Remote Sensing of Electron Density and Density Irregularities from Whistler and Z-Mode Sounding Experiments by RPI on IMAGE

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Discrete and diffuse whistler mode echoes are regularly observed when the Radio Plasma Imager (RPI) on the IMAGE satellite operates at the low end of its 3-kHz to 3-MHz sounding frequency range in the plasmasphere and at moderate to low altitudes over the polar regions. In regions poleward of the plasmasphere, diffuse Z-mode echoes are found to accompany both discrete and diffuse whistler-mode echoes 90% of the time.

Previous research indicates that discrete whistler-mode echoes are a consequence of RPI signal reflections at the bottom side of the ionosphere. The diffuse whistler-mode echoes are a result of scattering of RPI signals by geomagnetic-field-aligned electron density irregularities located within ~2000 km Earthward of the satellite and in directions close to that of the field line passing through IMAGE. Diffuse Z-mode echoes are believed to be due to the scattering of RPI signals from electron density irregularities within ~3000 km of the satellite, particularly those in the direction perpendicular to the geomagnetic field. Measurements of electron density and density structures close and remote to IMAGE location are possible from the analysis of whistler and Z-mode echoes: (1) The observed upper cutoff near the local upper hybrid resonance frequency and the observed "gap" near the gyrofrequency in the plasmagram of diffuse Z-mode permit determination of the local electron density. (2) The measured dispersion of discrete whistler mode echoes combined with raytracing analysis provides electron density profile along the field line passing through the satellite. (3) Diffuse whistler and Z mode echoes provide location and scale size of geomagnetic-field-aligned electron density irregularities located up to a few thousand kilometers from the satellite location in the direction parallel and perpendicular to the geomagnetic field.

We have analyzed several cases of whistler and Z-mode echoes to measure electron densities and to identify locations and scale sizes of density structures present in the mid to high latitude magnetosphere up to 5000 km altitude. The results obtained are in general agreement with those reported from previous spacecraft measurement of electron density and density structures.

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