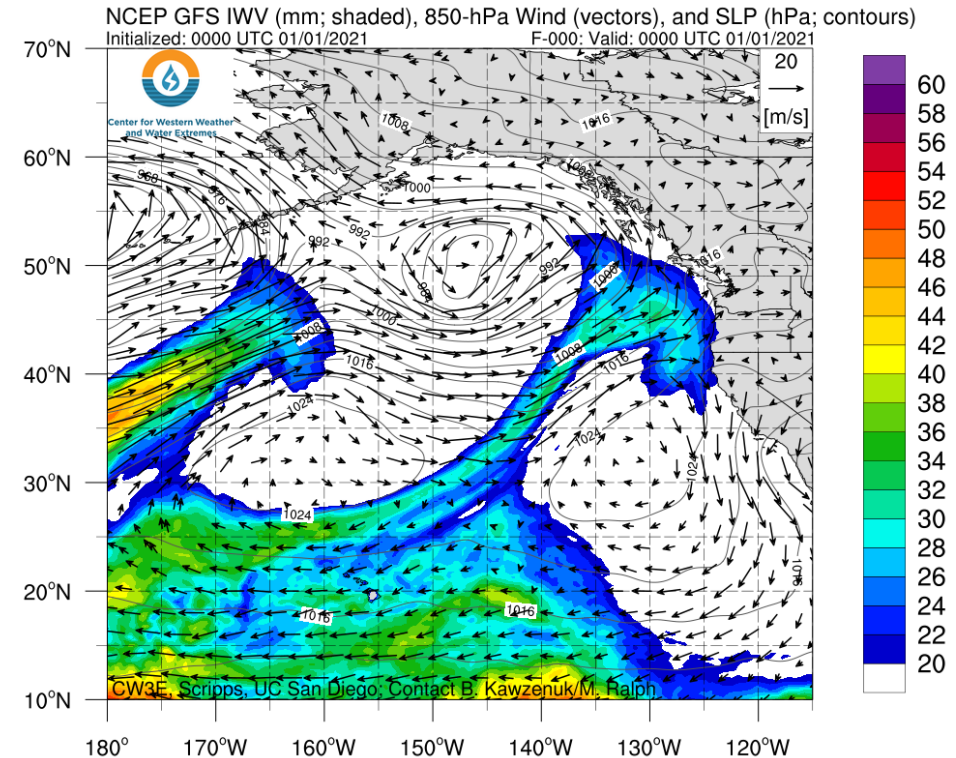
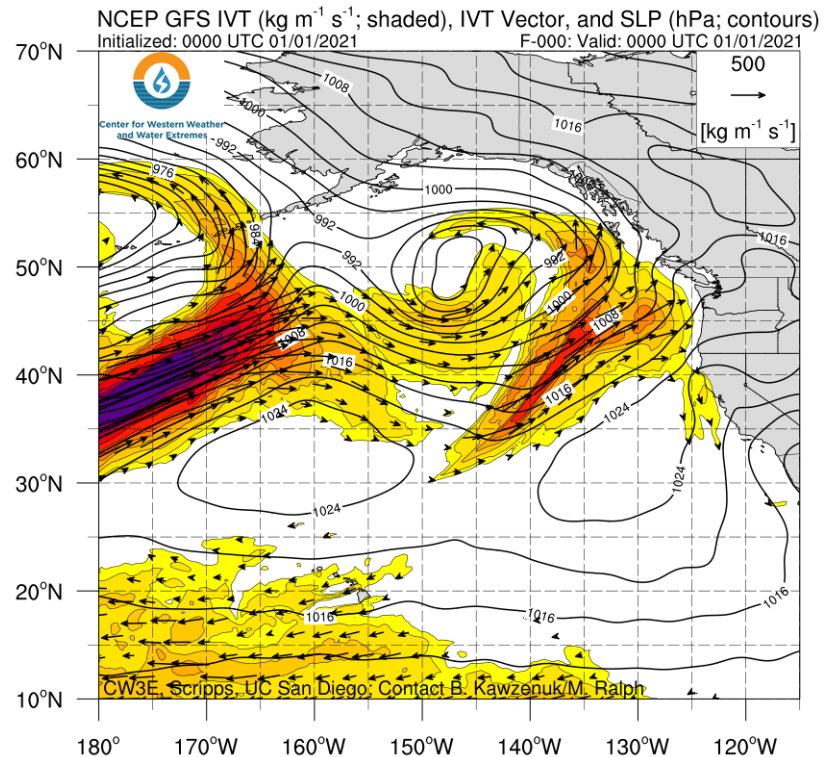


