

# CW3E Atmospheric River Outlook: 27 Dec 2023

## Pair of Atmospheric Rivers Forecast to Make Landfall along US West Coast

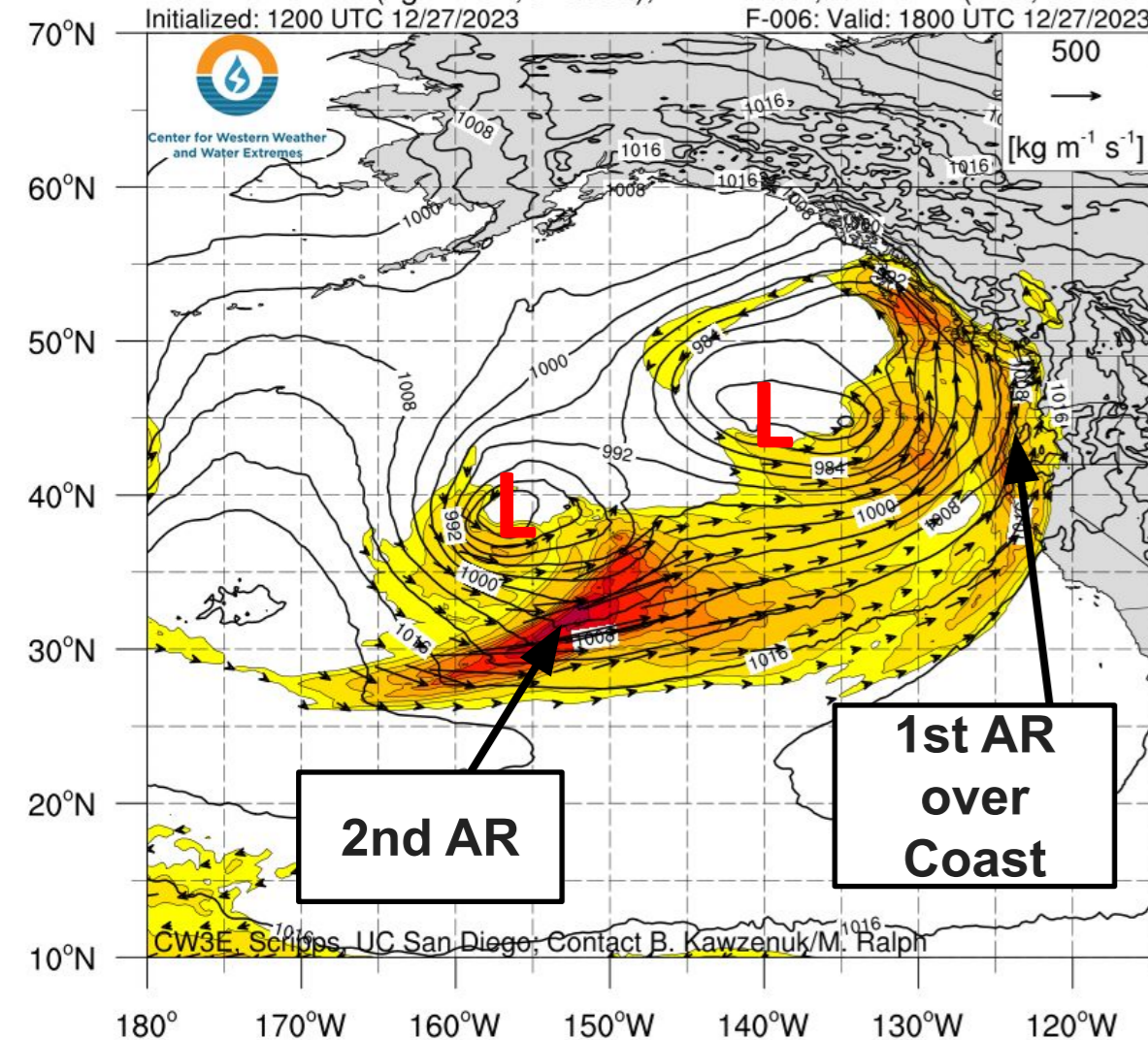
- A pair of Atmospheric Rivers (AR) are forecast to make landfall in the Pacific Northwest (PNW), with the first having already made landfall early Wed 27 Dec. AR conditions are forecast to continue through Sat 30 Dec.
- The GEFS control run is forecasting AR1 to AR3 conditions (based on Ralph et al. 2019 AR scale) for both ARs for the PNW.
- The GEFS control run is forecasting AR1 conditions for the first AR and AR1 to AR2 conditions for the second AR for Northern CA.
- There is uncertainty in the duration of AR conditions and possible break between ARs in the GFS and ECMWF model ensembles.
- The National Weather Service (NWS) Weather Prediction Center (WPC) is currently forecasting 3-day precipitation totals  $\geq 2$ " with highest precipitation totals over the Northern CA coast and CA/OR border.
- The WPC Excessive Rainfall Outlook (ERO) indicates a Marginal Risk (level 1 of 4, at least 5%) of exceeding flash flood guidance for Northern CA and the Southern OR coast for the 24-hour periods ending at 18Z on 30 Dec.

# CW3E AR Outlook: 27 Dec 2023

GFS Init 12Z Wed 27 Dec 2023

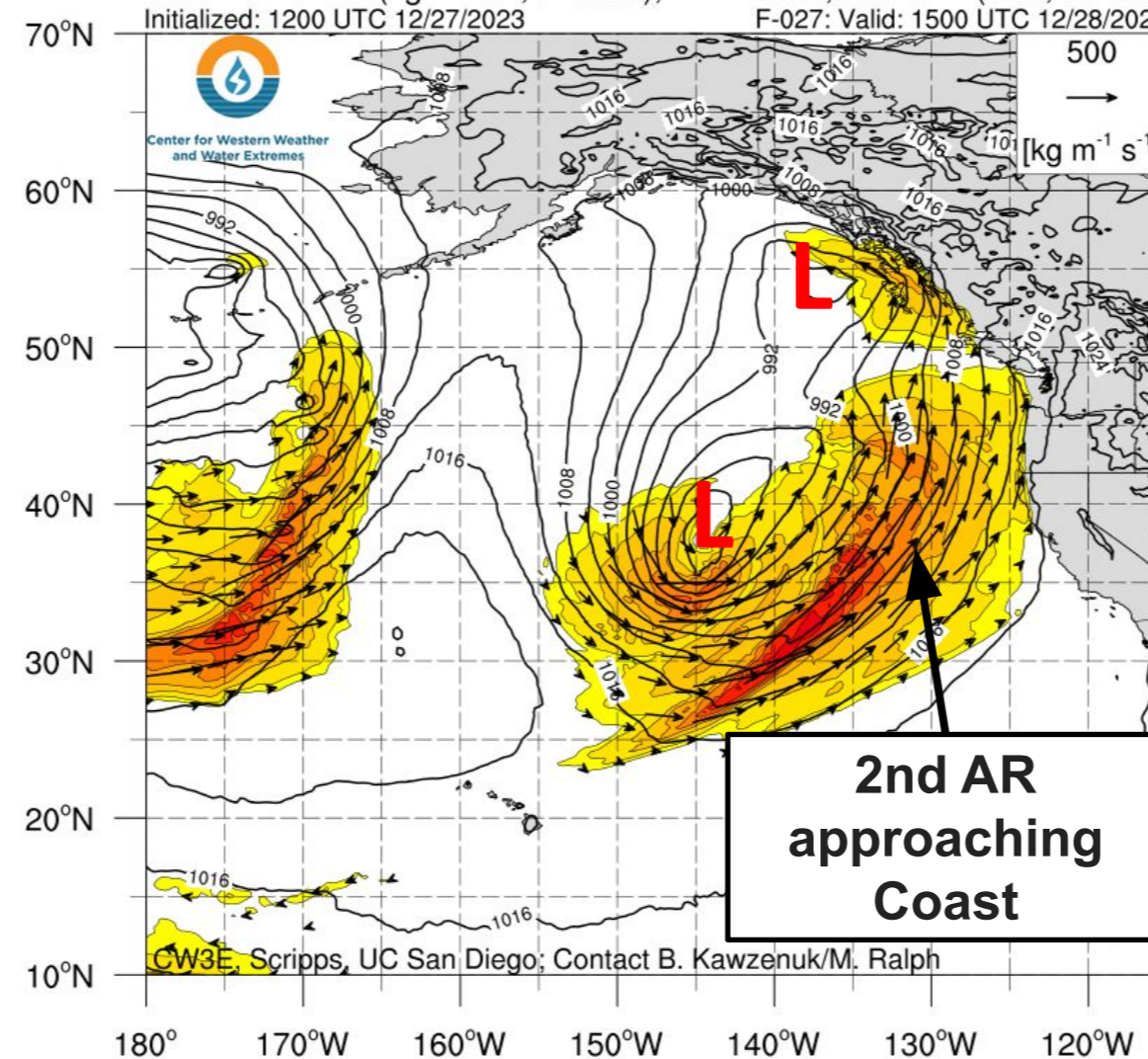
10AM PT Wed 27 Dec 2023

NCEP GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 1200 UTC 12/27/2023 F-006: Valid: 1800 UTC 12/27/2023



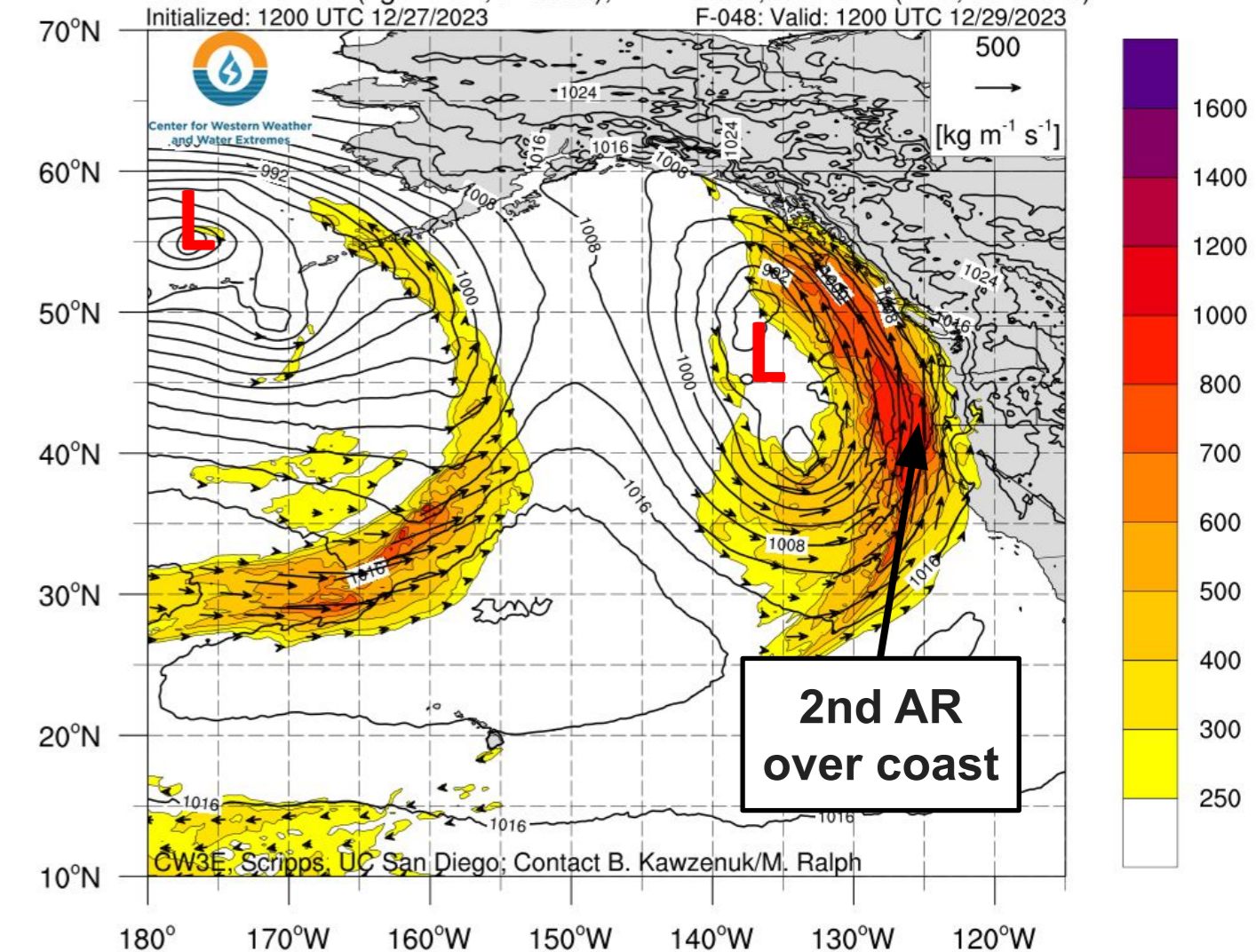
7AM PT Thu 28 Dec 2023

NCEP GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 1200 UTC 12/27/2023 F-027: Valid: 1500 UTC 12/28/2023



