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Effects of the horizontal propagation and refraction of gravity waves on elevated stratopause after sudden stratospheric warming

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Mesospheric temperature has been measured through the observation of airglow emissions from OH Meinel bands near 87 km altitude using the Fourier Transform Spectrometers (FTSs) operated at both Esrange (67°53′N, 21°04′E), Kiruna, Sweden and Korea Dasan station (78°55′N, 11°56′E), Ny-Ålesund, Svalbard since November 2002. The FTS observations have provided simultaneous records of time evolutions of air temperature at the two different latitudes in association with elevated stratopause (ES) after major sudden stratospheric warming (SSW) events. ES-like phenomena and relevant warming have been simulated using global circulation models such as the whole-atmosphere community climate model (WACCM), but the modeled warming is found to be much weaker compared with the FTS observations (and satellite observations) especially in the higher latitudes (e.g., Dasan station). Considering that gravity waves (GWs) may have substantial impacts in the generation and evolution of the ES, the discrepancy between observation and model may be attributed to common issues in GW parameterizations in the model simulation: Uncertainty in GW spectra and unrealism in GW propagation (i.e., columnar propagation). In this study, we investigate the effects of the horizontal propagation and refraction of GWs on the warming associated with the ES after major SSW events using a ray-tracing model with specified GW spectra. Preliminary results for steady background flows show that the horizontal propagation and refraction increase westward GW momentum forcing near z = 100 km in the NH high latitudes that can induce downward motions and adiabatic warming in the NH polar regions below z = 100 km. Results are extended for time-varying background flows and different GW spectra to consider tidal effects and improve robustness of results, respectively.