

# CW3E Atmospheric River Outlook: 27 January 2025

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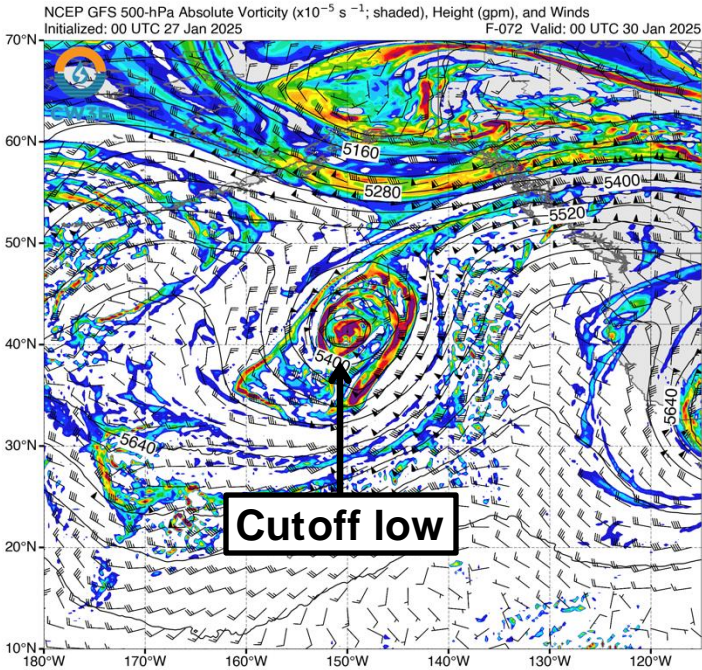
## Unsettled Weather Pattern Likely to Return to US West Coast This Week

- Multiple tropical moisture exports (TMEs) are forecast to develop over the Northeast Pacific this week, leading to landfalling atmospheric river (AR) activity over the US West Coast.
- The first AR is forecast to bring weak AR conditions ( $IVT < 500 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to Oregon and Northern California late Thu 30 Jan into Fri 31 Dec.
- After the initial AR landfall, a second AR is forecast to overtake the first AR and potentially stall over the US West Coast into early next week, which could result in significant precipitation amounts.
- Ensemble and deterministic models are showing large uncertainty in the evolution of these ARs and associated precipitation after the initial AR landfall.
- The EPS is showing a higher likelihood of landfalling AR activity continuing into early next week compared to GEFS. The EPS control run is also forecasting an AR 3 in Northern California (based on the Ralph et al. 2019 AR Scale), whereas the GEFS control is only forecasting an AR 1.
- Compared to the deterministic GFS, the deterministic ECMWF is also forecasting stronger moisture transport over Oregon and Northern California after the initial AR landfall, as well as a more northerly track for the second AR.
- In general, EPS is forecasting higher precipitation totals across western Oregon and Northern California during the next 10 days compared to GEFS. The deterministic ECMWF is forecasting  $> 10$  inches of total precipitation near the Oregon/California border through the middle of next week.

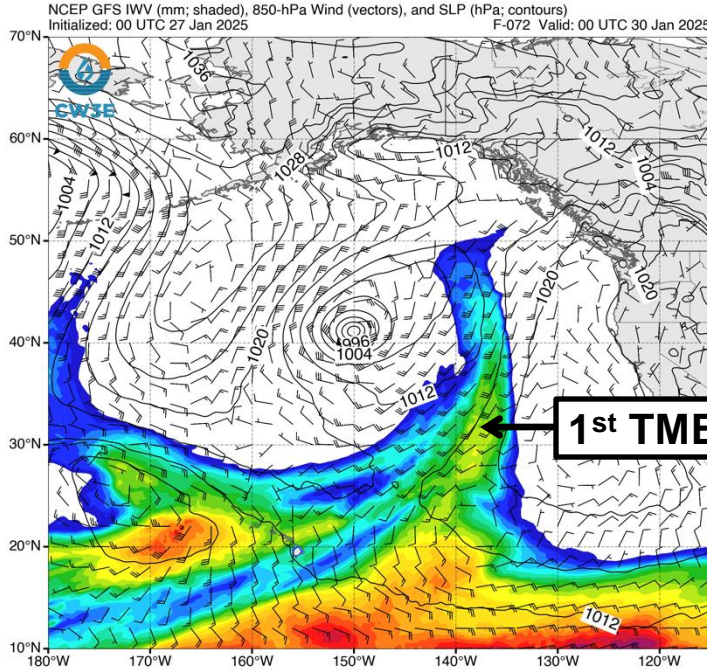
# AR Outlook: 27 January 2025

## GFS Model Forecasts: Valid 4 PM PT 29 Jan (F-72)

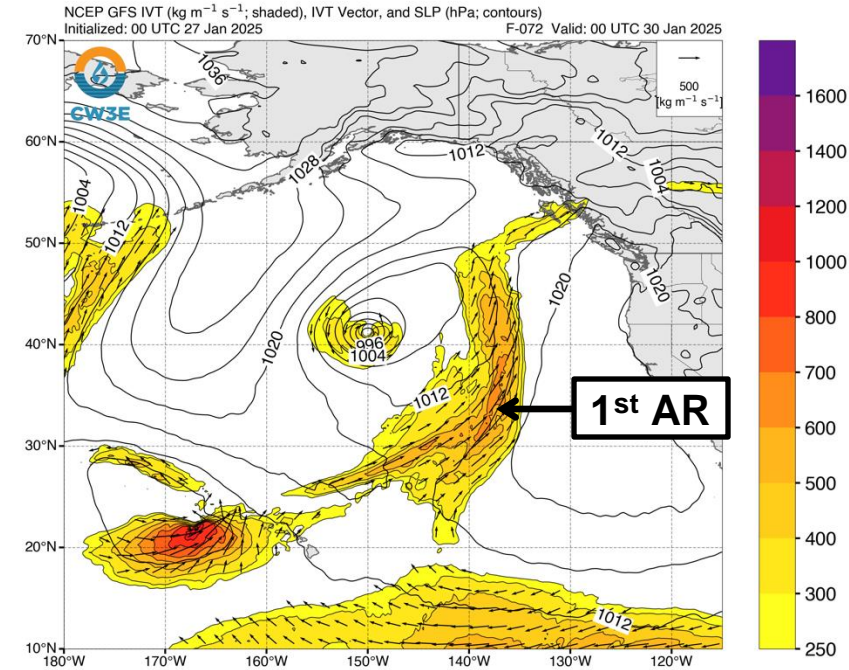
### 500-hPa Geopotential Height & Vorticity



### IWV & SLP



### IVT & SLP



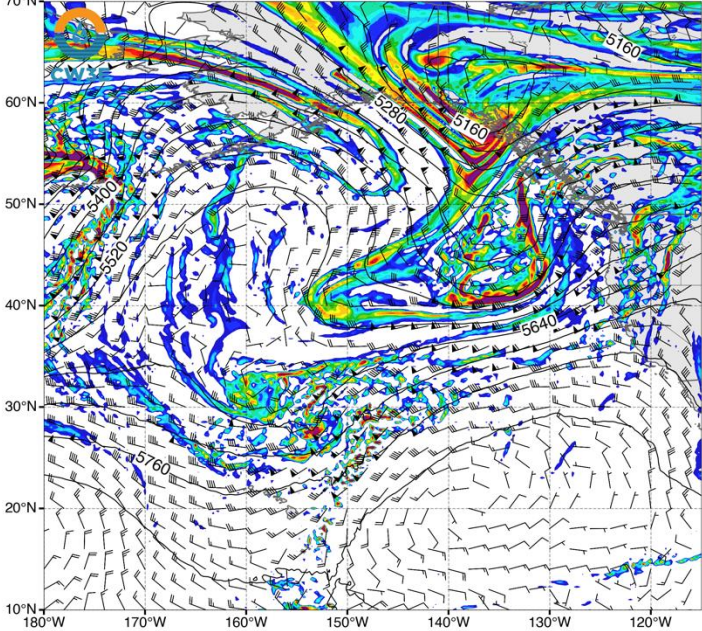
- Over the next few days, a cutoff low is forecast to develop over the Northeast Pacific and gradually drift eastward.
- This cutoff low is forecast to interact with the tropical moisture export (TME), leading to the formation of a surface cyclone and an atmospheric river (AR).

# AR Outlook: 27 January 2025

## GFS Model Forecasts: Valid 4 AM PT 31 Jan (F-108)

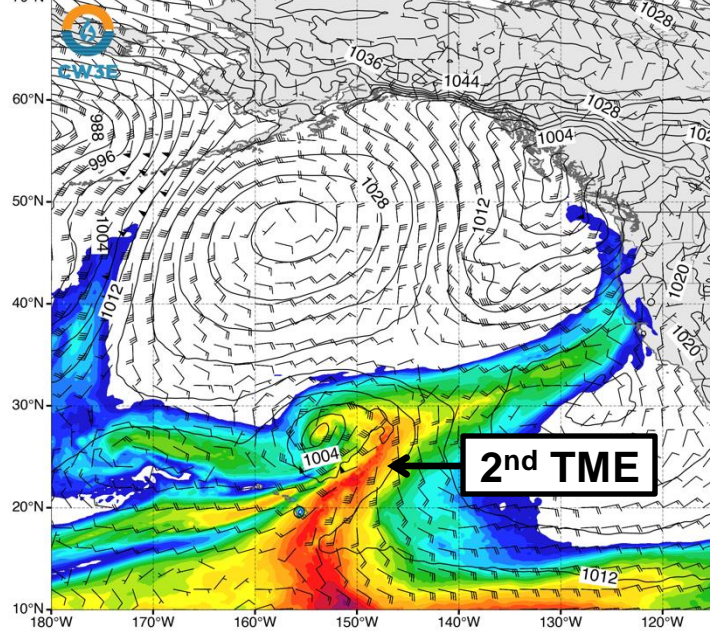
### 500-hPa Geopotential Height & Vorticity

NCEP GFS 500-hPa Absolute Vorticity ( $\times 10^{-5} \text{ s}^{-1}$ ; shaded), Height (gpm), and Winds  
Initialized: 00 UTC 27 Jan 2025 F-108 Valid: 12 UTC 31 Jan 2025



