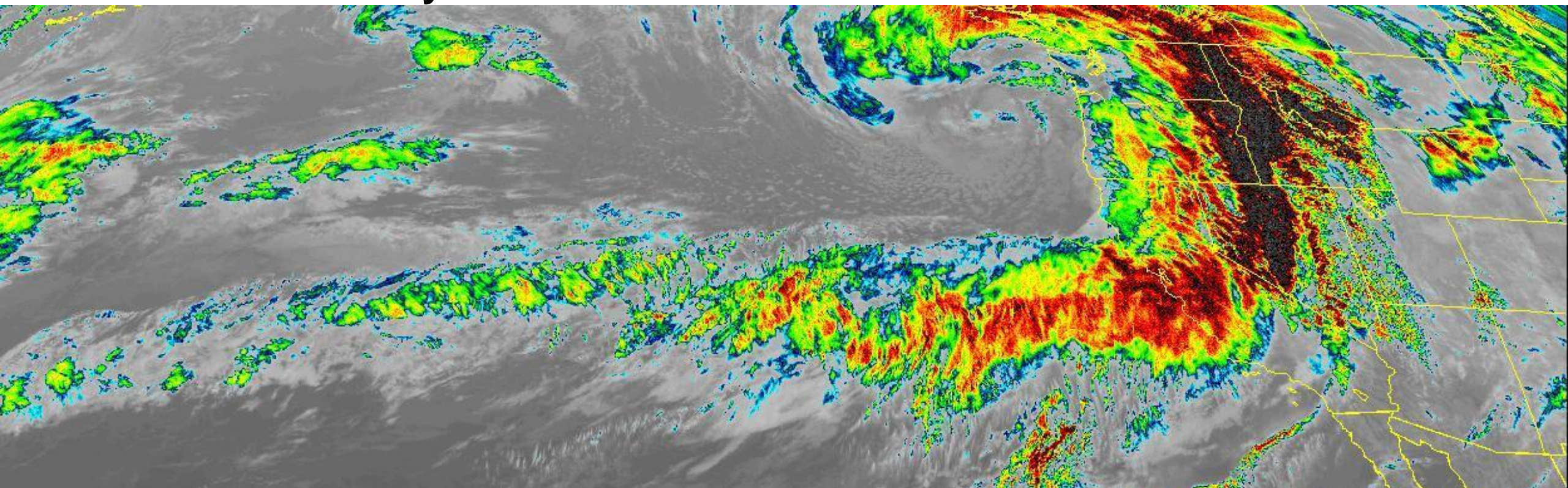


# CW3E Event Summary: 27 December 2022 – California

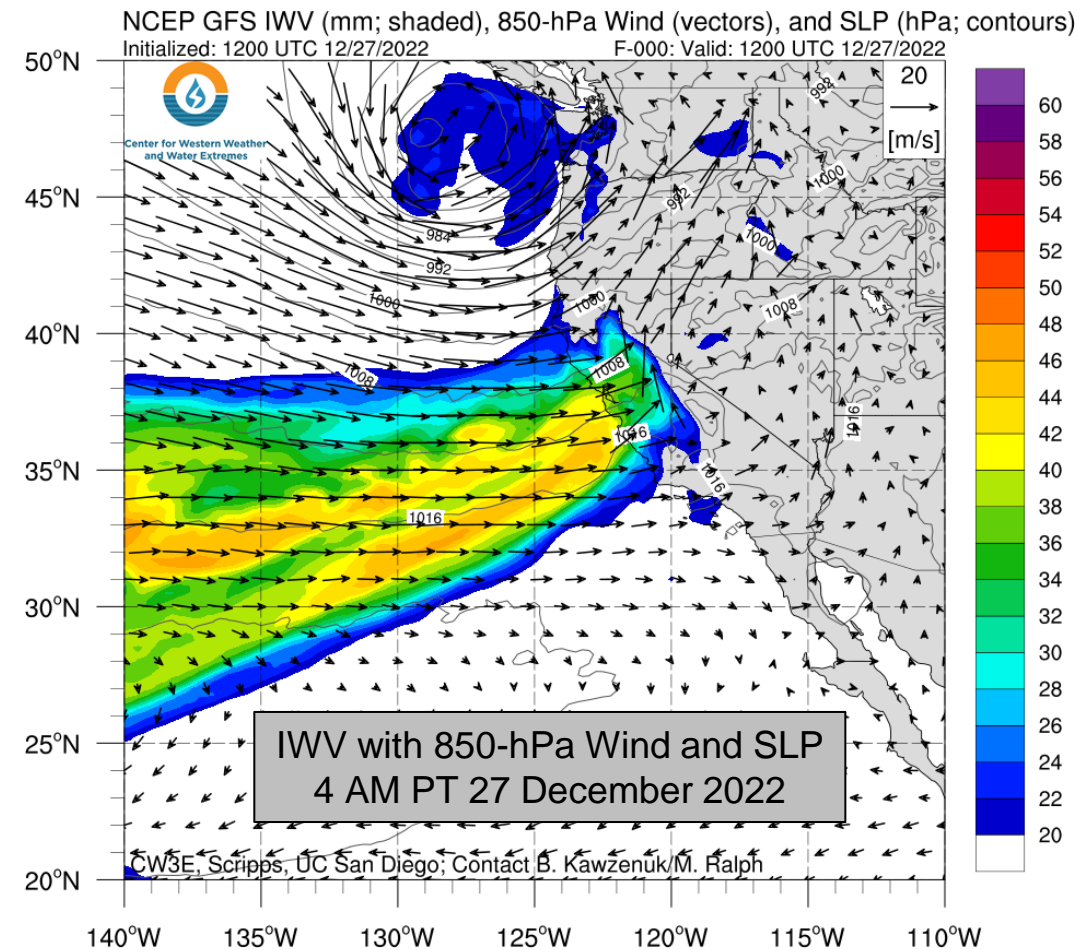
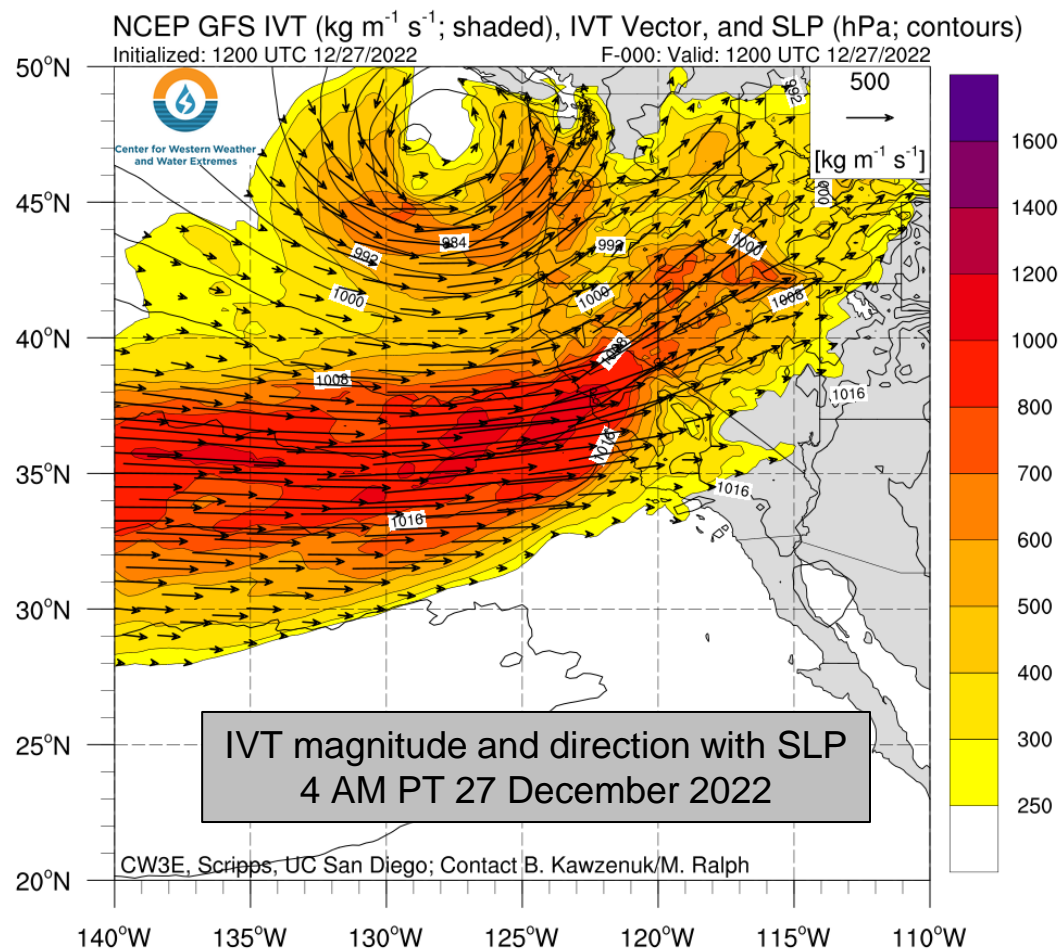


## **Landfalling AR brings short duration, but heavy rainfall to California**

- A low-pressure system over the Northeast Pacific and atmospheric river (AR) produced widespread short duration, but heavy rainfall in California on 27 December
- AR produced mostly rain with early-storm melting levels over 11,000 feet
- Due to relatively dry antecedent conditions and short duration, this strong AR produced primarily beneficial rainfall
- This event summary focuses on California; additional impacts from this storm system occurred in the PNW

