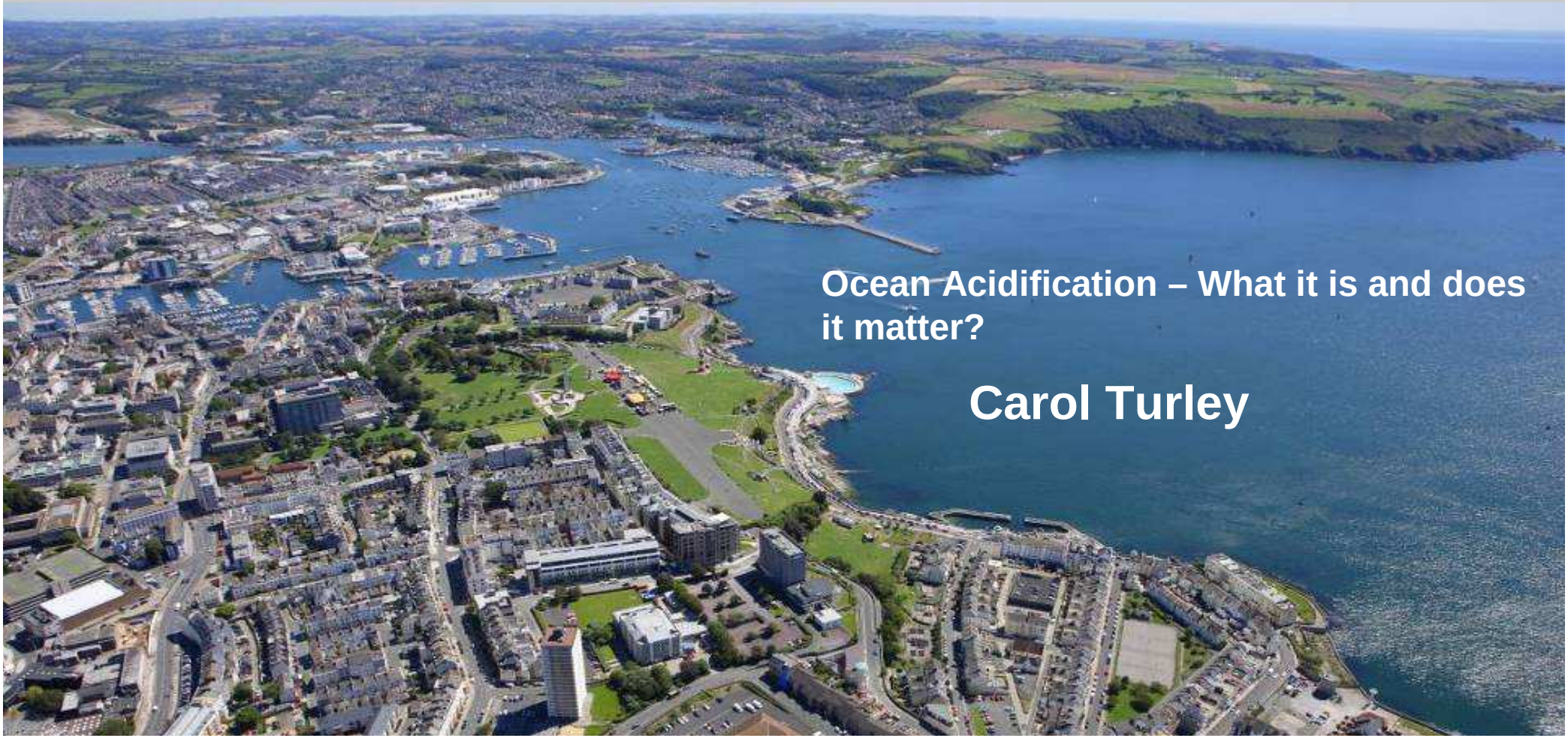
PML | Plymouth Marine Laboratory

EPOCA European Project on OCean Acidification

UK Ocean Acidification Research Programme

Marine Matters

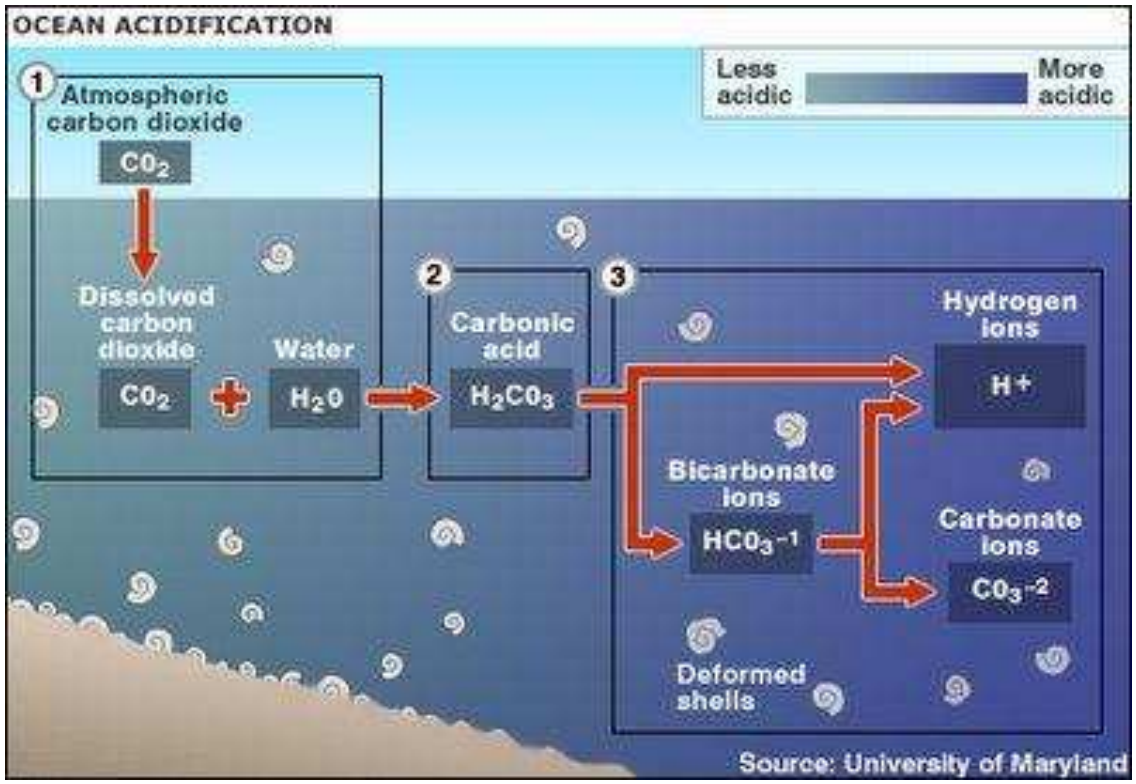
IUCN Event, COP16, Cancun, 7 December 2010.

