

# CW3E Atmospheric River Outlook: 30 October 2023

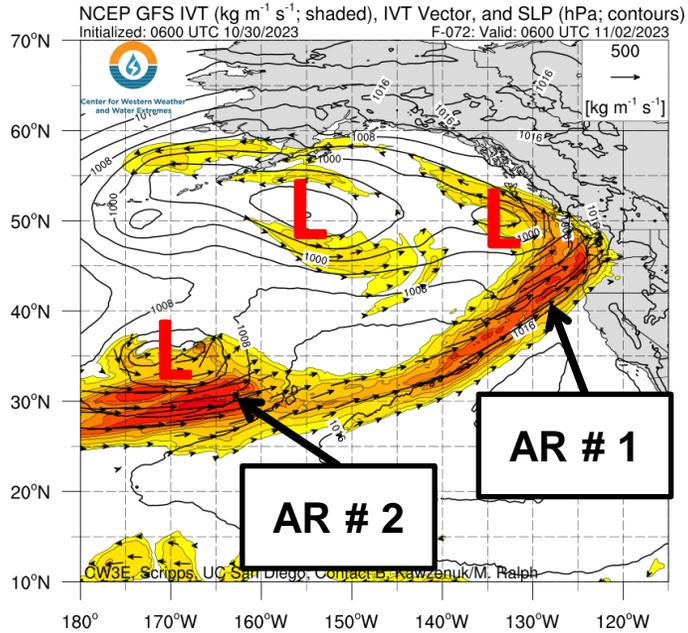
## Multiple Atmospheric Rivers Forecast to Impact Pacific Northwest and Northern California

- Multiple atmospheric rivers (AR) are forecast to make landfall in the Pacific Northwest over the next 7 days, the first late Wed 1 Nov
- AR2 conditions (based on Ralph et al. scale) are forecast during the first AR, with a ~24 hour period of IVT  $>800 \text{ kg m}^{-1} \text{ s}^{-1}$  forecast for Washington to Northern California in both the GFS and ECMWF
- There is disagreement in the timing, strength and duration of the ARs that follow between the models
- The GFS is forecasting AR1 conditions during the second AR along the coast of Central Oregon into Northern California early Sat 4 Nov, with a ~15 hour period of IVT  $>700 \text{ kg m}^{-1} \text{ s}^{-1}$  forecast in this region
- The second AR is forecast to make landfall late Fri 3 Nov in the ECMWF, where EPS ensemble members are forecasting the second AR to be stronger and for AR conditions to persist longer than the GEFS, resulting in significant differences in precipitation forecasts
- GEFS ensemble members show uncertainty of the forecast conditions for the third AR to register on the Ralph et al. scale, while the EPS shows many members forecasting AR conditions persisting from the second AR through to the third with the arrival of the next moisture corridor
- The NWS Weather Prediction Center (WPC) is forecasting precipitation totals of 2-5 inches during the first AR for the Olympic Peninsula, Cascade Range and Washington and Oregon Coasts
- Precipitation associated with these ARs are forecast to be primarily beneficial to the Pacific Northwest where widespread drought conditions are present, with no river levels forecast to rise above action stage within the boundaries of the NWS Northwest River Forecast center
- Most of the precipitation is expected to fall as rain, with freezing levels forecast to stay above 6000 feet throughout these events

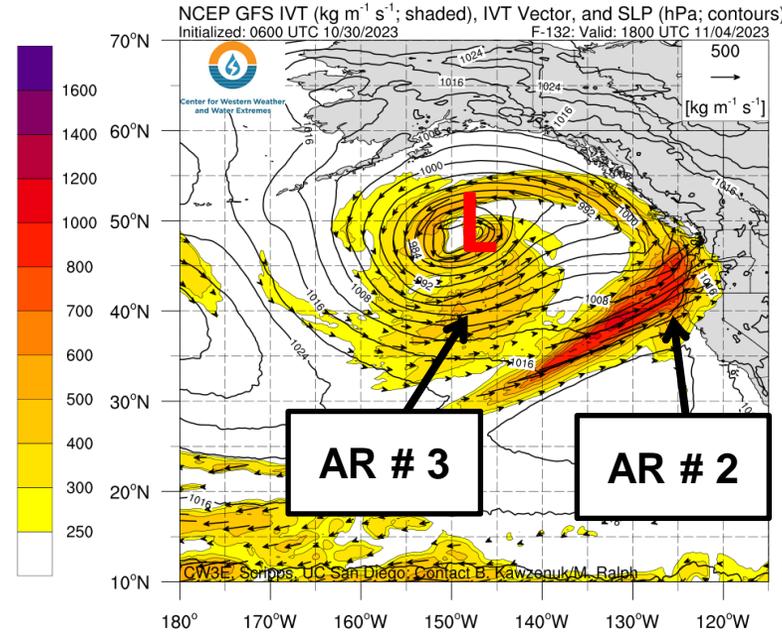
# CW3E AR Outlook: 30 October 2023

## GFS Model IVT Forecast: Initialized 06Z 30 Oct

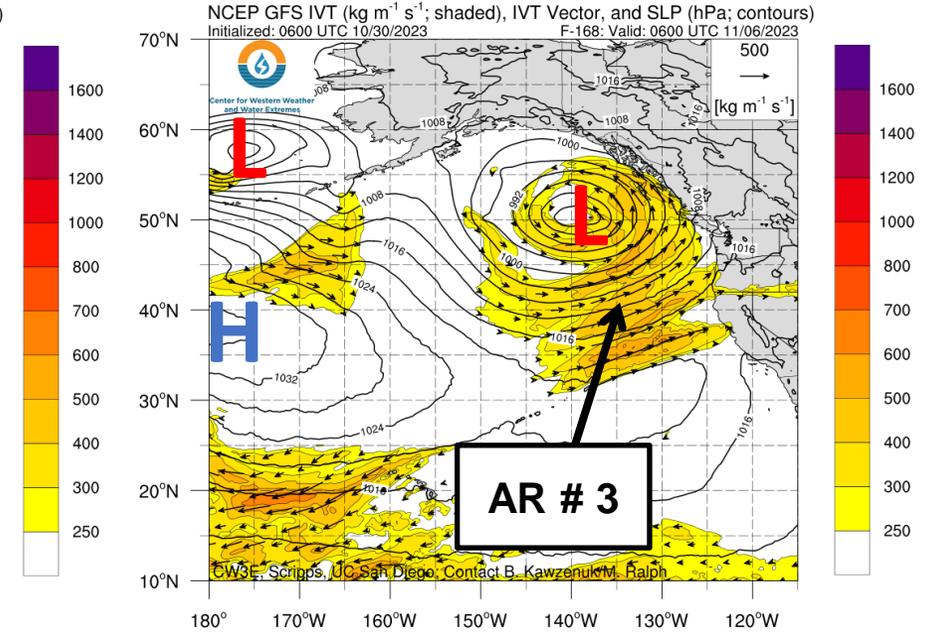
**A) Valid 11 PM PST  
Wed 1 Nov (F-72)**



**B) Valid 11 AM PST  
Sat 4 Nov (F-132)**



**C) Valid 11 PM PST  
Sun 5 Nov (F-168)**

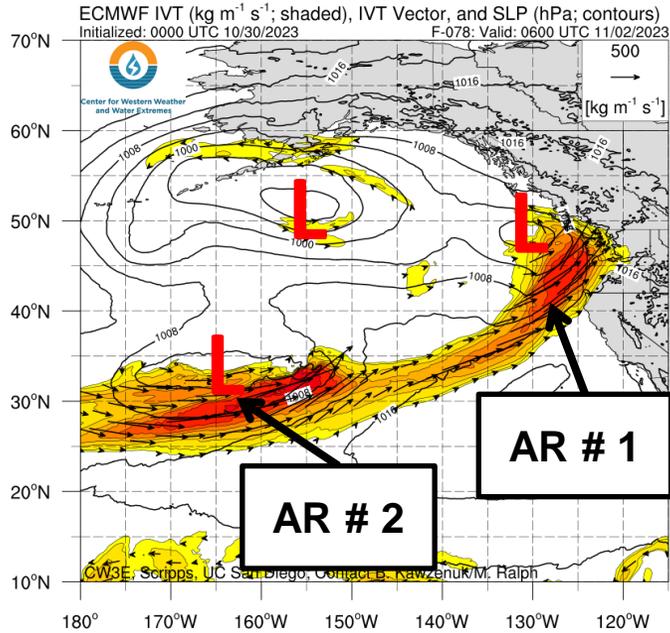


- Multiple ARs are forecast to track across the Pacific and make landfall along the US West Coast this week
- The 1<sup>st</sup> AR is forecast to bring IVT  $> 700 \text{ kg m}^{-1} \text{ s}^{-1}$  to the PNW late Wed 1 Nov (Fig. A)
- The 2<sup>nd</sup> AR is forecast to arrive morning of Sat 4 Nov bringing IVT  $> 700 \text{ kg m}^{-1} \text{ s}^{-1}$  to the PNW and far Northern California (Fig. B)
- A 3<sup>rd</sup> AR is forecast to develop with the surface low pressure behind the second AR, bringing weak AR conditions (IVT magnitudes  $> 300 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to the US West Coast late Mon 6 Nov (Fig. C)

