

CW3E Atmospheric River Outlook: 26 Jan 2024

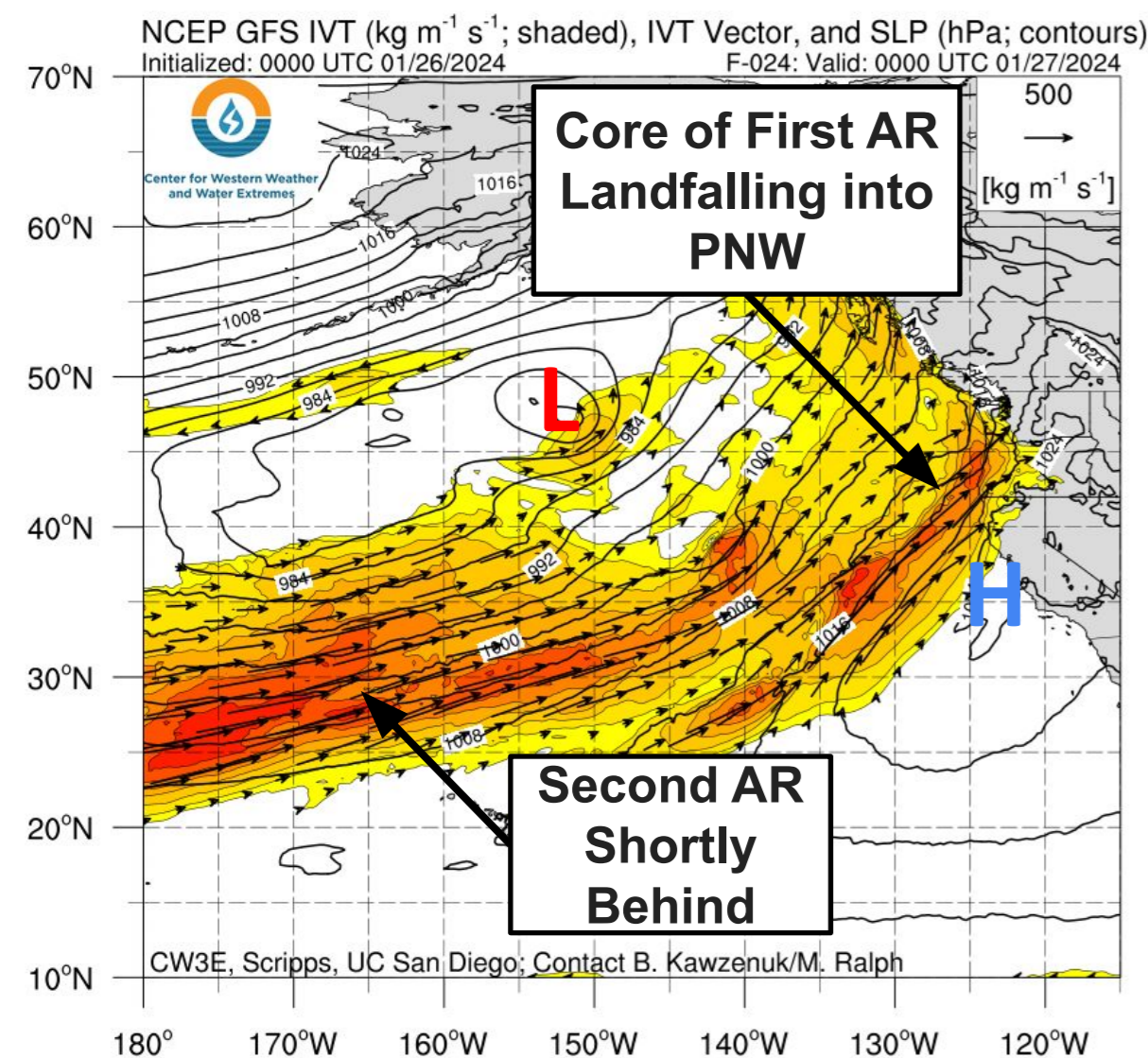
Several Strong ARs Forecast to Impact US West Coast Continuing Active Weather Period

- An active weather pattern for the US West Coast is forecast to continue through Wed 31 Jan and potentially beyond.
- The **first AR** made landfall early Fri 26 Jan into the PNW. This AR kicks off a period of AR conditions in the PNW and Northern California expected to continue through Wed 31 Jan.
- The **second AR**, stronger than the first, is forecast to make landfall early Sun 28 Jan into the PNW and British Columbia, continuing AR conditions in the region.
- The **third, strongest AR** is forecast to make landfall into British Columbia and the PNW toward the end of the second AR period on Tue 30 Jan.
- **All three ARs** are forecast to bring precipitation to the USWC, with the heaviest rainfall expected from the **first and second ARs** over CA/OR border and Olympic Peninsula and in N. CA with the **third AR**.
- The WPC Excessive Rainfall Outlook indicates a Slight Risk (level 2 of 4, or at least 15% chance) for flooding along the CA/OR border for the 24-hour period ending 4 AM PT Sat 27 Jan with the first AR.
- The **third AR** is forecast to progress down the USWC and potentially bring impacts to much of the Western US.
- The Climate Prediction Center (CPC) has already indicated a moderate risk for **heavy precipitation, heavy snow, and high winds** for regions in the Western US and possible flooding along the CA coast and in AZ for Feb 2 through Feb 5.
- The British Columbia River Forecast Center has issued Flood Watches for Vancouver Island, the South Coast and Fraser Valley as the **second and third ARs** are forecast to bring as much as 10 inches of rain to the region.

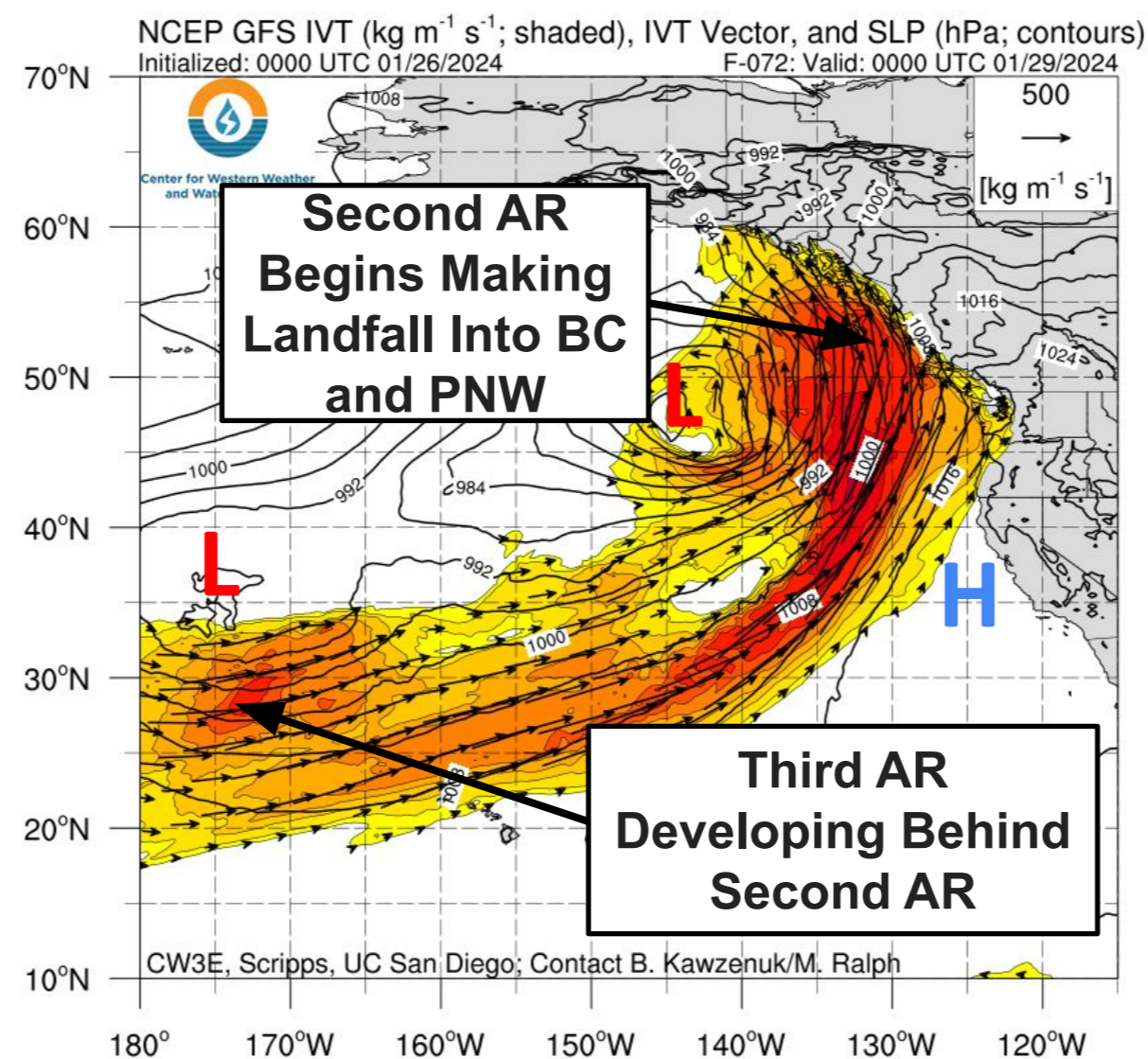
CW3E AR Outlook: 26 Jan 2024

GFS Init 0Z Fri 26 Jan 2024

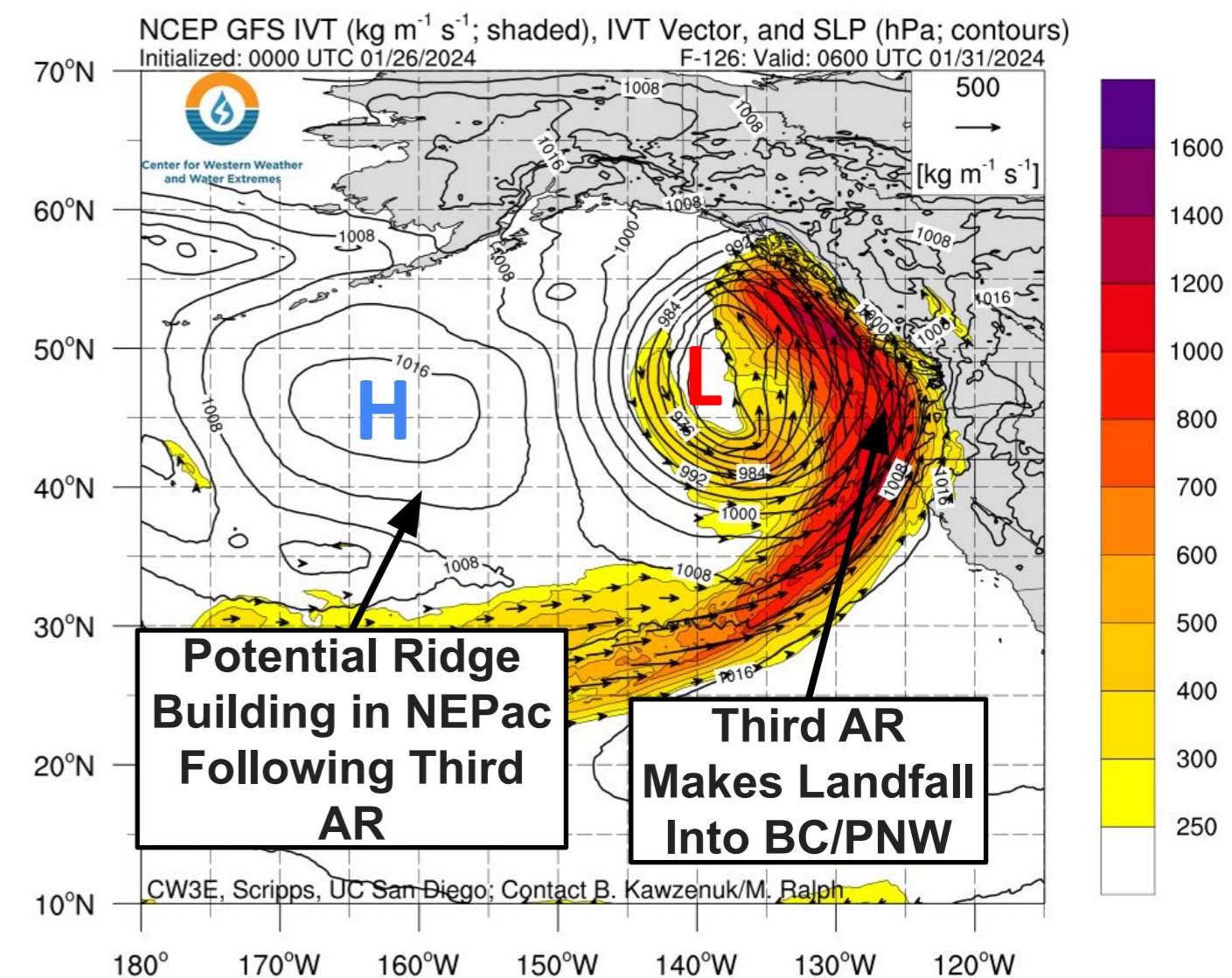
4PM PT Fri 26 Jan 2024



4PM PT Sun 28 Jan 2024



10PM PT Tue 30 Jan 2024

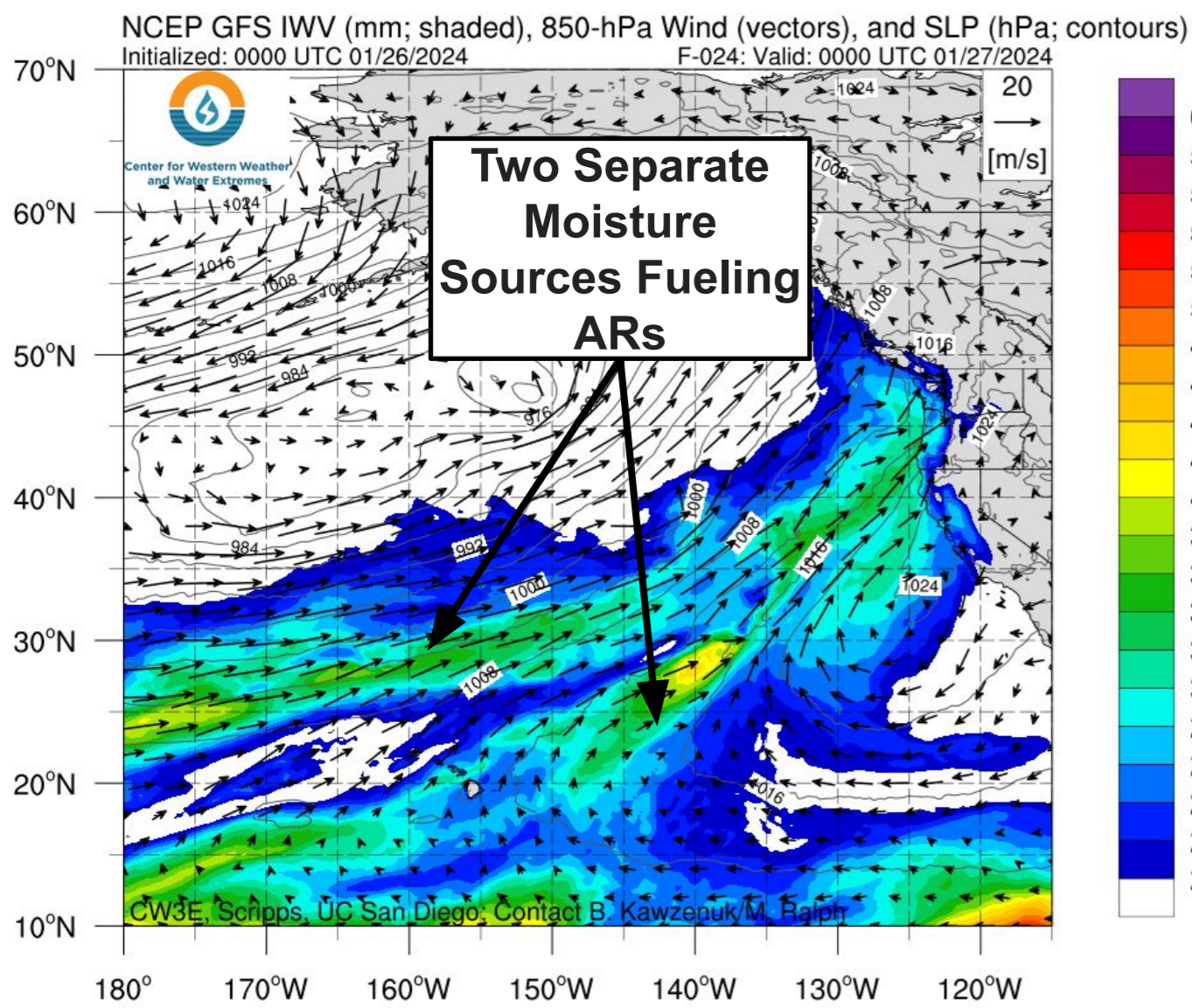


- The first AR made landfall early Fri 26 Jan, with the core of the AR coming onshore later in the day.
- The first AR begins a prolonged period of AR conditions in the PNW and N. CA, as AR conditions are forecast to continue through at least Wed 31 Jan.
- The second, stronger AR and low pressure system are forecast to form in the NE Pacific shortly behind the first AR and propagate toward the USWC through Sat 27 Jan before making landfall in the PNW and BC early Sun 28 Jan.
- Similarly, a third AR develops with a low pressure system behind the second AR, eventually making landfall into BC and the PNW on Tue 30 Jan.
- The third AR is forecast to be strong as well, likely bringing widespread impacts to the Western US into early February.

