Ray Tracing Study of Rising Tone EMIC-triggered Emissions

M. Hanzelka(1,2) (mha@ufa.cas.cz), O. Santolik(1,2), B. Grison(3), N. Comilleau-Wehrlein(3)

(1) Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic
(2) Department of Space Physics, Institute of Atmospheric Physics, CAS, Prague, Czech Republic
(3) Laboratoire de Physique des Plasmas, CNRS/Ecole Polytechnique, Palaiseau, France

INTRODUCTION
- Electromagnetic ion cyclotron (EMIC) triggered emissions have similar properties to whistler-mode chorus emissions.
- Characteristics: highly coherent, frequency range from 0.5 Hz to 2 Hz (below the helium or proton gyrofrequency), rising tone, mostly at the onset of geomagnetic storms.
- We perform ray tracing simulations and compare resulting polarizations, dispersions and wave vector angles with measured properties and mirrored wave vector in Maxwellian plasmaspheric plumes (modelled as field aligned ducts).
- We study the source locations close to the equator and in high density gradients of the plasma.
- We study three EMIC events observed by the Cluster spacecraft in years 2004-2006.

DATA SET
- We studied three EMIC events observed by the Cluster spacecraft in years 2004-2006.
- Wave analysis was done on STAFF-SC and FGM low frequency measurements with PRASSADCO code [1].

METHODS
- Ray tracing in cold plasma with continuous WKB condition control and computation of Landau and cyclotron damping in weak growth approximation for parallel propagation.
- Radial profile of electron density obtained from EFW data calibrated with WHISPER instrument data (80 cm⁻³ e density upper limit).
- Ion composition estimate based on crossover frequencies.
- Forward tracing from the equator with assumed left polarization and initial $k_z = 0°$ or backward tracing with measured properties and mirrored wave vector.

2005-08-16
- Two successive rising-tone emissions; only the first, more intense tone is studied.
- Spacecraft C4, in the afternoon sector, propagating southwards, rises above helium gyrofrequency.
- Helium and oxygen concentration assumed to be negligible.

CONCLUSIONS
- We explained the variation in $k_z$ and ellipticity in the 2004 case and obtained reasonable agreement in $k_z$ dispersion and ellipticity for all cases.
- Good knowledge of density profile and ion composition is crucial for obtaining correct results. All simulations gave best results when source location was on outer or inner boundary of plasmapause.
- No propagation without time variation of the environment cannot fully explain observations due to low group velocity of EMICs. Evolution of density structures can be estimated from different spacecraft of the Cluster fleet.
- Maxwellian distribution is insufficient for study of wave growth in EMICs [2].

References:
[1] Santolik, O., M. Parrot, and F. Lefèvre (2003), Radio Sci., 38, 1010

Acknowledgements: We thank F. Dauzouet (IRAB, Belgium) for the WHISPER and EFW density measurements.