Two world's apart:
Coastal resources and rapid global change: What can we do to avoid disaster?

Ove Hoegh-Guldberg
Queensland Premier's Fellow
Director, Global Change Institute
University of Queensland
St Lucia, Australia

GEF
Global
Environment
Facility

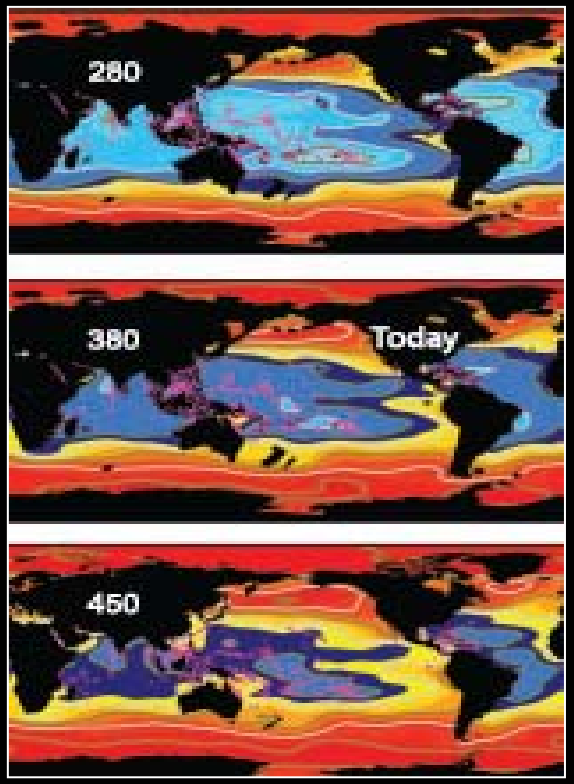
Coral Reef Targeted Research & Capacity Building for Management


Food, building materials, income, coastal stabilization and protection, as well as cultural and spiritual values
500 million people, billion dollar industries (fisheries, tourism).


Coastal resources: mangroves, seagrass meadows, soft sediment communities, rocky shores, coral reefs etc.

Overexploitation

Coastal development



Climate change

The likely response of tropical marine ecosystems to climate change

Coral reefs as a key focus

Coral Reefs: The most diverse marine ecosystem

Outline

What are the implications of climate change for coral reef ecosystems?

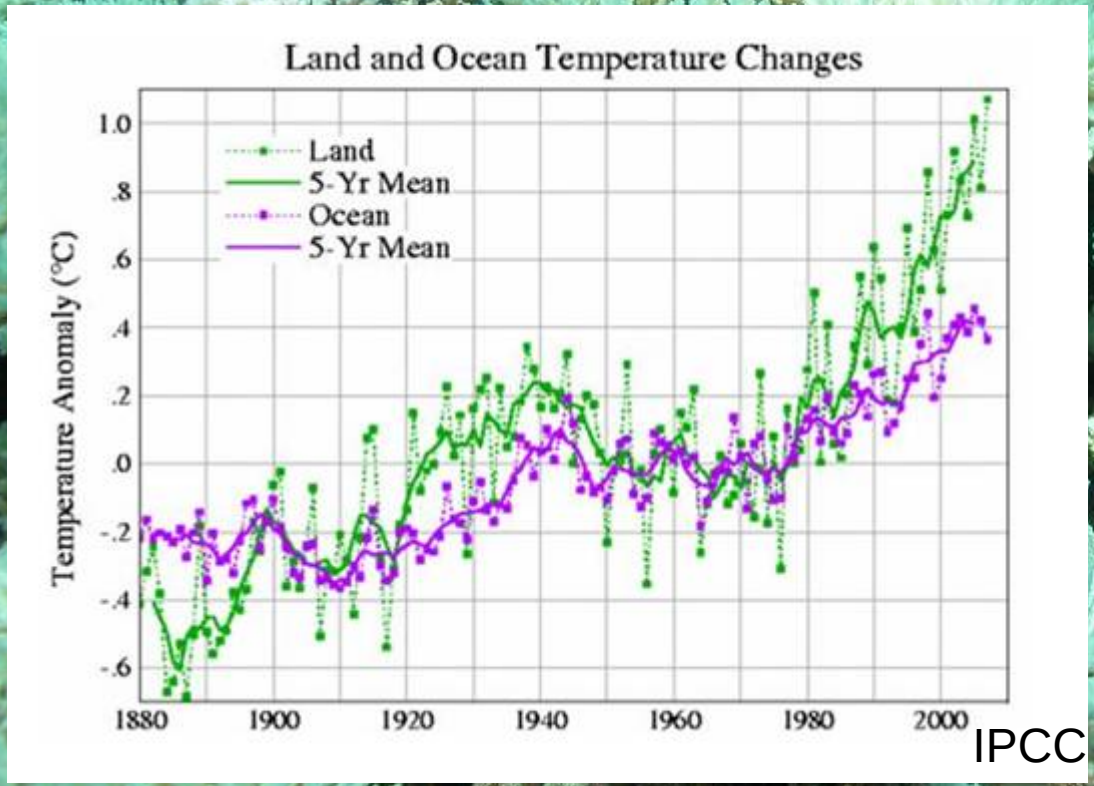
Limits?

Response?

- Mitigate — Here
- Adapt — Other speakers

Timeline?

