What can drought-stricken California expect from the El Niño winter forecast?

A science assessment by a subgroup of the NOAA Drought Task Force

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KEY POINTS

Recognizing the sensitivity of likely impacts on California winter precipitation to El Niño intensity, and also recognizing the spread of possible outcomes even for a very strong El Niño (see Fig. 3), the outlook must be expressed probabilistically. Nonetheless, this brief assessment leads to the following key points:

- ✦ **Impacts are likely to be greater in late winter than early winter.**
- ✦ **Southern California has a stronger chance of wet conditions than northern California.**
- ✦ **In case of a very strong El Niño, heavy precipitation is more likely across the entire state.**

During 2011-15, California experienced the driest four successive winters since 1895. Dry conditions have been widespread and, according to the U.S. Drought Monitor for August 2015, all of California is in severe to exceptional drought. Recent research[6] has demonstrated that sea surface temperature (SST) anomalies - cool conditions in the central to eastern equatorial Pacific and warm conditions in the west Pacific and Indian Ocean - were important factors contributing to the drought. This SST pattern has now changed. A developing El Niño, with strong warming of the east equatorial Pacific and cooling of the tropical west Pacific and North Pacific, reverses many of the anomalies prevailing during 2011-15. This El Niño ranks among the strongest in the historical record for this time of year and forecast models predict it to last into 2016.

How does El Niño alter risks for wet and dry winters over California? Is El Niño's impact over northern and southern California different? Do very strong El Niños (of which only1982/83 and 1997/98 have occurred since 1895) exert effects distinct from more typical El Niños? The NOAA Drought Task Force (DTF) report noted that statewide wet California winters since 1895 (top 15%) tend to occur during El Niño events but here, to address the questions above, two analyses are presented; observed historical relationships between El Niño and California rain and climate simulations of those relationships. The latter has the attribute that many more samples of California precipitation during very strong El Niños are created using ensemble methods. On the basis of these diagnoses and the current SST forecast, an indication for the range of winter precipitation that can be expected for the upcoming 2015/16 winter is provided.

Southern California has stronger chance of wet conditions than northern California: Fig.1 at right shows anomalies of SST, 200mb

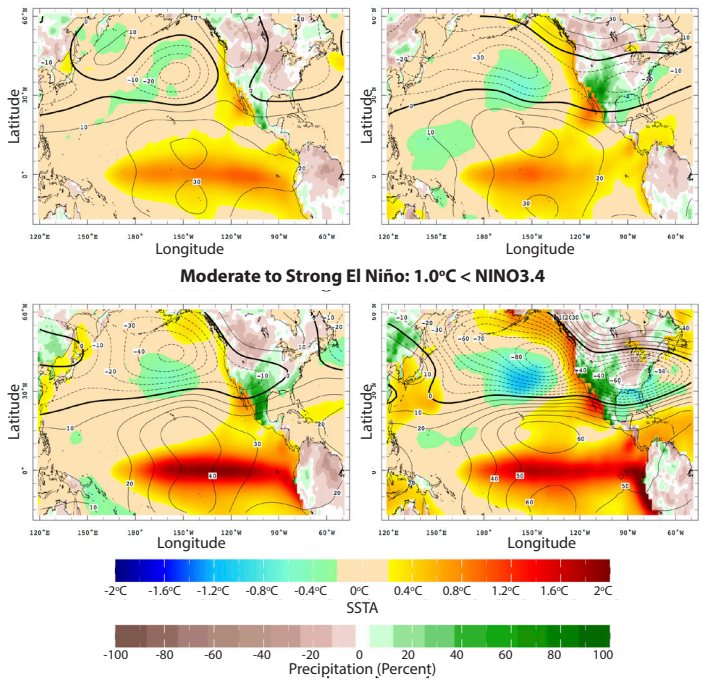

FIG. 1

Anomalies of SST (colors, ocean; NOAA ERSSTv4), precipitation (colors, land; GPCC % of average) and 200MB geopotential heights (contours; NOAA 20th Century Reanalysis) for weak (top) and moderate-strong (bottom) El Niños. All relative to a 1901-2015 climatology. El Niño strength is evaluated with the NINO3.4 index SST anomaly averaged over 5°N to 5°S and 170°W to 120°W with weak El Niño defined as between 0.5°C and 1°C and moderate-strong El Niño as greater than 1°C.

[6] (Wang and Schubert 2013; Seager et al. 2014, NOAA Drought Task Force report, http://cpo.noaa.gov/mapp/californiadroughtreport

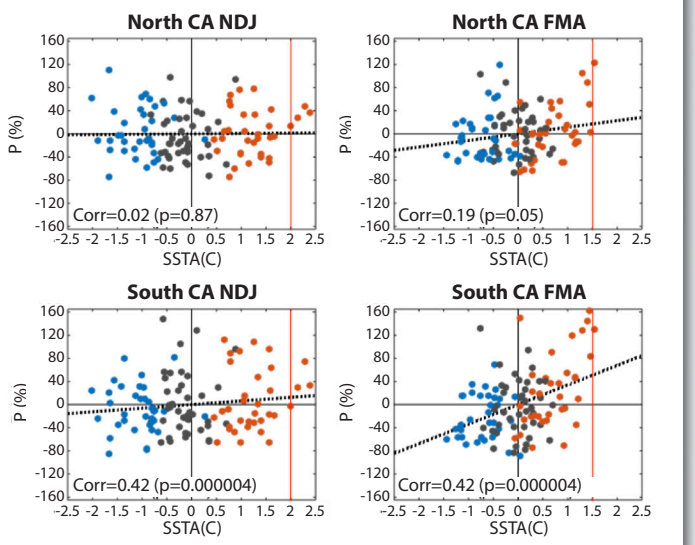

FIG. 2

Precipitation anomalies (% of climatology) as a function of NINO3.4 SST anomaly for northern (top) and southern (bottom) California and early (left) and late (right) winter. La Niña, neutral and El Niño conditions are colored as blue, black and red. The average of August initialized dynamical model forecasts have NINO3.4 values slightly in excess of those indicated by the vertical red lines.

