



European Project on Ocean Acidification

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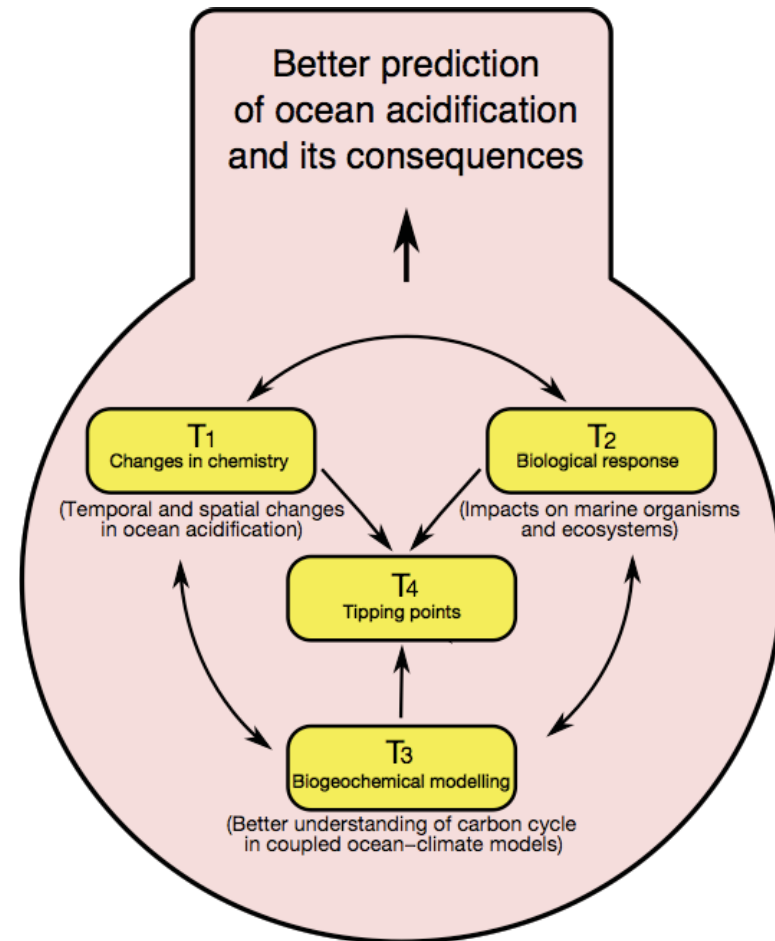
<http://epoca-project.eu>



