

L'acidification des océans - l'autre problème lié aux émissions de CO₂

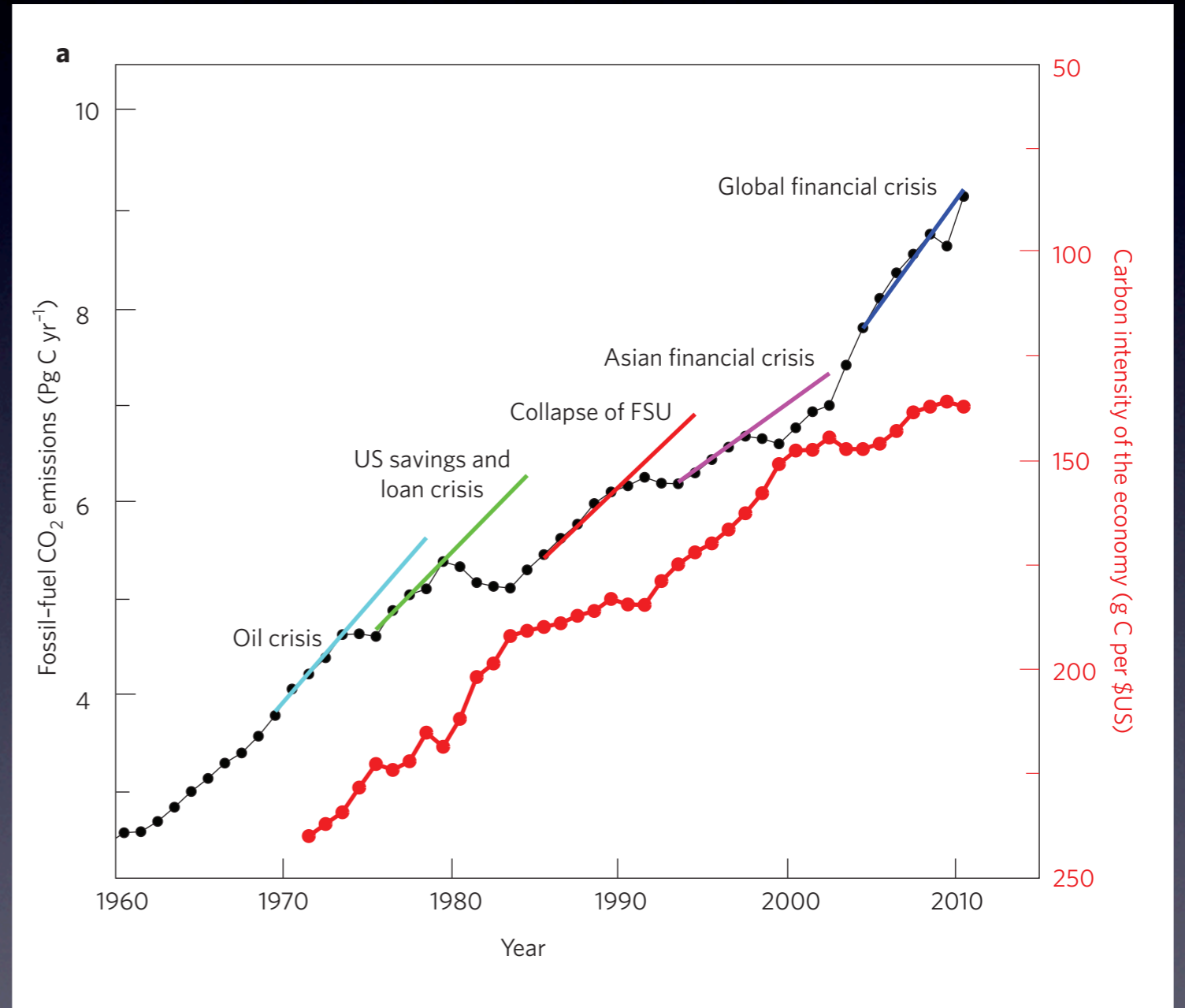
Jean-Pierre Gattuso

Laboratoire d'Océanographie de Villefranche
CNRS-Université Pierre et Marie Curie-Paris 6



Cause de l'acidification des océans

- Rejets de CO₂
 - 1990-1999 : +1% par an
 - 2000-2007 : +3.4 % par an
 - 2009 : -1.4 % par an
 - 2010 : +5.9 % par an



Rejets et puits de CO₂ (2007-2011)

1 Pg C an⁻¹



+

9.3 milliards
tonnes C an⁻¹

8.3 Pg C an⁻¹



(10.4 milliards
tonnes en 2011)

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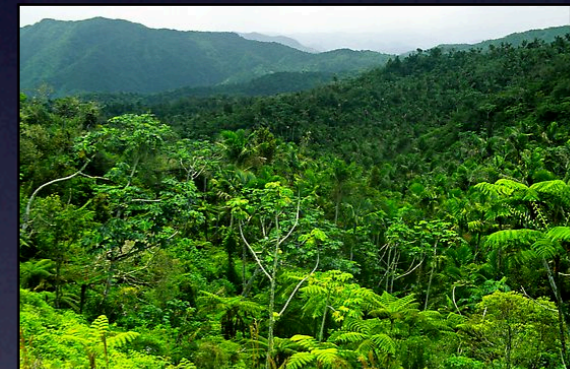
(10.4 milliards tonnes en 2011)

