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Interactive comment

Interactive comment on "Odd hydrogen response thresholds for indication of solar proton and electron impact in the mesosphere and stratosphere" *by* Tuomas Häkkilä et al.

Anonymous Referee #1

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General comments:

In this paper, the response of OH and HO2 in the stratosphere and mesosphere to large particle precipitation events – solar proton events and electron precipitation events – is investigated based on observations from the MLS satellite and model results from the WACCM chemistry-climate model. In particular, increases in both data-sets during periods of increased proton or electron flux are used to determine a threshold flux above which an observable response can be expected. The topic is of great interest as OH and HO2 observations during such particle precipitation events are good indicators of an atmospheric impact, and of potential great use to evaluate the particle impact in

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Discussion paper

chemistry-climate models used to study the climate feedback of these events. The paper is also very well written. However, in my opinion there is a problem with the methodology used to calculate the threshold which potentially leads to a high bias. I have summarized my concern below (specific comments), and am looking forward to a productive discussion of this point.

Specific comments:

Page 5, lines 20 and following, discussion of threshold determination: I have two comments on the determination of the threshold, which in my opinion could be improved considerably.

- Line 23: you use a linear fit between two datasets which have a very different range of variability: the particle fluxes vary over nearly six orders of magnitude, the anomalies vary by less than a factor of ten. I think this cannot work. Everything lower than about 10% of the maximum value of the x vector (particle flux) will be interpreted as essentially zero by the fitting routine, so whatever threshold value you derive here is probably within the uncertainty of the fit. You would see this clearly if you plotted the values on a linear scale – you lose the information about the lower flux values if you plot the flux on a linear, and not on a logarithmic scale, and the same is true if you do a linear fit on these values. You can see quite clearly in the left panel of Figure 4 that the fit did not work – just look at the black dots and black line (WACCM-D data and fit): for fluxes between 10 and 100, y-values are still rather high, but the dots are mostly to the left of the fitting line, that is, the lower flux values are not well represented by the fit. Only values with flux (SPE indicator) values above about 100 are well represented by the fit, as only those can be considered if the SPE indicator is used as a linear parameter. This also means that you overestimate the threshold value, and I think that this has to happen: the linear fit provides an artificial upper limit of about 10% of the highest value. If you just look at the black dots – there are a lot of dots between SPE flux values of 10 and 100 which are significantly above the fitting curve. If you just look at these dots, the threshold is probably around 10, not larger than 100 as your fit provides. I think using the log of the flux (SPE/RBE indicator) and a non-linear fitting function (polynomial) will provide a much better fit which also can account for the low flux values. If you do this with a multi-linear regression algorithm, you can still use the correlation coefficient as a measure of fitting quality.

- I think using half the standard deviation as a measure of significant enhancement is too low – this would be still in the noise floor. When you do the fit against log(flux) as suggested above, you can probably afford to use one standard deviation, and still get a lower threshold.

Technical corrections:

Page 4, lines 19-20: I think it would be more consistent to use the WACCM density for conversion, not the MLS HO2 density. Because even if the output format for WACCM species may be mixing ratio, internally number densities are likely used for the calculation of photochemistry.

Page 4, line 21: note formatting of HO2

Page 5, line 18-20: but would you not expect a difference in the HOx loss rates between summer and winter which likely affect the observed increase?

Page 6, line 30: missing full stop after “levels”

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