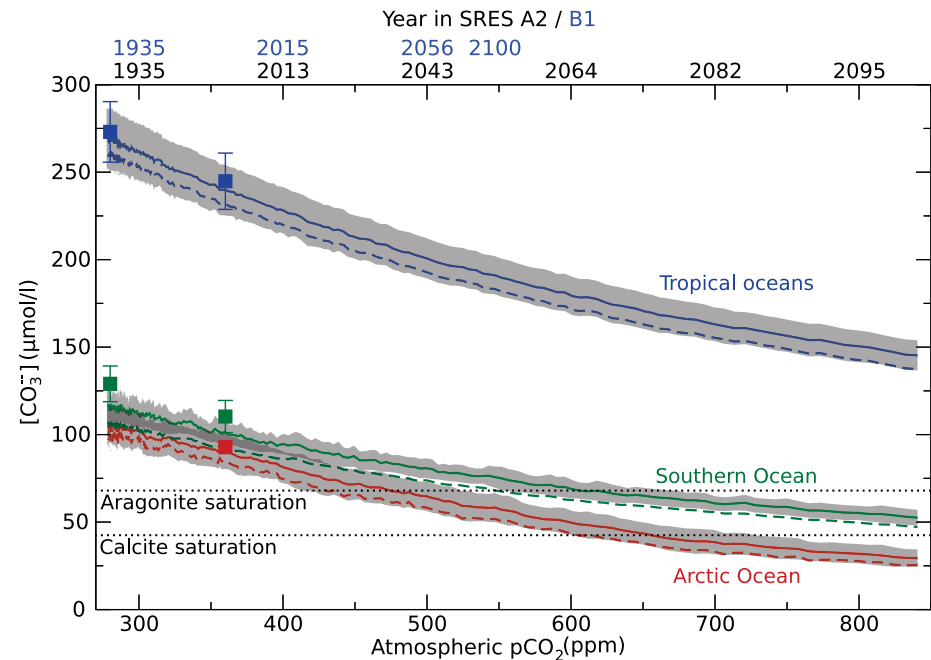
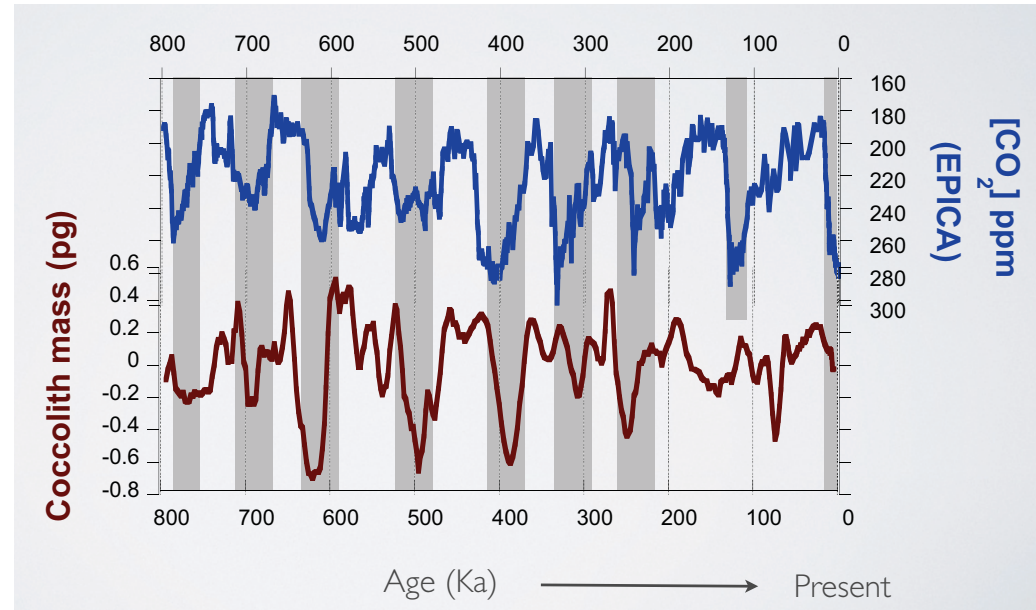
- A large-scale integrating project of the European Union which investigates ocean acidification and its consequences
- 100+ scientists from 31 laboratories and 10 countries
- Total budget of 16 M€, including 6.5 M€ from the EU (2008-2012)



- **Theme 1:** Improve the understanding of the past and present changes of ocean acidification
- **Theme 2:** Determine the impacts of ocean acidification on marine biota
- **Theme 3:** Improve understanding of future changes in ocean chemistry and biogeochemical feedbacks
- **Theme 4:** Synthesize information on tipping points; outreach; link with end-users and policy makers (RUG)



- In geological record, heavier coccoliths at lower $p\text{CO}_2$ (sometimes out of sync)
- Iceland Sea pH decline 1.5 times that in temperate Atlantic
- 10% of surface Arctic corrosive to aragonite within 10 years
- Some coastal upwelling systems appear as vulnerable as polar regions
- Ocean perturbed for century by CO_2 emitted in the next decades



- Negative effects (1st time):
 - key marine molluscs (pteropods)
 - deep-sea corals (1 study)
- Combined effects of T & CO₂ on cold-water spider crab
- Alterations
 - community composition (bacteria & archaea)
 - respiration rate (mesopelagic prokaryotes)
- 1st Arctic perturbation experiments (Svalbard 2009 & 2010)



Synthesis

- Tipping point group
- FAQ
- Sessions at annual meetings

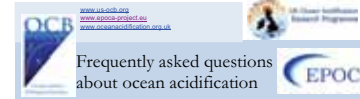
Outreach

- Web site
- Blogs:
 - EPOCA ocean acidification
 - EPOCA Svalbard 2009 experiment
 - EPOCA Svalbard 2010 experiment
- 25 newsletter articles, 25 press releases, 136 media articles, 15 TV and radio interviews
- EPOCA scientists have been involved in several recent key policy documents (e.g. Monaco declaration, ESF policy briefing, FAQs).

