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THE MAIN ADVANCES AND THE MOST COMMON MISLEADING APPLICATIONS RELATED TO LIGHTNING LOCATION SYSTEM DATA

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1. INTRODUCTION

Lightning location systems have collected a large number of cloud-to-ground (CG) lightning data on many countries for different applications by power utilities, weather services, aviation, scientific research and others (e.g. Pinto et al., 2007 and references therein). In spite of the many comprehensive descriptions of these systems (e.g. Cummins et al., 1998a,b; Rakov and Uman, 2003; Diendorfer, 2007), misleading applications of data provided by these systems remain.

In this article an overview of the main advances in the lightning research and applications provided by this type of data are outlined. In addition, the article describes some cases of misleading applications of these data still reported in the literature. The knowledge of these aspects can be useful to suggest future improvements of these systems, as well as to avoid incorrect interpretations of their data.

2. MAIN ADVANCES

Perhaps the main advance provided by the lightning location data was to map the lightning incidence at large spatial scale with larger reliability compared to the extrapolation of the local information provided by thunderstorm day statistics or flash counters. This can be inferred easily comparing keraunic maps available in large regions where lightning location systems are operational like United States, Canada and Brazil. This is because the lightning location data reliability is dependent on sensor redundancy. For this reason better quality data are obtained for large networks. For small networks the data should be seen with caution if a map of lightning incidence is concerning.

Another successful application of lightning location data is to estimate the percentage of flashes of different polarities. Considering that negative and positive cloud-to-ground (CG) flashes have different current waveforms, the determination of their relative incidence may be important for many applications related to lightning protection. In this sense, the lightning location system data have shown that the percentage of positive CG flashes is very dependent on the type of the predominant thunderstorm in a particular region. This is evident on the data provided by the NLDN network in United States, for instance, which indicated a large percentage of positive CG flashes in the Midwest. However, this type of result is very dependent on the level of intracloud contamination, as it will be discussed later.

The successful of the use of lightning location system data for other lightning or lightning-related parameters is only partial at this time. Data on multiplicity is very sensitive to the performance of the lightning location systems, in particular the stroke detection efficiency. Data on peak current, in turn, is in addition to the detection efficiency, sensitive to propagation effects. Data on the lightning-related parameters like front time and pulse width have very limited practical applications. Perhaps the more important one is the use of pulse width for CG/intracloud discrimination.

Finally, lightning location system data have been used with success to monitor lightning incidence in real time and for historical analysis for different engineering applications (e.g. Cummins et al, 1998b; Pinto et al., 2006).

3. MOST COMMON MISLEADING APPLICATIONS

As any other technology, lightning location systems have their own limitations, which if are not well understood may cause misleading applications. Below are described some of the more common applications.

3.1 Flash density information

There are many applications where flash densities are obtained from lightning location systems and compared with other data. Some examples of misleading use of these data are: use data obtained from outside the borders of the network without corrected them by a detection efficiency model; use data far away of the borders without corrected them for signal ionospheric reflections contamination (or even inside the network borders, when allowing network solutions for flashes at distances larger than 600 km from the sensors); different spatial resolutions, which in some cases can be responsible for most of the differences mainly when considering maximum values; or comparison of data obtained for networks using different types of sensors, with significant differences in their network performance. Typical misleading applications of this type include lightning association with geographical features and lightning protection.

3.2 Polarity information

For many applications the knowledge of the percentage of positive flashes is very important, because the different current characteristics of negative and positive flashes, in particular in terms of occurrence and intensity of the continuing current. Examples are the identification of different electrical structures of thunderstorms and mesoscale convective systems and evaluation of the importance of the lightning polarity on the lightning impact on different objects (from trees or any other vegetation causing forest fires to electrical/electronic systems). For these applications it is very important to consider the level of intracloud contamination on the positive flash densities for different lightning location systems (see, for instance, Biagi et al., 2007), considering the type of sensors and the system configuration (in particular the typical sensor baseline length).

3.3 Peak current information

Peak current estimates by lightning location systems are model dependent. Two models are involved: one to convert peak fields to peak current and other to consider the propagation effects on the fields. While data analyses have indicated that single values should be considered carefully, mainly for low peak current values, in terms of mean values (that is, peak current distribution) the results are expected to be quite confident (Rachidi, 2007). At this point it is important to observe that the perceptual error in single values are peak current dependent.

3.4 Information on other parameters

The use of the information of other parameters provided by lightning location systems requires specific knowledge about how they are obtained and what are their physical meaning. One example of these parameters is the rise-time. This is actually a field parameter and not a current parameter. In consequence, any application of this parameter as representative of the current rise-time requires considering the field propagation effects in details.

4. CONCLUSIONS

In this article an overview of the main advances in the lightning research and applications provided by this type of data are outlined. In addition, the article describes some cases of misleading applications of these data still reported in the recent literature. The knowledge of these aspects can be useful to suggest future improvements of these systems, as well as to avoid incorrect interpretations of their data.

5. REFERENCES

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