4AM PT Fri 29 Dec 2023

NCEP GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 1200 UTC 12/27/2023 F-048: Valid: 1200 UTC 12/29/2023

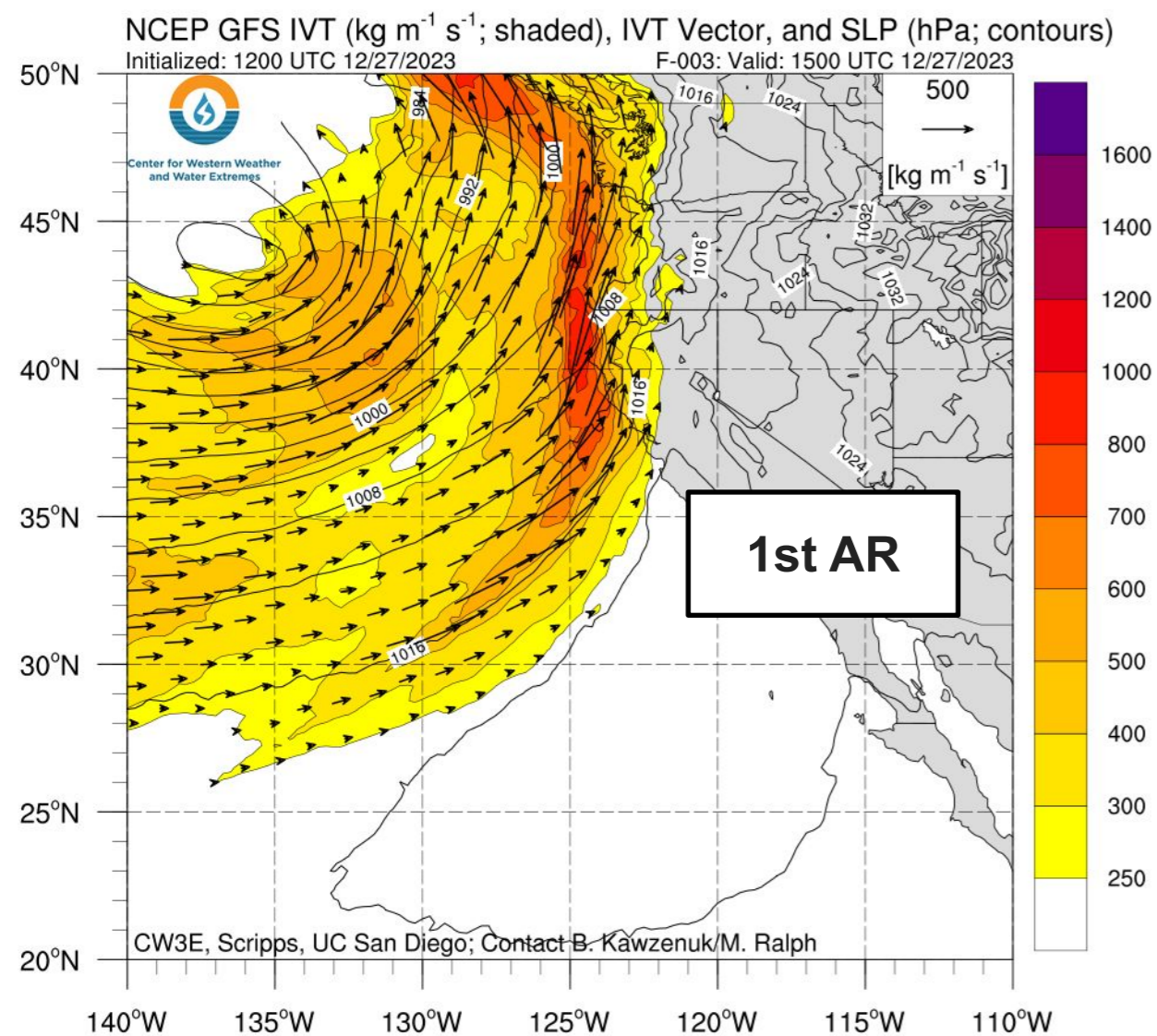


- The first AR made landfall in the PNW and Northern CA early Wed 27 Dec.
- AR conditions are forecast to continue through Wed 27 Dec into early Thu 28 Dec with a possible break in AR conditions late Thu.
- The second AR is forecast to make landfall on Fri 29 Dec and continue through Sat 30 Dec as the low pressure centers associated with the both ARs have merged and persist in the Gulf of Alaska.

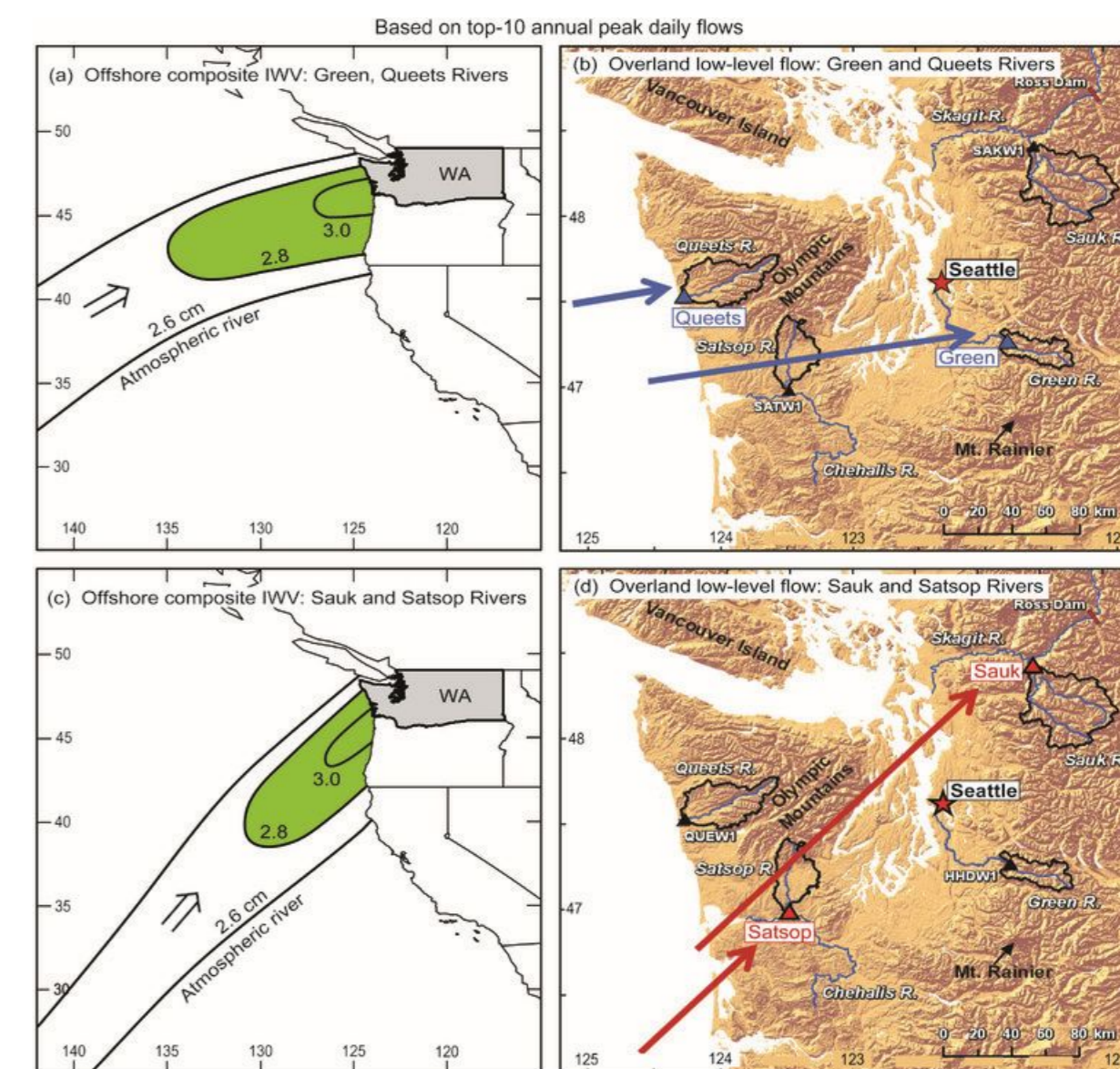
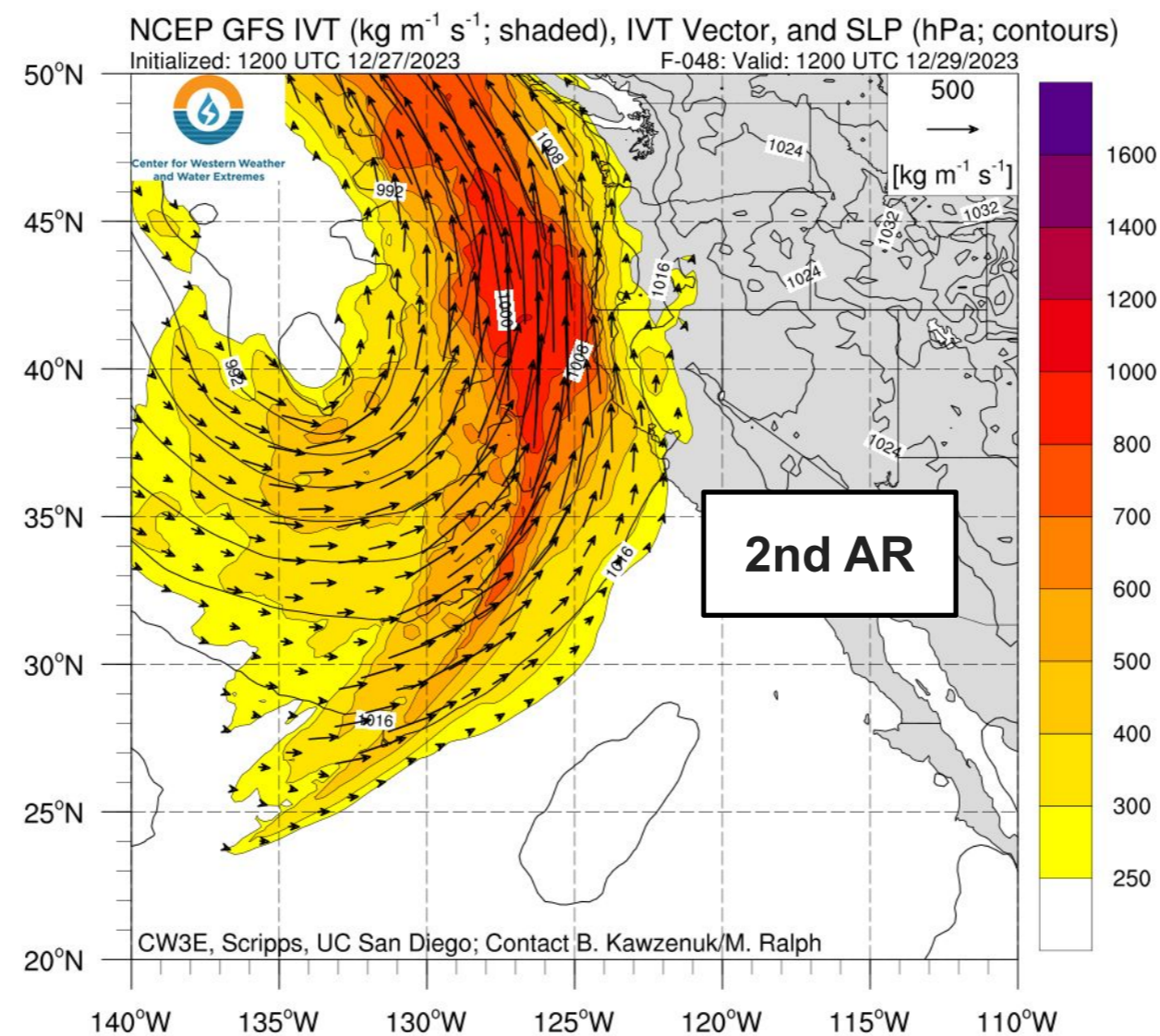
# CW3E AR Outlook: 27 Dec 2023

GFS Init 12Z Wed 27 Dec 2023

7AM PT Wed 27 Dec 2023



4AM PT Fri 29 Dec 2023



Adapted from Fig. 15 of Neiman et al. (2011)

