CW3E Atmospheric River Outlook: 18 Jan 2024

Active Weather Pattern Continues in Pacific, Bringing Precipitation to US West Coast

- An active weather pattern for the US West Coast is forecast to continue through Wed 23 Jan and potentially beyond.
- The **first AR** begins on Thu 18 Jan as a low-pressure system drives it up the USWC.
- The **first AR** is forecast to bring heavy precipitation to the PNW, including snowfall 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 **second AR** period begins late Sun 20 Jan as a large AR begins to make landfall across the USWC.
- A potential **third AR** follows shortly behind with a short burst of IVT into the PNW on Tue 23 Jan.
- The **second and third ARs** are forecast to bring precipitation to the USWC, with the heaviest precipitation expected from the **second AR** over the CA coast and in the Sierra Nevada, where heavy snowfall (>12”) is forecast through Tue 22 Jan.
- 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 Slight Risk (level 2 of 4, or at least 15% chance) for flooding in days 4 and 5 (24-hour periods ending 4 AM PT Mon 22 Jan and Tue 23 Jan) for much of the CA coast.
- There is potential for a **fourth AR** to make landfall in the PNW indicated by the ECMWF EPS. The Climate Prediction Center (CPC) has already indicated a slight risk for **heavy precipitation**, **heavy snow**, and **high winds** in the PNW for Jan 25-27 when it may make landfall.

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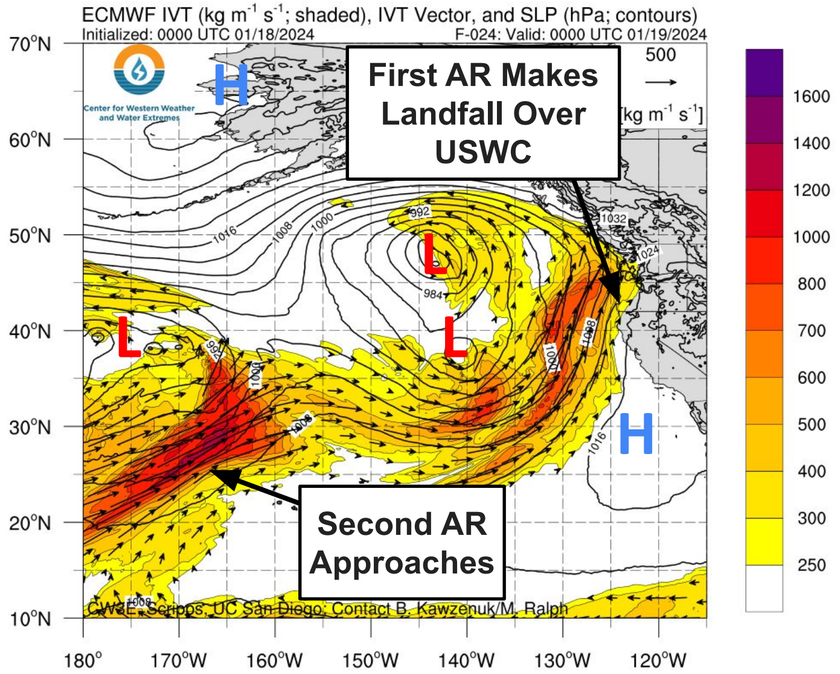
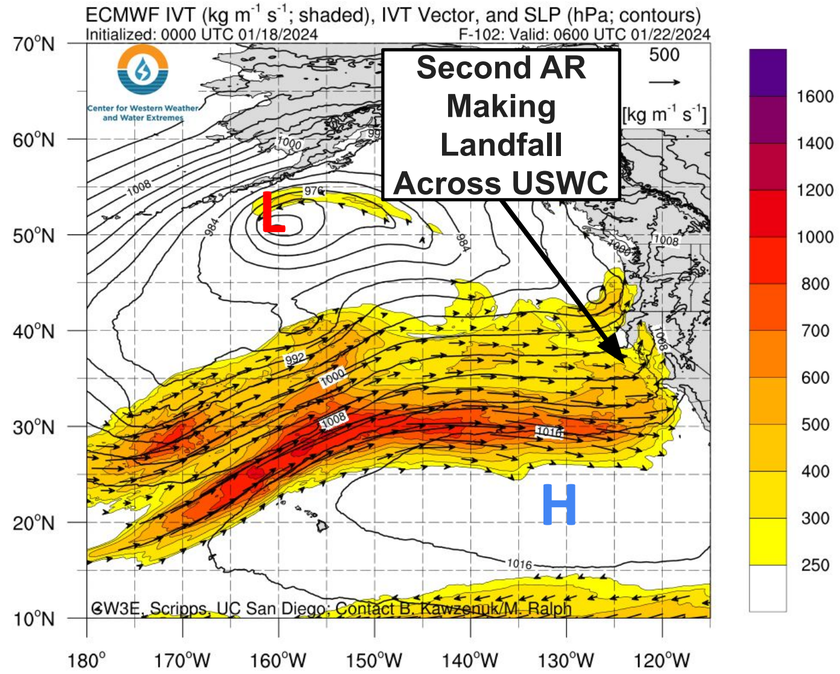
ECMWF Init 6Z Thu 18 Jan 2024

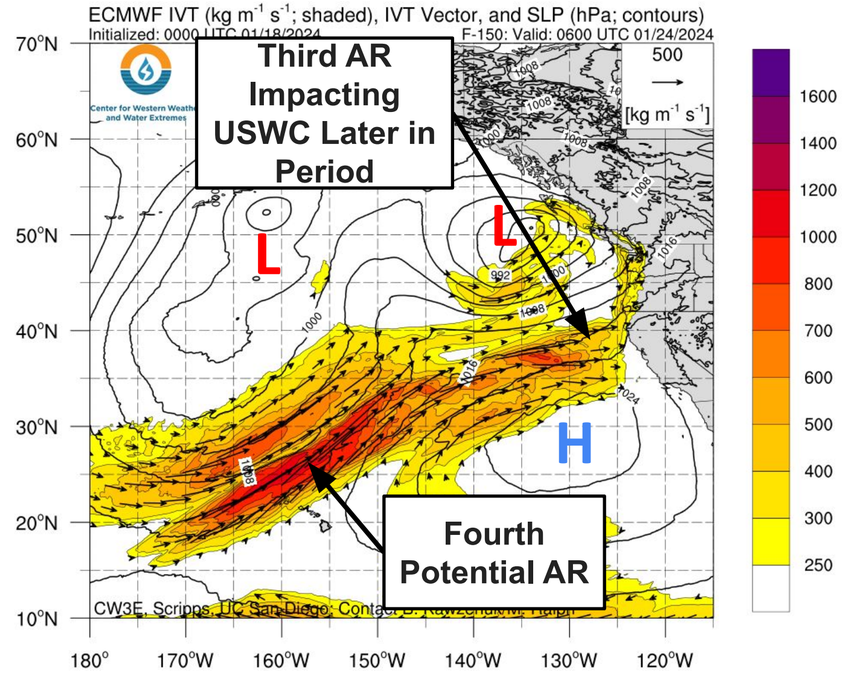
4PM PT Thu 18 Jan 2024



10PM PT Sun 21 Jan 2024



10PM PT Wed 23 Jan 2024



- An active period of AR conditions over the USWC is forecast to continue through Wed 23 Jan.
- The first AR begins late Thu 18 Jan as strong moisture transport is brought to the USWC alongside a low-pressure system.
- The direction of IVT over Oregon and Northern California with the first AR will be suboptimal for providing support for orographic precipitation in the region, likely limiting rainfall totals during the first system.
- 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 Sun 21 Jan, following a break in AR conditions with the previous system.
- A third, weak AR brings IVT to the PNW and N. Cal on Wed 23 Jan as the secondary low pressure system moves into the Gulf of Alaska. A fourth AR that has potential to impact the USWC has propagated into the NE Pacific at this time.

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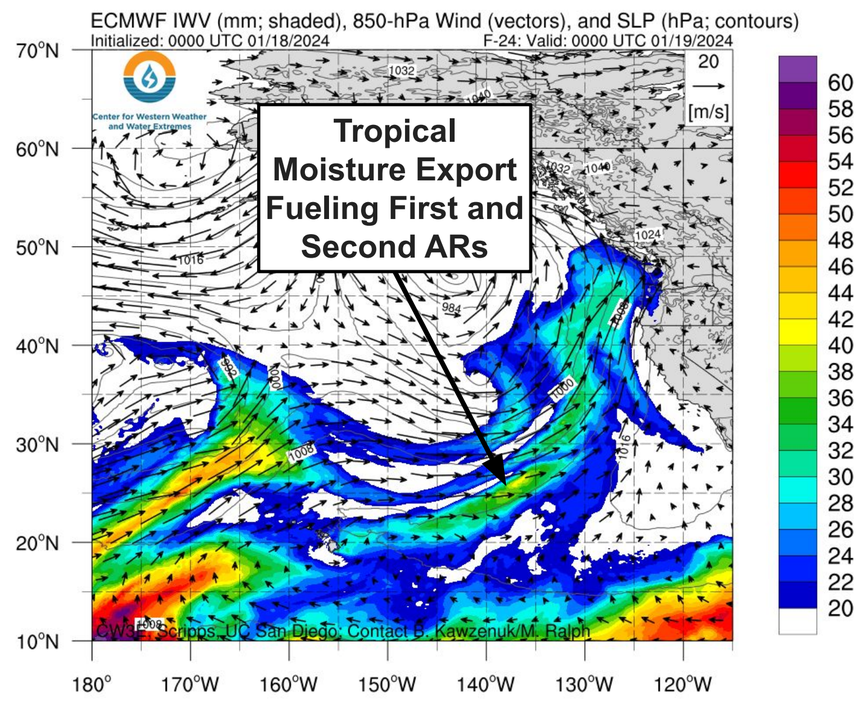
4PM PT Thu 18 Jan 2024



