Elevated Sea Levels During 2015-2016 Strong El Niño

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Due to El Niño and high ocean temperatures, NOAA's tide gauges along the California coast and NASA affiliate satellites are recording elevated sea levels. The tidal gauge records show that average water levels for October are 6-9 inches above normal (Figures 1- 3). Based on previous El Niño observations (Figures 1-3), scientists think that these water levels will continue to be higher than predicted, and could even increase, during our winter storm season into Spring 2016. These elevated water levels will be the base, on top of which additional high water levels will occur due to storms. Using peak sea levels during past strong El Nino's as a guide, large storms this winter could add an additional 1-2 feet of sea level excess to this elevated seasonal sea level height.

During past strong El Niño's, elevated water levels peaked in individual storm events in January and February, with maximum anomalies of approximately 1.5 feet in San Diego and maximum anomalies of approximately 3 feet in San Francisco (Figure 3). As an overall average during the winter season, the two very strong El Niño's of 1982-83 and 1997-08 produced 6-10 inches of higher water levels that persisted from October until late spring and then became elevated again the following summer through fall (Figures 1 and 2). During the past two years along the West Coast, surface waters have been unusually warm ("the Blob"), which has contributed to higher coastal water levels (Figures 4 and 5). These warm ocean waters and other regional processes have caused an increase in water levels of an additional few inches of higher water levels. Combining El Niño and the Blob, sea level anomalies seem likely to reach average levels of 1 foot this early winter and continue until Spring 2016, lower in the Summer 2016 and rise again temporarily during Fall 2016. When large storms occur, there will be additional increases from winds and low barometric pressure, producing peak high water levels which could amount to as much as 1.5-3 feet above predicted levels.

Greatest damage from heightened water levels occurs when large storms coincide with high tides. Strong El Niño conditions amplify sea levels, and also increase chances of large storms. Large storms cause high surface waves, which leads to coastal erosion and damage to coastal property and infrastructure. Highest tides occur during new moon and full moon each month. This winter's highest tides ("King Tides") are scheduled to occur November through February and will require extra precaution due to the elevated sea levels, causing "Tall Kings" or "Emperor Tides". If storms occur during these times, they could be especially damaging, drawing lessons from the winter of 1983.

The anomalous sea levels that California is experiencing this fall and that will likely be sustained through spring are approaching longer period increased levels that are projected under climate change for mid-century. The present El Niño is understood to be a short period climate fluctuation whose effects will likely subside in a year or two. Over the longer term, the changes brought on by global warming will pose an increasing challenge. The *State of California Sea-level Rise Guidance Document* projects a mid-range sea-level rise of approximately one foot by 2050.

Figure 1. Monthly Mean Sea Level Above Normal for La Jolla, CA During Past Strong El Niños and 2015

Credit: Reinhart Flick, Department of Boating and Waterways and Scripps Institution of Oceanography, UC San Diego