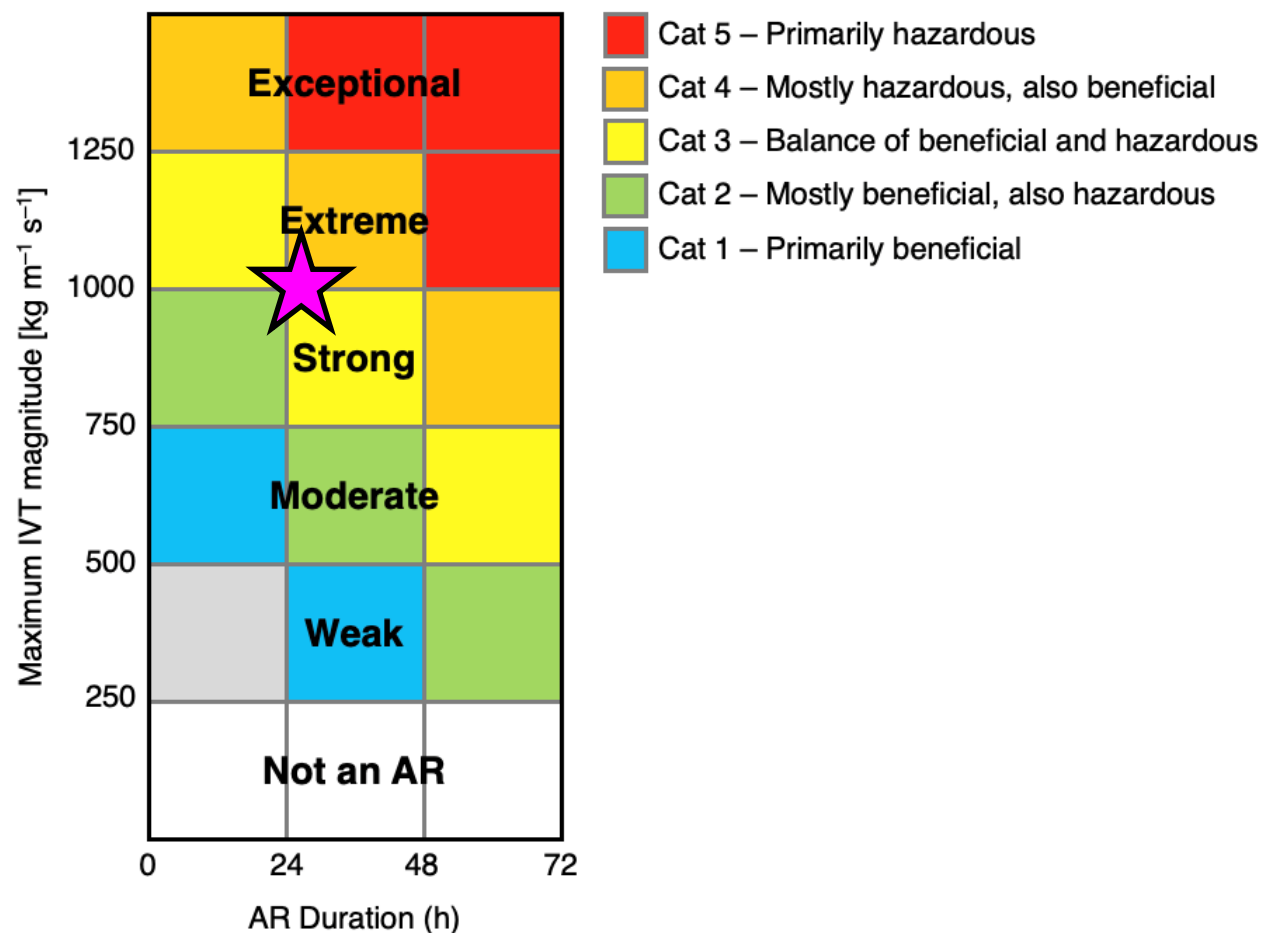
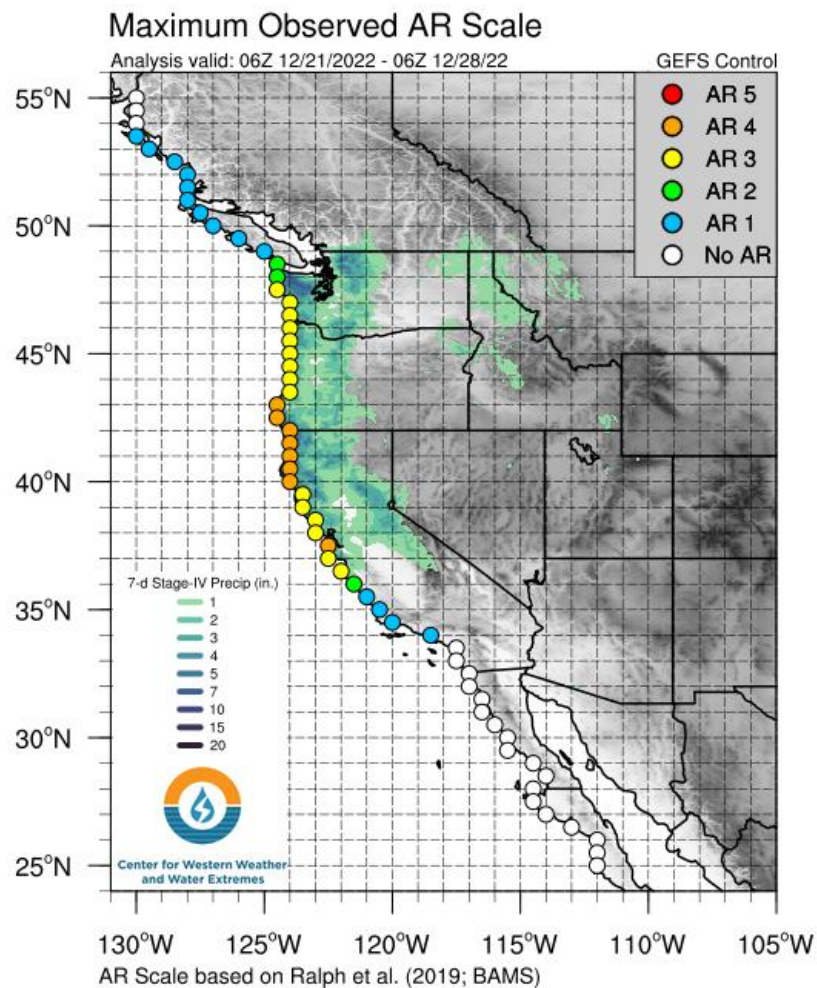
0900 UTC 27 Dec 2022 – GOES West – Band 07 – Courtesy NOAA/STAR

# CW3E Event Summary: 27 December 2022



- AR contained IVT magnitudes of  $\sim 1000 \text{ kg/ms}$  at landfall in San Francisco Bay Area with inland water vapor transport throughout Western U.S.
- Coastal IWV values exceeded 40 mm with values  $>35 \text{ mm}$  into Central Valley

# CW3E Event Summary: 27 December 2022



- GFS model analyzed **maximum IVT magnitude of 1000 kg/ms** at 37.5N, 122.5W near SFO with a duration of IVT magnitudes at or above 250 kg/ms for **24 hours**
- Ralph et al. (2019) AR Scale rank for this event in the Bay Area was AR4

# CW3E Event Summary: 27 December 2022

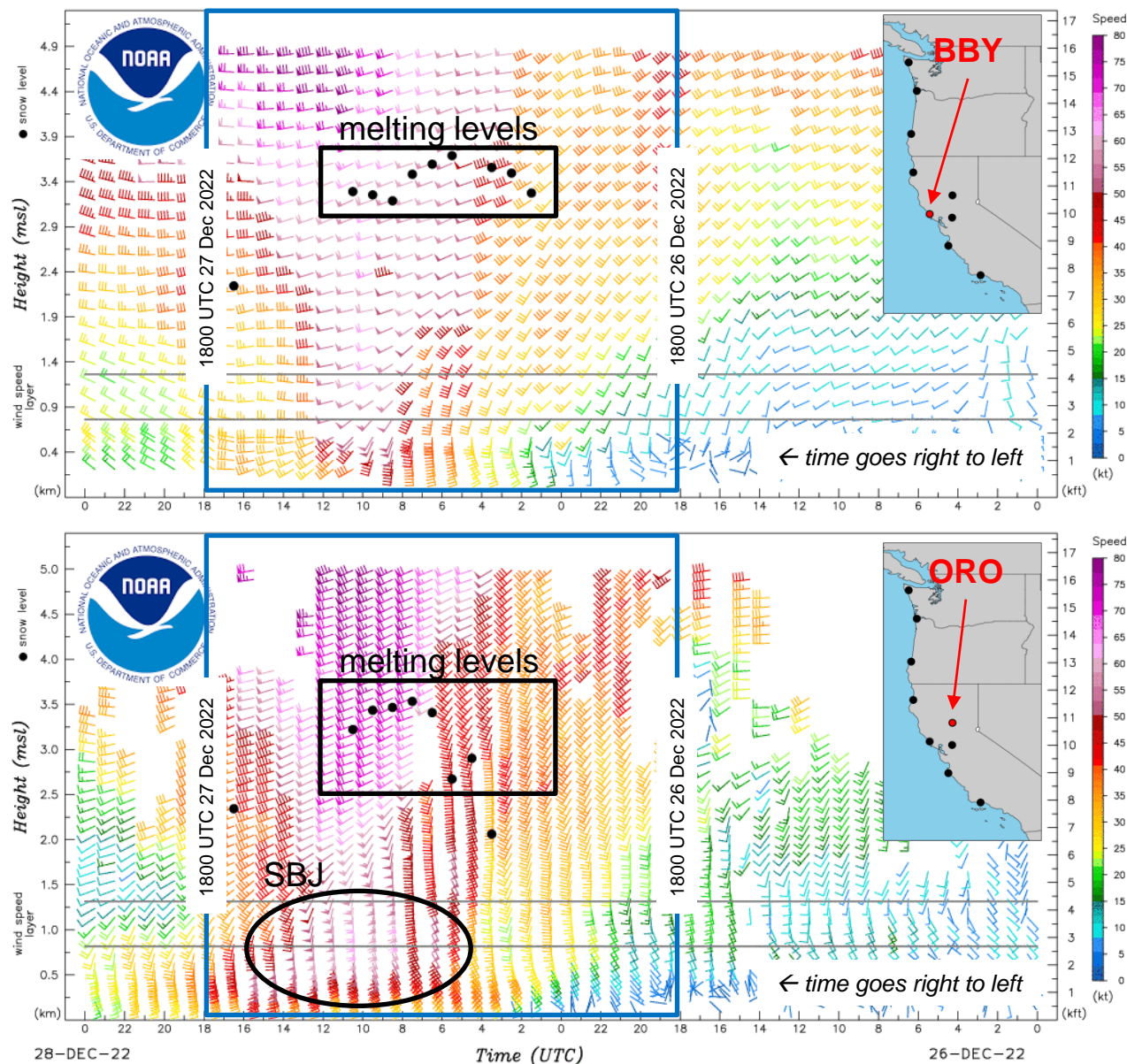
ERA5 Top-15 Landfalling ARs at 37.5N, 122.5W for 1 October 1980 through 30 September 2020

