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Combined Multipoint Remote and In Situ Observations of the Asymmetric Evolution of a Fast Coronal Mass Ejection

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A significant number of in situ detections and remote observations have allowed us to strongly constrain the shape of the fast coronal mass ejection (CME) of 7 March 2012 during its evolution through interplanetary space. The CME was imaged by both STEREO spacecraft and detected in situ by MESSENGER, Venus Express, Wind and Mars Express. Applying the novel constrained self-similar expansion method, which combines observations from STEREO's heliospheric imaging facilities with the four in situ detections, we derived different kinematical profiles for two different segments of the same CME. For the Venus- (and Mercury-) directed segment we found a gradual deceleration while the Earth- (and Mars-) directed part was decelerated abruptly close to the Sun. In order to study the background solar wind conditions we used a drag-based model, which revealed a comparatively small drag-force acting on the Venus-directed CME segment possibly caused by a preceding CME that cleared the way for the CME under study. The Earth-directed segment may have also been affected by a preceding CME. Here, we found different solar wind conditions along the CME path. A high drag-parameter below 35 solar radii suggests a high drag-force acting against the CME propagation, causing a strong deceleration. Subsequently, this part of the CME propagated with an almost constant speed.
The resulting deformation of the overall CME shape underlines the importance of using stereoscopic observations for being able to reduce the arrival time error in space weather forecasting.