

Comprehensive observations of CG leaders using newly developed TVLS

Intended for the Lightning Physics Session Topic

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A single-station-based lightning observation system termed TVLS (Thunder and VHF lightning Location System) is developed. This system adopts the advantages of VHF broadband interferometer and thunder imaging technology, could provide the temporal and quasi-3D spatial evolution of lightning discharges, as well as broadband EM radiation and acoustic information.

Field lightning observation was conducted using this system in the summer of 2011 in Nanjing, China. Ten leaders from two cloud-to-ground (CG) flashes are analyzed in this paper, with three leaders identified as stepped leaders, five dart leaders and two dart-stepped leaders.

Since the 3D trace of these leaders could be identified, the leader evolution characteristic could be examined in detail. Each leader channel is divided into several segments, and the changes of 3D velocity and radiation characteristic among these segments are compared and analyzed. The results show that leader parameters, such as velocity, electric field change (E-change) waveforms, VHF radiation spectrum and interval, are closely related to inherent mechanism in leader discharges, and the three type leaders behave quite different properties, which could be summarized in table 1. Dart-stepped leaders could be divided into two phases: dart phase and stepped phase, which behave similar as dart leader and stepped leader, respectively. The transition between the two phases lies in the range between 1km and 2.5km, which may be caused by the previous established channel becoming less conducting.

Table 1 Characteristic contrast of three typical leaders while approaching ground

	stepped leaders	dart leaders	dart-stepped leaders	
			dart phase	stepped phase
3D velocity (m/s)	$(1.3\sim 3.9)\times 10^5$	$(1.0\sim 2.9)\times 10^7$	$(1.0\sim 1.3)\times 10^7$	$(2.4\sim 6.8)\times 10^6$
Velocity changes	increasing	decreasing	decreasing	decreasing (increasing in part)
E-change characteristic	impulse	irregular	irregular	impulse
VHF radiation interval changes	decreasing	continuous	continuous	decreasing
VHF spectrum	concentrating in the lower frequency	notable in higher frequency	concentrating in the lower frequency	notable in higher frequency