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Poster
Coronal Mass Ejections (CMEs) are the major drivers of Space Weather (SWx), so predicting their arrival at Earth is one of the major aspects of SWx forecasting. Despite increasingly complex models proposed over the past decades, the mean absolute error (MAE) for predictions of CME arrival is still surpasses 10 hours. In this study we use machine learning (ML) techniques trained on the errors between observed and modeled solar wind (SW) at the L1 point, upstream of CMEs, to improve CME time of arrival (TOA) predictions. For our investigation we use CME data from the Database Of Notifications, Knowledge, Information (DONKI) developed by the NASA Community Coordinated Modeling center (CCMC). The WSA-ENLIL-Cone (WEC) model inputs and outputs are available on DONKI for each CME, along with the associated forecast errors. The dataset consists of 122 CME events observed with in the time period of March 2012 to March 2023. The recorded MAE for CME TOA for these events is 12.31 hours. OMNI data for the SW properties at L1 and publicly available simulation results based on the WEC model are obtained. Three machine learning (ML) models are employed: 1) k-nearest neighbors (KNN), 2) support vector machine (SVM), and 3) linear regression (LR) in our analysis. These ML techniques use the observed and modeled SW properties at 1 AU as input parameters, also called the features, and the WEC output quantities, also called the target, to quantify the forecast (or prediction) errors. Our models are set up to quantify and "correct" the errors in CME TOA associated with inaccuracies in the modeled SW properties at 1 AU. The errors in reproducing the properties of the ambient SW are tracked from the time of CME insertion to their arrival at Earth. Together with CME Cone model parameters they are used as features in our ML models. Univariate and multivariate ML schemes were developed to examine how individual features and their combinations contribute to reducing the MAE in CME TOA forecasts. While most ML runs reduced the TOA MAE, the best univariate and multivariate models improved the forecast by 36.6 and 46.8 minutes, respectively. Our results suggest that uncertainties in the SW background have a minimal impact on the TOA MAE in the WEC model, with the primary source of errors being associated with uncertainties in the initial CME parameters.

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