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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Climatologies from satellite measurements: the impact of orbital sampling on the standard error of the mean" *by* M. Toohey and T. von Clarmann

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The authors thank the reviewer for his/her helpful comments. In the following, the original review is printed in black while our replies are printed in blue.

The paper discusses the important issue: influence of sampling patterns by the satellite measurements on climatologic estimates. The focus of the paper is the standard error of the mean, in application to monthly zonal mean ozone data. The statement of the problem and the theory are well formulated. However, I have concerns about the realization of the idea:



1) Limited model resolution. CMAM (according to the given reference, Eyring et al, 2006) has a relatively low resolution, 3.75 deg x 3.75 deg. The size of model grid in latitude is comparable to the size of latitude bin for estimating of the monthly mean data (5 deg).

The resolution quoted by the reviewer is accurate and we will add this to the model description so that the reader doesn't need to check the Eyring et al., 2006 reference. However, we don;t think the low resolution is a problem, as discussed below.

Model temporal resolution, output every 18h, is quite coarse. Furthermore model gives snapshots at some (UTC) time, while satellite measurements at successive orbits at given latitude are performed at approximately the same local time.

This is true but since ozone does not show a pronounced diurnal change in the most part of the altitude range under consideration, this should not be an issue. We will add a statement in the sampling method description to point out that with such temporal resolution, such an exercise is possible only for long-lived species such as ozone.

It seems that the model field used in the analysis not only under-samples the "true" atmospheric ozone field, but also cannot reproduce the variability, which can be observed in satellite data.

Actually the horizontal resolution of the model is quite similar to the resolution of the measurements: 3.75 deg x 3.75 deg corresponds to approx. 400 km, which compares well with the 400-500 km resolution of ACE-FTS and 300-400 km resolution MIPAS (von Clarmann, 2009).

Unfortunately, the authors have not described the details of how they "subsample model fields based on the sampling pattern of a satellite instrument" (while this is very important). Unless a special technique is applied, the sampling of the low-resolution model field with dense sampling pattern will result in "correlated" measurements. This correlation can be stronger than in the real atmospheric field, thus affecting experimen-

tal estimates of the SEM (especially in case of dense sampling pattern).

A description of the sampling procedure will be added to the text as requested by both reviewers. The simplicity of the sampling method (simple linear interpolation in latitude and longitude) is appropriate only because of the similar horizontal resolution of the model fields and measurements, this important point is will be included in the manuscript.

2) Measurement noise is not taken into account in the simulation, while it makes measurements "more random".

This is a good point and we indeed have missed this. This issue will be further investigated and according to the outcome we will either show that this SEM component is negligibly small or we will include measurement noise in our analysis.

3) Even with very fine spatio-temporal resolution, chemistry-transport models do not describe all small-scale processes in the atmosphere. For example, perturbations caused by gravity waves are not simulated. Although small in magnitude, these perturbations result in additional variability (and thus randomness) of the ozone field. This should be at least mentioned.

Such small-scale perturbations should not have a significant impact on retrievals due to the fact that measurements represent a smoothed version of the true atmosphere due to the resolution of the measurements. To highlight this point we will add a statement regarding such small scale processes in the discussion of model and measurement resolutions.

These aspects might affect the quantitative estimates obtained in the paper.

Given the rather close agreement between the resolutions of the model and measurements, we feel that such issues should not be a major source of error in the analysis. This being said, it is quite important point, and we are thankful that the reviewer has raised the point, reminding us to include a small discussion in the manuscript. We also



note that the match of resolutions is specific to limb-sounding instruments, and so in order to apply this methodology to nadir-viewing instruments, model data with much higher resolution would be needed.

Technical comments/corrections

Fig.2 caption, misprint in "approximating"

Will be fixed.

Fig.5: Please indicate units.

Will be fixed.

-p.8246 , l.18. "exact"-> "exactly"

we will remove "exact"

- p. 8248: Why data from 13 January–17 February 2003 and from December 2008–26 January 2009 were used for March sampling? Why simply March sampling cannot be taken?

The focus on March was made for clarity of the paper, in fact the analysis was originally performed for all months. For simplicity, the same sampling pattern was used for all months.

References

T. von Clarmann, C. De Clerq, M. Ridolfi, M. Höpfner, and J.-C. Lambert, The horizontal resolution of MIPAS, Atmos. Meas. Techn., Vol. 2(1), 47-54, 2009

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Interactive comment on Atmos. Meas. Tech. Discuss., 5, 8241, 2012.