Geophysical Research Abstracts
Vol. 18, EGU2016-7916, 2016
EGU General Assembly 2016

Gravity wave observations by Doppler wind and temperature lidar measurements in the strato- and mesosphere

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The observation of wind and temperature perturbations by gravity waves propagating throughout the strato- and mesosphere is a challenging task. Both the kinetic and potential energy density can be derived and yield information about ensemble mean properties of gravity waves.

We measure temperatures and winds with the Doppler Rayleigh/Mie/Raman lidar at the ALOMAR research station in Northern Norway (69N, 16E). Using two independently steerable telescopes and lasers we are able to measure vertical profiles of two wind components and temperatures simultaneously. The observations can be performed even under sunlit conditions, which is essential for measuring atmospheric perturbations over several days and during summer at this location.

We report on the first observation of persistent inertia gravity wave signatures in the horizontal wind and temperature. The measurements cover the altitude range from 20 km to about 80 km during night and to about 70 km during daytime. For one case with observations lasting more than 50 hours, we find amplitudes of 5 to 25 m/s and 1 to 8 K in wind and temperature, respectively. The measured kinetic to potential energy density ratio is about 10, indicating that the majority of variability is due to waves with intrinsic frequencies close to the inertial frequency. The entire wave field is mainly characterized by the presence of multiple waves, however quasi-monochromatic waves can be identified at limited times and allow a more detailed analysis of wave properties like propagation direction, amplitudes and the momentum flux.