Process-oriented Diagnostics of Tropical Cyclones in Climate Models

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Abstract

The simulation of tropical cyclone (TC) activity in climate models is still a challenging problem. While some models are able to simulate TC activity with characteristics very similar to those observed, many models have very strong biases. While increasing horizontal resolution often improves the characteristics of model TCs, resolution alone is not sufficient for high skill in simulating TC activity. We use process-based diagnostics to identify model characteristics that are responsible for a good simulation of TCs in global atmospheric and ocean-atmosphere coupled climate models.

First, we will examine the relationship of large-scale environmental variables, such as vertical wind shear and potential intensity as well as various integrated genesis indices, to standard TC activity measures. Then we will test process-based diagnostics to investigate the mechanisms of TC intensification in climate models, in particular, the influence of model physics in four of these models. The diagnostics focus on how convection, moisture, clouds and related processes are coupled at individual grid points, and give information about how the convective parameterizations interact with resolved model dynamics. These diagnostics are strongly based on diagnostics originally used to analyze the Madden-Julian Oscillation in climate models. We will consider composites of various fields for tropical cyclones in the deep tropics from their formation time until the time of maximum lifetime intensity. We will examine the large-scale characteristics and the process diagnostics in five high-resolution global climate models developed at GFDL and NCAR, including the comparison of coupled and uncoupled versions of one of these models.

Key words: Tropical Cyclone, Process-oriented Diagnostics, High-resolution Global Models