

Onsets of equatorial plasma bubble and ionosphere-thermosphere system

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For advanced applications of Global Navigation Satellite System such as MTSAT Satellite-based Augmentation System (MSAS), ionospheric scintillations that cause outage of signals are a serious problem. Among many ionospheric disturbances, equatorial irregularities associated with plasma bubbles are most significant. The occurrence probability of plasma bubbles is known to vary with the solar activity, season, local time, and many other geophysical conditions. Although the climatology of plasma bubbles is well known, its responsible mechanisms and day-to-day variability of bubble onsets are still an enigma. Nevertheless forecasting plasma bubble onsets is an important issue for Ionospheric Space Weather.

To examine ionosphere-thermosphere conditions that lead to onsets of equatorial plasma bubbles, nocturnal ionospheric height variations were analyzed using ionosonde data obtained along the magnetic meridian of 100deg.E; two ionosondes were installed near the magnetic conjugate points, Chiang Mai, Thailand (18.8deg.N, 98.9deg.E; 13.0deg. Magnetic latitude) and Kototabang, Indonesia (0.2deg.S, 100.3deg.E; -10.0deg. Magnetic latitude), and the third ionosonde was installed near the magnetic equator, Chumphon, Thailand (10.7deg.N, 99.4deg.E; 3.3deg. Magnetic latitude). Ionospheric virtual heights were scaled every 15 minutes and vertical EXB drift velocities were inferred from the equatorial data. Incorporating the inferred vertical drift velocity, assuming equipotentials of the magnetic field lines, no-wind ionospheric bottom heights were modeled over the two low-latitude conjugate stations. The deviation of the heights from the model outputs was used to infer transequatorial thermospheric winds. The results were compared for the September and March equinoxes, in which plasma bubbles occur frequently at these longitudes.

A higher order oscillation, with a period of about 7 hours, of the meridional wind was observed in both the periods, and its amplitude was significantly larger in the September equinox than the March equinox. Also the evening enhancement of the zonal electric field was larger in the March equinox than the September equinox. These asymmetries in the ionosphere-thermosphere system were found to be tightly connected with the previously-reported equinoctial asymmetry of the occurrence probability of equatorial ionospheric irregularities. In other words, a higher order oscillation of the meridional wind might be involved with onsets of plasma bubbles. Although the observed equinoctial asymmetry of bubble occurrence is not very prominent compared with other morphological features, it would be a key to testing possible connections between the ionosphere-thermosphere system and the lower atmosphere, because direct solar influence to the ionosphere-thermosphere system is expected to be identical in both the equinoxes. Further, day-to-day variability of the thermospheric wind field must be a key to developing a forecasting system of equatorial scintillations.