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Severe Storm (Supercell) Over Nuevo Laredo on the Night of May 17, 2021

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Abstract: On the night of May 17, 2021 a severestorm hit Nuevo Laredo, Tamaulipas with very heavy rain and intense wind, causing damage to the city. Among the damages are the impact on the electric power supply, fallingtrees, branches, billboards and roofs, as well as floods in certain sectors, including the Quetzalcóatl international Airport in the city of Nuevo Laredo Tamaulipas, Mexico.
Keywords: flooding, heavy rain, severe storm, strong wind.

INTRODUCTION

A severe storm is called a storm that has sufficient potential to produce significant material damage and / or create a threat to life. They are directly related to phenomena of high social impact such as: flash floods, hail of considerable size (equal to or greater than 2.5 cm), electrical activity, violent gusts of wind (greater than 90 km / h), and even the development of tornadoes [1].

CONCEPTUAL SCHEME:

Severe storms almost always show some type of organization on a scale greater than that of individual clouds, they are usually organized as: a line, multicellular, or as a supercell, which is the system with the potential to develop severe storms par excellence [1].

THE SUPER CELLS

A Supercell (in English, supercell) is an immense storm in rotation. They tend to form under conditions of high instability. In addition, they present a more organized system of internal circulation that makes them last much longer than others. In the supercell, the appearance of strong rotating currents is common, making it potentially the most dangerous of the types of convective storms [2].

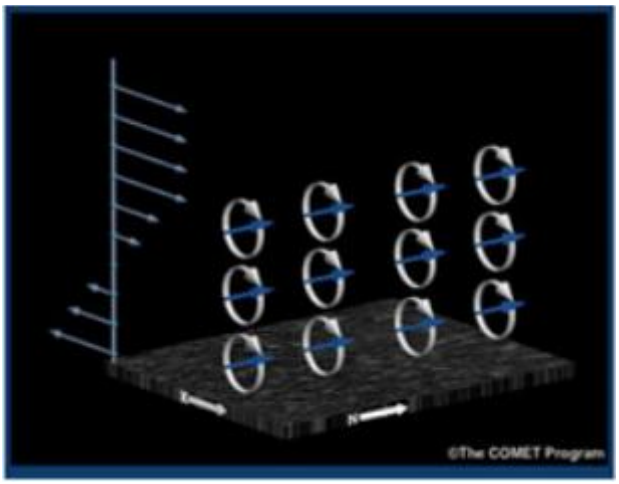

Figure 1. Environment prior to supercell formation [2].

This shear generates a zone of horizontal vorticity. This vorticity formation can be easily deduced visually. Let's imagine two perpendicular layers. Being affected by a constant wind speed profile with height, they do not tend to rotate and therefore the equivalent particle would not rotate on itself, that is, vorticity would

not be generated. However, if the profile is dependent on the height with an increase as we ascend, the layers tend to rotate, with which the same would happen to the fluid particle, that is, a vorticity would be generated [2].

In an unstable environment a convective updraft will form (Figure 1). If this current is strong enough (depending on instability) to overcome opposition to the movement created by these horizontal rollers, it tilts them in such a way that they rotate vertically. That is, the convective current has transformed a horizontal vorticity zone into a vertical vorticzone [2].

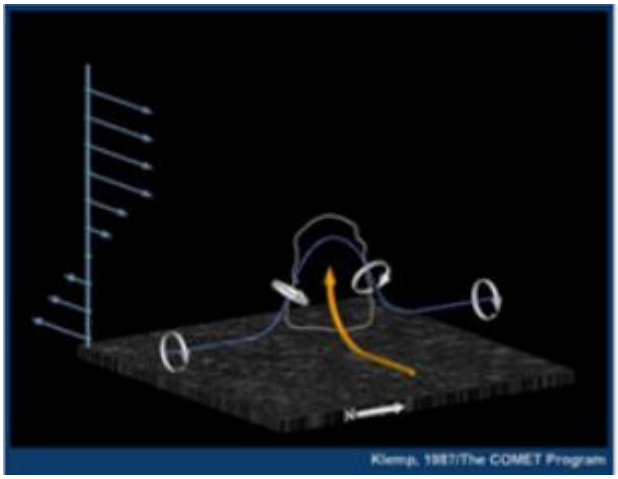

Figure 2. Diagram of the start of the supercell [2].

