

# CW3E Atmospheric River Outlook: 20 December 2022

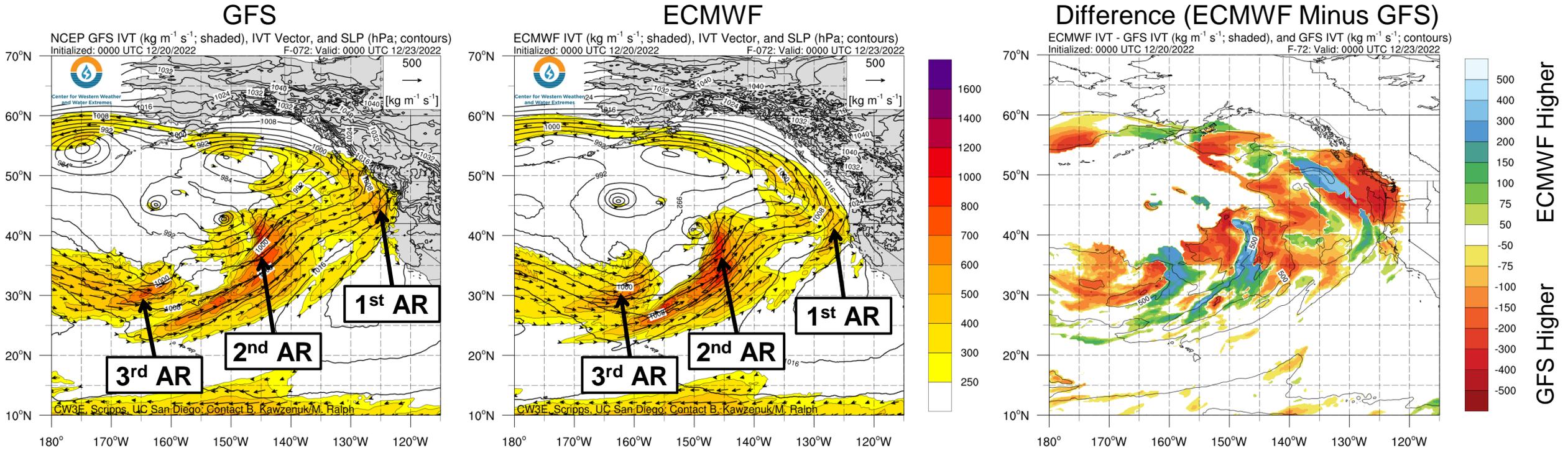
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## Potential for Multiple Atmospheric River Landfalls Over the US West Coast

- A series of atmospheric rivers (ARs) is forecast to move across the Northeast Pacific and make landfall along the West Coast of North America in rapid succession during 22–27 Dec. Per [Fish et al. \(2019\)](#), these types of multi-AR events, known as “AR families,” are not uncommon during boreal winter.
- Current model forecasts suggest that AR landfall during this period is most likely to occur over the Pacific Northwest and British Columbia, but there is considerable uncertainty in the timing, location, and intensity of these ARs
- Models are also showing the potential for landfalling AR activity in California during 28–31 Dec, but there is lower forecast confidence given the longer lead times
- The 00Z GEFS is showing a high likelihood of AR 3 or greater conditions (based on the Ralph et al. 2019 AR Scale) over coastal Oregon during the next 7 days
- Some locations are forecast to experience AR conditions for more than 96 consecutive hours across multiple AR landfalls
- These ARs are forecast to produce more than 5 inches of total precipitation over the Pacific Coast Ranges and Cascades during the next 7 days, with more than 10 inches possible in the Olympic Mountains
- There are large model differences in forecast precipitation, with the 00Z ECMWF forecasting lower precipitation amounts in western Washington and higher precipitation amounts near the Oregon/California border compared to the 00Z GFS

