

CW3E Atmospheric River Outlook: 16 Jan 2024

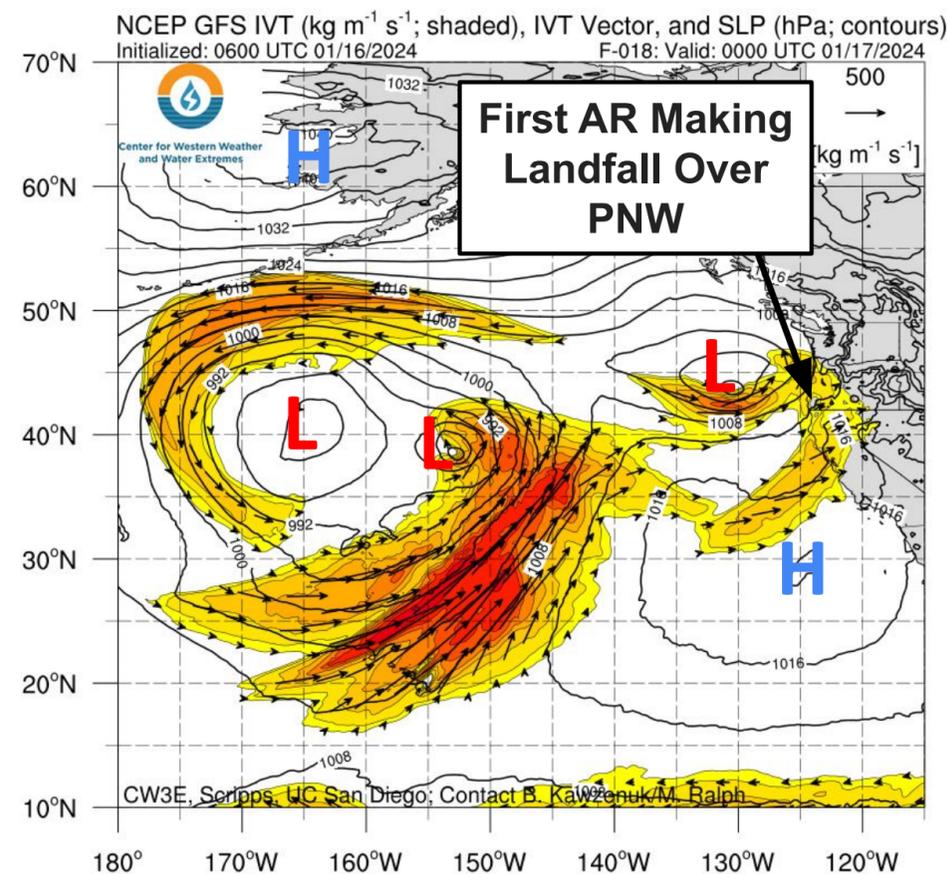
Active Weather Pattern to Bring Precipitation to US West Coast

- An active weather pattern for the US West Coast is forecast to begin late Tue 16 Jan, when the first of three AR periods begins.
- The **first AR** period begins late Tue 16 Jan and continues through Wed 17 Jan. The **second AR** follows close behind on Thu 18 Jan.
- The **first and second ARs** are forecast to bring heavy precipitation to the PNW, including heavy snowfall (>12") in the Northern Cascades and freezing rain in the Portland Metro area and regions along the WA/OR border through early Fri 19 Jan.
- The **third AR** period begins late Sun 20 Jan as a large AR begins to make landfall across the USWC.
- The **third AR** period is forecast to bring precipitation to the USWC, with the heaviest precipitation expected over the CA coast and in the Sierra Nevada, where heavy snowfall (>12") is forecast through Tue 22 Jan.
- The NWS Weather Prediction Center is forecasting > 6 inches of precipitation in the Cascades, Sierra Nevada and for regions along the WA, OR and CA coasts over the next 7 days.
- Fresh snowpack and moist soils from previous events that impacted the USWC present the risk for rain-on-snow flooding.
- The WPC Excessive Rainfall Outlook indicates a Marginal Risk (level 1 of 4, or at least 5% chance) for flooding in days 2 through 5 (24-hour periods ending 4 AM PT Thu 18 Jan through Sun 21 Jan).

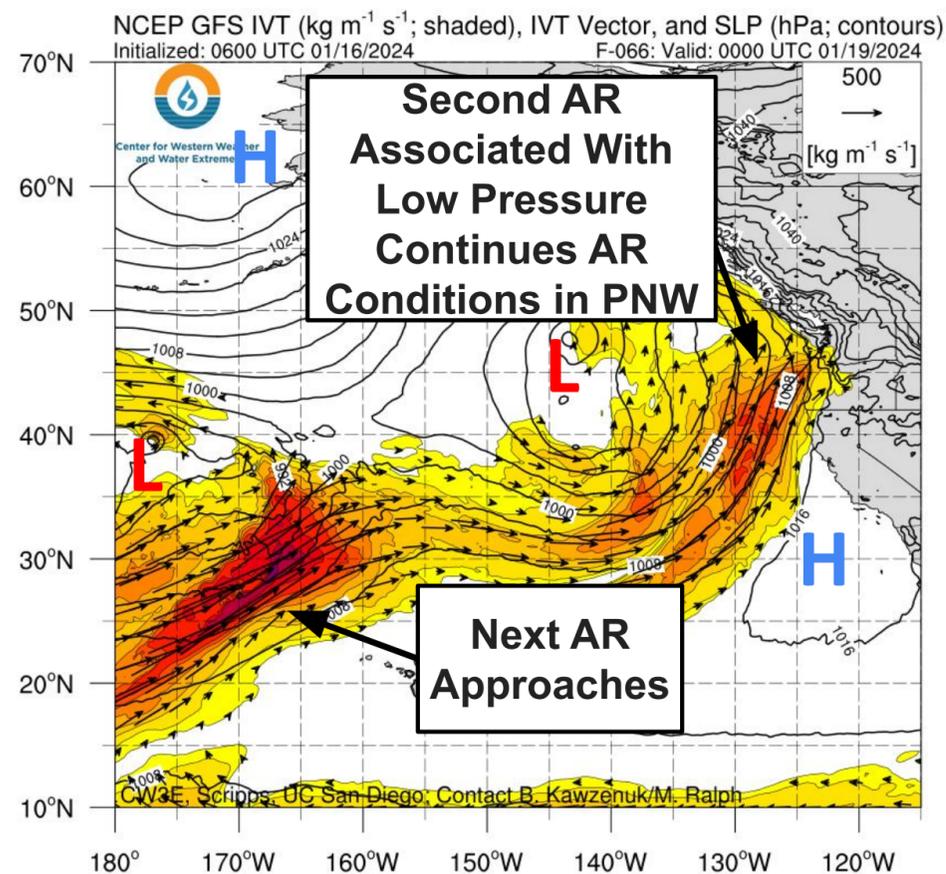
CW3E AR Outlook: 16 Jan 2024

GFS Init 6Z Wed 16 Jan 2024

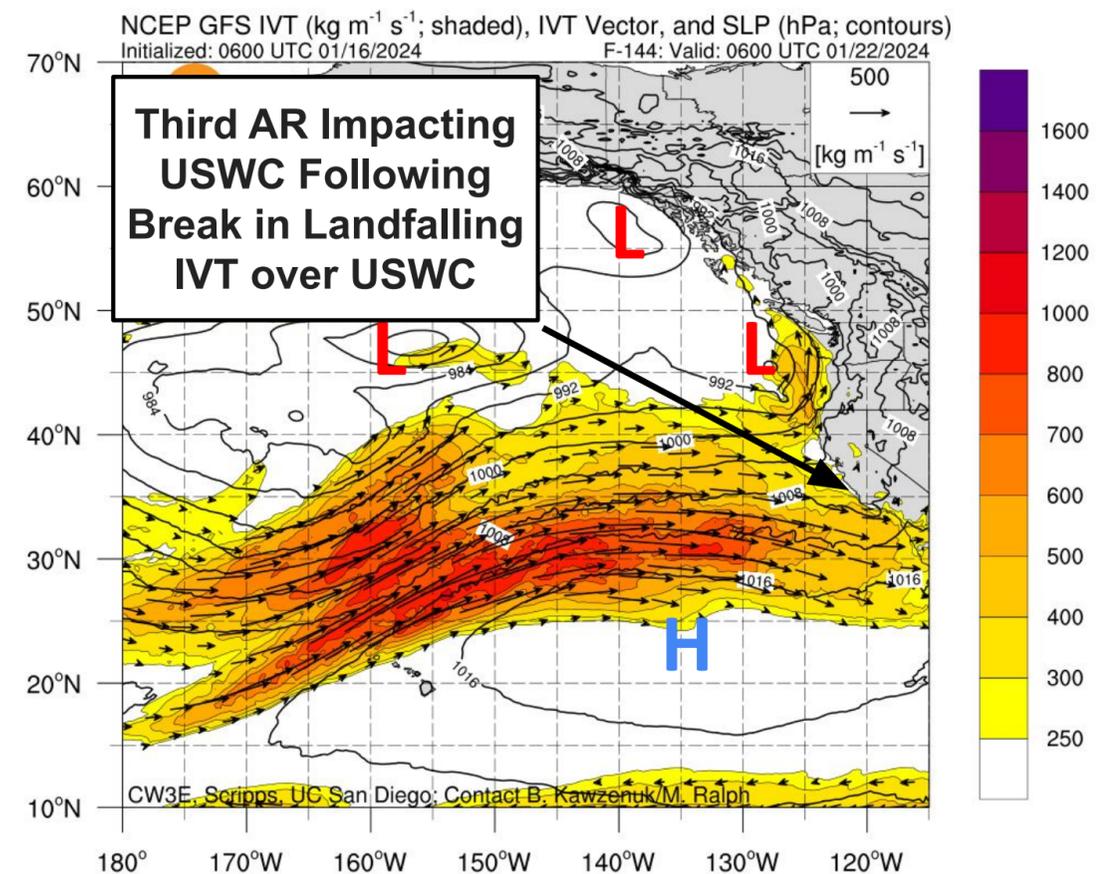
4PM PT Tue 16 Jan 2024



4PM PT Thu 18 Jan 2024



10PM PT Mon 21 Jan 2024

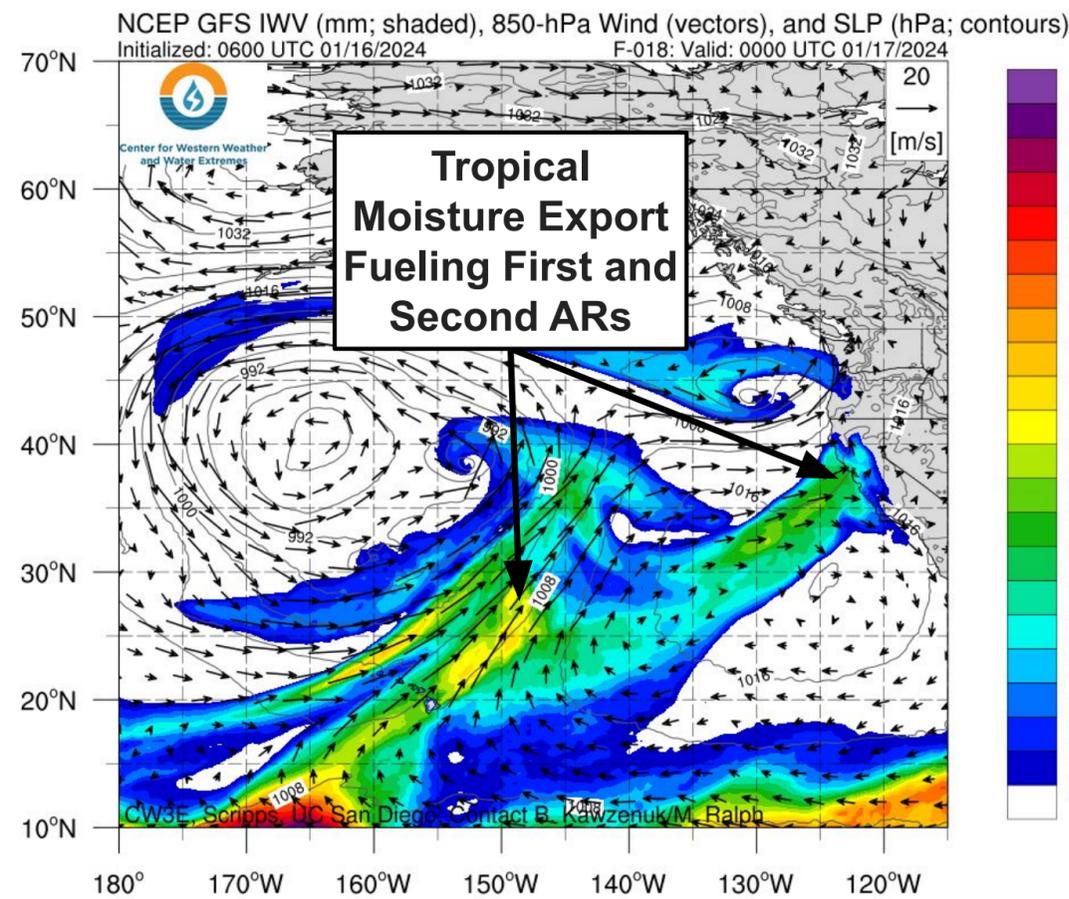


- An active period of AR conditions over the USWC is forecast to begin late Tue 16 Jan.
- The first period of AR conditions begins as IVT is brought to the USWC alongside a low pressure system late Tue 16 Jan.
- A secondary low pressure system in the NE Pacific and a stronger AR are forecast to propagate toward the USWC through Thu 18 Jan, with the leading edge of the IVT continuing AR conditions over the PNW
- A large AR propagating out of the western Pacific is forecast to make its way into the NE Pacific and begin impacting the USWC on Mon 21 Jan, following a break in AR conditions with the previous system.

