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CENTRO DE PREVISÃO DO TEMPO E CLIMA



CENTRO DE CIÊNCIA DO SISTEMA TERRESTRE  
GRUPO DE ELETRICIDADE ATMOSFÉRICA



# METHODOLOGY FOR CLOUD-TO-GROUND LIGHTNING NOWCASTING BASED ON DIFERENTE METEOROLOGICAL DATASETS

Part of MSc Dissertation

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# INTRODUCTION

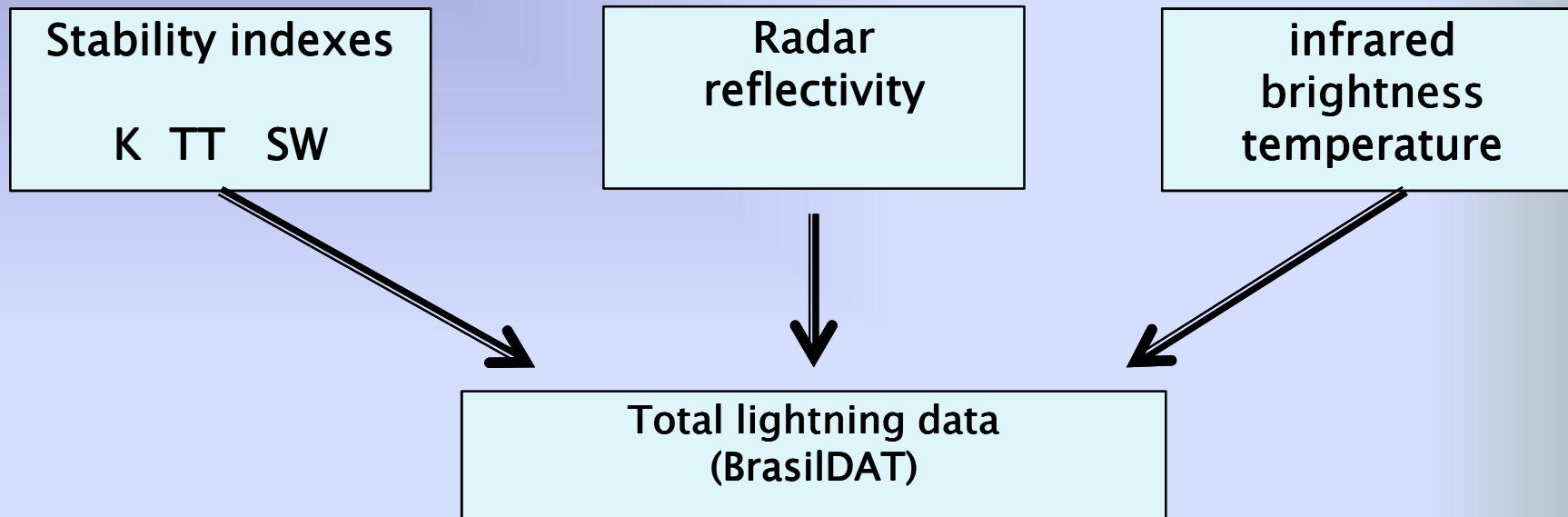
The Group of the Atmospheric Electricity ELAT / CCST / INPE have been developing new methodologies to issue cloud-to-ground (CG) lightning alerts for areas smaller than 10 km<sup>2</sup> using information of total lightning combined to different meteorological datasets.

In Brazil, about 80–90% of the thunderstorms start on areas with high convective potential and moves towards the monitored area. They are usually associated to frontal systems in the Southern and Southeastern Brazil.

In order to help predicting those thunderstorms, it have been using, together to other meteorological dataset, the simulations of the Weather Research and Forecast (WRF). As input data for WRF analysis were used the dataset from GFS (Global Forecast Model) with horizontal resolution of 0.5 for 24 hours for a grid of 30 x 30 km.



