



Multi-spacecraft observations of ICMEs propagating from 1 AU to 1.5 AU

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The propagation of ~ 30 interplanetary coronal mass ejections (ICMEs) from Earth's orbit (1AU) to Mars' orbit (~ 1.5 AU) has been studied with their propagation speed obtained from both measurements and simulations. We have used plasma, magnetic field and galactic cosmic ray (GCR) data from in-situ measurements at/near Earth, from both STEREO A and B as well as the GCR measurement by the Radiation Assessment Detector (RAD) onboard the Mars Science Laboratory (MSL) on the surface of Mars. A set of ICME events has been selected during the periods when Earth (or STEREO A or B) and Mars' locations were nearly in a straight line on the same side of the Sun in the ecliptic plane (so-called opposition phase). Such lineups allow us to estimate the ICMEs' transit time (between 1 and 1.5 AU) by estimating the delay time of the corresponding GCR Forbush decreases (caused by the enhancement of the magnetic fields related to ICMEs) measured at each location. Based on the ambient solar wind velocities, the properties of these ICMEs such as their launch speed, time and location as well as the determined speed at 1AU, we investigate the evolution of their propagation speeds and shapes from the Sun to Earth orbit and beyond. These results have also been compared to simulation data obtained from two CME propagating models, namely the Drag-Based Model (DBM) and WSA-ENLIL plus cone model.