

Ocean Carbon Storage

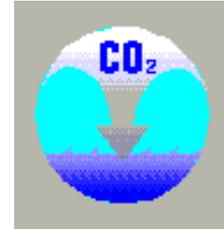
Ian S F Jones

University of Sydney

Australian Technology Park

Australia

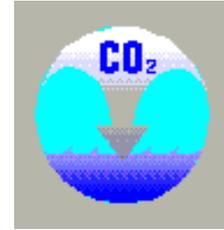
24.4.2008



OCEANS

70% of the surface area.

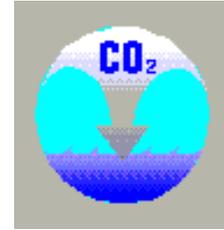
30% of the liberated carbon



UNFCCC

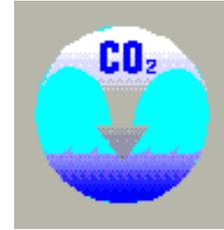
Commitment 1 (d) deals with “sinks and reservoirs of all greenhouse gases” and refers to “biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems”.

But not in Kyoto Protocol

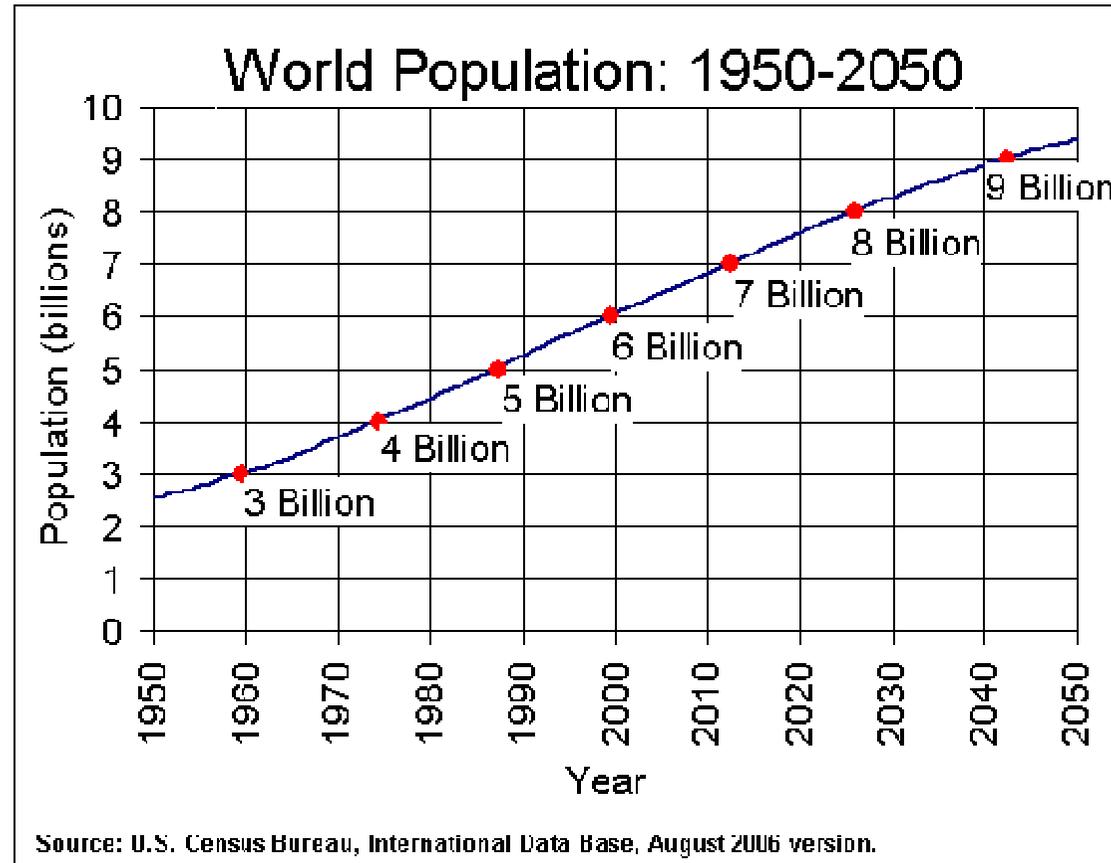


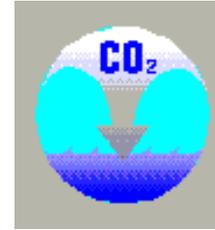
Post Kyoto

**We need to assess the
technologies not exclude
the sector**

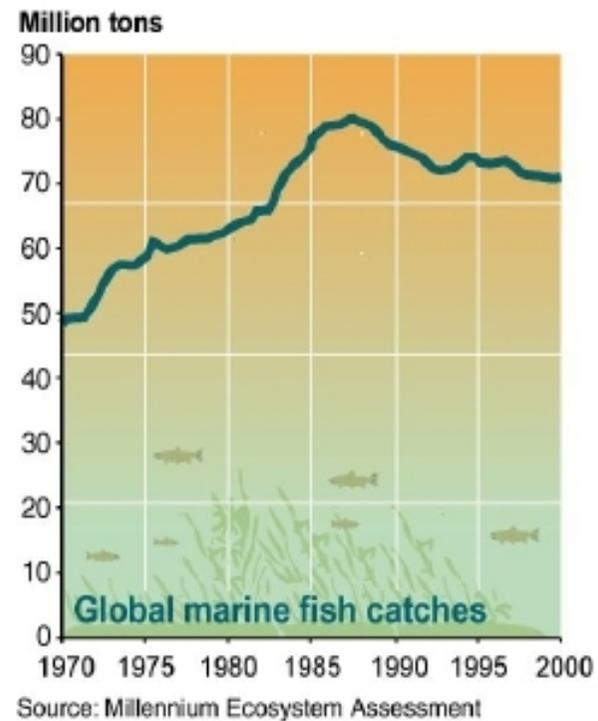


population 2 billion extra

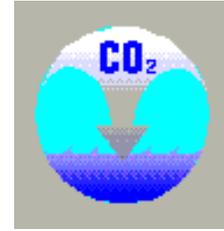




Wild fisheries are in decline



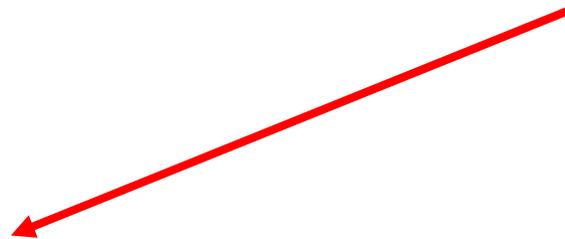
China?



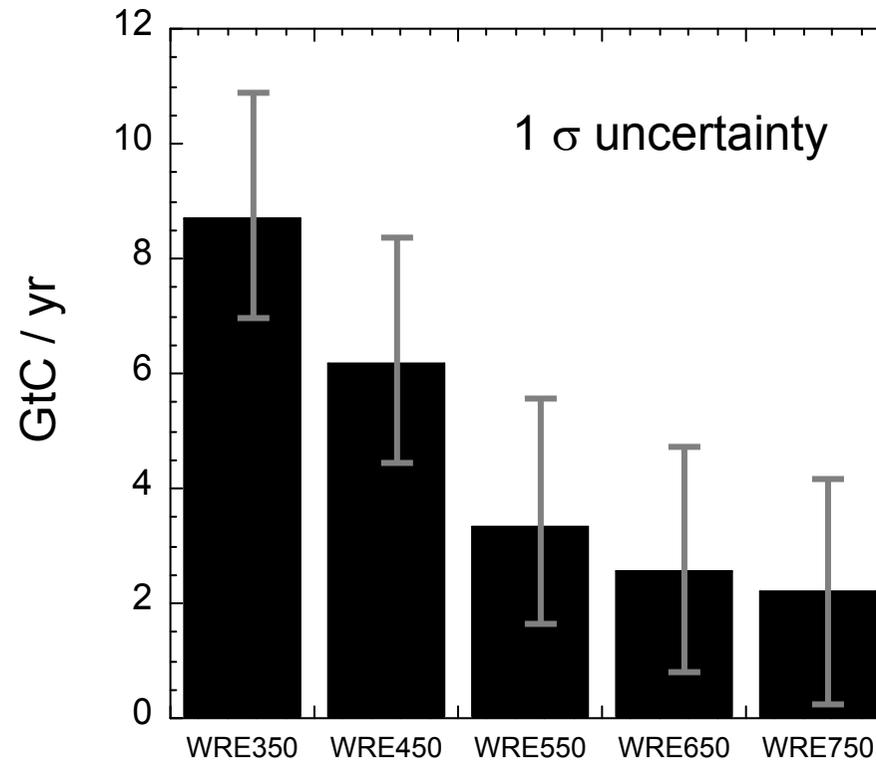
Food security

There is a shortage of economical protein

We are fishing down the food chain



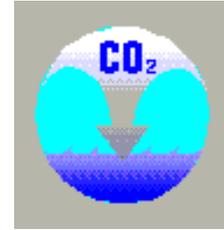
Total sequestration demand year 2025



CO₂ stabilization target → 350 450 550 650 750



Assumes IS92a fossil-fuel mix, constant year 2000 non-fossil energy, and 10% energy penalty for sequestration



