



Center for Western Weather
and Water Extremes

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AT UC SAN DIEGO

End of Winter Summary: WY 2021 (Oct 2020 – Mar 2021)

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7 April 2021

UC San Diego



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Lake Oroville, CA
Image provided by California DWR

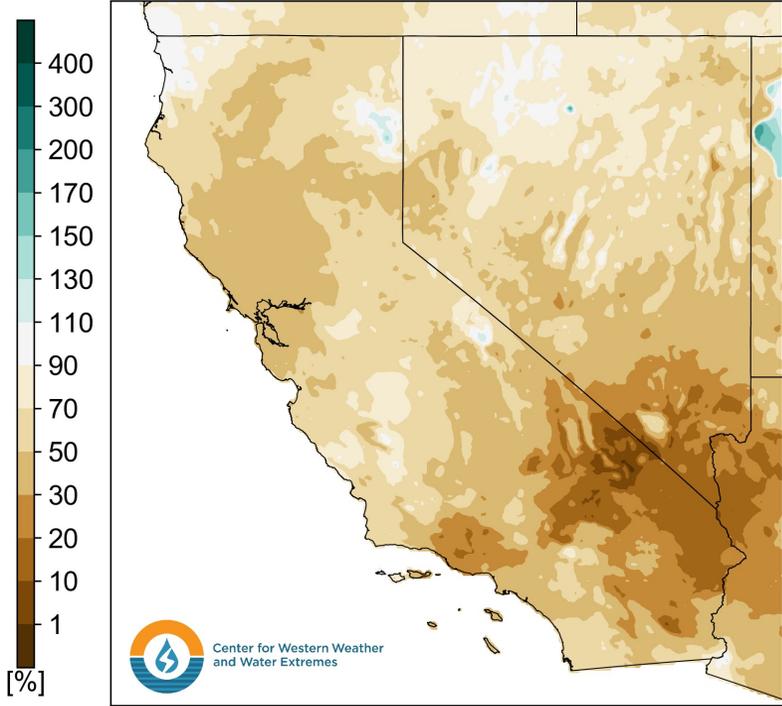
Water Year 2021 Characterized by Persistent Dry Weather and Worsening Drought in California

- Total precipitation has been well below normal throughout much of California during water year (WY) 2021
- In some regions, drier than normal conditions extend back to the start of WY 2020
- Drought has expanded and intensified across the state, and current water storage levels are below normal in many reservoirs
- Below-normal snowpack in the Sierra Nevada may limit water resource availability as summer approaches
- The abnormally dry conditions were driven by a lack of landfalling atmospheric rivers (ARs) and persistent ridging/blocking over the Northeast Pacific Ocean
- Drought is expected to continue through spring 2021, thereby increasing the threat of significant wildfire activity in summer 2021

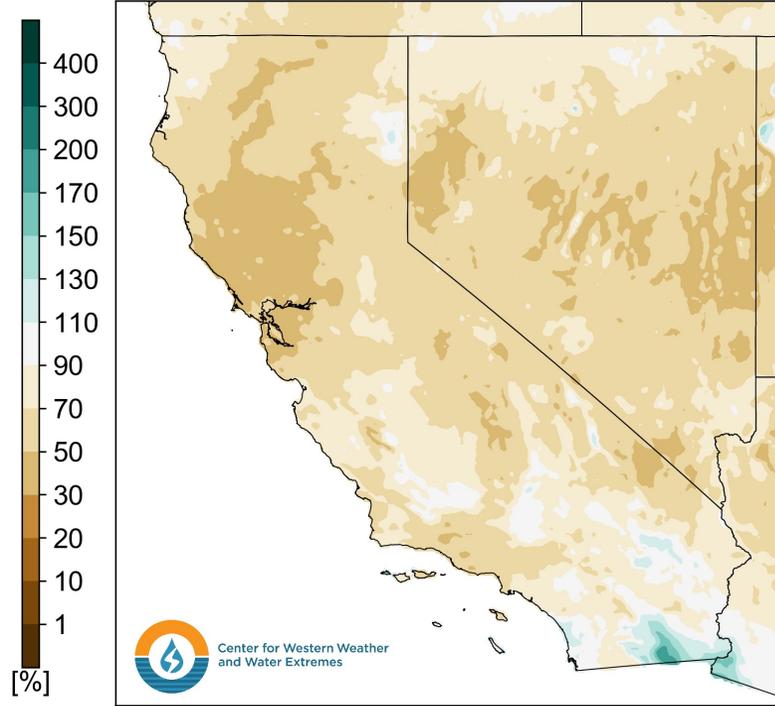
CW3E End of Winter Summary: Current Conditions

For California DWR's AR Program

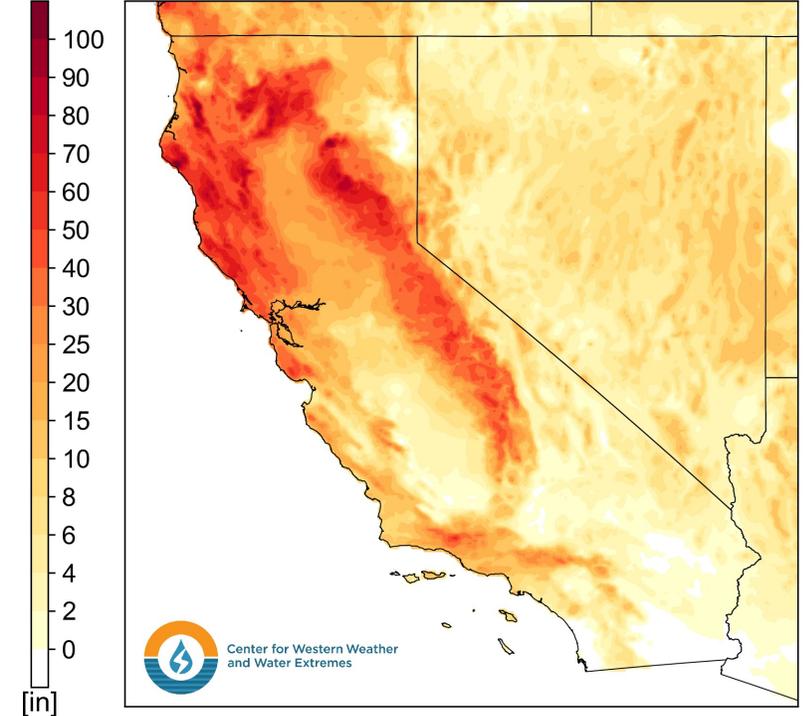
% of Normal Water Year-to-Date Precipitation (1 Apr 2021)



% of Normal Precipitation (Since 1 Oct 2019)



Total Precipitation Deficit (Since 1 Oct 2019)

