

CW3E Atmospheric River Outlook

For California DWR's AR Program

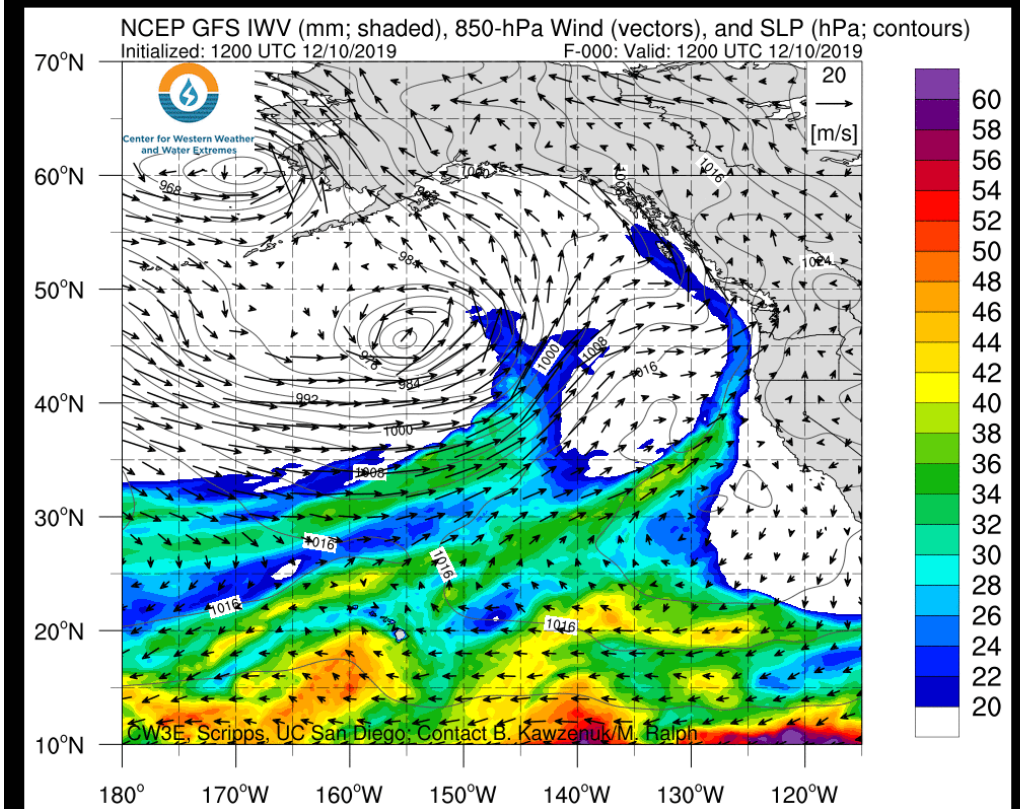
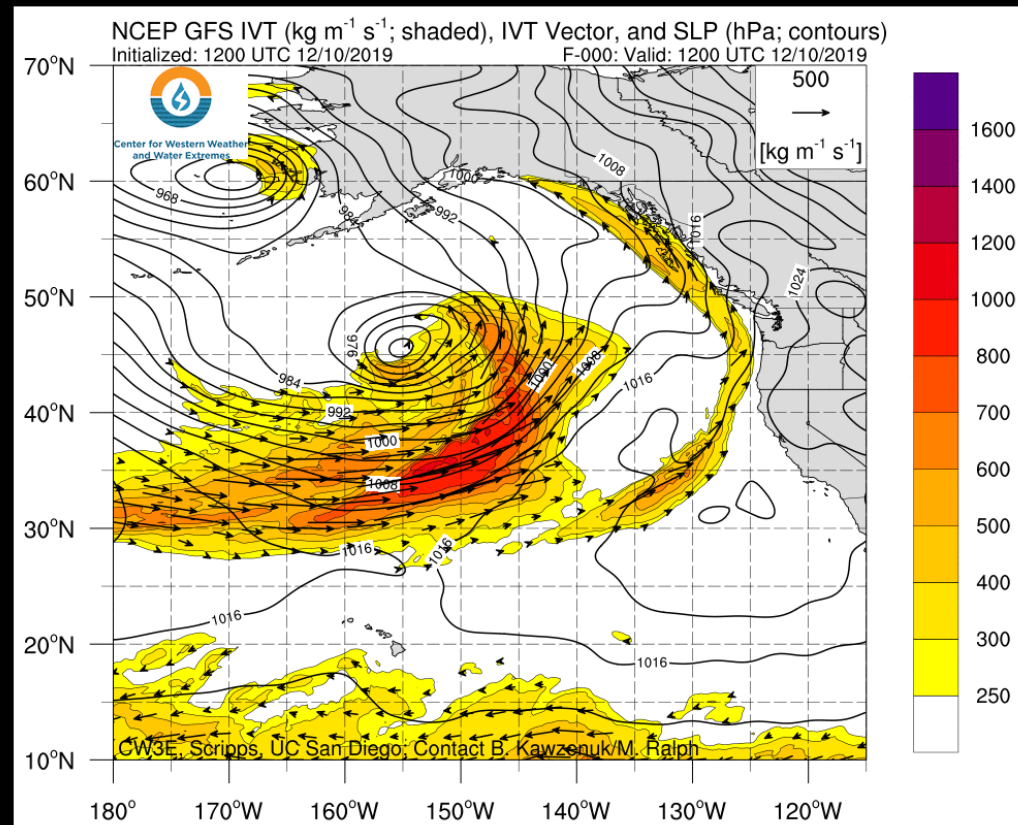


