Estimation of the IMF disturbances propagation delay time

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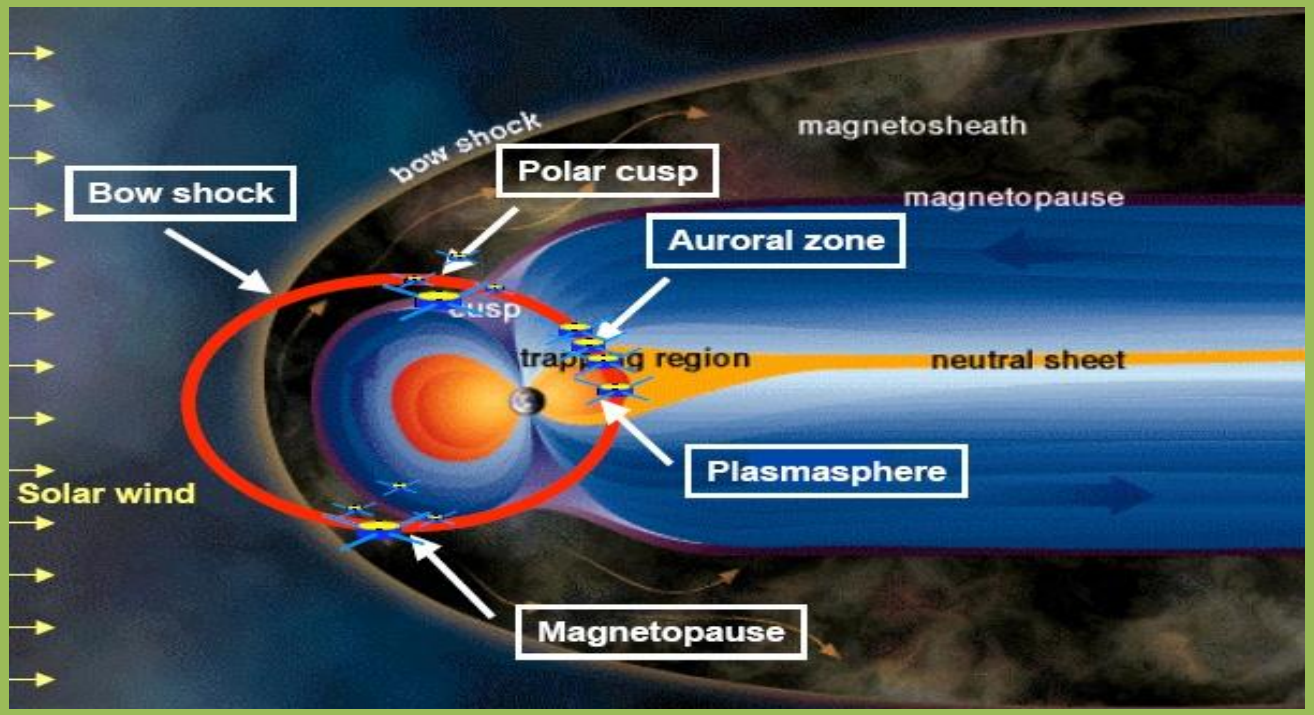
Background & Motivation

- Measurements of the Earth's magnetosphere are time shifted in comparison to the ACE measurements. This time shifting depends on the solar wind speed and IMF orientation.
- Estimation of the time delay is important for predicting of time of magnetospheric response to IMF discontinuities