Economic opportunity

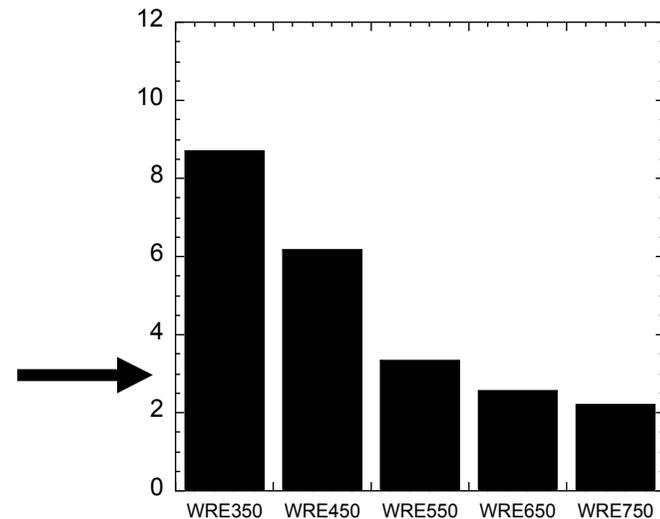
Value of activity

@US\$30 per tonne CO₂

@US\$120 per tonne C

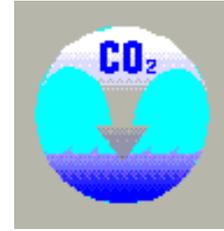
=\$360 billion per year

UK GDP =US\$2,000 billion





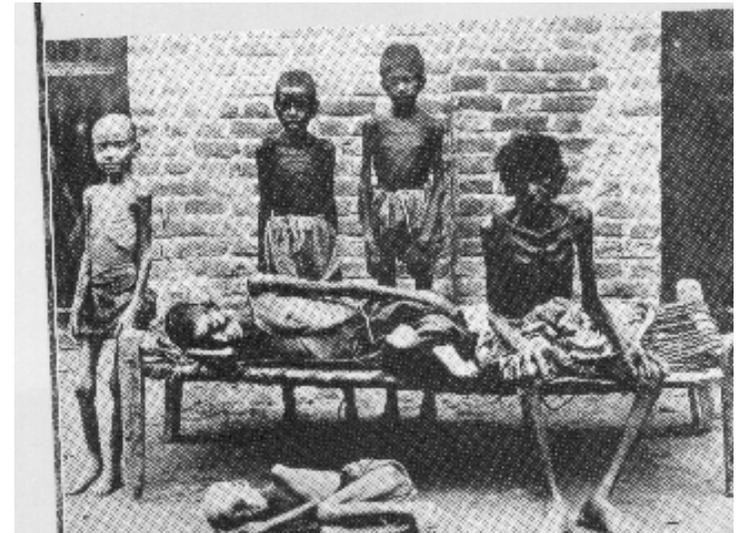
Global food security

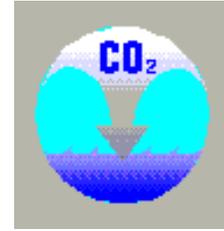


There is a shortage of economical protein

800 million suffer malnutrition

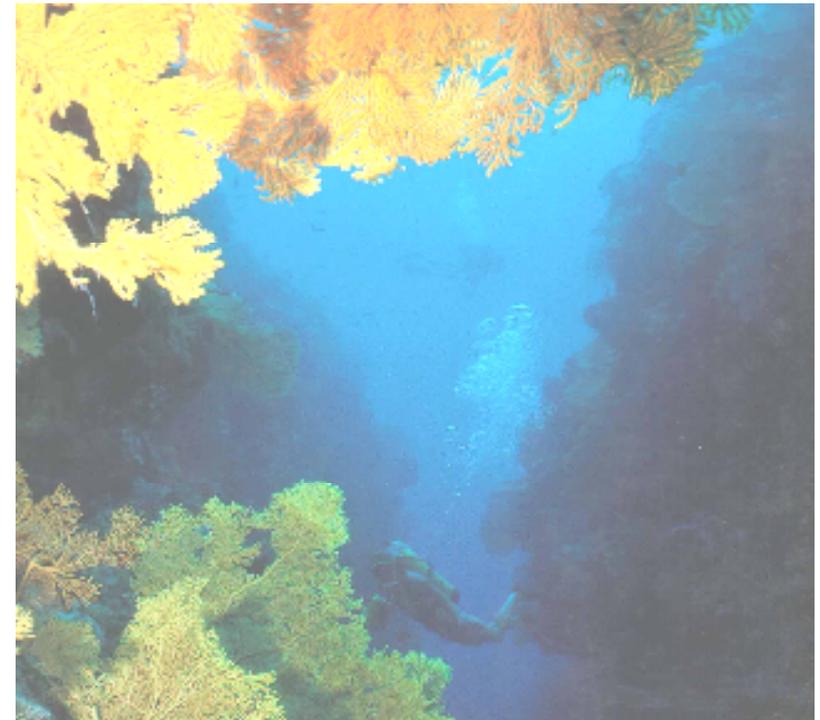
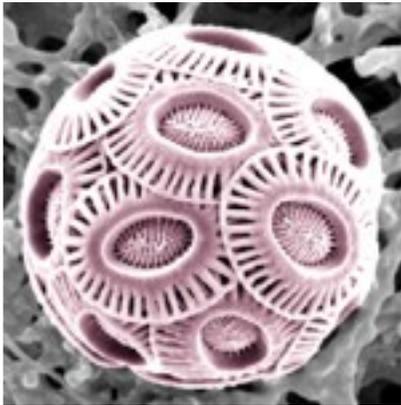
Climate change will increase this problem



