EGU22-10900
https://doi.org/10.5194/egusphere-egu22-10900
EGU General Assembly 2022

Multi-step vertical coupling from the troposphere to the thermosphere due to gravity waves

Erich Becker, Sharon L. Vadas, Larisa Goncharenko, and V. Lynn Harvey
NorthWest Research Associates, Boulder, USA (erich.becker@nwra.com)

Multi-step vertical coupling (MSVC) describes a paradigm shift regarding the role of gravity waves (GWs) in the winter middle and upper atmosphere. It is well known that primary GWs propagate into the winter stratosphere and lower mesosphere, where they dissipate. However, since this process is localized in space and intermittent, secondary GWs are generated. These propagate into the lower thermosphere, dissipate, and generate tertiary GWs and so forth. Recent modeling and observational studies showed that secondary and tertiary GWs from MSVC are the predominant GWs in the upper mesosphere and in the thermosphere during wintertime. MSVC cannot be simulated with GW parameterizations as used in conventional whole atmosphere models.

In this presentation, we describe the HIgh Altitude Mechanistic general Circulation Model (HIAMCM), which resolves medium-scale GWs from the surface up to z~450 km, including MSVC induced by primary GWs from jets, fronts, and orography. This is made possible by combining a sufficiently high spatial resolution with advanced methods for turbulent and molecular diffusion. Furthermore, the HIAMCM can be nudged to MERRA-2 reanalysis in the troposphere and stratosphere. The nudging is performed in spectral space and restricted to horizontal wavelenghs larger than ~1500-2000 km. As a result, the generation, propagation, and dissipation of resolved GWs is not affected by the nudging and simulated like in the free-running model. We present recent applications of the HIAMCM regarding 1) the role of secondary GWs in the winter polar mesopause region, 2) the wintertime thermospheric GW hotspot over the Southern Andes/Antarctic Peninsula, and 3) the southward propagation of thermospheric GWs during daytime (as a driver for corresponding traveling ionospheric disturbances). Furthermore, we contrast the MSVC during the strong polar vortex period in December 2016 to the MSVC during the sudden stratospheric warming in January/February 2017.