

# CW3E Atmospheric River Outlook: 13 October 2023

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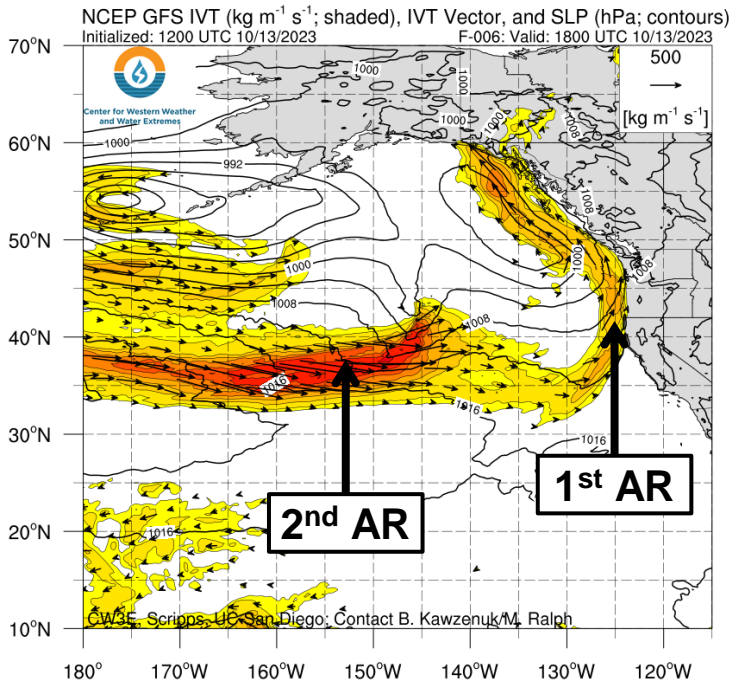
## Multiple Atmospheric Rivers Forecast to Impact Pacific Northwest Through the Weekend

- A series of atmospheric rivers (ARs) are forecast to make landfall over the Pacific Northwest during the next few days
- The first and second ARs are forecast to bring weak AR conditions ( $IVT < 500 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to coastal Washington, Oregon, and Northern California today and Saturday
- The third and strongest AR is forecast to make landfall Sunday into Monday
- An AR4/AR5 is possible in coastal OR due to IVT magnitudes potentially exceeding  $1000 \text{ kg m}^{-1} \text{ s}^{-1}$  and AR conditions potentially lasting more than 48 consecutive hours between the second and third ARs
- There is still considerable forecast uncertainty in the intensity of the third landfalling AR
- The ECMWF Ensemble Prediction System (EPS) continues to forecast higher IVT magnitudes in coastal OR and WA compared to the NCEP Global Ensemble Forecast System (GEFS)
- The NWS Weather Prediction Center (WPC) is forecasting at 2–5 inches of precipitation in the Olympic Mountains and North Cascades during the next 5 days
- Models are still showing some disagreement in forecast precipitation, with the ECMWF/EPS models predicting higher precipitation amounts in the Olympic Peninsula compared to the GFS/GEFS models
- Despite the high likelihood of strong AR conditions ( $IVT > 750 \text{ kg m}^{-1} \text{ s}^{-1}$ ) during the third AR, the south-southwesterly orientation of moisture transport will be unfavorable for orographic enhancement of precipitation in most areas, and significant hydrologic impacts are not anticipated

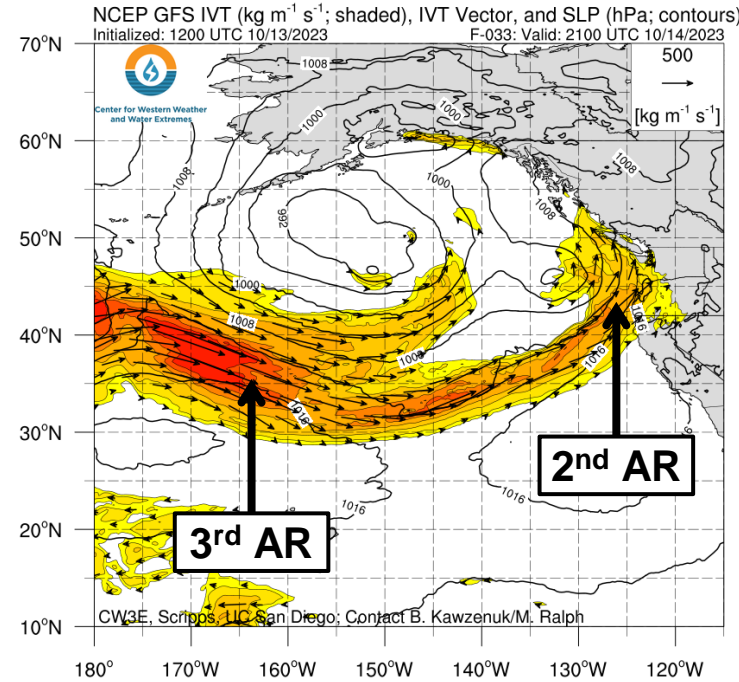
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## GFS IVT and SLP Forecasts

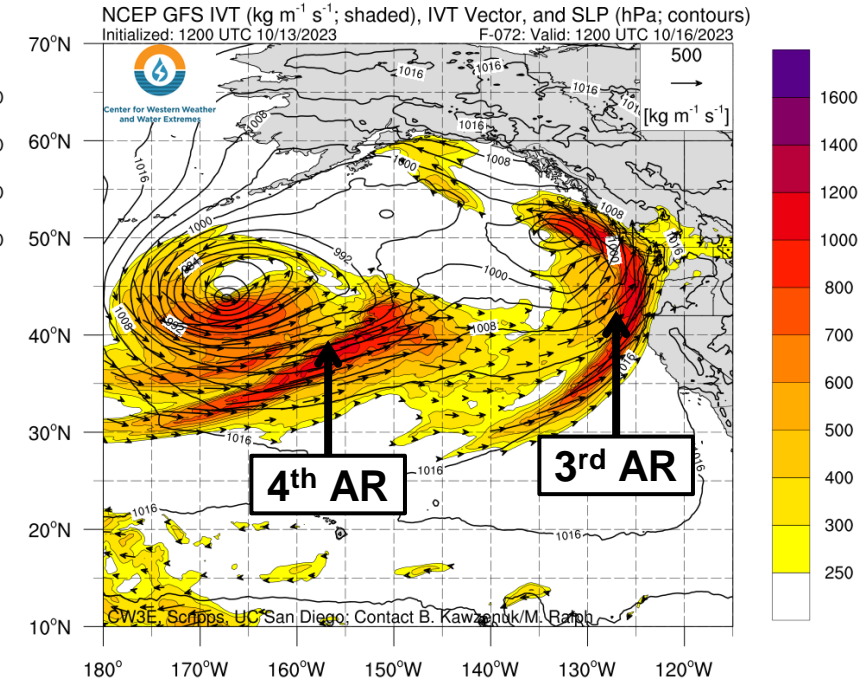
A) Valid 11 AM PT 13 Oct (F-6)



