

Tornadoes Analysis Concordia, Santa Catarina, Southern Brazil, 2022 Season

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Abstract—Large storms such as tornadoes and extratropical cyclones have become increasingly common in southern Brazil. The season of strong storms has been increasingly evident between autumn and winter in southern Brazil, such as hurricane Catarina. Several tornadoes were evidenced in 2022 in this region, and the ones discussed here are from It's and Concordia, which crossed the rural areas of Santa Catarina, causing great damage to their avian production. As the main focus, the one of Concordia was analyzed, classified as category F1, and approximate dimensions of 100m in diameter.

Index Terms—Tornadoes, Storms, Santa Catarina, Southern Brazil, Damage.

I. INTRODUCTION

A tornado is a violently rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. They are often referred to as twisters or cyclones, [1], [2], [3] although the word cyclone is used in meteorology, in a wider sense, to name any closed low pressure circulation.

The occurrence of tornadoes has become increasingly common in the southern region of Brazil. Several tornadoes have formed and evidenced in 2022 in the states of Parana, Santa Catarina and Rio Grande do Sul, southern region of Brazil. [4], [5], [6], [7], [8]

Tornadoes come in many shapes and sizes, but they are typically in the form of a visible condensation funnel, whose narrow end touches the earth and is often encircled by a cloud of debris and dust. Most tornadoes have wind speeds less than 110 miles per hour (180 km/h), are about 250 feet (80 m) across, and travel a few miles (several kilometers) before dissipating. The most extreme tornadoes can attain wind speeds of more than 300 miles per hour (480 km/h), stretch more than two miles (3 km) across, and stay on the ground for dozens of miles (more than 100 km). [9], [10], [11], [12]

Various types of tornadoes include the landspout, multiple vortex tornado, and waterspout. Waterspouts are characterized by a spiraling funnel-shaped wind current, connecting to a large cumulus or cumulonimbus cloud. They are generally classified as non-supercellular tornadoes that develop over bodies of water, but there is disagreement over whether to classify them as true tornadoes. These spiraling columns of air frequently develop in tropical areas close to the equator, and are less common at high latitudes [9], [10], [11]. Other tornado-like phenomenon that exist in nature include the gustnado, dust devil, fire whirls, and steam devil; downbursts are frequently confused with tornadoes, though their action is dissimilar [12].

II. NEWS

A. *Concordia*

The Civil Defense of Santa Catarina confirmed on Tuesday morning (28) the passage of a tornado in Concórdia, in the West, on Wednesday night (22). Wind gusts in the city reached 108km/h. According to the technical note of the agency, the tornado recorded in the municipality was of "low intensity and associated with a severe storm". At least 50 homes and rural properties were affected and the estimated damage so far has reached R\$ 10 million. There were no injuries. [13]

Wednesday's storm also wreaked havoc in other cities. There were records of landslides and flooding points in Chapecó, Cordilheira Alta and Campos Novos. In Aurora, in the Itajaí Valley, a flood blocked a section of the SC-350. According to the NSC Meteorological Center, a tornado is a weather phenomenon that occurs with the arrival of cold fronts when air moves quickly around a center of low pressure. [13]

B. *Itá*

The Civil Defense of Santa Catarina confirmed the passage of a tornado in the city of It'a on the afternoon of Thursday,



Fig. 1: Photo of the damage caused in rural areas where the tornado passed, municipality of Concórdia Santa Catarina. [14].



Fig. 2: Photo of the damage caused in rural areas where the tornado passed, municipality of Concórdia, Santa Catarina. [14]

the 13th. The official report was published in the early afternoon of this Friday, the 14th. According to information already disclosed, the storm caused damage to public and private improvements, vegetation fall on buildings and public roads, in addition to electricity and communication cables being hit. A damage assessment is still being completed. [14]

According to Civil Defense meteorologists, the phenomenon occurred between 4:20 pm and 4:40 pm and concluded that the instability supercell that passed through the municipality gave rise to a tornado, with an estimated speed of around 110-120 km/h. [14], [15]

The last record of a tornado in the region was in June of that year, when part of the interior of Conc'ordia suffered damage due to strong winds, which occurred in the region of BR 153 to the communities of Barra Bonita and Tiradentes. [14], [15]



Fig. 3: Photo of the damage caused in rural areas where the tornado passed, municipality of Concórdia, Santa Catarina. [14].