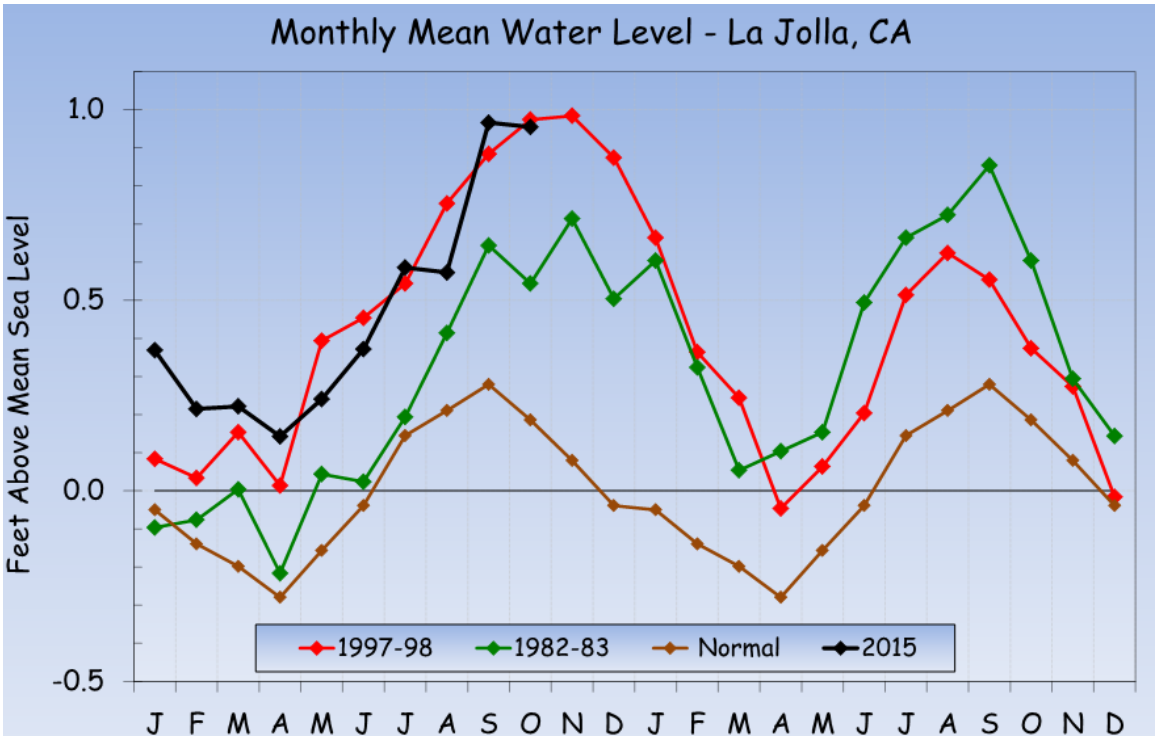

Figure 2. Monthly Mean Sea Level Above Normal for San Francisco, CA During Past Strong El Niños and 2015

Credit: Reinhart Flick, Department of Boating and Waterways and Scripps Institution of Oceanography, UC San Diego

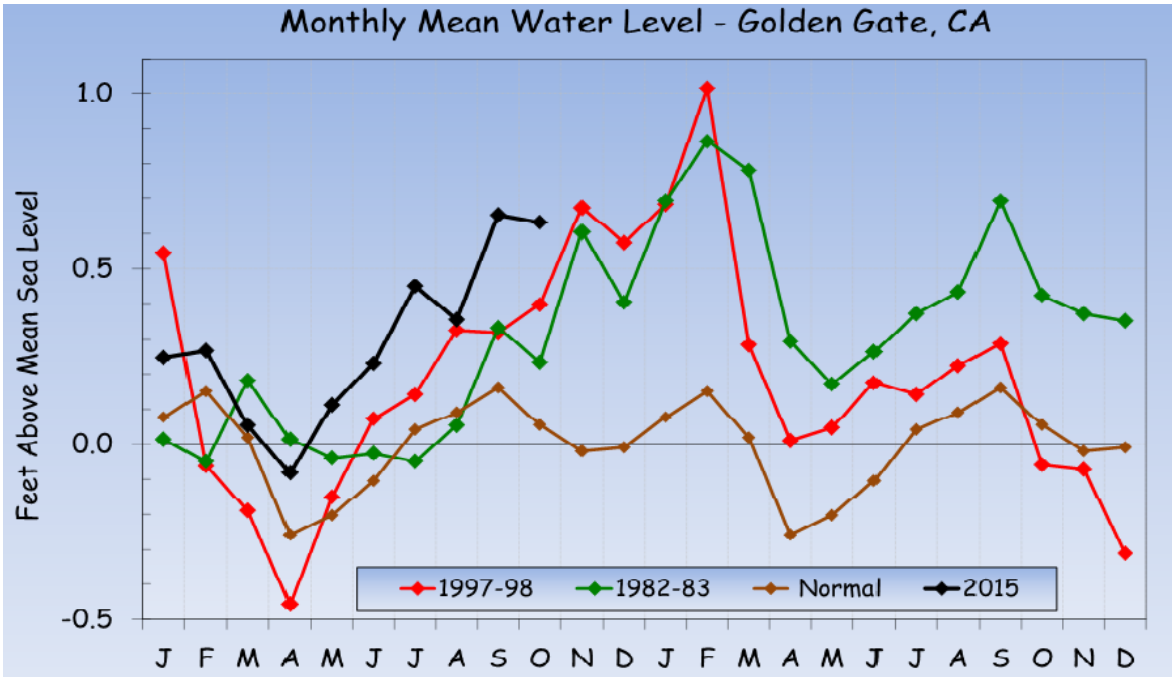

Figure 3. Maximum Daily Anomalous Water Levels (observed-predicted) for Crescent City, San Francisco and San Diego (La Jolla). Credit: Sam Iacobellis, CNAP RISA Program, Scripps Institution of Oceanography, UC San Diego