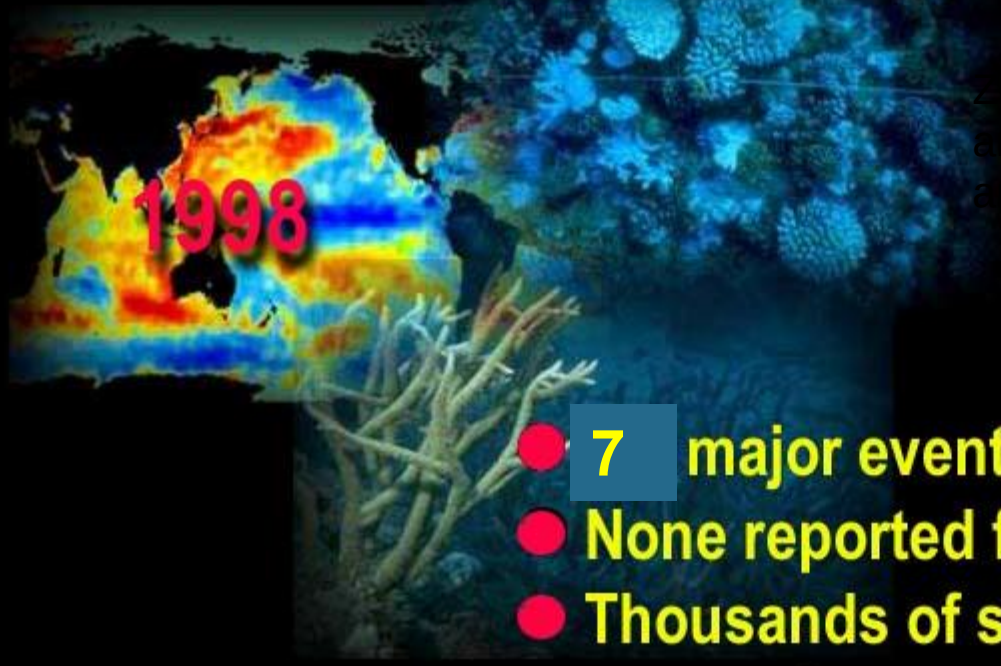
1-2^{o}C, over 6 week

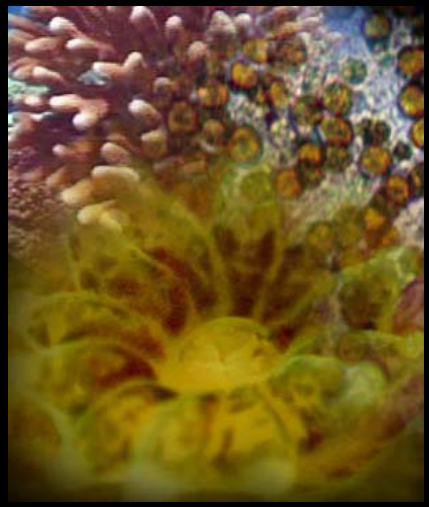


IPCC


Stress
Temperature,
light, CN- etc
Veron/Kelly

Coral bleaching and mortality

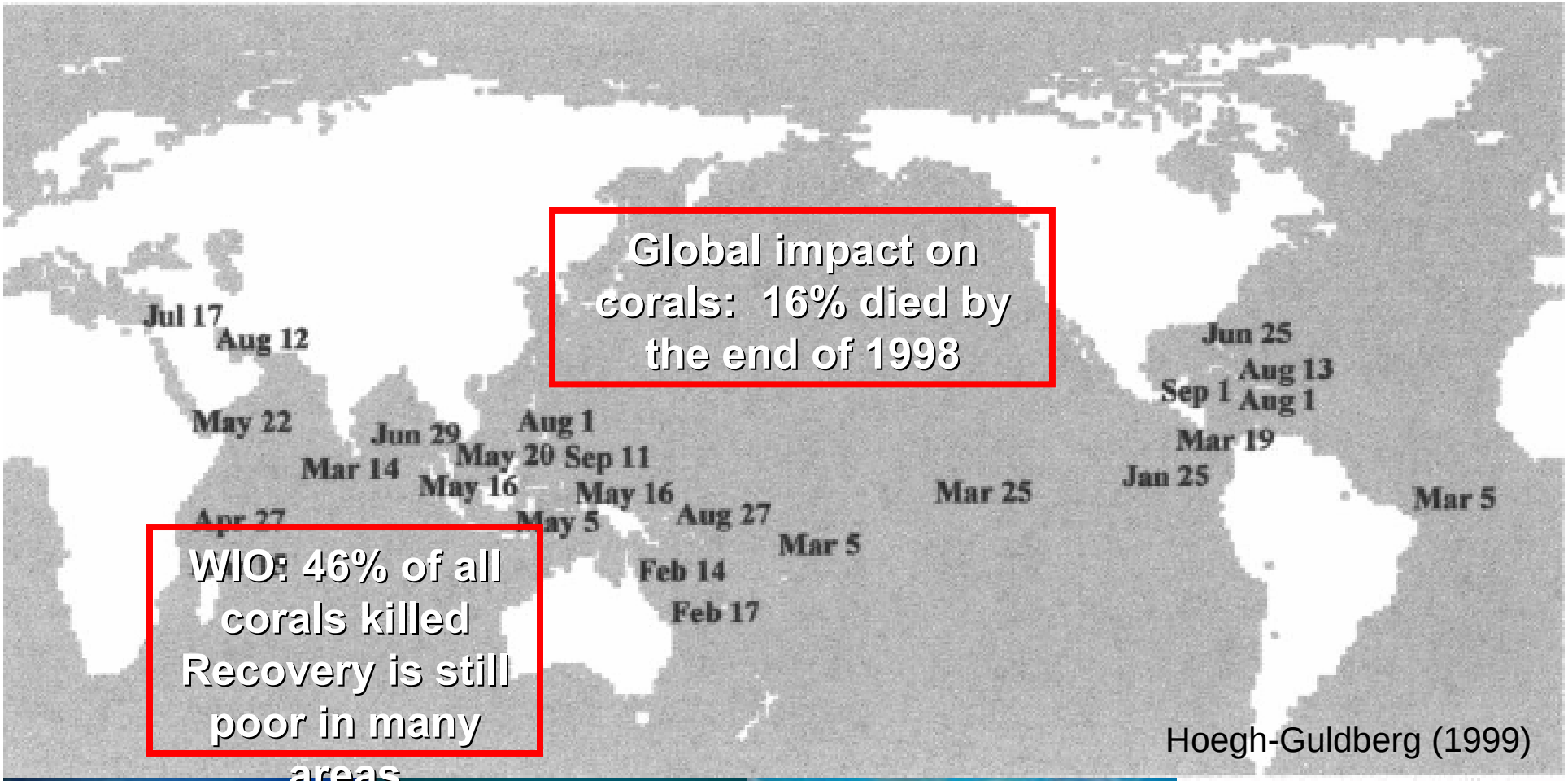


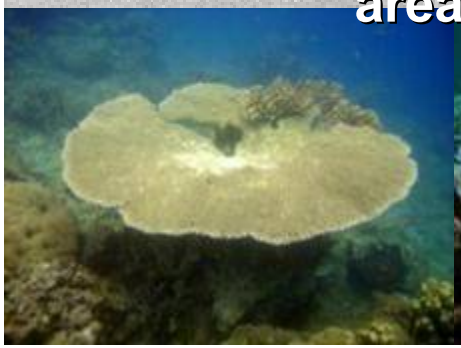


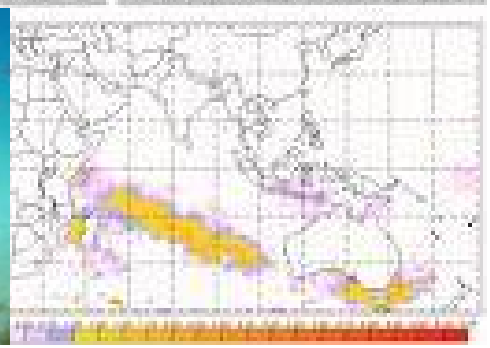
- **7** major events since 1979
- None reported formally before 1979
- Thousands of square miles affected
- May be followed by huge mortalities
- Increasing frequency and severity

Major factors associated with mass bleaching events:
