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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of model grid zooming on tracer transport in the 1999/2000 Arctic polar vortex" *by* M. M. P. van den Broek et al.

Anonymous Referee #2

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This paper addresses the effects of different model resolutions on the transport of long-lived trace substances (CH4 and HF). The investigations have been performed with the TM5 model which is forced by ECMWF analyses. The paper contains some important points which will be of interest to the scientific community. However, before publication in ACP revisions are required.

General Comments:

The authors investigate the impact of model grid zooming on tracer transport in the Arctic vortex by comparing model results with measurements. Unfortunately, they draw their conclusions from the comparison of about 30 profiles from which about 5 are described to be measured inside the polar vortex only. To make the paper more valuable I would suggest that the authors should focus not only on the Arctic polar vortex but

also extend their investigations on the northern hemisphere mid-latitudes as well. By this, they could compare their model results with more HALOE measurements which are measured mainly in mid-latitudes and make their results more representative.

Therefore, I would recommend that a section about correlations (outside vortex, vortex edge, inside vortex) during the course of the winter is included in the discussion which could help to extract the regions/times where the model shows the excessive mixing as proposed in the manuscript. Also, a correlation of measured HF versus modelled HF (and also CH4) colour-coded with equivalent latitude would help to distinguish between initialisation problems (see next paragraph) and mixing processes in the model runs.

As some of the differences (in particular in the polar vortex) seems to be due to initialisation problems (Section 4 / page 2272 / 1st paragraph) it should be worth to extend the description of the initialisation (e.g. How do you extrapolate the HALOE to the poles? Would an equivalent latitude approach for the initialisation of TM5 help to improve the agreement?).

In the profile comparison (Figures 3-5) it is obvious that the model profiles do not resolve some vertical features (see Figure 4). Were does the features came from in the measurements (filaments)? If these structures are caused by filaments why are they not resolved by the highest resolution (1°x1°) model run? Will there be an influence in the modelled profile structures if you consider all ECMWF model layers?

It remains unclear why the diabatic descent calculated with TM5 during the winter seems to be in fair agreement with the observations (Figure 7) whereas the inner vortex profiles show large discrepancies between the model results and the measurements (Figure 4). In the manuscript it is stated that excessive mixing could be the reason for the difference but there is nearly no difference between the different model runs (except for GL_96). What are the reasons for this resolution independent excessive mixing?

To give an impression of the horizontal distribution of CH4 and HF in the different model runs it would be very helpful if the authors show some northern hemispheric

ACPD

3, S665–S669, 2003

Interactive Comment

distributions during the winter. By this the gradients at vortex edge region should be emphasised in the discussion.

Specific Comments:

- Section 2.1 / page 2265 / line 11: Why the authors use the forecast fields of ECMWF and not the analyses?

- Section 2.2 / page 2266 / line 17: It is mentioned that at the two top levels CH4 and HF are constrained with HALOE data. How do you treat the regions in the model where no measurements are available?

- Section 3.1 / page 2267 / line 22: What are the errors in the HALOE HF measurements?

- Section 3.1 / page 2268 / line 6 ff.: The authors speculate about the reasons for the discrepancies in late winter. But by the end they exclude all their speculations. Thus, it is necessary that a discussion about the most probably reason for the differences is included in this section.

- Section 3.1 / Figure 3: It is interesting to see that model run GL_96 agree with the other model runs at the end of April 2000. Please insert a short discussion about the horizontal gradients at the measurement points to highlight the differences/agreements of the model runs.

- Section 3.4 / Figure 6: In all model runs there is a strong discrepancy between the measured and modelled HF distribution between 10 and 1 hPa. The gradient of the HF profiles is underestimated by all TM5 model runs. What is the reason for this underestimation (initialisation, transport)?

- Section 3.5 / page 2270 / line 24: The authors state that in the calculation of the descent rates only those profiles were used which are located inside the vortex at all altitudes. How many profiles are used in the calculation? How do you define the vortex edge at the top model layer at about 0.4 hPa?

ACPD

3, S665–S669, 2003

- Section 4 / page 2273 / lines 8-10: Please explain in more detail why the non-consideration of ozone depletion in early winter could lead to an underestimation of diabatic descent in the ECMWF model as the discrepancies in the diabatic descent shown in Figure 7 are most obvious in December where only a small ozone depletion occurs.

Minor Comments:

- Section 1 / page 2263 / line 18: Please specify which kind of models (CTM or GCM) fails to reproduce the age of air.

- Section 2.1 / page 2265 / line 11: Please rename ECMWF (...) to ECMWF (European Centre for Medium-Range Weather Forecasts).

- Section 2.1 / page 2265 / line 20: Please change "the lower levels and the stratosphere" to "the lower levels and the lower stratosphere".

- Section 2.1 / page 2266 / line 2: The reference for Tiedtke (1989) is missing in the reference list. Please add.

- Section 3.2 / page 2268 / line 22: Please add a reference for the estimated error of the TDLAS CH4 measurements.

- Section 3.5 / page 2270 / line 14: It is mentioned that the descent rates were calculated between 1 December 1999 and 1 April 2000 but in Figure 7 only model results are shown up to 1 March 2000. Therefore, please change "... 1 April 2000" to "... to 1 March 2000".

- Section 3.5 / page 2270 / line 20: Please add a reference for the calculated descent rates carried out with a large number of inner vortex N2O observations.

- References: Please update the references of Bregman et al. (2002) and van Aalst et al. (2003).

- Figure 4: There are different dates in the figure caption and above the profile plots

ACPD

3, S665–S669, 2003

(27 January vs Jan 28; 18 February vs Feb 27). Please correct. Please write "ch4" in capital letters at the axes of the plots.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 2261, 2003.