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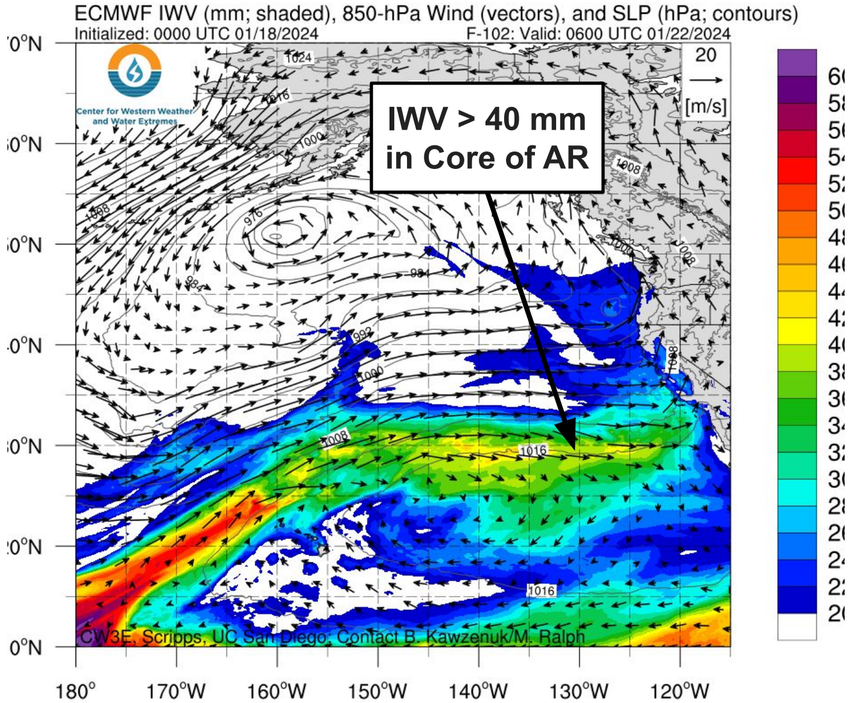
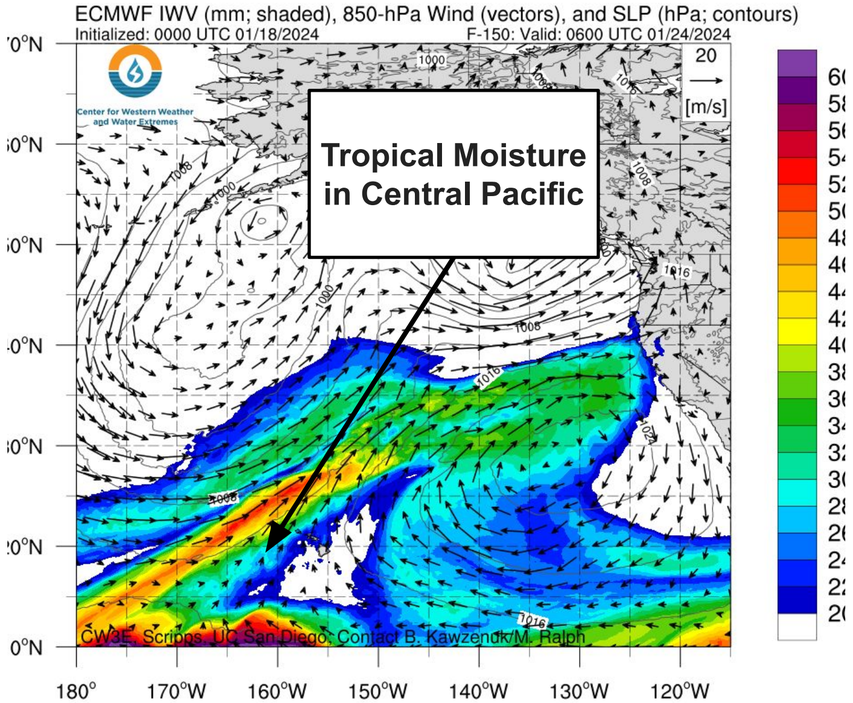


10PM PT Wed 23 Jan 2024



- The incoming first AR is supported by a strong tropical moisture export (TME) extending from south of Hawaii, with IWV > 30 mm forecast in the core of the AR as it makes landfall over the PNW on Thu 18 Jan.

- The second and third ARs are fueled by tropical moisture out of the central Pacific, with the second AR bringing higher IWV to the coast at landfall than the third.

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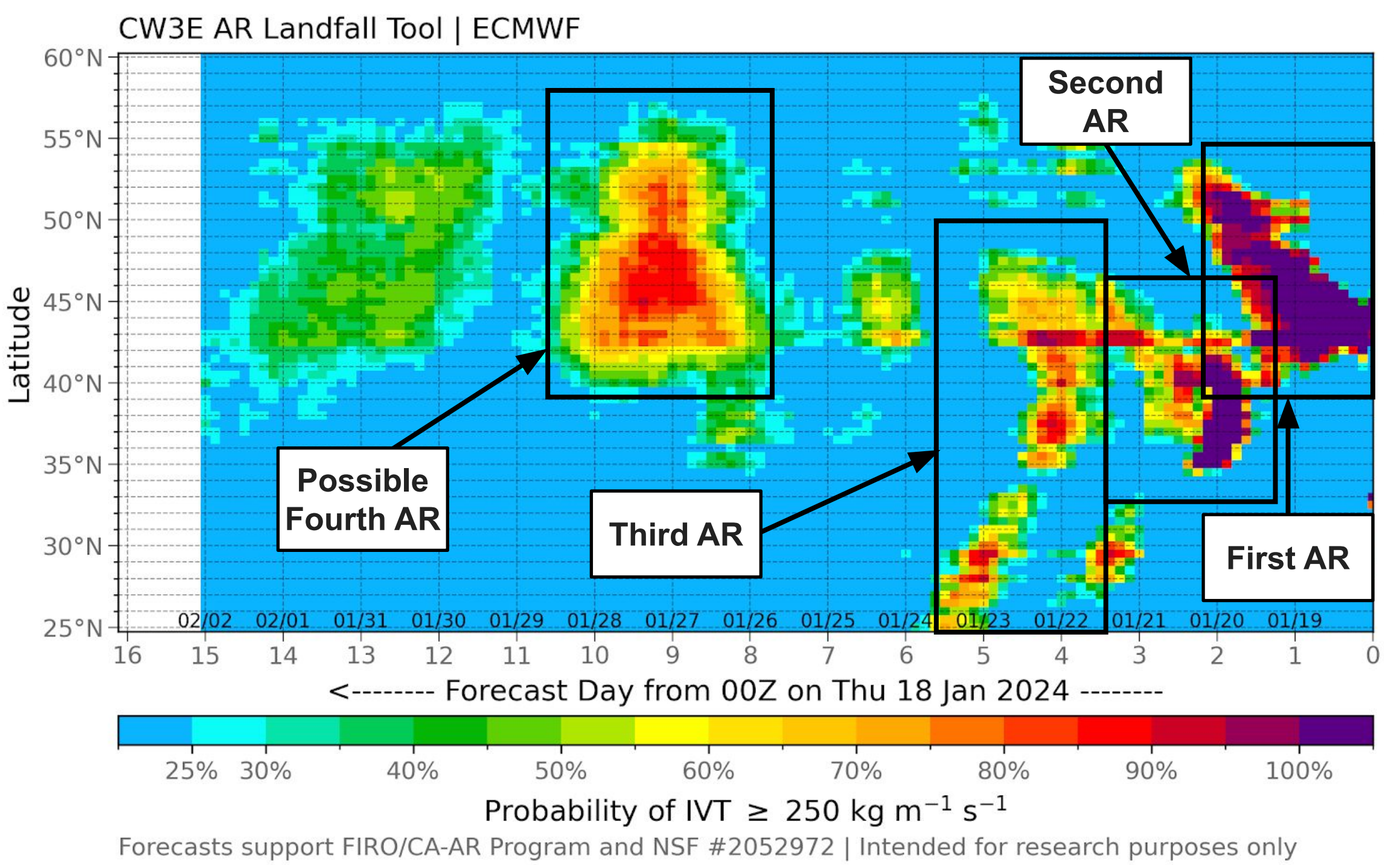
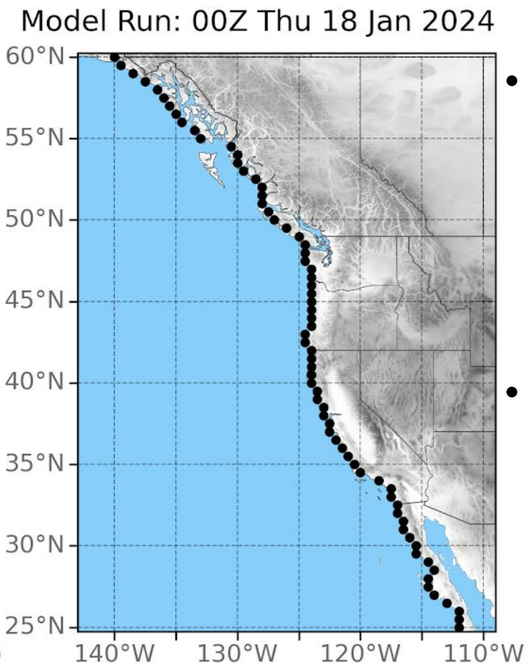