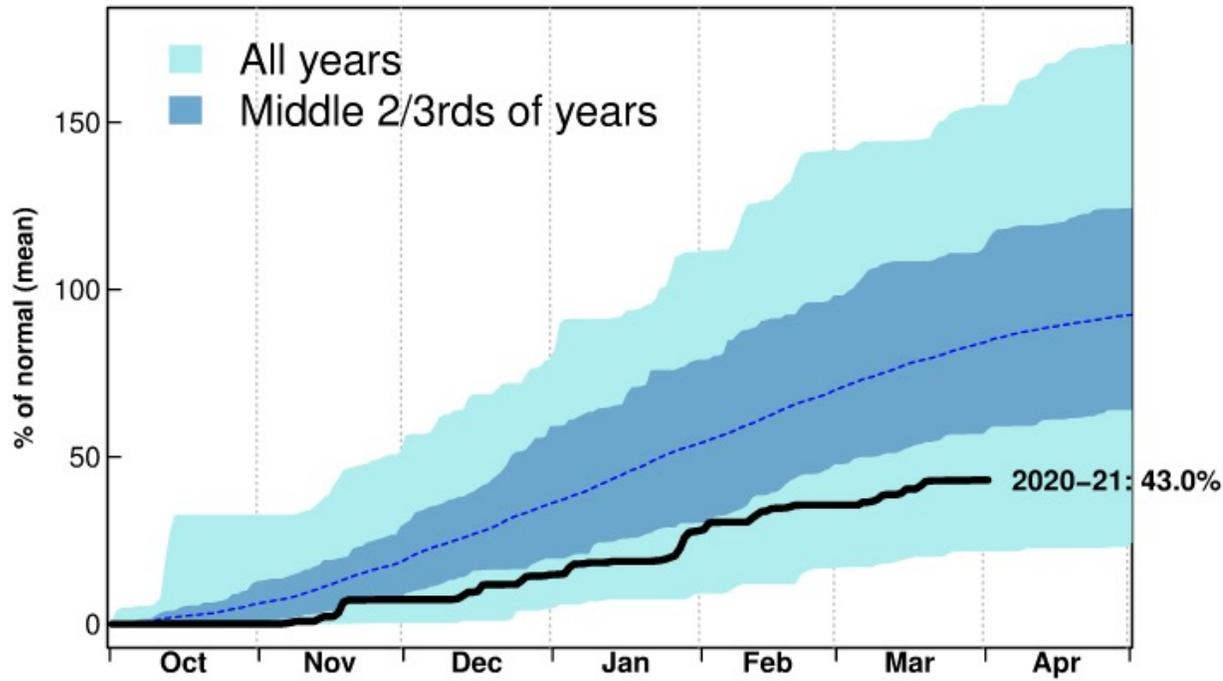


*Normals based on 1981–2010 Average Monthly Precipitation

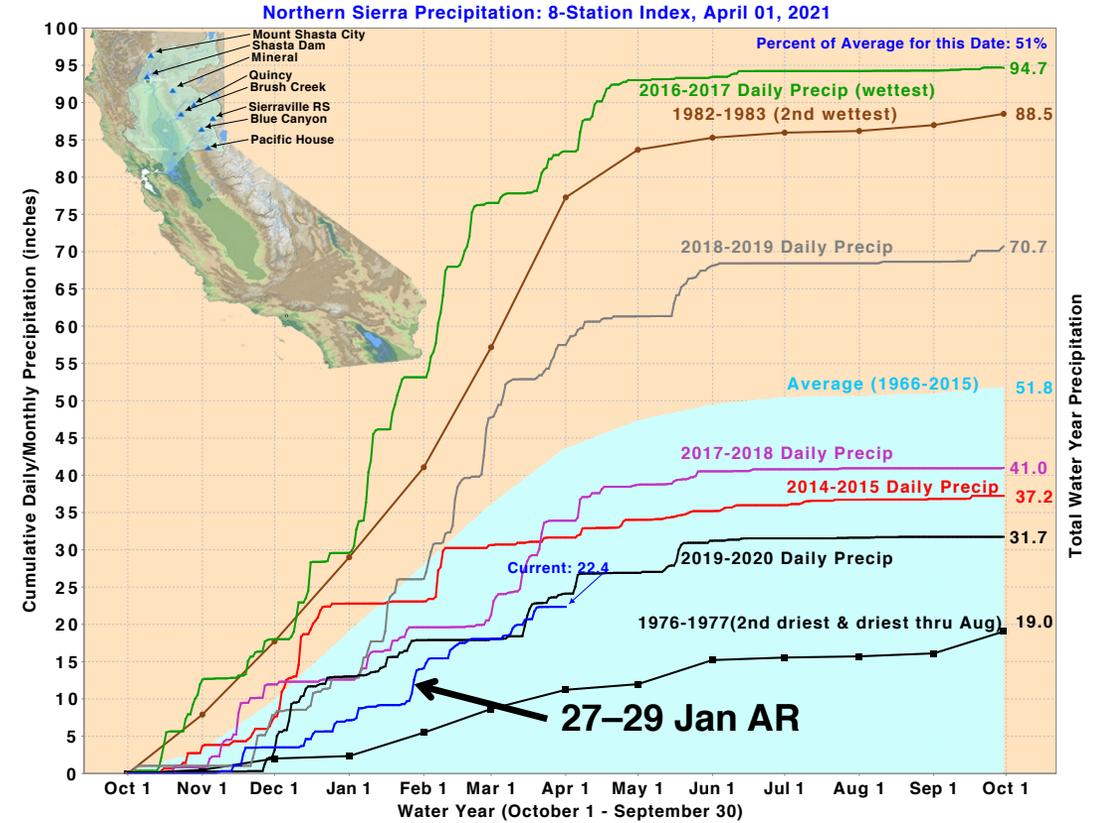
Data courtesy: PRISM Climate Group, Oregon State University, <https://prism.oregonstate.edu/>

- Current WY-to-date precipitation is well below normal (< 70% of normal) across much of California
- Portions of the Transverse Ranges, Mojave Desert, and Sonoran Desert have received less than 30% of normal precipitation
- Abnormally dry conditions have persisted in many areas since the start of WY 2020 (1 Oct 2019)
- The total precipitation deficit since the start of WY 2020 is > 50 inches in the Northern California Coast Ranges, Klamath Mountains, and Northern Sierra Nevada
- Only portions of Imperial County have been significantly wetter than normal since the start of WY 2020

Northern Sierra 8-Station Index (Thru 1 Apr 2021)



Source: California–Nevada Applications Program, <https://cnap.ucsd.edu/>

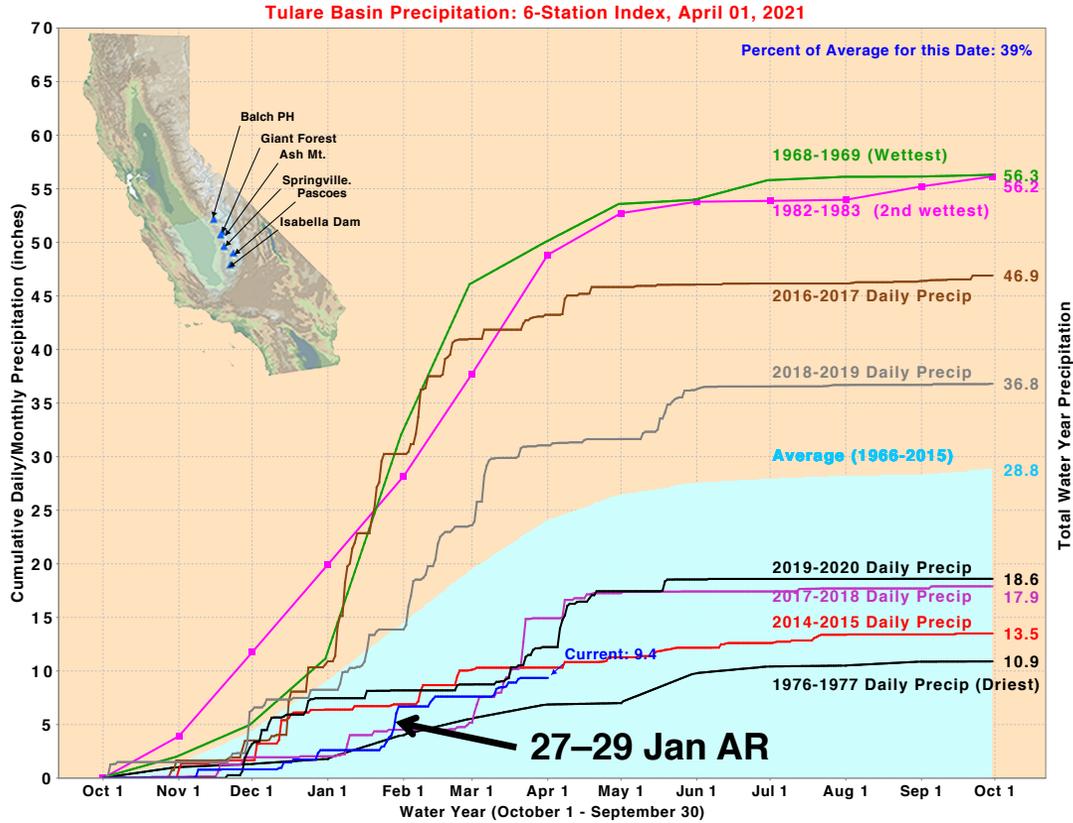


Source: California Department of Water Resources, <https://cdec.water.ca.gov/>

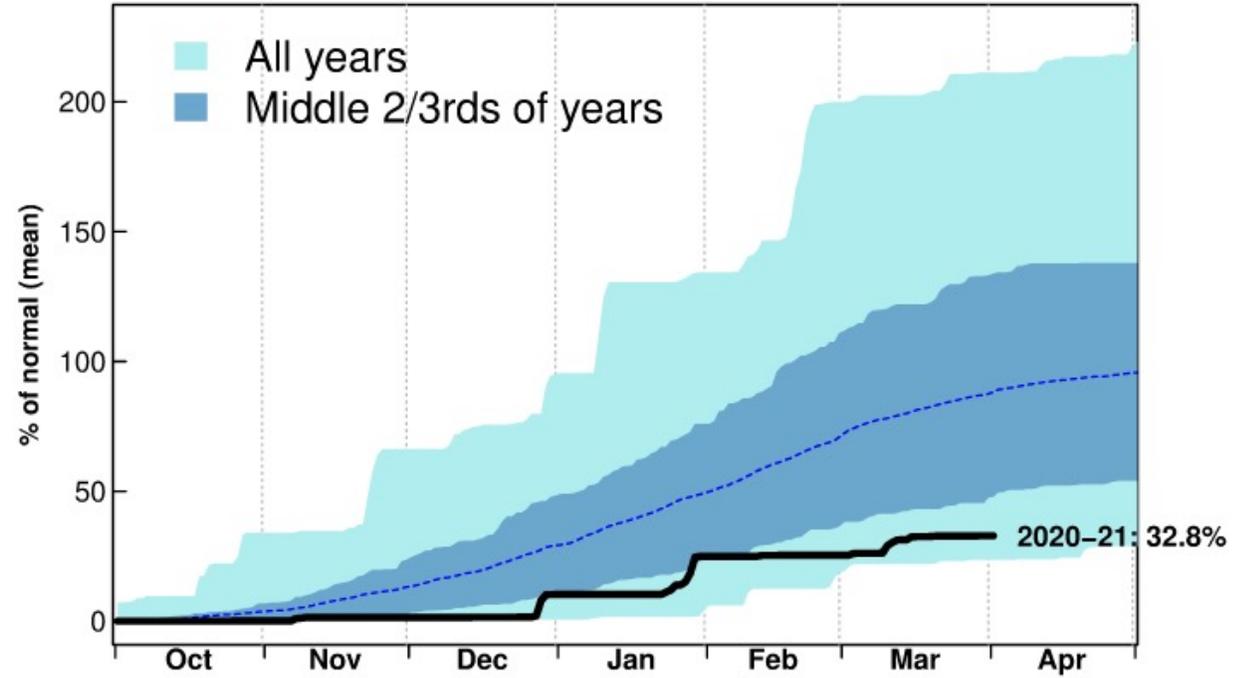
- The Northern Sierra 8-station index is a measure of the accumulated precipitation in the Northern Sierra Nevada and indicator of the water supply for the Sacramento Valley
- On average, the Northern Sierra 8-station region receives about 85% of its total WY precipitation by 1 April
- As of 1 April 2021, the Northern Sierra 8-station region has received only 43% (22.4 inches) of its normal total WY precipitation
- The WY-to-date precipitation accumulation curve highlights the general absence of major precipitation events, with the exception of the late January AR

CW3E End of Winter Summary: Current Conditions

For California DWR's AR Program



LA Basin Precipitation (Thru 1 Apr 2021)



Source: California–Nevada Applications Program, <https://cnap.ucsd.edu/>

Source: California Department of Water Resources, <https://cdec.water.ca.gov/>

- The Tulare Basin 6-station index is a measure of the accumulated precipitation in the Southern Sierra Nevada and indicator of the water supply for the southern San Joaquin Valley
- The precipitation deficit during WY 2021 is even more pronounced in this region compared to the Northern Sierra 8-station region
- The Tulare Basin 6-station region has received only 39% (9.4 inches) of its normal WY-to-date precipitation
- Farther south, the Los Angeles Basin has received only 33% of its normal total WY precipitation (37% of normal WY-to-date precipitation)

