SEVERE WINTER STORMS OVER THE WESTERN AND CENTRAL STATE OF SÃO PAULO, BRAZIL

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I. INTRODUCTION

The State of São Paulo is situated in the south-eastern region of Brazil and is, in general, characterized by summer rain and relatively dry winter months. The region is under the influence of both tropical and mid-latitude, large-scale synoptic systems. Severe thunderstorms can occur at any time of the year, although they are less frequent during the dry winter months. Most of the significant weather occurs between October and March, when the supply of solar energy and humidity is greatest, but severe winter storms, usually associated with baroclinic systems, do occur within the range of IPMet´s two S-band Doppler radars, which covers most of the State of São Paulo. This study presents an analysis of the anomalous winter storms during July 2007, which have produced considerable damage over parts of the State, as well as a precipitation field in excess of 300 mm over its central and western regions. A case study for 24 July 2007 is presented, focusing on the storm properties related to the hail-producing cells and the hail metrics parameters of the NCAR software TITAN (Thunderstorm Identification, Tracking, Analysis and Nowcasting; Dixon and Wiener, 1993). The data used for the analysis were from IPMet´s two Doppler radars located at Bauru (Lat: 22°21.5' S, Lon: 49°1.7' W, 624 m amsl) and Presidente Prudente (Lat: 22°10.5' S, Lon: 51°22.5'W, 420 m amsl), respectively (Figure 1). The main characteristics of both radars are: 2° beam width, 450 km range for surveillance mode and 240 km in volume scan mode, with 16 elevations (0.3° to 45°), 250 m radial and 1° azimuthal resolution, and a temporal resolution of 15 minutes or less, recording and archiving reflectivity, radial velocity and spectral width.

FIG. 1**:** Doppler radar network of IPMet (BRU = Bauru; PPR = Presidente Prudente), showing the 240 and 450 km range rings.

II. PRESENTATION OF RESEARCH

The TITAN system in ARCHIVE mode was deployed and tracking properties form the base for the analysis presented here. A TITAN cell was defined by the 40 dBZ threshold for the reflectivity and 50 km^3 for the volume, observed at least in two volume scans (15 minutes). The total rain field observed by IPMet´s radars for July 2007 was obtained using the climatological module of TITAN that computes geographically-distributed statistics from TITAN storm and track files. The TrackGridStats application has produced analyses of storm tracks for all periods with storm activity during July 2007. To derive the spatial distribution of storm precipitation and storm duration during July 2007, the storm areas were defined by the 25 dBZ reflectivity threshold, and all identified areas that exceeded the adopted threshold within the quantitative range of both radars, were considered.

III. RESULTS AND CONCLUSIONS

Synoptic Overview for July 2007

During July 2007, at least seven transient systems were observed over Brazil and five of these systems were frontal waves that had originated in the south and southeast regions (CPTEC, 2009), producing some of the very favorable large-scale environments, such as frontal systems and high-level cyclonic vortices that were all enhanced and have generated the extreme events observed in the State of São Paulo. An anomalous precipitation field between 200 and 300 mm above the expected mean over the central and western regions of the State was observed (Figure 2), changing completely the spatial distribution of rainfall for this relatively dry month, which is characterized by average rainfall within a range of 20 to 30mm for most of the State of São Paulo, except in the south and costal areas.

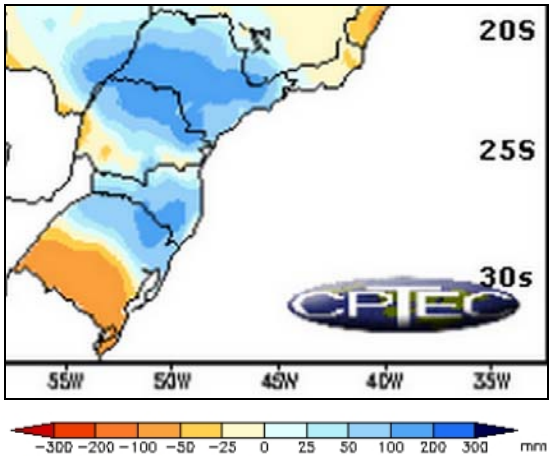

FIG 2: Precipitation anomaly for July 2007. Modified from CPTEC (2009), available at www.cptec.inpe.br.

Radar Rainfall for July 2007

The rainfall distribution for July 2007, obtained from radar data deploying the well known Marshall-Palmer (MP) equation for the Z-R relationship, is shown in Figure 3, where the major accumulation, in excess of 200 mm, located in the central and western parts of the State of São Paulo, is in good agreement with the results given by the observed surface rainfall, shown in Figure 2. Similar results were obtained from the analysis of the spatial distribution of storm duration for July 2007, highlighting areas where storms occurred for up to >15 hours during this period, as shown in Figure 4.

