

Climat Océan

L'EXPOSITION INTERACTIVE

Exhibition Booklet

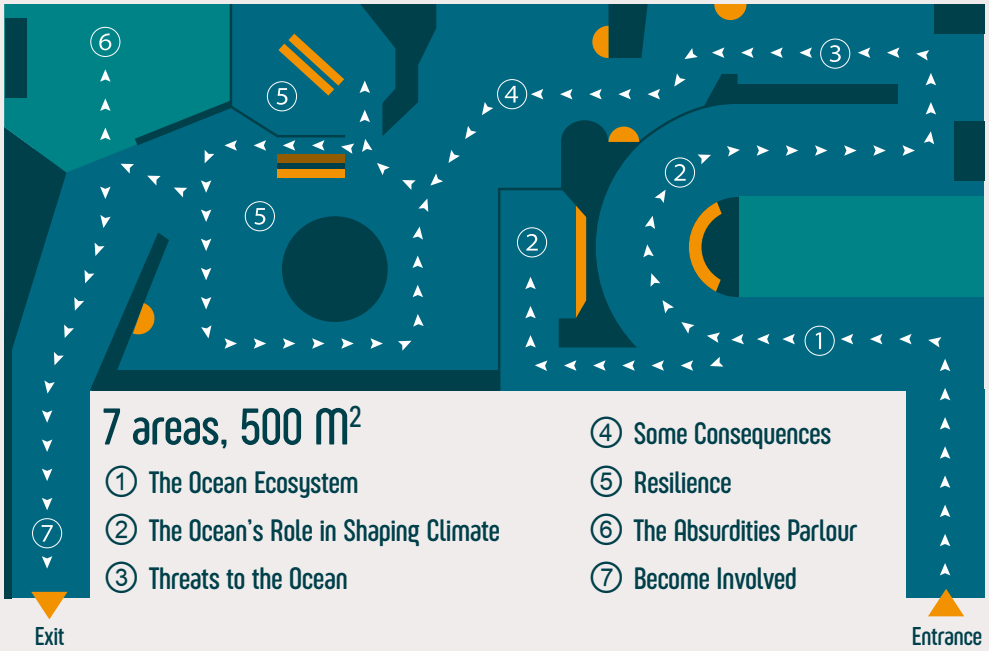


**MUSÉE
MARITIME
LA ROCHELLE**

larochelle.fr

**LA
ROCHELLE**

Exhibition floor plan



Ocean - a definition

Ocean: The vast expanse of the earth covered by seawater. The term 'world ocean' is used for all oceanic water as an energy system that interacts with the solid ocean floor and gaseous surface environments. The Caspian, Aral and Dead Seas are excluded, as they are in fact lakes. The world ocean has individual geographical divisions (entities) including the Atlantic Ocean, the Pacific Ocean and the Indian Ocean, to which the Southern and Arctic Oceans are sometimes added.

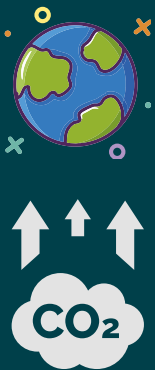
Climate - a definition

All the meteorological phenomena that characterise the average state of the atmosphere in a given place. The climate has varied greatly throughout the earth's history due to astronomical or geological phenomena. More recently, the unprecedented climate change that we are witnessing is due to human activities.

This interactive exhibition was designed as a journey into understanding the links between the ocean and the climate. It will be an introduction for some and a complete submersion for others, but for everyone, this journey will lead to an understanding of the importance of a healthy ocean for the health of humanity. It will help everyone to understand the effects global warming is having, both here in La Rochelle and in other parts of the world. Above all, this journey was designed to prompt visitors into reaching an individual and personal point of view and becoming part of the solution of regaining a healthy planet.

Table of Contents

① The Ocean Ecosystem	4-6
② The Ocean's Role in Shaping Climate	7-8
③ Threats to the Ocean	9-12
④ Some Consequences	13-18
⑤ Resilience	19-20
⑥ The Absurdities Parlour	21
⑦ Become Involved	22



The planet has two lungs, the biosphere and the ocean. The latter is the main producer of oxygen, which is essential for life on earth. It absorbs 90% of natural heat and carbon dioxide (CO₂) (photosynthesis). Together with the atmosphere, the ocean is also a climate regulator. Together they redistribute the energy that the planet receives from the sun, circulate the ocean seawater and capture much of the earth's carbon dioxide.



