

CW3E Event Summary: 24–29 November 2021

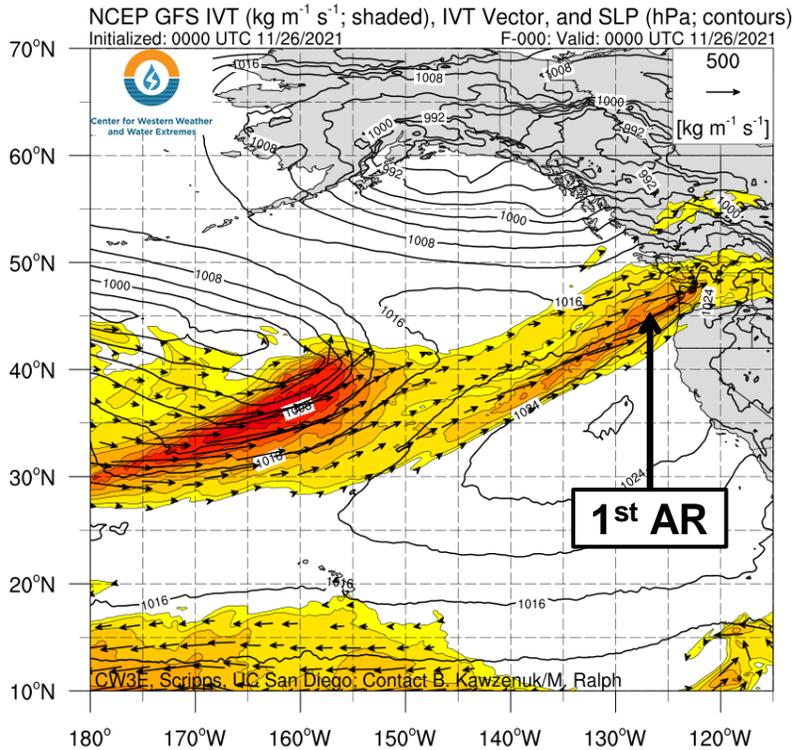
Atmospheric Rivers Produce Heavy Rainfall and Flooding in the Pacific Northwest

- The first two atmospheric rivers (ARs) in a sequence of three ARs impacted the Pacific Northwest between 24 Nov and 29 Nov
- The first AR produced AR 2 conditions (based on the Ralph et al. 2019 AR Scale) in coastal Oregon and Washington
- The second AR produced AR 3/AR 4 conditions in northern coastal Oregon and coastal Washington
- Some locations in the Olympic Peninsula and North Cascades received more than 10 inches of total precipitation from the first two ARs
- Heavy rain falling on moist soils resulted in flooding and mudslides in northern Washington and southern British Columbia
- This sequence of storms, which began less than two weeks after a series of destructive storms earlier this month, led Environment and Climate Change Canada to declare a “red alert” for British Columbia

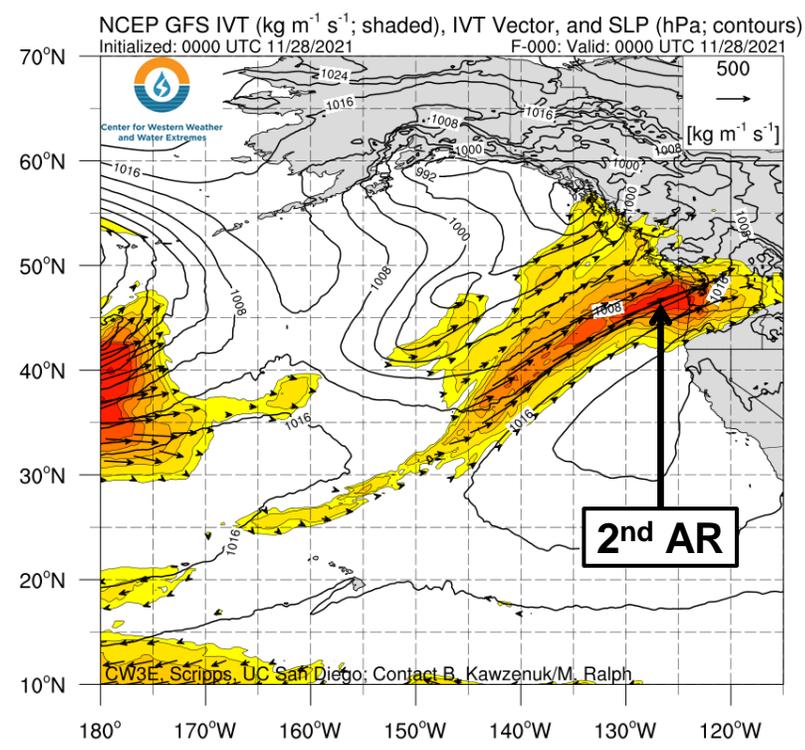
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GFS IVT Analyses and Forecasts