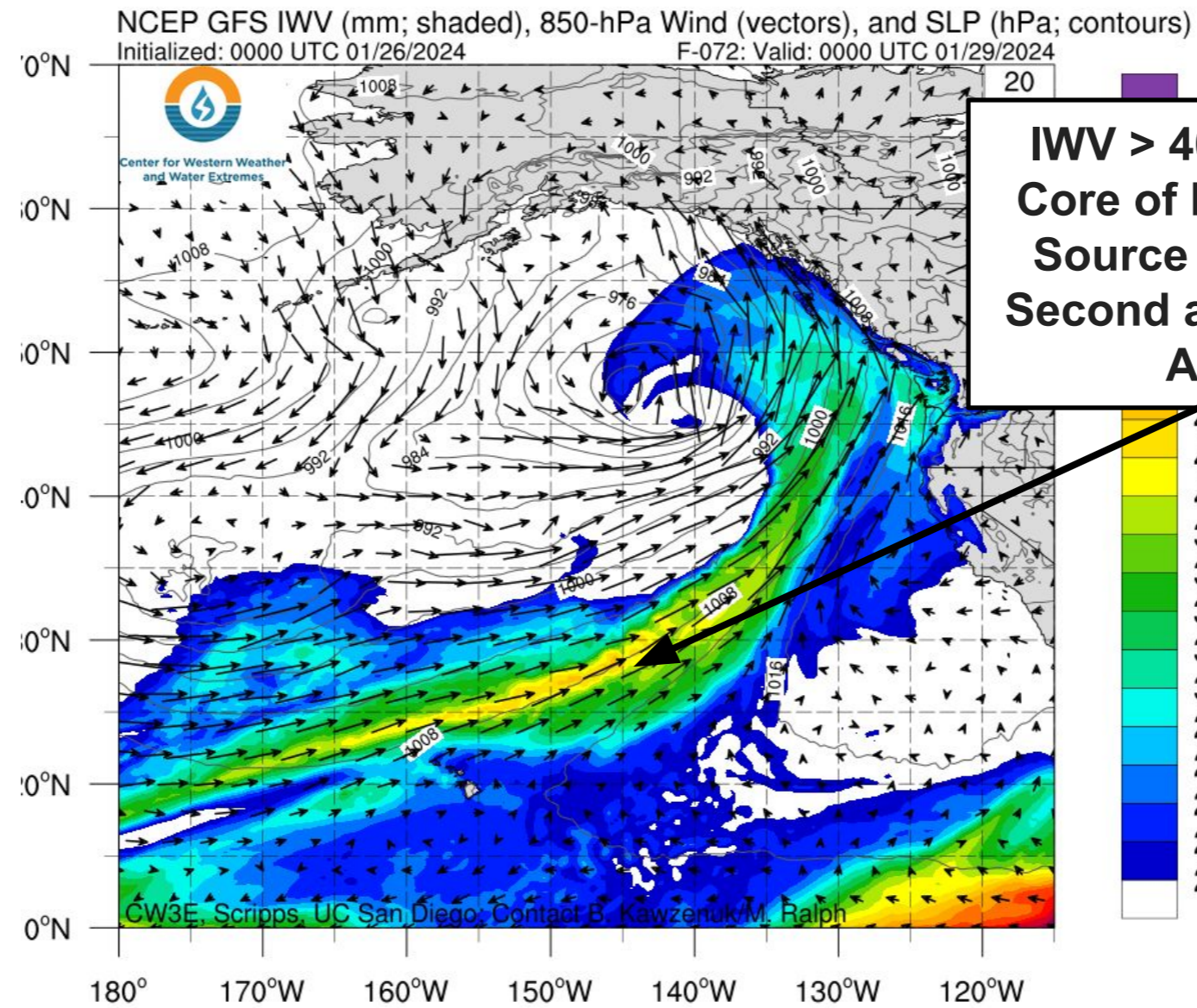
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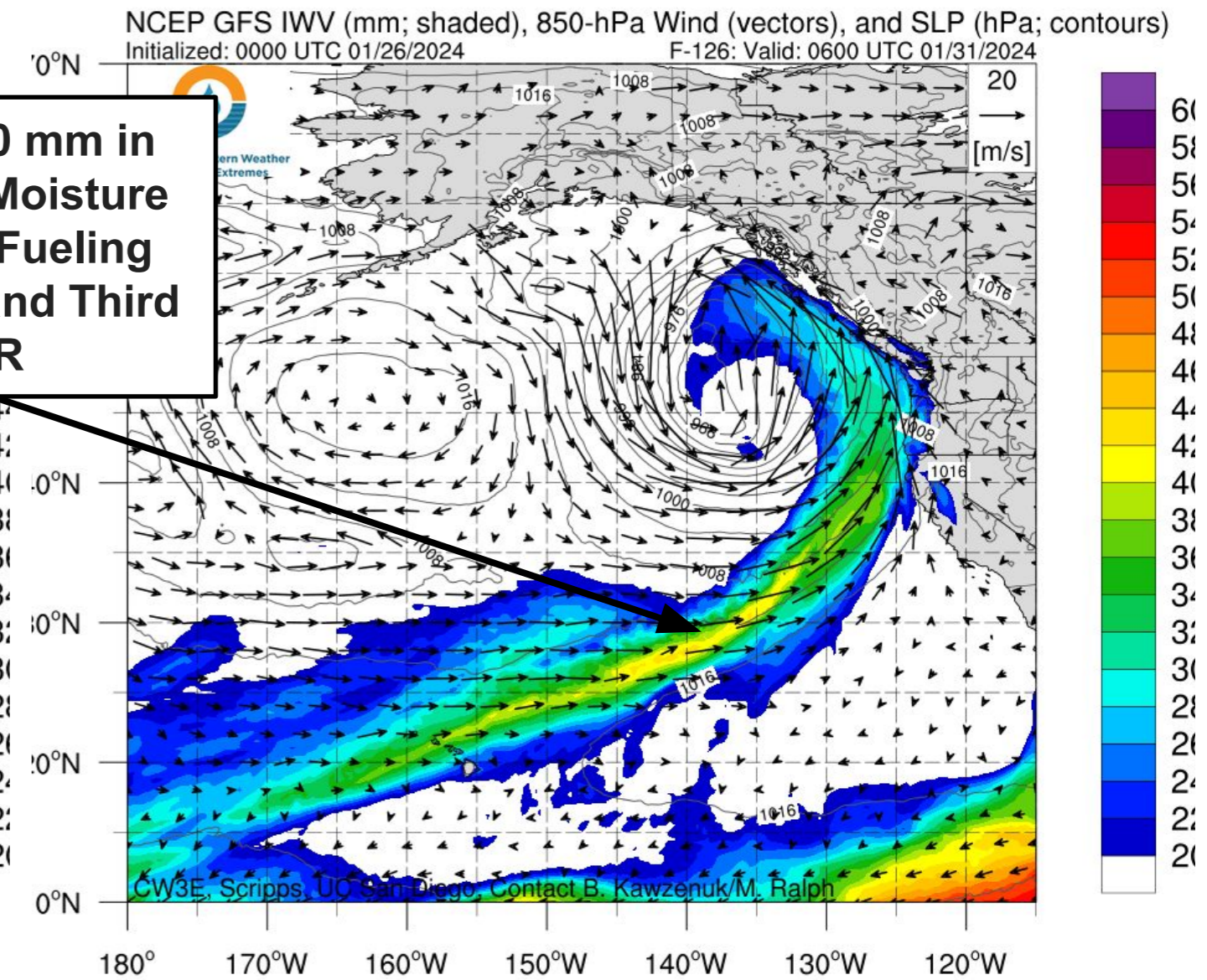
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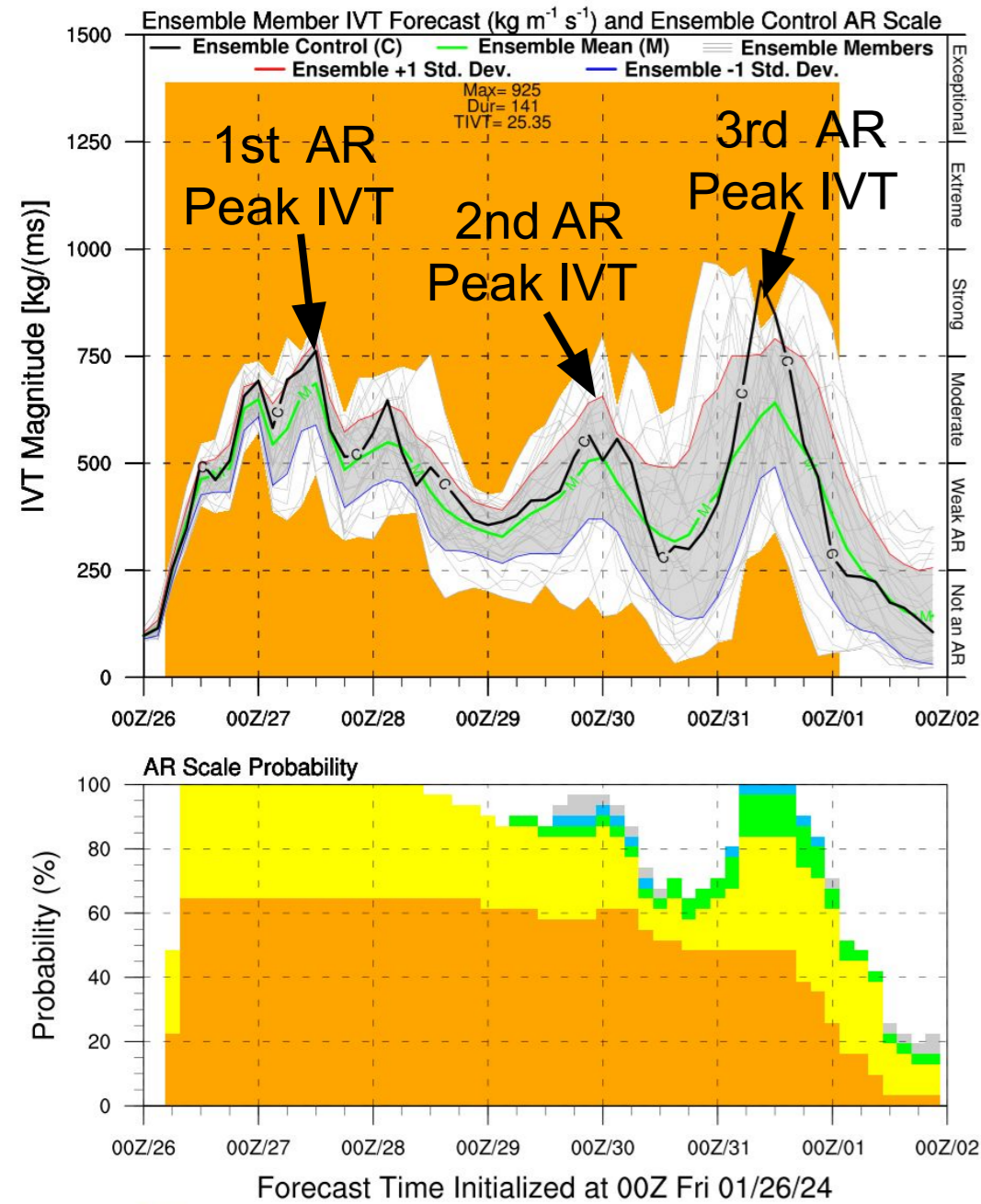
- This sequence of ARs is fueled by two separate tropical moisture sources coming together from the Eastern and Central Pacific.
- The first AR will bring tropical moisture into OR and N. CA at landfall whereas the second and third ARs are forecast to bring higher IWV to the PNW coast at landfall.
- The third AR brings IWV values > 35 mm into CA as it progresses down the USWC, which combined with optimal moisture transport direction supports heavy precipitation in N. CA.

CW3E AR Outlook: 26 Jan 2024

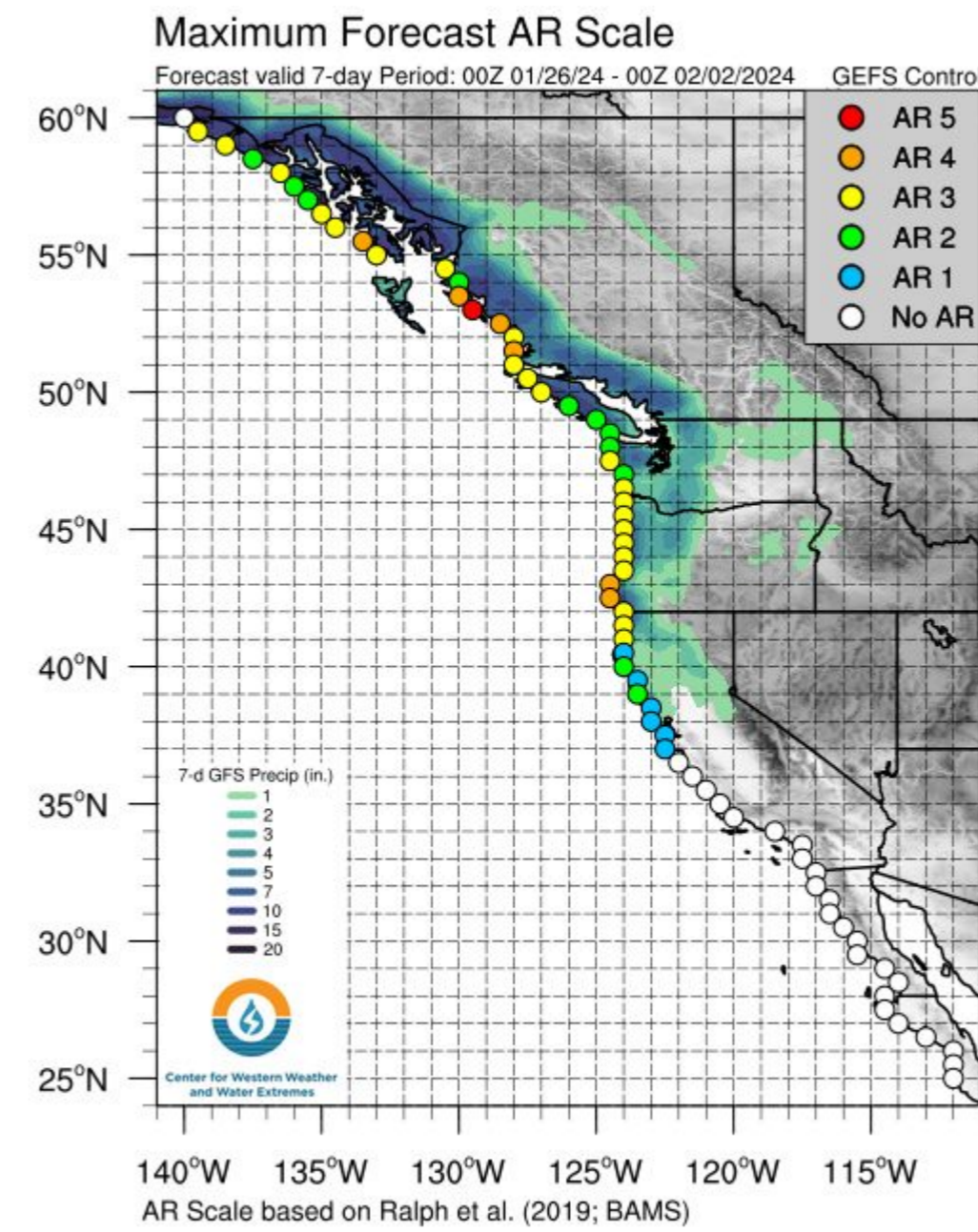
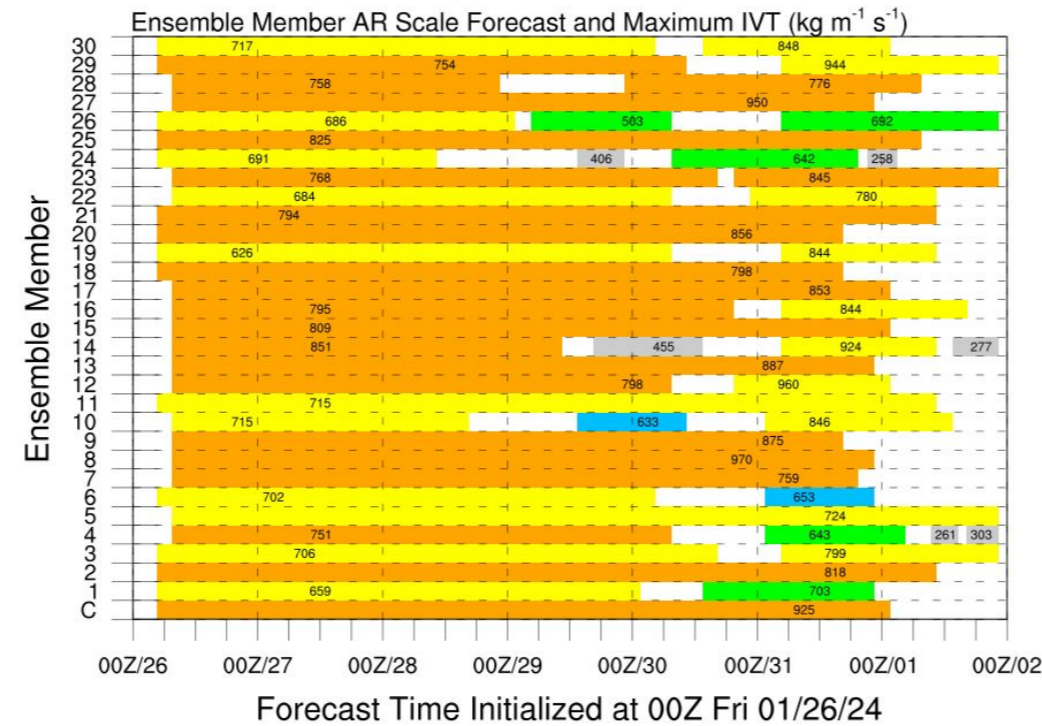
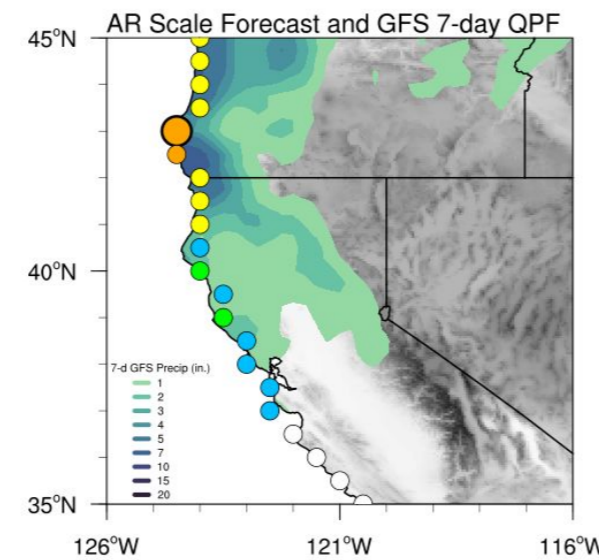
GEFS 7-day AR Scale and IVT Forecast

GFS Ensemble Initialized: 00Z Fri 01/26/24

Location: 43°N 124.5°W



Categorical AR Strength by Ralph/CW3E

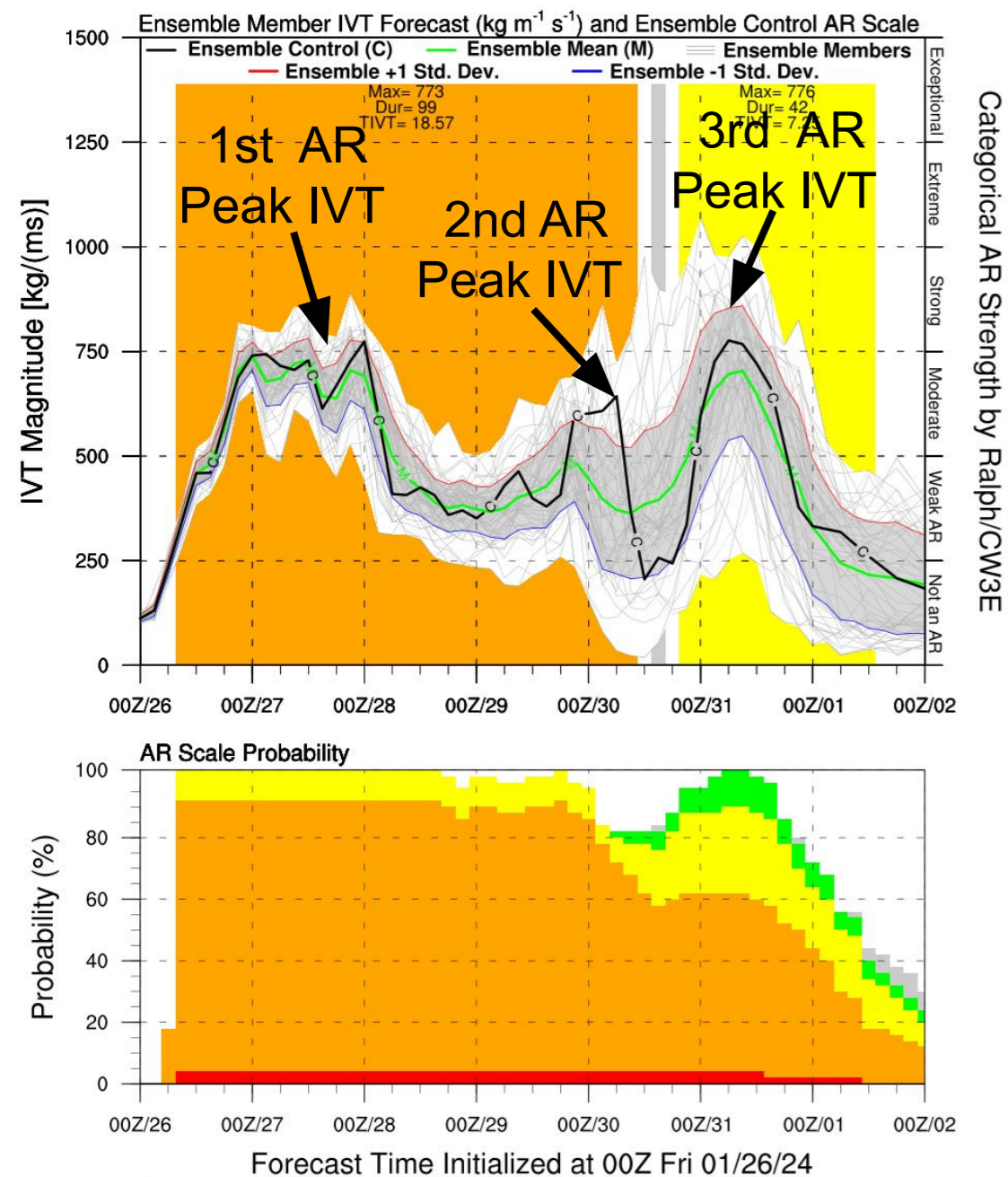


- The GEFS control member is forecasting persistent AR conditions for the point at 43.5° N, 124.5° W (SW OR) during the next 6 days.
- 31/31 (100%) GEFS ensemble members are forecasting at least AR3 conditions during the **AR period** for Jan 26-Feb 1.
- The majority of members are forecasting >72 hours of AR conditions at this point.
- There is uncertainty amongst the members on when or if a break in AR conditions will occur near the end of the period.

