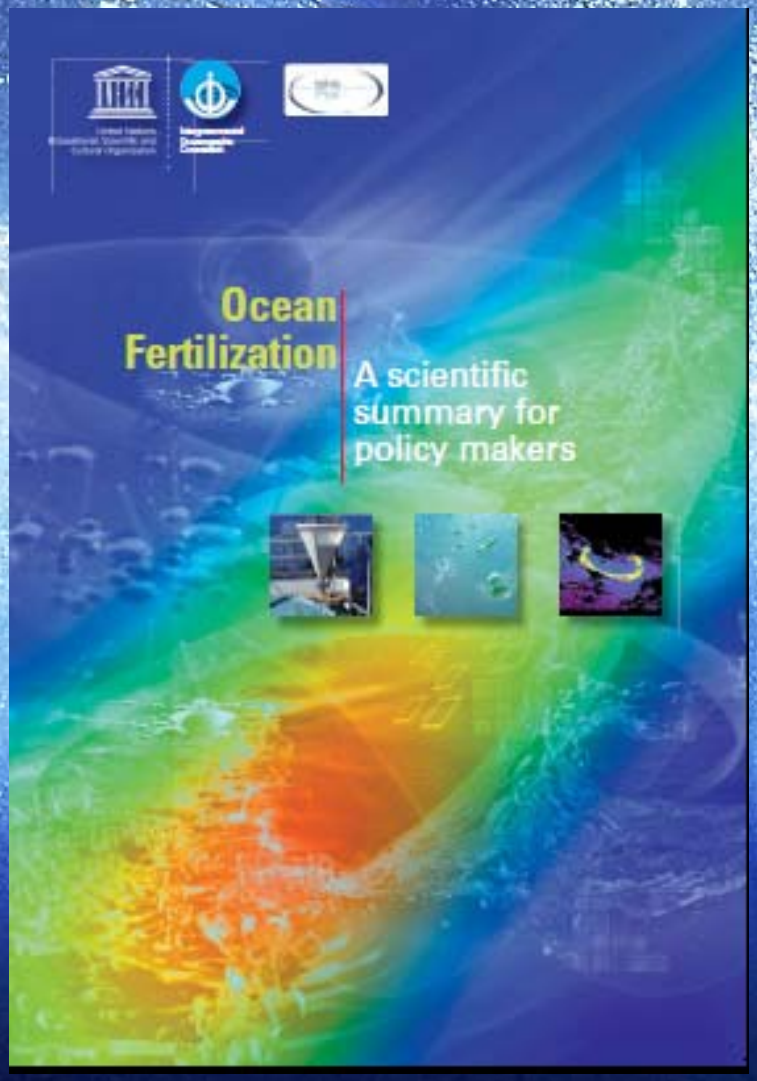


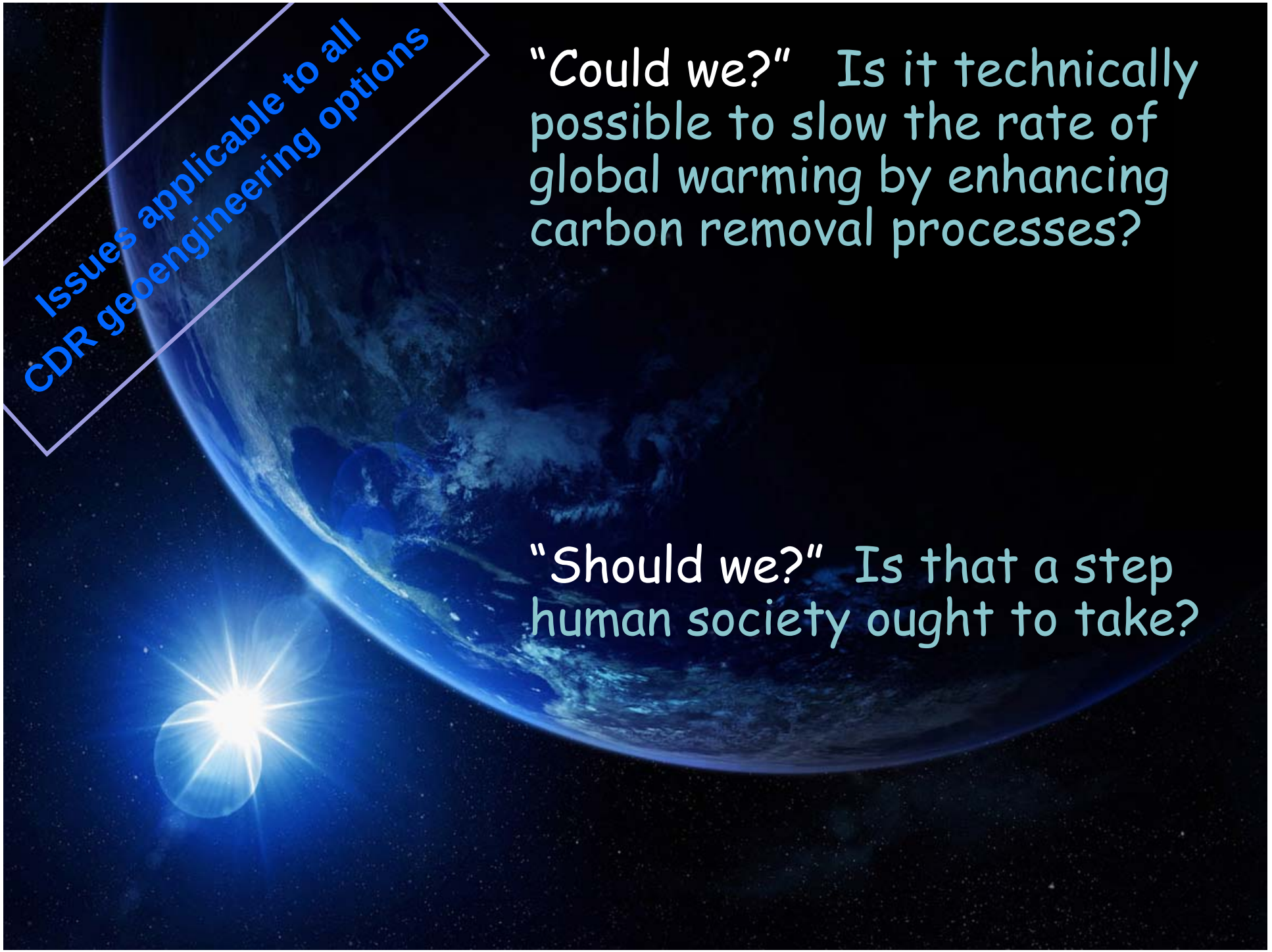
Ocean fertilization

An overview of an 'early promise' geoengineering technique for carbon dioxide reduction

Phil Williamson
p.williamson@uea.ac.uk

GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme

UNFCCC SBSTA
Bonn 2 June 2011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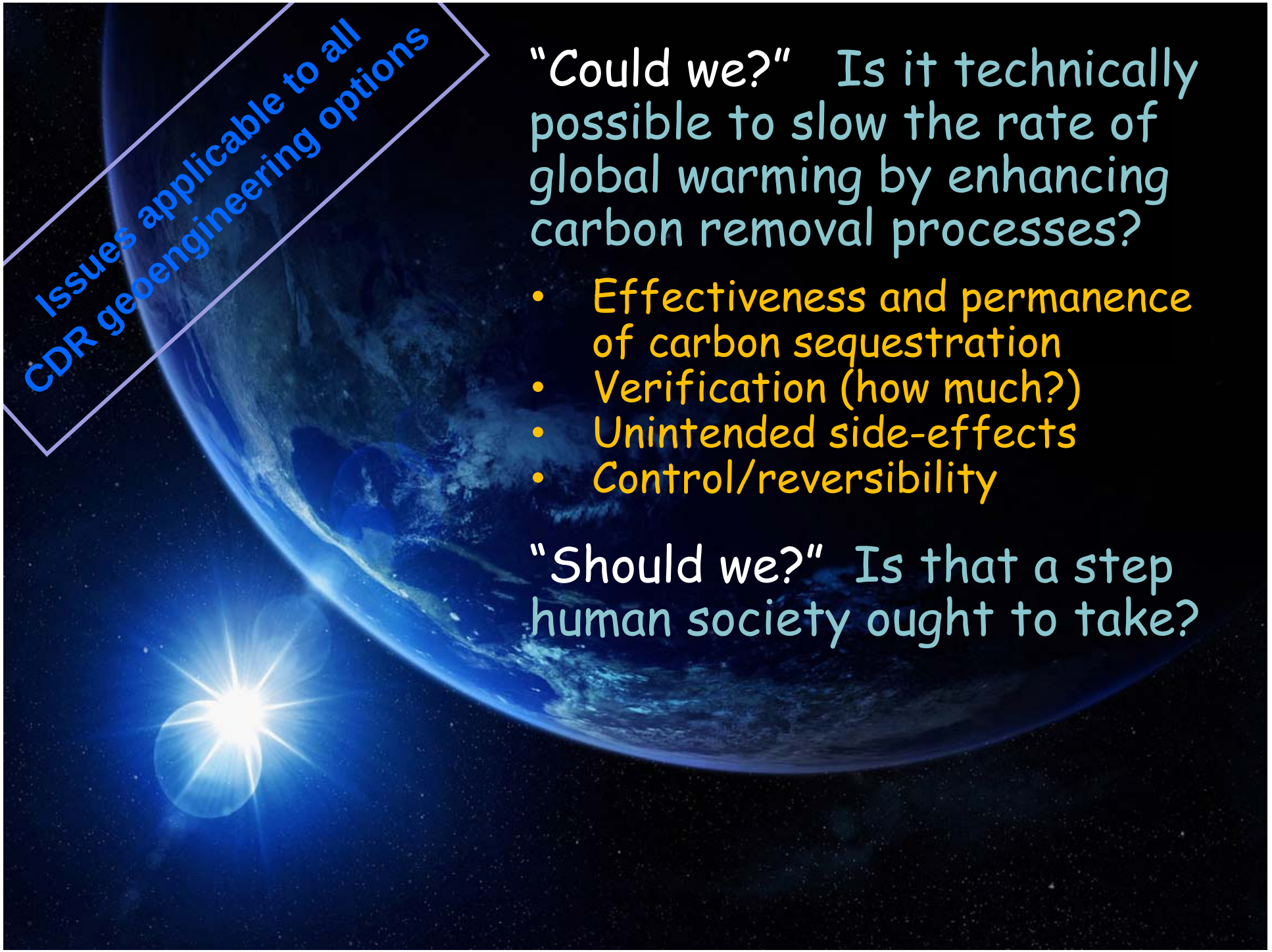
"Could we?" Is it technically possible to slow the rate of global warming by enhancing carbon removal processes?
"Should we?" Is that a step human society ought to take?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"Could we?" Is it technically possible to slow the rate of global warming by enhancing carbon removal processes?
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• Unintended side-effects
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• Cost effectiveness ($)
• Benefits v risks (equity)
• "Treadmill" (exit strategy)
• Who pays - and how?
• Who decides? (governance)

