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Significant influence of the boreal summer monsoon flow on the Indian Ocean response during dipole events

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A majority of positive Indian Ocean Dipole (IOD) events in the last 50-years were accompanied by enhanced summer-monsoon circulation and above-normal precipitation over central-north India. Given that IODs peak during boreal-autumn following the summer-monsoon season, this study examines the role of the summer-monsoon flow on the Indian Ocean (IO) response using a suite of ocean model experiments and supplementary data-diagnostics. The present results indicate that if the summer-monsoon Hadley-type circulation strengthens during positive-IOD events, then the strong off-equatorial south-easterly winds over the northern flanks of the intensified Australian High can effectively promote upwelling in the south-eastern tropical Indian Ocean and amplify the zonal-gradient of the IO heat-content response. While it is noted that a strong-monsoon cross-equatorial flow by itself may not generate a dipole-like response, a strengthening (weakening) of monsoon easterlies to the south-of-equator during positive-IOD events tends to reinforce (hinder) the zonal-gradient of the upper-ocean heat-content response. The findings show that an intensification of monsoonal-winds during positive-IOD periods produces nonlinear amplification of easterly wind-stress anomalies to the south-of-equator due to the nonlinear dependence of wind-stress on wind-speed. It is noted that such an off-equatorial intensification of easterlies over SH enhances upwelling in the eastern IO off Sumatra-Java; and the thermocline shoaling provides a zonal pressure-gradient which drives anomalous eastward equatorial under-currents (EUC) in the sub-surface. Furthermore, the combination of positive-IOD and stronger-than-normal monsoonal flow favors intensification of shallow transient meridional-overturning circulation in the eastern IO; and enhances the feed of cold subsurface off-equatorial waters to the EUC.

References:

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