

Ocean Acidification

*Addressing the Impacts of Ocean Acidification from the
Perspective of Developing Countries*

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Outline

- 1 The Science
- 2 Observations & Changes
- 3 The Impacts
- 4 Action for Brazil and other Developing Countries

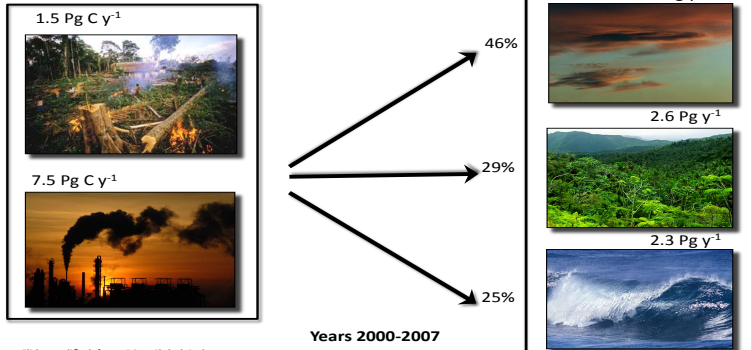
The Ocean is Acidifying Rapidly

OA is a direct result of CO₂ emissions

- OA occurs because each year, about 25% of the CO₂ we put into our atmosphere is taken up by the ocean.
- Adding CO₂ to water forms carbonic acid, which then breaks down into bicarbonate, and can further break down into carbonate
- The end result is that both the CO₂ concentration and the bicarbonate concentration **increase**, while the carbonate and the pH both **decrease**.

The CO₂ we put in the atmosphere

Where it ends up

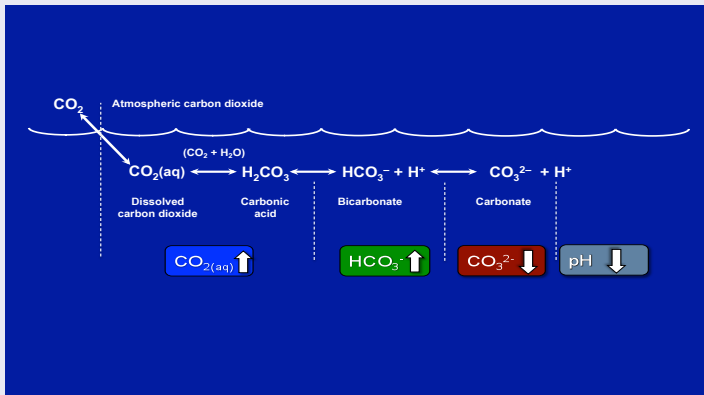


Slide modified from GCP - Global Carbon Budget Team

Canadell et al. 2007, PNAS (updated)

OA is a direct result of CO₂ emissions

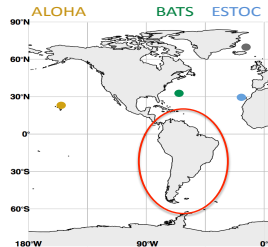
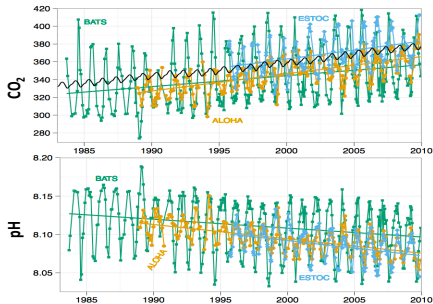
Simplified chemistry



Observational Evidence of OA

South and Central America: no data

Monthly measurements taken over the past 30 years, from a station in Hawaii, Bermuda, and the Canary Islands.

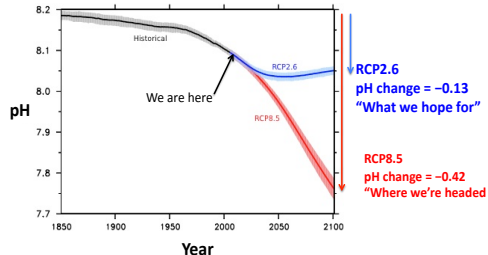


Jim Orr, 2010

OA in the 20th and 21st centuries

- The CO₂ increase in the ocean is locked to the increase in atmospheric CO₂.
- The pH, as predicted, is decreasing
- **pH** has changed since the year 1850, and it WILL change, depending on our energy policy decisions.

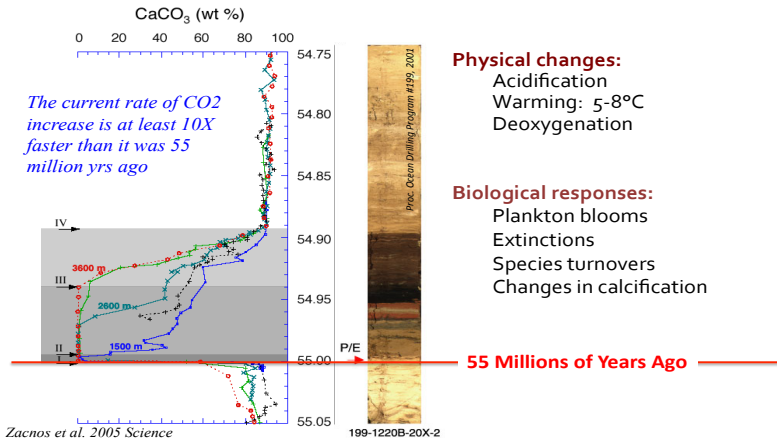
Average pH of the ocean surface



The pH change in the ocean (degree of OA) will be more than 3x worse in the red scenario versus the blue scenario.