LAND SURFACE AREA

148 940 000 km²

Ocean

71%

of the earth's surface

97%

of the water on earth
by volume

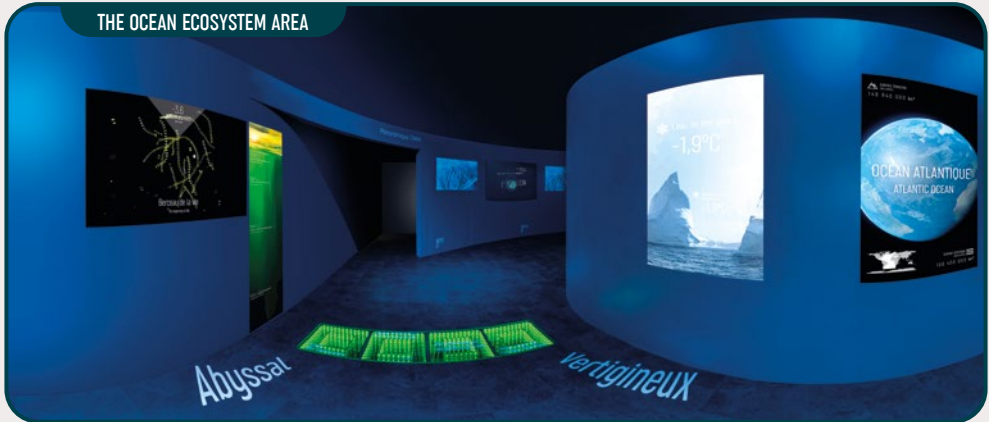


OCEAN SURFACE AREA

379 623 000 km²

① The Ocean Ecosystem

The ocean is global and continuous. It covers 71% of the earth's surface and holds 97% of the water on earth by volume. The ocean was crucial to the origin of life and is crucial to its ongoing evolution.



The ocean covers more than three quarters of the planet and is the world's largest water reservoir. There is only one World Ocean even though humans have given the different seas different names. Its two biggest characteristics are its salinity and its stability over millions of years.



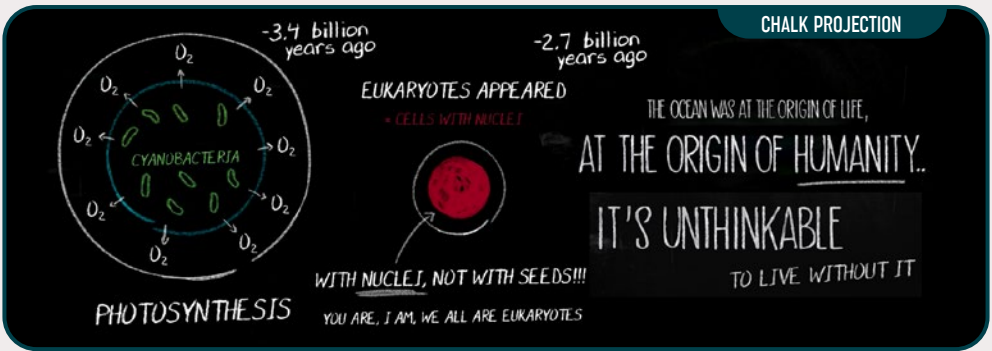
The ocean is the origin of life. The oldest fossils come from the ocean, even from before the creation of oxygen. Around 3.45 billion years ago, a form of bacteria called cyanobacteria caused the first creation of oxygen. When they came into contact with water, these first cells gave rise to photosynthesis, the origin of oxygen and life. Some 90% of the history of life on earth has taken place in the ocean. Humans retain traces of these origins in their body water and blood.

- *Ecosystem: The two-way relationship between living species and their physical environment.
- *Cynobacteria: Formerly known as blue-green algae, these bacteria have the particularity of developing with the help of solar energy.

The ocean is an asset shared by all humanity. It captures 97% of the heat generated by the sun's rays and thus regulates the planet's temperature. It produces more than 50% of the planet's oxygen while absorbing carbon through phytoplankton*. The ocean is also a formidable toxin recycler. It feeds billions of people with its resources, provides fossil fuels and molecules needed by the pharmaceutical industry. It is also a source of well-being that can inspire us.

Could we live without it?

No, like in a classroom, this blackboard exhibit presents the services provided by the ocean.



Tara Panorama

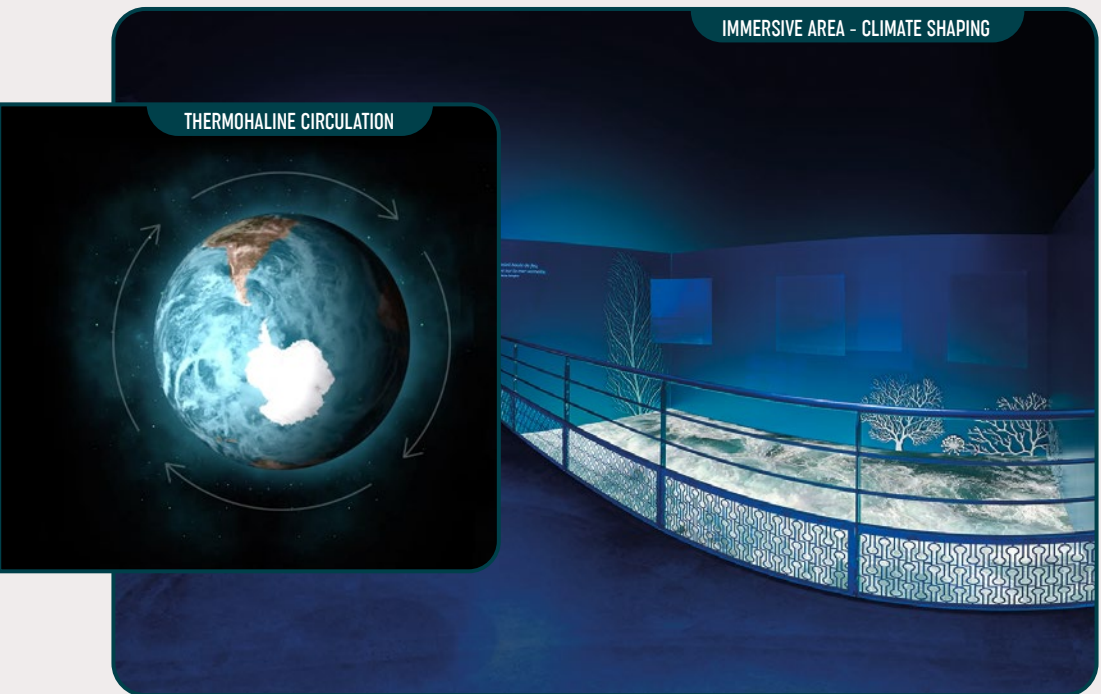
For over ten years, the Tara Foundation and their scientific partners have been studying the changes caused by global warming and the effect of human-generated pollution on oceanic biodiversity, both at sea and on coral reefs. The film presented was made for the COP21. It shows the ocean's role in determining climate, the threats posed by human activities, and the risks for humanity.