Fig. 4: Photo of the damage caused in rural areas where the tornado passed, municipality of Concórdia, Santa Catarina. [14].



Fig. 5: Photo of the damage caused in rural areas where the tornado passed, municipality of Concórdia, Santa Catarina. [14].

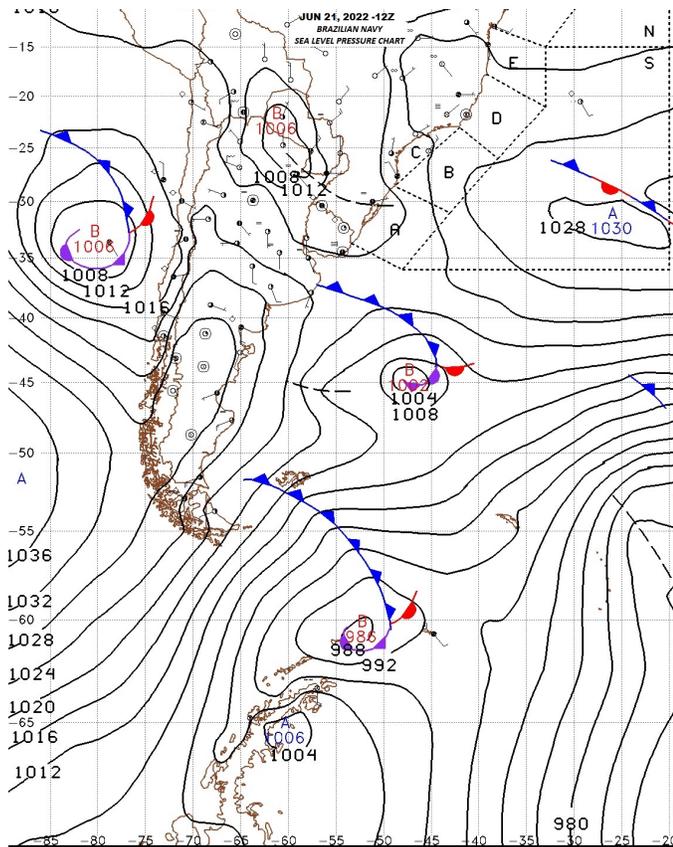


Fig. 6: The figure shows the sea level pressure chart image, formulated by the Brazilian Navy, for June 21, 2022, 0012Z. It stands out for the analysis of the causes of the formation of the tornado, two zones of high pressure, one to the south of the Pacific Ocean, the other covering the whole of Paraguay, and the north of Argentina. And a low pressure zone south of the Atlantic Ocean. All causing a mass displacement of cold air. [16],[Adapted by the authors].