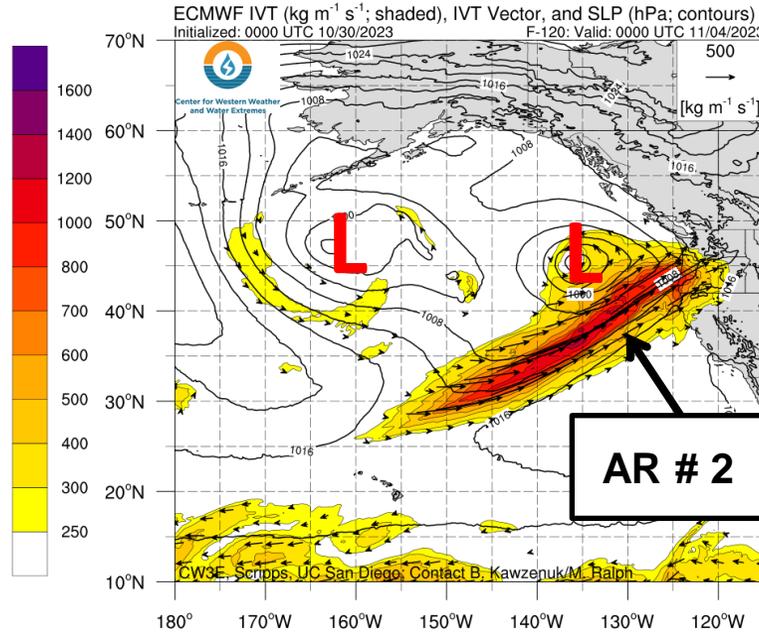
# CW3E AR Outlook: 30 October 2023

## ECMWF Model IVT Forecast: Initialized 06Z 30 Oct

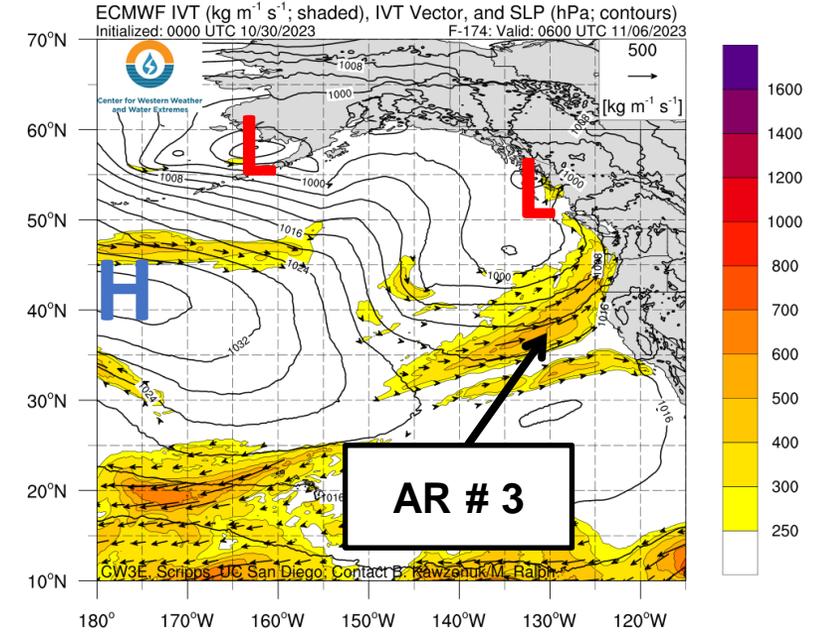
A) Valid 11 PM PST  
Wed 1 Nov (F-72)



B) Valid 6 PM PST  
Fri 3 Nov (F-132)

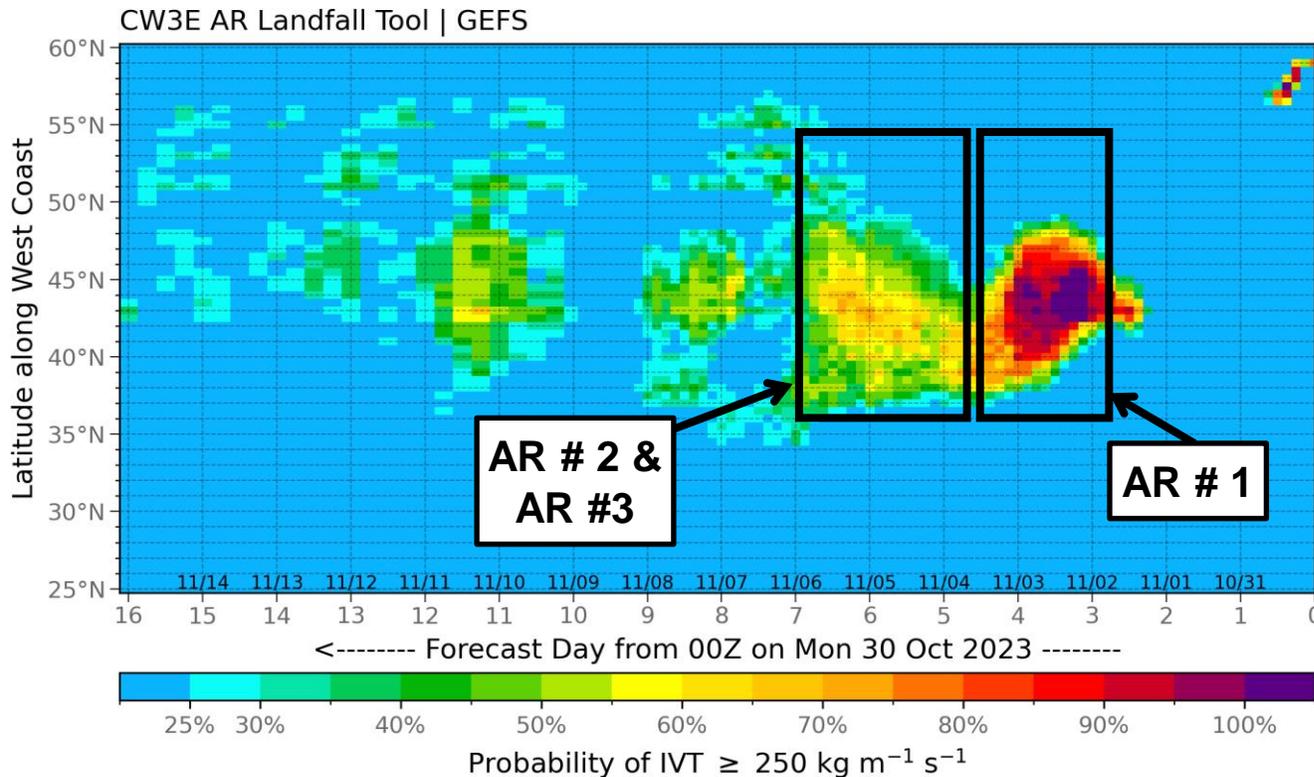


C) Valid 11 PM PST  
Sun 5 Nov (F-174)