*Phytoplankton: Coming from Greek and meaning «wandering plant», these are small, even microscopic plants that are suspended from the ocean surface. Being the first link in the food chain, they capture carbon dioxide (CO₂) and release oxygen. This photosynthesis phenomenon is well known in land plants.

② The Ocean's Role in Shaping Climate

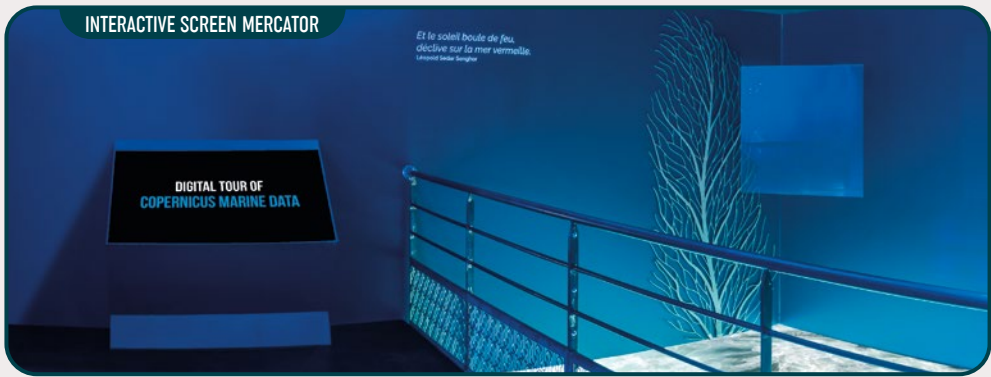
The ocean and the atmosphere are like a couple. They influence each other and exchange energy. The major movements of the ocean are modelled on the major movements of the atmosphere. On earth, the equatorial regions receive the most heat. Like the atmosphere, the ocean transports this accumulated tropical heat towards the poles and sends cold polar waters back to the tropics. Thus the ocean is responsible for half of the heat exchange between the poles and the equator. The ocean absorbs heat from the sun, transports it and releases it back into the atmosphere. Through thermohaline circulation*, heat and carbon, plankton, nutrients and oxygen are transported from the equator to the poles.



Ocean-atmospheric interaction can also be observed by studying the climates of tropical regions. The contrasts between the eastern and western zones can be explained by the presence of cold currents in the eastern oceans and warm currents in the west. Ocean movements are driven by surface winds and the Coriolis force*.

***Thermohaline circulation:** An ocean water movement which is generated by differences in seawater density (mass volume). These density differences are caused by two things: differences in water mass temperature and differences in salinity, hence the term "thermo" (for temperature) and "haline" (for salinity). This circulation is generated by surface currents, caused by the winds. They carry saltwater masses towards the poles. As the water becomes colder and denser, it sinks to the depths of the ocean and returns to the equator.

***Coriolis force:** This force was named after the French engineer Gaspard-Gustave Coriolis. It is an acceleration in circulation produced by the earth's rotation and is exerted on all moving bodies on the earth's surface. It determines the general direction of winds and ocean currents, deflecting them to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.



This exhibit designed by Mercator Ocean can help us to understand changes in currents, temperatures, sea ice and salinity all around the globe. Visitors can spin the globe and select information that Mercator Ocean has been carefully compiling since 1993.



Plankton, a photo by Julien Chauvet showing encapsulated plankton.

Plankton are living organisms that play an essential role in shaping the climate. They fall into three main categories: plant plankton (oxygen-producing and carbon-absorbing phytoplankton), animal plankton (zooplankton) and mixoplankton, which combine the characteristics of the first two. There are very wide varieties and sizes of plankton. Among the largest are jellyfish and krill whereas the smallest are only a few hundred nanometres in size and can only be seen under a microscope.

Gulf Stream: An oceanic current in the North Atlantic which causes warm tropical waters to flow upwards towards the far north.

③ Threats to the Ocean

The ocean's health is in danger. Over the past 250 years, human activities in industrial countries have weakened the ocean's capacity to regulate the climate. The factors that are threatening the ocean can be seen in both the surface waters (up to 1km in depth) and the deep sea.

