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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Seasonal variation of temperatures between 1 and 105 km altitude at 54° N observed by lidar" *by* M. Gerding et al.

Anonymous Referee #2

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This paper presents temperature climatology at the mid-latitude station of K¨uhlungsborn (Germany, 54N, 12E) between 1 km and 105 km, based on simultaneous and co-located nocturnal observation of a Rayleigh-Mie-Raman lidar and a potassium resonance lidar between June 2002 and July 2007, each of 3–15 h in length. A harmonic fit of the temperature variation at each altitude to a sum of constant, annual, semiannual and quarter-annual variation is calculated. From this smoothed, thought to be more representative data set, the authors made the first comprehensive investigation of the seasonal variations of nighttime temperatures covering the whole range from the troposphere to the lower thermosphere. The authors have made thorough comparison between the lidar climatology and those by the most recent MSIS climatology (NRLMSISE-00) and ECMWF analyses, as well as TIMED/SABER

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observations. Their results have also been carefully compared to other lidar observations in the literature, noticeably, the potassium lidar results at 54N to observations at 40N or 41 N by Na lidar, and the RMR lidar results to Rayleigh lidar observation at other latitude and longitudes.

The paper in general appears to be in very good shape and it is indeed an excellent and timely contribution. This said, in addition to a number of minor suggestions detailed below, I do have three major suggestions for the authors to consider: (1). Since the climatology was mainly derived from nighttime observations, to avoid confusion, I suggest the authors add the word “nocturnal” between “of” and “temperatures” in the title. (2). The use of the term “double mesopasure” in line 21, p.81, line 14, p.86, lines 18 and 20 p.92 require clarification. This is because if we take the mesopause to be the altitude where the temperature is the lowest in the mesosphere (in deed the whole atmosphere), then there can be only one mesopsause. For example, She et al. (1993) did not use the term “double mesopasure”. I would therefore suggest the authors first define the term “double mesopasure” before their use. (3). In section 2, description of the lidar systems, it is very good for the authors to state the altitude range of validity for each lidar system as, “The temperature profiles at K¨uhlungsborn are a combination of potassium resonance temperatures (85–105 km), Rayleigh temperature profiles in two altitude ranges using separate telescopes and detectors (44–85 km and 34–46 km), aerosol-corrected Rayleigh-temperature profiles (22–33 km), and rotational Raman temperatures (1–25 km).” I know of a lidar system [Berendt et al, Applied Optics, 43, 2930, 2004] that also successfully covers 1 km to 85 km with Rayleigh and rotational Raman scattering without the use of vibrational Raman scattering. I suggest that this work should be referred. In addition, for the benefit of readers who may wish to reproduce a similar lidar system, brief comments should be made on the pros and cons between the two systems, i.e., whether the use of a vibrational Raman channel is necessary.

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Minor suggestions:

Line 10, p.180 : an uncertainty of less than 10 K. Is this ś 5 K or ś 10 K?

Line 8, p. 181: “The aerosol-induced bias is largest in the lowest Rayleigh channels (up to 7 K) and remains visible up to about 31 km.” It might be better to change “visible” to “significant”.

Line 12, p.86: “At 87 km spring and autumn slope are similar (0.5 K/d). This slope results in a temperature decrease (increase) by 20 K within a single month. The fast temperature change leads to the quasi non-existence of a double mesopause in spring/autumn at our site”. What do you mean by “quasi non-existence”?

p.88:The discussion on seasonal variations, i.e., , amplitude and phases of annual, semiannual variation (Fig. 7), is very good. It would be worthwhile to compared to both earlier works, She et al. (GRL, 1995) and Blanc et al. (JGR, 1998). Please also comment on the notable differences. Are these differences due mainly to the latitude difference between 54N and 44N?

L4, p90: The sentence “Within the summer months a slight altitude decrease from 87 to 85 km is observed, following the temperature decrease (shrinking) in the upper mesosphere during summer.” is not clear.

L14, p96: “support the concept of the two level mesopause, “ Earlier, the term “bi-static” was used. Are “two-level” and “bi-static” the same? L15, p93: The bias induced by this method is small, as the tidal effect at 54N is small compared to the latitude of 40/41N where the observations of States and Gardner (2000) and Yuan et al. (2008) are performed (e.g. Hagan and Forbes, 2002; Huang et al., 2006).” Is this statement true for semidiurnal tides, in addition to diurnal tides?

L11, p.94: The summer mesopause temperatures decrease by about 10 K between

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1996/1997 and 2002–2007 (this data set), whereas the mesopause altitude remains unchanged. The reason for this temperature decrease remains open, as we can not distinguish from our data set between a general trend, a solar-cycle dependency or larger-scale variability.” Which summer mesopause temperatures is lower, during 1996/1997 or 2002-2007?

L,24, p.94: “Xu et al. (2007) examined the global mesopause structure with temperature profiles from the SABER instrument onboard the TIMED satellite for the period February 2002 to February 2006. They found the nighttime summer mesopause at the latitude of K¨uhlungsborn around 83 km at temperatures of 145–150 K, i.e. 3–4km lower than the mesopause in our observations, but at nearly the same temperature.” It would be worthwhile to point out that an earlier comparison based on 2003 SABER/lidar temperatures at 41N also showed agreement in winter mesopause, along with SABER summer mesopause lower by 2-3 km Xu et al., 2005].

L15, p.97: “they appear at polar latitudes with a shift of 1–2 weeks compared to summer solstice (L¨ubken, 1999; H¨offner and L¨ubken, 2007). It remains an open question why the minimal temperatures are reached earlier in time in midlatitudes, as the upwelling from the best of out knowledge starts in polar regions. By “with a shift of 1–2 weeks compared to”, do you mean “about 1-2 weeks after”? A typo, “out”.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 16175, 2008.