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Data-driven time-dependent magnetofrictional modelling of coronal mass ejections and sensitivity of the modelling output to the driving electric field

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Determination of the magnetic structure of erupting CMEs in the corona is one of the central open problems in CME research and in forecasting of their space weather effects. Since routine measurements of the coronal magnetic field are not currently available, the most promising approach to determine the magnetic structure of an erupting CME is *data-driven modelling* in which available measurements from the photosphere are used as a boundary condition. In particular, we employ time-dependent data-driven *magnetofrictional method* to determine the coronal magnetic field configuration at the time of the CME eruption. The approach is computationally feasible yet still has sufficient physical accuracy to constrain the CME magnetic field properties. The success of the method depends heavily on the realism of the photospheric boundary condition, the electric field. For this purpose we have created ELECTRICIT, a practical software toolkit for routine, faithful inversion of the electric field from time series of photospheric magnetic field and plasma velocity measurements. In this work we present an ensemble of magnetofrictional coronal simulations for a single active region, driven by the electric fields inverted using ELECTRICIT and a collection of different inversion techniques. We illustrate the feasibility of our data-driven approach in determining the magnetic structure of an erupting CME and study the sensitivity of the simulation output to the properties of the driving electric field, such as the Poynting and magnetic helicity fluxes from the photosphere to the corona.

Our data-driven modelling approach offers interesting possibilities to extend the CME analyses in HELCATS catalogues. Using LINKCAT source region identifications our data-driven modelling scheme can be applied to the correct active region to acquire the magnetic structure of a given CME in the low corona. This can be then combined with the catalogued kinematic properties of the CME to create a comprehensive description of the eruption.