WEATHER RADAR AND LIGHTNING OBSERVATIONS OF MESOSCALE CONVECTIVE SYSTEMS IN THE SOUTH OF BRAZIL

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ABSTRACT

This paper presents results of an analysis of 10 years of radar and lightning data, with the study of radar and electrical characteristics of mesoscale convective systems, considering relationships between the environment where those storms occurred and hydrometeorological observations from Doppler weather radar, lightning detection system and surface observations. The objective of this study is to better understand the evolution of these storms as they occur in this area in order to improve our abilities of analysis and forecast of severe weather events.

1. INTRODUCTION

In South America, southern parts of Brazil and northeastern Argentina are regions particularly prone to severe weather events (high lightning activity, intense precipitation, hail, flash floods, strong winds and occasional tornadoes). Most of the precipitation is associated with extra-tropical cyclones, mesoscale convective systems (MCSs), upper level jets and frontal systems. However, MCSs are responsible for a significant amount of the precipitation and severe weather which occur in this area, mainly during spring and summer.

In the south of Brazil, agricultural industry and electrical power generation are the main economic activities, and the region is responsible for 35% of all hydro-power energy production in the country, with long transmission lines to the main consumer regions which are severely affected by these extreme weather conditions. In this region, MCSs play an important role on the hydrological cycle and the incidence of severe weather events, highlighting the importance of improving the knowledge of those weather systems and also improving the forecast skills.

2. DATA AND METHODOLOGY

To characterize and evaluate the weather events in the region, a hydrometeorological observation system, comprising a network of automatic weather statins, a S-Band Doppler weather radar, lightning detection and location network, and satellite informa-tion, with the location and distribution of the system presented in Figure 1. In the analysis presented here, weather radar and lightning data information from the period of January 2001 to December 2010 was used.

In order to objectively identify the MCSs while in the radar area (200k range), after a quality control and interpolation of raw data, a convective-stratiform classification algo-rithm was developed (Biggerstaff and Listemaa 2000; Zhang and Qi 2010), using a threshold of VIL (Vertically Integrated Liquid) to sepa-rate the convective and stratiform precipitation areas within the radar coverage. For each cluster, using a PCA algorithm, ellipses were adjusted to the clusters in order to separate events with a minimum of 100km horizontal scale. Figure 2 presents an example of this convective-stratiform classification algorithm.

3. RESULTS

For each MCS identified, radar and cloud-to-ground lightning were analysed, specially vertical reflectivity profile and isothermal reflectivity, VIL, lightning flash rate and other characteristics.

The daily cycle of MCS occurrence in the radar area indicates a strong diurnal cycle with most of the events occurring late in the afternoon, and this is the same for the electrical activity in the region, as presented in Figure 3. The annual cycle , not presented here, indicates more organized MCS during spring and summer, as already observed in other studies.

An analysis of the mean vertical reflectivity profile, for the convective area, indicate the strong electrification processes occuring during the MCS life, specially considering observations of reflectivity around the 30dBZ well above the mixed-phase layer in the storms (around -10°C and -40°C) as indicated in Figure 4, for MCS observed with this radar. Another interesting feature, which should be investigated further, is the distribution of 40dBZ reflectivity levels above the -0°C to be used as indicative for lightning and hail with the storms (Liu et al 2012).

4. CONCLUSIONS

The present work shows some results of radar and lightning data analysis regarding the occurrence of mesoscale convective systems in the south of Brazil. With the pursuit of further improvement in the analysis of a long series of radar and lightning data, in conjunction with synoptical analysis such as with the use of numerical prediction systems, we expect to have a better understanding and improvement of our abilities to forecast these storms with strong precipitation and lightning.

REFERENCE

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Liu C., Cecil D. J., Zipser E., Kronfeld K., Robertson R., 2012: Relationships between lightning flash rates and radar reflectivity vertical structures in thunderstorms over the tropics and subtropics. J. Geo. Res., in press.

Zhang J., Qi Y., 2010: A real-time algorithm for the correction of brightband effects in radar-derived QPE. J. Hydromet., 11.

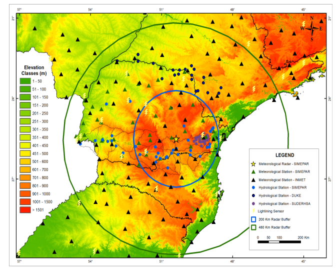

Figure 1: Hydrometeorological monitoring system infrastructure in the south of Brazil.

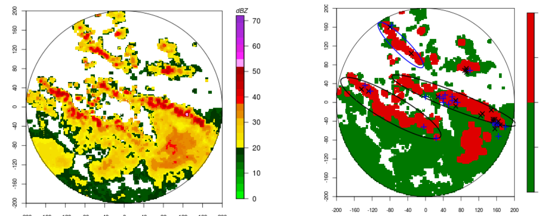

Figure 2: Example of MCS idenfication and convective-stratiform classification algorithm.

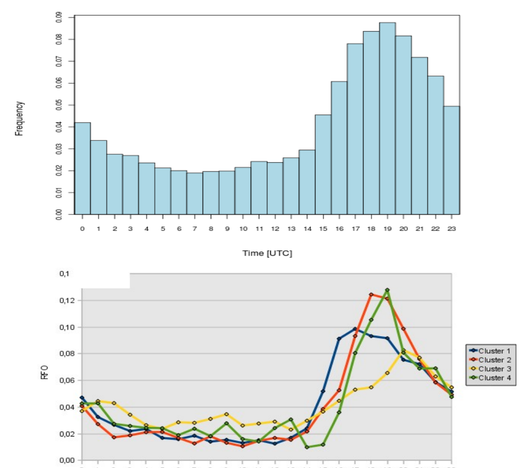

Figure 3: Diurnal cycle of MCS from radar observatins (top) and lightning (bottom).

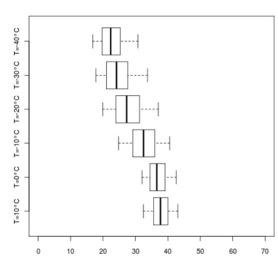

Figure 4: Box-Whisker plot of MCS maximum reflectivity for each isothermal layer, in the convective region of the cluster.