DWR Investments in Improving Forecasts at all Time Scales

Dr. Michael Anderson, State Climatologist

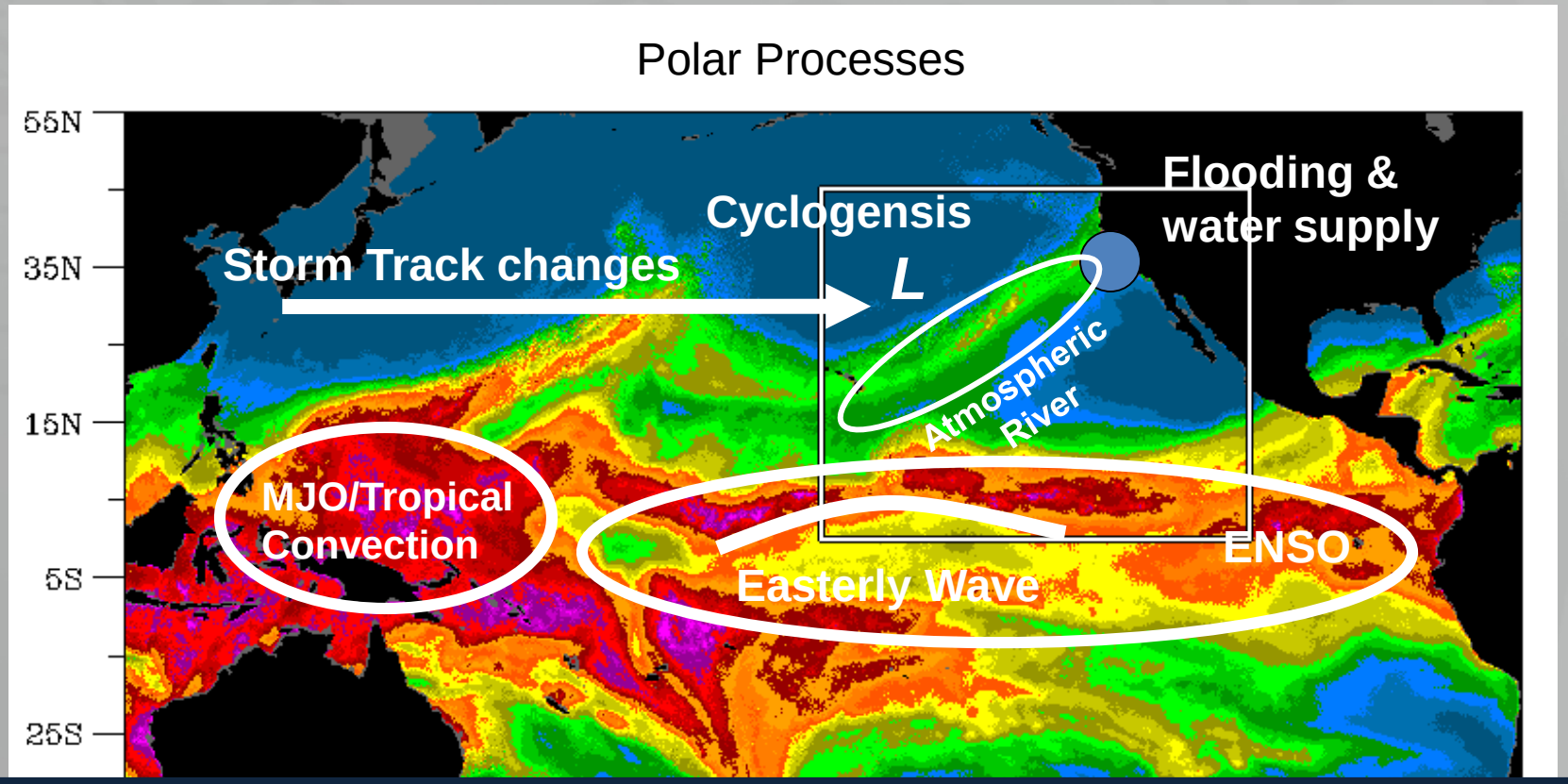
WEF Water Year 2019: Feast or Famine?

December 5, 2018

Talk Overview

- Drought, Flood, and Atmospheric Rivers
- New Observations and Forecast Opportunities
- Intel for Integrated Water Management in a Changing Climate

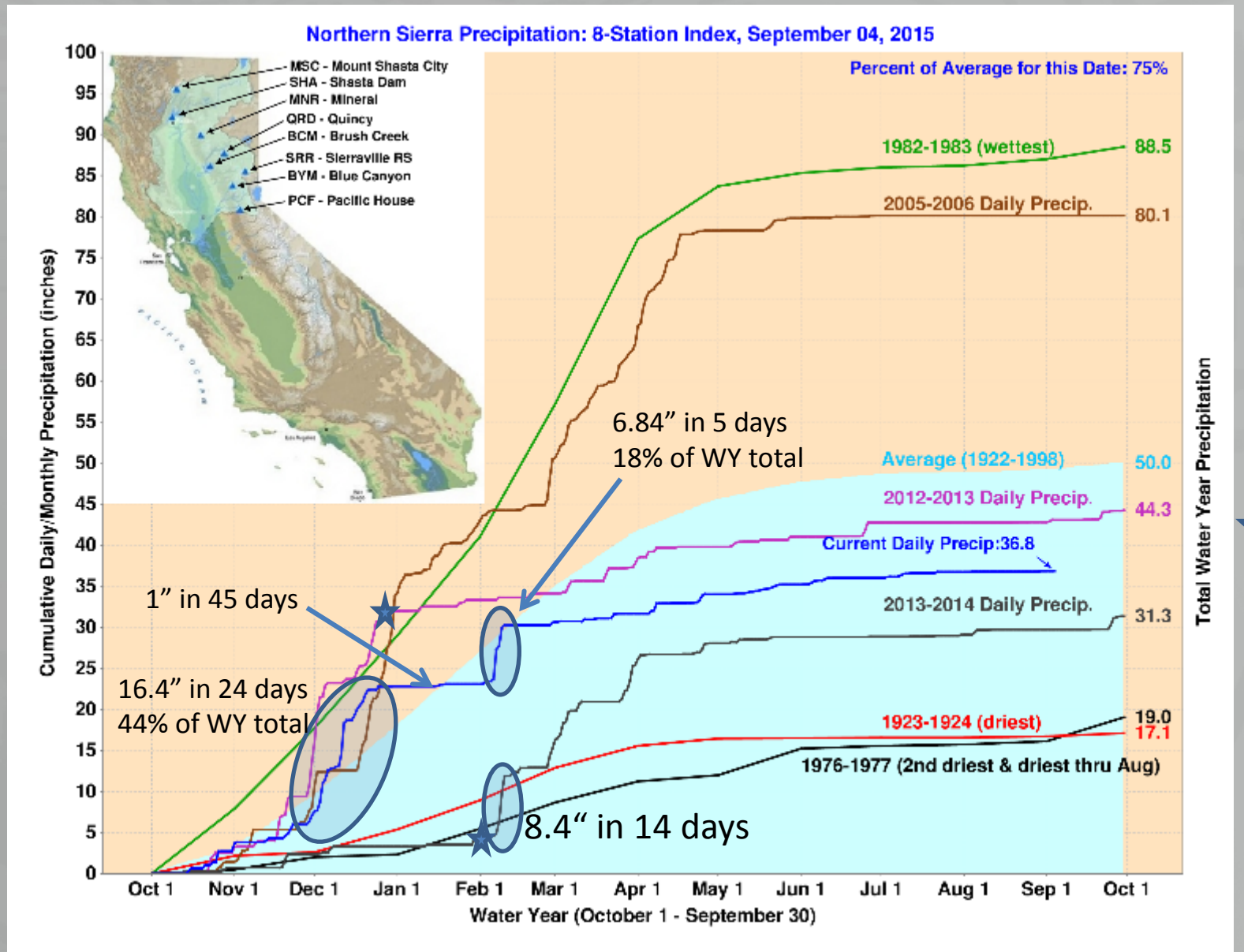
Key Phenomena Affecting California Water Supply/Flooding:



3 keys:
Water Vapor
Storm Dynamics
Terrain

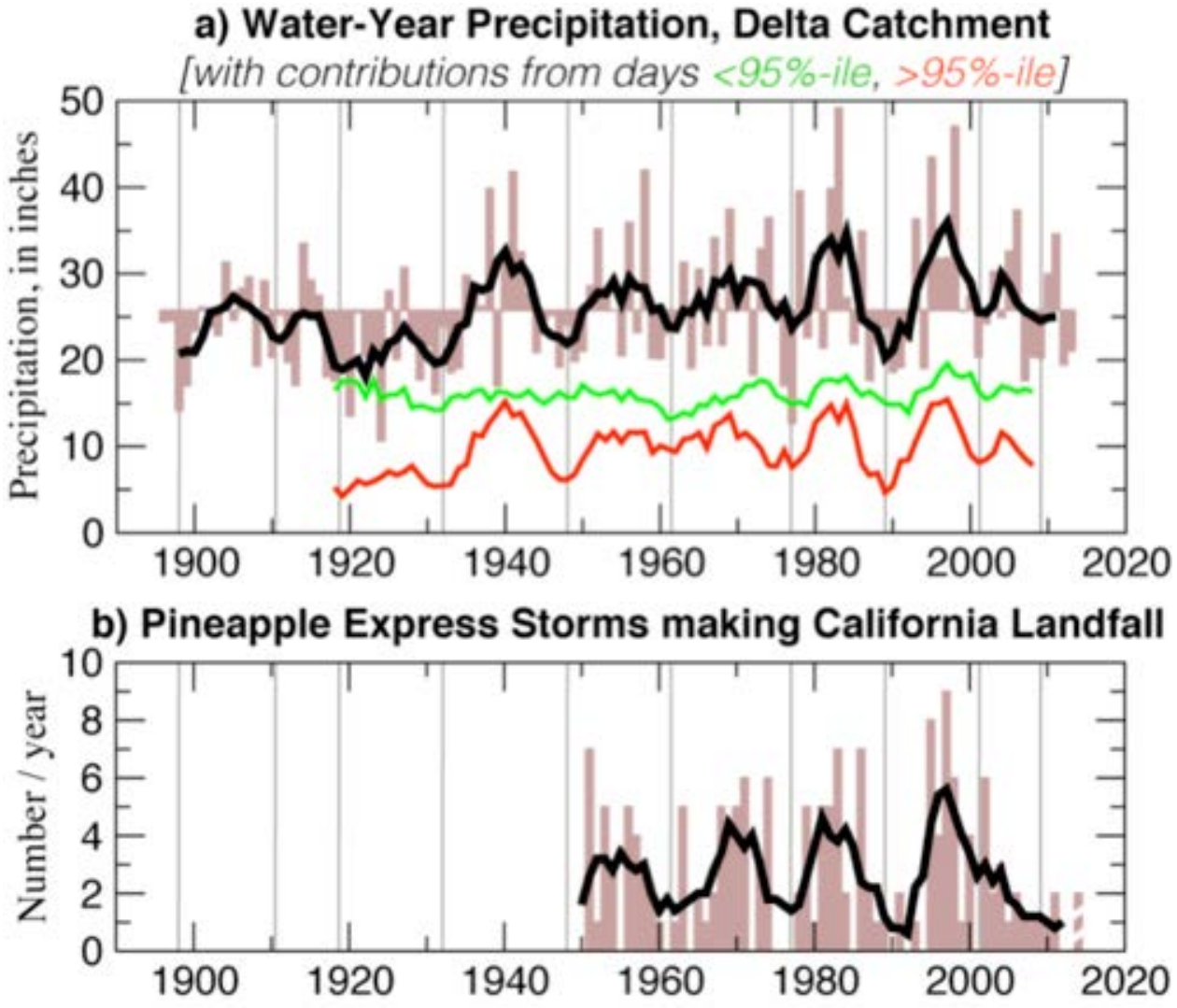
The size, number, and strength of atmospheric river events (ARs) result from the alignment of key physical processes operating on different space and time scales that will change with climate change

Atmospheric Rivers and Precipitation Accumulation – Variability on Multiple Scales



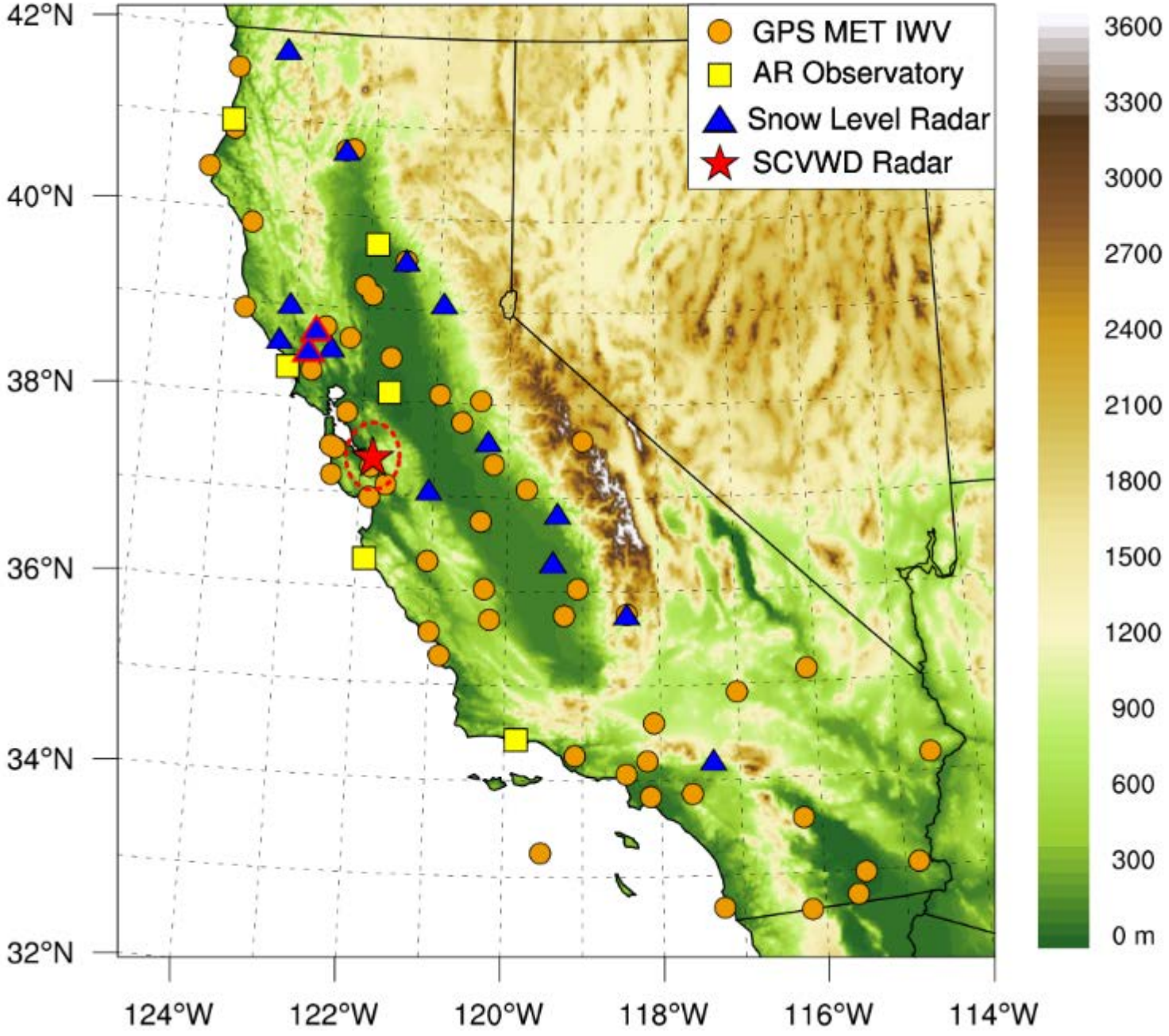
WY2015:
121 days
37.24"

