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Lidar measurements of temperature gravity waves over Kühlungsborn (Germany) from 1 – 105 km: a winter-summer comparison

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Since August 2002 continuous temperature soundings at night-time from 1 to 105 km altitude are carried out at the Leibniz-Institute of Atmospheric Physics (IAP) in Kühlungsborn (54° N, 12° E) with a combination of two different lidars (Rayleigh-Mie-Raman lidar and potassium lidar). Superimposed on the mean state we find periodic structures indicative of waves. Deviations from the mean are derived with a temporal and vertical resolution of 15 min and 1 km, respectively, which covers an important part of the gravity wave spectrum. With the wide altitude range of observation we are able to study the wave propagation from the troposphere up to the lower thermosphere.

In general temperature fluctuations are smaller in summer compared to winter and reach maximum values in the upper mesosphere of 10 K and 25 K, respectively. Typically, vertical phase velocities are in the range -0.25 to -1.9 m/s. The observed wave spectrum shows no distinctive time periods but covers the entire available range between 1 – 6 hours. At some altitudes local fluctuation minima are observed ('nodes') which are often linked to convective instabilities. The winter/summer ratio of temperature fluctuations is up to a factor of 2.5 in the mesosphere. In this altitude range the ratio is due to background conditions only, whereas outside of the mesosphere the ratio is strongly changed by filtering and damping. The wavelet analyses of dominating vertical wavelengths show that above the stratopause three most dominating waves are sufficient to explain the winter/summer ratio of amplitudes, but in the stratosphere more waves are required. The distribution of dominating vertical wavelengths covers the full detectable range (5 – 40 km). In addition, an accumulation of wavelengths smaller than 20 km exists, which are typical for gravity waves.