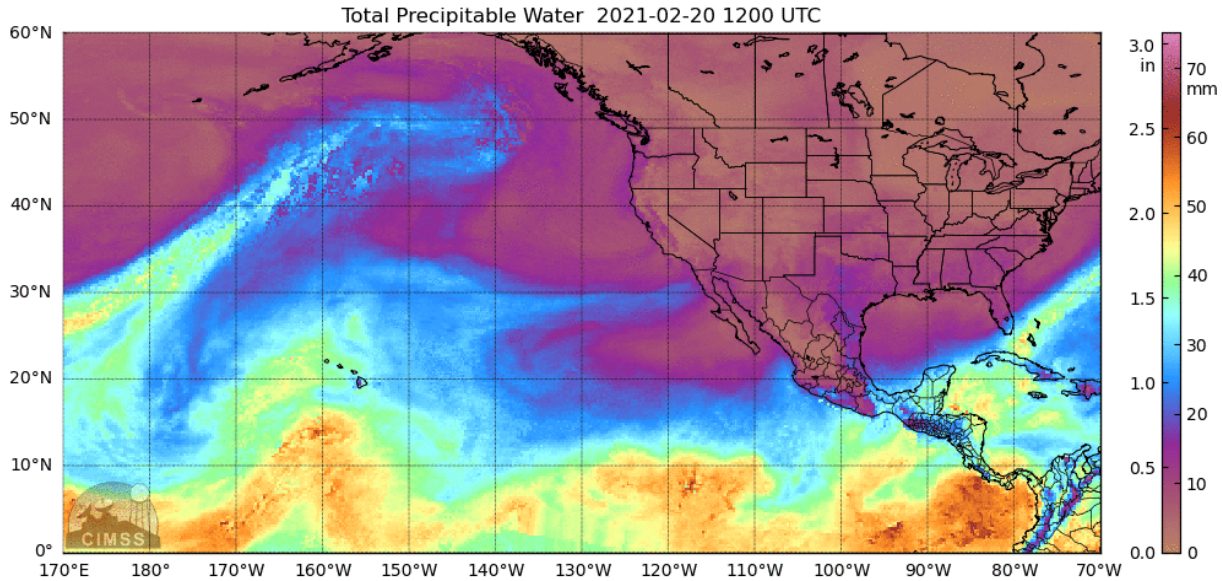
CW3E Event Summary: 21–23 Feb 2021

For California DWR's AR Program

Atmospheric River Brings Rain and Snow to Portions of the Northwestern U.S.

- The AR made landfall during the early morning of 21 February over Washington and northern Oregon
- Coastal locations in Washington and northwestern Oregon experienced AR 2 conditions (based on the Ralph et al. 2019 AR Scale)
- More than 5 inches of precipitation fell in parts of the Olympic Peninsula and North Cascades
- More than 2 feet of snow fell in the higher elevations of the Washington Cascades and Bitterroot Mountains
- The combination of near-saturated soil conditions, heavy rain, and melting snow produced minor flooding in western Washington
- Several avalanches were also reported near Stevens Pass (in addition to the planned avalanche control work)

