

eFOCE project: impacts of ocean acidification and update on COP21



Jean-Pierre Gattuso

CNRS-Université Pierre et Marie Curie-Paris 6

Institute for Sustainable Development and
International Relations

With invaluable help from Erin Cox & Frédéric Gazeau

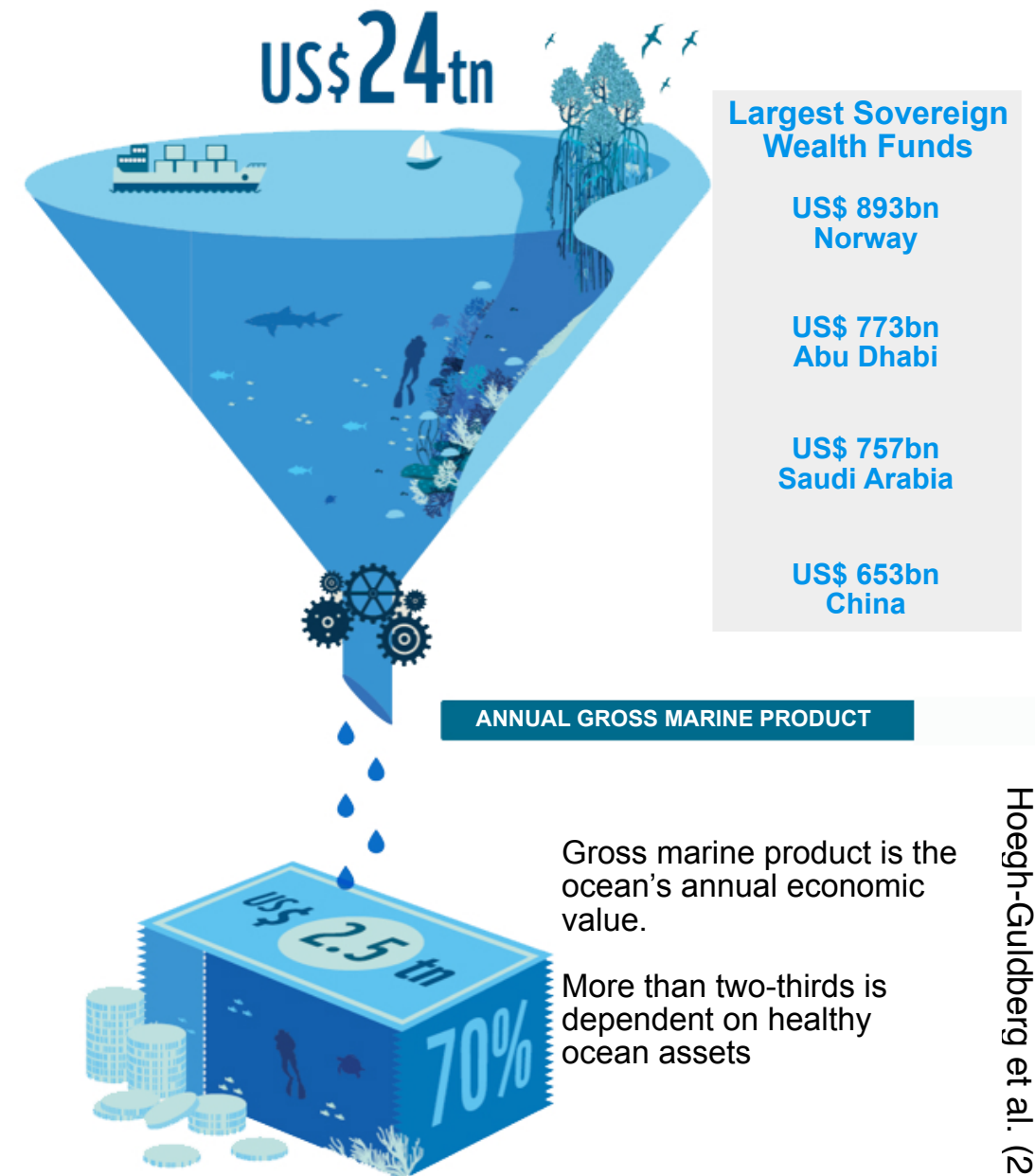


Ocean: considerable value

- Moderates climate change
- Represents more than 90% of the habitable space of the planet
- Hosts 25% of high-level species
- Provides 11% of global animal protein consumed by humans
- Ocean ecosystems protect coastlines
- ...

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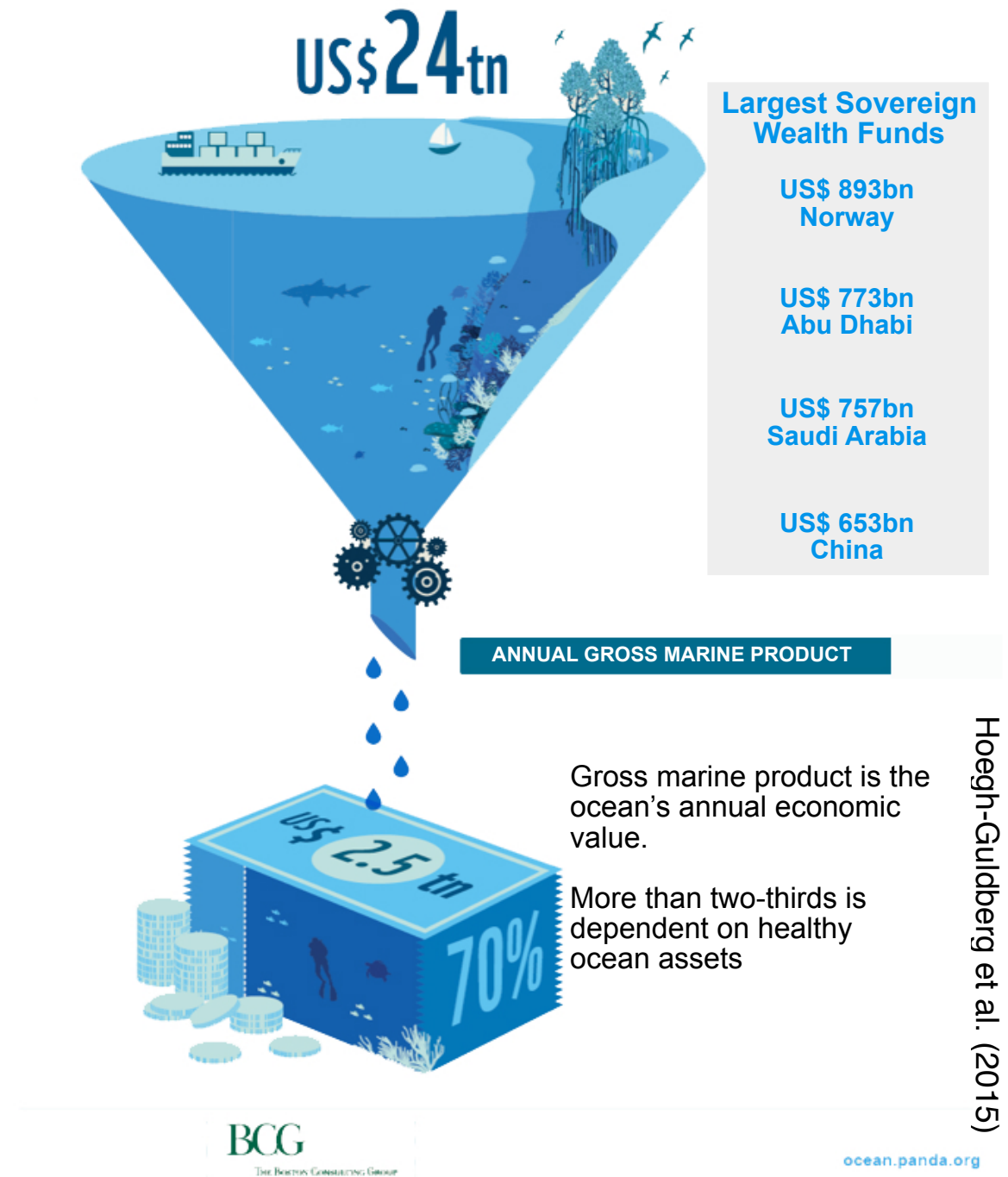
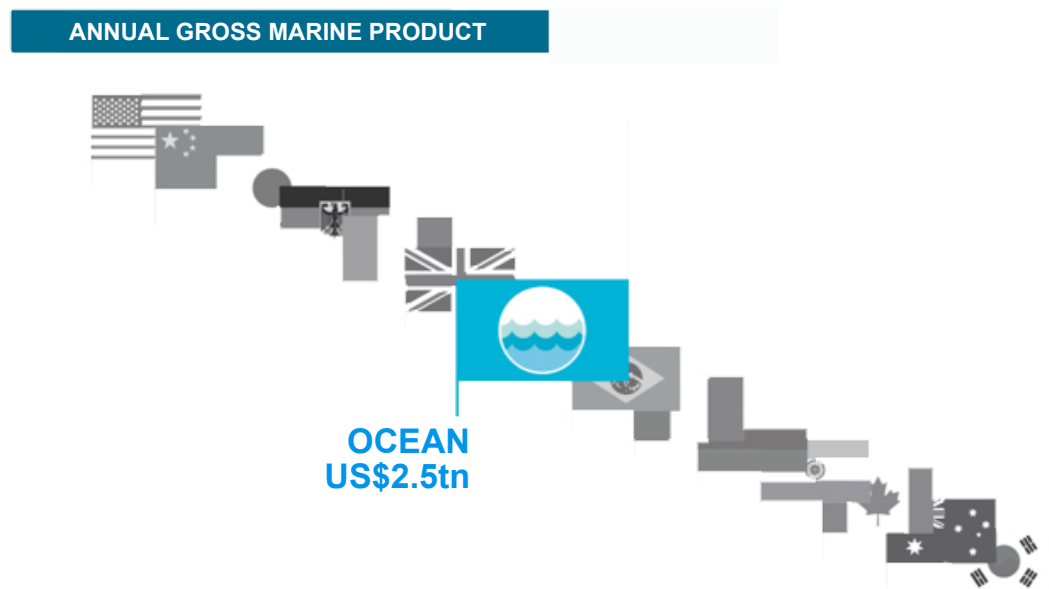
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Hoegh-Guldberg et al. (2015)

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Global carbon budget (2003-2012)