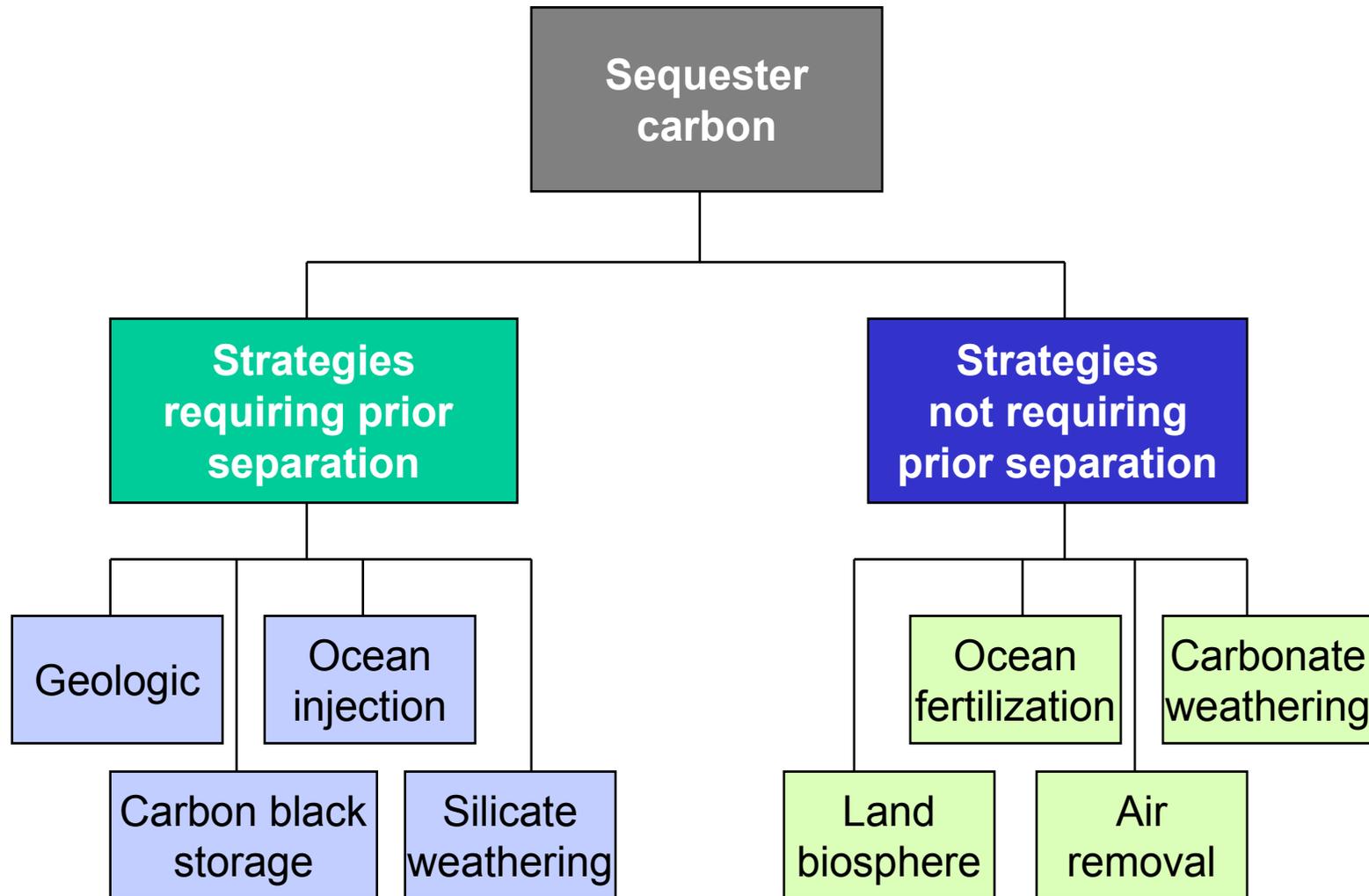


Climate Change

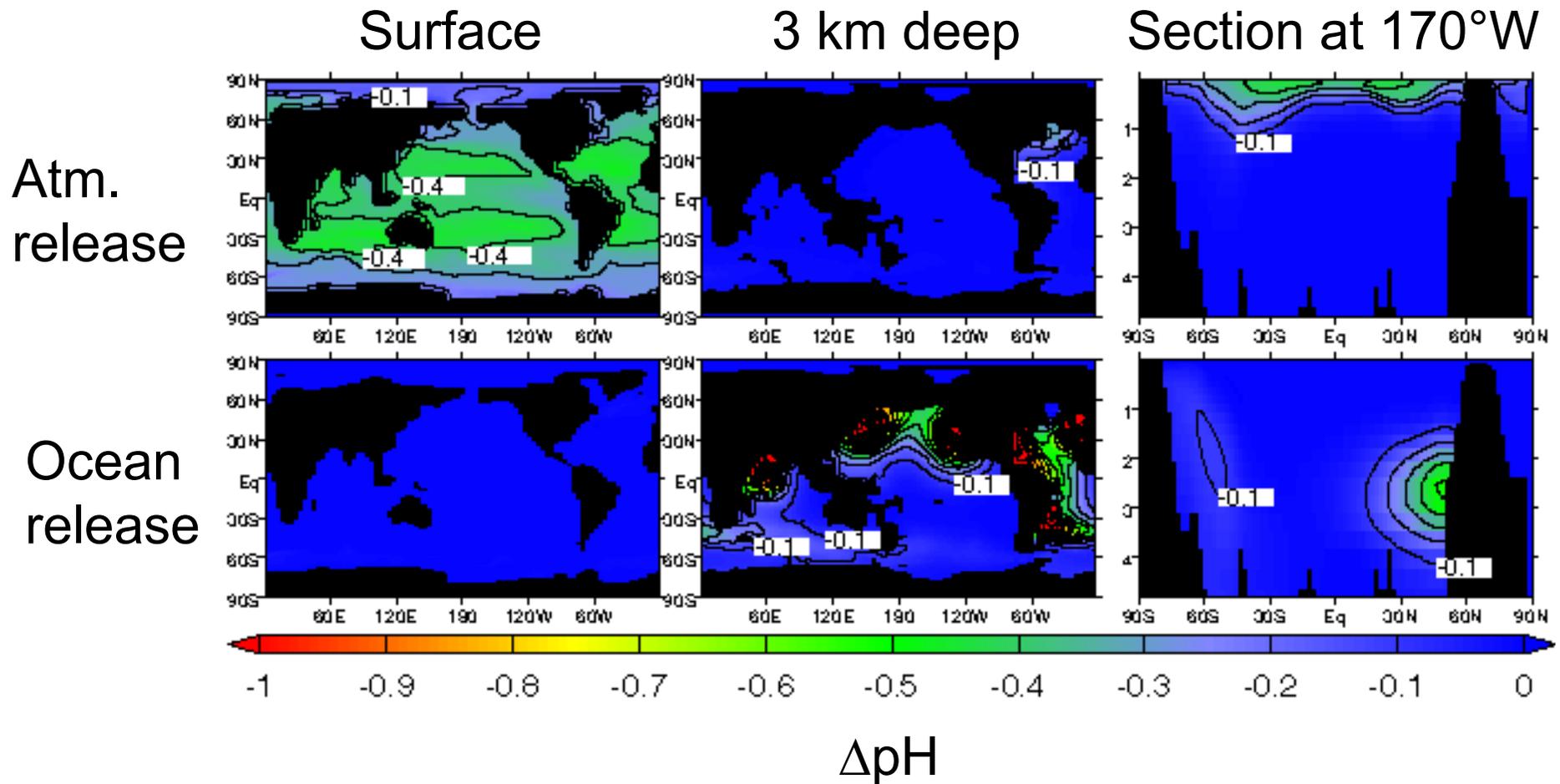
Disappearing coral
Change in phytoplankton



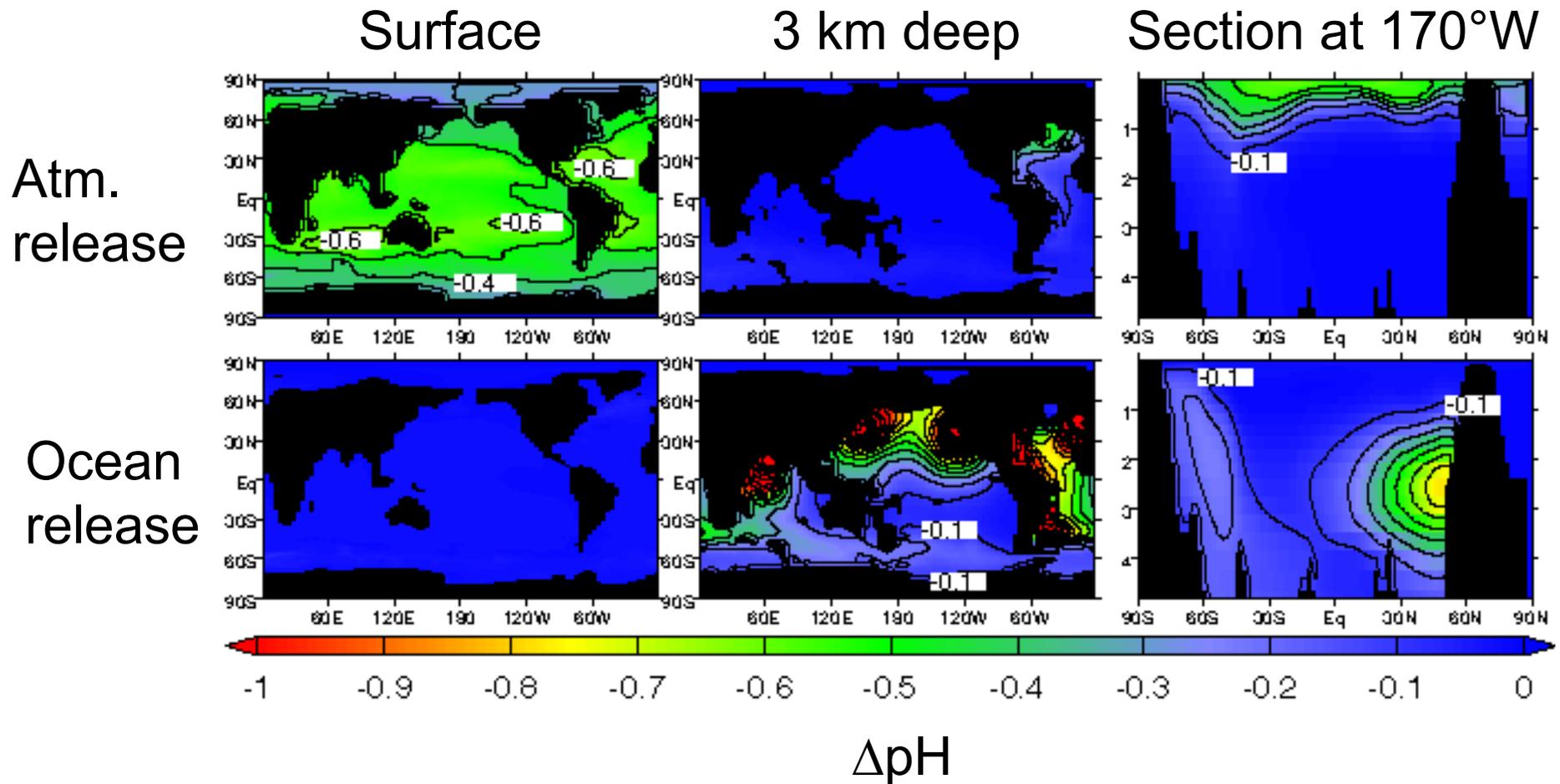
Carbon sequestration strategies

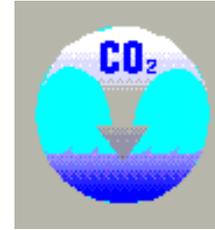


ΔpH after 110 years of CO_2 release



ΔpH after 200 years of CO_2 release



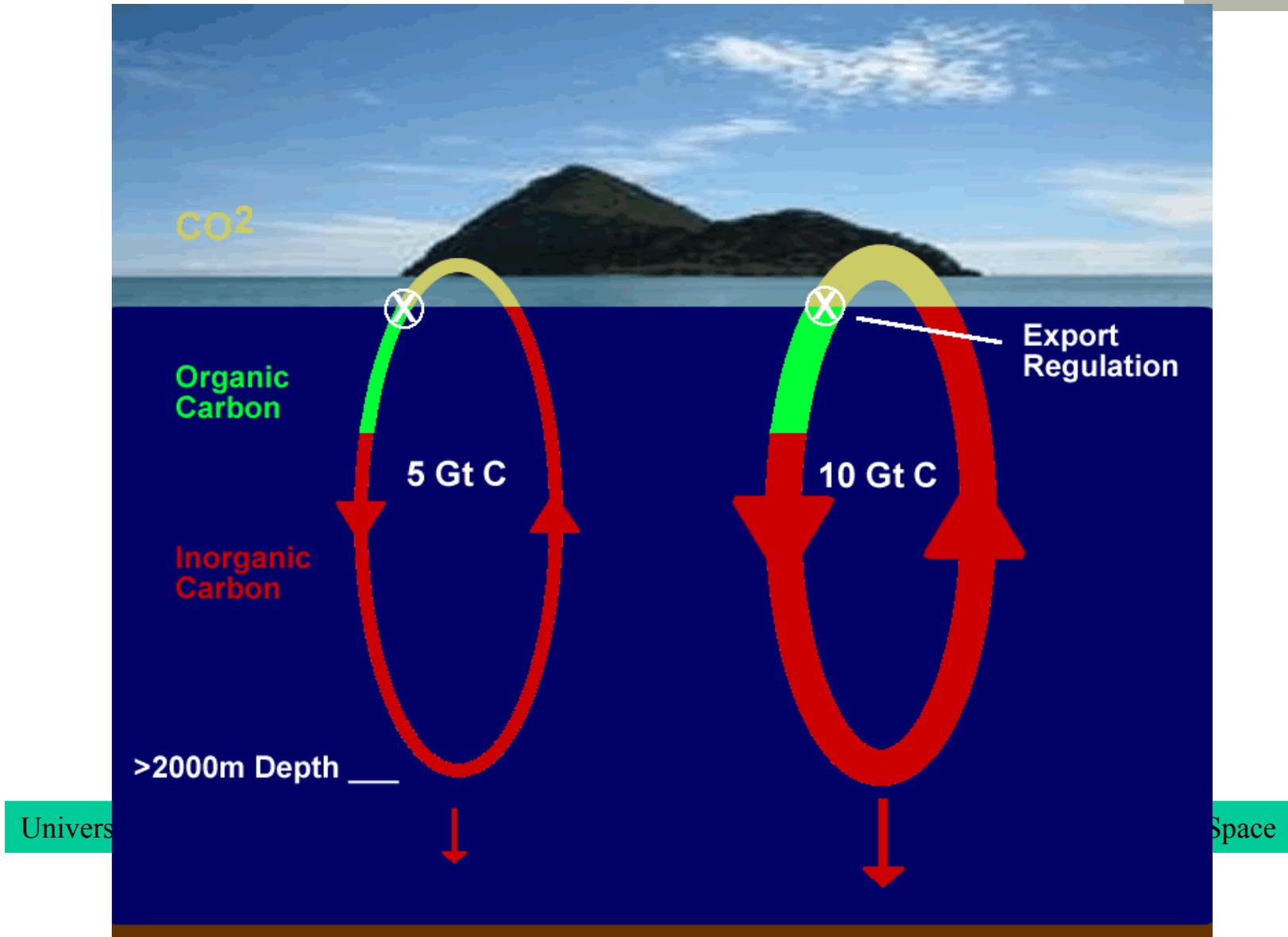
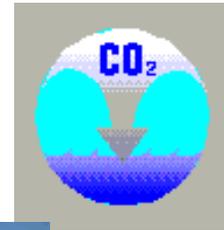