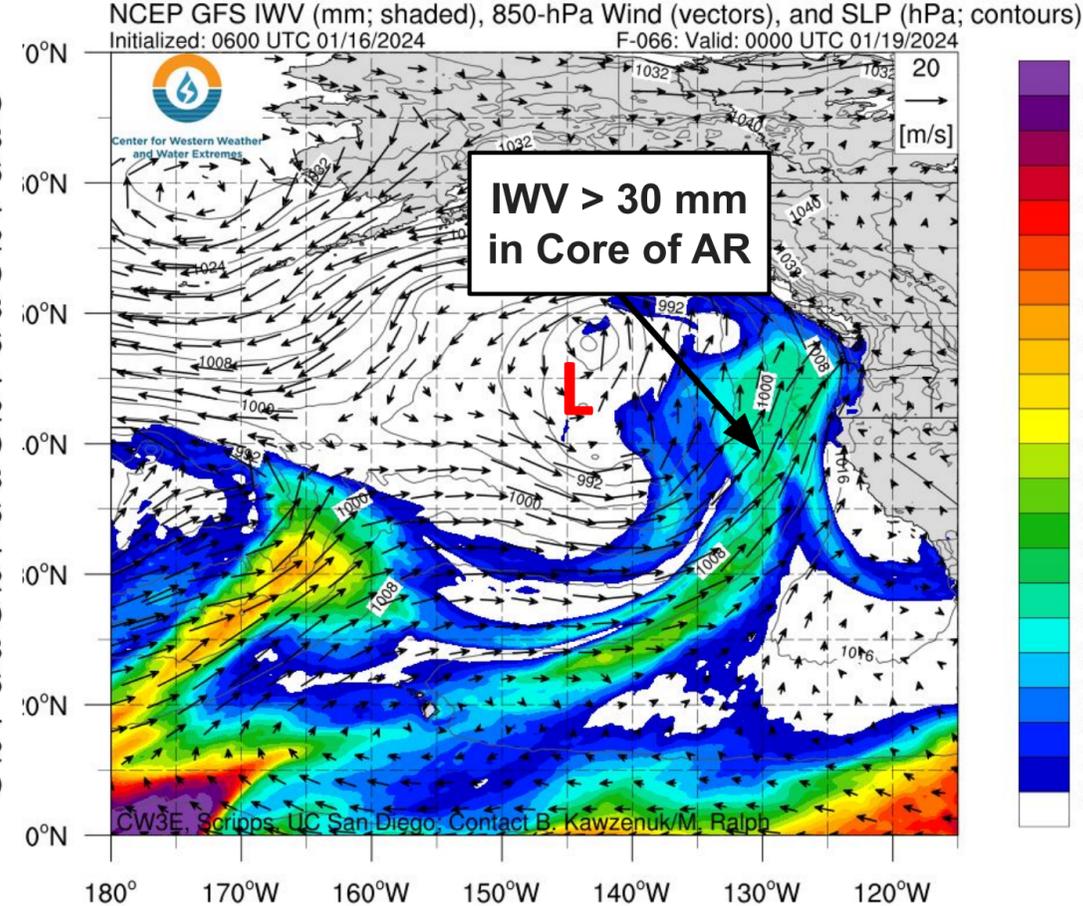
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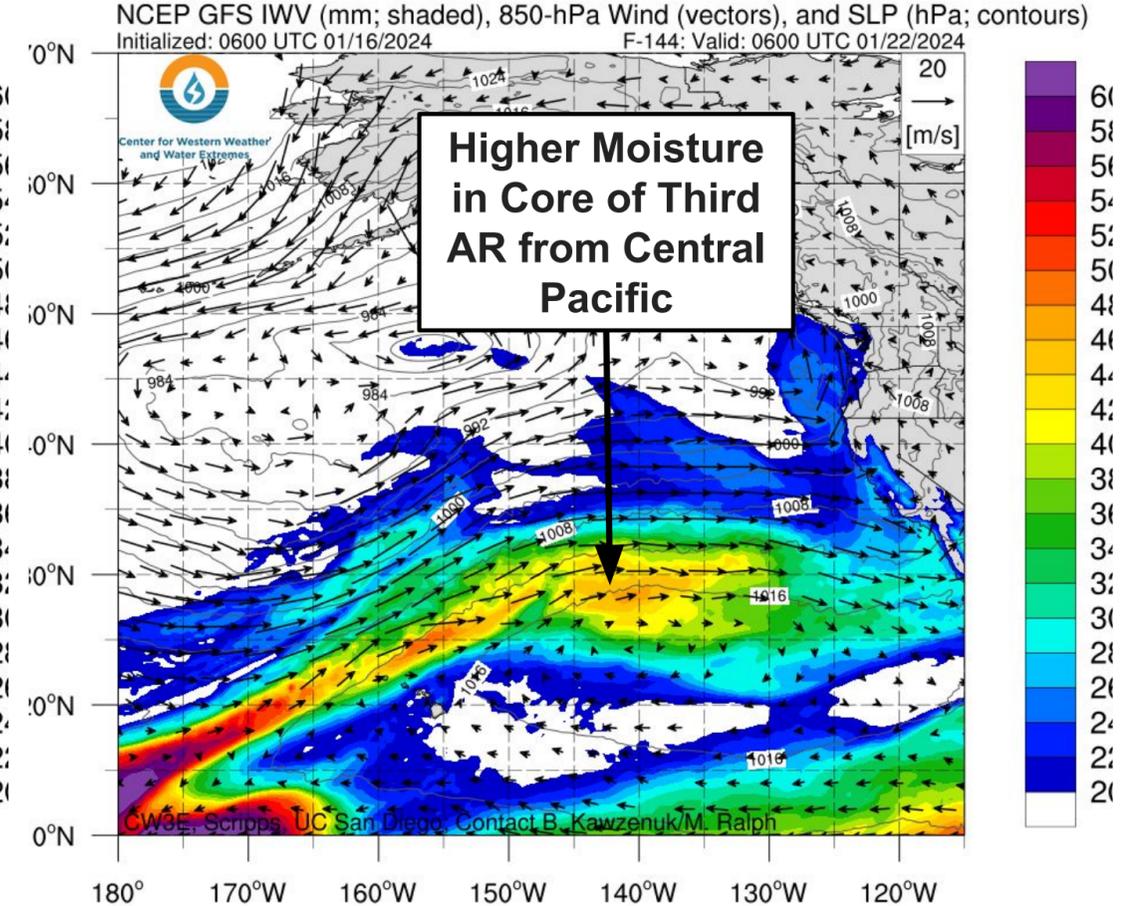
4PM PT Tue 16 Jan 2024



4PM PT Thu 18 Jan 2024

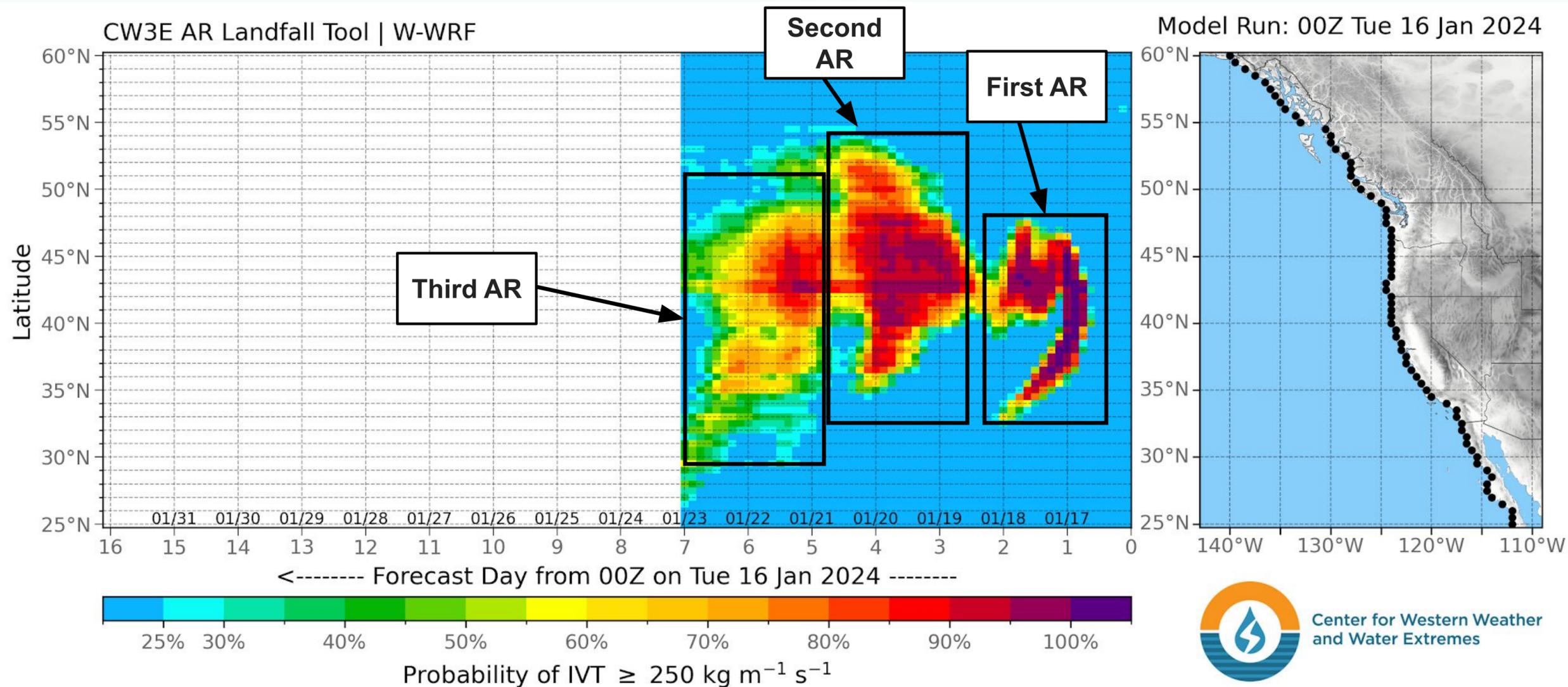


10PM PT Mon 21 Jan 2024



- The incoming first and second ARs are both supported by a strong tropical moisture export (TME) extending from south of Hawaii, with IWB > 30 mm is forecast in the core of the AR as it makes landfall over the PNW on Thu 18 Jan.
- The third AR is fueled by elevated moisture out of the central Pacific, however much of the highest moisture does not end up reaching the USWC.

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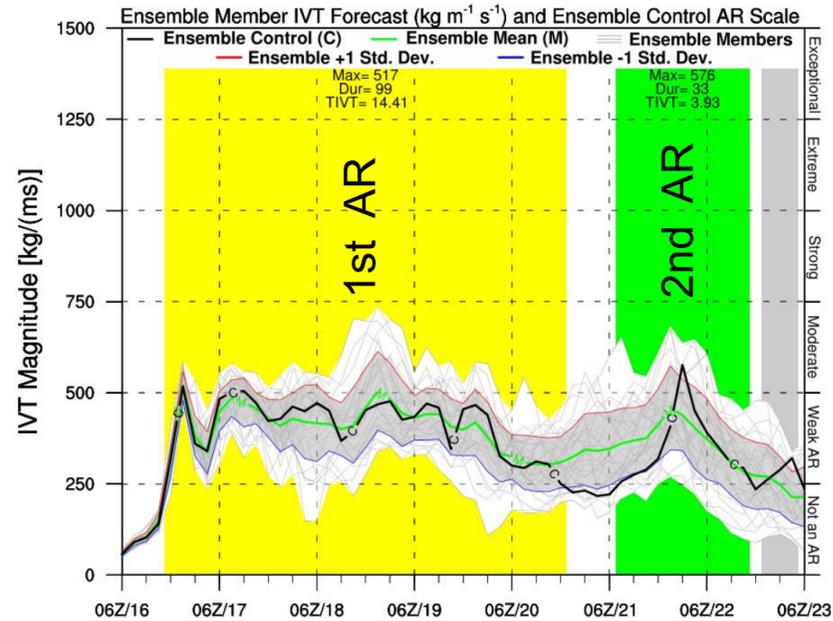
Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

- The West-WRF ensemble is forecasting an active period over the USWC for the next 7 days.
- The West-WRF is showing very high confidence ($>90\%$) in $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ making landfall over the USWC late Tue 16 Jan through Wed 17 Jan.
- Following a break in AR conditions for much of the USWC, an extended period of $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ over the USWC begins Thu 18 Jan continuing through Mon 22 Jan, with the highest confidence through Fri 19 Jan into Sat 20 Jan.

