Ocean Acidification (OA):

Recent Results from the EPOCA Project

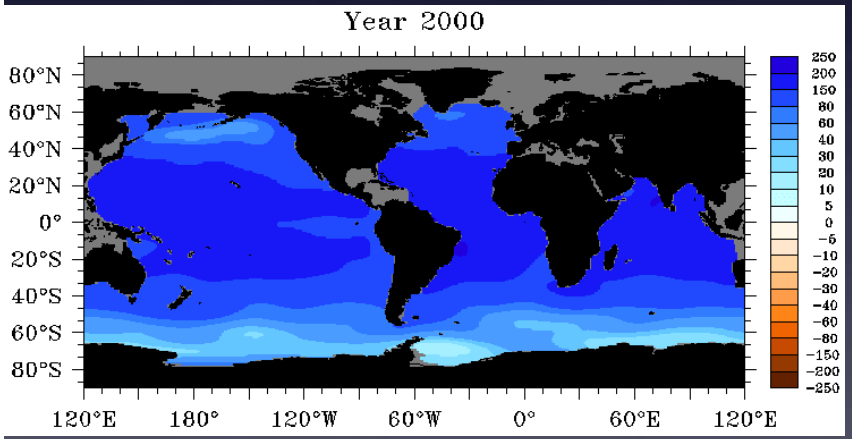
(European Project on Ocean Acidification)

Carol Turley (Plymouth Marine Laboratory)

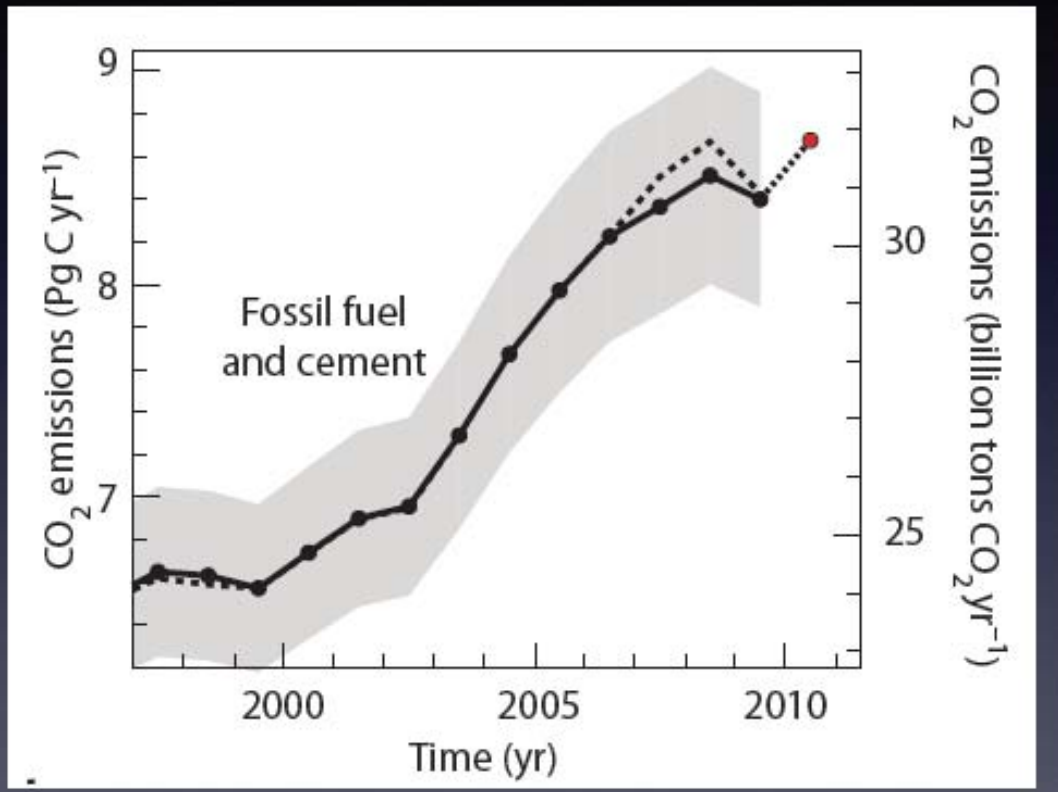
and the EPOCA Consortium

What is the cause of OA?