High sea temperatures, still and sunlit conditions

1998: Dates of sites of major coral bleaching

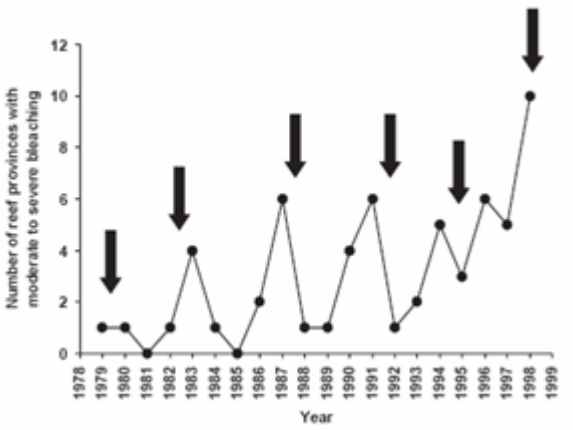




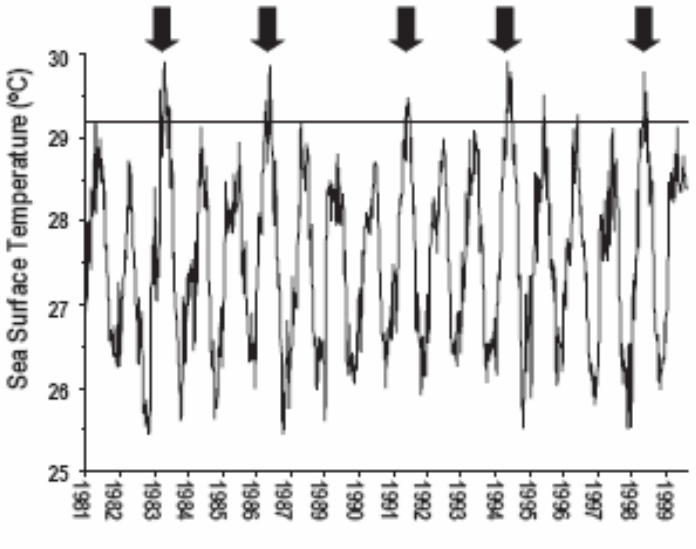


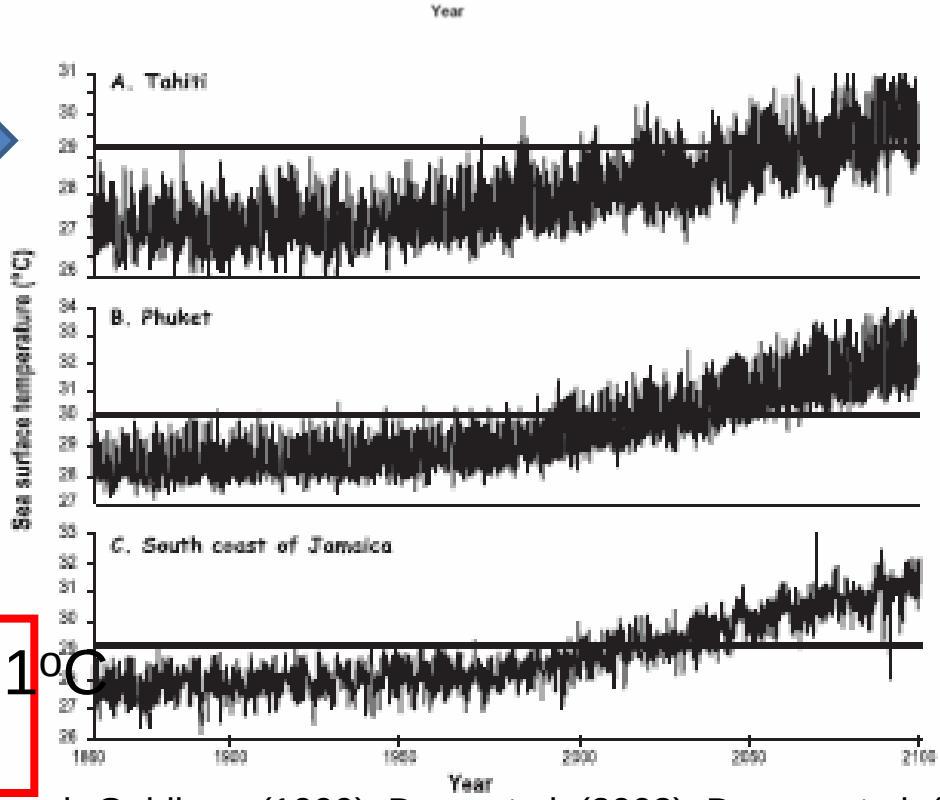
Projections for the future?

- Bleaching events are increasing in concert with sea temperatures



Bleaching events





Bleaching becomes chronic at +1°C
Critical threshold = +2°C

Hoegh-Guldberg (1999), Done et al. (2003); Donner et al. (20(

Ocean Acidification: Double trouble?

