

CW3E Atmospheric River Outlook: 5 January 2023

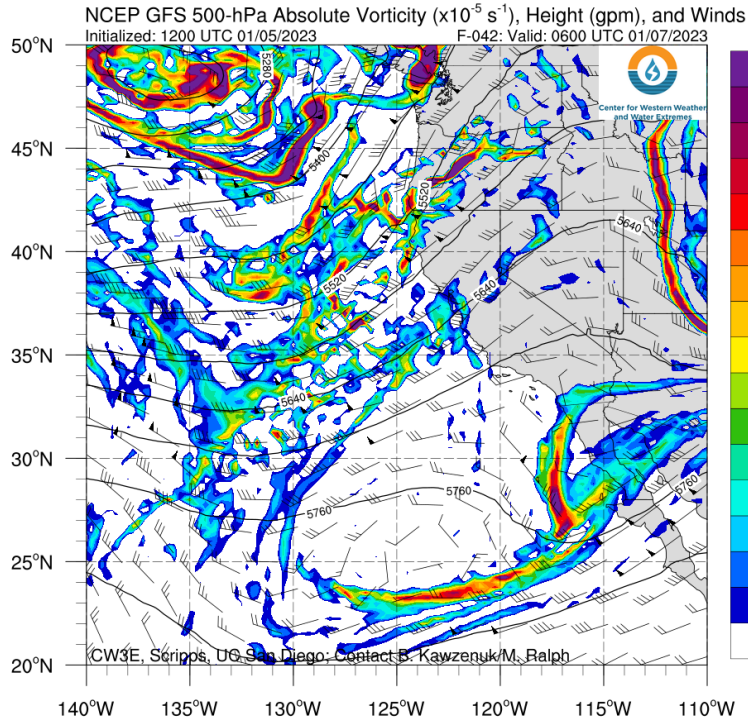
Atmospheric Rivers Forecast to Continue to Bring Additional Precipitation to Northern and Central California

- A family of ARs (Fish et al. 2019) is forecast to make landfall beginning Friday, continuing into early next week
- The first AR is forecast to make landfall late in the day Friday 6 Jan and bring a period of IVT $> 400 \text{ kg m}^{-1} \text{ s}^{-1}$ into Northern and Central California
- Before AR conditions from the first AR completely dissipate, a second AR associated with a surface low-pressure system is forecast to bring a stronger pulse of IVT $> 600 \text{ kg/ms}$ to the same areas, resulting in AR 2 conditions (based on the Ralph et al. 2019 AR Scale)
- The third and strongest AR is forecast to make landfall along the coast of Northern California with IVT exceeding $750 \text{ kg m}^{-1} \text{ s}^{-1}$ resulting in AR 3/AR 4 conditions in the region, although considerable uncertainty remains in the exact timing, intensity, duration, and position of this system
- The NWS Weather Prediction Center is forecasting more than 7 inches of precipitation for a broad area over coastal Northern and Central California, the Southern Cascades, and Sierra Nevada
- NWS WPC has also issued excessive rainfall outlooks for multiple days during this period, highlighting the hazard posed by additional rainfall on soils which are currently saturated
- Precipitation forecast for watersheds across Northern and Central California currently exceed 8 inches over a 7-day period, with the North Fork Feather > 10 inches over this forecast period
- The NWS California Nevada River Forecast Center has forecast streamflow to exceed flood stage at multiple locations in California in association with the precipitation from this sequence of ARs
- **Stay alert to official NWS forecasts, watches, and warnings at [weather.gov](https://www.weather.gov) and follow guidance from local emergency management officials**

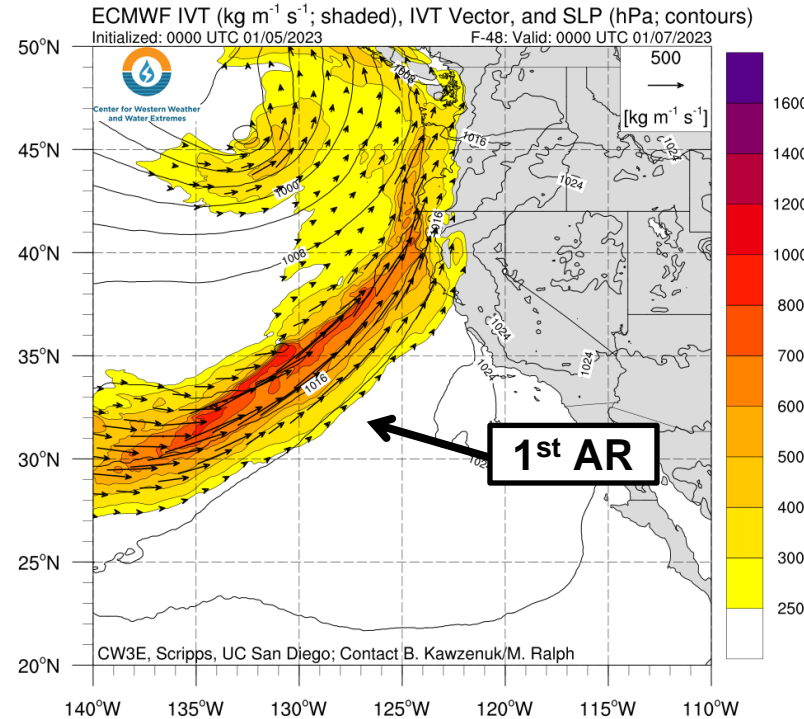
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GFS Model Forecast: Valid 10 PM PST 6 Jan (F-36)