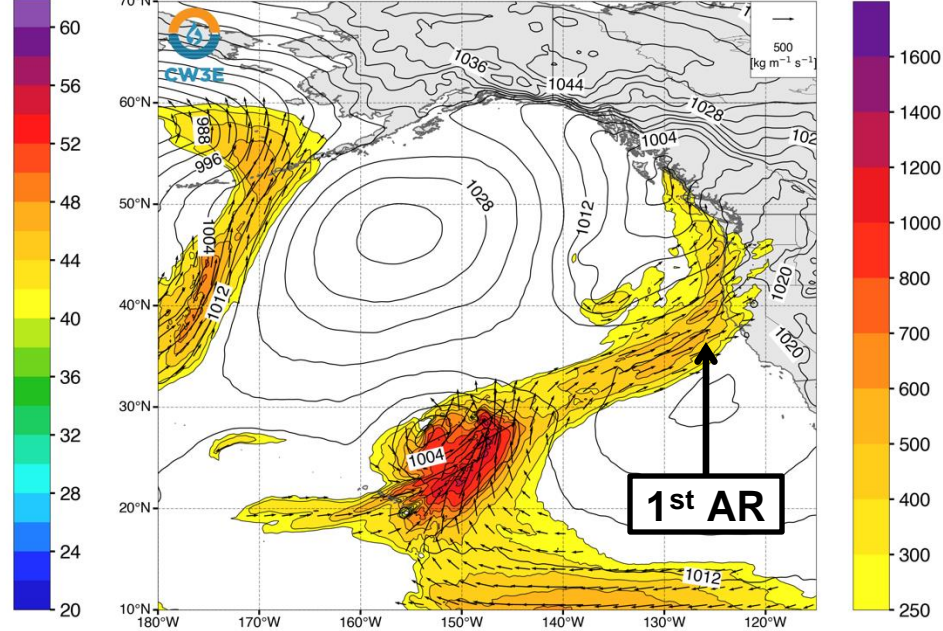
### IWV & SLP

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 00 UTC 27 Jan 2025 F-108 Valid: 12 UTC 31 Jan 2025



### IVT & SLP

NCEP GFS IVT ( $\text{kg m}^{-1} \text{ s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 00 UTC 27 Jan 2025 F-108 Valid: 12 UTC 31 Jan 2025



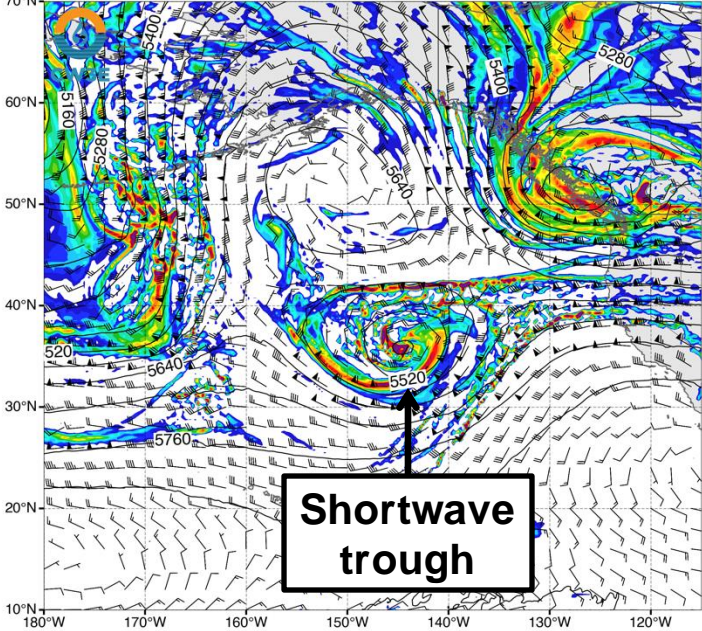
- As the cutoff low propagates eastward and weakens, the AR is forecast to make landfall over the US West Coast late Thu 30 Jan into Fri 31 Jan.
- The initial AR landfall is only forecast to bring weak AR conditions ( $\text{IVT} < 500 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to Oregon and Northern California.
- Meanwhile, a second and stronger TME is forecast to develop near Hawaii, eventually leading to the formation of a second AR.

# AR Outlook: 27 January 2025

## GFS Model Forecasts: Valid 4 AM PT 2 Feb (F-156)

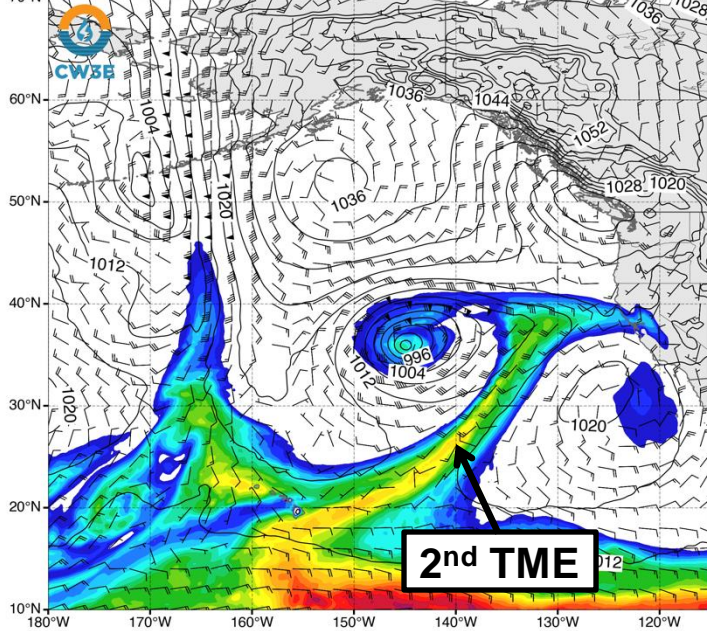
### 500-hPa Geopotential Height & Vorticity

NCEP GFS 500-hPa Absolute Vorticity ( $\times 10^{-5} \text{ s}^{-1}$ ; shaded), Height (gpm), and Winds  
Initialized: 00 UTC 27 Jan 2025 F-156 Valid: 12 UTC 02 Feb 2025



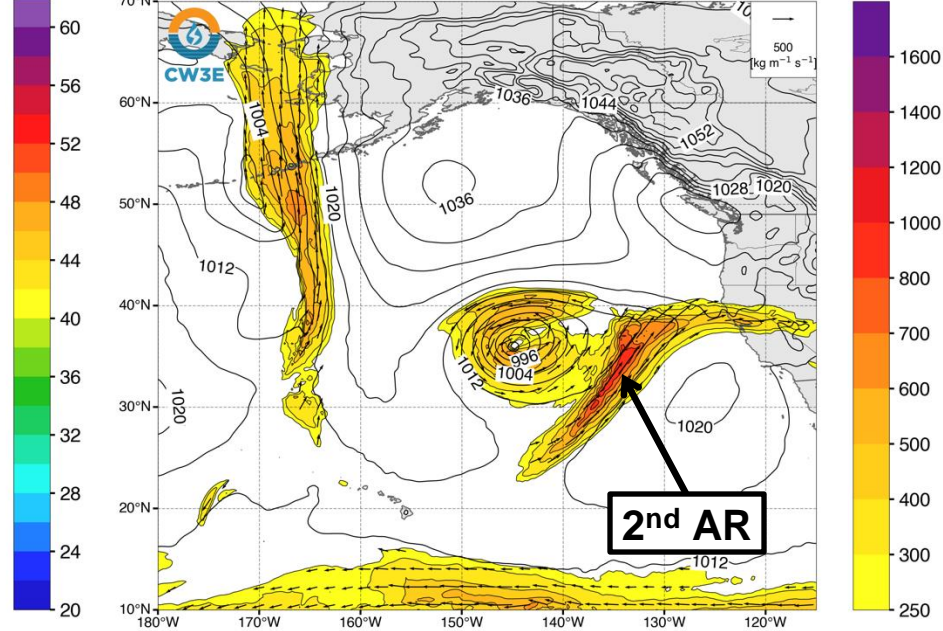
### IWV & SLP

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 00 UTC 27 Jan 2025 F-156 Valid: 12 UTC 02 Feb 2025



### IVT & SLP

NCEP GFS IVT ( $\text{kg m}^{-1} \text{ s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 00 UTC 27 Jan 2025 F-156 Valid: 12 UTC 02 Feb 2025

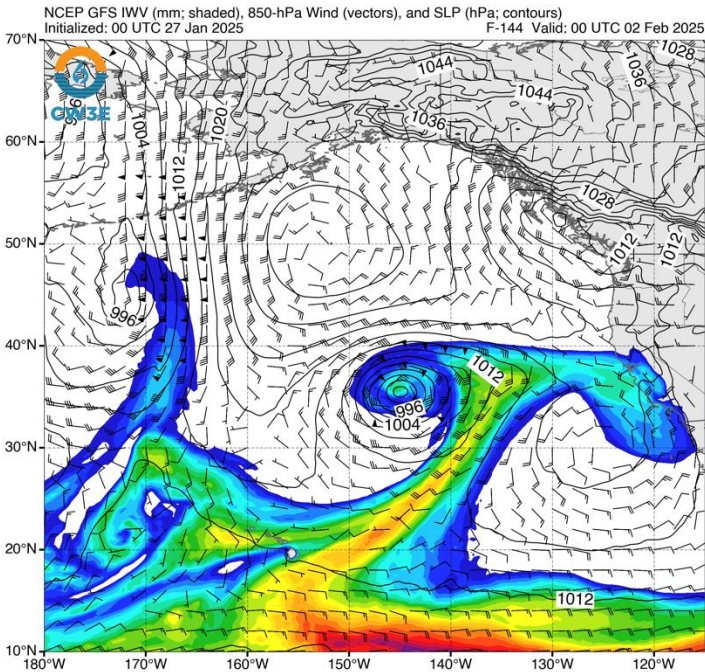


- As time progresses, a mid-level shortwave trough is forecast to develop south of a blocking ridge over Alaska and interact with the TME.
- The shortwave trough and second TME/AR are forecast to slowly propagate eastward and overtake the initial AR, potentially setting the stage for a long-duration AR event over Northern California.