Reef accretion declines to zero around 450 ppm CO_2

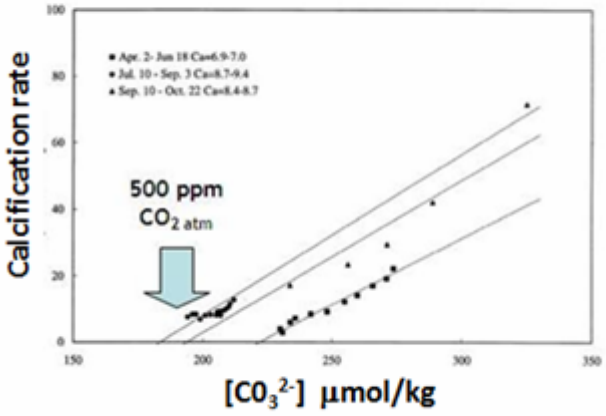
CO_2

$CO_2 + H_2O => HCO_3^- + H^+$

$H^+ + CO_3^{2-} => HCO_3^-$

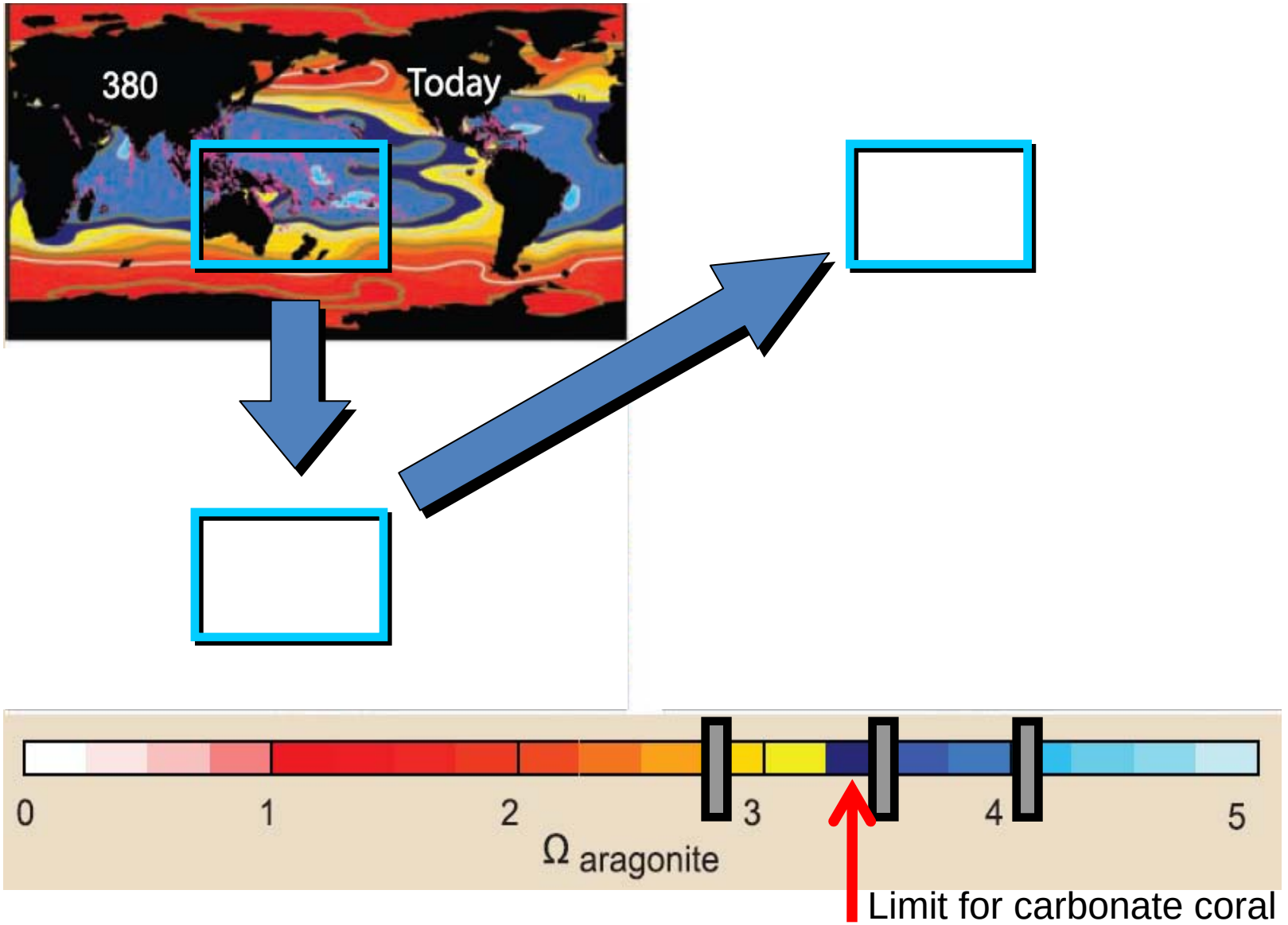
$CaCO_3 => Ca^{2+} + CO_3^{2-}$ (coral)

Net calcification decreases linearly with change in the carbonate ion concentration



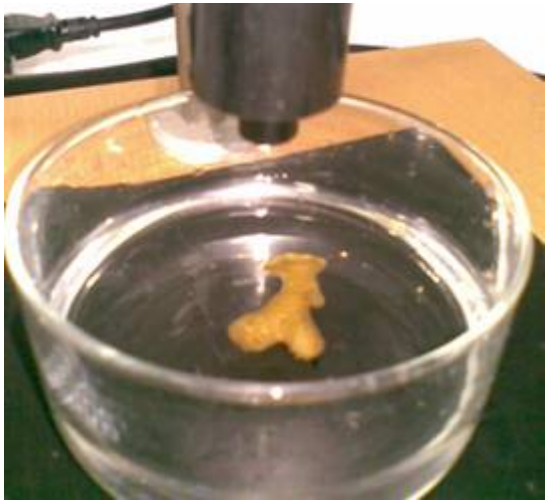
Raven et al. (2005); Kleypas and Langdon (2007)

