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Comment on angeo-2020-95

Anonymous Referee #2

Referee comment on "Fine Scale Dynamics of Fragmented Aurora-Like Emission" by Daniel K. Whiter et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2020-95-RC2, 2021

This paper provides additional observations and analysis of an optical phenomenon that has been identified close to auroral structures at high latitudes: the 'Fragmented Aurora-like Emission'. The authors have identified two cases that on the face of it look somewhat different but use the fine-scale capabilities of ASK to show that these are actually similar. The paper is well written, with good explanations and makes a commendable effort to constrain the causes of these FAE based on the available observations.

I recommend that the manuscript be accepted for publication after some minor revisions and after the authors have considered a couple of minor points.

- line 13: '...electrostatic ion cyclotron (EIC) waves and...'

-line 109: you mention that they share the same internal structuring and dynamics. Although you go on to explain this in a later section at this position in the manuscript it comes across as quite a bold statement of fact. It just feels a little jarring at this point.

Figures 1 & 3: although you do it for figure 4 I feel it would have been helpful to have the ASK fov shown on figures 1 & 3 where you are inviting the reader to compare the two observations from different instruments.

-line 95: you mention that the FAE are not visible in the all sky camera as they are small and quite fast moving. yet they are visible in the camera during the second event, and you go on to show that the phase and group speeds are comparable. So they cannot be invisible in the first due to being fast moving, if they are moving at the same speed as the structures in example 2. Or am I missing something about the instrument cadence? I suspect it is a matter of size (as you mention) and perhaps brightness.

-Figure 5: the ESR data is quite noisy, though the bulk structures do stand out. I am not totally familiar with all of the properties of sporadic E, so I wonder is it normal for enhancements in electron density during sporadic E to be associated with a bite out in ion temperature localised at the same altitude? If I saw this in the data it would give me a little cause for concern that there is something going wrong in the ISR fitting process, which would make me a little nervous, particularly as it accompanies peaks in electron temperature that might suggest a problem with the temperature ratio fitting. Have the

authors considered this? Although not a massive part of the paper, the supposed sporadic E layer is the strongest evidence of high electric field at this time, so it is worth making doubly sure that it is not an instrument artefact.

You say that the FAE never fill the radar beam, yet the period when the FAE are in nearest the magnetic zenith of ASK, there is an enhancement in Te and Ti. I would suggest that there are two other occasions that look similar in the data – after 19:02 and 19:05:30. Have the authors looked at what is happening around those times in the optics? I note that these are outside of the images presented in figure 1. If there are data available and it shows no FAE then it might seem very likely that the coincident Te and TI enhancements are unrelated. I note that you are rightly cautious in your description of a possible link already.

-line 169: you assume an emission height of 112.5 km but I don't think you justify/explain that anywhere. I assume that is because of the sporadic E peak in figure 5, yet in describing that feature you focus on temperature enhancements closer to 100km. This is confusing.

Especially as later you switch from 112.5 km to 100 km. I think you should be consistent in your altitude choice or explain why you use different altitudes.

Line 200 onwards: I am not as convinced as the authors that lack of apparent field-aligned component to the shape is indicative of a non-precipitation mechanism. At higher energies structures can diverge significantly from the field aligned structure – pulsating aurora for example. Plus, how are you defining field aligned at these scales? Analysis of optics is not my strongpoints and I recognise that there are significant experts in the author list, but I wonder if the emission difference could be due to the spectrum of precipitation rather than evidence of no precipitation?

I would like to emphasize that I am not advocating that this is a precipitation mechanism, rather that I do not feel the authors make the case strongly enough to completely dismiss it.