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Simplifications in gravity wave parameterizations assessed by global ray-tracing modeling

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All conventional gravity wave (GW) drag parameterizations, such as the Lindzen, Hines, Warner and McIntyre, and Medvedev and Klaassen schemes, have some fundamental assumptions in common. They generally assume GWs propagate upwards instantaneously and purely vertically in a limited number of horizontal directions and exchange momentum with the background winds by wave breaking only. We here use a global ray tracing experiment to test the validity of these assumptions. The spectral shape of a homogeneous and isotropic launch distribution is tuned so that the model best matches observational data in nothern hemisphere summer. For the tuning zonal means of GW squared temperature amplitudes from SABER and of GW momentum flux estimates from CRISTA were used. The chosen launch distribution is confirmed by comparing global maps and seasonal cycles of simulated GW squared amplitudes with SABER observations. We then calculate GW quantities not measured from space, such as zonal and meridional GW-induced mean-flow accelerations. We quantify the effects on the global acceleration distributions by GW lateral refraction (remote recoil effect), oblique/vertical wave propagation and the number of horizontal directions into which rays are launched at the source. We find meridional accelerations are almost completely suppressed by assuming purely vertical propagation. Launching GWs only into the four canonical directions causes large deviations. For the zonal accelerations changes of the global distributions due to the various simplifications are smaller but still significant.