Four major threats (including two sources of pollution) will be presented during this journey. Firstly, temperature rise which is due to greenhouse gas emissions and which causes water expansion, secondly, acidification which alters species' metabolism, thirdly, the loss of oxygen in wetlands and fourthly, pollution, which disrupts the way the ocean functions.

Global Warming and Sea Level Rise

Greenhouse gas emissions increase the temperature of both the atmosphere and the ocean surface. Most (93%) of this anthropogenic increase is being absorbed by the ocean, 3% is absorbed by ice sheets, 3% by the continents and only 1% by the atmosphere. However, warm waters have a lower capacity to absorb and dissolve CO₂ than cold waters. Ocean warming makes this «pumping» less efficient. Increases in ocean surface temperature cause the water to expand, causing the sea level to rise. Abyssal zones are less affected by ocean warming for the moment.

Over the last 30 years, the ocean has absorbed 93% of the energy produced by human activities. Its temperature has risen by 1°C and will continue to rise. Yet only cooler waters are able to absorb CO₂.

Since 1900, the ocean level has risen by an average of 1.5 mm per year, the biggest rise (8 cm over 20 years) being in the Western Pacific.





Ocean acidity has increased by

30% over the past 250 years.

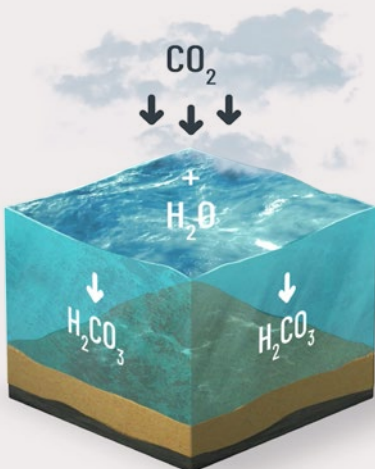
This rate of acidification is **100 times** faster than that which occurred over the last **300 million years**.



Acidification

Some of the carbon dioxide (CO₂) which is naturally present in the atmosphere falls into the ocean. When it comes into contact with particles of water, especially cold water, it dissolves and is transformed into carbonic acid.

Increased water acidification reduces the ocean's capacity to absorb CO₂ and thus to regulate the climate.



Since 1750, the ocean has captured 28% of the excess CO₂ emissions emitted by human activities. But the rate of acid production has increased 100 times since the 18th century compared to over the last 300 million years.

Ocean acidity has increased by 30%, and it is now undermining the ocean's capacity to absorb carbon.

The impact on living organisms

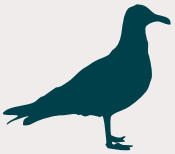
- ▼ A decrease in the quantity of carbonates that are used to make skeletons and shells.
- ▼ The food chain is at risk, starting with zooplankton that is eaten by fish that are caught in smaller quantities.





Pollution

Pollution destabilises the ocean and hampers the way it functions in many ways. Plastic and chemical pollution are focused on here. Plastic particles end up in the sea and are ingested by marine species, thus destabilising the ecosystem. It has recently been discovered that when these plastics come into contact with solar radiation, they in turn generate more greenhouse gases.



1 million birds
have died

The finest particles are the most harmful.

- ▲ Most (80%) of plastic waste comes from the land, carried by rivers or the wind.
- ▲ 3 out of 10 fish have ingested plastic. One million birds have died.
- ▲ The concentration of plastic in the sea is 10 times higher than that of plankton.



3 out of 10 fish have
ingested plastic

Today, the earth's 7th continent is made up of 5 areas of plastic accumulation and micro-fragments spread over the surface of all the oceans. Each area is 2 to 6 times the size of France, totalling 3.4 million km².

It will take 1000 years for these plastics to disappear... naturally!

Chemical contaminants

Endocrine disruptors, pesticides, insecticides, heavy metals, etc. end up in the ocean via rivers, estuaries and the coastline. They affect all species and in particular the photosynthesis mechanism of micro-algae.



The concentration of
plastic in the sea is
10 times higher
than that of plankton.

It is estimated that more than 40% of the ocean is affected by human activities. 87% of the ocean has been modified by the presence and demands of humans. Only 13% of the total ocean surface remains unaffected.

In the temperate zones of the North Atlantic, only 0.3% (about 13,000 km²) of wild marine areas now remain.

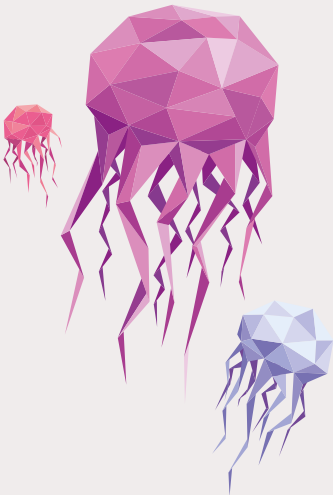
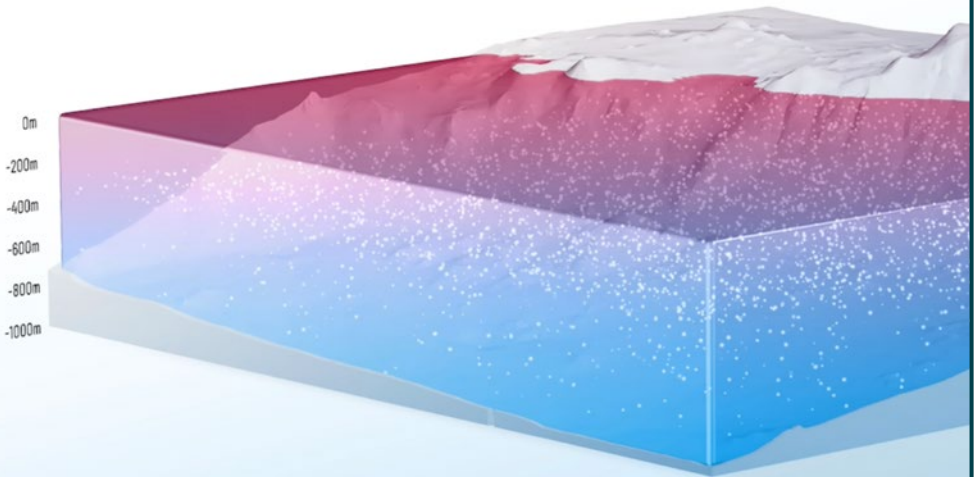
Deoxygenation