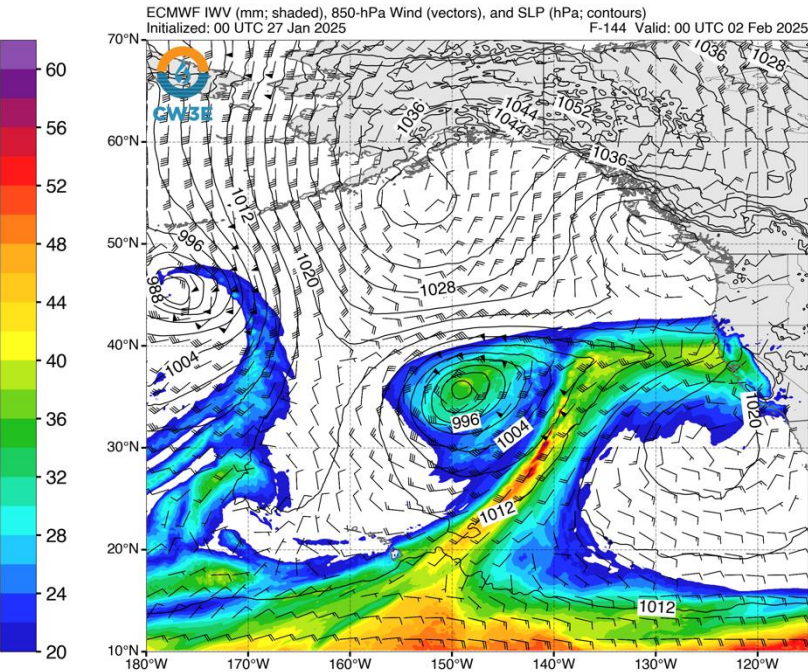
# AR Outlook: 27 January 2025

## GFS vs. ECMWF IWV Forecasts: Valid 4 PM PT 1 Feb (F-144)

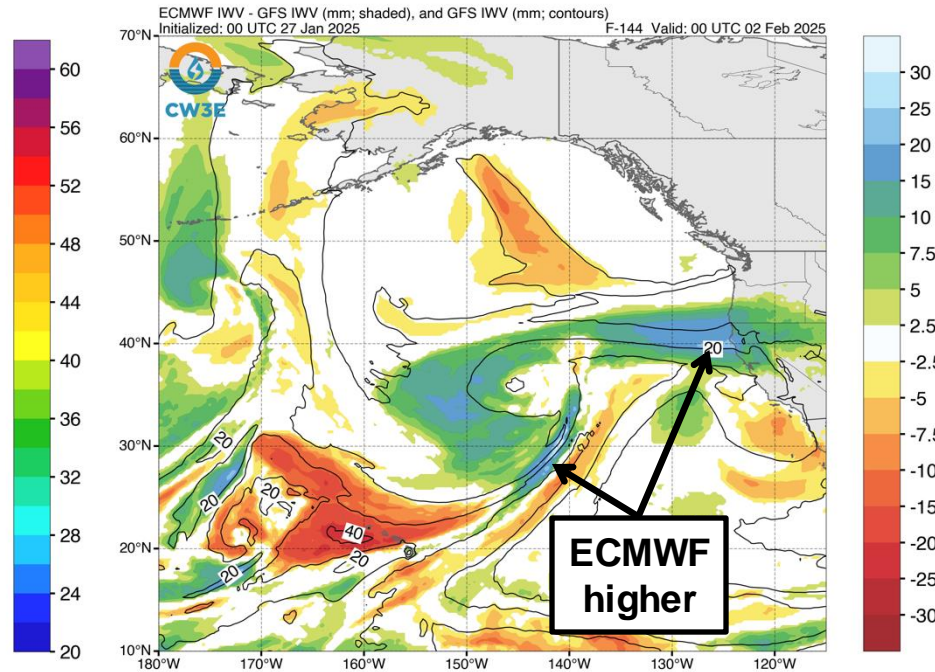
### GFS



### ECMWF



### ECMWF Minus GFS

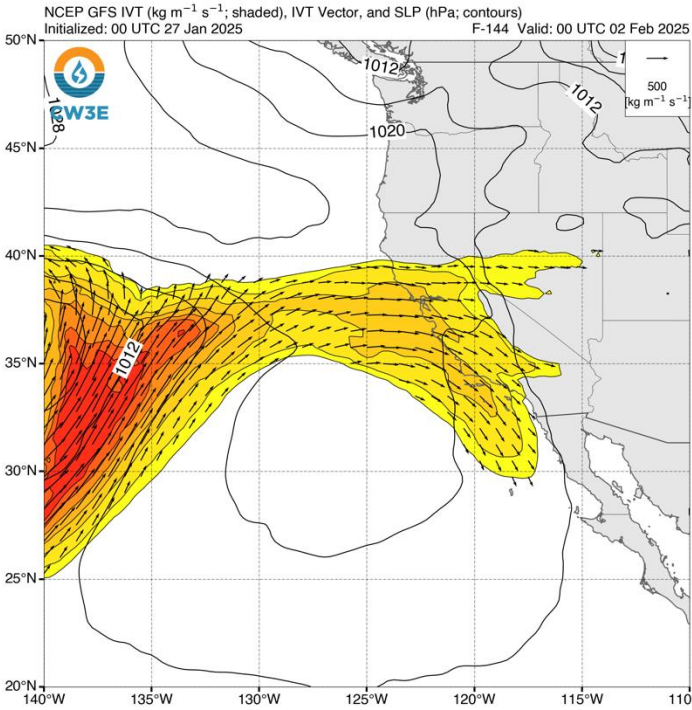


- The GFS and ECMWF models are showing differences in the evolution of the second TME, which could ultimately lead to differences in AR activity along the US West Coast after the initial AR landfall.
- The ECMWF is forecasting higher IWV values within the core of the second TME, with IWV > 30 mm extending northeastward into Northern California.
- Higher IWV values and southwesterly low-level winds (as opposed to northwesterly in the GFS) imply stronger upslope moisture flux over the Northern California Coast Ranges and Northern Sierra Nevada.

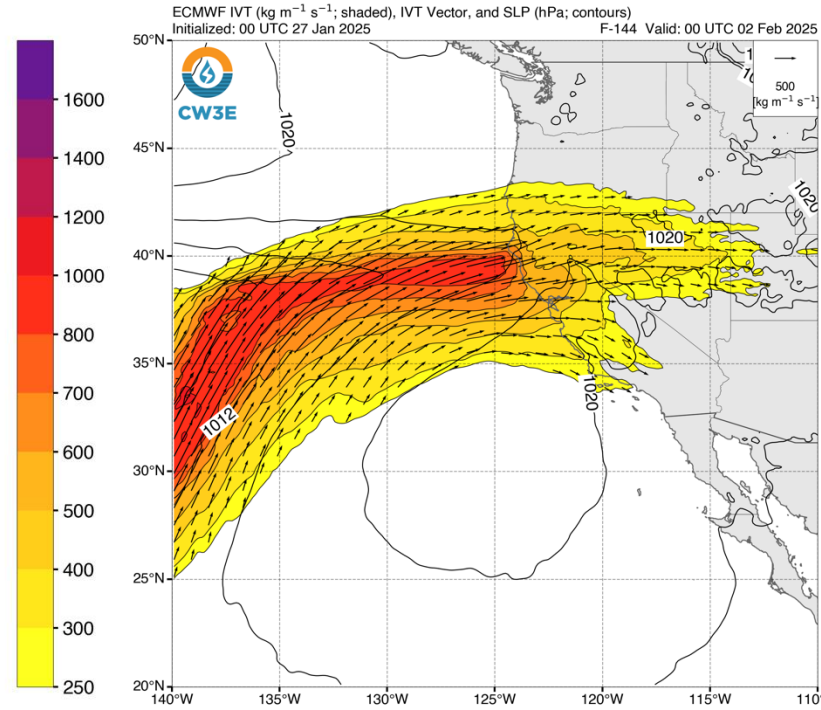
# AR Outlook: 27 January 2025

## GFS vs. ECMWF IVT Forecasts: Valid 4 PM PT 1 Feb (F-144)

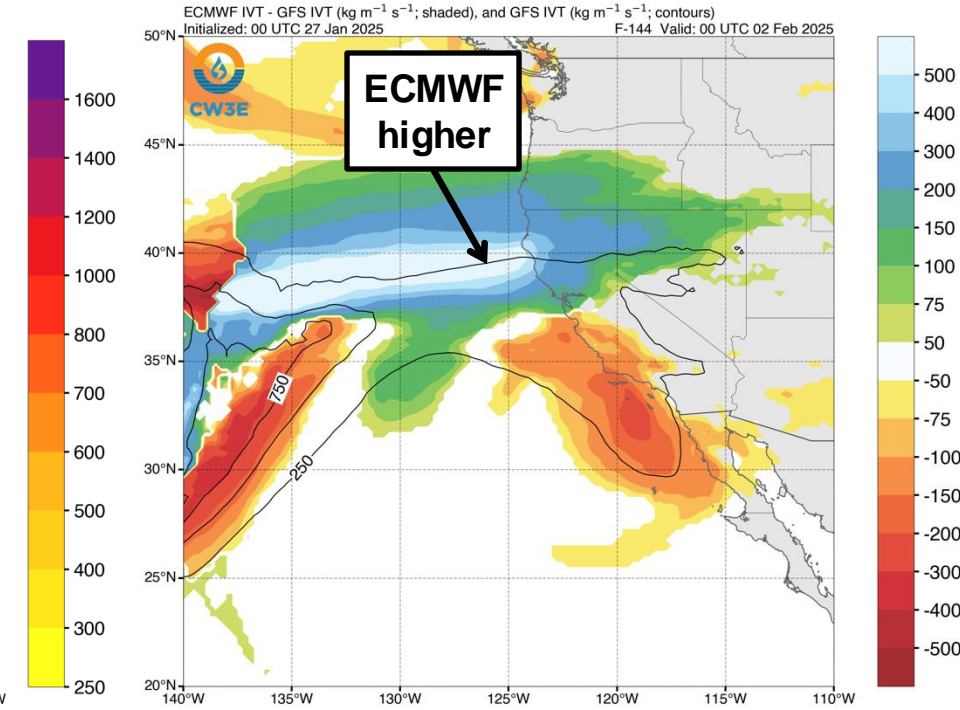
GFS



ECMWF



ECMWF Minus GFS



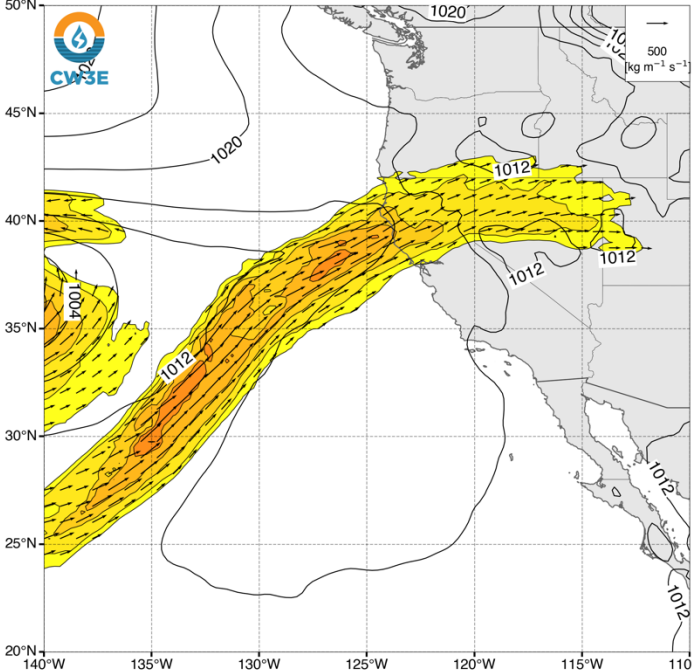
- At the same forecast time (4 PM PT Sat 1 Feb), ECMWF is forecasting much stronger and more westerly oriented bulk moisture transport over southern Oregon and Northern California ahead of the second AR.