Atmosphère
50%

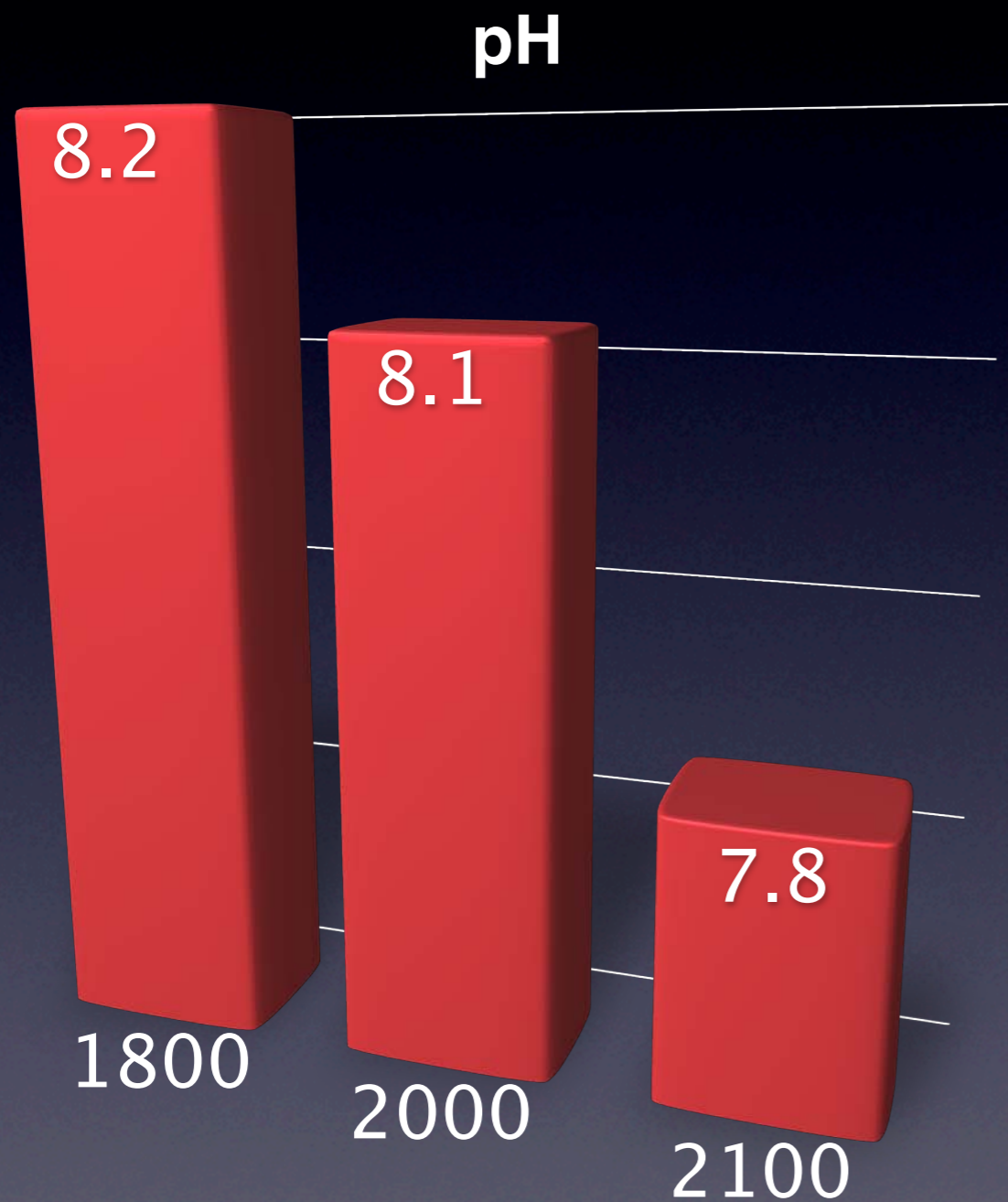
Végétation
26%

Océans
24%

