

CW3E Atmospheric River Outlook: 10 March 2025

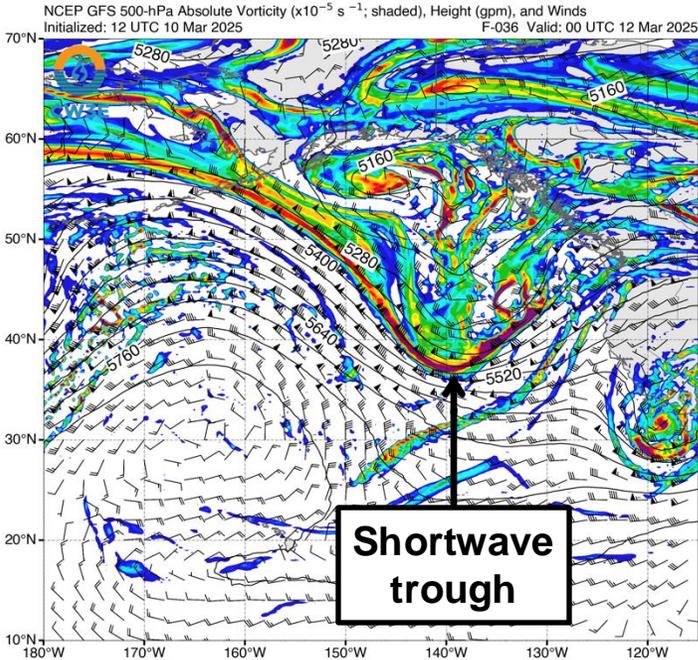
Multiple Atmospheric Rivers Forecast to Impact US West Coast This Week into This Weekend

- A weak atmospheric river (AR) is forecast to make landfall over coastal Oregon late Tue 11 Mar.
- As the upstream trough amplifies off the California coast, the AR is forecast to intensify over California, potentially bringing moderate AR conditions ($IVT \geq 500 \text{ kg m}^{-1} \text{ s}^{-1}$) to the Bay Area and Sacramento Valley.
- A second and potentially stronger AR is forecast to make landfall over the US West Coast this weekend in association with a strong low-pressure system.
- The GEFS control member is forecasting an AR 1 (based on the Ralph et al. 2019 AR Scale) over the Bay Area in association with the first AR.
- While moisture will be somewhat limited with these ARs, strong dynamical forcing and a favorable direction of moisture transport will likely facilitate heavy precipitation over the US West Coast.
- The first AR is forecast to produce 2–5 inches of precipitation in the Northern California Coast Ranges, Sierra Nevada, and eastern Transverse Ranges, and 1–3 inches of precipitation elsewhere in coastal California.
- The NWS Weather Prediction Center (WPC) has issued a **slight risk** excessive rainfall outlook (ERO) for the Transverse Ranges and a **marginal risk** ERO for the rest of coastal California, the Sacramento Valley, and the Sierra Nevada foothills.
- Low freezing levels during the first AR will facilitate heavy snowfall accumulations (at least 12–36 inches) above 4,000 feet throughout the Sierra Nevada. Major-to-extreme winter storm impacts are expected in these areas.
- Model differences in the evolution of the second AR and associated upstream trough are leading to large differences in forecast precipitation over California during the next 10 days. The EPS is favoring much higher precipitation totals over coastal California and the Sierra Nevada compared to GEFS.

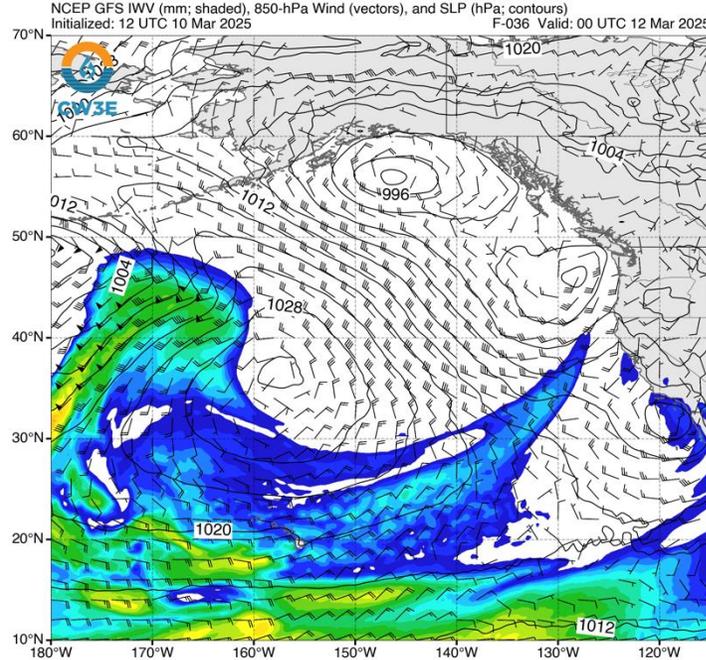
AR Outlook: 10 March 2025

GFS Model Forecasts: Valid 5 PM PT 11 Mar (F-036)

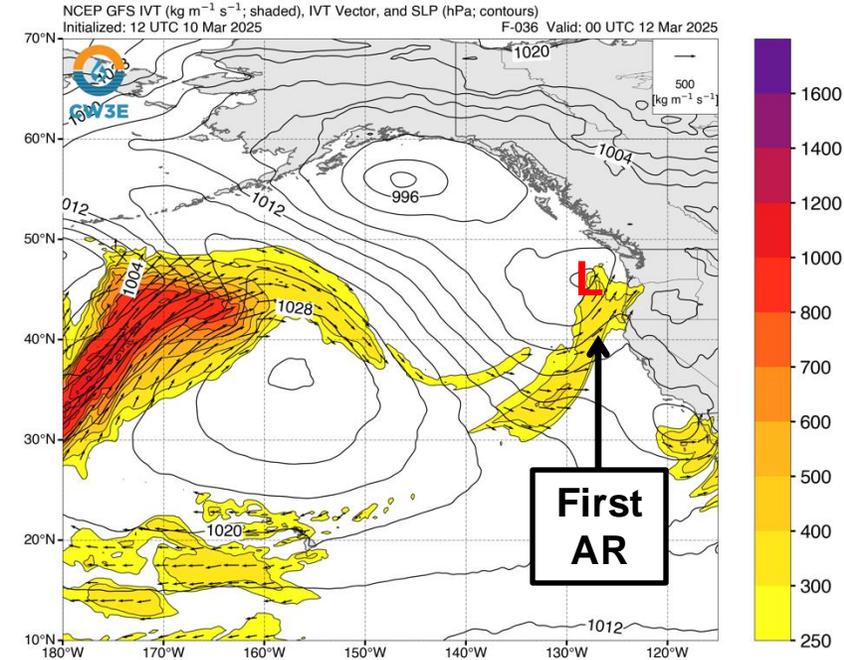
500-hPa Absolute Vorticity, Height, & Winds



IWV & SLP



IVT & SLP

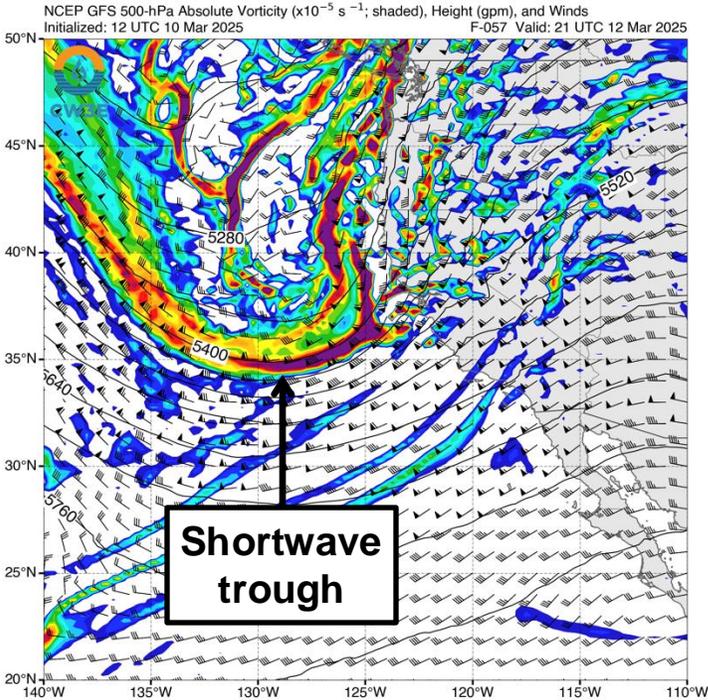


- The first AR will develop within a narrow plume of moisture extending from the central North Pacific Ocean and propagate eastward over the next 24 hours.
- This AR is forecast to initially make landfall over coastal Oregon late Tue 11 Mar in association with a weak low-pressure system downstream of a mid-level shortwave trough.