Goals

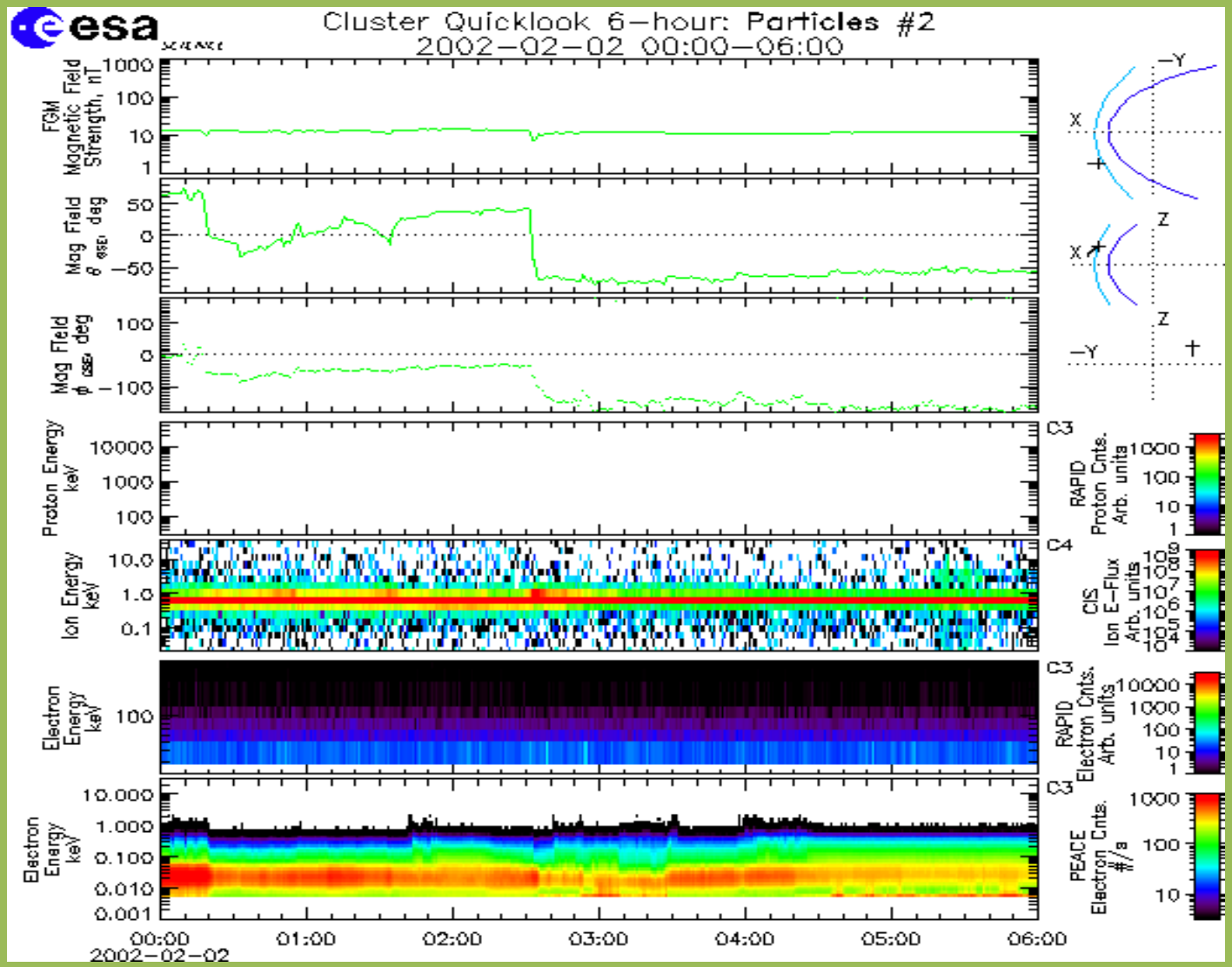
- Using three different methods for computation of the IMF time delay between ACE monitor and Cluster in the Solar wind region.
- What is the delay time using each method?
- Are more sophisticated methods better than simple model?
- What is the best method for computation of the delay time of the IMF?

Resources and Tools

- Cluster (SC3) data at
  http://www.cluster.rl.ac.uk/csdsweb-cgi/csdsweb_pick to find strong changes of **B** in the IMF.
- ACE data (cdf files) from
  http://cdaweb.gsfc.nasa.gov/istp_public.

- QSAS program to perform minimum variance analysis.
- Matlab code for calculation of the three models

