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Electron densities from funnel-shaped auroral hiss emissions in Saturn's auroral zone

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On December 2, 2006, the Cassini spacecraft crossed high-latitude field lines inside 6 R_S on its approach to Saturn in the southern hemisphere. The Radio and Plasma Wave Science (RPWS) instrument detected broadband emissions propagating in the whistler mode below the electron cyclotron frequency. As the wave frequency increases, the emission spreads out over a broad region both poleward and equatorward, producing a funnel-shaped signature that is characteristic of auroral hiss emissions in the Earth's magnetosphere. Saturn's auroral hiss funnel spans a narrow range of southern latitudes between L=12 and L=17 just inside 6 R_S. In magnetospheric regions where the plasma frequency is below the electron cyclotron frequency, the upper frequency cutoff of the whistler mode emissions is at the electron plasma frequency. Electron densities are derived from the upper frequency cutoff of the hiss emission using $f_p = 9\sqrt{n_e}$ where the plasma frequency is in kHz and the electron density is in cm^{-3}. The electron densities for this auroral zone crossing range from approximately 0.01 cm^{-3} at the poleward edge of the funnel to 0.02 cm^{-3} at the equatorward edge with a 50% density drop in the center of the funnel, forming a modest auroral plasma cavity centered on the L=14 field line at 5.3 R_S. Funnel-shaped emissions are also seen in the northern hemisphere at higher latitudes beyond 9 R_S. Along this part of Cassini's trajectory, Landau and cyclotron damping of the hiss emissions prevents the derivation of an absolute electron density profile.