The Use of Satellite Data for Nowcasting: The ForTraCC Technique

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(April 12, 2007)

I. INTRODUCTION

This study presents the ForTraCC (Forecasting and Tracking of Cloud Cluster) technique using satellite data. ForTraCC is an algorithm for tracking and forecast the physical characteristic of mesoscale convective systems (MCSs) through its whole life cycle using the thermal channel information (10.8 µm) of geostationary. The cloud cluster detection method is based on a threshold temperature; the morphological and radiative parameters of each MCS are evaluated and tracking trough the life cycle based on overlapping areas of MCSs in successive images. The forecast is built taking into account the life cycle history of each MCS, generating a virtual image for the next 120 minutes. The extrapolation is based on the possible displacement of MCS (considering the position of the center of mass of the cloud cluster in previous time steps) and its size evolution. The ForTraCC technique using GOES 12 data is an operational tool available on line

Machado and Laurent (2004) and Vila and Machado (2004) have introduce the basis for the ForTraCC. This extrapolation model uses satellite images to track and forecast mesoscale cloud organization. ForTraCC is an operational model, running at CPTEC and available on line at the CPTEC in the following web URL

http://moingatu.cptec.inpe.br/paginas/fortracc/fortracc.php.

ForTraCC uses GOES 10 Images, each 15 minutes, to produce extrapolation up to 120 minutes.

The objective of this study is to present the ForTraCC models.

II. THE FORTRACC MODEL

The ForTraCC technique is an algorithm that allows to track the MCS radiative and morphological properties and forecast the evolution of these physical properties (based on cloud top brightness temperature) up to 120 minutes, using infrared satellite imagery (10.8 µm).

The main steps of this algorithm are the following ones: (1) a cloud cluster detection method based on a size and temperature threshold; (2) a statistical module to perform morphological and radiative parameters of each MCS; (3) a tracking technique based on MCS overlapping areas between successive images; and (4) a forecast module based on MCS evolution in previous time steps. Vila et al. (2007) describe in detail the ForTraCC methodology and performance.

The brightness temperature threshold of 235 K has been chosen for MCS detection because this threshold seems to be suitable to detect clouds associated with convection in different regions of South America as suggested by Laurent et al. (2002) and Machado and Laurent (2004).

MCS identification process is carried out defining regions of contiguous pixels that fulfill the minimum size and temperature threshold. The tracking methodology is based on the tracking algorithm presented in Mathon and Laurent (2001). Tracking of convective clouds is based on area overlap method. This technique simply assumes that a cloud at a later time correspond to those at an earlier time when, there are common pixels in consecutive images. When several MCS overlap, the larger surface overlapping pair of MCS is chosen to continue the MCS life cycle. The others MCSs are considered as dissipated by merge. The methodology used to forecast the trajectory is based in the MCS vector displacement, estimated as the former displacement of the center of mass. If the first time the MCS is detected the displacement is considered equal of the neighbors. The forecast of life cycle phase (growth / decay) of a given MCS is based in the normalized area expansion typical of the MCS growing rate climatologically observed.

The area expansion rate is simply the normalized difference of the system area between two successive images (Machado et al., 1998). The area expansion is closely linked to the phase of the convective system life. The magnitude of the area expansion may be a good indicator to monitor the convective activity of the convective system, acting as a proxy to quantify the mass flux or the condensation rate inside the convective system.

Figure 1 shows an example of the ForTraCC web page and outputs. The web page can be used selecting a specific MCS by just clicking over the MCS image. A new page will be opened presenting many information about this selected MCS. This new page shows the time evolution of Convective fraction, the relationship between 210K area and 235K area, the Minimum Brightness temperature and the MCS area. The last three dots of each figure correspond to the forecast. This information is important because the forecaster can evaluate the behavior of the MCS during its life cycle.

III. FORTRACC COMBINED WITH LIGHTNING

The RINDAT is a lightning ground network covering the south and southeast part of Brazil. The lightning data is here combined with MCS lifecycle adding information about the number of lightning occurrences due to the MCS in the last 30 minutes. The possibility of describe the actual number of lightning and the time evolution of lightning combined with the area expansion and minimum brightness temperature is very useful for nowcasting. A statistical study was performed using data from two summer months. The results showed that the Ae (area expansion) is an important tool to forecast the probability of lightning activity. For instance, when Ae is larger than 200.10^{-6}/s there is 25% of probability to have lightning activity and when Ae is smaller than -200.10^{-6}/s this probability is smaller than 5%. The integrated product can be seen at the following web Pag

http://satelite.cptec.inpe.br/htmldocs/raio/desc_elet_nova.htm

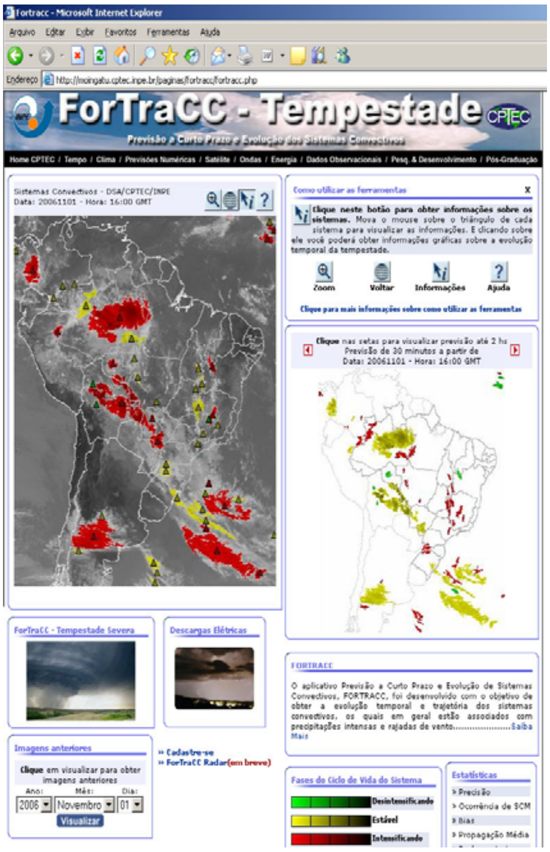

Figure 1 – Example of the ForTraCC web page (http://moingatu.cptec.inpe.br/paginas/fortracc/fortracc.php)

IV. SEVERE STORM TRACKING

The relationship between electric discharges and penetrative clouds was studied. The data used in this study were: Infra-Red (IR) and Water Vapor (WV) channels of the geostationary satellite GOES-12 data and lightning data supplied for RINDAT. The difference between WV and IR is a tracer of deep convection, because the strong absorption of the water vapor channel, this difference is positive only for over shooting cases. From the WV-IR difference and the electric activity of clouds was possible to adjusted an exponential curve that relates WV-IR difference with probability of occurrence of electric discharges, with a coefficient of determination of 0,9847. Through this process, we can estimation the probability of occurrence of lightning in all South America. The threshold of WV-IR>-2, corresponding to the probability of 10% to have lighting activity is used in the ForTracc to follow the more severe storm. This nowcasting tool can be seen in the following web page:
http://moingatu.cptec.inpe.br/paginas/fortracc/vapor.php

V. CONCLUSION

This study describes a methodology called ForTraCC to track and forecast the displacement and size of convective system using satellite. This technique was combined with lightning information showing some parameters that can be used to forecast the lightning activity, The Area expansion showed to be a very useful tool to forecast the vigor and lightning activity in the next hours.

VI. ACKNOWLEDGEMENTS

We acknowledge the Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq – Process number: 304631/2003-5

VII. REFERENCES

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