# DATA AND METHODOLOGY

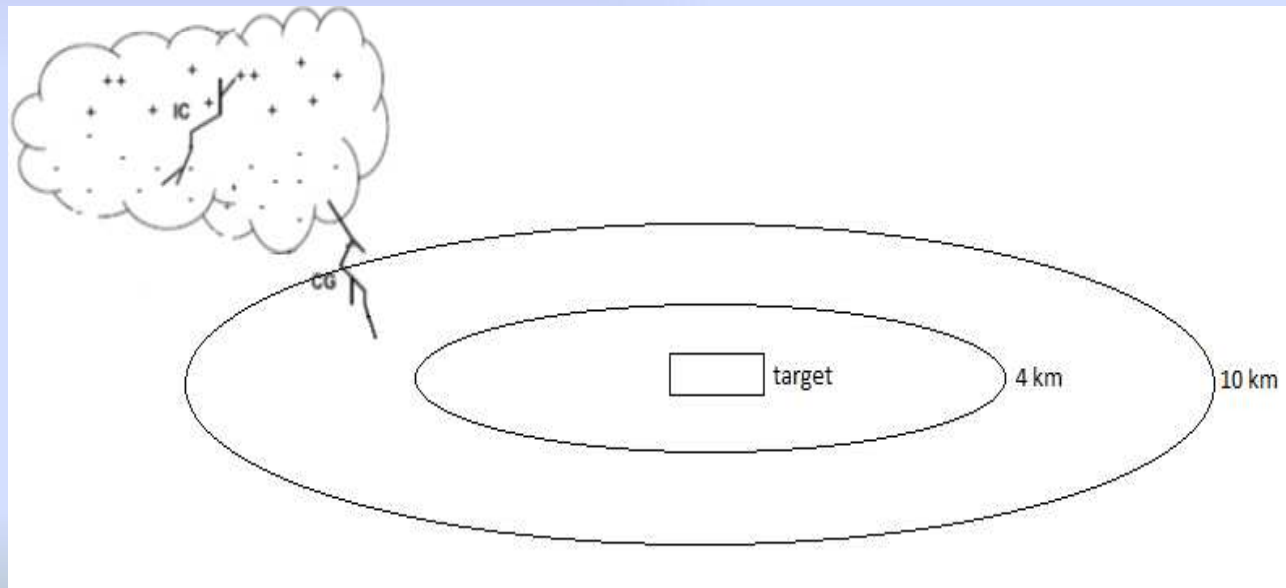


In order to issue a CG lightning warning with approximately one hour in advance. In a second phase of this work, it is planned to automate the warning system based on particular thresholds



## DATA AND METHODOLOGY

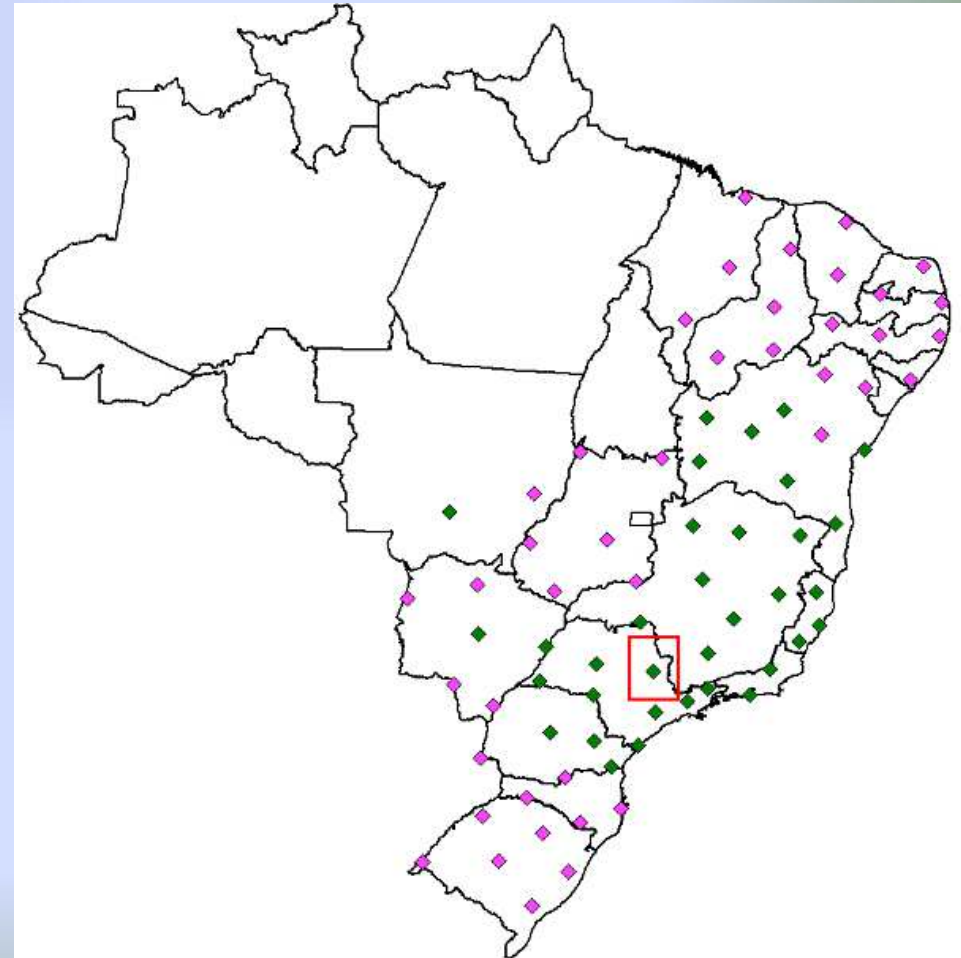
When the CG lightning incidence is located less than 20km from the monitored area, we start to analyze all datasets simultaneously to assess the probability of CG lightning occurrence (which might lead to a warning). If this distance decreases to 10 km, the warning is effectively issued stating that the thunderstorm will hit the monitored area. The risk level increases as the CG lightning activity moves to less than 4 km distance.