CW3E AR Outlook: 26 Jan 2024

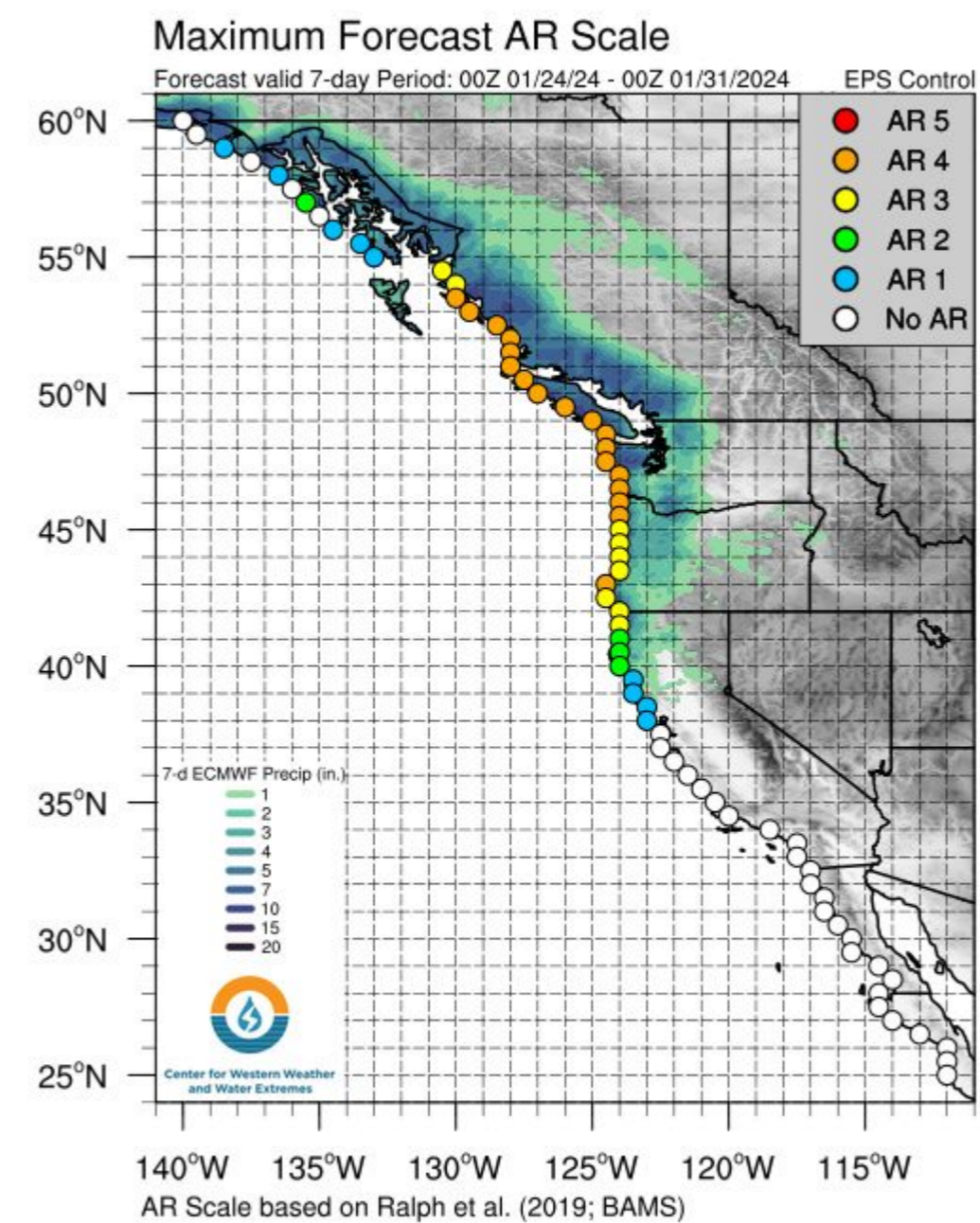
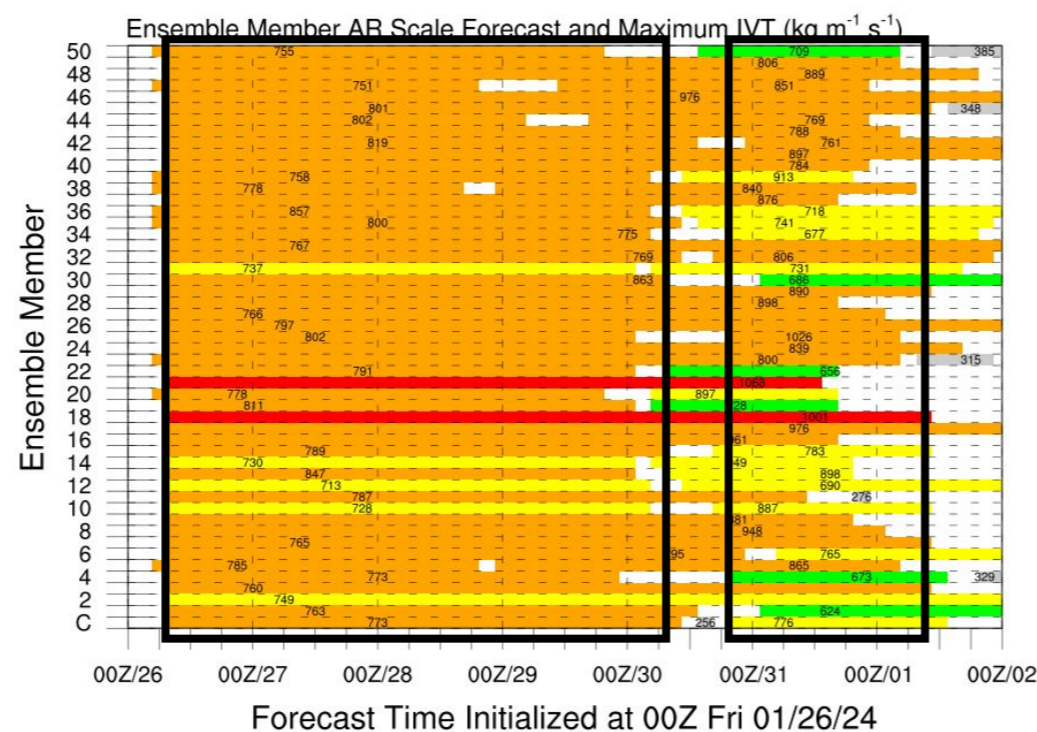
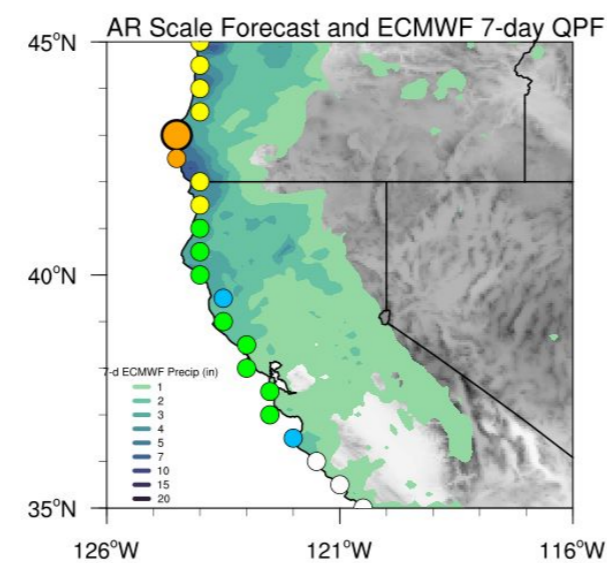
ECMWF EPS 7-day AR Scale and IVT Forecast

ECMWF Ensemble Initialized: 00Z Fri 01/26/24



Categorical AR Strength by Ralph/CW3E

Location: 43°N 124.5°W



- The ECMWF EPS control member is forecasting multiple ARs over the next 7 days for the point at 43° N, 124.5° W (CA/OR border).
- 46/51 (90%) EPS ensemble members are forecasting at least AR4 conditions during the **first and second ARs** for Jan 26- Feb 1.
- Similar to GEFS, the majority of ECMWF EPS members forecasting an AR4 or greater are forecasting >72 hours of AR conditions at this point.

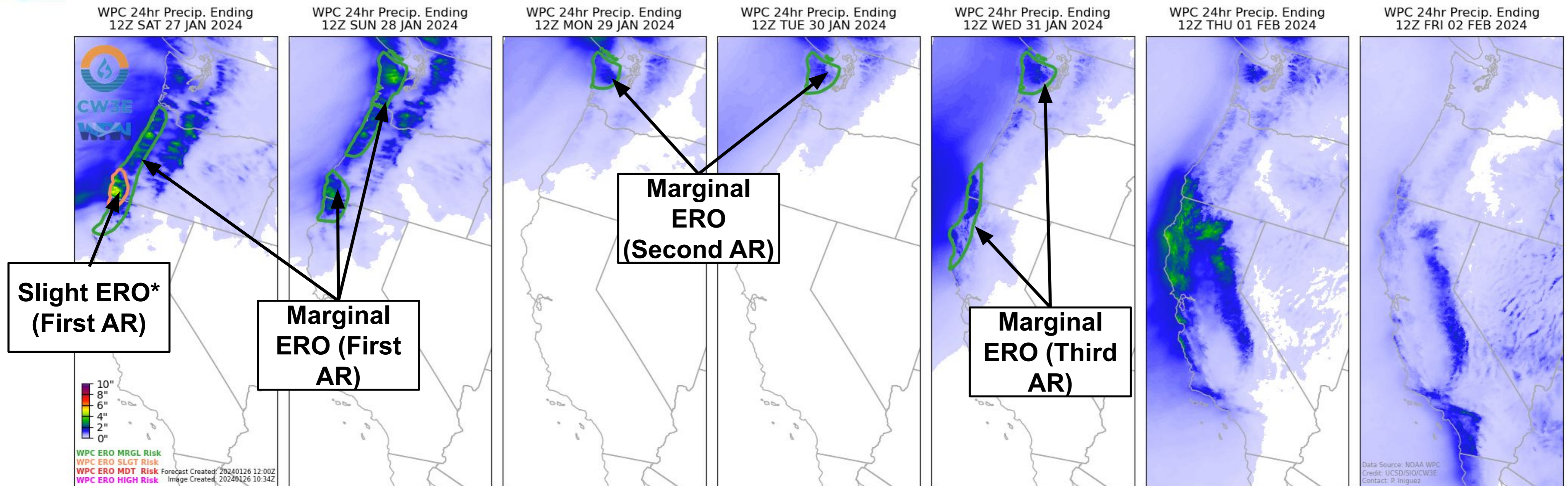


Image created: 09 UTC 01/26/2024

AR 1 AR 2 AR 3 AR 4 AR 5

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

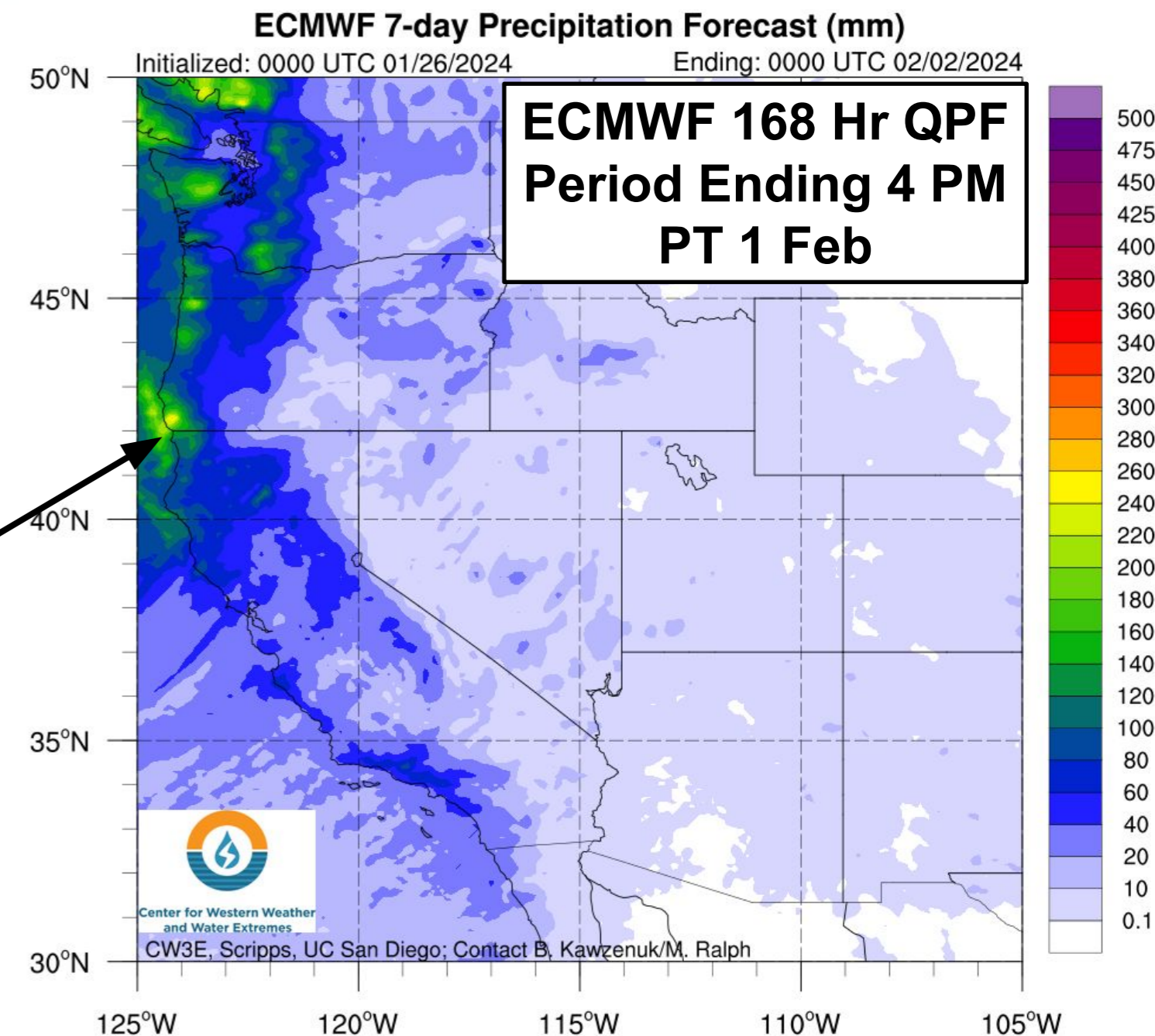
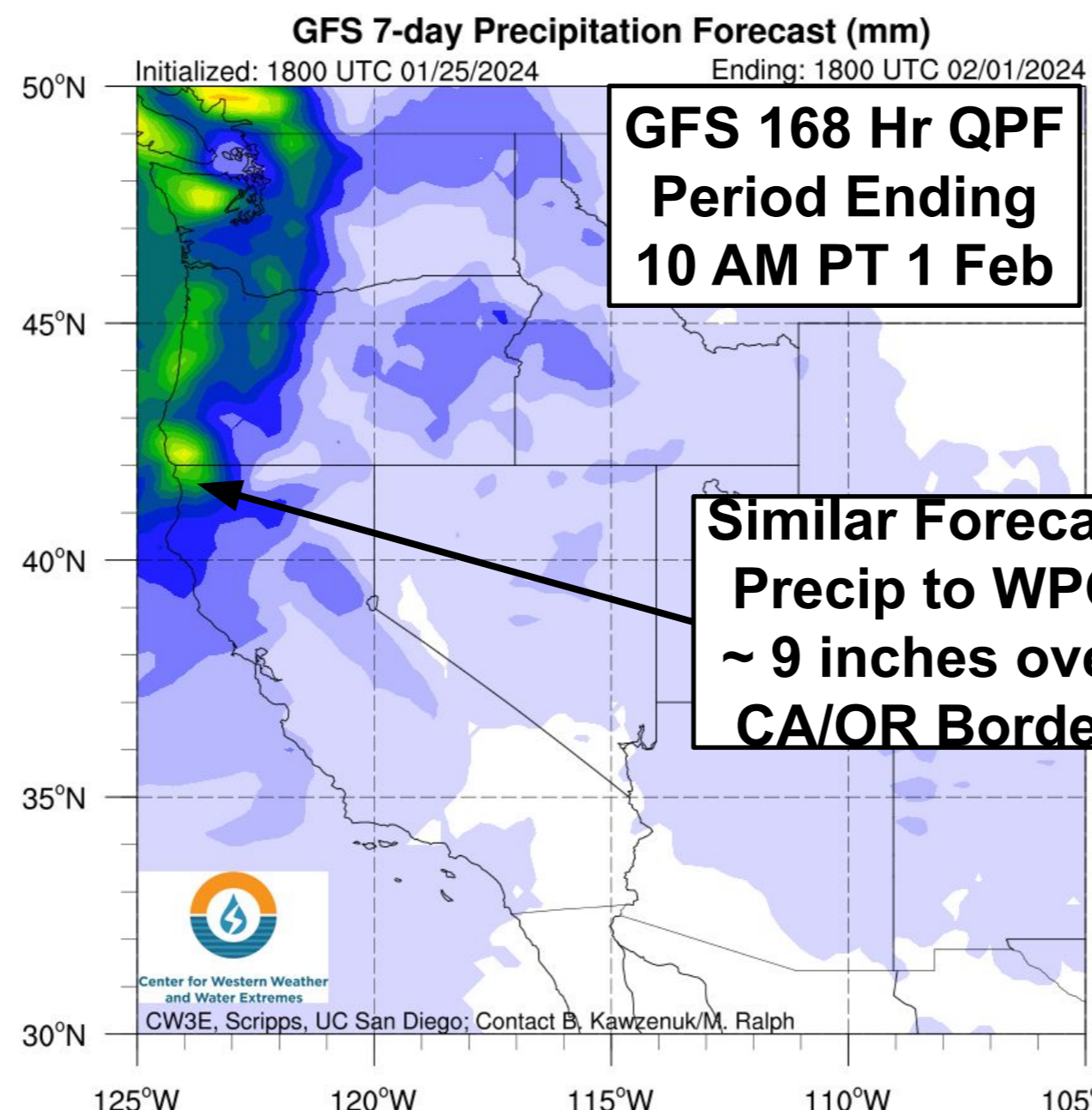
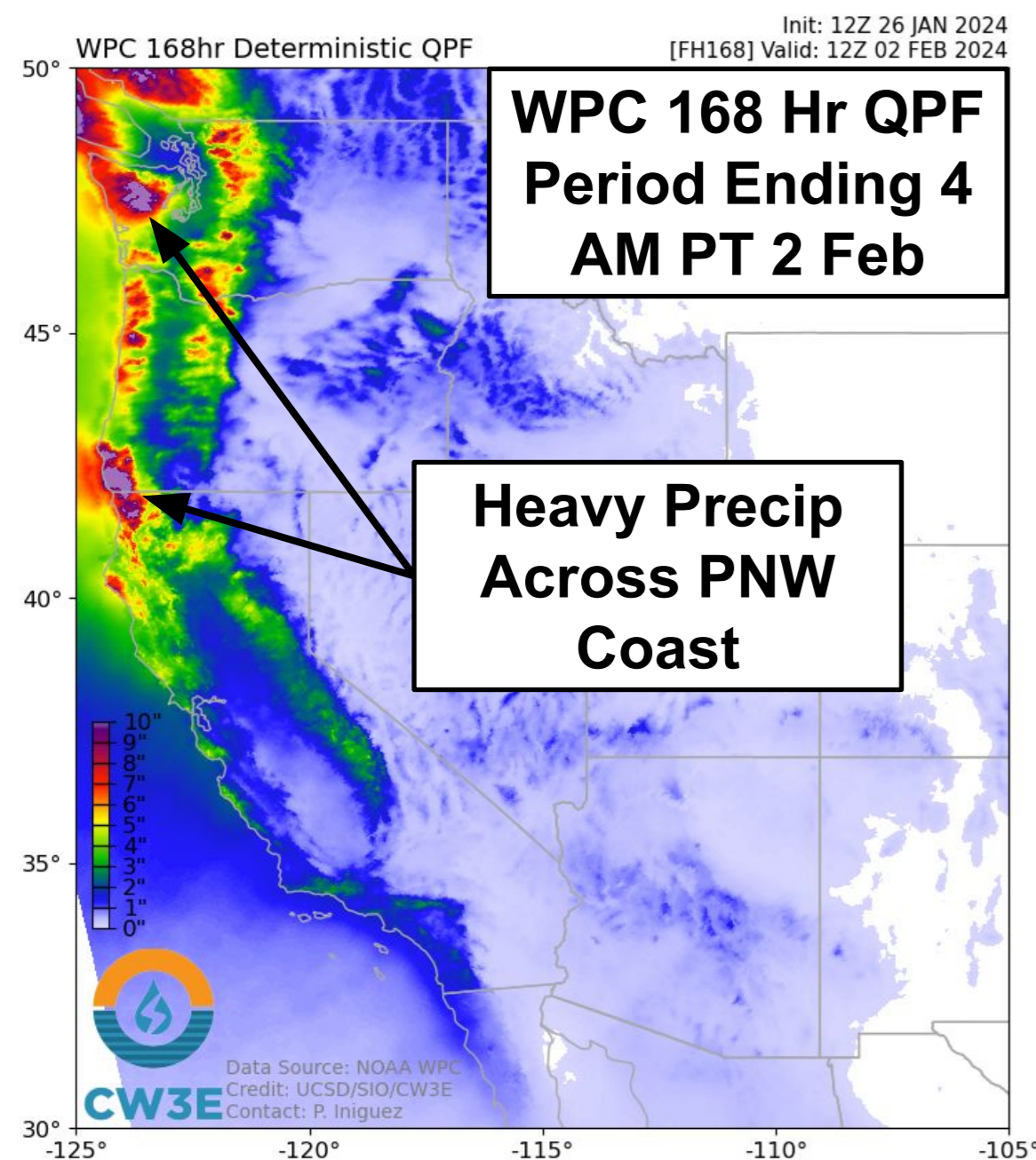
CW3E AR Outlook: 26 Jan 2024



- The NWS WPC is forecasting the heaviest precipitation in the PNW and along the CA/OR border for the **first** and **second** ARs (4 day period from 4 AM PT 27 Jan to 4 AM PT 30 Jan) and in Northern CA with the **third** AR (3 day period from 4 AM PT 31 Jan to 4 AM PT 2 Feb).
- A Slight Risk (level 2 of 4, or at least 15% chance) for flooding has been issued along the CA/OR border for the 24-hour period ending 4 AM PT Sat 27 Jan with the **first** AR.
- Marginal Risks (level 1 of 4, or at least 5% chance) for flooding have been issued for the Olympic Peninsula for the 4 day period from 4 AM PT 28 Jan to 4 AM PT 31 Jan, along the WA/OR coasts for the periods ending on 27 and 28 Jan and along the CA/OR border for the periods ending on Jan 27, 28 and 31 Jan.

