

Fine spectral and temporal structure of different VLF emissions observed by CLUSTER

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Some results of using different methods for Cluster Wideband Detectors (WBD) VLF data processing are presented. Direct waveform signal study revealed very fast variations of signal frequency and amplitude at the time scales about 1 millisecond without correlation for the different satellites. In a contrast with an ordinary FFT, autoregression models (AR) spectral analysis demonstrates constant presence of very fine spectral and temporal structures in VLF spectrograms. All emissions (hiss, chorus, and others) are often structured at the scales less than 10 hertz and 10 milliseconds, and spectral details are rather different, even if satellites space separation is less than 100 km. Different methods for precise detection of signals time shifts for Cluster satellites, and so for detecting the direction of emissions motion were also developed. For example, calculation of cross-correlation function for every horizontal line of AR-spectra for two satellites and constructing resulting two-dimensional picture of delays happened to be very useful for that. Method also allows revealing small frequency shift for different satellites signal. Results of Wavelet spectral analysis demonstrating different correlations between low (200-500 hertz) and high (3000-10000 hertz) components of spectra are also shown.