0.9 Pg C yr⁻¹



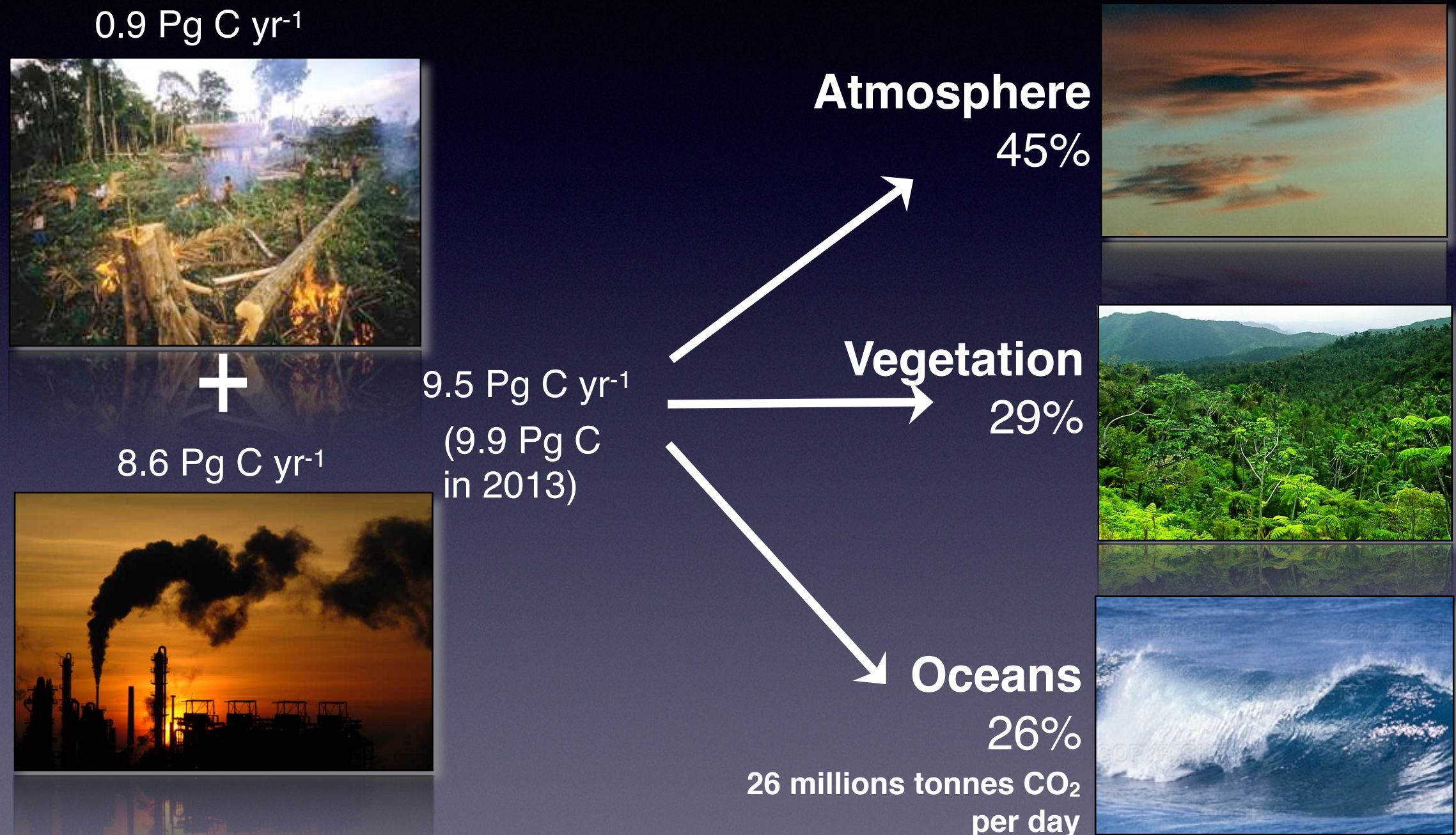
+

8.6 Pg C yr⁻¹

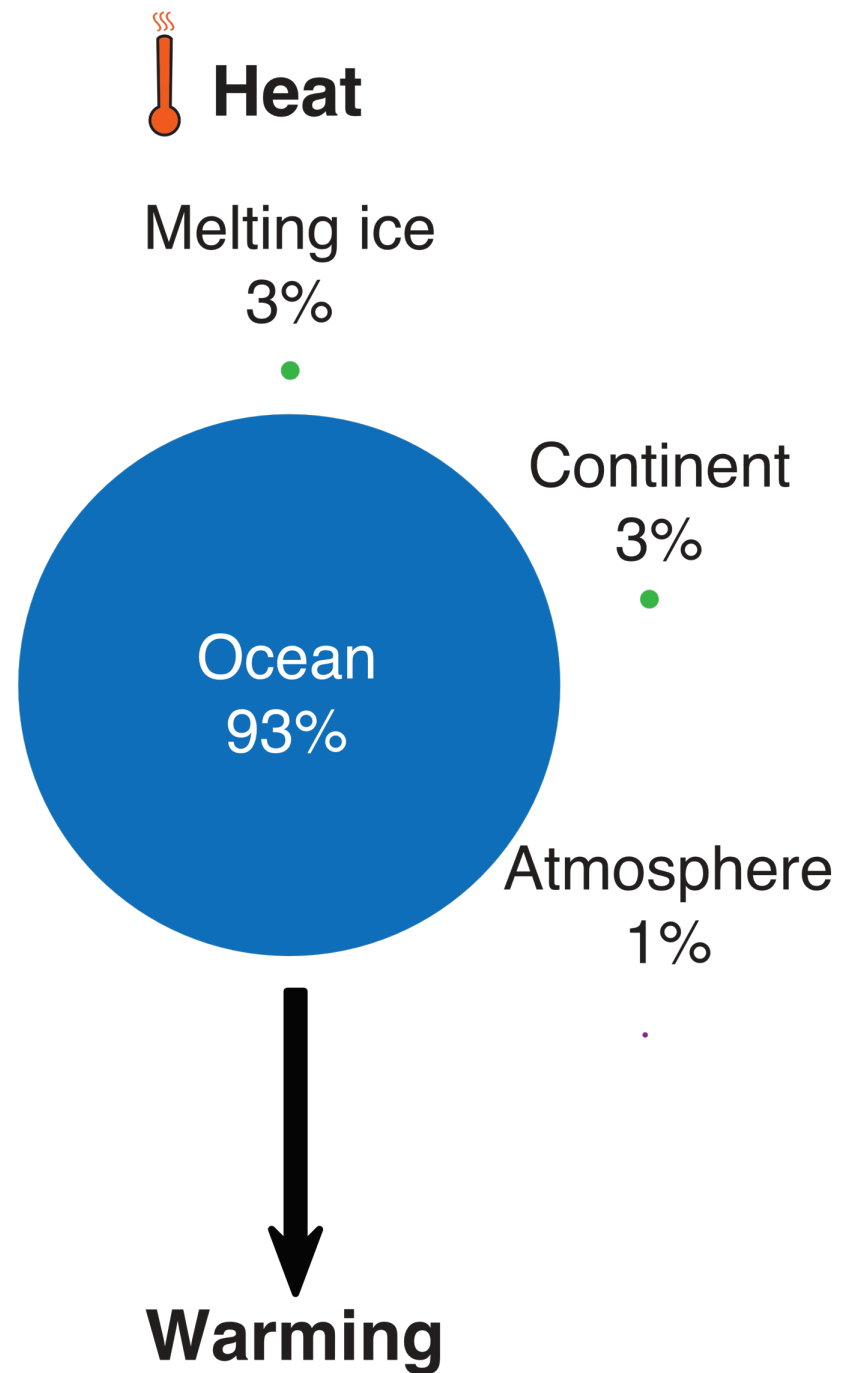


9.5 Pg C yr⁻¹
(9.9 Pg C
in 2013)

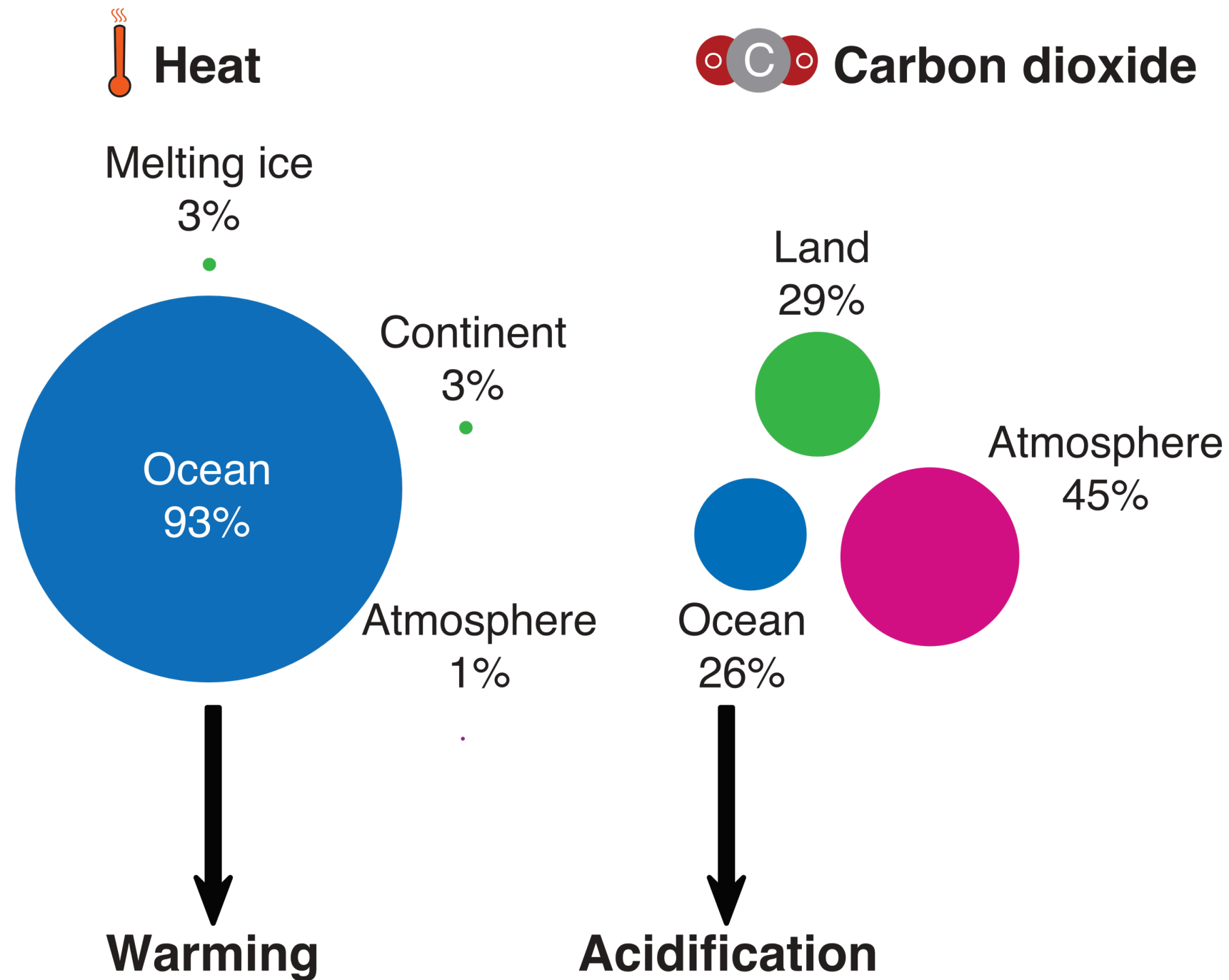
Global carbon budget (2003-2012)



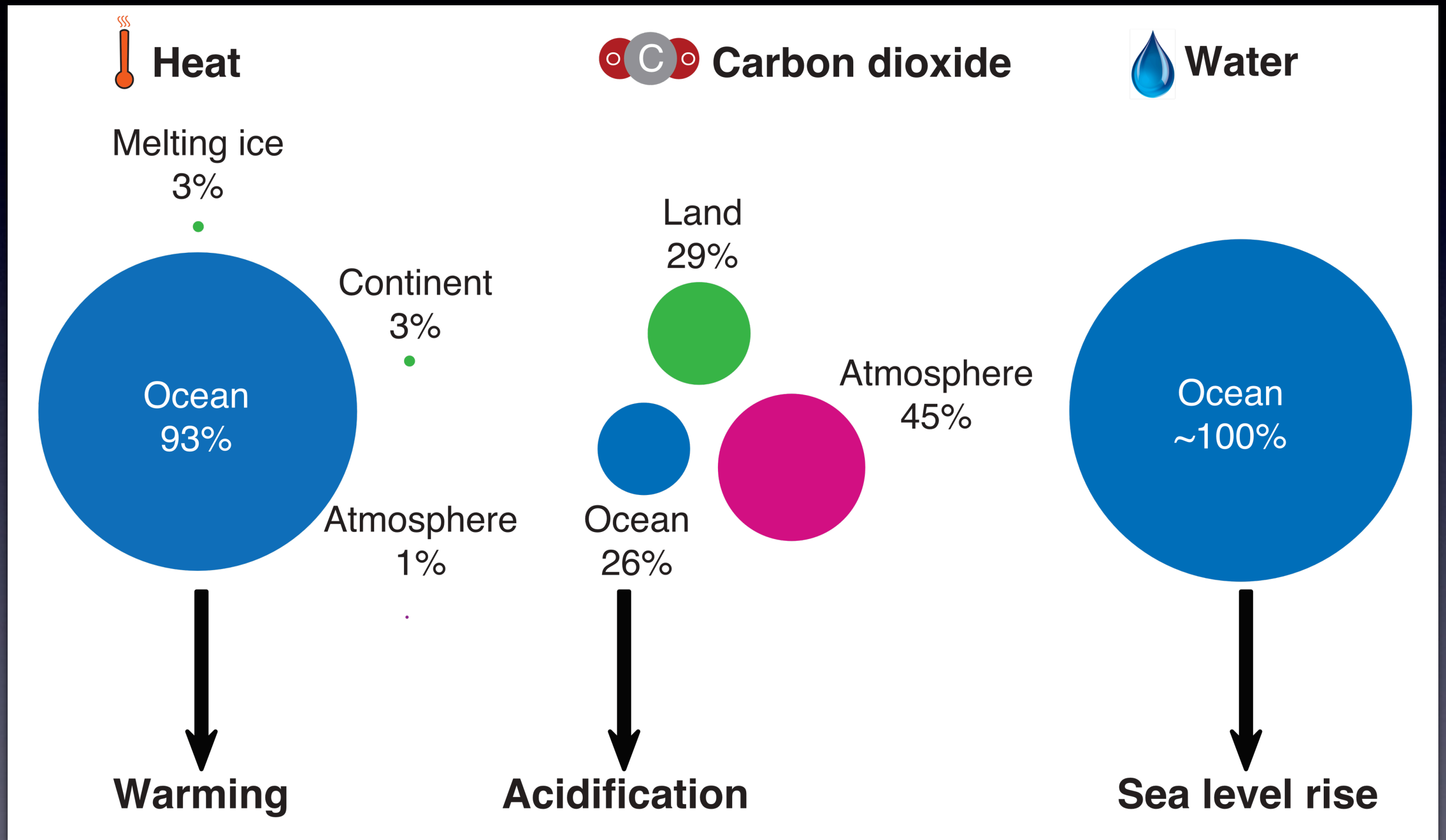
Ocean: actor and victim of climate change



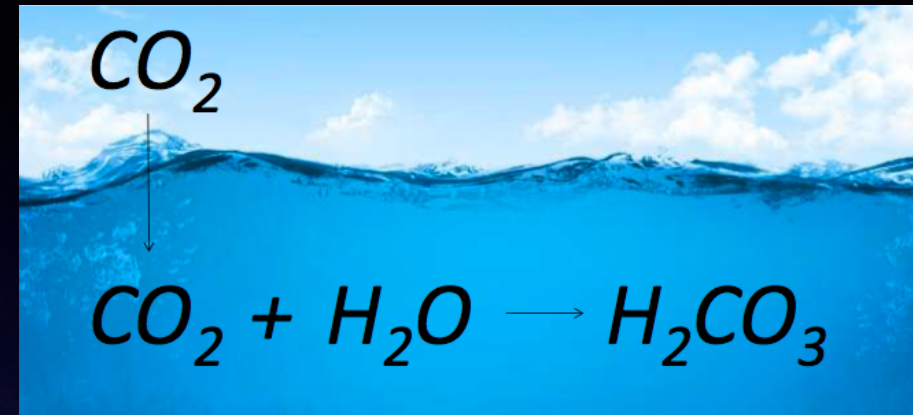
Ocean: actor and victim of climate change



Ocean: actor and victim of climate change



What is ocean acidification?