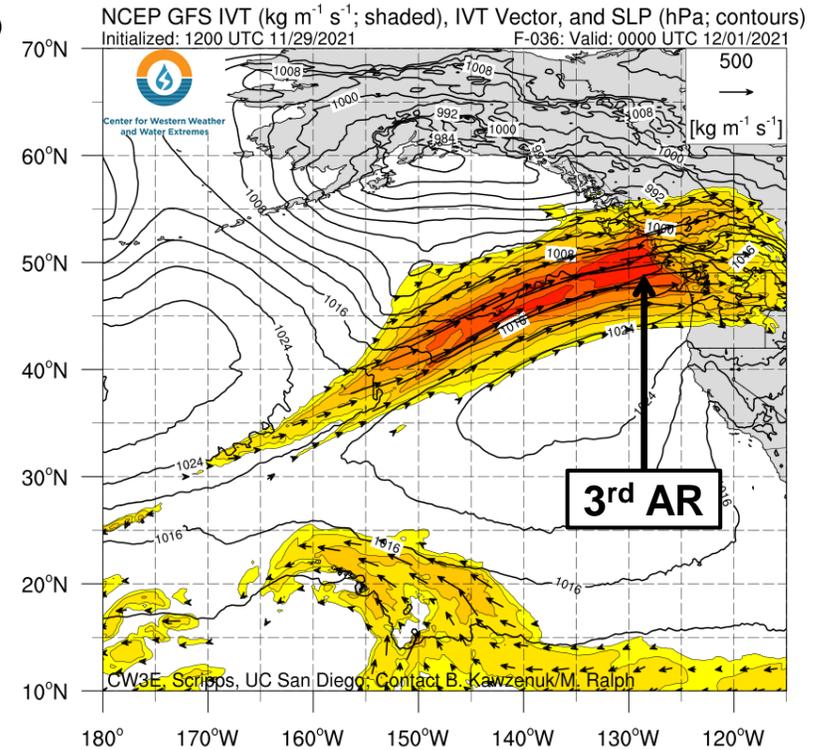
(A) Valid: 4 PM PT 25 Nov



(B) Valid: 4 PM PT 27 Nov



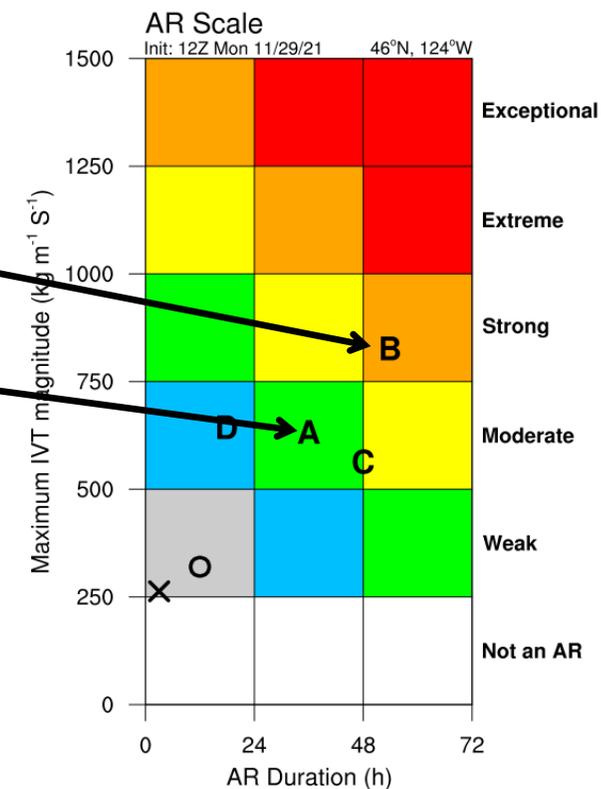
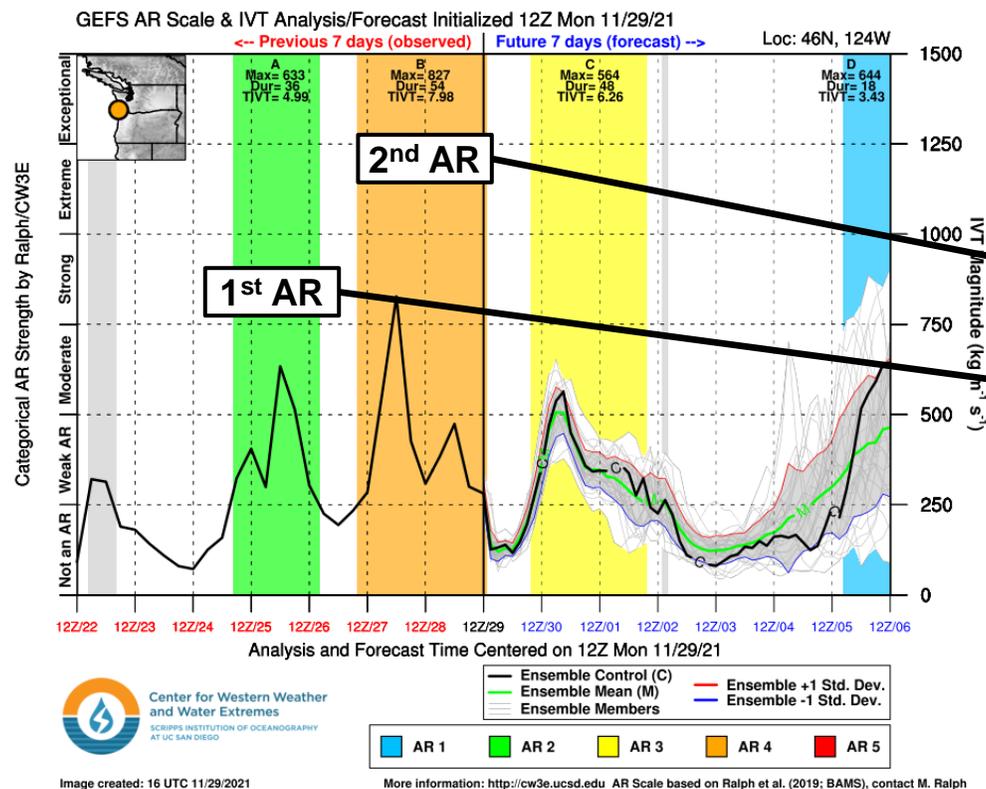
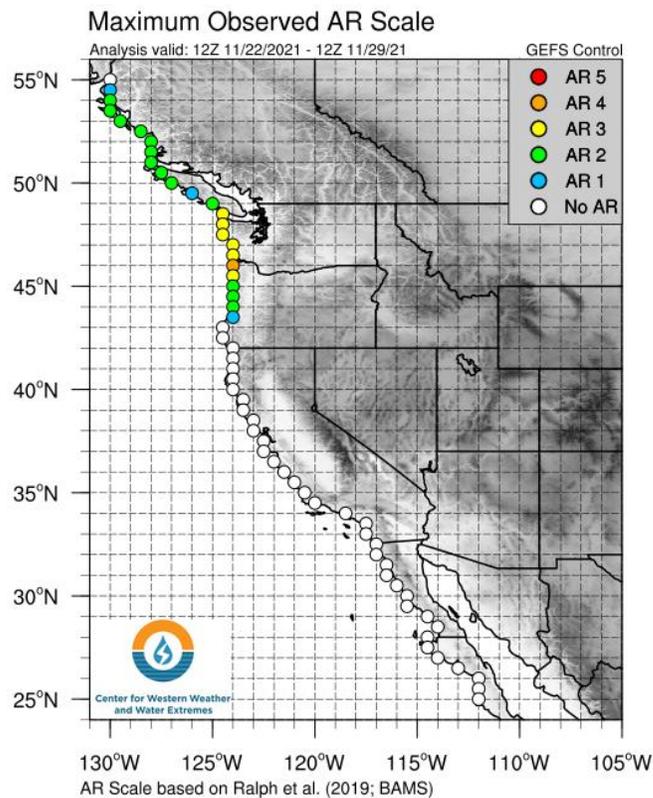
(C) Valid: 4 PM PT 30 Nov (F-36)