# AR Outlook: 27 January 2025

## GFS vs. ECMWF IVT Forecasts: Valid 4 PM PT 2 Feb (F-168)

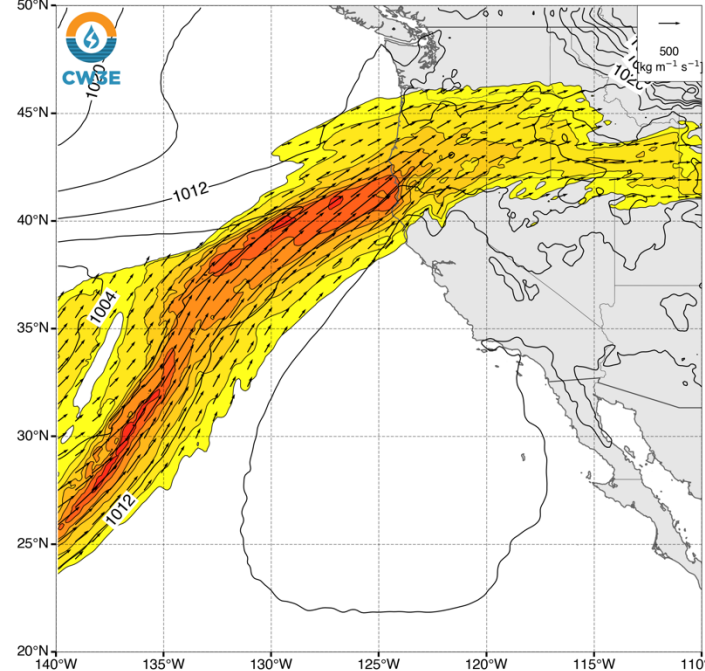
GFS

NCEP GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 00 UTC 27 Jan 2025 F-168 Valid: 00 UTC 03 Feb 2025



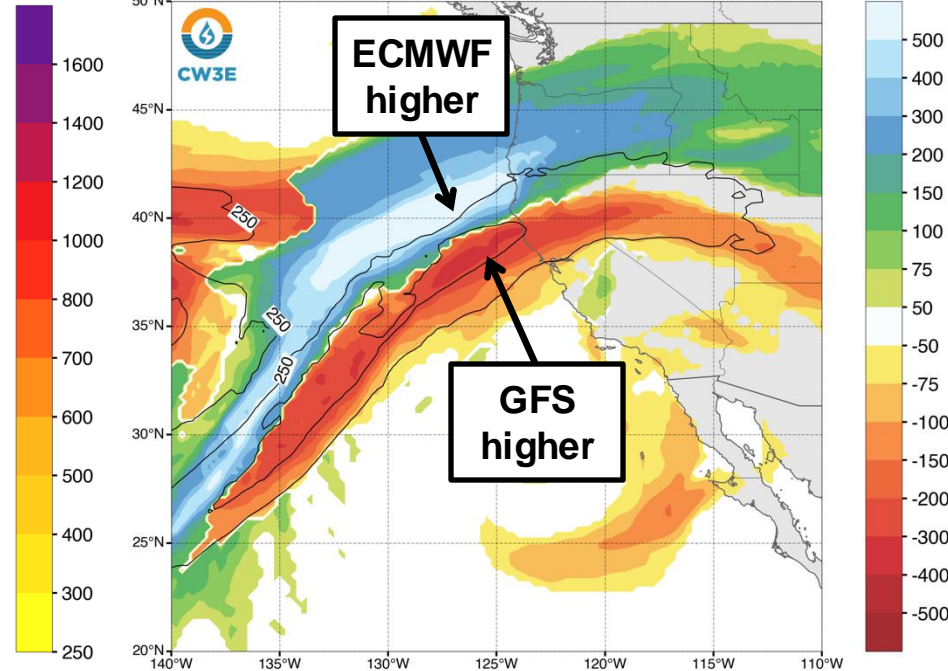
ECMWF

ECMWF IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
Initialized: 00 UTC 27 Jan 2025 F-168 Valid: 00 UTC 03 Feb 2025



ECMWF Minus GFS

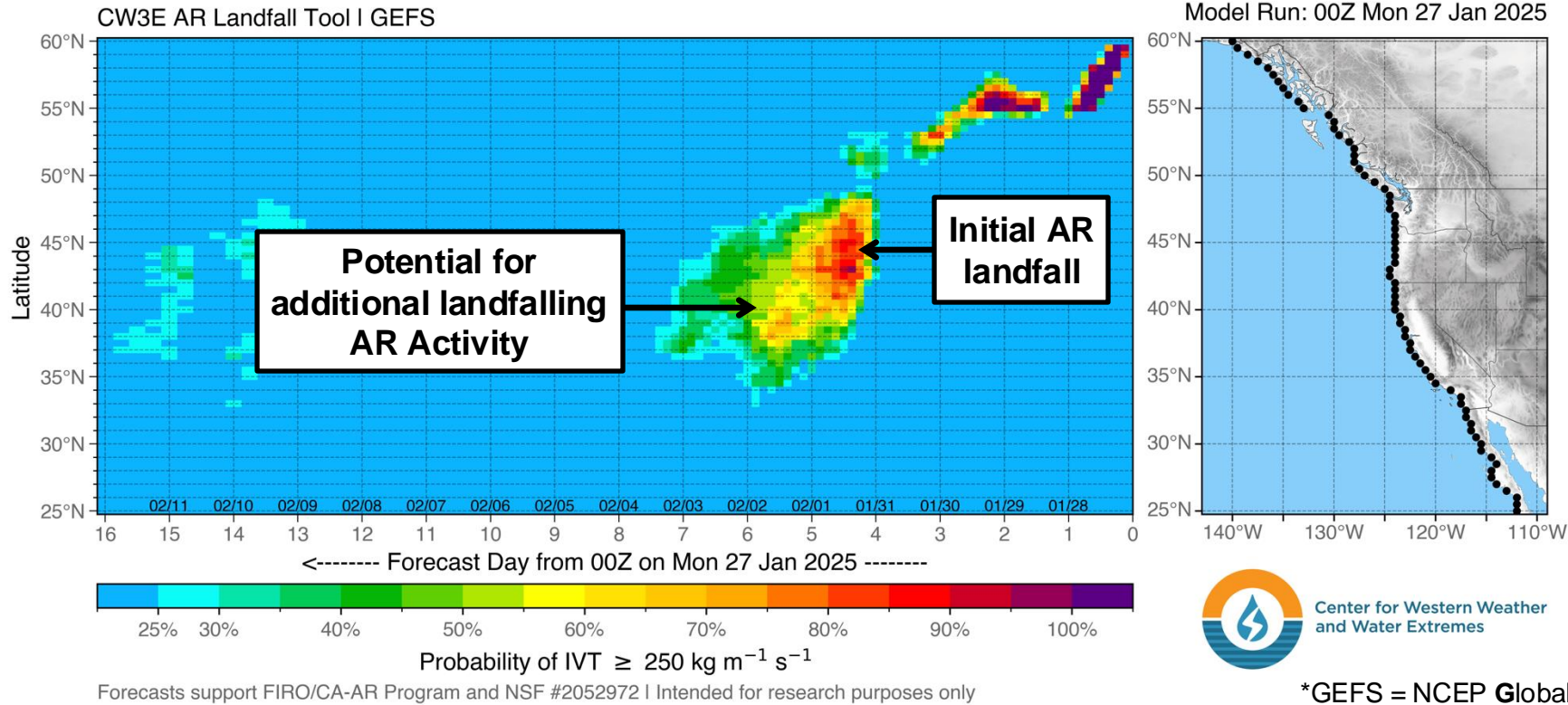
ECMWF IVT - GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), and GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; contours)  
Initialized: 00 UTC 27 Jan 2025 F-168 Valid: 00 UTC 03 Feb 2025



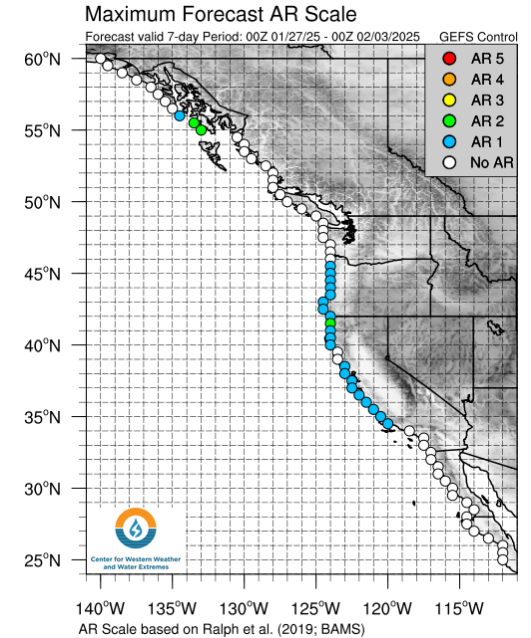
- The GFS is forecasting the second AR to make landfall over Northern California, with maximum IVT magnitudes  $\sim 500 \text{ kg m}^{-1} \text{ s}^{-1}$ .
- The ECMWF is forecasting the second AR to make landfall further north, with maximum IVT magnitudes exceeding  $700 \text{ kg m}^{-1} \text{ s}^{-1}$  near the Oregon/California border.
- Differences in the forecast location of AR landfall are clearly illustrated by the north-south dipole pattern in the IVT difference plot.