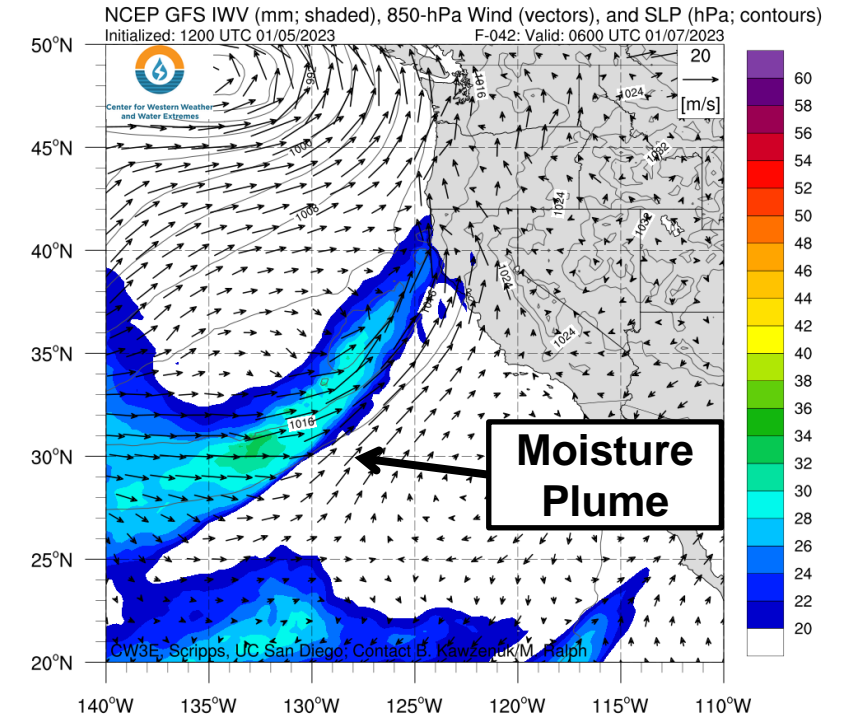
500-hPa Vorticity, Height, and Wind



IVT and SLP



IWV and 850-hPa Wind

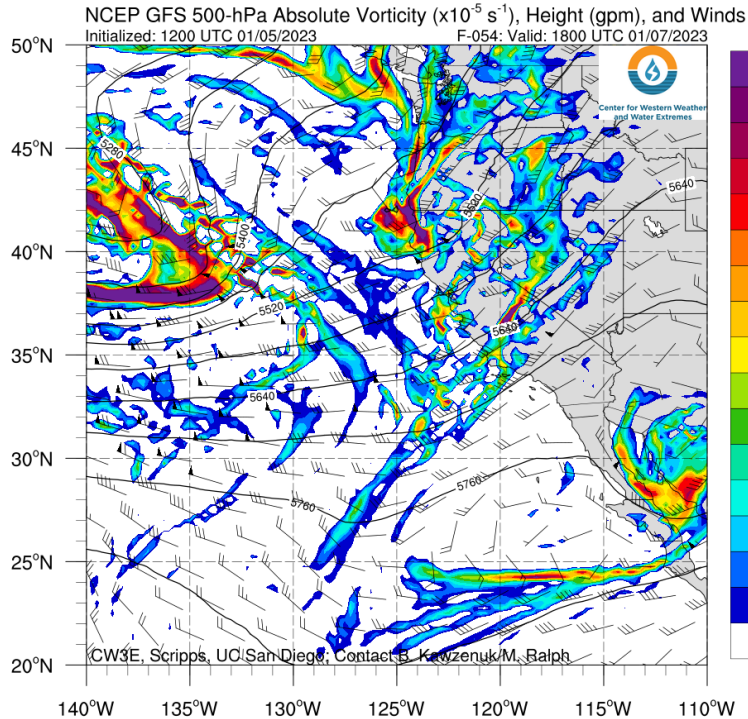


- The first AR is forecast to make landfall in association with a low-pressure system located over the North Pacific with $> 400 \text{ kg m}^{-1} \text{ s}^{-1}$ of IVT in the core of the plume during landfall
- This AR is associated with a narrow plume of moisture extending from the subtropics, reaching the US West Coast with IWV values $> 32 \text{ mm}$ in the core of the moisture plume

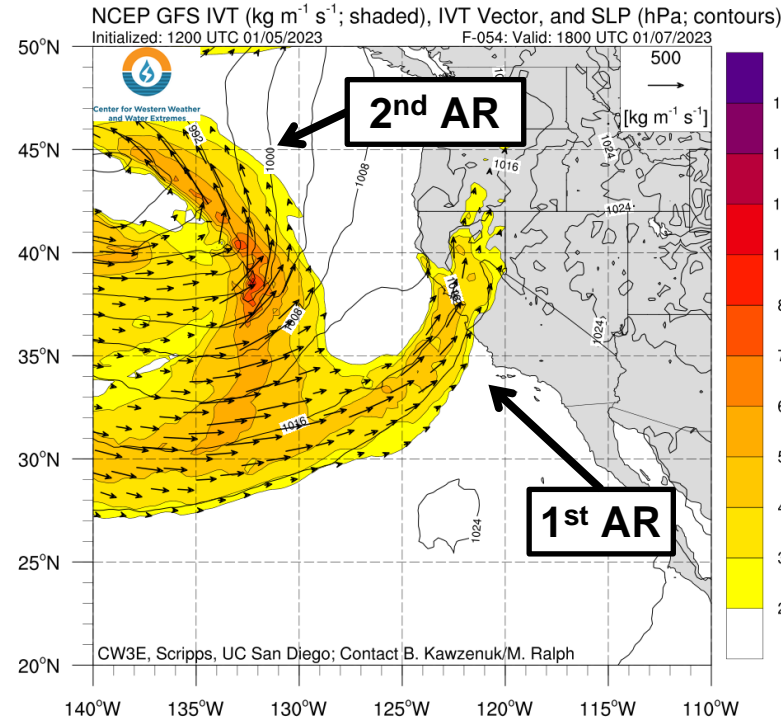
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GFS Model Forecast: Valid 10 AM PST 7 Jan (F-54)

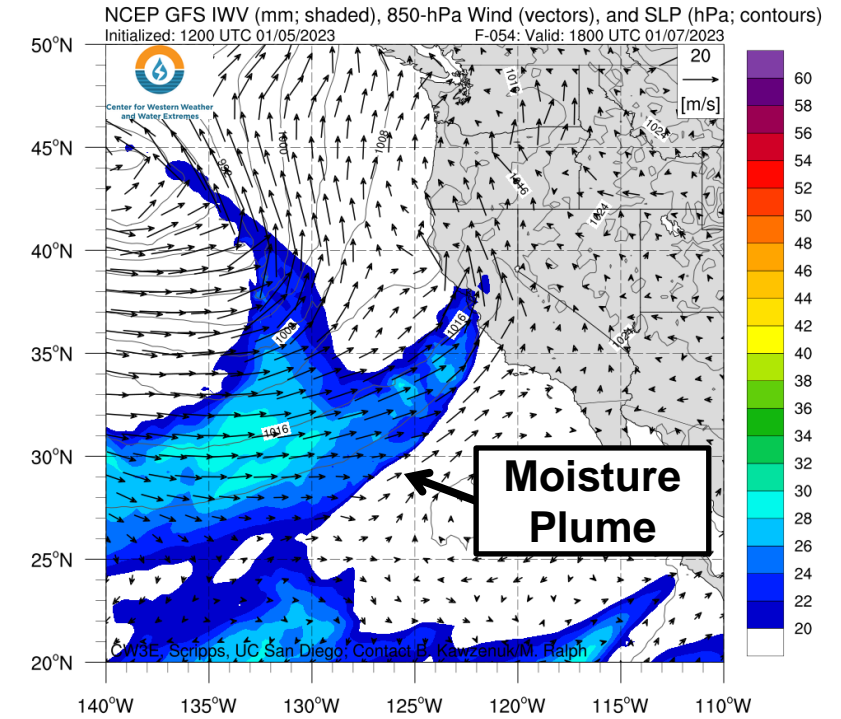
500-hPa Vorticity, Height, and Wind



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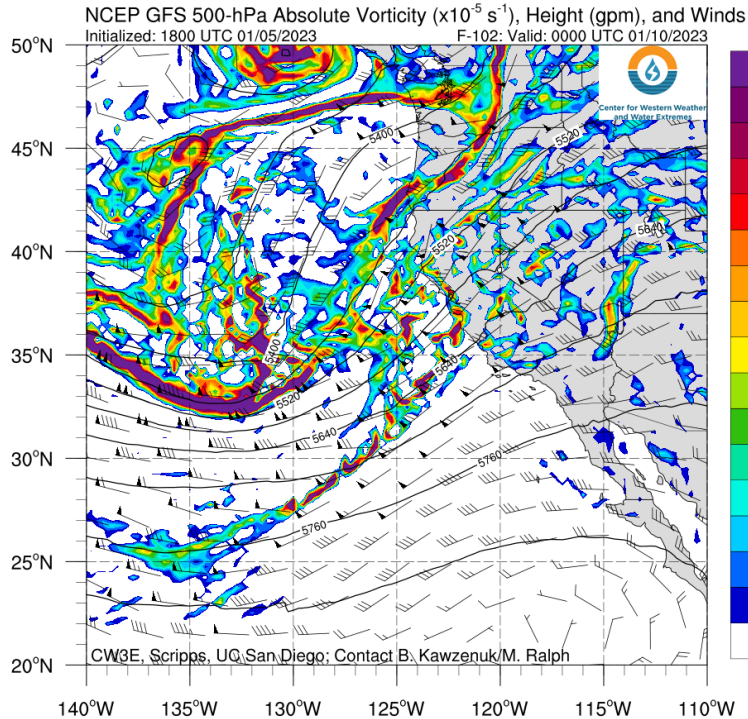


