

The Oceans in a High-CO₂ World II

Monaco, October 2008

What have we learnt about ocean acidification since 2004 and where should we be in 2012?

Jean-Pierre Gattuso

Laboratoire d'Océanographie
CNRS-University of Paris 6



European Project on Ocean Acidification

epoca-project.eu

Outline

- Introduction
- A journey through ocean acidification research
 - What did we know in 2004 (“High-CO₂ I”)?
 - What have we learnt since 2004 (“High-CO₂ II”)?
- A short bibliographic analysis
- Where should we be in 2012 (“High-CO₂ III”)?
- Are these predictions realistic?

Caveats

- Very short notice
- This is not meant to be a full-blown review
- Merely some personal views, with a possible bias against paleo and modeling aspects

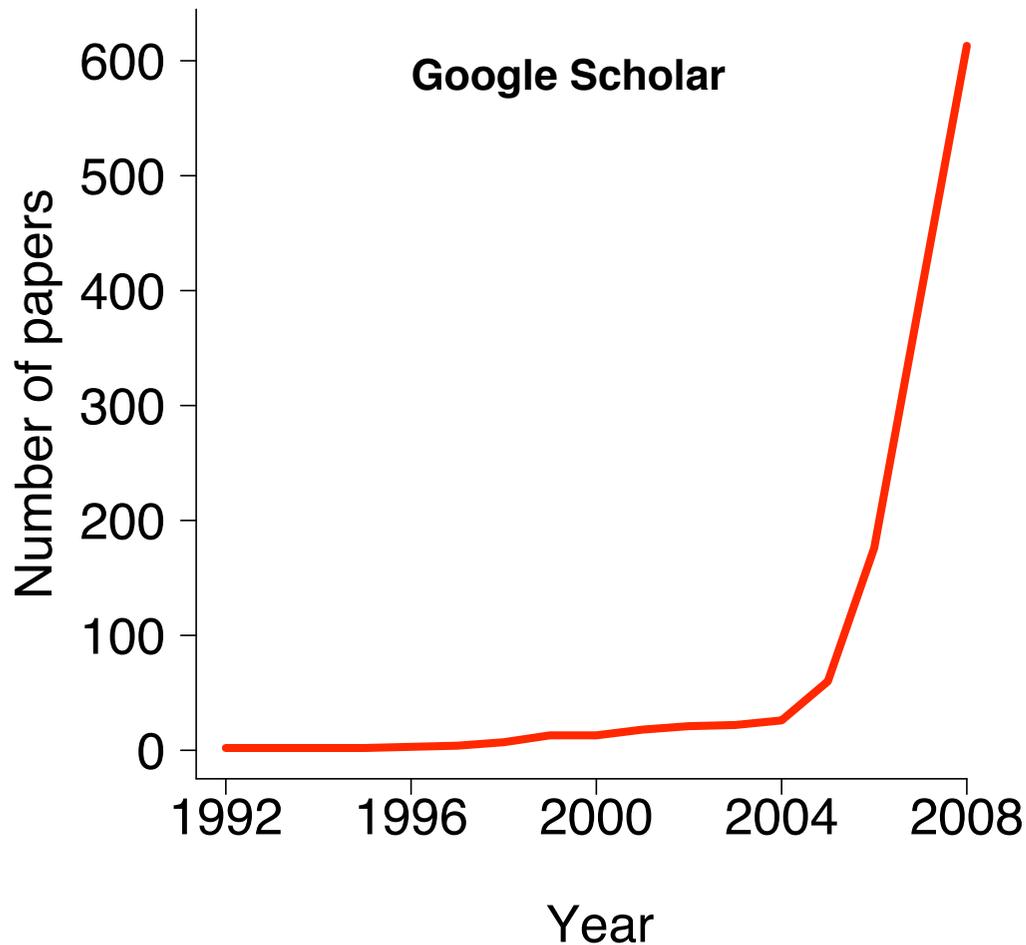
A journey through ocean acidification research

