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Dragonhead Cyclone in The Falkland Islands (Malvines Islands) has Double Cote's Spiral Like NGC 5247

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Abstract

Extratropical cyclones are common in the South Atlantic. They generally arise with the passage of cold fronts to the south of the South American continent, crossing the south of Chile and Argentina, in the regions of Puerto Natales, Punta Arenas (Chile), Rio Galegos, Rio Grande, El Calafate and Ushuaia (Argentina). The extratropical cyclone analyzed presented at its peak the very characteristic shape of a Chinese dragon. Other cyclones in the form of a Cote's spiral curve are part of this analysis (Gobato et al., 2018-2023). They present a mathematical form of a double Cotes Spiral curve. Here called the Dragonhead cyclone, indicate a structural similarity with spiral galaxies, especially NGC 5247, in the constellation Virgo. With an area of influence and a size of around 3,247 thousand km^2 at its peak, it moved quickly in a west-northwest (WNW) direction, with an average speed of 76 km/h, with winds of 84 km/h at 100 km from the nucleus, as it passed north of the Falkland Islands (Malvinas Islands). The cyclone temperature during its trajectory varies from -45ºC to -50ºC at its edge, while at its core it varies between -10ºC to -25ºC.

In the data collected (Gobato et al., 2018-2023), and analyzed from the Dragonhead cyclone, it is clear that all extratropical cyclones that appear south of the South American continent, below 40° latitude, have the shape of a spiral curve, like the spiral galaxy. Most of these are in the form of a double Cote's spiral curve.

Introduction

Cyclone

A cyclone is a large air mass that rotates around a strong center of low atmospheric pressure, counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere as viewed from above (opposite to an

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anticyclone). [1], [2], [3], [4], [27], [29] Subtropical cyclone is a weather system that can form between the equator and the 50th parallel. [1], [5], [6], [7], [8], [9], [26], [27] These storms usually have a radius of maximum winds that is larger than what is observed in purely tropical systems,and their maximum sustained winds have not been observedto exceed about 32 m/s (64 knots). Subtropical cyclones in the Atlantic basin are classified by their maximum sustained surface winds: Subtropical depressions have surface winds less than 18 m/s (35 knots), while subtropical storms have surface winds greater than or equal to 18 m/s. [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [26], [27], [28], [29], [39]

Tropical cyclones are compact, circular storms, generally some 320 km (200 miles) in diameter, whose winds swirl around a central region of low atmospheric pressure. The winds are driven by this low-pressure core and by the rotation of the Earth, which deflects the path of the wind througha phenomenon known as the Coriolis force. As a result, tropical cyclones rotate in a counterclockwise (or cyclonic) direction in the Northern Hemisphere and clockwise (or anticyclonic) direction in the Southern Hemisphere. [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [26], [27], [29], [39]

NGC 5247 Spiral Galaxy

Spiral galaxies [40, 41, 42, 43] form a class of galaxy originally described by Edwin Hubble in his 1936 work The Realm of the Nebulae and, as such, form part of the Hubble sequence. Most spiral galaxies consist of a flat, rotating disk containing stars, gas and dust, and a central concentration of stars known as the bulge. These are often surrounded by a much fainter halo of stars, many of which reside in globular clusters. [54]

Spiral galaxies are named by their spiral structures that extend from the center into the galactic disc. The spiral arms are sites of ongoing star formation and are brighter than the surrounding disc because of the young, hot OB stars that inhabit them [42, 43, 47, 54].

The Figure (1) shows NGC 5247, a grand design barred spiral galaxy, located 60–70 million light-years away. The galaxy lies face-on towards Earth, thus providing an excellent view of its pinwheel structure and multiple arms. It is in the zodiacal constellation of Virgo (the Maiden). [55]

The image was made in infrared light with the HAWK-I camera on ESO’s Very Large Telescope at Paranal Observatory in Chile. HAWK-I is one of the most powerful infrared imagers in the world, and this is one of the sharpest and most detailed pictures of this galaxy ever taken from Earth. The filters used were Y (shown here in blue), J (in light blue), H (in green), and K (in red). The field of view of the image is about 6.4 arc minutes. [55]

NGC 5247 is a face-on unbarred spiral galaxy located some 60 million light years away in the constellation Virgo. It is a member of the Virgo II Groups, a series of galaxies and galaxy clusters strung out from the southern edge of the Virgo Super cluster. This grand design spiral galaxy displays no indications of distortion caused by interaction with other galaxies. It has two spiral arms that bifurcate after wrapping halfway around the nucleus. The disk is estimated to be 4.9 ± 2.0 kly (1.5 ± 0.6 kpc) in thickness and it is inclined by roughly 28° to the line of sight. [56]

Cote’s spiral

In physics and in the mathematics of plane curves [29, 30, 31, 32, 33, 34, 35, 36], a Cote's spiral (also written Cotes' spiral and Cotes spiral) is one of a family of spirals classified by Roger Cotes.