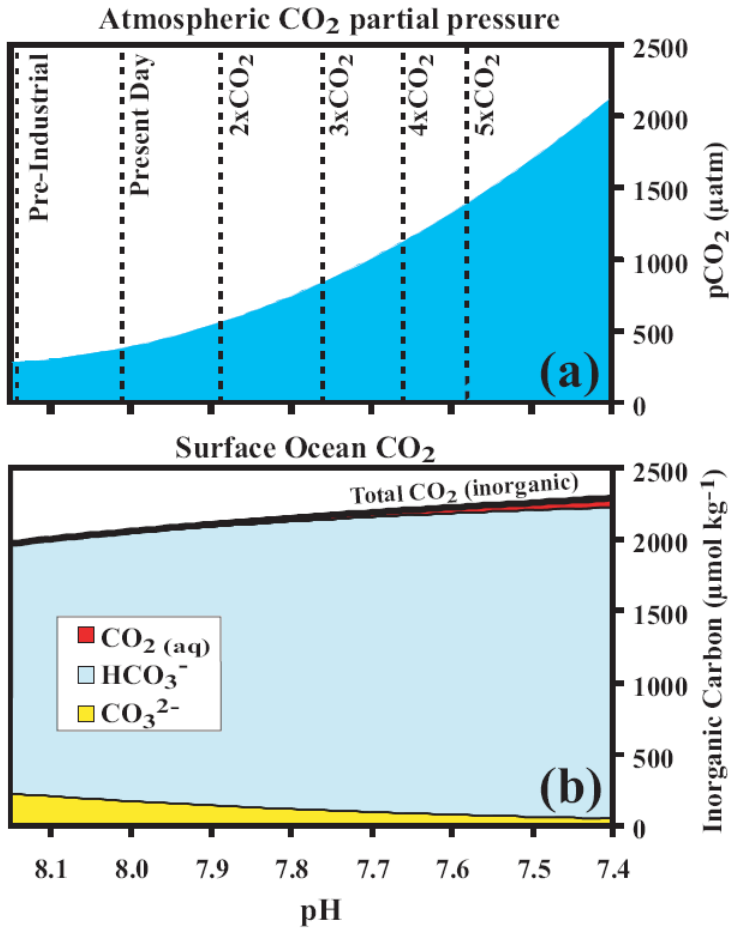


Ocean Acidification – What it is and does it matter?

Carol Turley

What is Ocean Acidification: the chemistry….





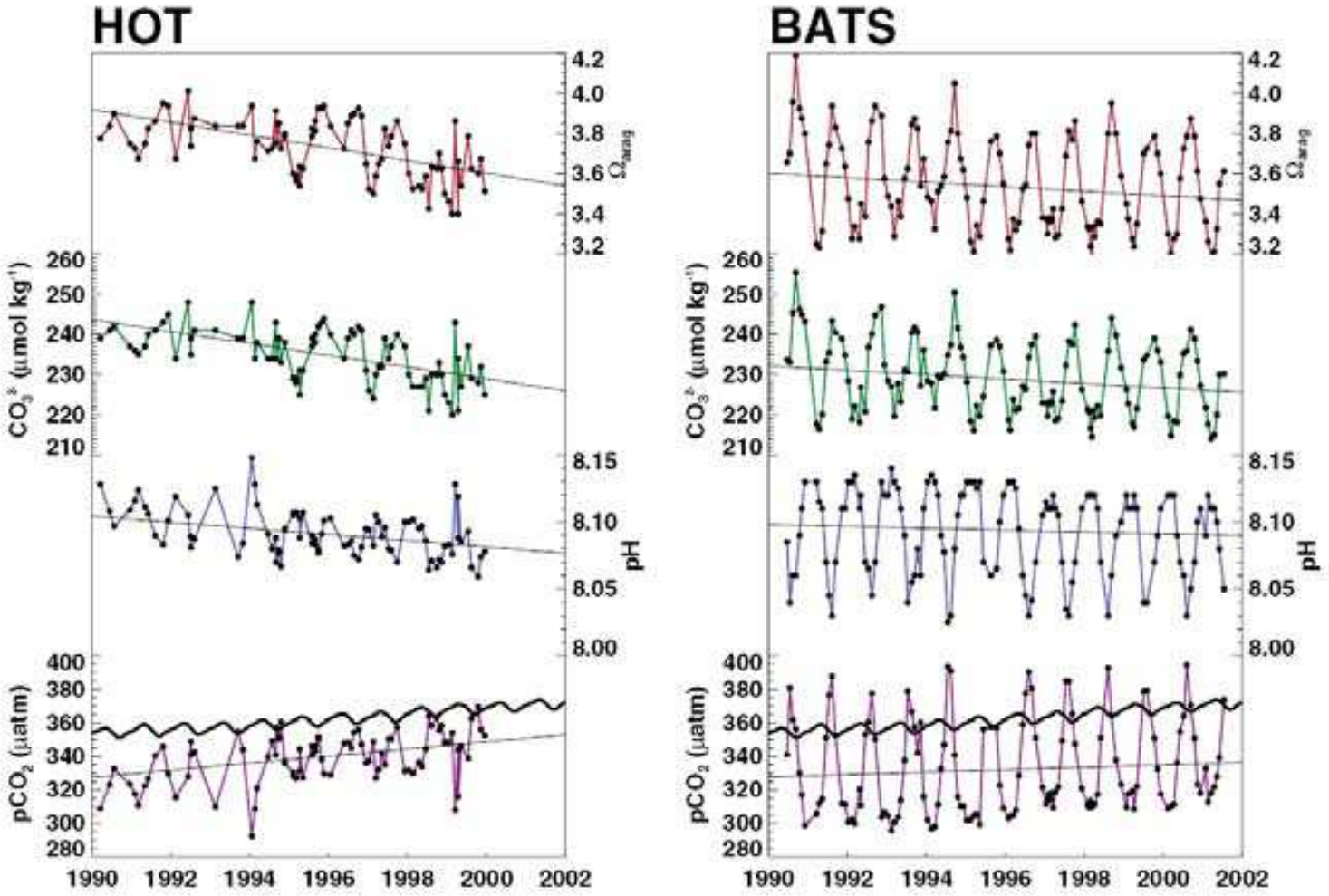
Over the last 200 yrs the oceans have taken up 25% of CO2 emissions, essentially buffering climate change

But at a cost as surface oceans have become 30% more acidic, lowering the pH and carbonate ions

