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METEOROLOGICAL ANALYSIS OF LIGHTNING RELATED INJURIES IN THE SOUTH/SOUTHEAST OF BRAZIL

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Abstract – This paper shows the lightning incidence in four reported accidents with humans (with 20 casualties) in two Brazilian states. In three cases, the incidence of atmospheric discharges started about 10 minutes before the register of the accident, whereas in the one event the storm approaches to the area next to the accident coming of more distant. It can be observed that the lightning network is capable to detect the atmospheric discharges in efficient way in the events and these information can be useful in the prevention of accidents of this nature.

1 INTRODUCTION

The accidents of humans with atmospheric discharges occurs preferentially when they stay in places unproctected in relation the incidence of atmospheric discharges. According [1], annual estimates of costs and losses related are around US$ 4 to 5 billions, with estimates of 1 accident (involving injuries and/or death) every hundred thousand lightning discharges per year, approximately. In Brazil we does not have a trustworthy statistics yet, but it believes that the same number in Brazil is of the same order or perhaps greater than that the registered in the United States.

The lightning incidence in Brazil's territory is estimated about sixty million ocorrences per year, one of the greatest of the world. Some parts of Brazil are very populated, especially in the great cities areas. Stydies shown that in that areas we have higher flash densities than other, but the protection against lightning are greater too. The cases of casualties occurs mainly on unprotected urban or rural areas.

2 METODOLOGY AND DATA

The goal is to show the behaviour of the lightning discharges (in a distancia of until 50km of the place of the accident) in the period between one hour before and one hour after the event's time. Because the exact location and the time of the occurrences does not have the same precision of the atmospheric discharges data, we will only describe the occurrences itselves and observe some general characteristics of the behavior of the atmospheric discharges. We will try to say if the people had conditions to take attitudes of protection with necessary antecedence for eventually preventing itself of the accidents that they had suffered.

2.1 Lightning data

Lightning data had been provided by the RINDAT (National Integrated Lightning Detection Network), whose general characteristics are described in [2]. The detection efficiency of the network is higher then 90% in all area of the events. The lightning incidence were taken in an area of 50km of distance to the point of the accident had been searched, whereas the interval of time taken for the research was of one hour before and one hour later to the time of the event. These data had been organized in graphs where we can observe the time evolution of the lightning incidence in the area next to the accident. The graph compares the difference of time (in seconds) between each atmospheric discharge detected and the time of the accident with the estimated distance between the lightning position and the place of the accident (in kilometers).

3 EVENTS ANALYSIS

Four events were selected for this paper. The event analysis describes the situation as it was registred, the meteorological situation of the area and nearby with pictures of meteorological satellite near the accident time (when available), and the descrition of lightning incidence.

The Table 1 summarises the number of deaths and injuries related to the events. We observe that in all events at least one person was dead and number of injuries were greater than by many times.

Table 1: Summary of casualties in four events.

Events	Deaths	Injuries
Londrina/PR 11/24/01	1	5
Alm. Tamandare/PR 01/20/06	1	8
Pres. Epitacio/SP 01/04/07	1	1
Sao Carlos/SP 02/02/07	1	2
Total	**4**	**16**

3.1 Event 11/24/2001 – Londrina/PR

A person died and five others had been injured by a lightning during the afternoon (about 17h00min local time) when they observes a funeral in one of the city's graveyards. The meteorological situation shows a cold front over the south of Brazil and it arrived at the Parana just during the night of that day. The storms in the Parana in the afternoon had been caused by pre-frontal instabilities in some areas of the state.

Figure 1 shows the GOES sattelite view of the accident's area near the moment of the event and Figura 2 shows the lightning incidence over a 50km area nearby the accident's location. It can be seen that the storms that produced lightning just grew up near Londrina and other cities. This meteorological situation is very tipical for that month and shows a high instability situation over the area.

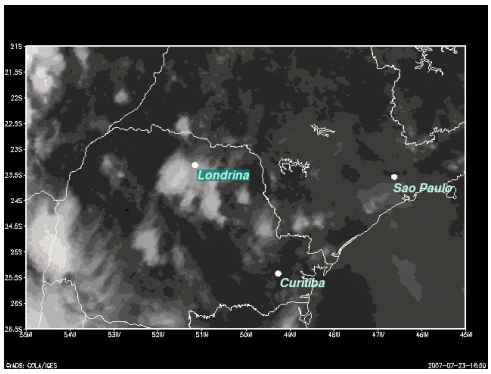

Fig. 1 – GOES satellite information of the event's area.

