Radial Evolution of Coronal Mass Ejections in the Inner Heliosphere: Catalog and Analysis

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Our knowledge of the properties of Coronal Mass Ejections (CMEs) in the inner heliosphere is constrained by the relative lack of plasma observations between the Sun and 1 AU. In this work, we present a comprehensive catalog of 47 CMEs measured in situ measurements by two or more radially aligned spacecraft (MESSENGER, Venus Express, STEREO, and Wind/ACE). We estimate the CME impact speeds at Mercury and Venus using a drag-based model and present an average propagation profile of CMEs (speed and deceleration/acceleration) in the inner heliosphere. We find that CME deceleration continues past Mercury's orbit but most of the deceleration occurs between the Sun and Mercury. We examine the exponential decrease of the maximum magnetic field strength in the CME with heliocentric distance using two approaches: a modified statistical method and analysis from individual conjunction events. Findings from both the approaches are on average consistent with previous studies but show significant event-to-event variability. We also find the expansion of the CME sheath to be well fit by a linear function. However, we observe the average sheath duration and its increase to be fairly independent of the initial CME speed, contradicting commonly held knowledge that slower CMEs drive larger sheaths. We also present an analysis of the 3 November 2011 CME observed in a longitudinal conjunction between MESSENGER, Venus Express, and STEREO-B focusing on the expansion of the CME and its correlation with the exponential fall-off of the maximum magnetic field strength in the ejecta.