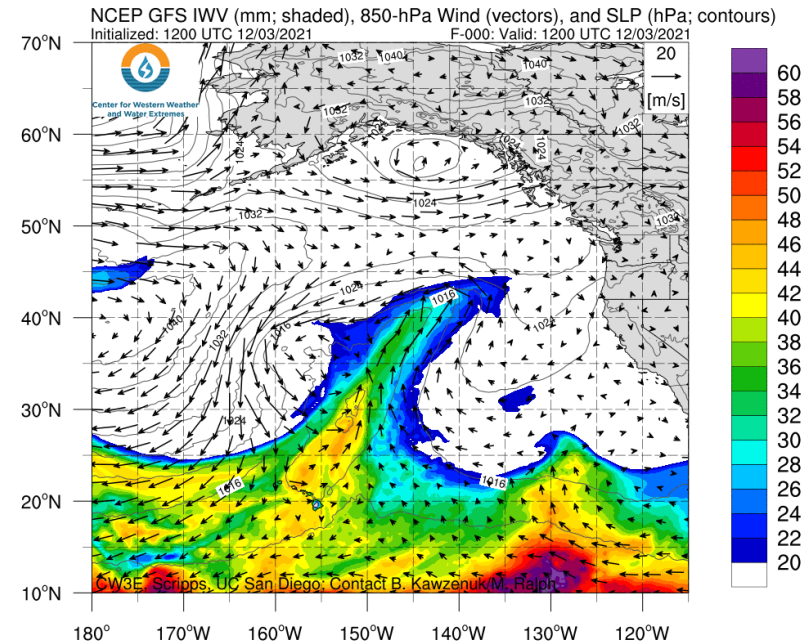
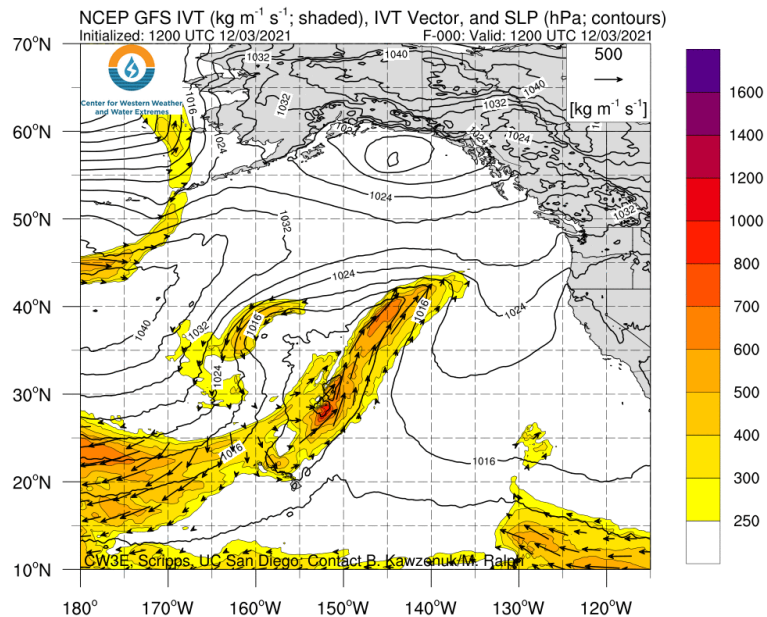


CW3E Atmospheric River Outlook

Multiple atmospheric rivers are forecast to make landfall over the US West Coast

- Two ARs and their parent lows are forecast to bring rain to the Pacific Northwest and parts of California over the next week
- These ARs are primarily being steered by persistent high pressure in the Eastern Pacific, which is resulting in a northwesterly orientation as the ARs make it to California
- Due to the northwesterly orientation of the IVT, the precipitation from these ARs will likely be much less than an AR of similar magnitude but a southwesterly orientation
- The parent lows of these ARs are forecast to move inland over the Pacific Northwest, which may result in very low freezing levels and snow showers at low elevations
- The WPC is currently forecasting ~3–5 inches of precipitation over the Cascades in Washington and 0.5 – 1.5 inches over the Sierra Nevada and Southern California Mountains