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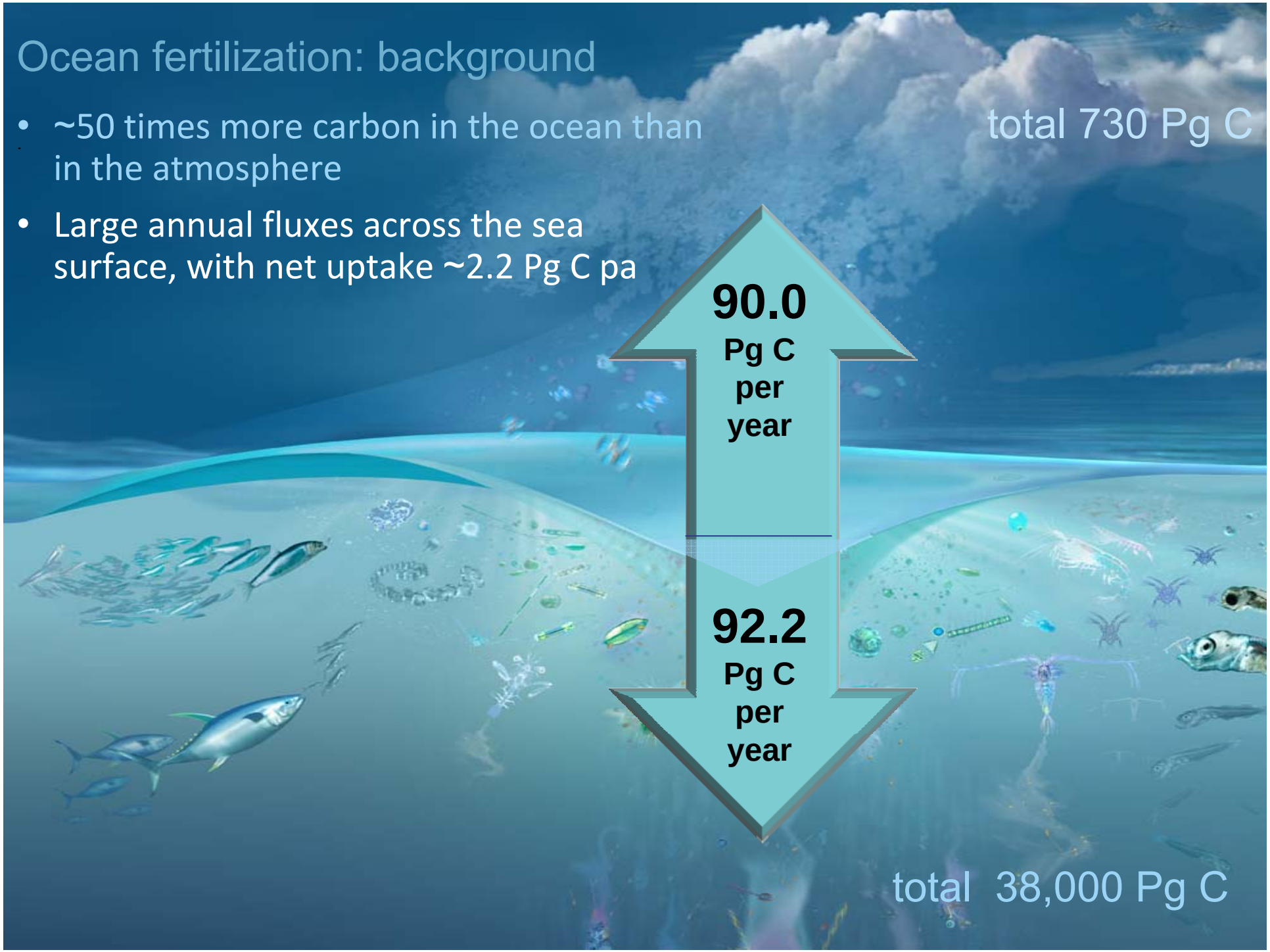

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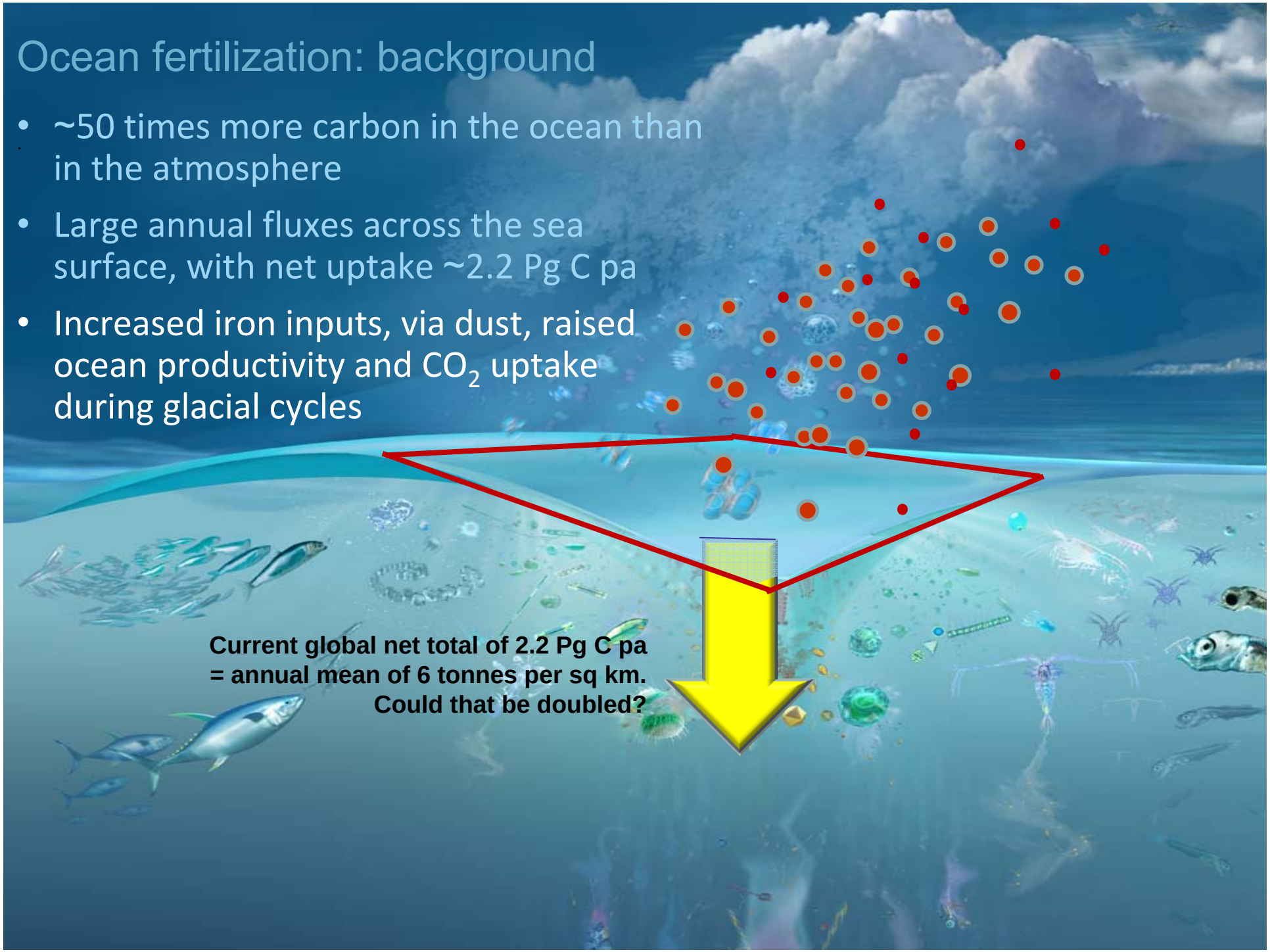

