Using Deflections to Constrain the Mass of CMEs: The 12 December 2008 Case

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Decades of observations show that CMEs can deflect from a purely radial trajectory yet no consensus exists as to the cause of these deflections. Observations typically show that the majority of the deflection motion occurs in the corona at distances where the magnetic energy dominates. In Kay et al. (2013) and Kay et al. (2014) we present ForeCAT, a model for CME deflections based on the magnetic forces (magnetic tension and magnetic pressure gradients). Kay et al. (2014) introduced an improved three-dimensional version of ForeCAT. We compare ForeCAT predictions to the observed deflection of the 2008 December 12 CME and find that ForeCAT can accurately reproduce the observations. From the observations, we are able to constrain all of the ForeCAT input parameters except the CME mass and the drag coefficient that affects the CME motion. By minimizing the reduced chi-squared, $\chi 2$, between the ForeCAT results and the observations we can determine the values of these two parameters. Varying the mass between 1e14 and 2e15 g and drag coefficients between 1 and 5 produces $\chi 2$ between 0.90 and 21.4. Restricting $\chi 2 \approx 1$ yields an acceptable mass range between 7.5e14 and 1e15 g and the drag coefficient between 2.7 and 3.2. By comparing ForeCAT results from an artificially scaled magnetic field background, we are able to constrain the rate at which the quiet sun magnetic field falls to be similar to the Potential Field Source Surface model.