## RESULTS AND DISCUSSION

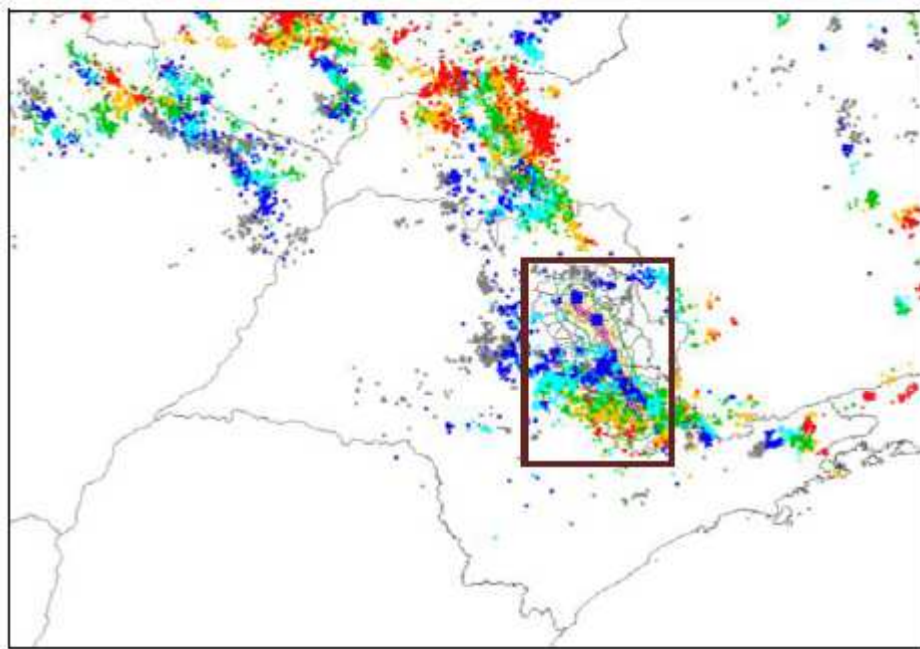
Based on this methodology, it is presented one day in Northeastern São Paulo State which was under the influence of an occluded wave front coupled with the South Atlantic Convergence Zone (SACZ). In this day, it was issued 07 warnings from 20UT (Feb 11<sup>st</sup>) to 02UT (Feb 12<sup>nd</sup>) within the red rectangle



