32 ANALYSIS OF A SEVERE “COMMA-SHAPED” SQUALL LINE IN SOUTHERN BRAZIL

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1. INTRODUCTION

On 19 October 2014, a squall line with an embedded 'comma-shaped' bow echo (inverted comma in Southern Hemisphere) impacted Southern Brazil, causing material damage due to severe straight-line winds. The damaging-wind path and duration suggest this event was a derecho. Storm morphology was analyzed using a S-band radar in the city of Santiago, Southern Brazil. Synoptic and thermodynamic environments were analyzed through surface stations and sounding data, as well as the CFSR reanalysis fields preceding the event.

2. DATA AND METHODOLOGY

This study analyses a severe squall line in southern Brazil with remote sensing tools, and uses reanalysis data to provide information about the synoptic environment preceding the event.

Radar imagery was taken from the Rede de Meteorologia do Comando da Aeronautica (REDEMET: http://www.redemet.aer.mil.br/?i=produtos&p=radares-meteorologicos), of Brazil. The radar user here is located in Santiago, RS, and opperates in S Band. We used only 3100-m CAPPI data in the analysis. Surface stations from the Instituto Nacional de Meteorologia (http://www.inmet.gov.br/portal/index.php?r=estacoes/estacoesAutomaticas), of Brazil, was used to access wind gusts. CFSR reanalysis (Saha et al., 2010) was also used to obtain the synoptic environment. This dataset has 0.5 degrees of horizontal resolution and is available in the synoptic times. Sounding data was obtained from the Univertity of Wyoming dataset (http://weather.uwyo.edu/upperair/ sounding.html).

3. EVOLUTION OF THE SQUALL LINE AND DAMAGE PATH

Figure 1 shows the observed wind gusts and approximate location of the 55-dBZ line along the squall line. It is possible to note that the strongest wing gust of 60 kt (at least measured by weather station) occurred in association with a mesovortex (V in Figure 1; Xu et al., 2015). This mesovortex can also be tracked in Figure 2.

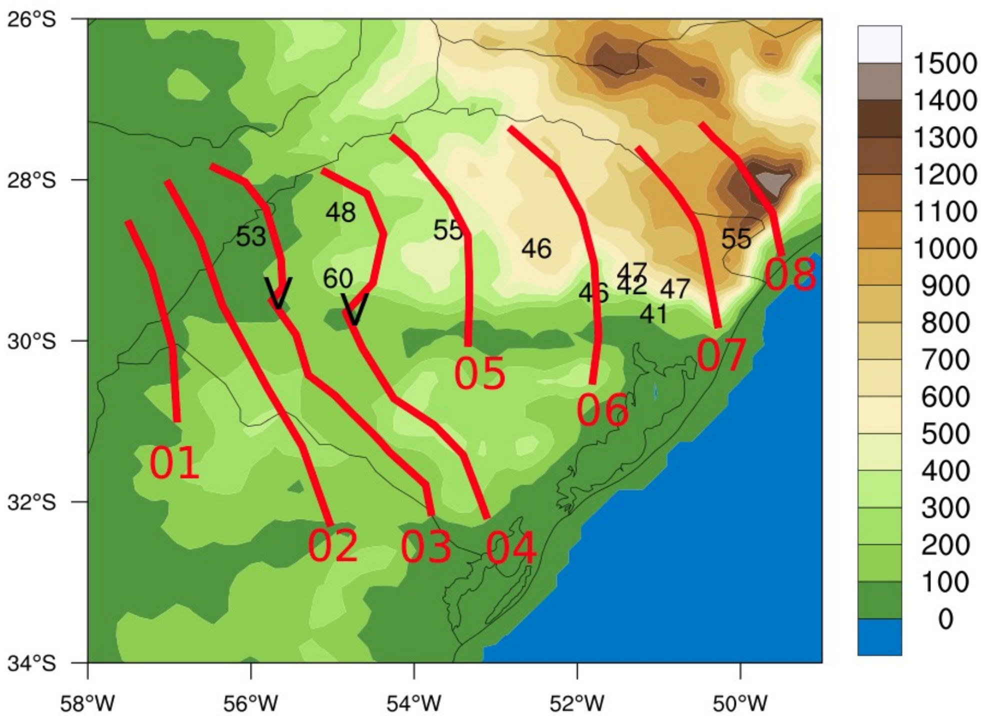

Figure 1: Wind gusts (kt) and approximate location of the 55-dBZ line (UTC time in red).