CCOS with neutralisation

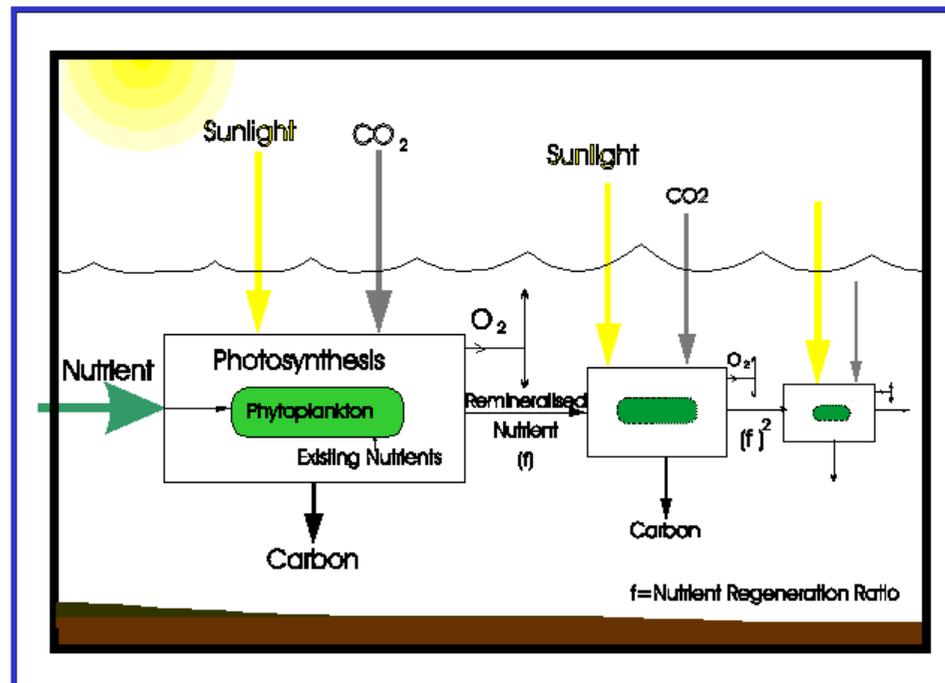
Calcium carbonate + carbon dioxide = bicarbonate



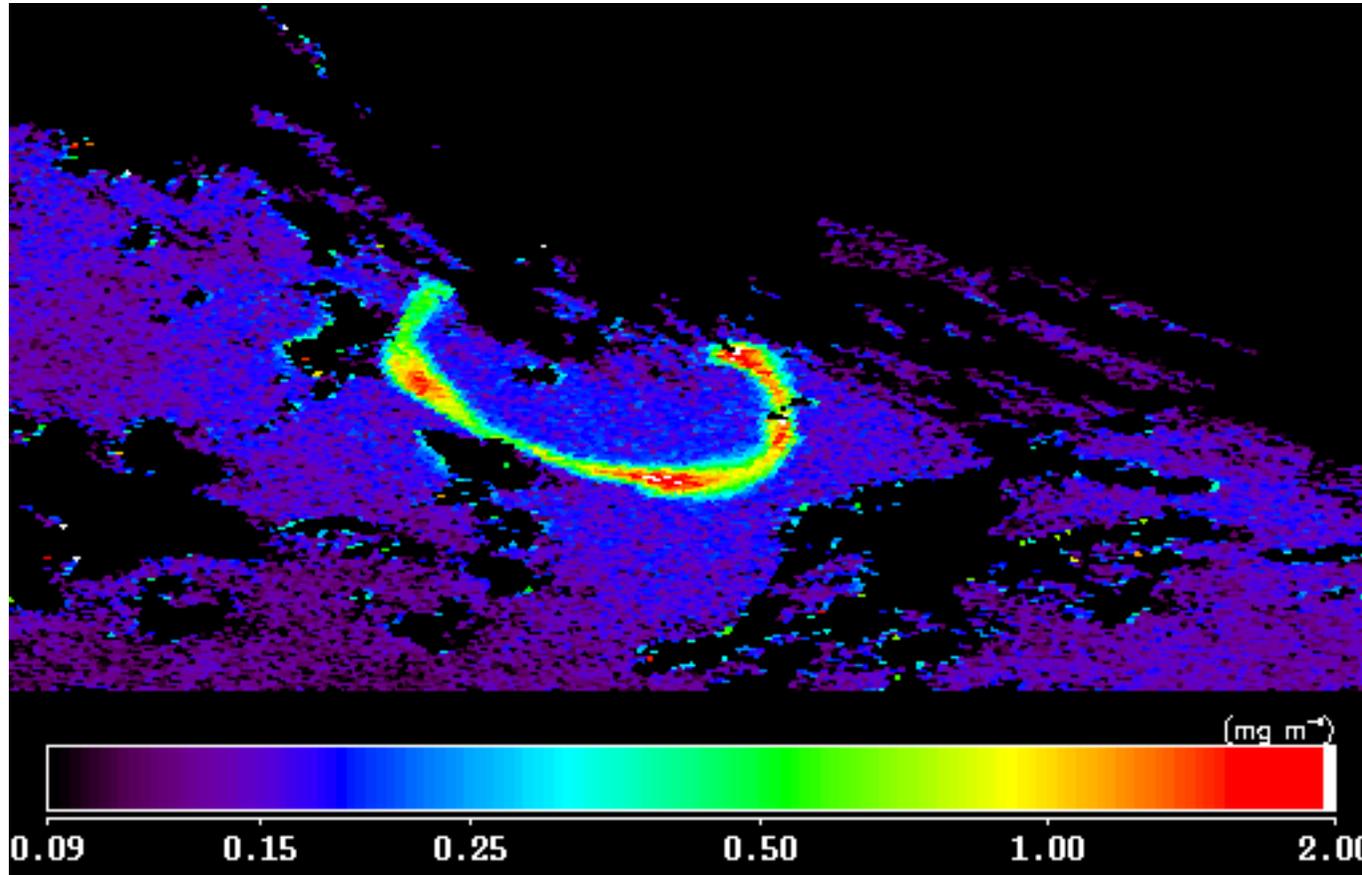
Ocean organic carbon cycle



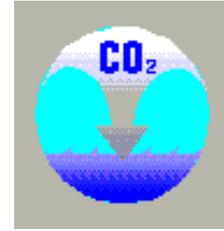
Photosynthesis



Intentionally added iron can stimulate increased organic carbon production



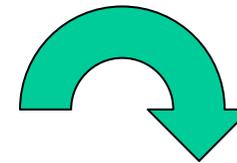
SEAWIFS image of the SOIREE phytoplankton bloom.