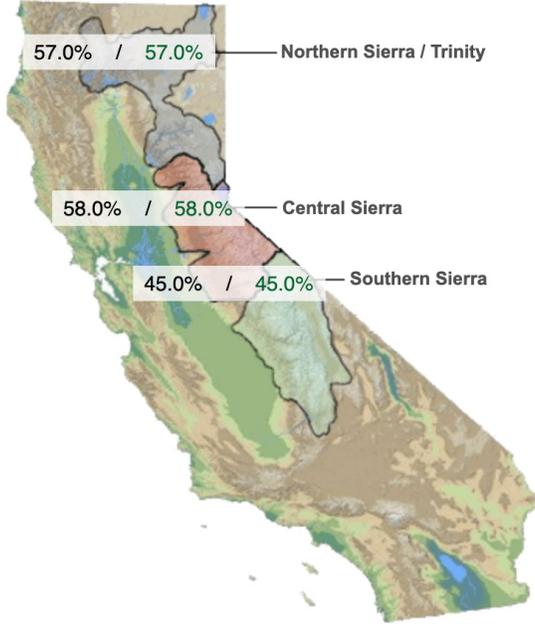
California Snowpack: 1 April 2020

➔ Snow Water Equivalents (inches)

Provided by the California Cooperative Snow Surveys

Data For: 01-Apr-2020

% Apr 1 Avg. / % Normal for this Date



STATEWIDE SUMMARY	
Data For: 01-Apr-2020	
Number of Stations Reporting	100
Average snow water equivalent	15.4"
Percent of April 1 Average	54%
Percent of normal for this date	54%

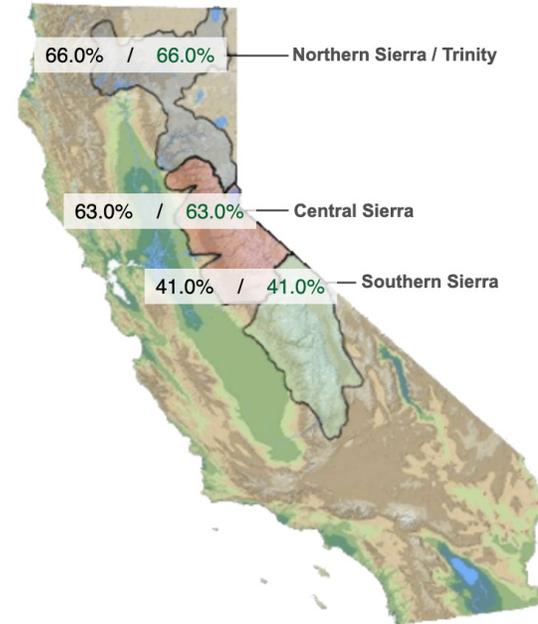
California Snowpack: 1 April 2021

➔ Snow Water Equivalents (inches)

Provided by the California Cooperative Snow Surveys

Data For: 01-Apr-2021

% Apr 1 Avg. / % Normal for this Date



STATEWIDE SUMMARY	
Data For: 01-Apr-2021	
Number of Stations Reporting	97
Average snow water equivalent	16.5"
Percent of April 1 Average	59%
Percent of normal for this date	59%

Source: California Department of Water Resources, <https://cdec.water.ca.gov/>

- Compared to this date last year, statewide snowpack is slightly closer to normal, with somewhat higher snow water equivalent (SWE) in the Central and Northern Sierra Nevada, and somewhat lower SWE in the Southern Sierra Nevada
- As of 1 April 2021, statewide snowpack is only 59% of normal
- Current snowpack is below normal in all regions, especially in the Southern Sierra Nevada (only 41% of normal)

CW3E End of Winter Summary: Current Conditions

For California DWR's AR Program

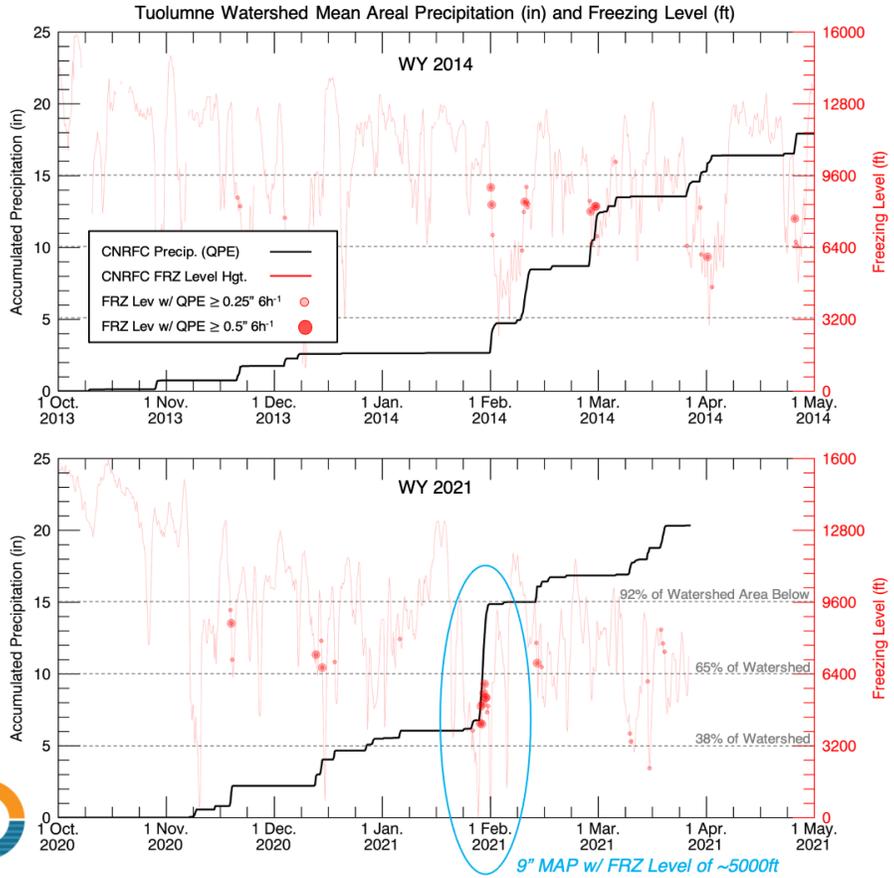


Figure provided by Forest Cannon (Contact: fcannon at ucsd.edu)

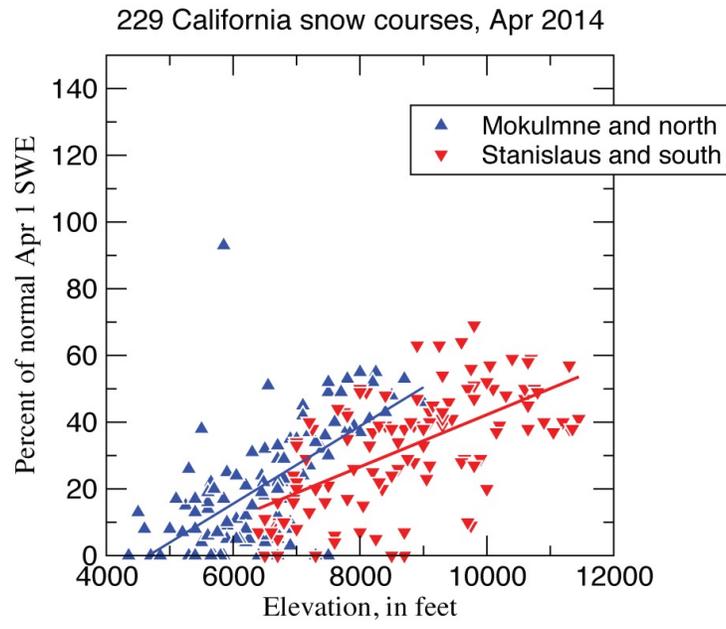
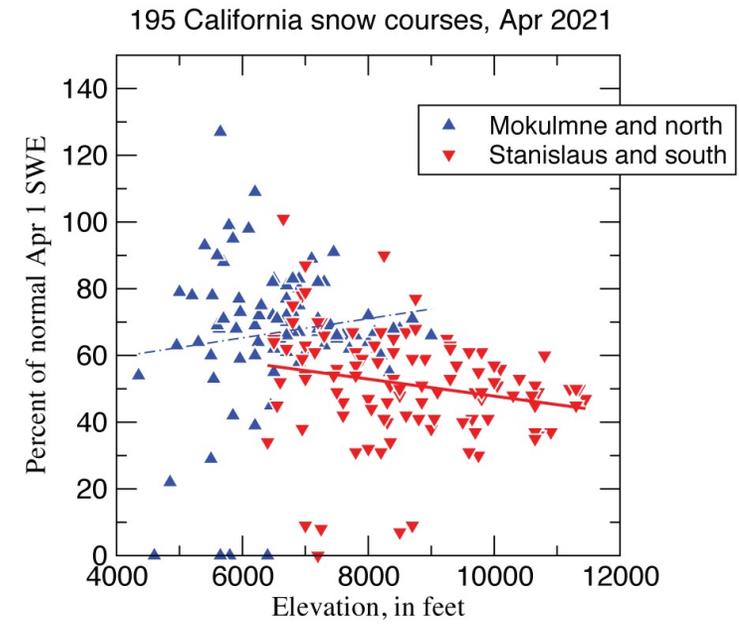
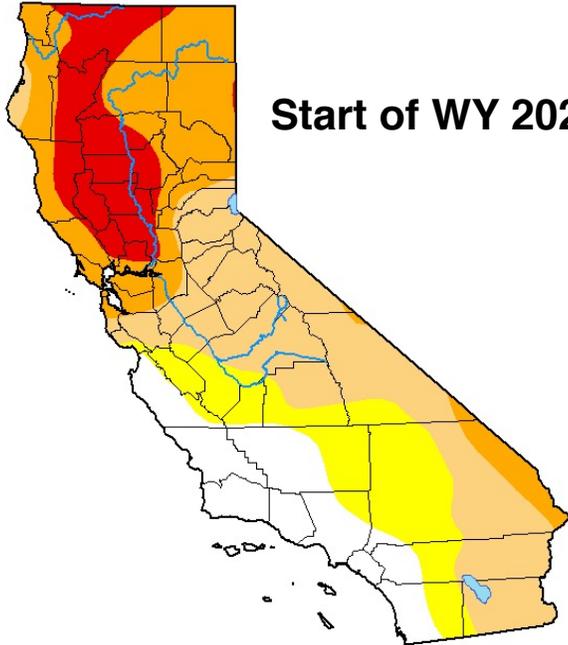


