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ABSTRACT: In this paper the first results of interstrokes and inter-K time intervals observations in Brazil by Miranda et al. (2003) with a 37 μs time resolution are presented. In addition, a description of a GPS (Global Positioning System) synchronized apparatus to measure the electric field waveform with a 1.25 μs time resolution is done. A comparison between future results provided by this apparatus and results provided by SLT (Thunderstorm Location System) also will be possible. It will also enable to investigate the relationship between the electric field and light intensity obtained by a fast camera (with a time resolution of 1000 frames per second). Preliminary data and results will be presented.

INTRODUCTION

Miranda et al. (2003) presented the first electric field waveforms observations of lightning in Brazil with a 37 μs time resolution. These observations stimulated the development of an apparatus to observe electric field waveforms with high time resolution and synchronized to GPS time. They found geometric mean values of 49.6 ms and 12.0 ms for the interstrokes time intervals and the inter-K time intervals respectively. They also found that the interstrokes and inter-K time intervals have no dependence on the return stroke order. The interstrokes time intervals and inter-K time intervals were found to obey a log normal distribution. These results are in agreement with those presented in the literature [Rakov and Uman (1990), Rakov et al. (1990), Thottappillil et al. (1990) and Rakov et al. (1994)].

APPARATUS DESCRIPTION

Figure 1 presents a scheme of the apparatus (electric field acquisition system) developed to obtain more refined data than Miranda et al. (2003). It is an electric field antenna (plate antenna and an integrator circuit) coupled to a digitizing system synchronized to GPS (Global Positioning System) time. Description of the synchronization between the digitizing system and the GPS time is presented by Miranda et al. (2002).

The plate antenna is shown in Figure 2. It is coupled to the integrator circuit (box under the lower plate) by a co-axial cable, with the lower plate grounded, and the integrator circuit coupled to the digitizing system by co-axial cable. The integrator circuit has a decay time of 150 μs and acts as a low pass filter with a 1061 Hz half-power frequency. It was also experimentally observed that the apparatus has a considerable response up to 50 kHz. The sampling resolution of 1.25 μs and the band of integration (up to 50 kHz) avoid aliasing effect. The milliseconds accuracy of the GPS time synchronization makes available a comparison between data provided by the electric field acquisition system and the SLT (Thunderstorm Location System).

A fast camera with a resolution of 1000 frames per second (1000 fps) runs simultaneously to the electric field acquisition system, so that we can correlate electric field waveforms and luminosity of lightning, and also see events not recorded by the SLT as the occurrence of continuing current.

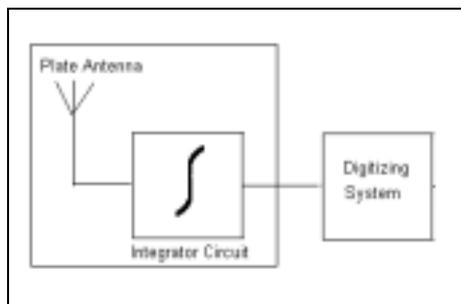


Figure 1 – Electric Field acquisition System



Figure 2 – Plate antenna

PRELIMINARY RESULTS

The results presented here were obtained between September (2002) and March (2003) related to thunderstorms over the city of São José dos Campos. Figures 3 and 4 are correlated electric field and light signals of a lightning occurred in 05-March-2003 at 17:20:45.801 UT. These figures show the coherence between the amplitude of the peaks (Figure 3) and the light intensity in the frames (Figure 4) and also is possible to see the coherence in the interstroke time observed from both figures. In Figure 4, the channel is in black color and the roundness is in gray color. Correspondent return strokes in both figures are characterized by the same letters (a, b, c, d).

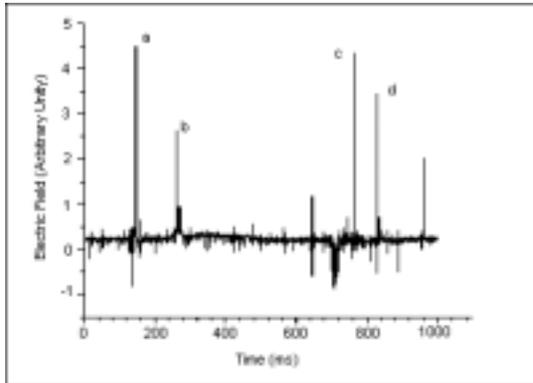


Figure 3 – Electric field waveform of a lightning occurred in São José dos Campos in 05-March-2003 at 17:20:45.801 UT.