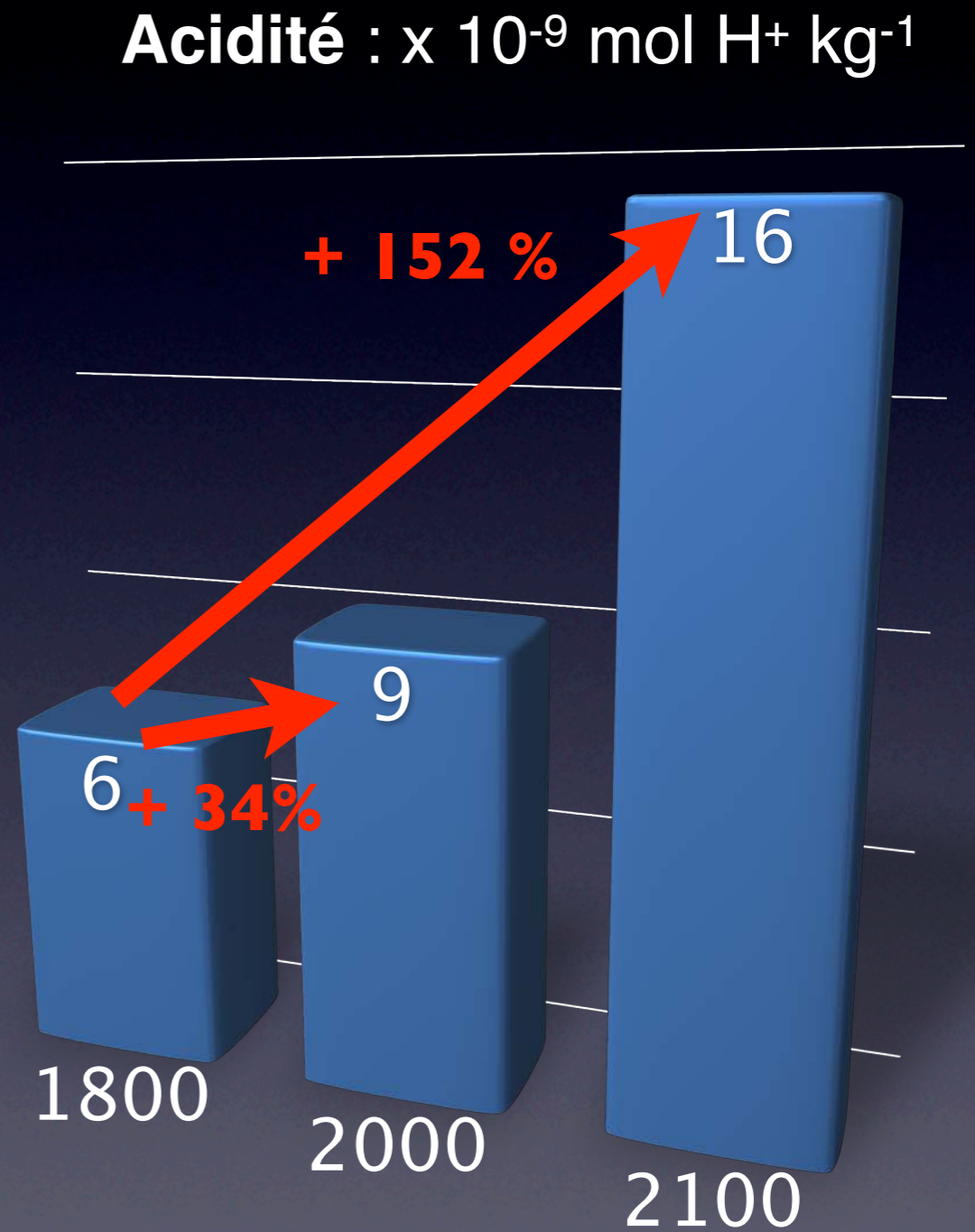
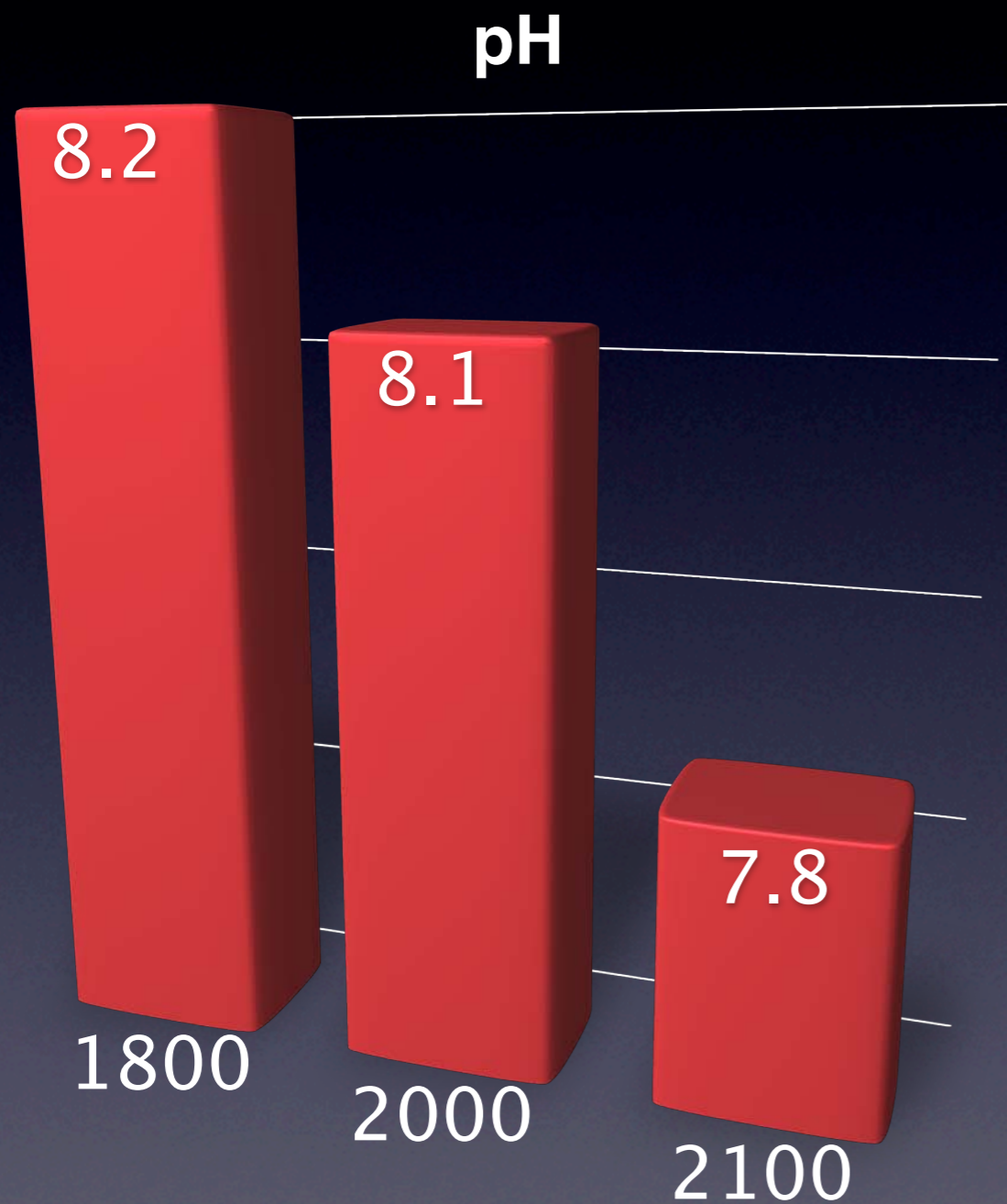
24 millions tonnes CO₂ par jour