	ID/Start	Start Date	End Date	Duration	Max IVT ▼	AR Scale	Max Date
1	1995121021	21Z 12/10/1995	22Z 12/12/1995	50	1,463.36	5	13Z 12/12/1995
2	1983110908	08Z 11/09/1983	11Z 11/11/1983	52	1,261.29	5	21Z 11/10/1983
3	1981111203	03Z 11/12/1981	15Z 11/14/1981	61	1,206.46	5	01Z 11/14/1981
4	2009101303	03Z 10/13/2009	19Z 10/14/2009	41	1,151.16	4	20Z 10/13/2009
5	1986021323	23Z 02/13/1986	18Z 02/19/1986	140	1,101.65	5	19Z 02/14/1986
6	1996122820	20Z 12/28/1996	06Z 01/03/1997	131	1,097.08	5	14Z 01/01/1997
7	1995030808	08Z 03/08/1995	21Z 03/09/1995	38	1,072.39	4	12Z 03/09/1995
8	2008010316	16Z 01/03/2008	02Z 01/05/2008	35	1,060.46	4	17Z 01/04/2008
9	2017010706	06Z 01/07/2017	09Z 01/09/2017	52	1,046.23	5	15Z 01/08/2017
10	2015020602	02Z 02/06/2015	10Z 02/07/2015	33	1,044.49	4	20Z 02/06/2015
11	2005123002	02Z 12/30/2005	20Z 12/31/2005	43	1,042.76	4	13Z 12/31/2005
12	1983012523	23Z 01/25/1983	08Z 01/27/1983	34	1,020.44	4	21Z 01/26/1983
13	1982041006	06Z 04/10/1982	04Z 04/12/1982	47	1,013.45	4	03Z 04/11/1982
14	2010102310	10Z 10/23/2010	16Z 10/25/2010	55	986.85	4	21Z 10/24/2010
15	2002121305	05Z 12/13/2002	05Z 12/15/2002	49	977.62	4	21Z 12/14/2002

This AR

- Based on maximum IVT magnitude, this landfalling AR would rank 14<sup>th</sup> based on data 1980–2020; 15<sup>th</sup> if you include the October 2021 storm not shown
- Of top-15 storms listed in ERA5 catalog above, this AR was by far *the shortest in duration* at 24 hours
- Although intense, its short duration promoted primarily beneficial and not widespread hazardous precipitation

# CW3E Event Summary: 27 December 2022

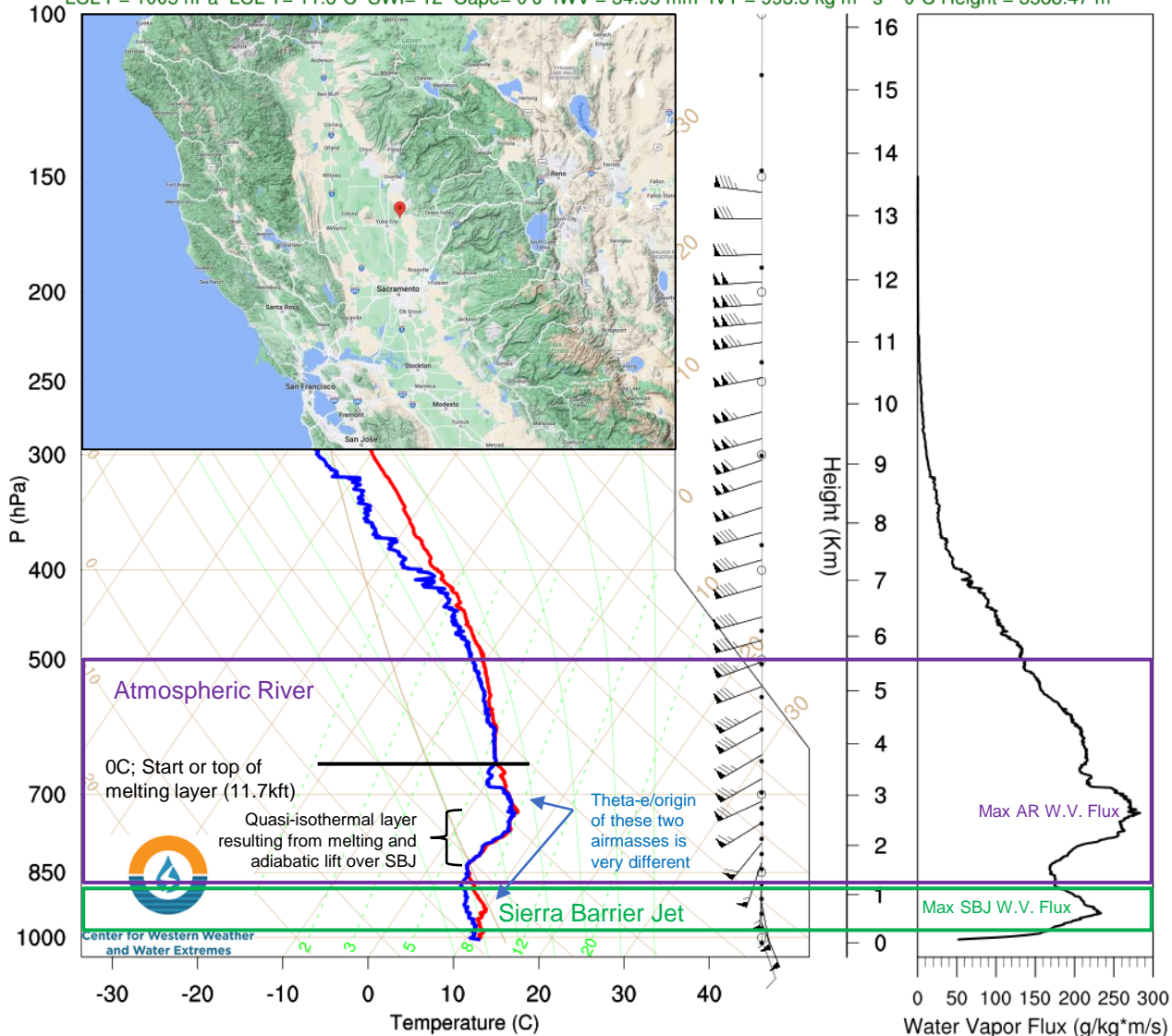


- Wind profilers with Atmospheric River Observatories at Bodega Bay (top; coastal) and Oroville (bottom; foothills) capture **elevated melting levels** near 3.5 km (~11.5kft) and 50–70 knot west-southwest flow between 1.5 and 3.5 km associated with landfalling AR
- Oroville profiler captures low-level south-southeast flow >50 knots consistent with Sierra Barrier Jet (SBJ) *below* the west-southwest AR flow aloft primarily between 0500 UTC and 1600 UTC on 27 December 2022

# CW3E Event Summary: 27 December 2022

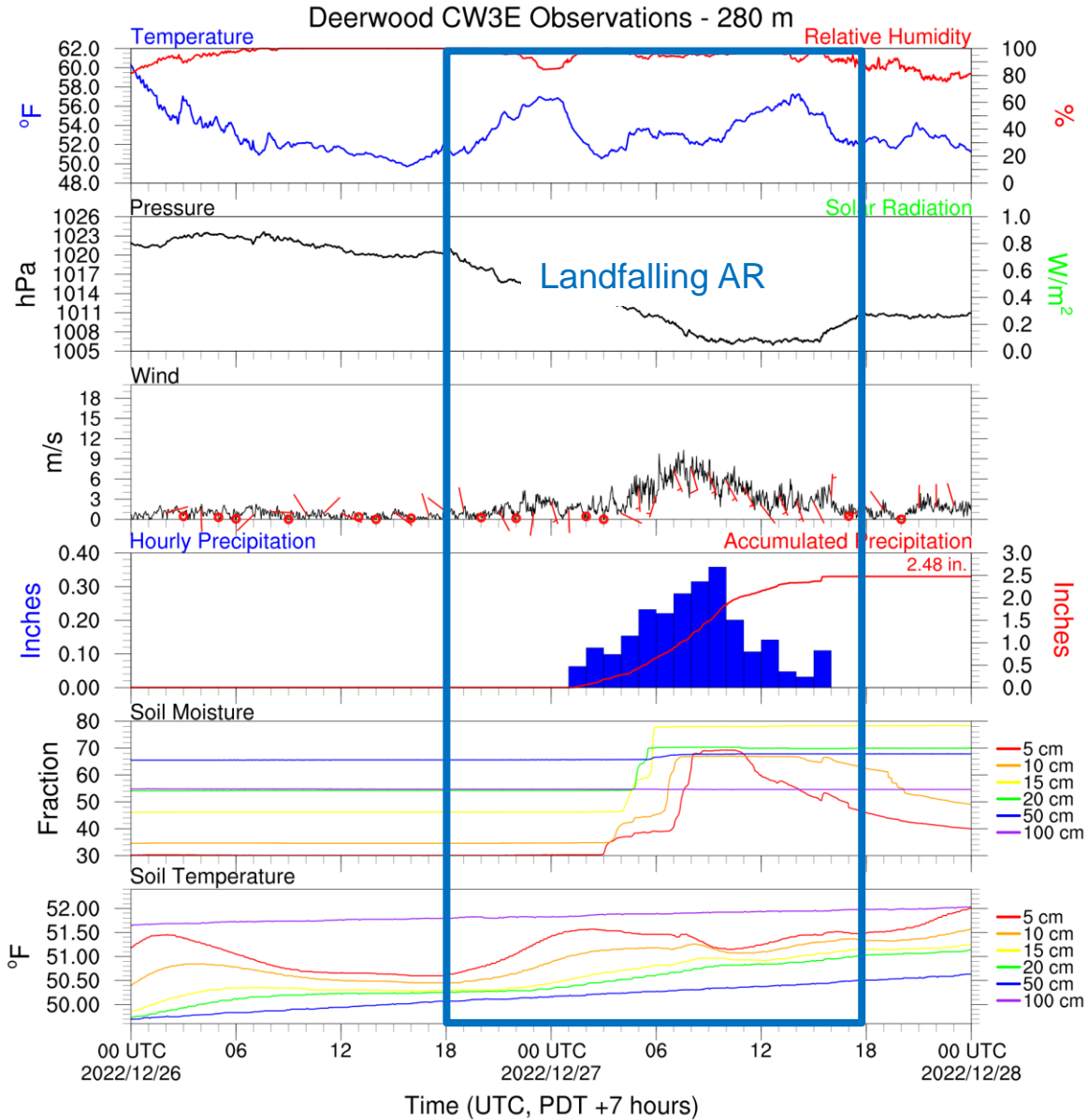
USYUB: 09:00 UTC 12/27/2022

LCL P= 1005 hPa LCL T= 11.6°C SWI= 12 Cape= 0 J IWV = 34.95 mm IVT = 993.3 kg m<sup>-1</sup> s<sup>-1</sup> 0°C Height = 3588.47 m