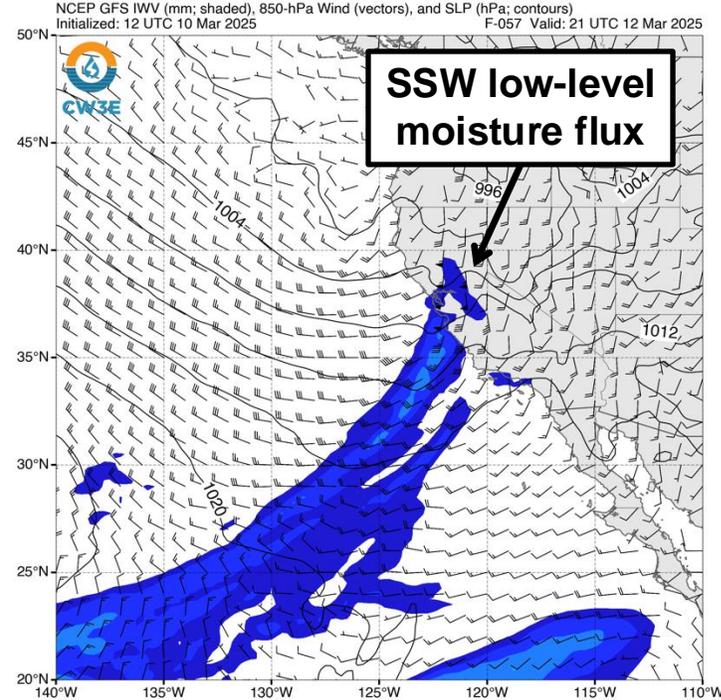
AR Outlook: 10 March 2025

GFS Model Forecasts: Valid 2 PM PT 12 Mar (F-057)

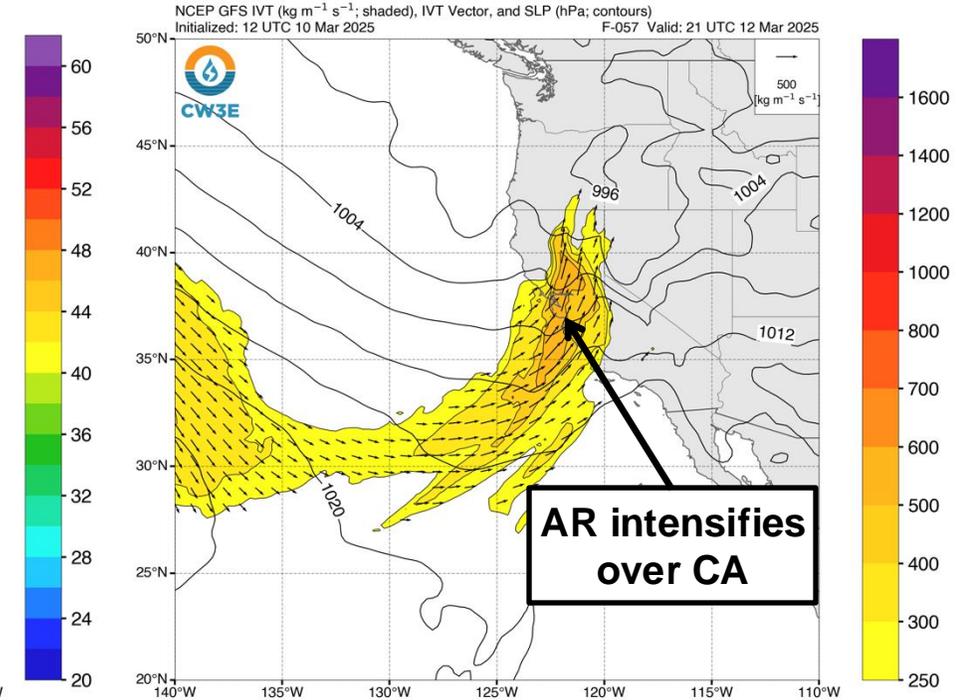
500-hPa Absolute Vorticity, Height, & Winds



IWW & SLP



IVT & SLP

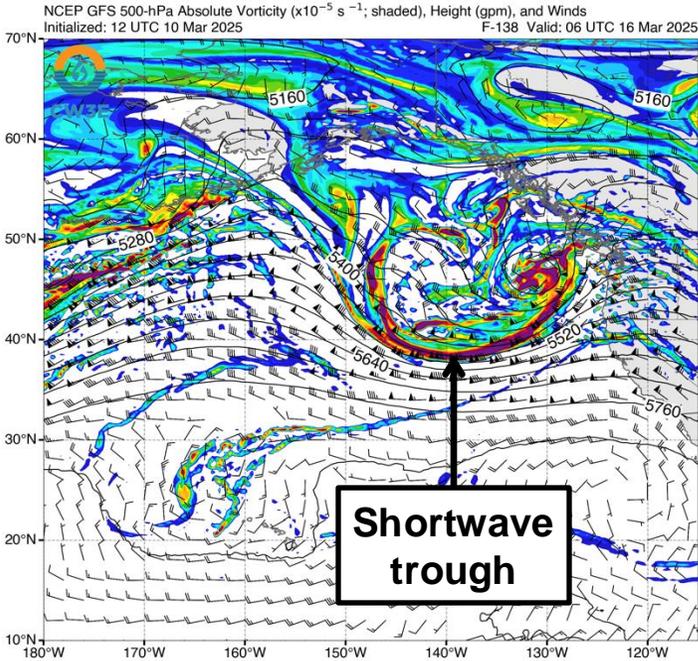


- As the AR drifts southward into California, the upstream trough is forecast to deepen off the California coast.
- Strengthening south-southwesterly low-to-midlevel winds downstream of the trough will facilitate the intensification of the AR as it passes over California, potentially bringing a brief period of moderate AR conditions ($\text{IVT} \geq 500 \text{ kg m}^{-1} \text{ s}^{-1}$) to the Bay Area and Sacramento Valley.
- South-southwesterly-to-southwesterly low-level moisture flux will likely support orographic enhancement of precipitation over the Sierra Nevada, California Coast Ranges, and Transverse Ranges.

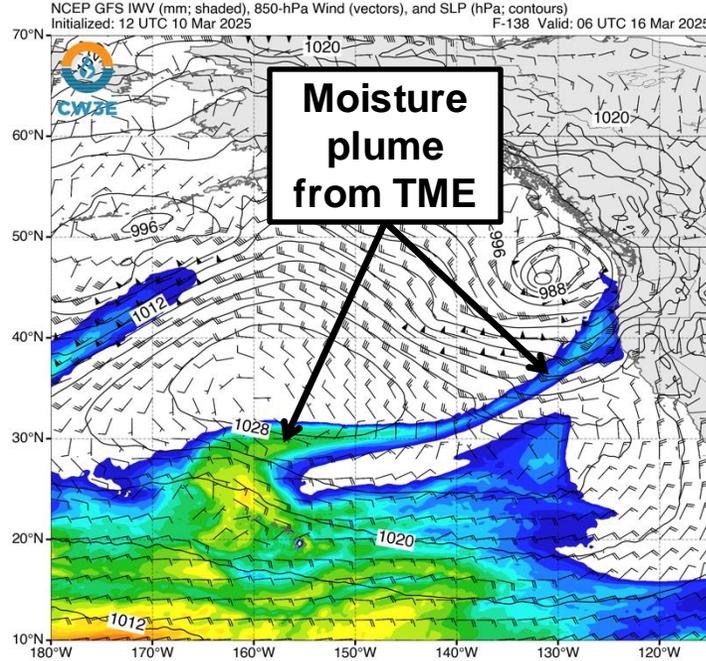
AR Outlook: 10 March 2025

GFS Model Forecasts: Valid 11 PM PT 15 Mar (F-138)

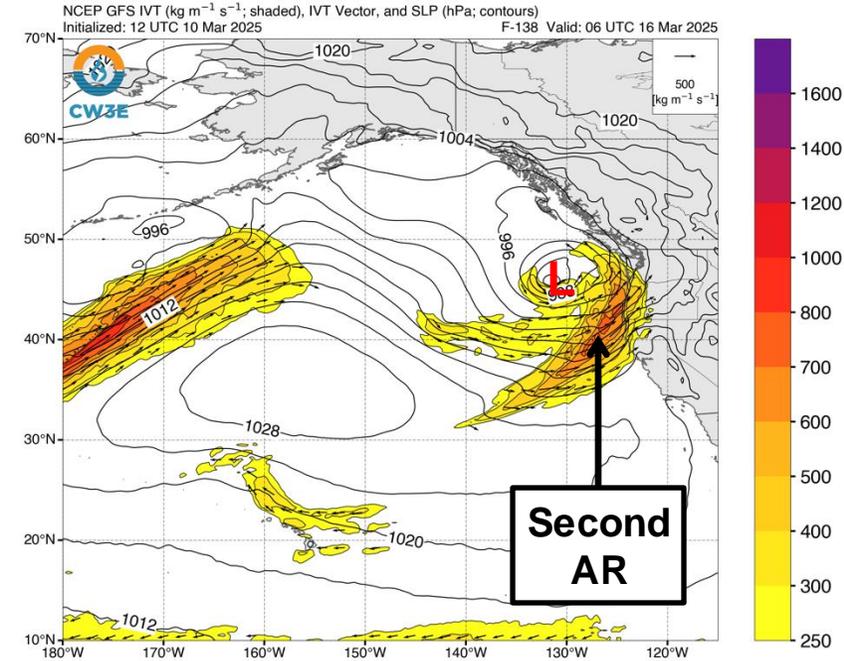
500-hPa Absolute Vorticity, Height, & Winds



