

Historical Context of Floods through an AR Lens

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Talk Overview

- The AR lens for Extreme Events
- Some historically notable events
- Next Steps

Distribution of Landfalling Atmospheric Rivers on the U.S. West Coast

(From 1 Oct 2016 to 12 April 2017)

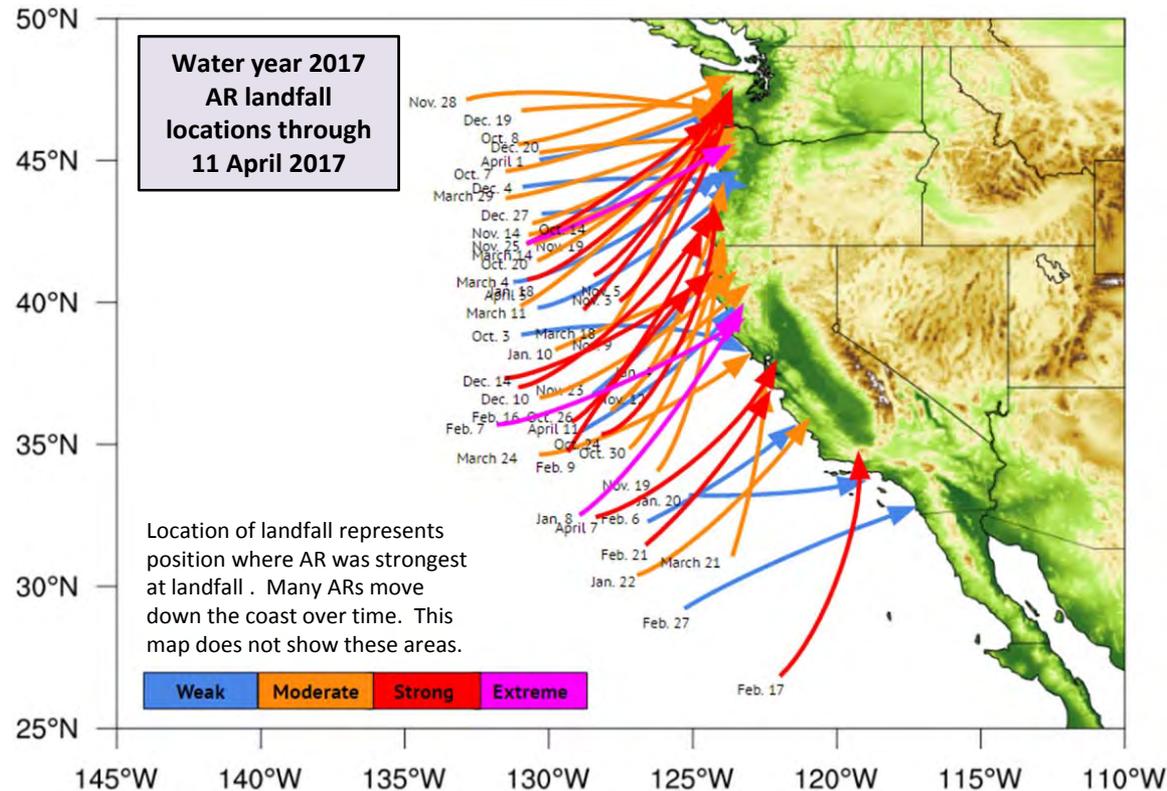
AR Strength	AR Count*
Weak	12
Moderate	21
Strong	13
Extreme	3

Ralph/CW3E AR Strength Scale

- Weak: $IVT=250-500 \text{ kg m}^{-1} \text{ s}^{-1}$
- Moderate: $IVT=500-750 \text{ kg m}^{-1} \text{ s}^{-1}$
- Strong: $IVT=750-1000 \text{ kg m}^{-1} \text{ s}^{-1}$
- Extreme: $IVT>1000 \text{ kg m}^{-1} \text{ s}^{-1}$

