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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Fast retrievals of tropospheric carbonyl sulphide with IASI" *by* R. Anthony Vincent and Anu Dudhia

Anonymous Referee #1

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This paper, presents a new way of doing linear retrievals from infrared satellite observations. The method is applied on OCS retrievals from the IASI instrument, but is equally adaptable to the retrieval of other species from other instruments. The paper ends with the presentation and discussion of the generated dataset of retrievals of one-year of OCS measurements.

In many ways the paper is exemplary: it is well-written, clear and innovative. This is especially true for the first part of the paper where the retrieval technique is detailed -it makes for very interesting reading. There is obviously room for improvement in some areas of the algorithm (for instance in the treatment of surface properties). The richness in ideas more than compensates this lack of maturity. The second part, the discussion of the retrieval results of the 2014 IASI data is less deep, but demonstrates that the algorithm is capable of capturing at least some of the global/seasonal OCS

variability. Although given the maturity of the product, caution should be exercises in drawing conclusions from the data as several identified enhancements/depletions are clearly related to problems in the retrieval. This is acknowledged by the authors but could be emphasized more clearly in places. Presentation-wise, the second part is also less strong than the first, and below, several improvements are suggested. Overall, I deem this paper to be suitable for publication in ACP after a minor revision.

Comments are listed in chronological order:

P1, L6. I would remove "rather than treated as effective noise". This is already pretty technical and few readers probably would understand this before having read the rest of the paper.

P1, L24. "fast retrieval methods". The use of a computer cluster is also a viable alternative.

P2, L3. a comma is missing after dramatically (sentence might need to be reworded, the 'indeed' sounds colloquial)

P4, L13/14. These are definitely not the main reasons. TES does not cross scan like IASI (it has no swath) and also has huge gaps in between two nadir pixels. I do not have the numbers at hand but the number of TES observations is several orders smaller than IASI's 1 million+ spectra per day.

P4, L21. "reduce" should probably be "reducing".

P7, F1. What does BBT stand for?

P7, F1. This figure would in my opinion be more useful if it showed the actual contribution of each of the species in the IASI spectrum rather than the jacobians. That is: for the bottom plots to plot the difference between the simulated spectrum and the simulated spectrum without the different individual species included in the forward model. That way, the individual contribution of each of the species is highlighted very clearly, and the reader can see the extend to which OCS, O3, etc. contribute to the

IASI spectrum.

P8. Clearly, and that I think is nowhere mentioned in the manuscript, it is actually not necessary to calculate G * y for all rows of G. If one is just interested in OCS, it would suffice to carry out the multiplication of the first row only. But of course, the first row in the matrix G is affected by the jacobians of the other parameters. I think it could benefit the reader to discuss this in short.

P8. How much does it really help to retrieve all these parameters along with OCS? Have you tried just retrieving OCS and carrying out the channel selection based for this? The retrieval of this full state vector is one of the main innovative aspects and it would therefore be well worth exploring/explaining/illustrating this further. It would in any case be more convincing if the results could be compared with or without retrieving a full state vector.

P11, L3. Levenberg-Marquardt method, please add a reference to the exact method which was used here (as the specific iterative procedure is not discussed)

P11, L23. "In reality", this confuses me as I feel I am missing something. It thought this followed naturally from the above? Please expand.

P13, L9-10. Is the same not done for the CO2 q branch (P14, L23). One could do this for the each channel thereby reducing the sensitivity to errors in the forward model.

P14. On which atmosphere was this analysis carried out?

P14. L34. "mean spectrum" what is the meaning of "mean" here. From what was said before 80 atmosphere yield 80 spectra, so I am not sure what is being averaged here - the term mean spectra is also used in several places afterwards.

P15 L5-10. This could be more clear. First, "x0" and "y0", shouldn't these be xj and yj, etc...with j=1..80? Then Chi_pr, G and K should all have an index j too, since they also depend on the specific atmosphere. Secondly, it would be good to show the extra step here (ie. eq (10) with Eq (2) substituted), I found this section especially confusing on a

first read, and that extra step would have helped.

P15 L9. "In some texts". Please give an example, what is the DRM generally used for or what does it in general represent?

P16. A fourth obvious approach is not listed here, that is to select the atmosphere based on closeness in time and location of the observed spectra and the time/location of the 80 reference atmospheres. I think it is worth to discuss this approach in short.

P17. F9. There seems to be bias in the linear assumption error. Do you have an idea why this is so? I see no reason why this would be so (the a priori is unbiased), so they should all four have been nicely spread around 0, but with a difference in spread?

P17 L4. shouldn't "three selection methods discussed" read "the three discussed selection methods"? (as a non-native English speaker I am unsure)

P18. L1/2. Why is that so? Did you try with even less channels? Clearly reducing the number of channels improves the chance of relying on badly modeled channels, but the channel selection procedure assumed a perfect model; so I see no obvious reason why this would be. It is a very interesting finding, but would be good if you could expand on the underlying reasons. This comes back in the conclusion (twice) and is each time stated, but the underlying reason is never given.

P18. L21/25 Five thermal contrast scenario's seem little. Thermal contrast can go up to 30 K in favorable circumstances. This is one of the places, where the retrieval algorithm could easily be improved.

P18. L29. But from what follows it seems chi_projected is calculated (equation 14). The two should be identical no?

P19. L6. Can you give (or at least cite) the exact formula which was used to calculate the specular solar reflection angle?

P19. L19. "Thus" the factor 2 doesn't strictly follow from what is written above. Perhaps

better would be "Thus, a reasonable criteria for accepting a ..."

P19. Section 4. There are three ways which I think would improve the presentation drastically. Firstly, 36 figures 6 x Fig10-15 are too much, especially since most of these bimonthly maps are not discussed. I would strongly suggest replacing these 36 figures, with a one page 4 x 2 panel figure showing just the OCS panels for AM/PM for the 4 seasons. This would allow to compare much easier the different seasons. All the other panels aren't that useful, and most of what is seen in them can also be seen on Figure 16, which can be kept in its current form.

P19. Section 4. The second presentation suggestion I have, is to display OCS as a VMR on a fixed altitude (altitude of max sensitivity?). Currently it is very difficult to interpret the columns over land because of orography. The maps now basically look like earth surface ground height maps. Satellites are of course sensitive to a column rather than vmr at a given location, still as only one parameter is retrieved and the whole profile is scaled uniformly, it really doesn't harm to show the value at one given altitude (even though care much be taken not to over-interpret those values of course). Orographic effects should be far less visible that way and in addition it would also be much clearer whether the retrieval sees an enhancement or depletion with respect to the a priori (the apriori could be indicated on the colorbar).

P19. Section 4. Thirdly, it would be nice to show a modeled plot of OCS vmrs to represent 'the state of the art' of the current knowledge on OCS distributions. This would greatly ease discussion (it could first be discussed in section 2, and then referred to in section 4).

P20. L4. "likely due". This would be very easy to check no? In fact, it wouldn't be too hard, and quite instructive to produce a map which for each place on Earth shows the filter which was most often applied.

P20. Section 4.1. One thing that occurred to me was that the daytime ocean seems to have higher highs and lower lows, can you confirm/explain?

P21 L4. Please add a number/point, as was done for the other points of interest.

P21/22. I would personally be even more cautious in over-interpreting the data, given the maturity of the product.

P23. L14. "import" should probably be "important"

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