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Phase-Space WKB Modelling of Gravity Waves in the Rotating Atmosphere

Junhong Wei, Ulrich Achatz, and Gergely Bölöni
Institute for Atmospheric and Environmental Sciences, Goethe University of Frankfurt, Frankfurt, Germany

This poster discusses the dynamics and parameterizations of the gravity waves in the rotating compressible atmosphere, with the following two models: 1) a gravity wave parameterization model based on the phase-space Wentzel–Kramers–Brillouin ray tracing theory, 2) a code for large eddy simulation used as a reference for the parametrization. Compared with the standard ray tracers, the advantage of the proposed parameterization model is that it avoids caustic-like situations by using wave-action phase-space density in position-wavenumber space for the wave amplitude instead of using wave action density itself. This model has been validated in the non-rotating atmosphere, and the current research works on the atmosphere with rotation.

Firstly, compared with inertia-gravity-wave parameterizations based on pseudo-momentum flux convergence in the current general circulation models, this study indicates in some cases a much better performance for the parameterizations based on both momentum flux convergence and an elastic term, especially for waves with relatively long horizontal wavelengths. Compared with the momentum flux convergence term, the elastic term is generally secondary, but it becomes more important for waves with larger vertical wave packet scale. Secondly, this study also investigates the different behaviors between mesoscale gravity waves and mesoscale geostrophic modes. Consistent with the past theoretical work, the higher harmonics of the geostrophic modes are much stronger and they are in intense nonlinear interaction. Thirdly, this poster also attempts to present preliminary parameterization results for two-dimensional or three-dimensional inertia-gravity-wave packets.

Understanding the dynamics of gravity waves in the rotating atmosphere will ultimately help us with better parameterizations of the unresolved wave spectrum in the future generation of weather and climate forecasts.