

Auroral substorm onset in satellite-based global images and ground-based all-sky images

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Substorm onset has originally been defined as a longitudinally extended sudden auroral brightening (Akasofu initial brightening: AIB) followed a few minutes later by an auroral poleward expansion in ground-based all-sky images (ASIs). In contrast, such clearly marked two-stage development has not been evident in satellite-based global images (GIs). Instead, substorm onsets have been identified as localized sudden brightenings that expand immediately poleward.

To resolve these differences, optical substorm onset signatures in GIs and ASIs are compared in this study for a substorm that occurred on December 7, 1999. For this substorm, the Polar satellite ultraviolet global imager was operated with a fixed-filter (170 nm) mode, enabling a higher time resolution (37 s) than usual to resolve the possible two-stage development. These data were compared with 20-s resolution green-line (557.7 nm) ASIs at Muonio in Finland. The ASIs revealed the AIB at 2124:50 UT and the subsequent poleward expansion at 2127:50 UT, whereas the GIs revealed only an onset brightening that started at 2127:49 UT.

Thus, the onset in the GIs was delayed relative to the AIB and in fact agreed with the poleward expansion in the ASIs. The fact that the AIB was not evident in the GIs may be attributed to the limited spatial resolution of GIs for thin auroral arc brightenings. The implications of these results for the definition of substorm onset are discussed herein.

Keywords: substorm, auroral breakup, aurora

Original substorm onset (Akasofu 1964; 2010)

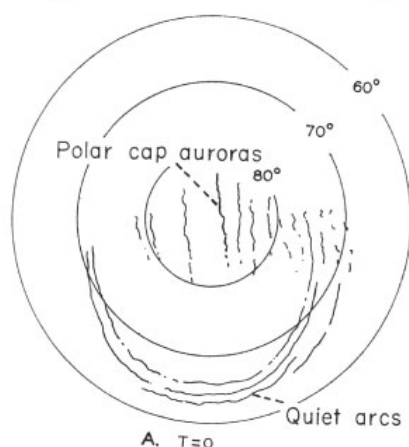


FIG. 2. THE DISTRIBUTION OF THE AURORAS DURING THE QUIET PHASE.

a Time < 0
Before onset
Quiet arc

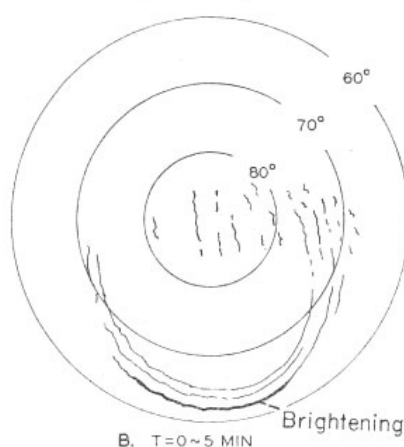


FIG. 3. AURORAS DURING THE EXPANSIVE PHASE (STAGE I).

b T = 0 ~ 5 min
Expansion phase stage 1
Initial brightening
T = 0: Substorm onset

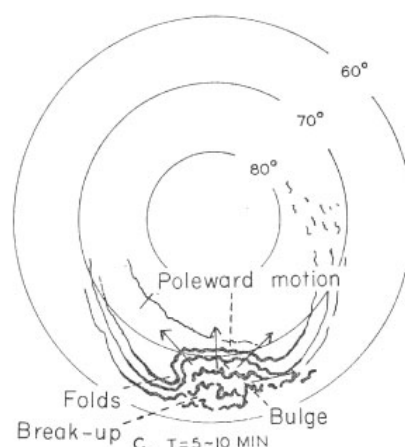


FIG. 4. AURORAS DURING THE EXPANSIVE PHASE (STAGE II).

c T = 5 ~ 10 min
Expansion phase stage 2
Poleward expansion
(Auroral breakup)

Ground and satellite observations (Ieda et al. 2018: 10.1186/s40623-018-0843-3)

