

# CW3E Atmospheric River Outlook: 29 Jan 2024

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## Pair of Strong ARs Forecast to Bring Heavy Precipitation to USWC

An active weather pattern for the US West Coast is forecast to continue through Fri 2 Feb as two more strong ARs make landfall along the USWC.

The **first AR** made landfall late 28 Sun Jan into British Columbia and the PNW. A second pulse of IVT associated with this system continues AR conditions in the PNW through Tue 30 Jan.

The **second AR** is forecast to make landfall across the USWC later on Tue 30 Jan and progress down the USWC through Fri 2 Feb.

There is likely development of a ridge over the Northeast Pacific following the second AR, leading to a break in AR conditions for the USWC.

**Both ARs** are forecast to bring precipitation to the USWC, with the heaviest rainfall expected from the **second AR** over Northern CA and heavy snowfall over the Sierra Nevada.

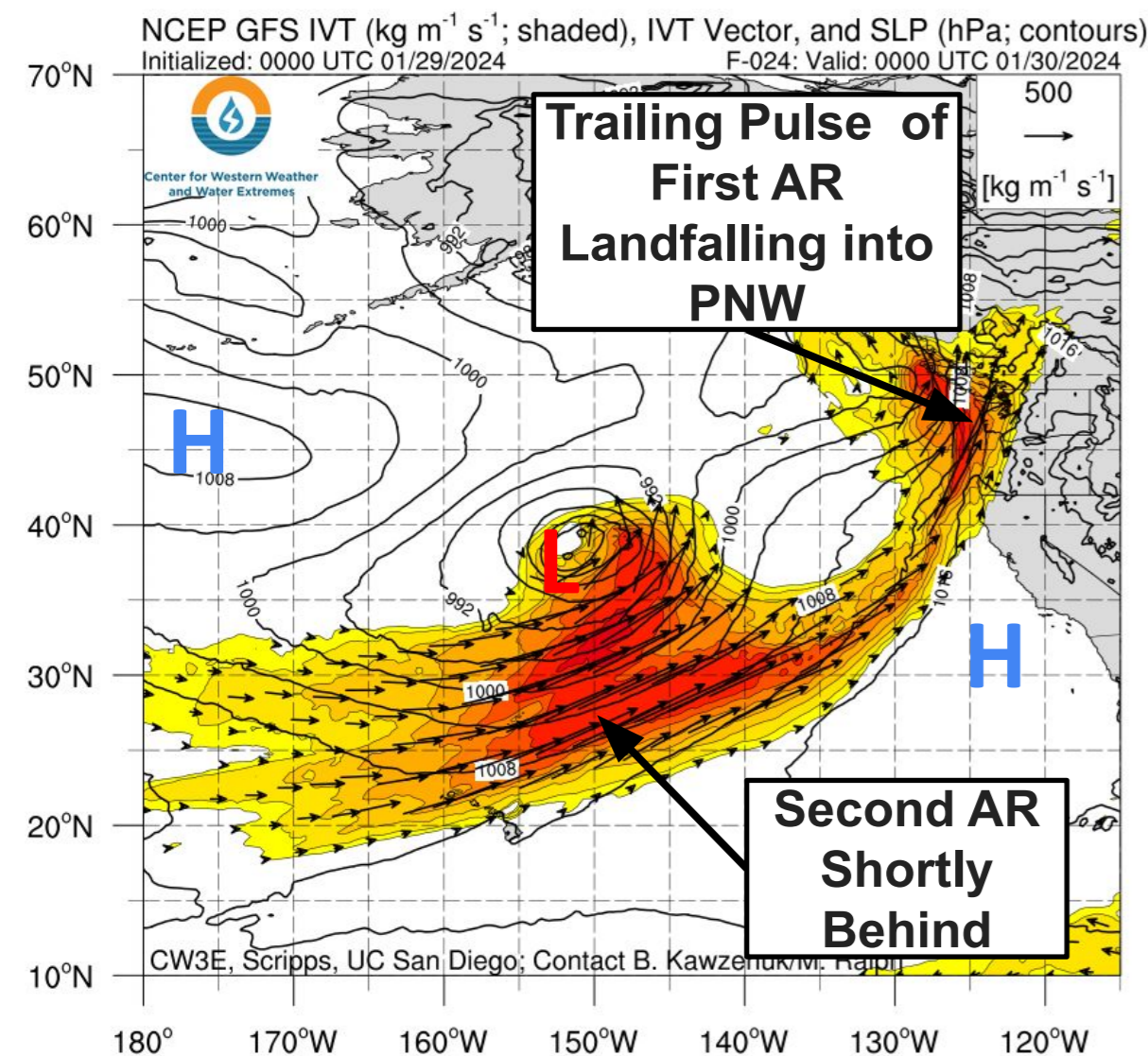
The WPC Excessive Rainfall Outlook indicates a Slight Risk (level 2 of 4, or at least 15% chance) for flash flooding in Northern CA for the 24-hour period ending 4 AM PT Thu 1 Feb and in Southern CA for the 24-hour period ending 4 AM PT Fri 2 Feb with the **second AR**.

Although there is potential for flooding in areas discussed in this outlook, the forecasts are not predicting anything in the magnitude of the ARkStorm scenarios developed by Porter et al., 2011 or Huang et. al., 2022.

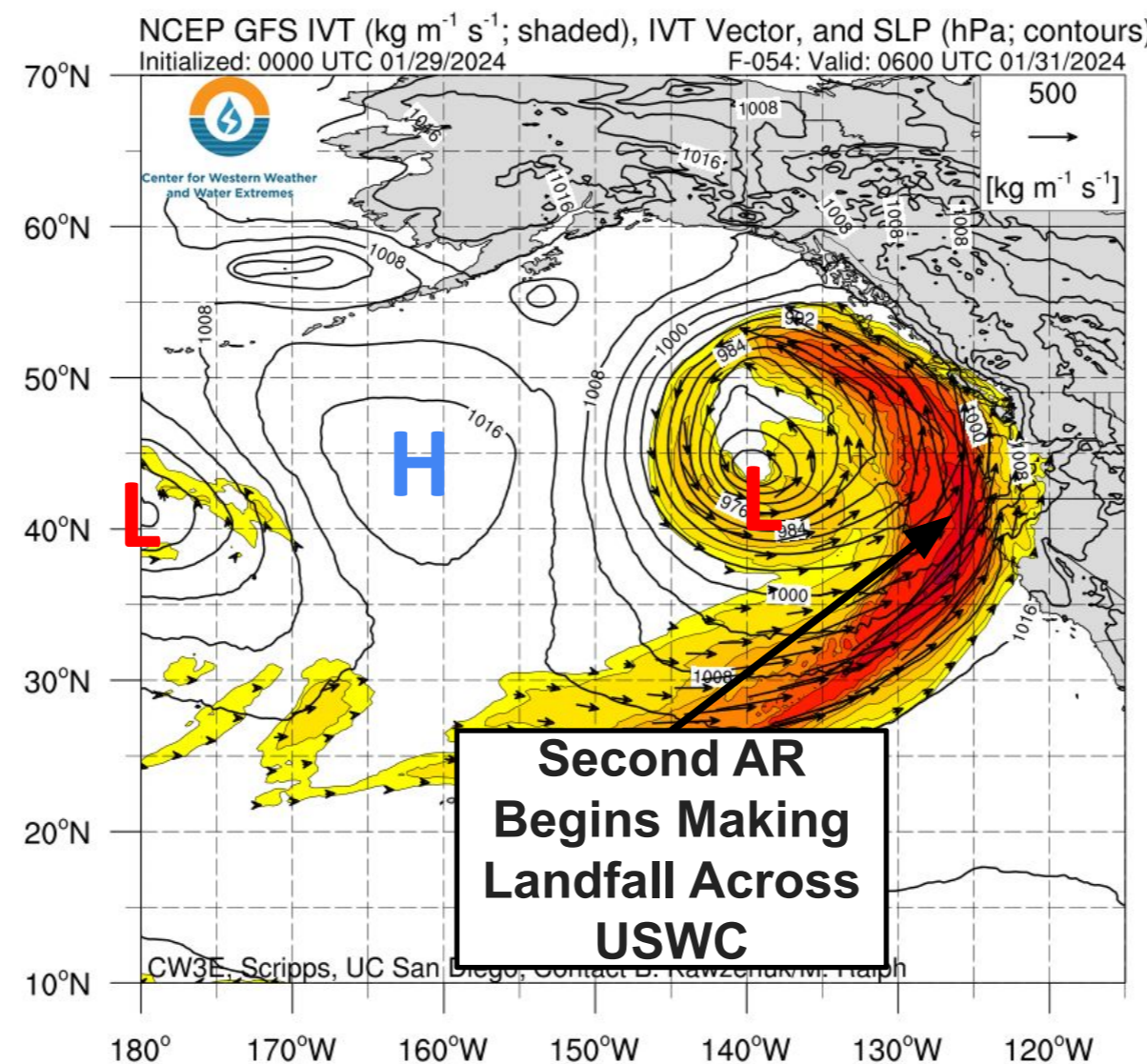
# CW3E AR Outlook: 29 Jan 2024

GFS Init 0Z Mon 29 Jan 2024

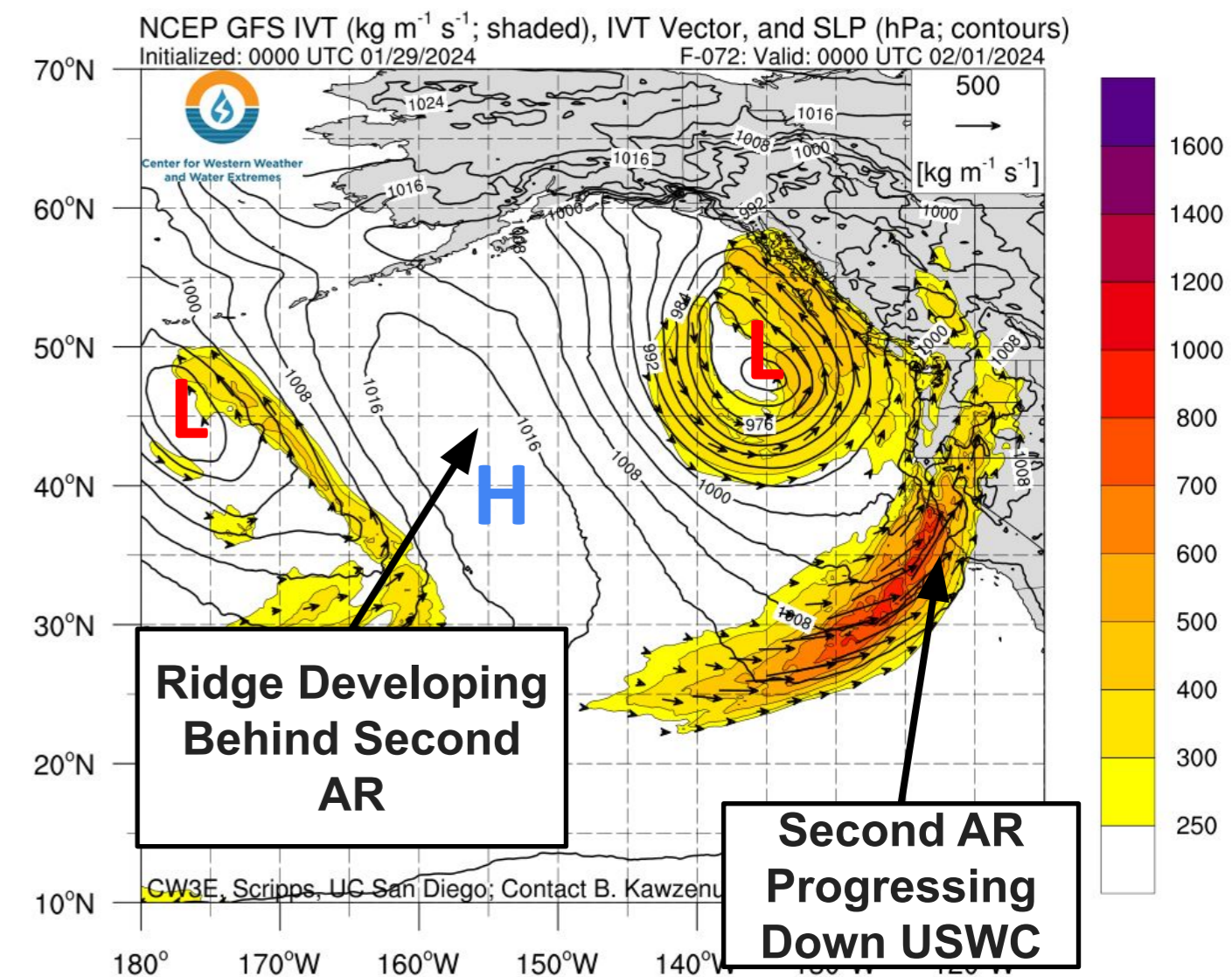
4PM PT Mon 29 Jan 2024



10PM PT Tue 30 Jan 2024



4PM PT Wed 31 Jan 2024

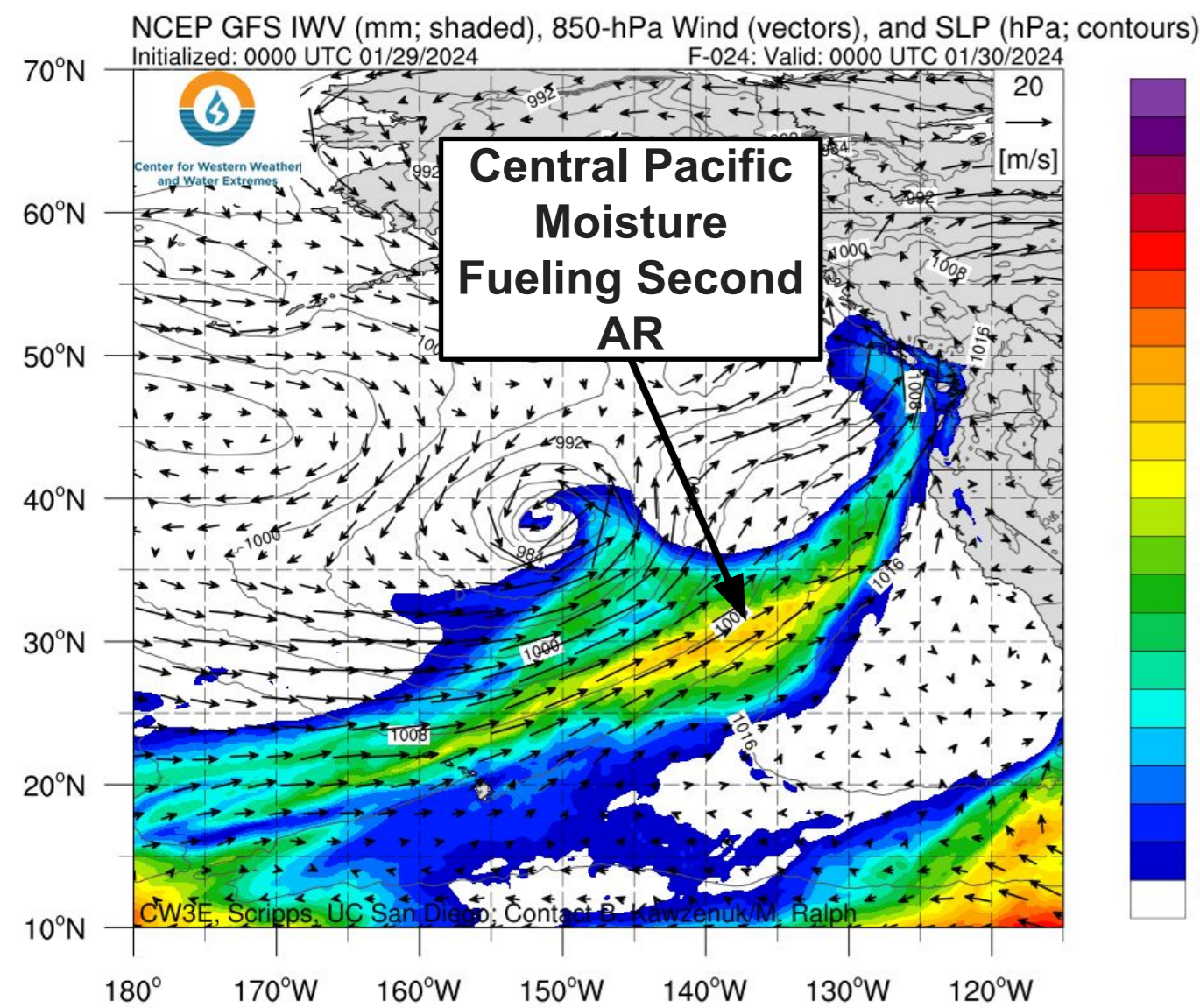


- The first AR made landfall late Sun 28 Jan, with the core of the AR positioned primarily over British Columbia. (*not shown*)
- There is forecast to be a secondary trailing pulse of IVT into the PNW on Mon 29 Jan continuing AR conditions in the PNW.
- The second, stronger AR and low pressure system are forecast propagate toward the USWC as the first AR is making landfall.
- The second AR makes landfall across the USWC on Tue 30 Jan, eventually progressing down the USWC through Fri 2 Feb.