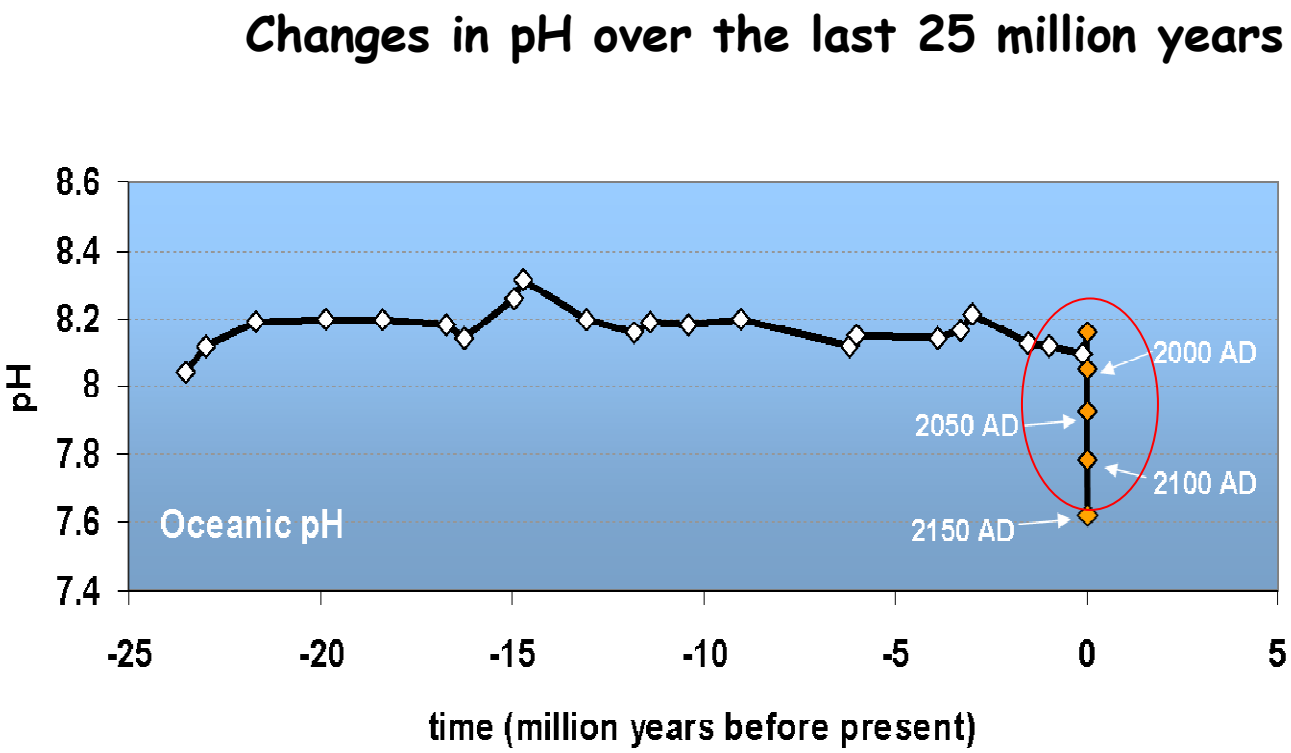
….by 2060 the oceans could become 120% more acidic

It is Happening and Measurable Now…….

Long term time series off Hawaii and Bermuda



Oceans are Acidifying Fast …….



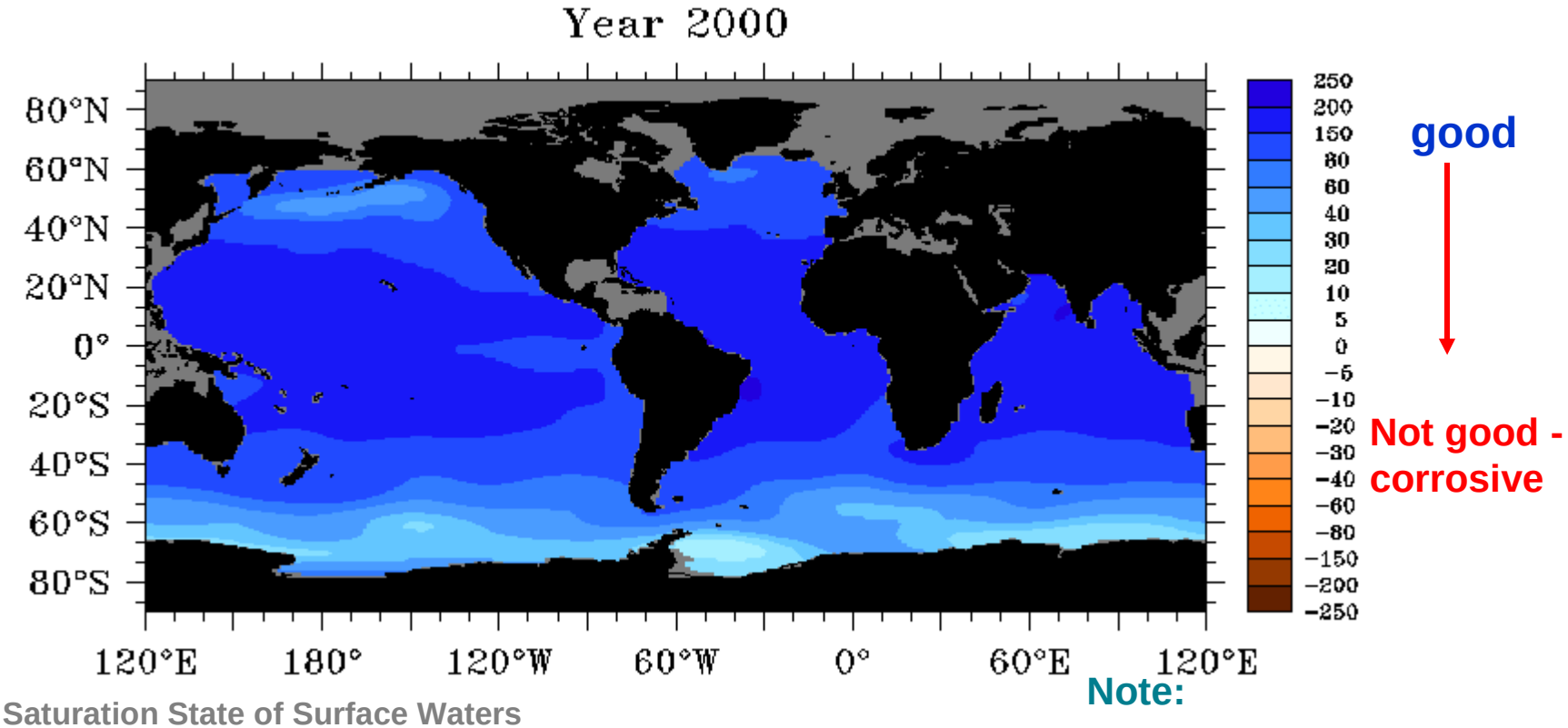
It is happening now, at a rate and to a level not experienced by marine organisms for ~ 20MY

Turley et al. 2006

Its Happening Globally ……

Aragonite is used by many organisms to make their shells and skeletons.

