

Reimei and FAST observations on acceleration and transport processes of the electrons and ions in the midnight auroral regions

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Expecting new findings and essential understandings about the space-Earth coupling processes and mechanisms, several innovative space exploration missions are now being developed or under preparation for proposal and realization in all of the major space agencies in the world. Also in Japan, we are leading the FACTORS (Frontiers of formation, acceleration, coupling, and transport mechanisms observed by the outer space research system) mission by using multiple compact/micro satellites to be launched during 2025-2027.

The most important mission target of these space explorations is the magnetosphere-ionosphere-thermosphere coupling, which could also be applied to universal phenomena observed in the vicinities of magnetized/unmagnetized planets with atmospheres in our solar system and even exoplanets whose atmospheres are interacting directly with stellar winds. In the terrestrial case, firstly the midnight auroral regions are most crucial because they are characterized by the most essential and complicated plasma and upper atmospheric dynamics and electromagnetic phenomena initiated and affected through the whole magnetosphere-ionosphere-thermosphere coupling processes. In particular, the continuous energy and mass transports in these near-Earth space are mostly controlled by the electromagnetic field effects on the ionized atmospheric particles and the space plasmas.

While state-of-the-art measurements in these important regions of understanding the space-Earth(planet) couplings have not been achieved yet, the previous space missions, represented by DE-1/2, Viking, Freja, Akebono, POLAR, FAST, CLUSTER-II, and Reimei, have been providing us with considerable elemental knowledge. Particularly, the acceleration and transport processes regarding the electrons and ions could be surveyed in more systematic and carefully based on the database of these satellite missions. We, therefore, have been analyzing the observational results made mainly by Reimei and FAST because these data are open, accessible, and easily investigated with some updated tools. The high-time resolution data obtained by these two satellites are available for studying the spatial distributions or time variations of the space plasmas by field-aligned electric fields and the wave-particle interaction processes although there are not made any simultaneous observations by Reimei and FAST.

In this presentation, we discuss the similarities and differences seen in the Reimei and FAST observations by focusing on the dynamics of the electrons and ions at the altitudes ranging from 400-4000 km in the midnight polar regions.