The warmer the surface water, the less it mixes with the deep waters. A screen preventing oxygen from reaching the sea floor can be formed. Close to the shoreline, close to human activities, close to discharges of nitrates, phosphates and nitrogen, an insufficiency in the supply of oxygen (deoxygenation) is occurring and this is causing algae to multiply, which in turn destroy the ecosystem. The insufficiency in the supply of oxygen for living organisms (hypoxia) is greater in coastal areas. It has an impact on the food chain and impoverishes fishing areas.

THREATENED AREAS

O₂ The ocean currently produces
50% of the oxygen we breath.

But as it increases in temperature, the ocean becomes more and more deoxygenated. Some parts of the ocean have lost **4%** of their oxygen over the last **10 years**, others are completely devoid of it.



Hypoxia is causing organisms to die.

Many species that are essential to the food chain are having to migrate to survive. New species arrive and thrive in the warming waters that were once cold and they decimate the existing species.



Marakihau, George Nuku

Plexiglass - Inv. VLR-2016-13

This work entwines three jellyfish and a sculpture called Marakihau. This sculpture represents the Gods of the Ocean and an underwater monster (taniwha) which can be found in the depths of the Bay of Plenty in New Zealand. The taniwha takes a human form with a fish tail and a long tubular tongue (ngongo) with which it was able to swallow canoes or men. According to George Nuku, whether or not the whole is a male or female form, the Marakihau is half fish, half woman, and a descendant of the God Tangaroa. It can symbolise an aggressor, a guide or a protector. By forming plastic objects into shapes, George Nuku aims to change the way we look at this material, which is considered a waste product once its contents are used. For the artist, plastic is sacred in the same way that jade was sacred to the Māori society. It originates from the bowels of the Earth (fossil energy), it is transformed into water bottles (containing a vital source for living organisms) and it is connected with life. This change in appreciation could be a solution to saving the Ocean from plastic pollution.

4 Some Consequences

Threats from industrial countries not only prevent the ocean from playing its role as a regulator but also accelerate global warming. The collapse of marine biodiversity and the appearance of invasive species* have led to species migration, a drop in phytoplankton productivity and a loss of food resources for humans. Coastlines are also being weakened by marine submersion and erosion.

This will result in:

- ▼ Melting ice and the opening of new shipping routes.
- ▲ Increases in extreme weather events: storms, cyclones, drought, heavy rainfall and flooding.
- ▼ A decline in biodiversity and the imbalance of the ocean ecosystem.
- ▲ Increased flooding and marine erosion.



Melting Polar Ice – New Shipping Routes

The ice cap is shrinking more and more every year. Warming air and seawater is causing land ice to rapidly melt and flow into the ocean and it is causing ice faces to subside, as they break off piece by piece. This large influx of fresh water into the sea has two effects. It causes the sea level to rise and it disrupts heat-regulating thermohaline circulation. Warming causes warming, the phenomenon is getting worse. Ice or snow-covered surfaces reflect solar radiation whereas dark surfaces absorb that radiation. A reduction in reflecting surfaces thus increases global warming. This phenomenon is called positive climate change feedback.

The melting ice is opening up new shipping routes through the north. These new passages have geopolitical and commercial implications and pose yet another threat to the ocean; the risk of increased pollution and increased climate change.

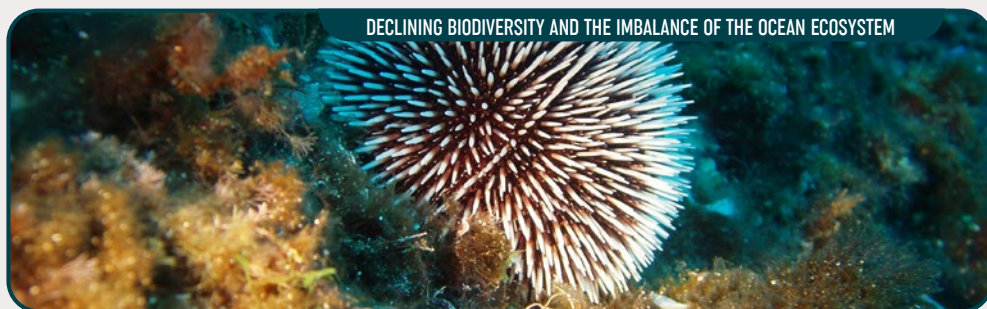
▼ Over the last 15 years, the ice pack has lost 1.81 million km². New Pacific-Atlantic sea routes via the north are being created.



