PIUFORTAVI

PROCÉDÉ INDUSTRIEL D'UPWELLING FOR TROPICAL AND VOLCANIC ISLAND

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PROCEDE INDUSTRIEL D'UPWELLING

Industrial Upwelling Process On the Cape Verde Archipelago To Reduce the Frequency and Intensity of the Cyclonic Activity on the North Atlantic

SUMMARY

Global warming is responsible in the increase of the intensity of tropical cyclones. Professor James Hansen of Columbia University prediction's, described in 2009 in his now unavoidable book, that our grandchildren would see monstrous cyclones with winds of more than 400 km / h, and was almost true in 2017 with the cyclone Irma whose winds have reached more than 350 km / h.

Hurricanes draw their energy from the warm ocean surface waters, if this temperature continues to increase it is obvious that these extreme weather events will be more and more devastating.

But with the technical means that humanity has at the moment we can stop the production of hot surface waters of volcanic islands around the equatorial belt between the two tropics.

On the continental shelf of each major island in this intertropical zone, high-speed centrifugal electric pumps (electricity produced by solar panels and wind turbines) should be installed at the beach or coastline. These pumps should be spaced at even distances to create an upwelling phenomenon or large-scale cold rise of water to obtain a cooling flow of the oceanic mixture layer of more than 2 degrees.

This is the subject of the presentation of the Upwelling Industrial Process for Tropical Island and Volcanic applied on the Cape Verde Archipelago, PIUFORTAVI, patent filed on ....

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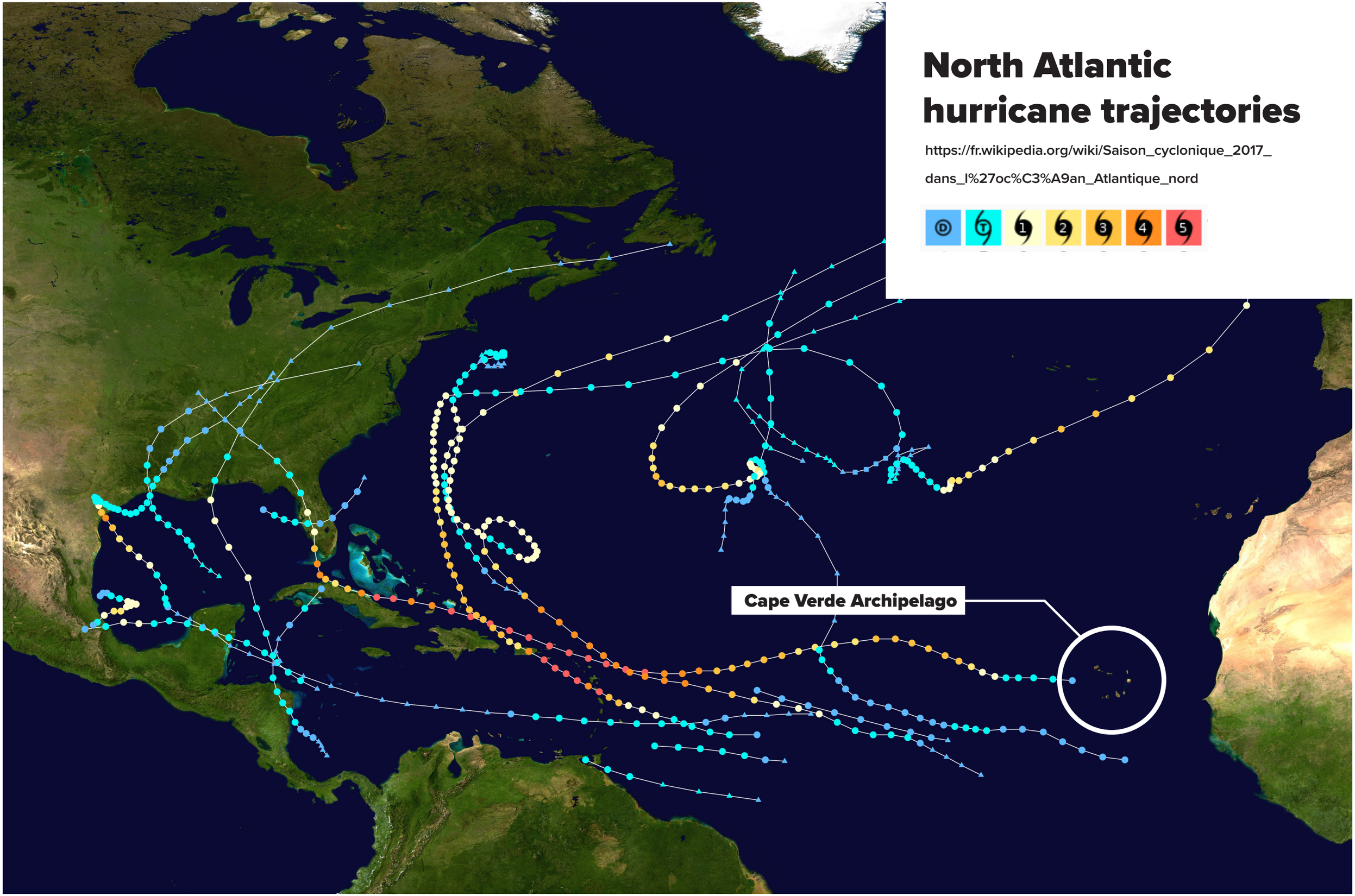
North Atlantic hurricane trajectories

https://fr.wikipedia.org/wiki/Saison_cyclonique_2017_dans_l%27oc%C3%A9an_Atlantique_nord



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NORTH ATLANTIC HURRICANE TRAJECTORIES

The 2017 hurricane season, from early July to late September, was particularly intense in the North Atlantic, with four major hurricanes, **Harvey, Irma , José and Maria**, reaching Category 5 the maximum intensity on the Saffir Simpson scale

The damages caused are considerable and coat more than $ 300 billion and affected countries including T**exas, Florida, Cuba, Puerto Rico, Haiti and Saint Martin**.

The highlights of these extreme weather phenomena:

- **Irma** , the deadliest in Haiti and Cuba with hundreds of victims;

- **Maria** was the most intense with a depression at 907 Hpa

- and the most expensive in Texas was **Harvey**, in terms of destruction of more than $ 190 billion in damage is due to Harvey.

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The genesis of a cyclone, known conditions for the formation of

- a hurricane in Northern Atlantic,

- cyclone in the Indian Ocean,

- typhoon in the Pacific Ocean

Cyclones need the convergence of several conditions to be created and develop:

1. Initially, a **high humidity** greater than 70%, which exists in the intertropical convergence zone (p23) , is needed for cumulonimbus cloud masses to form.

2. then, not to chase these convective clouds we need an absence of wind at altitude.

3. then a pressure gradient(p24) to set the moist air masses in motion and cause incipient depression.

4. we also need a geographical condition with the pseudo force of Coriolis (p25) to deviate to the right, in the northern hemisphere, moving particles in this nascent depression. Depressions and cyclones can not form near the equator where the horizontal component of the Coriolis force is zero.

5. Finally, of course, **warm, moist air is needed from the ocean / atmosphere exchange**. This exchange takes place only in the superficial layer of mixture above the thermo cline as the water is very cold at the bottom of the ocean. It therefore takes a last thermal condition to feed this nascent depression so that it becomes a cyclone, **the temperature of the surface water(p26) and in this layer of mixture must be greater than 26 ° C over a thickness of 50 meters.**

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Observation 1, the critical zone or nursery that feeds the cyclonic activity in the Northern Atlantic Ocean

Over 27 years of observation, between 1988 and 2015, 95% of the Northern Atlantic cyclones **originated around the Cape Verde archipelago** (600 nautical miles to the west, southwest) **between latitudes 12 ° and 17 ° North and longitudes 22 ° and 37 ° West.**

The major hurricanes of 2017 do not escape this statistic; they were also formed in this critical zone.

Indeed, in north-eastern part of this geographical area are the islands of Cape Verde of volcanic origin, almost desert and arranged as a horseshoe. This almost closed arrangement **blocks the ocean circulation of cold water from the natural upwelling(p6) that occurs on the Moroccan, Mauritanian and Senegalese coasts following terrestrial rotation.**

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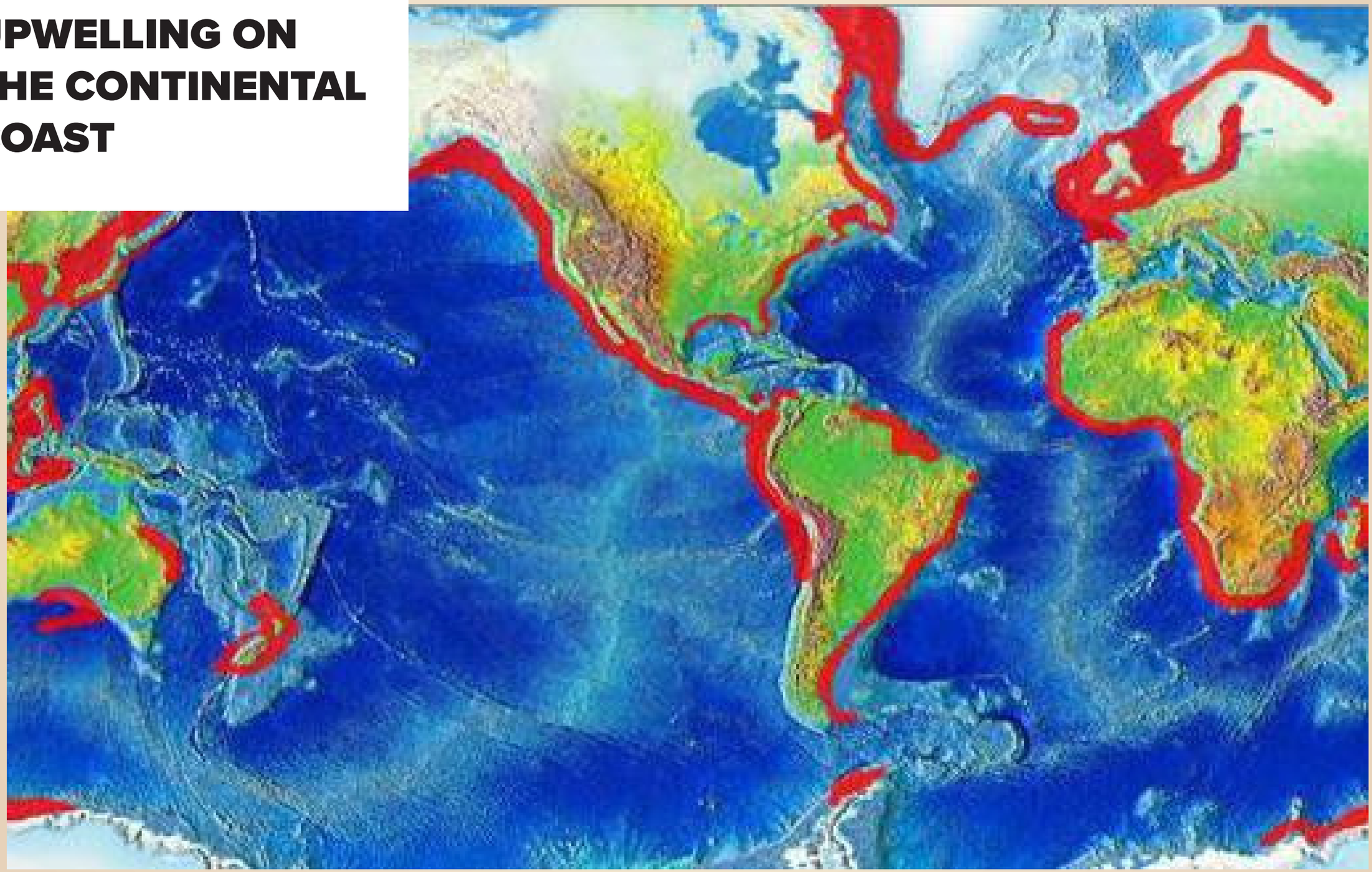
WORLD MAP OF UPWELLING ON THE CONTINENTAL COAST



