

# CW3E Atmospheric River Outlook: 16 Feb 2024

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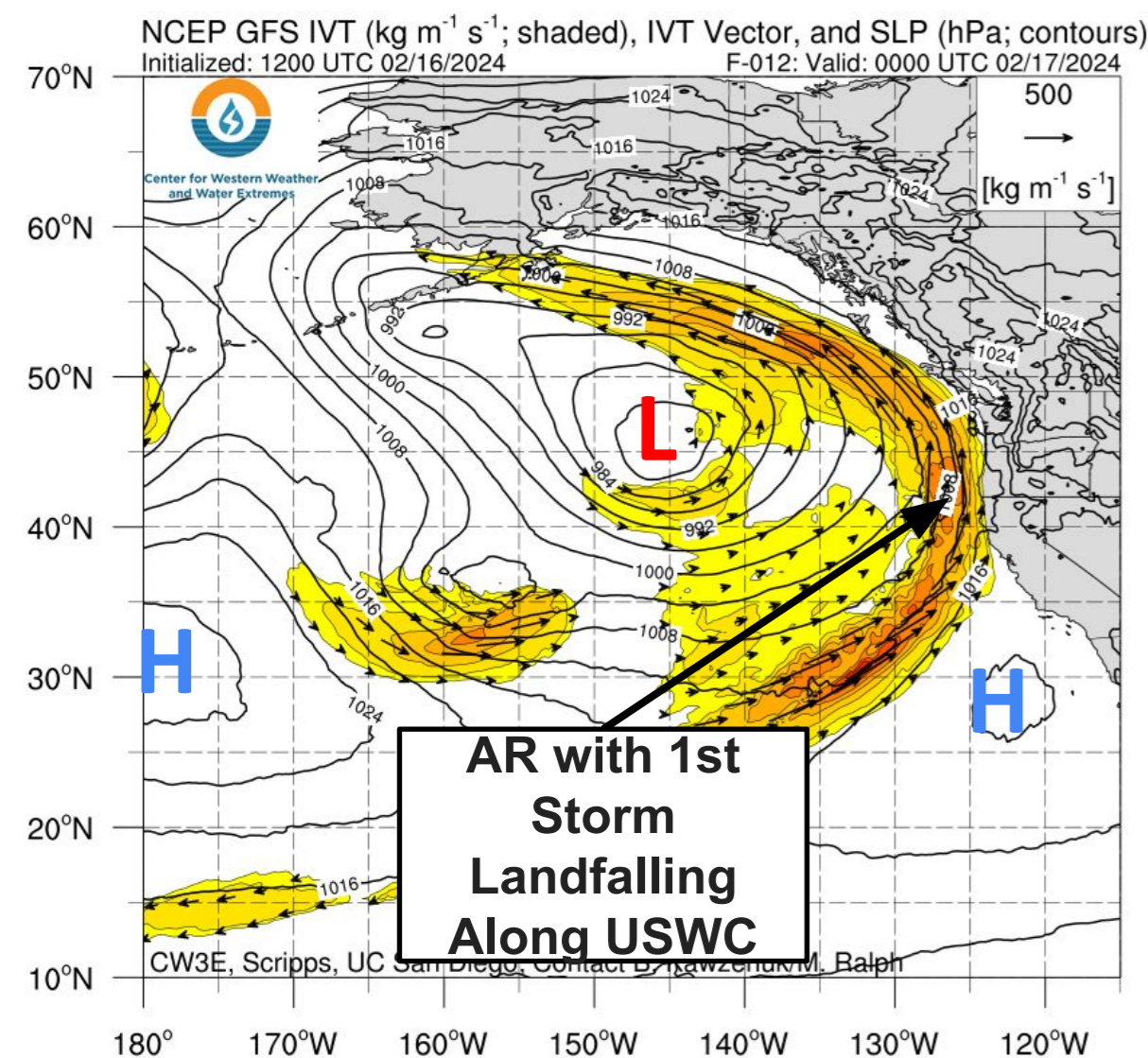
## Pair of Storms To Bring Precipitation to California

- A pair of storms are forecast to impact the US West Coast during the next several days.
- The first storm is an atmospheric river (AR) that makes landfall across the USWC on Fri 16 Feb.
- The landfall orientation of the this AR is likely to be suboptimal for orographic precipitation, potentially limiting the precipitation potential of this system.
- The second storm is a second AR that is forecast to make landfall alongside a low pressure system into central CA on Sun 18 Feb.
- The second system taps into remnant moisture from the first system, which combined with the persistence of the stationary low pressure system off the CA coast, will result in a multi-day precipitation event for the state.
- The NWS Weather Prediction Center (WPC) is forecast significant precipitation over the next 7 days along the northern and central CA coasts and in the Sierra Nevada.
- The WPC Excessive Rainfall Outlook (ERO) indicates a Slight Risk (level 2 of 4, or at least 15% chance) for flooding over the northern CA coast with the first storm and along the northern and central CA coasts with the second storm.
- The WPC ERO also indicates a Marginal Risk (level 1 of 4, or at least 5% chance) for flooding across broader areas.
- The second storm is likely to bring heavy snowfall to the Sierra Nevada. The National Blend of Models (NBM) indicates very high probabilities (>90%) of snowfall accumulations exceeding 24”.

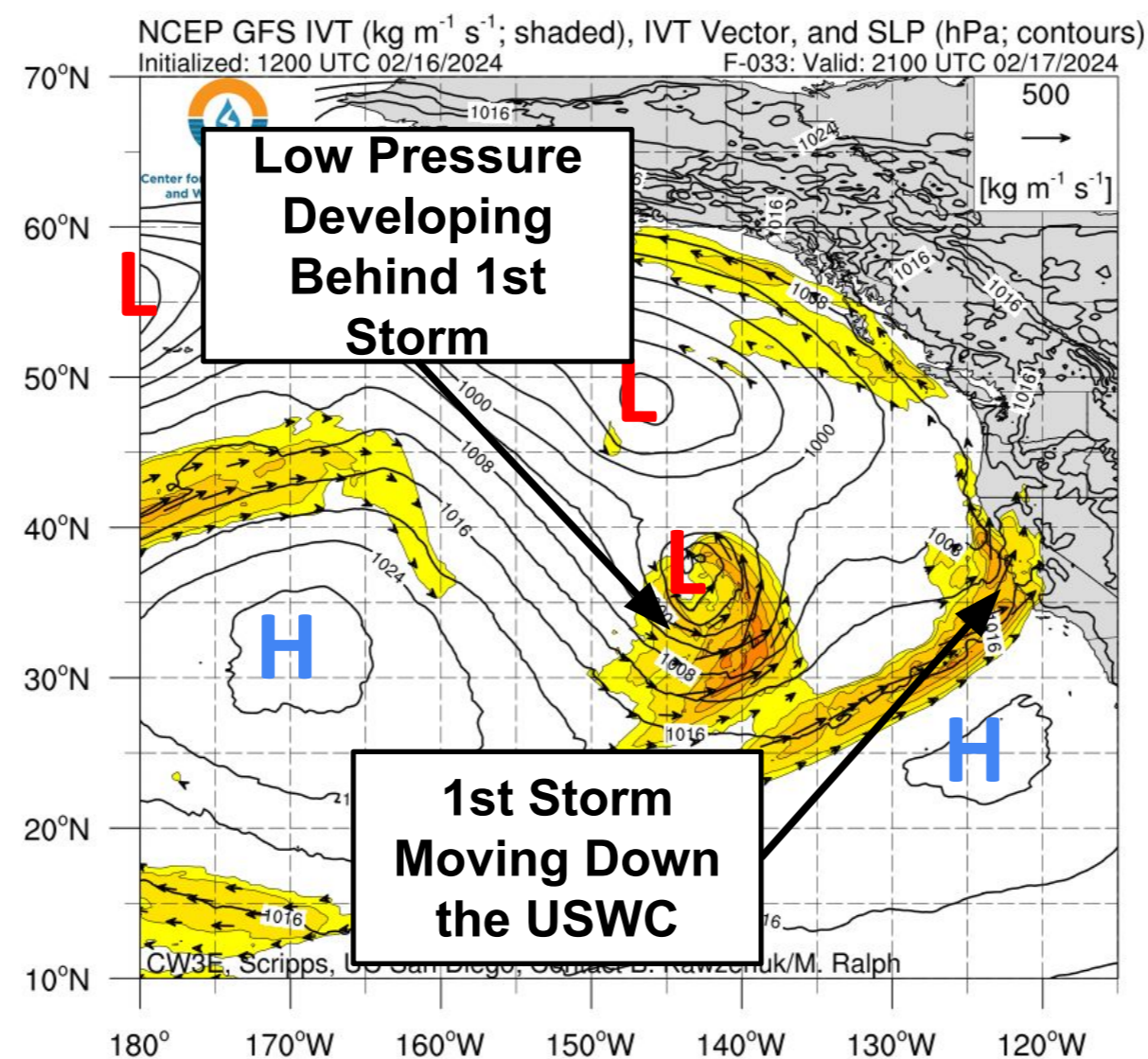
# CW3E AR Outlook: 16 Feb 2024

GFS Initialized: 12Z Fri 16 Feb 2024

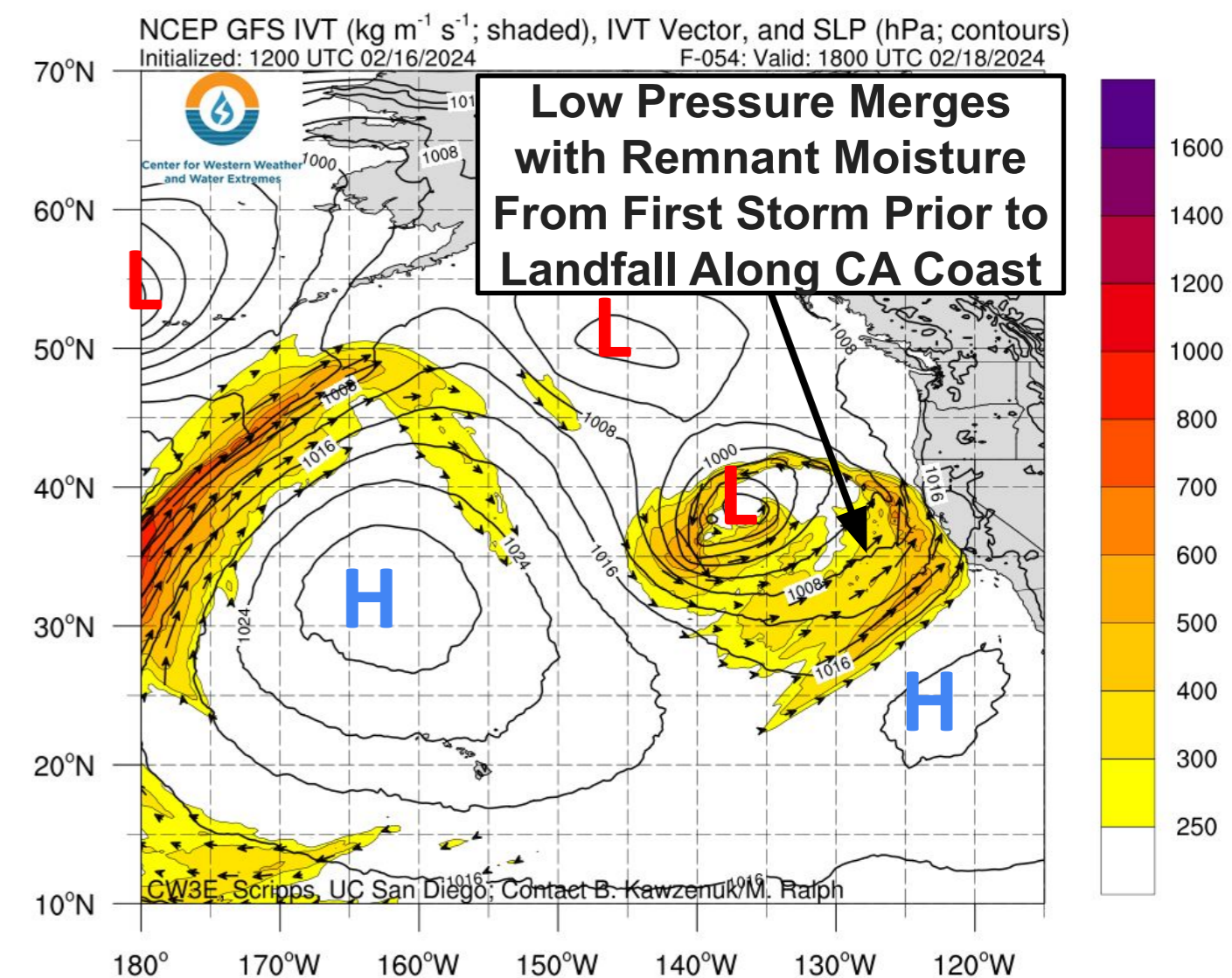
4PM PT Fri 16 Feb 2024



1PM PT Sat 17 Feb 2024



10AM PT Sun 18 Feb 2024



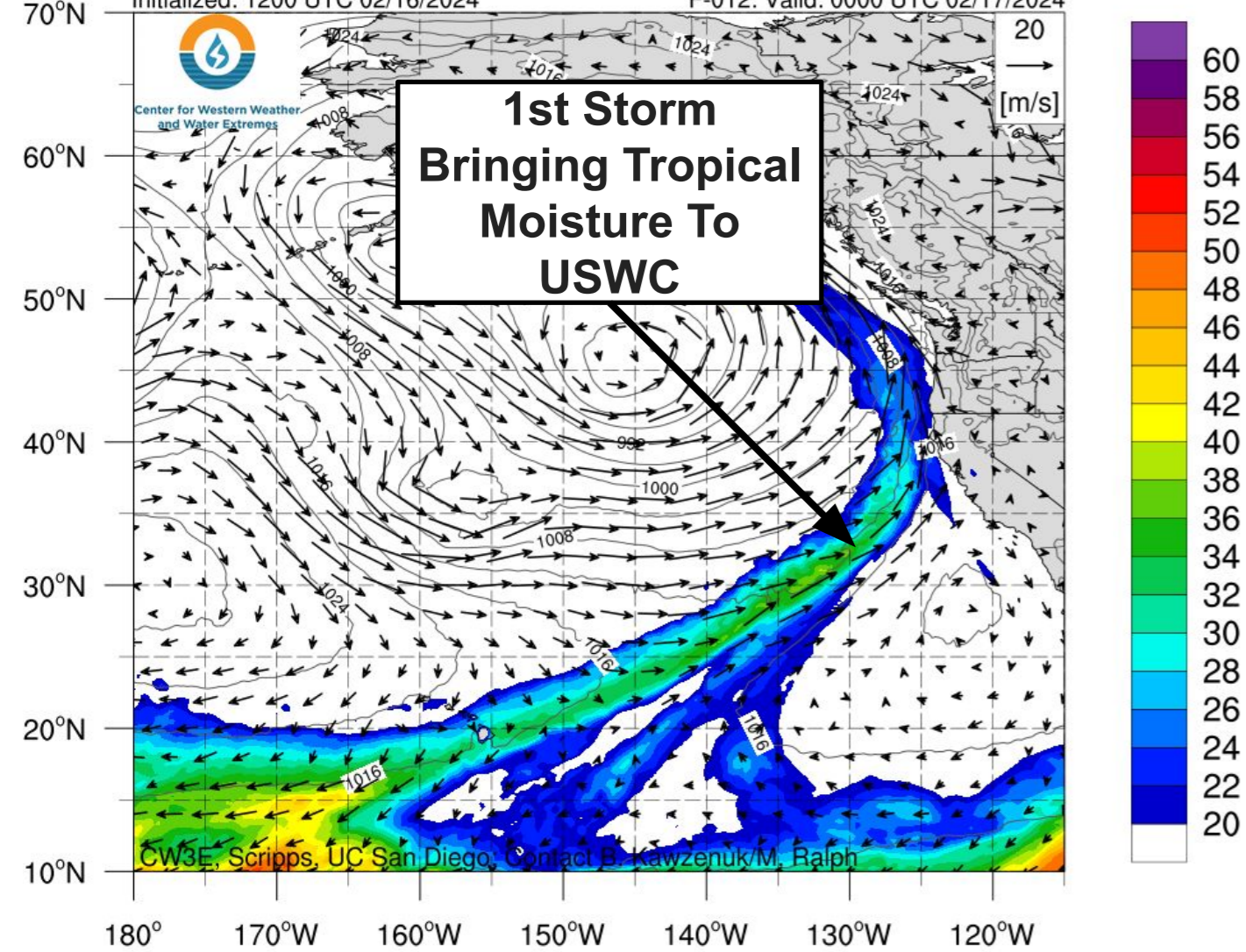
- The first storm is forecast to make landfall with an AR along the USWC Fri 16 Feb, with the tail of the AR moving down the CA coast. The landfall direction of the IVT is suboptimal for orographic precipitation, potentially limiting the **potential** precipitation from this AR.
- The second storm system and potential AR make landfall into central CA on Sun 18 Feb, with the AR moving down the CA coast through Mon 19 Feb. This low pressure system merges with remnant moisture from the first storm to strengthen the associated AR.
- The second low pressure system persists off the CA coast for several days, resulting in heavy precipitation across CA over several days.

