Ongoing OA related programmes and research: France

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Main national funding bodies

CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE

INSU

Financé par ANR

BOOM

LEFE-CYBER : 4 themes

Theme 1 : Ecosystem structure, functional diversity and biogeochemical cycles

Theme 2 : Biogeochemical cycles of trace elements and isotopes

Theme 3 : Biological and biogeochemical processes along continental margins

Theme 4 : Biological and biogeochemical processes at the ocean atmosphere interface

surface ocean solas lower atmosphere study

Hervé Claustre (President SSC)

Themes investigated

- Paleoreconstruction and consequences of ocean acidification
- Monitoring of ocean acidification
- Biological response (experimental)
- Biogeochemical consequences (modeling)
- Outreach (P. Saugier International Education Project)

Paleo aspects

Development of Boron isotopes and elemental geochemistry in corals in order to reconstruct paleo-pH changes of the Ocean

- Ocean Acidification -

Eric Douville, M. Paterne, N. Frank, A. Juillet-Leclerc, D. Blamart, M. Ghelen

Laboratory of Climate and Environment Sciences / IPSL – South Paris, France

Current collaborations: **Jérôme Gaillardet & Pascale Louvat - IPG, Paris, France**

Guy Cabioch - IRD, Nouméa, New Caledonia, France

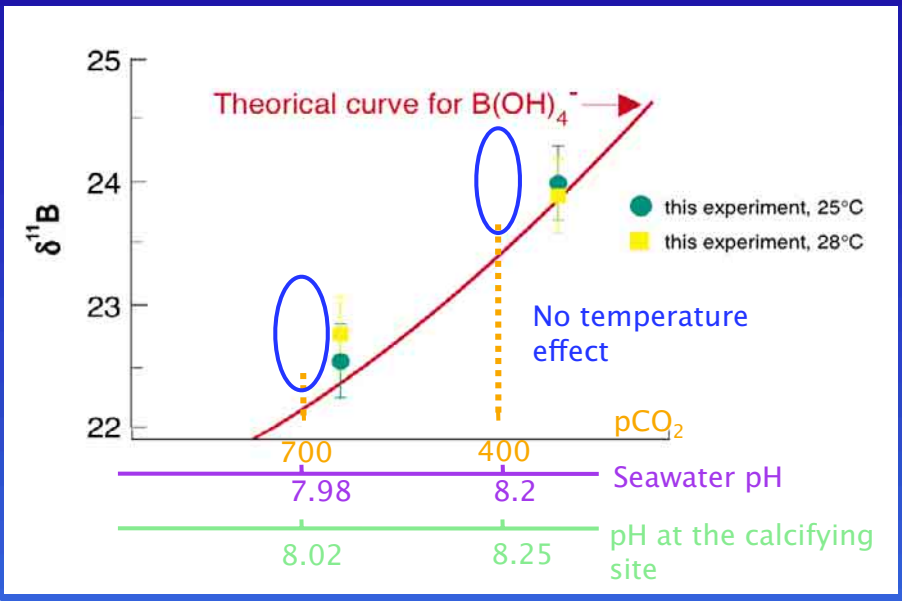
- **define the limits of the technique and if possible to refine it (seasons, $\delta^{11}B_{SW}$, α) for tropical (*Porites*) and deep-sea corals (*Lophelia pertusa*) ;**
- **characterize the properties of oceanic water masses in term of pH and contribute to the study of the past oceanic circulation (ENSO in the Pacific Ocean for example) ;**
- **study the pH changes of the water masses and the CO_2 exchange between Ocean and Atmosphere since the last deglaciation ;**
- **quantify the Ocean acidification over the last 200 years due to industrial era (Equatorial Pacific Ocean; Atlantic Northern Ocean).**

