Remote Sensing of Magnetospheric Plasma Density from the Analysis of Whistler Mode Echoes Received by RPI on IMAGE

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Whistler mode wave injection and reception using the RPI instrument on IMAGE satellite has led to a new remote sensing method to measure the plasma density and to locate and identify plasma density structures in the magnetosphere. During May – August 2000 period, RPI recorded discrete and diffuse whistler mode echoes on a number of days when IMAGE was in the inner plasmasphere and at moderate to low altitudes (<1500-6000 km) near its perigee in the southern hemisphere. The discrete echo is characterized by lightning-whistler-like discrete form whereas the diffuse echo is characterized by multiple echoes from a single transmission. Ray tracing simulations indicate that discrete echoes may result from reflections of RPI signals from the Earth-ionosphere boundary and diffuse echoes may result from scattering of RPI signals from small scale plasma density irregularities, commonly found in the high latitude magnetosphere. By comparing measured dispersion of RPI signals with those from ray tracing simulations it is possible to determine (1) the plasma density and (2) location and spatial size of irregularities responsible for diffuse echoes. The ray tracing analysis of observed dispersion of discrete echoes from several cases leads to electron density of ~500-1000 el/cc at ~4000 km with a R^{-N}, where N ~ 4-5, dependence in the auroral and polar magnetosphere. Analysis of diffuse echoes indicates presence of ~10-100 m scale plasma irregularities within ~1000 km of the IMAGE satellite at the time of observation. These results are in general consistent with previous observations of plasma density in the magnetosphere.