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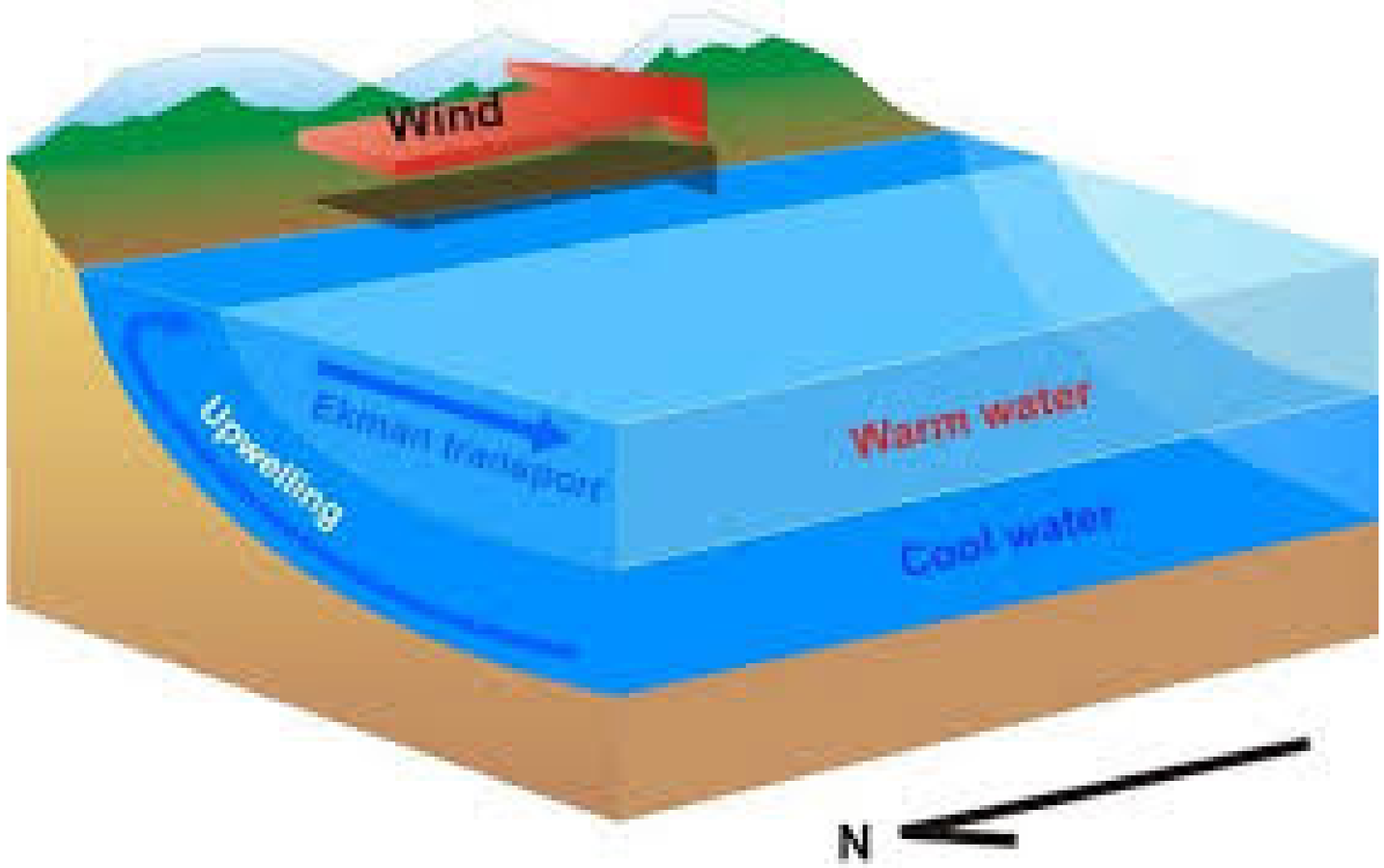
Definition of Upwelling, how does cold upwelling occur on a continent coast?

The mechanism of natural upwelling is shown here:

- In the northern hemisphere, on the Moroccan and Mauritanian coasts, as an example trade winds blow along the coast towards the south-west.

- The Coriolis force related to the Earth's rotation deflects the sea current generated by the wind to the right.

- So the warm surface waters are displaced towards the open sea and the void thus created is compensated by a rise in the cold waters of the seabed.



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Observation 2, production of surface warm water and mixed layer in the North Atlantic

The Cape Verde Islands Boavista, Maio, Sal, Sao Vicente and Santa Lucia, are huge thermal machines.

The most extensive, Boavista is a desert placed on the sea, an almost uninhabited island of sand. It is a **gigantic open-air pressure cooker** that produces extremely hot surface water from June to the end of September 27 with more from 28 ° in August.

These very warm waters are naturally transported to the west / southwest by the equatorial north ocean current whose velocity is between 0.5 and 1kt. In 24 hours 12 to 24 nautical miles are traveled. In one month these warm waters reach **the critical zone of Northern Atlantic cyclone formation.**

Added to this trend is the wind effect, the very strong trade winds from Northeast to Southwest, blow with a 5/6 force on the Beaufort scale at certain times of the year. The loop is complete to supply warm waters to developing cyclones in the critical zone.

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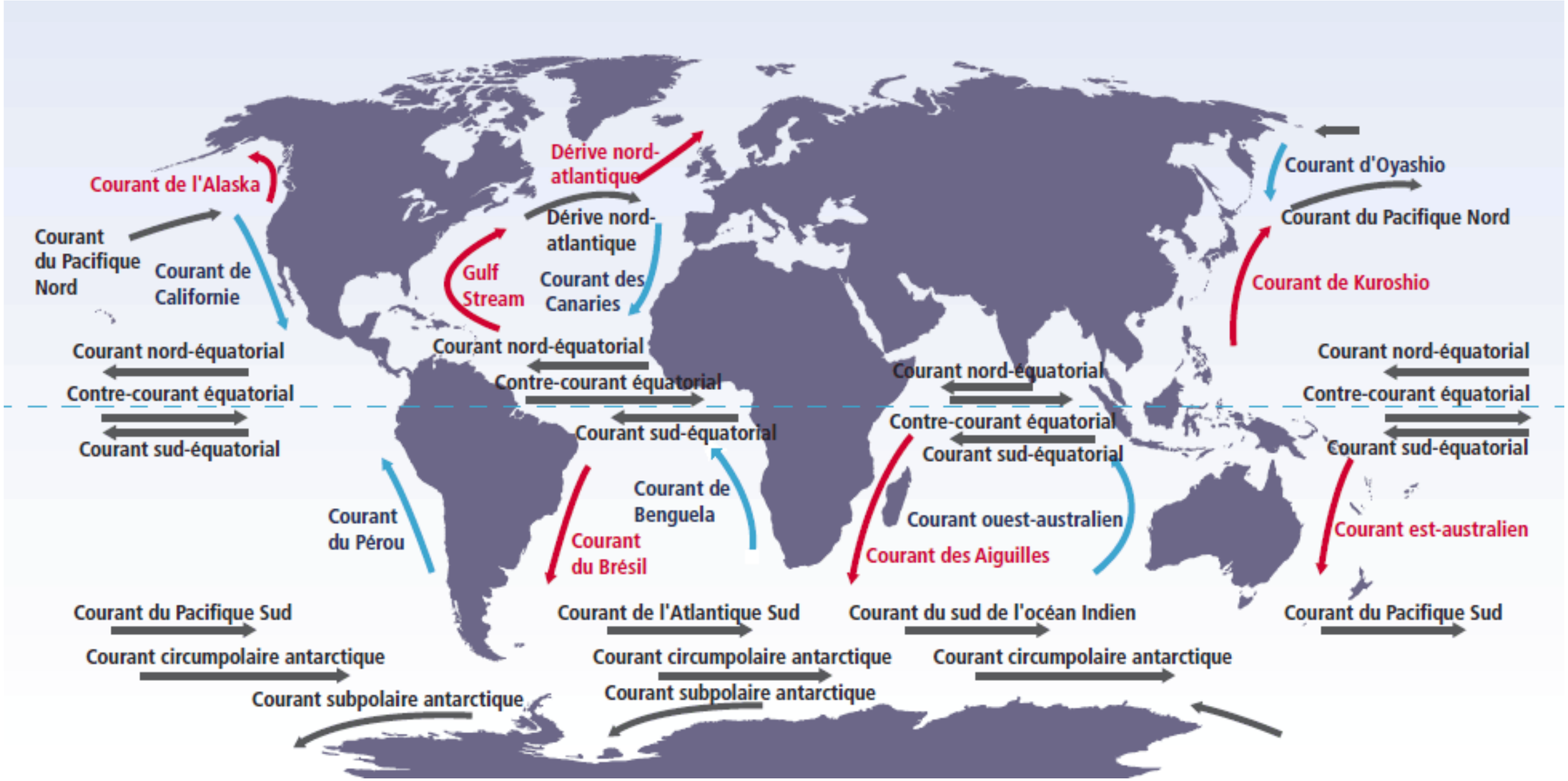
WORLD MAP OF OCEAN CURRENTS



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Northen Atlantic, The cold current of the Canaries

On the Northen Atlantic, **the Canary Islands cold current** of the North-East, resulting from the upwelling that occurs along the Moroccan, Mauritanian and Senegalese coasts, is hampered by the submarine relief formed by the volcanic activity that gave rise to the Cap verde Archipelago. The surface waters of the continental shelf of the various islands are warming above 26 degrees and are transported by the NEC (North equatorial current) from east to west, which favours and gives rise to tropical cyclones.