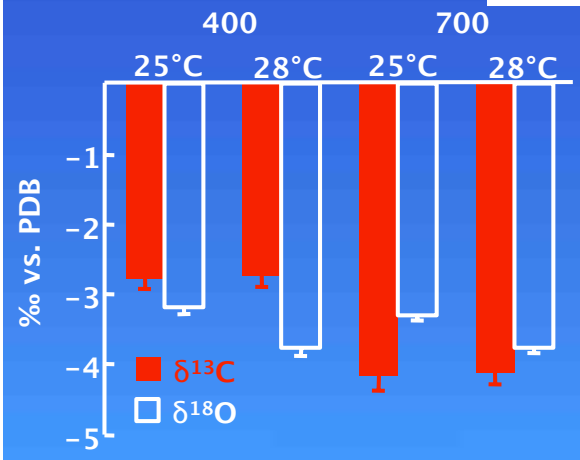
North Eastern Atlantic Ocean : *Lophelia p.*
European FP7: Ocean acidification
project EPOCA

Pacific Ocean : tropical coral (*Porites*)
National program LEFE/CYBER
project PHARE

3 – Isotopic composition

(boron, oxygen and carbon)





* Skeletal $\delta^{18}O$ decreases with temperature

No influence of pCO_2 on skeletal $\delta^{18}O$

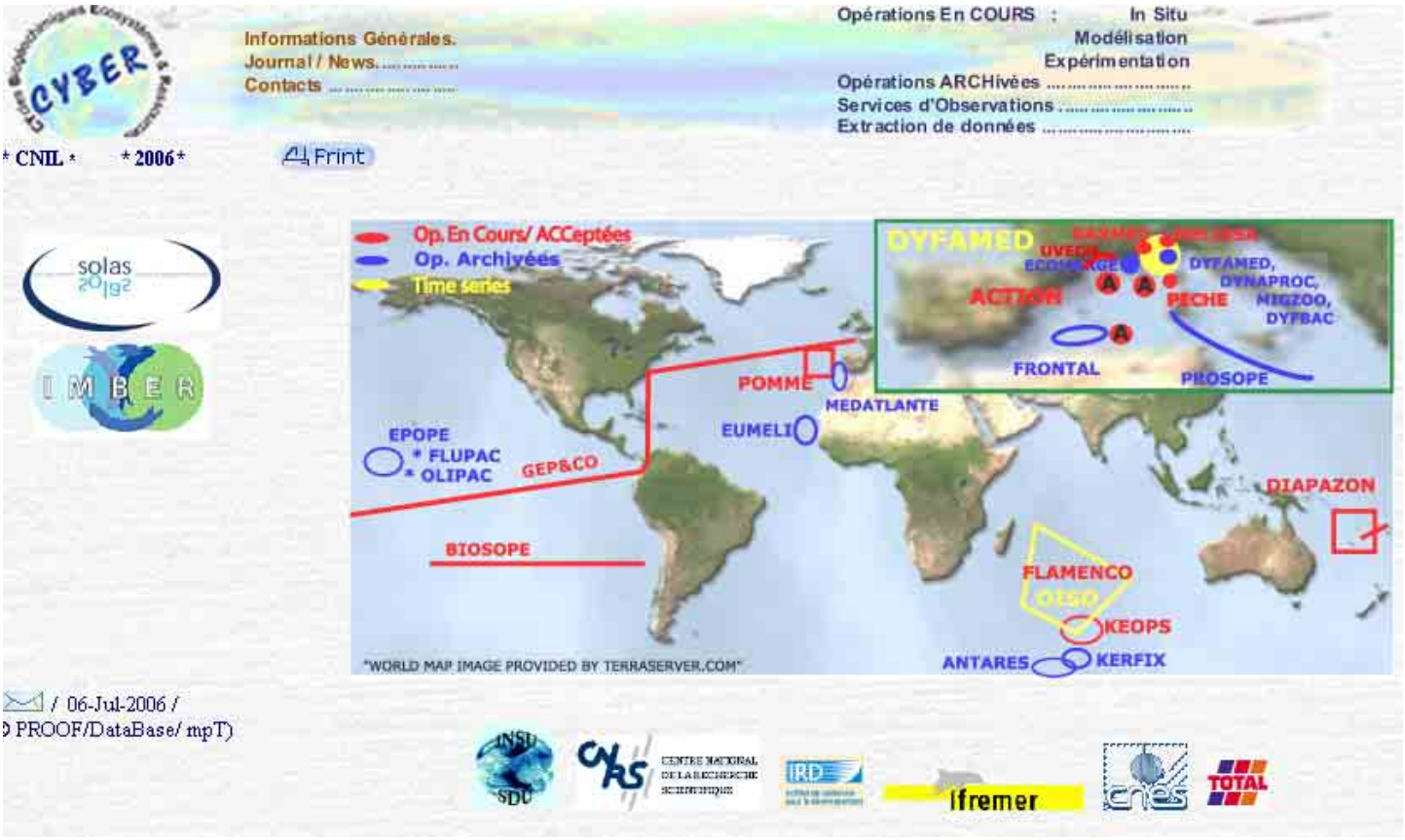
* No influence of temperature on skeletal $\delta^{13}C$