- The first two ARs made landfall on the poleward side of a surface anticyclone on 24 Nov and 27 Nov
- The first AR brought moderate AR conditions ($\text{IVT} > 500 \text{ kg m}^{-1} \text{s}^{-1}$) to portions of coastal Oregon and Washington (Figure A)
- The second AR produced strong AR conditions ($\text{IVT} > 750 \text{ kg m}^{-1} \text{s}^{-1}$) in the same areas (Figure B)
- Yet another AR will make landfall across the Pacific Northwest today, potentially bringing strong AR conditions to coastal British Columbia (Figure C)

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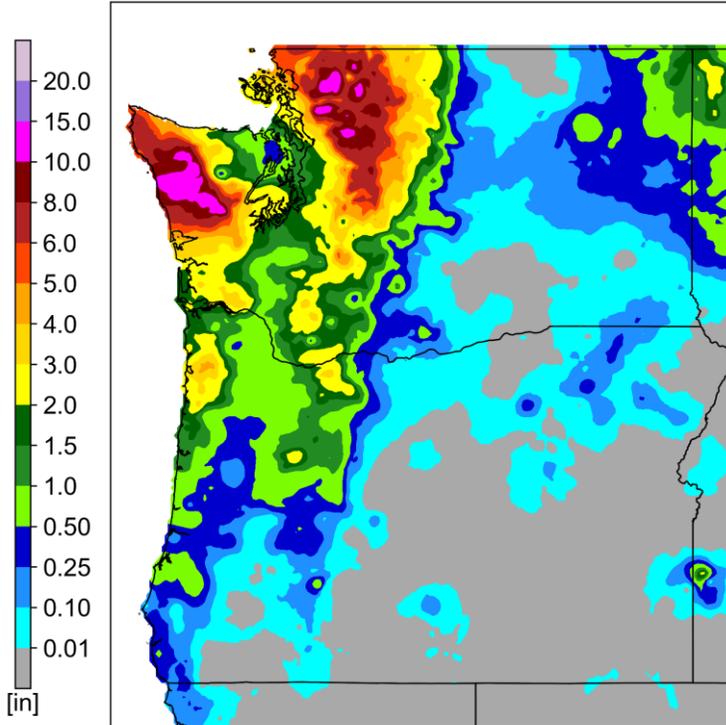
GEFS AR Scale & IVT Analyses of the first two ARs



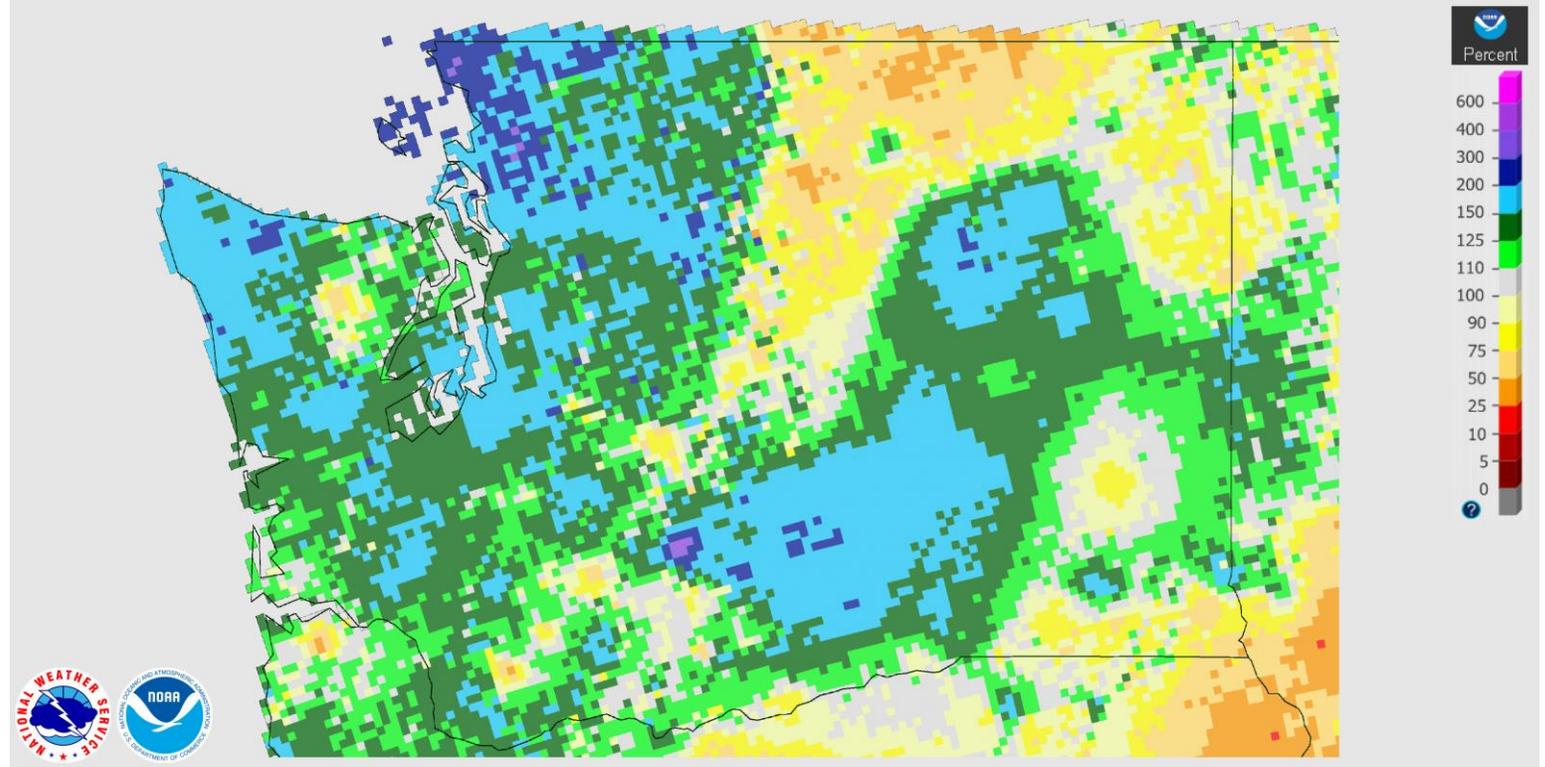
- The first AR produced AR 2 conditions (based on the Ralph et al. 2019 AR Scale) over coastal Oregon and Washington
- The second AR produced AR 3/AR 4 conditions over northern coastal Oregon and coastal Washington
- A maximum IVT of $827 \text{ kg m}^{-1} \text{ s}^{-1}$ and an AR duration of 54 hours was observed at 46°N , 124°W (Clatsop County, OR) during the second AR

