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

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Swarm field-aligned currents during a severe magnetic storm of September 2017 by Renata Lukianova

The paper presents the results of the analysis of FAC dynamics during the September 2017 geomagnetic storm as observed by the Swarm satellites at LEO. The analysis is based on the Swarm 1 Hz single satellite FAC product. FACs (density, dawn-dusk asymmetry) observed in four different MLT sectors (midnight, noon, dawn and dusk) are compared both at large and small scales. The movement of the equatorial boundary of the FACs associated with enhanced storm-time and substorm-time geomagnetic activity is also investigated. It is found that the most intense small-scale currents show up during substorms in the post-midnight sector and that the night-time FAC dynamics

is mainly controlled by substorms. Another finding of the paper is the dawn-dusk asymmetry manifested in the enhanced dusk-side downward R2 FACs. Moreover, a bipolar FAC structure is identified prior to a substorm onset that is attributed by the author to a mesoscale auroral arc.

General comments

In general, the paper presents a case study, interesting new observations, however, in some cases it is not clear whether the presented observation and result is new or just confirmation of previous findings. This should be clarified and emphasized in the discussion section. The study of the dawn-dusk asymmetry comparing the dusk-side and dawn-side portions of the same orbit (practically in 1D), especially at small scales, is questionable since this approach ignores the 3D distribution of the current system. Based on the presented figures and tables the calculation of the MLT is very suspicious (see below in the specific comments). Since the MLT information is essential for the whole analysis that may fundamentally affect all the results and conclusions, the paper cannot be accepted before this serious issue is fixed. There are a series of other smaller issues (listed below) that have to be considered before a possible acceptance.

Specific comments

p 3 l 1-10 The description of the storm evolution needs some correction and complementation. Give the time of the shock arrival on 6 Sep. The trigger of the first substorm is first identified as the southward turning Bz at 18:30 on 7 Sep, then a few lines later, as the second shock arriving at 22:00. In contrast with your description, SYM-H was not recovered on 8 Sep.

p 4 l 4 and 6 Description of the Swarm constellation has to be revised. The orbit inclination for SwB is different from that of the other two. As a consequence, the separation between B and (A and C) is increasing. In Sep 2017 it was already close to 6 h (and not 1.5 h) as you can easily check on your Fig. 2. p 4 l 6 The slow drift is in MLT not in longitude. p4 l 7 Since any orbit consists of two parts separated in local time by 12 h,

you only need around 4 and a half (and not 7-10) month of data to cover all local times.

p 4 l 8 The description of the derivation of the FAC product is very inaccurate ("from the measured magnetic field variations, which results from FACs, the current densities are computed. . ."). You may just describe the Swarm single-satellite FAC product mentioning its limitations.

p4 Description of the plasma product is missing.

Figure 2 a) From the polar plot presenting the orbits in the MLT-mlat system, it is suspicious that your MLT calculation is not correct. 2 h change in MLT within a few days is not realistic.

Figure 2 b) I cannot make sense of this figure: daily variation of MLT as a function of MLT. On the x-axis, MLT runs from 0-24. And it is not a straight line!

Your MLT calculation has to be revisited and clearly described in the paper.

Table 1 The same MLT issue.

Section 4.1 FAC densities You may want to rename this section in relation to the title of Section 4.4 'Small-scale FACs'.

Figure 3 b) and p 6 l 12-13 What I see is R1 upward and R2 downward.

p 7 l 5-6 This wording ('determined by averaging the positive (negative) FAC densities from a current free location at the lowest and highest MLat of each crossing') is confusing, rephrase. What is the advantage of using the average densities instead of the 'total' (integrated?) densities? As you mention, the two correlates. Does it mean that the variation of the range of FAC latitudes is not significant?

p 7 l 9 precession?

p 7 l 11-18

p 9 l 7 'The largest FACs are observed' > 'The corresponding/associated FACs are the

largest. . .' (after all the shocks and substorms already mentioned the reader is getting lost)

p 9 l 15 'there is no' > 'we could not find any'

p 10 l 10 The definition of the EqB is not clear: "at least eight values before and after the central point do not exceed 0.1 uA/mˆ2" Do you mean the smoothed values? Before and after? Central point of what? Estimate the scale of the considered FACs.

p 10 l 19 "considerable" > "moderate"

p 11 l 8 "is seen only . . .. unaffected" > "is the largest . . . less affected"

Figure 5 MLT values given in the figure caption and in the legend are different

p 12 l 6 "resolved spatial scale" > "spatial resolution"

p 13 l 5 and 7 Reference to Fig 7a and 7b are exchanged

p 14 l 10 FFT?? Isn't it just a boxcar smoothing?

p 14 l 17 20000-40000 cm-3 seems a bit low for topside Ne, please confirm

p 14 l 19 Note, that as far as I know, the Swarm Te values are still uncalibrated. If still so, please make a note.

p 15 l 13 ". . . a decrease in Ne (which is usually much less pronounced than a decrease . . ." ?

p 15 l 14 "are created" > "may be created"

p 17 l 24 "is associated" > "is likely associated"

p 18 l 5 "It confirms the fact" If it is a fact, why does it need confirmation? Your statement that large-scale FACs are composed of more intense small-scale FACs is not supported by your analysis. You also mention that others found that small-scale FACs are mostly associated with Alfvén-waves.

p 18 l 15 The scale length range in the brackets is for small-scales?. What scale was taken as a large scale? The given density value (0.5) is for large scale? Please clarify.

p 19 l 3 Is your definition of EqB of large-scale FACs is comparable to that of the cited paper?

p 19 l 15 Image > IMAGE (the name is an acronym)

p 19 l 22 equatorial > equatorward

p 20 l 9 'indication' this asymmetry is well-known, you may say, your observation is in accordance with this.

Technical corrections

p 6 l 11 Aan > An

p 7 l 4 is > are

p 9 l 5 and 7 (also elsewhere) 'in the northern hemisphere', 'in the night side', 'in the day side' > 'on the night side', 'on the dayside', 'on the northern hemisphere'

p 9 l 13 'coherence' > 'correlation'

p 14 l 7 (and elsewhere) 1-sec FAC > 1 s FAC or 1 Hz FAC

p 14 l 21 0.4 and 2% > 0.4% and 2%

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