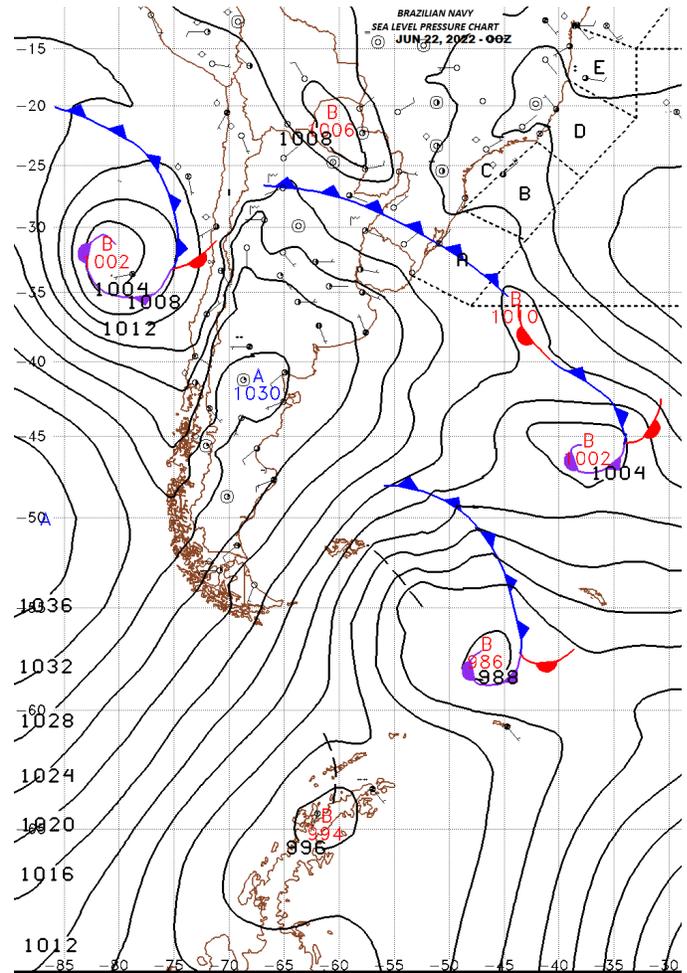


Fig. 7: The figure shows the sea level pressure chart image, formulated by the Brazilian Navy, for June 22, 2022, 00Z. It stands out for the analysis of the causes of the formation of the tornado, two zones of high pressure, one to the south of the Pacific Ocean, the other covering the whole of Paraguay, and the north of Argentina. And a low pressure zone south of the Atlantic Ocean. All causing a mass displacement of cold air. [16],[Adapted by the authors].

