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Ionospheric disturbances at Mars: Implications for radio propagation

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Using observations from the Radio Science Experiment onboard the Mars Global Surveyor (MGS) satellite, we have identified two classes of transient ionospheric disturbances that could impact radio communications and navigation systems at Mars. Above regions of strong crustal magnetic fields, the ionospheric electron density profiles show marked departures from the typically smooth altitude dependence seen at locations where the crustal fields are weak or non-existent. These anomalous profiles have localized depletions ('biteouts") that occur primarily in the topside ionosphere of Mars, at heights of $\sim$150-180 km. Other profiles show irregular enhancements superposed upon the topside decay pattern. These strong, localized gradients might seed the types of plasma instability mechanisms that occur on Earth, but the 2-hour orbital period of the MGS data taking method does not allow for adequate temporal diagnosis at fixed locations.

Following solar flares of both moderate to strong magnitude, bottomside portions of martian electron density profiles (90-110 km) show enhancements of 50 to 200%. These are caused by increases in the soft X-ray fluxes in the $\sim$20-50 A wavelength range. Hard X-rays ($<$10 A) increase dramatically during flares, radiation that creates ionization near 60 km on Mars. These electron density enhancements would cause the type of "D-layer absorption" of radio signals long known to be a strong solar-terrestrial disturbance effect on Earth.