

# CW3E Atmospheric River Outlook: 20 Dec 2021

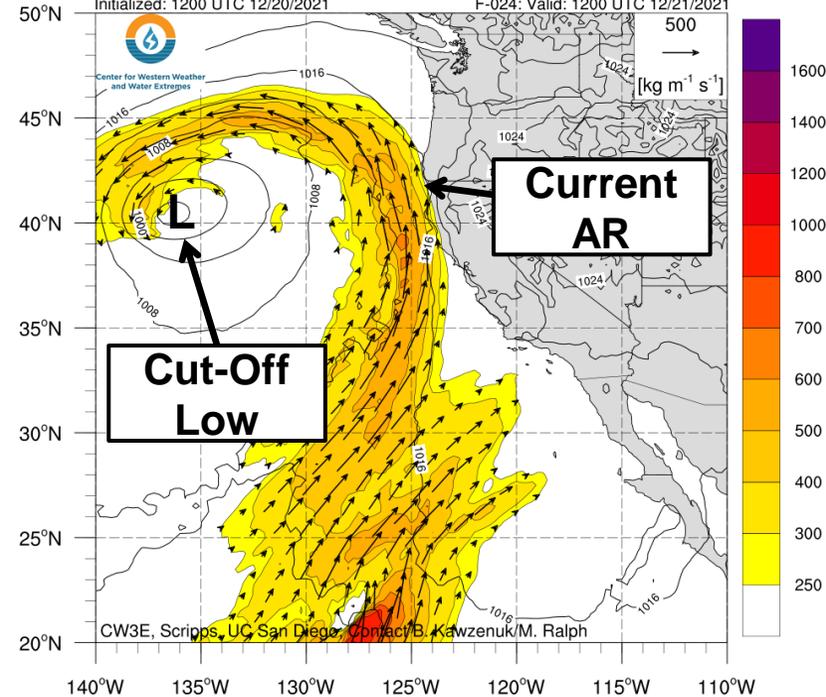
## Atmospheric River Conditions are Forecast Over the US West Coast this Week with Heavy Precipitation in California

- AR activity is forecasted to bring stormy conditions from the Pacific Northwest to Baja California this week
- The current AR and its parent low continue to bring rain to parts of the Pacific Northwest through tomorrow afternoon
- The break will be short-lived though, as additional precipitation moves onshore in association with multiple shortwave troughs
- The trough associated with the current AR is expected to cut off from the main flow and weaken
- As it weakens, tropical moisture is exported towards Southern California and Baja California as part of the 2<sup>nd</sup> AR
- There is still considerable uncertainty in the timing, magnitude, and duration of AR conditions and precipitation
- The 12Z GEFS control member is forecasting AR 4 conditions for northern Baja California and AR 3 conditions in San Diego County
- Over the next seven days, the NWS Weather Prediction Center (WPC) is forecasting 5–10 inches of total precipitation (locally > 10 inches) over the Sierra Nevada and 1–3 inches of total precipitation over coastal Southern California, the Transverse Ranges, and the Peninsular Ranges
- Several feet of snow are possible in the Sierra Nevada

## GFS IVT Analyses & Forecasts

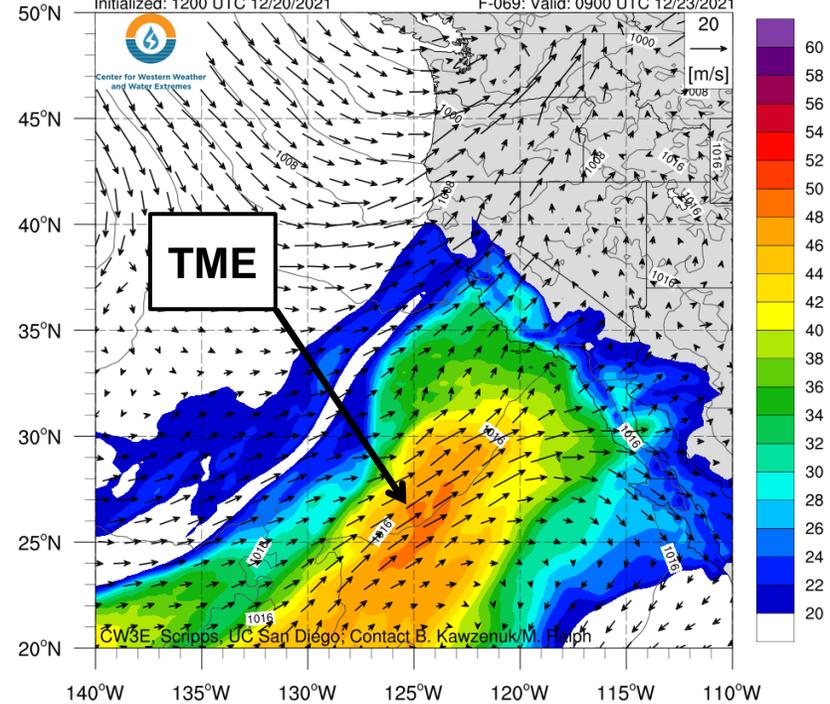
(A) Valid: 4 AM PT 21 Dec (F-24)

NCEP GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
 Initialized: 1200 UTC 12/20/2021 F-024: Valid: 1200 UTC 12/21/2021



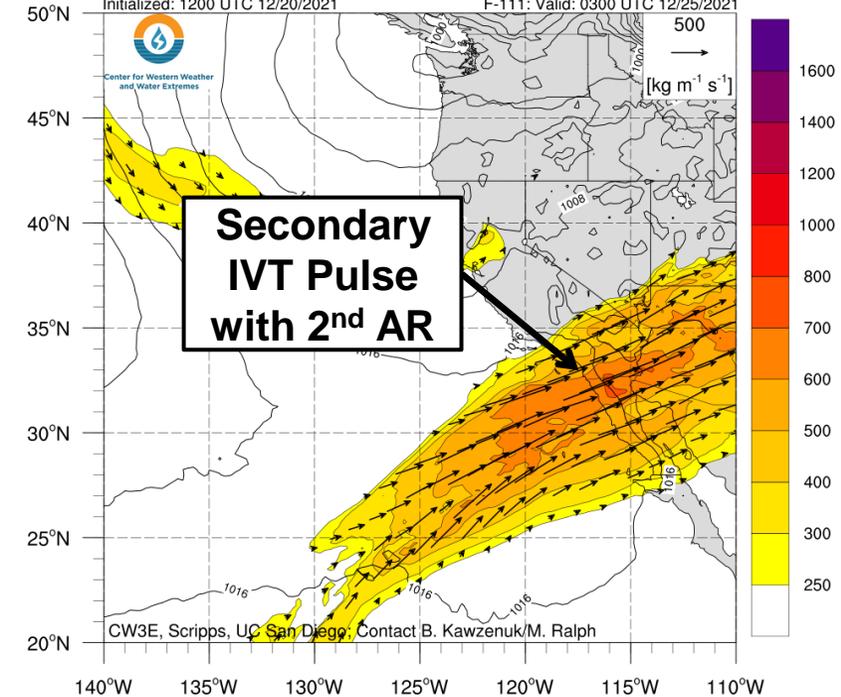
(B) Valid: 1 AM PT 23 Dec (F-69)