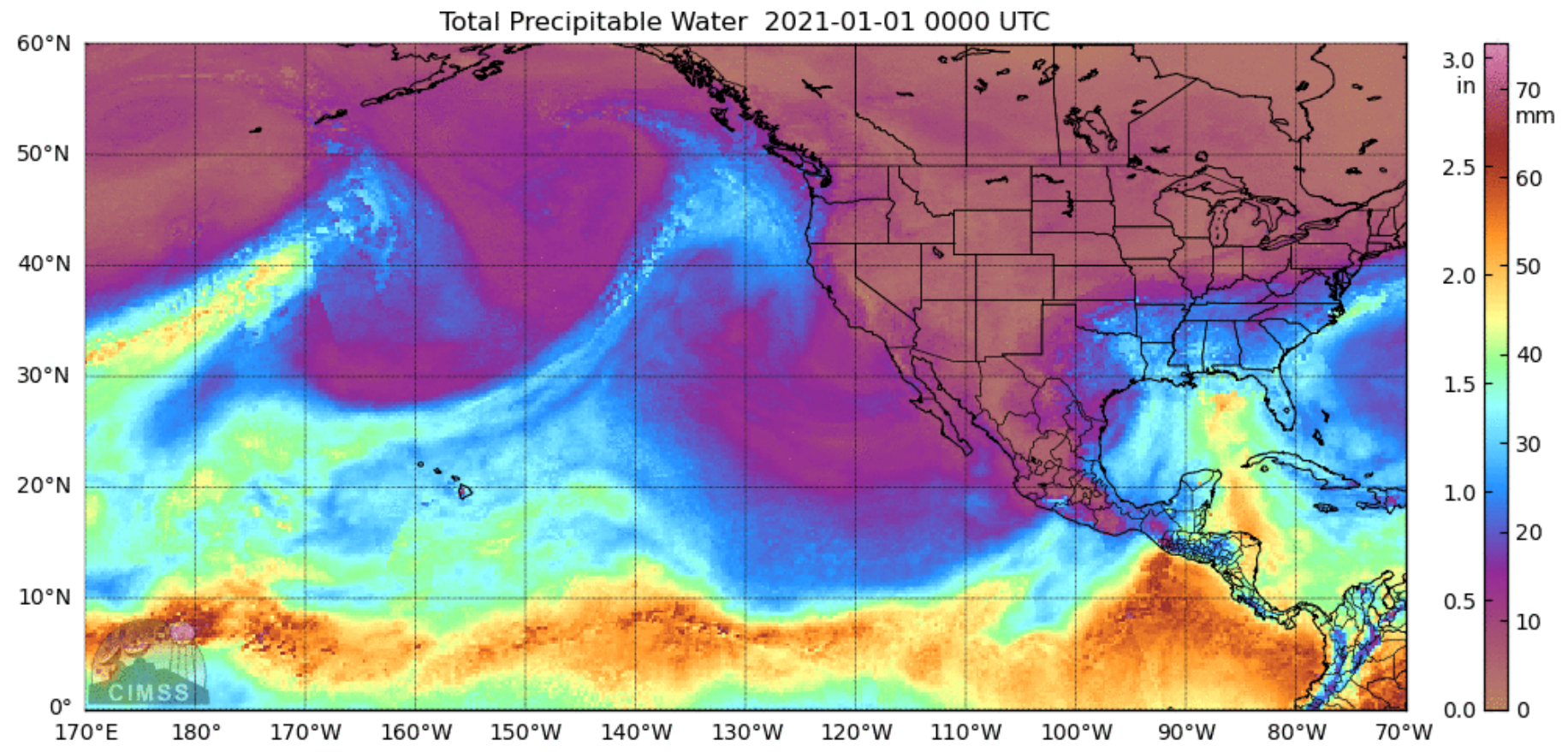
Active weather pattern produces an extremely wet start to 2021 in the Pacific Northwest

- Several ARs associated with a series of storms over the Northeast Pacific Ocean impacted the Pacific Northwest during the first week of 2021
- These storms produced at least 2–7 inches of total precipitation in northwestern California, western Oregon, and western Washington, with the highest amounts (> 10 inches) in the Olympic Mountains and North Cascades
- More than 5 feet of snow fell in parts of the Olympic Mountains and Washington Cascades
- Total water-year-to-date precipitation remains well-below normal across much of the western U.S.