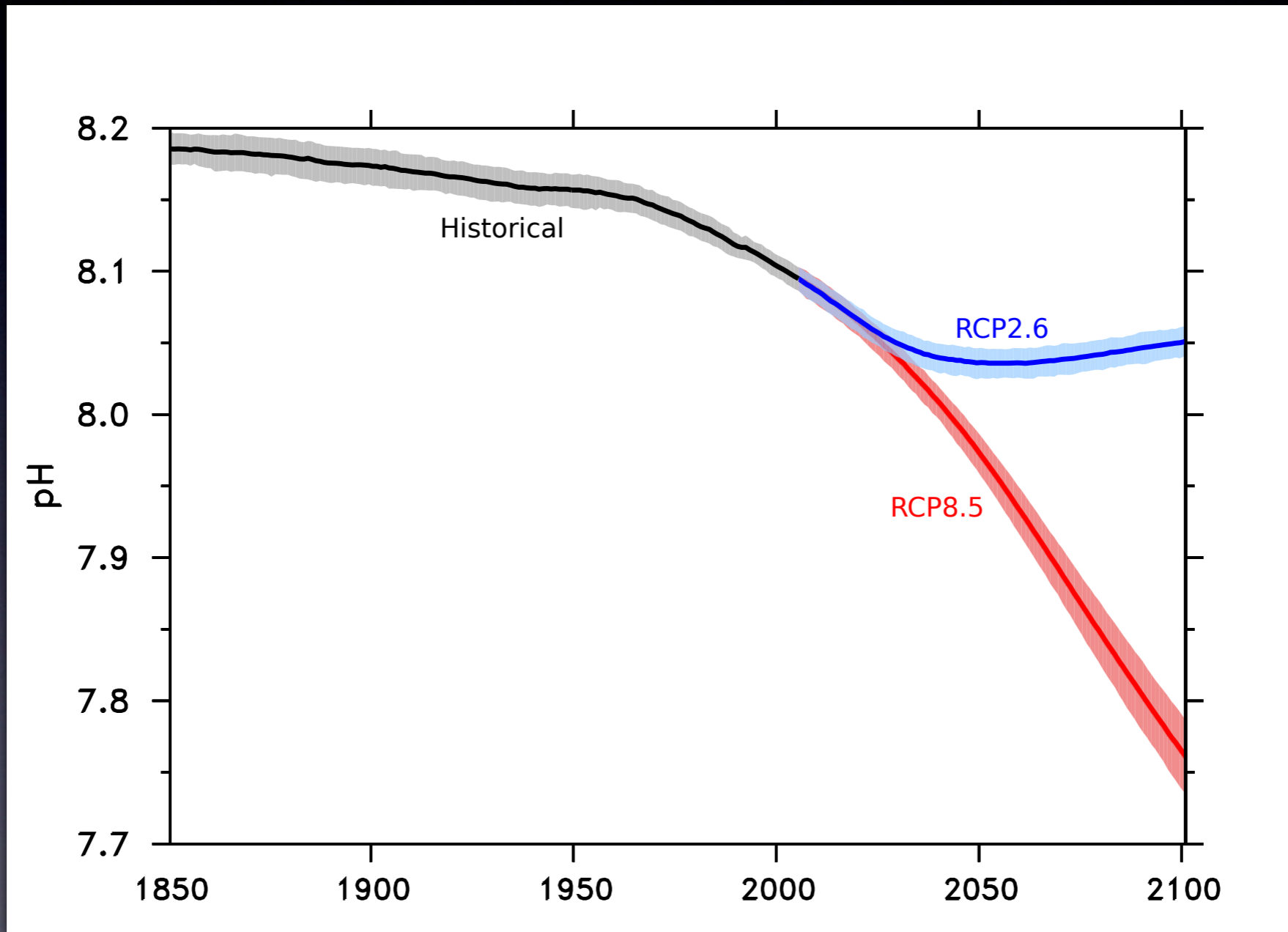
pH et acidité en surface



pH et acidité en surface



Projections



À l'échelle géologique

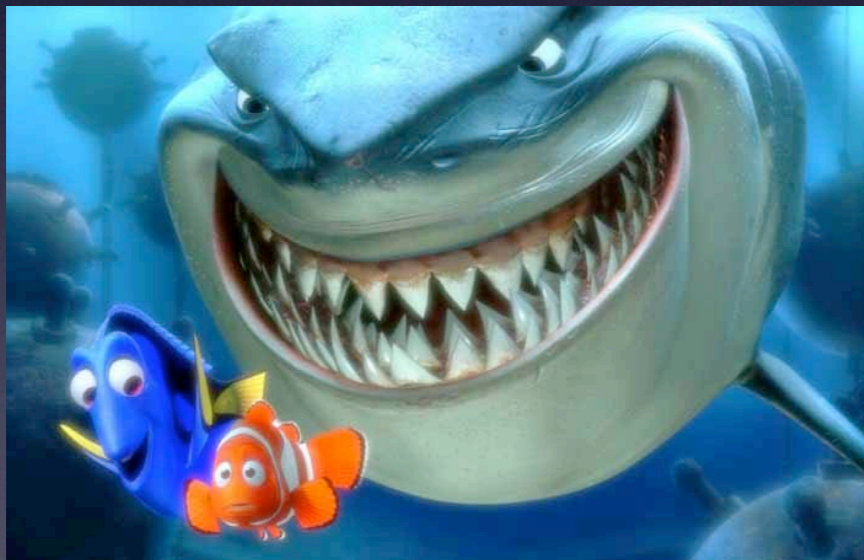
- 2100 : acidité la plus élevée depuis 800 000 ans
- Vitesse du changement inégalée depuis au moins 300 millions d'années

