General Comments

This study attempts to ascertain reasons for the diversity in modelling results regarding the 11-year solar cycle signal in the middle atmosphere. It does this by examining the solar signal in three different models, starting with the shortwave heating, ozone, and temperature anomalies at 1hPa (the direct solar signals), and then looking at the temperature and zonal wind anomalies lower down in the stratosphere, to see whether any evidence of a 'top-down' transmission of these initial solar signals can be found. When the models show variation in these indirect solar signals, possible reasons for this are examined.

I think the paper is well and logically structured, the overall scientific treatment is quite rigorous, and the ideas presented relevant to discussions about the atmospheric solar cycle imprint in models. Having said that, I think there are some issues with the paper in its current format which would need to be addressed before publication, outlined below. I would therefore recommend publication with minor revisions.

Specific comments

Please define ECHAM/MESSy (L45)

- ➔ **Reply:** The fifth-generation European Centre Hamburg general circulation model (ECHAM5)/Modular Earth Submodel System (MESSy).

Section 2.1 (climate models) needs significant reworking to improve readability. Please define all abbreviations as they appear in the text (e.g. NEMO3.6 L83, JSBACH L83, SOLCHEK L92, T42L47MA L93, MECCA L95, JVAL L94, RAD-FUBRAD L95, UBCNOx L95, GR15L40 L96).

- ➔ The descriptions are modified, we added part of the full names for the abbreviations to improve the readability. **Please see lines 85-87, 95-106.**

I'm not sure that figure 1 exactly supports what you say in L151-153. I think you need to add linear trendlines to the figures for values below about 150/180sfu. Also, I think the upper limit of this linear trend is possibly lower than 180sfu, maybe 150sfu. Again, a trendline would help to clarify this.

- ➔ **Reply:** The least squared regression lines are added to the Figures. Here, we would like to clarify that we removed the least squares quadratic trend for all the meteorological variables (take SWHR as an example) before we investigated their relationship with the solar cycle. So, the regression lines directly show the SWHR increased when the solar forcing increased (indicated by F10.7 index here).

Figure 1 in general is quite difficult to decipher, given the multiple models plotted and many data points. I would suggest replacing it with line plots, with the lines indicating ensemble-mean values, and a shadow region indicating the ensemble spread, similar to your other figures.

- ➔ **Reply:** Thanks for the suggestion. But the scatter plot can directly show some potential relationship between two variables from dimensionless arrays without any "further analysis".

As we explain above, the scatter plots can directly show a tendency of the SWHR anomaly when the strength of the solar forcing increases. We modified the scatter figures. The suggested line plots can be found in Figure A2.

Please explain why the spread in ensemble results above a certain value becomes bifurcated in figures 3, 6,7, 11, as indicated by the shadow regions.

➔ **Reply:** Sorry for the confusion. A linear method was used to find the boundaries of the ensemble spread, which failed when more than two boundaries appeared. The figures are updated.

L192 delete) after ozone

➔ **Reply:** It's revised.

L196 inset) after Fig 3

➔ **Reply:** It's revised.

Figures 4 & 5: Upon examination, I am concerned that we are seeing some aliasing with the QBO. Most of the subplots in figure 5 do show definite QBO-like equatorial zonal wind anomalies. FOCI is probably the greatest concern because at least some of these QBO-like zonal wind anomalies appear significant (e.g. Feb-Mar at ~30hPa). This could be significant because the QBO state (easterly vs westerly) has been shown to have an influence on the polar night jet strength, i.e. the Holton-Tan effect (see Holton & Tan 1980). Authors should address this concern, ideally by filtering their results for QBO phase (westerly vs. easterly, or neutral).

➔ **Reply:** Yes, the QBO influences the presentation and propagation of solar signals in the stratosphere. Although both FOCI and MPI-ESM-HR have an internally generated QBO, and thereby, its aliasing with the solar signal is expected to be largely reduced in the ensemble mean composite based on the solar cycle, our study suggests that the QBO signal remains in the average of 9 ensemble members. We added a discussion on this point. **Please see lines 281-291.**

L249 insert such before both: '...such that both the positive...'

➔ **Reply:** The texts are revised.

Figure 11: please adjust the x-axis scale range for each model as the scatter plots are coming out too squished horizontally. Consider doing to same for figures 8 & 9; you can always just highlight the different scale ranges in the figure captions/in-text discussion.

➔ **Reply:** Thanks for the suggestion. We modified the figures.

I think you should consider redoing all your line-style plots that show ensemble members and ensemble means (figures 1-3, 6-12) so they just show the ensemble mean and spread in the ensemble members, like in figure A3.

➔ **Reply:** We re-plotted them.

L264 remove quotation marks around "opposing"

➔ **Reply:** revised.

L274 add) after Fig. 8

➔ **Reply:** revised.

L287 and L363 change pole to polar

➔ **Reply:** revised.

L288 change EAR5 to ERA5 (also in L290, caption and column heading for table 1)

➔ **Reply:** revised.

References:

Holton, J. R., & Tan, H. C. (1982). The quasi-biennial oscillation in the Northern Hemisphere lower stratosphere. Journal of the Meteorological Society of Japan. Ser. II, 60(1), 140-148.