Replies to Referee #1 on the manuscript 'Assessment of the error budget for stratospheric ozone profiles retrieved from OMPS limb-scatter measurements ' by C. Arosio et al.

We thank the reviewer for the time she/he spent reading the manuscript and constructively commenting on the paper. In the text below, we address the comments from the Referee #1. Referee's comments are shown in italic and authors' responses are highlighted in blue.

 ——— **General comments**

This is a nice solid paper that does a thorough and robust job of quantifying the uncertainties associated with the Bremen group's retrievals of ozone profiles from the OMPS-LP instrument. My comments are only minor. The discussion is generally very clear and well motivated. The language and graphics are both of very good quality. I'm very happy to recommend this paper for publication pending the minor corrections that I detail below. I do not feel a need to review an updated version (but clicked on the "willing" button if the editor feels another read through is needed).

Thank you for the appreciation and the positive review, we address the comments below.

 ——— **Specific comments**

Line 2: I think the mission is now called the "Suomi National Polar-orbiting ..., Suomi NPP", right?

True, we changed the text accordingly and use now the SNPP acronym.

Line 3: I suggest rewording as: 'The error characteristics are presented in a form that is compliant with ...'. Note the spelling error on compliant (you have "complaint").

Thanks, we re-worded as 'The error characteristics are presented in a form that aims at being compliant with...'

Line 8: Suggest rewording start of sentence to: "We have classified the various different error..."

Done.

Line 11: You have a short hyphen (single "-" character in LaTeX) for the first (3-50%) range, but longer ones ("–" in LaTeX, which are more correct) for the other two. Modify the first to be consistent/correct.There were some other examples of this issue elsewhere in the paper.

Thanks for pointing this out, we replaced the short hyphens with long ones in those cases.

Line 12: "related" → "due"

Done.

Line 13: saying both "absolute value" and quoting a percent (which many would see as a "relative value" is confusing). Please clarify, do you mean abs(error) - to use programming terminology? - expressed as a percent?

Yes, exactly, we meant errors in 'absolute value', we removed the word absolute, which can lead to confusion.

Line 13: What above between 20 and 50 km, would be good to quantify that in abstract too.

We changed the sentence to '... The corresponding total bias exceeds 5 % only above 50 km and below 20 km'.

Line 18: Insert "Suomi" before "National"

Done.

Line 26: "was in the meantime" → "has since been"

Done.

Line 41: Put commas before and after "as in von Clarmann et al. (2020)"

Done.

Line 43: Would it be better to insert "mainly" before "contribute" here? I leave it to you.

Done.

Line 55: Suggest inserting "in Sect. 2.1" after "instrument" for better flow/consistency. Then insert "of" before "the retrieval algorithm" and delete "given"

Done.

Line 70: Suggest "increases" → "coarsens". "Increased" resolution sounds good from an English perspective, but is worse from a numerical perspective if quantified in terms of a length. (Similarly precision/accuracy. I generally advocate saying coarser/finer and/or better/worse rather than more/less for all such terms to avoid ambiguity).

Thanks, it is a good point, we used 'degrades' instead.

Line 81: Delete "what concerns"

Done, we replaced it with 'to choose'.

Line 86: "... and are preconvolved with the OMPS-LP instrument line shape" ("are beforehand" is awkward wording).

Done.

Line 90 (and 95): Not being familiar with UV/Vis instruments, I hadn't understood/remembered that the Chappuis bands are not in the UV. Thus this paragraph was very confusing to me (is the shift and squeeze included or not?). I suggest you make that clearer by pointing out that the Chappuis bands are in the visible spectrum).

Thanks, we didn't realize this. We clarified this in the text.

Line 91: "tells" → "suggests" or "implies"

Replaced with 'implies'.

Line 94: Not sure what is meant by "differential absorption" here, I presume you mean fine-scale spectral structure, but it's not 100% obvious. Saying "differential" could mean from TH to TH. Please clarify.

Thanks, yes we meant fine-scale spectral structures, so we changed 'differential' to 'fine-scale'.

Line 109: Suggest you delete "percentage" and then add ", expressed as a percentage of the true profile," after "reported" on the next line.

Done.

