Review of the manuscript "Assessment of the contribution of IRS for the characterisation of ozone over Europe" by Vittorioso et al.

This paper reports the outcome of an observing system simulation experiment (OSSE) conducted with simulated data from a future geostationary sensor, the MTG – Infrared Sounder (IRS). Only ozone sensitive channels are simulated and assimilated. The authors demonstrate that the IRS can be expected to have a positive impact on assimilated total ozone over Europe. The impacts on ozone profiles are less clear and, in my opinion, could use more discussion (see my general comment). Production and evaluation of an OSSE is an important step in the development of a new sensor. As such this work is firmly within the scope of AMT. Overall the manuscript is easy to follow and well sourced although the writing style could use some polishing. I've made some suggestions to that effect in my technical comments.

General comment

I would like to see some discussion of why assimilation of IRS radiances improves the mean and standard deviation of total and tropospheric ozone columns but not the profiles of standard deviation of the difference with the nature run (Fig. 14b). One possibility is that there's very little profile information in those radiances so that the increments simply reflect corrections to the total column and how these increments are distributed in the vertical is determined by a combination of the prescribed B matrix and altitudes where the weighting functions for those channels happen to peak. The resulting analysis profile may then have little to do with the "correct" one and instead represent the best fit to total ozone given the constraints. It may be instructive to see a plot of the weighting functions for the selected channels or some other metric of the sensitivity of those radiances to ozone distributions in the vertical. This is not a criticism of this work. The results are what they are and if IRS measurements alone cannot constrain ozone profiles, then this is an important conclusion, which the paper should clearly communicate and explain why this is the case. Generally speaking, it's hard to constrain profiles using nadir data so that conclusion would not be surprising. On the other hand, perhaps a different channel selection would do a better job?

Specific comments

L15-17. What about the representation of ozone variability? Standard deviations? Correlations?

L22 What behavior?

L25. I think the preferred term is "observing system".

L44. For those of us (myself included) less familiar with orbital dynamics, what does it mean for an orbit to be "*wider*"?

L106. Presumably not **all** the information content will be preserved in this dimension reduction procedure. Vast majority of it?

LL106-107. I would prefer to see an explicit statement of what approach is taken here instead of the PCs. Straightforward channel selection, presumably?

LL162-163. I suggest more careful wording here. This sentence makes it sound like the compromise is between observations and some kind of climate simulation. But that's not the case. The background state itself is obtained from a multitude of past observations previously assimilated and propagated by the model. I think this is an important point that is so often missed in casual explanations of DA. It's a very much data-based methodology.

L211. But in this case it's not a free-running simulation, is it? It is a specified dynamics simulation and it assimilates IASI. It would be good either to say it here or to drop this bit from the sentence. This sentence confused me a lot when I was trying to understand the OSSE setup in the next section.

L241-243. This sentence could be significantly shortened by omitting the explanation why the NR and CR must be different. This explanation has been given twice already. More generally, I suggest streamlining this and the preceding paragraph somewhat better to make it follow the structure of Fig.5 more closely. First, I would say that both the NR and CR use specified dynamics from ARPEGE and use the same CTM. Then I would say that two modifications were introduced to differentiate the CR from the NR and describe what they are: (1) emissions; (2) IASI assimilation in the NR.

L316. What was used for the noise and how the appropriate amount of noise was determined? Is it a realistic representation of the expected instrumental noise?

L341. "*higher values and most significant spread from the instrument noise*". I'm struggling to follow. Do you mean higher values and a greater spread than that seen in the instrumental noise?

L342. I don't understand what is meant by "*the small error in the observation operator*" and why it is responsible for the estimated uncertainties being larger than the noise added to the simulated observations. Perhaps you mean sources of error other than instrumental noise such as pointing error, representativeness error etc.?

L344. This sentence is tautological: correlations are related to covariance by construction. I suggest deleting it. It would, however, be interesting to understand how the correlations arise. Could you briefly comment on this?

Figure 11 and discussion. What exactly is plotted there? B is a covariance matrix so the units should be mixing ratio squared but the figure says ppmv. Is it standard deviations, i.e. square root of the diagonal?

Figure 13 should use the same color schemes and ranges as those in Fig. 6 for the reader to see how well the AR compares to the NR relative to the CR.

L384 and 393. I find the term "*error of the bias*" confusing (the bias is itself the average error). I would just call it standard deviation of the differences as you do in the caption. Similarly in the

discussion of Fig. 6 I saw the term "*standard deviation of the bias*". Same comment: it should be standard deviation of the difference.

L394. I think you mean "*color scheme*", not "*color map*".

L410. What is "*model restitution*"?

LL406-411. See my general comment above. The standard deviation result is disappointing but not necessarily unexpected. I think it merits more discussion. For example, could it be because there is very little vertical information in the radiance data and assimilation thus distributes increments incorrectly in the vertical? Plotting a few weighting functions might help.

Data availability. Ultimately it's up to the editor but I don't think "*All results are available upon request to the author*" is sufficient to meet the Copernicus requirements. At least the data used to make the figures and statistics should be in a publicly accessible repository. See the data policy here: https://www.atmospheric-measurement-techniques.net/policies/data_policy.html

Technical comments

L13 "along this study was the ozone" → in this study was ozone.

LL28-29. "they do not exist everywhere, since huge gaps exist between weather stations." Suggestion: they are spatially sparse.

L35. "within" → between

L66 "Since this study is a preliminary study" → Since this is a preliminary study.

L67. "the ozone" → ozone

L74 "oxidant" → oxidizing power

L81. "are issued from" → are based on

L118. "precious" → valuable

L121. "disposes of". Do you mean "consists of" or "allows"? In any case, you don't want to say "disposes of", which means "throws away".

L125-127. The sentence starting with "Through this system…" is very unclear. I actually don't understand it at all. Please, rephrase.

L203. "comply"; I think you mean "consist of" or something like that.

L213. Please revise this sentence for grammar and structure.

L251. Instead of saying "in the following", please specify in which subsection these details are provided.

Table 1. "Anthropic" → Anthropogenic.

L275. "in troposphere" → in the troposphere.

L292. What does "stronger" mean? Greater than?

L297. "sub-set" → subset

L342 "zone" → ozone

L347. "strongest values" → largest values.

L402. 'weaker' → lower.

L456. "in link". I think this should be "consistent with" or something like that.

The title of Appendix A appears to be in the wrong place. It is followed by statements on CI and acknowledgments and then a table, which I think is supposed to be the (sole?) content of the Appendix.

Thanks,
Kris Wargan