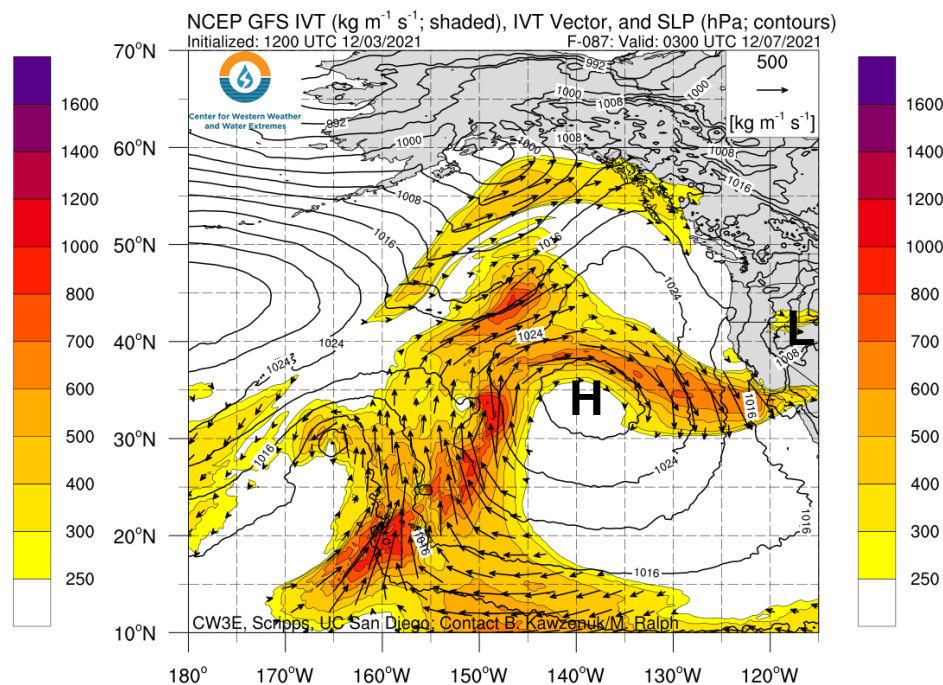
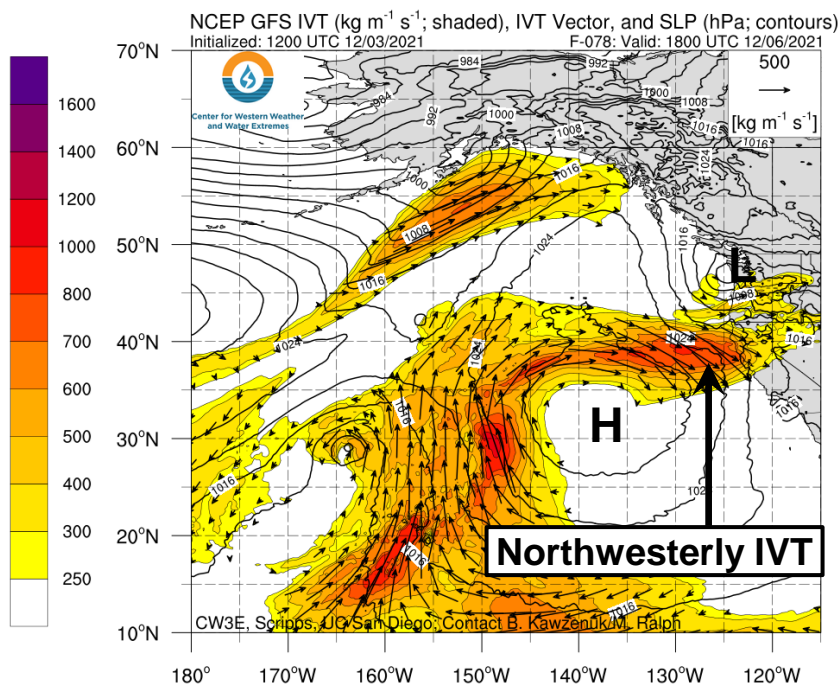
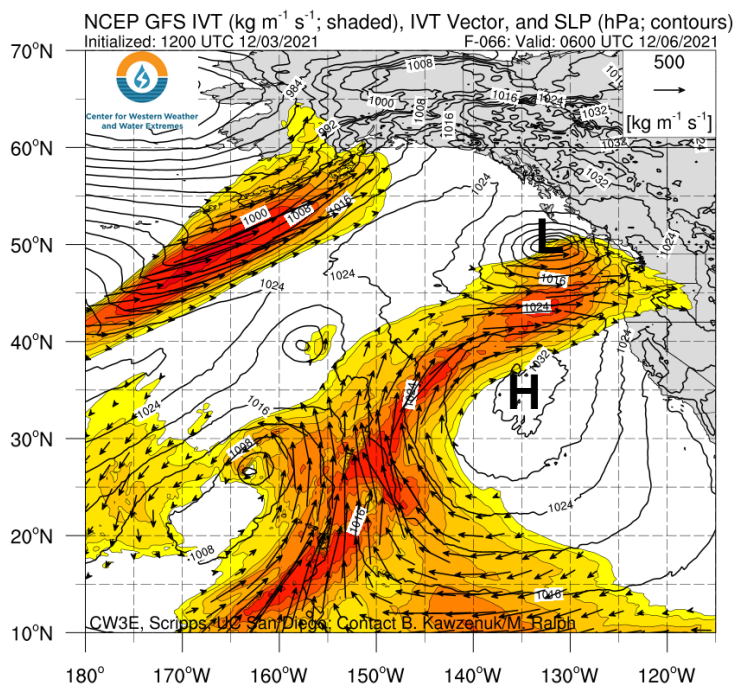


GFS IVT of the First AR

A) Valid: 10 PM PT 5 Dec 2021

B) Valid: 10 AM PT 6 Dec 2021

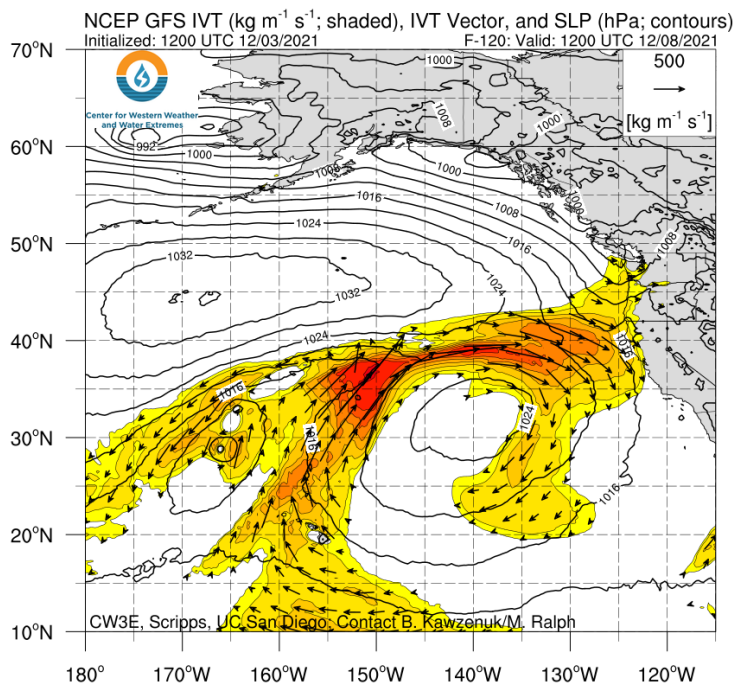
C) Valid: 7 PM PT 6 Dec 2021



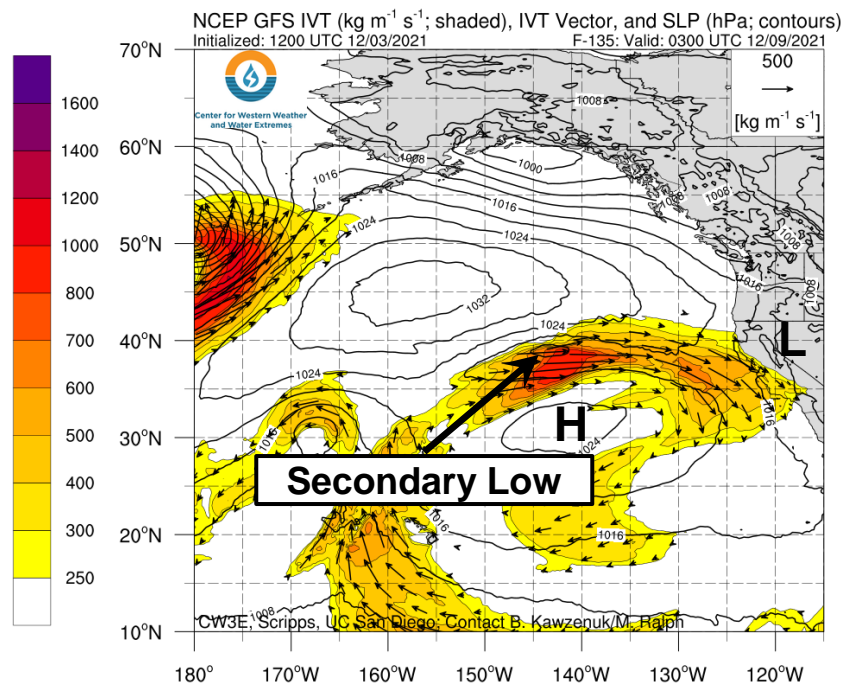
- The first AR is forecast to make landfall at ~11 PM PT on 5 December, bringing westerly IVT magnitudes of 400–600 kg/ms to coastal Washington and Oregon (Figure A)
- As the AR moves southward to coastal Northern California, the IVT is forecast to shift to a northwestward orientation on the downstream side of the persistent high pressure (Figure B)
- While the first AR is going to bring AR conditions to a majority of the California Coast, northwesterly to northerly IVT orientation will likely lead to minimal precipitation compared to an AR with a similar magnitude but a southwesterly orientation (Figure C)

