Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-799-AC3, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Solar 27-day signatures in standard phase height measurements above central Europe" *by* Christian von Savigny et al.

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Received and published: 21 December 2018

Reply to comments by reviewer #2

Note: our replies are boldfaced

Reviewer comment: The authors use Kühlungsborn phase height measurements to analyse the response of the D region / upper mesosphere to the 27 day solar cycle. They find a negative correlation as expected, seasonal and solar cycle effects, and, unexpectedly, a stronger effect during solar minimum than during solar maximum. There is a lag of few days between solar variability and (negative) phase height. They also use CMAM geopotential heights to gain some insight into possible atmospheric effects on the phase height variability. The results are new and interesting, the analysis is

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Discussion paper

made with care, and I recommend publication of the paper.

Reply: We thank the reviewer for this encouraging comment!

I found section 4.3.2 a bit unsatisfactorily. The authors present regression of phase heights and CMAM geopotential height maps at lag zero. Why was this lag chosen? Is there a lag between CMAM geopotential heights near the reflection point and the solar flux?

Reply: This is a misunderstanding because the lags belong to different research objectives.

On the one hand, there is a negative lag of a few days between (negative) SPH and Lyman-alpha (or F10.7) seen in SEA and in a correlation analysis, but this lag difference is only a hint, that the SPH minima appear before solar maximum, saying that SPH are possibly followed by a solar signal.

On the other hand, we used a regression analysis in order to show that the variability of the local SPH time series is statistically linked to the GH anomaly field of the boreal extra-tropics. The regression coefficient field is shown for two lags of regression (-12 and 0 days, Figure 12) in order to demonstrate the oscillation behavior in the NH at an upper mesospheric level (0.01 hPa about 80 km altitude) and in the stratopause region (1 hPa about 48 km). That means we demonstrated that the large-scale regression patterns are changing their sign during a period of about half of the "27 solar period". We also performed the regression analysis for a lag of -15 days, which essentially resulted in the same results as for a lag of -12 days.

The authors propose NO transport for being responsible for the negative correlation of phase heights and geopotential heights. Since NO or winds are not shown, this is only qualitative.

Reply: This is correct, but it is a future task which could be examined in model

study.

However, given this effect is working, phase heights should decrease as long as transport anomalies are southward, and a delay between geopotential heights and phase heights could be compared with this analysis, which could be based on gradient wind anomalies, or simply visual inspection of CMAM maps at different lag.

Reply: The transport time as well as the recombination times are fast so that in our opinion such a visual inspection of CMAM maps is not appropriate. A future sensitivity investigation with a middle atmosphere model including ion chemistry could be used to examine this issue.

Minor comments

L 85: I do not see a 27-day peak in Figure 3, but enhanced power also at about 23 days.

Reply: agreed, we changed the statement to

"Strong signatures at periods between 55 days and 22 days are identified"

L 95: The data analysis is the same than in section 3.1, but the whole time series is used, right?

Reply: correct, the whole time series are now used. We now mention this explicitly.

L 106: Have there been limitations concerning the solar flux maxima, e.g., amplitude, or distance between them?

Reply: Good question! No assumptions were made in terms of the amplitude of the solar proxy maxima, but implicitly a constraint has been applied regarding the temporal distance between the maxima: We checked for every day of the time series, whether the corresponding daily value is larger equal than the values in the period from -13 to +13 days around the corresponding day. This way,

multiple or minor maxima that are only a few days apart will not be identified. The automated search was applied to the F10.7 cm time series smoothed with a 5-day box-car function, as already mentioned in the manuscript. The identification of the maxima was checked visually and the approach was found to work well. This procedure is now briefly explained in the manuscript.

L 109: replace "N" by "N = 584".

Reply: Changed.

L 156: I do not understand, phase height and LYA have different units and amplitudes, what is the meaning of the ratio?

Reply: The reviewer is absolutely correct, giving a dimensionless ratio doesn't make sense here. We replaced the statement by:

"The SPH amplitudes are typically larger during winter compared to summer and for some solar cycles also appear to be larger during solar minimum than for solar maximum."

Fig. 6: Axis labels for LYA and solar flux should be added.

Reply: The figure was revised and the additional figure labels were added.

L 160: I see the negative correlation for the summer of 1985, but not for 1986.

Reply: The reviewer is right, in summer 1986 no clear negative correlation is present. We changed the statement to read:

"During May-July 1985 the two band-pass-filtered time series are out-of-phase (less obvious during May-July 1986) as expected from photo-ionization by Lyman-alpha, and the larger phase difference change during winter time may be due to atmospheric processes."

L 205: Maybe mention that the correlation between F10.7 and LYA does not hold for

solar minimum.

Reply: Good idea, we now mention this and cite Barth et al., Comparison of F10.7 cm radio flux with SME solar Lyman alpha flux, GRL, 17(5), 1990.

L 266: Insert a period after the URL.

Reply: Done.

Caption of Fig. 11: The bottom part refers to 0.01 hPa.

Reply: the bottom part refers to a 1 hPa. Thanks for pointing out that this was not mentioned. We added this piece of information to the Figure caption.

L 289: middle panel -> lower part of the upper panel.

Reply: Sentence adjusted, thanks!

L 312: Days -> days

Reply: done.

L 502: Add an URL

Reply: We added an URL for this paper, but we're not sure, whether it is consistent with the ACP guidelines. It may be removed again.

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