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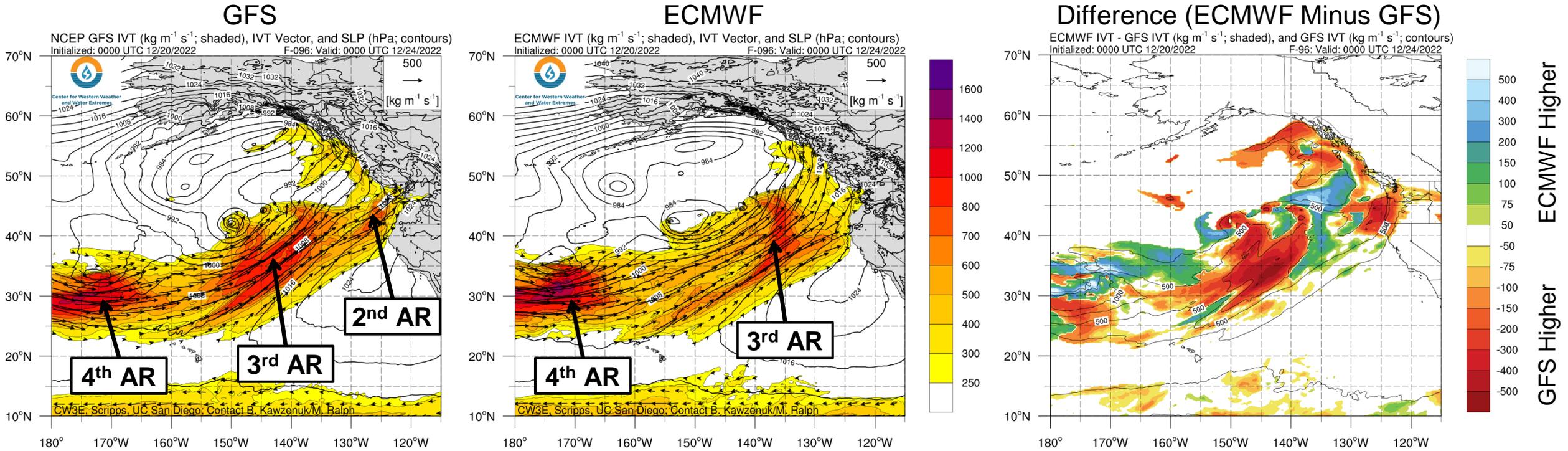
## Model IVT & SLP Forecasts: Valid 4 PM PT 22 Dec (F-72)



- Global forecast models are showing a prolonged period of AR activity over the Northeast Pacific Ocean, with multiple AR landfalls possible over the US West Coast
- The 00Z GFS is forecasting a weakening AR associated with a large low-pressure system to make landfall over the Pacific Northwest around midday 22 Dec
- Compared to the GFS, the 00Z ECMWF is forecasting this AR to make landfall about 6 hours later and bring weaker IVT magnitudes to Washington and Oregon

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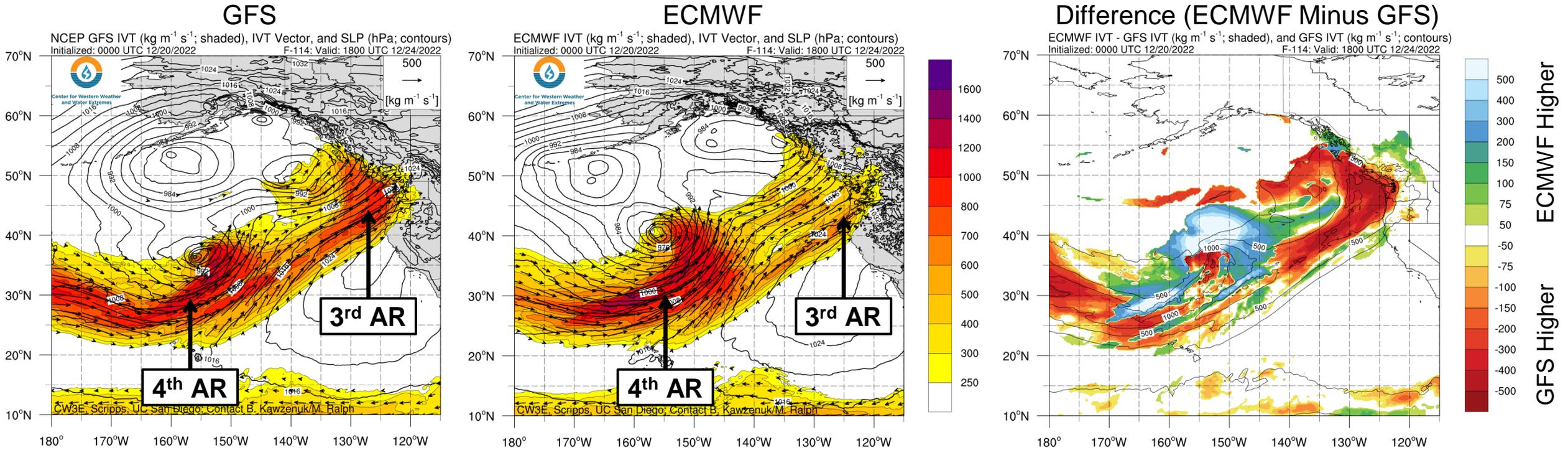
## Model IVT & SLP Forecasts: Valid 4 PM PT 23 Dec (F-96)