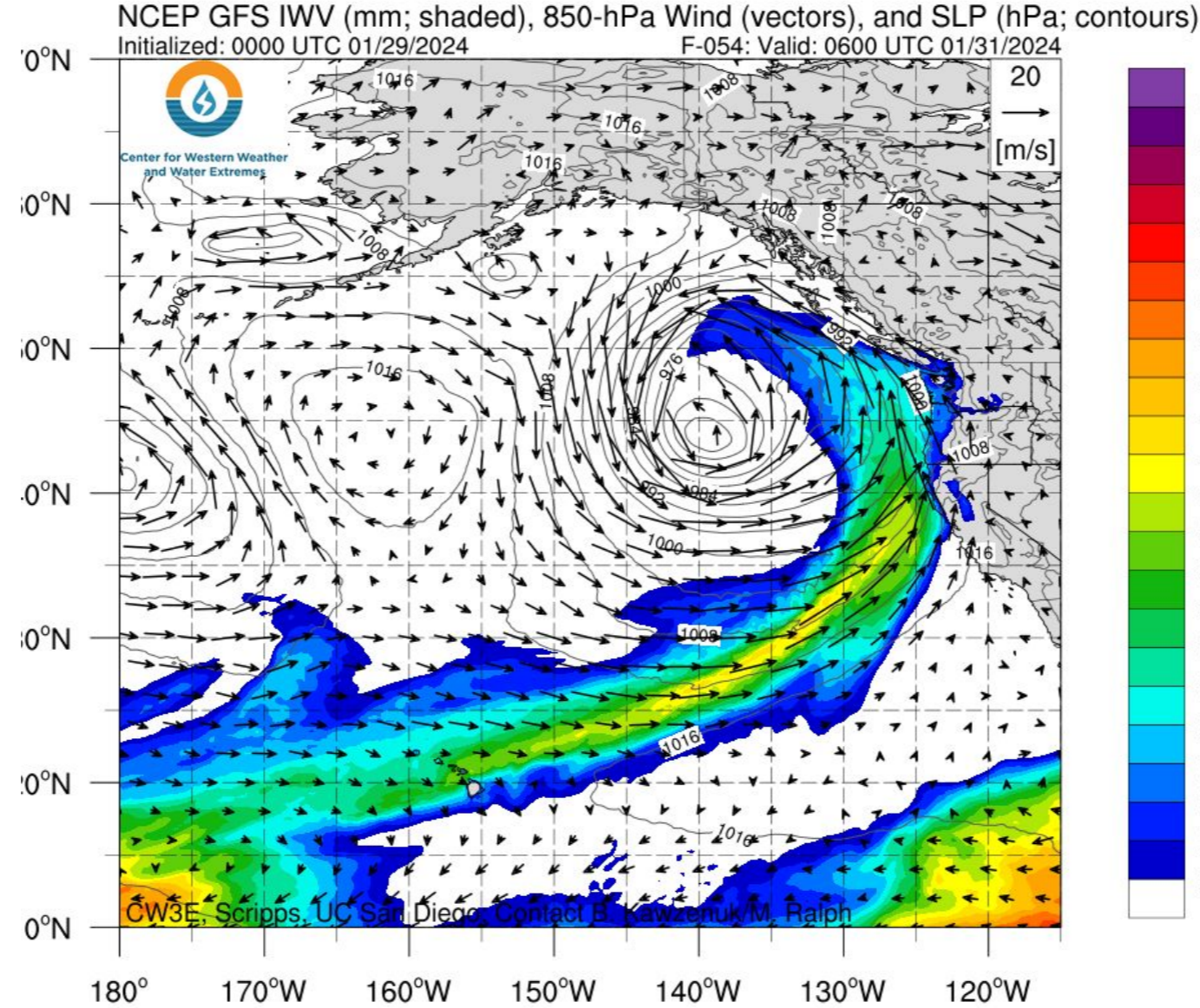
# CW3E AR Outlook: 29 Jan 2024

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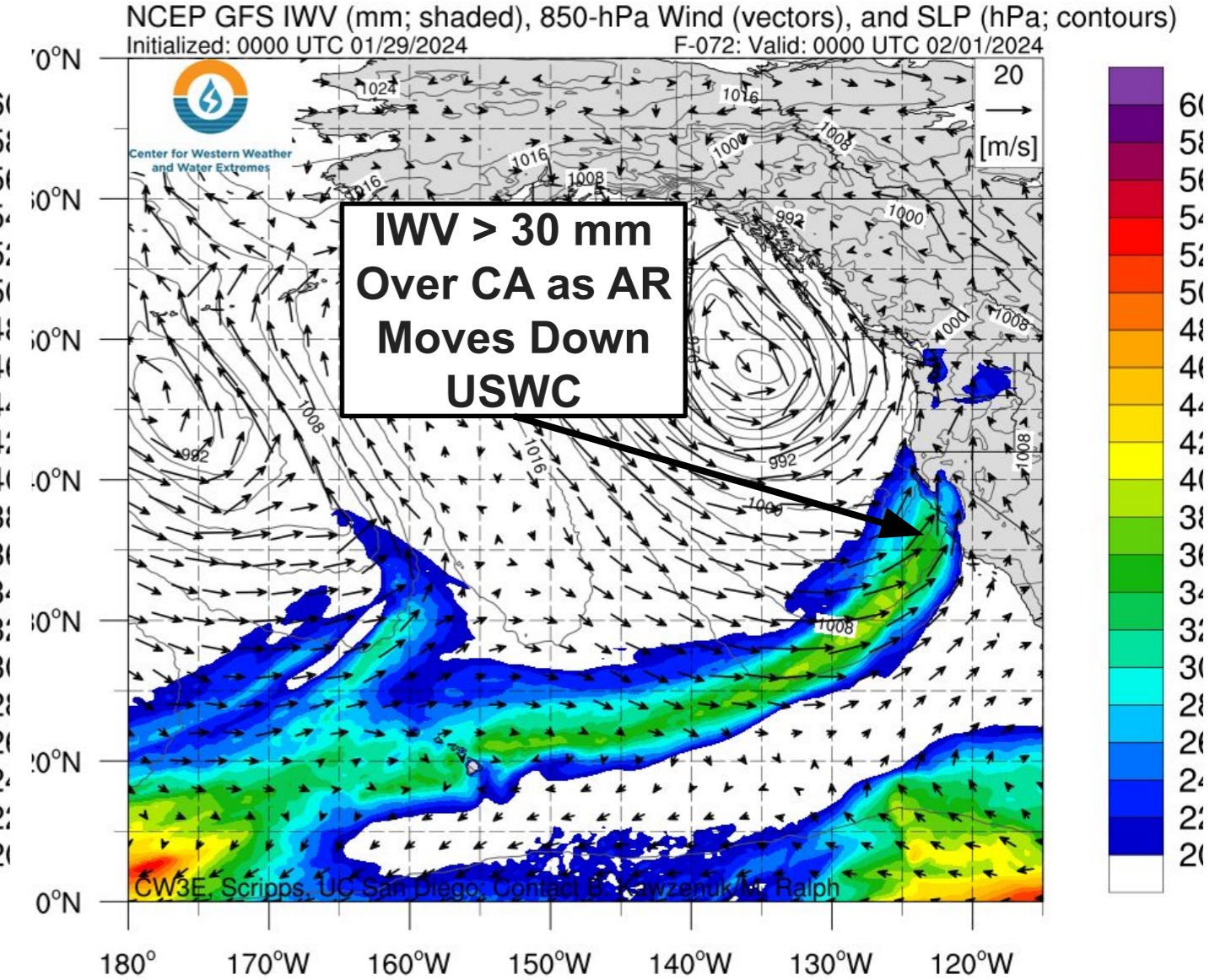
4PM PT Mon 29 Jan 2024



10PM PT Tue 30 Jan 2024

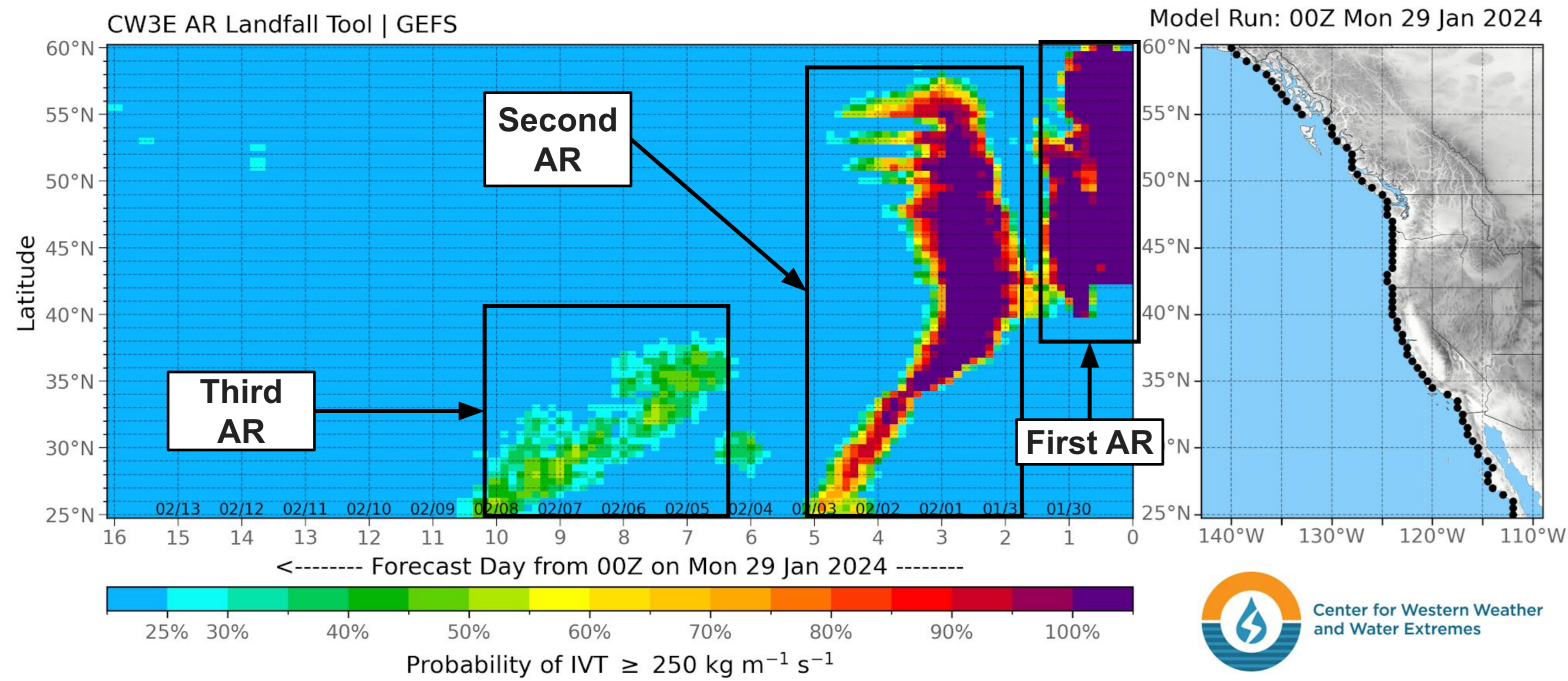


4PM PT Wed 31 Jan 2024



- The two landfalling ARs at the end of this sequence are fueled by tropical moisture from the Central Pacific.
- As the second AR makes landfall and moves down the coast, it brings IWV values > 30 mm over CA for an extended period of time, helping the drive heavy precipitation across the state.

# CW3E AR Outlook: 29 Jan 2024



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

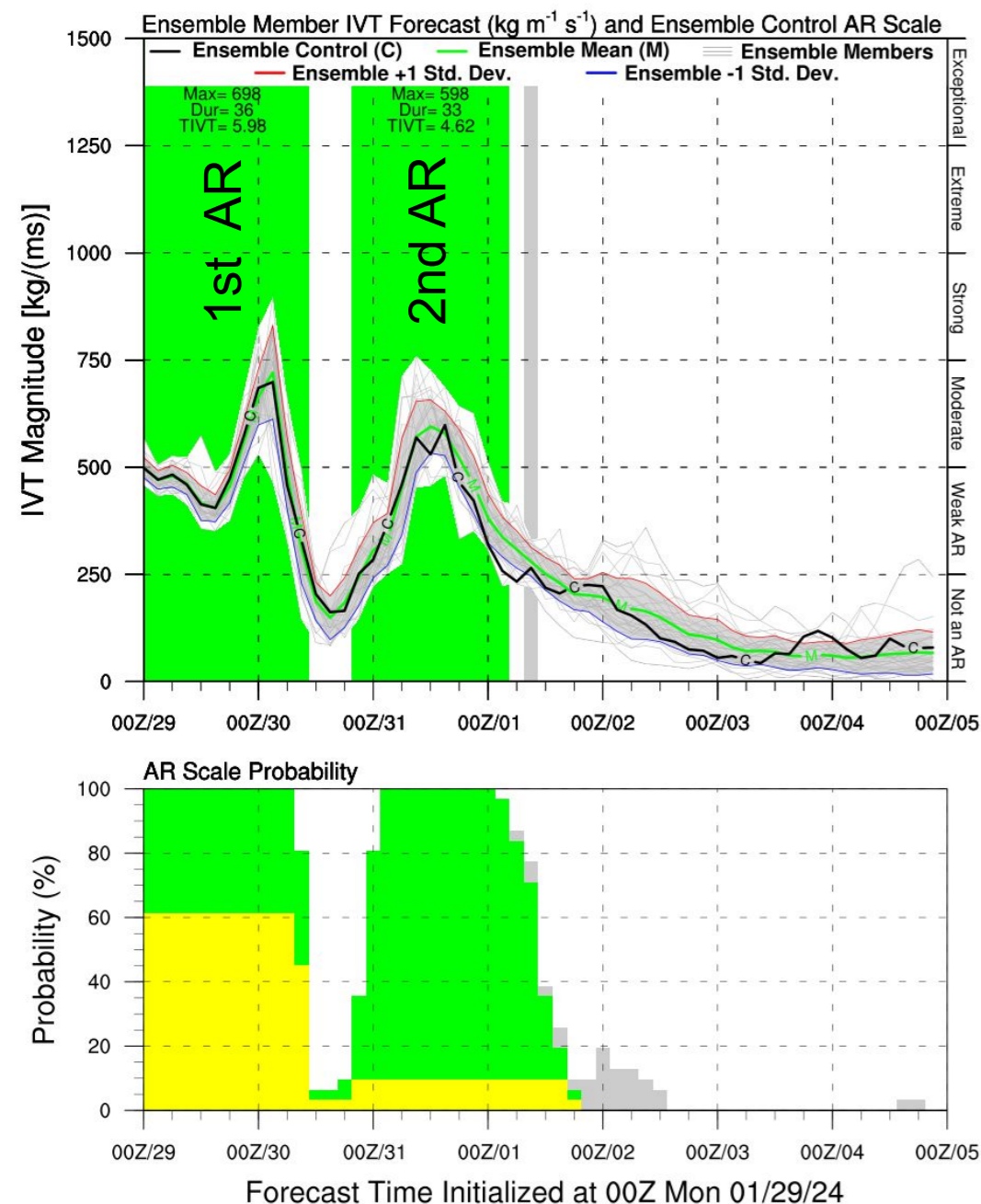
- The GEFS is showing very high confidence (>95%) in  $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$  making landfall along the USWC with both the first and second ARs.
- The GEFS is also quite confident (> 80% probability) in the second AR progressing down the USWC into the Baja Peninsula through Fri 2 Feb.
- There is a lower (40%) probability of  $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$  making landfall over Southern California Later in the period from Sun 4 Feb through Mon 5 Feb.

# CW3E AR Outlook: 29 Jan 2024

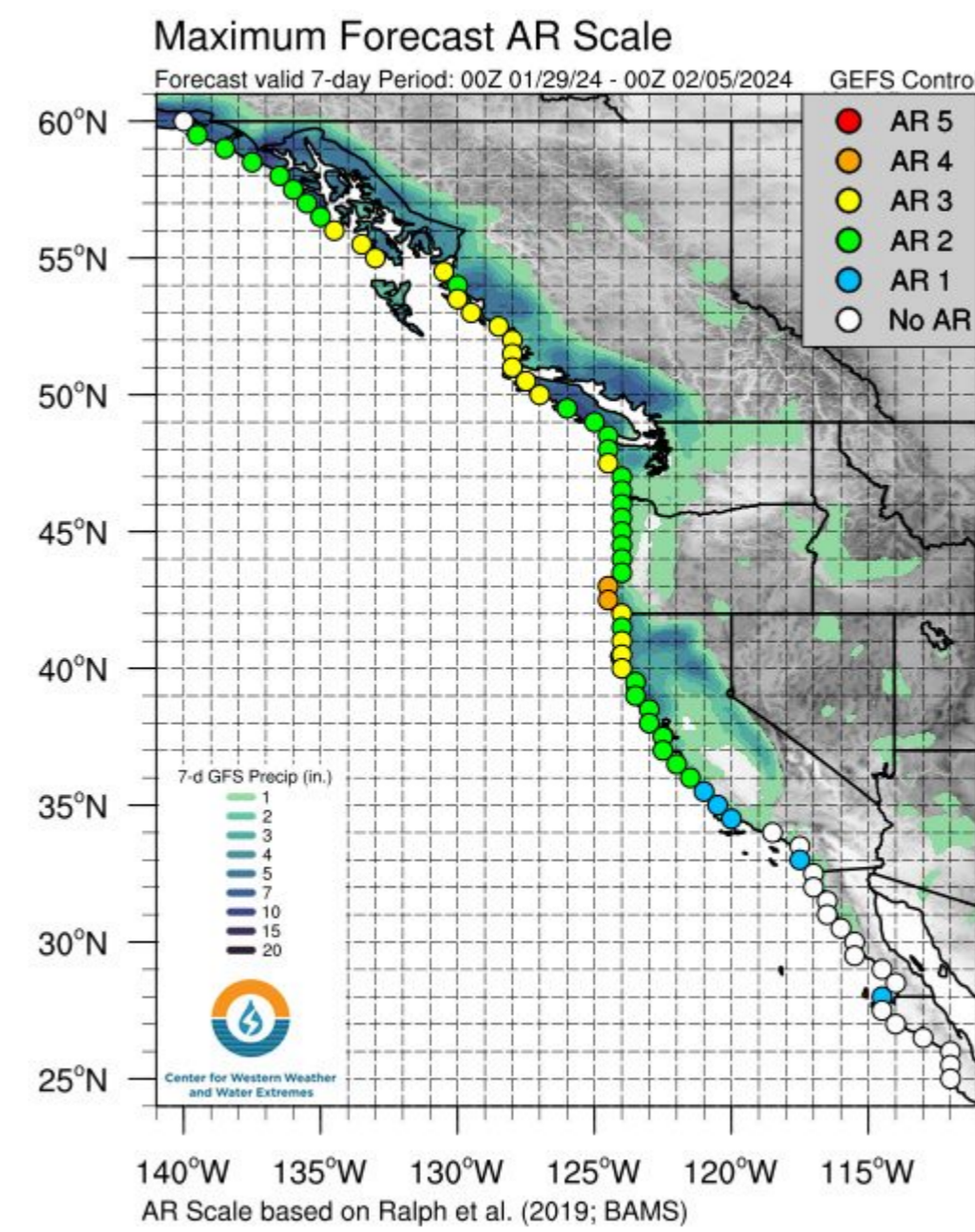
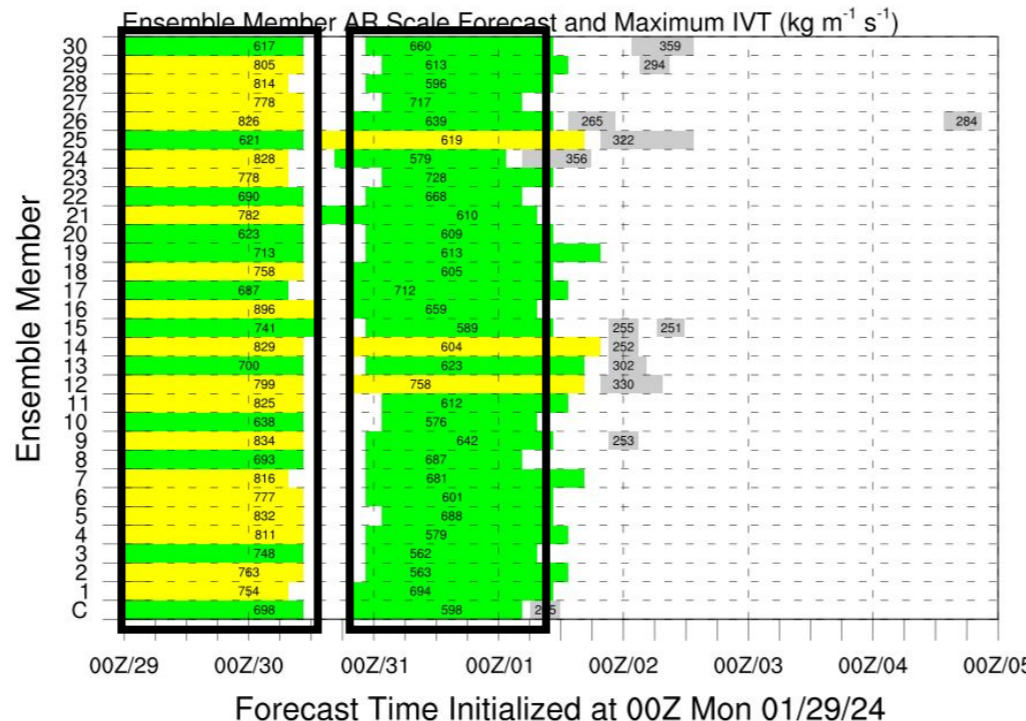
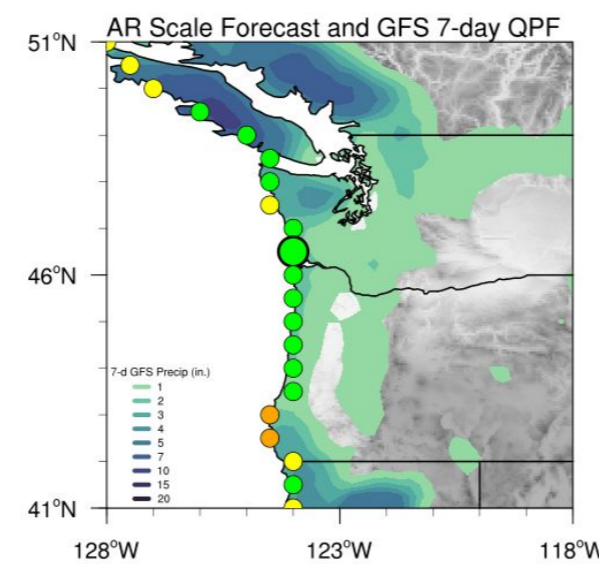
## GEFS 7-day AR Scale and IVT Forecast

GFS Ensemble Initialized: 00Z Mon 01/29/24

Location: 46.5°N 124°W



Categorical AR Strength by Ralph/CW3E



- The GEFS control member is forecasting two distinct ARs for the point at 46.5° N, 124° W (WA/OR Border) during the next 4 days.
- 31/31 (100%) GEFS ensemble members are forecasting at least AR2 conditions during **each AR period** for Jan 29-Feb 1.
- 20/31 (65%) GEFS ensemble members are forecasting at least AR3 conditions during **either AR period** for Jan 29-Feb 1.
- Every forecast member is forecasting a break in AR conditions between the first and second ARs.