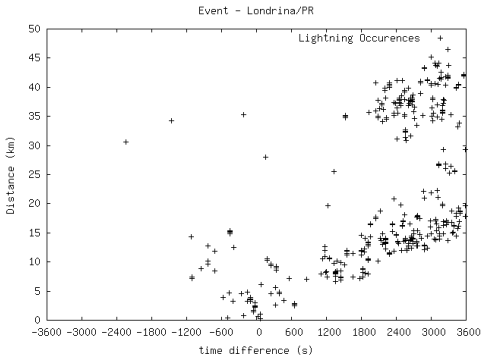

Fig. 2 – Lightning incidence nearby of the event's site.

Figure 2 shows that the lightning activity started about 20 minutes before the accident and over than 10km of distance. A new storm cell had formed about 10 minutes before the accident and caused some lightning discharges next to the place to the event, and then moving away from that place in the following hour. In the whole area were detected 612 strokes through the event.

3.2 Event 01/20/2006 - Almirante Tamandare/PR

A lightning struck a house in the beginning of the night (about 18h00min local time) of that day, causing the fall of the roof and part of the walls of the house. Inside the house there were nine people at that moment, of which one died and the other eight had been injured due to fall of the roofs. Witnesses told they had seen just a flash and heard a thunder, that resulted in the fall of the roof, practically destroying the entire house. At the accident´s moment just a light rain was falling (confirmed by met. radar data). In that day, a weak stationary front were on the Atlantic Ocean, close to Parana´s coast. In the afternoon and the night, instability areas had formed in the state of the Parana.

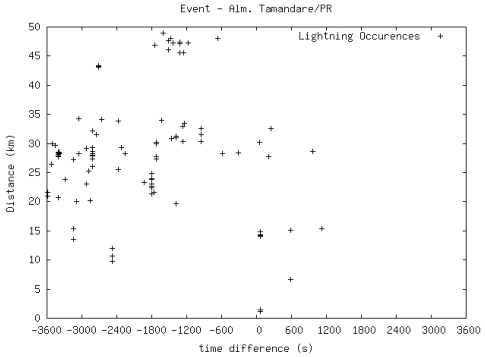

Fig. 3 – Lightning incidende nearby of the event's site.

Figure 3 shows that the lightning activity in the area was quite distant of the point of the accident in the previous hour and was vanishing with time. Stratiform rain over the area was also decrease your intensity (in agreement with the weather radar data that monitored the area). The strokes (of a 258 detected) that probably caused the accident and had been detected very next to the house site were positive and the peaks currentes evaluated by the RINDAT had been of 93 and 190kA. This case have some similarities with another one occurred in Connecticut USA on Feb 1996, where a house was destroyed and a occupant inside was injured by one 76kA positive stroke [3].

3.3 Event 01/04/2007 - Presidente Epitacio/SP

At the end of the afternoon (about 17h30min local time), two men were fishing in the edges of Parana river, when a lightning occurred and one of them, after he recovered the faint, noticed that the other one had disappeared. The

man´s body were located only in the next day by the rescue team, nearby the place of the accident. In that day a cold front were on the south of Brazil and at Sao Paulo´s area we observed the formation of squall lines that had formed storms in parts of Parana, Mato Grosso do Sul and Sao Paulo states.

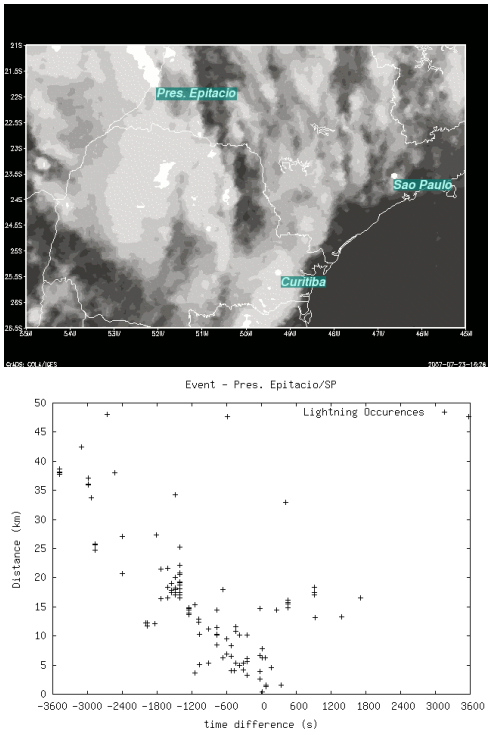

Fig. 4 – GOES satellite information of the event's area (above) and lightning incidende nearby (below) of the event's site.