Skeletal $\delta^{13}C$ decreases with pCO_2

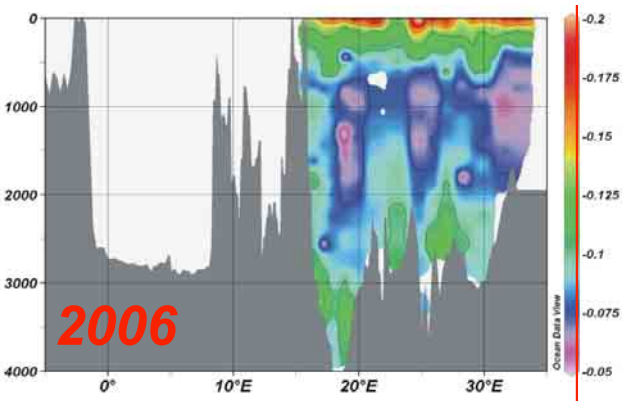
Stéphanie Reynaud, Monaco Scientific Center

Monitoring and present status

- DYFAMED station (NW Mediterranean): about 15 years on monthly measurements (ca. 7 depths, down to 2000 m)
- Point B station (coastal NW Mediterranean): weekly measurements since 2007 (surface and 50 m).
- Numerous cruises in all oceans



Case study: Mediterranean



- $\Delta pH = pH_{year2006} - pH_{pre\text{-}industrial}$
- acidification reaches the deepest layers of the Mediterranean Sea
- typical ΔpH values lower than - 0.1

Touratier & Goyet (pers. comm.)

Biological response

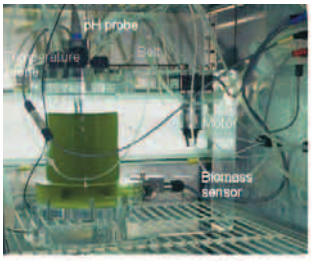
Véronique Martin-Jézéquel
EA 2160-CNRS-Université de Nantes

Impact of rising pCO_2 on the growth and diversity of phytoplankton. Consequences for the adaptation of diatoms

1-Phytoplankton natural populations

PeECE II & III (Pelagic Ecosystem CO_2 Enrichment Study)-European consortium (Leader U. Riebesell, IFM-GEOMAR, Kiel, Germany)

The influence of seawater CO_2 concentration was investigated during mesocosms experiments in Bergen (Norway), in 2003 & 2005. Natural phytoplanktonic populations were studied, for their biomass and species composition, in a range of pCO2 simulating pre-industrial (190 ppm), actual (370 ppm), future year 2100 (700 ppm) and year 2150 (1100 ppm) conditions. The evolution of the major phytoplanktonic taxa (Coccolithophorids, diatoms, dinoflagellates) and species was described, in relation with the increase of the CO_2 in the marine system.

