Small-scale Alfvén waves generated by the magnetosphere-ionosphere coupling

Anatoly V. Streltsov

Thayer School of Engineering, Dartmouth College, Hanover, USA

The results from the investigation of how the parameters of the ionosphere and the low-altitude magnetosphere mediate the formation and spatiotemporal properties of small-scale, intense electromagnetic structures observed by low-altitude satellites in the auroral and sub-auroral magnetosphere presented. The study is based on numerical modeling of a time-evolving, nonlinear system that describes multi-scale electrodynamics of the magnetosphere-ionosphere coupled system in terms of field-aligned currents, both quasi-static or Alfvénic. Simulations show that intense electric fields and currents with a perpendicular size of $10 - 20$ km at 120 km altitude can be generated by a large-scale, slowly evolving current system interacting with a weakly conducting ionosphere, even without a resonant cavity in the magnetosphere. These structures form in the strong gradient in the ionospheric conductivity that develops at the boundary between the large-scale upward and downward currents when the background ionospheric Pedersen conductivity, Σ_P, is low but higher than the Alfvén conductivity, $\Sigma_A = 1/\mu_0 v_A$, above the ionosphere. When $\Sigma_P \approx \Sigma_A$ the ionosphere can generate electromagnetic waves with perpendicular sizes less than 10 km. These waves can be trapped inside the cavity of the classical ionospheric Alfvén resonator, and their amplitude can be significantly amplified there by the ionospheric feedback instability.