Event Summary: 1–7 Jan 2021

For California DWR's AR Program



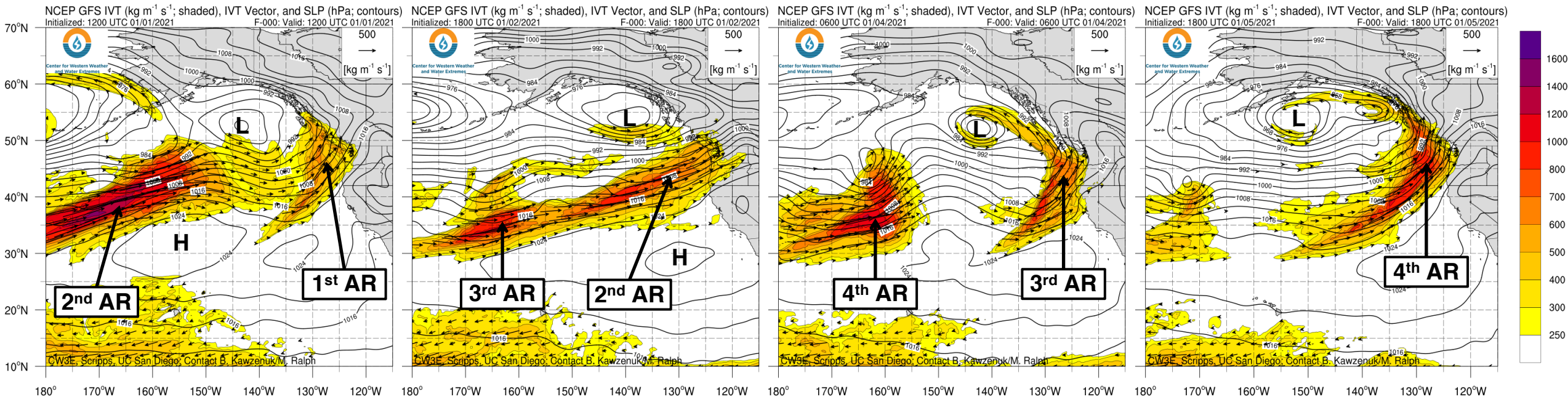
GFS IVT & SLP Analyses

Valid: 1200 UTC 1 Jan 2021

Valid: 1800 UTC 2 Jan 2021

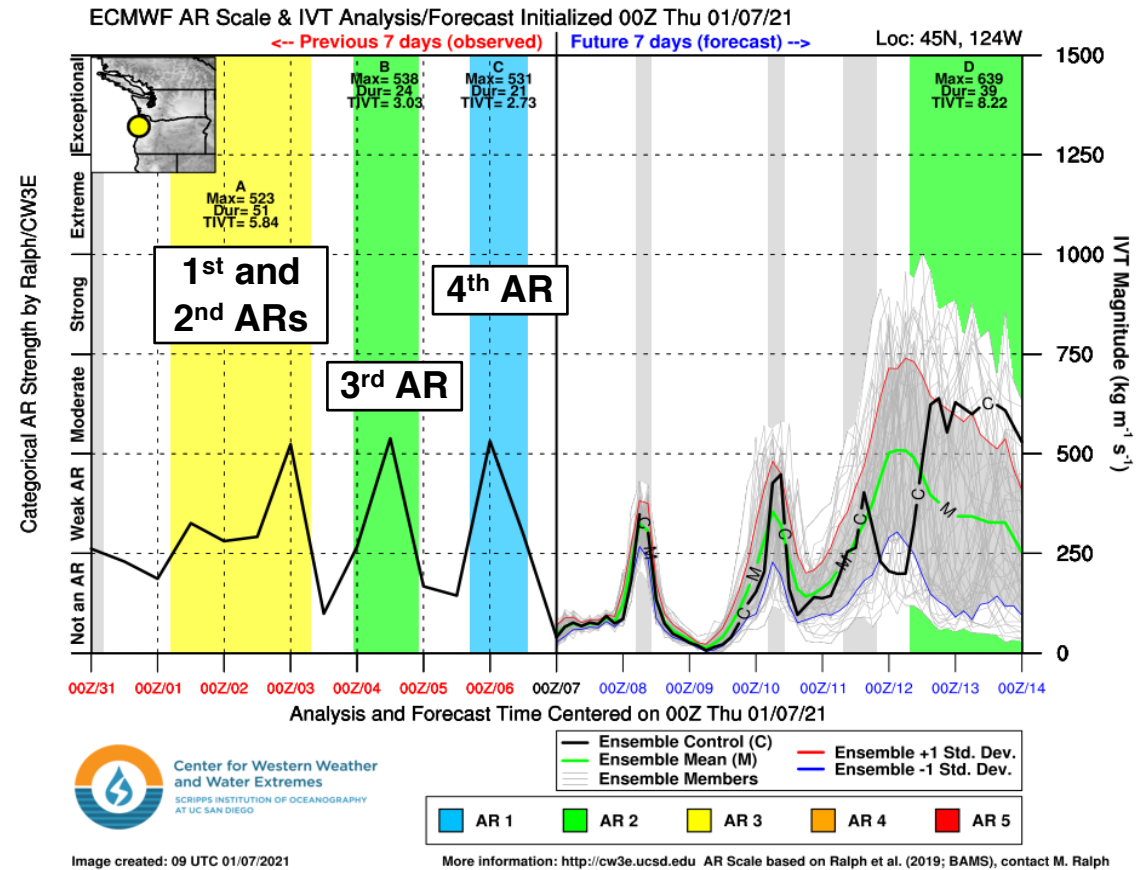
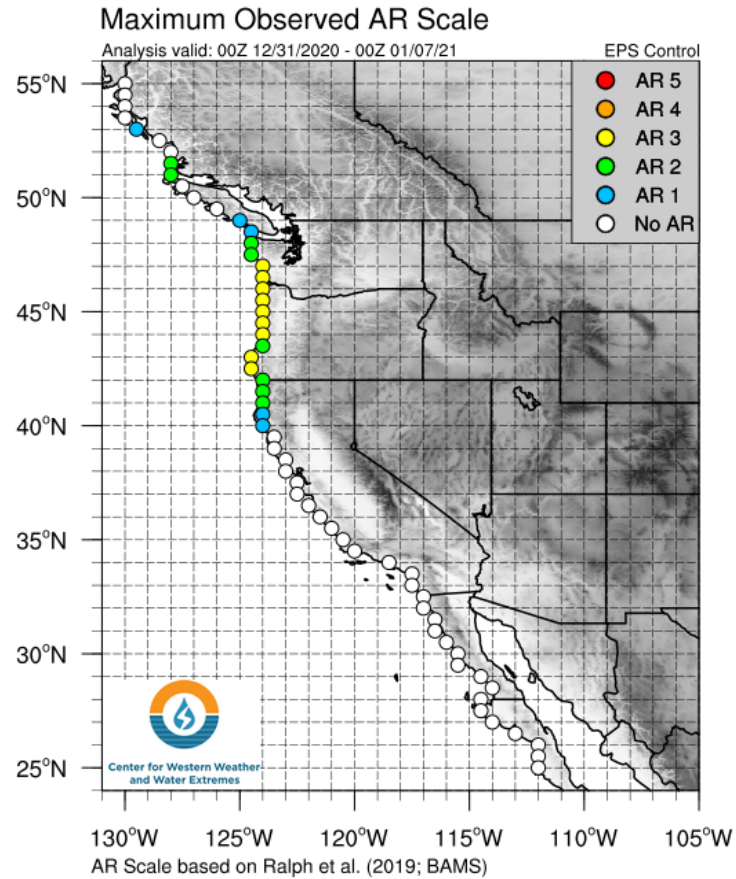
Valid: 0600 UTC 4 Jan 2021

Valid: 1800 UTC 5 Jan 2021



- Multiple ARs formed in association with a series of cyclogenesis events over the Northeast Pacific Ocean
- The first AR made landfall downstream of a surface cyclone in the Gulf of Alaska around 12Z 1 Jan
- A second, zonally elongated AR made landfall on the poleward side of a surface anticyclone around 18Z 2 Jan
- The third and fourth ARs followed similar trajectories and made landfall around 06Z 4 Jan and 18Z 5 Jan, respectively
- The most significant impacts (heavy precipitation, flooding, and landslides) were associated with the second AR