# AR Outlook: 27 January 2025

## GEFS Probability of AR Conditions Along Coast



## GEFS Control AR Scale



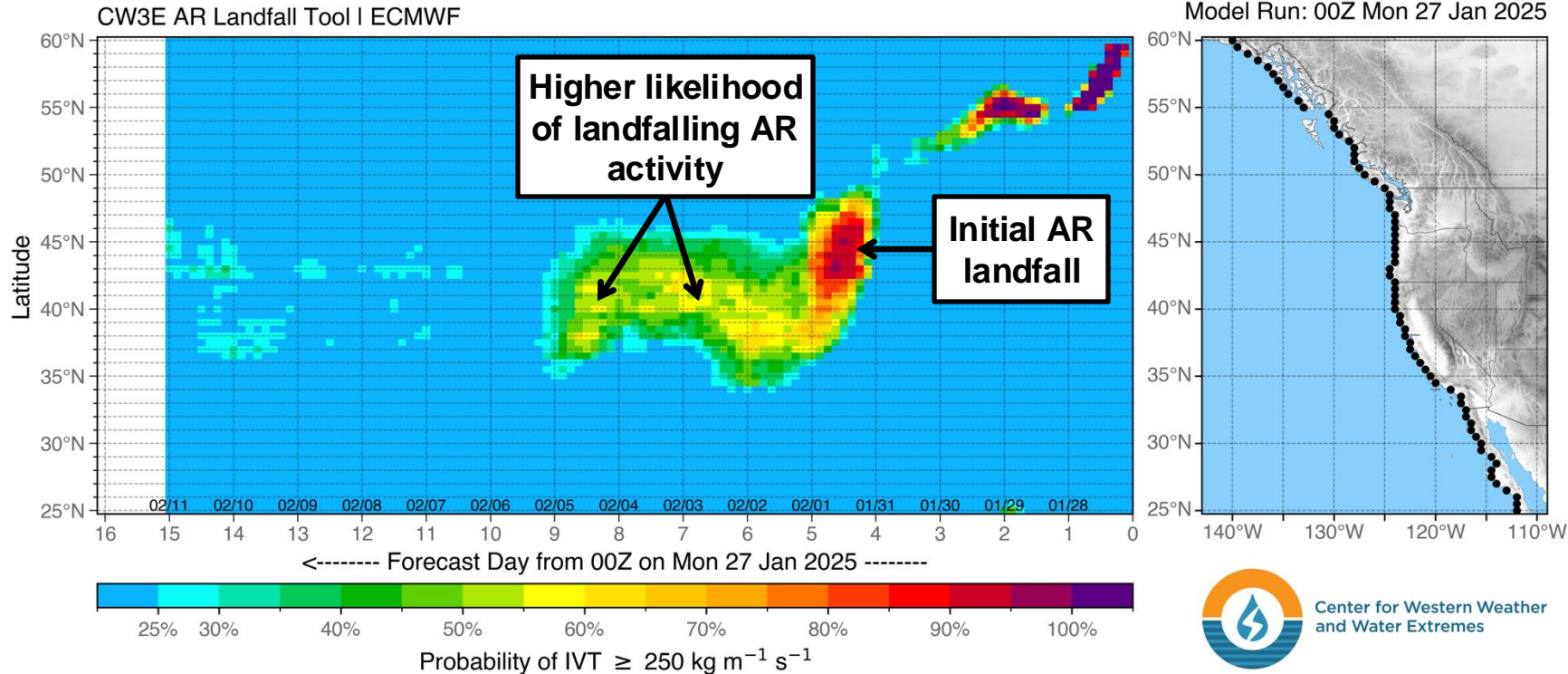
\*GEFS = NCEP Global Ensemble Forecast System (United States)

- The 00Z GEFS is showing high confidence (>70% probability) in AR conditions ( $IVT \geq 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) over coastal Oregon and far Northern California on Fri 31 Jan in association with the initial AR landfall.
- After the initial AR landfall, GEFS is showing moderate confidence (40–70% probability) in additional AR landfalling activity over the US West Coast through Sun 2 Feb, with the highest likelihood over Northern California on Sat 1 Feb.
- The 00Z GEFS control member is forecasting an AR 1 (based on the Ralph et al. 2019 AR Scale) over much of the US West Coast between northern Oregon and the Southern California Bight during the next 7 days

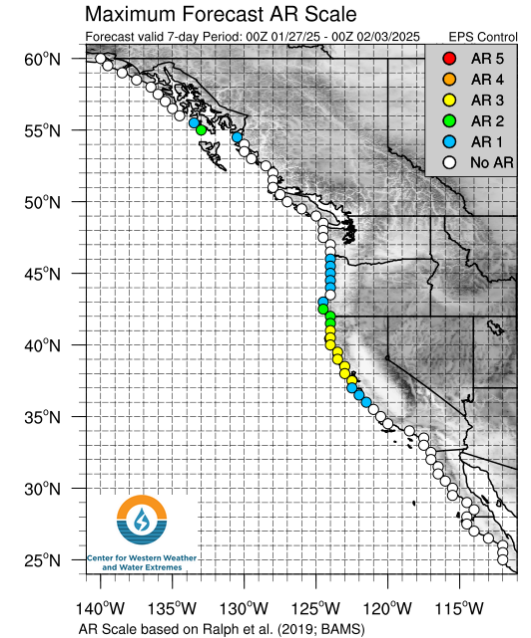


# AR Outlook: 27 January 2025

## EPS Probability of AR Conditions Along Coast



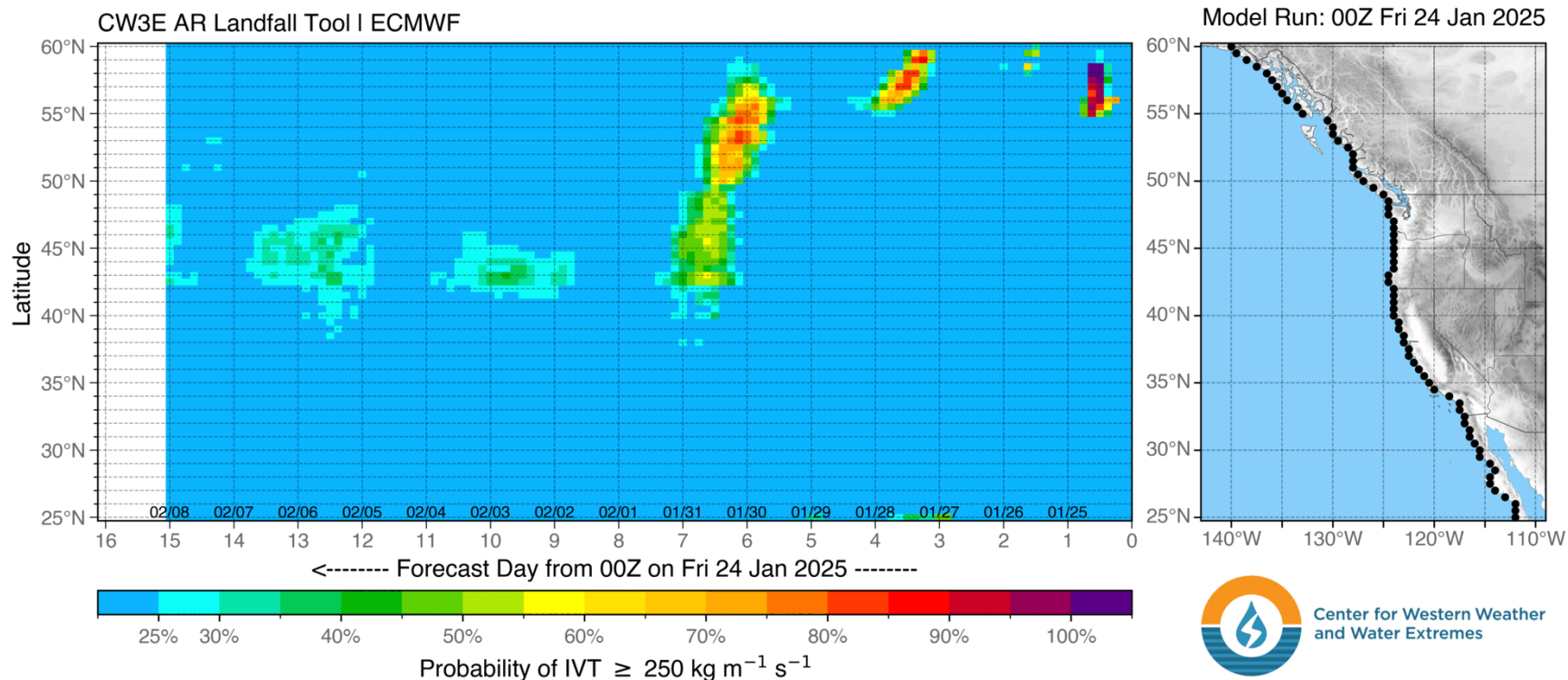
## EPS Control AR Scale



\*EPS = ECMWF Ensemble Prediction System (Europe)

- The 00Z EPS is also showing high confidence (>80% probability) in AR conditions over coastal Oregon and far Northern California on Fri 31 Jan in association with the initial AR landfall.
- Compared to GEFS, the EPS is showing a higher likelihood of additional landfalling AR activity continuing through Tue 4 Feb.
- The 00Z EPS control member is forecasting an AR 3 over much of coastal Northern California during the next 7 days, with an AR 2 forecast near the Oregon/California border, and an AR 1 forecast over coastal Central California.