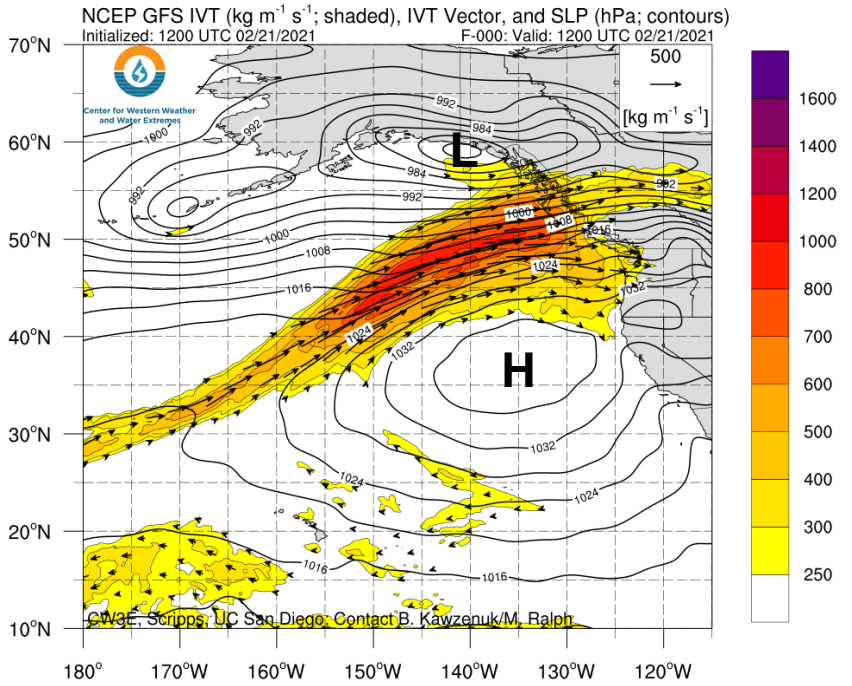


Event Summary: 21–23 Feb 2021

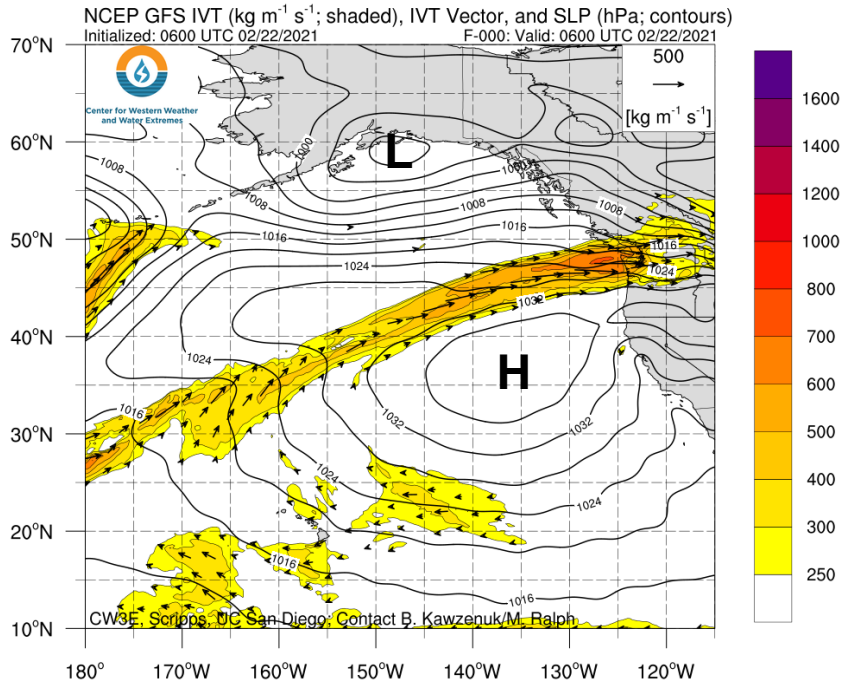
For California DWR's AR Program

GFS IVT & IWV Analyses

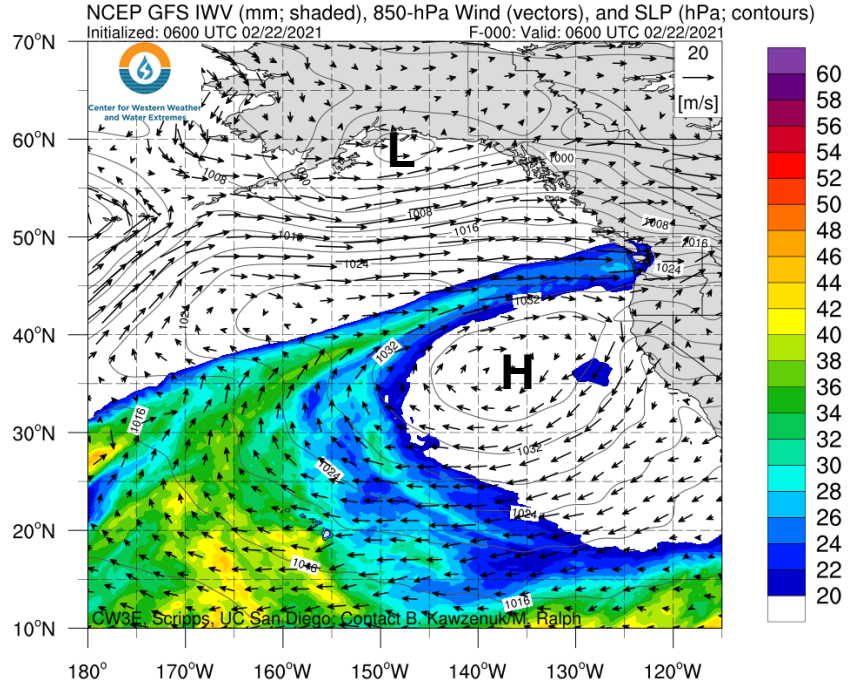
A) Valid: 1200 UTC 21 Feb



B) Valid: 0600 UTC 22 Feb



C) Valid: 0600 UTC 22 Feb



- This AR formed over the North Pacific Ocean and propagated eastward along the northern periphery of a surface anticyclone, finally making landfall across British Columbia and the Pacific Northwest slightly before 12Z 21 Feb (4 AM PST 21 Feb; Figure A)
- The strongest moisture transport in coastal Washington occurred around 06Z 22 Feb, with IVT values reaching 600 kg m^{-1} s^{-1} (Figure B)
- The GFS IWV analysis at 06Z 22 Feb clearly depicts a long, narrow plume of moist air (IWV > 20 mm) extending from northwest of Hawaii to the Washington coast (Figure C)