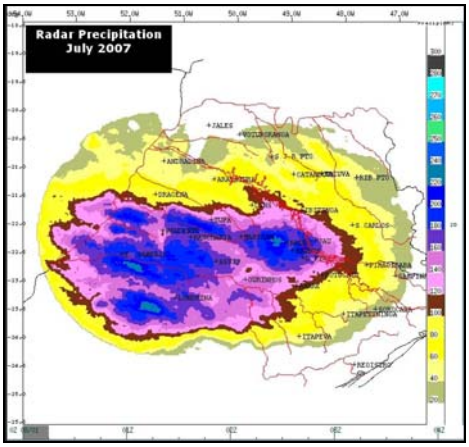

FIG 3: Storm precipitation distribution using composite reflectivity from both IPMet radars during July 2007.

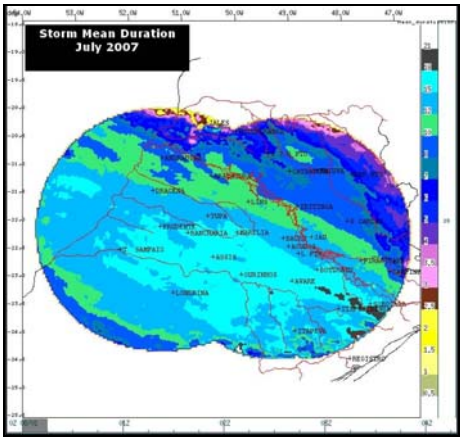

FIG 4: Storm duration distribution using composite reflectivity from both IPMet radars during July 2007.

The spatial distribution of storm duration shows that in the central and western parts of the State, storms with durations of 12 to 15 hours were traversing the region, contributing to the observed anomalous rainfall during July 2007. Such information, making use of the meteorological radars in the State of São Paulo and now available from TITAN, is very useful for agriculture and water planning purposes. Severe thunderstorms are a significant threat throughout the State of São Paulo, frequently causing extreme damage to agriculture, industry and property, including the occasional loss of lives. During the 2007 winter season, extensive damages to agriculture and property, caused by hailstorms observed mainly in the central areas of the State, were reported by newspapers, TV, etc.

Hail Event of 24 July 2007

Figure 5 shows the full tracks defined by the 40 dBZ reflectivity threshold on 24 July made by hailstorms that swept the northern areas of the State, causing extensive damage to orange plantations and resulting in a loss of 30% of the production, with direct implications for the coming year´s harvest according to farmers of these particular regions. Figures 6a and 6b show a severe cell structure, represented by the SSS index (Visser, 2001) and its forecast for the next 30 minutes, when the storm was to reach the rural area of Taiuva town. The hailstorm had resulted in severe damage to the local agricultural community.

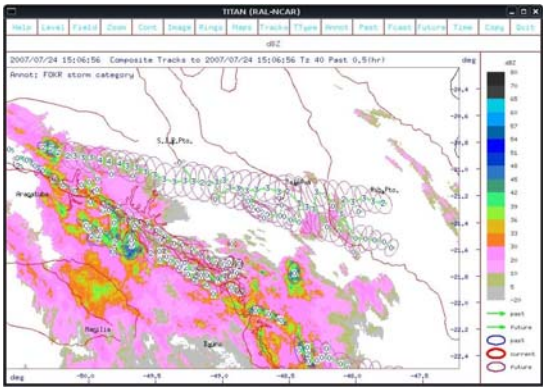

FIG 5: Storm track (light-green) showing cells that have produced severe hail during the 24 July 2007 event.

Many other places located within the path of this forecast track area have also reported hail on this day. TITAN with its built in algorithms that allow identification of potential severe storm “signatures” is certainly an important tool to be deployed in operational warning centers.

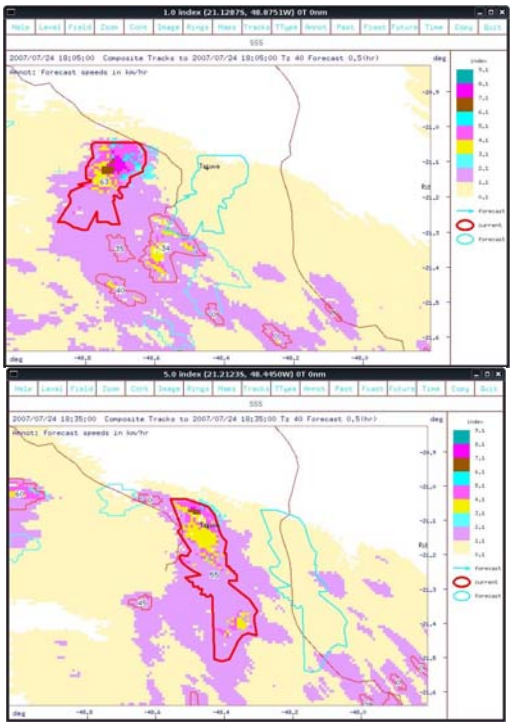

FIG 6: SSS index distribution for 15:05 LT (a) and the forecast for 15:35 LT (b) when hail was confirmed in the Taiuva rural area during the 24 July 2007 event.

IV. ACKNOWLEDGMENTS

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V. REFERENCES

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