Figure 2 shows the radar imagery in the night of 19 October 2014. A cyclonic mesovortex is readily identifiable in the images. As the squall line developed a bowing segment near 03 UTC, the 60-kt wind gust was observed. The mesovortex lasted for about 2 hours only, but the squall line progressed causing wind damage until 08 UTC.

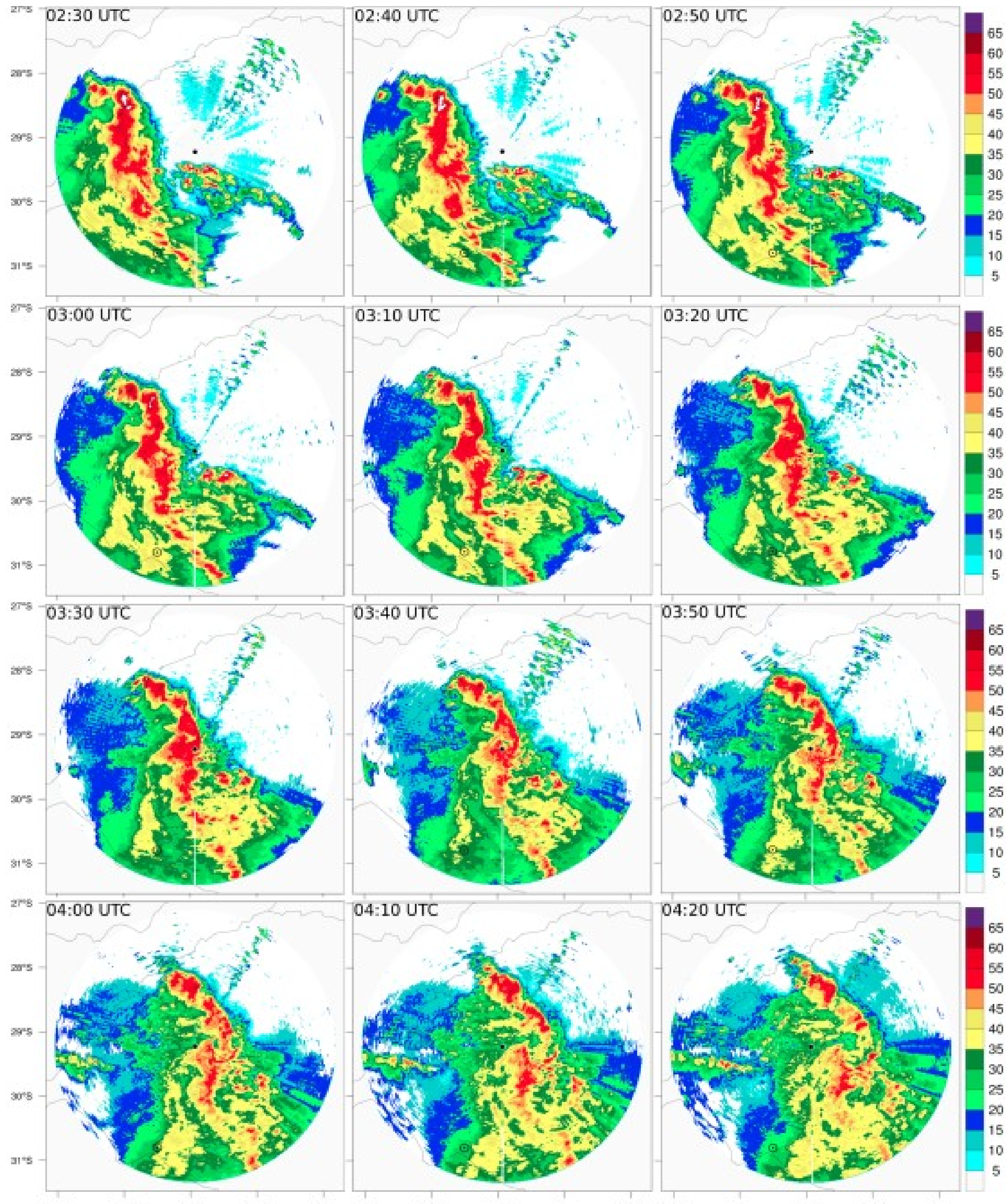

Figure 2: Santiago radar imagery from 02:30 UTC to 04:20 UTC.

4. ATMOSPHERIC ENVIRONMENT

Sattelite images (Figure 3) show that the squall line formed over a stable boundary layer, which has been cooled by an convective outflow from another older convective system farther south. This is also observed in the sounding (Figure 4), where a stable layer is observed from surface to about 800m. Even tough the boundary layer was relatively stable, the sounding shows significant temperature lapse rates from 900 to 500 hPa and strong wind shear at low levels, which favoured the development of the squall line.