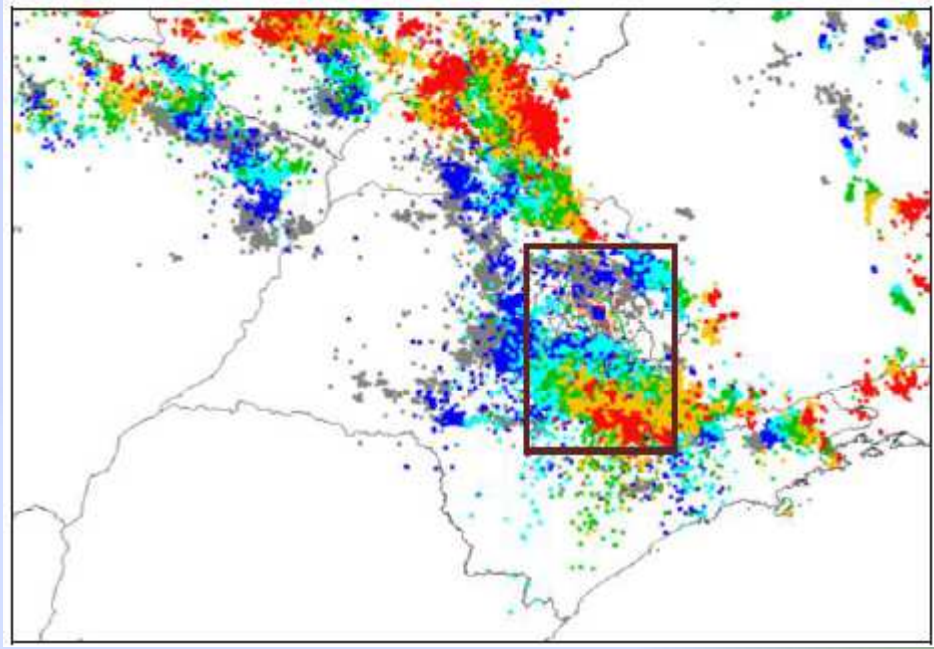




# RESULTS AND DISCUSSION



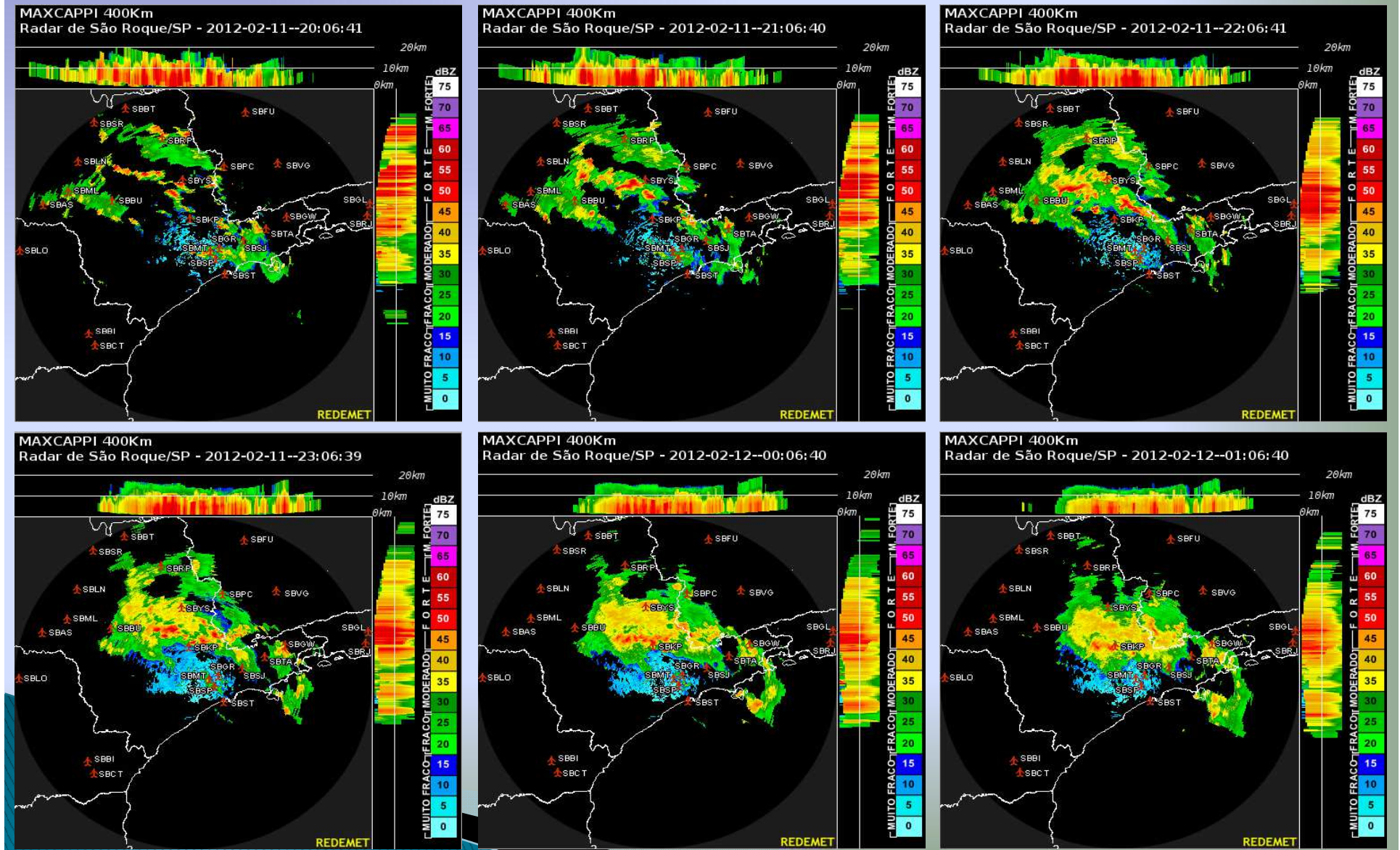
CG lightning activity over the monitored area (the dark rectangle) from 20UT of 11/02 to 02UT of 12/02.



IC discharges activity over the monitored area (dark rectangle) from 20UT of 11/02 to 02UT of 12/02.



