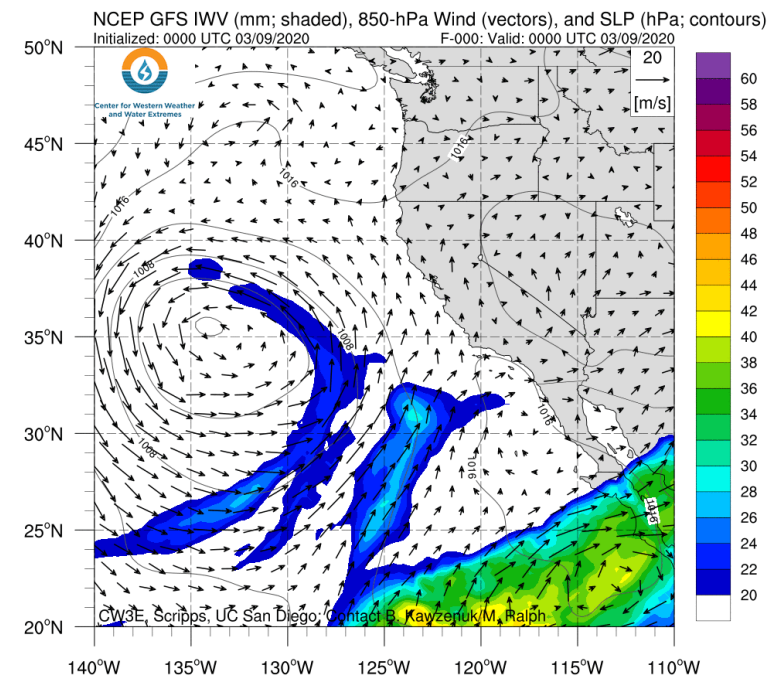
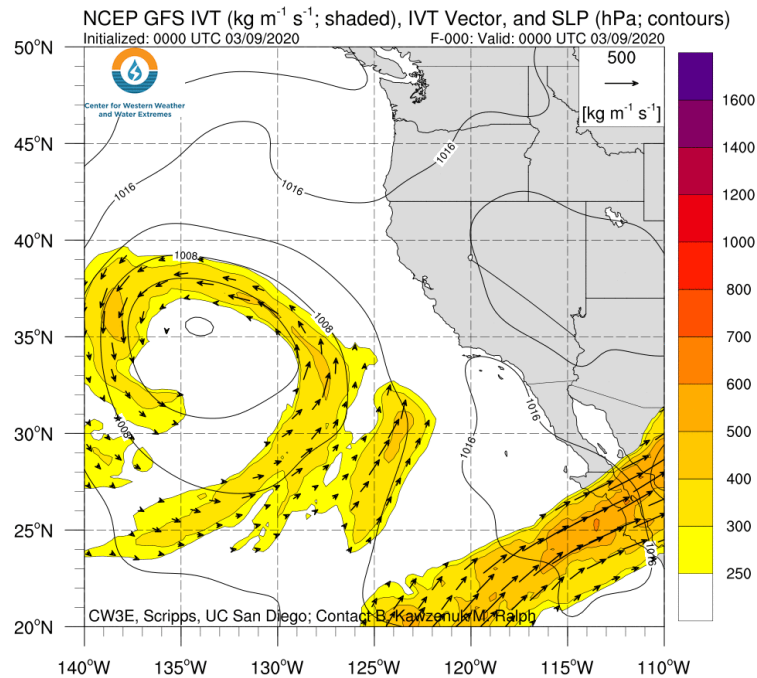




A cutoff low and landfalling AR will bring moderate-to-heavy rainfall to portions of the southwestern U.S.

- The interaction between a cutoff low off the California coast and tropical moisture over the Eastern Pacific will result in a landfalling atmospheric river (AR) over Baja California, Southern California, and Southern Arizona
- Some areas in southern Arizona may experience 48 hours of AR conditions
- The highest precipitation amounts (1–3 inches) are expected in Southern California and the Lower Colorado River Basin
- More than 3 inches of precipitation are possible over the Transverse Ranges, Peninsular Ranges, and higher terrain in central Arizona



AR Outlook: 9 Mar 2020

For California DWR's AR Program

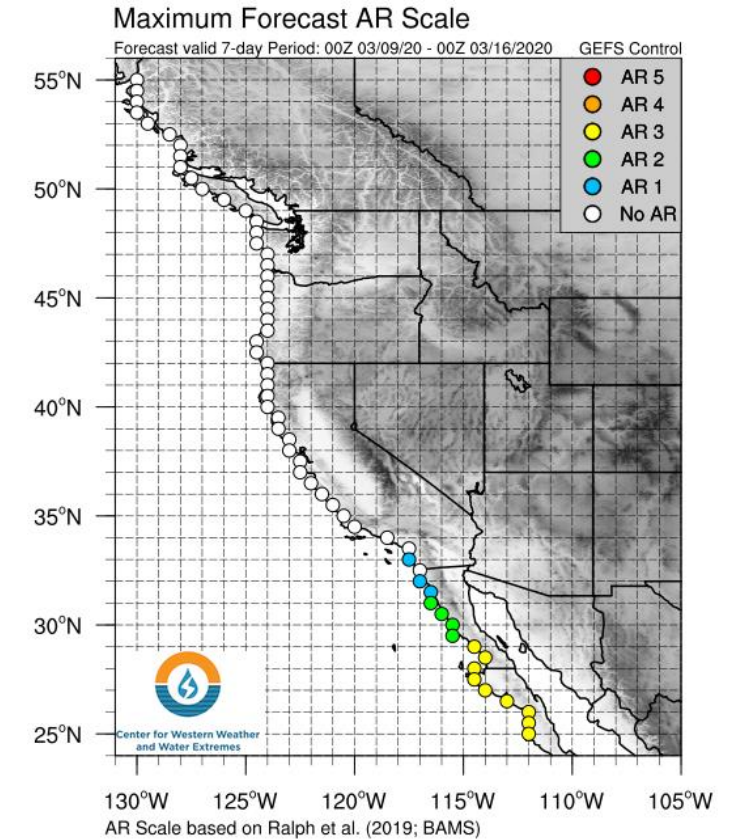
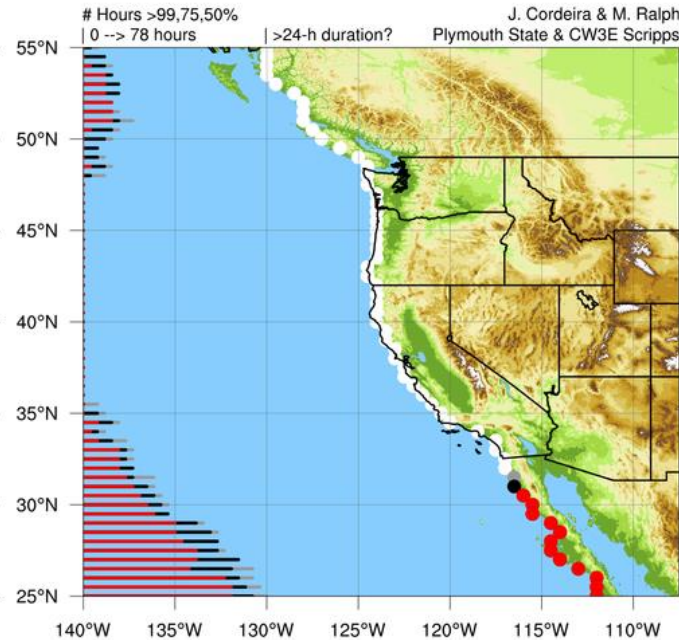
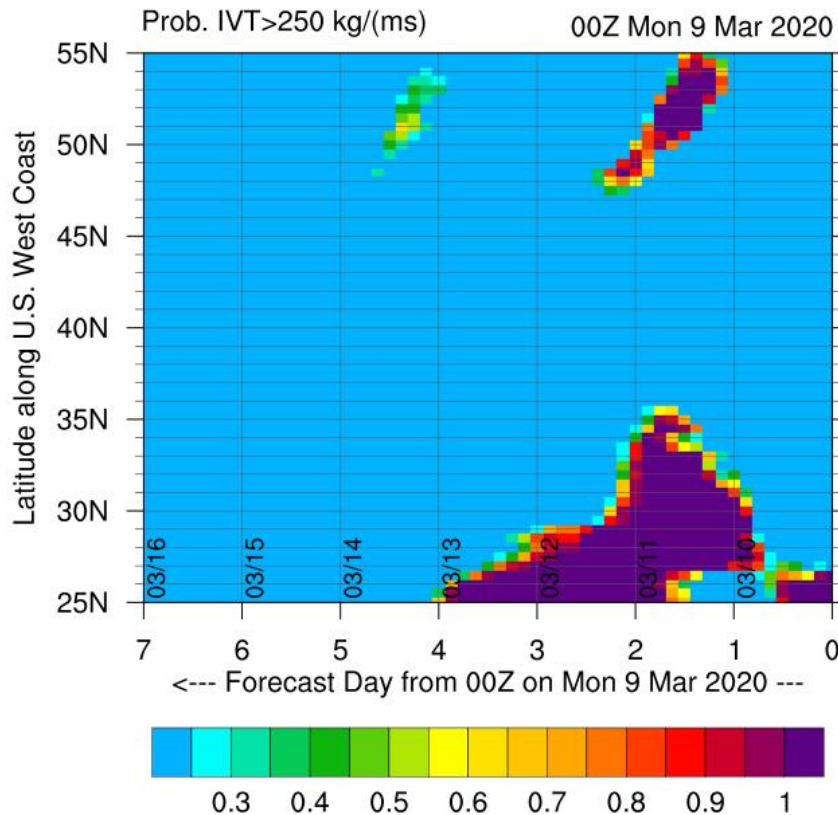


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GEFS AR Landfall Probabilities & AR Scale (Coastal)

*GEFS = Global Ensemble Forecast System



- Coastal AR landfall tool shows high confidence (> 90%) in prolonged period of AR conditions over the Baja Peninsula beginning around 0000 UTC 10 Mar
- A shorter period of AR conditions is also very likely (> 70% probability) over Southern California, but there is some uncertainty in the timing and northward extent of AR conditions
- GEFS control run is currently forecasting AR2/AR3 conditions over the Baja Peninsula and AR0/AR1 conditions over Southern California

