HAILSTORM IN EXTREME SOUTH OF BRAZIL: A CASE STUDY OF JANUARY 2009

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I. INTRODUCTION

Southern Brazil is struck by extreme meteorological events mainly during spring and summer. These systems are generally responsible for several economical and social damages. Recently, many researches such as Ludlan (1980), Nascimento (2005) and Zipzer et. al. (2006) have pointed to the fact that in South America, in the region located between the subtropical latitudes of the South America and the eastern side of the Andes Mountains, presented to potentially favorable conditions to the occurrence of severe storms.

During the early night of 08 January 2009, Salto do Jacuí city, in the northwest part of the state of Rio Grande do Sul (RS), was hit by a hailstorm, which destroyed the roofs of about 80% of the residences in the city, rooting out trees (Figure 1), injuring 20 people and the leaving the small town without electricity for hours. This paper aims at analyzing and describing the atmospheric conditions associated to that event, pointing out the importance of the use of tools of remote sensing as support to the analysis of severe weather.

FIG. 1 – One of the trees which were rooted out by the hailstorm. Source: Renoir Sampaio.

II. DATABASE

For the accomplishment of this study, synoptic maps have been analyzed. These are made by the Centro de Previsão de Tempo e Estudos Climáticos do Instituto Nacional de Pesquisas Espaciais – CPTEC/INPE (http://www.cptec.inpe.br/). Aerologic data of the city of Santa Maria have been used to determine the thermodynamics instability index of the atmosphere. These data are available in the website of the Master USP (www.master.usp).

Aiming at verifying the phase development of the convective system and the associated precipitation, the results of the applicative FORTRACC (Forecasting and Tracking of the Evolution of Cloud Clusters) and Hidroestimador (precipitation estimative by satellite) have been analyzed, respectively. A set of images generated by the meteorological satellite GOES-10, enhanced in infra-red channel, which show the top of clouds temperature have been used, these data was also obtained in the website of the CPTEC/INPE. The images generated by the Radar Doppler located in the city of Santiago, which is made available by Rede de Meteorologia do Comando da Aeronáutica – REDEMET (http://redemet.aer.mil.br), was used with the intention of verifying the intensity of the storm.

III. RESULTS

Through the visual analyzes of the synoptic surface maps on middle and high levels, at 00:00UTC on January 09 (not shown in the Figures), it was observed that southern Brazil was under influence of trough on surface. On the middle levels it was verified that the studied region was dominated by strong winds, and it was possible to observe divergence of the winds in 250hPa, due to the influence of the Subtropical Jet.

Analyzing the thermodynamic profile of the atmosphere for the city of Santa Maria on 08th January 2009, at 12 UTC (Figure 2), the proximity curves of temperature (T) and of temperature of the dew point (T_d), indicate humidity. Silva Dias (2000) has shown that the possibility of formation of severe storm can be observed from the different instability index, for example: Severe Weather Threat (SWEAT), Total Totals (TT), Lifted Index (LI), Showalter (SW) or the K.Index (K). This possibility increases for values of SWEAT > 270, TT > 50, K > 24, LI and SW lower than zero. By the thermodynamic profile verifies the indicative of atmospheric instability, cause: K = 32, LI = -2.7, SWEAT = 280, SW = 0.6 and TT = 47.

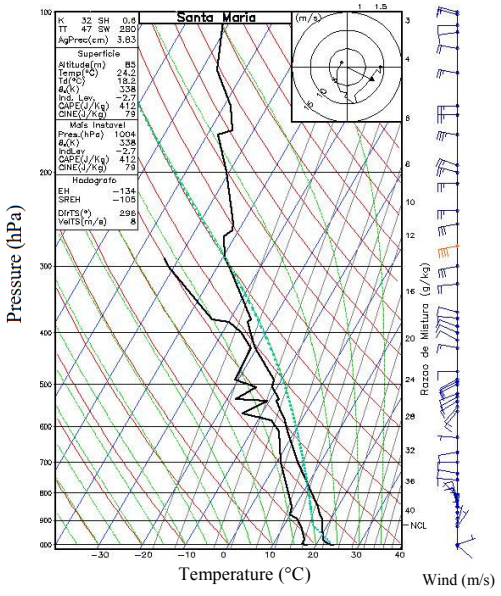

FIG. 2 – Thermodynamic profile of the atmosphere for the city of Santa Maria on January 08, 2009, at 12 UTC.