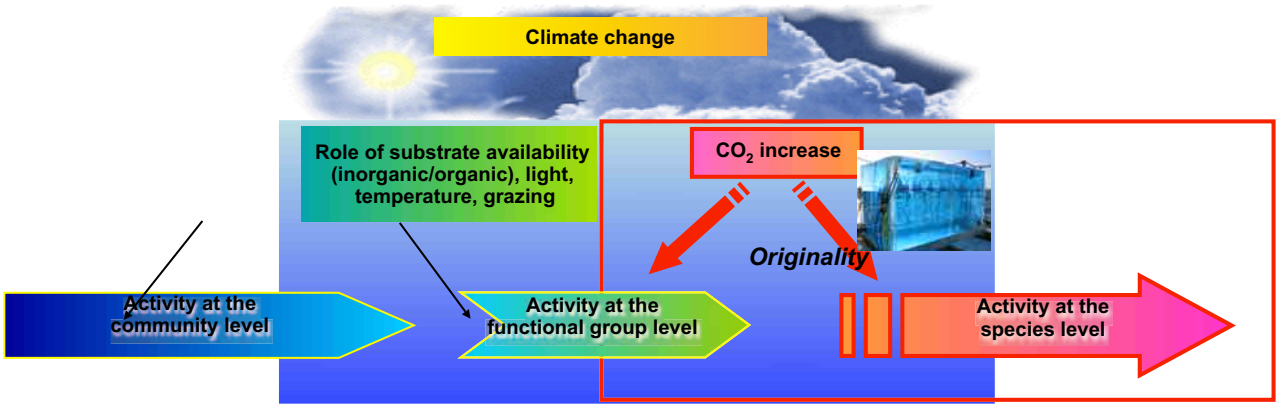


2-Diatom species –laboratory studies

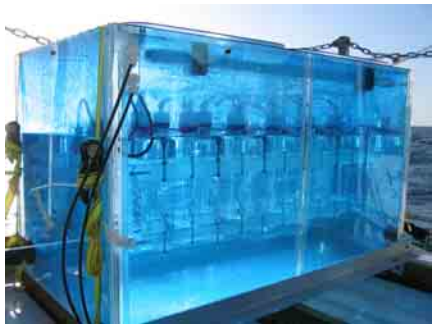
DIATOMICS-EU program (Leader C. Bowler, ENS, France)

The adaptation of diatoms on rising CO_2 and their metabolic regulations were investigated in laboratory experiments. Two key species: *Phaeodactylum tricornutum* and *Thalassiosira pseudonana*, for which the genome is described, were studied in controlled chemostat-cultures, under pCO_2 simulating actual (370 ppm) and future year 2100 (700 ppm). The impact of CO_2 concentration on their growth rate and biochemical composition was investigated, and the regulation of the carbon assimilation was detailed by the study on genes involved in photosynthesis and photorespiration pathways.

Karine Leblanc, CNRS-University of Marseilles



- **Scientific question : Impact of CO_2 on planktonic community structure**
- **Approach : Down to species specific activity, new molecular techniques**
- **Methodology : New chemostat apparatus, efficient experimental tool**



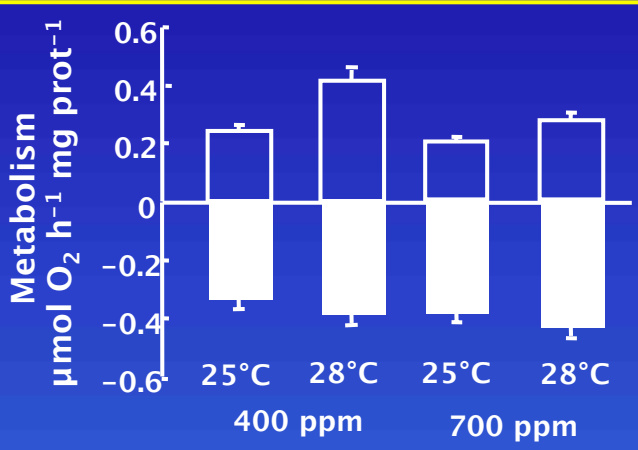
Shipboard chemostat system
(D.A. Hutchins' prototype)

Characteristics :
- Steady-state culturing system
- Adjustable CO2
- Adjustable Temperature
- Adjustable nutrients (also designed for trace metal clean work)