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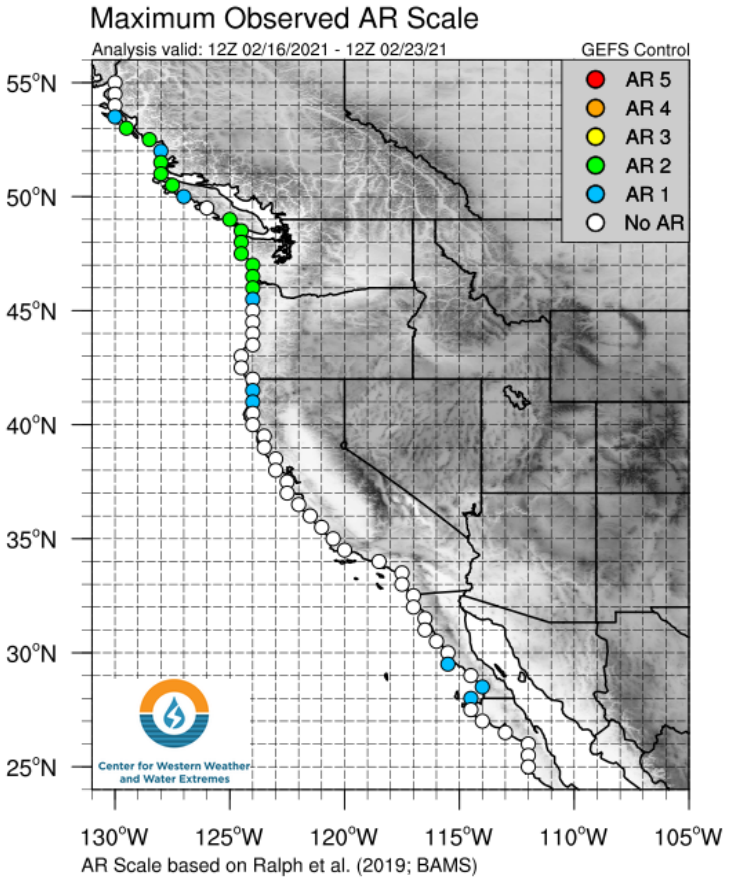
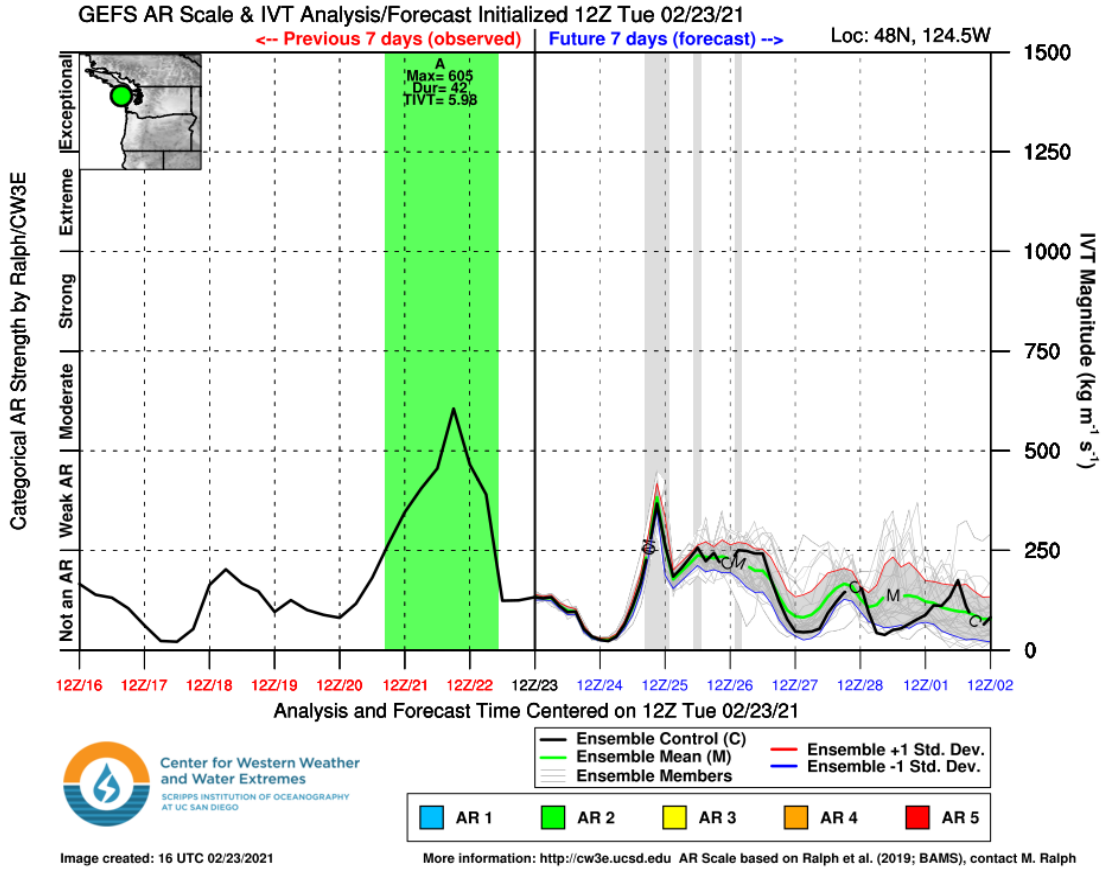
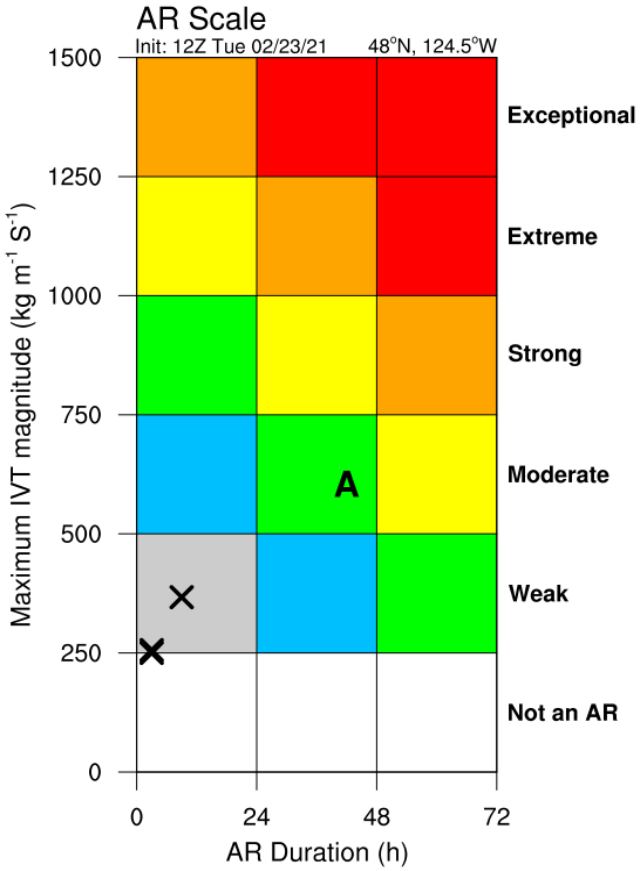
GEFS AR Scale & IVT Analyses







