

Interactive comment on “Diurnal variations of reactive chlorine and nitrogen oxides observed by MIPAS-B inside the January 2010 Arctic vortex” by G. Wetzel et al.

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Received and published: 21 May 2012

Response to referee #2:

First of all we thank the referee for his/her effort to carefully reading the manuscript and for all comments and suggestions for improvements.

General comments:

- 1) As suggested by the referee we performed an EMAC simulation using ClOOCl cross sections of Papanastasiou et al. (2009).
- 2) We enhanced the discussion in the paper corresponding to the expected ClOOCl
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photolysis.

3) We included a new data version of the MIPAS-B N₂O₅ retrieval since quasi-continuum PSC emissions are interfering with N₂O₅ emissions in the measured spectra.

4) Of course it would be interesting to monitor the temporal development of active chlorine and its reservoir species over the winter in the model. However, the focus of this paper lies on the observation of the changing species concentration around sunrise on a single day which was detected by MIPAS-B with high temporal resolution and not on the modelled chemical history of the winter. Hence, we did not include a further section on the temporal development of active chlorine.

5) We enhanced the discussion on PSC characteristics in the text.

Specific comments:

p. 4868 l. 4, l. 11, l. 16, and l. 19:

We modified the text according to the reviewer's suggestions.

p. 4868, l. 22:

We omitted "less quickly" because it is confusing.

p. 4869, l. 2, l. 3, l. 5, and l. 26:

We modified the text according to the reviewer's suggestions.

p. 4870, l. 5, l. 10, l. 12, and l. 18:

We modified the text according to the reviewer's suggestions.

p. 4872, l. 27:

Corrected.

p. 4873, l. 16:

The discussion about PSC has been enlarged. The particle type is estimated with the help of colour ratio calculations of three different spectral regions. The particle type is consistent with lidar observations published by Khosrawi et al. (2011). This is written in the text now. The only measured molecule (shown in this paper) which might be influenced by PSC emissions is N_2O_5 because this species shows up with a broad-band continuum-like emission in the spectra. During the January 2010 flight we see continuum-like emissions of PSC in our spectra below 25 km. Hence, these emissions can influence the retrieval of broad-band species like N_2O_5 . The retrieval of N_2O_5 has been re-calculated with an improved setting. These new data are now included in the paper.

p. 4875, l. 7:

A citation of ECHAM has already been included in the paper.

p. 4875, l. 23:

Modified.

p. 4875, l. 24:

As written in the model description STS are formed during cooling below a specific temperature threshold through uptake of nitric acid by sulphuric acid aerosols. In different laboratory measurements it has been shown that during cooling of STS the fraction of HNO_3 increases in the particles. We mention this in the text more clearly now. A detailed description of the submodel PSC is given in Kirner et al. (2011). Most relevant for the chlorine activation in EMAC is the temperature and not the particle type.

p. 4876, l. 10:

JPL02 ClOOCl cross sections are included in the EMAC version used. However, we modified EMAC such that new cross sections reported by Papanastasiou et al. (2009) could be used for a sensitivity run. However, the ClOOCl photolysis rate calculated with the new cross sections is only slightly stronger than the older one.

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p. 4876, l. 26:

The modelled HCl profiles also show clear signs of chlorine activation in the lower stratosphere but no diurnal variation. Between 19 and 23 km, about 80% to 90% of the simulated available chlorine (Cl_y) is in the form of ClO_x .

p. 4877, l. 5:

MIPAS-B ClO values near 1.0 ppbv are in line with the data observed by Sumińska-Ebersoldt et al. (2012) at 20 km.

p. 4877, l. 13, l. 23: This part of the text has been changed, such that the questions are not necessary any more.

p. 4878, l. 4:

The photolysis of the ClO dimer indeed starts very early in EMAC. Tropospheric clouds do not delay the ClO build-up. This is in line with the findings by Sumińska-Ebersoldt et al. (2012). However, stratospheric clouds have a significant influence on the start of the ClO build-up. The influence of stratospheric clouds was not investigated by Sumińska-Ebersoldt et al. (2012).

p. 4878, l. 15:

Modified.

p. 4878, l. 21:

Values are below 0.1 ppbv. This is stated in the text now.

p. 4878, l. 27:

This was already done and is described further down in the text.

p. 4879, l. 11:

Okay.

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p. 4879, l. 18:

Okay.

p. 4879, l. 22:

EMAC exhibits more NO_y (compared to MIPAS-B) between 26 and 29 km resulting in enhanced NO₂ mixing ratios.

p. 4880, l. 10, l. 11:

As already mentioned, we included a new data version of the MIPAS-B N₂O₅ retrieval since quasi-continuum PSC emissions are interfering with N₂O₅ emissions in the measured spectra. However, MIPAS-B N₂O₅ mixing ratios below 25 km might be still slightly overestimated. We made a corresponding note in the text.

p. 4881:

The model results show mainly liquid PSC during the time of the measurement. This is in good agreement with the CALIPSO observations. The strength of chlorine activation is mainly dependent on the modelled temperatures.

Fig. 5:

There is no explanation right now for the early start of the ClO build-up in the model. The model seems to underestimate the measurements at 32 – 34 km. However, ClO errors are quite large in this altitude region (somewhat around 50%).

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 4867, 2012.