Interacting effects of pCO_2 and temperature on reef-building corals

1 – Photosynthesis

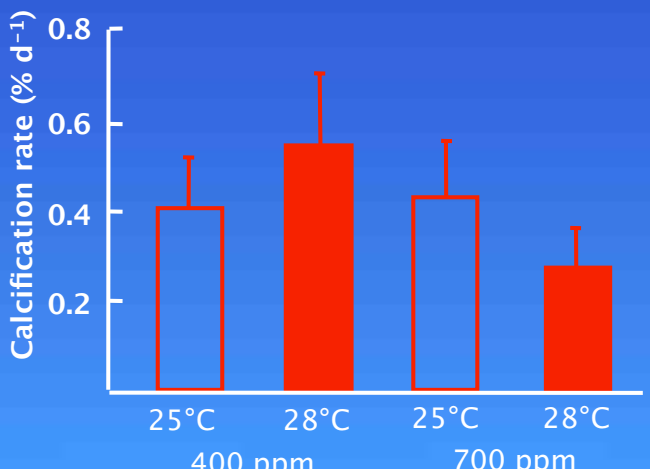
4 culture conditions:
pCO2 = 400, 25°C
pCO2 = 400, 28°C
pCO2 = 700, 25°C
pCO2 = 700, 28°C



R is not different between conditions

2 – Calcification

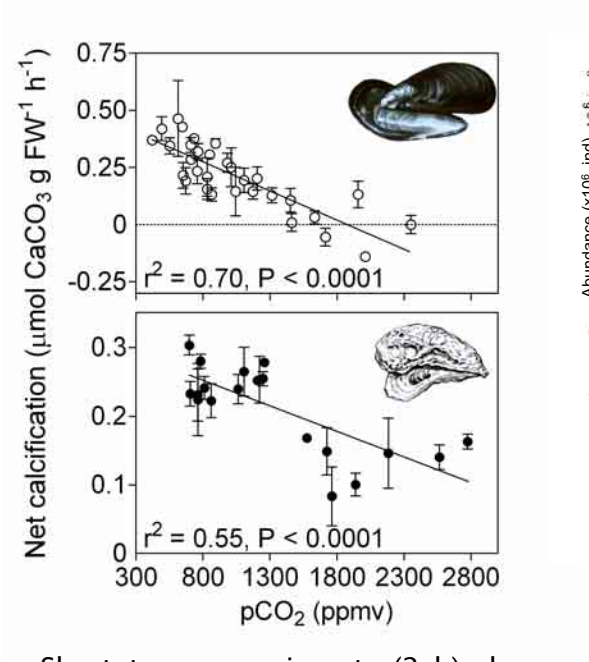
* P_n is not stimulated by an increase in pCO_2
* Increase of P_n with temperature under normal pCO_2



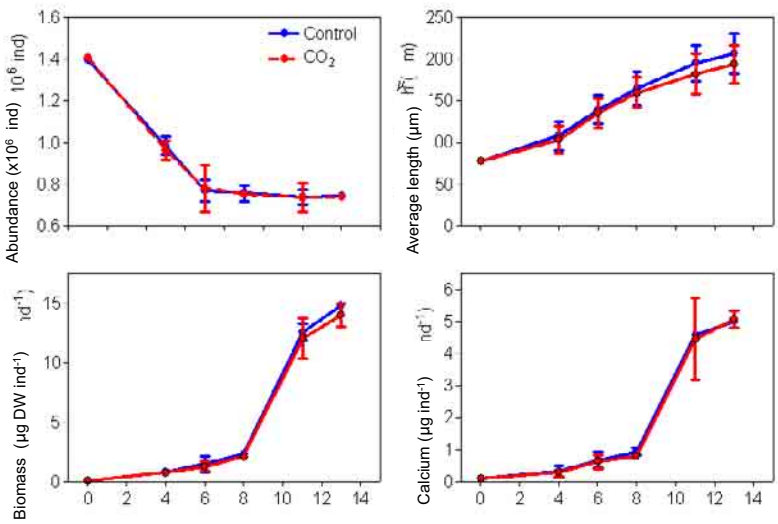
* Temperature increases G under normal pCO_2
* Temperature decreases G under high pCO_2
* pCO_2 decreases G under high temperature (54%)

Stéphanie Reynaud, Monaco Scientific Center

Effect of elevated pCO_2 on marine bivalves



Short-term experiments (2 h) show a strong impact on calcification by adult mussels and oysters. It decreases by 25% and 10% at the pCO_2 expected in 2100.