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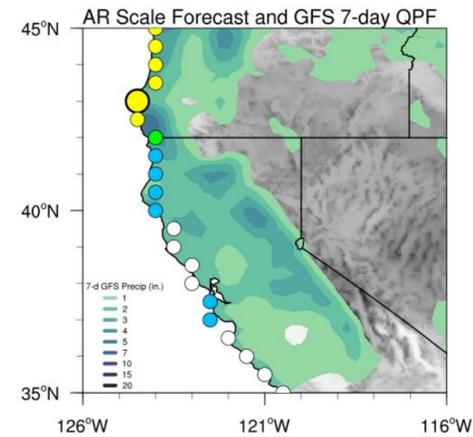
GEFS 7-day AR Scale and IVT Forecast

GFS Ensemble Initialized: 06Z Tue 01/16/24

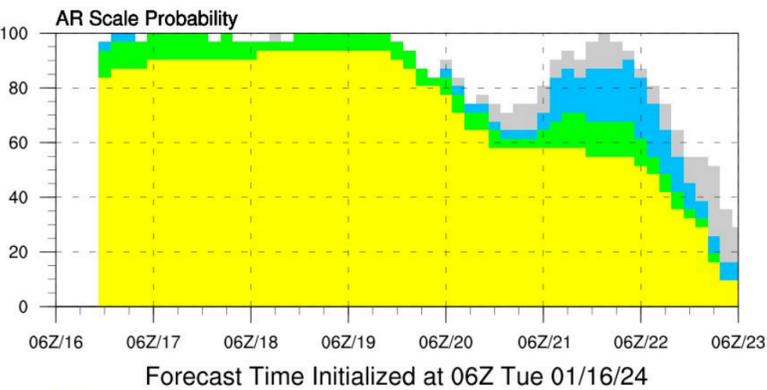
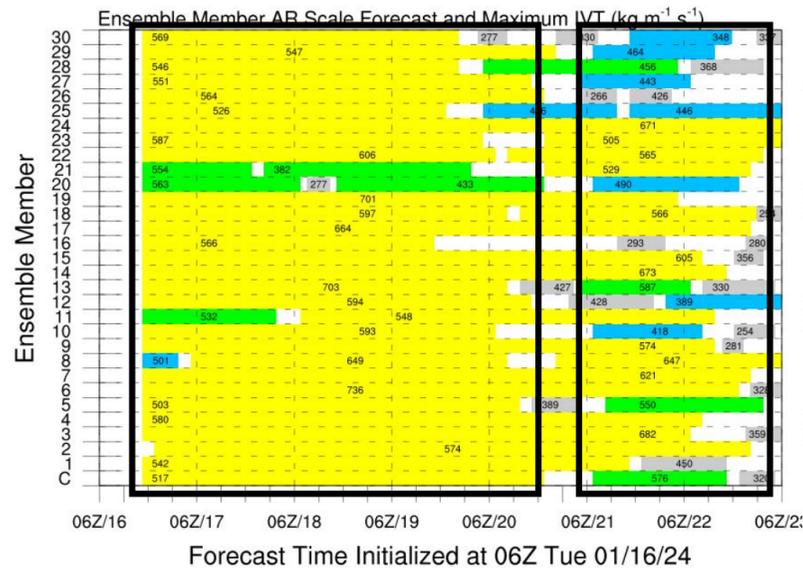
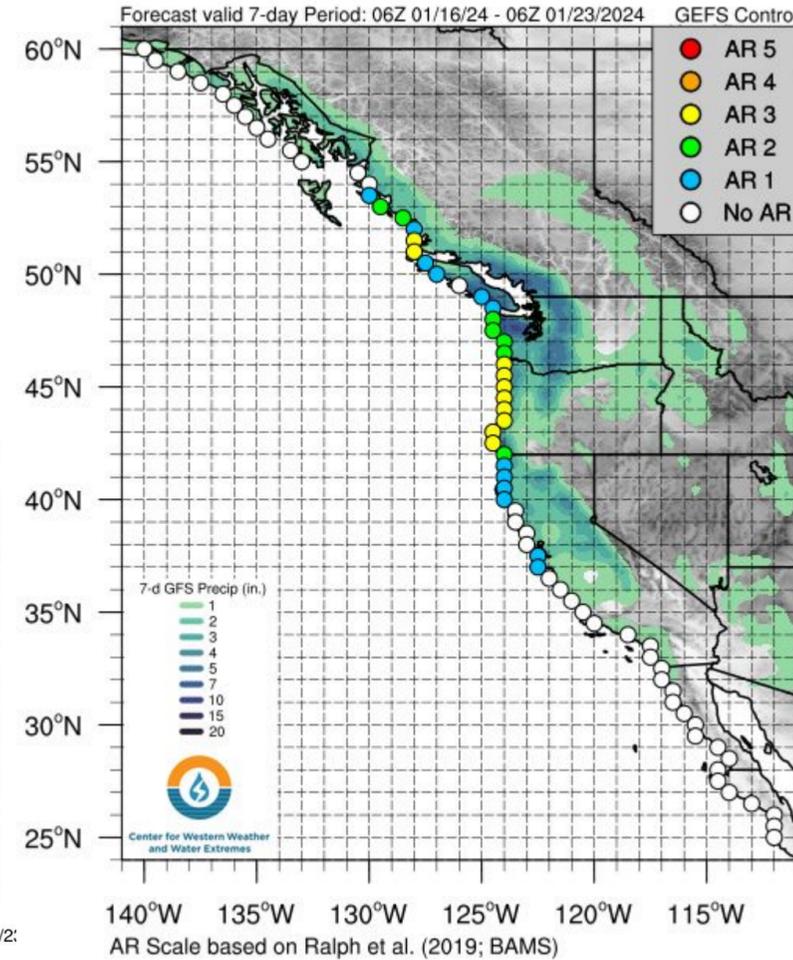


Categorical AR Strength by Ralph/CW3E

Location: 43°N 124.5°W



Maximum Forecast AR Scale



AR 1 AR 2 AR 3 AR 4 AR 5

Image created: 14 UTC 01/16/2024

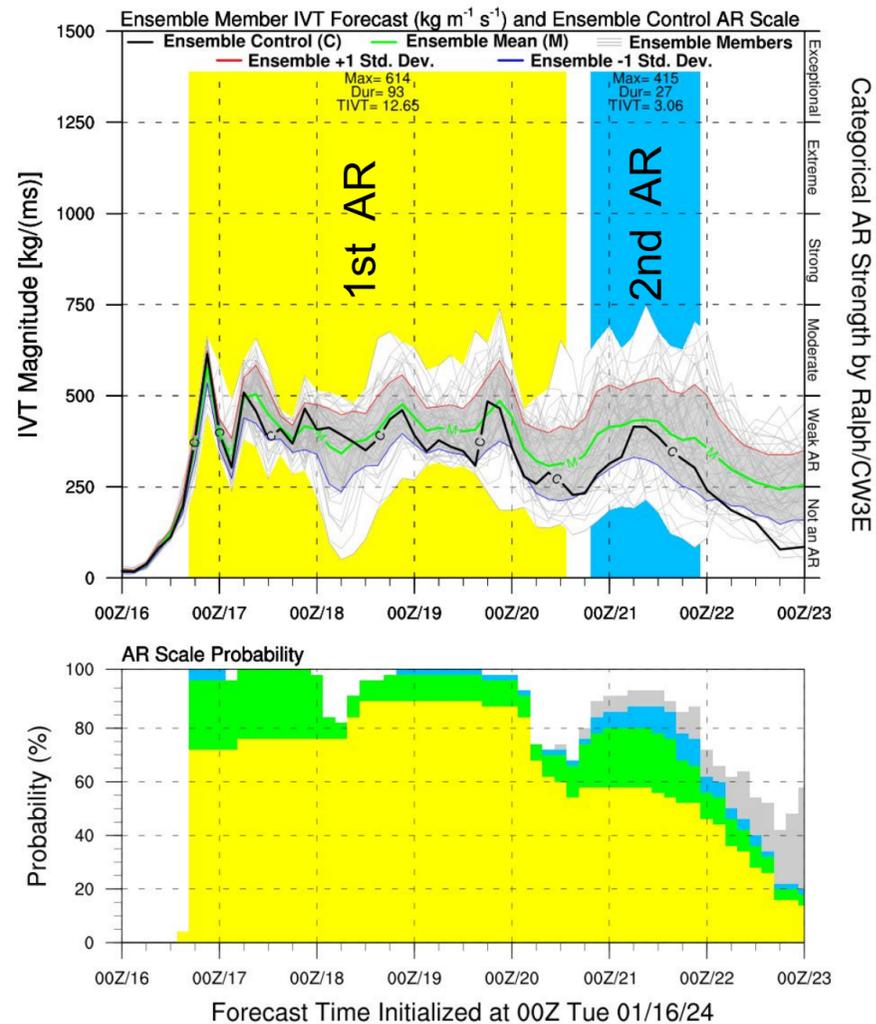
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

- The GEFS control member is forecasting multiple AR landfalls during the 7-day period for the point at 43° N, 124.5° W (coastal S.OR).
- 25/31 (81%) GEFS members are forecasting at least 72 hours of AR conditions during the first and second AR, leading to an AR3 on 16-20 Jan.
- 18/31 (58%) of the members (including the control) are forecasting a break in AR conditions on 20 Jan.
- 21/31 (68%) GEFS ensemble members are forecasting at least AR2 conditions during the third AR on 21-23 Jan.
- All ensemble members that do not forecast a break at this location are forecasting AR3 conditions for coastal OR

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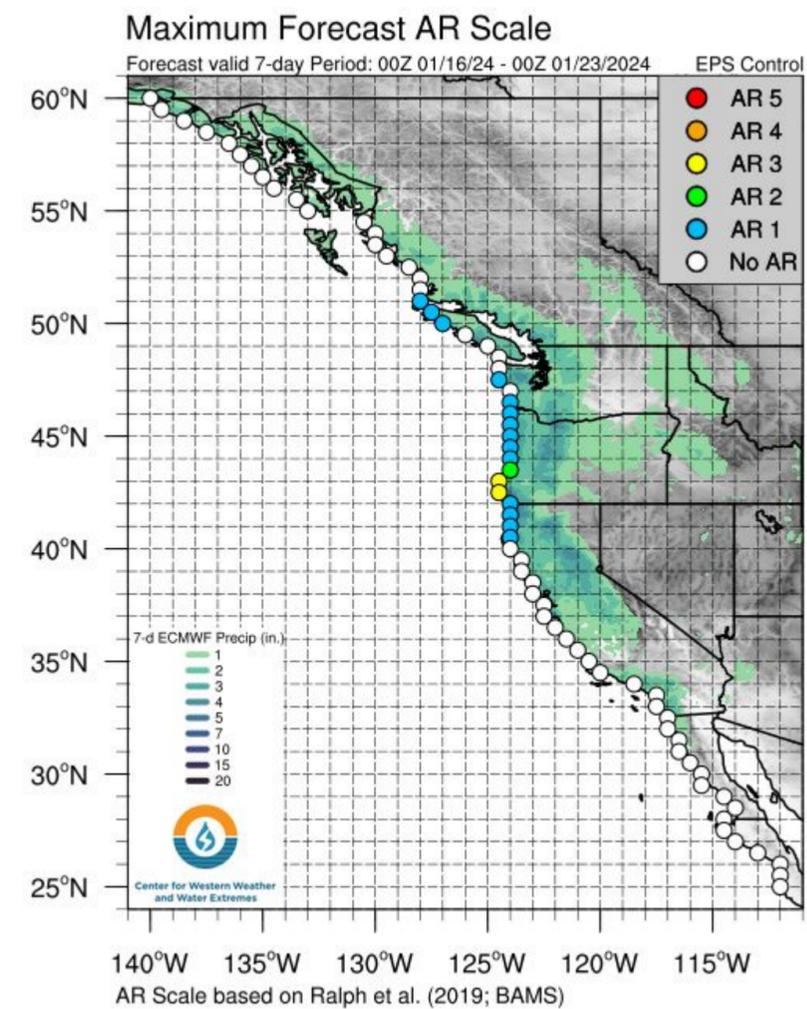
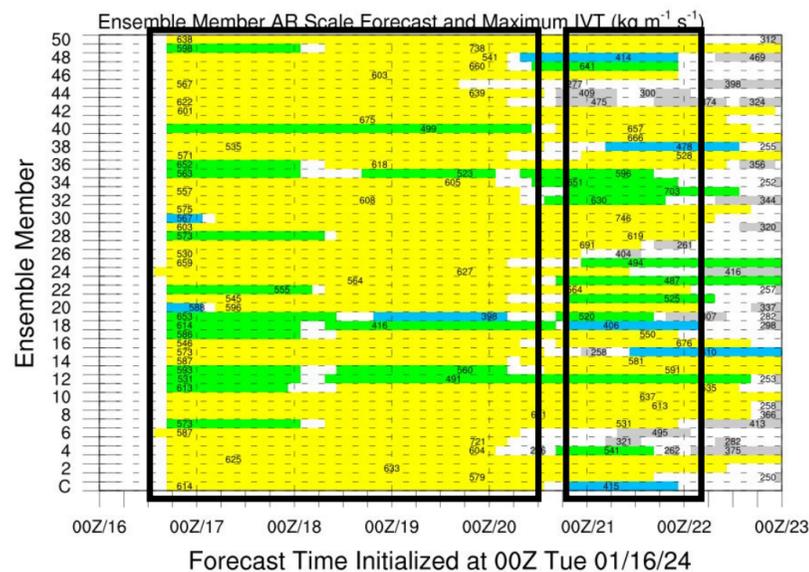
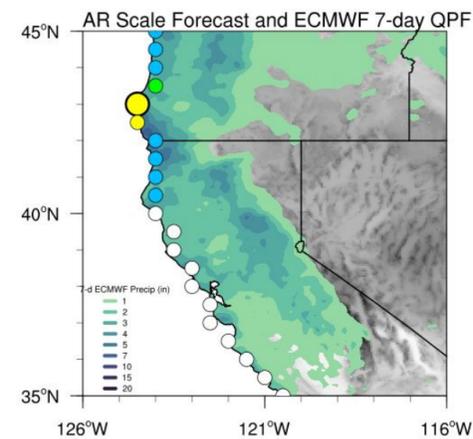
ECMWF EPS 7-day AR Scale and IVT Forecast

ECMWF Ensemble Initialized: 00Z Tue 01/16/24



Categorical AR Strength by Ralph/CW3E

Location: 43°N 124.5°W



- The ECMWF EPS control member is also forecasting multiple ARs for the point at 43° N, 124.5° W (coastal S.OR) during the next 7 days.
- 45/51 (88%) EPS ensemble members are forecasting at least 72 hours of AR conditions during the first AR on Jan 16-20.
- 40/51 (78%) of the members (not including the control) are forecasting at least AR2 conditions during the third AR on Jan 21-23.
- The EPS members are similarly split on the continuation of AR conditions late on Jan 20.



