El Niño typology and trends: Insight from three decades of weekly SST observations

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Despite decades of progress in observing, modeling, and understanding ENSO, surprises abound. A new type of El Niño, one in which the sea surface temperature (SST) warming occurs primarily in the central rather than eastern equatorial Pacific Ocean, was first reported in peer–reviewed literature in 2005. This phenomenon was coined "Dateline" El Niño; some discussion of semantics followed as the term "Modoki" (a Japanese word meaning "similar but different") was used one year earlier in the Japanese Media. In the five years since these papers, over 50 studies have been published in the classic ocean/atmosphere/climate literature identifying, contrasting, diagnosing, and predicting CP El Niños and their impacts on monsoons, tropical cyclones, ocean biology, Antarctic climate, and stratospheric variability. Furthermore, several studies have investigated whether CP El Niños are becoming more frequent and/or stronger, while others have questioned whether EP and CP El Niños are in fact distinct phenomena. This paper is concerned primarily with the latter two questions.

A straightforward interpretation of 30 years of reliable weekly mean sea surface temperature observations across the equatorial Pacific Ocean in time–longitude space reveals a rich diversity of El Niños, many of which are sequences or blends of various types. To identify El Niños (and La Niñas) of any origin, a simple index is defined that does not assume *a priori* the region(s) where SST anomalies are considered most important or illuminating of different types of events (*e.g.*, the Niño_3 [Niño_4] index, which is a measure of the equatorial SST anomaly averaged between 150°W–90°W [160°E–150°W]). Indices for warm and cold events are calculated separately to allow the possibility of concurrent events of opposite sign in the equatorial Pacific Ocean. Distinctly CP El Niños can be identified based on a time–longitude structure that begins with a warm anomaly west of the dateline (*i.e.*, an eastward extended warm pool), which propagates eastward several thousands of kilometers – but not to the eastern boundary, and retreats. Furthermore, all of the events that followed such evolution did so within a multi–year setting of an anomalously eastward position of the warm pool edge. The hypothesis that EP El Niños are fundamentally (or initially) CP El Niños that happened to also elicit a strong eastern response is not supported; EP El Niños are observed to occur independently of the characteristic CP signature, concurrent with CP El Niños, and prior to CP El Niños. These insights may be difficult to tease from discrete monthly data. Moreover, the zonal evolution and frequent overlap with anomalies that are EP in character would confound stationary box average indices designed to isolate CP events. The appearance of a trend over this period of time, particularly for Modoki El Niños, is not distinguishable from random chance.