CGD SEMINAR

DATE: Tuesday 2 April, 2019

TIME: 11 am – 12 pm

LOCATION: NCAR, 1850 Table Mesa Drive
Mesa Lab, Main Seminar Room

TITLE: Energetic constraints on seasonal migrations of the ITCZ

SPEAKER: Ho-Hsuan Wei, University of Colorado

ABSTRACT:

The atmospheric energy budget has recently been shown to provide important constraints on the position and shifts of the zonal and annual mean intertropical convergence zone (ITCZ). More specifically, these recent studies show the location of ITCZ lies close to the latitude of zero vertically integrated energy transport (energy flux equator, EFE), which could be determined based on energy balance. However, relatively little work has explored the applicability of the energetic framework to ITCZ shifts on shorter timescales. Here, we first show that, in idealized aquaplanet simulations with a seasonal cycle, the ITCZ always lags the EFE, making it possible for the EFE and the ITCZ to reside on opposite sides of the equator. At these times, the required energy balance is achieved not through shifts of the Hadley cell's ascending branch and ITCZ to track the EFE, but through changes in the cell's vertical structure. In other words, the development of a shallow return flow at levels of minimum moist static energy (MSE) favors a negative gross moist stability (GMS), which helps to achieve energy balance.

We then explore if similar mechanisms are seen in the observed seasonal cycle by analyzing MERRA2 reanalysis data. We find that, in the zonal mean, an offset exists between the ITCZ and the EFE near the end of the year as the ITCZ is retreating from the northern to the southern hemisphere. This occurs as the southern Hadley cell develops a bottom-heavy structure, favoring a northward energy transport. In the Eastern Pacific sector, the existence of two nodes of meridional energy transport during parts of the seasonal cycle suggests the possibility of negative GMS in the associated meridional overturning circulation. While bottom-heavy vertical velocity profiles favoring shallow return flows exist throughout the year, the bottom-heaviness becomes much stronger at times with negative GMS, which seems to be associated with weaker SSTs and stronger SST Laplacian. These results suggest that EFE and ITCZ are not related in any simple manner during the course of the seasonal cycle.

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