Impacts potentiels

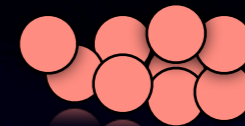
Physiologie

- Photosynthèse
- Calcification
- Respiration
- Croissance

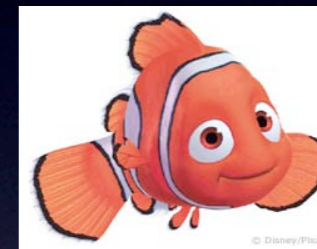
Chaine alimentaire



Reproduction



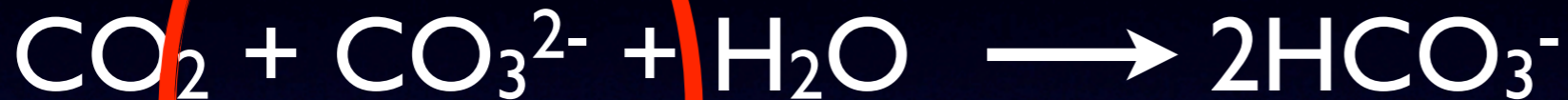
Comportement



Impacts biologiques

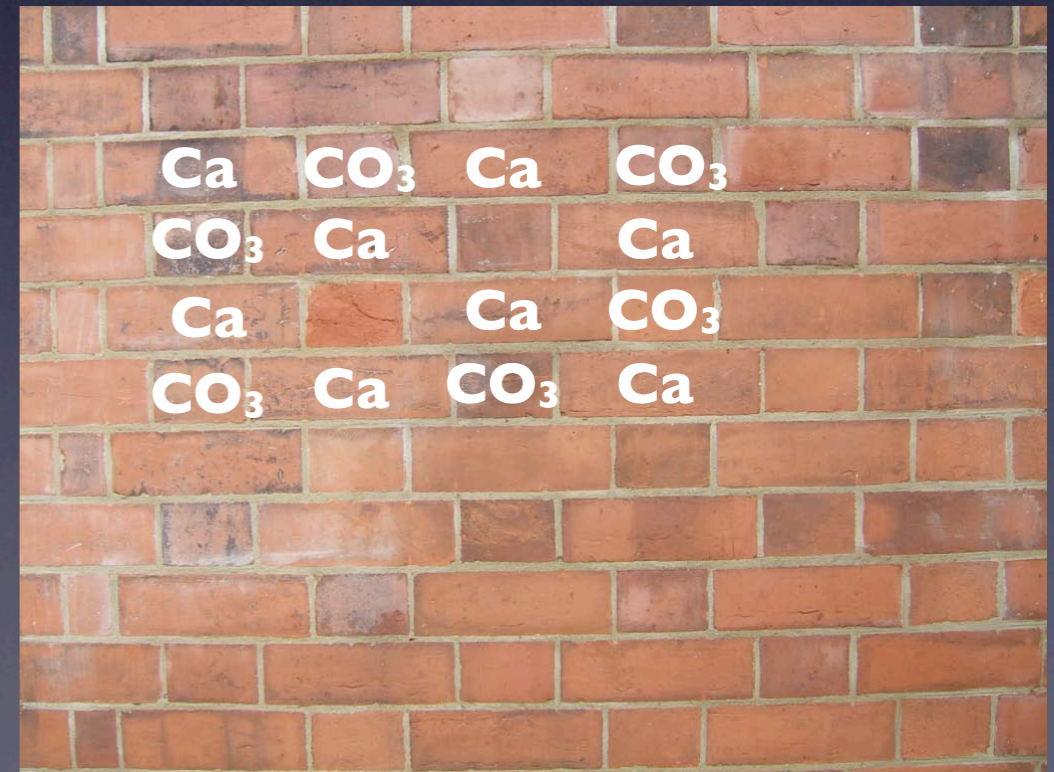
Augmentation de

CO₂

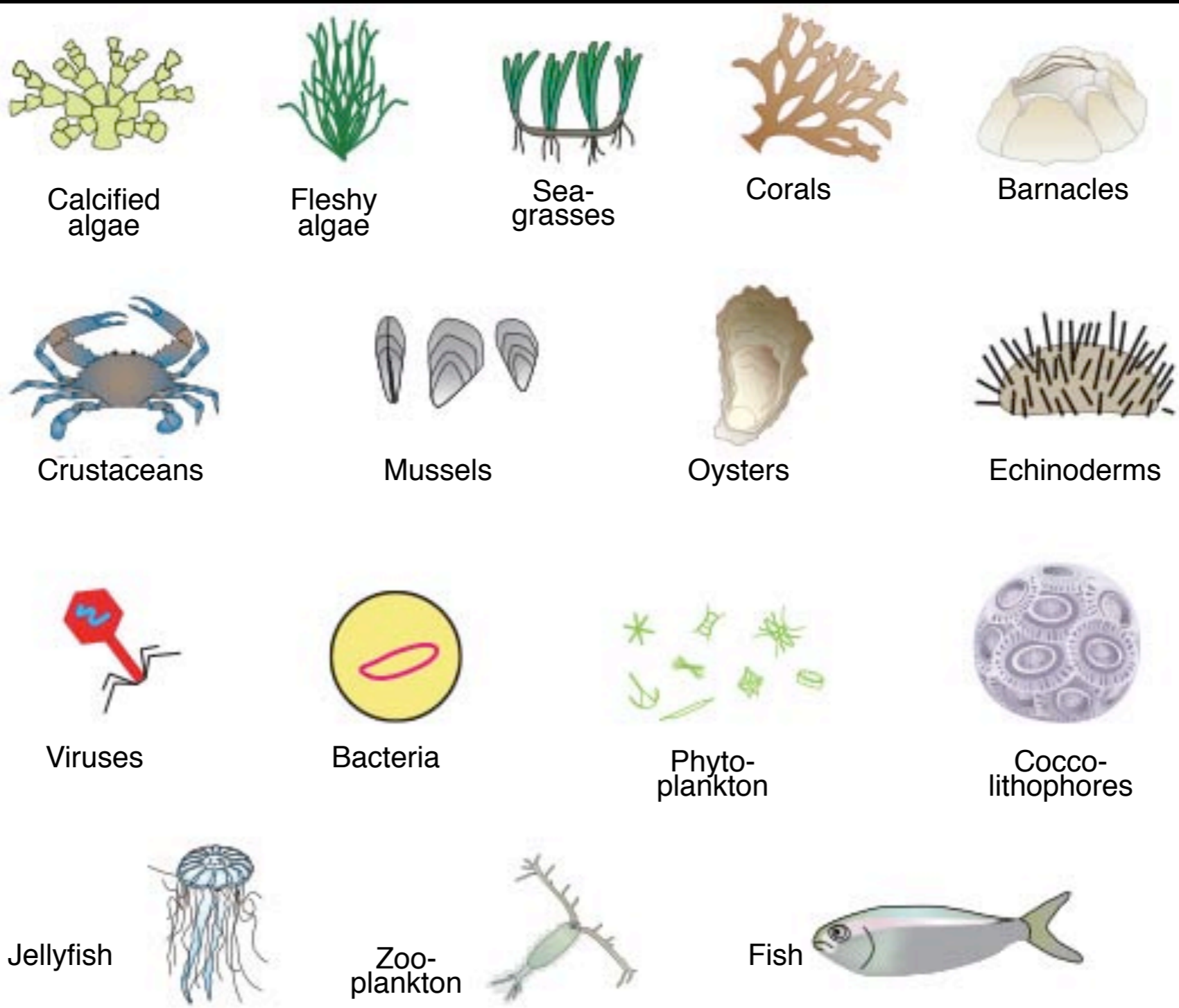


Baisse de
carbonates

CO₃²⁻ = brique utilisée par
plusieurs organismes marins
pour fabriquer leurs **coquilles**
et **squelettes**



Impacts biologiques



eFOCE

- Fondation BNP-Paribas ; 3 ans
- Deux problèmes majeurs des expériences passées :
 - Sortir du laboratoire pour aller sur le terrain
