Auroral acceleration at substorm onsets as derived from AKR spectrogram

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There are, currently, two major scenarios for the triggering of the substorm; the near Earth neutral line model (NENL model) [e.g., Baker et al., 1996; Shiokawa et al., 1998] and the current disruption model (CD model) [e.g., Lui et al., 1992; Lyons, 1995]. In any these scenarios, the abrupt particle acceleration along the auroral field line, that is, the sudden buildup of the parallel electric field in the magnetosphere-ionosphere (M-I) coupling system, is essential to complete the substorm onset process. Both scenarios, however, do not necessarily contain the consistent field aligned acceleration process in their mechanisms. To elucidate the relationship between the magnetospheric substorm onset and the auroral breakup, detailed observations of the dynamical behavior (vertical development) of the field aligned acceleration region at around the substorm onset is necessary.

In this study, we used AKR data observed from Polar/PWI, which provides us information on the distribution and its dynamics of the acceleration region. Two sources of AKR and their development prior to and during substorms were identified and were investigated in connection with the auroral acceleration process. One source is a low-altitude source region corresponding to middle-frequency AKR (MF-AKR), and the other is a high-altitude source region corresponding to low-frequency AKR (LF-AKR). The low-altitude source appears in the substorm growth phase at 4000 to 5000 km, and its intensity increases a few minutes prior to substorm onset, showing the precursor-like behavior. The high-altitude source abruptly appears at substorm onset in the altitude range of 6000 to 12,000 km with a remarkably fast growth rate. These AKR features at substorms were discussed in relation to the development of the auroral acceleration region. It was suggested that the low-altitude AKR source is related to the large-scale inverted-V acceleration region that would be generated through the self-consistent distribution of the magnetospheric plasma in the M-I coupling region. The high-altitude AKR source which is an indicator of a substorm onset would be generated from the local field-aligned acceleration caused by such as the current-driven instability in the M-I coupling region.