- After the first AR dissipates, the GFS is forecasting the second AR and surface low to bring a stronger pulse of IVT  $> 500 \text{ kg m}^{-1} \text{ s}^{-1}$  to the Oregon coast on 23 Dec
- The ECMWF is forecasting the second and third ARs to merge, with the third AR progressing across the Northeast Pacific much more rapidly than in the GFS

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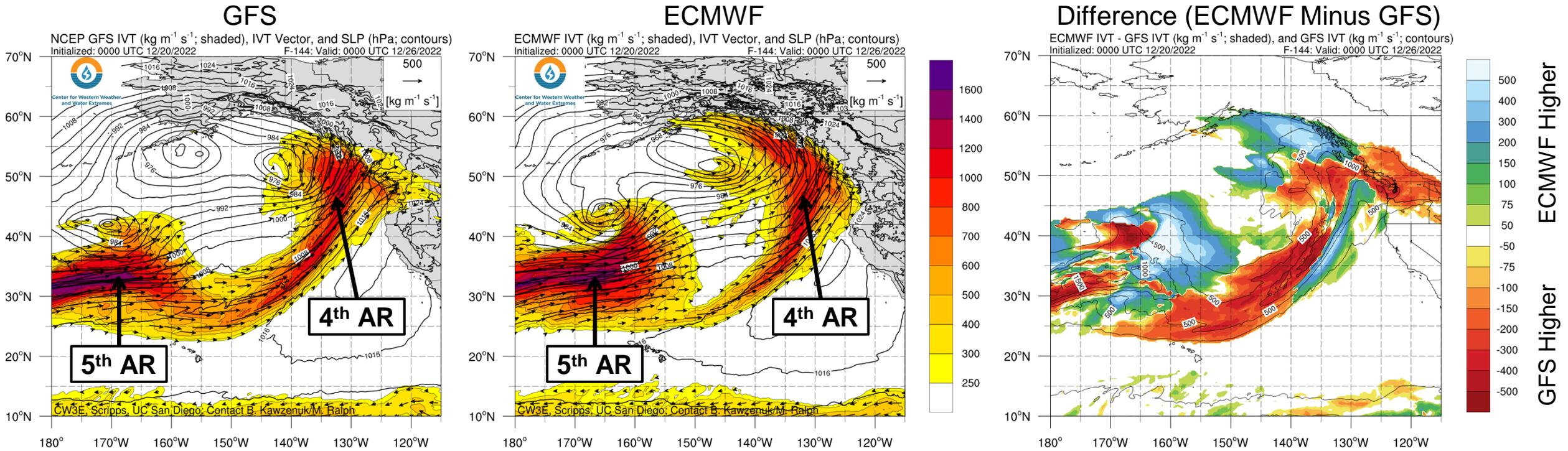
## Model IVT & SLP Forecasts: Valid 10 AM PT 24 Dec (F-114)



- The GFS is forecasting the third AR to make landfall over the Pacific Northwest during the early morning of 24 Dec and bring strong AR conditions ( $\text{IVT} > 750 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to coastal Washington and Oregon
- The ECMWF is forecasting the third AR to initially make landfall over British Columbia during the evening of 23 Dec and eventually bring moderate AR conditions ( $\text{IVT} > 500 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to coastal Washington and Oregon
- Compared to the GFS, the ECMWF is forecasting an earlier AR landfall and weaker moisture transport in the core of the third AR

