CW3E Atmospheric River Outlook: 13 Dec 2023

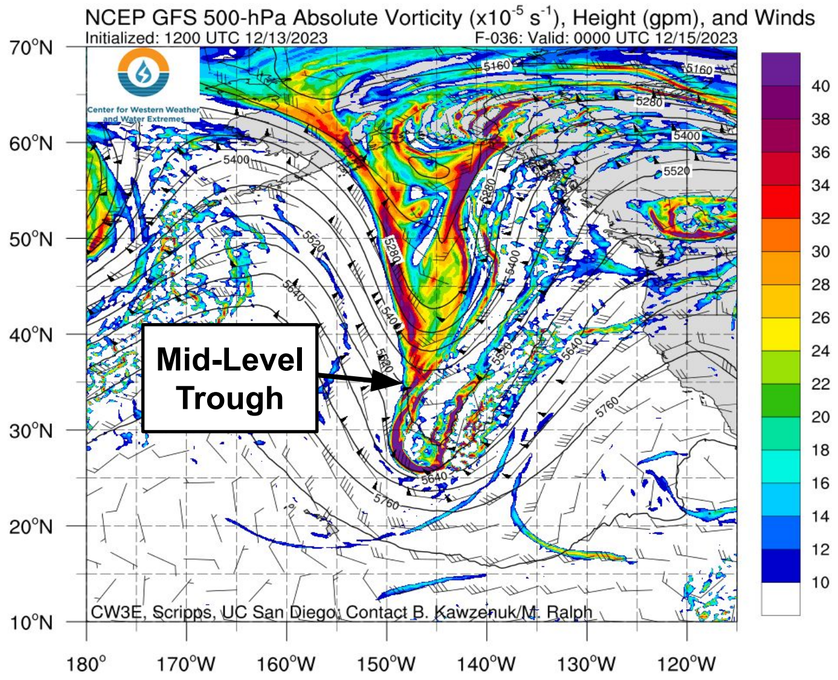
Cut Off Low Forecast to Bring Atmospheric River to California

- A mid-level trough currently just south of the Aleutian Islands is forecast to propagate into the Northeast Pacific and continue to deepen, eventually becoming cut off.
- The cut off low pressure system interacts with elevated moisture in the NE Pacific leading to the formation of an AR.
- The low pressure system is forecast to progress toward the USWC and bring AR conditions to CA beginning Sun 16 Dec.
- AR2 conditions (based on Ralph et al. 2019 AR scale) are forecast for this event.
- There is uncertainty in the AR landfall timing and duration in the GEFS, ECMWF EPS and West-WRF Ensemble.
- The NWS Weather Prediction Center (WPC) is currently forecasting 7-day precipitation totals ≥ 3” for much of the CA Coasts as well as the Sierras with isolated areas ≥ 6”.
- The NWS WPC Extreme Rainfall Outlook highlights a Marginal Risk for the CA Coast and foothills of the Sierras
- The NWS Climate Prediction Center’s Day 8-14 Hazard Outlook shows slight risks of heavy precipitation and high winds for the CA coasts and heavy snow in the Sierras 12/20-12/21 and 12/23-12/26.

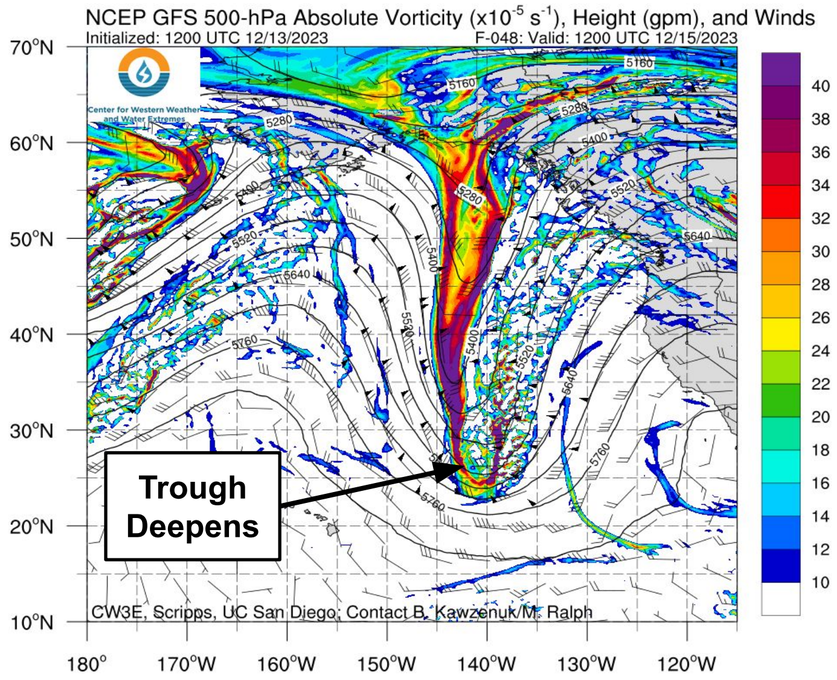
CW3E AR Outlook: 13 Dec 2023

GFS Init 12Z Wed 13 Dec 2023

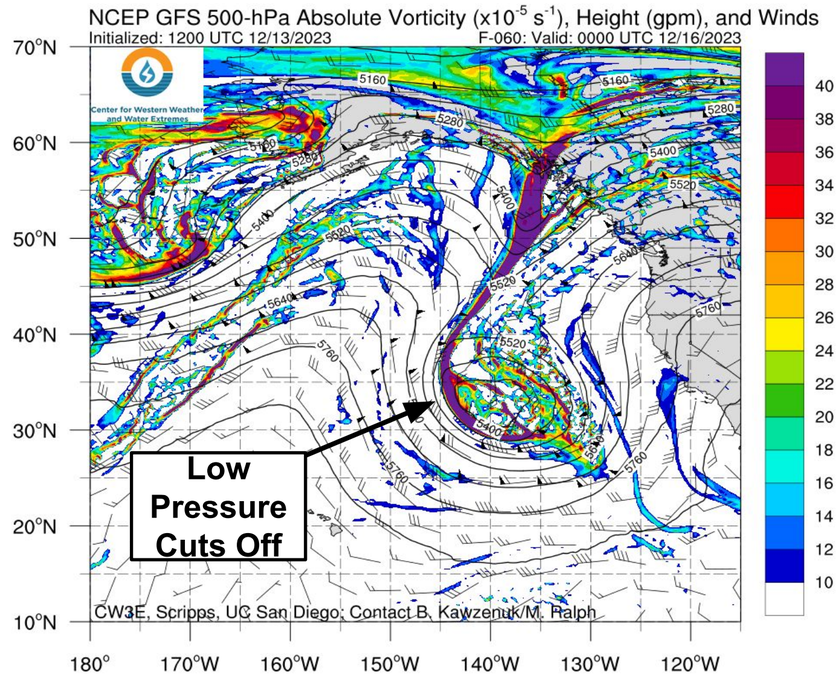
4PM PT Thu 14 Dec 2023



4AM PT Fri 15 Dec 2023



4PM PT Fri 15 Dec 2023

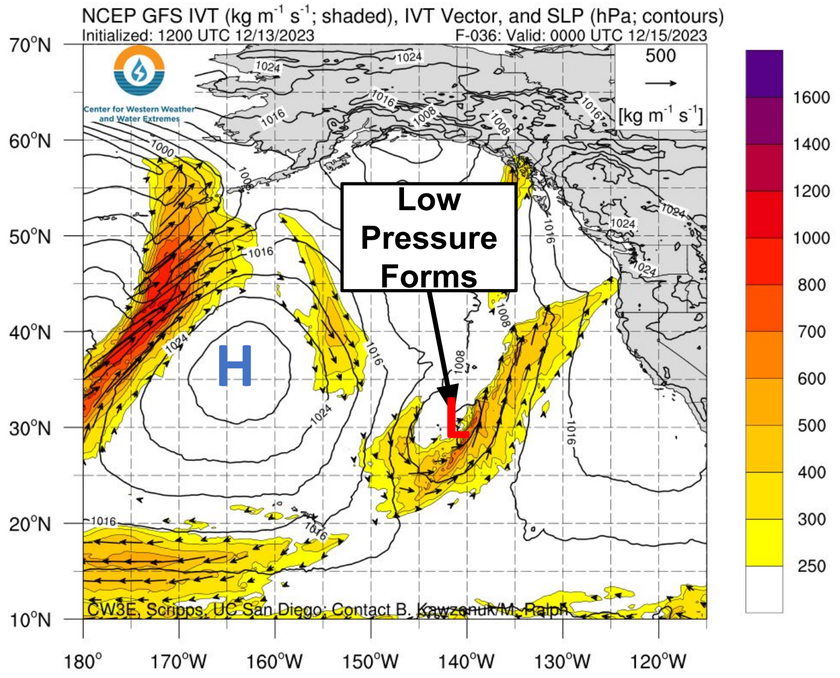


- A mid-level trough currently positioned south of the Aleutian Islands is forecast to shift to the eastern North Pacific in the coming days.
- The trough is forecast to continue to deepen through Thu 14 Dec before becoming cut off Fri 15 Dec.
- This cut off low is forecast to remain relatively stationary off the coast of California for a period of ~24 hours between 00Z 16-17 Dec.

CW3E AR Outlook: 13 Dec 2023

GFS Init 12Z Wed 13 Dec 2023

4PM PT Thu 14 Dec 2023



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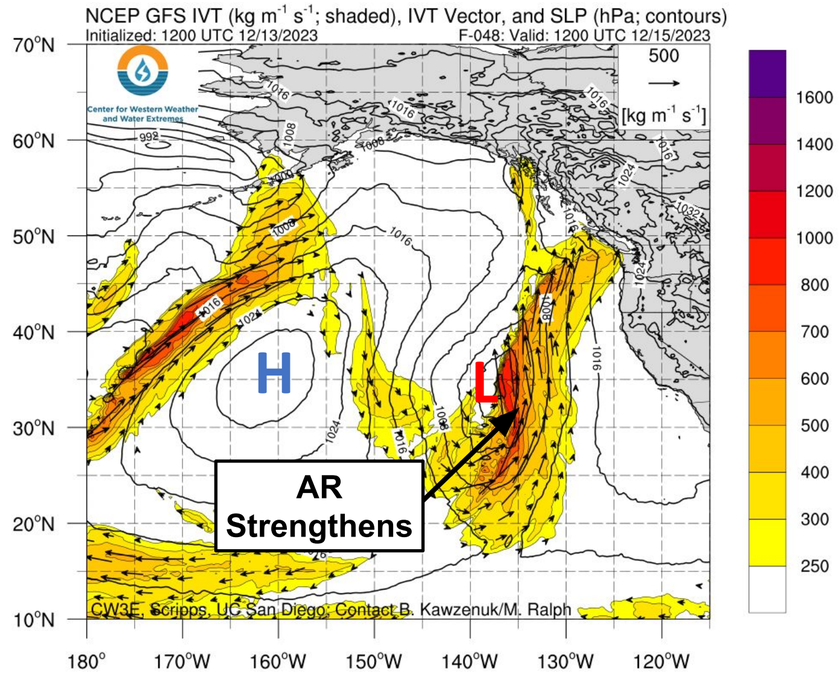
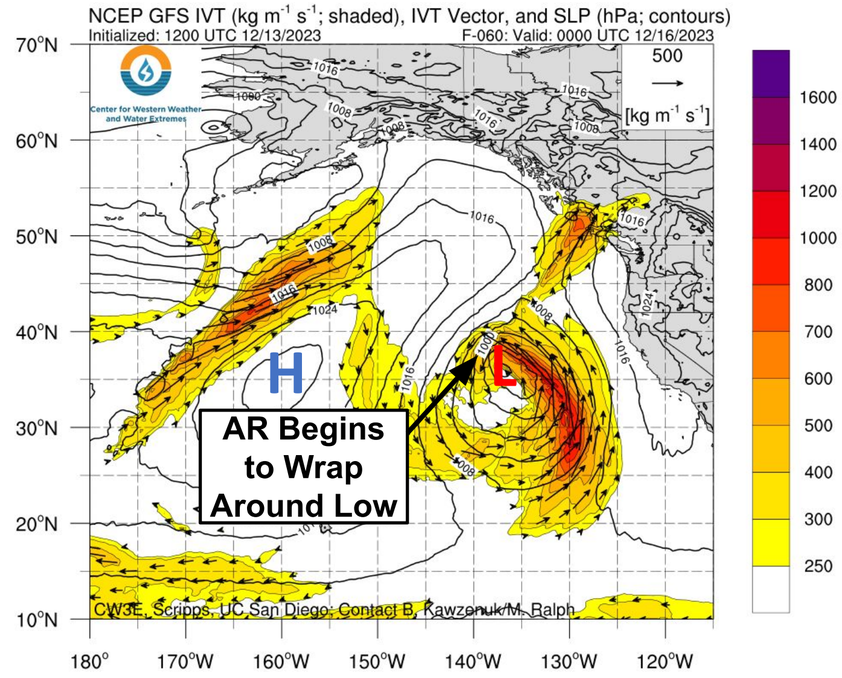