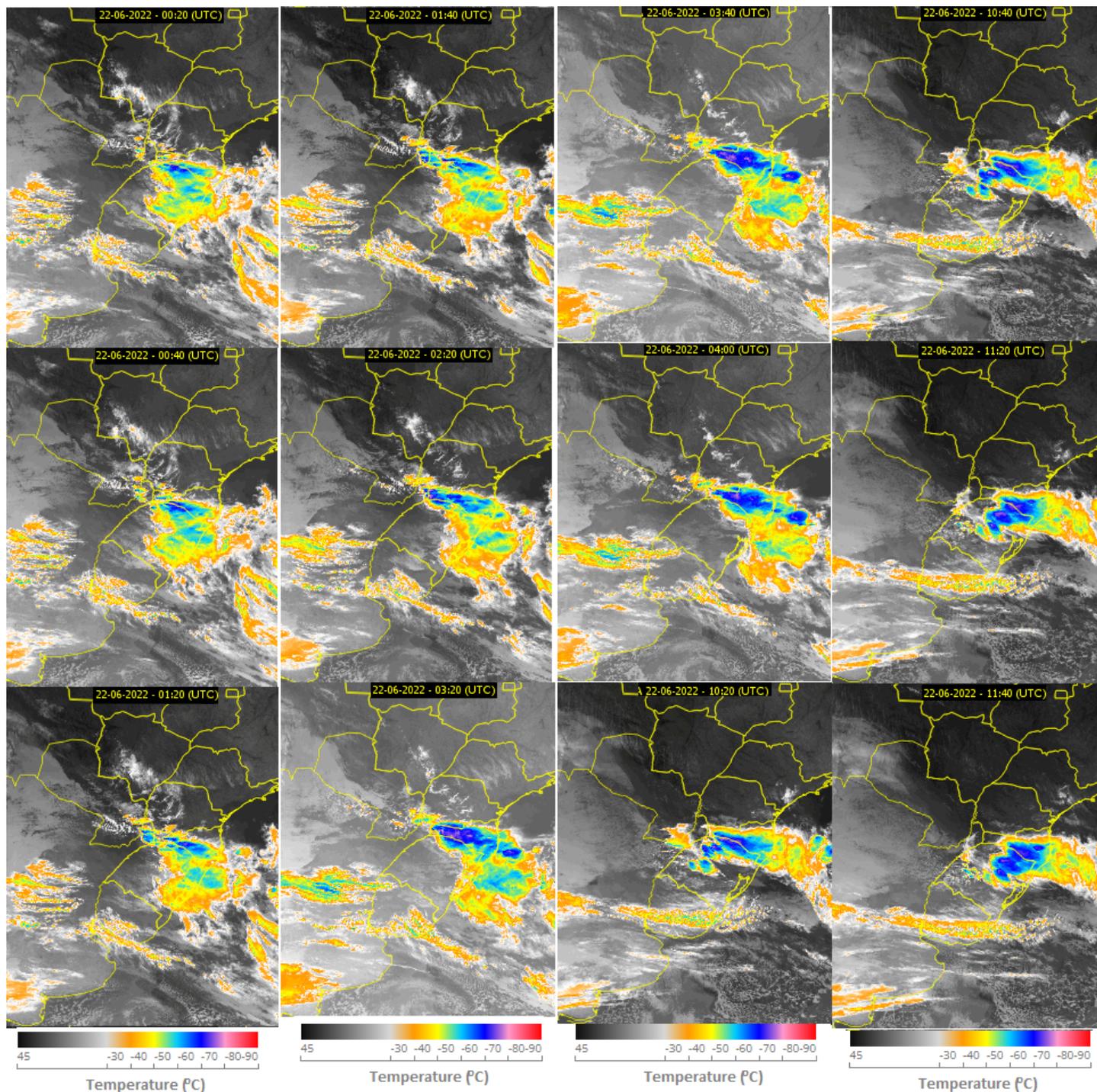


Fig. 8: The figure shows 12 satellite images highlighted as a function of the temperature of clouds near the surface, for the time (UTC) from 00:20 to 11:40 on June 22, 2022. [17],[Adapted by the authors].

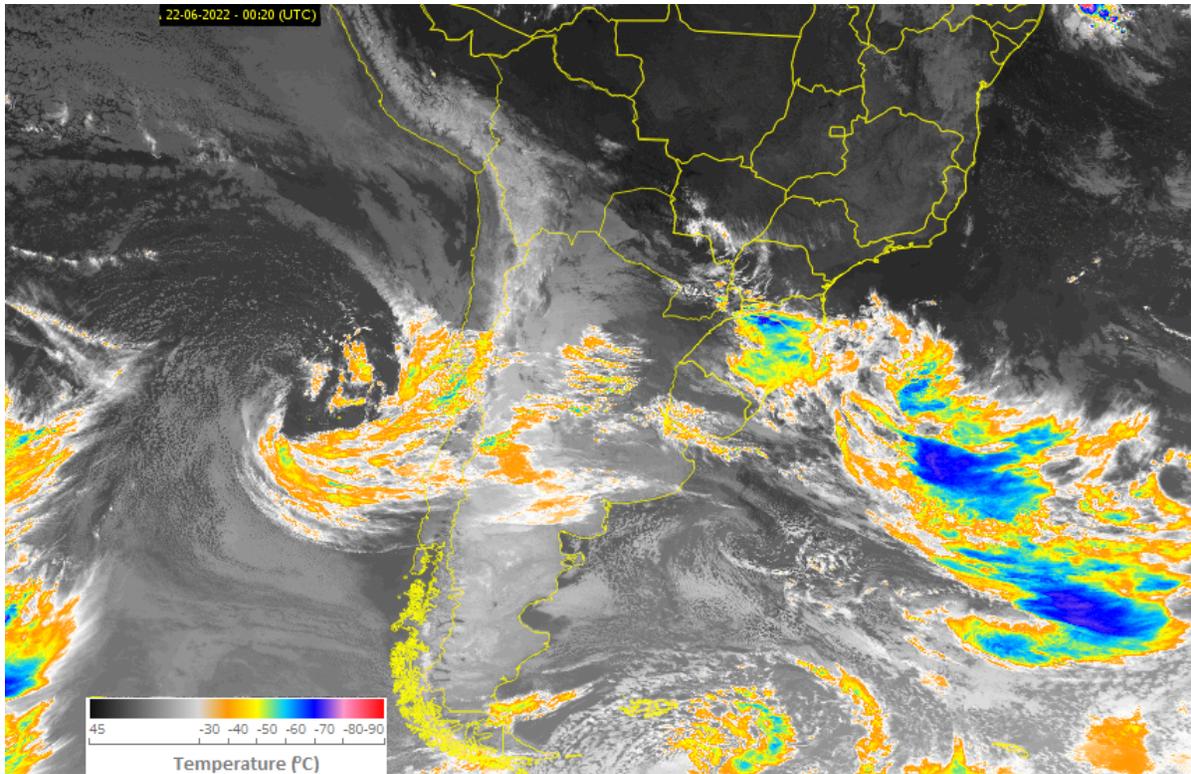


Fig. 9: The figure shows satellite images highlighted as a function of the temperature of clouds near the surface, for the time from 00:20 (UTC) on June 22, 2022. [17],[Adapted by the authors].

