



Ocean Acidification  
International  
Coordination Centre  
OA-ICC



# International ocean acidification initiatives and coordination (OA-ICC, GOA-ON, resources, data management)

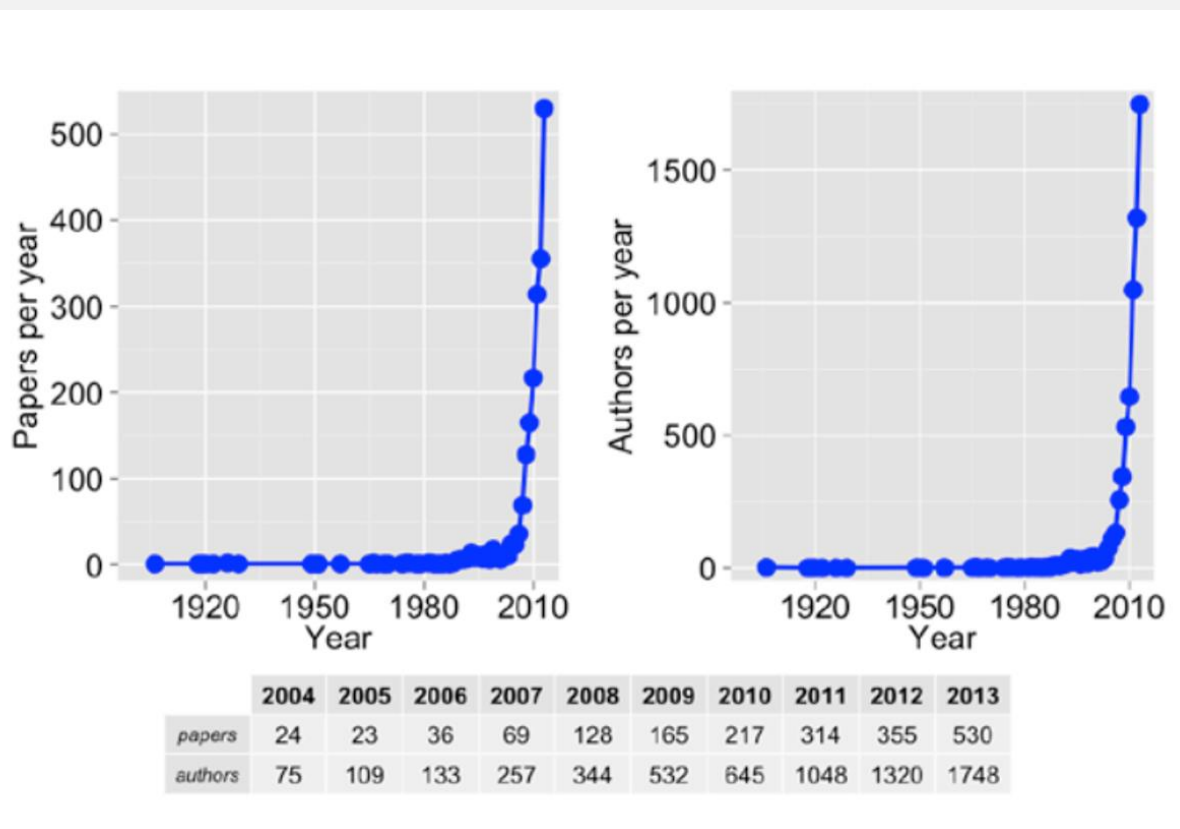
**Lina Hansson**  
OA-ICC Project Officer

IAEA Environment Laboratories  
International Atomic Energy Agency  
Principality of Monaco

[oaicc@iaea.org](mailto:oaicc@iaea.org)  
[www.iaea.org/ocean-acidification](http://www.iaea.org/ocean-acidification)  
<http://news-oceanacidification-icc.org/>

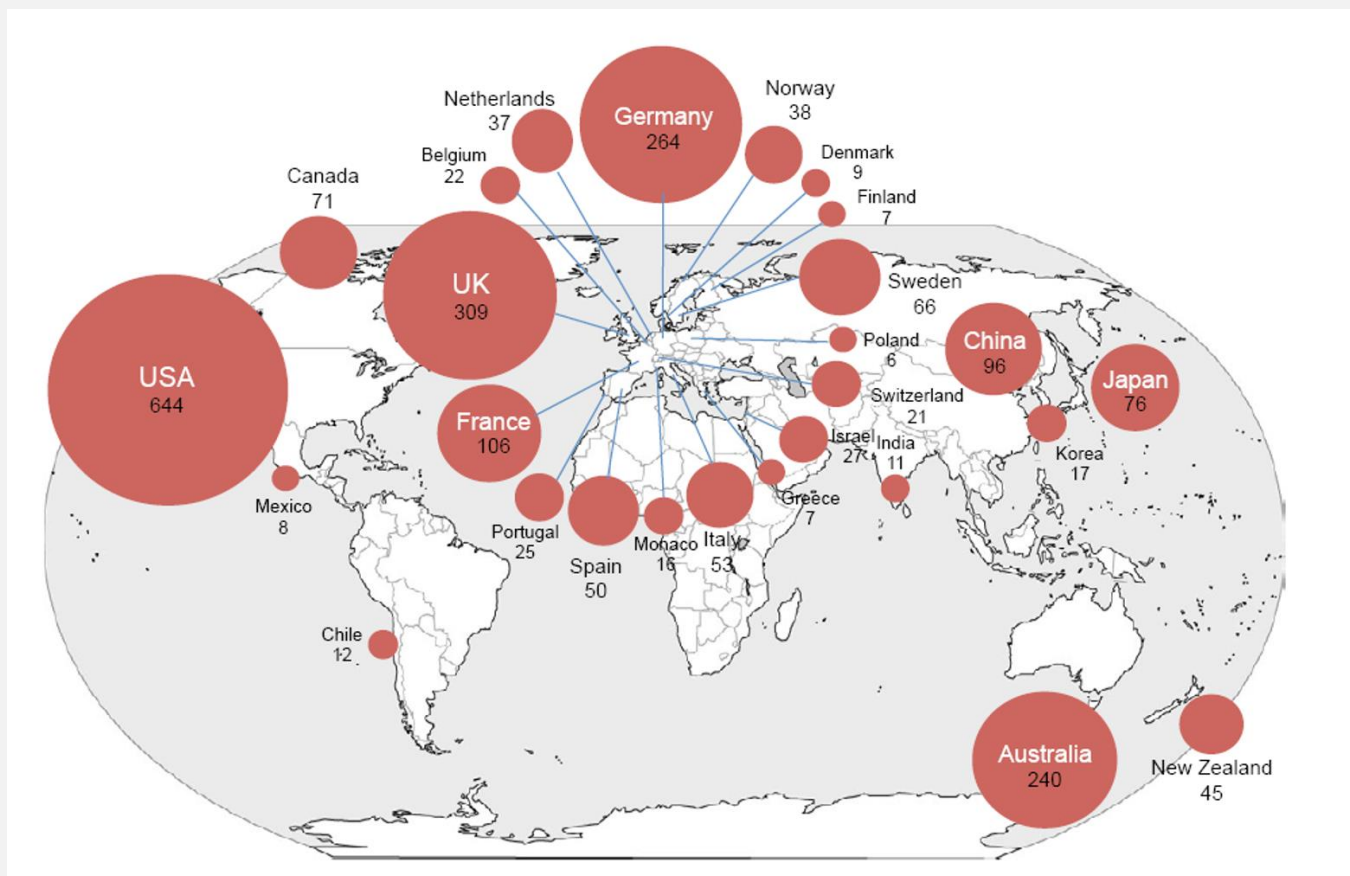


# Ocean acidification – a rapidly growing field





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# Ocean acidification – a rapidly growing field

