Analysis of lightning data on Paraguay Basin

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In this paper we present results of analysis of lightning data on Paraguay Basin. The corners of spatial window, for this analysis are: RightDown = (28 S, 51 W), LeftUp =(14 S, 68 W) and the period of time is January 2008 to February 2009. Lightning data were provided by starnet system through IAG-USP. Charts containing data are presented for each month and for this period of time. These charts contain information for calculate engineering parameters of protection. The main results are: the lightning activity is stronger over Andes's Ridge and over the cerrado. The main flooded area (pantanal) showed low lightning activity. The time of highest activity was around 18:00 UTC. There is another small peak of activity around 12:00 UTC. This data confirm previous results of preliminary research developed by LCA-UFMS team using satelite´s data of LIS (Lightning Image Sensor) at TRMM (Tropical Rain Measurement Mission) project. So, the main vulnerable area to extreme events of lightning discharge are located around the pantanal.

1. Introduction

Lightning activity is an important way of monitoring the weather. This activity is responsible for hazards and death of people. Monitoring lightning activity is a way to prevent these problems. Nowadays systems of lightning discharge detection are available and represent a way of monitoring weather and the severity of thunderstorms in urban area and crop fields. Some correlations of Lightning activity and weather were presented by Soares Jr. et al (2008). Lacerda et al (2003), presented a positive correlation between rain and lightning activity. Protection of electric systems (generation, transmission, distribution, and consumers) is dependent of the number of discharge by area and time (CEI/IEC, 1998, NBR5419, 2005). For characterizing the lightning activity over the Paraguay Basin we plot on a "window" that encloses the Paraguay Basin, data of lightning discharge provided by STARNET system operated by Instituto de Astronomia Geofísica e Ciências Atmosféricas da Universidade de São Paulo (IAG-USP) team. The coordinates of the corners of that window are: Right-Down = (28 s, 51 w), Left-Up =(14 s, 68 w).

2. Methodology and Results

Starnet is a system that record and store data of lightning discharge to ground. It is possible to plot the points where lightning is striking the ground. This information is important to calculate engineering parameters and establishing some criteria of protections systems against lightning. We analyze in this paper the data stored bay starnet over Paraguay Basin from February 2008 to January 2009.

Data of starnet were grouped in files that were processed in commercial worksheet. But, the size of archives were around 90 to 350 Mbytes and required several weeks and especial technics of programming for processing in several machines, simultaneously.

In figure 1 we can see the number of strokes by month. The strokes are not grouped in flash (or lightning), so, it is roughly around three times bigger than the number of lightning. Notice that the activity is bigger in January and December 2009.

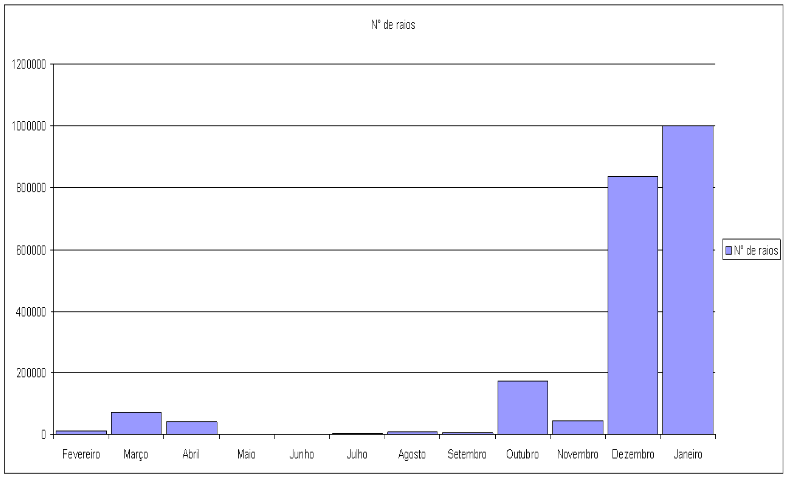

Figure 1. Number of strokes x month

In figure 2 we can see the number of strokes recorded versus hour of the day for the period of February of 2008 to January of 2009. This curve reproduces well the Carnegie's curve (Schonland, 1953, Macgorman and Rust, 1998) that represents the lightning activity trough the world.