Line 118: Not clear what "actual" means in this context. Does it refer to the spacing of the levels in the state vector? (I forget if that was discussed anywhere in the paper). If so, then I'm not quite sure how the UV vs. Chappuis comes into it, so perhaps that's a bad guess on my part. Please clarify.

Yes, the observations are reported on a 1-km grid but the vertical resolution of the retrieved profile is coarser. We removed the word 'actual'.

Line 131: Some inconsistency here, this discussion of the Gaussian generator and the multiplication by the SNR discussed in line 133 suggest that these "noise sequences" are Normal(mu=0, sigma=1). However, the caption for figure 3 states that the lower panel is showing the "noise sequences" too, and these clearly have sigma smaller than 1.0. Not a big deal, I'm sure everything's been Done. correctly, but make the terminology consistent between the text and the figure caption.

Yes, the generated gaussian samples have sigma = 1 but they are multiplied by the sqrt(RMS). We specified it in the caption as well.

Line 132: "Simulated spectrum" may be unclear here, as we're stil dealing with real OMPS data, right, not the radiances corresponding to a modeled truth. Perhaps "fitted" might be better for this particular sentence, rather than "simulated"?

Thanks, yes we meant SCIATRAN spectrum, i.e. the one that is fitted. We specify 'fitted model spectrum'

Line 134: Suggest you say 50 rather than N here, for consistency with earlier in the sentence (some may forget that N==50).

Done.

Line 136: "profile" → "profiles" or "a first guess profile"?

We replaced with 'profiles'.

Line 137: Clarify "unperturbed" here. It's clear to me that you mean you have yet to do any perturbations associated with parameters, calibration, spectroscopy etc., but readers less familiar may be confused as your 50 noise sequences are themselves perturbations.

We see the point, we specified as follows: 'all 50 retrieved unperturbed profiles (with different noise sequences applied)...'.

Line 143: insert "is" between "what" and "ideally"

Done.

Line 143/144: "This feature" is vague - is it the point discussed in the preceding sentence or the whole of this paragraph. Please clarify.

We replaced 'features' with 'discrepancies', which should be more clear.

Line 156: Suggest you change "shift-squeeze" in the math symbol to "shift&squeeze" to avoid confusion with a minus sign (& in LaTeX). Also, the kerning for this and other things (e.g., "param", "fix", etc.) is wrong because you're in math mode. Suggest you use, e.g., $\sigma_{x,shift\&squeeze}$ (needs amsmath.sty) or, $\sigma_{x,shift\&squeeze}$ if you prefer. And similar for others.

Done, thanks, we use the \text{} option for the subscripts.

Line 166 / Table 2: For completeness/clarify you should state what these numbers convey. Are they ranges? 95% confidence intervals? 1-sigma (which is what I assume the are, from the contex), 2-sigma? This then impacts the interpretation of the resulting O3 uncertainties.

We can assume these values to be the standard deviation of the parameters, i.e. $1\,\sigma$. We added this in the paper.

Line 168. The sentence here feels like it belongs at (or near) the end of the paragraph rather than at the start. Where it is now, it interrupts the flow of discussing the input parameter uncertainties.

We moved it to the end of the paragraph.

Line 186: Suggest adding "radiance" before "noise" to remind people what you mean here.

Thanks, we expanded as '...the Gaussian noise is added to the simulated radiances...'

Line 187: I wonder if the superscript "n" might not be better as an "i"? In any case, it should be defined.

We added at the end of sentence 'where n is the running number of the noise sequence'.

Equation 7: I can sort of see why you call this a sigma rather than a delta, but it feels like it should be the latter from the definition, so take some time to explain to the reader why you're not labeling it as a delta. Indeed, it might be easier to explain if you talk about the Monte Carlo approach first rather than second. Then this delta-like parameter becomes an estimate of the

associated sigma from the MC approach.

As long as the variables are properly defined we believe there is some freedom in using the notations and there is no need to justify the used symbol. We note that the used notations are common in the ozone profile retrieval community. However, we see the reviewer's point and her/his remark before the discussion phase and decided to indicate with sigma the random uncertainties and with a delta the systematic components.

