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Long-lead time predictions of the magnetic fields in Earth-impacting Coronal Mass Ejections using data-driven modelling approach

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The knowledge of the magnetic field is a crucial parameter in predicting space weather effects of coronal mass ejections (CMEs). However, coronal magnetic fields cannot be yet routinely measured, which is a huge problem for accurate long-lead time space weather forecasting. In this work, we present our data-driven modeling approach at the University of Helsinki designed to tackle specifically the question of predicting the magnetic structure of CME flux ropes using solar observations as the input. We apply a time-dependent magnetofrictional model up to about 2.5 solar radii from the Sun, which uses high-quality photospheric vector magnetograms from Solar Dynamics Observatory. This approach allows us modelling the magnetic field structure of the erupting CME self-consistently. Our modelling results are compared with a comprehensive multi-wavelength observational analysis that can also give independent space weather forecastings. We showcase our approach with a well-observed case study. We will also discuss our future prospects to couple outer coronal and heliospheric MHD models to the lower coronal simulation. This would allow taking into account the evolution of the CME (rotation and deflection) and capturing the whole Sun-Earth chain.