GFS IVT of the Second AR

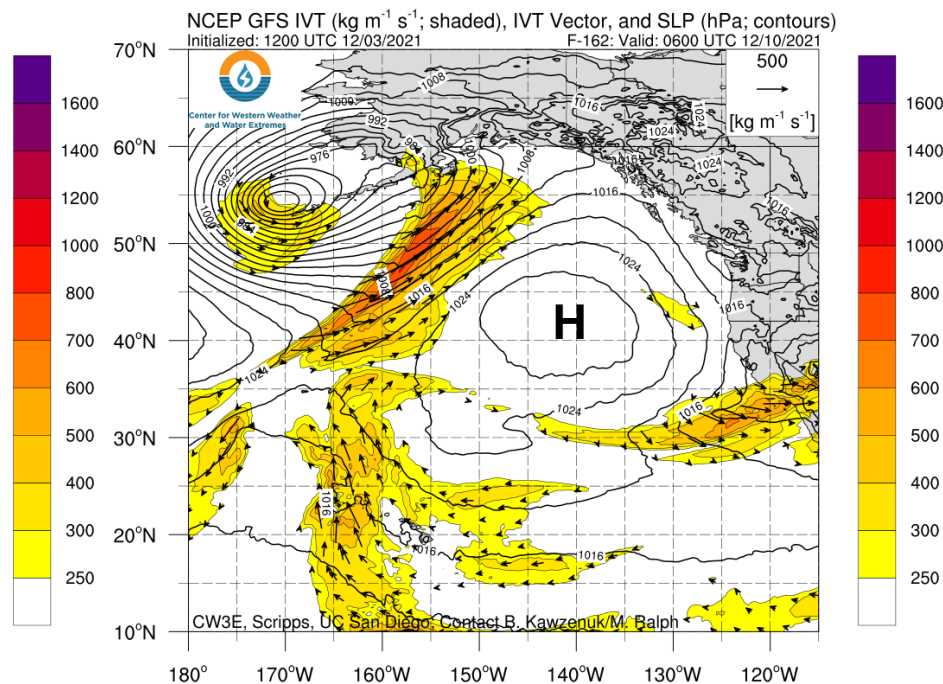
A) Valid: 4 AM PT 8 Dec 2021



B) Valid: 7 PM PT 8 Dec 2021



C) Valid: 10 PM PT 9 Dec 2021

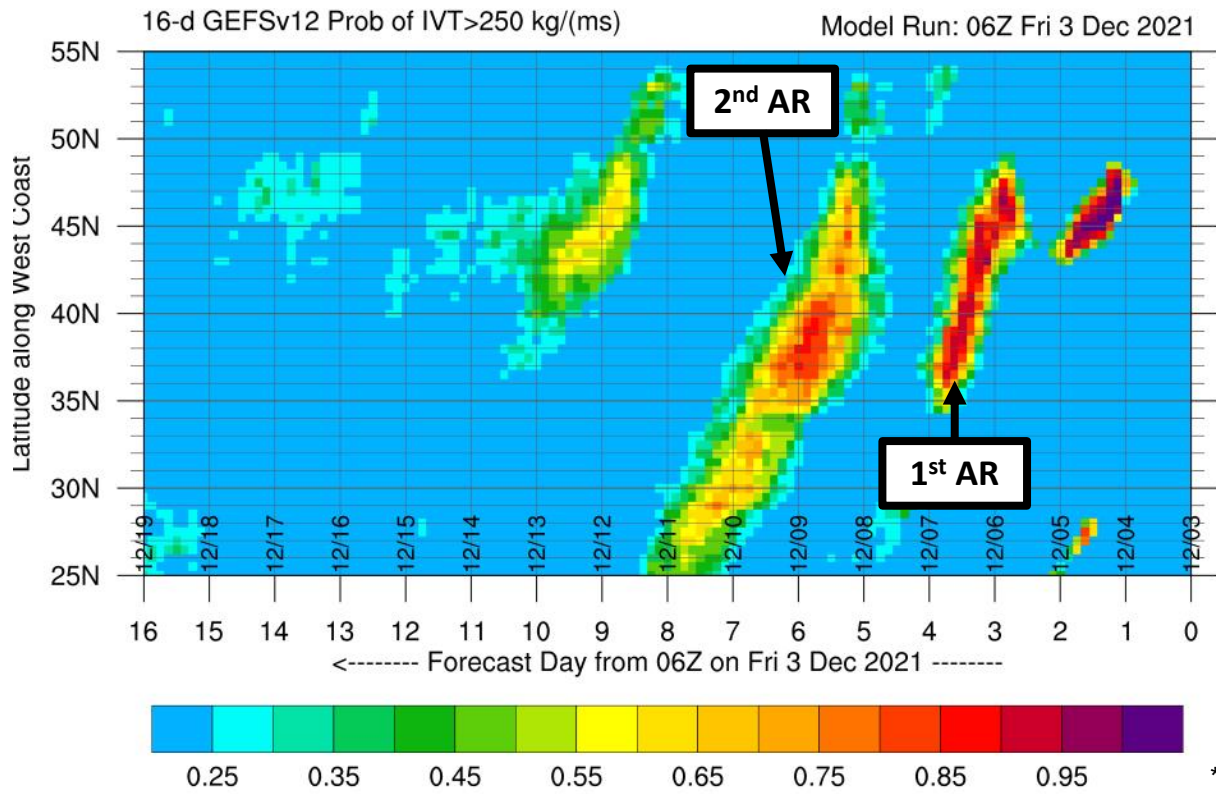


- The second AR is forecast to make landfall over N. CA and OR at 5 AM PT 8 December, but similar to the first AR, the IVT in the core of the AR is northwesterly, which is not conducive for upslope moisture flux over the mountains of CA (Figure A)
- As the second AR is skimming the CA Coast, a secondary low is forecast to generate between two high pressure systems, leading to stronger IVT in its vicinity (Figure B)
- The secondary low is then forecast to propagate otop of the high before making landfall over Southern California at 11 PM 9 December bringing IVT magnitudes of 500 to 600 kg/ms to the coast (Figure C)