AR Outlook: 9 Mar 2020

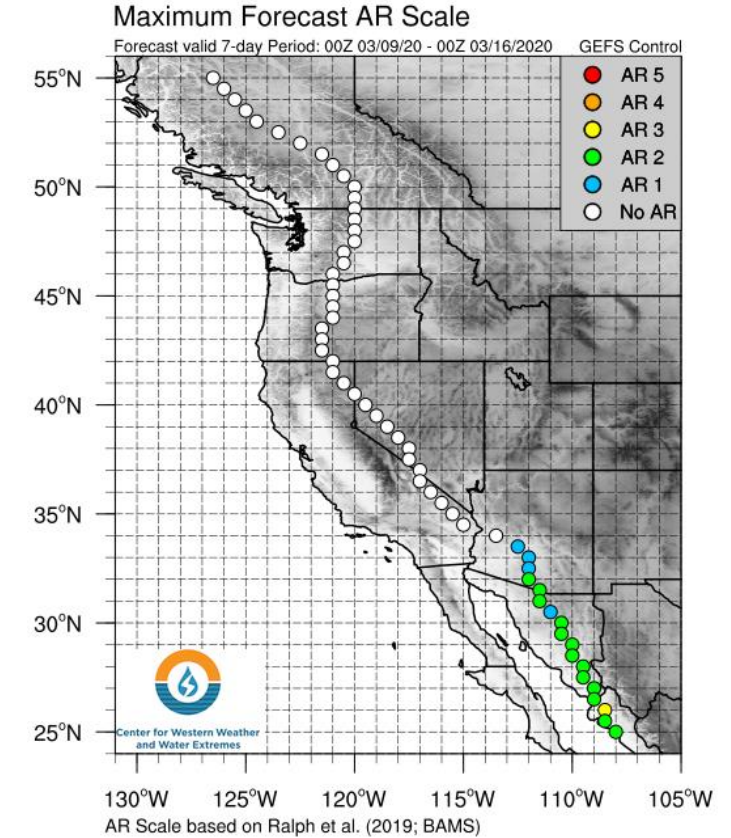
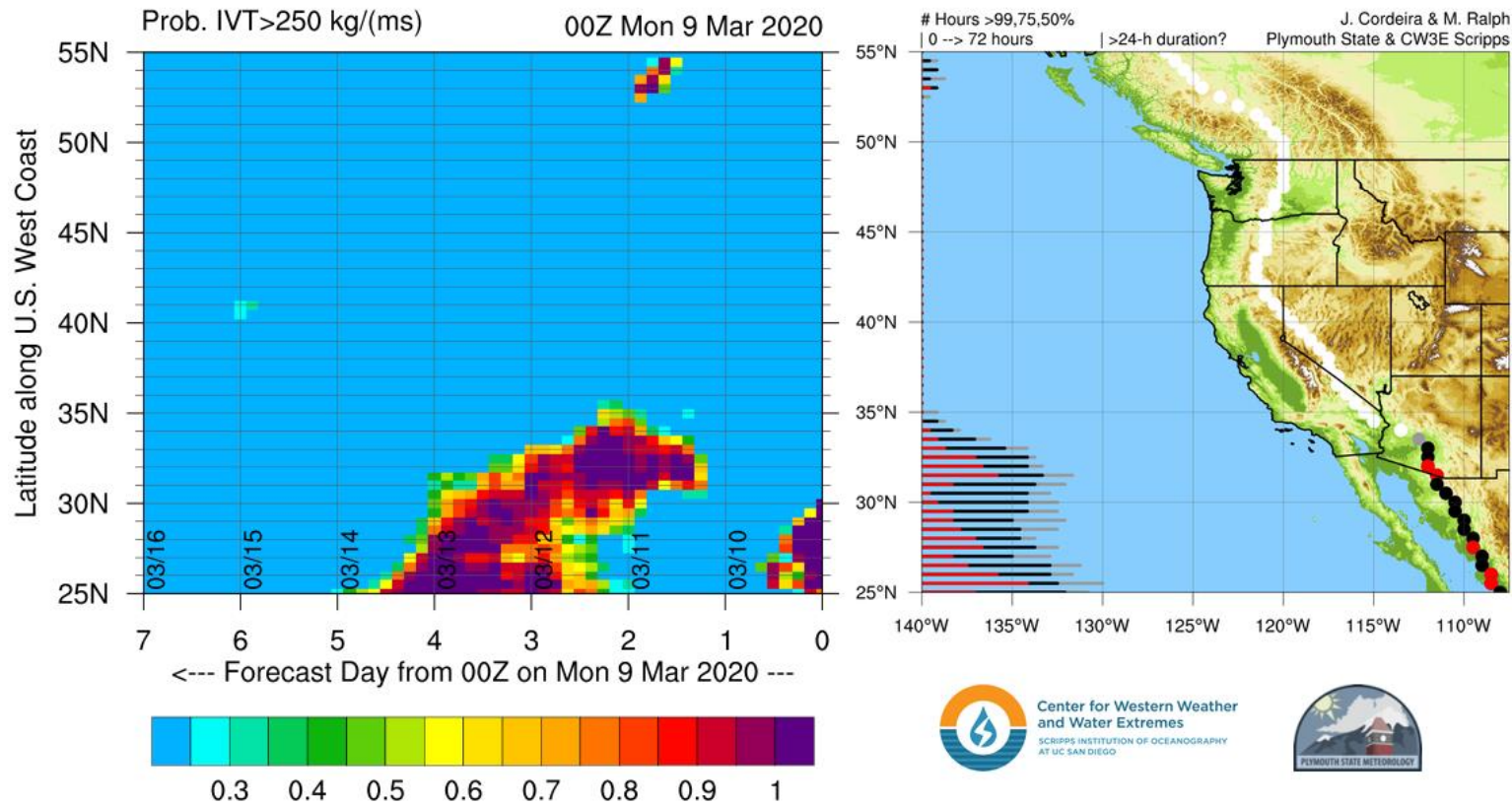
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GEFS AR Landfall Probabilities & AR Scale (Inland)



- Inland AR landfall tool shows high confidence (> 90%) in the inland penetration of AR conditions over northern Sonora and southern Arizona beginning around 1200 UTC 10 Mar
- GEFS control run is currently forecasting AR1/AR2 conditions over these areas

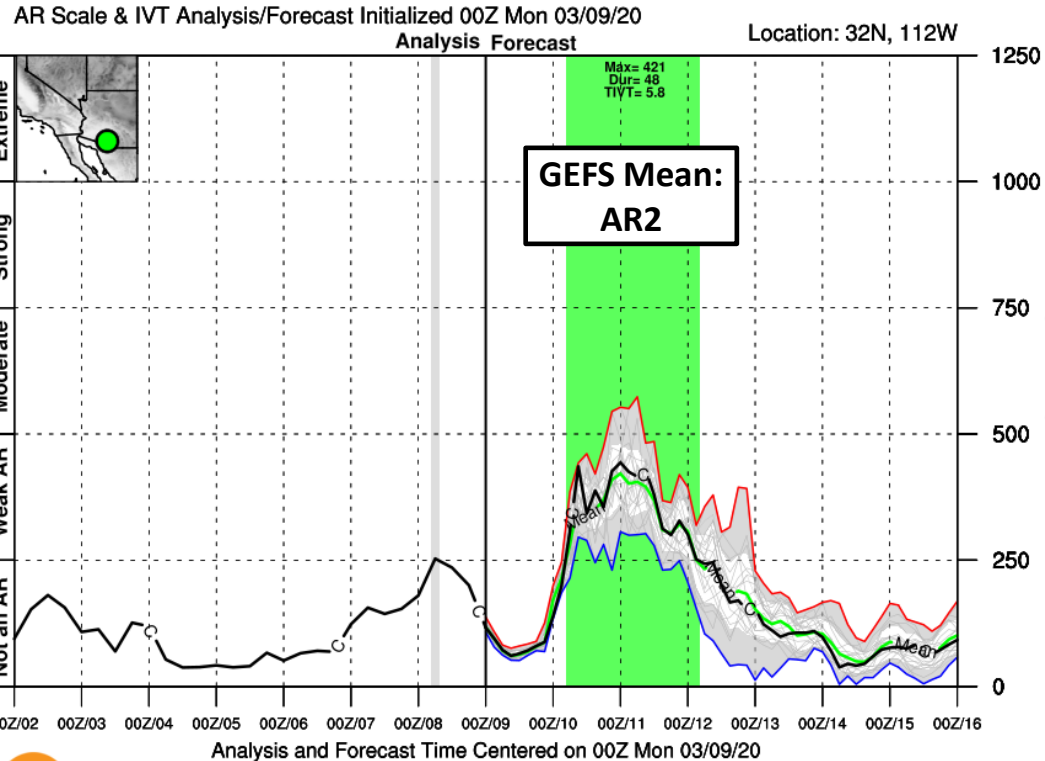
AR Outlook: 9 Mar 2020

For California DWR's AR Program



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GEFS IVT Forecast Plumes



AR 1 AR 2 AR 3 AR 4 AR 5

Image created: 09 UTC 03/09/2020 More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

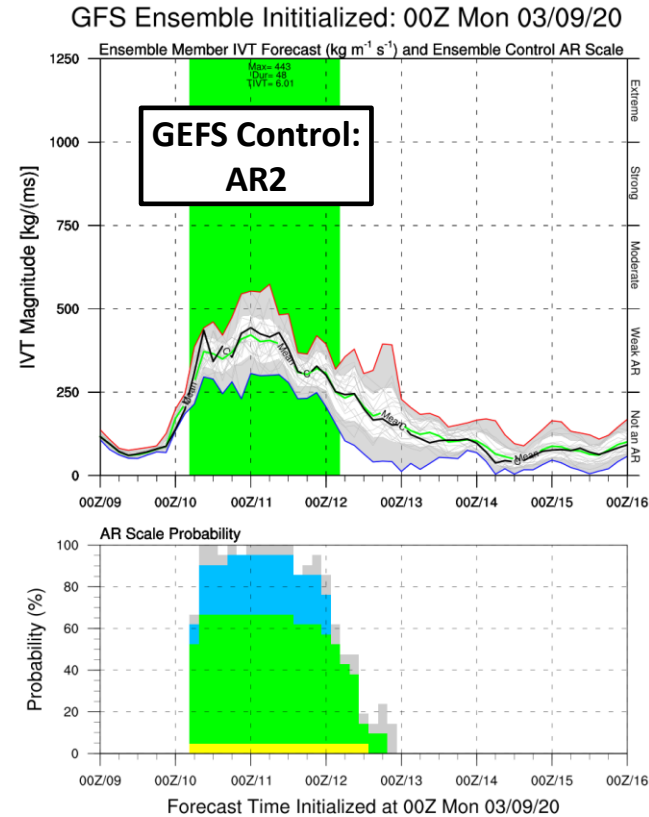


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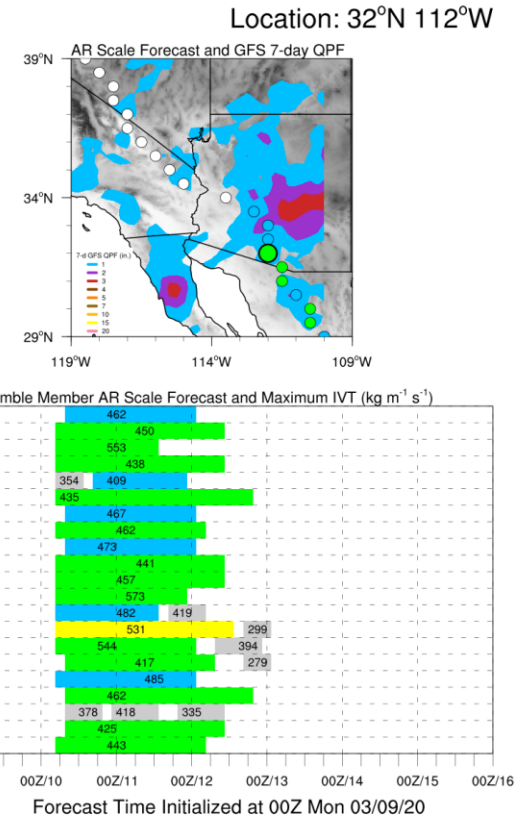


