

ACE/MAG Calibration Method:

November 7, 2007

Zero calibration of the ACE MAG instrument is performed by a Moore-Penrose quasi-inverse calculation (see Wolfram MathWorld web pages for Moore-Penrose analysis technique and Numerical Recipes for single-valued decompositions) that seeks to make the magnitude of the magnetic field $|B|$ constant while allowing the components of the magnetic field to vary. This is an ideal way to perform the calibration of zeroes that does not rely on curve fitting that is so often corrupted by start/stop time issues as would be the case for fitting of simple sinusoids. Residual uncertainties in sensor zero levels are the dominant contributor to the ± 0.1 nT uncertainty estimate in field component values.

Both MAG sensors (A and B on opposing sides of the spacecraft) are kept in calibration, but only sensor B is used for science-level data. Experience has shown that this sensor remains in the more sensitive range longer, yielding better data. Sensor A is maintained in the eventuality that sensor B may fail, thereby guaranteeing there is no loss of data should that occur.

The calibration routine is not foolproof and can yield poor results that sometimes exhibit good fit parameters (eigenvalues). Time and experience has led us to believe these solutions do not represent transient magnetic signatures associated with the spacecraft, but are simply poor solutions to the analysis for whatever reason. Data is processed in bulk and a best-fit calibration curve is run through the optimal solutions. Experience has shown that changing the calibration too often to fit the calibration analysis results in poor data quality with improper spectral characteristics. Hence, calibration of the MAG instrument is an interactive process best performed by experienced personnel.

All data processing and code maintenance is performed by the instrument lead, C.W. Smith. A recent change to the processing algorithm allows for the semi-automation of the zeroes analysis. This has greatly reduced the time needed for basic calibration work and freed time to be used more profitably in science and providing specialized data products for others.

The MAG analysis and data production platform is presently in transition from a VMS machine originally purchased one year before the ACE launch to a more modern DELL/UNIX platform that provides 30x the compute power. For this reason, significant changes in the processing codes are underway. MAG processing codes are written in a combination of HDF, C, and Fortran that are linked together through data passing structures. These languages are not constant across platforms and the transition to the new machine is slow. Once completed, the extra compute power will be used to further automate and refine the calibration analyses and a new release of MAG data is anticipated.