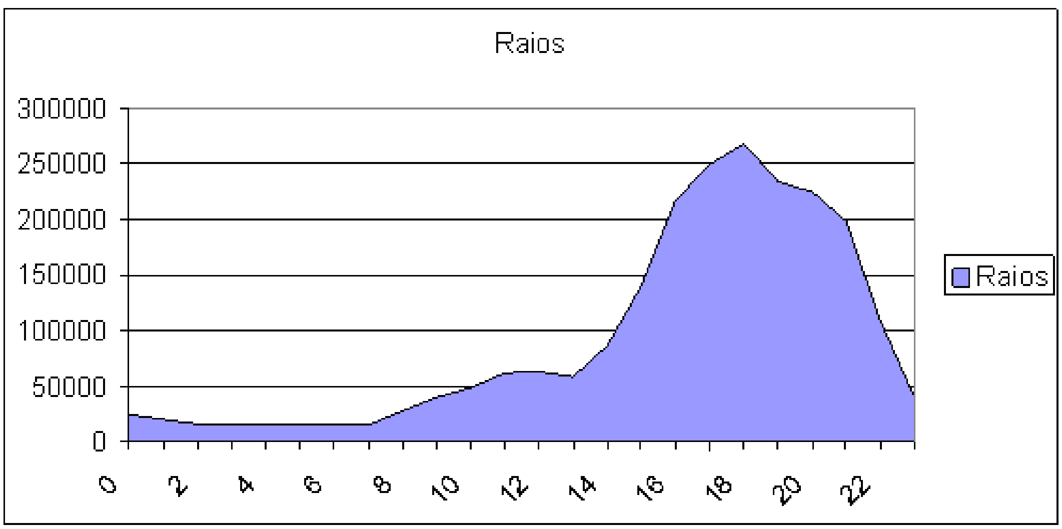

Fig. 2 - 2008 – number of strokes versus hour of the day

We selected two month, December and October to show the strokes directly over the Paraguay Basin. In figure 3 we see the distribution for December and in figure 4 for October (pink points). Notice that the lightning activity is stronger over Andes's Ridge and over the cerrado. The Pantanal is less stricken by lightning than the other regions.