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
 Initialized: 1200 UTC 12/20/2021 F-069: Valid: 0900 UTC 12/23/2021



(C) Valid: 7 PM PT 24 Dec (F-111)

NCEP GFS IVT ( $\text{kg m}^{-1} \text{s}^{-1}$ ; shaded), IVT Vector, and SLP (hPa; contours)  
 Initialized: 1200 UTC 12/20/2021 F-111: Valid: 0300 UTC 12/25/2021

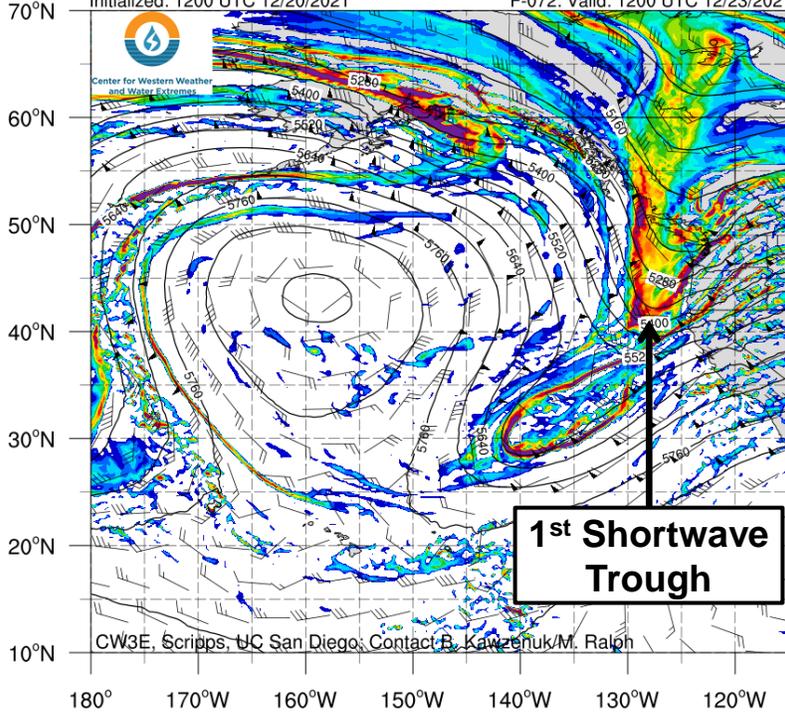


- The 12Z GEFS deterministic model is forecasting maximum IVT values between  $500$  and  $600 \text{ kg m}^{-1} \text{s}^{-1}$  to continue along the coast of Southern Oregon until 21 December in association with a quasi-stationary trough (Figure A)
- On 22 December, a 2<sup>nd</sup> AR is forecasted to make landfall in Southern California and Northern Baja California in association with significant Tropical Moisture Export (TME-Figure B)
- Maximum IVT values on 25 December, associated with a secondary pulse of IVT, are forecasted to be  $> 800 \text{ kg m}^{-1} \text{s}^{-1}$  along the coast of Northern Baja California with a duration of 93 hours (Figure C)

## GFS 500-mb Height & Vorticity Forecasts

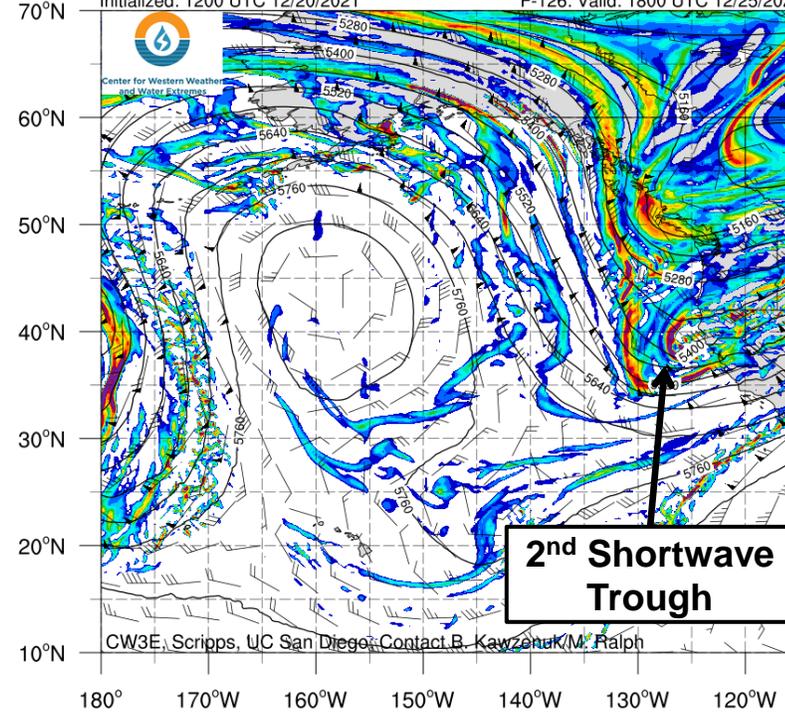
(A) Valid: 4 AM PT 23 Dec (F-72)

NCEP GFS 500-hPa Absolute Vorticity ( $\times 10^{-5} \text{ s}^{-1}$ ), Height (gpm), and  
Initialized: 1200 UTC 12/20/2021 F-072: Valid: 1200 UTC 12/23/2021



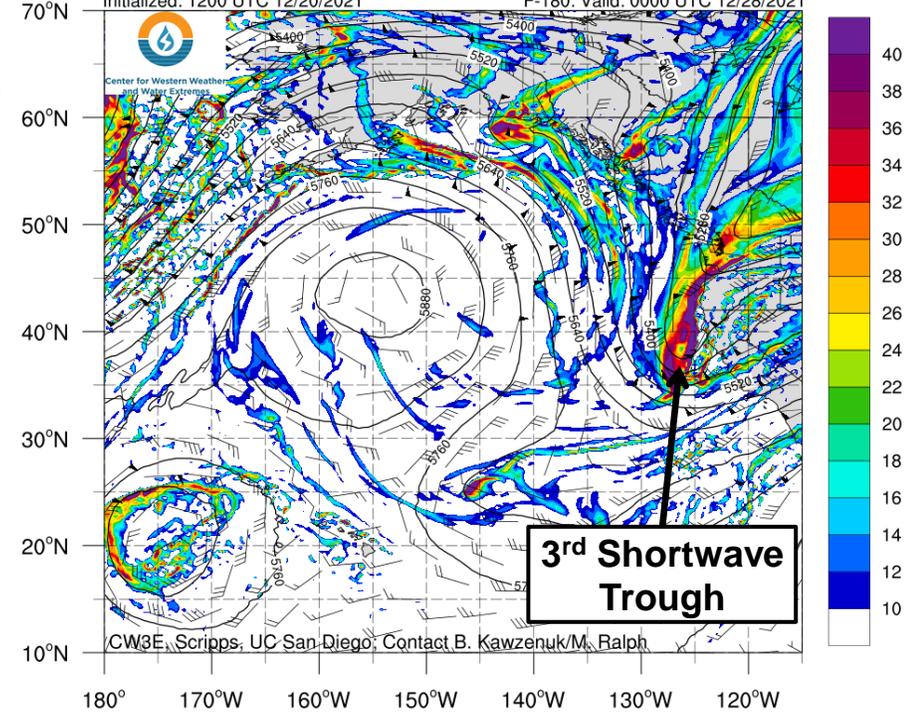
(B) Valid: 10 AM PT 25 Dec (F-126)

