

# Revisiting HELIOS: The Magnetic Field Data

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# HELIOS

- 370 kg, 74 kg payload
- 500 kbit on-board memory
- 1 Hz spin
- 13 instrument suites, called experiments (abbreviated "E")
- HELIOS 1:
  - Launch Dec. 1974
  - 191 d period of revolution
  - 0.31 AU perihel
  - Sent data until Sept. 1985 (E1)
- HELIOS 2:
  - Launch Jan. 1976
  - 186 d period of revolution
  - 0.29 AU perihel
  - Sent data until Mar. 1980 (E1)

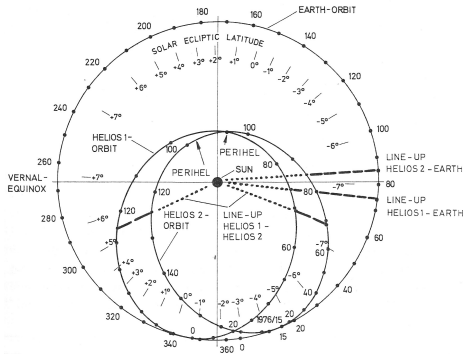


Figure: HELIOS Orbits (DoY 1976)

# The Instruments

- E1 Plasma-Experiment - Electrostatic Analyzers: Low-energy protons, alphas and electrons
- E2 Fluxgate Magnetometer I: Interplanetary quasi-stationary magnetic field and shocks
- E3 Fluxgate Magnetometer II: Interplanetary quasi-stationary magnetic field and shocks
- E4 Search Coil Magnetometer: Rapid magnetic field variations and magnetic shock waves

# The Different Datasets

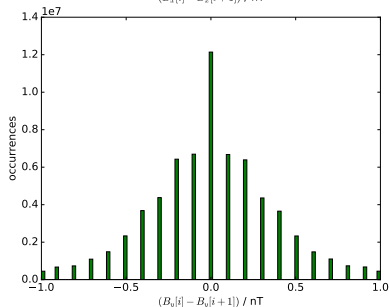
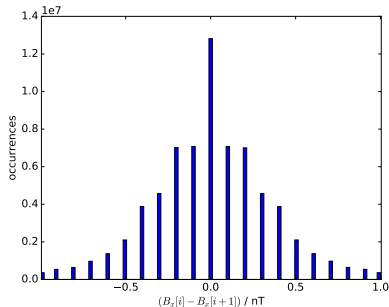
- 40.5 sec averaged data from the E1 dataset
- 40.5 sec averaged data from the NSSDC
- 4 Hz E2 data
- 6 sec averaged E3 data

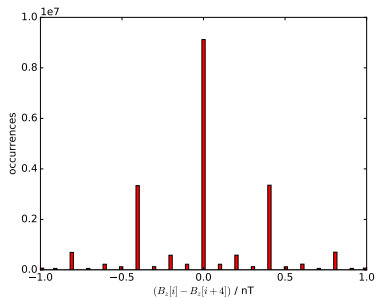
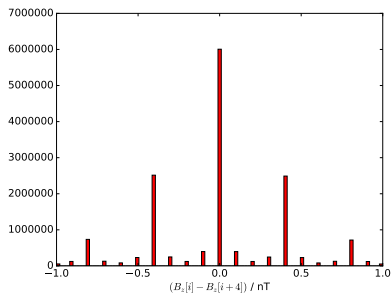
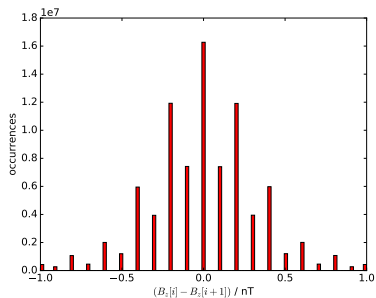
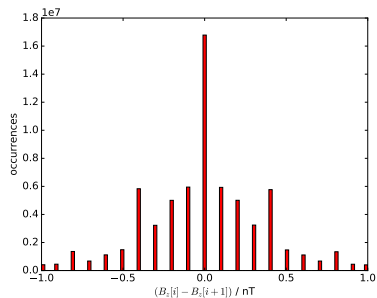


