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The storm time ring current dynamics and response to CMEs and CIRs using Van Allen Probes observations and CIMI simulations

Christopher Mouikis (1), Samuel Bingham (1), Lynn Kistler (1), Harlan Spence (1), and Matina Gkioulidou (2)

(1) University of New Hampshire, EOS, Space Science Center, Durham, United States (chris.mouikis@unh.edu), (2) The Johns Hopkins University Applied Physics Laboratory 11101 Johns Hopkins Rd Laurel MD 20723-6099, USA

The ring current responds differently to the different solar and interplanetary storm drivers such as coronal mass injections, (CME's), and co-rotating interaction regions (CIR's). Using Van Allen Probes observations, we develop an empirical ring current model of the ring current pressure, the pressure anisotropy and the current density development during the storm phases for both types of storm drivers and for all MLTs inside L$\sim$6. Delineating the differences in the ring current development between these two drivers will aid our understanding of the ring current dynamics. We find that during the storm main phase most of the ring current pressure in the pre-midnight inner magnetosphere is contributed by particles on open drift paths that cause the development of a strong partial ring current that causes most of the main phase Dst drop. These particles can reach as deep as L$\sim$2 and their pressure compares to the local magnetic field pressure as deep as L$\sim$3. During the recovery phase, if these particles are not lost at the magnetopause, will become trapped and will contribute to the symmetric ring current. However, the largest difference between the CME and CIR ring current responses during the storm main and early recovery phases is caused by how the 15 – 60 keV O+ responds to these drivers. This empirical model is compared to the results of CIMI simulations of a CMEs and a CIRs where the model input is comprised of the superposed epoch solar wind conditions of the storms that comprise the empirical model. Different inner magnetosphere boundary conditions are tested in order to match the empirical model results. Comparing the model and simulation results improves our understanding of the ring current dynamics as part of the highly coupled inner magnetosphere system. In addition, within the framework of this empirical model, the prediction of the EMIC wave generation linear theory is tested using the observed plasma parameters and comparing with the observations of EMIC waves.