サブストームオンセットのれいめい-THEMIS同時観測

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Simultaneous Reimei and THEMIS observations of a substorm onset

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At the time of substorm onset, significant temporal and spatial variations of magnetospheric and ionospheric phenomena occur with in a few minutes. The auroral initial brightening is one of the definitions of the substorm onset, while the substorm current wedge forms during substorms and produces field-aligned currents. Though there must be a close relationship between auroral variations in the ionosphere and magnetospheric dynamics during a substorm, our understanding of the precise relationship is limited.

We investigated a substorm onset at ~1058 UT on Jan. 28, 2008 using the data mainly from Reimei, THEMIS ground-based observatories (GBOs) and THEMIS satellites. Reimei provided us electron and ion data measured at an altitude of 640 km together with high-time and high-spatial resolution monochromatic auroral images at 428 nm (N2+ 1NG), 558 nm (OI) and 670 nm (N2 1PG) below the spacecraft. The GBO all-sky imager (ASI) network gave us the mosaic auroral image plot in the wide latitude and local time range from Canada to Alaska. THEMIS satellites provided the multi-point measurement data of magnetospheric properties.

At 1058 UT Reimei and the Inuvik ASI measure a poleward-moving intense auroral arc followed by snake-like auroral bands for this event. The strong Alfvenic acceleration is seen in the electron data at the poleward portion of the arc, suggesting the coupling between the leading edge of the moving arc and the ionospheric plasma. From Reimei electron data, it is found that the snake-like bands correspond to the most equatorward inverted-V. The precise time evolution of the auroral expansion in the vicinity of the onset region was measured at the GBO stations INUV, FYKN and FSIM from 1058 to 1105 UT. The onset arc probably corresponds to the snake bands.

The center of the initial auroral brightening region is located about 20 deg. westward of the THEMIS(TH)-E (P4) and D (P3) satellites during this event. The twin vortexes of plasma flows are observed by TH-E and D in the first 5 min after auroral breakup, that is, from 1058 to 1103 UT. The equivalent ionospheric currents (EICs) and the vertical component of their curl (proportional to FAC for uniform conductance), as they result from the analysis of ground magnetometer data using spherical elementary current systems (SECs) are estimated from ground-based magnetometer data. We found that the strong upward/downward current system appears at 1059 UT just after the appearance of the intense poleward-moving intense arc at 1058 UT. The vortexes seen in the EIC-map may be related to the evolution of the substorm current wedge system.