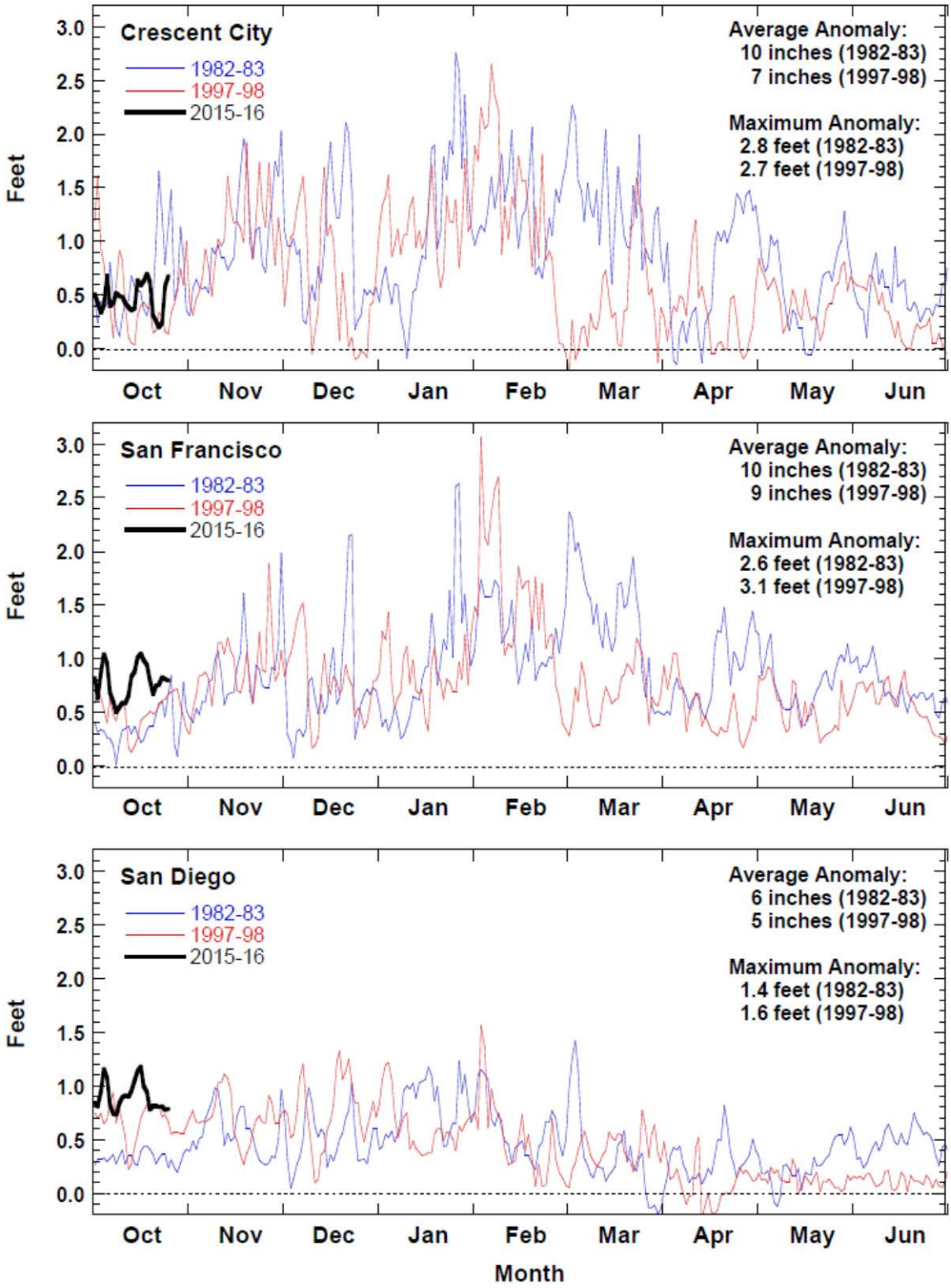

Figure 4. Sea Surface Temperature Anomaly Based on Satellite Observations. Image courtesy of Charles Thompson, PO.DAAC/JPL; Data: AVISO, France

