Responses to the Reviewer #1 comments on the revised manuscript [angeo-2024-28]

"Small- and meso-scale field-aligned auroral current structures, their spatial and temporal characteristics deduced by Swarm constellation"
by Hermann Lühr and Yun-Liang Zhou

We are grateful to the reviewer for the continued effort to review our manuscript. The constructive comments have helped to improve the study. Below, please find our replies. For the convenience of the reviewer, we first repeated the reviewer's comments and then give our answers in blue text. Modifications in the manuscript are marked as red text.

This is my second review of this manuscript. The manuscript seeks to examine field-aligned currents across a range of scales using data from the Swarm spacecraft, notably examining the extent (both spatially and temporally) that these currents are stable by using a period when the spacecraft separation was changing. They provide potentially interesting new insights into small-scale (km scale) currents.

Thank you for the positive rating of our revised manuscript.
Meanwhile we have extended our previous study to the smallest scale FAC structures at auroral latitudes, by making use of the high-resolution 50 Hz magnetic field samples of the Swarm A and C satellites. The close connection between the small-scale FACs (5-40 km scales) and km-scale FACs (0.5-5 km) becomes very evident. In the present study we could, due to limited time resolution, only suggest such a connection, but the new study shows that km-scale FACs only appear when the small-scale FACs exceed a certain amplitude. At the same time, the broad-band signal of the km-FACs contaminates the small-scale FAC B-field variations. All this confirms the conclusions derived in the present study. If there is an interest, a pre-print of the new study is available at:
https://editor.copernicus.org/EGUsphere/ms_records/egusphere-2025-1961

In the revised manuscript, at the end, an editorial note is added to this follow-up study.

The revised manuscript addresses many of the points raised in the earlier review, however I don't think the essence of my concern over the methodology has been fully addressed. The revised manuscript clarifies the data intervals and step sizes used for the different filtering bands but still shows that the number of possible FAC perturbations possible in each window varies for different filter bands. For example, for the 1-3 s band a 32 s data interval is used meaning 32 to ~11 perturbations can occur within that interval. The same interval is used for the 3-7 s band, which means ~11 to ~5 perturbations can occur within that interval. This has the potential to bias any cross correlation. In addition, because the step sizes are also held constant for a given data interval, the step size can varies between just over the size of one perturbation in the 1-3 s band to less than half a perturbation in the 7-13 s band. Given that the comparison between the bands is a key result of this manuscript, I believe it is necessary to be assured that the variation in relative interval and step size is not influencing the results. My suggestion to the authors is to pick use data intervals that are, for example, 3 times the longest period in the filter band and a step size that is half the data interval to test that their results are robust.

We have tested the reviewer's suggestion and repeated the cross-correlation analysis by using a set of time intervals and step sizes that closely follow the period ranges of our six signal bands. This change in processing scheme has hardly any effect on the obtained results. For demonstrating that, below are the original Figure 5 and the newly processed Figure 5 shown, as examples. Just the occurrence rate of the shortest period, 1-3 s, has become slightly larger.

In the revised manuscript we have adapted the proposed set of cross-correlation parameters, as listed in the new Table 1. We admit that it is more plausible. As a consequence, also the Figures 3, 4, 5, 6 and 8 have been replaced with the newly obtained. Luckily, no significant changes have resulted from this reprocessing. Therefore, hardly any changes in the manuscript are required. All the derived conclusions are still valid. Even though, we think, the study approach has become more convincing with this modification

