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Comparison of different techniques to estimate the direction of the Poynting vector of EMIC emissions

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Electromagnetic Ion Cyclotron (EMIC) waves usually grow in the inner magnetosphere from hot ion temperature anisotropy. The main source region is located close to the magnetic equator and there is a secondary EMIC source region off the magnetic equator in the dayside magnetosphere. The source region can be identified using measurements of the Poynting vector direction.

The Poynting vector is ideally derived from the measurement of 3 components of the wave electric field and 3 components of components of the wave magnetic field. However, spinning spacecraft often have only two long mutually perpendicular electric antennas in the spin plane, deployed by the centrifugal force. The third antenna, when present, is usually shorter owing to difficulties of deploying a antenna along the spin axis.

Estimations of the Poynting vector from measurements of three magnetic field components and two electric field components can be obtained assuming the presence of a single plane wave (and thus perpendicularity of the electric field and the magnetic field vectors, according to the Faraday's law), following the method developed by Loto'aniu et al. (2005). Applying this method to Cluster data, Allen et al. (2013) found the presence of bidirectional EMIC emissions off the magnetic equatorial region.

Another technique proposed earlier by Santolík et al. (2001) considers the phase shift estimation between the electric signals from each antenna and synthetic perpendicular magnetic field components obtained from the three-dimensional measurements. The method is based on cross-spectral estimates in the frequency domain and can be used to estimate sign of each component of the Poynting vector. Using this technique Grison et al. (2016) showed the importance of the transverse component of the EMIC emissions far from the source region.

We compare these methods for different events to check how the results of these two techniques differ. We also discuss what we can learn about the EMIC source region from these measurements.