Propagation Delay Prediction of Interplanetary Shocks to Earth's Magnetosphere: An Exploration of Methods

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Abstract

The use of a flat-plane propagation method (referred to as convection delay) to predict arrival times of CMEs and other solar-wind discontinuities results in significant error. Consequently, finding a method to accurately calculate the normal tilt of shock phase fronts, and thus improving on propagation-delay predictions, has become a topic of interest amongst space-weather researchers. A modified minimum variance analysis method, a cross product method, and a method that combines both of these techniques (MVAB-0, CP, and MVCP, respectively), have been suggested for use in calculating such a normal. Using ACE data from 104 sudden-impulse generating shocks, we present findings from our attempts to discover correlations between three shock parameters and delay error. After a coarse optimization of parameters, we also display results from an in-depth analysis on the effectiveness of the three techniques compared to convection delay. Synthesizing insights gained from our work, we are able to propose a shock propagation-delay prediction method to be used in real-time to aid forecasters at NOAA SWPC.