4PM PT Fri 15 Dec 2023

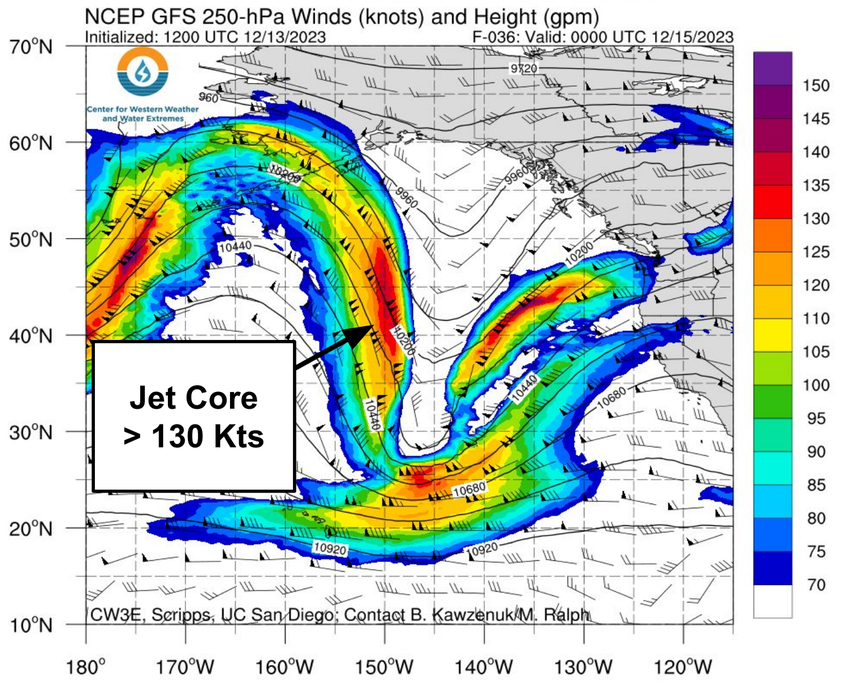


- In association with the deepening trough, the surface low pressure system begins to develop in NE Pacific midday Thu 14 Dec.
- The mid- to low-level flow interacts with remnant moisture from the AR making landfall in BC, leading to the formation of an AR.
- As the system progresses it is able to connect to the tropical moisture to help strengthen the associated AR.
- By midday Fri 15 Dec, the AR has begun to wrap further around the low pressure system.

CW3E AR Outlook: 13 Dec 2023

GFS Init 12Z Wed 13 Dec 2023

4PM PT Thu 14 Dec 2023



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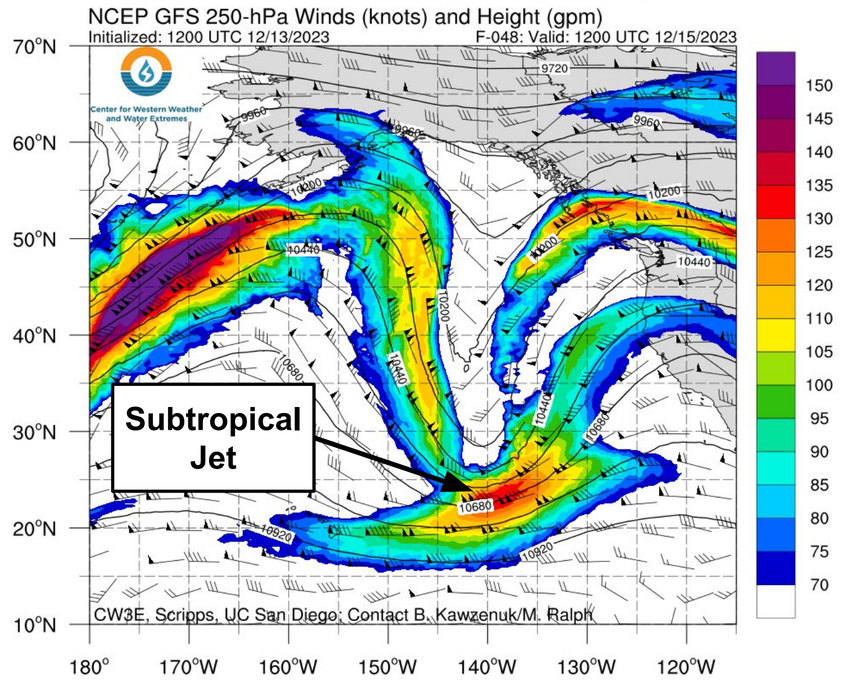
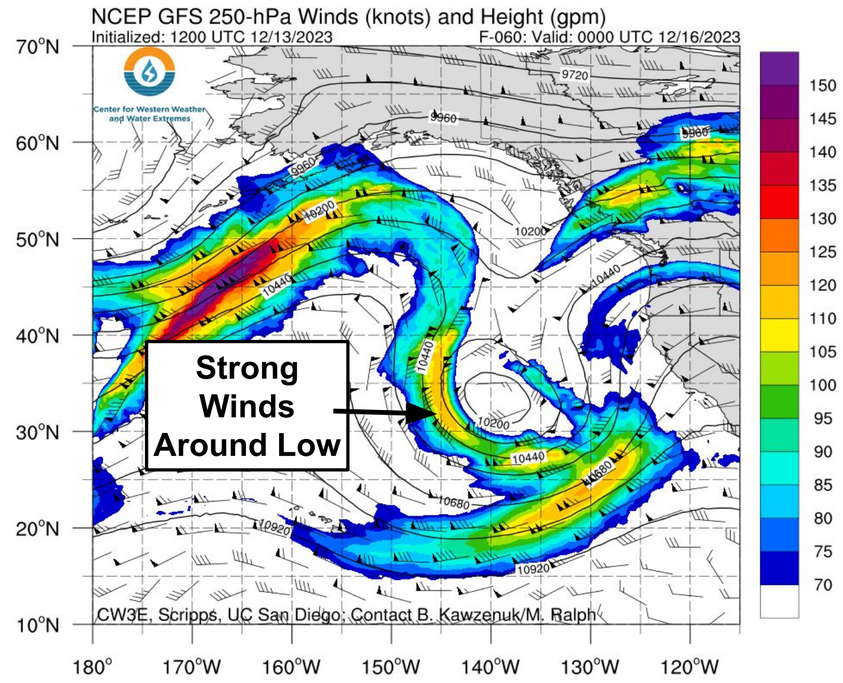


4PM PT Fri 15 Dec 2023

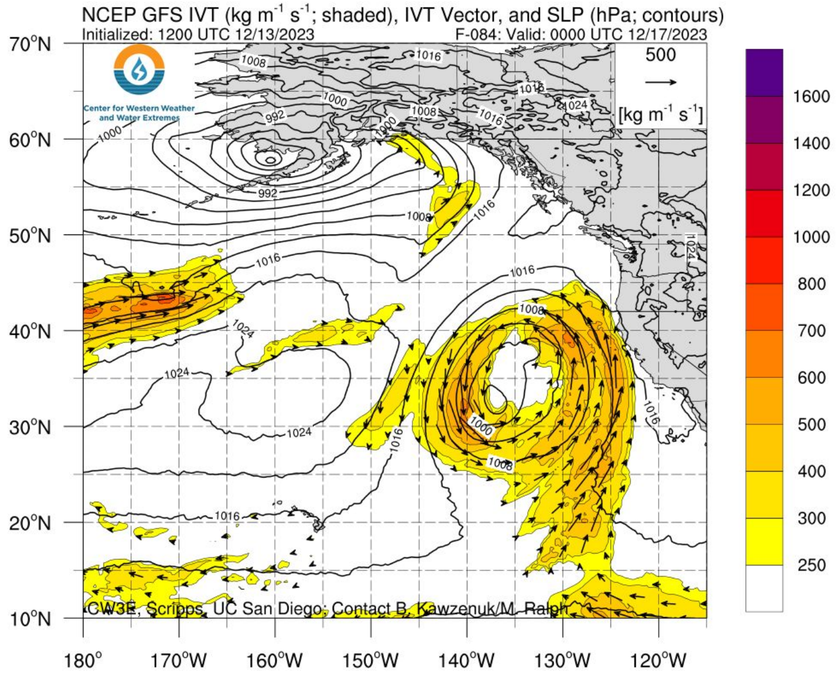


- Strong upper level winds help drive the deepening of the trough over the NE Pac.
- A strong subtropical jet is present at the base of the trough helping drive the system east into California.