NCEP GFS 500-hPa Absolute Vorticity ( $\times 10^{-5} \text{ s}^{-1}$ ), Height (gpm), and  
Initialized: 1200 UTC 12/20/2021 F-126: Valid: 1800 UTC 12/25/2021



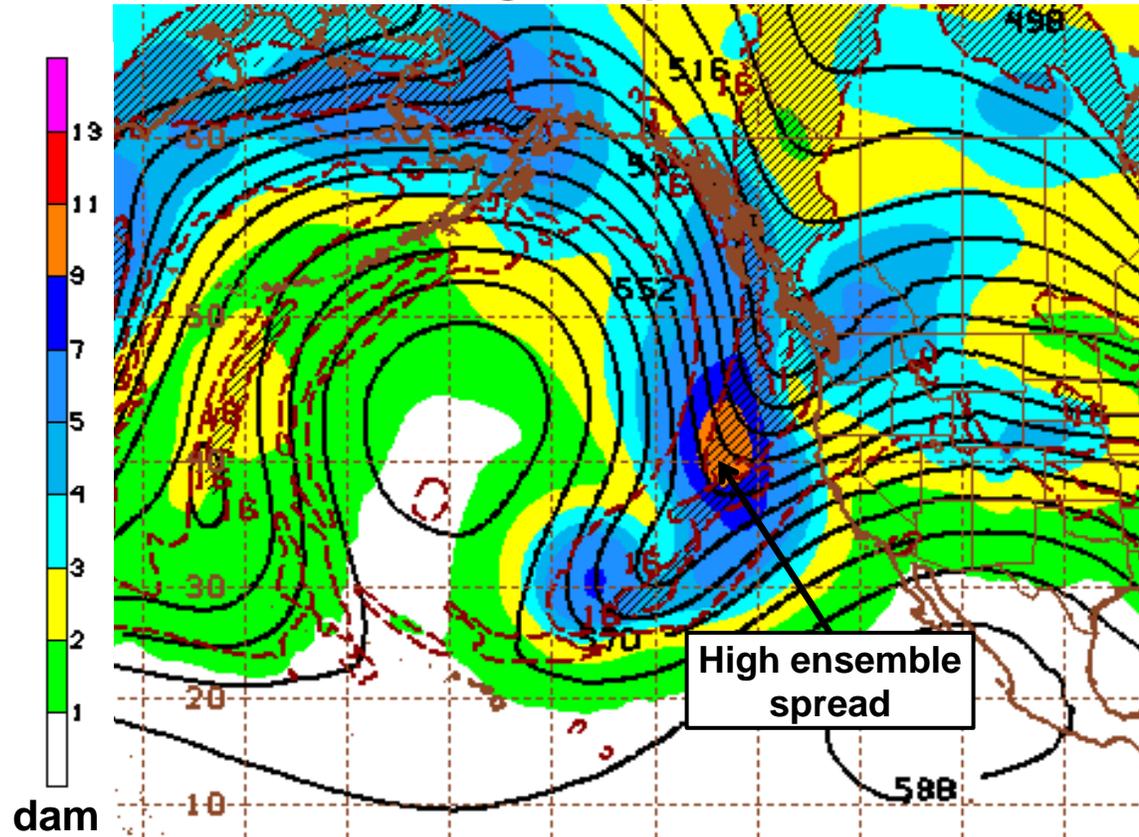
(C) Valid: 4 PM PT 27 Dec (F-180)

NCEP GFS 500-hPa Absolute Vorticity ( $\times 10^{-5} \text{ s}^{-1}$ ), Height (gpm), and Winds  
Initialized: 1200 UTC 12/20/2021 F-180: Valid: 0000 UTC 12/28/2021



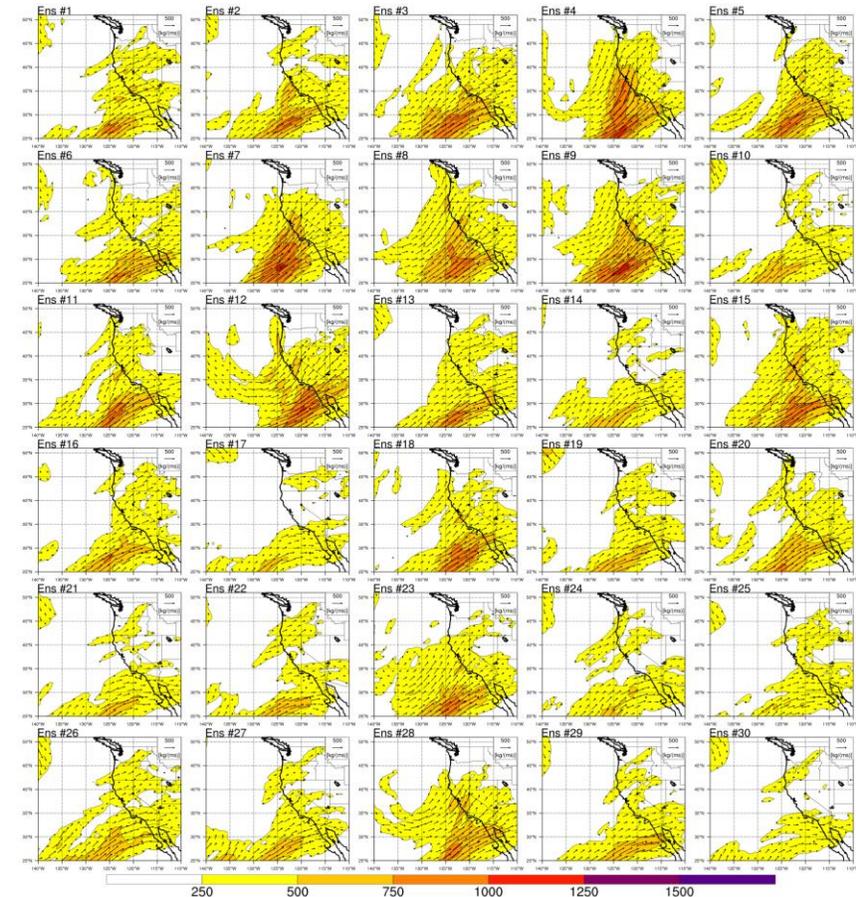
- As the TME surges northward on 22–23 Dec, an amplifying 500-hPa shortwave trough is forecasted to approach the US West Coast, providing additional forcing for upward vertical motion and precipitation in Northern California (Figure A)
- After a brief lull in activity, another round of heavy precipitation is forecasted across the Sierra Nevada on 25–26 Dec as a second shortwave trough approaches the US West Coast (Figure B)
- Yet another shortwave trough is forecasted to move down along the US West Coast on 27 Dec, potentially bringing additional precipitation to Northern and Central California (Figure C)