IWV & SLP

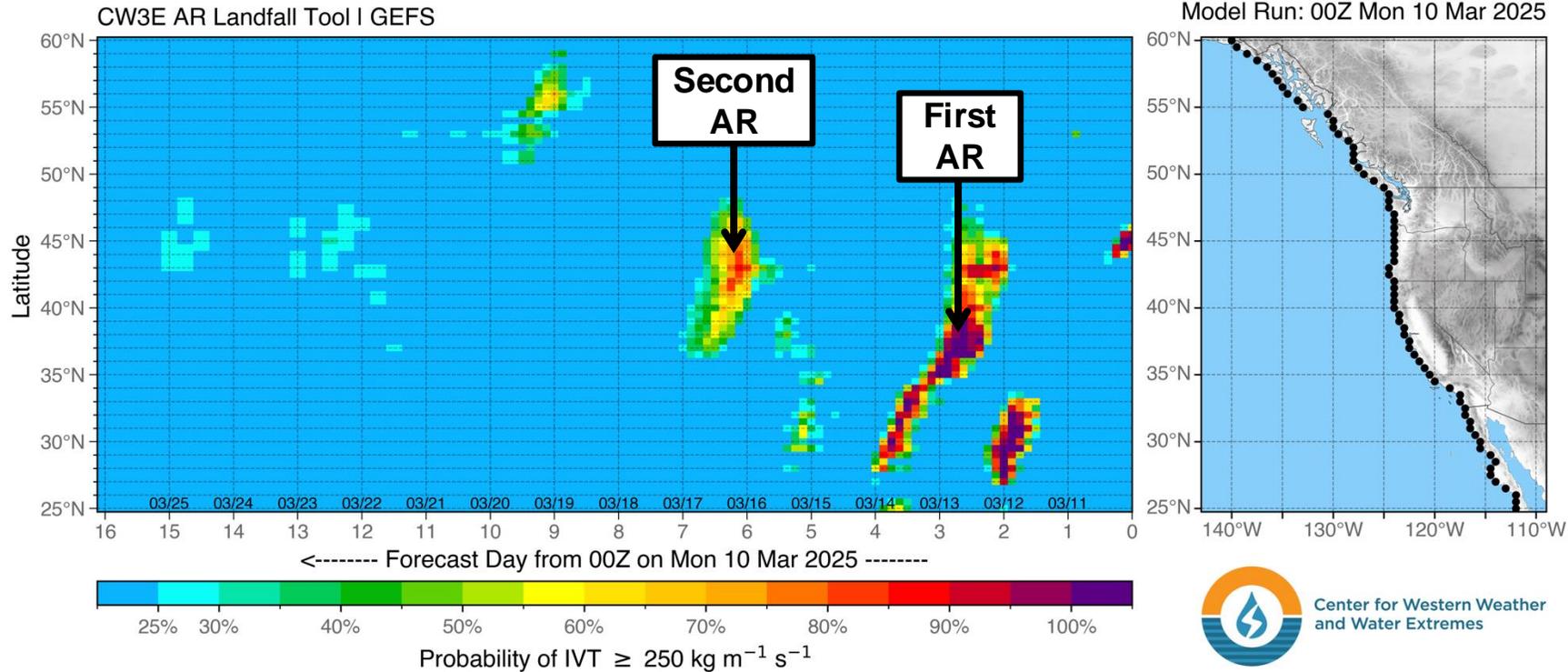


IVT & SLP



- After the first AR dissipates, a second AR is forecast develop north of Hawaii in association with a tropical moisture export (TME) and make landfall over the US West Coast on Sat 15 Mar.
- The presence of the AR may help fuel the formation of a strong low-pressure system near the leading edge of the AR as it approaches the US West Coast.
- There is still considerable uncertainty in the forecast evolution of the second AR due to uncertainty in the location and amplitude of the upstream shortwave trough.

GEFS Probability of AR Conditions Along Coast



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

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

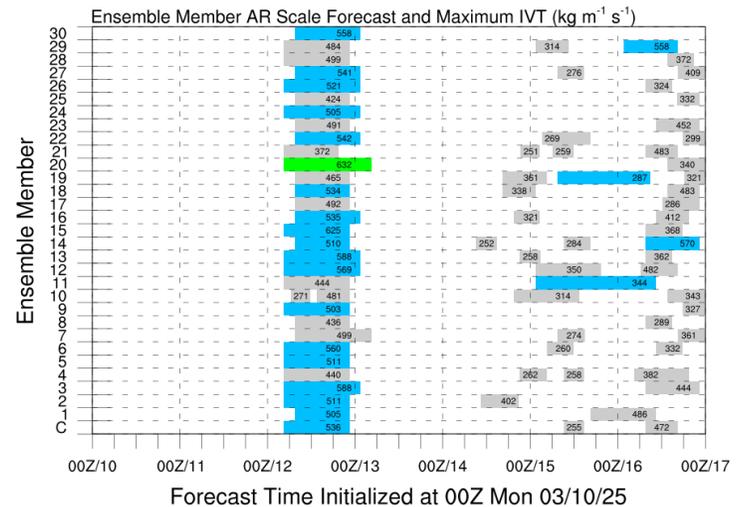
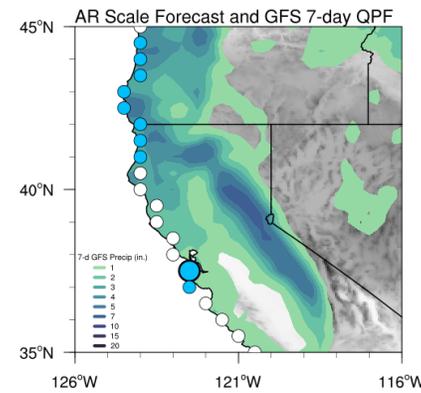
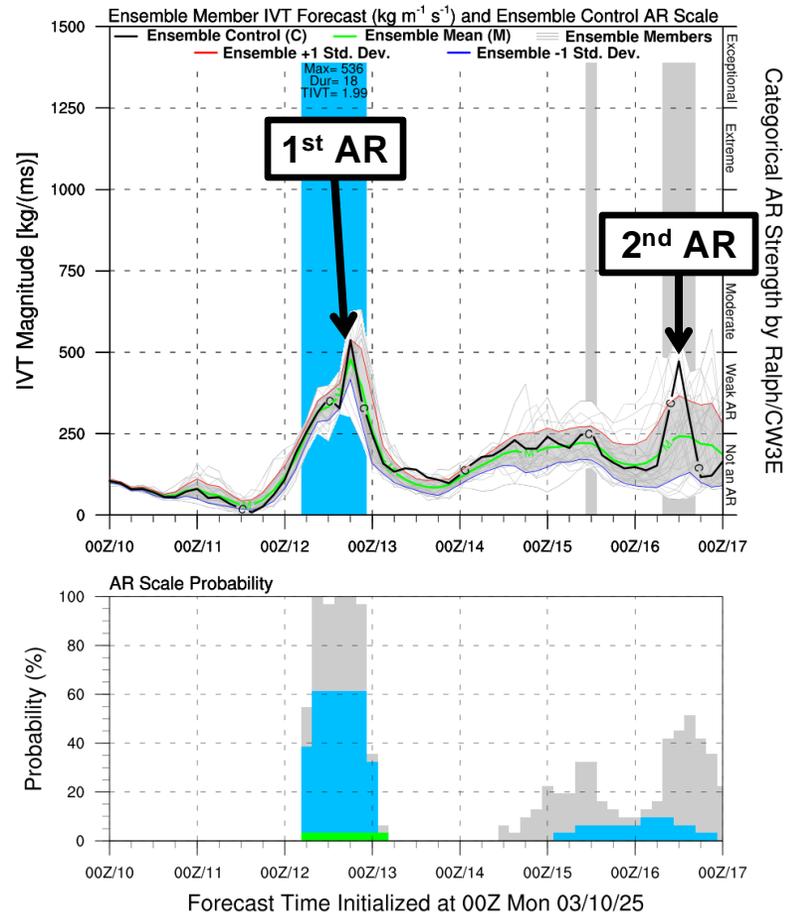
- The 00Z GEFS is showing high confidence (>90% probability) in a brief period of AR conditions ($IVT \geq 250 \text{ kg m}^{-1} \text{ s}^{-1}$) over coastal California on 12–13 Mar in association with the first AR.
- GEFS is also showing moderate-to-high confidence (55–85% probability) in a period of AR conditions over coastal Oregon and Northern California on 15–16 Mar in association with the second AR.

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GEFS AR Scale and IVT Forecasts

GFS Ensemble Initialized: 00Z Mon 03/10/25

Location: 37.5°N 122.5°W



- The GEFS control member is forecasting an AR 1 (based on the Ralph et al. 2019 AR Scale) at 37.5°N, 122.5°W (San Mateo County, CA) in association with the first AR.
- About 60% (18/31) of GEFS members are forecasting an AR 1 at this location.
- While there is some uncertainty in the peak IVT magnitude, there is generally good agreement in the timing and duration of AR conditions.
- GEFS is currently showing a very low probability of AR Scale conditions (only 4/31 members are forecasting an AR 1) at this location for the second AR on 15–16 Mar.



