CNAP

California-Nevada Climate Applications Program

— A NOAA RISA —

EL NIÑO IN CALIFORNIA AND NEVADA

DECEMBER 2015

What is El Niño?

El Niño occurs when Pacific trade winds slacken, which weakens equatorial upwelling and warms the waters at and below the surface in the eastern half of the tropical Pacific (Figure 1). NOAA declares El Niño conditions when sea surface temperatures (SSTs) in the Niño 3.4 region, east of the International Date Line, are 0.5˚C (~1˚F) warmer than normal for 5 or more overlapping 3-month periods. Associated with these abnormally warm SSTs, the region of deep convection (thunderstorms and rainfall) shifts eastward to the central and eastern tropical Pacific, linking anomalous conditions near the ocean's surface to the atmosphere aloft. The unusual heating of the tropical atmosphere changes temperature, precipitation, and atmospheric circulations over global scales. A common pattern during El Niño is a more expansive Aleutian Low with a southward shifted North Pacific storm track into the western US, which modifies weather in California and Nevada.

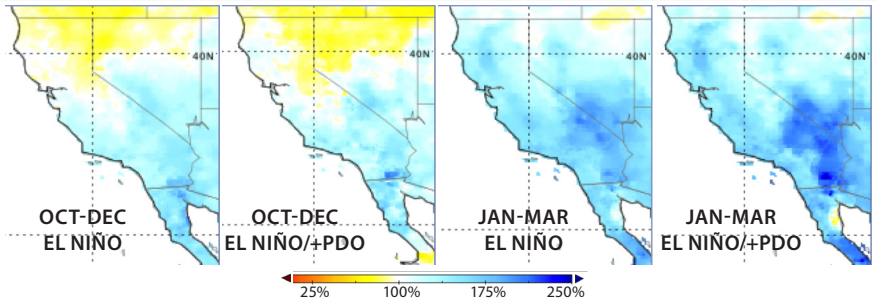


Figure 2. Composite precipitation % of normal for moderate/strong El Niño events: 1957-58, 1963-64, 1965-66, 1972-73, 1982-83, 1986-87, 1987-88, 1991-92, 1997-98, 2002-03, 2009-10; El Niño/+PDO events: 1982-83, 1986-87, 1987-88, 1991-92, 1997-98, 2002-03, 2009-10. Data source: Livneh

Past El Niño events in CA and NV

During El Niño, wintertime precipitation is often above normal across the southern third of CA and NV, but it has not been consistent (both wet and dry) in central and northern CA and NV. However, in past Very Strong El Niño events (Niño 3.4 SST anomalies >2.0˚ C), wetter conditions were more widespread, covering most of the two states. This fall (2015), the current El Niño is on par with the Very Strong 1982-83 and 1997-98 El Niño events-- thus there appears to be a higher likelihood of widespread above normal precipitation in CA and NV during winter 2015-16. Additionally, North Pacific SSTs are currently registering the positive phase of the Pacific Decadal Oscillation (PDO), as they were in 1982-83 and 1997-98, which can reinforce El Niño precipitation impacts in CA and NV-- thus the El Niño/+PDO composites shown in Figure 2 may serve as an analog for the current winter.