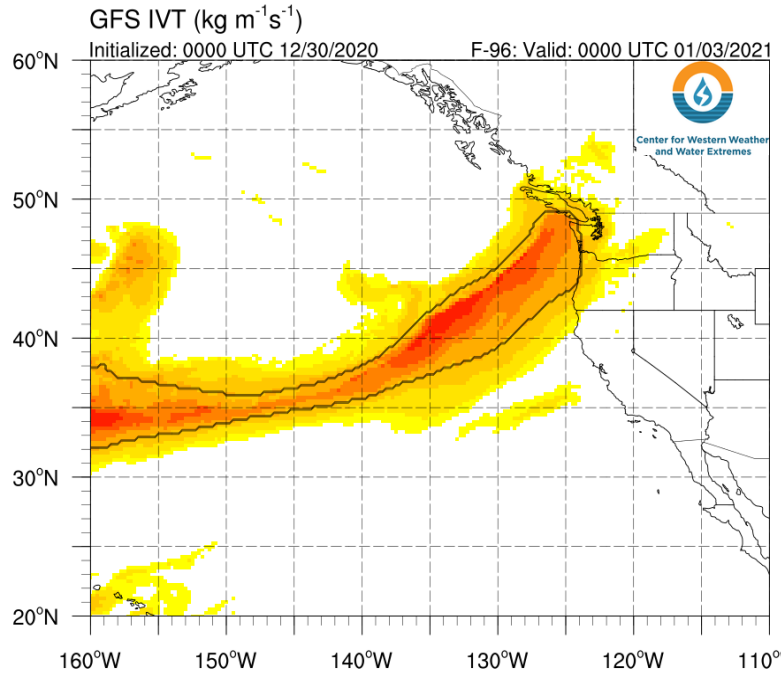
ECMWF AR Scale & IVT Analyses



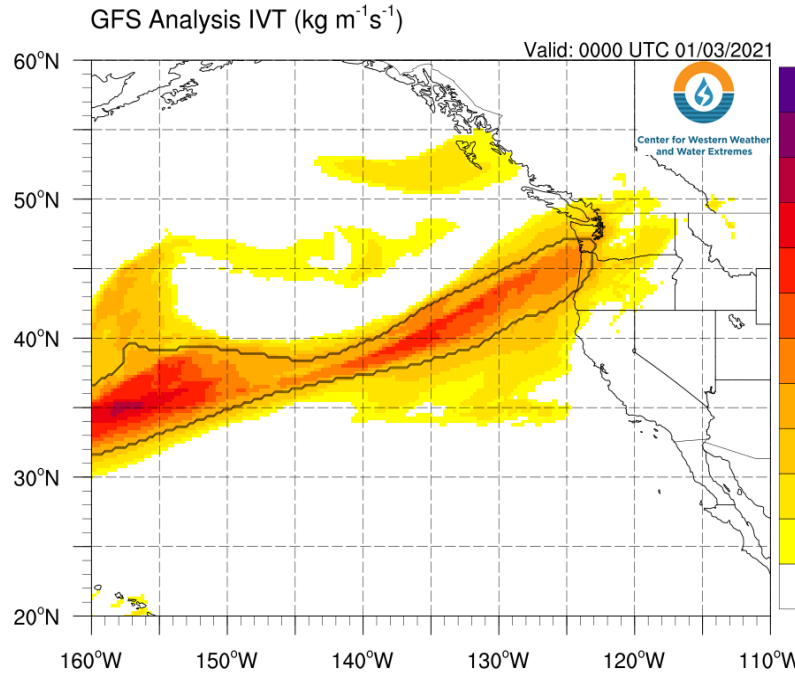
- The first and second ARs brought a prolonged period (≥ 48 hours) of continuous AR conditions ($\text{IVT} \geq 250 \text{ kg m}^{-1} \text{ s}^{-1}$) to portions of coastal Oregon and Washington, resulting in an AR 3 on the Ralph et al. 2019 AR Scale
- The third AR produced AR 2/AR 3 conditions in southern and central coastal Oregon

AR/IVT Forecast Verification

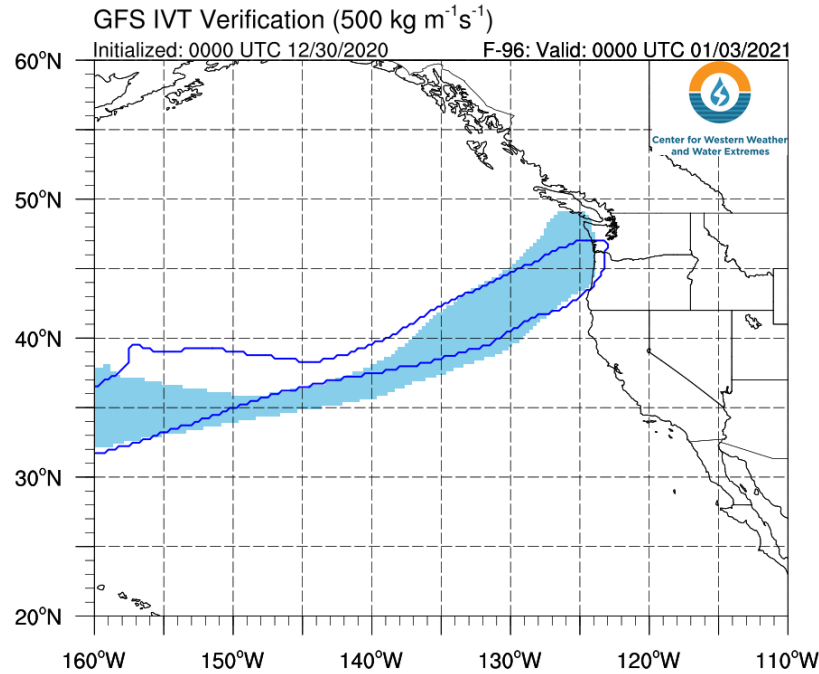
GFS IVT 96-h Forecast
Initialized: 0000 UTC 30 Dec 2020



GFS IVT Analysis
Valid: 0000 UTC 3 Jan 2021



GFS IVT Object Verification
IVT $\geq 250 \text{ kg m}^{-1} \text{ s}^{-1}$



- The overall structure, IVT magnitude, and timing of the second AR was well-forecasted at a 4-day (96-h) lead time
- The actual landfall location over northwestern Oregon and southwestern Washington was forecasted within 200 km
- The orientation of the observed AR was more zonal than the orientation of the forecasted AR

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

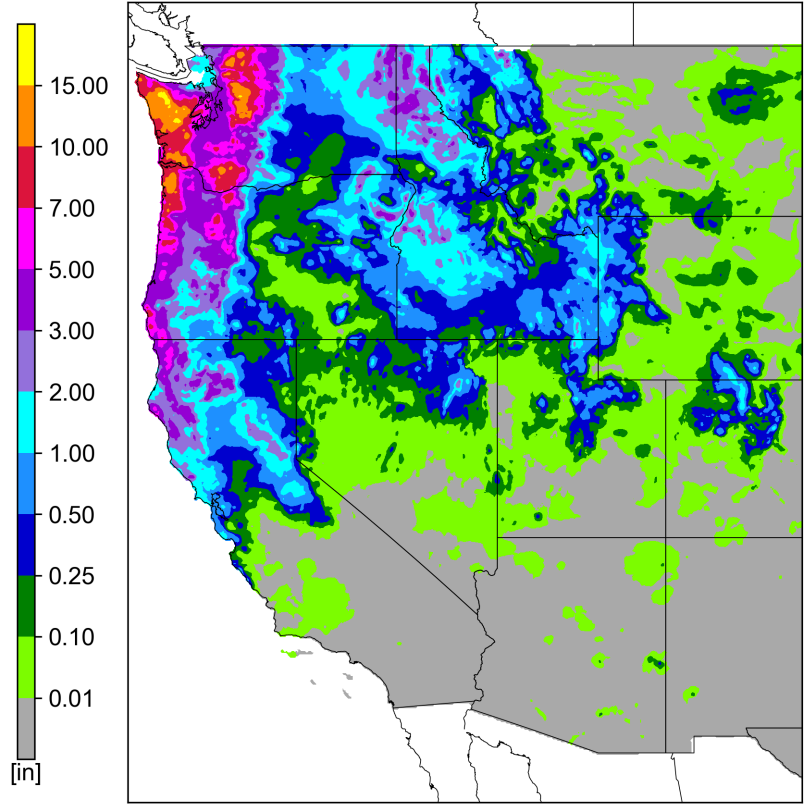
Contours = observed AR objects (black if no AR forecasted)