### GEFS 500-mb Height & Spread: Valid 06Z 23 Dec



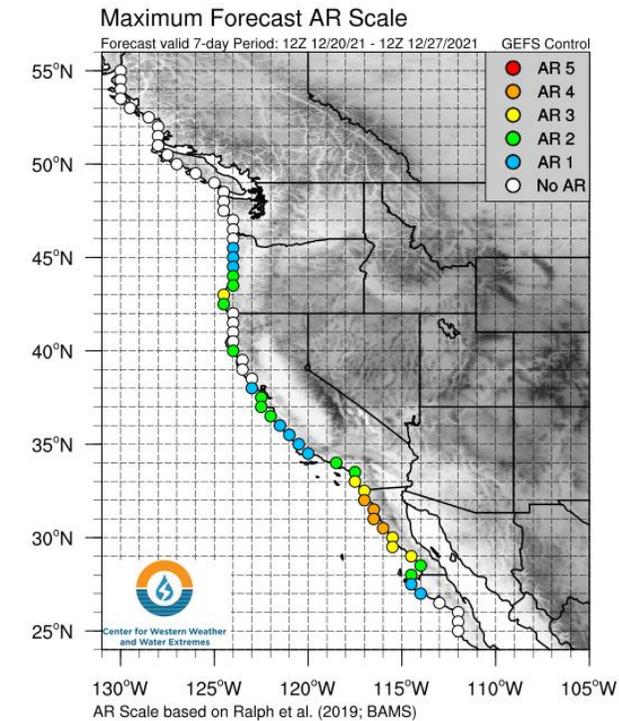
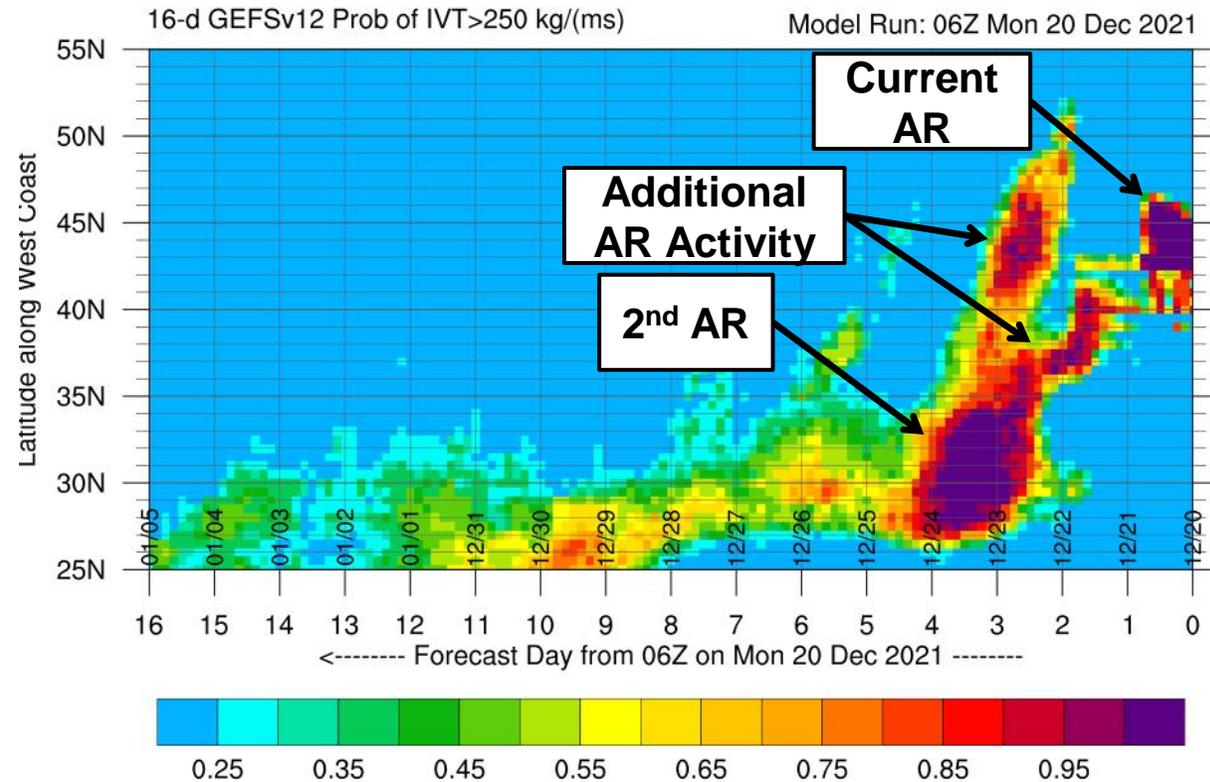
Source: NOAA/NWS/NCEP

### GEFS IVT [kg/(ms)] valid 6Z Thu 12/23/21 | F+72h



- There is still a large degree of uncertainty in the position and amplitude of the first 500-hPa shortwave trough as it approaches the USWC
- This is leading to uncertainty in the evolution of the TME as it moves northeastward over California on 22–23 Dec
- Several GEFS members are forecasting stronger and more southerly moisture transport reaching Northern California, whereas others are forecasting generally weak and westerly moisture transport across the state

## GEFS AR Scale & IVT Analyses



- The 06Z GEFS is showing very high confidence ( $> 95\%$  probability) for AR conditions ( $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to continue throughout coastal Oregon with the current AR
- There is high confidence ( $> 90\%$  probability) in short-lived periods of AR activity over much of California on 21–23 Dec
- The 12Z GEFS control run is also showing very high confidence ( $> 95\%$  probability) for AR conditions ( $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) over Southern California and Baja California in association with the 2nd AR

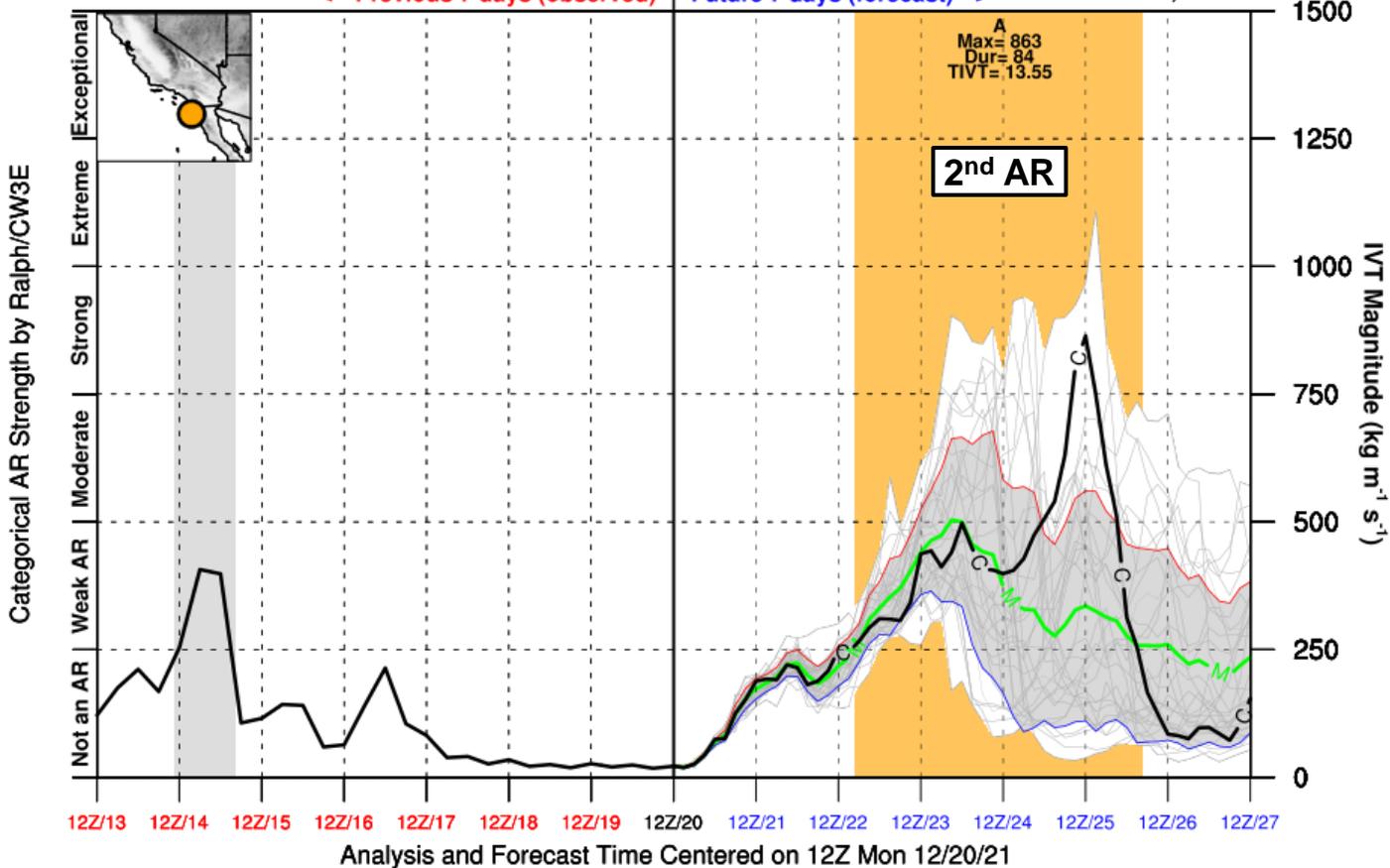
# CW3E Atmospheric River Outlook: 20 Dec 2021