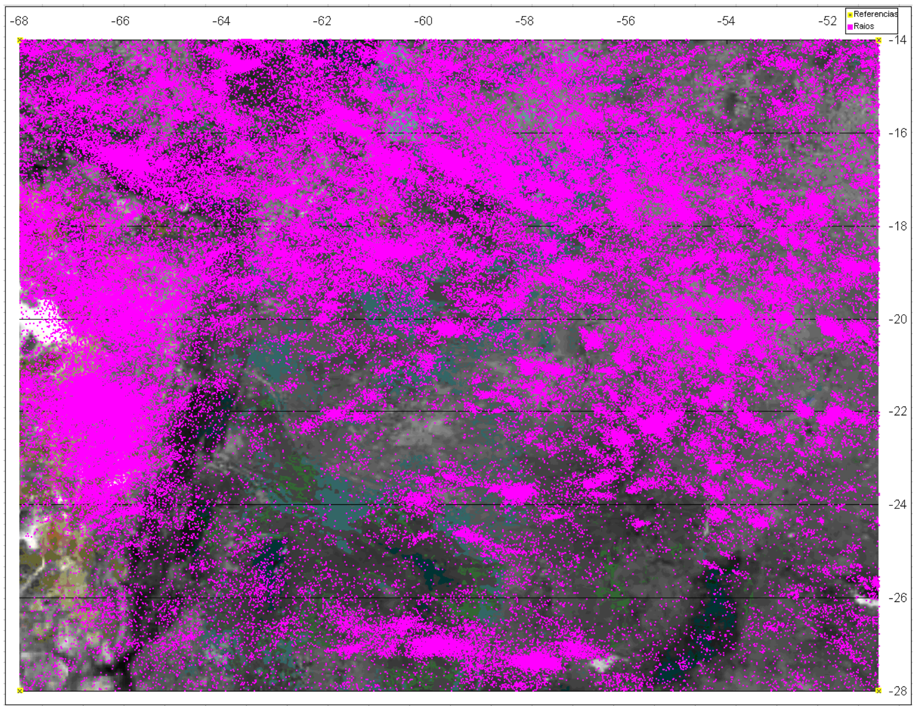

Fig. 3 - Typical spatial distribution pattern: December 2008 – 836228 strokes

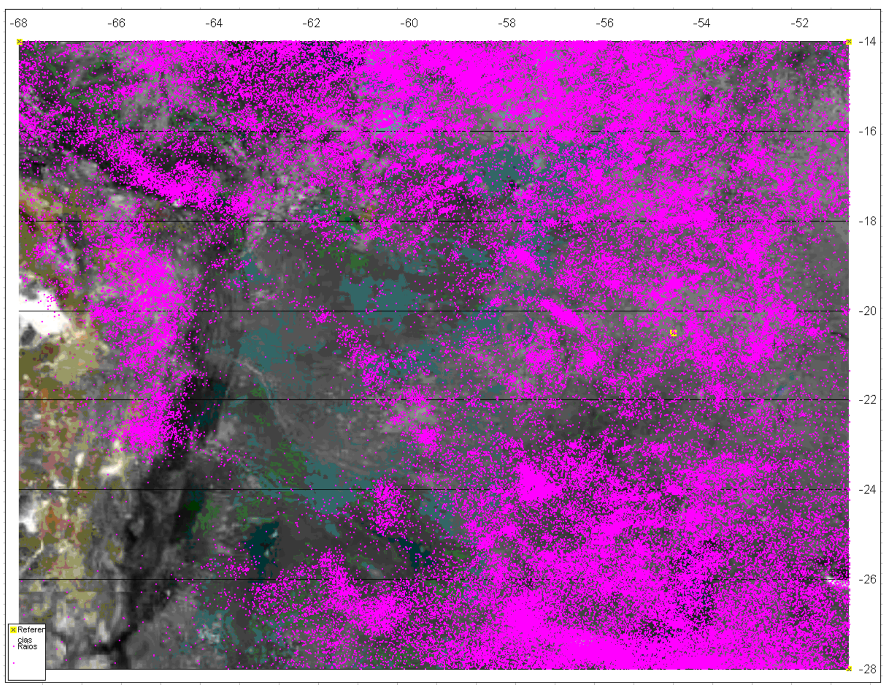

Fig. 4 - Typical pattern: October 2008: 175680 strokes

Figure 5 and 6 plot isolines that represent the same number of lightning inside a 100 x 100 km^2 square for one year of data. The figures 5 and 6 are divided in squares of 100 x 100 km^2, and the corners of each square are represented in degree of latitude (axis y) and longitude (axis x). The sign minus was used to represent south latitude and west longitude, respectively. In figure 5 the isolines are represented as a layer over the chart as background. In figure 6 the isolines are represented without background for better sight. To estimate roughly the number of discharge by area by year, Ng, for this year, divide the number of legend of figure 6 or 5 by 30000. This parameter, Ng, is used to estimate the risk of damage of buildings (CEI/IEC, 1998, NBR5419, 2005).

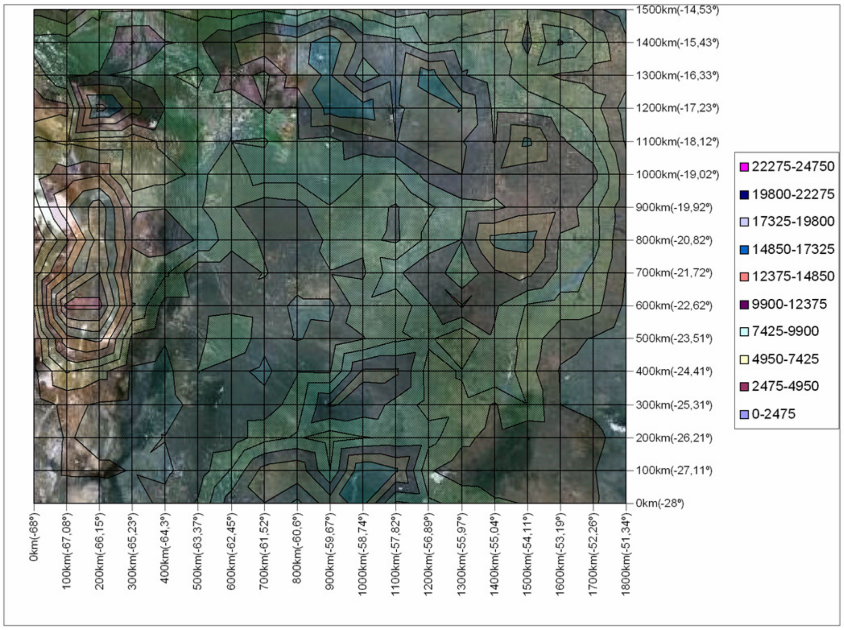

Fig. 5 number of strokes (isolines) for 100 km x 100 km from February 2008 to January 2009