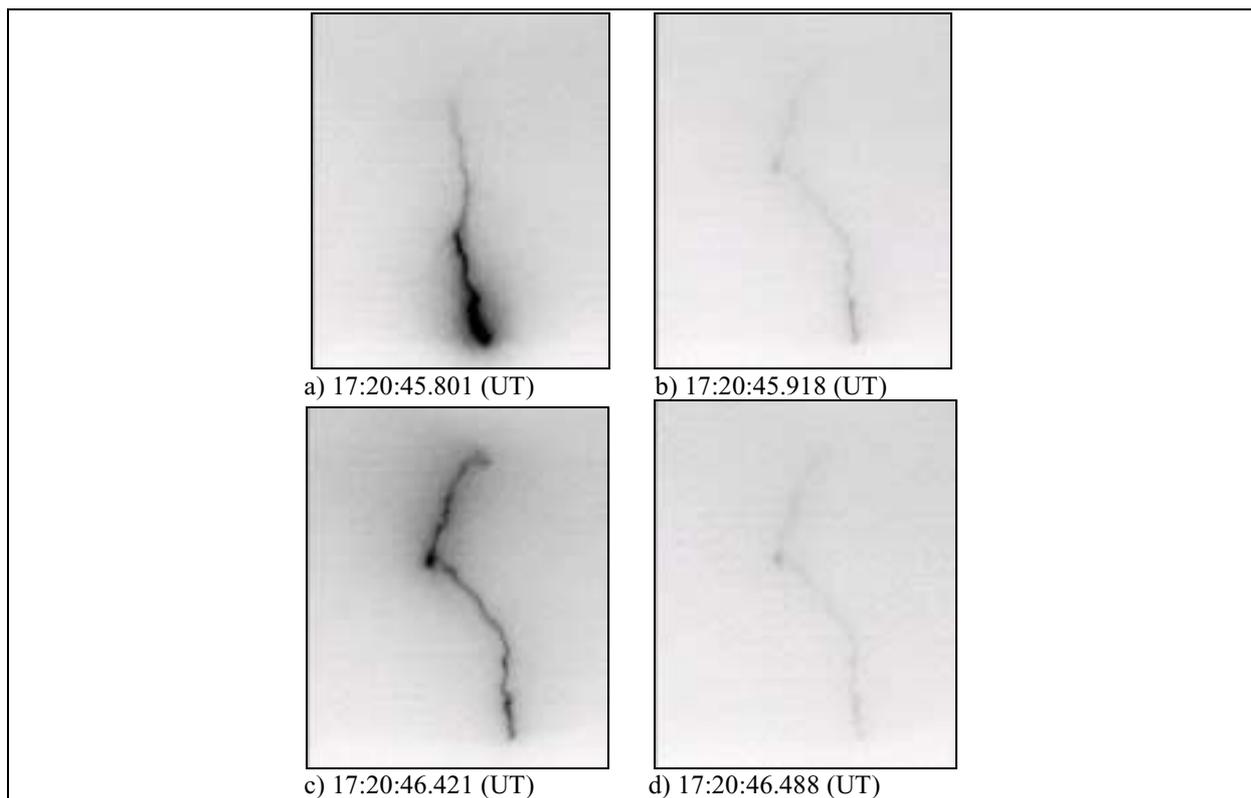


Figure 4 – Frames related to the electric field waveform presented in Figure 3

Figure 5 presents an electric field waveform of a negative lightning occurred in São José dos Campos in 21-Feb.-2003 at 00:52:28.870 UT, in which only the first and the seventh return strokes were detected by the SLT. The reason for that is still not well understood.

An interesting fact observed by the electric field acquisition system, but not observed by the SLT, was the frequent occurrence of continuing currents in negative lightning. In Figure 6 we can see an example of a negative return stroke (according to the atmospheric electricity convention) followed by a continuing current of about 700 μ s. This type of feature is not recorded by the SLT.

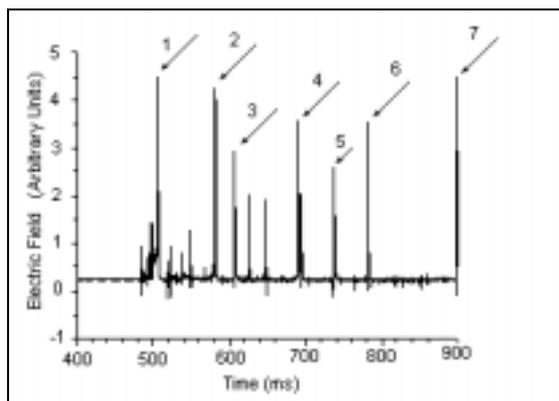


Figure 5 – Electric field of lightning with only two strokes detected by the SLT.

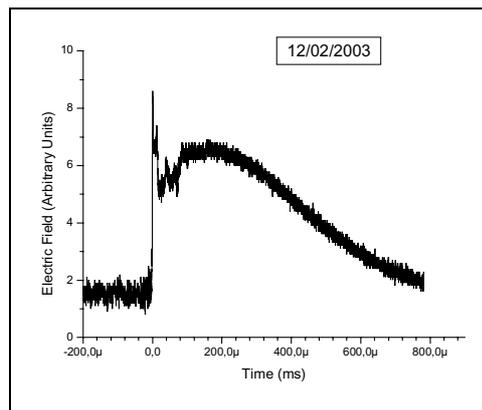


Figure 6 – Continuing current in a negative return stroke.

Several events of continuing current with some hundreds of ms were observed. A larger data set is being acquired to investigate possible local effects.

CONCLUSIONS

The preliminary observations show the success in the development of the electric field acquisition system (electric field antenna and the digitizing system) synchronized to GPS time. Simultaneous operation of the acquisition system with the fast camera makes possible observation of interesting aspects of lightning and also can be useful in evaluating the performance of the SLT. Aspects such as geometry, luminosity intensity, branches of the channel and their relation to the electric field waveform can be studied. Interesting characteristics such as frequent occurrence of continuing current following negative return strokes and continuing currents of some hundreds of ms were observed.

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