Image created: 09 UTC 01/16/2024

AR 1 AR 2 AR 3 AR 4 AR 5

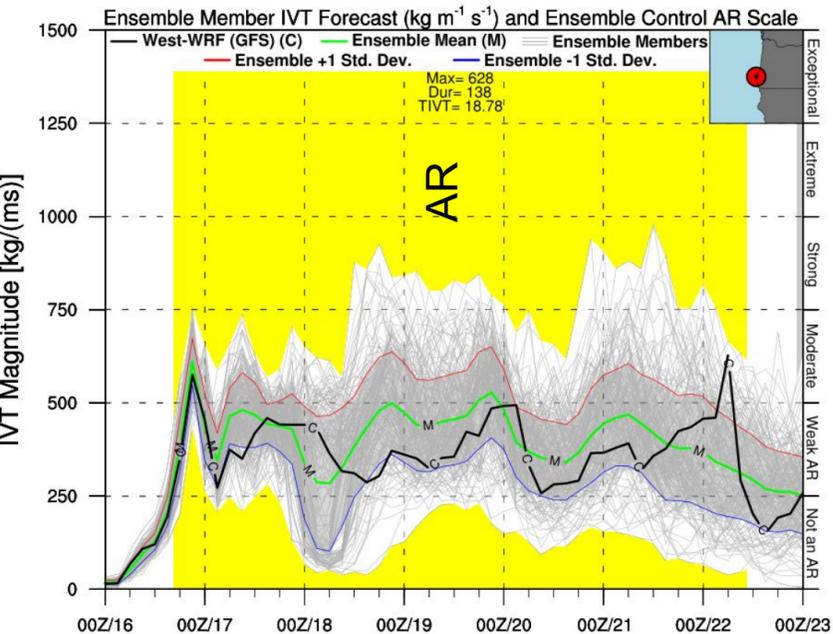
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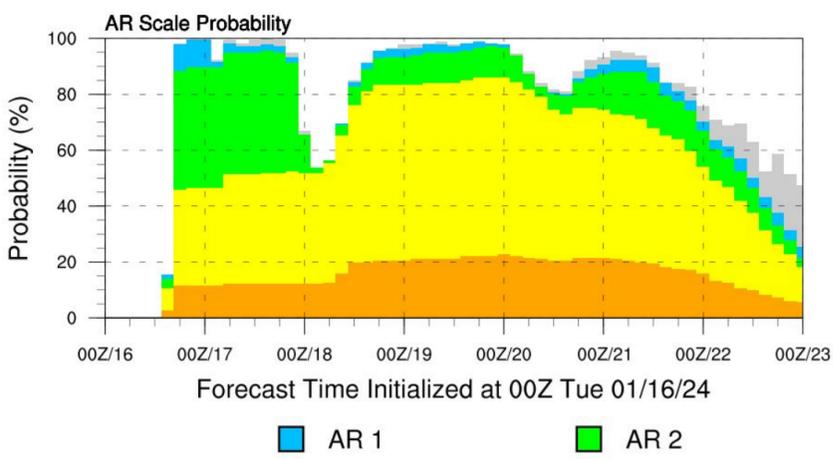
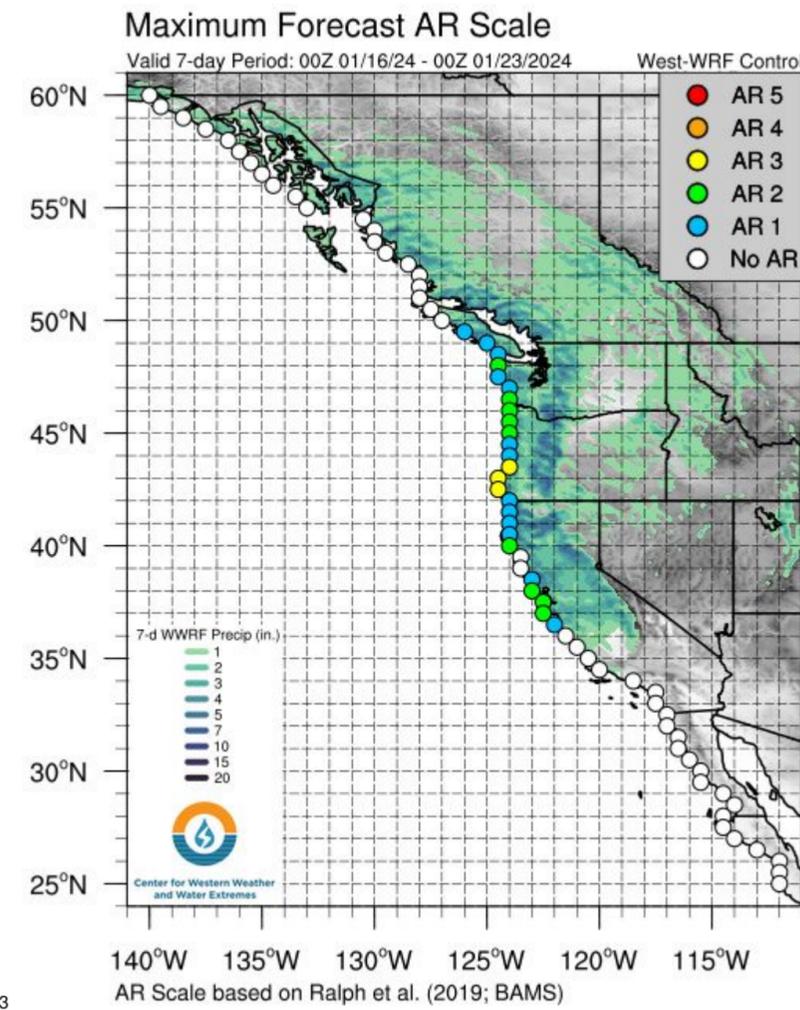
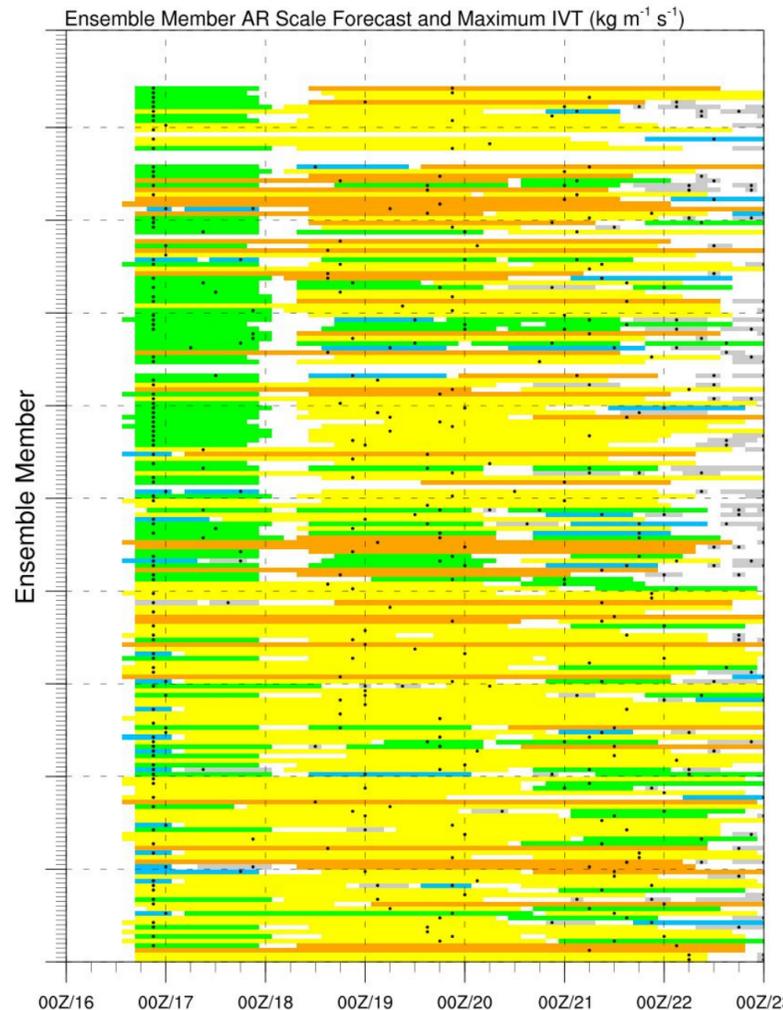
West-WRF Ensemble 7-day AR Scale and IVT Forecast

West-WRF Ensemble Initialized: 00Z Tue 01/16/24

Location: 43°N 124.5°W



Categorical AR Strength by Ralph/CW3E



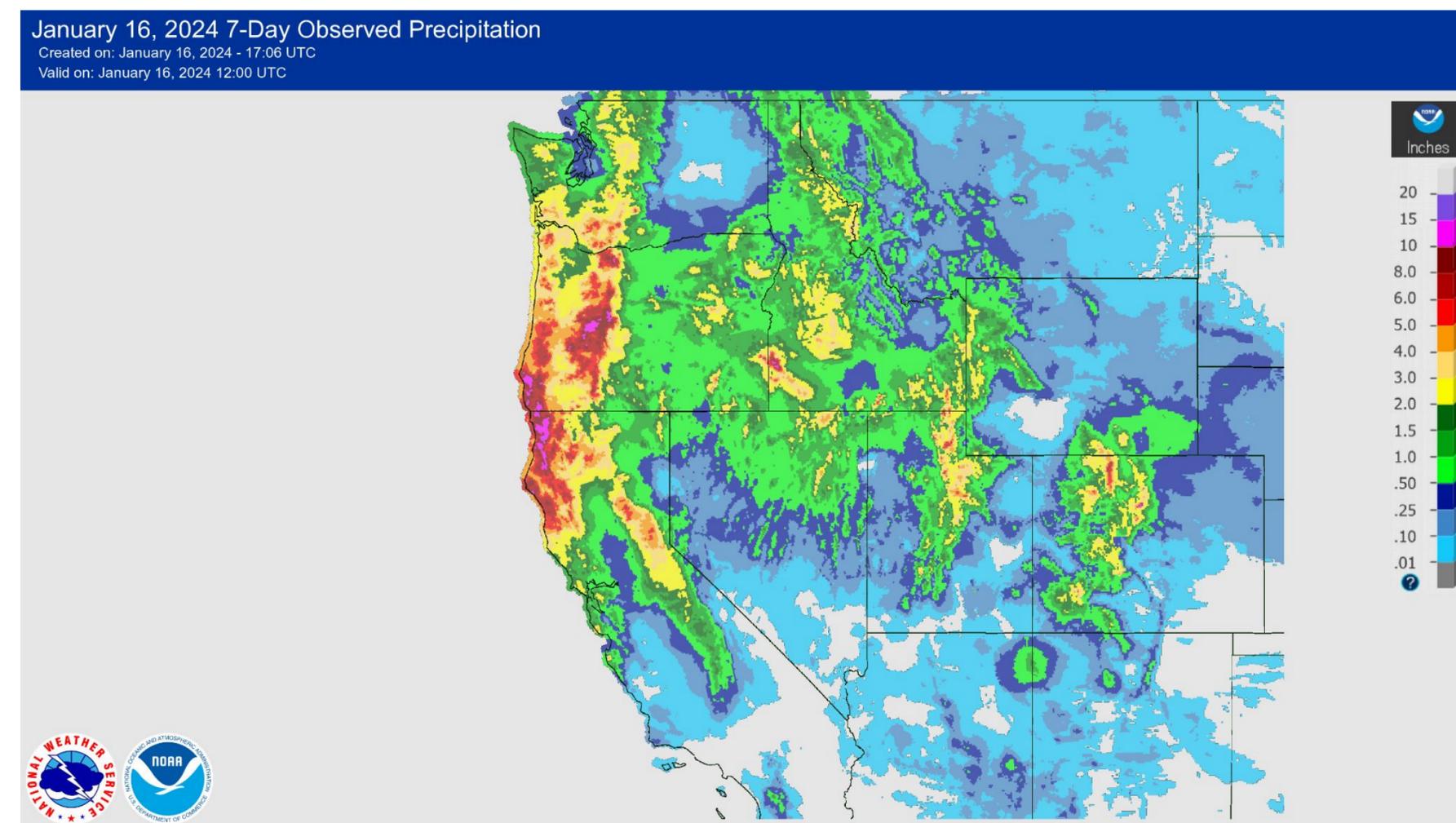
- The West-WRF Ensemble control member is forecasting continuous AR conditions from Tue 16 Jan through Mon 22 Jan for the point at 43° N, 124.5° W (coastal S.OR).
- Many of the West-WRF ensemble members are forecasting a break in AR conditions late Wed 17 Jan before a second extended period of AR conditions, opposite to that of the GEFS and EPS
- The vast majority of members are forecasting at least AR3 conditions for on of the ARs during the next 7 days at this location.