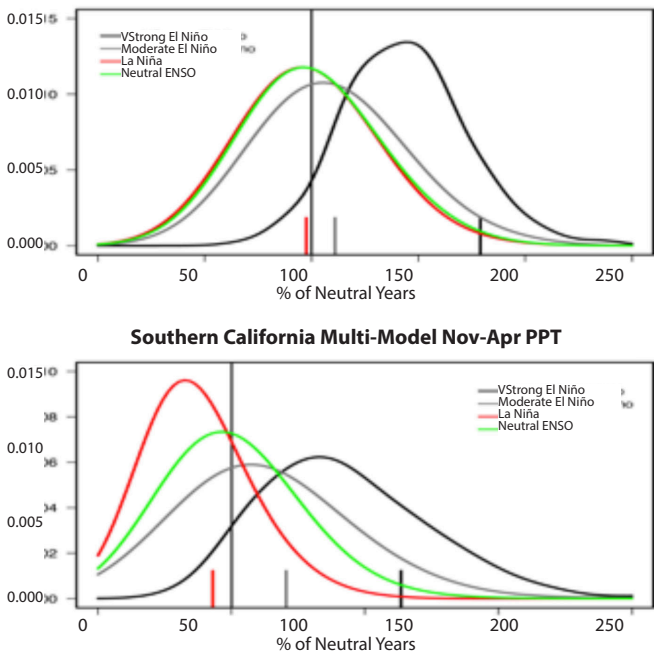

FIG. 3

November-April precipitation probability distribution functions for northern (top) and southern (bottom) California based on a multi-model 130-member ensemble of historical simulations. Results shown for very strong (black) and moderate (gray) El Niños, La Niñas (red), and neutral winters (green). The black (grey) vertical lines indicate the observed mean of very strong (moderate) El Niño events, and the red vertical line indicates the observed mean for La Niña events.

Tercile Precipitation Percent Anomalies for Strong and Weak El Niño

		NDJ			FMA		
		Lower	Middle	Upper	Lower	Middle	Upper
North	Strong El Niño	-43% (5)	-2% (9)	42% (7)	-0% (0)	-7% (6)	92% (4)
	Weak El Niño	-46% (5)	0% (3)	63% (4)	-49% (2)	6% (3)	37% (6)
South	Strong El Niño	-42% (5)	-10% (7)	55% (9)	-35% (1)	-9% (1)	107% (8)
	Weak El Niño	-48% (6)	-9% (2)	92% (4)	-71% (1)	-9% (5)	53% (5)

TABLE 1

Counts of which tercile of the distribution seasonal precipitation totals fall into as a function of weak and moderate-to-strong El Niños for northern and southern California. The number of seasons in each tercile is in parentheses together with the precipitation anomaly averaged across those, expressed as percent of climatology. E.g. for past cases of moderate-to-strong El Niños in late winter, one season has had below normal precipitation, one normal precipitation, and 8 above normal with the precipitation anomaly of those 8 averaging 107% above climatology (i.e. more than twice as much as normal).

geopotential heights and precipitation over land for early winter (November through January, NDJ) and late winter (February through March, FMA) for weak (top) and moderate-strong (bottom) El Niños. California has experienced wetter conditions during moderate-strong El Niños than during weak El Niños in both seasons. California precipitation anomalies are stronger in FMA than NDJ. Only in FMA, and during the stronger El Niños, has the entire state been wet.

To further illustrate the relationship between California precipitation and NINO3.4 SSTs, scatter plots indicate little link during early winter (Fig. 2) and a stronger link in late winter, especially in Southern California. During moderate-strong El Niños, late winter precipitation over northern and southern California has been near or appreciably above normal, with reduced risk of drought. Table 1 provides a summary.

Strong El Niños reduce risk of dry winters: Further exploring California precipitation sensitivity to El Niño, Figure 3 shows frequency distributions for northern and southern California precipitation during November-April using climate model data for a 130-member ensemble for 1979-2014 subjected to the observed SST variability. These yield 260 samples for the two very strong El Niños. The very strong El Niños produce intense, widespread increases in precipitation statewide, greatly reducing risks for dry winters. The models indicate that El Niños of 1982/83 and 1997/98 magnitude could greatly dent the drought. For northern California, where much of the state's water resources arise, the models show a 50% probability that precipitation would be at least 140% of normal, and dry conditions are unlikely. While such a radical shift in risks cannot be inferred from observations alone, they are consistent with experience during the two very strong El Niños.

Because of such a different sensitivity to very strong versus the more typical moderate El Niños (compare gray vs black curves in Fig. 3), the forecast strength of El Niño is highly relevant for advance warning. The latest ENSO forecast plume (released by NOAA in August 2015) indicates, amidst uncertainty, forecaster consensus unanimously favoring a strong El Niño, with peak 3-month SST departures in the Nino 3.4 region potentially near or exceeding +2.0°C.

These comments are provisional. A reliable prediction of a wetter than normal California winter requires a strong El Niño in late winter. Hence operational forecasts need to be monitored closely to see if the El Niño event weakens from the end of 2015 to spring 2016 or whether strong El Niño conditions continue into the late winter.