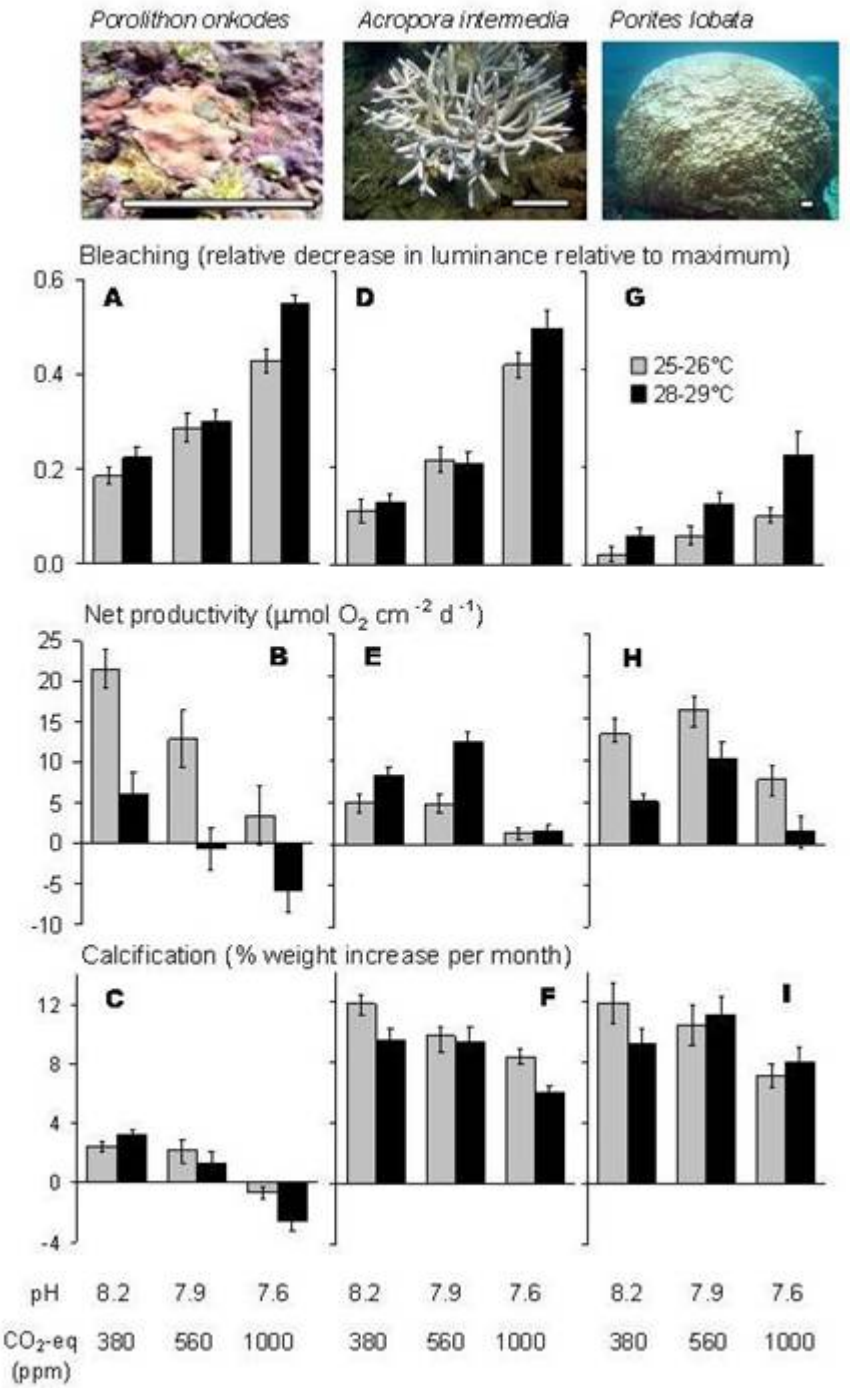
Ocean acidification and aragonite saturation Ω_{arag}



Hoegh-Guldberg et al. 2007 (*Science* review)

Synergies are also important as are processes outside calcification



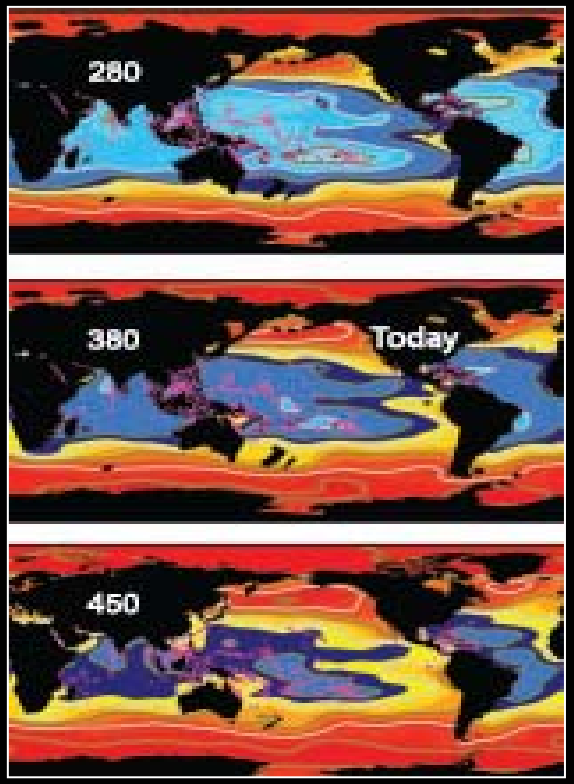


Anthony et al. (2009 - PNAS)

