Things you should know about **ocean acidification**

17 February 2014

SOLAS-IMBER Ocean Acidification Working Group
Ocean Acidification International Coordination Centre (OA-ICC)

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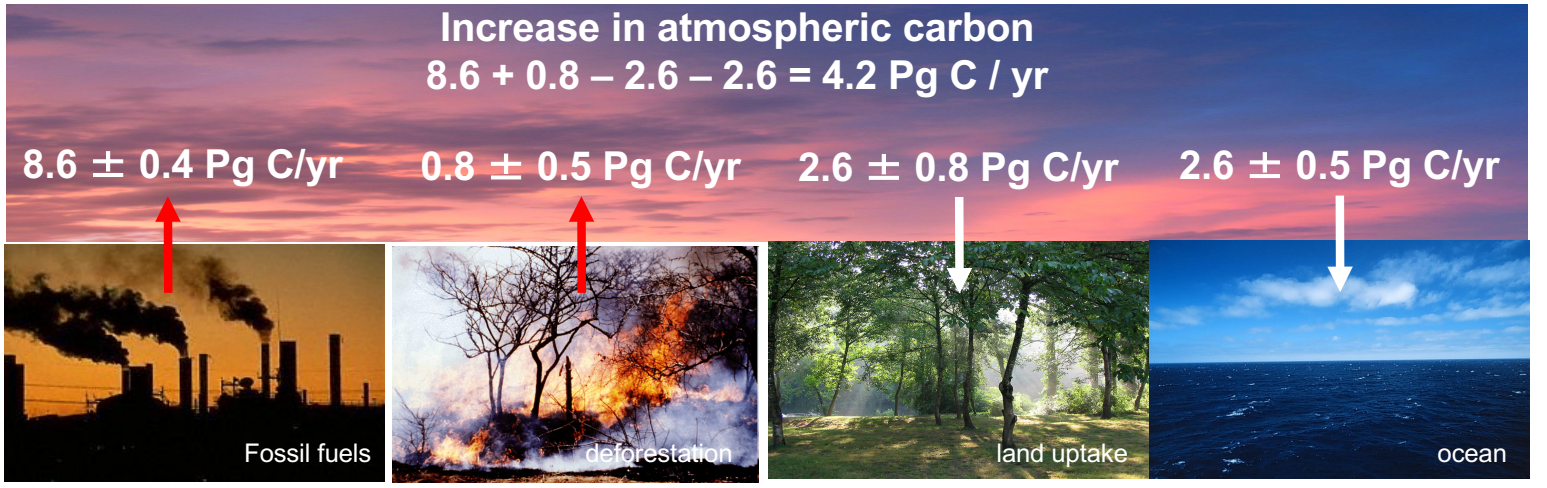
OA-ICC

#1 - Ocean absorbs one-fourth of man-made CO_2 emissions



2002-2013 Carbon budget *Global Carbon Project (2013)*

Half of emitted CO_2 remains in atmosphere (causing global warming)

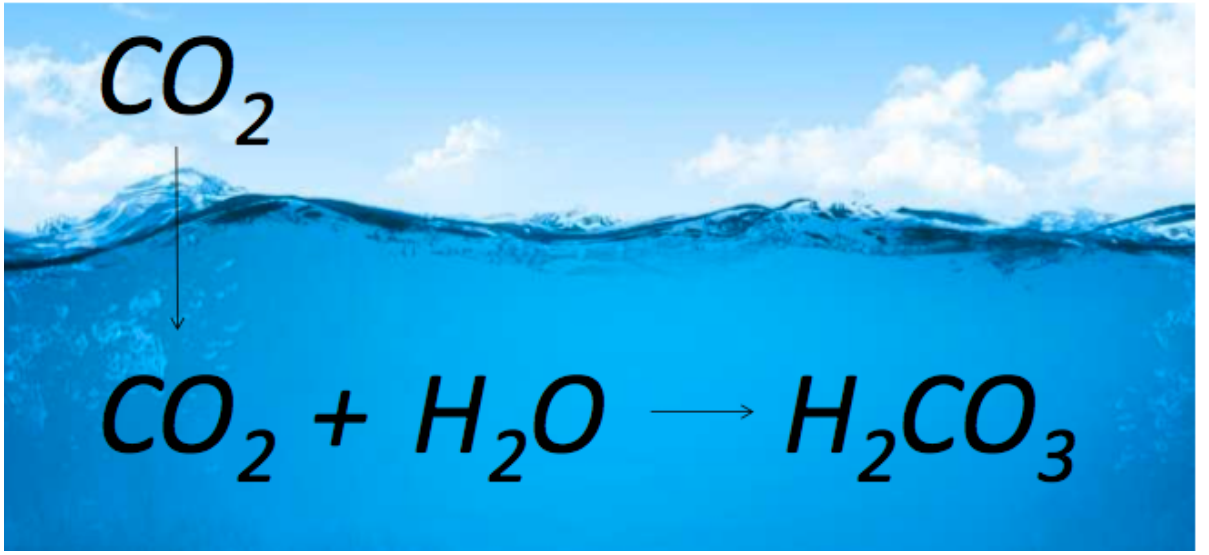
Half absorbed by ocean & land (trees, plants, and soils)

