

## ***Interactive comment on “Retrieval of ozone profiles from OMPS limb scattering observations” by Carlo Arosio et al.***

**Carlo Arosio et al.**

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### **Replies to Referee #2 on the manuscript ‘Retrieval of ozone profiles from OMPS limb scattering observations’ by C. Arosio et al.**

We thank the reviewers for the time they spent carefully reading the manuscript and constructively commenting on the paper. In the text below, we address the comments from the referee #2. Referee’s comments are shown in italicized font and authors’ responses are highlighted in blue.

#### **==== General comments**

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*This is a nice paper that does a good job of introducing a new OMPS-LP retrieval approach and describing the dataset resulting from it. I see this paper as ideally suited to the AMT journal and a welcome addition to the body of literature. My comments are all pretty minor and mainly involve requests for further clarification or suggestions of wording changes etc. I’m confident that, once these are addressed, the paper will be ready for publication.*

*Before I provide some line-by-line comments and suggestions, just a few “global” thoughts. In several places the paper presents comparisons between the IUP-OMPS and another dataset without (that I could readily find) being completely explicit about whether it’s <IUP-OMPS> minus <other> dataset that’s being presented (as I’m pretty sure it is) or the sign is reversed. Furthermore, when a percentage or relative difference is shown, you should be clear about what is in the denominator, is it IUP-OMPS, the other dataset or some combination of the two?*

**We added an explicit equation (Eq. 8) valid for all the relative differences in the paper and corresponding remarks in figure captions, where appropriate.**

*The abstract and introduction talk about this paper setting the stage for a potential “combined” dataset linking this new record to the SCIAMACY observations. It would be useful to return to this point in the conclusions section and briefly discuss the consequences of your findings for such an activity. Which of the factors uncovered in this analysis might present challenges to such data fusion?*

**That’s an interesting point: we added a couple of sentences in the conclusions: ‘In light of the results presented here, an additional work for tuning of some retrieval settings is needed before processing the whole data set and attempting the merging**

C2

with the SCIAMACHY time series. Since the same 1-D retrieval approach has been used for both data sets, we expect this to ease the merging. Unfortunately, only a couple of overlapping months between the two instruments are available, so that a third product must be used for the merging. After the good agreement found in the comparison of our retrievals with MLS, we are considering the use of the latter instrument as a transfer function to handle calibration issues in the merging procedure.'

*Finally, I'm aware of at least on other team developing an OMPS-LP data record, that being the OSIRIS team in Saskatoon. Depending on the availability of data from that team, it's worth considering the possibility of expanding section 4.1 (or adding a new section) that at least discusses their approach and its similarities and differences from yours and the NASA one, and perhaps even performs an additional data comparison if appropriate.*

That's true, a mention + citation of this other data set was added, however:

1) Also Saskatoon's paper is currently under discussion, even though the processing has already been extensively performed.

2) An inter-comparison with this data set is for us behind the scope of this paper, as the Saskatoon retrieval is not yet sufficiently validated and differences because of the usage of 2-D approach are expected. Thus, for now it is unclear how the differences in the results, which are expected to be identified, should be attributed properly.

3) A dedicated paper about retrieval errors using different algorithms is foreseen by NASA team.

#### **==== Specific comments**

– Abstract

*It would be good to spell out SCIAMACHY and MLS in the abstract (if space permits)*

C3

Done

– Page 1 Line 20: *Odd wording of 2nd sentence. How about "... in the atmosphere. It is most abundant in the stratospheric 'ozone layer', which absorbs..."?*

Reformulated as: *'It is most abundant in the stratospheric 'ozone layer', which absorbs...'*

– Page 2 Line 18: *For completeness, I suggest you add discussion of the GOZCARDS (doi:10.5194/acp-15-10471-2015) and SWOOSH (doi:10.5194/acp-15-10471-2015) datasets also.*

Added

– Page 3 Line 8: *"satellite missions" → "satellite instruments"*

Done

*Line 25/26: This needs rewording. First, OMPS is an instrument not a mission (the Suomi NPP missions has "stated aims" that go far beyond ozone). Secondly, while the OMPS-LP and OMPS-NP components are indeed focused on the vertical distribution, you've neglected the OMPS-NM mapping capability which has no vertical resolution and thus a different science focus.*

Yes thanks, we reformulated it, addressing the sentence just to OMPS-LP: *'The main objective of OMPS-LP is to monitor the ozone vertical distribution within the Earth*

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middle atmosphere at high accuracy level.'

– Page 6 Lines 1/2: "further prior handling" is odd wording (further and prior sound contradictory), how about "additional screening or processing" or something similar?

Reformulated: 'In this paper, version 2.5 of OMPS-LP L1G data has been used without any additional pre-processing related to stray light and pointing.'

– Page 7 Line 3: Give a citation or more details on the "another scene-based technique".

We introduced the other acronym as well. The paper Moy et al. has already been introduced.

Lines 7/8: This reasoning doesn't actually quite follow. Photons from any altitude can be scattered within the instrument to any other altitude. It so happens that there are more photons in the lower atmospheric views than the upper atmospheric one. The way it's currently written makes it sound more one way than theoretically can be (though granted, you do start with "For example").