- CO_2 emissions
  - 1990-1999 : 1% per year
  - 2000-2007 : 3.4% per year



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

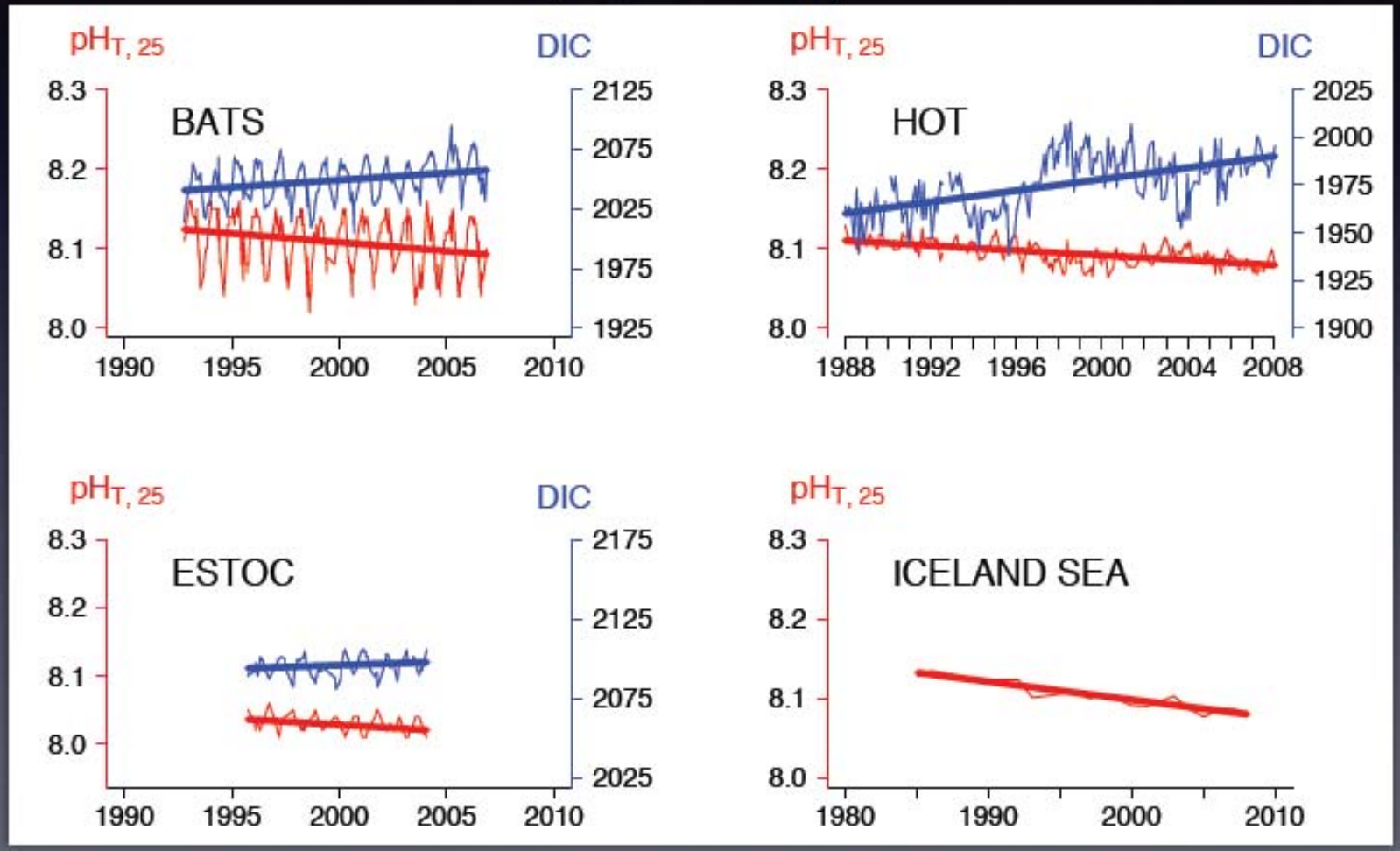


Ocean uptake of CO_2 emissions leading to increasing pH (acidity) and decreasing calcium carbonate

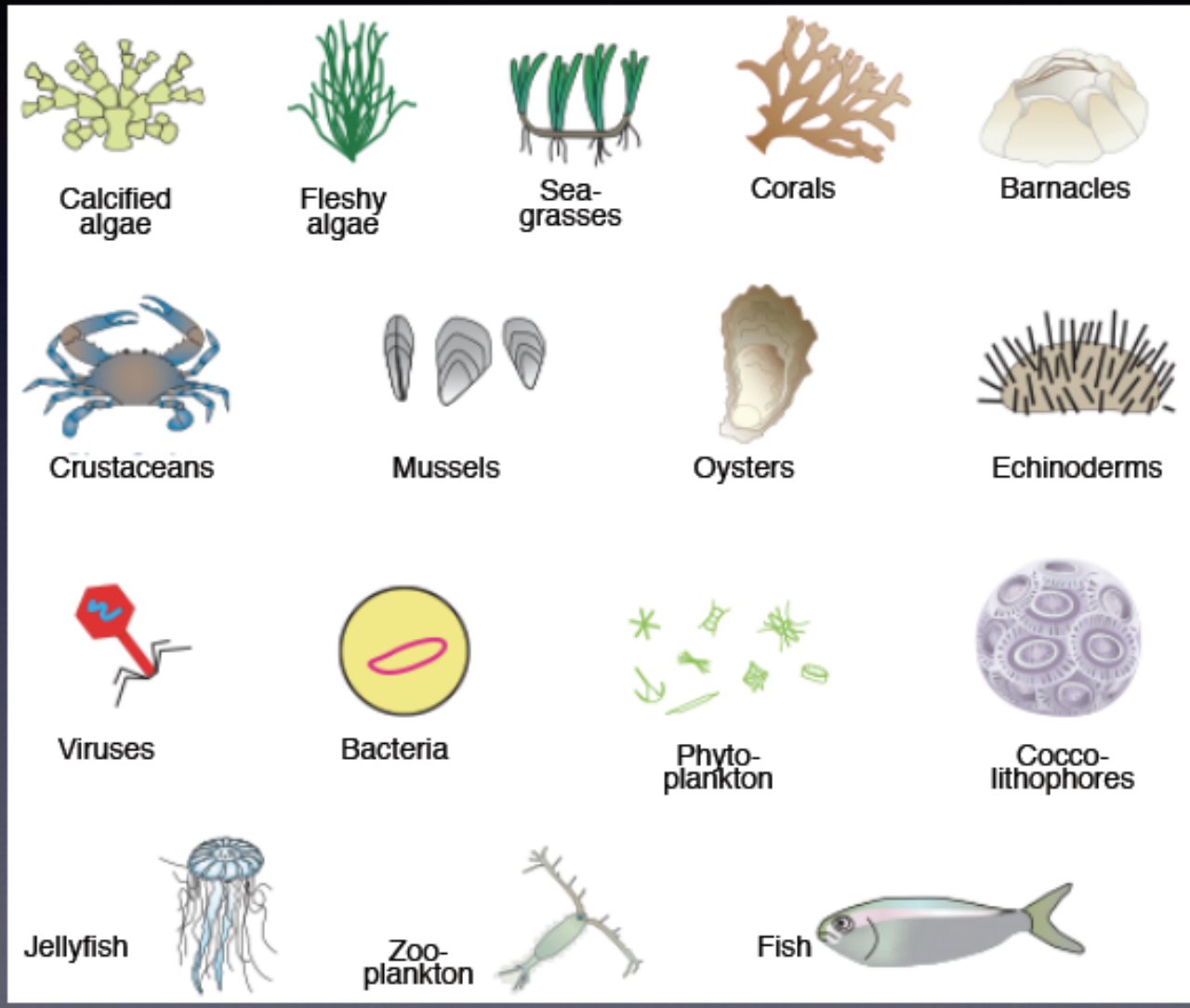
Global Carbon Project

Le Quéré et al. (2009); Friedlingstein et al. (2010)