For California DWR's AR Program

GEFS AR Scale & IVT Analysis/Forecast Initialized 12Z Mon 12/20/21

<-- Previous 7 days (observed) | Future 7 days (forecast) -->

Loc: 32N, 117W



Analysis and Forecast Time Centered on 12Z Mon 12/20/21

— Ensemble Control (C)  
 — Ensemble Mean (M)  
 Ensemble Members  
 — Ensemble +1 Std. Dev.  
 — Ensemble -1 Std. Dev.

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

- The 12Z GEFS control member is forecasting a maximum IVT of  $863 \text{ kg m}^{-1} \text{ s}^{-1}$  and a total duration of AR conditions of 84 hours in Northern Baja California resulting in AR 4 conditions on the AR scale
- There is still significant ensemble spread in the overall timing, magnitude, and duration of this AR, where 6 ensemble members are predicting AR 1 conditions, 3 for AR 2, 12 for AR 3, 8 for AR 4, and 1 for AR 5

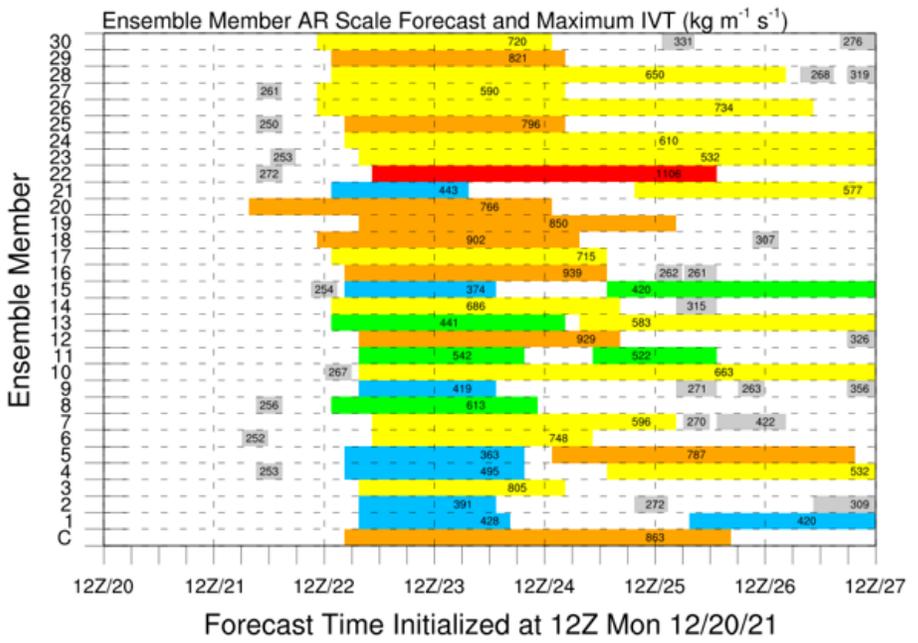
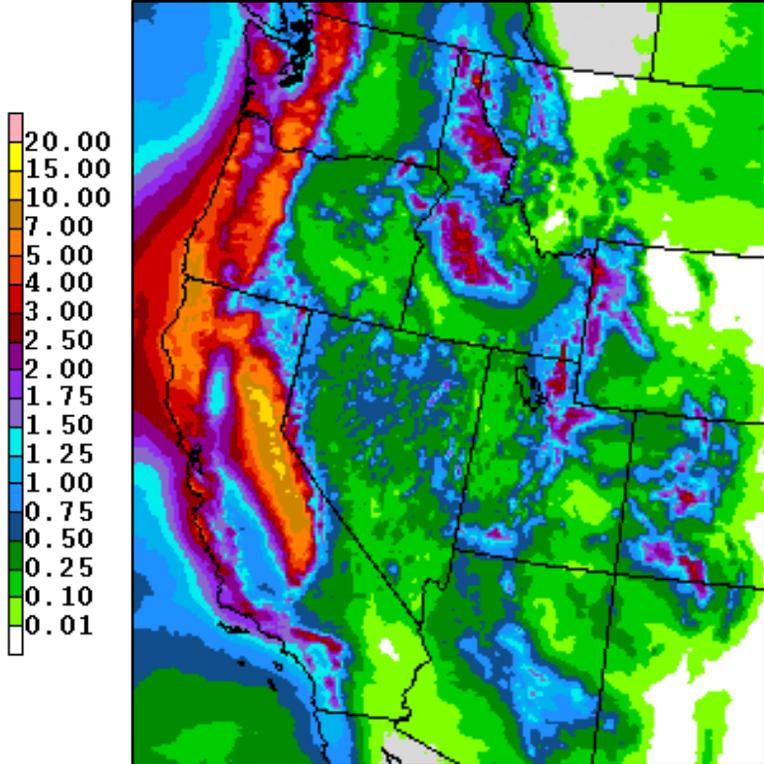