Sam Dupont

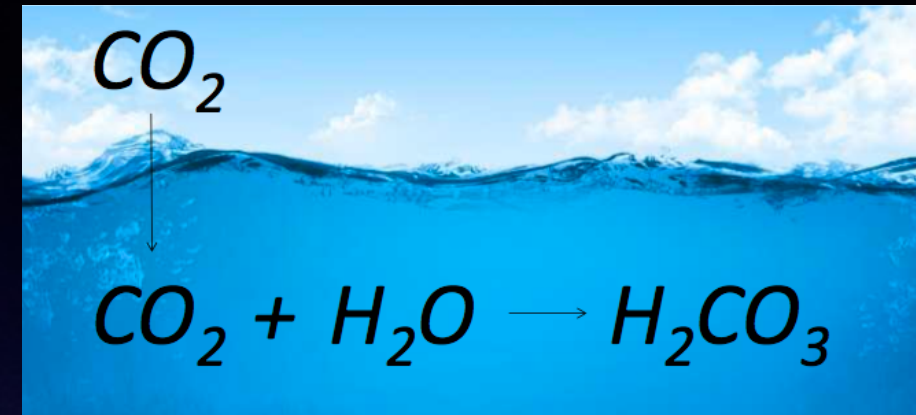
- CO_2 is an acid gas (it produces acid when combined with water)
- Each of us adds 4 kg CO_2 per day to the ocean (increasing acidity, reducing pH)

What is ocean acidification?

Concentrations of Hydrogen ions compared to distilled water (pH)		Examples of solutions and their respective pH
10,000,000	0	Battery Acid
1,000,000	1	Hydrochloric Acid
100,000	2	Lemon Juice, Vinegar
10,000	3	Orange Juice, Soda
1,000	4	Tomato Juice
100	5	Black Coffee, Acid Rain
10	6	Urine, Saliva
1	7	"Pure" Water
1/10	8	Sea Water
1/100	9	Baking Soda, Toothpaste
1/1,000	10	Milk of Magnesium
1/10,000	11	Household Ammonia
1/100,000	12	Soapy Water
1/1,000,000	13	Bleach, Oven Cleaner
1/10,000,000	14	Liquid Drain Cleaner

More acidity ↑

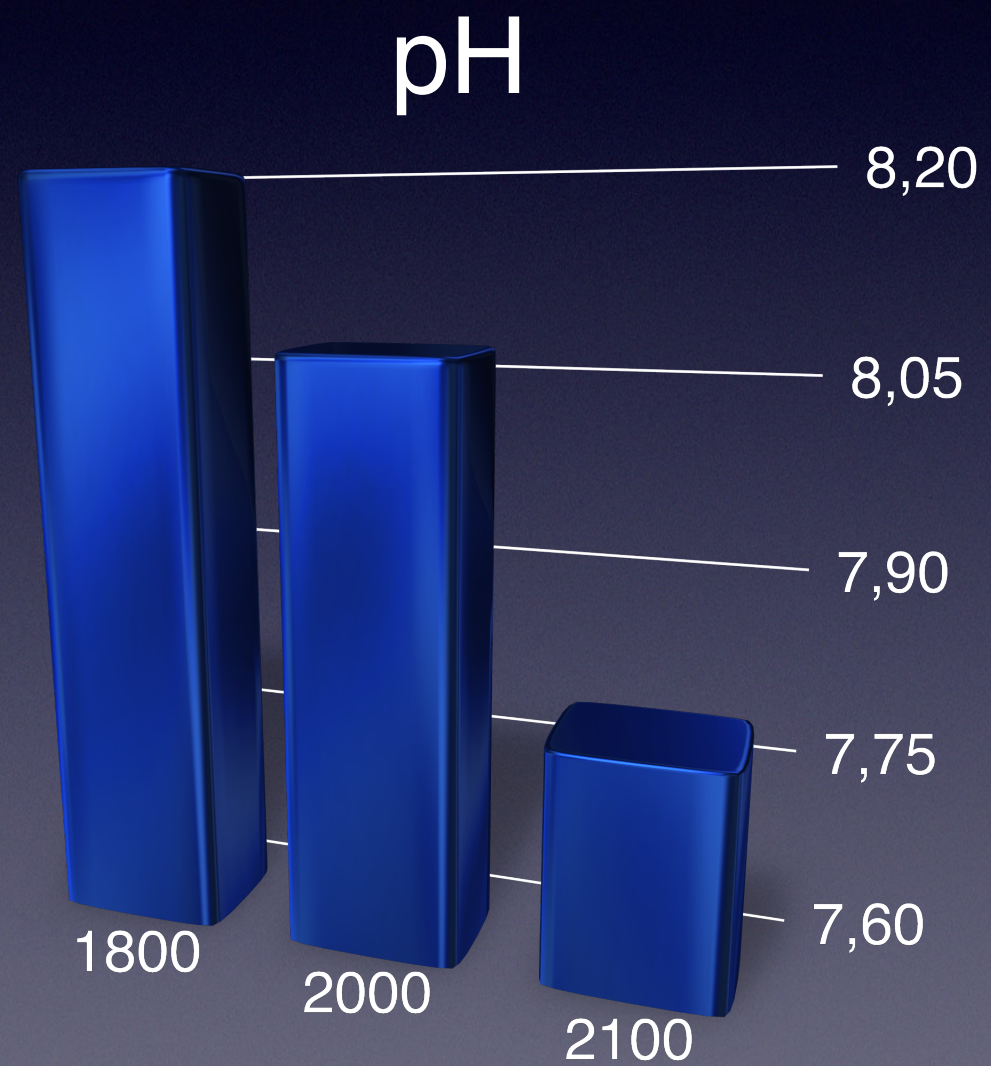
↓ Less acidity



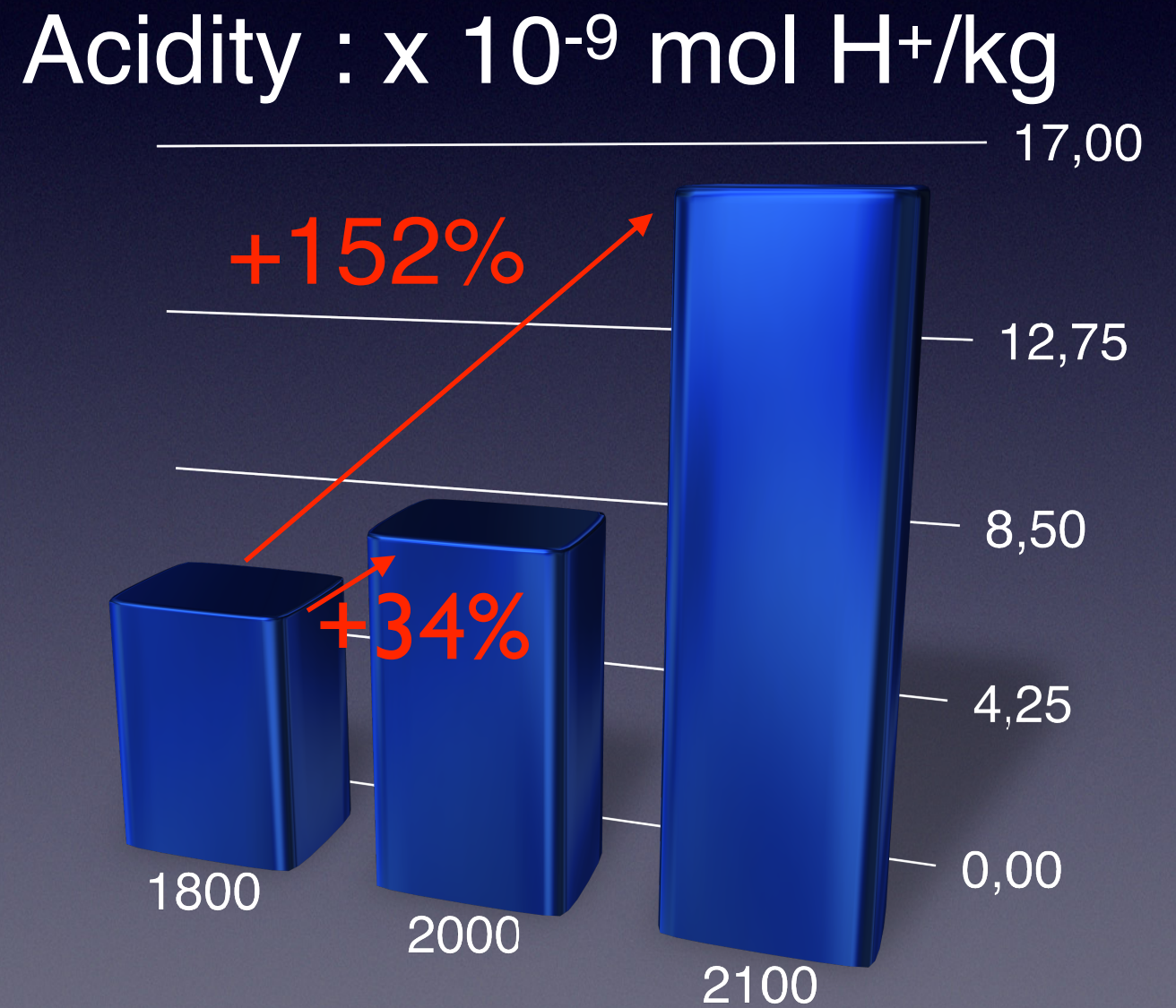
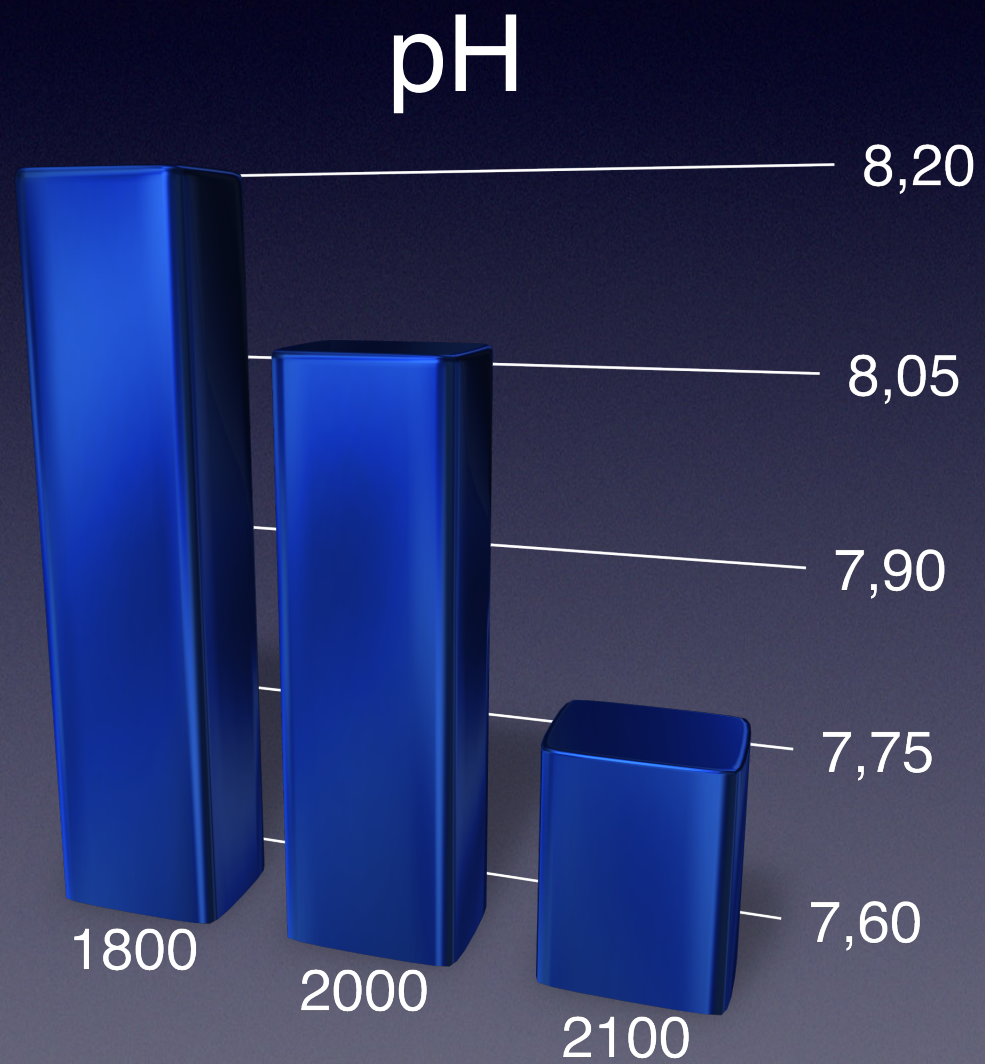
Sam Dupont