It is happening now and is measurable



Many organisms potentially affected



Some may be negatively impacted

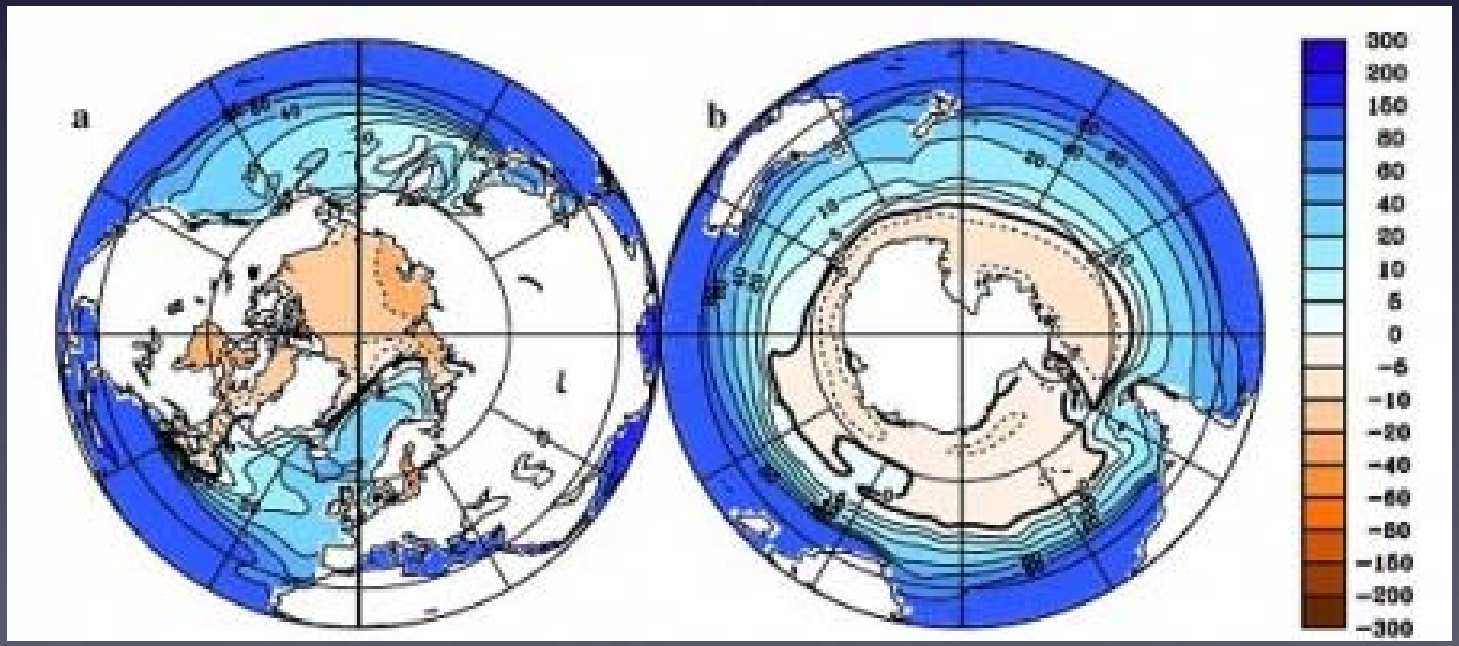
…but some may do well…

Just a few EPOCA highlights

Early OA projected in high latitudes

Carbonate saturation at pCO_2 567 ppm (ca. 2050)

Arctic Ocean Antarctic Ocean



saturated

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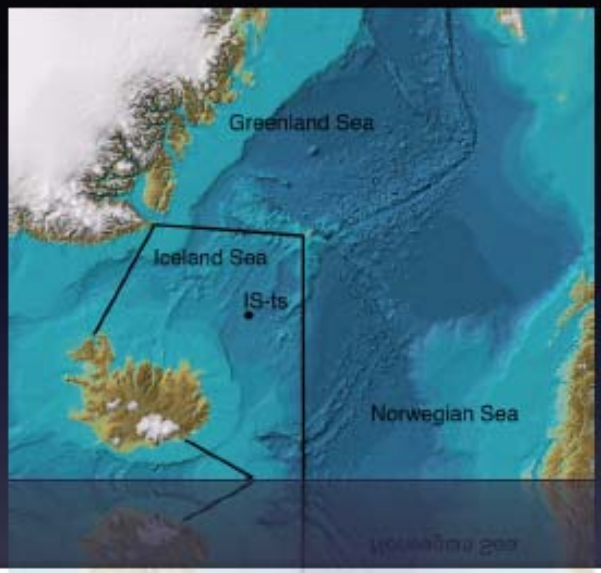
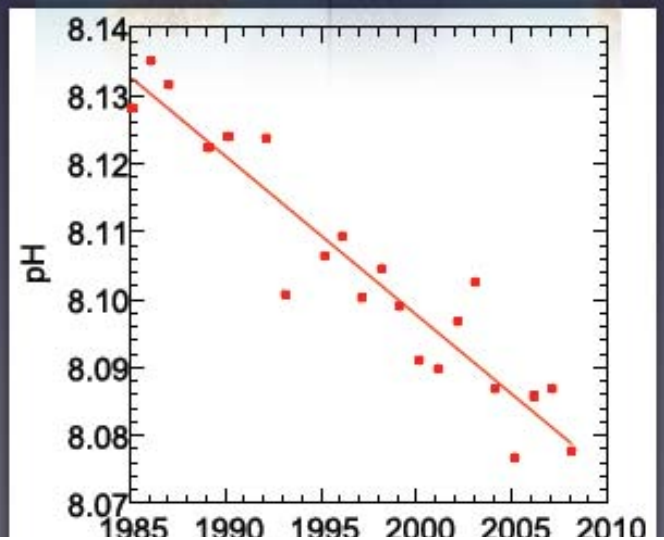
sub-saturated
(corrosive)