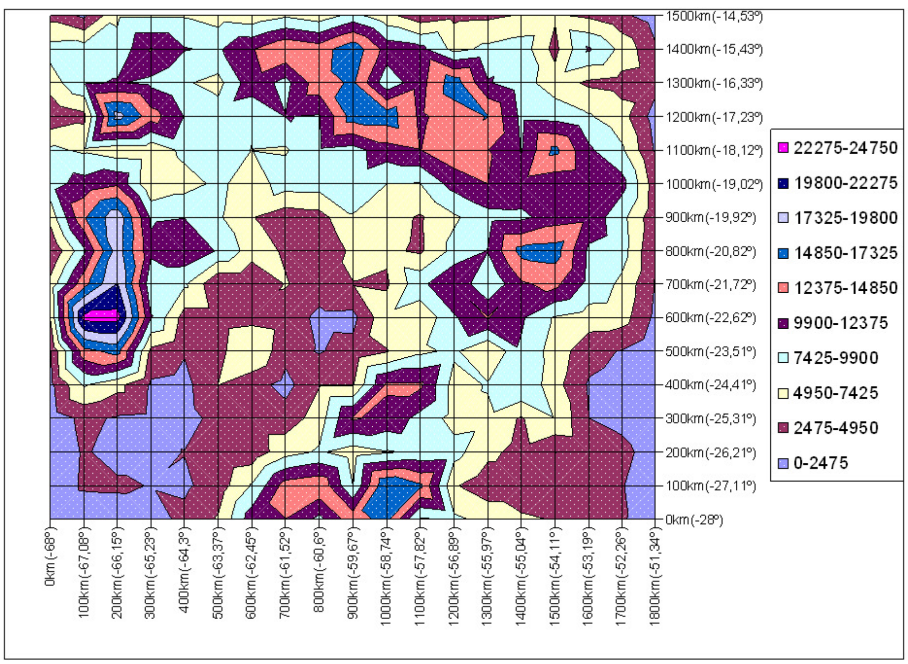

Fig. 6 Isolines of number of strokes (the same of figure 5)

Data of precipitation measurement used in this work are available at http://thunder.msfc.nasa.gov/data/. A detailed description of TRMM PR (Tropical Rain Measurement Mission Precipitation Radar) can be found at http://trmm.gsfc.nasa.gov/overview_dir/background.html.

The product used (2A25) (http://trmm.gsfc.nasa.gov/overview_dir/background.html) consists of a grade with resolution of 5° x 5° and 0,5° x 0,5°.

In the figure 7 we can see the precipitation (monthly accumulated rainfall) from 1998 to 2009. The pattern that emerges from this figure is a increasing precipitation from Andes's Ridge to the inner continental area. Except for a central area (blue) with precipitation between 42 and 63 mm.

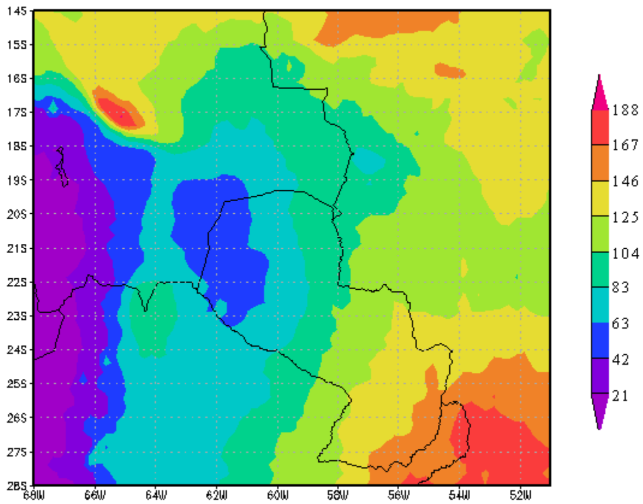

Figure 7. Monthly precipitation from 1998 to 2009 (mm).

The Figure 8 shows the rain rate in mm/h. It shows the same pattern of figure 7. Finally, the figure 9 shows the daily convective precipitation. The pattern is the same of the last two figures.

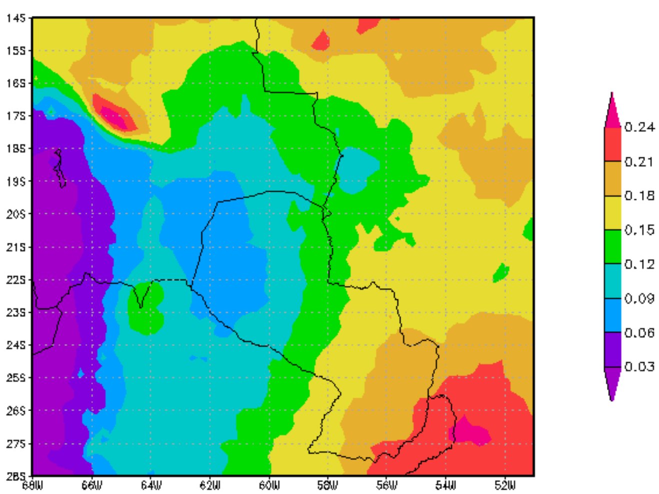

Figure 8. Daily rain rate in mm/h.