Since then, the storm has broken, that is, the supercell has formed (Figure 2). This rotation with the height of the wind direction, while its speed increases, induces on the upward current (which has transformed the horizontal rotation into vertical rotation) a helical rotation in theupwarddirection [2].

As can be seen in Figure 3, the updraft generates two vortices, one rotates cyclically (the one on the left) and the other anticyclonic (the one on the right). Up toheretwo situations are differentiated that will be given again by the shear, although this time in medium and high levels of the troposphere (from 5 to 15 km approximately) [2].

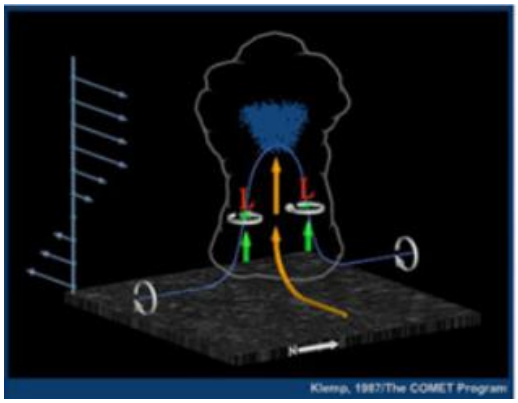

Figure 3. Explanatory graph of the interior of the supercell [2].

If the velocity profile is constant, the updraft cannot support the weight of the precipitation it has generated on its upper flank, a dowdraft is formed, falls on the same updraft and divides it in two parts. It can be said that at that moment a Storm-Splitting has taken place, the initial cell being divided into two symmetrical cells, one with an updraft on the right flank of the storm that presents cyclonic rotation and the other with an updraft on the flank. left of the storm showing ananticyclonicrotation [2].

On the other hand, if the velocity profile continues to vary with height, the upward and downward current (Figure 4), clearly decoupled. This separation favors the prolongation of the life of the storm since the downdraft, with its drag on precipitation, does not erode the updraft, and it can continue to feed it for much longer [2].

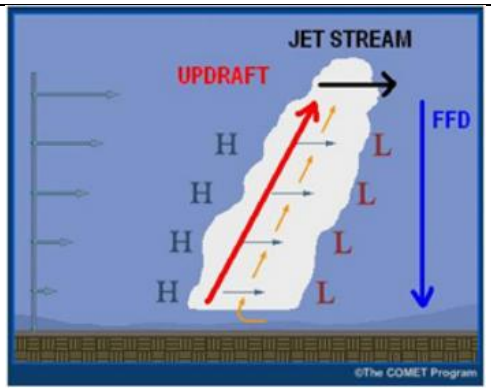

Figure 4. Uncoupling of the two streams by shear [2].

METHODOLOGY

Through the analysis of numerical forecasting models GFS and ECMWF assembly, as well as the meteorological observations (METAR) of that day, it is possible to analyze the severe storm (supercell) as described below:

The GFS analysis at 9:00 pm (Figure 5), prior to the storm, identifies a convergence zone at 850mb, as well as the vector field of converging winds and the humidity concentration over this zone, between the limits of the states of Coahuila, Nuevo León and Texas, which begins to be reflected in the following layers, up to the medium atmosphere, 500mb. At the top 250mb a divergent vector field of winds is observed out of phasebyshear.

Figure 5. Analysis of levels of 850mb, 700mb, 500mb and 250mb at 9:00 pm (the green dot locates the Nuevo Laredo area of interest) [3].

The GFS analysis at 10:00 pm (Figure 6), the convergence zone at 850mb deepens into the following layers, up to the middle atmosphere, 500mb. At the top 250mb, the divergent wind vector field begins to intensify favoring the development of the storm.