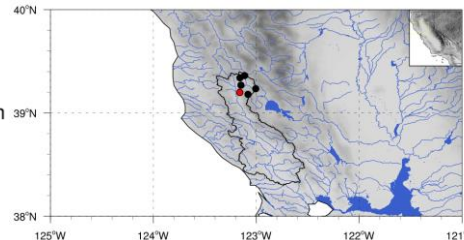


- CW3E launched several radiosondes from Marysville, CA on 27 December 2022
- Highest IWV values were ~35 mm and highest IVT magnitudes were 993 kg/ms at 0900 UTC (1 AM PT) 27 Dec with an observed height of freezing/melting level at 3588.5 meters (11,773 feet)
- Profile contained two maxima in water vapor flux coincided with SSE low-level Sierra Barrier Jet and WSW mid-level flow along AR
- Quasi-isothermal layer resulted from melting and adiabatic lift of incoming air over the stable SBJ in the Central Valley

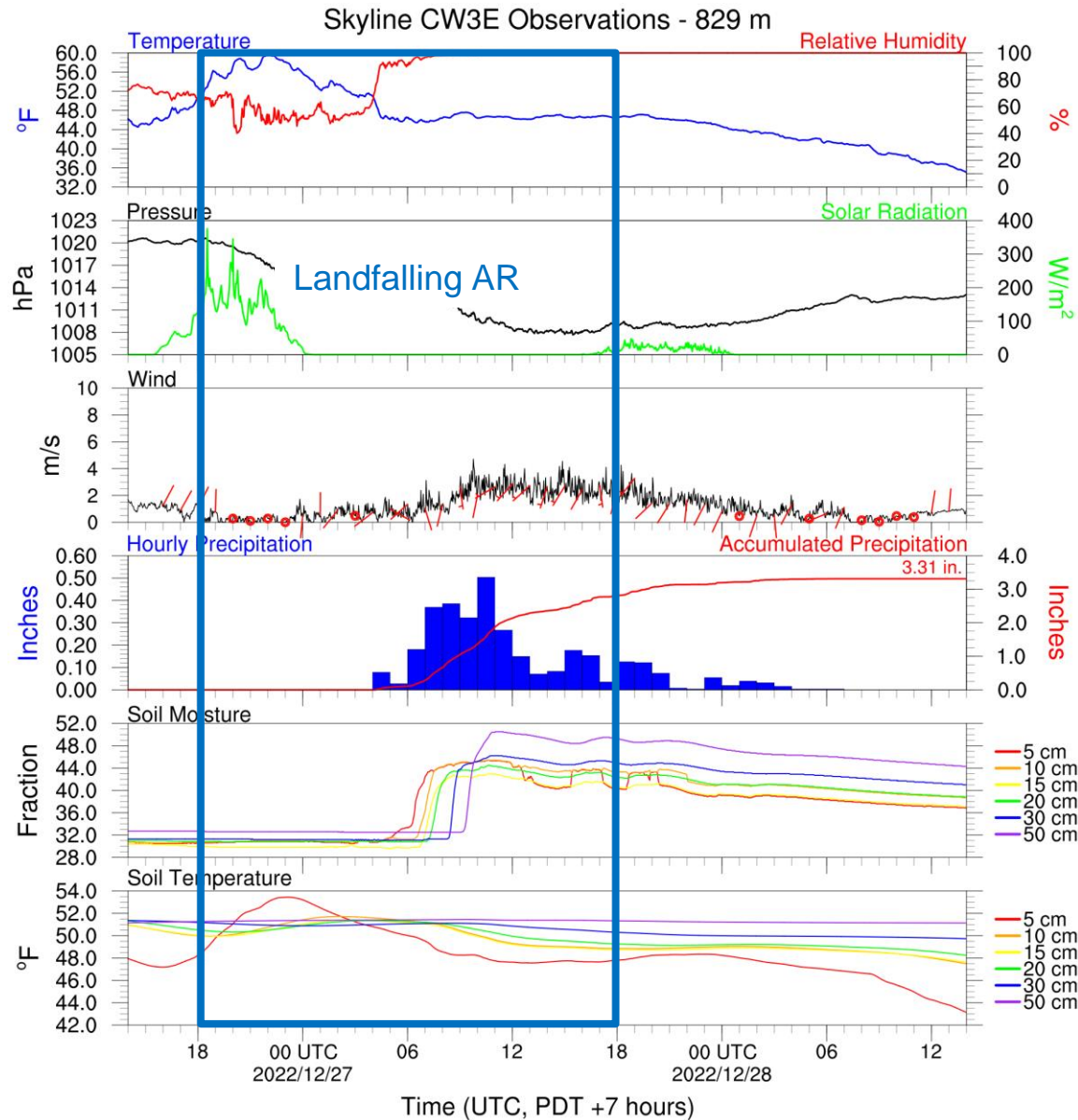
# CW3E Event Summary: 27 December 2022



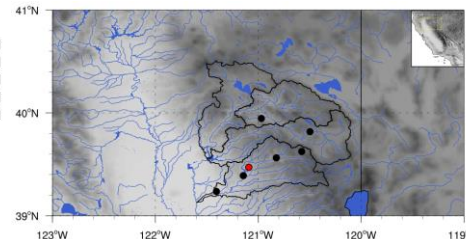
- CW3E instrumentation in the Russian River watershed above Lake Mendocino at Deerwood collected ~2.5 inches of precipitation with increases in soil moisture detected through a depth of ~20 cm



# CW3E Event Summary: 27 December 2022



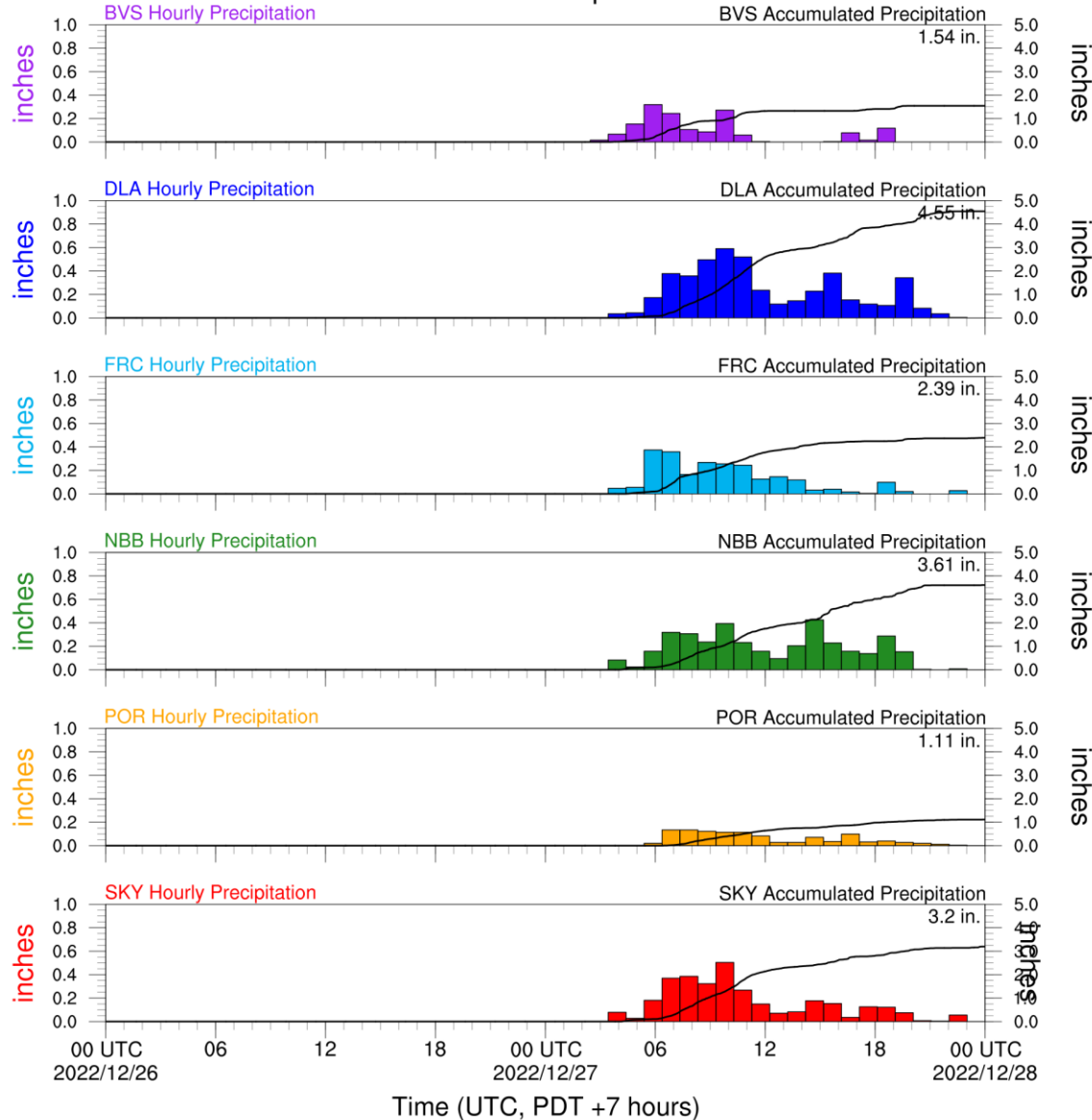
- CW3E instrumentation in the Yuba River watershed above New Bullards Bar at Skyline collected ~3.3 inches of precipitation with increases in soil moisture detected through a depth of >50 cm



