USING MULTISPECTRAL SEVIRI RADIANCES AT THE TOP OF DEEP CONVECTIVE STORM AS A POWERFUL TOOL FOR SHORT PREDICTION IN BRAZIL

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I. INTRODUCTION

The most severe thunderstorms in Southeast Brazil often occur during the summer months (hotter temperatures). With the elevated topography and near the Atlantic coast, all the ingredients help to drive these severe thunderstorms. They carry with them heavy rain, strong winds, hailstones, intense lightning and can cause serious damage to agriculture, industries, loss of many lives, especially when they affect densely populated areas, translating into many million dollar annual loss.

Multispectral satellite analysis has demonstrated its ability to depict cloud top features. The combination of water vapor and infrared window channels to describe deep convective clouds has been mostly used. Schmetz et al. (1997) suggested that positive differences between water vapor and infrared brightness temperature are only possible when deep convective clouds penetrate in the tropopause. Fritz and Laszlo (1993) also noted a brightness temperature from the water vapor channel warmer than from the infrared window channel over a region associated with deep convection. However, Setvák et al. (2008) found some cases that did not agree, and the positive difference was not linked to the minimal temperature.

With the aim of widening the use of multispectral SEVIRI images transmitted by EUMETSAT through the EUMETCast reception station in Brazil (Silva Junior et al. 2009), the meteorologist group of Laboratório de Análise e Processamento de Imagens de Satélite (LAPIS, http://www.lapismet.com/) at the Universidade Federal de Alagas (UFAL), in coolaboration with Turkish State Meteorological Service (TSMS) is assessing the overall performance of METEOSAT images in monitoring and forecasting severe weather condition, who intent to test the hypothesis that the difference between the water vapour and infrared channel can be used as a proxy for penetrative clouds. The validity of this hypothesis was investigated by a severe storm which took place in different areas of the Southeast Brazil on October 24th, 2007.

II. THE 24 OCTOBER 2007 CASE STUDY

Atmospheric conditions on October 24th 2007, wet and unstable air mass occurred over the southern parts of the State of Rio de Janeiro, were favorable for severe thunderstorms. Associated with this, an intense cold front moved southwards from South Brazil, bringing cold and dry air over the Southeast Brazil. Synoptically, the contrast of two completely different air masses was an obvious reason as to why the severe weather event took place at all (Fig. 1). Relating the event to SEVIRI imagery provides a glimpse of the destructive potential destruction the Amazon Basin rainfall monsoon bring along with it, in terms of producing case of severe weather. At 1730Z, the SEVIRI imagery showed signs of developing cells across the Amazon Basin coincident with the rain into an area southeast of Brazil. The cells were relatively sparse, were small in size, and relatively independent from each other, causing rain in separate portions of the Amazon Basin.

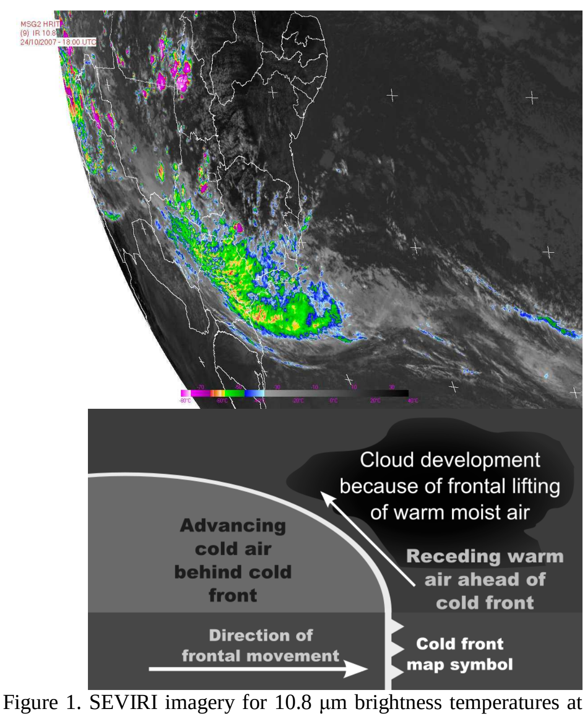

Figure 1. SEVIRI imagery for 10.8 μm brightness temperatures at 1730Z over Brazil and illustration of a cold front. On October 24th at 1730Z.