★16.8"
404 Days



Source: Dettinger and Cayan (2014)

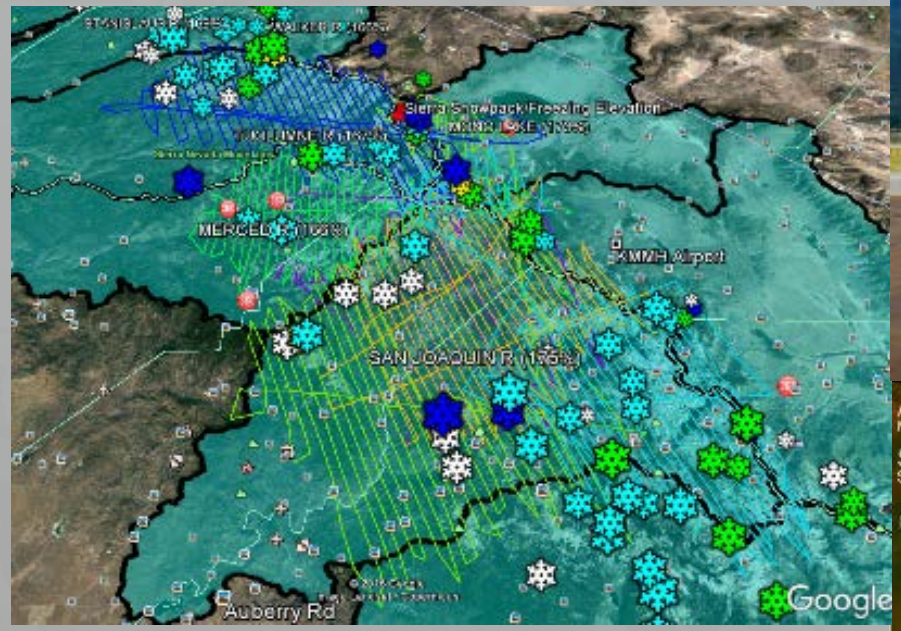
Decadal scale precipitation variability tied to Atmospheric River landfall variability

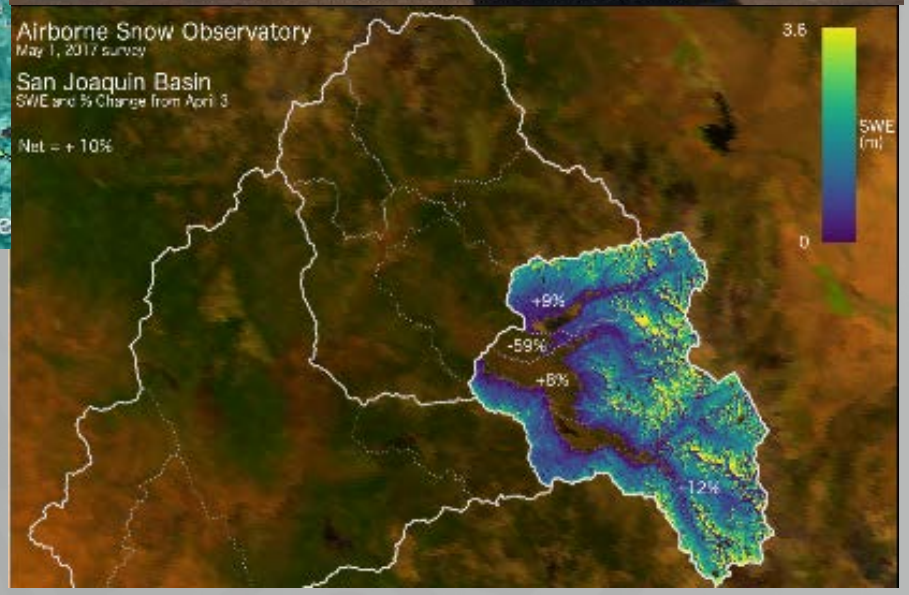


California's Advanced Observing System for Atmospheric Rivers

Starting in 2008 DWR collaborated with NOAA ESRL and Scripps Institution of Oceanography to develop AR Observing System