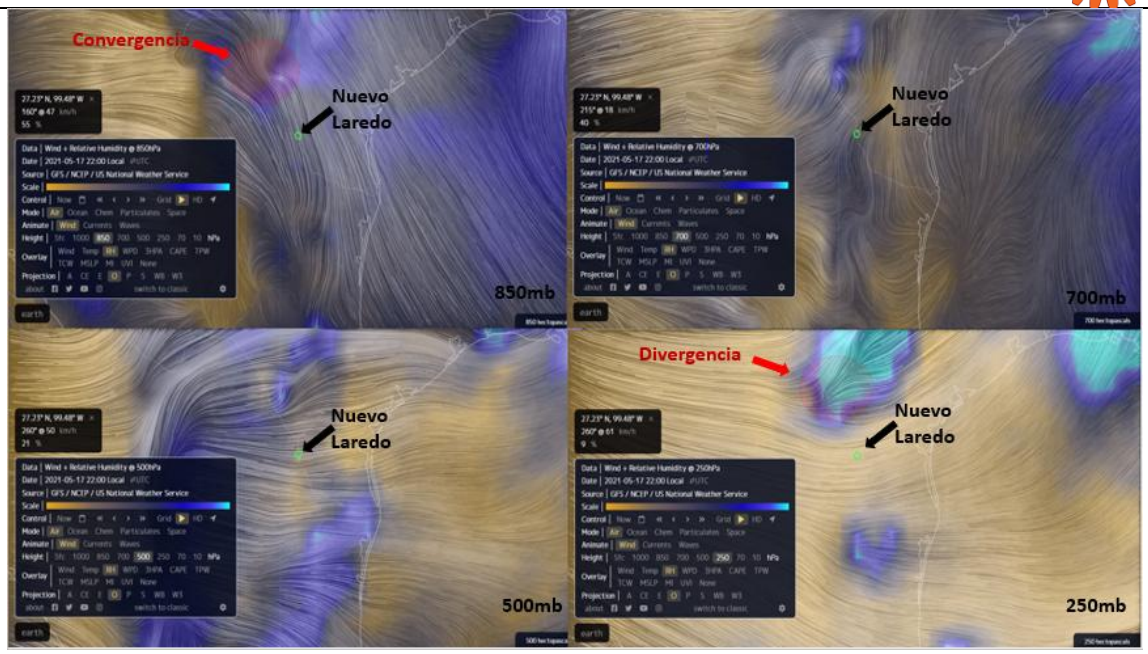

Figure 6. Analysis of levels of 850mb, 700mb, 500mb and 250mb at 10:00 pm [3].

The GFS analysis at 11:00 pm (Figure 7), the convergence zone at 850mb maintains its depth over the following layers, up to the middle atmosphere, 500mb. At the top 250mb, the divergent wind vector field begins to maintain its intensity favoring the development of the storm and challenging itself over the north of the storm convergence zone.

Figure 7. Analysis of levels of 850mb, 700mb, 500mb and 250mb at 11:00 pm [3].

The GFS analysis at 12:00 am (Figure 8), the convergence zone at 850mb and the humidity concentration represented by the clouds maintains its depth until the middle atmosphere, 500mb. In addition to the lower part approaching the city of Nuevo Laredo, In the upper part 250mb, the divergent wind vector field maintains its intensity and also moves towards the city, both the convergent and the divergent part of the storm remains in phase shift, that is, misaligned over the entire column of atmosphere, which prolongs the duration of the super cell.

Figure 8. Analysis of levels of 850mb, 700mb, 500mb and 250mb at 12:00 am [3].

The GFS analysis at 1:00 am (Figure 9), the convergence zone at 850mb and the humidity concentration represented by the clouds maintains its depth until the middle atmosphere, 500mb. Situation that is located over the city of Nuevo Laredo, In the upper part 250mb, the divergent vector field of winds maintains its intensity and also remains very close to the city, both the convergent and the divergent part of the storm are out of phase.

Figure 9. Analysis of levels of 850mb, 700mb, 500mb and 250mb at 1:00 am [3].

That same day, around 7pm, Cumulonimbus Mammatus clouds were observed (Figure 10), which are considered as the prelude to the storm, but also indicate the effects of rotation of the cloud, already explained above.