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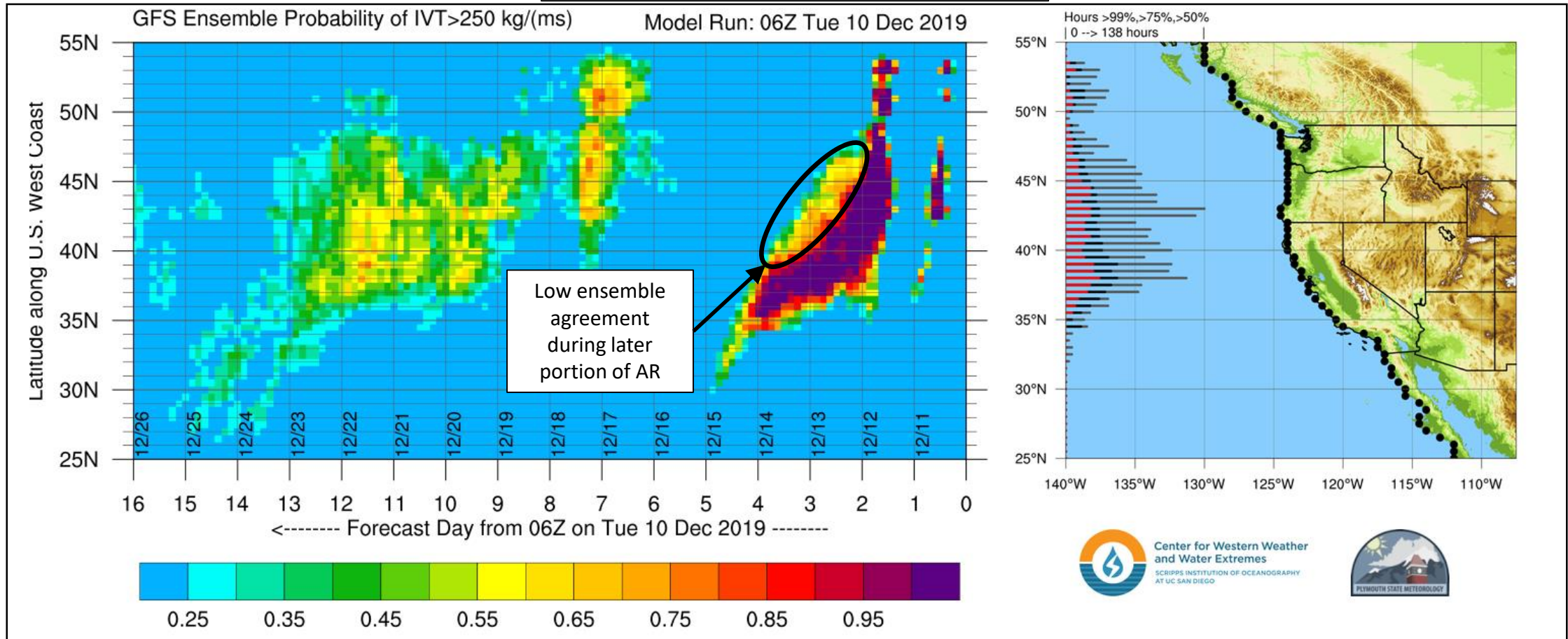
An Atmospheric River is Forecast to Make Landfall over Southern Oregon and Northern California Tomorrow, 11 Dec. 2019

- An AR is currently forecast to bring AR1/AR2 conditions to coastal locations from North/Central CA to WA
- The potential development of a MFW is introducing large forecast uncertainty in the overall duration of AR conditions over Southern OR and Northern CA
- Several high elevation locations from Northern CA to WA could receive >2 inches of precipitation in association with this event





Odds of AR Conditions Along Coast

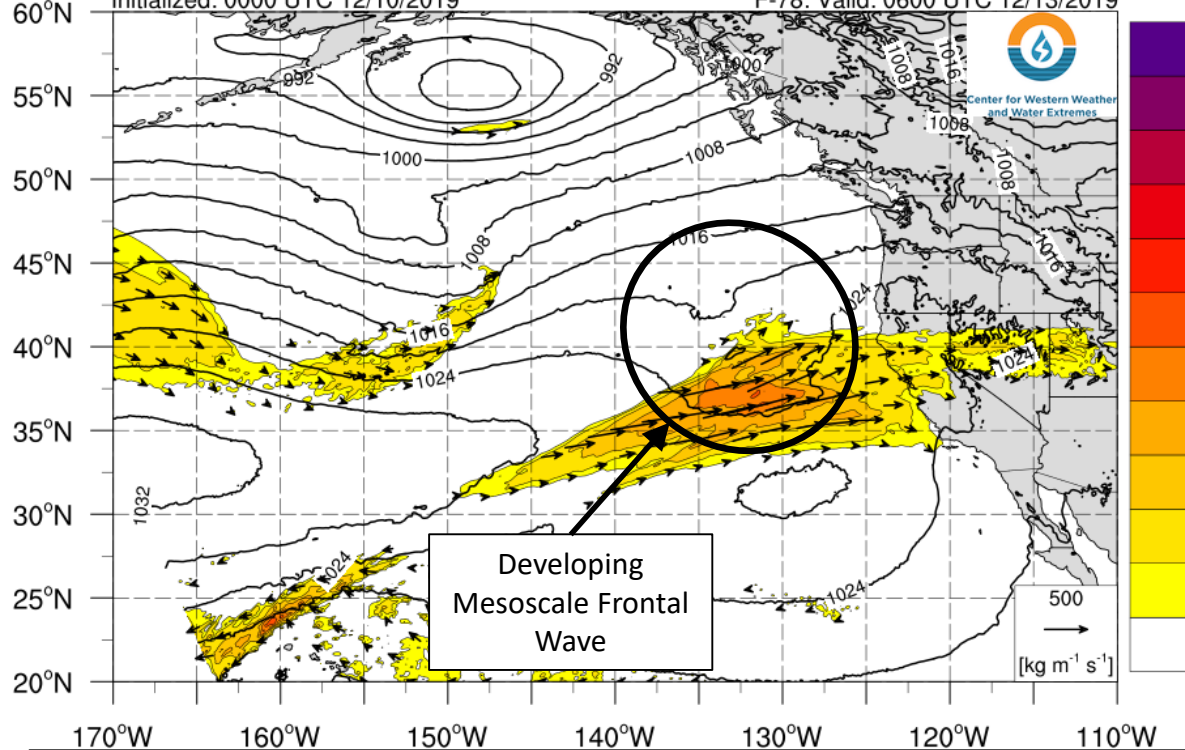


- The GFS Ensemble is currently exhibiting high confidence (>95% of ensemble members) in AR conditions ($IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) over Coastal Oregon and Northern to Central California between 11 and 14 December 2019
- There is lower confidence associated with the latter portion of the event, resulting in uncertainty in the overall duration of AR conditions over Southern OR and Northern CA
- The GEFS is also suggesting the potential for AR activity after day 7 (17 Dec.+), but uncertainty is currently very high