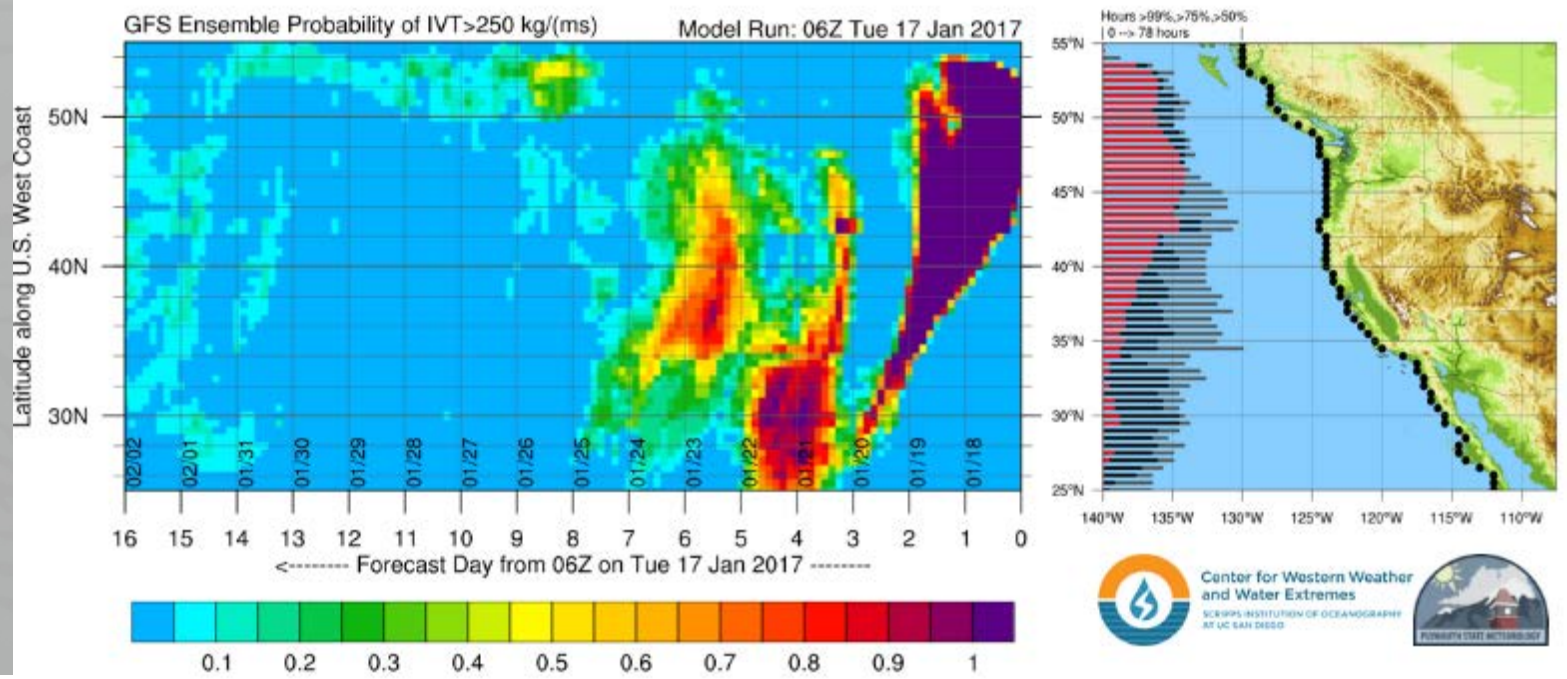
ASO – High Elevation Snow Observations

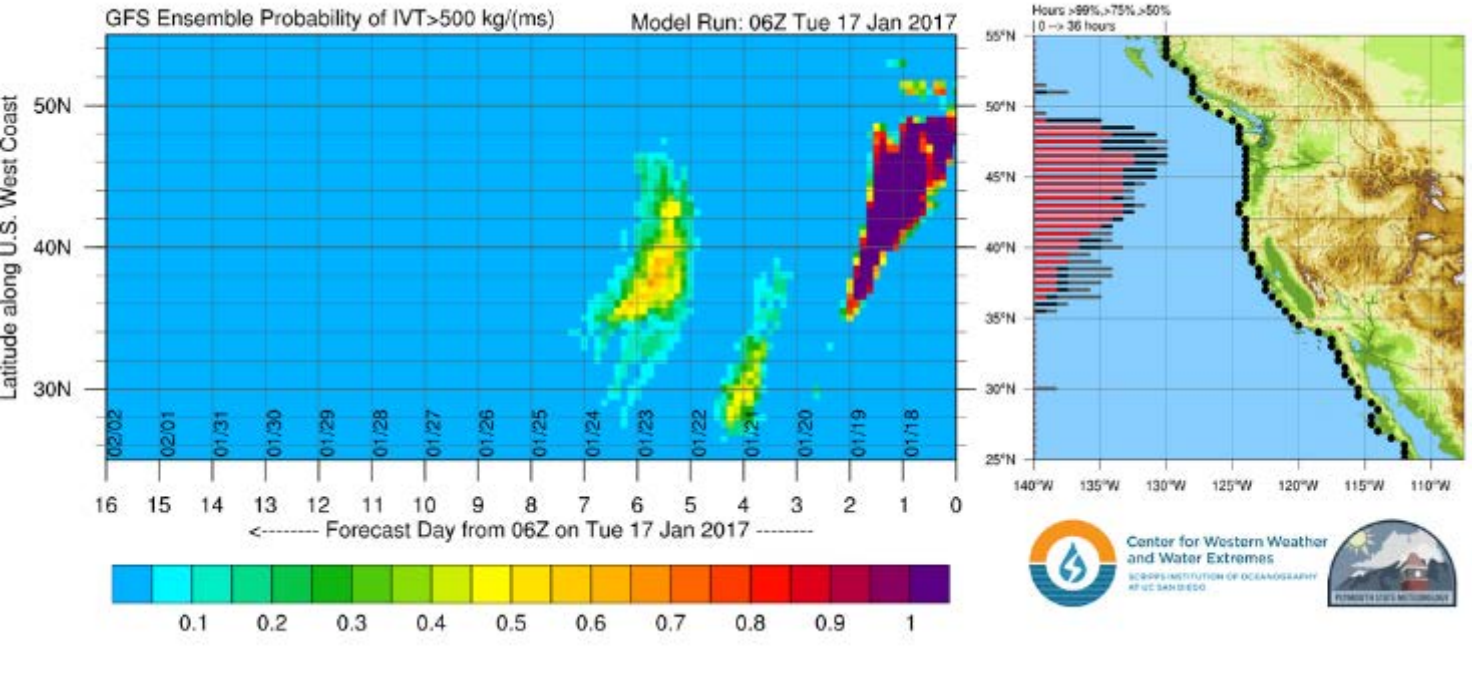




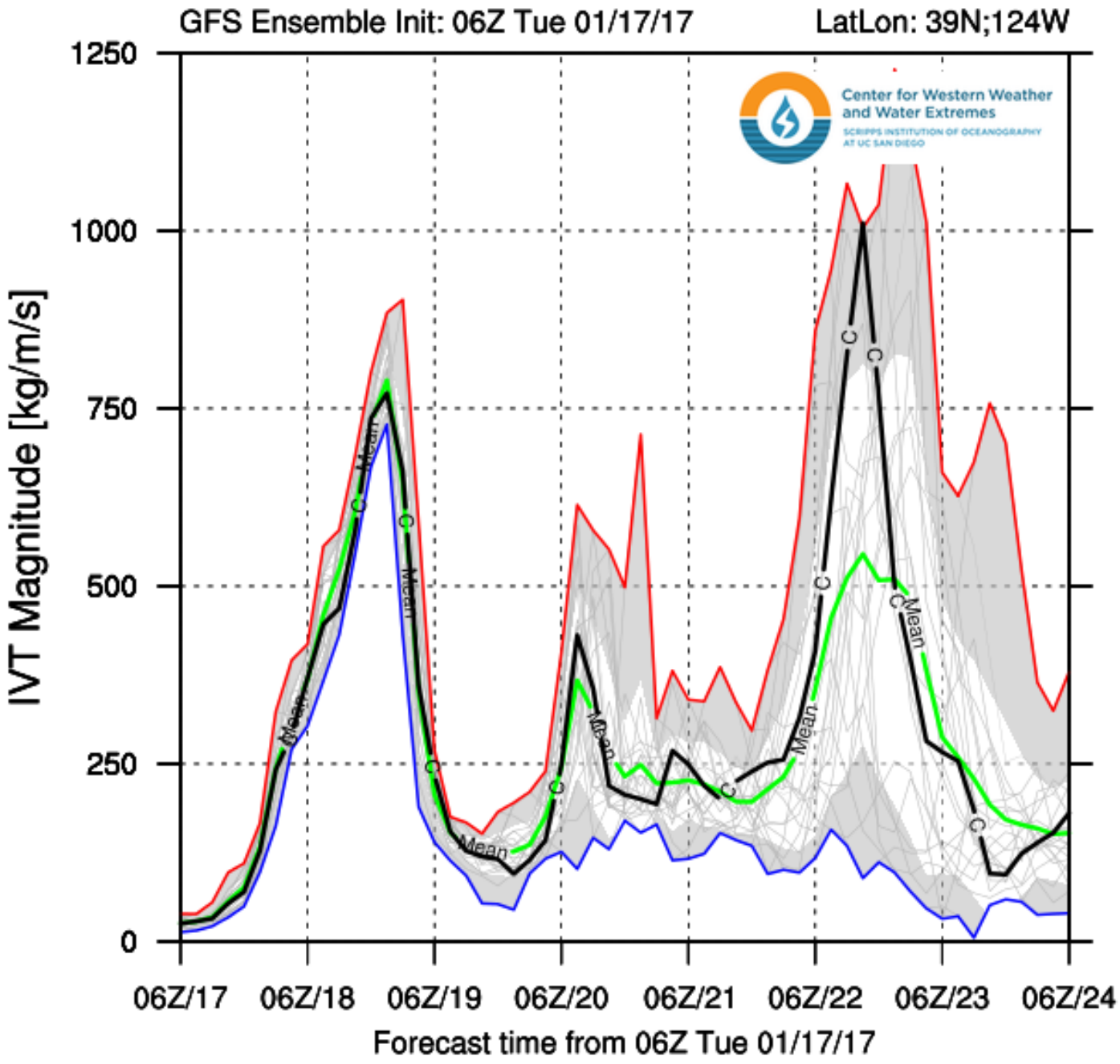
For more information see:
https://aso.jpl.nasa.gov/

Forecast Tools from the Center for Western Weather and Water Extremes (CW3E)

