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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying uncertainties of climate signals related to the 11–year solar cycle. Part I: Annual mean response in heating rates,temperature and ozone" *by* Markus Kunze et al.

Anonymous Referee #1

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This interesting and well written study addresses the impact of the choice of solar forcing model versus choice of CCM model through an ANOVA analysis of annual mean response rates. Although the study itself is performed under controlled conditions (no forcing from particles, no solar cycle, yearly means, ...) it sheds new light on the relative impact of the model choice and solar spectrum choice on heating rates, ozone, etc. In particular, the study highlights the influence of the CCM choice on the upper mesosphere and the impact of the prescribed solar forcing in the FUV on the response of the upper stratosphere and lower mesosphere. This excellent work is definitely worth

publishing in ACP.

General comments:

p3 line 10: the amplitudes are added... If the reference ATLAS3 spectrum underestimates the SSI in some spectral band, then this means that the departure from the true spectrum will affect all reconstructions, thus impacting the climatological state of the atmosphere. This effect may be significant in the visible and near-IR where Delta-SSI is relatively small as compared to the uncertainty on the reference spectrum. Although you briefly mention this in the conclusions I would recommend to address this issue (if it is one) here already because what follows heavily relies on the ATLAS3 reference spectrum.

p3 line 10: The SORCE dataset has received considerable attention (e.g. Haigh et al., 2010, https://doi.org/10.1038/nature09426) because of its anomalous solar cycle variability. Alas, it is implictly excluded from your analysis because of the considered time interval. Yet, I would still mention it here because of the continuing debate.

p3 line 15: here it is important to give a physical flavour of why your ANOVA analysis can be useful, e.g. by mentioning that it is closely connected to regression analysis. Just saying that you're the first to use it does not help much in understanding what it is about.

p8 line 16: please replace "solar signal" by solar signature or similar because you are not really considering a signal, rather perpetual conditions. In this whole section the question that immediately arises is to what degree the modulation of that solar forcing by the 11-year cycle can affect your conclusions, e.g. through coupling with the NAO or, more generally, with the lagged ocean response. Please explain if and how these effects may impact your conclusions.

p9 line 24: Here a brief rationale of why the ANOVA approach is pertinent is a must. Most readers are familiar with multilinear regression analysis, so that this

analogy can be easily exploited. Please also give some adequate references (e.g. H. von Storch and F. W. Zwiers, Statistical analysis in climate research, Cambridge Univeristy Press, 2002) and above all, explain in more physical terms what you are trying to quantify with your ANOVA analysis. I also recommend to cite some climate studies that illustrate the use of ANOVA analysis in climate studies, such as the early https://doi.org/10.1357/0022240943076911 or the more recent https://doi.org/10.1002/joc.3991

One additional request: why a two-way analysis? Again, for those who are unfamiliar with ANOVA analysis, I recommend to motivate these choices here and then defer to the appendix for technical details.

p9 line 25: Why consider annual means only and not separate seasons (e.g. DJF) for which we know that the sensitivity may be higher ? Yearly averages tends to smear these seasonal differences.

p17 I would suggest to mention as well the comparisons between the different spectral irradiance models and ozone observations (e.g. Ball et al., 2016, https://doi.org/10.1038/ngeo2640) which, broadly speaking, support your conclusions or at least do not contradict them.

p21 line 20: The investigation of more recent periods, instead of the 1989-1994 comparison would allow to better constrain the SSI variability (with SOLAR-ISS as you mention, but also other observational datasets such as AURA-OMI) and better overcome the main source of uncertainty in the solar forcing, which comes from the FUV range.

p23 line 15: Most ANOVA studies focus on the F ratio although one could also consider the coefficient of multiple determination R (e.g. von Storch and Zwiers, p. 176) which, arguably, gives a better physical picture. Did you consider it?

Technical corrections

Title: since this is part 1, what should we expect to find in part 2? The manuscript does not really tell this.

p4 line 27: the appropriate reference for the Bremen MgII is Snow et al., 2014 (https://doi.org/10.1051/swsc/2014001)

p6 line 10: observations

p35 Legend of Fig 4: does not pass –> do not pass

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