Project Details

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Program Element: Focused Science Topic

Topic: Prediction of the Interplanetary Magnetic Field Vector Bz at 1AU

Project Title:
Multi-spacecraft Observations and Modeling of Solar Energetic Particle Events

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Summary:
The objectives of this proposal are: (1) To quantify, from multi-spacecraft observations, how solar energetic particles (SEPs) of different types (electrons, protons, heavy ions) spread in longitude following a solar event. Observations from the twin STEREO spacecraft and spacecraft near the Earth will be a foundation of this study, in particular our recently compiled catalog of over 200 SEP events that include 25 MeV protons since the beginning of the STEREO mission (Richardson et al., 2014). Some 40 of these events were detected by both STEREO spacecraft and at the Earth. We have also summarized the longitude-dependence of the electron and proton intensities and delays to onset and peak intensity based on these three-spacecraft events. Both the catalog and these results will provide a starting point for our proposed studies and for co-operative work with other FST members. We also have a database of several hundred similar SEP events since 1967 which will allow us, for example, to infer whether particle transport is unusual in the current solar cycle; (2) We will formulate and construct sophisticated SEP transport models and use them to study the various possible scenarios of populating the inner heliosphere with SEPs over a wide range of longitudes. The simulations will be compared with or constrained by the SEP, solar wind, IMF, solar EUV and CME observations to test their validity. The models will also be used to investigate the radial variation of interplanetary perpendicular transport and to perform careful velocity dispersion analysis to deduce the first particle release time; (3) A newly-developed CME detection algorithm, the "Time Convolution Mapping Method" (TCMM; Thompson & Young, 2014) will be used to provide improved estimates of parameters and trajectories of CMEs associated with SEPs that will help to assess how these influence the spread of SEPs. There is a clear need for more reliable estimates of CME parameters which are crucial for understanding the relationship between CME properties and SEPs. The TCMM algorithm also allows the identification of CME-associated brightenings such as shocks and compression fronts, which are potential acceleration sites. Additionally, we will assess how inner coronal signatures of CMEs (such as EUV waves and dimmings) relate to 3-dimensional transient structures in the corona, with the goal of providing insight into how far SEPs will spread in the heliosphere and improving our ability to predict SEP intensities near 1 AU.

Publication References:

no references