## EPS Probability of AR Conditions Along Coast: dProg/dt



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

\*EPS = ECMWF Ensemble Prediction System (Europe)

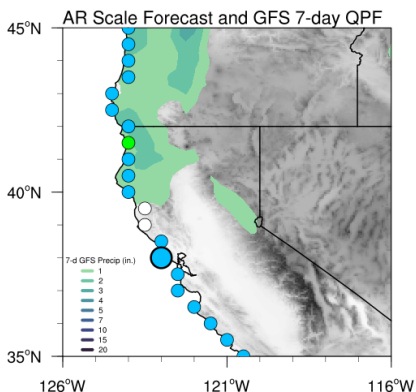
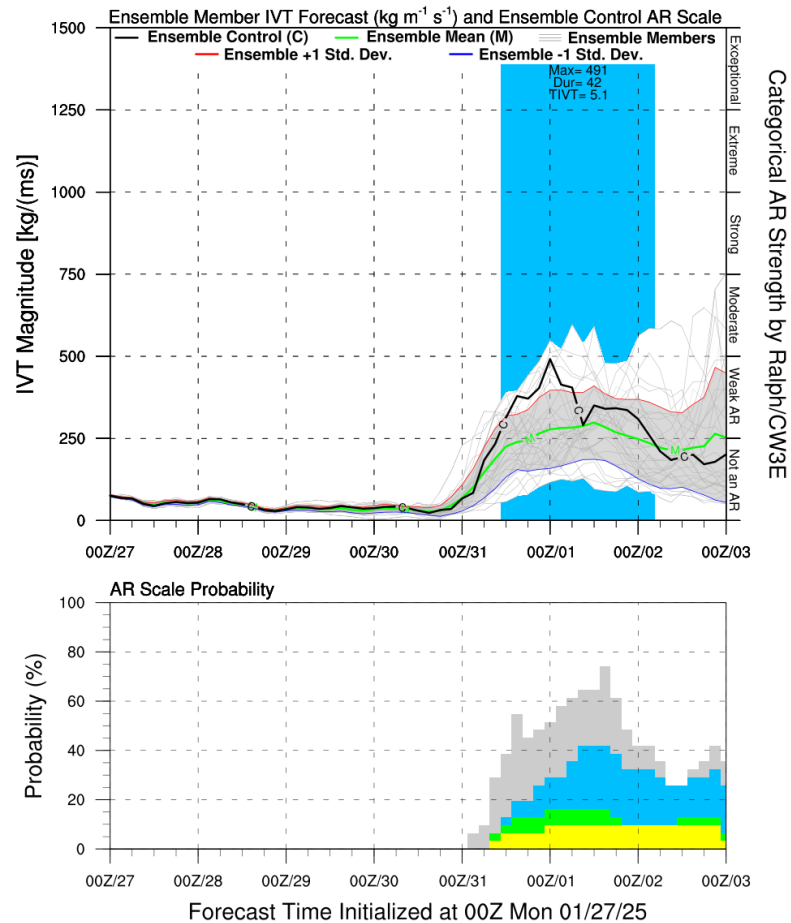
- Forecast confidence in landfalling AR activity over coastal Oregon and Northern California has steadily increased in both GEF S and EPS over the past 3 days.
- Recent EPS runs have also picked up on the potential for this period of AR activity to extend into early next week.

# AR Outlook: 27 January 2025

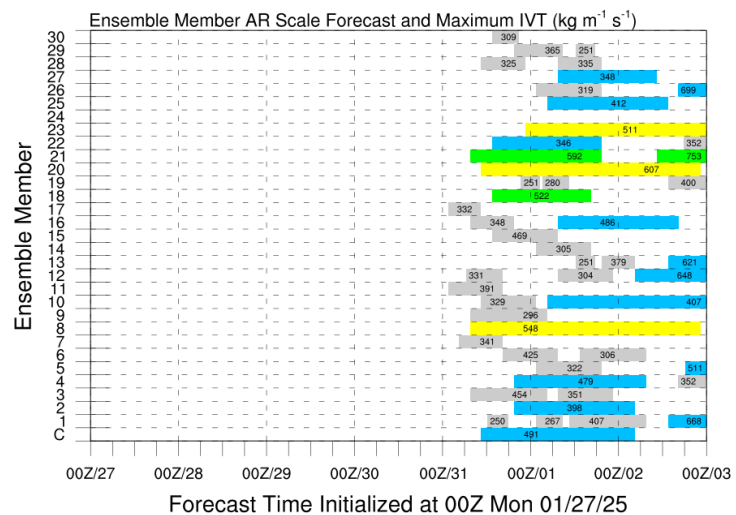
## GEFS AR Scale and IVT Forecasts

GFS Ensemble Initialized: 00Z Mon 01/27/25

Location: 38°N 123°W



- The 00Z GEFS control member is forecasting an AR 1 over coastal Northern California during the next 7 days.
- About 40% (13/31) of GEFS members are forecasting an AR 1 or greater at 38°N, 123°W (Marin County, CA) in association with the first and second ARs.



AR 1 AR 2 AR 3 AR 4 AR 5

Image created: 05 UTC 01/27/2025

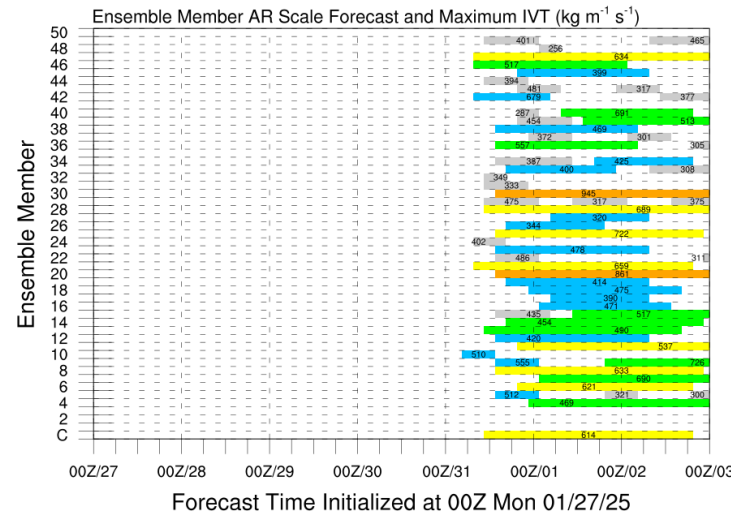
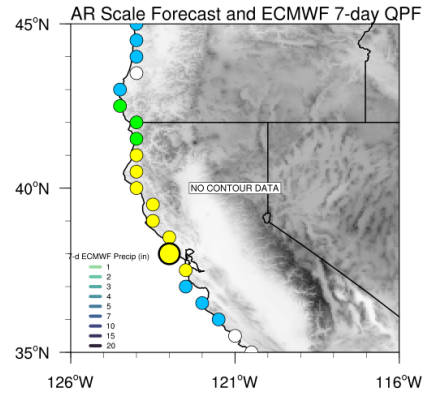
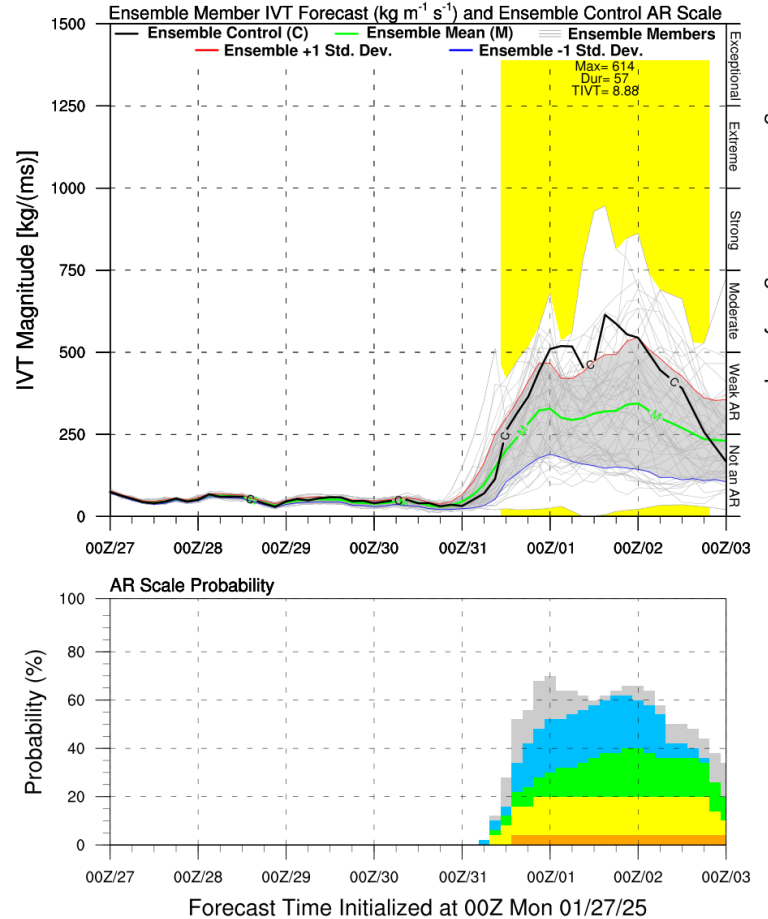
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

# AR Outlook: 27 January 2025

## EPS AR Scale and IVT Forecasts

ECMWF Ensemble Initialized: 00Z Mon 01/27/25

Location: 38°N 123°W



- The 00Z EPS control member is forecasting an AR 3 over coastal Northern California in association with the first and second ARs.
- About 40% (20/51) of EPS members are forecasting an AR 2 or greater at 38°N, 123°W (Marin County, CA) over the next 7 days.
- Compared to GEFS, EPS is generally forecasting stronger IVT to remain over Northern California, with many EPS members forecasting no break in AR conditions between the first and second ARs.