Figure provided by Michael Dettinger (Contact: mddettinger at gmail.com)



- Although WY 2021 precipitation has been well below normal in the Central Sierra Nevada (similar to WY 2014), current snowpack conditions are much closer to normal than in WY 2014
- The snowpack in WY 2021 has been largely influenced by one major precipitation event (27–29 Jan 2021), which was a relatively cold storm that produced significant snowfall accumulations below 8,000 feet
- The snowpack in WY 2014 was driven by several warmer storms with higher freezing levels, thereby limiting snowpack below 8,000 feet

U.S. Drought Monitor California



September 29, 2020
(Released Thursday, Oct. 1, 2020)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	15.35	84.65	67.65	35.62	12.74	0.00
Last Week 09-22-2020	15.62	84.38	67.09	35.27	3.39	0.00
3 Months Ago 06-30-2020	41.79	58.21	46.74	20.84	2.45	0.00
Start of Calendar Year 12-31-2019	96.43	3.57	0.00	0.00	0.00	0.00
Start of Water Year 10-01-2019	95.29	4.71	2.06	0.00	0.00	0.00
One Year Ago 10-01-2019	95.29	4.71	2.06	0.00	0.00	0.00

Intensity:

None	D2 Severe Drought
D0 Abnormally Dry	D3 Extreme Drought
D1 Moderate Drought	D4 Exceptional Drought

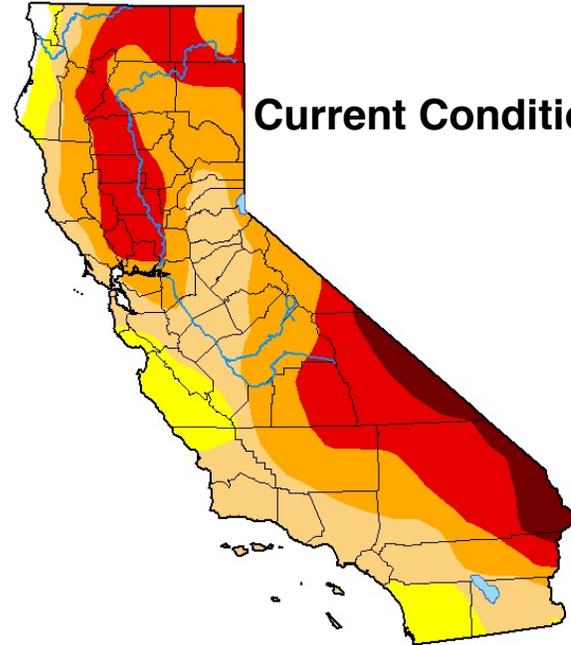
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:
Brad Rippey
U.S. Department of Agriculture



droughtmonitor.unl.edu

U.S. Drought Monitor California



March 30, 2021
(Released Thursday, Apr. 1, 2021)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.77	99.23	90.66	64.02	31.76	5.36
Last Week 03-23-2021	0.70	99.30	90.66	64.02	31.76	5.36
3 Months Ago 12-29-2020	0.00	100.00	95.17	74.34	33.75	1.19
Start of Calendar Year 12-31-2020	0.00	100.00	95.17	74.34	33.75	1.19
Start of Water Year 09-29-2020	15.35	84.65	67.65	35.62	12.74	0.00
One Year Ago 03-31-2020	24.86	75.14	43.31	1.30	0.00	0.00

Intensity:

None	D2 Severe Drought
D0 Abnormally Dry	D3 Extreme Drought
D1 Moderate Drought	D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

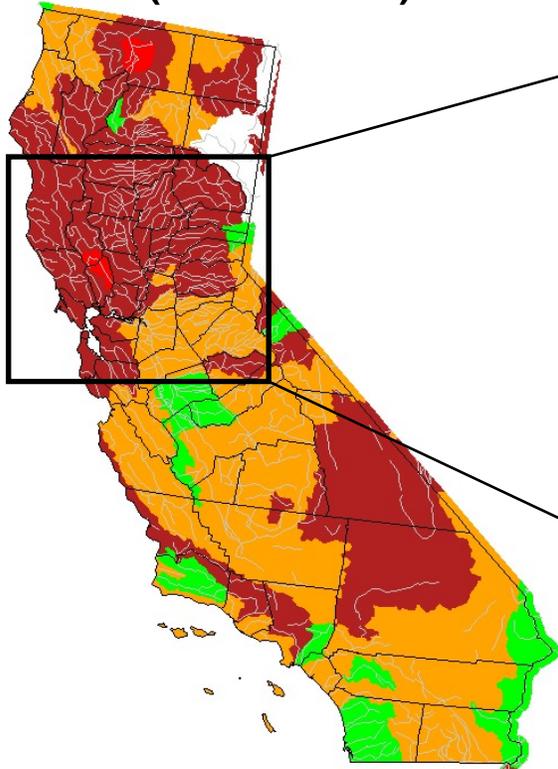
Author:
Brad Pugh
CPC/NOAA



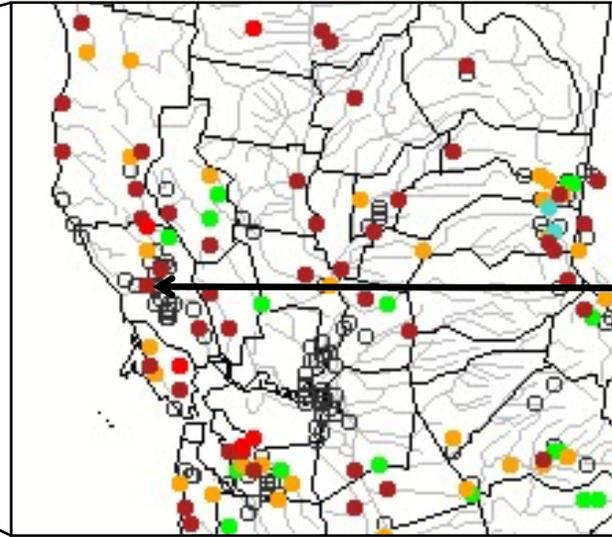
droughtmonitor.unl.edu

- Severe-to-extreme drought has persisted over most of Northern California (with the exception of far northern coastal California, where drought has subsided) since the start of WY 2021
- Drought conditions have deteriorated across much of Central and Southern California since the start of WY 2021
- As of 30 March, nearly all of California is experiencing drought conditions, and 64% of the state is experiencing severe, extreme, or exceptional drought
- Extreme-to-exceptional drought conditions are present across portions of interior Northern California and the Mojave Desert

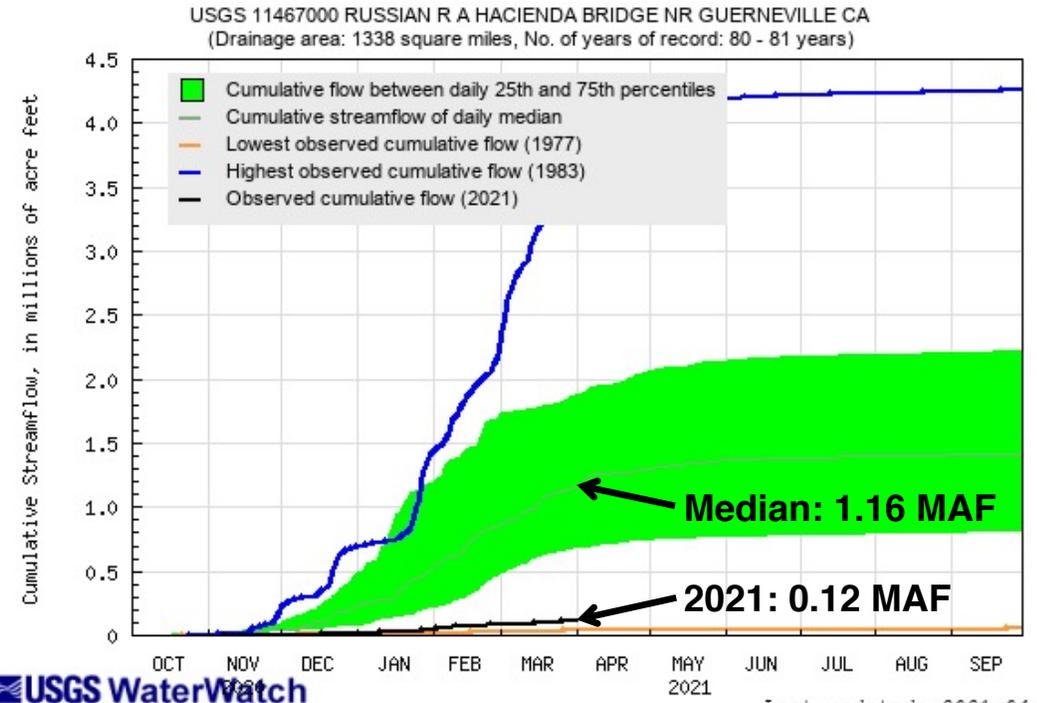
180-day Streamflow (Watersheds)



Current Streamflow (Stations)