# CW3E AR Outlook: 16 Feb 2024

GFS Init 12Z Fri 16 Feb 2024

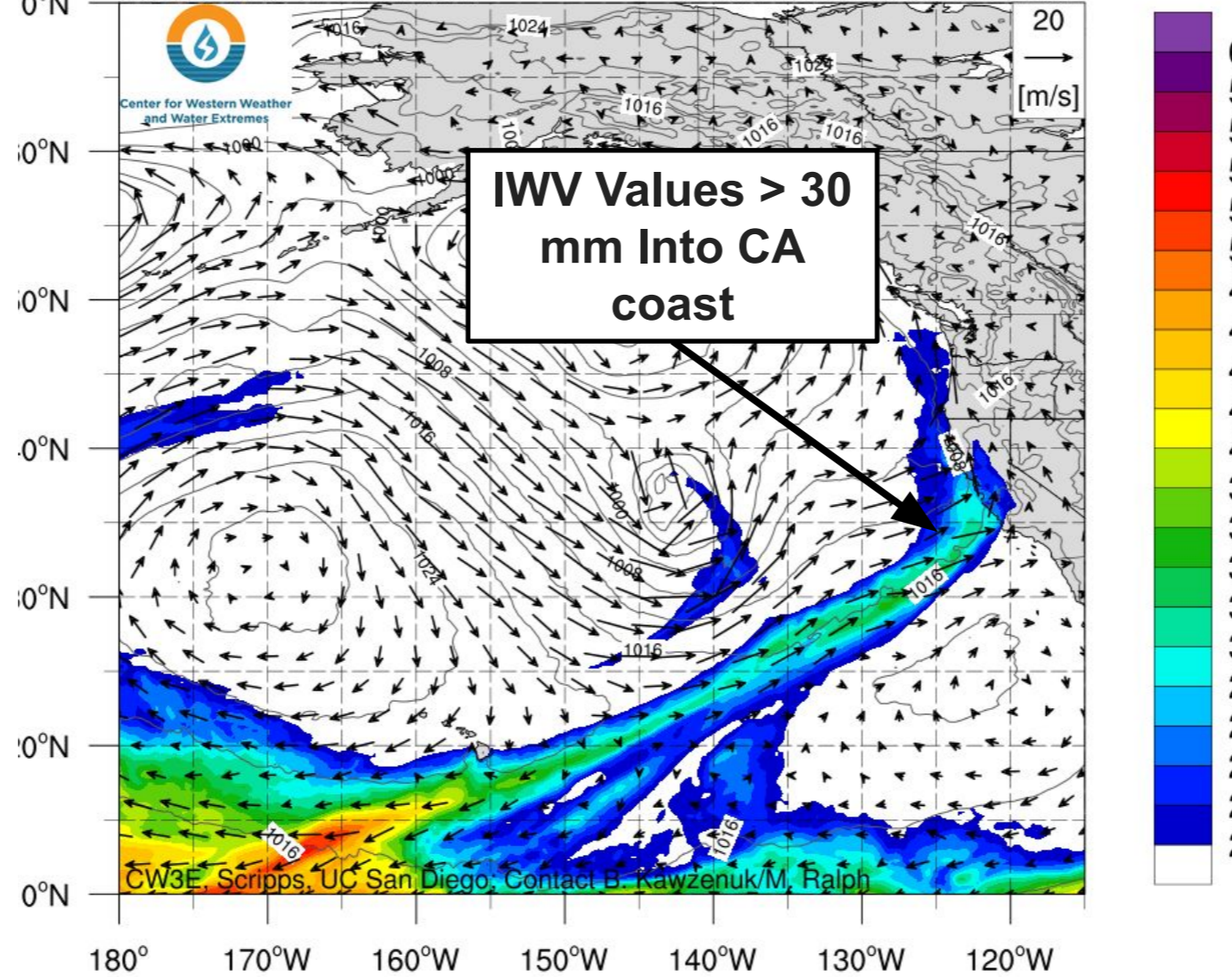
4PM PT Fri 16 Feb 2024

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 02/16/2024 F-012: Valid: 0000 UTC 02/17/2024



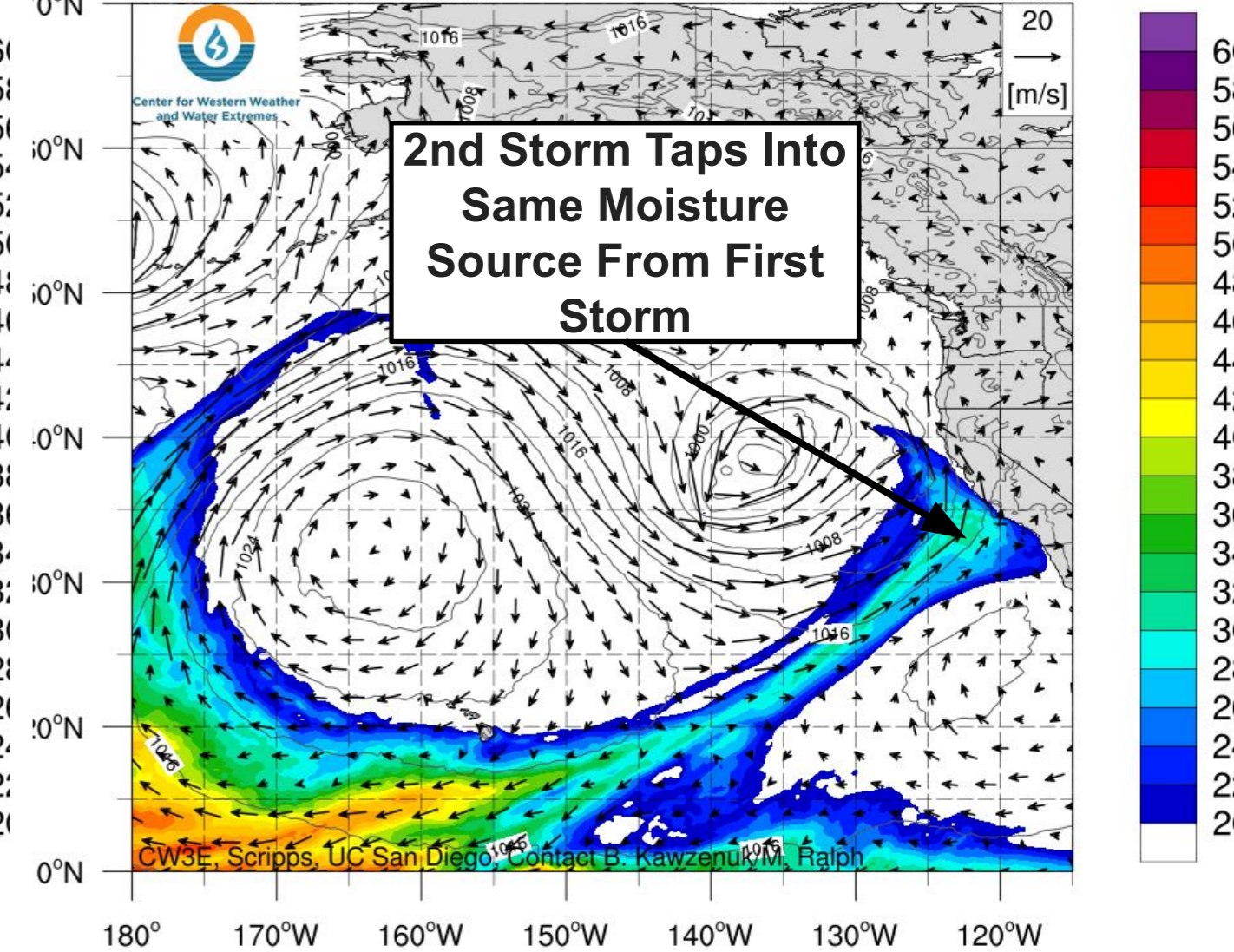
1PM PT Sat 17 Feb 2024

NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 02/16/2024 F-033: Valid: 2100 UTC 02/17/2024



10AM PT Sun 18 Jan 2024

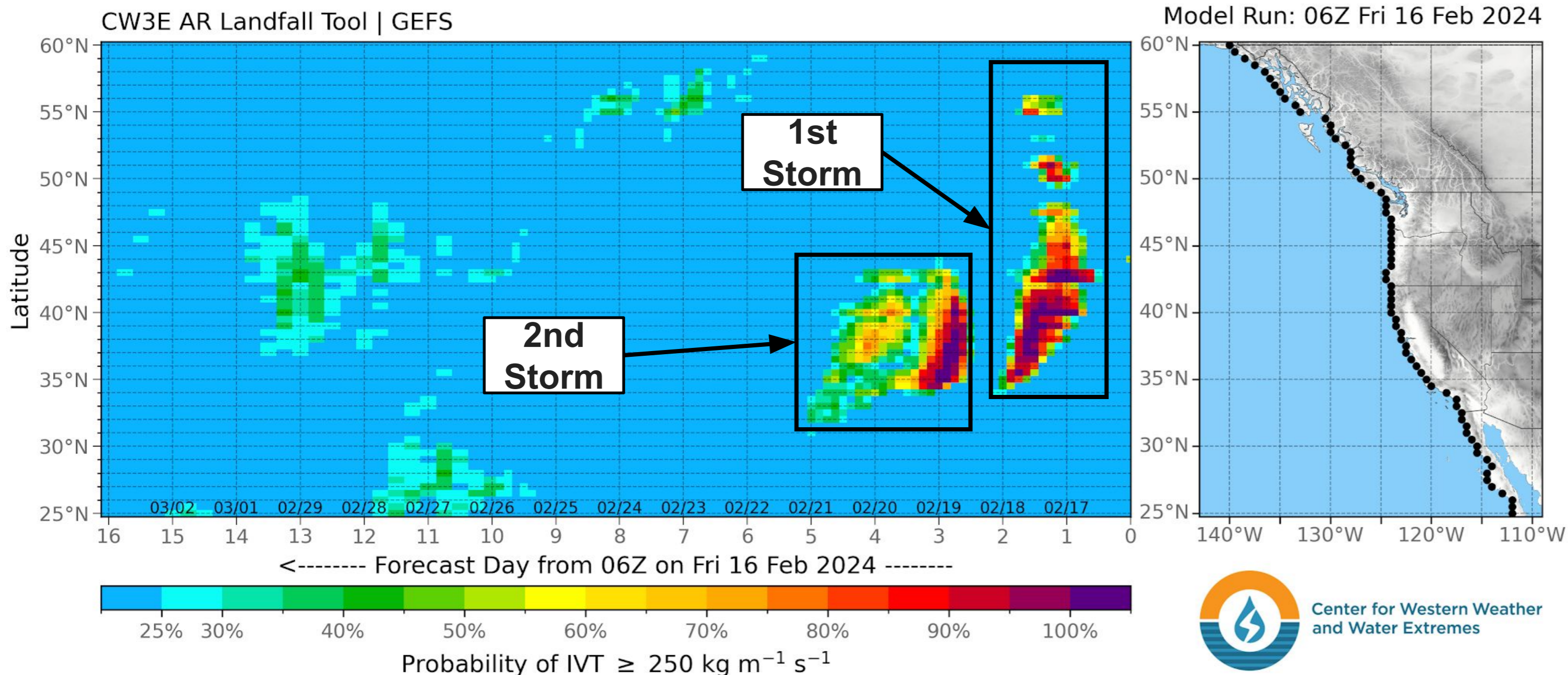
NCEP GFS IWV (mm; shaded), 850-hPa Wind (vectors), and SLP (hPa; contours)  
Initialized: 1200 UTC 02/16/2024 F-054: Valid: 1800 UTC 02/18/2024



- The AR with the first storm is fed by tropical moisture out of the central Pacific, with IWV values (IWV >30 mm) brought to the coast.
- The AR and low pressure system with the second storm are forecast to tap into the same moisture source region that fueled the first storm, bringing IWV > 30 mm over the CA coast.

# CW3E AR Outlook: 16 Feb 2024

- CW3E's ensemble AR Landfall tool illustrates the timing and intensity of the IVT associated with both storms as they move onshore
- The GEFS is showing high confidence (>80%) in IVT > 250 kg m<sup>-1</sup> s<sup>-1</sup> making landfall over CA on both 16-17 Feb and 19-20 Feb with the first and second storms respectively.



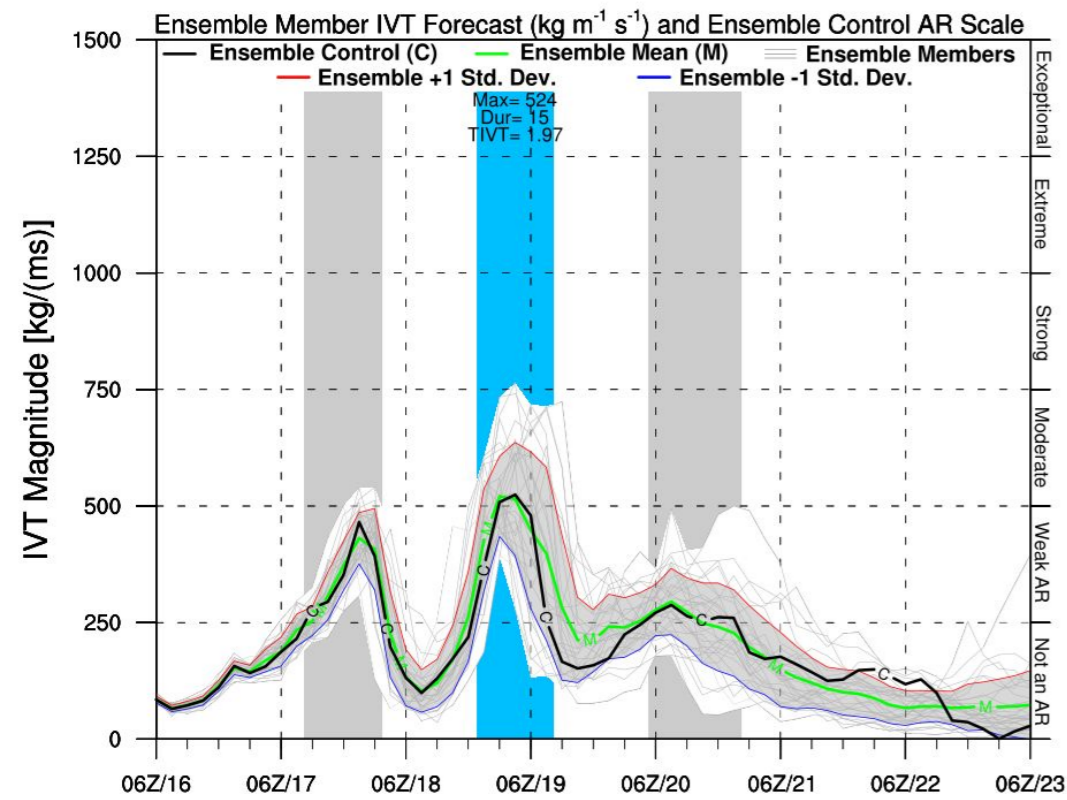
Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