- As a mid-level trough and surface low-pressure system move east early Saturday, a second AR is forecast to develop with $> 800 \text{ kg m}^{-1} \text{ s}^{-1}$ of IVT in the core of the plume offshore
- This second AR will make landfall in Northern and Central California on Saturday evening with IVT $> 400 \text{ kg m}^{-1} \text{ s}^{-1}$
- This secondary storm will bring another surge of subtropical moisture, enhancing the narrow plume of IWV with IWV values > 25 mm reaching the US West Coast

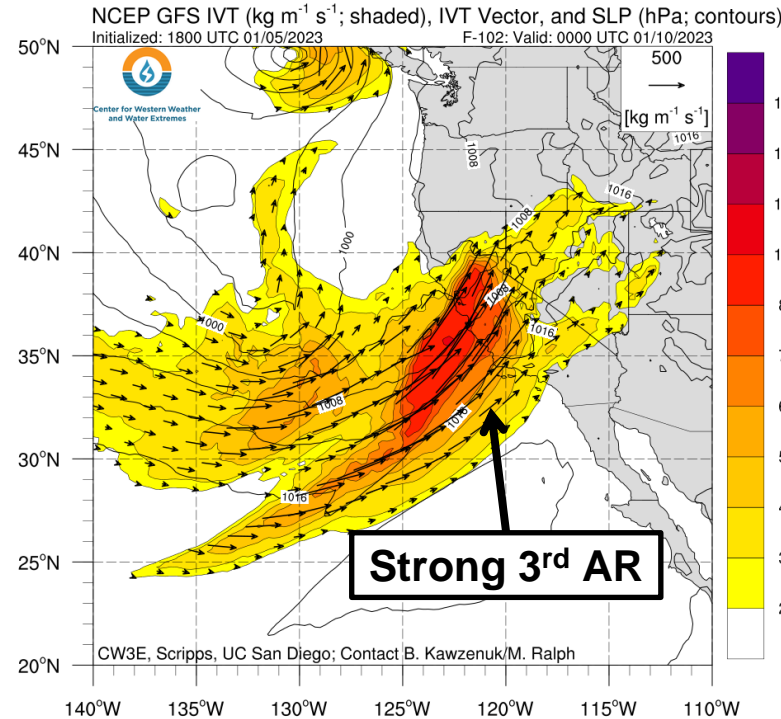
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GFS Model Forecast: Valid 4 PM PST 9 Jan (F-102)