 - Réaliser des expériences à long terme (1 an)



Récifs coralliens

- Moins de 0.1 % des océans mais 275 millions d'habitants à moins de 30 km d'un récif
- **Ressources** : 20% du poisson dans pays en voie de développement (surexploitation dans moitié des îles du Pacifique)
- **Tourisme** : plus de 100 pays. Australie : 5,4 milliards A\$, 54000 emplois
- **Protection** des rivages



Tuvalu (© Dean Sewell)

Récifs coralliens

- Perturbations locales:
 - développement urbain
 - pollution
- Perturbations globales:
 - Niveau de la mer
 - Réchauffement
 - Acidification



Tuvalu (© Dean Sewell)

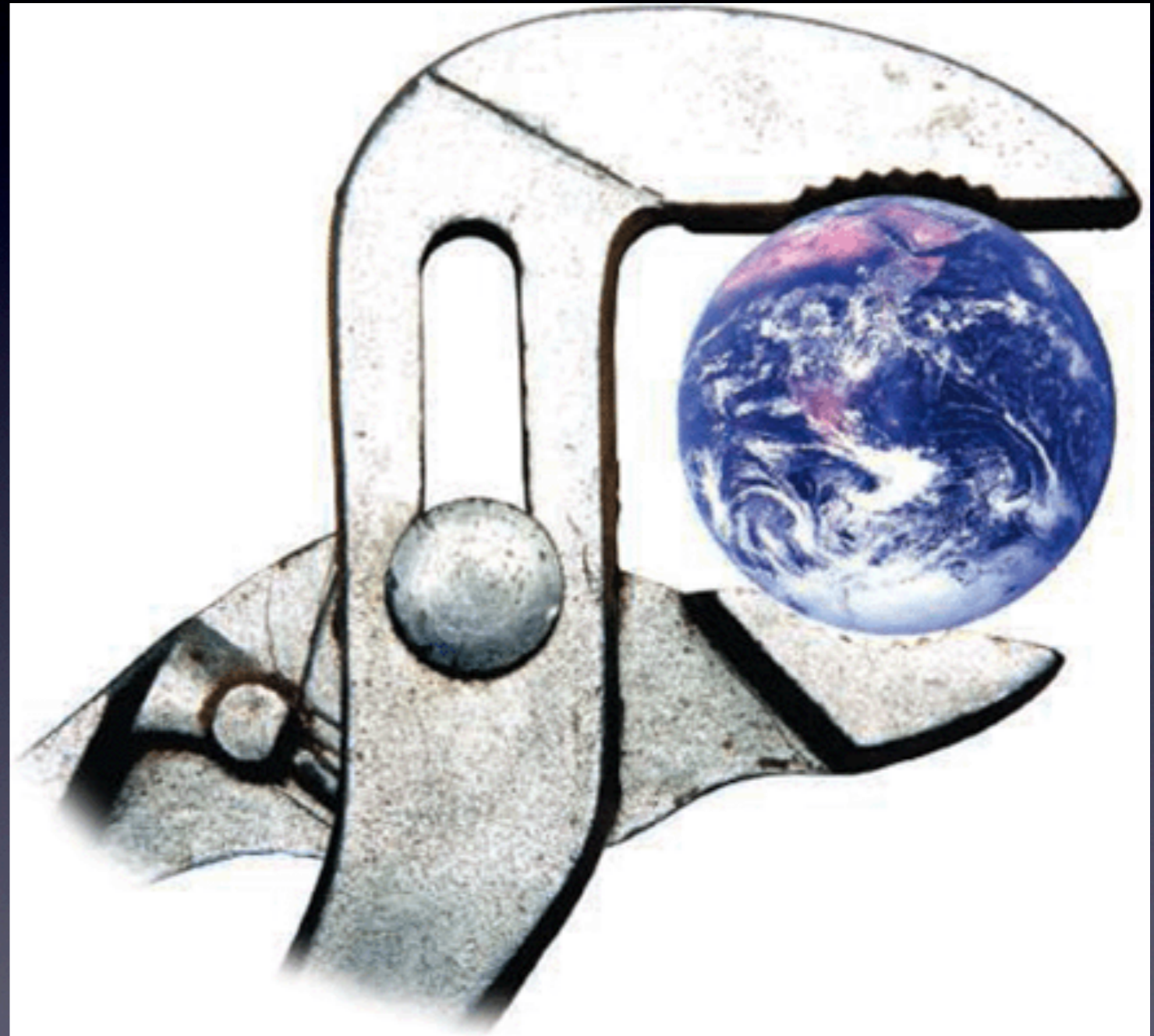
Que peut-on faire ?

