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Statistical Analysis of the Outer Radiation Belt and Inner Magnetospheric Response to Sheath Regions of Coronal Mass Ejections

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The energetic electron content in the Van Allen radiation belts surrounding the Earth can vary dramatically on timescales from minutes to days, and these strong electron fluxes present a hazard for spacecraft traversing the belts. Electron dynamics in the belt is governed by various competing acceleration, transport and loss processes in which wave-particle interactions play an important role, and the response to solar wind driving is yet largely unpredictable. We investigate here the electron flux response in the outer radiation belt to driving by sheath regions preceding interplanetary coronal mass ejections and the associated wave activity in the inner magnetosphere. We consider events in the Van Allen Probes era (from 2012 to present) to employ the unprecedented energy and radial distance resolved electron flux observations of the twin spacecraft mission. A statistical study of the events is performed using superposed epoch analysis, where the sheaths are superposed separately from the ejecta and resampled to the same average duration. Our results show that the ULF wave power in the Pc5 and EMIC range, as measured by geostationary GOES satellites, is higher during the sheaths than in the ejecta, while chorus wave power stays at about the same level despite on average stronger ring current enhancements during the ejecta. On average, the electron flux response at source (tens of keV) and seed (hundreds of keV) energies has a slightly increasing trend through the sheath and ejecta, while at MeV energies depleting events are slightly more common.