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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Validation of MIPAS $ClONO_2$ measurements" *by* M. Höpfner et al.

M. Höpfner et al.

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We would like to thank the referee for the suggestions and the effort to read through this kind of validation work.

1. *1. Introduction: The purpose of ClONO2 measurement is not well described. The role of ClONO2 in ozone depletion, especially in polar region should be more described in the introduction. Also, some recent works for ClONO2 measurements are not enough introduced. Please consider to introduce i.e. the following works in the introduction. Michelsen et al., (1999), J. Geophys. Res., 104, 26419-26436. Riese, M., et al., (2000), Geophys. Res. Lett., 27, 2221-2224. Nakajima, H., et al., (2006), J. Geophys. Res., 111, D11S09, doi:10.1029/2005JD006441.*

   In the revised version of the manuscript we have extended the description of the significance of $ClONO_2$ in stratospheric chemistry. The references suggested by the reviewer have been incorporated into the introduction.

2. *3.3 FIRS2 As stated in the general comments, I would propose to delete the comparison with FIRS2 from this paper, because the quality of FIRS2 ClONO2 is not supposed to be high, and not enough to use as validation data.*

   3.4 MIPAS-STR Also, I would propose to delete the comparison with MIPAS-STR from this paper, because the altitude range of MIPAS-STR ClONO2 is not enough for comparison (below the peak altitude of ClONO2 profile). Another reason is that the MIPAS-STR retrieval is too much affected by the above apriori ClONO2 profile.

   The referee proposes to skip comparisons with two experiments. For the following reasons we do not agree with these suggestions.

   - **General: the database of independent $ClONO_2$ measurements to compare with MIPAS is sparse compared, e.g., to validation work for temperature or ozone where many more observations exist and, thus, a selection of the most reliable ones can be performed. Further, there is no 'optimal' (e.g. like in-situ) method for chlorine nitrate measurements which would be possible to use as a standard. Thus, we think it is mandatory to use $ClONO_2$ products from as many as possible independent measurement techniques (observation geometry, sources of radiation, spectral bands) even in case the altitude region is not entirely covered or random errors are rather large (but given).**
   - **FIRS-2: One point of the referee is the poor statistics of the comparison with FIRS-2, since it is only one profile. But this argument could be applied also to other balloon instruments, and to single out one would be arbitrary.**

     We do not think that the comment about "the quality of FIRS2 $ClONO_2$ is not supposed to be high" is relevant, since FIRS-2 uses the same technique as MIPAS (thermal emission Fourier Transform Spectroscopy). The quality of the FIRS-2 $ClONO_2$ profiles is fully reflected

ACPD

6, S5971–S5975, 2007

Interactive Comment

EGU

in the error bars and, given these data, the reader has the possibility to make their own assessment also in combination with the comparison to the other balloon-borne instruments. E.g. it should be visible to the reader that there is indication for a deviation between FIRS-2 and MIPAS between 25 and 33 km. This would not be visible in case we would neglect the FIRS-2 dataset.

Another reason for keeping the FIRS-2 comparison is the variety and independence of measurement techniques addressed above: due to its far-IR spectral range, FIRS-2 is the only instrument which uses the ν_5 Q-branch of $ClONO_2$ at 563 cm^{-1} for analysis.

- **MIPAS-STR: the range of MIPAS-STR measurements is limited to heights below the flight level of about 18 km. However, there are still 3–4 independent pieces of information on the $ClONO_2$ profile in the important UT/LS (upper troposphere/lower stratosphere) region. If we would consequently apply the reasoning of the referee to other comparisons, also those with the ground based FTIR observations providing 'only' total column amounts would have to be deleted.**

  Further, the situation at high latitudes in March 2003 is especially suited to investigate the measurement capabilities of MIPAS/Envisat in the UT/LS. Due to the chlorine activation in the polar vortex during the Arctic winter the concentration maximum of $ClONO_2$ is located at altitudes near the flight level of the aircraft. Therefore, below 18 km there are still high levels of $ClONO_2$ (up to 2 ppbv) which do not exist at other latitudes or times of the year.

