Earth's magnetotail as the reservoir of accelerated single- and multicharged oxygen ions replenishing radiation belts

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In this work we are studying multicharged oxygen ion acceleration during substorms in the Earth's magnetotail as the source of ring current replenishment by energetic ion population. We used measurements obtained by the CRRES spacecraft for the comparison of experimental spectra of oxygen charge state in the outer region of the ring current and proton radiation belt with model results. We present a numerical model that allows to evaluate acceleration of oxygen ions O⁺⁺⁻O⁺⁸ in the course of two possible perturbation processes: A) passage of multiple dipolarization fronts in the magnetotail; B) passage of fronts followed by electromagnetic turbulence. It is shown that acceleration processes depend on particle charges and time scale of electric field variations. Oxygen ions O⁺⁸ with average initial energies 12 keV are accelerated efficiently during multiple dipolarization processes of type (A) and their energies increased up to 7.4 MeV, whereas ions O⁺ with the same energies were energized up to 1.9 MeV. It is shown that oxygen ions O⁺⁺⁻O⁺² are able to penetrate into the ring/radiation belts region with L between L=4.5 and L=7.5 in the process of plasma transfer on dipolarization fronts. For oxygen O⁺⁺⁻O⁺⁸ the additional acceleration mechanism is required, such as large-scale electromagnetic turbulence, when the ions can get energies comparable with experimentally observed ones in the indicated range of L shell values. It is shown that the taking into account electromagnetic fluctuations, accompanying magnetic dipolarization, may explain the appearance of oxygen ion flows with energies greater than 3MeV in the near- Earth's space.