The pattern of rainfall presented in figures 7, 8 and 9 are consistent with the figures 3, 4, and 6, and we can infer that the region of bigger precipitation corresponds to the bigger lightning activity. And the central region corresponds to less stricken by lightning and rainfall. One exception is the region of Ande's Ridge that present intense lightning activity, showed as a pink colored area in figures 5 and 6, and low accumulated rainfall.

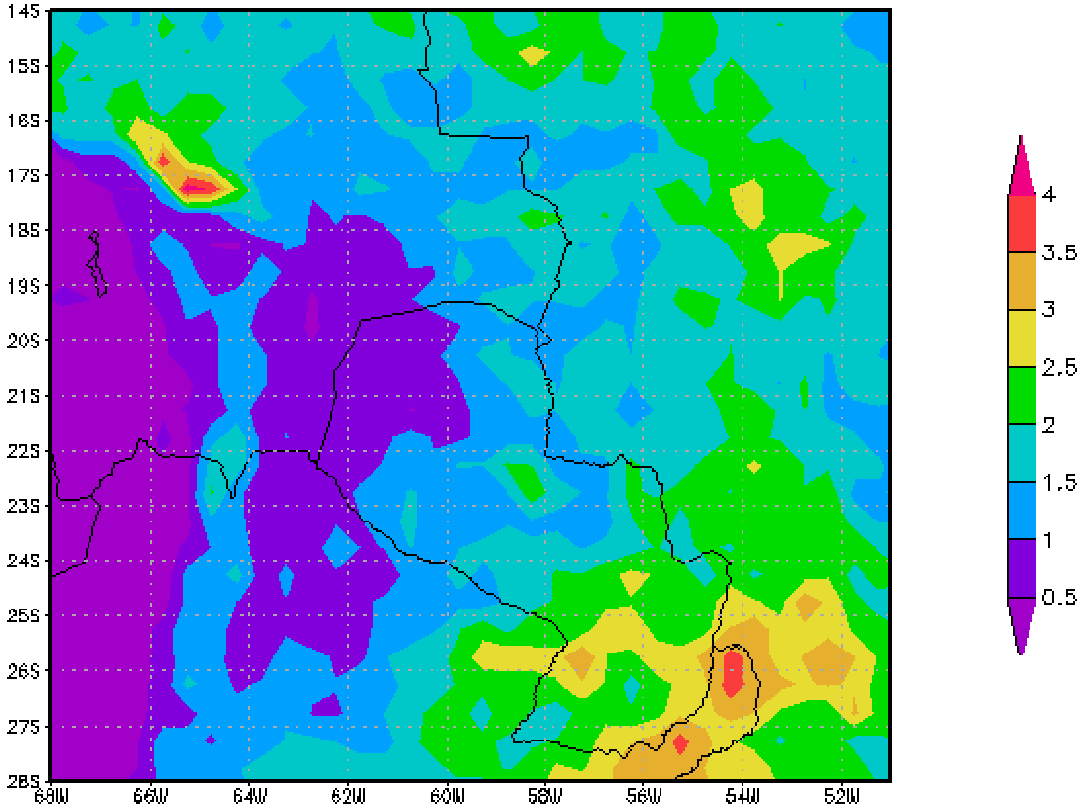

Figure 9. Daily convective precipitation (in mm)

3. Conclusions

We analyzed data of lightning discharge and rainfall for the Paraguay Basin and conclude that:

1. The main flooded area (Pantanal) showed low lightning activity. The highest level of activity was over Andes's Ridge and Cerrado.
2. The time of highest activity was around 18:00 UTC. There is another small peak of activity around 12:00 UTC
3. The maximum number of discharge by km^2 by year, Ng, using square of 100 x 100 km^2, assuming a multiplicity of 3 strokes for lightning, was roughly calculated as 0,8 Lightning/(km^2. year), over Andes's Ridge.
4. The pattern of rainfall is a increasing accumulated rain from the Andes's Ridge to the inner continental area. This pattern is the same for daily rain rate and convective rain rate.

Finally, we believe that this work presents a graphical representation of lightning activity an rain that allow to guide technical engineering people in evaluating the risk of damage of lightning activity and of rainfall.

4 .Bibliography

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