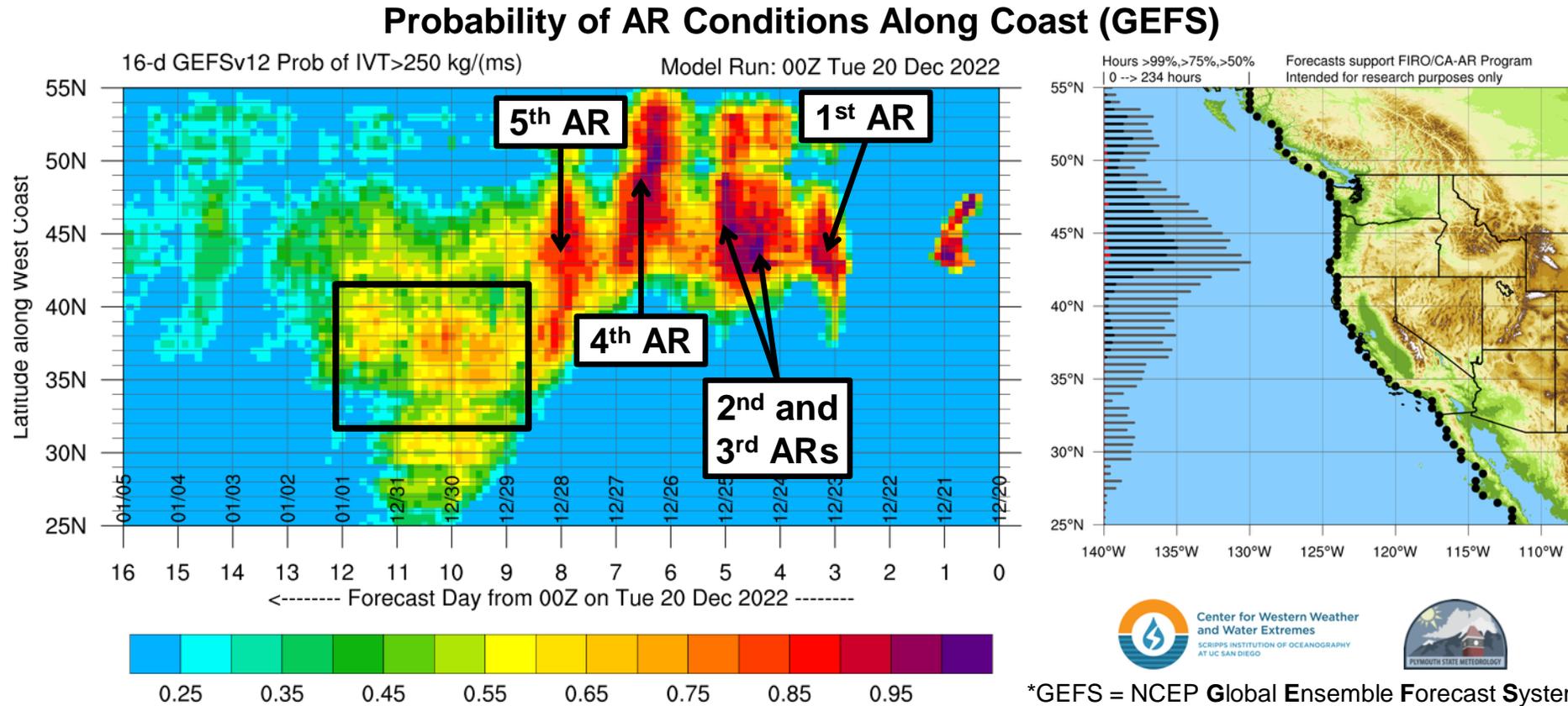
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## Model IVT & SLP Forecasts: Valid 4 PM PT 25 Dec (F-144)



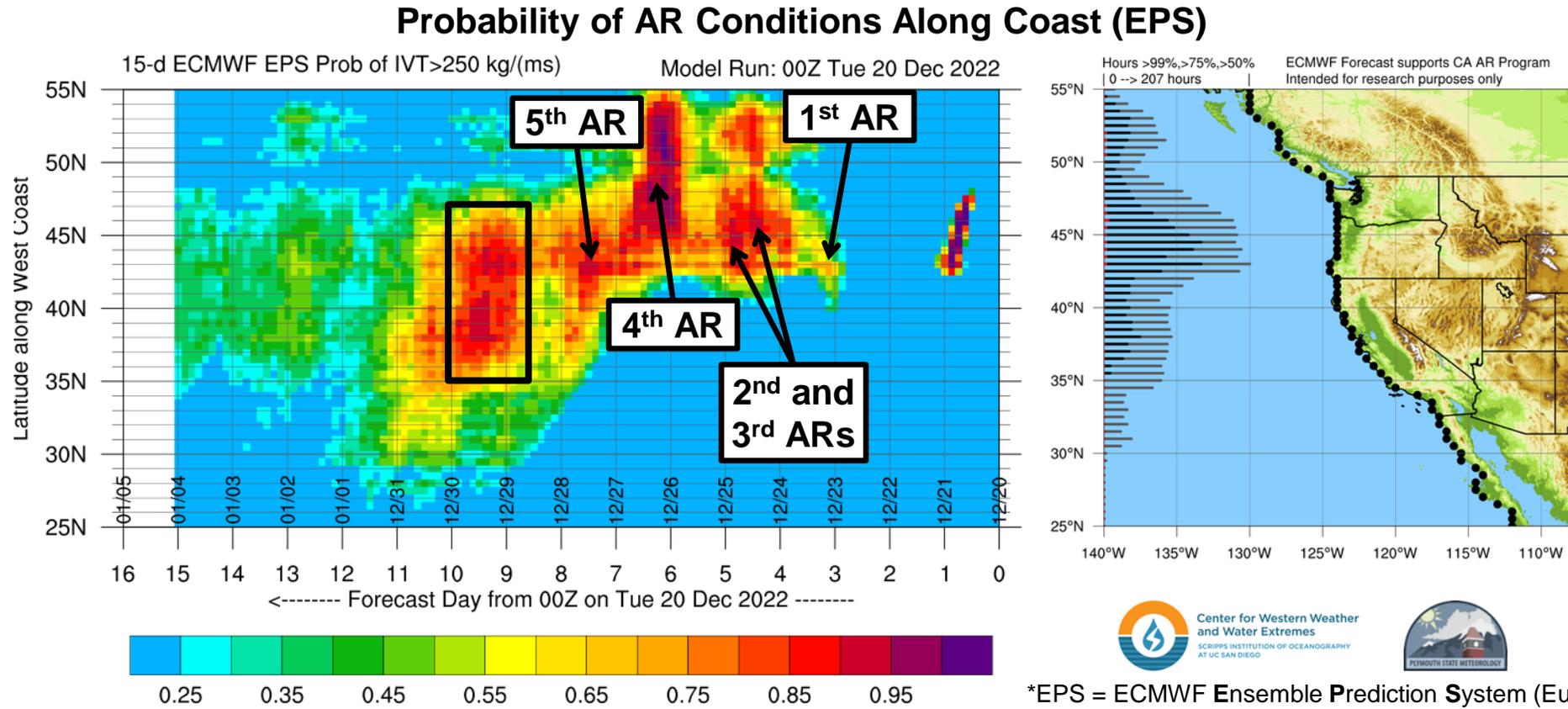
- The fourth AR is forecast to make landfall along the West Coast of North America in association with a strong low-pressure system on 25 Dec
- Both models are forecasting strong AR conditions ( $\text{IVT} > 750 \text{ kg m}^{-1} \text{ s}^{-1}$ ) over coastal British Columbia and moderate AR conditions ( $\text{IVT} > 500 \text{ kg m}^{-1} \text{ s}^{-1}$ ) over Washington and Oregon
- Compared to the GFS, the ECMWF is forecasting much higher IVT magnitudes wrapping around the surface low into the Gulf of Alaska, and weaker IVT magnitudes over the interior Pacific Northwest

