Annales Geophysicae Discussions

Ann. Geophys. Discuss., author comment AC2
https://doi.org/10.5194/angeo-2021-37-AC2, 2021

Reply on RC2

Sebastian Käki et al.

Author 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-AC2, 2021

We thank the anonymous referee for the helpful comments, and constructive remarks. Our replies are marked with *cursive* text. The supplement includes the same reply as pdf with color coding for the replies.

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.

We agree and will add more references to studies highlighting the 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.

We will expand the references relating to wedgelets and clarify the uncertainty of their exact role.

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.

This a good point and we will modify the usage of acronyms and pay attention to the consistency across the text.

Lines 55-63 would benefit from a few references.

We will take this into account.

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.

We will restructure the sentence. The Semi QD (quasi-dipole) is not equivalent to QD as the semi QD is a "normal" orthogonal spherical coordinate system where we can easily define an orthonormal basis. The QD basis is not orthonormal.

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

The years used have been mentioned in the text but will add also more information about the total amount of events. We will also correct the years included. The correct value should be 25 November 2013 – 31 December 2019.

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?

We will add more explanation of the SML and clarify the choice of the SuperMAG list. As the SuperMAG list is not dependent on visual data, its coverage will be better than visual lists, although the list is naturally dependent on the location and spacing of the contributing ground magnetometers. The Frey list does not overlap with Swarm lifetime so it cannot be used in this analysis.

Using the SOPHIE technique is technically possible, but the SuperMAG list was chosen because of the easy availability and accessibility of the list at the start of this study. It could be interesting to compare the analysis with different lists in future work, but we believe this is out of the scope of this paper.

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.

We will modify the text accordingly.

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?

The example is quite extreme, but we believe that it gives a good illustration of the probed parameters from the AEBS data. As we only calculate medians and percentiles, we do not expect these extreme events to affect the result very much. Certainly, the effect would be greater in means.

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.

We identify the time and MLT and latitude for each auroral oval crossing.
The same parameters are provided for the onsets by the substorm list. The parameters for the oval crossings are then binned in relation to the nearest substorm fulfilling our qualification of temporal separation of the previous substorm. We will reword this to make the sentence clearer.

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.

Our interpretation is that the slightly darker colors before the onset are the indeed the result of the onset locations being located around the nightside, thus statistically positioning the westward jet towards positive MLT differences and the eastward towards negative MLT differences. This is perhaps more clearly seen in the (a) panels of Figures 5 and 6. Our intention was to indicate the dominance only in the times before the onset, not the after it. This characteristic is what is more clearly seen in figures 5 and 6.

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

We will add the average location of the onset to the text.

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

We have not focused on the EEJ but we believe this is the time regime of analysis is where the mixing of substorm phases is quite large. It is also possible that there is much statistical variation, as the percentile ranges are quite large as can been in Figure 6. Another possibility could be variation caused by different driving conditions and saw tooth events.

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.

We modify the images to include the limits.

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 x10^5 A and 0.5-1.5 x10^5 A.

We will modify the units to kA.

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?

A clearer explanation will be added to the text.

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?

A clearer explanation of the plot will be added. We will also add the sectors and onset and point coverage of the post and pre midnight sets.

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.

We will fix the technical errors.

Please also note the supplement to this comment:
https://angeo.copernicus.org/preprints/angeo-2021-37/angeo-2021-37-AC2-supplement.pdf