Overexploitation

Coastal development

Climate change

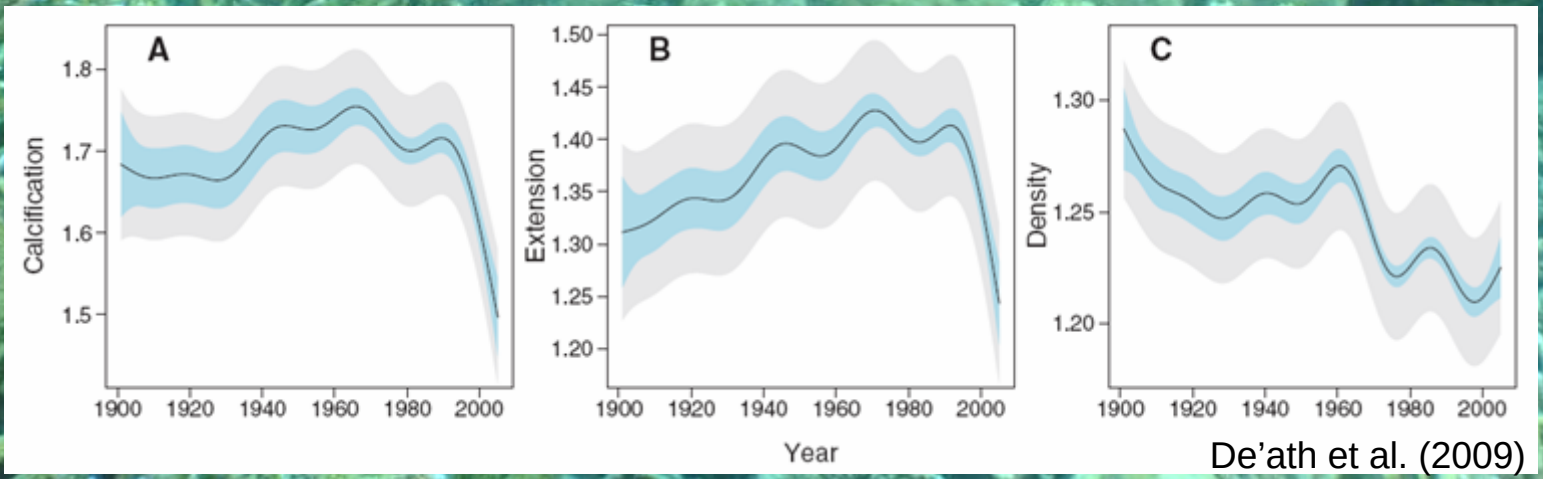


Opportunities?

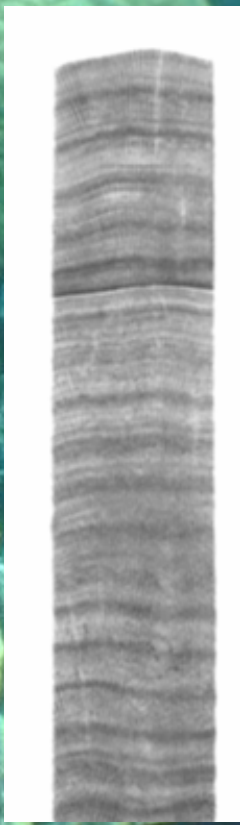
Effects being seen in the field:
15% decline in coral calcification since 1990

Great Barrier Reef:
De'ath et al. (2009, Science)

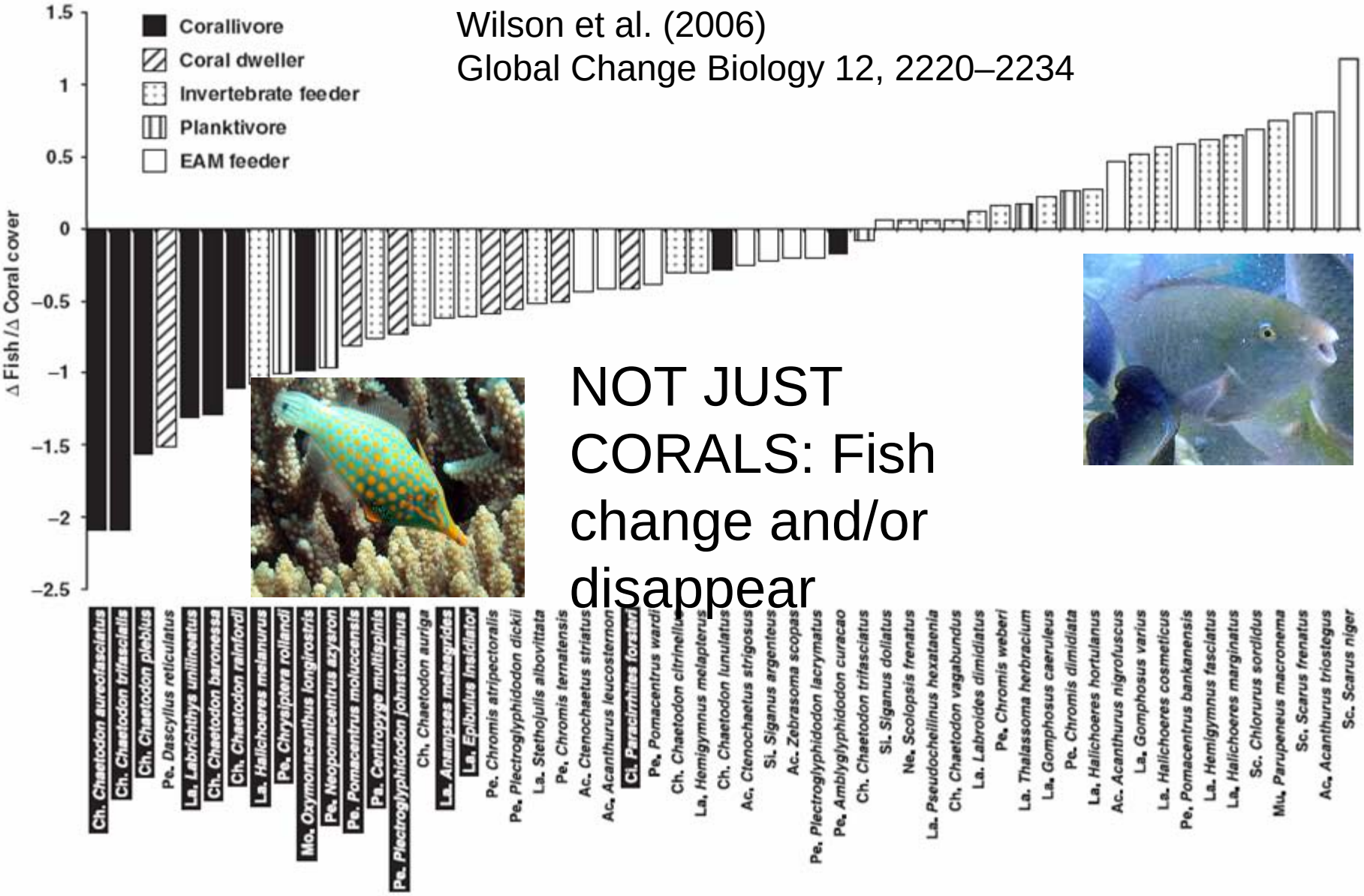
Thailand:
Tanzil et al. (2009)