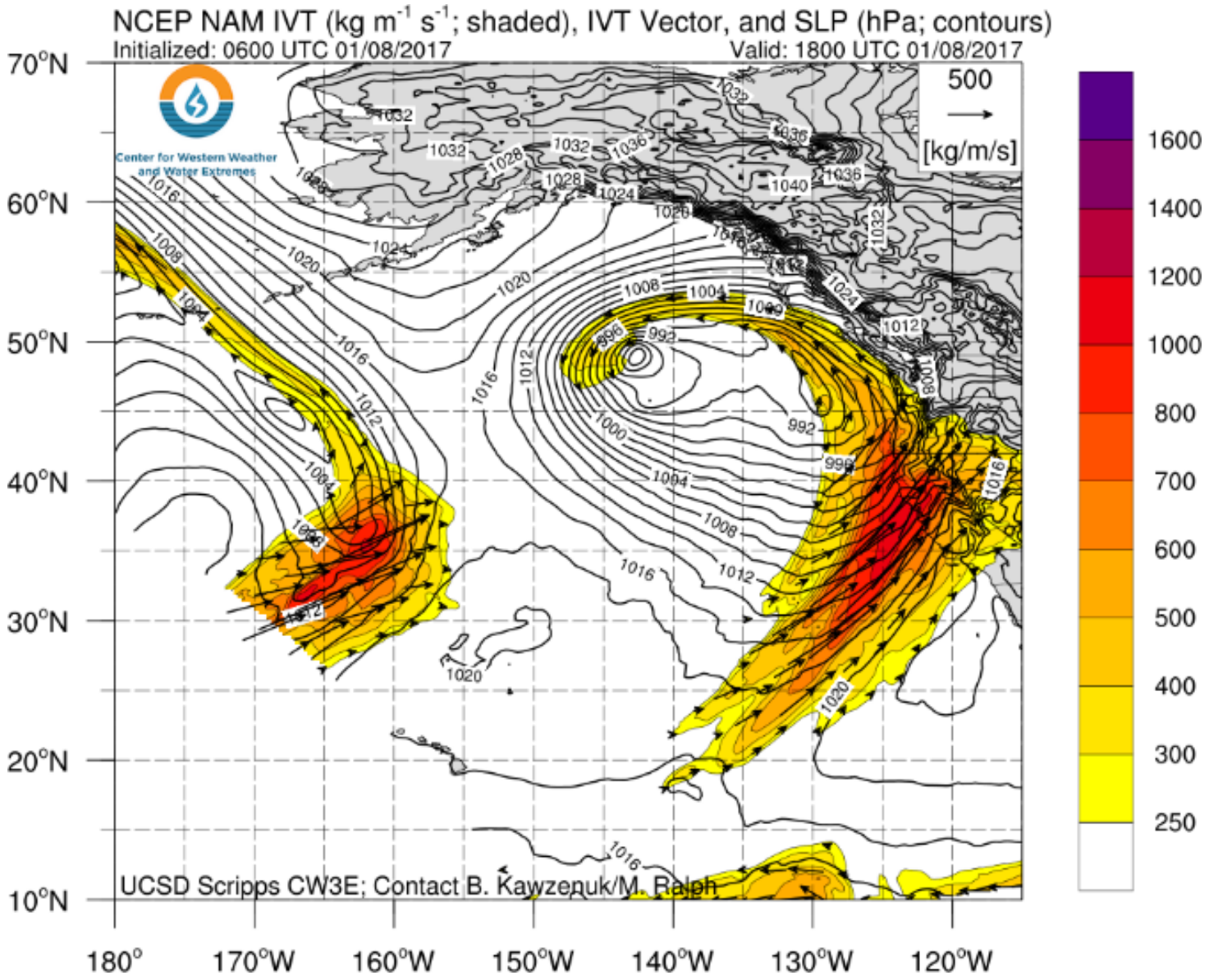




AR Outlook Tool



AR Strength Forecast and Uncertainty Tool



IVT as a Prognostic Variable in Weather Forecast Models

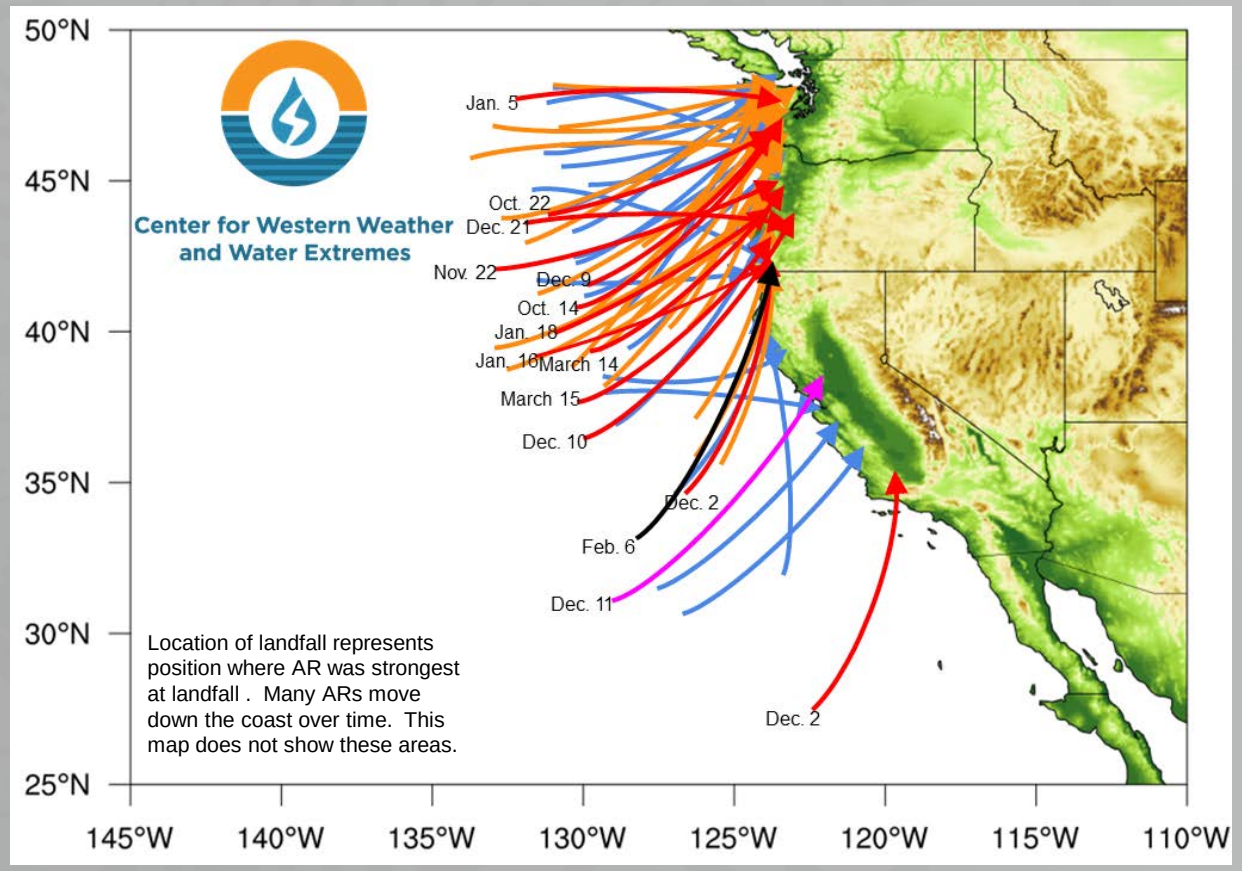
Distribution of Landfalling Atmospheric Rivers on the U.S. West Coast During Water Year 2015

- **57** Atmospheric Rivers made landfall on the USWC during the 2015 water year