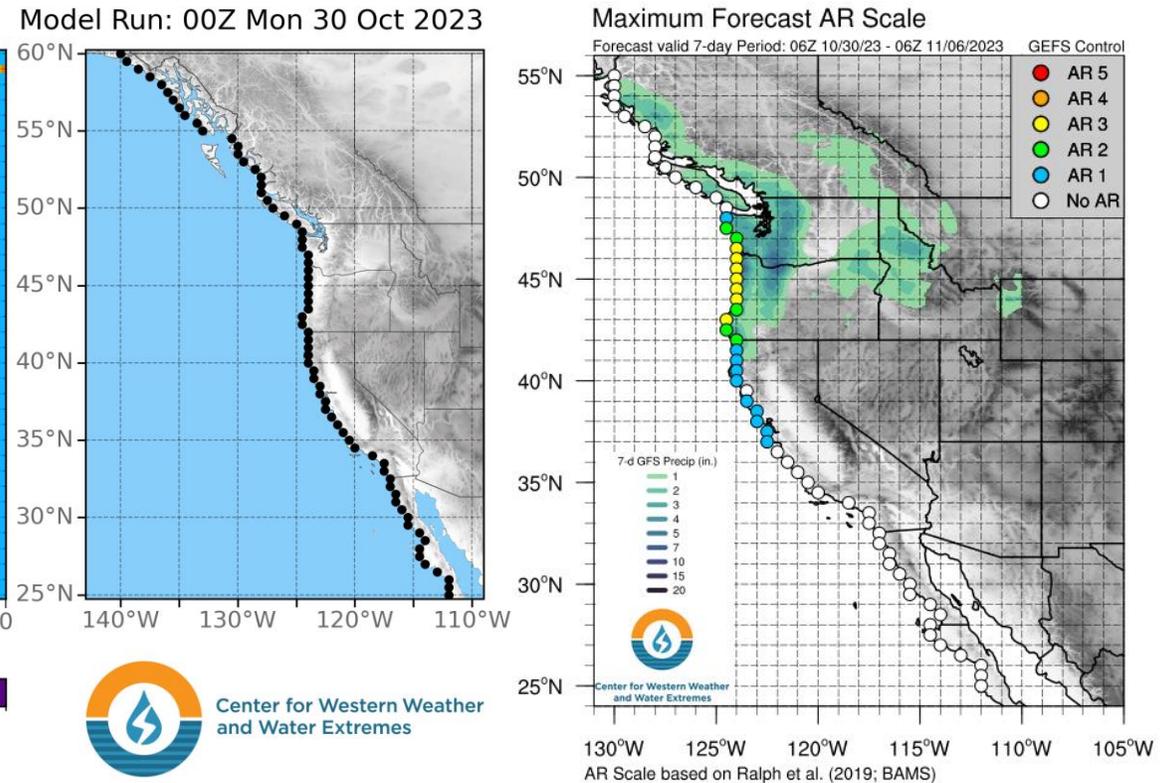
- ECMWF also shows multiple ARs making landfall this week along the US West Coast, however there are disagreements between the two models right now on the timing and strength of the ARs
- ECMWF deterministic shows the 1<sup>st</sup> AR making landfall late Wed 1 Nov much like the GFS, however the ECMWF shows strong AR conditions (IVT magnitudes  $> 800 \text{ kg m}^{-1} \text{ s}^{-1}$ ) in the core of the AR as it makes landfall in the PNW (Fig A)
- The 2<sup>nd</sup> AR is forecast to make an earlier landfall in the ECMWF, with strong AR conditions (IVT magnitudes  $> 750 \text{ kg m}^{-1} \text{ s}^{-1}$ ) making landfall in Oregon and Northern California late Fri 3 Nov (Fig B)
- The 3<sup>rd</sup> AR in the ECMWF is not forecast to impact as much of the North American west coast, but the IVT magnitudes in the core of the AR are similar in both models (Fig C)

## Probability of AR Conditions Along Coast (GEFS)



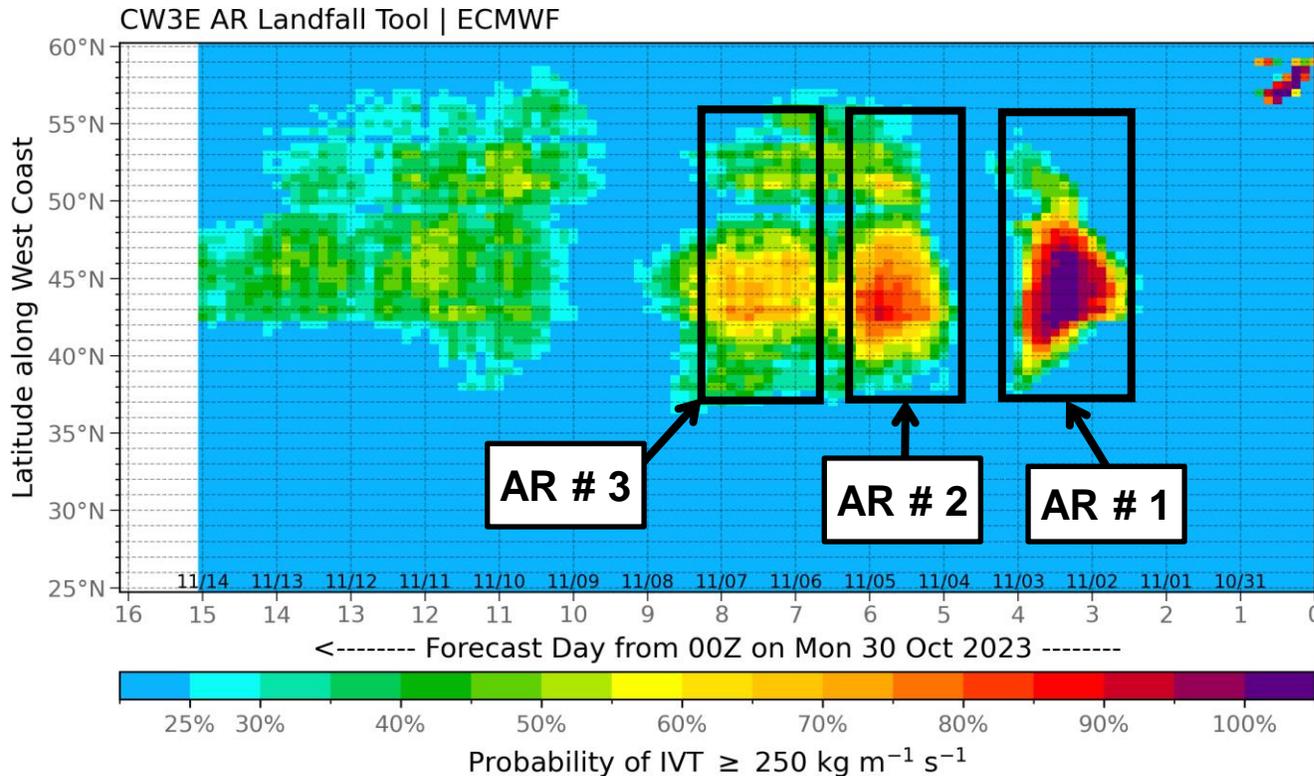
Forecasts support FIRO/CA-AR Program and NSF #2052972 | Intended for research purposes only

