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Atmospheric Chemistry and Physics Discussions

Interactive comment on "First airborne water vapor lidar measurements in the tropical upper troposphere and mid-latitudes lower stratosphere: accuracy evaluation and intercomparisons with other instruments" *by* C. Kiemle et al.

C. Kiemle et al.

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Referee 1 ———

Specific comment 1: Agreed. We will begin the sentence with "In clear sky ...“

Specific comment 2: The lidar measurement range runs from 100m (200m) distance from the aircraft to 10km (6.5km) for aerosol backscatter (water vapor) profiles. I will add this information to the manuscript. In Fig. 2, I would prefer keeping the contour plot for the following two reasons: a) since the horizontal resolution is 2km, the "boxes" would look like thin vertical lines of vertically variable length. The vertical resolution

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would not well be perceptible this way; rather, the plot would appear blurred. b) Filled boxes would significantly reduce the information content of the plot since the DIAL profiles were obtained using a “boxcar" retrieval and averaging method based on the higher-resolved raw data vertical grid. Yet showing the vertical resolution is a good point: I suggest adding two vertical bars at the top and the bottom right of Fig. 2, the thickness of which would correspond to the horizontal resolution, and the length to the vertical resolution. This plus an appropriate formulation in the figure caption would enable an unambiguous and immediate understanding of the spatial resolution.

Specific comment 3: The particles were detected in a layer extending vertically from ˜12 to 14.5km altitude, as described in section 2.3. Fig. 2 lies fully within that layer. Furthermore, there are no clouds in the area covered by Fig. 2. Hence particle/cloud outlines cannot be drawn onto Fig. 2. The described particle layer does not show pronounced structures, except that the lidar measurements taken during the whole flight reveal somewhat higher particle backscatter intensity in the vicinity of cirrus. The closest cirrus, an anvil cloud with its top at 14km altitude, is ˜30km outside of the right edge of Fig. 2. This information can be added to the text and the figure caption for clarification.

Specific comment 4: Fig. 2 confirms that the DIAL vertical resolution is significantly better than 500m. I will modify the statement “better than 500m” accordingly to avoid any misunderstanding.

Specific comment 5: I agree that the "quasi-straight lines" of Fig. 8 mainly reflect the Clausius-Clapeyron relationship since they run parallel to the ice saturation profiles and that the existence of a TTL can not directly be deduced from this. I will eliminate this point in the discussion and the conclusion.

Specific comment 6: Agreed. "Aerosol backscatter" is not shown and will be eliminated.

Specific comment 7: We agree that this is misleading. However, we cannot add the constant bias expressed in the first row to otherwise statistically fluctuating and hence

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geometrically (rms) added accuracy values. Instead we suggest to remove the first row of Table 2 (“water vapor absorption cross section accuracy: 2-5%”) and to put this information into the text.

Specific comment 8: I have estimated the natural variability of water vapor fluctuations at the scale of the distance between the DIAL and MIPAS profiles, from the DIAL two-dimensional measurements. They amount, vertically averaged, to 25% for Fig. 6a, 30% for Fig. 6b, 35% for Fig. 6c, 26% for Fig. 6d, 27% for Fig. 6e, and 25% for Fig. 6f. The overall average of natural variability for the six shown MIPAS-DIAL intercomparison cases is 28%. I would prefer to include this overall average into Fig. 7, because a) overplotting error bars in Figs. 6a to f would considerably deteriorate the clarity of these figures that already now are rather dense; b) following the style of Figs. 3 and 4, i.e. showing the range of natural variability in the difference plots rather than in the humidity profiles, would give more consistency to the paper.

Specific comment 9: Agreed: I suggest shading a box within +-28% (the overall natural variability) around the zero line for displaying the range of mean natural variability, following the style of Figs. 3 and 4.

Referee 2 ———

Specific comment 1: Since the estimated average variability is 28%, we agree that it cannot be made fully responsible for the observed 48% MIPAS-DIAL standard deviation. The line-of-sight pointing uncertainty of the IMK MIPAS retrievals is estimated at 150 m (precision, 1-sigma). The H2O vmr error budget as stated in the paper already contains the propagation of the line-of-sight uncertainty. On average, the line-of-sight uncertainty contributes by 5 to 25 % to the over-all H2O vmr precision. The assessment has been done for tropical profiles out of the comparison ensemble in the UTLS range. In single cases, however, the contribution of the line-of-sight pointing uncertainty, and thus the over-all H2O vmr error, increases to 50 - 70%, but in a narrow vertical range only (˜ 2km), which is at the transition from the TTL to the free troposphere where the

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vertical gradient of the H2O vmr profile experiences a sudden change. Since being restricted to a narrow altitude range and rather low altitude, this high error contribution cannot explain the standard deviations of the MIPAS-DIAL differences above 12 km which are also around 50%. Regarding the line-of-sight pointing uncertainty, the aspect of incorrect altitude registration may also be discussed (although already covered by the error assessment). Shifting MIPAS profiles by up to 150 m in altitude may improve agreement between DIAL and MIPAS in some cases. However, since the line-of-sight pointing uncertainty is of purely random and not systematic nature, i.e. the sign and actual value of the mis-registration is not known for the individual profiles, we have not further elaborated this aspect.

Specific comment 2: We agree that Fig. 8 shows a limited sample of profiles, and that therefore general statements have to be formulated very cautiously. However, all DIAL profiles between 18-22S and all radiosonde profiles shown in Fig. 8 are within tropical air masses, as described in section 3, while the measurements of Pommereau et al. and Durry et al. were partly within subtropical air. We will formulate more cautiously our statements about the location of the cold point tropopause and the hygropause.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 10353, 2008.