**Atmospheric
Chemistry
and Physics
Discussions**

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Comment

Interactive comment on "Key aspects of stratospheric tracer modeling" *by* B. Bregman et al.

Anonymous Referee #1

Summary

This paper discusses the impact of different parameters on stratospheric tracer transport in the global chemistry-transport model TM5. The analysed parameters include horizontal grid resolution, vertical resolution, advection scheme, update time interval and time interpolation of wind fields, and the data assimilation procedure. To cover the different spatial and time scales of stratospheric transport the authors examine Arctic polar vortex dynamics, the large-scale meridional circulation of the stratosphere as well as dispersion in the tropical lower stratosphere. Based on the results of different model experiments with the TM5 CTM and an additional trajectory model the authors conclude that the horizontal grid resolution is a crucial factor for tracer distribution in

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polar regions. Especially, reducing the polar grid resolution due to numerical instability results in worse agreement with observed tracer distributions. Furthermore, reducing the update frequency of the wind field improves the tracer distribution substantially, while time interpolation leads to only marginal improvement.

General comments

The paper is not very well structured and the approach seems to be incomplete in some way. Since the paper contains results that may be of interest for a wider modelling community, I suggest publication in ACP. However, I believe that the paper needs revision and clarification before it would be suitable for publication.

The presentation of the model approach as well as of the results and conclusions is confusing and unstructured. Since the description and labelling of model experiments is not consistent throughout the paper, I was not able to follow the overall approach and to understand the conclusions. For example, I am not even sure how many model simulations were performed:

- In Section 2 the authors state that "the reduction of the polar grid has not been validated because of computational limits" (p 4383). However, in Section 3 it is mentioned that "the effect of the reduced polar grid was examined in *all* model configurations" (p 4385). Therefore, I would expect various simulations with a reduced polar grid, e.g. including 3/6-hourly instantaneous and interpolated winds. However, in Table 1 there is only one simulation "red. grid". Model experiment "red. grid" was performed despite computational limits? If yes, in which model configuration?

- According to Section 3 a model experiment with 3-hourly instantaneous winds

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was performed (p 4385, l 25). Such a simulation is not mentioned in Table 1. Fig. 5 shows results of model simulation 6_hrly_interp and 3_hrly_interp (legend and caption are inconsistent anyway), a model simulation 3_hrly_inst is not discussed in Section 4. However, I believe that a set of 4 different model simulations is necessary to assess the impact of update time interval and time interpolation: 6_hrly_inst (default), 3_hrly_inst, 6_hrly_interp and 3_hrly_interp. Otherwise, conclusions like p 4389, l 17-21 are not possible.

- I recommend to revise the manuscript carefully. Description and figures have to be consistent. Please clarify the model approach and the experimental set-up. Otherwise, the reader would not be able to follow the conclusions.

The impact of the data assimilation system is assessed by back-trajectory experiments using 4DVAR Operational Data (OD) and 3DVAR ERA40. I am not sure about the purpose of these simulations. I think there are already similar studies. What is the difference to the study of Scheele et al. (2005)? Are there any new findings? Furthermore, there are no TM5 simulations using 3DVAR ERA40 data. Why not? From Section 4.5 it seems that 3DVAR ERA40 3-hourly is better than OD 6-hourly.

Another point concerns analysed transport regimes. The paper concentrates on the Arctic polar vortex dynamics, the Antarctic polar vortex is not discussed in the paper. However, northern and southern hemisphere polar vortex show very different dynamics. Therefore, I think it would be also very interesting to see the impact of the analysed key factors on the tracer distribution in the Antarctic polar vortex.

In the model description (p 4383) the authors state that the applied model version "differs in some important aspects" from the model version validated by van den Broek et al. (2003). I miss a short validation of the applied model version or at least a few sentences on how the changes in the model set-up influence the model results. I

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think the comparison of modelled and observed methane profiles (Section 4) is not sufficient for model validation.

Section 4 shows a lot of comparisons between the different model simulations, but I miss a more detailed discussion/explanation of the differences between the model configurations. For example, "30L" shows lower methane mixing ratios above 10 hPa than the other model experiments. Why? Is there any explanation?

