

Coexistence of a polar cap arc and a polar cap patch

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A polar cap arc aligned with the trailing edge of a polar cap patch was observed at 2350 UT on 23 December 2014 by an all-sky imager (ASI) installed at Longyearbyen, Svalbard. It is known that polar cap patches are manifestation of southward interplanetary magnetic field (IMF) while polar cap arcs are manifestation of northward IMF. It is also known that both polar cap patches and polar cap arcs may appear simultaneously when the direction of IMF reverses from southward ($B_z < 0$) to northward ($B_z > 0$). Known cases of such events showed that a patch and an arc were not far from each other, i.e. they were within the field of view of the instrument, but they were separated. In our observation, on the other hand, a patch and an arc were very close to each other. All-sky images of 630.0 nm emission showed that the brightness of the trailing edge of a patch suddenly increased just before entering the auroral oval. These images indicated that there was a narrow strip of auroral emission along the edge of the patch. The variation of the F-layer peak electron density ($N_m F_2$), deduced from F-layer critical frequency ($f_o F_2$) data observed by Svalbard Dynasonde, was in good agreement with the variation of 630.0 nm brightness at the zenith, indicating that the patchy object in the ASI image was actually the plasma patch. At the same time, the ASI-measured 557.7 nm brightness data suggest that the bright arc along the patch edge had an auroral nature. Almost exactly an hour before this event, the direction of IMF measured by ACE satellite reversed from southward to northward. Furthermore, Svalbard Dynasonde data showed a reversal of the east-west component of F-layer drift velocity at almost the same time as the arc appeared, suggesting that there was a horizontal velocity shear in the F region above Svalbard. This also suggests that the observed bright arc was indeed an auroral arc. One peculiarity of this event is that the observed arc was extended from east to west, unlike the well-known north-south polar-cap arcs. With these observational facts we will discuss the possible origin of the arc.

Keywords: polar cap patch, polar cap arc, polar ionosphere, magnetosphere, arc origin