

LIGHTNING RESEARCH IN BRAZIL: RECENT RESULTS

2. INDIRECT MEASUREMENTS

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ABSTRACT: The lightning research in Brazil is reviewed based on recent indirect measurements of electromagnetic radiation of natural lightning. The measurements were obtained by lightning networks, located at different parts of the country, and by the LIS (Lightning Imaging Sensor) optical sensor launched on board the TRMM satellite in 1997. In particular, the following topics will be discussed: multiplicity and peak current estimates of negative and positive cloud-to-ground (CG) flashes and intracloud/cloud-to-ground flash ratio at different parts of the country. Recent evidence of urban effects on the lightning characteristics and the present situation of the efforts to have an integrated national network in Brazil will also be presented. This network would be the largest one in the tropics.

INTRODUCTION

Lightning networks began to be operated in Brazil in 1988 in the state of Minas Gerais, in the Southeast region of the country. More recent lightning observations were made in the North region of Brazil by a small (Impact) lightning network installed in 1999. These observations provided the first lightning observations in the Amazon region. In this paper these observations are compared with similar data obtained in the same period in the Southeast region of Brazil, as well as LIS observations in the same region and period of time. From the comparison between these data, a cloud-to-ground flash density map for the country was obtained. The paper also presents very recent results of a long-term analysis of cloud-to-ground observations in the urban area of a large city of Brazil, which indicates significant effects on the lightning characteristics. Finally, the present situation of the effort to have a national large lightning detection network for the whole country is presented.

RECENT RESULTS

Figures 1 and 2 show the multiplicity of negative flashes and peak current for negative and positive flashes obtained for a six month period of data in the North and Southeast regions of Brazil, respectively. The data are presented in each 49-day window corresponding to the diurnal cycle of the LIS data. They show that negative flashes have lower multiplicity and similar peak current in the North region compared with the Southeast region, while positive flashes have lower peak current. More details can be found in Pinto Jr. et al. (2002).

Figure 3 shows the percentage of intracloud flashes in the North and Southeast regions computed by comparing the CG ground lightning data recorded during the LIS pass over the regions with LIS data. The average percentage of intracloud flashes for the whole period of observation is 56% in the North

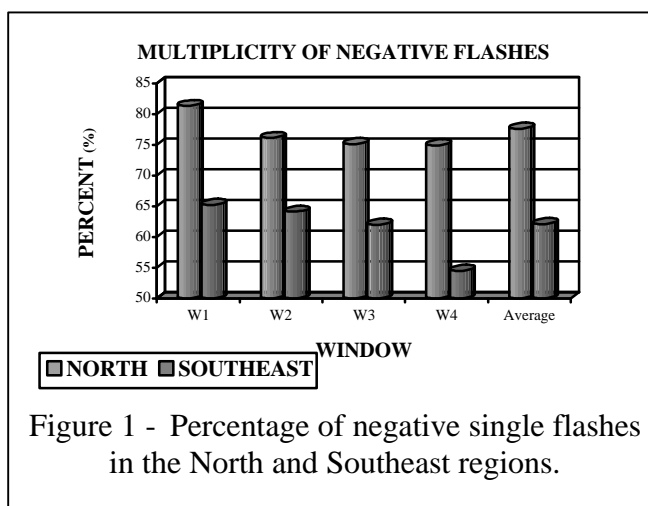


Figure 1 - Percentage of negative single flashes in the North and Southeast regions.

region and 61% in the Southeast region. They correspond to intracloud/CG flash ratios of 1.3 and 1.6, respectively. These ratios are in reasonable agreement with the values reported for this range of latitude (Mackerras et al., 1998). This percentage, however, is dependent on the assumed detection efficiency of the networks, as well as on the assumption that the LIS detection efficiencies for intracloud and CG flashes are equal. For instance, if we assume the LIS detection efficiency of CG flashes inferred by Thomas et al. (2000) (60 %), maintaining the intracloud detection efficiency equal to 90 %, the average percentage of intracloud flashes would be 62% and 67%, respectively.

Figure 4 shows the flash density map of the country obtained considering the LIS observations from 1998 to 2001, corrected for an average intracloud/CG ratio based on the above results (for more details see Pinto et al., 2002, 2003). Although this ratio is probably not constant for the whole country, as suggested by the results obtained by Boccippio et al. (2001), it is the best approach available at this time.