## AR Scale(GEFS)



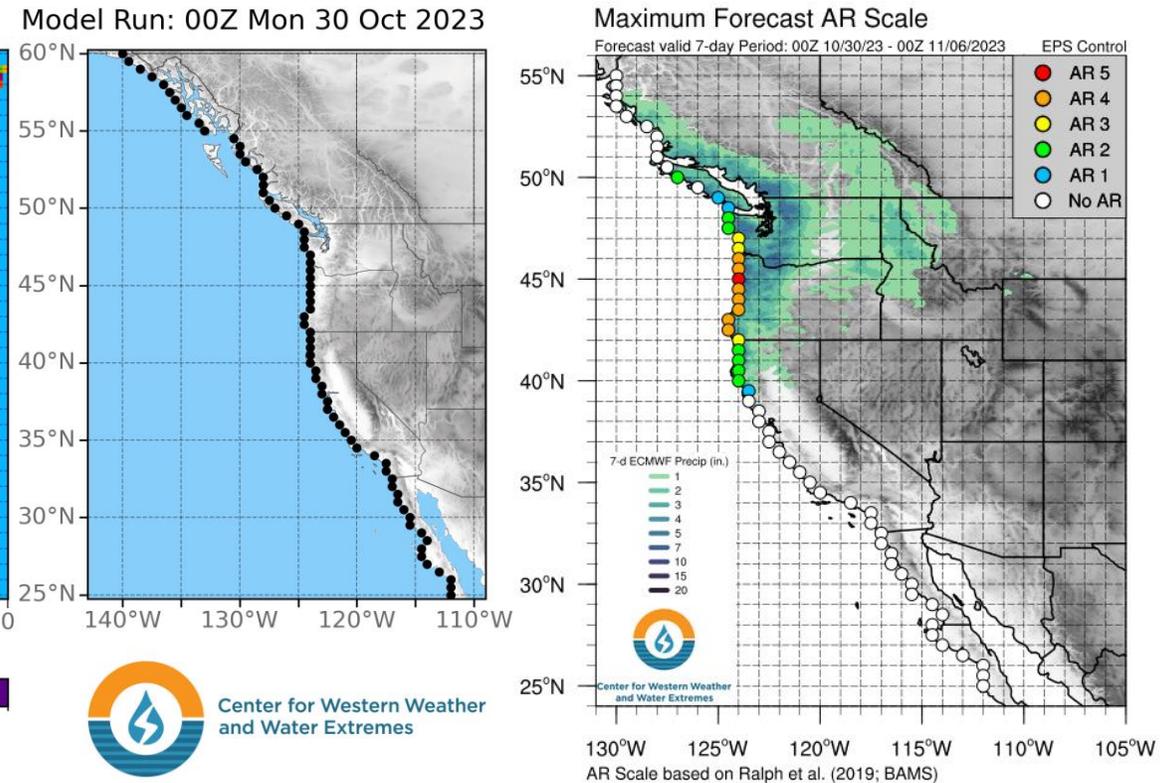
- The 00Z GEFS is showing very high confidence (> 95% probability) in a period of AR conditions ( $IVT > 250 \text{ m}^{-1} \text{ s}^{-1}$ ) over coastal Oregon with the first AR and less confidence (~60-90% probability) in Washington and Northern California
- Confidence levels are lower (60-70%) for an extended period of AR conditions after the first AR.

## Probability of AR Conditions Along Coast (ECMWF)



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## AR Scale (ECMWF)



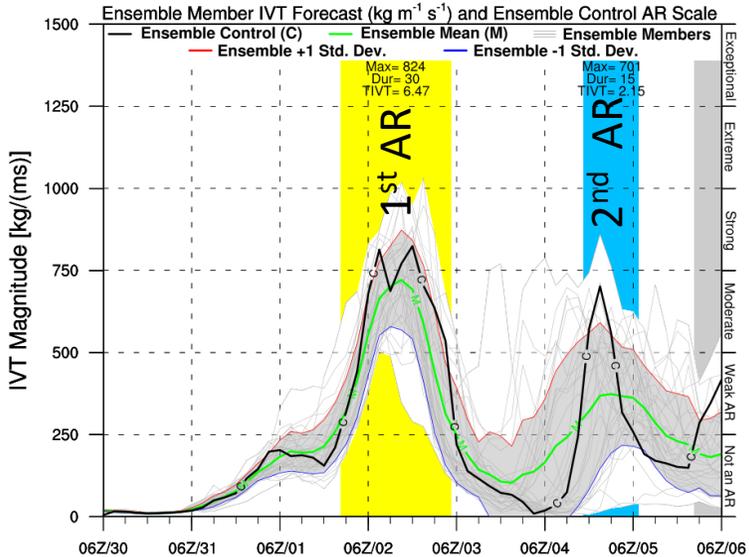
- The 00Z EPS shows greater confidence in three separate ARs along the Pacific Northwest and Northern California this week
- The 00Z EPS is showing very high confidence ( $> 95\%$  probability) in a period of AR conditions ( $IVT > 250 \text{ m}^{-1} \text{ s}^{-1}$ ) over coastal Oregon with the first AR, with a noticeable gap in AR conditions between the 1st and 2nd ARs, as compared to the GEFS
- The 2<sup>nd</sup> and 3<sup>rd</sup> ARs are much more distinct in the EPS and probabilities of AR conditions ( $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) are higher for both AR in the EPS, signifying tighter agreement on timing

# CW3E AR Outlook: 30 October 2023

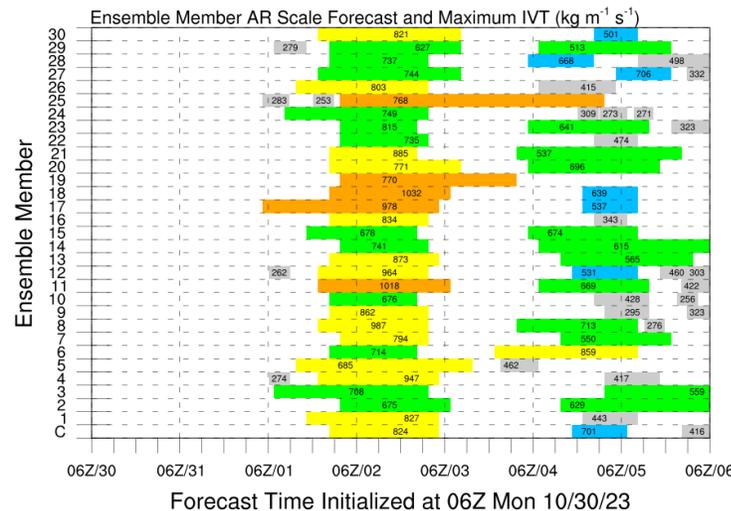
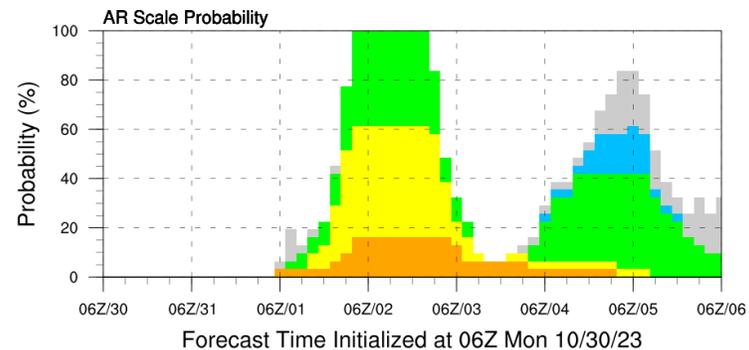
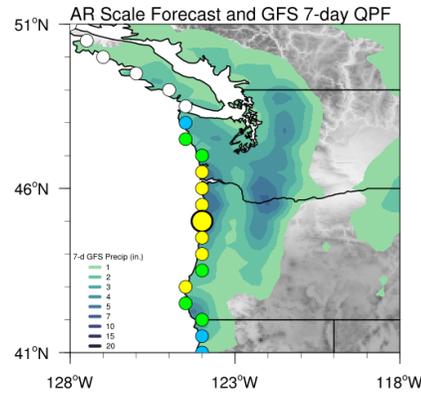
## GEFS 7-day AR Scale and IVT Forecast

GFS Ensemble Initialized: 06Z Mon 10/30/23

Location: 45°N 124°W



Categorical AR Strength by Ralph/CW3E



- For the first AR period, 31/31 (100%) GEFS ensemble members are forecasting at least AR2 conditions at 44.5° N, 124.0° W (costal OR)
- There is greater uncertainty in the 2<sup>nd</sup> and 3<sup>rd</sup> ARs, in both strength and duration
- 21/31 (67%) of the members (including the control) are forecasting at least AR1 conditions for the period around 5 Nov
- Many of the members do not currently show conditions great enough to register on AR Scale for the period on 6 Nov with the potential 3<sup>rd</sup> AR