The extent of aragonite saturation controls the rate an organism such as a reef forming coral can build its skeletons or shells

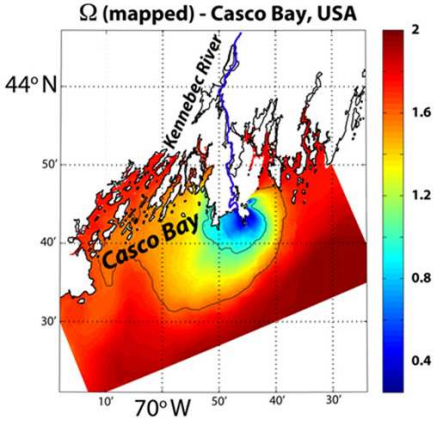


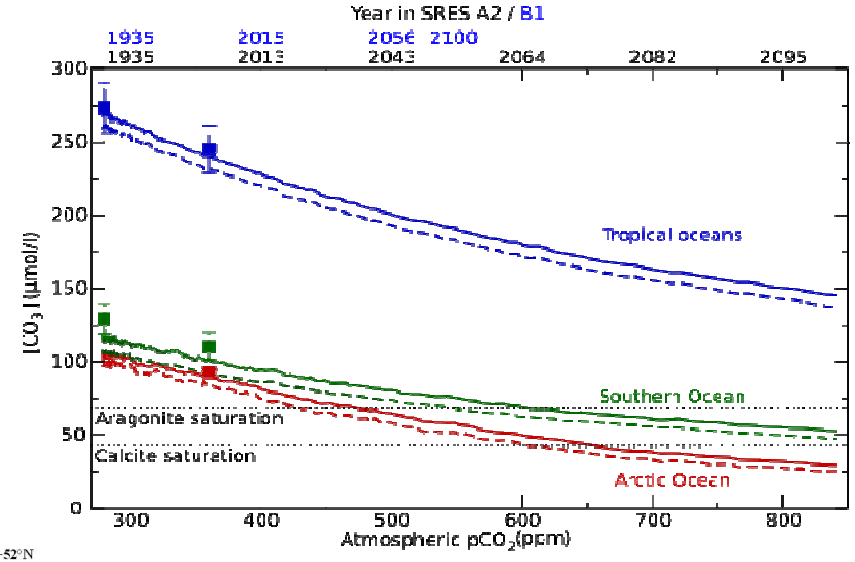
Aragonite Saturation State of Surface Waters
(Orr et al 2005, Nature)

Note:

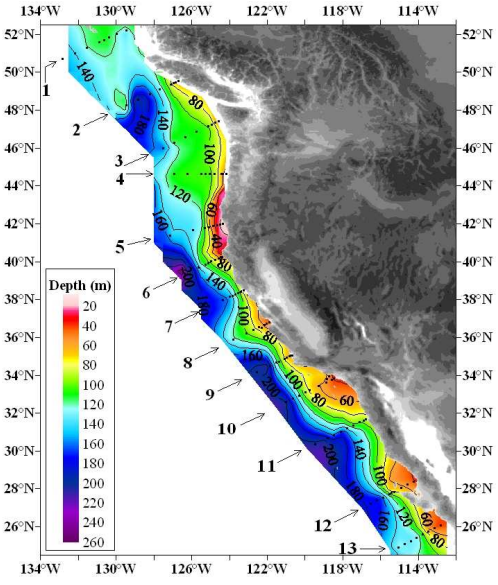
- **Overall decline in aragonite saturation in the global ocean**
- **Polar and subpolar waters become undersaturated (corrosive)**
- **Upwelling waters rich in CO_2 also vulnerable**

Early vulnerabilities: upwellings, estuaries, polar waters and tropical and cold water corals – important fisheries areas

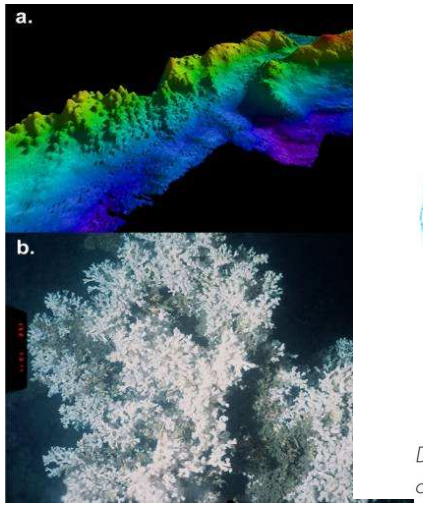




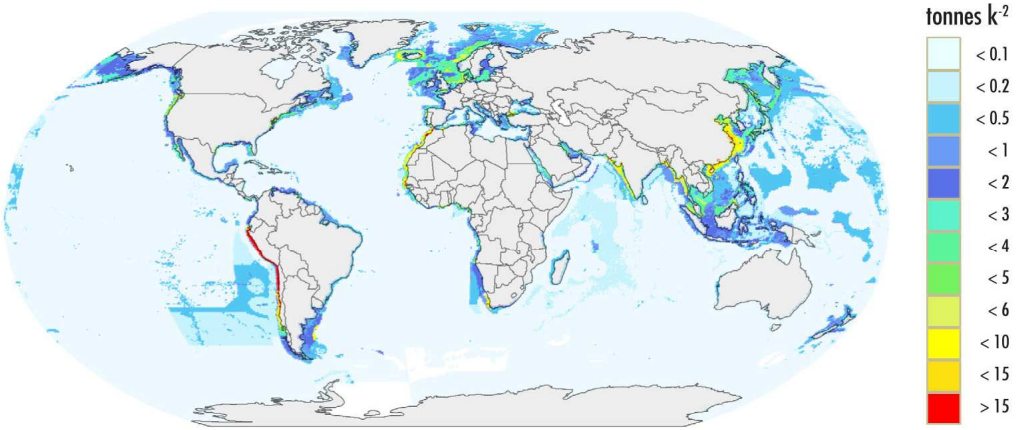
Steinacher et al. 2008, Orr et al. 2009



Feely et al. Science (2008)