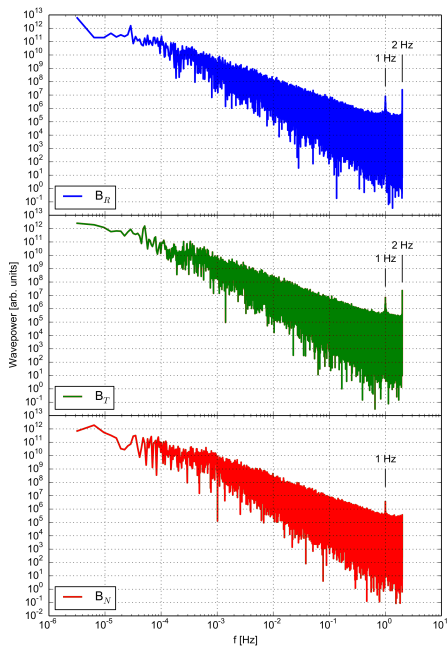
## Expected Precision:

- 8 bit and 1 bit sign
- $\pm 100$  nT measurement range

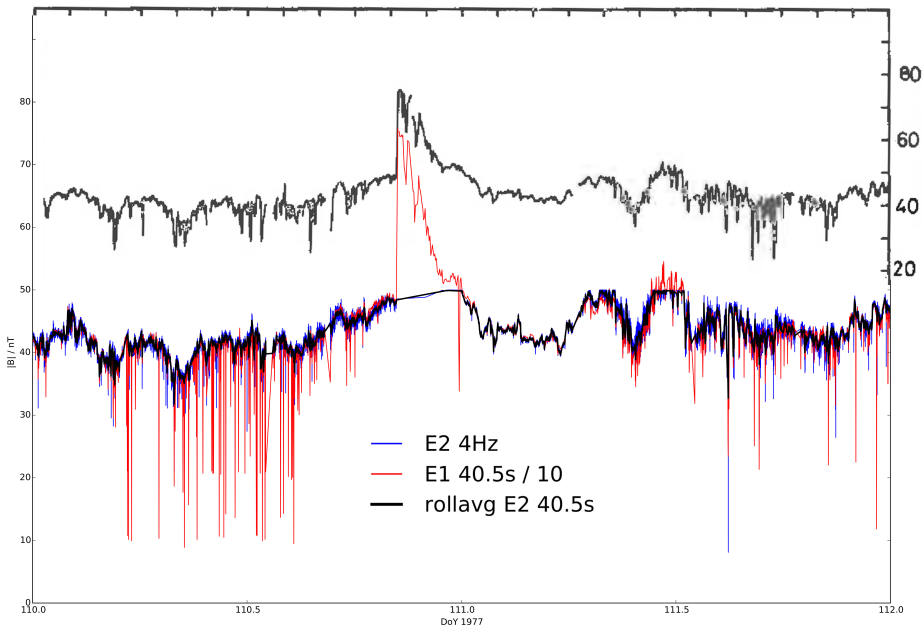
$$\rightarrow \frac{200 \text{ nT}}{2^9} \approx 0.4 \text{ nT}$$