- EPOCA RUG:
 - *“Ocean Acidification – the Facts”*
 - *“Ocean Acidification – Questions answered”*
 - *Monaco Ocean Acidification Action Plan (May 2011)*

- Ocean Acidification animation *“The Other CO₂ Problem”*
- French version of virtual lab on ocean acidification
- 8 page educational document for schools
- Svalbard educational project and flyer (English, German and French)

FAQ (EN, FR, CN)



Introduction

Ocean acidification is a new field of research in which most studies have been published in the past 10 years. Hence, there are some certainties, but many questions remain. Ocean acidification is also a multi-disciplinary research area that encompasses regions such as chemistry, paleontology, biology, ecology, biogeochemistry, modelling, and social sciences. Furthermore, some aspects of ocean acidification research, for example the carbonate chemistry, are intricate and cross-cutting. For these reasons, the media and the general public find some scientific issues or results confusing.

The U.S. Ocean Carbon and Biogeochemistry (OCB) www.ocebi.org program, supported by the European Project on Ocean Acidification (EPOCA), www.euro-poa.eu, and the UK Ocean Acidification Research Programme (www.oceanacidificationresearch.org), has compiled a list of frequently asked questions (FAQs). These questions were widely distributed to the research community with the request to draft concise replies summarizing current knowledge, yet avoiding jargon. The replies were then subject to an open peer review and revision process to ensure readability without any loss of scientific accuracy. The responses of the community was ambitious. In total, 27 scientists from 19 institutions in 12 countries contributed to the whole process.

We do hope that this FAQ list will prove useful and would like to point out that it is an on-going process. Anyone is invited to seek clarification or send comments to Sarah Cooley (scoley@tho.ucsb.edu). The list will be revised periodically using the input and maintained at www.ocebi.org/FAQ and www.euro-poa.eu/faq.

Juan Klepac and Richard Frank (OCB), Jean-François Gattuso (EPOCA), and Carol Turley (UK Ocean Acidification Research Programme)

The name “ocean acidification”

The ocean is not acidic, and media headlines say the ocean isn't ever become acidic. So why call it ocean acidification?

Ocean acidification refers to the process of lowering the ocean's pH that is, increasing the concentration of hydrogen ions (by dissolving additional carbon dioxide in seawater from the atmosphere). The word “acidification” refers to lowering pH from any starting point to any end point on the pH scale. This term is used in many other scientific fields including medicine and food science in terms of its additional, increasing, or decreasing, respectively, the solution's pH value. For example, even though seawater's pH is greater than 7.0 and therefore considered “basic” in terms of the pH scale, increasing and decreasing CO₂ levels are still causing the ocean's acidity and lowering its pH. In comparison, this lowering is similar to the way in which we think we should lower the temperature of a hot liquid from 40°C to 30°C (40°F to 30°F), it is still cold, but we call it “warming.” - A. Orr, C.E. Silliman, R. Key

EPOCA RUG Guide #1 (10 Dec. 2009)

A special introductory guide for policy advisers and decision makers

There is a clear consensus from the many scientific statements that are now being made about ocean acidification, that rapid, unprecedented changes are occurring.

This introductory guide is written especially for policy advisers and decision makers worldwide and is a wake-up call about the drastic impact on our way of climate change and ocean acidification caused by increasing atmospheric carbon dioxide levels. It sets out the basic facts about the alarming and progressive acidification of our oceans that is threatening our marine ecosystems. The Earth's geological record shows that previous episodes of ocean acidification were linked to mass extinctions of some species, and it is reasonable to assume that the episode could have the same consequences. There can be little doubt that our oceans are undergoing dramatic changes that will impact many lives here and in the coming generations, unless we act quickly and decisively.