*Excessive Rain Outlook (ERO)

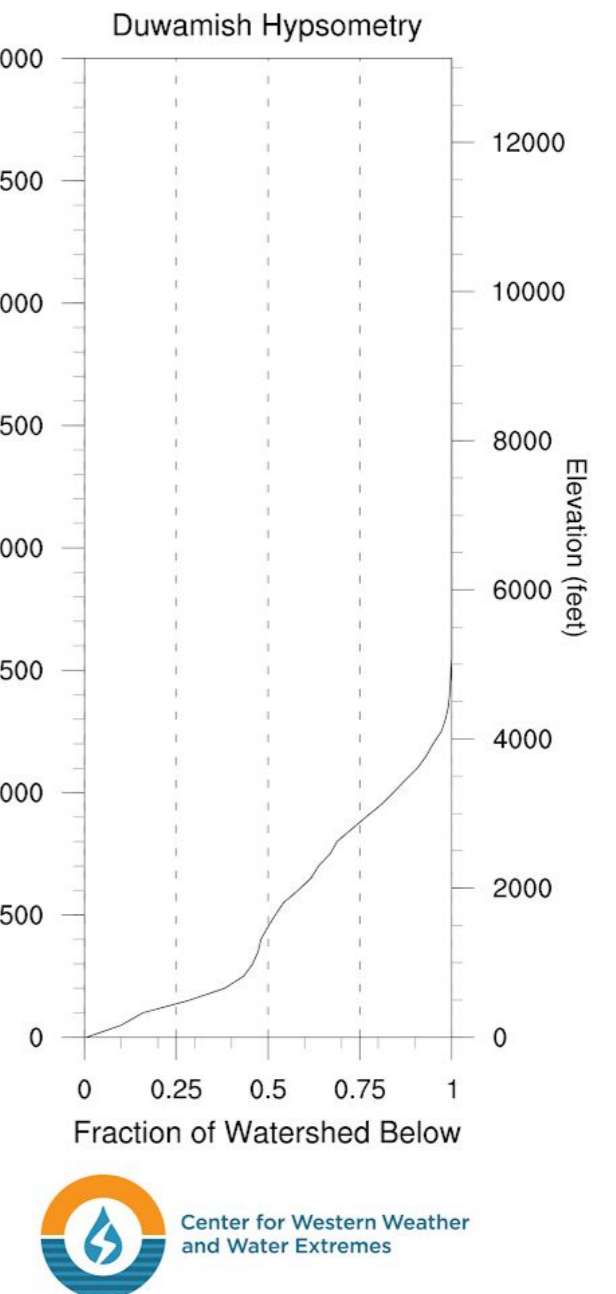
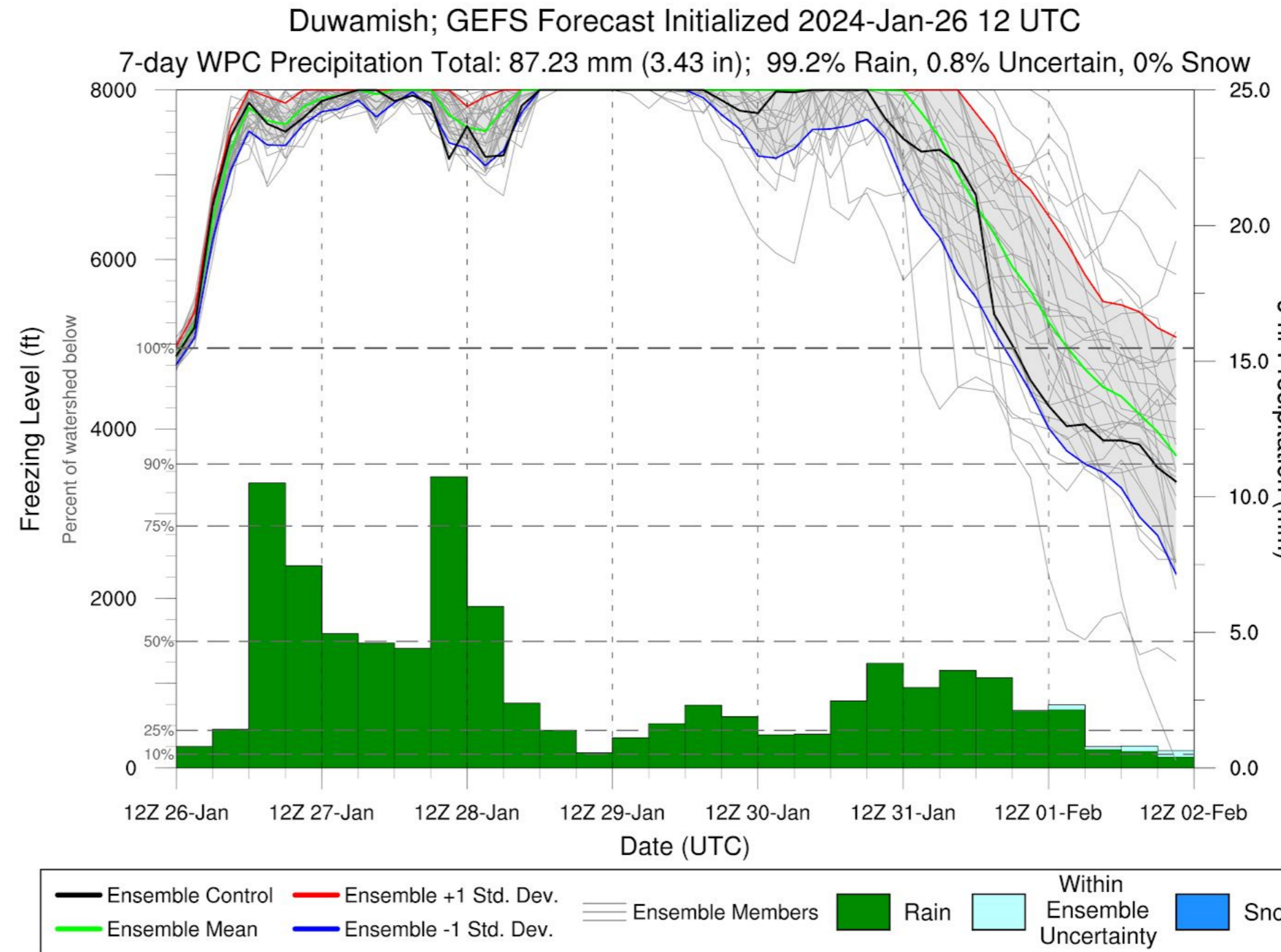
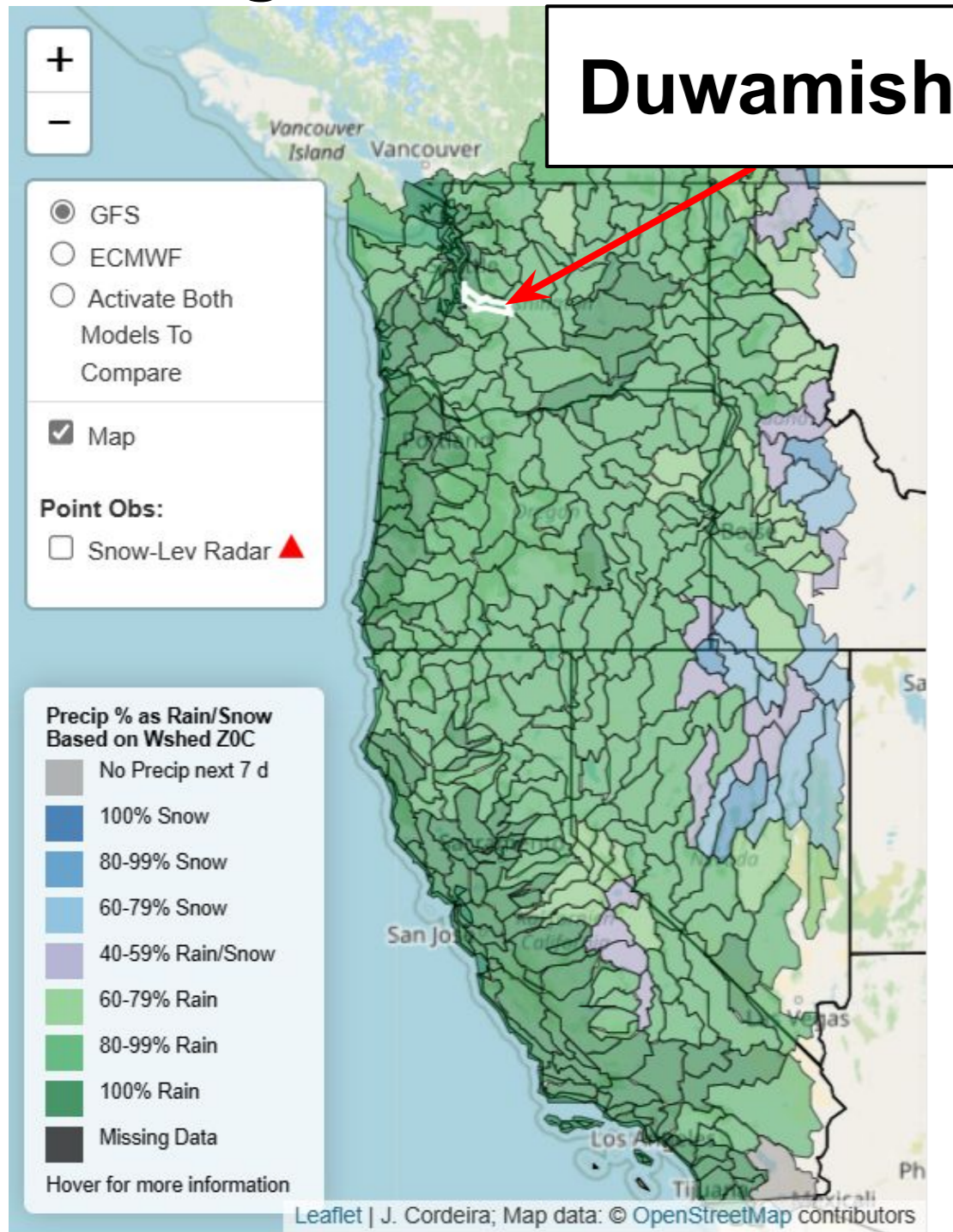
CW3E AR Outlook: 26 Jan 2024



- WPC, GFS and ECMWF are forecasting the highest 7-day precipitation totals over the Olympic Peninsula and along the CA/OR border.
- The ECMWF is currently forecasting higher precipitation in the Sierra Nevada and over the C. and S. CA coasts compared to the GFS.

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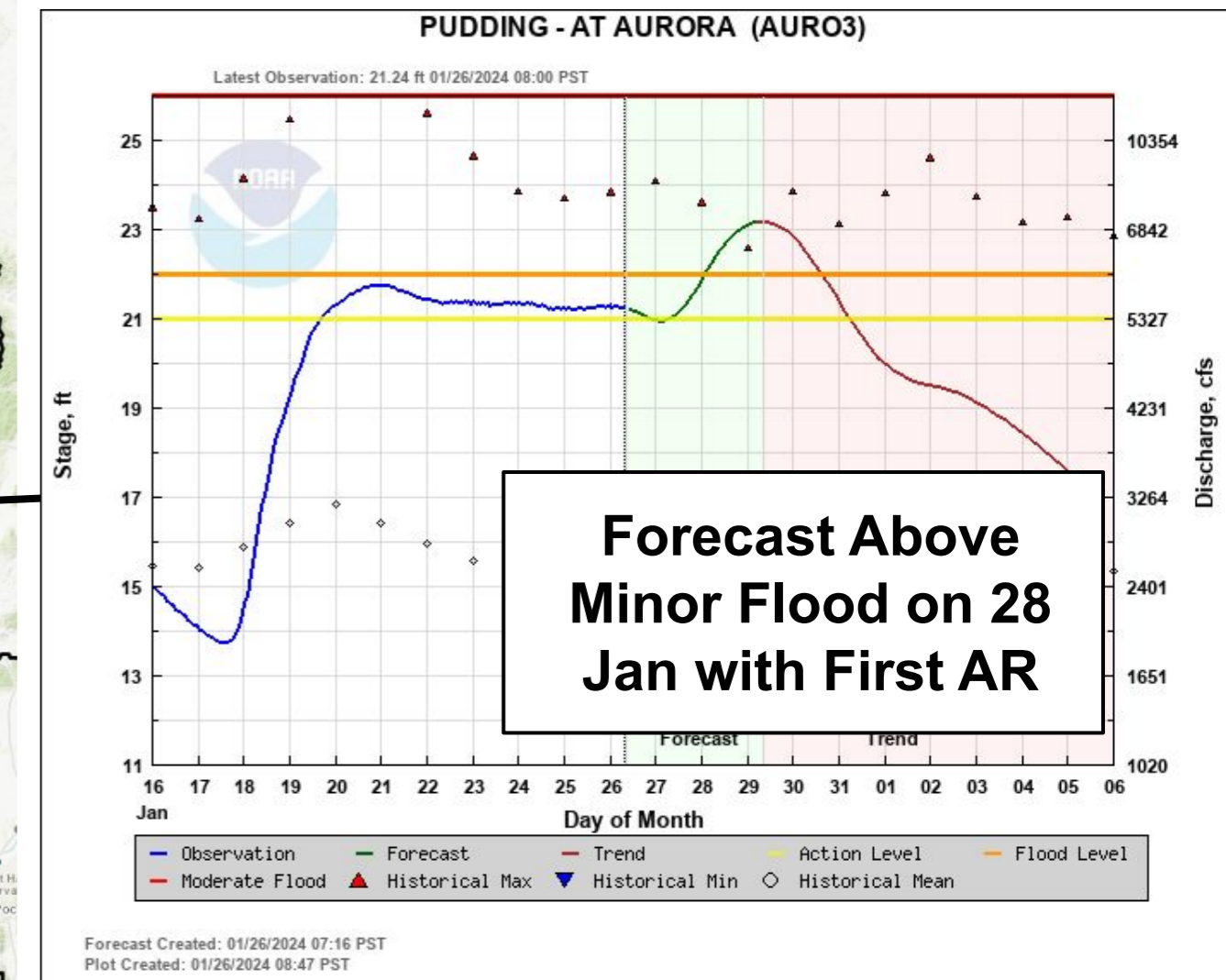
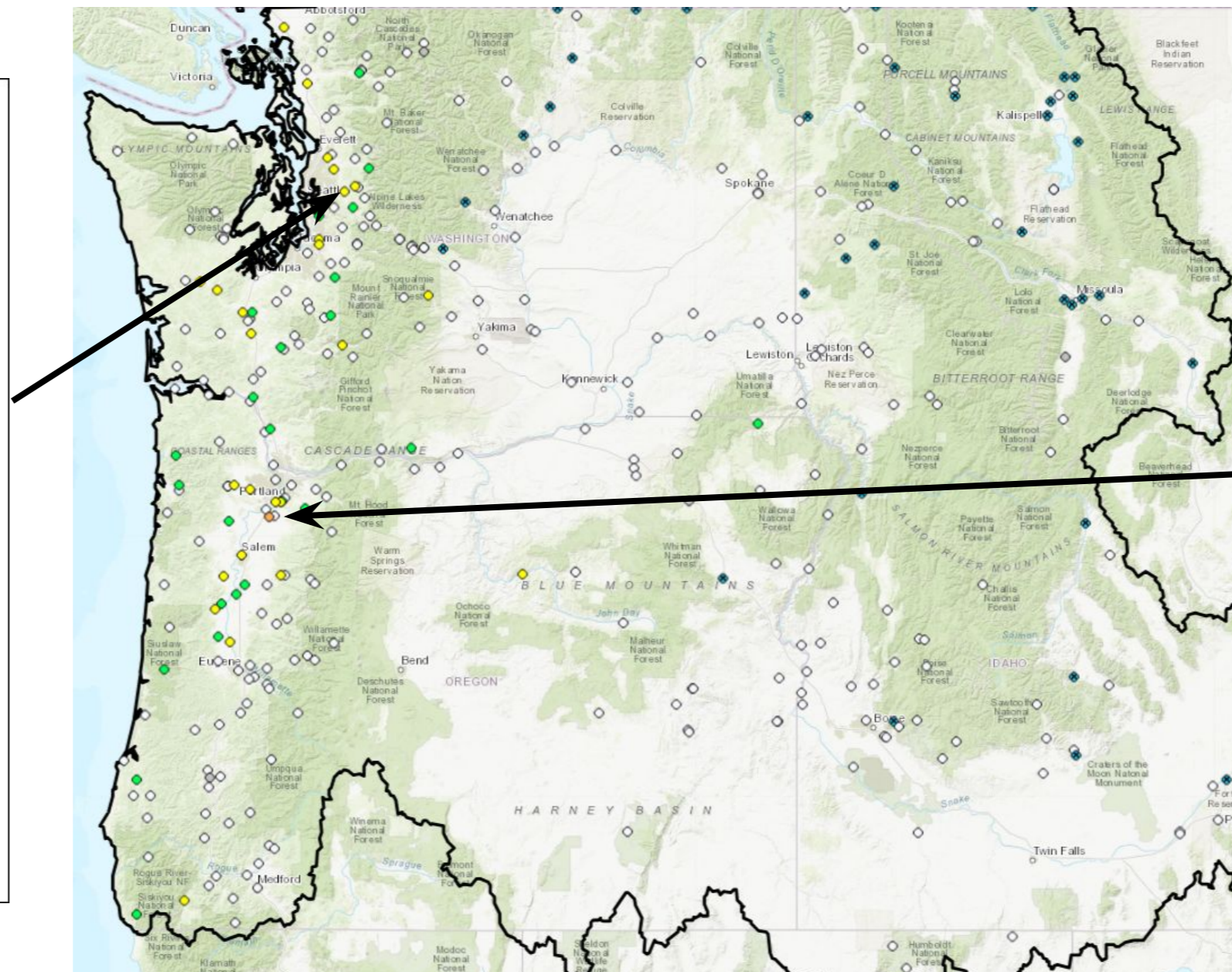
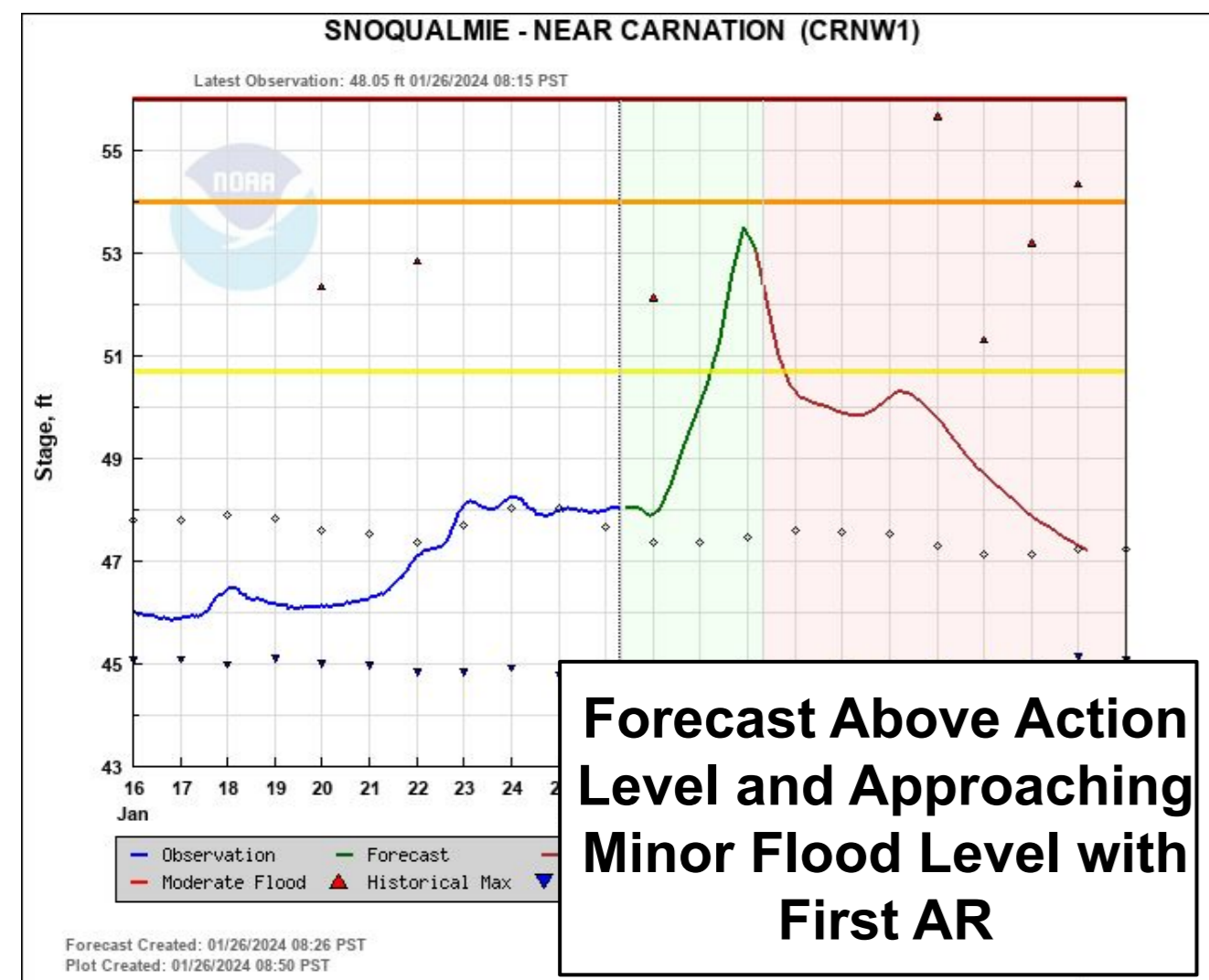
Freezing Level Forecast



- The freezing level is forecast to remain above ~6000 ft mean sea level (MSL) for the duration of the **first and second** ARs before falling throughout the duration of the **third** AR in the Duwamish watershed.
- The CW3E watershed freezing level tool is forecasting ~99% of the precipitation in the Duwamish to fall as rain over the next 7 days, with uncertainty in approximately ~20% of the precipitation forecast.

