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Radar observations of electron density enhancements associated with inverted-V electron precipitation on the nightside of Mars

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Abstract

Ionospheric electron density enhancements have been observed in association with inverted-V electron precipitation on the nightside of Mars. The electron density enhancements were detected using the ionospheric sounding mode of the MARSIS (Mars Advanced Radar for Subsurface and Ionospheric Sounder) instrument on the Mars Express spacecraft, and the associated inverted-V electron precipitation events were observed by the ASPERA-3 (Analyzer of Space Plasma and Energetic Atoms) instrument. Because the nightside MARSIS measurements were initially devoted primarily to subsurface sounding, it is only in recent times that significant amounts of ionospheric sounding data have become available. A survey of the available data show that a substantial fraction of the nightside soundings show evidence of oblique ionospheric reflections near or directly over regions where the ASPERA-3 instrument detects inverted-V electron precipitation. When the ionospheric soundings are displayed in the form of a "radargram," which is a plot of apparent range to the reflection point versus time, the ionospheric reflections often take the form of a hyperbola, or a portion of a hyperbola. Such radar returns are indicative of oblique reflections, either to the side of the spacecraft ground track, or directly along the track. When observable, the minimum apparent ranges are consistent with electron density enhancements at the expected height of the nightside ionosphere, i.e., approximately 150 to 200 km. In many cases the radar echo is diffuse, indicating incoherent scattering from a substantial region. Usually the density enhancements associated with the inverted-V precipitation occur over regions with significant crustal magnetic fields, although cases have been observed over regions with small or negligible crustal magnetic fields.
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