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TO: Distribution

FROM: 695/M. H. Acuña

Subject: STEREO spacecraft static field mapping after compensation magnets installation

1.0 General

The STEREO spacecraft (A & B) were tested to verify the correct installation and effectiveness of magnetic field compensation magnets. These magnets were designed to cancel out the significant static field produced by the latch valve assemblies and the TWTA amplifiers located near the base of the IMPACT boom. The fields produced by these assemblies were previously mapped at the component level and analytical quadrupole models developed to predict the magnetic field at the location of the IMPACT/MAG sensor. Based on these results and a the availability of suitable locations on the spacecraft bus, two compensation magnets per spacecraft were designed and selected to minimize the static field produced at the MAG sensor location. These magnets were adjusted and tested at GSFC prior to their installation on the respective spacecraft.

2.0 Mapping Procedure

The mapping procedure was based on tests previously conducted for other spacecraft such as ACE, Mars Global Surveyor, WIND, POLAR, etc. A handling fixture that would allow spacecraft rotation and translation on a horizontal plane parallel to the boom axis was not available. The STEREO IMPACT boom deploys along a direction parallel to the spacecraft lifting axis during ground mechanical operations so it was decided to implement the required translations by using an overhead crane to simulate deployments along the boom axis. A sensitive magnetometer (variometer) was placed on the floor immediately below the undeployed IMPACT boom and aligned with the boom axis. The overhead crane was then used to lift the spacecraft in a direction parallel to the boom axis at a maximum speed dictated by safety considerations. The maximum safe height above the floor and magnetometer sensor achieved by this procedure was ~ 3 meters measured from the spacecraft bottom panel. The magnetometer readings were recorded as time series as the spacecraft were repeatedly raised and lowered between ~0.6 m and ~3 m as measured from the bottom panel. The magnetometer ambient field readings due to the geomagnetic field were cancelled out prior to each lifting operation. The magnetic signatures of the overhead crane and lifting harness were mapped prior to attaching the spacecraft and found to be negligible at the measurement distance and as compared to the minimum detectable field change (~ 1 nT).