(J. Orr, 2009)

Rapid OA in the cold Arctic Iceland Sea

- Time series observations, Ólafsson (HAFRO-MRI)
- pH decrease: -0.0024 unit per year
- Decreases 50% faster than in the subtropics
- Corrosive waters shoal at 4 m/yr
- Additional 800 km^2 of seafloor exposed every year
- Permafrost thawing generates CO2; contributes to OA (Anderson, UGOT)





EPOCA Svalbard 2009

cnrs

PML | Plymouth Marine Laboratory

AWI

NIOO

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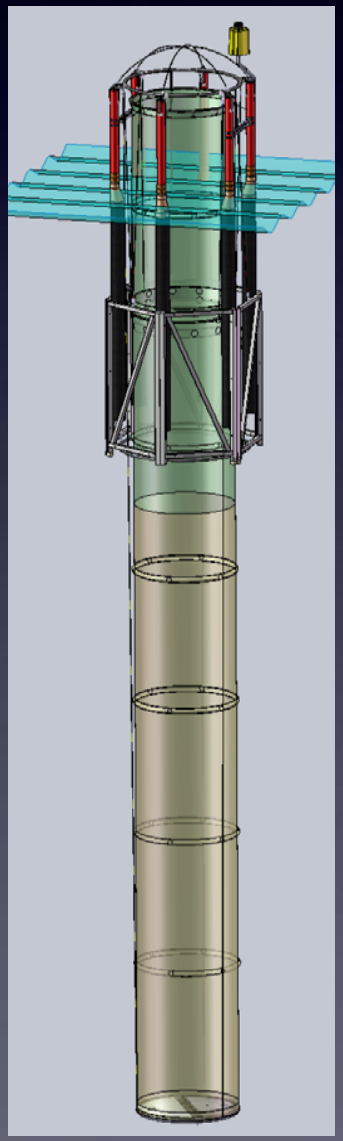
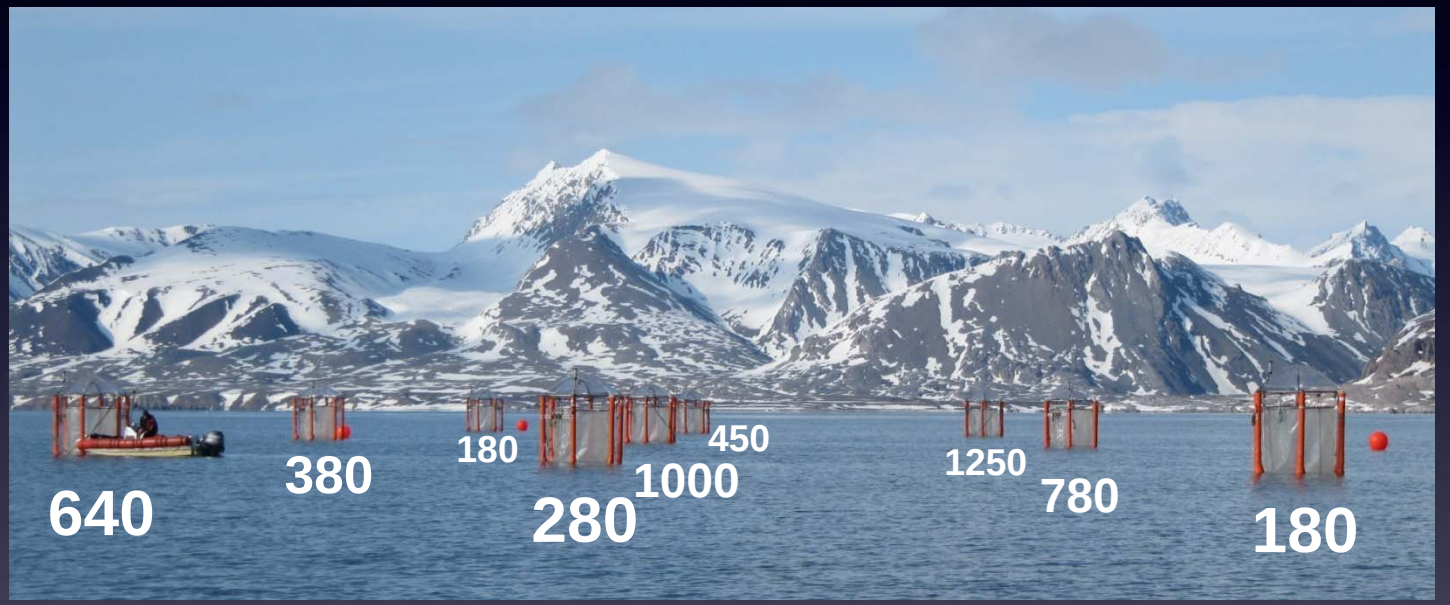
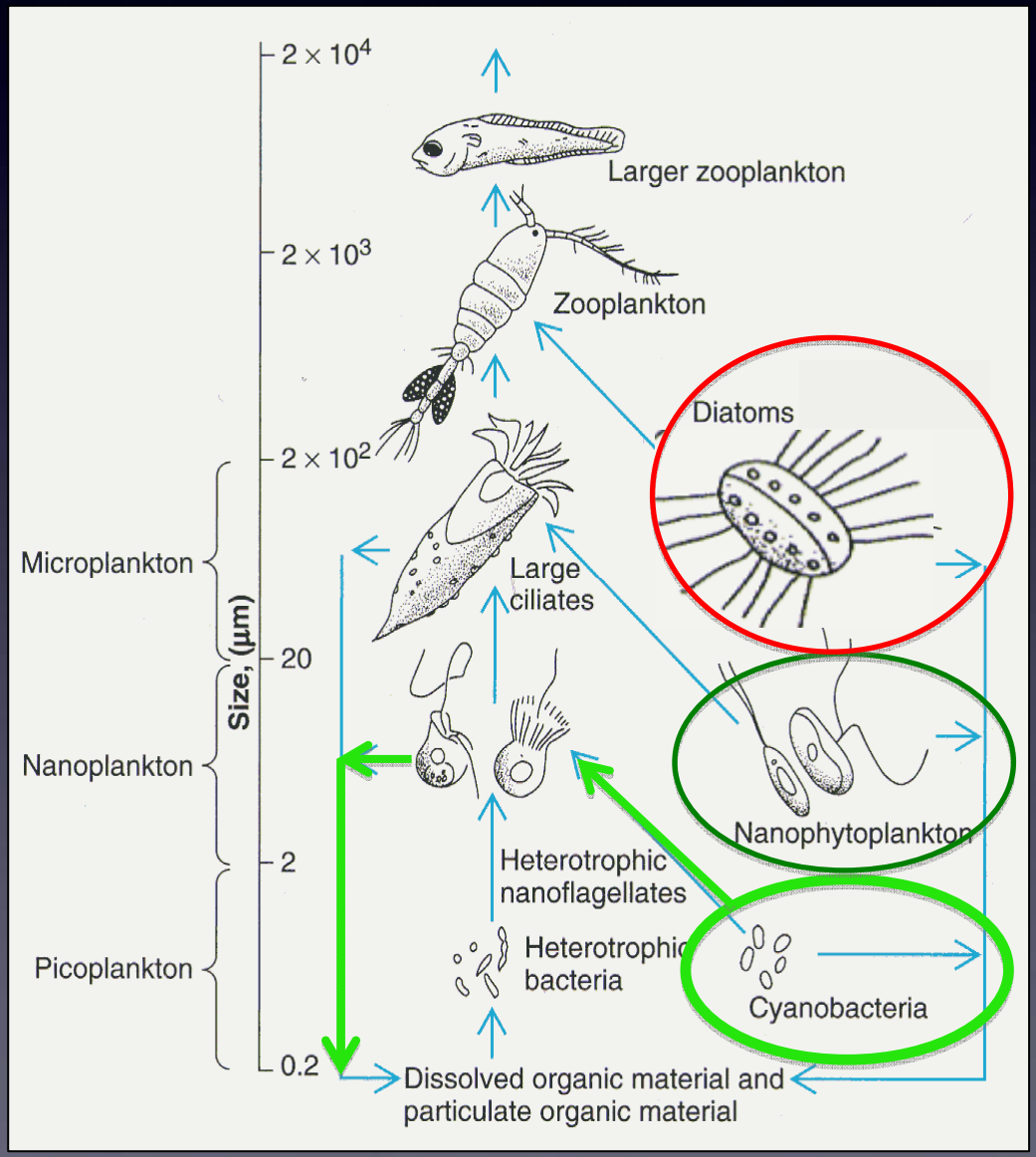
Svalbard 2010: CO_2 enriched mesocosms