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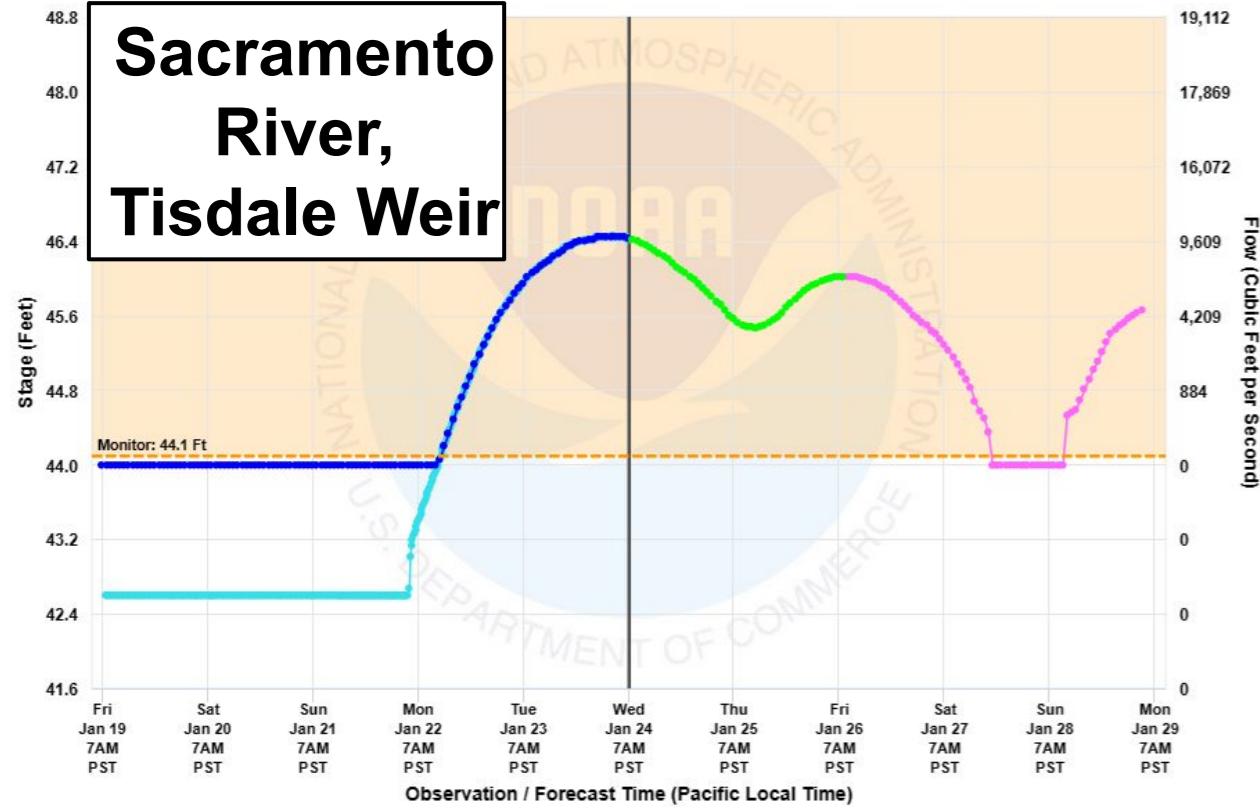
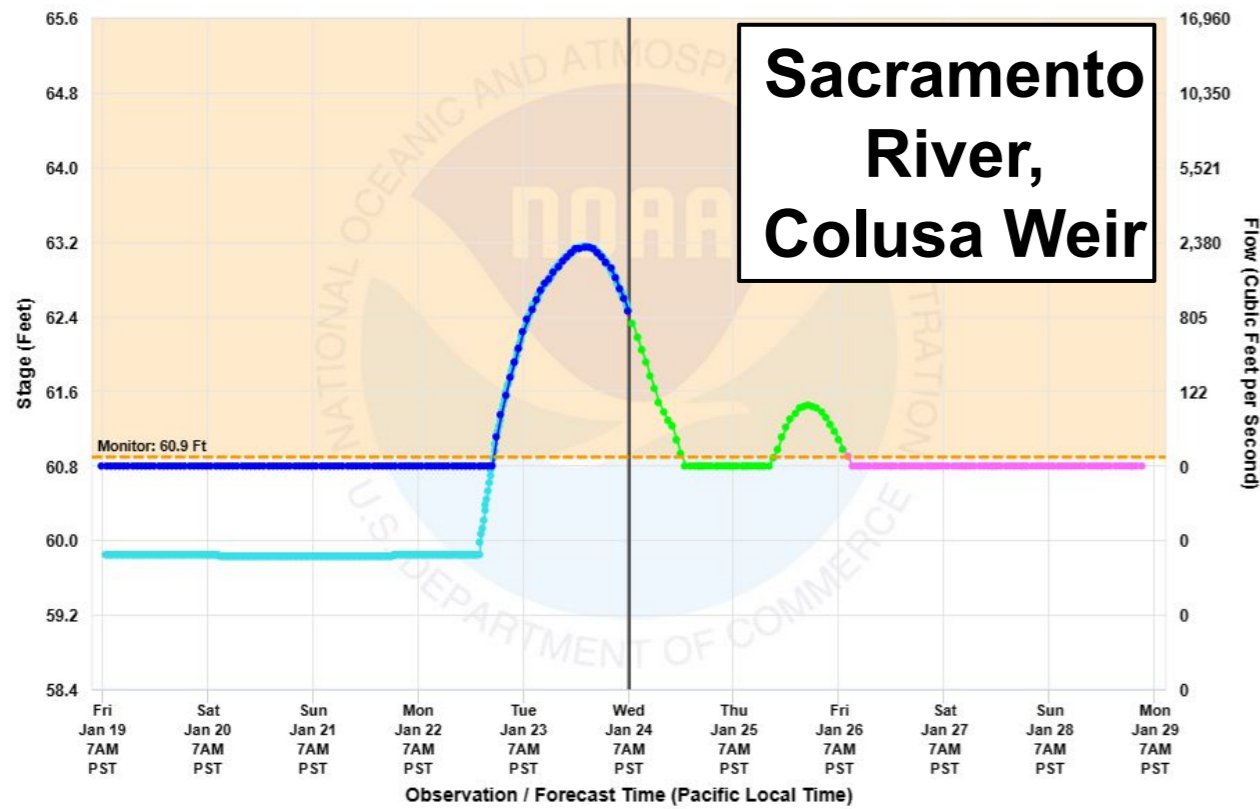
NWS NWRFC River Stage Forecast



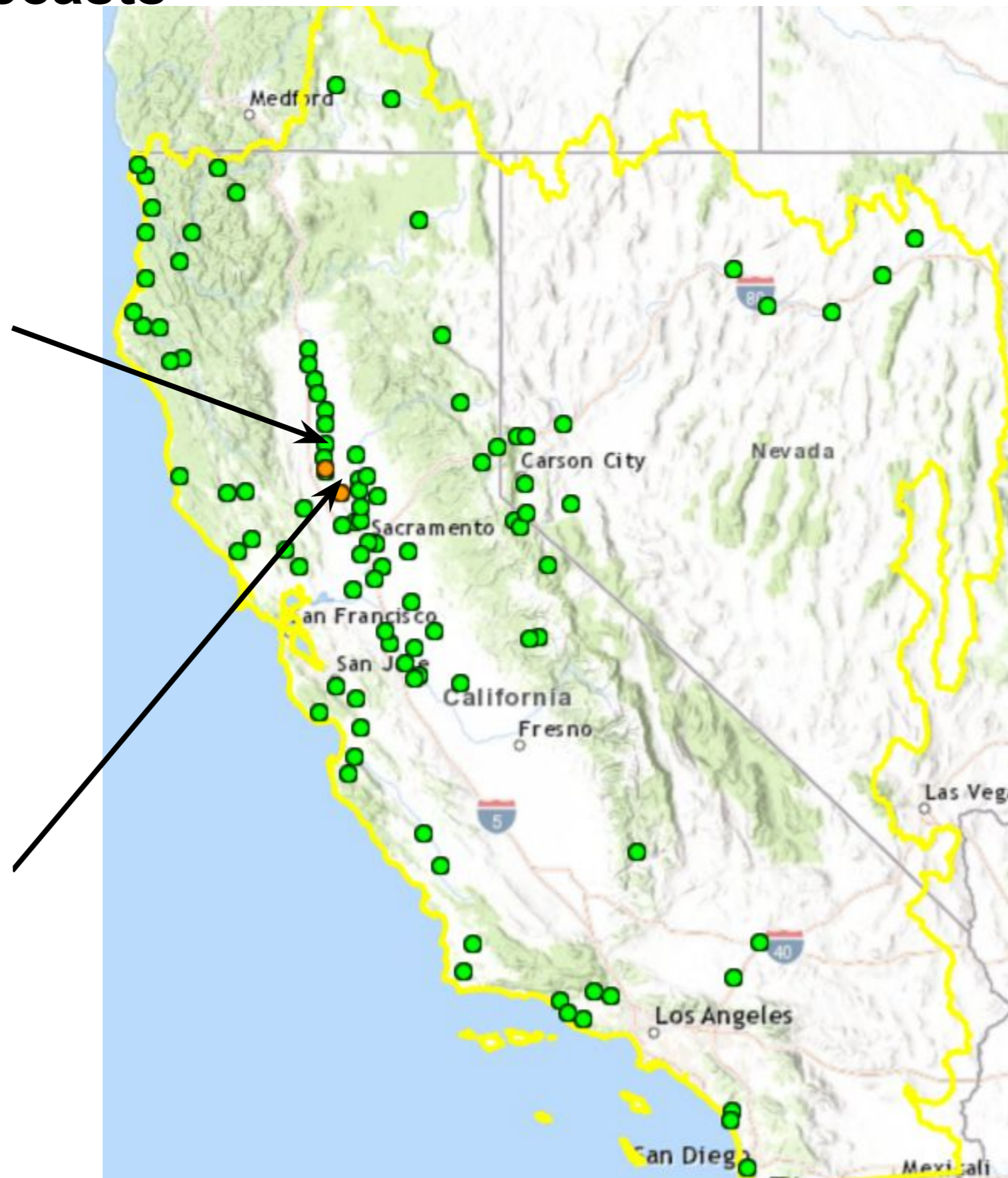
- Rivers across the Pacific Northwest are forecast to steadily rise as a result of the heavy precipitation associated with the **first** and **second** ARs.
- The NWRFC is currently forecasting 25 stream gages to reach bankfull stage (ex. Snoqualime River at Carnation on left) and one stream gages to exceed minor flood stage (Pudding River at Aurora on right), primarily along the WA and OR coasts.
- The station at Coquille has a chance to reach the moderate flood stage during the **first** AR.

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NWS CNRFC River Stage Forecasts



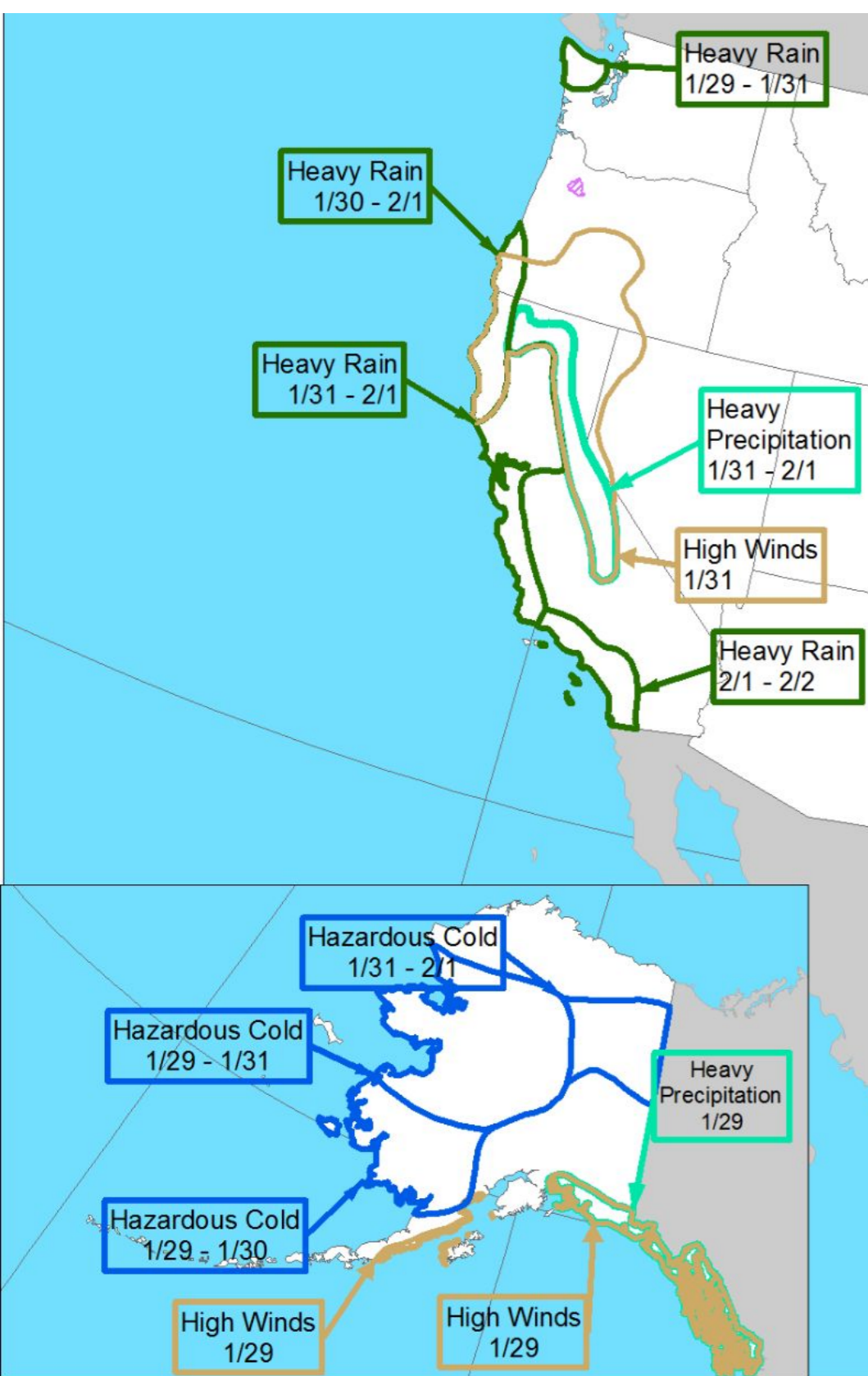
NOAA / NWS / California Nevada River Forecast Center • California Department of Water Resources
 — Observed (Raw Gauge) — Observed (Simulated) — Forecast — Guidance



- River stages in CA are forecast to rise as a result of the precipitation associated with the **first** and early portions of the **second** AR.
- CNRFC is currently forecasting 2 gages to exceed monitor stage, all within the Sacramento Valley
- The Colusa Weir (top left) reached monitor stage late Mon Jan 22 and is forecast to stay above until late Wed Jan 24 with another rise late Thu Jan 25, while the Tisdale Weir (bottom left) will remain above Monitor Stage until late Sat Jan 27.
- The forecast for the **third** AR that is likely to bring heavy rain to CA is not included in the current forecast.