Increasing Extreme Weather Events

Storms, cyclones, drought

Climate scientists are not able to predict when extreme events will occur, nor their recurrence cycles. However, given the aggravating factors, they are certain that these events will occur more often and become more violent.



Declining Biodiversity and the Imbalance of the Ocean Ecosystem

Climate change is altering the productivity of marine ecosystems and impacting fisheries at a time when the demand for fish for human consumption is increasing. Fish is the main source of animal protein for one billion people and is one of the most traded renewable resources in the world.

Changes in the physiochemical characteristics of seawater are having an effect on individual species' metabolism, animal life-cycles, and the relationships between prey and predators. Physiochemical changes are also modifying habitats and the geographical distribution of fish. Ecosystem dynamics could be profoundly disrupted in the coming decades, affecting global fisheries and compromising food security in many southern countries. Maintaining healthy and productive marine ecosystems is crucial.



Increased Flooding and Marine Erosion

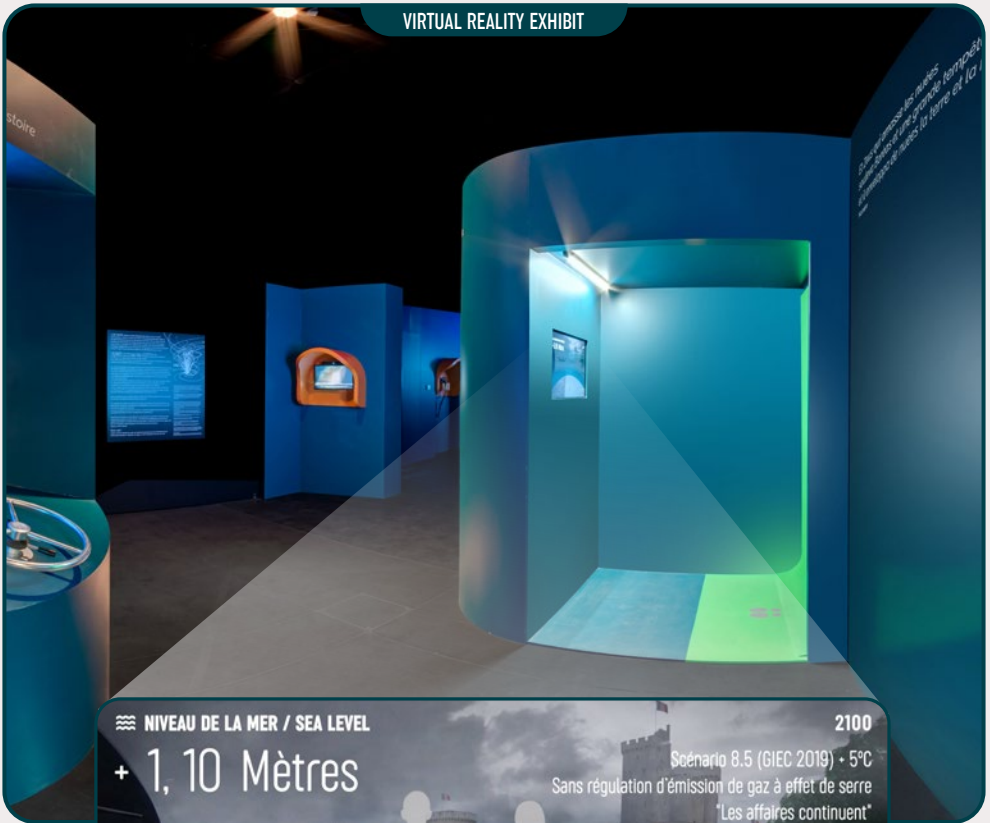
- ▲ Sea level rises can be caused by several factors, be they seismic, tectonic or global warming. Since the last glacial maximum (21,000 years ago) the earth has experienced gradual and regular climate warming, resulting in new coastlines on every continent. This phenomenon slowed down about 3,000 years ago, only to resume in the 19th century and considerably accelerate as a result of human activity. The rate of sea level rise over the last 20 years is double that of the beginning of the 20th century and now averages 3.5 millimetres per year. A 17 cm rise in sea level was recorded over the 20th century.
- ▲ Around the globe, marine transgression phenomena vary. In the western Pacific, for example, the rise is 2 to 3 times above average. The most reasonable forecasts predict a 60 cm to 1 m increase by 2100. Should the Arctic disappear over several centuries or even millennia, this would cause a 7-meter rise in the sea level.
- ▲ Rising sea levels are weakening, eroding and submerging coastal areas. A further rise in sea level is inevitable, even if greenhouse gas emissions are stabilised. We must therefore prepare to manage this risk.

Meteorology and climatology: Meteorology is the science associated with the phenomena which occur in the lower layers of the atmosphere (pressure, winds, temperature, precipitation, storms, etc.). The measurement of these events is used to make future weather forecasts. Climatology is the study of climates, i.e. the consequences of weather phenomena on different parts of the globe. Climatologists use the statistical data collected by meteorological services to understand changes in climate over time.