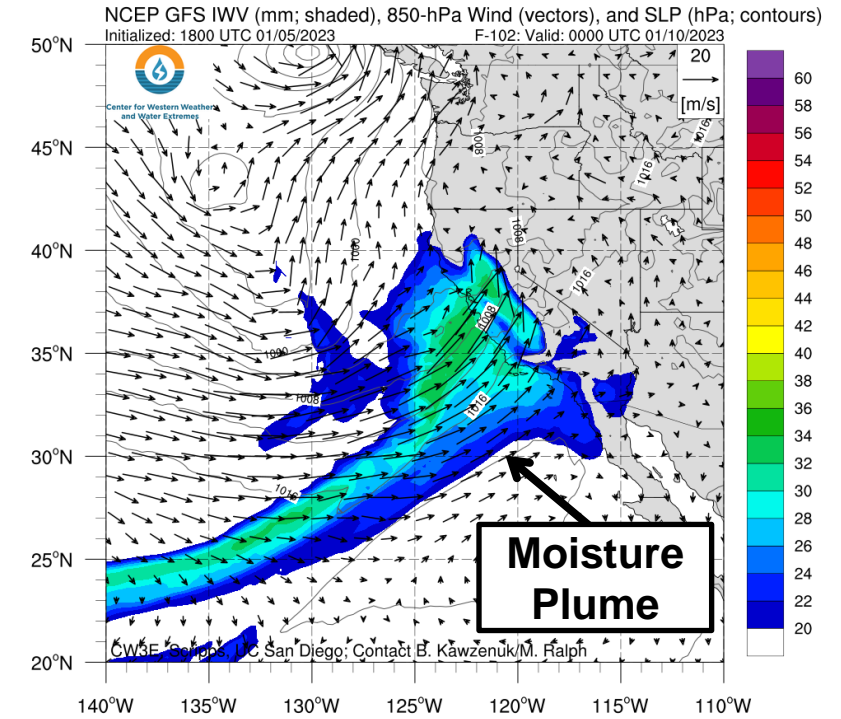
500-hPa Vorticity, Height, and Wind



IVT and SLP



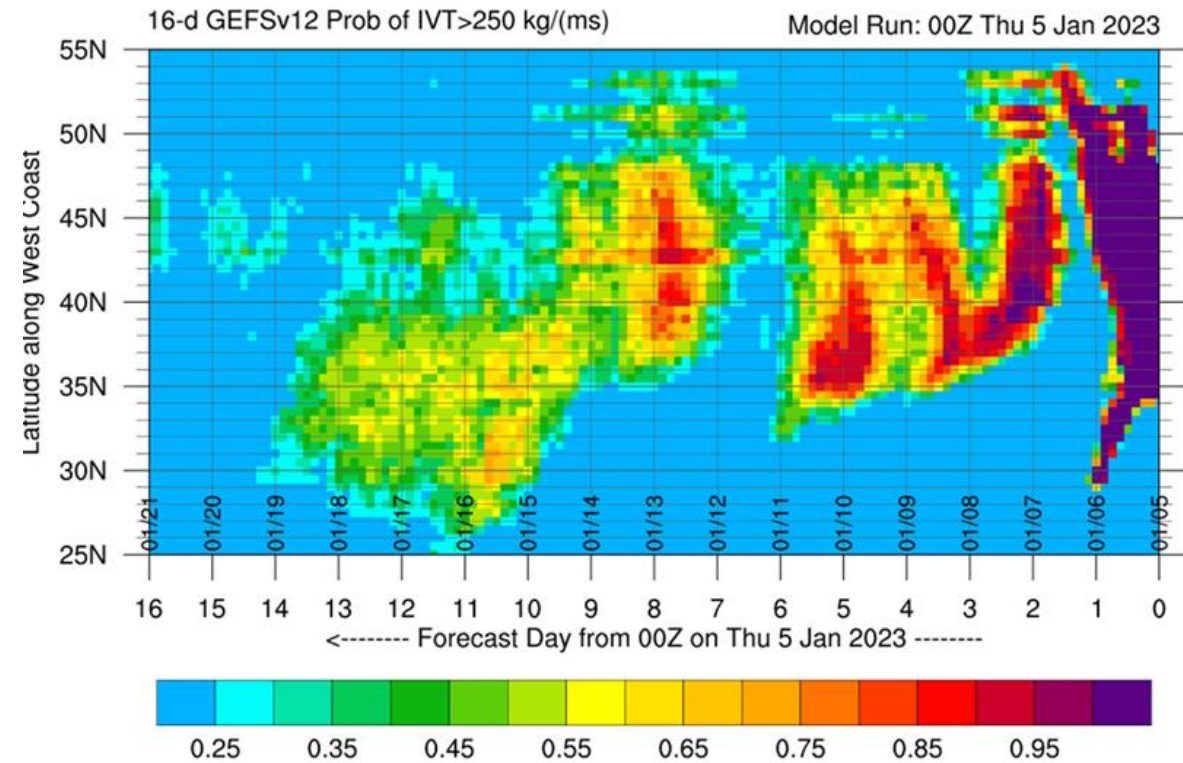
IWV and 850-hPa Wind



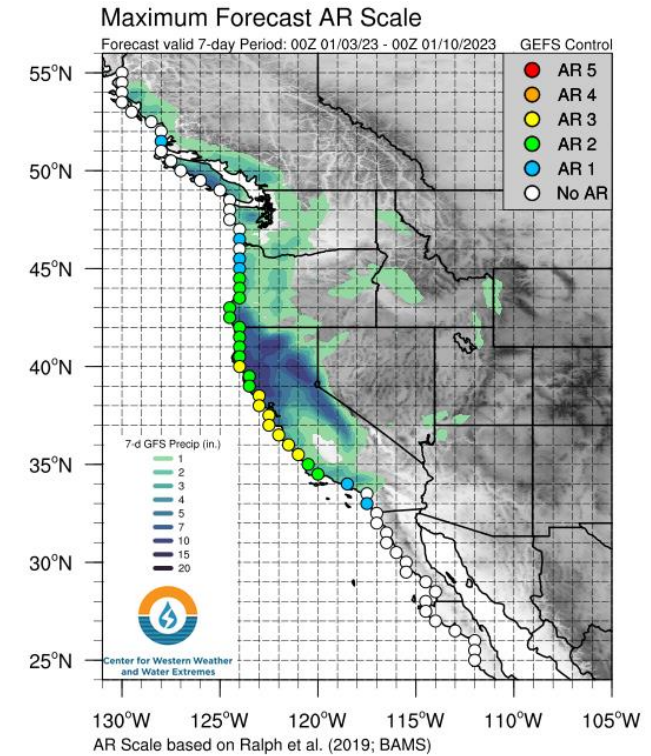
- A third AR is forecast to make landfall late Sunday through Tuesday in Northern and Central California, with maximum IVT in the core of the plume $> 800 \text{ kg m}^{-1} \text{ s}^{-1}$
- This AR will be supported by a second broad plume of moist air extending from the subtropics with IWV values $> 36 \text{ mm}$ coming onshore over a coastal California
- Considerable uncertainty remains in the exact timing, intensity, duration, and position of this third AR

CW3E AR Outlook: 5 January 2023

Probability of AR Conditions Along Coast (GEFS)



AR Scale

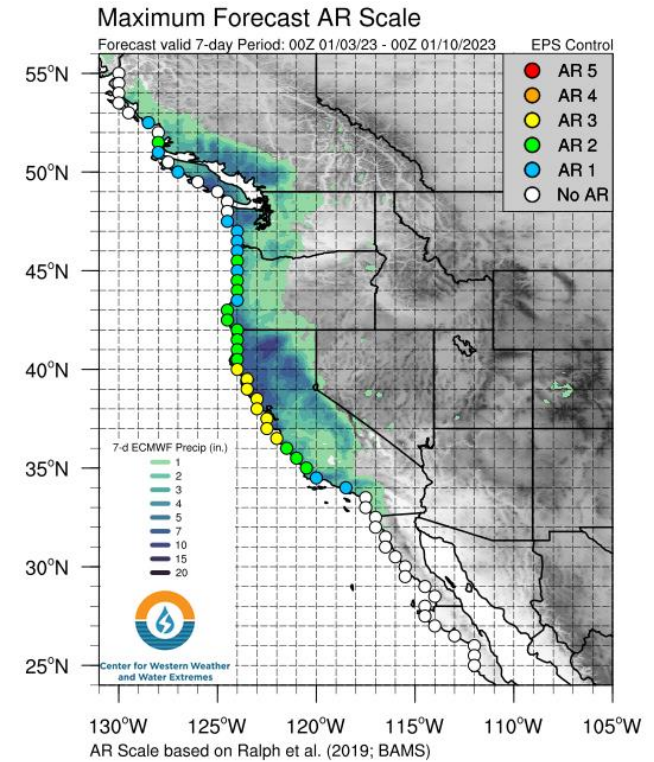
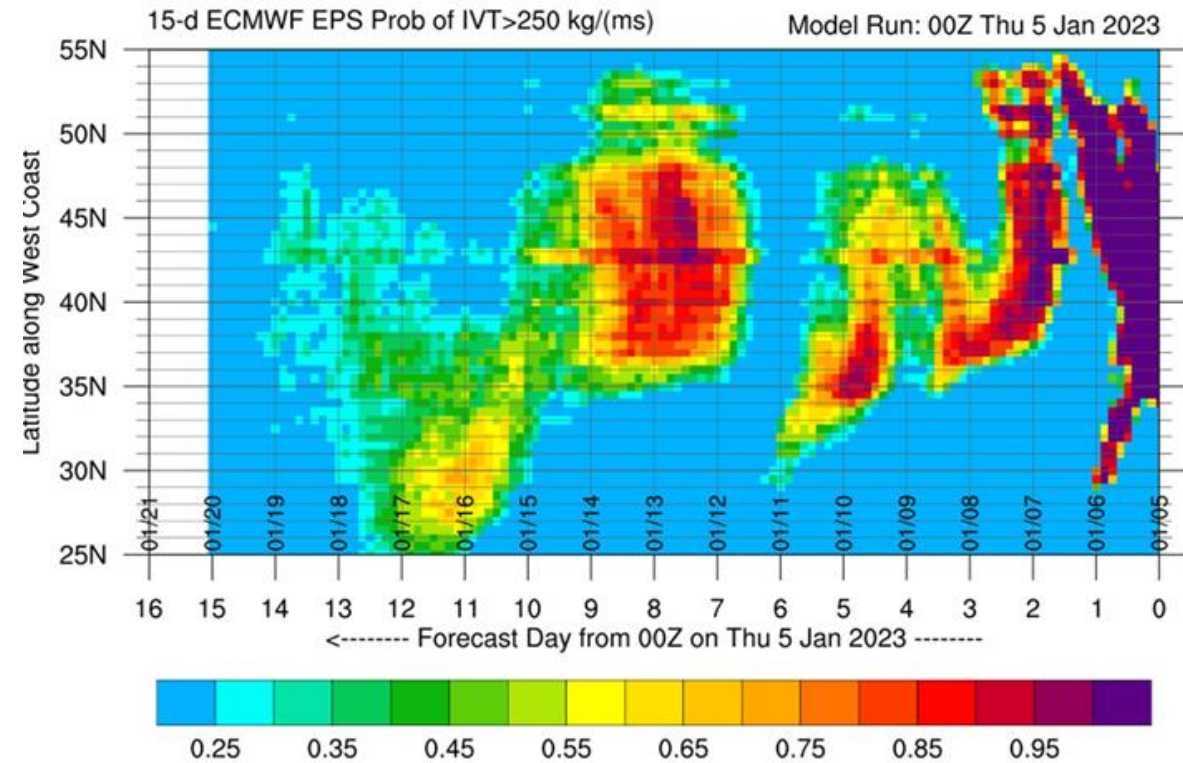