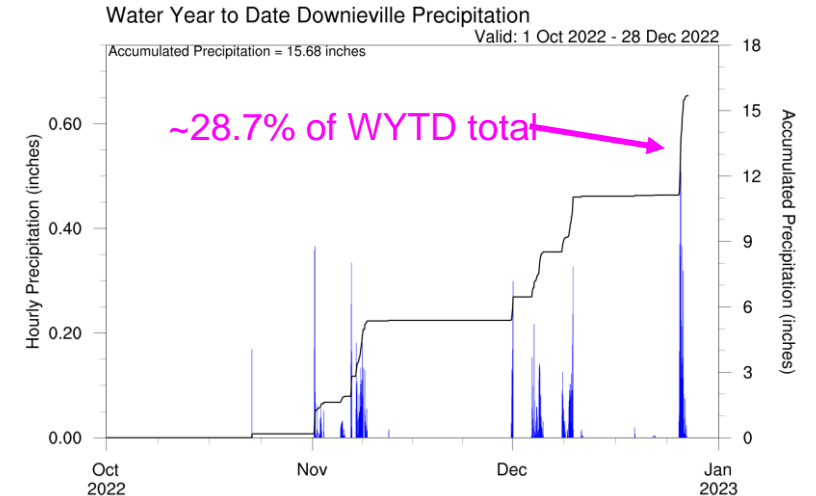
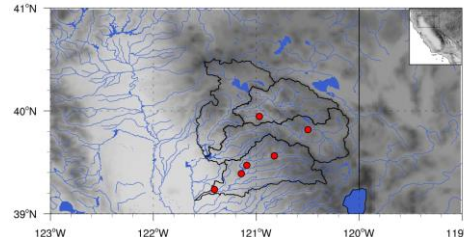


# CW3E Event Summary: 27 December 2022

Yuba River Watershed Precipitation Observations

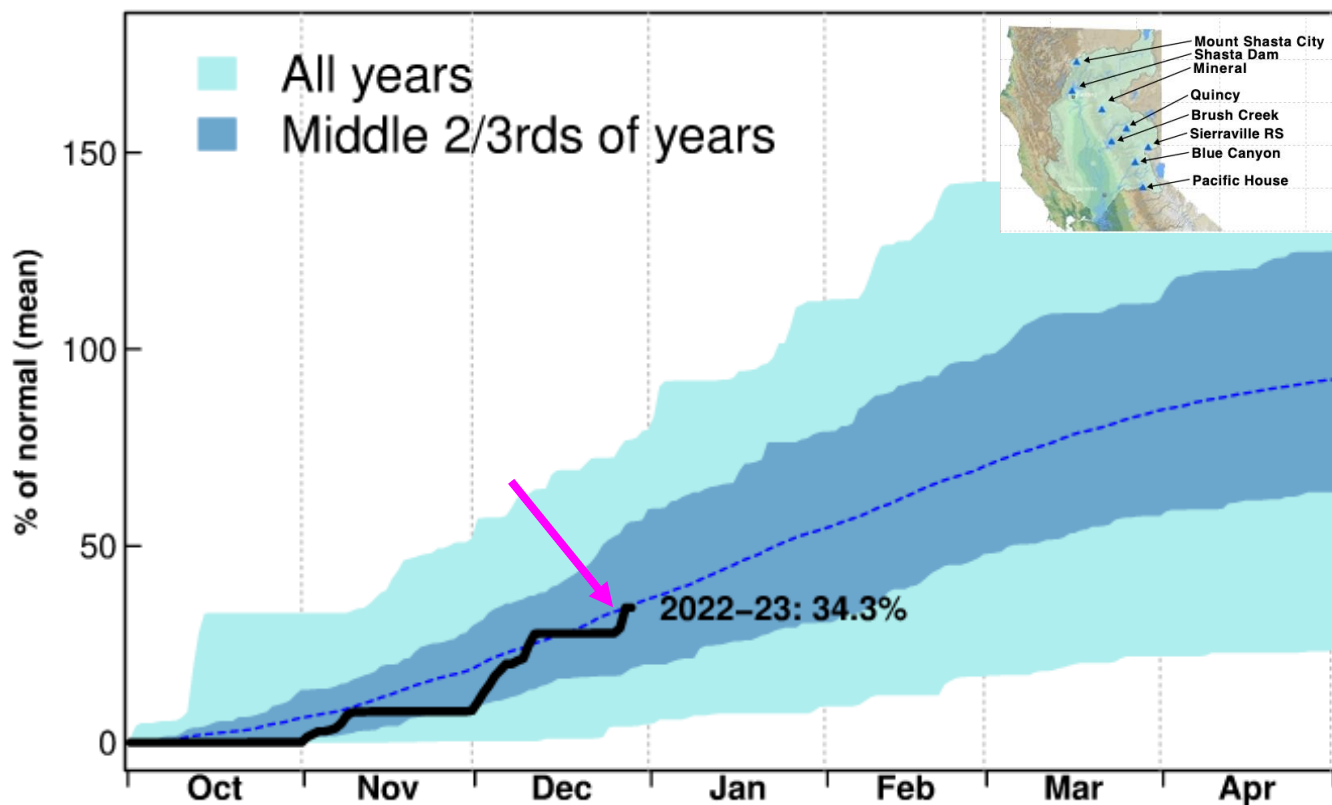


- Altogether across the Yuba and Feather River Watersheds in the Northern Sierra, CW3E precipitation observations ranged from ~1.1 inches at Portola (POR) to ~4.5 inches at Downieville (DLA).
- At **Downieville**, a total of ~4.5 inches represents ~29% of the total Water-Year-to-Date Precipitation



# CW3E Event Summary: 27 December 2022

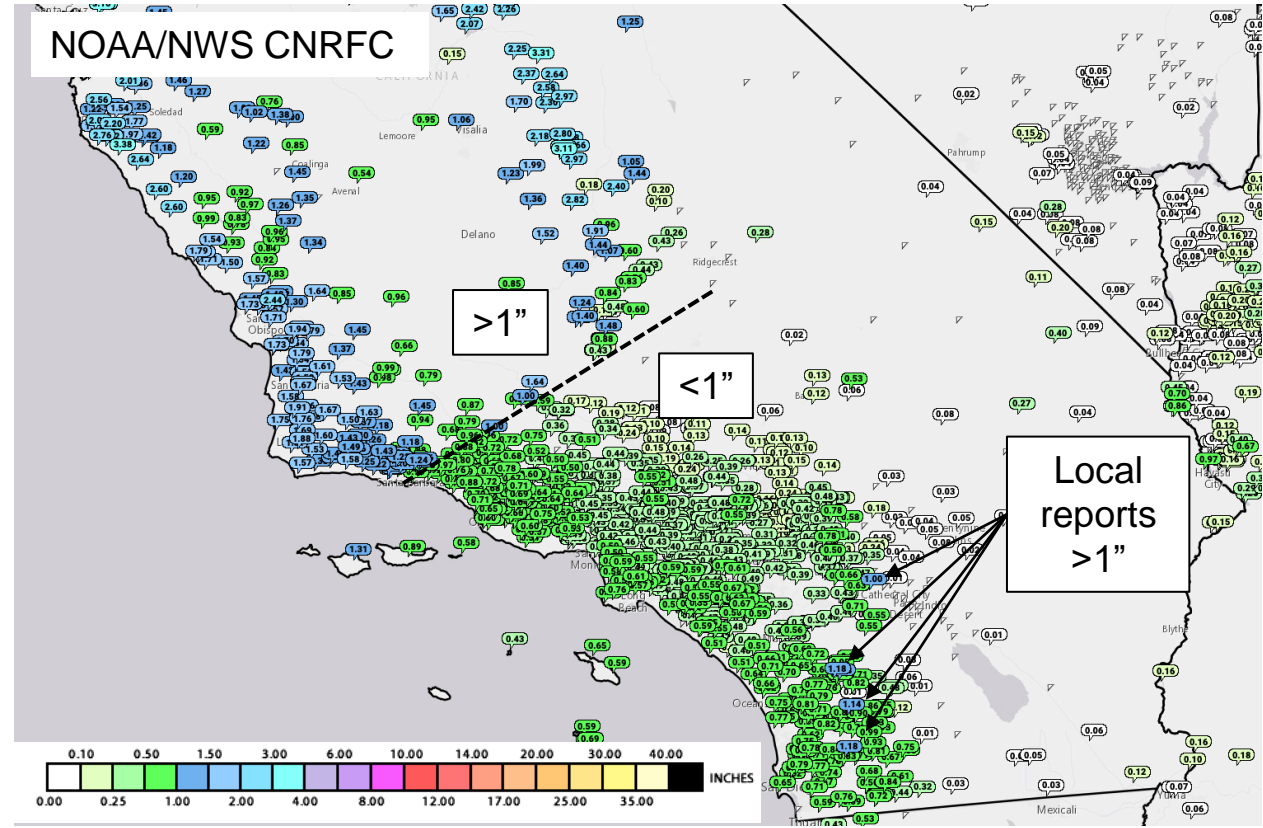
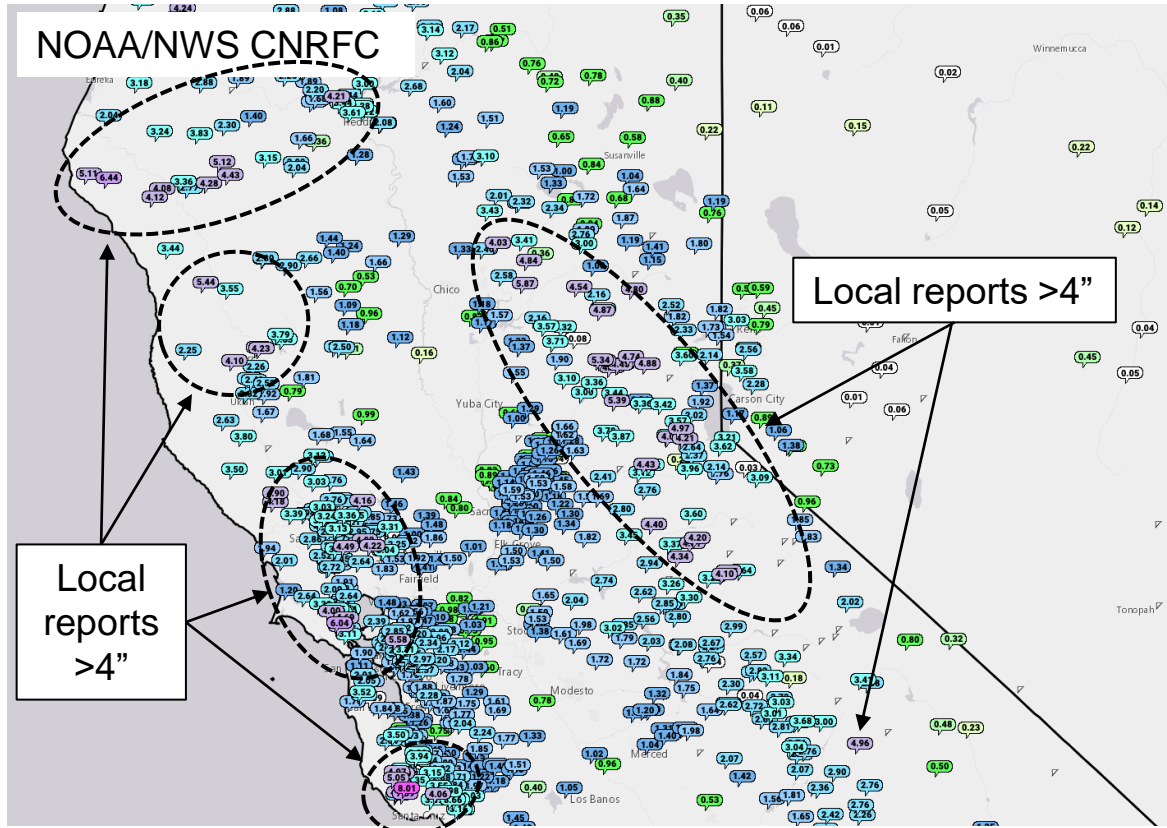
Seasonal precipitation in Northern Sierra 8 Station Index through 12/28



