Impacts of the Indian Ocean Dipole on Sea Level and Gyre Circulation of the Western Tropical Pacific Ocean

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Interannual variabilities of sea level and upper-ocean gyre circulation of the western tropical Pacific Ocean (WTPO) were predominantly attributed to El Niño-Southern Oscillation (ENSO). Results of the present study put forward important modulation effects by the Indian Ocean Dipole (IOD) mode. The observed sea level in the WTPO shows significant instantaneous and lagged correlations (around -0.60 and 0.40, respectively) with the IOD mode index (DMI). Composite of 14 'independent' IOD events for 1958-2017 shows negative sea level anomalies (SLAs) of 4~7 cm in the WTPO during positive IOD events and positive SLAs of 6~8 cm in the following year that are opposite in sign to the El Niño effect. The IOD impacts are reproduced by large-ensemble simulations of a climate model which generate respectively 430 and 519 positive and negative independent IOD events. A positive IOD induces westerly winds over the western and central tropical Pacific and causes negative SLAs through Ekman upwelling, and it facilitates the establishment of a La Niña condition in the following year that involves enhanced Pacific trade winds and causes positive SLAs in the WTPO. Ocean model experiments confirm that the IOD affects the WTPO sea level mainly through modulating the tropical Pacific winds. Variability of the Indonesian Throughflow (ITF) induced by IOD winds has relatively weak effect on the WTPO. The IOD's impacts on the major upper-ocean currents are also considerable, causing anomalies of 1~4 Sv in the South Equatorial Current (SEC) and North Equatorial Countercurrent (NECC) volume transports.

Keywords: Sea level, Indian Dipole mode, western tropical Pacific Ocean, El Niño-Southern Oscillation

