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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Assimilation of Envisat data (ASSET) project" *by* W. A. Lahoz et al.

W. A. Lahoz et al.

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We thank Ref. 2 for his/her constructive comments. This is our response:

General comments:

1. We will try to follow the referee's advice and draw a unified picture of the ASSET work in the main sections.

2. We will clarify data assimilation technical terms introduced in the paper (ref #1 also mentioned this). Note that we already cite Kalnay (2003) in the paper (p. 12772) as a source of information on data assimilation.

3. We will remind the reader of the orbital parameters and specifications of Envisat. This will likely be included in the Introduction.

Specific comments:

1. We will provide a short paragraph describing other work that used Envisat data outside the ASSET project (e.g. cal-val; the Antarctic ozone hole split of 2002). We will focus on the atmospheric chemistry instruments, GOMOS, MIPAS and SCIAMACHY.

2. We will follow the advice of the referee.

3. No technical note on the Met Office humidity assimilation has been written. Work describing this effort is in preparation. We propose to leave the text unchanged.

4. The referee mentions bias, but in this paragraph (2nd paragraph of p. 12778) the discussion is mainly about the excessive variability in the retrievals. Data assimilation experiments at the Met Office indicate that this high variability is mainly due to a problem with the background error covariances.

To clarify the issue of the dry bias in the upper stratosphere / lower mesosphere, we propose to add the following text in p. 12778, after line 15:

"Although the dry bias in the upper stratosphere / lower mesosphere cannot be explained by biases in the background or MIPAS observations at these levels, it was discovered that there are spurious correlations in the background error covariances that can give rise to large analysis increments at these levels from the assimilation of tropospheric humidity observations. It is possible that a bias between observations and background in the troposphere is thus giving rise to a bias in the upper stratosphere / lower mesosphere."

5. We will provide the following reference for HALOE temperature cal-val:

Hervig ME, Russell JM, Gordley LL, Drayson SR, Stone K, Thompson RE, Gelman ME, McDermid IS, Hauchecorne A, Keckhut P, McGee TJ, Singh UN, Gross MR; Validation of temperature measurements from the Halogen Occultation Experiment, JGR, 101, 10277-10285, 1996.

6. We will provide a description of a photochemical box model.

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7. We thank the referee for his/her positive comments.

8. We will remove the first reference to Table 1.

9. The referee is correct; the work described in the ASSET intercomparison does not encompass the boundary layer.

As suggested by the referee, we will flag in this part of section 2.3 that the following section will deal with the troposphere.

10. This would appear to be a result of slightly careless writing on our part. The referee is correct in pointing the pitfalls of the OmA (observation minus analysis) statistic when the observations concerned have been assimilated. What Fig. 10 represents is OmA when the observations in question (HALOE ozone) are independent, i.e., are not used in the assimilation. This is the ultimate test of the quality of the analysis.

In the ASSET intercomparison we calculated OmA statistics for both cases: observations assimilated (in this case MIPAS) and independent observations (e.g. HALOE). The Geer et al. paper discusses these tests in more detail.

We will clarify the text in p. 12789 (lines 2 and 14).

Note that referee # 1 raised a similar point (see our response).

11. We thank the referee for his/her positive comments.

12. We will quantify the improvement. For example:

There is a (retrieval - model) bias of -1.81x10^{14}molec/cm^2 and an RMS of 2.85x10^{15}molec/cm^2 without data assimilation, errors reduce to a bias of +1.34x10^{14}molec/cm^2 and an RMS of 2.12x10^{15}molec/cm^2 with 4D-var data assimilation, for September 12, 2003.

This improvement from the assimilation of satellite data must be contrasted to the problem of assimilation of NO2 surface in-situ data, where the error of representativity inhibits substantial improvements using a 54 km horizontal resolution. In this case, for NO2, bias and RMS are 2.04 ppbv and 6.87 ppbv, respectively, while in the case of assimilation the bias and RMS are 2.12 ppbv and 6.70 ppbv, respectively.

The problem of representativity of NO2 and NO in situ observations has been discussed in Elbern et al., 2007.

Elbern, H., A. Strunk, H. Schmidt, O. Talagrand, Emission rate and chemical state estimation by 4-dimensional variational inversion, ACPD, 2007. (Manuscript is accepted for ACPD, subject to technical corrections.)

We will include this information in the text.

13. Konovalov et al., 2006, ingested tropospheric GOME and SCIAMACHY retrievals into the CHIMERE model with 500 hPa top. In the study, a pragmatic inversion procedure is presented, where the NO2 source is adjusted to the signal in a sequential way.

We will include a reference to this paper.

14. The map suggested by the referee would look very much like the first guess depicted in Fig. 13a. This is due to the weak impact on the first guess of increments from assimilation of in situ NO2, mainly due to the mismatch between the resolution of the in situ observations and the model horizontal resolution of 54 km (see point 12 above). Instead of adding a figure, we will clarify the text by adding that the in situ observations have a weak impact on the analysis, and explain why this is the case.

15. We will be more precise as the referee suggests.

16. We understand that the referee implicitly accepts that the colour scheme in Figs. 2 and 4 is acceptable. Given that ACPD/ACP is available in colour from the web, and that colour printers are commonly available, we suggest that it is not necessary to change these figures so that a black/white printout is readable.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 12769, 2006.

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