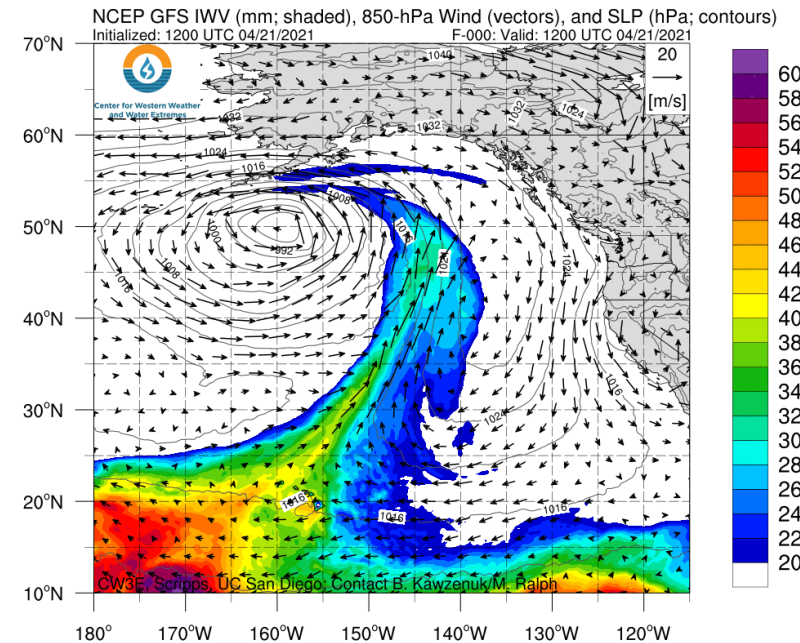
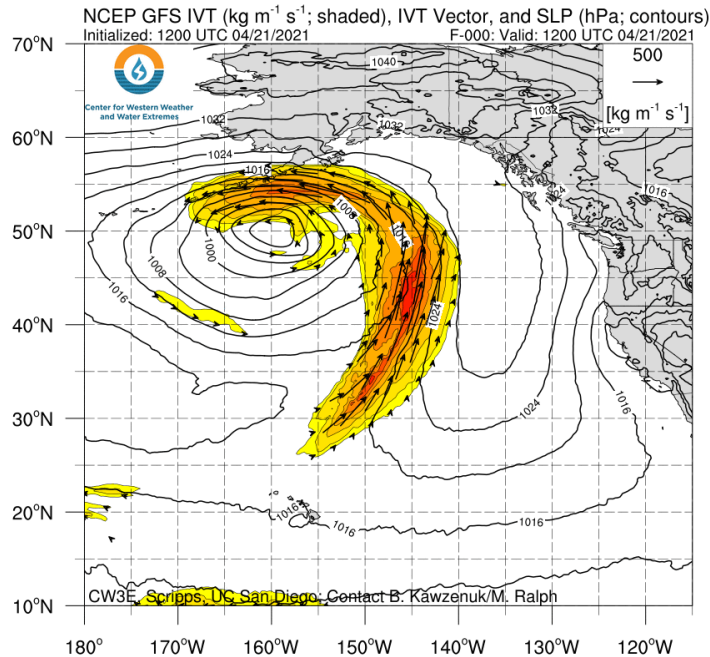


Multiple Atmospheric Rivers Forecast to impact U.S. West over Next Week

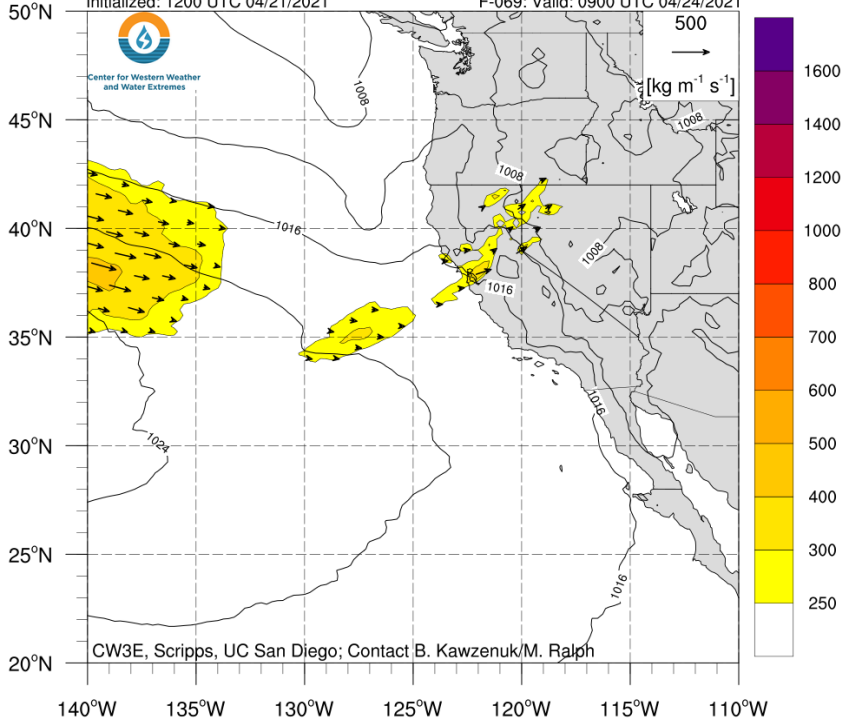
- Three ARs are forecast to make landfall over different locations across the U.S. West, bringing much needed precipitation to drought-stricken California
- The first and weakest AR is forecast to bring dissipating, disorganized, and brief AR conditions to Northern California on 24 April, resulting in <1 inch for much of the Northern CA mountains
- The Second AR is forecast to make landfall on the 25th, bringing as much as 2 inches of precipitation to Northern California
- The third AR is forecast to make landfall over the Pacific Northwest on April 28th and could bring IVT magnitudes >700 kg m⁻¹ s⁻¹ to coastal Oregon, through ensemble uncertainty is currently high.