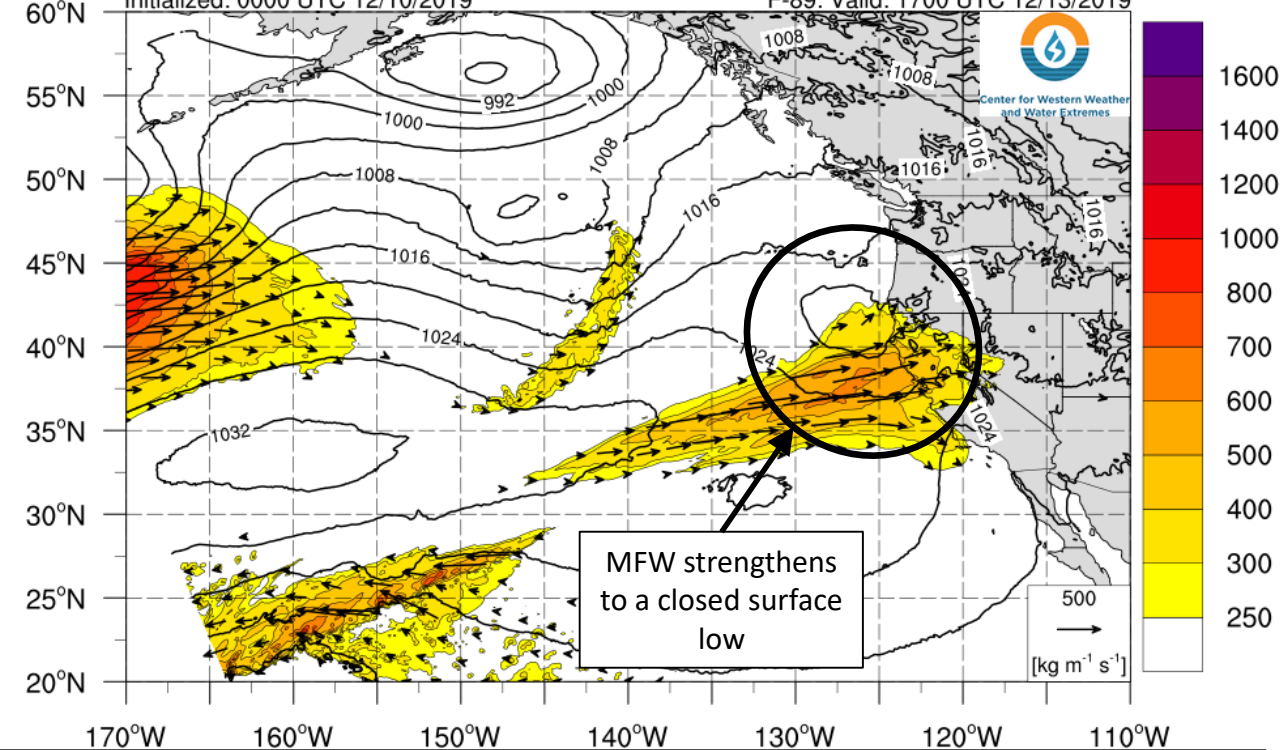


The uncertainty in AR conditions exhibited by the GEFS during the latter portions of the event may be due to the development of a mesoscale frontal wave, a phenomenon that tends to lead to larger forecast uncertainty along the northern extent of landfalling ARs

West-WRF 9km IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded and vectors) and SLP (hPa; contours)
Initialized: 0000 UTC 12/10/2019 F-78: Valid: 0600 UTC 12/13/2019



West-WRF 9km IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded and vectors) and SLP (hPa; contours)
Initialized: 0000 UTC 12/10/2019 F-89: Valid: 1700 UTC 12/13/2019



- The West-WRF (CW3E's in-house hi-res model) currently suggests the development of a MFW over the E. Pacific at ~6 UTC on 13 Dec.
- The MFW continues to strengthen and develops into a closed low before moving on shore at ~17 UTC 13 Dec.
- The development of the MFW would extend AR conditions further north along the Coast, prolonging the duration of AR conditions over far Northern CA and Southern OR, while the strengthening surface low would provide additional rising motion and support for precipitation production

