
RECENT RESEARCH ACTIVITIES

Simulations and Modeling of Geospace Environment

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We study space environment surrounding the Earth (geospace) using a large scale computer simulations. Concerning the generation mechanism of whistler-mode chorus emissions and triggered emissions through interaction with energetic electrons, we have confirmed the nonlinear wave growth theory and the saturation mechanism at the optimum wave amplitude [1], the nonlinear theory has also been confirmed by a recent spacecraft observation [2]. The nonlinear theory has been extended for interpretation of falling-tone emissions [3]. As a numerical model of chorus emissions, we have constructed a numerical model of a chorus emission evolving in space and time [4]. We have made a review of the theoretical achievements related to whistler-mode chorus emissions [5]. Electromagnetic Ion cyclotron (EMIC) waves also observed in the same inner magnetosphere as chorus emissions. Through interaction with energetic protons, EMIC triggered emissions are generated, inducing proton precipitation [6]. We also studied interaction of relativistic electrons with the EMIC triggered emissions, which cause very effective precipitation of relativistic electrons [7].

For the purpose of understanding the global structure and dynamics of energetic particles in geospace, we have performed a simulation of 4-dimensional Fokker-Planck equation under the time-dependent electric and magnetic fields provided by a global magnetohydrodynamics (MHD) simulation. When a substorm occurs, a stretched magnetic field line becomes dipole-like. The dipolarization does not proceed smoothly because of significant force imbalance. Consequently, the electric field oscillates with a period of 2–3 min, resulting in multiple injections of low-energy electrons (<50 keV) [8]. We have conducted all-sky auroral observation at the South Pole Station in collaboration with National Institute of Polar Research, Japan, Siena College, and National Science Foundation, USA. With numerical simulation, we found that poleward moving auroral forms that are frequently observed on the magnetically dayside can be explained by field line resonance [9]. By comparing signal from the GPS satellites and the multi-wavelength auroral images taken at the South Pole station, the GPS signal is found to undergo phase scintillation associated with auroral precipitation of hard electrons [10].

References

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