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Modeling of the Earth's radiation belts: Response to CME- and CIR-driven geomagnetic storms

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The Earth's magnetosphere responds differently to storms driven by coronal mass ejections (CME) and co-rotating interaction regions (CIR). CME-driven storms are characterized by their occurrence during solar maximum, irregular occurrence patterns, very dense plasma sheets, stronger ring currents, and less frequent enhancement of relativistic electron fluxes in the radiation belts. CIRs are usually observed during the declining phase of a solar cycle with a 27-day recurrence period and result in less dense but hotter plasma sheets, weaker ring currents, longer intervals of strong magnetospheric convection, and higher values of relativistic electron fluxes. To understand the effects of geomagnetic activity on the inner and outer magnetosphere, CME- and CIR-driven storms should be considered separately.

In this work, we investigate the impact of both types of storms on the radiation belt environment, using the Versatile Electron Radiation Belt (VERB) code. To classify storms, we use the HELCATS (HELiospheric Cataloguing, Analysis and Techniques Service) catalogs of CIR and interplanetary CME events. We use the Kp index as a measure of magnetospheric convection to parameterize wave models, diffusion coefficients, and the plasmapause location. The electron population is considered to originate from the plasma sheet, and we set up the outer boundary conditions at geostationary orbit using GOES and LANL data. We model each storm separately and compare the simulation results with spacecraft measurements (e.g. Van Allen Probes, POES, and THEMIS) to validate the model performance. Data assimilation methods will be used to assist with initial and boundary conditions and the validation. The work will show, how well we understand the response of the belts to CME and CIR drivers and help to identify the applicability of present wave models to CME- or CIR-driven storms.