Understanding the Role of the Diurnal Cycle and the Mean State on the Propagation of the Intraseasonal Variability over the Maritime Continent

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ABSTRACT

The Madden-Julian oscillation (MJO) and the boreal summer intraseasonal oscillation (BSISO) are the dominant modes of tropical intraseasonal variability (ISV), providing a primary source of predictability on intraseasonal timescales. Many global climate models (GCMs) suffer from poor representations of the MJO and BSISO, especially their propagation over the Maritime Continent (MC). The role of the strong MC diurnal cycle on the propagation of the ISV has remained poorly understood due to the lack of in-situ observations. The Years of Maritime Continent (YMC) and Propagation of Intra-Seasonal Tropical Oscillations (PISTON) field campaigns will collect in-situ observations of the diurnal variation of the atmospheric state, among many other things, which will provide a unique opportunity to enhance our understanding of the interactions among the diurnal cycle, the mean state, and the propagation of ISV over the MC.

The proposed work is organized around the following two hypotheses: 1) The diurnal cycle of convection in the MC islands and over the adjacent water destructively interferes with convection of the MJO and BSISO, weakening their intraseasonal convective envelopes, and disrupting their MJO/BSISO; and 2) The diurnal cycle over the MC plays a key role in determining/shaping the seasonal mean basic state. Biases in the MC diurnal cycle in GCMs deteriorate the basic state, which in turn prevents the model from simulating a realistic propagation of intraseasonal variability over the broader MC area. To test these hypotheses, the proposed research aims to use YMC and PISTON field campaign observations together with global and regional models to enhance our understanding of the role of the MC on the propagation of the MJO and BSISO. High-resolution cloud system resolving simulations with a regional climate model will be conducted targeting observed ISV events. A series of long uncoupled and coupled simulations will be made with a GCM that exhibits superior skill in simulating the ISV. The YMC and PISTON observations together with the satellite observations will be used to evaluate the MC diurnal cycle in the model simulations. The model simulations will be repeated with the MC diurnal cycle suppressed to examine the direct and indirect effect of the MC diurnal cycle on ISV propagation. Short-term hindcast experiments will be conducted with the GCM after the YMC and PISTON field campaigns to examine the role of the diurnal cycle on ISV propagation in the context of events that occurred during the field campaigns. Lastly, the NCEP operational model hindcast dataset will be analyzed, to understand the relationship among the biases in the diurnal cycle, the mean state, and the ISV propagation.

Relevance to the competition and NOAA's long-term climate goal: The proposed research strongly addresses the objective of the competition: "CVP - Observing and Understanding Processes Affecting the Propagation of Intraseasonal Oscillations in the Maritime Continent Region" as it focuses on the propagation of the tropical ISV through the MC using a combination of in situ and remote observations, modeling, and data analysis. The expected outcome of the proposed research will advance understanding of MJO dynamics and will provide key information for improving ISV prediction. By contributing to advancing our ability to predict the tropical ISV, which affects high-impact weather events over the US, our proposed project is also relevant to NOAA's long-term climate goal of "providing the essential and highest quality environmental information vital to our Nation's safety, prosperity and resilience".