S002-10
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14:20～14:35

2024 年 5 月の磁気嵐時におけるプラズマ圏・電離圏の電子密度の時間・空間変動について

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Temporal and spatial variation of electron density in the plasmasphere and ionosphere during the May 2024 storm

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Due to the arrival of strong southward interplanetary magnetic field (IMF) to the Earth's magnetosphere, a strong magnetospheric convection is driven by the dayside magnetic reconnection between the IMF and Earth's magnetic field. The magnetospheric convection electric field penetrates the plasmasphere and equatorial ionosphere together with the development of a ring current in the inner magnetosphere. The electric field changes a spatial distribution of the electron density in the plasmasphere and ionosphere. However, details of the temporal and spatial variation of the electron density have not fully been understood during a super geomagnetic storm such as the May 2024 storm with a SYM-H minimum value of -512 nT. In this study, we analyzed global navigation satellite system - total electron content (GNSS-TEC) and Arase satellite observation data to clarify the generation mechanism of the electron density variation in the plasmasphere and ionosphere during the May 2024 storm. To identify the electron density variation in the ionosphere, we calculated the ratio of the TEC difference (rTEC) defined as a difference from a 10 quiet-day average TEC normalized by the average value. Further, we obtained the electron density in the plasmasphere and inner magnetosphere from the upper limit frequency of upper-hybrid resonance (UHR) waves observed by the Arase satellite. As a result, an L-t diagram of the electron density shows a shrink of the plasmasphere from L=6.0 to L=2.0 after the onset of the storm. It persisted for 4 days, which is much longer than a usual CME-driven storm. This result suggests that the erosion of the plasmasphere is caused by the penetration of a strong convection electric field. Interestingly, the electron density in the inner plasmasphere of less than L=2.0 increased by a factor of 3-5 during the main and early recovery phases of the geomagnetic storm. This phenomenon is thought to be caused by the uplift of the lower altitude plasmaspheric and ionospheric plasmas due to the penetration of the eastward electric field or heating of the ionospheric plasmas by heat flux from the inner magnetosphere. On the other hand, a polar map of rTEC in the Northern Hemisphere shows that an enhancement of the rTEC value occurred around the cusp (12-13 h in magnetic local time (MLT)) approximately 1 hour after the onset of the storm sudden commencement. The enhanced rTEC region extended in the magnetic latitude (MLAT) and MLT directions as the geomagnetic storm developed. After that, a tongue of ionization (TOI) was form in the polar cap due to the enhancement of the two-cell convection in the high-latitude ionosphere. During the recovery phase of the geomagnetic storm, a spatial distribution of rTEC showed a large depletion of the rTEC value in the entire region of the ionosphere from the high to low latitudes. This phenomenon persisted at least for more than 4 days. The depletion suggests the occurrence of a negative storm due to the neutral composition (O/N2) change driven by energy input from the magnetosphere at the high-latitude thermosphere. Further, it is thought that the long duration of the negative storm prevents the plasmaspheric refilling process.