NUMERICAL SIMULATION OF ELECTRIC DIPOLE ANTENNAS IN THE INNER MAGNETOSPHERE

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The study of the radiation properties of electric dipole antennas in the magnetosphere has been an area of active research in recent years because of interest in pitch angle scattering of highly energetic electrons from the Earth's radiation belts. Previous analytical work has provided much insight into the properties of such antennas, but is limited to certain geometries and operating conditions to solve the closed form solutions. As a way to circumvent these limitations, the current distribution and input impedance of electric dipole antennas operating in a low density cold magnetoplasma at VLF (Very Low Frequency) are determined through simulation. A full wave solution of Maxwell's equations utilize the FDTD (Finite Difference Time Domain) method to simulate electromagnetic wave propagation in this highly anisotropic medium.

The PML (Perfectly Matched Layer) ABC (Absorbing Boundary Condition) is an effective and well established method for the absorption of electromagnetic waves in numerical simulations; however, the PML has been found to exhibit instabilities in the form of non-physical wave amplification in this environment. The instabilities are a result of waves that possess anti-parallel group and phase velocities within the PML medium. Various methods have been developed to circumvent these difficulties and include FIR (Finite Impulse Response) filtering of the time domain Maxwell's equations and a new PML, which utilizes information about the wave normal vector $\vec{k}$ to damp these unstable modes. The new PML is applicable to whistler mode propagation and exhibits reflection coefficients as low as -40dB. It has been found that the current distribution for electrically short antennas is roughly triangular. Calculated variations of input impedance for several case studies are given and compared with existing analytical work.

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