Current:	34.1%	1-day Δ:	5.07%	2-day Δ:	6.32%	3-day Δ:	6.32%
-----							
(1976/12/27)							
Rec_low:	4.2%	50-ptile:	0.34%	50-ptile:	0.64%	50-ptile:	0.97%
Typ_low:	18.0%	90-ptile:	2.62%	90-ptile:	4.30%	90-ptile:	5.94%
Mean:	34.3%	95-ptile:	3.54%	95-ptile:	6.04%	95-ptile:	7.93%
Typ_high:	55.3%	99-ptile:	5.75%	99-ptile:	9.74%	99-ptile:	12.30%
Rec_high:	76.8%	Record:	13.55%	Record:	20.79%	Record:	27.25%
(1983/12/27)		(1964/12/22)		(1964/12/23)		(1964/12/23)	

- Latest precipitation totals have brought the Northern Sierra 8 Station Index to near normal for the end of December; so far accumulating 34.3% of the average total seasonal precipitation
- The 1-day precipitation on 27 December represented ~5% of the average seasonal total, which is a daily total in the ~98<sup>th</sup> percentile
- The 2-day precipitation ending on 27 December represented ~6.3% of the average seasonal total, which is a two-day total in the ~95<sup>th</sup> percentile

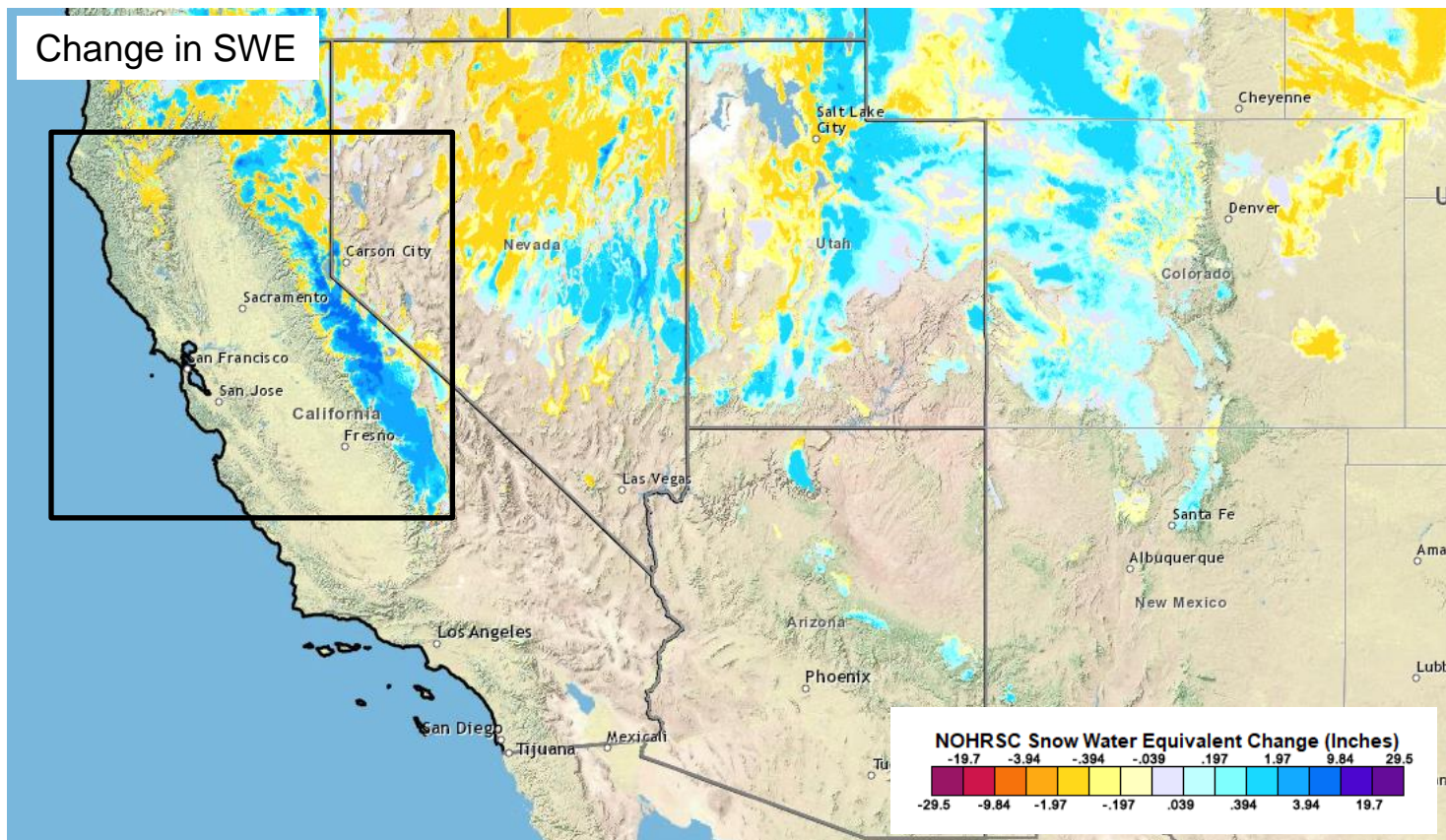
# CW3E Event Summary: 27 December 2022



## 48-hour precipitation reports provided by NOAA/NWS California–Nevada River Forecast Center:

- Maximum totals >4–6" across the Sierra and Coastal Mountains north/south of Bay Area
- Southern California precipitation generally <1" south/east of Transverse Ranges
- Highest totals at Bonny Doon FS – Martin Rd (BONC1) near Santa Cruz at 8.01"