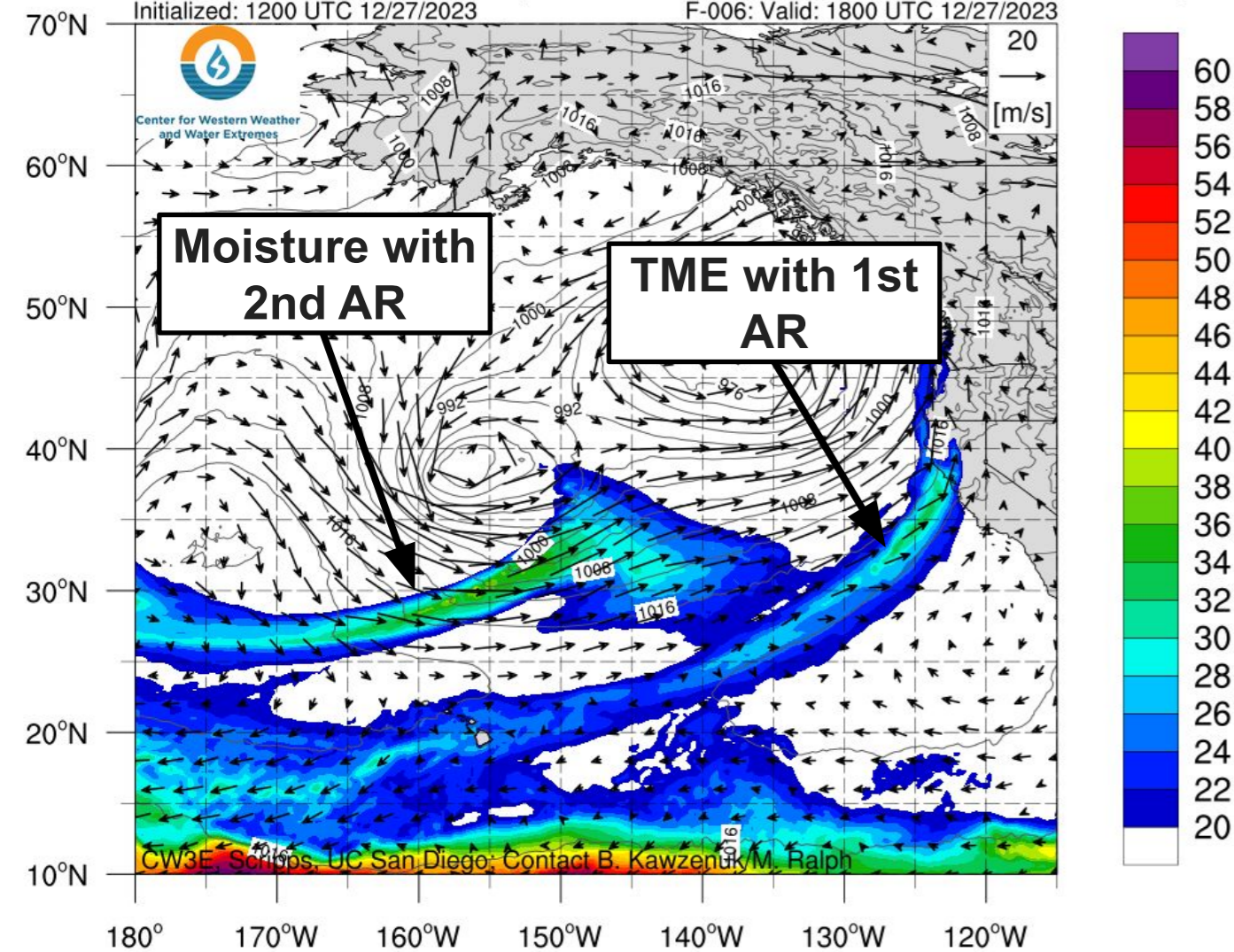
- Prior research by Neiman et al. (2011) found that the top-10 peak annual flows into the Green and Queets rivers (Fig a and b) and the Sauk and Satsop rivers (fig c and d) are associated with west-southwest to southwesterly moisture transport in an AR making landfall north of the high pressure into the PNW.
- Both the first and second ARs make landfall in suboptimal directions, limiting the precipitation potential with this event.

# CW3E AR Outlook: 27 Dec 2023

GFS Init 12Z Wed 27 Dec 2023

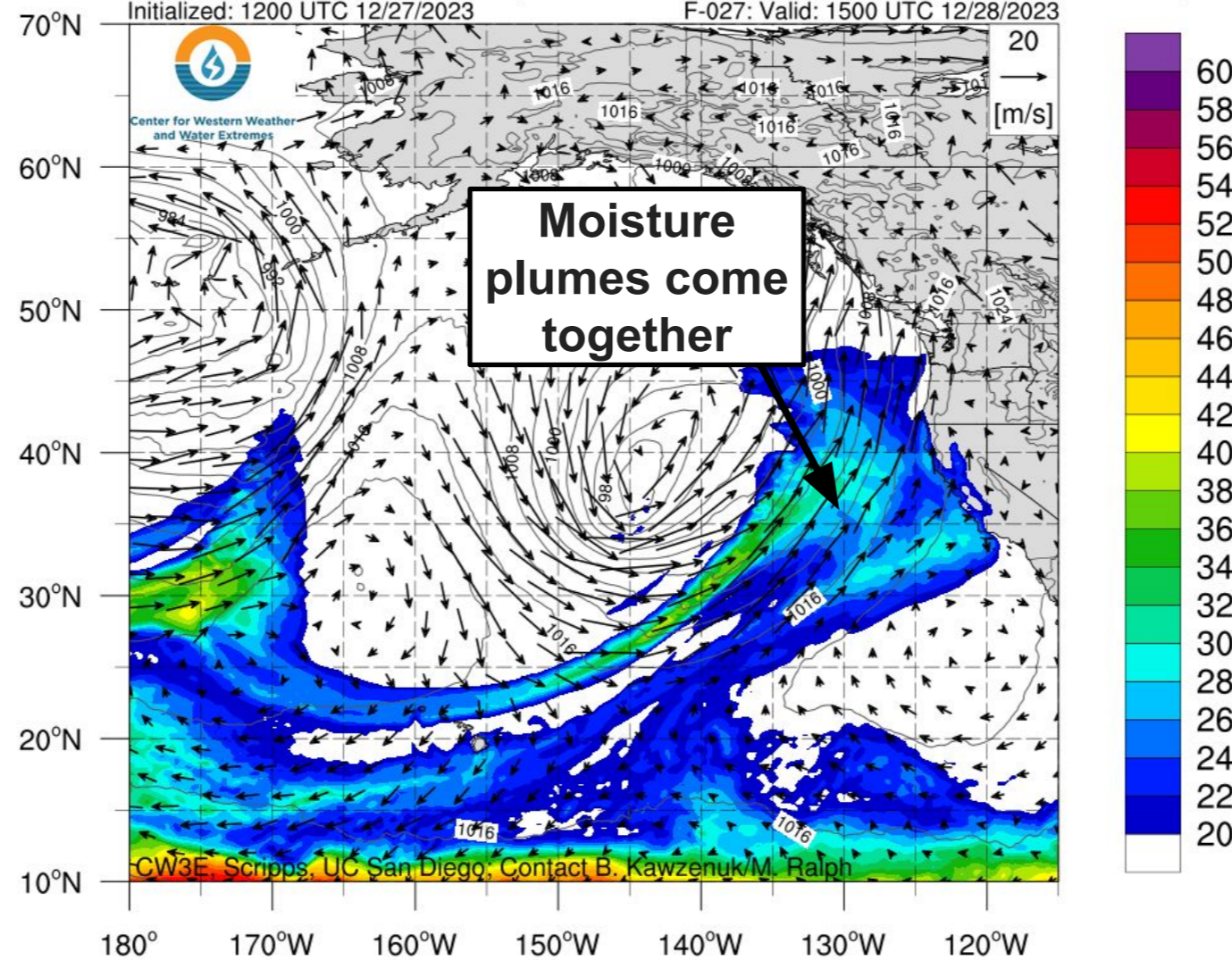
10AM PT Wed 27 Dec 2023

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 12/27/2023 F-006: Valid: 1800 UTC 12/27/2023



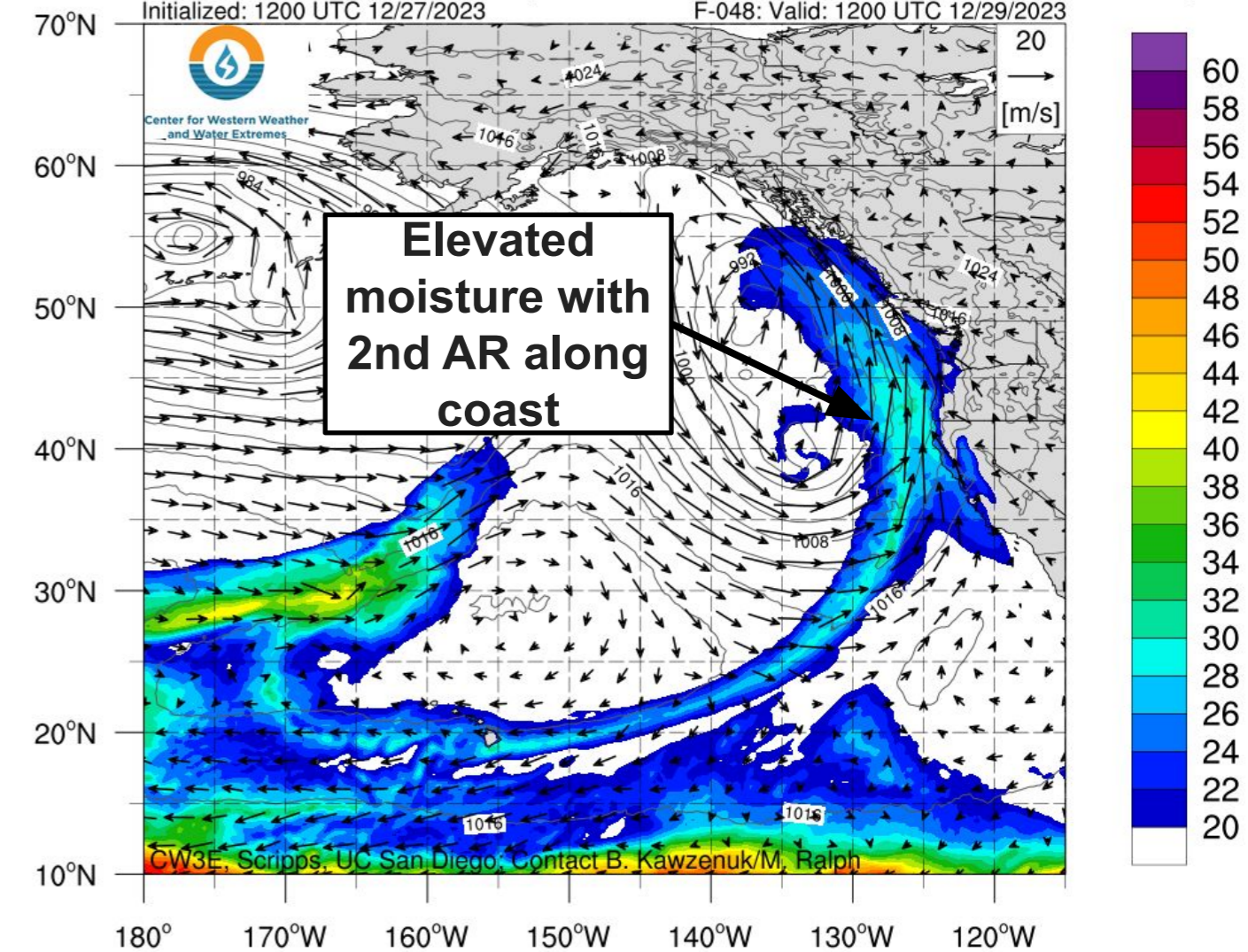
10PM PT Wed 27 Dec 2023

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 12/27/2023 F-027: Valid: 1500 UTC 12/28/2023



