サブストームのオンセット過程

森岡昭[1]、三好由純[2]、笠羽康正[3]，佐藤夏雄[4]、門倉昭[4]、三澤浩昭[1]、宮下幸長[2]
[1]東北大 PPARC
[2]名古屋大 STEL
[3]東北大地球物理
[4]極地研究所

Substorm onset process: Ignition of auroral acceleration and related substorm phases

Akira Morioka[1], Yoshizumi Miyoshi[2], Yasumasa Kasaba[3], N. Sato[4], Akira Kadokura[4], Hiroaki Misawa[1], and Yukinaga Miyashita[2],

[1]Planetary Plasma and Atmospheric Research Center, Tohoku University, Sendai, Miyagi, Japan
[2]Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Aichi, Japan
[3]Department of Geophysics, Graduate School of Science, Tohoku University, Sendai, Miyagi, Japan
[4]National Institute of Polar Research, Tachikawa, Tokyo, Japan

The substorm onset process is studied on the basis of the vertical evolution of auroral acceleration regions derived from auroral kilometric radiation (AKR) spectra and Pi pulsations on the ground. The field-aligned auroral acceleration at substorm onset shows two distinct phases. Low-altitude acceleration (h~3000-5000 km), which accompanies auroral initial brightening, pre-breakup Pi2, and direct current of ultra-low frequency pulsation (DC-ULF), is first activated and plays an important role (pre-condition) in the subsequent substorm expansion-phase onset. Pre-breakup Pi 2 is suggestive of the ballooning-mode wave generation, and negative decrease in DC-ULF suggests increasing field-aligned current (FAC). We call this stage the initial phase of substorm. A few minutes after this initial phase onset, high-altitude acceleration, which accompanies auroral breakup and poleward expansion with breakup Pi 1 and Pi 2 pulsations, suddenly breaks out in an altitude range of 8000-16000 km. Thus, substorm expansion onset originates in the magnetosphere-ionosphere (M-I) coupling region; substorm ignition in the M-I coupling region. After this ignition, current disruption and subsequent violent energy release take place. Statistical investigations revealed that about 65% of earthward flow bursts observed in the plasma sheet are accompanied by enhancement of low-altitude accelerations, suggesting that flow braking of bursts causes FAC and resultant low-altitude field-aligned acceleration in the M-I coupling region. On the basis of these observations, we propose a substorm onset scenario in which FAC originating from the braking of plasma flow burst first enhances low-altitude acceleration (substorm initial phase onset), then the increasing FAC induces current-driven instability in the M-I coupling region, and this leads to high-altitude acceleration and resultant substorm expansion-phase onset.