Image created: 09 UTC 03/09/2020 More information: <http://cw3e.ucsd.edu> AR Scale based on Ralph et al. (2019; BAMS), contact M. Ralph

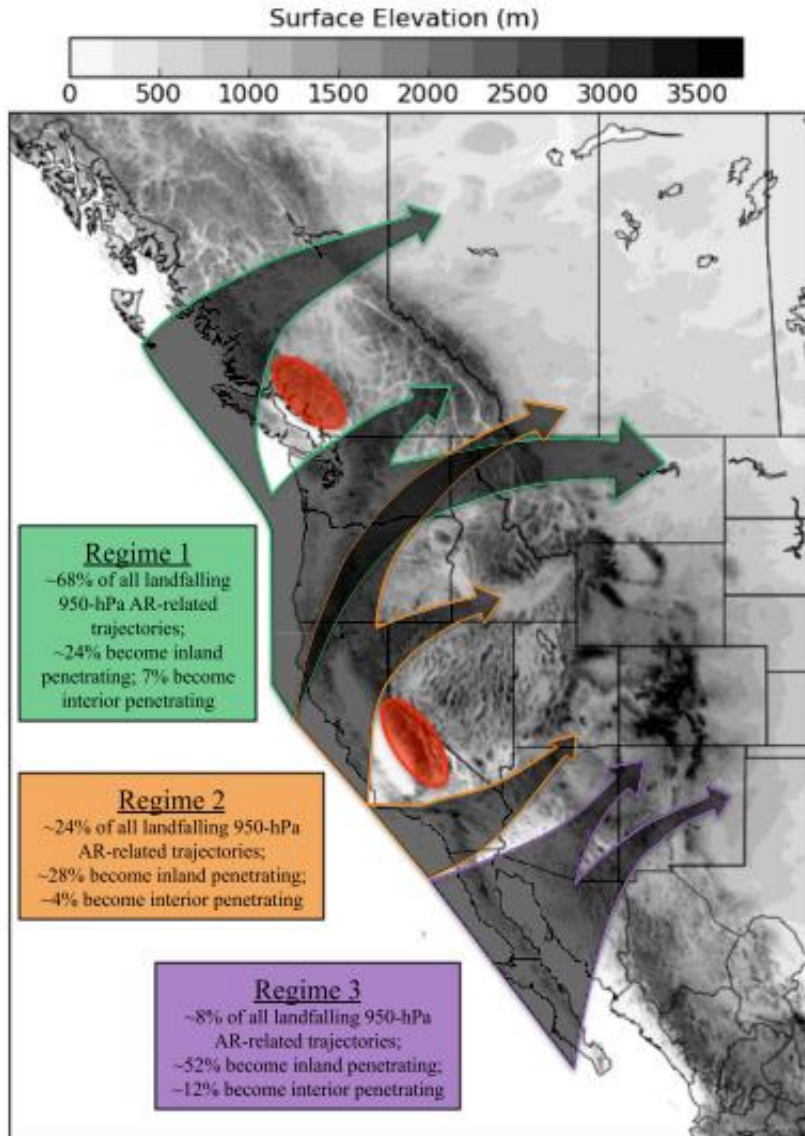
- GEFS control run and ensemble mean are suggesting the possibility of at least 48 hours of weak AR conditions [AR2 based on the *Ralph et al. (2019)* AR Scale] at 32°N, 112°W
- 13/21 (62%) GEFS members are predicting AR2 conditions, but there are significant differences in the forecast duration of continuous AR conditions

AR Outlook: 9 Mar 2020

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The Inland Penetration of Atmospheric Rivers over Western North America: A Lagrangian Analysis

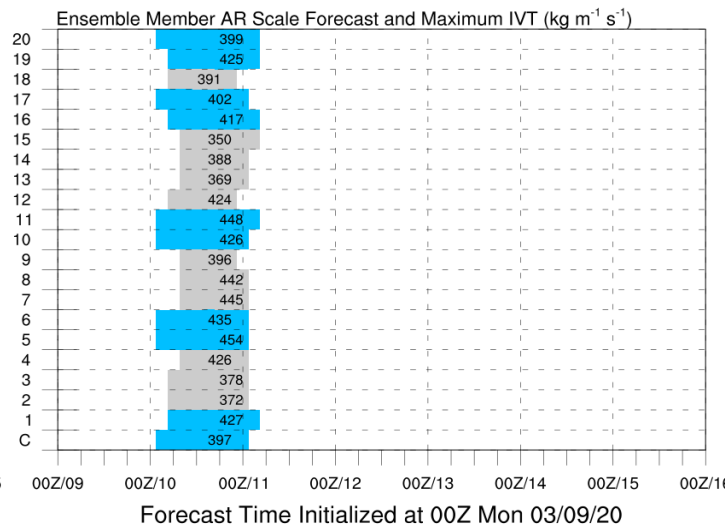
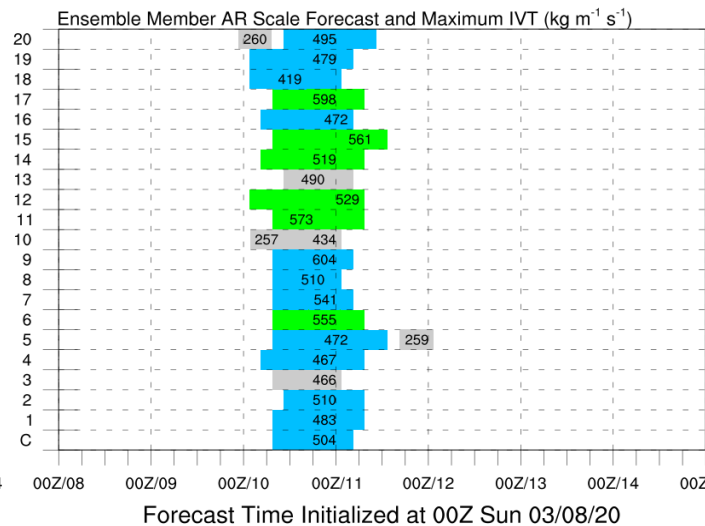
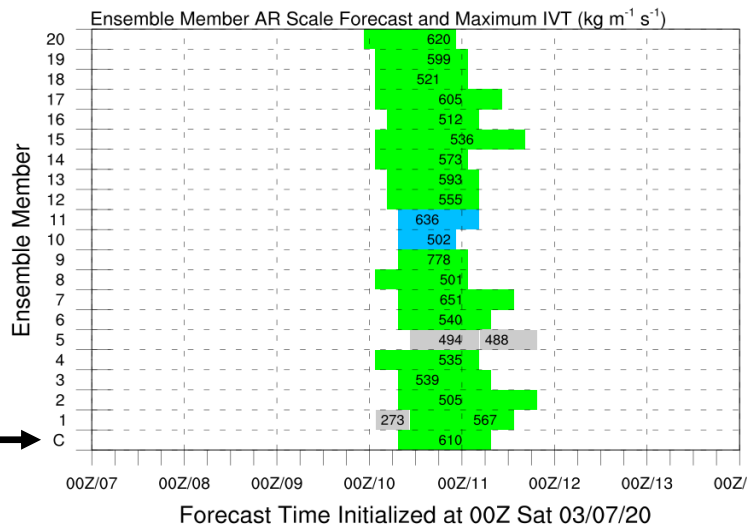
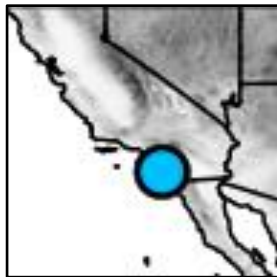
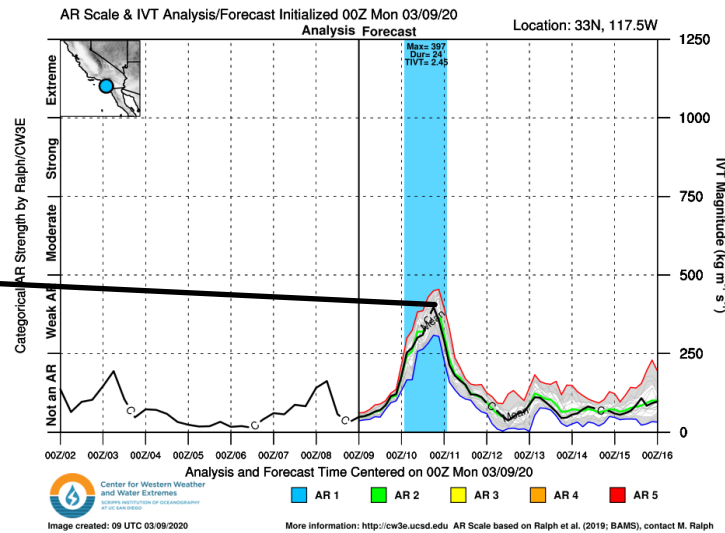
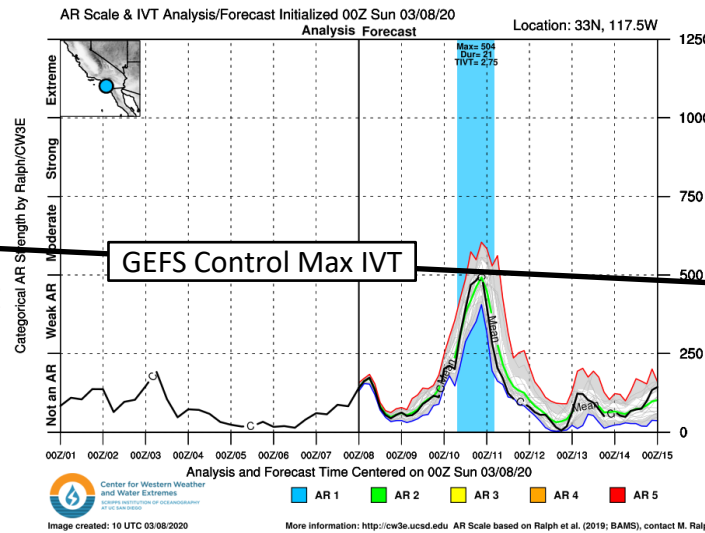
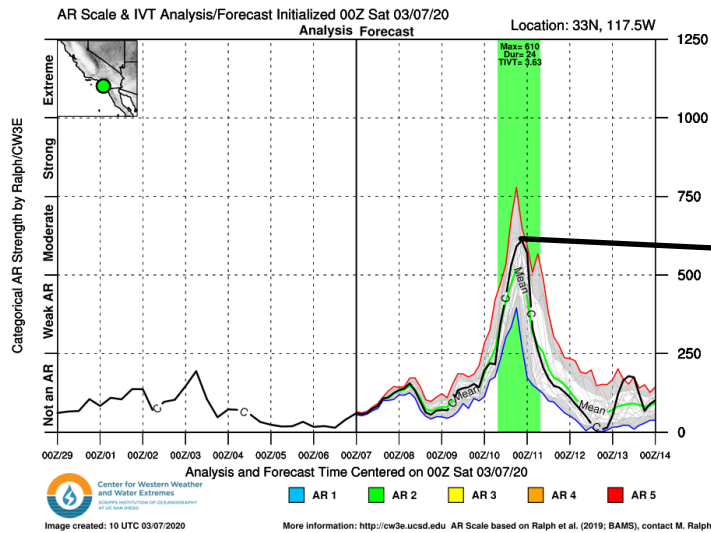
J.J. Rutz, J. W. Steenburgh and F.M. Ralph
Mon. Wea. Rev., 2015