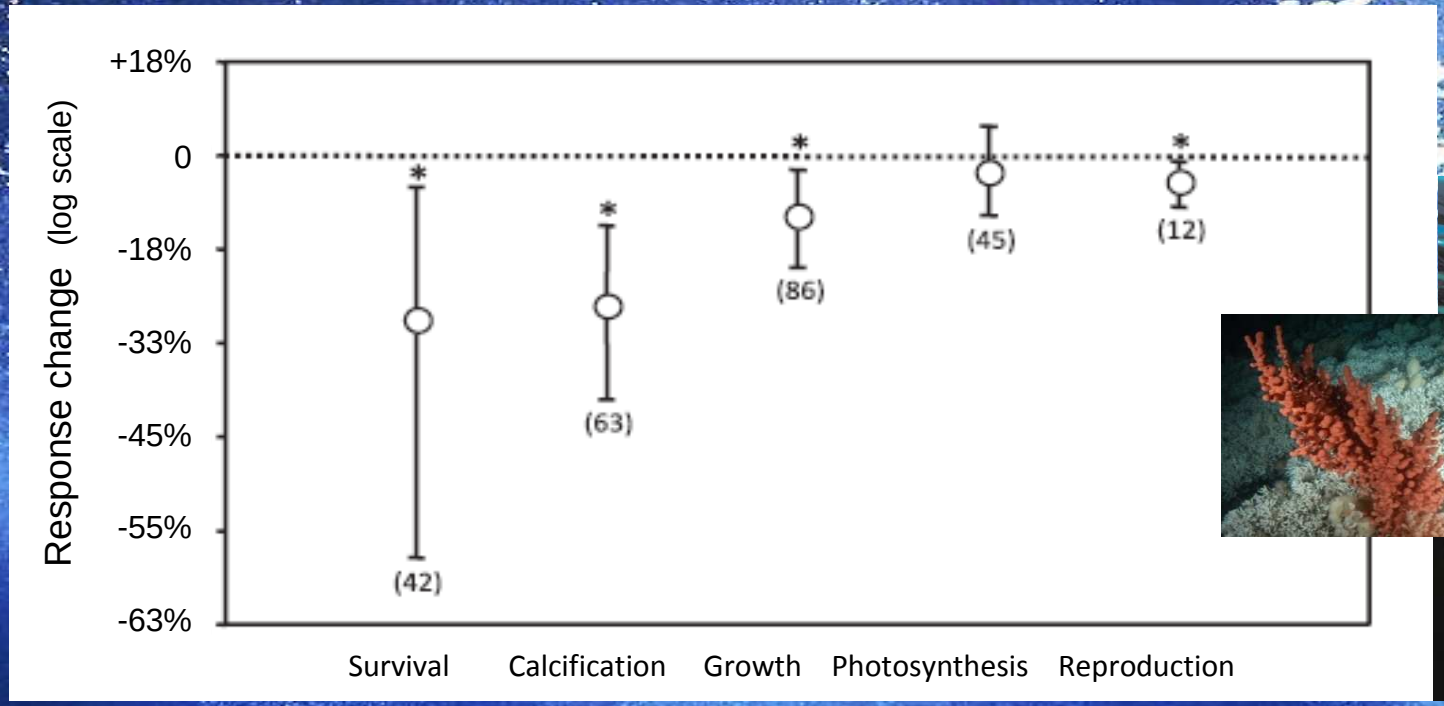


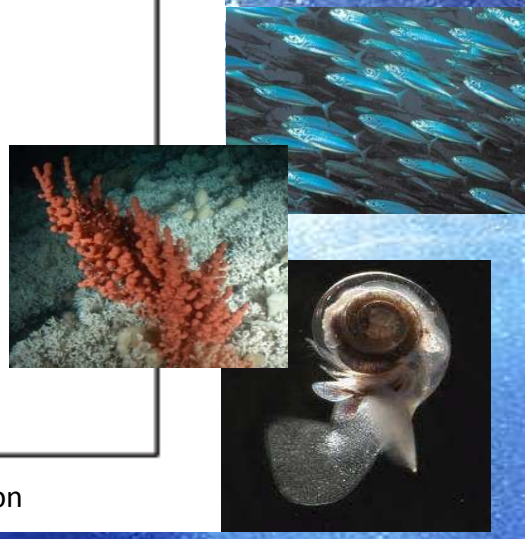
Guinotte et al 2006



Data source: Sea Around Us project, (University of British Columbia, http://www.seaaroundus.org). Map designed by Dr. Reg Watson (http://ecomarres.com). Used with permission.

Analysis from 139 Experiments Show Significant Reductions in Key Physiological Processes in Many Species



