Parameterizing the effects of gravity waves in the middle atmosphere

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Abstract

Internal inertia-gravity waves are generated in the troposphere by a variety of mechanisms (topography, frontal collapse, convection, etc.). While their amplitudes are generally negligible in the troposphere, they propagate up into the middle atmosphere and grow with altitude as the background density decreases. Eventually the waves break, again by a variety of possible mechanisms. Through this process, gravity waves transfer energy and momentum into the middle atmosphere. Since most of the gravity wave spectrum is not resolved in global models, this process must be largely parameterized. While the energy transfer is generally negligible below the mesopause compared with the effects of radiative transfer, the momentum transfer (known as "gravity wave drag") appears to be a major contributor to the zonal momentum budget and associated diabatic circulation. In particular, gravity waves are believed to be responsible for the remarkable observed reversal of the summer-to-winter temperature gradient in the upper mesosphere, and to play a crucial role in controlling temperatures in the Antarctic ozone hole. While there is no doubt that gravity waves are pervasive in the middle atmosphere, observational limitations are such that we know very little quantitatively. Thus, most of our knowledge is necessarily theoretical. This talk will review a number of aspects of the gravity-wave parameterization problem, identify some basic constraints associated with the energy and momentum transfer, and pose some questions concerning key uncertainties.