



# ***Interactive comment on “Overview and update of the SPARC Data Initiative: Comparison of stratospheric composition measurements from satellite limb sounders” by Michaela I. Hegglin et al.***

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Anonymous Referee 3

This manuscript describes the results of the SPARC initiative to identify and compare nearly all existing remote sensing data of the atmosphere from limb sounders, along with updates since the initial report. This was a long and careful effort, and the results are extremely impressive. Anyone using limb sounding measurements in their work (or interested in the chemical composition of the stratosphere and mesosphere) will

benefit from this project - to identify data availability, compare different instrumental data sets, or just to understand composition and chemistry in the region from about 200 hPa to 100 km altitude.

The authors used a "top-down" approach, in which all measurements are averaged into altitude-latitude bins and compared. For a project of this scope and completeness, this is probably the only feasible way to accomplish the goals and show the results in a finite amount of space. It is also a nice complement to more traditional methods of evaluating remote sensing data by comparing coincident profiles or measurements. Only some of the highlights are included here, but all data are available on a separate website. For many readers, the multi-instrument mean (MIM) will be most useful, but there are also carefully analyzed data on differences between each data set and the MIM, as well as details about sampling, and a brief description of the general level of understanding about each constituent. With a few minor revisions, this paper will be an excellent contribution to the literature.

We thank the reviewer for her/his positive assessment of the work we conducted within the SPARC Data Initiative and her/his valuable comments on our manuscript. Please find below our answers in blue.

P.17, SAGE II improvements - I am always cautious when data sets are reanalyzed to show better agreement. It is natural for the reanalysis to more closely approach the consensus value, but that is not necessarily the "true" value. The explanation is quite reasonable though; no changes needed.

We fully agree with the reviewer's cautioning remark! To express this more neutrally, we now say 'shows large changes when compared to' instead of 'has much improved over'. We still speak of an overall improvement between data versions at the end of the paragraph.

Section 4.5 and following - Peroxyacetyl nitrate (PAN) is not mentioned in the paper, but it does contribute to NO<sub>2</sub> at the lower end of the altitude range shown (Figure 15).

From in situ data from the NASA ATom mission, the fraction of PAN to NOy can be 1/3 to 1/2 in the tropics near 200 mbar. In the stratosphere (higher latitudes at 200 mbar), PAN is usually 10% at midlatitudes, probably more likely in the summer when the tropopause is higher. This will likely only affect the very bottom of the NOy plots, but it should probably be at least mentioned briefly in the text.

We have added the following statements in the nitrogen family section:

"While HNO<sub>3</sub> and NO<sub>x</sub> constitute 80-100% of all possible species of NOy in the LS, PAN can constitute as much as 20-50% in the tropical UT and extratropical UTLS (i.e., altitudes below 200 hPa) (Kendo et al., 1997; Fadnavis et al., 2014)."

"It should also be noted that although available from both MIPAS and ACE-FTS, none of the NOy climatologies presented here includes PAN, which can be a significant contribution to NOy at the lower end of the altitude range shown as mentioned above."

P.27, l.7 Besides the non-uniformity of sampling, another factor can be the long-term trends in various gases. For example, CFC11 and 12 reached a peak and are now decreasing. But for a gas like water, the long-term trend is not so obvious (and quite important for climate forcing). The "true" (or measured) MIM could be changing over time. This is beyond the scope of this paper, but could be (briefly) mentioned as a possibility in the section on H<sub>2</sub>O. My understanding of the MIM here is that it is the average over the duration of the measurements, and does not change with time. If that is not correct, then I missed it in the text.

Thank you for this comment. A sentence on trends being a potential issue has been added in the new Section 3.2.1, which discusses the methodology. We also clarify that the MIM is the average over all the measurements and all the years/months that are presented in a specific evaluation (and not over the full timeseries available) by adding the following statement: *The MIM is thereby calculated over the same years (or months) and instruments as presented in a given evaluation (and not over the full timeseries available)*. The MIM is thus changing with each evaluation done for different

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time periods, and depending on the different sets (instruments) considered.

Some further, more specific comments:

P.1, I.8 It is difficult to separate "long-lived trace gases" and "transport tracers". There is considerable overlap. Just an observation; no changes needed in the text.

We agree that our categorisation didn't make much sense and changed them to: ... the stratospheric trace gases of primary interest, O<sub>3</sub> and H<sub>2</sub>O, major long-lived trace gases (SF<sub>6</sub>, N<sub>2</sub>O, HF, CCl<sub>3</sub>F, CCl<sub>2</sub>F<sub>2</sub>, and NO<sub>y</sub>), trace gases with intermediate lifetimes HCl, CH<sub>4</sub>, CO, HNO<sub>3</sub>), and shorter-lived trace gases...

P.2, I.2 "nitrogens"? Maybe "nitrogen-containing species"

Thank you. Changed according to the reviewer's suggestion.

I.7 add comma after "climatologies" (if "which" refers back to "approach").

Corrected.

I.12 "intended summary"

Corrected to "as an intended summary...".

P.3, I. 25, I was initially confused why TES did not appear here, but was on the list on P.2, I.6. It is explained on P.5, and is fine; no changes needed.

We now have removed most (except initial) TES-references and explain that we will not treat it in this document.

I.27 At some point NO<sub>x</sub> and NO<sub>y</sub> should probably be defined, although almost everyone knows what they are. I was curious how NO<sub>y</sub> would be handled, since it's hard to measure all components of NO<sub>y</sub> with limb sounding. Defining them later in the paper is OK; see comment above about components of NO<sub>y</sub> in the troposphere.