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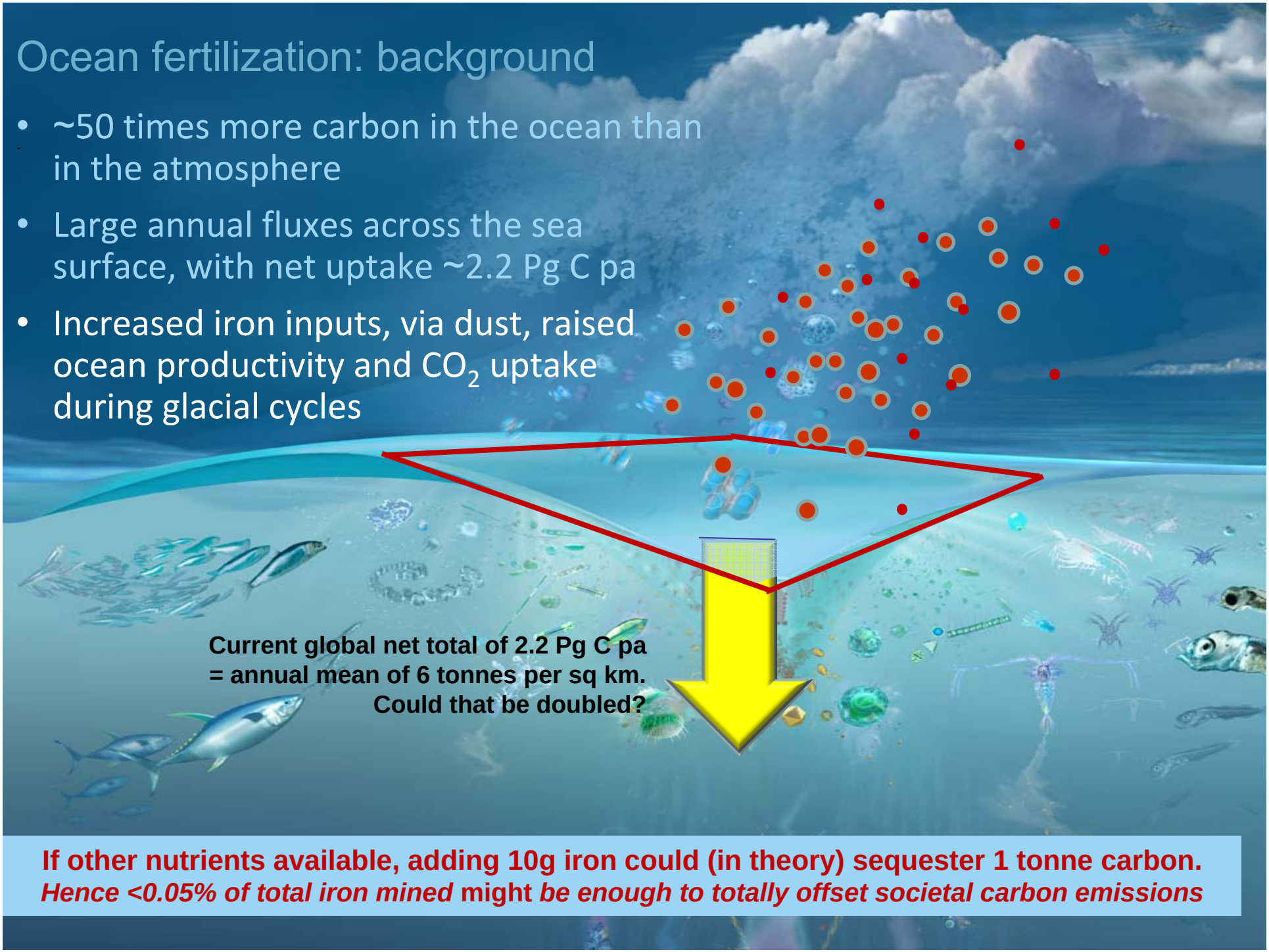