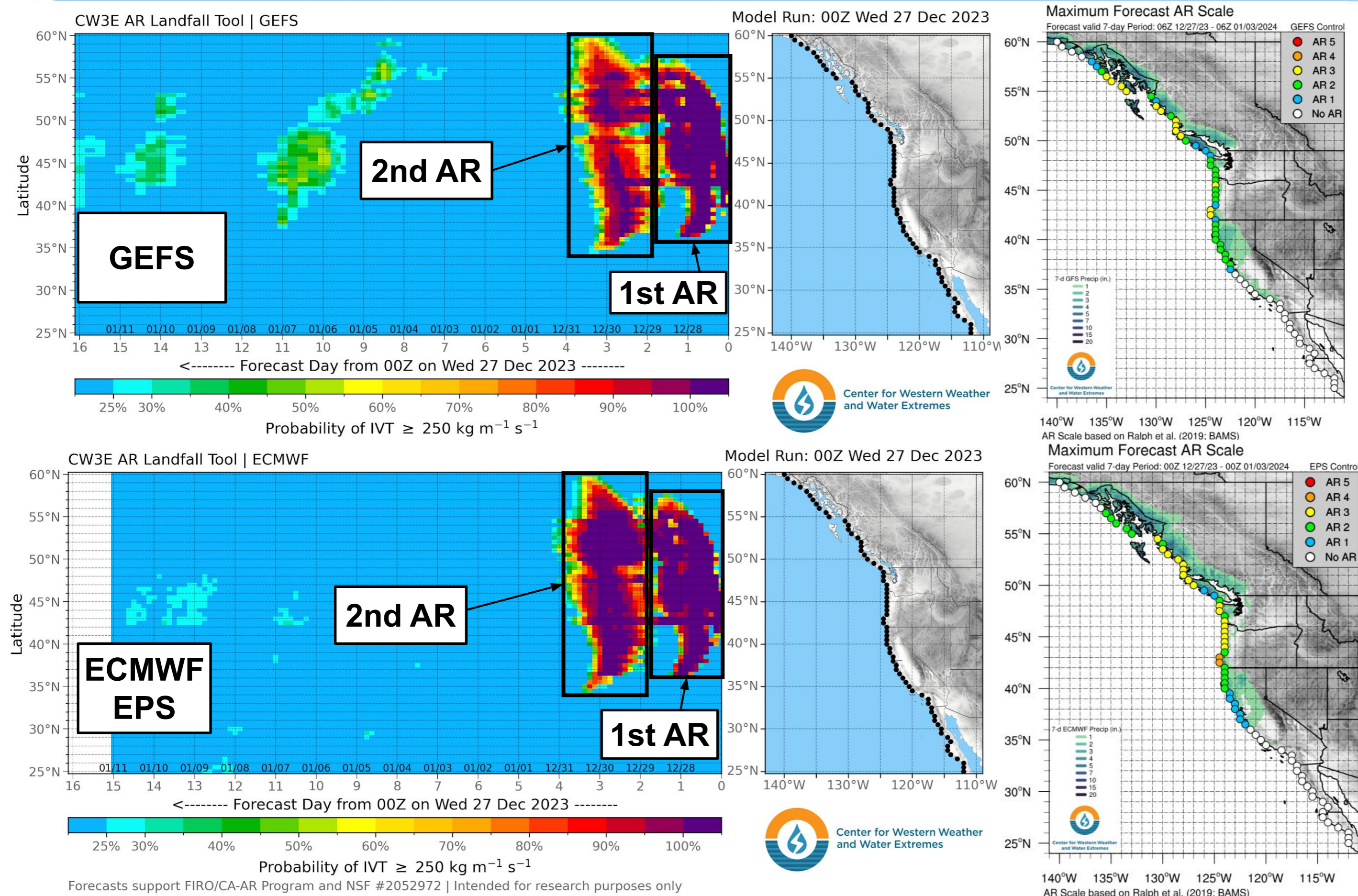
4AM PT Fri 29 Dec 2023

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 12/27/2023 F-048: Valid: 1200 UTC 12/29/2023



- The first AR is forecast to be associated with a tropical moisture export (TME) extending from Hawaii, with IWV > 30 mm in the core of the AR at landfall.
- The second AR is initially fed by moisture in the central Pacific but as it approaches the US West Coast, it merges with the TME of the first AR, helping to continue feeding moisture into the system

# CW3E AR Outlook: 27 Dec 2023



- The GEFS and ECMWF EPS show very high confidence in IVT  $> 250 \text{ kg m}^{-1} \text{ s}^{-1}$  over the North American West Coast for two ARs; the first from Wed 27 Dec through Thu 28 Dec, the second from Fri 29 Dec through Sat 30 Dec.
- ECMWF EPS has much higher confidence in IVT  $> 250 \text{ kg m}^{-1} \text{ s}^{-1}$  throughout the second AR.

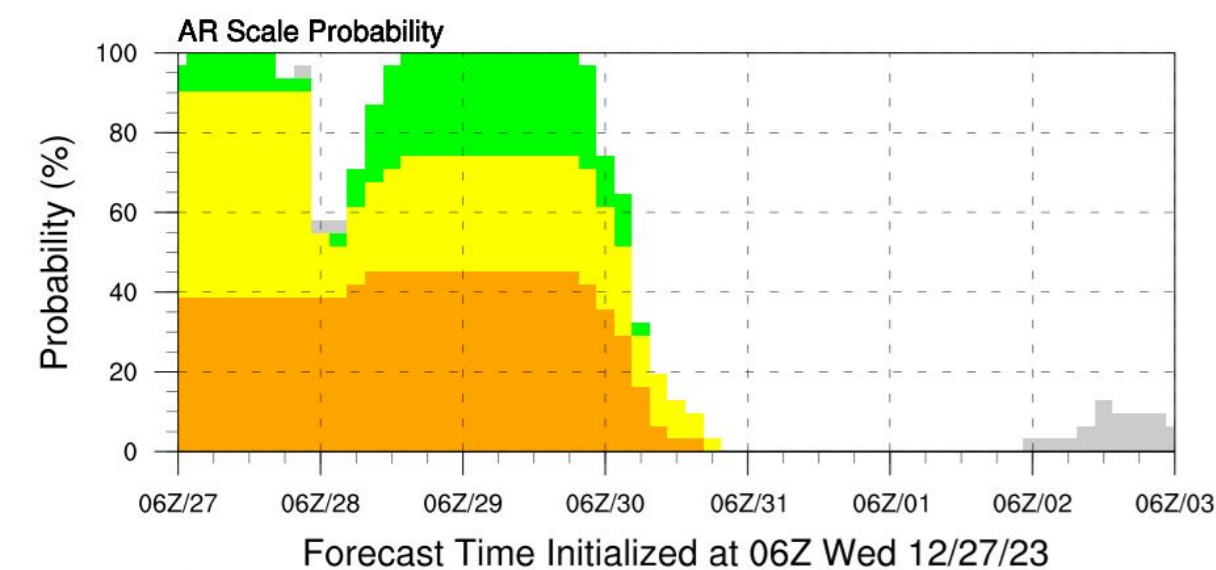
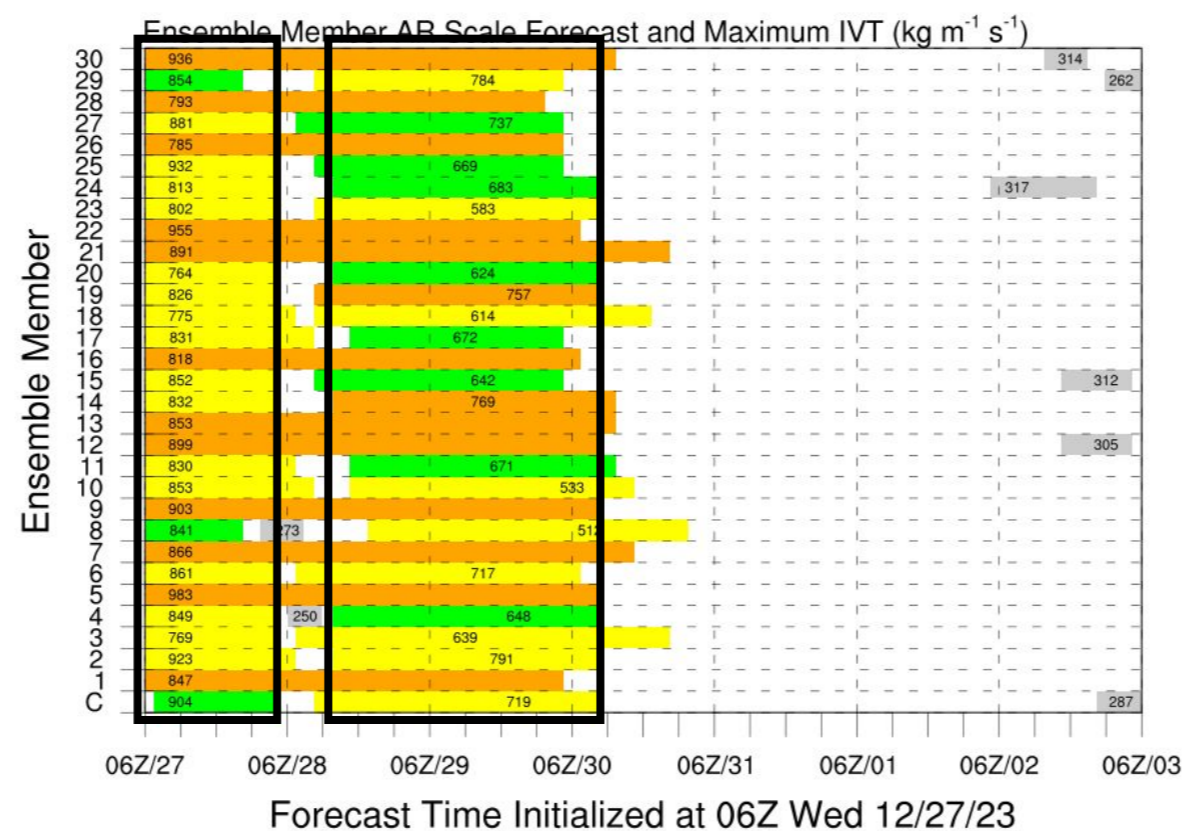
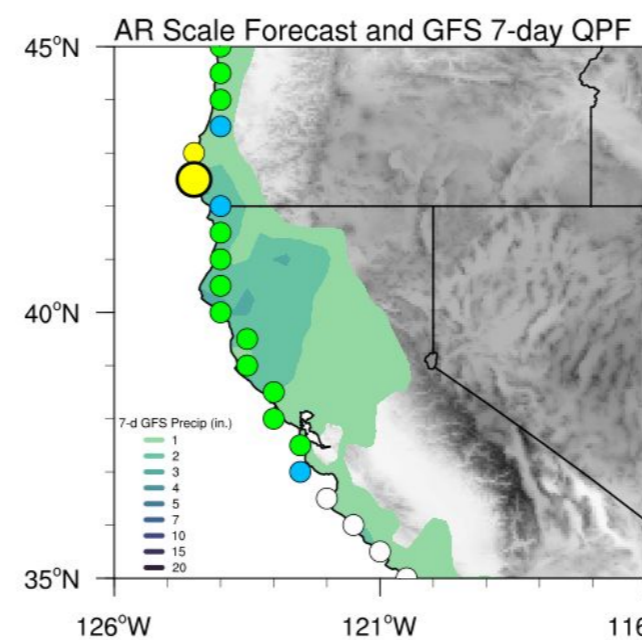
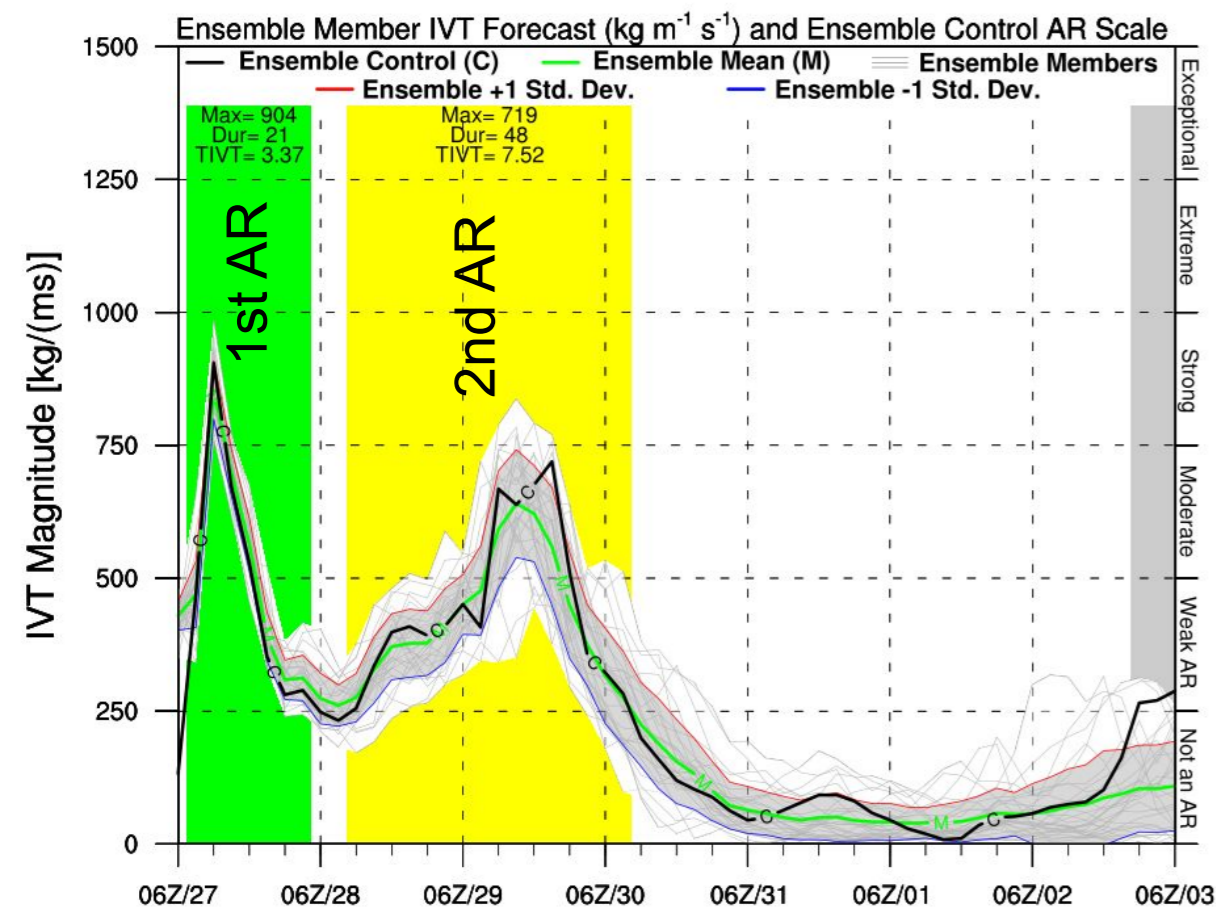
Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

# CW3E AR Outlook: 27 Dec 2023

## GEFS 7-day AR Scale and IVT Forecast

GEFS Ensemble Initialized: 06Z Wed 12/27/23

Location: 42.5°N 124.5°W



- The GEFS control member is forecasting two ARs for the point at 42.5° N, 124.5° W (coastal OR).
- 31/31 (100%) GEFS ensemble members are forecasting at least AR2 conditions for each AR.
- 28/31 (90%) of the members (including the control) are forecasting at least AR3 conditions during the first AR.
- 23/31 (74%) of the members (including the control) are forecasting at least AR3 conditions during the second AR.
- 12/31 (39%) of the members are not forecasting a break in AR conditions at this point.
- There is uncertainty in the duration of AR conditions amongst GEFS members.