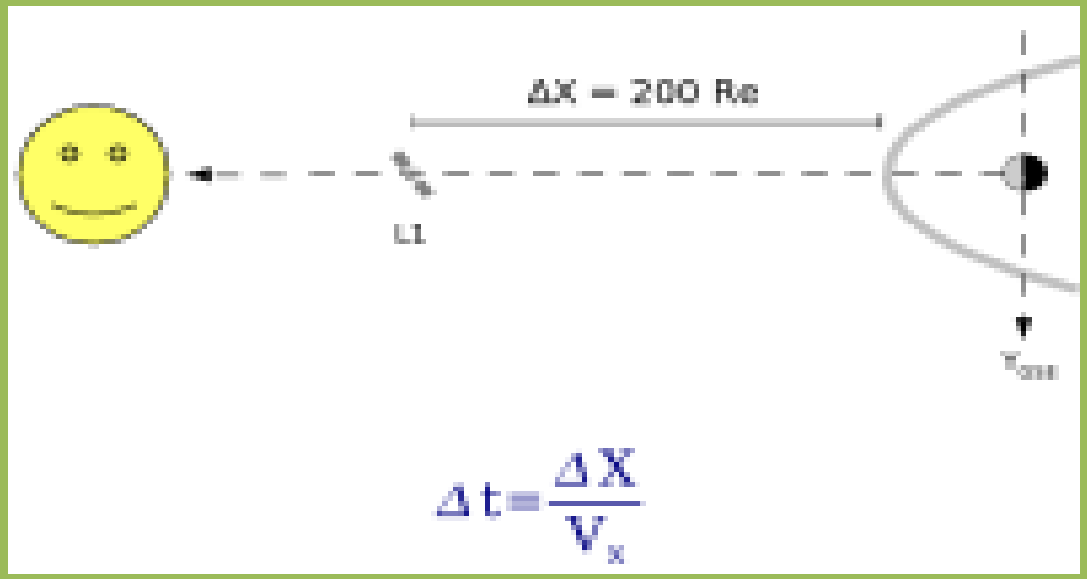
Example of input data – Cluster Quicklook



Methods (1)

Three methods were used for IMF time delay estimation

1. Simple method, which assumes a constant convective motion of disturbance along the Sun-Earth line.

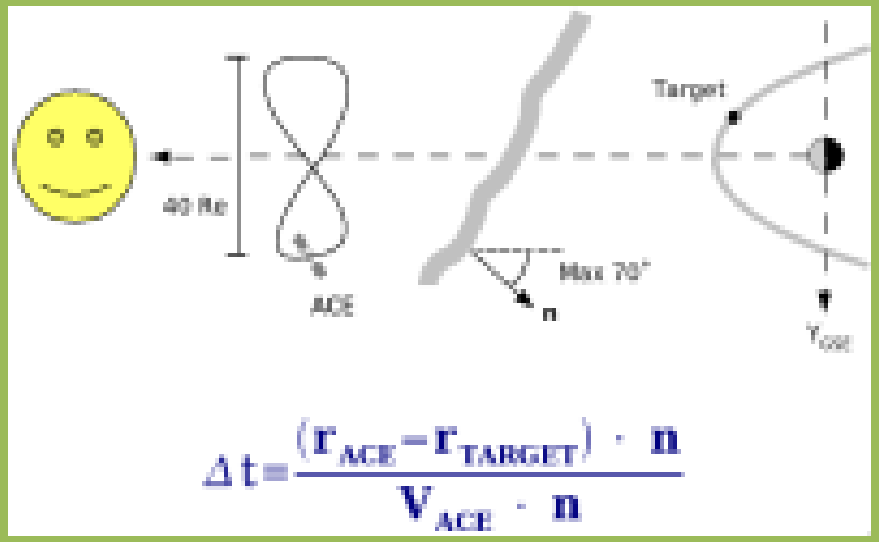


Δt – Time delay
ΔX – ACE-Cluster distance
Vx – Velocity of Solar wind along x direction (GSE)

