

Three-dimensional Observation of Chaotic Pulse Trains in Negative Cloud-to-Ground Lightning Using VHF Broadband Digital Interferometer

Intended for the Lightning Physics Topic

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In the summer of 2010, we performed a three-dimensional lightning locating experiment using synchronous observations of two VHF broadband interferometer systems near or at the Guangzhou Field Experiment Station for Lightning Research and Testing. During the experiments, a variety of lightning phenomenons were observed by our interferometer systems. CPTs (Chaotic Pulse Trains) event was one of them. The term “CPTs” is used here rather than “Chaotic Leader” because in several cases, the observed irregular sequences of pulse activity is not fairly close to subsequent return stroke.

In this study, we selected 10 negative Cloud-to-Ground lightning records which contained CPTs event. The discharge processes associated with CPTs was imaged in three dimensions using VHF broadband digital interferometers. The spatial and temporal characteristic, power spectral density (PSD) in the 30MHz to 290MHz band and pulse train structure of 10 CPTs records were analyzed.

We found that the breakdown process associated with CPTs is similar with attempt leader or dart leader. The statistical result shows the average progression speeds of these breakdown processes are about $10^6\text{ms}^{-1}\sim 10^7\text{ms}^{-1}$. The average PSD (Power Spectrum Density) of the CPT event’s VHF emission is 1.8~11.6dB or 2.4~12dB larger than that of the step leader or dart leader in the same negative cloud to ground lightning. The mean value and standard deviation of the pulse separations in these chaotic pulse trains are $5.3\sim 9.0\mu\text{s}$ and $2.7\sim 4.9\mu\text{s}$.

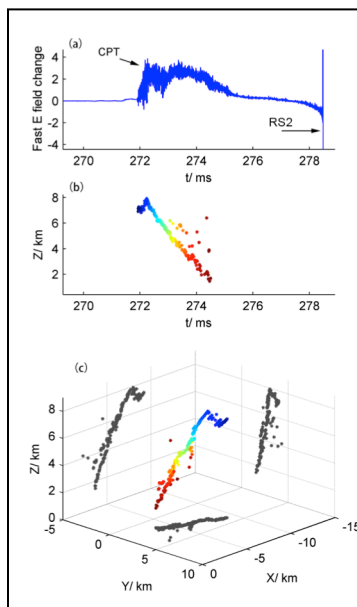


Fig1. The 3D location of CPT occurred in -CG Case 6: (a) the fast E field change waveform, (b) the height of sources (Z) versus time, and (c) the 3D location and its projection on three coordinate planes (graypoints)

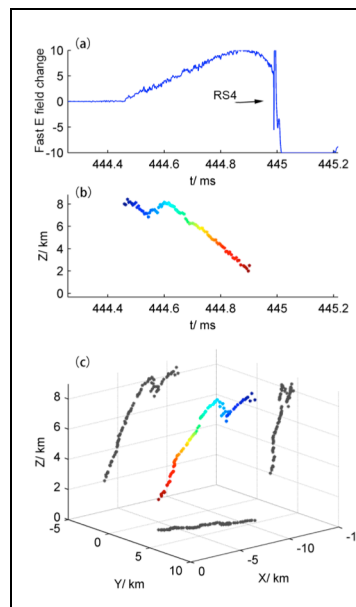


Fig2. Similar to Fig1, but for the 4th leader of Case 6