AR 1 AR 2 AR 3 AR 4 AR 5

Image created: 12 UTC 12/27/2023

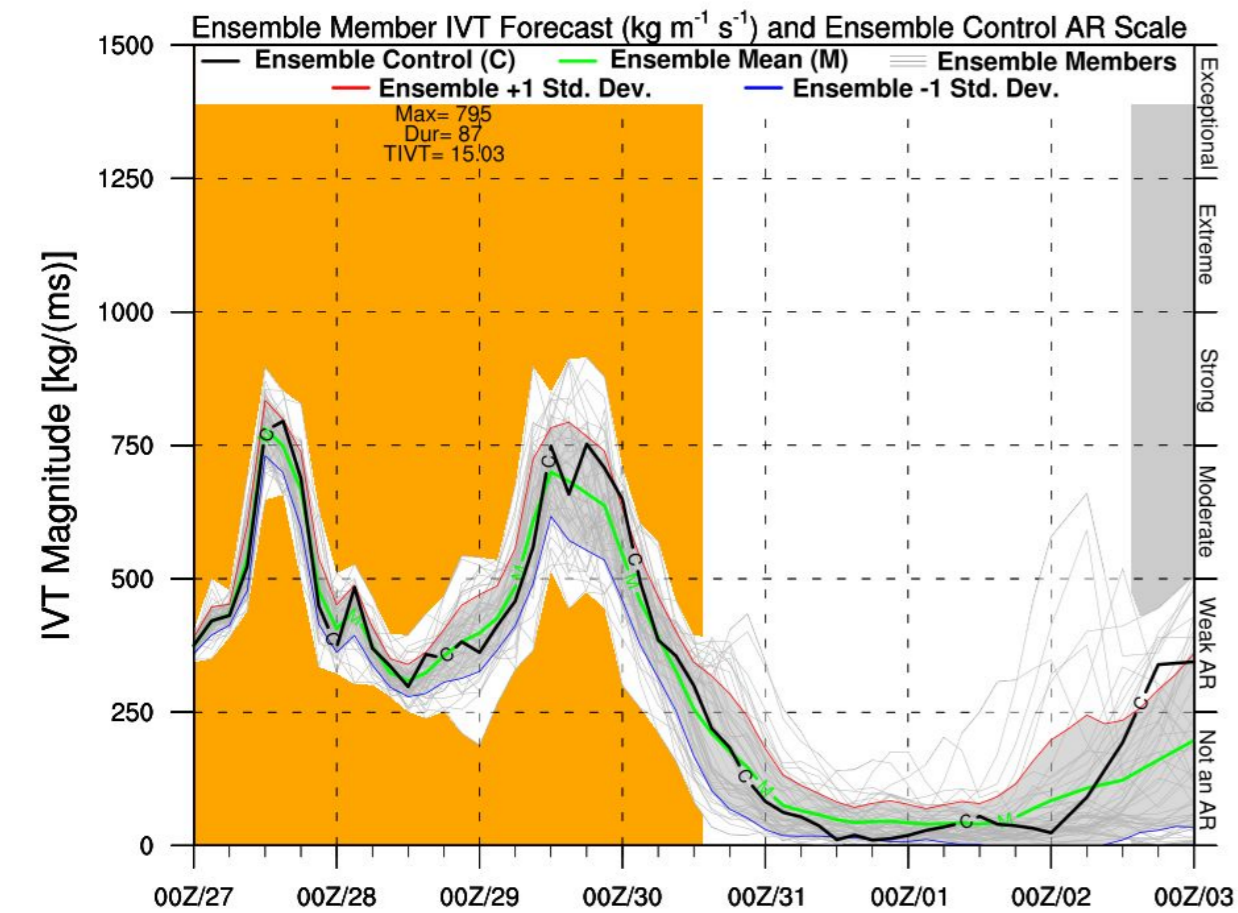
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

# CW3E AR Outlook: 27 Dec 2023

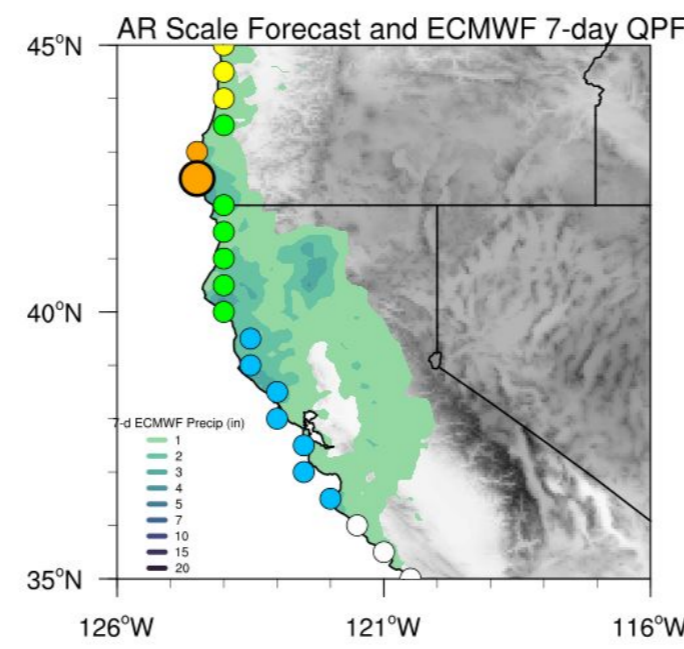
## ECMWF EPS 7-day AR Scale and IVT Forecast

ECMWF Ensemble Initialized: 00Z Wed 12/27/23

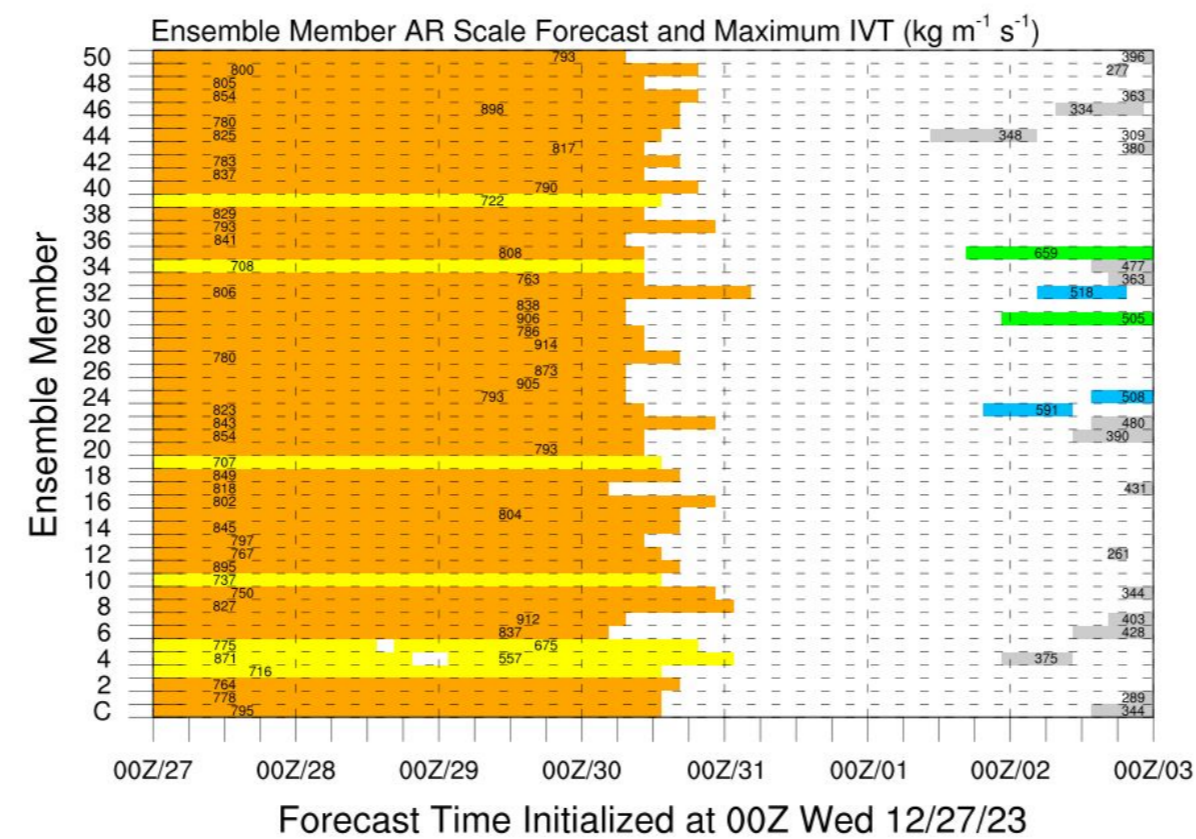
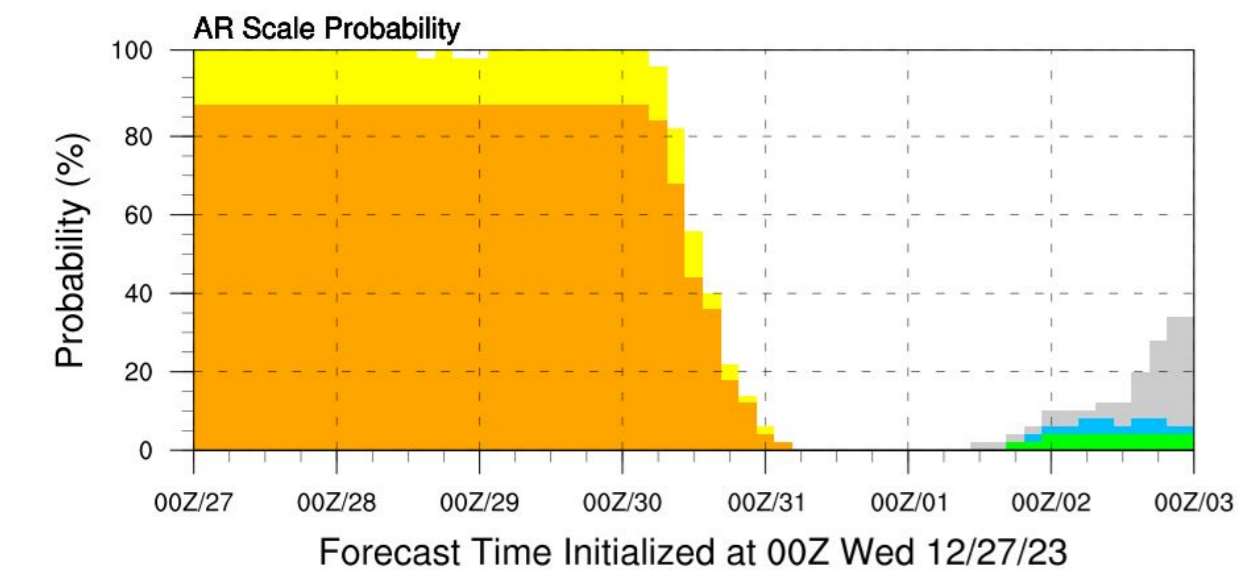
Location: 42.5°N 124.5°W



Categorical AR Strength by Ralph/CW3E



- The ECMWF EPS control member is forecasting a single AR for the point at 42.5° N, 124.5° W (coastal OR).
- 51/51 (100%) GEFS ensemble members are forecasting at least AR3 conditions.
- 2/51 (4%) of the members are forecasting a break in AR conditions at this point.
- There is uncertainty in the duration of AR conditions amongst ECMWF EPS members.



