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Trend analysis of tropical intraseasonal oscillations in the summer and winter during 1982-2009

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Based on the daily outgoing long-wave radiation (OLR) data of the National Oceanic and Atmospheric Administration (NOAA) from 1979 to 2012, we investigated the intensity changes of the 20-70-d boreal summer (June-September; JJAS) intra-seasonal oscillation (BSISO) and winter (December-February; DJF) intra-seasonal oscillation, also known as the Madden-Julian Oscillation (MJO). The results showed that the intensity of the BSISO has a significant intensifying trend during 1982-2009. On the other hand, little trend was found for boreal winter MJO during this period. The wavenumber-frequency analysis (Hayashi, 1982) was applied to separate ISO into westward propagation and eastward propagation parts. The significant intensified trend was observed over tropical Indian Ocean for the eastward-propagation BSISO. The weakened but not significant trend was observed over southern tropical Indian Ocean for the eastward-propagation MJO. To gain insight into the different ISO characteristics, the tendencies of sea surface temperature (SST) and the vertical shear of zonal wind were analyzed. The results showed that in both seasons from 1982 to 2009, the global SST trends were similar, and thus they could not be used to explain the BSISO upward trend. However, lower-tropospheric easterly shear in boreal summer over tropical Indian Ocean has a decreasing trend, while the easterly vertical shear over maritime continent was enhanced in winter. It is proposed that the reduced easterly vertical shear over tropical Indian Ocean favored the amplification of the eastward-propagating Kelvin wave, which led to the intensified eastward-propagating BSISO. The enhanced easterly vertical shear over maritime continent might be unfavorable to the amplification of the eastward-propagating Kelvin wave, but its impact was offset by the enhanced upward motion over maritime continent. As a result, there was little trend of the MJO in boreal winter. The hypothesis above was further verified by intermediate model results.