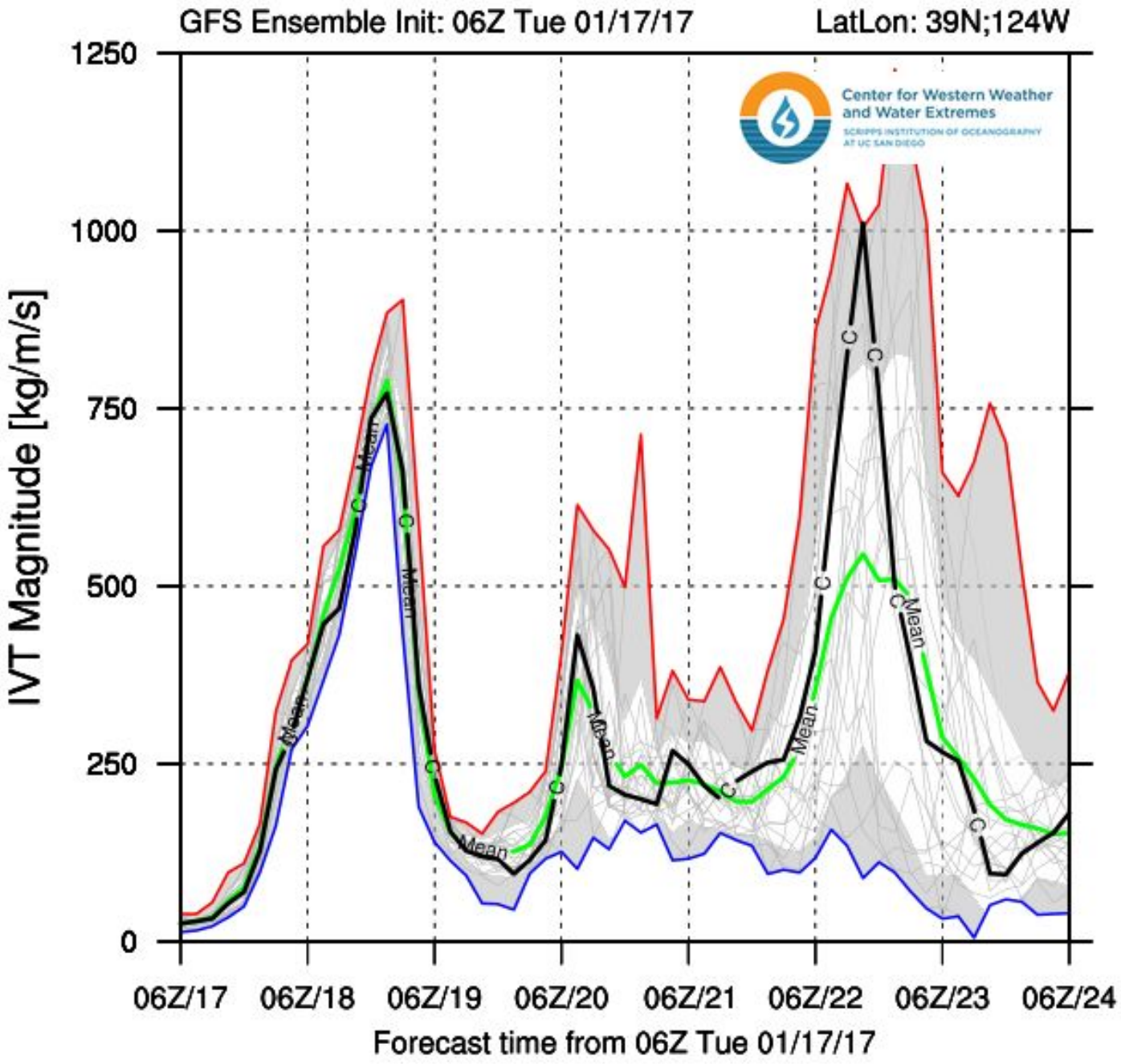
California's Advanced Observing System for Atmospheric Rivers


Meteorological Winter 2017:
A Subtropical Symphony!
Magnitude
Clustering
Event Duration
Duration Between
AR #6
AR #10
AR #11
AR #12
Bodega Bay Precipitable Water (mm)
5750'
Bucks Lake Snow Water Equivalent (in.)
Precipitable Water
Snow Water Equiv.
Snow Level
Streamflow
Precipitation
Accum. Precipitation
10,000ft
Freezing Elevation
2,000ft
???
Oroville Snow Level (ft.)
Merrimac Streamflow (cfs)
Bucks Lake (5750 ft.) Hourly Precipitation (in.)
Accumulated Precipitation (in.)
Created by
Benjamin Hatchett,
Desert Research Institute
12/01
12/07
12/13
12/19
12/25
12/31
01/06
01/12
01/18
01/24
01/30
02/05
02/11
02/17
02/23
Month/Day in 2017