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South Atlantic, Benguela's cold current

However, if we look at what is happening in the Southern Atlantic, nothing blocks the cold water circulation of the powerful Benguela current resulting from the natural upwelling that occurs in the Gulf of Guinea and on the Namibian and South African coasts.

This current joins the SEC (south equatorial current) and crosses the ocean from east to west south of the equator by regulating the surface temperature. The Royal Navy charts confirm that, for the most part, the temperature average surface area of the South Atlantic remains below 26 ° C.(p27)

Because of this natural regulation of the surface temperature and the mixing layer, no cyclone is formed in the austral summer (from January to March) in this part of the southern hemisphere and the coasts of Brazil, Uruguay and Argentina are spared the devastating winds of category 3, 4 or 5 hurricanes.

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Conclusion

These observations lead us to think that the common point of all the hurricanes which cross the North Atlantic from East to West, is their Cape Verde origin.

It is therefore appropriate to cool the surface waters of certain islands of this archipelago on their continental shelf.

For example, the equatorial north ocean current that brews and transports these surface waters to the cyclone formation zone will now not circulate warm waters but cooled waters that will have the effect of reducing the surface temperature and the temperature of mixing layer over a large part of the equatorial north Atlantic, below 26 ° C, as in the South Atlantic.

Stopping the supply of warm waters from the Cape Verdean islands to the critical zone of formation of the initial depression can thus significantly reduce the frequency and the devastating intensity of these extreme weather events.

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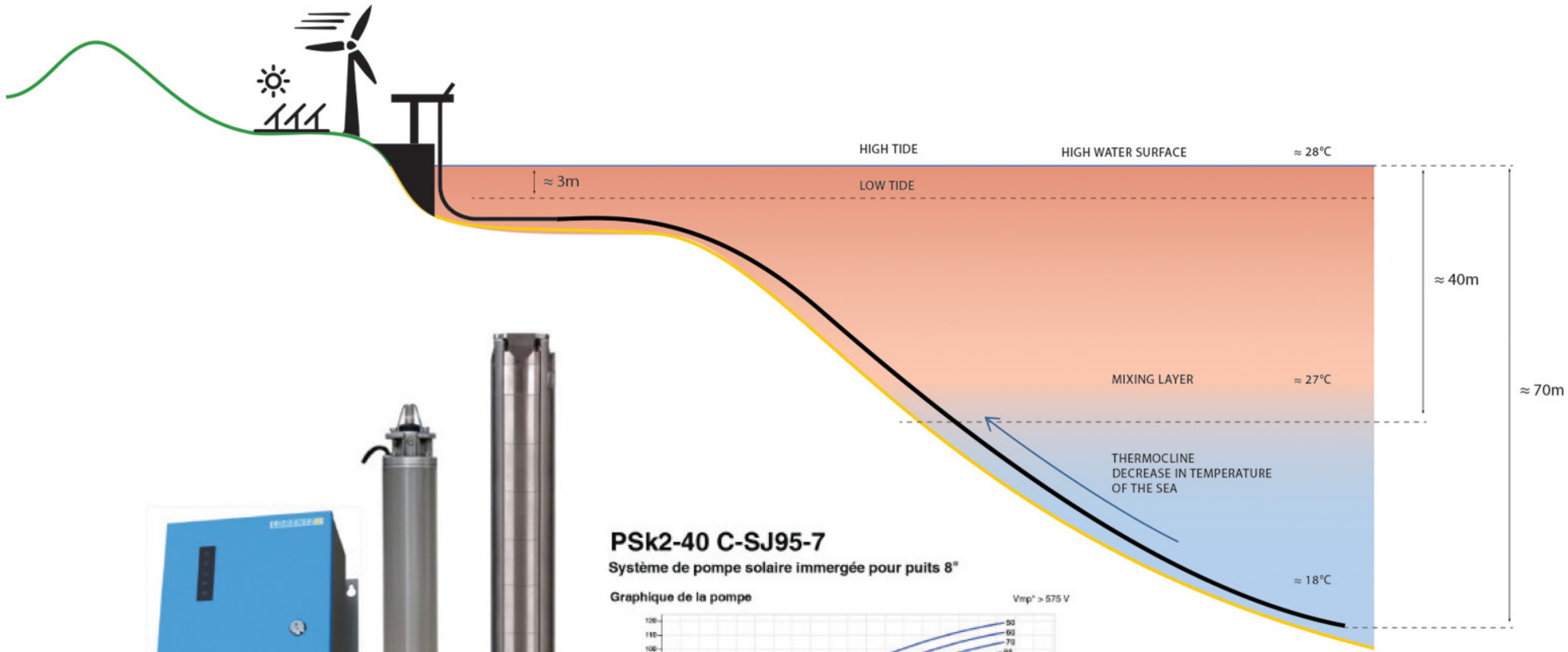
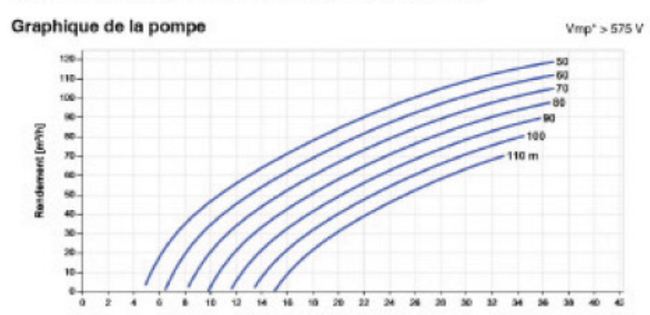
UPWELLING INDUSTRIAL PROCESS

Sectional appearance of the PIU installation of the pump group at the beach limit with solar panel and wind turbine plant. Diagram of the mixing layer of warm surface waters in red, cold waters deep in blue.





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UPWELLING INDUSTRIAL PROCESS

The industrial upwelling process consists of:

•Install on the Archipelago and at the beach or shore limit, on concrete ramps, 7000 electric centrifugal pumps with a large flow rate of more than 100m^3 per hour, submerged by 3 or 4 meters, linked to pipes in the seabed to the continental shelf limit to minus 70 m under the mixing layer. This arrangement makes it possible to raise cold water from the thermocline to around 18 ° Celsius.

•The energy will be provided by solar panels during the day with a useful life and satisfactory performance for about 10 hours. The efficiency of pumps is doubled by operating at night with wind energy. The investment is substantial but necessary to make a mix of both energies to have more flexibility during maintenance periods.

•It is on the largest and most deserted of the islands, Boavista, that it is necessary to concentrate the investment. Its perimeter is about 100 km and its continental shelf is on average 6km wide and 20m deep. There is therefore about 600km^2 of developed area and 12km^3 of water with mixed layer to be cooled, so 12 billion cubic meters.

•A pump operating with solar panels (for 10 hours) and with wind energy at night (for an additional 10 hours) and which already exists on the market for large watering plants, keeps daily 2000m^3 of cold water at 18 ° C. If it is dispersed with water cannons in a fine rain of 1,5cm / day, it can cover 133,000 m^2 or 0,133 km^2. To cover 600 km ^{2}, 4500 pumps will be needed.

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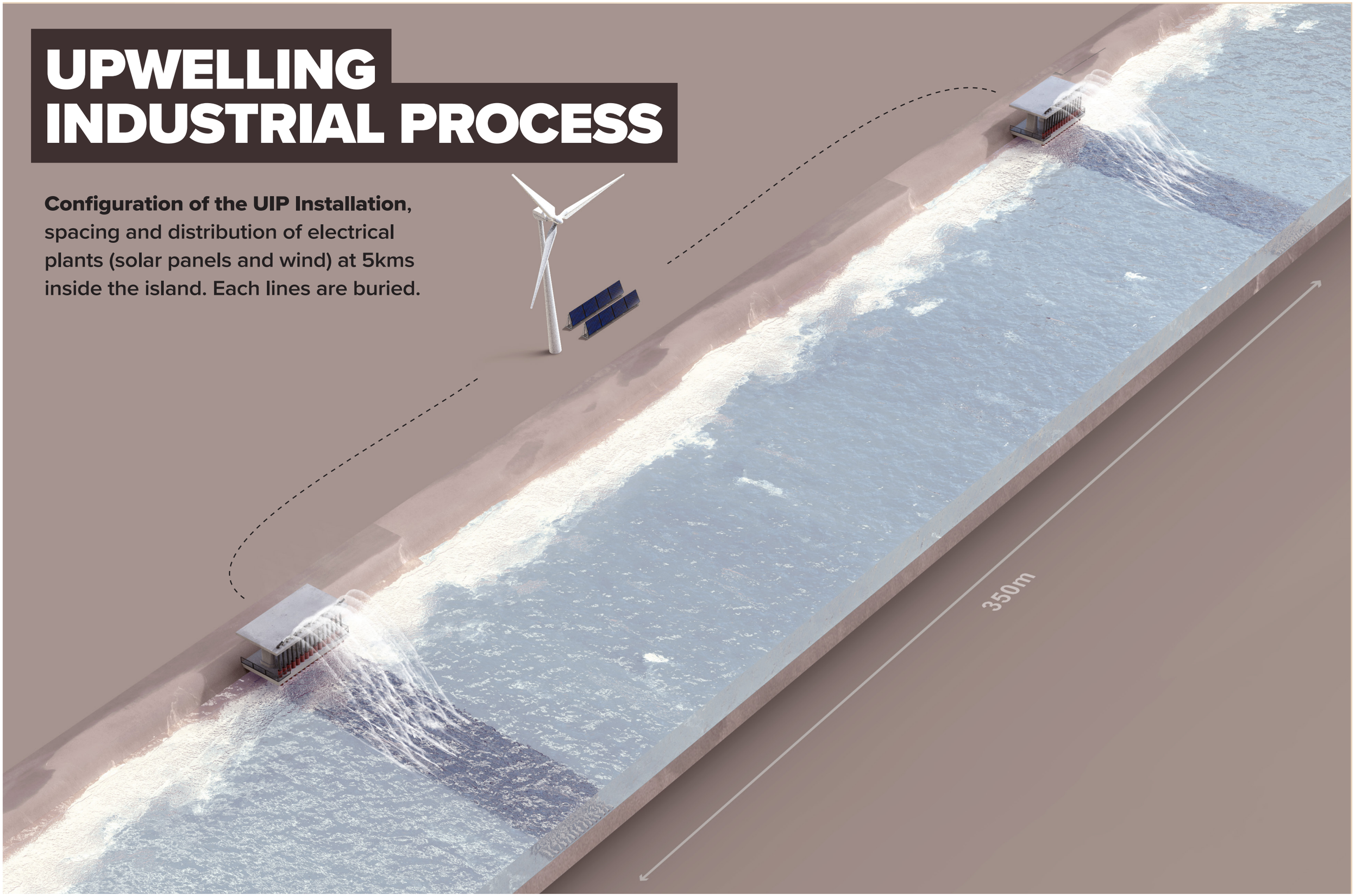
UPWELLING INDUSTRIAL PROCESS

