

CLOUD-TO-GROUND LIGHTNING FLASH DENSITY IN THE SOUTH AND SOUTHEASTERN OF BRAZIL: 1999-2001

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ABSTRACT: Cloud-to-ground lightning flash density results of south-southeastern Brazil have been analyzed from period of 1999 through 2001. About 10 million of cloud-to-ground (CG) lightning flashes were recorded in Sao Paulo and Parana. Annual ground flash density and median peak current for negative and positive flashes have been analyzed. Observed CG lightning flashes were predominantly negative. Flash density varies from less than 4 to values over 14 flashes/km²/yr. The maximum flash density is similar to results obtained in Florida. Observed median negative peak current and median positive peak current were 25kA and 35kA, respectively.

INTRODUCTION

Recent studies of lightning flash densities in the south and southeastern Brazil showed that Sao Paulo and Parana are regions heavily struck by lightning [Gin *et al.* 2000]. A network of cloud-to-ground (CG) lightning sensors has identified large activity of lightning flashes in the south and southeastern regions of Brazil, which must be investigated. In this paper we show some aspects of the geographical distribution of CG lightning flashes in the states of Parana and Sao Paulo for the period of 1999 - 2001.

DATA DESCRIPTION

A set of Lightning Positioning and Tracking System (LPATS) sensors from the Brazilian Integrated Lightning Detection Network (RIDAT) [Beneti and Sato 2000] covers the states of Parana and Sao Paulo. This set consists of 11 time-of-arrival (TOA) lightning sensors. Figure 1 shows a map of the region and sensor locations. It is estimated that lightning detection efficiency for RIDAT in this area is around 80%.

A total of 11 millions CG lightning flashes were selected for this study. Results presented in here are from about 10 millions of CG lightning flashes, since positive flashes with peak current less than 10kA were not considered for the analysis. According to Cummins *et al.* [1998] and Wicker and Orville [1999a, b], weak positive flashes (less than 10kA) are mostly cloud flashes.

The density maps (Figures 2 to 4) in this paper have a total of 2128 points (56 along the east-west direction and 38 along the north-south direction), with a spatial resolution of 400km². Variations of flash parameters occurring on a smaller scale will not be resolved in the present maps.

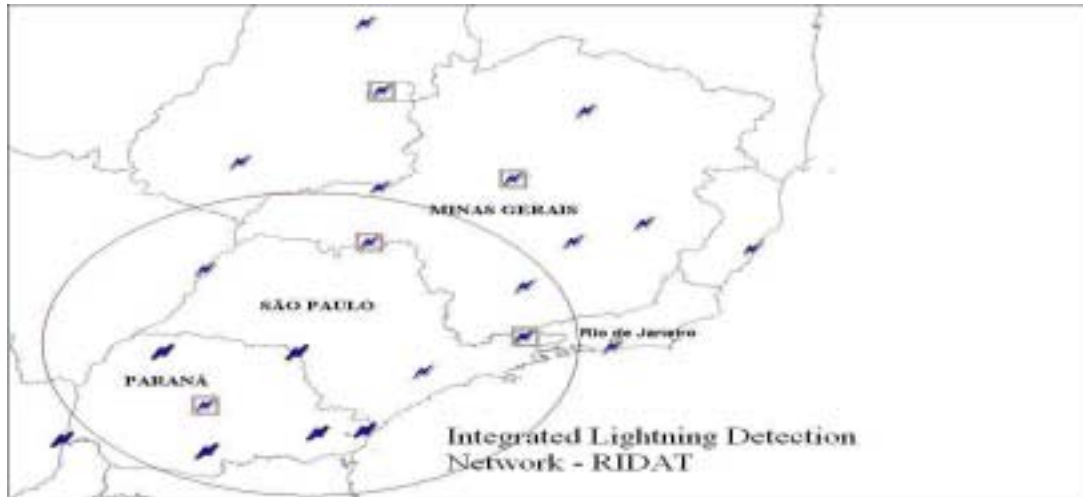


Figure 1. Map of RIDAT region and sensors location. Ellipsis indicates area of study.

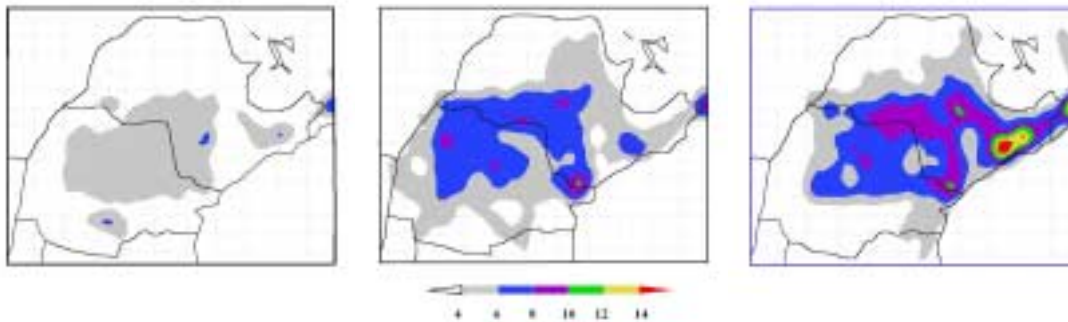
RESULTS

Table 1 summarizes the results of CG lightning flash incidence in the states of Parana and Sao Paulo for the period 1999-2001. About 10 millions CG lightning flashes were analyzed. From the total of CG flashes analyzed, about 87% were negative CG lightning flashes and about 13% were positive CG lightning flashes. This table shows the increase of flashes year after year. This fact is most probably related to the upgrade of the Lightning Detection Network in this region.