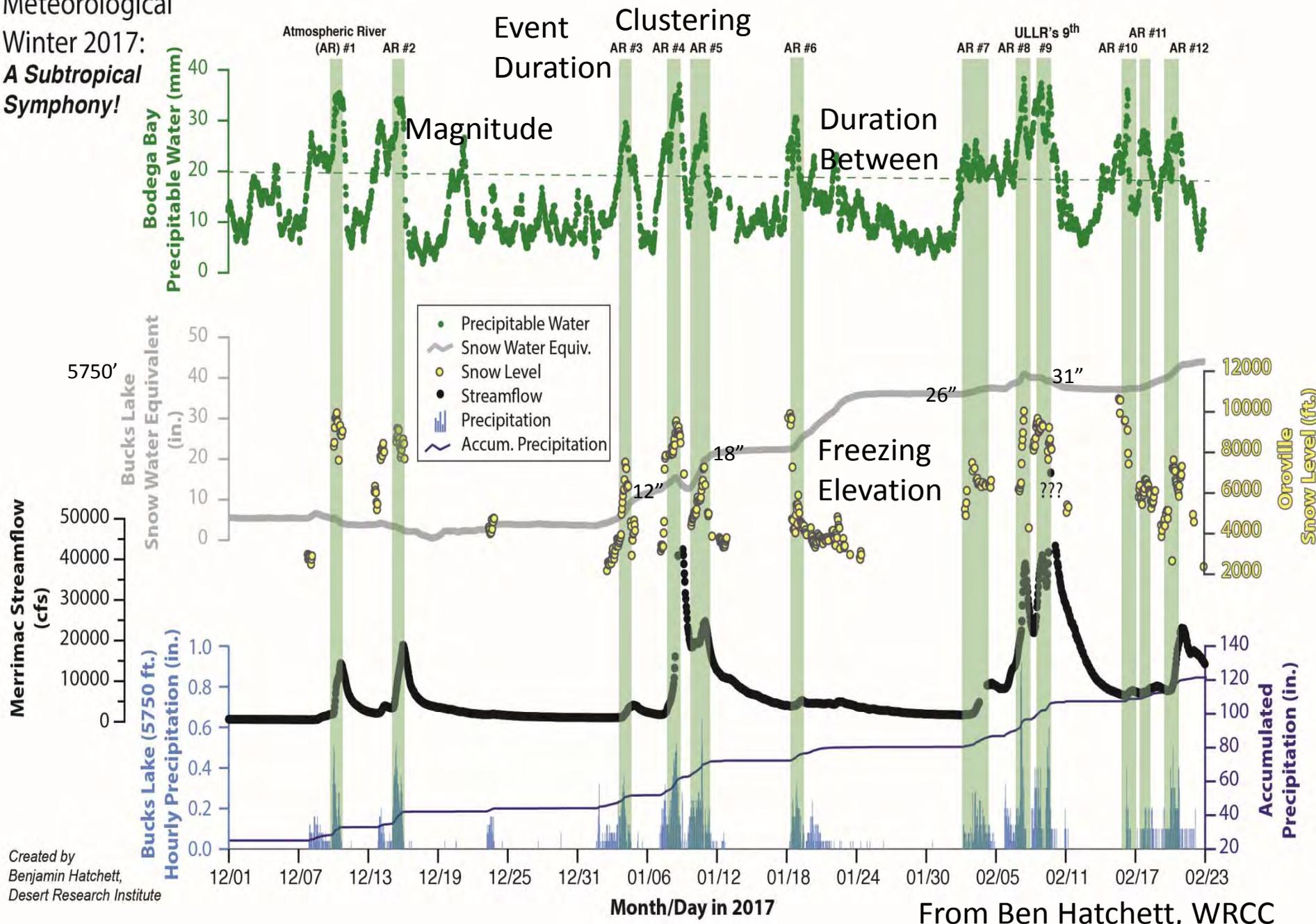
*Radiosondes at Bodega Bay, CA indicated the 10–11 Jan AR was strong (noted as moderate based on GFS analysis data) and 7–8 Feb AR was extreme (noted as strong)