Ocean absorbs 24 million tons of CO_2 every day (4 kg per person, daily)

Le Quéré et al 2013; CDIAC data; Global Carbon Project 2013

GLOBAL CARBON PROJECT

#2- More atmospheric CO_2 means increased ocean acidity



Schematic: Sam Dupont, University of Gothenburg

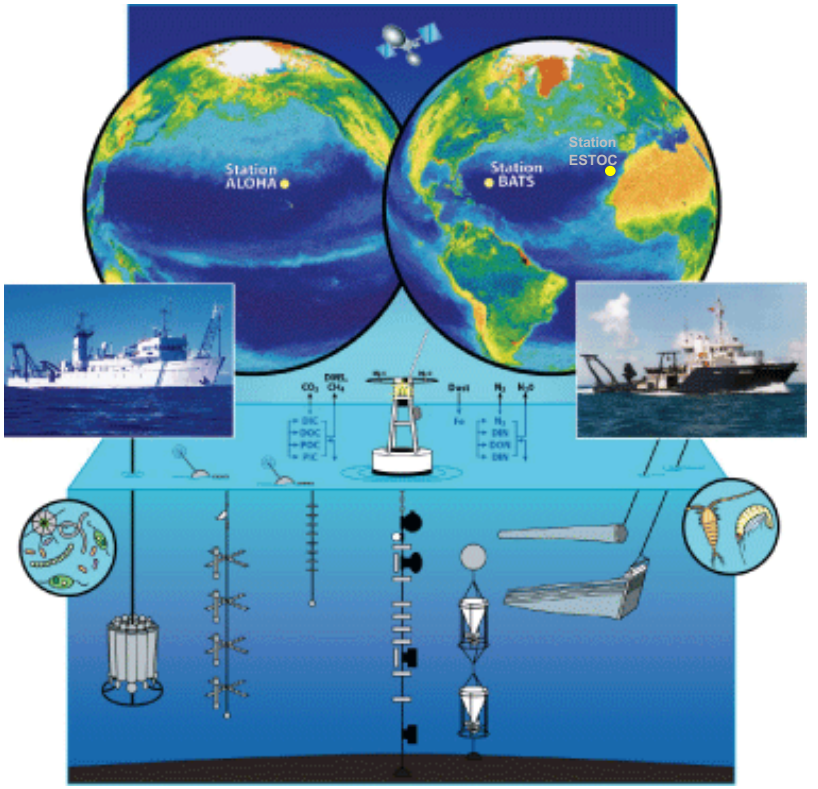
CO_2 is an acid gas (it produces acid when combined with water)

