Atmos. Meas. Tech. Discuss., 7, C2197–C2200, 2014
www.atmos-meas-tech-discuss.net/7/C2197/2014/

Atmospheric Measurement Techniques Discussions

AMTD
7, C2197–C2200, 2014

Interactive Comment

Interactive comment on "Tropospheric ozone and ozone profiles retrieved from GOME-2 and their validation" *by* G. M. Miles et al.

T. von Clarmann (Referee)

thomas.clarmann@kit.edu

Received and published: 15 August 2014

The paper by G. Milnes and colleagues is a thorough description of the most recent version of a GOME-2 ozone retrieval algorithm along with a validation study of the related data product. The description of the method is specific to the GOME-2 retrieval and thus goes far beyond a pure reproduction of the general retrieval equations found in the literature. I am particularly impressed of the careful assessment of various sources of uncertainty. The paper fits well in the scope of AMT. The overall quality of the paper is good, only a few major issues need to be tackled. I recommend publication after consideration of the following specific comments:

p7925 l6: Aren't the loss reactions of the Chapman cycle the most important ozone

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destructing reactions, which control, along with the source reactions, the ozone concentration in the stratosphere? Aren't the catalytic cycles only perturbations of the Chapman cycle? Otherwise ozone would accumulate everywhere except during ozone hole conditions and would never reach an equilibrium concentration. I think the statement is kind of oversimplifying and thus misleading.

p7932, Eq(6): This is not quite true: For optimal estimation, Eq(6) formally is a combination of the measurement noise propagated through the system and the smoothing error. The smoothing error, however, in order to be a meaningful quantity, needs to be evaluated on a grid fine enough to resolve all natural variability. Resolving all structures the instrument can see is not sufficient. The grid presented in Section 2.2 of the discussion paper and used here is certainly too coarse; thus the meaning of the $\mathbf{S}_x$ calculated here is not clear; it does not include the full smoothing error. A consequence of this is that Gaussian error propagation does NOT apply when the retrieved profile is interpolated to a finer grid, because $\mathbf{S}_a$ does not contain the variability on the finer grid. (c.f. von Clarmann, Smoothing error pitfalls, Atmos. Meas. Tech. Discuss., 7, 3301-3319, 2014) I think a related caveat would be appropriate. I further think it would be more adequate to use $\mathbf{G}^T\mathbf{S}_y\mathbf{G}$ to characterize the retrieval error, particular because you convolve the ozonesonde profiles with the GOME-2 averaging kernel anyway (se also my comment below).

p7937, Eq(9): I am a little confused here: The first term has the dimension of an averaging kernel (i.e. dimensionless), but the second term seems to have the dimension of the gain function. The key to understand this seems to be that the gain function $\mathbf{G}_{a3}$ is dimensionless because it does not involve any inversion. However, a more detailed discussion might be useful to clarify this issue.

p7938 l5-10: I appreciate that this issue is mentioned but I would prefer a somewhat more detailed discussion of the information crosstalk between stratosphere and troposphere. It also might be worthwhile to have a look at the off-diagonal elements of the error-covariance matrices. I think the dependence of tropospheric ozone retrievals

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on retrieved stratospheric ozone is a key issue to evaluate the quality of tropospheric ozone retrievals.

p7942 l1: The ensemble RMS difference between GOME-2 and sonde profiles still includes any bias contribution. Wouldn't it be appropriate to use the debiased differences (i.e. the standard deviation of the differences) to get an independent estimate of the RANDOM error?

p7942 l13: while on previous pages, σ was used as a generic abbreviation of any standard deviation, the σ here seems to have a specific meaning. Does it refer to the standard deviation defined in line 1 of this page? Please specify; possibly it would be helpful to use a subscript to distinguish this specific σ from the generic σ used elsewhere.

p7942ff and Fig 5: I suspect that the "estimated error on the retrieved subcolumn" is finally based on $\mathbf{S}_x$; if so, there are two pitfalls: (a) on p 7940 l9 you state that the values are interpolated to a finer grid before they are further processed; so I guess that error propagation was calculated accordingly. Here my comment on error propagation of the smoothing error applies. (b) $\mathbf{S}_x$ already contains an estimate of the smoothing error. However, prior to the intercomparison, GOME-2 averaging kernels and prior information seem to have been applied to the sonde profiles as described by Eq.(11). Doesn't that mean that the smoothing effect has been accounted for twice?

p7943 l15-24: I appreciate your careful wording in this paragraph. From the abstract I expected that you used a model to validate the satellite data, which appears unacceptable to me. The wording on p7943 is much more careful: It is only claimed that something can be learned from such a comparison, which is certainly true. Perhaps you could go a step further and write in l20: "Thus, validation of satellite data by model data would be a questionable approach. Intercomparison of satellite..."

p7946 l17-24: Are the planned improvements related to issues detected during the validation study? To me this last paragraph appears to be rather decoupled from the

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rest of the paper. If there are links, they should be made more obvious.

Fig 2: Don't the units of the averaging kernels cancel out? Although nearly trivial, it may be worthwhile to report (not in the figure caption, but in the text, of course) how you get the errors of the sub-columns (from the $\mathbf{S}_x$-matrix?)

Fig 4: Here you mention the standard deviations of GOME-2 minus sondes, while in the text you say that you use the RMS difference. This is not the same: The former is by definition debiased while the latter still contains the bias. Clarification is needed (see also my comment above).

Technical issues:

p 7930 l15: add another "km" after zero

p7937 l18: expectEd

p7938 l3: please check if the abbreviation "AK" for averaging kernel has been defined before it is used first.

p7939 l21: Only sonde PROFILES that extend ...

Thomas von Clarmann

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 7923, 2014.