Image created: 17 UTC 12/20/2021

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

## Precipitation Impacts

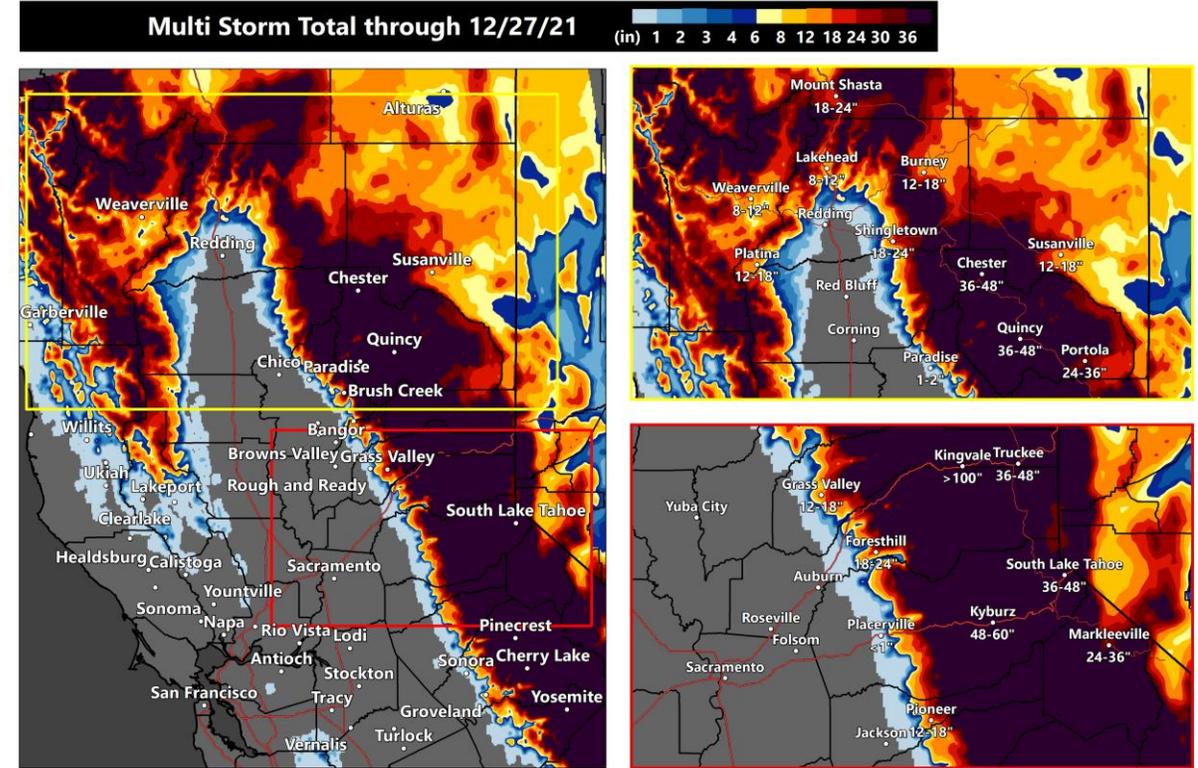
WPC 7-day QPF: Valid 4 AM PT 20–27 Dec



Source: NOAA/NWS Weather Prediction Center



## Snow Forecast

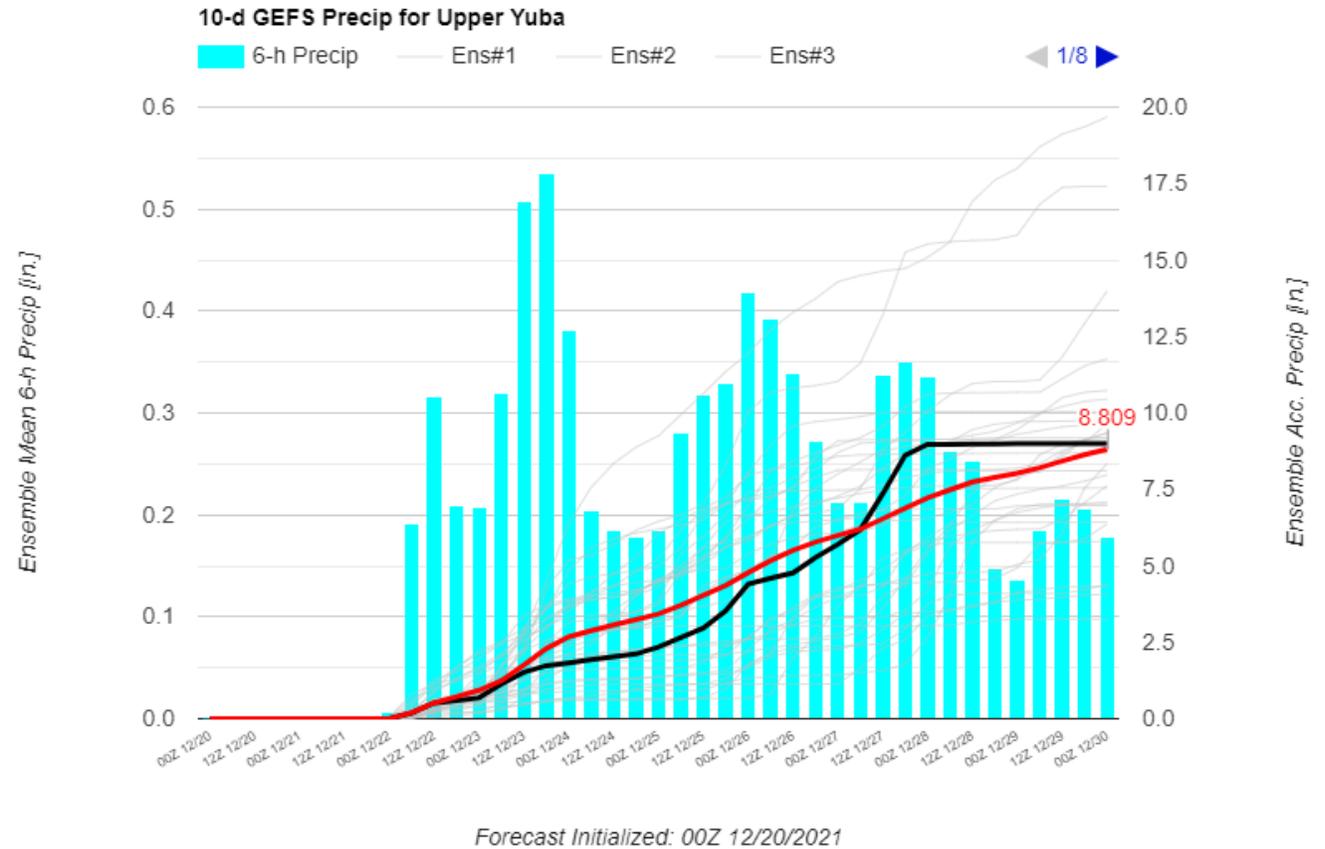
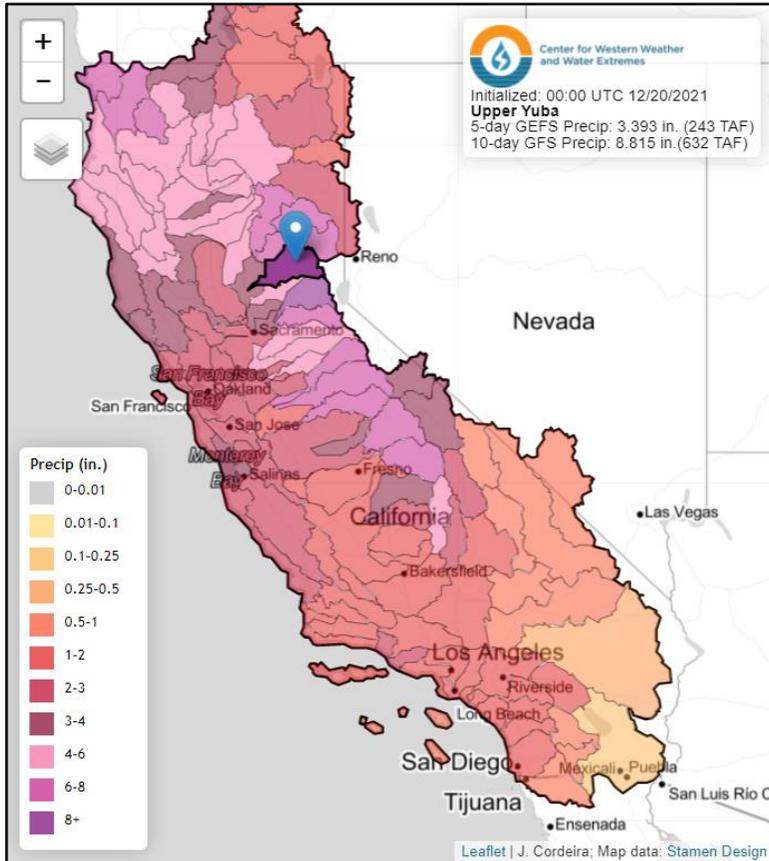


