Modeling the climatology of equatorial plasma bubbles observed by DMSP

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Abstract: Space environmental sensors on polar-orbiting Defense Meteorological Satellite Program (DMSP) spacecraft occasionally encounter plasma density depletions when they cross the geomagnetic equator in the evening sector. These equatorial plasma bubbles (EPBs) are observed around the times and locations when equatorial spread F and radio scintillation phenomena tend to occur. The solar cycle, seasonal, and longitudinal variations in the observed frequency of these depletions (determined over the past 19 years) are indeed similar to those of scintillation. To test our understanding of EPB formation, we simulated the observations using PBMOD, a suite of first-principle models of the ambient ionosphere and EPB formation, driven by climatological models for its input parameters such as the plasma drift velocity. Maps of the model calculations of EPB frequencies at 840 km as functions of season and longitude exhibit patterns similar to the DMSP observations, including the expected peaks in EPB frequency near the equinoxes, an additional winter peak in the American sector, a summer peak in the Pacific sector, and the proper trends with solar cycle phase. Adjusting the model to reproduce the DMSP EPB occurrence frequencies in detail will allow us to fine tune PBMOD and provides a means for using the DMSP data to enhance the empirical drivers for the Communication/Navigation Outage Forecasting System (C/NOFS) mission.

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