Event Summary: 1–7 Jan 2021

For California DWR's AR Program

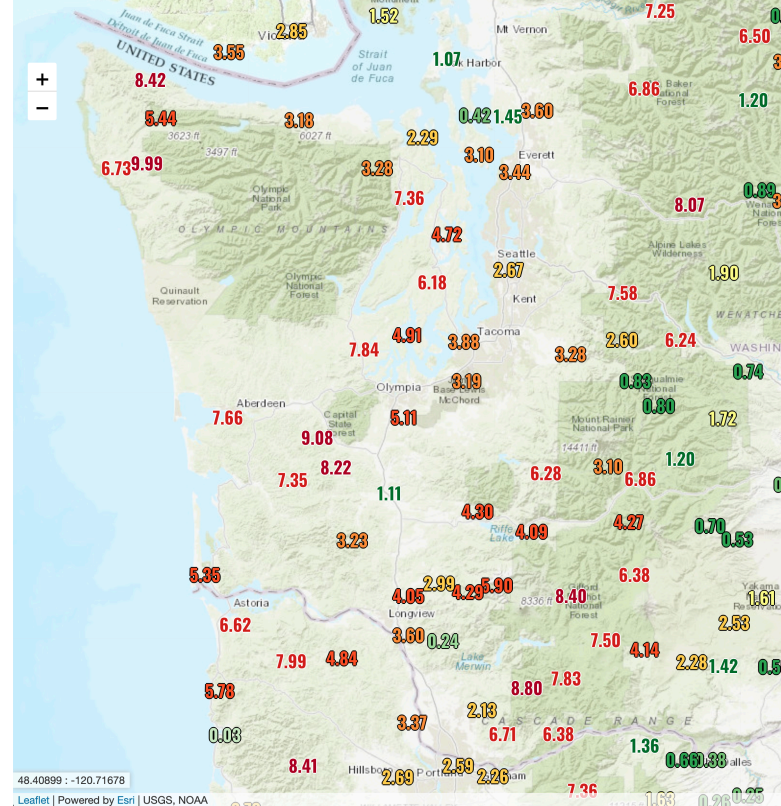
NCEP Stage IV 7-day QPE

Valid: 1200 UTC 31 Dec 2021 – 7 Jan 2021



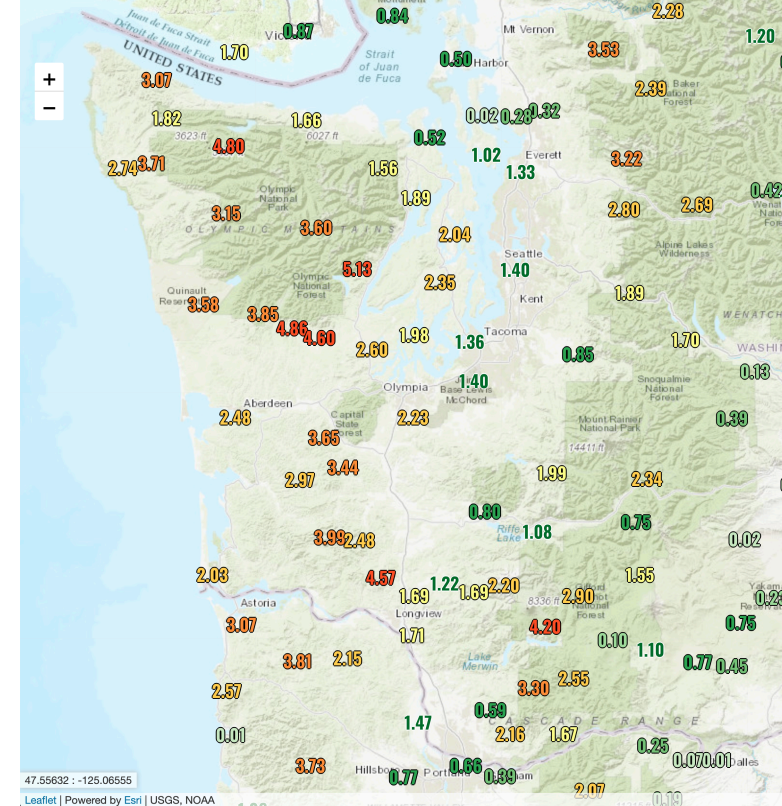
7-day Precipitation (Raw)

Valid: 1200 UTC 31 Dec 2021 – 7 Jan 2021



1-day Precipitation (Raw)

