Investigation of interhemispheric asymmetry of polar cap patch occurrence

Akiko Kagawa[1]; Keisuke Hosokawa[1]; Yasunobu Ogawa[2]; Akira Kadokura[2]; Yusuke Ebihara[3]; Hidekatsu Jin[4]; Kazuo Shiokawa[5]; Yuichi Otsuka[5]
[1] UEC; [2] NIPR; [3] RISH, Kyoto Univ.; [4] NICT; [5] ISEE, Nagoya Univ.

Polar cap patches are defined as regions of plasma density enhancements in the polar cap F region ionosphere. The electron density inside patches is 2 to 10 times larger than the background level. When discussing the generation mechanism of patches, it is important to consider the spatial distribution of 1) the daytime high-density plasma and 2) the high-latitude plasma convection. That is, to produce patches, there should be a spatial overlap of the above-mentioned two factors especially on the dayside. Taking this into account, if the distance (i.e., offset) between the geographic and geomagnetic poles (Altitude adjustment corrected geomagnetic coordinates) is sufficiently large, there should be a period when the entire polar cap is within the dark hemisphere and the intake of daytime high-density plasma (i.e., high-density patches) never happens. Thus, it is predicted that the production of patches deeply depends on the offset between the two poles. However, there has been no study that examined the dependence of patch occurrence (for example, UT distribution and seasonal distribution) on the offset because almost all of the past studies were targeted for patches in the northern hemisphere (NH) where the offset is smaller (~7 degrees) than that in southern hemisphere (SH) which is ~15 degrees. In this study, we reveal the role played by the offset in the patch production process by investigating the interhemispheric asymmetry of patch occurrence characteristics.

In order to perform statistics of patches in both hemispheres, we made use of 630.0 nm airglow images from all-sky imagers operated at Resolute Bay, Canada (OMTIs: 74.7 N, 265.1 E) and McMurdo, Antarctica (AWI: 77.5 S, 166.4 E) during local winter in 2015. In addition, to visualize the spatial distribution of the plasma density in the entire polar cap, we employed the GAIA (Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy) model. As a result of statistical analysis, it was found that almost no patches were observed in McMurdo during a few hours from 14 to 17 UT. In this time period, the entire high-latitude plasma convection system in the SH is in the dark hemisphere and there should be no interaction with the high-density plasma in the sunlit area. Such a configuration prevents the intake of sunlit high-density plasma which is the primary reason for the absence of patches in the SH in this specific time period. Similar UT dependence of patch occurrence was not seen in the NH because of the small offset between the poles. This indicates the difference in the offset between the poles indeed introduces an interhemispheric asymmetry in the climatology of patches. In addition to the analysis of UT dependence, we investigated the effect of the offset on the seasonal distribution of patches by using in-situ plasma density data from the Swarm satellites. We found that the occurrence rate of patches is higher during equinoctial periods, especially in the SH. This tendency can partly be explained by the so-called Russel-McPherron (R-M) effect, but the reason for the slight interhemispheric asymmetry is still unclear. In the presentation, by taking both the R-M effect and the difference in the offset into account, we discuss the interhemispheric asymmetry in the seasonal variation of patch occurrence rate.