**What did we know in 2004?
What have we learnt since 2004?**

Internet search

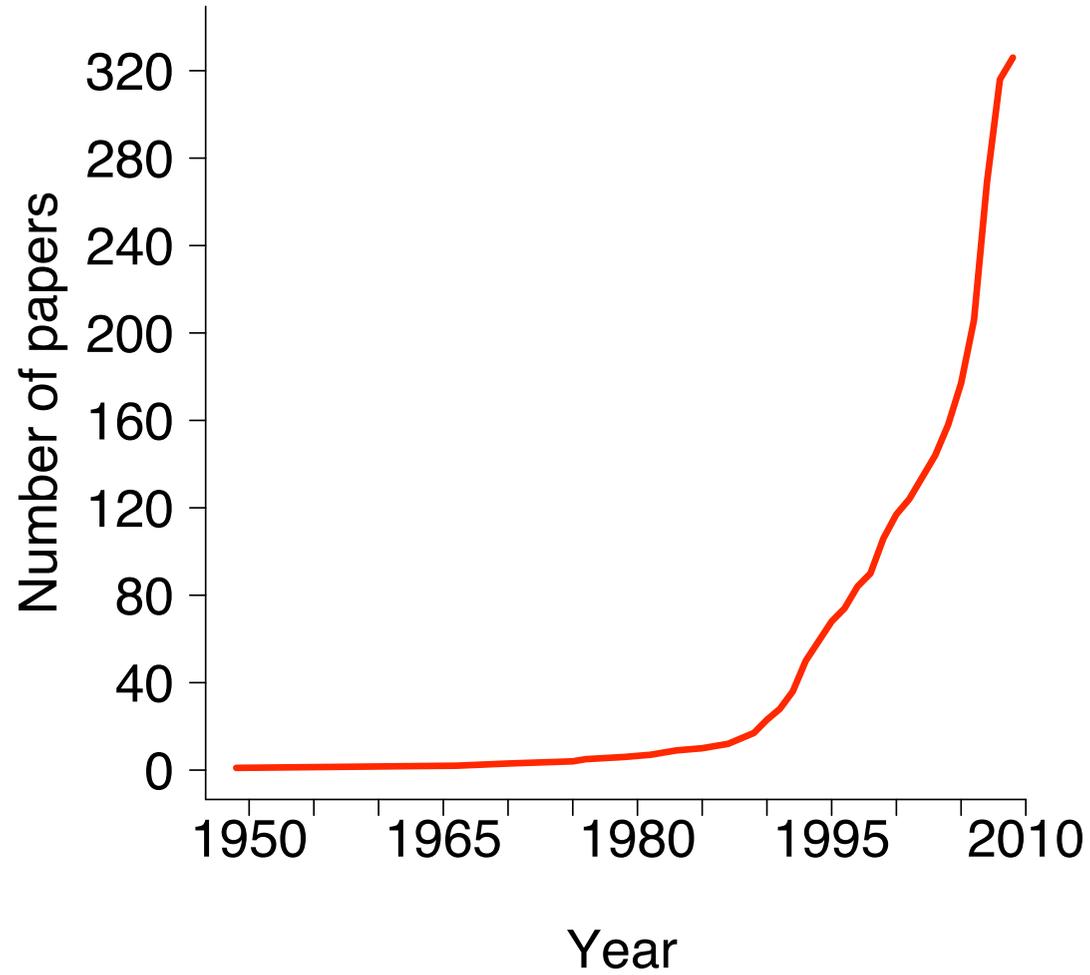
- **Google:** exact phrase-
116,000 hits
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844,000 hits
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hits total (includes pdfs
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- Search results of 23
September 2008