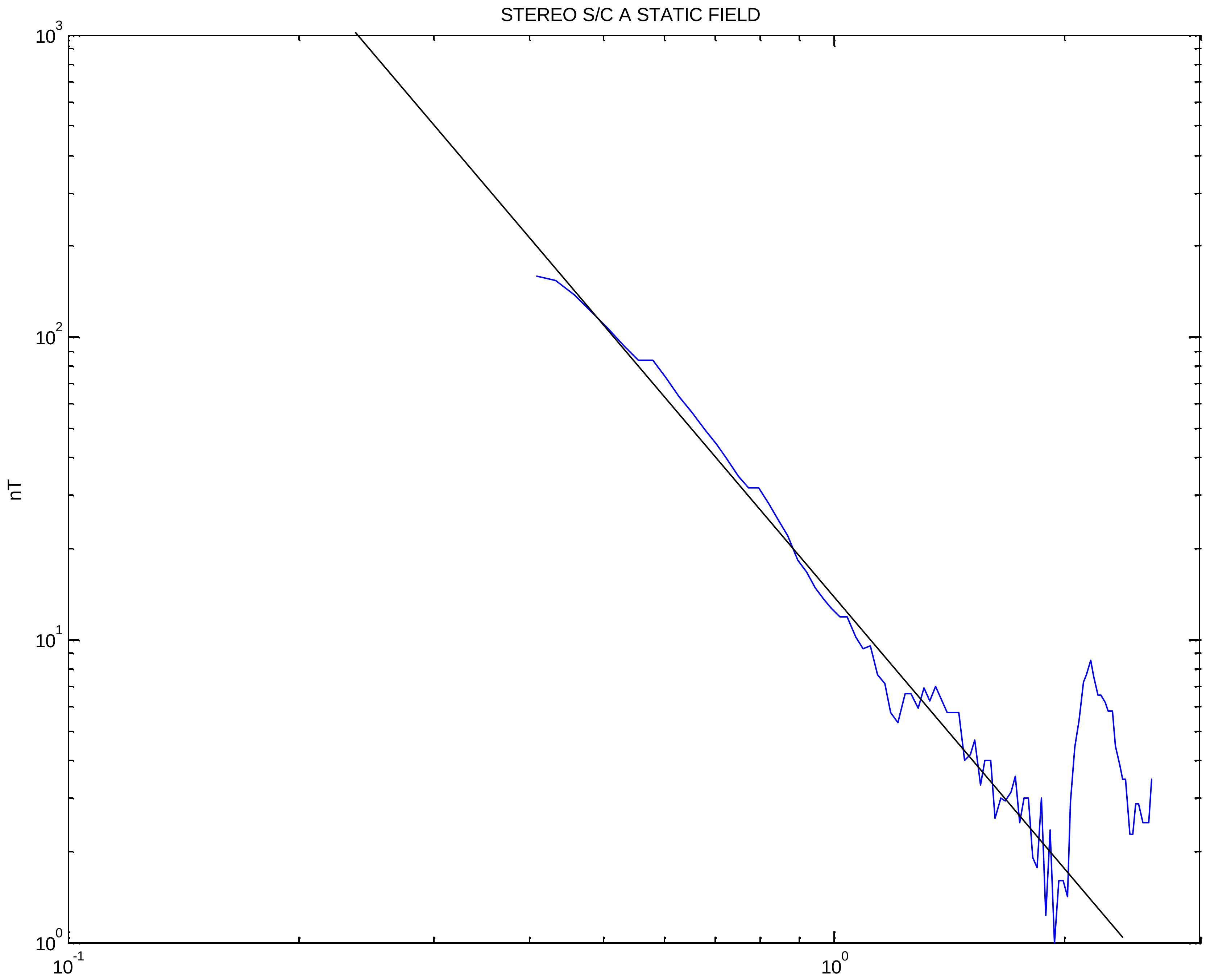
3.0 Results

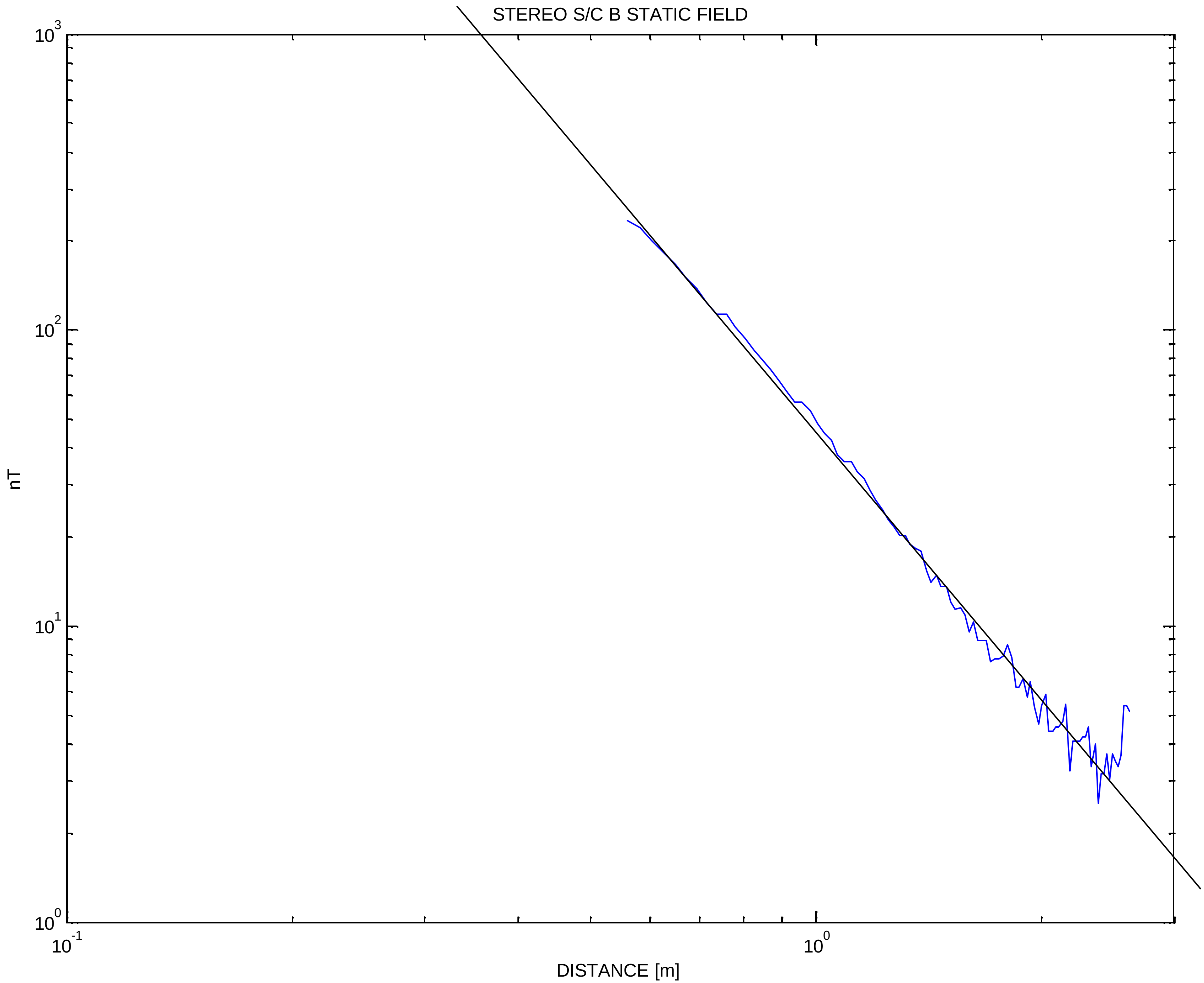
The total variational field (delta from ambient) recorded by the test magnetometer was plotted as a function of distance for repeated lifting tests of both spacecraft selected for minimum external perturbations. The results of these tests are summarized in Figures 1 and 2. Additional results obtained by “swinging” tests of each spacecraft were included in qualitative assessments of the measured fields. The figures show the static field measured by the test magnetometer as a function of “adjusted distance” with respect to an assumed ideal dipole source. This adjusted distance reflects the fact that the true near-distance to the assumed single dipolar source is not known a priori due to the distributed location of the latch valves, TWTA and compensation magnets. The radial variation of the measured field will only approximate that of an ideal dipole for distances that are larger than the extent of the source. In the case of the STEREO spacecraft tests, the reference distance was that measured between the floor and the bottom panel. The adjusted distances, selected to reflect the discussion above, include minor adjustments to the origin, typically < 0.1 - 0.2 m and have negligible effects on the conclusions.

Figure 1 shows the results obtained for Spacecraft “A” . The blue line illustrates the measured field while the straight black line illustrates the expected fall-off with distance for an ideal dipole field (1/r^3). The predicted field at the deployed location of the IMPACT magnetometer sensor is << 1 nT demonstrating excellent compensation of the TWTA and propulsion assembly static fields. The blue line also shows the effect of external perturbations not associated with the spacecraft field when the measured field becomes smaller than ~1 nT.

Similar results for the STEREO “B” spacecraft are shown in Figure 2. The predicted static field at the location of the deployed IMPACT MAG sensor is slightly larger, ~1.6 nT an acceptable value that illustrates an effective compensation of the TWTA and propulsion assembly fields. The difference with the results obtained for spacecraft “A” is attributed to the swapping of TWTA amplifiers with units for which exact magnetic field models were not available and similarity results had to be extrapolated. Nevertheless, the overall result of the compensation effort is considered to be within acceptable limits.

4.0 Figures


STEREO S/C A STATIC FIELD
nT
DISTANCE [m]
10^3
10^2
10^1
10^0
10^-1
10^0


STEREO S/C B STATIC FIELD
nT
DISTANCE [m]
10^3
10^2
10^1
10^0
10^{-1}
10^0