Configuration of the UIP Installation, spacing and distribution of electrical plants (solar panels and wind) at 5kms inside the island. Each lines are buried.



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Configuration of the installation of the electric factories inside the island (at least 5 kms from the coast)

- On the island of BOAVISTA, every kilometer,

- solar plants and wind turbines are being built on the ground

- to provide electricity, 45 pumps connected to

- water cannons by flexible and / or rigid tubes resting on the bottom according to the underwater relief.

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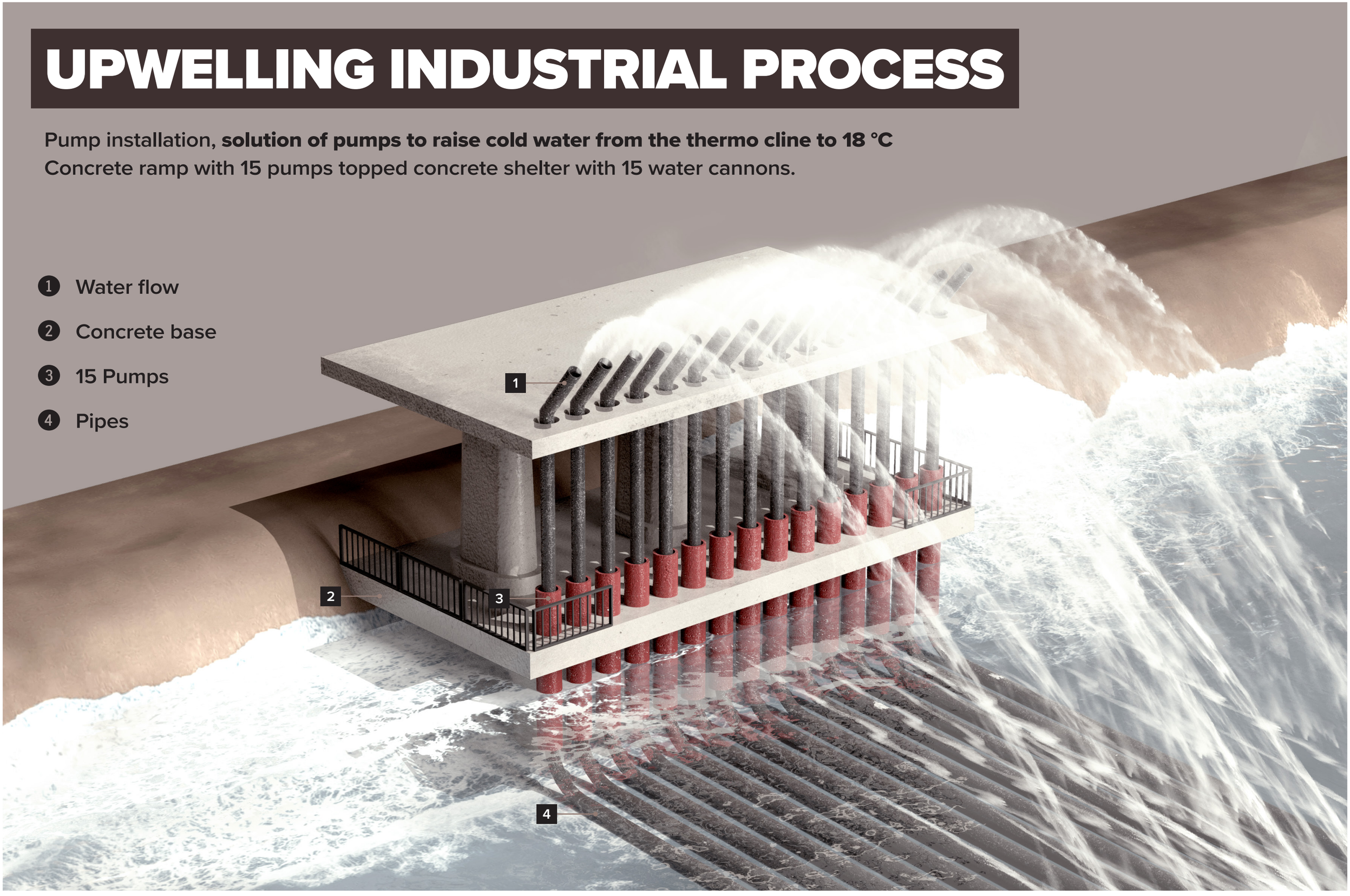
UPWELLING INDUSTRIAL PROCESS

Pump installation, **solution of pumps to raise cold water from the thermo cline to 18 °C**
Concrete ramp with 15 pumps topped concrete shelter with 15 water cannons.

1. Water flow
2. Concrete base
3. 15 Pumps
4. Pipes



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Example of Architecture and Design of beach ramp facilities at beach limit every 350 meters on Boavista Island.

- These water cannons placed on concrete foundations are located on the beach or coastline. Each solar and wind site provides 3 buried power lines spaced at 350 meters to each other.

- Each ramp of water cannons is fed by 15 pumps placed 3 to 4 meters deep to take account of the tide of about 1.5 meters on average. The pipes connecting each pumps arranged in seabed for several kms until in limit of continental shelf by 60/70 m of bottom.

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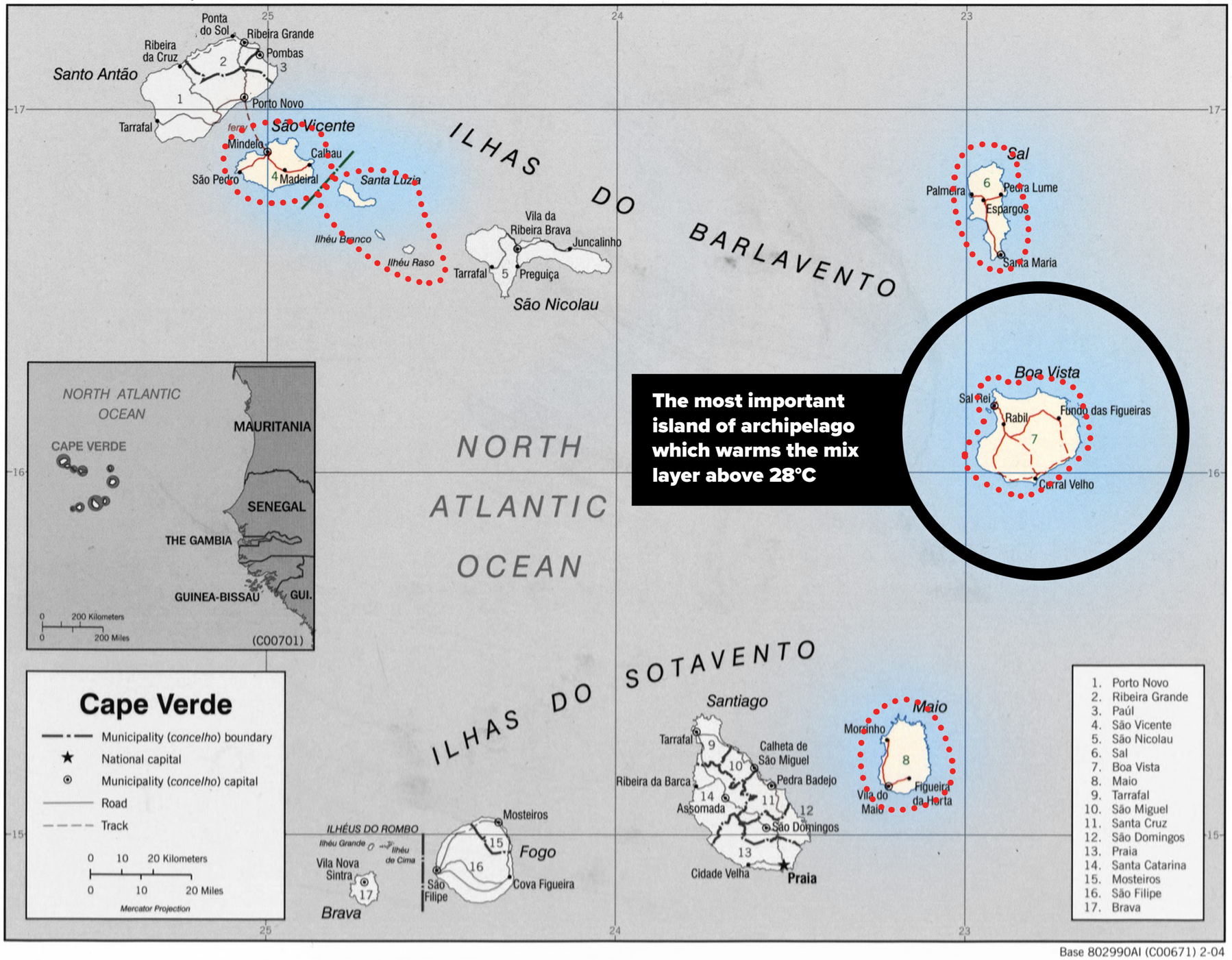

The most important island of archipelago which warms the mix layer above 28°C

Configuration of UIP positioning on the Cape Verde Archipelago

Distribution of 7000 pumps Islands equipped with UIP,

-Boavista 4500 pumps,

-Maio 1400 pumps,

-Sal 700 pumps,

-Sao Vicente 200 pumps,

-and Santa Lucia 200 pumps.