FAST FACTS...

- Currently, each year the oceans absorb nearly 25% of all the carbon dioxide (CO₂) we emit.
- This hidden ocean “sink” has been estimated to represent an annual subsidy to the global economy of 1550 – 15840 billion per year!
- That increasing acidity and rate of sea CO₂ emissions is progressively impacting the planet systems, causing the acidity of seawater to increase – the phenomenon is termed ocean acidification.
- Ocean acidity has increased by 30% since the beginning of the industrial revolution and the rate of acidification will accelerate in the coming decades. This rate of change, in the best of our knowledge, is many times faster than anything previously experienced over the last 15 million years.
- Numerous animals and plants in the sea have calcium carbonate skeletons or shells. Some are especially sensitive to small changes in acidity and that is some evidence they are already being affected. Many of these animals possess an ability or sensitivity of great cultural, economic or biological importance as primary producers, reef builders.
- The impact of ocean acidification on marine species and food webs will affect major economic interests and could increasingly put at risk food security, particularly in regions especially dependent on seafood products.
- Volcanic eruptions are being damaged or destroyed by acidification. It is predicted that atmospheric CO₂ levels could rise as fast as twice by 2100 compared to warm water coral reefs will be marginal and you can expect extinctions of some species. By 2100 70% of all low-lying coral reefs are expected to collapse.
- The impact of ocean acidification on coral reefs will compromise community security in low-lying areas that are protected from erosion and inundation by these ecosystems.
- Agreement and immediate cuts in CO₂ emissions leading to stabilization and ideally reductions in atmospheric CO₂ levels will be necessary to slow the progression of ocean acidification, as well as global climate change.

EPOCA RUG Guide #2 (Nov. 2010)

Making it clear

A fresh look at the global problem of ocean acidification for those people who want to know a little more

In this guide we do four new things. We answer some key questions many people are now asking about ocean acidification. We set how sure the international scientific community is about what is already happening to the ocean, we discuss what the future may hold for the ocean in a high carbon dioxide (CO₂) world, and we explore the consequences for all of us of what is now happening.

Questions Answered follows on from the highly successful multilingual guide called Ocean Acidification: The Facts, which was launched in winter 2009 at the UN climate change conference at Copenhagen. Questions Answered is inevitably more technical in nature than The Facts as it begins to help champion the science and reasoning behind frequently asked questions.

By getting to the point and improving understanding around these critical issues, we hope that many more people will not only be better informed about ocean acidification, but will also act with greater conviction, greater ambition and greater urgency to tackle one of the most significant environmental issues faced by present and future generations.

Two years on from the Monaco Declaration

Two years ago I hosted a meeting of more than 150 leading marine scientists from 25 countries organized and supported by the Intergovernmental Oceanographic Commission, the Scientific Committee on Oceanic Research, the Government of Monaco and my Foundation. These scientists joined in a call for immediate action by policy makers to reduce carbon dioxide emissions. A sharp reduction was urged from that meeting to avoid widespread and severe damage to marine ecosystems from ocean acidification. This warning formed the heart of the Monaco Declaration to which I was happy to lend my full support.

Two years on, significant work has been undertaken by science teams around the world on ocean acidification. Sometimes the results from this work confounded early predictions on the impacts of ocean acidification, but most of what we have learnt since the Monaco Declaration substantially increases concern about the speed and potential scale of impact that our emissions of carbon dioxide will have on the ocean, and in turn on us.

I am delighted that my Foundation supports Ocean Acidification: Questions Answered. Once again the science world has come together, this time in concert with the Ocean Acidification Reference List Group, to tackle a new issue – that of uncertainty and misinformation about ocean acidification.

I am convinced that, armed with these clarifications and answers to new questions that have arisen, this work will help inform decisions and overcome barriers that stand in the way between us and more rapid progress to tackle ocean acidification.