AR 1 AR 2 AR 3 AR 4 AR 5

Image created: 08 UTC 01/27/2025

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

## Precipitation Forecasts

### GFS 24-h QPF

Valid: 4 AM PT 2 Feb

### ECMWF 24-h QPF

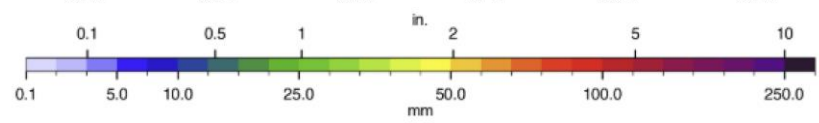
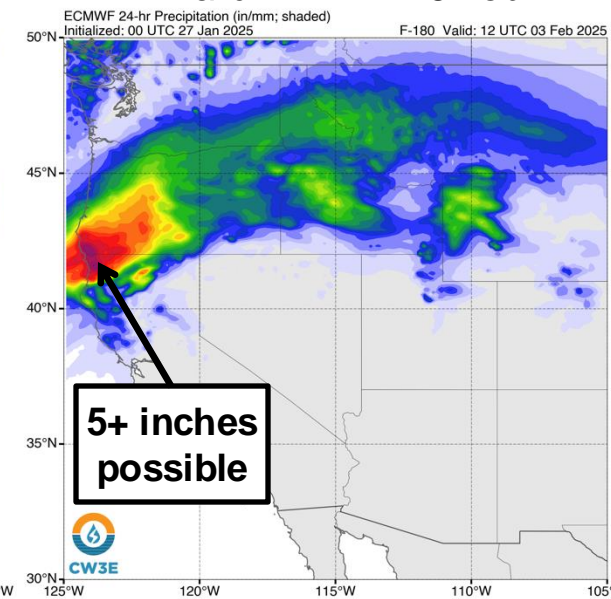
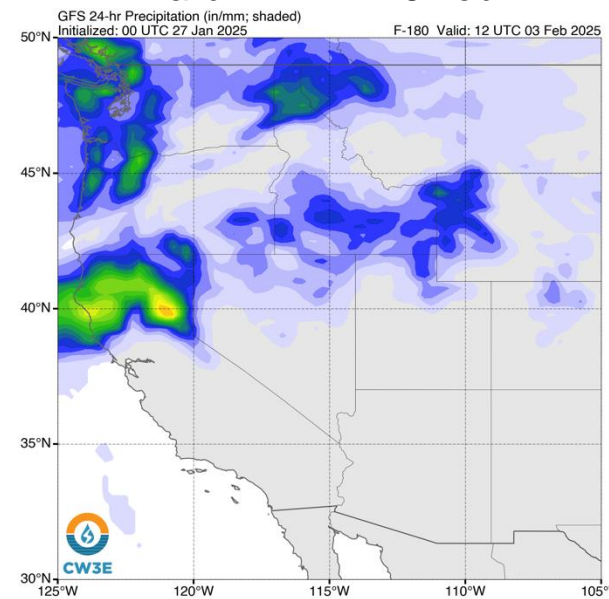
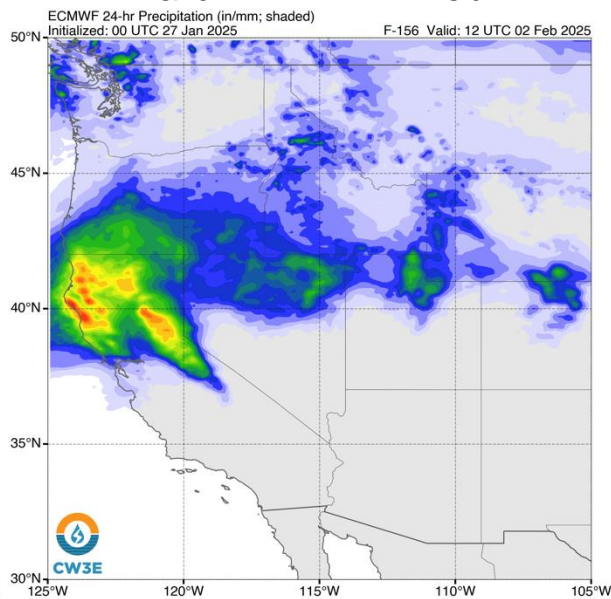
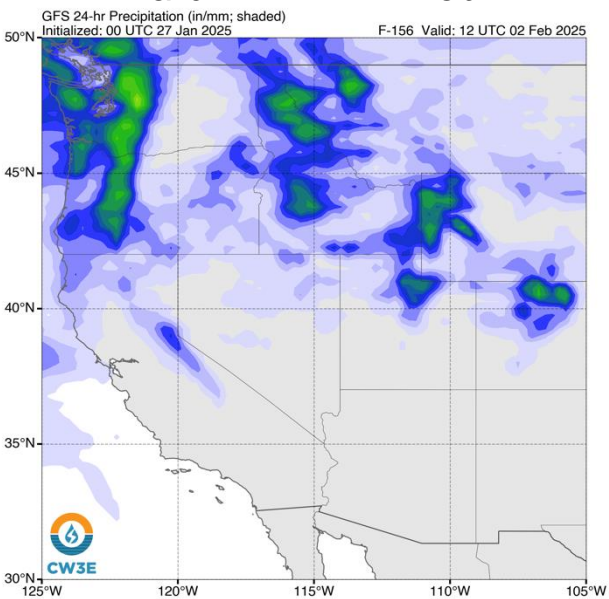
Valid: 4 AM PT 2 Feb

### GFS 24-h QPF

Valid: 4 AM PT 3 Feb

### ECMWF 24-h QPF

Valid: 4 AM PT 3 Feb

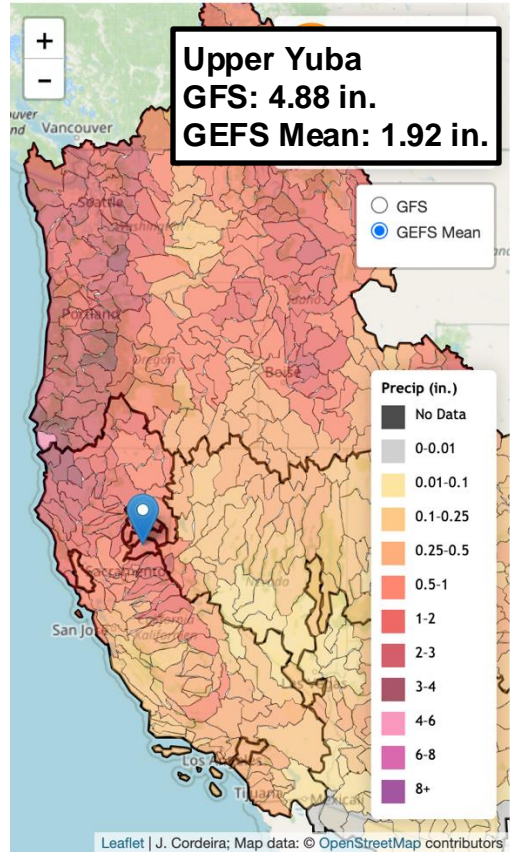


- Differences in the forecast evolution of these ARs beyond Fri 31 Jan are contributing to large differences in forecast precipitation.
- The deterministic ECMWF is forecasting heavier precipitation over Northern California Sat 1 Feb into early Sun 2 Feb due to stronger and more westerly IVT during this period.
- The ECMWF is forecasting the heaviest precipitation during the second AR near the Oregon/California border, while the GFS is forecasting the heaviest precipitation further south.
- The ECMWF is showing potential for 5+ inches of precipitation in some locations during the 24-hour period ending 4 AM PT Mon 3 Feb.

