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Sun-to-Earth simulations of geo-effective Coronal Mass Ejections with EUHFORIA: a heliospheric-magnetospheric model chain approach

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In this work we perform a Sun-to-Earth comprehensive analysis of the July 12, 2012 CME with the aim of testing the space weather predictive capabilities of the newly developed EUHFORIA heliospheric model integrated with a flux rope model. In order to achieve this goal, we make use of a model chain approach by using EUHFORIA outputs at Earth as input parameters for the OpenGGCM magnetospheric model.

We first reconstruct the CME kinematic parameters by means of single- and multi- spacecraft reconstruction methods based on coronagraphic and heliospheric CME observations. The magnetic field-related parameters of the flux-rope are estimated based on imaging observations of the photospheric and low coronal source region of the eruption. We then simulate the event with EUHFORIA, using both a cone and a flux-rope CME model in order to compare the effect of the different CME kinematical and magnetic input parameters on simulation results at L1. We compare simulations outputs with in-situ observations of the Interplanetary CME and we use them as input for the OpenGGCM model, so to investigate the magnetospheric response to ICME-driven solar wind perturbations modelled with EUHFORIA. We study the ICME-driven geomagnetic storm focusing on the predicted geomagnetic activity and compare it with actual data records. Finally, we discuss the forecasting capabilities of such kind of approach and its future improvements.