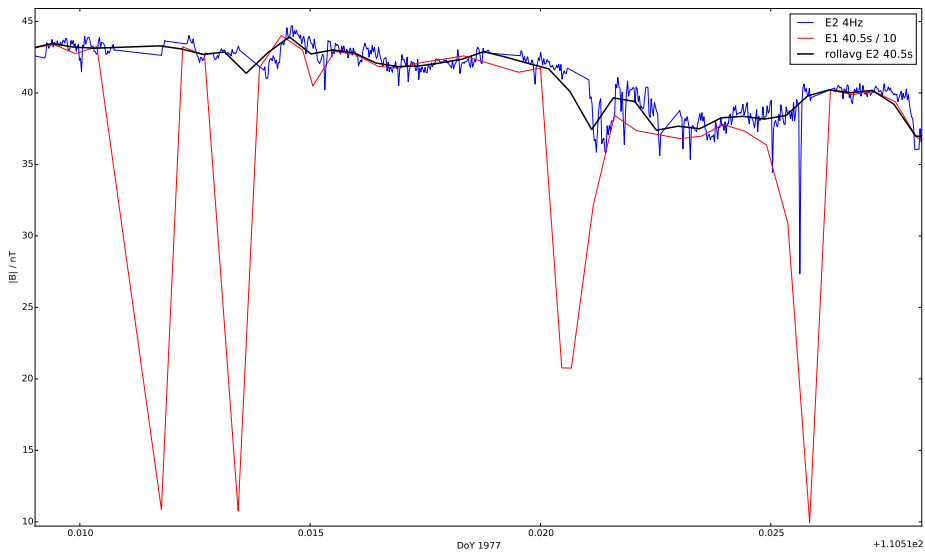


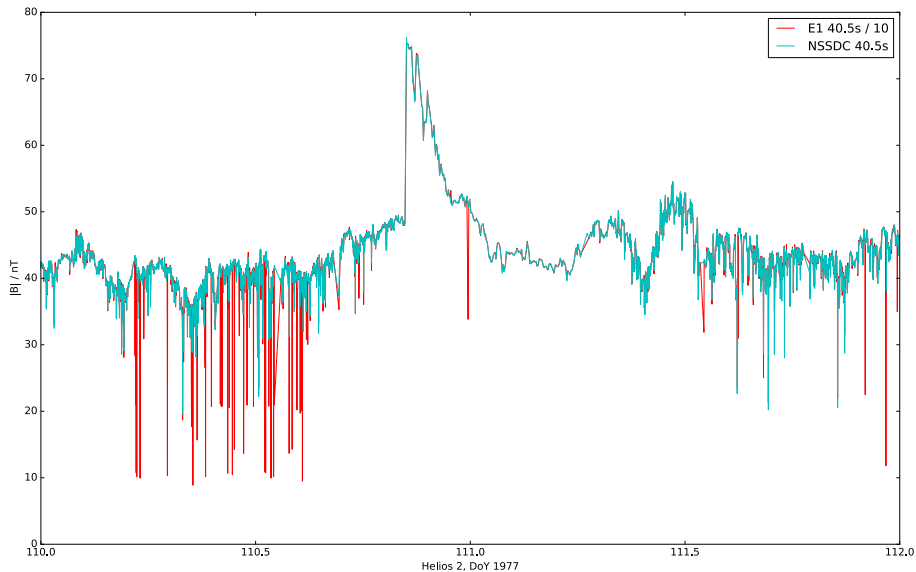


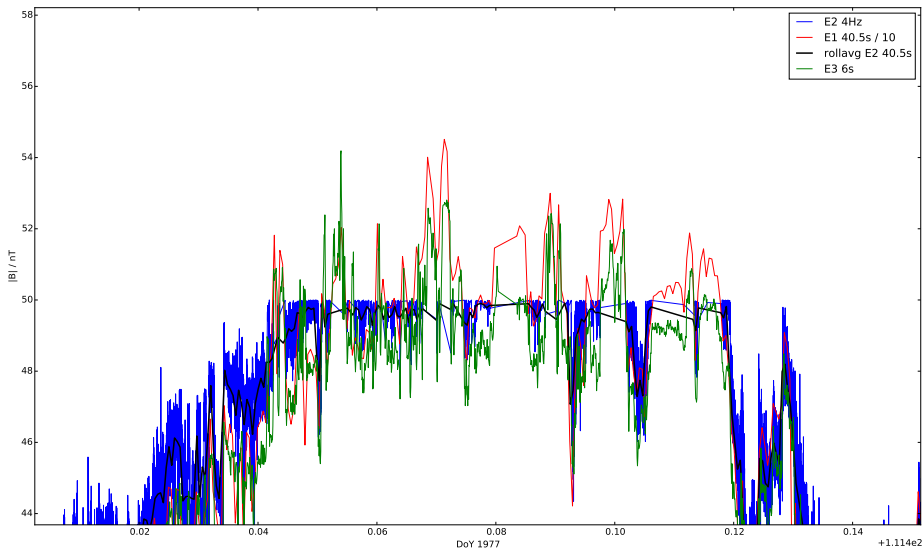


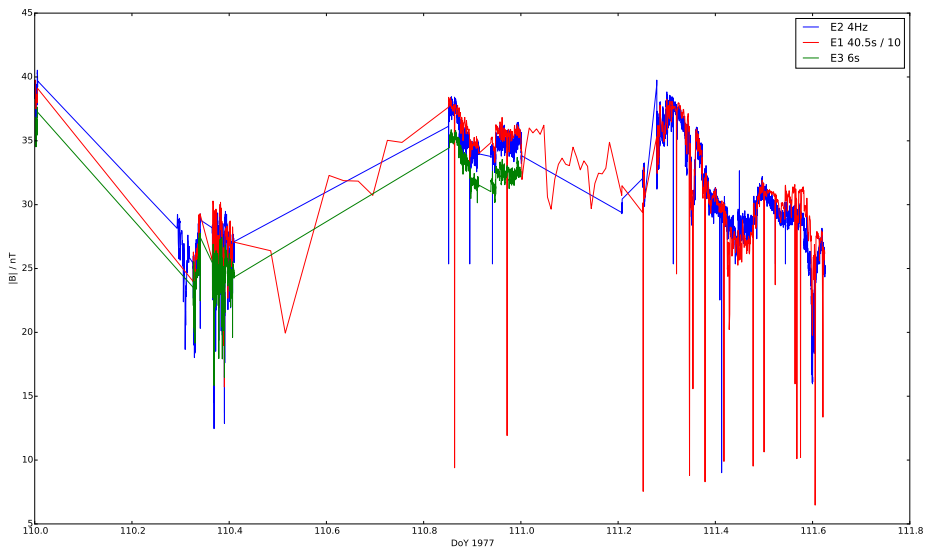


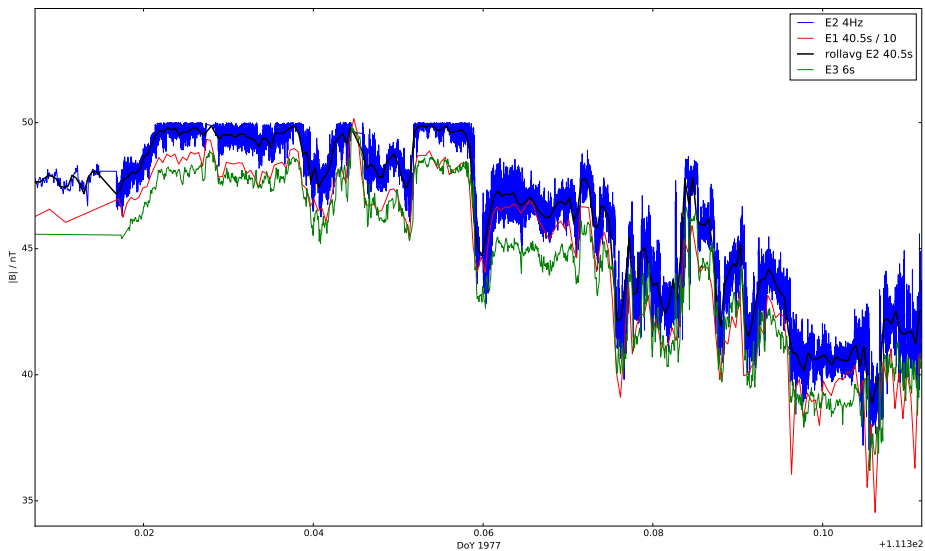


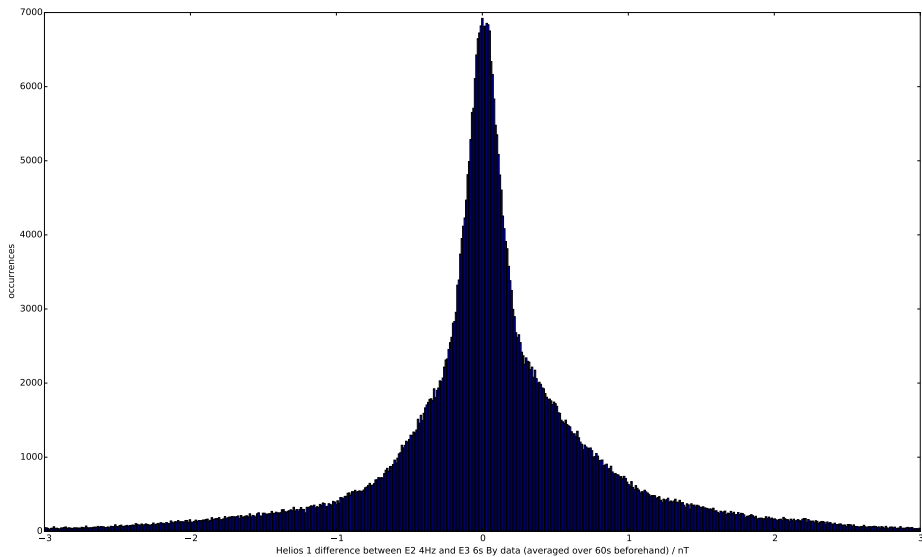


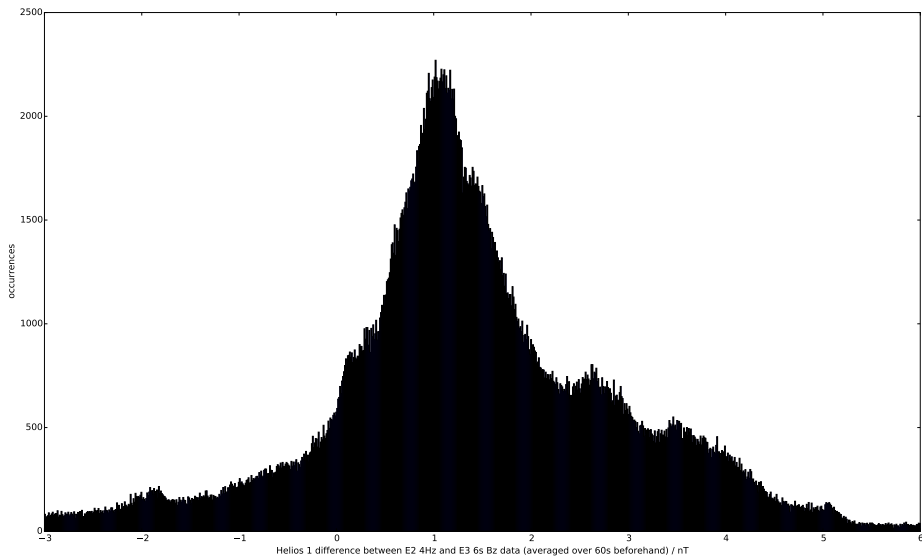




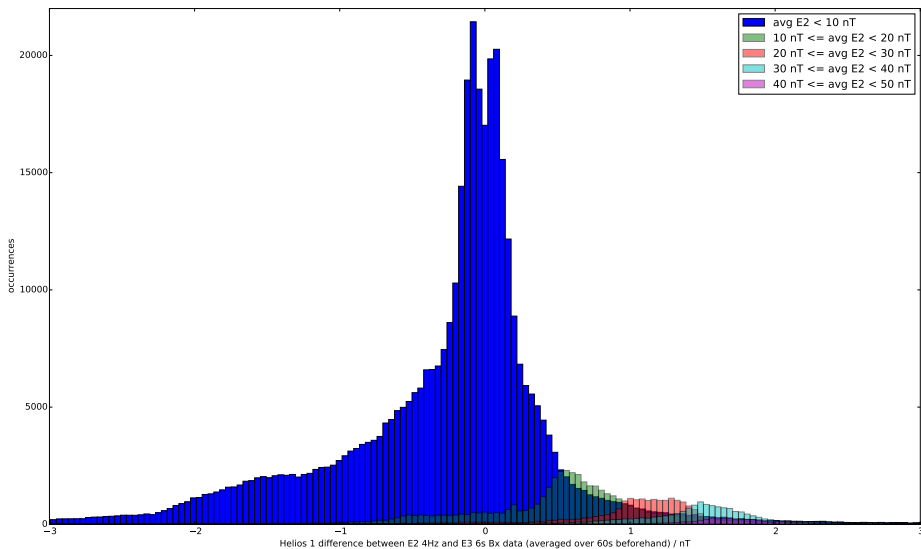


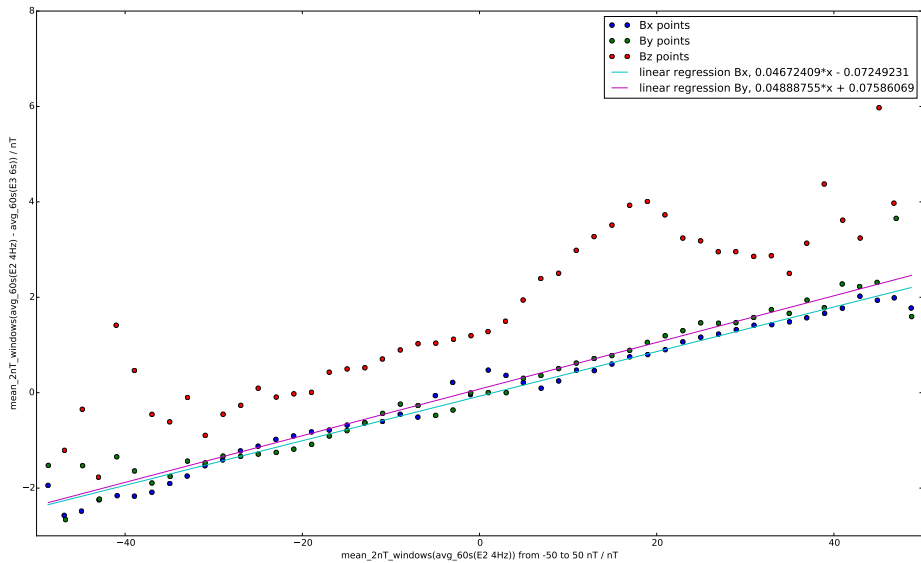












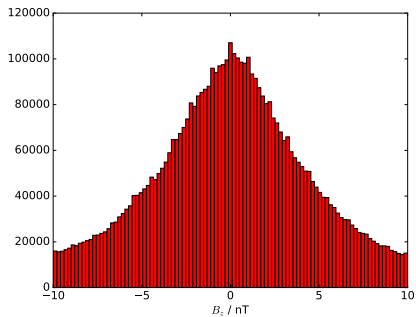
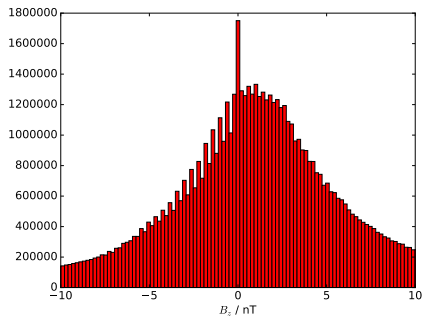
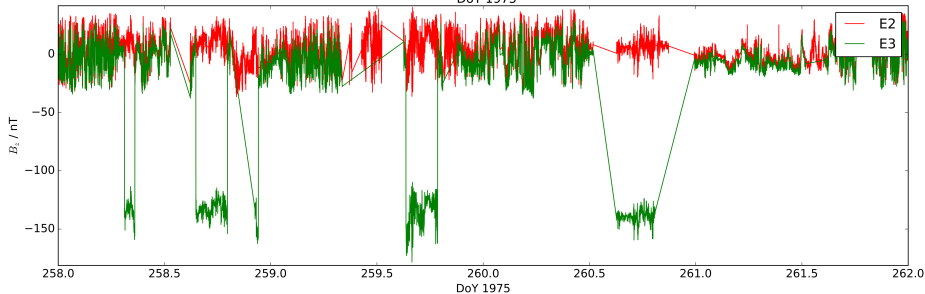
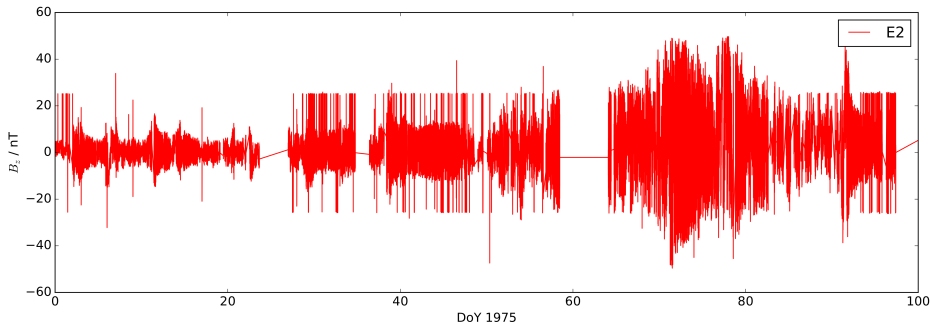


