CLOUD-TO-GROUND LIGHTNING FLASH CHARACTERISTICS OBTAINED IN THE SOUTHEASTERN BRAZIL USING THE LPATS TECHNIQUE AND THE NEW HYBRID LIGHTNING LOCATION METHODOLOGY

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ABSTRACT: Cloud-to-ground lightning flash characteristics in the southeastern Brazil were determined during two months based on data obtained by two different lightning location systems. In December 1995, the data were obtained by a lightning positioning and tracking system (LPATS), version III, and in December 1997, by a new hybrid lightning location methodology combining time-of-arrival (LPATS) and direction-finding techniques (Impact sensors). The results indicate that the flash characteristics are quite different from 1995 to 1997, mainly for positive flashes. Although limited to the small data sample, we believe that the most differences are mainly due to differences in the systems. We suggest that other independent techniques should be used in order to evaluate the performance of such systems.

INTRODUCTION

In the last decade cloud-to-ground lightning flash characteristics have been obtained by lightning location networks in several regions throughout the world (e.g., Fournier and Pyle, 1998; Matsui et al., 1998; Pinto et al., 1998 a, b). In part, these characteristics may be a result of geographical and meteorological conditions prevailing in each region. However, they may also be a result of the characteristics of the lightning location networks, such as efficiency, location accuracy and discrimination criteria adopted. How do to distinguish between natural and technical aspects is a subject of intense research at present.

In order to investigate this problem, the lightning flash characteristics obtained in the southeastern region of Brazil in December 1995 are compared with those obtained in the same region in December 1997. In 1995, the lightning data were obtained by a 6 LPATS-III network, while in 1997 the data were obtained by a hybrid network consisting of 6 LPATS-III and 2 Impact sensors. Due to the different number of sensors and the intrinsic differences in the lightning activity in each year, only relative flash numbers are compared. The differences in the flash characteristics of positive flashes are attributed to differences in the network. Such assumption is based on our analysis of the lightning data collected between 1988 and 1995 in the same region. Besides the network reconfiguration and sensor modifications, the network in 1997 has undergone central processing modifications, from which the most relevant to this study is concern to the criteria of discrimination between cloud-to-ground flashes and intracloud flashes. In 1995, in fact, no discrimination criteria to distinguish between cloud-to-ground and intracloud flashes existed. The intracloud flashes were supposed to be no detected by the system, considering that they could not produced a radiation field above a given threshold in three sensor if they were distant by 200 km or more to each other. In 1997, in turn, the intracloud flashes were supposed to be eliminated by considering only flash-related pulses with time width larger than 11 microseconds. The possible consequences associated with these assumptions are discussed.

RESULTS

Table 1 presents the flash characteristics for negative single and multiple flashes and positive single flashes in December 1995 and 1997.

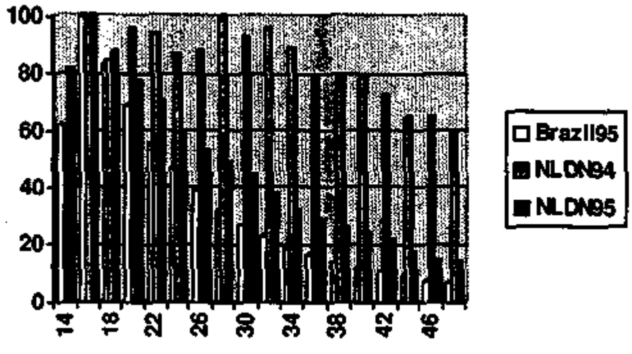
	1995	1997
Percentage Pos. Flashes (%)	28.5	2.3
Percentage Neg. Single Flashes (%)	74.8	75.3
Percentage Pos. Single Flashes (%)	100	93.8
Average Neg. Peak Current (kA)	53.5	34.2
Average Pos. Peak Current (kA)	26.5	46.2
Local Time Max. Flash Activity	15-16	15-16
Average Neg. Peak Current (Single Flashes)	53.1	34.4
Average Neg. Peak Current (Mult. Flashes)	55.3	33.5

DISCUSSION AND CONCLUSIONS

In terms of negative flashes, the results presented in Table 1 indicates that: the percentage of single flashes is almost the same in both years; the average peak current for single and multiple flashes is also almost the same; however, the average peak current for 1995 is significantly larger than that for 1997. Based on the variability of the peak current values measured between 1988 and 1995, we think that this last result is probably associated with such natural variability, being not influenced by the change in the configuration of the network.

For positive flashes, however, the results appear to be influenced by the change in the configuration of the network. In 1995, the percentage of positive flashes is significantly higher than that in 1997, whereas the average peak current is significantly lower. Both differences can be explained by assuming that in 1995 the positive cloud-to-ground flashes were contaminated by intracloud flashes. The value obtained in 1997, however, may not be representative of the region studied. Fig. 1 shows the peak current distribution of positive flashes for the whole year of 1995, compared with the NLDN distribution in the southeastern U.S. in 1994 and 1995 (Cummins et al., 1998). The data were obtained, respectively, before and after the upgrade of the NLDN network. Among other differences, in 1994 the NLDN rejected pulses below 11 microseconds width, whereas in 1995 this threshold was changed to 7.4 microseconds. Assuming that the criteria adopted by the NLDN network in 1995 (which, as far as we know, remains the same up to the present) is more realistic, the close similarity between our 1995 curve with the NLDN 1995 curve apparently indicates that the real percentage of positive flashes in southeastern Brazil is more close to the 1995 value than that in 1997 (whose configuration corresponds to the NLDN 1994 curve). Note that the differences in the NLDN curves in Fig. 1 are consistent with the differences in the average positive peak current shown in Table 1.

Clearly more data and research at different parts of the world are necessary before confident criteria to discriminate cloud-to-ground and intracloud flashes based on field waveforms can be defined. Some researchers have suggested that a peak current threshold for positive cloud-to-ground lightning should be used (Zaima et al., 1997; Zajac and Rutledge, 1998). It is even possible that such criteria may be different at different regions, due to differences in the thunderstorm formation.



PEAK CURRENT (kA)

Fig 1- Normalized Peak current distribution of positive flashes in the southeastern Brazil in 1995 (Brazil95), and in the southeastern U.S. in 1994 (NLDN94) and in 1995 (NLDN95)

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