R005-34
Zoom meeting C ：11/2 AM2 (10:45-12:30)
11:45-12:00

Occurrence feature of plasma bubbles during geomagnetic storms using long-term GNSS-TEC data

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Plasma bubbles are generated in the bottomside F region of the nighttime equatorial ionosphere after sunset by the Rayleigh-Taylor instability (RTI) mechanism [e.g., Farley et al., 1970; Kelley, 2009]. The growth rate of RTI depends on an intensity of eastward electric fields and an ionospheric altitude, and enhances with an increase of both parameters. The pre-reversal enhancement in the evening sector of the equatorial ionosphere, that is, an eastward electric field intensified at sunset, is believed to be the major contributor to a significant enhancement of the RTI growth rate [Rezende et al., 2007]. On the other hand, during a geomagnetic storm, the two main disturbance electric fields responsible for changes in the equatorial plasma drifts and current perturbations are the prompt penetration electric fields and the ionospheric disturbance dynamo electric fields, respectively. Although each electric field is believed to contribute to the generation of the equatorial plasma bubbles in the dusk and dawn sectors, respectively, the statistical view of the response of the plasma bubble generation to the storm-time electric fields has not yet been established. In this study, we analyzed total electron content (TEC) and rate of TEC index (ROTI) [Pi et al., 1997] data obtained from global navigation satellite system (GNSS) receivers over the world during 2000?2018 to investigate temporal and spatial variations of storm-time plasma bubbles and clarify causes of them.
We defined the SYM-H variations with the minimum value of less than -40 nT as a geomagnetic storm event, and identified 652 events during 2000?2018. For these storm events, we investigated the relationship between temporal and spatial variations of ROTI and other parameters (solar wind and geomagnetic indexes) in these events with a superposed epoch analysis. In this analysis, we defined the time of minimum value of SYM-H index as the zero epoch. As a result, an enhanced ROTI region appeared within 20o in geomagnetic latitude (GMLAT) between 19.5 and 0.5 MLT (magnetic local time) under the geomagnetically quiet conditions before the onset of the geomagnetic storms. During the main phase of the geomagnetic storms, the enhanced ROTI region expanded to the higher latitude. The upper limit of the latitude tended to increase with an increasing intensity of the geomagnetic storms. After that, the enhanced ROTI region moved to the post-midnight sector with time and another enhanced ROTI region appeared in the post -midnight to dawn sectors between 2 and 5 MLT during the recovery phase. On the other hand, the enhanced ROTI region in the dusk sector weakened within 15o (GMLAT) and was confined only between 20 and 22.5 MLT during the recovery phase.
Averaged ROTI values at the magnetic equator increased between 19 and 20.5 MLT during the late main phase of geomagnetic storms, corresponding to the enhancement of an averaged dawn-to-dusk component of interplanetary electric field. During the recovery phase of geomagnetic storms, the averaged ROTI values at the magnetic equator increased between 1 and 6 MLT while those at the magnetic equator decreased between 19.5 and approximately 1 MLT. Fejer et al. [2008] reported that the prompt penetration electric field is directed westward between the midnight and dawn sectors (0?7 h local time) and eastward between the dusk and midnight sectors (18?24 h local time). The disturbance dynamo electric field is directed eastward between the dusk and dawn sector (21?7 h local time) and westward in the dusk sector (18?21 h local time).
From these results, the plasma bubbles can be generated in the dusk sector due to the under-shielding prompt penetration electric field (eastward electric field) during the main phase of geomagnetic storms. Due to the over-shielding prompt penetration electric field or disturbance dynamo electric field, they can be generated in the post-midnight and dawn sectors (eastward electric field) and suppressed in the dusk sector (westward electric field) during the recovery phase.