"General comments"

The paper “Comparison of noise levels of different magnetometer types and space environments” by Gerlinde Timmermann et al. contributes to the instrumental base for studying magnetic phenomena in various areas of space. The scientific and technical questions addressed in the paper are within the scope of GI.

The authors carefully and comprehensively thoroughly analyze the intensity and spectral characteristics of low-frequency (from 0.001 to 2 Hz) magnetic field oscillations in various regions around Earth and evaluates the applicability of two types of magnetometers (fluxgate (FGM) and anisotropic magnetoresistive (AMR)) for measuring such signals. The noise performance of an instrument is used as the primary characteristic for comparison. As a FGM instrument a science grade magnetometer similar to those used on Rosetta, THEMIS and JUICE space missions was selected for the noise level estimation. One of the instruments of the magnetic measurement system, known as the Service Oriented Space Magnetometer (SOSMAG), was chosen as an AMR type magnetometer. This device was installed inside the Korean GEO KOMPSAT–2A satellite to correct high-intensity magnetic interference generated inside the satellite in the recordings of more precise fluxgate magnetometers in the SOSMAG system.
A comparison of noise level measurements shows a significant advantage of the FGM magnetometer over the AMR one. The authors concluded that the FGM instrument can be effectively used in all four scenarios considered for measuring magnetic phenomena in near-Earth space. The AMR magnetometer is capable of measuring natural signals only in the magnetosheath, where the most intensive magnetic field disturbances occur.
The paper does not answer the question of how the noise characteristics of the devices selected for analysis compare with various other FGM and AMR magnetometers in terms of this parameter.
So it is not comparison of “different magnetometer types” as the paper title declares, but rather a case study of the two FGM and AMR instruments for space applications.
In general noise level of fluxgate and search coil sensors depends on physical dimensions of their magnetic cores: the larger the core, the lower the noise level. How do the dimensions of the sensors in question compare?
What will the noise level of the FGM instrument be if its sensor is reduced to the size of the AMR sensor? Or what will the noise level of the AMR magnetometer be if its sensor is increased to the size of the FGM sensor?

The authors based their research on analysis of a large number of related studies and this is reflected in the list of references.

The abstract clearly and completely represent the contents of the paper. The paper's title suggests a broader scope than what's actually covered in the paper.
The overall presentation of the research results is well structured, but some statements and formulations are not sufficiently clear. Abbreviations, symbols and units are fairly defined and used.

"Specific comments"

page 4, lines 111-112

"Additionally, this leads to a noise floor where all disturbances are from the spacecraft (as seen later) and only general space phenomena are perceptible."

In my opinion, this sentence is not clear enough. It would be helpful to explain its meaning in more detail and provide a link to a specific subsection (or subsections) in the article instead of "as seen later".

page 4, lines 118-119

"For each data set and frequency, the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles of the square roots of the PSDs ($P(f)^{1/2}$, also called the amplitude spectral density) are calculated."

Please explain the rule used to calculate the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles of the PSD square roots.

page 11, lines 228-230

"The amplitude spectral density of the FGM is shown in Fig. 1(a). It has a spectral slope of $\alpha = -0.75$, approximately following a 1/f noise spectrum as is expected in this frequency range (Hooge et al., 1981). It exhibits the lowest values of all data sets, going down to 9 pT $Hz^{-1/2}$ at 1 Hz."

It appears that the article (Hooge et al., 1981) does not directly discuss 1/f noise in fluxgate magnetic sensors. At least, the chatGPT5 model provides the following response:
"That classic review (Hooge, Kleinpenning & Vandamme, Rep. Prog. Phys. 44, 479–532, 1981; DOI: 10.1088/0034-4885/44/5/001) surveys 1/f (flicker) noise across many electronic materials and devices (e.g., metals, semiconductors, MOS devices), but I can't find any indication that it treats fluxgate magnetic sensors specifically. Abstracts/records describe scope limited to general mechanisms and device phenomenology (e.g., McWhorter vs. mobility-fluctuation pictures) rather than fluxgates."
It would be helpful to indicate which section of the review (Hooge et al., 1981), if any, refers to magnetic noise in fluxgate sensors.
The topic of FGM magnetic noise (MN) is discussed in the paper Korepanov et al., 2001, see Section 2, p. 138:
"By its character MN is similar to flicker noise, for which α=1 (and even more than 1) is usually taken. However our detailed research of the MN frequency spectrum for different materials and designs in the frequency band up to 1 mHz showed that the value of α for FGS has to be accepted in the limits of 0.75–0.8."
Please note that Korepanov et al.,2001, used the slope parameter α in the formula
$b_F(f) = b_{F0} [1 + (f_0 /f)^{\alpha}]$, where b_{F0} is the minimum $b_F(f)$ value at relatively high frequencies, and f_0 is the corner frequency. Thus, their positive value of the parameter α corresponds to the negative value of the slope α in the paper under consideration.

"Technical corrections"

page 5, Table 1 and lines 132-134, page 11, line 237

The values of the amplitude spectral density of FGM and AMR magnetometers at 1 mHz (77.91 and 1277.36) and AMR at 1 Hz (157.09) in Table1 are different in comparison with values at these frequencies on the plots in Fig.1, 2, A1, A2 (110-115 at 1mHz for FGM, 2100 at 1 mHz and 210 at 1 Hz for AMR). It appears that the values (77.91 and 1277.36) in column $P(f)^{1/2}$ @ 3 mHz (1 mHz) of Table 1 are actually given at 3 mHz, not 1 mHz as stated in the Table 1 capture and line 134. The noise level of AMR magnetometer also mentioned later (page 11, line 237) as 157 $pT/Hz^{1/2}$ at 0.5 Hz is also in contradiction with plots in Figures 1(b), 2, A1, A2.

Neither 157, nor 210 $pT/Hz^{1/2}$ at 1 Hz does not corresponds to the overall instrument noise density 100 $pT/Hz^{1/2}$ at 1 Hz specified in Table IV "SOSMAG AMR Instrument Spec" of the paper (Leitner et al., 2015).

In addition, all amplitude spectral density values in Table 1 are unnecessarily precise. In my opinion, these numbers can be rounded to 1 pT without any loss of information.

page 11, lines 236-239

" However, the general noise level is significantly higher with 157 pT $Hz^{-1/2}$ at 0.5 Hz compared to the fluxgate magnetometer as already seen in the last section. Since this is at quite a high level, this AMR magnetometer is not suitable for scientific measurements at lower frequencies though there are other AMRs with lower noise floors as described in Brown et al. (2012)"

What means expression "*at lower frequencies*"? Lower than what and why "not suitable"?

Taking into account spectral slopes of the natural phenomena (-1.81 … -1.36 at f<0.1 Hz) and that of the AMR magnetometer (α=-1.02 at f<0.03) the lower frequency, the higher signal/noise ratio is expected. Thus, at a sufficiently low frequency, the signal-to-noise ratio becomes suitable for measuring natural signals, doesn't it?

References

Korepanov, V., Berkman, R., Rakhlin, L., Klymovych, Y., Prystai, A., Marussenkov, A., & Afanassenko, M. (2001). Advanced field magnetometers comparative study. *Measurement*, *29*(2), 137-146.