

# CW3E Atmospheric River Outlook: 20 Dec 2023

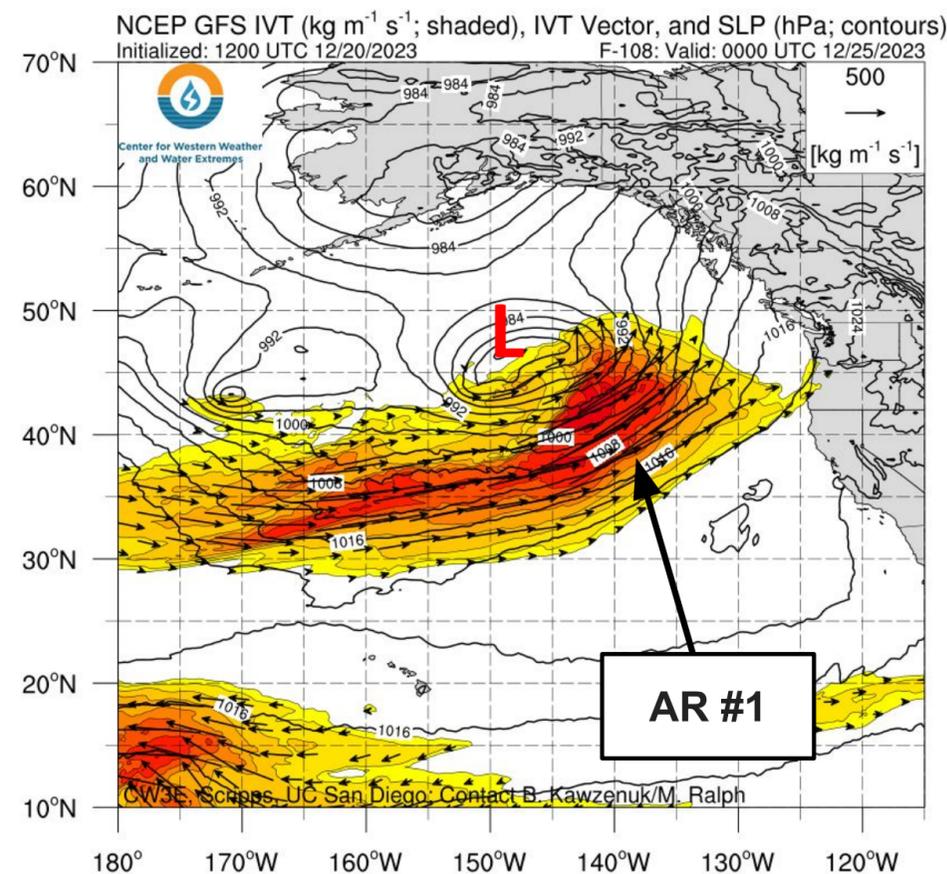
## Atmospheric River Forecast for US West Coast Landfall on Christmas

- An Atmospheric River (AR) is forecast to make landfall in the Pacific Northwest (PNW) early Mon 25 Dec and continue through Wed 27 Dec.
- The GEFS control run is forecasting AR3 to AR4 conditions (based on Ralph et al. 2019 AR scale) for the PNW.
- Due to the long lead time with this event, there is uncertainty in the AR landfall timing and duration in the GEFS, ECMWF EPS and West-WRF Ensemble.
- The NWS Weather Prediction Center (WPC) is currently forecasting 3-day precipitation totals  $\geq 2$ " with highest precipitation totals over the Olympic Peninsula and CA/OR border.
- The NWS Climate Prediction Center's Day 8-14 Hazard Outlook shows risks of heavy precipitation, heavy snow and high winds for Northern CA from 12/27 through 12/30.

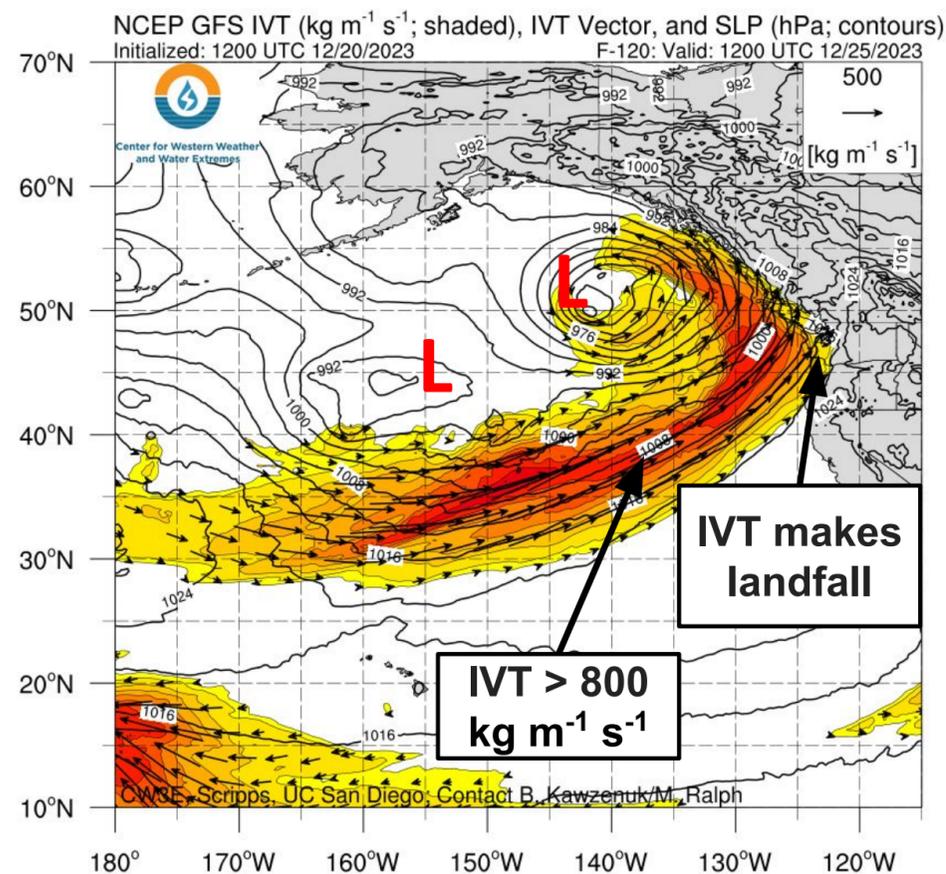
# CW3E AR Outlook: 20 Dec 2023

GFS Init 12Z Wed 20 Dec 2023

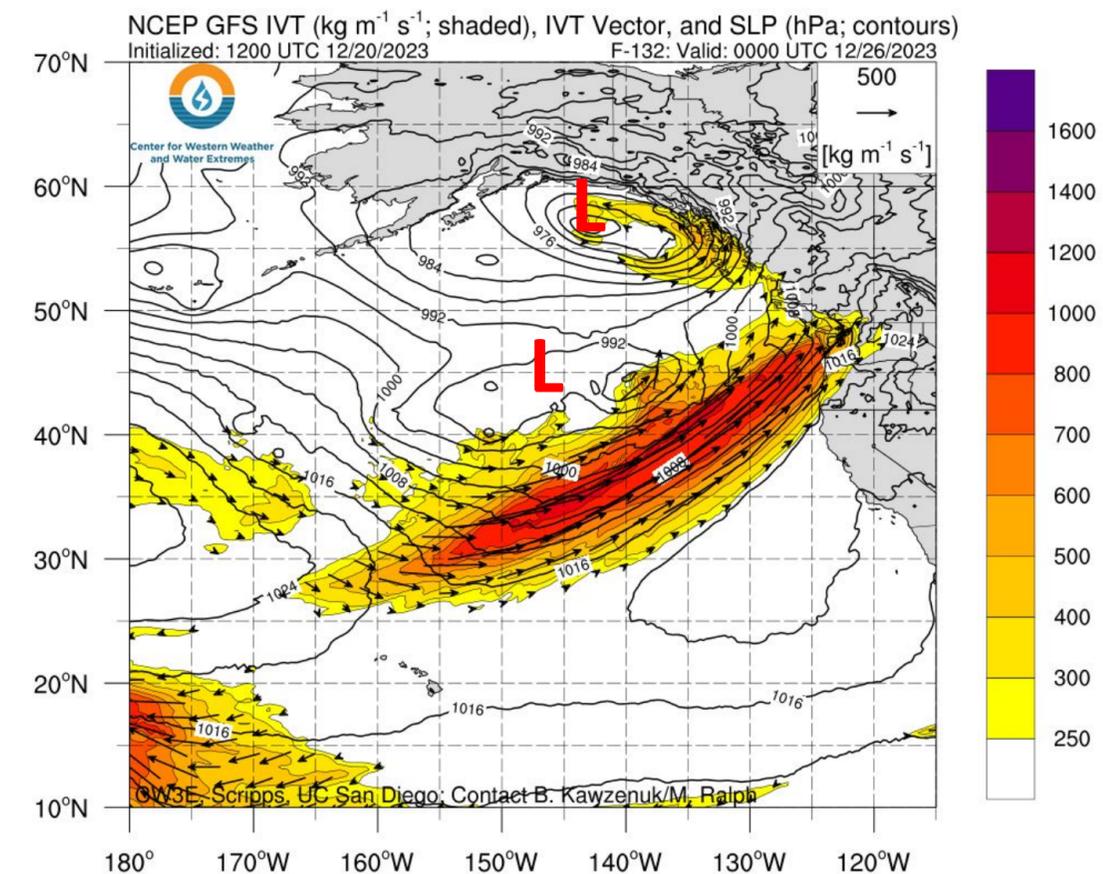
**A) 4PM PT Sun 24 Dec 2023**



**B) 4AM PT Mon 25 Dec 2023**



**C) 4PM PT Mon 25 Dec 2023**

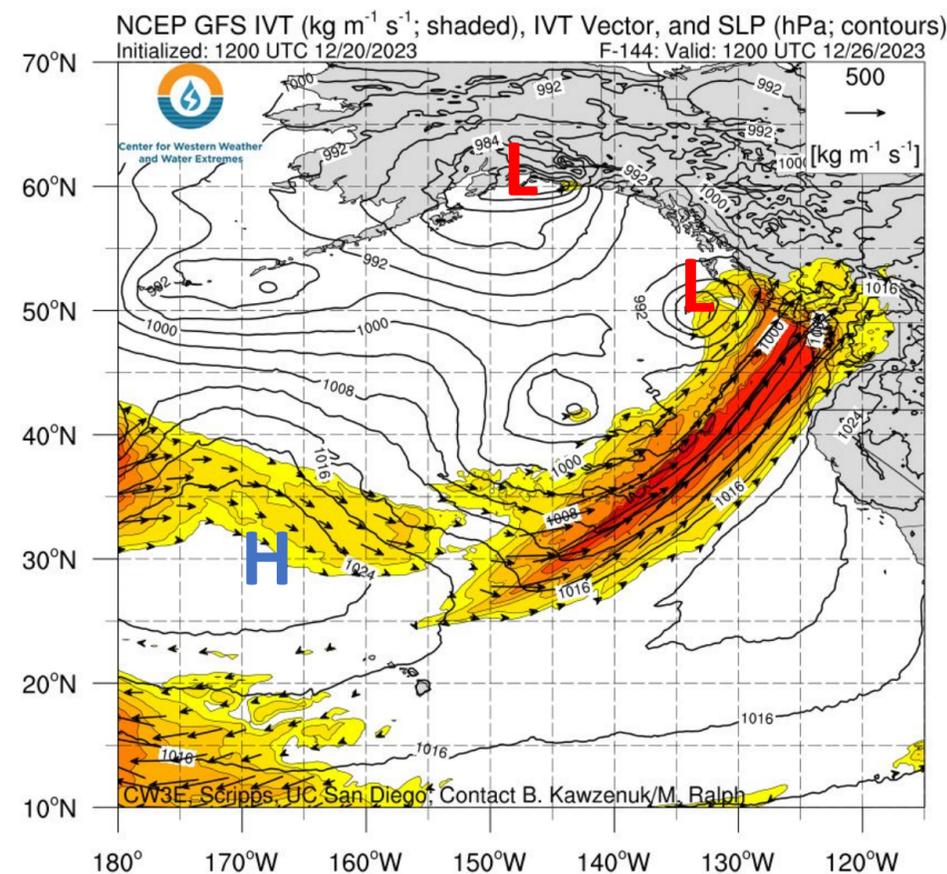


- The AR and associated low pressure system are forecast to progress toward the USWC through the weekend, making landfall into the PNW early Mon 25 Dec (Figure A).
- The GFS is forecasting  $\text{IVT} > 800 \text{ kg m}^{-1} \text{s}^{-1}$  in the core of the AR as it makes landfall into the PNW (Figure B).
- A second low pressure propagates into the NE Pacific behind the primary low pressure system helping to continue AR conditions in along the USWC (Figure C).