B) Valid 2 PM PT 14 Oct (F-33)



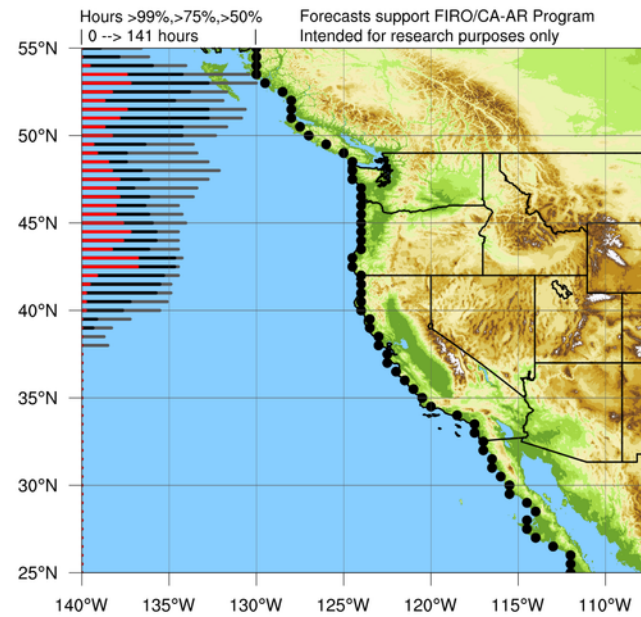
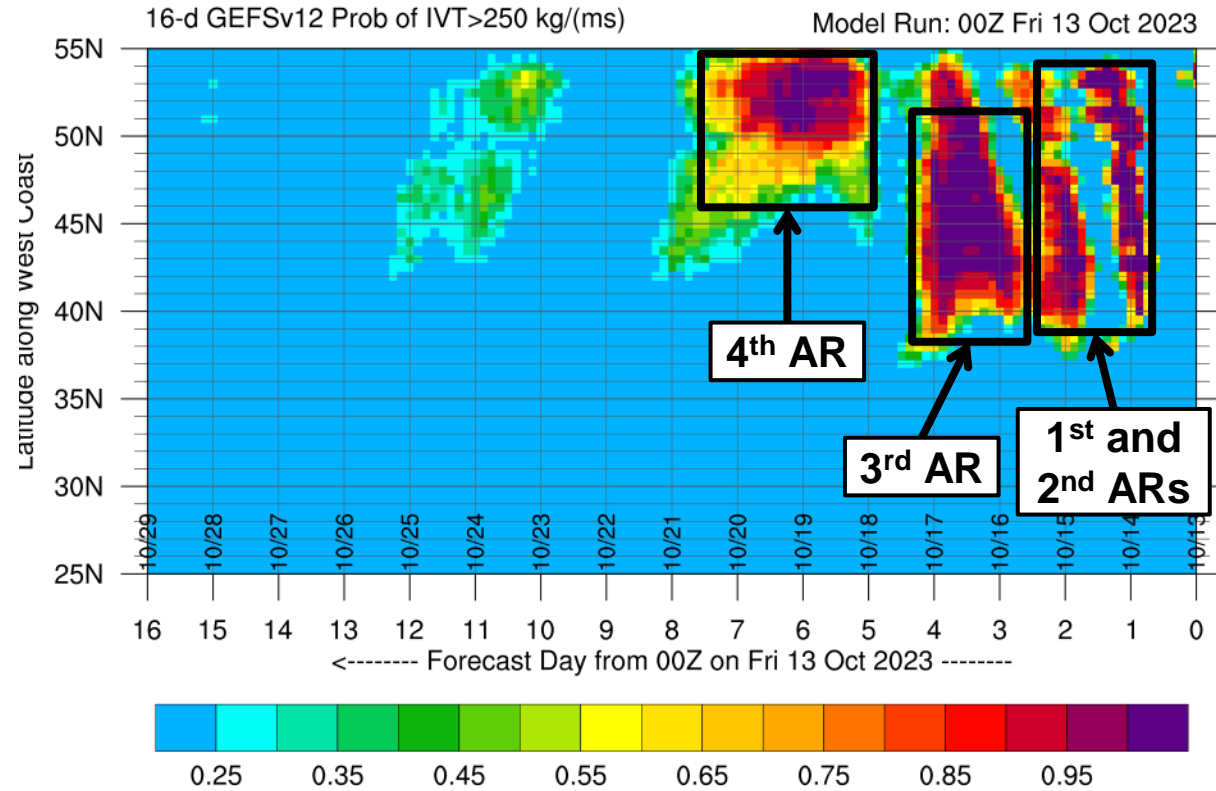
C) Valid 5 AM PT 16 Oct (F-72)



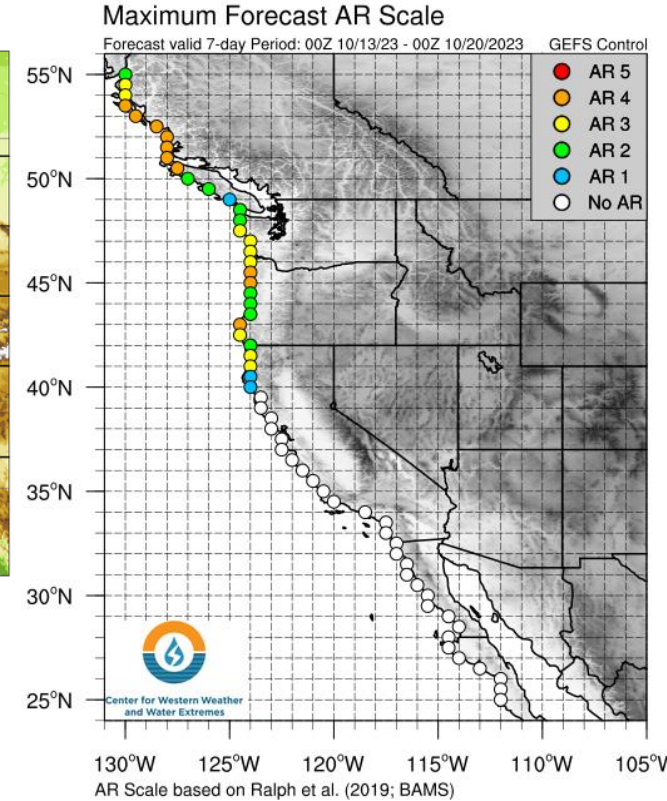
- A family of ARs is forecast to track across the Northeast Pacific and make landfall along the U.S. West Coast during the next few days
- The 1<sup>st</sup> and 2<sup>nd</sup> ARs are forecast to bring weak AR conditions ( $IVT < 500 \text{ kg m}^{-1} \text{ s}^{-1}$ ) to coastal WA, OR, and far Northern CA today and Saturday (Figures A and B)
- The 3<sup>rd</sup> and strongest AR is forecast to make landfall Sunday and potentially bring IVT magnitudes  $> 1000 \text{ kg m}^{-1} \text{ s}^{-1}$  to coastal OR (Figure C)
- Another strong AR (4<sup>th</sup> AR) is forecast to eventually make landfall over British Columbia on 17 Oct (Figure C)

