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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of high solar zenith angles on dynamical and chemical processes in a coupled chemistry-climate model" *by* D. Lamago et al.

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This paper uses a couple d chemistry-climate model to examine the role of high solar zenith angle (SZA) photolysis on the 1990s stratospheric chemistry, ozone and temperature. The authors find that inclusion oh high SZA photolysis leads to appreciably more ozone destruction and cooling in the Southern Hemisphere spring and conclude that it is important to include a representation of this effect in coupled-chemistry models.

The paper is succinct, well laid out and leads the reader nicely to very believable conclusions. It makes a worthwhile contribution to high SZA chemistry and has clear figures. I think it would benefit from more discussion , to place their findings in context , and a clearer separation of cause and effect (see ?specific comments?, below)

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General comments

1. I wondered if this ”improvement” to the photolysis rates made an improvement to the models ozone and temperature climatology. My hunch is that it in fact got worse. For example I think results could be compared to those in WMO (2003). E.g. if this change deepens the ozone hole would the temperature change would be too large in SH spring? (c.f. Fig 3-40 of WMO 2003, where- The Schnadt model already had too much cooling compared to the satellite data- wouldn?t this change make it cool more? However, it seems to improve total column ozone (c.f. fig 3-1 and 4-35, WMO,2003). Anyway I think it would be useful adding some discussion on this in the paper. For example if it makes the model worse does that mean other parameterizations need tweaking the other way?

2. It seems somewhat arbitrary to include these high angle photons in the photolysis rates and not the heating rate calculations (I presume this is the case, although this is never discussed). I wonder what effect this would have . I think people like Arve Kylling and Knut Stamnes have come up with parameterizations which cope with this. Have you tried looking at this? Perhaps the extra solar heating partially compensates for increased ozone destruction. My hunch is this effect would be small but it maybe worth investigating? A quick calculation of its significance maybe worthwhile?

3. Most importantly, Cause and Effect: this is really my only gripe with the paper. Figure 2 and section 3.1 discuss photolysis rate differences that are caused by both ozone differences and radiation scheme differences. This is then made out to be the driver of subsequent temperature and ozone changes. When in fact the initial driver is really the different photolysis rates for the climatology, the two climatologies are then driven apart to create the larger differences in Figure 2. I strongly feel that Fig.2 should be replaced by one showing the J differences for the same climatology and different radiation schemes. This is what starts the chain of events off. It appears then that a positive feedback is set up as less ozone further enhances photons, causing further destruction. The old figure 2 could then be shown to highlight this positive feedback,

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which is currently overlooked

Specific and technical comments

1. Abstract: I recommend adding some context to conclusion and telling us if will you implement this change in the model?

2. page 3683 line 19: ”some CCMs” can you expand on this or give examples ? are there any which do include high SZA effects?

3. 3686, line 19, table 1 not clickable!

4. page 3687, lines 14-15: ”mixing ratios..are... fixed” for each scenario?. This suggests to me that single numbers are used, earlier it was stated that full 3D distributions are used ? wording change could be useful?

5. page 3689, line 1. I found it hard to see a ”faster” depletion in figure 3 compared to figure 4- there may well be a better way to show this e.g. as an anomaly time series at a given latitude? This could substitute in for one of Figs 3 and 4, as I wasn?t sure both were needed?

6. page 3689, lines 6-21. These were the only paragraphs which were not very well written and I got a little confused.

a. I don’t think ”however” makes sense on line 8 and the sentence would read better if it were dropped.

b. Line 12, I think the ”i.e..(twilight..)” part of this sentence can be dropped for clarity.

c. Line 15, what do you mean by ”hints”? could you enlighted the reader as to what these are?

d. Line 19, surely you mean significant and not ”not significant”? Otherwise contradicts next sentence?

7. page 3690 line 19, what do you mean by applied CCM?

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8. page 3694, line 3- what do you mean by partially? do you mean some CCMs or CCMs account for some high SZA effect?

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3681, 2003.