Image created: 14 UTC 01/16/2024

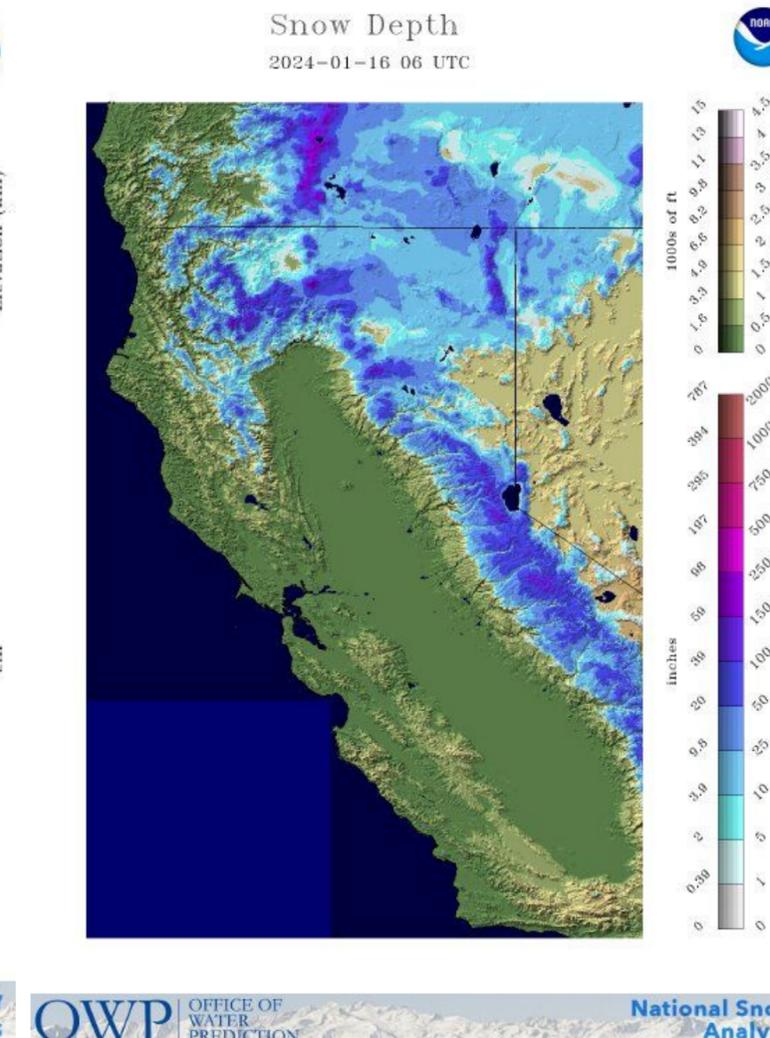
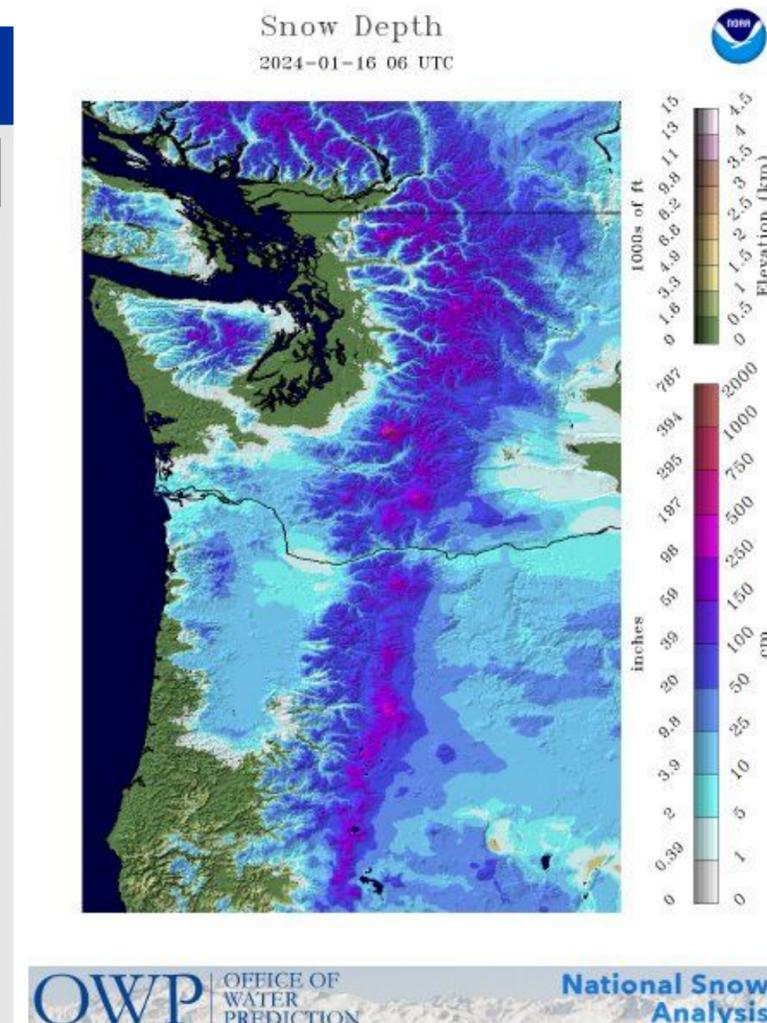
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

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Antecedent Conditions



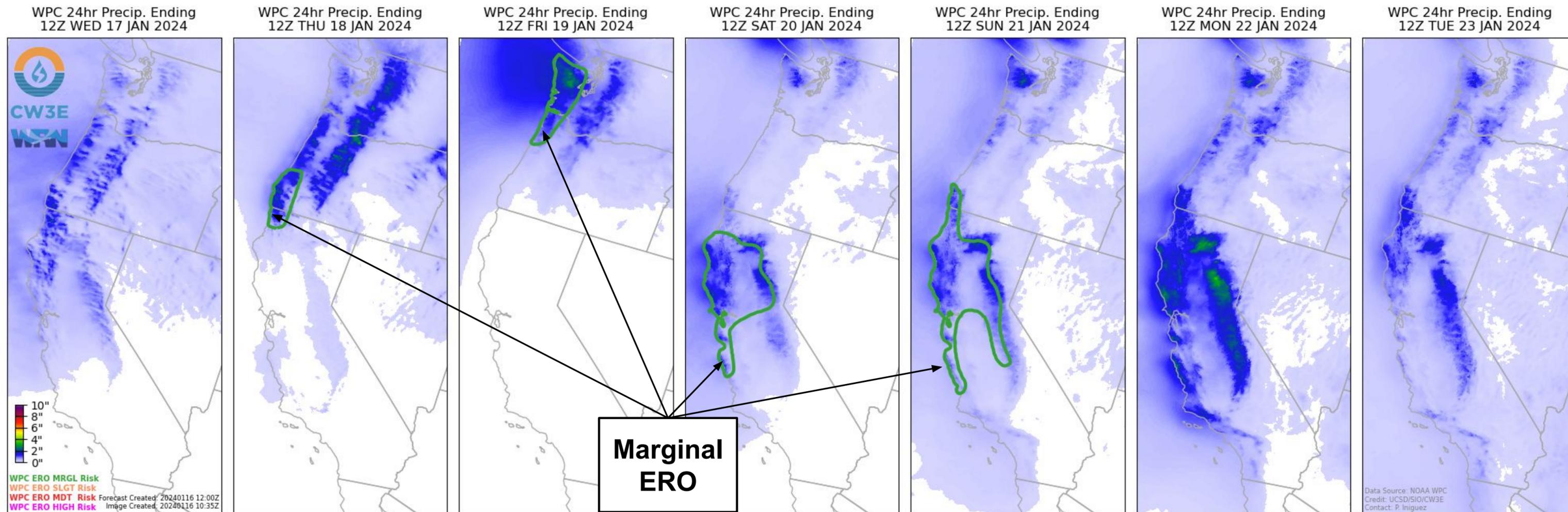
Source: NWS AHPS; <https://water.weather.gov/precip/>



Source: OWP; <https://www.nohrsc.noaa.gov/nsa/>

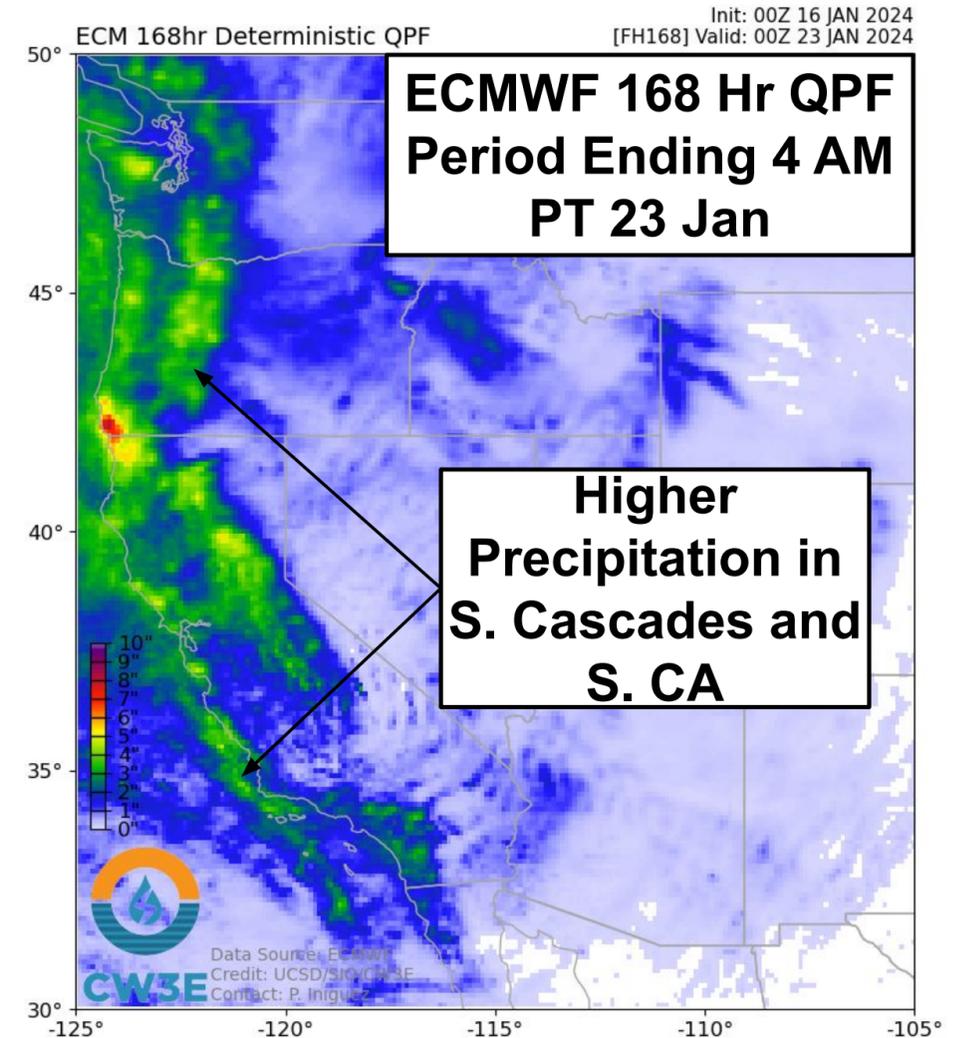
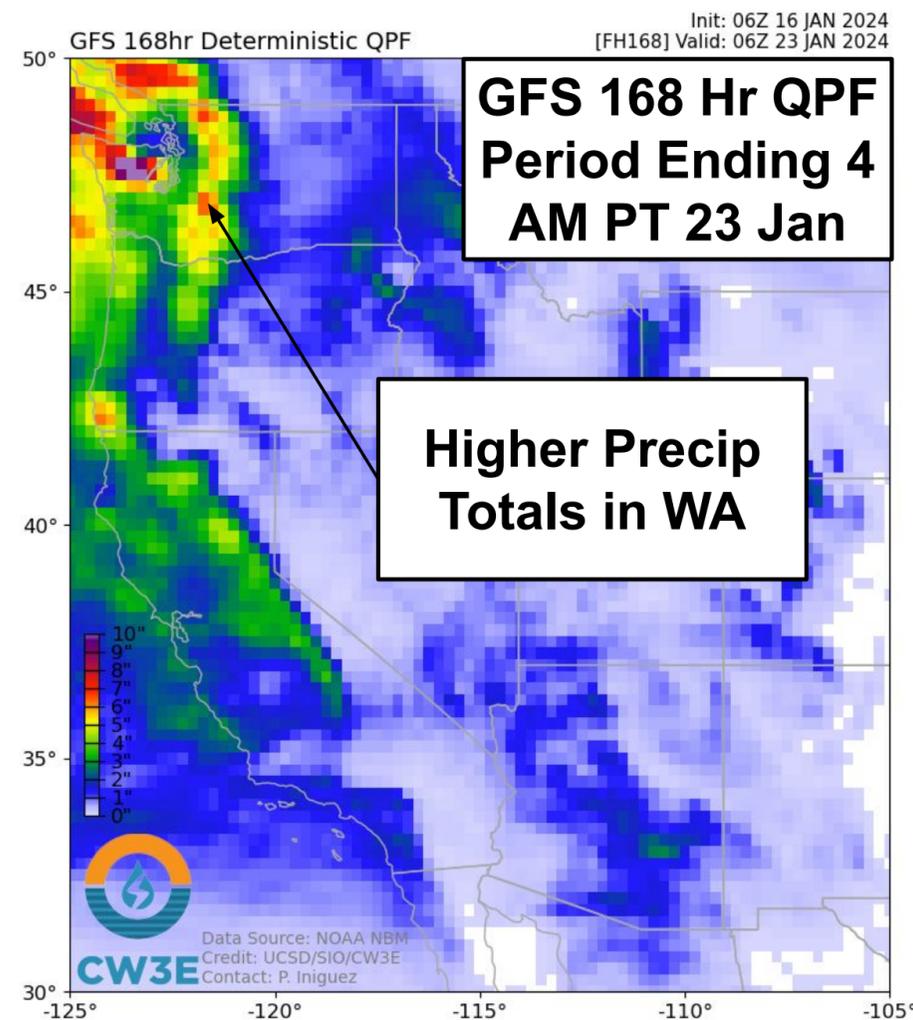
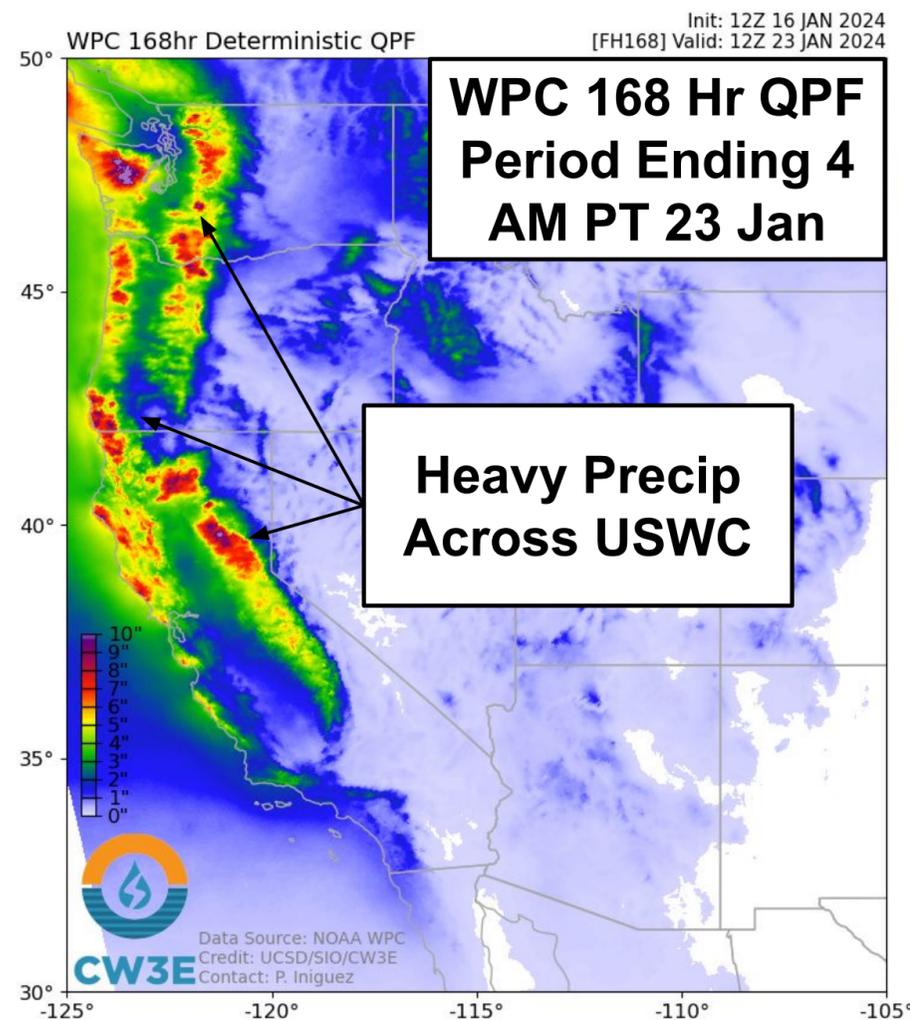
- The previous week brought substantial precipitation to much of the USWC.
- Given the antecedent conditions, the forecasted persistent rainfall and warmer events poses a flooding threat to the coastal regions that received 2"+ of rainfall as well as rain-on-snow flooding concerns to the Olympic Mountains, Cascades, and Northern Sierra Nevada.

