

Interactive comment on “Ozone-sensitive channel selection over IASI full spectrum with correlated observation errors for NWP” by Olivier Coopmann et al.

Anonymous Referee #2

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General comments:

The general theme of this paper, increasing the channel selection used operationally for IASI to include ozone sensitive channels, is relevant and useful. It's clear a lot of work has been done by the authors to generate a background error covariance matrix, an observation error covariance matrix, do a channel selection, and test various combinations of channels in a 1D-Var context.

However, I can't quite convince myself that there is problem here that is worth solving. The authors end up choosing 15 ozone-sensitive channels from the 306 available, with a stated aim of increasing both ozone and T/q information in the retrieval. Along the

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way, they test the addition of many more ozone channels to look at the combined information content. That seems to me to be a pointless exercise – why would you add 306 ozone channels to 122 operationally assimilated T/q/T_{skin} channels? If you wanted to increase the information content for T and q as well as ozone, you'd add 15 ozone channels, and another 100 T channels and a few tens of q channels, not 306 ozone channels. Furthermore, as is common with proposed innovations in channel selection, the result ends up gaining little over the channels chosen by Collard (2007). Many IASI channels are almost equivalent, and in choosing 15 from 306, this enhanced method manages to pick out four channels that are the same as the original method.

I feel that I want more out of this paper. Some proof that the new channel selection is genuinely better than the Collard selection. For example, add a comparison to Figures 13 and 14. See whether the addition of 10 Collard ozone channels together with a couple of high-peaking T sounding channels, a couple of low-peaking T sounding channels and a couple of extra water vapour channels would give an even better result. You could also compare fits of the retrieved profiles to the IASI channels, i.e. O-R statistics, particularly for independent (non-assimilated) channels. Something else that would make the paper feel more complete would be to present results of a real assimilation experiment. So, overall, I feel that the paper needs something extra to complete the picture of why this work is necessary.

It would also benefit from editing by a native English speaker. Although the writing is for the most part easy to understand, there are quite a few grammatical errors (too many to correct in this review). The citations are presented in a strange way and could do with editing – e.g. “(Han and McNally, 2010)” should quite often be “Han and McNally (2010)”.

Finally, the paper is a little heavy on unnecessary background information – very old references to use of ozone data; overkill on the acronym expansion for RTTOV (I don't think you need any at all); too much information about the IASI instrument – and repetitive information about the spectral range and channels.

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Specifics:

P1 L5: I am sure you know this, but one of the main reasons we need channel selection is because of high levels of null-space in the measurements and the effect that this has on the mathematics of inversion. In the end, data transmission isn't really an issue (many NWP centres receive the full spectrum).

P1 L14: In general, analysis is used to describe a full NWP analysis. I think "retrieval" is a more appropriate term to use for this study, and I would suggest you replace it everywhere (except, of course, where you definitely mean analysis, e.g. analysis of results). It's not clear, in this paragraph, how the 345 profiles are used – is it in the channel selection or the 1D-Var study that follows?

P1 L16: The way this is written the results are quite astonishing – a 20.9% reduction in humidity error relative to leaving out the 15 extra channels? I can't follow the calculation of these numbers. Fig 13 a,b show virtually no benefit of adding the extra 15 channels.

P1 L17: Obviously -> as expected

P1 L17: the order of the sentences should be swapped. The one that begins "in addition" should be in the previous paragraph.

P2 L5: It sounds like you assimilate 75% of all IR sounder obs, whereas you mean 75% of all observations assimilated are from IR sounders.

P2 and generally: "Metop" not "MetOp"

P2 L25: "Ozone is beneficial" – that's not what you mean. I think you are trying to say "Use of ozone-sensitive channels could be particularly beneficial because they may additionally provide information on temperature and humidity".

P3 L7: "Mostly... often" – how about "channel selections have usually been performed using diagonal..."

P3, L19: I don't think you need to expand RTTOV. It's just annoying to read all that. But

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I guess that decision is up to the journal. Also, see below, P5 L4.

P4, L10: Are your matchup criteria tight enough? Pougatchev, N., August, T., Calbet, X., Hultberg, T., Oduleye, O., Schlüssel, P, Stiller, B., St. Germain, K., & Bingham, G. (2009). IASI temperature and water vapor retrievals – Error assessment and validation. Atmospheric Chemistry and Physics, 9(17), 6453–6458.

P4, L20: Why 54 levels and not 100, which is recommended for hyperspectral sounders?

P5, L4: You don't say which version of RTTOV you are using. If you are using RTTOV-12, it no longer uses ISEM, but has a new sea surface emissivity model.

P5, L11-29: This is far too much information on MOCAGE.