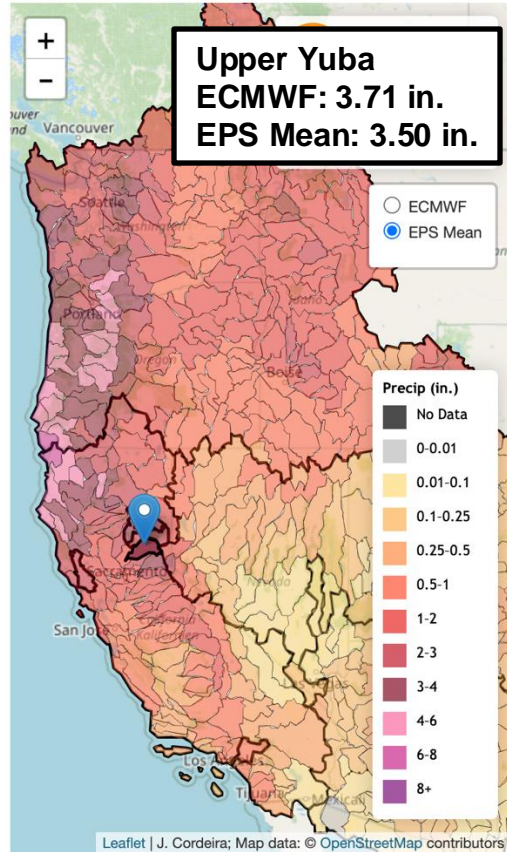
# AR Outlook: 27 January 2025

## Watershed Precipitation Forecasts

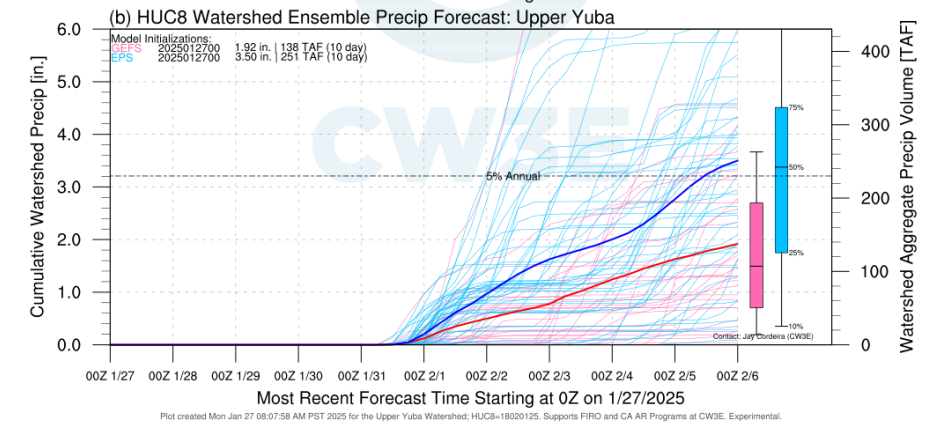
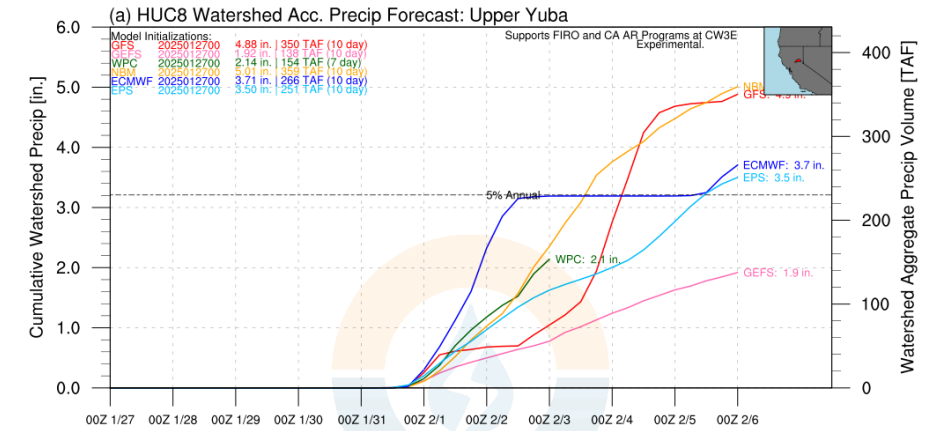
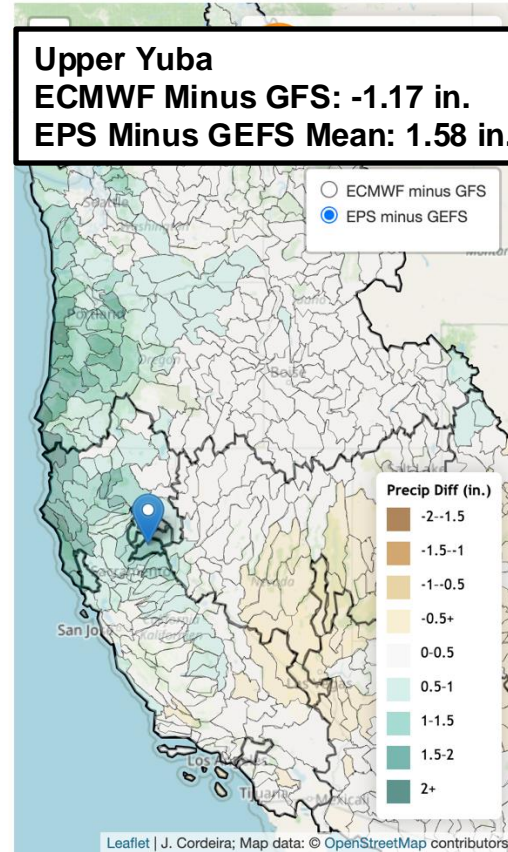
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



10-day Difference Precipitation Forecast

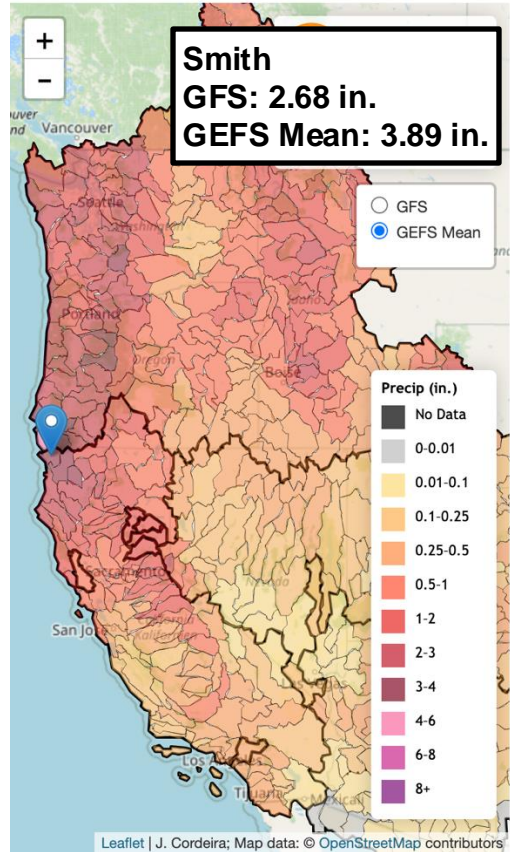


- Overall, the EPS is forecasting higher precipitation totals than the GEFS over much of western Oregon and Northern California during the next 10 days due to the EPS forecasting stronger moisture transport in these areas.
- In the Upper Yuba watershed, > 50% of EPS members and < 25% of GEFS members are forecasting 3+ inches of mean areal precipitation.
- While the EPS is forecasting higher precipitation amounts in the Upper Yuba than GEFS, the ECMWF deterministic model is actually forecasting less total precipitation than the GFS deterministic model due to the more northerly forecast in the second AR landfall.

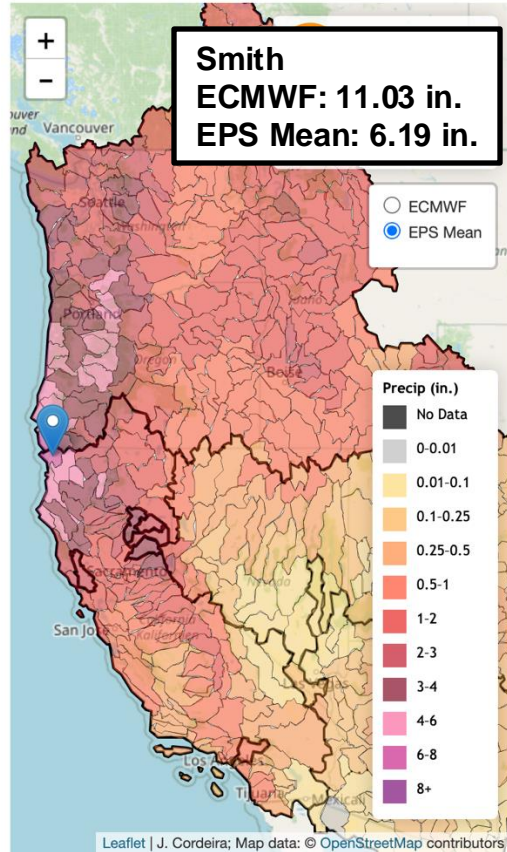
# AR Outlook: 27 January 2025

## Watershed Precipitation Forecasts

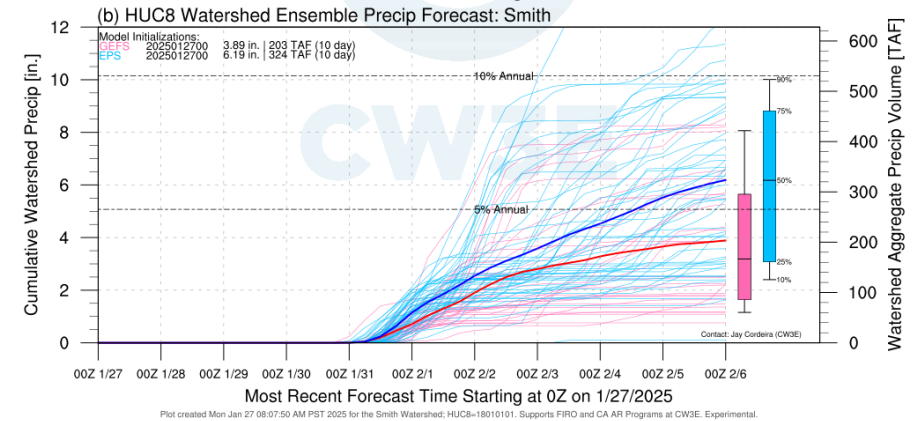
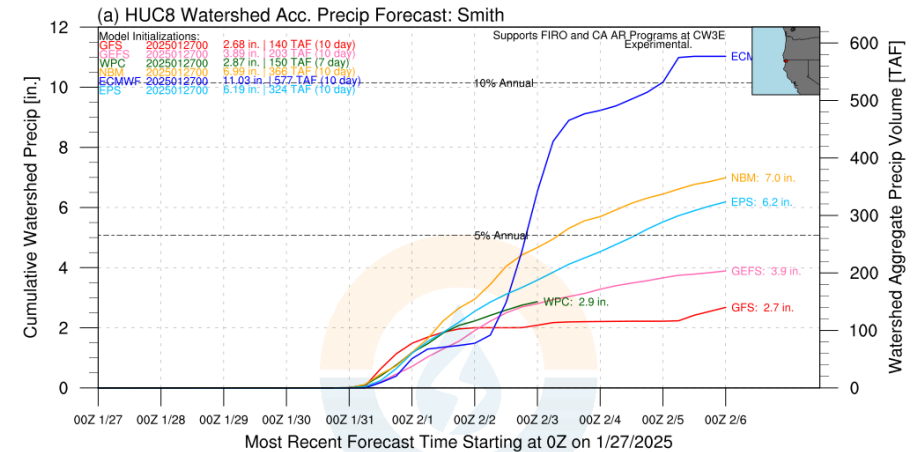
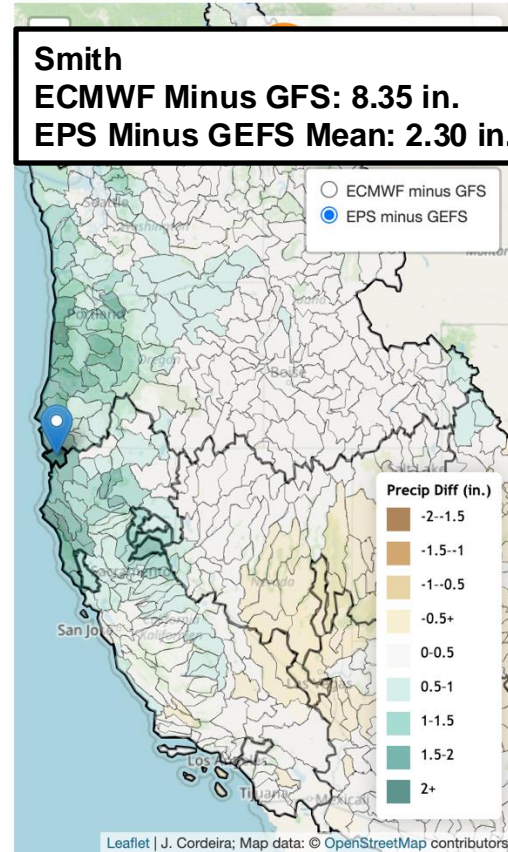
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



10-day Difference Precipitation Forecast



- In the Smith watershed, ~50% of EPS members and < 25% of GEFS members are forecasting 6+ inches of mean areal precipitation
- The ECMWF deterministic model is forecasting much higher precipitation amounts in the Smith than the GFS deterministic model (> 8 inches difference) due to the more northerly forecast in the second AR landfall.