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## GEFS Probability of AR Conditions Along Coast



## GEFS AR Scale



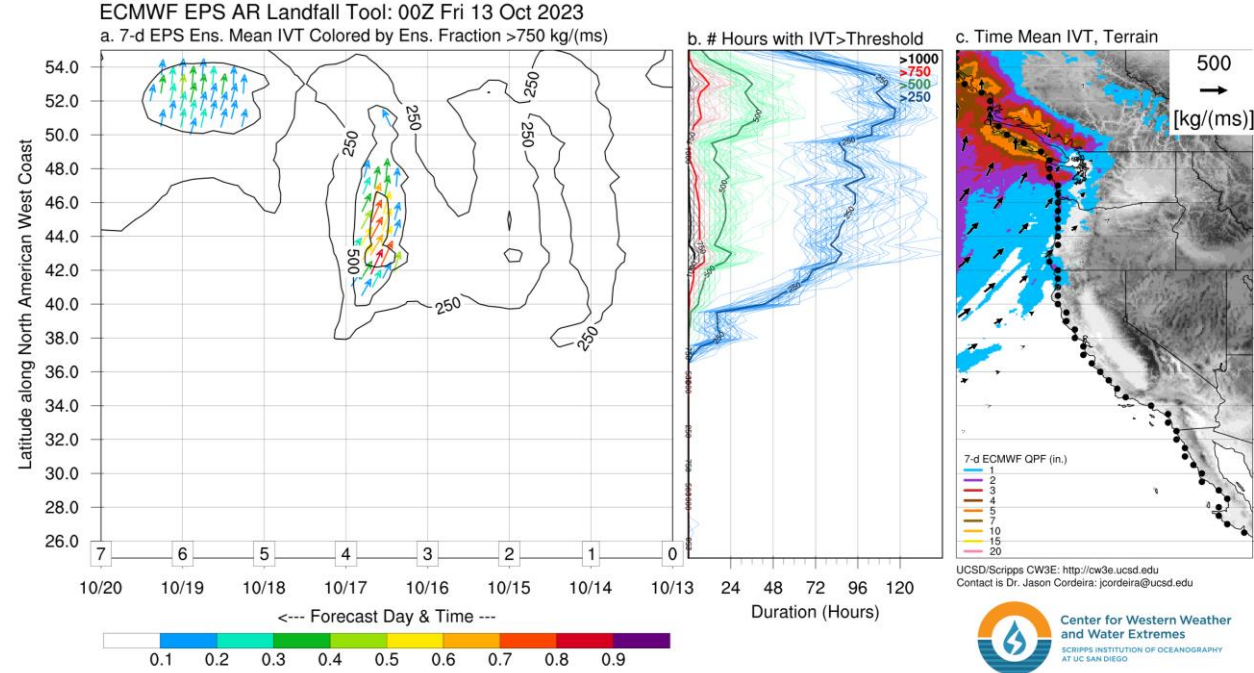
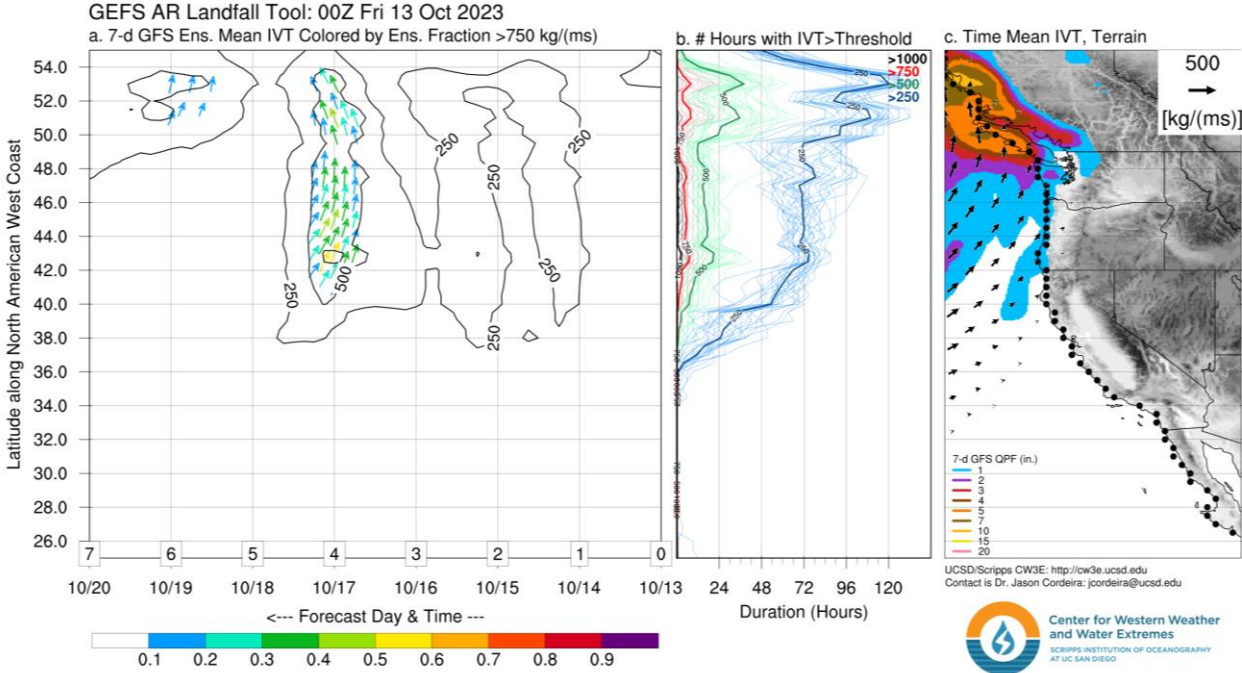
- The 00Z GEFS is showing a very high likelihood (> 90% probability) of AR conditions ( $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) over coastal WA, OR, and far Northern CA in association with the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> ARs
- The 3<sup>rd</sup> AR is forecast to bring AR2 to AR4 conditions to coastal WA, OR, and far Northern CA
- GEFS is also showing a high likelihood (> 70% probability) of a longer-duration AR over coastal British Columbia during 17–20 Oct, with a moderate likelihood (50–70% probability) of AR conditions extending southward into WA
- The GEFS control member is currently forecasting AR4 conditions over portions of coastal BC in association with the 4<sup>th</sup> AR