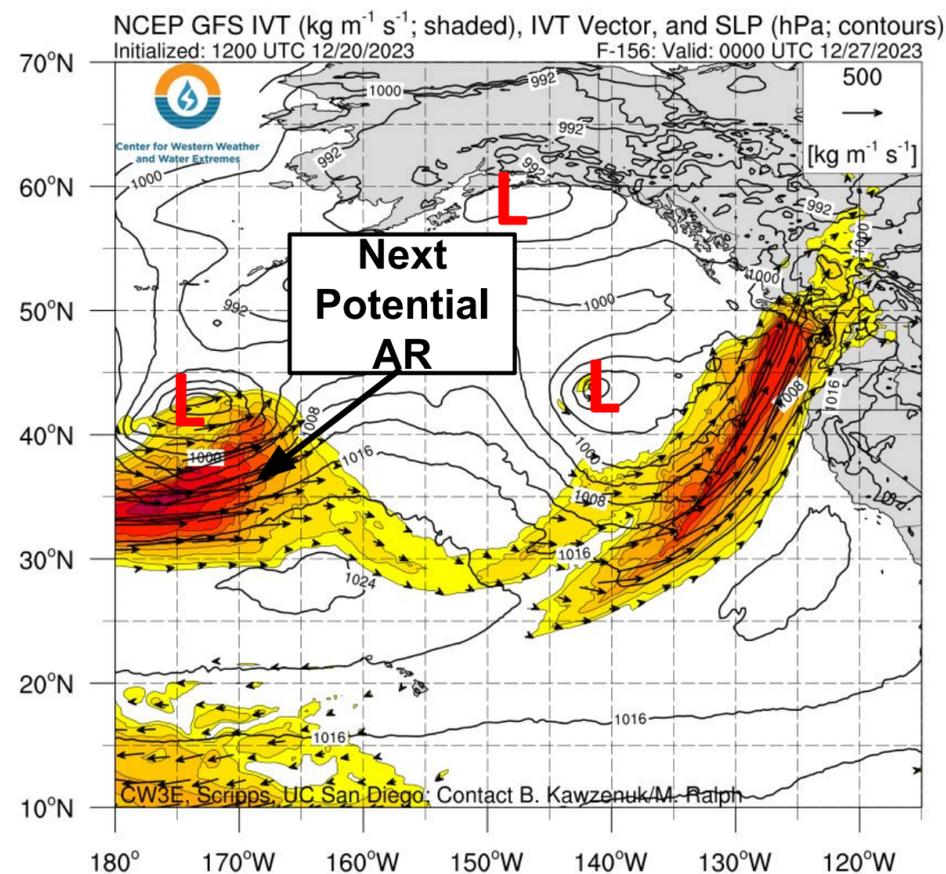
# CW3E AR Outlook: 20 Dec 2023

GFS Init 12Z Wed 20 Dec 2023

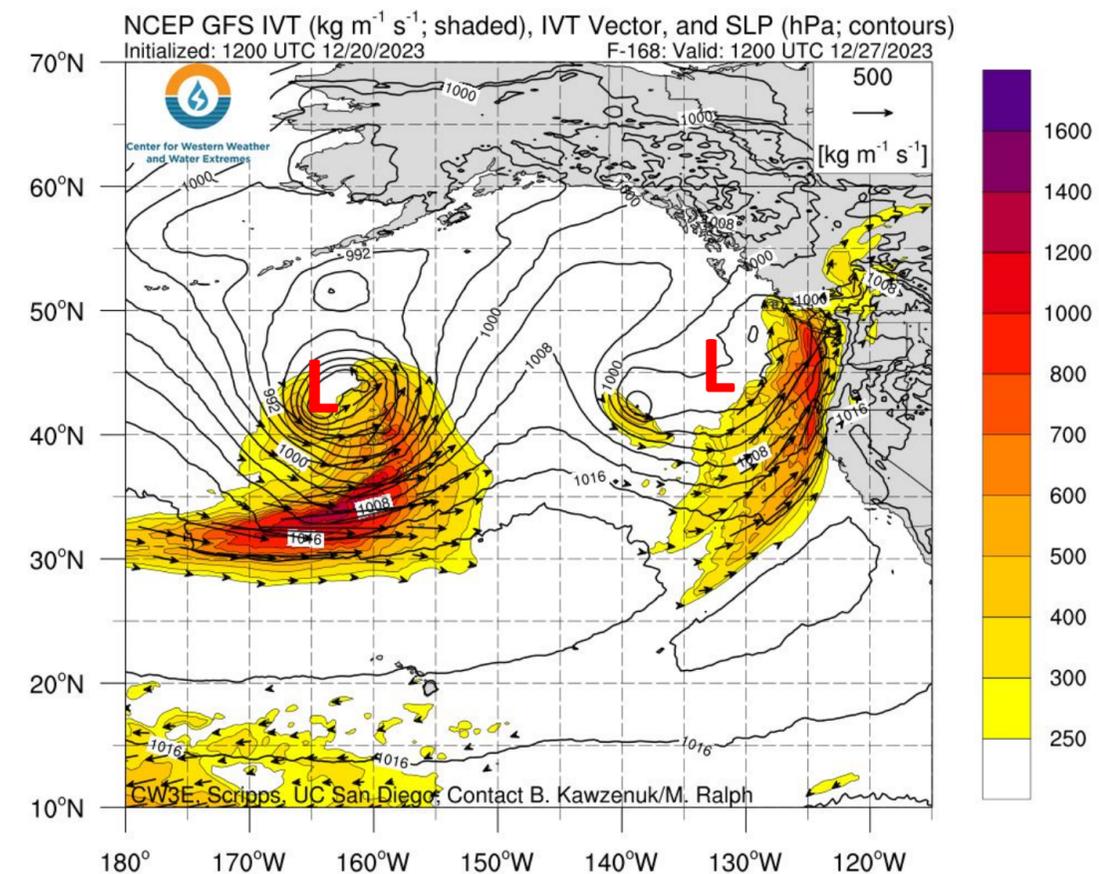
D) 4AM PT Tue 26 Dec 2023



E) 4PM PT Tue 26 Dec 2023



F) 4AM PT Wed 27 Dec 2023



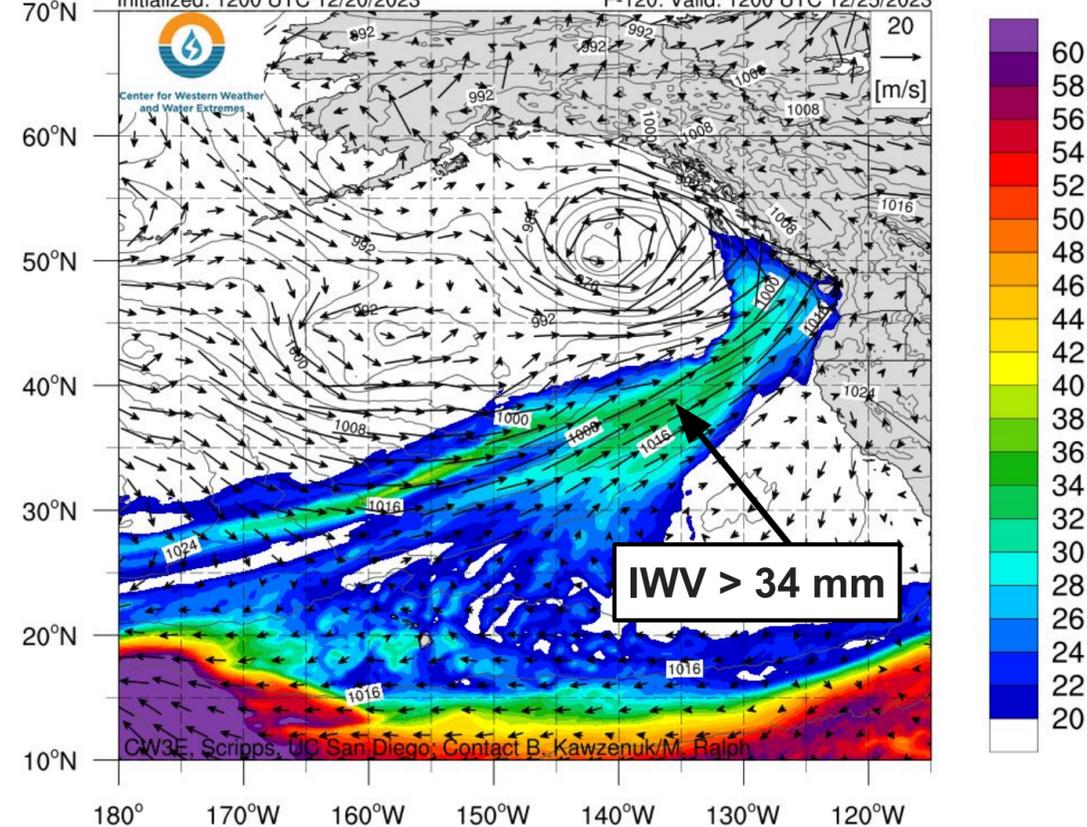
- AR conditions are forecast to continue over the PNW through Wed 27 Dec. as the parent cyclone associated with the first AR persists in the Gulf of Alaska (Figures D, E and F)
- By this forecast period, a secondary AR (that developed in the Central North Pacific on 25 Dec) is forecast to be positioned to the south of the Aleutian Islands (Figures E and F).