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

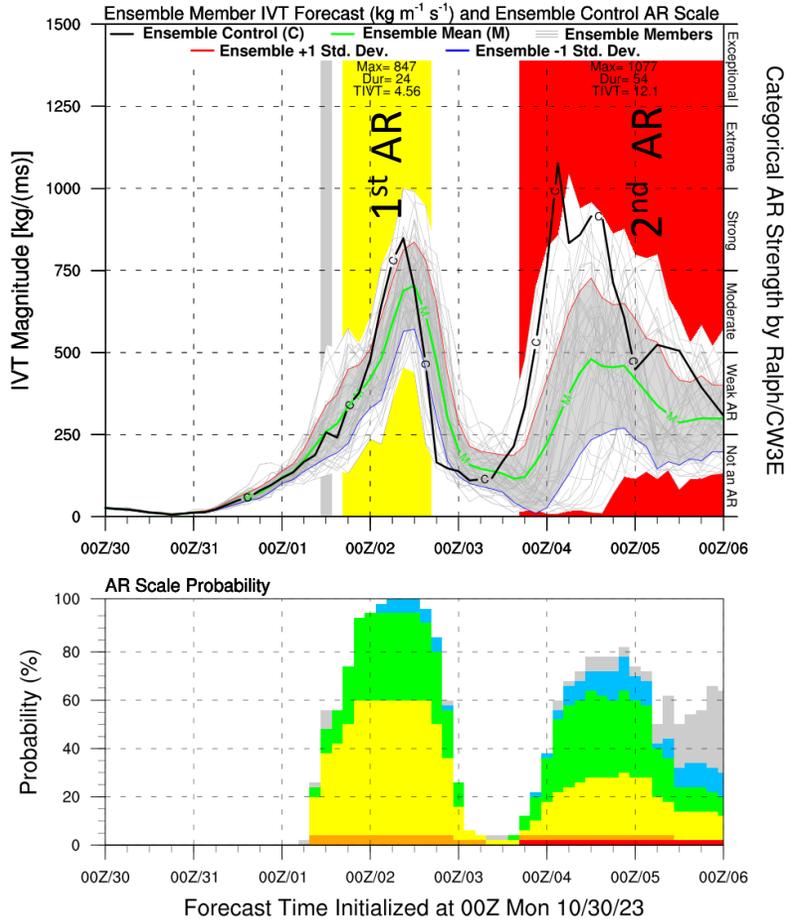
Image created: 11 UTC 10/30/2023

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

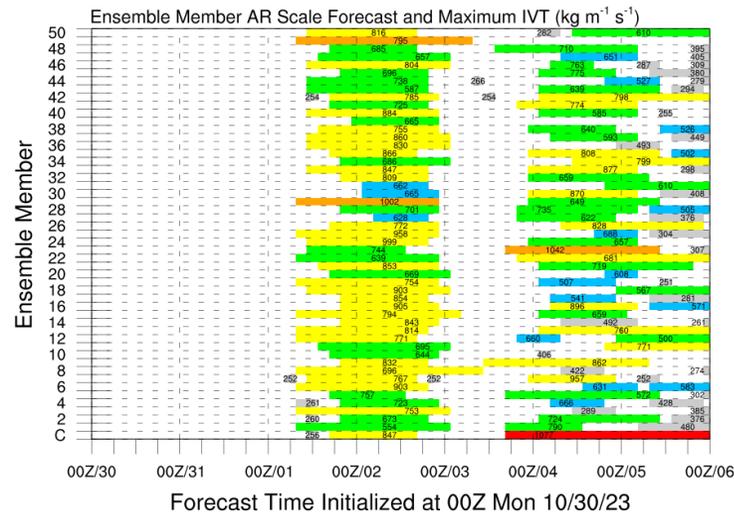
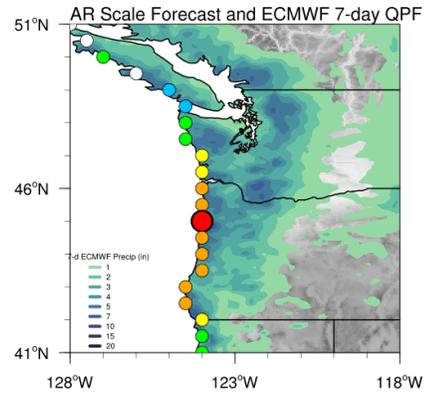
# CW3E AR Outlook: 30 October 2023

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

ECMWF Ensemble Initialized: 00Z Mon 10/30/23



Location: 45°N 124°W



- For the same location, the EPS shows similar conditions for the 1<sup>st</sup> AR
- For the first AR period, 48/51 (94%) EPS ensemble members are forecasting at least AR2 conditions
- The EPS shows greater confidence in at least AR2 conditions beginning 5 Nov and continuing through 6 Nov with the 2<sup>nd</sup> and 3<sup>rd</sup> ARs
- For the second and third AR period, 34/51 (67%) of EPS Ensemble members forecasting at least AR2 conditions.
- The individual ensemble members show substantial disagreement in the timing and magnitude of peak IVT, as well as the duration of AR conditions
- This is shown in the control member that has forecast AR5 conditions for this location based on the peak IVT of 1077  $\text{kg m}^{-1} \text{s}^{-1}$  and event duration of at least 48 hours, stronger than any other members



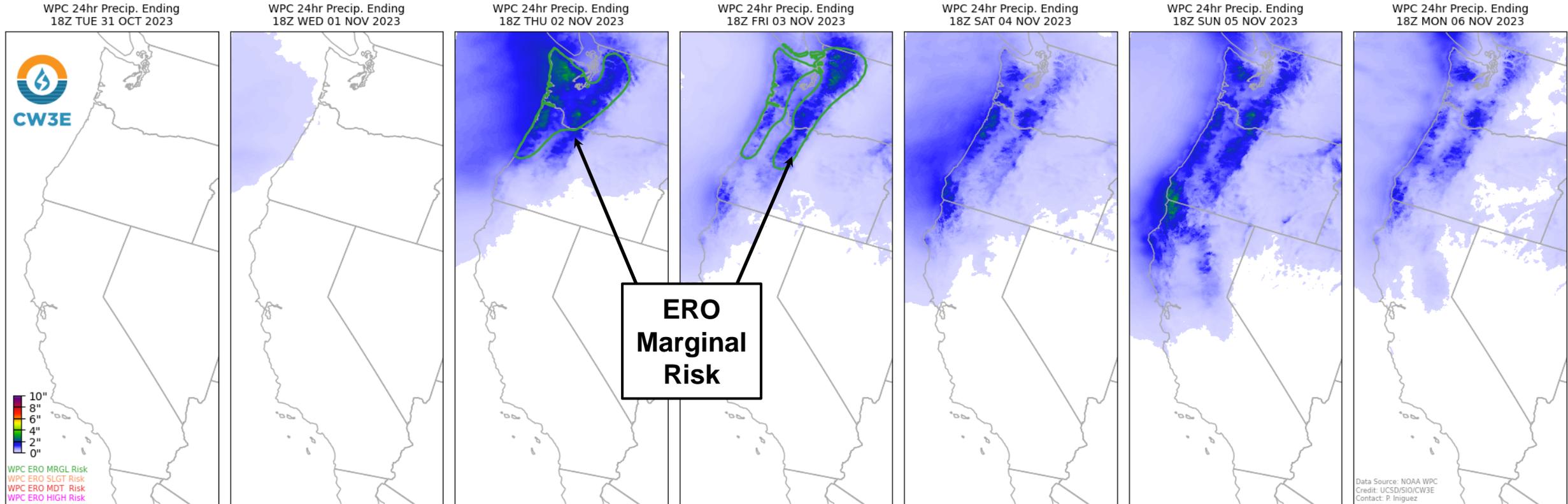
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AR 1 AR 2 AR 3 AR 4 AR 5