# CW3E AR Outlook: 16 Feb 2024

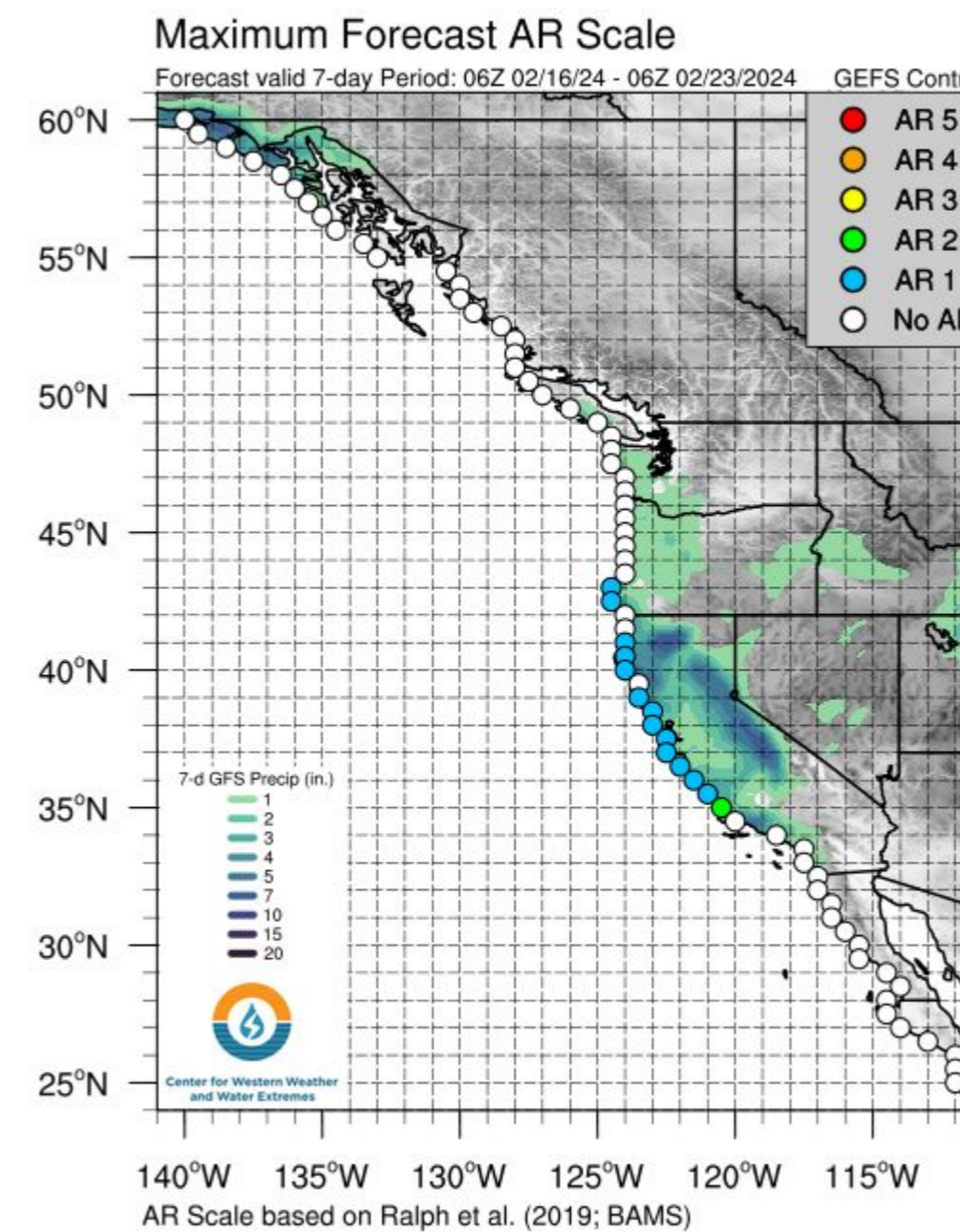
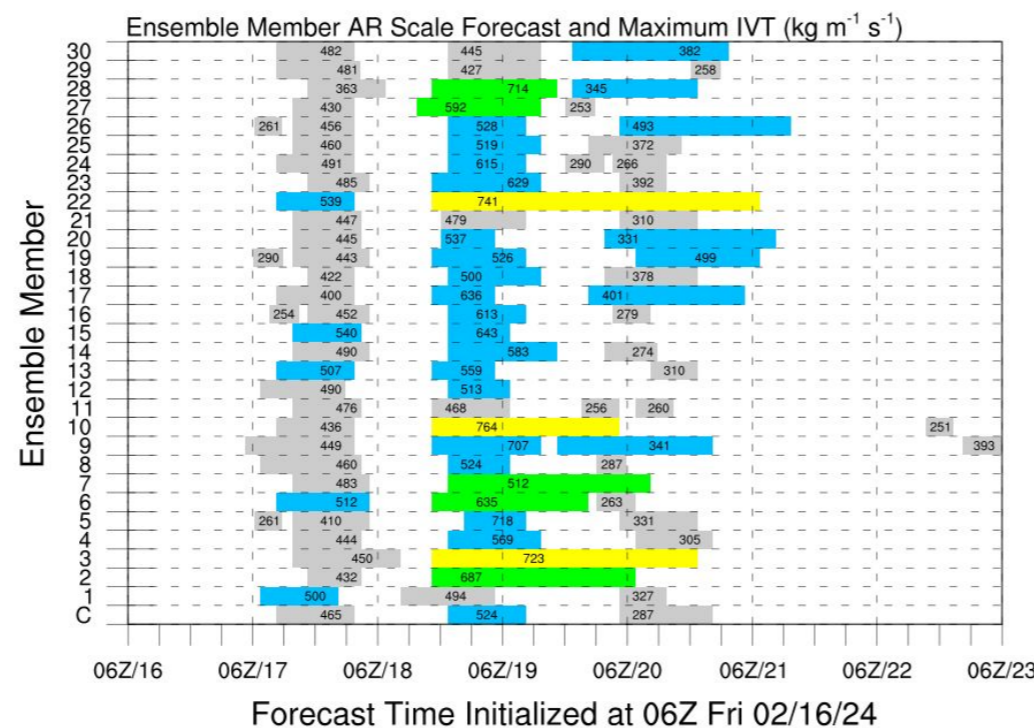
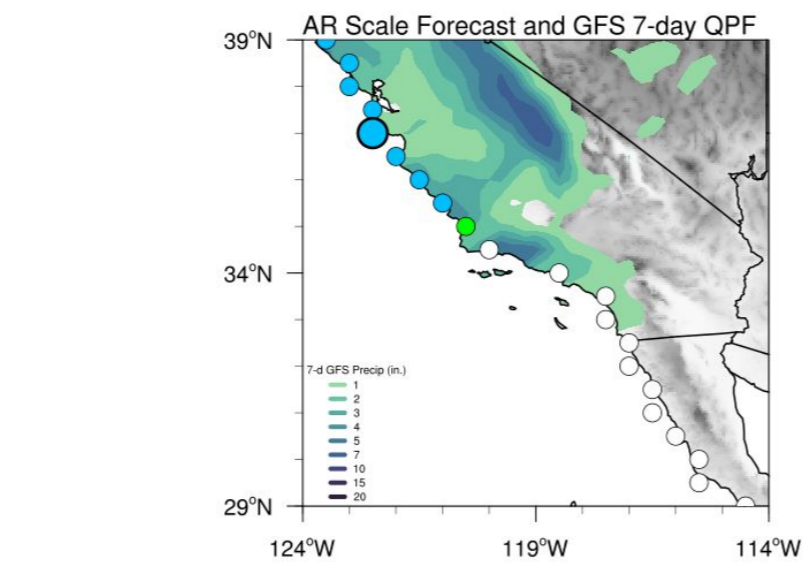
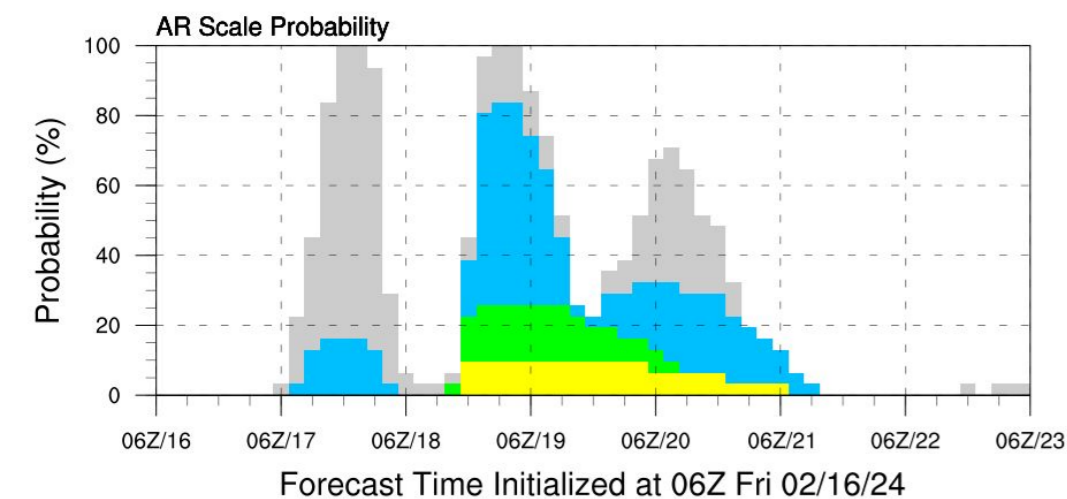
## GEFS 7-day AR Scale and IVT Forecast

GFS Ensemble Initialized: 06Z Fri 02/16/24

Location: 37°N 122.5°W



Categorical AR Strength by Ralph/CW3E



- The GEFS control member is forecasting AR1 to AR2 conditions along the CA coast over the next 7 days.
- 26/31 (84%) GEFS ensemble members are forecasting AR1 or greater conditions for 21Z Sun 18 Feb through 9Z Mon 19 Feb.
- The uncertainty amongst ensemble members for both storms is regarding the duration of AR conditions and peak landfall IVT in central CA, which will dictate the AR scale.