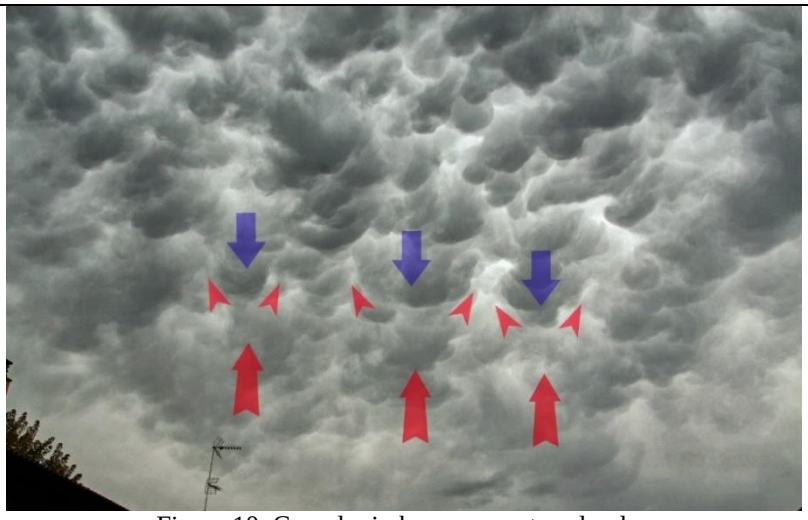

Figure 10. Cumulonimbus mammatus clouds.

In the meteorological observations (METAR) of May 16, a temperature of 33 ℃ was recorded, on May 17 39 ℃, close to 40 ℃ (Figure. 11), marking a thermal difference of more than 6 ℃ indicative of a heat island over the city of Nuevo Laredo.

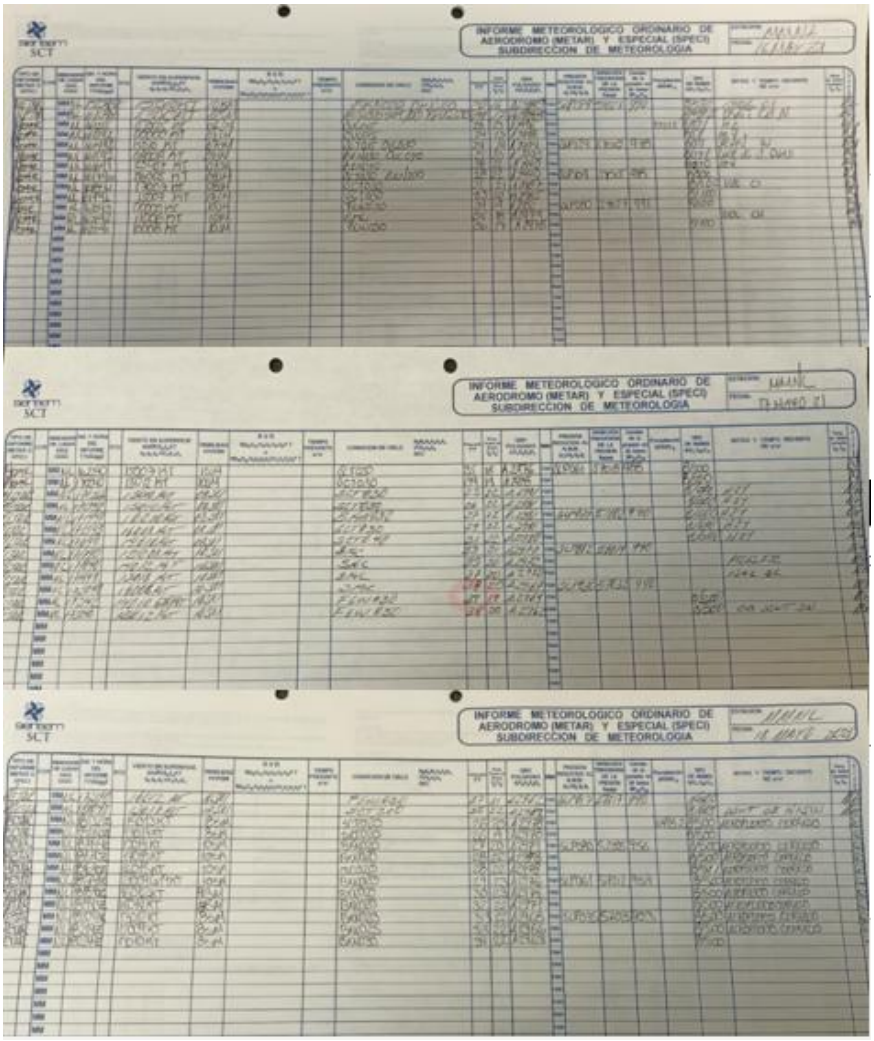

Figure 11. Meteorological observations (METAR) [4].

The WPC surface analysis at 10pm (03Z) (Figure 12) shows that during that night a low pressure system to the west of Texas, USA, interacted with various synoptic systems: a stationary front to the north, a dry line that it broke off and continued to the south, as well as a shear line that developed briefly during that period.

