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# Empirical electron density models for the inner magnetosphere derived from IMAGE RPI observations

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The radio plasma imager (RPI) onboard NASA's IMAGE satellite measured the electron density distribution in the inner magnetosphere using radio sounding techniques during almost six years from 2000 to 2005. RPI transmitted RF pulses and measured the echo delay times of signals reflected at the respective plasma cutoff frequencies, stepping through the frequency range from 3 to 3000 kHz. The echo traces in the plasmagrams of signals that propagated along magnetic field lines were inverted into electron density profiles along the field line. In contrast to previous in situ measurements which had to do a statistical composition of profiles, the entire RPI profile is obtained from one plasmagram recorded in less than a minute. Empirical models of the electron density distribution in the plasmasphere and the polar cap region were developed from the ensemble of profiles describing the plasma distribution. Nearly 1000 profiles were analyzed for the plasmasphere, and close to 2000 in the polar cap.

For the polar cap our study covers a geocentric distance of R from 1.4 to 5.0 RE, where the polar cap is defined by an empirical boundary model that takes into account the dynamic nature of the location and size of the polar cap. The RPI Ne data show that the electron density distribution in the polar cap depends on the geocentric distance, R, geomagnetic activity level as measured by the Kp index, and solar illumination (solar zenith angle) at the footprints of the geomagnetic field lines. Our analysis of polar cap Ne data shows that although an increase in geomagnetic activity leads to an enhanced Ne, the enhancement is found to be altitude dependent such that the enhancement in Ne is most pronounced at higher altitudes. At geocentric distance of 4.5 RE, an increase in the geomagnetic activity level from Kp smaller than 2 to 5 results in an Ne increase by a factor of 5. On the other hand, the observations show a strong solar illumination control of Ne at lower altitudes, and not at higher. RPI Ne data show that in the polar cap at geocentric distance of about 2 RE, the average Ne is larger on the sunlit side than on the dark side by a factor of 3 – 4 both for quiet and disturbed conditions. At a geocentric distance of 2.5 RE the effects of these two factors on Ne appear to be comparable. Similar to previous polar cap density models, the new empirical model of Ne developed in this study takes the form of a power law. While in the previous Ne functional representations the power index is a constant, the power index in our representation of Ne distribution is a function of Kp index and solar zenith angle, which itself is dependent on latitude and local time

In the plasmasphere, the data coverage is not very extensive but it is sufficient to describe the latitudinal variations. A hemispheric asymmetry was observed with higher densities in the winter hemisphere during solstices.

Attempts have been made to connect the plasmasphere models to the topside ionospheric models derived from ISIS topside sounder data using Vary-Chap representations.