



Oblique ionospheric reflections in the MARSIS data set

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In addition to reflections from the Martian ionosphere along the nadir direction, the Mars Advanced Radar for Sub-surface and Ionospheric Sounding (MARSIS) on board ESA's Mars Express (MEX) orbiter frequently detects 'oblique reflections' from additional targets away from the nadir direction. Such oblique reflections have been attributed to the presence of anomalous horizontal structure within the ionosphere, in which the ionospheric scale height is thought to have increased in regions where Mars' remnant crustal magnetic field has a 'open' or cusp-like configuration, possibly allowing for the heating of the ionosphere by precipitating solar wind plasma. This spatial structuring gives constant-density surfaces which are not parallel to the planet's surface, from which the sounding pulse from the MARSIS instrument can be reflected back towards the spacecraft at what would otherwise be oblique incidence. These oblique reflections form distinctive hyperbolas in time and apparent range, the apices of which are generally above the surrounding ionosphere, strongly suggesting that they have an extended horizontal structure. Here, employing the substantial MARSIS data set, we examine both the spatial distribution and repeatability of detection of these oblique reflections. These results are then related to the highly structured Martian crustal magnetic field, utilising a simplified ray-tracing code.