Processes Controlling the Surface Temperature Signature of the Madden-Julian Oscillation in the Thermocline Ridge of the Indian Ocean

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The Thermocline Ridge region of the southwest tropical Indian Ocean (TRIO, 5−10°S, 60°-90°E) is within the generation region of the Madden-Julian Oscillation (MJO) during boreal winter. It exhibits prominent maxima in intraseasonal Sea Surface Temperature (SST) associated with the MJO. It is hence important to understand the processes of the MJO SST signature in this region in view of past studies suggesting a consistent impact of air-sea coupling on MJO properties. Recent studies have also suggested that the MJO SST signature could be modulated by the interannual variability of the ocean content. In this context, we use observations and carefully designed experiments with an Ocean General Circulation Model (OGCM) to quantify these two effects during the 1997-2006 period.

Observational analysis allows showing that Ekman pumping does not contribute significantly, in average, to the intraseasonal SST perturbation. On the other hand, it is difficult to quantify the relative contribution of net heat fluxes and entrainment on SST intraseasonal variability from observations only. We hence use forced ocean experiments to that end. During 1997−2006, the contribution of surface heat fluxes to intraseasonal SST variability averaged over the TRIO region is 4 times larger than that of intraseasonal wind stress. The heat flux induced intraseasonal SST variability is dominated by shortwave variations (3/4), with latent heat flux playing a more modest role (1/4). The time scale of the heat-flux perturbation, in addition to its amplitude, is also important in controlling the intraseasonal SST signature, with longer periods favouring a larger response. Locally within the TRIO region, wind stress can however contribute significantly to intraseasonal SST variations.

There are also strong year-to-year variations of the respective role of heat fluxes and wind stress, with the contribution of intraseasonal wind stress becoming equivalent or larger than that due to heat fluxes during the significant intraseasonal SST event of 2000. Interannual variations of the subsurface thermal structure associated with the IOD/ENSO events modulate the MJO-driven SST signature by up to 30%, mainly by changing the temperature of water entrained into the mixed layer. The main factor that controls year-to-year changes in amplitude of the MJO SST signature is however the amplitude and time-scale of the air-sea fluxes intraseasonal perturbation.

Keywords: Madden-Julian Oscillation; Ocean General Circulation Model