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Tidal signatures in temperature data derived by lidars in the mid-latitude middle atmosphere

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Solar influence on Earth's atmosphere results in tidal variations of the temperature and wind field. Lidar observations of temperature and its variation allow examining the propagation of tidal waves through the middle atmosphere into the lower thermosphere. Additionally, multi-hour lidar runs enable separation of tidal and gravity waves. Nevertheless, up to now only very few lidars cover the whole mesosphere under daylight conditions. At Leibniz-Institute of Atmospheric Physics in Kühlungsborn (54°N, 12°E) we build up a daylight-capable Rayleigh-Mie-Raman (RMR) lidar in addition to the existing RMR lidar being limited to darkness. Daylight lidar measurements and thus a full diurnal coverage over an extensive altitude range allow for the first time a tidal analysis from temperature data in the mid-latitude middle atmosphere. During the day temperature soundings are feasible up to approx. 75 km and up to 90 km under night time conditions. Additionally, we perform soundings with a daylight-capable potassium (K) resonance lidar in an altitude range of ∼80-100 km. We will present absolute temperatures and their tidal variation over an altitude range of 40 to 100 km. Tidal analysis is possible within the mentioned altitude range, except for a gap region around 80 km where background is still too high during midday. Since summer 2010 the RMR lidar and K lidar are operated routinely during day and night. We will present an overview over the existing data set and show case studies on individual months like e. g. October 2011. In October 2011 weather conditions allowed continuous lidar soundings for a total time of about 165 h, forming a composite of 9 measurements that are longer than 6 hours. The available data is averaged for each particular time of day and altitude. The applied harmonic fit of the semidiurnal and diurnal tidal components is in good agreement to the observed variation. Below 75 km the amplitudes of diurnal and semidiurnal variations are up to 3 K and 4 K, respectively. Amplitudes above 80 km are up to ∼8 K for both the diurnal and the semidiurnal tidal component. Tidal phase progression is downward and comparable with expectations. The measured amplitudes and phases are compared with GSWM-09 model data, showing e. g. a general underestimation of the tidal amplitudes in the model.