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Ray-tracing simulations vs. satellite observations of gravity waves forced by deep convection

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Gravity waves (GW) are a prominent coupling mechanism between their tropospheric sources and the upper stratosphere to mesosphere region. They contribute prominently to the wave driving of the Quasi-biennial-oscillation (QBO) in the tropics and other large scale circulations like the Brewer-Dobson circulation. One important dynamic source of GWs is convection. Convective GWs have considerable short horizontal wavelengths and are therefore not entirely observable by infrared limb-sounding satellite instruments. For this reason, we present the results of GW ray-tracing calculations from convective sources up to the mesosphere. We utilized the Gravity wave Regional Or Global RAy-Tracer (GROGRAT) to perform the GW trajectory calculations. The launch conditions for each GW were calculated using the convective GW source scheme from Yonsei University (South Korea) to quantify the excitation by deep convection. Heating rates, cloud data, and atmospheric background data were provided by the MERRA dataset for the estimation of convective forcing by deep convection and as the atmospheric background for the ray-tracing calculations afterwards. The resulting momentum flux distributions are in remarkable coincidence with typical geographic regions of deep convection in the tropics. Additionally, the momentum flux distributions of higher latitude regions are simulated using a standard launch distribution for GWs.

In order to validate our findings we compare our simulation results with satellite measurements of temperature amplitudes and momentum flux from infrared limb-sounding satellite instruments. These validations are complemented with an in-depth analysis of the observational filter for two different satellite instruments (HIRDLS and SABER). Scanning geometry, limitations in the detection of short wavelengths, aliasing effects, and the detector sensitivity are taken into account to quantify the level of uncertainty in our results. This analysis finally shows a good agreement of simulation and observation with respect to the instrument's constrains for the tropics and extra-tropics including seasonal characteristics in the latitudinal momentum flux distribution.