

## ***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.***

**Anonymous Referee #3**

Received and published: 19 January 2021

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

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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.

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.

Section 4.5 and following - Peroxyacetyl nitrate (PAN) is not mentioned in the paper, but it does contribute to NO<sub>y</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 NO<sub>y</sub> 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% or less. But it can still be a measurable fraction of NO<sub>y</sub> in the midlatitudes, probably more likely in the summer when the tropopause is higher. This will likely only affect the very bottom of the NO<sub>y</sub> plots, but it should probably be at least mentioned briefly in the text.

P.27, I.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

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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.

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.

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

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

I.12 "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.

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.

I.33, "data are"

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

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

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

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

I.22, "on board Envisat"

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.

P.13, I.8, not sure why "roughly-uniform" is hyphenated. Or why "generally" and

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"roughly" are both used together. Perhaps "is roughly uniform with respect to longitude".

I.17 "can be found"

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

P.15, I.25 "spectroscopic"

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

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

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..."

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

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.

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

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

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

l.18 OK, here are the definitions of NO<sub>y</sub> and NO<sub>x</sub> (fine with me). In the mid-troposphere, peroxyacetyl nitrate (PAN) is one of the major components of NO<sub>y</sub>. This is mostly below the altitudes shown here, but see comment above.

l.25 "mechanisms"

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

l.32 "is taken into account"

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

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

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.

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

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).

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.

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.

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Interactive comment on Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2020-342>, 2020.

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