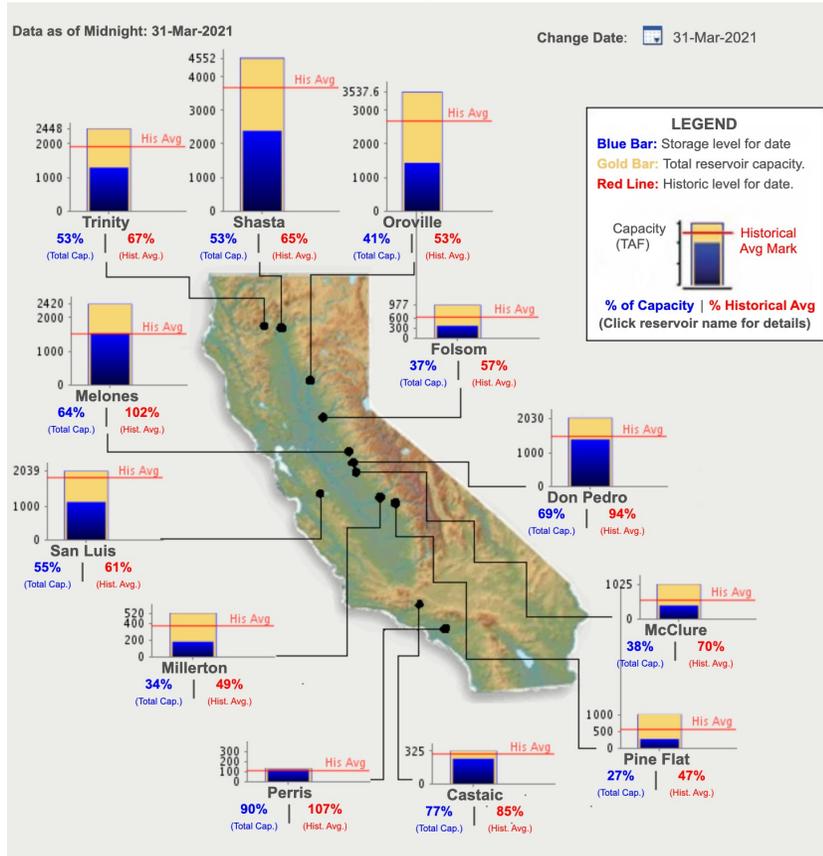
Explanation - Percentile classes							
●	●	●	●	●	●	●	○
Low	<10 Much below normal	10-24 Below normal	25-75 Normal	76-90 Above normal	>90 Much above normal	High	Not-ranked



Source: USGS WaterWatch, <https://waterwatch.usgs.gov/>

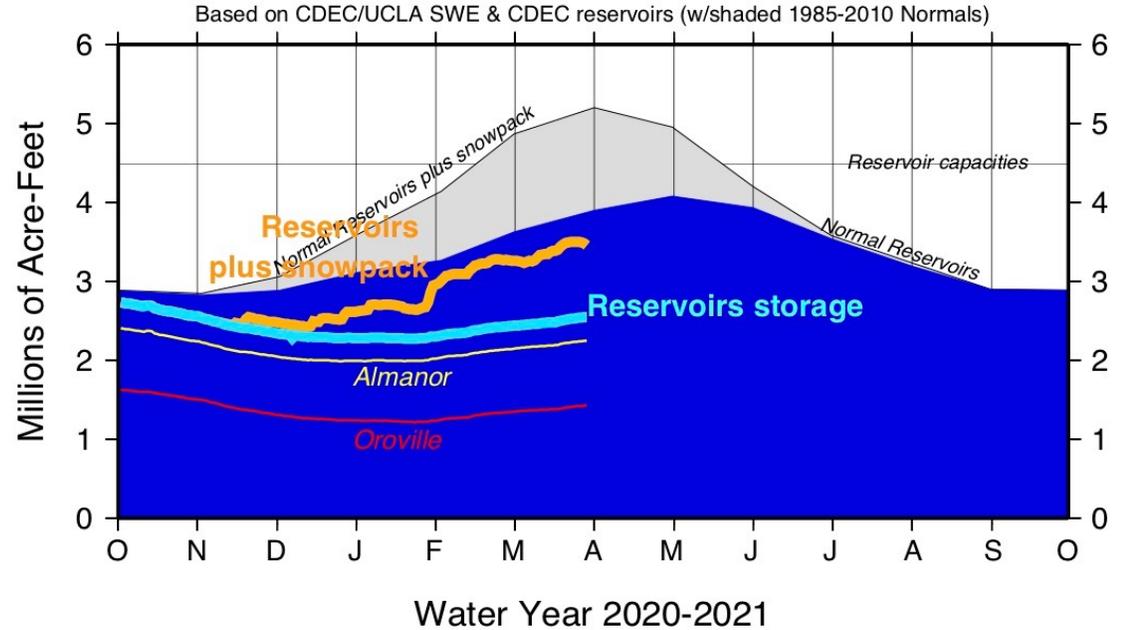
- Streamflow over the past 180 days (~6 months) has been significantly below normal (within the lowest 10% of historical streamflow levels) across much of Northern California, and generally below normal elsewhere in the state
- The current streamflow (as of 1 April) on the Russian River at Hacienda Bridge (near Guerneville, CA) is only 13% of the long-term median streamflow on this date
- The cumulative WY-to-date streamflow at this site is less than 10% of the long-term median cumulative streamflow

Reservoir Storage: 31 Mar 2021



Source: California Department of Water Resources, <https://cdec.water.ca.gov/>

Water Stored in 9 FEATHER reservoirs plus Snowpack



[Daily SWE from FEA snowtels: BKL, FOR, GOL, GRZ, HMB, KTL, PLP, RTL;
 Daily FEA reservoirs: ORO, ALM, ANT, BCL, BTV, DAV, FRD, LGV, SLC]
 [Daily SWE from YUB snowtels: CSL, GKS, IDC, HYS, SQV;
 Daily YUB reservoirs: BUL, ENG]

For info: mddettinger at gmail.com

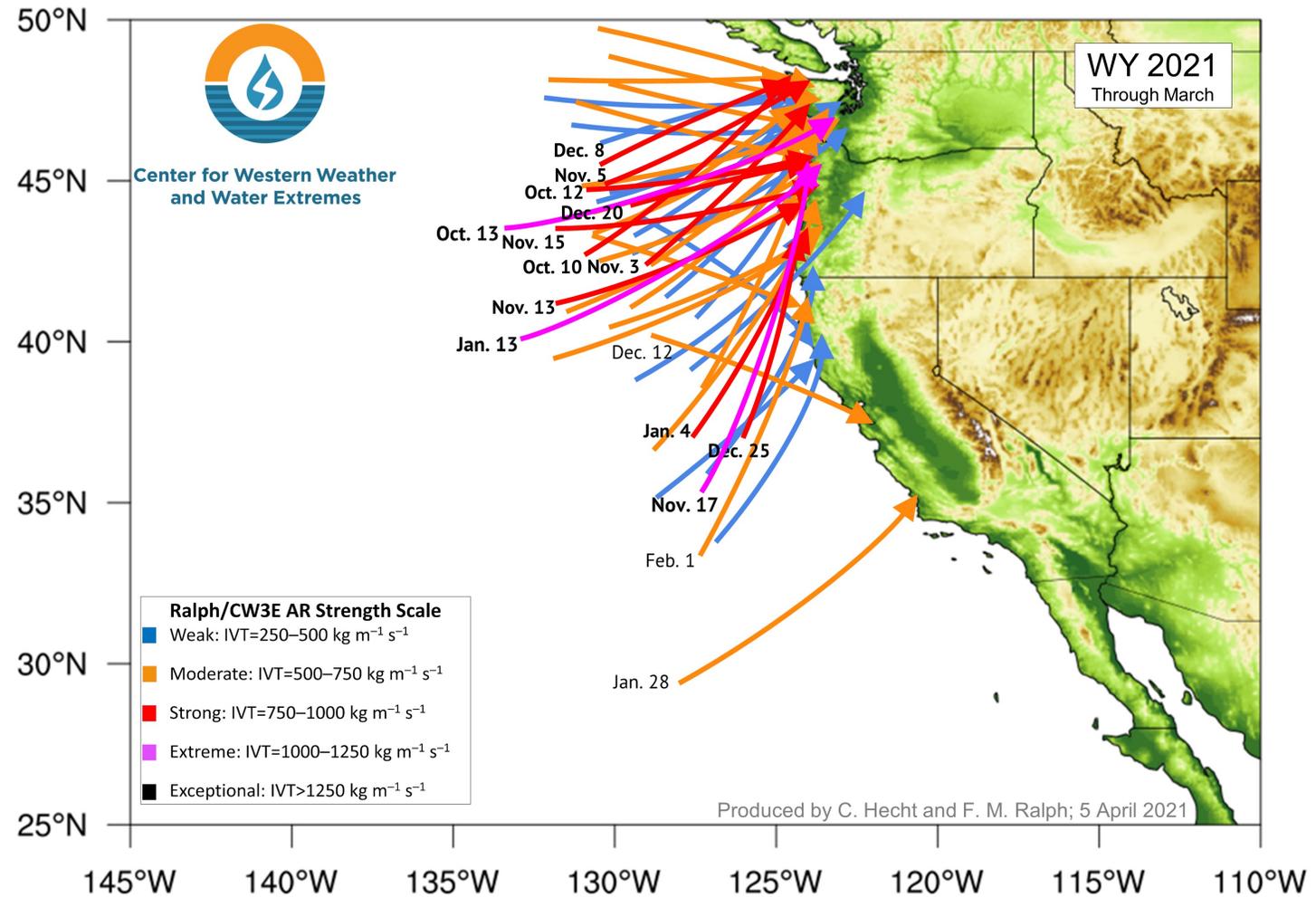
Source: California–Nevada Applications Program, <https://cnap.ucsd.edu/>

- Water storage is below the historical normal levels in many California reservoirs due to the lack of precipitation during WY 2021
- The California DWR is projecting statewide reservoir storage to be less than 60% of normal after the snowpack melts ([source](#))
- In the Feather River network, the combined reservoir + snowpack water storage is less than the normal reservoir-only water storage