Table 1. CG Lightning flashes summary for the Parana and Sao Paulo State 1999-2001

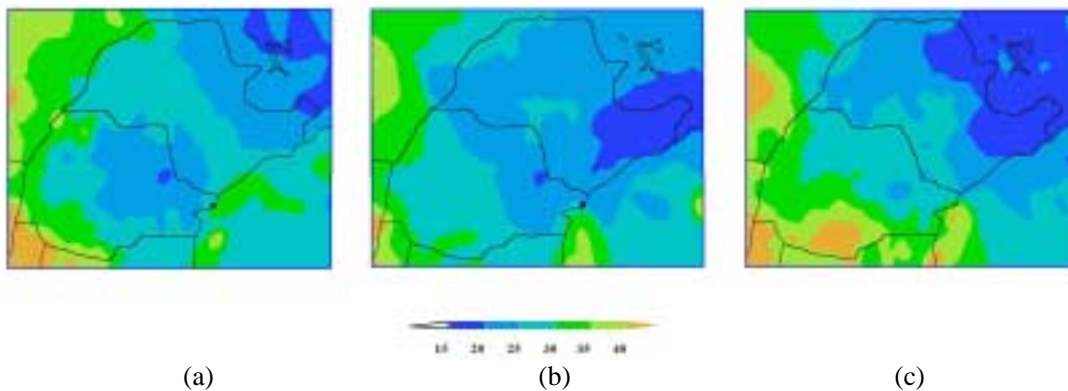
Total CG Lightning Flashes (not considered positive flash with peak current <10kA)		
Year	Flashes (million)	Percentage of Positive Flashes
1999	2.5	18%
2000	3.6	12%
2001	4.0	10%
All	10.1	13%

The annual lightning flash density in Parana and Sao Paulo is shown in Figure 2. The total flash density was corrected assuming that detection efficiency in this region is about 80%. It varies from less than 4 flashes/km²/yr to values over 14 flashes/km²/yr. In most part of the area the flash density is about 6-8 flashes/km²/yr. These densities are higher than the densities observed in the Southeast of U.S.A, which are around 3-6 flashes/km²/yr. However, similar densities were observed in the south of Louisiana, Mississippi and Alabama. Nevertheless, a region near Sao Paulo City presents lightning densities over 14 flashes/km²/yr. In Florida, lightning flash density is more than 6 flashes/km²/yr [Orville *et al*, 2002].



(a) (b) (c)
 Figure 2. Annual CG lightning flash density in Parana and Sao Paulo: (a) 1999, (b) 2000 and (c) 2001.

Figure 3 and 4 show the average peak current of negative and positive cloud-to-ground lightning flash distribution, respectively. The average peak current for negative flashes is around 20-30kA and the average peak current for positive flashes is 30-40kA. However, the average peak current in Parana is higher than those described above. These distributions of average peak current for negative flashes and positive flashes are superior to peak current observed in southwestern USA and in Florida. In these regions the average peak current is around 18-24kA for negative flashes and 15-20 kA for positive flashes. These results for Sao Paulo and Parana will be investigated in the future.



(a) (b) (c)
 Figure 3. Annual average negative peak current in Parana and Sao Paulo: (a) 1999, (b) 2000, (c) 2001.

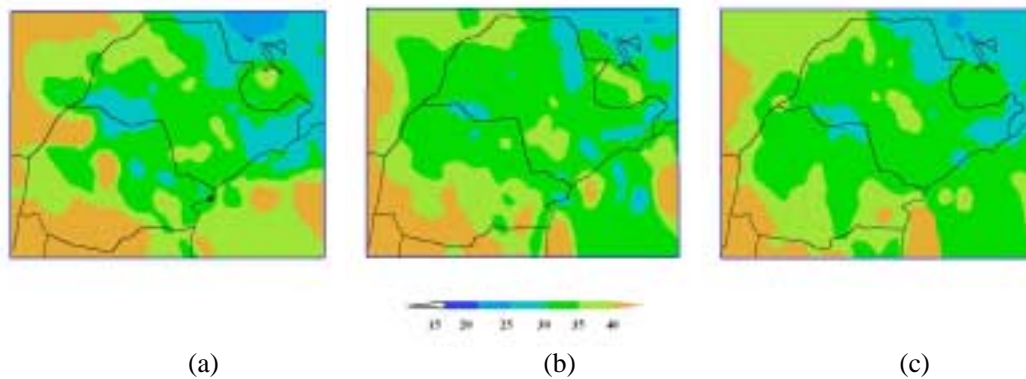


Figure 4. Annual average positive peak current in Parana and Sao Paulo: (a) 1999, (b) 2000, (c) 2001.

CONCLUSION

This paper shows some important aspects of lightning flash incidence in south and southeastern of Brazil. An increase in flash density during the period of 1999 - 2001 was observed, probably associated with an upgrade in the Lightning Detection Network in this region. However, large variation in mean peak current of lightning flashes was not observed. The distribution of average peak current of lightning flashes in this region is higher than the observed in southwestern USA and in Florida. These observations will be further investigated in the future.

ACKNOWLEDGMENTS: The authors thank the University of Inaciana Educational Foundation (FEI), Technological Institute SIMEPAR and Electrical Energy National Agency (ANEEL) for the support of this research.

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