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Interactive comment on "*Swarm* field-aligned currents during a severe magnetic storm of September 2017" *by* Renata Lukianova

Anonymous Referee #3

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The paper uses Swarm A, C and B data, mainly the 1-s FAC data product, to study the characteristics of an intense storm during 6-9 September 2017. Evolution of the current intensities and the equatorward displacement of FACs are analyzed while the satellites cross the pre-midnight, pre-noon, dusk and dawn sectors in both hemispheres. The main results given by the author are: (1) The equatorward boundaries of FACs mainly follow the dynamics of ring current (as monitored in terms of the SYM-H index). The minimum latitude of the FAC boundaries is limited to 50° MLat, below which saturation occurs. (2) The FAC densities are very variable and may increase dramatically, especially in the nightside ionosphere during the storm-time substorms. (3) The dawn–dusk asymmetry is manifested in the enhanced dusk-side R2 FACs in both hemispheres. (4) Filamentary high-density structures are always observed confirming that a substantial

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Discussion paper

fraction of R1/R2 FACs is composed of many small-scale currents.

The main problems with the paper are the following:

- It is not focused

- Many important details, especially related to the data and its analysis, are missing

- Many results given in the abstract are not new

- Throughout the text, many claims are not justified by references

The most interesting topic, which has not been so extensively studied (Wang et al., 2006 have studied one strong storm) is related to point (1). However, this point should be studied more carefully in the paper, since I can only partially agree with the given conclusion. Points (2) and (4) related to variability and existence of filamentary currents are well-known even though it is interesting, that the data product gives such high extreme values for one orbit (up to 80 microA/m2).

In summary, the paper needs such a big major revision that resubmission might be the best choice. However, the present manuscript has clear potential. The revised version should be more focused and the interesting thing would be the general behavior of currents during the different phases of the strong storm and the related substorms. At the moment, the section Discussion uses a lot of time on small-scale current dynamics, which is somewhat de-focusing. The author should pay special attention to references and maybe also search for recent Swarm papers.

Detailed comments:

Introduction:

- The first paragraph is written in a bit loose way, e.g. Are FACs flowing only from boundary layers? Why FAC system is evolved only by dayside (not nightside) reconnection? FAC may exceed its nominal level – what is meant by nominal level?

- In the second paragraph it is said that Wang et al. (2006) and Anderson and Korth (2008) have studied storms, but no results are given

Please swap Sections 2 and 3, it would be more logical

Section 2:

- Maybe the Clilverd et al. (2008) paper should be referred to?

Section 3:

- Here one should shortly explain how 1-s FAC data products are derived from the original magnetometer data

- Please explain what coordinate system for MLAT is used and how MLAT and MLT are derived

- SwB is not separated by 1.5 h in LT from SwA and C, but this difference depends on time

Section 4.1

- First sentence in Sect. 4.1.: give a reference

- Figure 3: Define FAC positive values (up- or downward current)

- Figure 4: It would be more informative for the reader to see in the upper right corner the mean MLT value (or text “pre-noon” etc) than the track identifier. One could also add standard deviations to the mean values by error bars (and expand the horizontal width of the figure)

Section 4.2

- Table 2 would need more explanation. Which MLATs are included in the calculation? What are the uncertainty limits behind these numbers? Has the author checked from the Southern hemisphere, which are the highest MLATs that the satellites reach and does that affect the estimates?

- Line 29: “From the FAC values presented in columns 5 and 6 one can see that in both hemispheres the dusk side downward current is stronger than all the other currents. This predominance implies an additional amplification of the storm-time R2 FAC on the dusk side, which is related to the partial ring current.” This would need more discussion and definitely a reference.

Section 4.3

- “pre-storm time”. It would be good to define from the beginning, what is the onset of the storm time, and maybe mark that in all the figures.

- l. 18 “Comparing Fig. 1 and Fig. 4 one can see that EqB more closely follows the variation of SYM-H.” I agree that since end of Sept 7, the boundaries seem to follow SYM-H, but not before that. Maybe the author could check the correlation to AE-index as well?

Section 4.4

- “The current intensity vary inversely with scale”. Please give a reference.

- It is unclear how Figure 7 is composed. What are the horizontal and vertical axes? Is the figure even needed in this paper?

- In this section suddenly Te and Usc are discussed without anywhere properly explained, how it has been derived (which instrument, references etc)

Section 5.1

- “The considerably elevated Te within the arc and just poleward of the arc is associated with a local amplification of electric field.” I don’t understand this sentence. To my understanding, electric field data is not used in this study. Furthermore, why Te enhancement would be associated with enhanced EF?

Section 5.2

- Reference to Wang et al. (2004) is not found from the list. maybe it should be 2006?

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