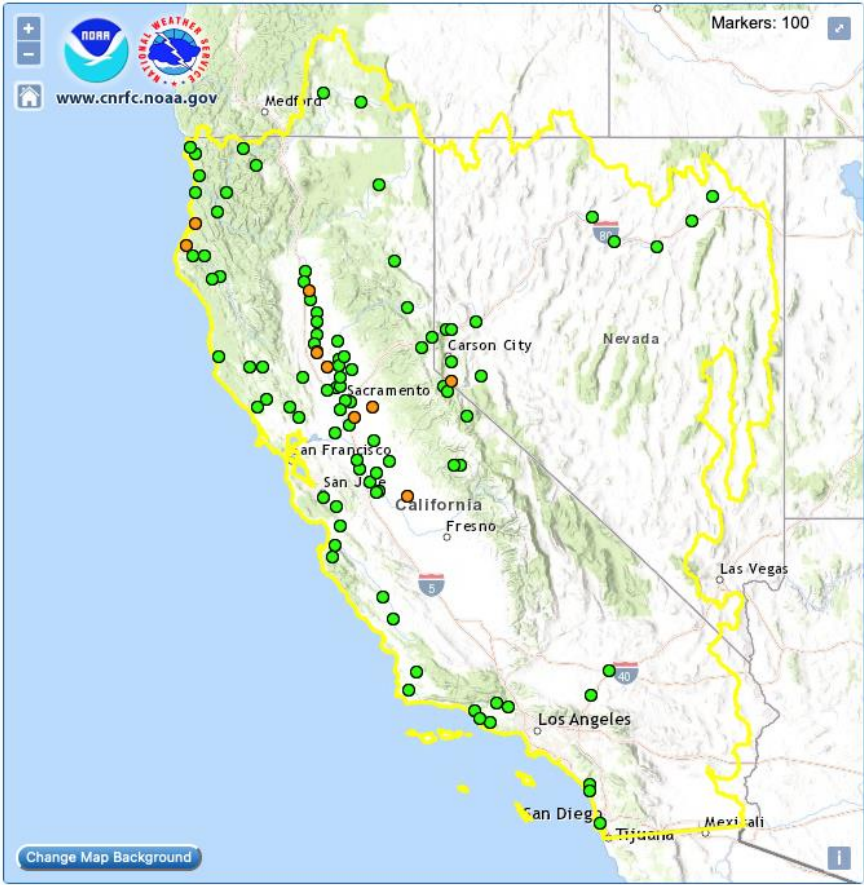
# CW3E Event Summary: 27 December 2022



## NOHRSC change in Snow-Water Equivalent (inches)

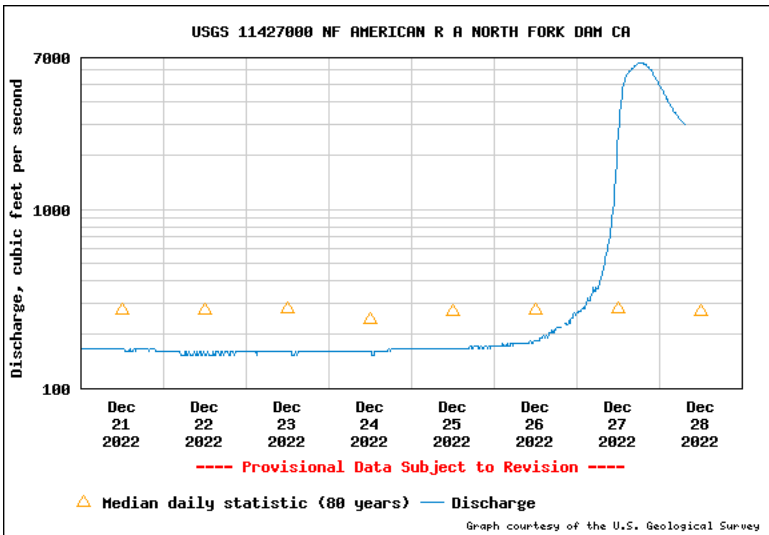
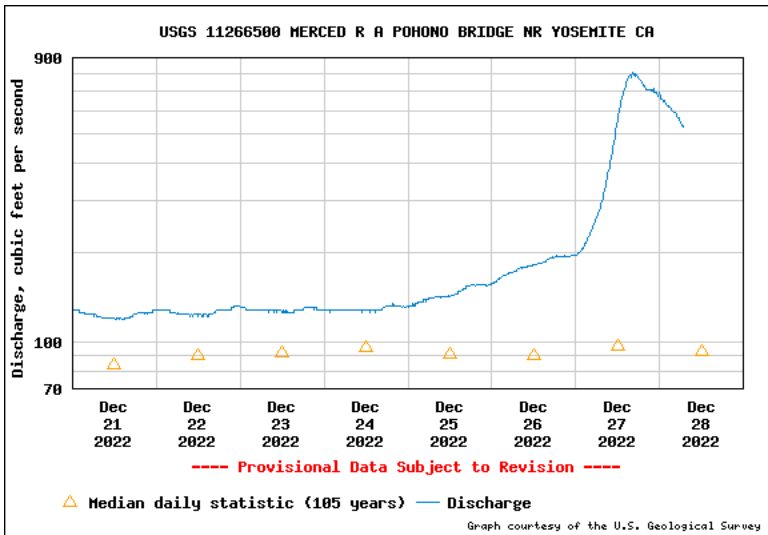
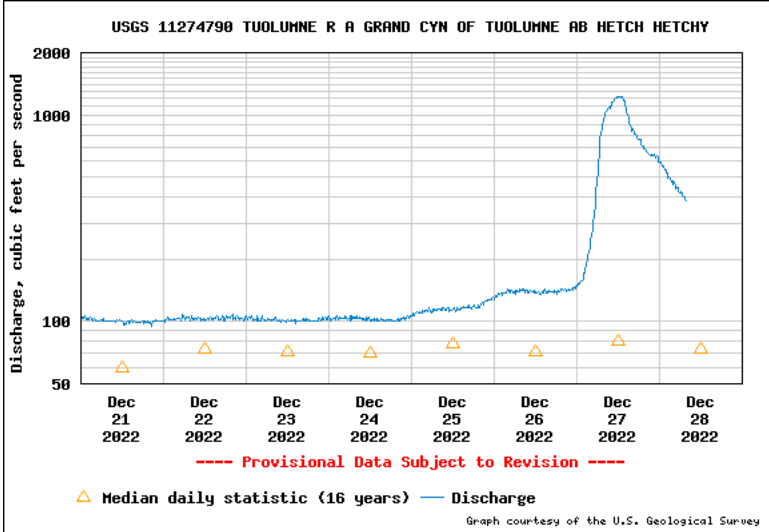
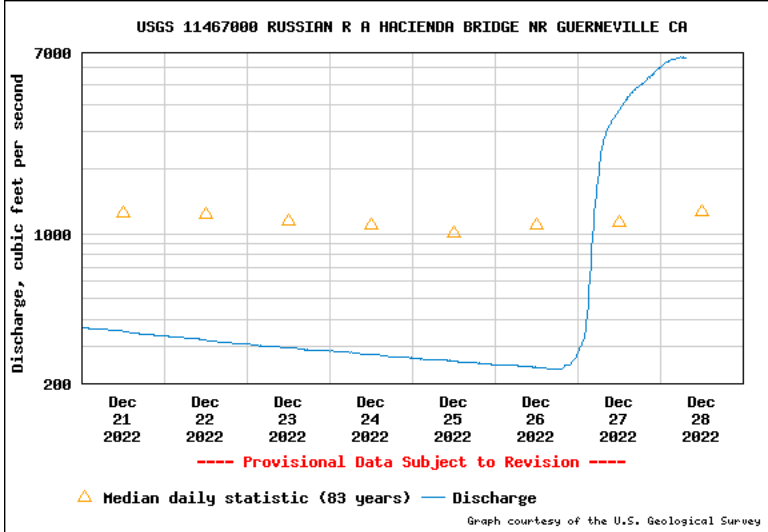
- Elevated melting levels in the Sierra foothills >11kft led to reductions in snow water equivalent (SWE) at middle elevations across northern California and eastward into Great Basin/Utah
- Snow levels across higher elevations in the Sierra dropped to ~7kft resulting in net gain in SWE
- Additional locations across the interior in the Wasatch high elevations and Upper Colorado gained SWE
- SWE continues to remain well above season-to-date normal in the Sierra (100–200+ percent)

# CW3E Event Summary: 27 December 2022

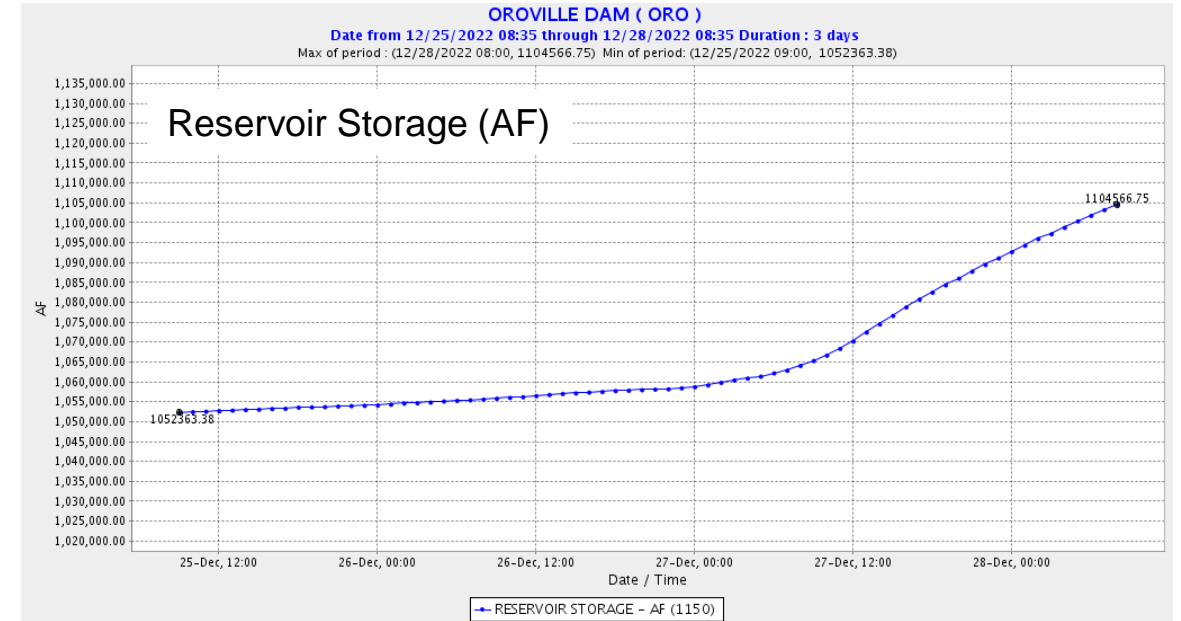
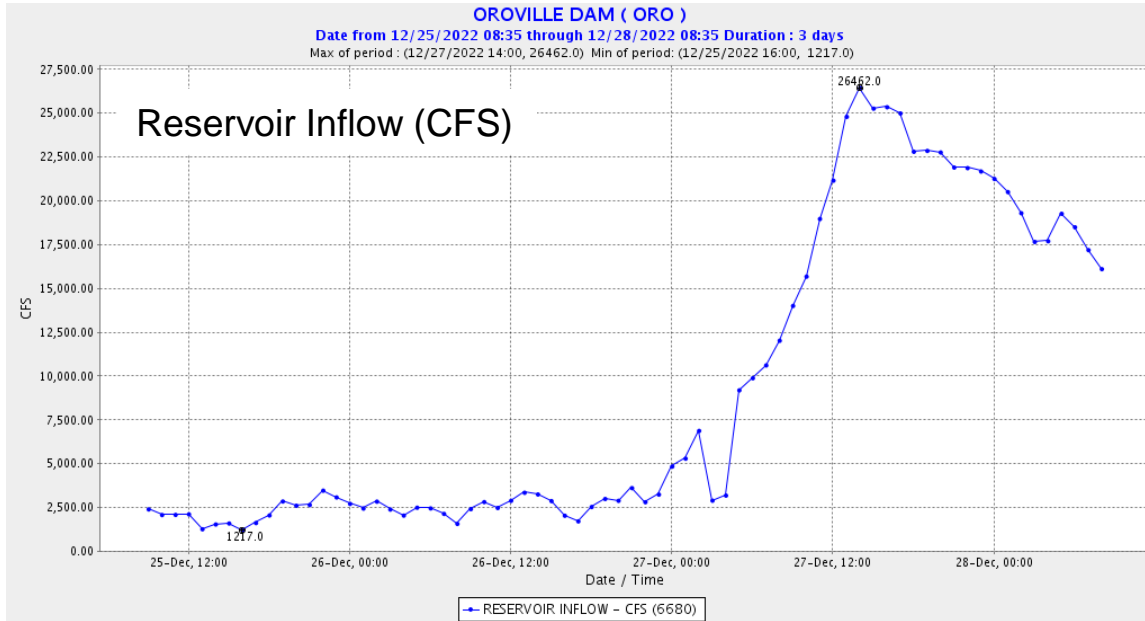


The number inside each circle above represents the number of gages with forecast conditions inside that category.