Image created: 11 UTC 02/16/2024

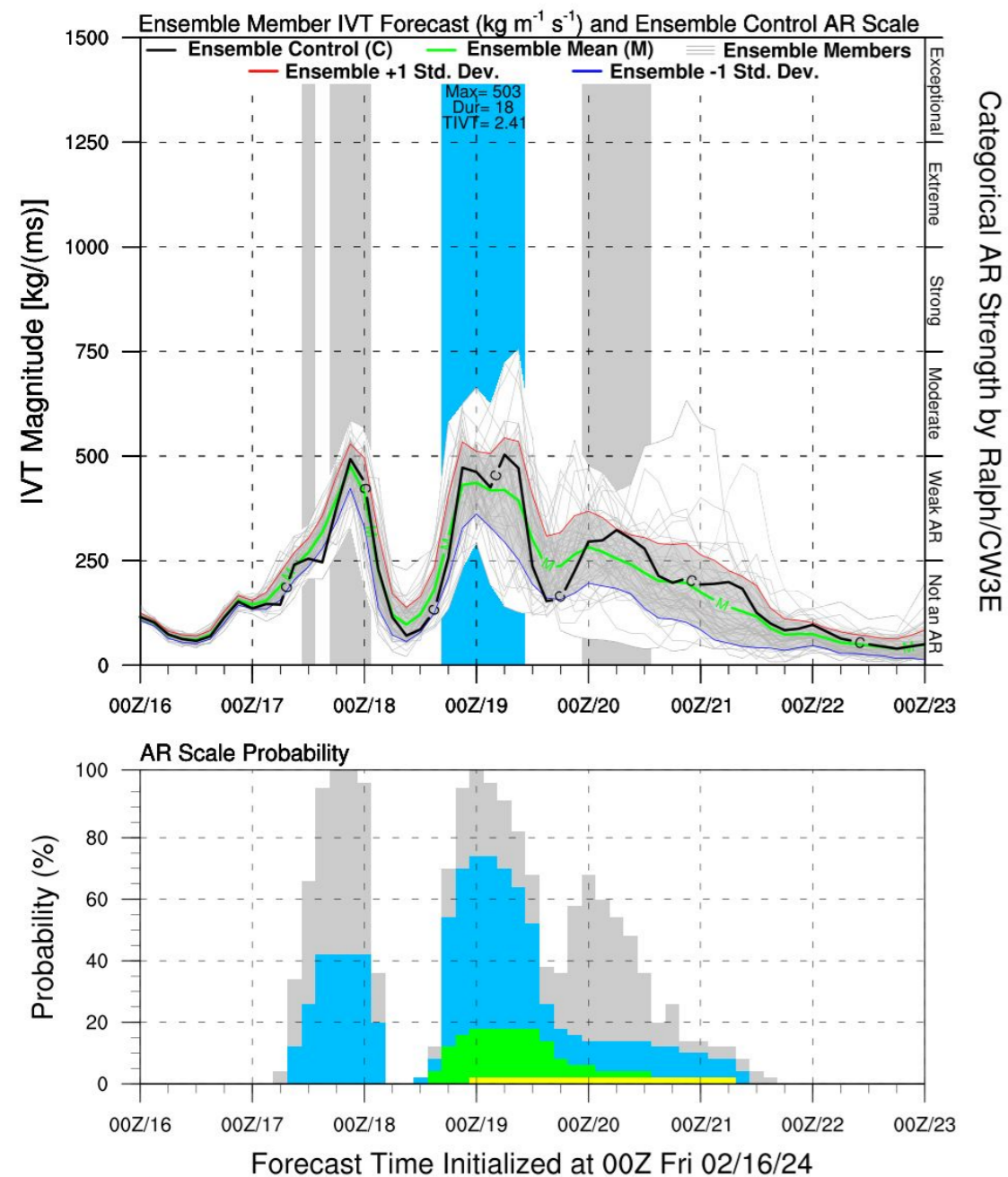
AR 1 AR 2 AR 3 AR 4 AR 5

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

# CW3E AR Outlook: 16 Feb 2024

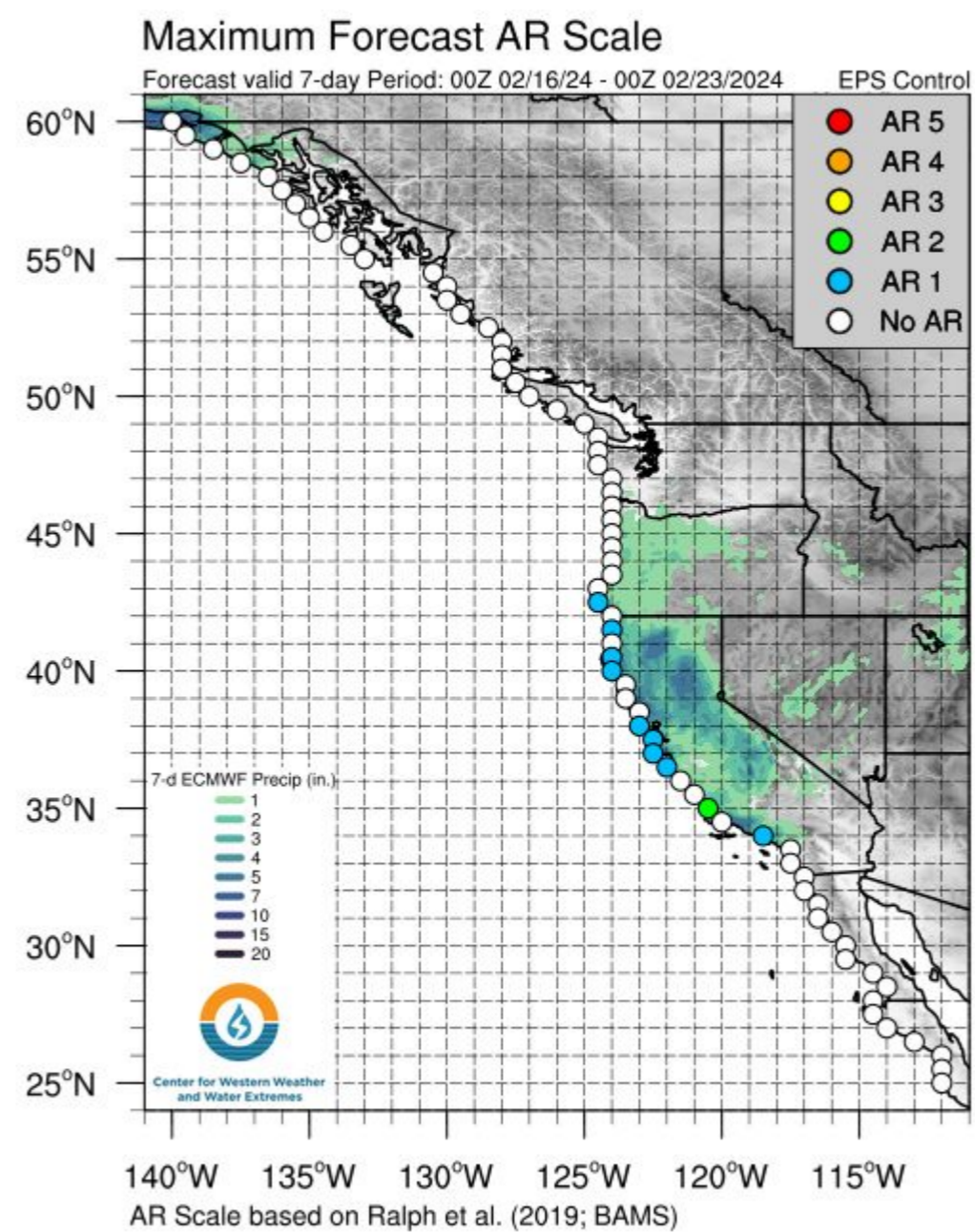
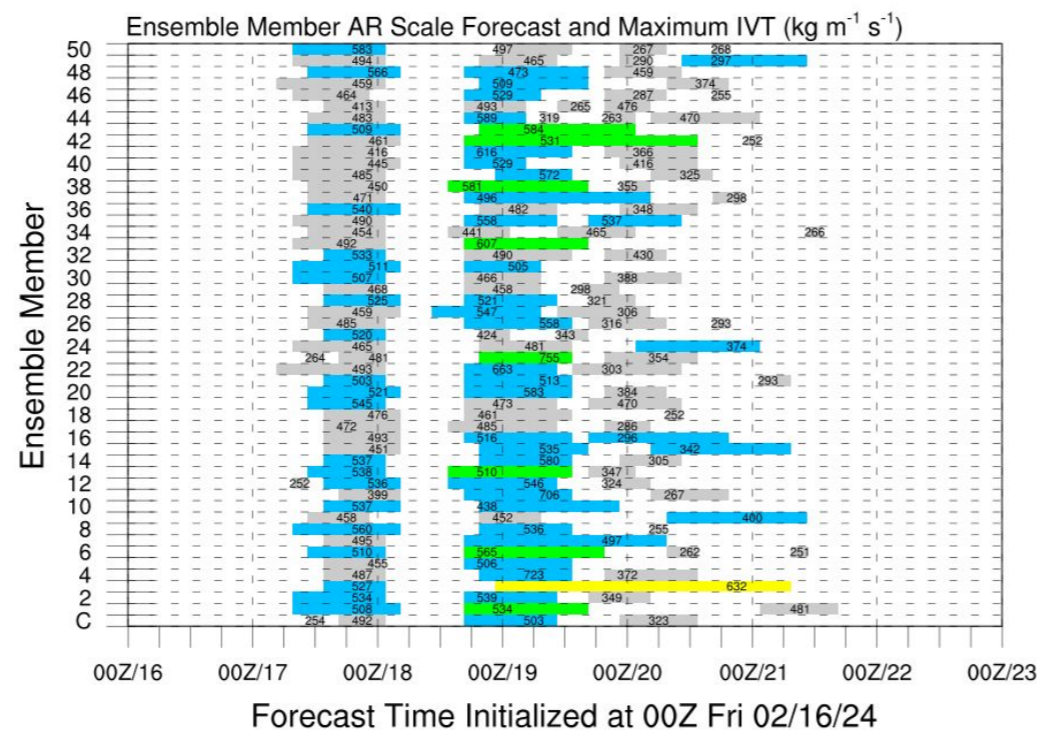
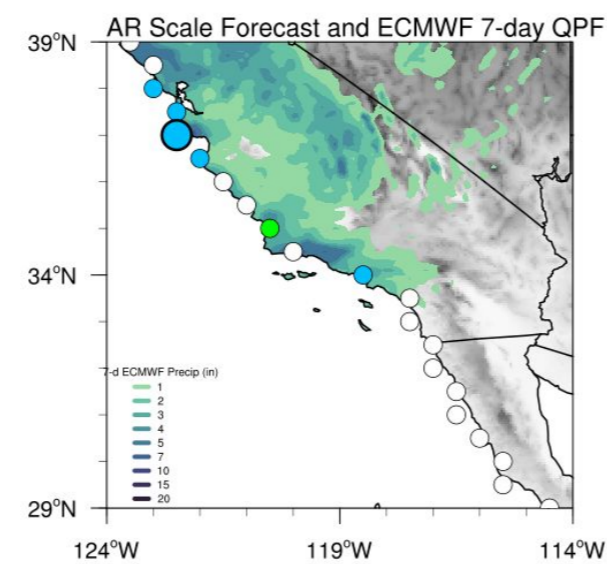
## ECMWF EPS 7-day AR Scale and IVT Forecast

ECMWF Ensemble Initialized: 00Z Fri 02/16/24



Categorical AR Strength by Ralph/CW3E

Location: 37°N 122.5°W



- The EPS is forecasting AR1 to AR2 conditions along the CA coast over the next 7 days like the GEFS, however there are less locations exceeding AR1 in the EPS.
- 37/51 (73%) EPS ensemble members are forecasting AR1 or greater conditions at 37° N, 122.5° W (near Santa Cruz CA) for 21Z Sun 18 Feb through 9Z Mon 19 Feb.
- EPS members are showing similar uncertainty in the duration and peak IVT of the incoming systems.



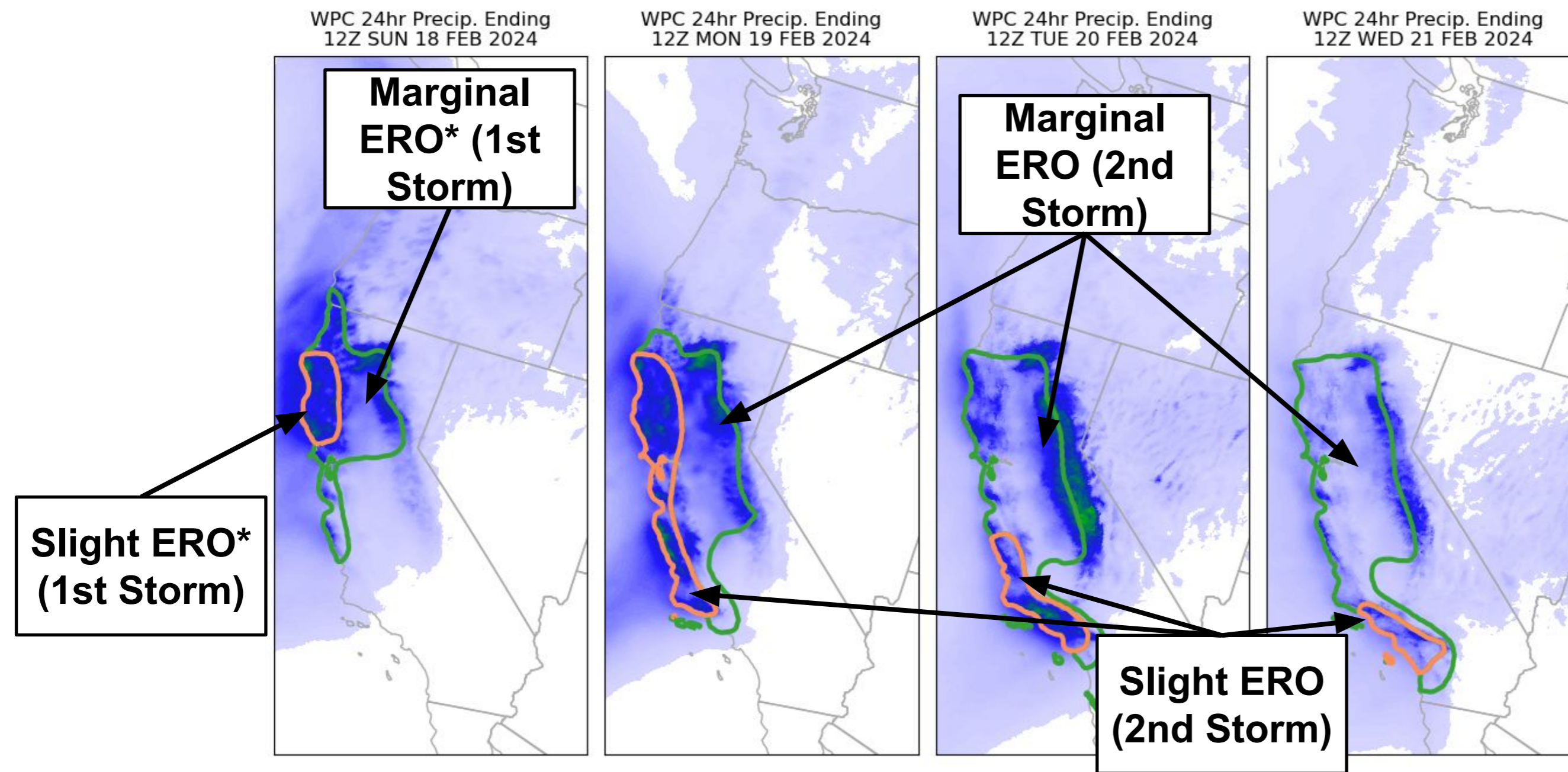
Image created: 09 UTC 02/16/2024

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

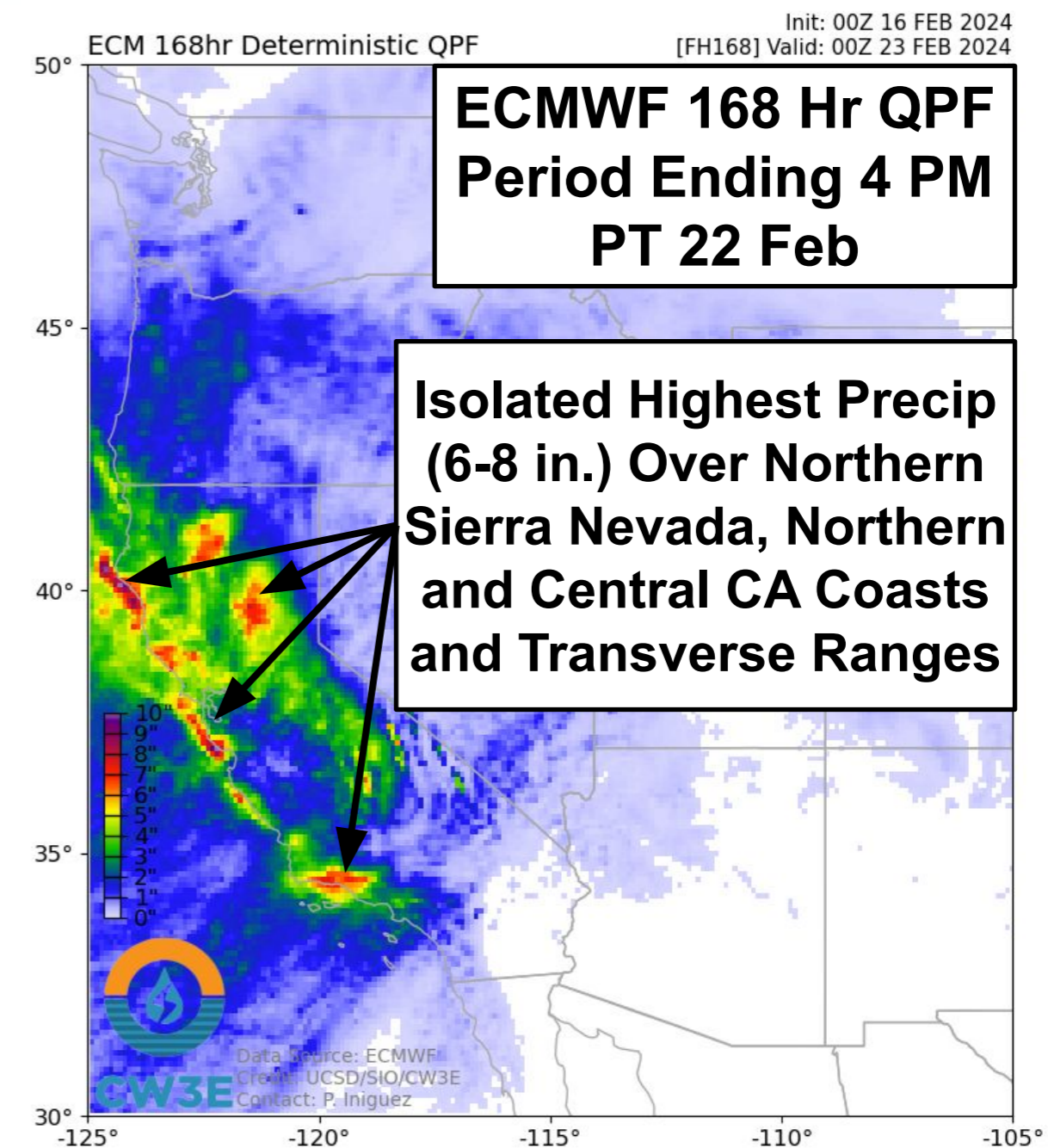
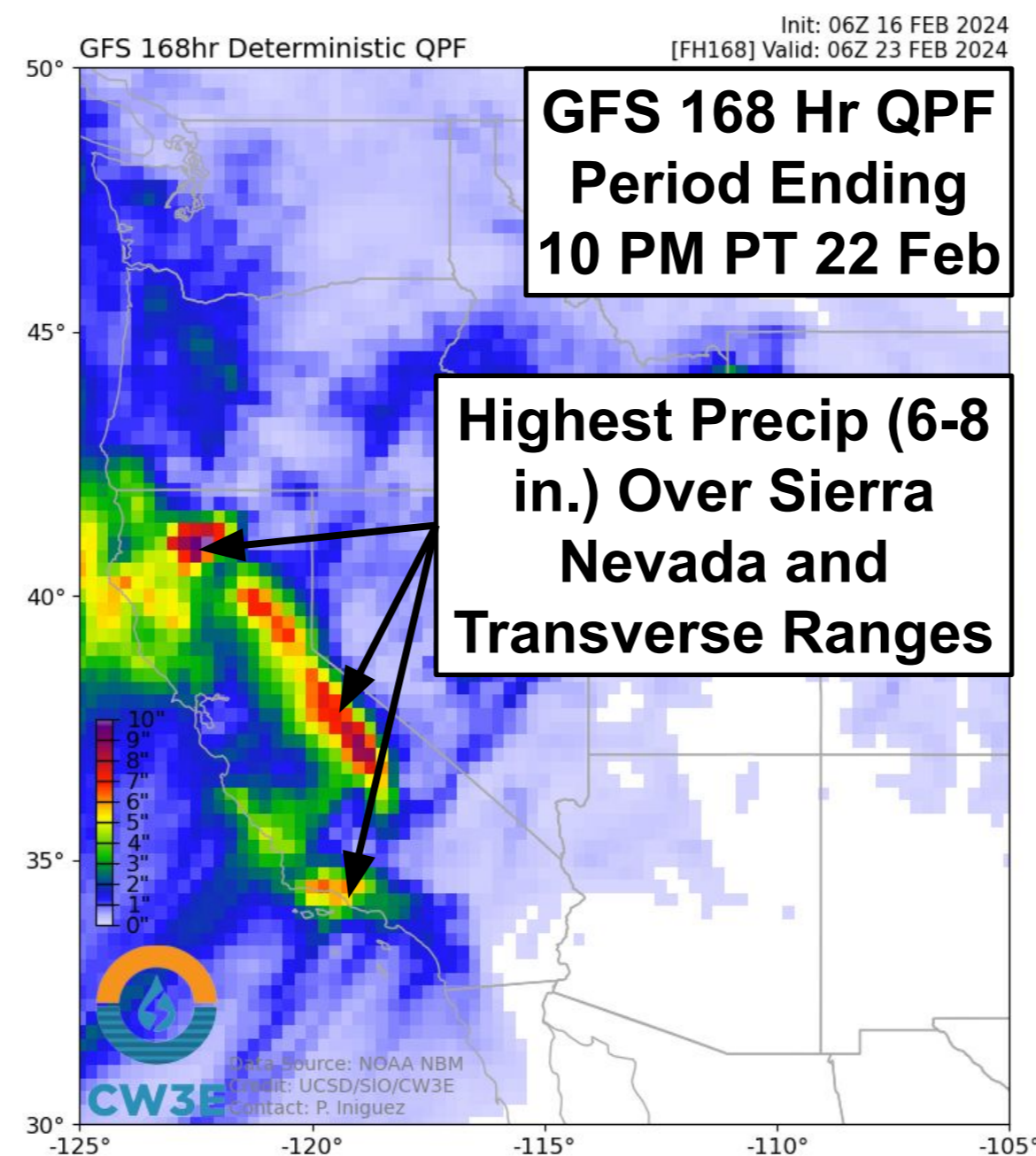
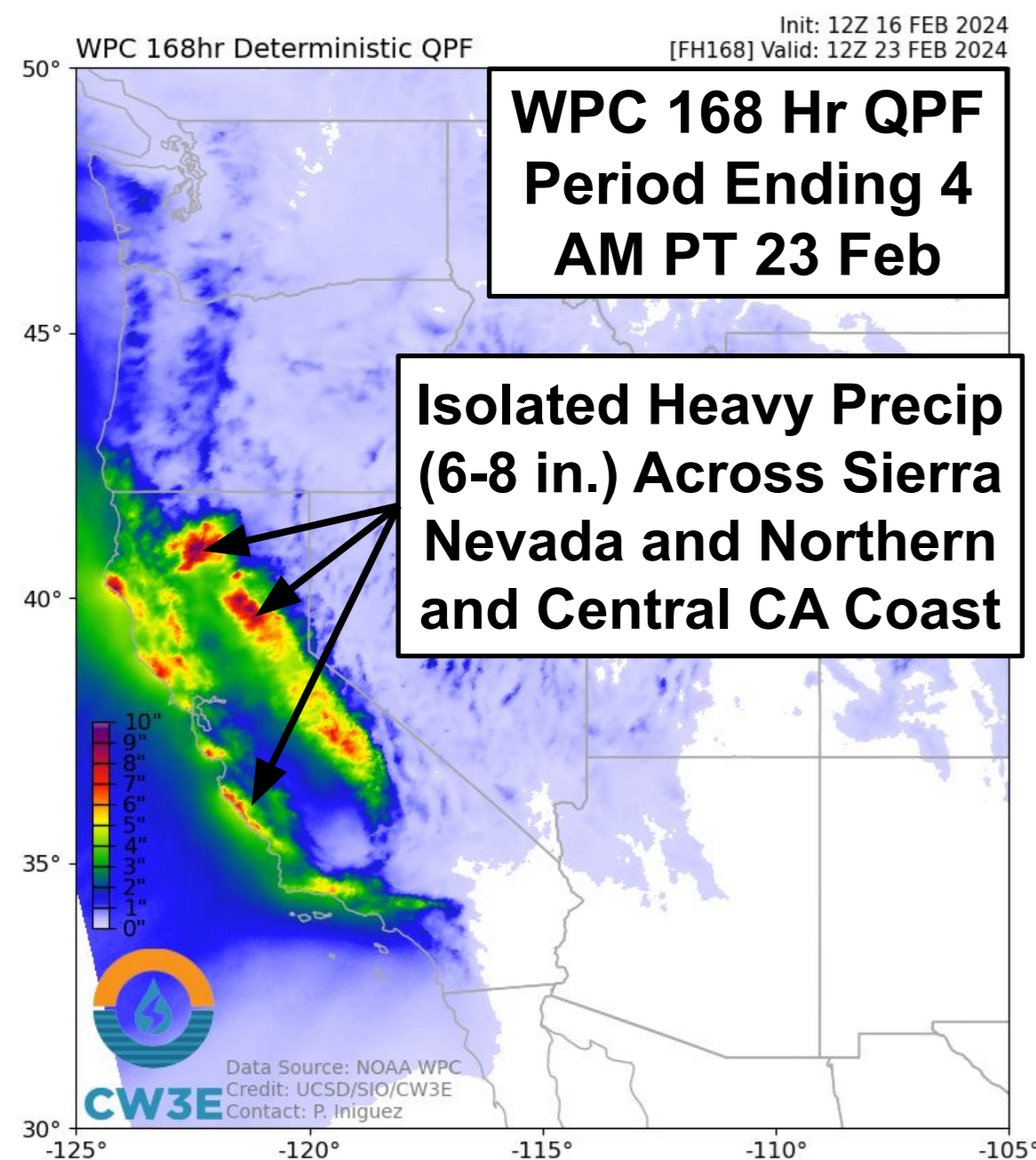
# CW3E AR Outlook: 16 Feb 2024