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

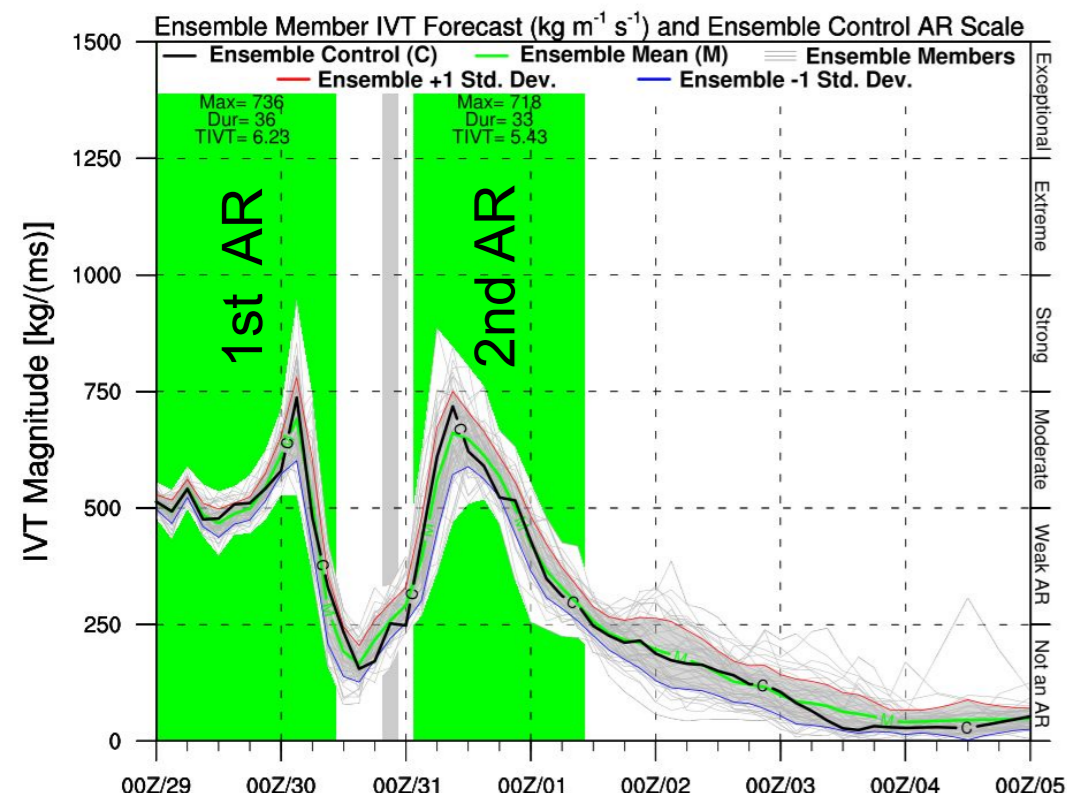


# CW3E AR Outlook: 29 Jan 2024

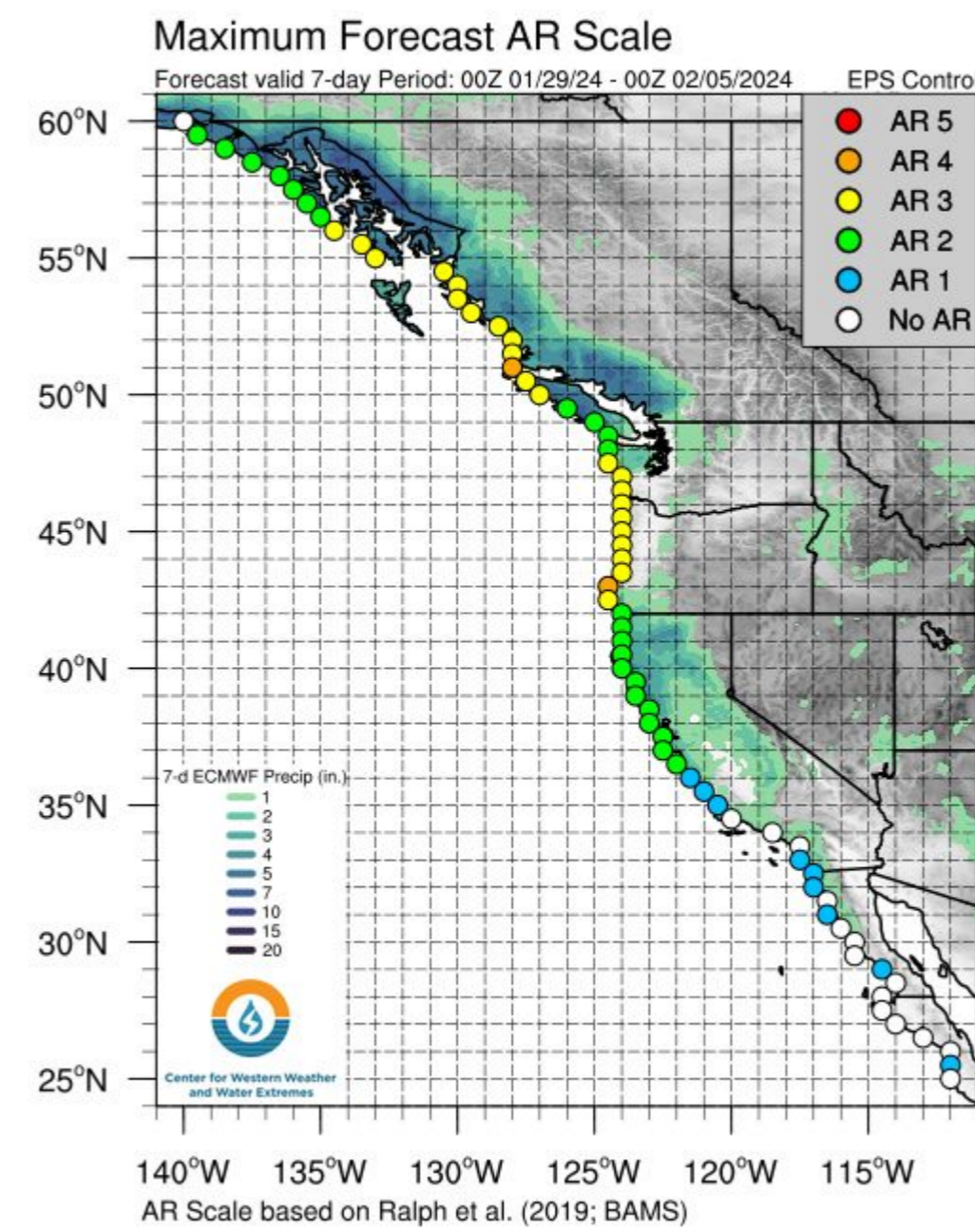
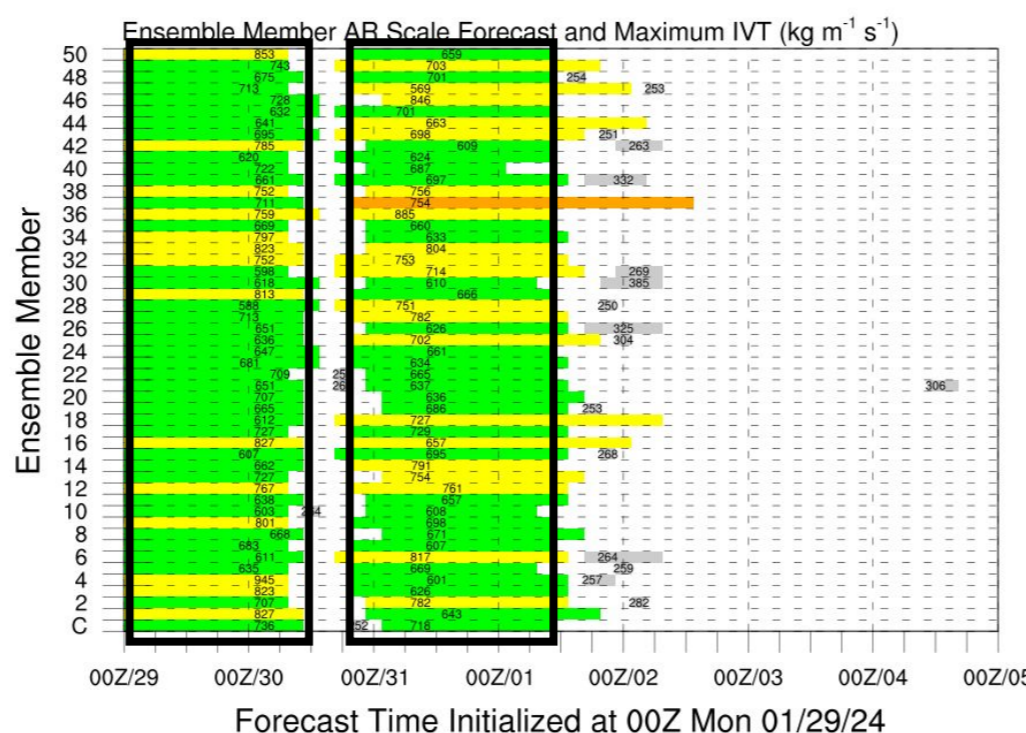
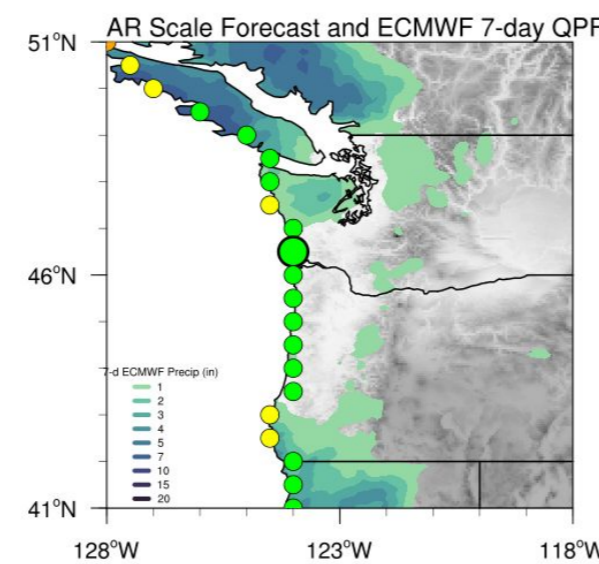
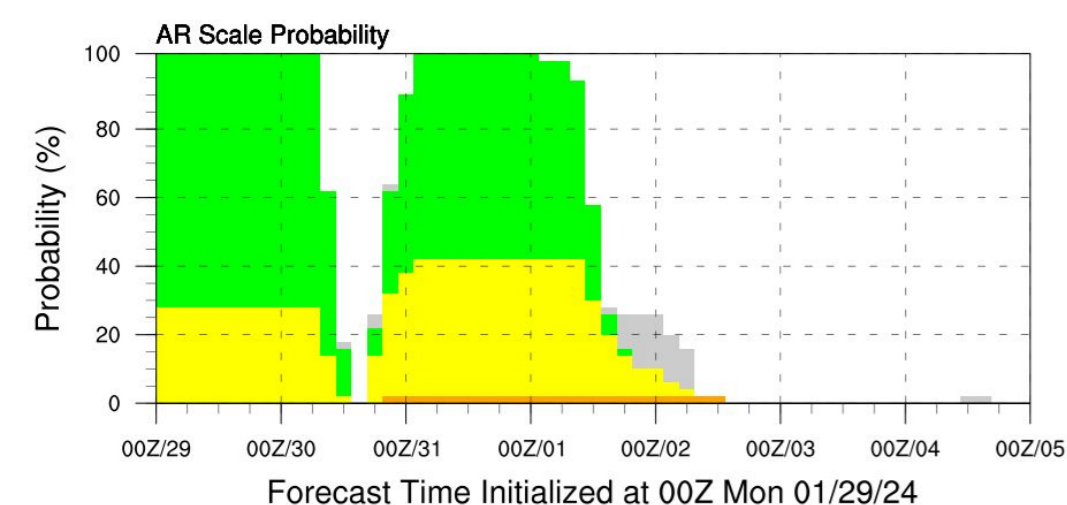
## ECMWF EPS 7-day AR Scale and IVT Forecast

ECMWF Ensemble Initialized: 00Z Mon 01/29/24

Location: 46.5°N 124°W



Categorical AR Strength by Ralph/CW3E



- The ECMWF EPS control member is also forecasting two distinct ARs over the next 4 days for the point at 46.5° N, 124° W (WA/OR border).
- 51/51 (100%) EPS ensemble members are forecasting at least AR2 conditions during the **each AR period** for Jan 29- Feb 1.
- 29/51 (57%) EPS ensemble members are forecasting at least AR3 conditions during **either AR** for Jan 29- Feb 1.
- Similar to GEFS, every EPS member is forecasting a break in AR conditions between the first and second ARs.



AR 1 (blue), AR 2 (green), AR 3 (yellow), AR 4 (orange), AR 5 (red)