Invasive species: Species that were voluntarily or involuntarily introduced into an environment and which disrupt the balance of the ecosystem. If they have no predators, they suppress other local species and proliferate.

Marine submersion and erosion: Coastlines are subject to variations in sea level. When the sea level rises, the sea encroaches upon lowlands (like La Rochelle) submerging it and higher waters cause cliffs to erode, causing the coastline to recede.

VIRTUAL REALITY EXHIBIT

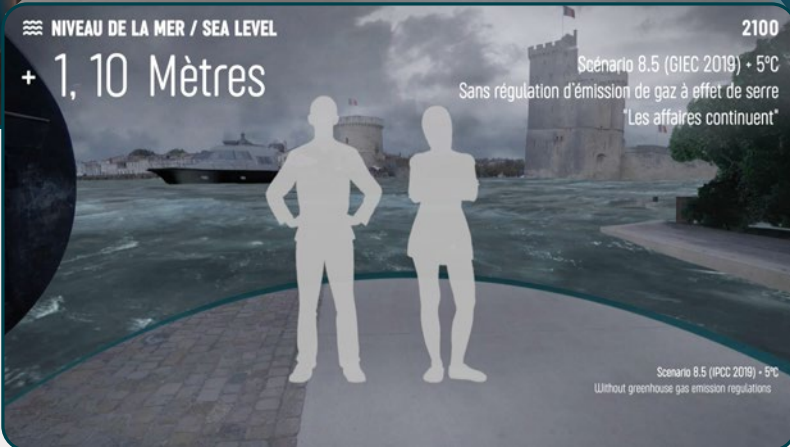


NIVEAU DE LA MER / SEA LEVEL

+ 1,10 Mètres

2100

Scénario 8.5 (GIEC 2019) - 5°C
Sans régulation d'émission de gaz à effet de serre
"Les affaires continuent"



LEVEL SCENARIOS



This virtual reality exhibit, based on the latest IPCC data as they will apply to La Rochelle in 2100, locates visitors in front of the La Rochelle Towers. Visitors can experiment with different rising water level scenarios.

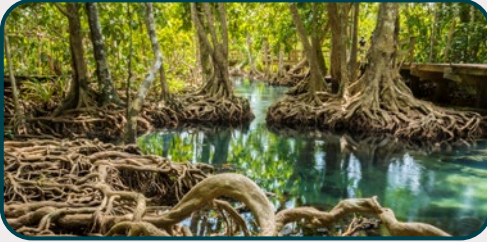
Paleoclimates



Throughout its long history, the earth has experienced warmer periods and colder periods, and more acidic oceans. But what is at issue today is the rapidity of these changes. Due to human activities, they have sped up to such a degree that species (including us) no longer have time to adapt.

This exhibit allows visitors to travel through past paleoclimatic changes and towards future centuries and to see the earth's changes over its 4.6 billion-year history.

5 Resilience



Wetlands capture carbon. Preventative actions are being taken to restore vulnerable natural marsh and mangrove areas whose protective role had long been ignored. Restoring and protecting our landscapes is one of the solutions to limiting global warming.

Human societies, like ecosystems, are resilient. Both have the capacity to withstand disturbances and to regain a balance that allows them to continue evolving. Human societies have already shown resilience to climate change in the past. Climate memory and past human responses are some of the solutions available to us today.

Two exhibition areas are devoted to resilience. The more scientific one shows the activities carried out by major operators to restore natural areas and protect the ocean, with a photo gallery of the types of resilient environments that protect us from climate change. The other is dedicated to three local and international artists and their visions of resilience. First, Yuki Kihara (Japan) displays choreography that lasts the same length of time as did the 2011 tsunami. It is about the transmission of risk.

Secondly, Kathy Jetnil-Kijiner reads a poem called «Tell Them» which speaks about personal attachment to territory, as a part of oneself and one's culture, even in the face of destruction. Thirdly, Olivier Crouzel has produced a poetic film about a building in Soulac-sur-Mer (la Signal) whose inhabitants were forced to abandon it and let the ocean take over.



Protected areas: Certain vulnerable areas are closed to the public in order to allow the environment to redevelop.

Offsetting: The La Rochelle region has committed itself to achieving carbon neutrality by 2040. This involves both limiting carbon emissions and offsetting them through carbon capturing initiatives such as restoring wetlands and the revegetation of certain areas.



The Ecosystem by Yann Nguema

Man can make change happen. Visitors can move the sea urchins on this sand table and become the authors of new compositions. The artist, Yann Nguema has put visitors back into the driver's seat of this interactive table exhibit.

⑥ The Absurdities Parlour

Fake news is difficult to recognize and to avoid. For our comfort and consumption we are destroying our planet. The earth is burning. The Mona Lisa is sweating. Femen are mermaids and bears are walking down Abbey Road.

In this space, Bruno Hubert has placed oblique objects and works of art that are intentionally bizarre. Are they absurd enough to make you reflect upon (or change) our society's behaviour? Absurd, did you say absurd?