- The 00Z GEFS is showing high confidence (> 95%) in a period of AR conditions ($IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) along the coast of Oregon, Northern, and Central California between 6 and 7 January in association with the first AR landfall, followed by a period of moderate confidence (> 75%) in AR conditions for the same region on 8 Jan.
- Model confidence is slightly lower (70%–90%) for a third period of AR conditions ($IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) between 9 Jan–11 Jan for locations along the coast of Central California in association with the third landfalling AR
- The GEFS ensemble control member is forecasting AR 3 conditions over coastal Central California in association with the third AR

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Probability of AR Conditions Along Coast (ECWMF EPS)

AR Scale



- The 00Z ECMWF EPS is showing high confidence ($> 95\%$) in a period of AR conditions ($IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) along the coast of Oregon and Northern California between 6 and 7 January in association with the first AR landfall, followed by a period of medium confidence (60%–70%) in AR conditions on 8 Jan for the same region
- ECMWF EPS model confidence is slightly lower (75%–85%) for a third period of AR conditions ($IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) making landfall between 9 and 11 Jan in Central California
- The ECMWF EPS ensemble control member is forecasting AR 3 conditions in association with the 3rd AR in Central California

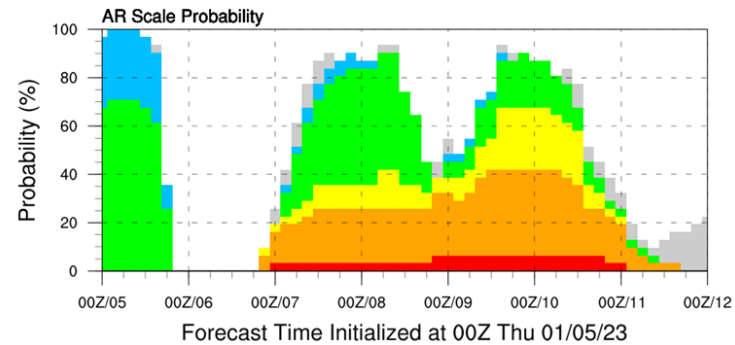
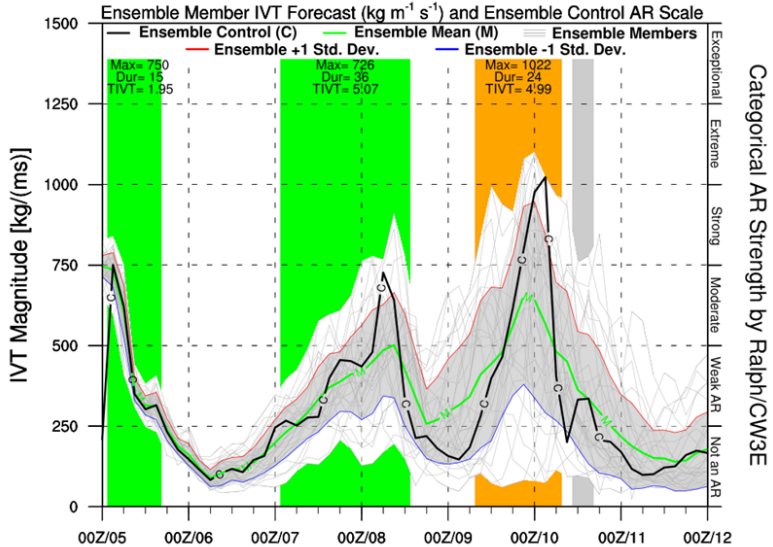
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7-day AR Scale and IVT Forecast: GFS & ECMWF Ensemble

Landfall Point: 37.5°N, 122.5°W

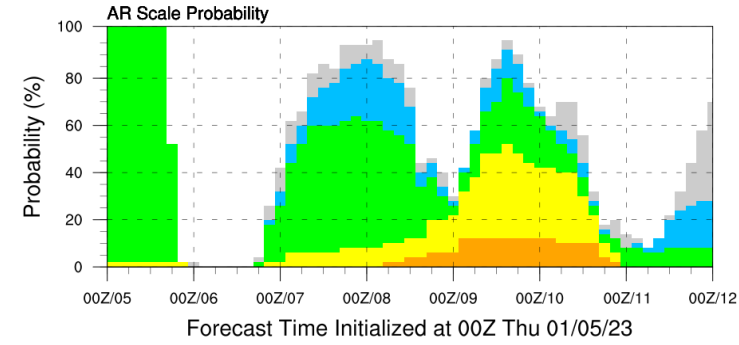
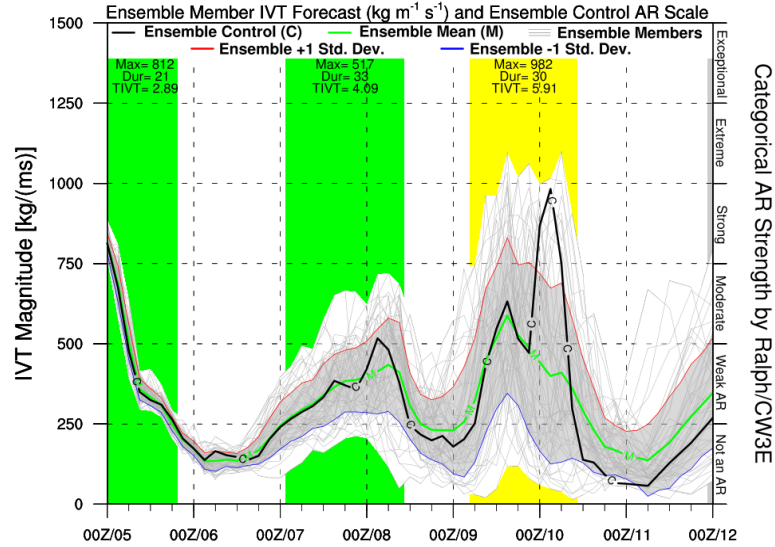
GEFS Ensemble

GFS Ensemble Initialized: 00Z Thu 01/05/23



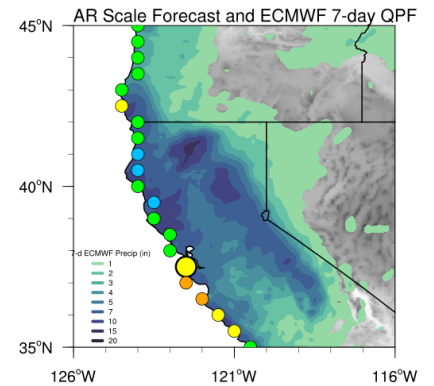
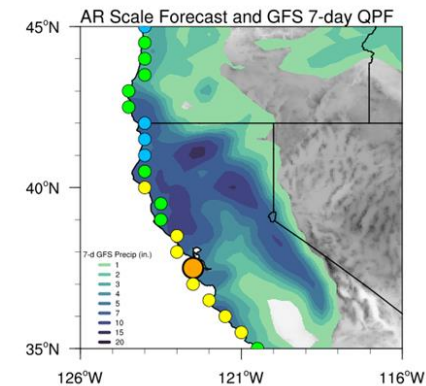
ECMWF Ensemble

ECMWF Ensemble Initialized: 00Z Thu 01/05/23



1st/2nd AR Ensemble Forecast

- 26/31 (84%) **GEFS ensemble** members are forecasting at least AR 2 conditions at this location.
- 33/51 (64%) **ECMWF ensemble** members are forecasting at least AR 2 conditions at this location
- There is considerable forecast uncertainty for the period between 00Z 7 Jan - 00Z 11 Jan regarding timing and intensity of these ARs
- > 60% of GEFS members and > 40% of ECMWF members are forecasting at least an AR 3 for the **third AR**