- 2 weeks experiments (from egg to settlement) showed that mussel larvae growth is not heavily impacted by a pH decrease (from 8.1 to 7.8, Ω_a>1). Decrease of 5% in growth (both in size and weight). No effect on mortality.
- Additional experiments showed a strong alteration of their development at pH 7.6 (Ω_a<1). Mortality increased by 25% and growth decreased by 40%.

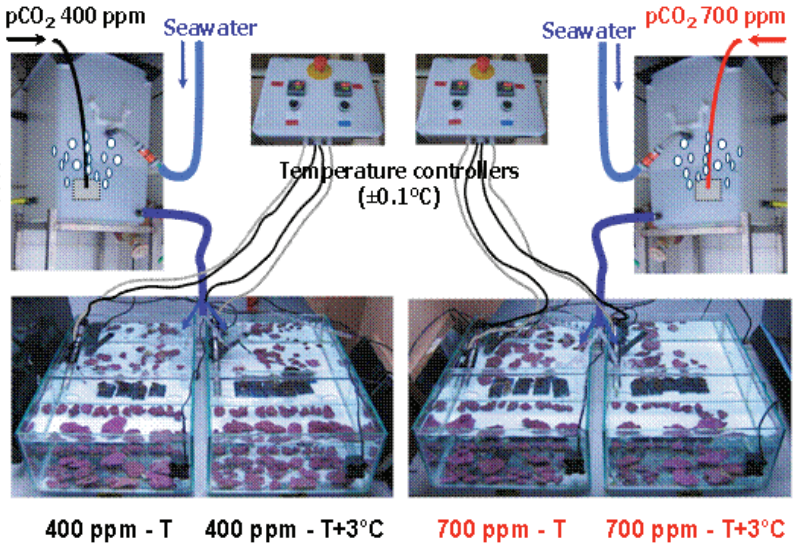
Source: Gazeau et al. (2007, GRL)

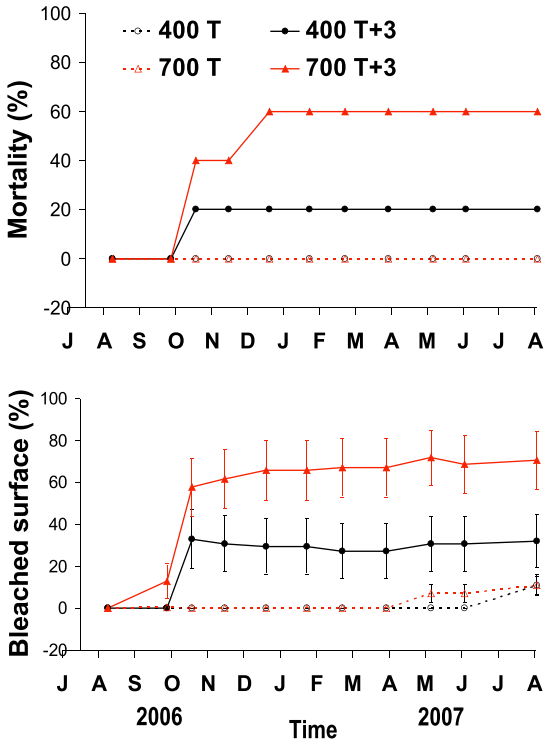
Source: Gazeau et al. (submitted)

Response of Mediterranean benthic calcifiers to elevated *p*CO_2 and temperature

S. Martin & J.-P. Gattuso

Laboratoire d'Océanographie de Villefranche
CNRS & University of Paris VI





www.carboocean.org

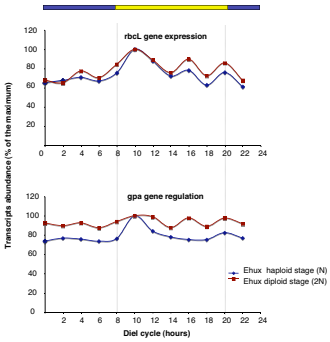
Source : Martin & Gattuso (in prep)

Other OA research at LOV

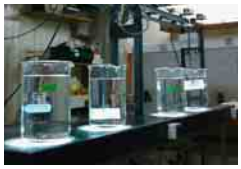
Coccolithophores
(S. Fiorini, EUR-OCEANS PhD student; A. Sciandra)
The response of calcification, growth and primary production to elevated pCO_2 and temperature is investigated in dilute batch cultures of haploid and diploid phases of 3 coccolithophore species. Possible long-term acclimation will be studied in a chemostat experiment.