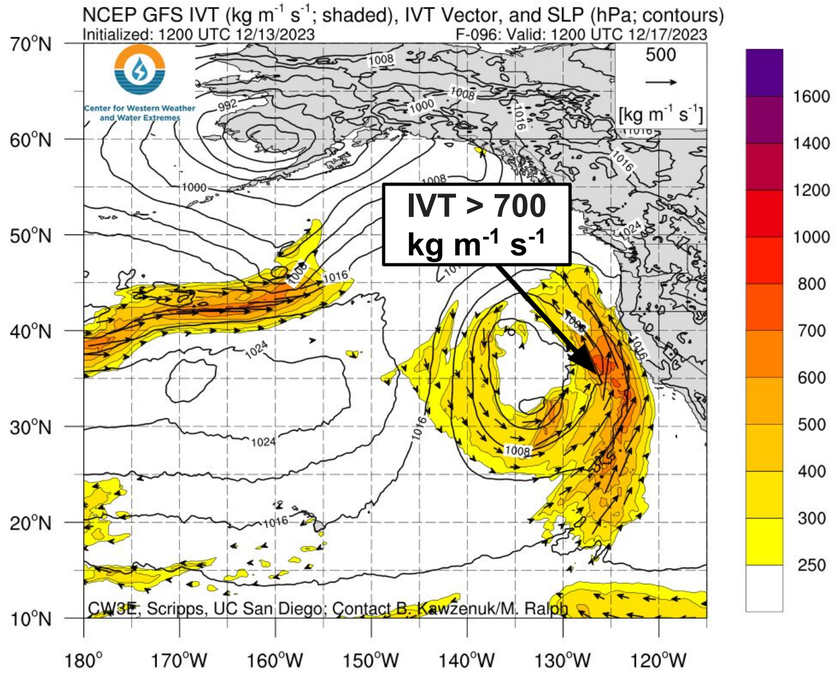
CW3E AR Outlook: 13 Dec 2023

GFS Init 12Z Wed 13 Dec 2023

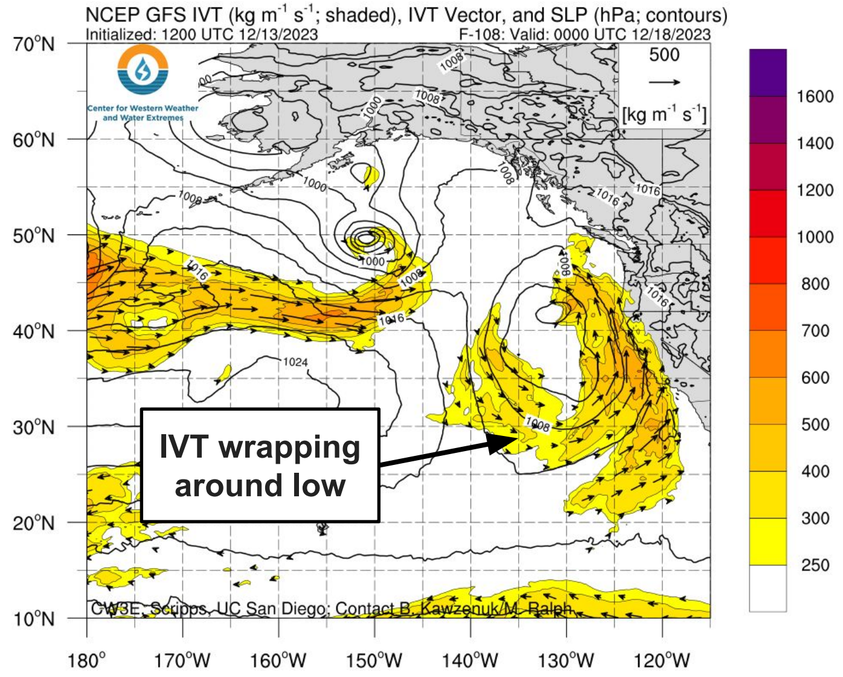
4PM PT Sat 16 Dec 2023



4AM PT Sun 17 Dec 2023



4PM PT Sun 17 Dec 2023

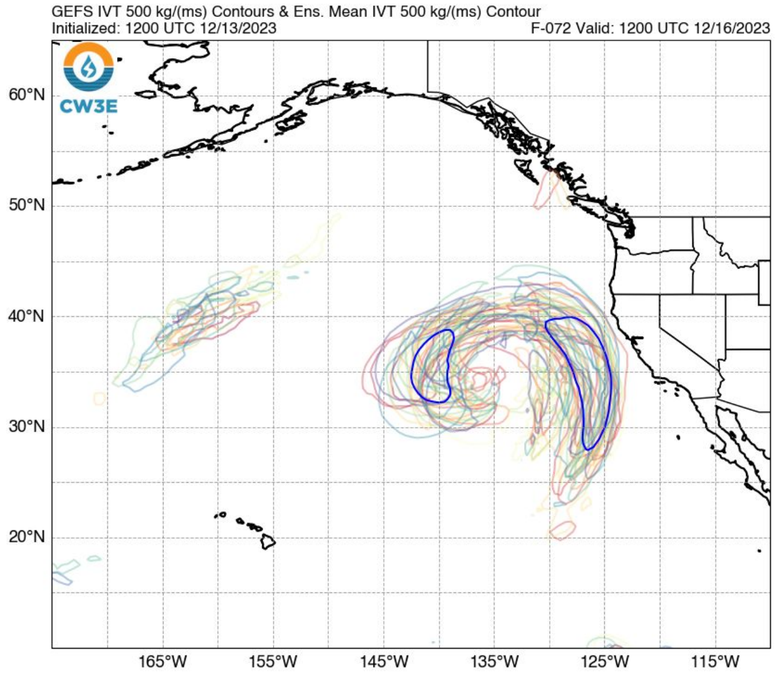


- AR conditions are forecast to begin over CA on Sun 17 Dec as the surface low continues progressing toward the USWC.
- The GFS is forecasting IVT > 700 kg m^{-1} s^{-1} in the core of the AR as it makes landfall along the CA coast.
- The IVT that is forecast to wrap up around the low pressure system feeds into the back of the AR, potentially helping to extend AR conditions over CA.

CW3E AR Outlook: 13 Dec 2023

GEFS 500 kg m^{-1} s^{-1} Contours

4AM PT Sat 16 Dec 2023



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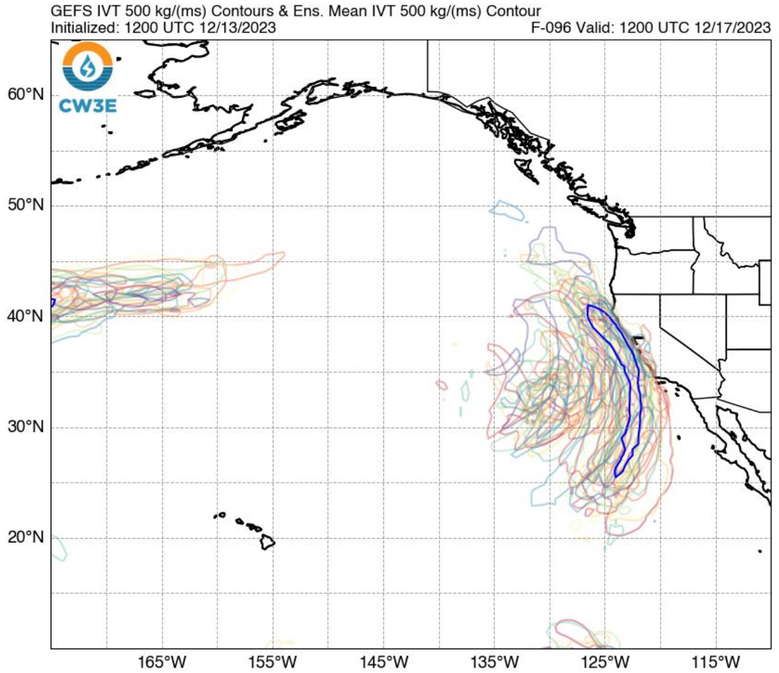
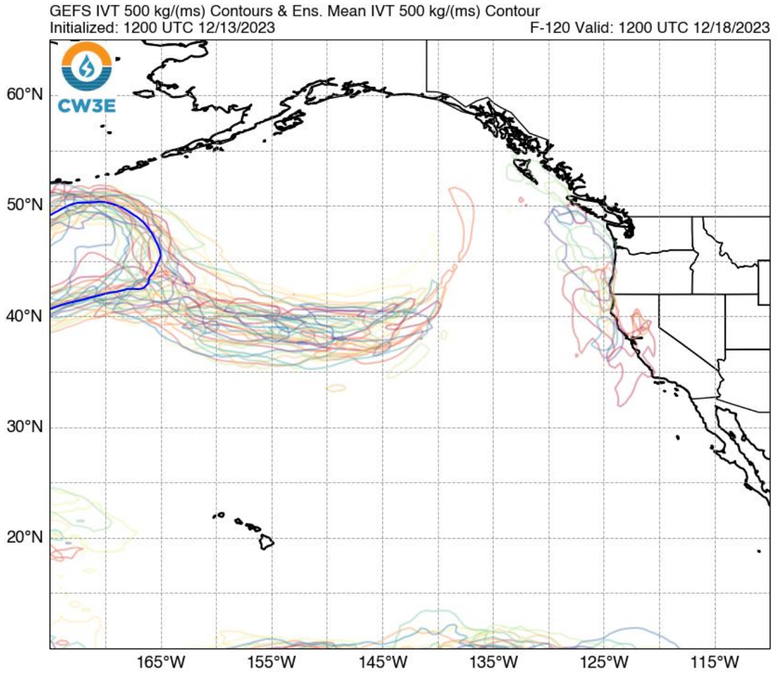


4AM PT Mon 18 Dec 2023

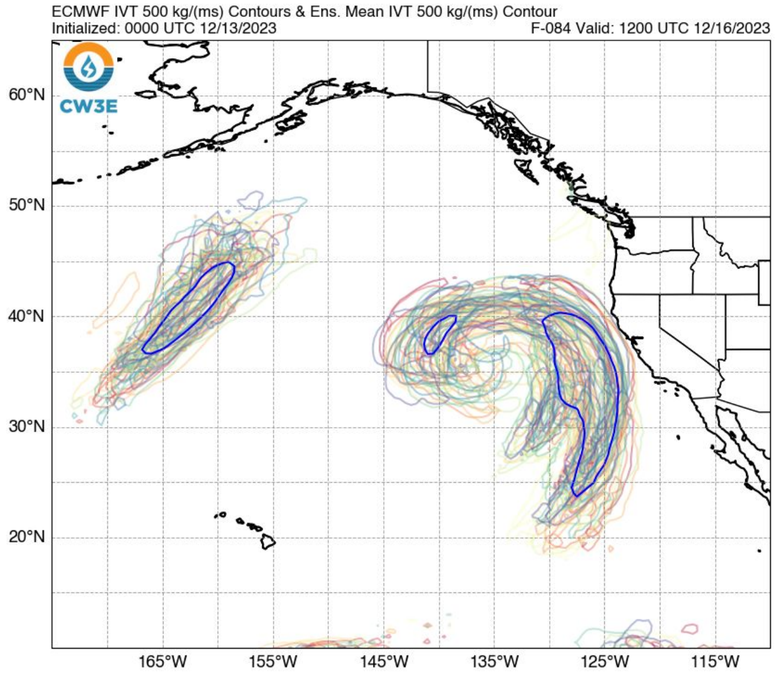


- The GEFS members are showing a fair amount of uncertainty in the position and timing of the moderate AR conditions.
- Ensemble mean contours (dark blue contour lines) show a landfall of IVT > 500 kg m^{-1} s^{-1} late Sat 16 Dec.
- Several members forecast the system progressing faster than the mean with IVT > 500 kg m^{-1} s^{-1} making landfall by midday Sat 16 Dec.
- Ensemble members also forecast the IVT wrapping around the low to follow initial AR landfall with much variability in the timing and area of IVT > 500 kg m^{-1} s^{-1}.

