FSU Meteorology Seminar Series, Spring 2021

Mr. Jacob Carstens
Earth, Ocean, and Atmos. Sci.
Florida State University

A Spectrum For Convective Self-Aggregation Based On Background Rotation

Abstract

Organized deep convection is of critical importance to our understanding of the tropics. Numerical modeling efforts have highlighted a tendency for convection to spontaneously self-organize, when initialized from radiative-convective equilibrium (RCE). This is known as "self-aggregation", and arises due to interactions between clouds, water vapor, radiation, and mesoscale circulations. Recent work has hinted that the relative roles of physical mechanisms influencing self-aggregation may change between nonrotating and rotating environments. This suggests that self-aggregation may be characterized as a continuous spectrum of sorts, where regimes shift as the background rotation is altered. We address this hypothesis using 31 cloud-resolving, f-plane model simulations to resemble a range of tropical latitudes between 0.1°-20°. Simulations are classified into three groups. The first group ("low-f", 0.1°-5°) is characterized by preferential drying of the domain, where several dry anomalies emerge early on. These amplify over time, due primarily to radiative effects such as differential longwave cooling from cloud coverage. Eventually, convection takes the form of either a nonrotating band or a quasi-circular region, the latter of which subsequently spins up into a tropical cyclone (TC). In contrast, the 9°-20° ("high-f") group dries less rapidly in the early stages, though enhanced surface flux effects aid in forming an anomalously moist region that eventually undergoes TC genesis. The TC serves as an "aggregating agent" of sorts, drying the domain due to its associated surface fluxes and longwave cloud radiative feedbacks. Finally, a set of 6°-8° ("medium-f") simulations fails to fully self-aggregate, continuing to produce convection across most of the domain. Feedback mechanisms that amplify moisture variance in the other simulations are significantly weaker in this group. Ongoing research seeks to understand why this "medium-f" set of simulations fails to exhibit self-aggregation under either of the other two regimes. Diagnostic equations reveal significant differences in the spatial variability of radiative cooling and surface enthalpy fluxes, but prognostic and more fundamental solutions remain the overarching goal. Hypotheses are presented for these at the conclusion of the talk, along with a brief description of a larger, cloud-resolving beta-plane simulation currently in development to further investigate these results.

Zoom Link

https://fsu.zoom.us/j/99318985413?pwd=Y0ZNYnJWYkt4VVNUVTlrOEYwNFlsUT09

Time:	Thursday, Jan. 21, 2021 @ 3:30 PM
Host:	Dr. Allison Wing
Note:	Meeting the speaker at 3:00 PM.