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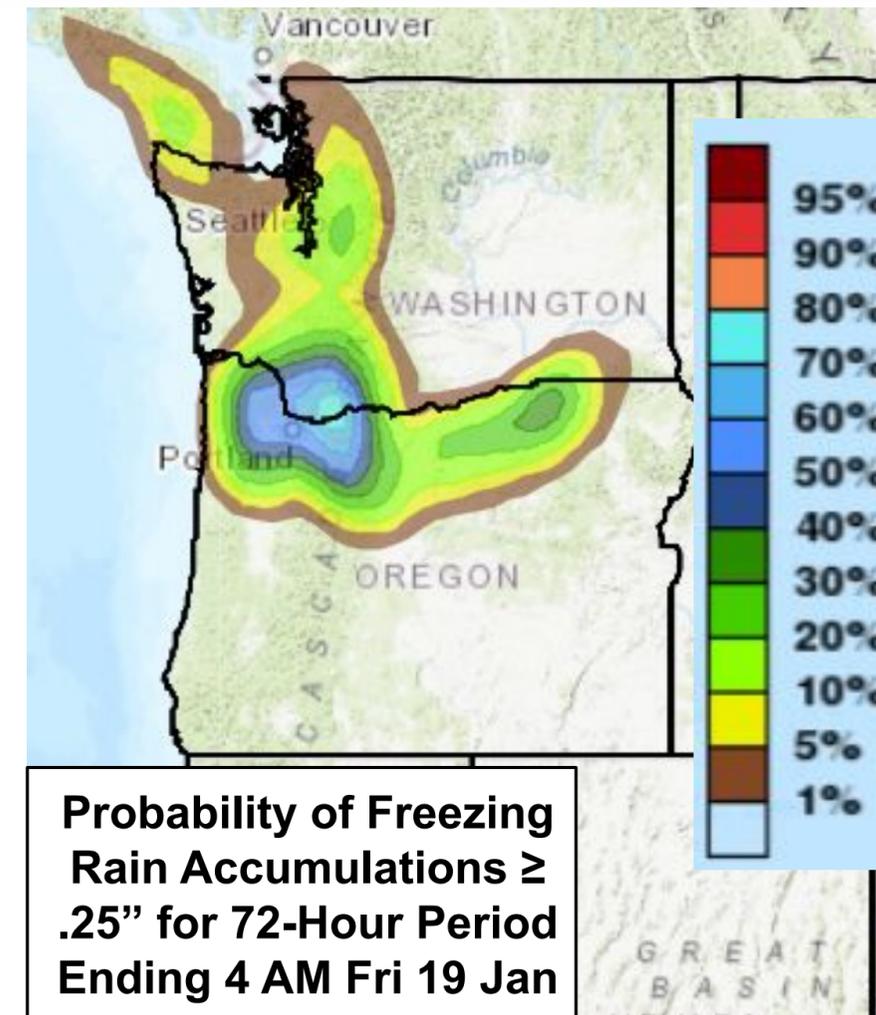
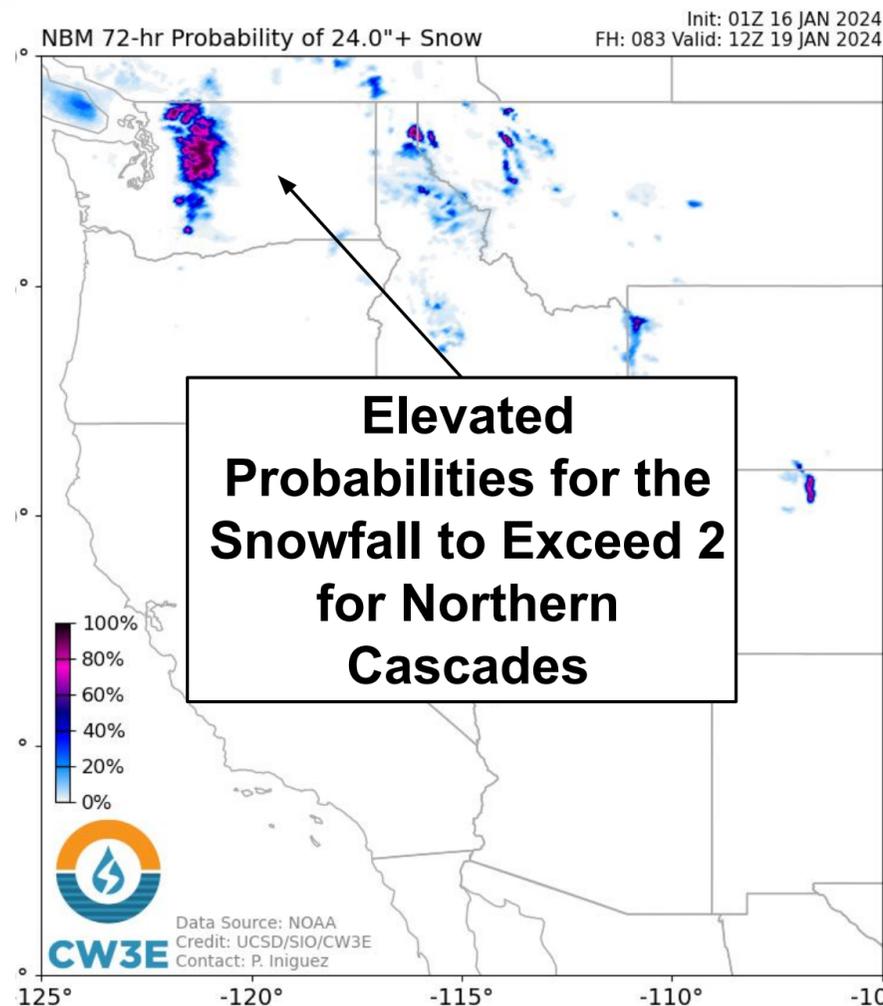
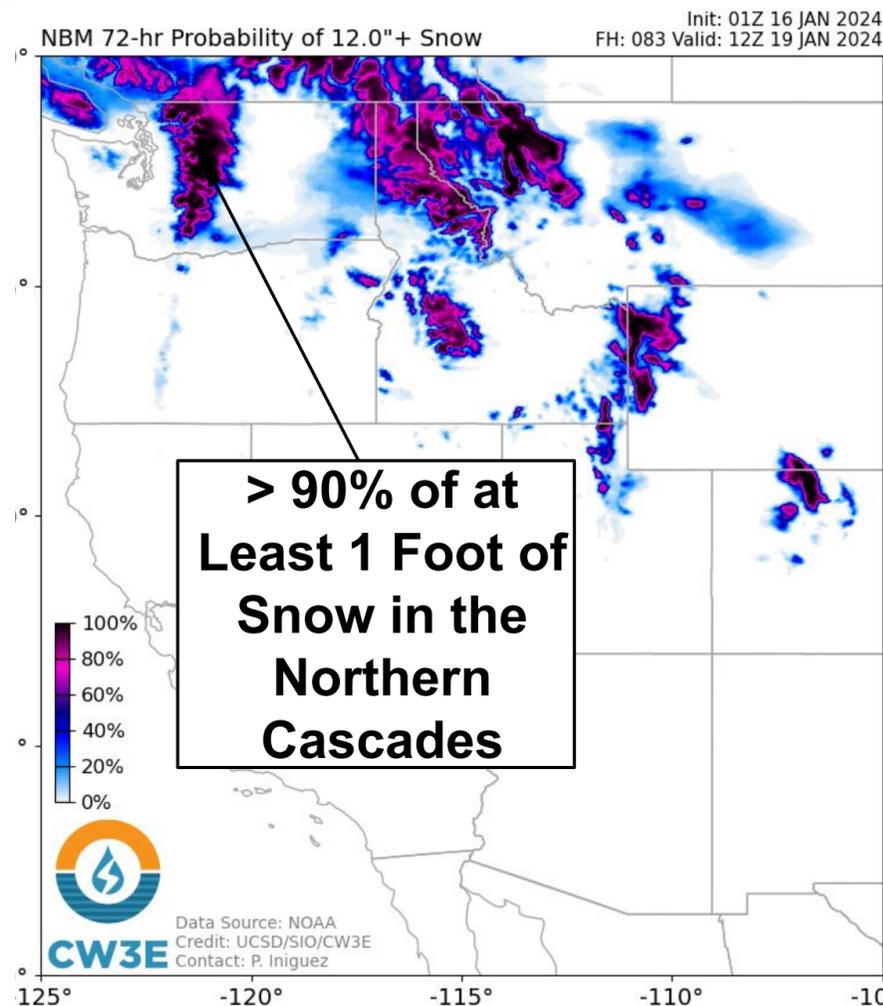
- The NWS WPC is forecasting the highest 24-hour precipitation totals to be in the PNW for the first two ARs (periods ending 4 AM PT 17 Jan through 19 Jan) and along the CA Coast and in the Sierra Nevada for the third AR (periods ending 4 AM PT 20 Jan through 23 Jan).
- The WPC Excessive Rainfall Outlook indicates a Marginal Risk (level 1 of 4, or at least 5% chance) for flooding to occur across the OR/ N.CA coast for the 24-hour period ending at 4 AM PT on Thu 18 Jan, for the Olympic Peninsula and WA/OR coasts for the period ending 4 AM PT on Fri 19 Jan and the CA coast and Sierras for the periods ending 4 AM PT on Sat 20 Jan and Sun 21 Jan.