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## Probability of Strong AR Conditions, Ensemble Mean IVT & Vectors, and 7-day QPF

### GEFS

### EPS



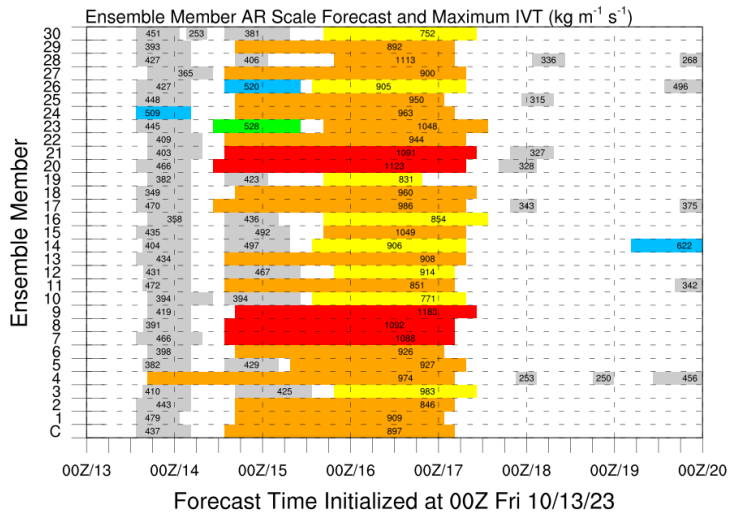
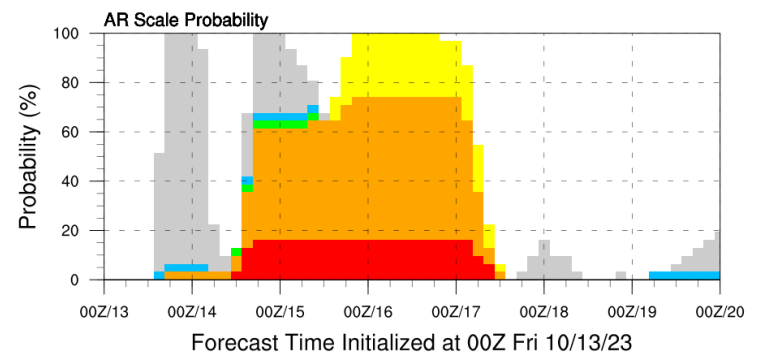
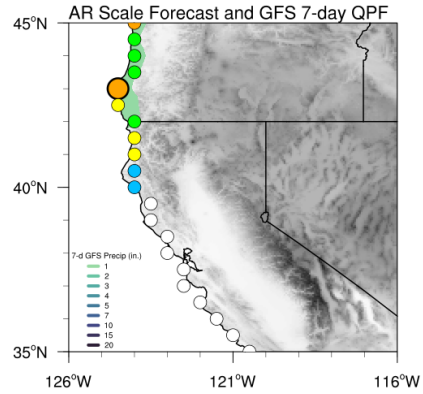
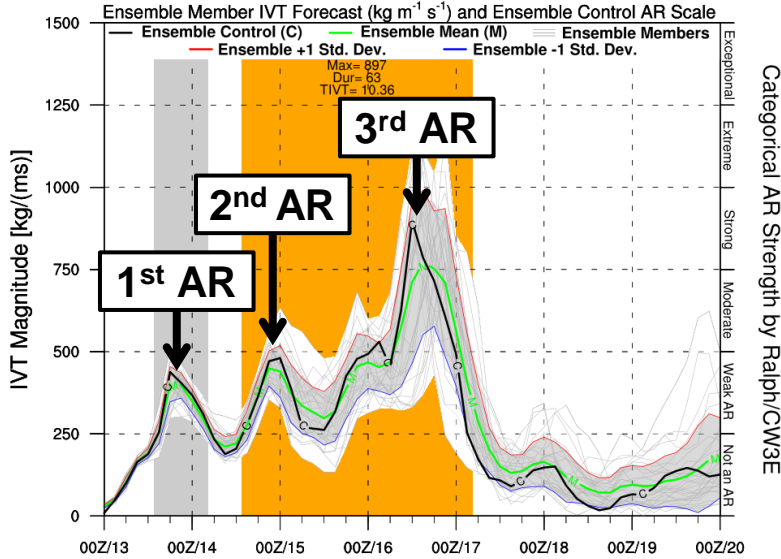
- While model forecasts of the 3<sup>rd</sup> AR have come into much better agreement over the past 48 hours, the ECMWF EPS is still forecasting higher IVT values and an earlier arrival (by 6–12 hours) of peak IVT over coastal OR compared to the NCEP GEFS
- Note that “lower” probabilities of strong AR conditions in GEFS are primarily due to greater uncertainty in the timing of peak IVT
- Despite the high likelihood of AR3 or greater conditions, precipitation amounts over the OR Coast Ranges will be limited due to IVT directions (south-southwesterly) that are unfavorable for orographic enhancement of precipitation

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## GEFS AR Scale and IVT Plume Forecasts

GFS Ensemble Initialized: 00Z Fri 10/13/23

Location: 43°N 124.5°W



- The 00Z GEFS control run is forecasting an AR4 at 43°N, 124.5°W (southern coastal OR), with no break in AR conditions between the 2<sup>nd</sup> and 3<sup>rd</sup> ARs
- 18/31 (58%) of ensemble members are forecasting an AR4 at this location, and 5/31 (16%) of ensemble members are forecasting AR5
- A majority of ensemble members are predicting > 48 hours of continuous AR conditions between the 2<sup>nd</sup> and 3<sup>rd</sup> ARs
- There is still considerable spread in the forecast maximum IVT during the 3<sup>rd</sup> AR, but all members are predicting a maximum IVT  $\geq 750 \text{ kg m}^{-1} \text{ s}^{-1}$



