Lidar temperature soundings of gravity and tidal waves from 1 to 105 km altitude at mid-latitudes

M. Gerding, M. Rauthe, J. Höffner, U. Berger, F.-J. Lübken

Leibniz-Institute of Atmospheric Physics, Kühlungsborn, Germany (gerding@iap-kborn.de)

Continuous temperature soundings from 1 to about 105 km altitude are performed with two different lidars at the Leibniz-Institute of Atmospheric Physics at Kühlungsborn, Germany (54°N, 12°E). Since autumn 2002 we combine the detection of rotational Raman backscatter (1-22 km), Rayleigh/vib-Raman backscatter (22-90 km) and potassium resonance backscatter (about 80-105 km) to retrieve temperature profiles during the night. Wave disturbances are identified as deviations from the night mean profile and wave propagation can be examined from about their source region up into the lower thermosphere. Within more than 200 soundings temperature wave structures have been identified in every single night. The soundings cover up to 14 h in winter and about 4 h in summer, so gravity waves and (terdiurnal and semidiurnal) tides can be separated in winter. The observed periods are varying from night to night, with waves being found in the whole observable range of periods. Frequency analyses of the temperature fluctuations with altitude reveal vertical wavelengths of up to 40 km, but about two third of all identified waves have vertical wavelengths below 20 km. Within a single night up to three waves have been identified at a particular altitude by their vertical wavelength. In the power spectra these three wave modes represent between 45 and 65 % of the total power. This fraction and the observed wavelength spectra are independent from summer or winter season. A seasonal difference exists in the wave amplitude below 80 km, with up to a factor of 2.5 larger amplitudes in winter compared to summer. Above 90 km the summertime wave amplitude increases strongly and equals the winter temperature fluctuations (up to ± 25 K). Only a limited number of our soundings show undisturbed wave propagation, but most of the time the amplitude scale height is smaller than the density. And even decreasing wave amplitudes with height ('nodes') have been observed on several occasions, partly coincident with reduced static stability. We will present the mean state of atmospheric gravity and tidal waves compiled from all summer and winter soundings as well as case studies from our observations. The analyses are complemented by model studies of wave propagation and interaction.