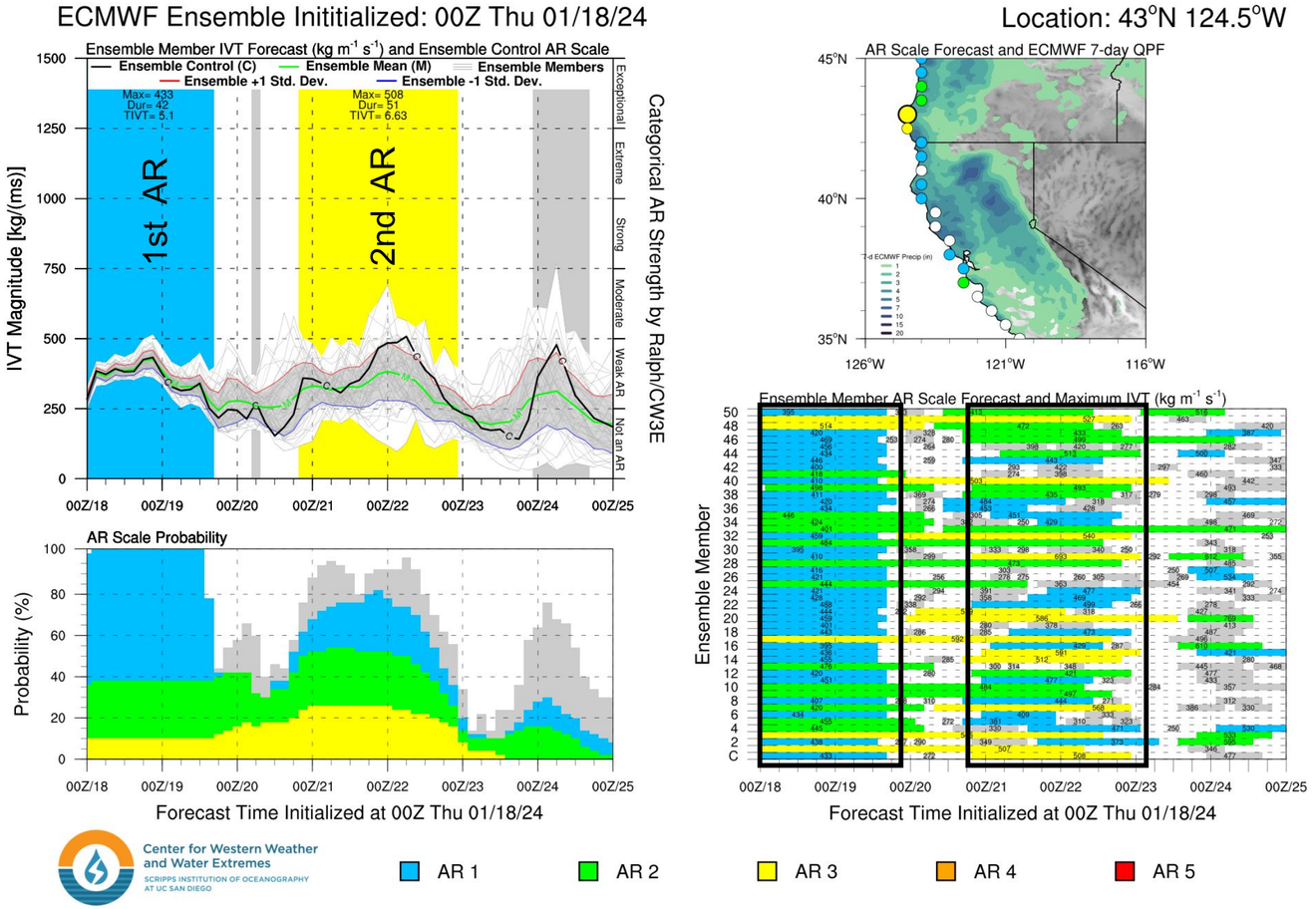


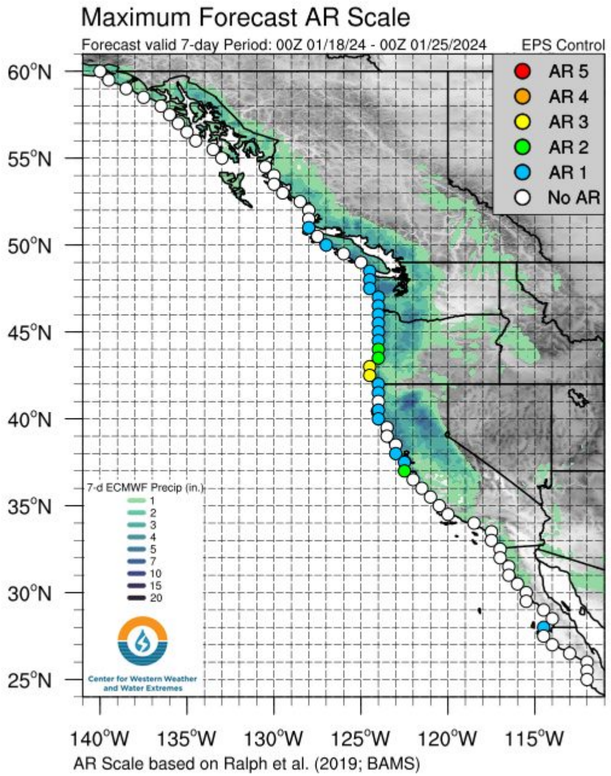
Center for Western Weather and Water Extremes

- The ECMWF EPS is forecasting an active AR period over the USWC for the next two weeks.
- The EPS is showing very high confidence (>90%) in IVT > 250 kg m^{-1} s^{-1} making landfall over the USWC Thu 18 Jan through Sat 20 Jan with the first and second ARs.
- The EPS is also showing high confidence (>80%) in in IVT > 250 kg m^{-1} s^{-1} progressing down the USWC from Mon 22 Jan through Tue 23 Jan with the third AR.
- In the longer term, the EPS is showing high confidence (>80%) in IVT > 250 kg m^{-1} s^{-1} over the PNW from 26-28 Jan and medium probabilities (>40%) from 30 Jan through 1 Feb.

CW3E AR Outlook: 18 Jan 2024

ECMWF EPS 7-day AR Scale and IVT Forecast

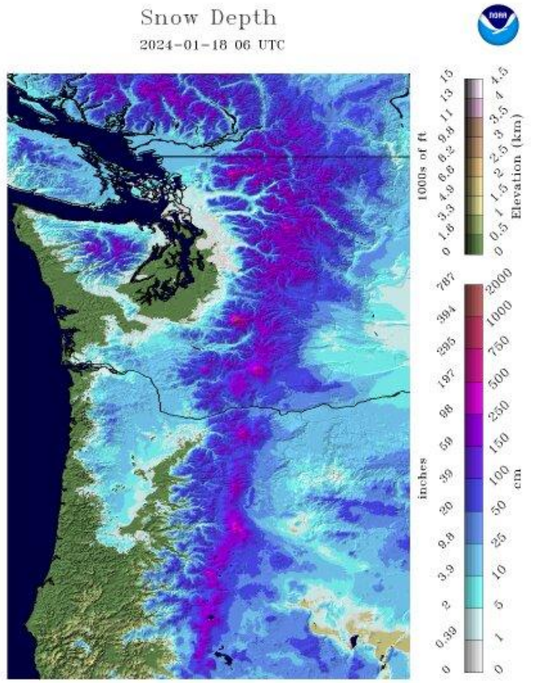




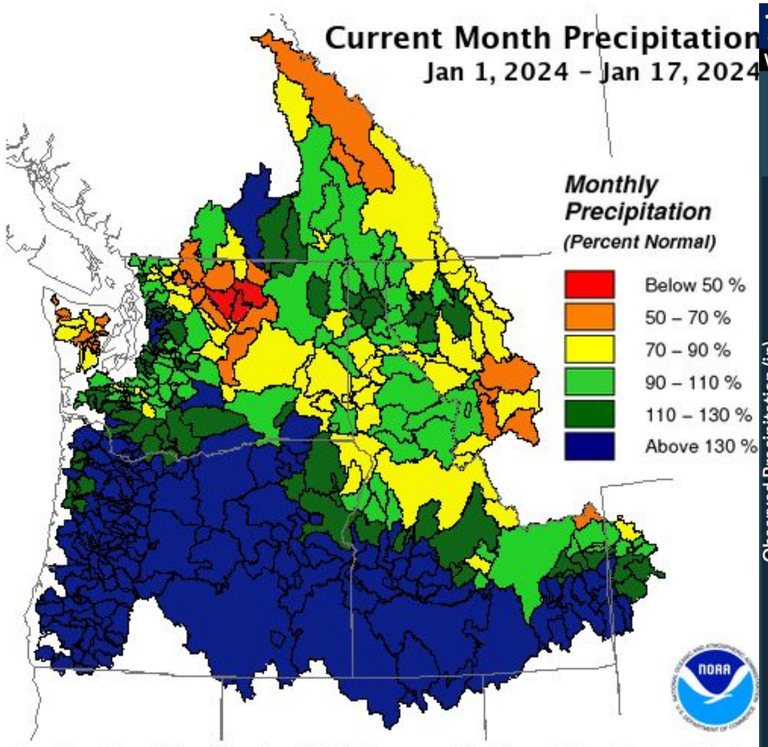
- The ECMWF EPS control member is also forecasting multiple ARs for the point at 43⁰ N, 124.5⁰ W (coastal S.OR) during the next 7 days.
- 51/51 (100%) EPS ensemble members are forecasting at least AR1 conditions during the first AR on Jan 18-20.
- Every member indicating greater than AR 1 for the first AR is forecasting ≥ 48 hours of AR conditions.
- 27/51 (53%) of the members are forecasting at least AR2 conditions, with the control member forecasting an AR3, during the second AR on Jan 21-23.
- Several EPS members are indicating a continuation of AR conditions between the first and second ARs.

CW3E AR Outlook: 18 Jan 2024

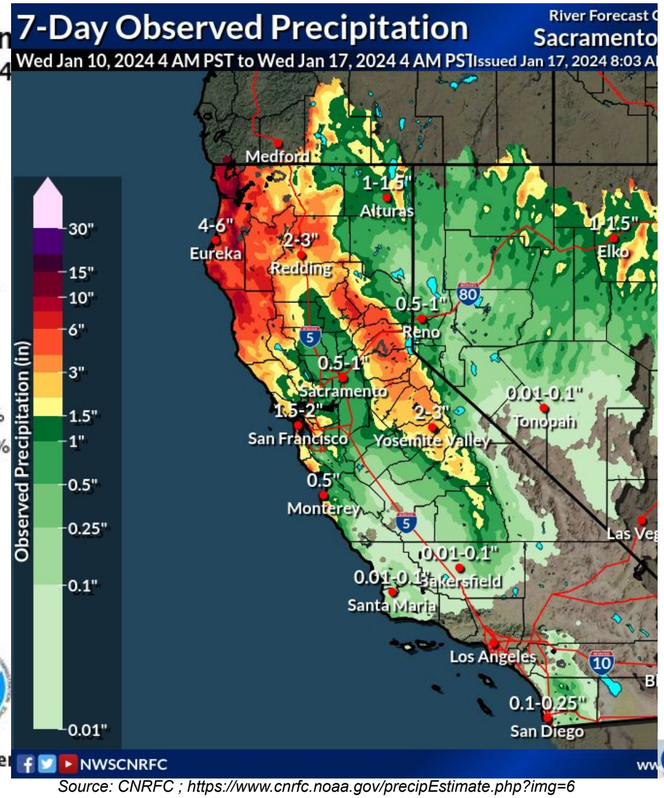
Antecedent Conditions



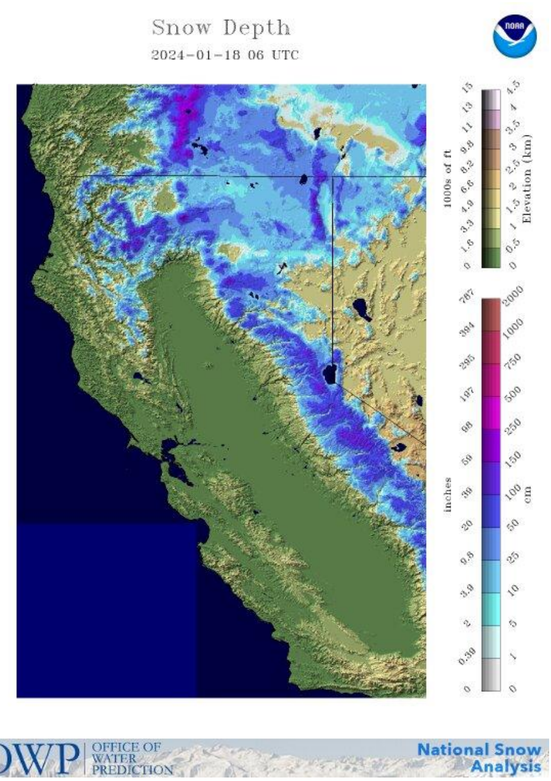
Source: OWP; https://www.nohrsc.noaa.gov/nsa/