# CW3E AR Outlook: 20 Dec 2023

GFS Init 12Z Wed 20 Dec 2023

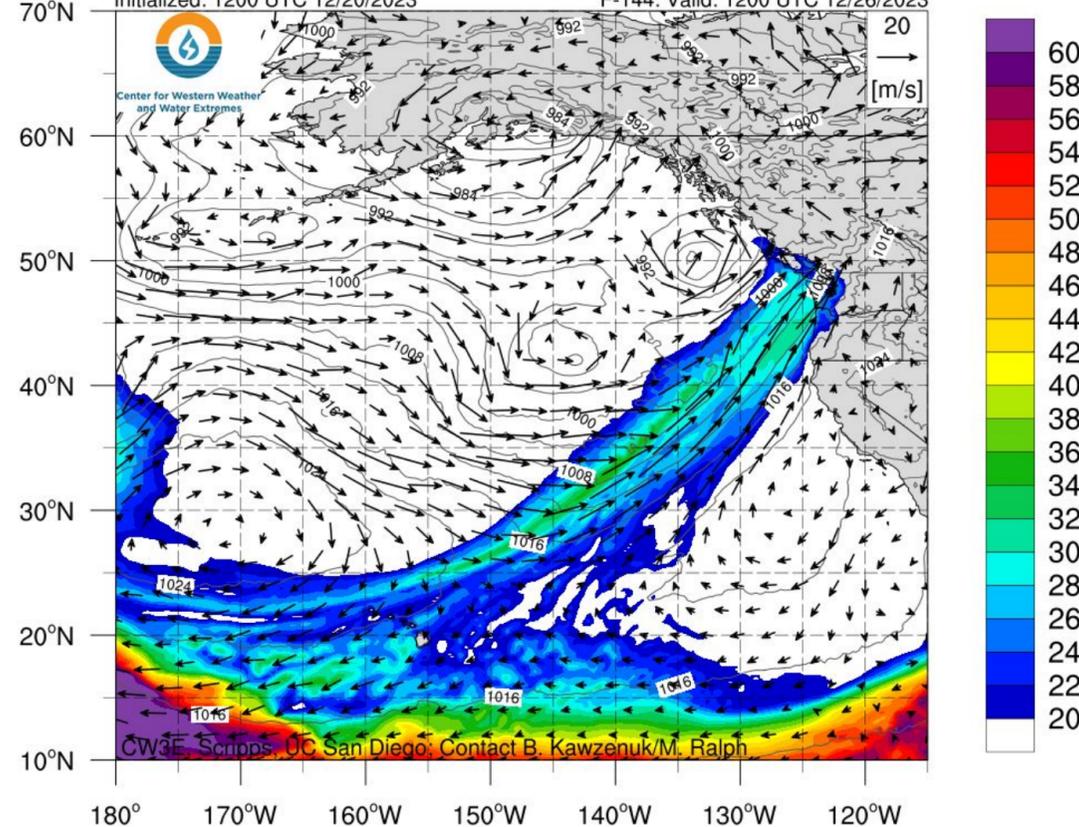
4PM PT Sun 24 Dec 2023

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 12/20/2023 F-120: Valid: 1200 UTC 12/25/2023



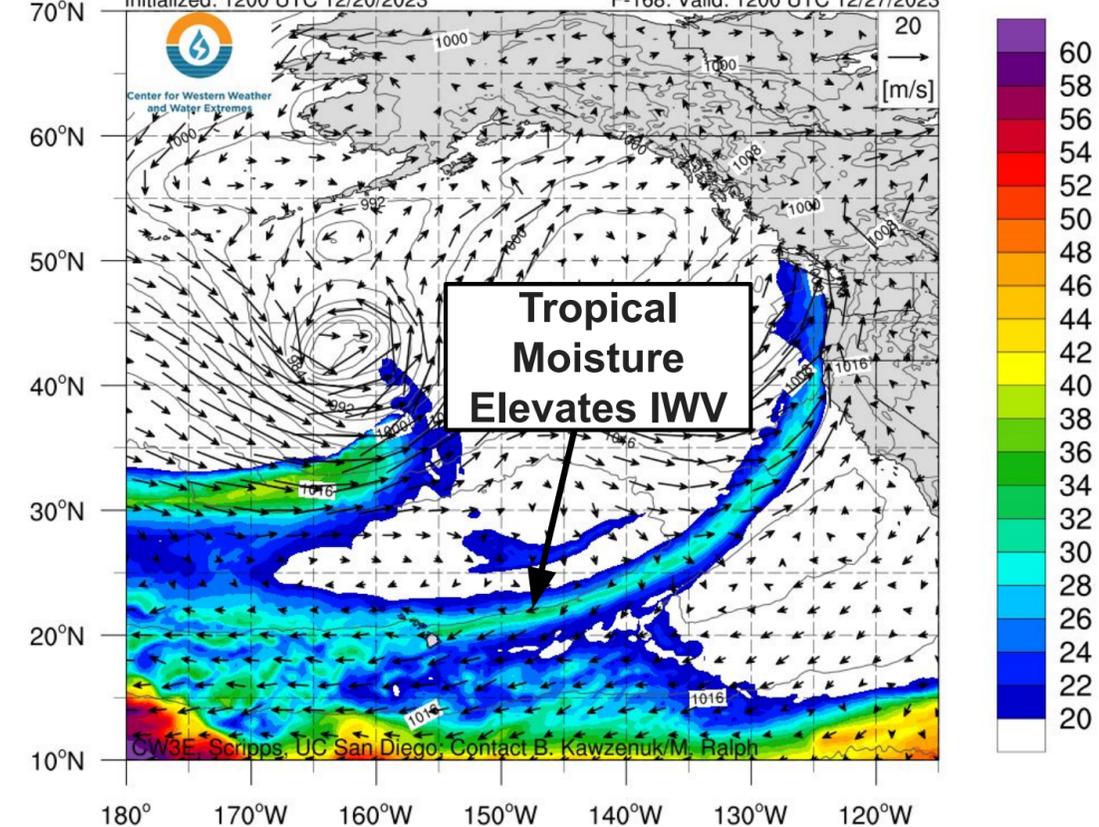
4PM PT Mon 25 Dec 2023

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
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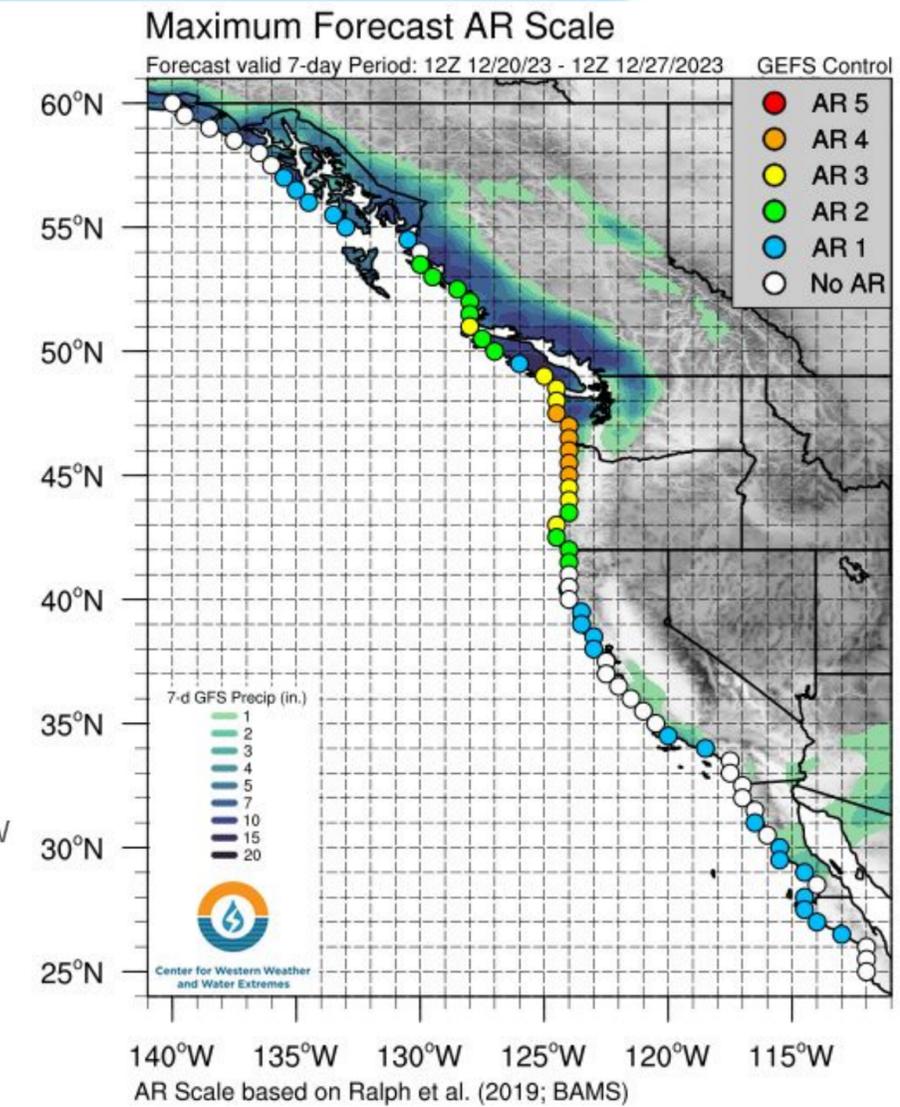
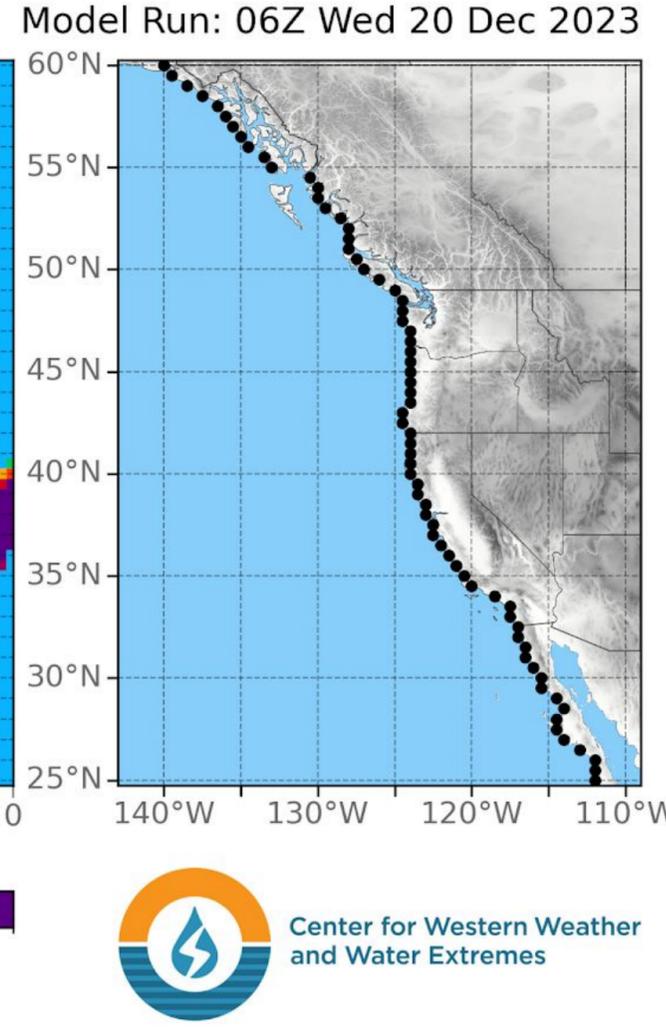
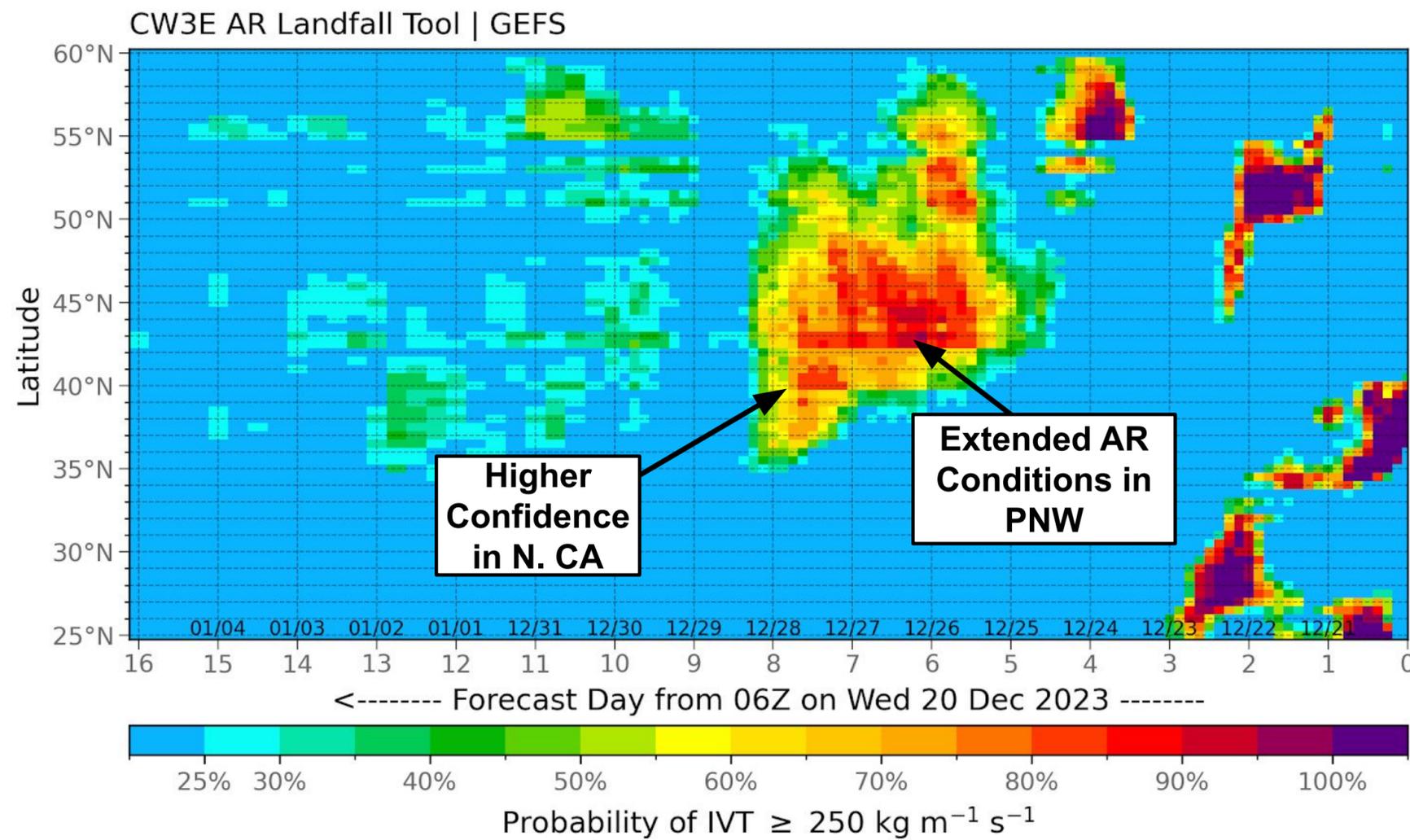
4PM PT Tue 26 Dec 2023