AR Outlook: 10 December 2019

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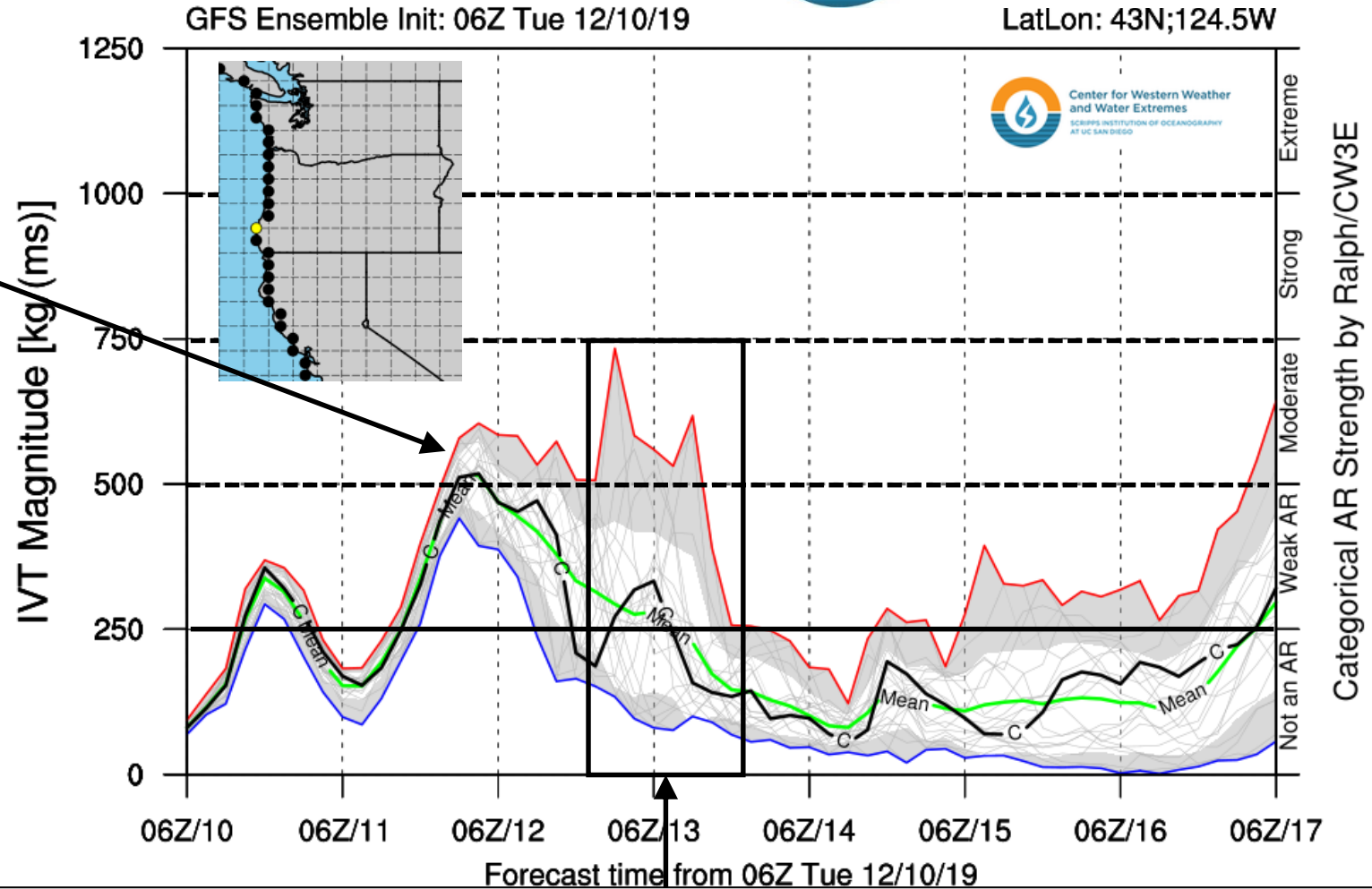
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The GEFS currently suggests the initial pulse of AR conditions into Southern OR could bring moderate AR conditions ($IVT > 500 \text{ kg m}^{-1} \text{ s}^{-1}$)

Potential Magnitude of AR

- Maximum predicted IVT $\sim 733 \text{ kg m}^{-1} \text{ s}^{-1}$
- Mean IVT $\sim 515 \text{ kg m}^{-1} \text{ s}^{-1}$
- Minimum IVT $\sim 490 \text{ kg m}^{-1} \text{ s}^{-1}$

- The forecast duration of AR conditions over Southern OR is dependent upon whether or not a mesoscale frontal wave (MFW) develops along the AR
 - If no MFW develops, AR conditions could last ~ 24 hours
 - If a MFW develops, AR conditions could last up to ~ 48 hours



- There is currently large uncertainty associated with the AR conditions accompanied by the potential development of a MFW
- Some ensemble members are currently predicting IVT magnitudes of $\sim 700 \text{ kg m}^{-1} \text{ s}^{-1}$ while other ensemble members currently suggest no MFW development

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Further south, over Northern California, the GEFS is not as uncertain in the overall duration and magnitude of AR conditions associated with this event