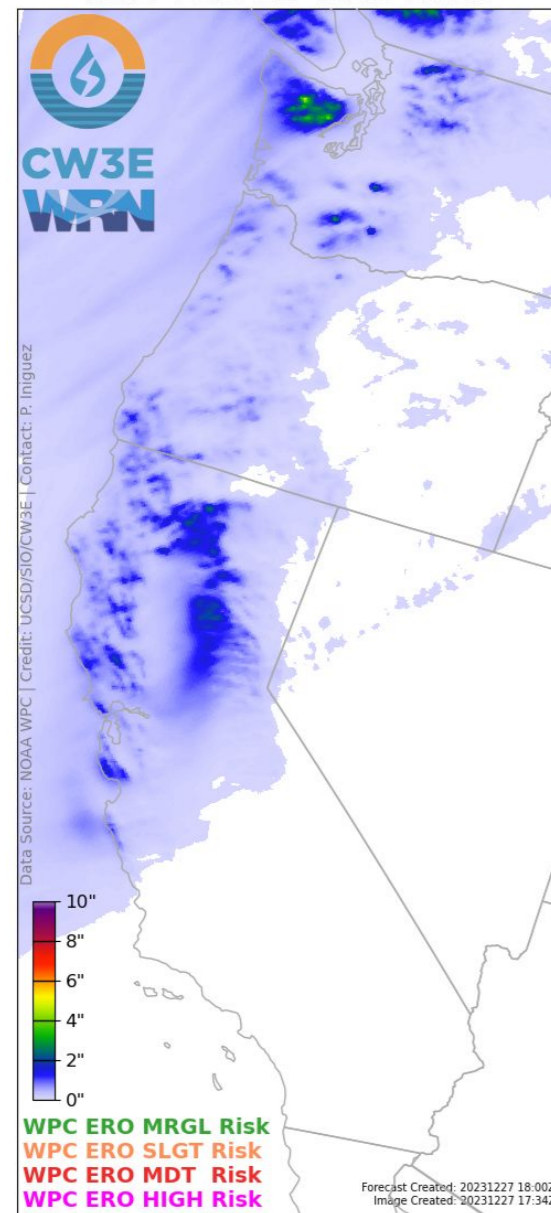
AR 1    AR 2    AR 3    AR 4    AR 5

Image created: 09 UTC 12/27/2023

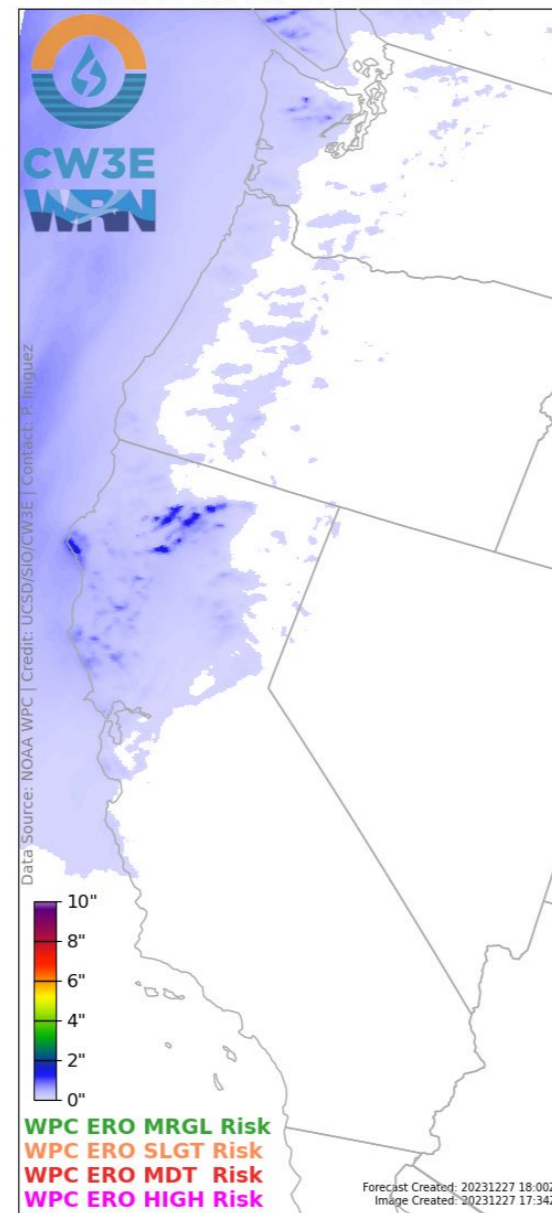
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# CW3E AR Outlook: 27 Dec 2023

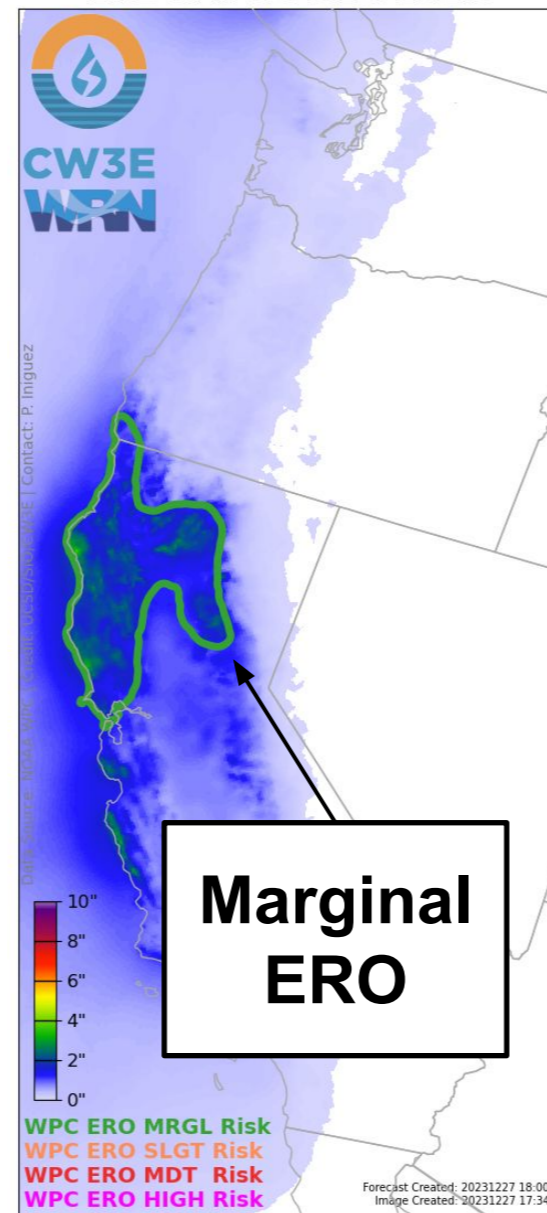
WPC 24hr Precip. Ending  
18Z THU 28 DEC 2023



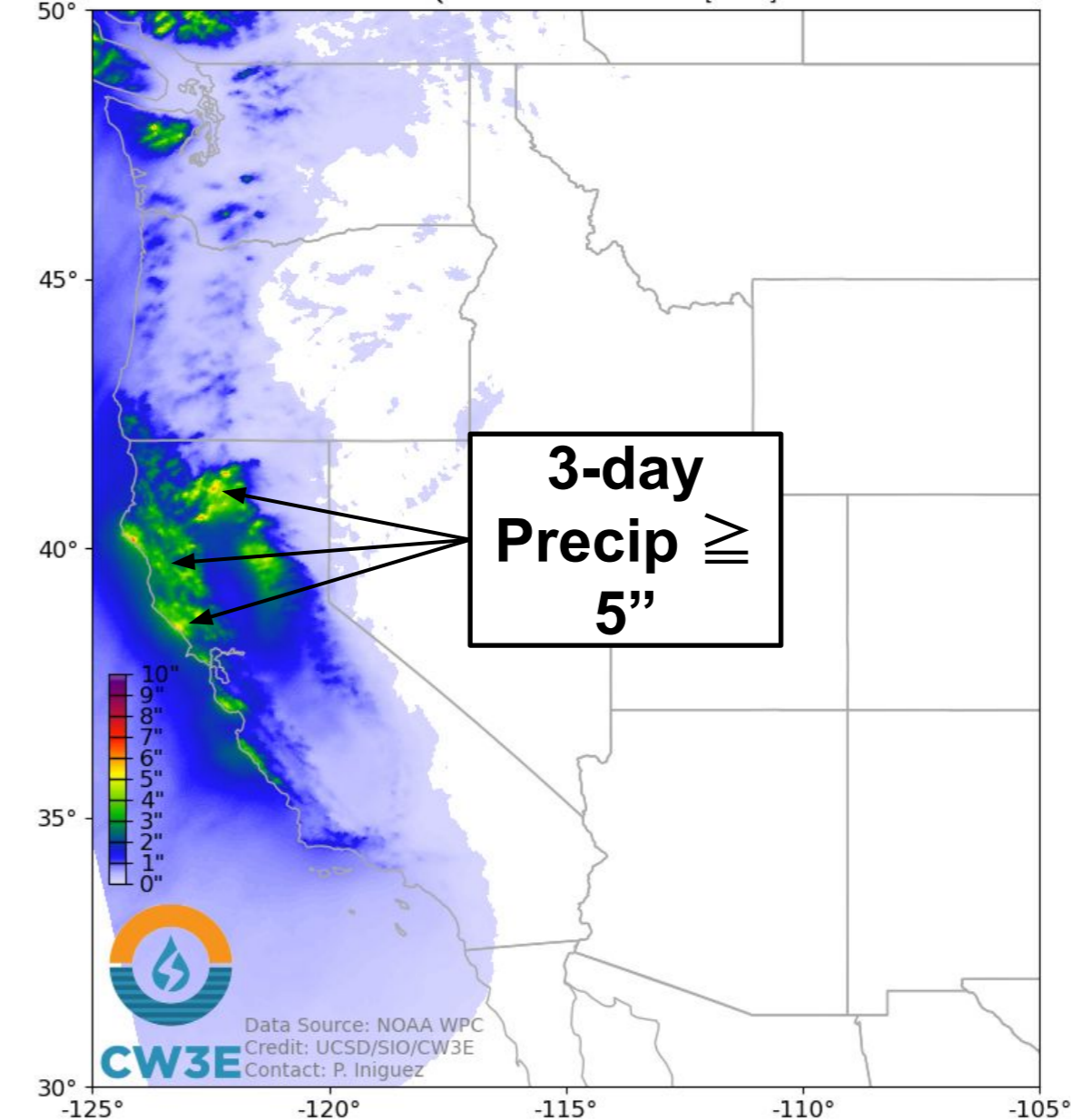
WPC 24hr Precip. Ending  
18Z FRI 29 DEC 2023



WPC 24hr Precip. Ending  
18Z SAT 30 DEC 2023



WPC 72hr Deterministic QPF  
Init: 18Z 27 DEC 2023  
[FH72] Valid: 18Z 30 DEC 2023