AR Strength	AR Count
Weak	22
Moderate	20
Strong	13
Extreme	1
Exceptional	1

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}



By F.M. Ralph, C. Hecht, J. Kalansky

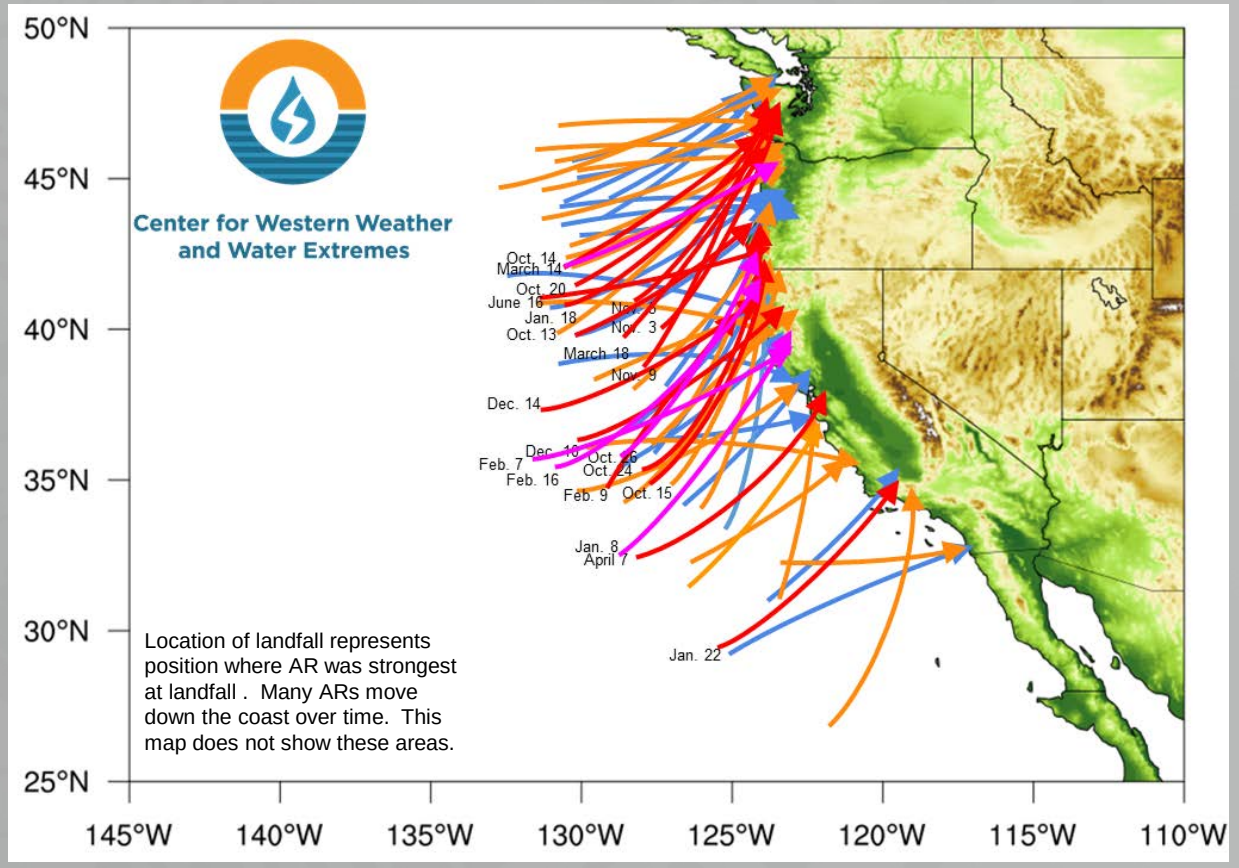
Distribution of Landfalling Atmospheric Rivers Over the U.S. West Coast During Water Year 2017