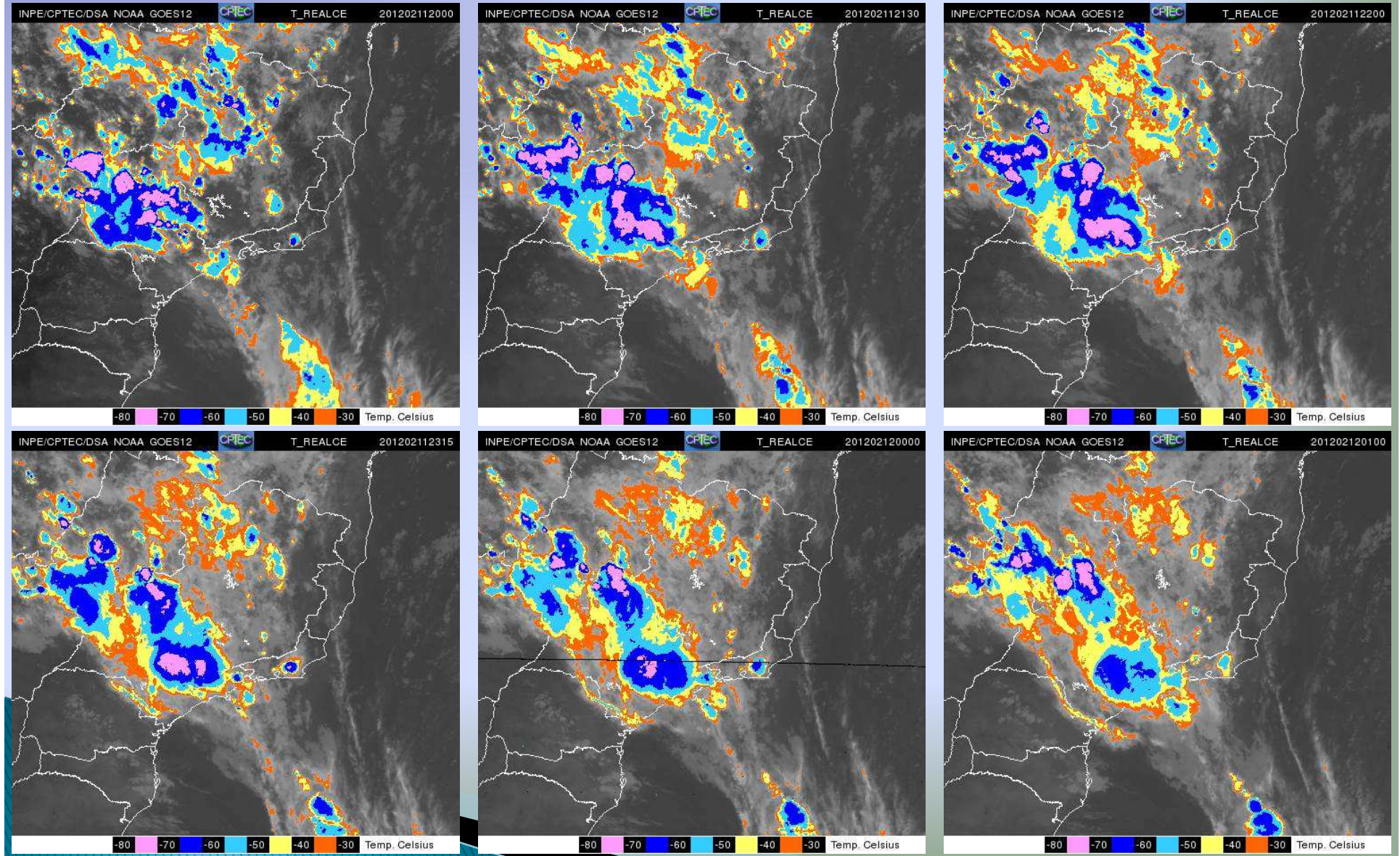
# RESULTS AND DISCUSSION







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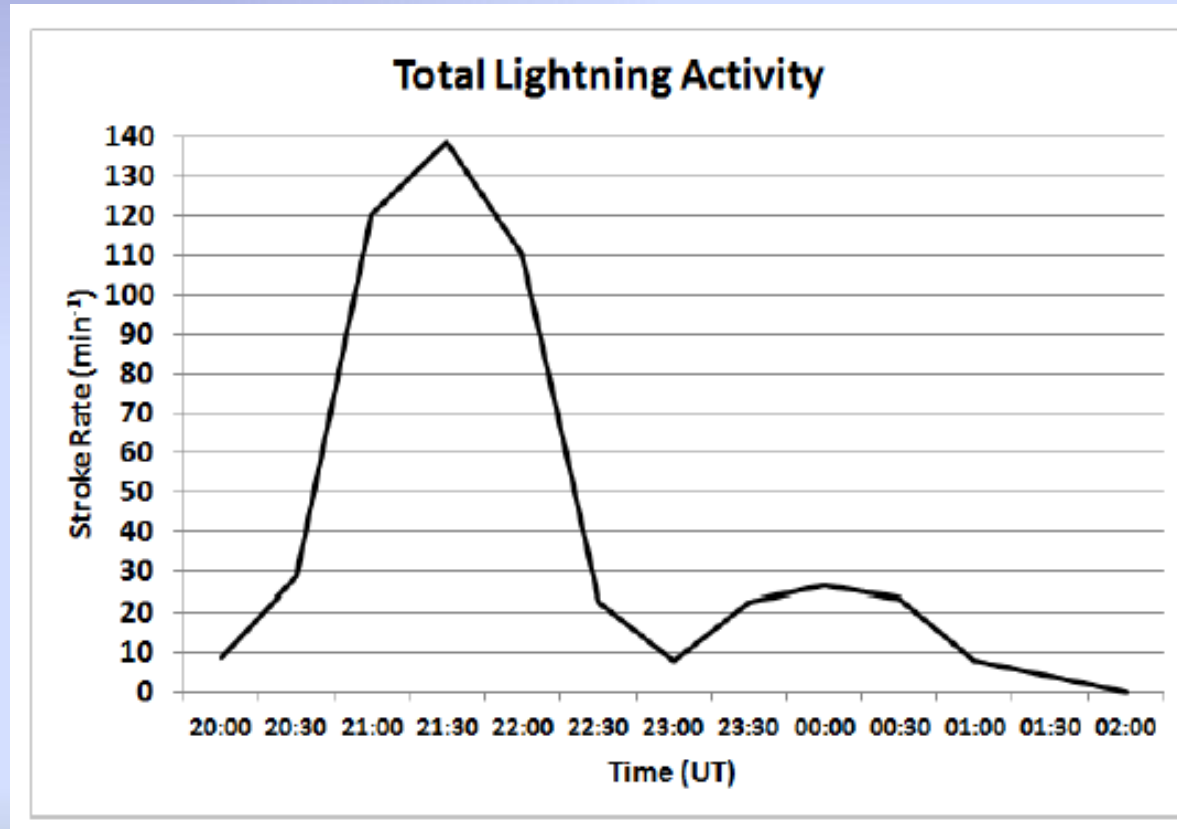






