Study of Lightning and Long Laboratory Sparks using Photographic Techniques

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Abstract

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Various imaging techniques have been used to study the properties of lightning since 1900. Use of time resolve photographs and analyzing the time dependent properties of the lightning started in the first quarter of 20^{th} century. In this study different properties of natural lightning and laboratory sparks were studied using still and time resolved images.

Expansion of the channel of long laboratory sparks were studied using a 0.3 m gap length and correlation between the peak current and the diameter of the channel was studied. The results were compared with the theoretically calculated diameter using Braginskii's (1958) model. The channel diameter of the 0.3 m long laboratory sparks were increasing with channel current with a non leaner relationship and Braginskii (1958) model was reasonable with modified constant as suggested by Cooray and Rahman (2005).

The channel tortuosity of long laboratory sparks and natural ground lightning flashes were studied using still images. The measured channel tortuosity of 8 m long laboratory sparks and natural ground lightning flashes were 22.3 ° ± 2.7 ° and 25.9 ° ± 3.71° respectively. Fourier spectrum of the angle of the channel direction shows that the fundamental harmonic is the most common for the natural ground flashes and fundamental and second harmonics are the most common components for the 8 m long laboratory sparks. Leader propagation speed, final jump distance and evaluation of final jump conditions were also studied for 8 m long laboratory sparks. The average leader speed was 1.8×10^4 m/s and leader was accelerated toward the ground plane and connecting process occurred satisfying the final jump conditions.

Length of the final jump or connecting leader was measured for the lightning flashes striking the sea. The average length of the final jump or the connecting leader was 51.5 ± 4.1 m. Considering sea surface as a flat surface the measured length were compared with the values calculated using two theoretical models. Traditional model was derived by Golde (1977) and the latest model was derived by Cooary et al. (2007). The results were in good agreement with the latter.

Continuing current of cloud flashes were studied for the first time using time resolved images. Duration of the continuing current and the wave shape of the time dependent relative brightness of the channel were compared with results obtained for the natural ground flashes.