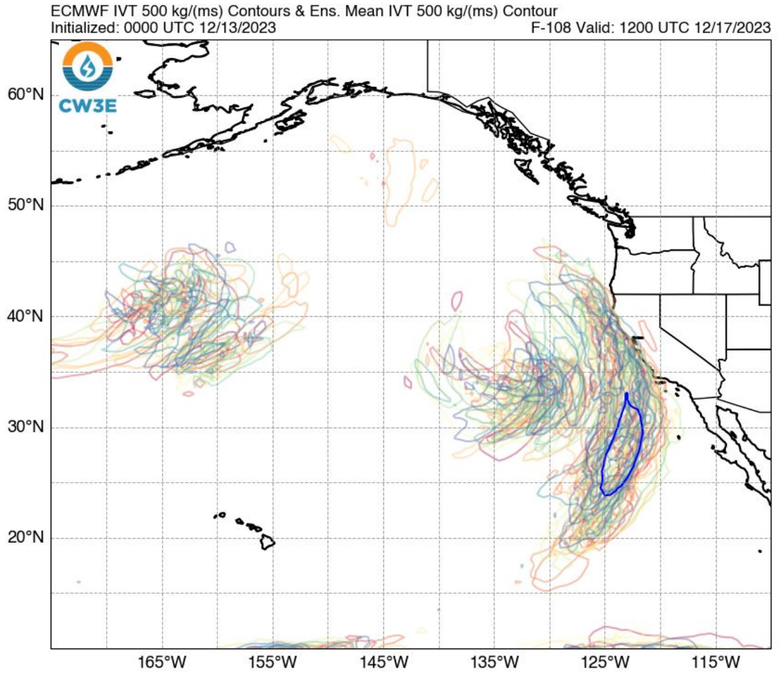
CW3E AR Outlook: 13 Dec 2023

ECMWF EPS 500 kg m^{-1} s^{-1} Contours

4AM PT Sat 16 Dec 2023



4AM PT Sun 17 Dec 2023



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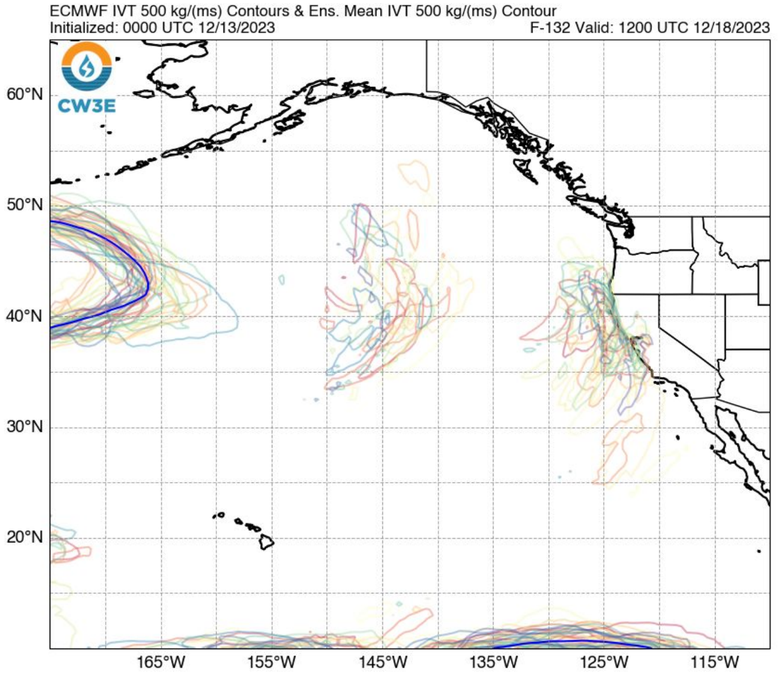
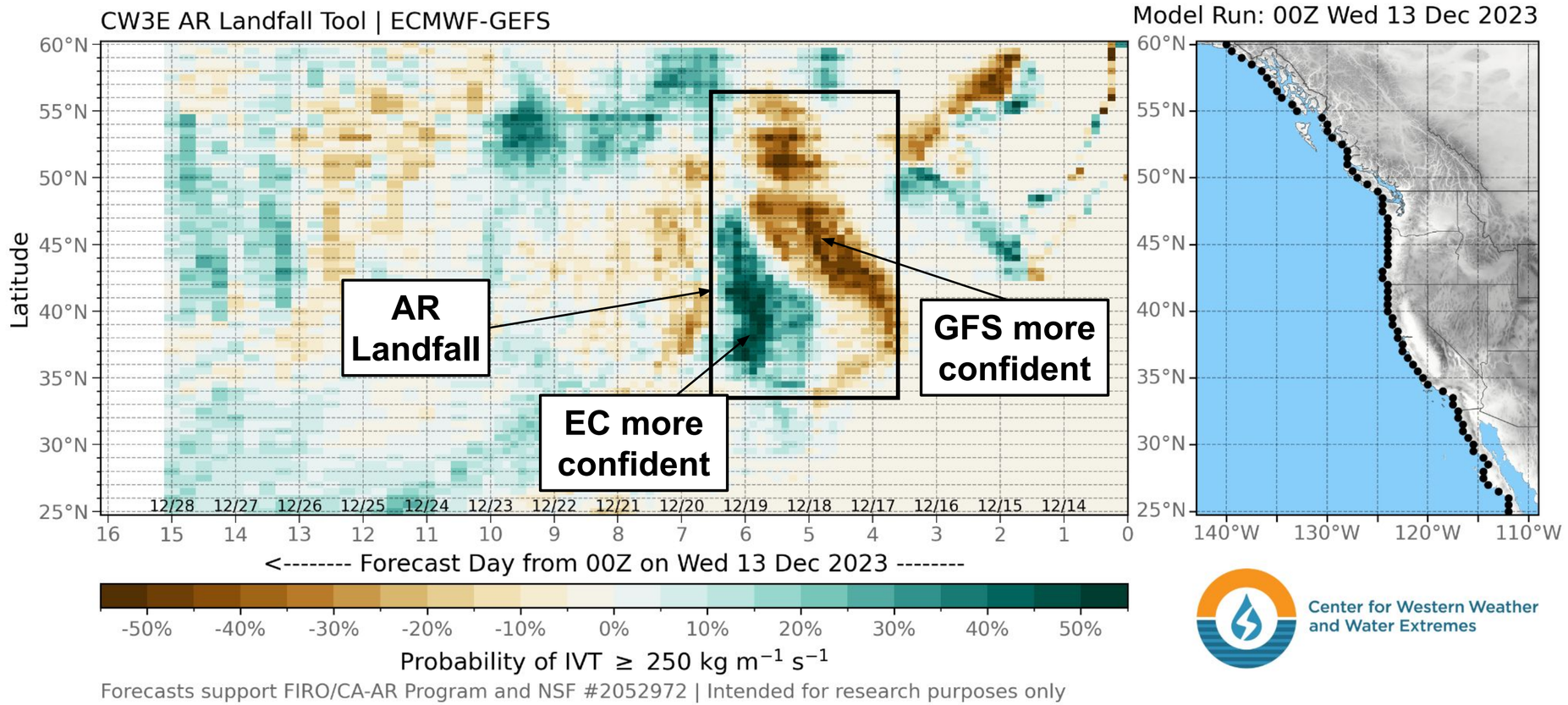


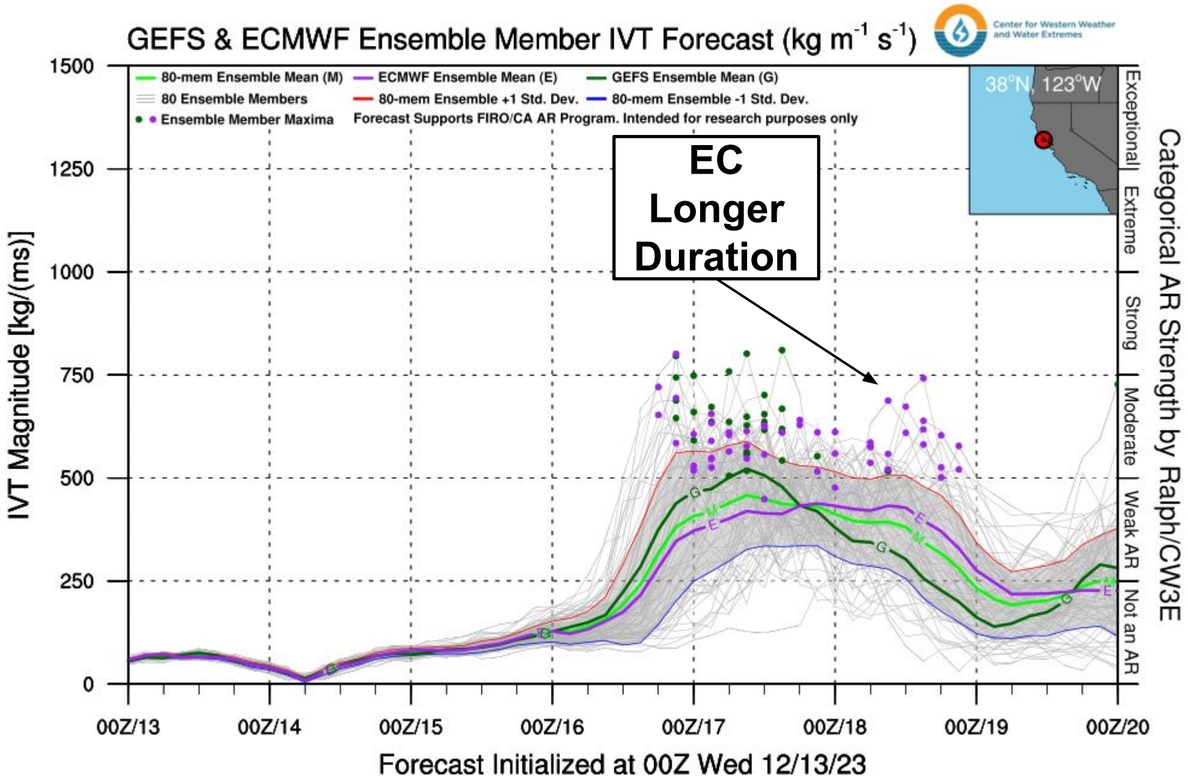
- ECMWF EPS members are also showing a fair amount of variability in the position and timing of the moderate AR conditions.
- EPS members are forecasting more IVT wrapping around the low to the north as well as more moderate IVT extending to the south with possibility of further south landfall.
- More EPS members have IVT > 500 kg m^{-1} s^{-1} persisting off the CA on Mon 18 Dec, highlighting the ECMWF forecast for a longer duration event

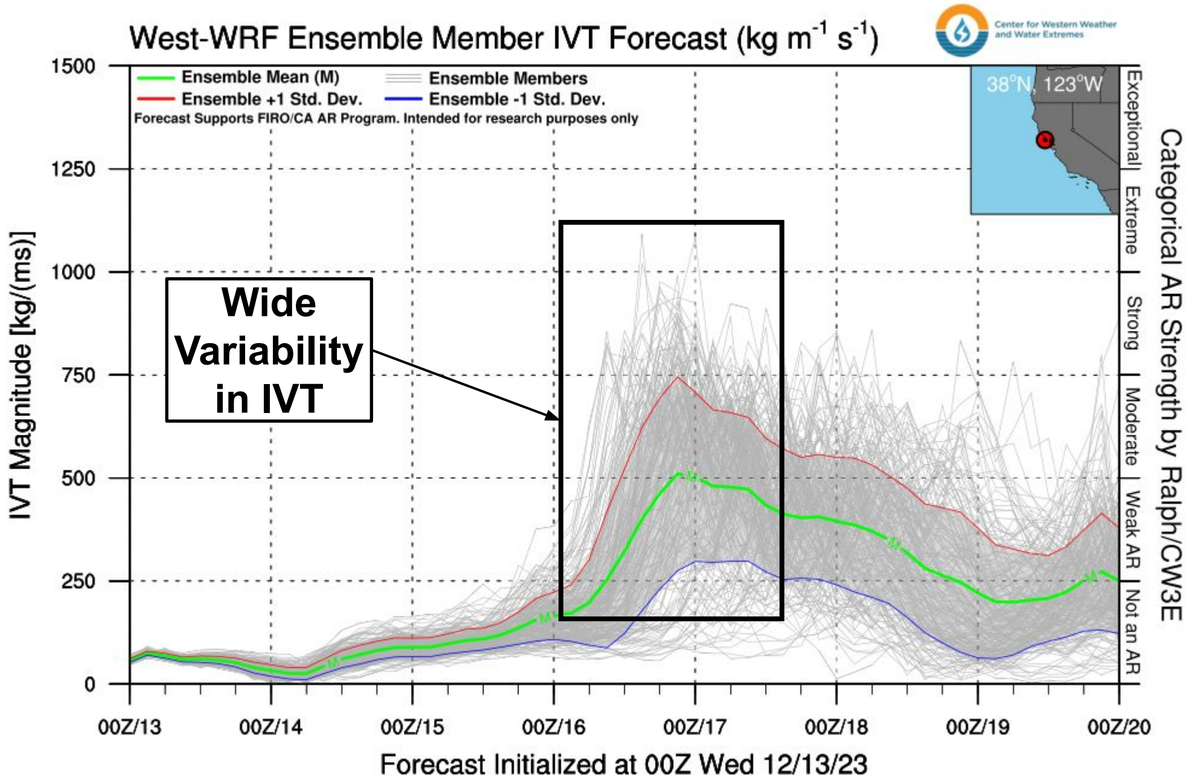
CW3E AR Outlook: 13 Dec 2023



- There is uncertainty in the landfall timing and location between the GEFS and ECMWF EPS.
- The GEFS is more confident in IVT > 250 kg m^{-1} s^{-1} making landfall over CA earlier and extending farther north while the EPS is more confident in AR conditions continuing later into Tue 19 Dec and further South.