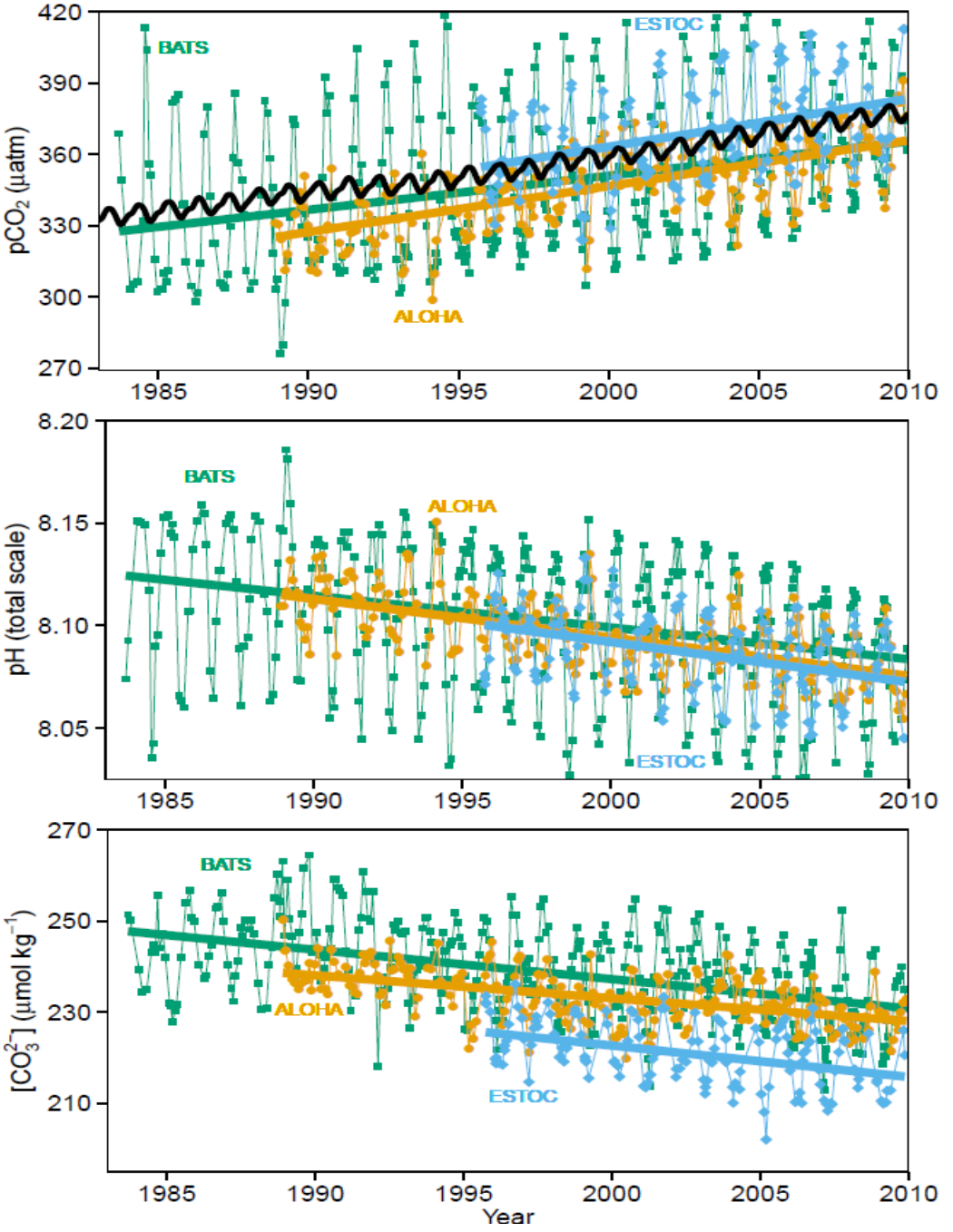
Each of us adds 4 kg CO_2 per day to the ocean (increasing acidity, reducing pH)