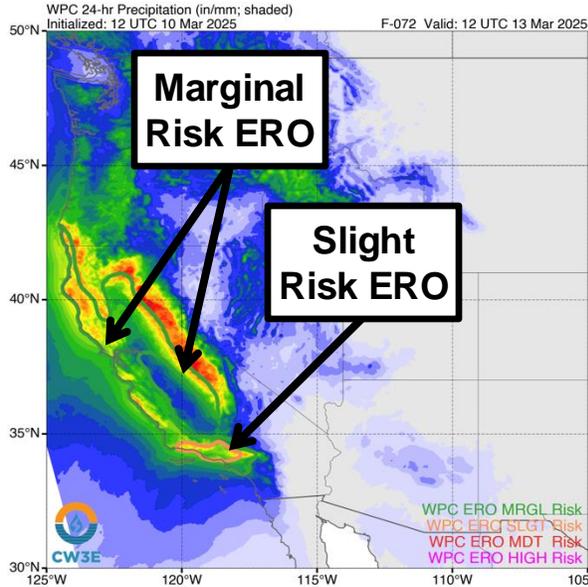
AR 1 AR 2 AR 3 AR 4 AR 5

Image created: 08 UTC 03/10/2025

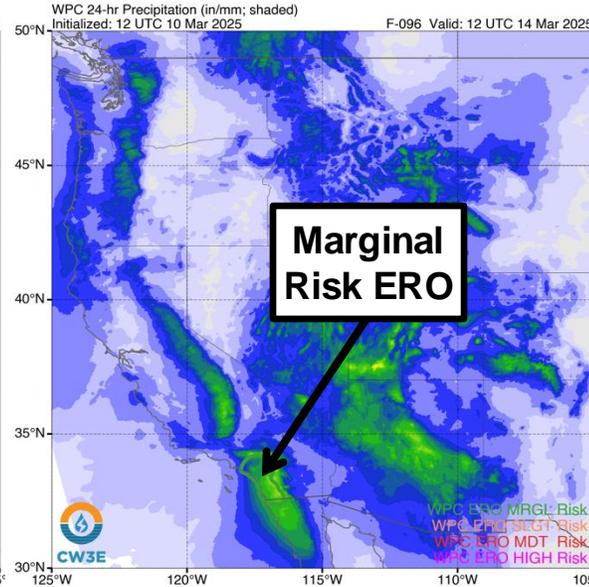
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

Precipitation Forecasts

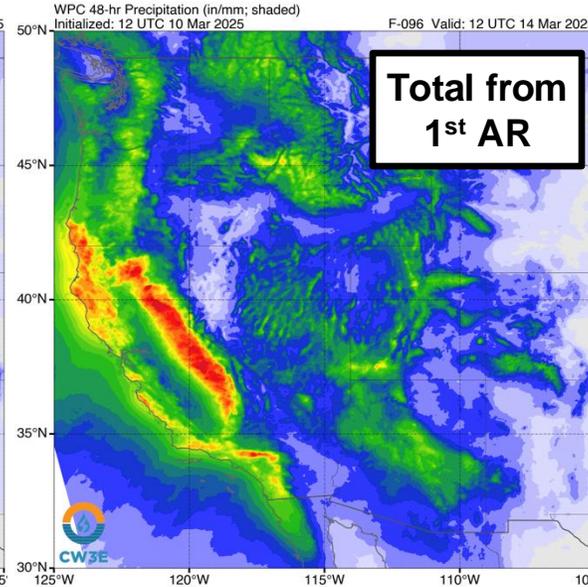
WPC Day 3 24-h QPF
Valid: 5 AM PT 13 Mar



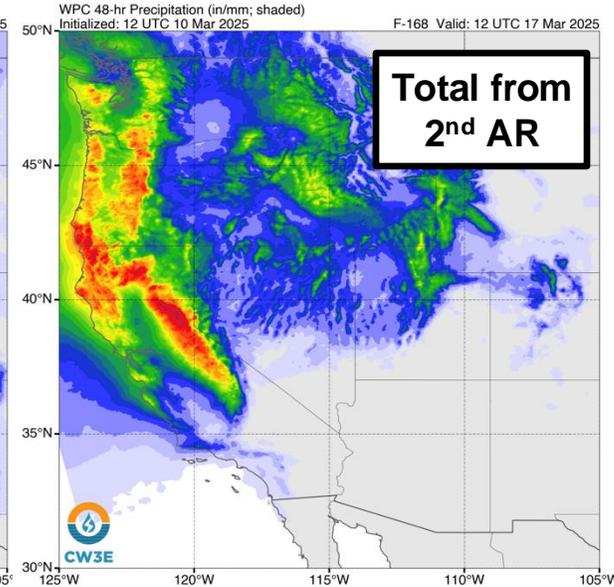
WPC Day 4 24-h QPF
Valid: 5 AM PT 14 Mar



WPC 48-h Total QPF
Valid: 5 AM PT 14 Mar



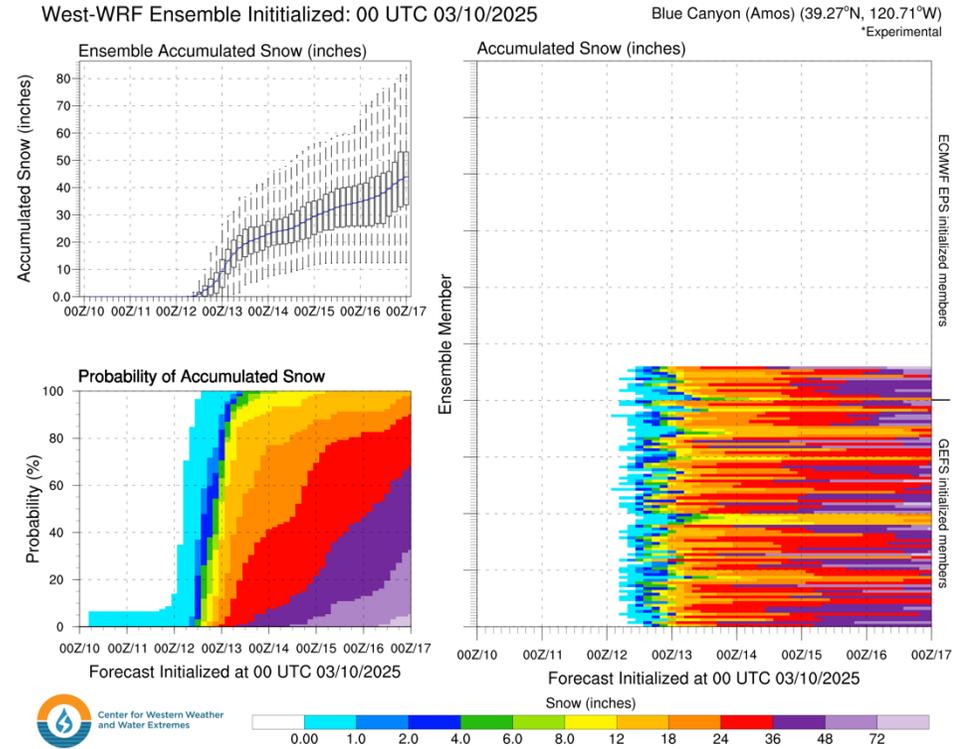
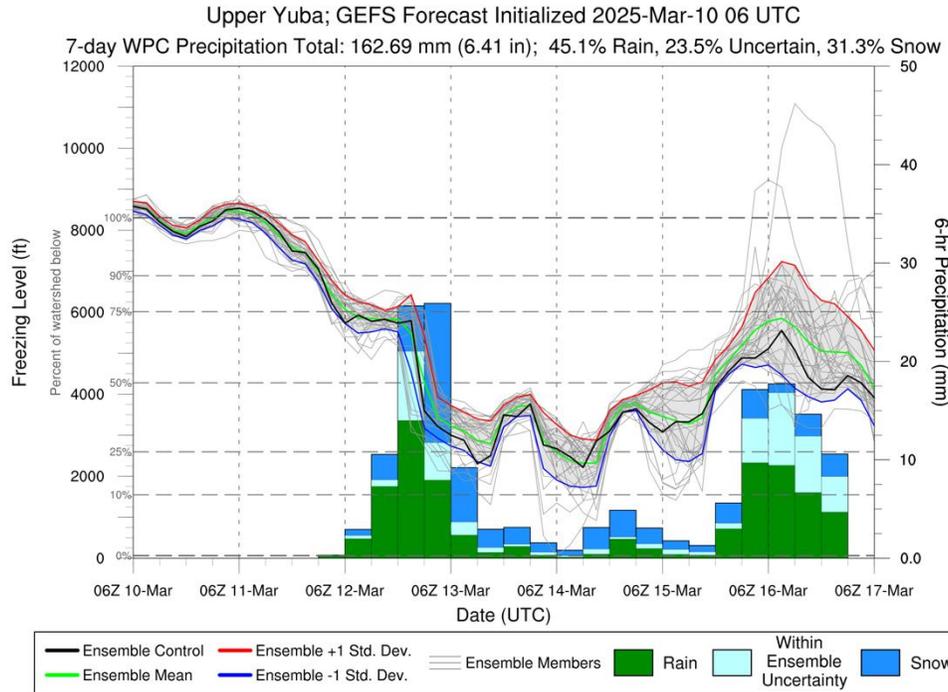
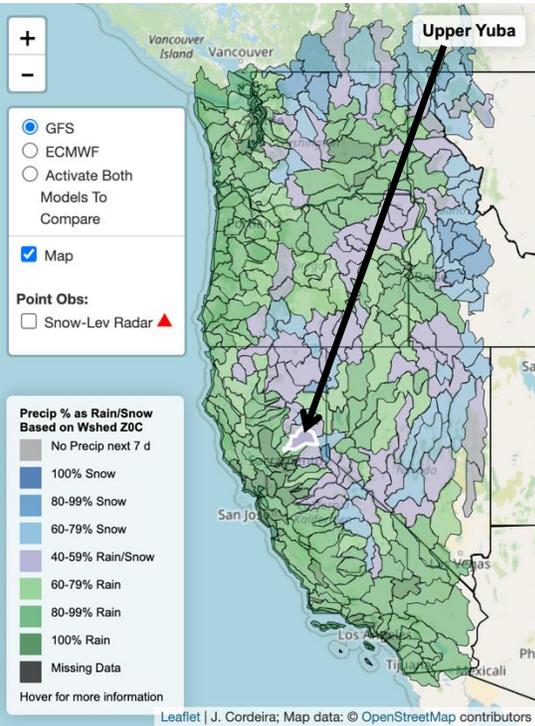
WPC 48-h Total QPF
Valid: 5 AM PT 17 Mar



- The first AR is forecast to produce 2–5 inches of precipitation in the Northern California Coast Ranges, southern Cascades, Sierra Nevada, and eastern Transverse Ranges, and 1–3 inches of precipitation elsewhere in coastal California.
- The NWS Weather Prediction Center (WPC) has issued a **slight risk** (level 2 of 4; $\geq 15\%$ probability of flooding) excessive rainfall outlook (ERO) for the Transverse Ranges Wed 12 Mar into Thu 13 Mar due to potential for flash flooding and debris flows in recent burn scars.
- **Marginal risk** (level 1 of 4; $\geq 5\%$ probability of flooding) EROs have been issued for the remainder of coastal California, the Sacramento Valley, and the Sierra Nevada foothills.
- The second AR is forecast to produce 2–6 inches of precipitation over the Cascades from southern Washington to Northern California, the Oregon Coast Ranges, the Northern California Coast Ranges, and the Northern and Central Sierra Nevada.

