



Low-frequency Variability and the Unusual Indian Ocean Dipole Events in 2015 and 2016

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An unusual positive Indian Ocean Dipole (IOD) event occurred in 2015 associated with the 2015/16 extreme El Niño. Unlike the canonical IOD, sea surface temperature (SST) warming in the west-central tropical Indian Ocean (TIO) dominated the strong zonal SST gradient as cooling off Sumatra-Java was weak. Over the southeastern TIO, deeper thermocline has suppressed the upwelling cooling since 2012. Such deepened thermocline related to a low-frequency adjustment and curtailed cool anomalies in the 2015 positive IOD but favored warm anomalies in the 2016 negative IOD. Based on statistical analyses, ocean assimilation data confirm that an IOD-like pattern exists in the TIO on decadal time-scale. During a negative decadal IOD-like phase, thermocline is deeper in the southeastern TIO; the thermocline-SST feedback is unfavorable for positive IOD occurrence and intensity, but conducive to negative IOD events. Thus, we propose that the 2015-2016 IOD events are modulated by the low-frequency variability of thermocline.