➔ **increasing need for  
international coordination  
and collaboration**

The IAEA launched the OA-ICC in 2012 upon recommendation of the SOLAS IMBER Ocean Acidification Working Group and increasing concern of its Member states



UN Rio+20 outcome document, paragraph 166:

*“We call for support to initiatives that **address ocean acidification** and the impacts of climate change on marine and coastal ecosystems and resources. In this regard, we reiterate the need to work collectively to prevent further ocean acidification, as well as enhance the resilience of marine ecosystems and of the communities whose livelihoods depend on them, and to support marine scientific research, monitoring and observation of ocean acidification and particularly vulnerable ecosystems, including through **enhanced international cooperation in this regard.**”*



## Why the IAEA?

### Nuclear applications in ocean acidification research

- The IAEA Environment labs are active in the field of monitoring and protecting the environment from radioactivity, but also in any field where isotopic and nuclear applications are relevant to understand environmental issues. Ocean acidification-related research carried out since 2008.
- Isotopic and nuclear techniques are unique tools e.g. to:
  - Study the Impact on primary production, growth and calcification rate, using e.g. Ca-45, C-14
  - Reconstruct past pH, using the isotopic ratio B-11/B-10 as a proxy



## IAEA Environment Laboratories – other projects with OA components

- Coordinated Research Programme: “Ocean Acidification and Economic Impacts on Fisheries”

- Current **IAEA Technical Cooperation projects** with OA component:

National project: Kuwait

National project: Indonesia

Regional project: Africa

Regional project: Latin America

Contacts:

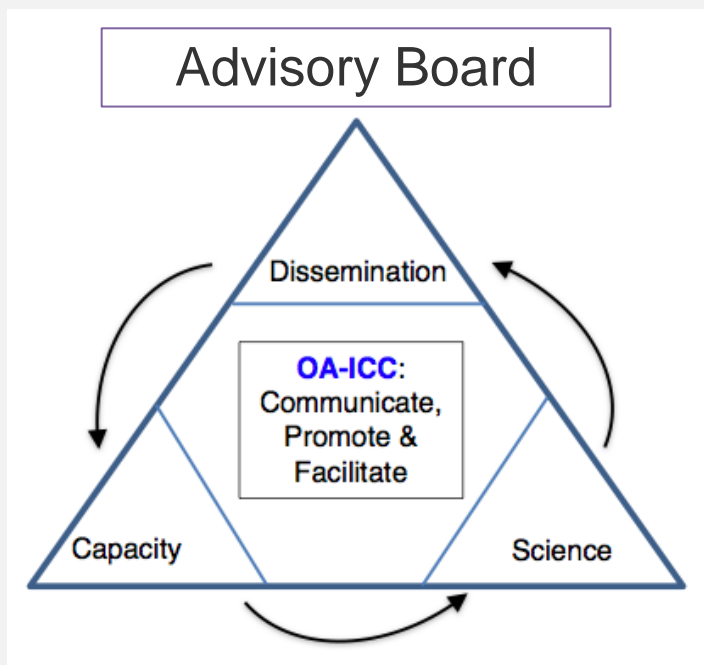
Juan-Carlos Miquel, Yasmine Bottein, Marc Metian

- Proposal:

Inter-regional project (Africa, Asia and South America) on OA monitoring

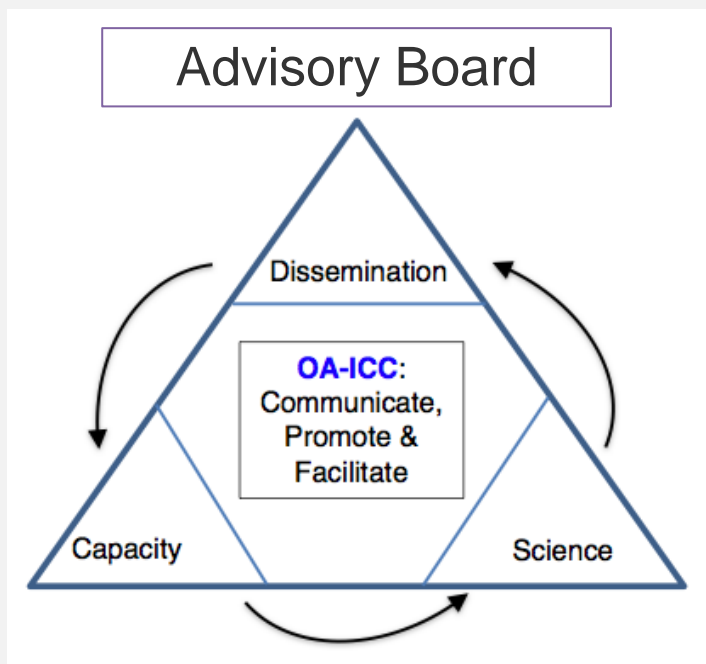


## IAEA Ocean Acidification International Coordination Centre (OA-ICC)



- **Objective:** act as a **hub** to communicate, promote and facilitate international activities on ocean acidification
- **End users:** scientific community and science users (e.g., policy makers, media, general public)





- **Functioning:**

Operated by the IAEA Environment Laboratories in Monaco

Announced in June 2012 at Rio+20 for an initial duration of 3 years

Advisory Board: UN agencies, key institutions and leading scientists in the field



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OA-ICC



## Project team

### IAEA staff:

Programme Manager, Mr David Osborn, Director IAEA Env.  
Laboratories

Project Officer, Ms Lina Hansson

Project Assistant, Ms Olga Anghelici

Admin, Ms Hasti Dessu and Ms Christelle Godes

### Partners:

Scientific Coordinator (Mr James Orr, in-kind contribution from CEA,  
France)

Data Curator (Ms Yan Yang, Xiamen Univ., China)



## Funding and support

Supported by the IAEA 'Peaceful Uses Initiative' (PUI) through direct and in-kind contributions from several IAEA Member States and research projects on ocean acidification:

Australia, France, Italy (ENEA), Japan, New Zealand, Norway, Spain, United Kingdom, United States  
NOAA OAP, IMBER, SOLAS, BIOACID, MedSeA, UKOA

Total budget: USD 2.4 M (USD 1.4 M cash and USD 1 M in-kind)



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# SCIENCE

*‘Promote activities to help advance ocean acidification research’*



## **Global observing network**

R. Feely, USA & L. Jewett, USA

## **Joint platforms & experiments**

U. Riebesell, Germany & J. Barry, USA

## **The human dimension (socio-economics)**

J. Bijma, Germany & S. Cooley, USA

## **Intercomparison exercises**

M. Dai, China

## **Best practices**

U. Riebesell, Germany & J.-P. Gattuso, France

## **Bibliographic database**

J.-P. Gattuso, France

## **Data management**

J.-P. Gattuso, France



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# CAPACITY BUILDING

*‘Help train tomorrow’s experts on ocean acidification’*



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**Regional training courses**

