The Development of Chorus, Source and Seed Electrons, and the Radiation Belt Response During ICME and CIR Storms

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Gyroresonant wave particle interactions with whistler mode chorus waves are major contributors to enhancements in the outer radiation belt during geomagnetic storms. The temperature anisotropy of source electrons (few–10s of keV) provides the free energy for chorus waves, which can accelerate sub-relativistic seed electrons (100s of keV) to relativistic energies. Using Van Allen Probes observations from 25 ICME and 35 CIR storms, superposed and storm-phase epoch analysis is performed to delineate the spatial and temporal relationship of chorus activity, source electron conditions associated with wave activity, the seed population, and the outer radiation belt response for the two types of storms.

The storm-phased epoch analysis shows that the observed chorus wave power follows the storm phase dependent access of source electrons to the inner magnetosphere. Chorus waves and source electrons primarily are found on the dawn side during the main phase – as the asymmetric ring current is enhanced. In the early and late recovery phases, chorus and source electrons are found with lower intensities at all MLTs – reflecting the weaker trapped symmetric electron ring current. CME and CIR storms display similar behavior and levels of average wave power, through chorus wave activity reaches lower L shells on average during CME storms compared to CIR storms.

The superposed epoch analysis of the flux and phase space density (PSD) for seed and relativistic electrons vs L^* shows a deeper, stronger, and earlier average seed electron enhancement and a greater average radiation belt electron enhancement during CME storms compared to CIR storms – despite similar levels and liftetimes of chorus waves. The average PSD vs L^* profile of the radiation belt enhancement shows some evidence of local acceleration during the early recovery phase of CME storms. The earlier and deeper seed electron enhancement during the CME storms, likely driven by the greater convection and substorm activity, produces a higher probability for local acceleration. These results emphasize the importance of the timing and level of seed electron enhancements in radiation belt dynamics.