- This AR produced AR 2 conditions (based on the Ralph et al. 2019 AR Scale) along the coast of Washington and far northern Oregon
- A maximum IVT value of 605 kg m^{-1} s^{-1} and an AR duration of 42 hours were observed at 48°N, 124.5°W (near Quillayute, WA)

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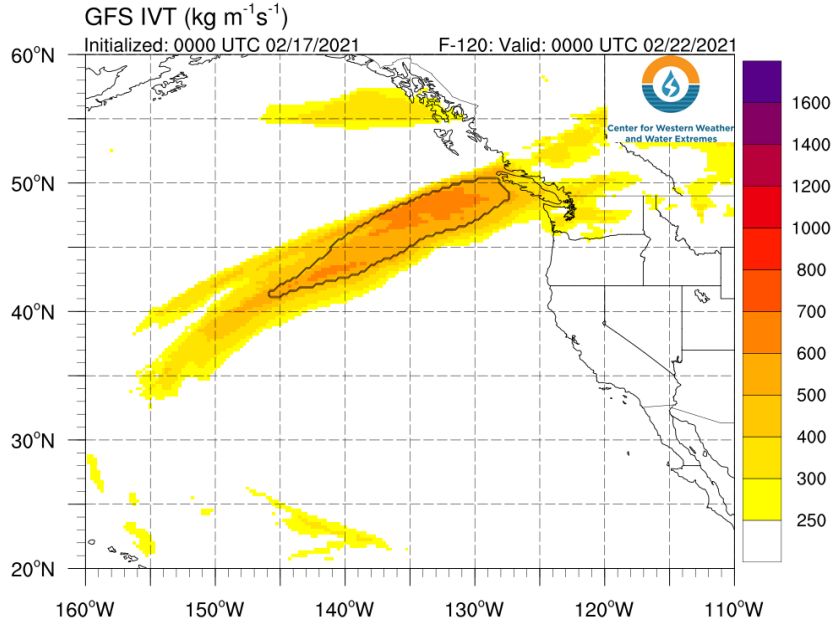
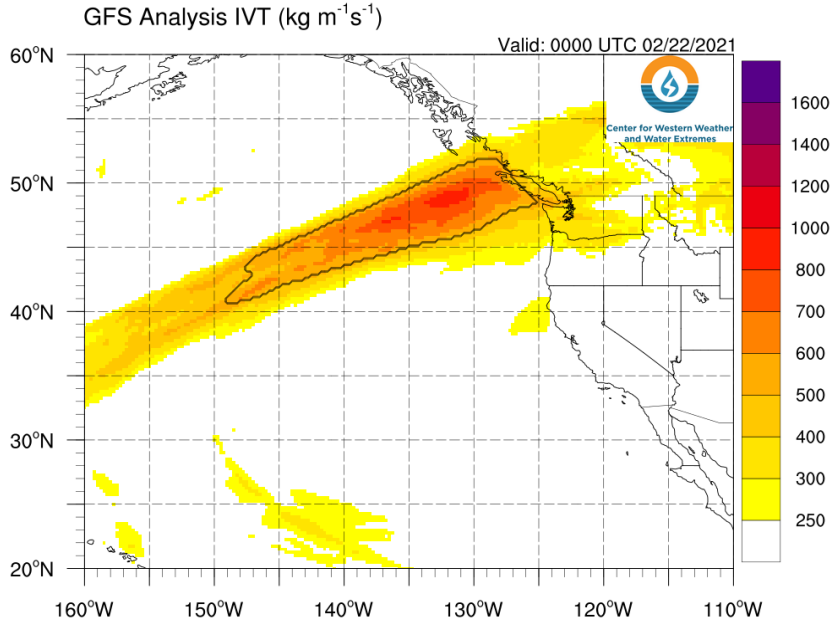
For California DWR's AR Program