III. ANALYSIS OF WEATHER OUTBREAK

In investigating the synoptics of this weather outbreak to find physical mechanisms to explain the penetrating clouds from shown in Fig.1, three different sources were employed: Atmospheric vertical soundings from the University of Wyoming's Department of Atmospheric Sciences (Fig. 2); the gridded data for relative vorticity (m/s) field for 200 hPa derived from the NCEP reanalysis data base (Fig. 3); and SEVIRI reflectivity from channels 1 and 2, and Brightness Temperature (BT) from channels 5 and 10 by exploiting the MSGView software from the TSMS (Fig. 4). The physical processes behind these analyses is that 1) clouds were cumulonimbus so they can be considered optically thick; and 2) they were considered blackbodies, and 3) the water vapor and infrared brightness temperature difference can be used as a proxy for deep convection.

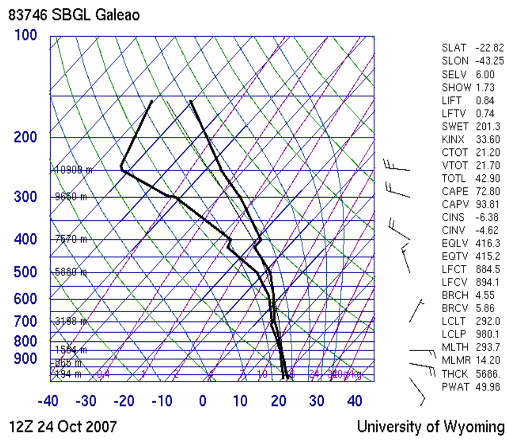

Figure 2. Vertical profile at 12Z taken from Galeão airport in Rio de Janeiro, Brazil.

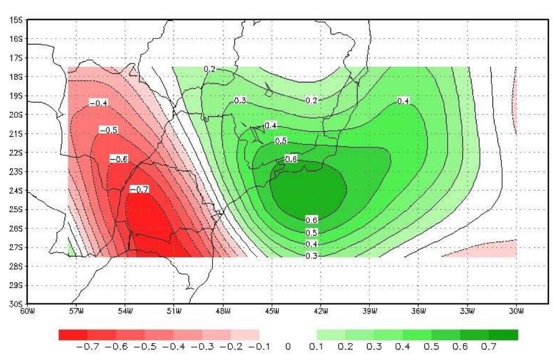

Figure 3. Relative vorticity (m/s) field for 200 hPa derived from the NCEP reanalysis data base (2.5°×2.5° resolution). On October 24th from 18 to 00Z.

IV. SYNOPTIC OVERVIEW

Soundings helped to aid in the investigation of the severe weather, on a local level. At 12Z October 24th, there was a conditionally unstable surface layer at Rio de Janeiro airport, alongside an elevated mixed layer. The elevated mixed layer was capped at around 425mb.The capping of the mixed layer was relatively weak, but the cap was present nonetheless. In investigating the synoptic features, the vorticity field strengthened the turbulent mixing between the in cloud air and its environment, resulting in widespread pre-frontal rainfall over the southern part of the State of Rio de Janeiro. At 1730Z, the SEVIRI water vapor and infrared brightness temperature difference (larger than +2K) showed that the steering level continued to affect the cumulus cloud (Fig. 4), leading to further convergence of the thunderstorm cells.

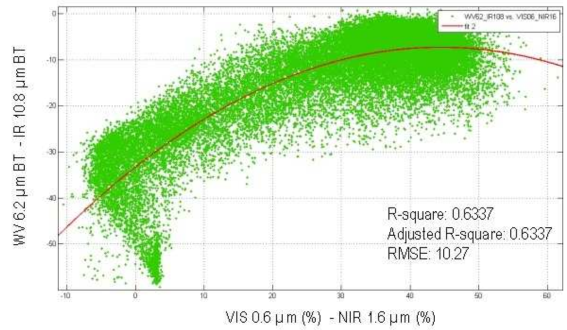

Figure 4. Adjusted a logarithmical curve for the water vapor and infrared brightness temperature difference as a function of visible and infrared reflectivity difference observed over thunderstorm tops over Southeast Brazil at 1730Z for the 24 October severe weather case.

V. CONCLUSION

The main results of a well-defined convective event may be summarized in two points. Firstly, the difference between vapor and infrared is a tracer of deep convection, because the strong absorption of the water vapor channel. This difference is positive only for clouds with very cold top (i.e., overshooting cases). Secondly, it was possible to adjusted a logarithmical curve for the water vapor and infrared brightness temperature difference as a function of visible and infrared reflectivity difference, with a coefficient of determination of 0.6337. Therefore, this application makes our multispectral SEVIRI radiance retrieval a useful tool for operationally forecasters.

VI. ACKNOWLEDGEMENTS

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