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Estimating the drift velocity of Equatorial Plasma Bubbles with GNSS and digisonde data

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1 Extended Abstract

This study presents a revision of the Blanch et al. method [1] to identify the occurrence of Equatorial Plasma Bubbles (EPBs) using data from Global Navigation Satellite System (GNSS) receivers. On the basis of GNSS data, the method identifies depletions in the total electron content (TEC) and determines whether EPBs anomalies are significant with respect an estimated background TEC. The introduced enhancements significantly improve the tool's robustness, resulting in a notable reduction in the false positive rate compared to its predecessor. The refinements extend to statistical techniques employed to achieve a more accurate fit for the background TEC, enhancing EPB characterization by improving the estimation of disturbance shape. In addition, the method has extended the multi-constellation analysis by adding signals from Galileo and Beidou to that of GPS, allowing analysis of data from more current GNSS receivers. These improvements contribute to the reliability of the automatic detection tool, available at the e-Science Centre of the Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access services: a Network of Research Facilities project (PITHIA-NRF) [2].

Expanding upon the capabilities of this enhanced tool, we have developed an advanced method for estimating EPB drift velocities, encompassing both speed and direction. Utilizing data from a densely populated GNSS receiver network, our investigation provides valuable insights into the dynamic behavior of EPBs in the Caribbean region throughout the year 2014. Our analysis reveals a predominant eastward propagation pattern of EPBs, closely aligned with modip isolines.

Moreover, through the integration of outcomes from the tool applied to GNSS with quasi co-located digisondes, estimations for EPB velocities and their spatial dimensions along the drift direction are successfully derived for different sectors. Our results of estimated drift velocities have been validated through comparison with those obtained by other independent studies. This cross-verification not only confirms the reliability of our methods but also emphasizes their soundness in capturing the nuanced characteristics of EPBs. Our approach advances the precision of EPB detection and contributes valuable insights into their spatiotemporal dynamics and behavior, providing a comprehensive framework for understanding and characterizing these phenomena in the equatorial ionosphere.

References

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