CW3E AR Outlook: 13 Dec 2023





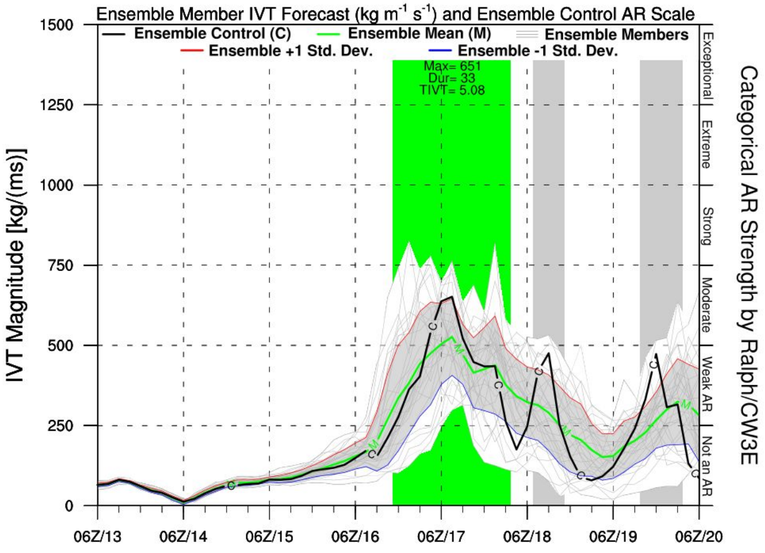
- GEFS and EPS plumes showcase the uncertainty in landfall timing between the ensembles, with the ECMWF EPS forecasting longer duration event.
- The West-WRF Ensemble similarly shows a wide variability amongst its members in the IVT magnitude at landfall as well as the duration of the event, highlighting the uncertainty of this event.

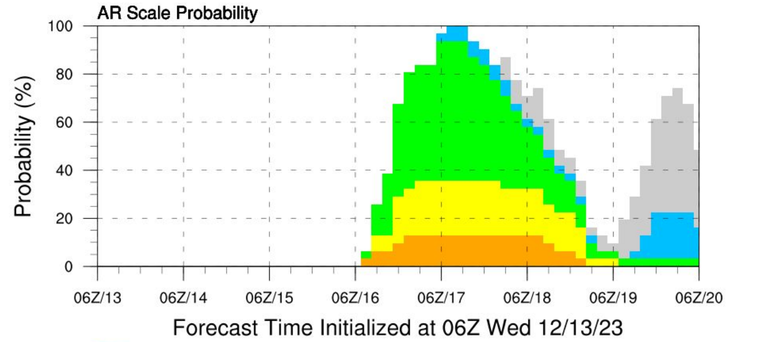
CW3E AR Outlook: 13 Dec 2023

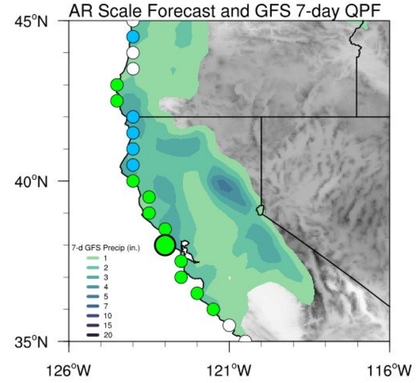
GEFS 7-day AR Scale and IVT Forecast

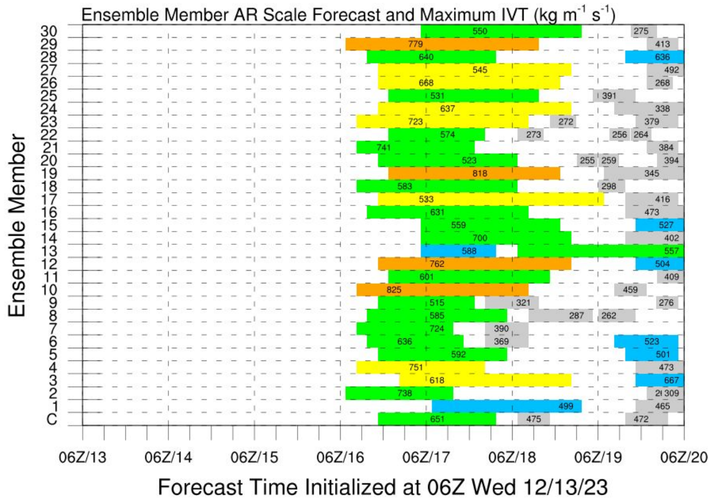
GFS Ensemble Inititialized: 06Z Wed 12/13/23

Location: 38°N 123°W









Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

AR 1 AR 2 AR 3 AR 4 AR 5

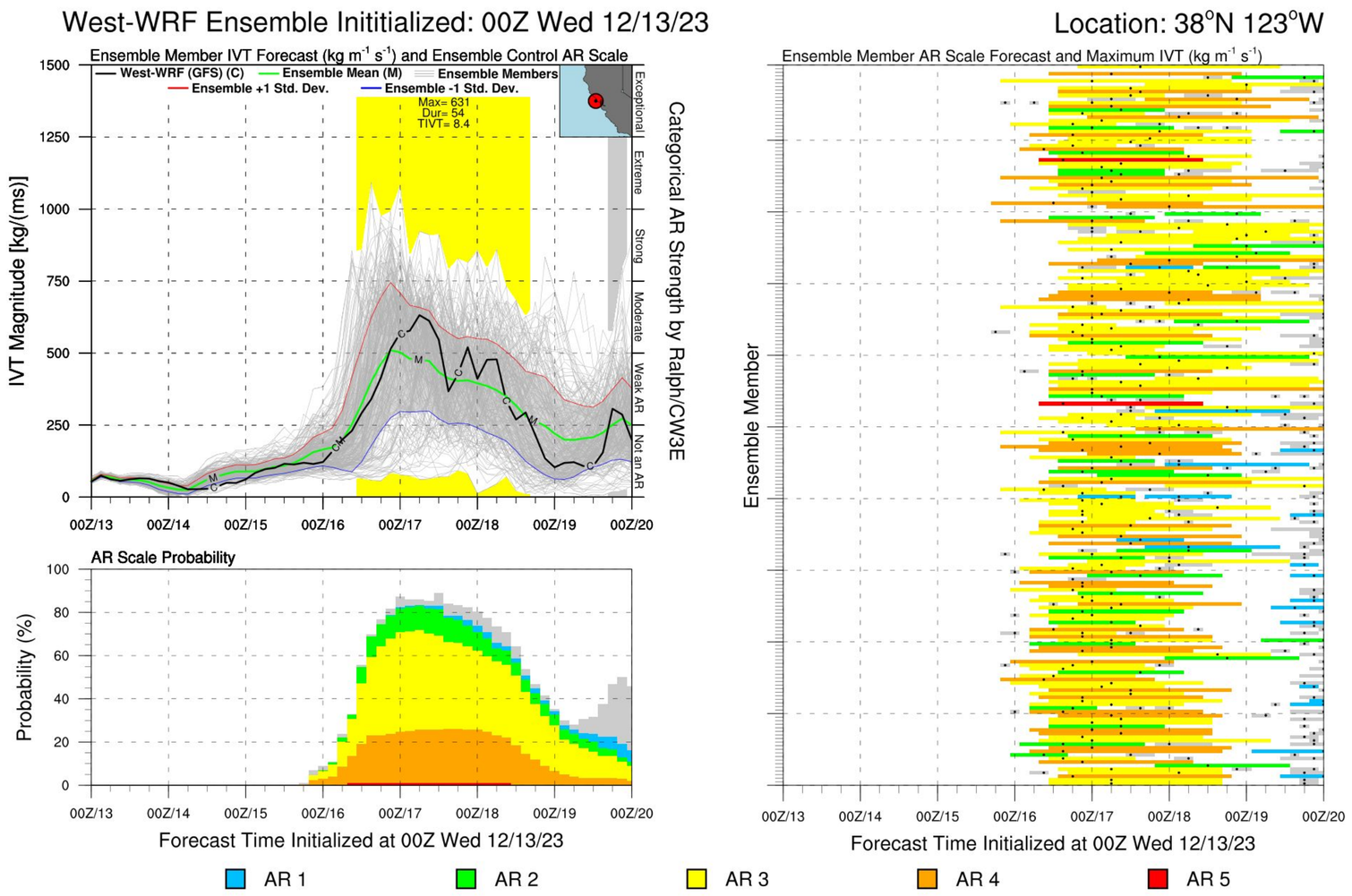
Image created: 12 UTC 12/13/2023

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

- 31/31 (100%) GEFS ensemble members are forecasting at least AR1 conditions at 38° N, 123.0° W (near Point Reyes, CA).
- 10/31 (32%) of the members (including the control) are forecasting at least AR3 conditions during the AR period.
- There is uncertainty in the timing of maximum IVT as well as duration of AR conditions amongst GEFS members.

