Simulation of magnetospheric magnetosonic wave propagation in inhomogeneous magnetized plasma

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Magnetosonic (MS) waves, also known as equatorial noises, are naturally-occurring electromagnetic emission confined near equatorial plane with frequency range from above proton gyrofrequency and below lower hybrid resonance frequency. MS waves play a potential role in energization of relativistic electrons in the radiation belt. Studying wave propagation provides valuable information of wave distribution in the magnetosphere and enables assess of electron energization efficiency. In this paper, one dimensional Finite-Difference Time-domain (FDTD) method is used to simulate the MS wave propagation along the radial direction on the equatorial plane. Magnetospheric medium is made of magnetized plasma with varying plasma density and magnetic field. We assume cold electron and proton plasma and adopt 1D FDTD with current calculated from both two species. The simulation shows when MS waves propagate inward and across the plasmapause (the boundary with a sharp density gradient of the high density plasmasphere), wave electric field components are significantly reduced, but wave magnetic field components are enhanced. The effect of plasmapause width on wave reflection and transmission is investigated. 7 percent and 1 third of incident wave power is reflected when the product of wave number and plasmapause width is 26.6 and 4.7, repectively. The transmission coefficient decreases rapidly when this product approaches to 1. We also investigate the behavior of MS waves when waves propagate inward with wave frequency approaching proton gyrofrequency. The wave is totally reflected when the proton gyrofrequency is about 2 thirds of wave frequency. Our simulation is consistent with the cold plasma wave theory very well.

Key words: FDTD method, MS wave, transmission coefficient, magnetosphere