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The role of external forcing and Pacific trade winds in recent changes of the global climate system

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The Pacific trade winds experienced an unprecedented strengthening since the mid 1990s. Several studies have proposed that the increased Pacific trade winds were associated with the reduced rate of global mean surface temperature warming in the first decade of the 21st century, as well as far-reaching atmospheric teleconnections. We designed a set of ensemble partial coupling experiments using the IPSL-CM5A-LR coupled model that allow us to cleanly distinguish the influence of Pacific trade wind variability from that of external forcing over the past few decades. In this study, we quantify the respective impacts of these processes on surface temperature, ocean heat content, and atmospheric teleconnections.

We designed two ensembles of coupled simulations using partial coupling with the IPSL-CM5A-LR model to separate the Pacific internal variability and that of external radiative forcing. We prescribe surface wind stress in the tropical Pacific (20°S to 20°N) from 1979–2014 in two ensembles of 30 members each:
(1) Prescribed climatological model wind stress, which allows us to estimate the influence of external radiative forcing in the absence of variability within the Pacific Ocean.
(2) Wind stress anomalies from ERA-Interim reanalysis added to the model wind stress climatology, which accounts for the effects of both external radiative forcing and the wind stress variability.

We find that the observed wind stress anomalies account for the pattern of eastern tropical Pacific cooling when compared to the climatology experiment, so that it resembles the observed trends from 1992-2011. The tropical Pacific shows dominant heat uptake in the western Pacific above the 20°C isotherm, which contributed to slow the warming of tropical SST during the 2000s. The trade wind increase is associated with a strengthening of the Pacific Walker circulation, and zonal shifts in tropical rainfall. Despite tropical SST biases which affect the response of tropical rainfall and the location of deep convection, the wind stress anomaly forcing effectively simulates the wave train pattern emanating from the tropical Pacific, and associated extratropical teleconnections such as a weakening of the Aleutian Low and drought in North America.