GFS AR/IVT Forecast Verification

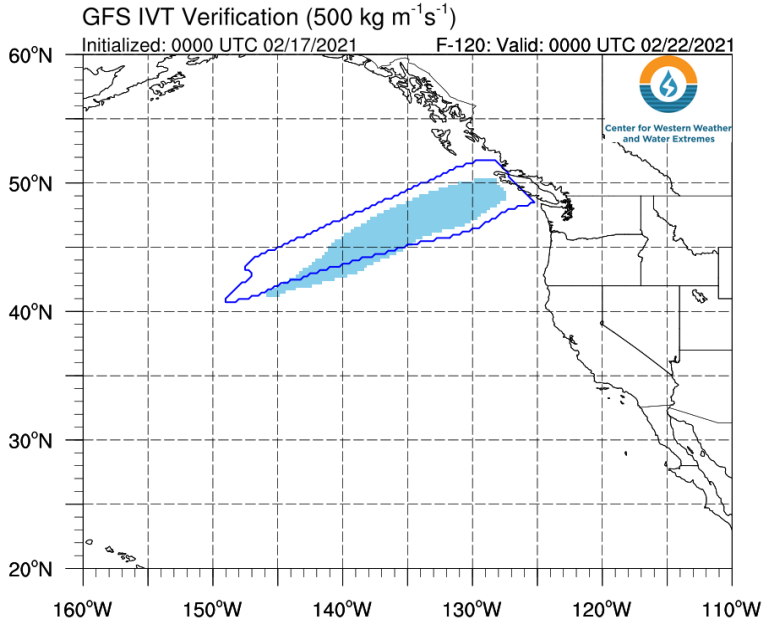
GFS 120-h IVT Forecast
Initialized: 0000 UTC 17 Feb 2021



GFS IVT Analysis
Valid: 0000 UTC 22 Feb 2021



GFS IVT Object Verification
IVT ≥ 500 kg m^{-1} s^{-1}



- The overall structure, location, and timing of the AR was well-forecasted by the GFS model at a 5-day (120-h) lead time
- The 5-day forecast underestimated the IVT magnitudes in the core of the AR, as well as the spatial extent of the region of moderate AR conditions (IVT > 500 kg m^{-1} s^{-1})

Shading = forecasted AR objects (grey if no AR observed)

Contours = observed AR objects (black if no AR forecasted)

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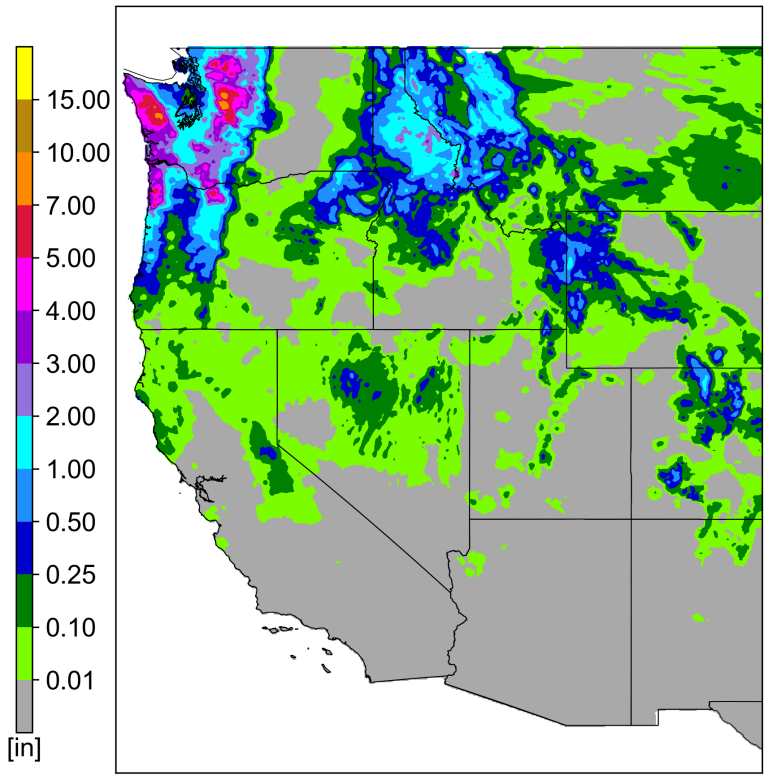
For California DWR's AR Program

