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Momentum Flux Spectrum of Convective Gravity Waves: Validation of a Parameterization Using Ensemble Mesoscale Simulations

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The source and momentum flux spectra of a parameterization of convective gravity wave drag (GWDC) are validated in three-dimensional spectral space against numerical mesoscale simulations for various ideal and real convective storms. From this, two important free parameters included in the GWDC parameterization, the wave-propagation direction and moving speed of the convective source, are determined. In the numerical simulations, the source spectrum shows nearly isotropic features in terms of magnitude, and its primary peak in any azimuthal direction occurs at a phase speed that equals to the moving speed of the convective source in the same direction. It is found that the moving speed of the convective source is closely correlated with the basic-state wind averaged below 700 hPa. When the analytic source spectrum of the parameterization is calculated using the source speed determined by the basic-state wind averaged below 700 hPa, its structure is in good agreement with that from the simulation for all storm cases. The momentum flux spectrum above the source level is also calculated using the basic-state conditions and the source speed obtained from the numerical simulation. A comparison between the parameterization and simulation shows that the parameterization reproduces the momentum flux spectrum from the simulation reasonably well. For the wave-propagation direction, the two directions of 45° (northeast and southwest) and 135° (northwest and southeast) are chosen when the minimum number of wave-propagation directions is required to reproduce the momentum flux spectrum integrated over all directions reasonably well.