Journal of Atmospheric and Solar-Terrestrial Physics 112 (2014) 31–37

Contents lists available at ScienceDirect

Journal of Atmospheric and Solar-Terrestrial Physics

journal homepage: www.elsevier.com/locate/jastp

Performance of lightning locating systems in extracting lightning flash characteristics

Upul Sonnadara [a,*], Vindu Kathriarachchi [a], Vernon Cooray [b], Raul Montano [b], Thomas Götschl [b]

[a] Department of Physics, University of Colombo, Colombo 3, Sri Lanka
[b] Division for Electricity and Lightning Research, Uppsala University, Sweden

ARTICLE INFO

Article history:
Received 17 June 2013
Received in revised form
29 January 2014
Accepted 4 February 2014
Available online 12 February 2014

Keywords:
Lightning
Sweden
Lightning detection
Lightning climatology

ABSTRACT

A study was carried out to compare the negative cloud to ground lightning discharges recorded using Swedish lightning locating system against time correlated direct field measurements. Only the first 200 ms time window was investigated. A total of 167 flashes were recorded and time matched against the lightning locating system records. The comparison shows that for negative cloud-to-ground lightning flashes, the stroke detection efficiency of lightning locating system is at 93% for detecting the first stroke accurately. The efficiency drops to about 77% in detecting all strokes accurately. Thus, the system tends to give a low value for average multiplicity and a significantly higher value for parameters such as percentage of single stroke flashes. In agreement with the direct field measurements, when the individual strokes are identified correctly, both systems show the expected 2:1 ratio between the first and subsequent stroke peak field. Data also shows that the LLS system has a tendency of identifying isolated cloud pulses as positive return strokes. Hence one must take into account the systematic deficiency in lightning locating systems when reporting characteristics of cloud to ground lightning flashes.

1. Introduction

Lightning locating systems are used in many countries to obtain the point of strike of cloud-to-ground lightning discharges (e.g. Fernando et al., 1998; Shinjo et al., 1999; Zajac and Rutledge, 2001; Chen et al., 2002; Orville et al., 2002; Bernardi and Ferrari, 2004). Although lightning locating systems are primarily designed to locate the point of strike of cloud-to-ground lightning discharges, published data show that the information given by the lightning locating systems are not only used to extract the strike point but also as a scientific tool to study the characteristics of lightning parameters (e.g. Diendofer et al., 1998; Areitio et al., 2001; Soriano and De Pablo, 2002; Pinto et al., 2003; Sonnadara et al., 2006a). Even though these systems are quite useful in obtaining general characteristics of lightning discharges such as lightning ground flash densities and seasonal variations or to monitor trends over long periods, the accuracy in estimating parameters such as multiplicities (number of strokes per flash), interstroke intervals and lightning peak current distributions is somewhat questionable (Diendofer et al., 1998; Schulz and Diendorfer, 2006) due to misidentifications and inefficiency in detecting individual strokes accurately. Independent studies which estimate the accuracy of these systems against direct field measurements on an event-by-event basis is scarce in the literature (Biagi et al., 2007; Krider et al., 2007; Saba et al., 2006).

The characteristics of lighting ground discharges in different geographical regions are useful in engineering applications and in understanding the interactions between the lightning and earth's atmosphere (Cooray and Jayaratne, 1994). There are a number of studies conducted in temperate and semitropical regions (Uman, 1987; Rakov et al., 1994; Cooray and Perez, 1994). A few studies are also available for tropical regions (Cooray and Jayaratne, 1994; Cooray and Lundquist, 1985; Rakov and Uman, 1990). These studies show that strong similarities exist between the characteristics of lightning ground discharges observed in different regions. Especially, the studies show that for negative cloud-to-ground lightning discharges, the ratio of first return stroke field peak to the subsequent stroke field peak is approximately a factor of 2. However, this ratio is not in agreement with the studies carried out using the information extracted from the lightning locating systems (Rakov and Uman, 2003). The Austrian lightning detection and information system (ALDIS) indicates that this ratio is closer to 1 (Diendofer et al., 1998) implying that the peak currents in the first and subsequent strokes are similar. So far no plausible explanation is available for the difference between the two measurements although poor detection of relatively small subsequent strokes and higher percentage of flashes with at least one subsequent stroke greater than the first

* Corresponding author. Tel./fax: +94 11 2584777.
E-mail address: upul@phys.cmb.ac.lk (U. Sonnadara).

http://dx.doi.org/10.1016/j.jastp.2014.02.001
1364-6826