AR Strength	AR Count
Weak	15
Moderate	20
Strong	11
Extreme	3
Exceptional	0

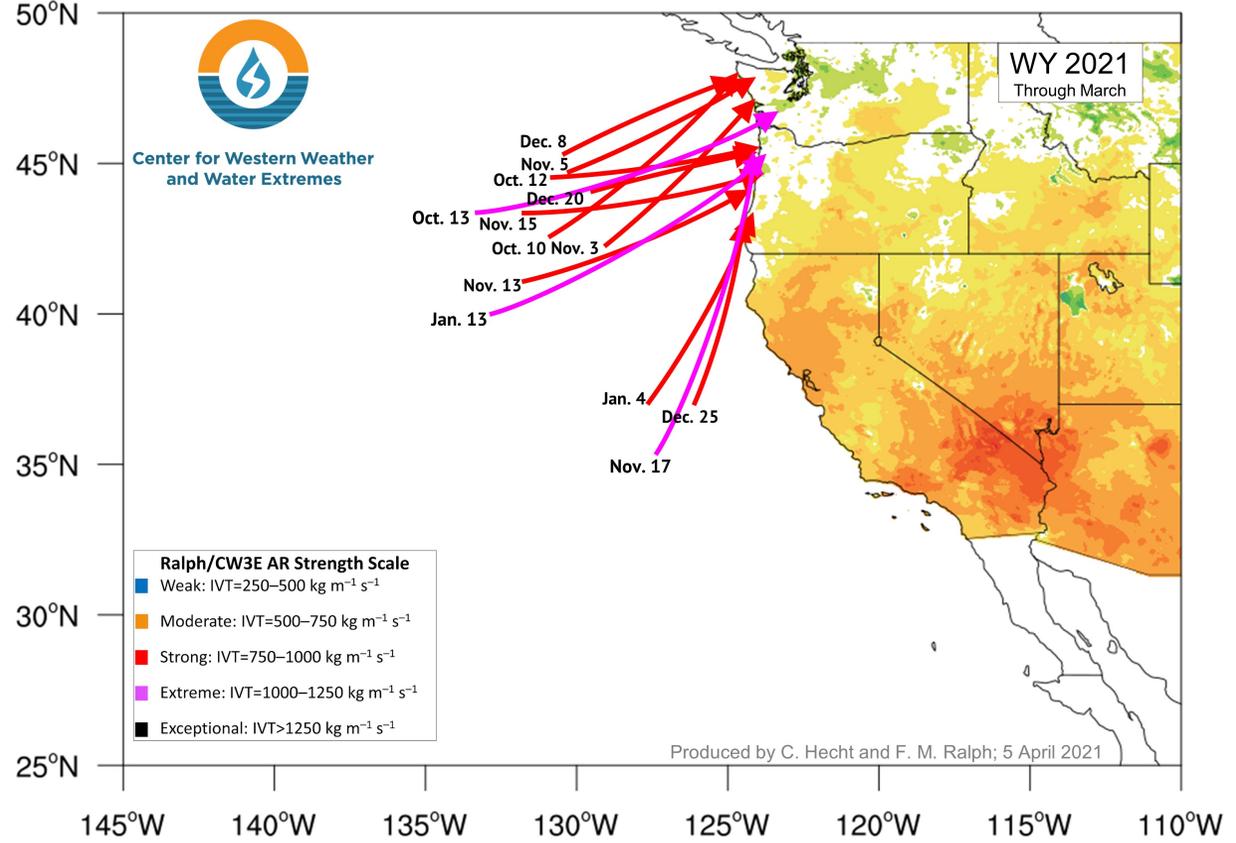
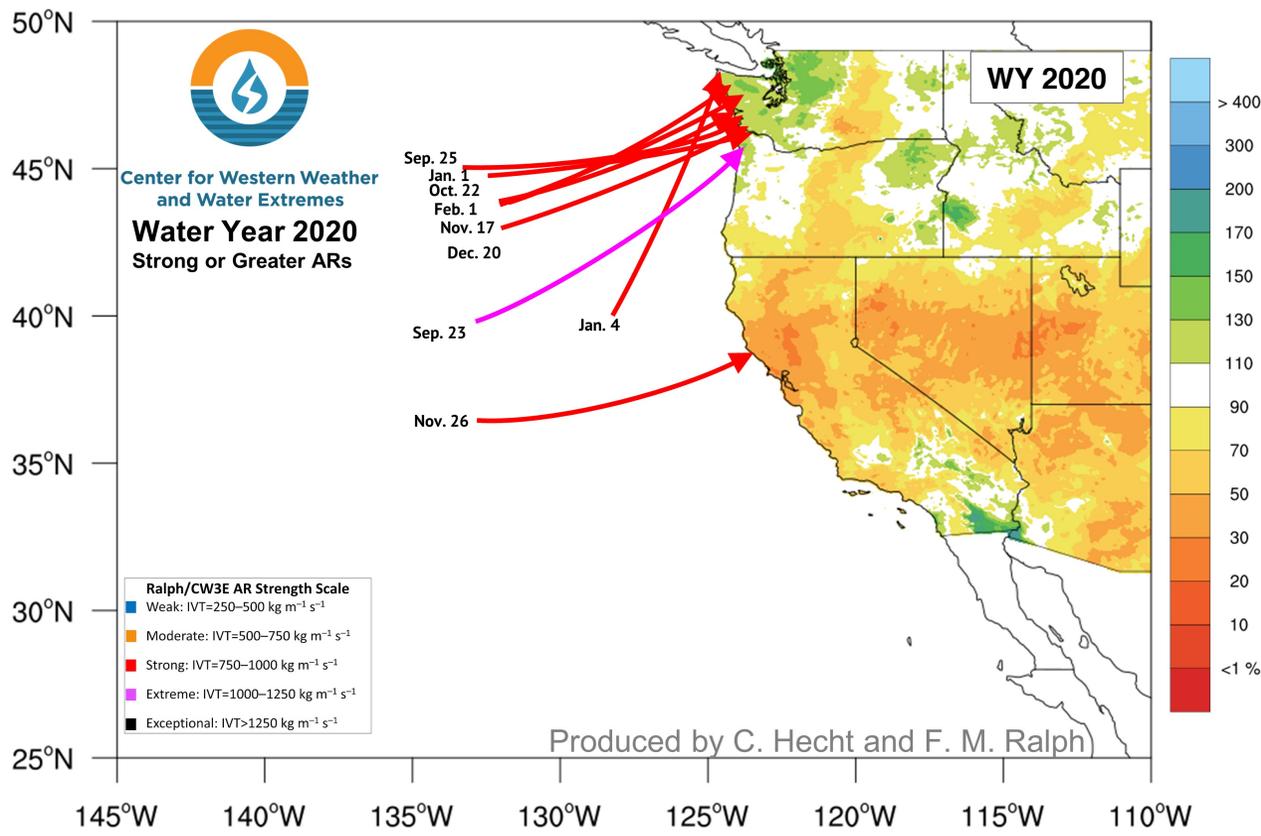
Regions Impacted by Each AR	
State/Region	AR Conditions
Washington	45
Oregon	48
Northern CA	30
Central CA	15
Southern CA	6

49 atmospheric rivers have made landfall over the U.S. West Coast during WY 2021, a majority of which primarily impacted the Pacific Northwest

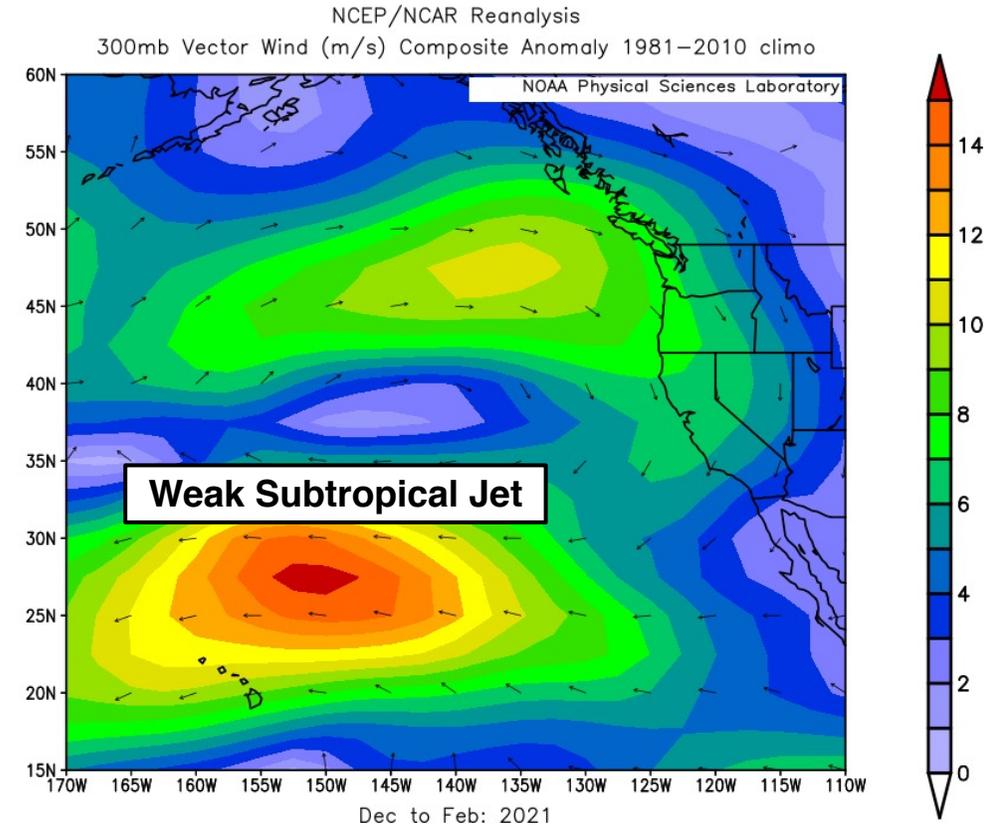
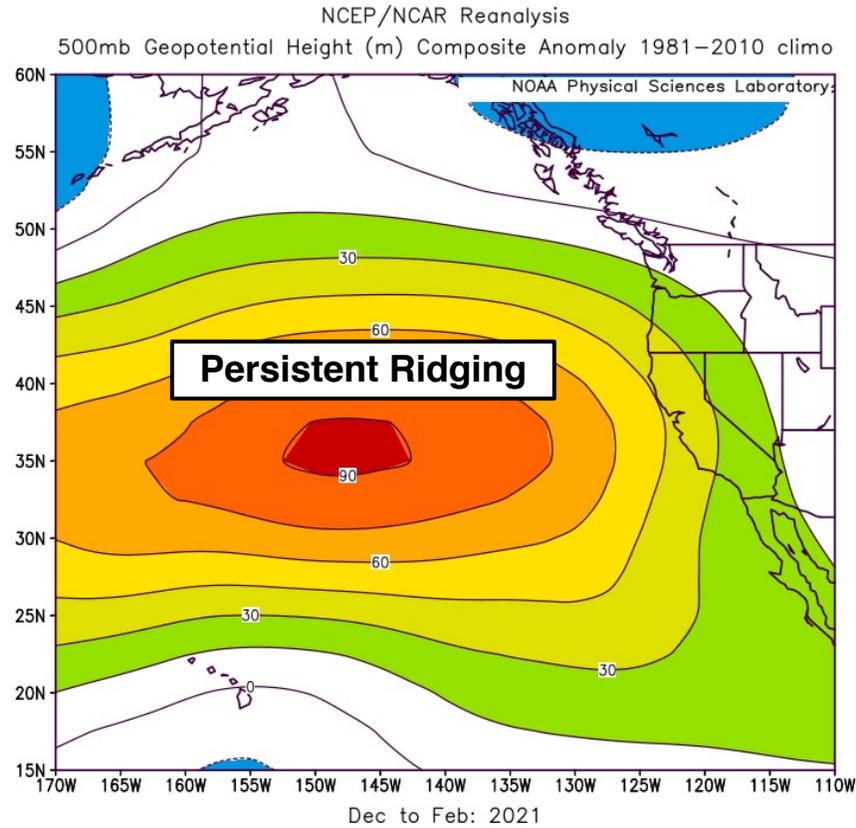


