Geophysical Research Abstracts
Vol. 14, EGU2012-13251, 2012
EGU General Assembly 2012
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Sounding of the Plasmasphere by McMAC Magnetometers

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Properly positioned ground magnetometers can be used to detect resonance of magnetospheric field lines as a way to make unique observations of the plasma mass density of the magnetosphere. In this paper we describe the field line resonance (FLR) frequencies systematically observed by the Mid-continent MAgnetoseismic Chain (McMAC), which consists of 10 stations in the United States and Mexico along 300° magnetic longitude. With an average separation by 272 km between adjacent stations McMAC is well suited to remotely sensing the plasma density at L-values between 1.6 and 3.3 through the gradient method of FLR measurements. We analyzed a full year of McMAC observations spanning between July 2006 and June 2007, and FLR frequencies were automatically identified in cross-phase and cross-power spectrograms by a computer routine. In all of the FLR observations by pairs of McMAC stations, the occurrence rate of FLR can reach as high as 55% around local noon at L = 2.7. The occurrence rate drops at lower latitudes due to weaker FLR signals. At L = 3.3 the FLR occurrence is clearly reduced in afternoon hours, possibly because of occasional presence of the plasmapause that can obstruct FLR generation and/or detection. By examining the results from all possible pairs of McMAC stations, we find that, at $L \leq 2.5$, FLR signatures can still be found even when the separation between two stations exceeds 1000 km. The fundamental mode FLR frequencies, in addition to the inferred equatorial plasma mass densities of the magnetosphere, are tabulated with respect to L-value and time. The most probable fundamental mode frequency is found to be approximately 75 mHz at L = 1.6 and decreases with increasing L-value. The distribution of the fundamental mode frequency at L = 3.3, however, exhibits two distinct groups: The lower frequencies centered at 10 mHz representing the measurements inside the plasmasphere whereas the higher frequencies centered at 39 mHz indicating the faster field line oscillations in the more tenuous plasmatrough. Through statistical analysis we also examine the effects of local time, solar flux, and geomagnetic conditions on the fundamental mode frequency and the inferred density of the plasmasphere.