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pH and acidity



pH and acidity

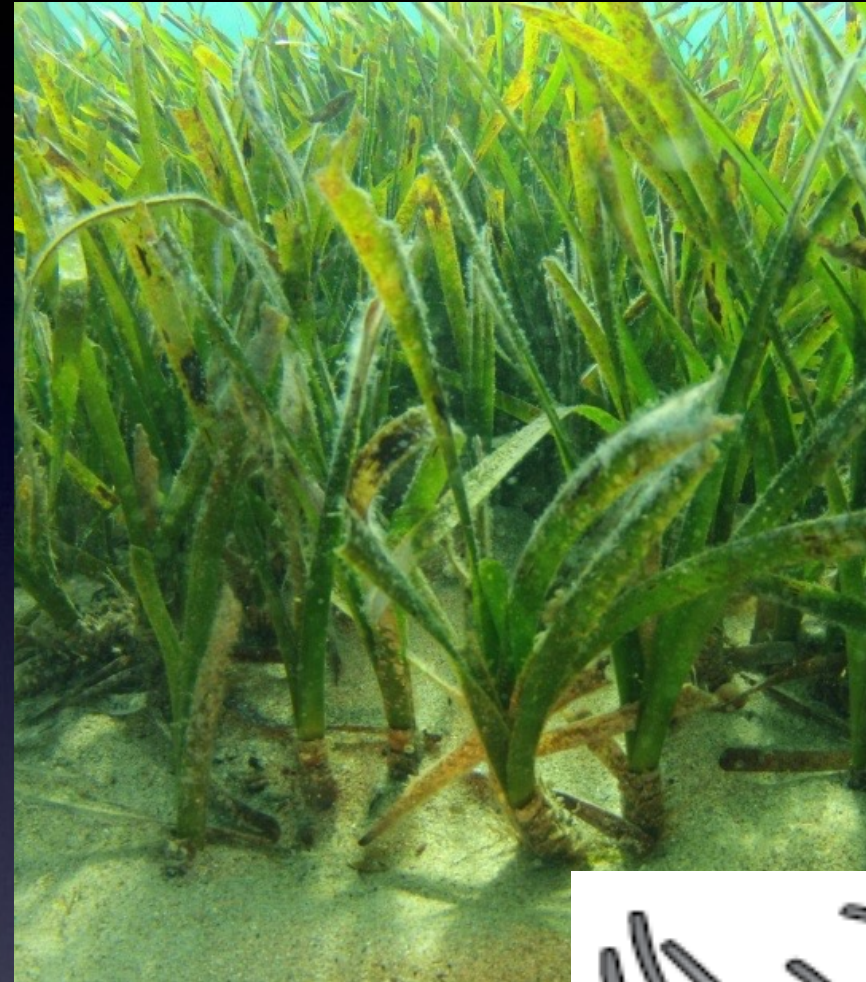


P. oceanica is a plant in the ocean



j. delille

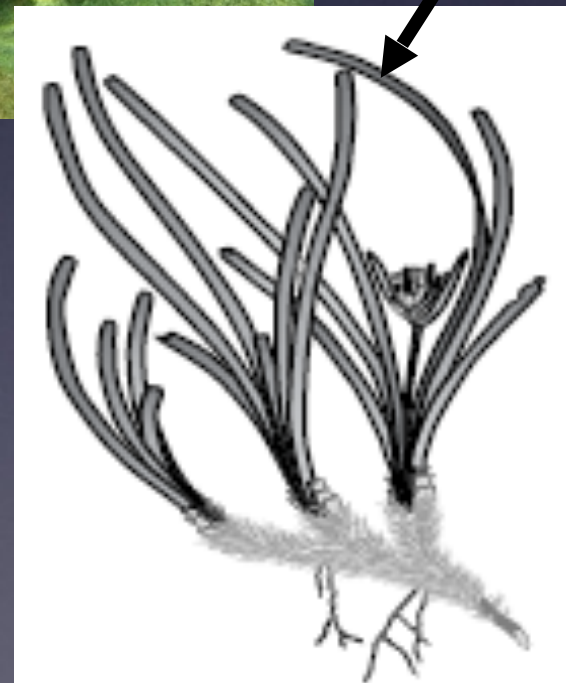
~1 m



~30 cm



~30 cm



Posidonia oceanica

- 1 of 4 seagrass in the Mediterranean Sea
- Covers up to 50,000 km² in shallow waters
- Ecosystem engineer



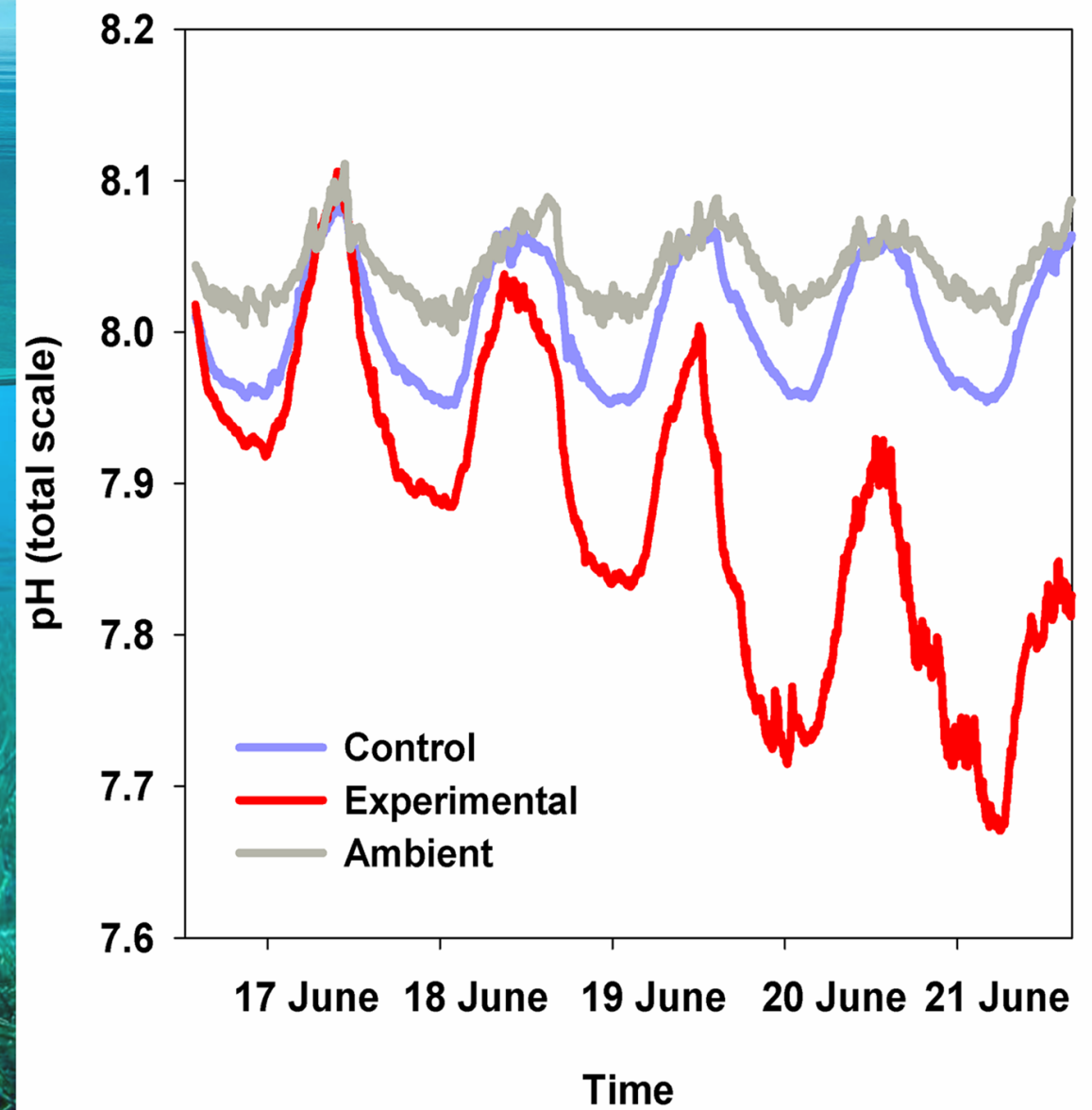
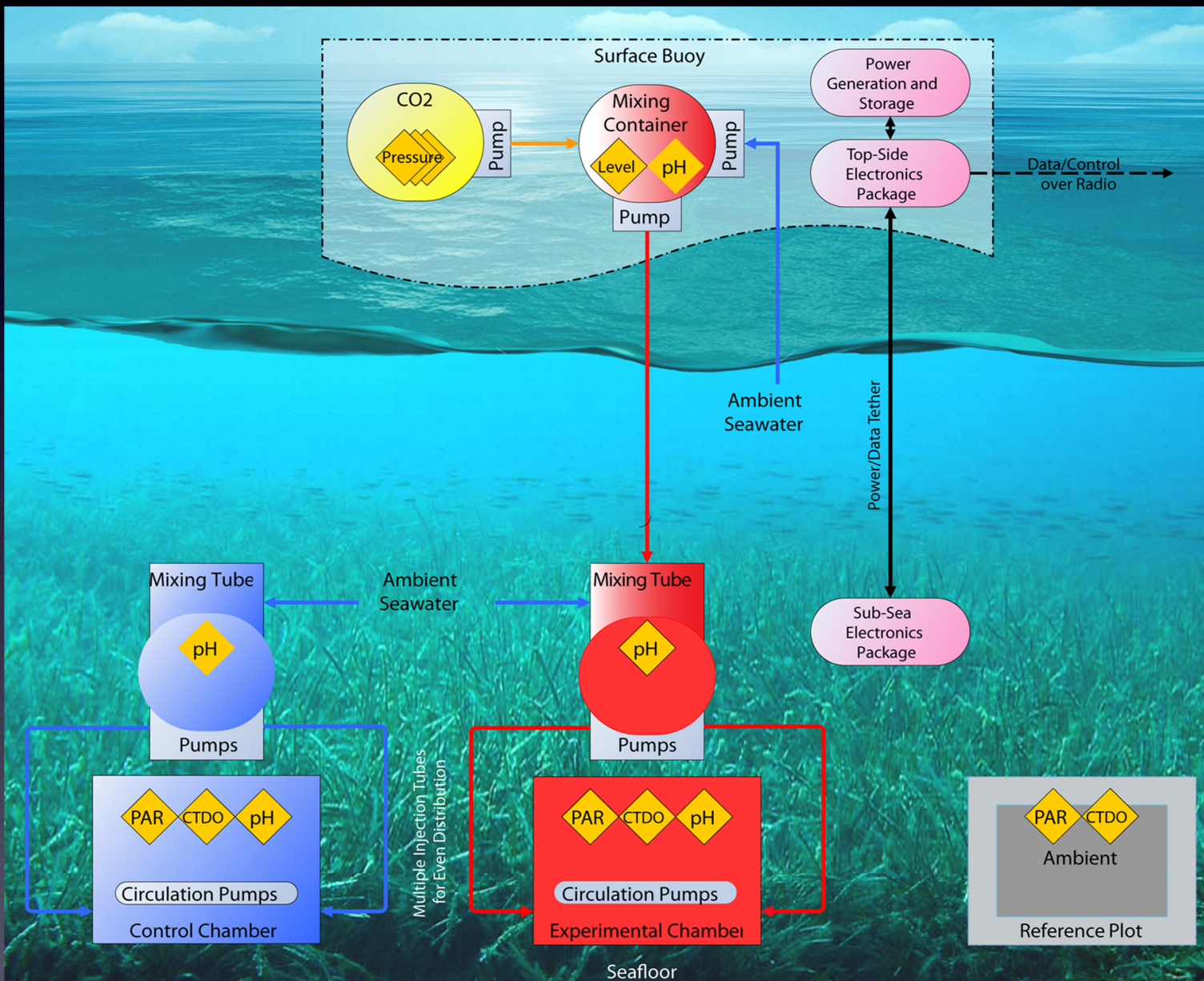
Its photosynthesis has an affinity for carbon dioxide

Will it benefit from ocean acidification?

