

Ann. Geophys. Discuss., referee comment RC2
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Comment on angeo-2021-37

Anonymous Referee #2

Referee comment on "Spatio-temporal development of large-scale auroral electrojet currents relative to substorm onsets" by Sebastian Käki et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-37-RC2>, 2021

General comments

The paper combines two very different datasets to statistically characterize substorm onset parameters using interesting methods such as the spherical elementary current system method and methods of aligning local times and latitudes. The authors have displayed their data in a series of informative and astatically pleasing figures which will prove useful to the field. I have no major corrections, just some comments on how to make the paper clearer. A very enjoyable read.

Specific comments

Introduction

The introduction provides a good summary of the field and how this research fits into that. It could perhaps use a few more references in places to highlight as the authors say that it 'is still an active research topic' with many different ideas and opinions.

Line 35: A few more references to the recent interest in wedgelets may be useful eg. Plus

an acknowledgement that their role is still very much up for debate.

The amount of acronyms in the intro is very hard to follow! I would suggest the authors consider if all the acronyms are necessary, particularly two word acronyms such as AEJ, CF, DF etc. For example, given that 'curl-free' shouldn't even increase your word count and is only used three times I think using CF makes the manuscript harder to follow. AEJ is defined twice but the authors have still used 'auroral electrojet' several more times within the text. Please consider if all are necessary and if the authors decide they are, please check for consistency throughout the text.

Lines 55-63 would benefit from a few references.

Data and Methods

Line 89-90: This sentence is confusing. If it's pole is in Quasi-Dipole coordinates how is it Semi QD? I assume QD is quasi-dipole but this is not clear. Please restructure this sentence to make it clearer.

What years does your dataset include? How many events does this study include?

Line 101: Could you explain that SML is an auroral electrojet index and a bit more about what it is and why it is used for the SuperMAG list? What are the benefits and negatives of defining onset purely from SML? Why has this list been used over other list such as the SOPHIE technique or the Frey list?

Forsyth, C., et al. "A new technique for determining Substorm Onsets and Phases from Indices of the Electrojet (SOPHIE)." *Journal of Geophysical Research: Space Physics* 120.12 (2015): 10-592.

Frey, H. U., S. B. Mende, V. Angelopoulos, and E. F. Donovan (2004), Substorm onset observations by IMAGE-FUV, *J. Geophys. Res.*, 109, A10304, doi:10.1029/2004JA010607.

The SM stands for superMAG as it is the SuperMAG AL index so it shouldn't be necessary to write 'SuperMAG SML'. Information and references are available in the indices section on the superMAG website.

Line 110: The example chosen for figure 1 and 2 is actually quite an extreme event. Could the authors comment on this and how it effects figure 1 and 2? What would a smaller, more typical event look like? If one of the very high bins in later figures contained this or other extreme events would that cause significant inflation of the values?

Line 113: Are you associating the time and MLT location for each auroral oval crossing with the substorm onset parameters? It would be helpful to reword this sentence slightly.

Results

Lines 141-143: What in the plot is supposed to show me that the dawn dusk electrojets are dominating? The slightly darker colours in the dawn dusk sector? Please explain how I am to interpret the plots.

Could you state what the average onset location is for reference?

Line 145-150: Is there a comment on the higher values of the EEJ in the E1 section 50-100 minutes after the onset?

Figure 5-8: Can you mark on the W1, W2 etc MLT lines? This would aid reading the results section by avoiding the need to flick back to figure 3.

Section 3.2: It would help if the units in the figures were the same as those used in the text e.g. either write the y axis in kA if you want to write 50-150 kA in line 156, or write the y axis as $\times 10^5$ A and 0.5-1.5 $\times 10^5$ A.

Line 166: It took me some time to figure out what was meant by 'intensification seems to move eastward'. Perhaps the authors could make this clearer?

Figure 11: Could the authors again add W1 and W2 boundaries to this plot and comment on the difference in magnitude between pre and post. A comment that pre-midnight is the bottom and post is the top would save thinking time! Is there much difference in coverage for pre and post midnight? How many onsets in each?

Discussion & Conclusion

Clear and representative of the work.

Technical corrections

Line 4 & 45 & 77: ESA is used repeatedly without introducing the acronym. European Space Agency is then used in line 77 without the acronym.

Line 45: Where does the S in AEBS come from?

Line 50 & 60 & 240: You have used ground-based throughout the rest of the manuscript.

Line 64: Switch word order to "can also provide observations. ."

Line 64 & 87: Use FAC

Line 70: You have already defined AEJs above.

Line 86: You have already defined and used SECS many times.

Line 88 & 90: If you're going to use DF throughout use it here.

107: 18-6 hrs.

123: The evolution of the parameters of interest ARE then inferred..

278: two `or`

299: updated

309: The superMAG webpage has went a bit funny.