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Temperature lidar measurements from 1 to 105 km altitude using resonance, Rayleigh, and Rotational Raman scattering

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Abstract. For the first time, three different temperature lidar methods are combined to obtain time-resolved complete temperature profiles with high altitude resolution over an altitude range from the planetary boundary layer up to the lower thermosphere (about 1–105 km). The Leibniz-Institute of Atmospheric Physics (IAP) at Kühlungsborn, Germany (54° N, 12° E) operates two lidar instruments, using three different temperature measurement methods, optimized for three altitude ranges: (1) Probing the spectral Doppler broadening of the potassium D_1 resonance lines with a tunable narrow-band laser allows atmospheric temperature profiles to be determined at metal layer altitudes (80–105 km). (2) Between about 20 and 90 km, temperatures were calculated from Rayleigh backscattering by air molecules, where the upper start values for the calculation algorithm were taken from the potassium lidar results. Correction methods have been applied to account for, e.g. Rayleigh extinction or Mie scattering of aerosols below about 32 km. (3) At altitudes below about 25 km, backscattering in the Rotational Raman lines is strong enough to obtain temperatures by measuring the temperature dependent spectral shape of the Rotational Raman spectrum. This method works well down to about 1 km. The instrumental configurations of the IAP lidars were optimized for a 3–6 km overlap of the temperature profiles at the method transition altitudes. We present two night-long measurements with clear wave structures propagating from the lower stratosphere up to the lower thermosphere.

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