Yeah, we deleted this part and referred the example to the collection of multiple images on 1 single CCD.

Line 23: "In the preparation time of this paper" → "At the time of writing this paper"

Done, sentence moved at the beginning of the 'Results' section

C5

Line 33: Perhaps delete "the" before "North"?

Done

– Page 8 Lines 10-15: Please be explicit about whether "approximate spherical" is referring to the assumed shape of the Earth (as I assume it is) or to the shape of scattering particles. How does "approximate spherical" (line 12) relate to "pseudo-spherical" (line 14, page 9 line 1). Also how is all of this related to the oblateness of the Earth, are you assuming a spherical Earth surface but with a radius tuned to give approximately the same shape as the Earth ellipsoid along the line of sight?

Clarified in the paper.

– Page 9 Lines 20-24: Please give more details on what this "shift and squeeze" is correcting (some instrumental anomaly?) and why this correction is necessary (also why it is not needed in the UV range).

Sentences added: 'This pre-processing is performed for each observation at each TH independently and is introduced to account for issues related to the spectral calibration and possible thermal expansion of the detector.' and 'As the shift and squeeze correction algorithm works with the differential absorption structures, it cannot be applied in the UV range. Furthermore, as the UV retrieval uses either radiances themselves or their slopes, the influences off a possible spectral misalignment are rather small.'

– Page 10 Line 12: Typo with Tikhonov

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Checked but it was correct.

*Also line 12: If gamma linearly increases with height then it's a vector rather than a scalar surely (or even possibly a diagonal matrix). Please clarify.*

True, we address gamma as a diagonal matrix.

*Line 24: Insert "Level 1" after "normalized"?*

Reformulated: 'Surface albedo is simultaneously retrieved with ozone using the sun-normalized radiance provided in the L1G data.'

*Line 27-29: I'm not quite sure I understand this. It seems like you're preselecting which wavelength/height subsets of the Level 1 data to use based on the strength of the weighting functions. However, the retrieval factors those strengths in when deciding how much attention to pay to each individual measurement anyway. Why is this additional step, which, in effect, second guesses the retrieval, needed? If including the "weaker" signals has undesirable effects on the result, is it understood why that is? Also, this means that, potentially, each ozone profile was generated by a different "subset" of the instrument, making for a measurement dataset whose properties (precision, resolution etc.) are a moving target, complicating the development of average datasets, long term records, etc. Some discussion of the size of these effects would be good.*

This was just a description about what was done at the beginning to adjust the

C7

spectral ranges used into the retrieval. Once chosen, the settings are then kept fixed throughout the processing. After the review, we decided to delete this paragraph because it can lead to misunderstandings.

– Page 11 Line 5: suggest "... to reject THs <with radiances> affected by ..."

Changed to 'A cloud filter is applied during the ozone retrieval to reject THs at which a cloud is present in the field of view of the instrument'.

*Line 14: Insert "liquid" before "water"?*

Done

– Page 12 Line 5: Start of line: "Aerosol extinction..." → "An aerosol extinction..."

Changed to 'The aerosol extinction...'

*Line 6: "... has a coarser spectral resolution <than SCIAMACHY>, ..."*

Done

– Page 13 Line 1: "downwards from" → "below"

We kept 'downward from' because we reject also the TH where the cloud has been detected.

C8

Line 15: "At the moment of submission of the paper" → "At the time of writing"

Sentence deleted: the section has been updated using the V2.5 of NASA L2 data.

Line 17: "... Fig. 8, which shows relative ..."

Changed as: ' Fig. 8 shows a comparison between NASA-OMPS retrievals and our results'.

– Page 14 Line 2: "AURA" → "Aura"

Done

Line 4: "satellite suite" → "MLS instrument"

Done

Line 8: *Is there a reference or definition for "modified potential vorticity".*

I just meant potential vorticity, the term came from the ERA Interim extractor we use. 'Modified' was deleted.

Lines 11-14: *Please state what temperature/height information is used to do the*

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*density/height to pressure/vmr conversion?*

It is stated in line 13 'using MLS geopotential height': we are aware of possible trend in this variable but we think that it doesn't have impact on our analysis of few months of data. We are surely going to use ECMWF ERA Interim for the analysis of the whole time series and future merging of the data set.

– Page 15: Line 9: *"... related to impacts of polar mesospheric clouds on the signals that were not successfully screened out of the Level 1 data" or similar wording?*

Paragraph partially modified: 'Looking at panel (b) we notice that the discrepancy increases: these are months when PMCs are expected. This is an indication of a sub-optimal screening of these clouds...'

– Page 17 Line 16: "about" → "into"

Reformulated as: 'The reasons for this behavior are still under investigation.'

– Figure 1 *Wouldn't hurt to define TH, TP in the caption.*

Both acronyms were introduced in the caption.

– Figure 2 *Again, make figure more "stand alone" by defining "TP"*

The acronym was defined in the caption.

C10

– Figures 8 and on: Be clear in each what the sign of the differences shown are. (Do it in both the body text and the figure/caption to allow the figures to "stand alone")

References to Eq. 8 have been added.