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 12/20/2023 F-168: Valid: 1200 UTC 12/27/2023



- The AR is forecast to be associated with a robust tropical moisture export (TME) extending from north of Hawaii, with IWV > 34 mm in the core of the AR.
- Elevated IWV continues in the core through the duration of the event, tapping into moisture from the Central Pacific to continue feeding the moisture in the system.

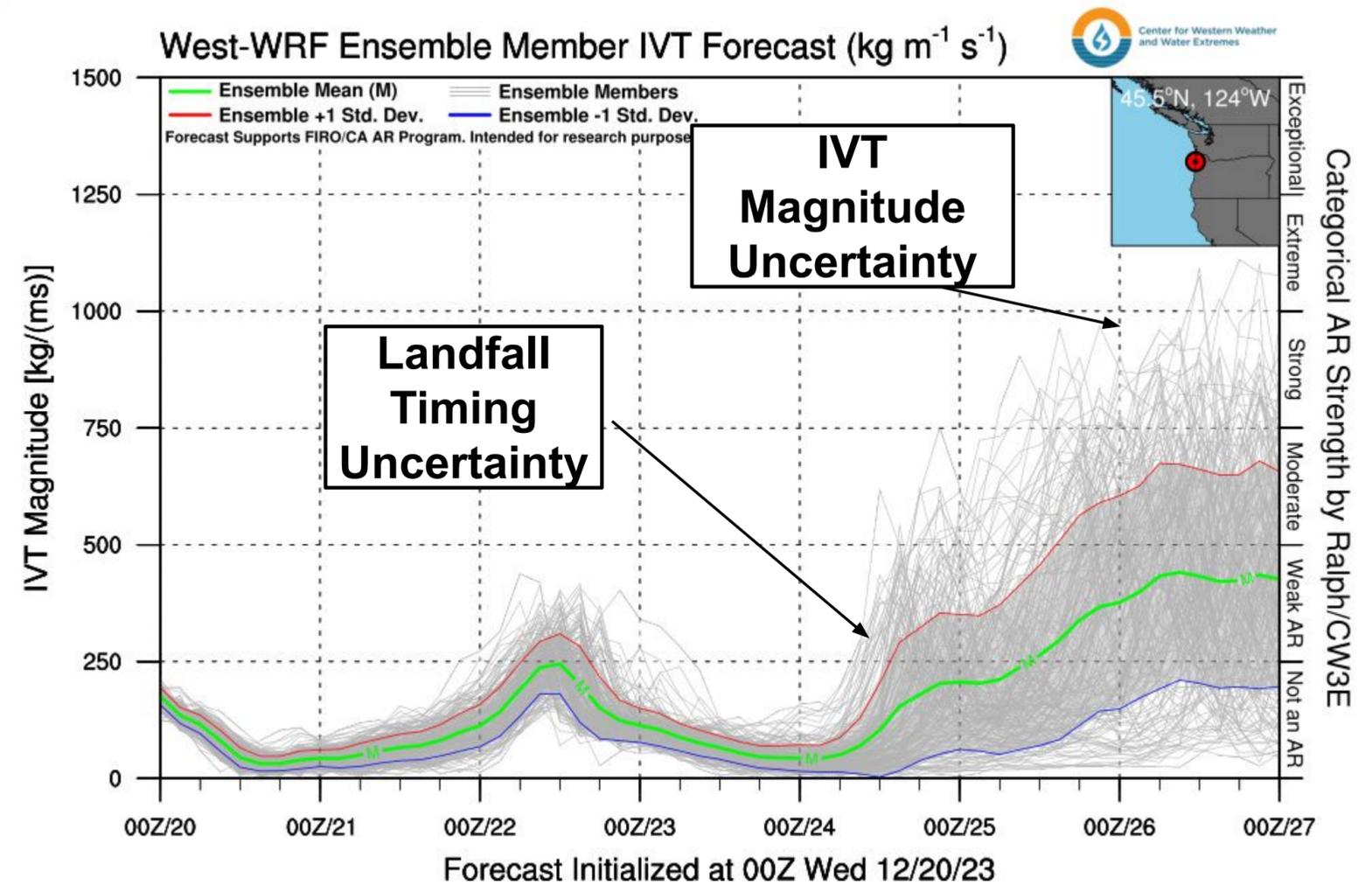
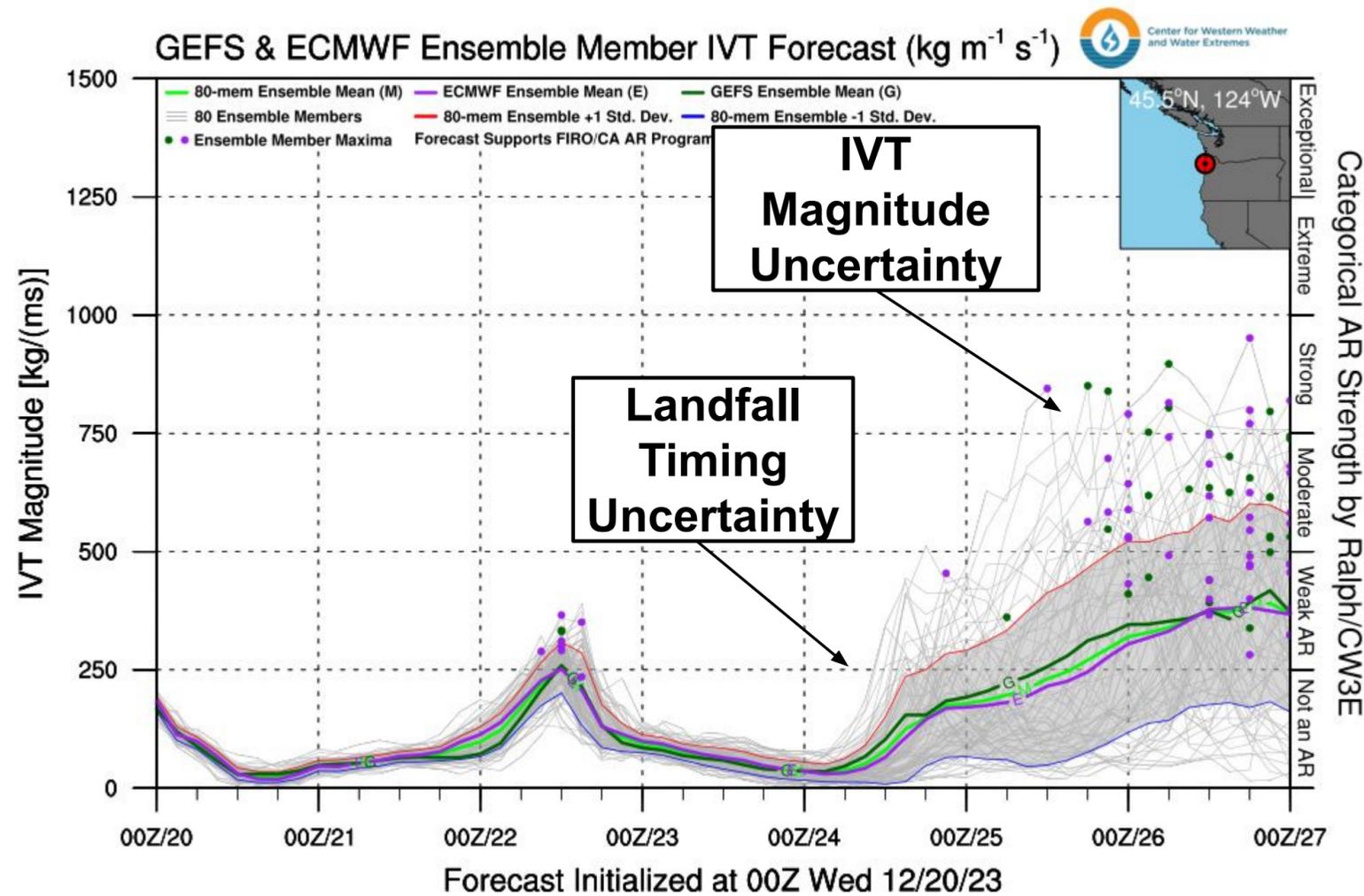
# CW3E AR Outlook: 20 Dec 2023



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

- CW3E's GEFS AR Landfall tool is showing high forecast confidence ( $>80\%$ ) in a 48 hour period of  $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$  between 42 DEG N and 48 DEG N over the PNW during this AR, resulting in AR3/AR4 conditions for much of coastal Washington and northern Oregon.
- There is increased confidence in  $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$  over coastal Northern CA later in the period, with the highest confidence ( $>80\%$ ) on Wed 27 Dec.