THE SKULL OF THE FIRST CUBIST MAN



HOMME CUBAISIEN
Craie du premier
homme cubiste

BREADED FISH FOSSIL

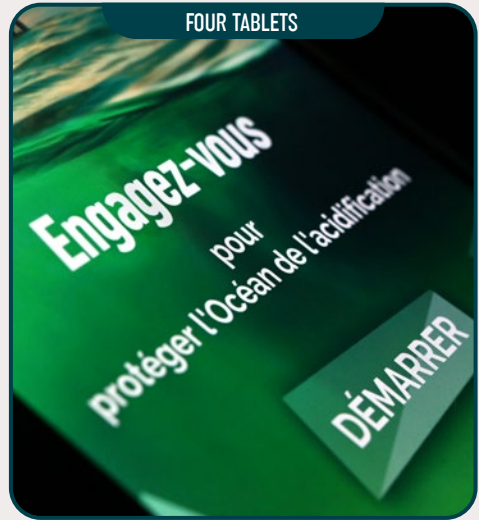


PISCES ANGIUS-
OCULORUM
Fossile du poisson
pané dit « findexator »

7 Become Involved

This exhibit allows visitors to choose the strength of a wave according to their mood. Absurd? Next, visitors are led to a humorous video whose caustic and provocative speech is designed to make them react.

Four tablets have quizzes for visitors which prompt individual and personal commitments. On the wall, a counter shows the number of visitors who are committed to taking action and helping to protect the ocean. For our future?



Climat Océan

L'EXPOSITION INTERACTIVE

9 NOVEMBRE 2019 - NOVEMBRE 2022

EXPOSITION RÉALISÉE PAR LA VILLE DE LA ROCHELLE AVEC LE SOUTIEN DE DEUX PARTENAIRES MAJEURS
LA FONDATION LÉA NATURE ET LA RÉGION NOUVELLE-AQUITAINE

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Guigone Camus Ethnologue, Université de Polynésie française, Tahiti.
Eric Chaumillon Professeur de géologie marine, Directeur du Département sciences de la terre, Laboratoire Liens, La Rochelle Université.
Michel Hontarède Ingénieur, ancien Directeur du centre Météo France de La Rochelle, Vice-président d'Escal'Océan.
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David Salas y Melia Climatologue CNRM (UMR Météo-France & CNRS), Responsable du Groupe de Météorologie de Grande Echelle et Climat (GMGEC)
Frédéric Surville Historien local, correspondant pour La Rochelle d'AcclimaTerra
Patrick de Wever Géologue, professeur au MNHN, parrain d'Escal'Océan

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SCÉNOGRAPHIE

Thomas Girault Directeur artistique

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TEXTES

Elian Monteiro, Thomas Girault et Elise Patole-Edoumba

TRADUCTION

Peter Rawlinsong

ARTISTES

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Yuki Kihara, chorégraphe, Siva in motion
Kathy Jetnil-Kijner, poète, Tell them
Bruno Hubert, le cabinet d'absurdité
Ernst Haeckel, naturaliste
Yann Nguema, plasticien table interactive Ecosystème
Sophia de Mello Breyner Andresen, écrivaine
Georges Nuku, Te Whare Tohora /Whale house
Thomas Monin, Sculpteur, Aurora, installation extérieure
Olivier Crouzel & Sophie Poirier, art vidéo, Le Signal
David Gallais, ébéniste, Machine à vent
René-Claude Girault, artiste peintre
Blue Yeti et La boîte à films, Paléoclimat

MONTAGE TECHNIQUE - VILLE DE LA ROCHELLE

Menuiserie : Patrick Grellet, Nicolas Fisher, Rémi Fisher, Teddy Perochain, Daniel Soenen, Loïc Bourdeau, Jean-François Seudre
Peinture : Bernard Raballand, Patrick Nédau, Alain Liaigre, Hervé Dubus. Signalétique et décors : Florence Borie, Morgan Barraux, Serrurerie : Pascal Sicard, Jérôme Soulard
Electricité : Jean-Luc Chagneau, Musée maritime : Eric Chaumeton, Christophe Coutant, Francis Demons, Pascale Fidelle, Alain Petit, Fabien Perez, Sylviane Ruaud
Carré Amelot : Mickaël Gaudin, Nicolas Petro

VOIX

Isabelle Autissier, Claire Le Floch

RECHERCHE DOCUMENTAIRE & GESTION DES DROITS

Multiples Muséographie - Marine Rocher

FONDS AUDIOVISUELS & PHOTOGRAPHIQUES

Conservatoire du Littoral, Exposure labs, Footage courtesy of Chasing Coral, Netflix. Director: Jeff Orlowski ; Producer: Larissa Rhodes-exposureelabs.com. Le cinquième rêve production, Le piège blanc avec Alban Michon et Vincent Berthet, réalisé par Thierry Robert Dieulefit - lecinquiemereve.fr. M.I.C.S. Mingan Island Cetacean Study, Richard Sears, - rorqual.com. Parafilms, Christian & Noé Sardet, Sharif Mirshak- planktonchronicles.org. Saison Cinq, production audiovisuelle, Lège-Cap Ferret - saisoncinq.com Zeuxo productions, production de films documentaires, Bordeaux zeuxoproduction.com. Fonds Audiovisuel de Recherches (F.A.R.), Fondation Tara Océan, réalisateur Pierre de Parscau/ Isabelle Larvoire Calonne (Images sous-marines)

RELATIONS PRESSE

Anne Michon

CATALOGUE

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