Dear dr.Rae, thank you for your comment. We will take all your suggestions into account. Point-by-point answers are given below and marked with the colour.

Interactive comment on "A case study of the spectral parameters of ULF fluctuations before substorms with no evident trigger in the interplanetary space" *by* Nataliya Sergeevna Nosikova et al.

Jonathan Rae (Referee)

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This manuscript is a case study of ultra-low frequency (ULF) waves that occur in the magnetosphere and ionosphere before an isolated substorm. These ULF waves are proposed to be either from the solar wind, or from processes inside of the magnetosphere. If these waves are generated by either the solar wind or generated inside of the magnetosphere, then the proposition is that these ULF waves may be considered as a a pre-conditioning of the magnetosphere or trigger for the substorm.

If I understand correctly, the solar wind is ruled out as a generation mechanism, and hence these waves are generated inside of the magnetosphere and these waves could play a role in substorm onset physics.

Most of my concerns are on the conclusions, which are that Pc5 pulsations were observed several hours before the substorm and these pulsations could be related to substorm onset. The substorm starts at 2030 UT. The Pc5 waves occur between ~1500-1800 UT. I'm sorry to say that I can't see the causal link between ULF pulsations that occur 2-3 hours before a small substorm bay and the manuscript does not say how this link really works. I found the analysis of the Pc5 waves to be a very nice study of their coherence, but I'm sorry to say that I don't see the relationship between these waves and a substorm that happens 2-3 hours later. For example, the average substorm cycle is around 2-3 hours, and the average substorm expansion phase is ~minutes, and so it is not clear to me how these waves and this substorm are related when they are observed hours apart.

This manuscript is based on the previous paper (Yagova et al, 2017) and it develops the idea proposed in the paper. The mentioned study is aimed on the investigation of

geomagnetic and auroral luminosity pulsations in the frequency range 1-4 mHz using ground-based magnetometer and Meridional Scanning Photometer data. Days with the undisturbed solar wind and interplanetary magnetic field parameters and were selected and divided into 2 sets: days with a substorm and quiet days. The second set was used to determine a background variation of the spectral parameters of the ULF pulsations. The first set consists of 15 non-triggered substorms, i.e. substorms without any evident trigger in the IMF nor SW; 7 out of 15 substorms were considered as an isolated, i.e. separated from other substorm with at list 3 hours. It was shown, that for days with substorms, the PSD of Pc5/Pi3 geomagnetic pulsations, recorded in the Northern Polar Cap for several hours, preceding a substorm, is much higher as compared with the quiet days. Such pulsations are coherent with fluctuations in auroral luminosity (557.7 nm). The analysis also showed distinct spectral changes (as determined by the spectral slope α and the parameter Q) during 3-4 hours before a substorm onset. It was speculated that these pulsations might be caused by ULF activity in the IMF and SW or be a «precursor» of an upcoming substorm. If the first scenario is realized, then ULF fluctuations should be added in the list of substorm triggers. In the second scenario the pulsations could indicate a preparation of the magnetosphere to a substorm.

The present case study illustrates the possibility of the second scenario by combining ground magnetometer with in-situ measurements inside the magnetosphere (from Cluster). The analysis is thus focused on the time period, 3-4 hours before substorm onset, in line with the finding from Yagova et al (2017). While ULF fluctuations almost die out in the SW and IMF, ULF activity starts to grow in the Magnetosphere as shown from both the Cluster and ground magnetometer data.

In the revised version we plan to include the main results of Yagova et al., 2017 and the preceding research on the relationship between an auroral substorm and ULF activity in the polar caps in the Introduction section. We will also discuss the possible physical reasons in the Discussion section.

I do have a suggestion, which is that I think that the Pc5 wave analysis is very good and very clear. It is possible that this analysis and interpretation could form a manuscript all by itself without the link to substorms. Whether that is something that the authors were intending and I misunderstood I do not know but if I did misunderstand then I apologise. In summary, I would suggest either the manuscript is clearly rewritten to make clear how the Pc5 waves are related to the substorm, or to just concentrate on the very nice analysis of the Pc5 waves themselves and not relate them to the substorm onset process which is not quite demonstrated at this point. At the moment the manuscript seems to be somewhere in between these two points of view.

We will add more detailed description of the previous study to make the connection between Pc5 waves observed in the 3-4 hours preceding a substorm more evident to the reader.

A few more comments on the general introduction and discussion. I would recommend that the referencing of the relevant publications in the field could be added to. There are plenty of references on ULF waves as a trigger for substorm onset, originating with the seminal work of Samson and most of those references could be found within Rae et al. [2014] and Smith et al. [2019] - that itself cites a wide range of Samson and other relevant papers with which the literature review could be improved. This is also true in the Introduction, where there are very few substorm references to be found (lines 20-30) other than the Bland et al. reference. Some of these papers might not be relevant but I offer these as papers who discuss ULF waves, Pc5 waves and potential triggering of substorm onset. I'm happy to provide more references to the authors if that is helpful.

Thank you so much for the provided references. Two of them were cited in the previous paper. It also was mentioned there, that most of studies are focused on the last pre-substorm minutes and just a few of them pay attention to the longterm preceding period. We plan to discuss the results of these publications and to add the newest suggested paper in the introduction of the current manuscript.

I would recommend that the introduction could be expanded to include some of the literature that discusses the physics of triggering of substorm onset by the solar wind and by internal processes.

We will expand the introduction with the recommended topic.

Data Processing. I would recommend that the data processing aspects of the work are discussed in the sections closer to the Figures that are being described. I think that it would aid in the readability of the manuscript if the data processing were to be close to the Figures being described.

We will give a short data processing description in each section

Figures. I would recommend using Universal Time for the figures, instead of "time since 1530 UT". It would really help the readability of the paper to use a common time for each plot so that the reader can understand where each plot starts and finishes relative to the others.

We will replot figures with a common time axis.

References Rae, I. J., Murphy, K. R., Watt, C. E. J., Rostoker, G., Rankin, R., Mann, I. R., Hodgson, C. R., Frey, H. U., Degeling, A. W., and Forsyth, C. (2014), Field line resonances as a trigger and a tracer for substorm onset, J. Geophys. Res. Space Physics, 119, 5343– 5363, doi:10.1002/2013JA018889. Samson, J. C., D. D. Wallis, T. J. Hughes, F. Creutzberg, J. M. Ruohoniemi, and R. A. Greenwald (1992), Substorm intensifications and field line resonances in the nightside magnetosphere, J. Geophys. Res., 97, 8495–8518, doi:10.1029/91JA03156. Smith,

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