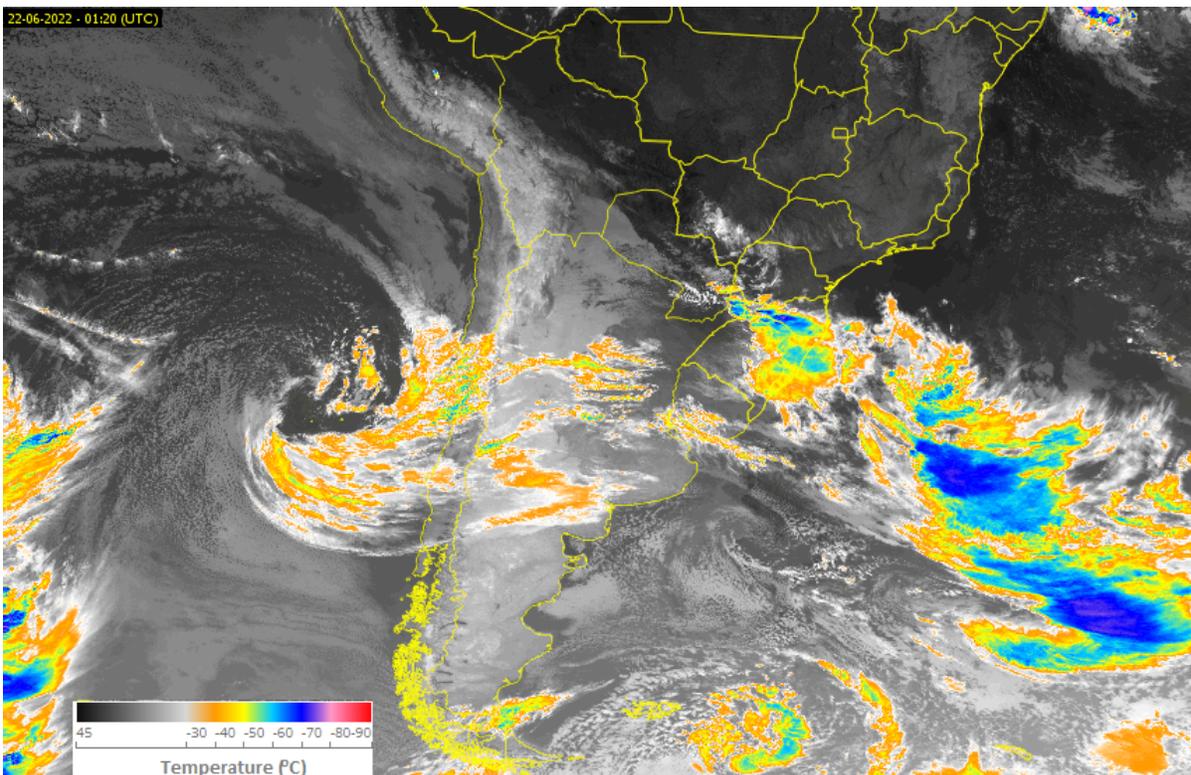


Fig. 10: The figure shows satellite images highlighted as a function of the temperature of clouds near the surface, for the time from 01:20 (UTC) on June 22, 2022. [17],[Adapted by the authors].

