Referee report on the manuscript "Optimized Merging of Search Coil and Fluxgate Data for MMS" by D. Fischer et al.

General comments

For measurements of some quantity the instruments of different types are often used. Particularly in space-born projects as well as during ground-based geophysical surveys the magnetic field fluctuations are simultaneously measured by fluxgate and search coil magnetometers. The optimal combining data of both instruments is important task for obtaining high quality results with the best available signal-noise ratio (SNR). From this point of view the approach, methods, models and techniques described in the paper are important not only for a case study devoted to the Magnetosperic Multiscale mission (MMS), but for a wide range of similar applications. Surely the paper tries to answer questions within the scope of GI journal.

In general the approach used by authors to merge data from the instruments with different frequency responses is straightforward and clear. It contains following steps. Basing on the noise characteristics specify the merging frequency, where noise levels of both magnetometers are equal. Then estimate the end-to-end frequency responses of individual instruments and develop its appropriate models. Apply these models for the frequency compensation of the magnetometers data, convert data to the same sampling frequency and synchronize samplings. Make alignment of the axes and gain corrections and, finally, apply appropriate crossover filters and merge the data taken in the appropriate for each magnetometer frequency bands.

The presented in the paper example of this approach application confirms that merging in-flight data were synchronized within required limits (<100 μs), however the estimation of the gain mismatch was quite large due to the low signal-noise ratio in the analyzed frequency band 10-50 Hz. Probably, a higher signal-noise ratio and better validation of the proposed merging procedure could be obtained, if the records of the noise signals used for the frequency response calibration would be compared instead or in addition to the in-flight data processing. The estimation of the noise level of the merged fluxgate and search coil data is highly recommended, as it would also confirm achieving of the main goal of this work – improving SNR of the combined data. In my opinion, the step and impulse responses of the merged data have to be checked too, in order to estimate the possible differences between the combined data and the original magnetic field signatures during the fast changes of the latter.

The important task is a selection of the proper parameters of the crossover filter for merging data. The authors states that a high order crossover filter is necessary in order "...to track the best noise floor..." of the instruments, however, this statement was not backgrounded in the paper and no appropriate references were given. First of all, it is unclear how the crossover filter could track the instruments' noise floor. Secondly, in my opinion, even the second order crossover filter is sufficient for combining data.

The overall presentation is quite well structured and clear, however, in some cases using mathematical expressions and formulae instead of text descriptions, as well as giving more details about the developed models and data processing techniques would be more useful for reproduction of the proposed approach by other researchers.

Specific comments

p. 6, section 2.3 Model Development.
For the sake of traceability of results the developed IIR model of SCM would be presented by expression in analytic form, and the typical shape of the impulse response of the FIR models for fluxgate magnetometers would be given.

p. 4, lines 27-29 and p. 5, lines 3-7. Was the current in the coil measured by an independent instrument? If not, it is not clear how accurately the frequency response of the DSP voltage channels was estimated. Is it assumed that the current amplitude at all applied frequencies was constant?

p. 5 lines 14-22. What were parameters of FFT-based frequency response calibration - duration of the stimulus signals, FFT length, overlapping, type of the correcting window, if any? What are principal limitations, which did not allow improving phase delay estimations at the frequencies < 20 Hz?

p. 6, lines 12-13. It is unclear why so high DC gain (220 dB) of the shelving filter is necessary for frequency compensation of the SCM transfer function in the band from 0.1 Hz to 500 Hz, while the ratio of the gains of the original transfer function at these frequencies is approximately equal to -86 dB (Figure 4 in the manuscript and Figures 9 and 14 in Le Contel et al., 2014).

Technical corrections

p. 2, line 4, in my opinion, it is better to use "...5 $pT/\sqrt{Hz}$..." or "...5 $pT/Hz^{1/2}$..." or "...5 $pT\ Hz^{-1/2}$..." instead of "...5 $pT\ \sqrt{Hz^{-1}}$ ..."

p. 4, line 31, probably word "with" could be omitted.

p. 5, lines 7, 8. The sentence "The later noise tests were therefore conducted using the current measurements of the DSP channels, as this resulted in reduced effort in calculations. " What does the phrase "the current measurements of the DSP channels" mean? Does it mean that during the noise tests the voltage proportional to the stimulus current in the coil was measured using one of the DSP voltage channels? In this case, probably, it has to be formulated as follows "the current measurements **via** the DSP channels".

p. 6, line 26, probably, the second word "instead" could be omitted.

p. 9, lines 17, 18, probably, the second word "interpretation" could be omitted.