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Preferential Propagation of Equatorial Noise in Earth's Inner Magnetosphere: Event Study and PIC Simulations

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Typically in ray tracing studies and others, propagation of near-equatorial magnetosonic waves (also called equatorial noise; MS waves hereinafter) in directions perpendicular to the background magnetic field is assumed to have no directionality, even though a statistical study in 2013 using the Cluster mission has suggested that there may be a preferential direction of propagation in the source region. Recently, analysis of an event observed by the Van Allen Probes in the source region has corroborated the previous finding that MS waves propagate preferentially in the azimuthal direction, implying that wave amplification should occur during azimuthal propagation. This calls for importance of taking the directionality of MS wave propagation into account to better understand the properties of MS waves in the inner magnetosphere. In this paper, 2-D particle-in-cell simulations are used to demonstrate that for conditions closely simulating those from the event, the growing electric and magnetic field fluctuations in the system, which are of the fast magnetosonic mode, propagate dominantly in the azimuthal direction. The electric field polarization parameters (used to determine MS wave propagation observationally) extracted from the simulation are compared against those observed to justify the simulation results, showing excellent agreement. The mechanism and potential implication of the preferential azimuthal propagation are discussed.

References
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