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NCEP Stage IV 120-h QPE:
Valid 4 AM PT 24–29 Nov



November 29, 2021 Month to Date Percent Precipitation
Created on: November 29, 2021 - 20:38 UTC
Valid on: November 29, 2021 12:00 UTC

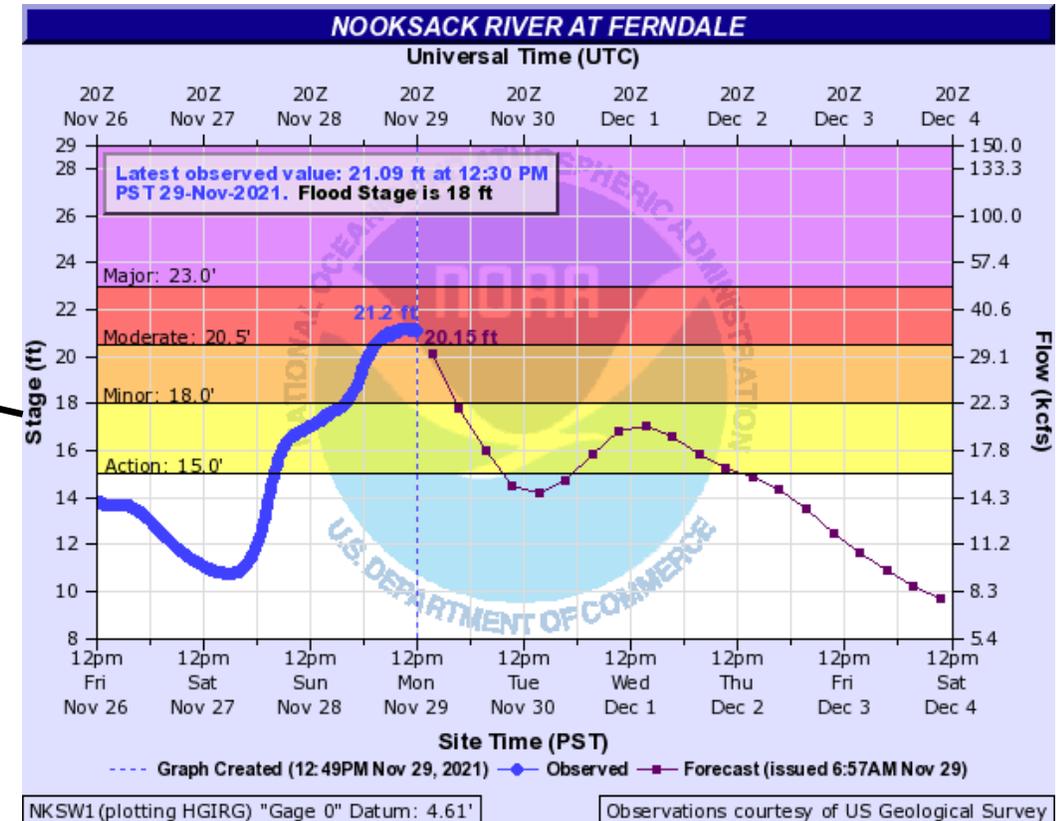
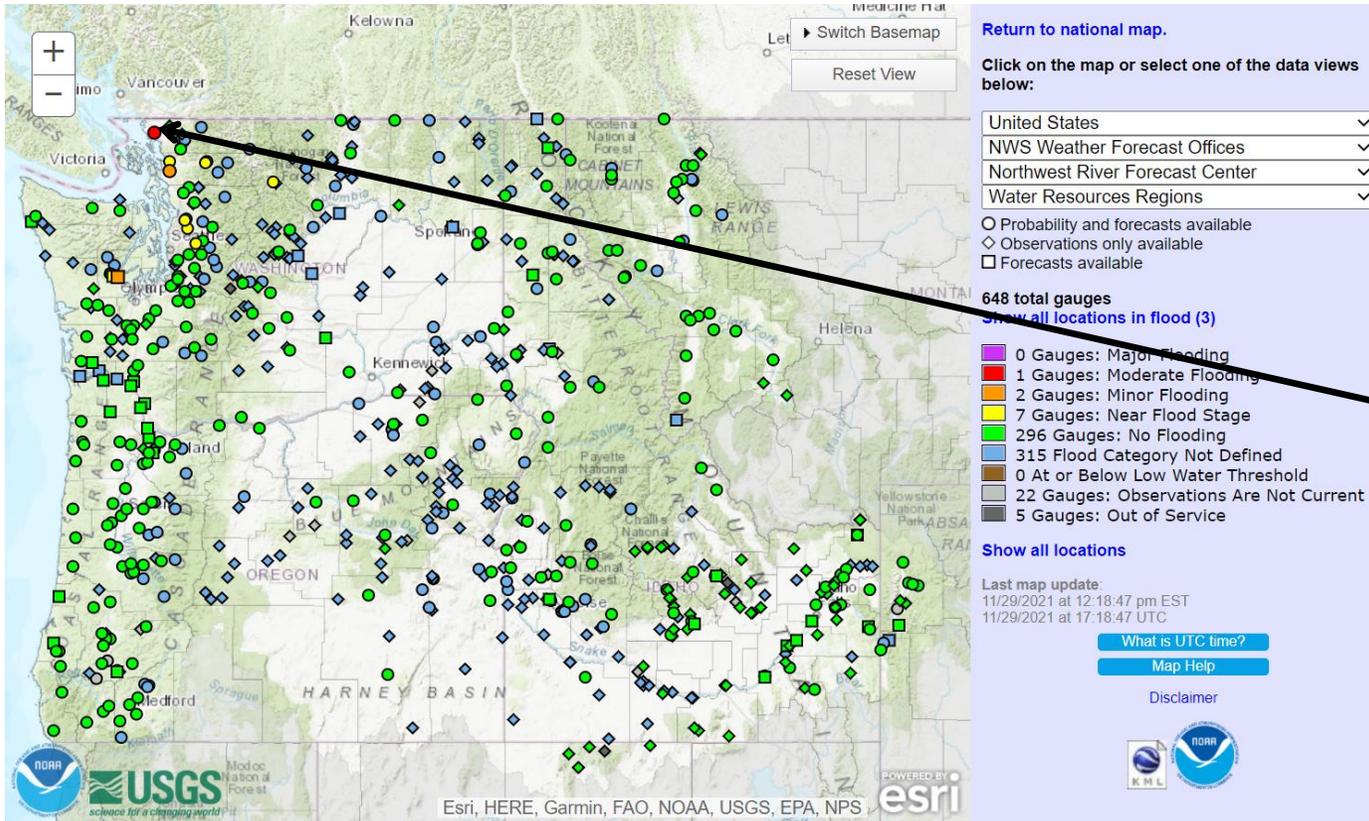