CW3E AR Outlook: 13 Dec 2023

West-WRF Ensemble 7-day AR Scale and IVT Forecast

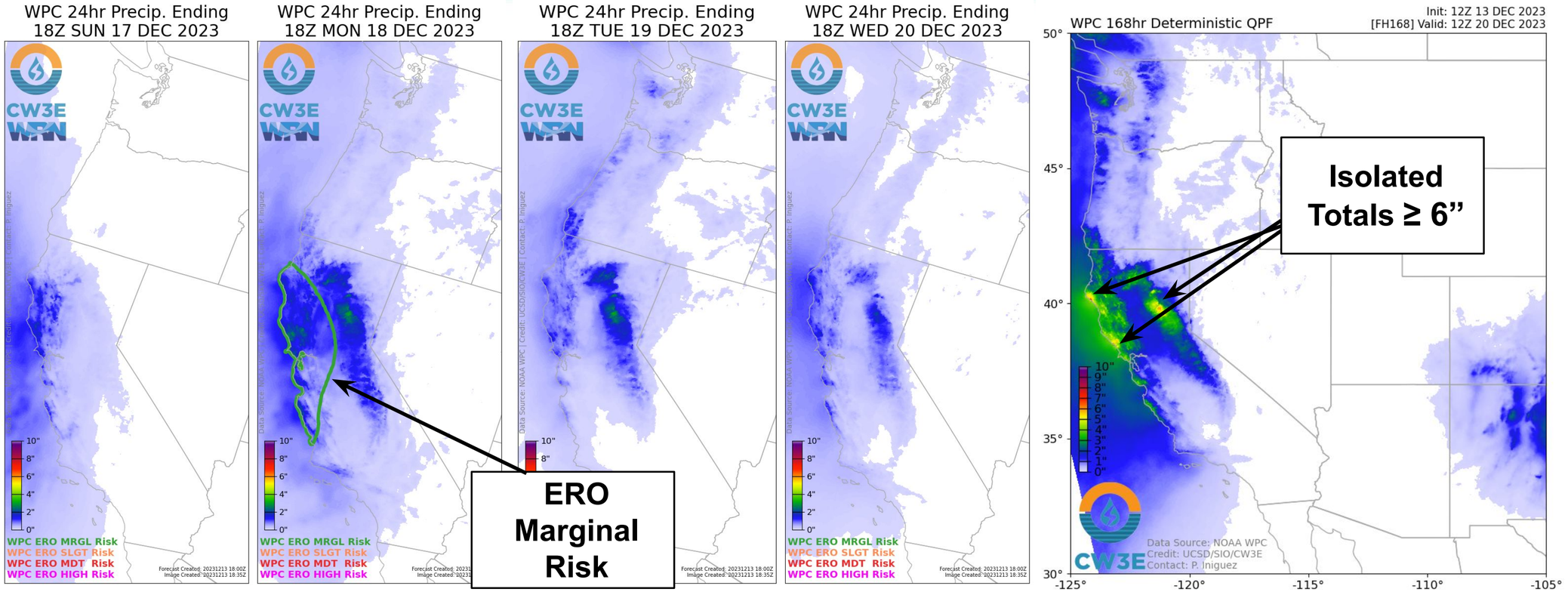


- The vast majority of West-WRF ensemble members are forecasting at least AR1 conditions at 38° N, 123.0° W (near Point Reyes, CA).
- Like the West-WRF control, many of the members (~70%) are forecasting AR3 or greater conditions for this AR.
- The West-WRF members are also showing a wide spread in AR duration and timing of peak IVT.

Image created: 14 UTC 12/13/2023

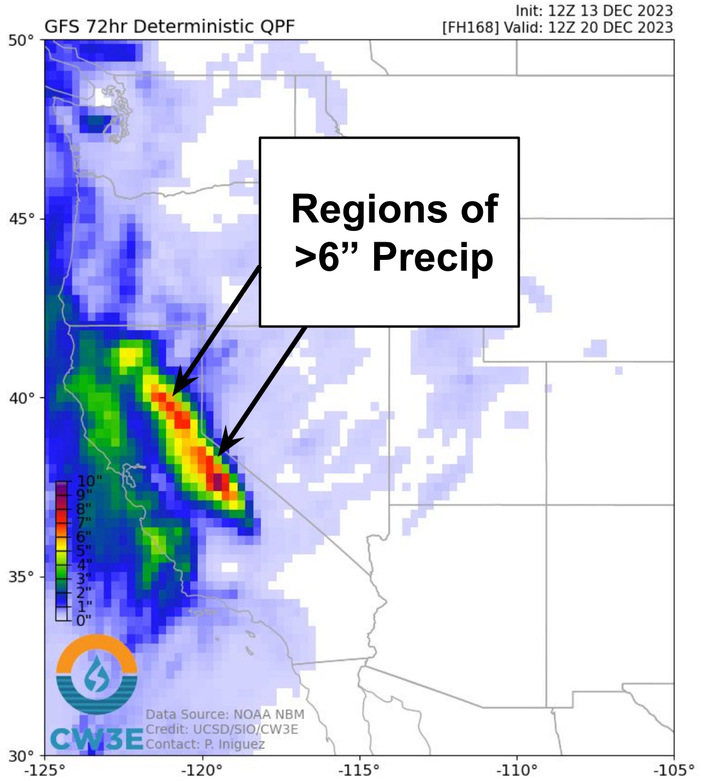
More information: http://cw3e.ucsd.edu AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

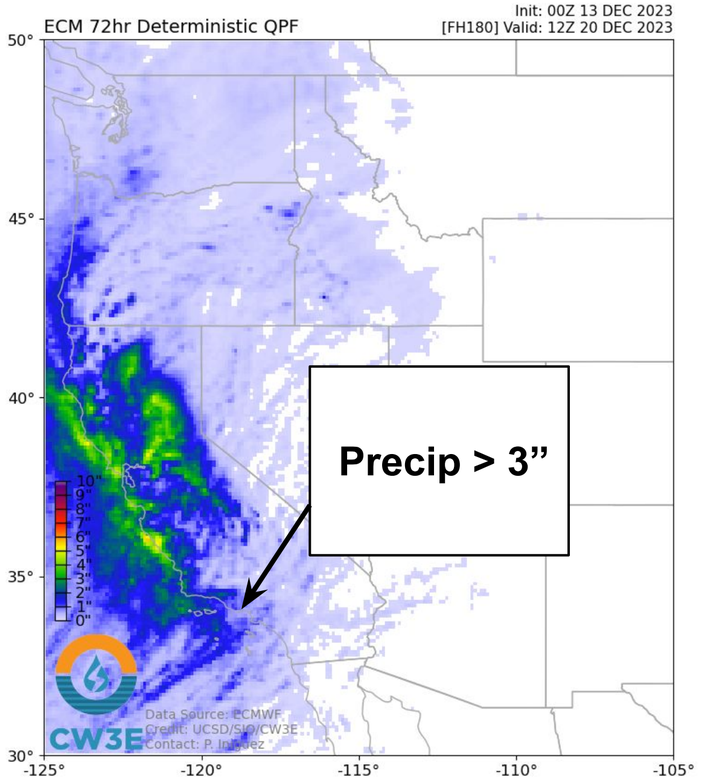
CW3E AR Outlook: 13 Dec 2023

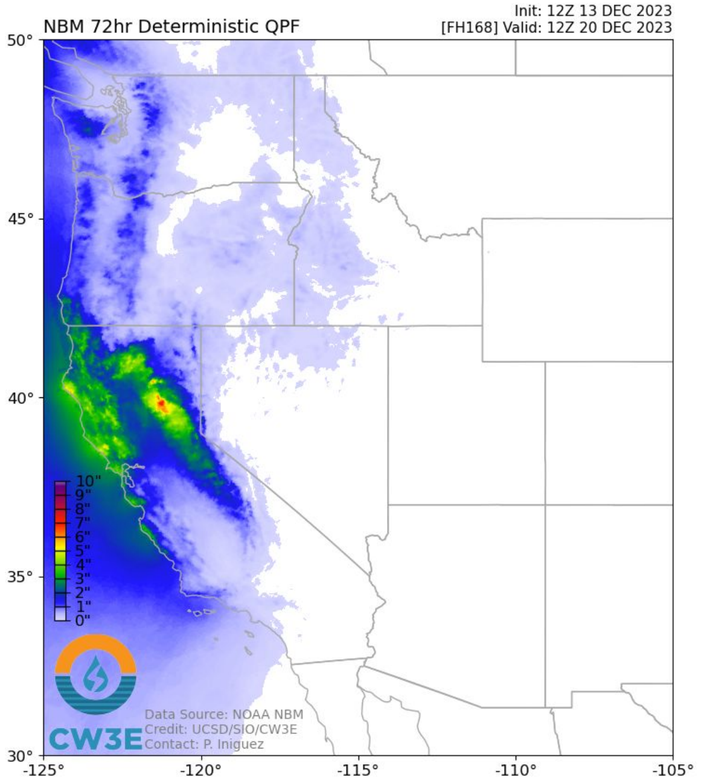


- The NWS WPC is currently forecasting precipitation totals ≥ 2 inches for regions along the CA Coast and into the Sierras.
- NWS WPC 7-day precipitation totals are forecast to exceed 3 inches for much of the N. CA coast and the Sierras, with localized precipitation amounts exceeding 6 inches.
- Excessive Rainfall Outlooks from the WPC show marginal risk of flooding for the regions along the CA coast and foothills of the Sierras following AR landfall.

CW3E AR Outlook: 13 Dec 2023





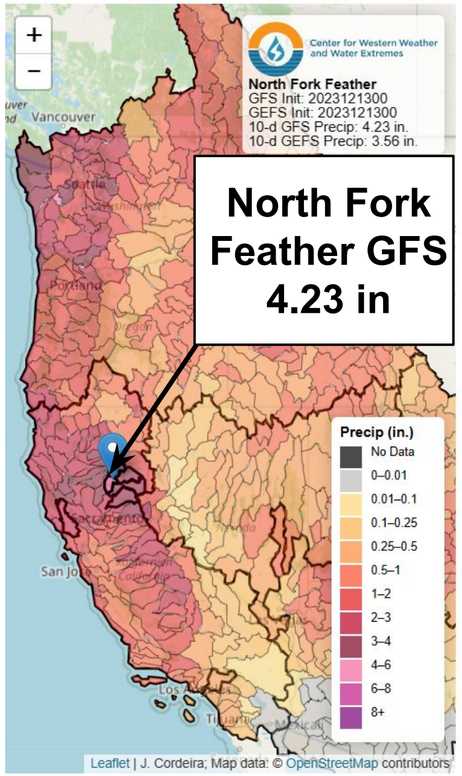


- 72-hour precipitation totals for the forecasted duration of this system vary between the GFS, ECMWF and NBM.
- Precipitation totals along the CA coast are broadly similar, with large regions ≥ 3 inches. The GFS is forecasting higher precipitation totals over the Sierras than either of the ECMWF and NBM, with large regions of precipitation totals ≥ 6 inches.

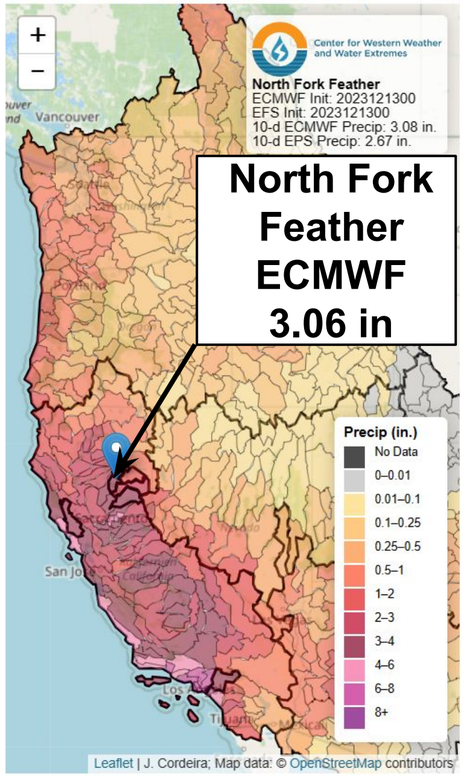
CW3E AR Outlook: 13 Dec 2023

10-day Watershed Precipitation Forecasts (Initialized 00Z 13 Dec)