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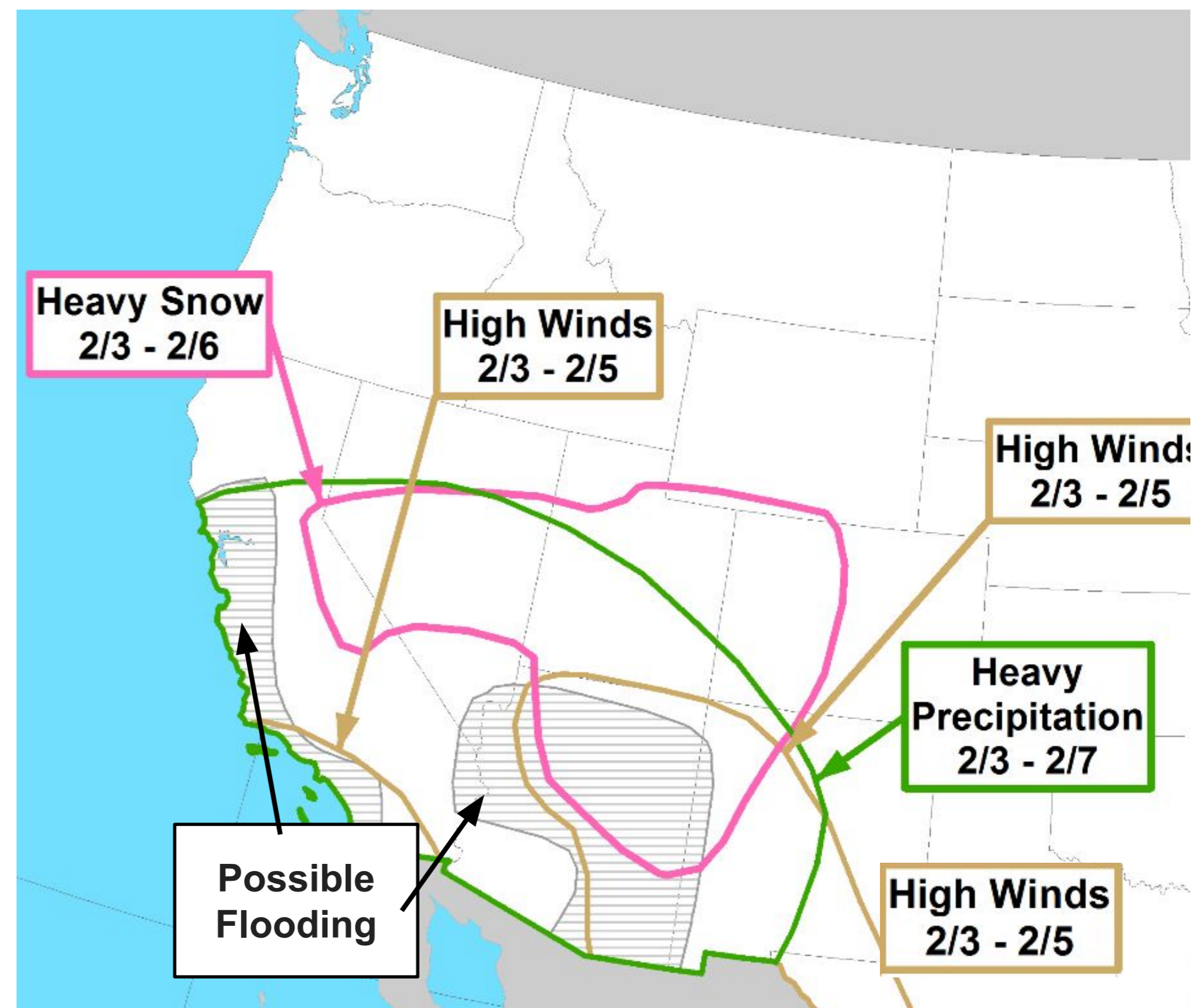
WPC Day 3-7 Hazard Outlook



- WPC's Day 3-7 Hazard Outlook is highlighting risks of **heavy rain**, **heavy precipitation** and **high winds** across the USWC for Jan 30 to Feb 2.
- The CPC's day 8-14 hazard outlook is highlighting potential for **heavy rain** and **heavy snow** in the southwestern US, as well as **flooding** in coastal CA and AZ during 3-7 Feb.
- Altogether, the hazard outlooks highlight likely high precipitation in regions of CA from Jan 30 through Feb 5

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

CPC Day 8-14 Hazard Outlook

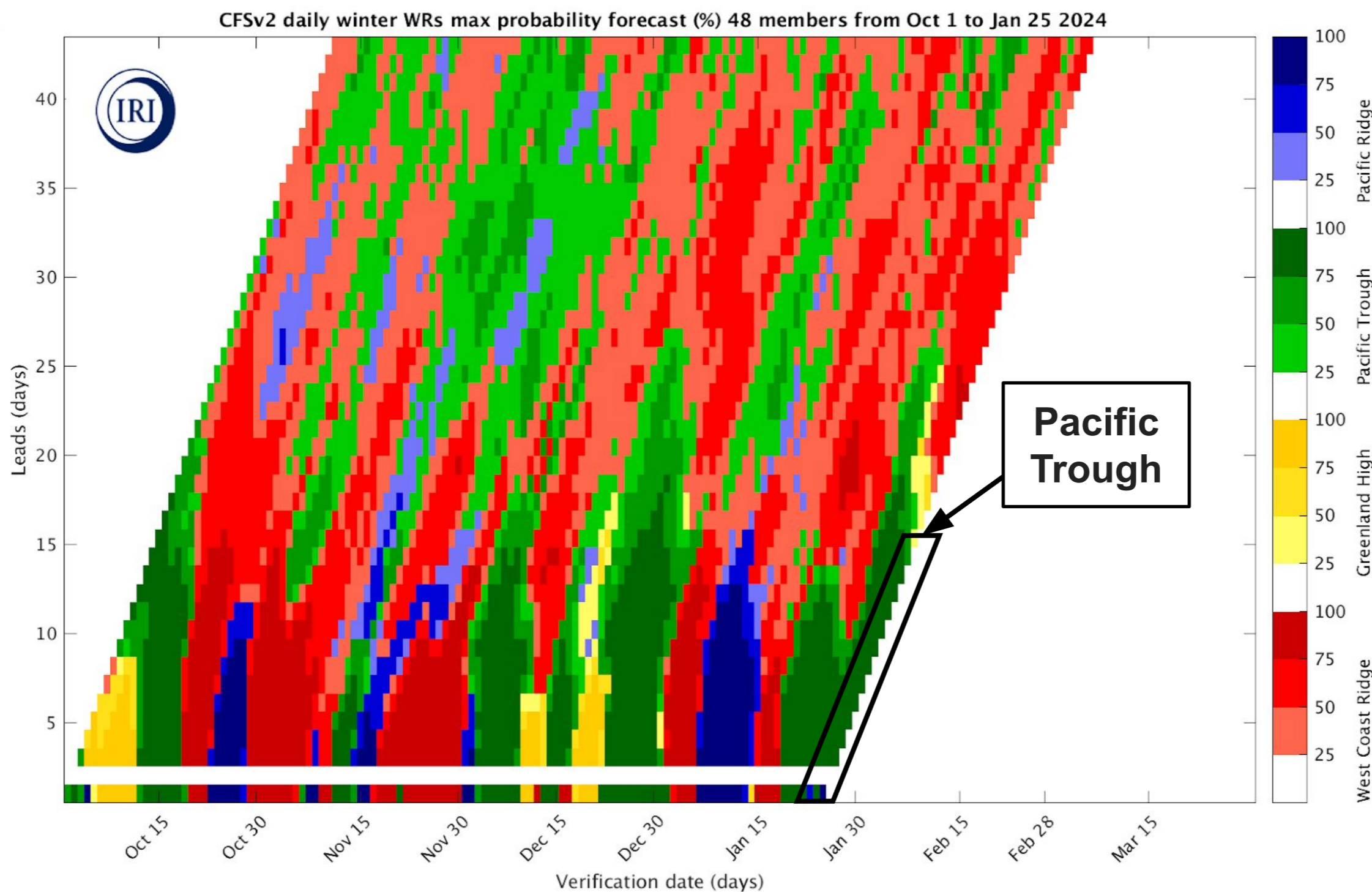
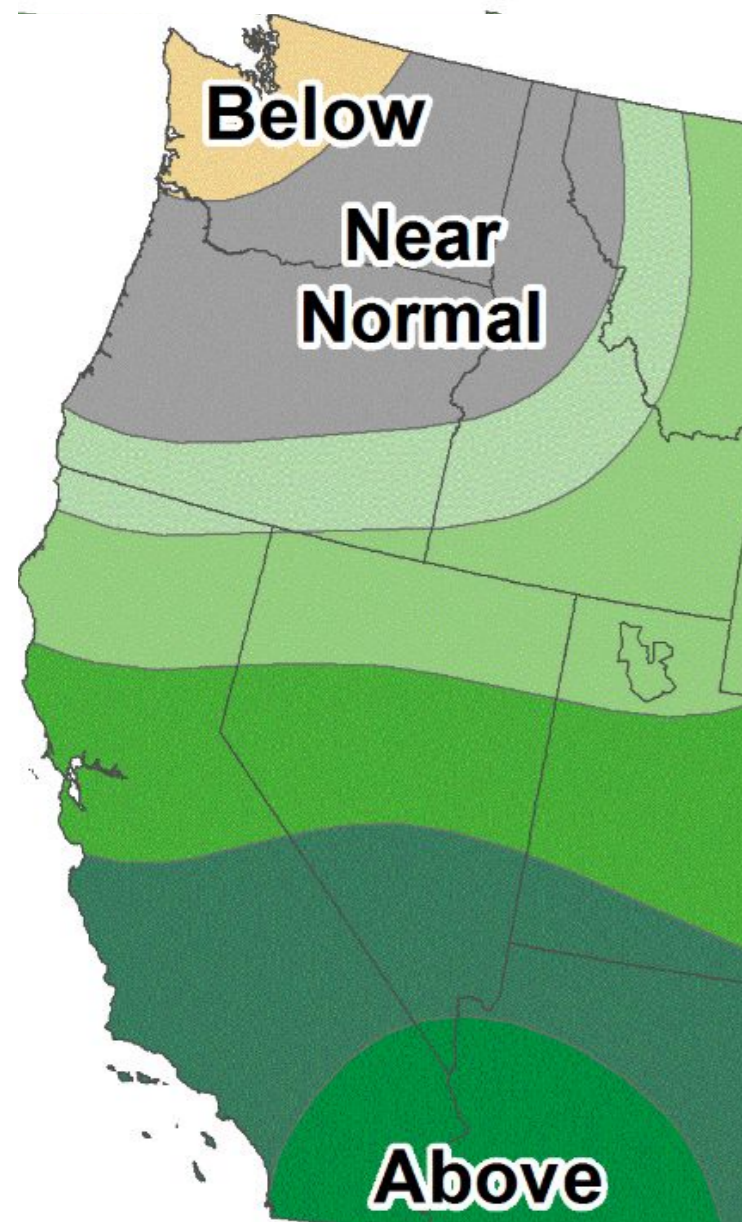


<https://www.cpc.ncep.noaa.gov/products/predictions/threats/threats.php>

CW3E AR Outlook: 26 Jan 2024

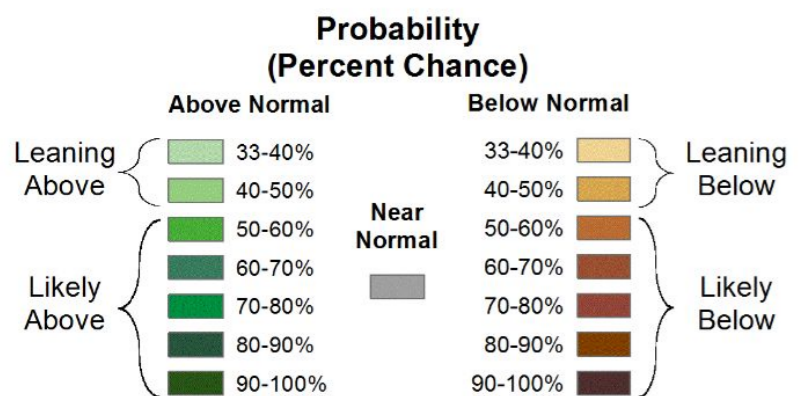
CPC Day 8-14 Precipitation Outlook and IRI Regime Forecast

Valid: February 3 - 9, 2024
 Issued: January 26, 2024



- The CPC's Day 8-14 Precipitation Outlook is showing high probabilities (70-80%) of **above normal** precipitation for S.CA, S. NV, AZ, NM and portions of UT, CO, TX and OK as the **third** AR impacts downstream weather.

- The IRI Regime Forecast is highlighting a continuation of the **Pacific Trough** Regime through early-mid February. This regime indicates a **greater likelihood** for **wet conditions** for the USWC.

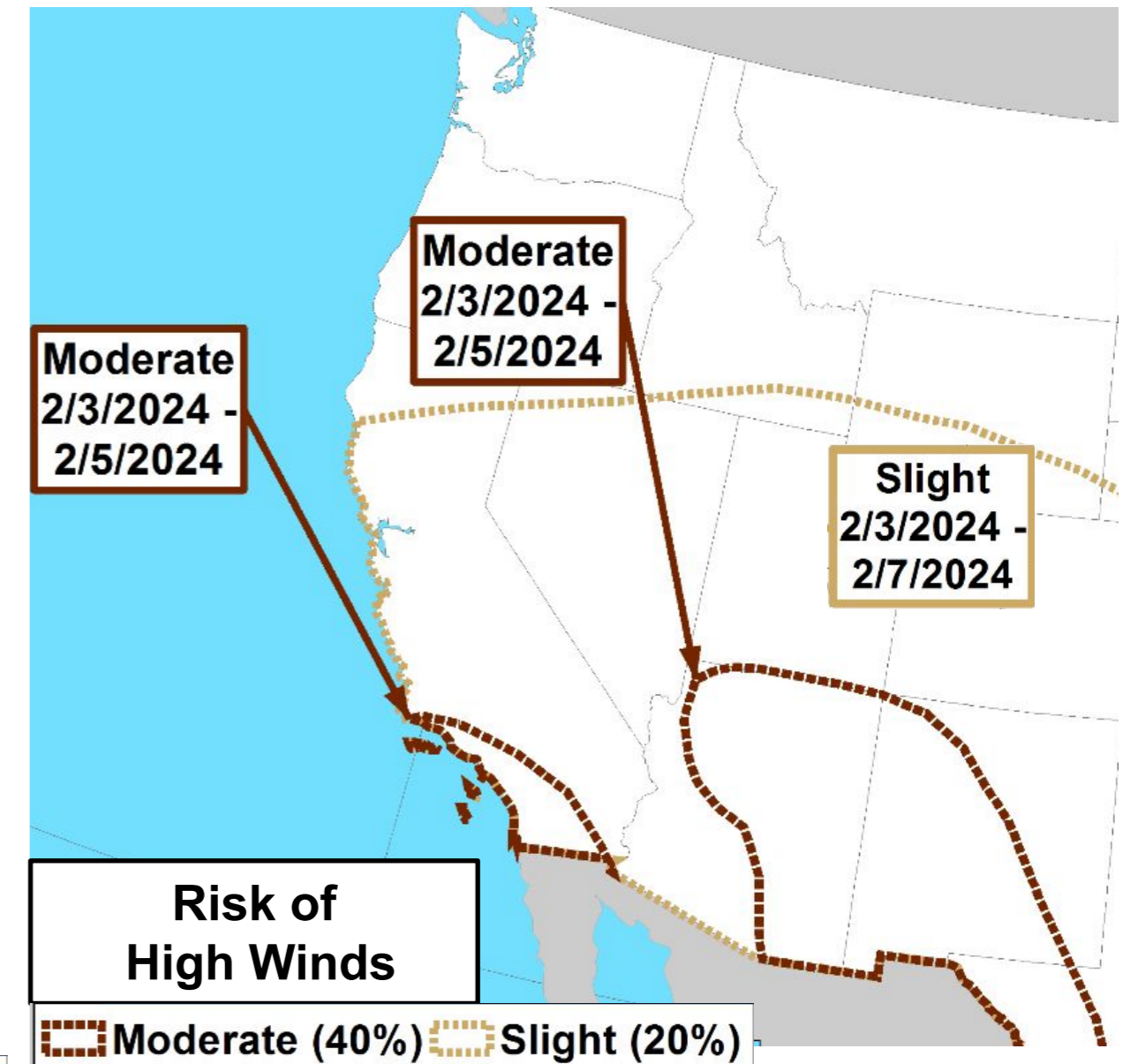
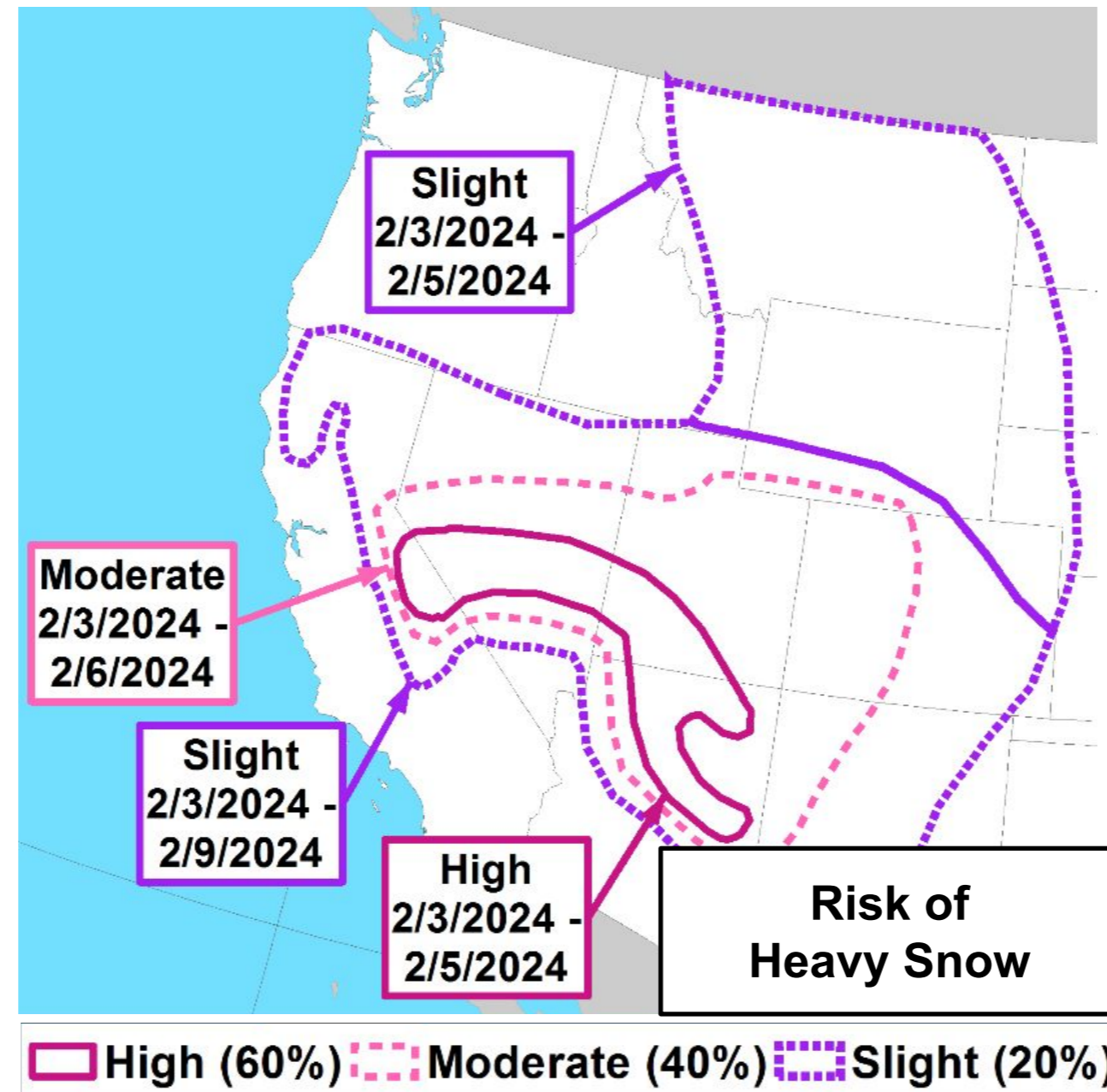
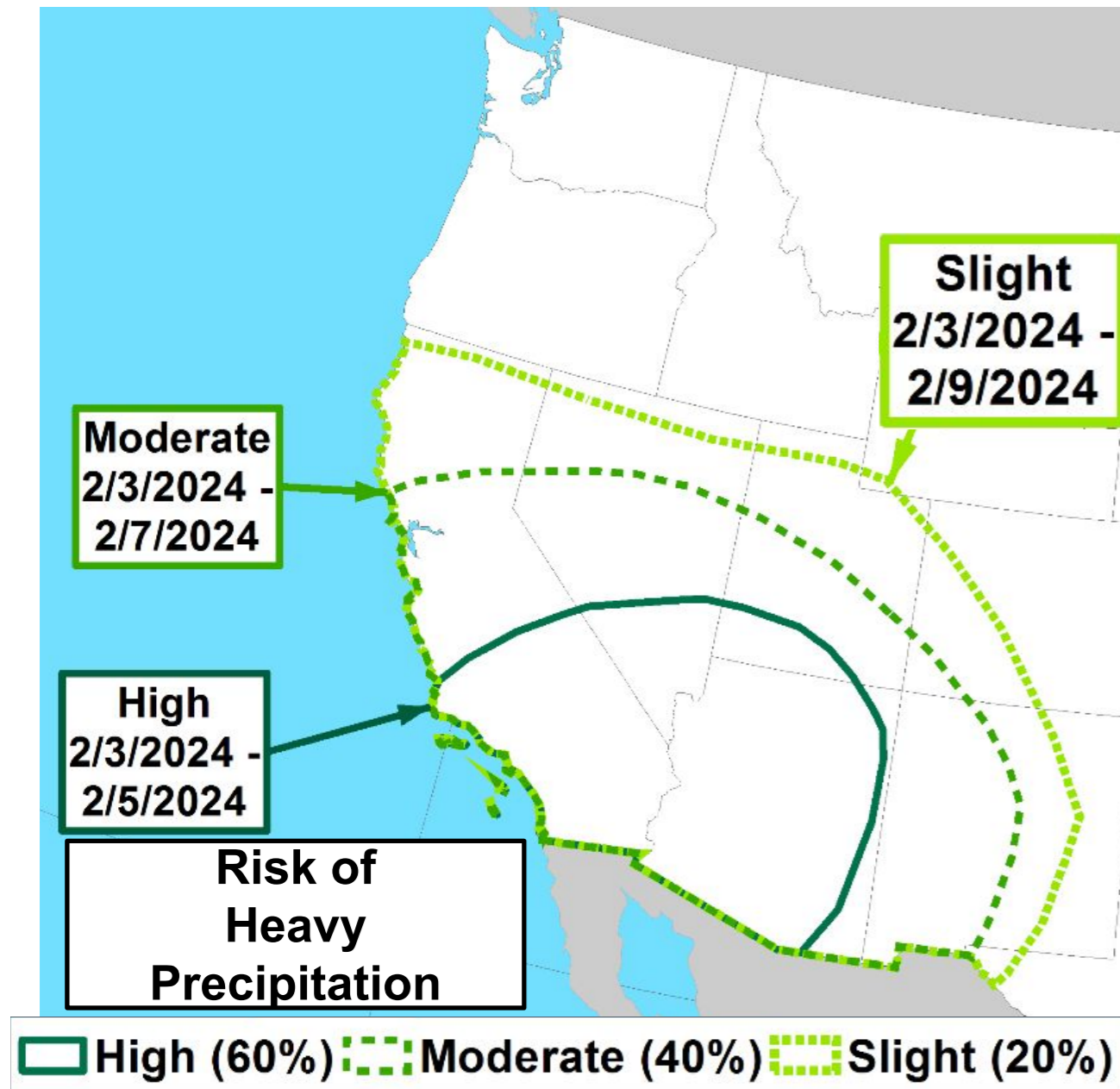