Source: NOAA/NWS Advanced Hydrologic Prediction Service

- The first two ARs produced more than 6 inches of total precipitation across much of the Olympic Peninsula and North Cascades, with some locations receiving more than 10 inches during the 120-hour period ending 4 AM 29 Nov
- Bellingham, WA, set new daily precipitation records on 24 Nov (1.43”), 26 Nov (1.17”), and 27 Nov (1.63”)
- Western Washington has experienced wetter-than-normal conditions during November, with some areas receiving more than twice the normal monthly precipitation
- Bellingham, WA, and Seattle–Tacoma International Airport have both experienced their wettest autumn periods (Sep–Nov) on record

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Hydrologic Impacts



Source: NOAA/NWS Advanced Hydrologic Prediction Center

- Heavy rain falling on moist soils resulted in flooding in parts of northern Washington
- These areas experienced severe flooding earlier this month (see the [10–16 November 2021 event summary](#) for more details)
- The Nooksack River (at Ferndale, WA) rose above moderate flood stage (20.5 ft) on 29 Nov, reaching a peak stage height of 21.2 ft

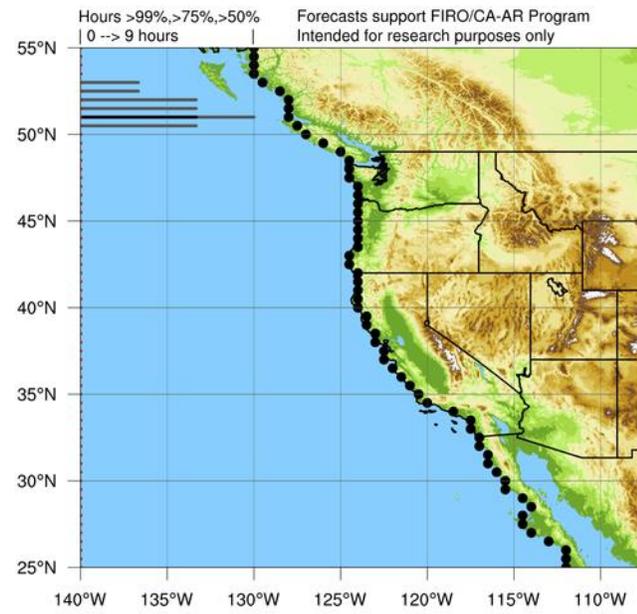
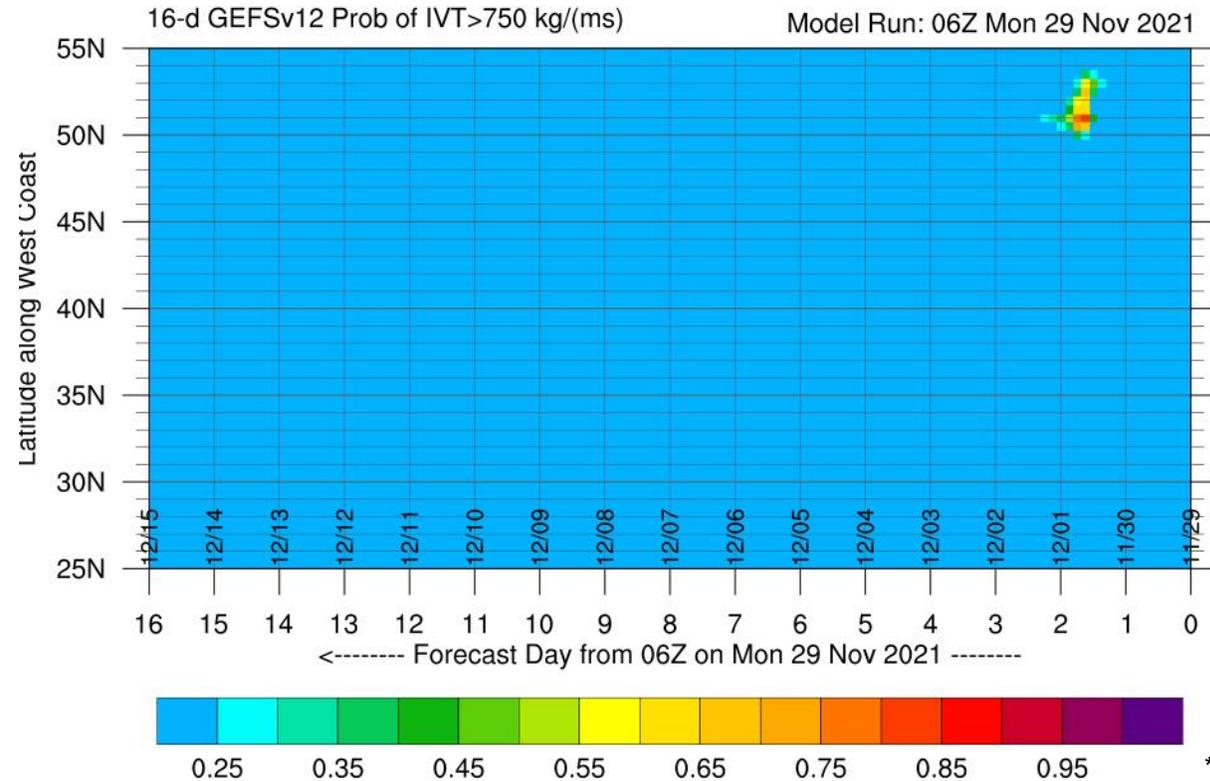
CW3E Atmospheric River Outlook: 29 November 2021