Valid: 12 AM PST 2 Jan – 12 AM PST 3 Jan

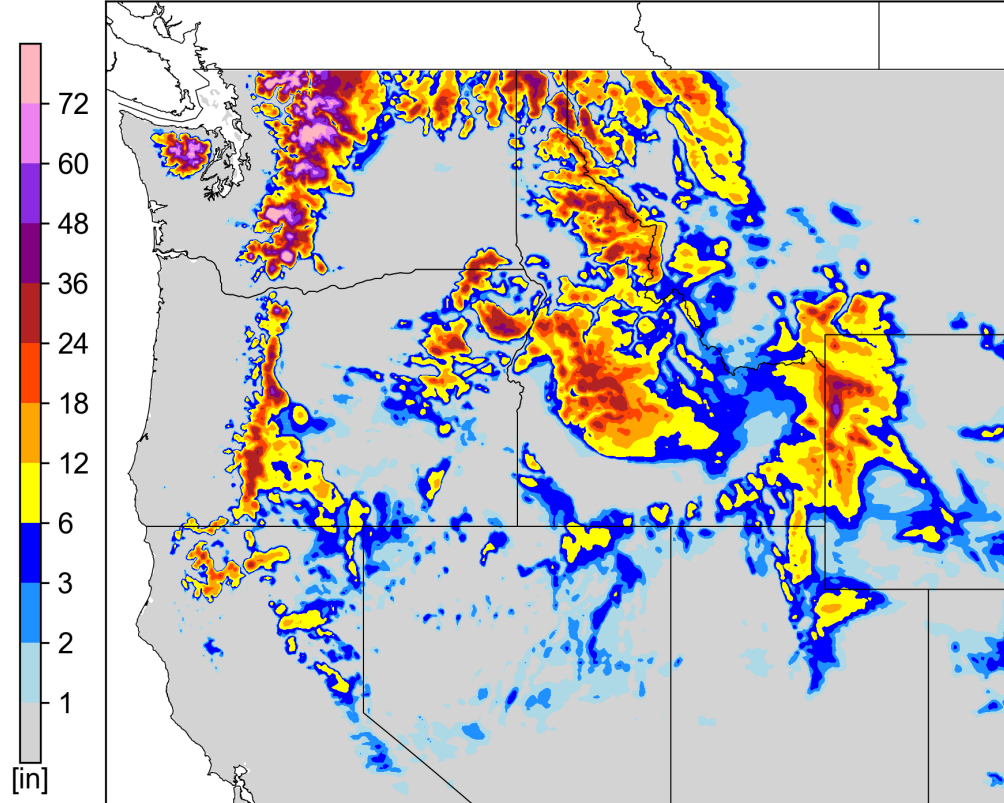


Source: NOAA/NWS Western Region Headquarters, <https://www.wrh.noaa.gov/map/>

- These storms produced at least 2–7 inches of total precipitation across much of northwestern California, western Oregon, and western Washington, with the highest amounts (> 10 inches) over the Olympic Mountains and North Cascades
- The heaviest precipitation fell on 2 Jan in association with the second AR
- Quillayute Airport (2.77 inches), Hoquiam Airport (2.72 inches), Olympia Airport (2.26 inches), and WFO Seattle (1.21 inches) all set new daily precipitation records for 2 Jan

NOHRSC 7-day Interpolated Snowfall

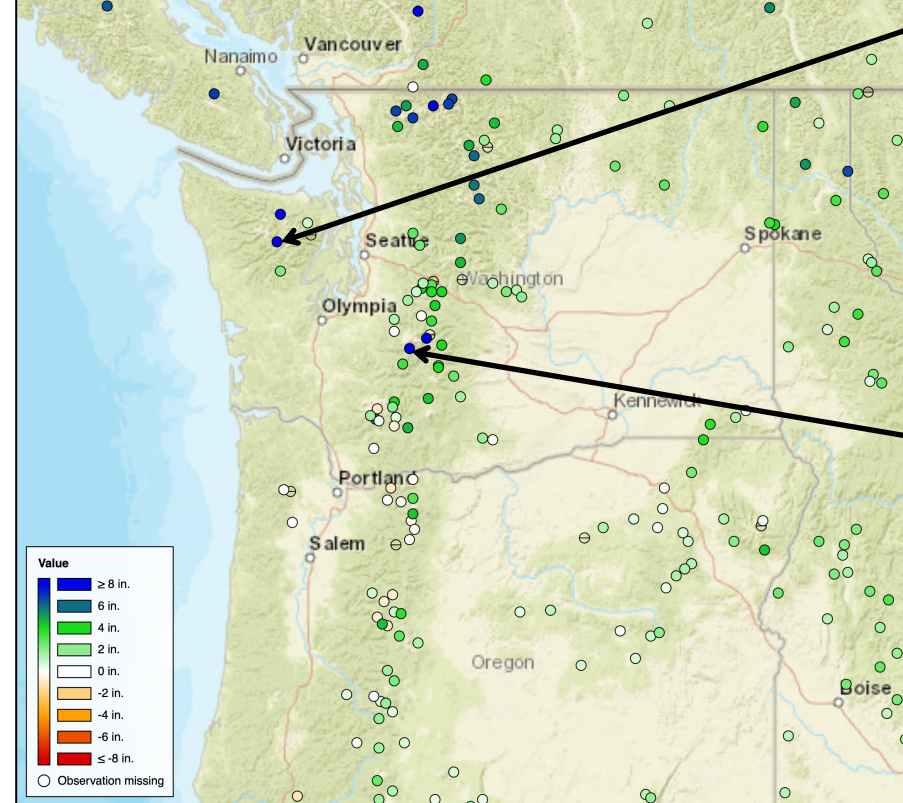
Valid: 1200 UTC 31 Dec 2020 – 7 Jan 2021



Source: NOAA/NWS NOHRSC, <https://www.nohrsc.noaa.gov/>

USDA-NRCS 5-day SWE Change

Valid: 1–6 Jan 2021 (Start of Day)



Source: USDA NRCS National Water and Climate Center, <https://www.wcc.nrcs.usda.gov/>

Buckinghamhorse SNOTEL (4870 ft)

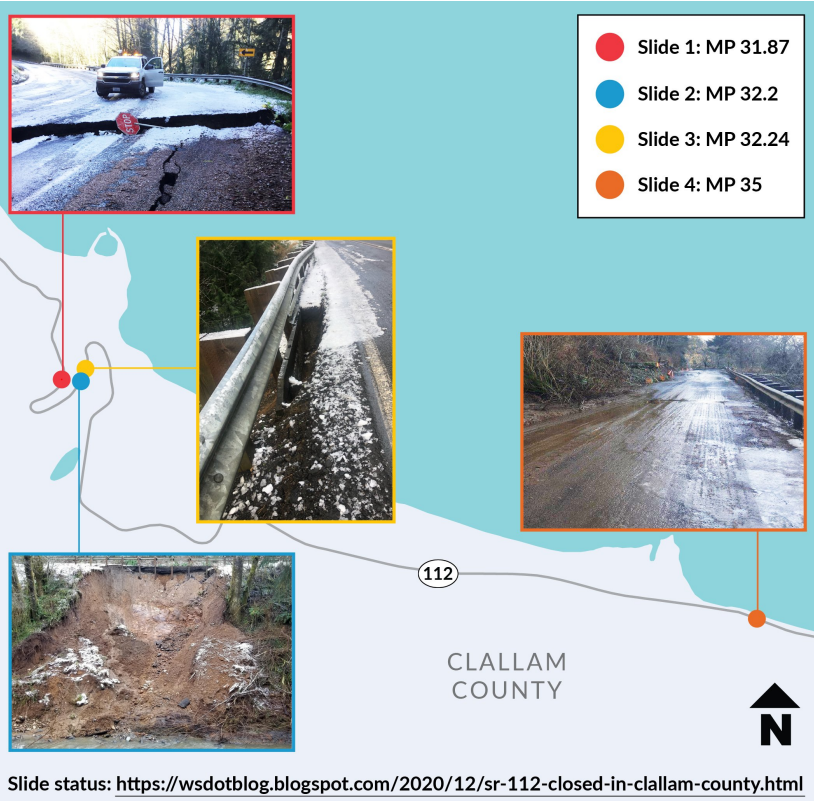
Date	Buckinghamhorse (1107) Snow Water Equivalent (in) Start of Day Values	Buckinghamhorse (1107) Snow Depth (in) Start of Day Values	Buckinghamhorse (1107) Precipitation Accumulation (in) Start of Day Values
2021-01-01	26.1	86	53.0
2021-01-02	27.5	86	54.8
2021-01-03	31.2	100	58.2
2021-01-04	32.1	103	59.0
2021-01-05	34.4	112	61.0
2021-01-06	37.3	125	61.1

