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HELCATS Prediction of Planetary CME arrival times

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We present the first results of CME arrival time prediction at different planetary locations and their comparison to the in situ data within the HELCATS project.

The EU FP7 HELCATS (Heliospheric Cataloguing, Analysis & Techniques Service) is a European effort to consolidate the exploitation of the maturing field of heliospheric imaging. HELCATS aims to catalogue solar wind transients, observed by the NASA STEREO Heliospheric Imager (HI) instruments, and validate different methods for the determination of their kinematic properties. This validation includes comparison with arrivals at Earth, and elsewhere in the heliosphere, as well as onsets at the Sun (http://www.helcats-fp7.eu/).

A preliminary catalogue of manually identified CMEs, with over 1000 separate events, has been created from observations made by the STEREO/HI instruments covering the years 2007-2013. Initial speeds and directions of each CME have been derived through fitting the time elongation profile to the state of the art Self-Similar Expansion Fitting (SSEF) geometric technique (Davies et al., 2012). The technique assumes that, in the plane corresponding to the position angle of interest, CMEs can be modelled as circles subtending a fixed angular width to Sun-center and propagating anti-sunward in a fixed direction at a constant speed (we use an angular width of 30 degrees in our initial results). The model has advantages over previous geometric models (e.g. harmonic mean or fixed phi) as it allows one to predict whether a CME will 'hit' a specific heliospheric location, as well as to what degree (e.g. direct assault or glancing blow). We use correction formulae (Möstl and Davies, 2013) to convert CME speeds, direction and launch time to speed and arrival time at any in situ location. From the preliminary CME dataset, we derive arrival times for over 400 Earth-directed CMEs, and for over 100 Mercury-, Venus-, Mars- and Saturn-directed CMEs predicted to impact each planet.

We present statistics of predicted CME arrival properties. In addition, we independently identify CME arrival at in situ locations using magnetic field data from the Venus Express, Messenger, and Ulysses spacecraft and show first comparisons to predicted arrival times. The results hold important implications for space weather prediction at Earth and other locations, allowing model and predicted CME parameters to be compared to their in situ counterparts.