Ocean acidity up by 30% since start of industrial age

Most of that only in last 40 years

#3- Change in pH from ocean acidification already measurable

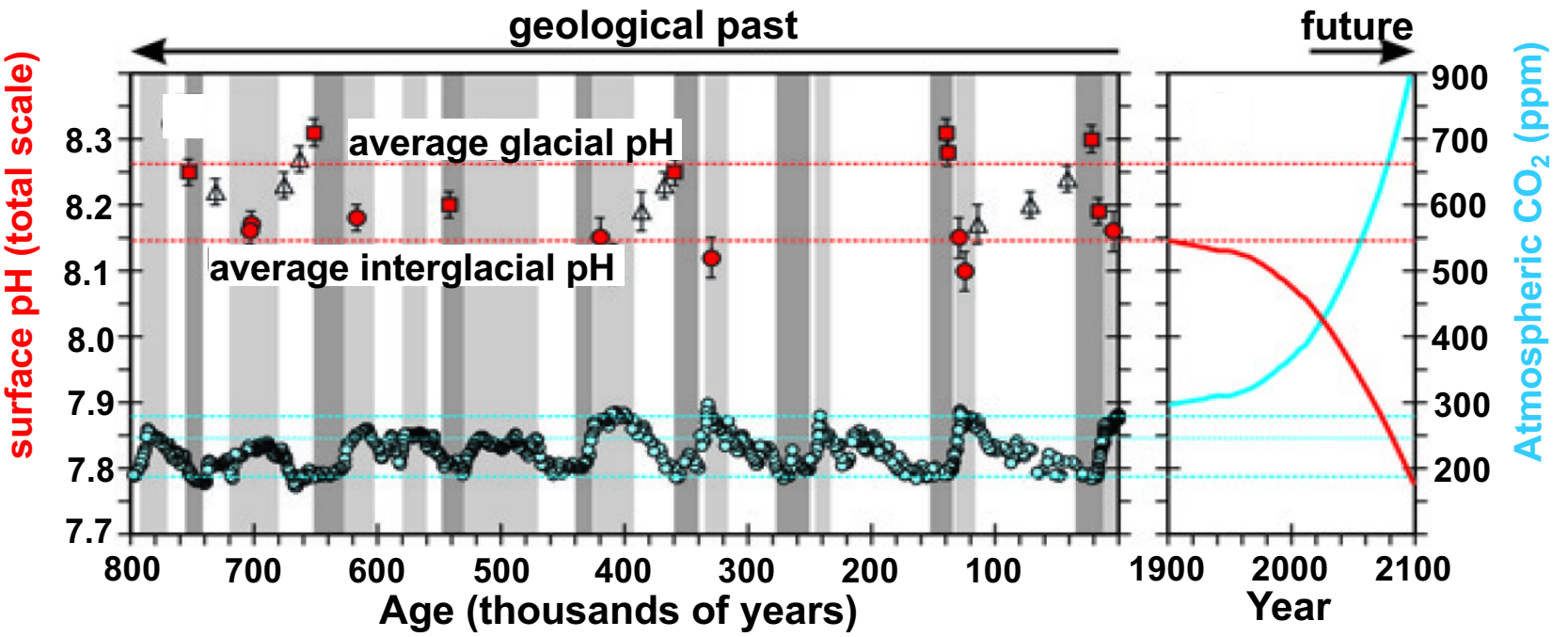




Data:
Bates (2007)
Dore et al. (2009)
Santana-Casiano et al. (2007)
Gonzàles-Dàvila et al. (2010)

IPCC AR5 WG1 Report, Chap. 3 (2013)