35 participants from 12 partner institutes

Major changes at the base of the food web



.... with likely consequences for higher trophic levels

outcompeted at high CO_2

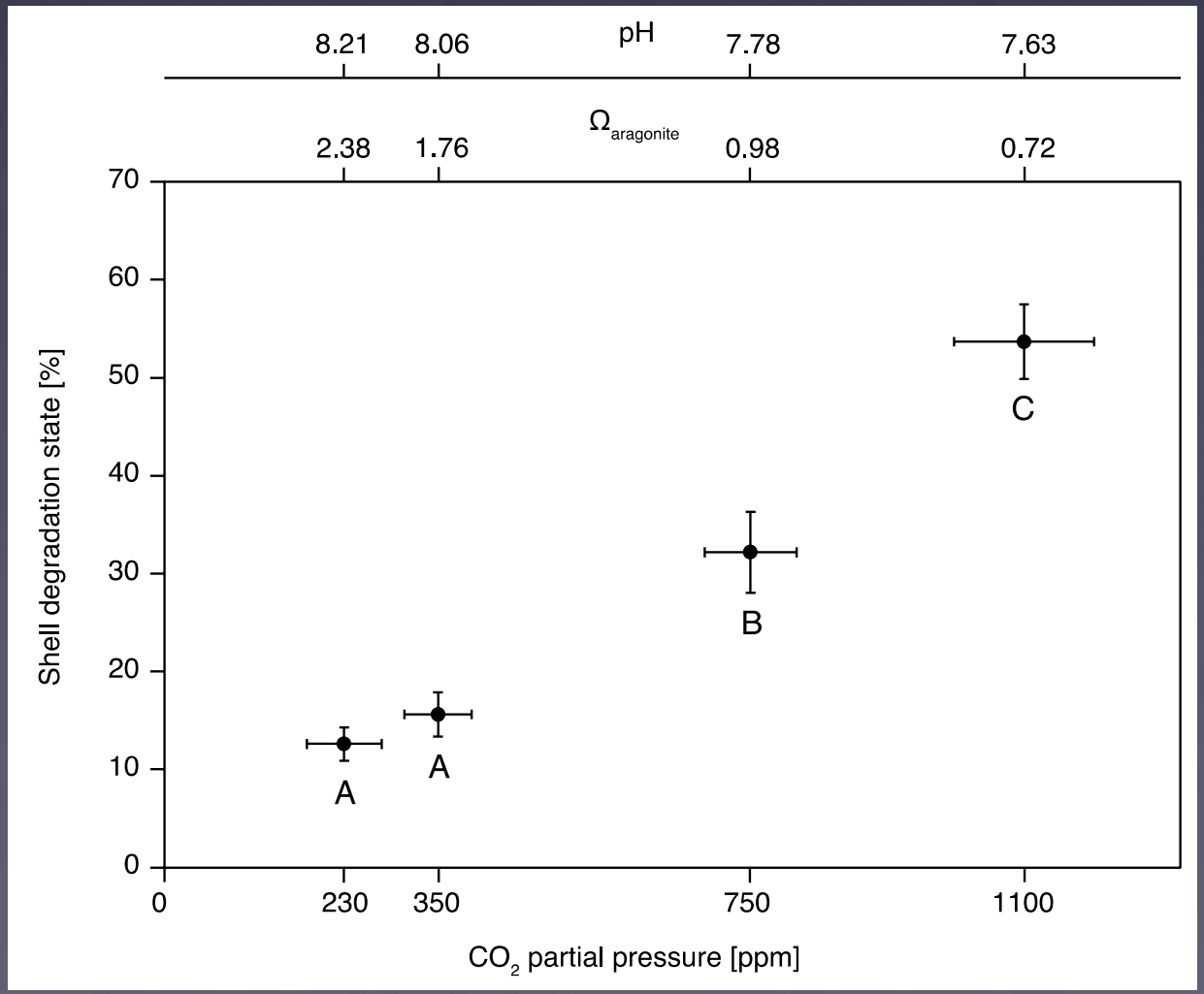
moderately stimulated at high CO_2

strongly stimulated at high CO_2

(unpublished data)

Shell corrosion in the sea butterfly (pteropod)

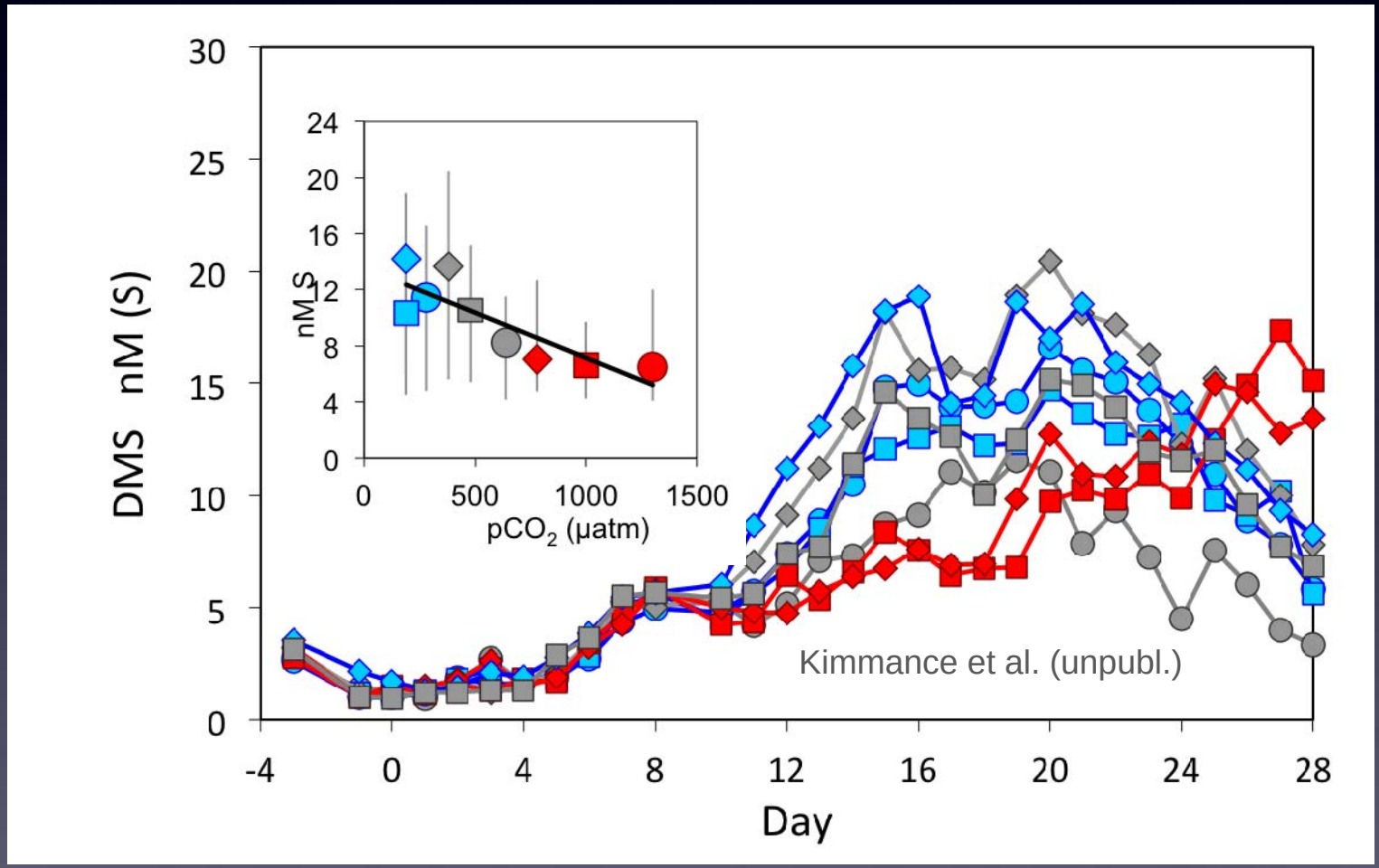
Key link in food chain



Lischka et al. (subm.)

