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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Odin stratospheric proxy NO_y measurements and climatology" *by* S. Brohede et al.

Anonymous Referee #1

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1 General comments:

The paper combines ODIN/SMR HNO_3 with ODIN/OSIRIS NO_2 observations and describes the construction of proxy NO_y measurements with the help of a photochemical box model. The NO_y climatology is compared to other data sets and model simulations, and the time series is shortly discussed. While I believe that this approach can result in a very valuable data set to be used for model validation, trend assessments, and many more scientific applications, I find a number of flaws in the method and/or the presentation which leave me not totally convinced about the resulting data set. At least a more thorough discussion at several points of the paper is required: 1) What role plays the adjustment of SMR HNO_3 to ACE-FTS HNO_3 observations, given the

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a posteriori validation of the ODIN proxy NO_y with ACE-FTS measurements? 2) The authors claim that the NO_y partitioning is rather independent of the absolute total NO_y, and this an important baseline (maybe the most important) of their analysis, but I am not convinced that the full atmospheric variablity (in altitude, season and latitude) really has been covered when elaborating towards this statement. 3) The treatment of heterogeneous chemistry in the photochemical box model is not clear; this has implications for the interpretation of observations under PSC occurrence. 4) The paper is hard to read and at several places (as detailed in the specific comments below) specific information should be provided earlier for better understanding. 5) Finally, I would appreciate if the restriction to daytime (or, at least, the exclusion of polar night) conditions could be considered in the title of the paper, since, as stated at many places throughout the paper, the proxy NO_y is not provided for polar night conditions. I recommend publication after these and the following specific comments have been considered.

2 Specific comments:

p5849,l8: More recently, Funke et al. (2005) have found that the mesospheric source of NO_x transported into the stratosphere during Antarctic polar winter may represent up to 9% of total stratospheric NO_y in the Southern hemisphere.
Further, Funke et al. (2008) have found that up to 6 ppbv mesospheric N_2O can be produced by the reaction $NO_2 + N(^4S) \rightarrow N_2O + O$ which is subsequently transported into the stratosphere. This amount will be missing in the NO_y budget; does the photochemical box model include this reaction?
p5851, l11: Orsolini et al. (2005) and Stiller et al. (2005) found HNO_3 volume mixing ratios of up to 14 ppbv in the upper stratosphere, during episodes of strong downward transport in the polar vortex.
p5851, l21: Other and possibly better suited references for MIPAS NO_y measure-

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ments would be: Mengistu Tsidu et al., 2004; Mengistu Tsidu et al., 2005; Wang et al., 2007a,b; Fischer et al., 2008.
Further, the MIPAS instrument is still operational (after a disruption from March 2004 to January 2005). However, it has to be admitted that data provision is delayed, and only very few level-2 data (trace gas distributions) have been made operationally available by ESA for the period after January 2005. Full data provision for this period is announced for this summer (2008) by ESA.
p5854, l3-7: Please quantify "good agreement with various solar occultation instruments". What does it mean that "OSIRIS climatological NO_2 is found to be consistent with the Chemical Transport Model (CTM) simulations except in the polar vortex region ..."? Should we trust in the measurements or the model? Could you give a reference for the model? Is it validated?
p5855, l2: What is the conclusion on the ACE-FTS NO_y validation regarding accuracy and precision?
p5855, l9ff: Does the photochemical box model include heterogeneous chemistry on PSC particles? If so, this must be stated here. Discussion on p5867, l11-21 is dependent on this information.
p5855, l20: You use monthly global means of NO_y from elsewhere for the photochemical model; does this mean that the NO_y partitioning is independent of total available NO_y? The discussion of this point comes too late (in section 3.1).
p5857, l17-19: This is a central part for understanding of the method, and discussion is much too short. Please elaborate further and extend description of Fig.4: What does a "+0.4 and a -0.4 perturbation" mean, variation of NO_y between 60% and 140% of the reference value? If this interpretation is correct, is this variation sufficient to cover all situations in the stratosphere? I don't believe so. For which altitude are the curves given? Is a change of 0.08 to 0.04 (i.e. a factor of 2) as in case of $ClONO_2$ really negligible? I don't understand at all the lower panel of the figure.
p5858, l11-16: I understand that SMR HNO_3 is adjusted to ACE-FTS HNO_3, and HNO_3 makes up about 80% of NO_y in the lower stratosphere (around 20 km, see Fig.1); un-

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der these conditions, is it surprising that the ODIN proxy NO_y and ACE-FTS NO_y agree within 20% (see Fig. 6)? Secondly, why has an altitude shift of 1 km applied if the shift identified in the Wang et al. (2007) paper is 1.5 km (1-2 km as stated on p5853,l18)?

p5859, section 3.1.1: Why does N_2O_5 and $ClONO_2$ always scale with HNO_3 (in case of SMR) and NO_2 (in case of OSIRIS)? Compare comment on p5857, l17-19 regarding this point, in particular the comment on $ClONO_2$. Please discuss critically possible conversion reactions.

p5863, l15-17: How meaningful is the comparison to ACE-FTS given the fact that HNO_3 from SMR has been adjusted to ACE-FTS observations, and HNO_3 can make up to 80% of the NO_y budget? Please discuss this point in more detail.

p5865, l19 - p5866, l7: This discussion comes far too late and should be moved into section 3.1. Regarding Appendix A, I would like to see a much more detailed discussion of the deviations between model and MkIV data regarding $ClONO_2$, N_2O_5, and HNO_3 (e.g. julian day 75, year 2000; julian day 337, year 1999; julian day 350, year 2002).