The Last Big Acidification Event (55 M years ago)

55 M years ago, an ocean acidification event occurred.



Impact is a very complex issue (global and regional)

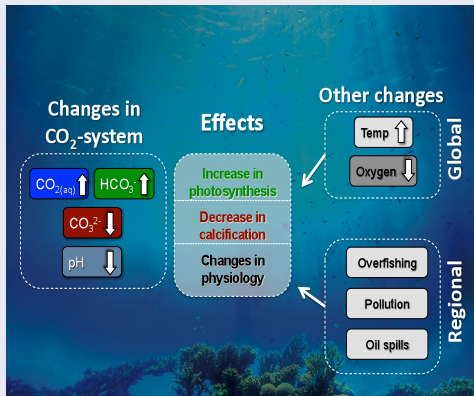
There are many ways that OA affects organisms on global scale

- The oceans are **warming** and losing **oxygen**
- Marine organisms have complex biology: capacity to adjust to change (physiology) and adapt (genetically) across generations
- On regional scale other stressors come into play (e.g. pollution)

How CO₂ in seawater affects marine life

Marine organisms are subjected to multiple stressors

- CO₂ concentrations are **INCREASING** (increase in photosynthesis)
- Carbonate concentration is **DECREASING** (decrease in calcification)
- pH is **DECREASING** (changes in physiology)



For the Developing World

Society relies on their oceans

- Fisheries
- Tourism
- Human health and well-being
- Ecosystem services

OA impacts the state (health) of the oceans

OA impacts on the marine ecosystems: support for fisheries



Tropical Corals

OA causes calcification to decline in most species – but some species are tougher than others

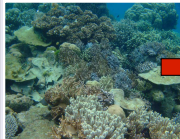


Cold water corals

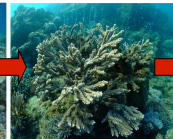
Ocean acidification causes calcification to decline, made worse by elevated temperature

A window into the future of coral reefs?

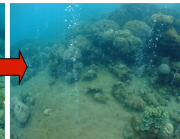
pH 8.05: Today



pH 7.95: ~ year 2050



pH 7.8: ~ year 2100



Fabricius et al. (2010) Nat Clim Change

Coastal countries depend on ecosystem services

Marine Ecosystems

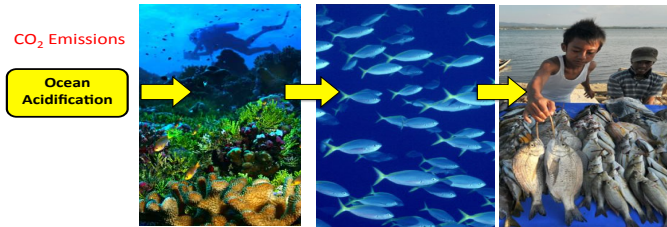
- Food webs
- Fish stocks
- Coral Reefs

Ecosystem Services

- Fish Catch
- Aquaculture
- Tourism
- Coastal protection
- Biodiversity

Socio-economic impacts

- Population
- Income



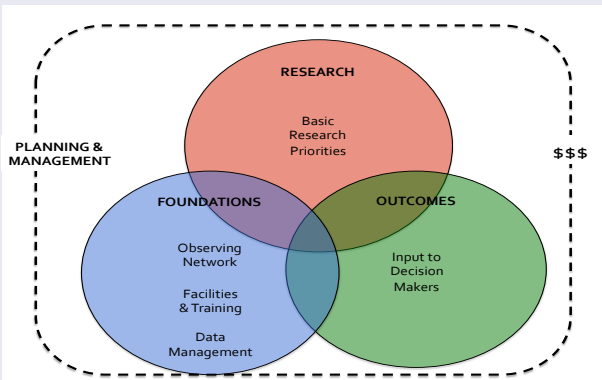
If the ecosystem can no longer support fish, then it is no longer providing that “free” service to the community: economic loss

Strategy in Brazil - our society relies on the oceans

- Development & strengthening of **human resources**
- Making the linkage between **science and action happen**;
- Obtaining quantitative information and tools for the political and economic decision makers;
- Deployment of a network of **long-term monitoring** of biogeochemical and physical parameters in oceanic and coastal regions of economic and social importance.
- Creating a South Atlantic Ocean biogeochemical dataset to build upon other international data sets already available in the network.
- **Regional-scale** habitat mapping.
- Improving coordination, strengthening partnerships, raising public awareness

Link research, observational and technical needs with outcomes and input to decision makers

Recently created in Brazil a National Institute of Oceans and Waterways (INPOH)



1st Capacity Building Workshop on OA : BRazilian Ocean Acidification Research – BROA

Participants were provided information

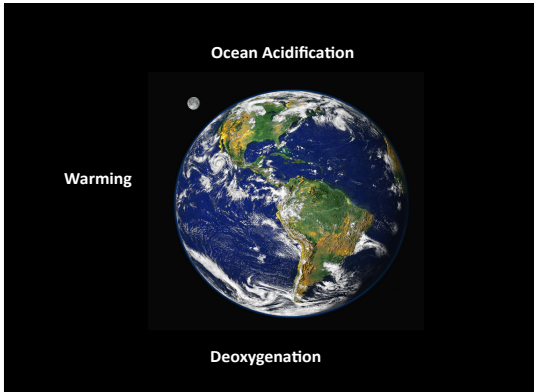
- On the CO₂-system chemistry of ocean acidification and how to measure it;
- On how to design experiments to measure the impacts of ocean acidification on marine organisms and communities, and
- Understanding of what resources, instrumentation and tools are available for conducting ocean acidification research.

1st Capacity Building Workshop on OA : BRazilian Ocean Acidification Research – BROA

A Regional Initiative Example from Brazil: BRazilian Ocean Acidification Research – BROA



Rising CO₂ related to multiple health issues in the oceans



- Reduce CO₂ emissions
- Call for more integrated approach to marine research