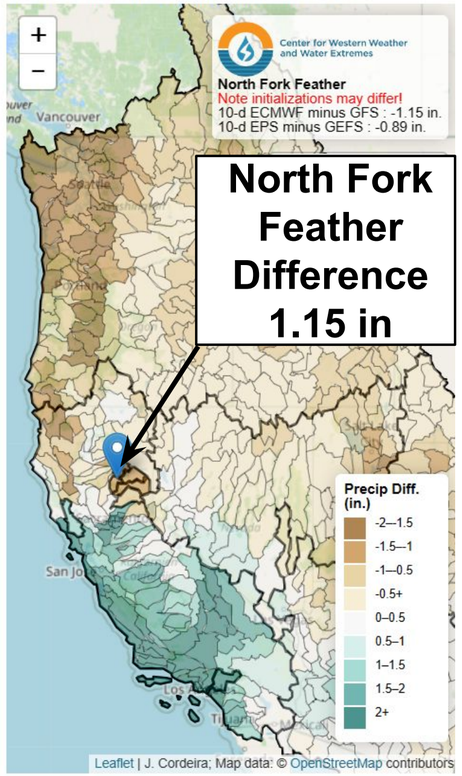
10-day GFS/GEFS Precipitation Forecasts

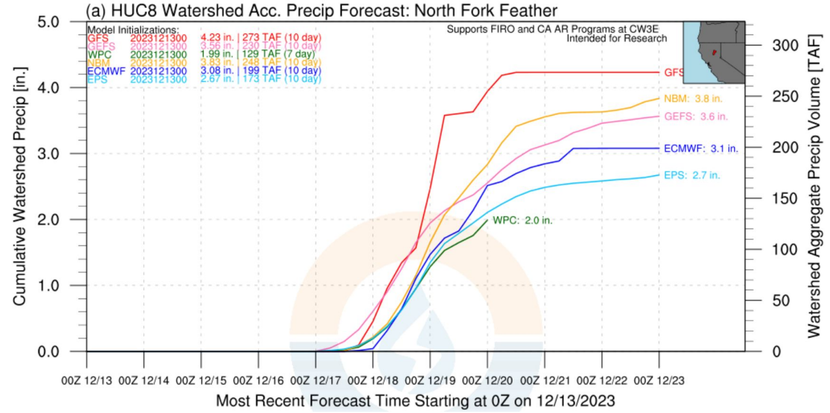


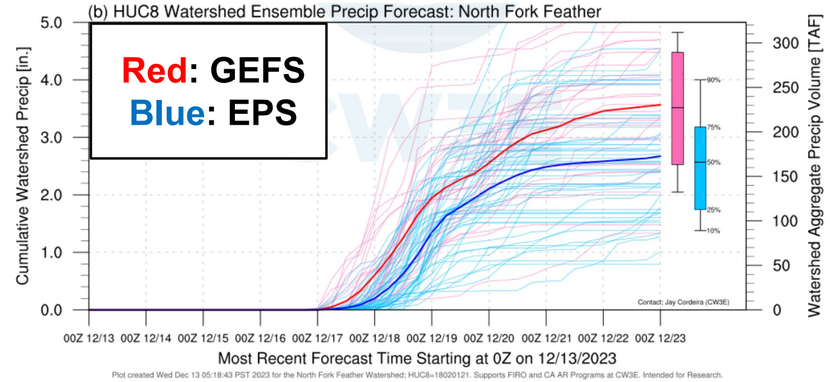
10-day ECMWF/EFS Precipitation Forecast



10-day Difference Precipitation Forecast



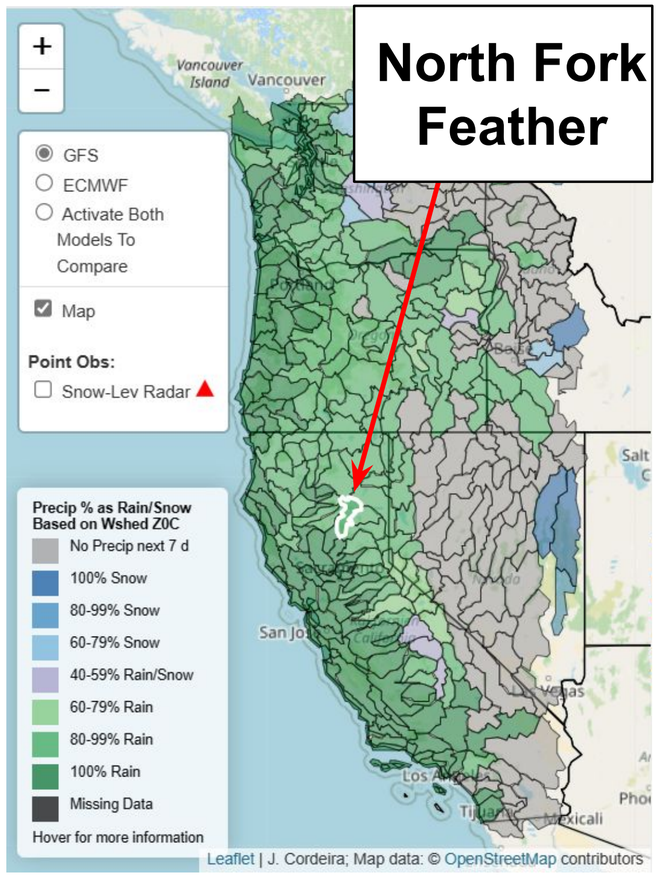


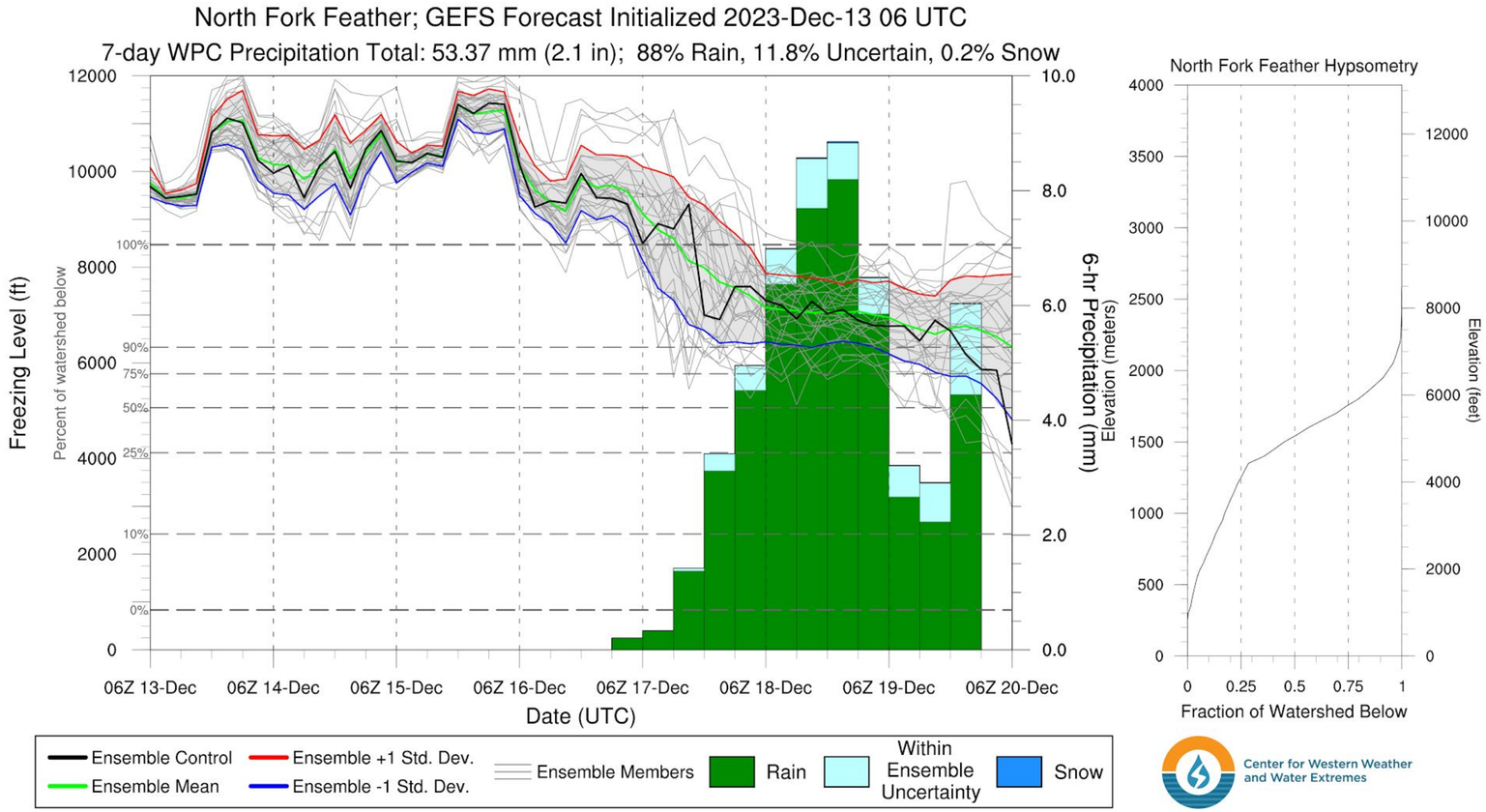


- The 00Z GFS is forecasting higher 10-day watershed precipitation totals in N. CA while the 00Z ECMWF is forecasting higher precipitation totals in S.CA.
- The 00Z GFS is forecasting 4.23” of mean areal precipitation in the North Fork Feather watershed over the next 10 days, while the 00Z ECMWF is forecasting 3.06” over the same watershed. Both ensembles’ members are showing uncertainty in the 10-day precipitation totals, with GEFS leaning towards more precipitation than EPS.

CW3E AR Outlook: 13 Dec 2023

Freezing Level Forecast

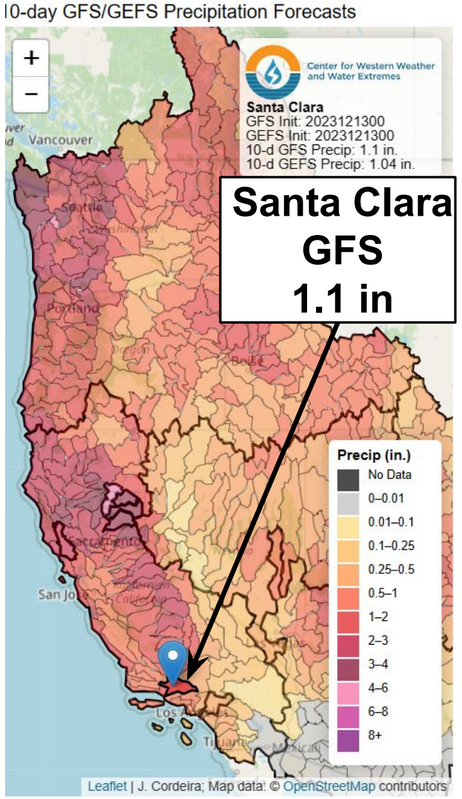


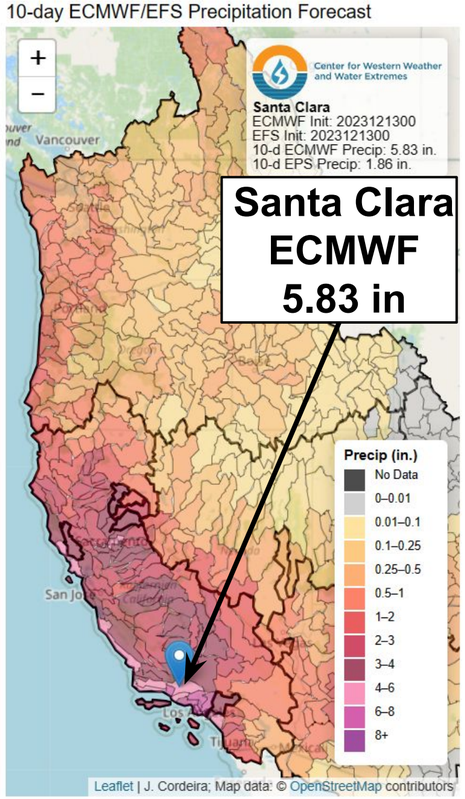


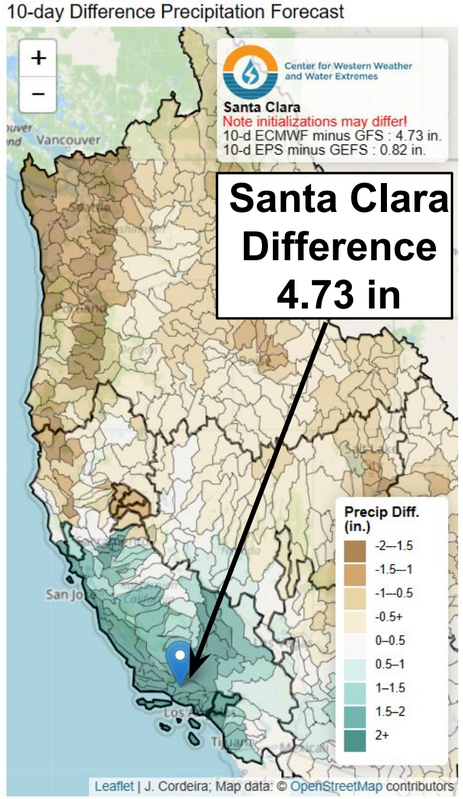
- Freezing levels are forecast to fall through the duration of this AR in the North Fork Feather.
- There is significant uncertainty in the forecasted freezing levels through the duration of this AR.