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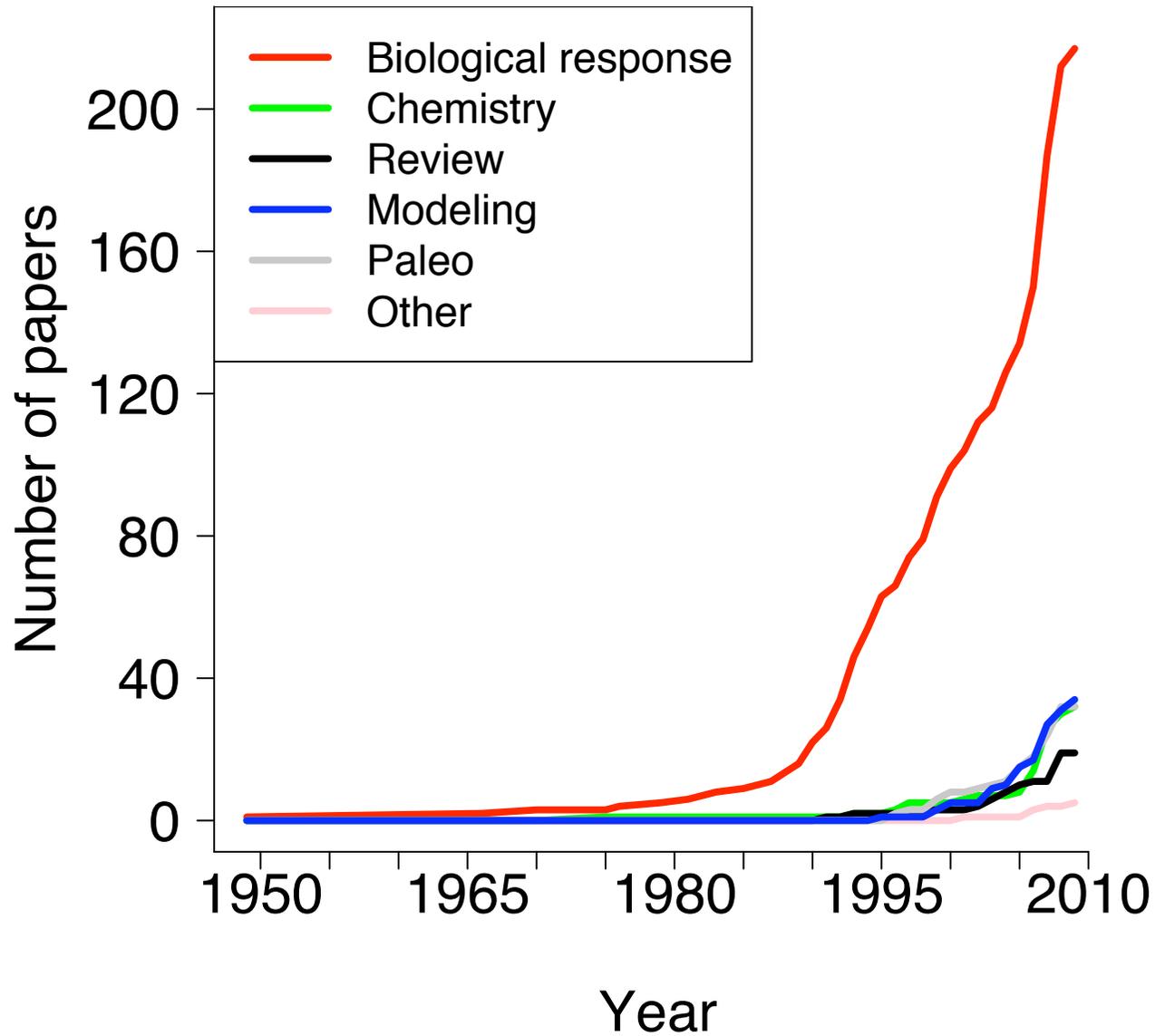


