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Simultaneous observations of the poleward and reflected chorus waves onboard THEMIS

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Discrete ELF/VLF chorus emissions are the most intense electromagnetic plasma waves observed in the radiation belts of the Earth magnetosphere. Chorus is supposed to propagates from its well localized source region in the vicinity of the magnetic equator towards polar regions roughly along the magnetic field lines and can be reflected at low altitudes. After reflection, wave packets can return to the equatorial plane region but usually not to the same magnetic tube. The characteristics of the reflection process are very important for the correct description of the wave-particle interaction. We focus our study on the properties of the reflected chorus emissions registered by the THEMIS spacecraft Search Coil Magnetometer (SCM) and Electric Field Instrument (EFI) at low magnetic latitudes. Three axis waveform measurements of SCM and EFI in the burst mode cover the same frequency bandwidth, from 0.1 Hz to 4 kHz, in the ULF/ELF frequency range. Most of the measurements in this mode were carried out in the regions of L greater then 7. Typical duration of the time intervals of measurements in the burst mode was less then 2 minutes.

Using the measurements of the electric and magnetic field fluctuations we determine the direction of the Poynting flux and wave vector distribution for direct and reflected waves. The reflected chorus emissions captured in the vicinity of the magnetic equator have discrete structure roughly similar to direct chorus structure; however the amplitude of the reflected signal is significantly (ten – thirty times) smaller. Reflected emissions observed by the particular spacecraft have frequency shift with respect to chorus propagating from magnetic equator.

For each event of the simultaneous registration of the direct and reflected chorus we model chorus propagation and reflection by means of ray-tracing technique employing WHAMP – based geometrical optics tracer. Ray tracing study allowed us to reconstruct chorus source region and to explain observed frequency shifts and propagation characteristics. Typically reflected waves return to the magnetic equator plane with the wave vector oriented nearly parallel to the field lines.