We have added a more succinct definition of NO<sub>y</sub> and the following statement to the first paragraph of Section 4.5, which in concert with addition above hopefully answers

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the request of the reviewer:

While HNO<sub>3</sub> and NO<sub>x</sub> constitute 80-100% of all possible species of NO<sub>y</sub> in the LS above 200 hPa, PAN can constitute as much as 20-50% in the tropical UT and (extratropical) UTLS (Kendo et al., 1997; Fadnavis et al., 2014).

I.33, "data are"

Corrected.

P.4, I.29 "its" instead of "the above" (since I don't see any disadvantages listed above)

Corrected.

P.5, I.4, "JGR - Atmospheres"

Corrected.

P.6, I.5 vs. I.17, dates include S3/ISS or not?

Dates corrected.

P.8, I.12, "98.55 S"? Maybe drop the "S"?

Corrected.

I.22, "on board Envisat"

Corrected.

P.10, I.29 perhaps something like "demonstration of ultrasensitive sub-mm limb emission observations..." And I don't think 4 K should be hyphenated.

Suggestion adopted.

P.13, I.8, not sure why "roughly-uniform" is hyphenated. Or why "generally" and "roughly" are both used together. Perhaps "is roughly uniform with respect to longitude".

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Suggestion adopted.

I.17 "can be found"

Corrected.

P.14,I.17 Where can this second summary be found? In SPARC 2017?

This paragraph has been removed to answer a similar comment from another reviewer.

P.15,I.25 "spectroscopic"

Corrected.

I.30, I don't think that MS and US have been defined.

Now corrected, but see also Table 4.

P.16,I.28, What is the "LM"? OK, it's all in Table 4 (I missed the reference to it on P.12,

We now define the abbreviations in addition at their first occurrence (except in the abstract).

I.7). But would it be worthwhile to include the stratopause in a figure somewhere too (like the top panel of Figure 4, where it won't get in the way too much)? Maybe not. It was not obvious to me whether the boundary between the US and LM is simply taken as an altitude or pressure level, or whether it has latitudinal structure (or varies with month). Not an important point, and I may have missed a description of this - fine as long as it is clear to an interested reader. (If needed, you could probably put any explanations in the Table 4 caption.)

The following sentence has been added in Table 4 caption: "The transition between the stratosphere and the mesosphere (the stratopause) is here defined uniformly across all latitudes as the 1 hPa pressure level."

I.33, "carbon dioxide and other anthropogenically emitted greenhouse gases" or something like that. And maybe combine the next two sentences as "H<sub>2</sub>O is also a key

constituent in atmospheric chemistry as a source gas of the hydroxyl radical..."

This sentence now reads: "...a positive feedback to climate change driven by anthropogenic emissions of carbon dioxide and other greenhouse gases." We have also adopted the reviewer's second suggestion.

P.18, I.15 Does USLM mean "upper stratosphere and lower mesosphere"?

Yes, the explanation of such composites is described in Table 8

P.19, I.27 Need to edit this sentence - something like "a somewhat patchier difference field, however, it provides supporting evidence..." or "a somewhat patchier difference field, however, which provides supporting evidence..." or "a somewhat patchier difference field, however, providing supporting evidence..." I'm not sure I follow the logic in this sentence.

We have rewritten this indeed rather complicated sentence to: "MIPAS(2), despite exhibiting a somewhat patchier difference field, provides supporting evidence for a high bias in MIPAS(1) at this pressure level." and hope this clarifies the content.

I.33 I assume that "overlap year" describes when all three instruments were reporting data. Also, "confirms the results described here"

We have rewritten this sentence to: "It is important to note that CH4 showed only small trends in the troposphere over the time period 1998-2008, thus a trend in this trace gas is not expected to contribute significantly to the inter-instrument differences. An evaluation limited to the year 2005 (during which all instruments were reporting data) mostly confirms the results described here (not shown)."

P.20, I.1 I would not hyphenate "mean state".

Corrected.

P.21, I.16 "for which they provided data."

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Corrected.

I.18 OK, here are the definitions of NOy and NOx (fine with me). In the midtroposphere, peroxyacetyl nitrate (PAN) is one of the major components of NOy. This is mostly below the altitudes shown here, but see comment above.

See answer above, we have now added a more detailed definition and highlighted that the instruments don't measure all of the species contributing to NOy.

I.25 "mechanisms"

Corrected.

I.29 "conversion" instead of "exchange"?

Corrected.

I.32 "is taken into account"

Corrected.

P.22, I.25, "latitude bands"?

Corrected.

P.23, I.8, "consistent with" rather than "confirming"?

Corrected.

P.58 I did not notice the reference to table 3 while reading the text. That is a fine way to make all the descriptions quantitative.

Yes, chapter 3 includes a reference to table 3.

Table A2, perhaps "added recently" or at least "newly added"

Corrected, thank you.

Figure 8 - missing units on the color bars. I am guessing they should be ppm and

percent, but the lower one could be ppb. Also, some of the subscript "4" look a little too small and too close to the "CH" (like for HALOE).

Corrected, thanks.

Figure 10 - x-axis labels are a little confusing. Is there room to write "Jan 2006" etc.? If not, then having the year under the month should work. Similar comment for Figure 12.

Changed to year numbers only.

Figure A1 - About the units on the color bars: In the middle figures, do the grid boxes represent the number of samples per year, and in the lower figures, the boxes represent the number of samples per month in each latitude bin for each month? I suppose so, but maybe that can be included in the figure (like in the color bar) or in the caption.

Included according to the reviewer's suggestion.

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