Line 214: "are going to be" $\rightarrow$ "will be". Also, end of line change "fix" to "fixed".

Done.

Line 215: "... and conveys information on the relationship between the sign of the parameter perturbation and the sign of the consequent ozone perturbation."

Thanks, implemented.

Line 224: Would be good (here or somewhere else) to point out that you're changing Temperature at all heights by 2K, not just one height (or each height in turn, right?). Indeed there are multiple temperature, pressure, TH, and aerosol perturbations that could be made, but only one albedo one, correct? (Though hydrostatic balance, if you're imposing that, reduces the degrees of freedom for Temperature/pressure/TH perturbations) Perhaps discuss this more, and explain why you didn't consider more complex (i.e., height-dependent perturbations).

Thanks, for pointing this out, it's an interesting discussion. Temperature, pressure and aerosol errors could indeed be assumed to vary randomly in altitude; though for TH it is rather a single value for all altitudes as it is related to the pointing of the instrument as a whole. We investigated the difference between considering the perturbation constant over altitude (correlated) or free to change randomly (uncorrelated). Fig. 2 shows the comparison between these two cases, in terms of ozone errors, i.e. standard deviations of 50 retrieved profiles with perturbed aerosol and temperature profiles, with correlated (magenta shaded area) and uncorrelated (green) errors. In the first case we used 50 generated noise sequences as SNR, whereas in the second we kept the SNR from the actual OMPS measurement. Superimposed are also shown the two cases of fixed perturbation, using the SNR from the OMPS observation. Differences are negligible for aerosol but not for temperature (and pressure, here not shown). We have to note that from the nature of P and T data, i.e. model, a systematic error in the altitude domain is more probable. We added a sentence in this respect at the end of Section 4 and these figures in the Supplements.
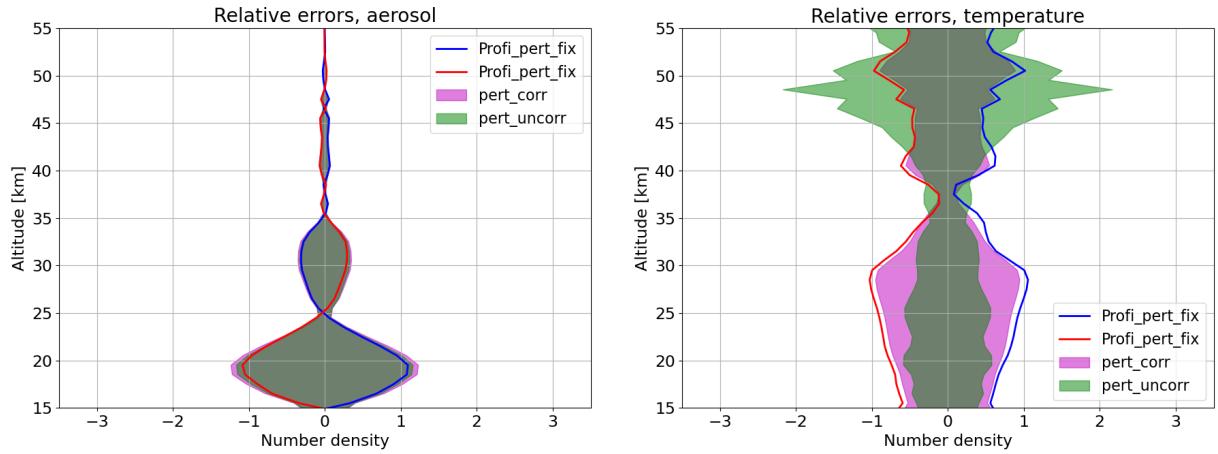
Figure 1: Comparison of estimated ozone errors when using correlated or uncorrelated parameter errors in altitude, for aerosol and temperature.

Figure 5 caption, line 2, insert "in the top and bottom rows, " before "respectively". Also, delete "- like" after "Monte Carlo"

Done.

Line 282: "It has to be taken into consideration that" → "It should be borne in mind that"

Done.

Line 284: "On the contrary" → "In contrast"

Done.

Line 285: "less" → "fewer", or "a narrower range of" if that's a better description.

We use 'fewer'.

Line 437: "exemplification" → "example"

Done.