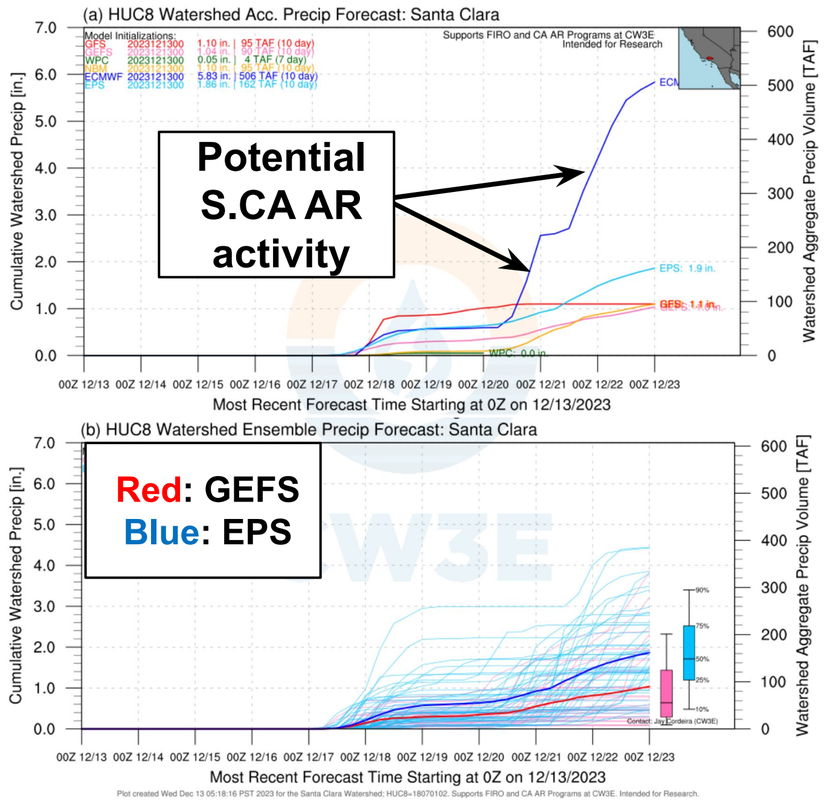
CW3E AR Outlook: 13 Dec 2023

10-day Watershed Precipitation Forecasts (Initialized 00Z 13 Dec)





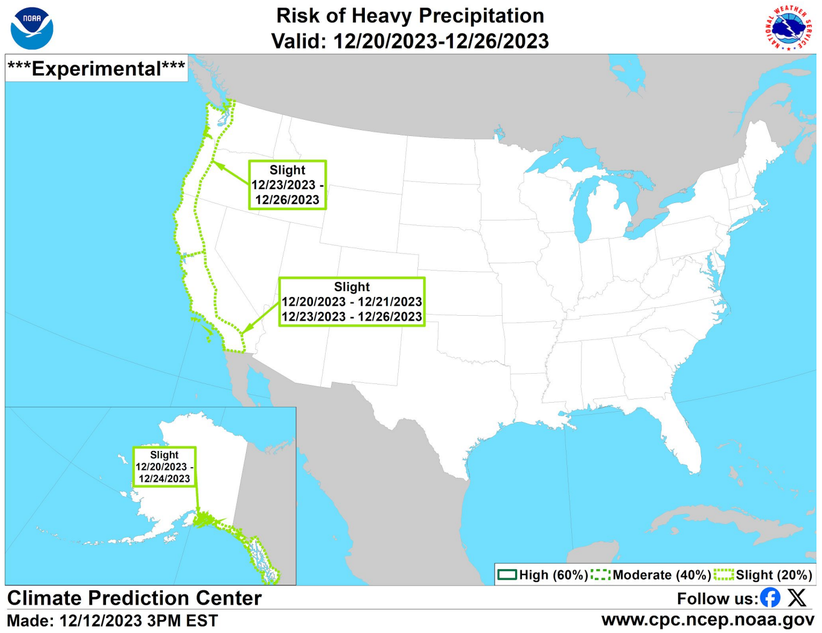


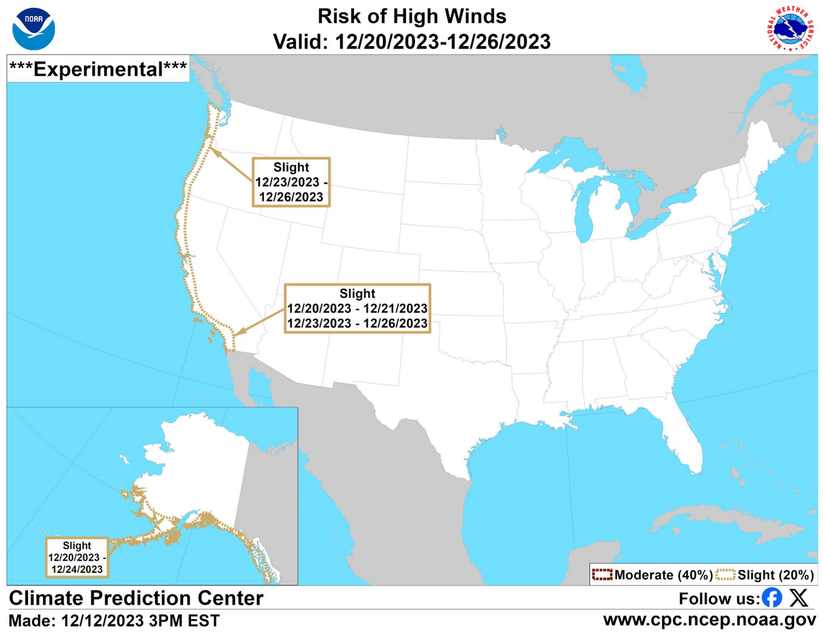


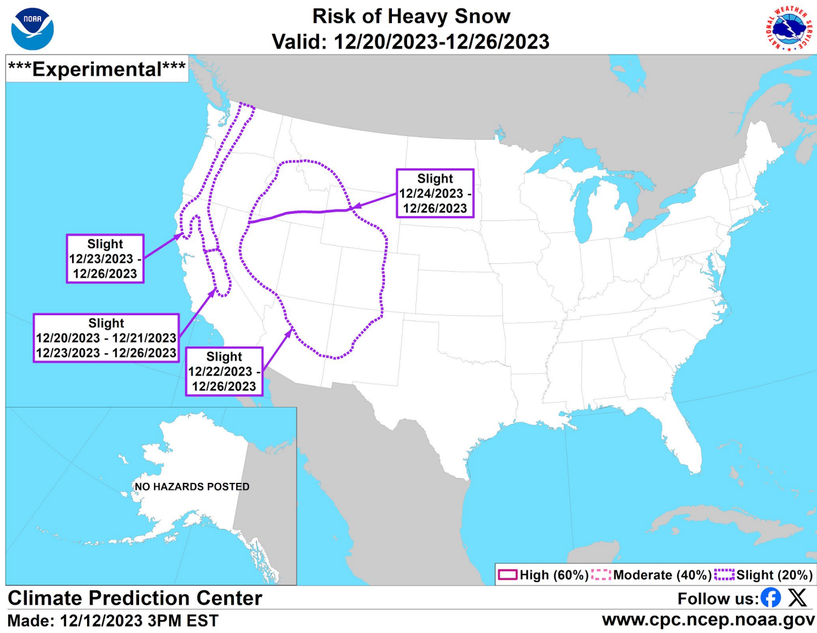
- The Santa Clara (Castaic Lake) watershed highlights the forecast difference in S.CA between the 00Z GFS and 00Z ECMWF.
- The 00Z GFS is forecasting 1.1” of mean areal precipitation in the Santa Clara watershed over the next 10 days, while the 00Z ECMWF is forecasting 5.83” over the same watershed.
- ECMWF totals are much higher than the GFS deterministic and both ensembles. This is largely due to forecasted AR activity in the middle of next week.

CW3E AR Outlook: 13 Dec 2023

Climate Prediction Center 8-14 Day Hazard Outlooks



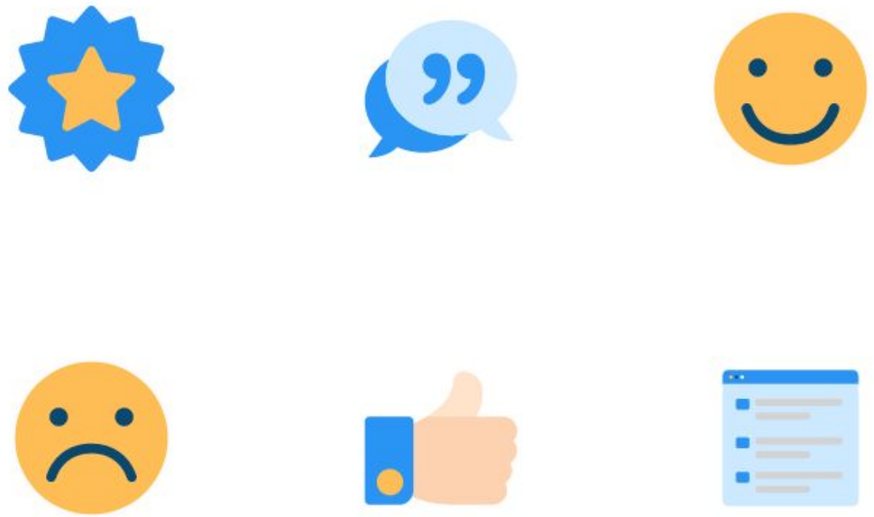




https://www.cpc.ncep.noaa.gov/products/predictions/threats/threats.php

- The NWS Climate Prediction Center issues Day 8-14 Hazard Outlooks for the US highlighting areas with elevated risk for Heavy Precipitation, High Winds and Heavy Snow.
- Current CPC hazard outlooks highlight slight risks of heavy precipitation and high winds in coastal CA, as well as heavy snow in the Sierra Nevada on 12/20-12/21 and 12/23-12/26.
- Noted hazard risks along with the potential forecasted prolonged AR activity in S. CA in the ECMWF emphasizes the need to carefully watch the upcoming forecasts.

CW3E AR Outlook: 28 Nov 2023



We value your feedback! Please complete this short survey to help us improve these outlooks.