## RESULTS AND DISCUSSION

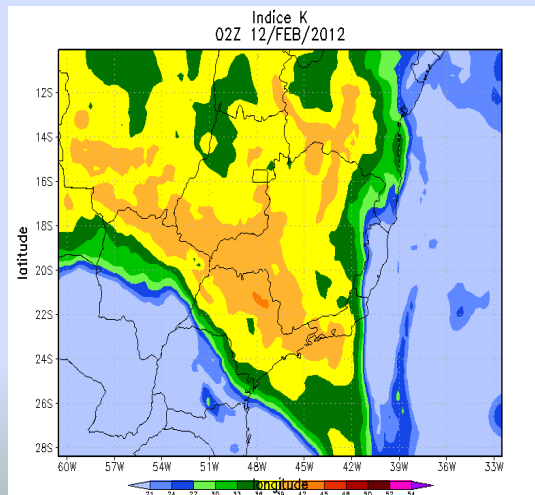
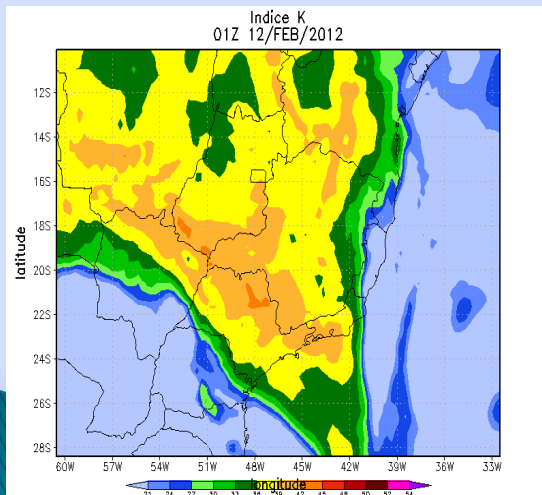
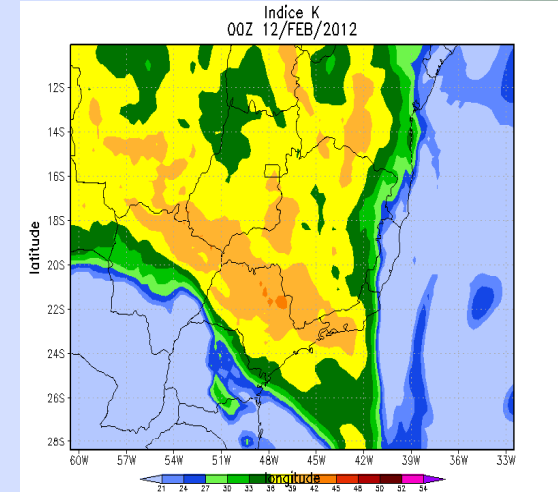
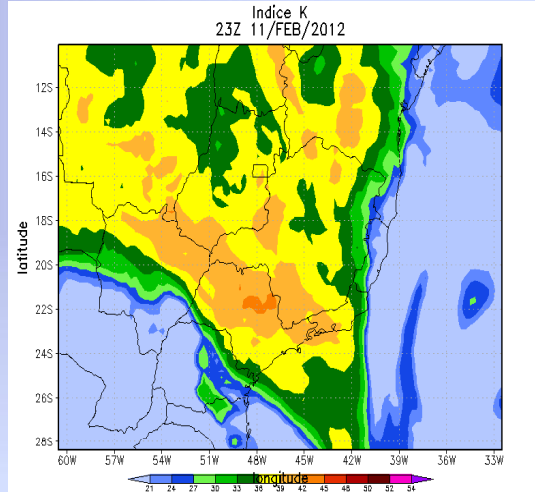
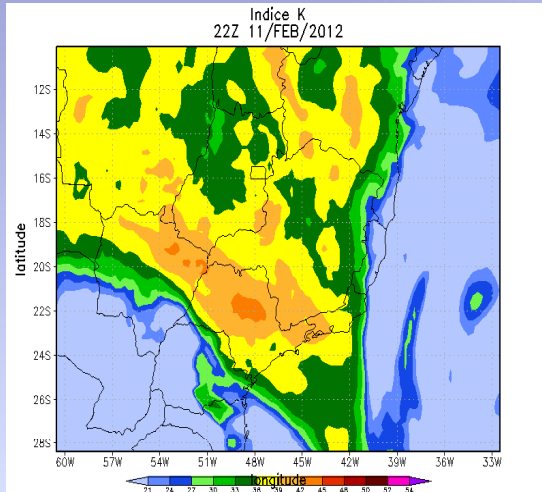
The maximum total lightning activity was observed from 21UT to 22UT. The average leading time for the warnings was about 50 min.