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Figure 1. HAWK-I image of NGC 5247 Galaxy.
Source: [55]

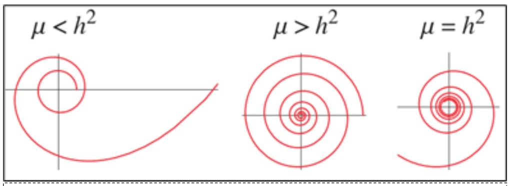

Figure 2. Shapes of curves called Cote's spiral gives the solution to the central orbit problem, where the radial force has the form equation (1).
Source: [58, 59, 60, 61]

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Development

After an analysis of the different types of spirals [29, 30, 31, 32, 33, 34, 35, 36], it was concluded that the form that came closest the spiral, Figure (1, 2, 4-6), is a double Cotes's Spiral, for the case $\mu < h^2$, Figure (2) [26].

It was determined the mathematical equation of the shape of the Dragonhead cyclone, in the shape of a spiral called Cotes's Spiral", for the case $\mu < h^2$, Figure (2) [24, 25, 26].

A spiral that gives the solution to the central orbit problem under a radial force law

$$\ddot{r} = -\mu[r] - 3\hat{r} \qquad (1)$$

where μ is a positive constant. There are three solution regimes,

$$r = A sec\ (k\theta + \epsilon) \qquad (2)$$

where $k^2 = 1 - \frac{\mu}{h^2}$, when $\mu < h^2$,

where A and ε are constants, and h is the specific angular momentum [26, 37, 38].

Analyzing the shape of the Spiral shape called "Cotes's Spiral" for $\mu < h^2$ [24, 25], it appears that adding two constants to Equation (2) makes the necessary adjustments for the Isobaric ones. In the case of Dragonhead cyclone, the spiral that gives the solution to a radial force law is given by Equation (1).

An adjustment in Equation (2) is necessary to obtain the graph of Figure (7). Then, adding the constants

$B \neq 0$ and C where for $\mu < h^2$.

The equation is defined for the Dragonhead Cyclone:

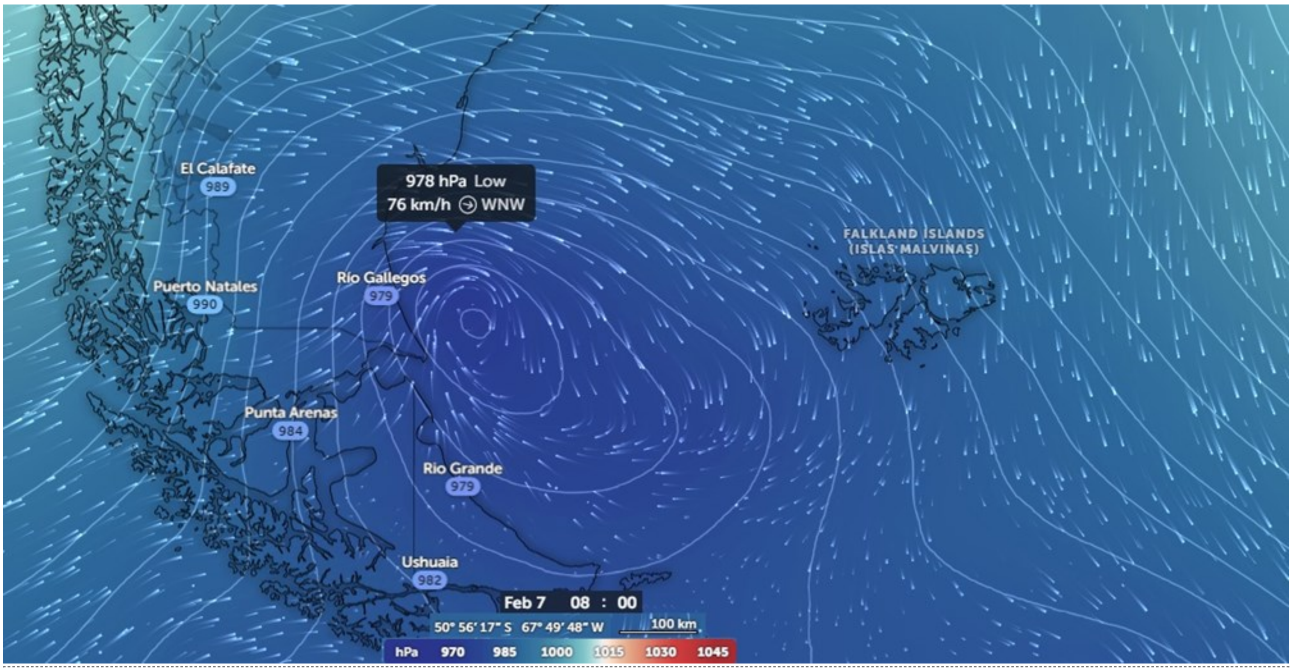

Figure 3. The Figure shows isobaric and wind lines at 500 m height, in the south of the American continent. Source: [57, Adapted Authors]

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Figure 4. Image of the Dragonhead cyclone, at 8 am (UTC), February 7, 2024.
Source: [57, Adapted Authors]

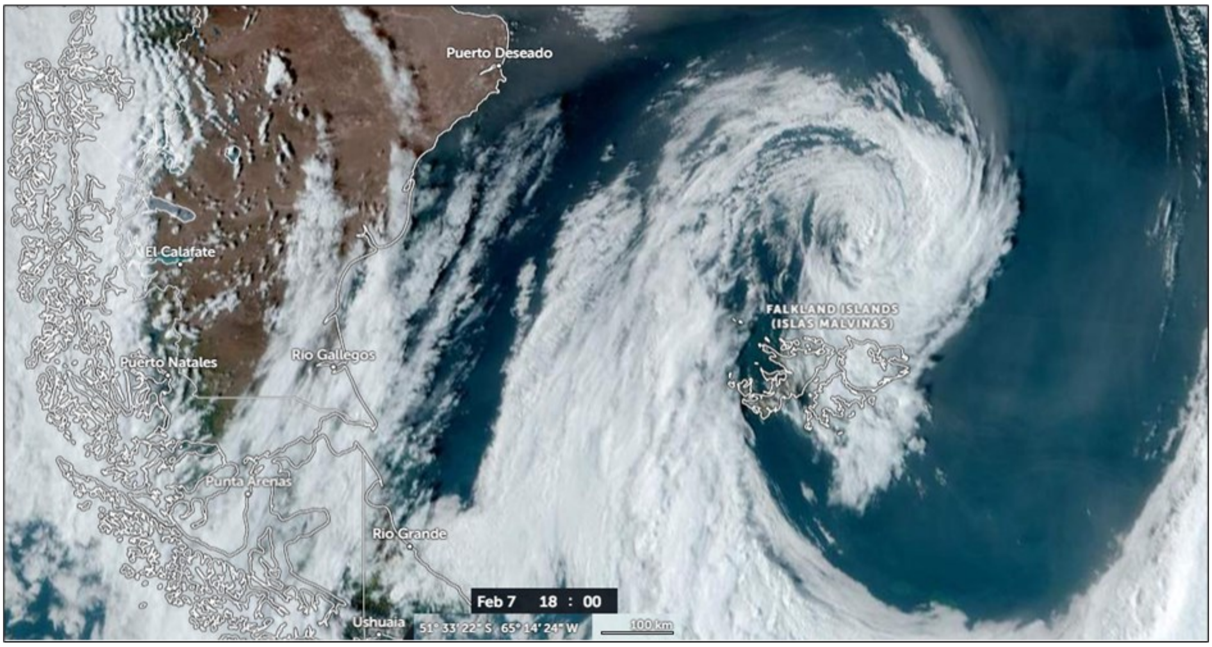

Figure 5. Image of the Dragonhead cyclone, at 6 pm (UTC), February 7, 2024.
Source: [57, Adapted Authors]

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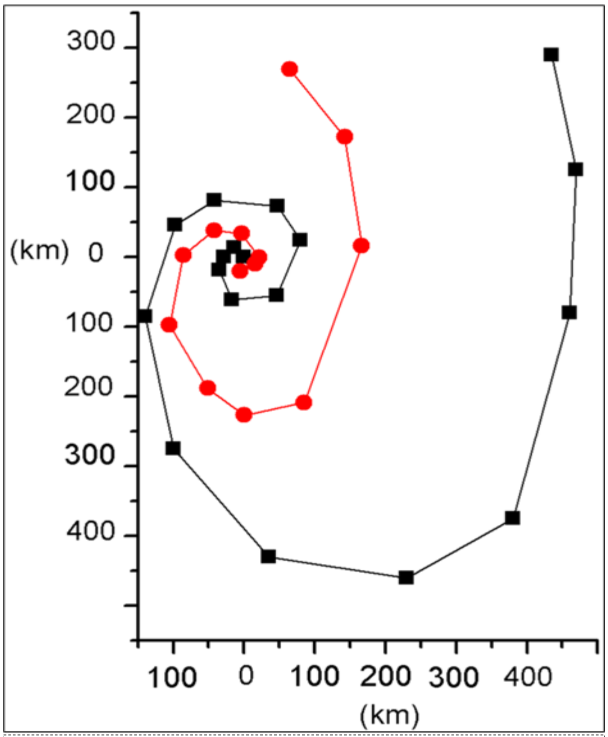

