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A Self-Similar Expansion Model for use in Solar Transient Propagation Studies

Since the launch of the STEREO spacecraft, a plethora of techniques have been developed to investigate the three-dimensional kinematics of solar transients, such as Coronal Mass Ejections (CMEs), from their signatures in imaging observations. These techniques, which range from the highly complex and computationally intensive forward modelling method to methods based on simple curve fitting, all have their inherent advantages and drawbacks. Much use, both for the analysis of single and dual spacecraft observations, has been made of the so-called fixed phi (FP) and harmonic mean (HM) models of solar transient geometry, which consider the transient to be a radially-propagating point source and a radially-expanding sphere anchored at Sun-centre, respectively. Initially, we compare the velocity and propagation direction results derived from the use of these two models in the analysis of a large set of single spacecraft solar transient observations from the STEREO/Heliospheric Imager (HI) instruments. As these two models clearly constitute extreme descriptions of solar transients in terms of their line-of-sight extent, we define a model with a more generalised geometry (based on self similar expansion, SSE) for which the FP and HM models form the limiting cases. In addition to providing estimates of transient propagation direction and velocity from the HI observations, this model potentially enables us to estimate the transient extent in the plane perpendicular to the viewing plane. Using Monte-Carlo simulations we endeavour to identify the regimes over which use of this model could be expected to provide reliable results.

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