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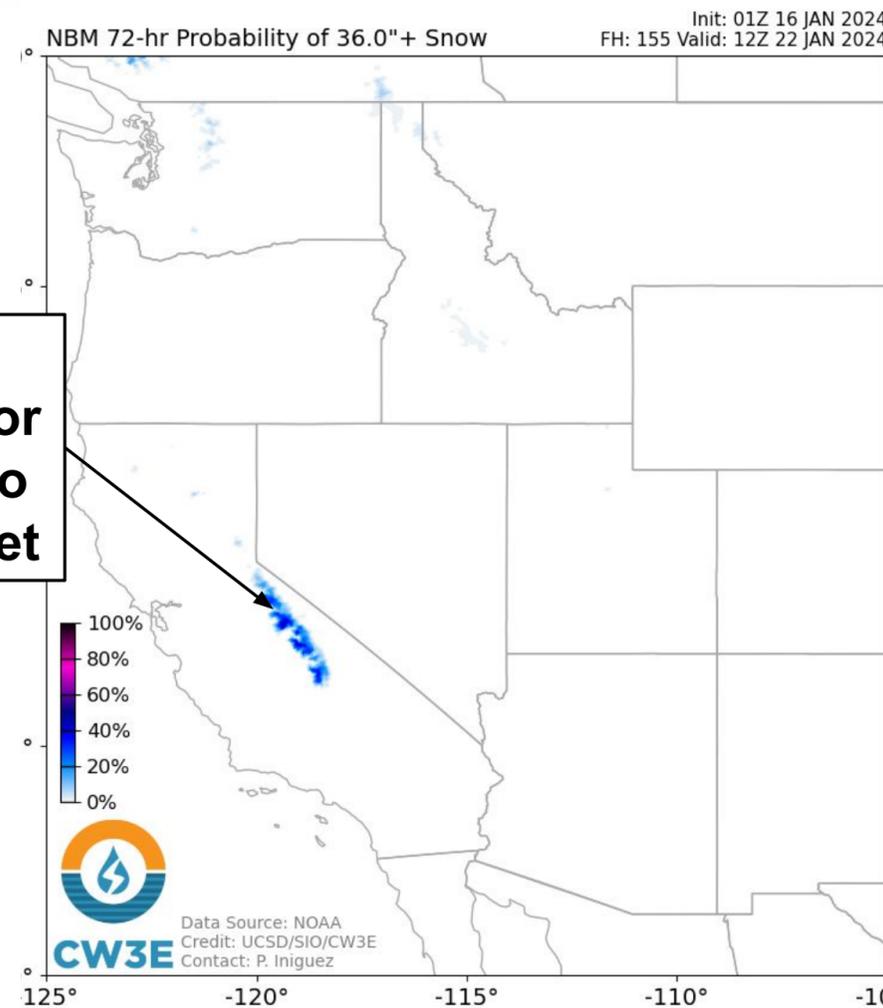
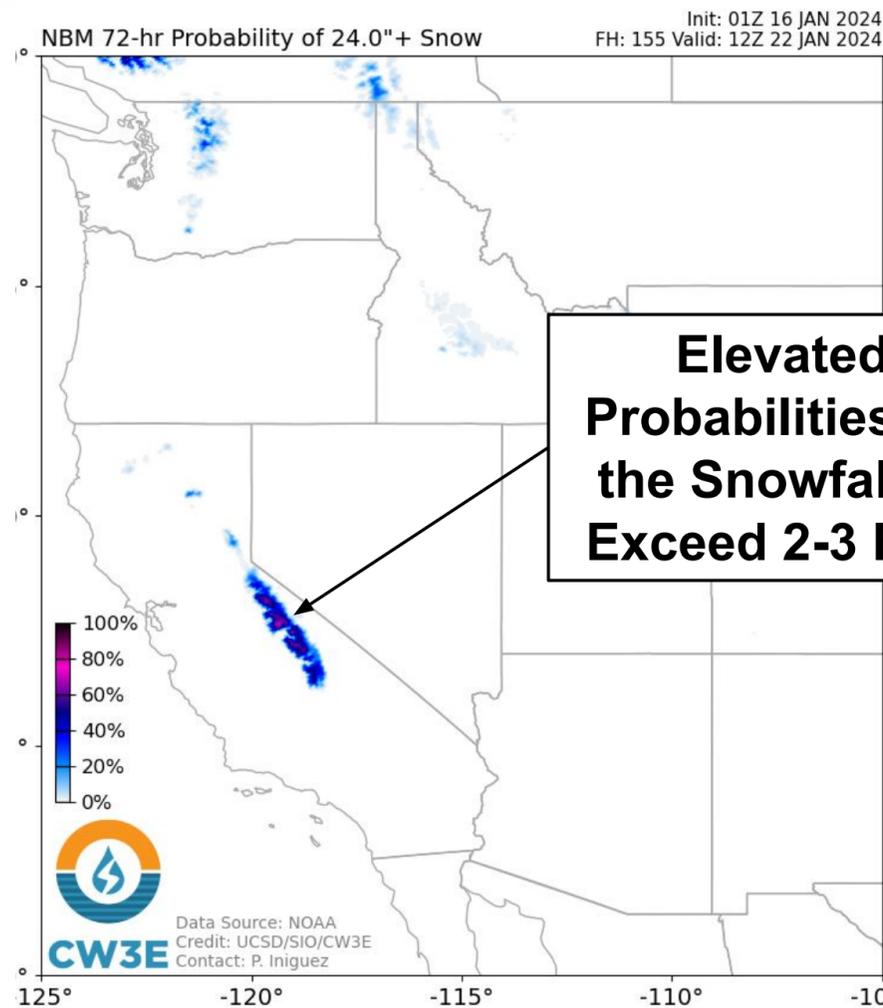
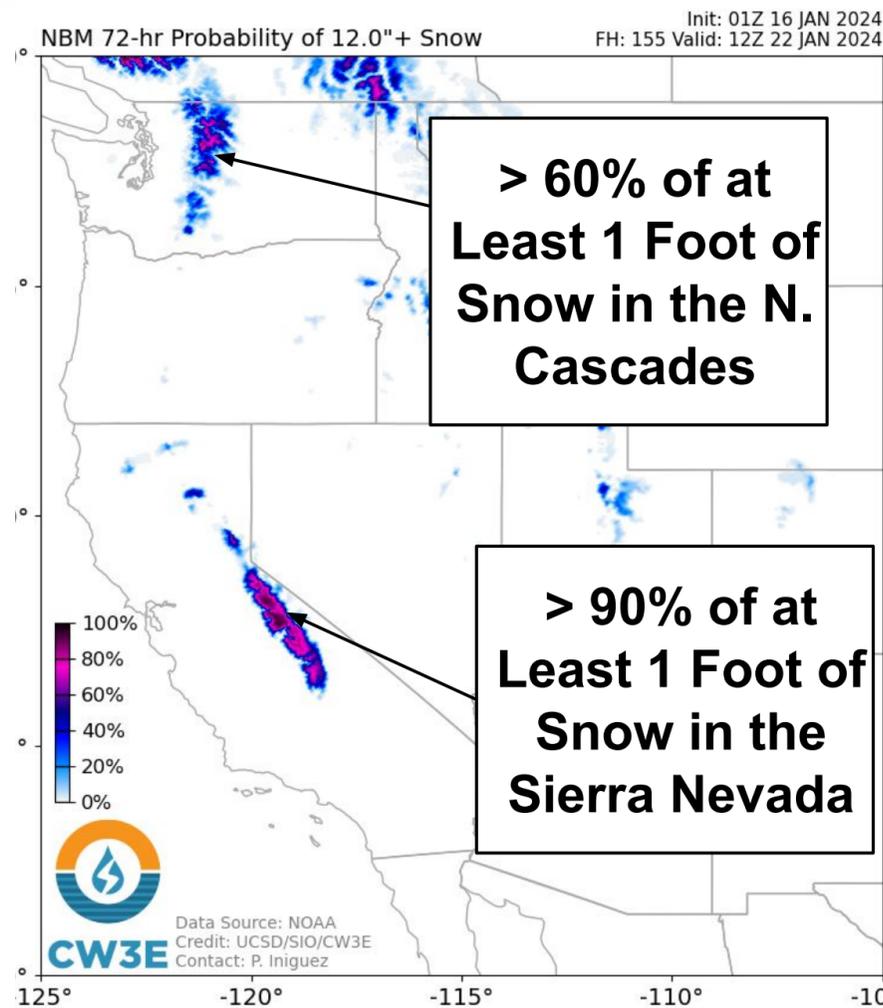
- The GFS 168-hr precipitation forecast is further to the north, with the highest precipitation totals in the N. Cascades and over the Olympic Peninsula, while the ECMWF is forecasting higher precipitation totals forecast for the S. Cascades and S. CA
- The WPC 168-hr forecast has higher precipitation totals for much of the USWC as compared to the GFS and ECMWF, with precipitation totals exceeding 6" in the Sierra Nevada, Cascades and along the Coast.

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- For the 72-hour period ending at 4 AM PT Sun 19 Jan, the NBM is showing very high probabilities (> 90%) that the N. Cascades receive at least 12" of snowfall.
- In the NBM's most recent forecast, portions of the N. Cascades also have high probabilities of snowfall totals exceeding 2'
- There are medium probabilities (>50%) of freezing rain accumulations \geq .25" for the same period in the Portland Metro area and along the OR/WA border.

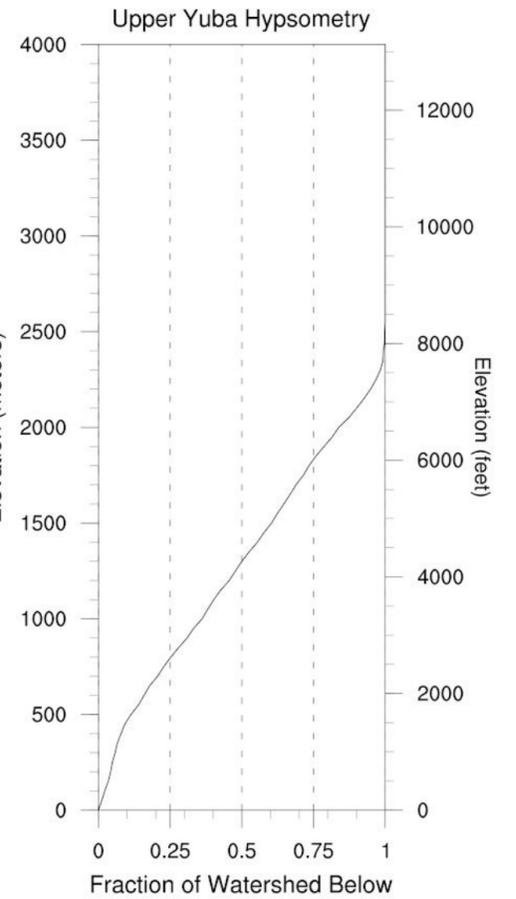
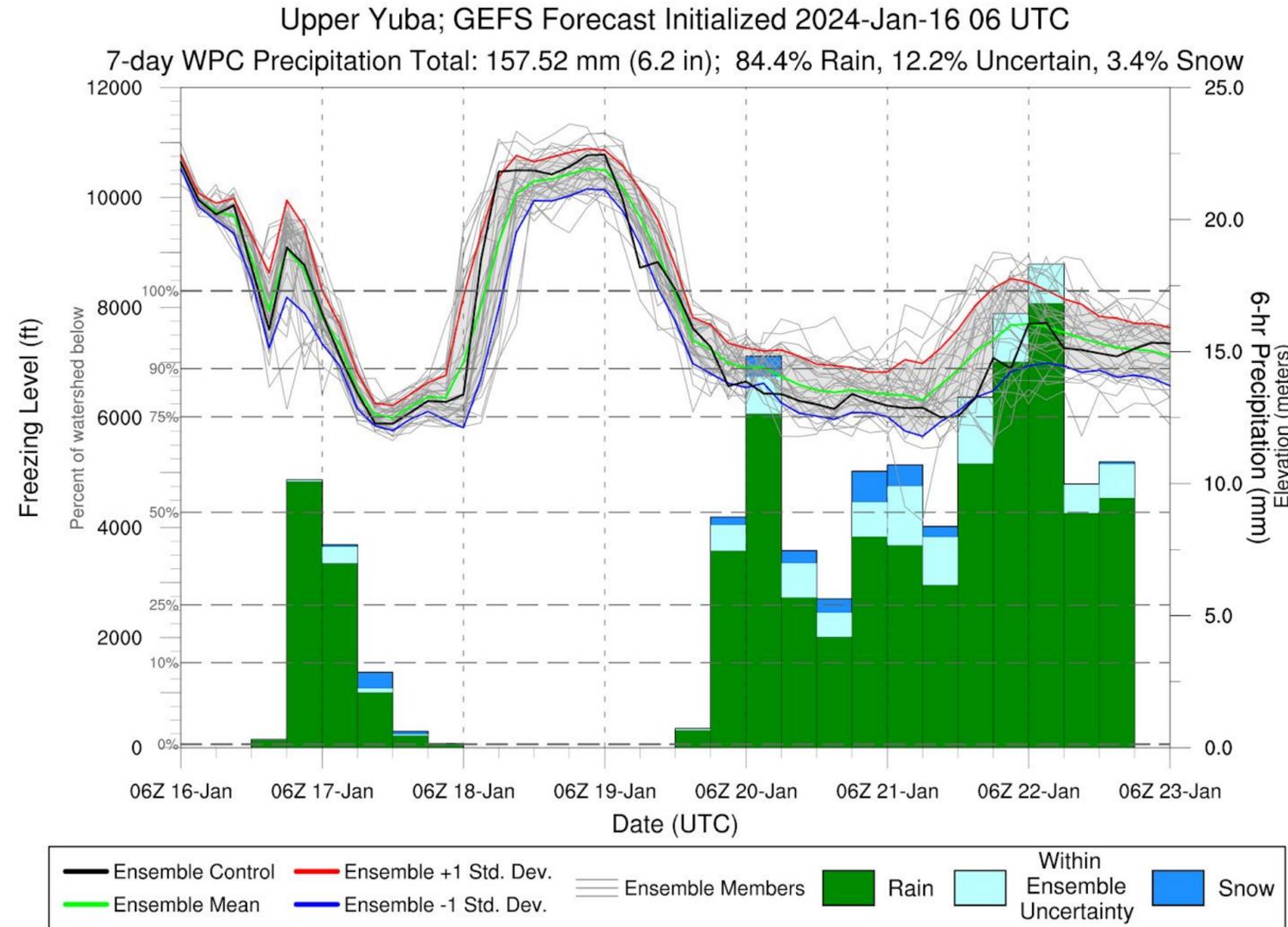
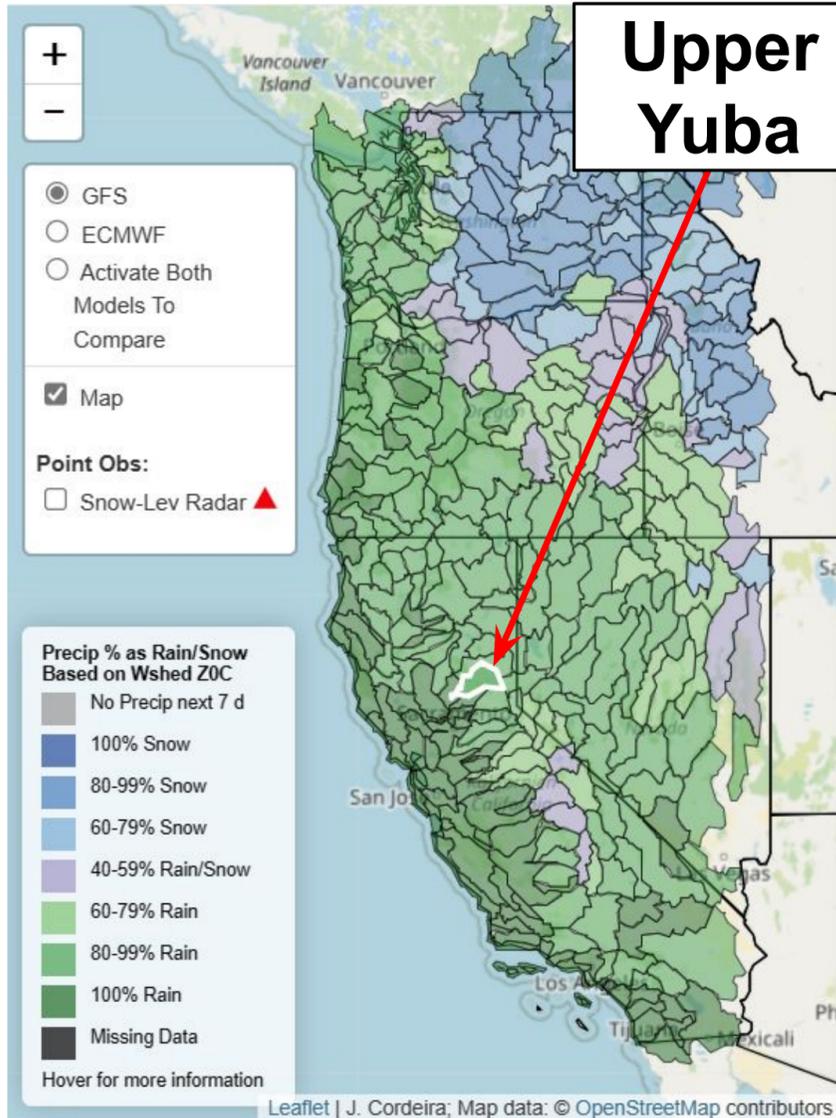
CW3E AR Outlook: 16 Jan 2024



- For the 72-hour period ending at 4 AM PT Mon 22 Jan, the NBM is showing very high probabilities (> 90%) of at least 12" of snowfall in the Sierra Nevada and moderate probabilities (>60%) of at least 12" in the N. Cascades
- The NBM is currently forecasting lower probabilities (>30%) of this snowfall exceeding 2'-3' in the Sierra Nevada.