De'ath et al. (2009)



Wilson et al. (2006)
Global Change Biology 12, 2220–2234



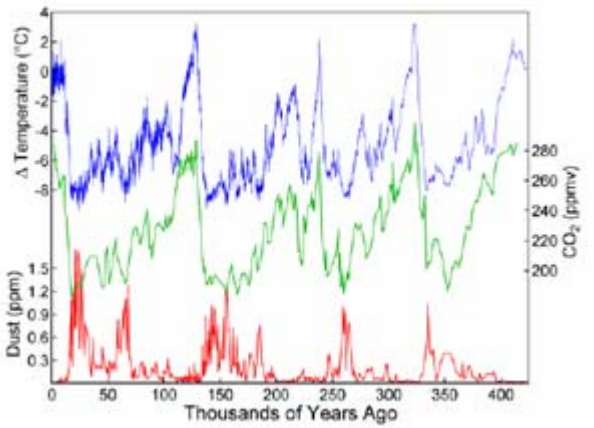
NOT JUST CORALS: Fish change and/or disappear

Fig. 2 Response of 55 fish species to decline in coral cover. Responses are mean values, calculated from four or more locations. Species names are highlighted if mean value with 95% confidence interval fails to intersect 0, indicating consistency of response among locations. Letters preceding species name indicate family: Ac, Acanthuridae; Ch, Chaetodontidae; Ci, Cirrhitidae; La, Labridae; Mo, Monacanthidae; Ne, Nemipteridae; Pa, Pomacanthidae; Pe, Pomacentridae; Sc, Scaridae; Si, Siganidae.

