Response of the Systems for Lightning Generated High Frequency Wave

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Abstract

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HF radiations associated with lightning generated by tropical and temperate thunderstorm were studied to elaborate the existing knowledge of interaction of the HF radiation due to lightning with structures. The study concentrates on the temporal behavior of the 3, 5 and 10 MHz HF radiation generated by both ground and cloud flashes in tropics (Sri Lanka) and 10 MHz HF radiation generated by cloud flashes in temperate region (Sweden).

The HF radiation was observed with the onset of preliminary breakdown (PB) activity and return stroke together with corresponding broad band electric field changes for ground flashes pertaining to tropical thunderstorms. The PB activity has been found to radiate the HF radiations intermittently and found to be stronger in the return stroke stage compared to those at the PB stage. The mean duration of PB activity was found to be 3.5 ms for both HF and broadband fields. The mean time between RS to predominant PB pulse was 6.5 ms.

The tropical cloud flashes were observed to begin with a large electrostatic field change with sub micro-second scale electric field pulses embedded in it. The corresponding HF radiation is found to begin with the onset of electric field change. It was observed that the amplitude of the high frequency radiations to be maximum at the initial stage with a gradual decay. This clearly supports the two stage model of cloud flashes in which the initial stage is the very active stage.

The analysis of HF radiation at 10 MHz corresponding to cloud flashes pertinent to the temperate thunderstorms indicates that the HF radiations at 10 MHz are initiated with the initiation of the cloud flashes without any significant delay. Furthermore, the temperate cloud flashes also have been found to radiate the HF radiation intermittently throughout the flash. In the majority of temperate cloud flashes the amplitude of HF radiations was found higher at the beginning.

An analysis of the amplitudes of the HF radiation and corresponding broadband electric field pulses reveals weak correlations with the amplitudes of the corresponding broadband fields while a strong correlation was found among the amplitudes of the HF radiation with each other.

The HF response for a small structure has also been computed using transmission line theory by applying the broadband electric field on the structures. It is observed that the signature of the HF radiation and the response of the structure to the broadband electric field show peaks located at the same instant of time. This indicates that the induced voltages show characteristics similar to the 3MHz – 10 MHz radiation associated with the lightning flash. Thus, these radiations can be used as a vehicle to identify the sections of the broadband electric fields that are important in the study of the interaction of lightning electromagnetic fields with structures.

The trend of lightning activity over Sri Lanka is of interest to the lightning community and has also been analysed in this study. An analysis of seasonal lightning flash density shows that the first inter monsoon has the maximum density. The mean monthly lightning flash counts shows that the most of the lightning activity occur from March to May with a peak in April. The diurnal variation of maximum flash rate is observed to peak at 1630 LT.

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