Upscale Feedback of Higher-Frequency Modes to MJO over Maritime Continent

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ABSTRACT

This proposal articulates an endeavor in responding to NOAA CPO Competition 4: Climate Variability and Predictability Program (CVP) - Observing and Understanding Processes Affecting the Propagation of Intraseasonal Oscillations in Maritime Continent Regions. MJO is the most important sub-seasonal variability that bridges weather and climate scales. Current models, however, have difficulty to simulates its evolution and in particular its interaction with higher-frequency (HF) motions. This proposal consists of three major research thrusts to advance our current understanding of MJO multi-scale interaction. The first thrust is to investigate the impact of MJO on HF modes including diurnal cycles, synoptic perturbations, and convectively coupled equatorial waves such as Kelvin waves, westward-moving inertia-gravity waves, Rossby waves and mixed Rossby-gravity waves. The structure and evolution characteristics of the HF modes at various phases of MJO near the Maritime Continent will be examined. In addition to the observational data analysis, we will conduct sensitivity numerical model experiments to understand mechanisms through which MJO modulate the HF modes.

The second thrust is to reveal the role of upscale feedback of the HF modes in modulating MJO intensity, structure and propagation. Various diagnostic tools developed by the PI will be used. These diagnoses are from different dynamic and thermodynamic perspectives, including eddy momentum transport, barotropic energy conversion, nonlinear rectification of diabatic heating and surface latent heat flux, and eddy kinetic energy and moist static energy budgets. The upscale feedback of selected HF modes such as dry Rossby waves from tropical central Pacific will be examined through idealized numerical experiments.

The third research thrust is to examine the two-way interactions in 27 start-of-art general circulation models (GCMs) that participated in MJO Task Force (MJOTF) and GEWEX Atmospheric System Study (GASS) multi-model intercomparison project. Column integrated moist static energy (MSE) budget will be investigated to unveil the fundamental processes that control propagating and non-propagating MJOs across the Maritime Continent. A special attention will be paid to the HF mode – MJO interaction and the MJO – mean flow interaction in modulating anomalous vertical and horizontal MSE advection terms. We will also examine how the MJO-HF mode interactions depend on model physics, air-sea coupling, mean state bias, and ENSO.