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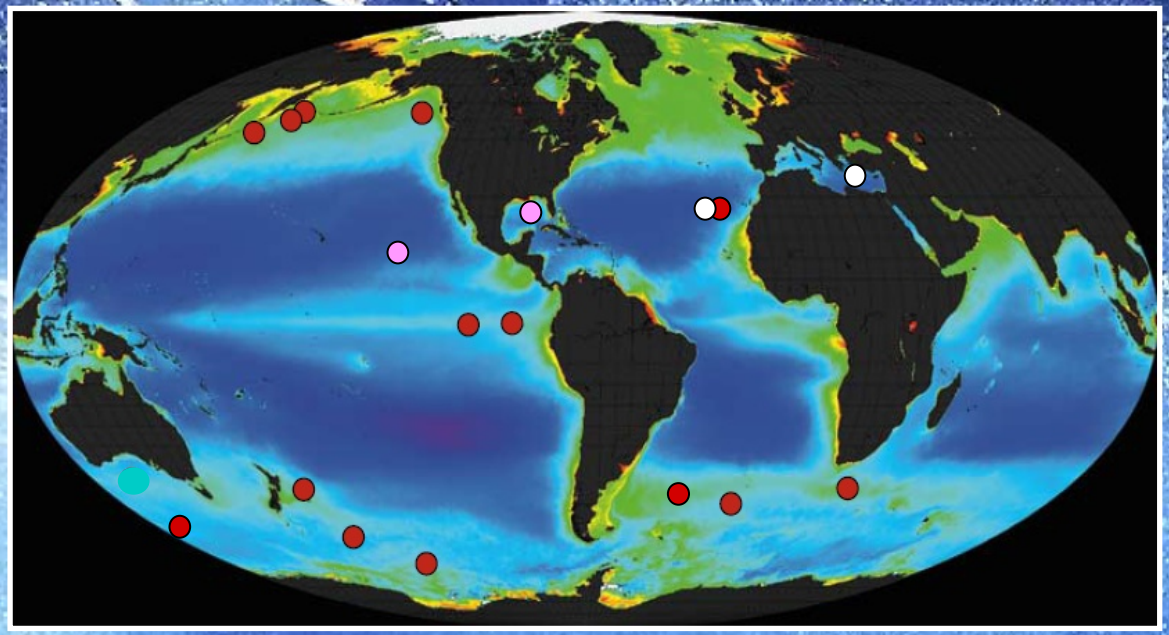
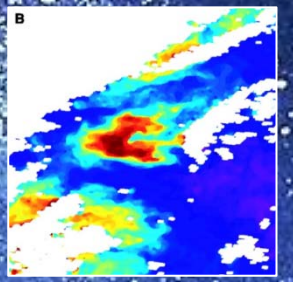
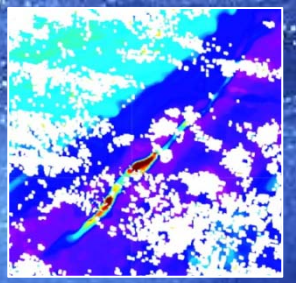
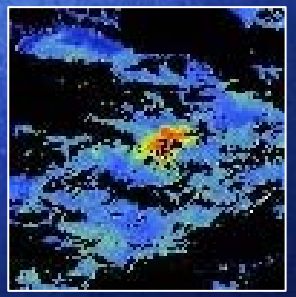
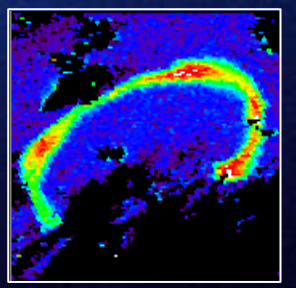
If other nutrients available, adding 10g iron could (in theory) sequester 1 tonne carbon.
Hence <0.05% of total iron mined* might *be enough to totally offset societal carbon emissions







