

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

**M. Gerding et al.**

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We thank the referee #2 for the positive feedback. We have considered the remarks in detail and respond to the reviewers' remarks point by point in the following.

**Major comment 1 (nocturnal observations):** We agree with the reviewer that the term 'nocturnal' would clarify the heading and we will add it accordingly.

**Major comment 2 ('double' mesopause):** The mesopause is indeed defined as the temperature minimum between mesosphere and thermosphere. In observations the mesopause is often obscured by waves of different scales, i.e. the altitude of the absolute temperature minimum changes within hours by several kilometers. Therefore the mesopause is typically determined on a daily, weekly or even seasonal basis. By this,

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partly two local minima are observed between about 85 and 105 km altitude, especially in spring and autumn. This gave reason for the term 'double temperature minima' in She et al, GRL, 1993, or 'double mesopause' in Berger et al., JGR, 1999. As both describe the same phenomenon with similar words, we will keep both references. We add a short definition of the 'double mesopause' for the readers not familiar with the term.

**Major comment 3 (possible methods at 20–30 km):** We agree with the reviewer that Behrendt et al., AO, 2004, describe a powerful temperature lidar system. A profound description of the lidar techniques used for our observations as well as a detailed discussion are outside the scope of this paper. Instead, we have provided several references for the extensive technical description. On the other hand, the aerosol effects on temperature retrieval are an important topic for this paper presenting representative absolute temperatures. We will add the following paragraph in the discussion (Sec. 7.1): 'Behrendt et al. (2004) described a lidar system using the rotational Raman technique also well above 30 km altitude, i.e. including the whole aerosol layer. For typical aerosol conditions above 20 km both methods should yield correct temperature profiles, whereas the statistical uncertainty of the rotational Raman temperatures is higher than the uncertainty of the data presented here. Furthermore, our method requires less laser power and/or less telescope area.'

#### Minor comments:

**p. 16180, l. 10:** The uncertainty is up to  $\pm 10$  K for hourly profiles, now mentioned in the text more clearly.

**p. 16181, l. 8:** We will replace the term as suggested.

**p. 16186, l. 12:** We will replace the term 'quasi-nonexistence' with a more extended description of the fact, that a double mesopause is not observed in the monthly means but exists in longer averages.

**p. 16188:** We have discussed the observed annual and semi-annual variation in Sec. 7.2 on page 16195/16196. We stated there that 'we interpret the differences [...] as latitudinal differences in temperature structure due to the residual pole-to-pole circulation.' We will add the reference of She et al., GRL, 1993, as requested, showing essentially the same results as Leblanc et al., JGR, 1998, even if the data sets are slightly different.

**p. 16190, l. 4:** We will replace the word 'following' by 'caused by'.

**p. 16192, l. 13:** The 'two-level mesopause' and the 'bi-stable state of the mesopause' mean the same. We will add the phrase 'bi-stable' on page 16192, line 13.

**p. 16193, l. 15:** The statement is true for diurnal and semi-diurnal tides. We will quote Hagan and Forbes, JGR, 2003, for clarity, describing the decrease of semi-diurnal tide amplitudes with increasing latitude.

**p. 16194, l. 11:** The temperature in the second period is lower. We will use the phrase 'decrease by about 10 K from 1996/97 to 2002–2007' for clarification.

**p. 16194, l. 24:** We will add the reference on Xu et al., JGR, 2006, describing the comparison of lidar and SABER at 41° N.

**p. 16197, l. 15:** We apologize for the confusing phrase. We will replace it by '1–2 weeks after summer solstice'. We will correct the typo.

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

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