Unsettled Weather to Continue through the End of November in Pacific Northwest

- The third AR in a sequence of ARs is forecasted to make landfall over British Columbia and Washington today
- AR 4 conditions are possible across portions of coastal British Columbia, whereas AR 3 conditions are currently forecasted across coastal Washington
- An additional 2–4 inches of precipitation are forecasted over the Olympic Peninsula and North Cascades during the next 3 days, with higher amounts (> 5 inches) possible in coastal British Columbia
- The British Columbia River Forecast Centre has issued Flood Watches and Flood Warnings ahead of the third AR

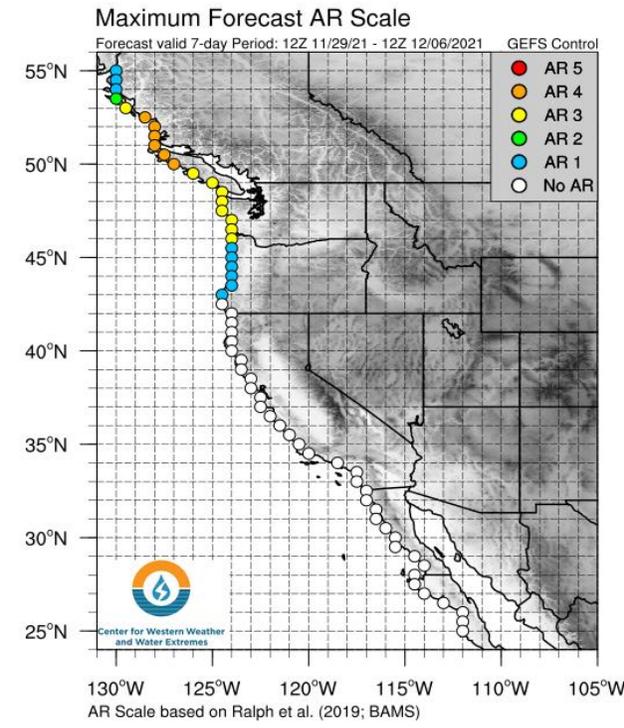
CW3E AR Outlook: 29 Nov 2021

Probability of Strong AR Conditions Along Coast



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

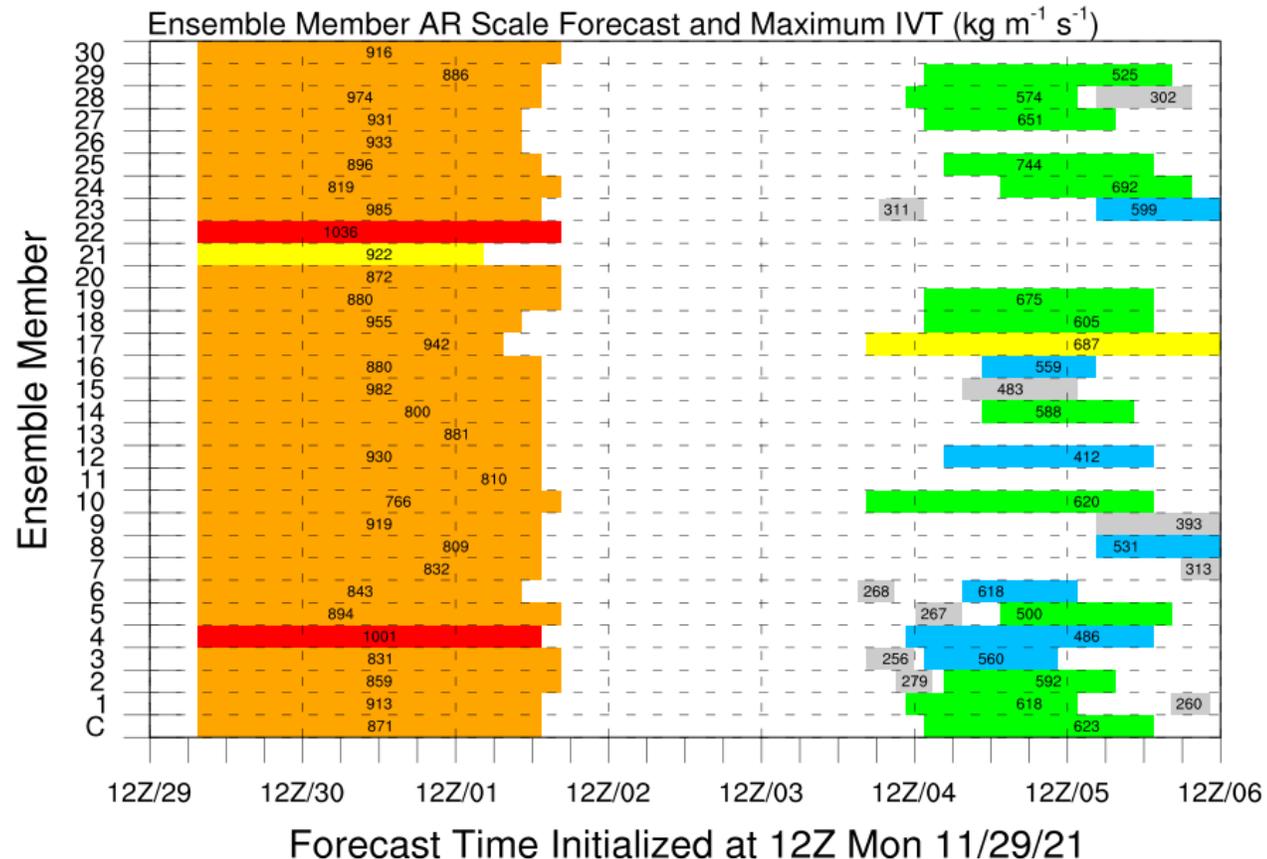
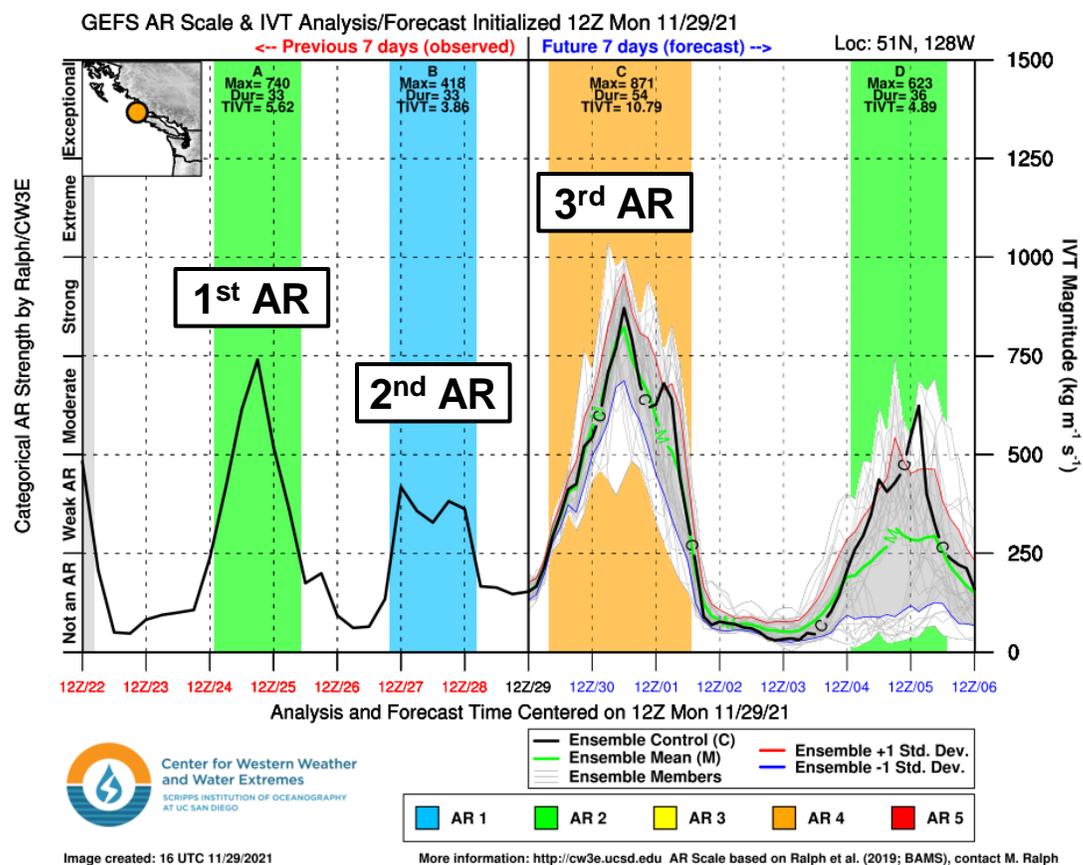
AR Scale