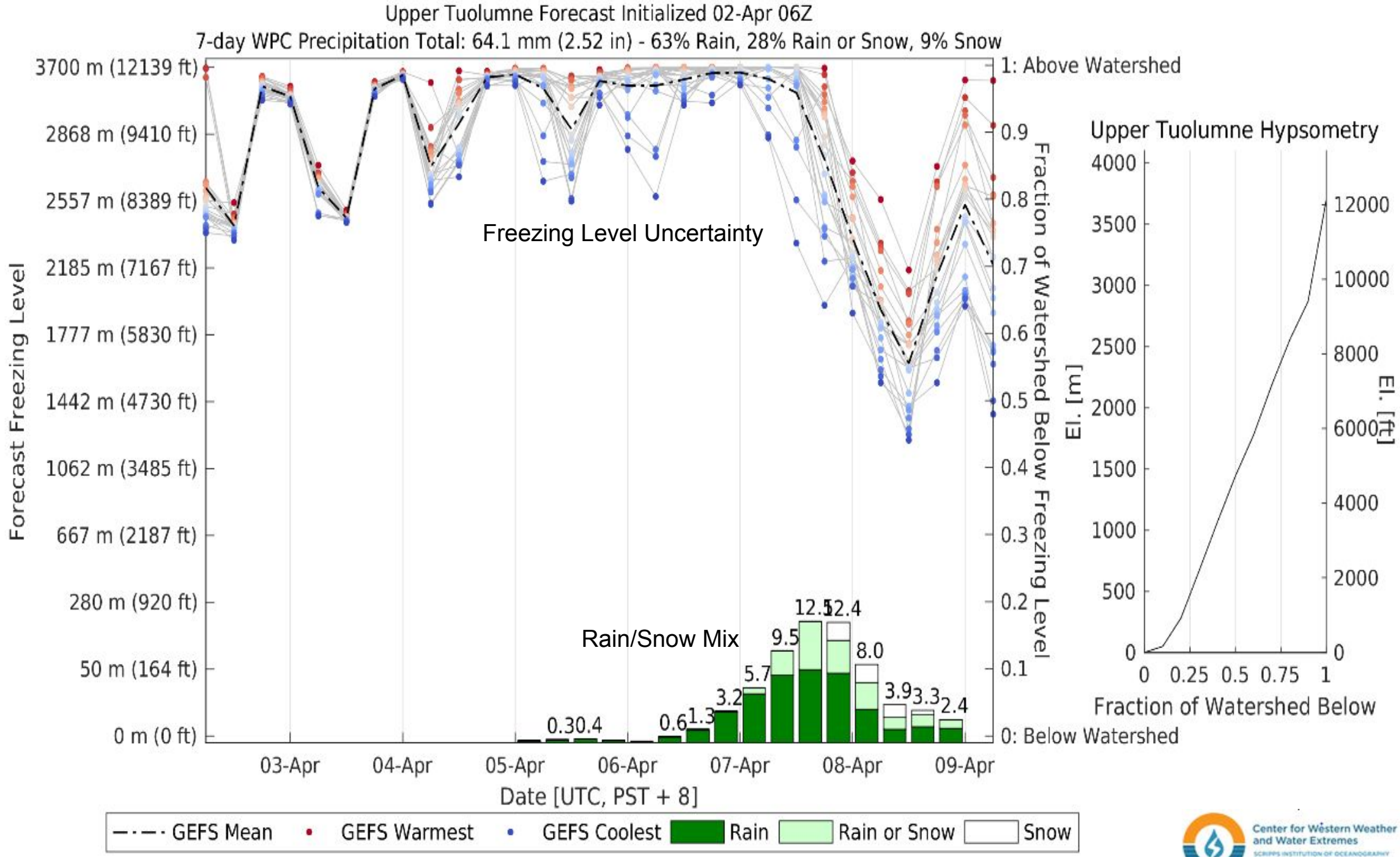

Northern CA Coast Precipitable Water (mm)
Record High PW Values!
Feather River at Merrimac Flow (cfs)
4 cm Eagle Lake SCAN Soil Moisture (%)
Chico Snow Level (ft)
12k ft
10k ft
Possibly Highest Observed Snow Levels Since 2002!?
3rd driest winter
Winter came in March
Bucks Lake Hourly Precipitation (in)
Dry Spell #1
Dry Spell #2
Bucks Lake SWE (in.)
Accumulated PPT (in./2)
Date (MM/DD) during Water Year 2018
Benjamin Hatchett
Desert Research Institute
Western Regional Climate Center


Yosemite Flood: April 7, 2018
MORE VIDEOS
YNP Video Image


Jeremy Lancaster



AR Strength Forecast and Uncertainty Tool



Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

Integrated Water Resources Management

Public Safety – Forecast/Warning
Extremes Response and Coordination

Storm Water Management
Groundwater Management

Supply Reliability
Resource Stewardship

Observations

In Situ

HMT/AQPI
HYDAS
USGS Stream Gages
ASO

Radar

MODIS (satellite)
AR Airborne Recon

Airborne

Satellite

Decision Support Tool Kit

RFC Forecast Points
HEC-HMS/HED
71/PRMS
B120
INFORM
FCO/FIRO
AQPI DSS

Forecasts

QPF

NWS
CNRFC
NWS CPC
NASA JPL
NOAA
ESRL
IRI
CW3E

Week 1/ Week2

30-Day

90-Day

Water Year Outlook

Atmospheric Rivers – number, size, character, spacing, and timing

Federal State and Local Alignment

- DWR plays a key role in facilitating the transition of new science in observations, forecasting, and decision support from research to operations for water management.

- Relationships with federal, local, and academic partners have been built over the past decade with the availability of resources on a project-by-project basis.

- Continued engagement is key to adapting to a warming world.

“Be Curious, Be Present, Embrace Uncertainty”

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