L. Robbins, USA

**Participation of scientists from eligible countries in international meetings**

**Regional coordination meetings**



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# COMMUNICATION

*‘Serve as a hub of information for different audiences (scientists, policy makers, media...)’*



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**Exhibits, side events, publications (in cooperation with the Ocean Acidification International Reference User Group; OA-iRUG)**

D. Laffoley, UK & C. Turley, UK

**Web site & news stream**

**Distribution of material**



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# OA-ICC key online resources

## OA-ICC web site

[iaea.org/ocean-acidification](http://iaea.org/ocean-acidification)

## OA-ICC news stream

[news-oceanacidification-icc.org](http://news-oceanacidification-icc.org)

## OA-ICC data compilation

<http://tinyurl.com/oaicc-data>

## OA-ICC bibliographic database

<http://tinyurl.com/oaicc-biblio>

The image shows two screenshots of the OA-ICC website. The top screenshot is the main website homepage, featuring the IAEA logo, navigation tabs (About Us, Our Work, News Centre, Publications, Nucleus), and a banner with the text "PROMOTING GLOBAL COOPERATION IN A CHANGING OCEAN WORLD". The bottom screenshot is a news stream article titled "Seagrass ecosystem response to long-term high CO2 in a Mediterranean volcanic vent". The article text includes: "We examined the long-term effect of naturally acidified water on a *Cymodocea nodosa* meadow growing at a shallow volcanic CO2 vent in Vulcano Island (Italy). Seagrass and adjacent unvegetated habitats growing at a low pH station (pH = 7.65 ± 0.02) were compared with corresponding habitats at a control station (pH = 8.21 ± 0.01). Density and biomass showed a clear decreasing trend at the low pH station and the below- to above-ground biomass ratio was more than 10 times lower compared to the control. C content and δ13C of leaves and epiphytes were significantly lower at the low pH station. Photosynthetic activity of *C. nodosa* was stimulated by low pH as seen by the significant increase in Chla content of leaves, maximum electron transport rate and compensation irradiance. Seagrass community metabolism was intense at the low pH station, with significantly higher net community production, respiration and gross primary production than the control community, whereas metabolism of the unvegetated community did not differ between stations. Productivity was promoted by the low pH, but this was not translated into biomass, probably due to nutrient limitation, grazing or poor environmental conditions. The results indicate that seagrass response in naturally acidified conditions is dependant upon species and geochemical characteristics of the site and highlight the need for a better understanding of complex interactions in these environments." Below the article text are social media sharing options and a "Share this post!" button.



# OA-ICC highlights



## CAPACITY BUILDING



ENE training course participants

The OA-ICC co-organized two training courses together with local partners. The first one, focusing on ocean acidification and climate change in the Mediterranean Sea, was held in Italy in cooperation with ENEA and MARES.

1-8 September 2014. The course brought together 9 participants from Algeria, Egypt, India, Indonesia, Lebanon, Poland, Tunisia and UK. [More information.](#)

The second one, held in Chile (9-16 November 2014) in cooperation with the University of Concepcion, gathered 19 students from 7 Latin American countries (Argentina, Brazil, Chile, Columbia, Ecuador, Mexico and Peru). [More information.](#)

Ocean acidification [Best Practices](#) guides and OA-ICC USB sticks with electronic course material were distributed to the participants of both courses.

## COMMUNICATION



Laura Ramajo (Chile) at the 'Ocean under stress' stand, COP20, Lima, Peru

The OA-ICC partnered with PML, NOAA, IOC-UNESCO and various other organizations for an exhibit stand and side events at the UNFCCC COP20 in Lima, December 2014. The OA-ICC also supported the participation of two early career scientists from Chile to attend the COP for more information on COP20, see full [report](#) by UKOA.

IOC-UNESCO and the OA-ICC produced a 'video corner' on ocean acidification for the UNESCO 2nd International Ocean Research Conference, 17-21 November, Barcelona.

## SCIENCE

A short meeting [report](#) from the OA-ICC Data Management meeting (April 2014) was published in Eos.

The OA-ICC also contributed to several articles and reports, e.g. a Chapter in the [CBD/UNEP report](#) on OA, a Chapter in an [Inter-Agency UNDESA Publication](#) and a Box in the Annual [WMO Greenhouse Gas Bulletin](#).

The first edition of the Global Ocean Acidification Observing Network (GOA-ON) [Requirements and Governance Plan](#) was published with the support of the OA-ICC.



## OA-ICC ONLINE RESOURCES

The [OA-ICC news stream](#) informs scientists of recent publications, media coverage, meeting announcements, and jobs on a daily basis.

The [OA-ICC web site](#) provides, among others, resources on ocean acidification listed according to audience and language.

The [OA-ICC bibliographic database](#) with currently more than 2500 references includes citations, abstracts and keywords to simplify searches and bibliographic statistical analysis.

The [OA-ICC data compilation](#) on the biological response to ocean acidification provides easy access to regularly updated experimental data.



## SCIENCE



Workshop participants

The OA-ICC and the Scientific Centre of Monaco (CSM) organized the 3rd International Workshop "Bridging the gap between ocean acidification and economic valuation", 12-14 January 2015, Monaco. The workshop focused on the impacts of ocean acidification on coastal communities. It brought together over 50 participants from a range of different backgrounds: natural sciences, economics, sociology, industry, government and policy making. [More information.](#)

One of the OA-ICC's intercomparison activities has led to the publication of a peer-reviewed scientific paper that compares ten public packages computing ocean carbonate chemistry. The article was published in *Biogeosciences*. [View publication.](#)

The OA-ICC also contributed to an article on the monitoring of ocean carbon and ocean acidification published in the *WMO Bulletin* in March 2015. [View article.](#)

## COMMUNICATION



The 2nd annual meeting of the Ocean Acidification International Reference User Group (OAIRUG) took place on 14-16 January 2015 at the Oceanographic Museum of Monaco. The OAIRUG works closely with the OA-ICC to convey scientific results to non-scientific audiences, in particular policy and decision makers.

Entitled "Acting on ocean acidification: getting ahead of the curve", the meeting aimed at setting the stage for the development of an ocean acidification forecasting system that would help society prepare for and anticipate global ocean changes. [More information.](#)

## CAPACITY BUILDING

The OA-ICC supported a group of 15 researchers from several IAEA Member States (Brazil, China, India, Philippines and Mexico) to participate in a session on ocean acidification at the [ICES/PICES/IOC/UNESCO 3rd International Symposium «Effects of climate change on the world's oceans»](#), 23-27 March 2015, Brazil. The session discussed historical and future trends in ocean acidification, anthropogenic drivers and climate change relationships with ocean acidification, and the physical and biogeochemical impacts of increased seawater acidity on marine biogeochemistry and ecosystems. [More information.](#)

Mr David Osborn, Director of the IAEA Environment Laboratories, chaired one of the plenary sessions of the symposium.

## OA-ICC ONLINE RESOURCES

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The [OA-ICC web site](#) provides, among others, resources on ocean acidification listed according to audience and language.