GFS IVT/IWV Analyses and Forecasts

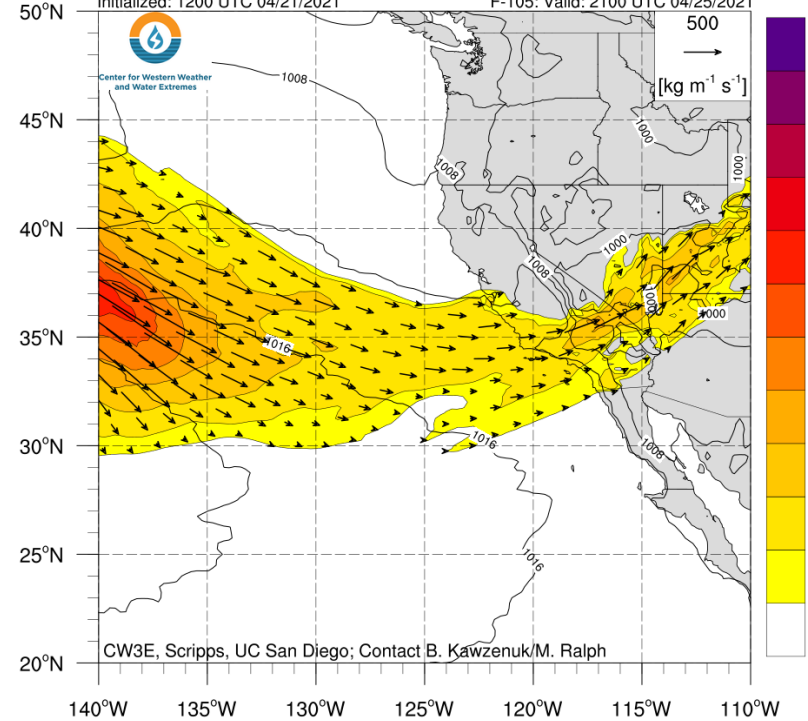
(A) Valid: 0900 UTC 24 April (F-69)

NCEP GFS IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded), IVT Vector, and SLP (hPa; contours)
Initialized: 1200 UTC 04/21/2021 F-069: Valid: 0900 UTC 04/24/2021



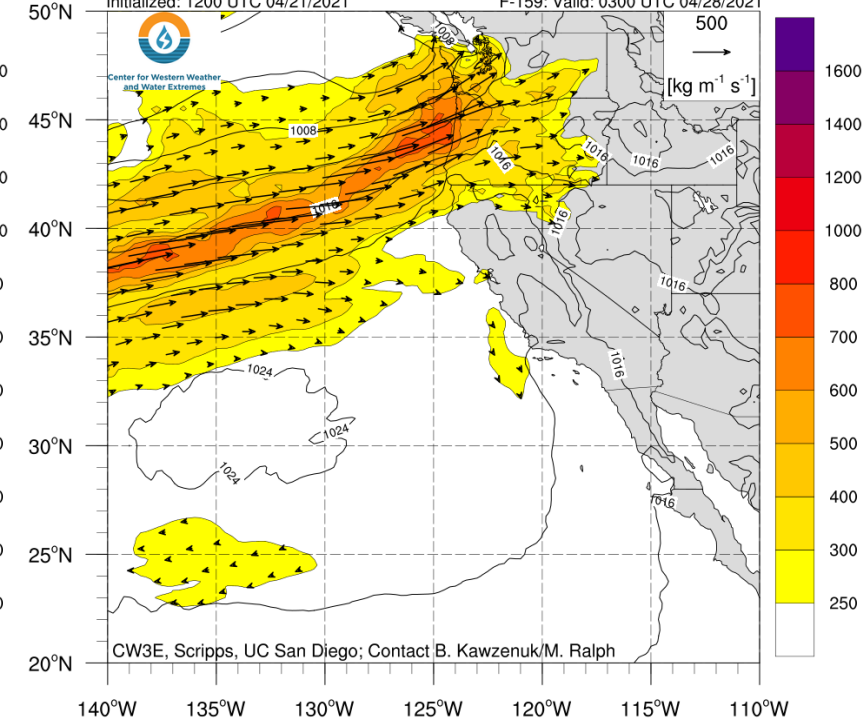
(B) Valid: 2100 UTC 25 April (F-105)

NCEP GFS IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded), IVT Vector, and SLP (hPa; contours)
Initialized: 1200 UTC 04/21/2021 F-105: Valid: 2100 UTC 04/25/2021



