Predicting the Magnetic Field of Earth-Impacting CMEs With the ForeCAT In Situ Data Observer (FIDO)

Christina Kay (671/USRA)

Predicting the impact of coronal mass ejections (CMEs) and the southward component of their magnetic field is one of the key goals of space weather forecasting. We present a new model, the ForeCAT In situ Data Observer (FIDO), for predicting the in situ magnetic field of CMEs. We first simulate a CME using ForeCAT, a model for CME deflection and rotation resulting from the background solar magnetic forces (Kay et al. 2015b). Using the CME position and orientation from ForeCAT, we then determine the passage of the CME over a simulated spacecraft. We model the CME's magnetic field using a force free flux rope and we determine the in situ magnetic profile at the synthetic spacecraft. We show that FIDO can reproduce the general behavior of four observed CMEs. FIDO results are very sensitive to the CME's position and orientation, and we show that the uncertainty in a CME's position and orientation from coronagraph images corresponds to a wide range of in situ magnitudes and even polarities. This small range of positions and orientations also includes CMEs that entirely miss the satellite. We show that two derived parameters (the normalized angular distance between the CME nose and satellite position and the angular difference between the CME tilt and the position angle of the satellite with respect to the CME nose) can be used to reliably determine whether an impact or miss occurs. We find that the same criteria separates the impacts and misses for cases representing all four observed CMEs.