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Acceleration of plasma in current sheet during substorm dipolarizations in the Earth's magnetotail: comparison of different mechanisms

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This work is devoted to the investigation of particle acceleration during magnetospheric dipolarizations. A numerical model is presented taking into account four scenarios of plasma acceleration that can be realized: (A) total dipolarization with characteristic time scales $\approx$ 3 min; (B) single peak of value of the normal magnetic component B_z happening on the time scale less than 1 min;(C) a sequence of rapid jumps of B_z interpreted as the passage of a chain of multiple dipolarization fronts (DFs); (D) the simultaneous action of mechanism (C) followed by consequent enhancement of electric and magnetic fluctuations with the small characteristic time scale $\leq$ 1 s. In a frame of the model we have obtained and analyzed the energy spectra of four plasma populations: electrons e-, protons H+, helium He+ and oxygen O+ ions, accelerated by abovementioned processes (A) - (D). It is shown that O+ ions can be accelerated mainly due to the mechanism (A); H+, He+ ions (and to some extent electrons) can be more effectively accelerated due to the mechanism (C) than the single dipolarization (B). It is found that high-frequency electric and magnetic fluctuations accompanying multiple DFs (D) can strongly accelerate electrons e- and really weakly influence other populations of plasma. Results of modeling demonstrated clearly distinguishable spatial and temporal resonance character of particle acceleration processes. The maximum particle energies depending from the scale of magnetic acceleration region and the value of magnetic field are estimated. The shapes of energy spectra are discussed.