Figure 6. Graphic plot of the dimensions and shape of the Dragonhead cyclone, as at 18 am (UTC), February 7, 2024.
Source: [Authors]

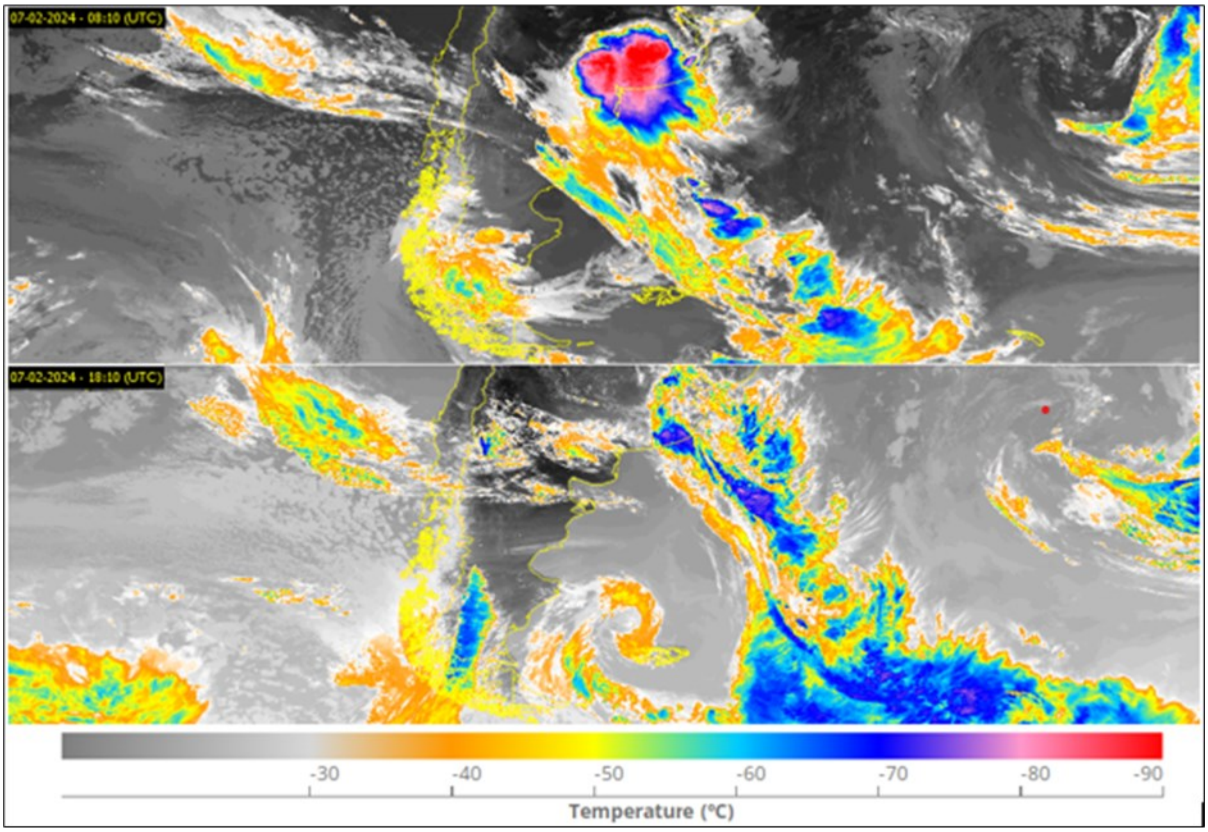

Figure 7. Image of atmospheric temperature at 500m altitude of the Dragonhead cyclone, 8:10 am (UTC) at 6:10 pm (UTC), February 7, 2024.
Source: [64, Adapted Authors]

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Table 1. Dragonhead cyclone coordinates/Pressure/Temperature, in accordance with the analyzes and measurements in Figures (4) and (7).