Figure 5 shows the mean annual negative flash density in the region of Belo Horizonte, a large 2.5 million people city in the Southeast of Brazil. It can be see clearly a significant enhancement (approximately 100%) in the flash density over and downwind the city. It was also observed an increase in the positive flash density (less evident), a decrease in the percentage of positive flashes and no variation of the peak current of both polarities in the same region. These results are in agreement with the recent results obtained by Steiger and Orville (2002) for Houston, except that the strength of the density effect is two times larger than in Houston. More details are discussed in more details in Pinto et al. (2003).

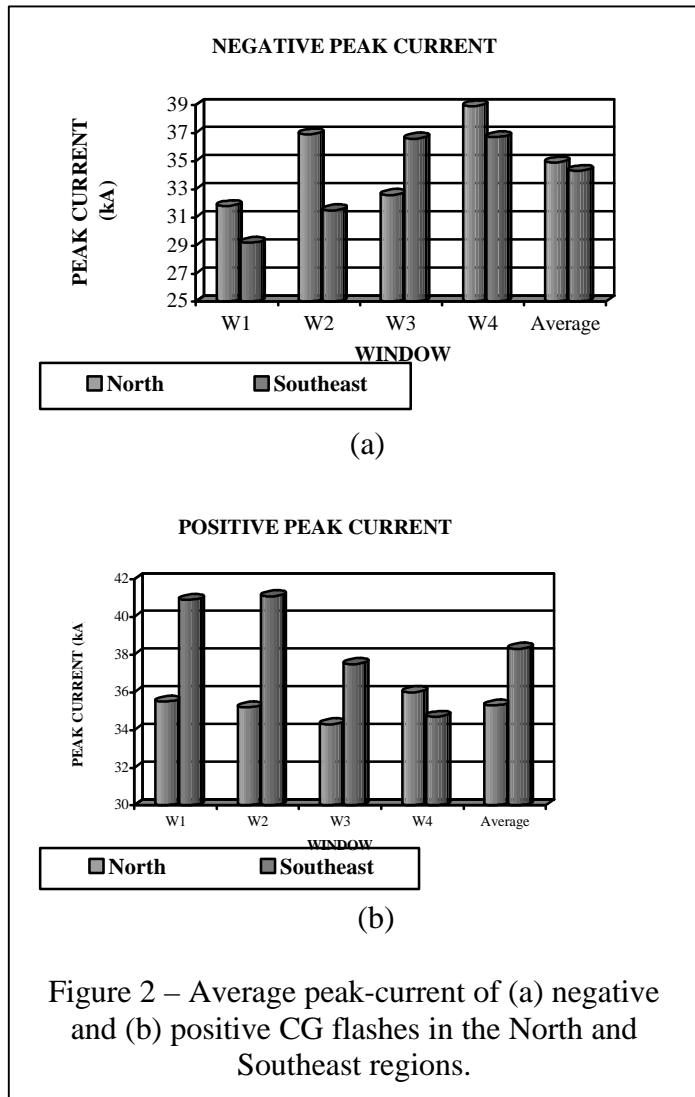


Figure 2 – Average peak-current of (a) negative and (b) positive CG flashes in the North and Southeast regions.

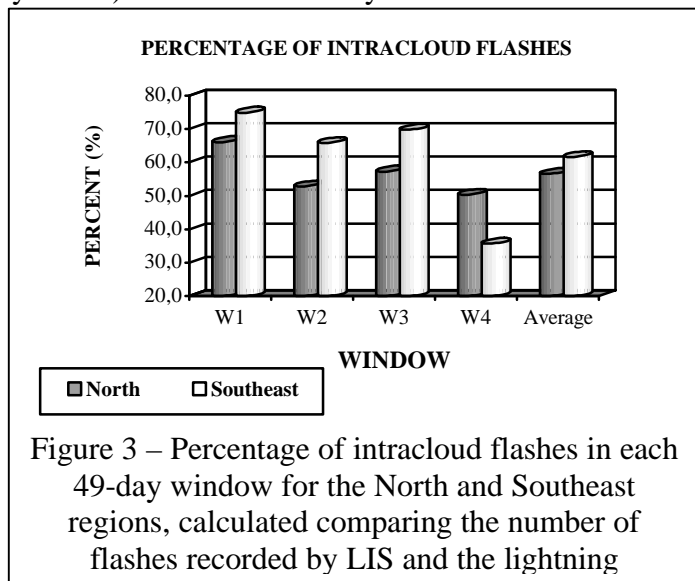


Figure 3 – Percentage of intracloud flashes in each 49-day window for the North and Southeast regions, calculated comparing the number of flashes recorded by LIS and the lightning