p5867, l11-21: How reliable are the NO_y proxys for situations including heterogeneous chemistry, i.e. is the NO_y partitioning given correctly? This depends on the inclusion of heterogeneous chemistry into the photochemical box model used for constructing the proxy NO_y. Please provide the respective information.

p5868, l1-3: I would expect much higher inter-annual variation of denitrification in the Northern winter polar vortex, given the high variability of the Northern polar vortex. Please comment why you expect/see higher inter-annual variation in the Southern Hemisphere.

p5871, l14-16: I believe there is still some discussion going on where and when the enhanced NO_x vmrs were produced before being transported downwards; compare for example Seppälä et al., 2007.

p5851, l 22-25: The remark on the QBO signal seems highly speculative to me; it needs more elaboration if it is to be retained in the paper.

p5873, l15: As shown by Funke et al. (2005) descent of air from the mesosphere leads

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to higher amounts of NO_x (and, thus, NO_y) in the polar stratosphere, not lower ones. NO_y is removed from the stratosphere by sedimentation of PSC particles.
p5873, l19: Compare comment to p5871, l14-16.

3 Technical corrections:

p 5855, l4: Reference "Qin, 2007" (remove "January").
Fig. 13 The labelling in the Figure and the figure caption are inconsistent.
p5874, l4: I believe there is a typo in the web address.

4 References

Fischer, H., Birk, M., Blom, C., Carli, B., Carlotti, M., von Clarmann, T., Delbouille, L., Dudhia, A., Ehhalt, D., Endemann, M., Flaud, J. M., Gessner, R., Kleinert, A., Koopman, R., Langen, J., López-Puertas, M., Mosner, P., Nett, H., Oelhaf, H., Perron, G., Remedios, J., Ridolfi, M., Stiller, G., and Zander, R.: MIPAS: an instrument for atmospheric and climate research, Atmos. Chem. Phys., 8, 2151-2188, 2008.

Funke, B., M. López-Puertas, S. Gil-López, T. von Clarmann, G. P. Stiller, H. Fischer, and S. Kellmann (2005), Downward transport of upper atmospheric NO_x into the polar stratosphere and lower mesosphere during the Antarctic 2003 and Arctic 2002/2003 winters, J. Geophys. Res., 110, D24308, doi:10.1029/2005JD006463.

Funke, B., García-Comas, M., López-Puertas, M., Glatthor, N., Stiller, G. P., von Clarmann, T., Semeniuk, K., and McConnell, J. C.: Enhancement of N_2O during

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8, S2661–S2667, 2008

the October-November 2003 solar proton events, Atmos. Chem. Phys. Discuss., 8, 4669-4691, 2008.

Mengistu Tsidu, G., et al. (2004), Stratospheric N_2O_5 in the austral spring 2002 as retrieved from limb emission spectra recorded by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), J. Geophys. Res., 109, D18301, doi:10.1029/2004JD004856.

Mengistu Tsidu, G., et al. (2005), NO_y from Michelson Interferometer for Passive Atmospheric Sounding on Environmental Satellite during the Southern Hemisphere polar vortex split in September/October 2002, J. Geophys. Res., 110, D11301, doi:10.1029/2004JD005322.

Orsolini Y. J., G. L. Manney, M. L. Santee, C. E. Randall (2005), An upper stratospheric layer of enhanced HNO_3 following exceptional solar storms, Geophys. Res. Lett., 32, L12S01, doi:10.1029/2004GL021588.

Seppälä A., P. T. Verronen, M. A. Clilverd, C. E. Randall, J. Tamminen, V. Sofieva, L. Backman, E. Kyrölä (2007), Arctic and Antarctic polar winter NO_x and energetic particle precipitation in 2002-2006, Geophys. Res. Lett., 34, L12810, doi:10.1029/2007GL029733.

Stiller, G. P., et al. (2005), An enhanced HNO3 second maximum in the Antarctic midwinter upper stratosphere 2003, J. Geophys. Res., 110, D20303, doi:10.1029/2005JD006011.

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Wang, D. Y., Höpfner, M., Blom, C. E., Ward, W. E., Fischer, H., Blumenstock, T., Hase, F., Keim, C., Liu, G. Y., Mikuteit, S., Oelhaf, H., Wetzel, G., Cortesi, U., Mencaraglia, F., Bianchini, G., Redaelli, G., Pirre, M., Catoire, V., Huret, N., Vigouroux, C., De Mazière, M., Mahieu, E., Demoulin, P., Wood, S., Smale, D., Jones, N., Nakajima, H., Sugita, T., Urban, J., Murtagh, D., Boone, C. D., Bernath, P. F., Walker, K. A., Kuttippurath, J., Kleinböhl, A., Toon, G., and Piccolo, C.: Validation of MIPAS HNO_3 operational data, Atmos. Chem. Phys., 7, 4905-4934, 2007a.

Wang, D. Y., Höpfner, M., Mengistu Tsidu, G., Stiller, G. P., von Clarmann, T., Fischer, H., Blumenstock, T., Glatthor, N., Grabowski, U., Hase, F., Kellmann, S., Linden, A., Milz, M., Oelhaf, H., Schneider, M., Steck, T., Wetzel, G., López-Puertas, M., Funke, B., Koukouli, M. E., Nakajima, H., Sugita, T., Irie, H., Urban, J., Murtagh, D., Santee, M. L., Toon, G., Gunson, M. R., Irion, F. W., Boone, C. D., Walker, K., and Bernath, P. F.: Validation of nitric acid retrieved by the IMK-IAA processor from MIPAS/ENVISAT measurements, Atmos. Chem. Phys., 7, 721-738, 2007b.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 5847, 2008.