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Lightning a Fundamental of Atmospheric Electricity

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Abstract

This paper discussed briefly the basic connection between lightning phenomena and atmospheric electricity. Characteristics pertaining to lightning discharges were reviewed in order to elucidate some elementary mystics that are still associated with lightning events in some parts of the world and that lightning strike when and where it will. Various lightning protection principles were discussed. The essence of lightning protection device is to prevent lightning strikes from taking place over or around an installation or structure.

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Keywords: Lightning; Static electricity; Electrostatic discharges

1. Introduction

Electrostatic discharge is due to static charge build-up, which occurs as a result of tribo-charging or by electrostatic induction. The theory of electrostatic discharge (ESD) which is the momentary flow of electrical energy between electrically charged bodies when in contact with each other is the base for understanding of lightning.

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The sudden flow of electrical energy can result in electric sparks accompanied by some sound. It is the larger scale of such ESD occurrence in the atmosphere that is referred to as lightning and thunder (Anderson and Eriksson, 1980; Kasemir, 1960, Thomson, 1985).

In simple terms, lightning is the process of spontaneous momentary high-current electrostatic discharge, which often is initiated in the cloud and the path usually stretch over kilometers in length (Uman, 1987). In the time of upward draft, tiny ice particles in the cloud rub against each other setting up polarization process. Positive charges generated in the process drift upward in the cloud while negative charges drift downward, the reason for this is still under investigation by researchers (Rakov and Uman 2003). As the cloud size increases, there is increase in electric potential difference between the upper positive and lower negative parts, which unavoidably lead to ESD reaction between the regions. When these discharges are limited to the same cloud, it is called intra-cloud discharges, while those that involve two or more clouds are called inter-clouds or cloud-to-cloud discharges, (Fig. 1). These types of discharges account for about 75% of global lightning occurrences and do not involve the earth surface (Rakov, 2007). Cloud to ground (CG) discharges are the most relevant of all the lightning discharges to human and other life existence on earth surface (Fig. 1).

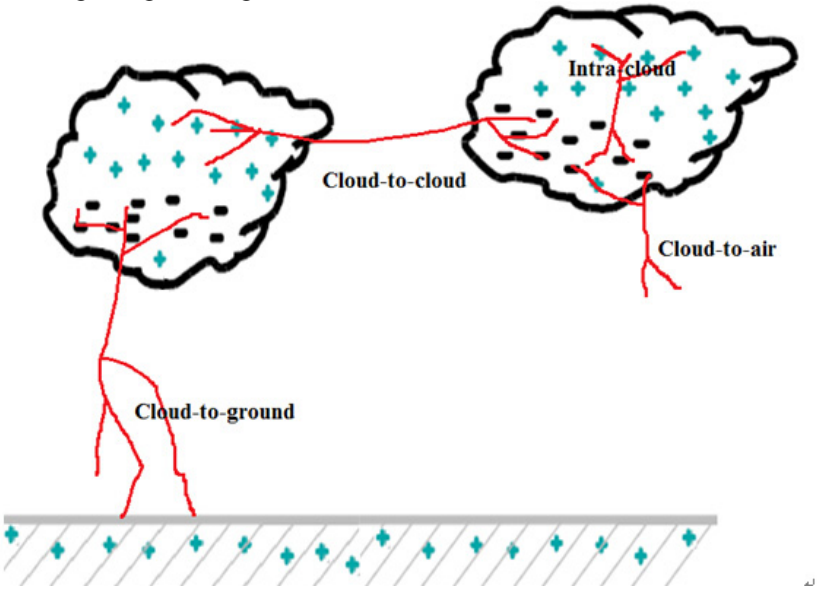

Fig.1 Different types of lightning discharge (Rakov, 2007)

1.1 Types of Cloud-to-Ground (CG) Lightning Discharges

The CG discharges are categorized into four major types namely; (i) downward negative lightning (ii) downward positive lightning (iii) upward negative lightning and (iv) upward positive lightning as shown in figures 2(a-d).

The downward negative lightning discharge is believed to be the most common, accounting for about 90% of the CG discharges globally, while less than 10% are downward positive lightning. According to Uman, 1987 and Rakov, 2007, on the average, negative cloud-to-ground lightning discharge is composed of 3 to 5 leader/return stroke sequences, but occasionally, two leader/return stroke sequences occur in the same lightning channel with a time interval between them as short as 1 ms or less. According to them, positive CG discharges are associated with the after effects of prolonged cloud-to-cloud discharges which finally result in downward positive discharges. The upward negative and upward positive lightning discharge types are