\*Excessive Rain Outlook (ERO)



- The WPC is forecasting the heaviest precipitation over northern CA with the first storm(1-3 in.) and along the central CA coast and in the Sierra Nevada for the second storm (1-3 in. per day).
- A Slight Risk (level 2 of 4, or at least 15% chance) for flooding is forecast by WPC along the northern CA coast for the 24-hr period ending 4 AM PT Sun 18 Feb with the second storm and for regions along the central and southern CA coast for the 24-hr period ending 4 AM PT Sun 18 Feb through Wed 21 Feb with the second storm.
- A Marginal Risk (level 1 of 4, or at least 5% chance) for flash flooding is forecast by WPC for northern CA with the first storm and broader regions along the northern and central CA coasts and the Sacramento Valley for the second storm.

# CW3E AR Outlook: 16 Feb 2024



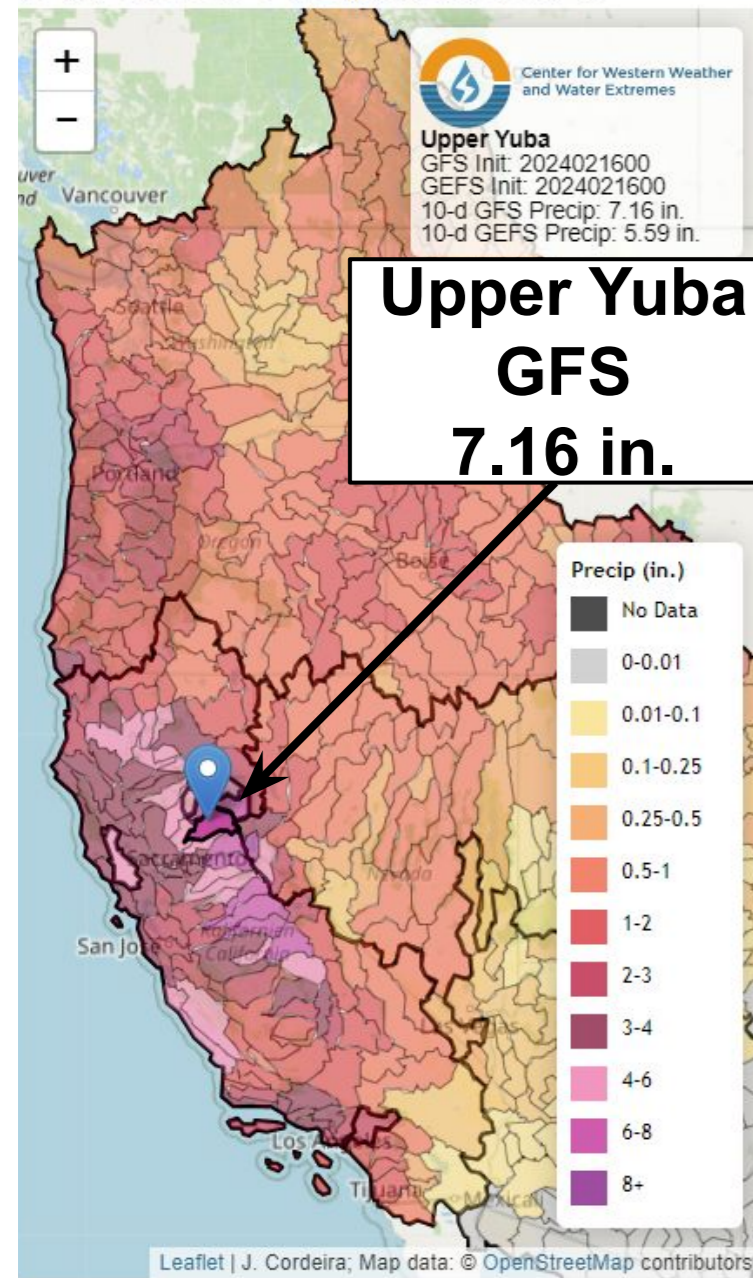
- WPC, GFS and ECMWF are forecasting significant precipitation in CA over the next 7 days, although there is uncertainty between forecast precipitation totals in the Sierra Nevada and along coastal California.
- GFS is forecasting higher precipitation totals over the Sierra Nevada (6-8 in.) while also forecasting lower precipitation along the CA coast compared to the WPC and ECMWF, which each have isolated regions of 5-7 in. along the coast.
- The ECMWF and GFS are forecasting greater precipitation over the Transverse Ranges than the WPC, with both models forecasting a larger region of 6-8 in. whereas the WPC is forecasting 3-5 in.



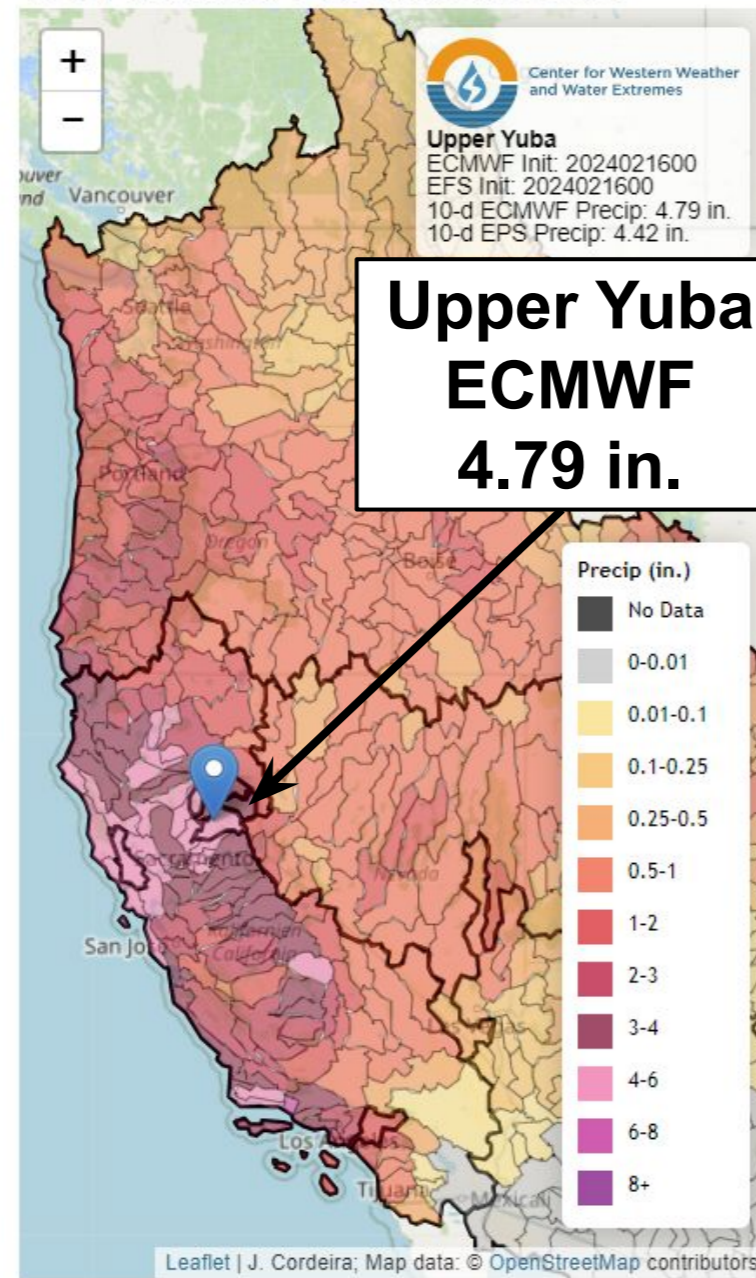
# CW3E AR Outlook: 16 Feb 2024

## 10-day Watershed Precipitation Forecasts (Initialized 00Z 16 Feb)

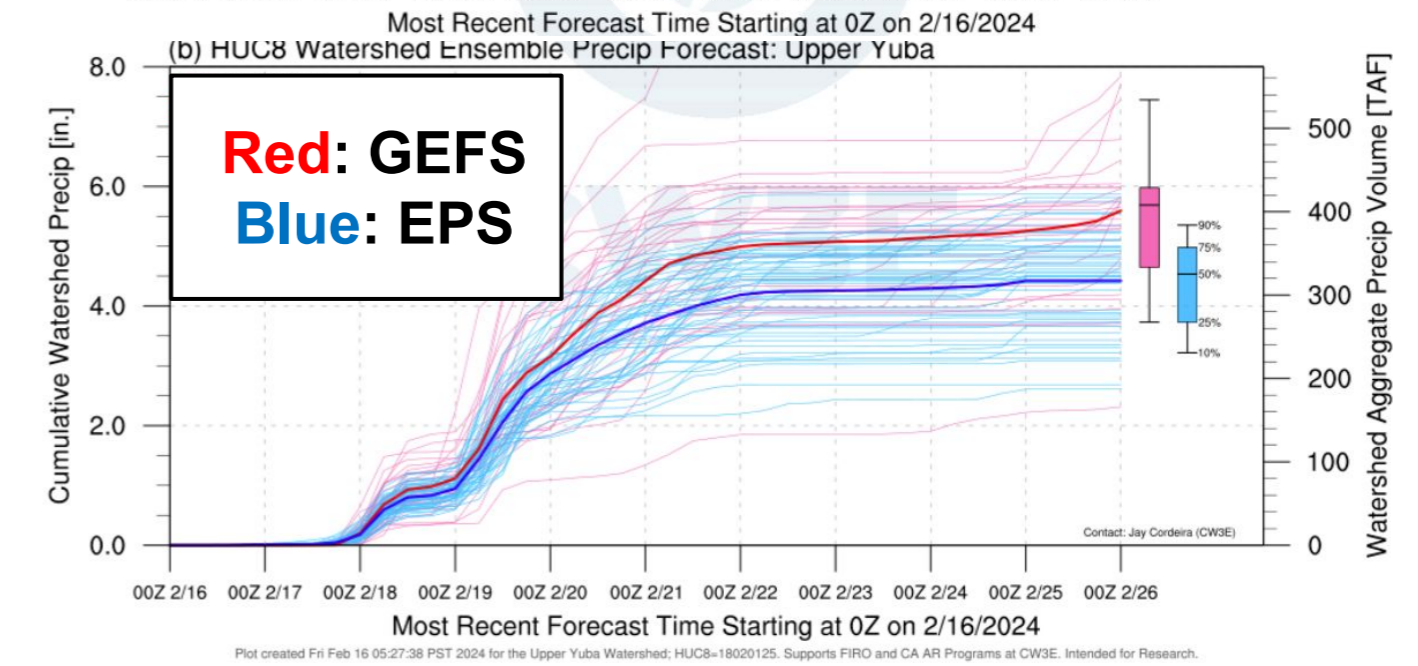
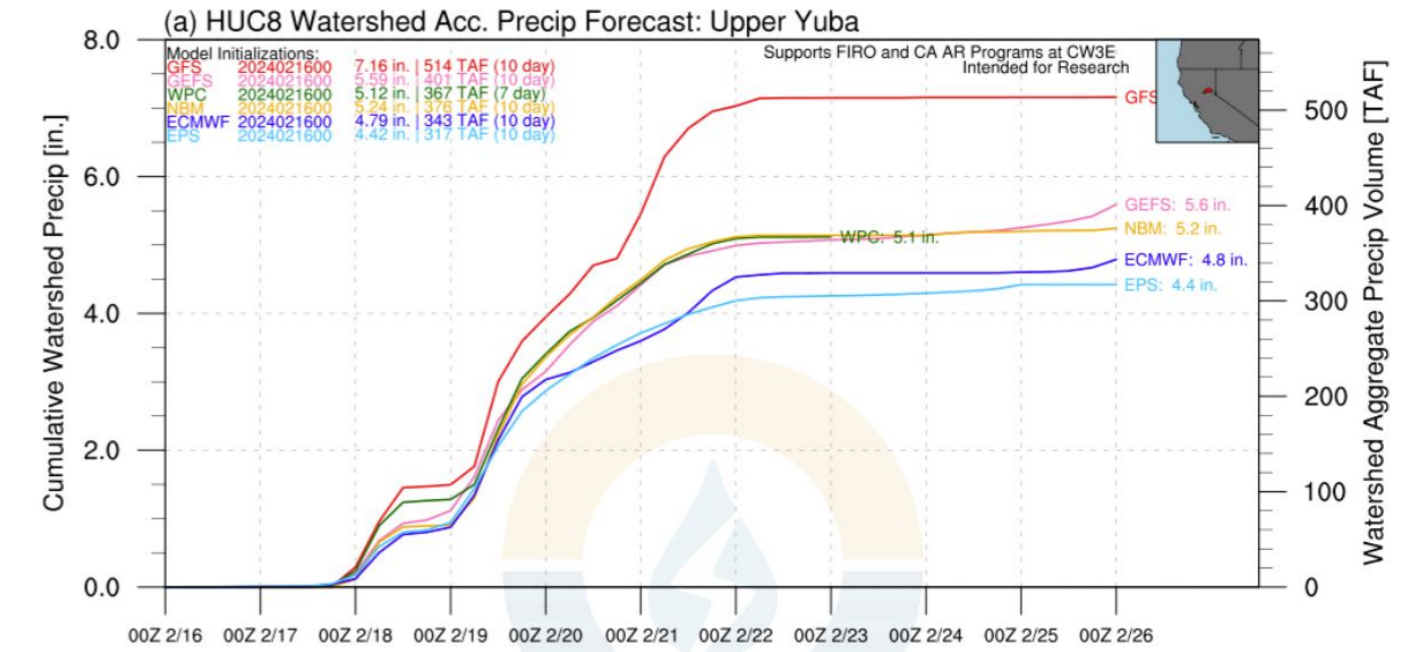
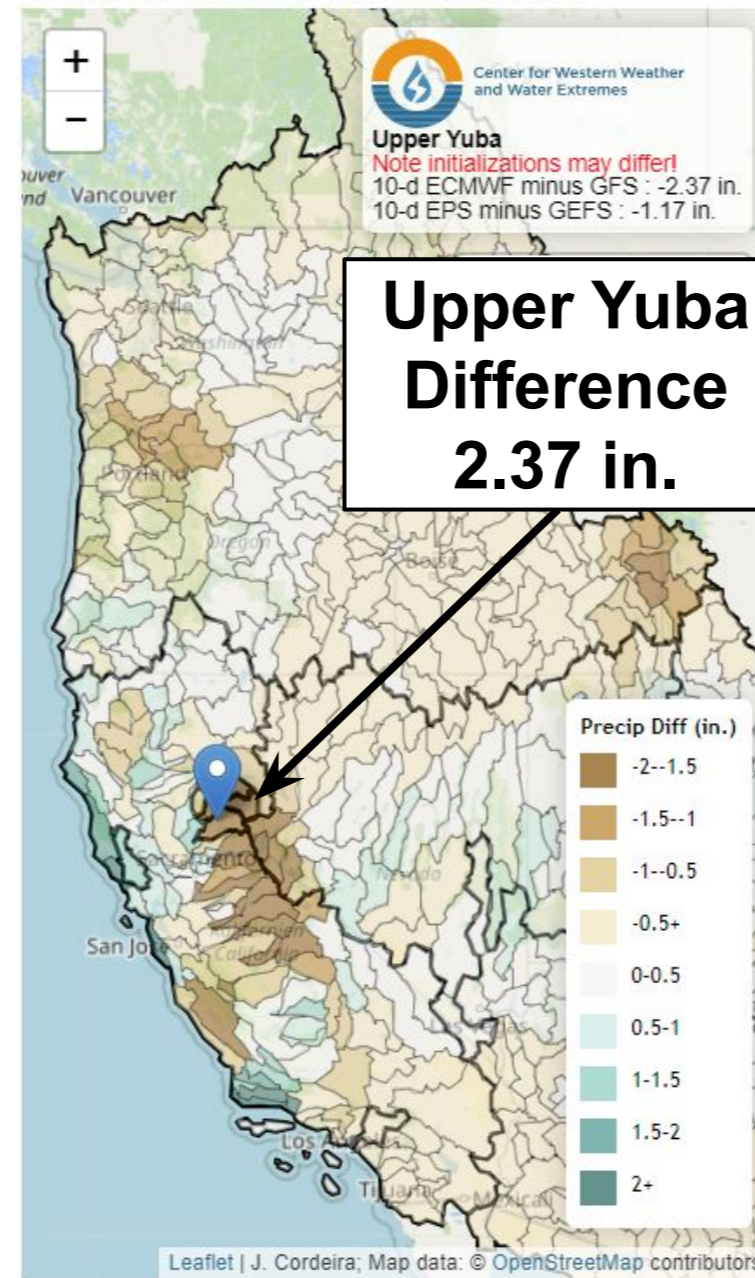
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