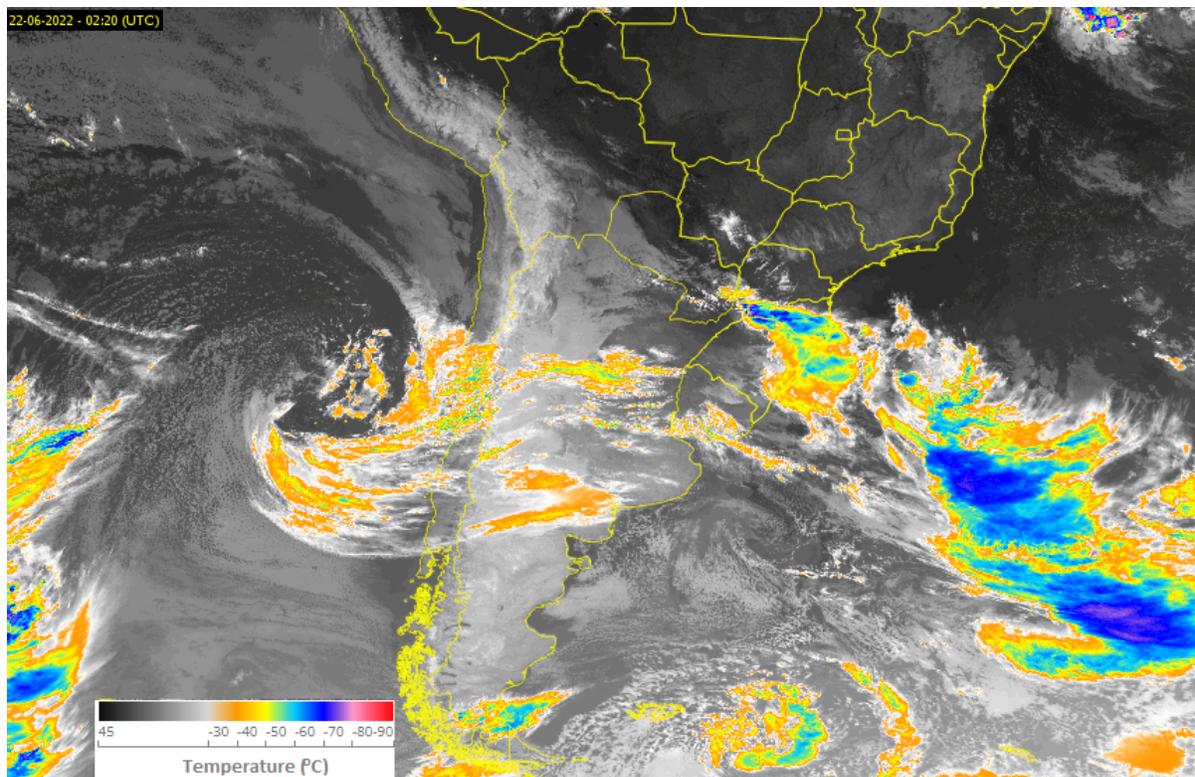


Fig. 11: The figure shows satellite images highlighted as a function of the temperature of clouds near the surface, for the time from 02:20 (UTC) on June 22, 2022. [17],[Adapted by the authors].