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- The 00Z GEFS is showing high confidence (> 80% probability) in multiple periods of AR conditions ( $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) over the Pacific Northwest in association with multiple landfalling ARs between 22 Dec and 28 Dec
- There is moderate-to-high confidence (65–85% probability) in AR conditions over Northern California during 27–28 Dec
- Some ensemble members are predicting AR conditions to persist for several consecutive days along the Oregon coast
- There is also potential for landfalling AR activity over California and Baja California during 28–31 Dec, with higher confidence in Northern California (60–85% probability) than in Southern California (50–70% probability)

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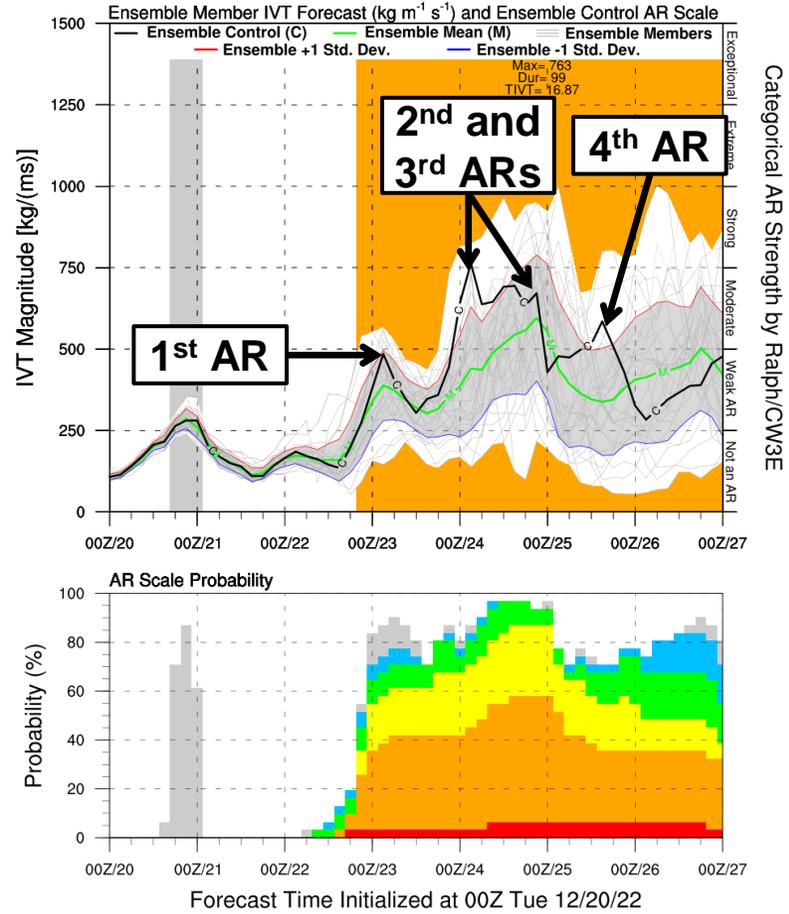