Source: NWRFC https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=3



Source: CNRFC ; https://www.cnrfc.noaa.gov/precipEstimate.php?img=6



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

- Portions of the Western US, especially OR and Northern CA have received substantial precipitation in January 2024, much of it in the last week (Jan 10 to Jan 17).
- Given the antecedent conditions, the forecasted persistent rainfall and warmer events poses an increased risk of flooding 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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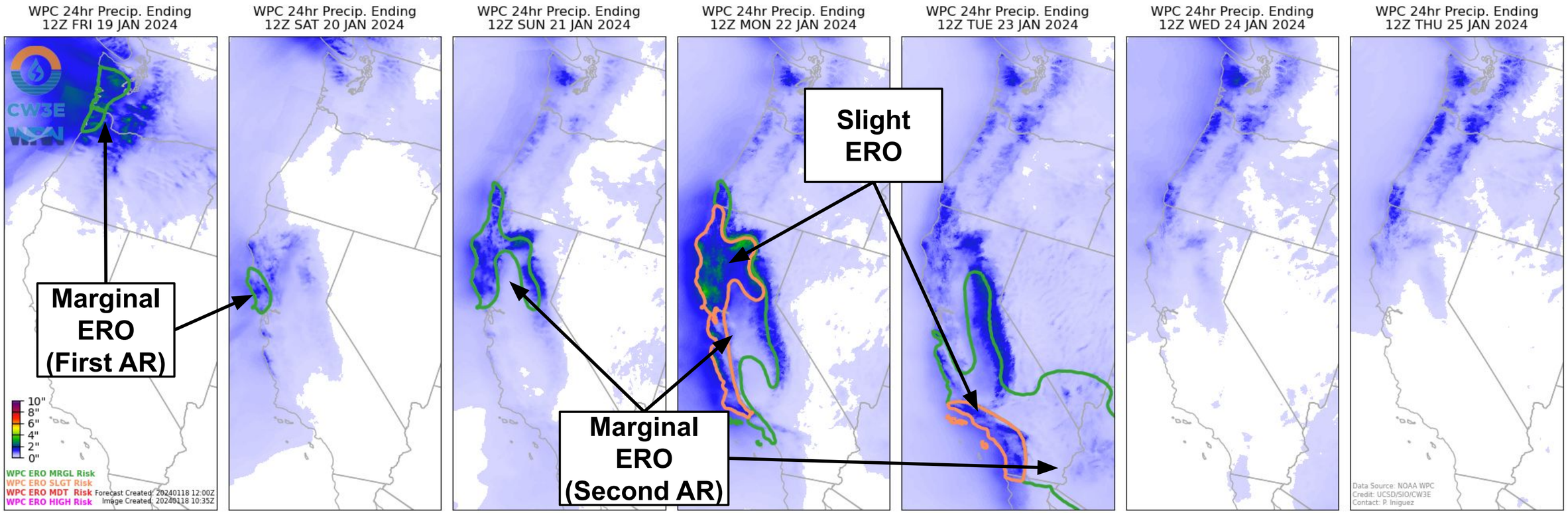
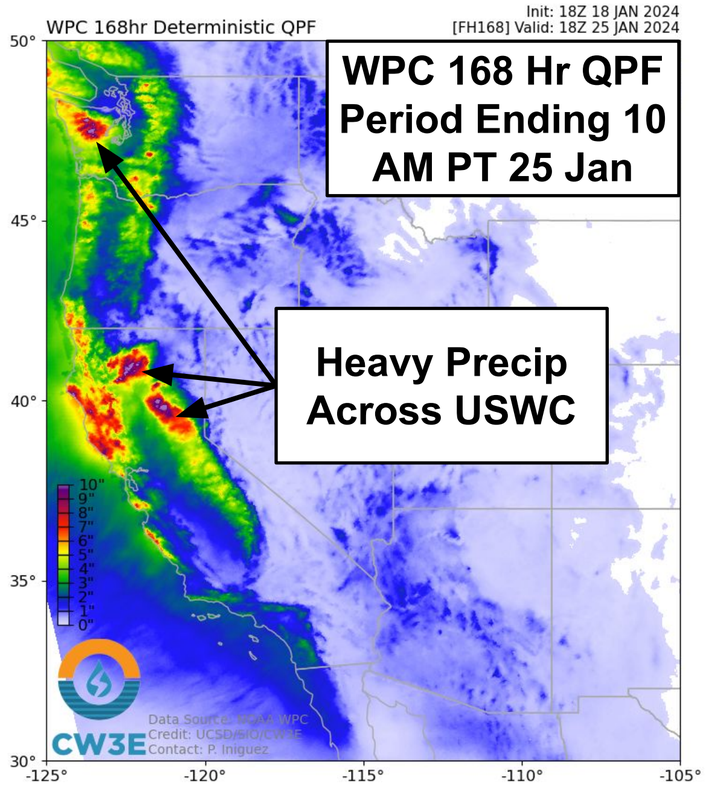
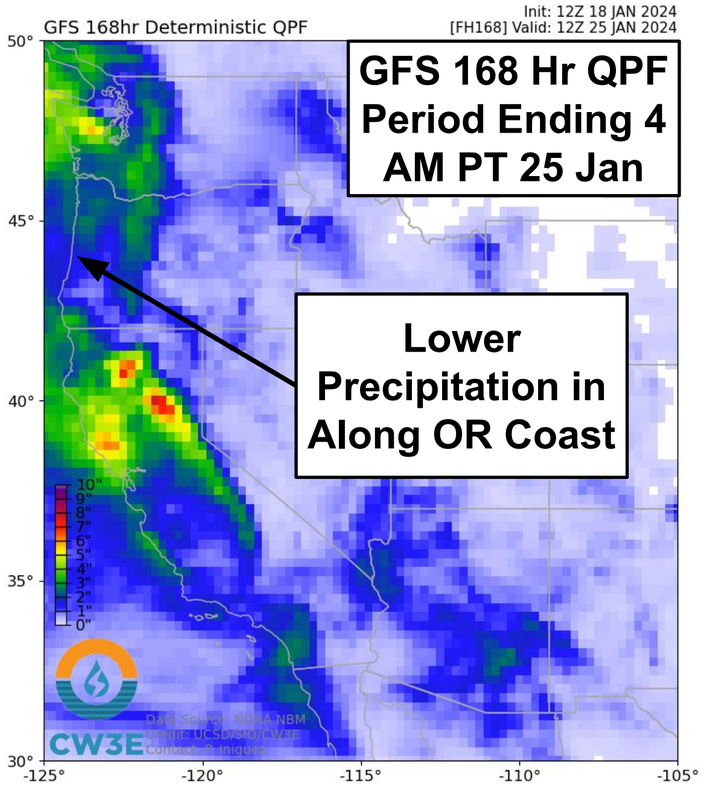
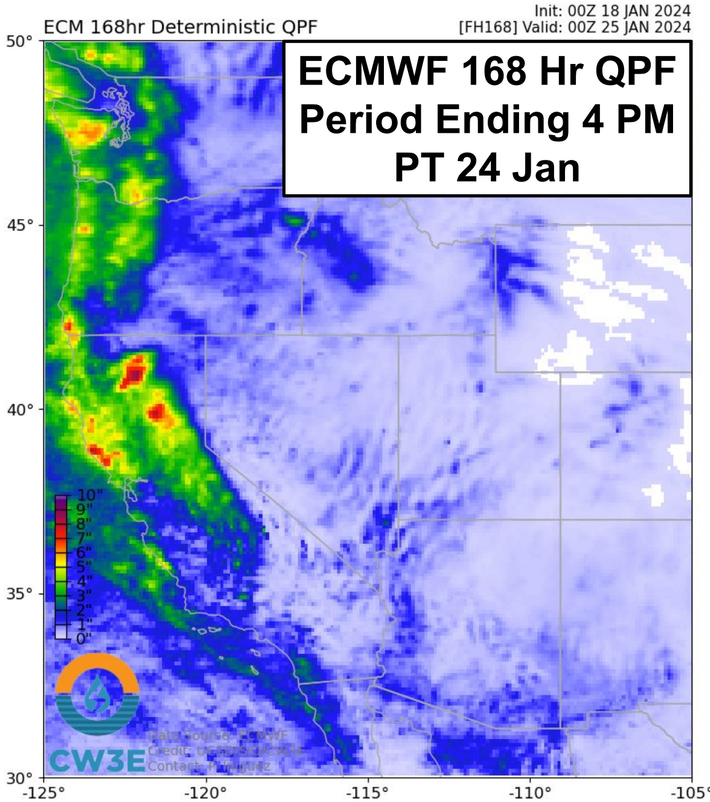


- The NWS WPC is forecasting the heaviest precipitation in the PNW for the first and third AR (periods ending 4 AM PT 19 Jan and 24-25 Jan) and along the CA Coast and in the Sierra Nevada for the second AR (periods ending 4 AM PT 20 Jan through 23 Jan).
- The WPC Excessive Rainfall Outlook indicates a Slight Risk (level 2 of 4, or at least 15% chance) for flooding to occur across the CA coast and Northern Sierra Nevada for the 24-hour period ending at 4 AM PT on Mon 22 Jan and Tue 23 Jan.
- Marginal Risks (level 1 of 4, or at least 5% chance) for flooding have been issued for the Olympic Peninsula and WA/OR coasts for the period ending 4 AM PT on Fri 19 Jan and the CA coast and Central Valley for the periods ending 4 AM PT 20 Jan through 23 Jan.

CW3E AR Outlook: 18 Jan 2024







- WPC, GFS and ECMWF 168-hr precipitation forecasts are forecasting the highest precipitation totals over the Olympic Peninsula, N. Sierra and N. CA coast.
- The most noticeable difference in the GFS compared to the WPC and ECMWF is lower forecasted precipitation along the OR coast in the OR Cascades.
- 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 Northern Sierra Nevada, Cascades and along the Coast Ranges.

