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Substorm ignition in the M-I coupling region

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The sudden formation of parallel electric fields in the magnetosphere-ionosphere (M-I) coupling system is essential to complete substorm onset. From this standpoint, we focus substorm ignition on field-aligned acceleration, by studying the dynamical behavior of auroral kilometric radiation (AKR). Field-aligned auroral acceleration shows distinct two-step evolution at substorm onset: the activation of low-altitude acceleration (h~4000-5000 km) which corresponds to auroral initial brightening, and subsequent abrupt breakout of high-altitude acceleration (h~6000-12000 km) which corresponds to auroral breakup. Cases when only low-altitude acceleration (first step evolution) is activated are pseudo-substorms. This indicates that the second evolution of field-aligned acceleration divides full-substorm from pseudo-substorm. The statistical relationship between the plasma-flow burst in the plasma sheet and its response to the M-I coupling region shows that about 65 % of flow bursts cause pseudo-breakup/initial-brightening and one third of them develops into full-substorm, while the magnitude of flow velocity does not necessarily determine the substorm intensity. This suggests that some plasma flow bursts originate field-aligned current (FAC) which first enhance low-altitude acceleration, and the increasing field-aligned current induces second acceleration above the pre-existing low-altitude acceleration as a consequence of current/current-driven instabilities. In this sense, substorm is finally ignited in the auroral M-I coupling region.

Keywords: substorm, aorural accelerartion, M-I coupling region