  The error induced by the a-priory profile on the MIPAS-STR results could have been included in the MIPAS-STR error estimation. However, we have decided to show its effect on the results explicitly in the single comparisons (Figs. 9–11). We stress that this represents kind of a maximum error since it is the difference between the assumption

ACPD

6, S5971–S5975, 2007

when a null profile is applied versus using the ’real’ one (from MIPAS). For the combined comparison (Fig. 12) we have used the MIPAS-STR results derived when the MIPAS profile is applied in order to reduce the induced error as far as possible.

A further reason for not deleting the MIPAS-STR observations is that these have been made during a dedicated validation campaign and, thus, are closely matched in time and location with MIPAS. Thus, apart from the MIPAS-B measurements on 24 Sep 2002 and 20/21 Mar 2003 the MIPAS-STR data are the only $ClONO_2$ observations exactly matching those of MIPAS/Envisat.

3. *4. Comparison with ground-based measurements: FTIR P.9783, L.5: The matching criteria of Delta_d_max=800 km seems too large for me. I did similar validation study before, and have found that matching criteria should be more or less smaller than 500 km in many cases, due to the nature of airmass. I recommend the authors to re-sort the validation data for those within 500 km and 300 km for stricter criterion.*

   Due to the following reasons we prefer to maintain our coincidence criteria for the ground based FTIR comparisons:

   - $\Delta d_{\mathrm{max}} = 800$ **km is not the only criterion used for the selection, but it is combined with** $\Delta t_{\mathrm{max}} = 8$ **h, and** $\Delta pv_{\mathrm{max}} = 3\times10^{-6}$ **Km^2 kg^{-1} s^{-1} at the 475 K potential temperature surface. The selection with respect to potential vorticity constrains the variation of the airmasses sounded, which is especially important near the polar vortices in winter/spring when $ClONO_2$ is enhanced inside the vortex due to chlorine activation.**
   - **During summer or at lower latitudes where there do not exist such large horizontal gradients in trace gas distributions, the PV criterion combined with a** $\Delta d_{\mathrm{max}} = 800$ **km has the advantage that it restricts to**

ACPD

6, S5971–S5975, 2007

Interactive Comment

similar airmasses but still keeps enough comparisons which is mandatory for meaningful statistics. In case we would only use a Δd_{max} criterion we agree with the reviewer that 800 km might be too large but by restricting it to meaningful values for wintertime we would loose co-incidences and unnecessarily sacrifice statistics in e.g. summertime cases.

- **In addition to the $\Delta d_{\mathrm{max}}= 800$ km, $\Delta t_{\mathrm{max}}= 8$ h, and $\Delta pv_{\mathrm{max}}= 3\times10^{-6}$ Km^2 kg^{-1} s^{-1} criteria we also show the case of $\Delta d_{\mathrm{max}}= 400$ km, $\Delta t_{\mathrm{max}}= 4$ h, and $\Delta pv_{\mathrm{max}}= 3\times10^{-6}$ Km^2 kg^{-1} s^{-1} which is close to the values (500/300 km) suggested by the reviewer (see Table 8 and Table 9 in the manuscript). The fact that there is no significant improvement in the comparison for most of the stations between the two cases strongly indicates that even the weaker criteria are sufficient for a meaningful intercomparison.**

4. *5. Comparison with spaceborne measurements: ACE-FTS P.9785, L.19: The satellite name is not ACE, but SCISAT-1.*

   Right, the satellite is called SCISAT-1. However, the mission is called ACE. The sentence has been changed accordingly: "The Atmospheric Chemistry Experiment (ACE) satellite mission was launched into orbit on 13 August 2003 with the solar occultation sounder ACE-FTS (ACE-Fourier Transform Spectrometer) on board."

5. *P.9786, L22 and L24: co-incidences → coincidences*

   Corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 9765, 2006.