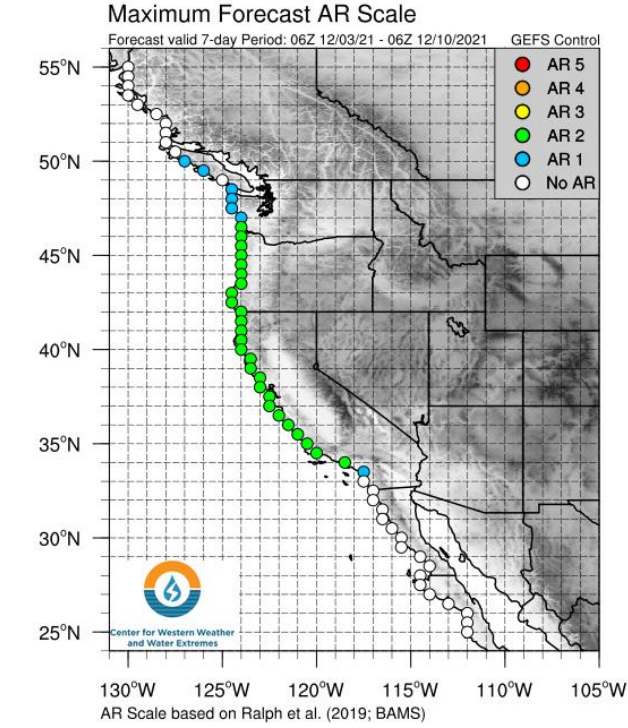
Atmospheric River Outlook: 03 December 2021

For California DWR's AR Program

Probability of AR Conditions Along Coast



AR Scale



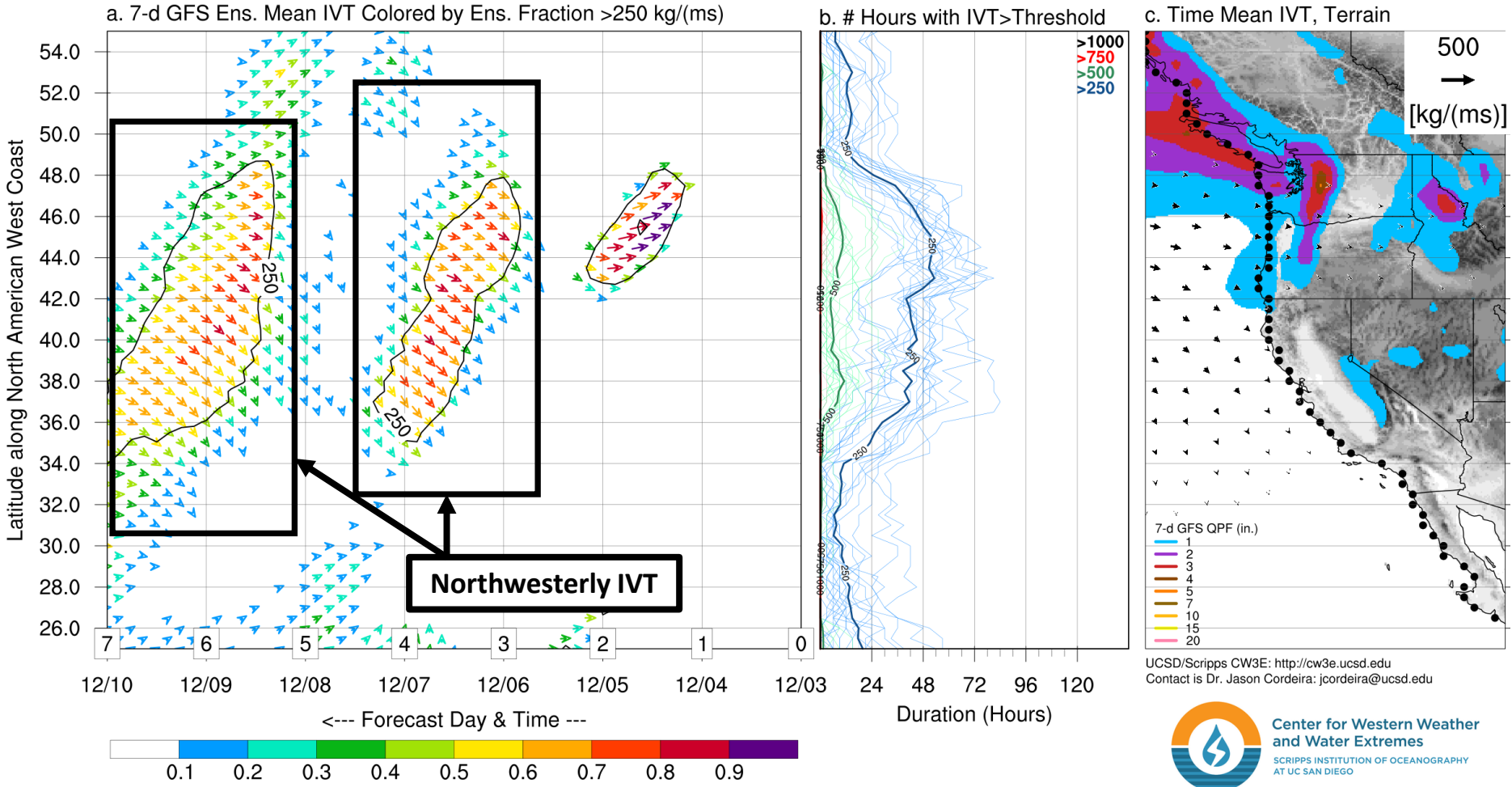
*GEFS = NCEP Global Ensemble Forecast System (United States)

- The GEFS is showing high confidence (> 80% probability) in a period of AR conditions over coastal Central California to southern Washington on 5-6 Dec in association with the first AR
- ~60-80% of ensembles are indicating AR conditions will impact most of the West Coast during a period from 8-11 Dec with the second AR
- The 12z GEFS control run is forecasting AR 2 conditions (based on the Ralph et al. 2019 AR Scale) from Los Angeles, CA to southern Washington

