Spatial distribution of the contributions from electrons, protons, and oxygen ions to energy density in the inner magnetosphere

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The ring current is controlled by the plasma pressure and its spatial gradient. It has been reported that the pressure is dominated by plasma with energies of a few to a few 100s keV. Oxygen ions of ionospheric origin can be energized in the plasma sheet and/or the inner magnetosphere up to a few tens to a few hundreds of keV. The ionospheric oxygen ions make a significant contribution to the ion pressure during geomagnetically active periods. This paper examines spatial variations of the contribution from electrons, protons, and oxygen ions to energy density during the main and early recovery phases of magnetic storms. We primarily use electron, proton, and oxygen ion data from the MEP-e and MEP-i instruments on board the Arase (ERG) spacecraft. MEP-e measures energetic electrons with energies of 7-87 keV. MEP-i measures energetic ions with energies of 9-180 keV/q; ion mass-per-charge is derived from energy and velocity measurements by an electrostatic analyzer and the time-of-flight system, respectively. We select all magnetic storms with the Dst index minimum smaller than -50 nT during the first year of the Arase mission. For example, during the 27 March 2017 storm, the O-to-H ratio increased by about an order of magnitude, from ~0.02 to 0.2-0.3. The high-flux >10 keV/q ions consisted of clearly different two populations: one dominated by 5-20 keV/q ions, likely originating from pre-existing cold plasma sheet population; and the other with structured dispersion signatures at 30-90 keV/q, likely due to the penetration of ions accelerated in the near-Earth plasma sheet. We found that both populations contributed to the total pressure almost equally. We also study energy-spectral evolution of the contribution to the energy density to discuss about possible mass-dependent/selective acceleration in the near-Earth plasma sheet.

Keywords: inner magnetosphere, ring current, geomagnetic storm, oxygen ions of ionospheric origin, acceleration, heating, and transport of magnetospheric ions