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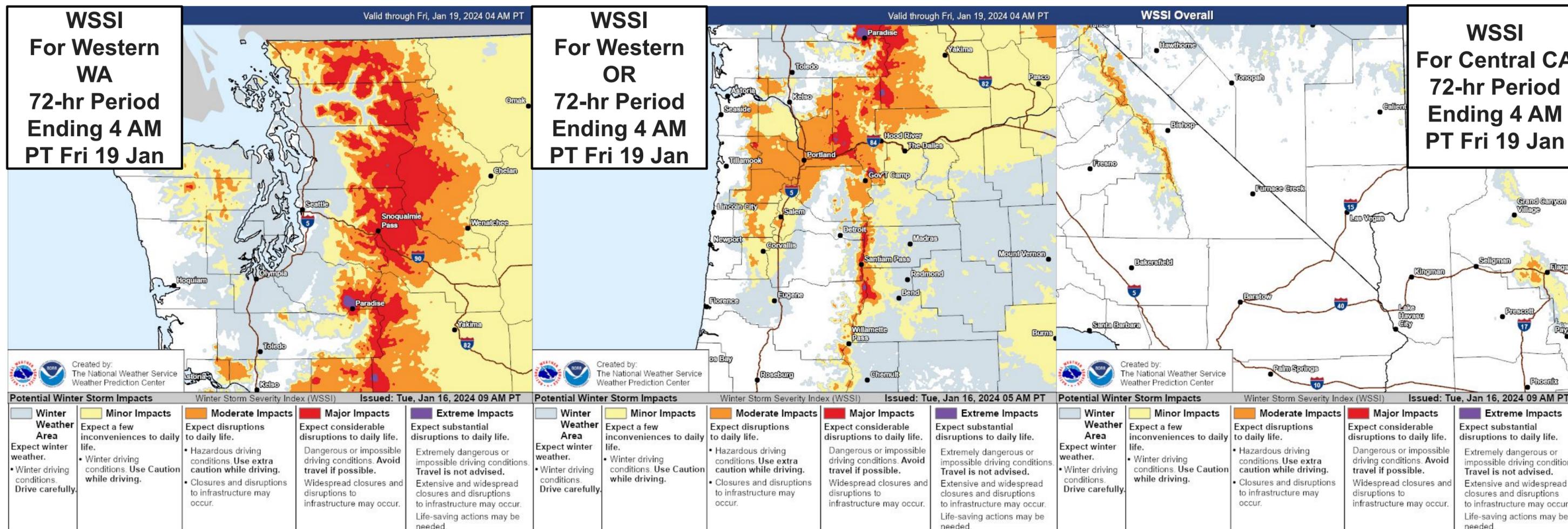
Freezing Level Forecast



- The freezing level is forecast to remain above ~6000 ft above mean sea level (MSL) for the duration of the approaching ARs in the Upper Yuba watershed.
- The CW3E watershed freezing level tool is forecasting >80% of the precipitation in the Upper Yuba to fall as rain over the next 7 days, highlighting the risk for rain-on-snow flooding.

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WPC Winter Storm Severity Index (WSSI)

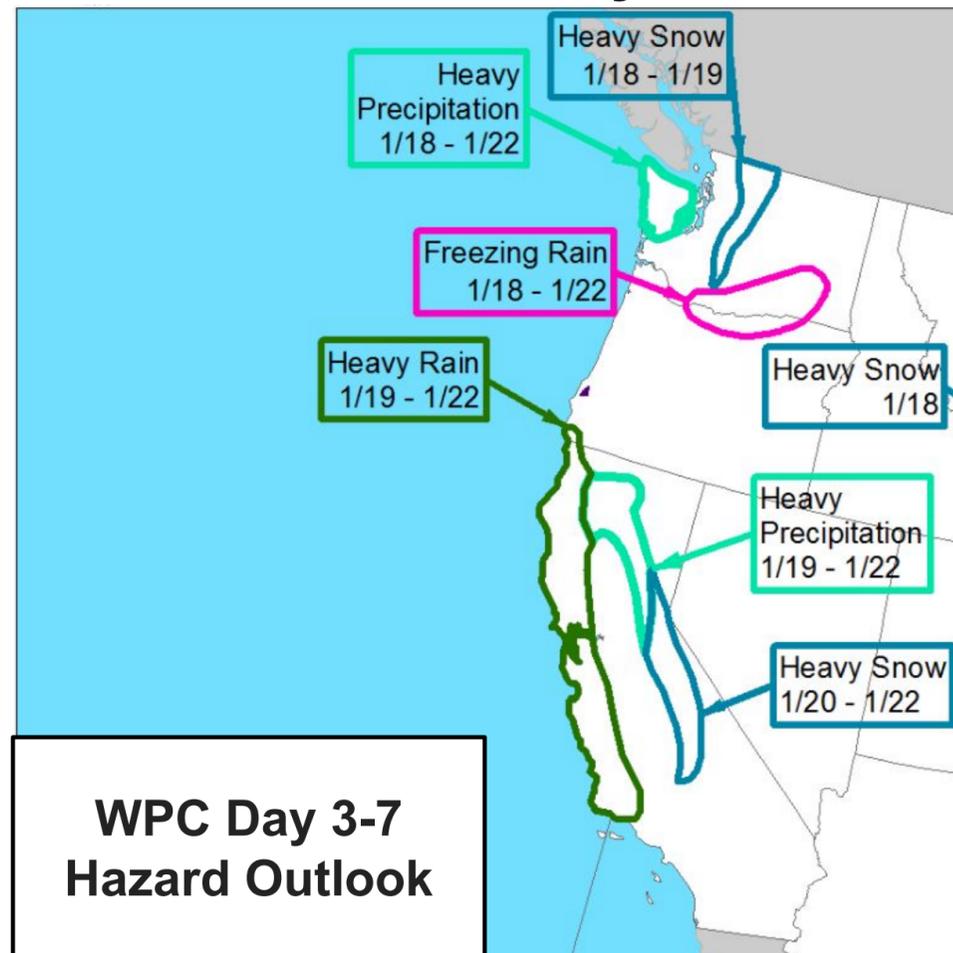


Source: WPC; <https://www.wpc.ncep.noaa.gov/wwd/wssi/wssi.php>

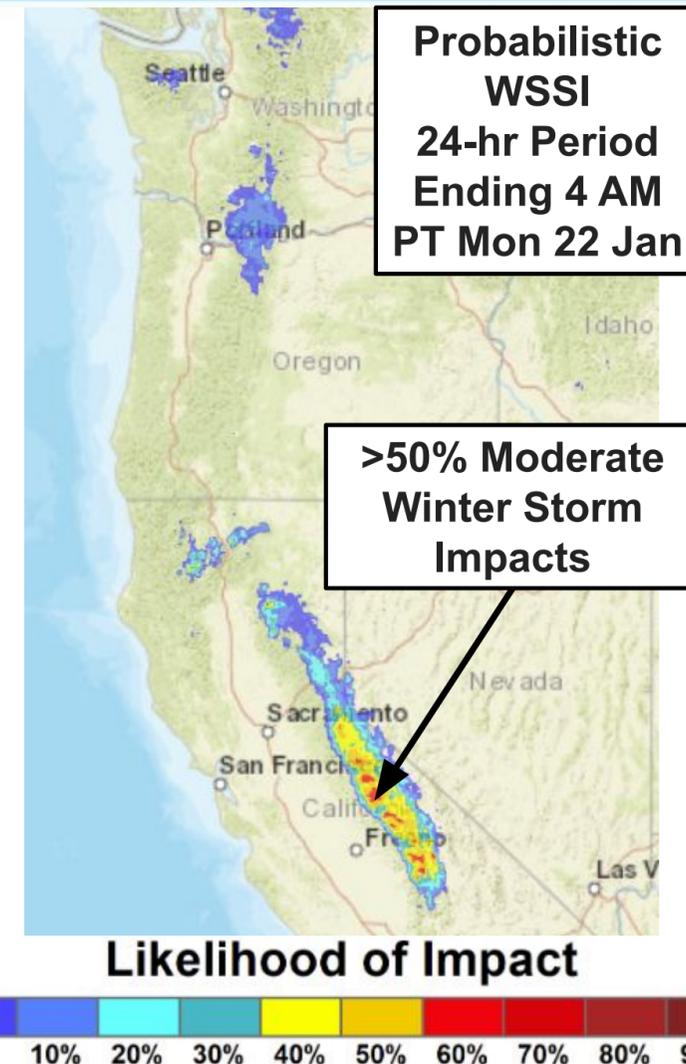
- WPC WSSI for the 3-day period ending at 4 AM PT Fri 19 Jan highlights likelihood for **major impacts** throughout the Cascades during the first AR.
- For the same time period there are smaller regions of **moderate impacts** forecast for the Sierra Nevada.

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WPC Probabilistic WSSI and Day 3-7 Hazard Outlook



Source: WPC; https://www.wpc.ncep.noaa.gov/threats/final/hazards_d3_7_contours.png



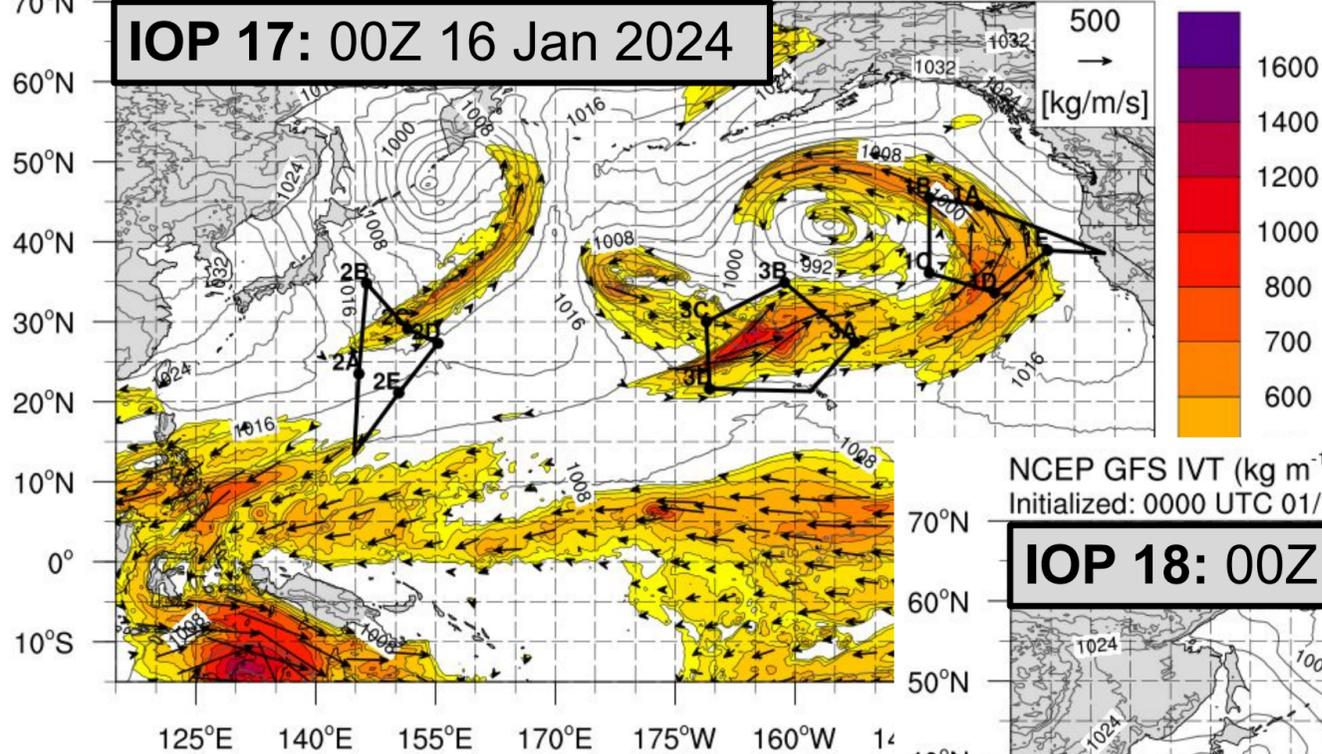
Source: WPC; https://www.wpc.ncep.noaa.gov/wwd/wssi/prob_wssi.php

- WPC Probabilistic WSSI for the 24-hr period ending at 4 AM PT Mon 21 Jan forecasts > 50% chance for **moderate impacts** in the Sierra Nevada.
- For the end of the first AR and second AR period, WPC's day 3-7 Hazard Outlook is highlighting a moderate risk of **freezing rain** along the WA/OR border, **heavy snow** in the N.Cascades and Sierras, **heavy rain** along the CA coast and **heavy precipitation** over the Olympic Peninsula and N. Sierra Nevada.

CW3E AR Outlook: 16 Jan 2024

Current AR Recon Flight Sequence

NCEP GFS IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded), IVT Vector, and SLP (hPa; contours)
 Initialized: 0000 UTC 01/14/2024 IOP 17: F-048: Valid: 0000 UTC 01/16/2024



NCEP GFS IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded), IVT Vector, and SLP (hPa; contours)
 Initialized: 0000 UTC 01/15/2024 IOP 18: F-048: Valid: 0000 UTC 01/17/2024