- Compared to the 00Z GEFS, the 00Z EPS is showing lower probabilities of AR conditions over southern Oregon (60–85%) and Northern California (generally < 50%) during 22–24 Dec
- There are differences in the timing of the third, fourth, and fifth ARs, with EPS generally predicting these ARs to make landfall 6–12 hours earlier than GEFS
- Compared to GEFS, EPS is also showing much higher confidence (80–95% probability) in AR conditions over Oregon and Northern California on 28–29 Dec, and lower confidence (40–55% probability) in AR conditions over Southern California

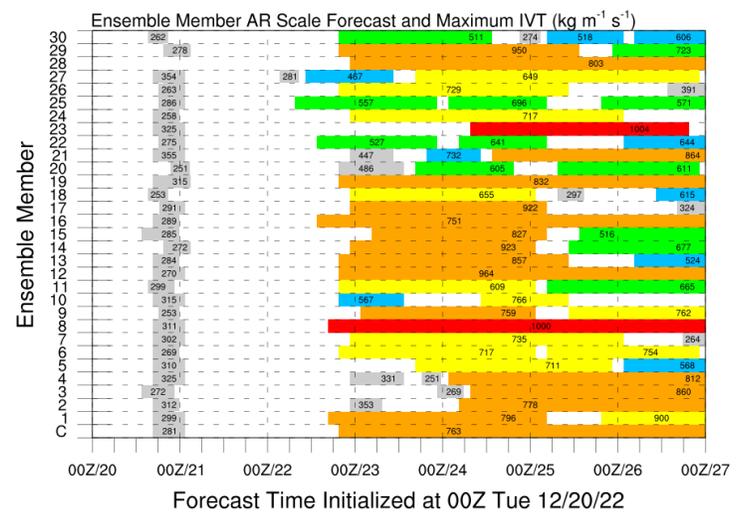
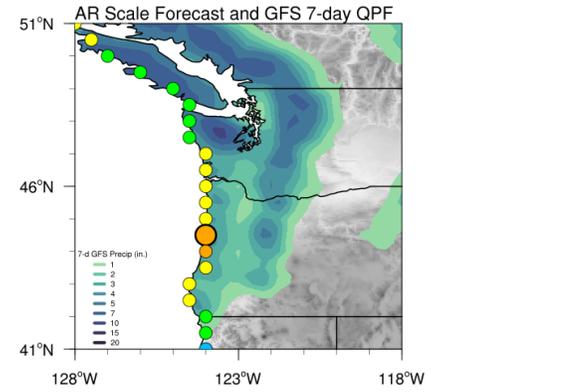
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## GEFS AR Scale and IVT Forecasts

GFS Ensemble Initialized: 00Z Tue 12/20/22



Location: 44.5°N 124°W



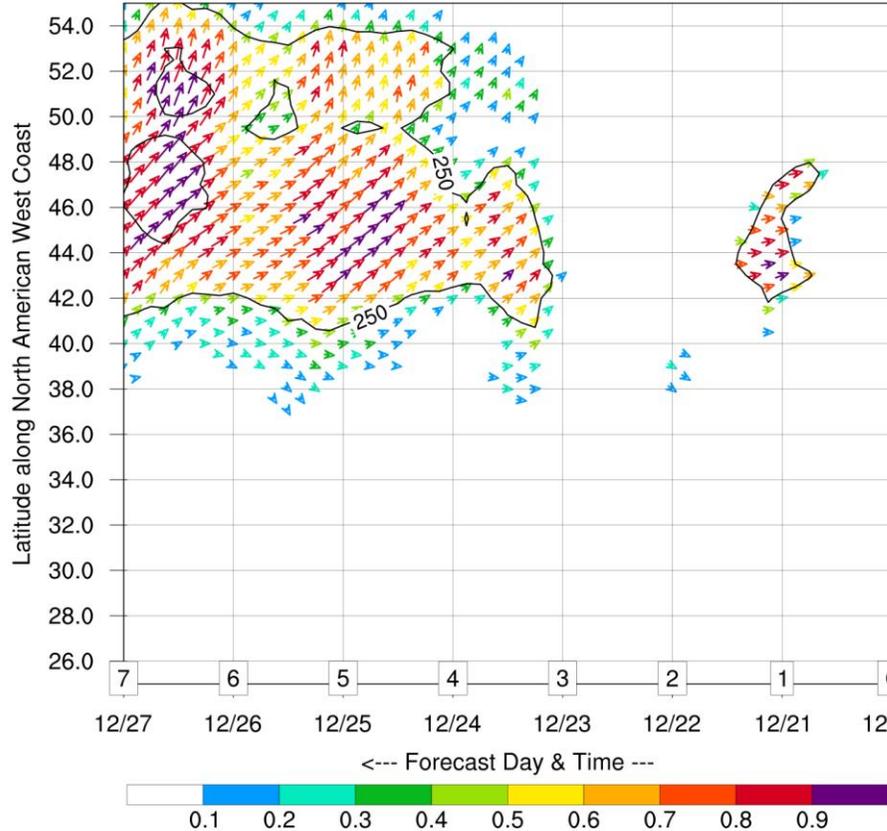
- The 00Z GEFS control is forecasting AR 3/AR 4 conditions over coastal Oregon and southern coastal Washington during the next 7 days
- 27/31 (87%) ensemble members are predicting an AR 3 or greater at 44.5°N, 124°W (Lincoln County, OR), and 18/31 (58%) are predicting an AR 4 or greater
- Some ensemble members, including the GEFS control, are forecasting > 96 hours of continuous AR conditions across multiple AR landfalls during 22–26 Dec
- All ensemble members are predicting a maximum IVT > 500  $\text{kg m}^{-1} \text{s}^{-1}$  at this location during the next 7 days, and 20/31 (65%) are predicting a maximum IVT > 750  $\text{kg m}^{-1} \text{s}^{-1}$
- There is considerable forecast uncertainty in the timing, duration, and intensity of these ARs