Methods (2a, 2b) – Minimum Variance Analysis

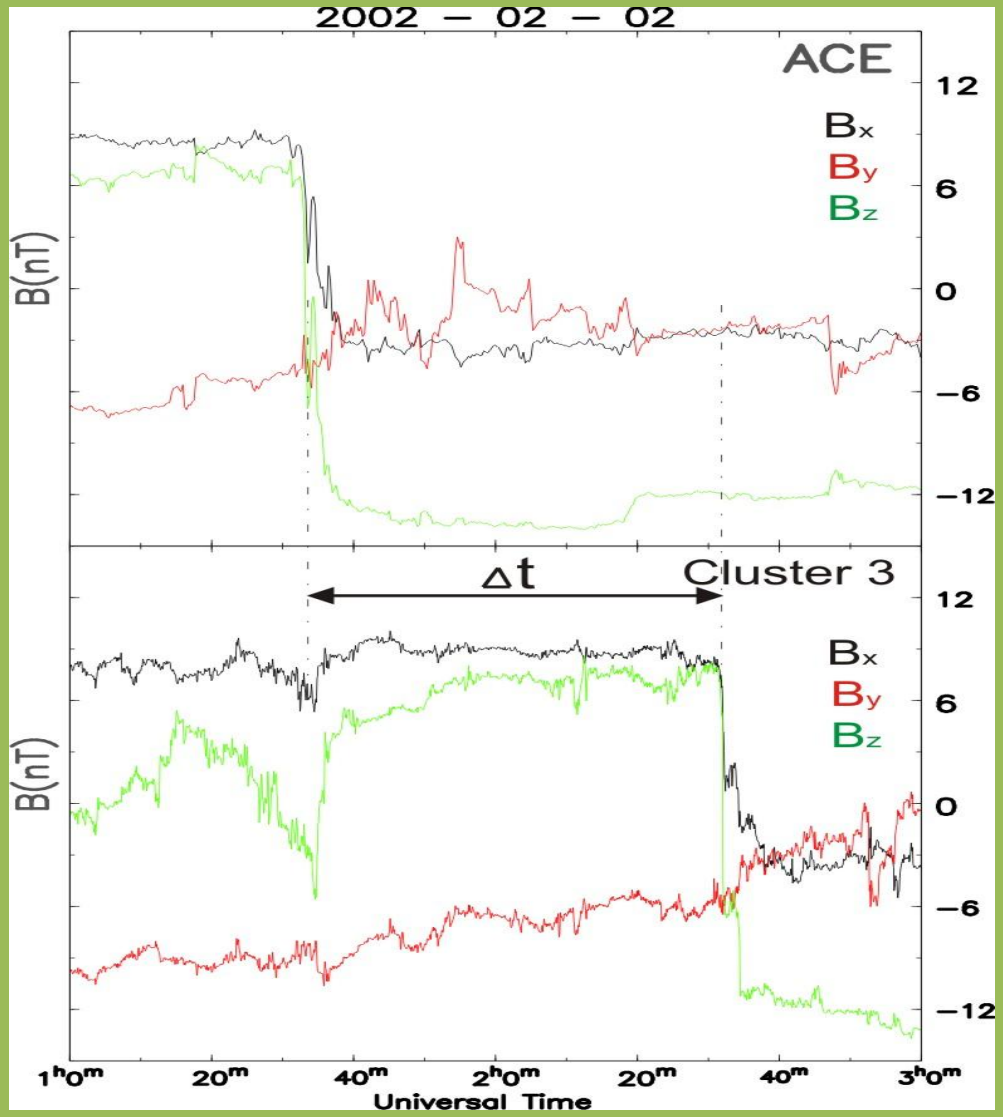
2a “Weimer unconstrained method”, that takes the orientation of discontinuity and real position of the solar wind monitor into account.

2b “Weimer constrained method”, which assumes that there is no magnetic field component along normal direction.



Δt – Time delay
rACE – ACE position vector
rTARGET – Cluster pos. Vector
VACE – Solar wind velocity at ACE position
n – Vector perpendicular to the IMF discontinuity computed by the means of MVA

Estimation of Real Time Delay



The value Δt is estimated using magnetic field measurement from ACE and Cluster. The time shift of **B** component gives the real value.

Time and organization management

- Bagrat Mailyan & Artur Reymers – ASRSEG (Armenian Space Research and Solar Event Group): finding events registered by Cluster 3 and ACE. Verified that both spacecrafts registered the same event, then download data. Analysis of some events using QSAS.
- Costel Munteanu – QSAS specialist: Analysis of most events with the program QSAS (calculation of the real delay time, minimum variance analyses).
- Zbysek Mosna – MS (Matlab Specialist): Computation of delay times using prepared data.
- Stein Haaland, Götz Paschmann – (KMPS) Knowledge, Motivation and Psychological Support.

Results

Date	H:M	φ(degrees)		Delay Time (min)			
		unc.	con.	Real Time	Method 1	Method 2a	Method 2b
12-Feb-01	12:11	33	57	57	58	62	48
2-Feb-02	2:33	44	51	59	65	56	52
23-Feb-02	21:42	44	25	61	65	57	61
1-Jan-03	19:29	85	58	65	63	151	68
2-Mar-03	9:44	53	46	50	53	50	50
28-Mar-03	15:05	49	53	39	43	40	39
21-Feb-04	21:29	34	46	58	55	56	57
22-Feb-04	2:18	66	63	43	57	42	44
11-Feb-02	18:09	47	44	39	42	36	37

Green – good results (<=2min) **Red – bad results (>= 6min)**

Conclusions

- The constrained method gives the best results for the dataset.
- The simple method is a good approximation for fast computation.
- All the methods fail in case of large φ.

Future work

- Continue analysis of the delay time for other events to provide statistics.
- Looking for better methods for delay time estimation, e.g. for large values of φ.

Thank you