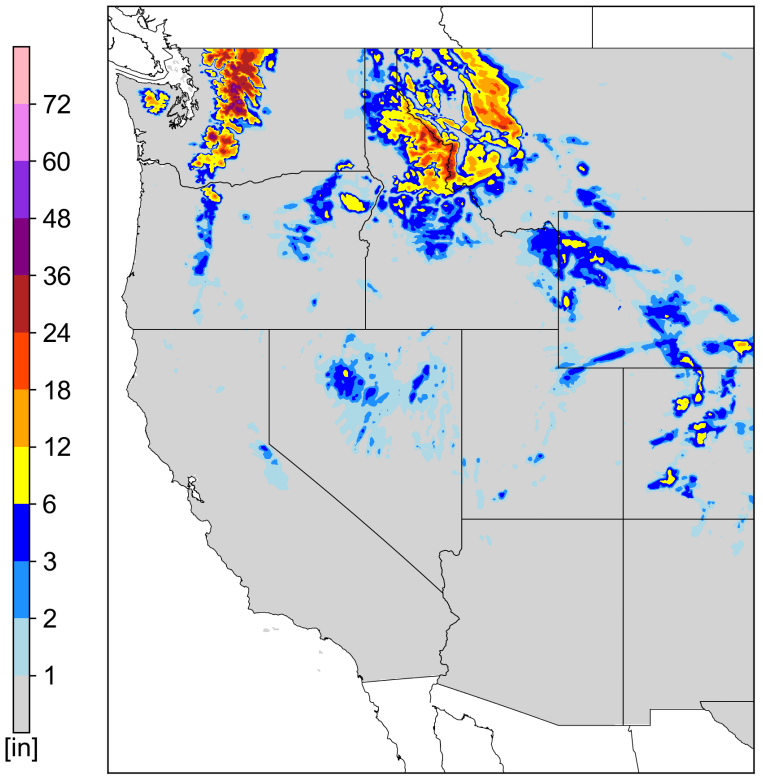
NCEP Stage IV 72-h QPE

Valid: 1200 UTC 20–23 Feb



NOHRSC 72-h Interpolated Snow

Valid: 1200 UTC 20–23 Feb



Avalanche Control on US-2

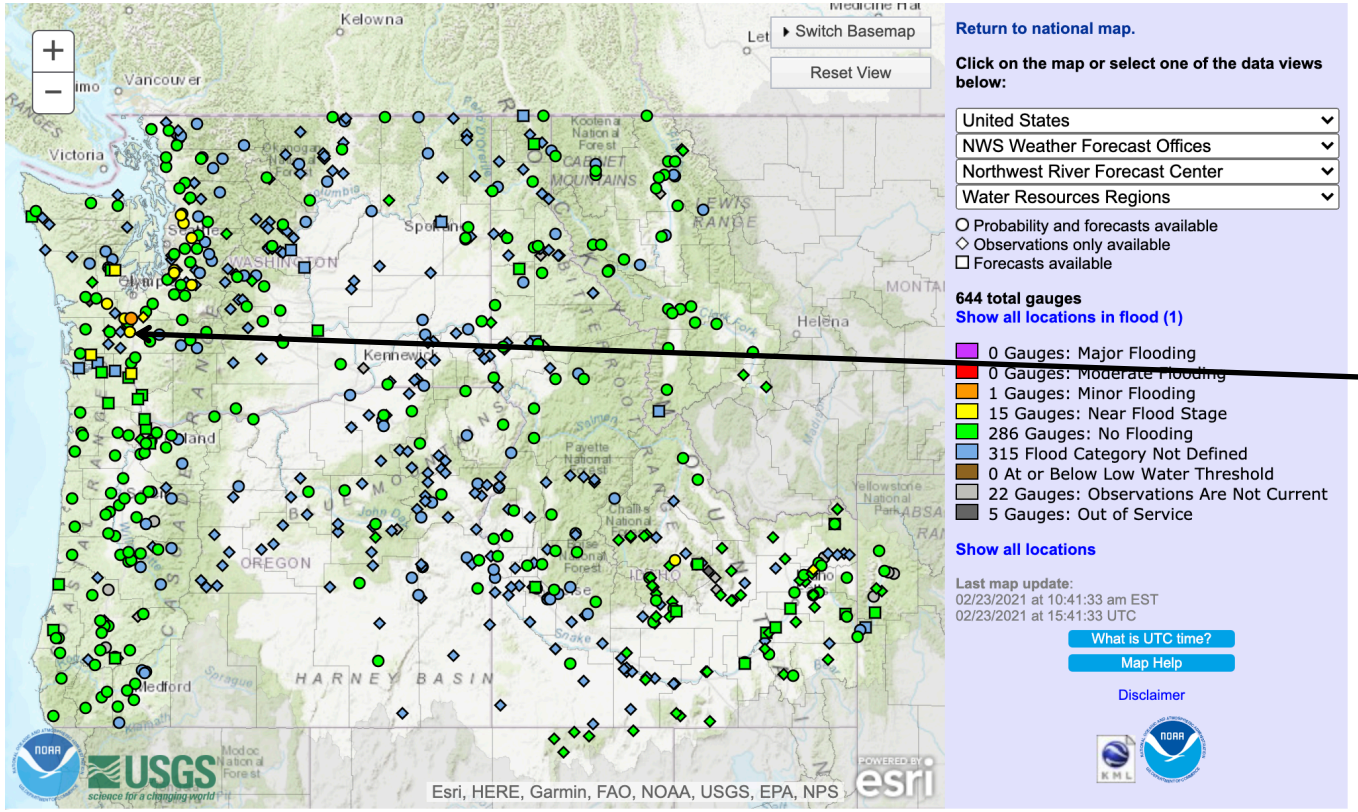
Source: Washington State DOT, https://wsdot.wa.gov/