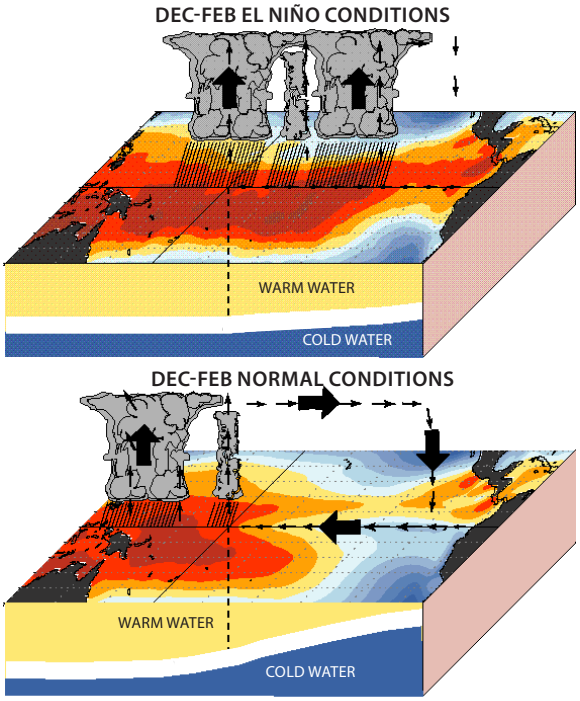
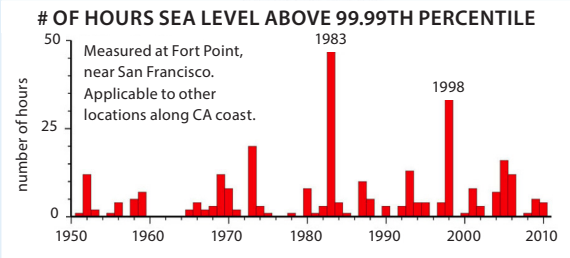


Figure 1. During El Niño conditions (top figure), the typically thin layer of warm surface water (shown in bottom figure) in the eastern equatorial Pacific thickens. Sea surface temperatures increase off the coast of South America and in the central Pacific along the equator. The warmer equatorial Pacific surface waters observed during El Niño result from the confluence of several events in the atmosphere and ocean. Image source: NOAA NWS

COASTAL FLOODING



During an El Niño event, water along the West coast is often warmer than normal and upwelling is supressed, creating higher than normal sea levels. Along the California coast, sea levels during Very Strong El Niño events, especially 1982-83, were extremely high. When heightened sea levels coincide with high tides and strong storms, coastal flooding can occur, as it did in California during the 1982-83 El Niño event.

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Do California's largest floods occur during El Niño?

With a strong El Niño expected this winter, many communities worry about an increased risk of flooding. The highest peak flows of California's coastal rivers (Russian River for example, Figure 3 top) have been observed in El Niño, neutral, and La Niña years. In contrast, Sierra Nevada rivers (Merced River for example, Figure 3 bottom) generally observe their highest peak flows in neutral or La Niña years. Flooding in CA and NV is often associated with atmospheric rivers, narrow plumes of high water vapor transport. Preliminary research suggests the development of atmospheric rivers over the Pacific is slightly less favorable during El Niño conditions. However, flooding can occur during any season and any year in both CA and NV. Residents and decision-makers should remain vigilant and take necessary precautions if flood warnings are issued.

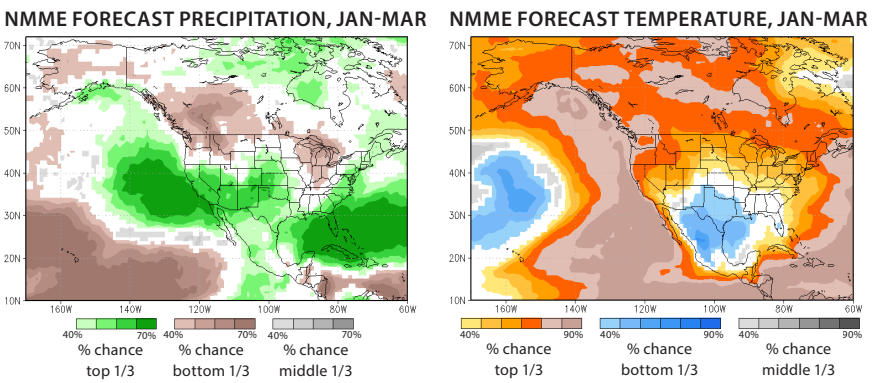


Figure 4. Experimental forecasts for Jan-Mar from the North American Multi-Model Ensemble. Forecasts show the chance of temperature/precipitation being among the top, middle, or bottom 1/3 (tercile) of all observed values at a location. Nearly all of California and Nevada are favored to be in the upper tercile (>66th percentile) for temperature and precipitation for Jan-Mar.