The [OA-ICC bibliographic database](#) with currently more than 2500 references includes citations, abstracts and keywords to simplify searches and bibliographic statistical analysis.

The [OA-ICC data compilation](#) on the biological response to ocean acidification provides easy access to regularly updated experimental data from nearly 600 scientific papers.





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## **More great OA resources!**

**BIOACID web site and Facebook page**

**NOAA OAP web site and Twitter**

**UK Ocean Acidification Research Programme web site**

**[www.ocean-acidification.net](http://www.ocean-acidification.net) (IGBP/IOC/SCOR)**

**OCB Ocean Acidification page**



Global Ocean Acidification  
Observing Network

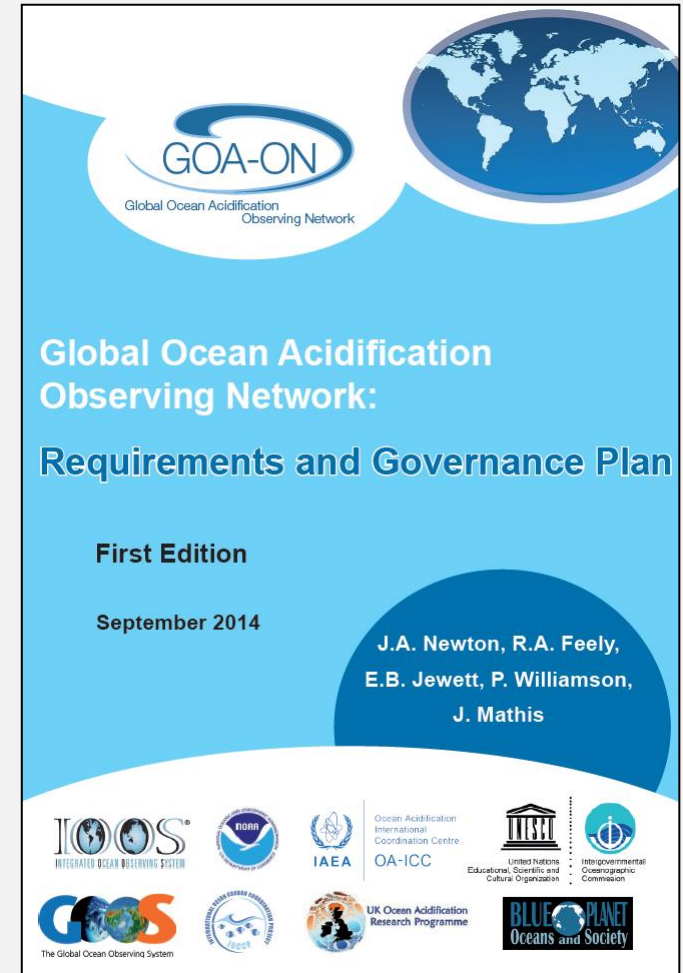


## Background

- Community initiative: 2 international workshops (Seattle 2012 and St Andrews 2013)
- 155 members from 30 countries
- Co-chairs: L. Jewett (NOAA OAP, USA) and Bronte Tilbrook (CSIRO, Australia)
- Strategy outlined in GOA-ON Plan
- Friends of GOA-ON

## Upcoming

- Expert workshops (data portal and synthesis products)
- Training course, Mozambique (S. Dupont)
- 3d scientific meeting Hobart, 8-10 May 2016, following the 4<sup>th</sup> Ocean in a High CO<sub>2</sub> World Symposium (focus on biology)



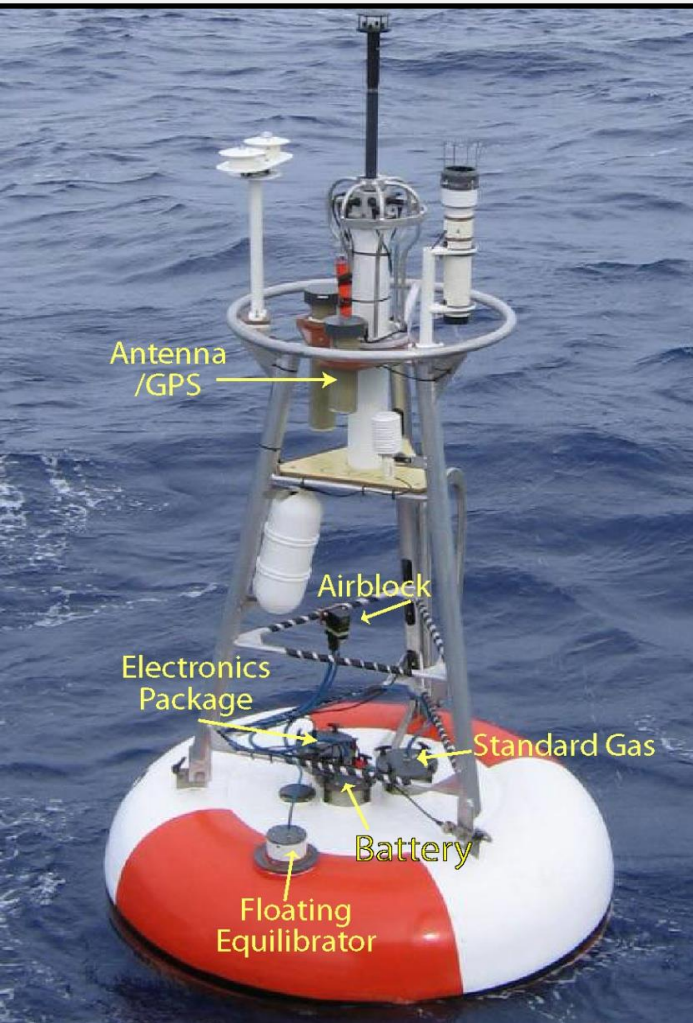
## ***Observations across various ecosystems:***