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The Cape Verde Islands equipped with UIP

A similar calculation leads to install:

- On **Maio island 1400 pumps**,

- on **Sal island 700 pumps**,

- on **Sao Vicente islands 200 pumps**,

- and on **Santa Lucia island 200 pumps**.

Which makes a **total of 7000 pumps**

- for an estimated cost of 700 million to 1 billion €

- infrastructure (roads, bridges, habitat, desalination plants for the population, air and sea links, reforestation ...) to make or improve.

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Generalisation of PIU and side effects to exploit

The upwelling industrial process in the Cape Verde Archipelago will reduce the frequency and intensity of hurricanes in the North Atlantic at first, but it will certainly be necessary to generalise it for more efficiency on the archipelago of Caribbean islands who have an important continental shelf: **Martinique, Guadeloupe, PortoRico, Dominican Republic, Haiti, Jamaica, Cuba** and in the Gulf of Mexico it will also be necessary to equip C**ampeche Bay and northern Yucatan** with PIU.

This industrial process can be generalised on the equatorial belt around the world after studying maps and currents,

- in the Indian Ocean on the nursery located in the **Chagos Archipelago**,

- on the North Pacific nursery located in the **Mariana Archipelago**

and on that of the **South Pacific** in the area of **Fiji, Vanautu, New Guinea and Solomon Islands**

Beneficial side effects:

- The cooling of the surface water and the mixing layer renews the water in contact with the atmosphere which favors the absorption of carbon dioxide, a greenhouse gas, by the ocean.

- The upwelling favors the fishery resources which favors the development of marine farms.

We have 4 hours per day of free renewable energies to develop human activities after desalination of seawater:

- improvement of agriculture, livestock and food crops,

- reforestation prospects in coffee, cocoa, vines, exotic fruits ...

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Efficiency of the PIU

-To measure the efficiency of the process, we carry out the c**alculation of the average temperature of the mixture of water masses M and m.**

-**M** being the water body of the continental shelf around Boavista, for exemple, at the temperature of t1 = 28 degrees, then t2 is day 2, then ti after i number of days (i varies from 1 to 365).

-**m** is the mass of the body of water reassembled daily by the PIU at temperature t (around -70m t = 18 degrees).

-After one day of operation of the PIU, the average temperature is in the ratio of water masses in the presence as follows: t2 = (Mt1 + mt) / (M + m)

-This equation is simplified by asking x = m / M which gives: t2 = (t1 + xt) / (1 + x)

-x being very small we can approach the value 1 / (1 + x) by the first 2 terms of its limited development (complete formula on Wikipedia), we retain the approximate value: 1 / (1 + x) # 1-x

-Hence the equation of the value of t2 becomes: t2 = (t1 + xt) (1-x)

-After development, the term squared is negligible and the approximate formula is finalized by: t2 = t1-x (t1-t)

-By an iterative calculation it comes: t3 = t2-x (t2-t)

-We replace t2 by its value as a function of t1 and by neglecting the square terms of x we have thus: t3 = t1-2x (t1-t)

-And so on, the term of rank i becomes ti = t1- (i-1) x (t1-t)

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Digital application on the continental shelf of Boavista Island

-**Numerical application for i = 365, t1 = 28 ° C, t = 18 ° C**

-**After one year of operation of the PIU we have: t365 = 28-3640x**

-The values of x = m / M on the island of Boavista: for M, the volume to be cooled is 12 billion m3.

-With a **solar power operation of only 10 h per day**, 4500 pumps go up m = 4.5 million m3day and x = 3.75 / 10000.

-It comes t365 = 28-3640 * 3.75 / 10000 ie: **t365 = 26.635 degrees**

-It is deduced that the cooling of only 1.365 ° C is largely insufficient.

-Let's now examine with a **solar and wind operation of 20h per day** m = 9 million m3 / day,

-x = 0.75 / 1000 and it comes for t365 = 28-3640 * 0.75 / 1000 ie: **t365 = 25.27 degrees.**

-This cooling of more than 2 degrees, applied to the Cape Verde Islands, is sufficient to keep the surface waters of the critical North Atlantic area below the 26-degree threshold, which triggers the hurricane formation process.

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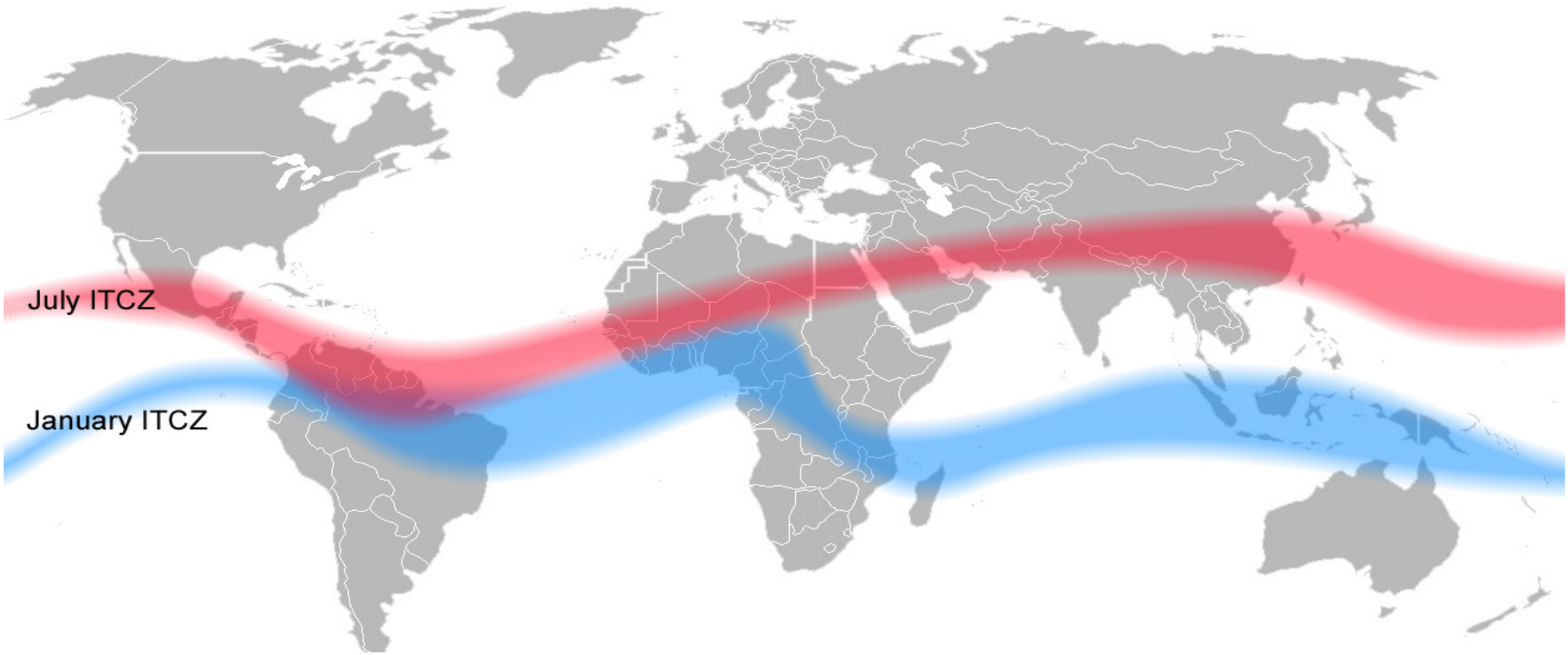
Appendix 1: Definition of the Intertropical Convergence Zone

The **Intertropical Convergence Zone (ITCZ)**, known by sailors as the doldrums, is a belt of a few hundred kilometers with low pressure areas, encircling Earth near the Equator, where the northeast and southeast trade winds converge.

"It is formed by the convergence of hot, humid, anticyclonic air masses coming from the tropics carried by Trade Winds. It is characterized by convective motions of Hadley's cells that lead to significant cumulonimbus formations.