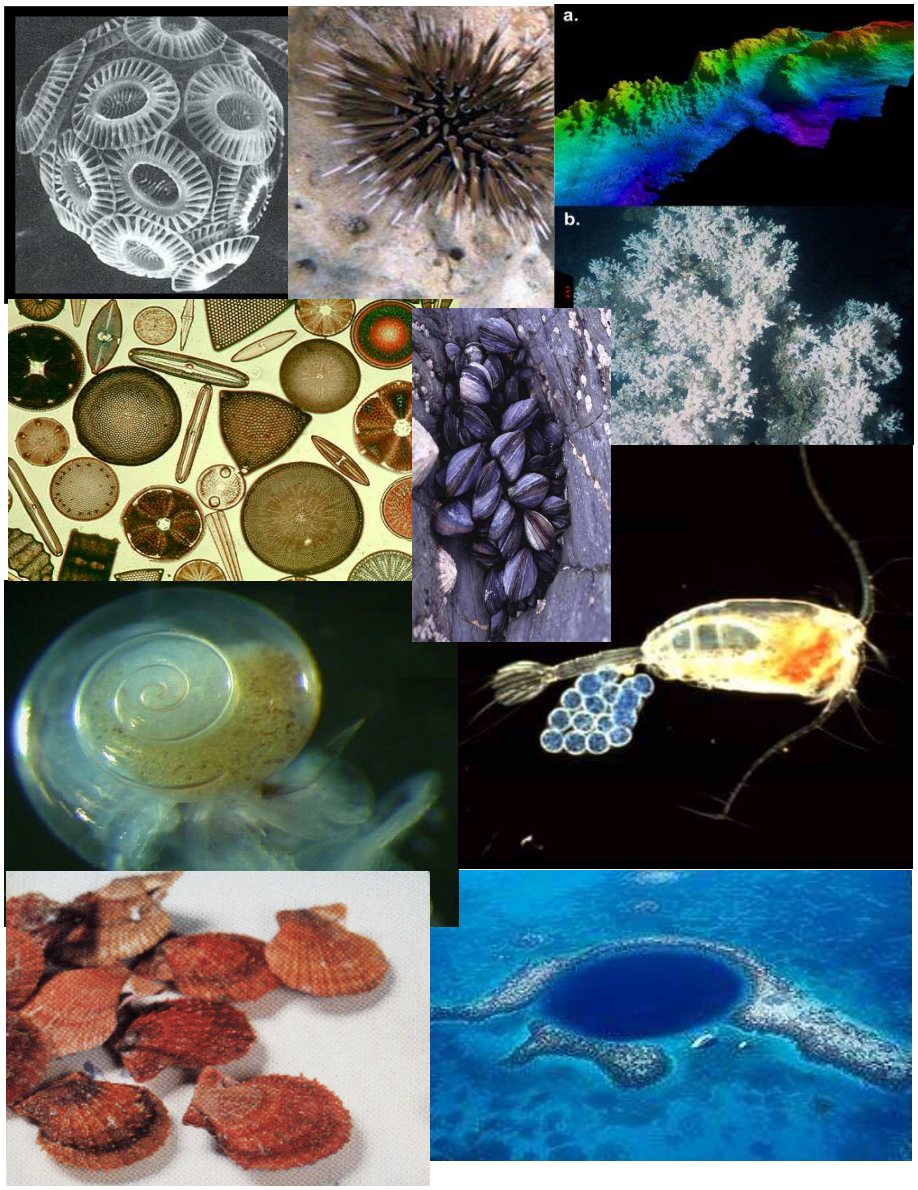


Meta-analysis by Kroeker *et al* (2010): impact of 0.4 pH change. (N) = no of studies

Biological effects of ocean acidification:

•But processes are not well-understood, variability is high and ecosystem effects (and their socio-economic impacts) are uncertain

Mounting Concern for Survival of Many Marine Organisms, Food Webs & Ecosystems.....



- **What will ocean ecosystems look like in a future high CO_2 world?**
- **And what will they be able to provide Mankind?**
- **Ocean acidification may impact food security:**
  - **Directly on food providing organisms**
  - **Indirectly through food webs and ecosystems**
  - **Many countries and 1 billion people depend nearly totally on fish as their main protein source**

C. Turley

Including Food Providing Organisms .....

Carol Turley and Kelvin Boot (2010)

Some may be sensitive as adults, others at larval or egg development stages or physiology can be effected in others.

In some their ability to withstand warming is reduced

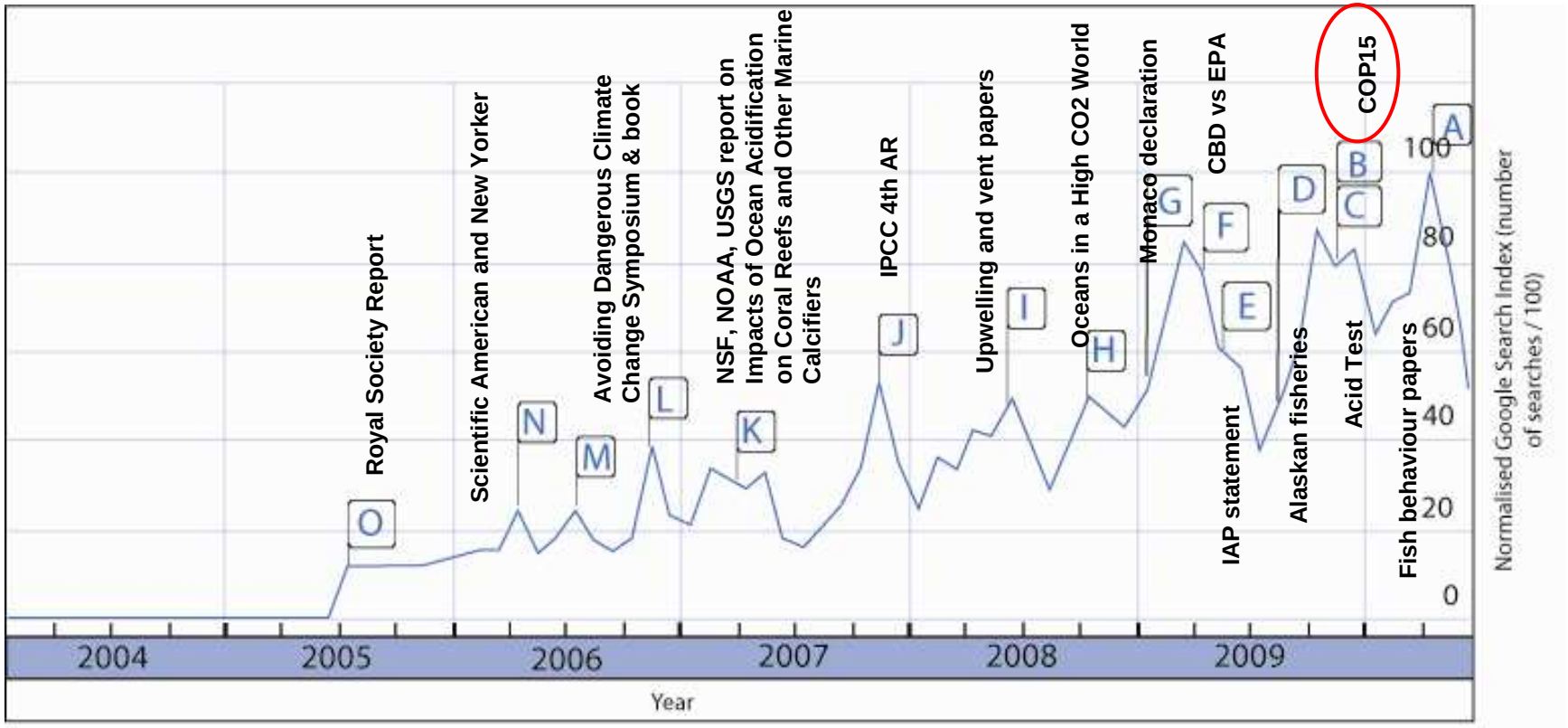
UNEP Launched Report at COP16, Cancun, 2 December 2010

Getting the Message to Stakeholders – a concerted international effort

Since 2005 there has been a growing number of reports highlighting the issue, the concerns and research needs

IGBP-SCOR Fast Track Initiative "Ocean Acidification"

