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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Middle atmosphere response to different descriptions of the 11-yr solar cycle in spectral irradiance in a chemistry-climate model" *by* W. H. Swartz et al.

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We greatly appreciate the constructive comments by Referee #1 (L. Hood). The revised manuscript for ACP submission incorporates the following responses. Quotations from the revised manuscript appear below in *italics.*

Specific Comments:

1. In the revised manuscript, we have noted in Sect. 5.1.1 the smaller secondary ozone peak in the lower stratosphere compared to the Austin et al. (2008) models, and

we added a short discussion of possible explanations.

The magnitude of the secondary lower stratospheric maximum, below 50 hPa, is somewhat smaller and confined to lower altitudes than those simulated by most of the models studied by Austin et al. One possible explanation for the difference is that the simulations considered by Austin et al. were transient simulations, whereas the GEOS CCM simulations shown here are time slices. However, Austin et al. and Marsh et al. (2007) have also found that the size of the lower stratospheric peak from transient solar forcing is sensitive to the time period analyzed due to the aliasing of other periodic or quasi-periodic forcings. See Figure 4 for the tropical ozone response.

Consideration of time-slice vs. transient simulation and the QBO are addressed in our response to Comment 3, below.

2. The recent Lean and DeLand paper is now cited in Sect. 6 (we feel that it goes better there rather than in Sect. 2, as suggested by the Referee).

Lean and DeLand (2012) in fact argue that the unexpected solar cycle variations inferred from the SORCE SIM instrument are the result of undetected instrument sensitivity drifts and therefore caution against using the SIM-derived 11-yr solar cycle in climate simulations until further validation and uncertainty estimation are available.

3. A discussion of the rationale for the time-slice simulations (and attendant caveats) now appears in Sect. 4.1.

Compared to transient simulations (with time-dependent solar forcing), time-slice

simulations may not fully account for varying tropospheric and ocean feedbacks during different phases of the solar cycle, particularly in the lower stratosphere, but eight multi-ensemble transient simulations would be too computationally expensive. As shown below in Sect. 5, the ozone and temperature responses to the solar cycle in the GEOS CCM time slices are largely consistent with transient simulations using other models forced with the NRL SSI, so for the purposes of this study, the use of computationally economical time slices is justified.

Further assessment of the time-slice simplification will be made in the future using transient simulations with the GEOS CCM.

4. The caveat associated with total ozone from a time-slice simulations is now noted in Sect. 5.2.

Because most of the total ozone column is in the lower stratosphere, however, note the limitations of time-slice simulations discussed above (Sect. 4.1) regarding details of lower stratospheric ozone. The total ozone maxima near 20° N and 20° S latitude in the observations in Fig. 6 are an indication of dynamical processes in the lower stratosphere (see also Hood and Soukharev, 2012) that are not captured in the time-slice simulations.

Minor Corrections:

5. Lean and DeLand (2012) is now cited.

6. The GEOS CCM has a coupled troposphere. In a transient simulation, we would

also want at least prescribed SSTs. The extent to which a coupled, free-running ocean will shed light on solar cycle response (for example the "bottom-up" mechanism) is something we will be able to address with the GEOS CCM in the near future.

7. Corrected.

8. Clarified as suggested.

9. We considered the suggestion but decided to keep the current wording.

10. Clarified as suggested.

11. The distinction concerning the lower stratosphere has been clarified.

We agree about the dash (hyphen). This hyphen was an em dash in the submitted manuscript. The copy editor, however, apparently does not believe in em dashes and converted them to en dashes with spaces before and after. This one got converted to a simple hyphen and we missed it in the galley proof stage. This has now been corrected.

12. Clarified as suggested.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 7039, 2012.