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Earth's relativistic electron radiation belt 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 more common occurrence during solar maximum, irregular occurrence patterns, a very dense plasma sheet, and stronger ring currents. CIRs are usually observed during the declining phase of a solar cycle with a 27-day recurrence period and result in a less dense but hotter plasma sheet, weaker ring currents and longer intervals of strong magnetospheric convection. 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 during the Van Allen Probe era, using the Versatile Electron Radiation Belt (VERB) code. To classify storms, we use different catalogs of CIR and interplanetary CME events. We use the Kp index as a measure of geomagnetic activity 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 data. We model storm individually and with long-term simulations, and compare the simulation results with Van Allen Probes measurements to validate the model performance. We use data assimilation methods to assist with initial and boundary conditions and the validation and we utilize different performance metrics. The work shows, how well we understand the response of the belts to CME and CIR drivers and helps to identify the applicability of present wave models to CME- or CIR-driven storms.