Google Searches – an indicator of growing outreach and impact



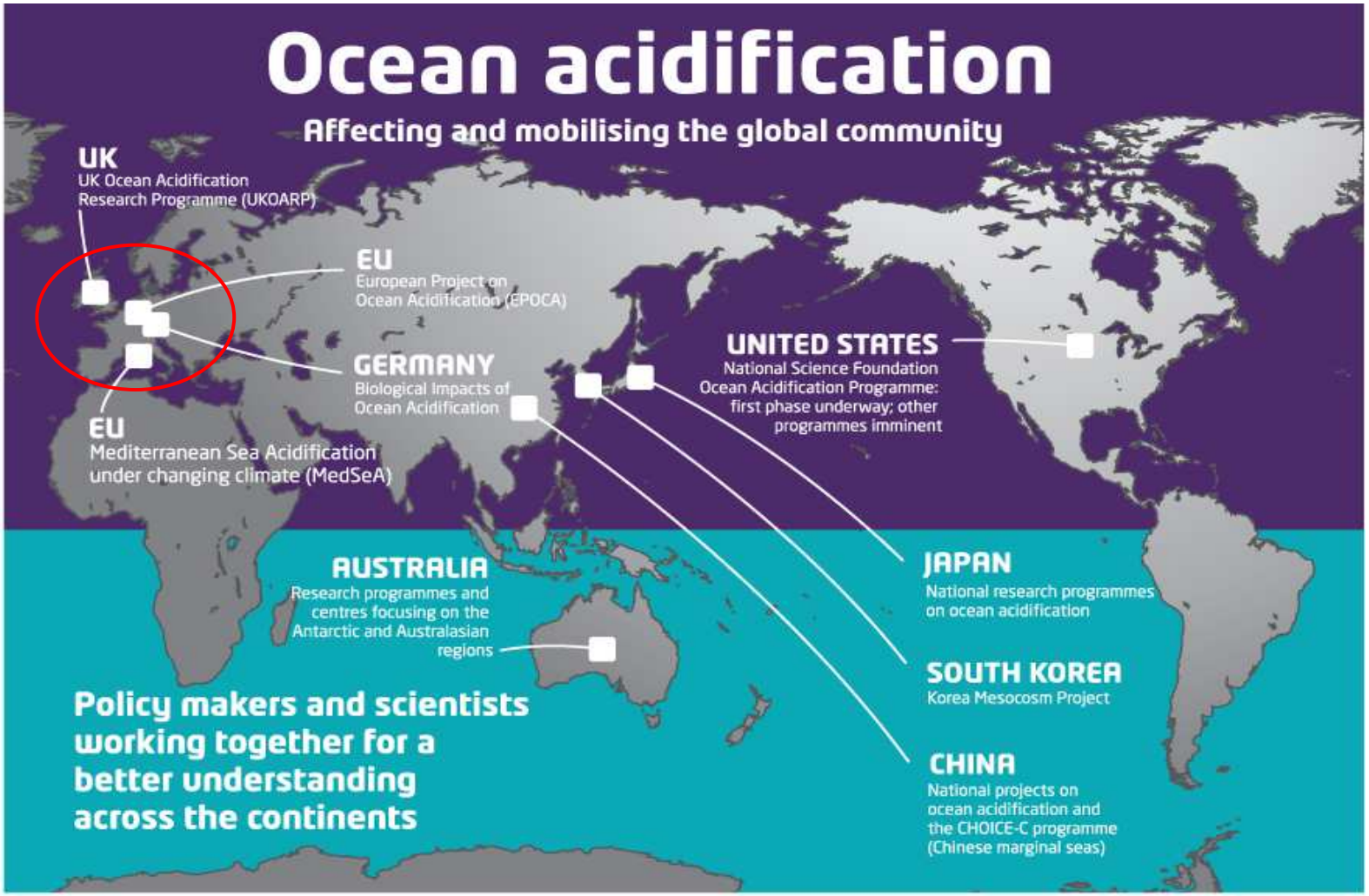
O= Royal Society Report
N= Scientific American and New Yorker
M and L = Avoiding Dangerous Climate Change Symposium & book
K= NSF, NOAA, USGS report on Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers
J= IPCC 4th Assessment Report on Climate Change
I= Key articles e.g. upwelling of high CO2 water off the west coast on North America and vulnerability of calcifiers around natural CO2 vents
H= Oceans in a High CO2 World symposium,

G= Monaco declaration
F =CBD legal proceedings against the EPA,
E= Interacademy Statement on ocean acidification,
D= threat of high CO2 waters to Alaskan fisheries,
C= launch of the Film 'Acid Test',
B= Oceans Day and other ocean acidification activities during COP15.
A= Paper on fish behavioural response to predators under high CO2

The increasing baseline interest in ocean acidification since 2004 will also be in response to the increasing numbers of research publications over this period stimulating increasing 'take-up' by stakeholders.

Turley and Boot (in press) OUP Book on Ocean Acidification (Gattuso and Hansson eds.)

Ocean Major Acidification Research Efforts Across the World….



Europe is trying to integrate

But need for cross boundary collaboration recognised

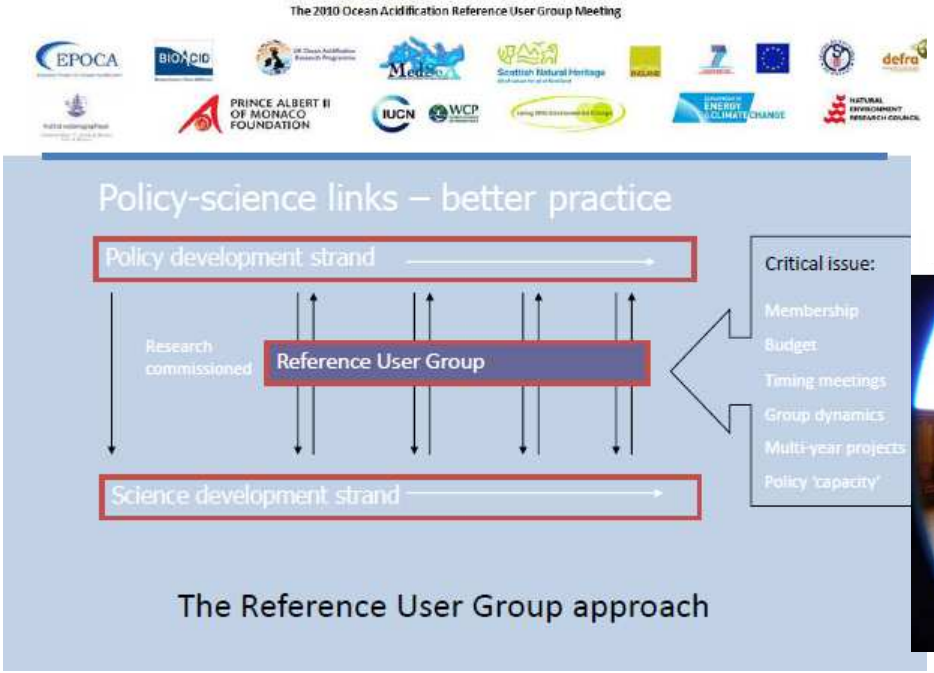
The Ocean acidification Reference User Group

