E1-04: The determination of lightning charge centre location from two station electrostatic field change measurements

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The charge distribution of a thunder cloud is one of the fundamental parameters, as it relates to the dynamic characteristic of the storm which determines the other lightning parameters such as electric field recovery after a lightning flash, the lightning flash interval, multiplicity and the energy dissipation in a lightning flash. Although extensive studies have been carried out in temperate and sub-tropical regions to understand the electrical structure

of thunderstorms, so far, only a few studies have been conducted in the tropics. The results reported here are from a preliminary study made as a part of a broader programme of investigations directed towards the study of electrical structure of tropical thunderstorms.

Electrostatic field changes due a lightning discharge to ground were made simultaneously using 2 field mills. The 2 field mills were kept at 2 measuring stations situated 5 km apart. The stations were located at Kalutara in the South-western coast of Sri Lanka. At each station, a field mill was mounted in an open area with its sensor plates at a level of 2 m from the ground. This was to ensure minimum disturbances caused by the electrode effect that may prevail under thunderstorm weather conditions. The response time of each field mill was 50 ms with maximum sensitivity limit 5 V m^{-1}. The 2 field mills were calibrated and the reduction factors were evaluated using a third field mill with its sensor plates kept at ground level. The electric field changes due to lightning discharges were recorded by coupling each field mill to a flatbed x-t penchart recorder.

The experiment was performed during the April-May 1995 intermonsoonal thunderstorm period. Simultaneous measurement of E-field (and E-field changes due to lightning flashes) were recorded for 6 thunderstorms which occurred between 1600 h to 2000 h. The distance from the observation site to a lightning flash was determined by the time difference between occurrence of a field change and thunder heard. Only the nearby ground flashes observed within the field reversal distance (distance to any station < 10 km) were taken into account. This was to distinguish the field changes due to ground flashes from that of cloud flashes.

Point charge model of a thunder cloud with vertical bipolar structure was used for calculations. The mean value of charge lowered in 55 lightning flashes transporting negative charge to the ground was found to be 11.4 C (S.D. 7.1 C) with maximum and minimum values being 31.9 C and 2.7 C, respectively. The mean value of the height to the negative charge centre was 9.3 km (S.D. 3.6 km) with maximum and minimum values being 15.2 km and 2.9 km, respectively.

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