#4 Today's rate of ocean acidfication may be unprecedented



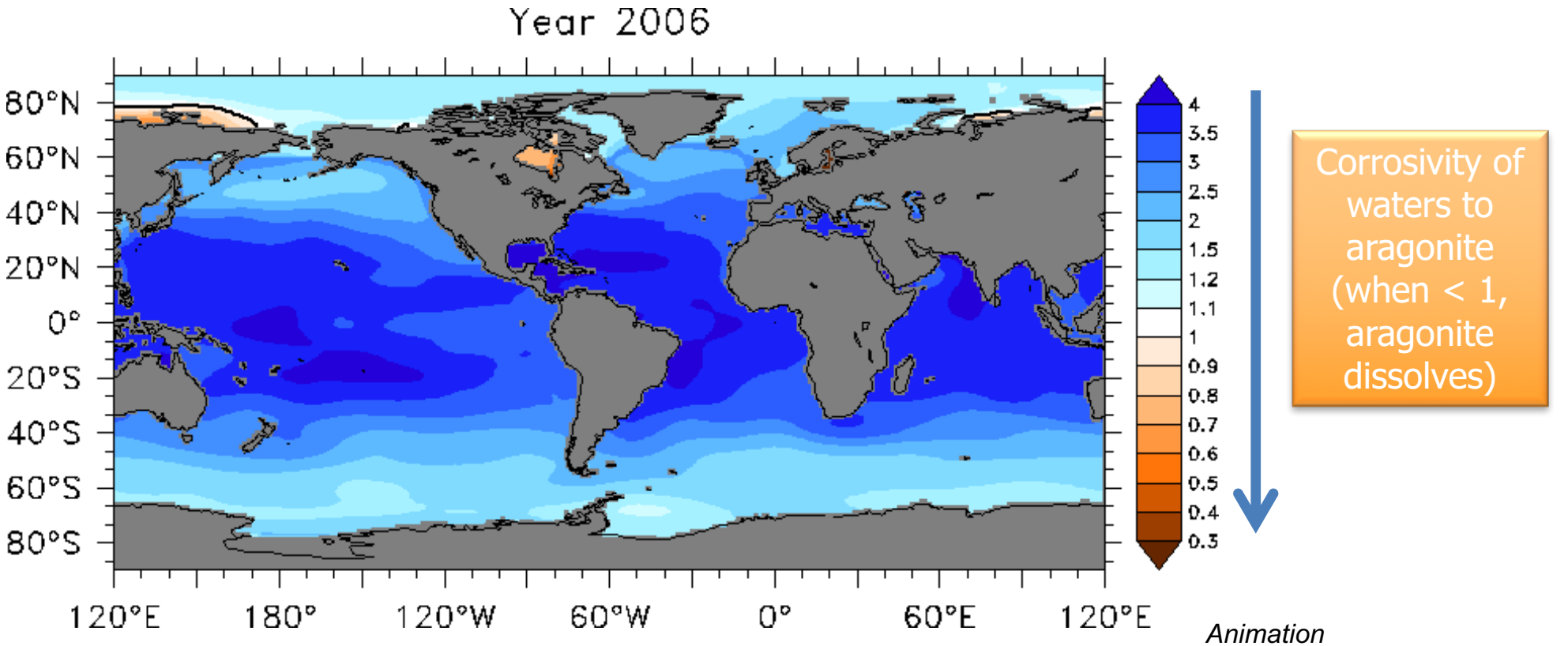
Barker and Ridgwell (2012)

Current change:

- overwhelms natural variations (last 800 000 years)
- may be 10 times faster than natural event (55 million years ago)
- rate may be unprecedented (over last 300 million of years)
- 30% increase in acidity (H^+) during industrial era
- 100% increase (or more) projected by 2100

#5- Polar oceans become corrosive to shell material within decades

Models project that cold waters soon become corrosive to aragonite, a ($CaCO_3$) mineral in some marine shells & skeletons



Animation
Copyright: James C. Orr

Latest model projections (IPCC AR5 WG1, 2013)

Confirms original warnings: Orr et al. (2005), Caldeira & Wickett (2005), Steinacher et al. (2009)

see also Bopp et al. (2013)

#6 These corrosive conditions dissolve shells of sea butterflies

Movie: Brad Seibel, University of Rhode Island

Sea butterfly shells ($CaCO_3$) exposed to corrosive conditions expected by 2100

Day 1

Day 2

Day 16

Orr et al. (2005)

Fabry et al. (2008)

Comeau et al. (2009; 2011; 2012)

Lischka et al. (2011); Lischka & Riebesell (2012)

Bednarsek et al. (2012)