*Arrows are placed on the map where each AR was strongest over the coast

Strong or Greater Magnitude ARs During WYs 2020 and 2021

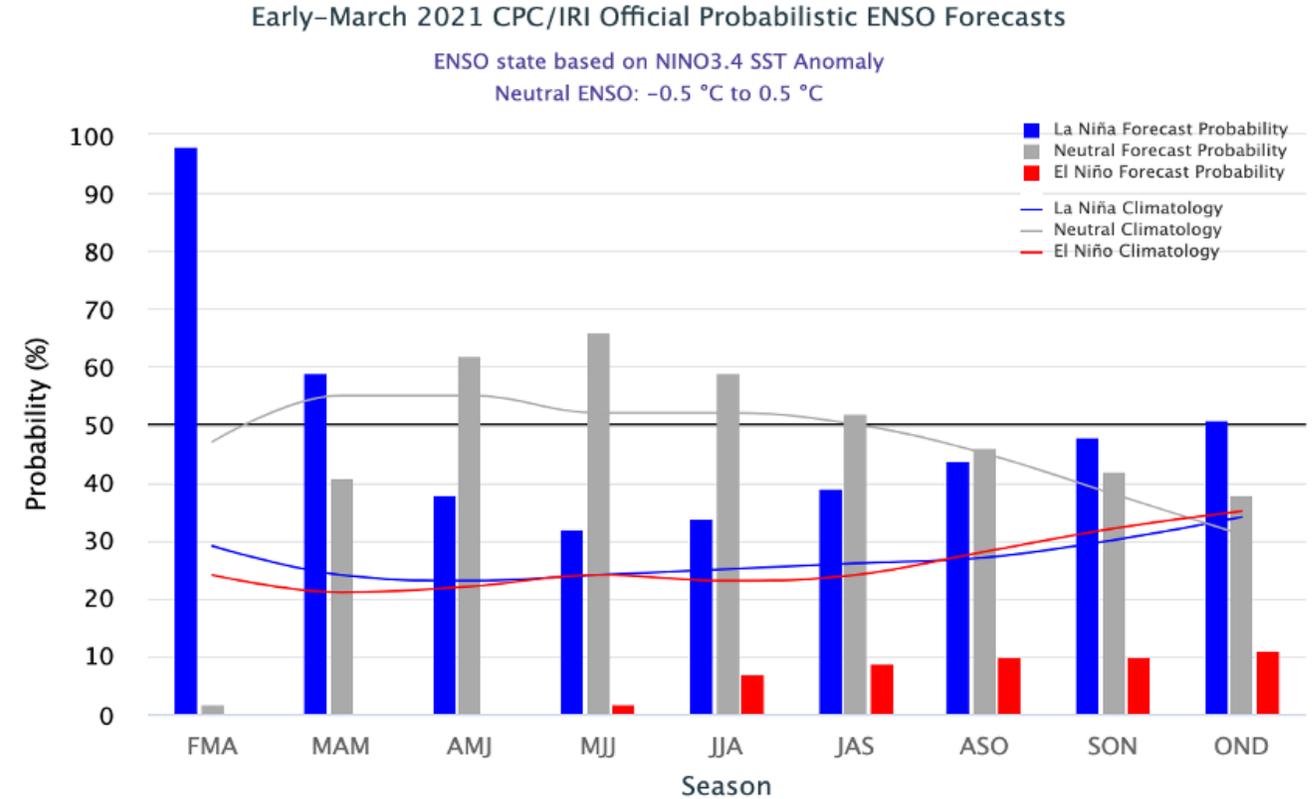
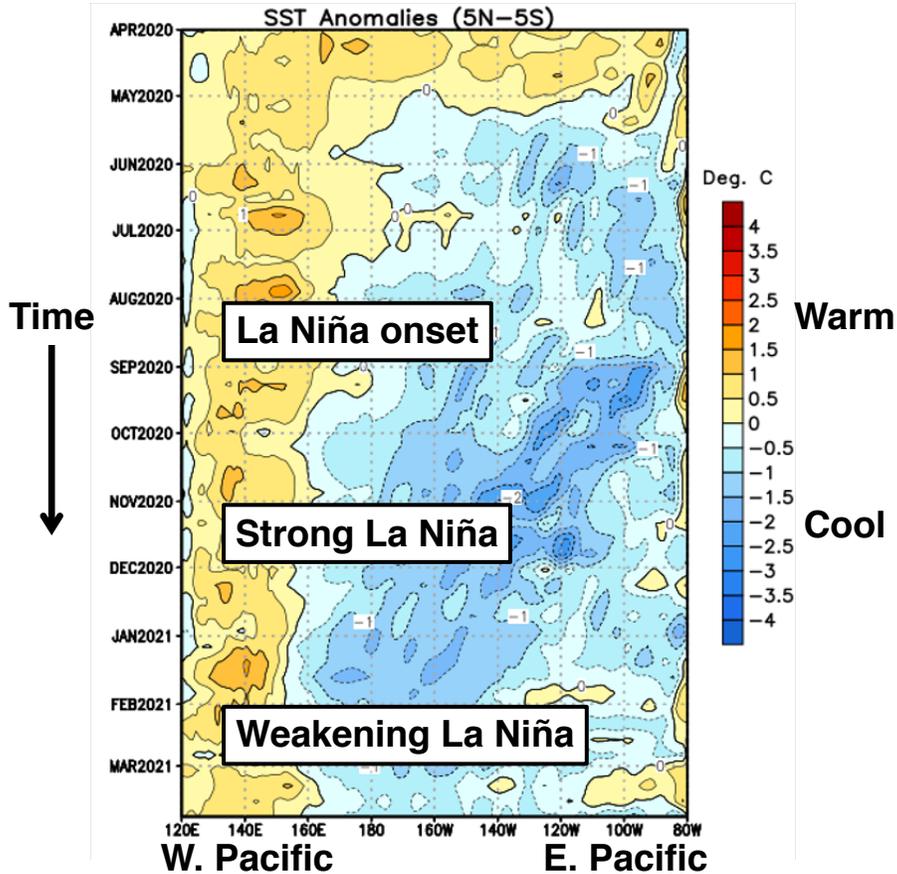


- One of the main drivers of the dry conditions across California was the lack of strong or greater magnitude ARs ($IVT > 750 \text{ kg m}^{-1} \text{ s}^{-1}$) in back-to-back water years of 2020 and 2021
- There was only one strong AR that was strongest over California during November 2019 and none during WY 2021
- The lack of strong ARs resulted in well below normal precipitation accumulations during both water years ($< 30\%$), exacerbating drought conditions across much of the state



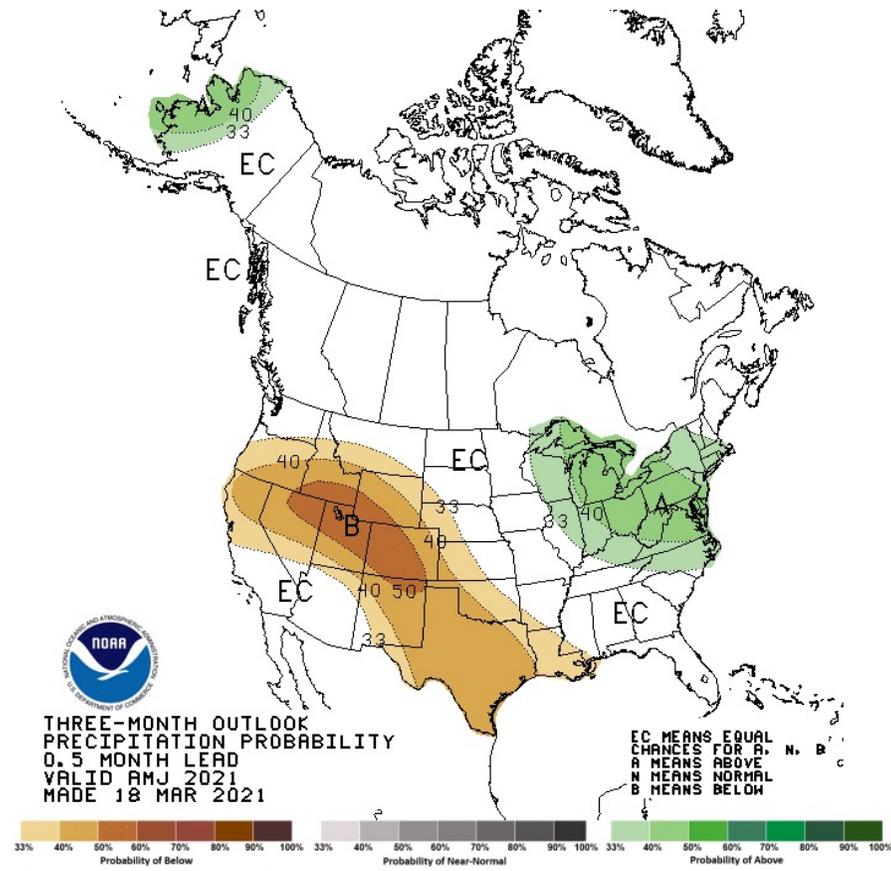
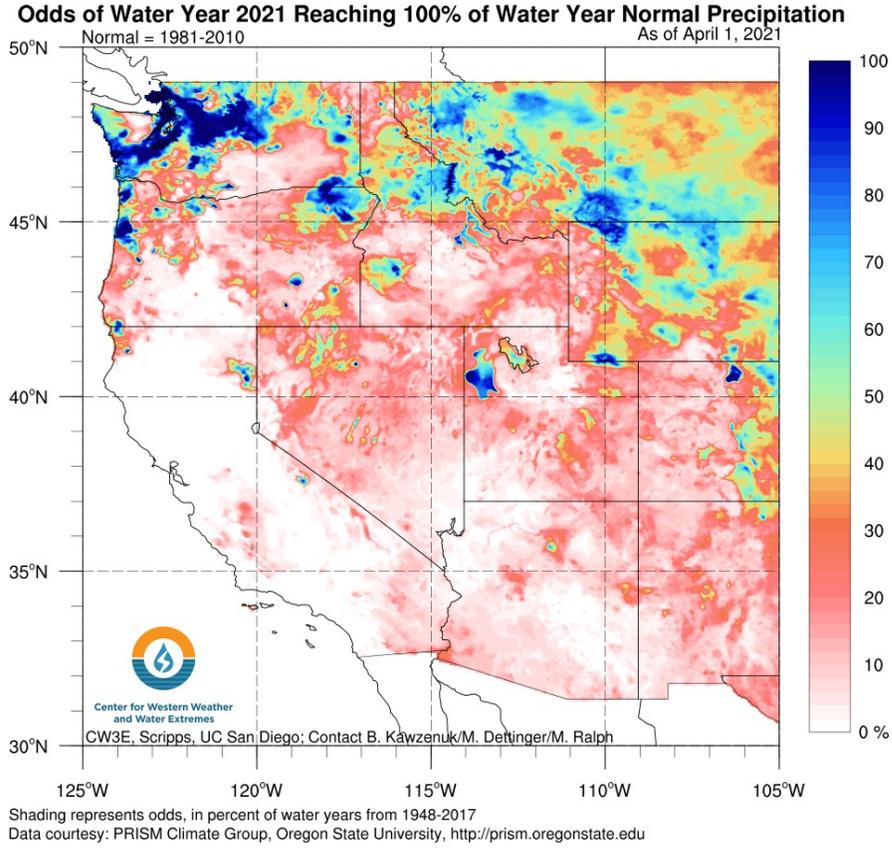
Source: NOAA/ESRL/Physical Sciences Laboratory, <https://psl.noaa.gov/>

