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. Based on the simulation results obtained from the supercomputing on the KDK system, we have developed the nonlinear wave growth theory of whistler-mode chorus waves [1,2] and electromagnetic ion cyclotron waves [3] observed in the inner magnetosphere including the radiation belts. The methods of the simulations are electromagnetic-full particle codes, hybrid code, Vlasov hybrid code, and test particle simulations. While the electromagnetic particle codes have successfully reproduced chorus emissions [4, 5] with reduced space and time models, the hybrid code simulation has reproduced the EMIC triggered emissions with real parameters [6]. The Vlasov hybrid code has also reproduced chorus emissions with both rising-tone and falling-tone emissions. Based on an analysis with the Vlasov hybrid code, we developed a theory of triggering the rising-tone emissions [7], as well as falling-tone emissions. [8]. Chorus emissions can accelerate electrons to relativistic energy (MeV). The relativistic electrons are scattered into the auroral atmosphere by EMIC rising-tone emissions very effectively [9].

By using particle data acquired by the Polar satellite, we found that the number of the ions constituting the ring current is increased, decreased, or unchanged, depending on kinetic energy and magnetic local times during the magnetic storms [10]. An interesting feature is that high energy ions with energy greater than 125 keV are increased during the storm recovery phase. This is opposite to the low energy ions. Our study suggests that energetic ions may have a point in common with high energy electrons. By performing a computer simulation, we found that a rapid decay of the ring current can be reasonably explained by pitch angle scattering of energetic ions in the stretched magnetic field [11]. Recently, we have also developed the drift kinetic simulation that solves transport of relativistic electrons in the inner magnetosphere. By incorporating with the large-scale electric and magnetic fields provided by a global magnetohydrodynamics (MHD) simulation, we found that the relativistic electrons are redistributed by two types of electric fields that are self-consistently induced in the inner magnetosphere in the course of substorms. Our simulations suggest that the force-induced processes, which are self-consistently coupled to the electromagnetic processes, play an essential role in the substorm-associated redistribution of particles in the radiation belt.

References

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