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Atmospheric Measurement Techniques Discussions

Interactive comment on "Intercomparison of atmospheric water vapor soundings from the differential absorption lidar (DIAL) and the solar FTIR system on Mt. Zugspitze" *by* H. Vogelmann et al.

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Answer to comments from referee 2:

Dear referee

thank you very much for your comments which helped to improve significantly our manuscript. Due to the suggestions of referee 1 we reproduced the scatterplot

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with two different sets of spectral data. To point out the differences between both datasets we used an enhanced spectral resolution for calculating the cross sections. This changed some numbers in the results.

Page 5413, line 5:
The latest reference will be inserted with "references therein" and an additional sentence will point out that the FTIR technique is capable to provide information about the vertical distribution of water vapor.

Page 5415, line 25:
Thank you for this comment. The vertical resolution is determined by the retrieval algorithm of the DIAL, which is explained in detail by Vogelmann (2008). In a major step the water-vapor density is retrieved by deriving the quotient of the two lidar returns with a gliding linear regression (least square fit), while the length of the regression interval is a function of altitude (quadratically growing with the distance from the lidar receiver) in order to control the signal to noise ratio in a reasonable way. The vertical resolution of this method is $\approx \frac{1}{3}$ of the length of the regression interval, if referring to the definition of vertical resolution in the "VDI Guideline 4210". This will be explained in the manuscript and a citation (VDI Guidelines) will be added.

Page 5415, line 28:
The demanding requirements are high spectral purity (>99.5%), frequency stability ($\leq \pm$210 MHz) and linewidth ($\leq$390 MHz) (see Table 4 in Bösenberg (1998)). For completeness a statement about the frequency stability will be added here.

Page 5417, lines 3-4, 14:
The 178 pairs have of not been preselected from certain azimuth angels, but, of course, due to the short coincidence interval the pairs are shrunken to azimuth angels where the sun is above the horizon. The indicated outliers have been removed before

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plotting and, thus, are not part of the ensemble. This will be stated more clearly in the manuscript. Also statement about the seasonal distribution will be added (from a suggestion of referee 1).

Page 5417, line 6:
An ”overdrive” in the lidar receiver may occur if too much backscattared light from a certain altitude is collected and imaged on the detector (avalanche photo diode, APD). Usually this is not a problem for the APD itself which can handle a very high dynamic range, but this may lead to an overflow in the transient digitizer. Its maximum input voltage range is adapted to clear-sky conditions in the free troposphere where the lidar return is dominated by Rayleigh backscatter. If particles, e.g., snow crystals or Saharan dust enter the field of view of the very sensitive far-field detection channel (starting above 3.3 km a.s.l.) this may lead to an extremely enhanced lidar return resulting in a range overflow of the transient digitizer. This is indicated by a so called overflow-bit or in most cases can easily be seen visually in the raw lidar return profile which is mis-shaped by clipping. We decided it is better to call this ”overexposure”. A sentence to explain the problems with overexposure will be added to the manuscript.

Page 5417, line 19; and page 5419, line 8:
The overall bias is the arithmetic average over all pairwise differences in IWV. If regarding the FTIR instrument as a reference, the DIAL shows up a negative bias. A ”-” is missing at page 5419, line 8, but also at some more places. This will be corrected and expressed more clearly.

Page 5418, line 8-9:
Thank you for this comment. This was an error of formulation. The results shown in Fig. 3, of course, are not based on a subset of pairs shown in Fig. 2. The nodes in Fig. 3 correspond with own sets of pairs corresponding with different coincidence intervals which are reduced to ”subsets” with certain azimuth angels. This will be clarified.

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Page 5419, lines 24-26: Good comment, the third sentence of section 3.2 will be changed to make this more clear.

Table 2:
The results of Table 2 where calculated without regarding the mentioned outliers. This will be clarified in the context (see above).

The numbers of table 2 under tighter coincidence criteria do not change significantly, but due to the diminishing numbers of pairs, errors increase. 22 min is the best choice (minimum σ_{IWV}) if regarding pairs from all azimuth angles. A sentence to explain this will be added.

Figure 2:
The mentioned outliers are not plotted anyway. To highlight the 9 pairs from the 18-min-node of Fig. 3 is a good idea. Fig. 2 will be revised also due to some suggestions from referee 1.

Technical corrections:

Page 5412, lines 2 and 5:
"UFS" will be deleted because it is not needed in the following context and "FTIR" will be defined.

Page 5412, line 6:
Will be corrected.

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Page 5412, lines 9-10; and page 5419, lines 6-8:
The numbers in brackets indicate the error of the last digit(s) of the preceding number. This has been commonly done so by others before.

Same number of significant figures will be used in text and Fig. 2

Page 5412, lines 20-21:
Will be corrected.

Page 5413, line 2:
”already” will be deleted.

Page 5413, lines 5 and 6:
Will be corrected.

Page 5413, line 28:
Will be corrected.

Page 5414, line 16:
Will be corrected.

Page 5414, line 20:
Will be corrected.

Page 5414, line 24:
”new” will be deleted. ”HITRAN 2008” will be added.

Page 5416, line 5:

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Changed to ”dominates”.

Page 5416, line 21:
Will be corrected.

Page 5417, line 28:
”extraordinary” will be changed to ”very good”.

Page 5417, line 28:
Will be corrected.

Page 5418, line 18:
Will be corrected.

Page 5419, line 16:
”also” will be inserted.

Table 1:
Will be corrected.

Figure 1:
”asl.” will be changed to ”a.s.l.”

Figure 3 caption:
Correction will be made and σ will be defined.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 5411, 2010.