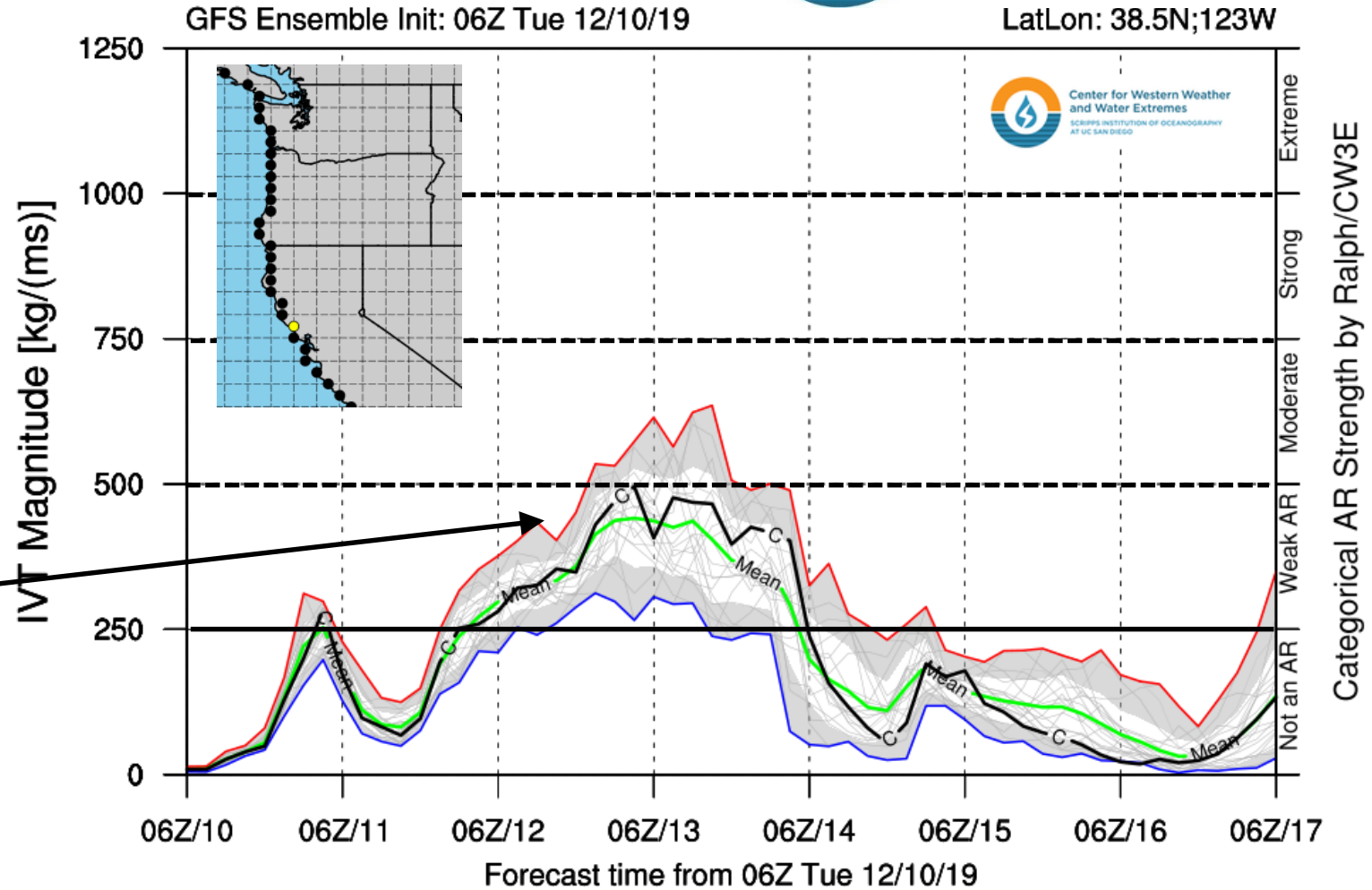
The GEFS is currently suggesting the potential for a long duration AR (>48 hours) over Coastal Northern CA

Magnitude of potential AR Northern California

- Maximum predicted IVT $\sim 630 \text{ kg m}^{-1} \text{ s}^{-1}$
- Mean IVT $\sim 441 \text{ kg m}^{-1} \text{ s}^{-1}$
- Minimum IVT $\sim 400 \text{ kg m}^{-1} \text{ s}^{-1}$