HSH Prince Albert II of Monaco



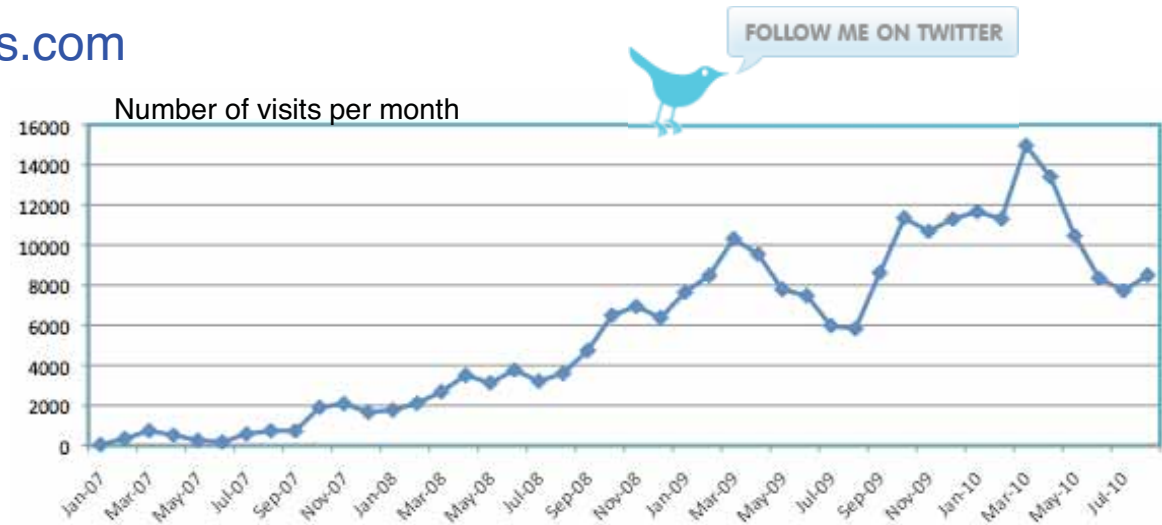
Ocean Acidification QUESTIONS ANSWERED

THE FACTS Ocean Acidification



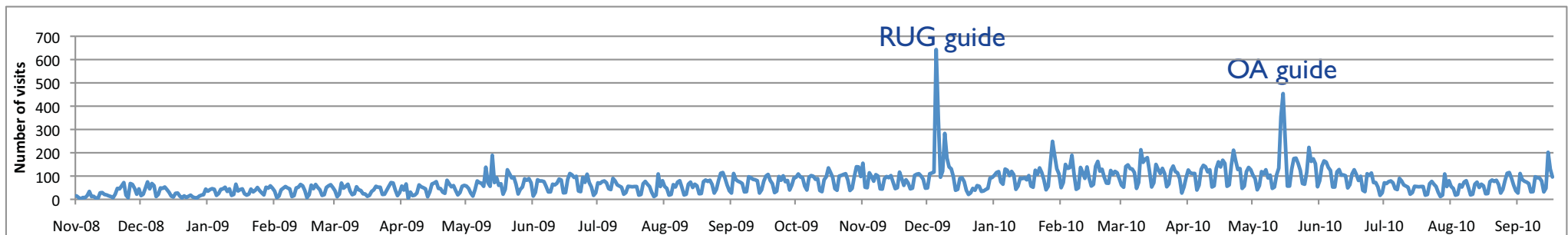
Blog: oceanacidification.wordpress.com

- Created July 2006
- Since January 2007:
 - Posts: 2108
 - Total views: 253 821
 - Average views per day: 350
 - Subscribers: 386
- Twitter followers: 130
- FaceBook

