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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.

S. Brohede et al.

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1 General comments

- *Unfortunately it is not possible to find it on the given website.*

  The Odin NO_y climatology is now on the Saskatoon website.

2 Specific comments

- *In the abstract the remark on the flaws in the Antarctic vortex of CMAM is not necessary. Like it is written now it is misleading.*

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We agree to remove the statement "A particularly large disagreement within the Antarctic vortex in the upper stratosphere during spring indicates too strong descent of air in CMAM" from the abstract.

- Page 5851, line 18: It might be added: ", however, perturbed by a major volcanic eruption".

Good comment. We have added a subordinate clause on the Mt Pinatubo major volcanic eruption here.

- *Page 5855, section 2.3: Add at the beginning: "If NOy should be derived from Odin data only,". Does the box model consider heterogeneous reactions on PSCs and aerosol? A short remark on this would be useful. The introduction of 'pressure altitude' in UARS-style is confusing here. I suppose, the satellite data are given on altitude. This is also in contradiction to the text on page 5865 where ECMWF temperature data are used for conversion. Please clarify, messing the different definitions of pressure up can introduce large errors.*

The box model prescribes only background heterogeneous chemistry on aerosols but no PSCs, so under perturbed conditions in the vortex the box model partitioning may have larger errors. A sentence has been added in section 2.3 to point this out more clearly.

The PRATMO standard grid is on pressure-altitude levels, but pressure-altitude is never used as altitude. Each PRATMO pressure-altitude has an altitude associated with it and so this is used in any interpolation. We've simplified the text to say that PRATMO uses 25 pressure altitudes between 10 and 58 km and explained that values on true altitudes are obtained by interpolation.

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- *Page 5856, line 25f: In a CCM the expression "well-mixed greenhouse gases", a slang word of tropospheric climate modelers, is not useful. Future scenarios are not of interest here but 'REF2' was used because for the period to 2005 no 'REF1' data were available. The text might be modified here.*

  We have changed the text to specify the forcing terms (well-mixed GHGs). However, since the NOy dataset used here (from 1996-2005) covers both the past period (when observations were used to derive the surface forcings) and the future period (when a scenario was used for to derive the surface forcings) we feel it is relevant to mention that a scenario is used for the future.

- *Page 5858, line 2: The lifetime of NO_2 against photolysis is in the order of 100 s. Figure 3 gives the impression that O_3 needed in Eqn. R10 is taken from OSIRIS, it would be useful to repeat this after Eqn. R10. Also it should be repeated that total chlorine in the model is constrained by tracer correlations to N_2O (from SMR?).*

  The lifetime of NO_2 in the upper stratosphere (50 km) it is around 10 s, but increases to around 100 s at 30 km according to Brasseur and Solomon (1986). It may be more appropriate to give the lower photolysis rate (100 s) to prove our point, as suggested by the reviewer. The text has been changed accordingly.

  As the reviewer points out, O_3 comes from OSIRIS, and we've repeated this message after Eqn. R10 for clarification. However, we don't think it's necessary to repeat that the total chlorine is constrained by tracer correlation correlations with N_2O, which is clearly stated in section 2.3. Note that the N_2O comes from another 3D model (not SMR). The next version of the box model calculations will use the SMR N_2O to define total chlorine and bromine.

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- *Page 5864, line 12f: What means F-M northern latitudes? The region 30N to 90N? Please clarify. I suppose differences in that region are again related to PSCs and/or NOx from the upper atmosphere.*

  We assume the reviewer refers to page 5863, not 5864. F-M means February and March, which is clearly stated on page 5862 line 18. On the same page, northern latitudes is defined as 30N to 90N. These denotations are consistent throughout the text and simplifies the discussion and results section and Figure 7.

  It's hard to disentangle what the is the main cause of the larger differences in this region since it's likely a combination of increased measurement errors (both Odin and ACE), heterogeneous model (merging) errors and increased natural variability. We think the difference is only partly due to the lack of PSC in PRATMO or possibly NOx from the upper atmosphere. PSCs are however more common in the southern hemisphere (in S-O) where the systematic difference is lesser.

- *Page 5864, line 20: Is pressure taken from this estimate or calculated as described on the next page?*

  The pressures come from ECMWF but are then interpolated to a common pressure grid according to the equation on line 20. The idea is to create a pressure grid that is roughly equidistant in altitude. Since this is not totally clear, we've added a sentence saying "In the next step, converted data are interpolated onto the fixed vertical grids as specified above" in this section.

- *Page 5868, line 18 to page 5869, line 7: The neglect of sedimentation of PSC particles (and NOy in the form of NAT) is not state of the art (see page 5556, line 15ff) and is the main reason for the differences of CMAM to the satellite data in Figure 11. This was visible and stated in the draft version, now the interpretation*

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is rather fuzzy. The text should be shortened here using a clear statement. Then it is OK to grey out the region where the model is far off.