- Prévenir l'acidification
 - Limiter le CO₂ atmosphérique
 - Réduire les facteurs locaux
 - eutrophisation
 - rivières à forte acidité
- Augmenter la résilience des écosystèmes
- Adapter les activités humaines
 - modifier comportements et processus
 - se déplacer
- Réparer l'acidification
 - diminuant acidité
 - restauration d'écosystèmes dégradés



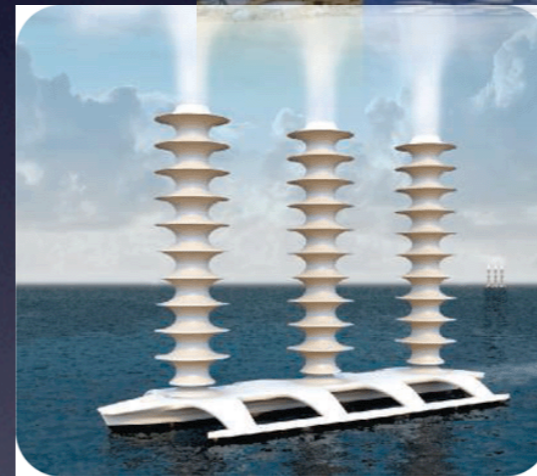
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Que peut-on faire ?

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Originally published Thursday, June 21, 2012 at 9:24 PM

Willapa Bay oyster grower sounds alarm, starts hatchery in Hawaii

A Willapa Bay shellfish company is shifting some of its business to Hawaii because of ocean acidification that scientists believe is killing tiny oyster larvae in shellfish farms along Washington's coast.

By [Craig Welch](#)
Seattle Times environment reporter

After 34 years rearing shellfish in Willapa Bay, Dave Nisbet was in a bind: Nature had stopped providing.

Oysters were no longer reproducing naturally on the Washington Coast. Oyster larvae were even dying in nearby hatcheries, which use seawater to raise baby shellfish that get sold as starter seed to companies like Nisbet's Goose Point Oysters.

But when, in 2009, Nisbet heard oceanographers identify the likely culprit — increasingly corrosive ocean water, a byproduct of the same

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BRIAN J. CANTWELL / THE SEATTLE TIMES

Messages clés

- Nos émissions de CO₂ causent une acidification des océans
- Conséquences négatives pour la plupart des organismes qui fabriquent une coquille ou un squelette calcaire
- Impacts sur la biodiversité
- Besoin critique de clarifier des inconnues
- L'acidification durera longtemps
- Il n'est pas trop tard pour s'attaquer à ce problème

Informations complémentaires

Messages for Rio+20

Making it clear

A special introductory guide for policy advisers and decision makers

Frequently asked questions about ocean acidification

OCB **EPOCA**

Introduction

Ocean acidification is a term that is used to describe the process of the ocean becoming more acidic. It is caused by the absorption of atmospheric CO₂ by the ocean. This process is occurring at an unprecedented rate and is expected to have significant impacts on marine ecosystems and the global food chain.

Contents:

- The name "ocean acidification"
- Measurements & Observations
- Causes & Consequences
- Impacts & Ecosystems
- Policy Development & Legislation
- Conclusions

THE FACTS

QUESTIONS ANSWERED

Ocean Acidification: ACTING ON EVIDENCE

the INTERACADEMY PANEL on international issues iap

IAP STATEMENT ON OCEAN ACIDIFICATION

Headline messages:

- Oceans play a critical role in the global carbon cycle by absorbing about a quarter of the CO₂ emitted to the atmosphere from human activities.
- The rapid increase in CO₂ emissions since the industrial revolution has increased the acidity of the world's oceans with potentially profound consequences for marine plants and animals, especially those that require calcium carbonate to grow and survive, and other species that rely on their shells for food.
- At current emission rates models suggest that all coral reefs and polar ecosystems will be severely affected by 2050 or potentially even earlier.
- Marine food supplies are likely to be reduced with significant implications for food production and security in regions dependent on fish proteins and marine health and wellbeing.
- Ocean acidification is inseparable an illustration of at least two of thousands of years.
- Even with stabilization of atmospheric CO₂ at 450 ppm, ocean acidification will have profound impacts on many marine systems. Large and rapid reductions of global CO₂ emissions are needed globally by at least 50% by 2050.

1. CO₂ and ocean chemistry

Over the past 200 years, the oceans have absorbed approximately a quarter of the CO₂ produced from human activities. The CO₂ acidification has led to a 0.1 pH unit decrease in the average surface ocean pH, a change that is equivalent to the acidification of rain water. The average pH of surface ocean waters has been lowered by 0.1 units since the pre-industrial period. The equivalent 0.1 pH increase in hydrogen ion activity highlights the stark contrast between the pre-industrial world, which was a more neutral environment, such as coral and mollusks, to produce their shells, and the modern world, which is a more acidic environment. The loss of calcium carbonate shells is a threat to the calcification of corals, mollusks and shells, which are critical to many marine organisms. Calcification rates are now being reduced by at least 50% in some regions.

