

LIGHTNING FLASH CHARACTERISTICS IN THE SOUTHEASTERN BRAZIL

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ABSTRACT

In this work it will be presented the characteristics of cloud-to-ground lightning flashes in the Southeastern Brazil during the 1993 summer season. Some results, like the large percentage of low-intensity positive cloud-to-ground flashes seems to indicate that the cloud electrical charge structure in this region may be different from the other regions. A possible theory to explain this fact will be discussed.

INTRODUCTION

Brazil is known as one of the principal regions of lightning activity in the world (Sagalyn et al., 1961). In spite of this fact, local research on lightning just began at the end of 80's, through balloon electric field (Gin, 1992; Gin, 1993; Gin et al., 1994; Pinto et al., 1992; Pinto et al., 1991; Pinto et al., 1993; Pinto Jr et al., 1992) and ground measurements (Araújo et al., 1990, Pinto Jr et al., 1995; Pinto Jr. and Pinto, 1995).

About half percent of cloud-to-ground flashes are formed by several intermittent discharges, called return strokes, separated by about 40 milliseconds (Uman, 1987). The flash has a duration from hundreds of milliseconds to about 2 seconds. The number of strokes of a flash is called multiplicity. In a flash an average of 20 coulombs are transferred from cloud to ground (Uman, 1987). Lightning flashes can be classified also in terms of their polarity as positive, negative and bipolar, depending on the signal of the charge transferred to ground. Negative flashes have in general just one to three strokes. Positive flashes have in general one stroke. The positive cloud-to-ground flashes have been studied in detail due to the fact that they seem to be associated with most forest fires (Freedman, 1990).

The present study is based on lightning cloud-to-ground flash data obtained by a Lightning Positioning and Tracking System (LPATS) located in the state of Minas Gerais. The system is similar to those used in several other countries, being the only one operating in South America. The LPATS data were compared with METEOSAT and radiosonde data. The period of study goes from 21 December, to 10 March 1993, which corresponds to the South Hemisphere summer season.

RESULTS AND DISCUSSION

During the 1993 summer season about 300.000 lightning cloud-to-ground flashes were measured in the state of Minas Gerais. Most of them were associated with mesoscale convective systems. About 63% were negative flashes. Most characteristics of the negative cloud-to-ground lightning flashes obtained in our study were similar to those in other regions. However, the average peak current of negative flashes was about 40 kA, larger than the values obtained in most other studies (Orville et al., 1987; Montandon et al., 1992). This large value was in agreement with the data obtained by an instrumented tower operated by the Centrais Elétricas de Minas Gerais (CEMIG) near Belo Horizonte since 1985. Positive flashes were 35%. This value is larger than those obtained in other studies (Fuquay, 1982; Beasley, 1985; Orville et al., 1987; Reap and Mac Gorman, 1989; Hojo et al., 1989). The average peak current

of positive flashes was, about 20 kA, lower than the values obtained in other studies (Orville et al., 1987). Bipolar flashes were just 2%, with average multiplicity of 4 and average peak current of 25 kA.

The maximum peak current found for negative flashes was 599 kA. This value is larger than the maximum reported in the literature (346 kA) by Petersen and Rutledge (1992). For positive flashes, in turn, the maximum peak current was 376 kA. Almost the same value was reported by Orville et al (1987). For bipolar flashes, the maximum peak current was 373 kA. No similar information is available in the literature.

The characteristics of positive flashes seem to indicate that the electrical structure of the thunderstorm in this region of Brazil may be different from that in other regions of the world. The tilted dipole theory, normally associated with low altitude winter thunderstorms, can not explain our observations. It seems that in order to explain our observations we need to invoke a large positive charge near the cloud base. Such charge would be produced in association with the charge-reversal temperature process that occurs in the lower part of the thunderstorms.

We suggest that more measurements in the southeast region of Brazil during the summer season should be done, so that to determine if the characteristics above are a normal feature of the climatology of this region.

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