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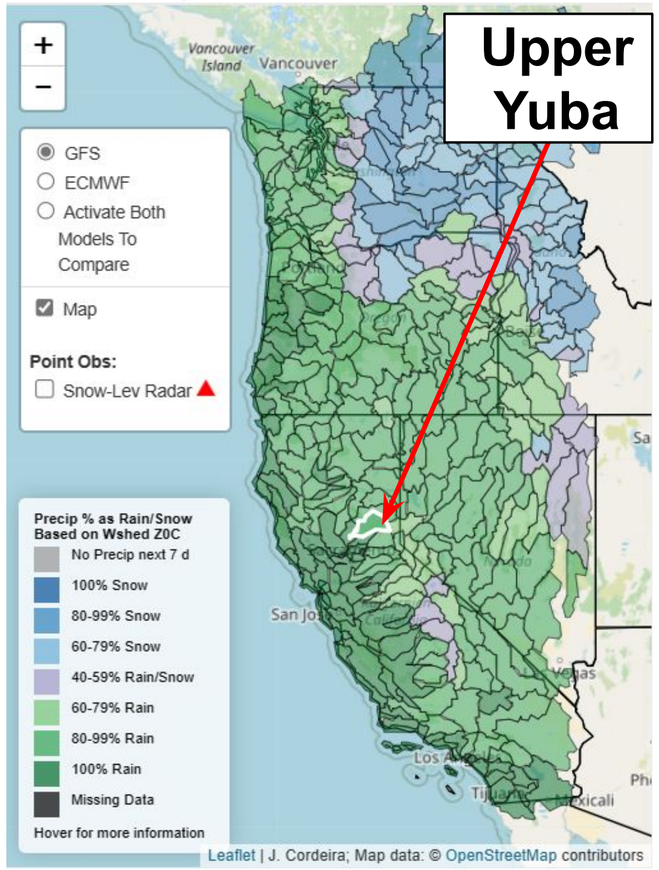
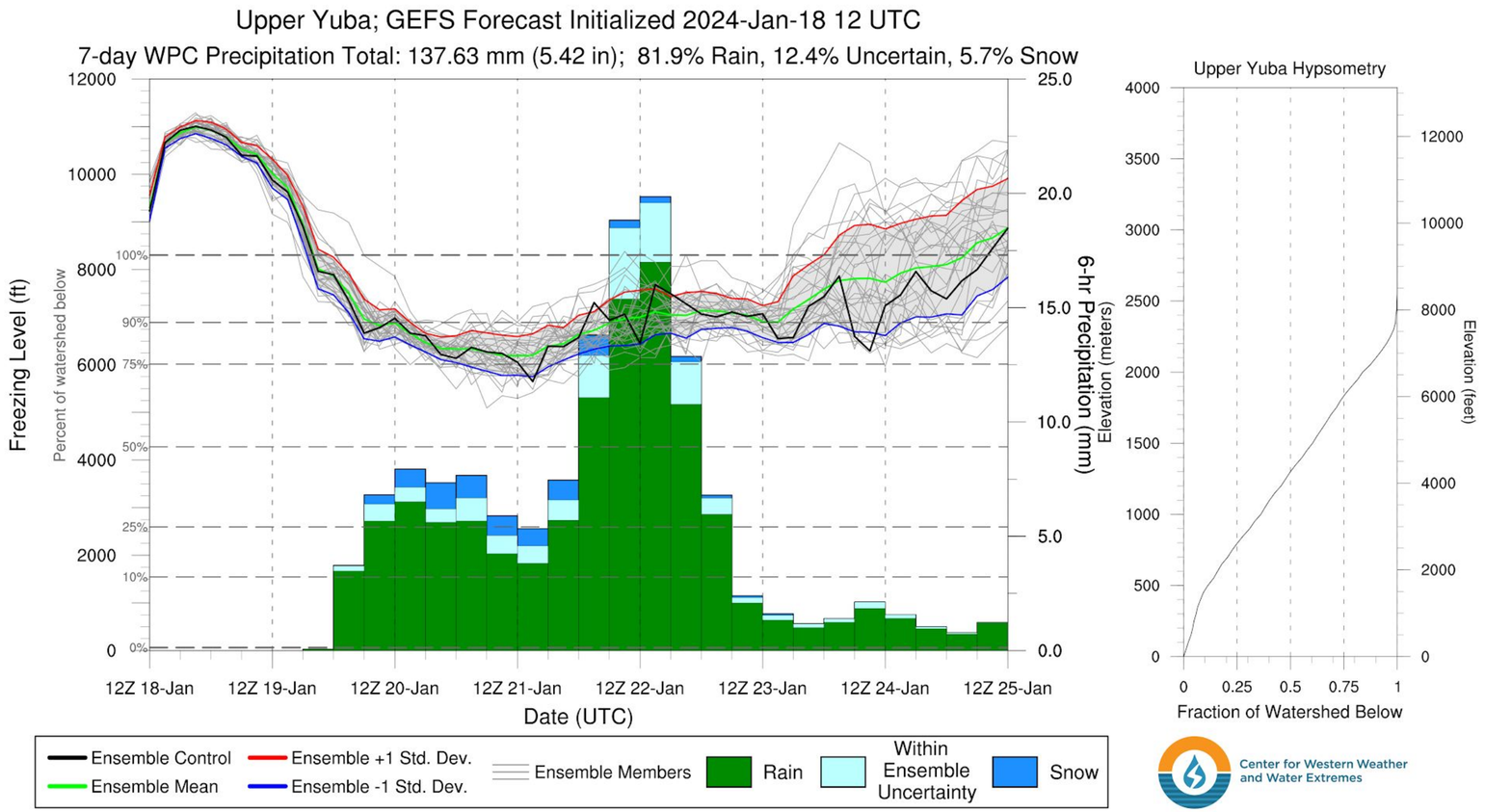
Freezing Level Forecast





- 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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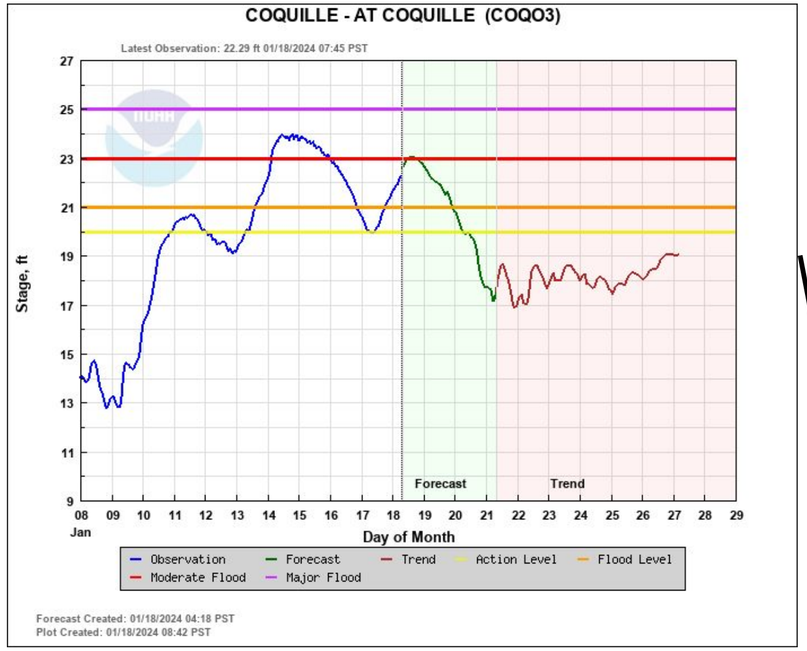
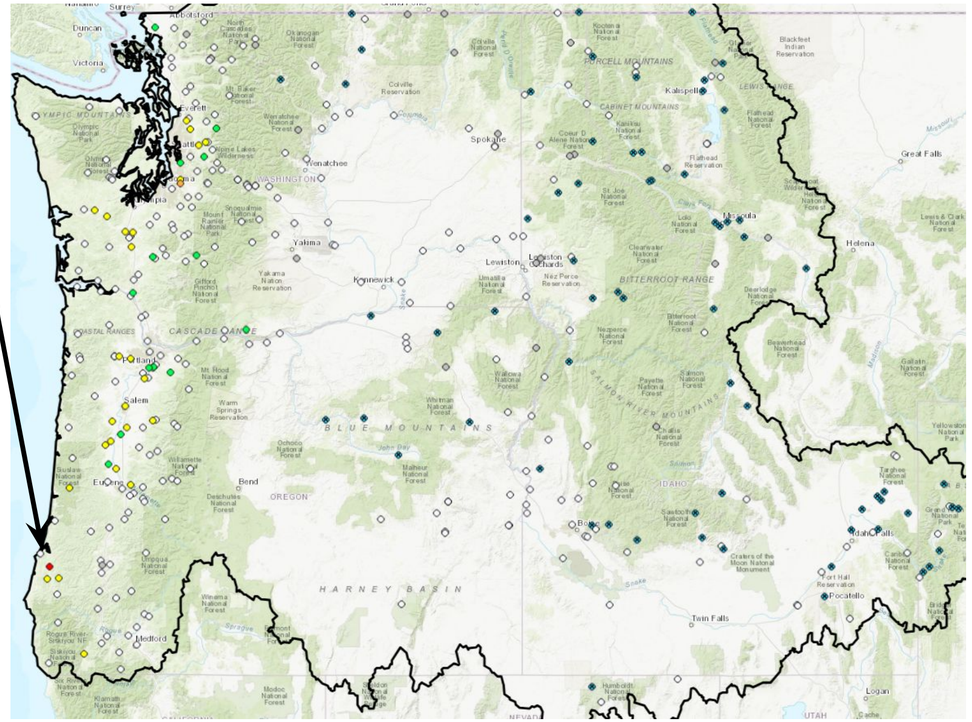
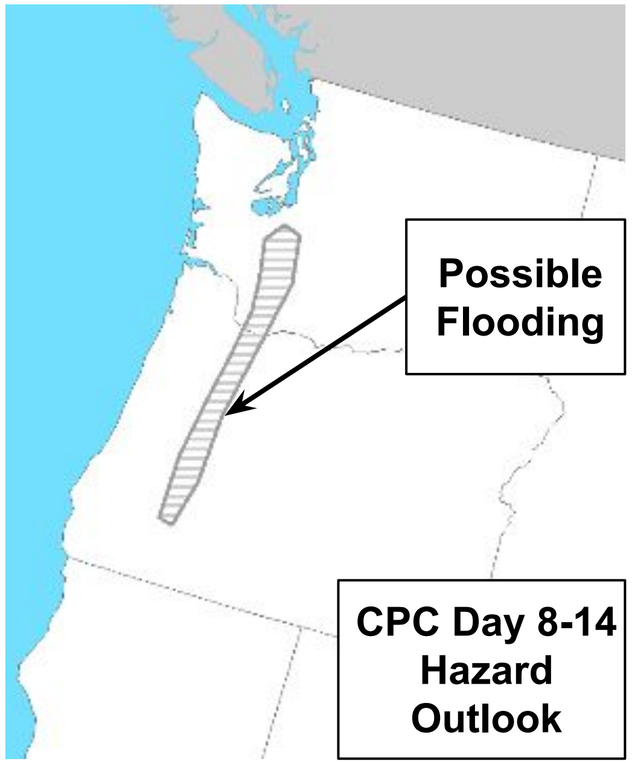
NWS NWRFC River Stage Forecast







- River stages across the Pacific Northwest are forecast to steadily rise as a result of the heavy precipitation associated with the first AR.
- The NWRFC is currently forecasting one stream gage to exceed minor flood stage and one stream gages to exceed moderate flood stage (Coquille, shown on left), primarily in western WA.
- The CPC's Day 8-14 Hazard Outlook, which goes beyond the stream forecasts issued by the NWRFC, already indicates possible flooding with the potential AR activity next weekend.