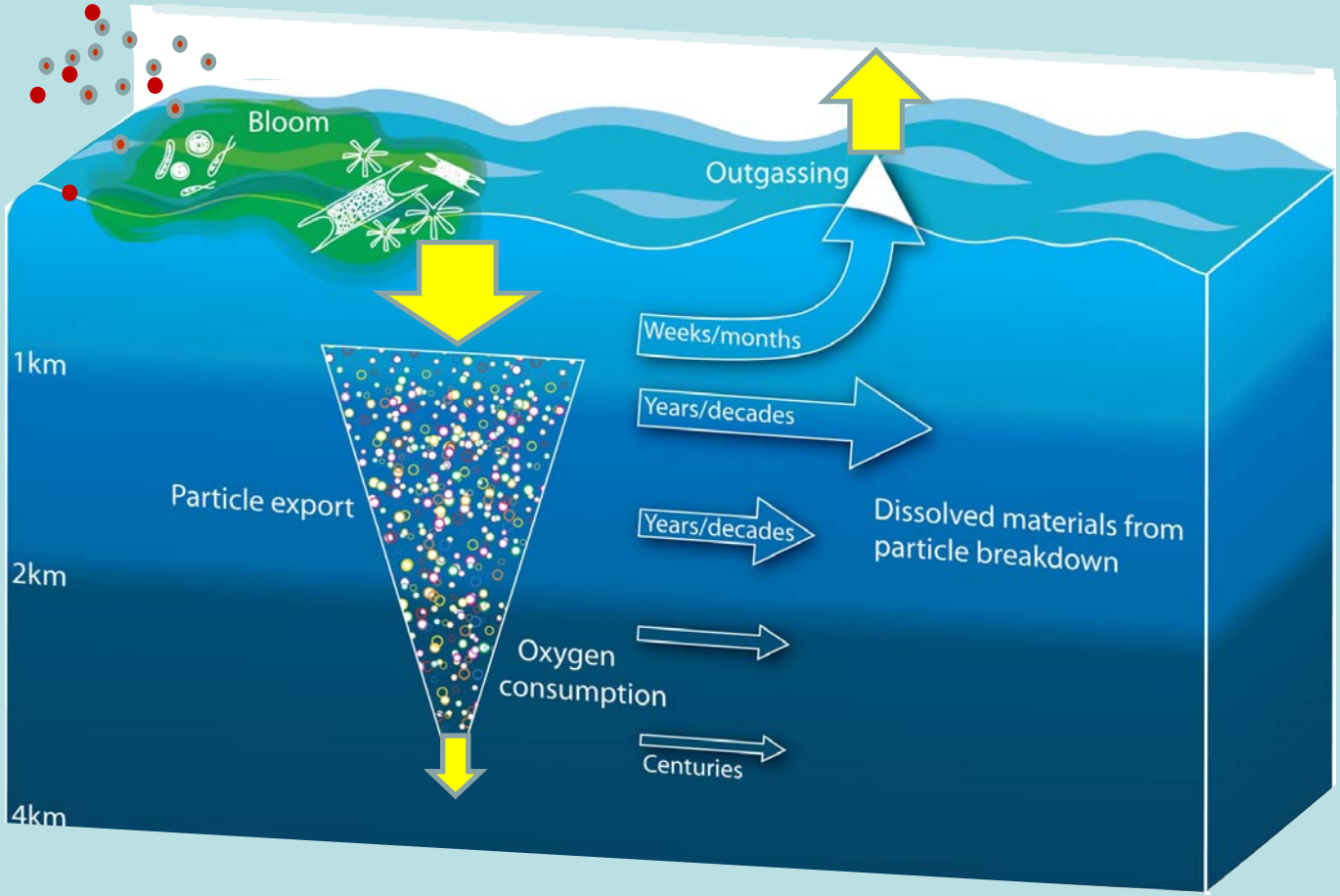




13 iron addition experiments (●), two commercial trials (●) and two phosphate addition experiments (○) have been carried out to date, at scale of 10-100 km^2. Most induced a phytoplankton bloom, but only three conclusively demonstrated increased carbon export to deeper water.

Map background: Satellite-based ocean primary production
Small images: Examples of experimentally-induced blooms. Cloud cover is white in upper images, black in lower ones.

Unresolved issues for ocean fertilization



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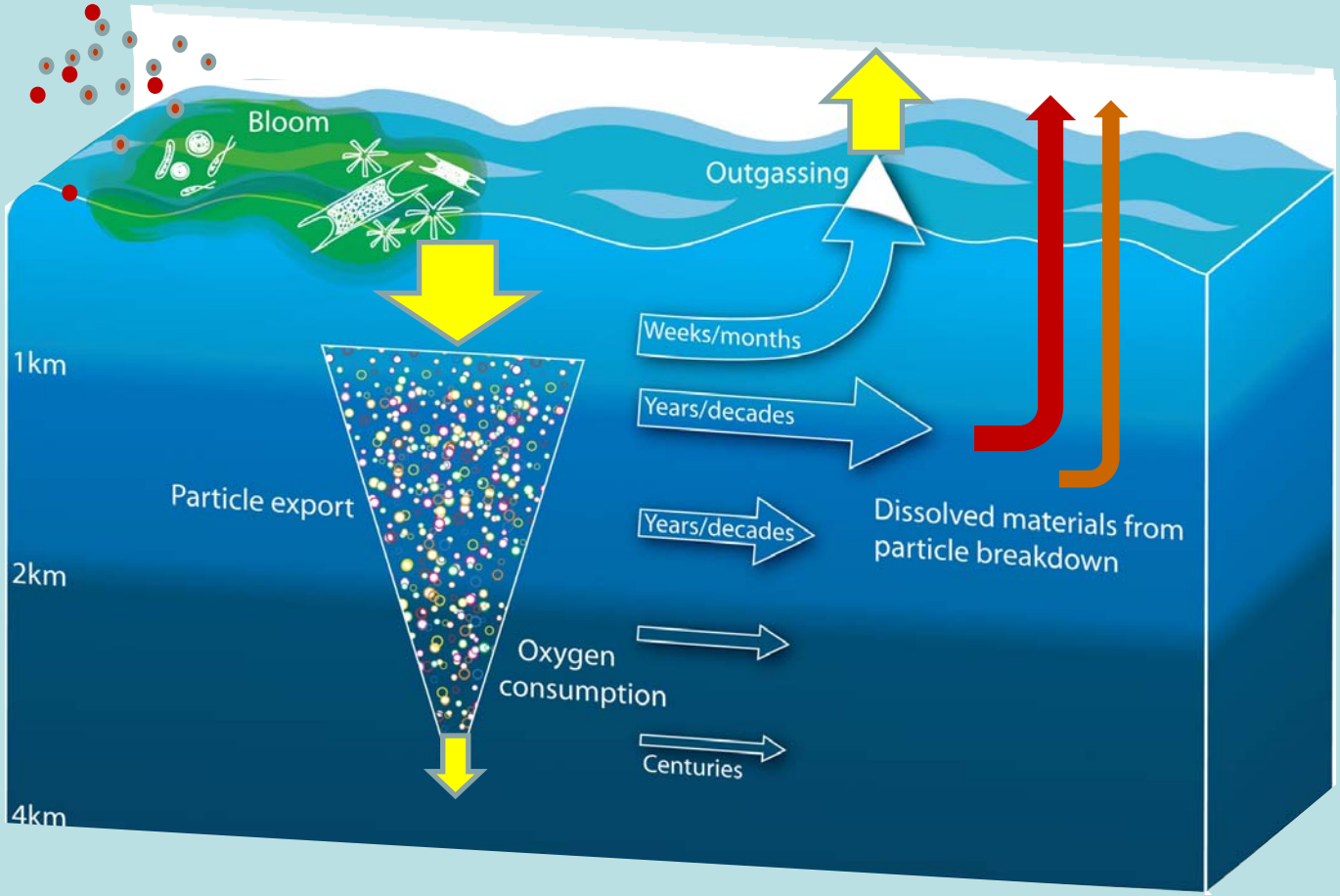