© J. Young (NMNH)

Gene expression
(S. Richier, ANR postdoc)
qPCR is used to investigate the impact of increases in temperature, pCO_2, or both on the transcriptional activity of gene. The long-term perspective is to (1) investigate acclimation and adaptation of phytoplankton and (2) design proxies for key biogeochemical processes.

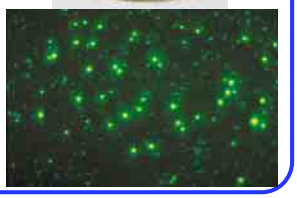


Pteropods
(S. Comeau, PhD student; G. Gorsky)
Thecosome Pteropods (Gastropod) play an important role in the food web of several ecosystems and on the global $CaCO_3$ cycle. Experiments on the response of calcification, nutrition and development of pteropods to elevated pCO_2 and temperature will be carried out.



Mediterranean deep-sea corals
(C. Maier, Marie Curie fellow)

Microbial processes (J. Liu; M. Weinbauer; J. Dolan)



Modeling

Ocean Acidification in the 21st century:

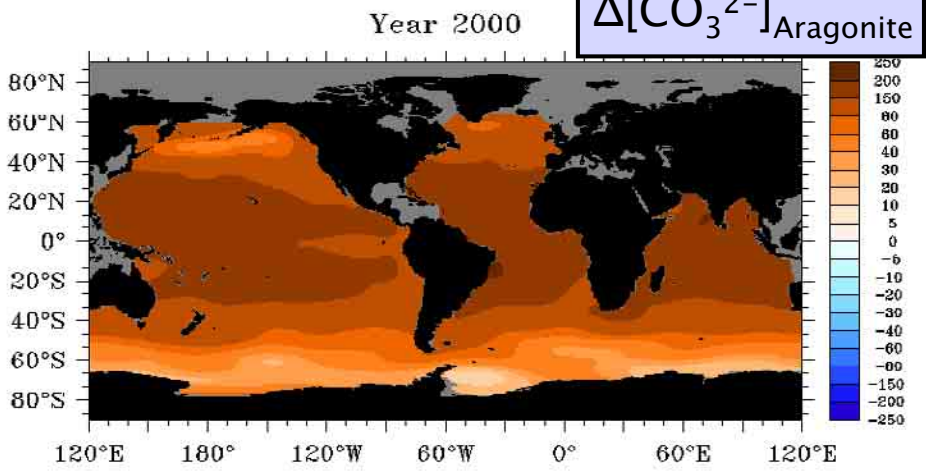
http://www.ipsl.jussieu.fr/~jomce/acidification

In 2100 (scenario IS92a)

- pH réduction = 0.3 - 0.4
- $\Omega_A < 1$
  - Southern Ocean
  - North Pacific
  - Arctic?

les eaux froides

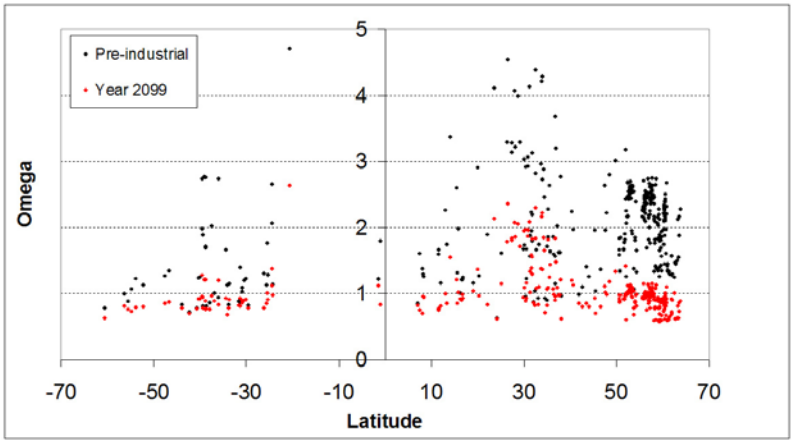
Orr et al. 2005 (Nature)