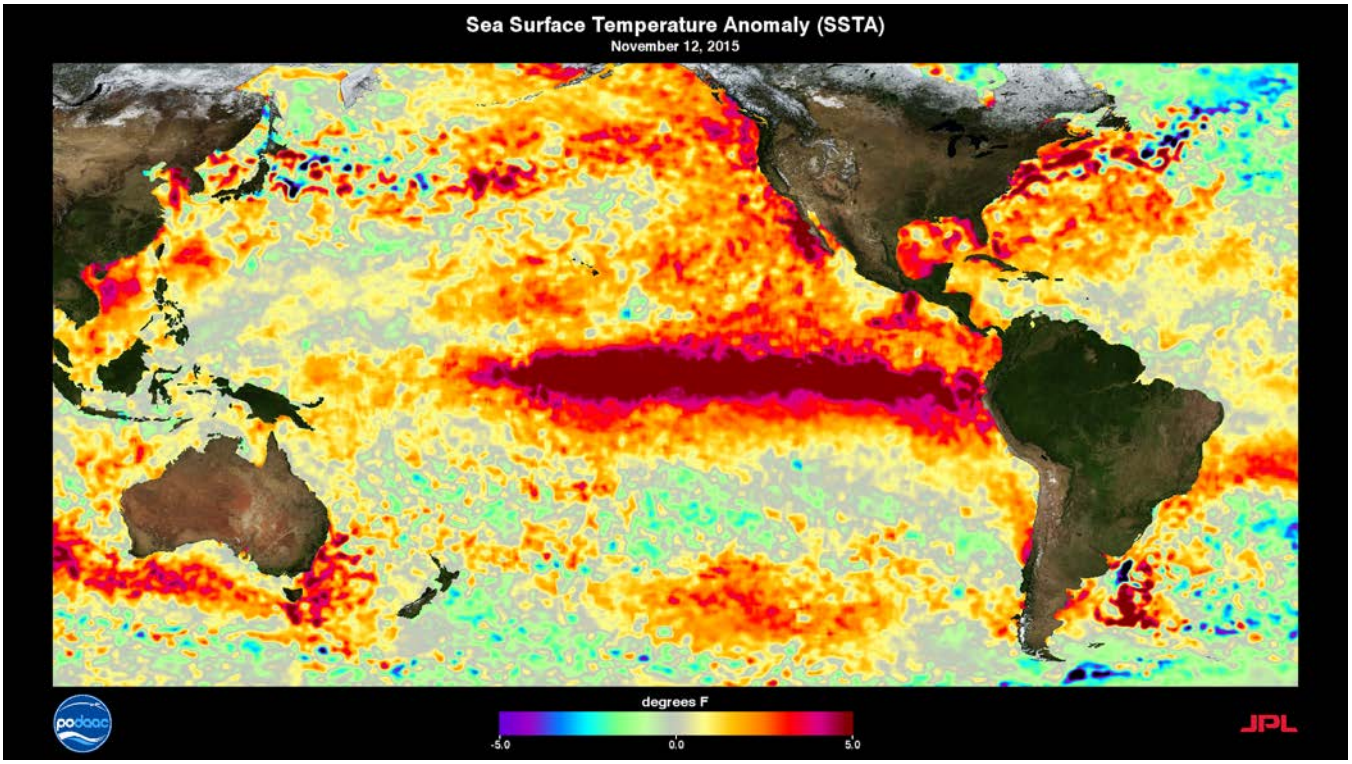

Figure 5. Sea Level Anomaly Based on Satellite Observations. Image courtesy of Charles Thompson, PO.DAAC/JPL; Data: AVISO, France