- Open ocean: polar, temperate, tropical
- Coasts and estuaries
- Coral reefs



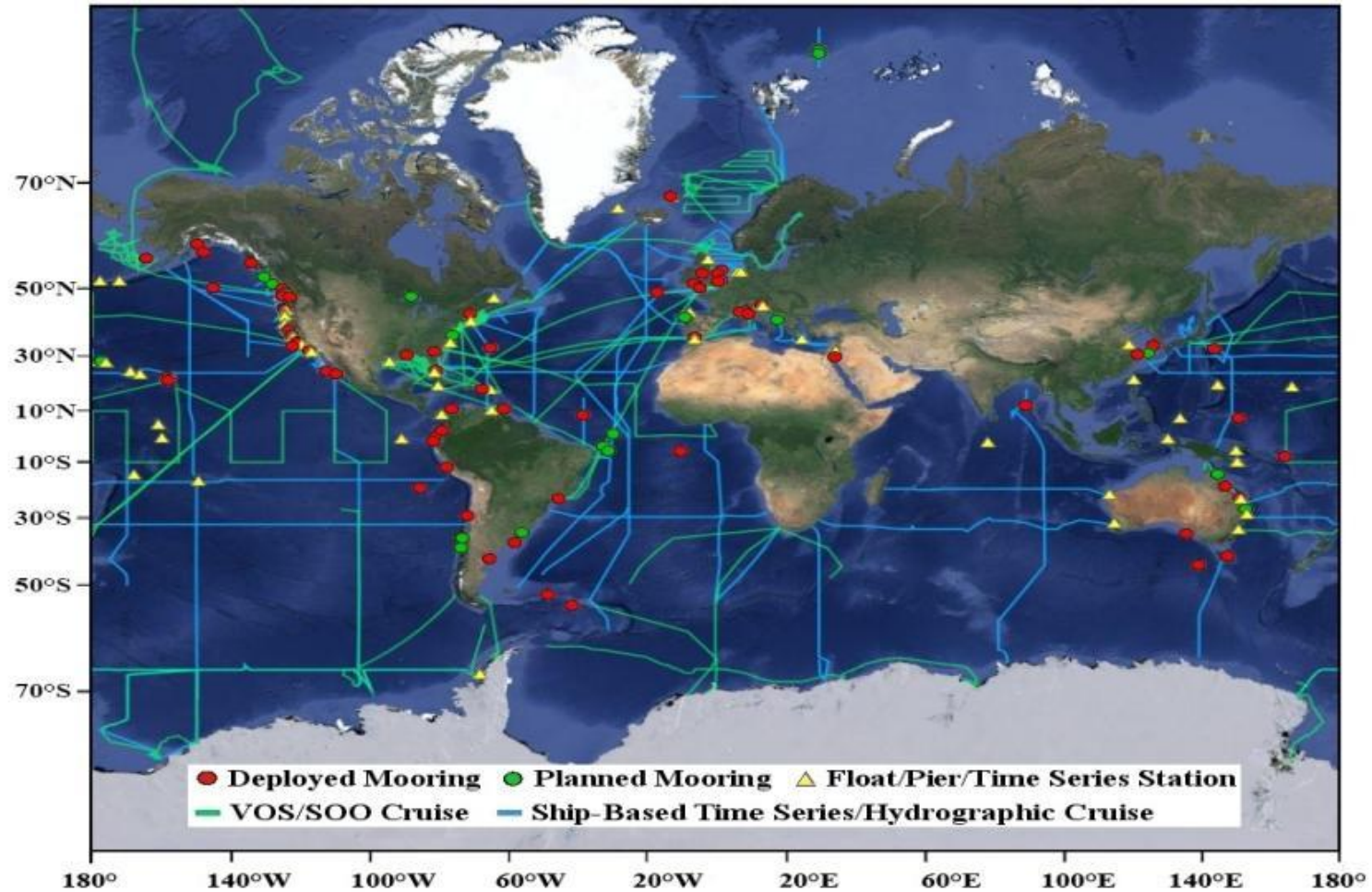
## Utilizing various platforms:

- Ship-based surveys & volunteer observing ships
- Moorings & piers
- Gliders & floats



100 m ↑      2 m ↓





Inventory – interactive map available at [www.goa-on.org](http://www.goa-on.org)

# GOA-ON defined two data quality objectives:

- **'Climate data'**: of sufficient and defined quality to assess long term trends with defined level of confidence  
*Detection of changes in OA state over multi-decadal timescales*
- **'Weather data'**: of sufficient and defined quality to identify relative spatial patterns and short-term changes  
*Mechanistic interpretation of the ecosystem response to local, immediate OA dynamics*