Total lightning stroke rate (min<sup>-1</sup>) as a function of time within the monitored area



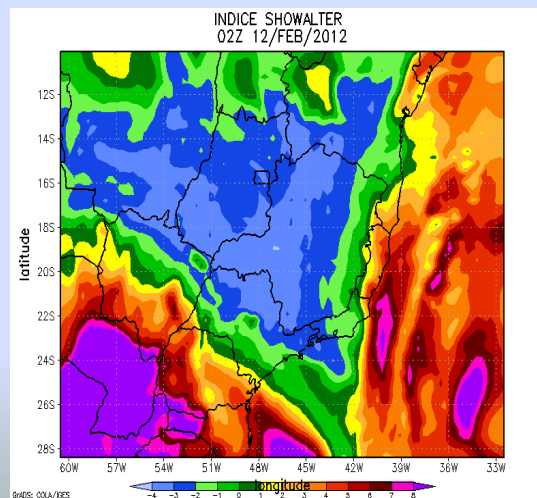
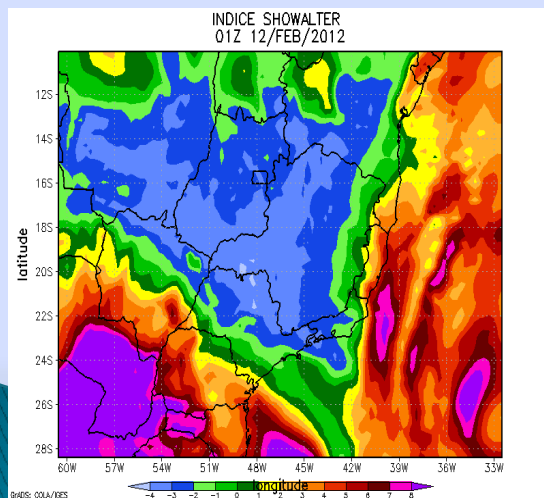
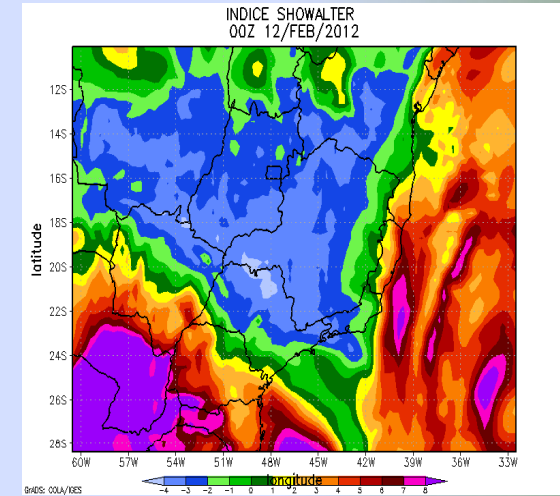
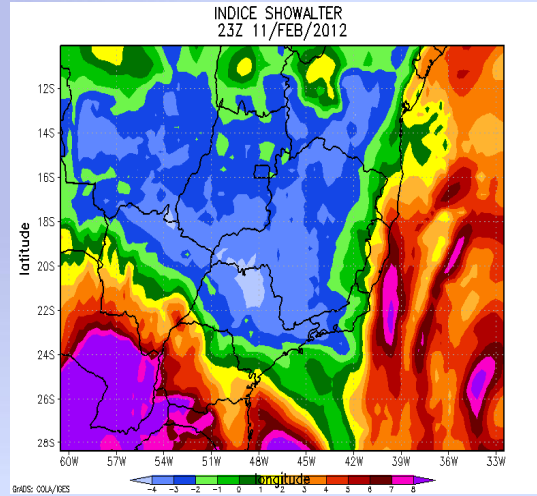
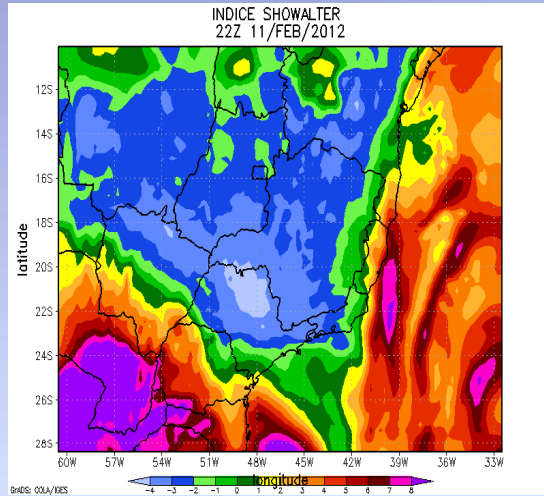
# RESULTS AND DISCUSSION



The K index ranged from 40 to 45 indicating potential for severe weather within the monitored area.