- 49 Atmospheric Rivers have made landfall on the West Coast thus far during the 2017 water year (1 Oct. – 12 April 2017)
- This is much greater than normal
- 1/3 of the landfalling ARs have been “strong” or “extreme”



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

Meteorological
Winter 2017:
*A Subtropical
Symphony!*



Created by
Benjamin Hatchett,
Desert Research Institute

From Ben Hatchett, WRCC

Historically Notable Events

- New Year's 1997
- February 1986
- December 1964
- December 1955
- The Great Flood of Water Year 1862

Extreme Events and HMR 37 circa 1962

- Describes 3 Major Storm Types:
 - Low latitude storms
 - Mid latitude storms
 - High latitude storms
- Notes Moisture Transport and its Components
 - Wind direction, speed, synoptic controls, and moisture restrictions on optimal windflow
 - Latitude and seasonal considerations for moisture
 - Vertical distribution of moisture

Other Documentation

- 1964 Special Weather Summary by Weather Bureau State Climatologist C. Robert Elford
- USBR Report titled “One Day from Disaster” on 1964 storms
- CNRFC Storm Summary 1986 Event
- 1997 DWR Report authored by Jim Goodridge titled “Historic Rainstorms in California”
- NCDC Event Record Details 1997 Flood

December 1955 Storms

- Described in HMR 37 as a Low-Latitude type storm with large areal extent, duration, and precipitation intensity
- Wet antecedent conditions with notable snow starting 4500 feet in north and 6500 feet south Sierra Nevada
- Two periods of precipitation over 9 day period with different characteristics and multiple waves of precipitation in each period
- Snowmelt up to 10,000 feet noted as a contributor to flooding (Historic Storms)