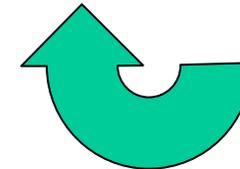
Ocean organic carbon cycle

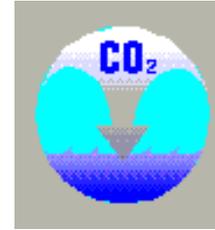
The base of the marine food chain

Photosynthesis
Death and export

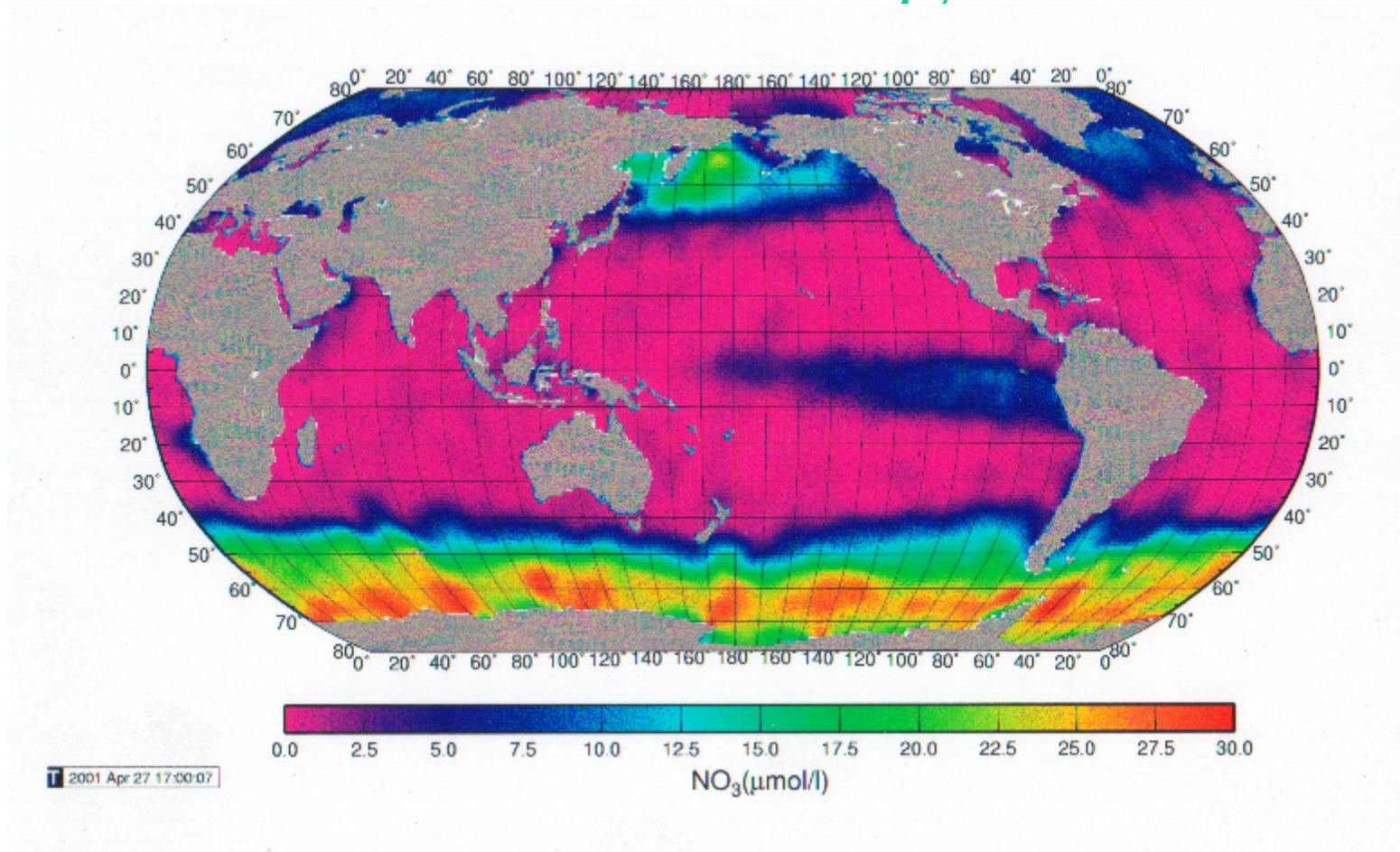


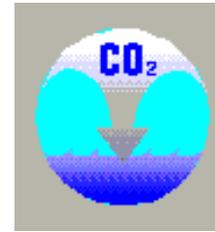
Remineralisation by bacteria
Upwelling to the surface



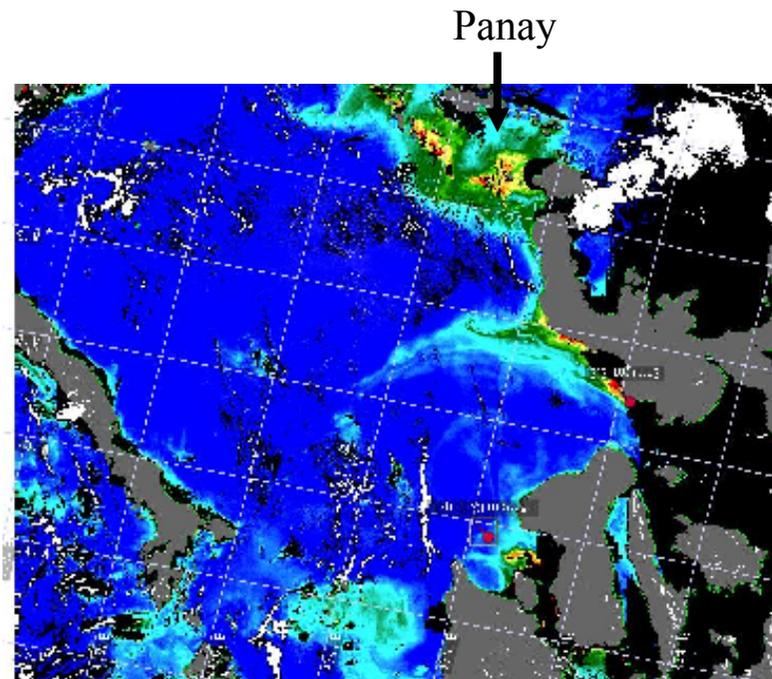


Ocean Nitrogen

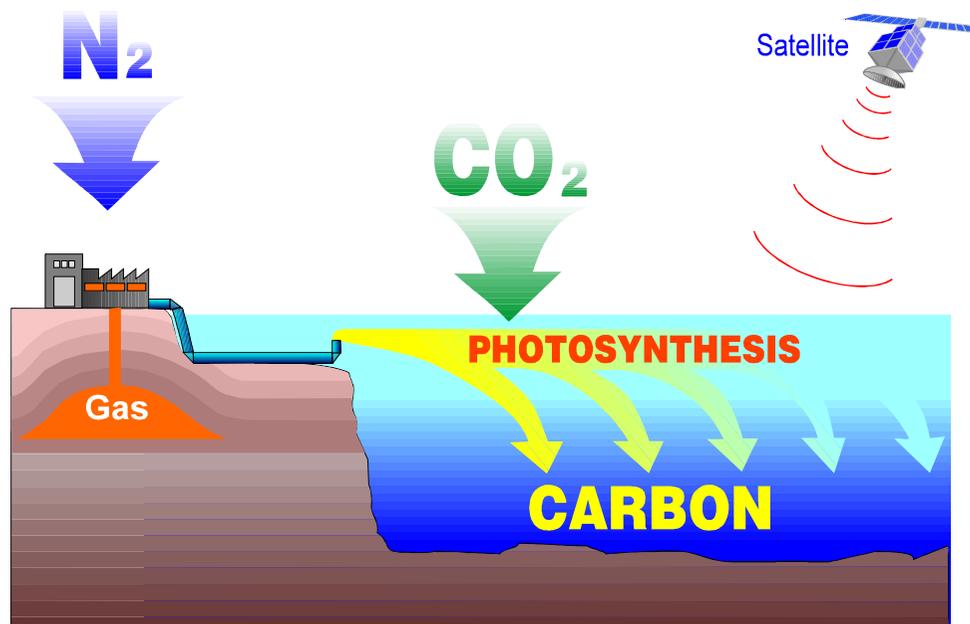
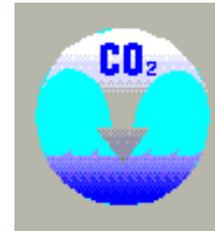