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

Image created: 05 UTC 10/13/2023

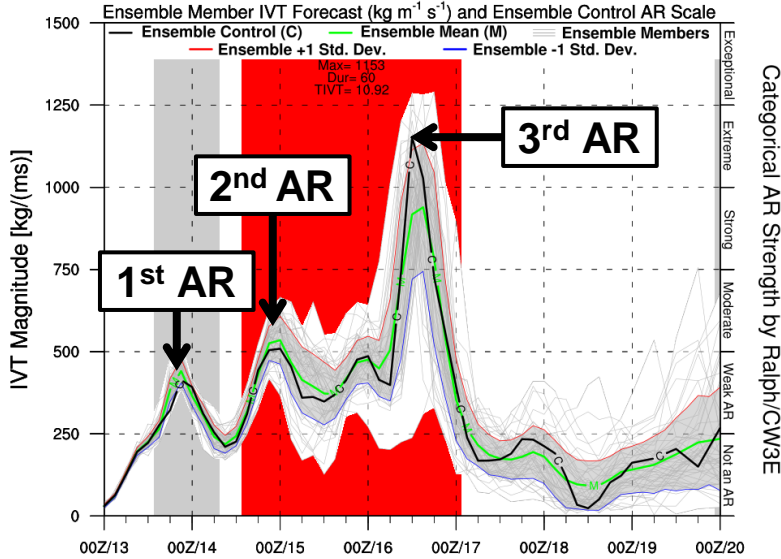
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

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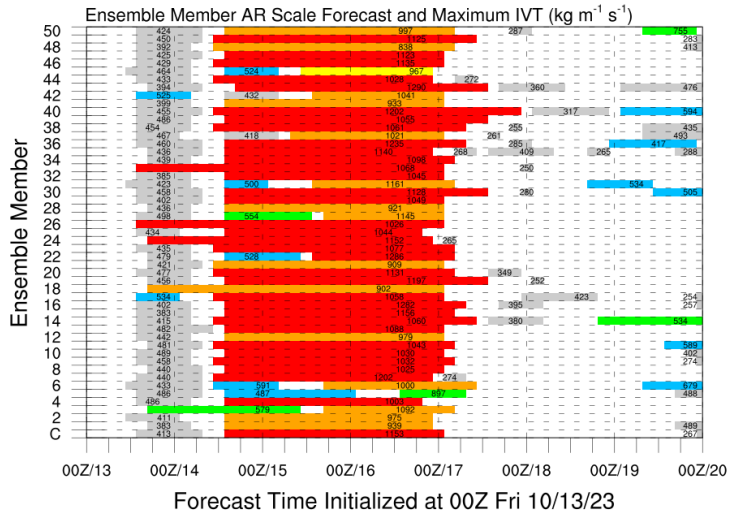
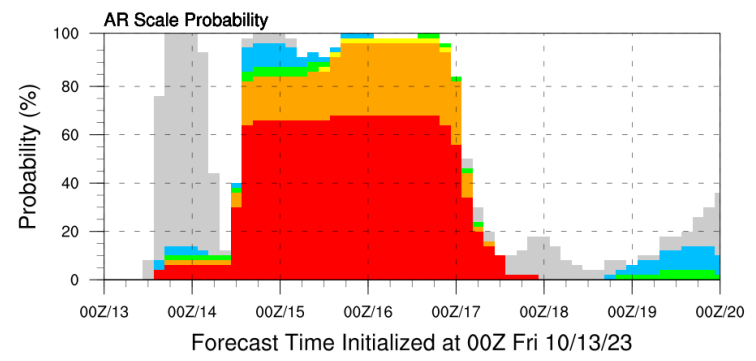
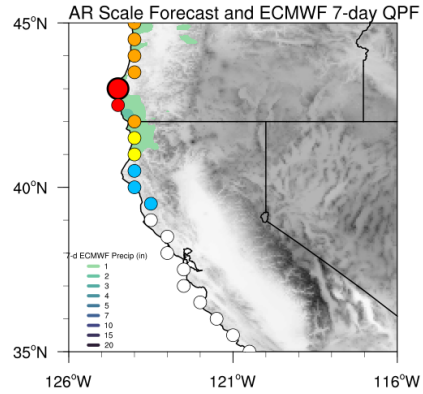
## EPS AR Scale and IVT Plume Forecasts

ECMWF Ensemble Initialized: 00Z Fri 10/13/23

Location: 43°N 124.5°W



Categorical AR Strength by Ralph/CW3E



- The 00Z EPS control run is forecasting an AR5 at 43°N, 124.5°W (southern coastal OR), with no break in AR conditions between the 2<sup>nd</sup> and 3<sup>rd</sup> ARs
- 15/51 (29%) ensemble members are forecasting an AR4 at this location, and 34/51 (67%) ensemble members are forecasting an AR5
- More than 80% of ensemble members are predicting > 48 hours of continuous AR conditions between the 2<sup>nd</sup> and 3<sup>rd</sup> ARs
- Similar to GEFS, there is considerable spread in the forecast maximum IVT during the 3<sup>rd</sup> AR, but nearly 80% of ensemble members are predicting a maximum IVT  $\geq 1000 \text{ kg m}^{-1} \text{ s}^{-1}$