- **Provides a forum for the 4 European OA projects: EPOCA, UKOARP, BIOACID and MedSeA**
- **Advise on the types of products that will help**
- **Advise on what those products should look like**
- **Advise on how to get them out with impact**
- **Helps to keep key sector and parent organisation well informed and to look beyond the boundaries of current research initiatives**

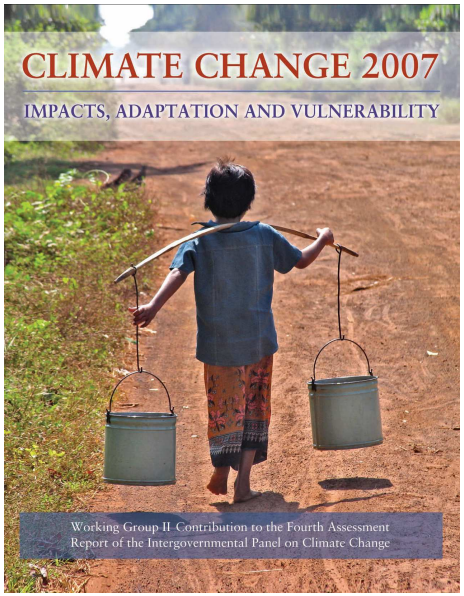
2009

2010

2011



IPCC now Recognise Ocean Acidification …..



- IPCC 4th Assessment Report on climate change in 2007 included ocean acidification for the first time

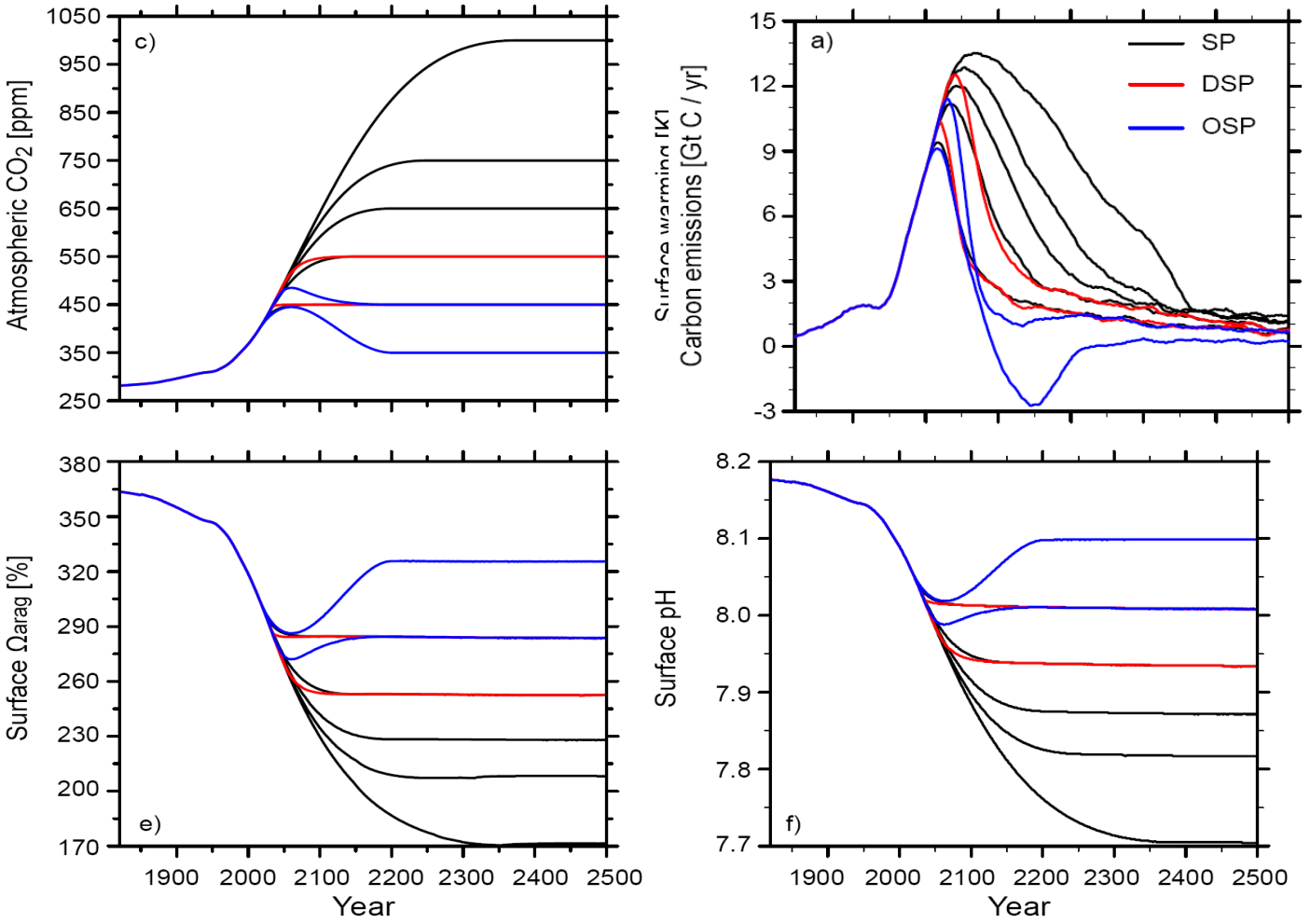
IPCC 5th Assessment report on climate change will have 2 chapters dedicated to oceans, including their acidification.

Many OA experts will contribute

- IPCC WGII/WGI Workshop on Impacts of Ocean Acidification on Marine Biology and Ecosystems
17-19 January 2011, Okinawa, Japan

Many participants from the EPOCA, BIOACID and UKOARP have been invited

The Challenge of Mitigation Scenarios for Ocean Acidification



Joos et al. (2010)

- **Large and rapid changes in ocean chemistry are *underway now***
- **Stabilization requires *large* reduction in emissions.**
- **Emissions mitigation measures *reduces* ocean acidification compared to business-as-usual**
- **Trends can be *persistent* and impacts of carbon emissions may aggravate for decades and centuries, long after carbon emissions have been reduced**

Mitigate ocean acidification = mitigate climate change

Sunset Over an Ocean with Man's Footprint Now Detectable – Warmer, Less Diverse, Over Exploited……. And More Acidic

Oceans will become more acidic – very high certainty.

The impact on ocean food webs, ecosystems & food security could be serious – less certain.

The only way of reducing the impact of global ocean acidification is a substantial and urgent reduction in CO_2 emissions – very high certainty.

Mitigation will make a difference – ocean acidification argues for stabilizing CO_2 lower than 450 ppm.