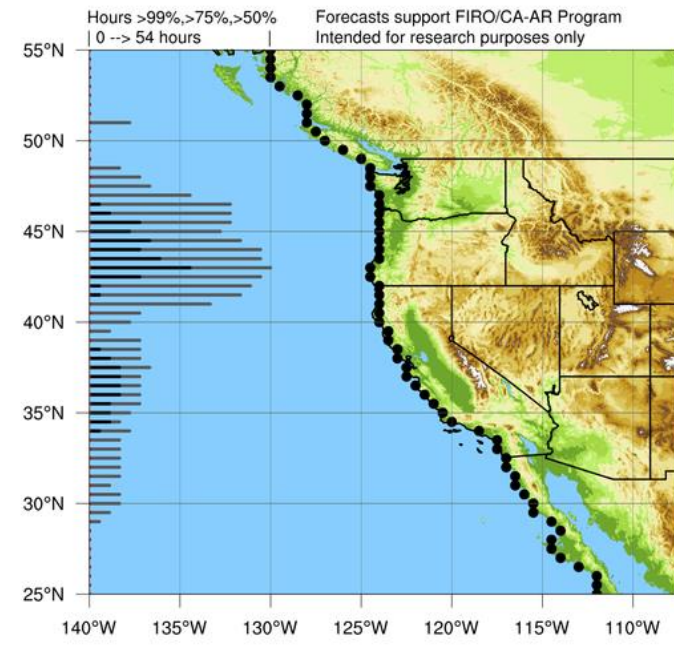
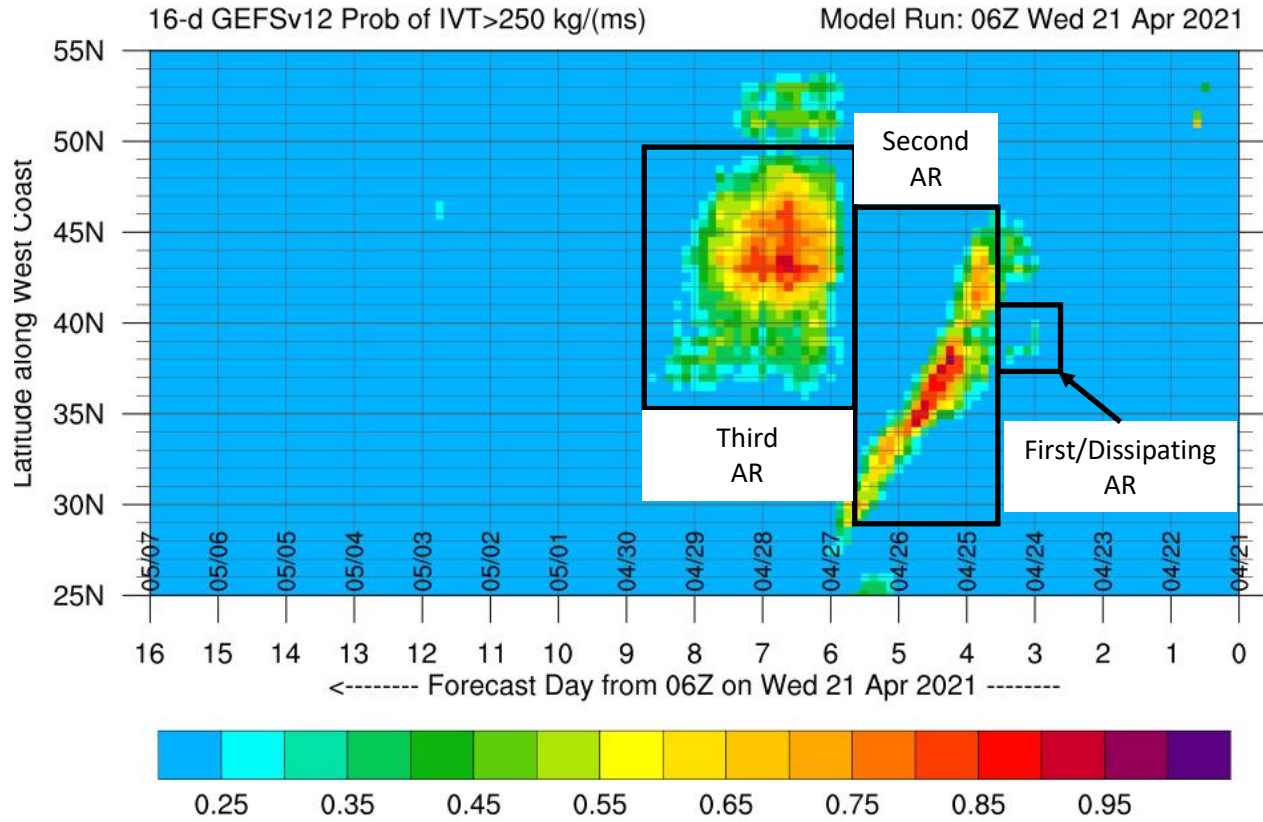
(C) Valid: 0300 UTC 21 April (F-159)

NCEP GFS IVT ($\text{kg m}^{-1} \text{s}^{-1}$; shaded), IVT Vector, and SLP (hPa; contours)
Initialized: 1200 UTC 04/21/2021 F-159: Valid: 0300 UTC 04/28/2021



- The first chance of precipitation during this active stretch comes as a dissipating AR moves inland and brings upslope moisture flux to much of Northern California at ~9 UTC (2 AM PT) 24 April (Figure A)
- A second and more organized AR is forecast to make landfall over Central California before bringing weak AR conditions to a majority of S. CA at ~21 UTC (2 PM PT) 25 April (Figure B)
- A third and stronger AR is then forecast to make landfall over the Pacific Northwest on the 27th/28th and could potentially bring IVT $>700 \text{ kg m}^{-1} \text{ s}^{-1}$ to coastal Oregon