Paradise SNOTEL (5130 ft)

Date	Paradise (679) Snow Water Equivalent (in) Start of Day Values	Paradise (679) Snow Depth (in) Start of Day Values	Paradise (679) Precipitation Accumulation (in) Start of Day Values
2021-01-01	33.7	83	48.4
2021-01-02	35.3	90	49.3
2021-01-03	38.2	100	49.9
2021-01-04	39.3		49.9
2021-01-05	41.3		54.0
2021-01-06	42.2		53.9

- At least 1–3 feet of total snow fell across the higher terrain of the Olympic Mountains, Cascades, and interior northwestern U.S.
- Some areas in the Olympic Mountains and Washington Cascades received more than 5 feet of total snowfall
- The Buckinghamhorse and Paradise SNOTEL sites recorded 5-day SWE increases of 11.2 inches and 8.5 inches, respectively, between 1 Jan and 6 Jan

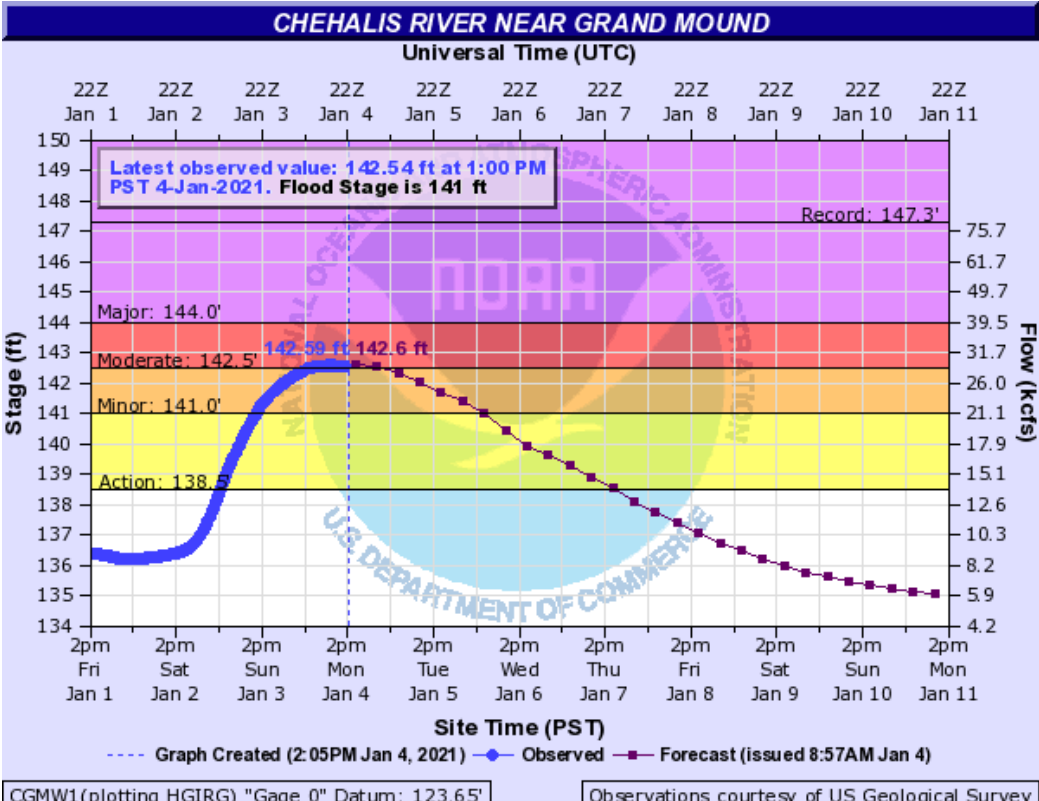
Landslides on SR 112



Landslide on SR 2



Flooding on Chehalis River



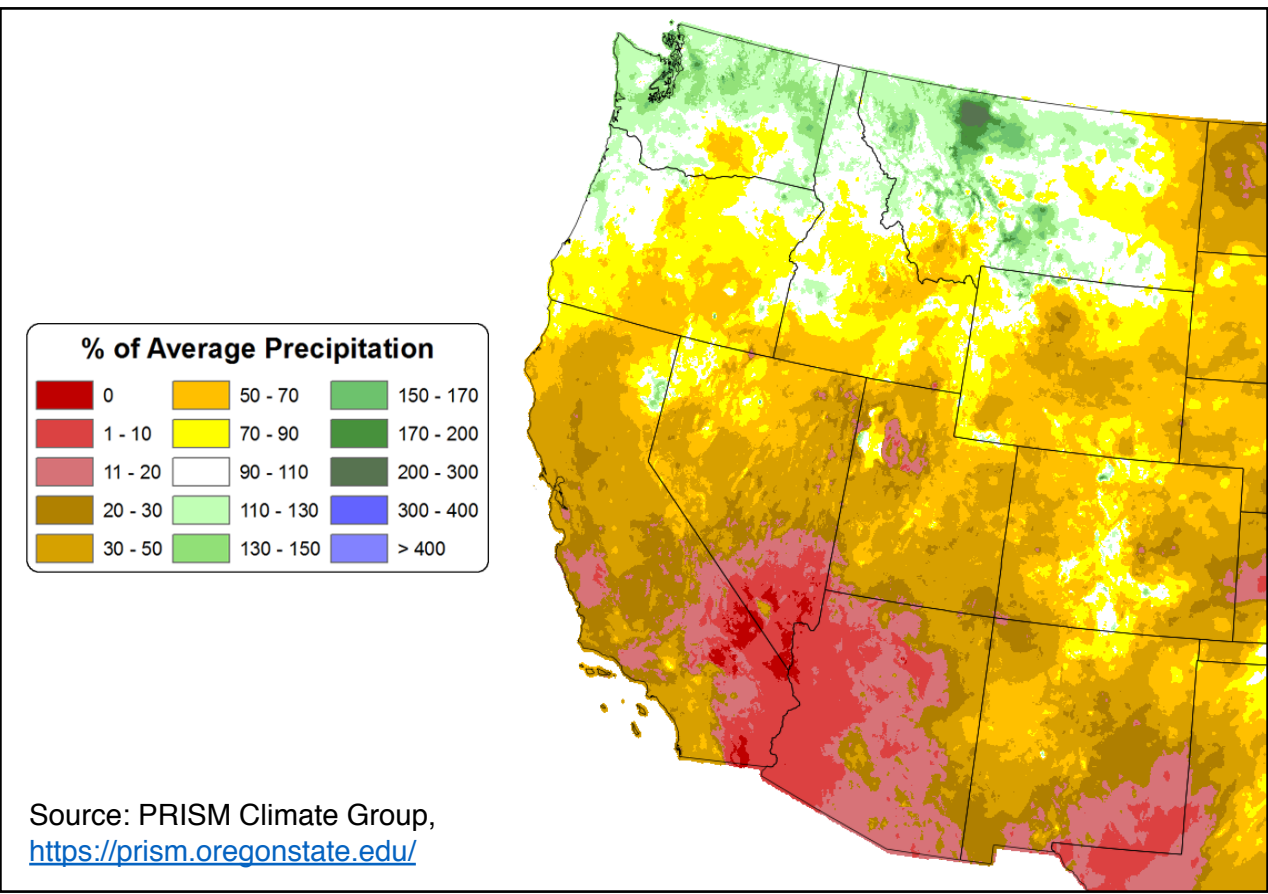
Source: Washington State DOT, <https://wsdot.wa.gov/>