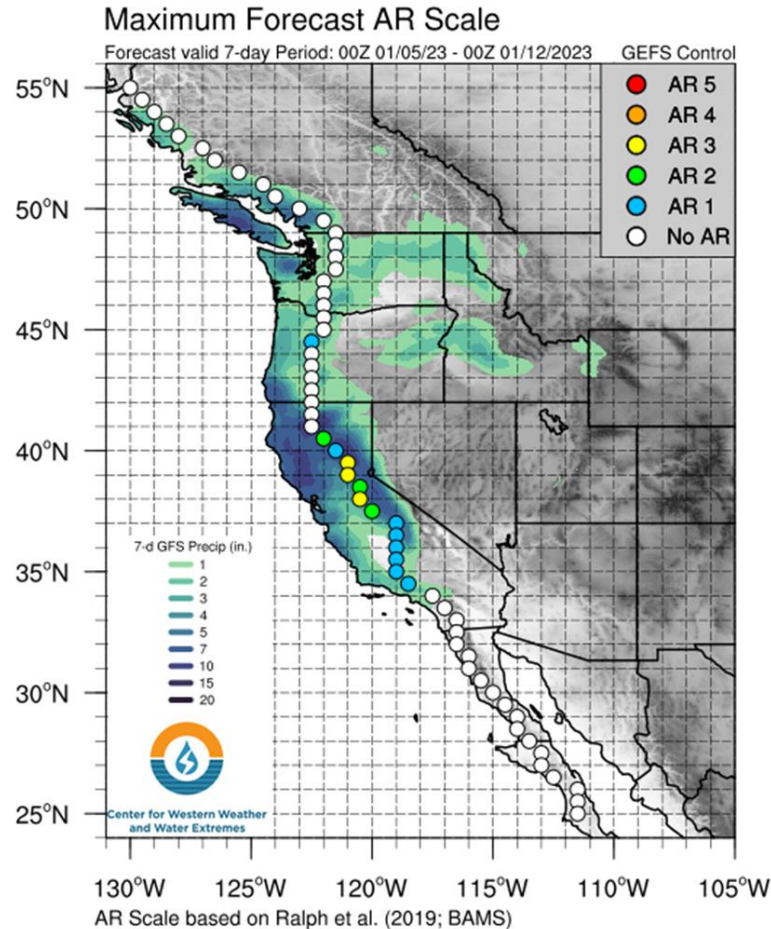


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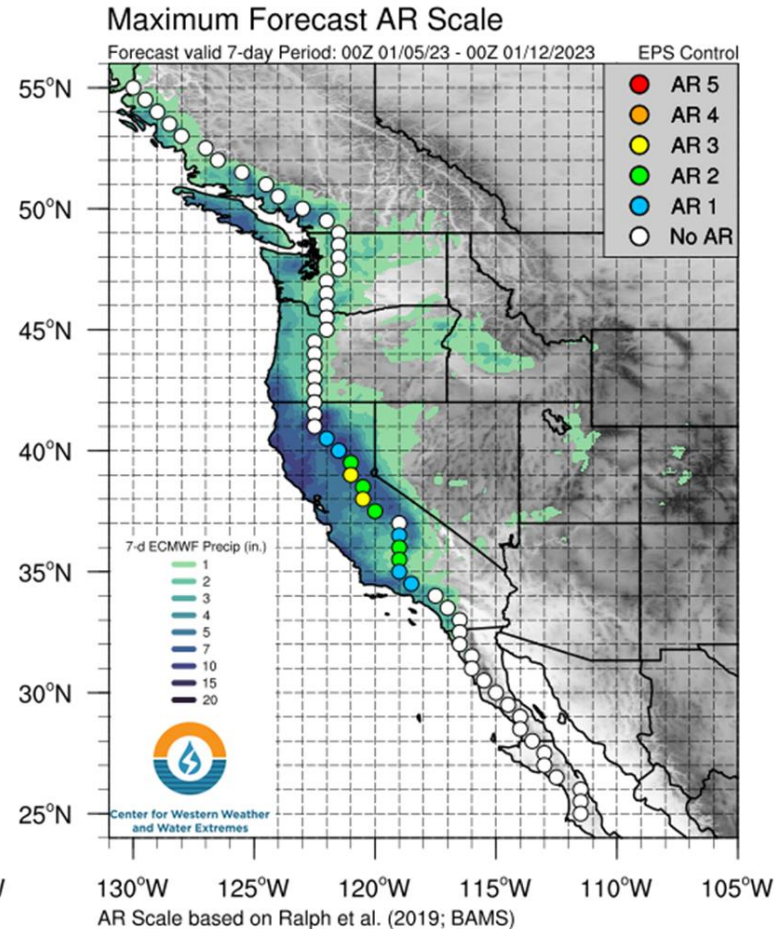
Onshore AR Scale Conditions

Valid: 00Z 5 Jan – 00Z 12 Jan

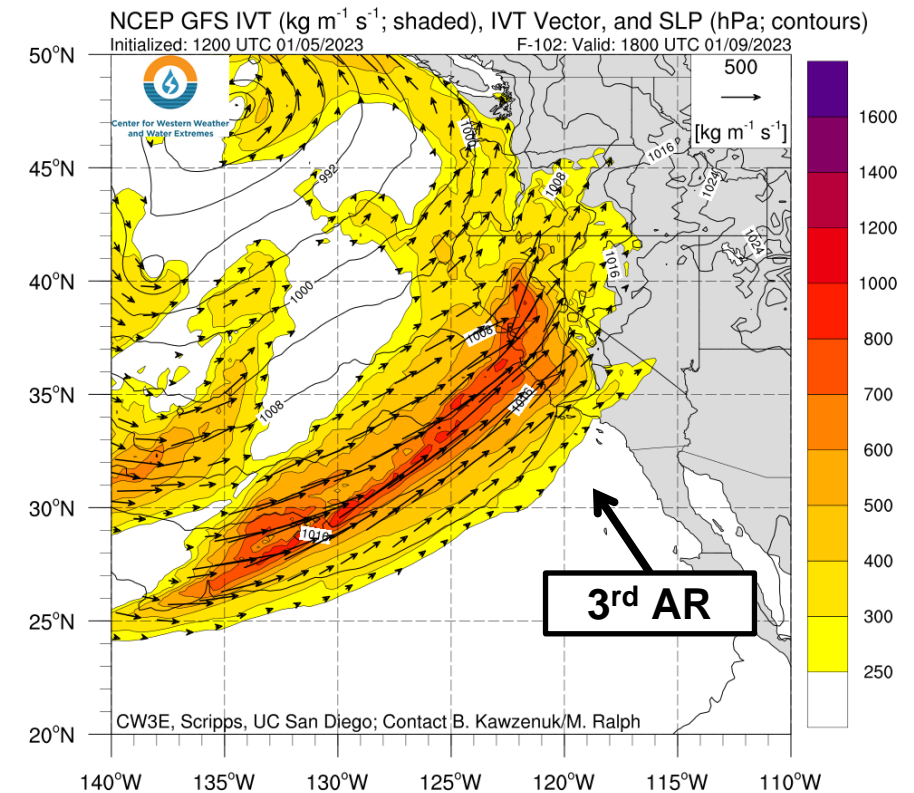
GEFS Control



ECMWF EPS Control



- The third AR is forecast to bring $IVT > 700 \text{ kg m}^{-1} \text{ s}^{-1}$ onshore and well inland in central California
- The 00Z GFS and ECMWF control members are both forecasting AR 3 conditions for points in the central Sierra Nevada on Monday