Forecast duration of AR conditions

- Weak 54 hours \pm 10
- Moderate 6 hours \pm 6

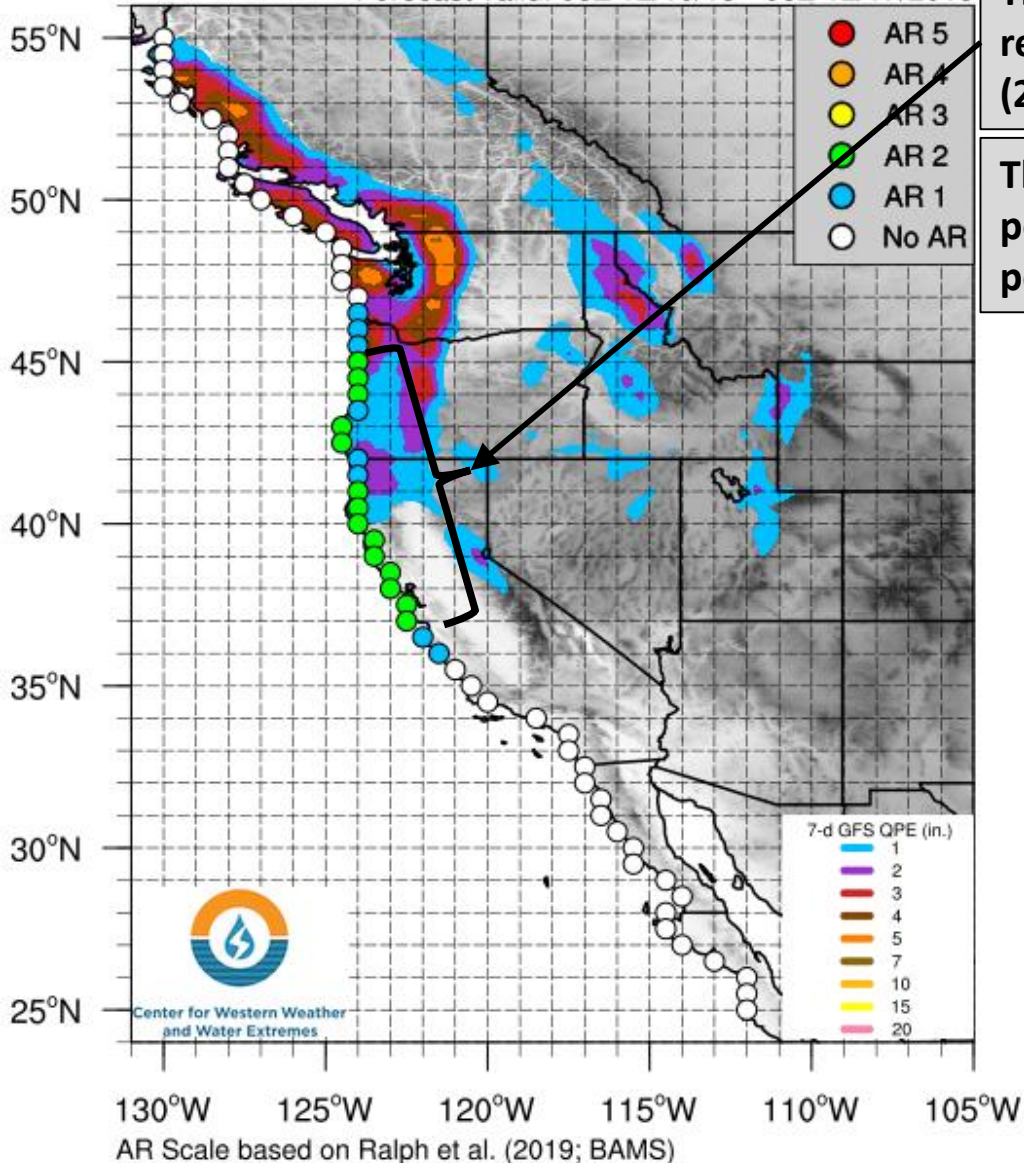


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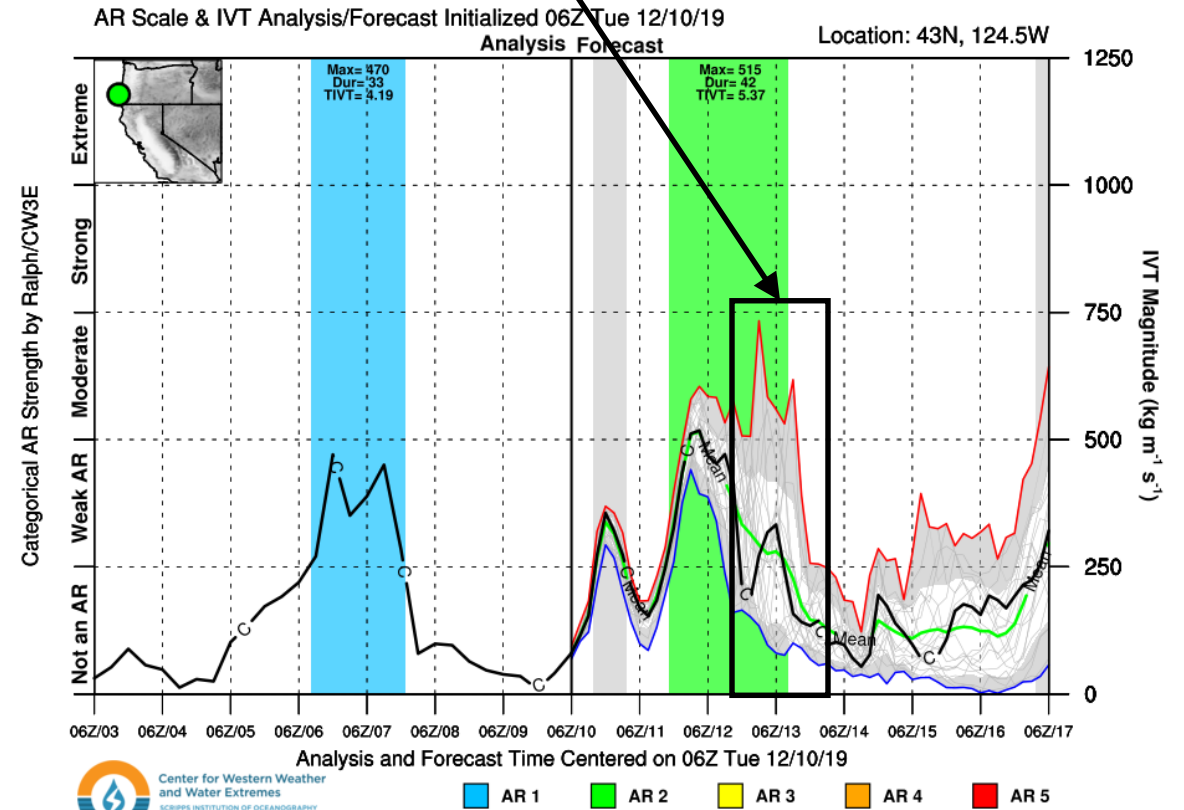
GEFS Control AR Scale and GFS 7-day QPF

Forecast valid: 06Z 12/10/19 - 06Z 12/17/2019



The GEFS suggests that numerous coastal locations from California to Oregon could receive AR2 conditions based on the recently developed AR Scale from Ralph et al. (2019)

There is currently large uncertainty in forecast AR Scale over Southern OR due to the potential development of a MFW, which may prolong the duration of AR conditions, potentially resulting in AR3 conditions



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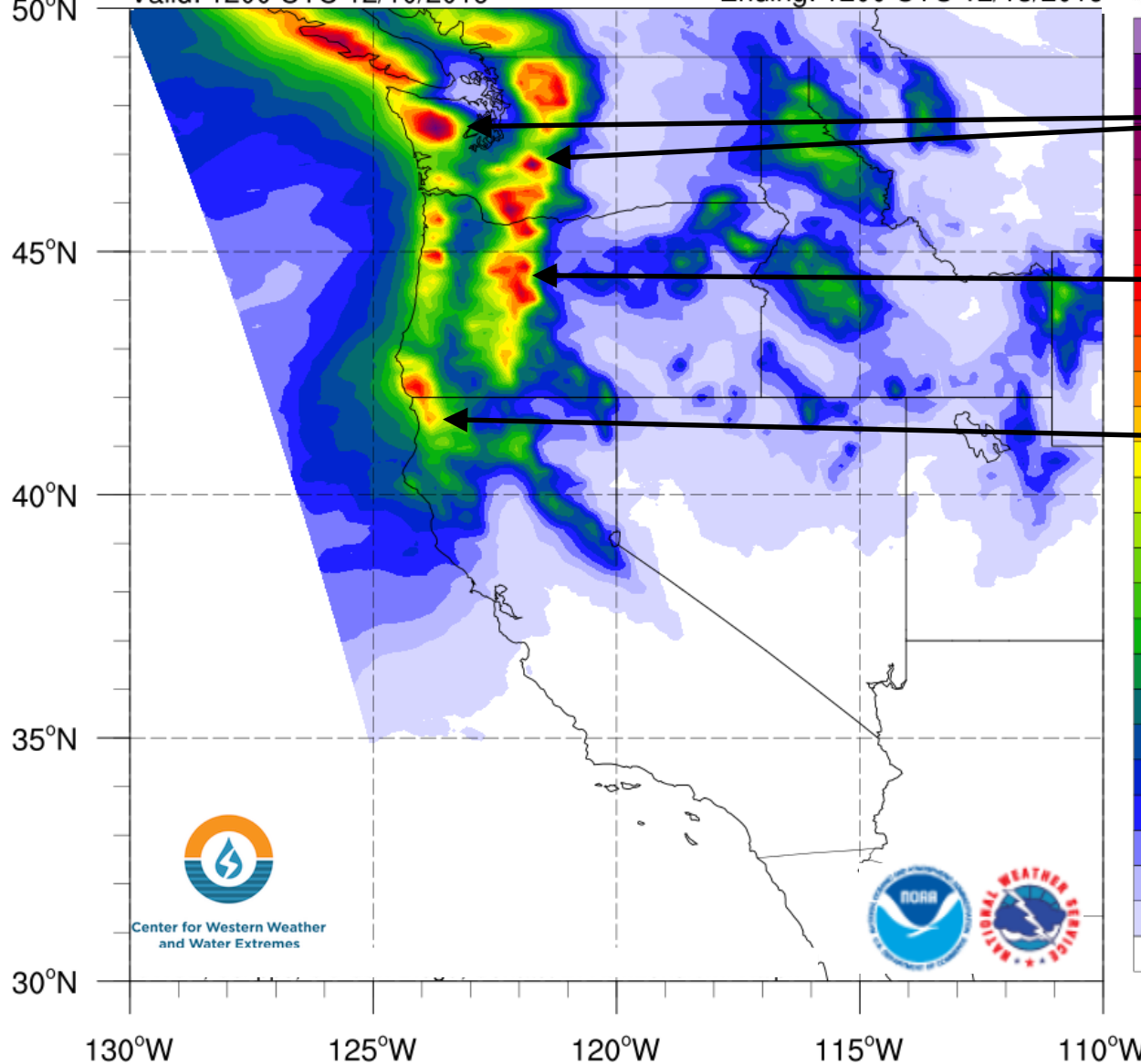