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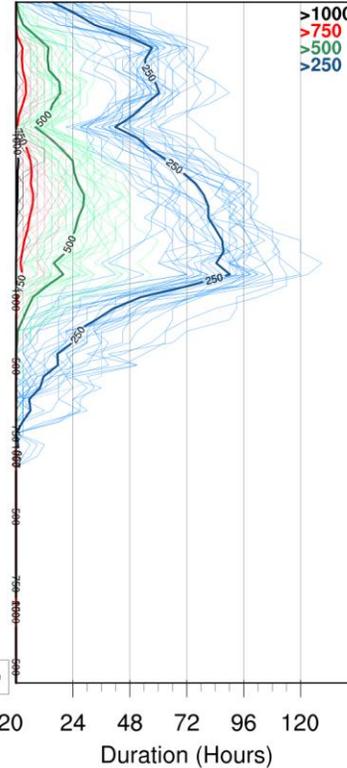
## GEFS Landfall Tool with IVT Vectors and GFS QPF

GEFS AR Landfall Tool: 00Z Tue 20 Dec 2022

a. 7-d GFS Ens. Mean IVT Colored by Ens. Fraction >250 kg/(ms)



b. # Hours with IVT > Threshold



c. Time Mean IVT, Terrain



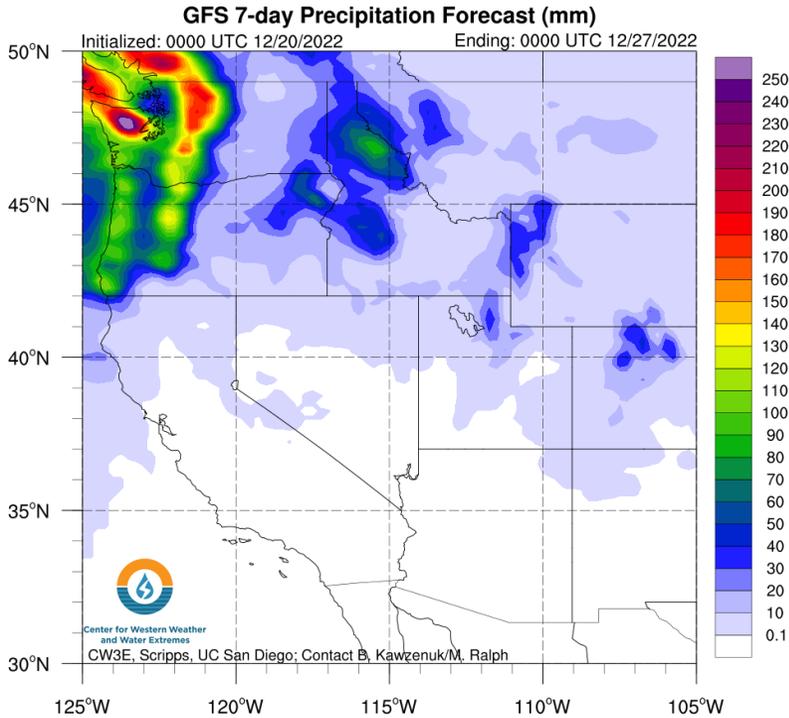
- Although locations along the central Oregon coast are forecast to experience the longest durations of AR conditions, the heaviest precipitation is forecast farther north
- This is likely due the southwesterly orientation of the IVT vectors, which leads to stronger orographic enhancement of precipitation over the Olympic Peninsula and Vancouver Island



