A wideband active lightning E-Dot sensor and observations of cloud-ground lightning

Intended for the Lightning Detection Technologies Session Topic

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Traditional E-Dot sensor usually consists of a plate and a terminal resistance, whose upper critical frequency is limited by the time constant effect of the equivalent RC circuit. In order to overcome this problem, a wideband active lightning E-Dot sensor is developed. Numerical simulation and lab calibration demonstrate that this sensor could span a flat bandwidth up to several tens of megahertz, which is limited by the OP performance.

This E-Dot sensor is further applied in field lightning observations during the summer of 2011 in Nanjing, China. Synchronized observation with an electric field changes (also called fast antenna) is conducted, and the full wave of dE/dt and E changes for the close cloud-ground (CG) lightning flashes (within 5km) are collected and analyzed.

As the initial leader approaching ground, dE/dt radiation is becoming more and more intensive. The highest dE/dt radiation in CG is generates by return strokes, with peak radiation in frequency range 0.5MHz~2.5MHz; most of the dE/dt radiation would persist longer than 100μs immediately after the occurrence of first return stroke, while for the subsequent stroke it will attenuate to the noise level in tens of microsecond; the integrated dE/dt pulses are well consistent with the synchronous electric filed waveforms, and the primary difference comes from the estimation of the background DC level of dE/dt waveforms. Generally, dE/dt radiation pulses are more intensive and denser than E change waveforms, indicating dE/dt measurement is preferable in recording high frequency radiation.

According to the waveshape of dE/dt measurements, events in CG flashes could be classified into two typical patterns. The first pattern consists of initial breakdown process (IB) , stepped leaders and regular pulse bursts (RPB), et al., which is characterized by a sequence of isolated dE/dt pulses, with pulse intervals from several microseconds to several tens of microseconds. The return stroke, dart leader, Q-noise event usually produce much noisy-like oscillation, which is obviously different from the first pattern, so they are grouped into the second pattern. Since the dE/dt radiation is closely related to the ionization condition of the discharge channel, it is suggested that the two patterns reflect two physical processes: the first corresponding to the channel creating events, while the second corresponding to channel retracing events.