Probability of AR Conditions Along Coast

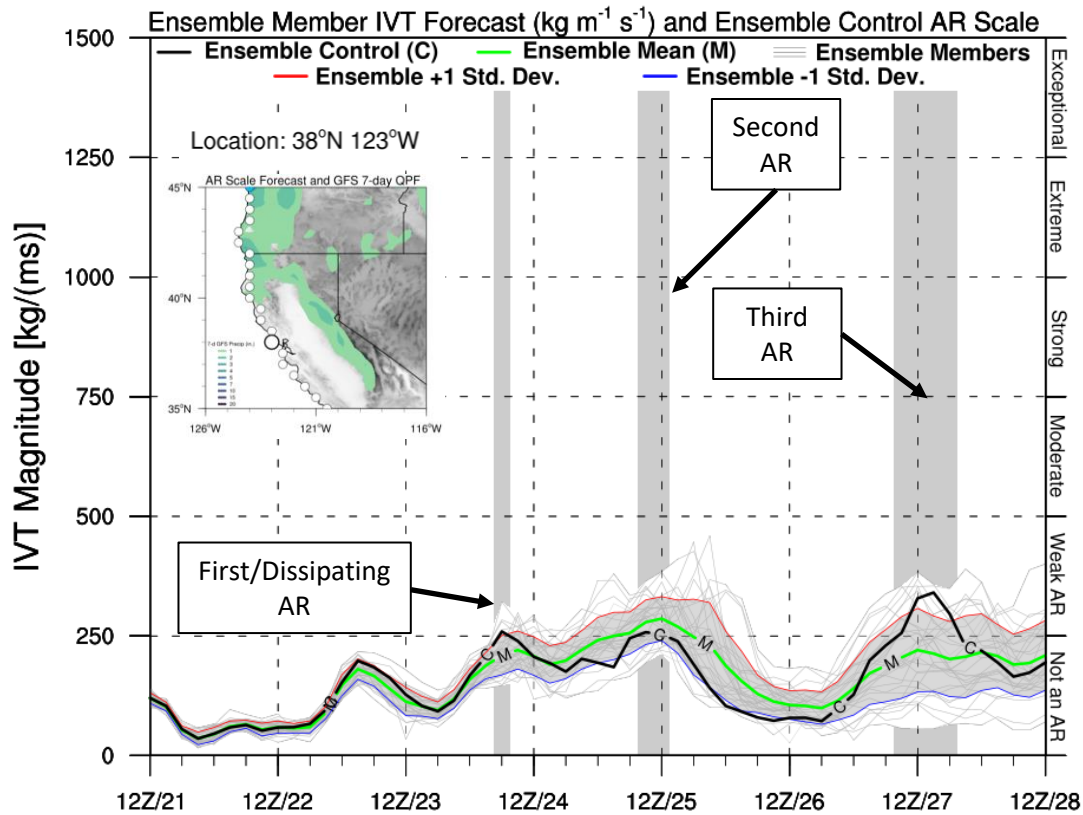


*GEFS = NCEP Global Ensemble Forecast System (United States)

- The GEFS is indicating three separate periods of potential AR activity (AR conditions= $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$) over a 7-day stretch from 24 to 29 April
- The first and dissipating AR is currently exhibiting the lowest forecast confidence, with only a few brief timesteps with probabilities $> 25\%$ between 23 and 24 April
- During the second AR, the GEFS is suggesting the highest ensemble probabilities ($> 80\%$) over Northern to Central CA, and lower probabilities (25–80%) over Southern Oregon and Southern California
- The GEFS suggests the third AR could be a longer duration event, though there less ensemble agreement surrounding the onset and end time of AR conditions

