The relationship between F-region disappearance in the polar cap region and field-aligned currents at geosynchronous orbit during the 11 May 2019 magnetic storm

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The 2nd Antarctic station of Korea, Jang Bogo Station (JBS, AACGM latitude: 79.87°S) has been operating ‘Vertical Incidence Pulsed Ionospheric Radar (VIPIR)’ to monitor the variations of the ionosphere since 2015. During the main phase of the 11 May 2019 geomagnetic storm, we confirmed the absence of F-region for ~12 hours from ~10:00 UT to ~22:00 UT in night time from the VIPIR observations. During the interval of the F-region disappearance, Geo-KOMPSAT-2A (GK-2A), located west of JBS with ~2-hr local time separation, observed strong westward geomagnetic field perturbations at geosynchronous orbit. These field perturbations at GK-2A can be attributed to the field-aligned currents (FAC) flowing out of the ionosphere in the Southern Hemisphere below the satellite in the pre-midnight sector and into the ionosphere in the Northern Hemisphere above the satellite in the post-midnight sector. We examined the relationship between NmF2 at JBS and the amplitude of westward perturbation at GK-2A and found that NmF2 decreases as the amplitude of westward perturbation increases (i.e., as the intensity of FAC increases). This indicates that the F-region plasma density decrease at the polar cap region is associated with FAC during the main phase of the geomagnetic storm. Since the plasma density decrease is related to the O/N2 decrease, we suggest that the heating of the polar atmosphere is driven by FAC, causing the Joule heating in the auroral zone.

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