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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A three-dimensional model study of long-term mid-high latitude lower stratosphere ozone changes" *by* M. P. Chipperfield

Anonymous Referee #1

Received and published: 26 March 2003

This paper addresses an important issue: the causes of the observed long-term ozone changes in the mid and high latitude lower stratosphere. The causes have been investigated by multiannual model calculations performed with the 3-D SLIMCAT with detailed stratospheric chemistry. Therefore, the paper extents the investigations published by Hadjinicolaou et al. (2002) using SLIMCAT with a parameterised ozone chemistry only. It is well written and I recommend publication in ACP.

General Comment:

The results of run C are only mentioned in one sentence in the manuscript "In the early 1990s the enhanced aerosol increased O3 loss while in the early 1990s run C had more O3 than run A." (page 1090 / line 6). As this model run C could highlight the importance of aerosol chemistry on mid-latitude ozone (in particular after the Mt.

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Pinatubo eruption in 1991) the results of this run should be discussed in more detail in the manuscript.

Specific Comments:

- Section 2.1 / page 1086 / line 15: How are the 2D model results interpolated in space (equivalent latitude concept?) and time (linear in time? How are the short lived species like ClO treated?) to the 3D model during the 3D simulation?

- Section 2.2 / page 1087 / line 13: As shown in Figure 3 the difference between the 2D and 3D mid-latitude ozone column in January 1979 is about 70 DU. This difference extends the possible tropospheric contribution to the partial ozone column of the 3D model. Therefore, the initialisation of the 3D CTM calculations seems to be different from the January 1, 1979 mixing ratios of the 2D model. Please add some information about the initialisation of the 3-D model runs.

- Section 3.1: The model results of run A are plotted from 1980 till 1997 only, though in Section 2.2 it is mentioned that the 3D CTM simulations are integrated over the period 1979-1998. As it is discussed in Section 3.1 that in the 2D model run Cly has peaked in 1997, the 3D model results for 1998 of run A should be included in Figure 1b and a short discussion on the Cly trend (and a possible peak) in run A should be added to Section 3.1.

- Section 3.2: As stated in the manuscript the mean March NH ozone columns differ from the TOMS data substantially for the years 1993-1995. For 1994 and 1995 this difference is explained by the change from ERA-15 to operational ECMWF analyses. But the difference for March 1993 (and also to my mind for 1994 as the ERA-15 data are used until 28 February 1994) could not be explained by this change in the meteorological analyses. Please add a discussion about the possible reasons of the differences in March 1993 and March 1994.

- Section 3.3: Please exclude run D from Figures 3c and 3d, respectively, or include

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a short discussion about the influence of "no polar chemistry" model run on the calculated mid-latitude ozone columns. Also, the model runs B, C, and D are included in Figure 4 but there is no discussion about the differences. Please add. In Figure 4 the "% change from 1980" columns are shown. Why do the changes of the model runs and also for the TOMS data differ from 0% in 1980 (also in Figure 5)?

- Section 3.4: Are the CTM results shown in Figure 5 partial columns?

- Section 3.5: In Section 3.4 a solar cycle effect is discussed which improves the agreement between model results and TOMS data. For sections 3.5, 3.6, and 3.7 it is not clear whether the solar cycle effect has been included in the model results shown. If not, in which altitudes would the author expect the most prominent effect of the solar cycle and would this change the conclusions drawn in sections 3.5 to 3.7? In Figure 6 ozone profile data from Hohenpeissenberg (48°N) and Edmonton (53°N) are compared with CTM data from Jungfraujoch and Edmonton, respectively. As the CTM calculations have been performed with a relatively coarse horizontal resolution of 7.5°x7.5° a better horizontal resolution would have an impact on the calculated ozone profiles. Please add a short discussion about the influence of the horizontal resolution on the model results.

- Section 3.6: In Section 3.6 mid-latitude profile changes between 1996/97 and 1980/81 are investigated. One major conclusion of the paper is the limitation in diagnosing dynamical trends after February 1994 due to the changes in the operational ECMWF data assimilation system. Therefore, it remains unclear why the changes between 1996/97 and 1980/81 are investigated. An investigation of the changes between 1993/94 and 1980/81 with ERA-15 data only would exclude the influence of changes in the operational ECMWF assimilation system after February 1994. Please add the reasons for the choice of the 1996/97 - 1980/81 period. In this section it is mentioned that the profile shape is similar to measurements but displaced to lower altitudes (page 1092 / line 17). Please add some arguments about the possible reasons of this discrepancy. In both hemispheres the impact of meteorological variability seems to be strongest in

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March. Please add a discussion about the causes of this hemispheric symmetry.

- Section 3.7: Are the calculated ozone trends affected by the Mt. Pinatubo eruption in 1991? If they are, please include a discussion about the strength of the influence. Please specify the "other factors, possibly related to dynamics" which could cause a larger summer/autumn trend.

Minor Comments:

- Abstract / line 8: Please add "of ozone" after "evolution of the springtime depletion".

- Section 1 / page 1085 / line 21: Please change "Sect. 5" to "Section 5".

- Section 2 / page 1085 / line 24: Please insert "to 1998" after "... over the period from 1979".

- Section 2 / page 1085 / line 26: Please add "for this period" after "... currently available".

- Section 3.5 / page 1091 / line 28: Please insert "lower stratosphere (LS)"

- References / page 198 / line 13: Please add a comma after "as expected?"

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 1081, 2003.