Image created: 09 UTC 01/29/2024

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

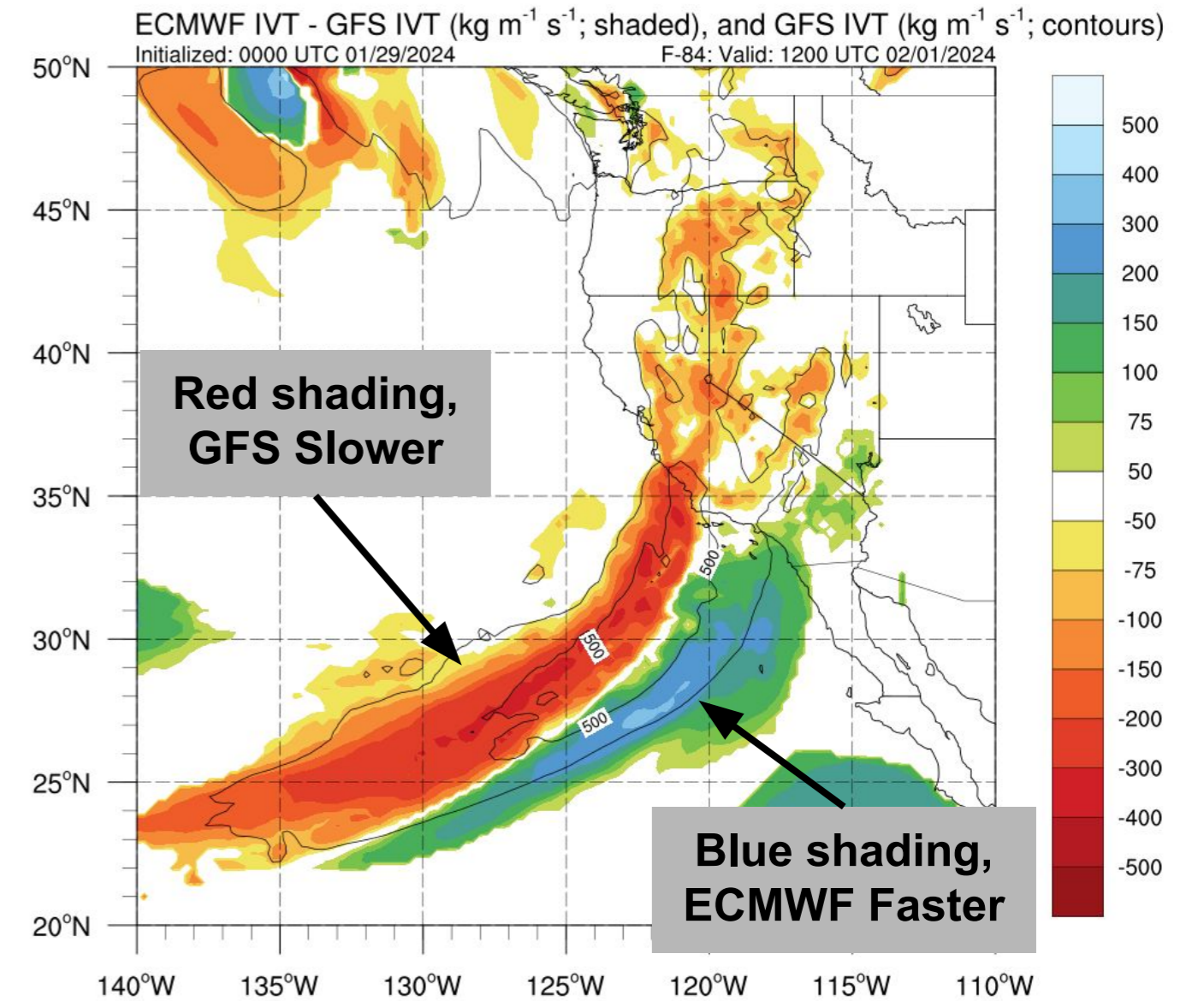
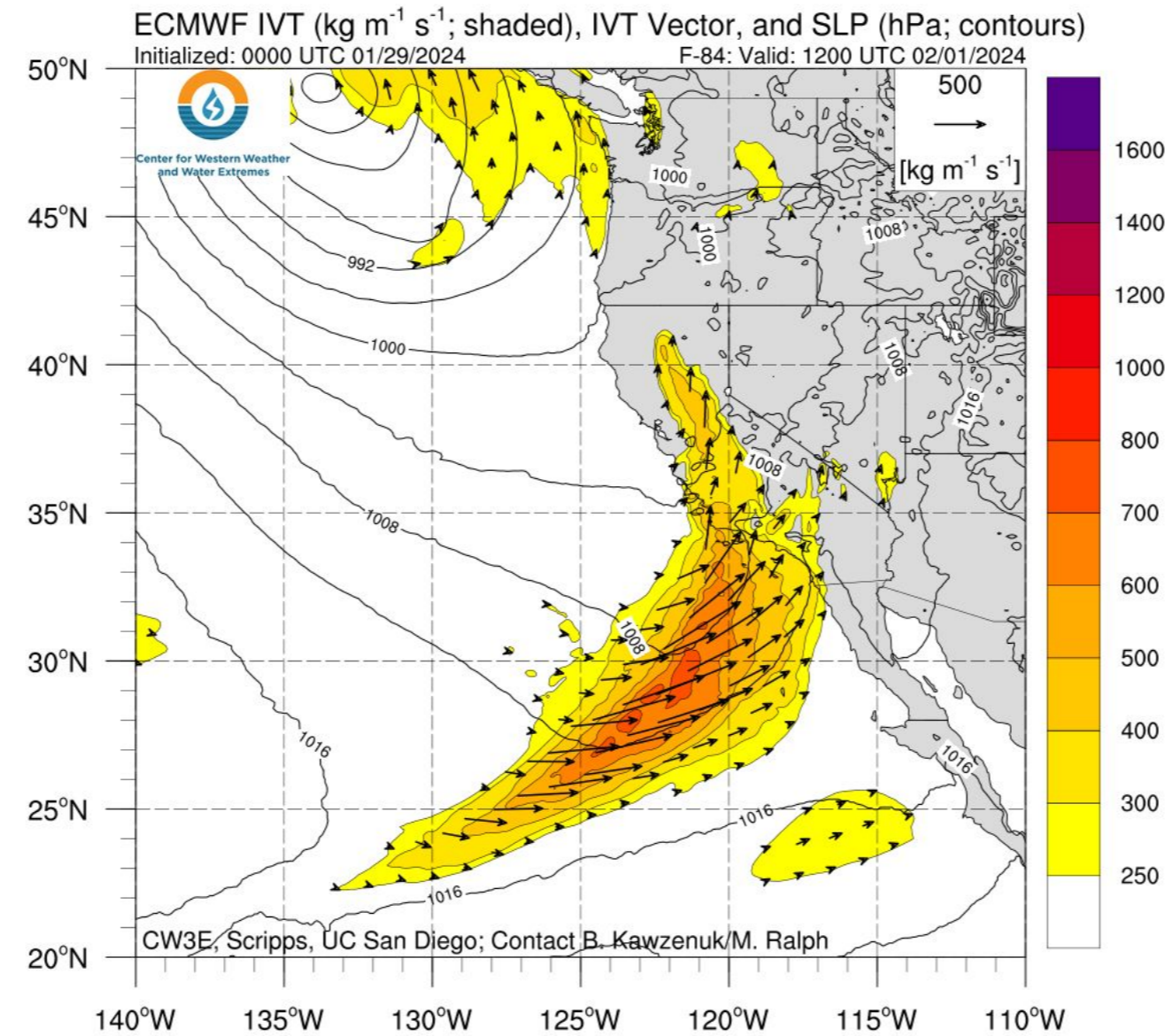
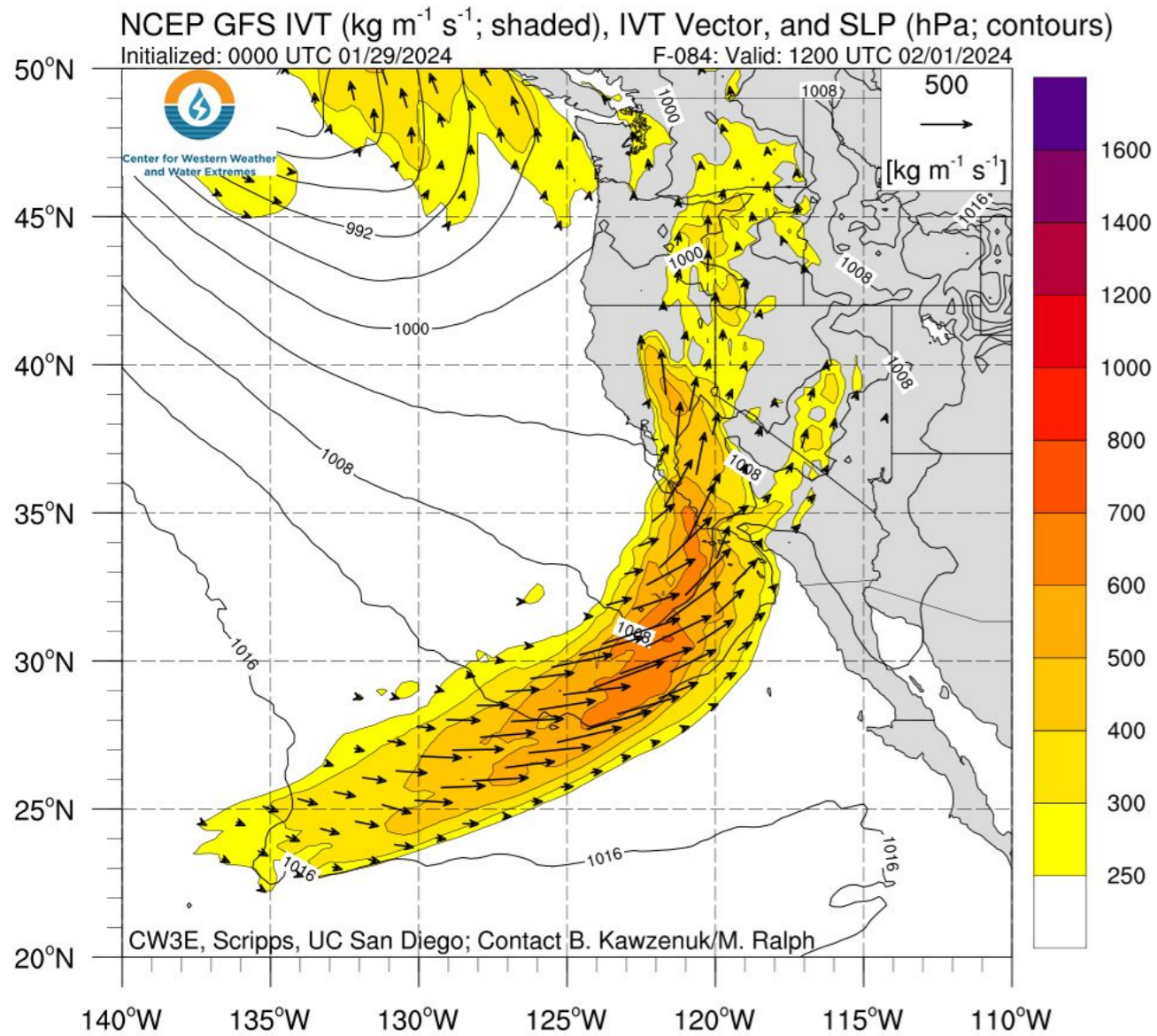
# CW3E AR Outlook: 29 Jan 2024

## Model Comparison; Valid 4 AM PT Thu Feb 1

### 00Z 29 Jan GFS IVT

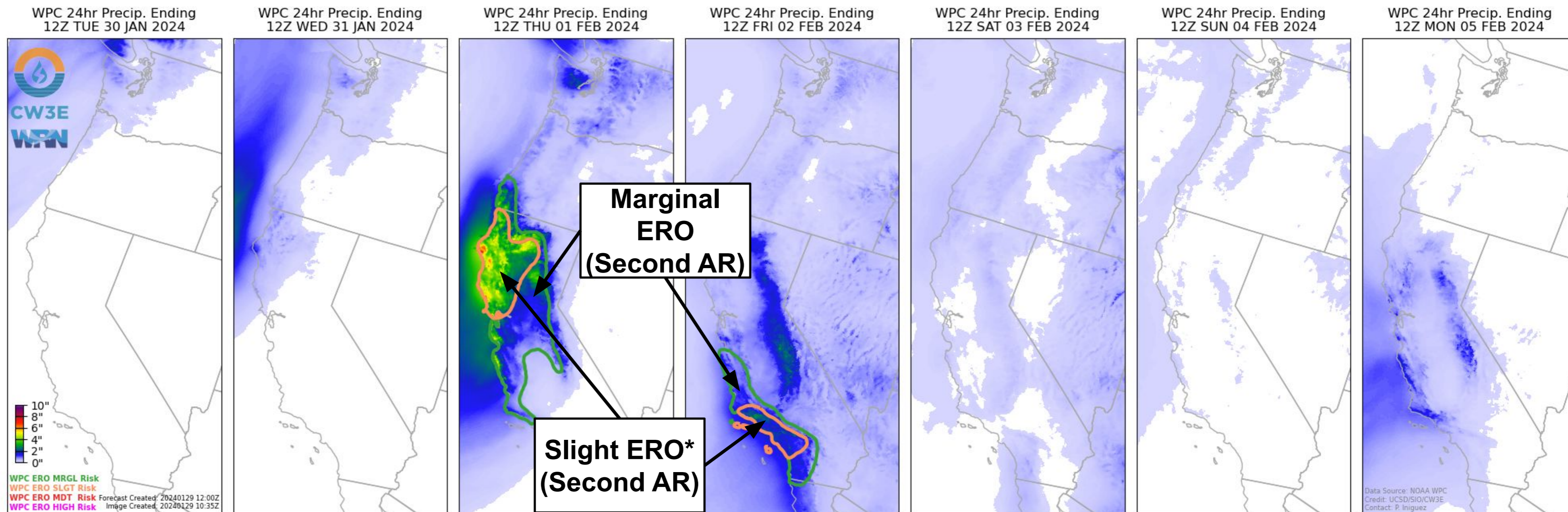
### 00Z 29 Jan ECMWF IVT

### ECMWF IVT minus GFS IVT



- The 00Z GFS (*left*) forecasts the second AR to propagate south along California approx. 6 hours slower than the 00Z ECMWF (*center*)
- The speed at which the AR propagates down the US West Coast will influence the exact timing and duration of the precipitation within California.
- A slower moving AR (as in the GFS) means potentially longer duration AR conditions, leading to additional precipitation in California.

# CW3E AR Outlook: 29 Jan 2024



- The NWS WPC is forecasting the heaviest precipitation in the PNW for the **first** AR (24 hour period ending 4 AM PT 30 Jan) and in Northern CA with the **second** 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 in N. CA for the 24 hour period ending 4 AM PT Thu 1 Feb and S. CA for the 24 hour period ending 4 AM PT Fri 2 Feb with the **second** AR.
- Marginal Risks (level 1 of 4, or at least 5% chance) for flooding have been issued from along the coast from the CA/OR border down into S. CA and into the Sierra Nevada for the period ending 24 hour period ending 4 AM PT Thu 1 Feb and along the S. CA coast for for the 24 hour period ending 4 AM PT Fri 2 Feb with the **second** AR.

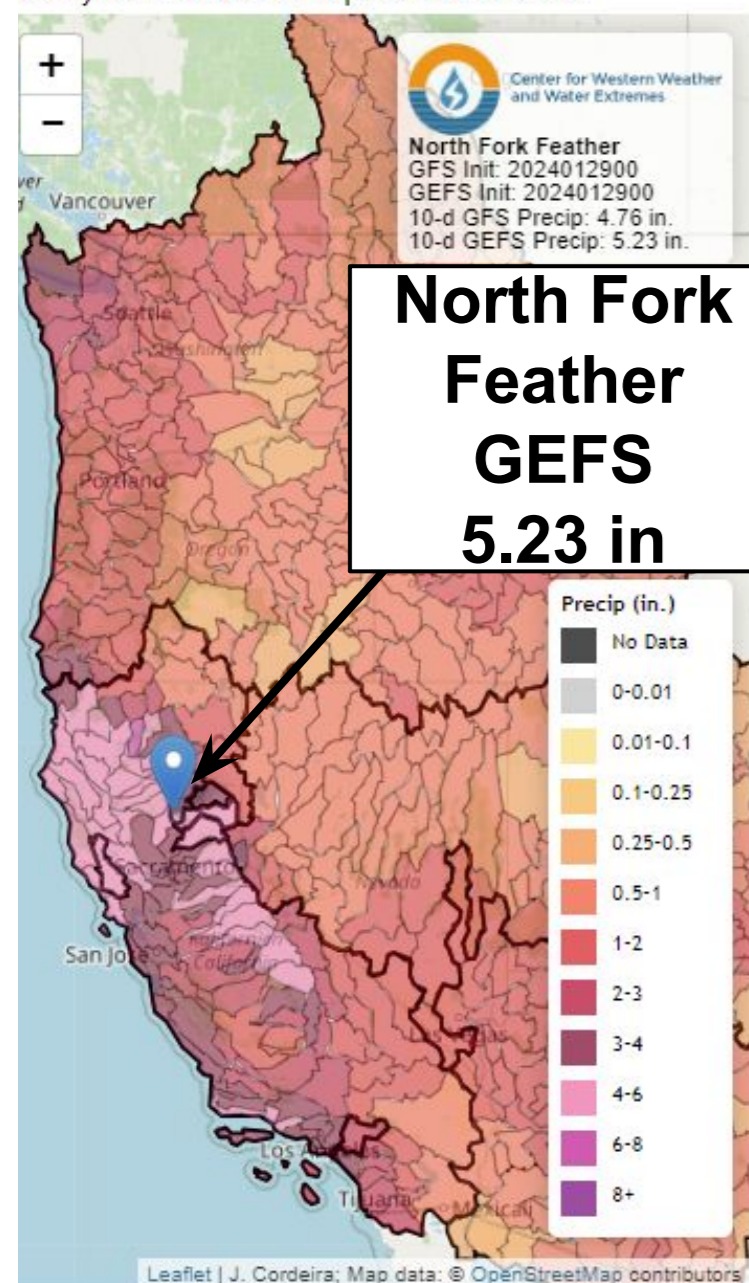
\*Excessive Rain Outlook (ERO)



