TREATMENT OF SATELLITE ERRORS IN THE PROCESSING OF MAGNETIC SURVEY DATA

Malcolm D. Shuster, Business and Technological Systems, Inc.,
Suite 440, 10210 Greenbelt Road, Seabrook, Maryland 20706.

A number of spacecraft errors effect the processing of magnetic satellite survey data. These include:

- payload alignment errors
- payload calibration errors
- random payload noise
- spacecraft attitude sensor alignment errors
- attitude sensor calibration errors
- random attitude sensor noise
- orbit determination errors

Payload errors naturally receive careful scrutiny in the scientific data analysis. However, the contribution of the time-dependent attitude sensor errors have not always been taken into account. This leads to an overestimate of the accuracy of the magnetic field data and may account for part of the current disparity between computed field-model estimation errors and observed sampled errors.[1] As an example, consider the contribution of random attitude sensor noise on the measurements of a mission like Magsat. If P_θ is the covariance of the attitude errors and P_B is the covariance of the vector magnetometer errors (both computed with respect to estimated body axes), then the covariance of the errors in the measured magnetic field is not P_B but

$$P_B + M_B \, P_\theta \, M_B^T \, ,$$

where M_B is the antisymmetric matrix having elements $(M_B)_{12} = B_3$ and cyclically. For Magsat, attitude determination errors were about 15 arc sec per axis, leading to a contribution to the effective field measurement error of as much as 4 nT per axis. This should be compared with the error budget for the vector magnetometer itself, which was less than 4 nT per axis.

The contribution of all error sources to the analysis of magnetic satellite survey data will be examined and the proper treatment of these in data processing discussed.

---

[1] R. A. Langel, "Main Field" in *Geomagnetism Vol. 1*, J. A. Jacobs (ed.), Academic Press (in Press)