# CW3E AR Outlook: 20 Dec 2023



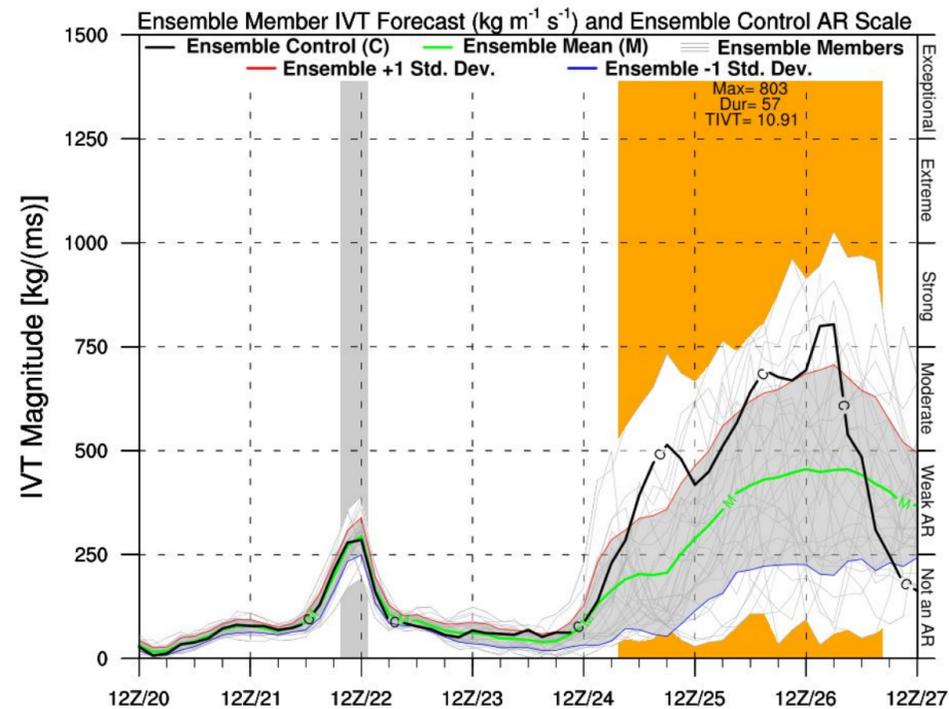
- IVT forecast plumes from the global models show considerable uncertainty in landfall timing and maximum IVT.
- The West-WRF Ensemble similarly shows large variability amongst its members in the IVT magnitude as well as the timing and peak of maximum IVT at this location. West-WRF mean and peak IVT is higher than either of the GEFS and ECMWF.

# CW3E AR Outlook: 20 Dec 2023

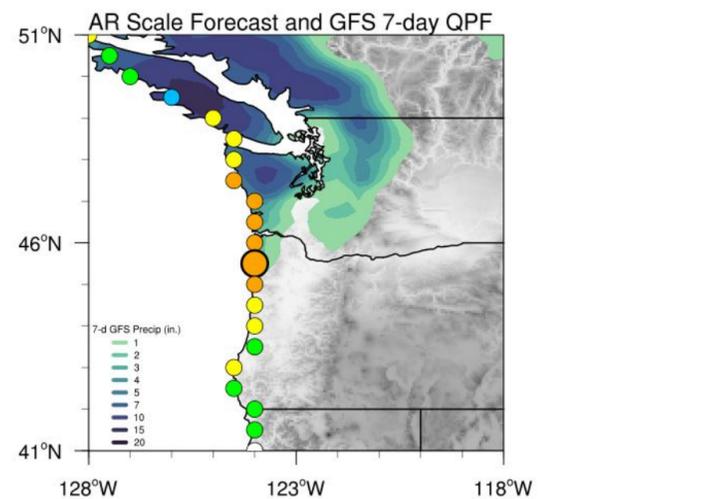
## GEFS 7-day AR Scale and IVT Forecast

GEFS Ensemble Initialized: 12Z Wed 12/20/23

Location: 45.5°N 124°W



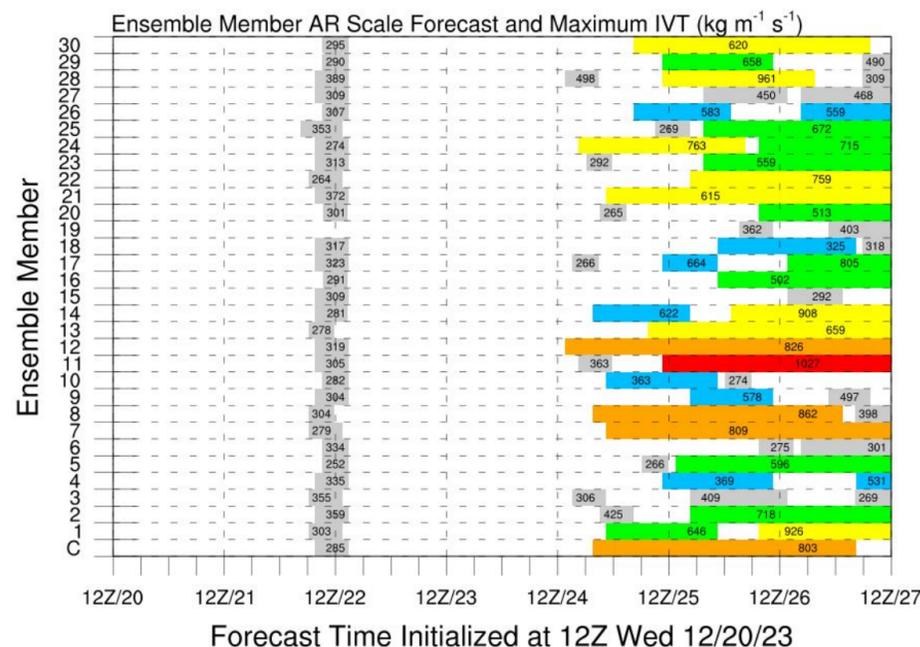
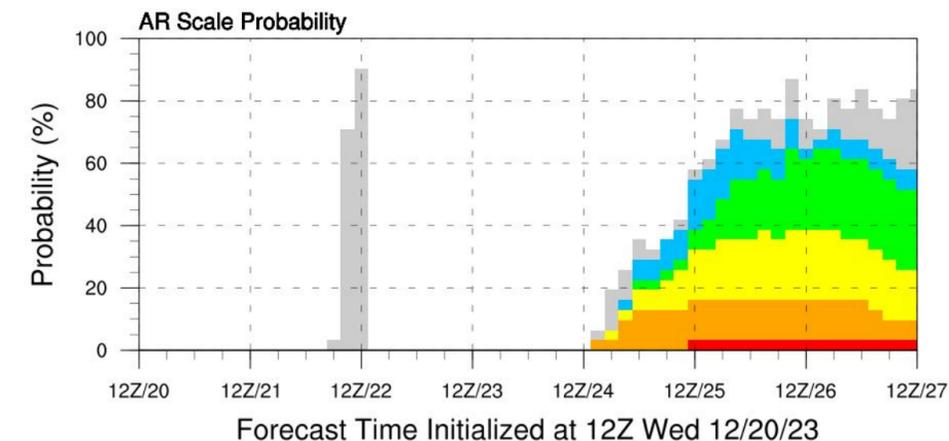
Categorical AR Strength by Ralph/CW3E



- 26/31 (87%) GEFS ensemble members are forecasting at least AR1 conditions at 45.5° N, 124.0° W from 00Z Mon 25 Dec through 12Z Wed 27 Dec.

- 13/31 (42%) of the members are forecasting at least AR3 conditions at this point for this AR.

- There is uncertainty in the timing of maximum IVT as well as duration of AR conditions amongst GEFS members.

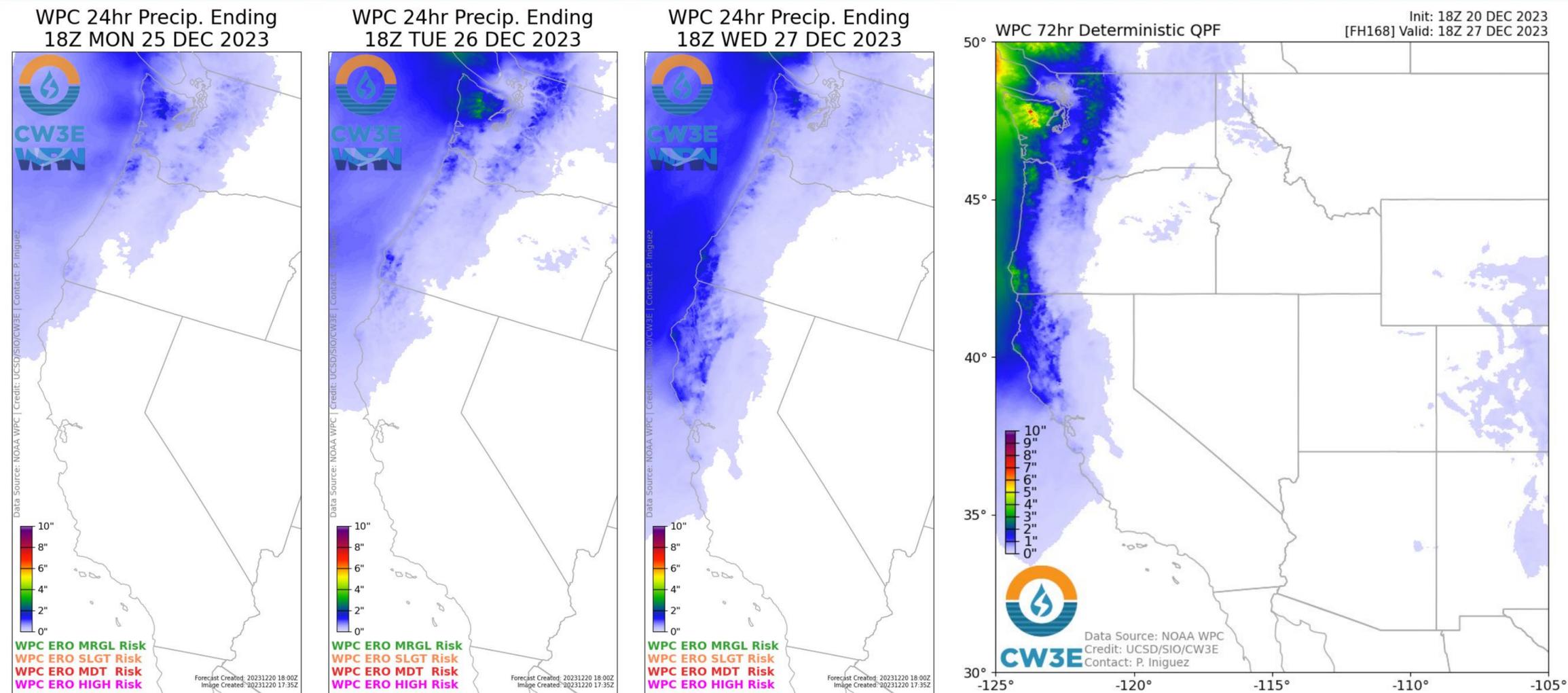


AR 1 (blue) AR 2 (green) AR 3 (yellow) AR 4 (orange) AR 5 (red)