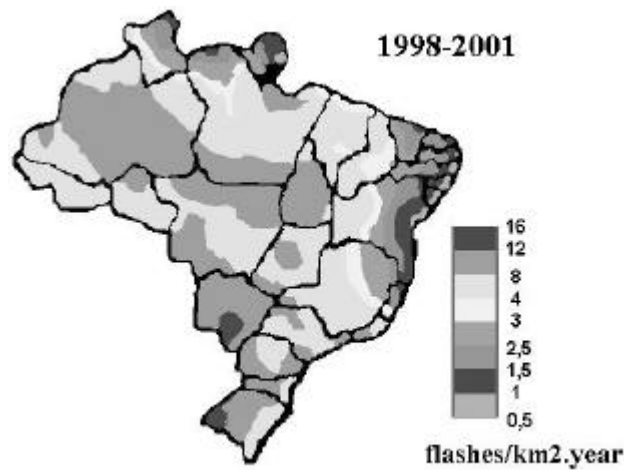


Figure 4 - Cloud-to-ground flash density map for Brazil for the 1998-2002 period.

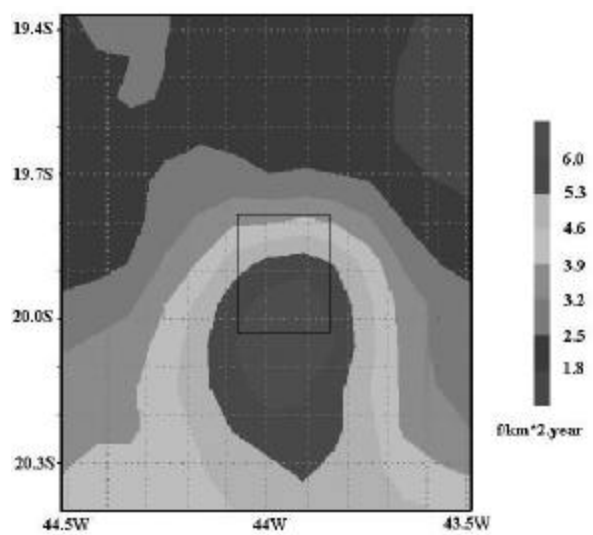


Figure 5 – Eight-year (1988-1996) mean annual negative flash density in flashes km⁻¹ yr⁻¹ centered on Belo Horizonte (indicated by a black rectangle), at a spatial resolution of 9 km.

Finally, Figure 6 shows a map indicating the location of all lightning sensors that are believed to be in operation before the end of 2003. The network of Impact/LPATS sensors will cover about 60-70% of the country. A small network of Safir sensors also will be operating in party of the South region of the country.

CONCLUSIONS

In the last decade a large development was observed in Brazil in the observation of lightning by lightning detection networks. As a result, several interesting effects have been observed. We expect for the end of 2003 a national network covering approximately 60-70% of the country.

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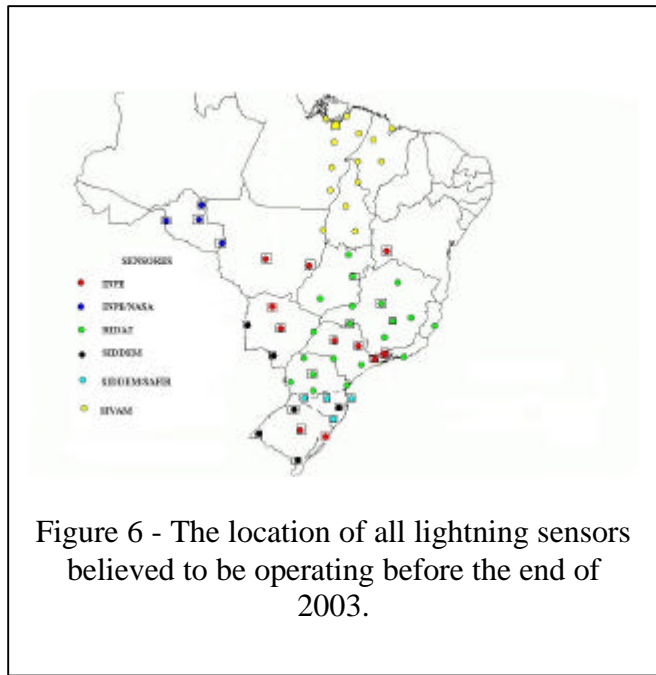


Figure 6 - The location of all lightning sensors believed to be operating before the end of 2003.

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