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Comment on acp-2022-534

Anonymous Referee #2

Referee comment on "Latitudinal Dependence of the Geomagnetic and Solar Activity Effect on Sporadic-E layer" by Qiong Tang et al., Atmos. Chem. Phys. Discuss.,
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Referee comment on "Latitudinal Dependence of the Geomagnetic and Solar Activity Effect on Sporadic-E layer" by Tang et al.

The paper presents analyses of the global S4 irregularity index distribution using S4 data from 2007-2018 as downloaded from the COSMIC Data Analysis and Archive Center. The authors claim that S4 above a certain threshold represents the occurrence of sporadic E (Es) layers. In the paper, a seasonal climatology is presented, and the manuscript includes an attempt to analyze the connection of Es occurrence with magnetic variability and the solar cycle.

The manuscript shows several weaknesses. An important one concerns the interpretation of S4 as Es occurrence. In section 2 it is described that simply a S4 index maximum > 0.3 is taken as the signature of the Es layer. Have there been additional criteria applied, or how do the authors know that the signal is not due to other irregularities or artefacts? Of course, the overall long-term distribution of S4 is similar to the one known for Es as shown in Fig. 1, and this information is not new. But, as shown in Fig. 2, for example, in magnetically disturbed cases the S4 distribution becomes very irregular and it is unclear how much of it is owing to Es then. Thus, a more critical analysis of S4 in terms of Es occurrence is necessary, or, if it had been done, must be described in more detail.

Another concern is related to the analysis and interpretation. The authors simply present long-term mean distributions of S4 without any statistical analysis and interpretation. On several occasions, the authors write of correlation or significance, but do not provide correlation coefficients or significance levels. Not even the numbers of used occultations for the different seasons, latitude ranges, or magnetic or solar ranges are provided. Given in particular that the magnetically disturbed cases are more rare than the quiet ones, the differences shown in Fig. 3 may be insignificant, if they relate to Es at all. The analyses of magnetic and solar influence is obviously done without consideration of the seasonal cycle. This would mean that any possible effect if dominated by the respective summer, does this have an influence of the results?

More minor issues relate to the presentation and discussion of the results. What is the use of not simply showing height-time cross-sections in Figs. 1, 2, and 5? A disadvantage of the present form is that for low altitudes the diurnal cycle is not well visible. And how have the spirals in Fig. 1 been calculated? In my view, this presentation can only show whether diurnal or semidiurnal variability is dominating, but this has been shown before, including higher order tidal variability. In Fig. 1, the seasons should be presented as boreal spring, summer, etc., otherwise it is incorrect for the southern hemisphere. Close inspection of Figs. 4 and 7 show some slight differences to Figs. 3 and 6, so for example, in Fig. 6, 10-20N, the occurrence rates decreases with F10.7 while in Fig. 7 it increases again for high solar activity. A further point is the presentation of the IMF in Fig. 8. IMF is somehow related to the solar cycle, but shows a delay with larger values during the declining phase. Therefore, if the authors claim that the Es solar variability could be due to IMF variations, they should repeat their analyses using IMF instead of F10.7.

To summarize, I have some concern of the validity of the analysis method, at least when low numbers of occultations are used, and the statistical analysis of the results is by far not sufficient. The paper is probably hastily written, as there are many typos and other errors, which would have been visible by a careful check. If the authors can resolve the concerns about the Es analysis method, and provide a much more thorough statistical analysis, more care should be given to the presentation in the manuscript.