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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.

Anonymous Referee #1

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This is an interesting and well-designed study of 27-day solar UV-induced variations of "standard phase height" (SPH) measurements in the ionospheric D region. While the observed inverse correlation of SPH with 27-day variations of solar EUV flux and the agreement of derived sensitivities with those obtained on the 11-year time scale are consistent with a purely photochemical mechanism (enhanced photo-ionisation of NO leading to lower effective reflection heights), a number of characteristics of the response are not consistent with such a mechanism. This leads the authors to further analyses identifying "non-trivial dynamical effects" and "clear evidence that planetary waves are associated with quasi 27-day periods". After revisions in response to comments by the other two reviewers and by Jan Lastovicka as well as my comments, publication is recommended in ACP.

(1) One major disagreement with expectations for a purely photochemical origin is the fact (lines 358-360) that "the minimum in SPH precedes the maximum in solar forcing by a few days". This statement agrees with the phase shift listing in Table 1, which shows shifts ranging from -2 to -4 days with no apparent dependence on solar activity level (F10.7 flux threshold). The negative phase lag of a few days can also be discerned in Figure 4, which shows the superposed epoch analysis (SEA) results for all available data (584 epochs). However, this is not so clear from the SEA results for low solar activity periods. Looking at the smooth red curve in the lower panel of Figure 10, the minimum in the SPH anomaly shows no significant negative lag when epochs with F10.7 less than 130 sfu are considered. Please explain.

(2) A second major disagreement is that (lines 361-362) "not only the SPH sensitivity to solar forcing is larger for periods of low solar activity, even the amplitude of the potential solar 27-day signature is larger during solar minimum". The authors go on to note that a model study by Gruzdev et al. (2009) did find increased sensitivities with decreased forcing but did not find an amplitude increase with decreasing forcing. The main evidence for an amplitude increase seems to come from a combination of Figure 10 (showing the SEA results for high and low solar activity epochs) and Table 1, which lists the results as a function of the threshold value of F10.7 used to select the epochs that are analyzed. The lower panel of Figure 10 (F10.7 $<$ 130 sfu) does indeed show a larger amplitude of the 27-day SPH variation than the upper panel (F10.7 $>$ 130 sfu). However, this difference is not so clear from Table 1. The top entry corresponds to all data (F10.7 threshold of at least 60 units, 584 epochs) and gives an amplitude of 47.8 meters. The eighth entry corresponds to all data when F10.7 was at least 130 sfu (303 epochs) and gives an amplitude of only 31.5 meters, which is roughly consistent with the upper panel of Figure 10. However, the next entry in the table corresponds to data when F10.7 was at least 140 sfu (267 epochs) and gives an amplitude of 40.5 meters, considerably larger than that when 130 sfu is used as the threshold and maybe not significantly less than the 47.8 meter value obtained when all data are considered. So, I would ask the authors to re-examine their conclusion that the amplitude is larger

under solar minimum conditions.

(3) The listings in Table 2 (summarizing the results for different times of the year) are hard to understand. The mean 27-day sensitivities are larger for the summer (May to Sept.) and winter (Oct. to Feb.) seasons (-.45 and -.49, respectively) than they are for the whole year (-.37). Is this because the sensitivities in March and April are much lower than for the rest of the year? Please explain. Also, the amplitude of the SPH change is about a factor of 2 larger in the winter season than in the summer season even though the mean sensitivities in the two seasons are about the same. The discussion in section 5 (lines 375-389) gives some explanation for why the amplitude should be larger in winter, involving larger downward transport of NO from the thermosphere, increased 27-day NO production in the Auroral zone, etc. But shouldn't the sensitivities be larger in winter also?

(4) One standard deviation error limits are shown in the figures (e.g., Figure 4). If I remember correctly, the probability that the true value lies within these limits is only around 68%. Two standard deviation limits corresponds to about 95% confidence. I would not insist on changing the plotted limits to two standard deviations in the figures but at least it should be mentioned in the text that two standard deviations would provide a better indicator of whether a real signal is being detected. For example, in the upper panel of Figure 10, the peaks in the mean amplitude curve are not significantly different from the minimum near zero lag if two standard deviation limits are used.

Minor Points:

(6) This is probably just personal preference but I would use "inversely correlated" rather than anti-correlated, which could be misinterpreted to mean no correlation.

(7) It is necessary to read the details of section 2 to understand what standard phase height means. Since this manuscript is apparently submitted to a special issue on layered phenomena in the mesopause region, it may be obvious to most readers that this term refers to an effect in the upper atmosphere. However, to save many casual

readers the trouble of reading section 2 to understand what the manuscript is about, it would be better to indicate in the abstract (preferred) or introduction what is being investigated. For example, in the abstract, you could change line 2 to read: "standard phase height measurements in the ionospheric D region carried out in central Europe."

(8) Line 86: ... such as the atmospheric processes ...

(9) Line 130: ... by checking how many of the ...

(10) Lines 329-330. Please re-write this sentence.

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