

Interactive comment on “Solar cycle variations of stratospheric ozone and temperature in simulations of a coupled chemistry-climate model” by J. Austin et al.

Anonymous Referee #2

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General comment:

The paper presents interesting results for the 27-day cycle and the 11-year solar cycle in ozone and temperature for three transient (REF1) ensemble runs with the AMTRAC model. Additionally two runs with fixed solar cycle phase and fixed SSTs are analyzed.

The 27-day results are in qualitatively good agreement with observations and are compared to earlier model experiments with the UMETRAC model. However, there are certain differences, especially for the temperature response that are at least partly attributed to the fact that the model only includes 27-day changes in the photochemistry but not in radiation.

The results for the 11-year solar cycle are analyzed with respect to the vertical structure of ozone and temperature response in the tropics between 25S and 25N. The authors relate the minimum in the ozone response around 20hPa to the fact that the simulation had a time varying solar cycle as well as varying SSTs. For a long time a discrepancy in the vertical structure of the tropical ozone and temperature response to the 11-year solar cycle between observations and different (2D and 3D) models was present. With the newest generation of chemistry climate models and the increasing computer capacity and the possibility to simulate a time-varying solar cycle, this discrepancy seems to be overcome. The current work is the first that highlights and publishes this and is therefore very interesting and important. However, I would like to see a more balanced discussion with respect to the 11-year solar cycle results. The observations themselves differ quite significantly from each other and it is hard to tell whether this is really an improvement of the model simulation. Also, there are longer datasets available (Randel and Wu, 2006) that should be included in the discussion. It is also not possible from the experiments presented here to separate how much of the changes are due to the transient solar cycle and how much to the transient SSTs or possible other effects. I would also like to see more discussion on the whole vertical structure of the solar response, so far the minimum in the middle stratosphere is the only focus. As the paper only concentrates on the tropics, I would like to see this highlighted in the title, in the abstract and in the conclusions of the paper.

In general, the paper is well written and presented. Therefore I recommend publication after the comments have been taken into account by the authors.

Specific comments:

Page (P) 12122, abstract: It should be highlighted that the analysis is only performed for the tropics (25S-25N) and that it is not clear from the results presented here whether the vertical structure in ozone is related to the time variation of the solar cycle or the variable SSTs or possible other factors (what about the increasing GHGs, volcanoes, etc.?).

P121222, line (L) L23/24: “although some studies have a less direct link to tropospheric processes...” This statement needs to be explained in more detail as it is not clear. I have the feeling that the two mentioned references are not giving the most relevant papers on this topic.

P12123, L4: “... but only about two solar cycles are available...”, this sounds to negative for me. Why don't you say almost three or 2 1/2?

L11: “... spectral changes in UV flux than the 11-year Schwabe cycle.”

L12: “Models so far have been consistent in simulating...” There are more and more models now that show a better, i.e. more realistic vertical structure as mentioned later in the conclusions.

L18-21: “To date,...” I think it should be clarified that computer resources only recently became available for longer integrations of time varying solar cycle experiments. Before a compromise had to be made by doing the fixed solar max /min experiments.

L23ff: Why are EEPs and NO_x so highlighted in this paragraph? The presented experiments do not include any of this.

P12125 L2: What are the intervals of the spectral wavelength ranges and how many intervals exist?

L8/9: “...solar maximum and solar minimum conditions...” I thought a mid-cycle run was set up instead of the solar min?

P26: How did you determine these numbers (69.6 and 154.3); a typical difference between solar max and min is between 125 and 140 to 150 F10.7 cm flux.

P12129 L1: “... the 1981 results...” Could parts of it be due to the changes only in photochemistry?

L29: Discussion of O₃ sensitivity at zero lag is missing

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P121130 L19: "...importance of the neglect..." Is there any chance to run a sensitivity experiment and test this hypothesis?

The results for the 27-day cycle should be compared to a recent paper by Rozanov, Egorova, Schmutz and Peter (2006), JASTP 68, 2203-2213. The MLS data in their Figure 7 and Figure 4 of this paper seem to differ - any explanation for this?

P121131 L1: Why is JJA so different compared to the other seasons? L3: change "model" to "CCM" L7/8: "... with a minimum in the pressure range...", the minimum is not statistically significant, this should be mentioned here. L9: HALOE data cover only one solar cycle L21: Again, the JJA response is different compared to the other seasons. Do you have an explanation for this?

P12132 L2-4: What do you mean exactly? Please explain in more detail. L14: "...from each other in between." L18: Analysis of observations cover even less than 4 solar cycles. L19/20: Which processes could be important that haven't been included in the regression analysis?

P12133 L9: This section only talks about the possible modulation of the tropical upwelling through the solar cycle. This is only one aspect of the dynamical response and I therefore suggest to rename this section. L20: for which height range? L26: May be it is better to show the seasonal upwelling for the transient runs instead of the annual mean in Fig. 11?

P12134 L6: How do the changes in upward motion relate to ozone and temperature changes?

P12137 L1/2: What kind of simulations do the authors have in mind?

Caption Figure 6: Is the same linear regression model applied to the model and the observational data?

Figure 10: Why is the range of the x-axis different from Figure 6?

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Technical comments:

P12128L18: "... into two 500 day..."

Contour interval in caption of Figs. 2 and 3 are missing

Caption Figure 4: typo "linear regression analysis"

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