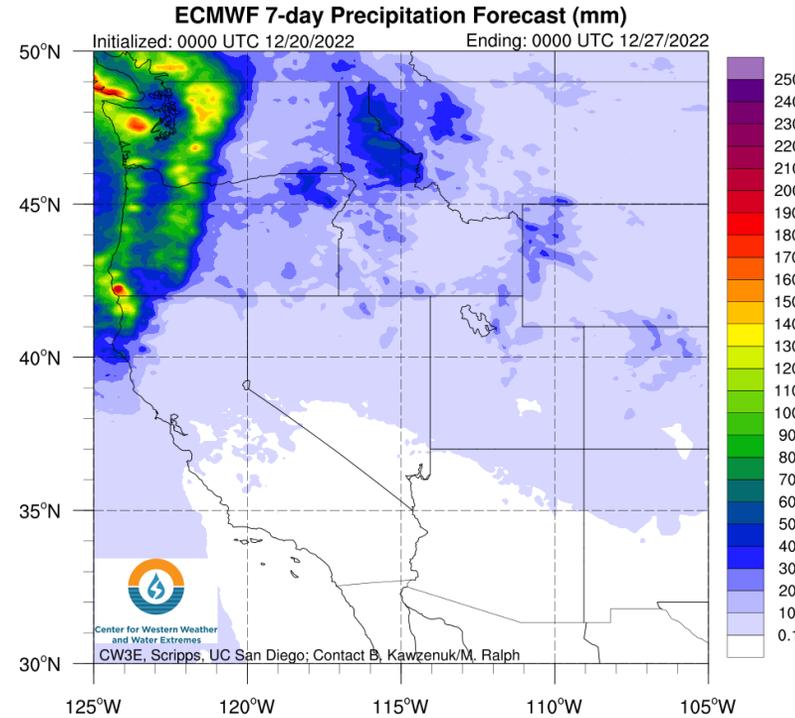
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## 7-day Model Precipitation Forecasts: Valid 4 PM 26 Dec

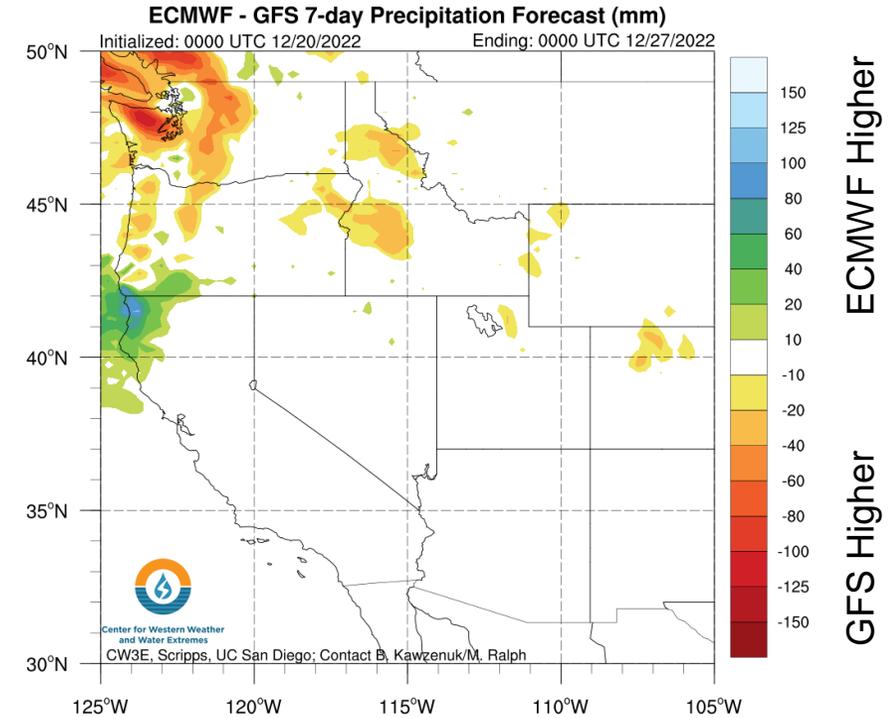
GFS



ECMWF



Difference (ECMWF Minus GFS)



- More than 5 inches of total precipitation are forecast over portions of the Pacific Coast Ranges and Cascades during the next 7 days, with more than 10 inches possible in the Olympic Mountains
- Compared to the GFS, the ECMWF is forecasting lower precipitation over the Olympic Mountains and Washington Cascades, and higher precipitation over the Coast Ranges near the Oregon/California border