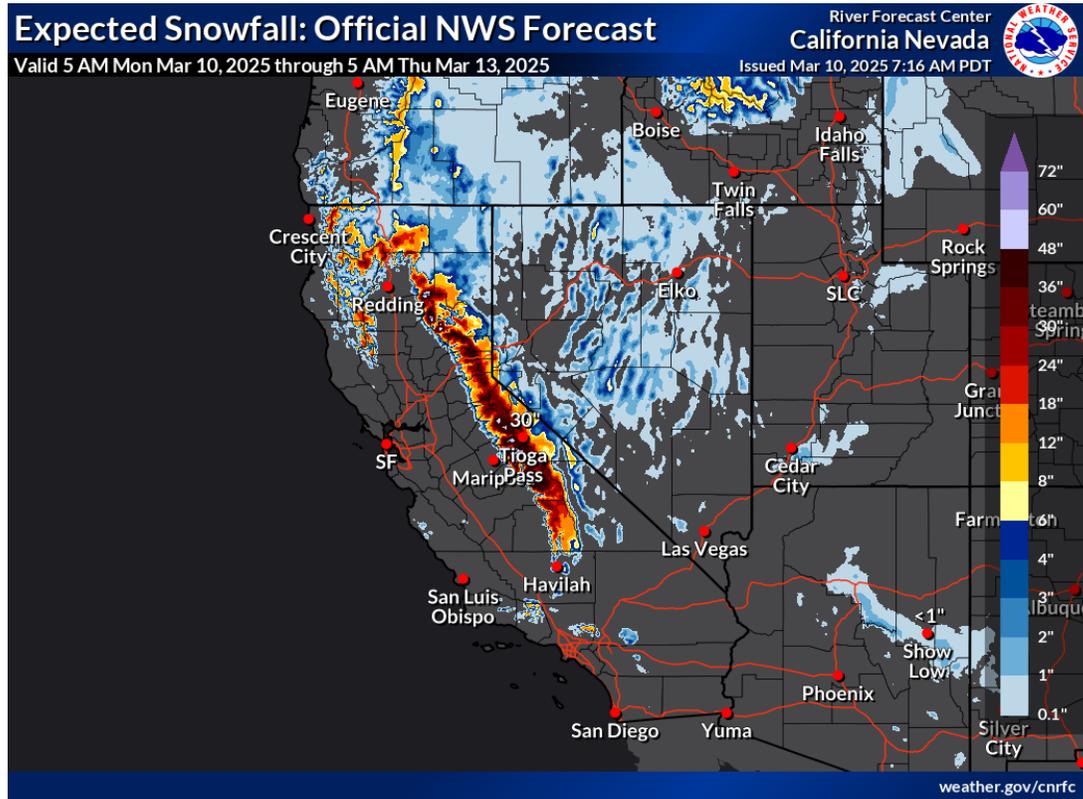
AR Outlook: 10 March 2025

GEFS Freezing Level & West-WRF Snowfall Forecasts

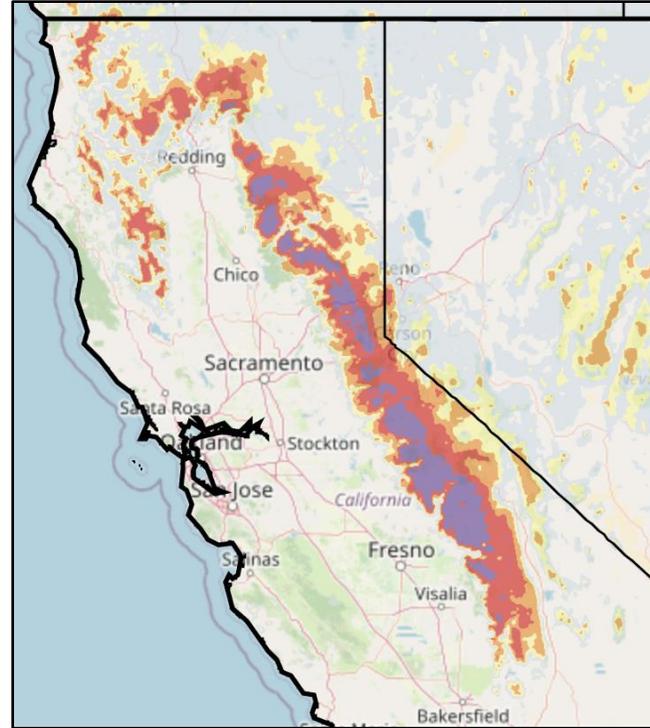


- Freezing levels in the Northern and Central Sierra Nevada are forecast to drop from ~6,000 feet to below 4,000 feet after the first AR makes landfall on Wed 12 Mar.
- Low freezing levels will facilitate heavy snowfall accumulations above 4,000 feet in much of the Sierra Nevada.
- CW3E's West-WRF ensemble is showing ~40% likelihood of 24+ inches of total snow at Blue Canyon (elevation: 5,285 feet) by late afternoon Thu 13 Mar.

Winter Storm Impacts



Winter Storm Severity Index: Valid 24-h Period Ending 5 AM PT 13 Mar



Potential Winter Storm Impacts	
	Winter Weather Area Expect Winter Weather. • Winter driving conditions. Drive carefully.
	Minor Impacts Expect a few inconveniences to daily life. • Winter driving conditions. Use caution while driving.
	Moderate Impacts Expect disruptions to daily life. • Hazardous driving conditions. Use extra caution while driving. • Closures and disruptions to infrastructure may occur.
	Major Impacts Expect considerable disruptions to daily life. • Dangerous or impossible driving conditions. Avoid travel if possible. • Widespread closures and disruptions to infrastructure may occur.
	Extreme Impacts Expect substantial disruptions to daily life. • Extremely dangerous or impossible driving conditions. Travel is not advised. • Extensive and widespread closures and disruptions to infrastructure may occur. • Life-saving actions may be needed.

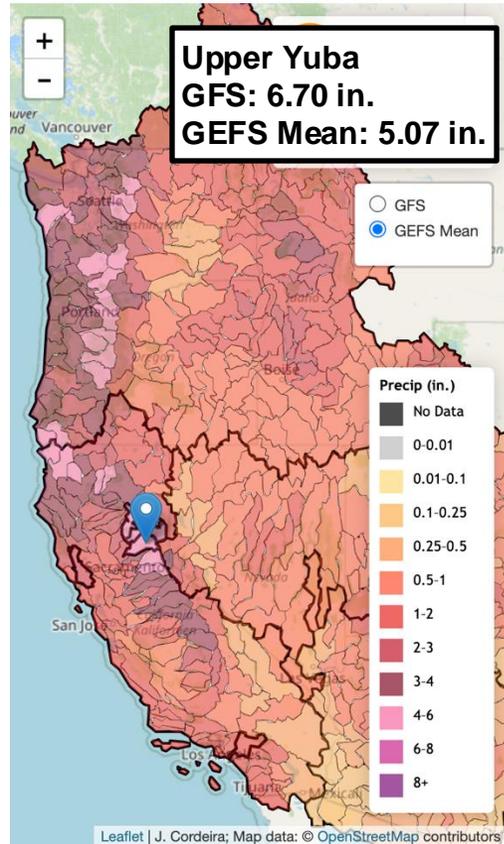
Credit: NOAA NWS Weather Prediction Center

- The first storm is forecast to produce 12–36 inches of snow above 4,000 feet throughout the Sierra Nevada, with as much as 48 inches possible over the higher peaks.
- Snowfall accumulations >12 inches are also possible above 6,000 feet in the Transverse Ranges of Southern California.
- The combination of heavy snow and strong winds is expected to result in major-to-extreme winter storm impacts over the Sierra Nevada on Wed 12 Mar into early Thu 13 Mar.