December 20, 2021 Forecast

Source: NWS Sacramento

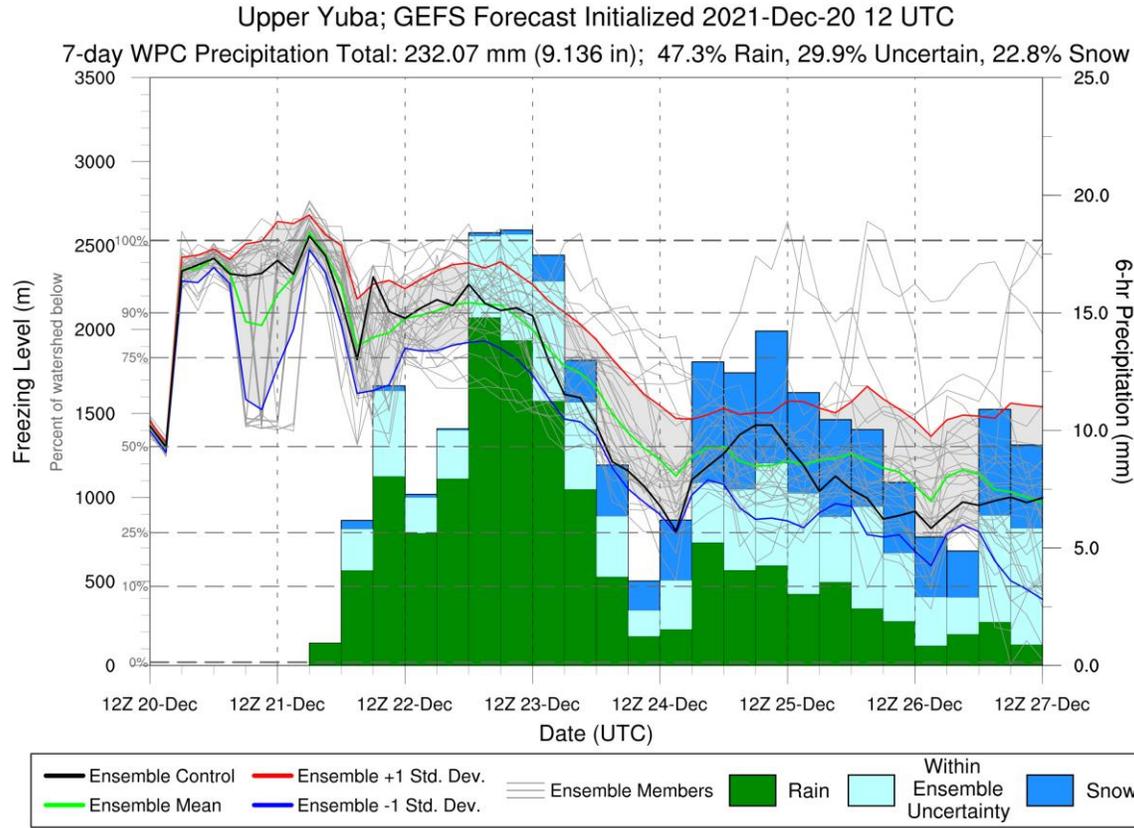
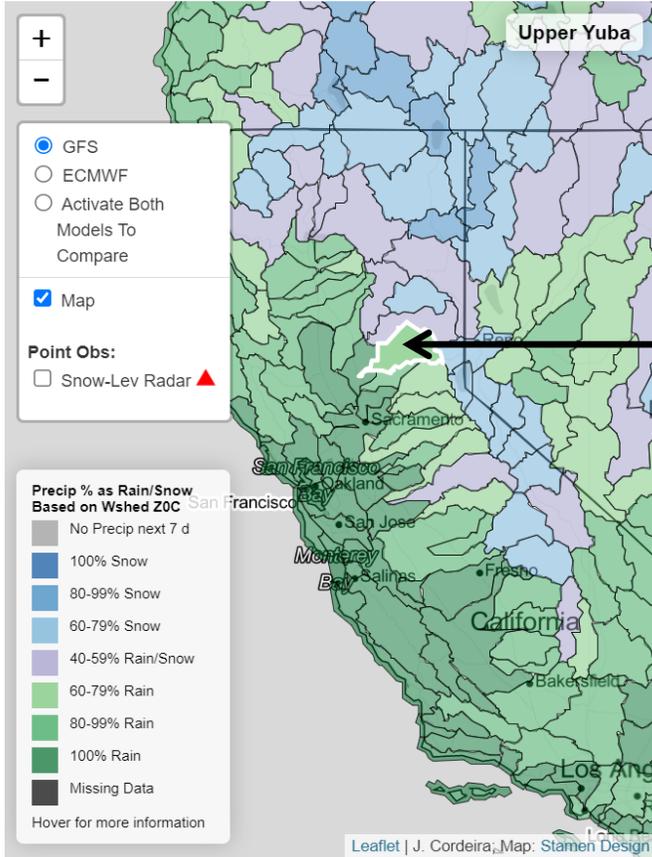
- The NWS WPC is forecasting at least 5–10 inches of total precipitation (locally > 10 inches) over the Sierra Nevada during the next 7 days
- About 1–3 inches of precipitation are forecasted over coastal Southern California, the Transverse Ranges, and the Peninsular Ranges
- Several feet of snow are expected in the higher terrain of the Sierra Nevada over the next 7 days
- Some locations could receive more than 8 feet of total snowfall