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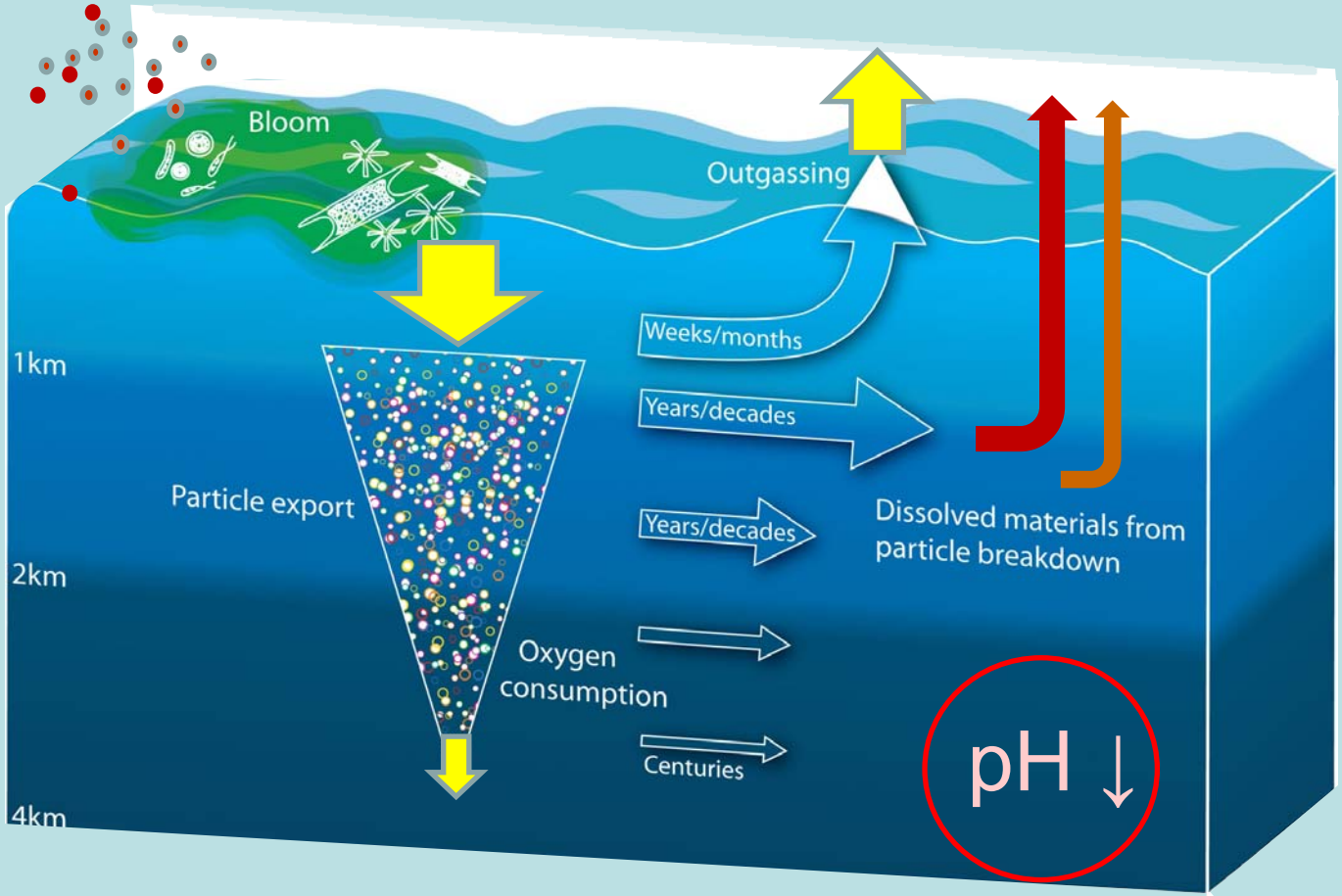

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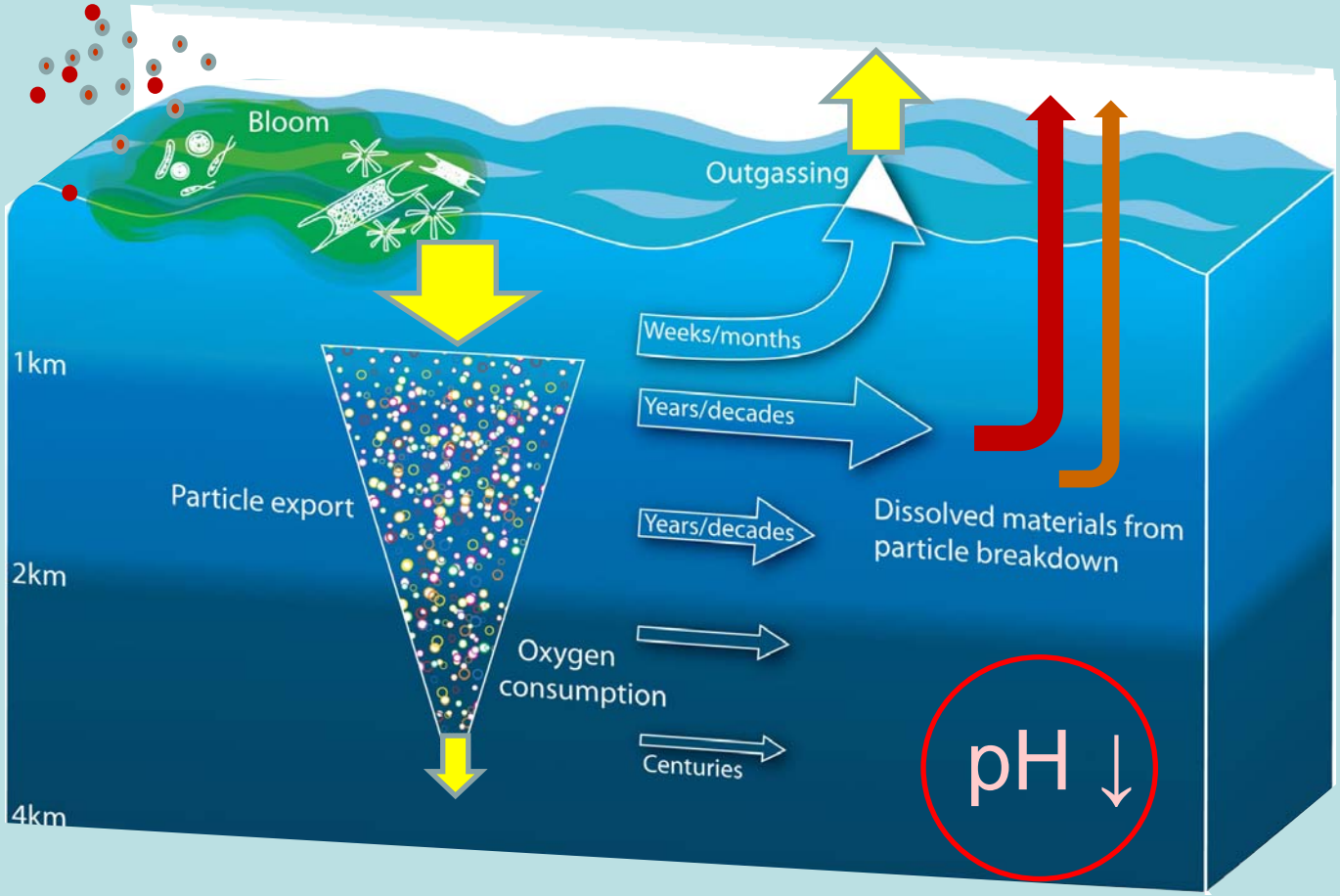