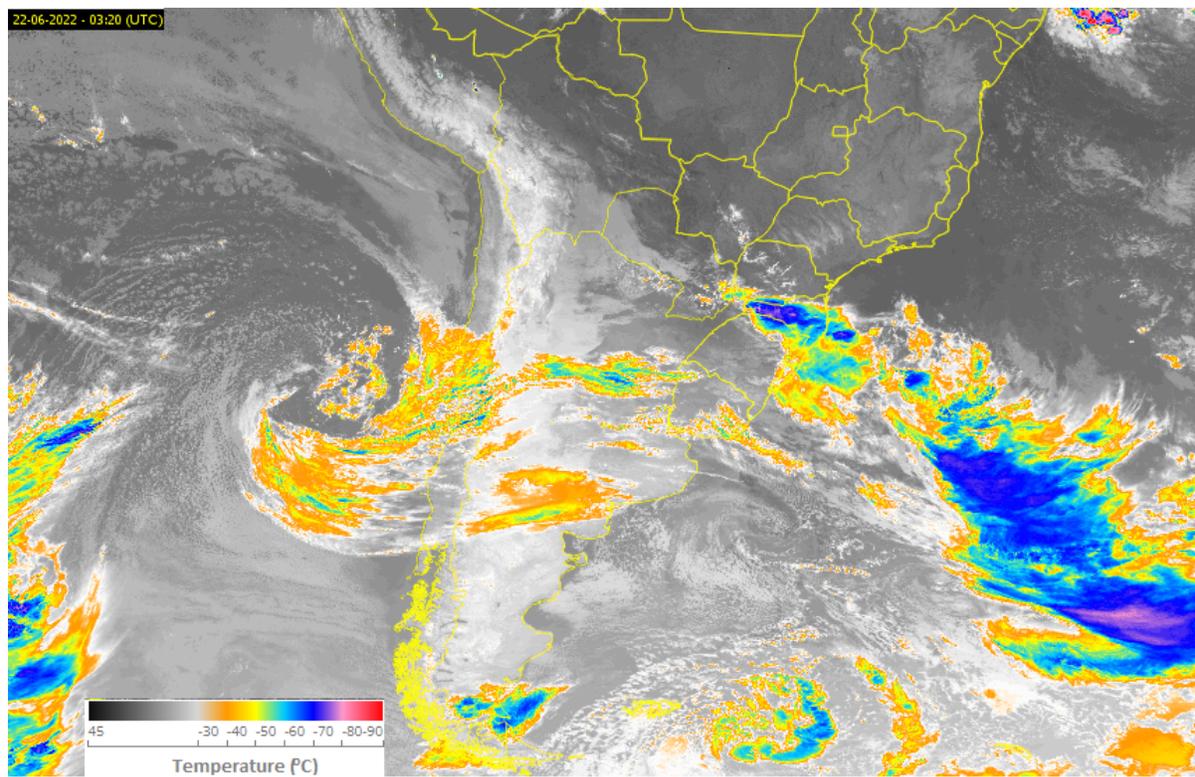


Fig. 12: The figure shows satellite images highlighted as a function of the temperature of clouds near the surface, for the time from 03:20 (UTC) on June 22, 2022. [17],[Adapted by the authors].

III. ANALYSIS

Large storms such as tornadoes and extratropical cyclones have become increasingly common in southern Brazil. The season of strong storms has been increasingly evident between autumn and winter in southern Brazil [18], [19], [20], [21], [22], [23], [24], [25], [26], such as hurricane Catarina [27].

The Figure (6)-(7) shows the sea level pressure chart image, formulated by the Brazilian Navy, for June 21, 2022, 0012Z. It stands out for the analysis of the causes of the formation of the tornado, two zones of high pressure, one to the south of the Pacific Ocean, the other covering the whole of Paraguay, and the north of Argentina. And a low pressure zone south of the Atlantic Ocean. All causing a mass displacement of cold air.

The tornado observed by the Civil Defense of the State of Santa Catarina, was formed due to the shock of a large mass of hot air that were stationed over the Center-West, Southeast and Parana state regions, which blocked the advance of the cold front. coming from Argentina, from which it was forced to move to the west of the southern region of Brazil, forming in the west and between the states of Rio Grande do Sul and Santa Catarina.

Analyzing the enhanced satellite images obtained from the REDEMETS website [28], Figure (8), for the cloud temperature of June 22, 2022, time (UTC) 00:00 to 11:40, it appears that the tornado has probably formed between 2 am and 4 am on the 22nd, with greater intensity at 03:20. According to the damage caused to rural properties in the municipality of Chapecó, Figures (1)-(5), it can be classified as category F1 [29], with approximate dimensions of 100 m in diameter.

A low pressure area of 1002 mb formed in the Pacific Ocean, west of the Chilean coast, between the 25th and 40th parallels, generated winds that gave rise to a cold front that moved into the southern region of Chile and Argentina, Figures (6)-(7). Pulled by a 1030 mb high pressure zone formed in southern Argentina, between parallels 40 and 45 South, added to the extratropical cyclone of 986 mb of pressure in the South Atlantic, between parallels 55 and 60 South, created conditions for the formation of this strong cold front, which advanced through Argentina, Uruguay, Rio Grande do Sul, Santa Catarina. After the passage of this strong storm through these areas, it dispersed on the east coast of southern Brazil, entering the Atlantic Ocean, Figures (9)-(12).

IV. CONCLUSIONS

Large storms such as tornadoes and extratropical cyclones have become increasingly common in southern Brazil. The season of strong storms has been increasingly evident between autumn and winter in southern Brazil, such as hurricane Catarina.

With a low pressure area of 1002 mb formed in the Pacific Ocean, west of the Chilean coast, between the 25th and 40th parallels, generated winds that gave rise to a cold front that moved into the southern region of Chile and Argentina. Pulled by a 1030 mb high pressure zone formed in southern Argentina, between parallels 40 and 45 South, added to the extratropical cyclone of 986 mb of pressure in the South Atlantic, between parallels 55 and 60 South, created conditions for the formation of this strong cold front, which advanced through Argentina, Uruguay, Rio Grande do Sul, Santa Catarina. After the passage of this strong storm through these areas, it dispersed on the east coast of southern Brazil, entering the Atlantic Ocean.

Several tornadoes have formed and evidenced in 2022 in the states of Parana, Santa Catarina and Rio Grande do Sul, southern region of Brazil. The Concordia tornado, which crossed the rural area of Santa Catarina, caused great damage to its avian production. Classified here as category F1, and approximate dimensions of 100m in diameter.

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