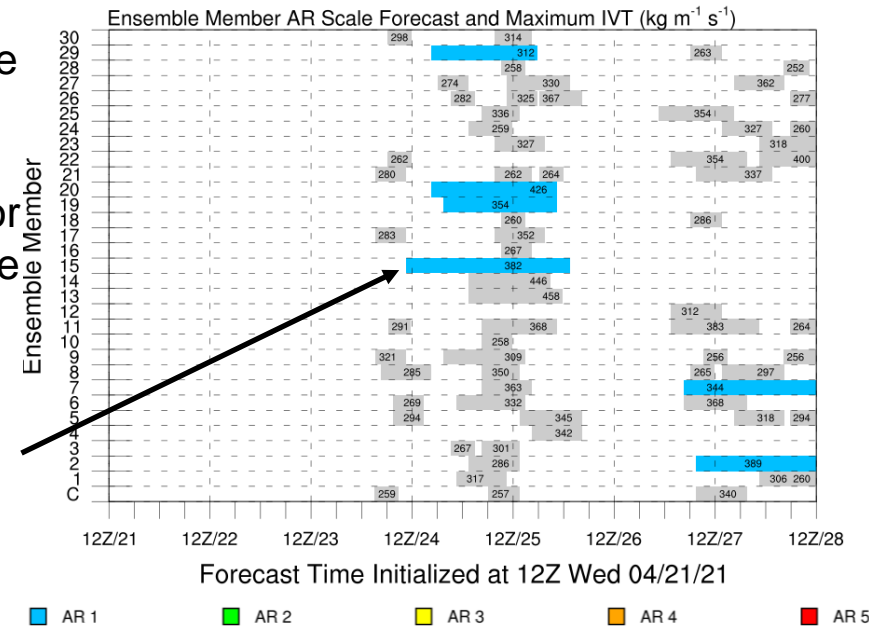
GEFS IVT Plume and AR Scale Forecasts

GFS Ensemble Initialized: 12Z Wed 04/21/21



Categorical AR Strength by Ralph/CW3E

- The GEFS is currently illustrating high ensemble uncertainty surrounding the overall onset, magnitude and duration of AR conditions for each AR that is forecast to impact Northern CA
- During the first AR, only a few ensemble members have IVT rising above $250 \text{ kg m}^{-1} \text{ s}^{-1}$
- There is a higher probability of $\text{IVT} > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ during the second AR, though there are large ensemble differences pertaining to the timing of the peak
- Similar to the second AR, there is currently large ensemble spread in timing and magnitude associated with the third event as the AR propagates down the U.S. West Coast
- There is also a low probability that any of the three forecast ARs will produce AR conditions that are strong enough or long enough to fall on the AR Scale
- The GEFS has 4 ensemble members that are forecasting AR 1 conditions for North-Coastal CA during the second AR