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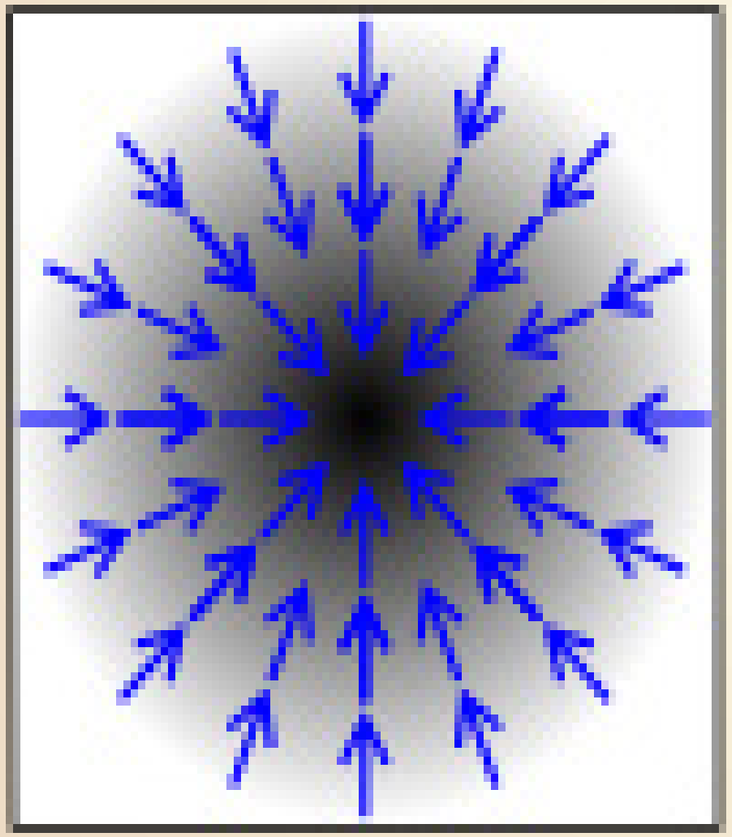
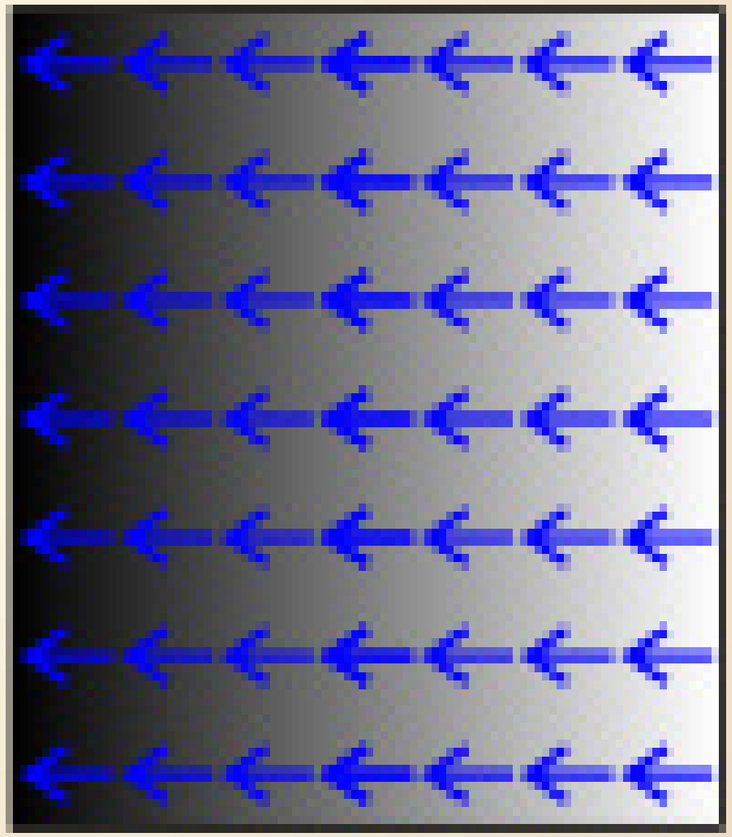
Appendix 2: Definition of the pressure gradient

"The pressure gradient is one of the main forces that act on the air and cause it to move, producing the wind. The force exerted by the pressure gradient, directs high pressure areas towards low pressure areas. "





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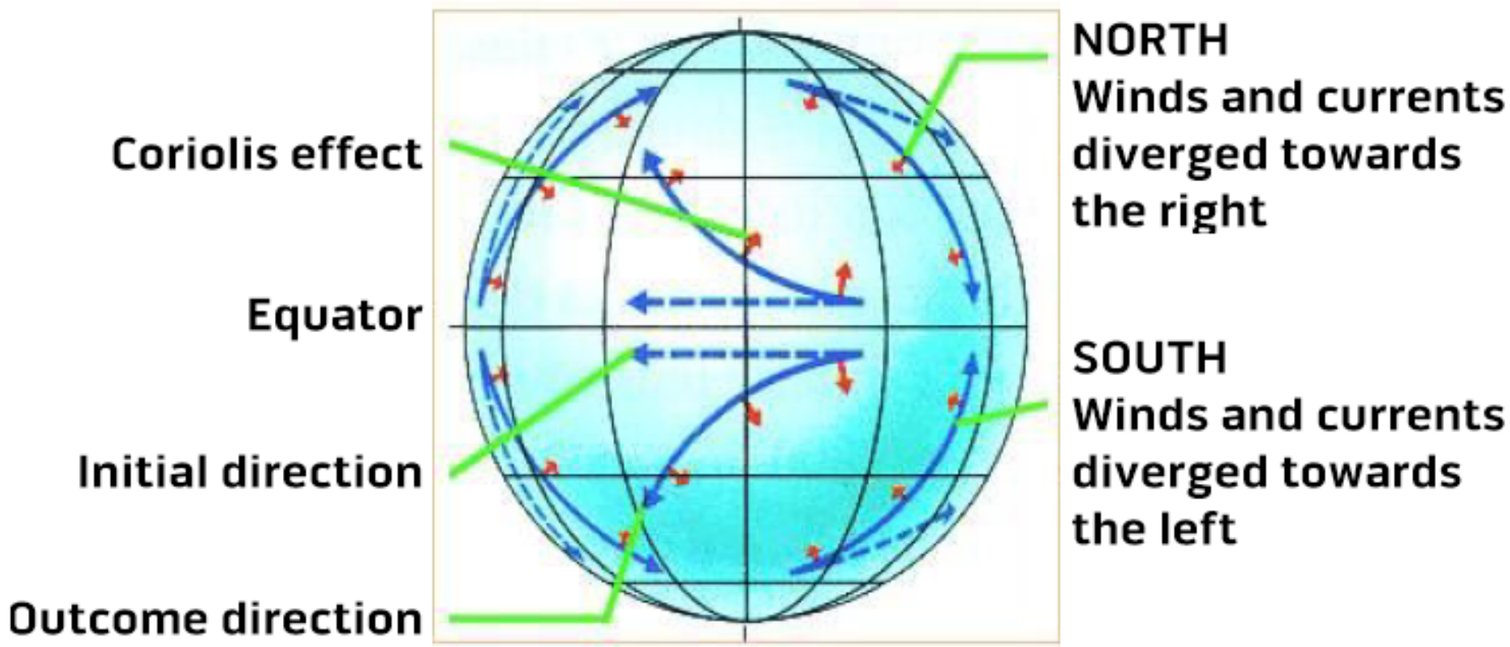
Appendix 3: Pseudo force of Coriolis definition

The Coriolis Effect (Universalis encyclopedia)

"Because of the rotation of the Earth, the Coriolis force deflects any movement to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. It therefore has enormous consequences on the movement of water and air currents: thus, the general direction of surface ocean currents occurs in a clockwise direction the northern hemisphere and counter-clockwise in the southern hemisphere; the trajectory of trade winds blowing westward on either side of the equator curves northward in the northern hemisphere and southward in the southern hemisphere; the direction of rotation of atmospheric turbulence ,cyclones and tornadoes, follows the same principle. The Coriolis force is zero at the equator and increases with latitude to its maximum at each poles. "



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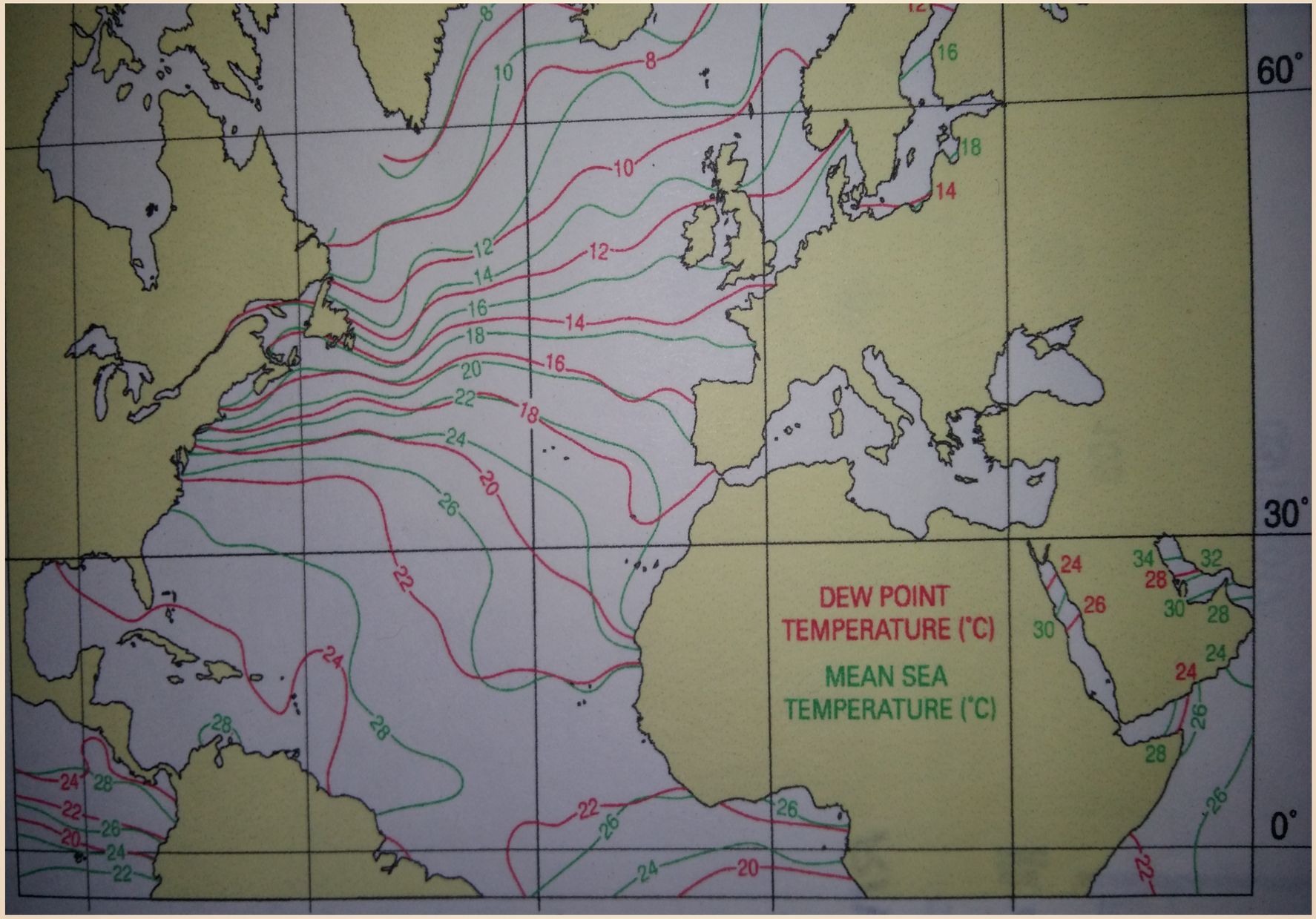
Appendix 4: Surface temperature of the North Atlantic Ocean in August

Source: Royal Navy North Atlantic map (August 5124)



