

Observation of lightning discharges using VHF broadband interferometers

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Compact intracloud discharge (CID) is a distinct intracloud lightning discharge characterized by strong VHF emissions, and it is one of the most mysterious lightning events. The CID channel evolution images obtained by using VHF broadband interferometers are presented for the first time. Analysis of 11 CIDs shows that the channels of CIDs develop mainly in a vertical direction. The vertical scale of CIDs is in the range of 0.40~1.9 km. The average duration of VHF broadband emissions is 15 ms. The average apparent speed of CIDs is in a range of $0.44\sim 1.0\times 10^8$ m/s with a mean value of 0.61×10^8 m/s. The temporal-spatial evolution of the radiation sources of the CID shows an oscillation pattern, confirming the previous prediction that there is an oscillating current being reflected at the two ends of the CID channel. The estimated speed of the current wave in the CID channel is in a range of $0.56\sim 2.6\times 10^8$ m/s with a mean value of 1.4×10^8 m/s.

In this study, the spatial and temporal characteristic, power spectral density (PSD) in the 30MHz to 290MHz band and pulse train structure of 10 CPT records were analyzed. We found that the breakdown process associated with CPT is negative and similar with attempt leader or dart leader. The statistical result shows the average progression speeds of 10 CPT events are about 3.23×10^6 ms⁻¹ ~ 1.93×10^7 ms⁻¹ with the mean value being 1.02×10^7 ms⁻¹. The average PSD of the CPT in the 30MHz~290MHz band is 1.8~11.6dB and 2.4~12dB larger than that of the step leader and 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 ~ 9.0us and 2.7 ~ 4.9us.

Keywords: Compact Intracloud Discharges (CIDs), Pulse Burst, Lightning Locating, Broadband Interferometer