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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Validation of Ozone Monitoring Instrument (OMI) ozone profiles and stratospheric ozone columns with Microwave Limb Sounder (MLS) measurements" *by* X. Liu et al.

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Response to referee 1's comments

We would like to thank the referee for constructive comments on our paper. We have addressed them as follows and made changes in the revised manuscript.

Specific comments:

S.1 Section 2.1, p24918, l22: How can the vertical resolution be at worst 14 km in the

troposphere if the tropospheric degrees of freedom go down to zero? This seems to contradict each other.

Response: The vertical resolution is ˜10-14 km in the troposphere when corresponding averaging kernels can be well defined and there is adequate tropospheric retrieval sensitivity. We added "(when there is adequate retrieval sensitivity to tropospheric ozone)" after "10-14 km in the troposphere" and changed "Vertical resolution varies" to "Vertical resolution generally varies"

S.2 Section 2.1, p24918, l7: Application of Eq 1 does not remove the total OMI smoothing error but it removes the smoothing-error related component of the difference between the OMI and the MLS profile. The text should be clearer about this.

Response: We agree. We added "with relative to MLS data" after "The difference between X/MLS and XMLS are the estimated OMI smoothing errors." We also changed "This process removes OMI smoothing errors" to "Although this process does not remove the total smoothing errors, it removes the smoothing-error related component of the differences between OMI and MLS profiles"

S.3 Section 3.1, p24923, l3-4: I appreciate that the authors consider the error reduction by convolution, an issue forgotten in many papers I have read. However, the reduction by a square root of 2 seems to be based on the assumption that retrieval errors are uncorrelated between adjacent altitudes. This assumption often is not fulfilled. Either evidence for the uncorrelated nature of errors should be provided, of the correlations should be taken into account.

Response: Note that we are reducing just the precision (i.e., random-noise errors) of MLS data because we average MLS values at 2 pressure levels to calculate the mean value for the layer. Therefore, it is reasonable to assume that the precision is uncorrelated between adjacent altitudes especially for limb measurements like MLS.

To clarify this, we added "(random error)" after "MLS precision"

S.4 Section 3.1. p24926, l20: Evidence must be provided that these correlations are indeed positive. Oscillating errors, i.e. errors anticorrelated with altitude, are a typical feature of profile retrievals. On the other hand, I disagree with the conclusion that positive correlations would further reduce the error. The contrary is true: negative error correlations (the ones I actualle expect!) reduce the column error because of compensation effects. If error correlations were positive, the column error tends to the linear (not quadratic) sum of the layer-related errors.

Response: We agree with you that negative correlation reduces the column error. In our OMI ozone profile retrievals, correlations between two adjacent layers are generally significantly positive, but there are significantly negative errors between a layer and several layers that are more than 1 layer apart. These negative error correlations generally outweigh positive correlations, so the column errors are generally smaller than the root sum square of errors at individual layers. We changed the sentence "The generally positive correlation between adjacent layers will further reduce the error" to "The actual overall error is generally even smaller due to negative correlation between close layers."

S.5 Figure 3: Is the purple line the combined precision based on original MLS data or that based on reduced MLS errors due to degradation of the vertical resolution? The latter one would be the appropriate one for comparison with the red line.

Response: It is the latter one, where original MLS precision is reduced by square root of 2 due to averaging. This has been stated in line 3 of p24923.

Technical corrections and wording issues etc:

T.1 Abstract, l9: It is not quite clear what the standard deviation is. On page 24914 it

becomes clear that the standard deviation of differences is meant, but this information should be given earlier.

Response: We added "of the differences" after "the standard deviations"

T.2 Intro, p2497 l1: Here the term ‘retrieval error’ is defined. Later in the paper, the term solution error’ is used. Is this the same? If so, I would prefer to use the term ‘retrieval error’ throughout, because it is better established in this context.

T.3 Section 2.1, p24918, l7: I would suggest abundanceS

T.4 Section 2.1, p24918, l 14: It is not usual to use the verb ’constrain’ in the context of random noise measurement errors. I suggest :?The retrievals are constrained ... (McPeters et al.2007) under consideration of OMI random-noise measurement errors.?

Response: We made all the changes.

T.5 Section 3.1, p24921, l12: Not clear what the ‘also’ refers to.

Response: This is because we mention in the first sentence of sect. 3.1 "We first compare OMI retrievals with original MLS..." To be clearer, we added "In addition to comparison with original MLS profiles, " before "We also"

T.6 Section 3.1, p24922, l13: ‘a priori values’ is a bit vague. Better ‘square roots of the a priori variances’.

Response: We agree that it is vague. We change "a priori values" to "those for the differences between a priori and original MLS profiles" We also change "The smaller a priori errors" in the following sentence to "The smaller standard deviations for a priori profiles"

T.7 Section 3.1, p24923, l11: caN

T.8 Figures 1 and 2 are very small and should be enlarged.

T.9 Figures 3–6: In figure titles and figure captions the term ‘standard deviation’ should be replaced by ‘standard deviation of differences’.

T.10 Figure 9: Please explain the meaning of the color scale in the figure caption.

Response: We made these changes. We added in Figure 9 caption "The color scale shows the percentage of observations falling in 5 DU x 5 DU areas."

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