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

Image created: 09 UTC 10/13/2023

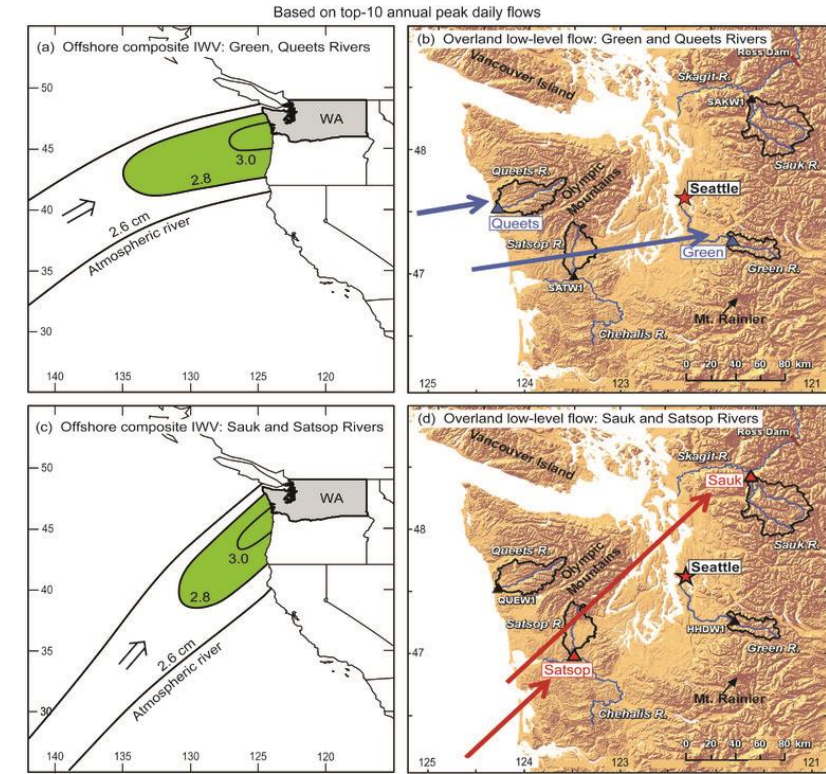
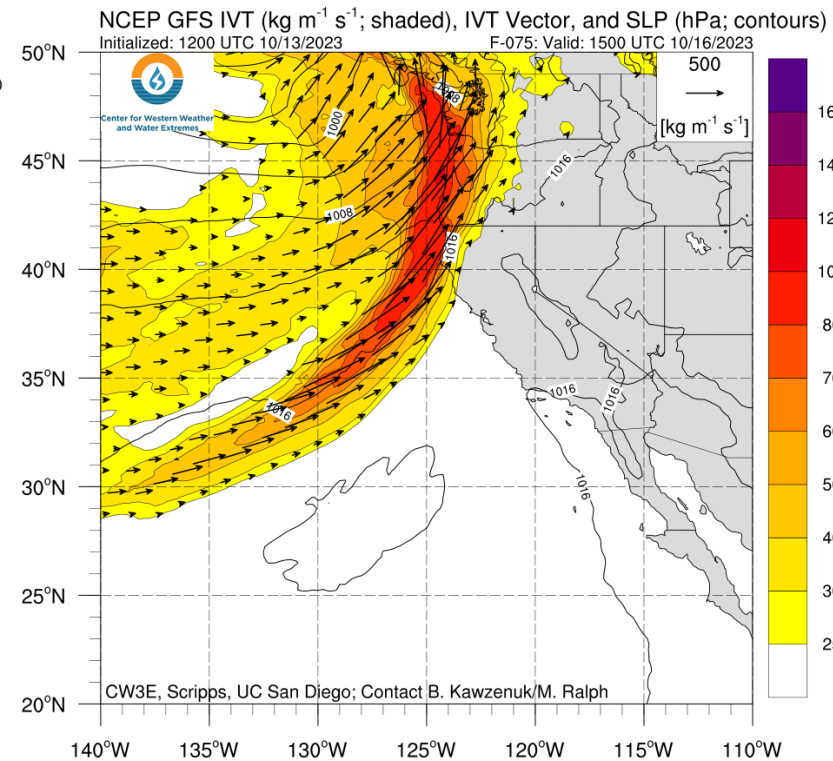
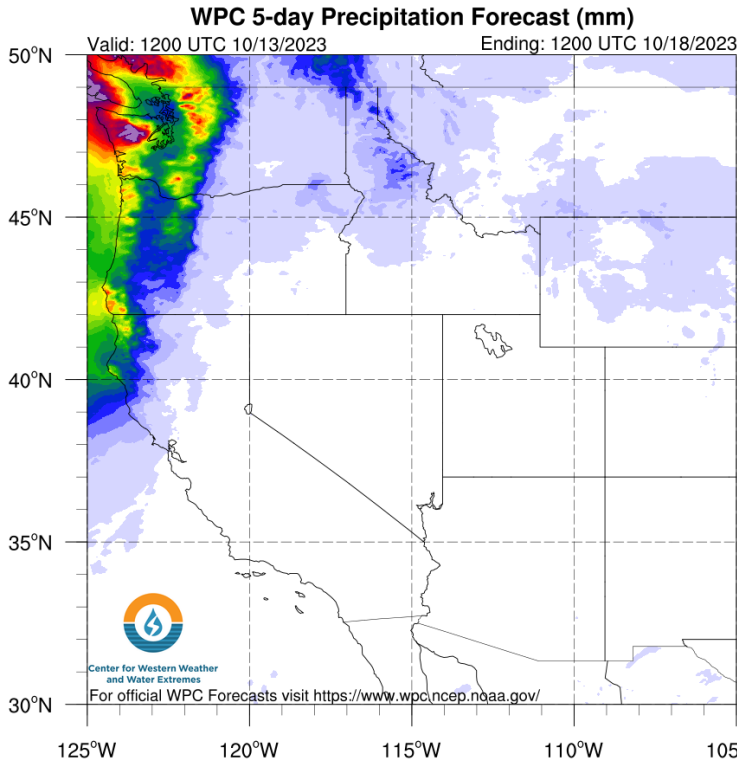
More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

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## GFS IVT and WPC Precipitation Forecasts

WPC 5-day QPF: Valid 5 AM PT 18 Oct

GFS IVT & SLP: Valid 8 AM PT 16 Oct



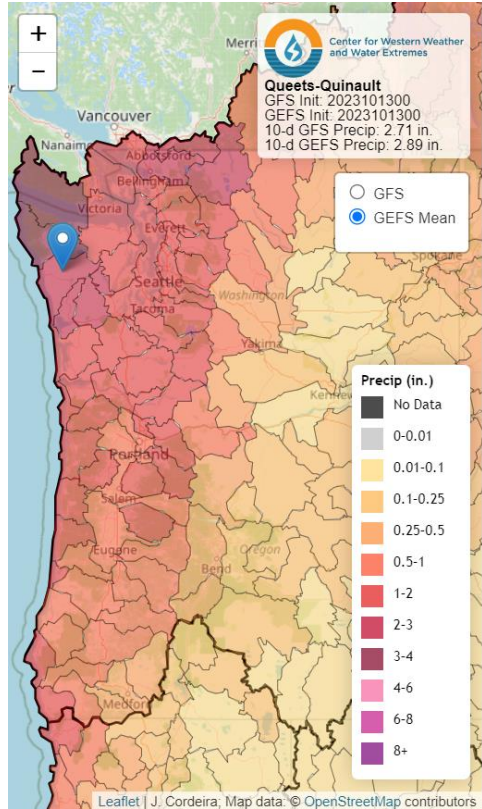
Source: Figure 15 from Neiman et al. (2011)