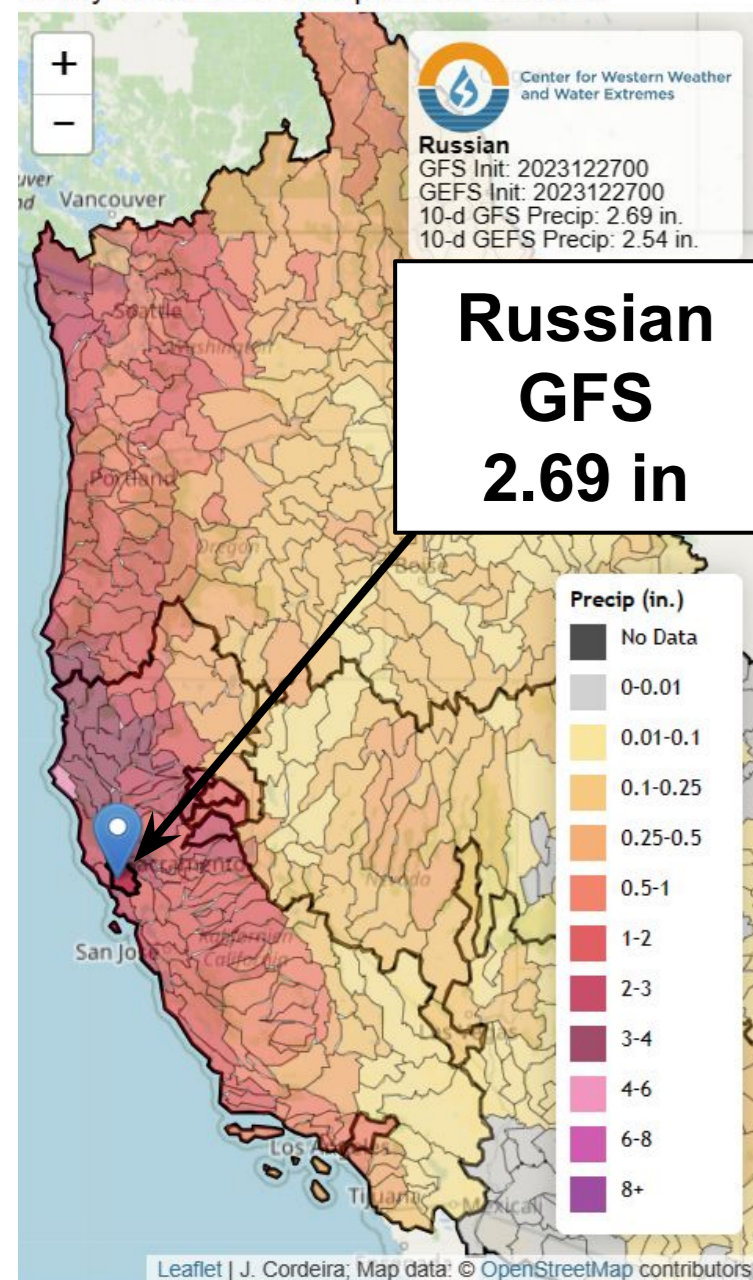
- The NWS WPC is forecasting precipitation totals  $\geq$  1 inch for regions along the Southern OR and Northern and Central CA coasts and into the Northern Sierra during the 24-hour periods ending at 12Z on 28 and 30 Dec.
- NWS WPC 3-day precipitation totals are forecast to exceed 2 inches for the same regions with the highest precipitation totals  $\geq$  5 inches in coastal Sonoma and Humboldt Counties as well as the Northern Sierras.
- A marginal risk (level 1 of 4, at least 5%) of exceeding flash flood guidance has been issued for Northern CA and the Southern OR coast for the 24-hour periods ending at 18Z on 30 Dec.



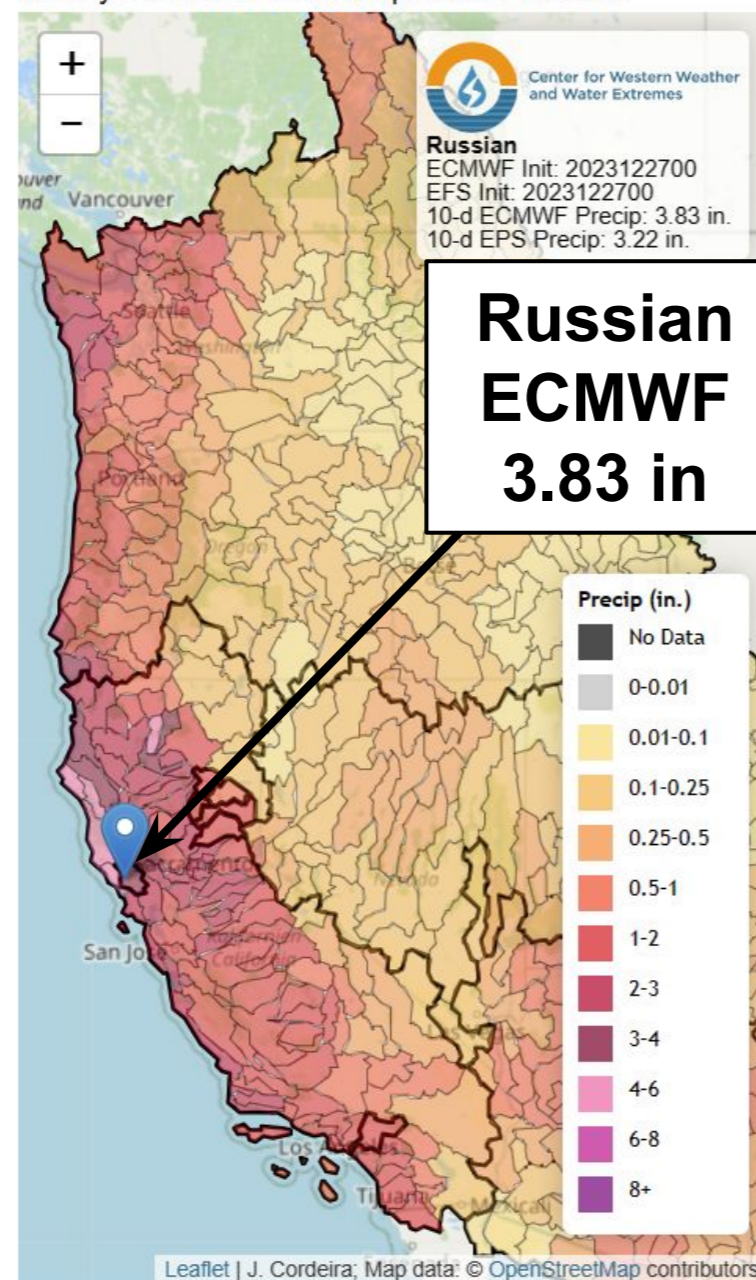
# CW3E AR Outlook: 27 Dec 2023

## 10-day Watershed Precipitation Forecasts (Initialized 00Z 27 Dec)

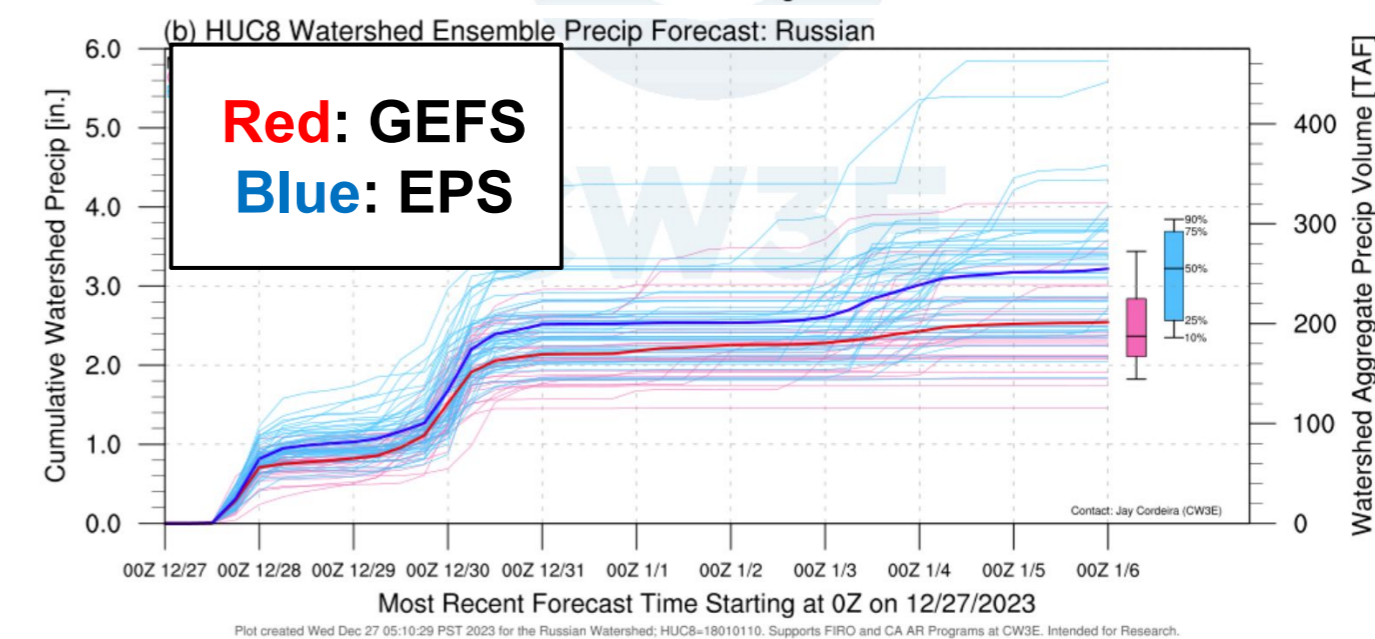
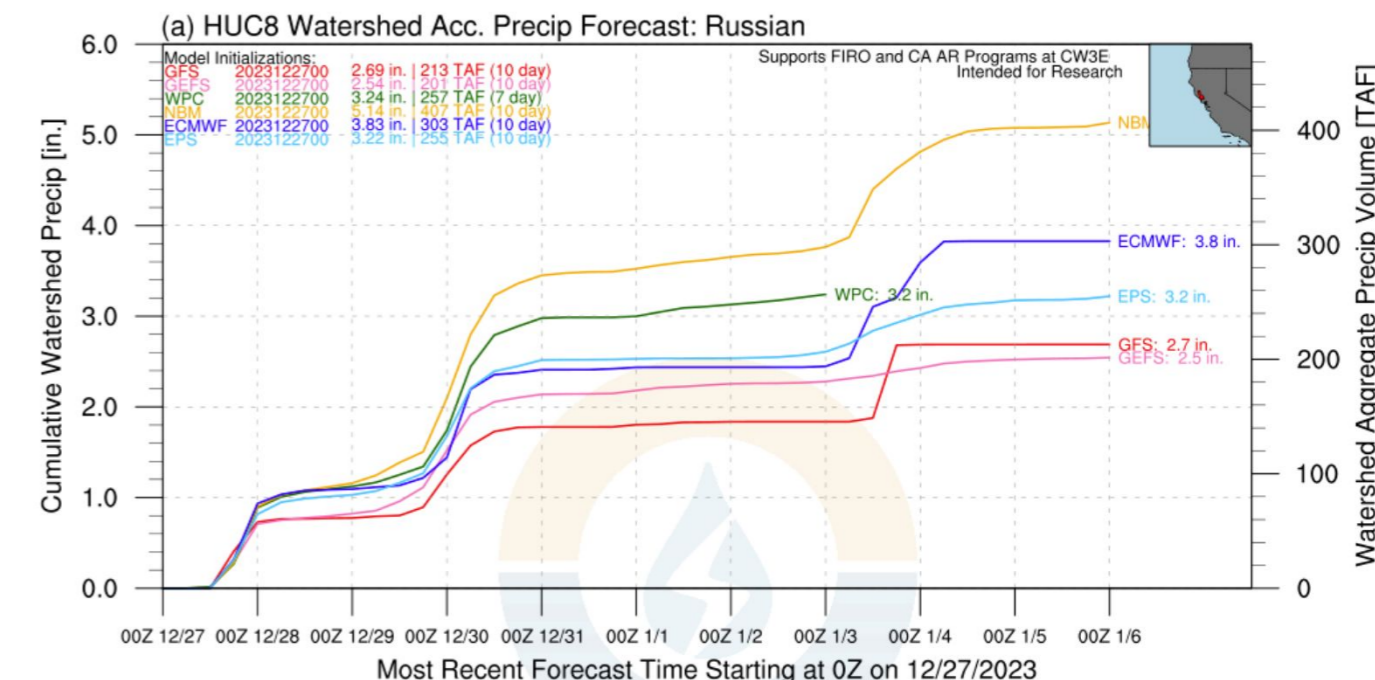
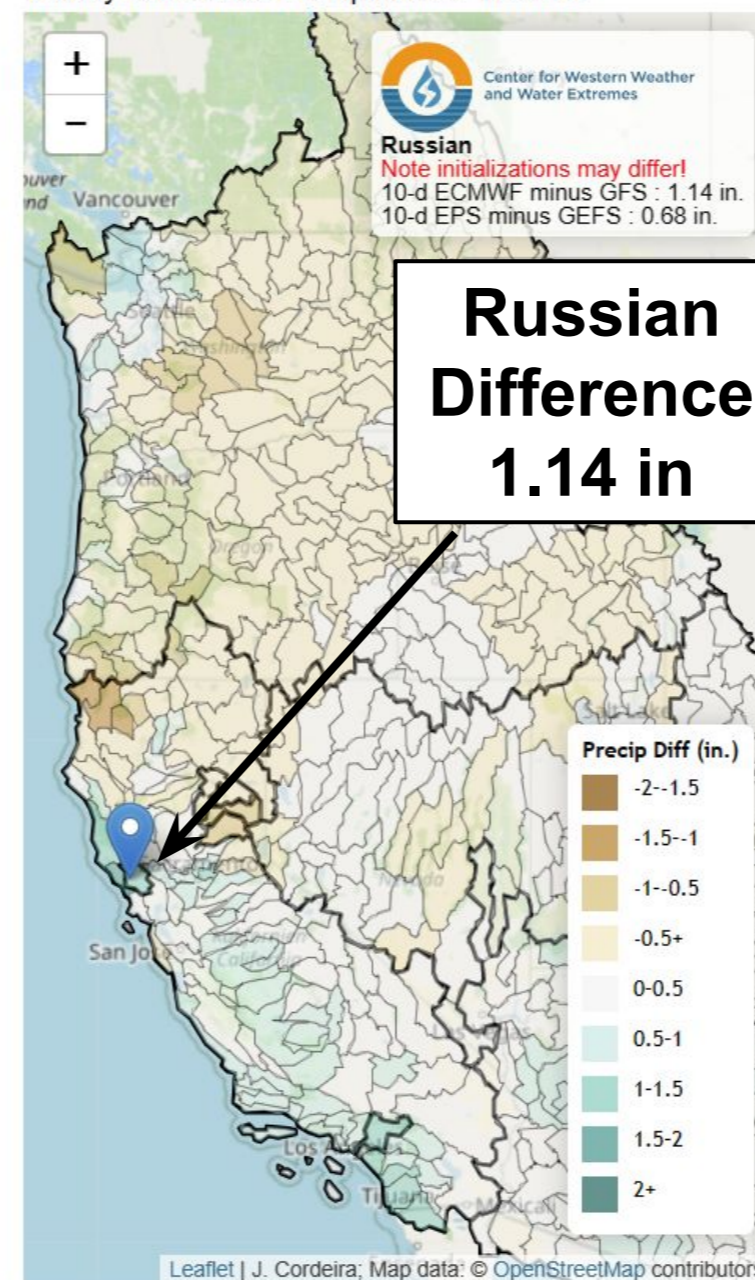
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