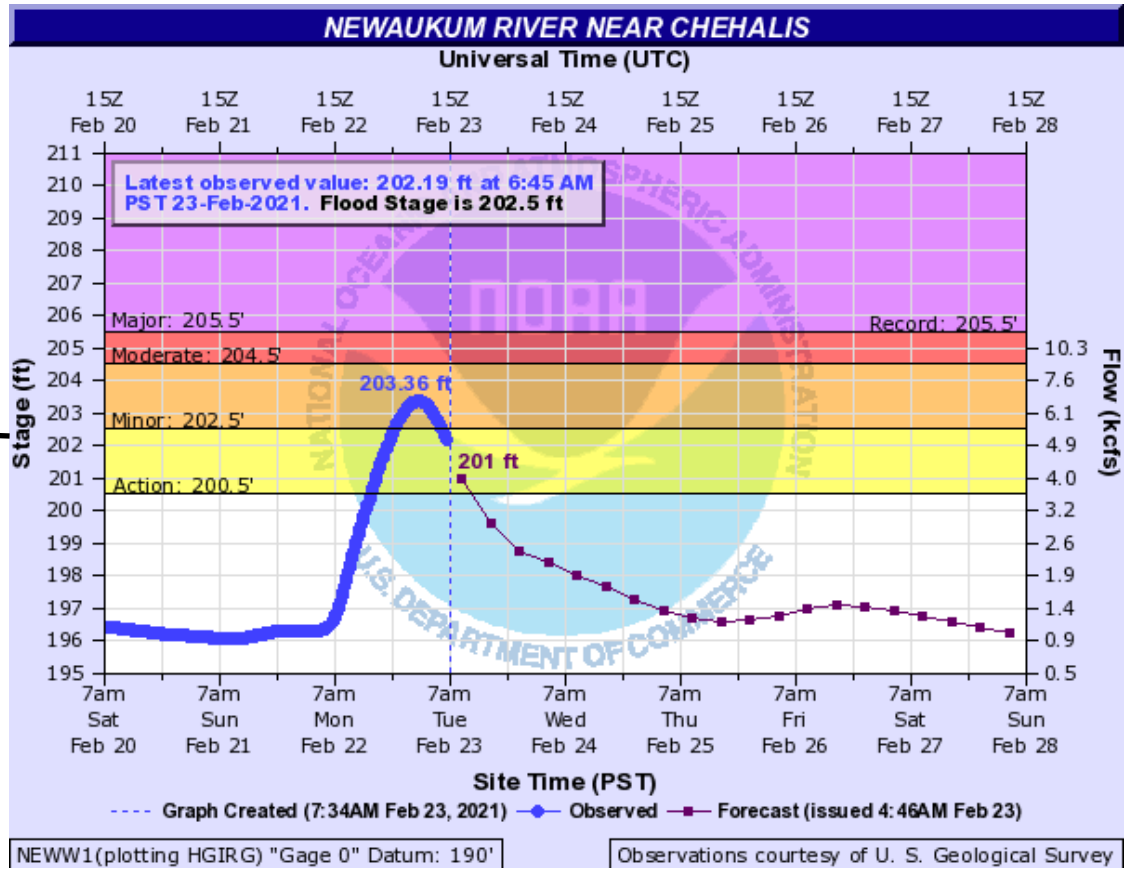
- At least 2–5 inches of precipitation fell in portions of the Pacific Coast Ranges and Cascades in western Washington and northwestern Oregon
- The heaviest precipitation (locally > 7 inches) occurred in the Olympic Peninsula and North Cascades
- More than 2 feet of snow fell in the higher elevations of the Washington Cascades and the Bitterroot Mountains
- The combination of heavy snowfall in recent weeks and forecasts of warmer temperatures, rain-on-snow, and strong winds associated with this AR prompted avalanche warnings, avalanche control measures, and high-elevation road closures in the Washington Cascades
- In addition to the planned avalanche control work, several natural slides were reported near Stevens Pass

Event Summary: 21–23 Feb 2021

For California DWR's AR Program

NWRFC River Observations: Valid 1541 UTC (7:41 PST)





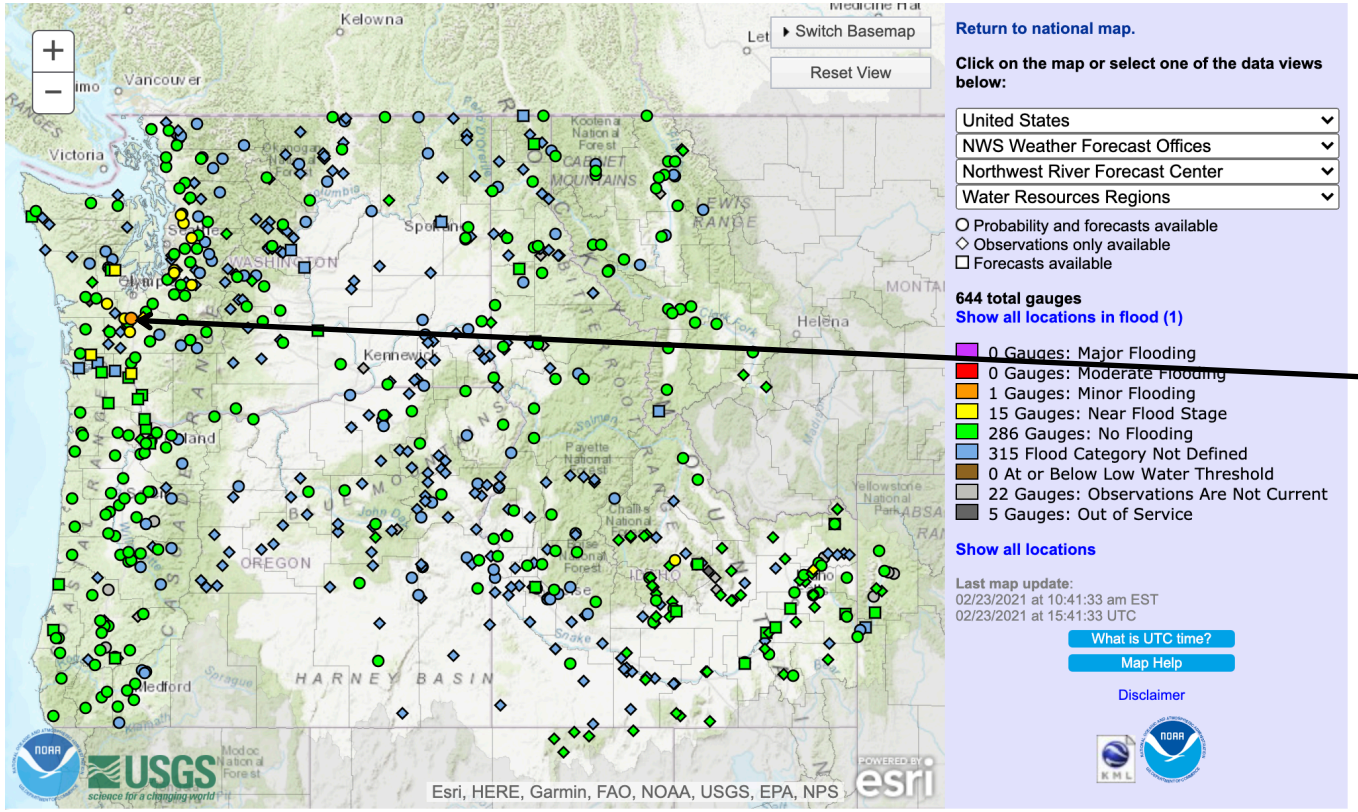
Source: NOAA/NWS Advanced Hydrologic Prediction Service, https://water.weather.gov/ahps/