- The 06Z GEFS is showing high confidence ($> 75\%$ probability) in a brief period of strong AR conditions ($IVT > 750 \text{ kg m}^{-1} \text{ s}^{-1}$) over northern Vancouver Island during the third AR
- The 12Z GEFS control run is forecasting AR 4 conditions over northern Vancouver Island and AR 3 conditions over southern Vancouver Island and coastal Washington

CW3E AR Outlook: 29 Nov 2021

GEFS AR Scale and IVT Forecasts

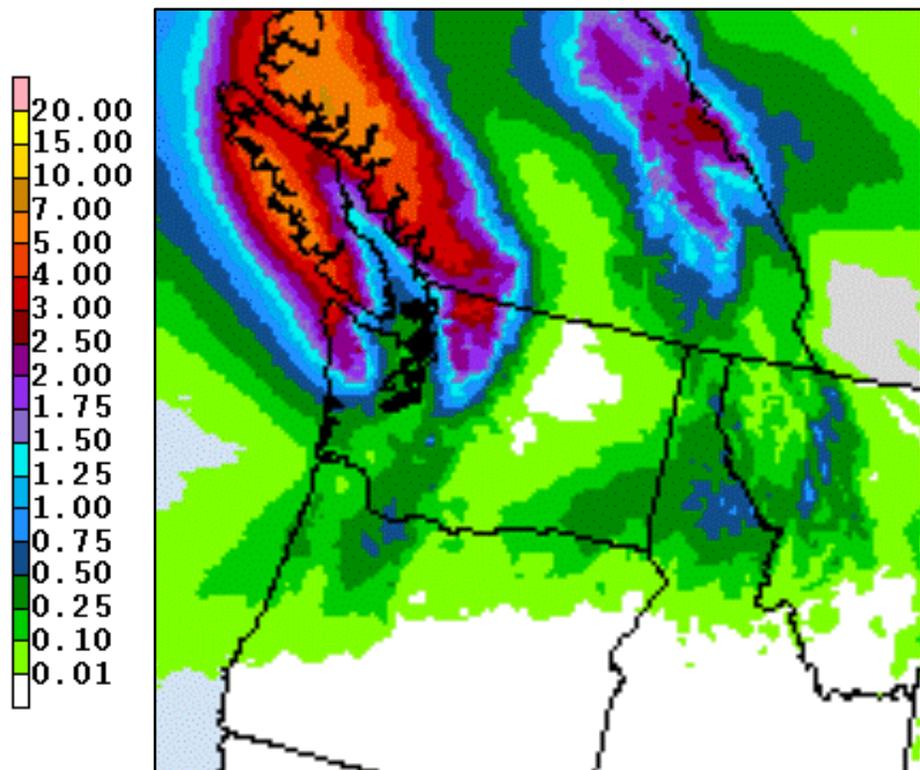


- The 12Z GEFS control run is forecasting AR 4 conditions at 51°N, 128°W (northern Vancouver Island) in association with the third AR
- While there is still some uncertainty in the maximum IVT magnitude, 28/31 (90%) ensemble members are predicting an AR 4, and nearly all are predicting an AR duration ≥ 48 hours at this location

