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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Nitric acid in the stratosphere based on Odin observations from 2001 to 2007 – Part 1: A global climatology" *by* J. Urban et al.

J. Urban et al.

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Reply to anonymous referee 3

The authors show an interesting results of the spatial and seasonal variation of stratospheric HNO3 from Odin/SMR observations from 2001 to 2007 as well as comparing with UARS/MLS HNO3 climatology. These observations should be very useful to evaluate the atmospheric chemistry models (ie. CCMs and CTMs) later on. The objective of the paper is quite clear. In general, I find that this is an interesting study, and the issue has a wider interest to the scientific community for the validation of the measurements and the models. My major concern is that the authors did not emphasis the importance of this study to improve

our scientific understanding about HNO3 related processes and also usefulness of the Odin/SMR stratospheric HNO3 climatology compare to UARS/MLS. The manuscript should be published in ACP after revision.

1) It should be better to emphasis and focus on the motivation in the last paragraph after line 25 in Page 9571.

A short paragraph was added to the introduction providing clear objectives for creating a nitric acid climatology.

2) The authors need to discuss more about HNO3 retrieval for Odin/SMR in Section 2.1.

The description of the HNO3 measurements goes already over roughly 20 lines, and references to publications describing Odin level-2 processing and data quality (in even more detail) are given.

3) Is there any improvement for the HNO3 retrieval in Chalmers version 2.0? What has changed compared with previous version(s)? It is worth to mention what major progress in the version 2.0 retrieval.

This is described in detail in the references [Urban et al. 2007b] and [Urban et al., 2005c]. We consider v2.0 as the first stable Odin level-2 version for nitric acid and avoid therefore comparisons with older (not recommended, not validated) data.

4) In Fig.1, Can you explain why the observed HNO3 at 520K is so low in late Winter/ early spring for the Antarctic winters 2006 and 2007 but relative high in 2002 and 2004?

Done. See manuscript, discussion of inter-annual variability in section-3.

What caused the low HNO3 values in the middle stratosphere (ie.1200K) in Antarctic winter 2006 compared to other Antarctic winters?

The formation of HNO3 in the middle stratosphere depends on a complex interplay of

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several factors such as formation of NOx in the mesosphere, thermosphere or direct production in the stratosphere (both depending on solar activity), on atmospheric dynamics (here: downward transport), as well as on background load of aerosols and water ion clusters (required for the heterogeneous conversion of N2O5 into HNO3). There was no particular solar activity in 2006, in contrast for example to 2003 when a very strong HNO3 signal was observed. We added some information in Section 3.4. Since further discussion goes beyond the scope of this climatology paper, we decided to put a more detailed discussion in a separate paper (see Part-II).

5) The definition of HNO3 anomaly calculation in Fig.2 and 3 is unclear. The authors mentioned that it is "the differences from the average profile", but I am not sure how to get "average profile". Does "average" here mean that you get daily HNO3 means over the available period from 2001-2007 or calculate it in another way?

An average profile is simply obtained by averaging all individual profiles (each level separately). Explanation added.

6) Is it necessary to use the new term "reversed tape-recorder effect"? It maybe make readers confused. Actually it is the descent effect.

Well - it is not only a descent effect, but the modulation (by seasonally varying transport) of a (seasonally varying) source of HNO3. Due to the similarity in the transport pattern, the analogy with the better known water tape-recorder effect ("just an ascent effect"?) is used to better illustrate the issue.

7) Can you explain why tropical HNO3 from Odin is 1-2ppbv higher than UARS/MLS?

We can only speculate that this is the combined effect arising from systematic biases in the UARS/MLS (estimated accuracy: 2-3ppbv) and Odin/SMR (estimated accuracy: 0.7ppbv) measurements, but we cannot give any more detailed explanation.

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8) It would be better to add some implication of using Odin/SMR climatology in the section "summary and conclusion" rather than just summary the results.

The conclusion section has been expanded.

Minor comment:

1) Abstract: Page 9570, line 15-19 is very long and confusing, need to reword it.

Sounds good for me, no good idea how to write this better. Small corrections made (commas), in order to improve readability.

2) Page 9570 Line 6: Change (1.5-60hPa) to (75-1.5hPa)

Changed to 19-45km (1.5-60hPa), for consistency. Depends however very much on season, geographical location, and definition of lower limit for measurements and can thus be only approximative. Statement 18-45km (1.5-60hPa) is still true within the Antarctic vortex ...

3) Page 9570 Line 53: add "+2Cl2O2" ClOx=Cl+ClO+2Cl2O2

Done.

4) Page 9571 Line 23-25. What is the precision of HNO3 above 30Km.

Done (<=1ppbv). Was already mentioned, slightly reworded for clarity.

5) Consistent expression, Sometimes it shows Odin, while it shows Odin/SMR. Similarly, the authors say "UARS climatology" but then say "MLS climatology". I think that term should be consistent in the whole paper.

We changed this into Odin/SMR and UARS/MLS, although it should have been clear from the context anyway (Odin HNO3 climatology = Odin/SMR HNO3 climatology, both is correct).

6)Page 9572: Figure 1: Colour bar should be from 0 to 3ppbv at 1200K.

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-1 to 3 ppbv is correct (the systematical error was estimated to be roughly 0.7ppbv, so one has to live with slightly negative values).

7) Page 9572, line 18-19, what is "similar magnitude"?

I think this is correct (about 300km).

8) Page 9575 Line 23: Change "profile" to "profiles"

Done.

9) P5576 Line 25. It need to change "excellent" to "better". In the SH, there is still 3ppbv difference from September to November at 40S-60S.

Replaced "excellent" with "very good" (everything is relative... in particular adjectives). It has additionally been clarified that the two data sets agree within their observed inter-annual variability.

10) Page 9577, Line 7-10, need to rewrite the sentences about "slightly large minumum values" and "systematically slightly lower by....".

Corrected and reworded.

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