Image created: 18 UTC 12/20/2023

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

# CW3E AR Outlook: 20 Dec 2023

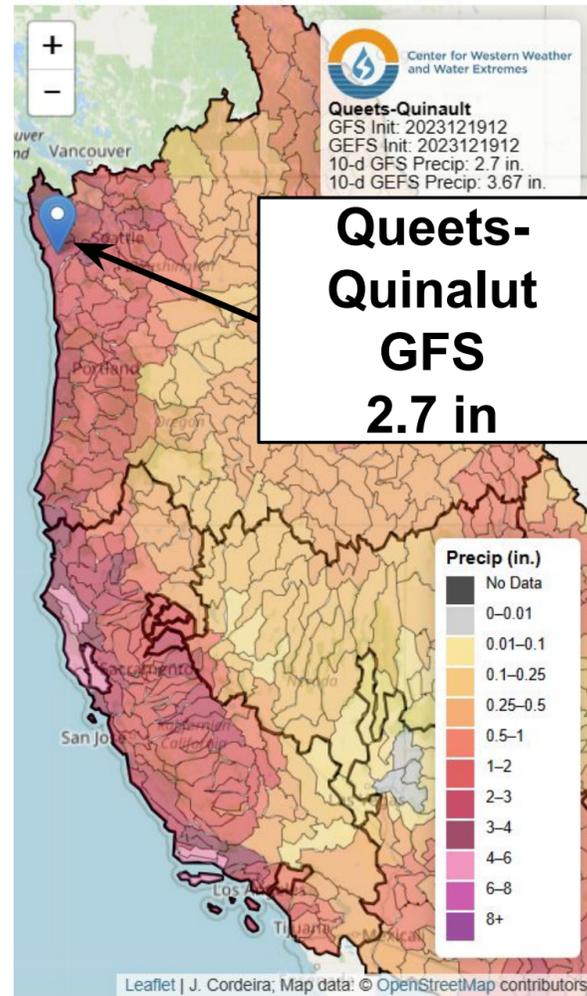


- The National Weather Service (NWS) Weather Prediction Center (WPC) is currently forecasting precipitation totals  $\geq 1$  inches for regions along the PNW and Northern CA coasts and into the Cascades during the 24-hour periods ending at 18Z on 25, 26, and 27 Dec.
- NWS WPC 3-day precipitation totals are forecast to exceed 2 inches for the PNW coasts with the highest precipitation totals  $\geq 5$  inches over the Olympic Peninsula.

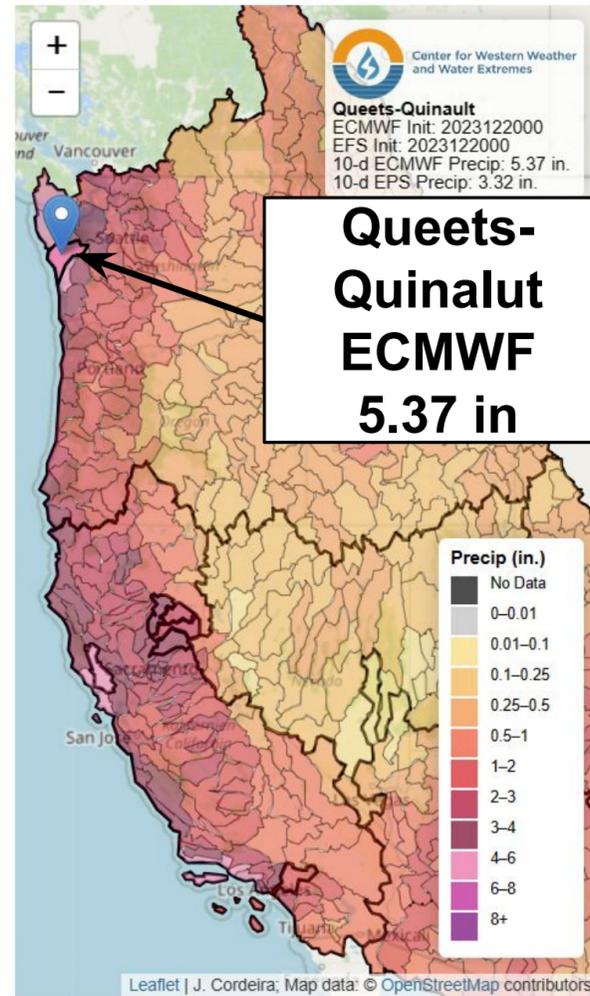
# CW3E AR Outlook: 20 Dec 2023

## 10-day Watershed Precipitation Forecasts (Initialized 00Z 20 Dec)

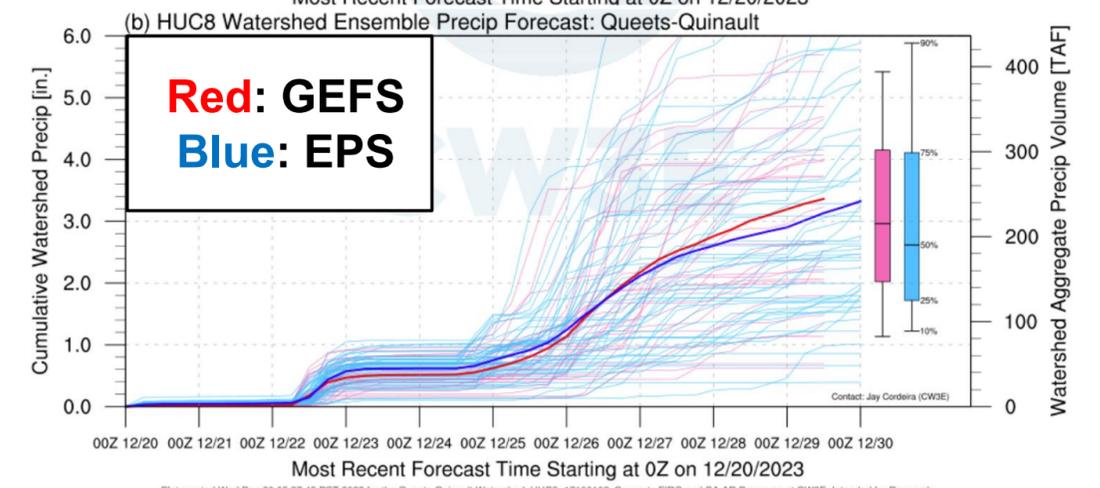
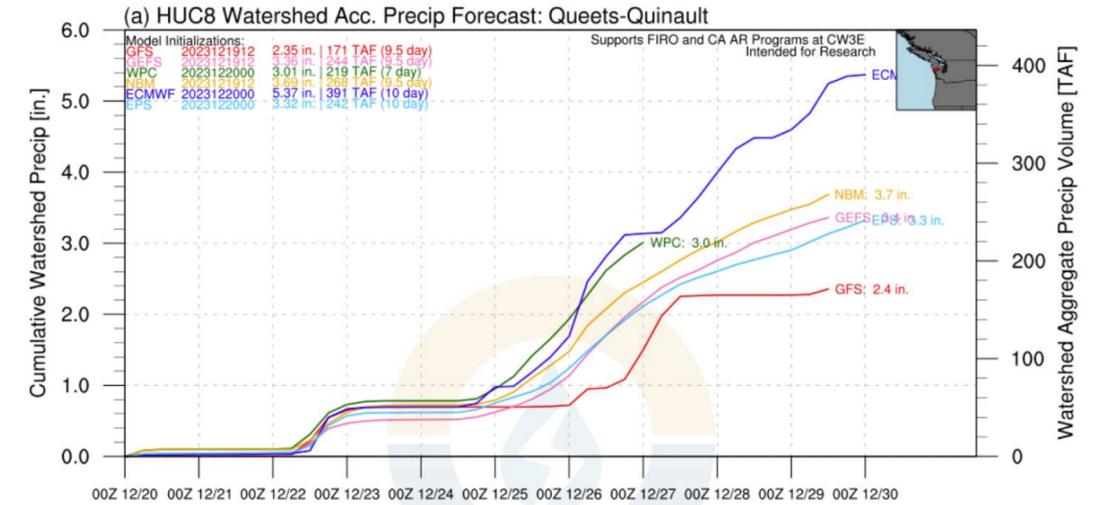
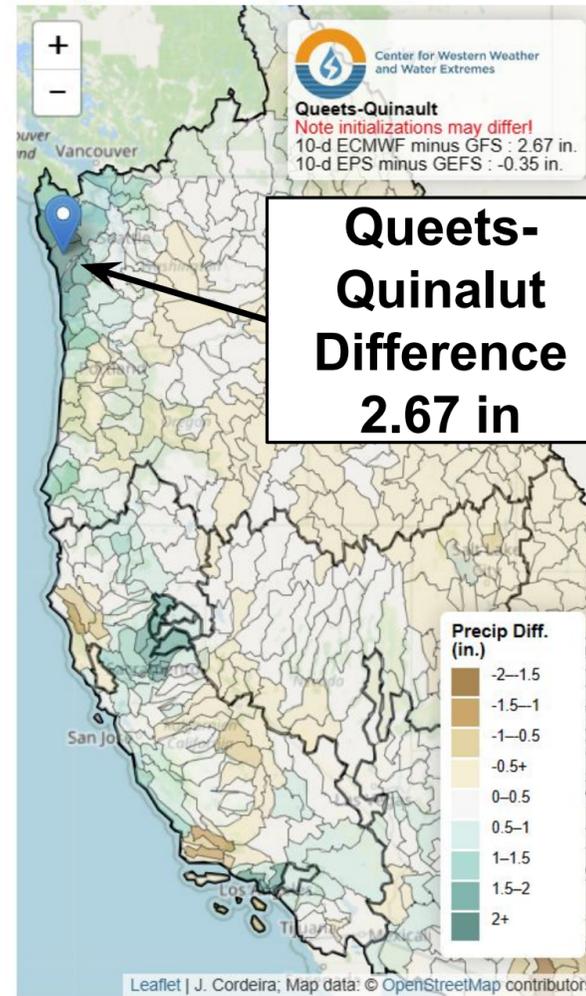
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



10-day Difference Precipitation Forecast

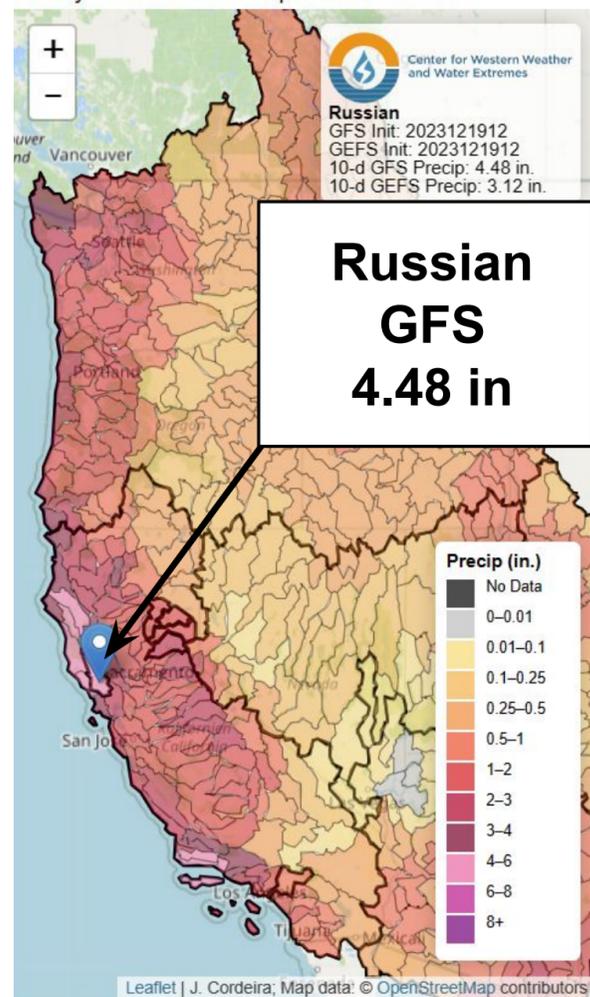


- The 00Z ECMWF and 00Z GFS are forecasting similar 10-day watershed precipitation totals across the USWC. The primary difference between the models is ECMWF forecasting higher precipitation totals over the Olympic Peninsula.
- The 00Z ECMWF is forecasting 5.37” of mean areal precipitation in the Queets-Quinalut watershed over the next 10 days, while the 00Z GFS is forecasting 2.7” over the same watershed. Both ensembles’ members are showing uncertainty in the 10-day precipitation totals, with GEFS and EPS showing similar ranges of precipitation totals.