It is important to mention that the sounding was made in the morning and the hailstorm was registered at the beginning of the night. However, until the moment that the storm occurred, the atmosphere presented high temperatures due to the diurnal heating, contributing for the development of the thermodynamic processes.

Through the analysis of the applicative FORTRACC (Figure 3), it has been seen that the convective system was in stable phase (continuity) of development. In Figure 4, referent to the precipitation estimative by satellite, a convective cell for the maximum 17 mm/h has been observed.

From the satellite image at 21:00 UTC (Figure 5), it is noticed that the system was present in nearly the entire region, cloudiness area with Cloud-Top temperature around -40°C, and in the region where hail was observed it was identified a nucleus with temperature -50°C.

The radar detected cloudiness with points of strong reflectivity, making it possible to observe a nucleus of 65 dBz, above 5 km, where the convective system presented cloudiness with top higher than 10 km, identifying the hailstorm (Figure 6). As observed by Waldvogel et. al. (1979) and Gomes et. al. (2006), hail is always present when the reflectivity of 45 dBz is observed on 1.4 km or higher, above the freezing level. This probability increases when these reflectivities exceed to the threshold of 45 dBz above the freezing level.

IV. CONCLUSIONS

In accordance with the data analyzed in this study, it was concluded that due to the existence of a trough on the surface, strong winds in 500hPa and divergence in 250hPa favored the atmospheric instability, propitiating cloudiness development. By the use of remote sensing tools, these conclusions have responded satisfactorily to the essay's aims.

V. ACKNOWLEDGMENTS

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VI. REFERENCES

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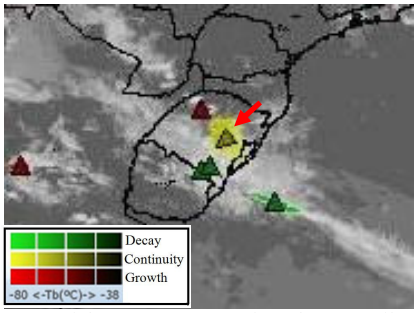

FIG. 3 – Image of the FORTRACC, of southern Brazil, on January 08, 2009, at 21:00 UTC.

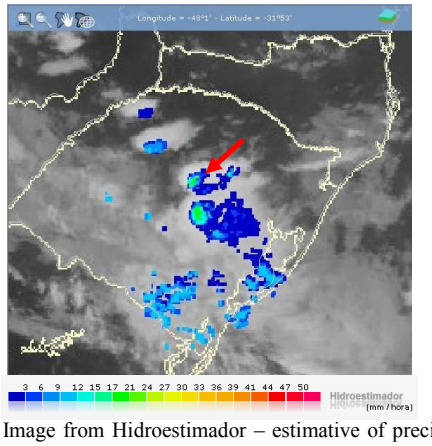

FIG. 4 – Image from Hidroestimador – estimative of precipitation in southern Brazil, on January 08, 2009, at 21:00 UTC.

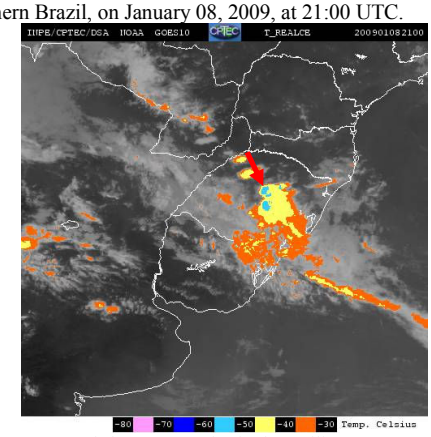

FIG. 5 – Image of the Meteorological satellite Goes-10, enhanced in the infra-red channel, of southern Brazil, on January 08, 2009, at 21:00 UTC.

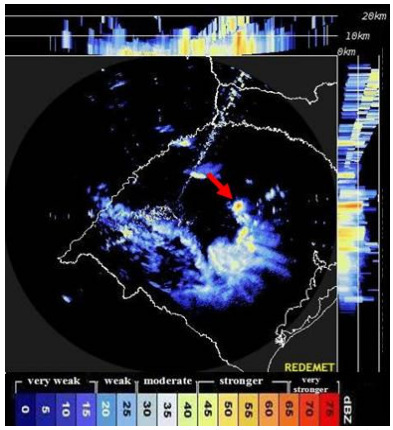

FIG. 6 – Images of the Meteorological radar, located in the city of Santiago, on January 08, 2009, at the 21:00 UTC.