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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the quality of MIPAS kinetic temperature in the middle atmosphere" *by* M. García-Comas et al.

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We thank Dr. Ellis Remsberg for reviewing our manuscript and for his useful comments. We think we addressed all issues he raised. The answers (AA) to his comments (RC) are given below.

RC: p. 24237, line 12 - The sentence beginning "Although . . ." needs to be revised for clarity, possibly as two sentences.

AA: We rewrote and divided lines 12-16 in two sentences. Also, after a comment made by Reviewer Dr. Kaufmann, we added a new reference. The sentences now read as: "Initially, the standard temperature retrievals were performed up to 90 km in altitude, covered 60S-60N and assumed LTE (Riese et al., 1999). The re-processing

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of measurements extended to 110 km and 74S-74N considered, for the first time, non-LTE and revealed retrieved temperatures up to 30K smaller than the standard results (LTE) at the cold high latitude mesopause (Gusev et al., 2006)."

RC: Lines 20 and 21 - HIDRLS should be HIRDLS

AA: Done.

RC: p. 24239/40-MIPAS data are definitely obtained with a state-of-the-art temperature retrieval algorithm.

AA: We included "state-of-the-art" in the very first sentence of section 2.

RC: p. 24245, Figure 2 - Please explain the pattern of horizontal bands in the plots of vertical resolution.

AA: We included the following explanation: "The horizontal band structure of the zonal averaged vertical resolution profiles results from the altitude-constant retrieval grid that does not coincide with the tangent altitude sampling. Retrieval grid points close to observed tangent heights show a better vertical resolution as those in between."

RC: p. 24247 - Figure 3 is an excellent diagnostic of the accuracy of the pointing corrections and of the linear corrections for gradients.

AA: In fact, we mention: "Kiefer et al. (2010) investigated the impact of horizontal temperature inhomogenities in MIPAS retrievals from nominal observations by looking at differences between ascending and descending orbit branches (i.e., observations at local times 10 p.m. and 10 a.m., respectively)".

RC: On p. 24241 you used ECMWF fields for your initial horizontal T gradients. But here you seem to imply that you actually used a 2-D method to retrieve the horizontal gradient and account for it in the LOS algorithm. Please be clear about what you did.

AA: In all cases, single scan temperatures (and LOS) have been retrieved jointly with single scan longitudinal and latitudinal temperature gradients. The a priori for these

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gradients has been extracted from ECMWF. A 2D method (i.e., a multi-scan retrieval) has not been applied. That is described in detail in Clarmann et al. (2009). In the first paragraph of section 2 (4th sentence), we are now more specific and write: "the joint retrieval of horizontal gradients in latitudinal and longitudinal directions from single scans".

RC: p. 24254, lines 1-3 - should say "show 2-3 K COLDER MIPAS. . .", most likely due to the known SABER WARM bias at those altitudes.

AA: Done.

RC: p. 24255 - It is also worth noting that the SABER V1.07 retrievals do not account for effects of LOS T gradients.

AA: We included the following sentence: "SABER v1.07 retrievals do not account for LOS temperature gradients. That may partly explain the increase of the differences with latitude, that is, since LOS Tk gradients are larger when observing the high latitudes, errors in SABER from not including them are larger there"

RC: p. 24257, line 1 - shows comparisons. . .

AA: Done.

RC: p. 24258, line 23 - findings in Remsberg et al. (2008) were based on SABER V1.07, not V1.06. How did the SABER T bias change between the 2 versions in the mesosphere?

AA: According to Figure 2 of Remsberg et al. (2008) differences between SABER v1.06 and v1.07 in the LTE region (below 70 km) are not significant. We are referring here to the lower mesosphere (below 70 km; see Sica et al. (2008)). Therefore, SABER-v1.07 – ACE-FTS should not differ significantly from SABER-v1.6 – ACE-FTS in that region. We included a clarification in the text: "(note that, although Remsberg et al. (2008) findings were based on SABER v1.07, they point out that differences between v1.06 and v1.07 below 70 km are not significant)"

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RC: Line 28 - HALOE temperatures merge to climatology near 80 km, I believe.