Figure:  $B_z$  histograms for the 4 Hz E2 (left) and 6 sec E3 (right) datasets, Helios 1

All datasets are pre-processed - this states the main problem. 40 years after HELIOS was launched, we cannot do anything about it.

- E1 The 40.5 sec magnetic field data was averaged with a fixed number of points, not considering data gaps. This is not the case for the NSSDC 40.5 sec averages.
- E2 The dataset is capped hard at 50 nT, but shows other unexpected data gaps too. The reason remains unclear; it might be that the shock mode data is missing.  
The  $B_z$ -component looks compromised due to a wrong zero-point correction.
- E3 The dataset is already averaged to a 6 sec resolution and has significantly more data gaps than E2.



# Conclusions

- The 40.5 sec averages (NSSDC and E1) were calculated with a more complete E2 dataset, but differently. They were not necessarily derived from the same dataset.
- Alfen speeds calculated with the E1 40.5 sec averages are erroneous, at least to some percentage.
- Recalculating the averages for E1 is challenging. The additional data gaps that were not present at the time of the first calculation and the 50 nT cap limit this effort. If one considers the zero-point correction issues as a minor problem, it should nevertheless be possible in many cases.
- The 6 sec E3 data may serve as a benchmark and as a substitution for the 4 Hz data in some cases, although the time resolution is comparably poor.
- All datasets combined offer the chance to bypass the problems of the individual ones. Nevertheless this requires a case-to-case analysis; automation to some degree looks possible but difficult.