December 1964 Storms

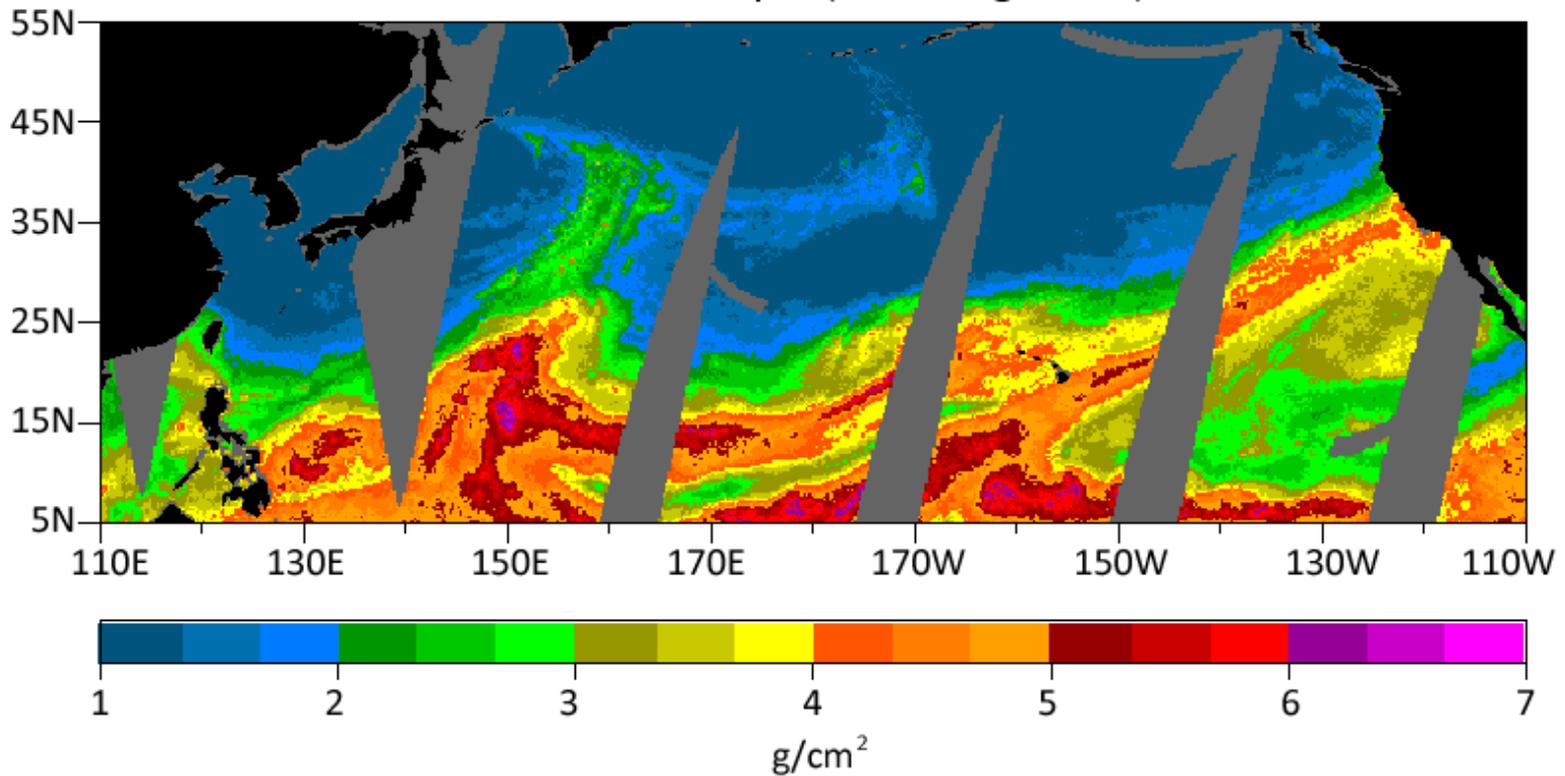
- Antecedent conditions wetter in north, and central while drier in southern CA
- USBR notes lower Shasta Reservoir level prior to storm very beneficial/more than 20 inches of rain in 3 days at Blue Canyon at peak and more than 24 inches in 5 days
- 7-day period of heavy rainfall estimated to be higher than 1955 event by 110 to 150% in coastal mountains and Feather/Yuba/American watersheds (Elford)
- Elford also notes low-latitude setup in his discussion with offshore intensification due to cold air intrusion into warm storms

February 1986 Storms

- Three storms over 9 day period each wetter than the last (CNRFC Storm Summary)
- CNRFC notes more spillover than normal during February events
- Historic Storms notes precipitation totals ranged from 50 percent of annual mean to 95 percent of annual mean from this event
- Focus of storms between Yosemite and Feather River (Historic Storms)

