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Geoscientific
Model Development
Discussions

Interactive comment on "Upgrading photolysis in the p-TOMCAT CTM: model validation and assessment of the role of clouds" *by* A. Voulgarakis et al.

A. Voulgarakis et al.

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We would like to thank the reviewer for the positive and clear comments. Our response to the points raised follows:

1) General/major comments:

In-cloud or grid-box averages (referring to line 15-17, page 350 of the discussion manuscript): the water contents are provided by the ECMWF as grid-box averages and not as in-cloud values. We have slightly changed the sentence and made this clearer.

Slingo and Schrecker equation (equation 1): First we note that the ECMWF does not

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provide 3-D cloud optical depths, but only water contents. The original Slingo and Schrecker equation was indeed constructed for liquid water clouds. But later, DelGenio et al. (2006) extended it to be applied for both liquid and ice clouds. A simplified version of the DelGenio scheme is being used here. The only difference is that in our implementation, the effective radius of the cloud droplets (both for liquid and ice) does not depend on the water content. Instead, it is fixed for ice clouds (40 μm) and for liquid clouds has a linear dependence on height from 10 μm at the surface to 45 μm at the top of the atmosphere, based on earlier (2004) assumptions used in the radiation code of the ECMWF IFS model. This modification was not only applied for simplicity, but also because it led to calculated optical depths which generally compared better with observations. In a nutshell, we did take differences between liquid and ice clouds into account by using different effective radii in the DelGenio et al. equation, which effectively is a later, more complete version of the Slingo and Schrecker equation.

We add the DelGenio et al. (2006) reference in the text and make the description of the equation clearer. Also, we change the dividend of the equation from LWC to WC, which is a more accurate representation.

2) Specific comments:

Abstract (line 1-5): Information added.

Section 2.1 (line 18-19): As stated in previous studies, use of the ECMWF re-analysis data leads to too strong stratospheric circulation and, consequently, to stratosphere-troposphere transport being overestimated. We have used, as has been done in a large variety of other studies, the ECMWF product for the several advantages that it provides, but also noting its disadvantages. We add the Uppala et al. (2005) reference to make clear that we are aware of the above mentioned weakness.

Section 2.1 (line 20-21): GOCART aerosols have been used only for the simulation of heterogeneous chemistry, not for the radiative transfer. The text has been modified for clarity.

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Section 2.3 (line 1-28): Paragraph moved.

Eq.2 and Fig.1: Caption of Fig.1 has been modified.

Page 353 (line 9 and 18): Our results are very similar to what was found by Liu et al. (2006) which is the main study we compare against (most recent). Liu et al. had found that their results are “comparable” to Tie et al. (2003), not identical. We do not expect our results to be very close to the earlier study, as the latter used a substantially different photolysis code and a thinner high-cloud layer compared to what was used by Liu et al. (2006) and us (9-11 Km instead of 9-12 Km). We rephrase to make clearer. Please see reply to Reviewer 1 for some other changes related to Figure 2.

Standard scheme vs old scheme: We decide to use “standard scheme” as we have been using it as a standard photolysis code until the present-day. Changes have been applied to the text.

Page 360 (line 6-7): We add a sentence to make clearer why we show this figure.

Page 360 (line 19-20): There was a mistake there and it has been corrected.

Page 361 (line 5-7): The difference is of a similar magnitude to the one found between Liu et al. (2006) and Tie et al. (2003). Liu et al. (2006) ruled out the possibility that vertical cloud distributions or the different way of calculating global mean OH concentrations could be the cause of the discrepances. Since our results are very similar to Liu et al. (2006), and the GEOS-CHEM model (which was used for the latter study) uses significantly different water vapor fields (from GEOS data), we believe that differences in water vapor concentrations are not likely to be driving the disagreement between our OH results and the ones presented by Tie et al. (2003).

Figure 1: We agree that the vertical distribution of clouds can be important. This issue, however, is being examined in a paper we now submitted for discussion. Readers will be able to find related figures there.

3) Technical corrections:

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Section 2.3 (line 15-25): Done.

Section 2.3 (line 24): Done.

Page 351: Done.

Page 353: Yes. Corrected.

Page 356 (line 5): Done.

Page 357 (line 20): Corrected.

Page 362: Done.

Table 2: Done.

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