



Diurnal variation of summertime cloud-to-ground lightning activity in the southeastern Brazil

Iara R.C.A. Pinto and Osmar Pinto Jr. ⁽¹⁾ José H. Diniz, André M. Carvalho and Armando Cazetta Filho⁽²⁾

1-Instituto Nacional de Pesquisas Espaciais - INPE, Brazil

2-Companhia Energética de Minas Gerais - CEMIG, Brazil

ABSTRACT

This paper reports the results of an analysis of 300,000 cloud-to-ground flashes recorded in the southeastern Brazil in the summer season of 1993 in terms of the local time dependence of their characteristics. Whereas the lightning activity of negative and positive cloud-to-ground flashes exhibit a diurnal cycle with a well-defined time of maximum frequency in the afternoon, the flash multiplicity and peak current intensity do not exhibit such a local time variation. The local time dependence and geographic distribution of the lightning activity are in agreement with what is expected from isolated thunderstorms. In turn, the peak current intensity and the flash multiplicity did not show any dependence on local time. The results are compared with similar data obtained in the western and eastern U.S. in the period 1995-97.

INTRODUCTION

The hourly variability of the cloud-to-ground lightning activity is well known to have a large peak associated with the maximum convective activity in the afternoon. Such behavior is typically observed in regions where the lightning activity is predominantly associated with isolated thunderstorms. Variations in this pattern can exist associated with local meteorological aspects (e.g., Lopez and Holle, 1986; Zajac and Rutledge, 1998). However, there is only a few evidence indicating that the flash characteristics also show a diurnal variation (Zajac and Rutledge, 1998).

In this paper we report the results of an analysis of 300,000 cloud-to-ground flashes recorded in the southeastern Brazil in the summer season of 1993 in terms of the local time dependence of their characteristics. The results are compared with similar data obtained in the western and eastern U.S. in the period 1995-97.

RESULTS AND DISCUSSION

The diurnal variation of negative and positive flashes in the southeastern Brazil during the 1993 summer season is shown in Fig. 1, in terms of the relative frequency in percent. Only positive flashes with peak currents higher than 15 kA were considered in this figure in order to avoid possible intracloud contamination (Pinto et al., 1998 a, b). Both distribution show a maximum around 15 – 17 LT, indicating that they are associated predominantly with isolated air-mass thunderstorms. This assumption was confirmed by the analysis of the geographical distribution of these flashes, which indicates that the negative and positive flashes occurred in almost the same regions, with no evidence of bipolar pattern typically associated with mesoscale convective systems.

The relative frequency of negative and positive flashes shown in Fig. 1 are very similar to those reported by Zajac and Rutledge (1998) from 1994-96 in Alabama, showing in the the lightning activity is modulated by the diurnal cycle of the convective with a afternoon maximum. In the results in Alabama, the positive cloud-to-ground lightning activity lags negative activity by roughly an hour. In Fig. 1 such a lag is not evident. In order to check if such a difference is significant, we have extended the analysis in Fig. 1 for several summer seasons between 1990 and 1994. Then, the same an hour lag was found. This lag is also consistent with the assumption that the lightning activity in the southeastern Brazil, like Alabama, is predominantly associated with ordinary thunderstorms. The diurnal variation of the relative frequency of negative and positive flashes reported by Zajac and Rutledge (1998) from 1994-96 in South Dakota, however, shows a very different behavior. Even though both diurnal variations exhibit a diurnal cycle, maximum hourly positive activity occurs roughly five hours before the maximum hourly negative one (that is, 18 LT versus 23 LT). Zajac and Rutledge (1998) attributed this large time lag to a diurnal variation in the convective type. They found that most activity in South Dakota was associated with the presence of MCSs with extensive stratiform regions. In the evening, the higher production of positive flashes is associated with more formative stages of MCS development, while nocturnal events with higher production of negative flashes tended to be associated with more mature stages of MCS development.

Zajac and Rutledge (1998) have also found that the peak current of positive flashes and the multiplicity of negative flashes show a local time dependence, which were attributed to diurnal variation in the convective type. Following this suggestion a search was done to identify if such variations would occur in the southeastern Brazil. No local dependence

of these parameters on local time was found, confirming that the convection in this region is only associated with one type of thunderstorms. It is possible that small variations could exist. However, in order to get statistically significant variations, a larger data set is necessary.

CONCLUSION

The main conclusion of this study is that the lightning activity in the southeastern Brazil during the summer season of 1993 was predominantly associated with isolated ordinary thunderstorms.

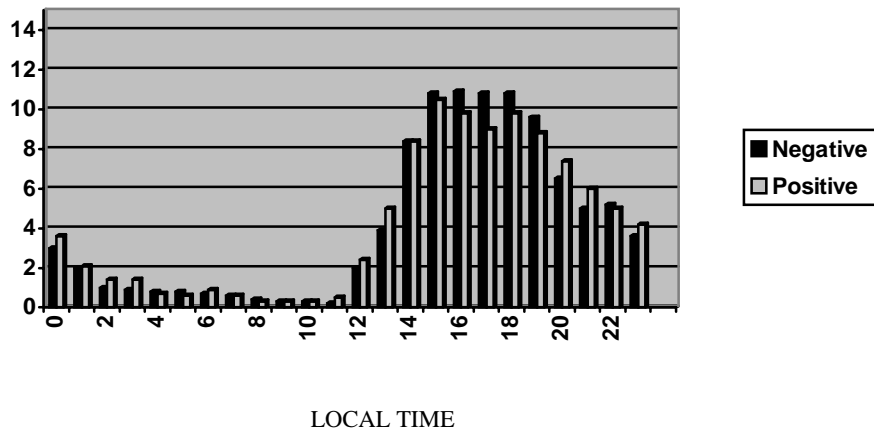


Fig. 1 – Relative frequency (in percent) of negative and positive flashes in the summer season of 1993 in the southeastern Brazil versus local time.

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ACKNOWLEDGMENTS

We would like to thank Dr. Steve Rutledge from Colorado State University for providing information used in this work, and the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for providing financial support.