Monitoring of plasma bubble occurrence by multi-frequency observations

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ABSTRACT

To monitor the plasma bubble occurrence, we employ multi-frequency observations in high frequency (HF), Very high frequency (VHF), ultra high frequency (UHF), and microwave bands. The final goal is to forecast plasma bubble occurrence and arrival time near the Japanese meridian. Plasma bubble is known to be actively generated when the Equatorial Ionization Anomaly (EIA) is symmetric. This paper reveals a relation of the EIA structure and the plasma bubble occurrence, and a statistical study of plasma bubble occurrence that are significant results for plasma bubble forecast in the near future. Plasma bubble, which penetrates the Japanese meridian at later time, supposes to be generated in the west of the Japanese meridian. Plasma bubble monitored in Southeast Asia where is in the west of the Japanese meridian is employed in this work.

Key words: Plasma bubble, EIA, Ionosphere, Beacon TEC, GPS.

Methodology

National Institute of Information and Communications Technology (NICT) has been operating the SouthEast Asia Low-latitude IOnospheric Network (SEALION) since 2003 for monitoring and forecasting equatorial ionospheric disturbances, especially plasma bubbles. SEALION is a unique ionospheric observation network in having the conjugate observational points in the northern and southern hemispheres and around the magnetic equator. The main instruments of SEALION that are used in this work are GPS receivers (microwave) and ionosondes (HF). Besides the SEALION, beacon receivers are available in Southeast Asia in the same meridian to receive VHF/ UHF signals. Each of the polar beacon satellites, e.g., DMSP, RADCAL, COSMOS series, and newly launched CASSIOPE, is always available for about 15 passes a day, on average. It allows a monitoring of ionospheric disturbances constantly available. Beacon networks are sensitive to monitor precise EIA structure [1] that plays a role in the plasma bubble occurrence. This paper presents the relation of the EIA structure and the plasma bubble occurrence. Beacon TEC [2] from more than 600 satellite-

passes are used to capture the precise structure of EIA. The small-scale fluctuations in beacon TEC during an equatorial spread *F* appearance are captured as the structure of plasma bubbles. The Rate Of TEC change Index (ROTI) of GPS is used to monitor the plasma bubble occurrence. Temporal variation of the bottom side of the *F* layer is measured by the ionosonde. Equatorial Atmospheric Radar is used additionally for detecting Field Aligned Irregularities (FAI). The Plasma bubble occurrence is statistically studied by using all available dataset during 2008 and 2013.

Results

Plasma bubbles are frequently observed during nighttime (~12-19 UT, 18-01 LT) especially in equinox seasons. The precise EIA structures obtained from the beacon TEC in the evening before the plasma bubble appearance were mostly symmetric. When severe asymmetric EIAs appeared, plasma bubble was not detected in the same meridian. Besides the EIA structure, the solar activity also plays a role in an occurrence of plasma bubble. During high solar activity period (in 2010), plasma bubble appeared for all stations from 18.8 N to 8.9 N (geographic latitude). On the other hand, plasma bubble in low solar activity year (2009) was detected at latitudes lower than 13.7 N (geographic latitude) where the apex altitude lower than ~425 km. Furthermore, latitudes of plasma bubble occurrence were decreased in 2008.

Conclusions

The results confirmed that EIA symmetry/ asymmetry plays an important role on plasma bubble occurrence. Solar activity control how far from the dip equator where plasma bubbles can reach. Local operation of beacon network improves the data set of the precise EIA structure in Southeast Asia. By using SEALION data and beacon data for simultaneous observation of precise EIA and plasma bubble occurrence, it helps deepening knowledge of regional characteristic of the plasma bubble occurrence. This study helps improving the database of plasma bubble occurrence in Southeast Asia that contributes to a development of a forecast of plasma bubble occurrence and its arrival time near the Japanese meridian.

References

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