

Cloud-to-Ground Lightning Flash Characteristics in Meteorological Conditions

R.B.B. Gin
O. Pinto Jr.
I.R.C.A. Pinto
O. Mendes Jr.

Instituto Nacional de Pesquisas Espaciais - INPE

About 200,000 lightning flashes recorded in the summer season of 1993 in the state of Minas Gerais, Brazil, were analysed in terms of the predominant meteorological condition in the synoptic scale. The results indicate that most lightning characteristics are independent on the synoptical conditions. However, the mean intensity of first-order strokes in both negative and positive lightning flashes were found to be lower in flashes associated with isolated thunderstorms than in flashes associated with cold front or tropical convection.

INTRODUCTION

Lightning characteristics associated with different meteorological conditions have been studied by several authors (e.g. Orville et al., 1988; Rutledge et al., 1988). In Brazil, the first study of this type has been recently made by Gin (1996), based on about 200,000 lightning flashes recorded by a lightning positioning and tracking system (LPATS) in the state of Minas Gerais, Brazil, during the months of January and March of 1993. For details about the system see Pinto et al. (1996). The lightning data were analysed in terms of the predominant meteorological conditions in the synoptical scale, as identified by infrared and visible Meteorosat satellite data.

In the state of Minas Gerais, in the southeastern region of Brazil, during the summer season three different types of convective activity usually occur: local convection, cold front convection and tropical convection. The tropical convection originates mainly in the Amazon region, sometimes extending to central and southeastern regions. In such cases, the tropical convection can interact with frontal systems organizing and enhancing the convective cloudiness, and producing a band of convective clouds. In this paper the polarity, multiplicity, peak-current intensity and percentage of flashes with at least one subsequent stroke more intense the first-order stroke were determined for negative and positive flashes, corresponding to the three different meteorological conditions cited above.

OBSERVATIONS

Most (67%) lightning flashes recorded in the months of January and March of 1993 in the state of Minas Gerais were associated with cold front convection. Only 7% of the flashes were produced by local isolated thunderstorms. The remainder were associated with tropical convection.

Table 1 shows the characteristics of negative and positive flashes versus the meteorological condition. It can be seen that, except for the peak-

current intensity, all other characteristics remain almost the same independently of the meteorological condition associated. In turn, the mean and maximum value of the peak-current intensity in the case of local thunderstorms were significantly lower than the values associated with cold front and tropical convection. Using the t-statistics and assuming a log-normal distribution of the peak-current intensities, it was found that the difference in the average peak-current values between local and non-local thunderstorms is significant at 0.0001 significance level.

CONCLUSIONS

From the comparison between lightning data obtained in the southeastern region of Brazil during the summer season of 1993 and meteorological satellite data, it was possible to determine the dependence of the lightning characteristics on different meteorological conditions. The main conclusions were:

- The lightning polarity, multiplicity, and the percentage of subsequent strokes more intense than first-order strokes were found to be not dependent on the meteorological condition in the synoptic scale;
- The peak-current lightning intensity of negative and positive flashes in isolated local thunderstorms were lower than the values in thunderstorms associated with cold front and tropical convection.

ACKNOWLEDGMENTS

The authors would like to thank the Companhia Energética de Minas Gerais (CEMIG) for providing the lightning data and the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) and the CNPq for supporting during the research.

REFERENCES

Gin, R.B.B., Study of the lightning characteristics in the southeastern region of Brazil in the 1992-93 summer season, PhD Thesis, Instituto Nacional de Pesquisas Espaciais (INPE), 1997.

Orville, R.E., Henderson, R.W., and Bosart, L.F., Bopole patterns revealed by lightning locations in mesoscale storm systems, *Geophys. Res. Lett.*, 15: 129-132, 1988.

Pinto Jr., O., Gin, R.B.B., Pinto, I.R.C.A., Mendes Jr., O., Diniz, J.H., and Carvalho, A.M., Cloud-to-ground lightning flash characteristics in the southeastern Brazil

during the 1992-1993 summer season, *J. Geophys. Res.*, 101: 29,627-29,635, 1996.

Rutledge, S.A., and MacGorman, D.R., Cloud-to-ground lightning activity in the 10-11 June 1985 mesoscale convective system observed during the Oklahoma-Kansas pre-storm project, *Mon. Wea. Rev.*, 116: 1393-1408, 1988.

Table 1 - Lightning cloud-to-ground characteristics associated with different meteorological conditions: (-) negative flashes, (+) positive flashes

	Cold front convection		Tropical convection		Local convection	
Percentage of flashes	64 (-)	36 (+)	69 (-)	31 (+)	63 (-)	37 (+)
Percentage of singles flashes	59 (-)	88 (+)	59 (-)	91 (+)	56 (-)	89 (+)
Mean multiplicity of multiple flashes	3 (-)	2 (+)	3 (-)	2 (+)	3 (-)	2 (+)
Mean first-order stroke peak-current (kA)	42 (-)	21 (+)	42 (-)	23 (+)	26 (-)	16 (+)
Maximum first-order stroke peak-current	490 (-)	270 (+)	600 (-)	376 (+)	240 (-)	130 (+)
Percentage of flashes with at least one subsequent stroke more intense than the first	50 (-)	55 (+)	50 (-)	52 (+)	53 (-)	54 (+)