# RESULTS AND DISCUSSION

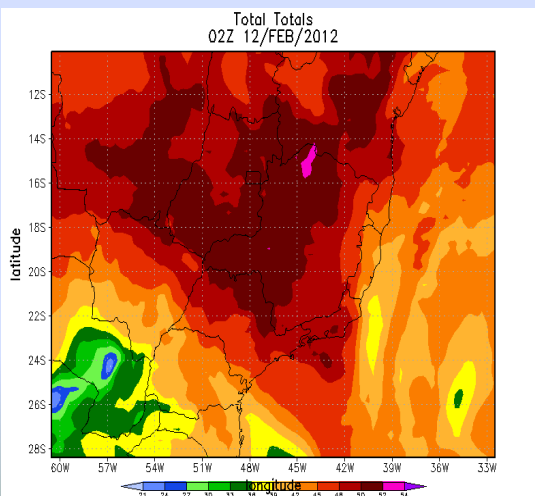
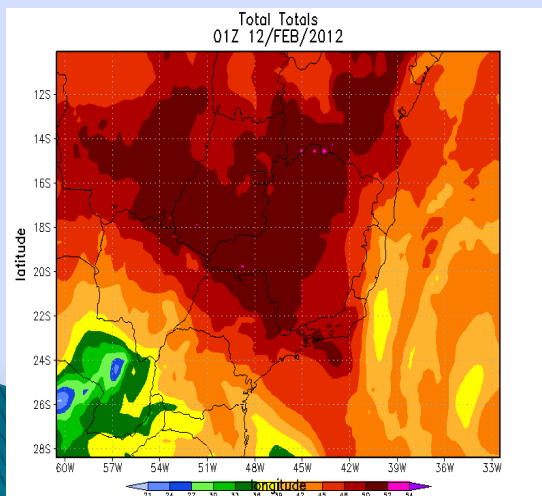
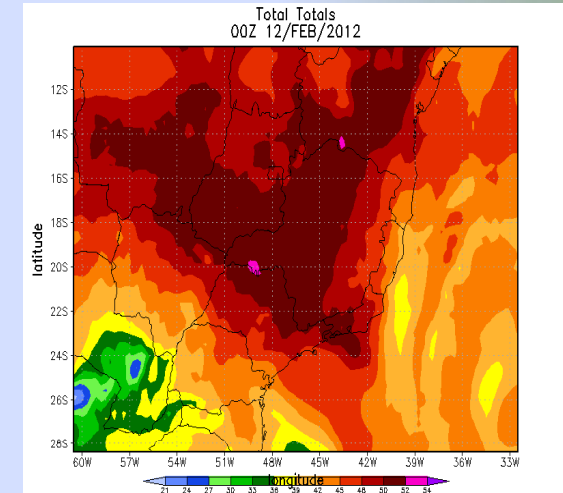
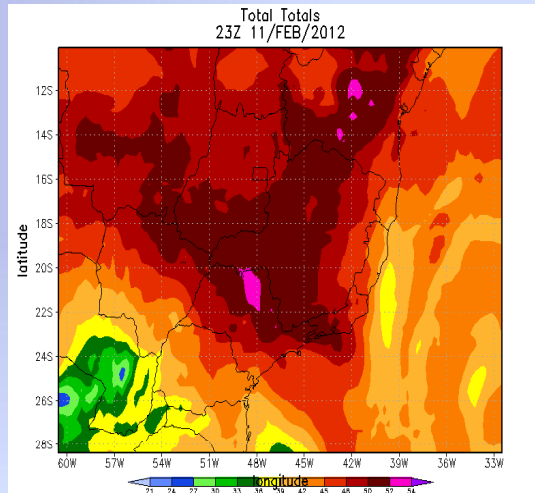
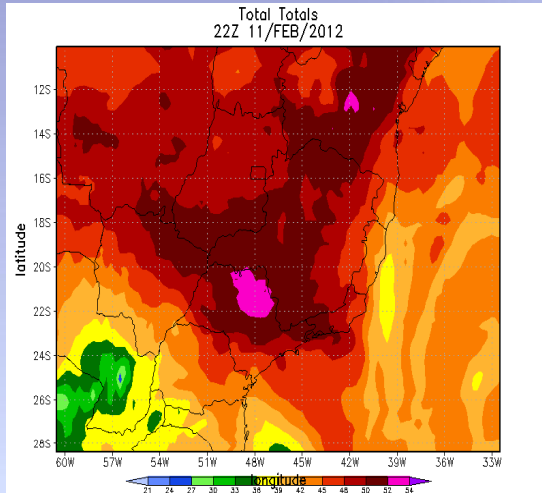


The SW index ranged from  $-3$  to  $-5$  indicating an extremely unstable atmosphere within the monitored area.





# RESULTS AND DISCUSSION



The TT index ranged from 50 to 55 meaning likely storms within the monitored area.



## RESULTS AND DISCUSSION

The satellite and radar images confirmed the high instability showed by the indexes.

High reflectivity values ranging from 35 to 45 dBz were observed at more intense convective areas reaching 55 dBz from 21UT to 01UT in agreement with the increase on the total lightning activity.

Satellite images showed very cold ( $-50$  to  $-70^{\circ}\text{C}$ ) convective areas indicating deep clouds (strong convection).

The SW and TT indexes peaked from 20UT to 00UT while K index values were extremely high throughout all the period.

From radar and satellite images, it can be observed that the maximum convection occur in the south of State of SP while the indexes predicted more intense convection in the northern part. This suggests that the indexes can be better correlated to the location of the thunderstorms genesis. Their movement can then be tracked using radar, satellite and total lightning data combined.



## CONCLUSIONS

This paper presented an alternative methodology for CG lightning nowcasting based on a combination of total lightning data, radar and satellite images and stability indexes provided by the WRF model. It was shown that it is possible to issue warnings with about 1 hour advance using all combined data. All this information is analyzed by a meteorologist who assesses the probability of a thunderstorm to move over the monitored area. The preliminary results showed that the instability indexes roughly indicate the location of the storm formation and the radar and satellite can be used to track its displacement. The next step is to develop a computer-based system capable of automatically issue CG lightning warnings based on predefined thresholds for all information that was studied.





**OBRIGADO**