- **68** Atmospheric Rivers made landfall on the USWC during the 2017 water year

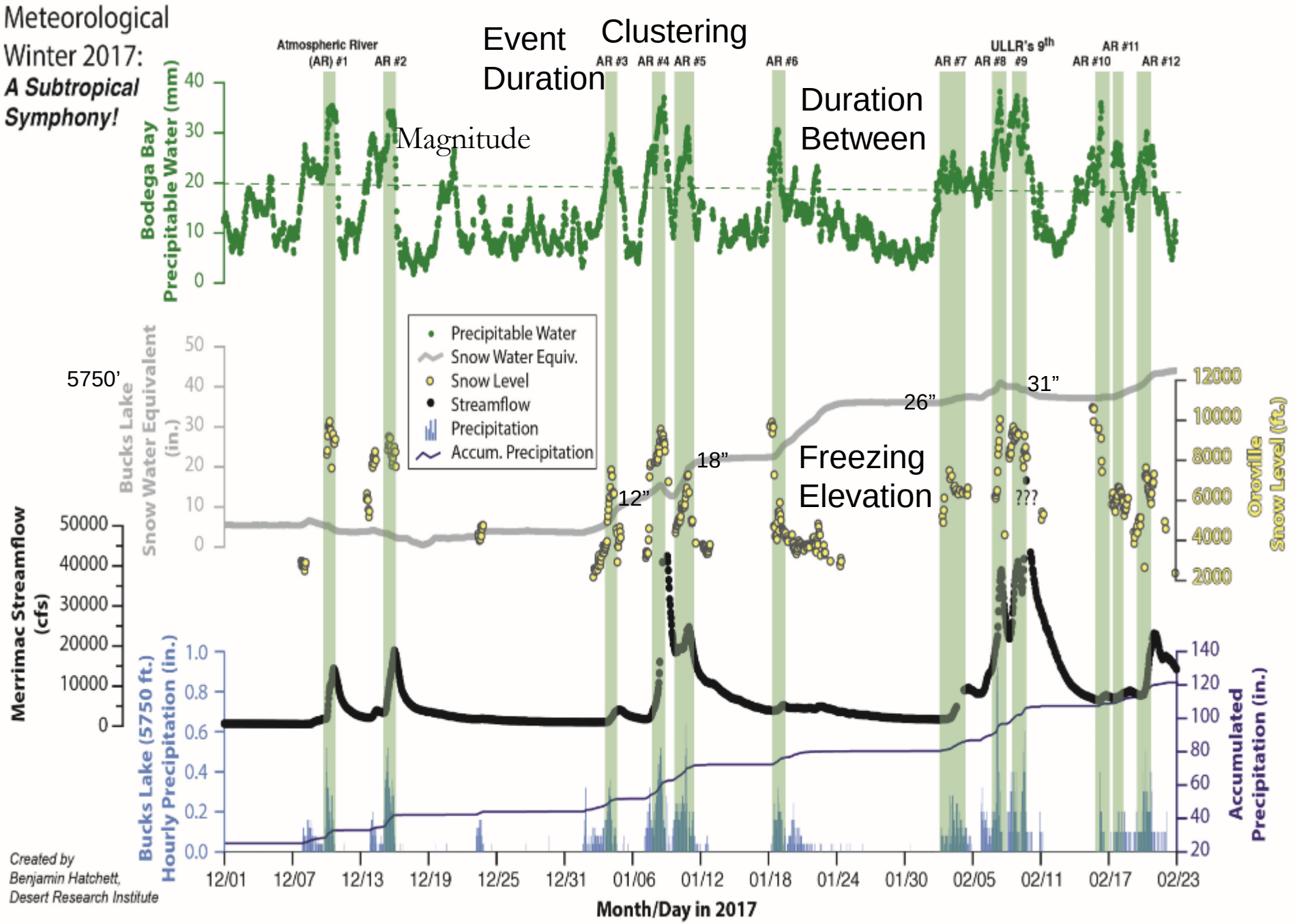
AR Strength	AR Count
Weak	21
Moderate	26
Strong	16
Extreme	5
Exceptional	0

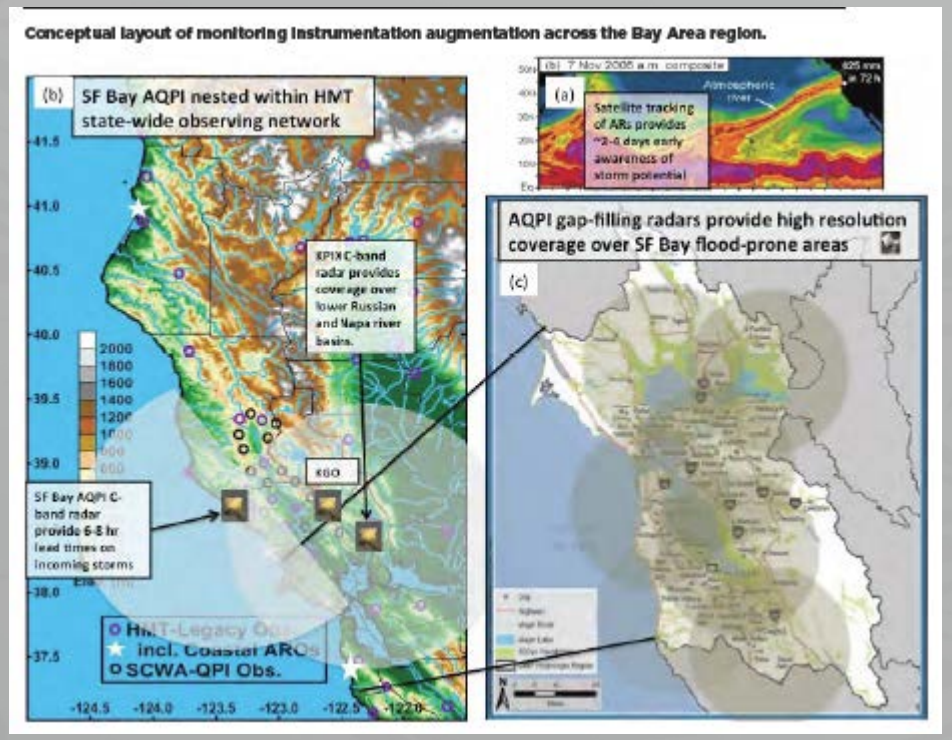
Ralph/CW3E AR Strength Scale

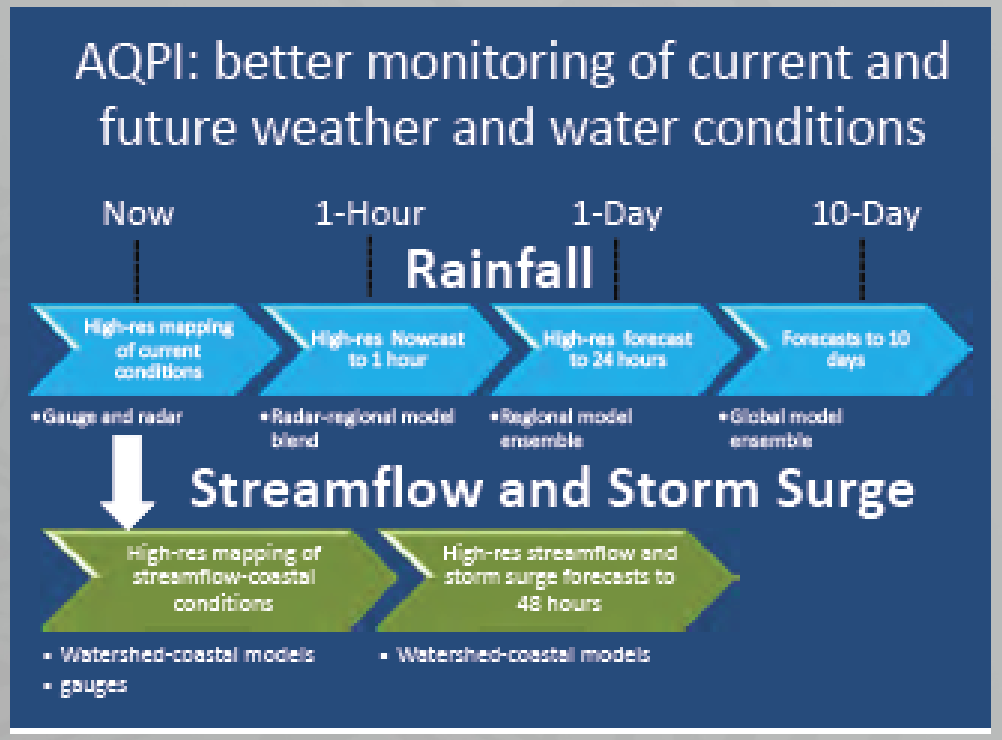
- Weak: IVT=250–500 kg m^{-1} s^{-1}
- Moderate: IVT=500–750 kg m^{-1} s^{-1}
- Strong: IVT=750–1000 kg m^{-1} s^{-1}
- Extreme: IVT=1000–1250 kg m^{-1} s^{-1}
- Exceptional: IVT>1250 kg m^{-1} s^{-1}