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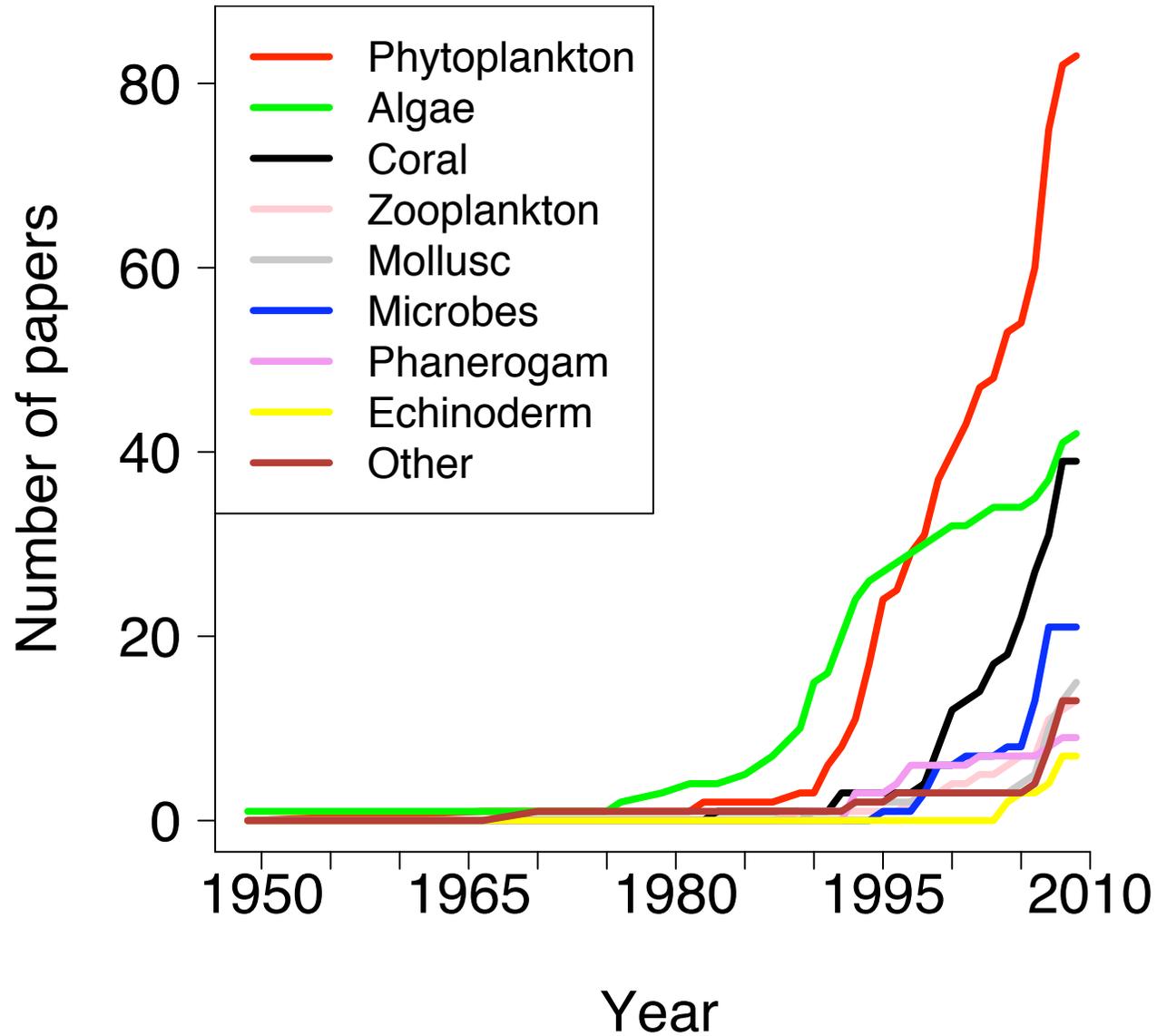
Number of publications as a function of time (LOV database)



