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Lagrangian spectral parameterization of gravity wave drag induced by cumulus convection

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Momentum transport by convective internal gravity waves is one of crucial factors responsible for the dynamics of the middle atmosphere. In most GCMs, however, such small-scale gravity waves are not resolved, and thus the deposition of their momentum to the large-scale flow should be parameterized. Parameterizations of gravity wave drag (GWD) induced by cumulus convection (GWDC) have been developed through sophisticated analytic wave spectra that they can consider explicitly physical properties of convection and large-scale flow. Such analytic spectra have been used together with conventional column-based methods, but the conventional methods have limitations in properly representing the wave propagation. Therefore, for more reliable parameterization, we propose a Lagrangian spectral GWDC (LSGWDC) parameterization that can consider explicitly propagation characteristics of gravity waves. This LSGWDC parameterization consists of two separate parts: the determination of wave spectra at the top of deep convection and the calculation of the propagation of each wave component consisting of the spectra. The wave spectra are given by analytic wave momentum spectra, and the wave propagation is calculated using ray tracing equations. The LSGWDC parameterization is implemented in Whole Atmosphere Community Climate Model (WACCM) version 1b developed at NCAR. Preliminary results demonstrate that the LSGWDC scheme produces weaker momentum forcing with significantly different spatial structure, compared with the column-based method by Song et al. (2006). This is because the horizontal wave propagation is substantial in the middle atmosphere. More results will be presented at the conference.

Reference: Song, I.-S., H.-Y. Chun, R. R. Garcia, and B. A. Boville, 2006: Momentum flux spectrum of convectively forced internal gravity waves and its application to gravity wave drag parameterization. Part III: Impacts in a GCM (WACCM). *J. Atmos. Sci.* (submitted)