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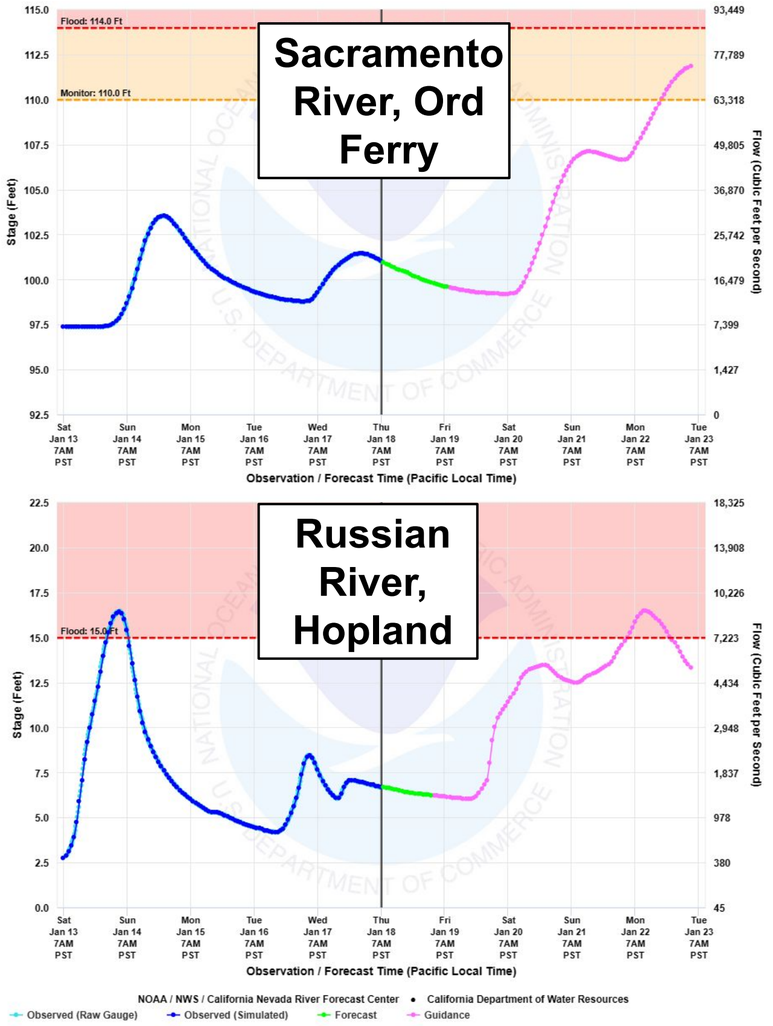
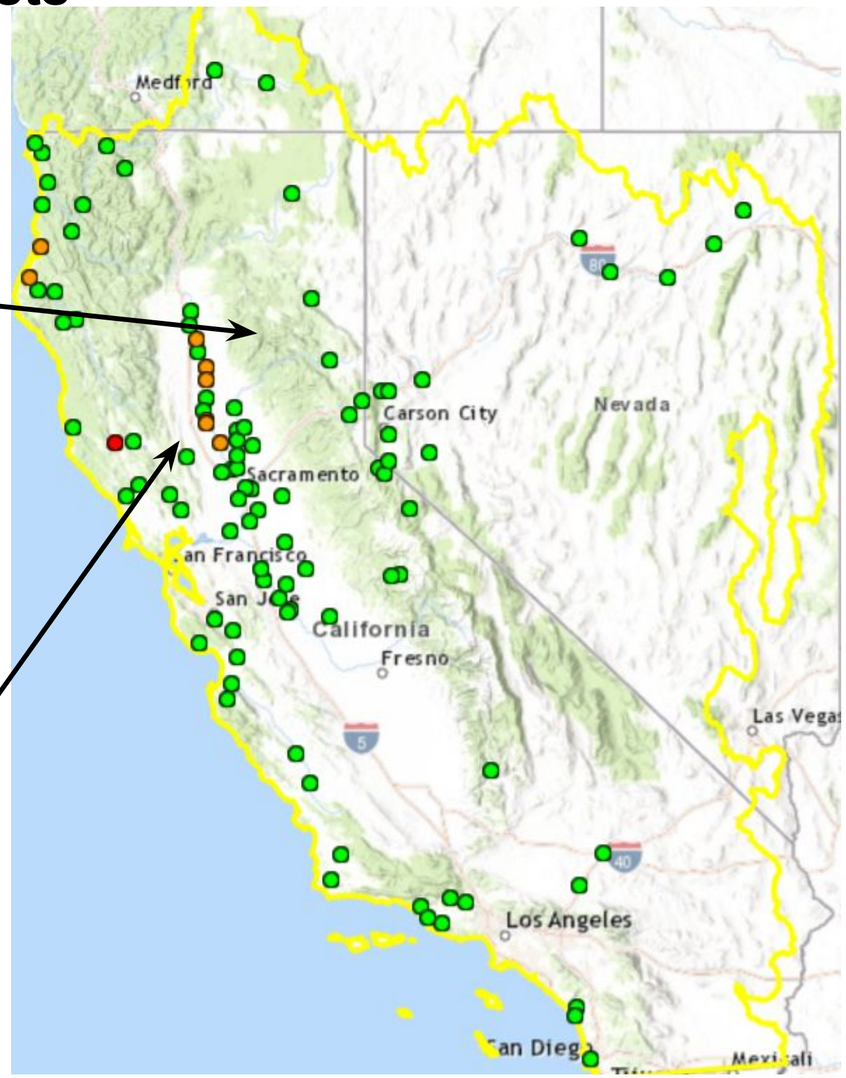
NWS CNRFC River Stage Forecasts





- River stages in CA are forecast to rise as a result of the heavy precipitation associated with the second AR.
- The CNRFC is currently forecasting eight stream gages to exceed monitor stage and one stream gages to exceed flood stage, primarily along the CA coast and in the Sacramento Valley.
- The Russian River near Hopland (bottom left) is forecast to reach flood stage on Tue Jan 23 while the station at Ord Ferry (top left) is one of several stations along the Sacramento River to rise to monitor stage on Tue Jan 23.

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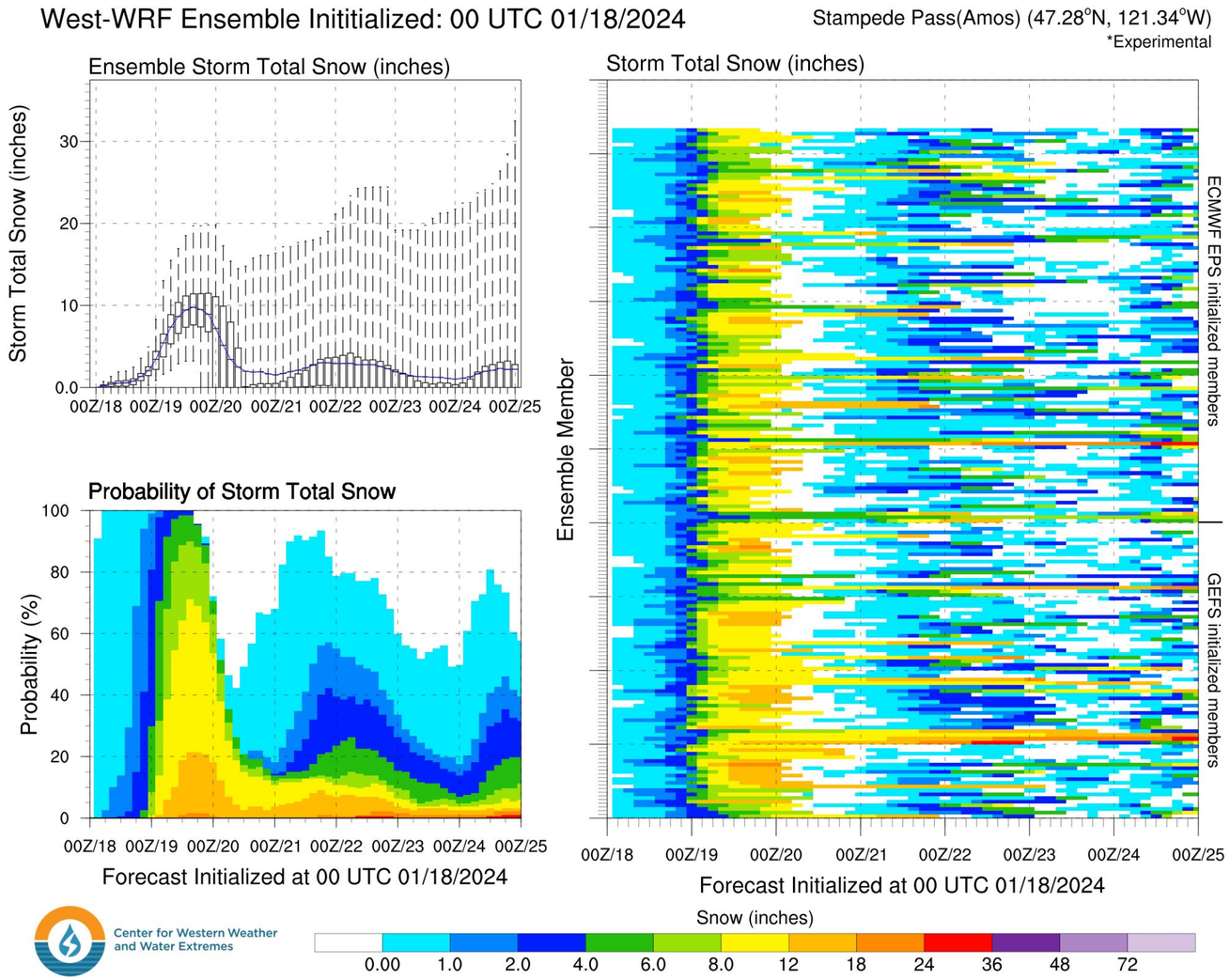
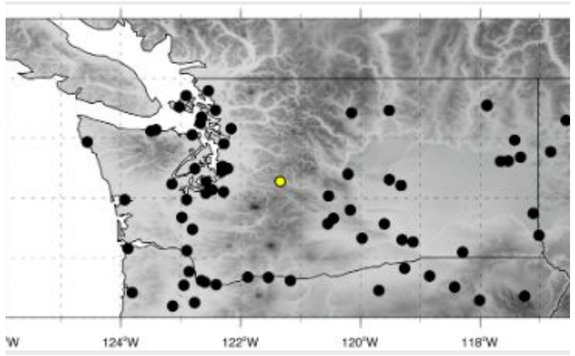
West-WRF Ensemble Meteogram





- The West-WRF ensemble produces meteograms showing accumulated precipitation at select locations across the West Coast.
- For this location at Stampede Pass in the WA Cascades, the West-WRF ensemble members are forecasting a ~70% chance of 8”+ of accumulated snowfall during the first AR.
- The majority of members are forecasting at least 8” of accumulated snow, with several members forecasting totals greater than 18” for this station during the event.
- The ensemble spread for this location is quite substantial for both the duration of the first AR and beyond.