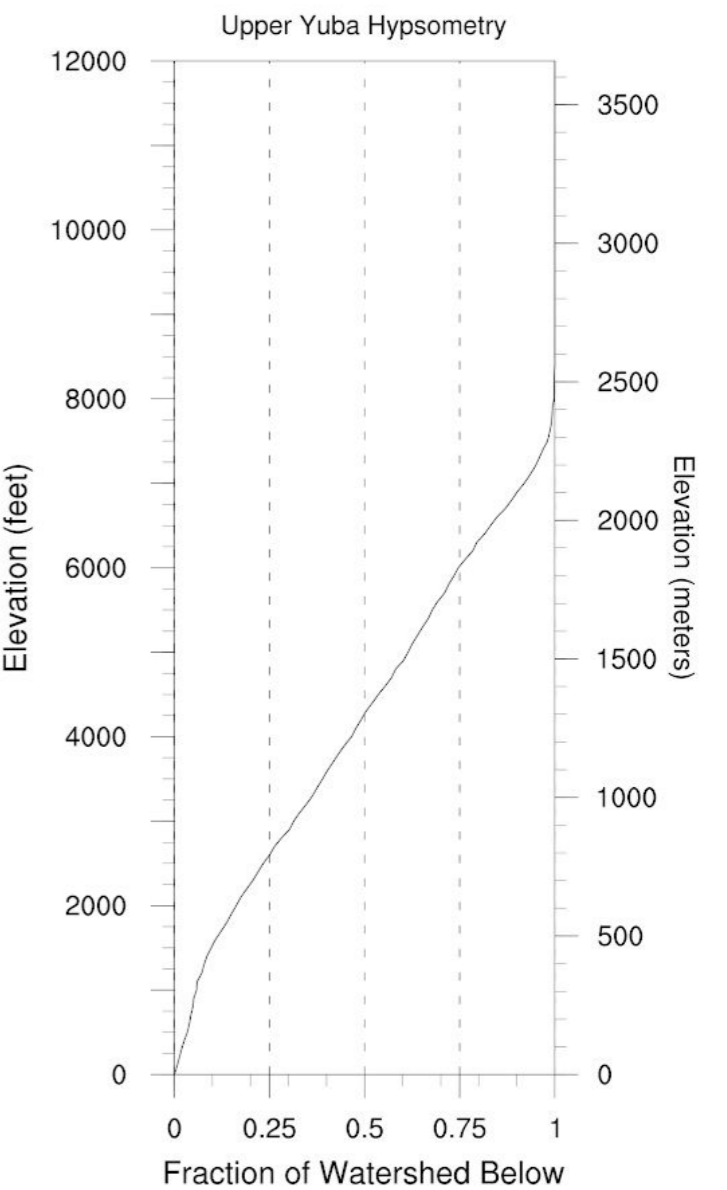
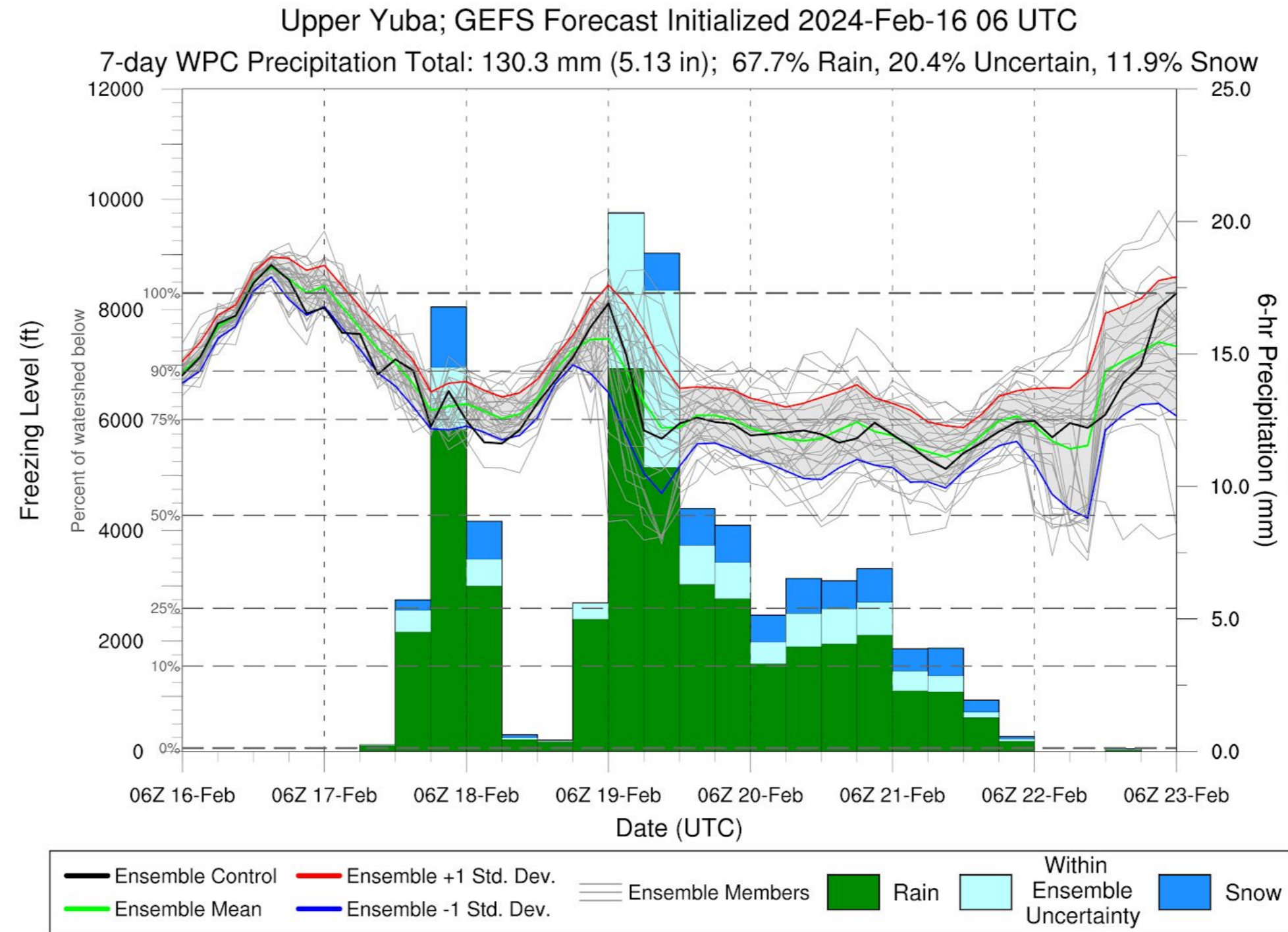
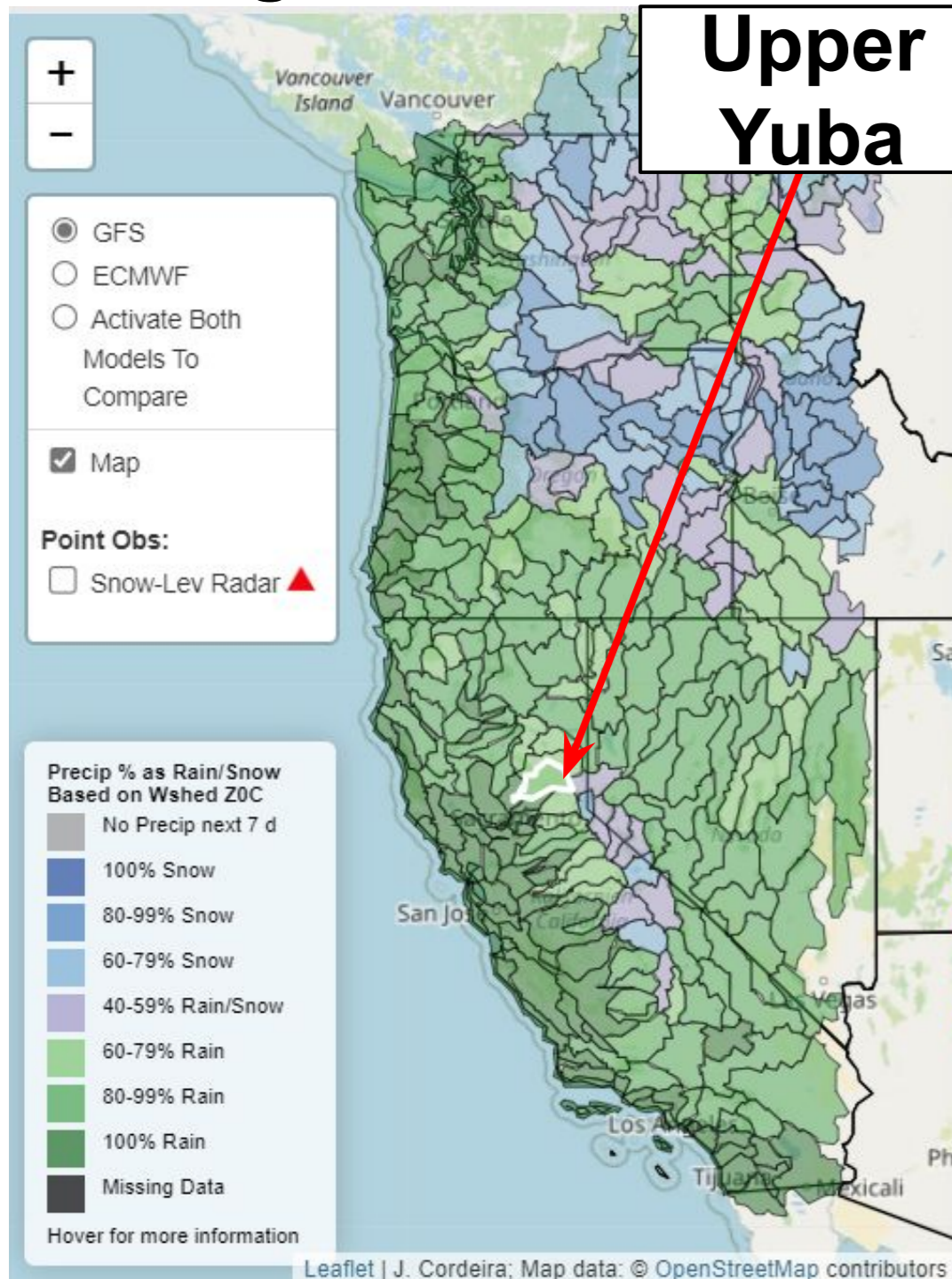
10-day Difference Precipitation Forecast



- The 00Z GFS and 00Z ECMWF 10-day watershed precipitation totals vary for CA during the period, where the GFS is forecasting greater precipitation in the Sierra Nevada watersheds and the ECMWF is greater for some northern and central CA coastal watersheds.
- The 00Z GFS is forecasting 7.16 in. of mean areal precipitation in the Upper Yuba River watershed over the next 10 days, while the 00Z ECMWF is forecasting 4.79 in. over the same watershed. The GEFS is showing more uncertainty in 10 totals than the EPS.