- Work by Rutz et al. 2015 identified that southwesterly oriented ARs that make landfall over the Mexican Baja are able to penetrate inland through gaps of lower terrain and bring AR conditions and impacts to Arizona
- While landfalling ARs are rare over the Mexican Baja compared to northern West Coast ARs, they tend to be more efficient at penetrating inland and impacting the Desert Southwestern States
- ~52% and ~12% of ARs that make landfall over the Mexican Baja become inland and interior penetrating respectively, a proportion much higher (~2 times more) than ARs that make landfall at higher latitudes along the North American coast (Regime 1; Green and Regime 2; Orange)

AR Outlook: 9 Mar 2020

For California DWR's AR Program

GEFS IVT
Forecast
Plumes:
dProg/dt



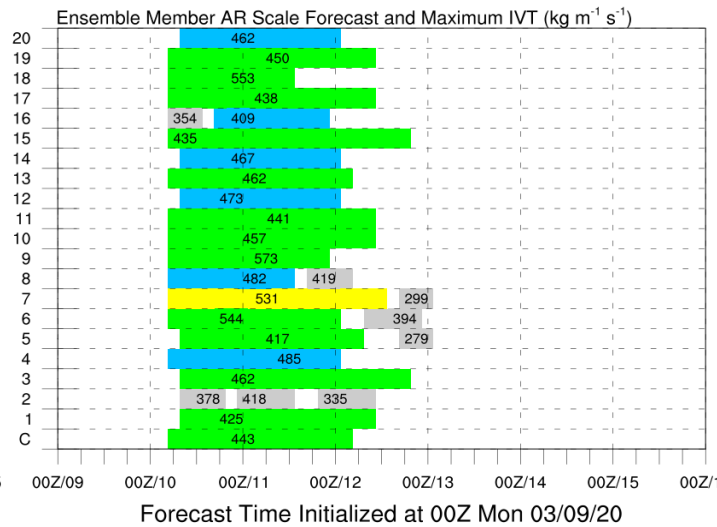
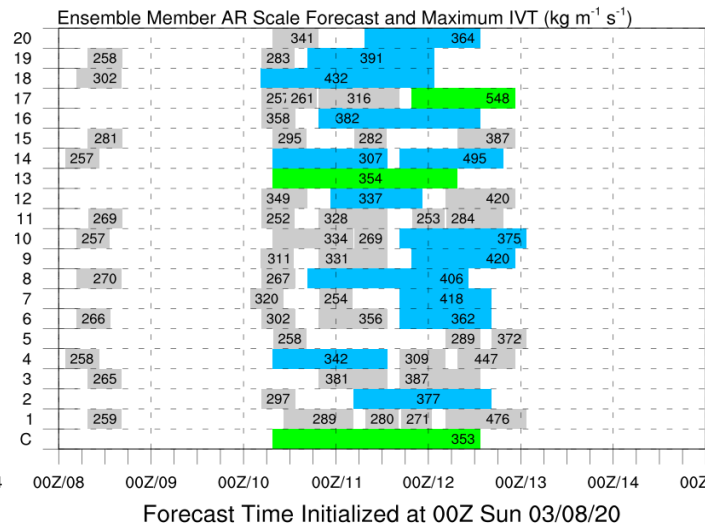
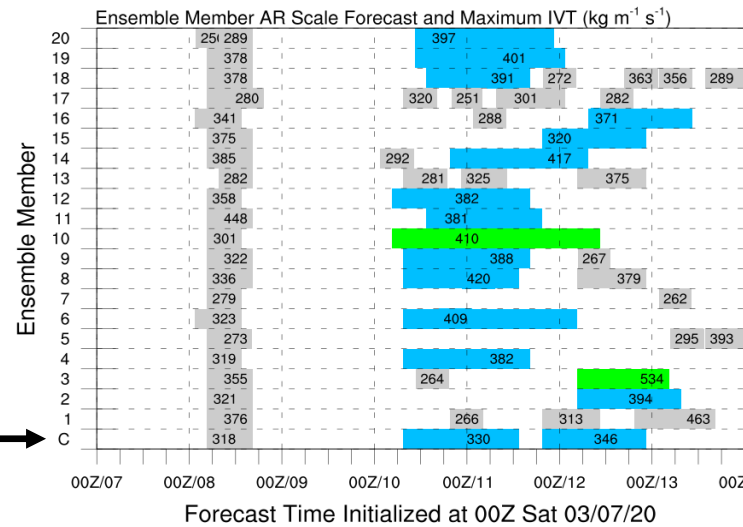
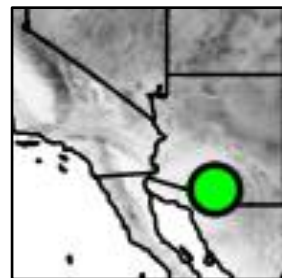
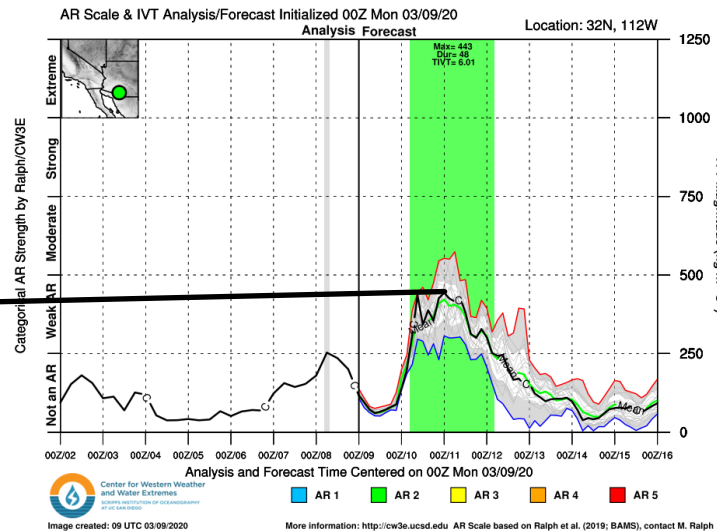
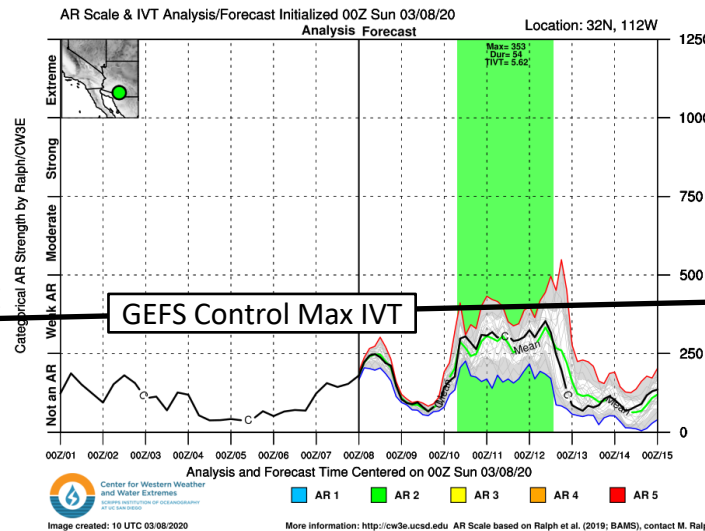
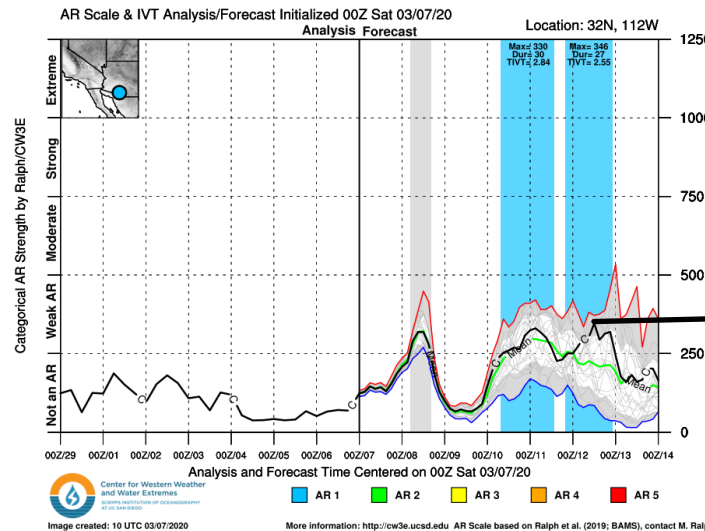
GEFS Control →

