ON THE NATURE OF LIGHTNING FLASHES:
With Special Attention To The Initiation, Modelling And Remote Sensing Of Return Strokes

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Thesis submitted in fulfilment of the requirements of the degree of
Doctor in Philosophy of the University of Colombo

1999

Abstract

The temporal characteristics are analysed of preliminary breakdown pulse trains of both negative and positive ground flashes, chaotic pulse trains that are associated with negative subsequent strokes and isolated cloud flashes. The relative strength (with respect to the succeeding return strokes) of preliminary breakdown pulse trains of negative return strokes are compared between a data set obtained in Sri Lanka and that in Sweden. The absolute pulse amplitudes are given for a sample of isolated cloud flashes distance ranged by time to thunder measurements. The leader fields, the total leader field change and the ratio of the total leader field change to that of the return strokes are calculated for channels of which an upper segment is inclined towards horizontal direction. A large number of return stroke models are reviewed under their concepts. The widely used engineering type models are generalised by two sets of equations. The suitability and limitations of the return stroke validation methods are also discussed. A brief review is given on the analytical expressions which can be applied to estimate channel base currents once the measured field parameters are fed as the input. A recently proposed return stroke model was validated with triggered lightning data by employing a statistical approach. The long impulse currents of positive return strokes are estimated by feeding measured long distance fields in to a recently proposed positive return stroke model and also taking into account the physics of the propagation of ELF sferics in the earth-ionosphere waveguide. The results are extended to describe some observations pertinent to Red Sprites and Elves. Laboratory experiments were conducted to investigate the relations between the optical and current signatures of long sparks. Consequently, the applicability of the results to deduce lightning parameters were discussed.