Ionospheric feedback instability in the ionospheric Alfven resonator at high latitudes: Modeling and Observations

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We present results from a numerical study of physical processes responsible for the generation of small-scale, intense electromagnetic structures in the ultra-low-frequency range frequently observed in the close vicinity of bright discrete auroral arcs. In particular, our research is focused on the role of the ionosphere in generating these structures. A significant body of observations demonstrate that small-scale electromagnetic waves with frequencies below 1 Hz are detected at high latitudes where the large-scale, downward magnetic field-aligned current (FAC) interact with the ionosphere. Some theoretical studies suggest that these waves can be generated by the ionospheric feedback instability (IFI) inside the ionospheric Alfven resonator (IAR). The ionospheric feedback instability occurs when the magnetic field-aligned currents change the conductivity in the ionosphere by precipitating and removing electrons from it and the variations in the conductivity positively "feed back" on the structure and amplitude of the FACs increasing their magnitude. The ionospheric Alfven resonator is the region in the low-altitude magnetosphere bounded by the strong gradient in the Alfven speed at high altitude and the conducting bottom of the ionosphere (ionospheric E-region) at low altitude.

To study ULF waves in this region we use a numerical model developed from reduced two-fluid MHD equations describing shear Alfven waves in the ionosphere and magnetosphere of the earth. The active ionospheric feedback on structure and amplitude of magnetic FACs that interact with the ionosphere is implemented through the ionospheric boundary conditions that link the parallel current density with the plasma density and the perpendicular electric field in the ionosphere. Our numerical results are compared with the *in situ* measurements performed by the Magnetosphere-Ionosphere Coupling in the Alfven Resonator (MICA) sounding rocket, launched on February 19, 2012 from Poker Flat Research Range in Alaska to measure fields and particles during a passage through a discreet auroral arc. Parameters of the simulations are chosen to match actual MICA parameters, allowing the comparison in the most precise and rigorous way. This comparison demonstrate a strong correlation between the simulations and the measured data, which suggest that both IAR and IFI plays important role in the electromagnetic coupling between the ionosphere and magnetosphere high latitudes.