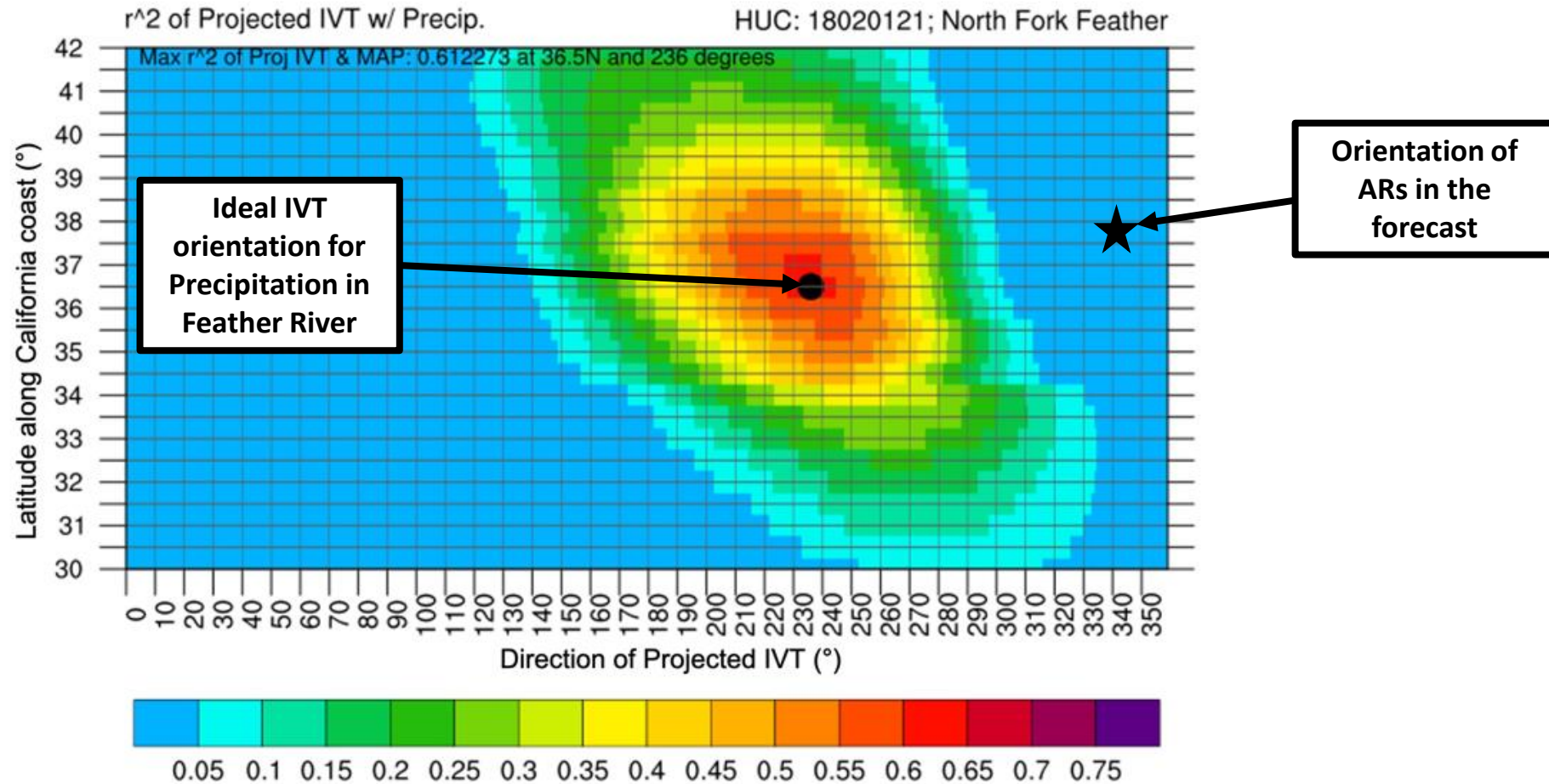
Atmospheric River Outlook: 03 December 2021

For California DWR's AR Program

AR Landfall Tool: 06Z Fri 3 Dec 2021



- While the GEFS landfall tool is showing a high probability of AR conditions over coastal California, the orientation of the moisture transport is forecast to be from the northwest, which is an unfavorable orientation for upslope moisture flux over the Coastal and Sierra Nevada Mountain Ranges of California
- Therefore, these two ARs are not likely to produce as much precipitation as an AR of similar magnitude but a southwesterly orientation



- Research by Ricciotti (2021) identified the IVT orientation that best correlated with precipitation within the watersheds throughout California
- In a watershed like the North Fork Feather, in Northern California, an AR orientation of ~240° (southwesterly) at ~36.5°N along the coast, resulted in the best correlation to precipitation.
- The ARs in the forecast are primarily from ~340° along the coast, resulting in a r² of <0.05 to precipitation over the Feather River

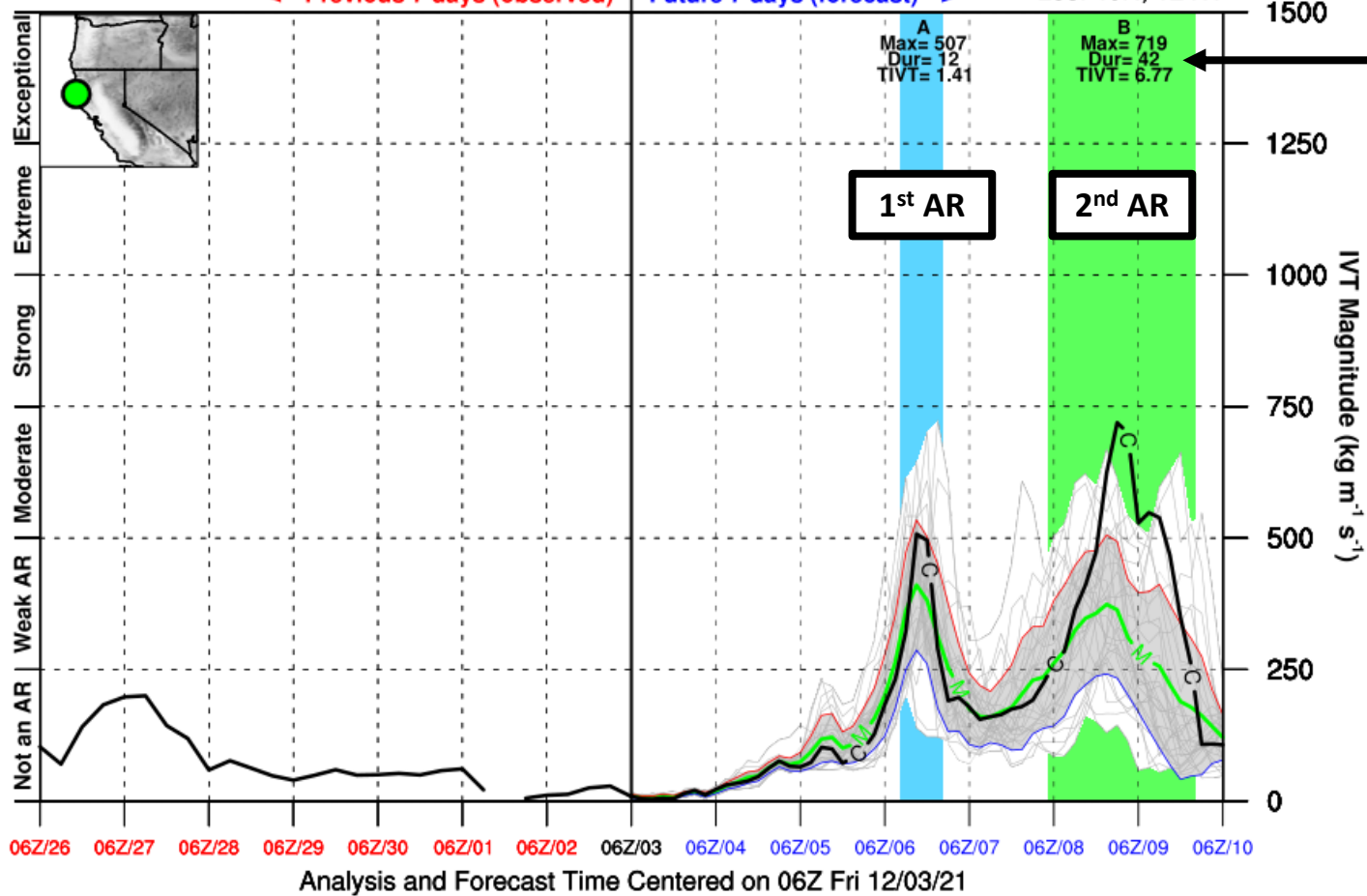
Atmospheric River Outlook: 03 December 2021