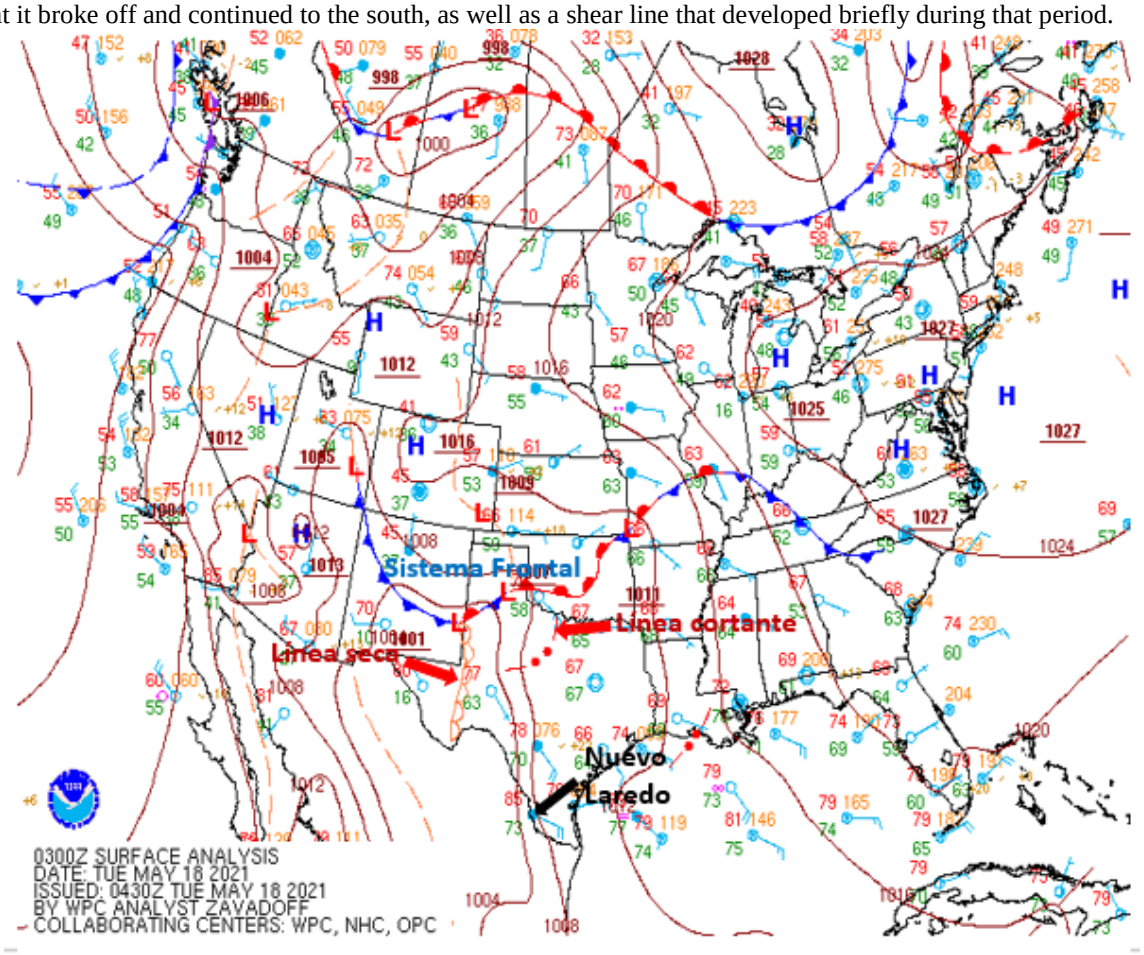

Figure 12. Surface analysis of the 18th of 0430Z, (May 17 at night) [5].

The satellite image at 15:06 pm and LAUNCHLIN radar image at 16:10 pm (Figure 13), shows the beginning of the formation of convection clouds over the northeast of the country, in the states of Coahuila and Nuevo Leon moving to the East.