Cold-water corals:

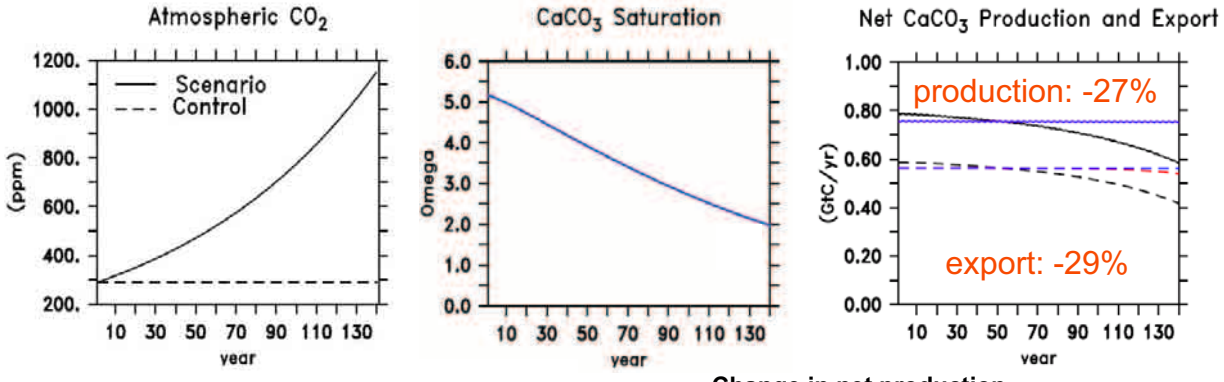
- 2005 : 95% with $\Omega_A < 1$
- 2100 : 35% with $\Omega_A < 1$

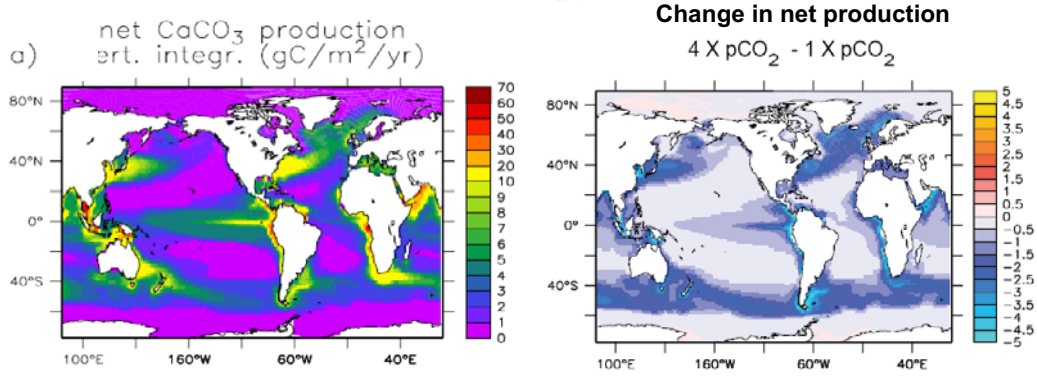
Guinotte et al. 2006 (Frontiers in Ecology and the Environment)



Jim Orr (CEA/IAEA)

Impact of ocean acidification on pelagic calcification





Gehlen et al., *Biogeosciences*, 2007

Conclusion

- There is a strong French community working on ocean acidification
- Topics addressed are:
  - paleo aspects
  - monitoring and analyzing large data sets
  - biological response
  - modeling
  - outreach
- There is **no coordination** at the national level
- Strong involvement in EPOCA (5 labs)
- Proposal in preparation for submission to ANR