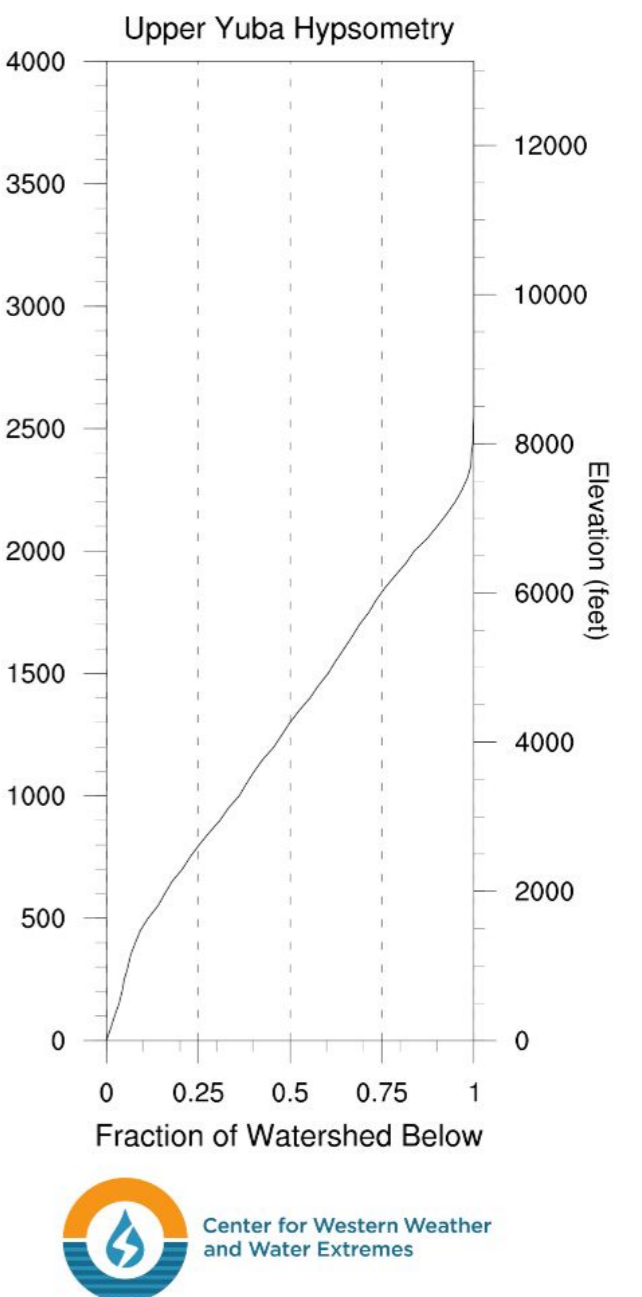
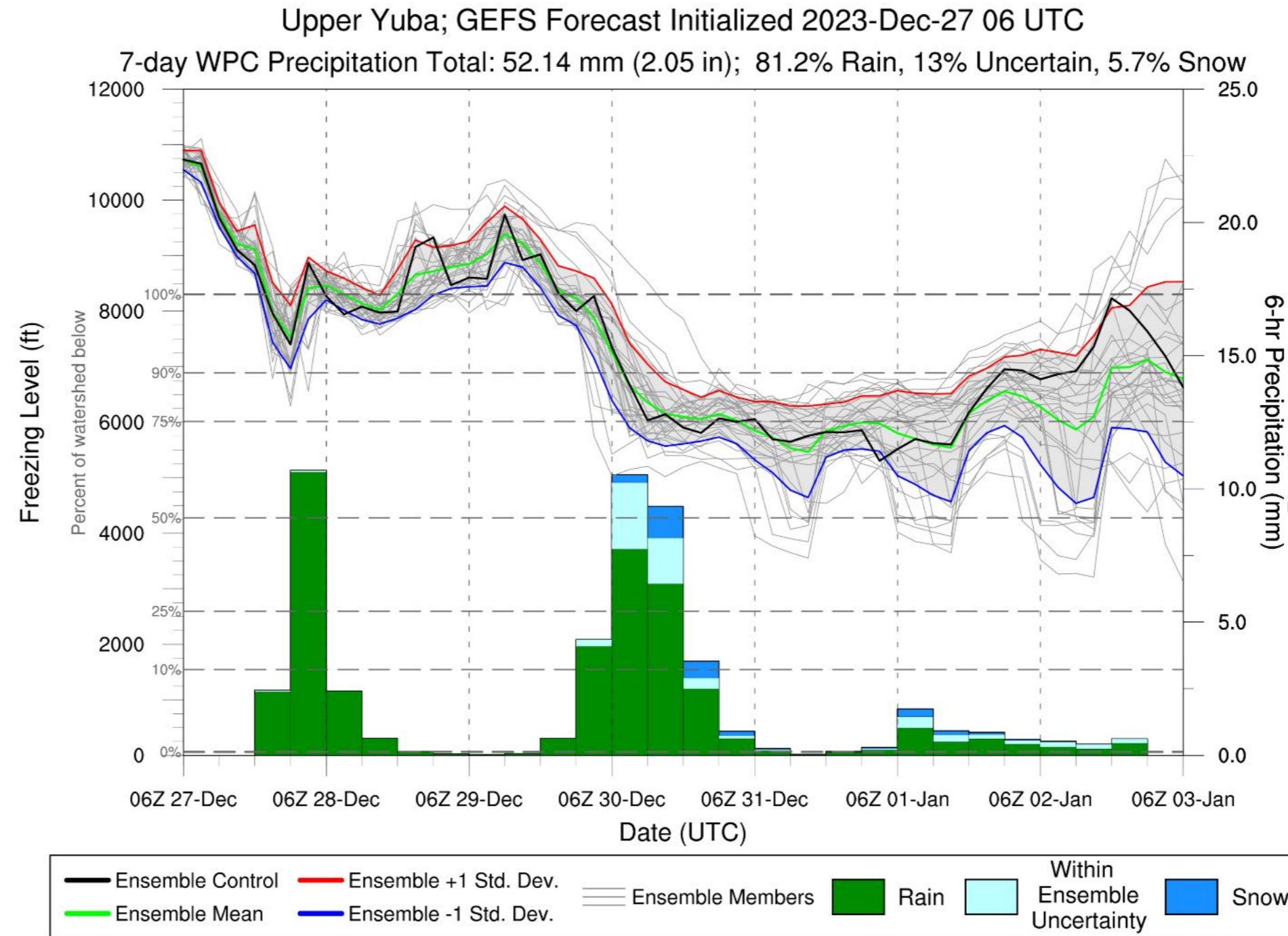
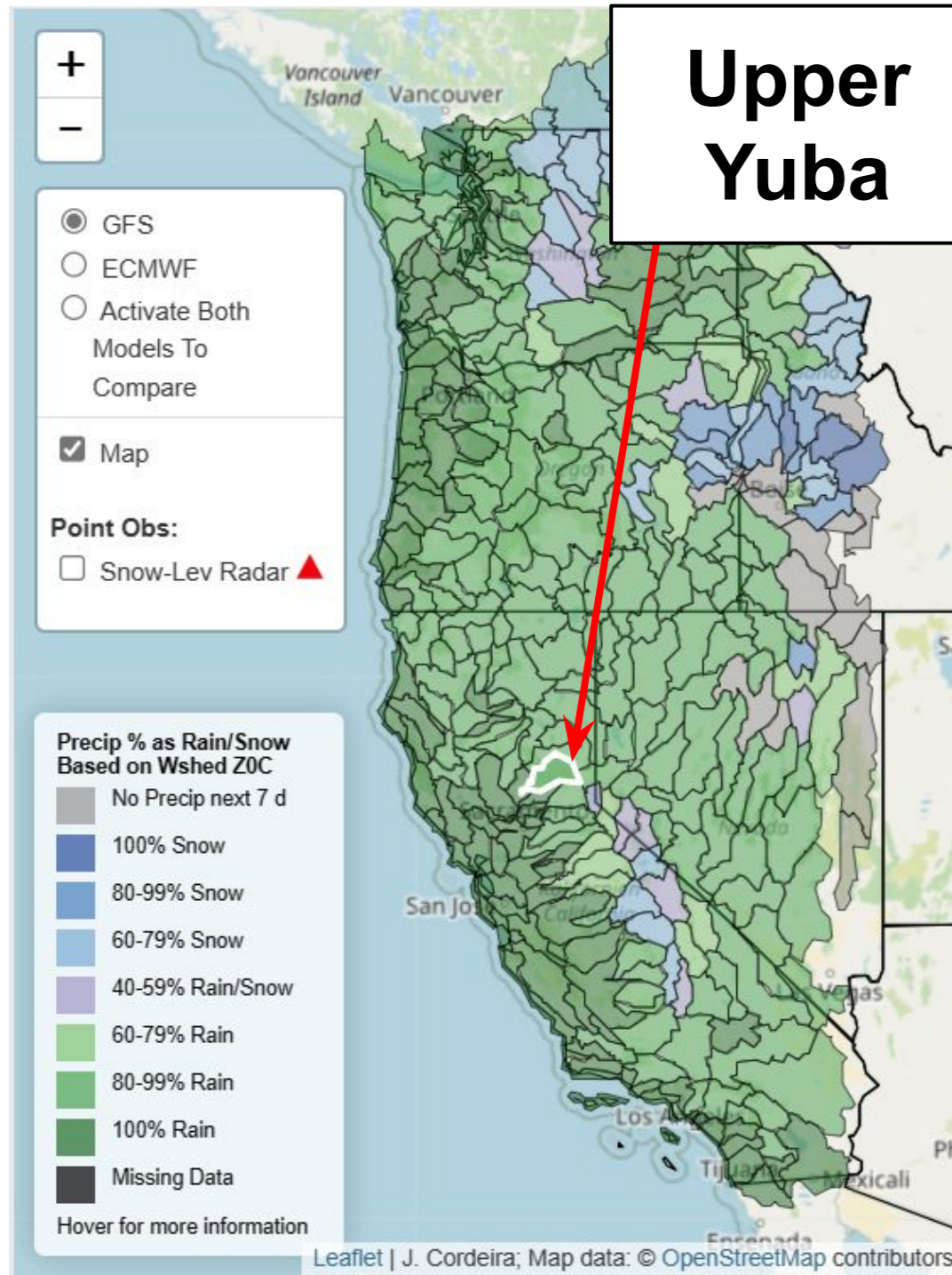
10-day Difference Precipitation Forecast



- The 00Z ECMWF and 00Z GFS are forecasting similar 10-day watershed precipitation totals across the US West Coast. Primary forecast differences are in Northern CA where the GFS is forecasting more precipitation closer to the OR border and the ECMWF is forecasting more precipitation closer to Central CA as a result of weather later in the period.
- The 00Z ECMWF is forecasting 3.83” of mean areal precipitation in the Russian watershed over the next 10 days, while the 00Z GFS is forecasting 2.69” over the same watershed. Both ensembles’ members are showing agreement in the 10-day totals.

# CW3E AR Outlook: 27 Dec 2023

## Freezing Level Forecast



- Freezing levels are forecast to remain near the highest peaks in many high elevation watersheds which increases the risk for rain-on-snow
- The CW3E watershed freezing level tool is forecasting 80%+ of the precipitation in the Upper Yuba watershed to fall as rain