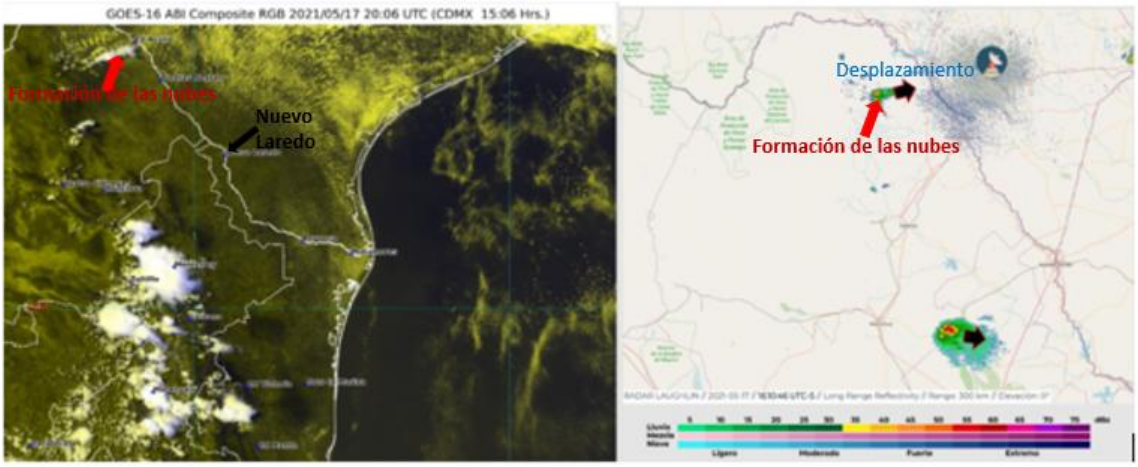

Figure 13. GOES 16 RGB satellite image and LAUCHLIN radar image [6].

The satellite image at 18:31 pm and LAUNCHLIN radar image at 19:00 pm (Figure 14), shows a greater development of convection clouds over the northeast of the country, in the states of Coahuila, Nuevo León and Tamaulipas, which continue to move to the East.

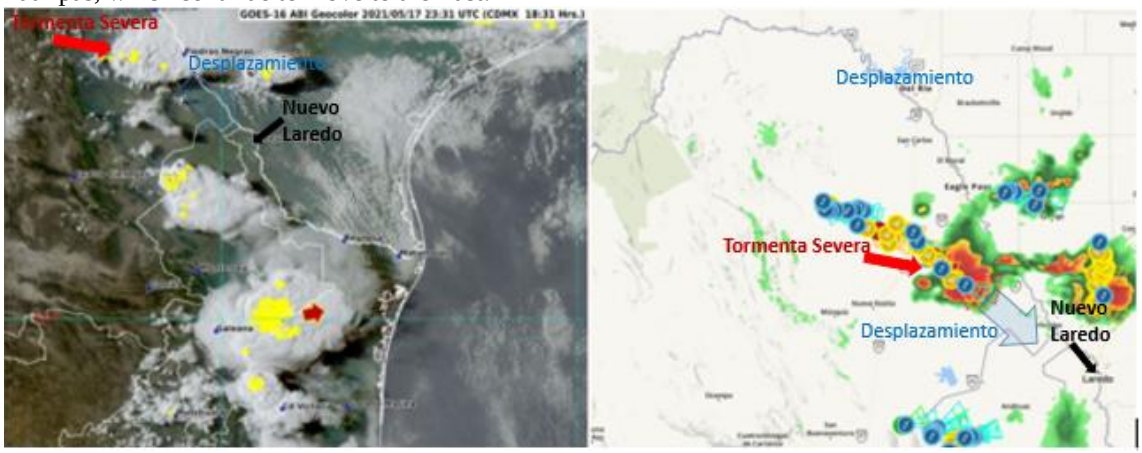

Figure 14. GOES 16 ABI Geocolor satellite image and LAUCHLIN radar image [6].

The radar image at 10:00 shows the severe storm near Nuevo Laredo, already at around 10:30 pm (Figure 15) the radar shows a reflectivity of greater than 50dBZ where the storm is intense, in addition to having points of rotation on itself, the duration of the storm was approximately 3 to 4 hours, remaining over Nuevo Laredo during this time. The intensity of the rain with this scheme is considered in values of 30 to 60 mm / h.