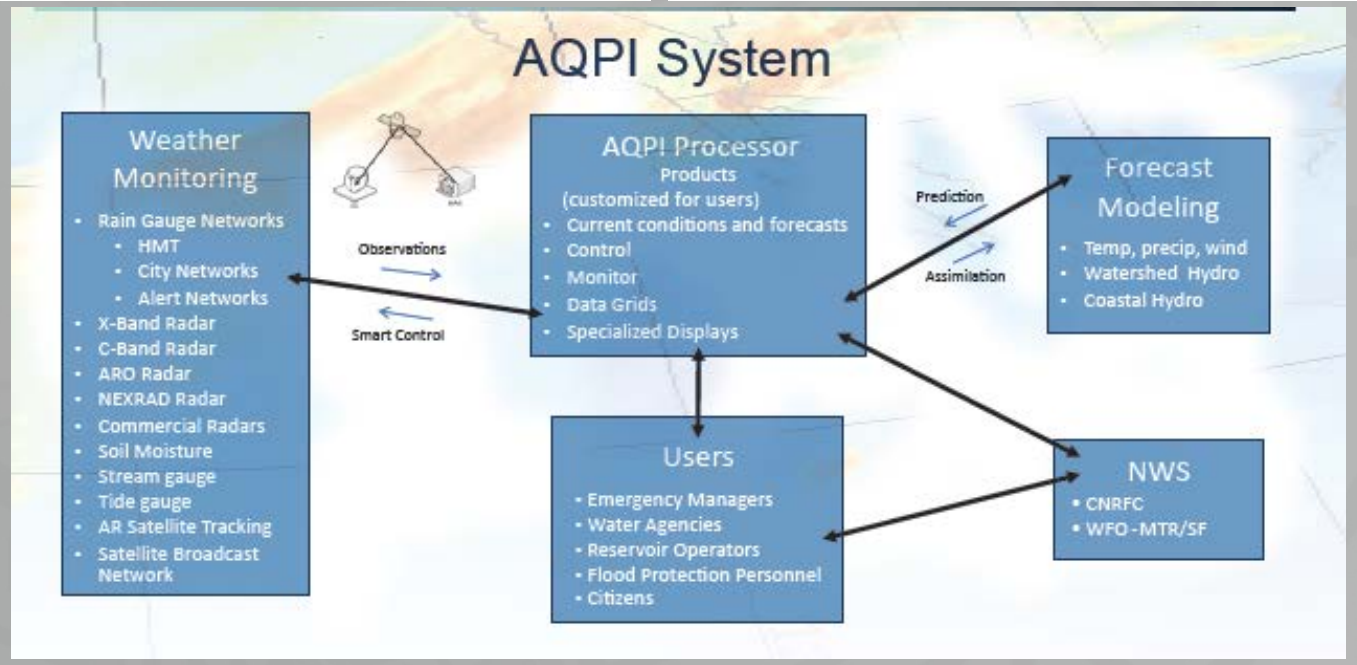


By F.M. Ralph, C. Hecht, J. Kalansky


Meteorological Winter 2017:
A Subtropical Symphony!
Event Duration
Clustering
Magnitude
Duration Between
Freezing Elevation
Atmospheric River (AR) #1
AR #2
AR #3
AR #4
AR #5
AR #6
AR #7
AR #8
ULLR's 9th #9
AR #10
AR #11
AR #12
Bodega Bay Precipitable Water (mm)
Bucks Lake Snow Water Equivalent (in.)
Precipitable Water
Snow Water Equiv.
Snow Level
Streamflow
Precipitation
Accum. Precipitation
5750'
12"
18"
26"
31"
???
Merrimac Streamflow (cfs)
Bucks Lake (5750 ft.) Hourly Precipitation (in.)
Oroville Snow Level (ft.)
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


Conceptual layout of monitoring instrumentation augmentation across the Bay Area region.
(b) SF Bay AQPI nested within HMT state-wide observing network
(a) Satellite tracking of ARs provides ~2-6 days early awareness of storm potential
AQPI gap-filling radars provide high resolution coverage over SF Bay flood-prone areas
(c)
XPIX C-band radar provides coverage over lower Russian and Napa river basins.
SF Bay AQPI C-band radar provide 6-8 hr lead times on incoming storms
SCWA-QPI Obs.


AQPI: better monitoring of current and future weather and water conditions
Now
1-Hour
1-Day
10-Day
Rainfall
High-res mapping of current conditions
High-res Nowcast to 1 hour
High-res forecast to 24 hours
Forecasts to 10 days
•Gauge and radar
•Radar-regional model blend
•Regional model ensemble
•Global model ensemble
Streamflow and Storm Surge
High-res mapping of streamflow-coastal conditions
High-res streamflow and storm surge forecasts to 48 hours
• Watershed-coastal models
• gauges
• Watershed-coastal models


AQPI System
Weather Monitoring
• Rain Gauge Networks
• HMT
• City Networks
• Alert Networks
• X-Band Radar
• C-Band Radar
• ARO Radar
• NEXRAD Radar
• Commercial Radars
• Soil Moisture
• Stream gauge
• Tide gauge
• AR Satellite Tracking
• Satellite Broadcast Network
Observations
Smart Control
AQPI Processor
Products
(customized for users)
• Current conditions and forecasts
• Control
• Monitor
• Data Grids
• Specialized Displays
Prediction
Assimilation
Forecast Modeling
• Temp, precip, wind
• Watershed Hydro
• Coastal Hydro
Users
• Emergency Managers
• Water Agencies
• Reservoir Operators
• Flood Protection Personnel
• Citizens
NWS
• CNRFC
• WFO - MTR/SF

Summary Thoughts

- Over the past decade, DWR has invested significantly in observations and work with collaborative partners to improve forecasts from the event to seasonal time scales
- Investments in observations and forecasts go hand in hand and must be accompanied by decision support development to translate new data streams into actionable information.
- These investments continue at a time where potential exists to generate meaningful decision support for water resources management in the next decade

Questions?

Michael.L.Anderson@water.ca.gov