For California DWR's AR Program

GEFS AR Scale & IVT Analysis/Forecast Initialized 06Z Fri 12/03/21

<-- Previous 7 days (observed) | Future 7 days (forecast) -->

Loc: 40N, 124W



- The 06Z GEFS control member is predicting a maximum IVT of 719 kg/m/s and a total duration of AR conditions of 42 hours in Northern California, resulting in AR 2 conditions on the AR Scale
- There is significant ensemble spread in the overall timing, magnitude, and duration of the third AR, where 8 ensemble members are predicting AR 1 conditions, 12 for AR 2, and 1 for AR 3

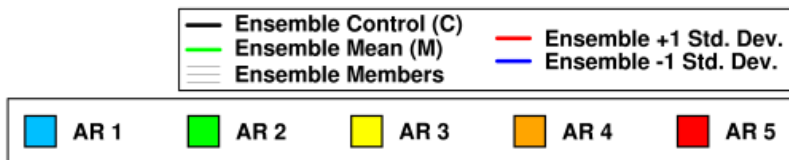
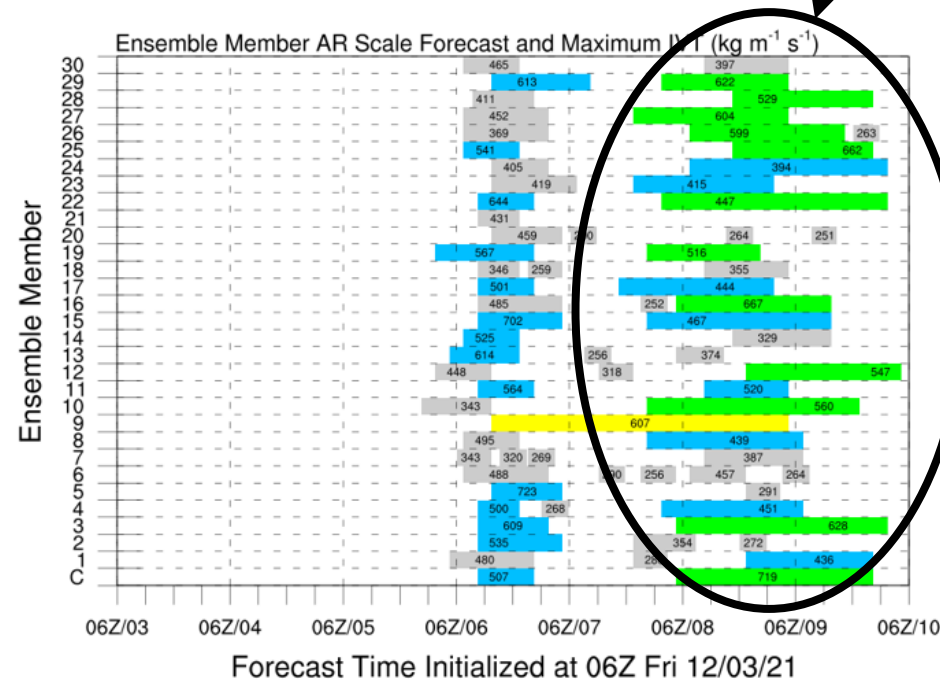


Image created: 10 UTC 12/03/2021

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

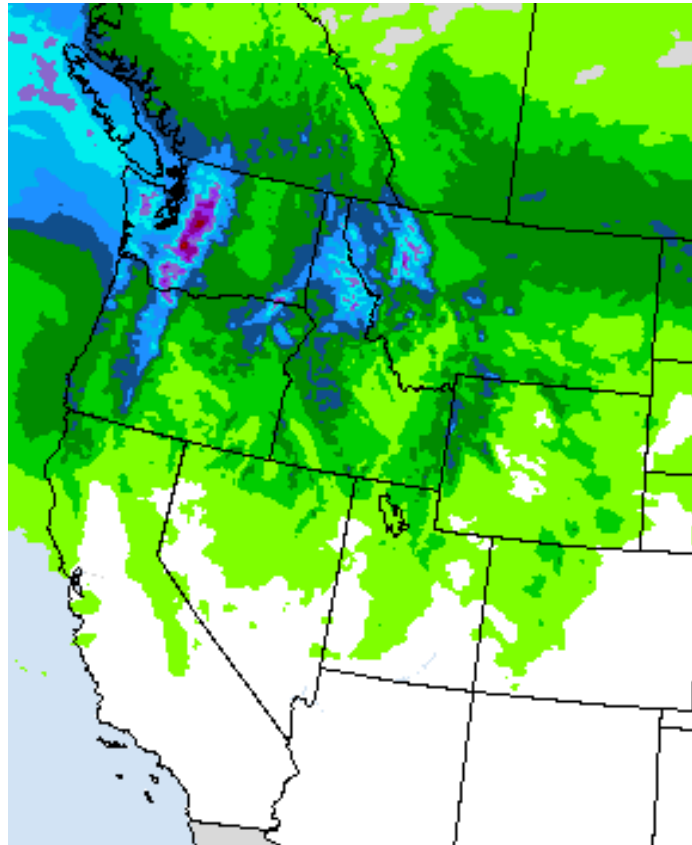
Atmospheric River Outlook: 03 December 2021