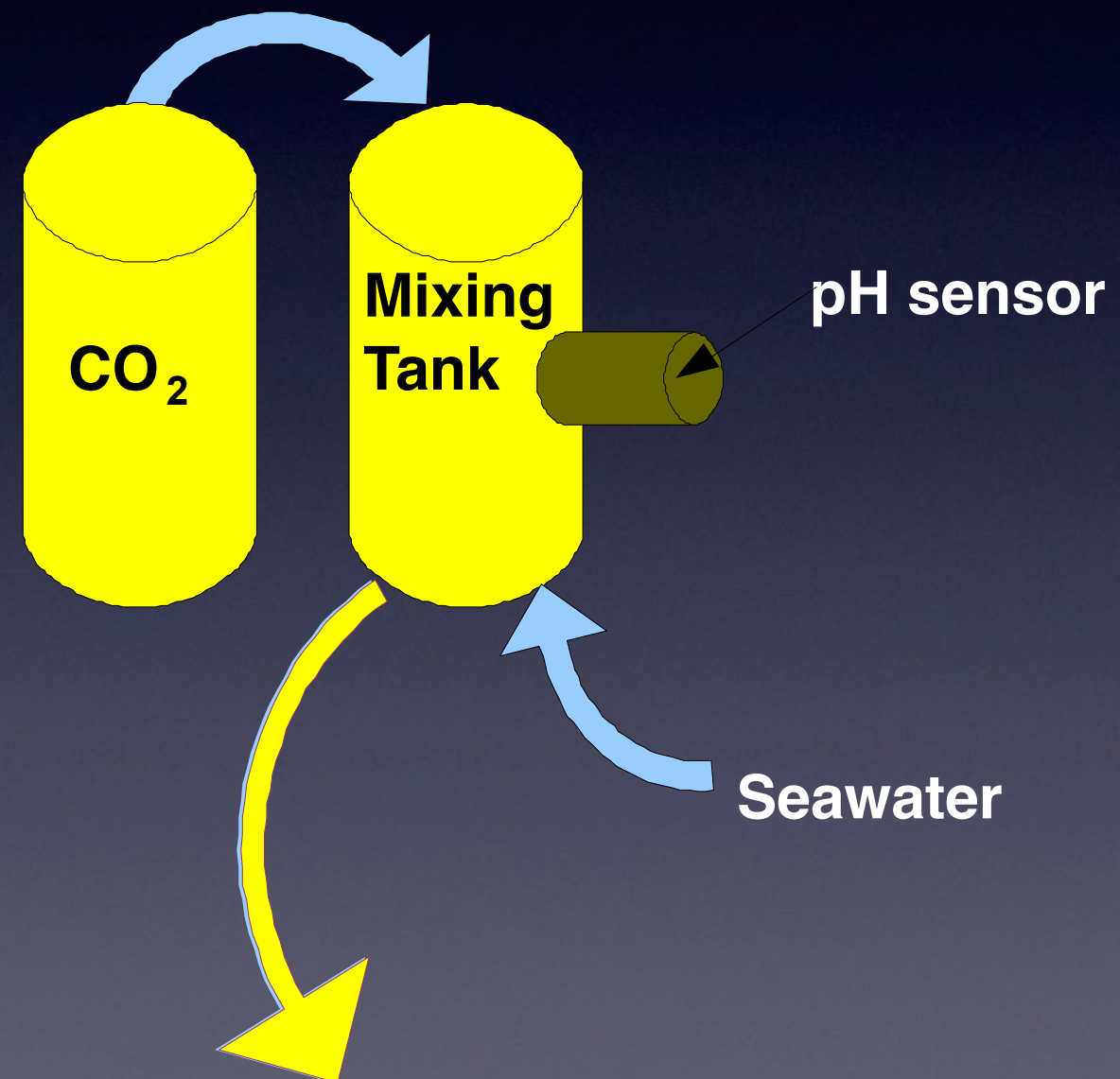
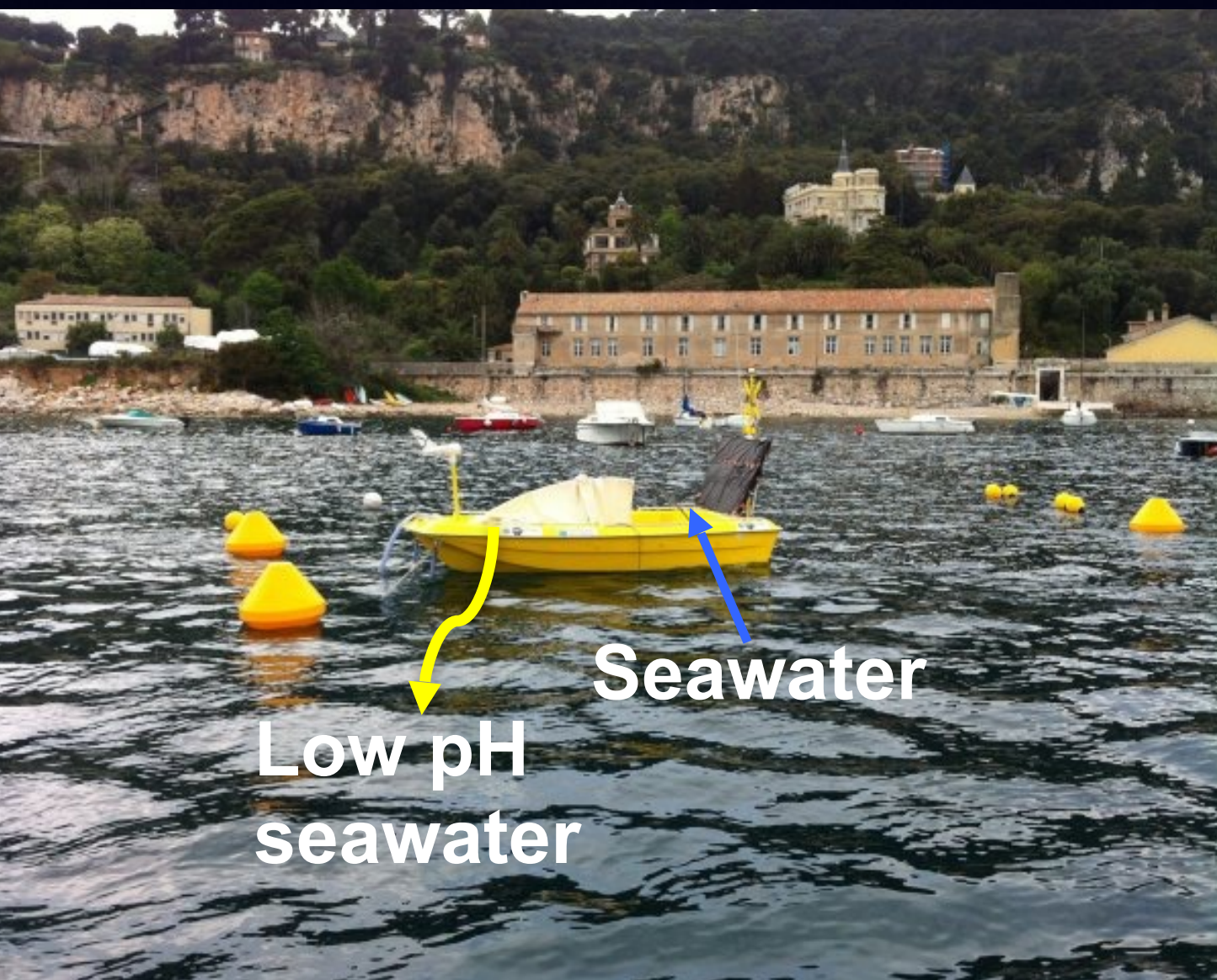
**europaean Free Ocean Carbon Dioxide Enrichment
was used to test *in situ* ocean acidification effects**



