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Interactive comment on "Advanced calibration of magnetometers on spin-stabilized spacecraft based on parameter decoupling" *by* Ferdinand Plaschke et al.

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To begin, this is an excellent paper.

The paper describes an in situ calibration methodology for spacecraft vector magnetometers, which this reader views as a process of four steps from ambient field to despun discrete time series data. These four steps are:

1. signal collection by a spinning magnetometer system, which is a full quadrature amplitude modulation.

2. disturbances to the signal in the form of offsets, gain and alignment errors

3. inverse transformation to correct for disturbances

4. despinning of the data, which is a full quadrature amplitude demodulation.

The paper is largely about determining the parameters for step 3, the inverse transformation. The determination process is that of a typical inverse problem where the the minor terms of eq's 24-26 serve as the residuals. Iterative processing is normally used to minimize the residuals, which the authors indicate as having occurred here. The process has been further optimized by the use of unbiased selection of data segments likely to yield best inverse transformation parameter estimates.

Any mismatch between the disturbances and the inverse transformation leads to data errors in the form of carrier feed-through and non-zero frequency sum and difference components which manifest as baseband and 2nd harmonic terms. These terms are highlighted in equations 24-26, and in Section 4.

Equations (20,21)

Although it is entirely obvious that ωt is the spin parameter, to be consistent with the excellent presentation of parameter definitions up to this point, ωt could beneficially be defined here. As the paper is written this spin parameter appears to apply to both steps 1 and 4, the amplitude modulations and demodulations. In the case that the modulation frequencies are identical the situation can be called synchronous demodulation, which has huge advantages. In general though, the modulation and demodulation frequencies are not identical, but are determined and matched very accurately. As the spacecraft ages and fuel is used, not only are spin angles changing, but so are moments of inertia. The spin frequency cannot be determined from the short analysis periods, due to well understood uncertainty principles. As noted earlier in the paper the spin frequency/angle were determined as a priors, using the IGRF and other tools. Some brief discussion is recommended as to the definition of ω and ωt, and how they relate to the amplitude demodulation parameters. Also, for the determination of g, the X/Y gain ratio, the choices of +/-15% [page 15] of the carrier/spin frequency seem large in context of equations 30 and 31. Is this a requirement of the data rate?

Equations (24,25)

Each of these equations consists of five terms, pair-wise similar. As this is the end of section 3, for the general reader some brief summary descriptions could be useful. The first terms are the primary measurement terms, while the second and third terms represent (roughly) the modulations of the X/Y offsets and the projection from the spin axis into the spin tone. The fourth and fifth terms are the 2nd harmonic terms resulting mainly from the differential gains of the X/Y channels. A quick review of the physical mechanism leading to a detectable 2nd harmonic term would be useful as the reader at this point needs a clear understanding that he or she is considering only despun data. Section 4 goes into all of this in further detail.

The use of rotations in fields as the basis for a calibration methodology now has a long history. This reader's first contact with such ideas was that of A.W. Green Jr, in the 1980's. Green took on the much easier task of calibrating observatory magnetometers, for which multiple rotation axes were possible. Green's description of his method can be found as doi.org/10.1016/0031-9201(90)90217-L . Such methods have come a long way.

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