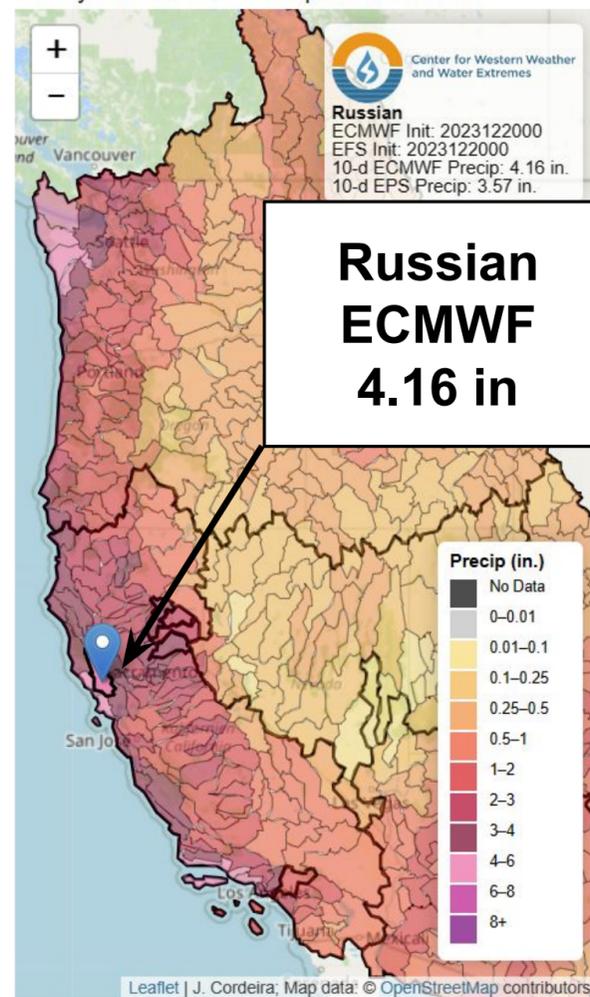
# CW3E AR Outlook: 20 Dec 2023

## 10-day Watershed Precipitation Forecasts (Initialized 00Z 13 Dec)

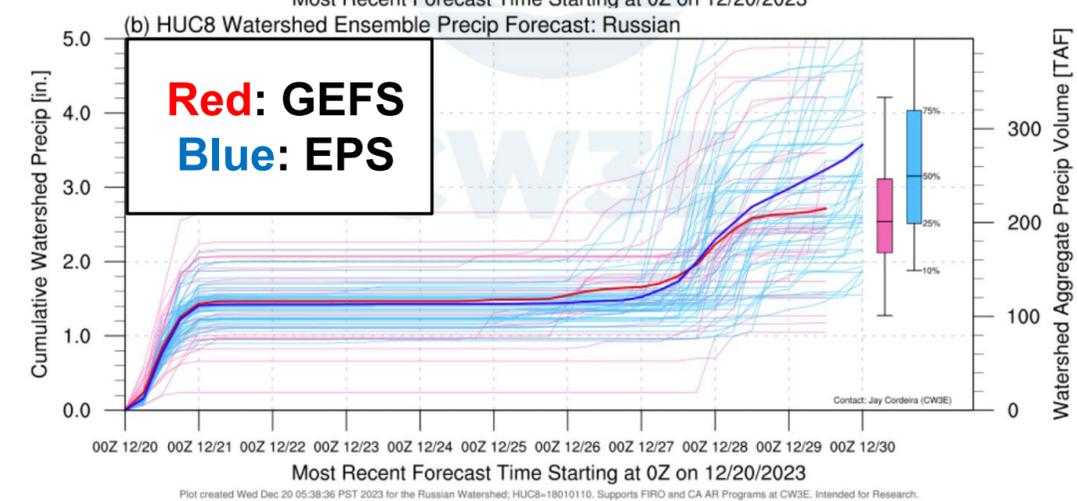
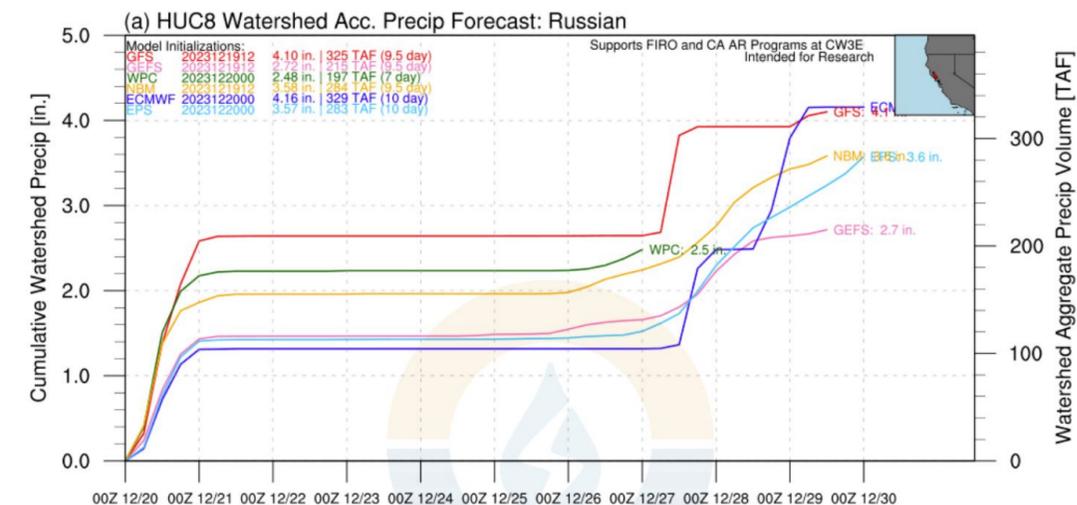
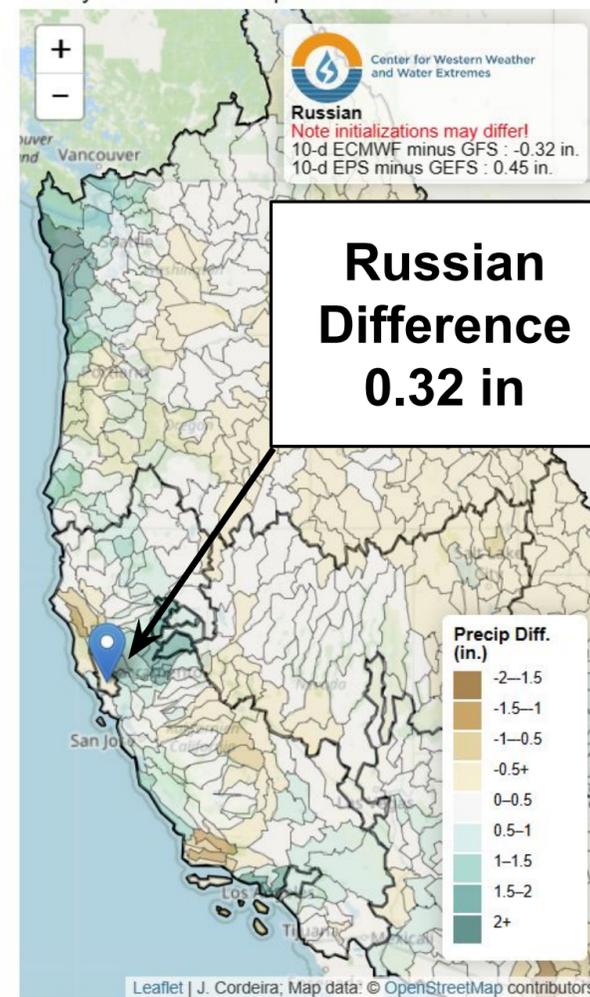
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



