Role of Air-Sea-Land Interaction in the MJO Prediction Barrier over the Maritime Continent: A Cloud-Resolving Coupled Modeling Study

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ABSTRACT

The global impact of the MJO depends on whether its convection center is located over the Indian Ocean, Maritime Continent (MC), or western Pacific. In observations, not all MJO events initiated over the Indian Ocean propagate through the MC. This is known as the MJO barrier over the MC. This barrier effect is exaggerated in numerical prediction models, creating an MJO prediction barrier problem with particularly low prediction skill for the MJO moving through the MC. This MJO prediction barrier problem inevitably hinders our ability of accurately predicting global weather, including high-impact events, on subseasonal timescales. Reasons behind the MJO barrier effect of the MC, in models as well as in nature, are subjects of debate. The MJO prediction barrier problem of the MC must be resolved to advance subseasonal prediction.

In this proposed research, we plan to investigate the MJO prediction barrier problem. We will treat air-sea-land interaction within the MC region as a centerpiece linking other processes that possibly are crucial to the MJO barrier problem. These processes include the diurnal cycle, land, topography, and atmospheric convection. An important aspect of air-sea-land interaction in the MC is its close connection with the unique land-sea geography, where the local land-sea circulation on the diurnal timescale interacts with the MJO. The focus on air-sea-land interaction is motivated by observational and modeling results that main convection signals of the MJO in the MC are over water, and SST and convection of the MC are sensitive to upper-ocean mixing within the MC. We hypothesize that the MJO barrier effect of the MC is exaggerated in models because air-sea-land interaction processes are not adequately represented, even by coupled models of coarse resolutions. We propose to test this hypothesis through modeling experiment using a cloud-resolving coupled atmosphere-ocean model that has demonstrated its capability of reproducing the MJO propagation through the MC.

The general strategy of this study is to first select MJO events that propagated through the MC in observations but failed in global model forecasts. For a given MJO event, a set of model simulations will be made, with a specific model configuration for each simulation (with or without land, air-sea coupling, tidal mixing, and the diurnal cycle; high- or low-resolution representation of topography; parameterized or explicit atmospheric convection). Through diagnosing these simulations, we will isolate and quantify effects on simulated MJO propagation through the MC by air-sea-land interaction, the diurnal cycle, topography, and treatment of convection. Observations from ONR PISTON and international YMC field campaigns will be used to evaluate coupled model results when they become available during this proposed study.

This proposed research is in response to the CVP solicitation - Observing and Understanding Processes Affecting the Propagation of Intraseasonal Oscillations in the Maritime Continent Region,which “aim to improve understanding of processes that affect the propagation (speed, intensity, disruption, geographic placement) of intraseasonal oscillations in the Maritime Continent and broader region by using a combination of in situ and remote observations, data analysis, modeling, and/or theoretical understanding of local and remote processes”. Results from this project would provide a better understanding and quantitative assessment on possible sources of the MJO prediction barrier problem in numerical models. This would guide the strategy of model development and improvement of MJO prediction in general, and

help fulfill NOAA’s long-term climate goal of improved scientific understanding of the changing climate system and its impacts, and address challenges in weather and climate extremes.