The dynamics of the atmospheric mesoscale kinetic energy spectrum: What are our models telling us?

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One of the unsolved questions in atmospheric dynamics concerns the energetics responsible for the horizontal wavenumber k^(-5/3) scaling observed in the mesoscale portion of the atmospheric kinetic energy (KE) spectrum. Model spectra qualitatively reproduce the observations-based spectrum in both the synoptic-scale k^(-3) and mesoscale k^(-5/3) regions, and given the limitations of the observations, modeling-based studies have become the primary approach for examining the mesoscale dynamics of the spectrum. We are computing atmospheric spectra for global NWP forecasts using the atmospheric component of the Model for Prediction Across Scales (MPAS) to study these dynamics. As in past studies, we find a mesoscale region in the model spectrum when resolution is sufficiently fine. The first part of the present study examines the accuracy of model solutions, where we find that typical model configurations produce solutions that are significantly under-resolved vertically as revealed in convergence test results for KE spectra and examination of inertia gravity wave structure. The second part of this study examines KE dissipation and its associated dynamics. The mesoscale region is thought to be characterized as possessing a net downscale energy cascade, and the dynamics in the regions of energy dissipation should play a role in the downscale cascade. Understanding these dynamics should help test existing theories for the mesoscale KE spectrum. We will present results illustrating these points, and we will discuss the implications of these results for current theories for the mesoscale KE spectrum. We will also discuss the implications for atmospheric modeling applications in weather and climate given that current operational weather and climate model configurations do not resolve well the mesoscale KE, particularly in the upper troposphere and lower stratosphere.

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Refreshments 3:15 PM
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