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Satellite observations of atmosphere-ionosphere vertical coupling by gravity waves

Thai Trinh, Manfred Ern, Peter Preusse, and Martin Riese
Juelich Research Center, IEK-7, Germany (t.trinh@fz-juelich.de)

The Earth's thermosphere/ionosphere (T/I) is strongly influenced by various processes from above as well as from below. One of the most important processes from below is vertical coupling by atmospheric waves. Among these waves, gravity waves (GWs) excited in the lower atmosphere, mainly in the troposphere and tropopause region, are likely essential for the mean state of the T/I system. The penetration of GWs into the T/I system is however not well understood in modeling as well as observations. In this work, we analyze the correlation between different GW parameters at lower altitudes (below 90 km) and GW induced perturbations in the T/I. At lower altitudes, GW parameters are derived from temperature observations of the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER). In the T/I, GW induced perturbations of neutral density measured by Gravity field and Ocean Circulation Explorer (GOCE) and CHAllenging Minisatellite Payload (CHAMP) are analyzed. Interestingly, we find positive correlations between the spatial distributions at low altitudes (i.e. below 90km) and the spatial distributions of GW-induced density fluctuations in the T/I (at 200km and above), which suggests that many waves seen in the T/I have their origins in the troposphere or lower stratosphere. It is also indicated that mountain waves generated near the Andes and Antarctic Peninsula propagate up to the T/I. Strong positive correlations between GW perturbations in the T/I and GW parameters at 30 km are mainly found at mid latitudes, which may be an indicator of propagation of convectively generated GWs. Increase of correlation starting from 70 km in many cases shows that filtering of the GW distribution by the background atmosphere is very important. Processes that are likely involved are GW dissipation, generation of secondary GWs, as well as horizontal propagation of GWs. Limitations of our method and of the observations are also discussed.