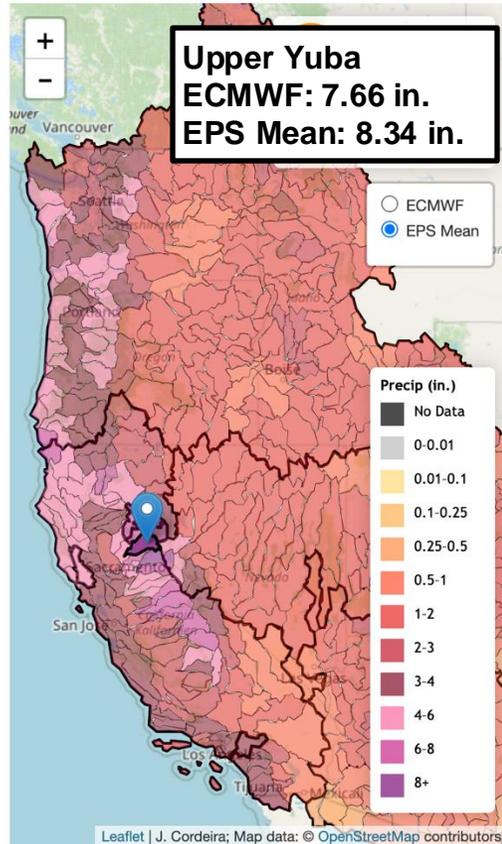
AR Outlook: 10 March 2025

Watershed Precipitation Forecasts

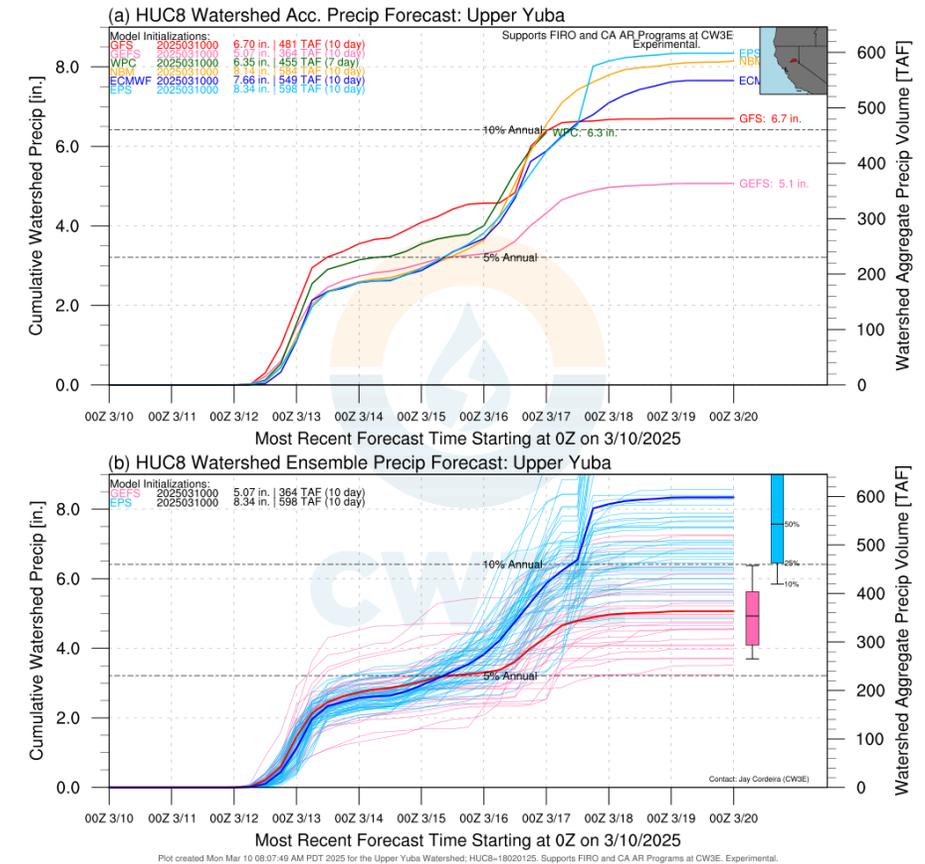
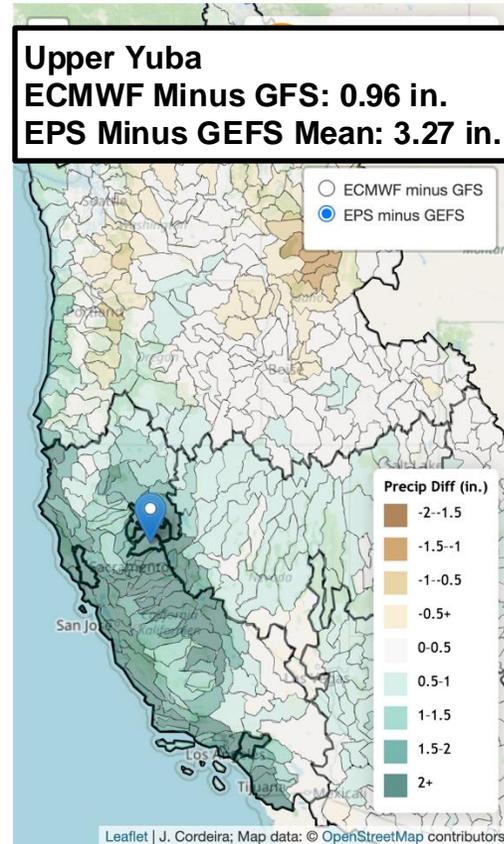
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



10-day Difference Precipitation Forecast

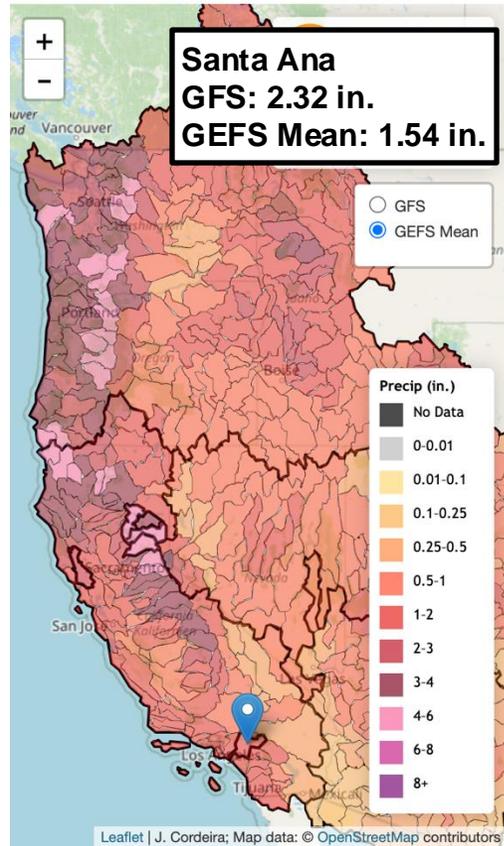


- Overall, EPS is forecasting much higher precipitation totals than GEFS over coastal California and the Sierra Nevada during the next 10 days, with much of the difference attributable to the second storm this weekend into early next week.
- In the Upper Yuba watershed, ~75% of EPS members are forecasting at least 10% of normal annual precipitation (~6.4 inches) over the next 10 days. Only ~10% of GEFS members are forecasting 10% or more of normal annual precipitation.

