Answers to the comments from Anonymous Referee #1

We thank the referee very much for their time and their detailed comments! We are sure the proposed changes will improve the paper. In the following, we will address each point separately.

General comments:

The title was changed to “Comparison of noise levels of two magnetometer types and their suitability for different space environments” to represent we only used two magnetometers and different space regions. Additionally, we made it clearer that the FGM used is state-of-the-art and thus comparable to others (page 3, line 80).

The size of the ring cores of the FGMs used is 13 mm (for XZ direction) and 18 mm (for YZ direction) (analog to the ring cores used in Auster et al., 2008). This was also added in the paper (line 82f.)

The AMR hybrid sensor has a volume of 1.67 cm^3 with a 16 mm diameter and 8.3 mm height. (Leitner et al., 2015) This was also added in the paper (line 88).

It is of course true that there is a correlation between the general noise level of an FGM instrument and the physical dimensions of its magnetic core. Of comparable influence are the impacts on the noise level due to production variation, excitation power, feedback noise, winding numbers or pickup tuning, to name a few. In addition, bigger fluxgates are heavier and need more power, making them disadvantaged for use in space applications.

Nevertheless, this study was not targeting a full parameter study of fluxgate sensors, but to illustrate the usability of the presented instruments for different space environments.

It is a valid point to say the AMR and the FGM used are of different sizes. AMR magnetometers are smaller than FGMs and need less power. However, they are based on thin films in the micrometer range that give them their uniqe properties. Increasing the AMR to the size of the FGM would make them lose the thin film specific desired behavior, so they would not yield the same functionality as before. Additionally, these components would not be off-the-shelf available anymore and thus increase the price, which is a key selling point for using AMR magnetometers in the first place (low cost).

There is work being done on so-called fluxgate on chip, see e.g. Ma et al., 2024 (600 µm ring core) or Lu et al., 2014 (less than 1 mm wide core). These come with higher noise levels than the fluxgate sensor used in this paper (61-87 pT/Hz1/2 at 1 Hz depending on direction in Ma et al., 2024; 50 pT/Hz1/2 @ 1 Hz with 50 Hz excitation and 790 pT/Hz1/2 @ 1 Hz with 25 Hz excitation in Lu et al., 2014), but they are mostly still lower than the noise levels of the AMR magnetometer presented in this study. Furthermore, we think going into such detail of the different sizes of magnetometers is – though quite interesting – out of the scope of this paper.

We checked again for consistency in abbreviations, symbol usage, and units and made corrections/ adjustments where necessary.

Specific comments:

page 4, lines 111-112:
The sentence was changed and a link to the results section is now given.

page 4, lines 118-119:
An explanation for the percentiles is now included in the text.

page 11, lines 228-230:
Thank you very much for pointing out a better source for a comparison value of spectral slope! The old one has been replaced.

Technical Corrections:
page 5, Table 1 and lines 132-134, page 11, line 237:
The unmatching values of Table I and the caption/text have been corrected. The values have been rounded to 1 pT.

I got the measurement data from A. Valavanoglou (as shown in the reference list), if plotted one can see it is not the exact same measurement as used in Leitner et al. (2015) (difference in levels of B and temperature). Nevertheless, they are from sensors developed for SOSMAG. The noise levels of 210 pT/Hz1/2 are in the same order of magnitude as given in the paper (100 pT/Hz1/2), thus saying "an AMR magnetometer as used in SOSMAG" seems - in our opinion - appropriate.

page 11, lines 236-239:
The expression "at lower frequencies" has been specified as well as the meaning of "not suitable". We agree that in theory, at sufficiently low frequencies the SNR of an AMR should become suitable for measuring natural signals. However, the lowest frequency is given by the length of the time interval measured. For this study, the time intervals of the natural signal measurements were chosen to be 5 min long, giving a minimum frequency of 3.3 mHz. Also, it needs to be taken into account that the length of the time intervals is restricted by how long a spacecraft can dwell in the space region under consideration. This is restricted by the spacecraft's velocity, which is usually in the one digit km/s range, given e.g. for a THEMIS satellite an orbit period of about 26 h. In this time period, it will cross several space regions. If it was staying in only one space region, this would yield frequencies in the µHz range. At last, the offset stability for AMR magnetometer cannot be assumed to be constant for long time periods. (see Schulz et al., 2019)

References

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