Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
https://doi.org/10.5194/amt-2021-340-RC2, 2021

Comment on amt-2021-340

Anonymous Referee #2

Referee comment on "Variations of Arctic winter ozone from the LIMS Level 3 dataset" by Ellis Remsberg et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-340-RC2, 2021

Report for manuscript AMT-2021-340 on "Variations of Arctic winter ozone from the LIMS Level 3 dataset" by Remsberg et al.

General comments:

I understand that the major focus of the paper is to demonstrate "the value and use" of the LIMS V6 Level 3 data of the arctic winter 1978-1979. In doing so the authors try to show that some O3 phenomena and characteristics, found in posterior analysis of more recent (and some more complete) datasets, are also present in the LIMS V6 L3 dataset (a clear example of this is Sec. 5).

From the point of view of science, I see no aspect which is really new. On the other hand, to show that some O3 features are also present in LIMS data is useful, as this is an independent dataset. Hence, although I cannot see any major scientific contribution I cannot see any either strong reason for not publishing it -the manuscript is very well written-. It is a shame that some of these phenomena have not been published before using LIMS data.

One possibility to enhance the manuscript value would be to compare more quantitatively the variations/characteristics found in LIMS with previous studies. This will be more useful for readers, instead of just showing "... some LIMS examples of the larger-scale variations of Arctic ozone, temperature, and GPH".

On another note, I am not fully convinced that this paper falls completely in the AMT scope. The main aim of the manuscript is not to present the LIMS L3 dataset, which it seems has been published before (Remsberg et al., AMT, 2021; Remsberg et al., 2011;

Remsberg and Lingenfelser, 2010), but some O3 phenomenology.

Minor/moderate comments:

P2, L27-28, I do not understand this sentence. V6 are satellite measurements. Hence, I do not understand why "V6 satellite data" "are important for interpreting satellite limb infrared measurements versus local measurements." Maybe the authors want to say that LIMS V6 are important for interpreting other (non-satellite) "local" measurements?

P2, L41, For many readers the middle atmosphere includes the mesosphere. This sentence should be re-written. Something like: "Ozone is an excellent tracer of the stratosphere (or lower stratosphere)".

P3, L52, I suggest adding also the SABER observations (Smith et al. GRL, 2009).

P5, L115-116, LIMS V6 free of non-LTE below ~0.05 hPa. This is true for most conditions except in the polar winter regions, (or during strat-warm) where it is expected to be significant (see, Fig. 22d in Funke et al., 2012).

P6, L141-142, see comment above. The data might be affected by NLTE even at night.

P6, L147-148, "A tertiary ozone maximum is present in the upper mesosphere near the day/night terminator zones of the LIMS measurements for January (~50°S …". This seems very interesting. However, such a tertiary maximum is not present in MIPAS measurements in January in the Southern hemisphere (e.g. ~50ºS) (see Fig. 12 in Lopez-Puertas et al., 2018). It is not present either in the Southern hemisphere winter, e.g. July near 50ºN. Also, I have not seen this kind of enhancement in otehr O3 datasets. Those conditions are polar summer. Should we expect a tertiary maximum in summer conditions? Could the authors check this behaviour. If it is found to be real it would be very useful to comment in the manuscript about the reasons for the maximum in those regions.

P6, L150, "The location (~0.02 hPa) and magnitude (~3.5 ppmv) of the NH maximum agree with those reported from subsequent satellite studies by Smith et al." I would probably say slightly larger: MIPAS values are always below ~2.5 ppmv (Smith et al., 2018, Fig. 4 and Lopez-Puertas et al., 2018, Fig. 12).

P6, L154, "Thus, the decrease of mesospheric V6 ozone at 0.1 hPa and poleward of 60°S

in Fig. 1 indicates merely a change from night to day values''. That is correct. The diurnal variation of O3 is clearly seen, for example, in Figs. 11, 12 and 13 of Lopez-Puertas et al., 2018.

P8, L199-200. Could the authors comment on the differences in local time between the rocket O3 measurements and the satellite measurements? They could lead to significant differences in O3 (see, e.g. Studer et al., 2014, Figs. 4a).

P8, L205. Which is the meaning of the asterisk?

P8. L211-212. I do not understand this point. Temperature differences between datasonde and V6 at ~0.5-1 hPa are significant, close to 10K, but O3 compares well. How can this be explained?

P9, L232-233. I do not fully understand the aim of this sentence. Is it that "V6 ozone has very little bias due to temperature" (the temperature measured by LIMS I guess)? I believe this has been verified before, in validation studies. Otherwise, I think the authors should not reach this important conclusion from just comparing a few profiles which, btw, differ by more than 5 K.