- Forecast IVT magnitude near San Diego, CA, has decreased in GEFS control run and individual members since 00Z 7 Mar
- Less than 50% of GEFS members are currently forecasting AR1 conditions (> 80% were forecasting AR2 conditions 48 hours ago)

AR Outlook: 9 Mar 2020

For California DWR's AR Program

GEFS IVT Forecast Plumes: dProg/dt



GEFS Control →

- Forecast AR duration and IVT magnitude in southern Arizona have increased in GEFS control run and individual members since 00Z 7 Mar
- Confidence in AR2 conditions has increased over the past 48 hours (only 2 members were predicting AR2 conditions at 00Z 7 Mar)

AR Outlook: 9 Mar 2020

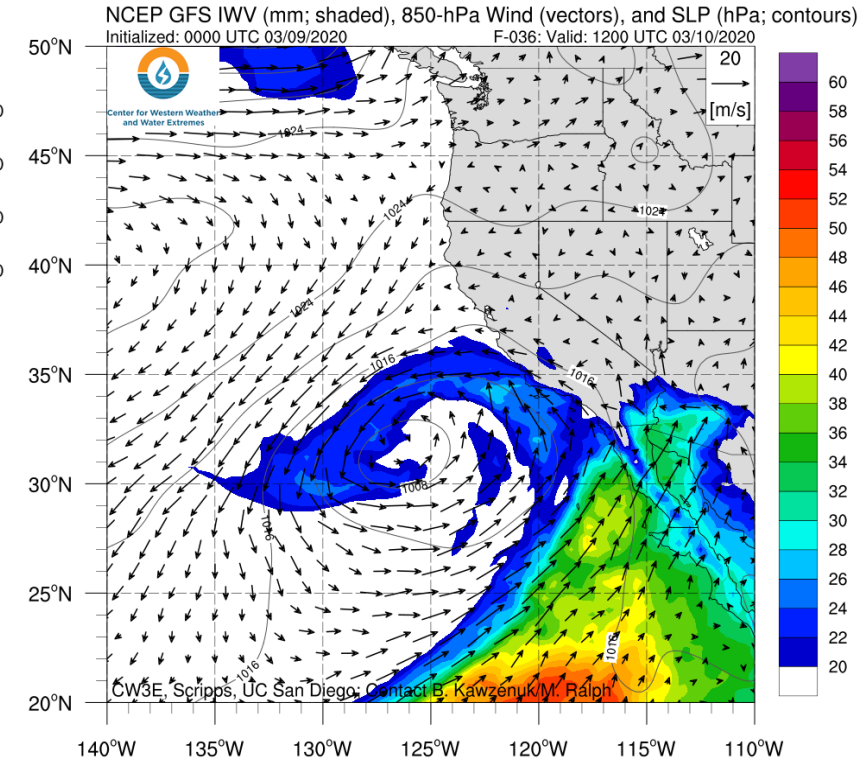
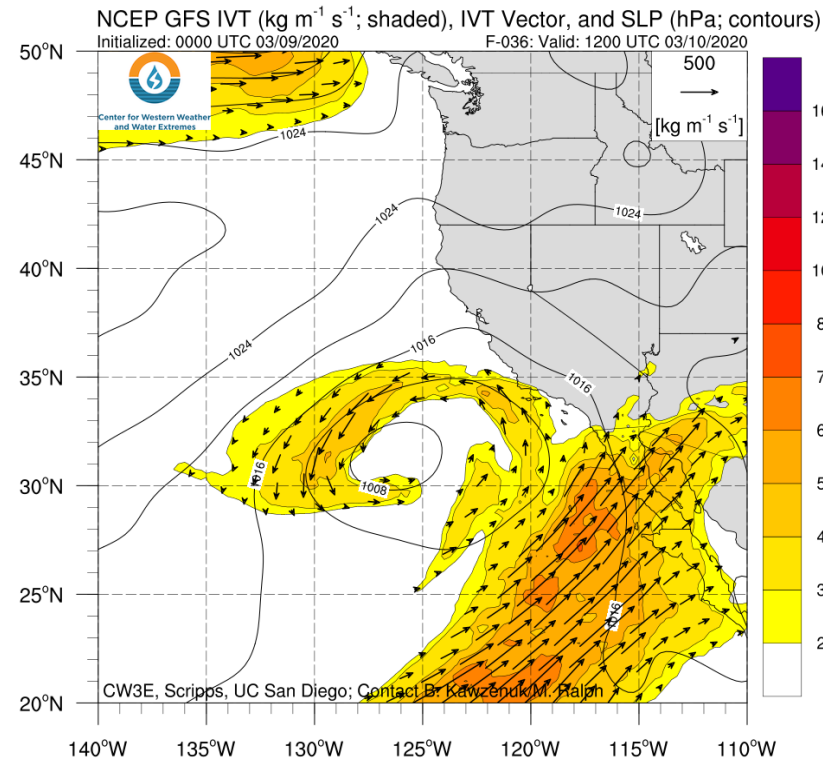
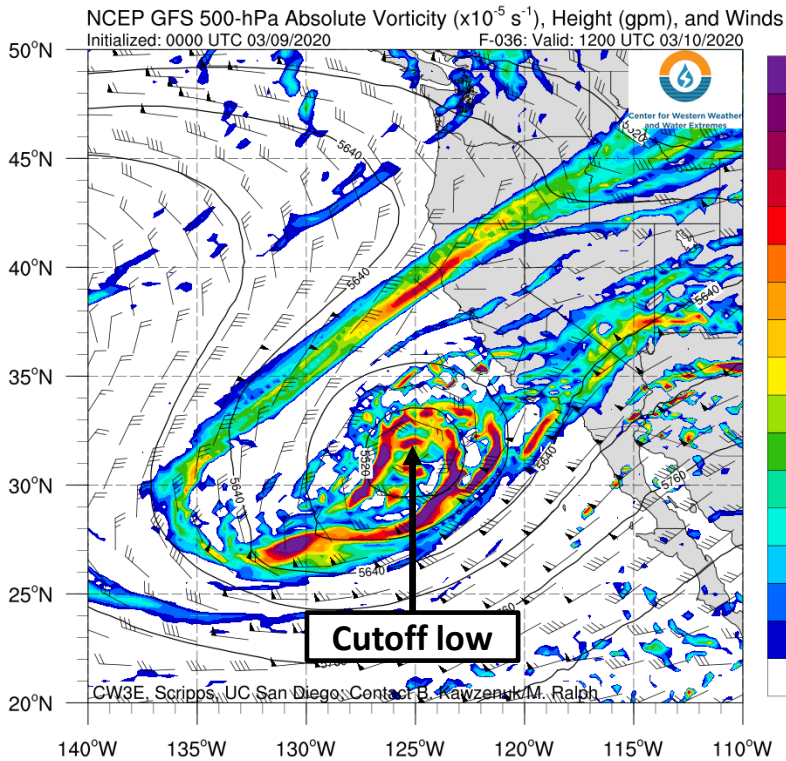
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GFS Forecasts: Valid 1200 UTC 10 Mar



- Over the next 24–48 hours, a cutoff low west of Baja California will interact with a region of deep tropical moisture over the Eastern Pacific Ocean, resulting in a landfalling AR over the Baja Peninsula
- By 1200 UTC 10 Mar, higher values of IVT ($> 400 \text{ kg m}^{-1} \text{ s}^{-1}$) and IWV ($> 30 \text{ mm}$) are forecast to spread into southwestern Arizona