Image: Victoria Fabry, California State University San Marcos

#7- Acidification will change marine ecosystems

Organisms react differently

Corals and shell builders decline

Seagrasses may increase

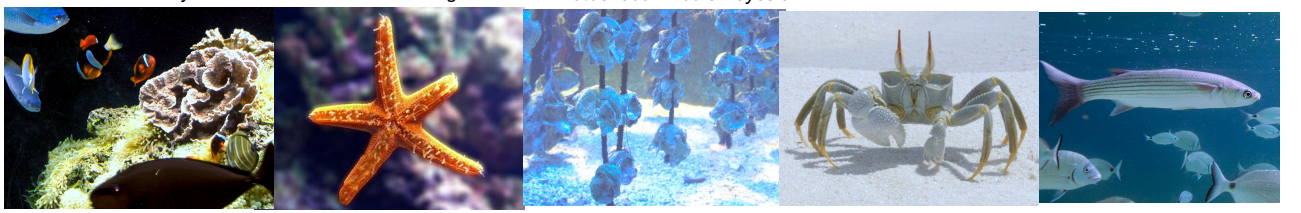
Fish become disoriented

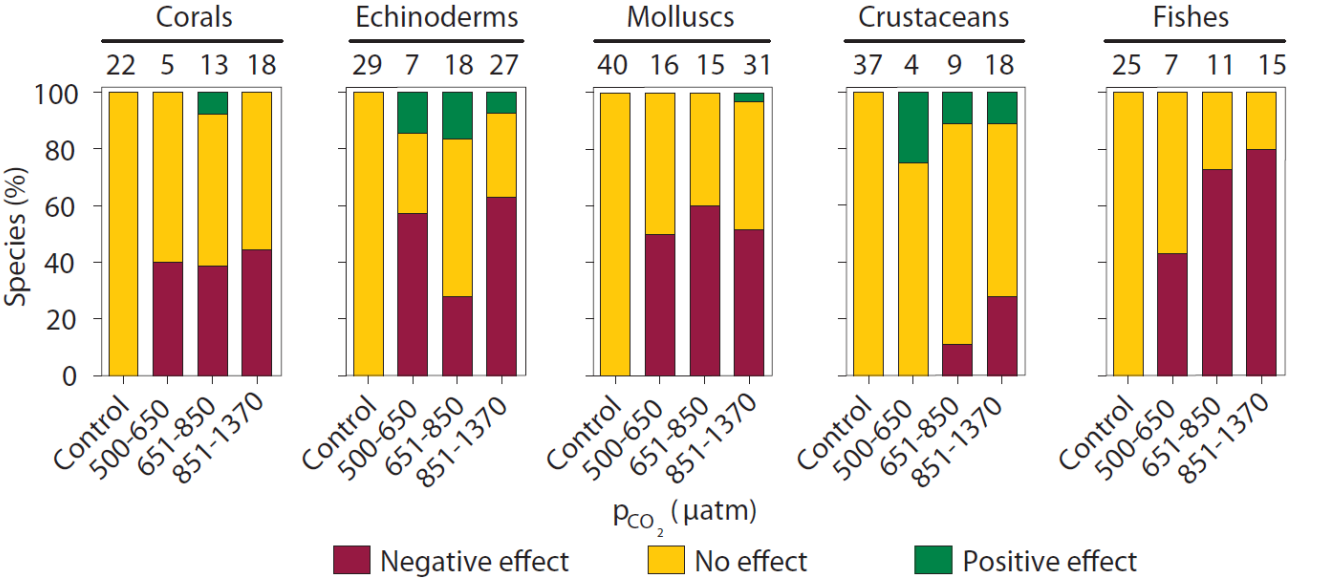
Prey loss affects predators

Potential fish catch decline

Synthesis of existing experimental studies

Photo: J.-L. Teyssié *Photo: Ana Laangova** *Photos: Jean-Louis Teyssié →*





Wittmann & Pörtner (2013)

see also Kroeker et al. (2013)

#8 Ocean areas naturally rich in CO_2 confirm expected future trends

- Less biodiversity
- Fewer calcifiers
- More fragile shells
- More invasive species
- More seagrasses, degraded corals

CO_2 bubbles rise from seafloor at Ischia, Bay of Naples, a natural lab to study acidification

Hall-Spencer et al. (2008)

Rodolfo-Metalpa et al. (2008)