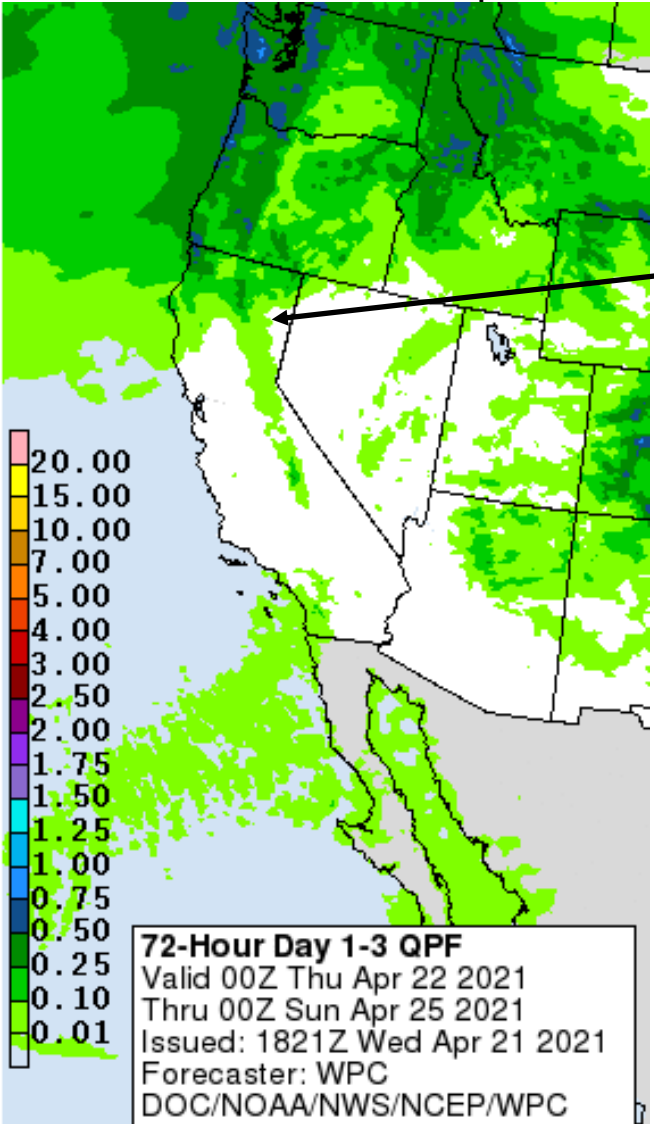
AR Outlook: 21 April 2021



For California DWR's AR Program

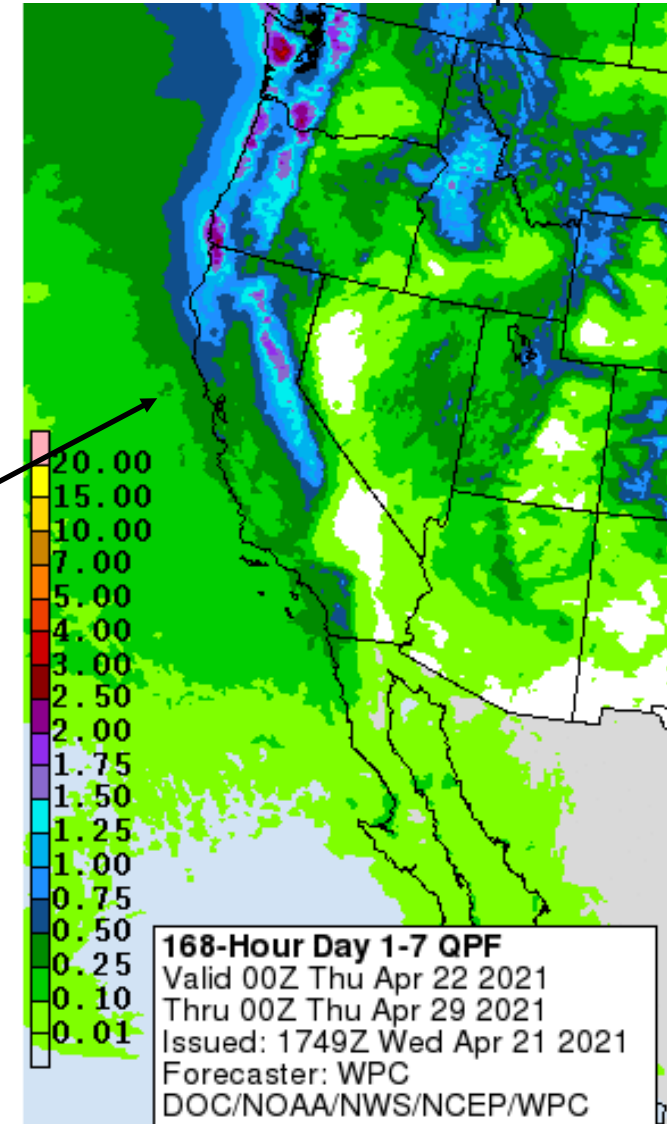
WPC 1-3 Day QPF:
Valid 00Z 22-25 April

WPC 1-7 Day QPF:
Valid 00Z 22-29 April



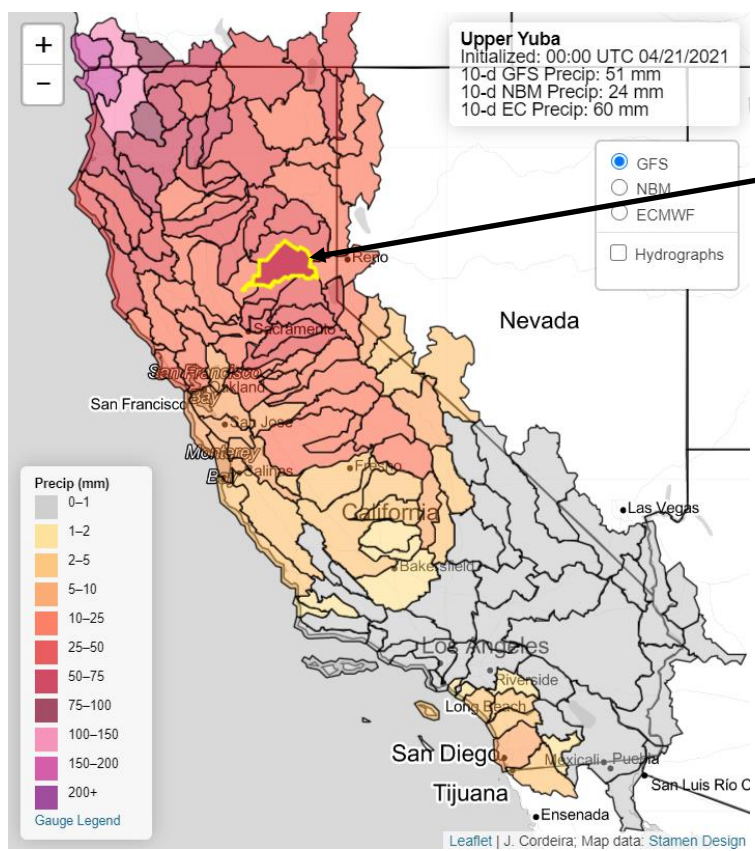
- The NOAA Weather Prediction Center is currently forecasting <0.75 inches of precipitation over much of Northern CA and the Pacific Northwest as the first and dissipating AR moves onshore on 24 April
- The second and third AR (which extends past 7 days) are forecast to produce more precipitation when compared to the first, bringing the 7-day total to as much as 2+ inches over the Northern Sierra, Coast, and Cascade ranges of Northern CA and the Pacific Northwest