February 7, 2024	Coordinates	Pressure (hPa)	Temperature (ºC)
08:00 am (UTC)	52°46’08”S 67°49’48”W	978	-50
06:00 pm (UTC)	51°33’22”S 65°14’24”W	970	-45

$$r = BAsec\ (k\theta + \epsilon)\ + C \qquad (3)$$

The Software for creating the graphics was Origin Lab evaluation version 2018, Figure (6). [63]

For calculations the computer used a Desktop with SUSE Linux Enterprise Desktop [64], AMD Ryzen 7 1800X processor [65], ASUS Prime A320M-K motherboard [66], 16GB of RAM, with 500GB SSD [67].

Figures (4) and (5) were used to determine the speed, atmospheric pressure, temperature, dimensions of the Dragonhead cyclone.

Analysis and Results

With winds coming from the Pacific Ocean, the cold front crosses southern Chile and Argentina. Forming from the region of Puerto Natales, Punta Arenas (Chile), El Calafate, Rio Galegos, Rio Grande and Ushuaia (Argentina), as shown in Figure (4), 4h UTC on February 7, 2024. The cold coming from the Pacific collides with a mass of hot air coming from the north of the province of Santa Cruz and central-south of Chubut.

On February 7, 2024 at 18:00 UTC, the cyclone reached an area of influence of 3,247 thousand km^2. It had a head/neck of elliptical dimensions measuring 639 km by 552 km, whose core was located at 45° 36'S, 21°31'W, north of the Falkland Islands. With winds of 84 km/h, it had already traveled 640 km in 10 hours, with an average of 64 km/h, according to the analyzes and measurements in Figures (4-6).

The variation in temperature and water sality were not studied in the work, leaving their influence on the formation of cyclones in the region for later studies. As for the cyclone temperature during its formation, Table (1) varies from -45ºC to -50ºC at its edge, while at its core it varies between -10ºC to -25ºC.

It had a pressure of 978 hPa, February 7, 2024 at 08:00 am (UTC), 100 km north of the nucleus Figure (5), with winds of 76 km/h, with a nucleus at 970 hPa. Taking off in the WNW direction.

It appears that the spiral shape of the Dragonhead is very similar to the shape of the spiral galaxy NGC 5247, presenting the same shape. The analogous shape of Dragonhead cyclone and the NGC 5247 Galaxy, studied here is clear. These present a double Cote's spiral. Studied by Lindblad [47], but with the Cote’s spiral form, (Gobato et al. 2022) [8], [9], [11].

The Figure (2) show shapes of curves called Cote's spiral gives the solution to the central orbit problem.

The Table (1) shows the coordinates of Dragonhead cyclone, February 07, 2024, am/pm, a central vortex pressure of 951 hPa, with an approximate dimension of 10 km.

The Figure (3) shows isobaric and wind lines at 500 m height, in the south of the American continent.

The pressure at 500m height in the cities of El Calafate, Puerto Natales, Ushuaia, Rio Grande, Rio

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Galegos, are 989, 990, 984, 982, 979 and 979 hPa, respectively. In the Falkland Islands (Malvinas Islands) it is between 984 and 990 hPa.

The Figures (4) and (5) show the trajectory of the dragonhead cyclone between 08:00 am (UTC) and 06:00 pm, February 7, 2024.

The Figure (6) it represents the dimensions of the points collected from Figure (5), in km, using the Isobaric [30,31] found in Figures (3-5).

The Figure (7) show the cyclone temperature during its trajectory, Table (1), varies from -45ºC to -50ºC at its edge, while at its core it varies between -10ºC to -25ºC.

Other spiral galaxies, vortex storms, have also been analyzed [48, 49, 50, 51, 52, 53].

Conclusions

Extratropical cyclones are common in the South Atlantic. They generally arise with the passage of cold fronts to the south of the South American continent, crossing the south of Chile and Argentina, in the regions of Puerto Natales, Punta Arenas (Chile), Rio Galegos, Rio Grande, El Calafate, and Ushuaia (Argentina). The extratropical cyclone analyzed, presented at its peak the very characteristic shape of a Chinese dragon. Mathematical analysis of the way the cyclone pressure curve behaves is that of a double Cotes's Spiral . Here called the Dragonhead cyclone, indicate structural similarity with spiral galaxies, especially NGC 5247, in the constellation Virgo. With an area of influence and a size of around 3,247 thousand km^2 at its peak, it moved quickly in a WNW direction, with an average speed of 76 km/h, with winds of 84 km/h at 100 km from the nucleus, as it passed north of the Falkland Islands (Malvinas Islands).

In the data collected [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21] and analyzed from the Dragonhead cyclone, it is clear that all extratropical cyclones that appear south of the South American continent, below 40° latitude, have the shape of a spiral curve, like the spiral galaxy. Most of these are in the form of a double Cote's spiral curve.

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