Statistical Analysis of Substorm-Associated SAR arcs at Subauroral Latitudes Based on All-sky Imaging Observations at Athabasca, Canada

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SAR arcs are the optical phenomenon caused by low-energy electron precipitation into the ionospheric F layer from the interaction region between the ring current and the plasmasphere. In the recovery phase of geomagnetic storms, low-energy electrons in the plasmasphere are heated by high-energy plasma in the ring current, and these electrons precipitate into the F layer at subauroral latitude where oxygen atoms are excited at altitudes about 400 km. Thus, SAR arcs have been observed at subauroral latitudes during geomagnetic storms. However, Shiokawa et al. (2009) reported an event of SAR arcs detached from the main oval after substorms, based on observation at Athabasca, Canada (54.7N, 246.7E, magnetic latitude = 61.7N). However, statistical analysis of such substorm-associated SAR arcs have not been done yet. Thus, in this study, we do a statistical analysis of substorm-associated SAR arcs observed at Athabasca. We analyzed all-sky images at wavelengths of 630.0 nm obtained at Athabasca from 3 September, 2005 to 31 December, 2009, and found 98 events. This result indicates that the SAR arcs are often detached from the main oval after substorms at Athabasca. We investigated dependences of these SAR arc appearances and their latitudes and durations on AU/AL indices, SYM-H, X component of magnetic field variation at Yellowknife (YKC), north of Athabasca in the auroral zone, solar wind pressure, and IMF-Bz. We found that when SAR arcs occur, AL and YKC-X component tend to decrease, indicating substorm association of these SAR arcs. We found that the SAR arc occurrence peak is around midnight with a peak rate of ~5 % with decreasing rates in both pre-midnight and post-midnight sectors. We then classified these SAR arcs into 3 types by using simultaneous 557.7-nm images as: 1) 557.7-nm images show weak structures similar to the 630.0-nm SAR arcs (30 %), 2) 557.7-nm images does not show structures similar to the 630.0-nm SAR arcs (55 %), 3) 557.7-nm images show structures different from the 630.0-nm SAR arcs (15 %). In the presentation, we will discuss possible cause of the detachment of SAR arcs from the main oval associated with substorms.

Keywords: SAR arc, substorm, MI coupling