The reviewer's conclusion that the neglect of NAT and sedimentation in the CMAM simulation "is the main reason for the differences of CMAM to the satellite data in Figure 11" (presumably the reviewer is referring to the southern hemisphere polar lower stratosphere region, which is greyed-out) is incorrect. Our statement in the draft version of the paper (in which data was not greyed-out) was a misinterpretation of the model data. After the submission of the draft version of the paper a numerical problem in the model was discovered, which unfortunately has led to unphysical (overestimated) NOy mixing ratios in the southern hemisphere polar lower stratosphere region in the simulations used for this study.

Without going into too much into detail here, we can say that the numerical problem is related to the spectral transport routine, which results in nitrogen being non-conserved in the vicinity of PSCs under certain conditions. Thus the model NOy bias in the affected region is primarily numerical and not due to lack of representation of processes.

To be clear, the NOy overestimation presented in the draft version of the paper was not caused by the lack of NAT and PSC sedimentation. The paper is currently quite clear on the reason for greyed-out region of the model data (see page 5856, lines 18-23; page 5868, lines 19-22; page 5872, lines 5-9; and caption of Fig. 11). The description is certainly not "fuzzy" as suggested by the reviewer.

Regarding this point it could be added that work is under way to try to diagnose,

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understand, and correct the numerical problem causing the unphysical NOy values, but unfortunately, a solution is not yet available.

- *Page 5869, line 8ff: Showing results on equivalent latitude might reduce differences in Arctic winter considerably. Did you look on that?*

  Good point. The Odin NOy climatology based on EqLs show significant differences to the Odin NOy climatology based on pure latitudes at the edge of the Arctic vortex but very small differences at the northern most latitudes where the difference to CMAM are largest. This indicates that the CMAM differences won't go away when switching to EqLs in figure 11. Unfortunately, the CMAM data provided for this study, do not contain the PV information nedded to calculate the EqLs, so figure 11 cannot be reproduced in this way. This has been added to the Discussion.

  One thing to mention here is that the Odin data for northern latitudes in January all emanate from a specific year (2003) where Odin was scheduled for off axis pointing (into sunlight). In normal pointing mode (along track) these regions will be in darkness during January and hence not covered by OSIRIS. The special measurement conditions (extreme measurement angles) may introduce additional retrieval errors, but the main reason is likely the limited measurement days. Two sentences have been added to address this.

- *Page 5871, line 9f: Is there something missing, I don't understand the meaning of this sentence.*

  See answer to the previous comment. The meaning is that these region should be treated with caution since the measurements emanate from only one year as

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compared to several years for other regions. We've added a sentence to make this a bit clearer.

- *Page 5871, line 14f: There are publications based on MIPAS data showing an enhancement of HNO_3.*

  We've added two relevant MIPAS reference in this section. One by Funke et al (2005) on NO_x and the other by Stiller et al on HNO_3.

- *Page 5872, line 6: Address neglect of sedimentation of solid particles, modify also at the end of the section.*

  It is unclear to us what the reviewer means by "Address neglect...". As was mentioned above, work is under way to fix the numerical problem in the model affecting NOy. Towards the end of the section we have reworded the sentence "Future work will... common feature of atmospheric models" to clarify the point we are trying to make:

  "Future work will include comparisons with several CCMs and CTMs (Chemical Transport Models) to study whether the CMAM BIASES ARE OCCURRING ALSO IN OTHER atmospheric models".

- *Page 5885: Which mean? At the fixed local times of observations? Page 5886: A typical line or range in the lower right panel would be a helpful addition to the numbers in the caption.*

  Yes, the values are given at the local times of the observation. Since AM and PM averages are not significantly different, we've chosen to average all local times of the measurements. We've added "...and local times" in the caption. Typical

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values for the HNO_3 vertical resolution from (Urban et al,2007) are now added in the lower right panel as suggested.

- *Page 5890: Caption appears to be inconsistent with text. Is the upper row with or without F-M-30N-90N? Please define more clearly.*

  The upper panel does NOT include F-M-30N-90N. We've changes the caption to be clear on this point.

- *Page 5895: Numerical problems!*

  We believe that the issue regarding the greyed-out section of the CMAM data, due to a numerical problem, has been addressed above.

3 Technical corrections

- *Page 5859, Eqns. 2-5: The subscript in NO_{α}^{Odin} (and the following variables) should α be replaced because it is difficult to distinguish from σ. Something like NO_{Rest} would reflect more the meaning. Also parentheses around the ratio in Eqn. 2 would be helpful for understanding.*

  Good point. We have changed the notation accordingly.

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