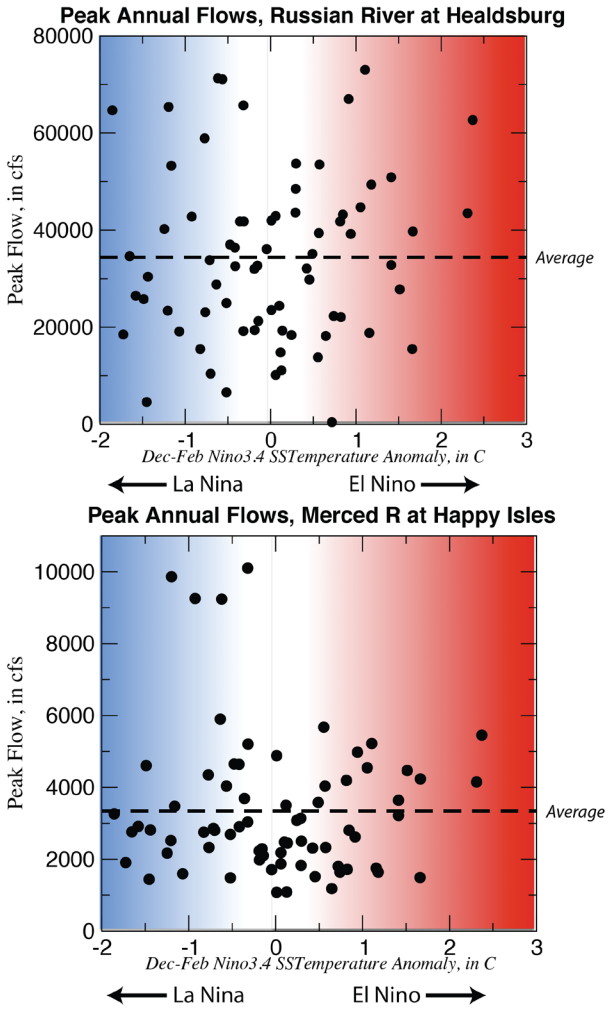


Figure 3. Peak flows of the Russian River in coastal northern CA (top) and the Merced River in central interior CA (bottom) for each year from 1940 to 2014. Data source: USGS

Forecasting El Niño temperature and precipitation for CA and NV

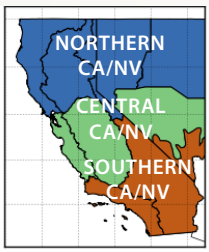
One of the latest tools scientists are using to understand and predict seasonal climate is the North American Multi-Model Ensemble (NMME). The NMME is a global forecast system consisting of seven climate models from different agencies and is run about 100 times each month for up to a year in the future. Having multiple models and examining the commonalities and differences among them helps forecasters reduce some of the error or bias that any one particular model has and include multiple possible scenarios in the seasonal forecast. The Jan-Mar NMME forecast is shown in Figure 4. An ongoing study compares current NMME forecasts for the upcoming Dec-Feb and Jan-Mar seasons with forecasts made at the same time during 1982-83 and 1997-98 (left). During these two Very Strong El Niño events, the NMME correctly forecasted higher chances of above normal precipitation in CA-NV. In general, the forecast likelihood of equal to or more than 100% or 150% of normal precipitation is comparable to 1982 and less than it was at the same time in 1997. The forecast likelihood of equal to or more than 100% or 150% is greater over southern CA/NV than in the northern and central parts of the region.

Northern CA and NV

	December-February			January-March		
% of normal precipitation	1982-83	1997-98	2015-2016	1982-83	1997-98	2015-2016
100	60	84	67	73	82	76
150	13	28	14	17	28	18

Central CA and NV

	December-February			January-March		
% of normal precipitation	1982-83	1997-98	2015-2016	1982-83	1997-98	2015-2016
100	66	86	71	72	85	73
150	27	39	27	38	39	35

Southern CA and NV

	December-February			January-March		
% of normal precipitation	1982-83	1997-98	2015-2016	1982-83	1997-98	2015-2016
100	71	87	71	72	80	79
150	41	48	36	43	44	43