Forecasting coronal mass ejections at 1 AU using Heliospheric Imagers


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CONCEPTS

- We present first results of a study on the feasibility of using a Heliospheric Imager (HI) instrument, such as STEREO/HI, for space weather forecasting of interplanetary coronal mass ejections (ICMEs) at 1 AU.
- We compare the predictions for speed and arrival time of 17 ICME events, each observed remotely by one STEREO spacecraft, to the speed and arrival time observed at in situ observatories.
- We use geometrical modeling of ICMEs, with 3 different approaches, using a single-spacecraft HI instrument; from point-like (Fixed-Phi), to a circle with a given width (Self-Similar-Expansion) to a very wide circle (Harmonic Mean).
- Partly, the configuration mimics the situation of a single HI observatory parked at the L4 or L5 point in the Sun-Earth System. Problems can arise by CME-CME interactions leading to complicated Jmaps.
- For assessing the accuracy of these predictions we look at in situ data mainly at 1 AU: by Wind/ACE, STEREO-A/B, and Venus Express at 0.72 AU.
- We compare the results of these methods work also for fast CMEs (>1000 km/s). This has been possible in 2012, with periods of strong CME activity e.g. at the end of January and early March.

Techniques

- We call this "Geometrical Modeling".
- Assumptions are: single-spacecraft HI observer (similar to a L5 mission, Solar Orbiter)
- CME has constant speed and direction
- Geometry of the CME front is assumed: Fixed Phi = CME is point-like
- Harmonic Mean = CME is a wide circular Self Similar Expansion = circle varying width

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Selected papers on these techniques:

- Space-jet-like flow (Fixed-Phi)
- But this is the first time possible to forecast the first time possible to study very fast CMEs with STEREO/HI (speeds >> 1000 km/s).
- Important effects arise for very fast CMEs: 1) The predicted speeds can be too high by up to 1000 km/s. This is because they are averages over the propagation range measured with HI, and decleration is not taken into account. 2) But this does not make the arrival times accurate. The average error is only 4-6 hours. 3) Differences between FPF/HMF are marginal.

How good are the predictions?

- We tested the STEREO/HI instrument for its forecasting capabilities, using in situ data.
- Motivation. We had a successful real-time forecast with FPF (error < 1 hour) of the 15-16 Feb 2011 CME, using HI beacon data.
- With the solar cycle now ascending, it was for the first time possible to study very fast CMEs with STEREO/HI (speeds >> 1000 km/s).

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