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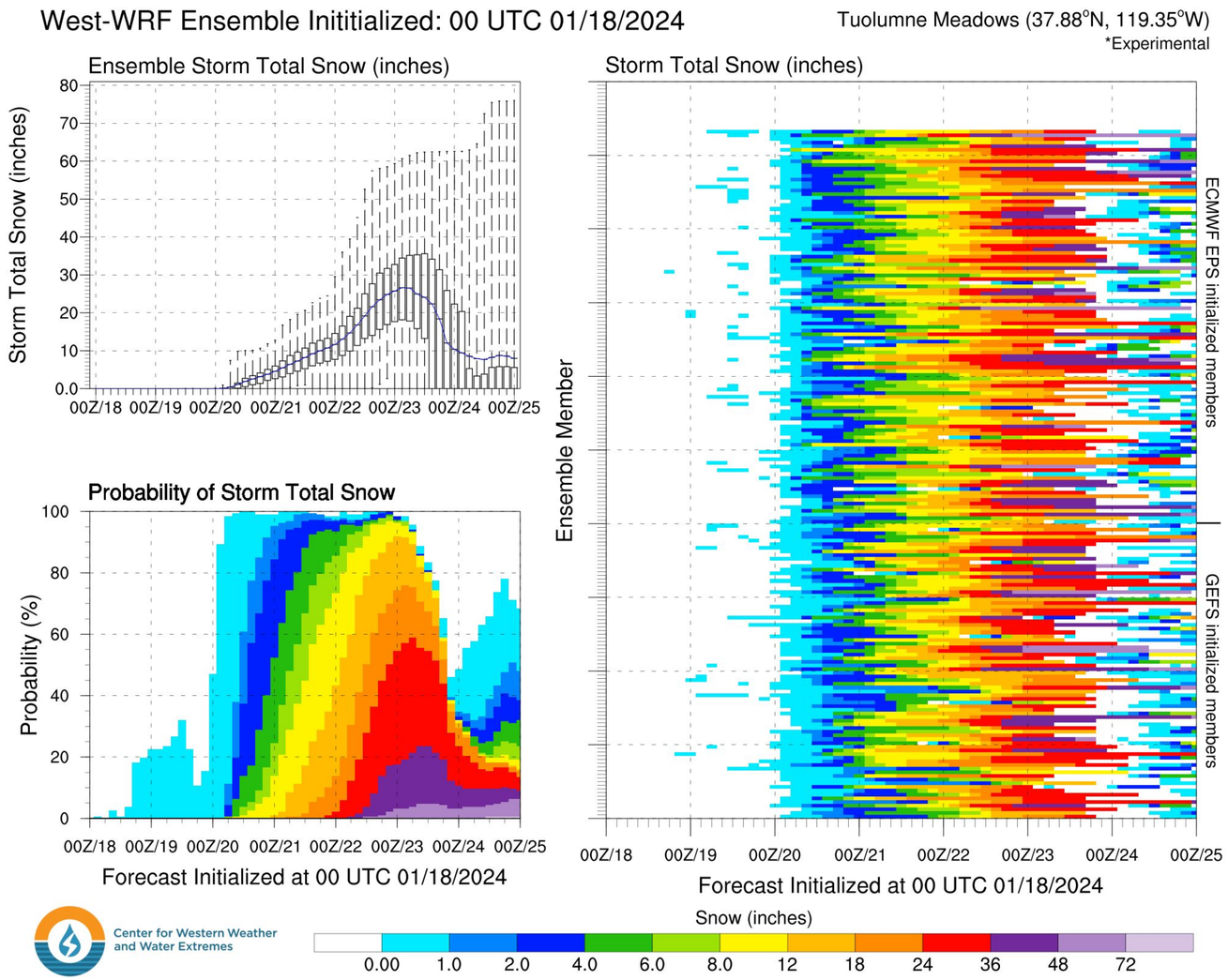
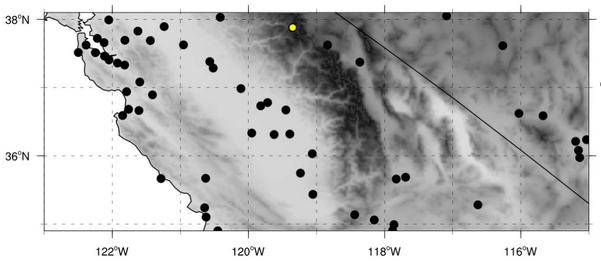
West-WRF Ensemble Meteogram





- For this location at Tuolumne Meadows in the Sierras, the West-WRF ensemble members are forecasting a >70% chance of 18”+ of accumulated snowfall during the second AR.
- All but one member is forecasting greater than 12” of accumulated snow during the period, with many members forecasting totals greater than 24”.
- The ensemble spread for the snowfall totals is substantial with this event, indicating uncertainty amongst the ensemble members.

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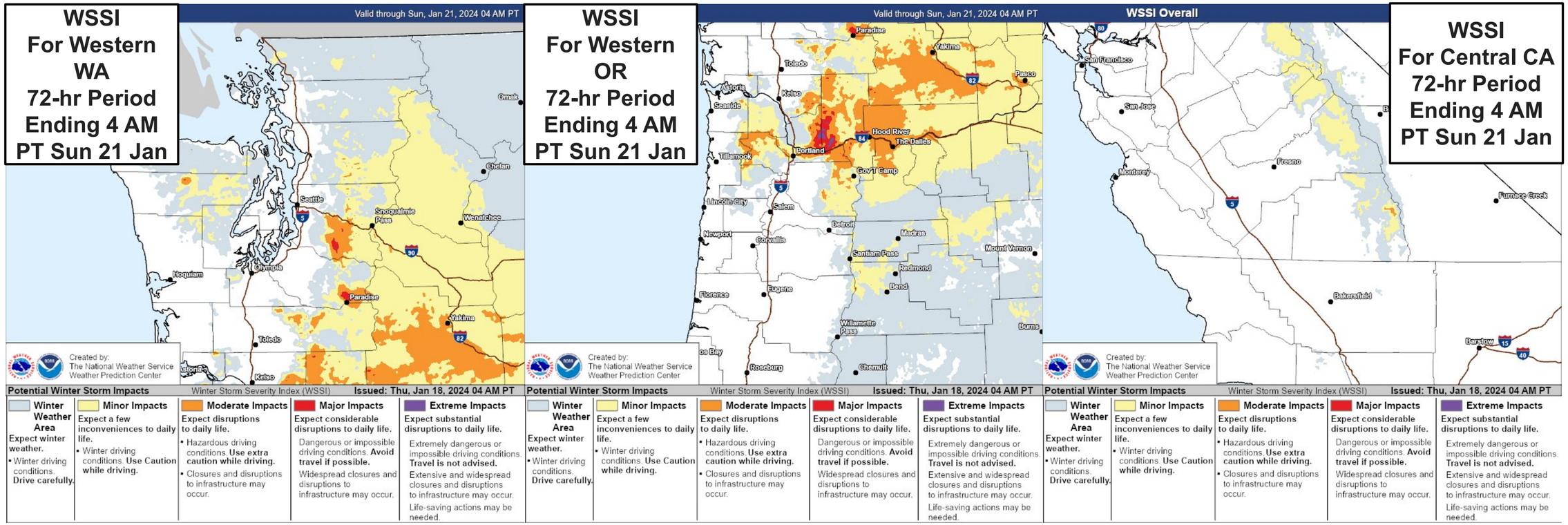
WPC Winter Storm Severity Index (WSSI)

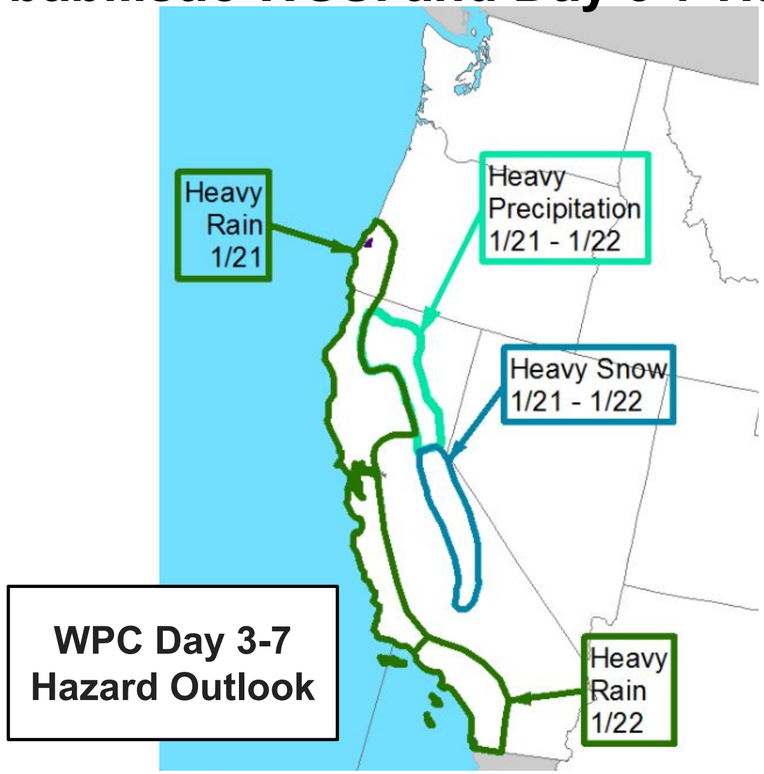


Source: WPC; https://www.wpc.ncep.noaa.gov/wwd/wssi/wssi.php

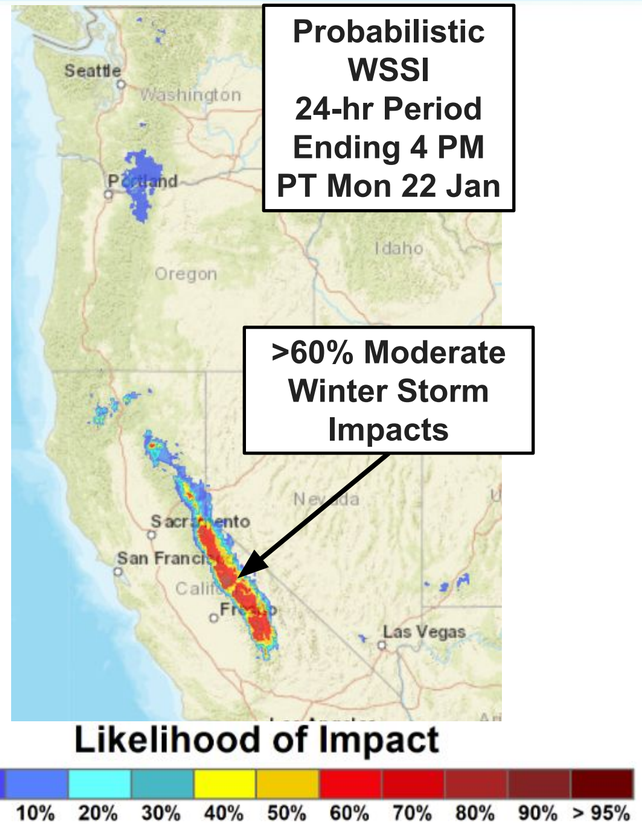
- WPC WSSI for the 3-day period ending at 4 AM PT Sun 21 Jan highlights likelihood for **moderate impacts** for parts of the N. Cascades and the Sierra Nevada during the first AR.
- For the same time period there isolated regions of **major and extreme impacts** to the northeast of Portland associated with the freezing rain continuing to impact that area.