AR Outlook: 9 Mar 2020

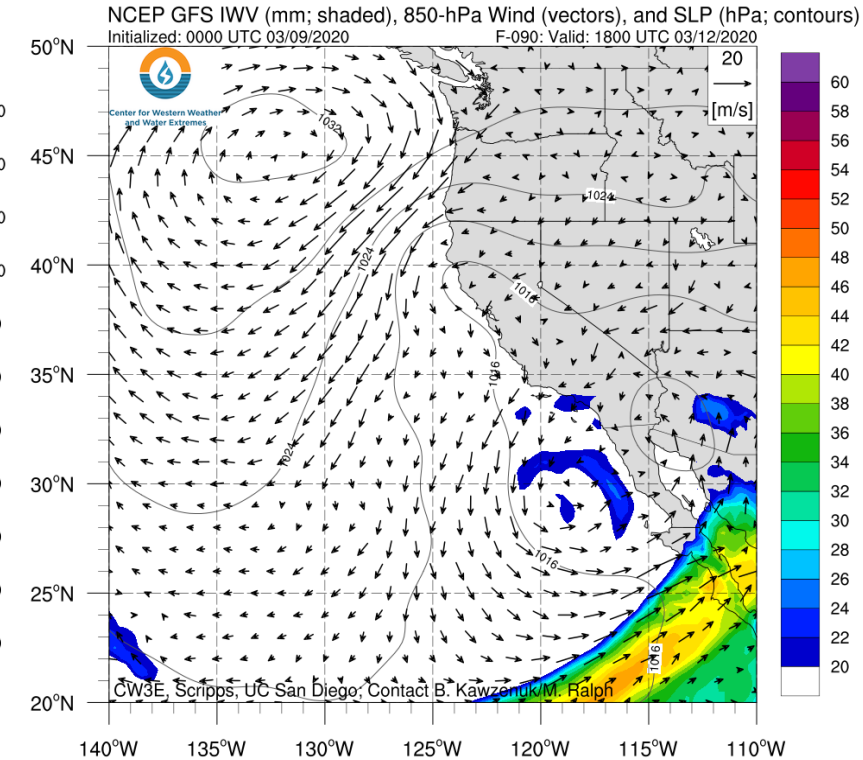
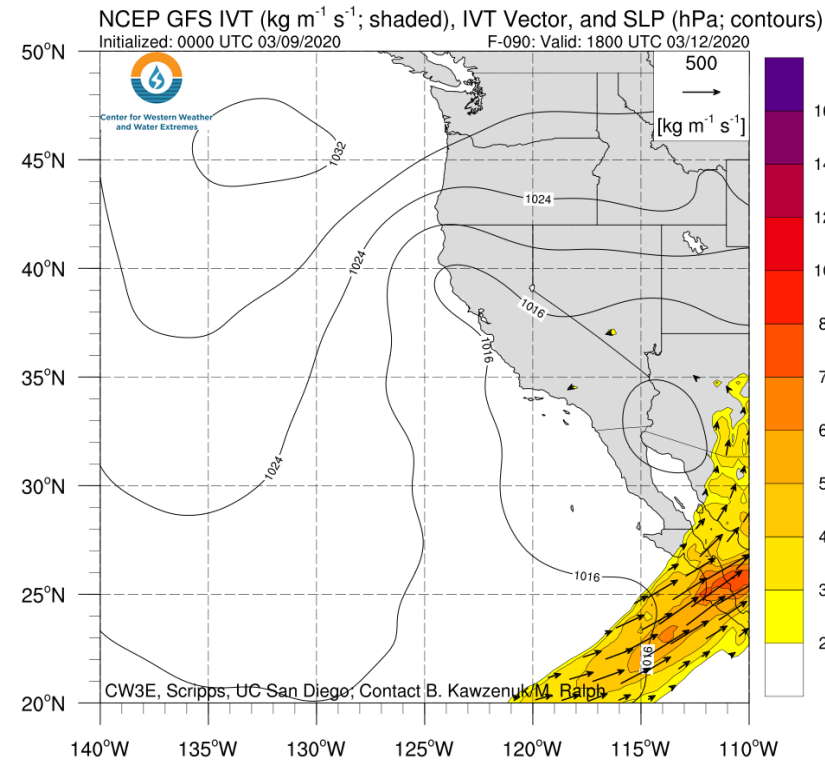
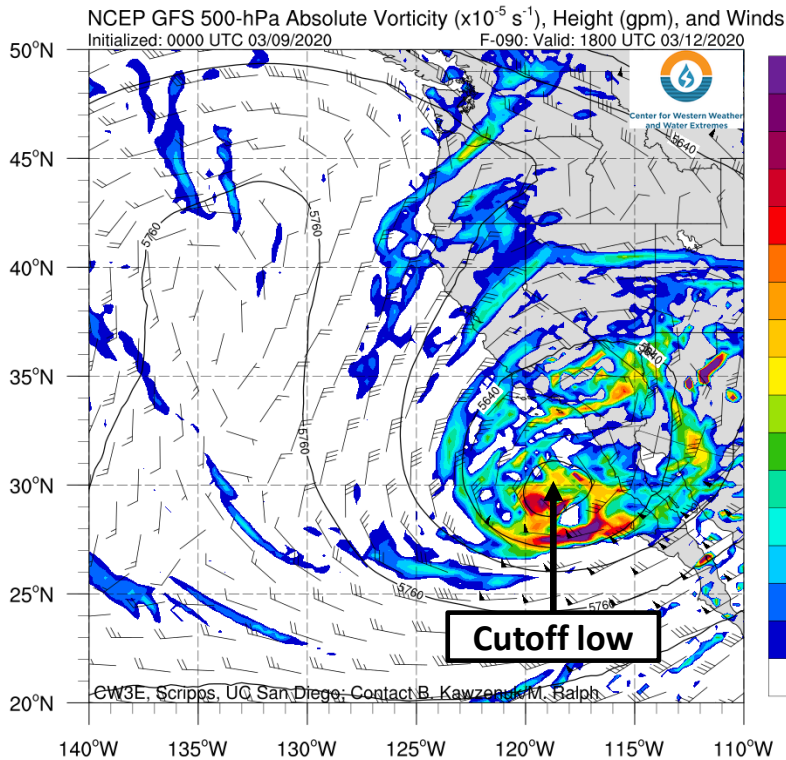
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GFS Forecasts: Valid 1800 UTC 12 Mar



- As time progresses, the cutoff low will slowly drift eastward, and AR conditions will diminish over Baja California, Southern California, and western Arizona
- Strengthening low-to-midlevel southerly flow will lead to a re-intensification of moisture transport over eastern Arizona
- Although the forecast IWV values are not particularly high, a combination of favorable dynamical forcing for ascent and upslope moisture flux may lead to additional heavy precipitation over portions of the Four Corners Region

AR Outlook: 9 Mar 2020

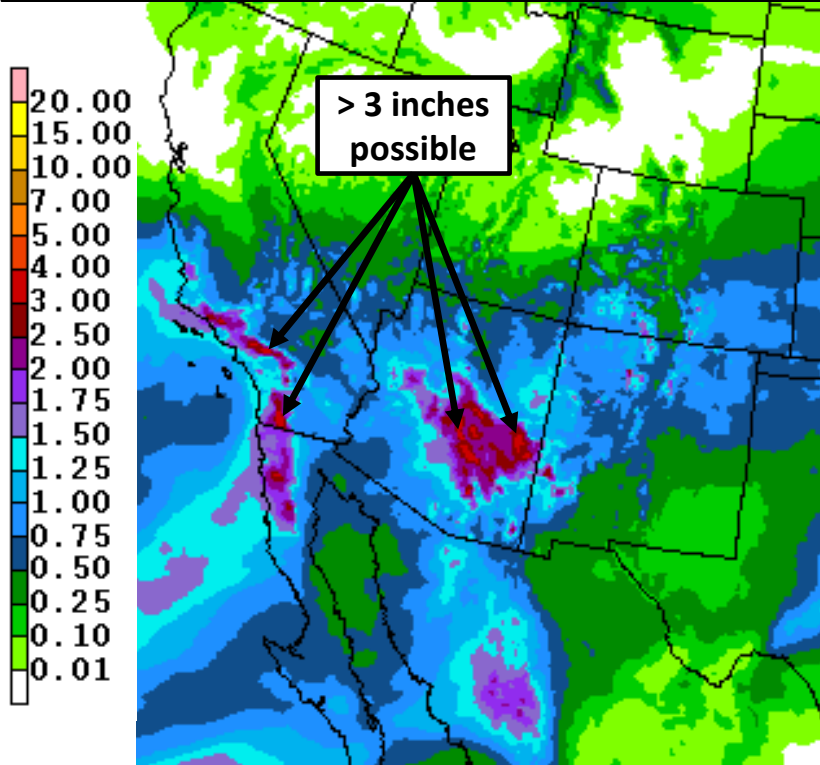
For California DWR's AR Program



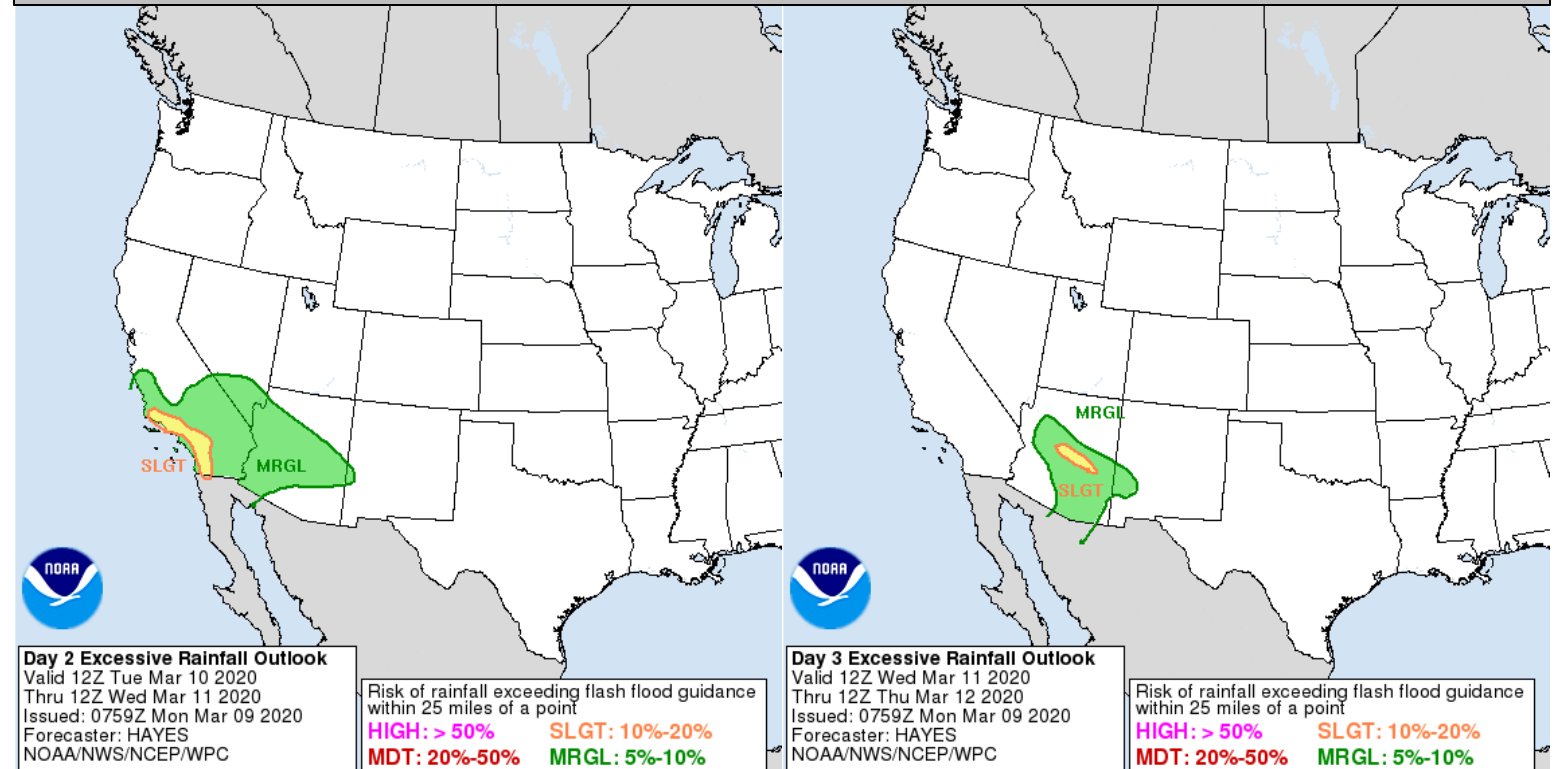
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WPC 5-day QPF: Valid 1200 UTC 9–14 Mar



WPC Days 2 & 3 Excessive Rainfall Outlook



Source: NOAA/NWS Weather Prediction Center, <https://www.wpc.ncep.noaa.gov/>

- Widespread precipitation is forecast across the southwestern U.S. during the next 5 days, with the heaviest precipitation (1–3 inches) expected in Southern California and the Lower Colorado River Basin
- More than 3 inches of precipitation are possible over the Transverse and Peninsular Ranges in Southern California, as well as across the higher terrain in central Arizona
- NWS WPC has issued a slight risk of excessive rainfall in Southern California (Day 2) and central Arizona (Day 3)