IRI: <https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>

CPC: <https://www.cpc.ncep.noaa.gov/products/predictions/814day/814prcp.new.gif>

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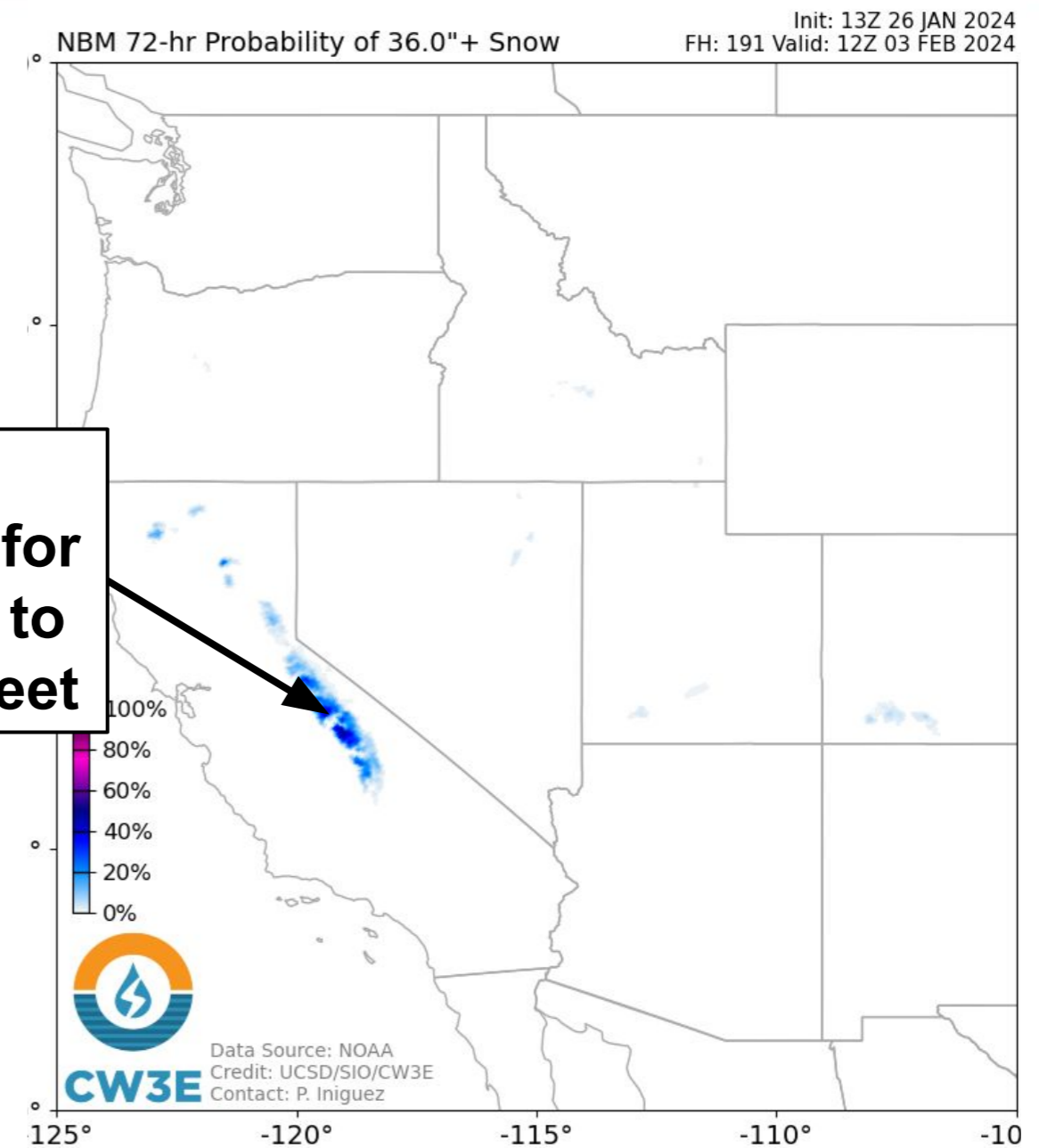
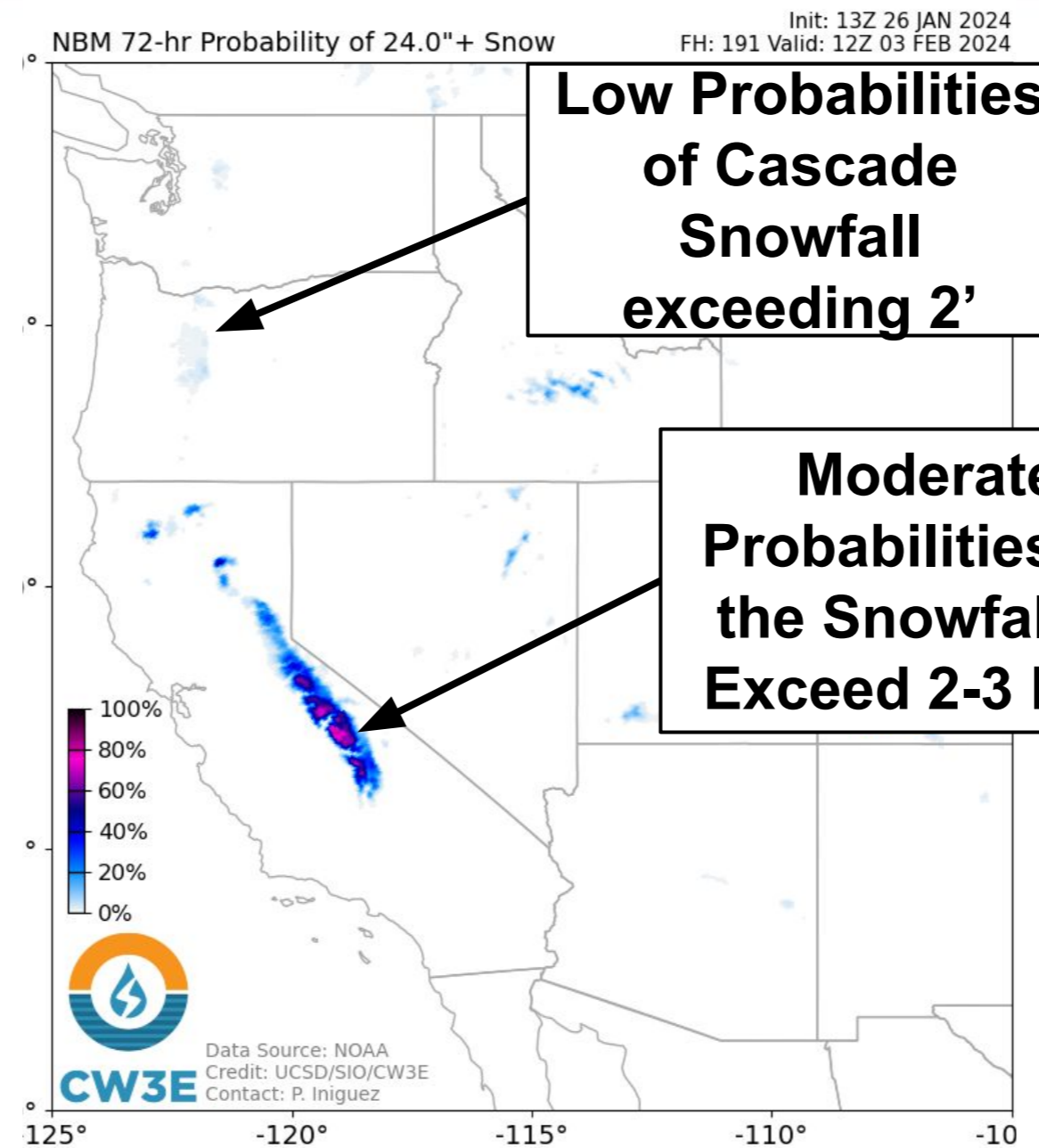
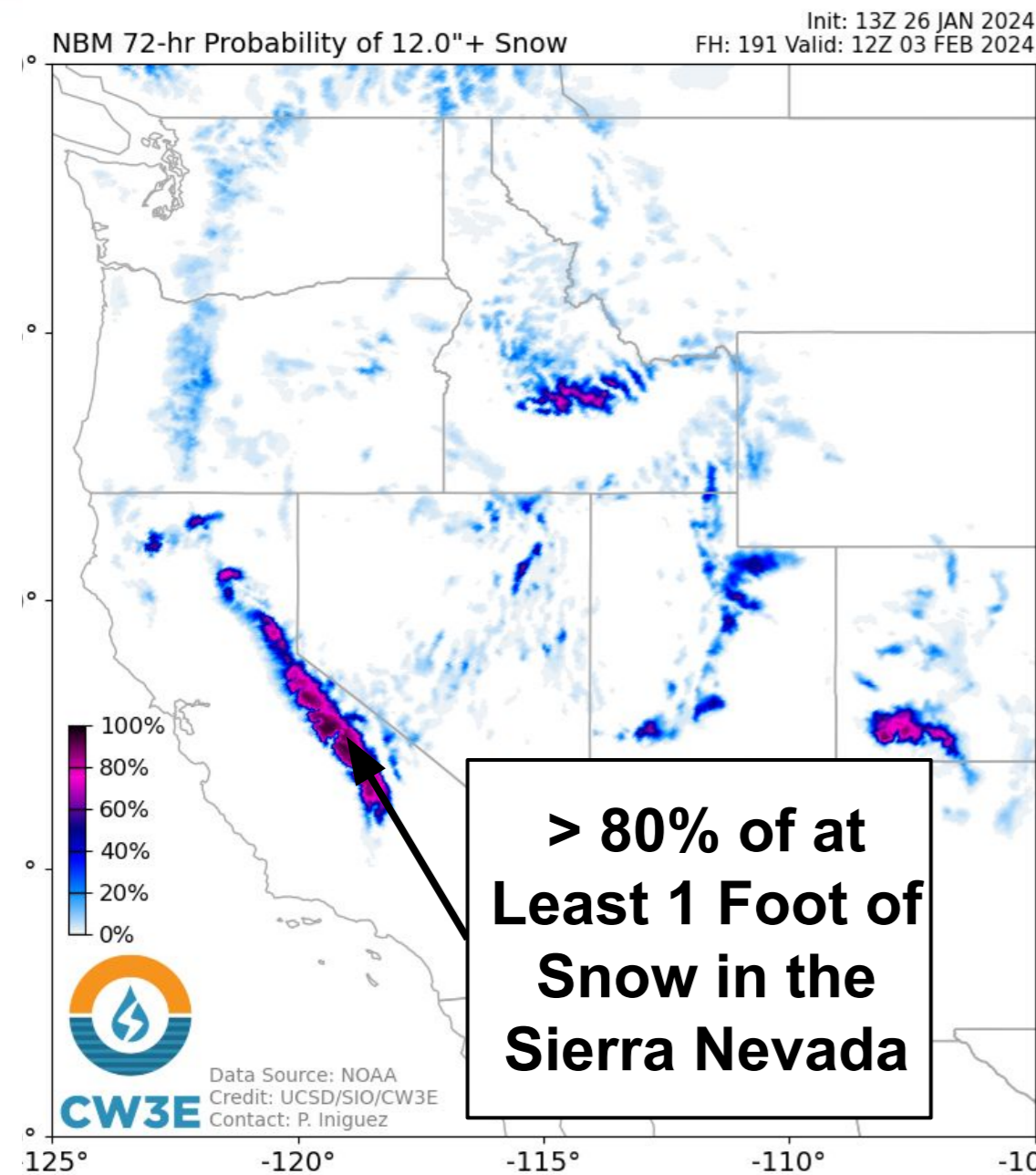
Climate Prediction Center 8-14 Day Hazard Outlooks



- A look into the Day 8-14 outlooks each hazard show a **high risk of heavy precipitation** and of **heavy snow** as well as a **moderate risk of high winds** in the Southwestern US for 3 to 7 Feb.

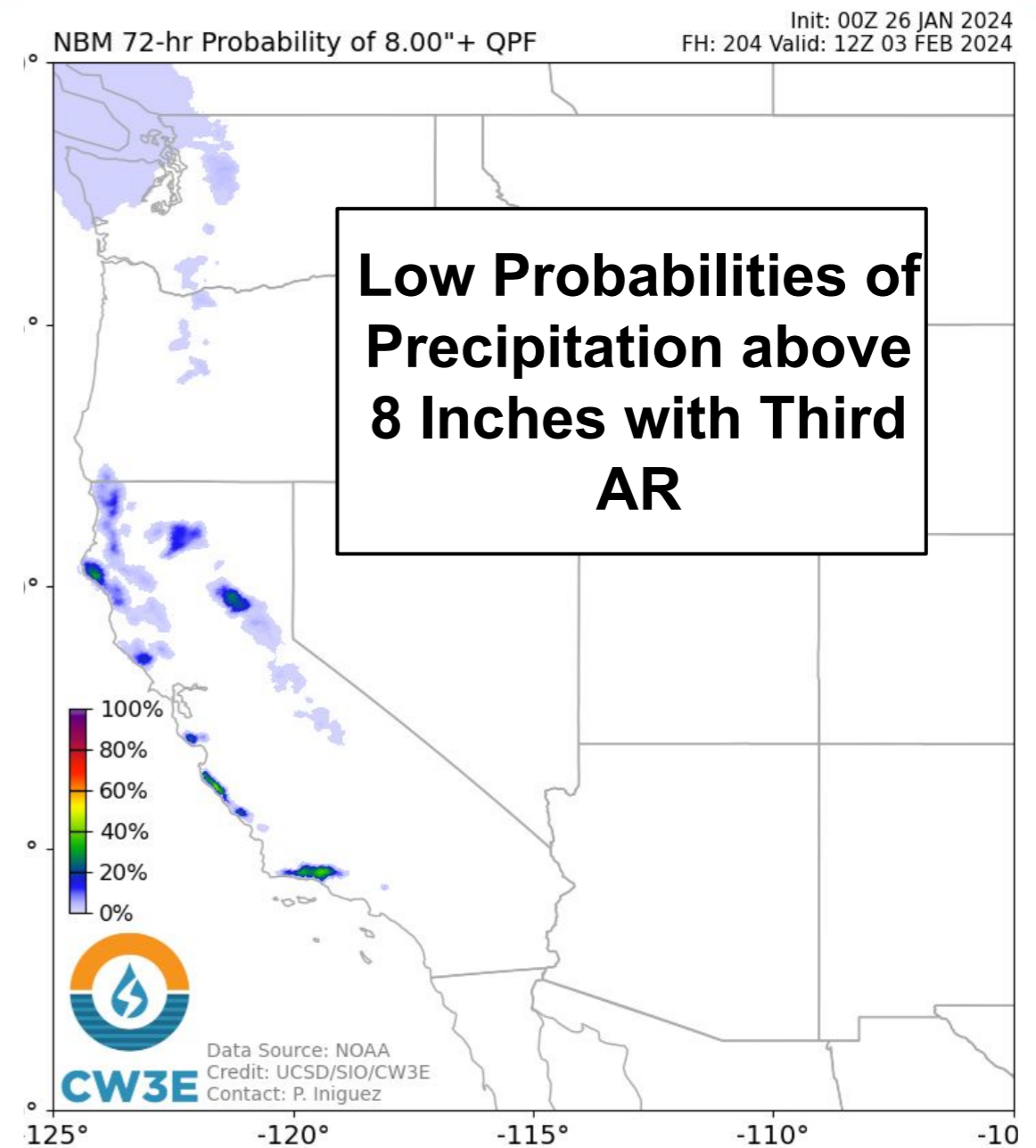
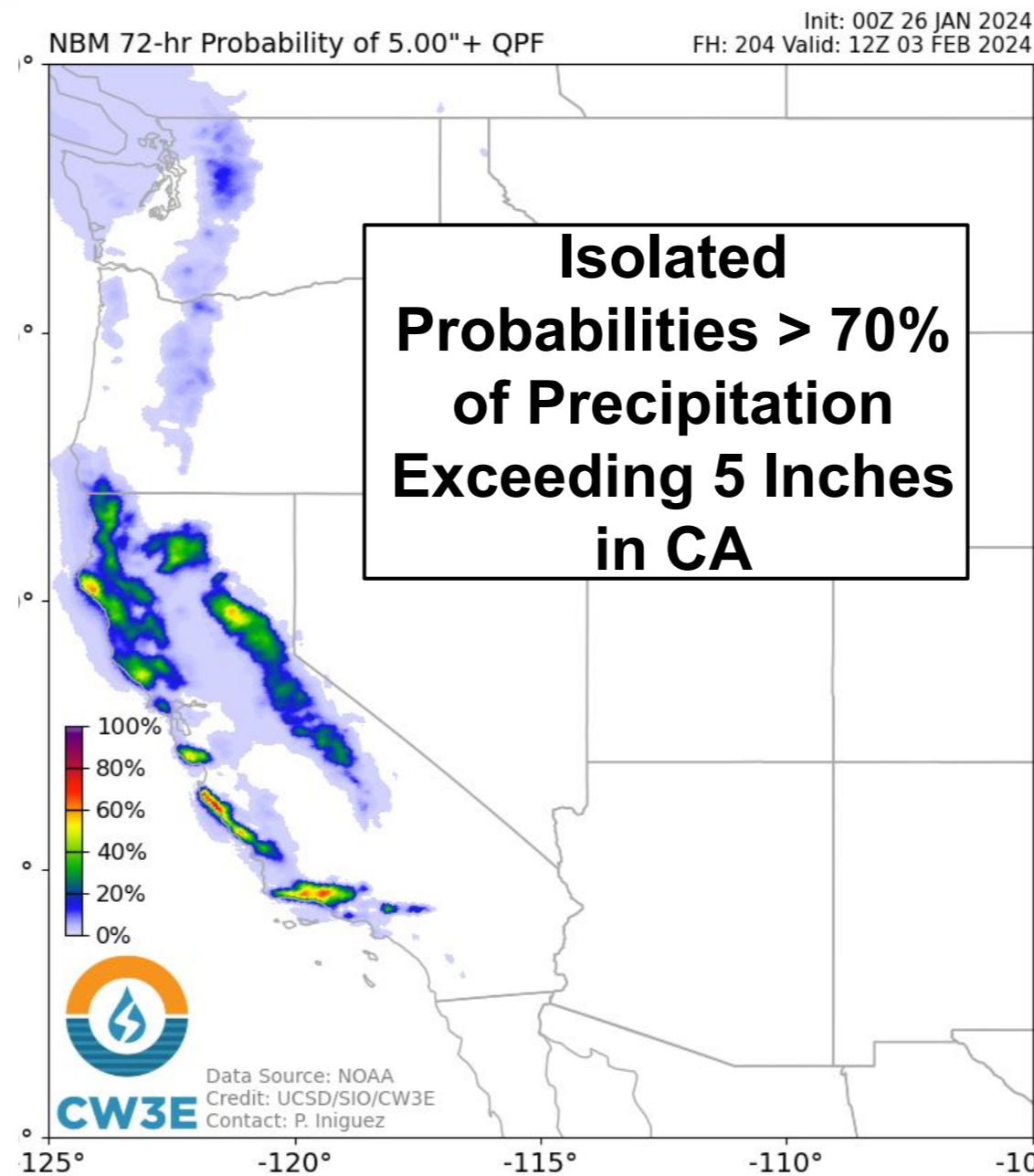
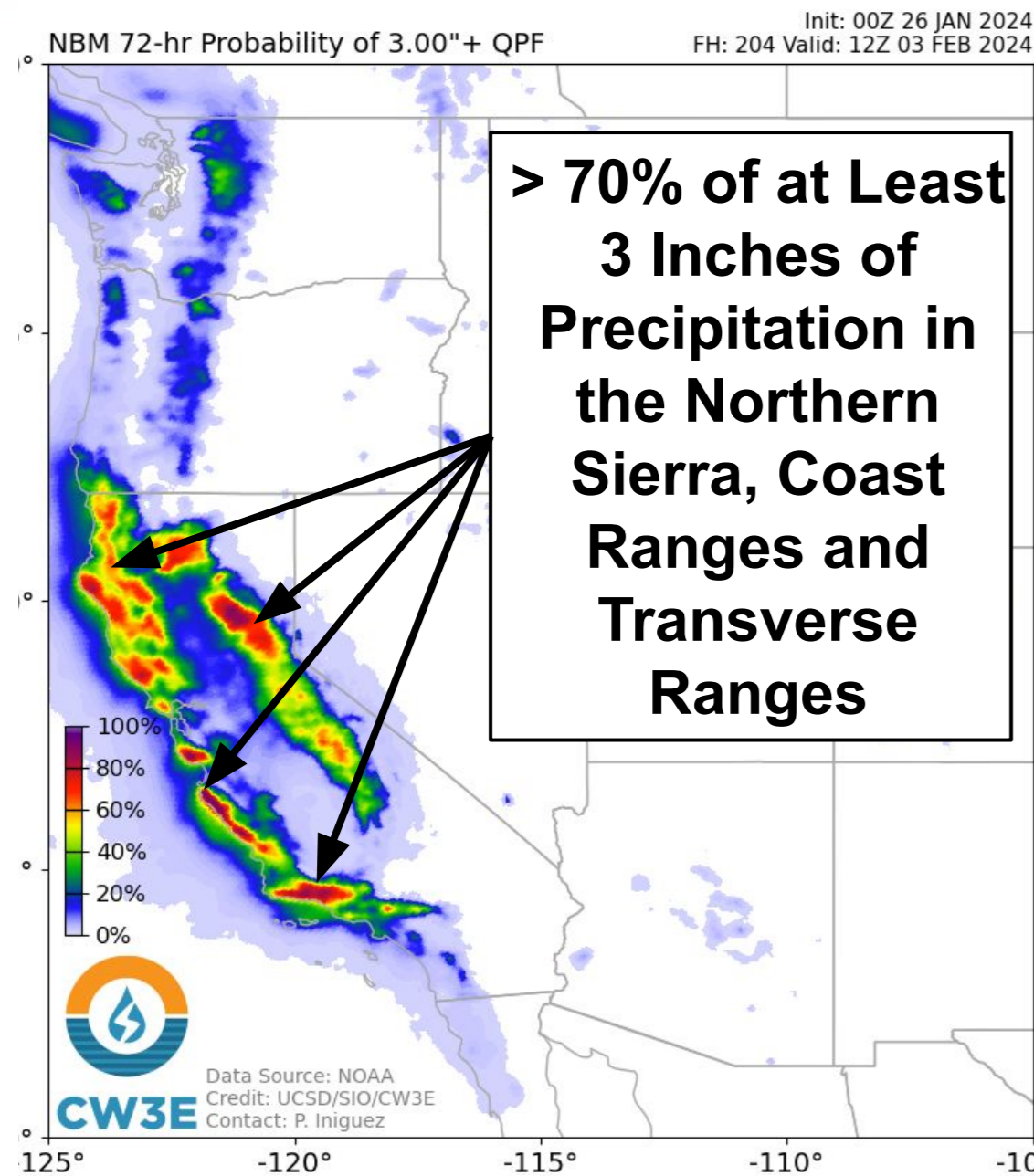
<https://www.cpc.ncep.noaa.gov/products/predictions/threats/threats.php>