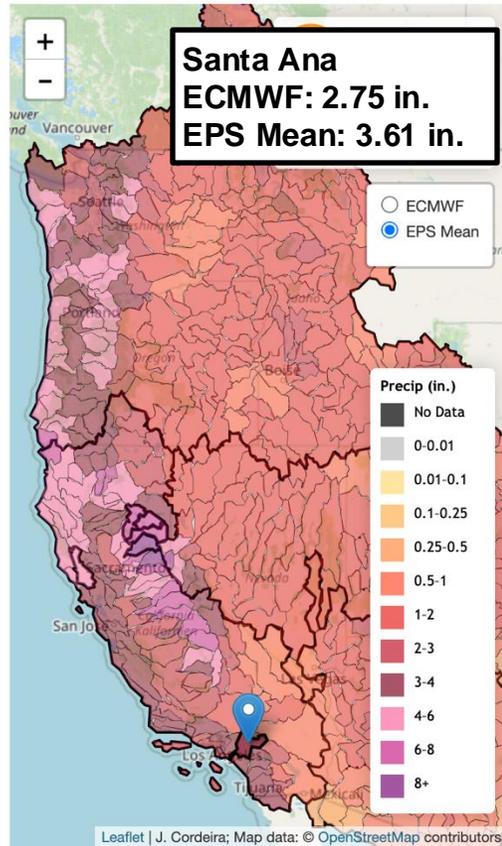
AR Outlook: 10 March 2025

Watershed Precipitation Forecasts

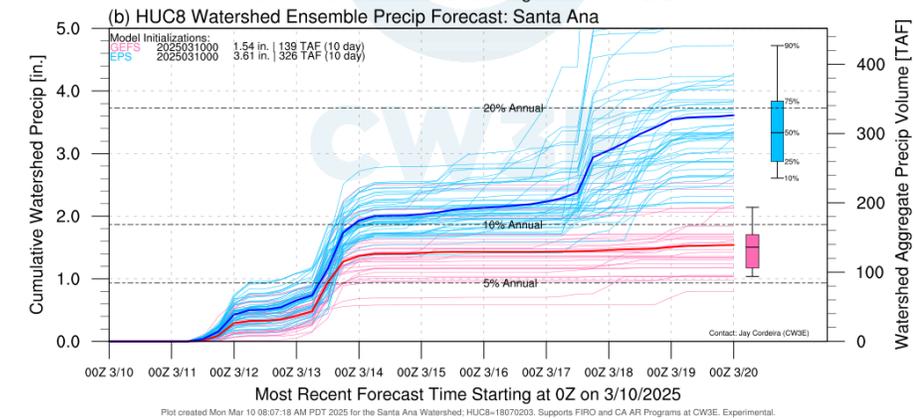
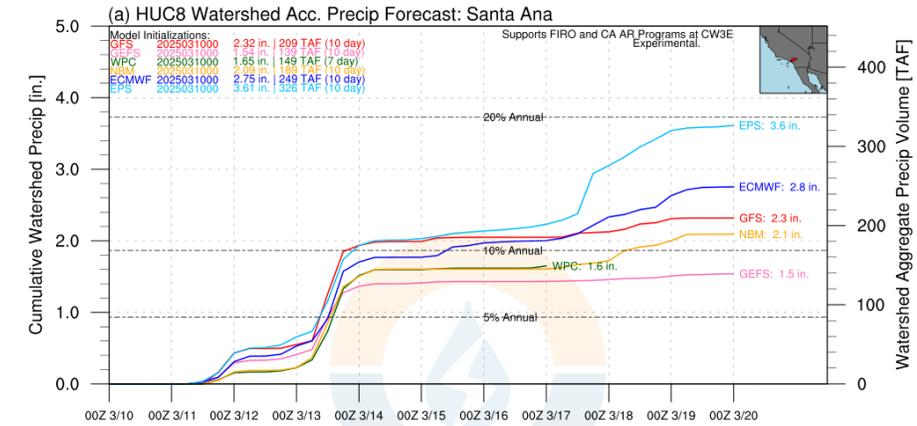
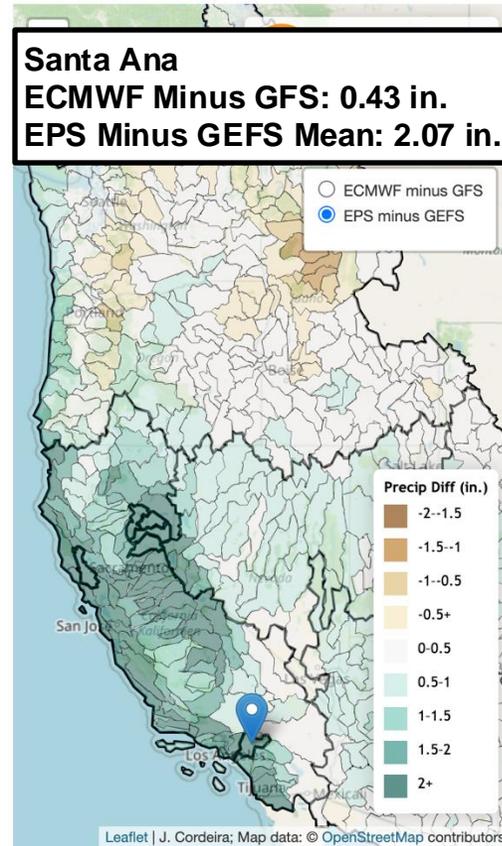
10-day GFS/GEFS Precipitation Forecasts



10-day ECMWF/EFS Precipitation Forecast



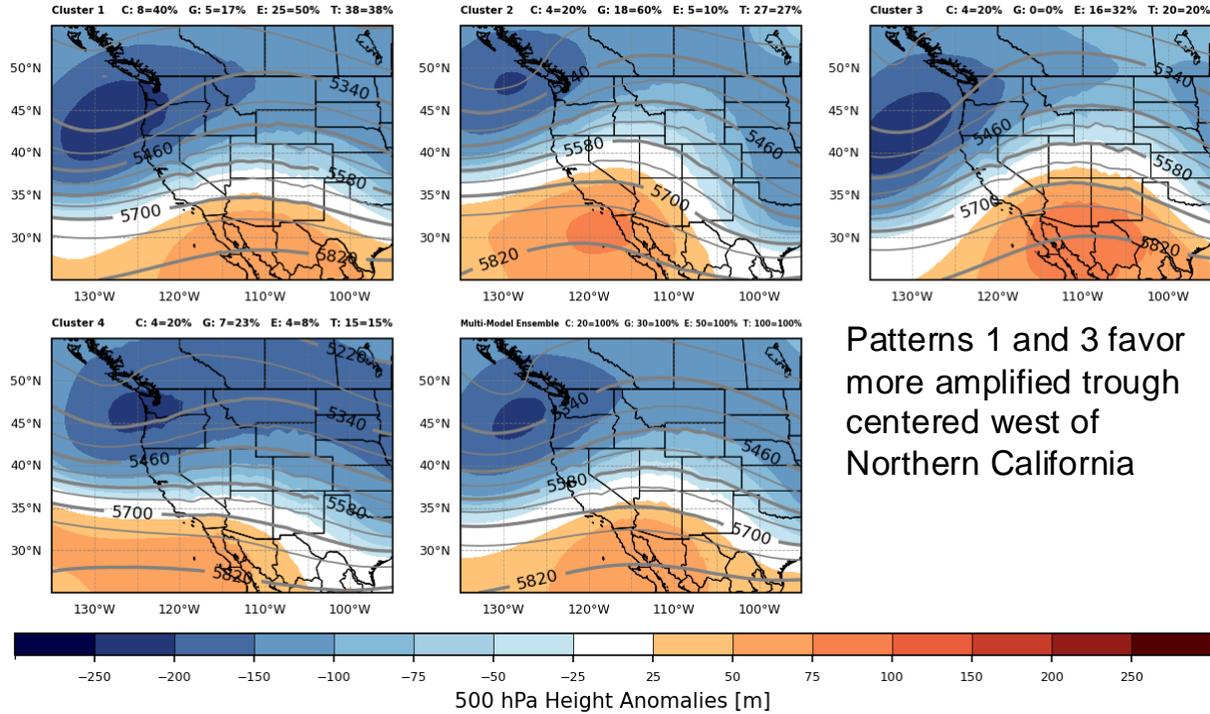
10-day Difference Precipitation Forecast



- In the Santa Ana watershed, 100% of EPS members and <25% of GEFS members are forecasting at least 10% of normal annual precipitation (~1.85 inches) over the next 10 days
- Additionally, >25% of EPS members are forecasting at least 20% of normal annual precipitation (~3.75 inches).

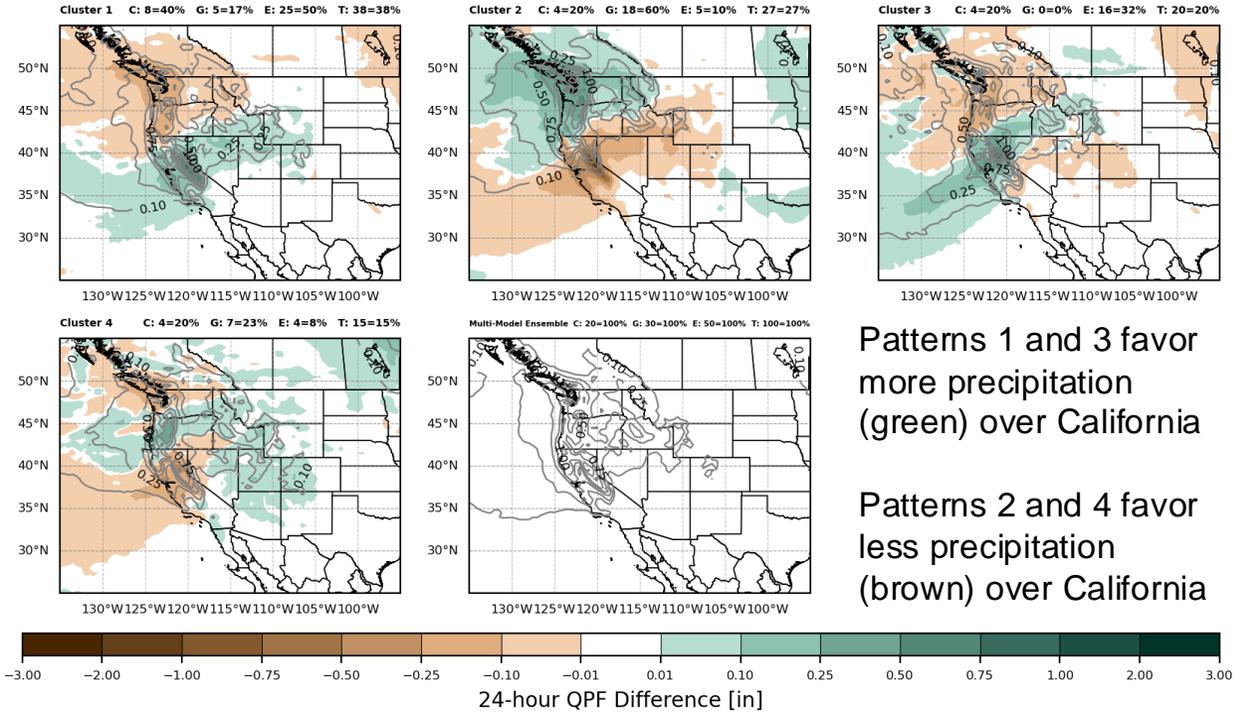
WPC Day 3–9 Ensemble Cluster Prototype Tool

Cluster Mean 24-hour Mean 500-hPa Heights and Anomalies [meters]
 Init: 00Z Mon Mar 10 2025 --> Valid: 24-hours Ending 00Z Mon Mar 17 2025



Patterns 1 and 3 favor more amplified trough centered west of Northern California

24-hour QPF Difference from Multi-Model Mean [in]
 Init: 00Z Mon Mar 10 2025 --> Valid: 24-hours Ending 00Z Mon Mar 17 2025