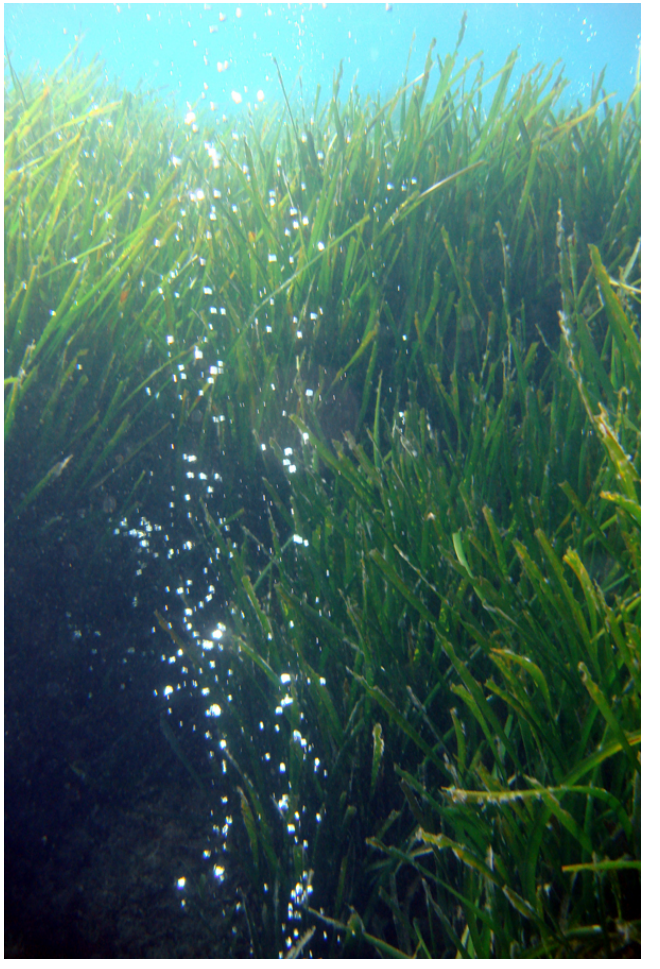


Photo: Jason Hall-Spencer, University of Plymouth

Photo: Steve Ringman, Seattle Times

Another natural CO_2 vent site in Papua, New Guinea, used to study effects of acidification on corals

#9- Ocean acidification will also affect humans

- Fish is primary source of animal protein for 1 billion people, mostly in developing countries (FAO)
- Coral reefs provide
  - home for millions of species
  - storm protection for coastlines
  - income from tourism
  - biodiversity legacy for future
- Ocean acidification already affecting oyster industry (U.S. west coast)
- Ocean acidification may generally affect aquaculture, fisheries, and human livelihoods

Photo: Rodolfo Quevenco, IAEA

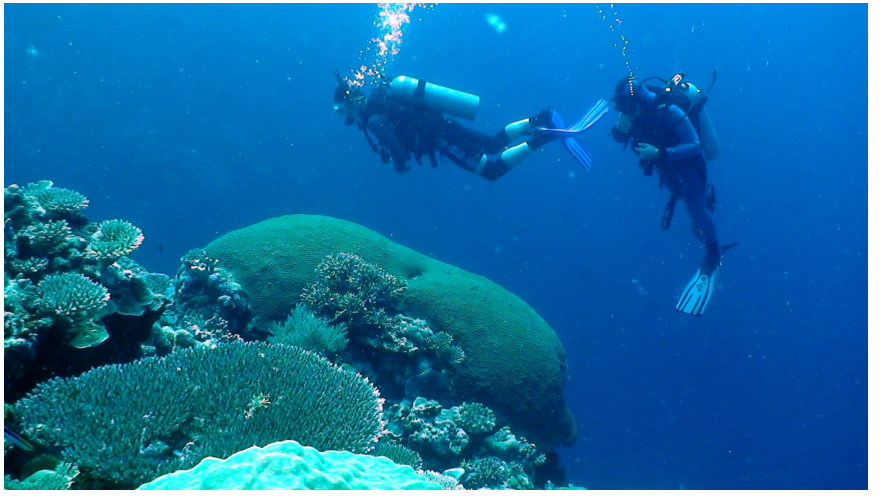
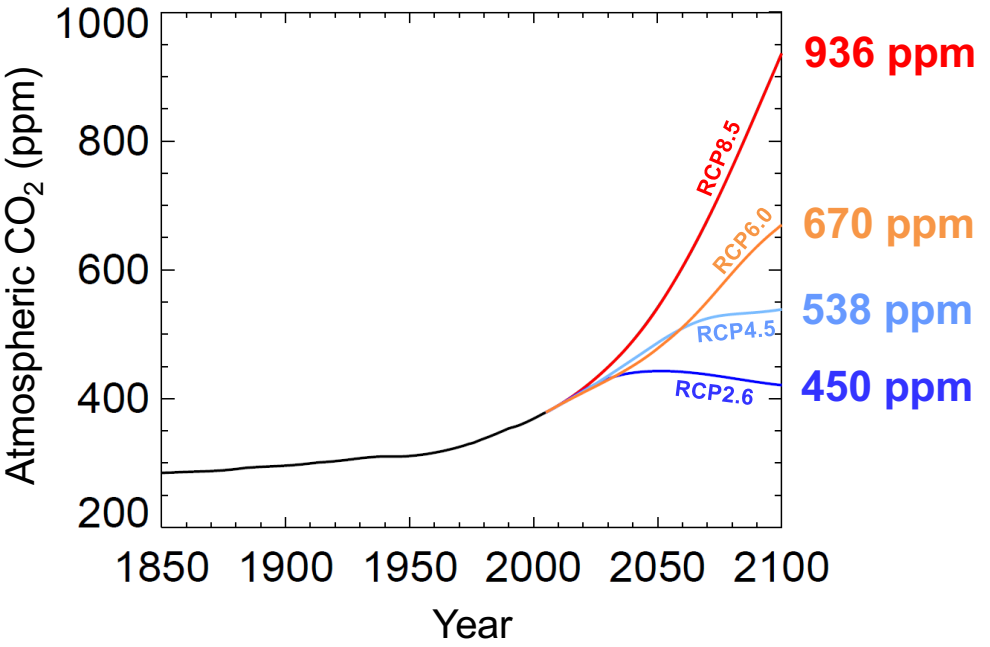