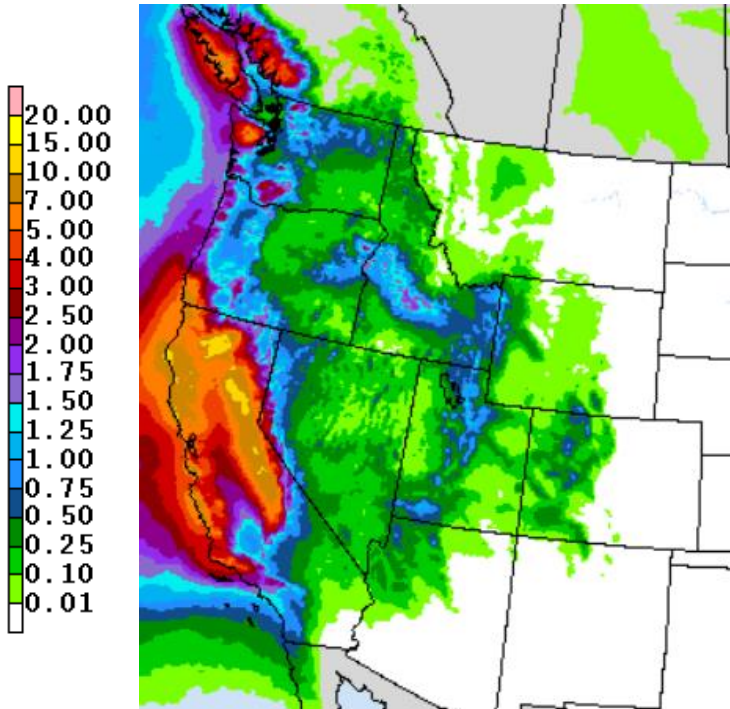


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Precipitation Forecast and Excessive Rainfall Outlook

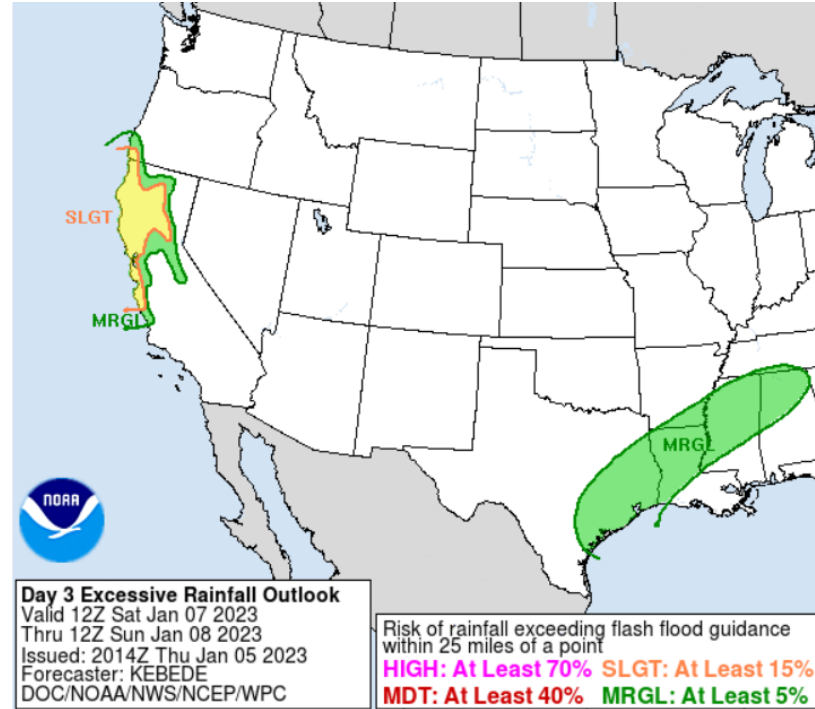
WPC 5-day QPF:

Valid 4 PM PT 05-10 Jan



WPC Day 3 Excessive Rainfall Outlook:

Valid 4 AM PT 7-8 Jan



WPC Day 5 Excessive Rainfall Outlook:

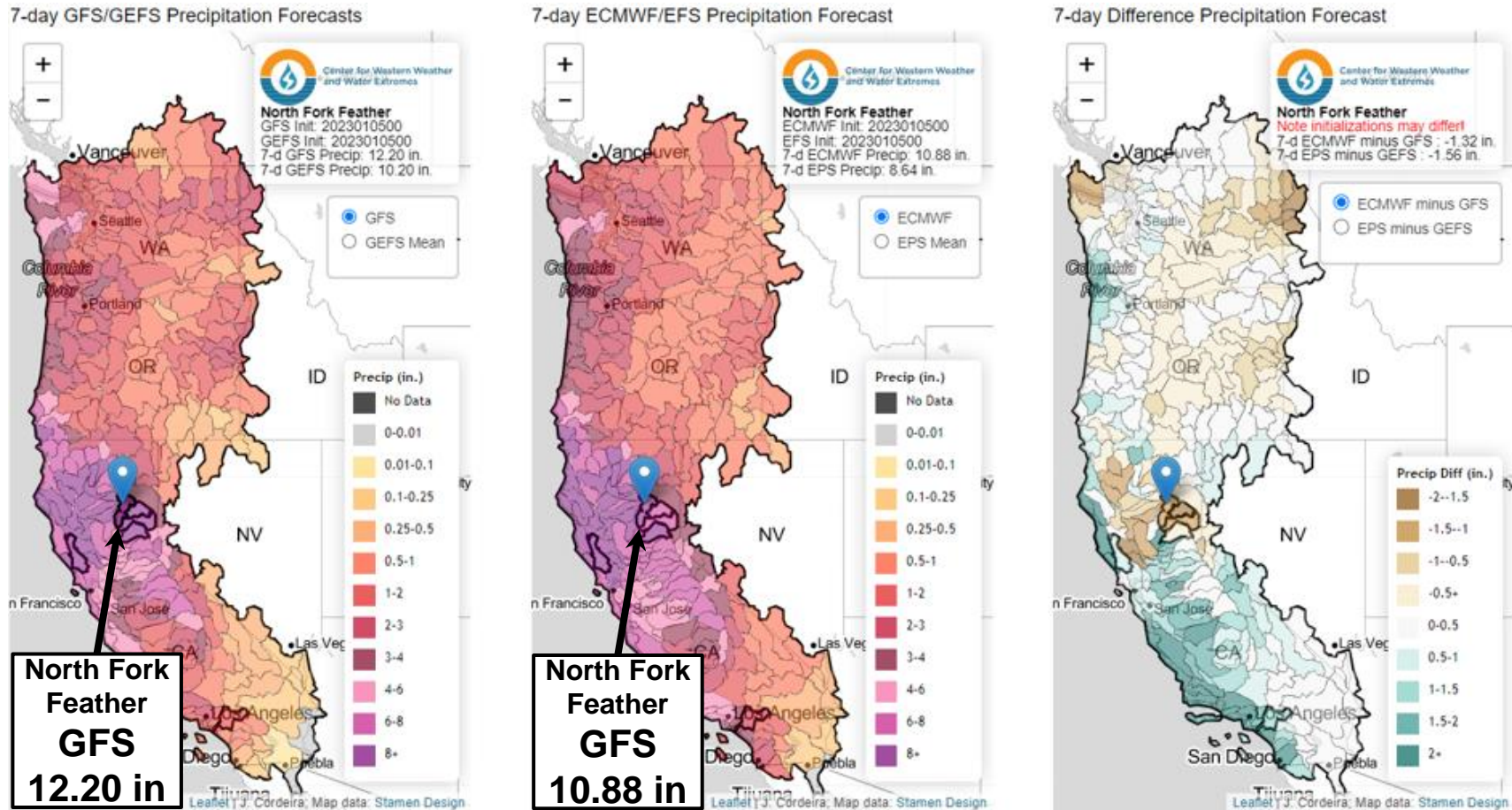
Valid 4 AM PT 9-10 Jan



- The WPC is forecasting precipitation totals exceeding 7 inches over the Sierra Nevada, Klamath Mountains, and California Coast Ranges over the next 5 days with some locations forecast to receive >10 inches
- The WPC has issued a slight risk (at least 15%) of excessive rainfall for Northern California for 07-08 Jan
- WPC has also issued a moderate risk (at least 40%) of excessive rainfall for the same region in association with the third AR