Patterns 1 and 3 favor more precipitation (green) over California

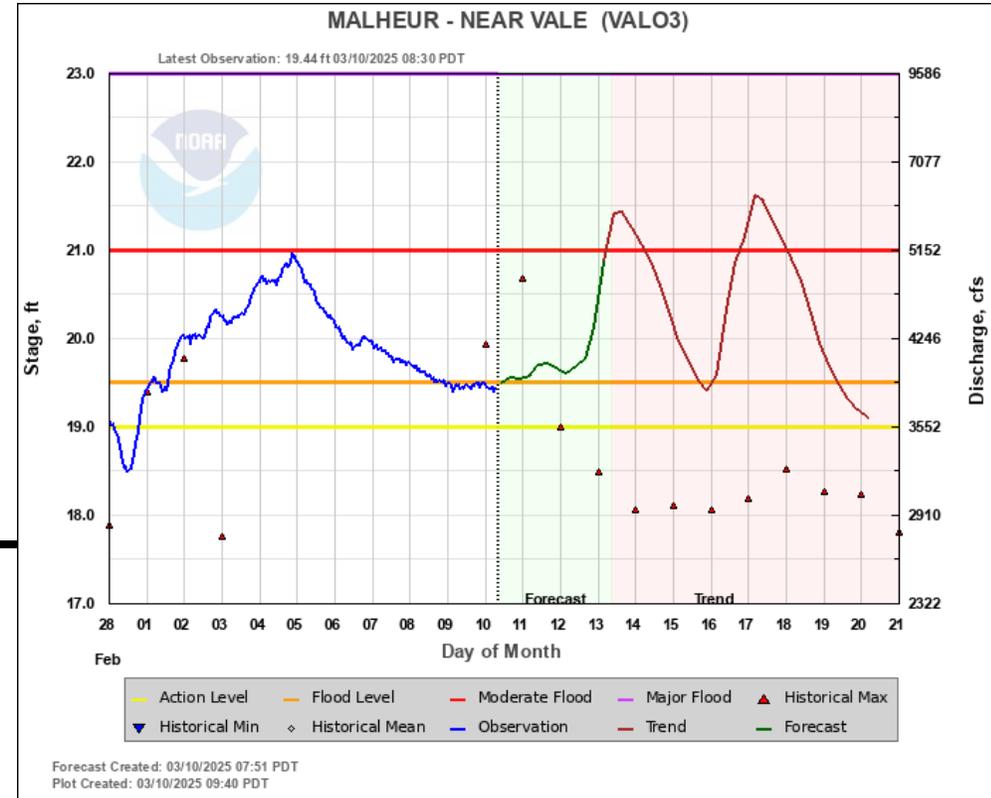
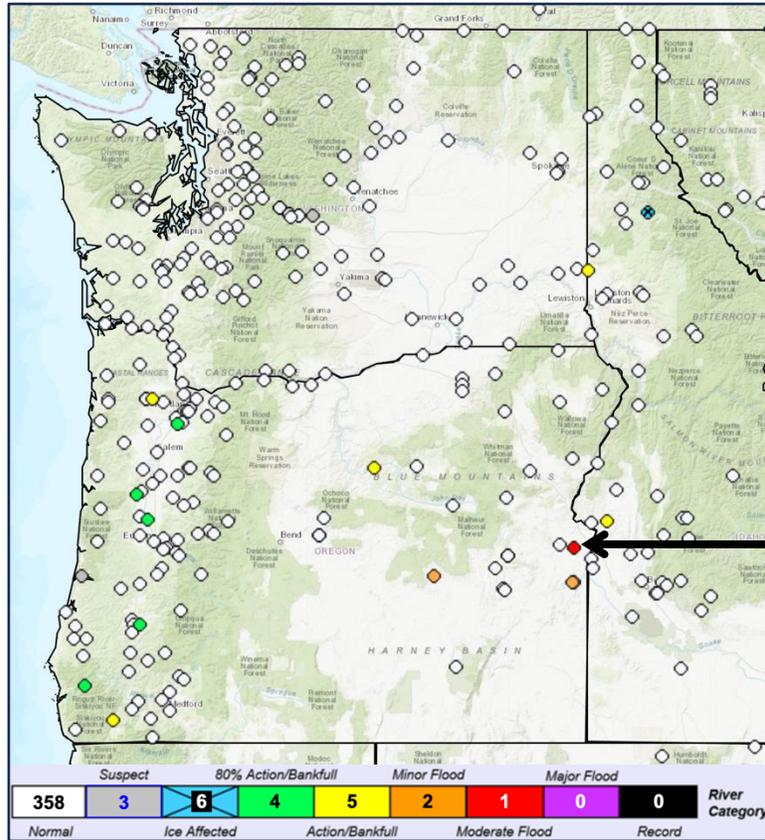
Patterns 2 and 4 favor less precipitation (brown) over California

Credit: NOAA NWS Weather Prediction Center

- Model differences in forecast precipitation during the second AR are being driven by differences in the evolution of the upstream trough.
- WPC's experimental ensemble cluster tool shows that EPS is favoring a more amplified and southward-displaced trough near the US West Coast on Day 6 (24-hour period ending 5 PM PT Sun 16 Mar), whereas GEFS is favoring a less amplified and northward-displaced trough.
- As a result, a large majority of EPS members (82%) are forecasting more precipitation and a large majority of GEFS members (83%) are forecasting less precipitation over Northern and Central California compared to the multi-model ensemble mean.

Hydrologic Impacts

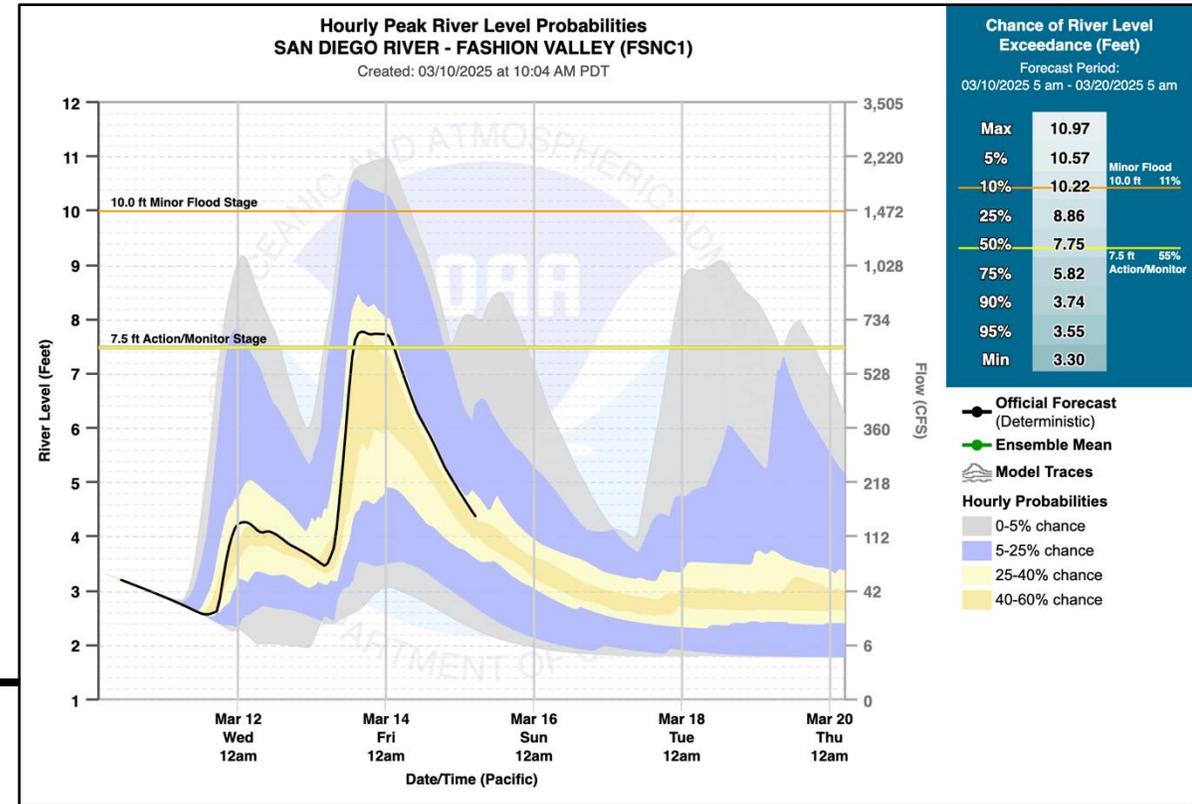
NWRFC 10-day Streamflow Forecasts



Credit: NOAA NWS Northwest River Forecast Center

- Current streamflow remains elevated over portions of interior Oregon due to recent snowmelt and precipitation events. Precipitation from the next two storms may result in additional flooding in these areas.
- The Northwest River Forecast Center (NWRFC) is forecasting two stream gages to rise above minor stage and one stream gage (Malheur River near Vale) to rise above moderate flood stage during the next 10 days.

Hydrologic Impacts



Credit: NOAA NWS California–Nevada River Forecast Center

- The California–Nevada River Forecast Center (CNRFC) is showing potential for several stream gages to rise above action/monitor stage in Northern and Central California over the next 10 days due to precipitation from these storms.
- Ensemble streamflow forecasts from the CNRFC are indicating a 55% likelihood of the San Diego River exceeding action/monitor stage at Fashion Valley, with an 11% likelihood of exceeding minor flood stage.