AA: According to Remsberg et al. (2002), HALOE v19 temperatures may be considered nearly all HALOE from the altitude range of 37.5 to 87.5 km. We now specify that we are referring to comparisons at altitudes above 70 km and also mention that the ACE-FTS bias in that region is also based in comparisons with lidars. We write now: "the comparisons with lidars and with HALOE show 5-6K larger ACE-FTS temperatures above 70 km."

RC: p. 24259 - The vertical coordinate is altitude for the comparison plots. Are there any biases for the conversion of MIPAS pressures to ACE altitudes?

AA: As explained in the inversion procedure (section 2), the line of sight pointing (tangent height) is simultaneously retrieved with temperature. Each single tangent altitude is retrieved as an absolute quantity and information on the relative tangent altitudes, i.e., vertical distances between adjacent tangent altitudes, are retrieved implicitly. Pressure is a dependent variable that is calculated using the hydrostatic equation afterwards. Thus, there is no such a conversion from MIPAS pressure to altitude. Nevertheless, there are errors due to the assumed p0, which would affect rather the MIPAS altitudes than the pressures. Thus, we included the following sentence at the end of section 2.2.2: "the pointing errors due to uncertainties in the pressure assumed for the first altitude level are smaller than $\pm$200 m"

RC: Are the ACE measurements affected by horizontal temperature gradients?

AA: Yes, horizontal temperature gradients could introduce errors in retrieved ACE-FTS temperatures. Analysis of ACE-FTS measurements assumes that variations in temperature along the line of sight are "regular" (i.e., internally consistent with the temperature profile as a function of altitude that is being retrieved) and symmetric about the tangent point. Any deviations from these assumptions may lead to errors in the derived "local" temperature (i.e., the temperature in the vicinity of the tangent point). No effort has been made so far to identify or account for such effects on ACE-FTS temperatures.

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RC: p. 24261-64 - Agreement between MIPAS and MLS is impressive, even though the scale of the x-axis of their difference plots is twice that of the SABER and ACE comparisons.

AA: We agree with the referee that MIPAS and MLS agreement is very good, particularly, below the 5e-3 mb level ($\sim$85 km). We used an x-axis scale twice as big as that in SABER and ACE-FTS comparisons to show the larger differences at levels above. No action needed.

RC: Section 3.4 - Rayleigh lidar is our best "truth" measurement of middle atmosphere temperature. A comment would also be helpful here on the pressure/altitude conversion for these comparisons.

AA: Please, see the answer above explaining that there is not such a pressure/altitude conversion in MIPAS measurements.

RC: p. 24273, line 7 - change to "MIPAS, the difference being smaller. . ."

AA: Done.

RC: Figure 20 - There are 8 plots here, yet the caption says 6 dates.

AA: Done.

RC: Any comment about the differences with the sphere climatology? Mesospheric cooling trend? Bias in corrections at Mach 1 for data on sphere descent in the mid-mesosphere?

AA: We extended the discussion of the FS and MIPAS comparison including in the corresponding section the following: "Since, except for April and end of June, MIPAS mesopause (measured more than a decade after the FS measurements) is warmer than that of FS, there is no evidence in these comparison of any mesopause cooling trend. These comparisons do not show either the expected colder FS temperatures around 70 km (about 10K colder according to Lübken et al. (1994)) due to the discon-

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tinuity in the drag coefficient around Mach 1."

RC: p. 24275, line 28 - change to "all seasons, MIPAS being generally. . ."

AA: Done.

REFERENCES (not included in the manuscript)

Remsberg, E., et al., An assessment of the quality of Halogen Occultation Experiment temperature profiles in the mesosphere based on comparisons with Rayleigh backscatter lidar and inflatable falling sphere measurements, J. Geophys. Res., 107(D20), 4447, doi:10.1029/2001JD001521, 2002.

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