✓ sea butterflys are sensitive to ocean acidification

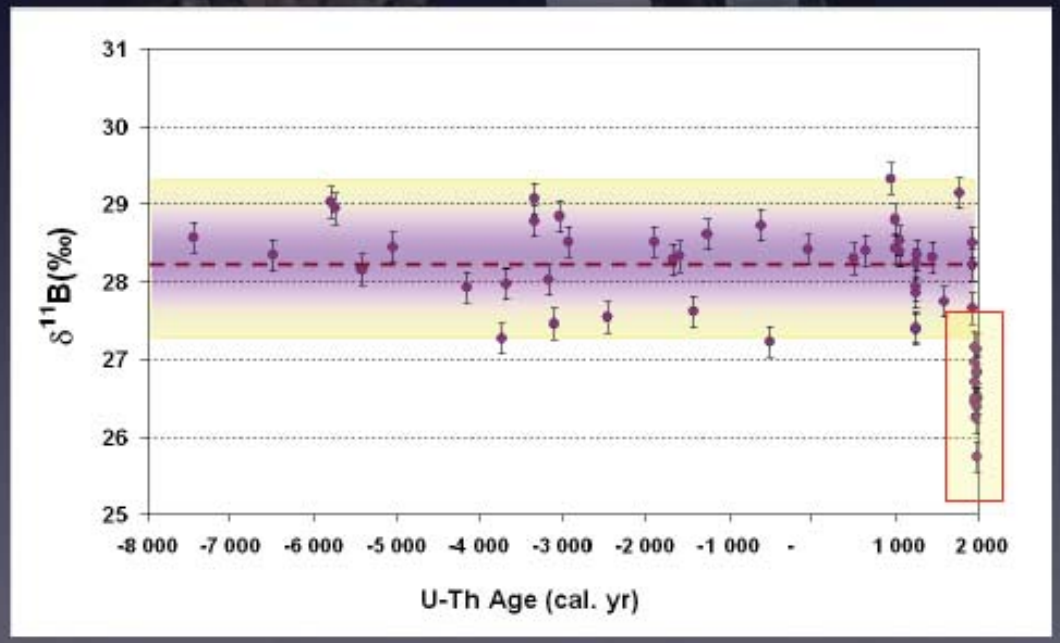
Production of Dimethyl sulphide (DMS)



- DMS is oxidised to produce aerosols that impact radiative forcing
- Arctic atmosphere particularly vulnerable to changes in aerosol forcing

Evidence of 20th century OA at high latitudes

- Douville (CEA)
- Fossil cold water coral
- North Atlantic; 750 m depth
- Abrupt fall of $\delta^{11}B$ (pH) during the 20th century



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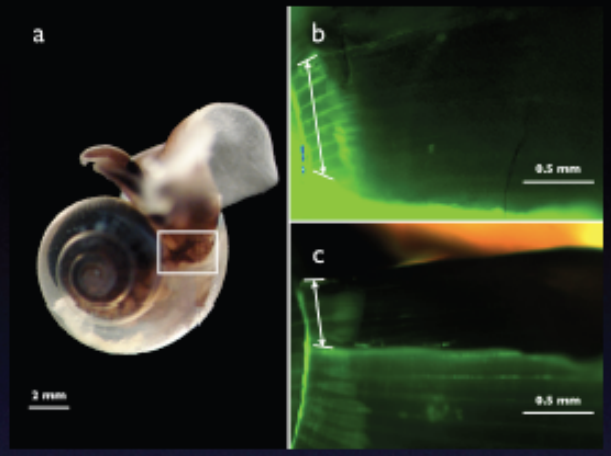
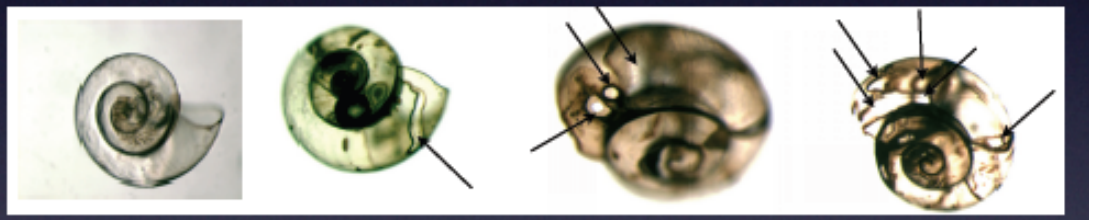
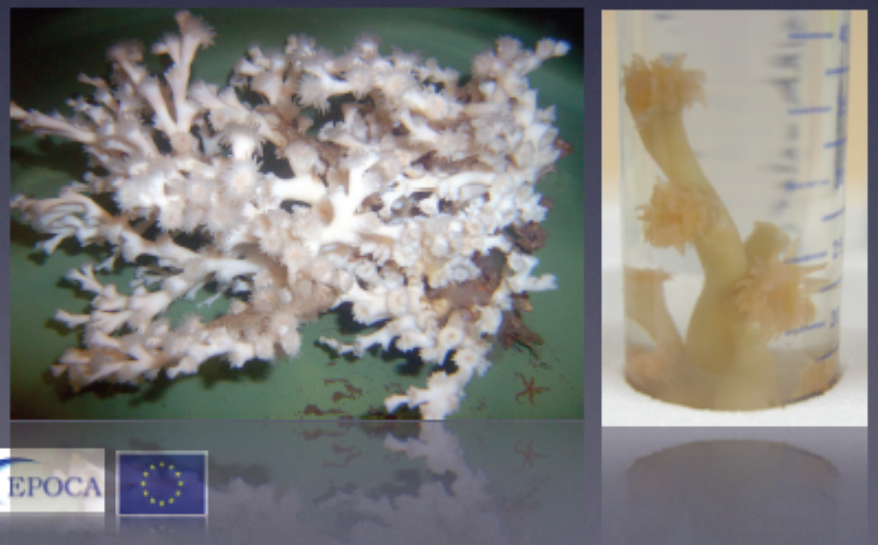
Impact on key organisms

- Pteropods and cold-water corals (Gattuso, CNRS-LOV and Riebesell, IFM-GEOMAR)
- Decreased calcification at increased levels of acidity
- Calcification possible in corrosive waters
- Long-term acclimation possible for cold-water coral ??







