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On the application of WKB theory for the simulation of multi-scale gravity wave interactions

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Gravity waves play an important role in the circulation of the atmosphere. Even the highest-resolution weather-forecast models, however, cannot resolve the entire range of gravity wave scales, much less the even smaller scales involved in gravity wave breaking and wave-turbulence interactions, so the smaller scale waves and their effect on the large scale flow must be parameterized. Many gravity wave parametrizations are based on WKB theory, where the amplitude, wavelength and frequency of the wave field are represented as slowly varying functions of space and time. Common parameterization schemes simplify the general WKB theory by neglecting both horizontal gradients and transience in the large-scale flow. Indications are that these simplifications are no longer justifiable when there are significant interactions between gravity waves and solar tides [1] or between small-scale (parameterized) gravity waves and large-scale explicitly resolved gravity waves. To our knowledge a code solving the complete WKB equations while fully incorporating the interaction of the waves with the large-scale flow has never been validated against simulations of explicitly resolved gravity waves.

We have developed a finite-volume algorithm that formulates the wave action equation as a conservation law for wave action density in position-wavenumber phase space [2] coupled to an equation for the large-scale background flow. It turns out that this approach is especially suited to cases where the wavenumber becomes a multivalued function of position, a ubiquitous situation when the background flow is time-dependent. We will present results from a case study of a packet of small-scale gravity waves propagating upward through a background with varying stratification (a limiting case of resolved hydrostatic gravity wave). Results from the WKB model are in good agreement with simulations using a weakly nonlinear wave-resolving model as well as with a fully nonlinear large-eddy simulation code [3].

REFERENCES

[1] F. Senf and U. Achatz, 2011: On the impact of middle-atmosphere thermal tides on the propagation and dissipation of gravity waves. *J. Geophys. Res.*, 116, D24110, doi:10.1029/2011JD015794.

[2] A. Hertzog, C. Souprayen and A. Hauchecorne, 2002: Eikonal simulations for the formation and the maintenance of atmospheric gravity wave spectra. *J. Geophys. Res.*, 107, D12,4145, doi:10.1029/2001JD000815.

[3] S. Hickel, N. Adams and A. Domaradzki, 2006: An adaptive local deconvolution method for implicit LES. *J. Comput. Phys.*, 213, 413-436.