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

# CW3E AR Outlook: 30 October 2023

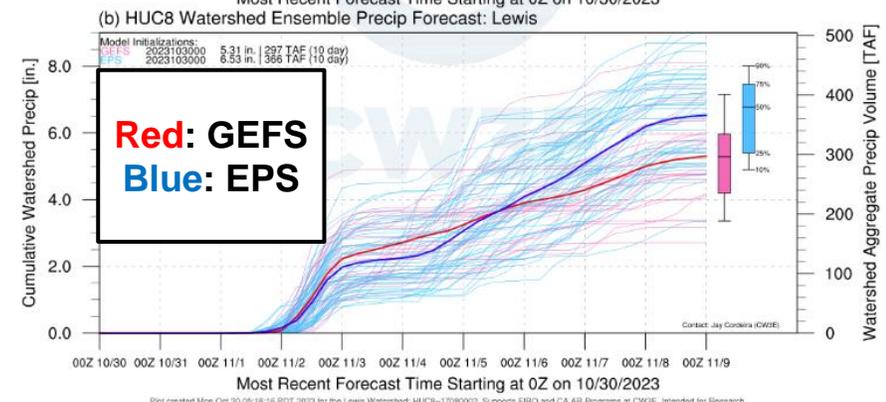
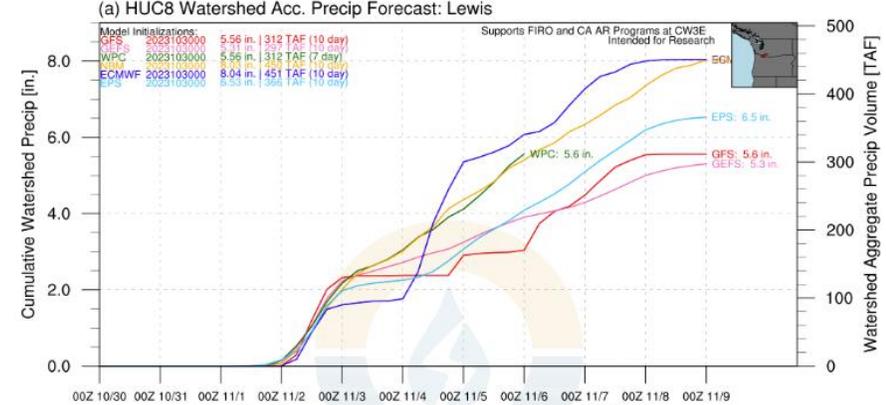
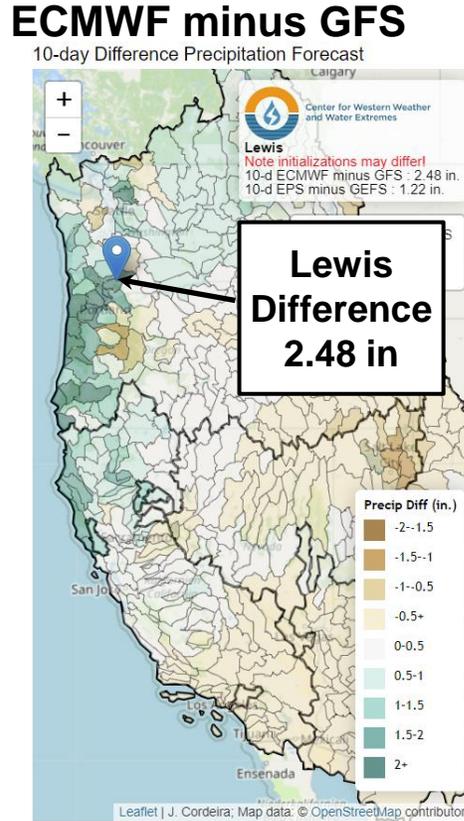
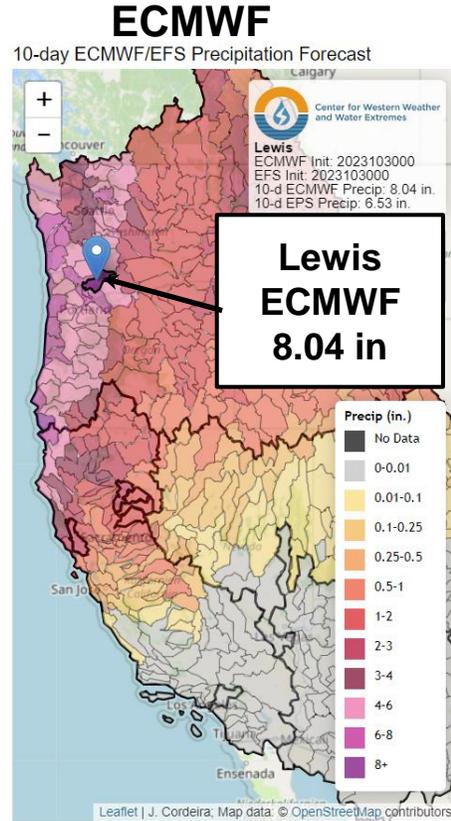
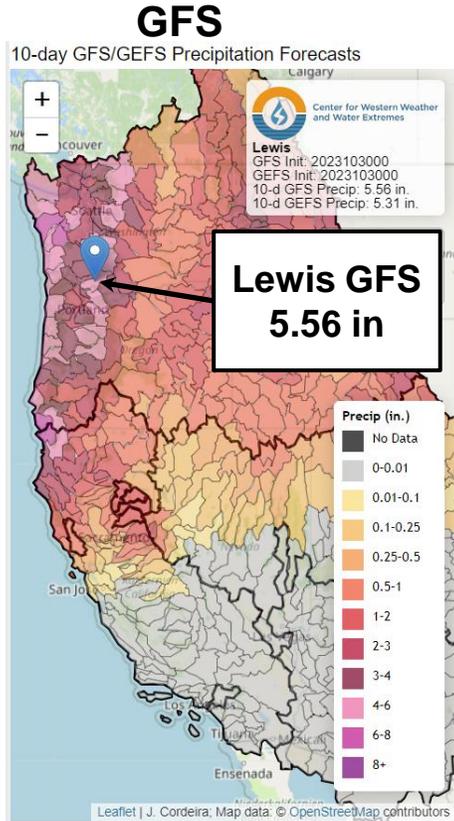
## WPC Days 1-7 Quantitative Precipitation Forecasts



- The NWS WPC is currently forecasting precipitation totals of 2-5 inches along the Washington-Oregon border, Olympic Peninsula and Cascade Range on Thursday through Friday (18Z 1-3 Nov) during the duration of the 1<sup>st</sup> AR
- Excessive Rainfall Outlooks from the WPC show marginal risk of flooding for the regions receiving the most precipitation with the 1<sup>st</sup> AR
- Precipitation totals >1.5 inches are also forecast across the Washington to Northern California coasts and Cascade Ranges during the duration of the 2<sup>nd</sup> AR, where the highest forecast precipitation totals are seen along the Oregon-California Border

