Dear Editor,

here are the answers to the Referees:

Referee 1:

Q1. The paper has been rewritten substantially. The aim of
the analysis has become much clearer now.

A1. Thank you for the compliment.

Q2. The authors investigate the time evolution
of the Ap substorm index applying a Fourier-series analysis
(not a FFT as I originally misunderstood) with base time period
27 days (sun-related) to some quiet and disturbed time periods.
They expect to see the appearance of higher harmonics (frequencies)
at geomagnetically disturbed times while finding the contrary.
If reliable, shorter periods they find suppressed during disturbed
times.

A2. It was naturally to expect an increase in higher frequencies content of the Fourier decomposition during geomagnetic storms and substorms, but we observe the decrease.

The contourplots of c_{nl} are fragmented with solid pronounced $n=1$ and $n=2$ components during the Ap increase.

Q3: The effect is in fact rather weak.

A3: We have not studied the Fourier spectrum during powerful superstorms but now seems that higher frequencies will be suppressed during such events as well.

Q4: I have no problem with publication of the result after considering the following remarks. However, the pure detection of this contradiction to the expectation is, as a spund physical result not quite sufficient. It would require several extensions which the authors should consider in future work. First: Fig 2 on which the conclusion is essentially based shows a substantial scatter in index n and the coourored intensity. This raises the question whether the effect sustains if the width of the scattering is accounted for.

A4: We interpret the question this way: if the upper limit of n, N, will be larger, say 240, then maybe the pattern will be different.

The frequencies which correspond to n>120

have very small c_nl and practically do not contribute to the

reconstructed function Ap. And addition of n>120 does not change

the pattern for n<120

Q5: Second: Feb 2001 shows the drop in n related to the increase in DST between Feb 11-18 while such a drop is absent on Feb 2003 for higher Dst and occurs on Feb 2017 for quiet Dst. So Dst seems unrelated. Wouldn't this would suggest that Ap is basically intrinsic and only weakly related

to solar activity (which underlies the analysis by chosing T)?
In this case the effect in n would only be apparent not real?

A5: We would interpret the result as the fact that the geomagnetic activity is triggered by the solar/solar wind events, but the evolution of the geomagnetic storms and substorms is more complicated and does not follow the main frequency of the solar activity.
The period of the Fourier decomposition could be different, for example it can be shorter, but this will mean removing the solar frequencies from the consideration. They are present and should be considered.

Q6: Third: Fig 3 shows a colour plot of \phi/n (n) as function of time for the three cases. Most of this figure is noise. What does it mean that always on Feb 1 for al three events \phi/n is largest? Just the few first days of Feb 2001 and Feb 2003 show a week indication of excitation of n< few. To me this Figure contains zero information and should be dropped.

A6: Figure 3 shows that the normalized phase decreases with time at different speed for different n, and this speed changes with time. The contour plots demonstrate much of similarity at mid and higher frequencies, while at lower frequencies each contourplot is unique.

Q7: What would instead be more interesting

to see is the total spectrum f (n) =|A(t) |^2 as function of

time.

A7: The spectrum of Ap^2 will be slightly different from that of Ap.

Because Ap^2 is not widely used in geophysical applications,

there is no need to study its spectrum.

Q8: This is somehow mimicked by Figure 4 but not instructive. What does \ph/n(n)

mean physically? Why is it largest for n=100? The cos in the

sum over n in A_{pl} is simply cos(-\phi +n\omega t) with argument

always smaller than 2\pi. So what does \ph/n mean? This needs

some discussion, otherwise the figure is useless or misleading

suggesting that large harmonics dominate.

A8: By definition ph_n/n is normalized phase. The argument of sin and

cos is ph_n+w_n t, which can be rewritten as ph_n+n w t=n(ph_n/n+wt).

Figure 4 shows that ph_100/100 is 90 degrees larger than ph_20/20 after

28 days, while they were almost the same in the beginning of

the interval.

Q9: Finally: To me this analysis shows that there

is no solar effect on A_p. The relation to the solar period

seems to provide a nonresult. The auroral index A_p is mainly

determined by processes intrinsic to the magnetosphere.

A9: We agree and added the sentence about this (ll. 143-144).

Referee 2

Q1: Section "Method", Line 38: "... where the period is T = 27 days". The periods are give in line 33 as "... February 2001, 2003, and 2017 ...". Each of these months have 28 days, not 27? The x axis of Figures 1-5 seem to show days 1-28?

A1: Period T=27 days specifies the length of the interval on which the Fourier analysis is performed. For example, to have reconstructed value of Ap of February 14 at 0h0m, we use the Ap data from February 0h0m - 13.5 days to February 0h0m + 13.5 days.

Q2: The authors have added a motivation for their work, and describe their expectations about intensification of higher frequency componennts during disturbed periods and the somewhat disappointing negative outcome. This is ok, but still quite thin for a paper to publish in a journal for geophysics. The authors focus on "higher frequency components" but especiall Figure 2 shows structure mainly at the lower frequency components, uncommented. I suggest to expand a bit more on the features revealed by the Fourier analysis. A hint would be that raw magnetic data typically show atmospheric tides at diurnal and semi-diurnal periods. If I'm not mistaken this would be n=27 and n=54? Especially in Febuary 2017 and 2003 there seem to be clear lines in the lower frequencies. Less so in February 2001 which was more active. Could it be that geomagnetic activity covers the magnetic signatures of atmospheric tides and also planetary waves (at lower n) which otherwise are visible in Ap time series? Disappearance of tidal signals in Ap would then indicate geomagnetic activity?

Related work:

Chen, S. S., Yamazaki, Y., Denardini, C. M., Resende, L. C. A., Chagas, R. A. J., & Stolle, C. (2024). Tidal composition analysis of global Sq current system. Journal of Geophysical Research: Space Physics, 129, e2023JA032382. https://doi.org/10.1029/2023JA032382

A2: We agree and added sentences about this (ll. 96-102) and the suggested reference.

We thank Referees for their suggestions.

The Authors.