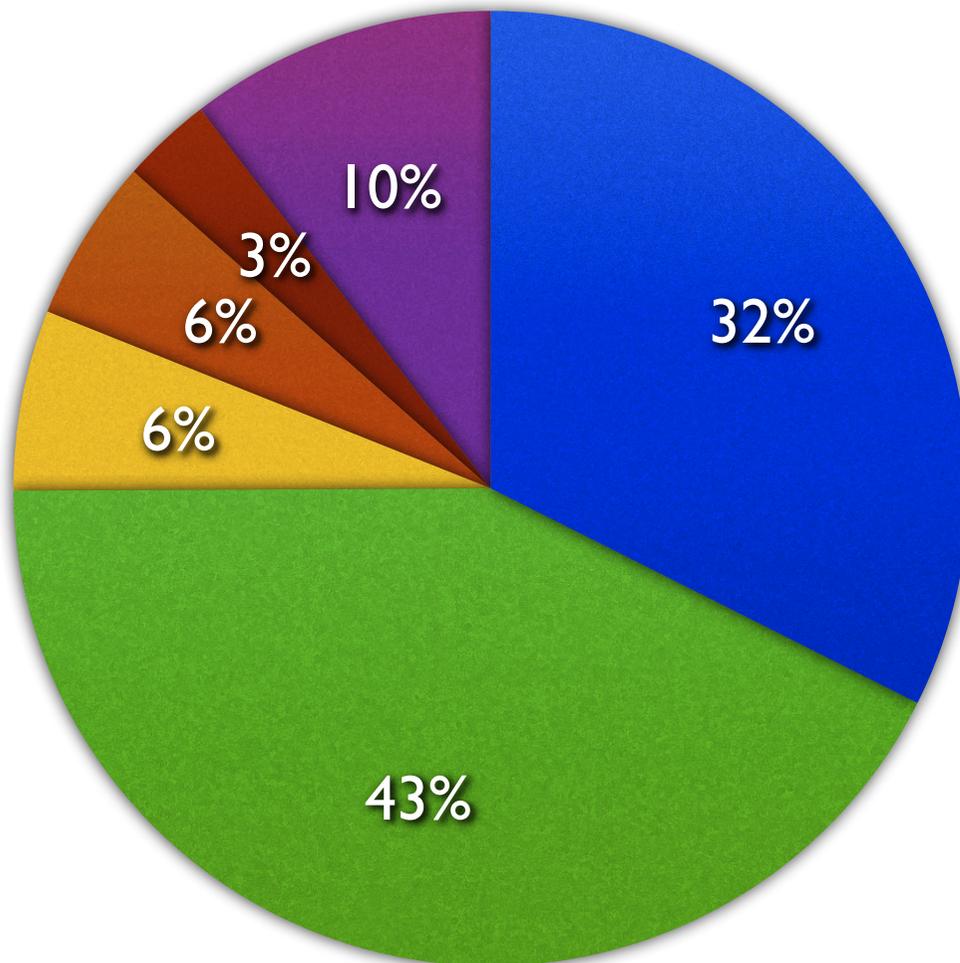
Scientific themes



Biological response: groups investigated



Country of affiliation of first authors



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(with a little help...)

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- Study of deep-sea CO₂ vents (Boetius et al.)

Where should we be in 2012?



October 2012, Incognitapolis

October 2012, Incognitapolis

The Oceans in a High-CO₂ World III

October 2012, Incognitapolis

The Oceans in a High-CO₂ World III

**Status of ocean acidification research:
progress made since the 2008 meeting**

Dr. XYZ

2012 overview: Monitoring

- TRIS and AMP buffers readily available to use the right pH scale
- Automated instruments measuring at least 2 parameters of the carbonate system have become available
- Previous monitoring sites have been continued, with increased frequency of data acquisition
- New permanent sites established in key areas:
 - Arctic
 - Southern Ocean
 - Eastern boundary upwelling systems
 - Enclosed seas:
 - Mediterranean Sea
 - Black Sea
 - Baltic Sea

2012 overview: Paleo

- A reliable proxy of a second parameter of the carbonate system has become available
- Paleo reconstructions with better accuracy and time resolution
- Multi-proxies have enabled to go beyond simple correlations between (1) atmospheric $p\text{CO}_2$ and (2) calcification, biodiversity and biogeography
- Both carbonate chemistry and other drivers (e.g. Mg/Ca) are considered
- Use of organic proxies to go beyond calcifiers

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- Few previous discrepancies were shown to relate to the approaches used to manipulate the carbonate chemistry, most result from intra-specific or inter-specific difference (physiological or molecular pathways)

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- After a lot of speculations, we have at last some idea on the direct and indirect impacts on fisheries

2012 overview: Modeling

- Better scenarios of CO₂ emissions have constrained projections of the future carbonate chemistry
- Better understanding of biological responses enable to improve considerably the primitive modeling experiments pre-2008
- Relatively solid prediction on biogeochemical feedbacks
- Not only the C and CaCO₃ biogeochemical cycles, but also those of nitrogen, iron, sulfur and other climate-relevant gases

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- Outreach and educational activities have led to increased awareness of ocean acidification in the public, including the younger generation



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Overall: tentative yes!