Sulu Sea phytoplankton

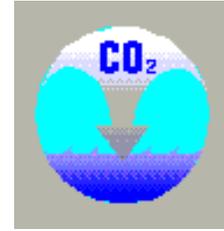


Ocean Nourishment

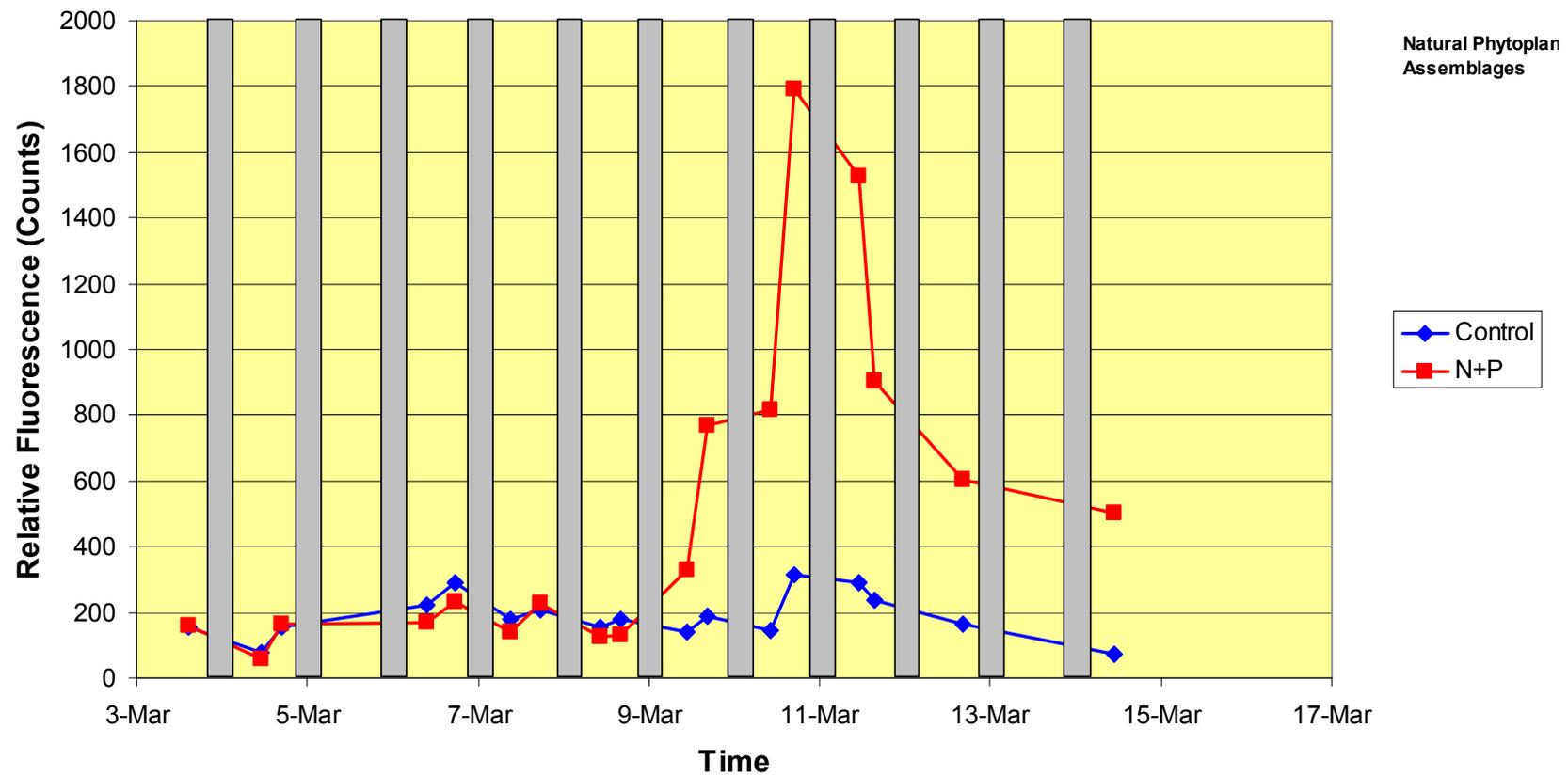




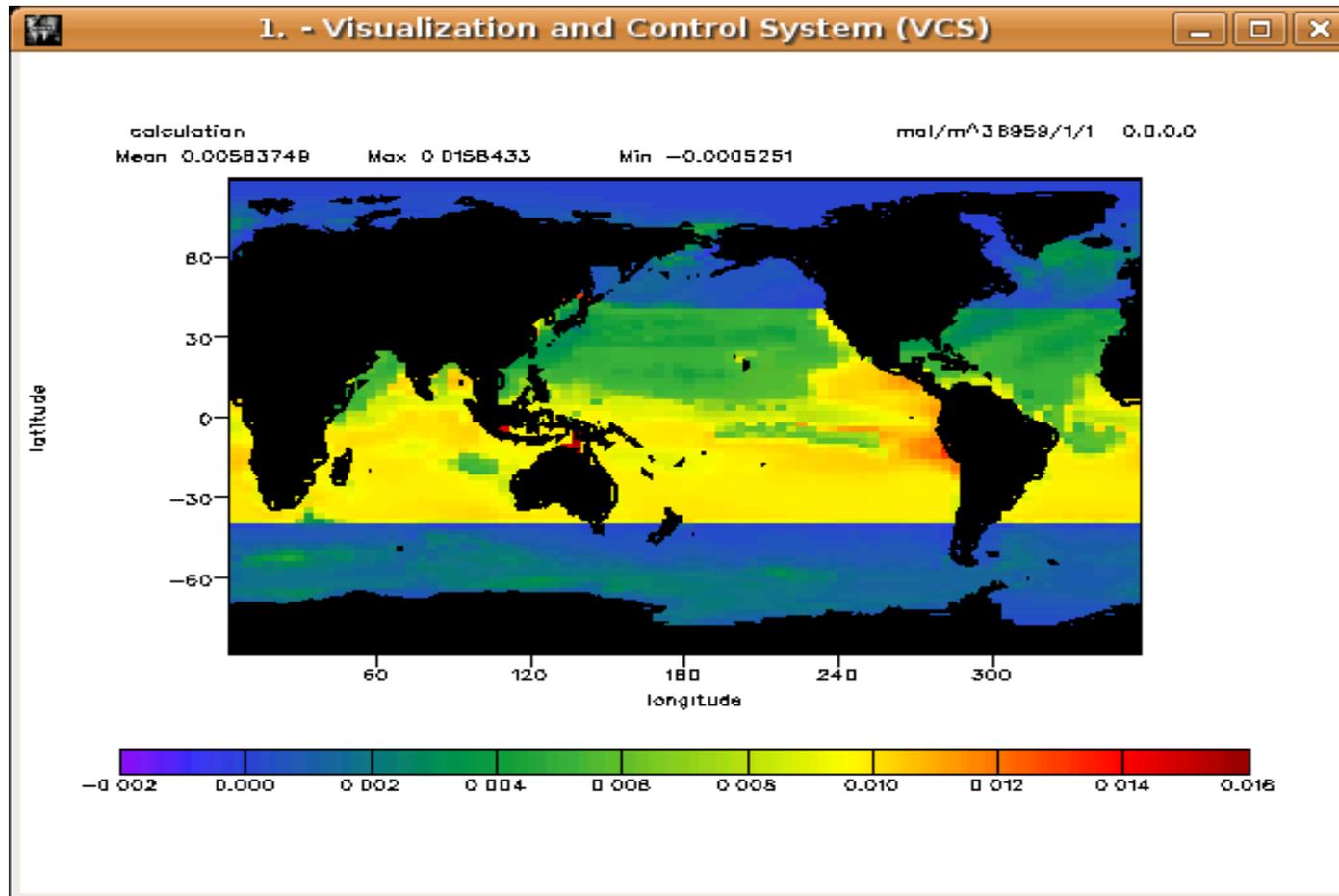
Large scale culturing



Culture bottle



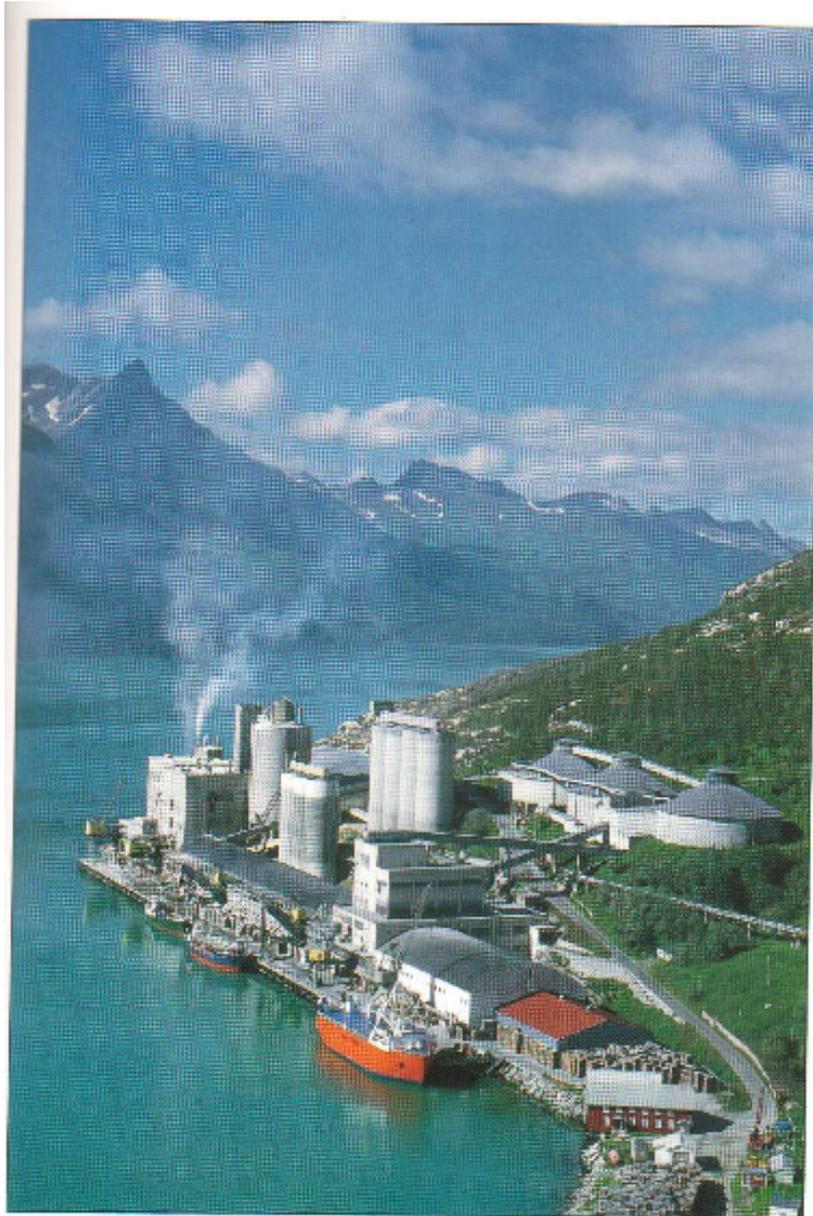
Modelling



0.016 mol / m³ of reactive nitrogen in surface layer. It is enough to store 7 GtC once.