- The NWS Weather Prediction Center (WPC) is currently forecasting 2–5 inches of total precipitation in the Olympic Mountains and North Cascades during the next 5 days
- Despite the likelihood of strong AR conditions during the 3<sup>rd</sup> AR, lighter amounts (1–3 inches) are forecast in the OR Coast Ranges, where the south-southwesterly orientation of the IVT vectors will be generally unfavorable for orographic enhancement of precipitation
- Previous research also suggests that south-southwesterly moisture transport can lead to orographic enhancement over the Olympic Mountains and North Cascades, as well as rain shadowing in the Duwamish watershed

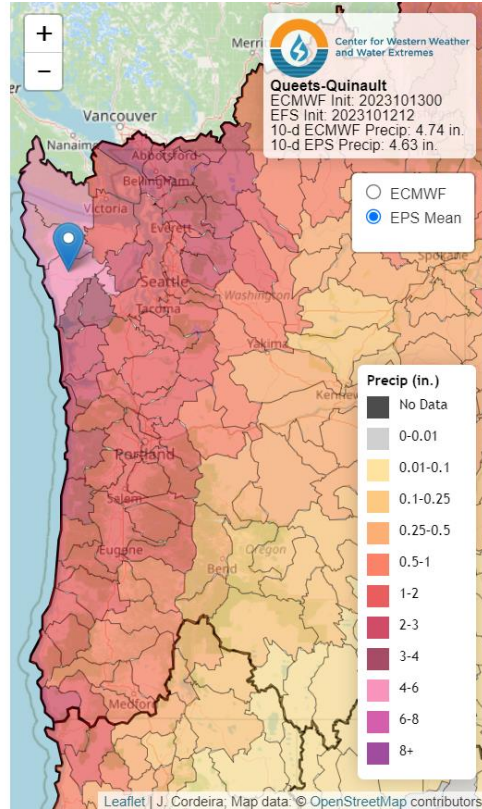
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## Watershed Precipitation Forecasts

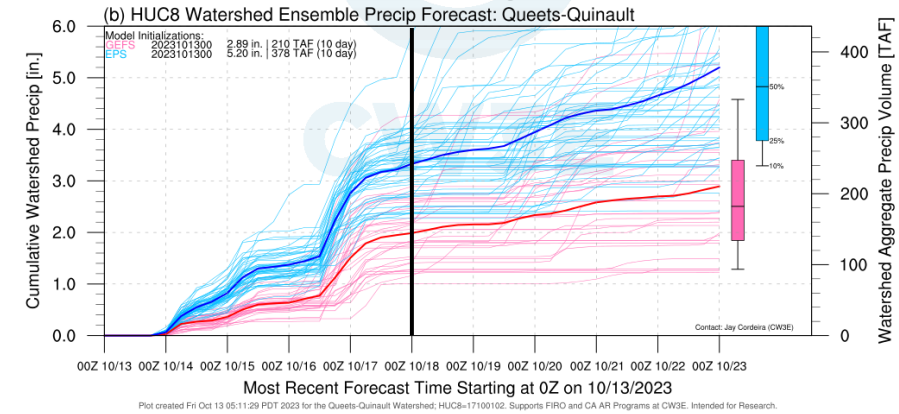
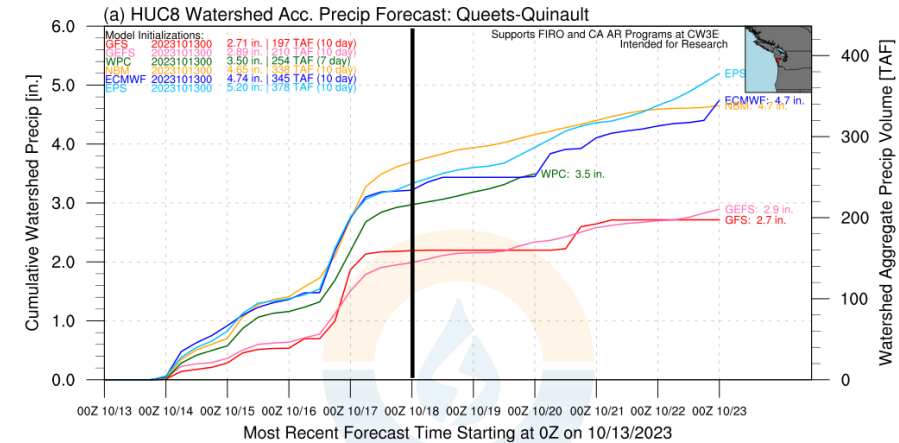
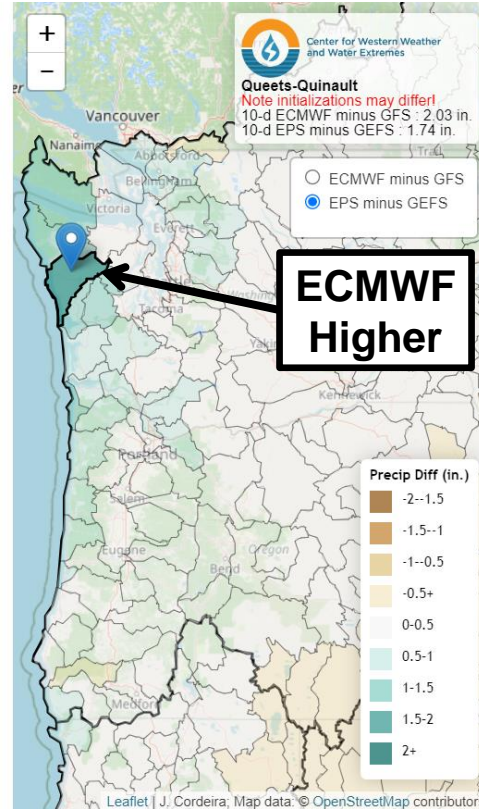
### GEFS



