

Analysis for characteristics estimation of REIMEI current monitor using full-particle ES simulation

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The small scientific satellite REIMEI has continued the observation of auroral environment in the sun-synchronous polar orbit. It is equipped a patch type single-probe so called Langmuir probe and two double probes for the plasma-current monitors (CRM) designed for high-time/spatial resolution measurements. Theoretically, the background plasma parameters can reasonably be obtained from the probe characteristics over most of the polar region. The data is expected to show changing of the plasma temperature during aurora particle precipitation, as well as for statistical study.

As the high energy particle impinging upon a satellite body, the floating potential of a piggy back satellite such like REIMEI easily moves according to the charging of the satellite. The LEO satellite also has to take into account the drift velocity of the satellite itself, because the satellite velocity is usually faster than the ion thermal velocity. More over in REIMEI satellite case, the aurora particles flow along the Earth's magnetic field which is orthogonal to the satellite's orbiting velocity. Although some chamber experiments for the newly developed probes are conducted, quantitative characteristics of CRM in the auroral environment including effects of the satellite geometry have not been obtained. A numerical simulation will be helpful to estimate the characteristics, if it could reproduce the current collection of the probe in the plasma environment.

For study of spacecraft-plasma interactions, higher accuracy as well as reasonable performance is required to numerical simulations. Achieving both requirements, we have developed the numerical space chamber for spacecraft in electrostatic environment based on full particle-in-cell (PIC) plasma code optimized for parallel supercomputers. The numerical spacecraft modeling techniques of Multi-Utility Spacecraft Charging Analysis Tool (MUSCAT) is combined to our simulator, it enables us to study nonstationary geospace environment with realistic spacecraft modeling.

As the first application of the simulator, we have worked on interpretation of the observation data by REIMEI CRM. We can monitor time histories of the satellite and space potentials, configuration of the plasma sheath, and each probe current during sweep the bias potential. It is shown that the electron density and temperature are estimated lower than the value of background plasma because the collected electron current must be fewer in the negative potential sheath surrounding the satellite.