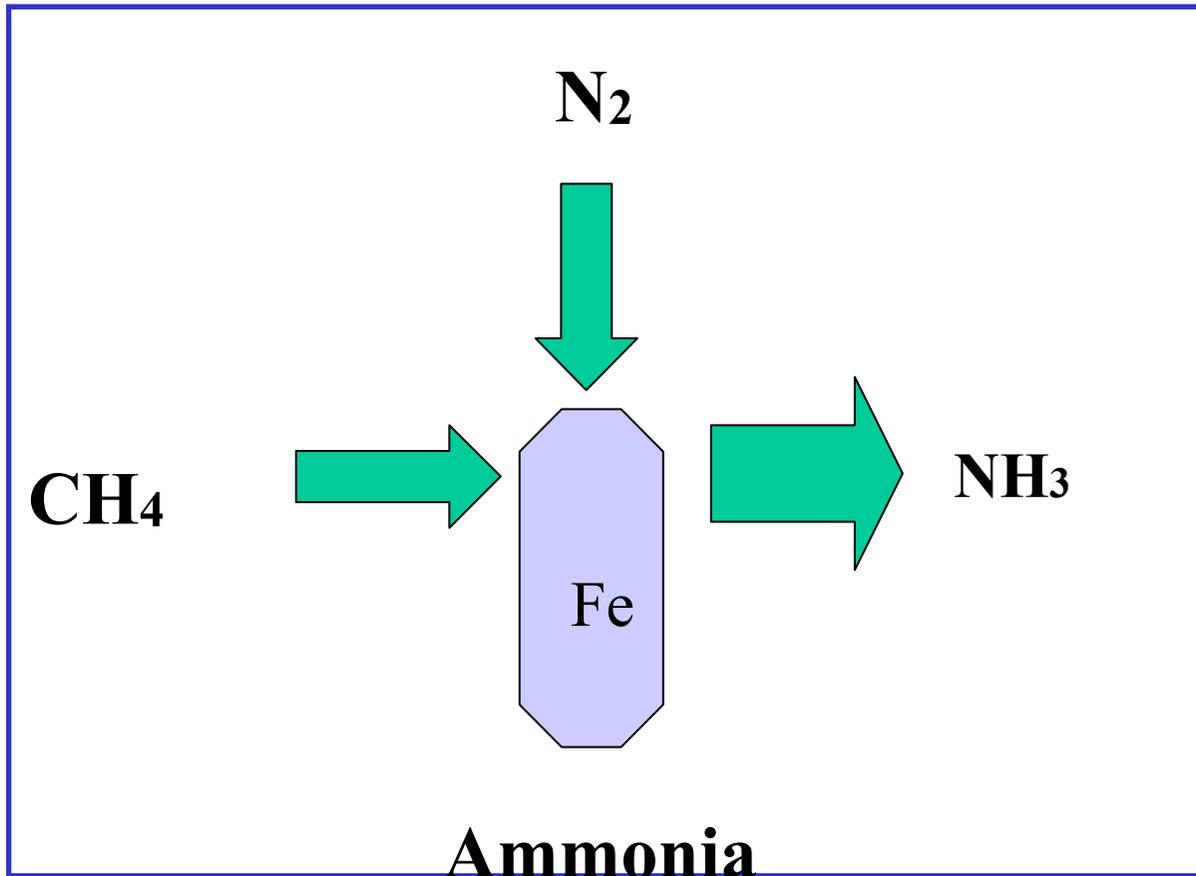


Nitrogen manufacture



*NPK fertilizer factory, Glomfjord, Norway.
Photo: K. Foss, Norsk Hydro.*

Nutrient manufacture



Nitrogen – catalyst



Transport catalyst not CO₂

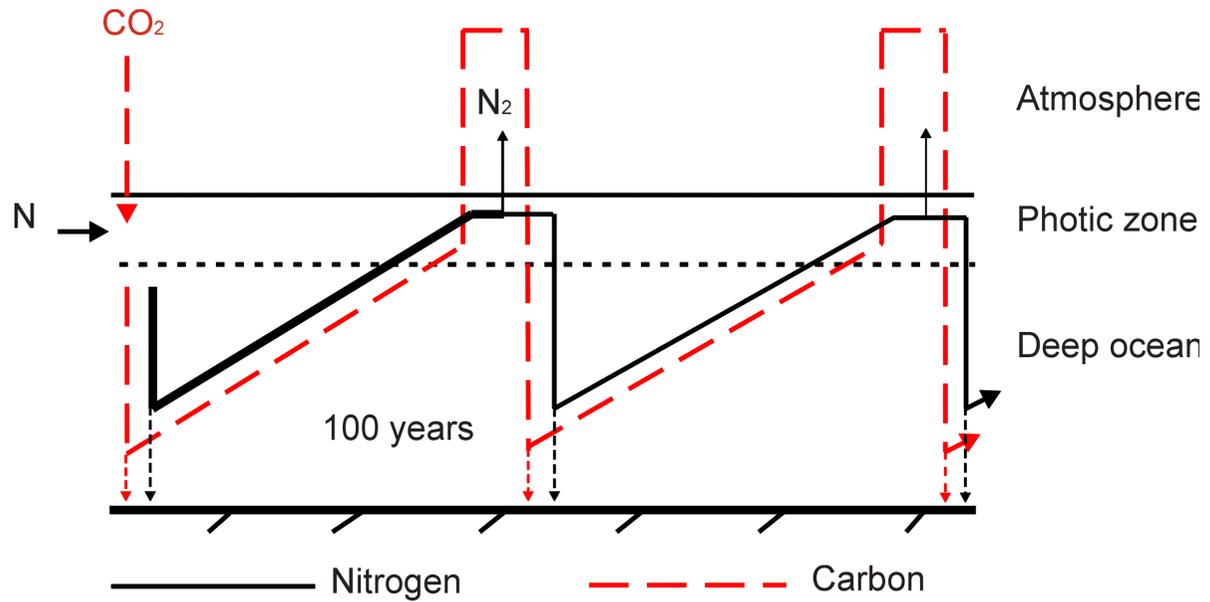
N : C : CO₂

1 : 7 : 26

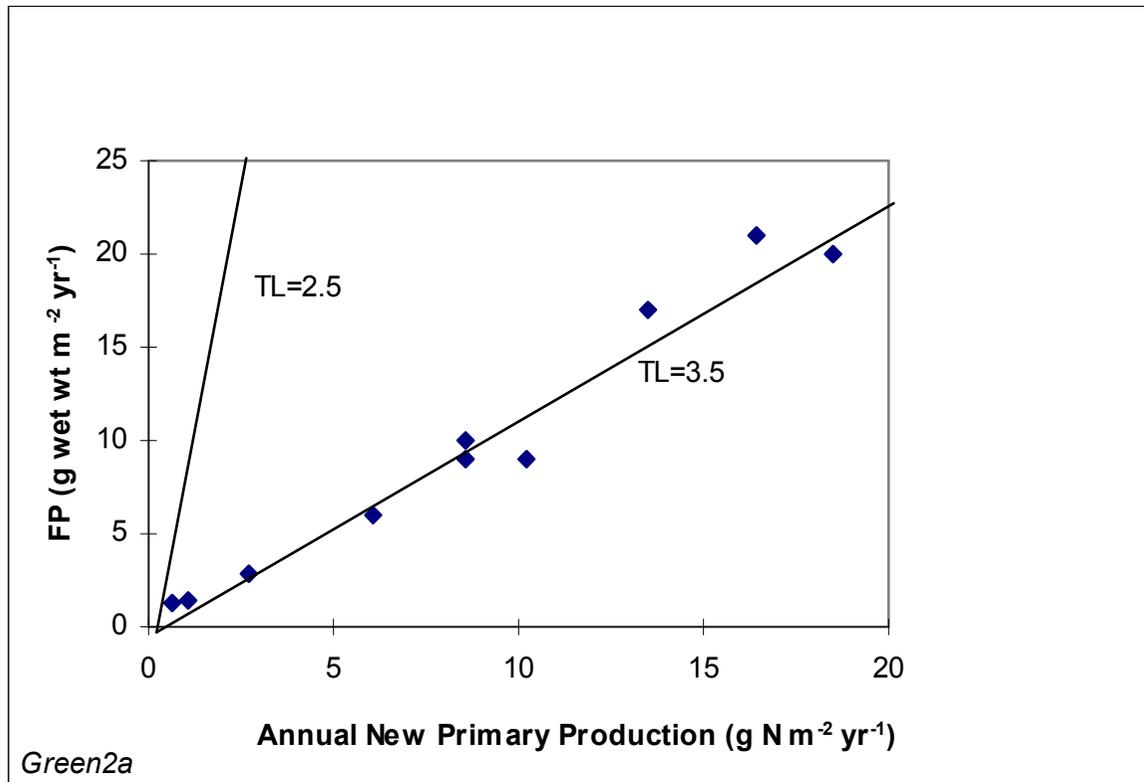
Redfield equation



recycling

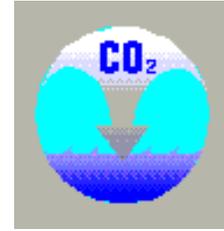


Fish stocks





Cost of fish



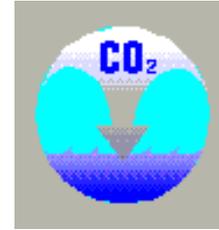
Details Jones 2004

Ocean Nourishment

One tonne Nitrogen =

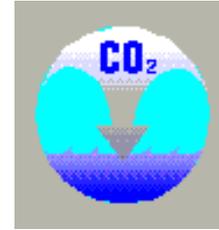
One tonne sustainable fish catch

Carbon credit benefit: free fish worth \$100s per tonne



Conclusions

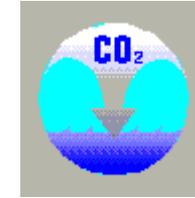
- Ocean is an overlooked opportunity
- Already 40,000 Gt C
- Post Kyoto needs to allow this opportunity to be available



Conclusions

- Food security is problem for the coming decades
- Ocean is an opportunity here also

Ocean Carbon Storage further information



<http://mee.k.u-tokyo.ac.jp/ona>

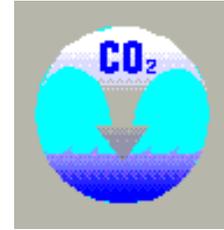
<http://www.otg.usyd.edu.au>

<http://www.oceanourishment.com>

Journal papers

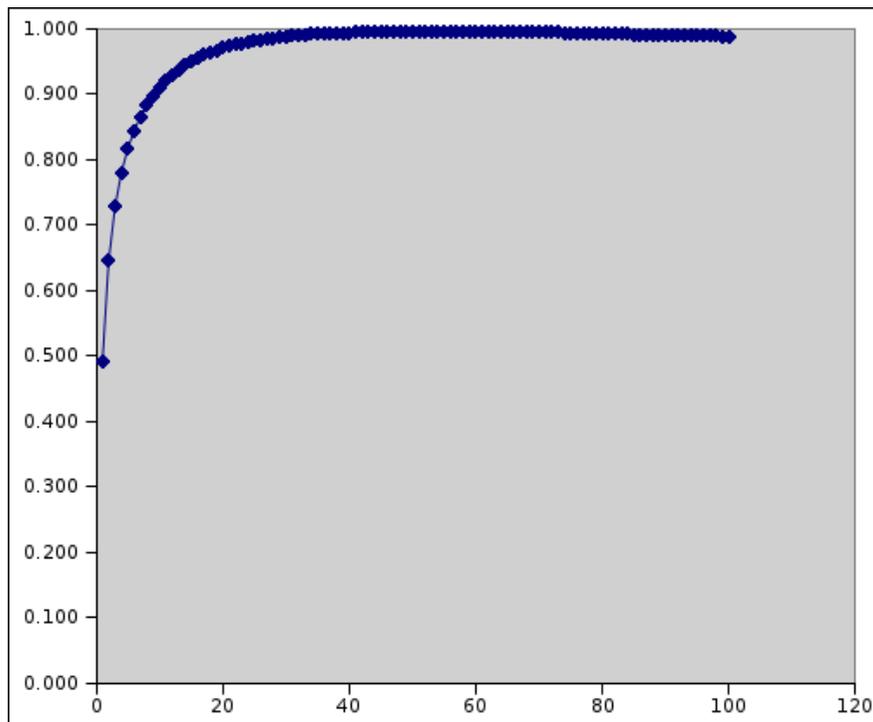
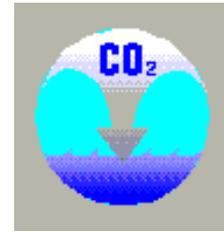
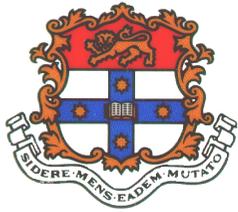


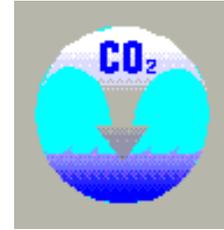
University of Sydney



But what about the fish?