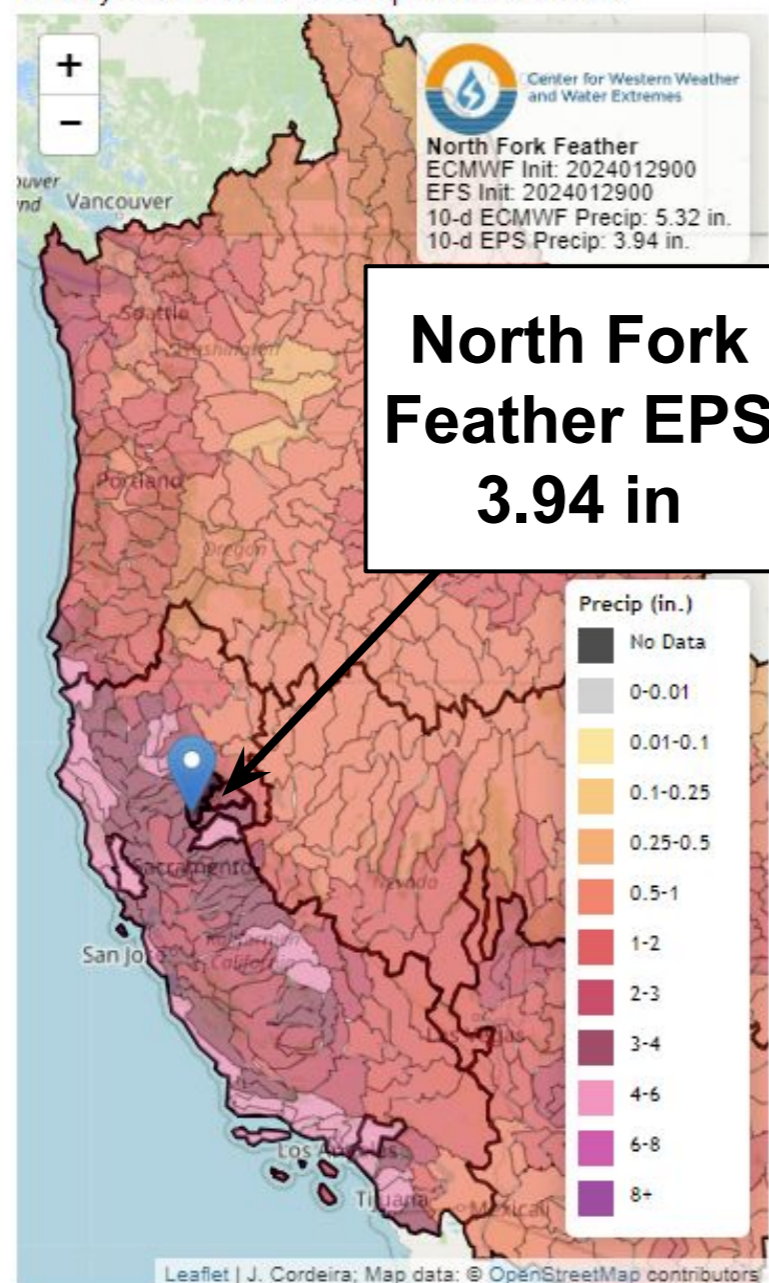
# CW3E AR Outlook: 29 Jan 2024

## 10-day Watershed Precipitation Forecasts (Initialized 00Z 29 Jan)

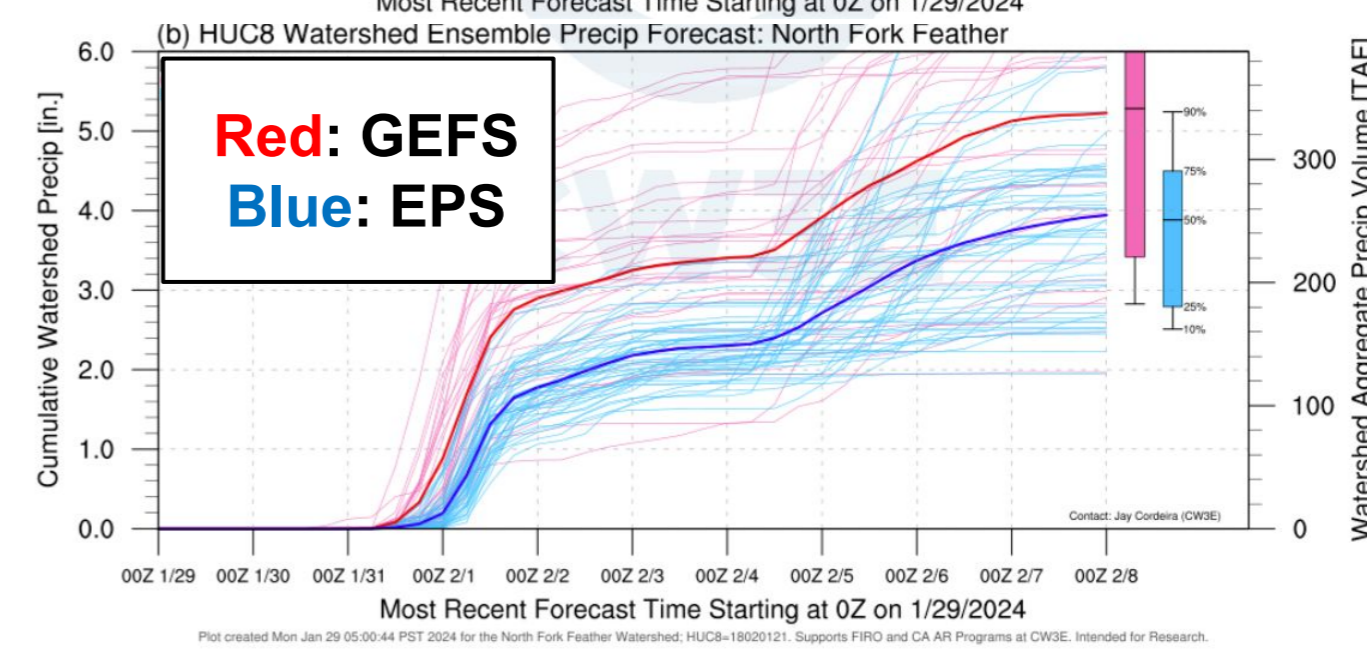
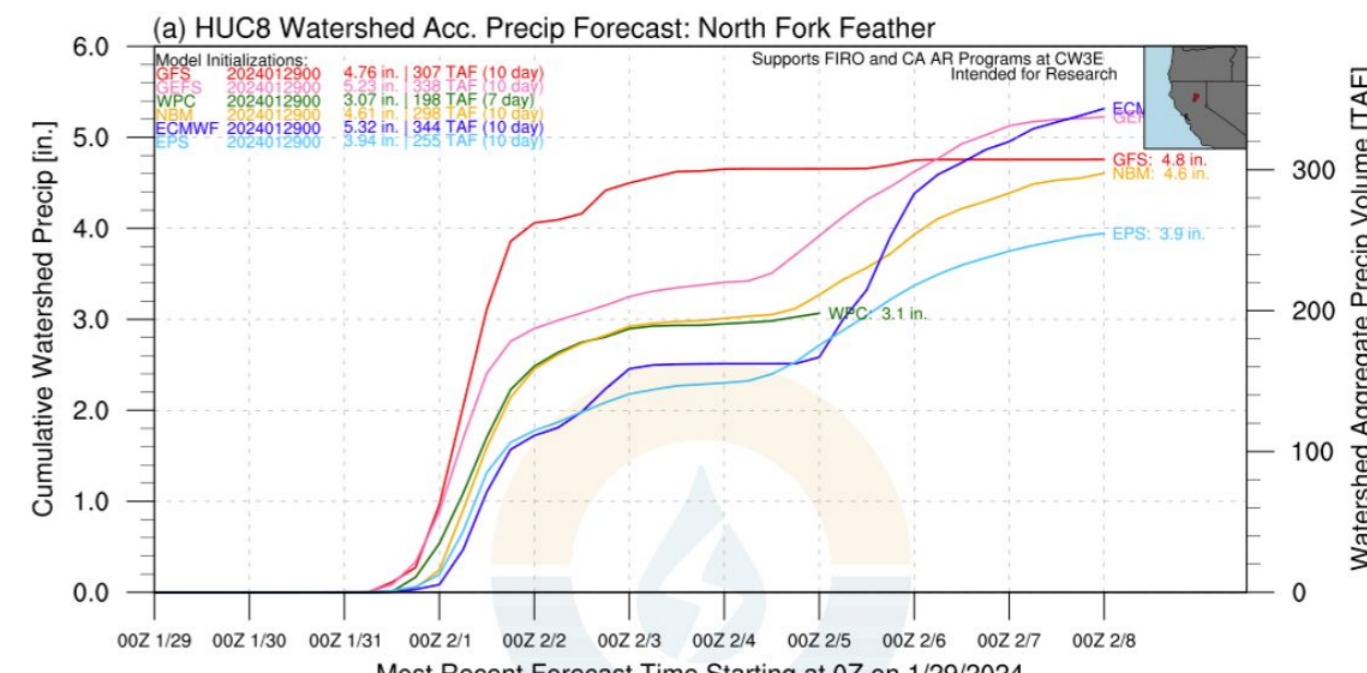
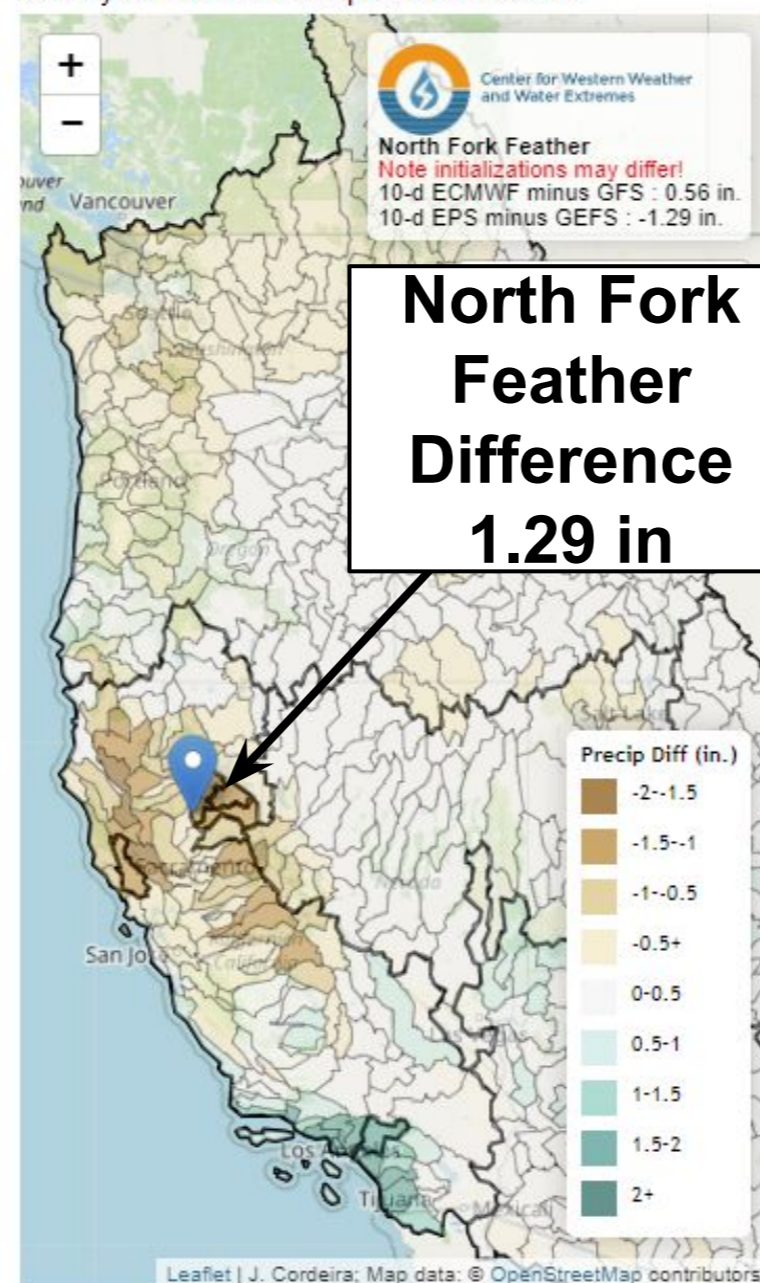
0-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast

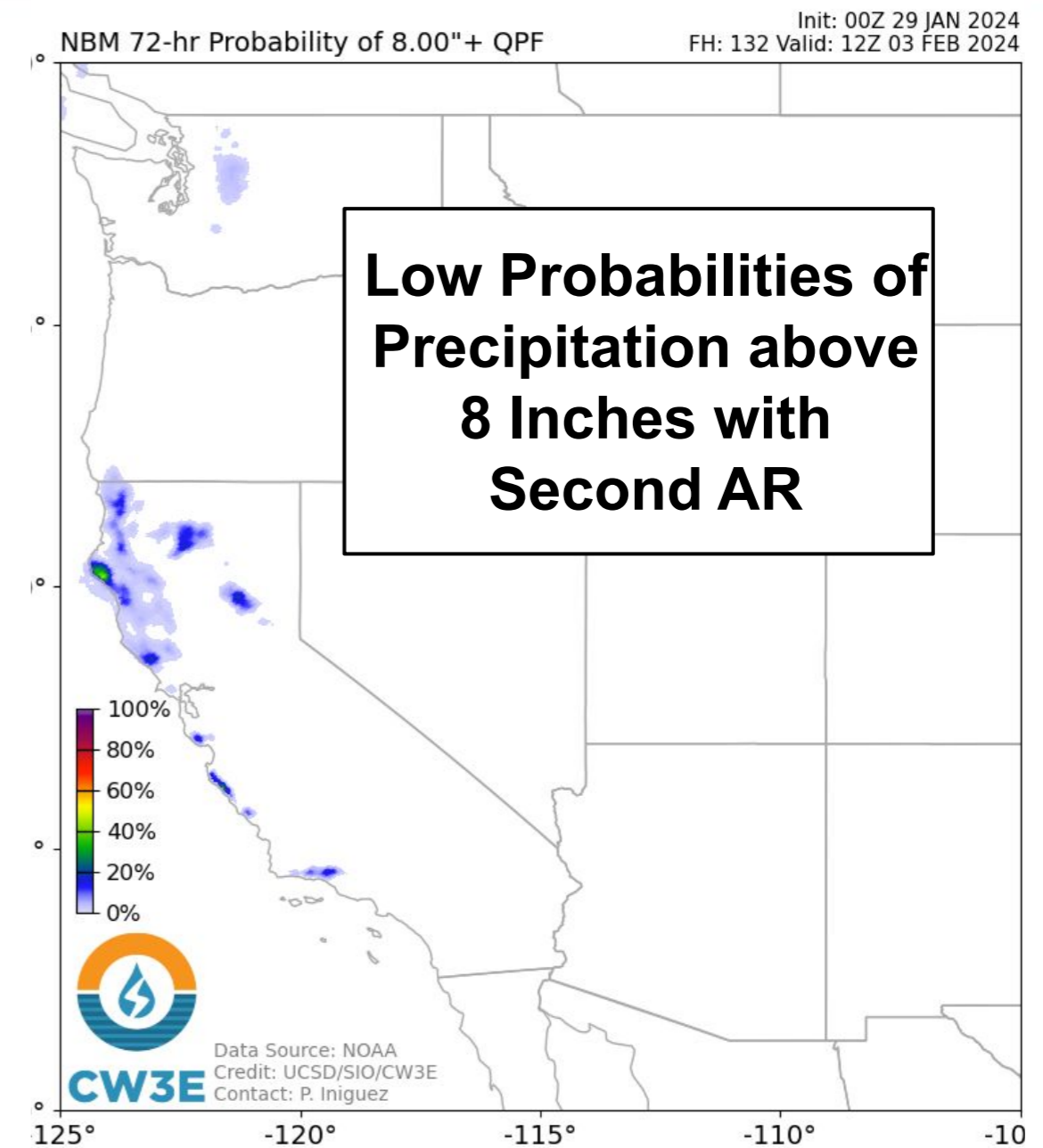
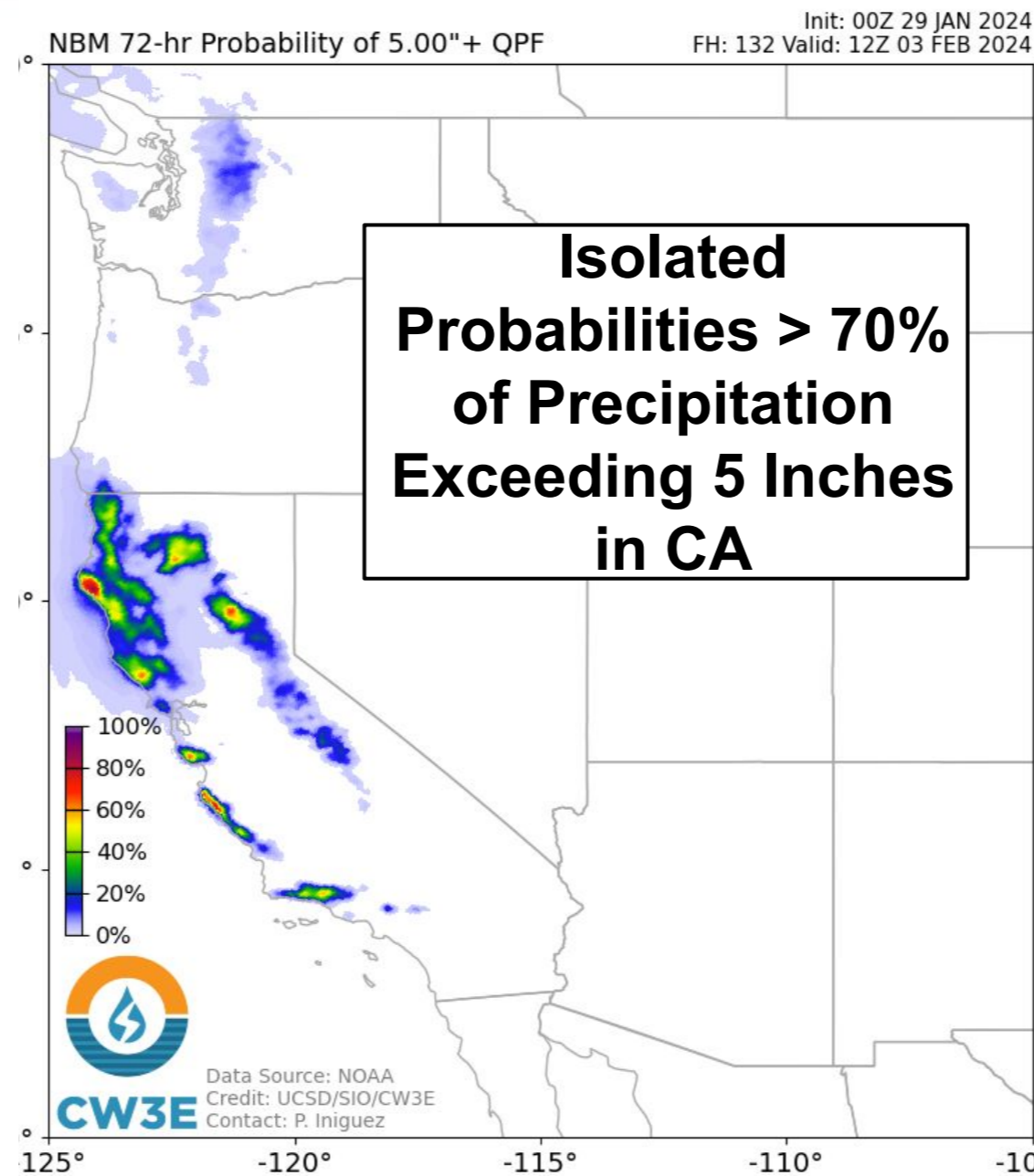
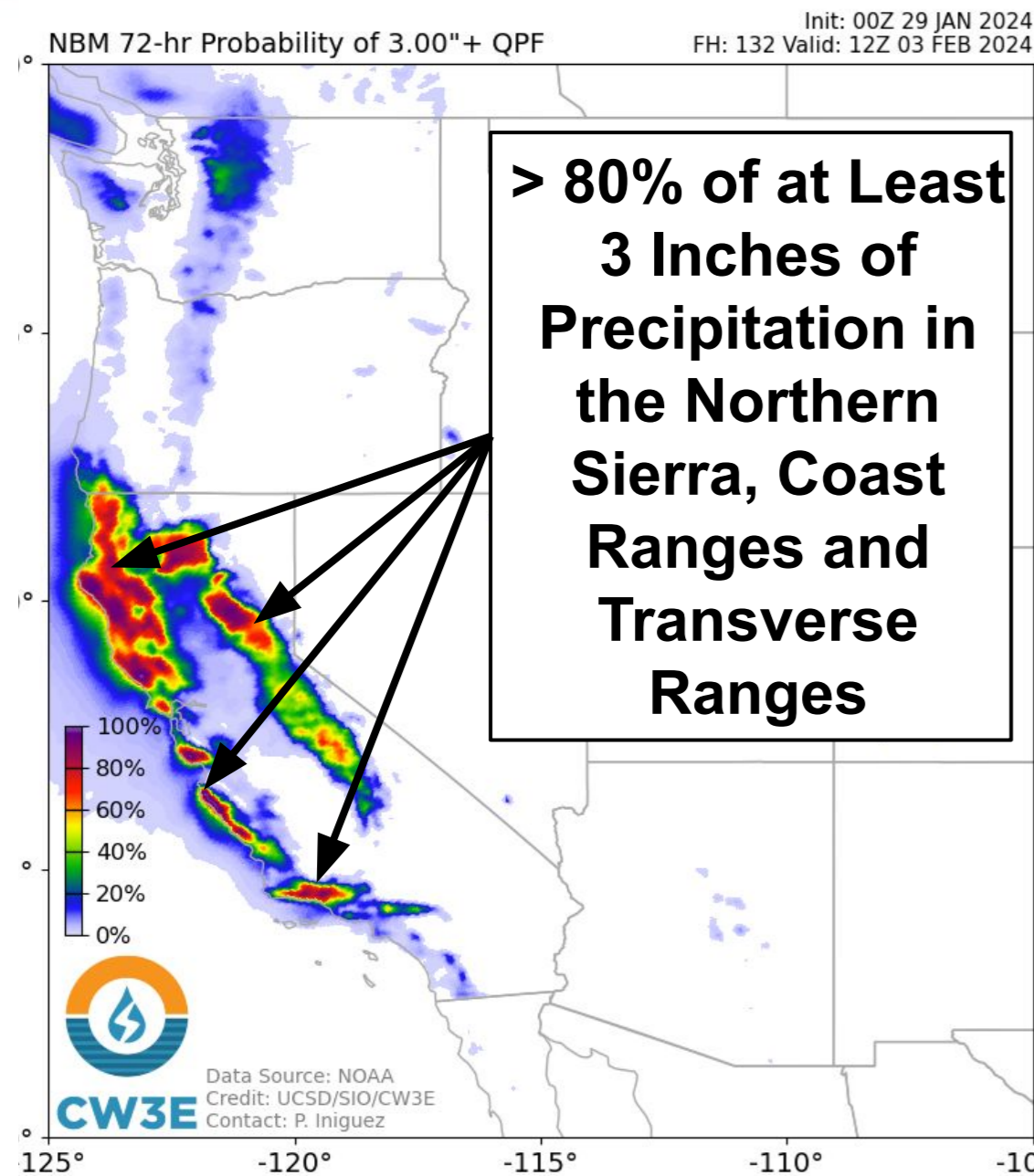


10-day Difference Precipitation Forecast



- The 00Z GEFS and 00Z EPS are forecasting similar 10-day watershed precipitation totals in the PNW. Primary forecast differences are in the Northern and Southern CA, where the GEFS is higher Northern CA and the EPS is higher in Southern CA.
- The 00Z GEFS is forecasting 5.23" of mean areal precipitation in the North Fork Feather watershed over the next 10 days, while the 00Z EPS is forecasting 3.94" over the same watershed. Both ensembles' members show large uncertainty in the 10-day totals.
- Some of the difference between the models is due to the possibility is due to the potential for AR activity near the end of the week.