CW3E AR Outlook: 18 Jan 2024

WPC Probabilistic WSSI and Day 3-7 Hazard Outlook



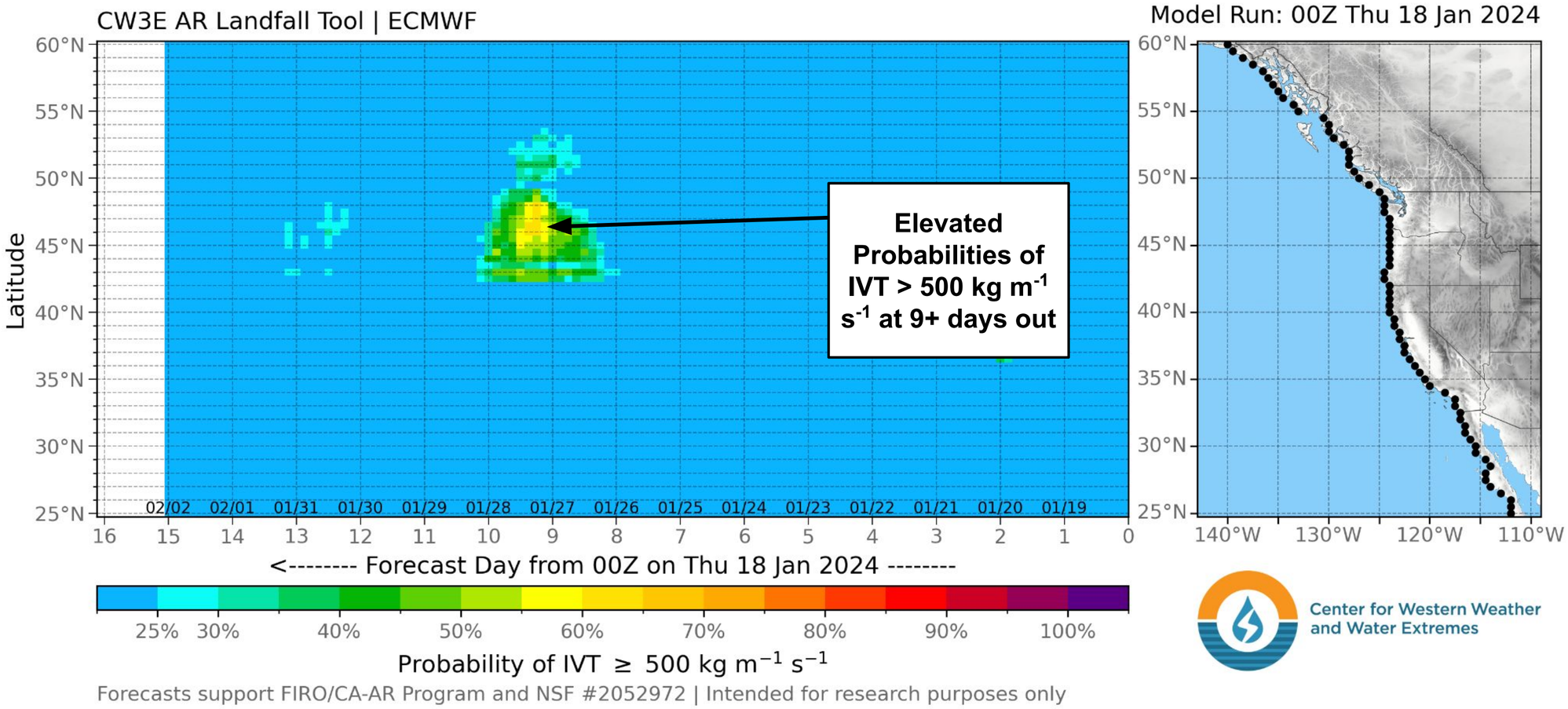
Source: WPC; https://www.wpc.ncep.noaa.gov/threats/final/hazards_d3_7_contours.png



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

- WPC Probabilistic WSSI for the 24-hr period ending at 4 PM PT Mon 22 Jan forecasts > 60% chance for **moderate impacts** in the Sierra Nevada during the **second AR**.
- For the the second and beginning of the third AR, WPC's day 3-7 Hazard Outlook is highlighting **heavy snow** in the Sierra Nevada (21 and 22 Jan), **heavy rain** along the N. CA coast (21 Jan) and C. and S. CA coasts (22 Jan), and **heavy precipitation** over the N. Sierra Nevada (21 and 22 Jan) during the **second AR**.

CW3E AR Outlook: 18 Jan 2024

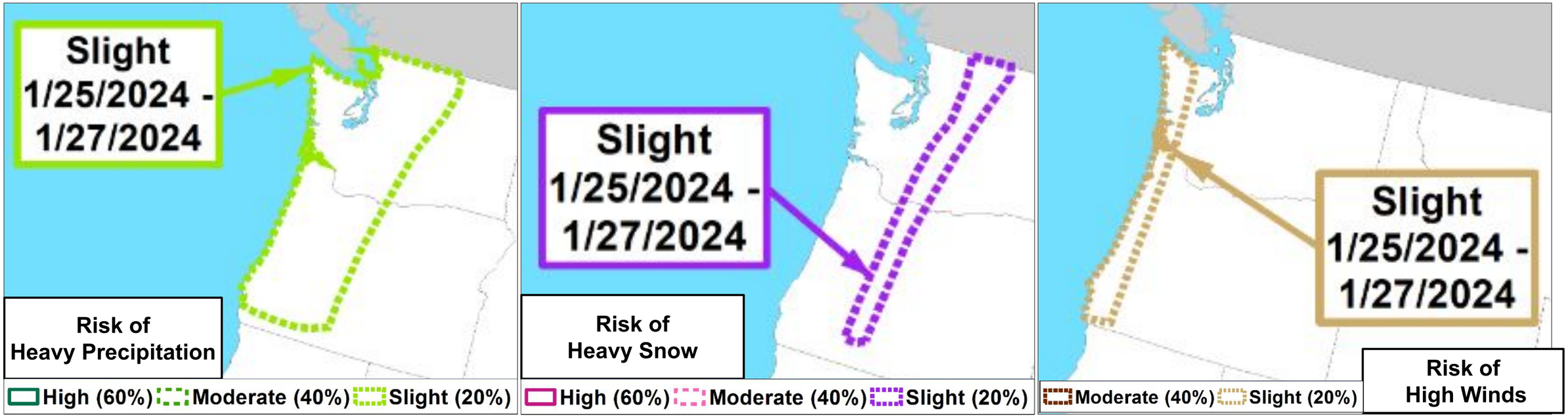


- The ECMWF IVT Landfall tool is highlighting medium probabilities (>55%) of IVT > 500 kg m^{-1} s^{-1} making landfall over the PNW on day 9 (Jan 27)!
- Higher probabilities this far out from an event may indicate a stronger event is possible to occur given model bias toward lower end results this far out.

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

CW3E AR Outlook: 18 Jan 2024

Climate Prediction Center 8-14 Day Hazard Outlooks

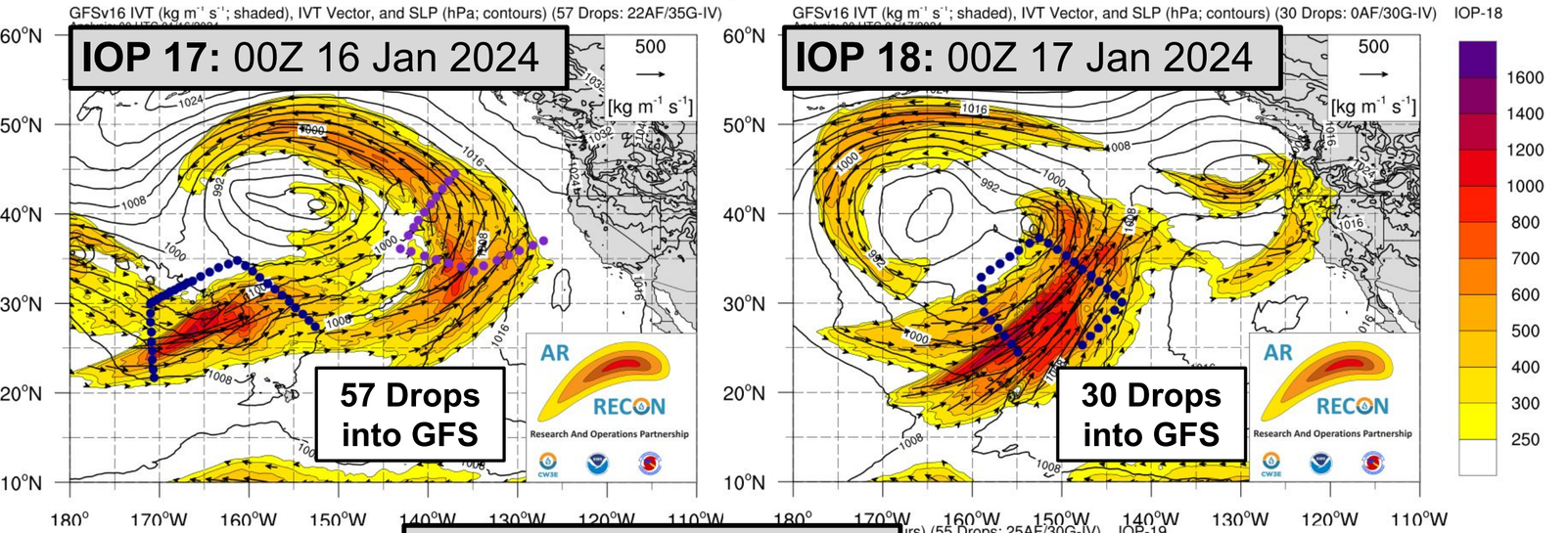


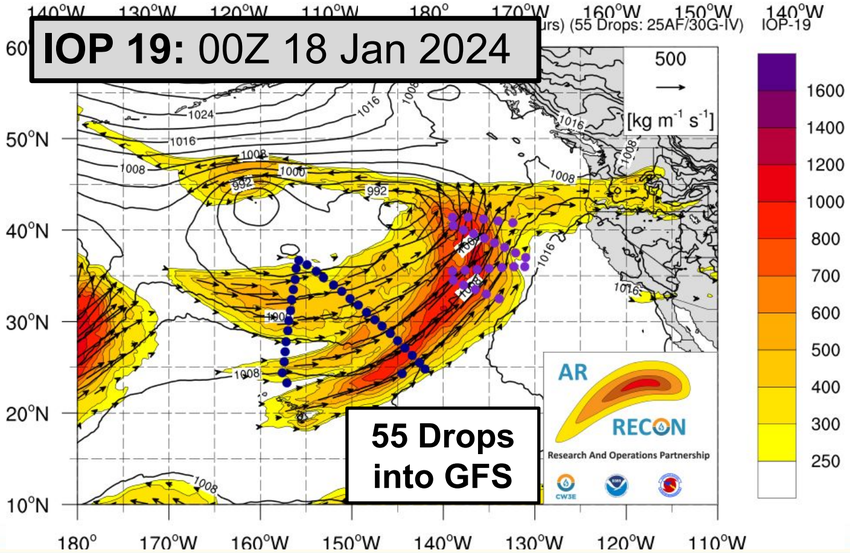
- Looking further into the forecast, the NWS Climate Prediction Center (CPC) is indicating a slight risk for potential for **heavy precipitation**, **heavy snow** and **strong winds** in the PNW for 25 Jan to 27 Jan with the possible fourth AR in this sequence.

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

CW3E AR Outlook: 18 Jan 2024

Current AR Recon Flight Sequence





- CW3E's Atmospheric River Reconnaissance (AR Recon) field campaign continues in WY 2024, with the most recent sequence of flights focusing on the approaching systems.
- There were three flights planned for each Intensive Observation Period (IOP); out of Mather Air Force Base in CA (AF C-130), Honolulu, HI (NOAA G-IV) and Guam (AF C-130). The dropsonde data from the Guam flights did not make it into the models.
- The Guam C-130 traveled to Hawaii and will be making flights from Honolulu in the near future.
- The flight sequence has allowed for sampling of each AR forecast to impact the USWC in the next 7 days.
- Additional flights have been planned in this sequence to continue sampling the series of ARs as they progress through the Northeast Pacific.