Figure 4 shows the that convective activity was well marked in whole area as can be seen in the satellite image (above). Many cumulunimbus grouped in squall lines present a typical summer day in that region. The diagram of incidence of atmospheric discharges (below) shows that the storm approached to the area in the previous hour to the event, caused some discharges in the neighborhoods (one of them struck near both of two men) and after that this storm practically ceased its electric activity in the area. The total of detected atmospheric discharges was of 447 discharges in tha area.

3.4 Event 02/02/2007 - Sao Carlos/SP

During the afternoon (about 15h30min local time), three men were in a square of the city playing domino when a lightning stroke nearby the place where they were. All of them had suffered injuries, burnings and had been taken to the hospital of the city. One of the men died hours after the accident in the hospital. In that day a weak stationary front stayed on the Atlantic Ocean, near the coast to the Sao Paulo state. Associated to this front a low pressure system helped to form areas of instability areas in many places of the state in that day.

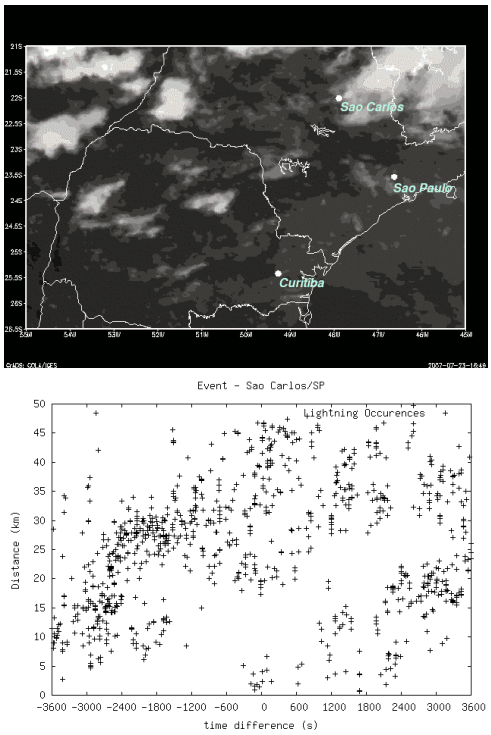

Fig. 5 – GOES satellite information of the event's area (above) and lightning incidende nearby (below) of the event's site.

Figure 5 presents the weather conditions in Sao Paulo state close to the event. We can observe that in that day the storm clouds had developed quickly and easaly, but with little or almost no significant horizontal displacement. The lightning activity was so great, as much that in the seek area (around 50km of the point of the accident), had the detection of 1749 atmospheric discharges, the biggest incidence of the four studied cases. However, when we observe in the diagram of lightning incidence we note that in the neighborhoods of the accident´s place, it had practically not occurred discharges in the previous hour to the accident. The storm that caused the discharges close to the event´s point had formed with much rapidity and the lightnings in that area were concentrated in a very short time period (of approximately 10 minutes). Later it had some new incidences in the area. This case, as well as the others previously, shows that just few lightning discharges are enough (even only one) to make an fatal accident happens.

4 CONCLUSION

Four events of lightning discharges accidents with victims in Sao Paulo and Parana states had been studied. In three cases, the people, who were in unproctected places for lightning discharges, had disdained the risk to be hitten and had not looked for a shelter in skillful time. In just one of the cases, the lightning discharge caused the collapse of the house where victims were inside, causing

the accident. Lightning alerts could be useful but people should first be trained to use them correctly.

The lightning incidence diagrams show that, for the three events, the incidence close to the accident's area started about 10 minutes before the event. Just in only one the storm formed far away of the area and approached to the place in the previous hour. Perhaps this restrictive time condition, associate with the probable unfamiliarity of protection attitudes in relation to the lightning discharges can be causes of those accidents.

Finally, the RINDAT was capable to detect and justify all events studied in this work, showing that its products can be used as a qualified information for storm monitoring and alert that can take risks for critical structures and/or people in unprotected areas.

5 REFERENCES

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