### EPS



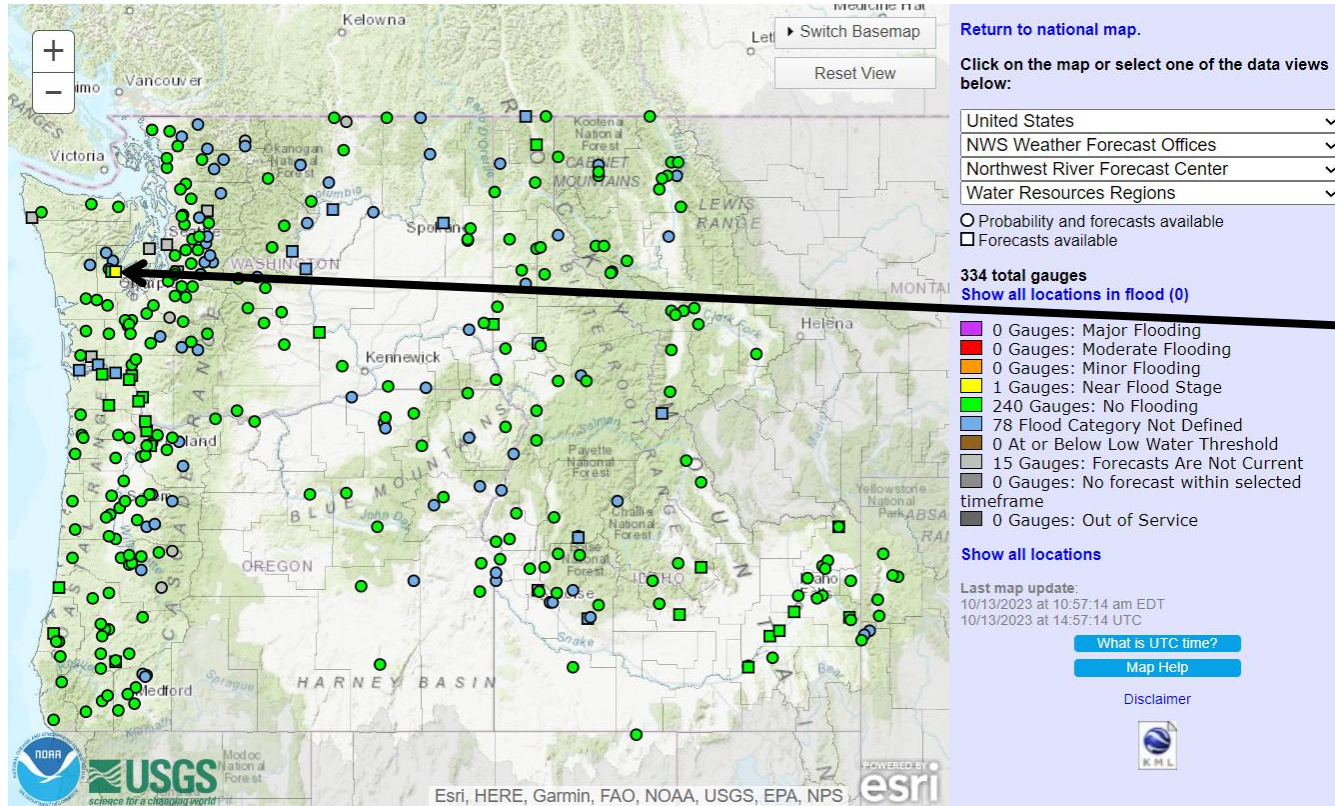
### EPS Minus GEFS



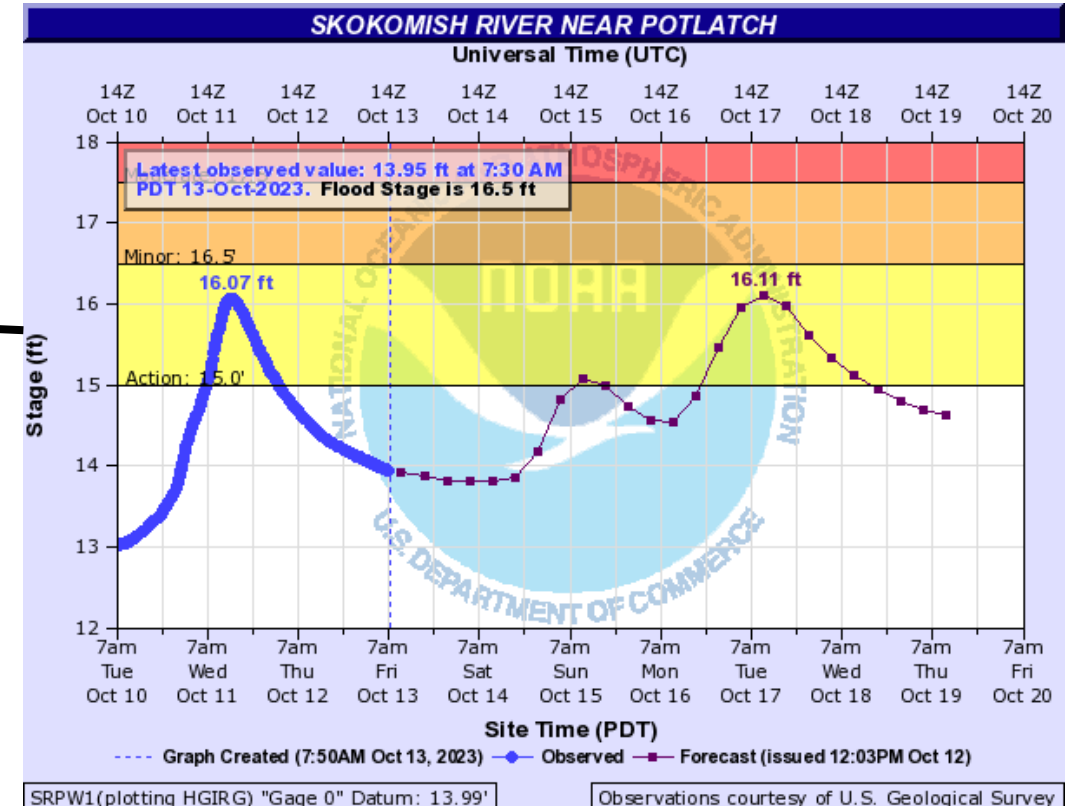
- Compared to the GFS/GEFS models, the ECMWF/EPS models are forecasting higher precipitation amounts from the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> ARs over the Olympic Peninsula
- The GEFS ensemble mean areal precipitation in the Queets-Quinault watershed is ~2.2 inches through 5 PM PT 17 October, whereas the EPS ensemble mean areal precipitation is ~3.3 inches



## Hydrologic Impacts



Source: NOAA/NWS Advanced Hydrologic Prediction Service



Source: NOAA/NWS Advanced Hydrologic Prediction Service

- While many rivers in western WA are forecast to rise in response to AR-related precipitation, these ARs are not expected to produce significant hydrologic impacts
- Only one stream gage (Skokomish River near Potlatch, WA) is currently forecast to rise above monitor stage following the 3<sup>rd</sup> AR landfall