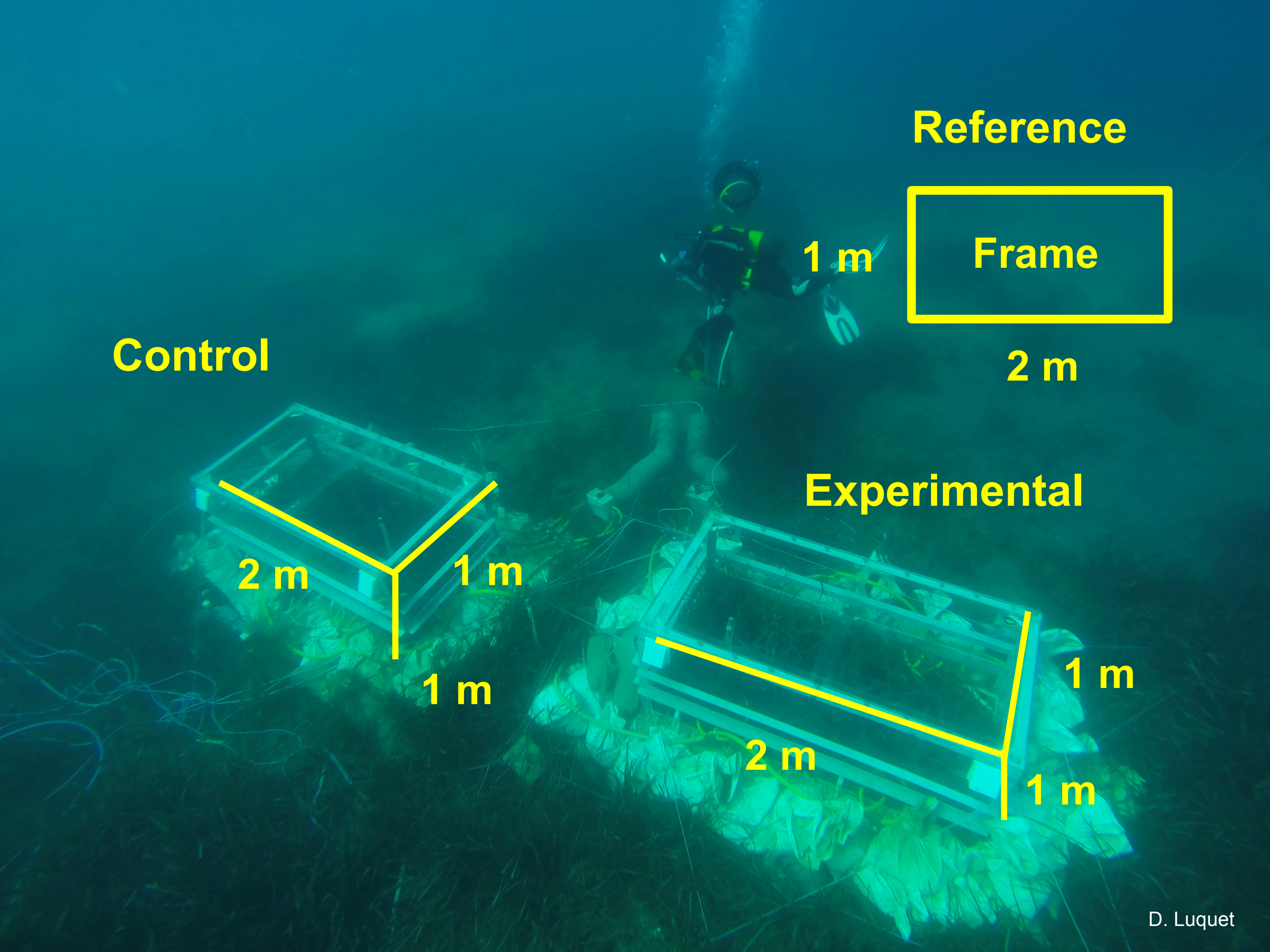
eFOCE Concept



Surface boat







Reference

Frame

1 m

2 m

Control

Experimental

2 m

1 m

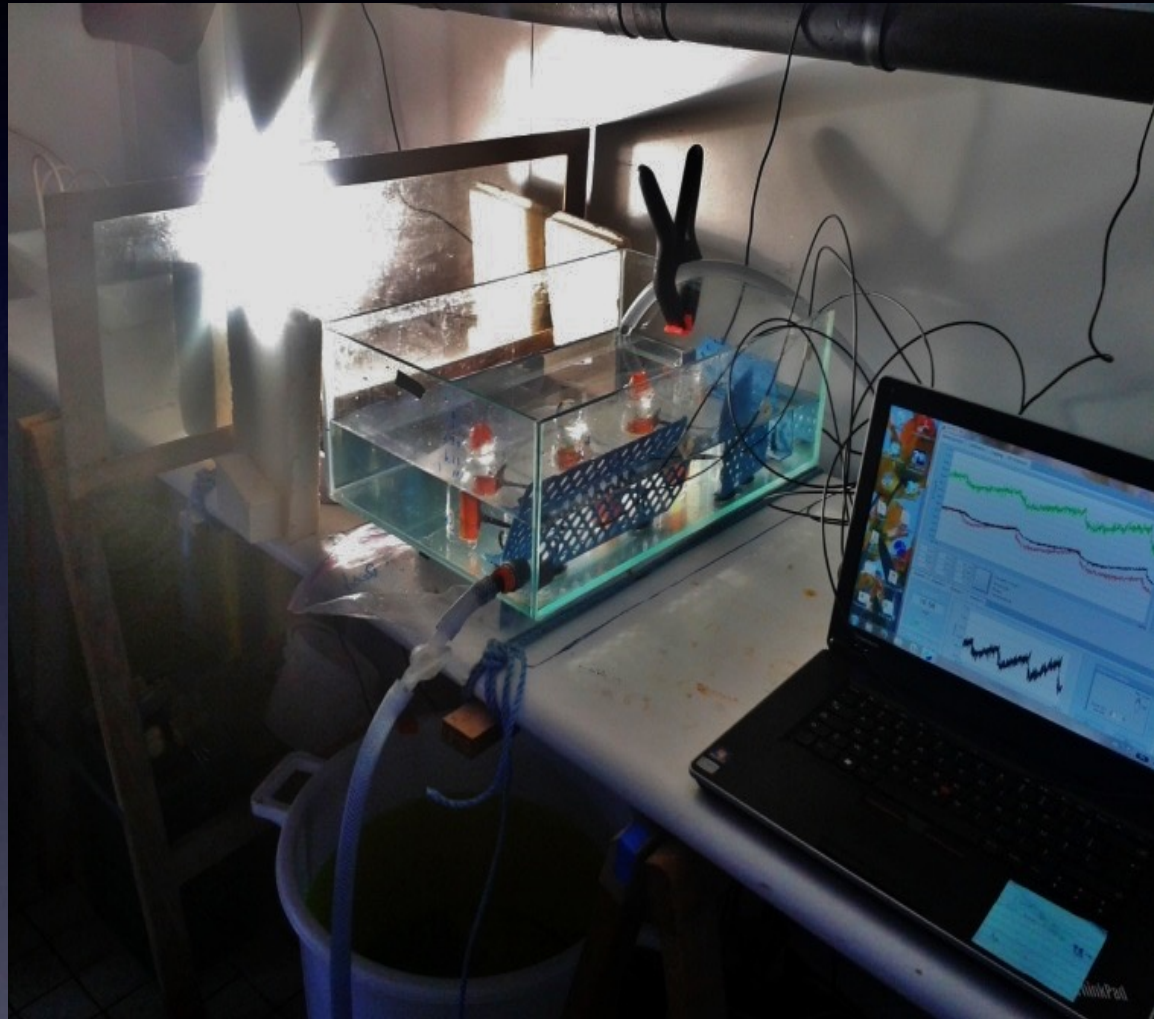
1 m

1 m

2 m

1 m

No change in photosynthesis



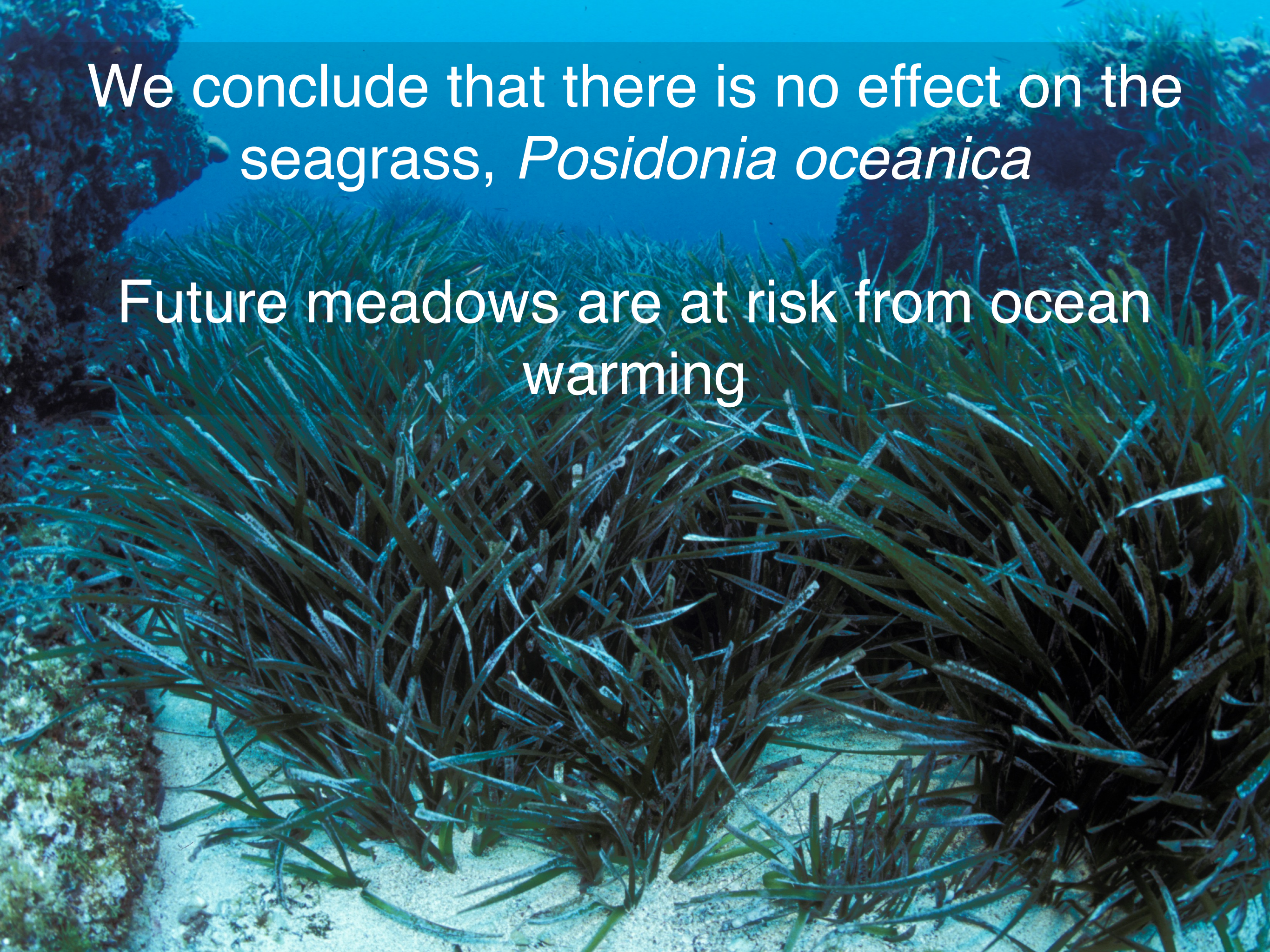
S. Schenone



D. Luquet

No change in the abundance of organisms



An underwater photograph showing a dense meadow of seagrass, identified as *Posidonia oceanica*. The seagrass has long, narrow, dark green leaves that grow in clumps. The background is a clear blue water column. The text is overlaid on the top half of the image.

We conclude that there is no effect on the
seagrass, *Posidonia oceanica*

Future meadows are at risk from ocean
warming

We express our gratitude to:

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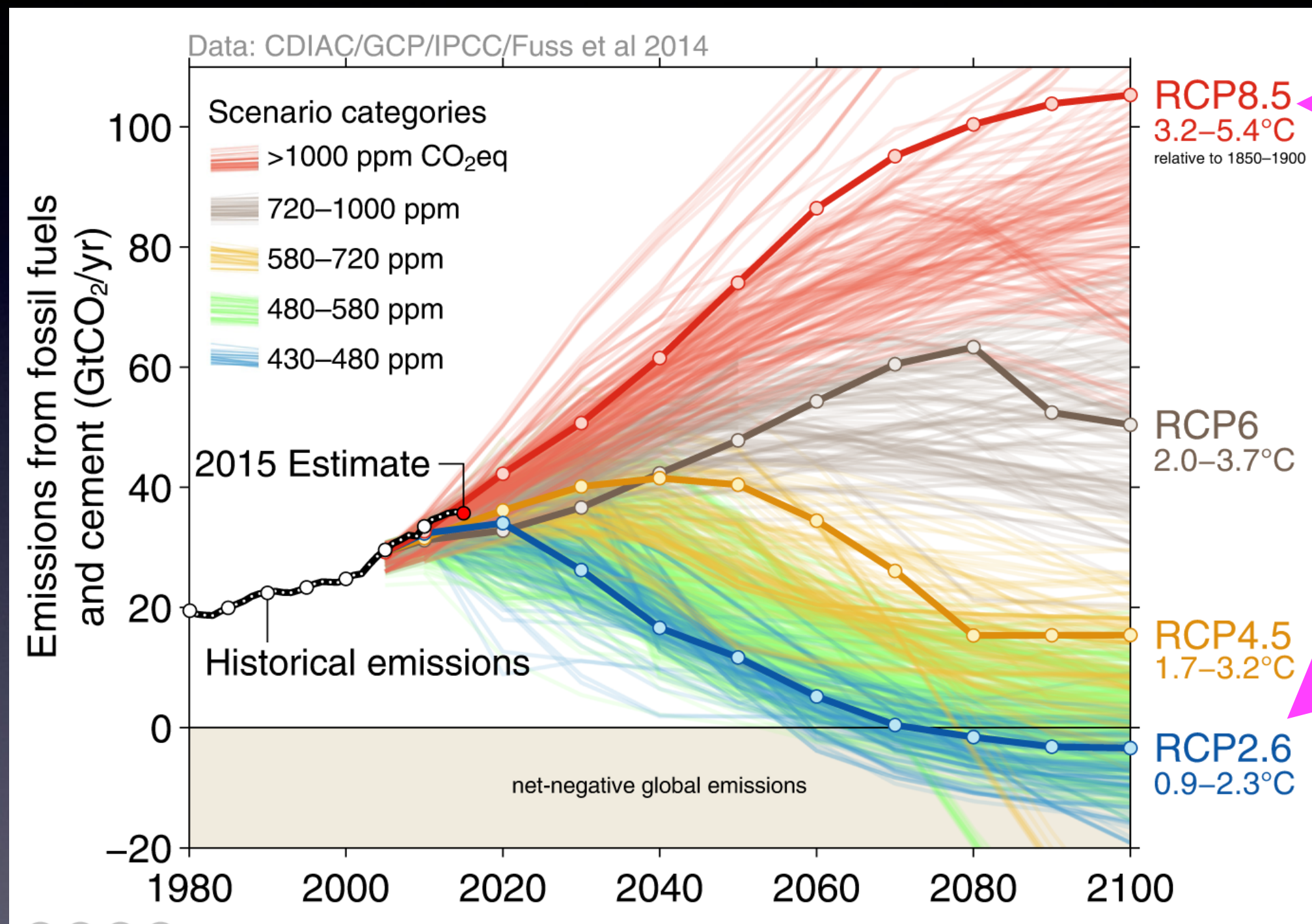
Service d'Observation Rade de Villefranche, Service d'Observation en Milieu Littoral, Service National d'Analyse des Paramètres Océaniques