# CW3E AR Outlook: 16 Feb 2024

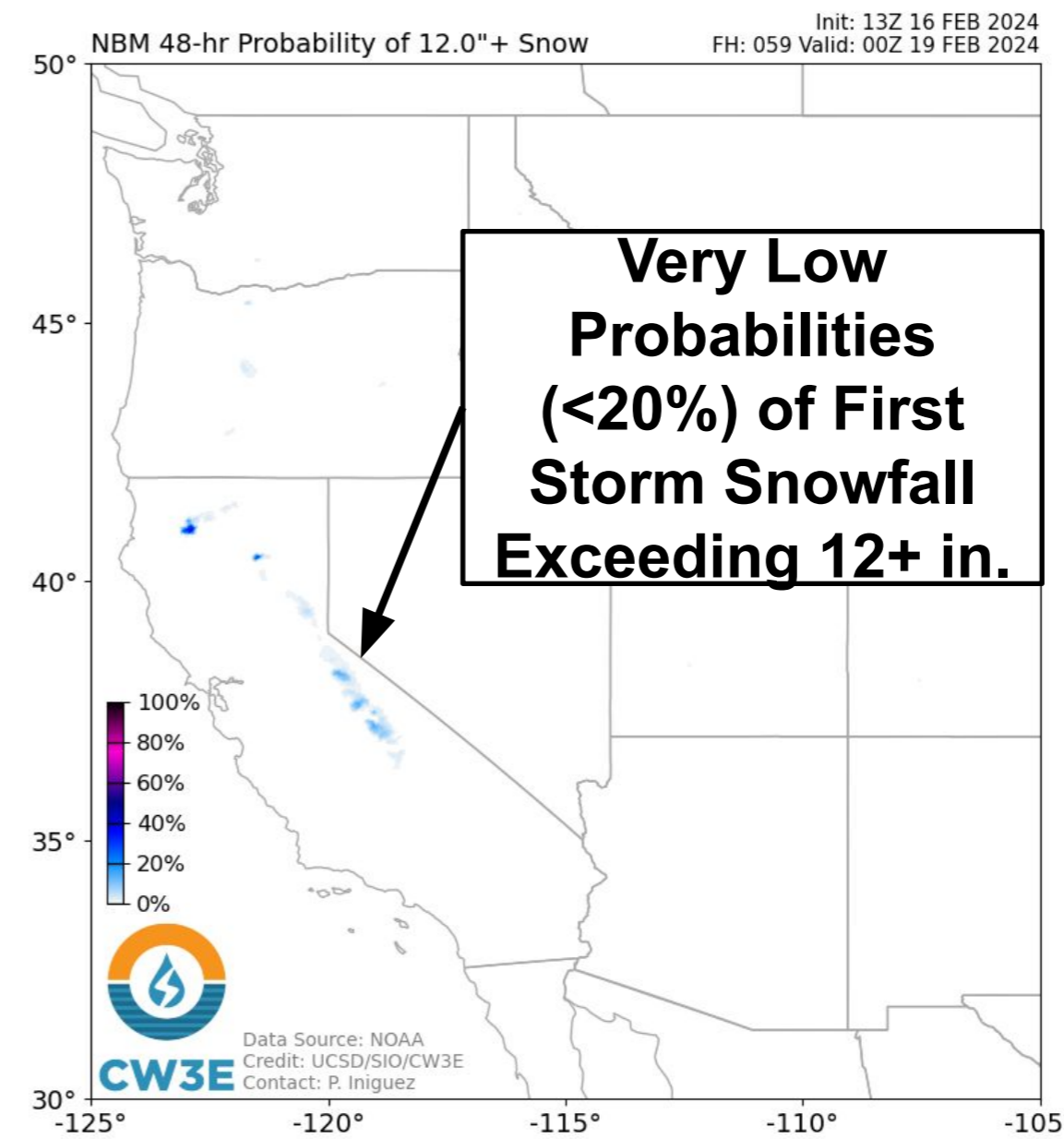
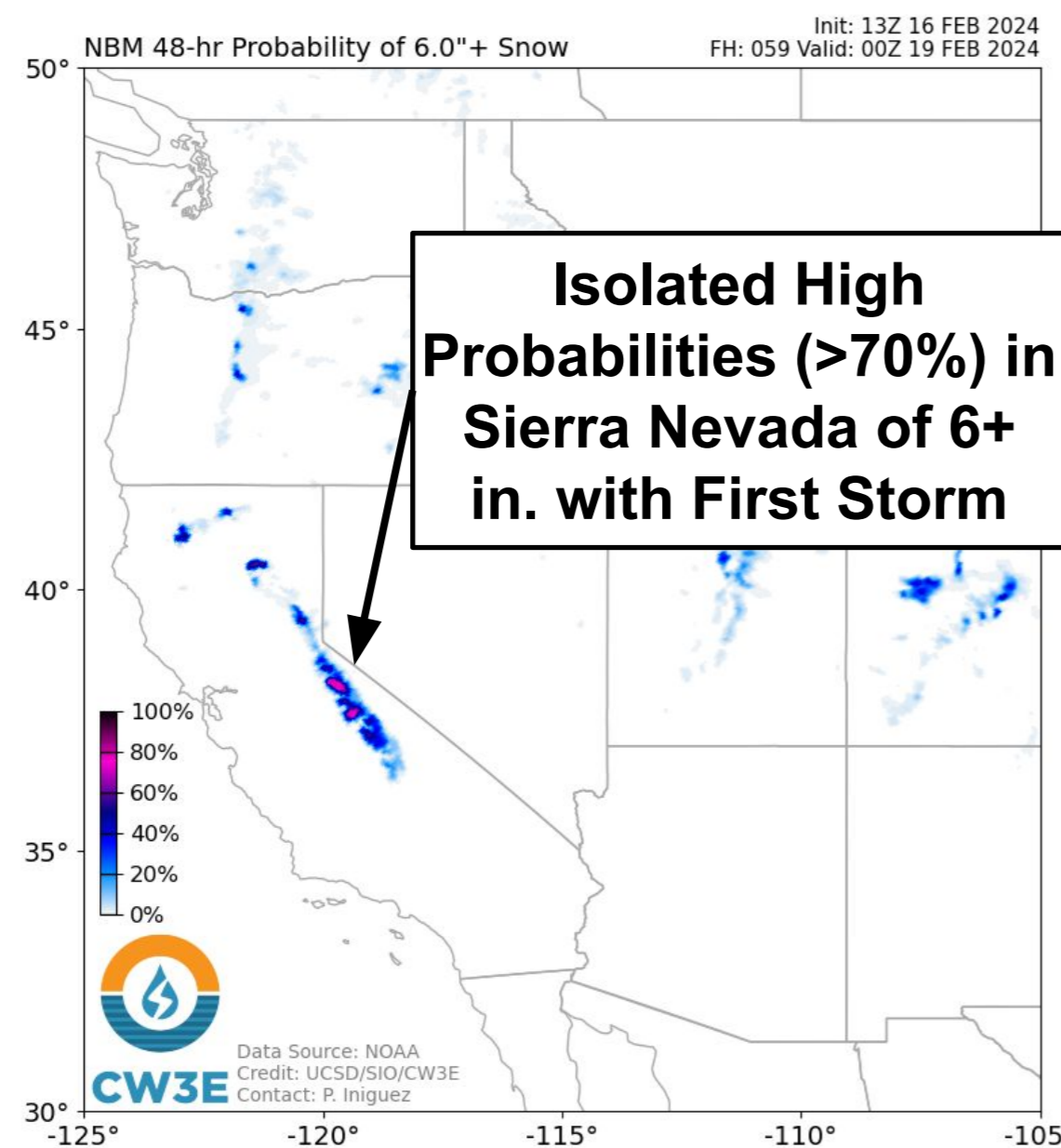
## Freezing Level Forecast



- The freezing level is forecast to be between ~5000 and ~7000 feet above Mean Sea Level (MSL) during the first and second storms in the Upper Yuba watershed.
- The freezing level forecast in the Upper Yuba results in the majority of ensemble members forecasting the precipitation to fall as rain (67.7%).

# CW3E AR Outlook: 16 Feb 2024

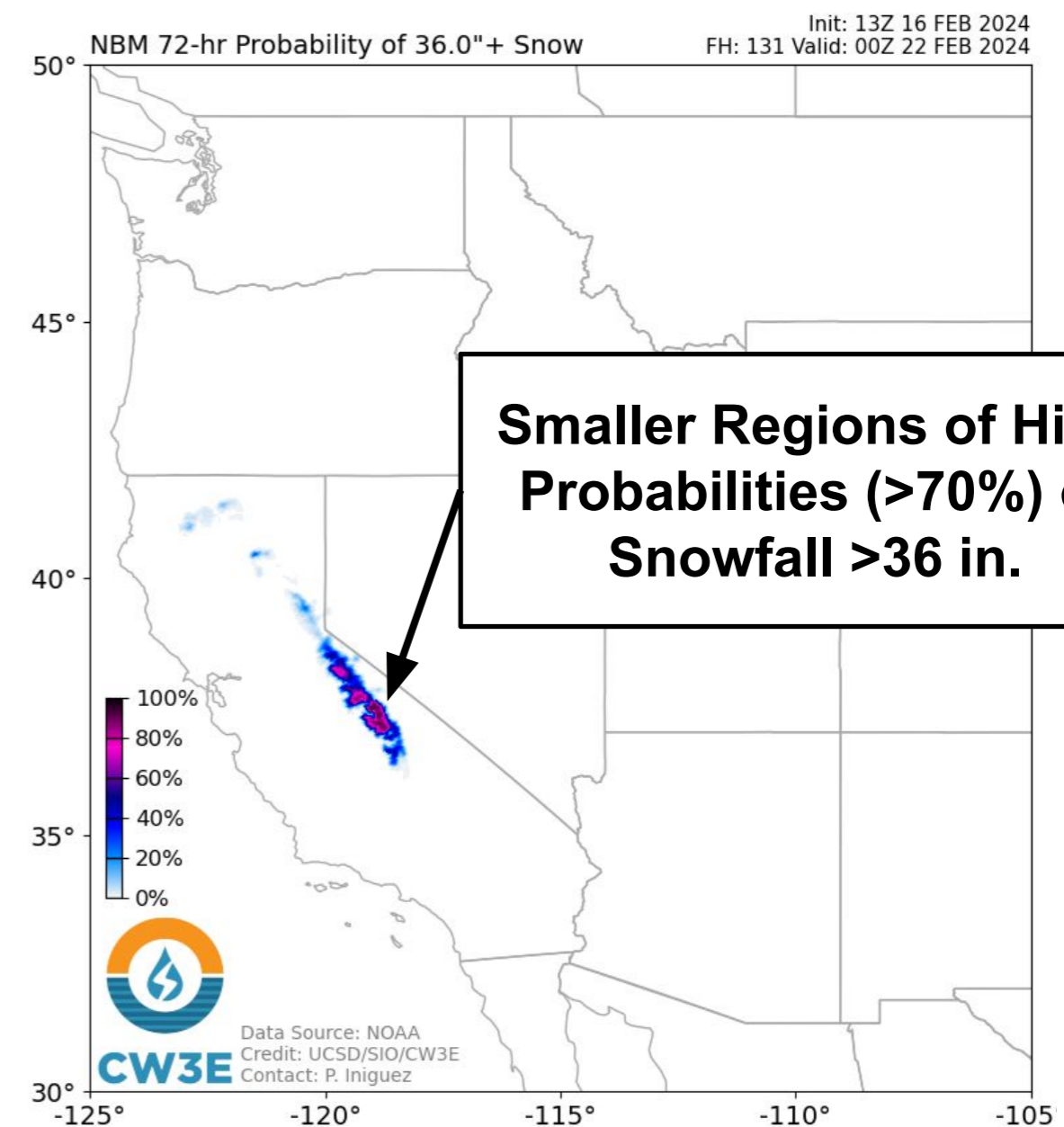
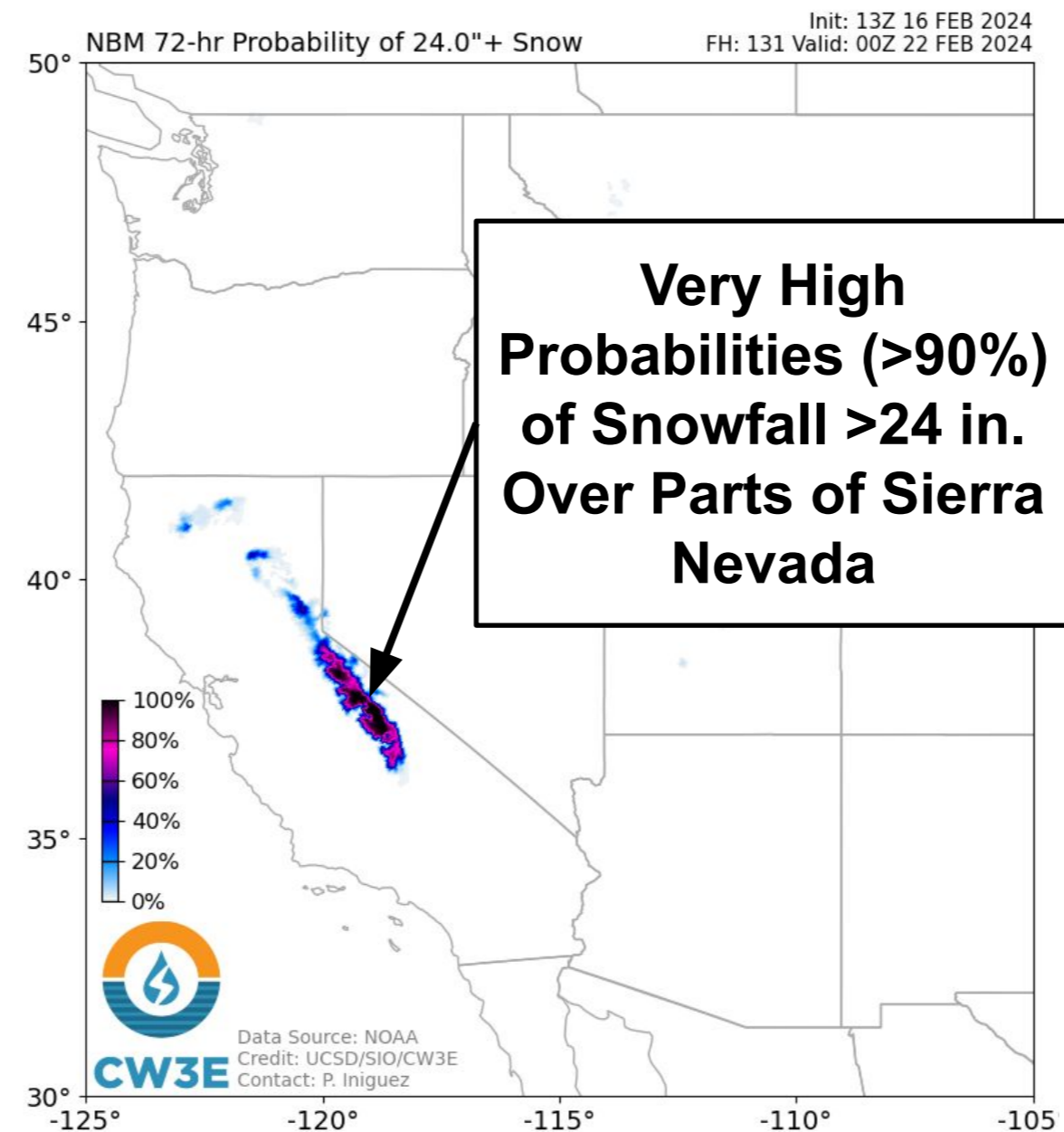
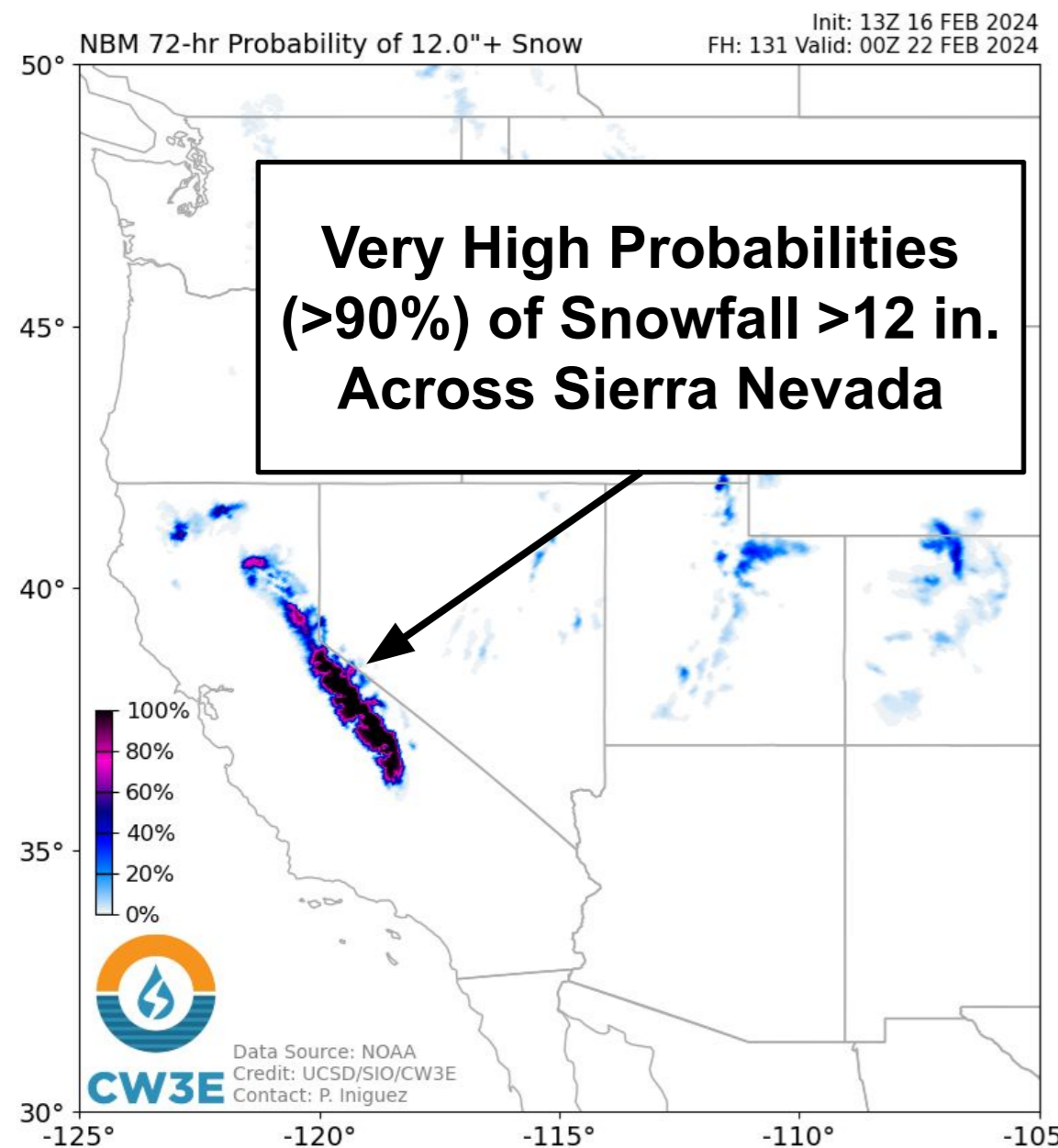
## NBM First Storm Snowfall Accumulation Probabilities



- The National Blend of Models (NBM) snowfall accumulation forecast show isolated regions of higher probabilities for >6 in. of snow in the Sierra Nevada for the 48 hour period ending 4 PM PT 18 Feb for the first storm.