**One plant 1,000,000 tonnes of
sustainable fish per year**





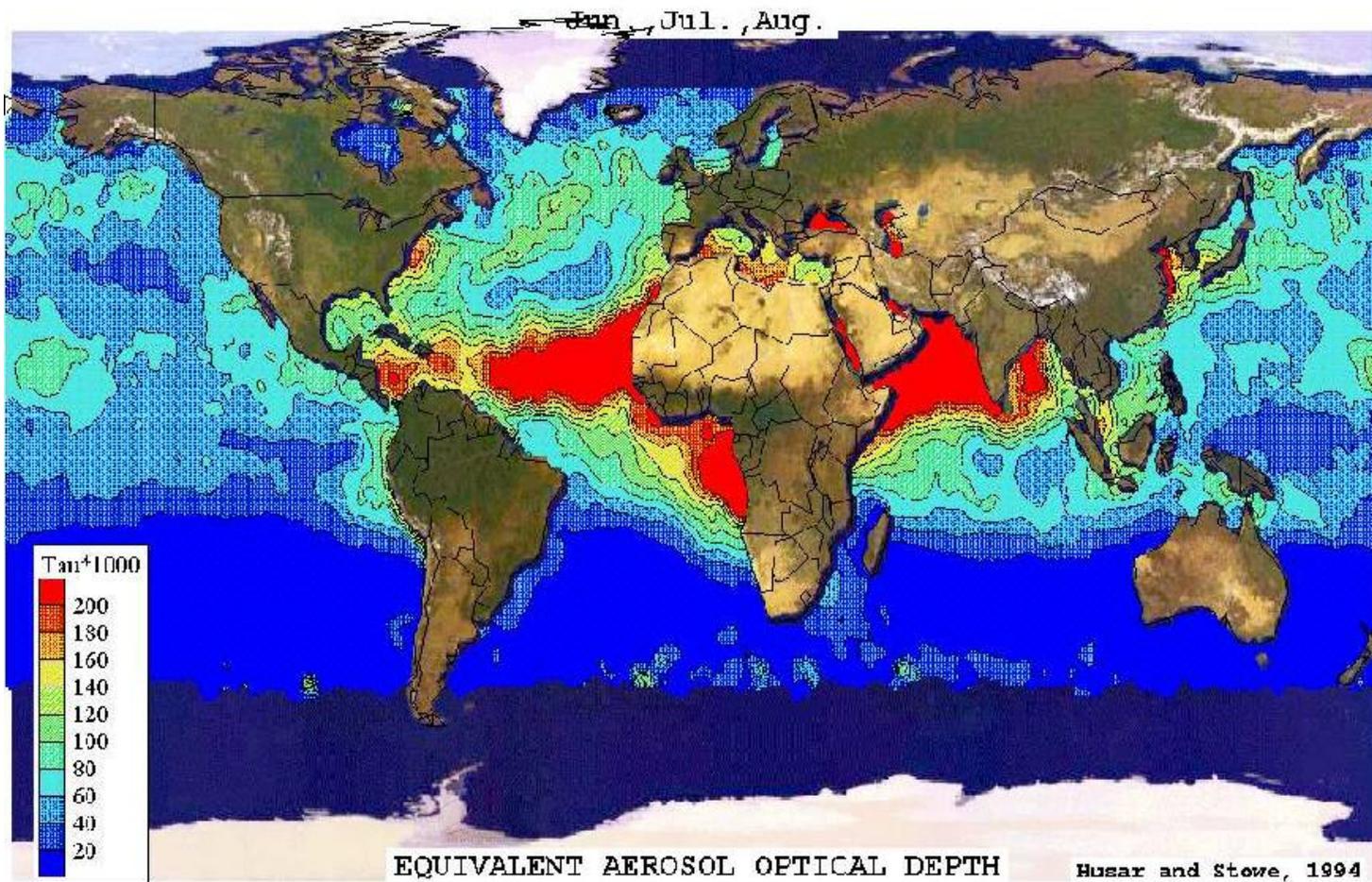
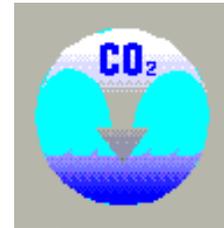
**5,000,000,000 tonnes of carbon per year
cycles thru the deep ocean**

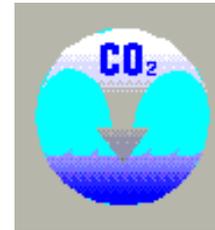
Residence time = 100s of years

Total carbon in the pipe = 600GtC



dust





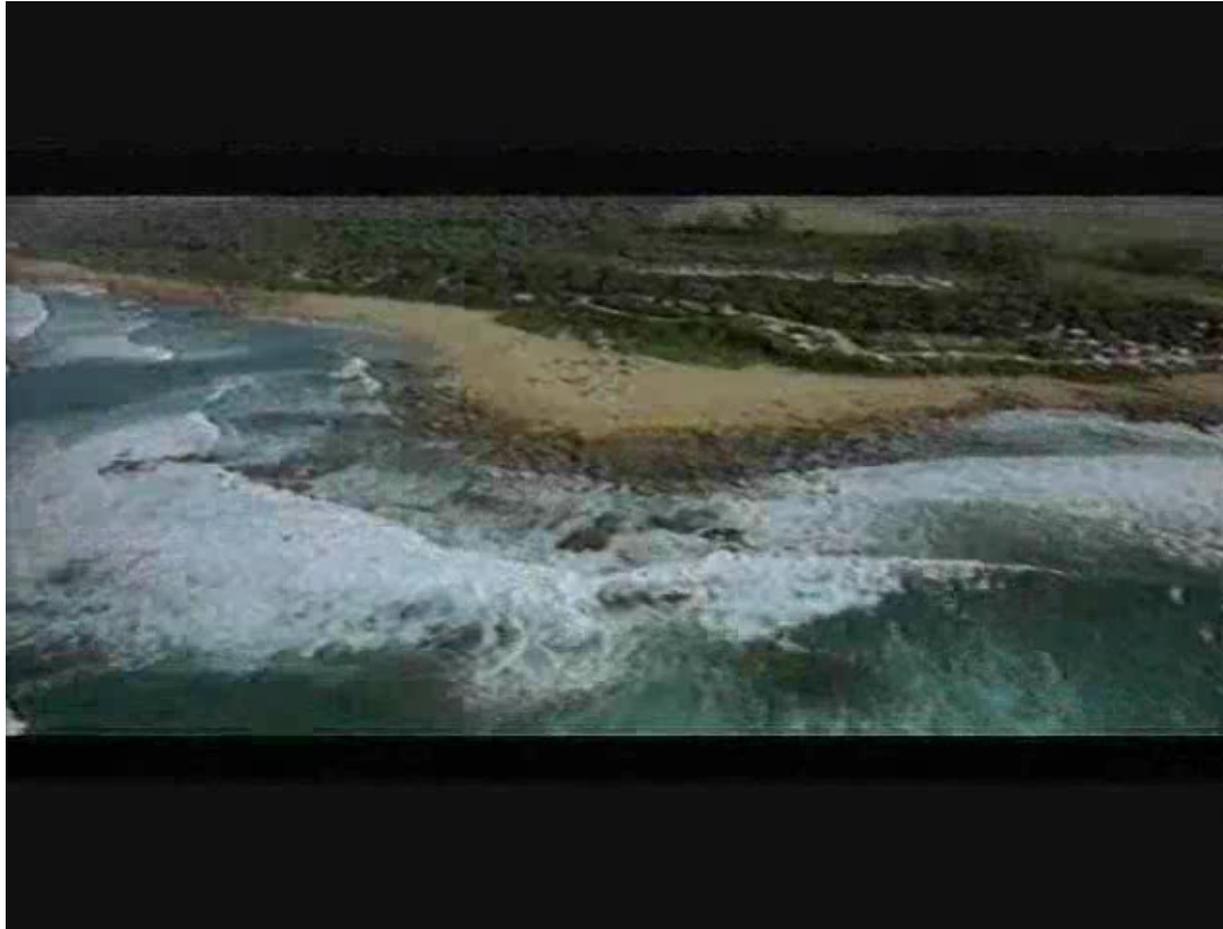
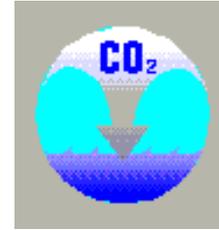
5 Ways to save the world

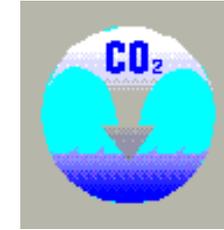
Broadcast by BBC in March 2007

geoengineering



Richard Attenborough





Carbon Credits

The cost range (Shoji & Jones, 2001) urea

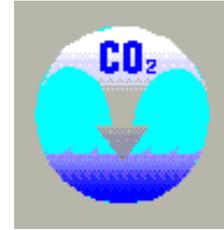
US\$7 –US\$18 per tonne of CO₂

Capital costs

US\$ 300million for 10million tonnes/yr



Benefits



Adaptation savings

Energy savings

Marine protein