Several rivers peaked above monitor stage, but remained below flood stage across California



# CW3E Event Summary: 27 December 2022



## Oroville Reservoir Levels (above)

- Enhanced runoff due to rain and snow melt in the Feather River Basin led to increases in inflow at Lake Oroville at 12:00AM PST 27 December, peaking at ~26.5kcfs at 2:00 PM PST 27 December.
- Oroville storage increased ~100 TAF, representing an ~10% increase in storage.
- Oroville has a capacity of ~3.5 MAF and is currently only ~31.6% full.

## New Bullards Bar (not shown)

- New Bullards Bar in Yuba River Basin increased its storage by ~18 TAF, representing an ~3% increase in storage. New Bullards Bar is currently ~61% full.

# CW3E Event Summary: 27 December 2022

Westbound I-580  
in Oakland  
*SF Chronicle*



Salinas  
*Associated Press*



While riverine flooding was minimal during this AR, the heavy precipitation resulted in urban flooding across portions of California, making for difficult travel

# CW3E Event Summary: 27 December 2022



CHP Truckee @CHP\_Truckee · 5h

❄️ CHAIN CONTROL UPDATE ❄️

12/28/22 6:45am

- I-80 westbound is R2 from the Donner Lake Interchange to Eagle Lakes.
- I-80 eastbound is R2 from Kingvale to Truckee.
- SR-267 is R2 from Northstar to Kings Beach.
- SR-28 is R2 from Tahoe City to Kings Beach.

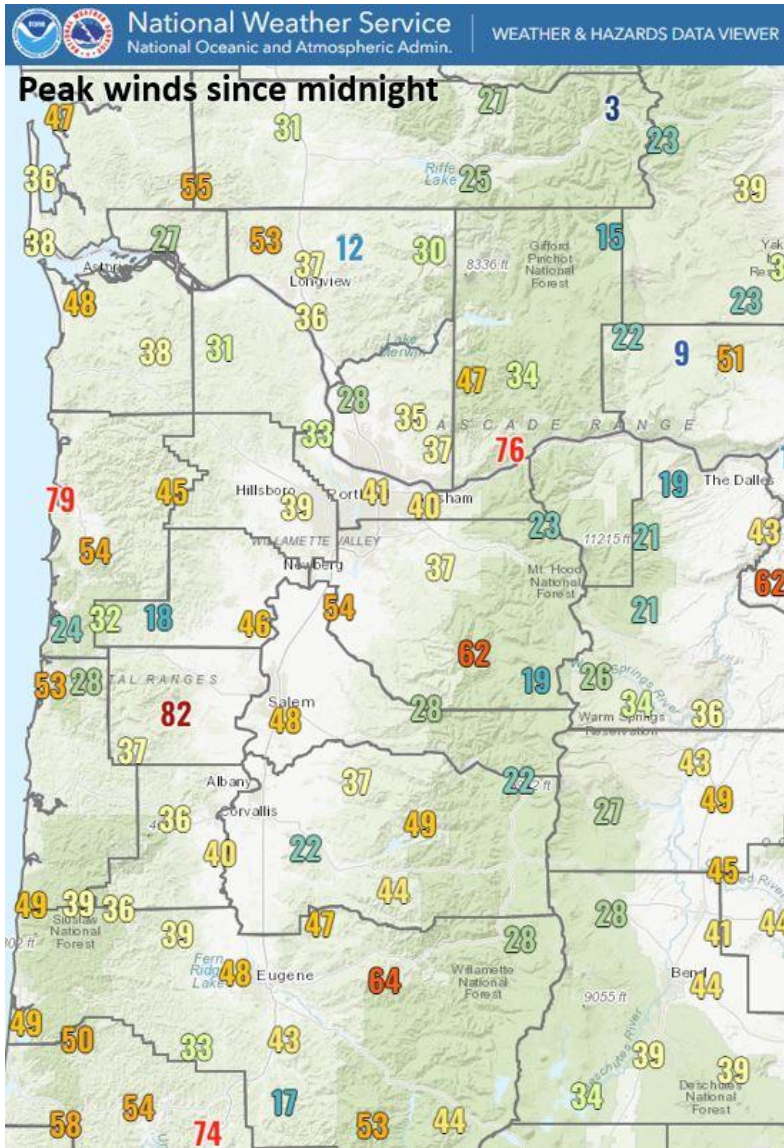


- Lowering snow-levels towards end of AR resulted in accumulating snow down to mountain passes, resulting in difficult travel conditions
- Strong winds (>100 mph) and heavy snow at mountain peaks resulted in whiteout conditions, closing several ski lifts around Tahoe





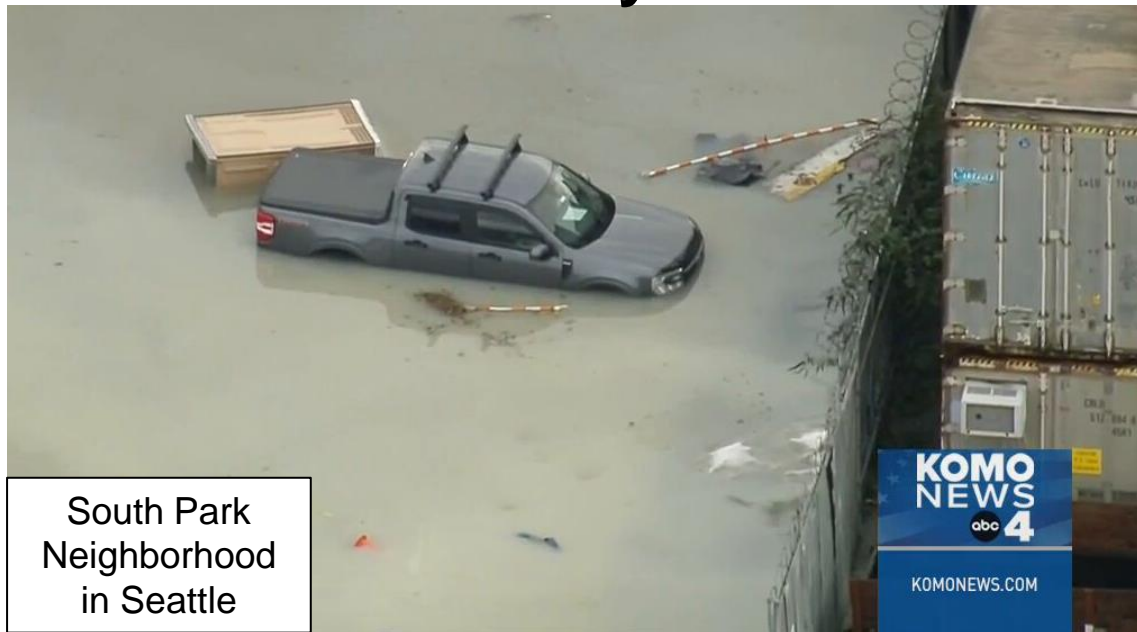
# CW3E Event Summary: 27 December 2022



- As AR was impacting California, the strong parent low-pressure system brought strong winds to a large swath of Pacific Northwest
- Several Locations measured wind gusts over 60 mph leading to downed trees and power outages across the region



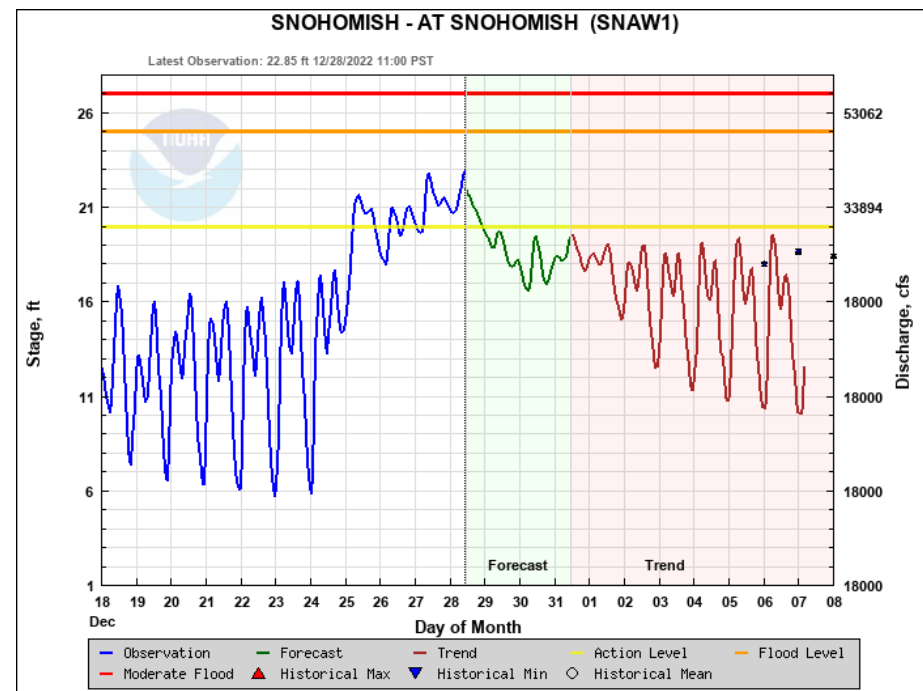
# CW3E Event Summary: 27 December 2022



South Park Neighborhood in Seattle



South Park Neighborhood in Seattle



## Coastal Flooding in Pacific Northwest

- Combination of storm surge, strong onshore wind, precipitation, and king tides led to coastal flooding in Washington and Oregon
- Snohomish River at Snohomish, WA crested at 24 feet, ~4 feet above action level