Source: NOAA/NWS WPC, <https://www.wpc.ncep.noaa.gov/>

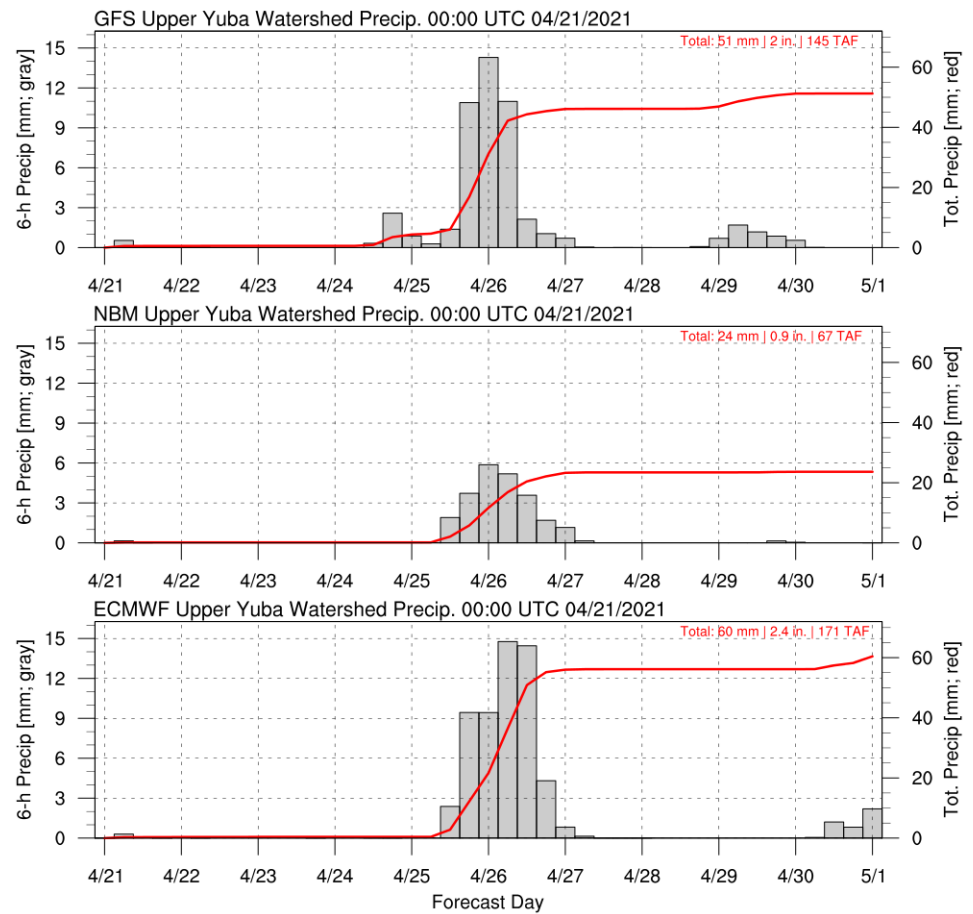


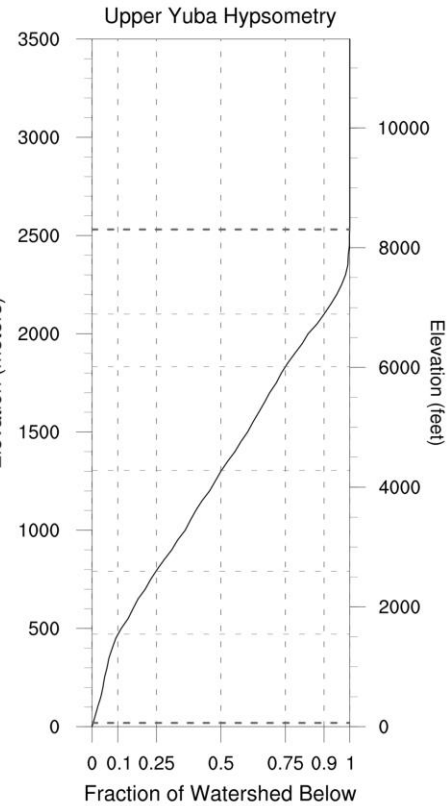
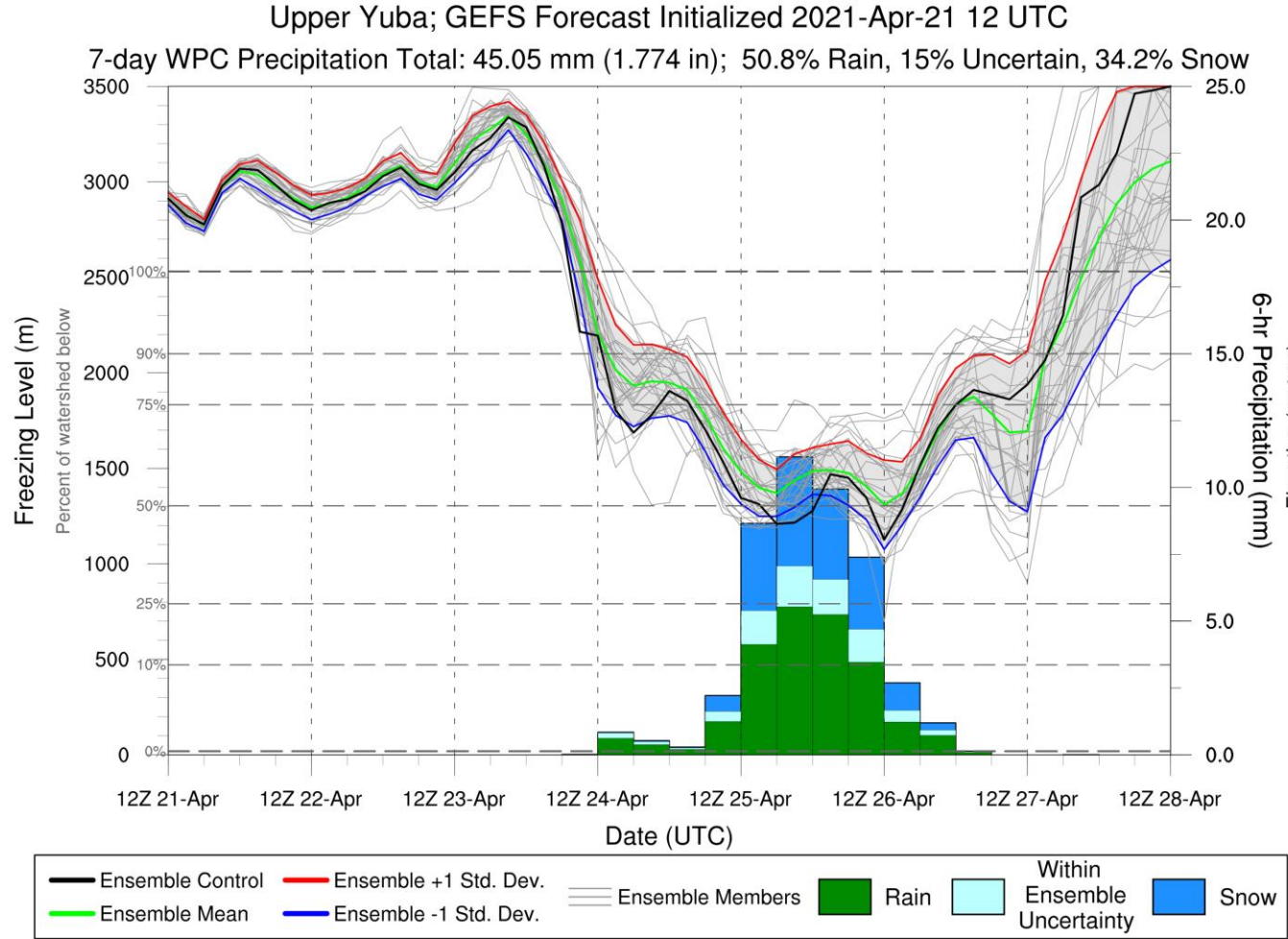
AR Outlook: 21 April 2021

