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

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INTRODUCTION

The Lightning Nowcasting Center (LNC) from ELAT / CCST / INPE have been developing new methodologies to issue cloud-to-ground (CG) lighning alerts for areas smaller than 10 km^2 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, LNC have been using, together to other meteorological dataset, the simulations of the Weather Research and Forecast (WRF). WRF is a regional model, non-hydrostatic developed for operational forecasting and scientific researchs, moreover it is adaptable for different spatial scales from a few meters to thousands miles. 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

Basically the methodology consists to analyze of instability indices K, TT and SW provided by WRF, the radar reflectivity and infrared brightness temperature together with the total lightning activity detected by the new Brazilian Total Lightning Network (BTLN) to decide of issuing 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 thresholds analyzed and assessed by the meteorologists.

RESULTS AND DISCUSSION

When the CG lightning incidence is located less than 20km from the monitored area, the meteorologist starts 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 efectivelly 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. Based on this methodology, it was studied one day in Northeastern São Paulo which was under the influence of a wave front occluded coupled with the Convergence Zone South Atlantic (CZSA). In this day, it was issued 07 warnings from 20UT (Feb 11st) to 02UT (Feb 12nd). The maximum total lightning activity was observed from 21UT to 22UT (Figure 1). The average time in advance of the warning was about 50 min.

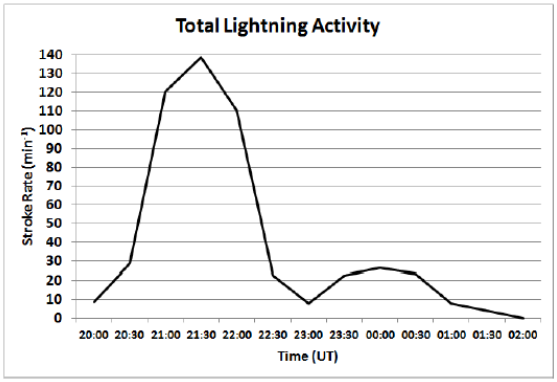

Figure 1 - Total lightning stroke rate (min^{-1}) as a function of time.

The atmospheric instability was high between 20 UT and 02 UT as shown by the SW index (-3 to -5) indicating an

extremely unstable atmosphere. The K index K ranged from 40 to 45 indicating potential for severe weather. The TT index ranged from 50 to 55 meaning likely storms. The satellite and radar images confirmed the high instability showed by the indexes as shown in Figures 3 and 4. High reflectivity values ranging from 35 to 45 dBz were observed at more intense convective areas reaching 55 dBz from 21UT to 01UT. Satellite images showed very cold (-50 to -70°C) convective areas indicating very deep clouds.

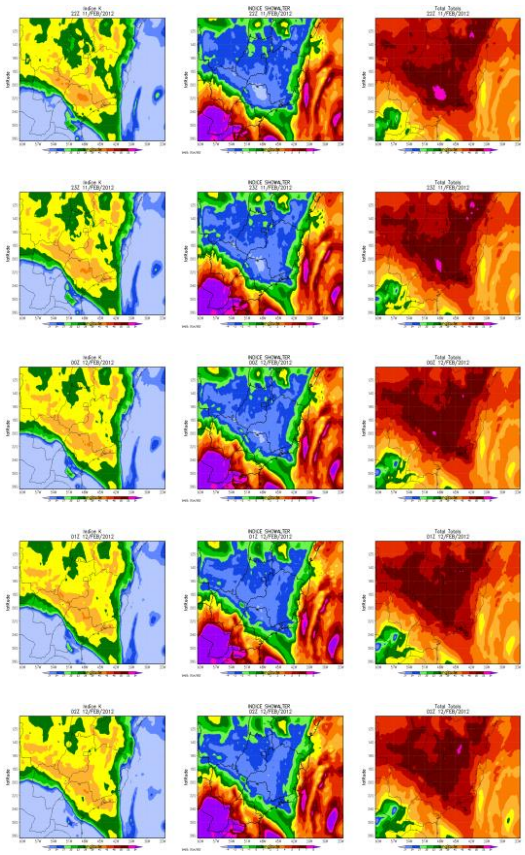

Figure 2 - Indices of instability K, SW and TT produced by WRF between 20UT (Feb 11st) to 02UT (Feb 12nd).

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 be then tracked by radar and satellite.

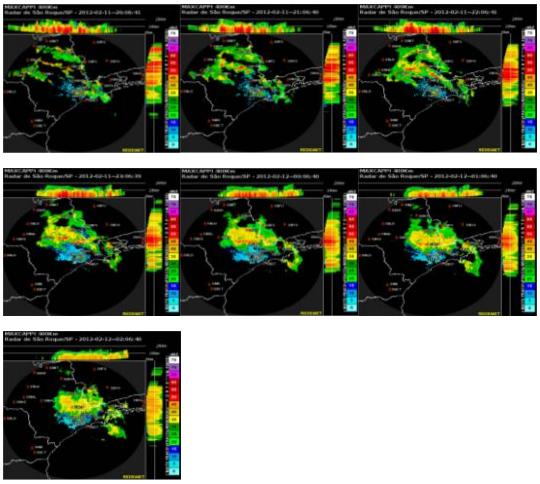

Figure 3 - MAXCAPPI 400km images from São Roque Radar in SP State.

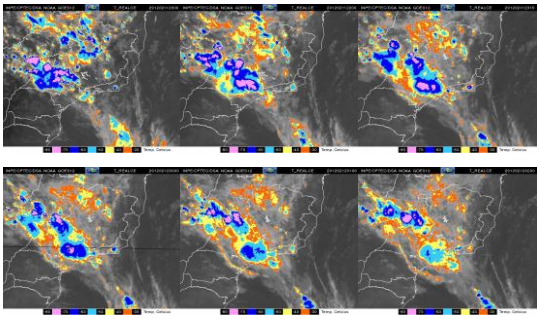

Figure 4 - Brightness temperature images from GOES 12 Weather Satellite.

CONCLUSIONS

This paper presented a alternative methodology for CG lightning nowcasting based on the combination of multiple data sources, including numerical mesoescale model outputs. It was shown that it is possible to issue warnings with about 1 hour advance using a combination of total lightning data, radar and satellite images and instability indexes provided by the WRF model. 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 roughtly 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 parameters.