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Does strong tropospheric forcing cause large amplitude mesospheric gravity waves? A Deepwave Case Study

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On 4 July 2014, during the Deep Propagating Gravity Wave Experiment (DEEPWAVE), strong horizontal winds up to $35\ \mathrm{m\,s^{-1}}$ caused the excitation of gravity waves containing the largest energy fluxes of the complete campaign ($38\ \mathrm{W\,m^{-2}}$). At the same time, large amplitude mesospheric gravity waves were detected by the Temperature Lidar for Middle Atmospheric Research (TELMA) located in Lauder (45.0° S, 169.7° E). This combination lead to the question whether the observed mesospheric gravity waves are generated by the tropospheric forcing.
For our study we use an extensive data set which comprises TELMA data, in situ measurements of the two aircraft, radiosondes, wind lidar measurements aboard DLR Falcon as well as Rayleigh lidar and advanced mesospheric temperature mapper (AMTM) measurements aboard the NSF/NCAR GV. To complement the measurements, studies with limited area simulations of the Unified Model are taken into account. This unique data set allows for the observation of the evolution of the gravity waves from the troposphere to the mesosphere.
Our investigations revealed a complicated situation where the propagation of mountain waves is influenced by partial reflection at the tropopause, a valve layer in the lower stratosphere filtering a part of the wave spectrum and possibly partial reflection at the polar night jet. Nevertheless stationary waves are found in the AMTM measurements with horizontal wavelengths between 30 and 130 km. Although the measurements comprised all altitudes from the troposphere to the mesosphere, still numerical studies proved to be a valuable asset in order to answer the question raised.