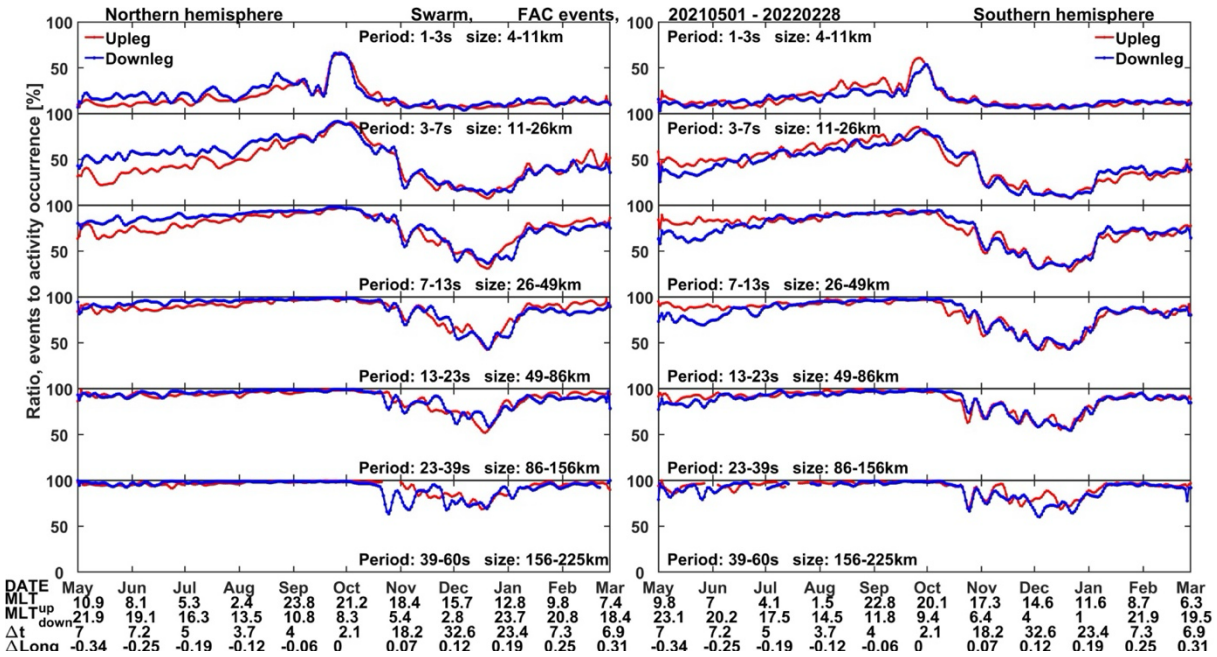

Figure 5. The same format as Figure 3, but for the ratio of detected static FAC structures (Fig. 4) divided by all the number of wave structures presented in Figure 3.

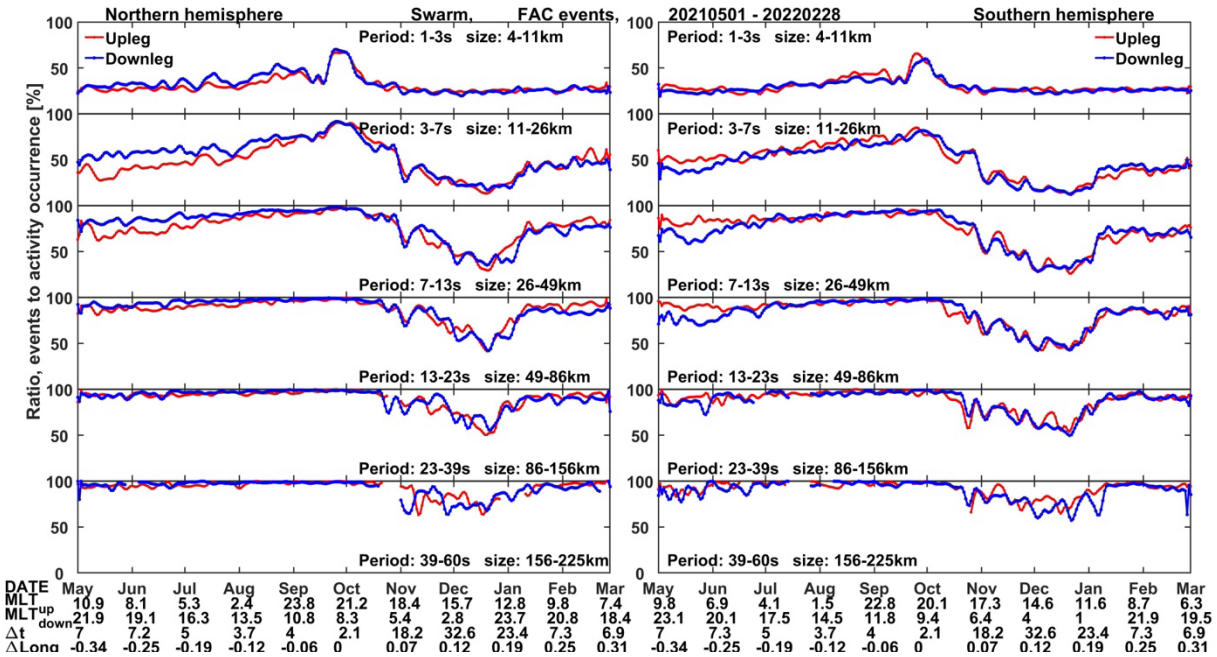

Figure 5. New version

Minor comments:
Line 23 - I am not sure what is being referred to when the text says "it is weaker". If it is the strength of the small-scale FACs then could I suggest "these FACS are weaker"

The text has been changed accordingly.

Throughout - the text refers to "along track wavelength" (Line 118), "scale size" and "horizontal size" (Line 182) and similar within the text. I suggest it would be helpful to the reader if these were referred to consistently. I would proffer that along-track and cross-track scale size or longitudinal and latitudinal scale size would be a good way to refer to the different scales.

We use the term "along-track wavelength" deliberately in the beginning of the manuscript because it provides a direct relation to the apparent period of the signal recorded by the satellites. This changes from line 176 onward, where we define the scale size, which is halve the wavelength. Subsequently, we refer to FAC scale size or scale length, as recommended. In individual later cases, where the term "wavelength" still appears, it better fits the context. The term, e.g. "horizontal scale" is only used when referring to related statements in cited papers.