CW3E AR Outlook: 26 Jan 2024



- For the 72-hour period ending at 4 AM PT Sat 3 Feb, the NBM is showing high probabilities (>80%) that the Sierra Nevada receives at least 12" of snowfall during the **third AR**.
- The NBM is showing moderate probabilities (40-70%) of snowfall exceeding 2 ft and low probabilities (<40%) of snowfall exceeding 3 ft in the Sierra Nevada
- There are low probabilities (>30%) of snowfall in the Cascades exceeding 1', with low probabilities (>10%) of snowfall exceeding 2'.

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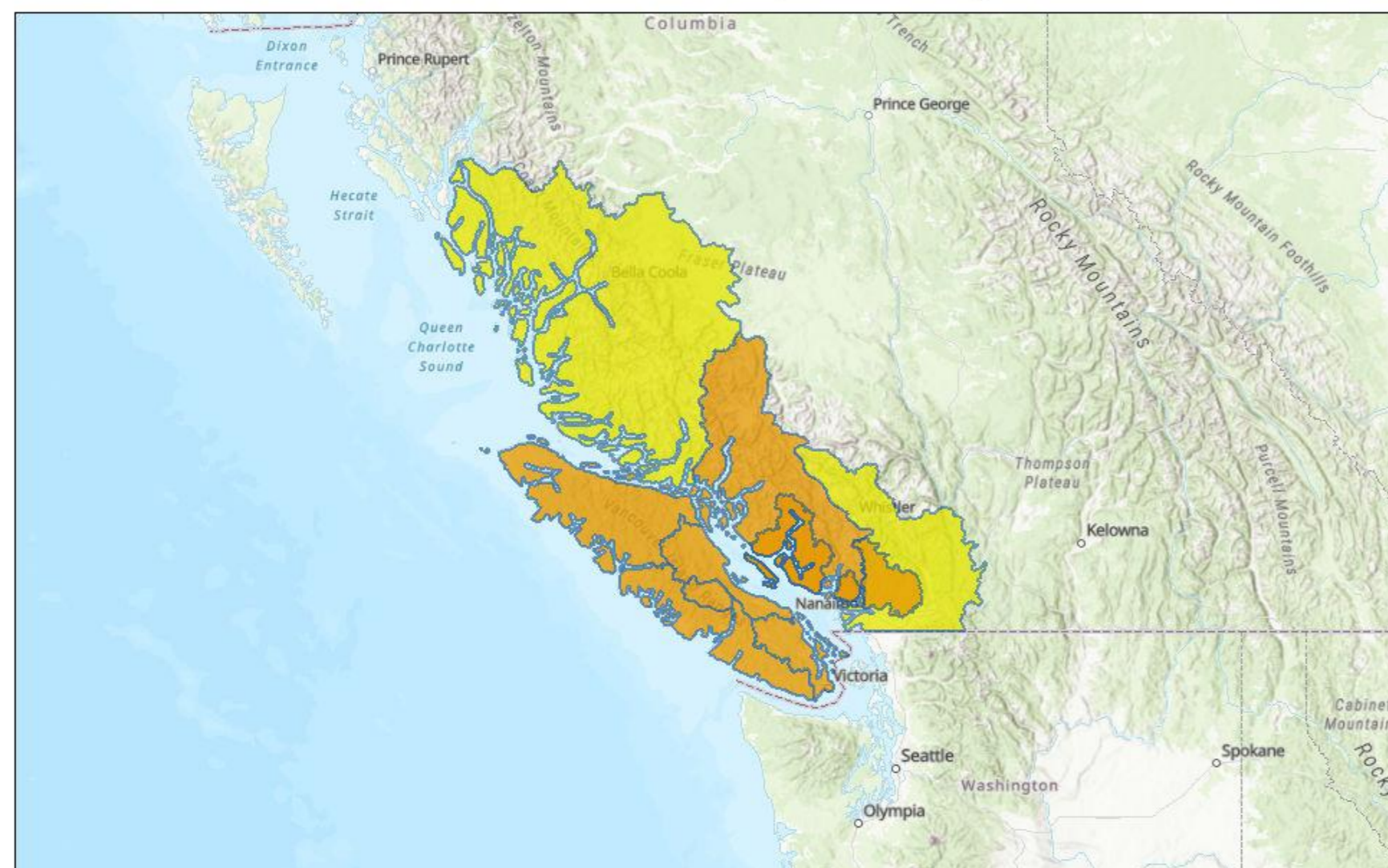


- For the 72-hour period ending at 4 AM PT Sat 3 Feb, the NBM is showing high probabilities (> 80%) that the Sierra Nevada, Coast Ranges and Transverse Ranges receive at least 3" of precipitation.
- The NBM is now showing isolated regions of higher probabilities (>70%) of 72-h precipitation exceeding 5" in the Northern Sierra Nevada, Coast Ranges and Transverse Ranges during the third AR.
- There are also low probabilities (>20%) of precipitation exceeding 3" in the Cascades and along the WA/OR coast.

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British Columbia River Forecast Centre Advisories and Streamflow

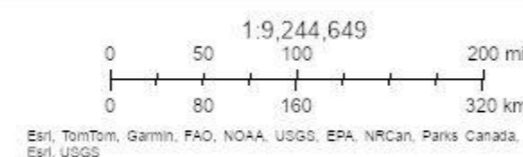
River Forecast Centre Flood Advisory and Warning Notifications



1/26/2024, 10:56:59 AM

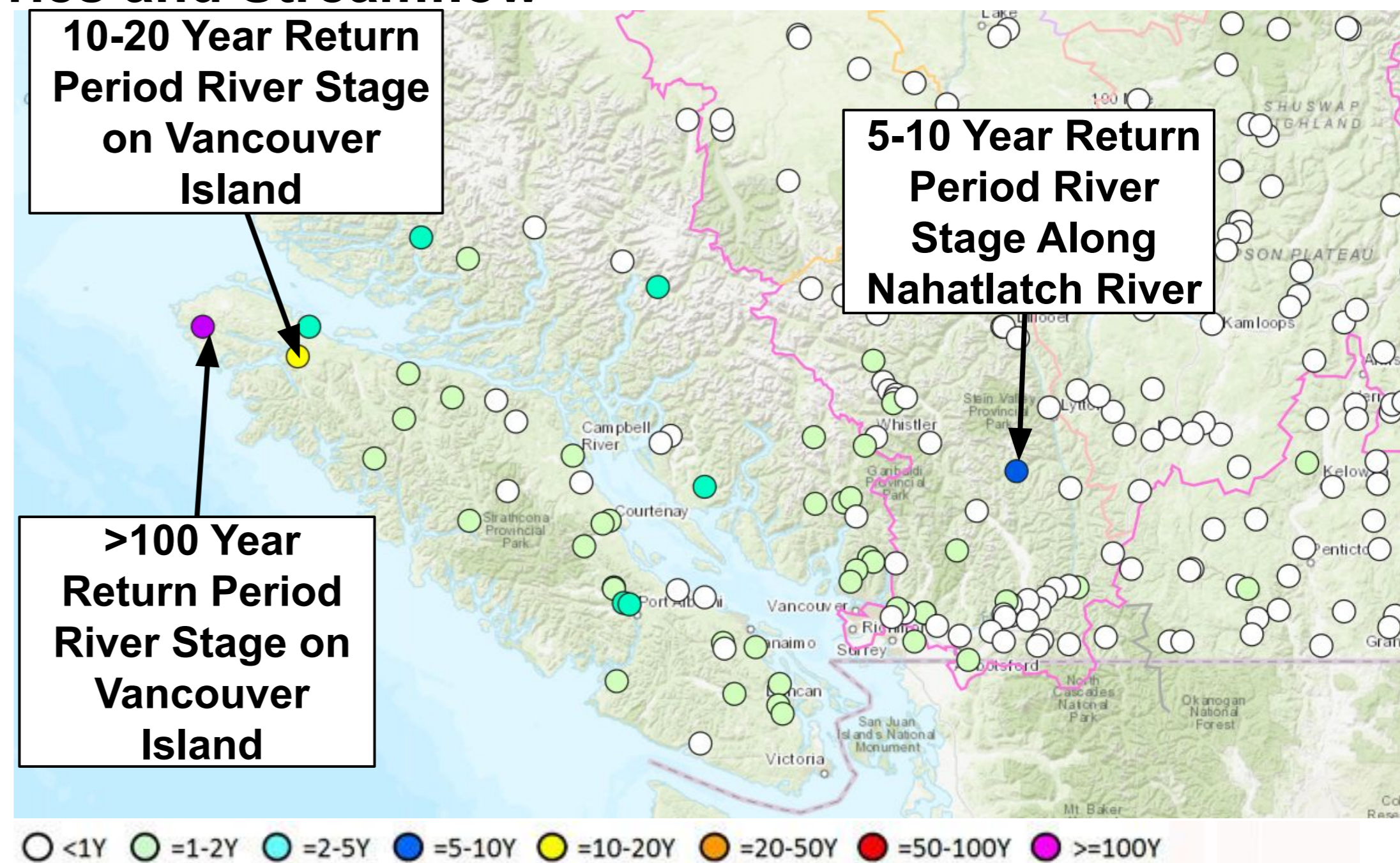
BC Flood Advisory and Warning Notifications - Major Basin

- Flood Watch
- High Streamflow Advisory



Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCAN, Parks Canada, Esri, USGS

River Forecast Centre
© Province of British Columbia

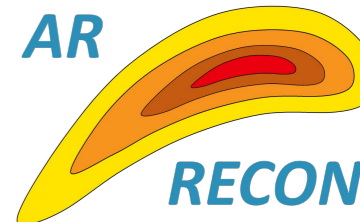


○ <1Y ● =1-2Y ● =2-5Y ● =5-10Y ● =10-20Y ● =20-50Y ● =50-100Y ● >=100Y

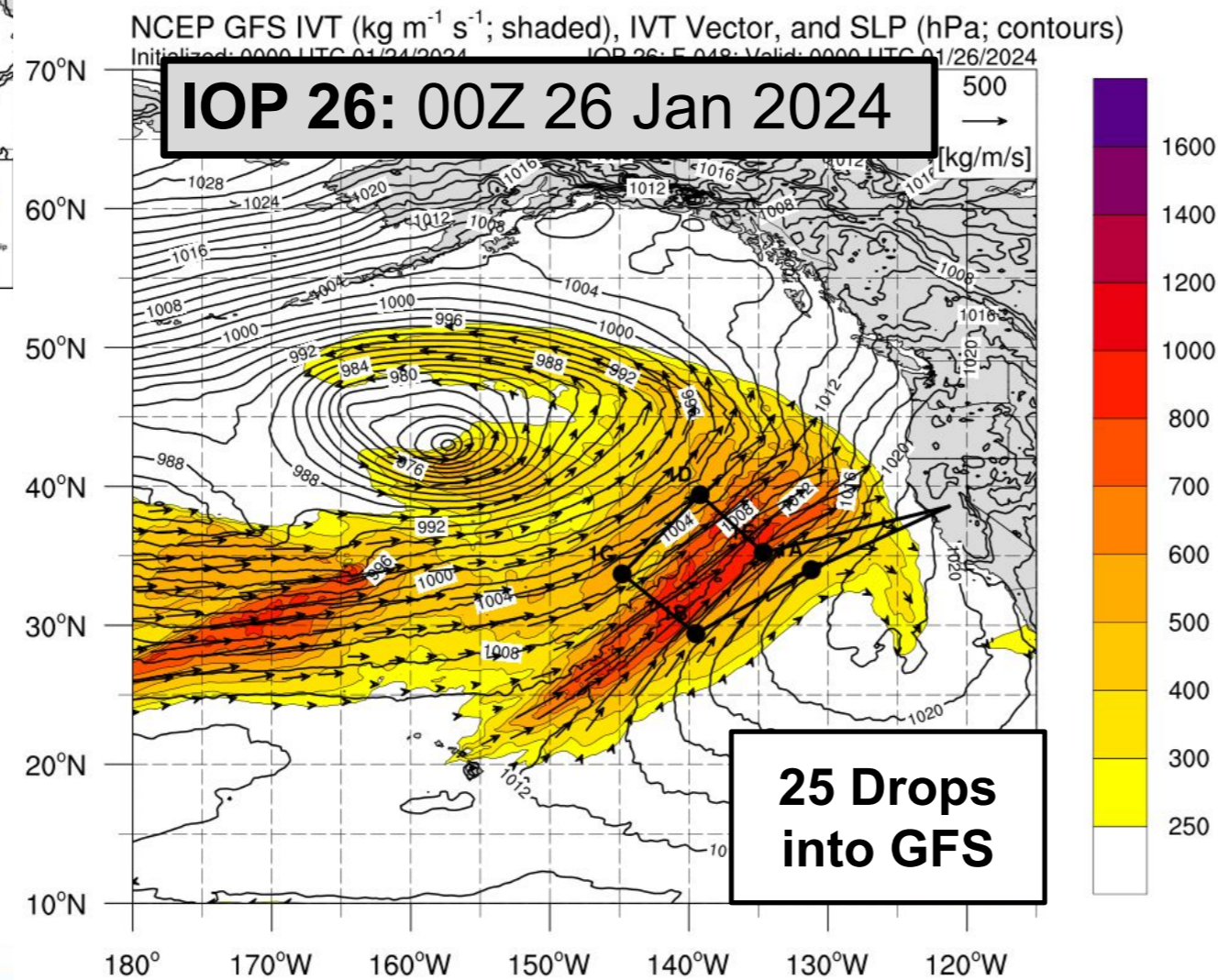
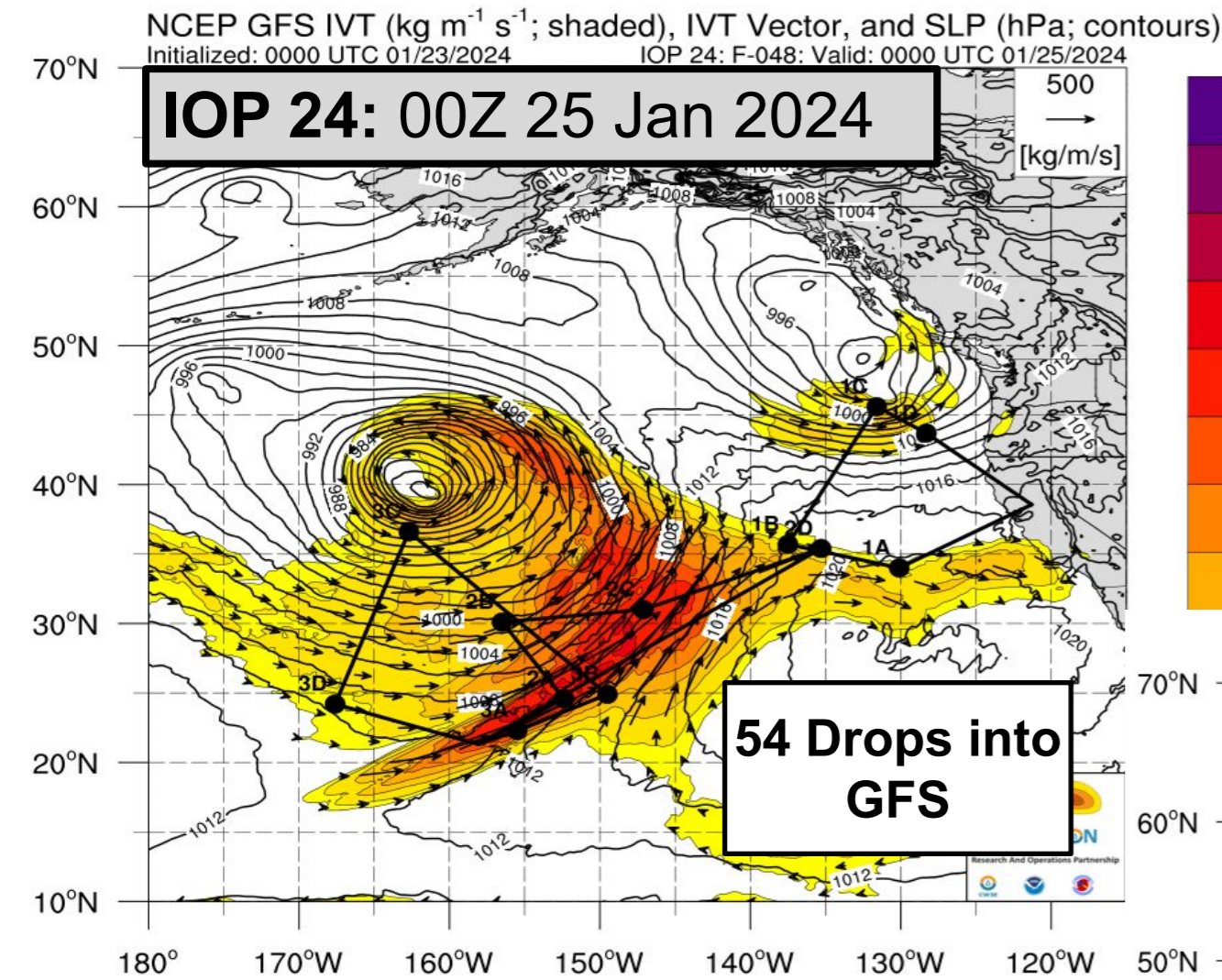
- The **second** and **third** ARs are forecast to potentially bring > 10 inches of precipitation to British Columbia. As a result the British Columbia River Forecast Center has issued a Flood Watch for Vancouver Island, the South Coast and Fraser Valley.
- Their CLEVER model 10-day river forecasts highlight several stations in Southern British Columbia to see streamflow of 1-2 year and 2-5 year return periods.
- Streamflow at three stations is forecast to exceed: a 5-10 year return period inland along the Nahatlach River, a 10-20 year return period on Vancouver Island along the Marble River, and a >100 year period on Vancouver Island along the San Josef River.

CW3E AR Outlook: 26 Jan 2024

Current AR Recon Flight Sequence



Research And Operations Partnership



- 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) and Honolulu, HI (NOAA G-IV and AF C-130).
- The flight sequence has allowed for sampling of each AR that was forecast to impact the USWC.
- Additional flights have been planned in this sequence to continue sampling the series of ARs as they progress through the Northeast Pacific.