Geosci. Instrum. Method. Data Syst. Discuss., 4, C28–C31, 2014
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Geoscientific Instrumentation Methods and Data Systems Discussions

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4, C28–C31, 2014

Interactive Comment

Interactive comment on "An initial investigation of the long-term trends in the fluxgate magnetometer (FGM) calibration parameters on the four Cluster spacecraft" *by* L. N. S. Alconcel et al.

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Received and published: 29 April 2014

The authors would like to thank the reviewer for these detailed comments. We have addressed the comments point by point below.

"Abstract (and conclusion), "... the observed long-term accuracy demonstrated in this initial study gives confidence in the relative accuracy ...": The authors should point what exactly is meant with relative accuracy. Furthermore, it would be important to get a number for the remaining uncertainty (e.g. spin axis offsets during the phase without calibration) followed by a discussion of its compliance with the initial performance

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requirements defined for the Cluster mission."

We have decided to remove the term "relative" from the abstract. We have also added text to Sections 2.6 and 3 to re-emphasize that the article is a primarily descriptive account of the calibration parameter survey. We have not attempted to quantify the uncertainty in the FGM parameters post-calibration, nor incorporate them into a comprehensive error analysis of the instrument, which would be an enormous, and entirely separate, piece of work. Our response to Reviewer 2 includes additional information that might be of interest.

"Figure 10 - Figure 14: Plotting the gain and angular drifts with identical scaling could improve the readability."

Figure 10 to Figure 14: These plots have been regenerated, since corrections to the largest outliers to the calibration parameters have been made. The removal of extreme values has improved the readability. The axis ranges have been chosen to make the best use of the available plotting space and bring out as much detail as possible.

"Fluctuations in gains and angles: It is quite a surprise that the gains as well as the angles fluctuate so much. Was this also measured during ground calibration before flight? It would be very important to list the gain drift parameters due to sensor temperature variations measured on ground. There are fluctuations of the gains in the order of several percent which cannot easily be explained with changes of the sensor as well as maybe the electronics temperature."

We have modified section 2.6 to emphasize that the calibration parameters selected from the Fourier analysis are selected solely to minimize the signal power at the first and second harmonics of the spacecraft spin frequency. For the large fluctuations seen in, for example, the spin-axis gain in Range 4, we are aware that these values cannot be explained by physical phenomena and are therefore likely due to calibration errors. As stated in the Conclusion, we plan to revisit and, where possible, correct all of the anomalous calibration parameters observed during this study.

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"The variations in the angles is almost a mystery. The alignment angles are normally sensor specific and should be the same in ALL RANGES; if not in all ranges then at least in the three lower ranges R2 - R4. Here it is definitely not the case and therefore it would be very interesting to have a comparison with the pre-flight calibration. Was it different too?"

Our response to the previous comment also applies here. We have added a statement to Section 3.2.1. to the effect that the standard deviations for the calibration parameters (including the angles) should be viewed as a measure of the calibration error rather than physical variability in the sensor itself.

"Conclusion: What would be the goal of future investigations of correlating features observed in the instrument housekeeping and calibration parameters?"

Potentially, dependence on the instrument electronics v. the sensor could be elucidated. For example, if a parameter showed a dependence on the bus current, its variability could be linked to the electronics.

"What temperature is meant on page 13, line 8? Are the drift parameters similar like those measured during ground calibration?"

The sensor temperature. The text has been modified to state this specifically. On the ground, the offset parameter drift was observed to be 0.02 nT per degree C, which is consistent with what is observed in flight.

"Page 14: Frequently switching through all ranges in low field would have solved some problems discussed in this part of chapter 3.2.1. Is there a specific reason why this hasn't been done?"

We presume this comment refers to the shortage of calibration information, particularly offsets, for the higher instrument ranges. The use of the higher ranges for scientific purposes was not anticipated during the earlier phases of the mission. Calibration sequences involving cycling through the higher ranges in low field have recently been

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added to the instrument operations, but the results have not yet been investigated thoroughly.

"Page 16, line 4: The interesting behaviour of the spin plain gains in Fig. 11 are also seen in the relative azimuthal angles of Fig. 14. The authors might consider it to be a processing artefact since those two parameters are linked in the spin tone correction?"

We appreciate this very good point. Both the azimuthal angle difference and gain difference in the spin plane contribute to the second harmonic. None of the absolute angles we have calculated exhibit this behaviour, which would suggest that the link to the temperature cycling may be coincidental. It may be noise-related. The data are much cleaner in the Tail season, which might lead to reduced fluctuation in the calculation of these parameters, for example. We have modified the text to include this potential explanation.

"Page 16, line 15: "... spikes of around 0.002 and 0.04_ occur ...": Is this a typo because in the figure the spikes are much larger."

This was indeed a typo, which has been corrected. The plots have also been re-generated, since the calibration parameters have been corrected, so the spikes are somewhat smaller – though sadly still not in the range of 0.002 degrees!

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 4, 43, 2014.