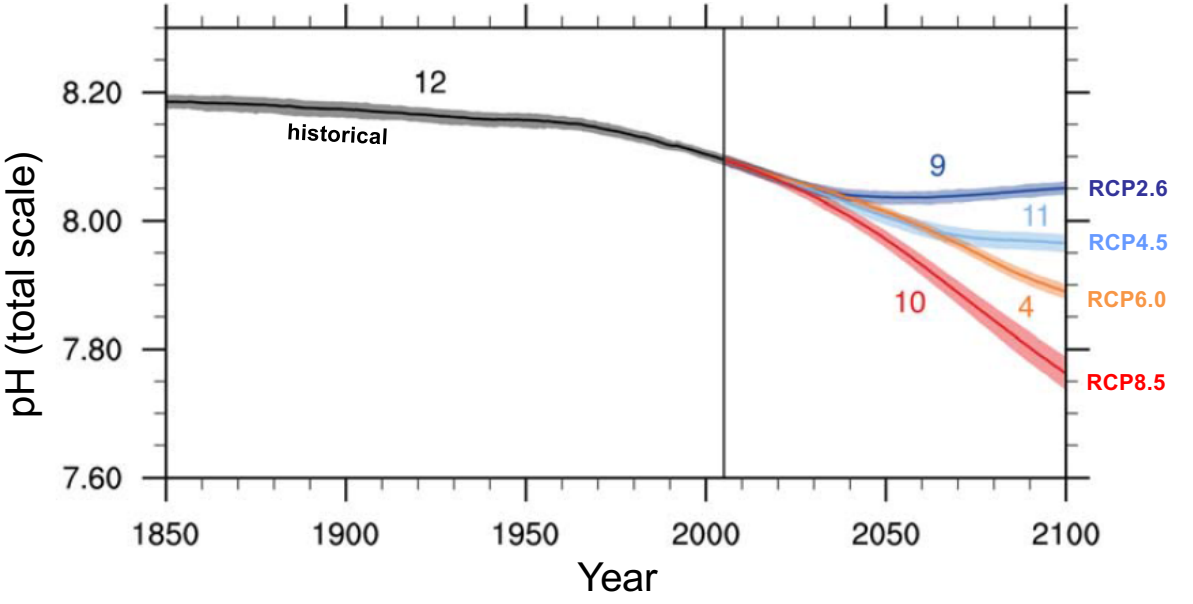
Photo: Jean-Louis Teyssié, IAEA

#10- The intensity of ocean acidification depends on us

Future atmospheric CO_2 (latest IPCC scenarios)



Intensity of ocean acidification (change in pH) varies by a factor of 3



IPCC AR5 WG1, Technical Summary (2013)

see also Bopp et al. (2013)


For more information and
resources on ocean acidification:
iaea.org/ocean-acidification