AR Outlook: 9 Mar 2020

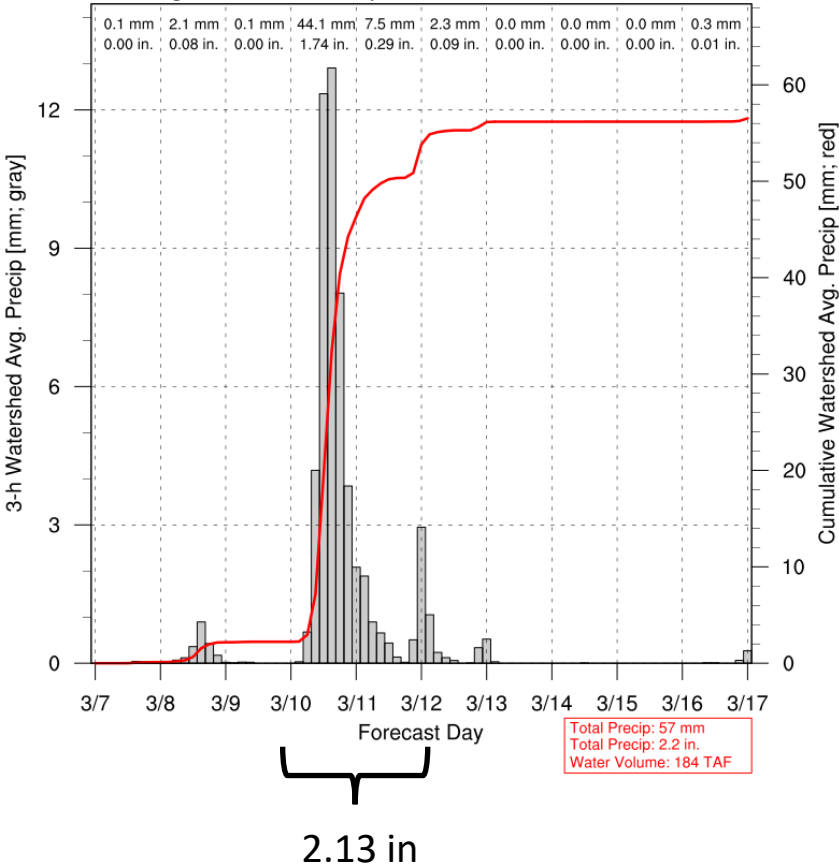
For California DWR's AR Program



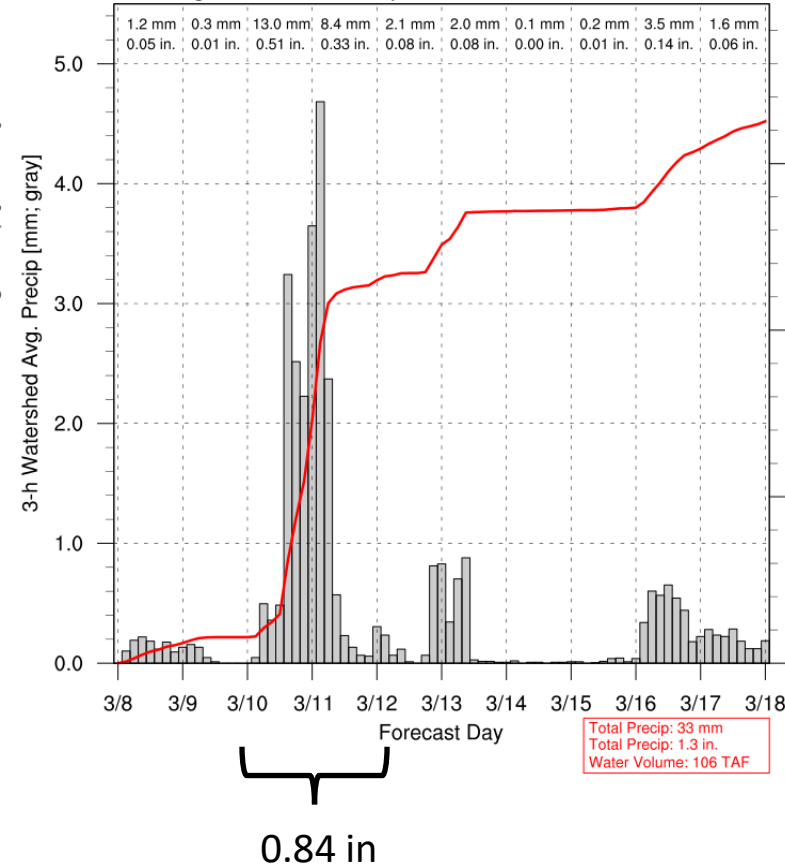
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GFS 10-day Watershed Precipitation Forecasts

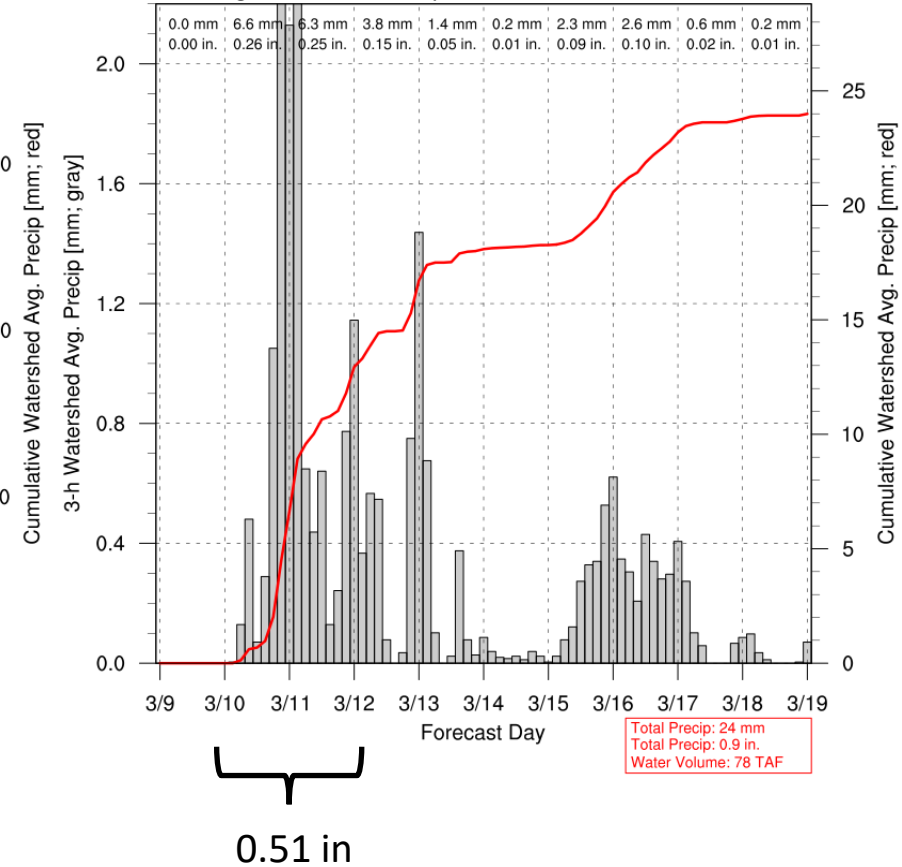
San Diego Watershed Precip. 00Z Sat 03/07/20



San Diego Watershed Precip. 00Z Sun 03/08/20



San Diego Watershed Precip. 00Z Mon 03/09/20



- GFS forecast precipitation over the San Diego Watershed has decreased substantially over the past 2–3 days
- 00Z 9 Mar GFS run is forecasting only 0.51 inches of aerial average precipitation between 0000 UTC 10 Mar and 0000 UTC 12 Mar (compared to 2.13 inches from the 00Z 7 Mar GFS run)