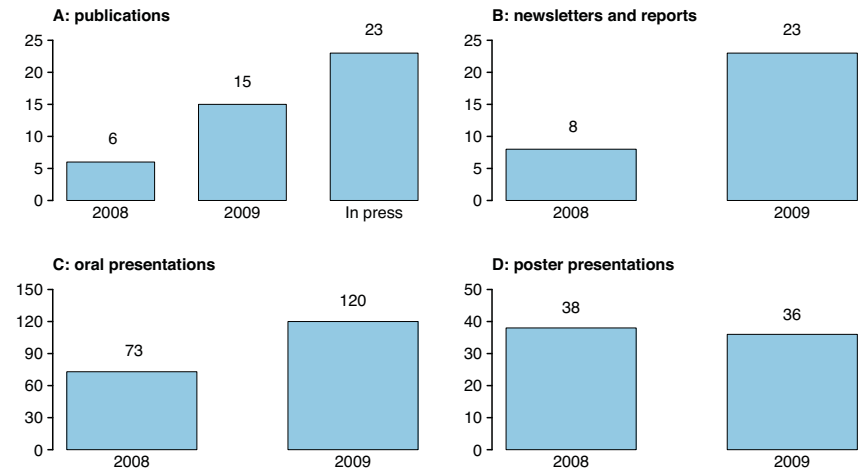


Web site

- Web pages: 290
- Visits (total): 45 631 (8500 in 2009)
- Page views: 148 471 (over 100 000 more compared to 2009)
- average ~100 per day
- Most visited pages (besides the home page): “Best practices guide” and “What is ocean acidification?”



- **68 publications during the first 2 years of the project** (Full list available at: <http://www.epoca-project.eu/index.php/Dissemination-and-media/Publications.html>)



- **Key publication:** “Guide to best practices in ocean acidification reach and data reporting” site (<http://www.epoca-project.eu/index.php/Home/Guide-to-OA-Research/>)





"Tipping Point"

Un film de Laurence Jourdan
Image: Marine Tadié, Montage : Françoise Bouleque
Images sous marines : Yves Gladu

- **EPOCA data**

- Total number of archived data sets: 28
- Published and archived: 16
- Published and not received: 8
- Shortly to be archived: 7

- **Svalbard 2009 archived data**

- pteropod experiment, LOV
- sediment and fluxes experiment, NIOO
- CTD and field data
- echinoderms larvae experiment, PML
- adult echinoderms experiment, PML

- **EPOCA/EUR-OCEANS data compilation**

- Archived: 90 data sets from 110 papers
- 4 soon to be archived
- 44 data sets are lost or could not be obtained from the authors
- in 50 relevant data sets, not enough parameters were measured

Nisumaa A.-M., Pesant S., Bellerby R. G. J., Delille B., Middelburg J., Orr J. C., Riebesell U., Tyrrell T., Wolf-Gladrow D. & Gattuso J.-P., 2010. EPOCA/EUR-OCEANS data compilation on the biological and biogeochemical responses to ocean acidification. *Earth System Science Data* 2(2): 167-175.

- **Collaborations EPOCA with**
 - OCB
 - BIOACID and UKOARP
 - SIOA
 - MedSea
- **International coordination**
 - SOLAS-IMBER working group on OA launched in Sep. 2009
 - Tasks:
 - synthesis and review
 - help coordinating international activities
- **IPCC**
 - AR5 in preparation; publication in March 2014
 - Should cover ocean acidification well
 - Several EPOCA scientists involved:
 - WG I: L. Bopp, C. Heinze
 - WG II: J.-P. Gattuso, H.-O. Pörtner, D. Schmidt, C. Turley
 - Others involved: K. Caldeira, V. J. Fabry, R. Feely, O. Hoegh-Guldberg, Y. Nojiri
 - Meeting organized by Y. Nojiri, Okinawa, January 2011
 - **Literature cutoff: July 2013**

- **Project web site:** epoca-project.eu
- **Ocean acidification blog:**
oceanacidification.wordpress.com
- **Blogs EPOCA Arctic campaigns:**
epochaarctic2009.wordpress.com
epochaarctic2010.wordpress.com
- **Contacts:**
 - Jean-Pierre Gattuso: gattuso@obs-vlfr.fr
 - Lina Hansson: hansson@obs-vlfr.fr