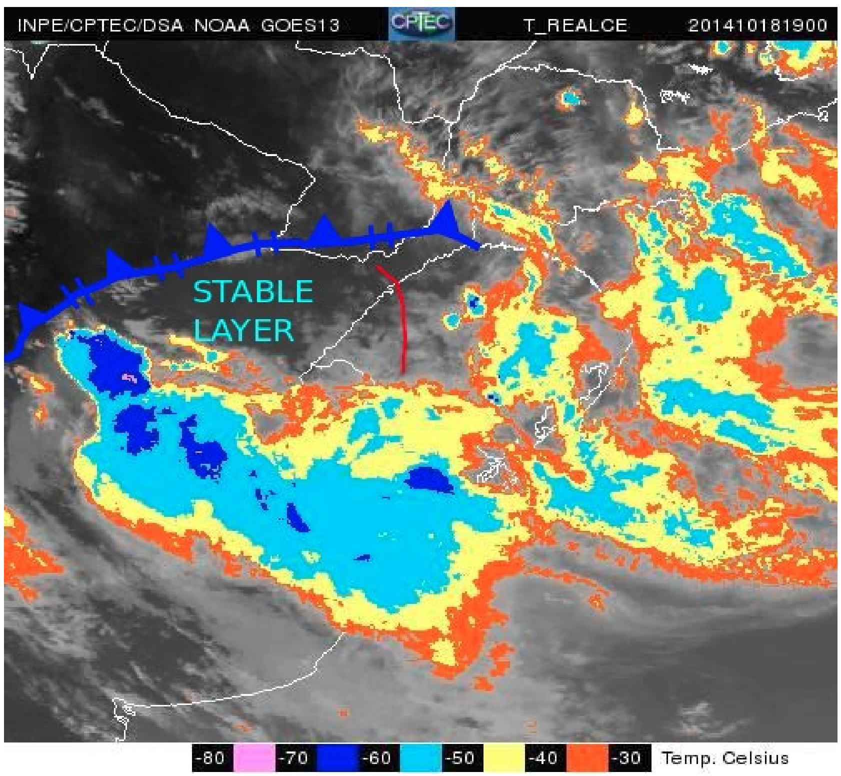

Figure 3: Infrared images of 00 UTC 19 October 2014, about 1 hour prior to the convective initiation. Red line indicates the squall line at 03 UTC.

The sounding-derived Most Unstable CAPE was more than 2100 J/kg, with a precipitable water of 40 mm. Deep-layer shear was 30 m/s, and the 0-1-km shear was 18 m/s.