BNP Paribas Foundation and European Commission

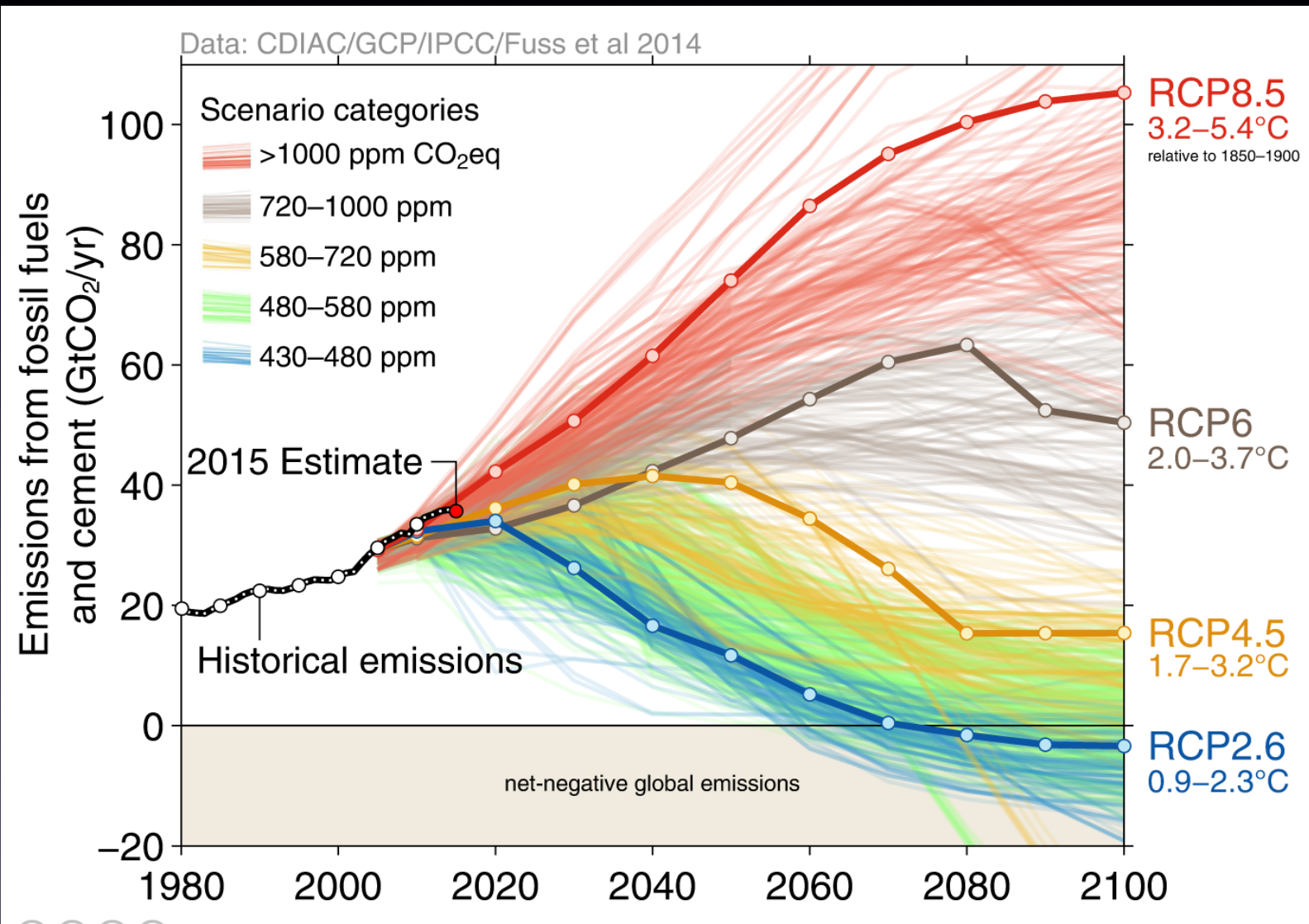


**FONDATION
BNP PARIBAS**

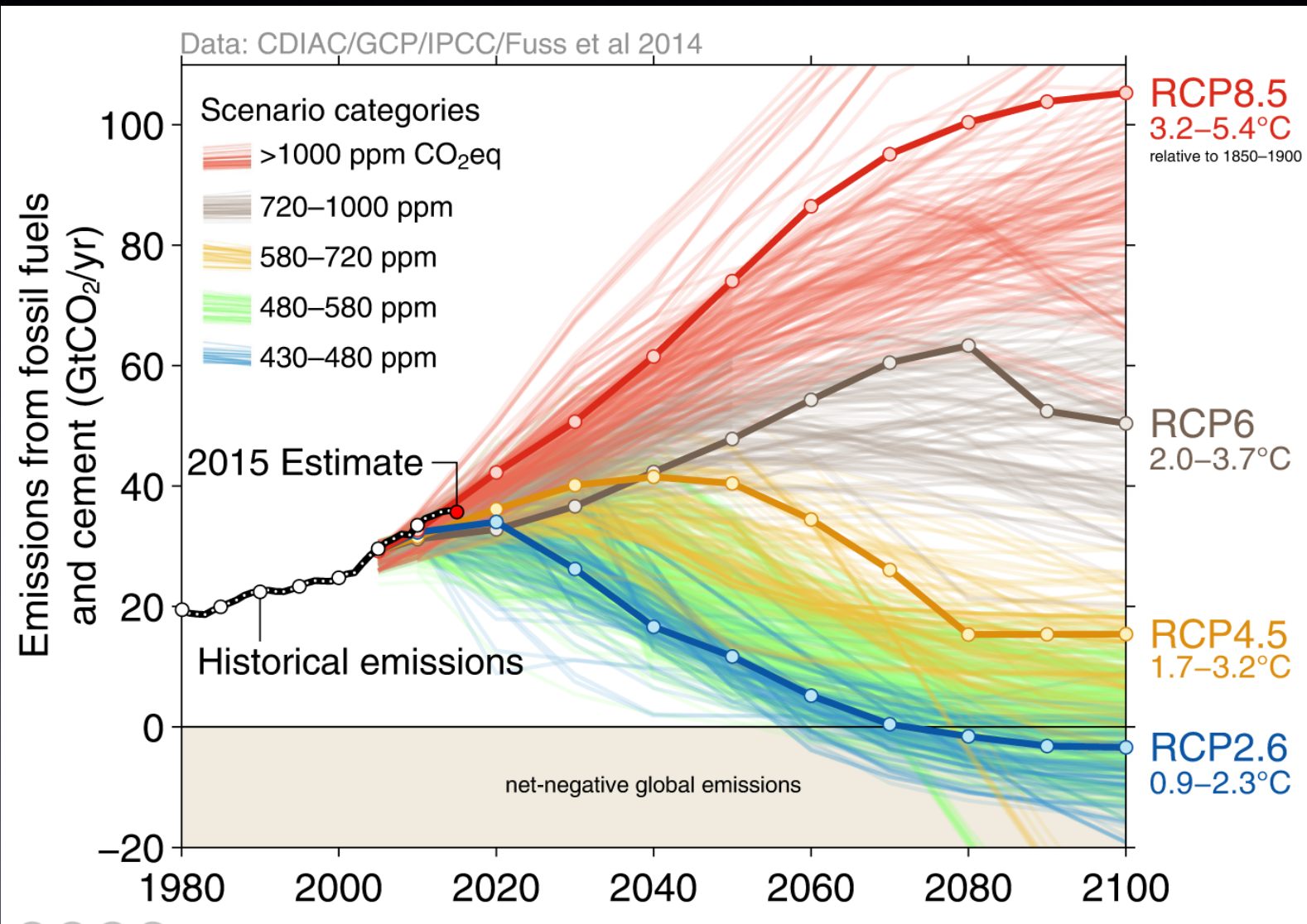
Future scenarios



Future scenarios

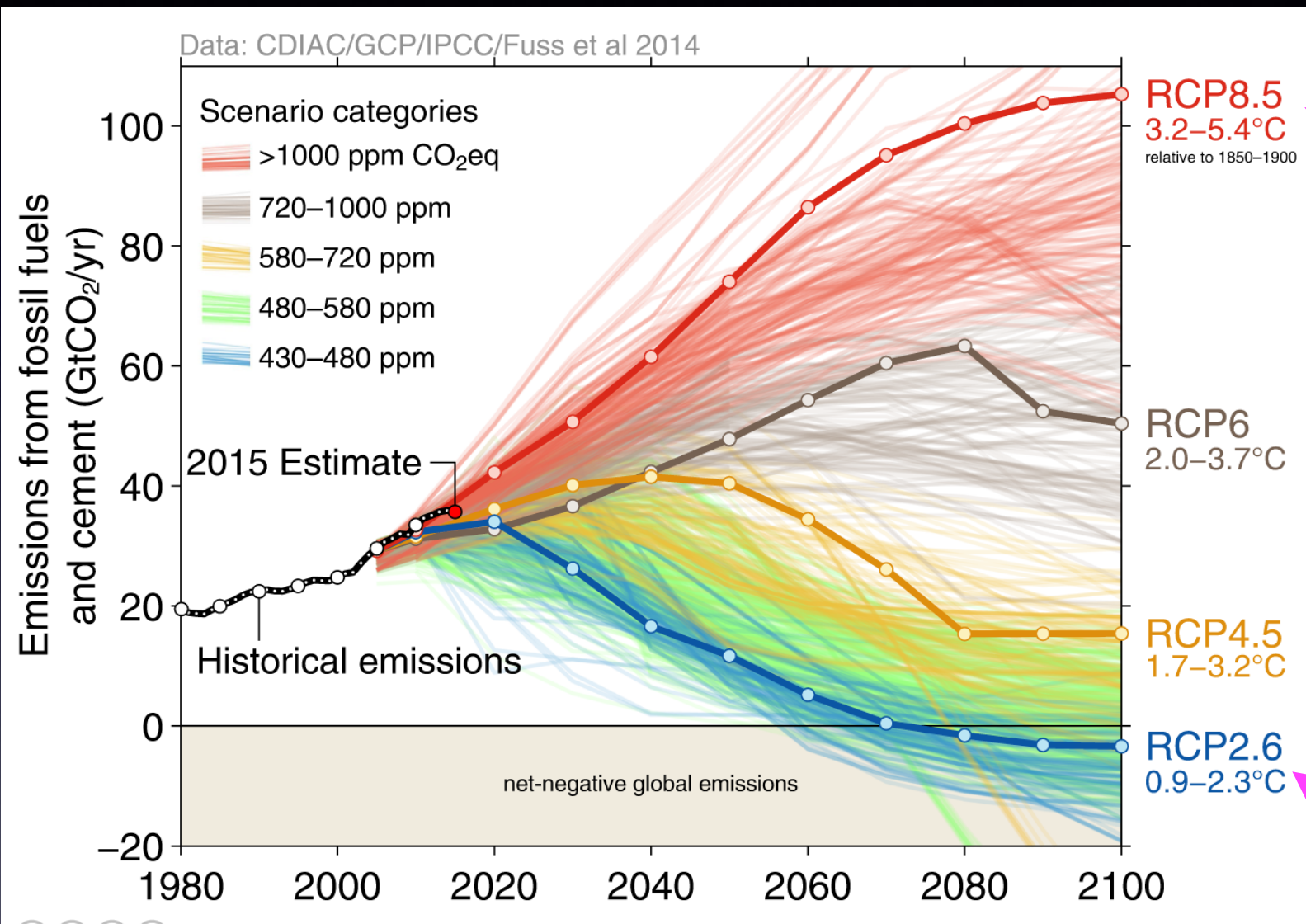


Future scenarios



+1.5 °C and -0.2 pH over
69% of the surface ocean

Future scenarios



+1.5 °C and -0.2 pH over
69% of the surface ocean

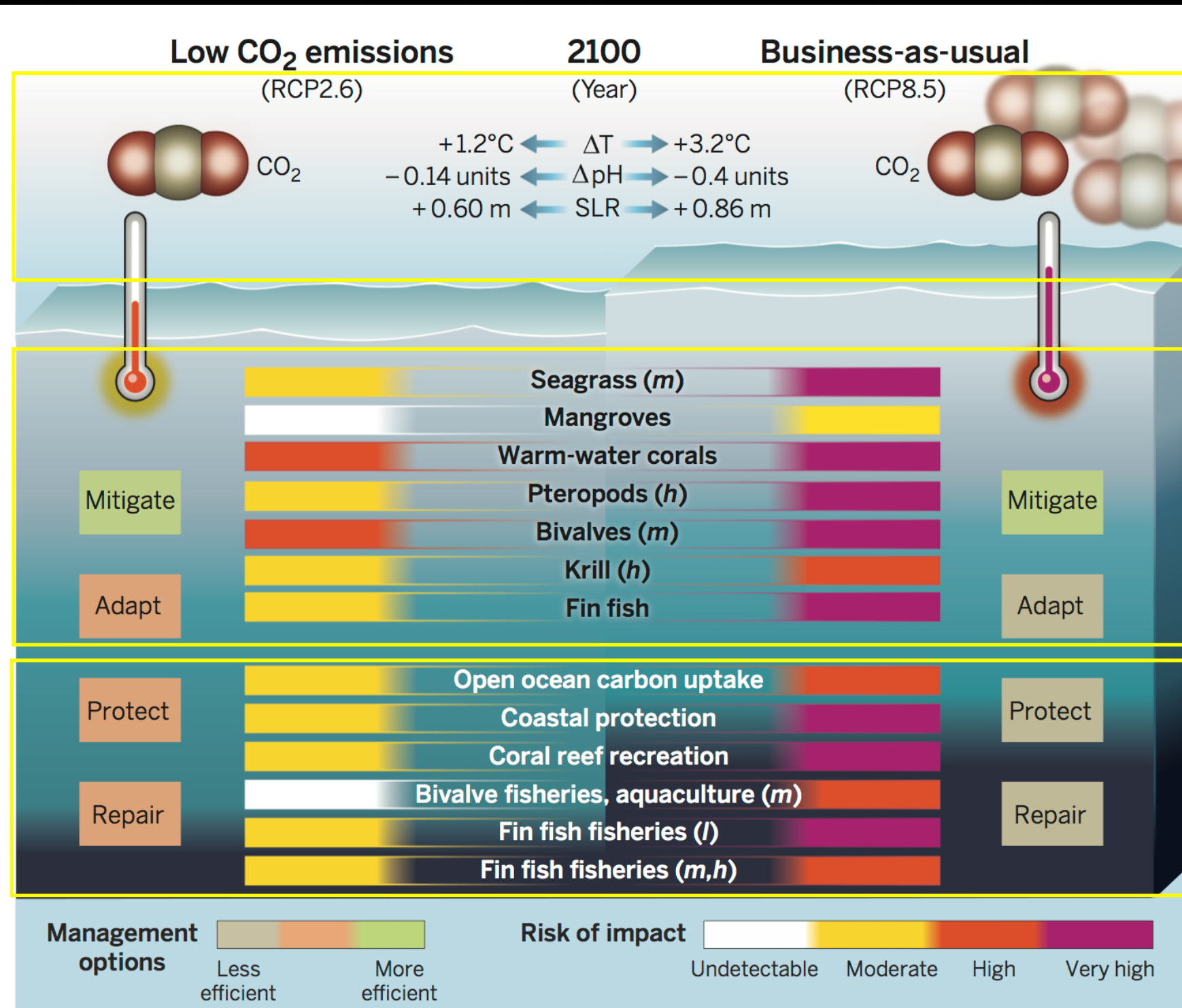
+1.5 °C and -0.2 pH over less than
1% of the surface ocean

Risks of impacts

Physics & chemistry

Organisms

Services



Gattuso et al. (2015)

4 key messages

1. Ocean strongly influences the climate system and important provider of key services
2. Impacts already detectable, high risk of impacts well before 2100, even with a low emission scenario
3. Immediate and substantial reduction of CO₂ emissions to prevent massive and mostly irreversible impacts
4. As CO₂ increases, the protection, adaptation, and repair options become fewer and less effective



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www.idddri.org

Institut du développement durable
et des relations internationales
27, rue Saint-Guillaume
75337 Paris cedex 07 France

SciencesPo

POLICY BRIEF

N°04/15 SEPTEMBER 2015 | CLIMATE - OCEANS AND COASTAL ZONES

Intertwined ocean and climate: implications for international climate negotiations

Alexandre K. Magnan (IDDDRI), Raphaël Billé (Secretariat of the Pacific Community), Sarah R. Cooley (Ocean Conservancy), Ryan Kelly (University of Washington), Hans-Otto Pörtner (Alfred Wegener Institute), Carol Turley (Plymouth Marine Laboratory), Jean-Pierre Gattuso (CNRS-INSU, Sorbonne Universités, IDDDRI)

INTRODUCTION

The atmosphere and ocean are two components of the Earth system that are essential for life, yet humankind is altering both. Contemporary climate change is now a well-identified problem: anthropogenic causes, disturbance in extreme events patterns, gradual environmental changes, widespread impacts on life and natural resources, and multiple threats to human societies all around the world. But part of the problem remains largely unknown outside the scientific community: significant changes are also occurring in the ocean, threatening life and its sustainability on Earth.

This Policy Brief explains the significance of these changes in the ocean. It is based on a scientific paper recently published in *Science* (Gattuso *et al.*, 2015), which synthesizes recent and future changes to the ocean and its ecosystems, as well as to the goods and services they provide to humans. Two contrasting CO₂ emission scenarios are considered: the high emissions scenario (also known as "business-as-usual" and as the Representative Concentration Pathway 8.5, RCP8.5) and a stringent emissions scenario (RCP2.6) consistent with the Copenhagen Accord¹ of keeping mean global temperature increase below 2°C in 2100.