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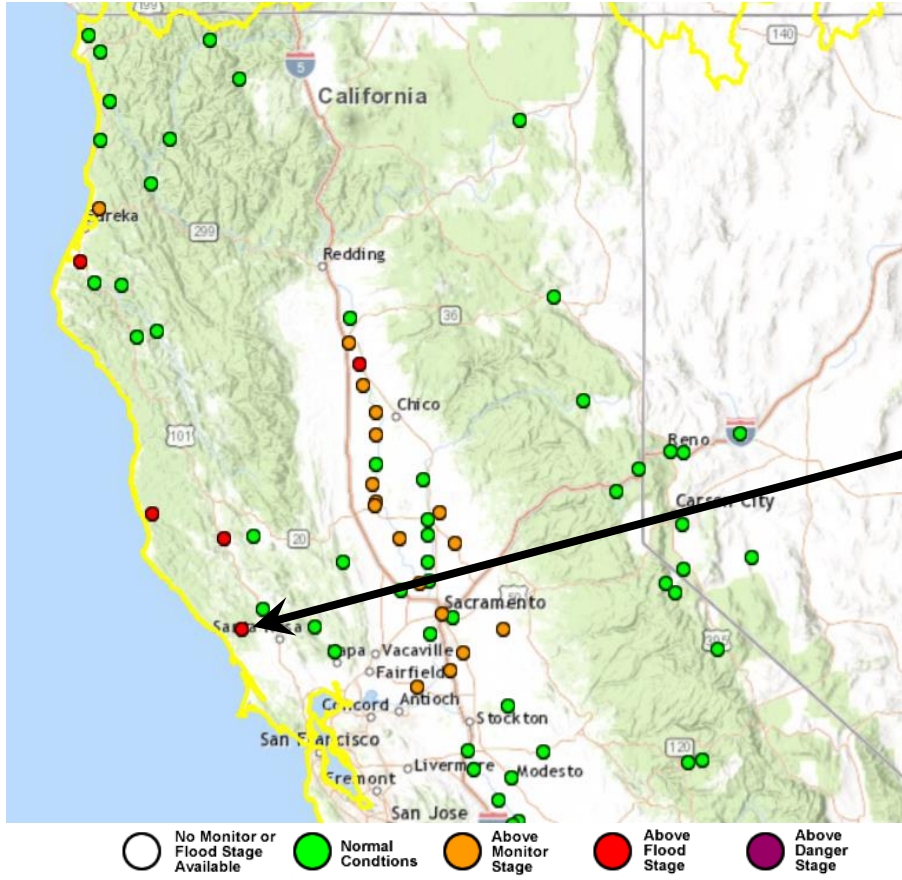
GFS/GEFS and ECMWF/EPS 7-day Watershed Precipitation Forecast (Initialized 00Z 05 Jan 2023)



- 7-day watershed precipitation forecasts across Northern California and the Sierra Nevada are >6–8”
- Compared to the ECMWF, the GFS is wetter in Northern California but drier along the California coast and the Central Valley
- The GFS is forecasting 12.20 inches of mean areal precipitation in the North Fork Feather Watershed, while the ECMWF is forecasting 10.88 inches over the same watershed

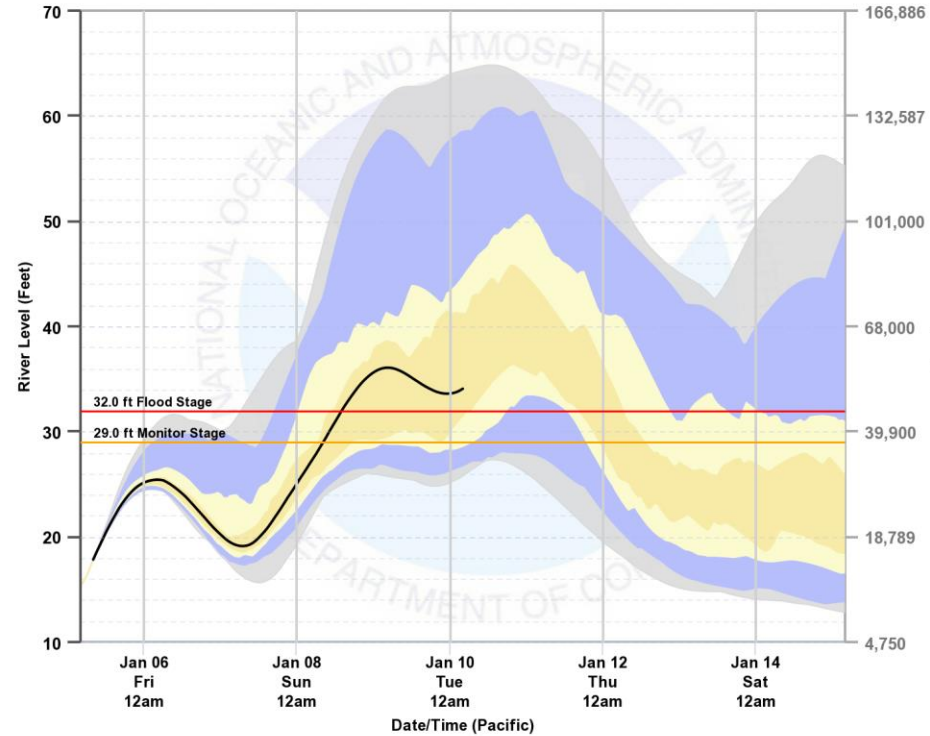
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NOAA/NWS CNRFC River Stage Forecast



Hourly River Level Probabilities
RUSSIAN RIVER - GUERNEVILLE (GUEC1)

Created: 01/05/2023 at 9:27 AM PST



Chance of River Level Exceedance (Feet)
Forecast Period: 01/05/2023 4 am - 01/15/2023 4 am

Max	64.84
5%	62.99
10%	60.01
25%	52.43
50%	42.12
75%	34.47
90%	30.64
95%	29.74
Min	28.14

Flood Stage 32.0 ft 86%
Monitor Stage 29.0 ft > 98%

- Official Forecast (Deterministic)
- Ensemble Mean
- Model Traces
- Hourly Probabilities
 - 0-5% chance
 - 5-25% chance
 - 25-40% chance
 - 40-60% chance

- Heavy rainfall is expected to bring the Russian River at Guerneville above flood stage (32 ft) in the early morning hours of 9 Jan, local time, with an official forecast peak stage of 36.1 ft
- Ensemble-based odds of reaching flood stage are 86%
- There is a 25% chance of the river level exceeding the 02/18/1986 flood of record (49.5 ft) following the third AR