Source: Washington State Patrol, <https://wsp.wa.gov/>

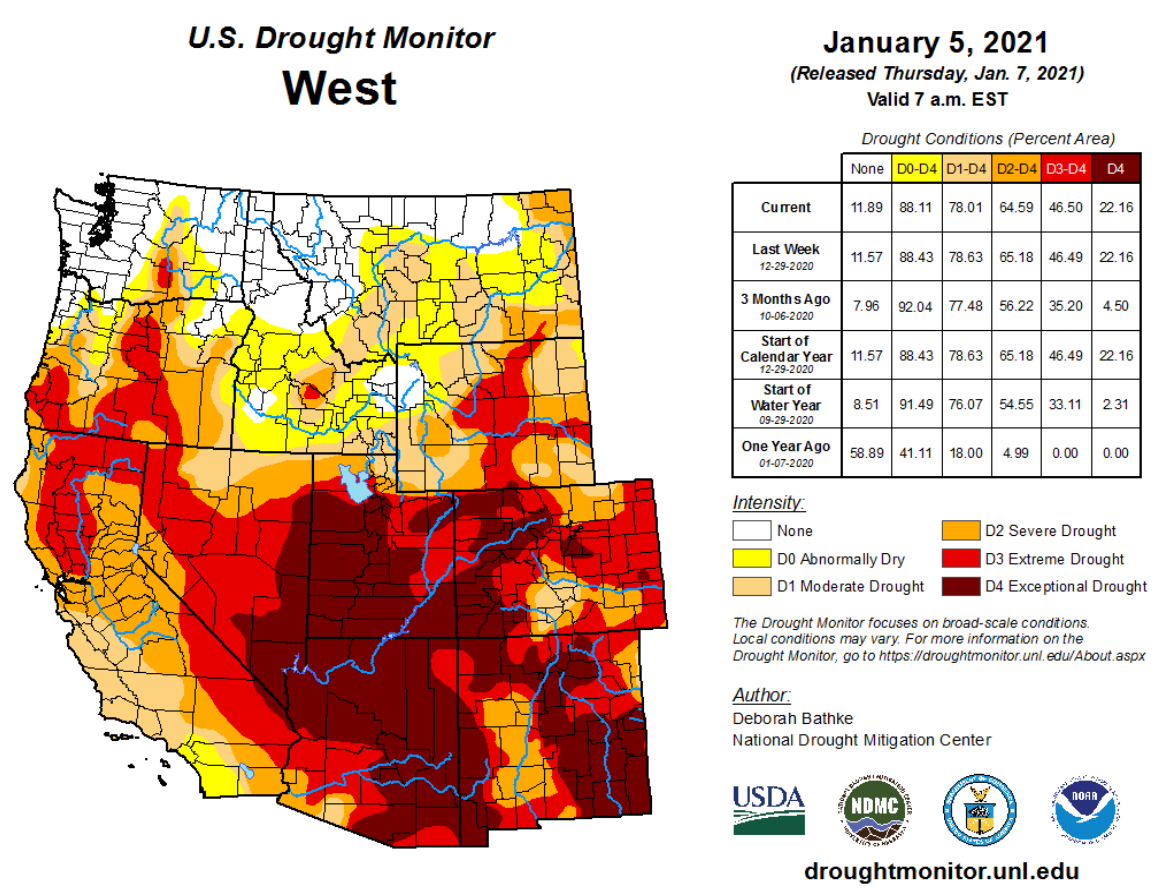
Source: NOAA/NWS AHPS, <https://water.weather.gov/ahps/>

- Intense precipitation caused river flooding and landslides in western Washington
- Landslides resulted in road closures on SR 112 in Clallam County and SR 2 near Leavenworth, WA
- The Chehalis River (near Grand Mound, WA) reached moderate flood stage (142.5 ft; peak stage: 142.59 ft) on 4 Jan, and remained above flood stage (141.0 ft) for ~72 consecutive hours

% of Average Water Year Precipitation (6 Jan 2021)



U.S. Drought Monitor (5 Jan 2021)



- As of 6 Jan 2021, total water year (since 1 Oct 2020) precipitation is significantly below average throughout the southwestern U.S., while wetter-than-normal conditions have been observed across Washington, northern Idaho, and western Montana
- The lack of precipitation has exacerbated drought conditions, particularly over the Four Corners Region