## 10-day GEFS Watershed Precipitation Forecasts: Upper Yuba



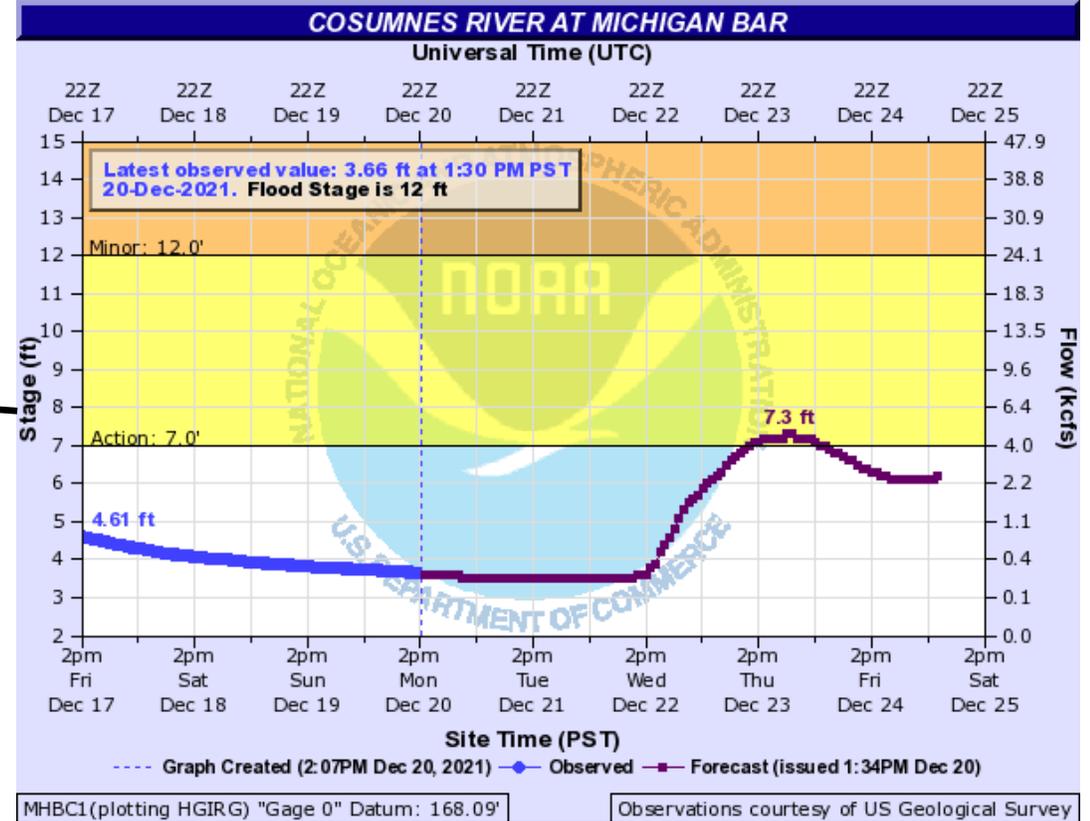
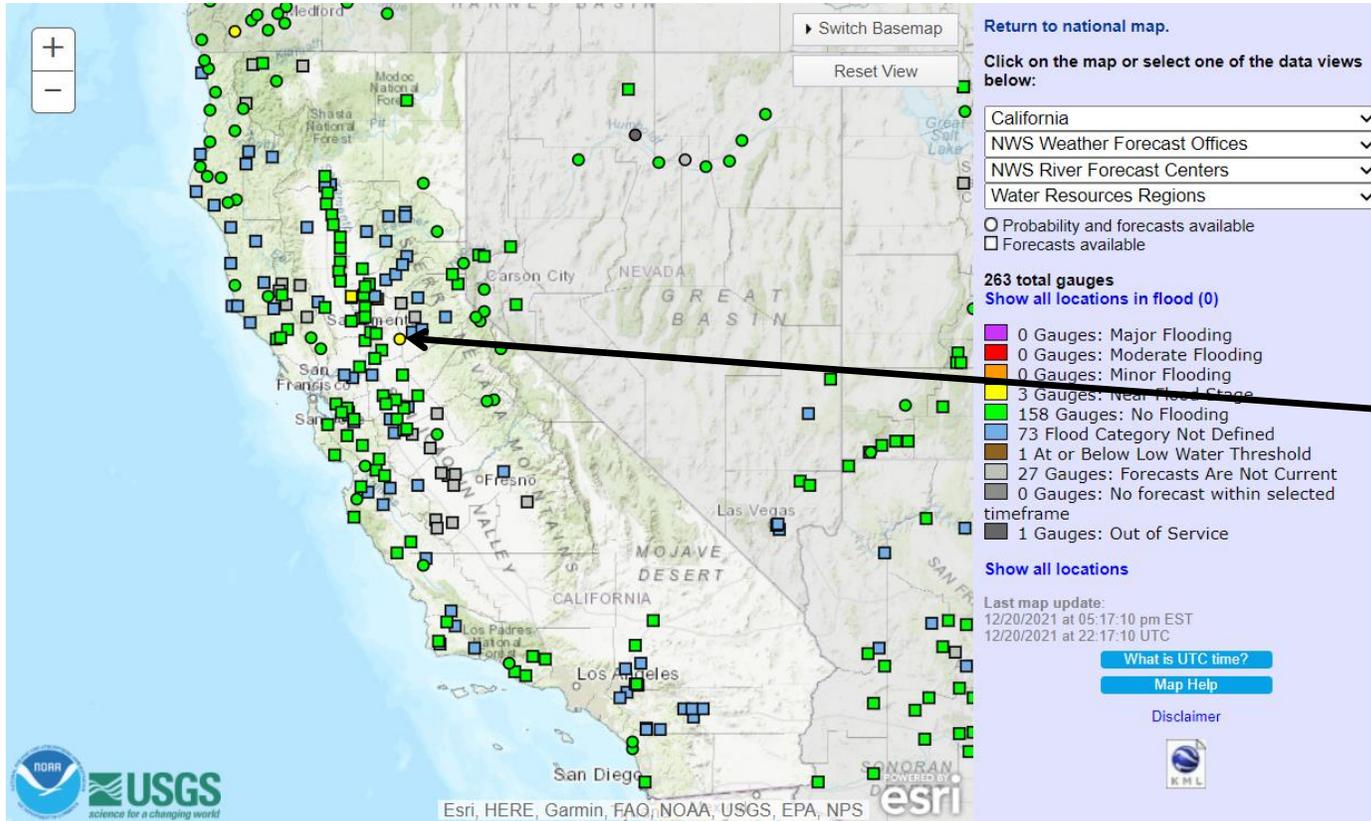
- While models are now showing higher confidence in a prolonged period of precipitation in Northern California, there is still considerable uncertainty in the total forecasted precipitation during the next 10 days
- Some 00Z GEFS members are predicting more than 12 inches of mean areal precipitation in the Upper Yuba watershed, whereas other ensemble members are predicting less than 5 inches of total precipitation
- The 10-day 00Z GEFS ensemble mean precipitation (red line) is about 8.8 inches for this watershed

## 7-day GEFS Watershed Freezing Level Forecasts: Upper Yuba



- The NWS WPC is forecasting about 9 inches of mean areal precipitation in the Upper Yuba watershed during the next 7 days
- While freezing levels are initially forecasted to be above 6,000 feet during much of the first precipitation episode, freezing levels are forecasted to fall during the day on 23 Dec and remain below 5,000 feet through 27 Dec
- Lower forecasted freezing levels suggest that a significant portion of the precipitation in the watershed may fall as snow after the first precipitation episode, which would limit surface runoff and flooding in the Sacramento Basin

## Hydrologic Impacts



- Despite the potential for heavy precipitation over the next 7–10 days, major hydrologic impacts are not currently forecasted in California
- The Cosumnes River (at Michigan Bar) is forecasted to reach action stage (7.0 ft) on 23 Dec