For California DWR's AR Program



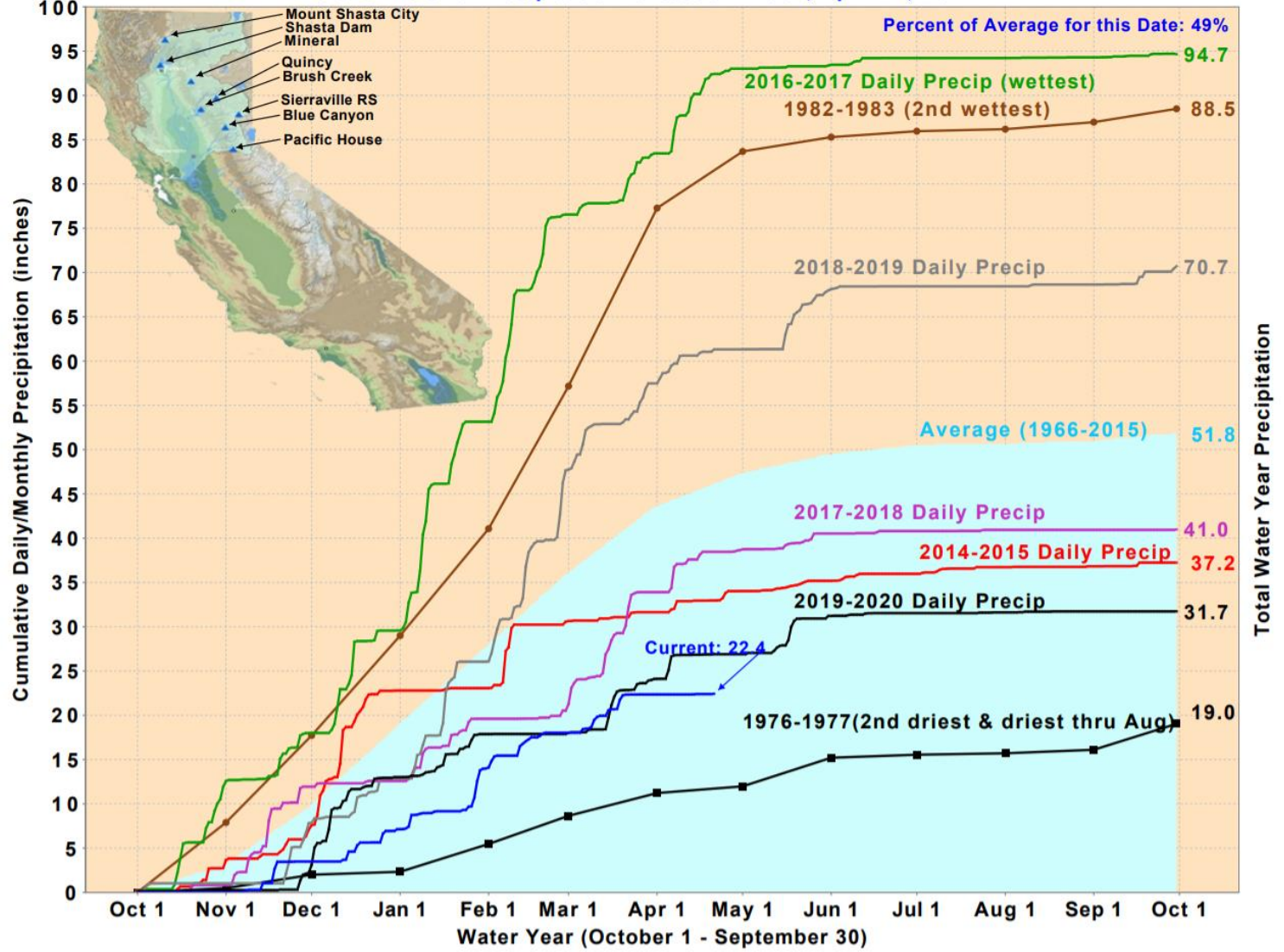
- The Upper Yuba Watershed in Northern California is forecast to receive 2 and 2.4 inches of watershed average precipitation by the GFS and ECMWF, respectively
- The GFS is currently forecasting the first AR to produce ~.2 inches of watershed average precipitation while the ECMWF is forecasting little or no precipitation during the same time period
- Both the EC and GFS suggest the second AR will be more productive, resulting in >2 inches of watershed average precipitation
- The GFS and EC are forecasting the third AR to propagate far enough down the coast to bring light to moderate precipitation to the Upper Yuba watershed, though there is large disagreement on timing





- Freezing levels over the Upper Yuba watershed are forecast to lower to below 5,000 feet during the second AR, which could result in accumulating snow over higher elevations and hazardous travel through the numerous passes across the Northern Sierra

Northern Sierra Precipitation: 8-Station Index, April 21, 2021



- The Northern Sierra 8-Station Index, an important index for California precipitation and water resources, has received well below the normal amount of precipitation for a given water year to this date (<50%)
- While these late season ARs will bring some much-needed precipitation, they will not produce enough precipitation to bring Northern California out of its current deficit