NOAA Weather Prediction Center Precipitation Forecasts

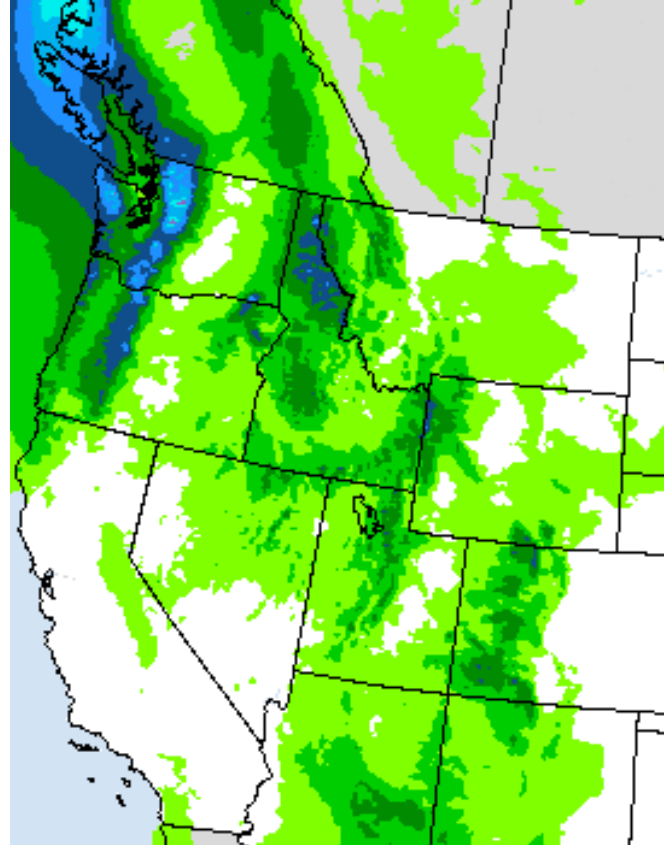
Days 1–3 QPF

Valid: 00Z 4-7 December



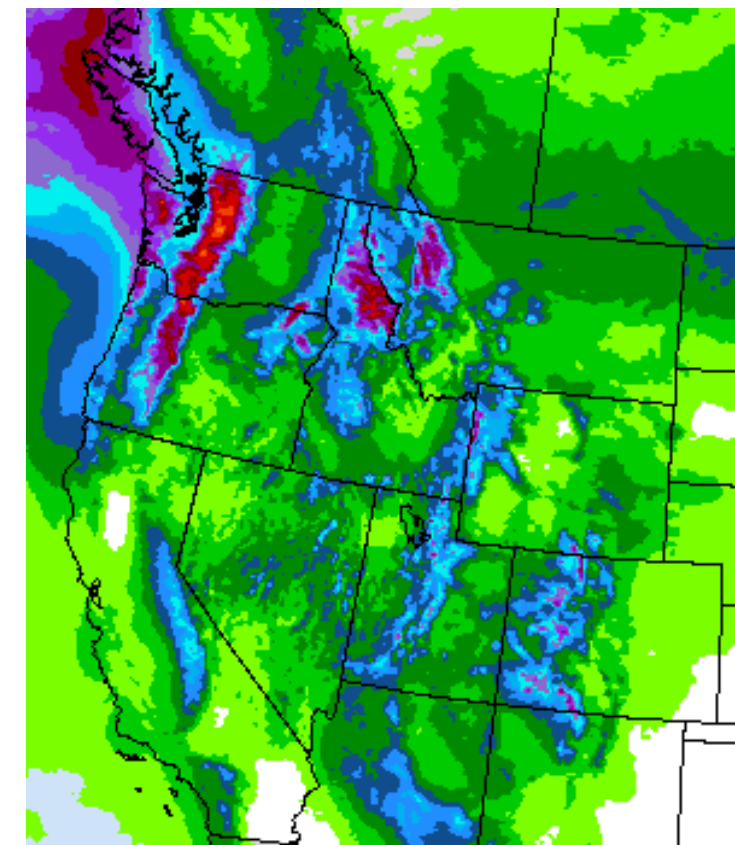
Days 4 & 5 QPF

Valid: 00Z 7-9 December



Days 1–7 QPF

Valid: 00Z 4-11 December

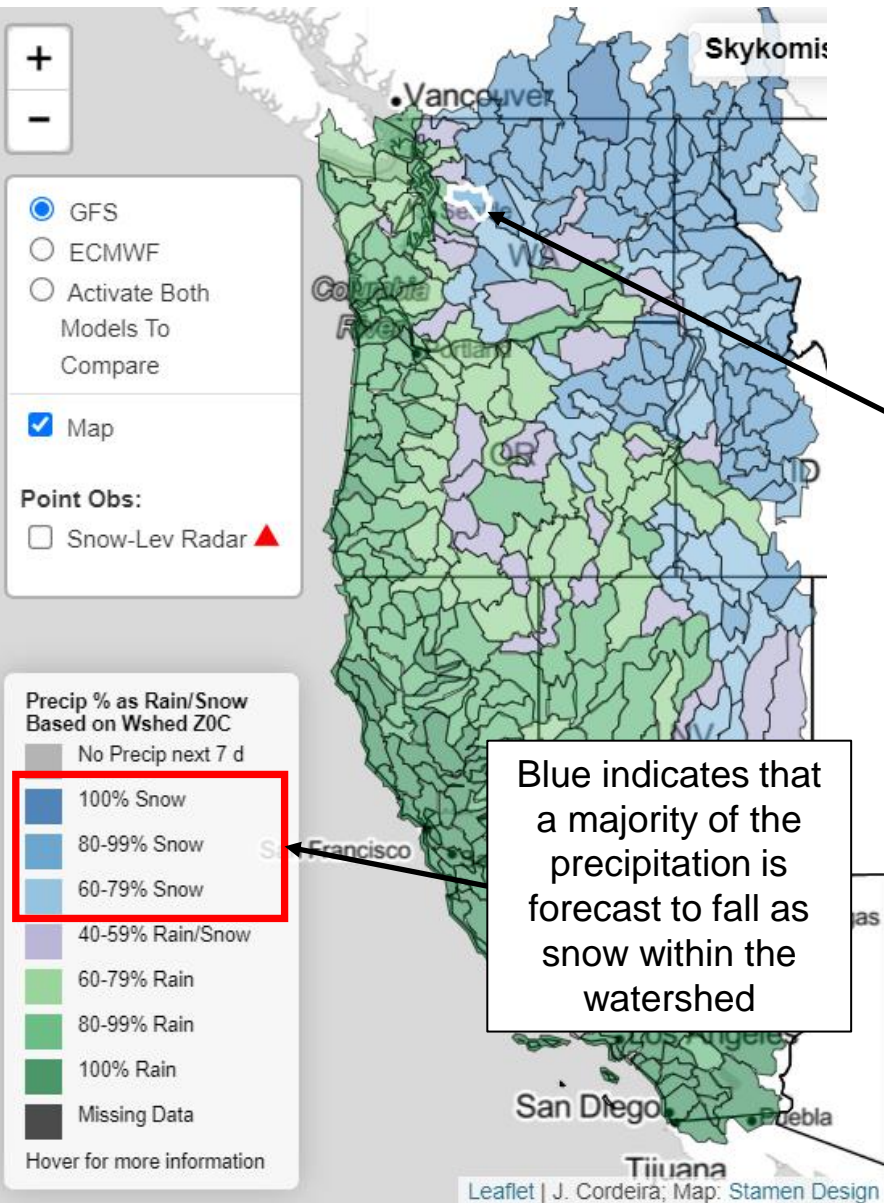


The WPC is currently forecasting >1.5 in. of precip. to fall over the higher elevations of the Cascade and Coastal Mountains in the PNW during 4, 5, & 6 Dec. from the first AR and parent low

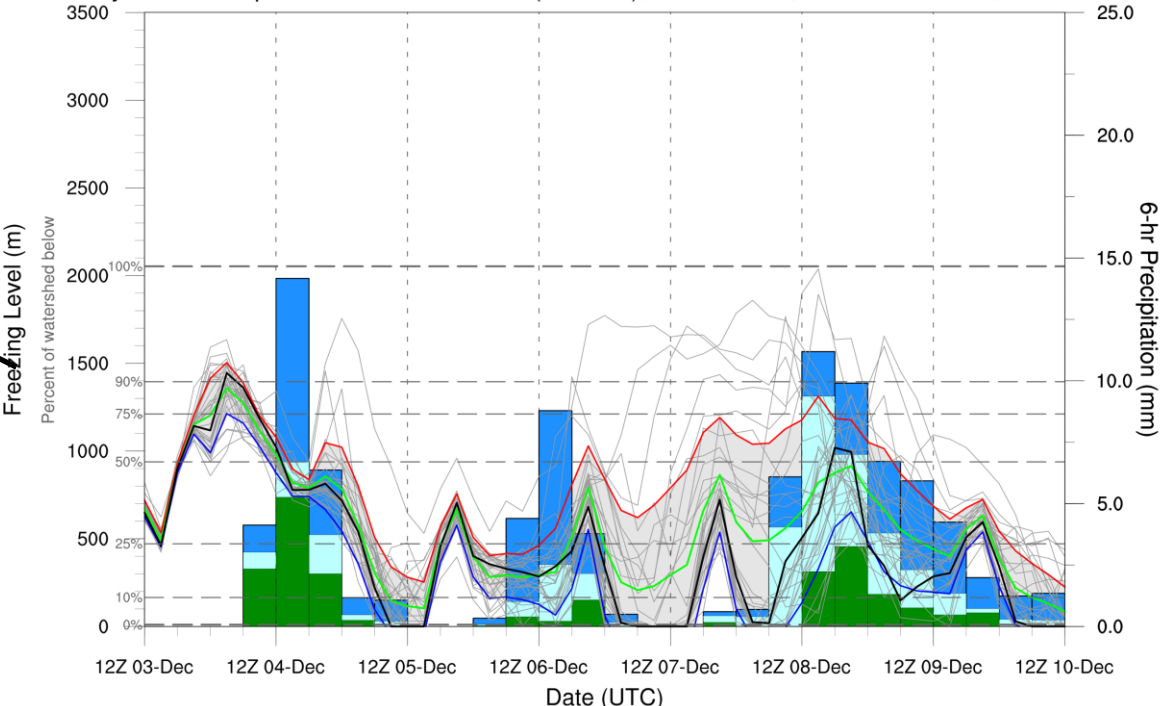
The second AR is not forecast to produce much precipitation over CA due to the northwesterly IVT, but the parent low is forecast to produce up to 1.5 inches over the Cascades of WA

In total, the Cascades in Washington, and Oregon could receive >3 in. whereas the Sierra Nevada and SoCal MTS. could receive >0.75 inches during the next 7 days

