The Role of Oceanic Processes in the Initiation of Boreal Winter Intraseasonal Oscillations over the Indian Ocean

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Key Points

* Most (71%) of global-scale Indian Ocean MJO events from 2001-2012 initiated in the Seychelles-Chagos Thermocline Ridge (SCTR).  
* Oceanic processes contributed about 30% of large-scale pre-convection sea surface temperature anomalies (SSTAs) in 4/17 of the Thermocline Ridge ISO events.  
* Two of the oceanic process influenced events were primary MJO events and were associated with oceanic equatorial Rossby waves.

Background

The motivation for this project is to determine the role of oceanic processes (e.g., entrainment, upwelling, and advection) on SSTAs prior to the initiation of the boreal winter MJO and other ISOs, which strongly impact weather and climate in the tropics and extratropics. To do this, we examined 39 ISO events that passed through the Indian Ocean Warm Pool (WP) during the Nov.—Apr. season from 2001—2012.

We separated the 39 WP events based on their initiation location, then examined intraseasonally filtered satellite and in situ observations and reanalyses and a set of HYCOM OGCM experiments to quantify to what degree pre-convection SSTAs were affected by: wind stress (oceanic processes), radiative heat flux, and turbulent heat flux (based on the setup of Li et al., 2014). Improving our understanding of how oceanic processes affect <SSTAs prior to the MJO initiation will inform how these processes are represented in weather and climate models, leading to improved predictability of the MJO.

Composite of 17/39 WP ISO events that initiated in the SCTR

- 4/17 strong QBO events
- 17% of SCTR events were associated with oceanic Rossby waves
- 13/17 weak QBO events
- 24% of WP ISOs were associated with equatorial Rossby waves

Feedback from the ocean to the atmosphere

We used the atmospheric Mixed Layer Model (MLM) of Back and Bertheron (2009a), based on Stevens et al. (2002), which is based on a momentum balance in the mixed layer between Coriolis, pressure gradient, downward momentum mixing from the free troposphere, and friction.

The PBL component contributed >40% of the total convergence for the strong QBO events (a), but only ~20% for the weak QBO events (b). For the Jan. 2002 case study, the model performed particularly well and the PBL component peaked 9 days prior to the total convergence, supporting the hypothesis that the ocean may act as a trigger for the initiation of some MJO events.