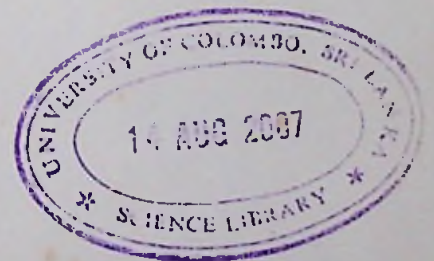




Electromagnetic Fields Radiated by Lightning in Tropical and Temperate Regions

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Abstract

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The electrical nature of lightning was first understood more than 250 years ago. However, the lightning phenomenon is not well understood as yet. In this study it was tried to contribute to the available knowledge of lightning by studying the electromagnetic fields generated by tropical and temperate thunderstorms.

Moreover, the magnetic sensors, introduced in this study, can be the prospective sensors to sense the magnetic fields of lightning discharge within about 25 km from it.

In order to get a better understanding of the initiation of negative ground flashes electric fields generated by tropical and temperate lightning were measured and analyzed. The initial breakdown activity associated with the negative ground flashes were found to be less pronounced for the tropical lightning as compared to those of temperate lightning. About 60% of the negative ground flashes belonging to the tropical thunderstorms were found to be preceded by the initial breakdown activity, whereas all the negative ground flashes were preceded by the initial breakdown activity in the temperate thunderstorms.

Cloud flashes pertinent to the temperate thunderstorms, generally exhibit two stage model with large micro second scale pulses of both polarities occurring at the beginning of the flash. However, the flashes preceded by positive initial polarity pulses were more common. The mean duration of the pulse train with positive initial polarity pulses was found to be 3.4 ms, whereas that of negative initial polarity pulses was 1.4 ms. The mean inter-pulse interval between the successive pulses with positive initial polarity was found to be 323 μ s and that for negative initial polarity pulses was 78.7 μ s. The peak amplitude of the pulses belonging to the initial 10 ms of the cloud flashes shows a linear correlation with the amplitude of corresponding overshoot.

Further studies on electric and magnetic fields revealed two different events in the two geographical regions. Narrow positive bipolar pulses were the unique events for the tropical thunderstorms and were not observed in the temperate region. These events were observed at the beginning and active stage of thunderstorm. The mean duration of these narrow bipolar pulses was found to be 13.3 ± 6.7 μ s. Isolated breakdown pulses, on the other hand, were unique events in temperate regions and were not observed in the tropics. Such breakdown activities consist of microsecond scale pulses with both negative and positive initial polarity pulses and do not lead to any subsequent activity. The mean duration of the isolated breakdown activity accompanied by positive initial polarity pulses was found to be 6.9 ms with average of 3.9 pulses in it. The mean duration for the isolated breakdown activity accompanied by the negative initial polarity pulses was 0.98 ms with an average of 8.5 pulses in it.

The frequency spectra of positive ground flashes measured in temperate regions revealed that, they are a strong source of HF radiation above 10 MHz. Evidently, the positive ground flashes not only pose a higher risk to life and physical structures due to the higher magnitude of current but also pose risk to the physical structures due to the HF radiations.

The outcome of this study, as it was intended, is anticipated to be helpful to better understand the lightning phenomena.