# CW3E AR Outlook: 16 Feb 2024

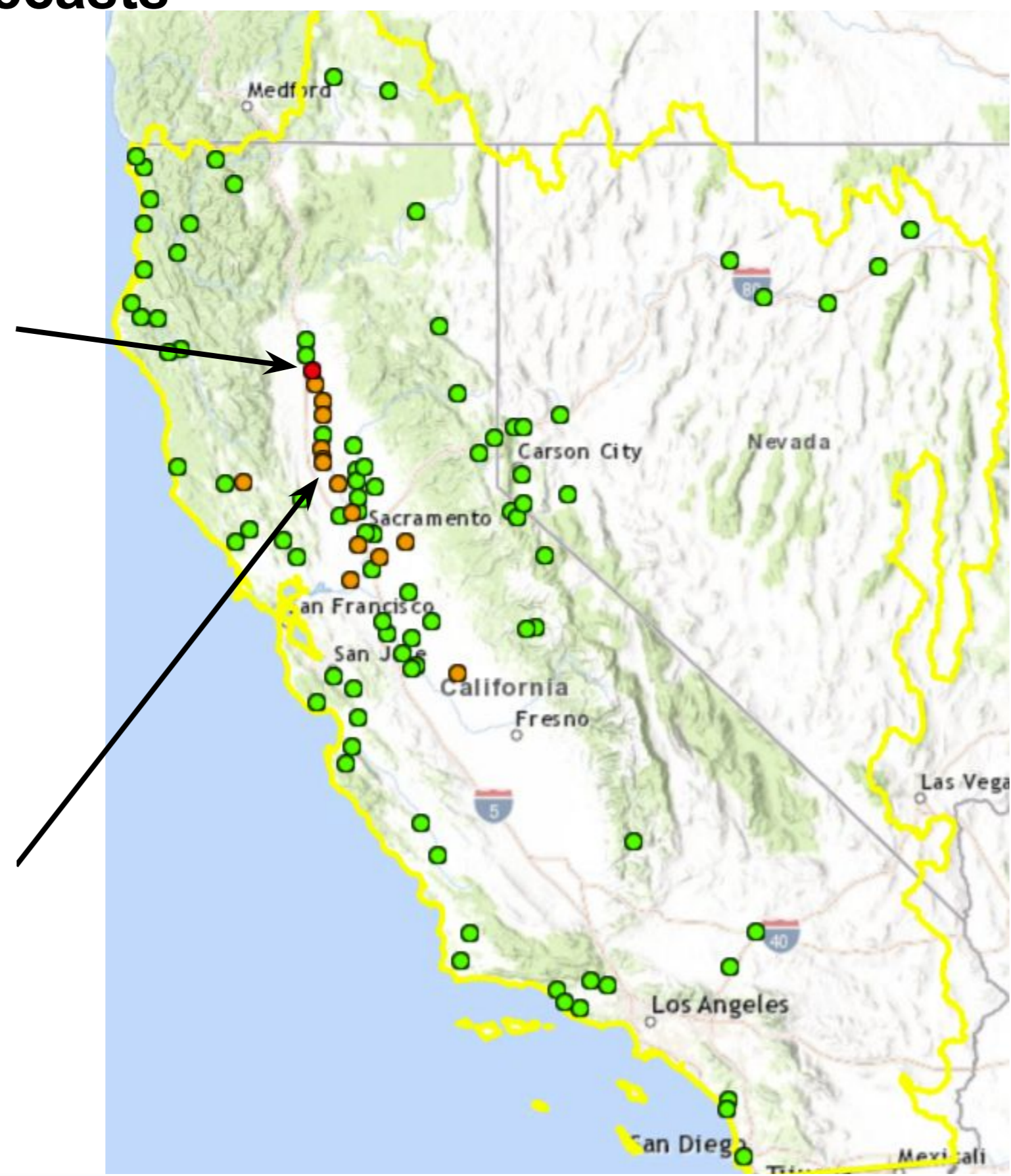
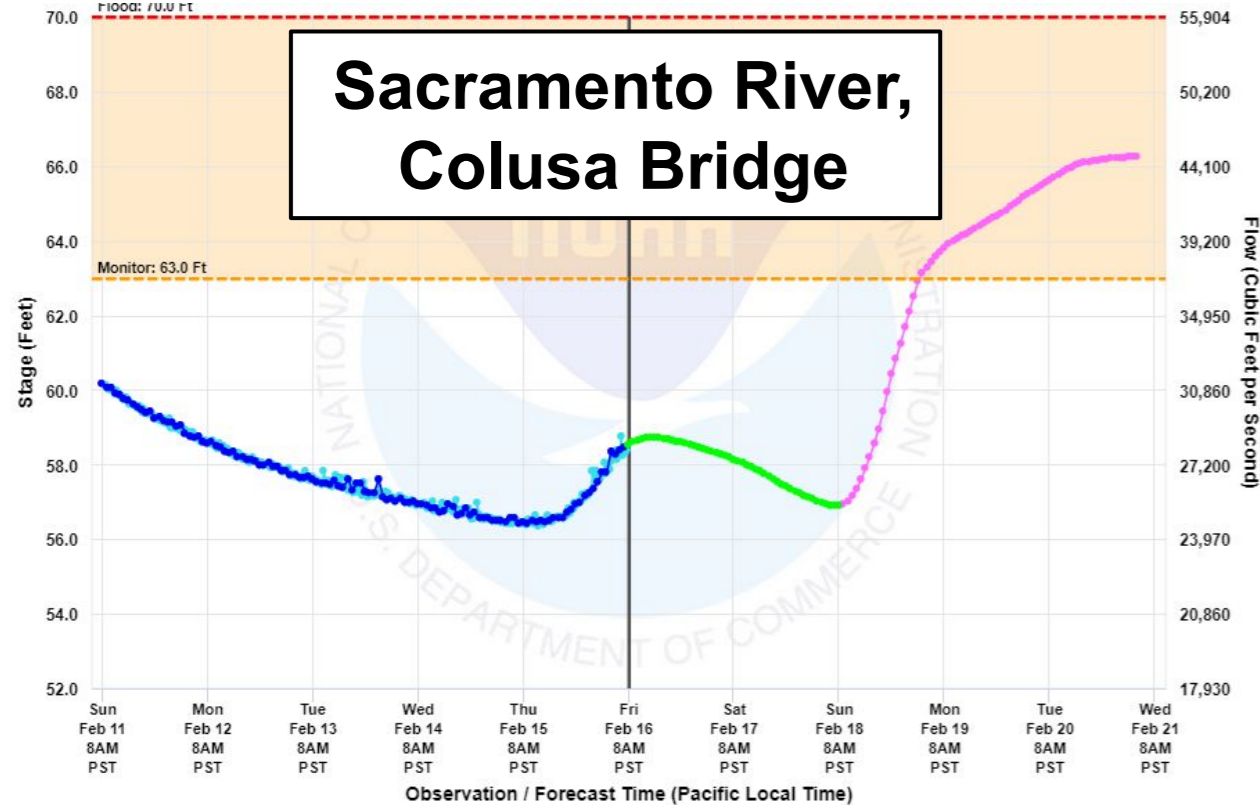
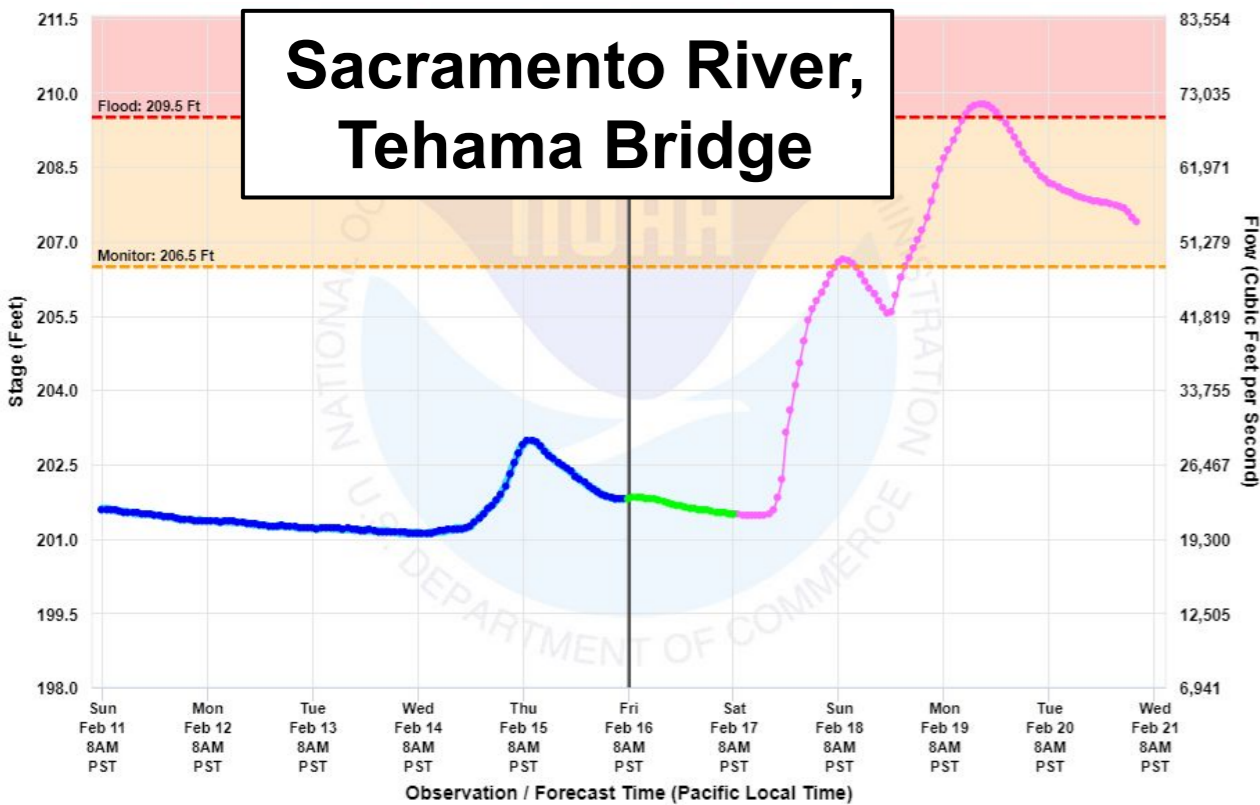
## NBM Second Storm Snowfall Accumulation Probabilities



- The NBM is showing much greater probabilities for heavy snowfall during the second storm than the first.
- Currently, the NBM is forecasting very high probabilities (>90%) of 72 hour snowfall accumulations (for period ending 4 PM PT Wed 21 Feb) exceeding 12 in. across much of the Sierra Nevada and 24 in.+ for the central Sierra Nevada.
- There are smaller regions of high probabilities (>70%) of snowfall accumulations exceeding 36 + in. in the central Sierra Nevada.

# CW3E AR Outlook: 16 Feb 2024

## NWS CNRFC River Stage Forecasts

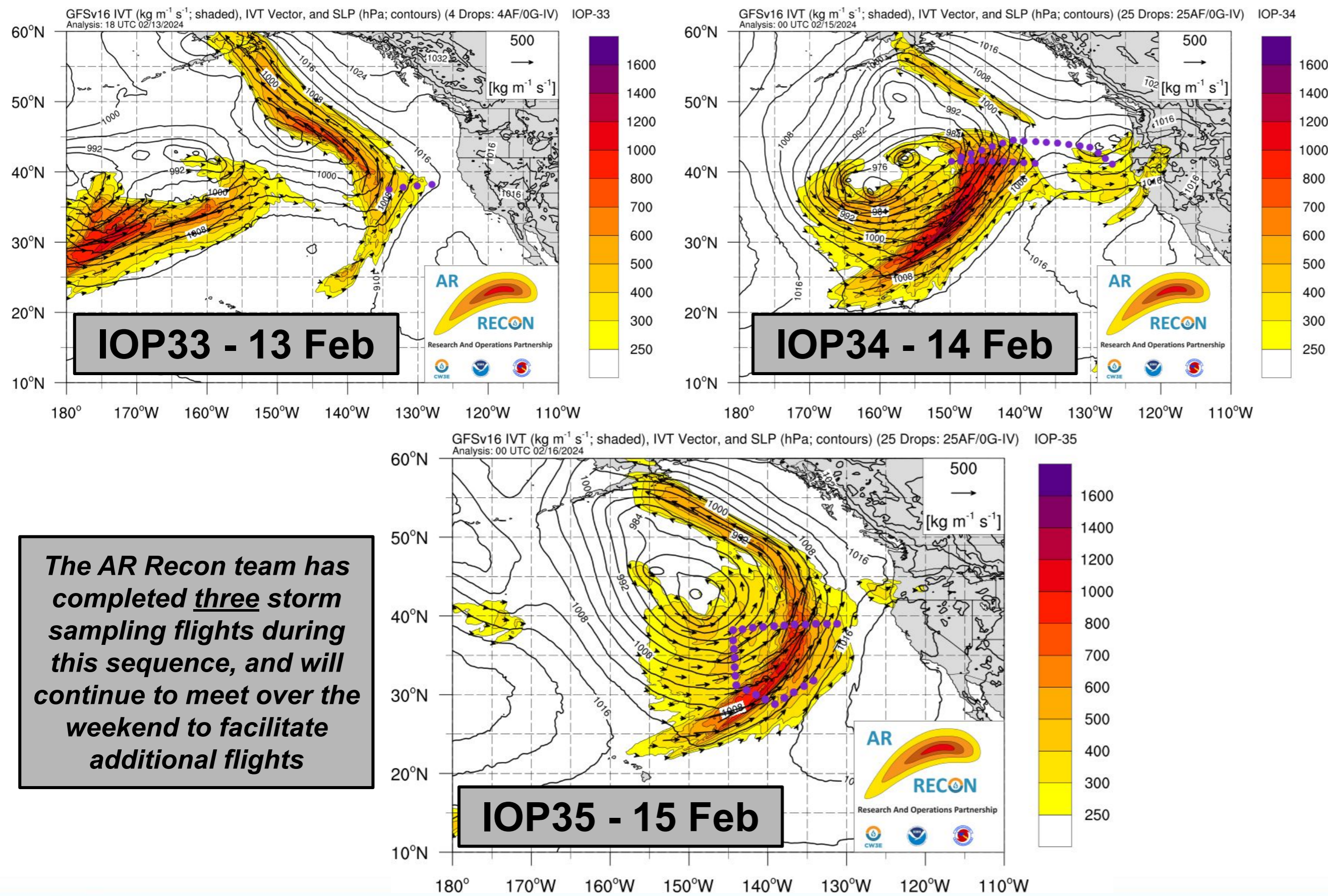


- River levels in northern CA are forecast to rise as a result of the precipitation from the storms during this period.
- CNRFC is currently forecasting 14 gages to exceed monitor stage and 1 gages to exceed flood stage in the next 5 days.
- The Sacramento River at Tehama Bridge (top left) guidance shows the river reaching flood stage during the afternoon on Mon 19 Feb.
- The Sacramento River at Colusa Bridge (bottom left) guidance shows the river exceeding monitor stage late Sun 18 Feb and remaining there through the end of the guidance period.

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

# CW3E AR Outlook: 16 Feb 2024

## Current AR Recon Planned Flight Sequence



*The AR Recon team has completed three storm sampling flights during this sequence, and will continue to meet over the weekend to facilitate additional flights*



- CW3E's Atmospheric River Reconnaissance (AR Recon) field campaign continues in WY2024, with the most recent sequence of flights focusing on the development of the current sequence of storms.
- The AR Recon team planned multiple flights, departing from Sacramento, CA to fly over and around ARs in the eastern N. Pacific
- These sampling missions provide data in near real-time to the global forecast models to improve weather forecasts. Data from these missions are archived for future AR research.
- Flights sample the atmosphere and its essential atmospheric structures, in addition to regions of forecast sensitivity.