New Year's 1997 Flood

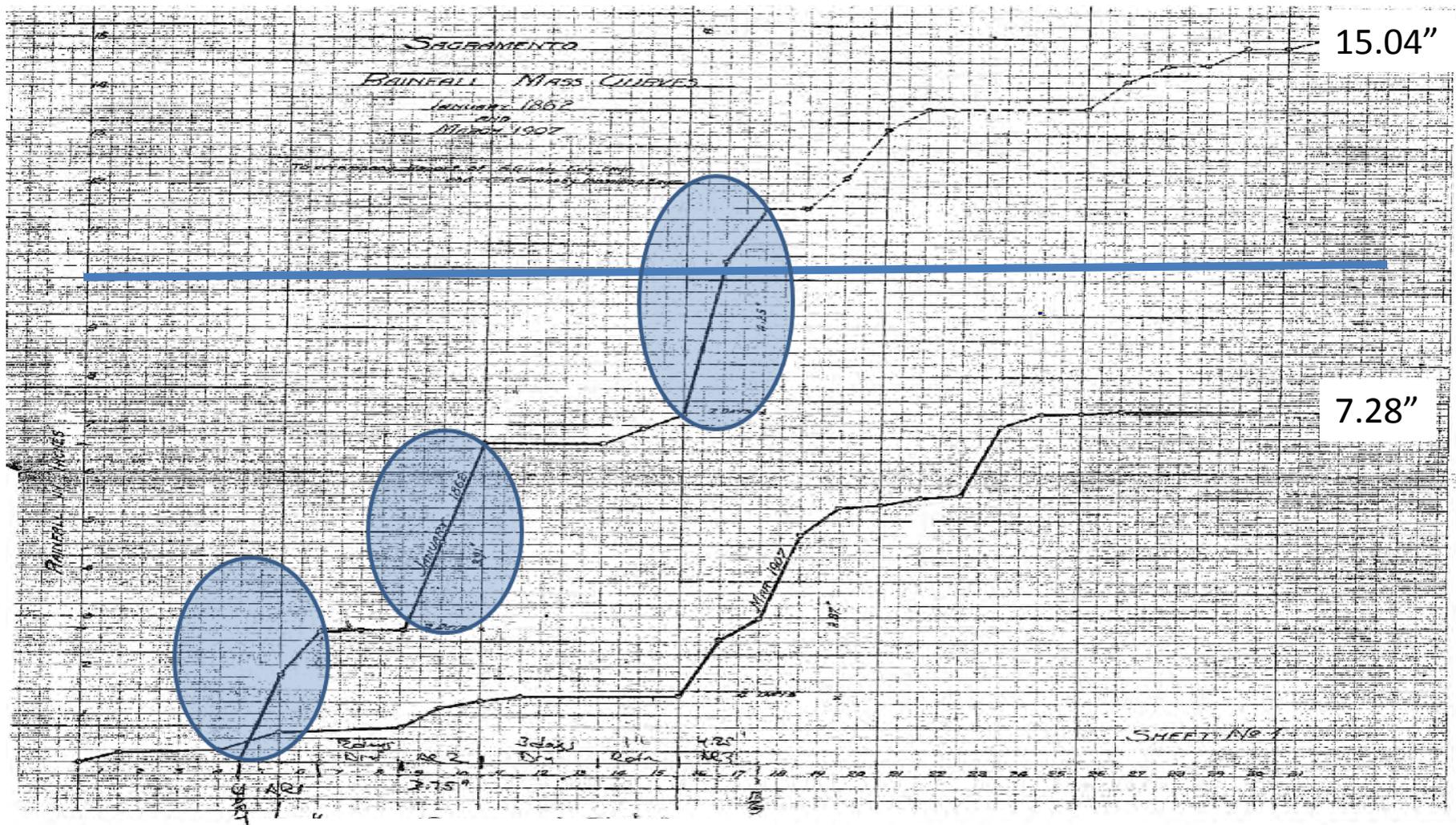
January 02, 1997 12-24 UTC
SSMI Water Vapor (Wentz algorithm)



1997 Storms

- Wet antecedent conditions with cold storms dropping snow to lower elevations and for to six feet of snow below 7000 feet in the Sierra Nevada
- Rains from December 30 through January 6 with heaviest on January 1 and 2 with snow levels as high as 11,700 feet
- Snowmelt contributed to flood peaks with flood of record resulting in many locations