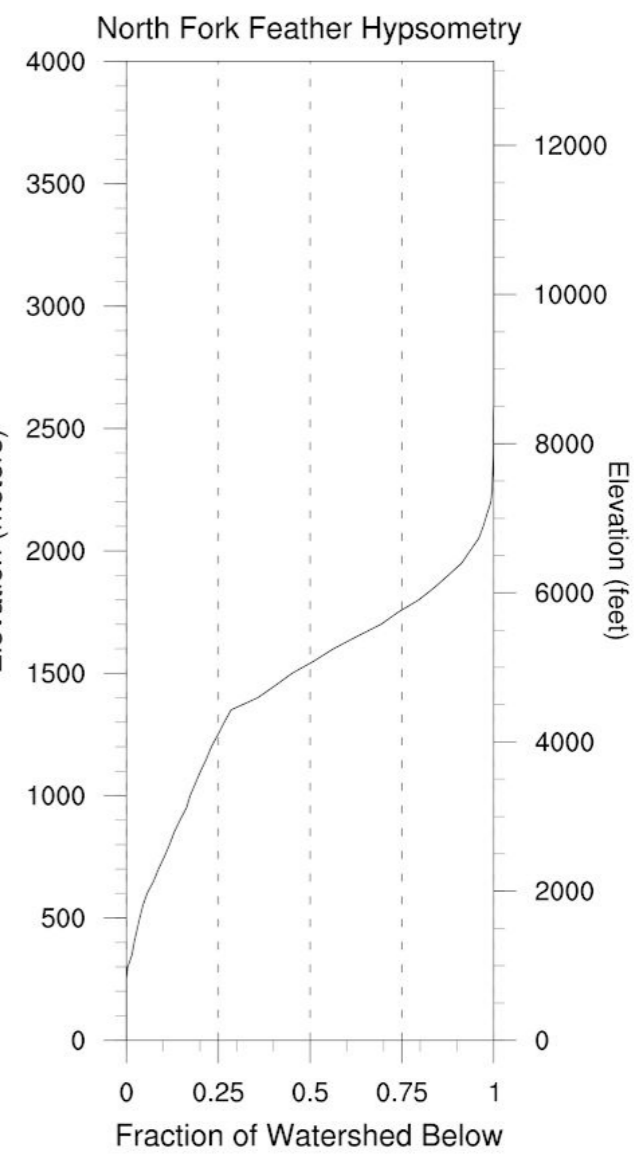
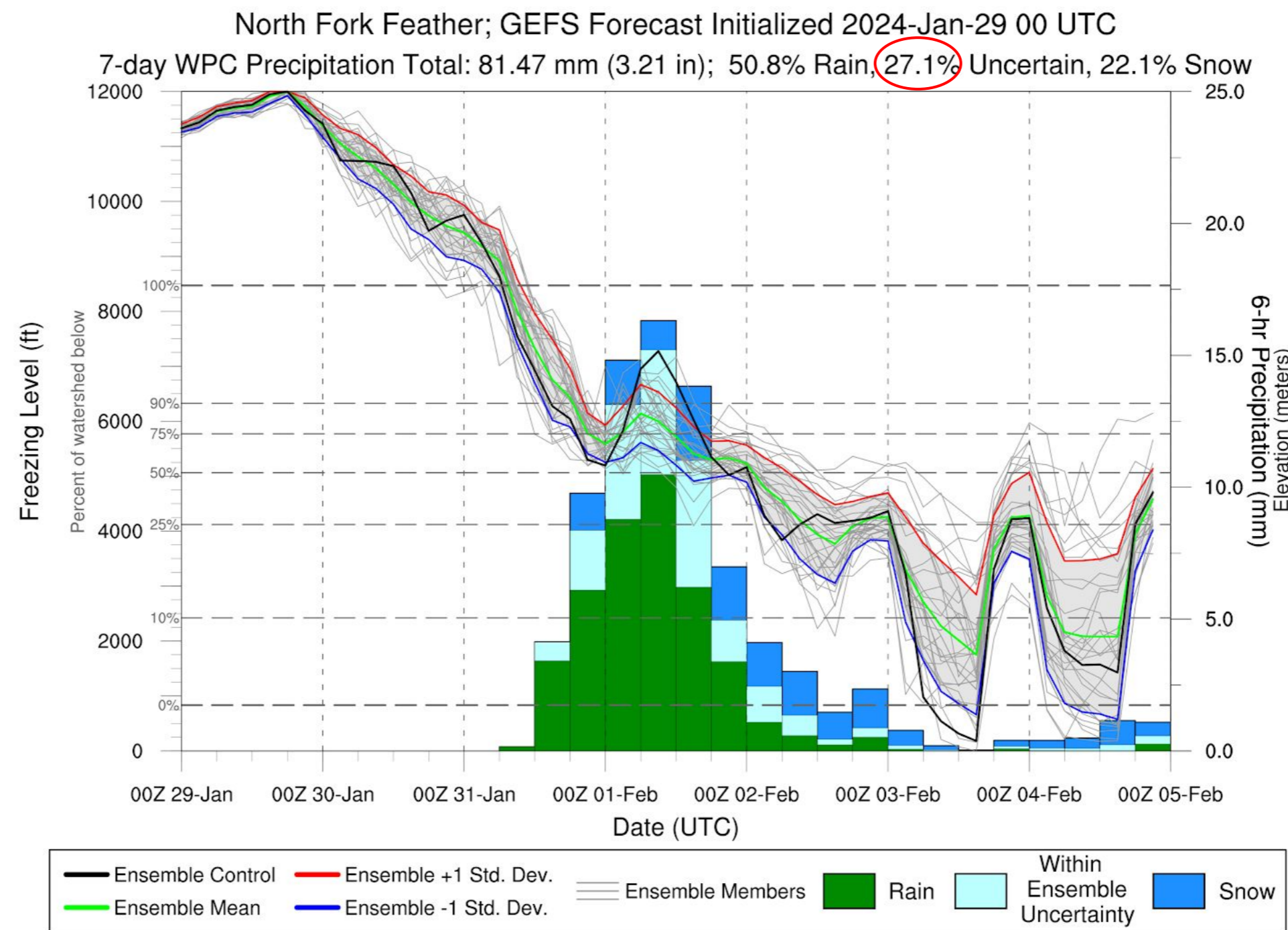
# CW3E AR Outlook: 29 Jan 2024



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

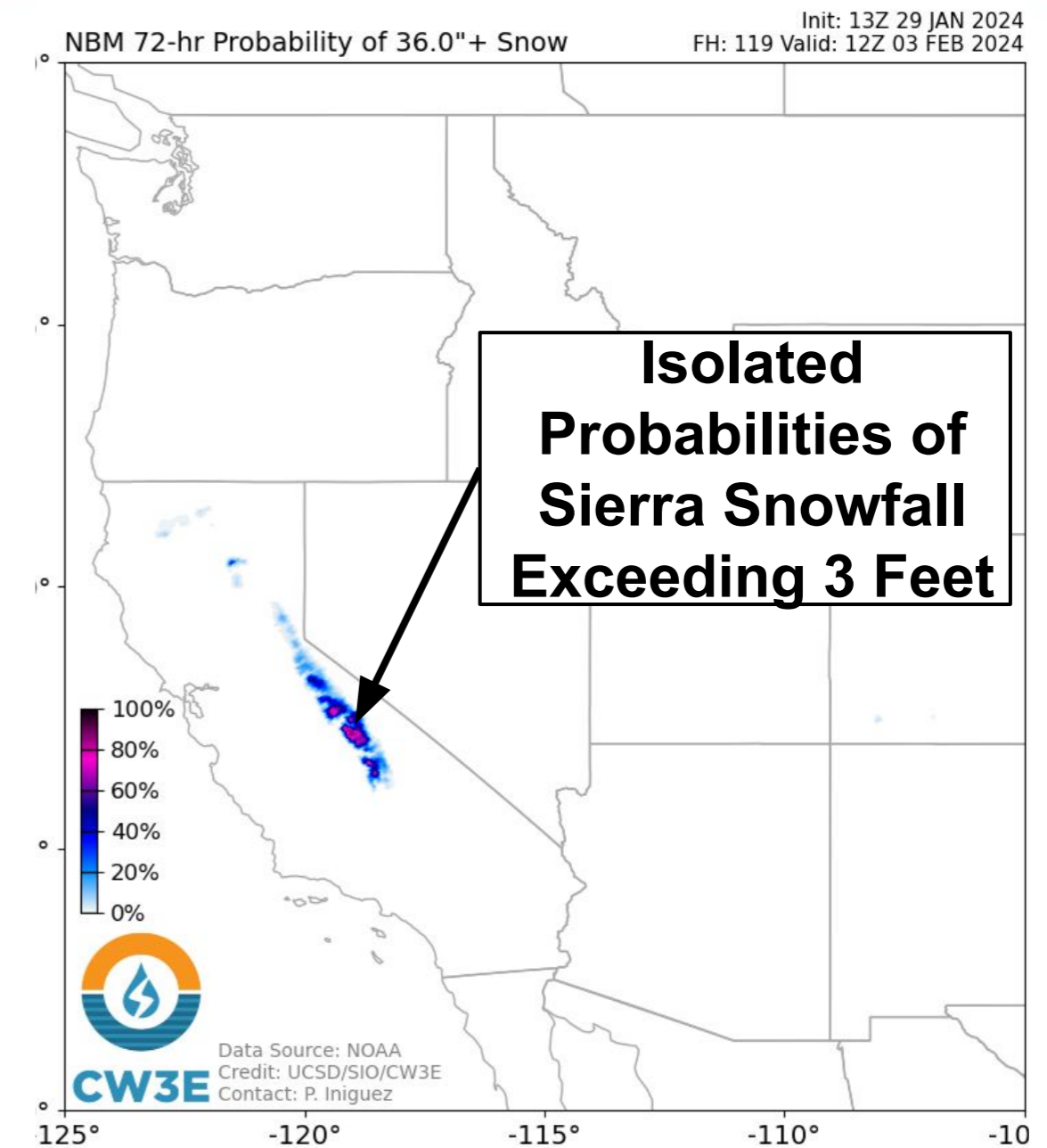
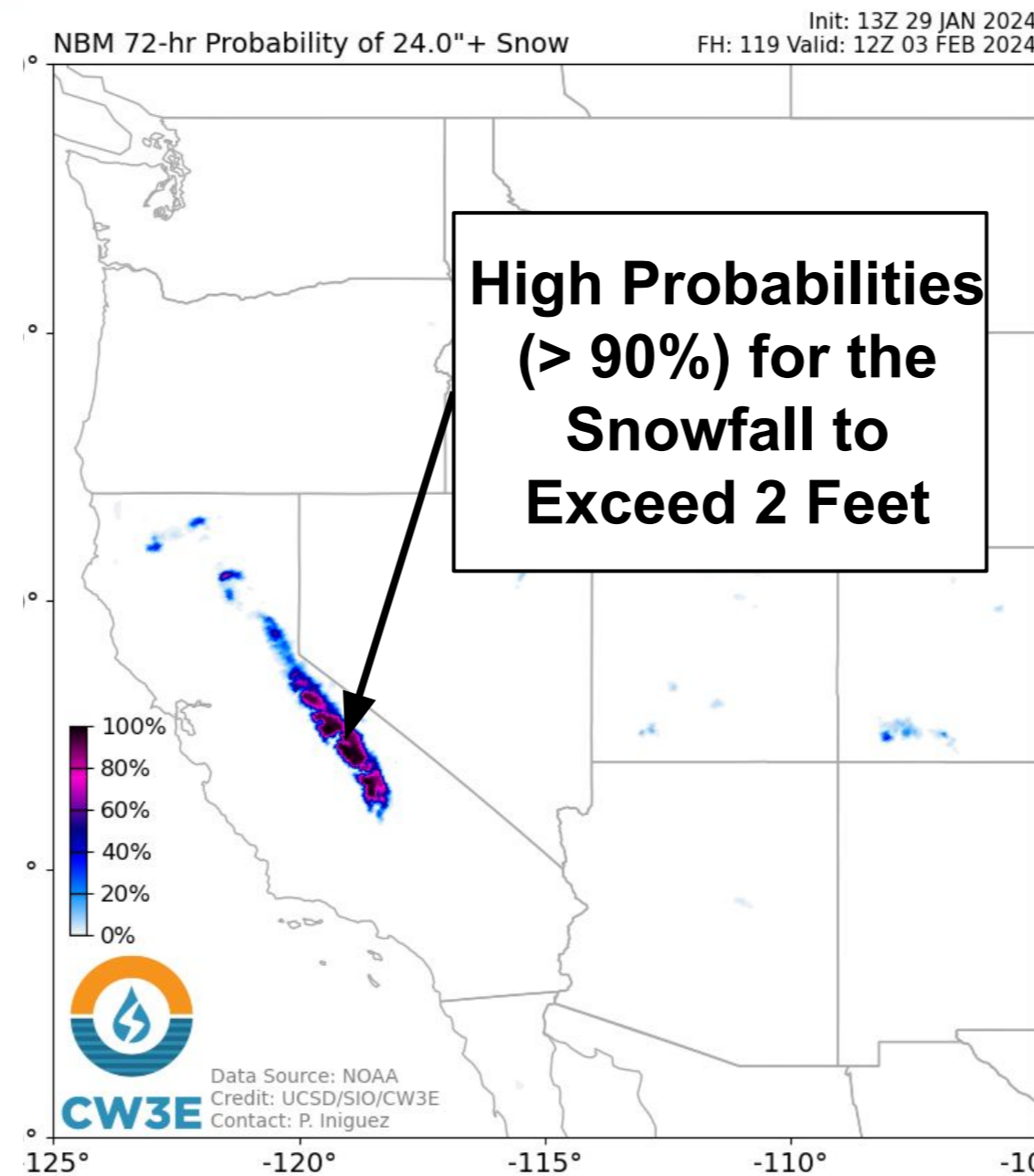
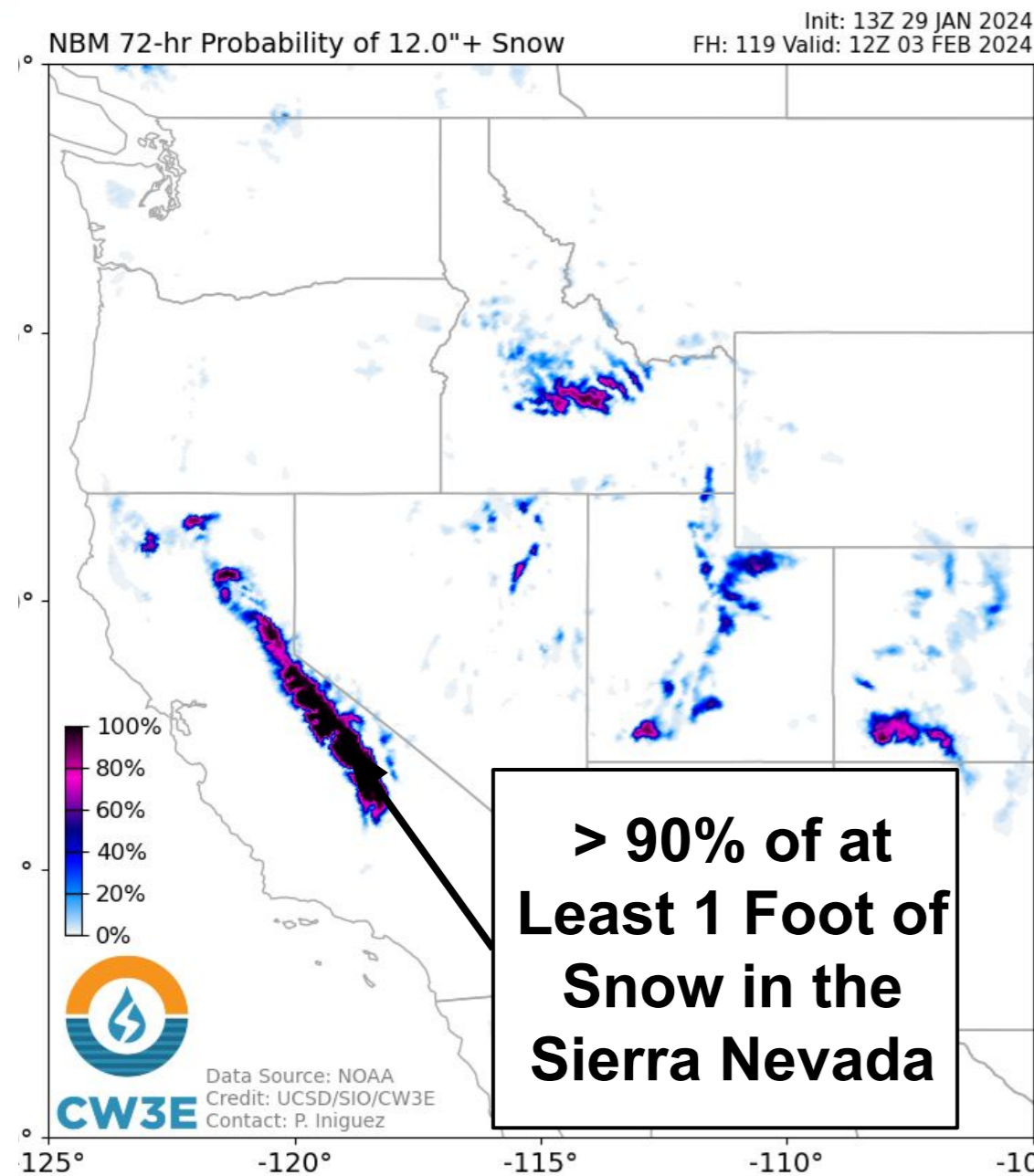
# CW3E AR Outlook: 29 Jan 2024

## Freezing Level Forecast



- The freezing level is forecast to fall to around ~4000 ft mean sea level (MSL) through the duration of the **second** AR in the North Fork Feather Watershed.
- The falling freezing level in the North Fork Feather results in approximately 27% uncertainty in the precipitation type forecast, although a majority of the ensemble members are forecasting rain (50.7%) versus snow (22.1%) as the dominant precip. type.