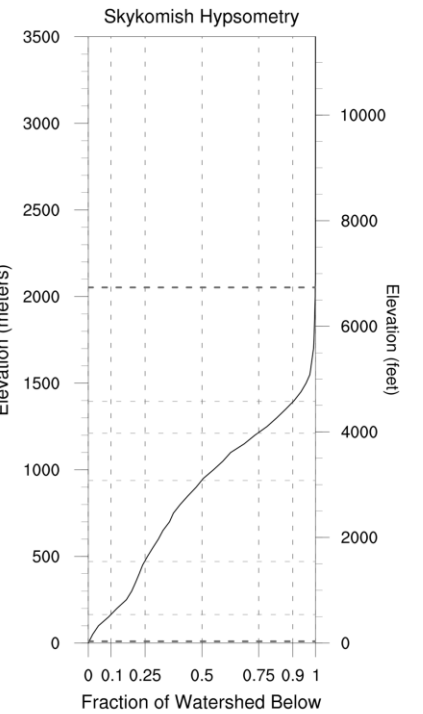
Atmospheric River Outlook: 03 December 2021



Skykomish; GEFS Forecast Initialized 2021-Dec-03 12 UTC
 7-day WPC Precipitation Total: 94.61 mm (3.725 in); 21.7% Rain, 31.2% Uncertain, 47.1% Snow



— Ensemble Control — Ensemble +1 Std. Dev. — Ensemble Members ■ Rain ■ Within Ensemble Uncertainty ■ Snow
 — Ensemble Mean — Ensemble -1 Std. Dev.



- As the parent low pressure system of these ARs moves onshore over the Pacific Northwest, freezing levels are forecast to drop substantially, bringing snow to a majority of the mountains and the potential for snow showers down to sea-level on Sunday night.
- The GEFS is currently predicting that 47.1% of the precipitation within the Skykomish watershed will fall as snow with 31.2% in the uncertain range over the next 7 days.