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大規模磁気嵐中の電離圏起源リングカレントイオンのエネルギースペクトル変動

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Energy-spectral evolution of ring current ions of ionospheric origin during intense magnetic storms

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O+ ions significantly influence plasma pressure in Earth's inner magnetosphere during magnetic storms. This is primarily due to the increased supply of O+ from the ionosphere and the preferential energization of O+ in the magnetotail. Our previous study, which analyzed approximately 40 moderate magnetic storms, revealed the statistical characteristics of energetic ions that predominantly contribute to the ring current. The radial profile of the pressure-contributing first adiabatic invariant (mu_max) indicates that lower-mu O+ ions dominate at L <4, while higher-mu O+ ions dominate at L >6, compared to H+ ions. The dominance of lower-mu O+ in the lower L-shells highlights the importance of Earth-origin low-energy (<a few hundred eV) O+ ions in the plasma sheet, sometimes called warm cloak, for building up the inner ring current. Conversely, the contribution of higher-mu O+ in the higher L-shells emphasizes the vital role of preferential energization in enhancing the outer ring current.

The present study extends our analysis to intense storms with a minimum Dst smaller than -100 nT that occurred in 2023 and later. Additionally, we incorporate measurements of other ionospheric-origin ion species, such as He+ and O++, into our database. We utilize data from the Medium-Energy Particle experiments - ion mass analyzer (MEP-i), which measures ions with energies ranging from ˜10 to 180 keV/q and differentiates between ion species. We have confirmed that the MEP-i energy range can cover typical contributing mu values, from 0.05 to 0.5 keV/nT, across a wide range of radial distances. Our goal is to identify the relative contributions of the supply of low-mu O+ and the generation of high-mu O+ to the buildup of the ring current. Furthermore, we aim to examine how these contributions depend on the storm intensity.