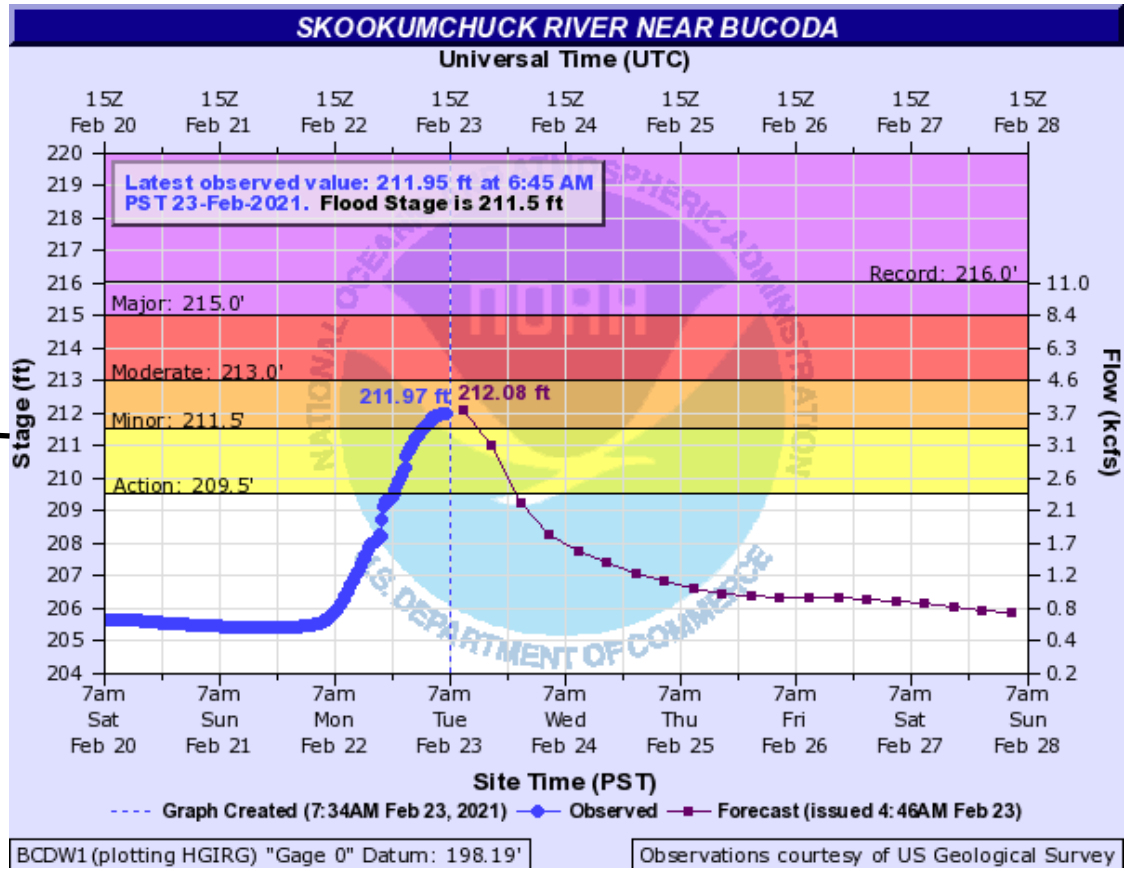
- Heavy precipitation and melting snow caused minor flooding in western Washington
- The Newaukum River (near Chehalis, WA) rose above flood stage (202.5 ft) during the evening of 22 Feb, reaching a peak stage height of 203.36 ft at 1 AM PST on 23 Feb

Event Summary: 21–23 Feb 2021

For California DWR's AR Program

NWRFC River Observations: Valid 1541 UTC (7:41 PST)





Source: NOAA/NWS Advanced Hydrologic Prediction Service, https://water.weather.gov/ahps/

- The Skookumchuck River (near Bucoda, WA) rose above flood stage (211.5 ft) around midnight on 22 Feb, reaching a peak stage height of 211.97 ft at 6:30 AM PST on 23 Feb