Atmos. Chem. Phys. Discuss., 8, S10901–S10904, 2009
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Energetic particle precipitation in ECHAM5/MESSy1 – Part 1: Downward transport of upper atmospheric NO_x produced by low energy electrons" *by* A. J. G. Baumgaertner et al.

Anonymous Referee #3

Received and published: 4 February 2009

This paper discusses ECHAM5/MESSy1 simulations that has been extended by processes that parameterize particle precipitation. The focus is on low energy electrons (LEE) that produce NOx in the upper atmosphere. The production of additional NOx is based on a measure of geomagnetic activity, the Ap index. The implementation of the parameterization as the sub-model SPACENOX in ECHAM5/MESSy1 is described and results from test simulations are discussed.

The paper is well written, but in general the authors should discuss their results in

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more detail. The paper is worth to be published in ACP, after minor revisions.

Mayor comments:

1) In general the authors analyze the downward transport of upper atmospheric NOx produced by low energy electrons. However the authors did not discuss the quality of the downward transport of the ECHAM5/MESSy1 model.

2) Abstract, line 19:
'The NOx enhancements and associated effects on ozone are shown to be in good agreement with independent measurements.'

I found no comparison of simulated ozone with measurements in the paper. Remove this statement or add an comparison with measured ozone in you paper.

3) Section 2.2, page 21207:
'However, Funke et al. (2005) showed that in the middle atmosphere the enhancements are confined to the vortex (their Figs. 5, 6, 7). Therefore we have here used a minimum absolute latitude of 55 degree representing a conservative estimate.'

Why did you not use the equivalent latitude?

4) Results and discussion, NOx enhancements in the Antarctic winter 2003 p. 21210, line 5 –9:
'From the model results in Fig. 4 the downward transport of a NOx enhancement exceeding 50 ppbv is clearly discernable and is in excellent agreement with the

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MIPAS observations (Fig. 5) with respect to magnitude, timing, and altitude of the enhancements.'

I don't see in Figure 4 and 5 an excellent agreement! At 3000K potential temperature you have at the beginning of June enhanced NOx between 50 - 60 ppbv within the MIPAS observations. The model results show a similar feature with NOx mixing ratios around 45 pptv. Is that your excellent agreement? The observations show enhanced NOx mixing ratios between 2500K and 3000K at the beginning of July. What is the reason for that and why do you not see that within the simulations? Further the downward transport of NOx within ECHAM5/MESSy1 seems to be too high compared to the measurements. Please could you discuss this point.

5) Results and discussion: NOx enhancements in the Artic winter 2002/2003 p. 21210, line 12 – 25

You should mention that nighttime NO2 is only a lower limit for NOx. Further, I would not say in general that you have an excellent agreement between observations and measurements. You should discuss the comparison between model results and observations in more detail. E.g: Qualitatively the NOx enhancements at 3000K in Nov 02 and Feb 03 are reproduced by the model, but not that in Dec 02. Quantitatively the NOx enhancements are somewhat lower compared to observations...Nevertheless the main features are reproduced by the model and SPACENOX is a very good tool to describe NOx produced by LEE ...

6) Results and discussion: Ozone loss p. 21212, line 25 ...

The authors infered an additional ozone loss due to LEE NOx comparing ozone of the

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Antarctic winter 2003 and 1969. Why do you not compare ECHAM5/MESSy1 simulations with and without the SPACENOX module for the Antarctic winter 2003. Thus that you can really quantify the additional ozone loss only due to LEE NOx. Further the local relative difference between ozone says not much about the impact on the total accumulated ozone loss over the winter. It would be very usefully if the authors also quantify the impact of LEE NOx on total accumulated ozone loss during the winter.

Minor comments:

1) I suggest to mention also in the introduction that meteorological conditions modulate the downward transport of NOx in the polar stratosphere in particular in the Arctic (e. g. Randall et al, GRL, 2006): A stronger vortex leads to increasing NOx in the stratosphere caused by the descent of NOx-rich air masses from the mesosphere and thermosphere within a well-isolated vortex.

2) Section 2.2, page 21206:
It would be very useful for the reader if you would explain how Randall et al [2007] defined 'excess NOx'.

3) Please add in the figure captions of Fig. 4 and 5 that the Nash criterion was used to define the vortex edge.

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