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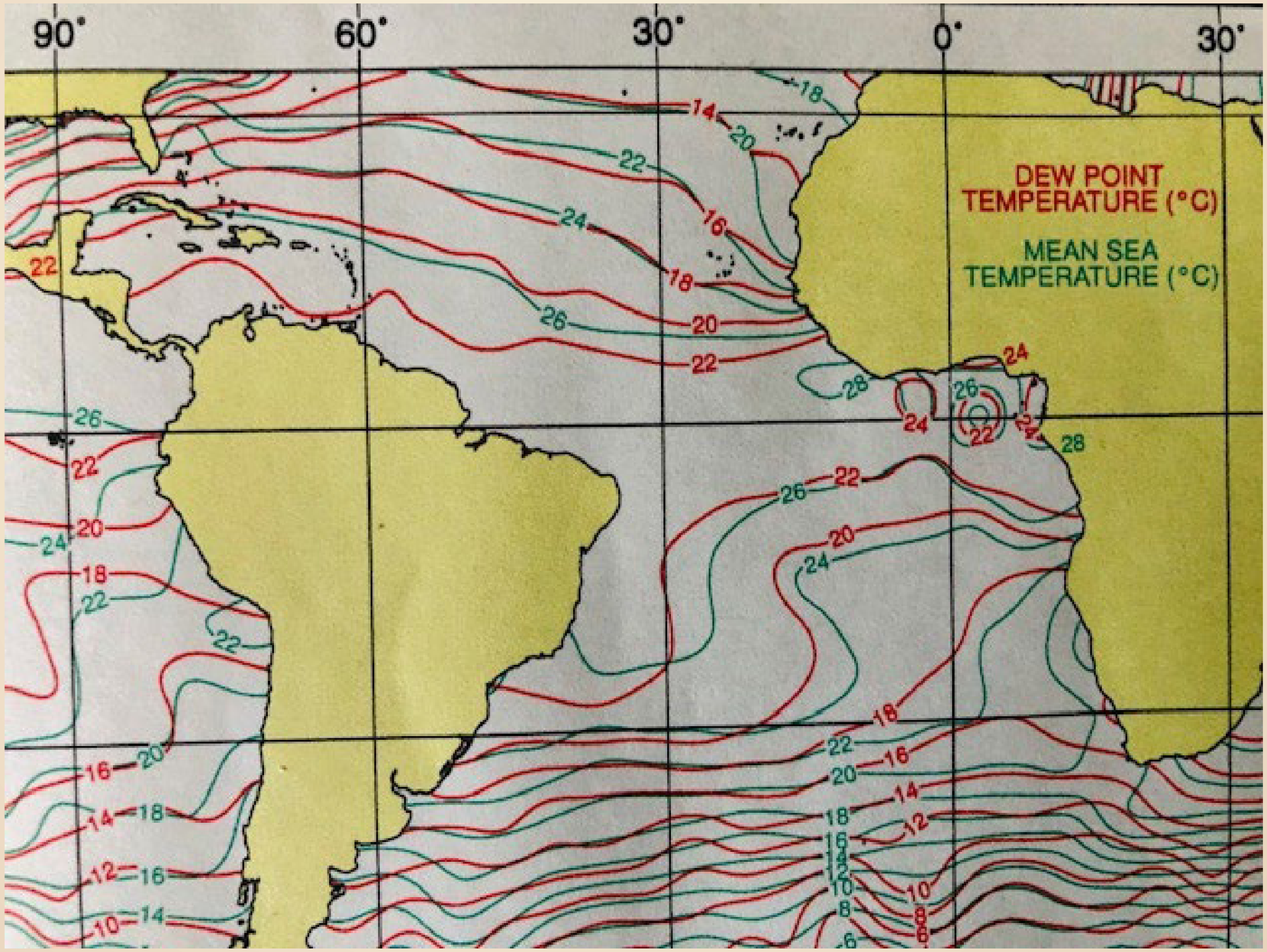
Appendix 5: Temperature of the South Atlantic Ocean in January

Source: Royal Navy South Atlantic map (January 5125)



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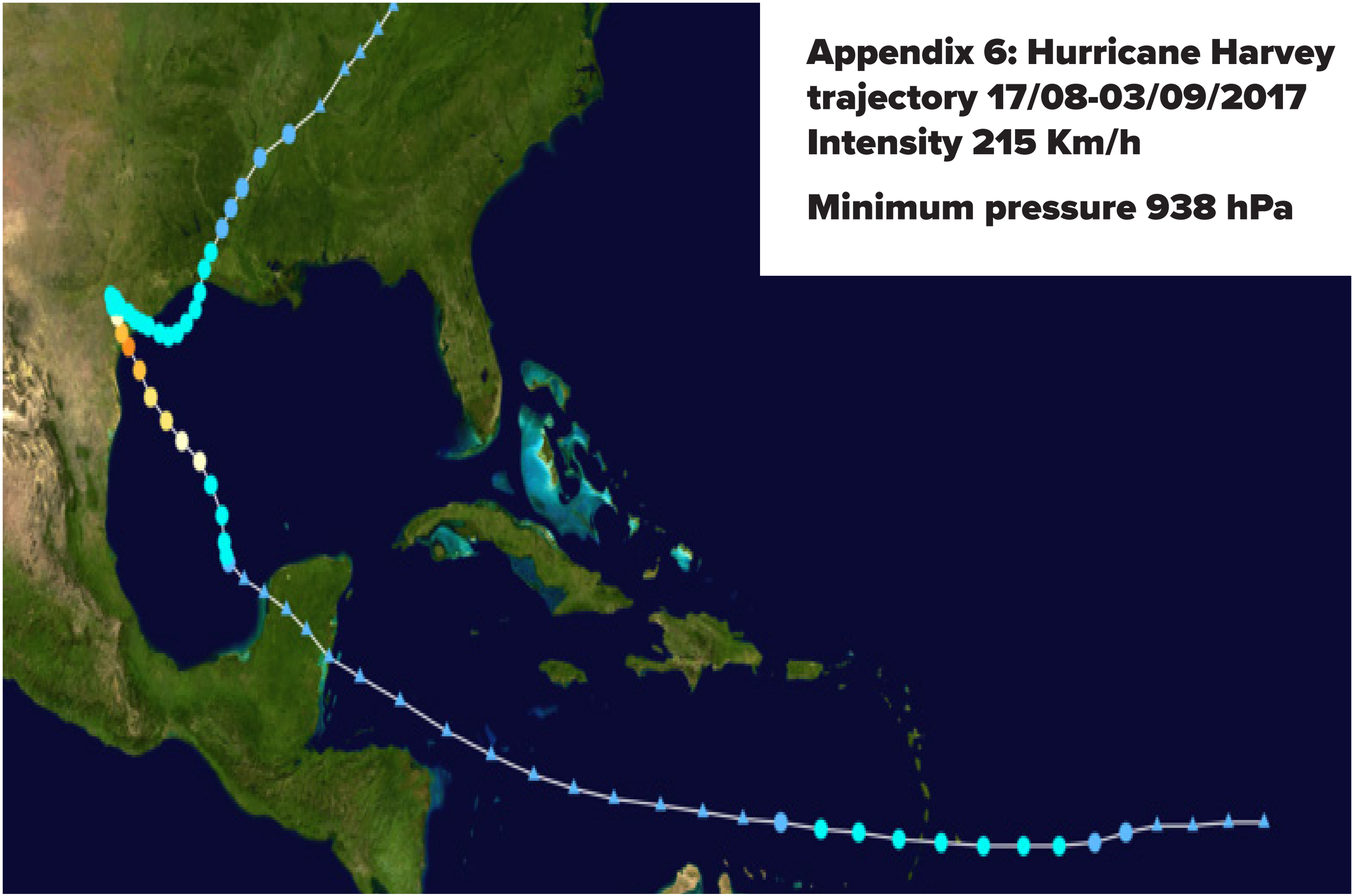