Goal 1: Global OA conditions

Goal 2: Ecosystem response to  
OA

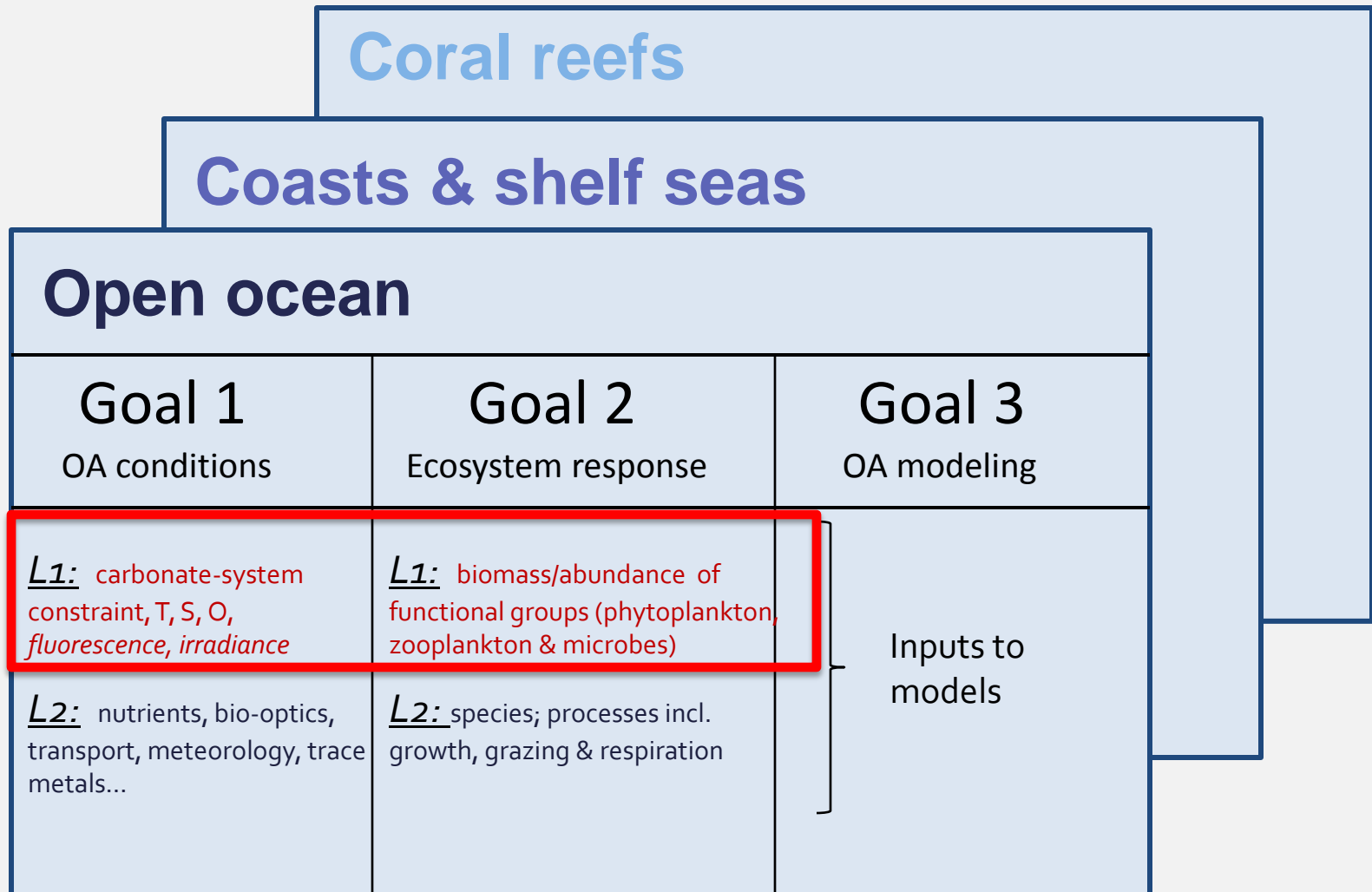
Goal 3: Data to optimize OA  
modeling



# Nested system design

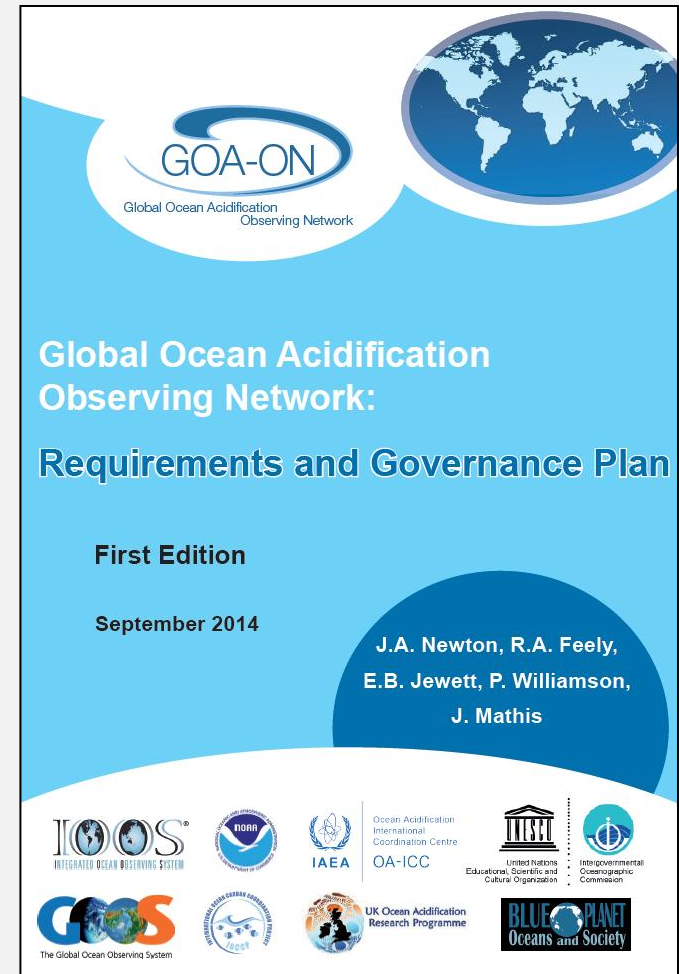
- To address network goals, GOA-ON observations will be based on a **nested design**:
  - Level 1: **critical minimum measurements**
  - Level 2: measurements for integrated assessment to enhance interpretation
  - Level 3: measurements that are not yet fully ready for standardization; in development or evaluation
- Ecosystem responses will only be measured in a subset of total OA observation stations

# GOA-ON has a nested system design



# More information

- Get involved:  
[www.goa-on.org](http://www.goa-on.org)  
[info@goa-on.org](mailto:info@goa-on.org)
- Newsletter
- Next workshop:  
Hobart, 8-10 May  
2016



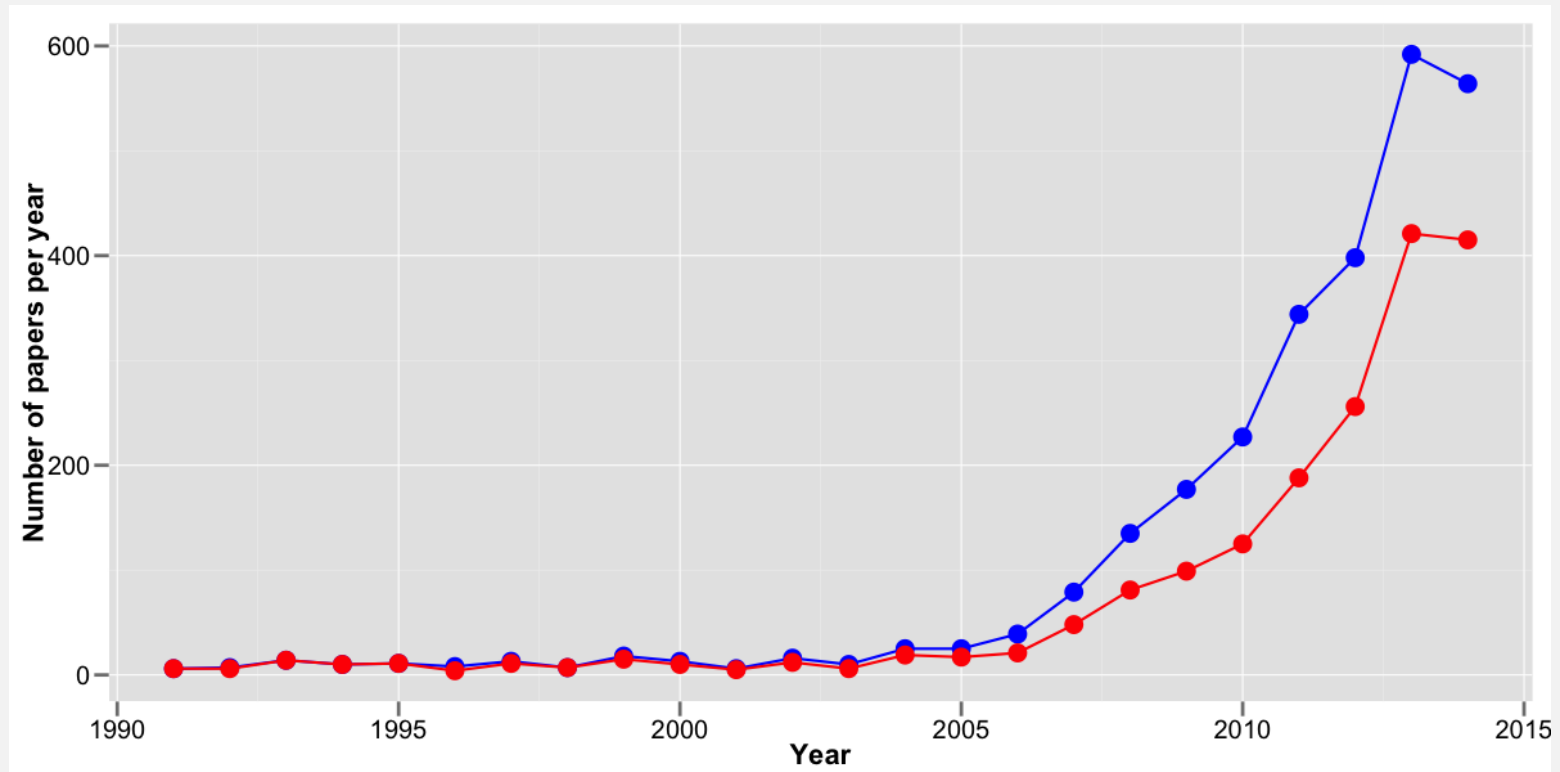


## OA-ICC Data Management Activity

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- OA-ICC Data Compilation: Experimental ocean acidification biological response data (published)
- Facilitate expert meetings to forward international data management (observational (GOA-ON) and experimental data)

# The number of papers addressing biological responses to ocean acidification has increased steeply in the past decade



Total number of publications on ocean acidification (OA) (blue) and number of publications investigating the biological response to OA (red) published per year. Revised from Gattuso & Hansson (2011) using bibliographic data compiled by the Ocean Acidification International Coordination Centre (<https://www.iaea.org/ocean-acidification/page.php?page=2196>).