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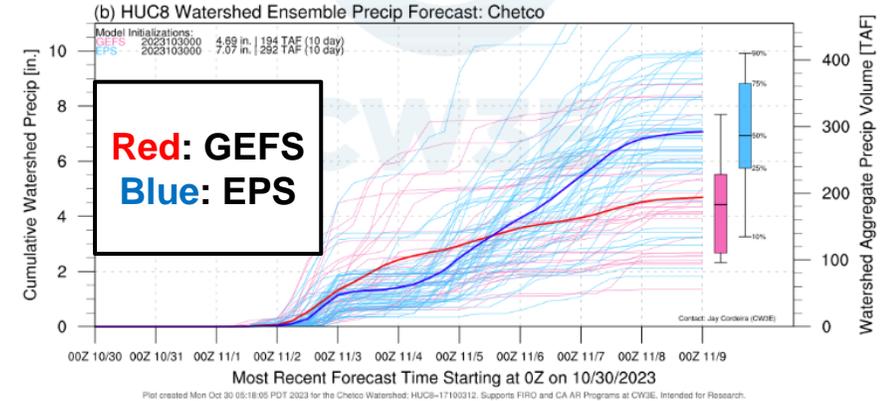
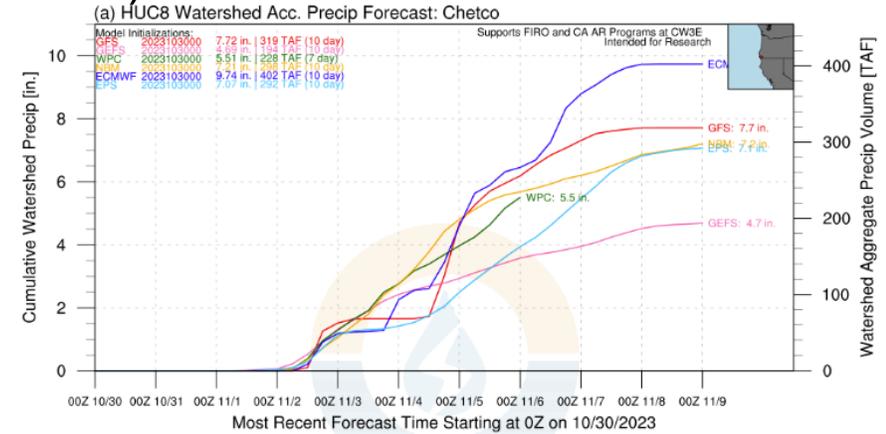
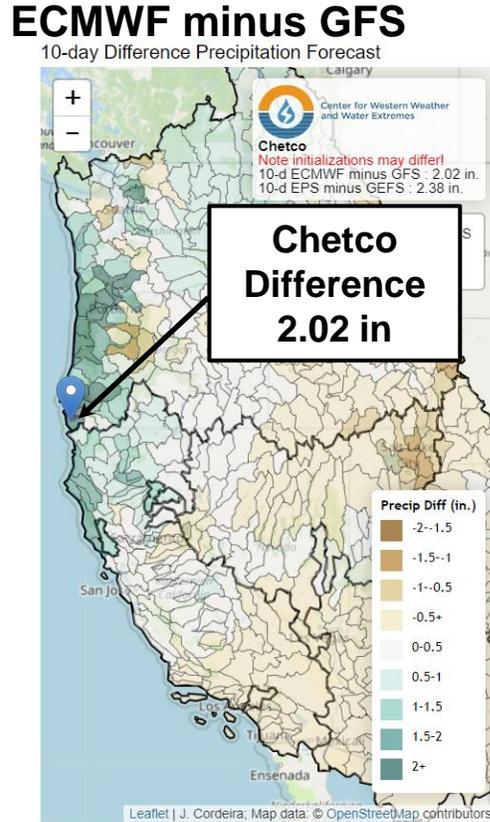
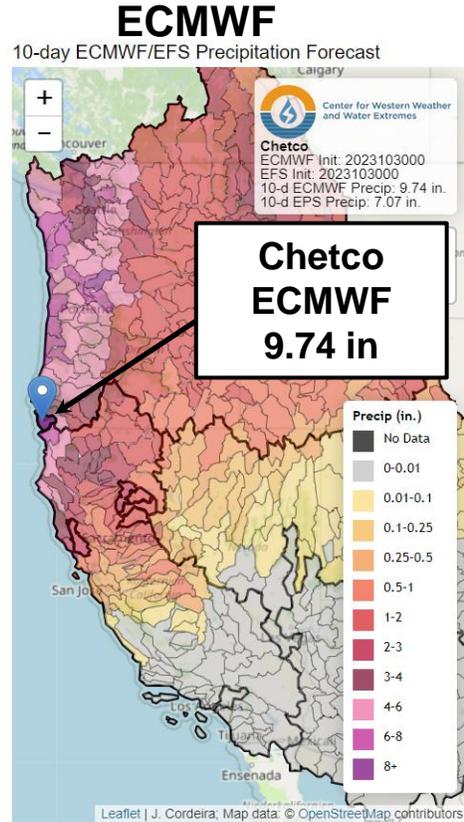
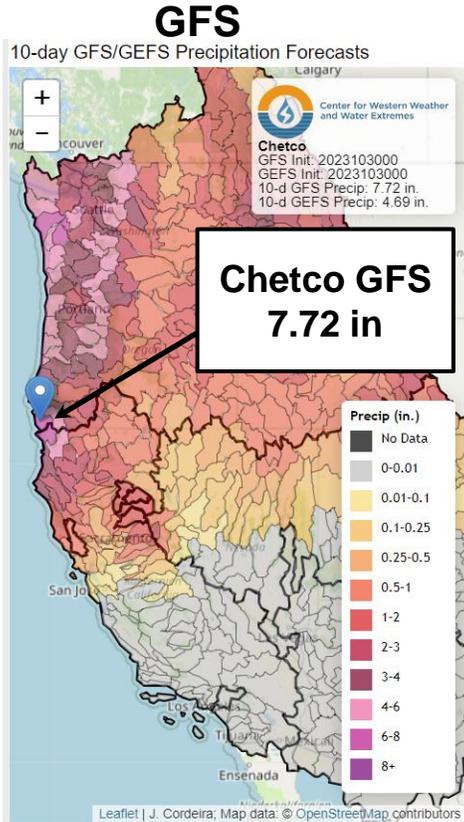
## 10-day Watershed Precipitation Forecasts (Initialized 5 PM PT 29 Oct)



- The 00Z EPS is forecasting higher 10-day watershed precipitation totals along much of the USWC and in the Cascade Range as compared to the 00Z GEFS, likely due to the forecast of stronger IVT values
- The 00Z ECMWF is forecasting 8.04 inches of mean areal precipitation in the Lewis watershed along the Oregon-Washington border over the next 10 days, while the 00Z GFS is forecasting 5.56 inches over the same watershed
- The GEFS and EPS forecasts show significant uncertainty in the 10-day precipitation forecast for the Lewis, with 10-day precipitation totals ranging from ~3 inches to > 9 inches

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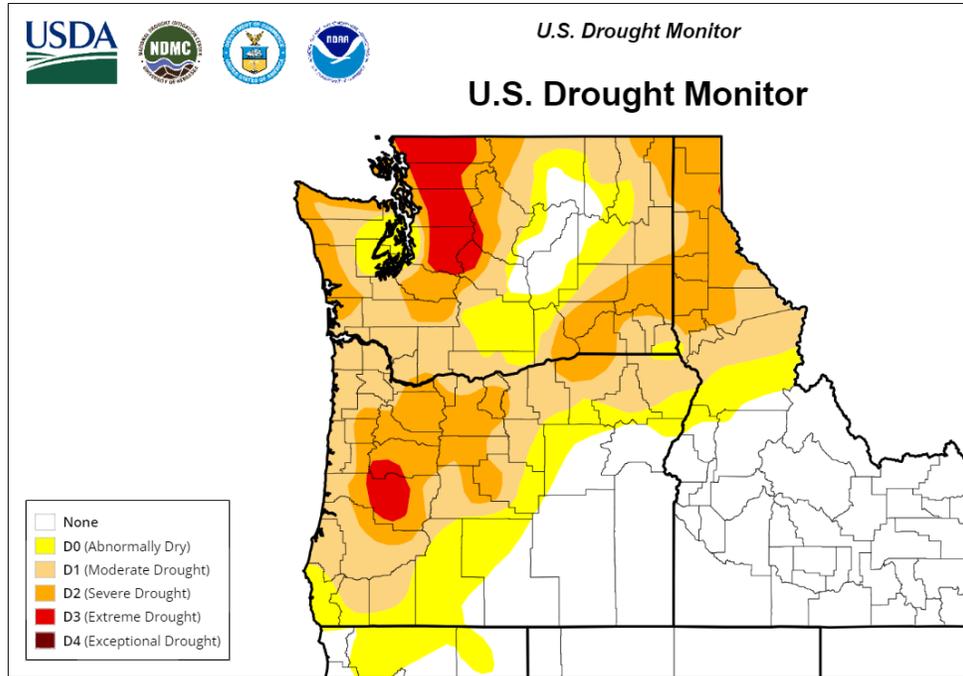
## 10-day Watershed Precipitation Forecasts (Initialized 5 PM PT 29 Oct)