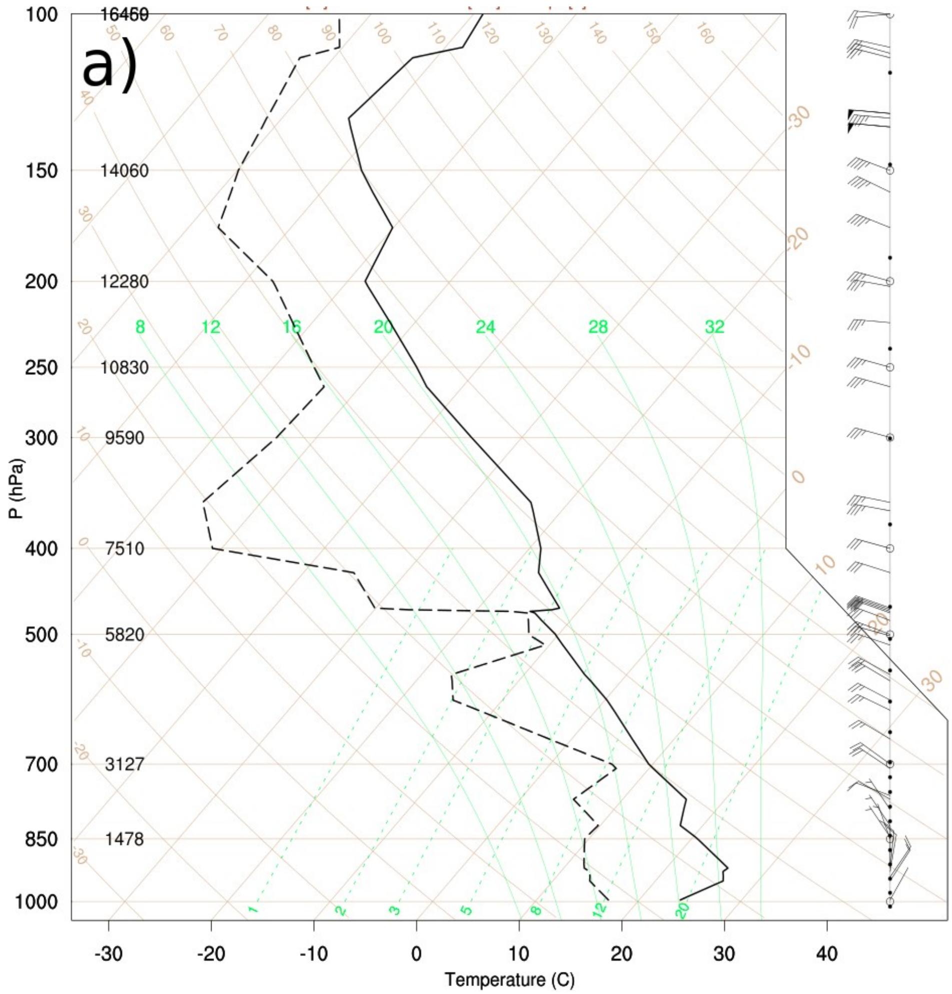

Figure 4: Sounding from Santa Maria, about 100 km SE of Santiago.

CFSR data of 19 UTC (Figure 5a) shows a jet streak at the upper troposphere. The squall line formed in the anticyclonic side of the jet streak, so the mesovortex has not been formed with support of environmental vorticity (Evans et al., 2014). A strong low-level jet (Figure 5b) with peak wind near 50 kt in northern Paraguay was analysed by the CFSR, which increased the moisture and heat support and the low-level shear to 15-20 m/s in the region (Figure 5c). Lapse rates were above 8 K/km farther south, which could have been supporting the ongoing convection in that region.

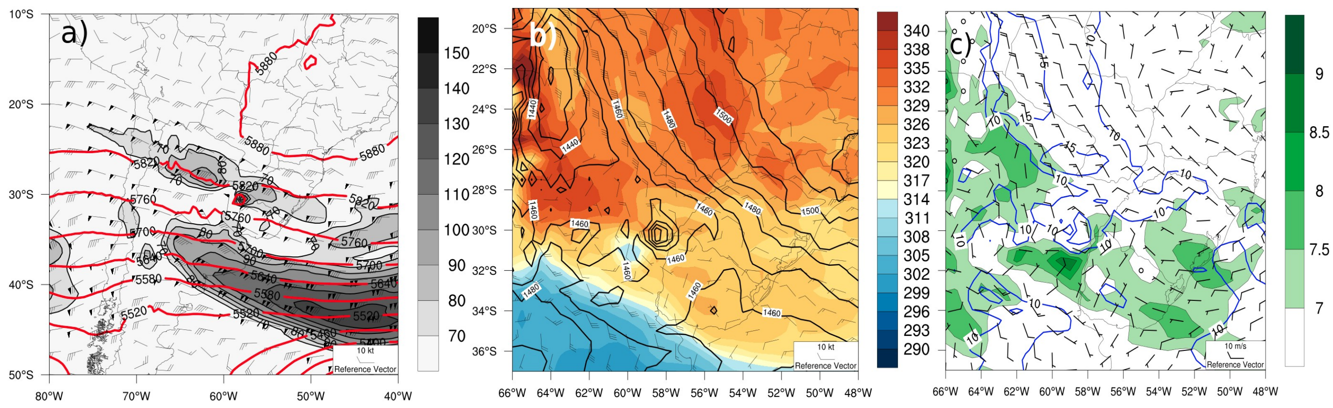

Figure 4: CFSR analysis at 00 UTC 19 October 2010 (squall line formation). a) 500-hPa geopotential height (red contours, gpm), 250-hPa wind barbs and isotachs (shaded, kt). b) 850-hPa geopotential height (contours, gpm), 850-hPa wind barbs (kt) and 850-hPa equivalent potential temperature (shaded, K). c) 1000-850-hPa vertical wind shear (blue contours and wind barbs, m/s) and 700-500-hPa temperature lapse rate (green shading, K/km).

5. **CONCLUSIONS**

This is a very preliminar analysis of a severe comma-shaped squall line occurred in Southern Brazil. Tha relative lack of observations in this part of the world do not allow us to go much further in this investigation. Numerical simulations are required in order to analyze in detail the mesoscale features of this mesovortex.

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