2. Environmental damage from ocean acidification

Ocean acidification impacts on marine life will depend on the rate and magnitude of change in ocean chemistry and biological responses. While the overall impact is expected to be significant, high-impact, low-frequency events such as marine heatwaves, hypoxic events, and extreme weather events, may have a more immediate and visible impact on marine life. The loss of calcium carbonate shells is a threat to the calcification of corals, mollusks and shells, which are critical to many marine organisms. Calcification rates are now being reduced by at least 50% in some regions.

SECOND INTERNATIONAL SYMPOSIUM ON THE OCEAN IN A HIGH-CO₂ WORLD

MONACO - OCTOBER 6-9, 2008

Monaco Declaration

It was while taking part in the working sessions of the scientific community, which met in Monaco last October for the second international symposium on the ocean in a high CO₂ world, that I expressed my earnest wishes for the Monaco Declaration to be drafted. The sea and ocean absorb one fourth of the carbon dioxide emitted to the atmosphere from human activities, which in turn is driving their acidification at a rate that is unprecedented. This chemical modification will alter marine ecosystems, upon which one half of the world's population depends for its primary source of food. This declaration, based on available scientific knowledge and signed by 125 scientists from 26 nations, sets forth recommendations, calling the policymakers to address this immense problem. I strongly support this declaration, which is a full acknowledgment of the scientific community's concern for the future of our oceans and the role of the international community in addressing this global challenge. I hope that it will be heard by all the political leaders meeting in Copenhagen in December 2009.

H.S.H. Prince Albert II

GLOBAL CHANGE

SCOR **IAEA** **ICES** **FAO** **WFP** **WHO** **UNEP** **UNESCO** **WFP** **WHO** **UNEP** **UNESCO**

Documents for policy makers – some written by EPOCA's Reference User Group of stakeholders

World leading website and blog on ocean acidification

A book and two award winning films one by school children and another by professional film makers

Dialogue with policy makers and media at climate change negotiations in Copenhagen, Cancun and Capetown

TIPPING POINT

A film by Laurence Jourdan
Camera: Marlene Tardif, Editing: Françoise Boisjoly
Underwater filming: Yves Gladi

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the other CO₂ problem

A powerful animation from the younger generation on the threat and environmental implications of ocean acidification

ocean acidification

Jean-Pierre Gattuso and Lina Hansson

STARRING

EPOCA

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Ocean acidification is a term that is used to describe the process of the ocean becoming more acidic. It is caused by the absorption of atmospheric carbon dioxide (CO₂) by the ocean. This process has been occurring since the beginning of time, but it is now happening at a much faster rate due to human activities. The resulting increase in acidity can have serious impacts on marine life, particularly on organisms with calcium carbonate shells or skeletons. This document provides a comprehensive overview of the science of ocean acidification, its causes, and its potential impacts on the world's oceans. It also discusses the current state of research and the need for urgent action to mitigate the effects of climate change on our oceans.

the INTERACADEMY PANEL ON OCEAN ACIDIFICATION

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- Even with stabilization of atmospheric CO₂ at 450 ppm, ocean acidification will have profound impacts on many marine systems. Large and rapid reductions of global CO₂ emissions are needed globally by at least 50% by 2050.

1. CO₂ and ocean chemistry

Over the past 200 years, the oceans have absorbed approximately a quarter of the CO₂ produced from human activities. The CO₂ acidifies seawater to form carbonic acid, which then dissociates to bicarbonate and carbonate ions. The absorption of the CO₂ has affected ocean chemistry and has caused the oceans to become on average slightly more acidic. The average pH of ocean surface waters has been lowered by 0.1 units since the pre-industrial period. The equivalent 0.1% increase in hydrogen ion activity highlights the potential for the biological effects of ocean acidification, such as coral and shellfish, to produce their skeletons, shells and other hard parts. The loss of calcium carbonate from the oceans will have significant impacts on many marine organisms, including coral reefs, mollusks, and other organisms that rely on calcium carbonate for their shells and skeletons. Carbonate ion concentrations are now lower than at any other time during the last 800,000 years.

2. Environmental damage from ocean acidification

Ocean acidification impacts on marine life will depend on the rate and magnitude of change in ocean chemistry and biological responses. While the overall ocean chemistry change is predictable with high confidence, our understanding of the impacts is still developing. Significant research is ongoing to better understand the potential impacts of ocean acidification on marine life. Impacts are already being observed in the polar and tropical regions. Coral calcification rates have declined in recent decades, although attributing causes for these changes to multiple drivers including warming, pollution, etc. is a challenge. Fundamental ecological ocean processes will be affected as many marine organisms depend directly or indirectly on calcium carbonate saturation states and are adapted to current levels of carbonate ion concentrations. This includes processes such as calcification, growth and reproduction. The pH change required will exceed the natural and regional seasonal variability in many areas.

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Group

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Site web EPOCA: epoca-project.eu

Blog EPOCA: oceanacidification.wordpress.com

A book on ocean acidification for policy makers

Dialogue with policy makers and media at climate change negotiations in Copenhagen, Cancun and Capetown

TIPPING POINT

A film by Camera-Markus Tiedtke

EPOCA

Increasing levels of CO₂ in the atmosphere are not only causing global warming. Oceans are absorbing huge quantities of CO₂ which in turn is changing their chemical composition and altering the marine environment. By following leading international researchers, Tipping Point will take us around the world and under the sea to see the real consequences of a changing marine environment and what scientists believe can be done to solve the problem.

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