- The lack of precipitation and AR landfalls in California during winter 2020/2021 can be explained by the presence of persistent large-scale circulation anomalies over the Northeast Pacific Ocean
- During DJF, the large-scale circulation pattern was characterized by a broad region of positive 500-hPa geopotential height anomalies, indicative of persistent ridging/blocking
- The 300-hPa vector wind field shows a significant easterly wind anomaly over the subtropical Northeast Pacific, indicative of a weak subtropical North Pacific jet and reduced storm track activity over California



Source: NOAA/NWS/NCEP/Climate Prediction Center, <https://www.cpc.ncep.noaa.gov/>

- The observed circulation patterns during winter 2020/2021 be may partially related to the presence of La Niña conditions (note the below-normal SSTs in the Central and Eastern Pacific)
- La Niña conditions typically favor increased blocking over the Northeast Pacific and a weaker, less persistent North Pacific jet, both of which generally reduce cyclone activity and precipitation over the southwestern U.S.
- The latest projections from the CPC suggest a return to ENSO neutral conditions in late spring and summer 2021
- Beyond summer 2021, model uncertainty is high, with nearly equal forecast probabilities of La Niña and ENSO neutral conditions

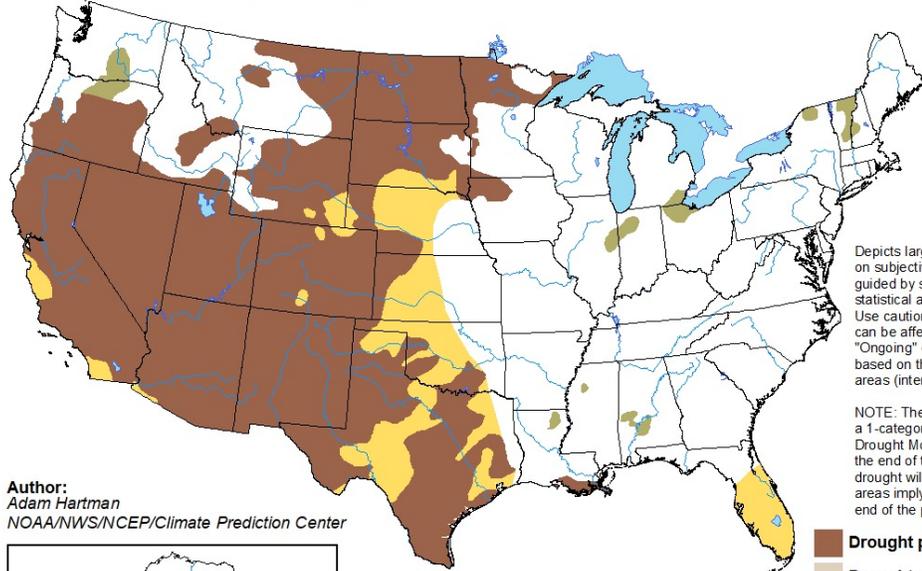


Source: NOAA/NWS/NCEP/Climate Prediction Center, <https://www.cpc.ncep.noaa.gov/>

- Based on the current WY-to-date precipitation, the historical probability of reaching normal total WY precipitation is less than 10% across much of California
- The only areas where the probability of reaching normal WY precipitation exceeds 50% are Del Norte and Lassen Counties
- The 3-month (April–June) precipitation outlook from the CPC suggests low chances of drought relief in Northern California this spring

U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

Valid for March 18 - June 30, 2021
Released March 18



Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

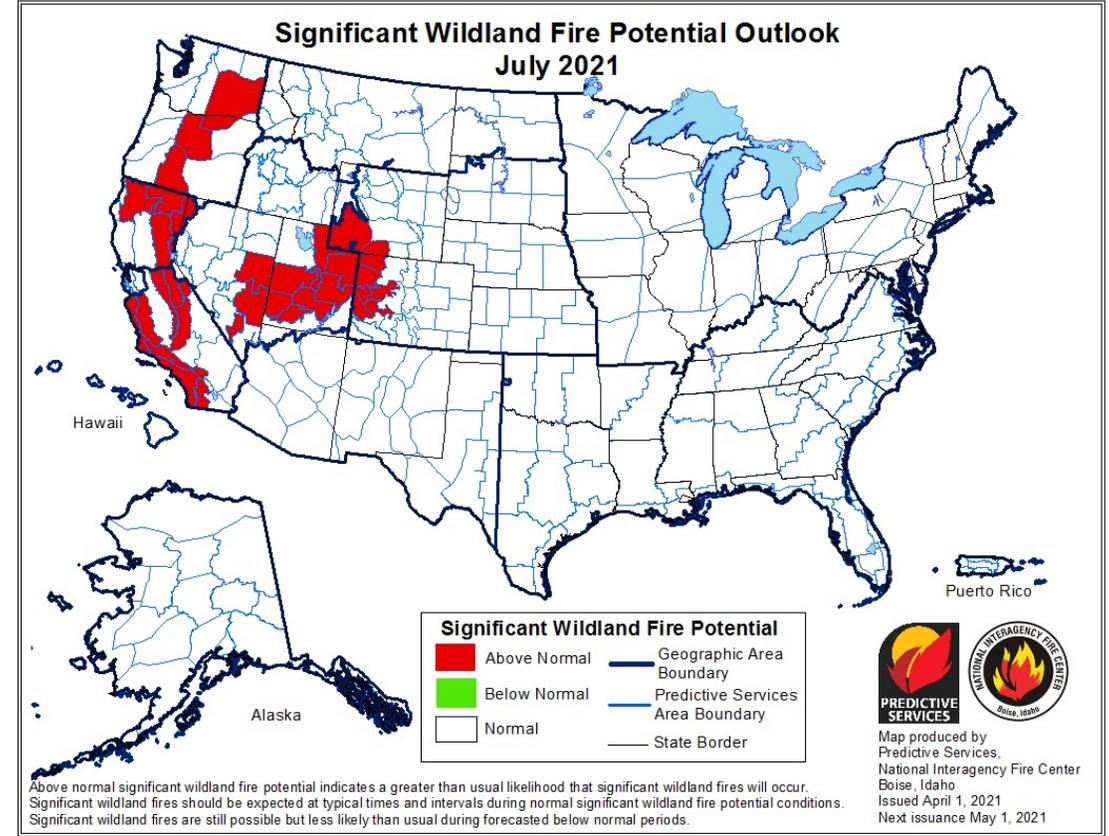
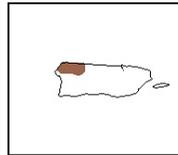
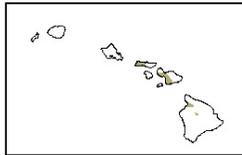
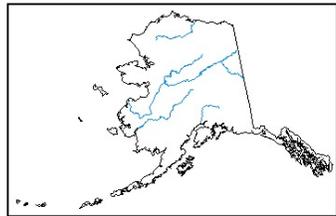
NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

- Drought persists
- Drought remains but improves
- Drought removal likely
- Drought development likely



<http://go.usa.gov/3eZ73>

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- | Significant Wildland Fire Potential | |
|---|--|
| Above Normal | Geographic Area Boundary |
| Below Normal | Predictive Services Area Boundary |
| Normal | State Border |



Above normal significant wildland fire potential indicates a greater than usual likelihood that significant wildland fires will occur. Significant wildland fires should be expected at typical times and intervals during normal significant wildland fire potential conditions. Significant wildland fires are still possible but less likely than usual during forecasted below normal periods.

Map produced by
Predictive Services,
National Interagency Fire Center
Boise, Idaho
Issued April 1, 2021
Next issuance May 1, 2021

Source: NOAA/NWS/NCEP/Climate Prediction Center, <https://www.cpc.ncep.noaa.gov/>

Source: National Interagency Fire Center, <https://www.nifc.gov/>

- Drought conditions are expected to persist and/or worsen across the southwestern U.S. during the next three months, thereby elevating the wildfire potential for summer 2021
- The National Interagency Fire Center is currently predicting an increased likelihood of significant wildfire activity in July 2021 over coastal Central and Southern California, the Sierra Nevada, and the Klamath Mountains