Uncoupled El Niño Warming

Zeng-Zhen Hu,1 Michael J. McPhaden,2 Arun Kumar,1 Jin-Yi Yu,3 and Nathaniel C. Johnson4,5

1Climate Prediction Center, NCEP/NWS/NOAA, College Park, MD
2NOAA Pacific Marine Environment Laboratory, Seattle, WA
3Department of Earth System Science, University of California, Irvine, CA
4Atmospheric and Oceanic Sciences Program, Princeton University, Princeton, NJ
5NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ

ABSTRACT

In light of a warming climate, the complexity of the El Niño/Southern Oscillation (ENSO) makes its prediction a challenge. In addition to various flavors of ENSO, oceanic warming in the central and eastern tropical Pacific is not always accompanied by corresponding atmospheric anomalies, i.e., the atmosphere and ocean remain uncoupled. Such uncoupled warm events as happened in 1979, 2004, 2014, and 2018 are rare (Fig. 1) and represent an unusual form of ENSO diversity.

Fig. 1 Evolutions of 3-month running mean sea surface temperature (SST; shading) and outgoing longwave radiation (OLR; Contours) anomalies averaged between 2°S and 2°N during (a) July 1979- November 1980, (b) July 2004- November 2005, (c) July 2014- November 2015, (d) July 2018- November 2019, (e) July 1982- November 1983, and (f) July 1997- November 1998. The unit is °C for SST, and W/m² for OLR. Panels (a-d) correspond to uncoupled warming events, whereas (e, f) correspond to strong El Niño.
A weaker zonal sea surface temperature anomaly gradient across the tropical Pacific compared to a conventional El Niño may partially account for the decoupling (Fig. 2). Also, the uncoupled warm events typically start late in the calendar year, which raises the possible influence of seasonality in background conditions for the lack of coupling. Without coupling, the impact of the warming in the central and eastern tropical Pacific on extratropical climate is different from that of its coupled counterpart.

Fig. 2 Composites of monthly mean anomalies of SST and wind at 1000 hPa for (a) Niño3.4 ≥ 0.5°C and CP_OLR < 0.0, (b) Niño3.4 ≥ 0.5°C and CP_OLR > 0.0 during January 1979-December 2019. Monthly data were used in the composites, which include 111 months in (a) and 28 months in (b), respectively. The hatches indicate that the composite anomalies are significantly different at 5% level from those of the non-selected month based on a t-test. Lead and lag correlations between (c) the CP_OLR and Niño3.4 indices; (d) the CP_OLR and SSTA zonal gradient indices; and (e) the zonal wind and SSTA zonal gradient indices. The SSTA zonal gradient index is defined as the SSTA mean difference of the central (5°S-5°N, 160°E-160°W) minus the eastern (5°S-5°N, 120°W-90°W) tropical Pacific (the green rectangles in Fig. 2b). The zonal wind index is defined as the surface zonal wind stress anomaly averaged in (5°S-5°N, 160°W-120°W; the blue rectangles with dashed line in Fig. 2b). The horizontal dot-dash lines in (c-e) represent the 5% significance level using the t-test with estimated independent sample size following Bretherton et al. (1999).

This study has been published in Geophysical Research Letters in 2020.

References