My last comment is a more "philosophic" one. I think the title is very general. The paper discusses a subset of aspects concerning the stratospheric tracer transport in the TM5 model. It is not a comprehensive review article on the subject of stratospheric transport. Therefore, I recommend to change the title, but that is not mandatory for publication.

Specific comments

- A consistent and uniform notation concerning the names of the model experiments in text and figures would be very helpful!

- In my opinion the introduction is too extensive. I think some parts could be moved to a separate section discussing the current results with previous findings.

- p 4376, l 6: "wind fields"

- p 4376, l 6/7: What is the difference between "update time intervals" and "update frequency"?

- p 4377, l 8: What is meant by "wind fluxes"?

- p 4377, l 19: "These results..."

- p 4377, l 21: Which findings? Searle et al., Marchand et al. or van den Broek et al.?

- p 4381, l 1/2: What is the advantage of hybrid sigma-p-coordinated concerning the treatment of cloud processes and convection?

- p 4383, l 12: How many vertical levels are used in the previous model version?

- p 4383, l 14/15: Please add a few sentences on how the advection time step is locally adjusted.

- p 4384, l 2: "CFL violation" ?

- Section 3, experimental set-up: This section is very confusing and should be carefully re-written.

- p 4384, l 13/26: I think many readers do not want to read 2 or 3 additional papers to understand the methodology. Therefore I would like the authors to include at least a short summary of the experimental set-up.

- p 4384, l 12: "is similar"

- p 4385, l 3: When are the trajectories started? On which day?

- p 4385, l 9: "ERA40 reanalyses"

- p 4385, l 10: "$3°x2°$"

- p 4385, l 13: "$1°x1°$"

- p 4385, l 22: Why can integrations including a zoom area only be preformed with 1st order advection scheme?

- p 4347: Are the observed methane profiles an average value of all available observations or single measurements? Which latitude/longitude? Are the model values averaged over a certain region or just a single grid point? Please give some more information.

- p 4388, Fig. 4: I suggest to include simulation "slopes" in Fig. 4 for a better comparison of both model simulations with 1st order advection scheme.

- p 4388, l 7-9: Is there any explanation for the difference between the current study and the study of van den Broek et al.?

- p 4389, l 11: "Figure 5 shows the calculated CH_4 profiles from default, 6_hrly_interp and 3_hrly_interp ..."

- p 4389, l 12: "as in Fig. 3 and 4"

- p 4390, l 17: include reference to Fig. 8

- p 4392, l 12: What is meant by "polar study"? Section 4.2?

- p 4392, l 23: remove "(red line)"

- p 4393: According to Fig. 13, ERA40 3-hourly has a smaller dispersion than ERA40 6-hourly and OD 6-hourly. I think this result is in contrast with the statement in line 2/3.

- Please include all necessary information in the figure caption and avoid statements like "see text for more details".

- Some figures are very tiny, especially Fig. 2

- Fig. 2: The model experiments "30L" and "slopes" are not shown in Fig. 2. Why not? I suggest to add both simulations to Fig. 2.

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- Fig. 3 does not show methane profiles at 15 March 2000, but 5 different days (caption).

- Fig. 4: Why is day 2000-02-27 omitted? Please include it.

- Fig. 5, Caption: Day 2000-02-27 is not omitted.

- Fig. 3, 5: Since the model simulations differ especially in the upper stratosphere, it would be nice to have observations above 10 hPa. I am not sure, but HALOE measurements could be available above 10 hPa, at least for the late winter and up to 60°N.

- Fig. 7: "default" and "red. grid" show the same number of data points. Why? I would expect less grid points in polar regions in "red. grid", when grid cells are merged.

- Fig. 9: Legend and caption are not consistent. Which experiment is shown? "6_hrly_inst" or "6_hrly_interp"?

- Fig. 10: A uniform colour bar would be desirable (lower panel). Lowest value 0.4 or 0.6?

- Fig. 12: If possible, please include a zonal mean tropopause in the figure.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 4375, 2006.

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