P5, L31: Repetitive about RTTOV.

P6, L5-14: Repetitive and too much about IASI. The swath stuff isn't relevant to the study.

P7, L24: "Realistic but do not represent reality" – I don't really like that sentence! Realistic means like reality... Maybe you should say they are realistic but biased (and find a reference for that!)

P8, L3: Remove "typically" – either it was 10% or it wasn't. If it wasn't always 10%, you need to be more specific.

P8, L14: I personally like the use of units K K⁻¹, but note that it is unconventional to express it this way (they are unitless)

P8, L24: The problem is to ensure that all this information is partitioned correctly and doesn't end up with ozone signal being transferred to T_{surf}, or T_{strat}, or whatever. This is why, normally, one might consider it best to pick channels with pure sensitivity to one species where possible.

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P8, L25: Center (not centers)

P8, L26: Applied (not applied)

P8, L29: "MOCAGE was run to provide temperature, specific humidity (from ARPEGE) and ozone 3D distributions." – It sounds like your temperature fields came from MOCAGE. Is that the case? If so, why?

P8, L32: These aren't complete sentences.

P9, L1: I found this description nearly impossible to understand. "every day an ozone forecast up to 24 h range is produced using ARPEGE forecasts" – it sounds like you are using ARPEGE to do the ozone forecast. See previous comment about P8, L29, which was the opposite!

P9, L23: "This assumption prevents feedback effects of ozone on temperature and humidity" – except that you say you want to extract information on temperature and humidity from the ozone channels... IF you were that concerned, you would try to pick ozone channels that were not sensitive to humidity, as Collard did, or Ventress, or Gambacorta...

P9, L25: Why are you using 49 levels, and not the 54 RTTOV levels, or some other number of levels that matches any of your input datasets?

P9, L29-30: There are quite a few nowadays that use full error covariance matrices. Some in publication, some not peer reviewed (e.g. <https://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.647097>), but there are some that are already in the literature. E.g. <https://journals.ametsoc.org/doi/pdf/10.1175/MWR-D-14-00249.1>. Also, I think you've cited the wrong Bormann paper there – you want the other one that deals with IASI correlations, not the microwave paper.

P9, L32: The sentence that begins "A first step" should be in a new paragraph.

P10, L30: "We note large positive correlations between O3 and stratospheric CO2 sen-

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sitive channels" – they look to be about 0.2 to me, which I wouldn't say was especially "large".

P11, L11 onwards: It is not at all clear how you have made the actual channel selection. You talk about, and show, a mean and standard deviation in DFS, over 345 profiles. But how do you pick each channels? Based on one main profile (and if so which?), or do you use the method that involves picking the channel that is chosen by most of the 345 cases? If the latter, you need to point out that there is a possibility that you would tie for most-chosen, and that the selection amongst those two would then have an important influence on which channels were subsequently chosen, due to correlations.

P11, L31: "Choice of selection" – that's an odd title, and doesn't really describe what you're doing in this section, namely seeing how few channels can be added yet still provide information content.

P12: Again, why would you add 300 ozone channels? It seems a very bizarre experiment to perform.

P12, L14: What did you do above the top of the sonde profiles? Because of long tails in the Jacobians, what you do above the model top can have a profound effect on the averaging kernels.

P13, L19: Or maybe the observations are insufficiently unambiguous to resolve the multiple species

P13, L24: "Conversely, the objective of our study is to select ozone-sensitive channels with information to also improve temperature and humidity analyses" – again, why? Why not aim to select a few ozone channels and add some more T or q channels as well if you want to increase DFS there.

P14, L19: There's very little vertical information on ozone from IASI. Your own DFS plot shows that with 15 channels you have about 1.5 DFS in this system. That's not enough to locate the changes in the vertical; it's the background error covariance matrix that is

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defining where the information on ozone is placed in the vertical.

P15, L15: I don't think this is an important result. You would get a good increase in temperature information content by adding in any additional 300 channels. And nobody in their right mind would add 300 ozone channels to an operational system assimilating just 120 mainstream channels

Fig 7: I found this figure difficult to understand – what is the point of the first line of circles? It would be useful to add another day to the figure?

Fig 9a: Your IASI noise looks wrong (too low) – see Figure 3 of Hilton et al, 2012 (The BAMS paper) for example. 9a and b: how does this look compared with the normal Desroziers matrix derived from ARPEGE.

Fig 11: I can't see the blue dashed line at all. I found the caption confusing – you mean “Collard's ozone channel selection” – otherwise it seems like you mean the “Collard selection” as a whole (and then you'd be degrading to begin with. . . .

Fig 13c: I can't help but feel a little unexcited by this plot and result

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