Dramatic effects at CO_2 vents

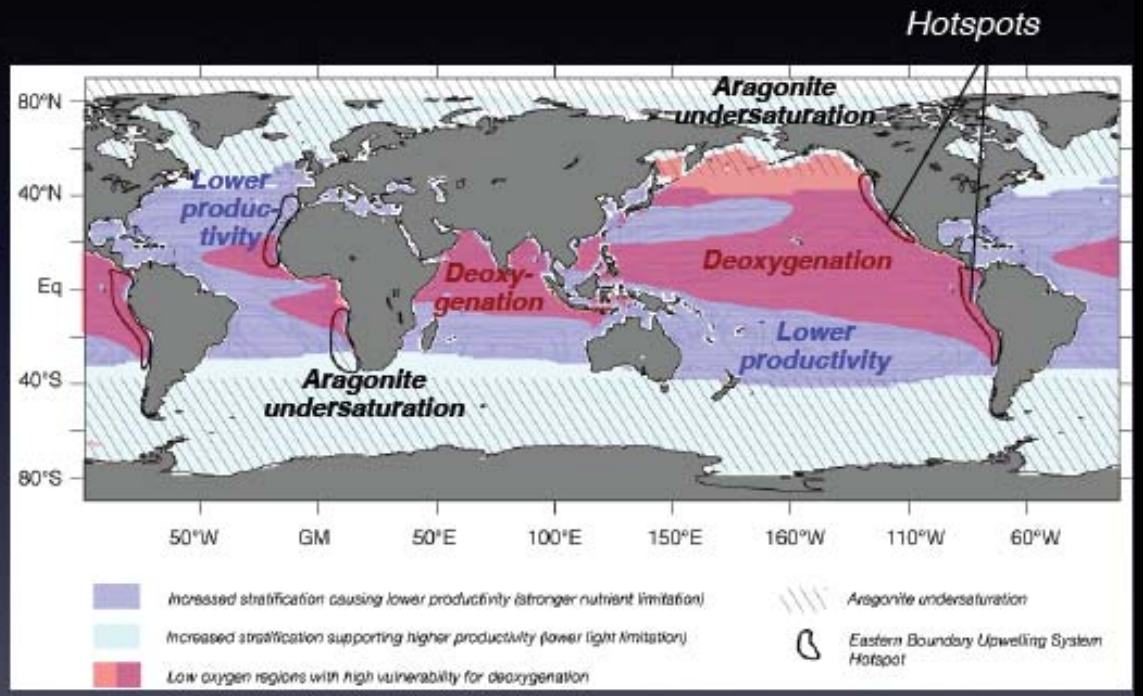
- Work at Ischia Is., Hall-Spencer (UoP)
- Corals and mollusks dissolve as pH falls below 7.7
- % of taxa decreases with lowering pH
- Reduction higher on calcifying species

pH 8.1

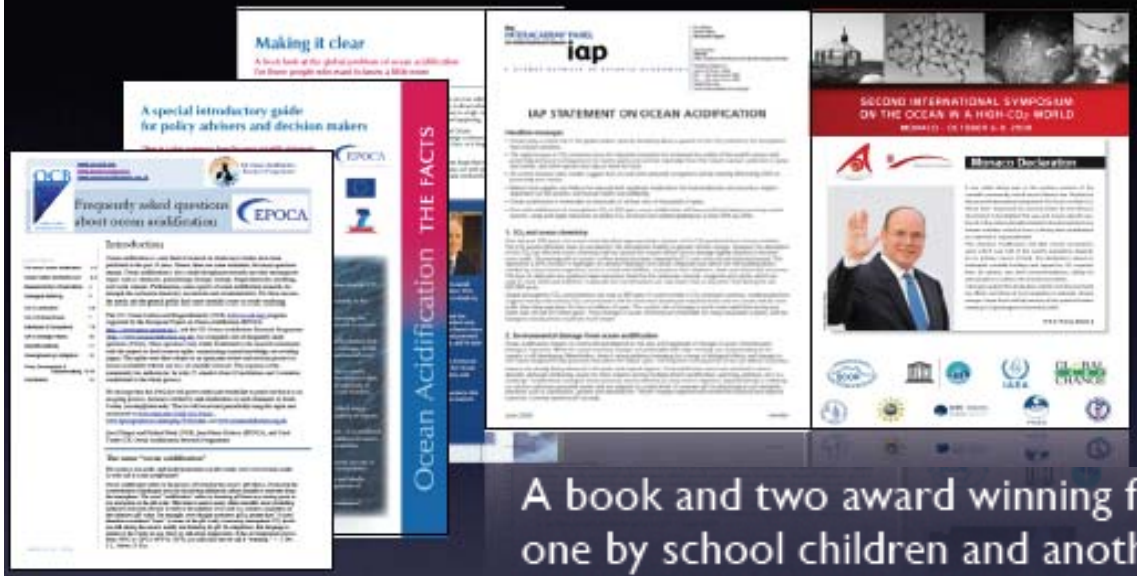
pH < 7.7

Triple trouble for the ocean

- Modeling study, Gruber (ETH)
- OA not acting in isolation
- Warming increases oxygen loss
- Warming, acidification, and deoxygenation in 21st century
- Only begun to fathom ecological and biogeochemical effects



Dissemination and outreach



Documents for policy makers – some written by EPOCA's Reference User Group of stakeholders

World leading website and blog on ocean acidification

A book and two award winning films one by school children and another by professional film makers

Dialogue with policy makers and media at climate change negotiations at in Copenhagen and Cancun

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