January 1862 versus March 1907 Sacramento



11.5 inches in 13 days for 1862

Constants in Historical Events

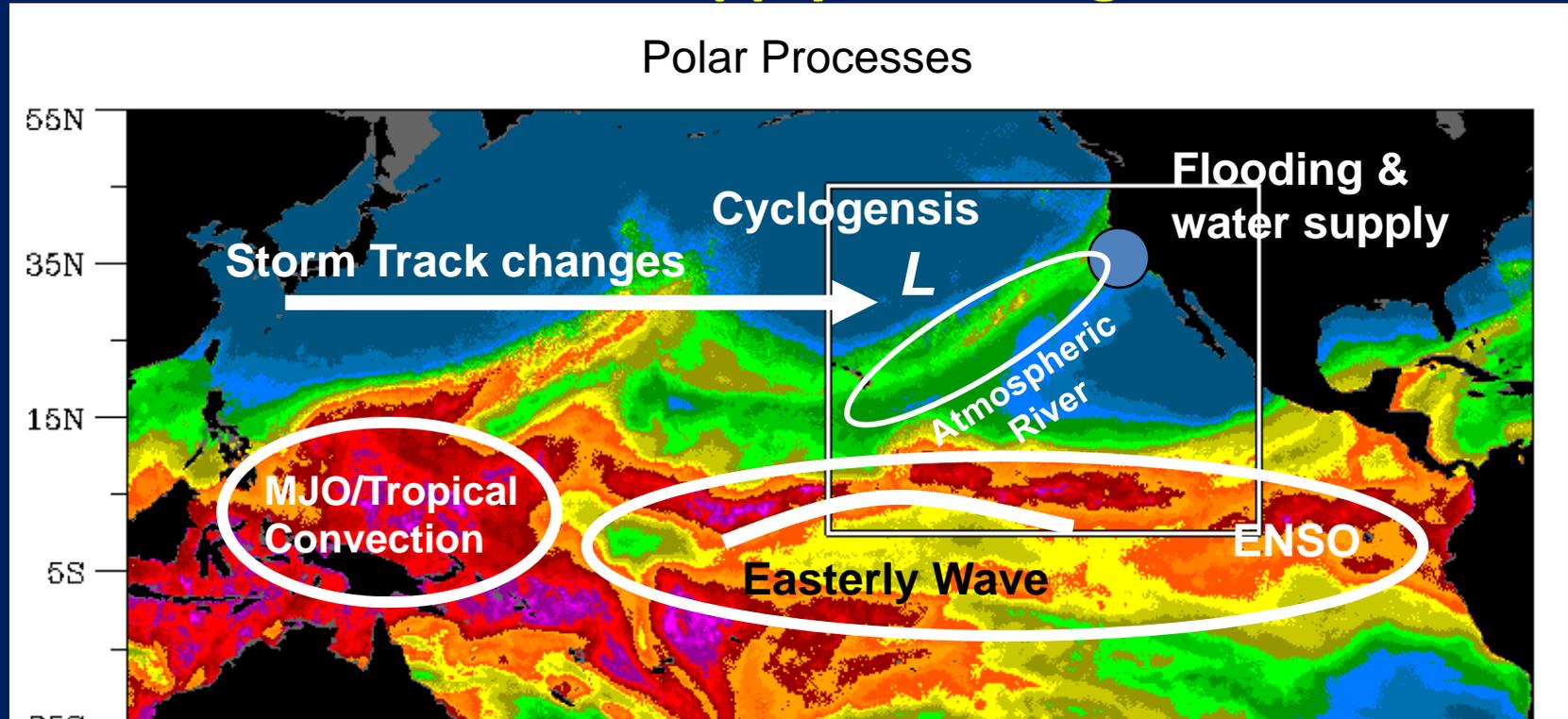
- Wet antecedent conditions, some with snow that enhances flooding (rain on snow)
- High snow lines with heaviest precipitation (suggestive of AR landfall)
- Suggestions of clustering of ARs over a 7-10 day window
- Suggestion of synoptic set-up supporting extreme events (multiple scales of dynamics of interest)

Next Steps

- Multiple lines of investigation on scales of dynamics and their interaction as well as interaction with moisture field structure and advection
- More detail on temperature and its evolution before, during, and after event(s)
- Better description/forecast of clustering of AR events and knowledge of interevent times
- Multiple levels of communication from science level to agency level to public level regarding science, event description, and impacts

Key Phenomena Affecting California

Water Supply/Flooding:



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