

# Analyses of the key factors that may lead to a misclassification of negative flashes reported by lightning locating systems (LLS)

A. C. V. Saraiva<sup>1</sup>, M. M. F. Saba<sup>1</sup>, O. Pinto Jr.<sup>1</sup>, K. L. Cummins<sup>2</sup>, E. P. Krider<sup>2</sup>

1 - INPE, National Institute of Space Research,  
S.J. Campos, São Paulo, 12227-010, Brazil

2 - Institute of Atmospheric Physics, University of Arizona,  
Tucson, Arizona, USA

**ABSTRACT:** How many strokes are produced by negative lightning flashes to ground? Although many instruments are able to determine/count precisely the total number of strokes within a given flash, it is more difficult to determine the multiplicity of a flash when it produces multiple ground terminations. Clearly, if all the strokes follow the same path to ground, it is usually easy to view them as one flash. For more than 100 years, researchers have used some simple boundary conditions to assign different strokes to a flash, and time-resolving cameras have been one of the most reliable sources of that information. This knowledge is also applied by Lightning Location Systems (LLS) that detect the electromagnetic waveforms produced by individual return strokes and then combine them into flashes. It is well known that any LLS can miss strokes within a flash and even entire flashes, primarily if the strokes are small. However, sometimes a LLS will double-report a flash, i.e. assign different strokes produced by one flash to two different flashes. In this paper, we will describe an analysis of flashes that were reported by a LLS and also recorded using high-speed cameras to determine the causes and extent of the LLS double-reporting. These campaigns were held in São José dos Campos, Brazil (using BrasilDAT data) and Tucson, USA (using NLDN data), in 2003/2004, 2007 and 2008. For each flash that was detected by both a camera and a LLS, we determined whether the LLS reported all the strokes, the LLS detection efficiency for both strokes and flashes, and the causes of flashes being double-reported when that occurred. We found that, in general, the LLS tended to double-report about 10% of the multiple-stroke flashes, which means that the LLS stroke grouping algorithm should be reevaluated. We will propose some improved grouping criteria.

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\* Correspondence to:

Antonio Carlos Varela Saraiva, Geophysics Division, National Institute of Space Research, S.J. Campos, SP, 12227-010, Brazil. Email: acvsaraiva@gmail.com