CW3E AR Outlook: 29 Nov 2021

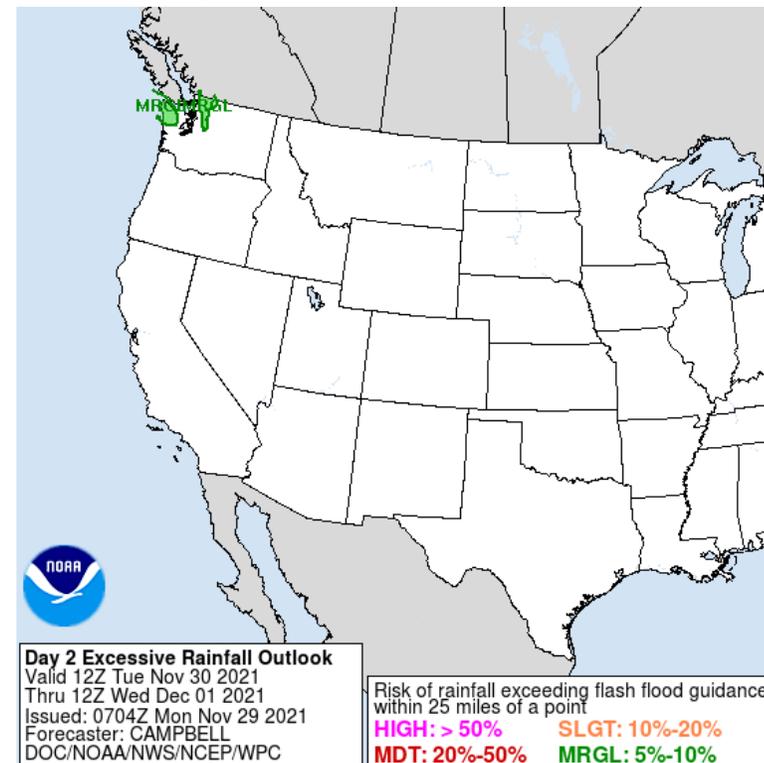
Precipitation and Hydrologic Impacts

72-h QPE: Valid 4 AM PT 29 Nov – 2 Dec



Source: NOAA/NWS Weather Prediction Center

WPC Day 2 Excessive Rainfall Outlook



- The NWS Weather Prediction Center is forecasting an additional 2–4 inches of precipitation in the Olympic Peninsula and North Cascades over the next 3 days
- The NWS WPC has issued a marginal risk of rainfall exceeding flash flooding guidance in these areas
- The heaviest precipitation (> 5 inches) is expected to occur over coastal British Columbia

Precipitation and Hydrologic Impacts

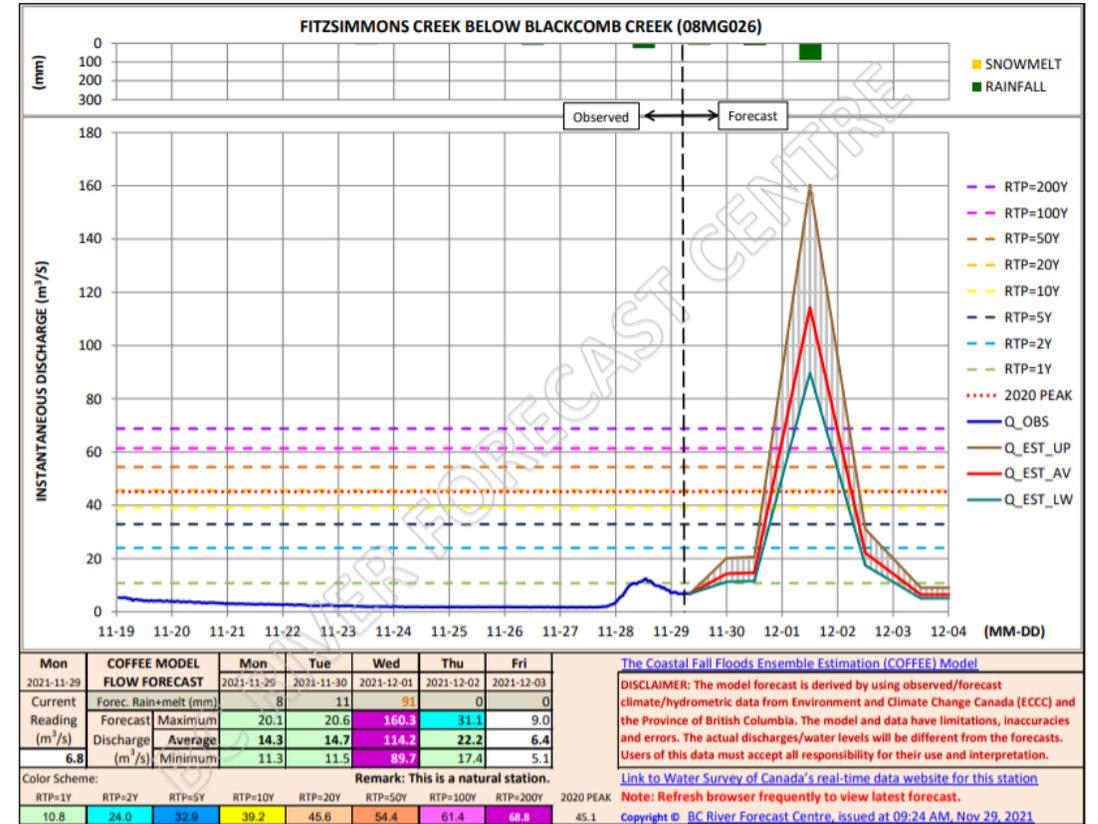
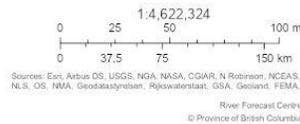
River Forecast Centre Flood Advisory and Warning Notifications



11/29/2021, 2:31:11 PM

BC Flood Advisory and Warning Notifications - Major Basin

- Flood Watch
- High Streamflow Advisory



Source: British Columbia River Forecast Center

- The British Columbia River Forecast Centre has issued Flood Watches and Flood Warnings throughout western British Columbia ahead of the third AR
- The discharge at Fitzsimmons Creek below Blackcomb Creek (near Whistler, BC) is expected to exceed the 200-year return level on 1 Dec