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WPC 3-day Precipitation Forecast (mm)

Valid: 1200 UTC 12/10/2019

Ending: 1200 UTC 12/13/2019



The NOAA WPC is currently forecasting >3 inches of precipitation over the Olympic and Cascade Mountains in WA during the next 72-hours

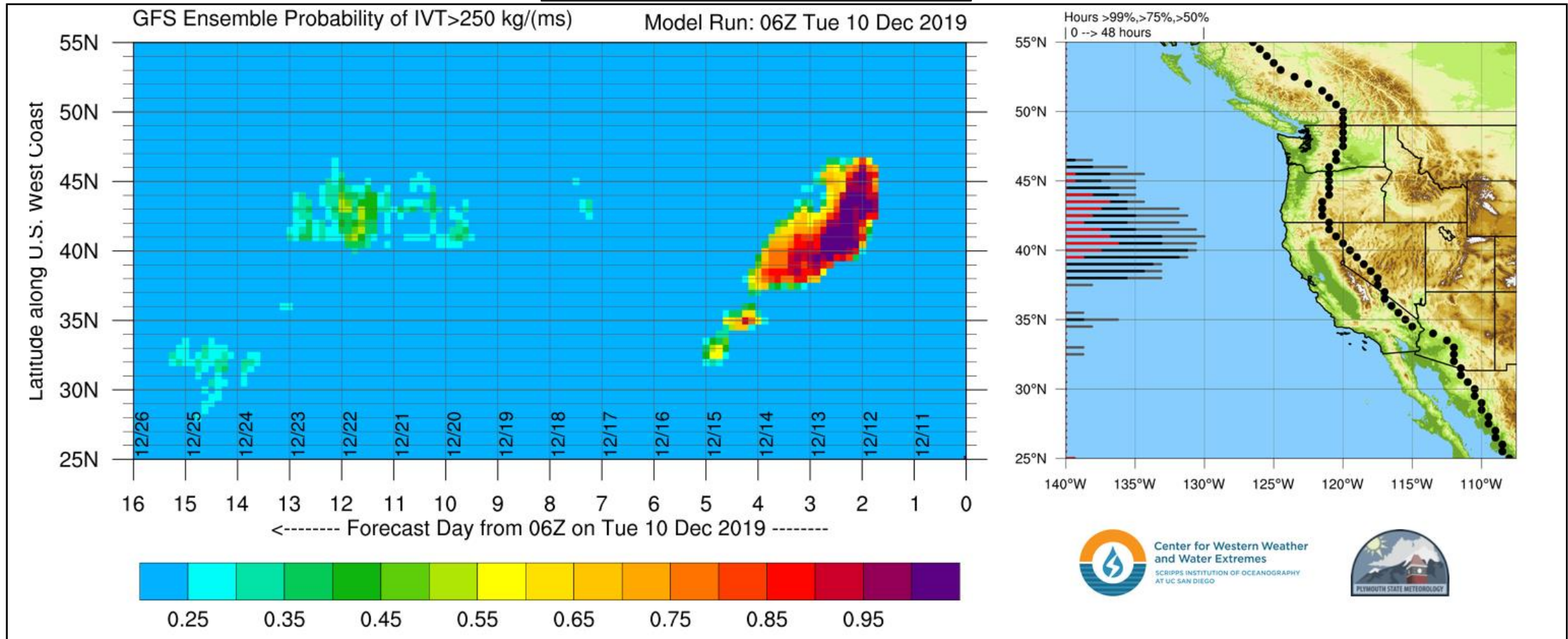
The Coastal and Cascade Mountains in Oregon could receive as much as 2.5 inches

The Coastal and Sierra Nevada Mountains in Northern CA could receive .5 to 2.5 inches of precipitation over the next 72 hours

Other low elevation locations across the U.S. West are currently predicted to receive .25 to 1.5 inches of precipitation