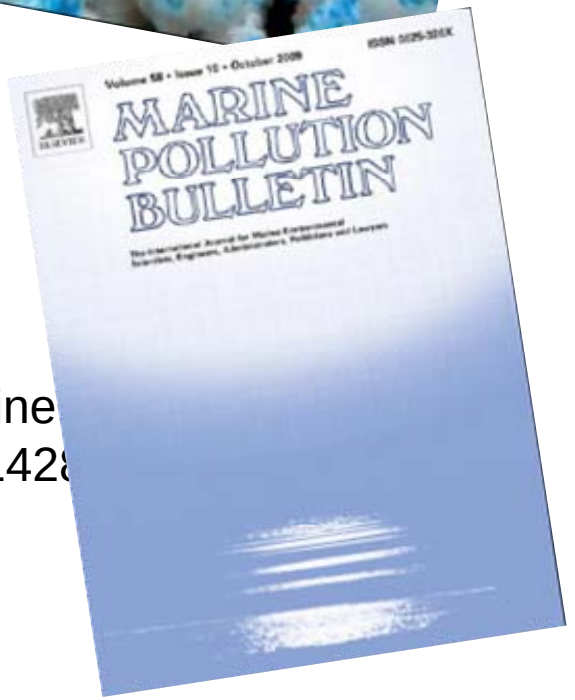
Dangerous limit
450 ppm

Hoegh-Guldberg et al. 2009
Science 318: 1737-1742

Safe limit?
350 ppm



Veron et al. 2009 Marine
Pollution Bulletin 58: 142
1436

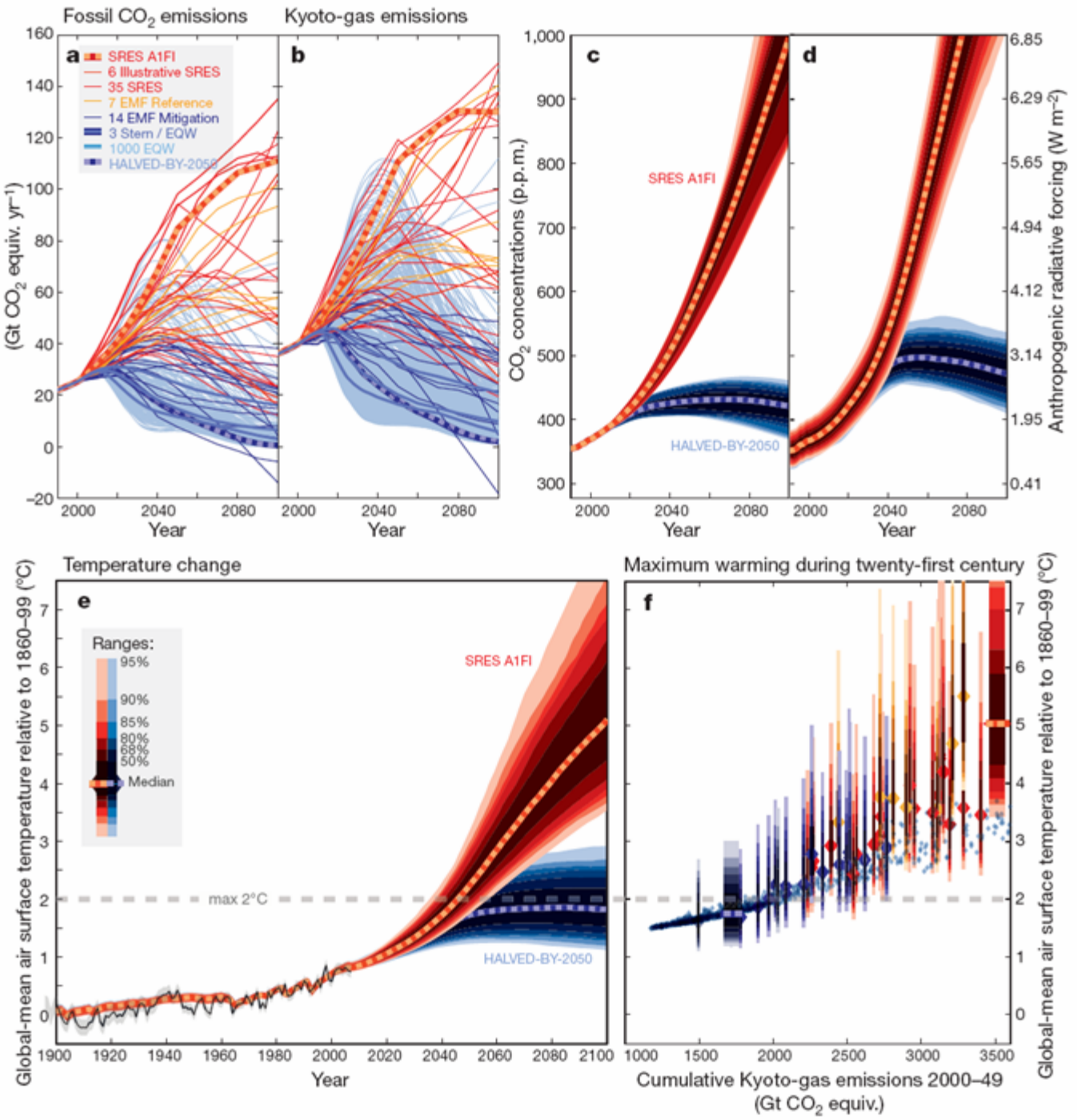


Response and Timeline?

Mitigate

&

Adapt



NATURE|Vol 458|30 April 2009

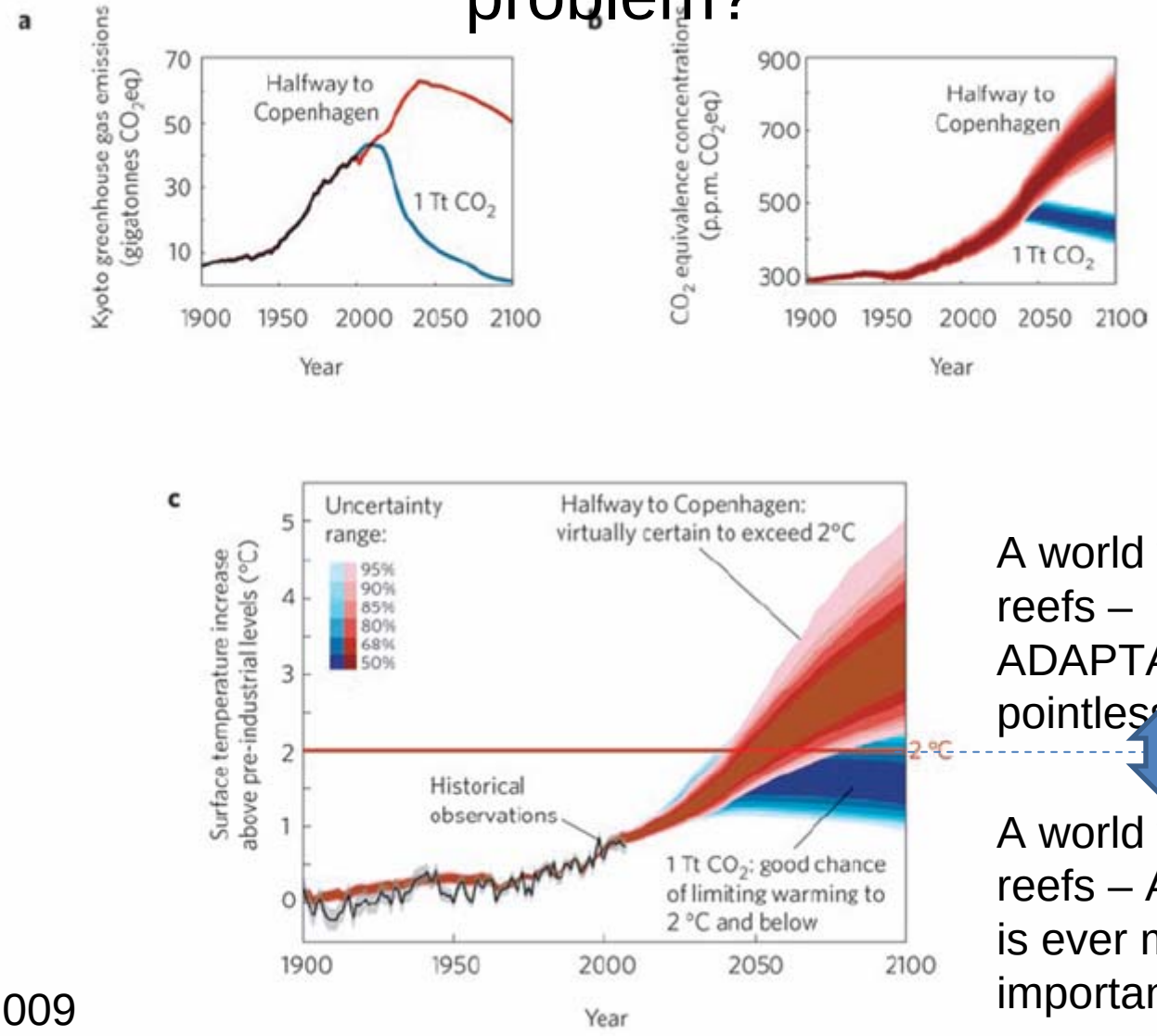
Meinshausen et al. (2009)

Only scenarios that bring emissions down to 5% of today by 2050 have any chance of stabilizing CO_2* 450 ppm.

How are we doing on our way to the Copenhagen negotiations?

**Other GHGs aside*

The current emission targets that international negotiators have committed do not solve the problem?



A world without coral reefs – ADAPTATION is pointless

A world with coral reefs – ADAPTATION is ever more important

Rogelj et al. 2009

nature reports climate change | VOL 3 | JULY 2009 |


Food, building materials, income, coastal stabilization and protection, as well as cultural and spiritual values
Sea Level Rise?
Storm intensity?
500 million people, billion dollar industries (fisheries, tourism).

Two worlds apart?

Extreme conditions
> 700 ppm

Our negotiator's world ...

Dangerous limit
450 ppm

Hoegh-Guldberg et al. 2009
Science 318: 1737-1742

Safe limit?
350 ppm

Veron et al. 2009 Marine Pollution Bulletin 58: 1428-1436

A safe world