Geophysical Research Abstracts
Vol. 19, EGU2017-11207, 2017
EGU General Assembly 2017

Comparison of tropical cyclogenesis processes in climate model and cloud-resolving model simulations using moist static energy budget analysis

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In recent years, climate models have improved such that high-resolution simulations are able to reproduce the climatology of tropical cyclone activity with some fidelity and show some skill in seasonal forecasting. However biases remain in many models, motivating a better understanding of what factors control the representation of tropical cyclone activity in climate models.

We explore the tropical cyclogenesis processes in five high-resolution climate models, including both coupled and uncoupled configurations. Our analysis framework focuses on how convection, moisture, clouds and related processes are coupled and employs budgets of column moist static energy and the spatial variance of column moist static energy. The latter was originally developed to study the mechanisms of tropical convective organization in idealized cloud-resolving models, and allows us to quantify the different feedback processes responsible for the amplification of moist static energy anomalies associated with the organization of convection and cyclogenesis. We track the formation and evolution of tropical cyclones in the climate model simulations and apply our analysis both along the individual tracks and composited over many tropical cyclones. We then compare the genesis processes; in particular, the role of cloud-radiation interactions, to those of spontaneous tropical cyclogenesis in idealized cloud-resolving model simulations.