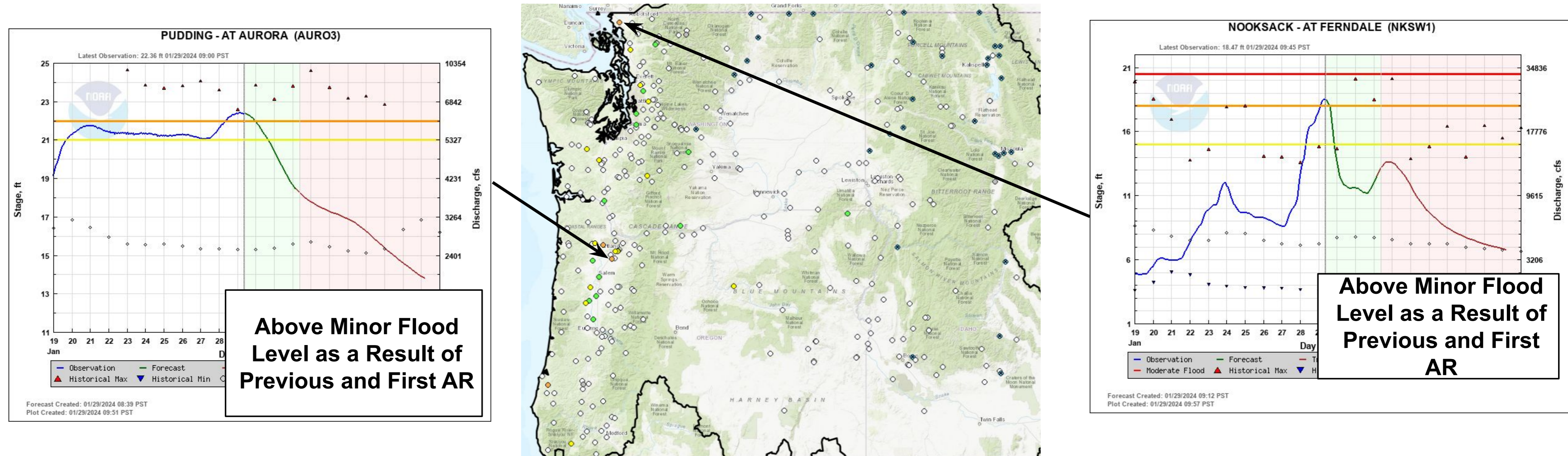
# CW3E AR Outlook: 29 Jan 2024



- For the 72-hour period ending at 4 AM PT Sat 3 Feb, the NBM is showing very high probabilities (>90%) that the Sierra Nevada receives at least 12 inches of snowfall during the **second AR**.
- The NBM is showing smaller regions of very high probabilities (>90%) of snowfall exceeding 2 feet and isolated moderate probabilities (60-70%) of snowfall exceeding 3 ft in the Sierra Nevada.

# CW3E AR Outlook: 29 Jan 2024

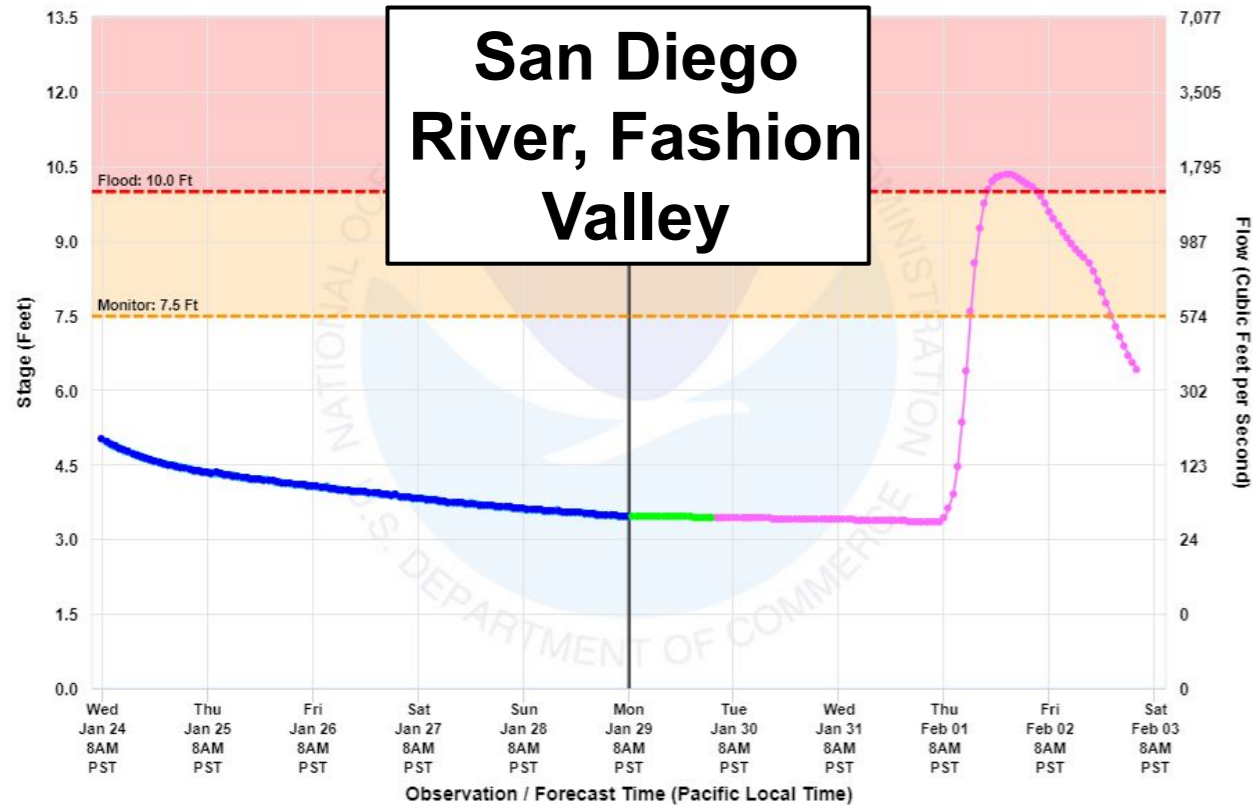
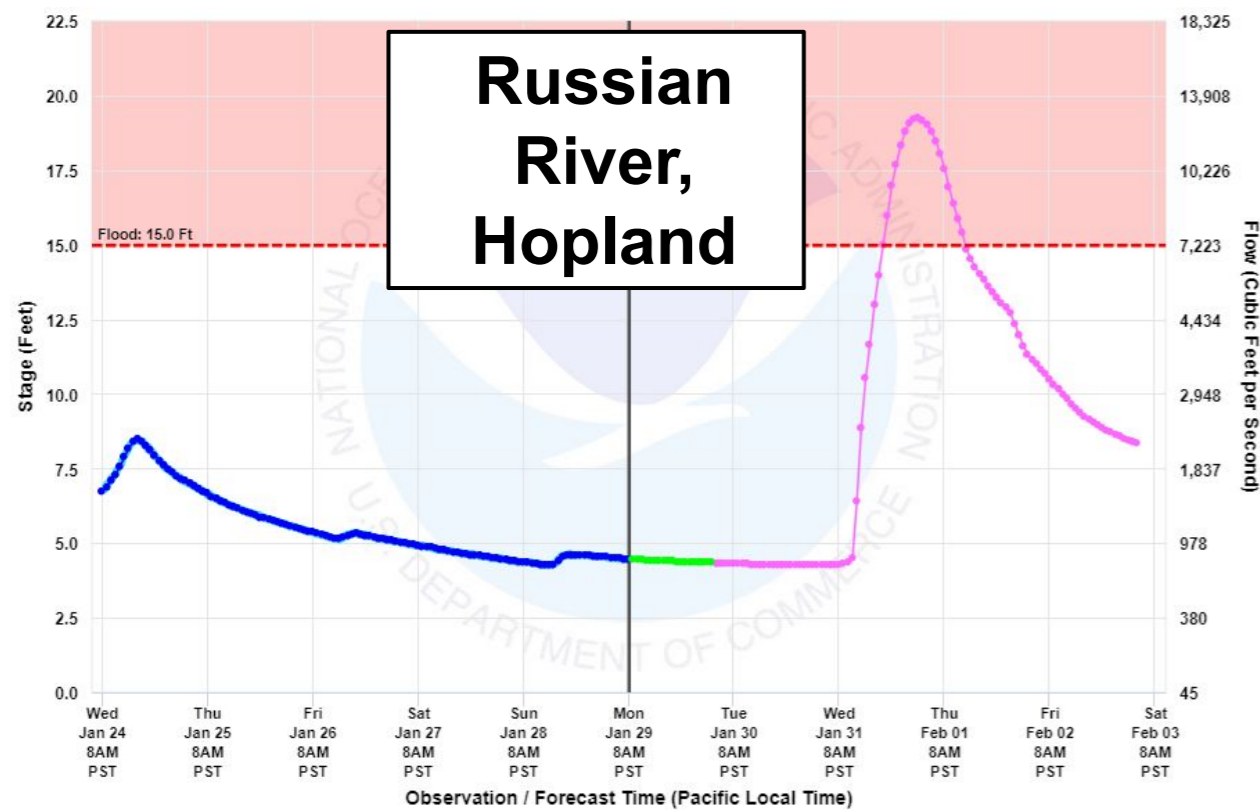
## NWS NWRFC River Stage Forecast



- Rivers across the Pacific Northwest have risen as a result of the AR that had made landfall early in this sequence.
- The NWRFC is currently reading 13 stream gages in the bankfull stage and four stream gages in the minor flood stage (Pudding River at Aurora on left and Nooksack River at Ferndale on right), along the WA and OR coasts.
- Following the passage of the first AR, stream levels are forecast to decrease.

# CW3E AR Outlook: 29 Jan 2024

## NWS CNRFC River Stage Forecasts



- River stages in CA are forecast to rise as a result of the precipitation associated **second** AR.
- CNRFC is currently forecasting 12 gages to exceed monitor stage and 5 gages to exceed flood stage in the next 5 days.
- The Russian River at Hopland (top left) guidance shows the river reaching flood level on Wed Jan 31. River stage at this location is forecast to rise 15 feet through the 31st.
- The San Diego River at Fashion Valley (bottom left) guidance shows the river reaching flood level on Thu Feb 1 as the **second** AR moves down the coast, bringing heavy precipitation to S. CA.

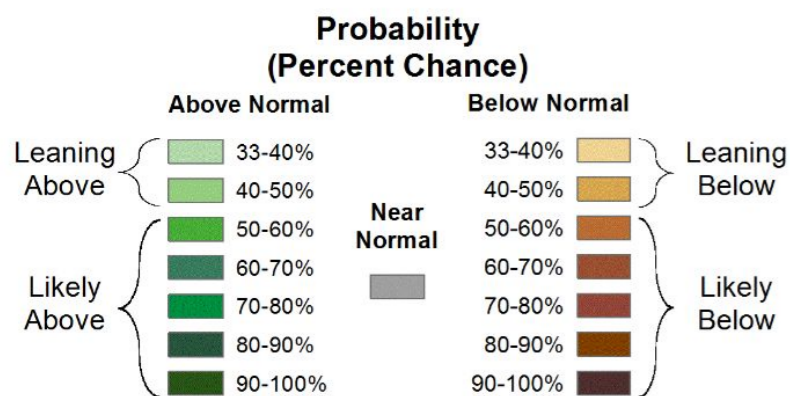
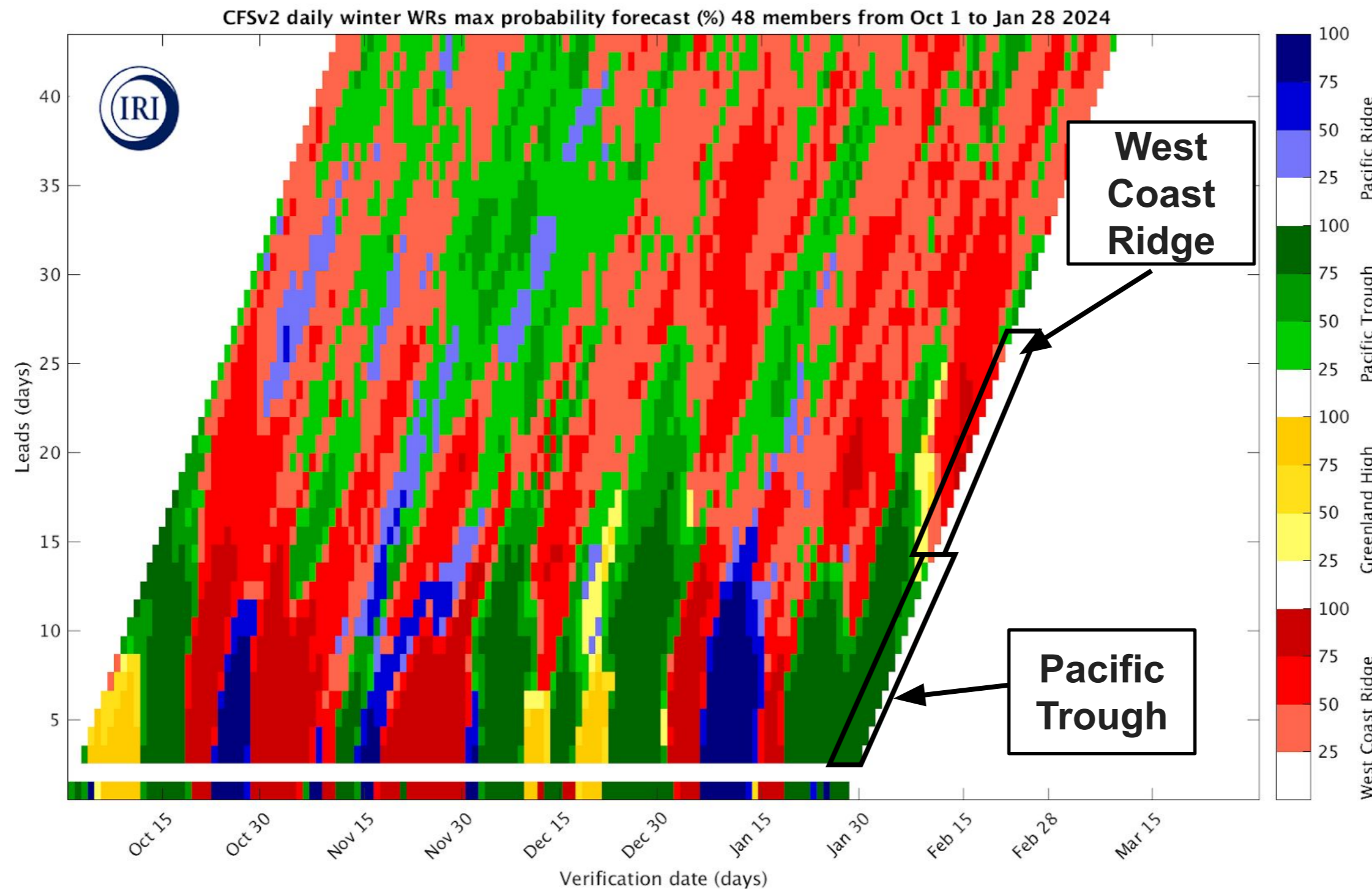
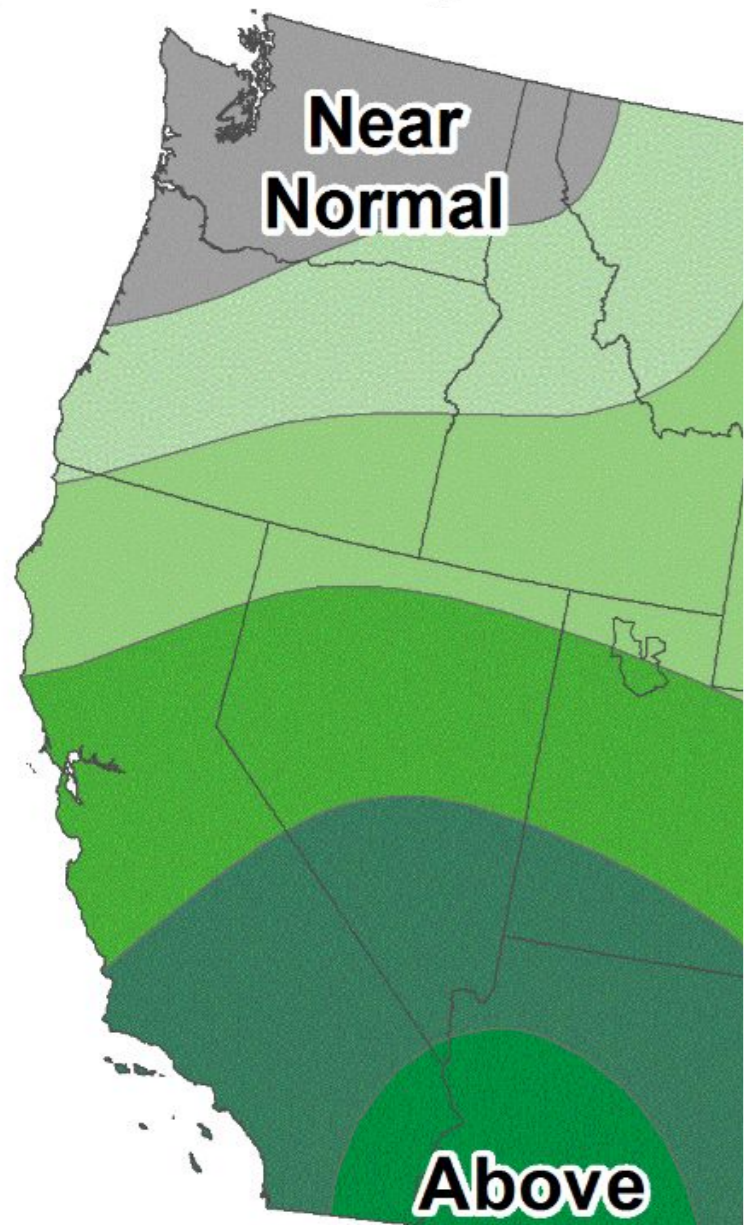
NOAA / NWS / California Nevada River Forecast Center • California Department of Water Resources  
 - Observed (Raw Gauge) - Observed (Simulated) - Forecast - Guidance