AR Outlook: 9 Mar 2020

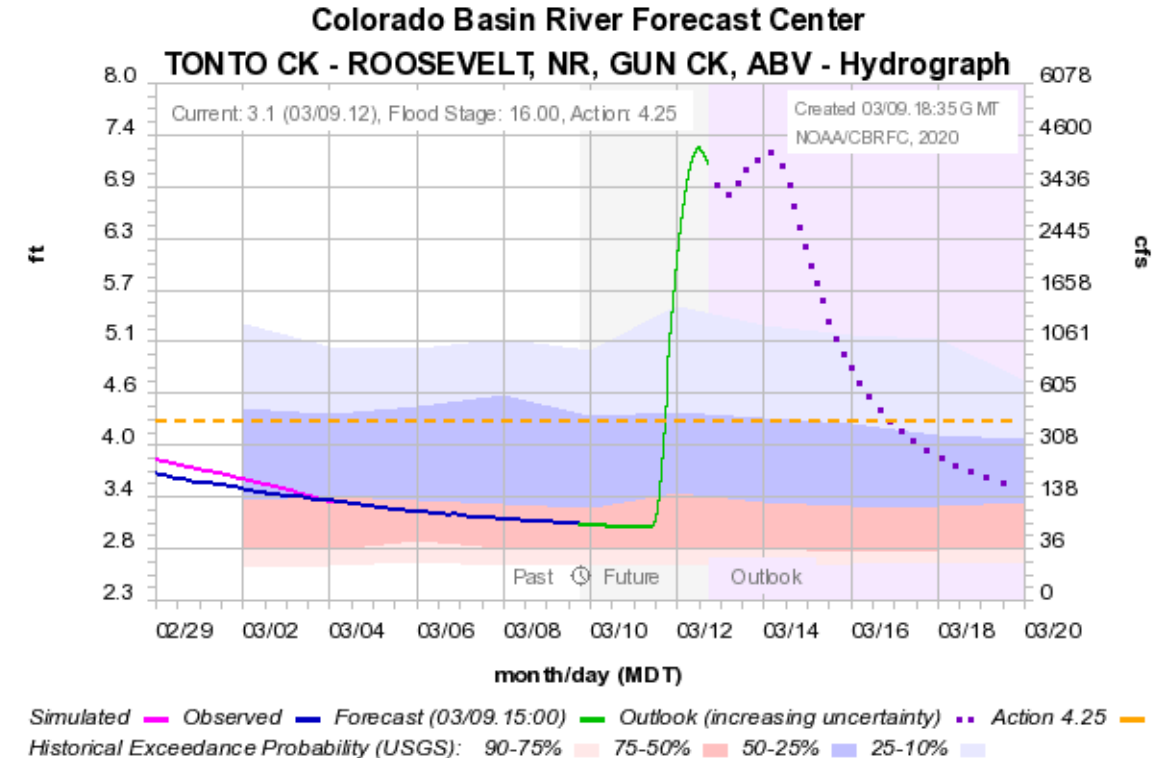
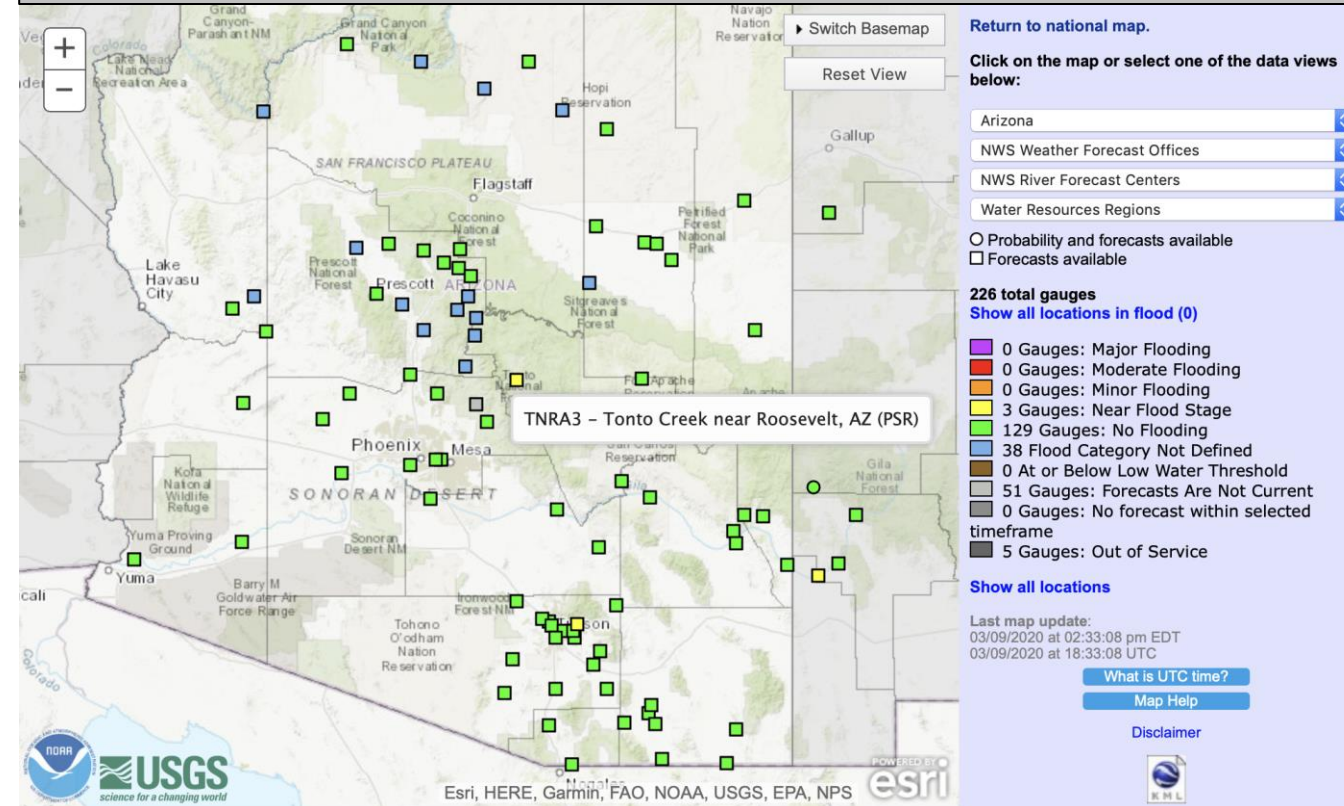
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6-day Maximum Forecast Flood Category



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

Source: NOAA/NWS CBRFC, <https://www.cbrfc.noaa.gov>

- Heavy rainfall central Arizona will lead to rising rivers and creeks over the next few days
- Tonto Creek (near Roosevelt, AZ) is forecast to exceed action stage on 11 Mar and remain above action stage for several days
- Elevated streamflow levels may lead to localized flooding, especially in areas with low-water crossings

AR Outlook: 9 Mar 2020

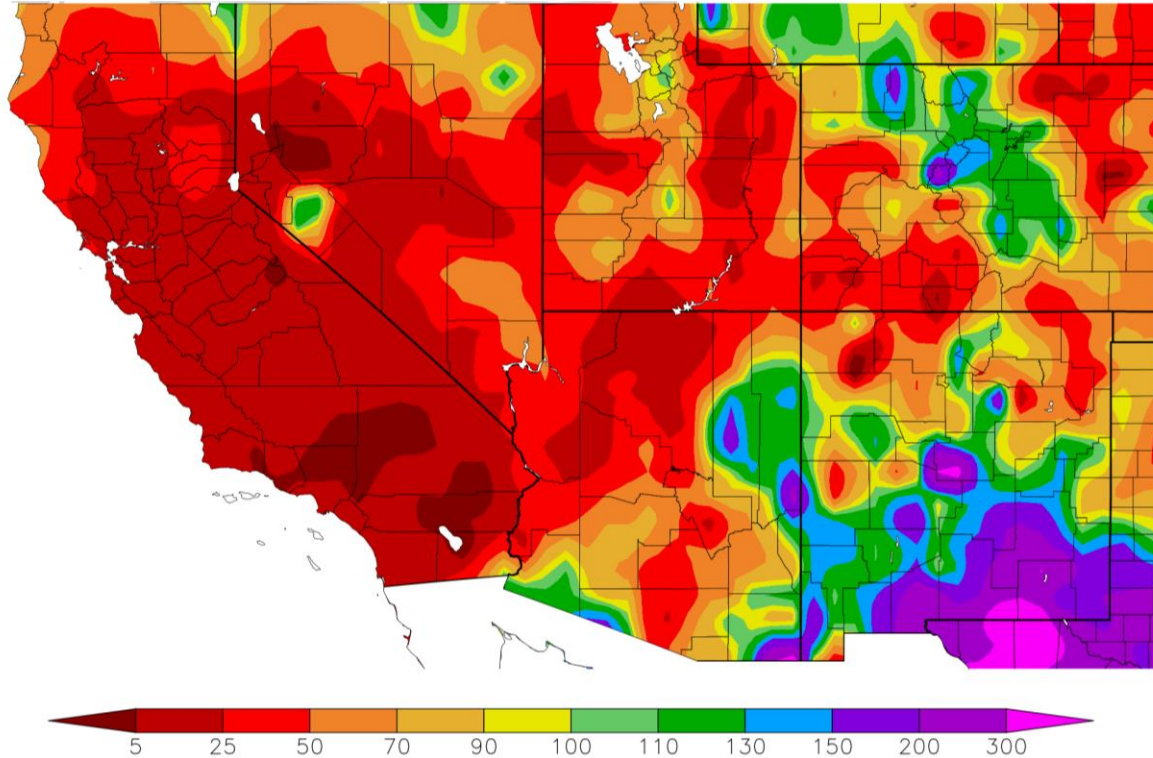
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Percent of Normal Precipitation (%): 1 Jan – 8 Mar



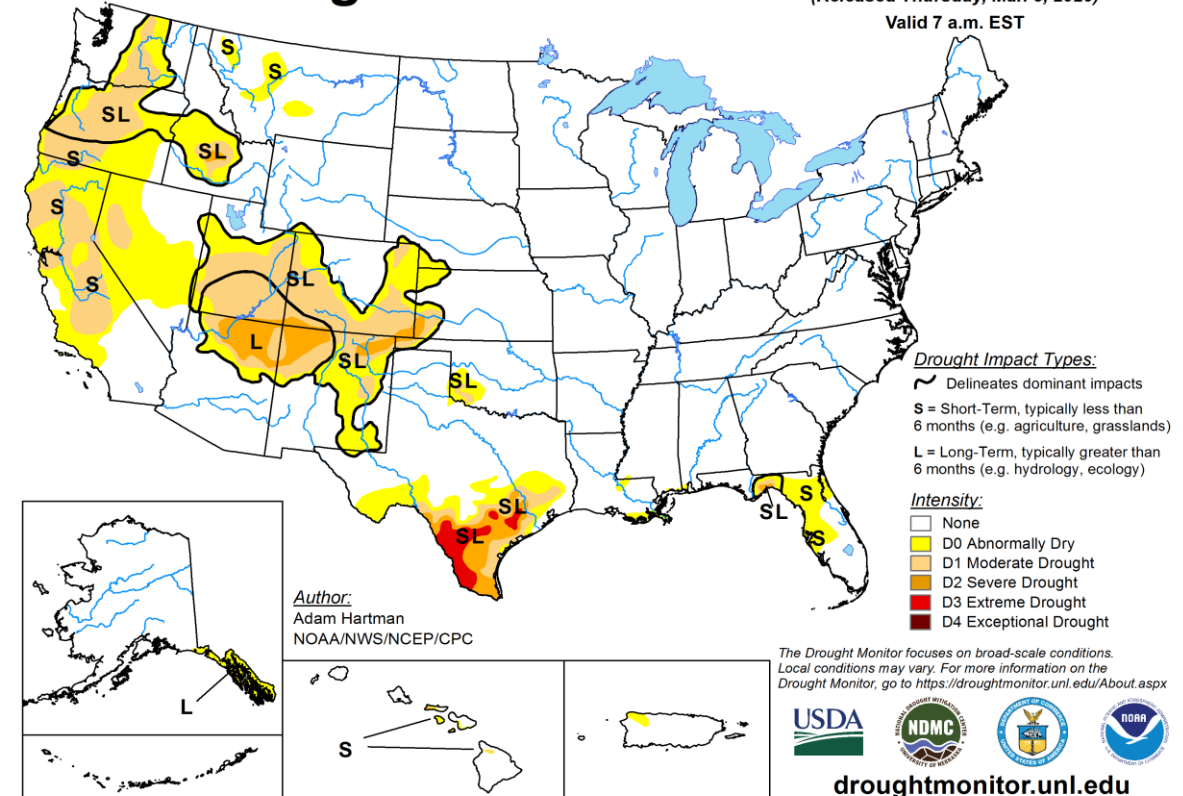
Generated 3/9/2020 at HPRCC using provisional data.

NOAA Regional Climate Centers

Source: High Plains Regional Climate Center, <https://hprcc.unl.edu>

U.S. Drought Monitor

March 3, 2020
(Released Thursday, Mar. 5, 2020)
Valid 7 a.m. EST



Source: National Drought Mitigation Center, UNL, <https://droughtmonitor.unl.edu>

- Year-to-date precipitation is below normal across much of the southwestern U.S., especially in California
- Moderate-to-severe drought conditions have persisted over portions of the Four Corners region for more than 6 months
- While this event will bring some precipitation relief to the southwestern U.S., the heaviest precipitation is primarily expected in areas without preexisting drought conditions (Southern California and central Arizona)