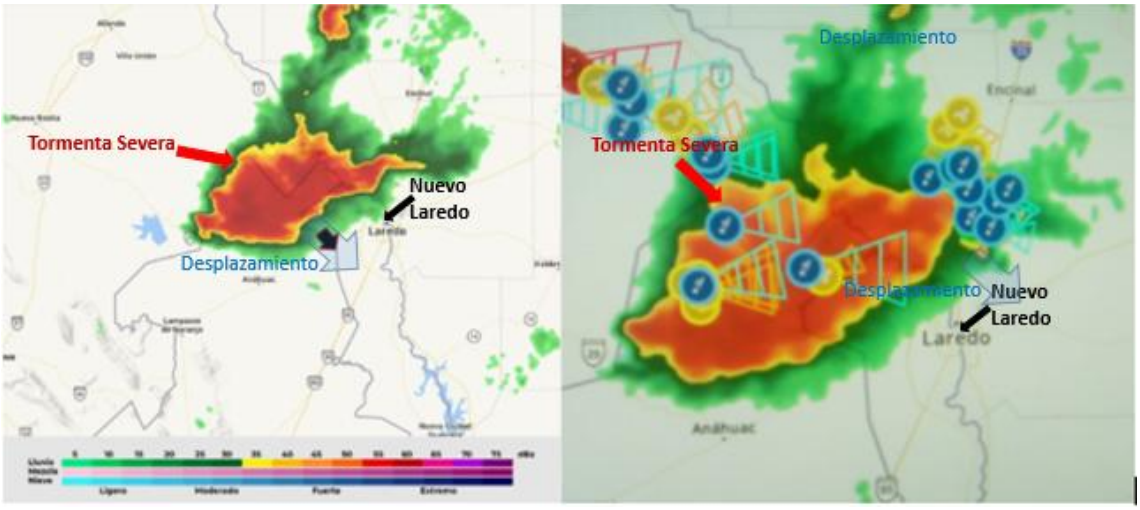

Figure 15. LAUCHLIN radar image [6].

The intensity of the sustained winds was between 150 to 200 km / h since the city of Nuevo Laredo was exposed during that time the descending part of the storm (Figure 16) as explained previously.

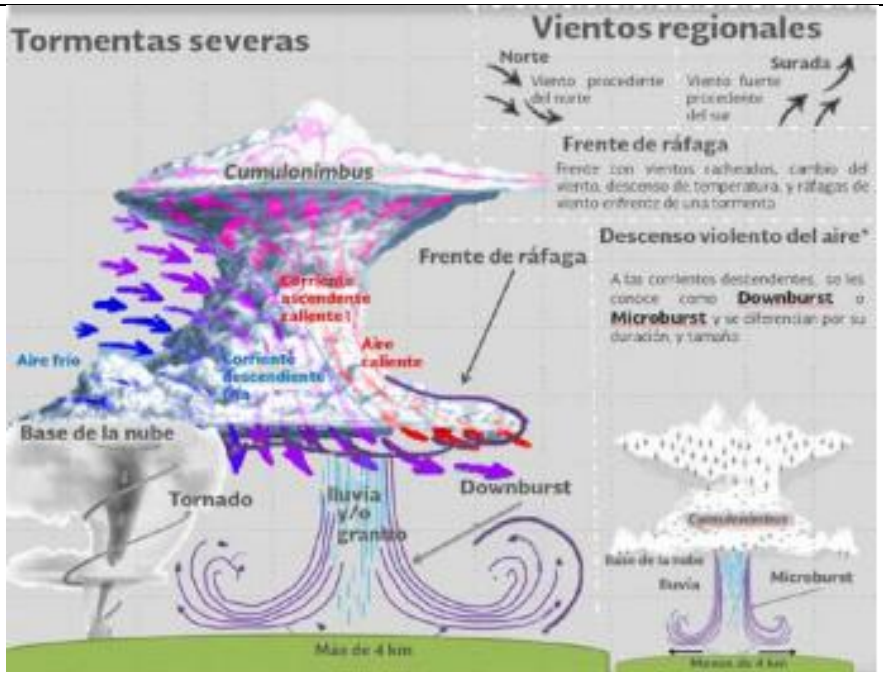

Figure 16. Descending part of the Supercell [8].

CONCLUSIONS

Based on the arguments that describe a conceptual scheme of the development of the severe storm that occurred in the city of Nuevo Laredo Tamaulipas, during the night of May 17, a reference can be made to create a surveillance system by sectors, where learn about the occurrence of this type of severe atmospheric phenomena, in order that the population can create habits of resilience, which can help save human lives, as well as material goods.

With this type of work, it is possible to understand and understand the conditions and environment in which severe storms develop over Northeast Mexico, which would contribute to creating better mitigation strategies against the effects of severe meteorological phenomena.

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