

# ANALYSIS AND VALIDATION OF SEVERE STORM PARAMETERS DERIVED FROM TITAN IN SOUTHEAST BRAZIL



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## INTRODUCTION

The State of São Paulo is situated in the south-eastern region of Brazil and is under the influence of both tropical and mid-latitude, large-scale synoptic systems. Convective activity is mostly concentrated during the summer period, where most of significant weather occurs between October and March. The severe storms are a significant threat and certainly can cause enormous damage to agriculture, urban areas, industries and the loss of many lives, due to strong winds - including tornadoes, hail, lightning and intense floods. The Meteorological Research Institute (IPMet) of the UNESP has been monitoring the three-dimensional structure of thunderstorms since 1992 and 1994, respectively, using two S-band Doppler radars in the central and western part of the State of São Paulo. One of the tools used presently for monitoring and warning of storm systems is the latest version of NCAR's (National Center for Atmospheric Research) TITAN (Thunderstorm Identification Tracking Analysis and Nowcasting) Software, which had been implemented at IPMet and adapted for local requirements. A research version, in *Archive mode* is deployed for post-fact analysis.

## IPMET'S RADAR CHARACTERISTICS



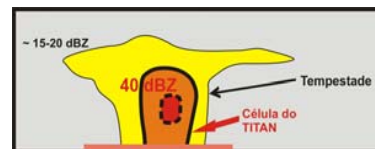
The main characteristics of both radars are: 2° beam width, 450 km range for surveillance mode and 240 km in volume scan mode, with 16 elevations (0.3° to 45°), 250 m radial and 1° azimuthal resolution, and a temporal resolution of 15 minutes or less, recording and archiving reflectivity, radial velocity and spectral width.

## OBJECTIVES

- To verify the potential of the new tools available with the TITAN system and to also utilize the hail reports received from voluntary hail observers to cross-check the occurrence of hail within the radar surveillance areas against the TITAN predictions.
- To determine "signatures" in severe events producing hail and therefore, as from 2008, to use an online standard form, allowing for greater detail on the occurrence of a severe event within the surveillance area of both radars.

## DATA USED IN THIS STUDY

- Volume Scans from Bauru radar (BRU), covering a quantitative 240 km range, generated every 7.5 min,
- TITAN system is used to identify and track the cells by setting a minimum area threshold of 16 km<sup>2</sup> and a reflectivity threshold of 40 dBZ, observed at least in two volume scans (15 minutes),
- The Hail Report sent by the Voluntary Observer was used as from October 2008 to October 2013 to process all available information about storm characteristics, such as: onset time, duration and size of hail.

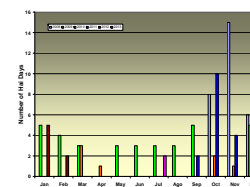
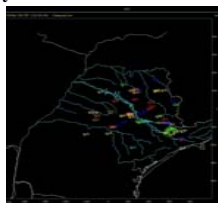


Schematic representation of a TITAN cell.

Hail Report available on IPMet's Website to be completed by the Voluntary Observers.  
[http://www.ipmet.unesp.br/index2.php?menu\\_esq1=&abre-ipmet\\_html/granizo/texto\\_granizo.html](http://www.ipmet.unesp.br/index2.php?menu_esq1=&abre-ipmet_html/granizo/texto_granizo.html)

## SEVERE STORM PARAMETER

- TITAN can identify multiple storms and from that is possible to extract a detailed information;
- The indices relating to hail metrics, such as probability of hail (POH), the FOKR index and the mass of accumulated ice aloft (HMA) were calculated;
- Sudden drop of these indices were used to identify a signature of the potential cell severity for which hail fall was confirmed on ground by the voluntary observers.



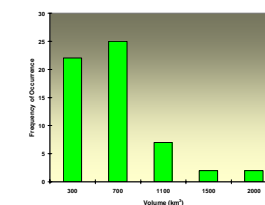
Spatial and temporal distribution of hailfall events, as documented by the Hail Observer Network during the period from October 2008 to October 2013.

## Acknowledgments

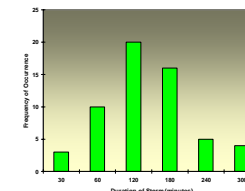
The authors would like to thank J. M. Kokitsu for the implementation of TITAN routines used in the analysis and Drs J. Wilson and M. Dixon of NCAR for facilitating the implementation of TITAN at IPMet/UNESP.

## RESULTS

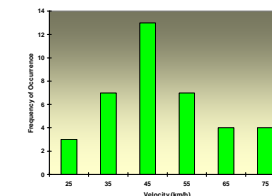
### HAILSTORM PROPERTIES



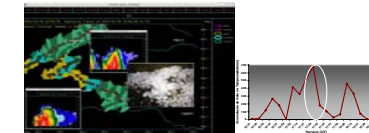
Frequency distribution of the Mean Volume for hail producing cells during 2008 - 2013.



Frequency distribution of storm duration during 2008-2013.



Frequency distribution of velocity for hail producing cells.



Composite tracks for hail producing cells and vertical cross-sections reaching Rancharia (top) and Cruzalia (bottom) on 05/01/2012 at 14:51 LT (local time). The third insert demonstrates the hailstones collected at Rancharia with its HMA values shown at the right.

## FINAL REMARKS

- The results have demonstrated the great potential of TITAN severity indices to support the issuing of severe weather warnings within the 240 km range of the Doppler radars operated by IPMet;
- Hail reports from IPMet's Voluntary Observer Network were used in this study as "ground truth" to validate the occurrence and the onset of hail fall;
- The analysis of the time evolution for the properties of storm cells enabled the identification of the following key signatures for cells producing hail:
  - Mean volume of >300 km<sup>3</sup>;
  - Average speeds of >45 km.h<sup>-1</sup>;
  - FOKR values of 3 and 4 and POH 0,8 and 1, observed at the time as hail reported to have fallen on the ground;
  - HMA (mass of hail accumulated aloft) >200 ktons near the time of the hail observed on the ground;
- The onset time of hail, indicated in the reports, corroborates the time near the observed collapse of the cells, indicated by a sudden decrease of the HMA value obtained by TITAN, in 63% of the cases.
- This study is part of ongoing research and more cases will be added to include not only hail-producing cells, but also those associated with extreme winds and flash floods.