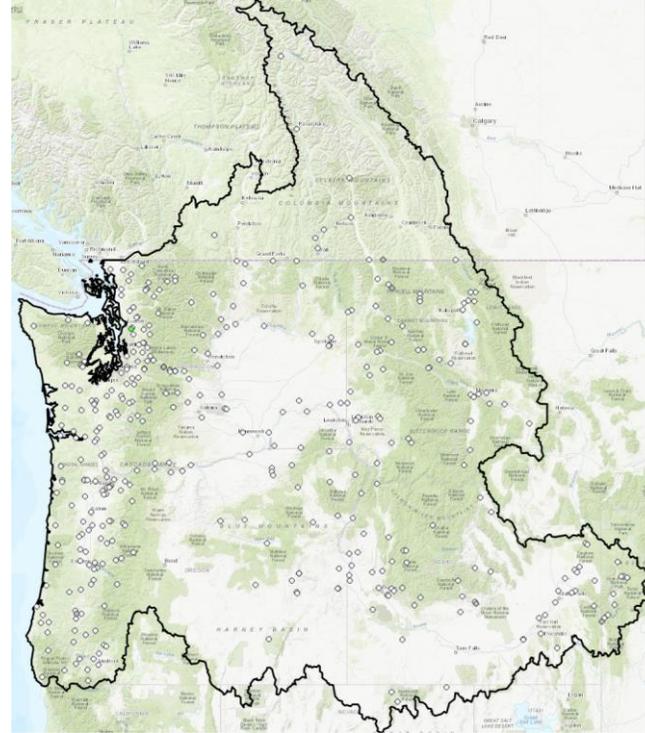
- Similarly, in the coastal Chetco watershed along the Oregon-California border, the ECMWF is forecasting 9.74 inches of mean area precipitation over the next 10-day compared to 7.72 inches in the GFS
- The GEFS and EPS forecasts show significant uncertainty here as well, with 10-day precipitation totals ranging from ~2 inches to > 10 inches
- The large amount of ensemble spread in the precipitation forecasts reflects the uncertainty in forecast storm track and AR activity this weekend into early next week

# CW3E AR Outlook: 30 October 2023

## NWS River Stage Forecasts and Drought Monitor



### NWS NWRFC



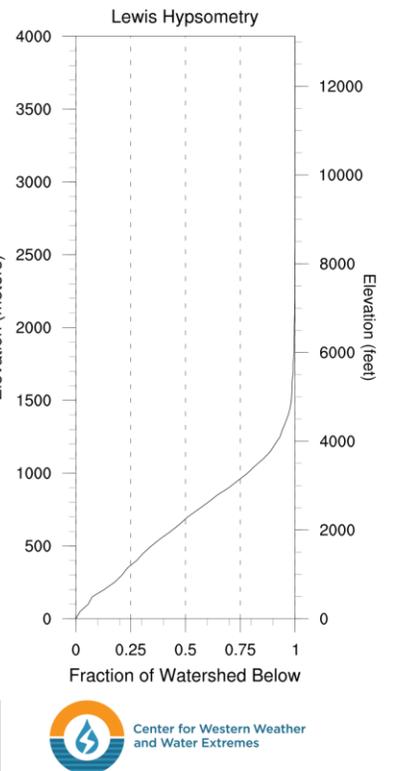
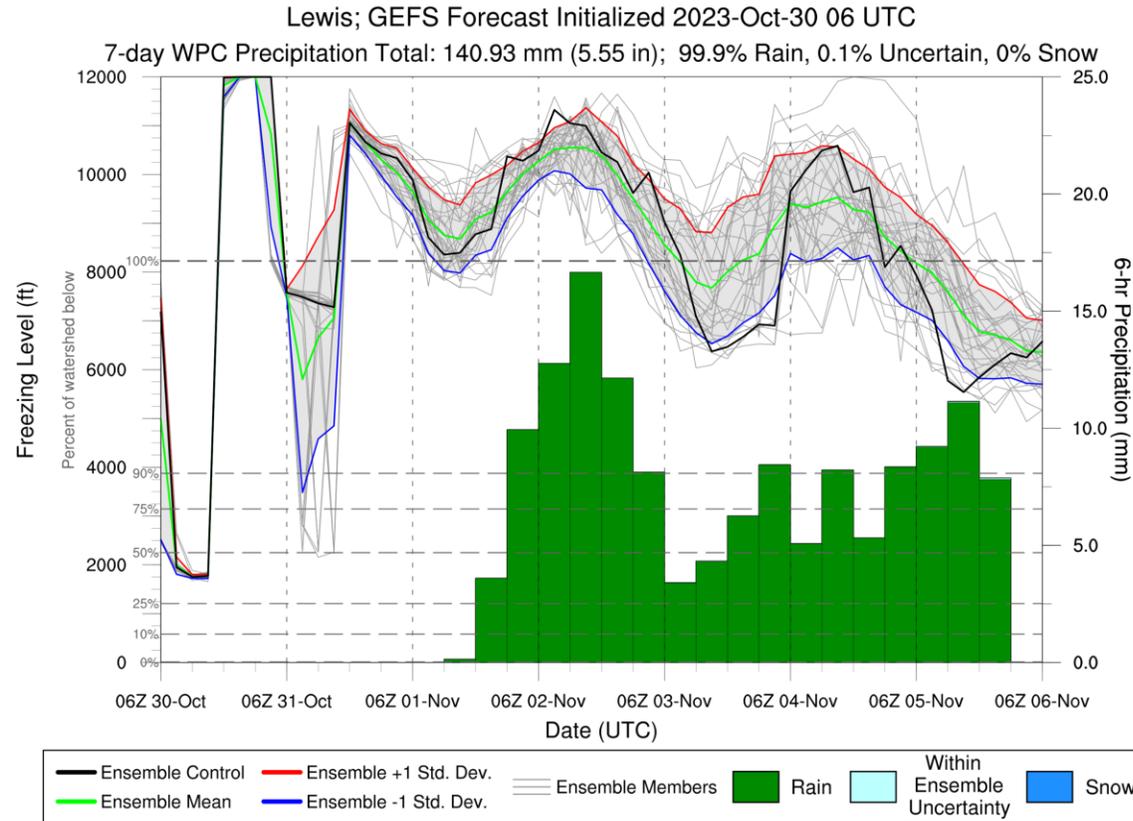
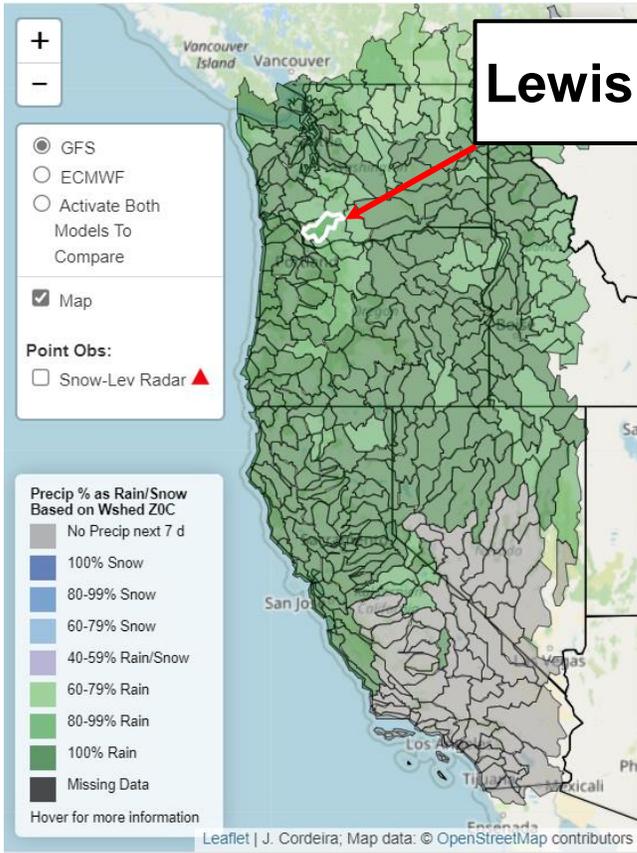
### NWS CNRFC



- Drought conditions exist across much of the Pacific Northwest, with a broad region of Extreme Drought along the windward (west) side of the Cascades and Coast Ranges of Washington and Oregon
- River levels across the Pacific Northwest are forecast to rise as a result of the precipitation associated with this 1<sup>st</sup> AR, but all stations within the NWS NWRFC are forecast to remain below the monitor or action stage

# CW3E AR Outlook: 30 October 2023

## NWS River Stage Forecasts and Drought Monitor



- These storms are forecast to be warm, and as a result most of the precipitation is expected to fall as rain
- Freezing levels in southern Washington are forecast to remain above 6,000 feet during the next 7 days