Appendix 6: Hurricane Harvey trajectory 17/08-03/09/2017 Intensity 215 Km/h

Minimum pressure 938 hPa

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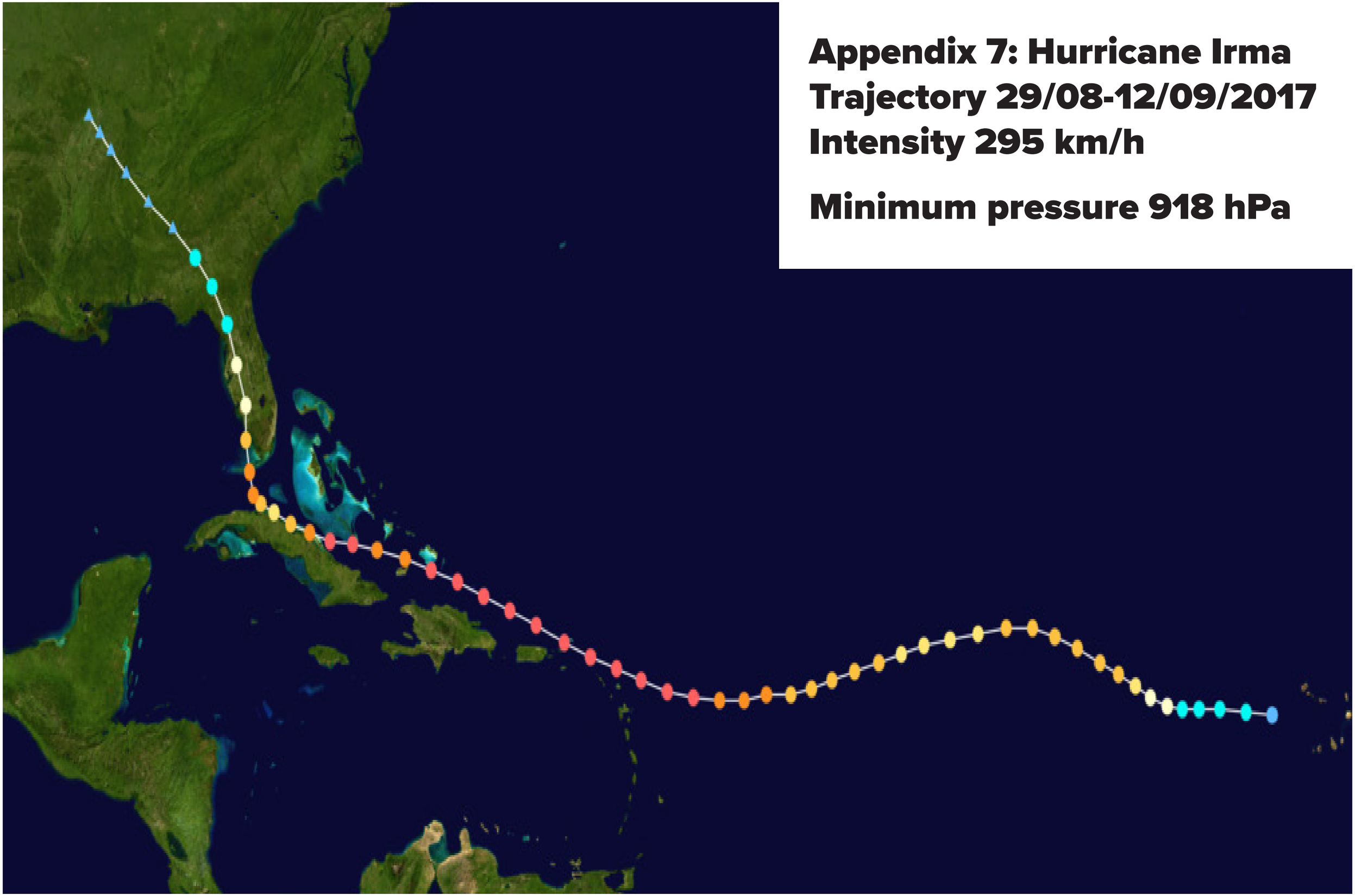
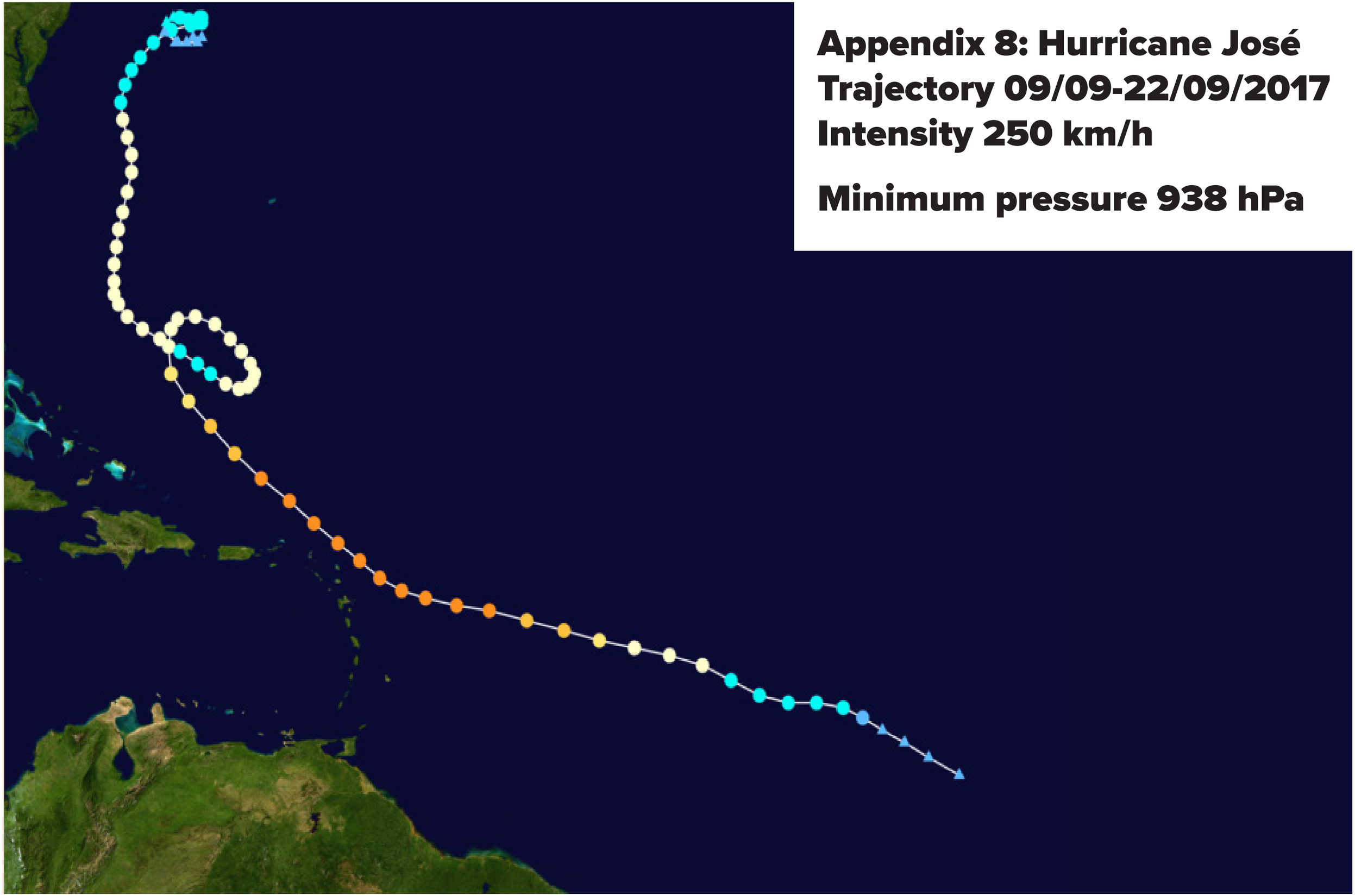


Appendix 7: Hurricane Irma Trajectory 29/08-12/09/2017 Intensity 295 km/h

Minimum pressure 918 hPa

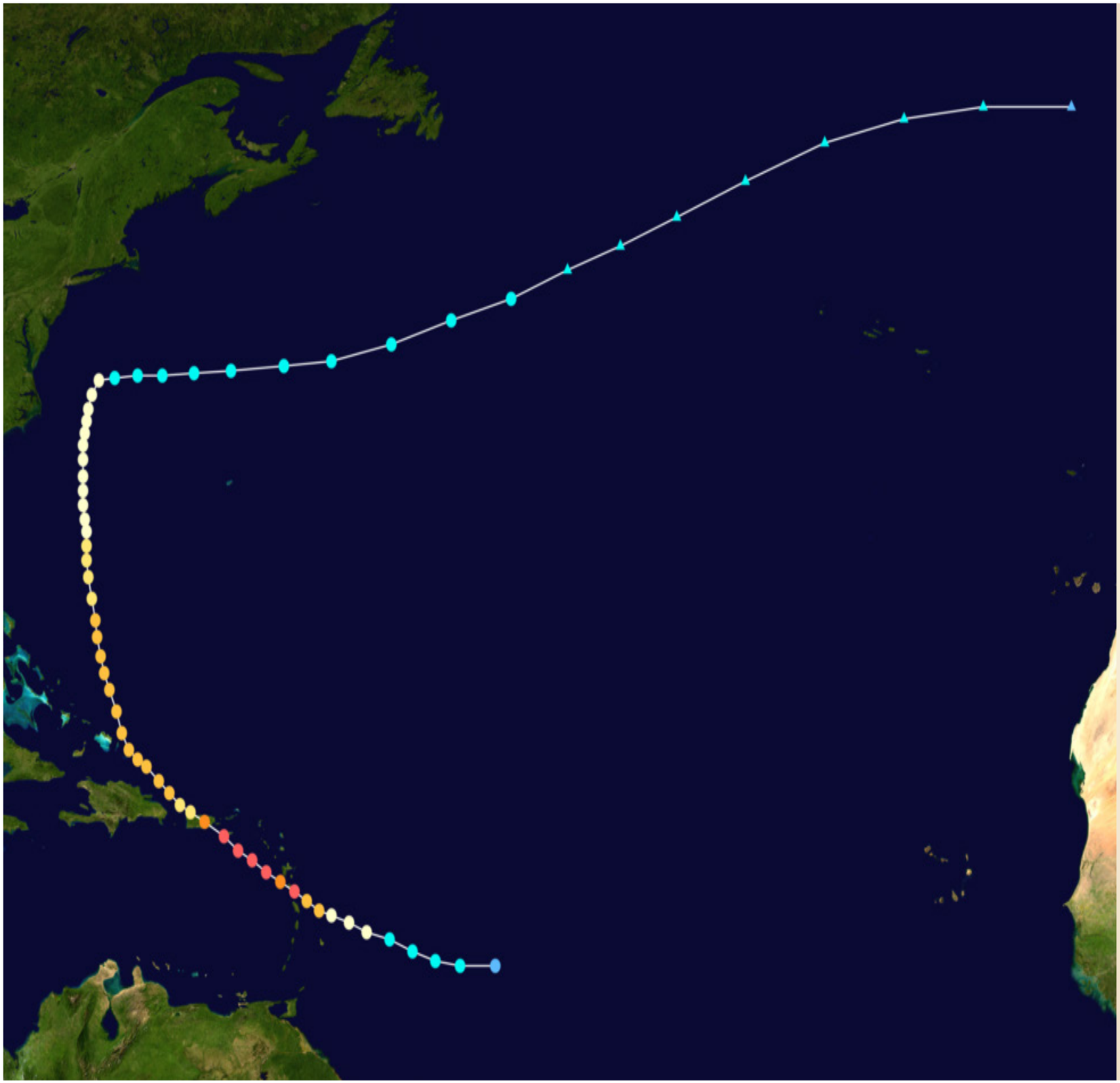
Toutes propriétés intellectuelles appartenant à des tiers intégrées par accident, ou à des fins de compréhension de biens ou de services sur ces tableaux sont uniquement à titre illustratif et ne déduisent aucune relation commerciale ou juridique.



Appendix 8: Hurricane José Trajectory 09/09-22/09/2017 Intensity 250 km/h

Minimum pressure 938 hPa

Toutes propriétés intellectuelles appartenant à des tiers intégrées par accident, ou à des fins de compréhension de biens ou de services sur ces tableaux sont uniquement à titre illustratif et ne déduisent aucune relation commerciale ou juridique.



Appendix 9: Hurricane Maria Trajectory 16/09-30/09/2017 Intensity 280km/h

Minimum pressure 908 hPa

Toutes propriétés intellectuelles appartenant à des tiers intégrées par accident, ou à des fins de compréhension de biens ou de services sur ces tableaux sont uniquement à titre illustratif et ne déduisent aucune relation commerciale ou juridique.