Forecast Coronal Mass Ejection Arrival at the Earth: An Integrated Automated System and Its Performance

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Coronal mass ejections (CMEs) are one of the most violent events in the interplanetary space. CMEs can produce geomagnetic storms and other space weather phenomena when propagating near the Earth. Therefore, it is an important task to forecast whether or not a CME will arrive at the Earth. We develop an integrated CME arrival forecasting (iCAF) system, which consists of the modules of CME detection, three-dimensional (3D) parameter derivation and trajectory reconstruction based on coronagraph observations, to predict the Earth-arrival of a CME. The performance of iCAF is tested by comparing the 2D projected parameters with those in the catalog at the Coordinated Data Analysis Workshop (CDAW) Data Center, comparing the 3D parameters with those of the gradual cylindrical shell (GCS) model and estimating the success rate of the CME Earth-arrival predictions based on in-situ observations. It is found that the 2D parameters provided by both iCAF and the CDAW catalog are consistent with each other, but the iCAF angular widths are 20% smaller than those of the CDAW catalog because the automatic CME detection could not detect the faint edge of a CME. The ice cream cone model is found to be appropriate to be used to fit the CME 3D parameters when there are only single-view observations. Moreover, the success rate of the arrival predictions with deflection in iCAF is about 82%, which is 19% higher than that without deflection. iCAF is a worthwhile attempt since it is a completely automatic system with CME deflection in the interplanetary space, i.e., a key issue for the space weather forecasting, taken into account.

Keywords: Coronal mass ejection, Earth arrival, Integrated automated forecasting system

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