1. Copenhagen Accord, Decision 2/CP.15: Copenhagen accord (United Nations Framework Convention on Climate Change, Geneva, 2009).

KEY MESSAGES

- Climate and ocean are inseparable: the ocean moderates anthropogenic climate change by absorbing significant proportions of the heat and CO₂ that accumulate in the atmosphere, as well as by receiving all water from melting ice.
- This climate-regulating function happens at the cost of profound alterations of the ocean's physics and chemistry, leading to ocean warming and acidification, as well as to sea level rise. These changes significantly affect the ocean's ecology (organisms and ecosystems) and eventually marine and coastal human activities (fisheries, aquaculture, tourism, health...).
- As atmospheric CO₂ increases, possible human responses become fewer and less effective.
- This scientific statement provides further compelling arguments for immediate and ambitious CO₂ emissions reduction at the international level. This conclusion applies to COP21 as well as to the post-2015 climate regime at large.

COP21

CarbonBrief
CLEAR ON CLIMATE

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COUNTDOWN TO THE PARIS CLIMATE CONFERENCE

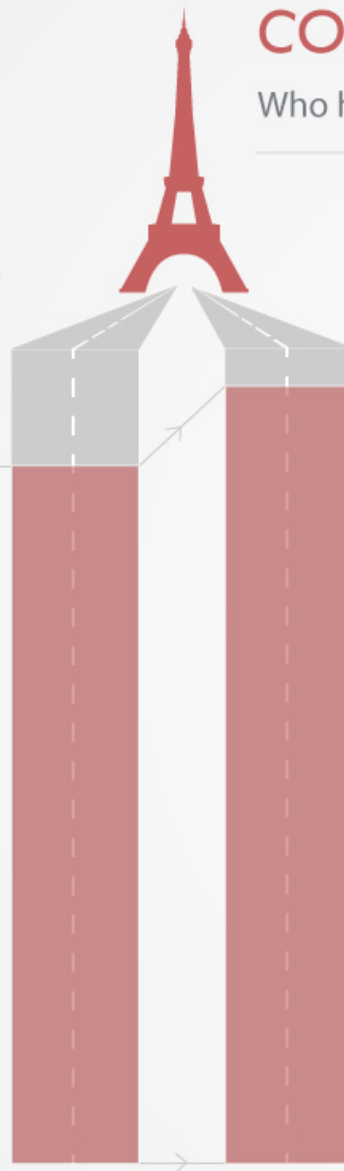
Who has submitted their pledge for Paris?

196
parties

52.4 billion
tonnes of emissions*

168 parties

St. Lucia
St. Vincent &
the Grenadines
Bahamas
Nauru
Somalia
El Salvador
Pakistan
Iraq
Egypt
Saudi Arabia
Sudan
Fiji
Sri Lanka
United Arab Emirates
Oman
Antigua & Barbuda
Bolivia
Uganda
Bosnia & Herzegovina
Afghanistan
Ecuador
Belize
...



100%

95.5%
of territorial emissions covered
under current pledges

*of greenhouse gases in 2012 excluding international aviation and shipping

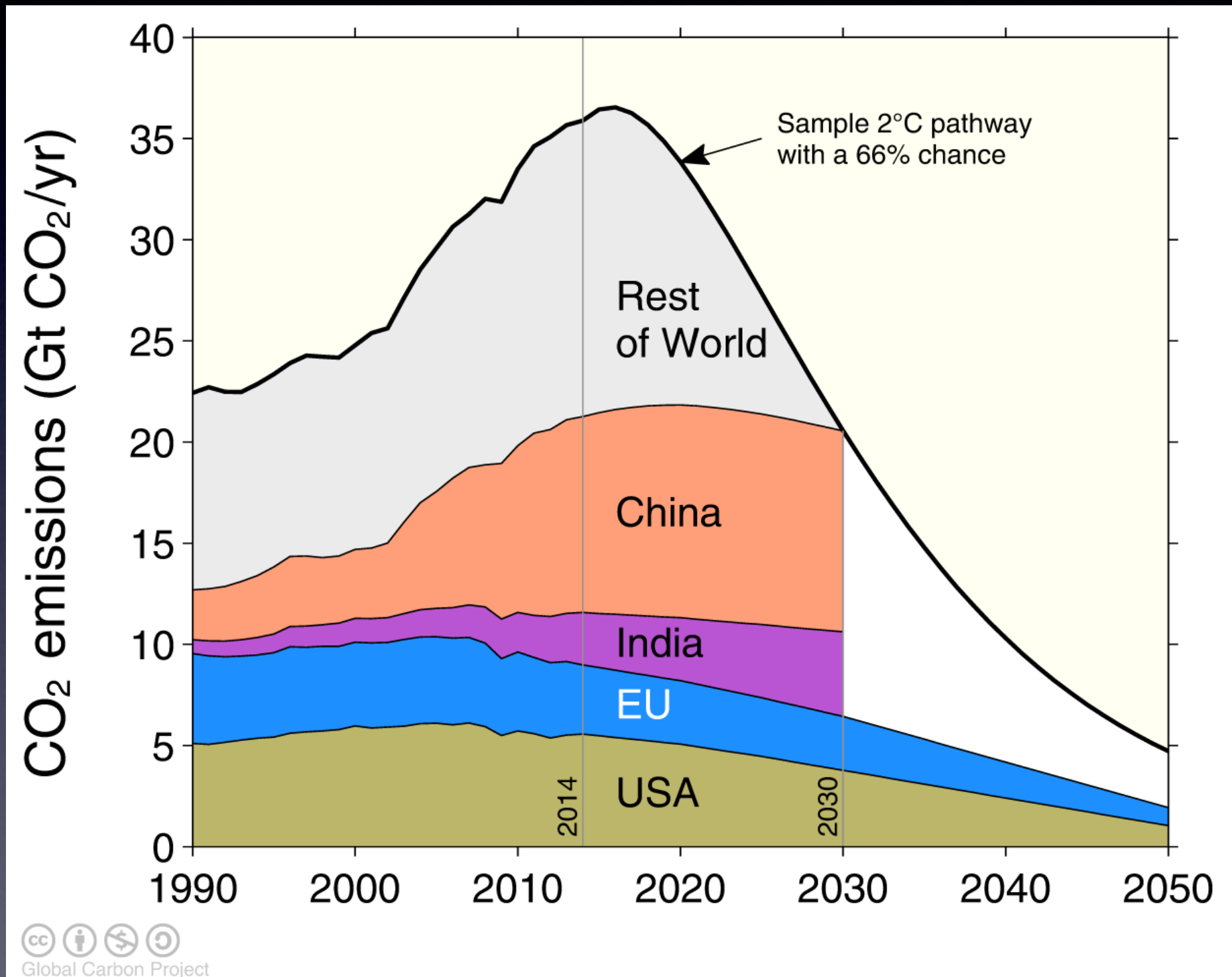
■ Has submitted climate pledge ■ Yet to submit pledge

*of greenhouse gases in 2012 excluding international aviation and shipping

■ Has submitted climate pledge ■ Yet to submit pledge

The emission pledges (INDCs) of the top-4 emitters

Pledges from the US, EU, China, and India leave little room for other countries to emit in a 2°C emission budget (66% chance)



Source: [Peters et al 2015](#); [Global Carbon Budget 2015](#)

A simple, 3 min summary

BLUE OCEAN

OCEANS 2015
INITIATIVE

More: <http://bit.ly/1M6YiS6>

OCEANS 2015 INITIATIVE

IDDRI



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IAEA

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