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Understanding the impact of model resolution on tropical cyclones in CAM5 using rotating radiative-convective equilibrium

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In our continued effort to understand the climate system and improve its representation in general circulation models (GCMs) it is crucial to develop new methods to evaluate these models. This is certainly true as the GCM community advances towards high horizontal resolutions (i.e. grid spacing less than 0.5 degrees), which will require interpreting and improving the performance of many model components. Of specific interest is the simulation of tropical cyclones at these spatial scales. Idealized, or reduced complexity, frameworks can be used to investigate how model assumptions impact behavior across scales.

Here we explore the implication of horizontal resolution on tropical cyclones in GCMs using an idealized global rotating radiative-convective equilibrium (RCE) configuration. The National Center for Atmospheric Research and U.S. Department of Energy supported Community Atmosphere Model 5 (CAM5) is configured for an ocean-covered earth with diurnally varying, spatially uniform insolation and spatially uniform rotation, a setup that permits the formation of tropical cyclones throughout the entire global domain. CAM5 is run with the spectral element dynamics package at two horizontal resolutions: a standard resolution of approximately 1 degree grid spacing and a high-resolution of approximately 0.25 degree grid spacing. In this unique testbed, the statistics of tropical cyclone intensity and outer size, as measured by the azimuthal-mean radius of 12 m/s, are analyzed under both configurations. Implications of the results for both model development and tropical cyclone physics are discussed.