Comparative Studies Among Auroral Particles/Emissions and Field-Aligned Currents for Rapid Variations of Fine-Scale Auroral Arcs

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The Reimei satellite orbiting in the polar magnetosphere at the low altitude of about 630 km has been providing us with a number of excellent conjunction events enabling us to investigate the relations among the auroral particles/emissions and field-aligned currents observed near the midnight meridian of the winter hemisphere. It has been quite uncommon for a long time to conduct this type of the comparative studies on the basis of direct/remote-sensing measurements because satellite missions with suitable conditions like our Reimei satellite have not been realized ever. The auroral particle instruments (ESA/ISA for electrons and ions) on Reimei could obtain full pitch angle distributions of auroral electrons and ions over the energies of 12 eV to 12 keV within 40 msec while the multi-spectral (monochromatic) auroral camera (MAC) is taking images of successive auroral forms over 70 km X 70 km areas every 130 msec. The magnetic field data by 4-Hz sampling and 1-sec averaging are also available with an onboard geomagnetic aspect sensor (GAS) for clarifying the field-aligned current distributions related with the auroral arc activities. These three aspects of observations would be most important for elucidating the interrelation of the fine-scale auroral arcs to the auroral particles and field-aligned current, especially for cases with rapid variations, in which the high-time resolution data obtained by Reimei are crucial because we could refer to the short-term generation and growth of parallel potential drop structures accelerating Inverted-V electrons as well as the Alfvenic electron accelerations. These observational specifications would bring us with great advantages, for instance toward discussing whether the initiation and time variation of the upward parallel electric fields affect or are affected by properties of electrons accelerated by propagating kinetic Alfven waves. Several rapid and fine-scale auroral events observed by MAC, ESA, and GAS have been analyzed in order to characterize their auroral properties and their physical connections. The recent researches based on these fine measurements indicate that the small-size transition regions with strong downward electric fields and intense field-aligned currents are spatially associated or neighbored with the upward electric fields with precipitating inverted-V electrons. The sharply field-aligned electron precipitations are also typical at the beginning or the edge of the rapid variations of the auroral arcs. In this presentation, we comprehensively discuss the observational characteristics recognized in several typical or prominent cases showing rapid initiation, growth, and motion of the fine-scale auroral arcs, particularly by focusing on the electron and ion distribution functions and the field-aligned currents, through the accurate comparisons with auroral images presenting active arcs.