P10, L263-264. Are the authors suggesting that LIMS data would be useful to study LOPs in the mesosphere? I think it is not the case. O3 should not be considered a good tracer in the mesosphere.

P11, L287-288. It seems to me rather descriptive and a bit speculative. To confirm this would require a quantitative analysis. Further, this contrasts with the idea mentioned above that O3 can be considered as a good tracer in the mid-stratospheric arctic region.

P12, L312. It would be useful to draw the terminator in the upper panels of Fig. 11.

P12, L312-313. Can the behaviour shown, derived from two single days in different months, be considered as representative of the tendency along the winter? E.g. an increase of the O3 tertiary maximum as the winter progresses? MIPAS O3 shows no clear tendency and it varies from year to year (see Fig. 15, bottom/right panel of Lopez-Puertas et al., 2018). Also, the data reported by Smith et al. (2018) shows that the O3 tertiary maximum decreases in Feb (see their Fig. 3, right panels).

P12, L329-330. About the sentence "Although the seasonal evolution of the tertiary ozone

maximum is understood reasonably well (Smith et al., 2018), there is more information about this ozone feature from the daily maps of ozone, T(p), and GPH from Level 3.", Could the authors clarify which "more information" is in LIMS data which is not available from later sensors (e.g. SABER, MIPAS, GOMOS, ACE, etc.) that also measures O3 globally, over longer time scales, with more extended altitude ranges and with better sensitivity (see, e.g., Smith et al. 2013). Many of those instruments also measured daily maps. I understand "more information" in the sense that it provides very important measurements taken more than two decades before, in the winter of 1978-1979, but not in the other respects.

Some suggestions for the figures and figures captions:

Fig. 1. What are the conditions for lat. >55ºS? Only daytime?

Fig. 3. Zonal "mean"? Maybe the caption could be made more explicitly, as in the text.

Fig. 4. I suggest specifying the illuminations conditions (day? night? local solar time of the CHEM sonde?). Also, please add the text included in the caption of Fig. 5 ("where the short-dashed curve is for 29.2° and the long-dashed curve is for 37.2°").

Fig. 5. Why use a different pressure level for the temperature map than for O3 in Fig. 4?

Fig. 6. Please add the sentence about the altitudes as in Fig. 4: ("Latitudes (dotted circles) are spaced every 10°.").

Fig. 7, top panel. Improve contrast, make axis lines and marks thicker.

Fig. 12. Is O3 for daytime? nighttime? both?

References

- Funke, B., López-Puertas, M., Garcia-Comas, M., Kaufmann, M., Höpfner, M., and Stiller, G. P.: GRANADA: a generic RAdiative traNsfer AnD non-LTE population algorithm, J. Quant. Spectros. Radiat. Transfer, 113, 1771–1817, https://doi.org/doi: 10.1016/j.jqsrt.2012.05.001, 2012.

- López-Puertas, M., García-Comas, M., Funke, B., Gardini, A., Stiller, G. P., Clarmann, T. von, Glatthor, N., Laeng, A., Kaufmann, M., Sofieva, V. F., Froidevaux, L., Walker, K. A., and Shiotani, M.: MIPAS observations of ozone in the middle atmosphere, Atmos. Meas. Tech., 11, 2187–2212, https://doi.org/10.5194/amt-11-2187-2018, 2018.
- Smith, A. K., López-Puertas, M., García-Comas, M., and Tukiainen, S.: SABER observations of mesospheric ozone during NH late winter 2002–2009, 36, L23804, https://doi.org/10.1029/2009GL040942, 2009.
- Smith, A. K., Harvey, V. L., Mlynczak, M. G., Funke, B., Garcia-Comas, M., Hervig, M., Kaufmann, M., Kyrölä, E., López-Puertas, M., McDade, I., Randall, C. E., Russell III, J. M., Sheese, P. E., Shiotani, M., Skinner, W. R., Suzuki, M., and Walker, K. A.: Satellite observations of ozone in the upper mesosphere, Journal of Geophysical Research, 118, 5803–5821, https://doi.org/10.1002/jgrd.50445, 2013.
- Studer, S., Hocke, K., Schanz, A., Schmidt, H., and Kämpfer, N.: A climatology of the diurnal variations in stratospheric and mesospheric ozone over Bern, Switzerland, Atmos. Chem. Phys., 14, 5905–5919, https://doi.org/10.5194/acp-14-5905-2014, 2014.