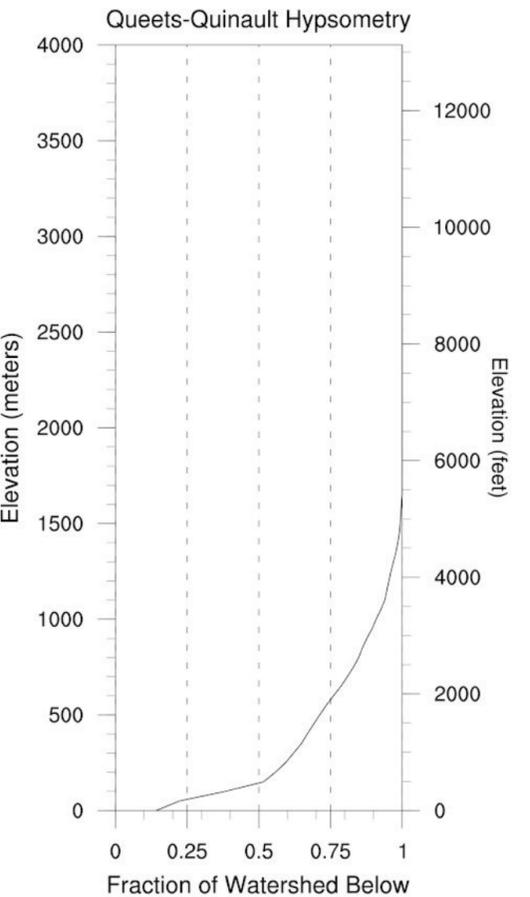
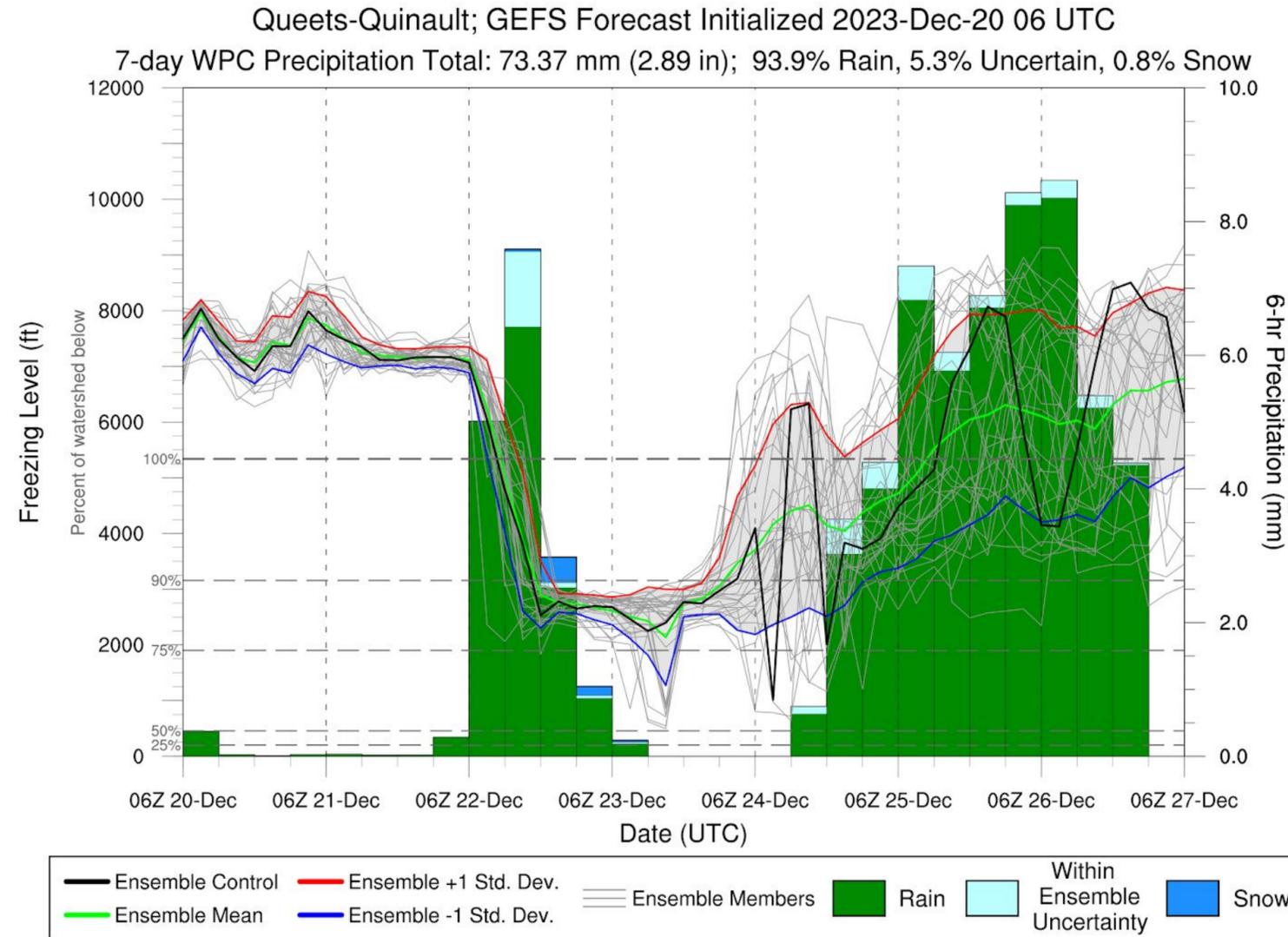
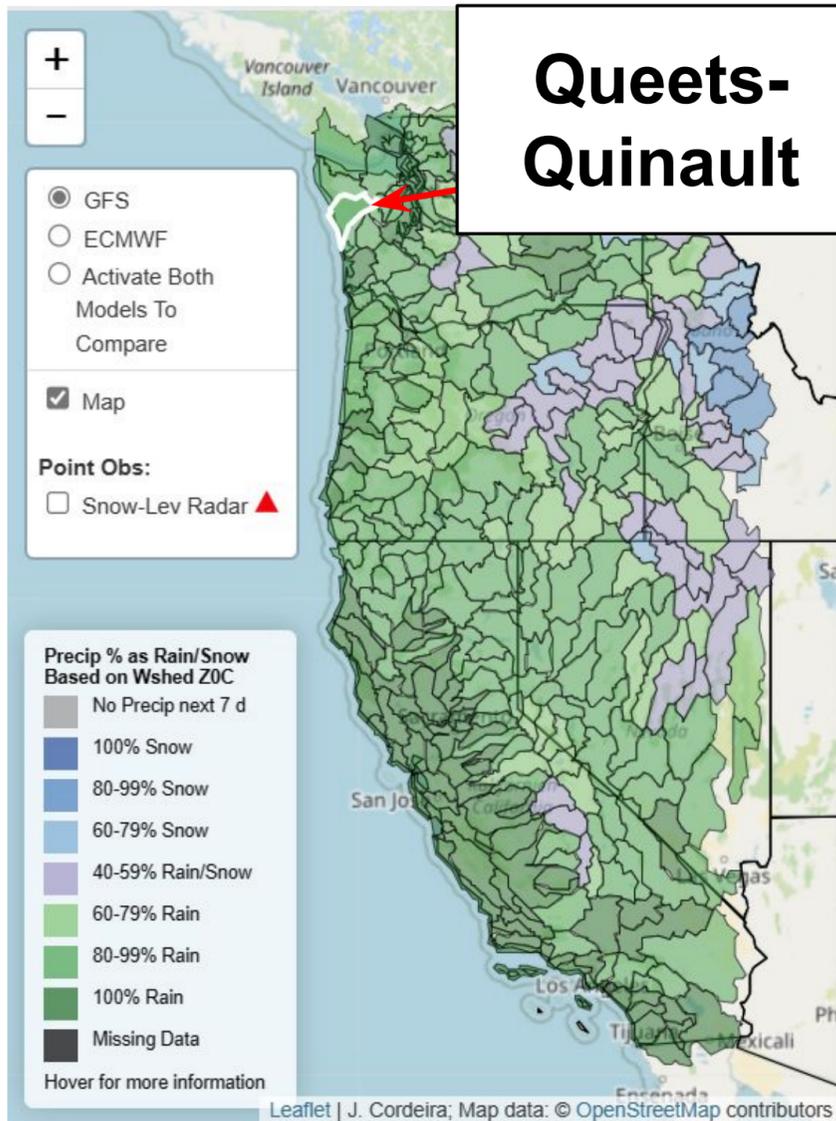
10-day Difference Precipitation Forecast



- The 00Z GFS and 00Z ECMWF are also showing uncertainty in the precipitation in Central CA.
- The 00Z GFS is forecasting 4.48” of mean areal precipitation in the North Fork Feather watershed over the next 10 days, while the 00Z ECMWF is forecasting 4.16” over the same watershed. Both ensembles’ members are showing uncertainty in the 10-day precipitation totals, with EPS leaning towards more precipitation than GEFS.

# CW3E AR Outlook: 20 Dec 2023

## Freezing Level Forecast



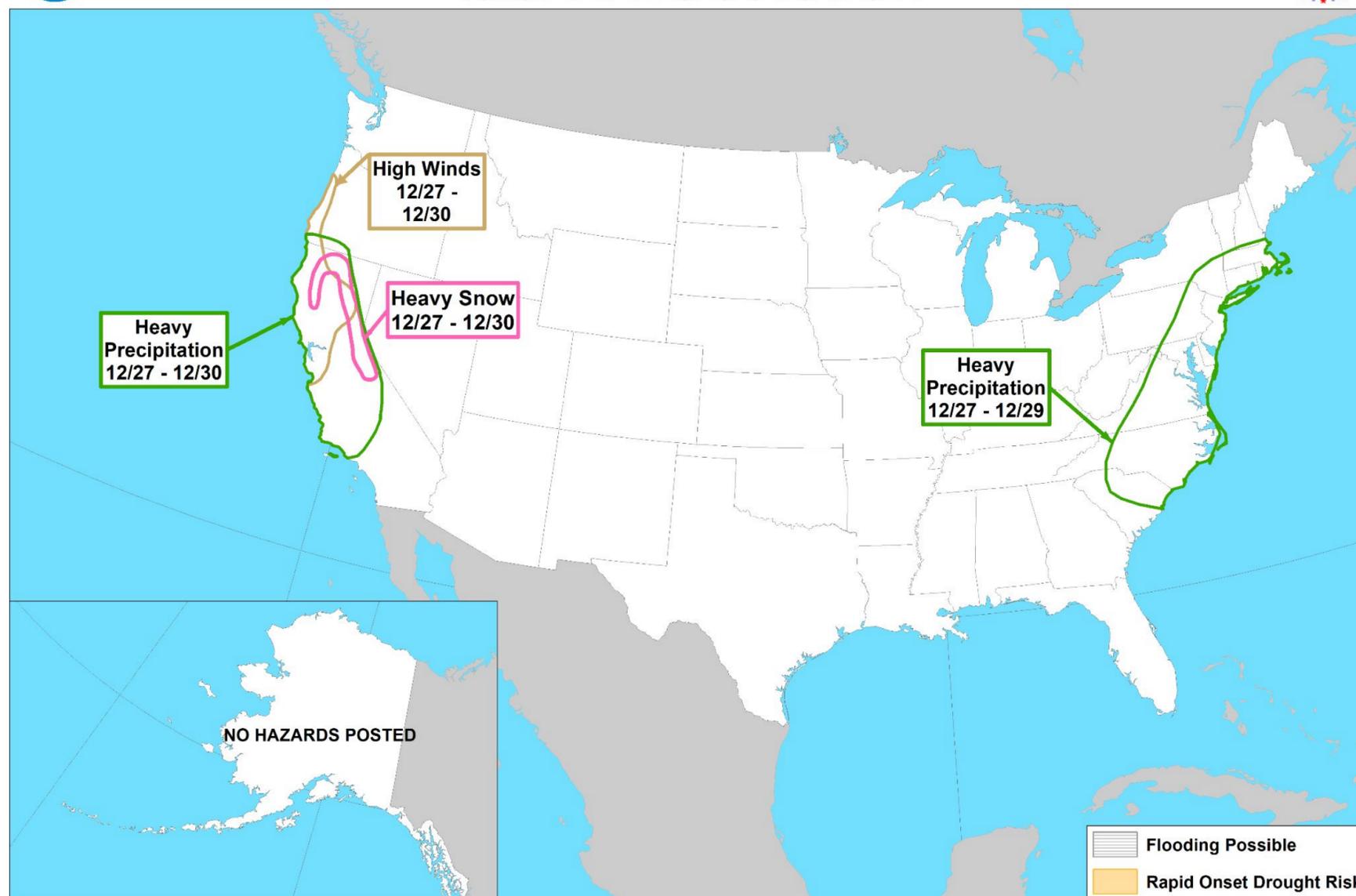
- Freezing levels are forecast to rise from around 3,000 feet before the event to around 6-7,000 following the event in the Queets-Quinault watershed
- There is significant uncertainty in the forecasted freezing levels through the duration of this AR.

# CW3E AR Outlook: 20 Dec 2023

## Climate Prediction Center 8-14 Day Hazard Outlooks



Day 8-14 U.S. Hazards Outlook  
Valid: 12/27/2023-01/02/2024



Climate Prediction Center

Made: 12/19/2023 3PM EST

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- The NWS Climate Prediction Center (CPC) issues Day 8-14 Hazard Outlooks for the US highlighting areas with elevated risk for Heavy Precipitation, High Winds and Heavy Snow.
- With the AR weakening and moving down the USWC, the elevated moisture that remains in the region is likely to continue influencing weather in inland Northern CA
- Current CPC hazard outlooks highlight risks of:
  - Heavy Precipitation in Central to Northern CA.
  - Heavy Snow in the Central and Northern Sierra Nevada, Southern Cascades, and Coastal Ranges of Northern CA.
  - High Winds in Northern CA and Coastal OR.

<https://www.cpc.ncep.noaa.gov/products/predictions/threats/threats.php>