Odds of Inland AR Conditions



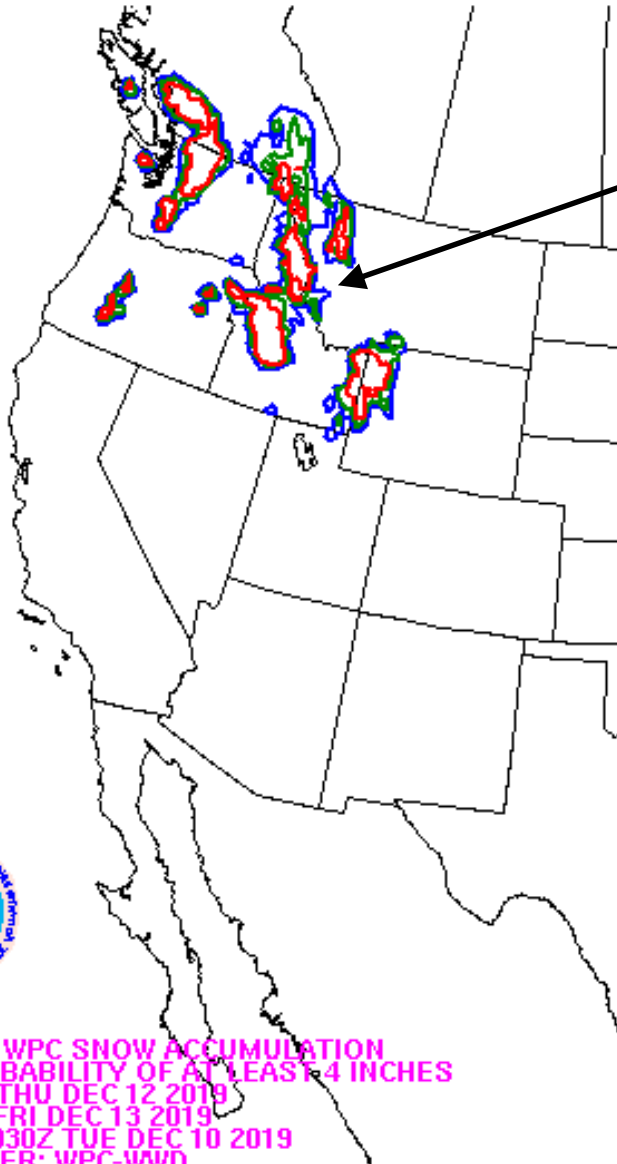
- There is currently high probability (>95% of GFS ensemble members) of AR conditions ($IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) penetrating inland to the Intermountain West
- Similar to coastal locations, there is higher uncertainty towards the latter portion of the AR

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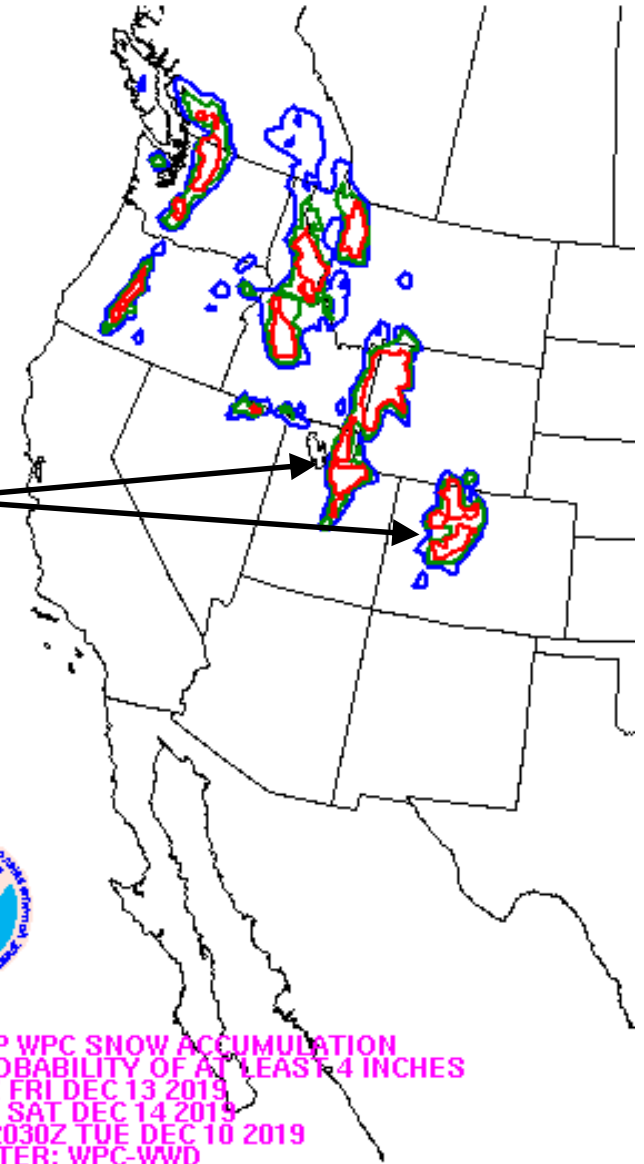


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The inland penetration of the AR is resulting in a high probability (>70%) of at least 4 inches of snow over certain high elevation locations of the Intermountain West on Thursday and Friday 12 and 13 December 2019

The high probabilities of >4 inches of snow shift further south and east into Northern Utah and Colorado by Friday 13 December 2019



NWS NCEP WPC SNOW ACCUMULATION
DAY 2 PROBABILITY OF AT LEAST 4 INCHES
VALID 00Z THU DEC 12 2019
THRU 00Z FRI DEC 13 2019
ISSUED: 2030Z TUE DEC 10 2019
FORECASTER: WPC-WWD

PROBABILITY LEGEND
SLGT: AT LEAST 10% PROB
MDT: AT LEAST 40% PROB
HIGH: AT LEAST 70% PROB



NWS NCEP WPC SNOW ACCUMULATION
DAY 3 PROBABILITY OF AT LEAST 4 INCHES
VALID 00Z FRI DEC 13 2019
THRU 00Z SAT DEC 14 2019
ISSUED: 2030Z TUE DEC 10 2019
FORECASTER: WPC-WWD