Abstract

CVP: Propagation and Predictabilty of the Tropical Intraseasonal Oscillation in the Maritime Continent Region

The tropical intraseasonal oscillation (ISO) is one of the most important phenomena in the tropics. It exerts a profound influence on a wide range of weather-climate systems not only in the tropics but also in the extratropics. Thus, predicting the ISO accurately is of critical importance, although our current prediction skill of the ISO based on general circulation models (GCMs) remains unsatisfactory. This is largely due to uncertainties in model physics as well in model initialization. Of the uncertainties in model physics, the cloud and precipitation processes are particularly important. The convective component of the ISO is made up primarily of a number of mesoscale convective systems (MCSs). On the other hand, there is lots of evidence that a substantial fraction of MCSs occur in association with synoptic-scale equatorial waves, often referred to as convectively coupled equatorial waves (CCEWs). However, how the interactions among MCSs, CCEWs, and the ISO operate are poorly understood. The presence of the Maritime Continent (MC) exacerbates the situation. A pronounced diurnal cycle in conjunction with the complex geography comes into play in the interaction. As a result, the ISO convection skirts around the islands and weakens significantly, and simulating the ISO with fidelity is particularly difficult in the MC region, a strong limiting factor in our predictive skill.

Taking advantage of the YMC opportunity, this project aims to improve our understanding of the processes that affect the propagation of the ISO in the MC region, especially from the viewpoint of multiscale interaction, through synergistic use of both observations and state-of-the-art numerical models. Because of the diversity in the ISO, a thorough and comprehensive observational and modeling treatment will be the key to any successful diagnosis of ISO dynamics and physics. In this research, we will carefully identify the types of ISOs based on three different indices. We hypothesize from our previous results that CCEWs play a central role in the propagation of the ISO. Novel objective methods including the spatio-temporal wavelet transform (STWT) and objective-based tracking approach will be used to test our hypothesis from morphological point of view. Rigorous analysis of moisture, momentum, and temperature fields with respect to CCEWs, MCSs, and other prominent synoptic-scale components will help us quantify the roles of individual components in the propagation of the ISO. We will further use forecasts of conventional GCMs including CFSv2 and a global-cloud resolving model, NICAM, to examine the processes that are responsible for the propagation of the ISO. By conducting a meticulous comparison among observations, conventional GCMs' forecasts, and NICAM forecasts in terms of both morphology and budget approaches, it is anticipated that we will gain invaluable insights into the convective processes that affect the propagation and thus predictability of the ISO.

Although we will pay special attention to YMC, we will make use of past field campaign opportunities including the CINDY/DYNAMO (October 2011-March 2012) and Pre-YMC (November-December 2015) as well as long-term observational and forecast data in an attempt to draw statistically robust conclusions. Our research will contribute not only to advancing our understanding of the propagation and structure of the ISO, but also to identifying the problematic processes in models simulating the ISO in the MC, which eventually contribute to improving their predictability of the ISO.

The objective of this project is entirely in line with the CVP's goal that "*aims 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*" as well as NOAA's long-term climate goals.