Gattuso J.-P. & Hansson L., 2011. Ocean acidification: background and history. In: Gattuso J.-P. & Hansson L. (Eds.), *Ocean acidification*, pp. 1-20. Oxford: Oxford University Press.

# Numerous problems for data comparison

- pH are reported in different scales

e.g., at pH = 8.08, DIC = 2 mmol/kg, S = 35, T = 25 °C:

pH scale	pH	$p\text{CO}_2$ $\mu\text{atm}$	$\text{CO}_2$ (aq) $\mu\text{mol/kg}$	$\text{HCO}_3^-$ $\mu\text{mol/kg}$	$\text{CO}_3^{2-}$ $\mu\text{mol/kg}$
Seawater	8.08	354	10	1735	255
Total	8.08	363	10.3	1739	250
Free	8.08	478	13.6	1786	201

- Carbonate chemistry are calculated using different dissolution constants, e.g., at DIC = 2 mmol/kg, TA = 2.35 mmol/kg, S = 35, T = 25°C:

Author	pH <sub>sws</sub>	$p\text{CO}_2$ $\mu\text{atm}$	$\text{CO}_2$ (aq) $\mu\text{mol/kg}$	$\text{HCO}_3^-$ $\mu\text{mol/kg}$	$\text{CO}_3^{2-}$ $\mu\text{mol/kg}$
Roy	8.08	354	10	1735	255
Hansson	8.10	343	9.7	1739	251
Mehrbach	8.11	327	9.3	1742	249

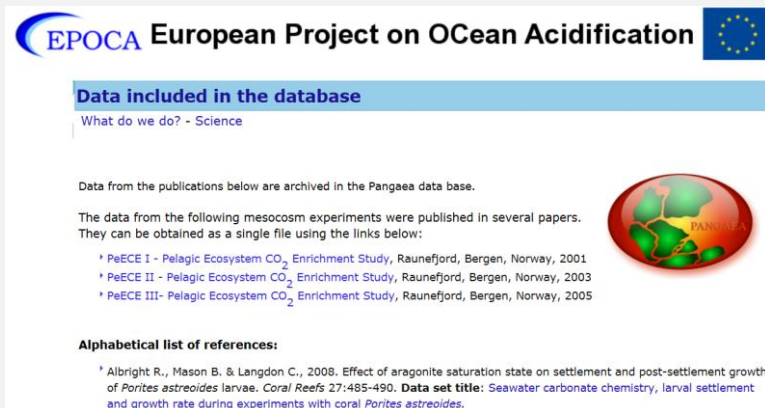
*Zeebe & Wolf-Gladrow (2001)*

# Data compilation on the biological response to ocean acidification

- Under two EU projects: EUR-OCEANS (2007) and EPOCA (2008-2012)

Nisumaa, A.-M., Pesant, S., Bellerby, R. G. J., Delille, B., Middelburg, J. 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.

- Maintained in the framework of the IAEA project OA-ICC in close collaboration with Xiamen University and the data publisher PANGAEA
- Maintained by Yan Yang, under the supervision of Jean-Pierre Gattuso (OA-ICC focal point for data management)



**EPOCA European Project on Ocean Acidification**

**Data included in the database**

What do we do? - Science

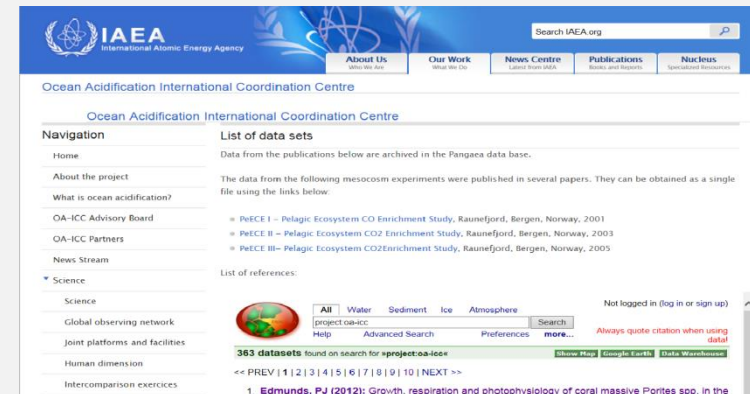
Data from the publications below are archived in the Pangaea data base.

The data from the following mesocosm experiments were published in several papers. They can be obtained as a single file using the links below:

- \* PeECE I - Pelagic Ecosystem CO<sub>2</sub> Enrichment Study, Raunefjord, Bergen, Norway, 2001
- \* PeECE II - Pelagic Ecosystem CO<sub>2</sub> Enrichment Study, Raunefjord, Bergen, Norway, 2003
- \* PeECE III- Pelagic Ecosystem CO<sub>2</sub> Enrichment Study, Raunefjord, Bergen, Norway, 2005

**Alphabetical list of references:**

- \* Albright R., Mason B. & Langdon C., 2008. Effect of aragonite saturation state on settlement and post-settlement growth of *Porites astreoides* larvae. *Coral Reefs* 27:485-490. **Data set title:** Seawater carbonate chemistry, larval settlement and growth rate during experiments with coral *Porites astreoides*.



**IAEA International Atomic Energy Agency**

Search IAEA.org

Navigation: Home, About the project, What is ocean acidification?, OA-ICC Advisory Board, OA-ICC Partners, News Stream, Science, Global observing network, Joint platforms and facilities, Human dimension, Intercomparison exercises

**List of data sets**

Data from the publications below are archived in the Pangaea data base.

The data from the following mesocosm experiments were published in several papers. They can be obtained as a single file using the links below:

- \* PeECE I - Pelagic Ecosystem CO<sub>2</sub> Enrichment Study, Raunefjord, Bergen, Norway, 2001
- \* PeECE II - Pelagic Ecosystem CO<sub>2</sub> Enrichment Study, Raunefjord, Bergen, Norway, 2003
- \* PeECE III- Pelagic Ecosystem CO<sub>2</sub> Enrichment Study, Raunefjord, Bergen, Norway, 2005

