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The role of sea surface salinity in ENSO related water cycle anomaly

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This study investigates the role of sea surface salinity (SSS) in the water cycle anomaly associated with El Niño Southern Oscillation (ENSO). The 2015-16 El Niño, one of the strongest ENSO events observed in centuries, coincident with unprecedented coverage of spacebased remote sensing of SSS over global oceans. We analyze three SSS data sets: from the NASA's missions of SMAP and Aquarius, and the ESA's Soil Moisture and Ocean Salinity (SMOS).

One typical characteristics of an ENSO event is the zonal displacement of the Western equatorial Pacific Fresh Pool (WPFP). The edge of the pool extends eastward during El Niño, retreats westward during La Niña. For super El Niño, the eastern edge of WPFP extends much more east across the equatorial Pacific. Indeed, SSS from SMAP reveals much stronger eastward migration of WPFP starting in April 2015. The eastern edge of WPFP reached 140°W in March 2016, about 40° more eastward extension than Aquarius observed in previous years. In the following months from March to June 2016, WPFP retreated westward, coincident with the ending of this strong El Niño event [WMO, El Nino/La Nina update, 2016]. SMOS data shows similar feature, confirming that there is no systematic biases between SMAP and Aquarius retrievals.

We examine the linkage between the observed SSS variation and ENSO related water cycle anomaly by integrated analysis of SSS data sets in conjunction with other satellite and in situ measurements on rain, wind, evaporation and ocean currents. Based on the governing equation of the mixed layer salt budget, the freshwater exchange between air-sea interfaces is estimated as residual of the mixed-layer salinity (MLS) temporal change and advection (Focean), as an alternative to evaporation minus precipitation (FE-P). We analyzed the spatial and temporal variation of Focean and FE-P to explore the anomalous signature in the oceanic and atmospheric branches of the water cycle associated with 2015/16 ENSO. The maximum anomalous along the Equator shown in Focean occurred a few weeks ahead of FE-P, suggesting that salinity is not only a passive tracer but also plays an active role in the onset and evolvement of an ENSO event.