Spatial scales and properties of EMIC waves using simultaneous multi-satellite observations

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Electromagnetic ion cyclotron (EMIC) waves are known to play an important role in pitch angle scattering of relativistic electrons from the magnetosphere to the ionosphere via wave-particle interaction. Wave properties, such as wave intensity, spatial extent and spatial variation, are key factors in determining the efficiency of EMIC waves in scattering relativistic electrons. Thus, a better estimation of the spatial scale and spatial variations of EMIC waves is critical for theoretical understanding, reproducing and forecasting this process.

Previous studies showed that the spatial scale of EMIC waves span a wide range transverse to local magnetic field lines, ranging from a few hundred kilometers to more than one earth radii, depending on *L* shell and magnetic local time (MLT). Moreover, EMIC wave properties, such as wave intensity, wave normal angle, ellipticity, etc., show clear dependences on *L* shell, MLT, and magnetic latitude (MLAT).

By taking the full advantage of simultaneous multi-satellite wave measurements from two Van Allen Probes, three inner Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft and four Magnetospheric Multiscale (MMS) satellites, we calculate spatial scales of EMIC waves, including hydrogen band (below the proton gyrofrequency) and helium band (below the helium ion gyrofrequency) waves, in the radial and azimuthal direction, covering both inner and outer magnetosphere. Furthermore, we quantitatively characterize the spatial variations of EMIC wave properties along the magnetic field line, by analyzing the latitudinal distribution of wave intensity, wave normal angle and ellipticity. These results provide essential information on the properties of EMIC waves, which are critical for understanding their generation, propagation and damping mechanisms and useful for quantifying their effects on energetic electron dynamics.