**List of references:**

363 datasets found on search for **project:oa-icc**

<< PREV | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NEXT >>

1. Edmunds, P.J. (2012): Growth, respiration and photophysiology of coral massive *Porites* spp. in the

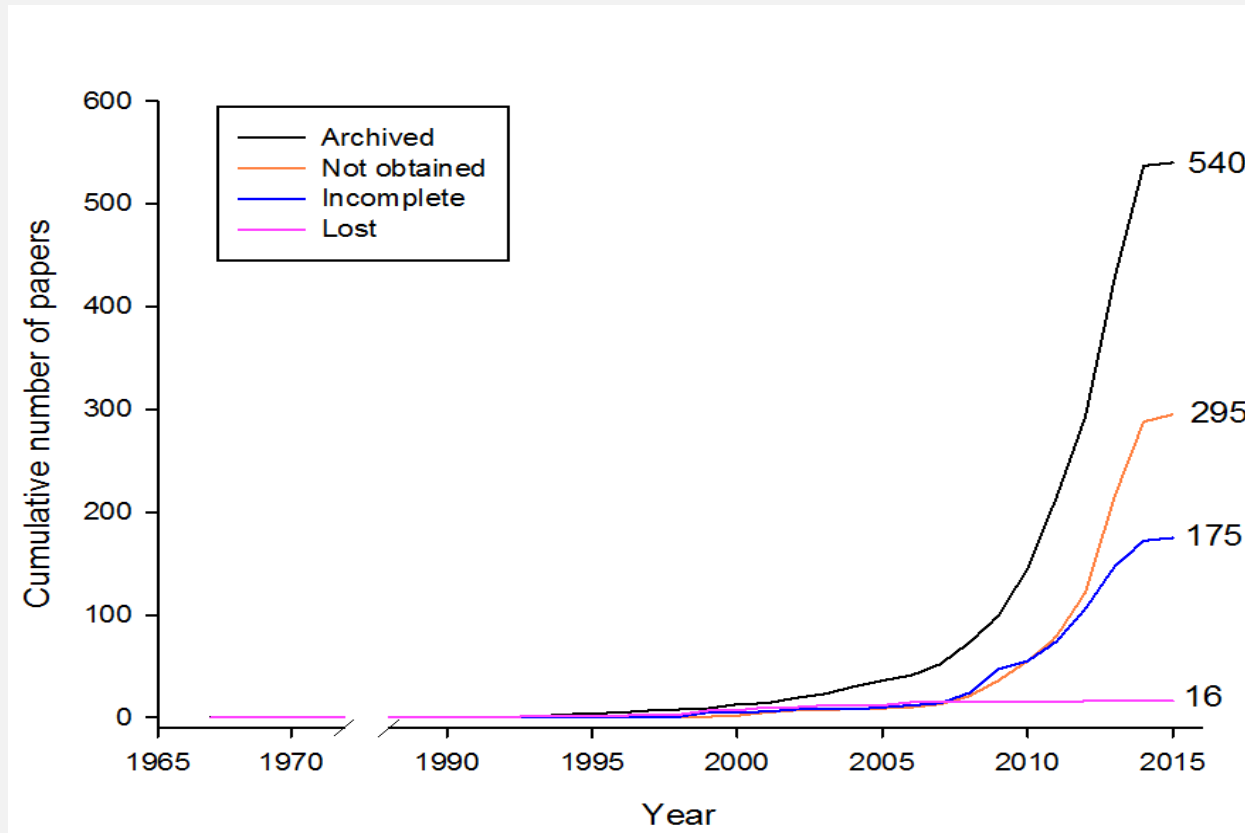
# Objectives

- Gather data on the biological response to ocean acidification (carbonate chemistry, biogeochemical processes and ancillary data) from published articles
- Transform the information into common framework (the carbonate system variables are recalculated in a consistent way)
- Make data freely available via the data publisher PANGAEA (<http://www.pangaea.de>)



# Statistics

Total of 1026 papers were identified for inclusion in the compilation, data from 540 papers have been archived at PANGAEA (<http://www.iaea.org/ocean-acidification/page.php?page=2205>)



Not obtained: papers for which data could not be obtained

Incomplete: papers which reported less than two carbonate system parameters

Lost: data lost by authors

# Three meta-analysis and a modeling study used the OA-ICC data compilation

- Kroeker, K. J., Kordas, R. L., Crim, R. N., & Singh, G. G., 2010. Meta-analysis reveals negative yet variable effects of ocean acidification on marine organisms. *Ecology Letters* 13(11): 1419-1434.
- Kroeker, K. J., Kordas R. L., Crim R., Hendriks I. E., Ramajo L., Singh G. S., Duarte C. M., & Gattuso J.-P., 2013. Impacts of ocean acidification on marine organisms: quantifying sensitivities and interaction with warming. *Global Change Biology* 19 (6): 1884-1896.
- Liu, J., Weinbauer, M. G., Maier, C., Dai, M., & Gattuso, J.-P., 2010. Effect of ocean acidification on microbial diversity and on microbe-driven biogeochemistry and ecosystem functioning. *Aquatic Microbial Biology* 61:291-305.
- Muller E. B. & Nisbet R. M., 2014. Dynamic energy budget modeling reveals the potential of future growth and calcification for the coccolithophore *Emiliana huxleyi* in an acidified ocean. *Global Change Biology* 20(6): 2031–2038.

# Challenges

- Slow feedback from authors  
Only 53% of the relevant papers were archived
- Different names for the same variable

Calcification rate	Growth rate, PIC production
Primary production	Carbon fixation, photosynthesis rate, POC production
Respiration rate	Oxygen consumption



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## **Goal: data portal(s) for easy access to ocean acidification data**

OA-ICC supported meetings, Monaco (2014, 2015)

Development of common metadata templates, vocabularies etc.



## Recommendations/guidelines (Gattuso et al.)

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At least two of the carbonate system parameters, + S, t, hydrostatic pressure :

- Dissolved inorganic carbon (CT;  $\mu\text{mol kg}^{-1}$ )
- Total alkalinity (AT;  $\mu\text{mol kg}^{-1}$ )
- pH (it is critical to mention its scale; see below)
- Partial pressure of carbon dioxide ( $p\text{CO}_2$ ;  $\mu\text{atm}$ )
- Fugacity of carbon dioxide ( $f\text{CO}_2$ ;  $\mu\text{atm}$ )
- Carbonate ion concentration ( $\text{CO}_3^{2-}$ ;  $\mu\text{mol kg}^{-1}$ )

Concentrations of total dissolved inorganic phosphorus and total dissolved inorganic silicon (in  $\mu\text{mol kg}^{-1}$ ) whenever possible

How the parameters were measured and protocol followed.

Certified Reference Materials, source, and batch numbers

pH scale (NBS, free, total, or seawater)



## Recommendations/guidelines (Gattuso et al.)

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Temperature at the time of sampling and at the time of measurement, if different.

Formulations used to calculate:

- Concentrations of total boron
- CO<sub>2</sub> solubility ( $K_0$ )
- Dissociation constants of carbonic acid ( $K_1$  and  $K_2$ ), boric acid ( $K_b$ ), water ( $K_w$ ), phosphoric acid ( $K_{p1}$ ,  $K_{p2}$ ,  $K_{p3}$ ), silicic acid ( $K_{si}$ ), hydrogen fluoride ( $K_f$ ), and bisulfate ( $K_s$ )
- Solubility products of calcite ( $K_{spc}$ ) and aragonite ( $K_{spa}$ )

Software package used to calculate the carbonate chemistry, version number, and any associated options.

Average reproducibility of the performed measurements (with number of measurements)

Strongly recommended that the chemistry and biological data are either archived in an on-line database (preferred) or provided along with the paper as supplementary information.



## Don't be strangers! 😊

- Let us know about your projects/progress
- Participate in community efforts
- Make use of resources and provide feedback
- Look out for opportunities



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# Thank you!

## **Web site**

*[iaea.org/ocean-acidification](http://iaea.org/ocean-acidification)*

## **News stream**

*[news-oceanacidification-icc.org](http://news-oceanacidification-icc.org)*

## **Data compilation**

*<http://tinyurl.com/oaicc-data>*

## **Bibliographic database**

*<http://tinyurl.com/oaicc-biblio>*