# CW3E AR Outlook: 29 Jan 2024

## CPC Day 8-14 Precipitation Outlook and IRI Regime Forecast

Valid: February 5 - 11, 2024

Issued: January 28, 2024

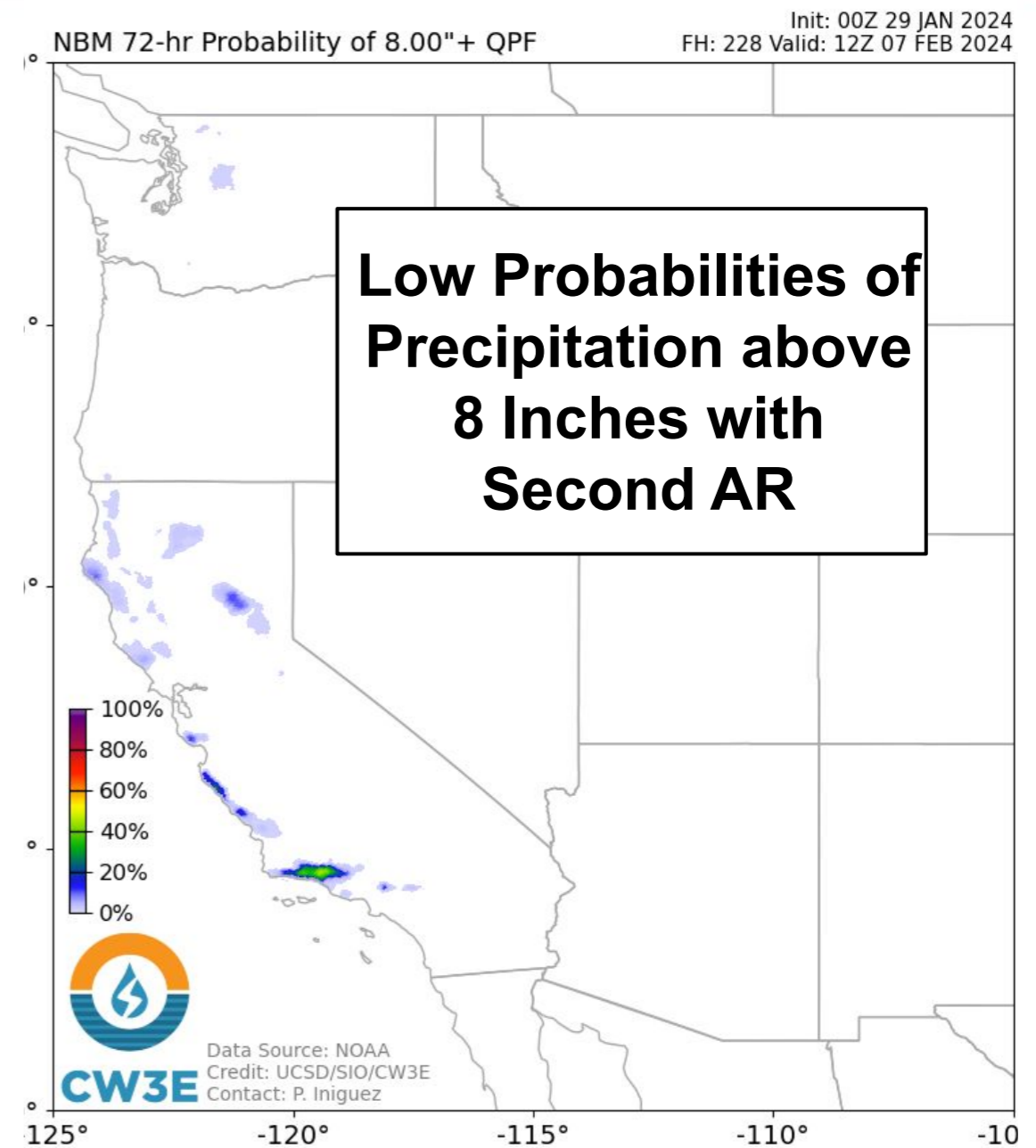
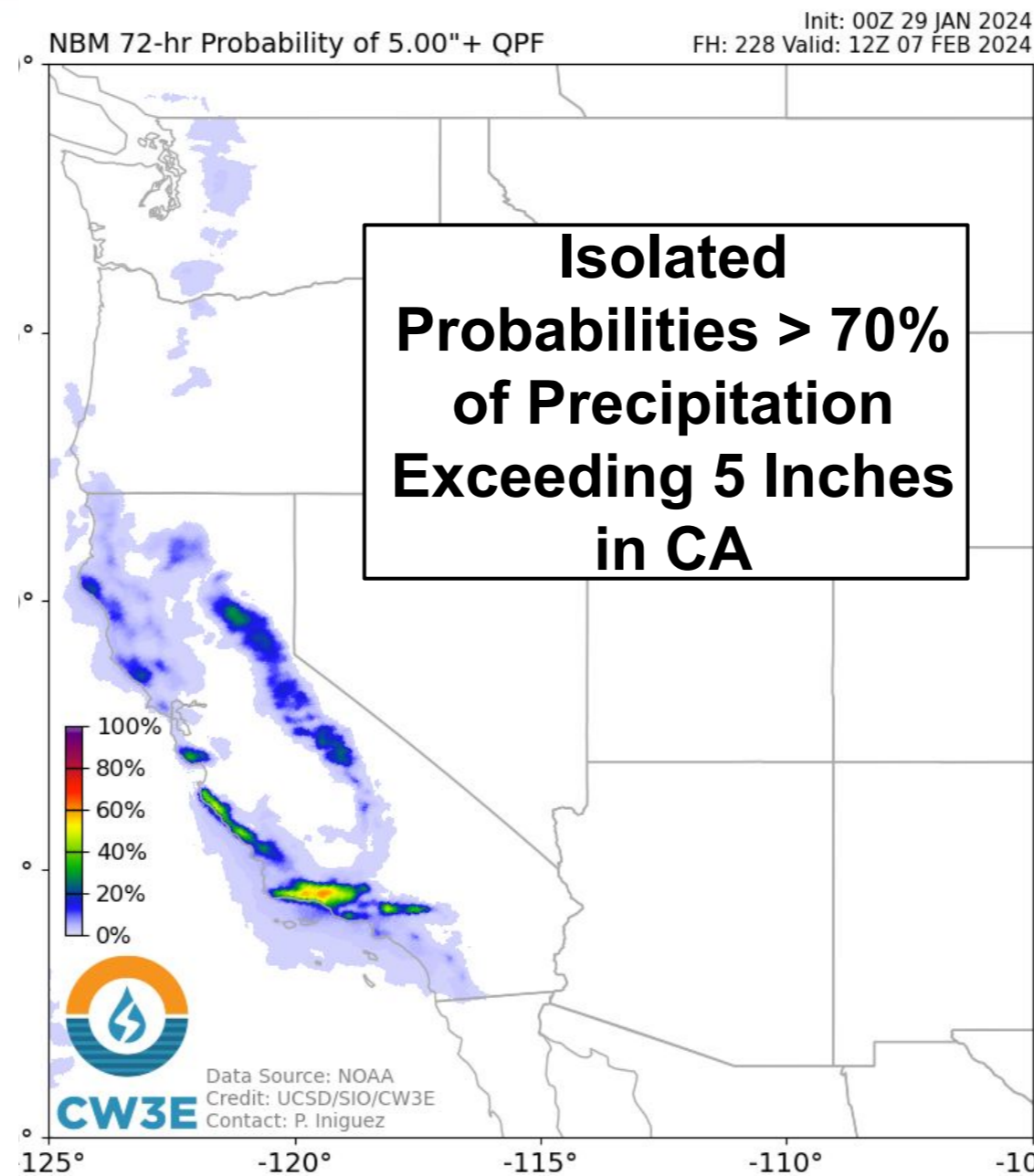
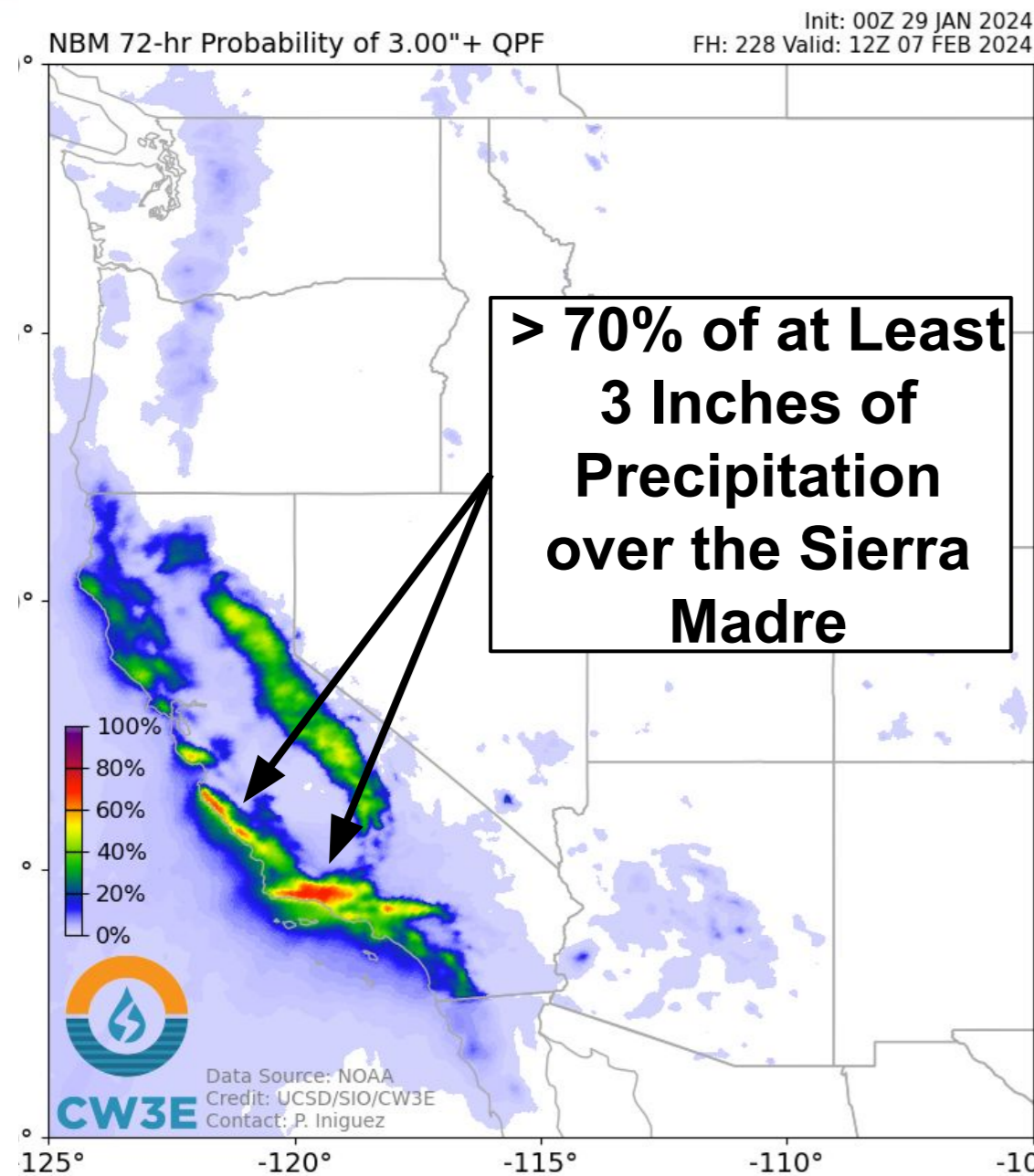


IRI: <https://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs>

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

- The CPC's Day 8-14 Precipitation Outlook is showing moderate probabilities (>60%) of **above normal** precipitation C. and S. CA, AZ, NV, UT, NM and CO as the **second** AR brings impacts across the Southwestern US.
- 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.
- A shift toward the West Coast Ridge Type is forecast to follow, indicating a **greater likelihood** for drier conditions for the USWC.

# CW3E AR Outlook: 29 Jan 2024

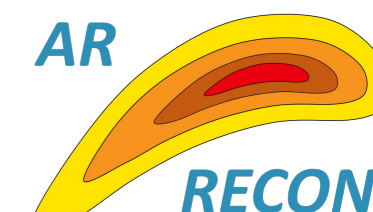


- For the 72-hour period ending at 4 AM PT Wed 7 Feb, the NBM is showing high probabilities (> 70%) the Sierra Madre receive at least 3 inches of precipitation during the potential **third** AR.
- The NBM is now showing isolated region of higher probabilities (>60%) of 72-h precipitation exceeding 5 inches in the Sierra Madre during the **third** AR.



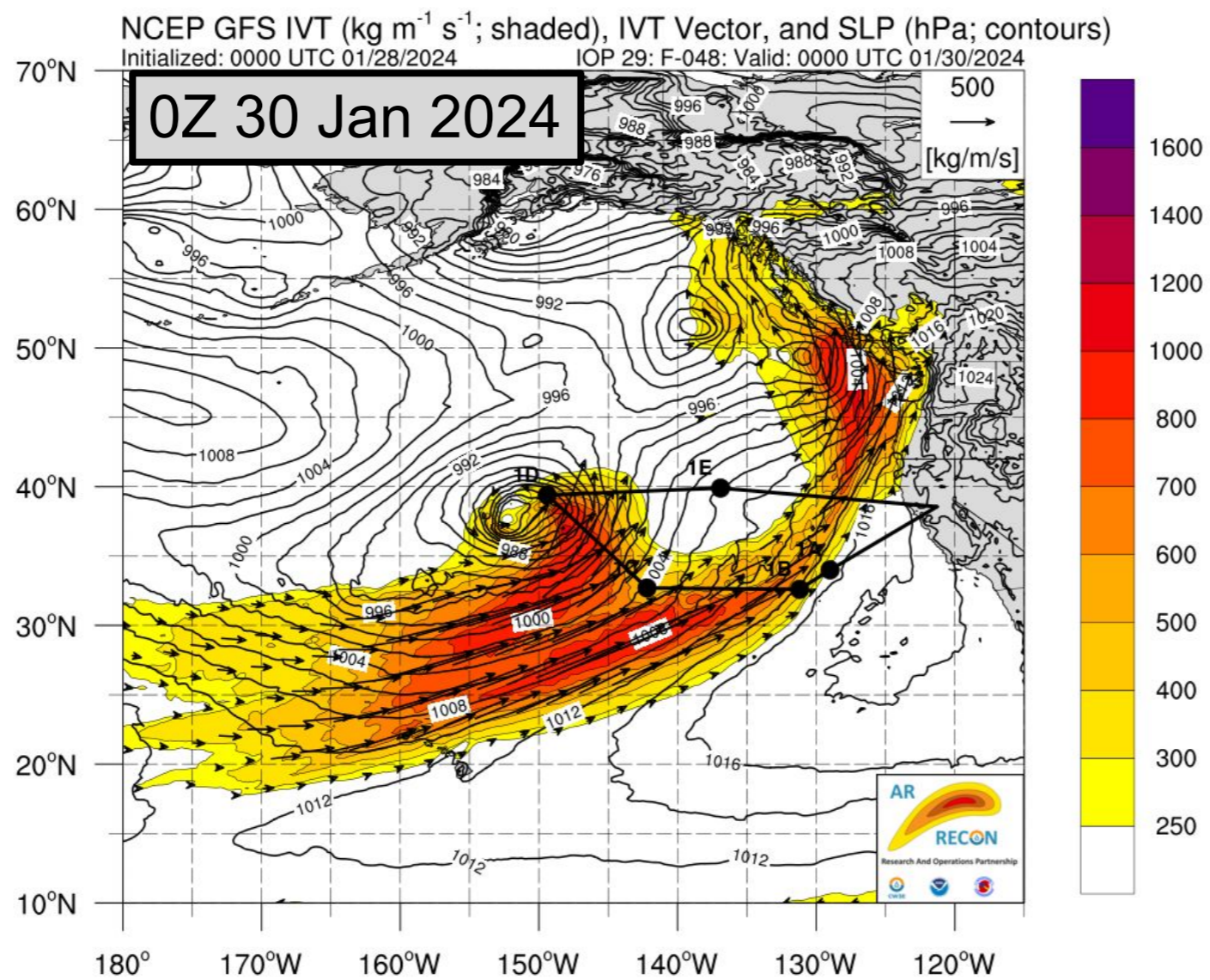
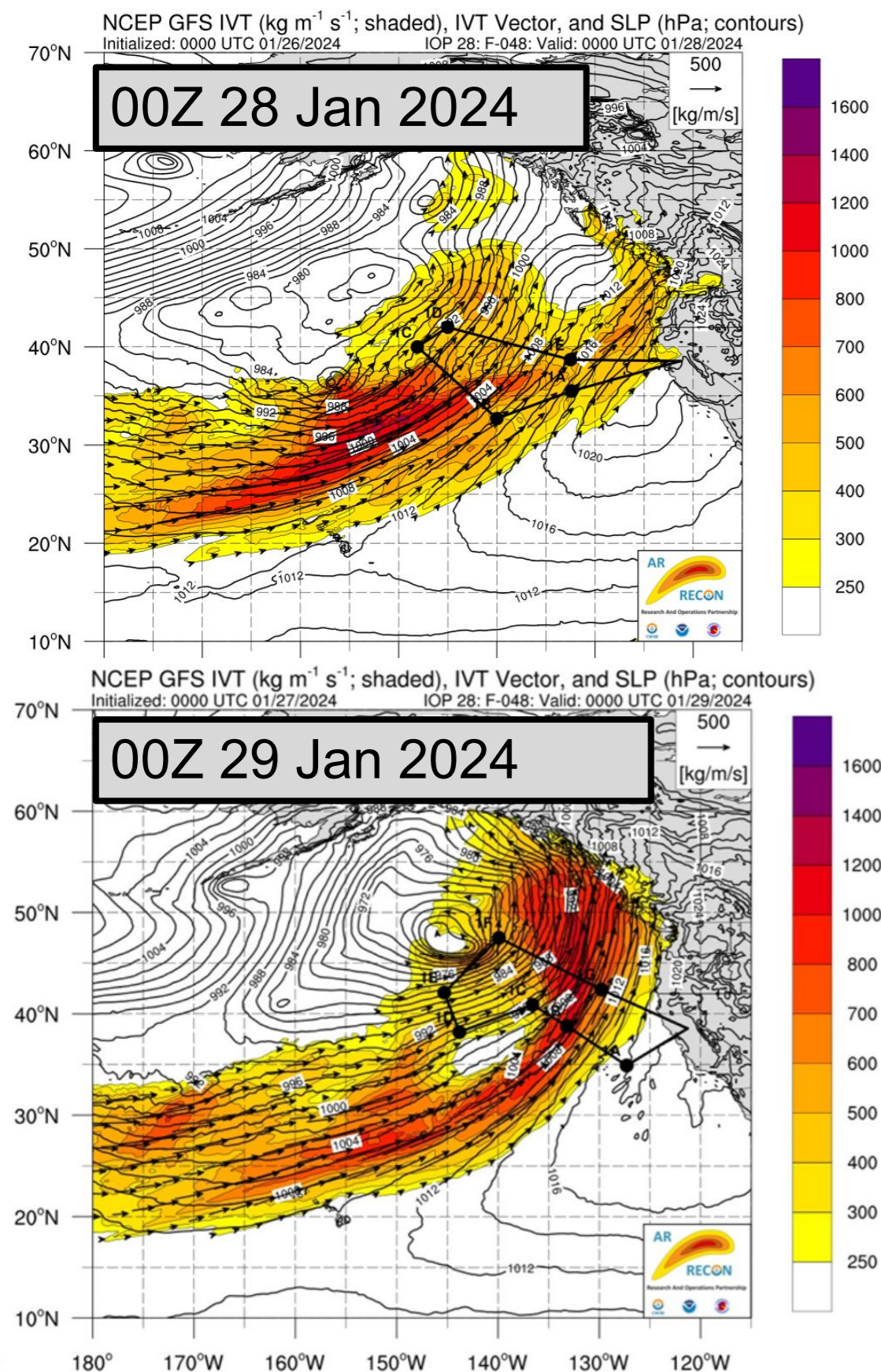
# CW3E AR Outlook: 29 Jan 2024

## Current AR Recon Planned Flight Sequence



CW3E 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.
- The AR Recon team has planned multiple flights, departing from Sacramento, CA to fly out into these ARs in the eastern N. Pacific
- These sampling missions provide data in near real-time to the global forecast models to improve weather forecasts and are also archived for future studies on ARs.
- Flights sample the atmospheric and its essential atmospheric structures, in addition to regions of forecast sensitivity.



Note, flights for 00Z 28 Jan. & 29 Jan. were unfortunately cancel due unforeseen circumstances