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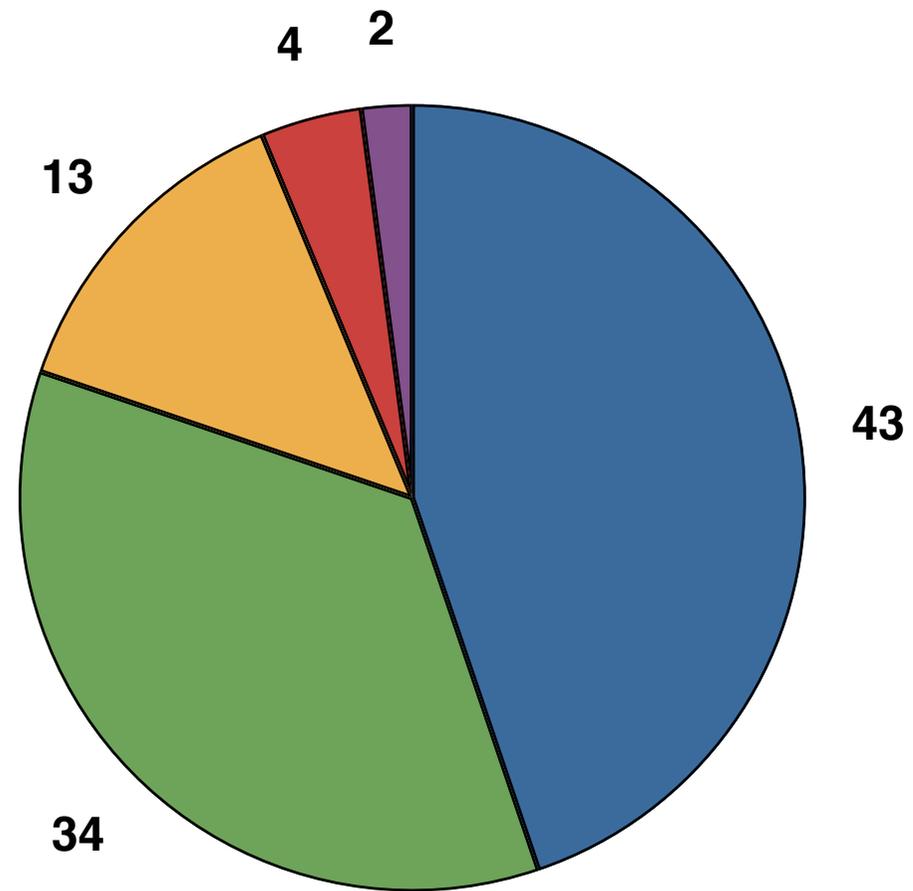
- Considerable increase in research activities
 - National projects: Norwegian MERCLIM, Chinese CHOICE, Japanese projects, German BIOACID, UK project, US efforts (FORAM act 2007, OCB subcommittee on OA),...
 - International projects: EPOCA, ESF...
 - International programs: strong support from IMBER, SOLAS, LOICZ (IHDP?)
 - Support from regional organizations: ICES, PICES, CSIEM, PSA...
- Considerable increase of the workforce, especially students and postdocs
- Guide on the best practices for ocean acidification research and reporting (following Kiel 2008)
- Training courses for young scientists (EPOCA, Bergen 2009)
- Critical to provide access to observational and model data

EUR-OCEANS data compilation project

- Number of perturbation experiments has increased and much more data to come
- Meta-analysis: a key tool to investigate very diverse responses
- Few publications include data
- Data required:
 - carbonate chemistry (at least 2 parameters) measured according to Dickson et al. (2007)
 - salinity and temperature
 - processes investigated
 - any other ancillary data
- Could be in the paper, as supplementary information or uploaded in a database (cf. EPOCA)
- Small-scale EUR-OCEANS project involved 10 EU scientists
- 96 papers identified
- Will be uploaded on the WDC-MARE database in November and made available to everyone
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International collaboration

- EU research hopefully strongly linked via EPOCA
- Plans for a strong EU-US link (OCB, NOAA...)
- **But** joint activities are difficult to organize because coordination is on an ad-hoc basis and lacks dedicated funding (cf. Kiel workshop)
- Do we need an international coordination or forum?
 - SCOR, IOC, IGBP, IMBER, SOLAS and PAGES may play a role
 - should be bottom-up
 - identify a leader (not me!)

Acknowledgements

- Jim Orr
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- Anne-Marin Nisumaa
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- EPOCA consortium
- Financial support from the European Commission through EPOCA