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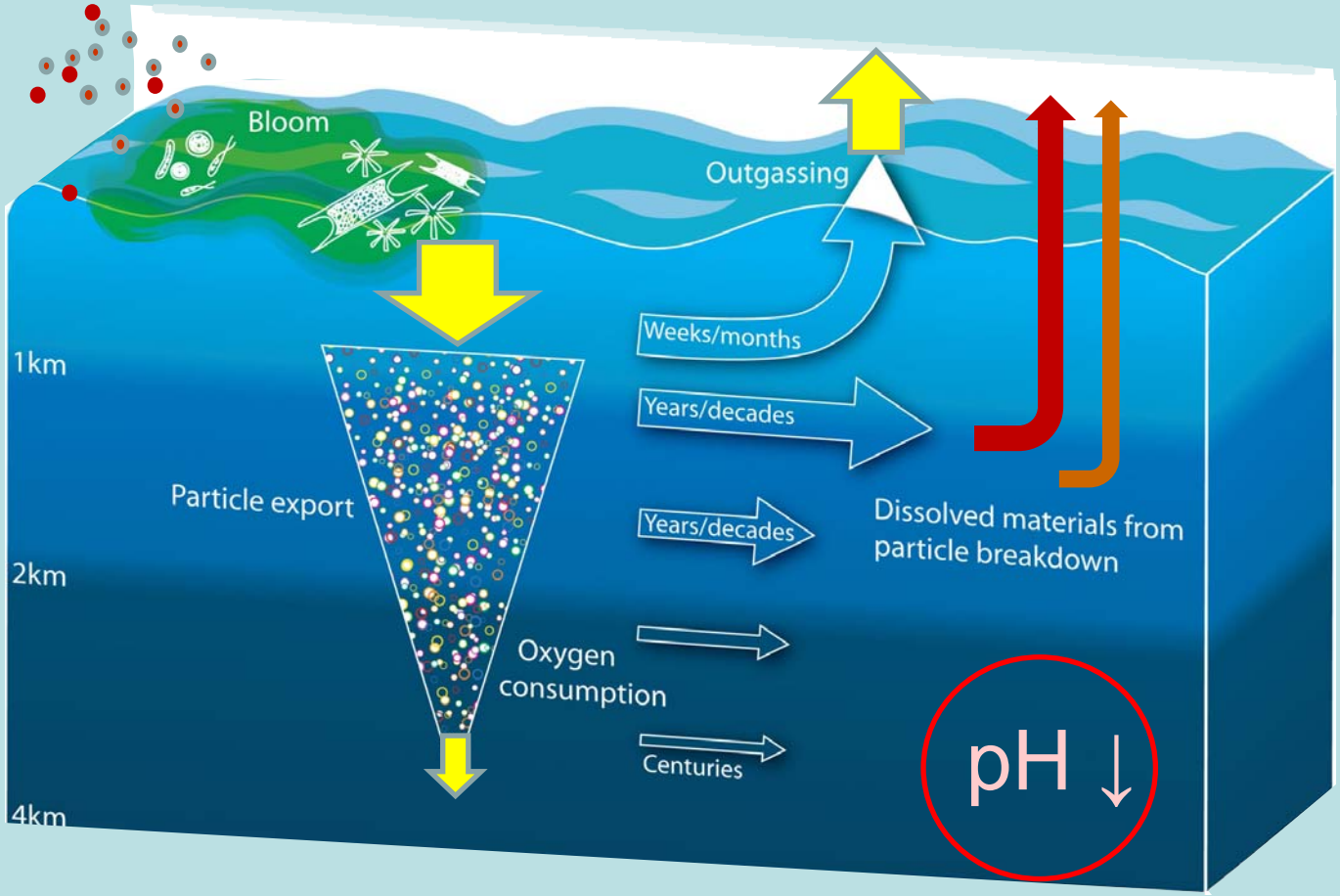

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To answer these questions, experiments at scale of 1000-10,000 km^2 over time period of months-years are required. *These would require an impact assessment and international approval to comply with recent CBD and LC/LP decisions*

CBD: Convention on Biological Diversity

Moratorium on ocean fertilization activities until adequate scientific basis, with global regulatory mechanism... (exception for "small-scale studies in coastal waters") *COP Decision IX/16, May 2008*

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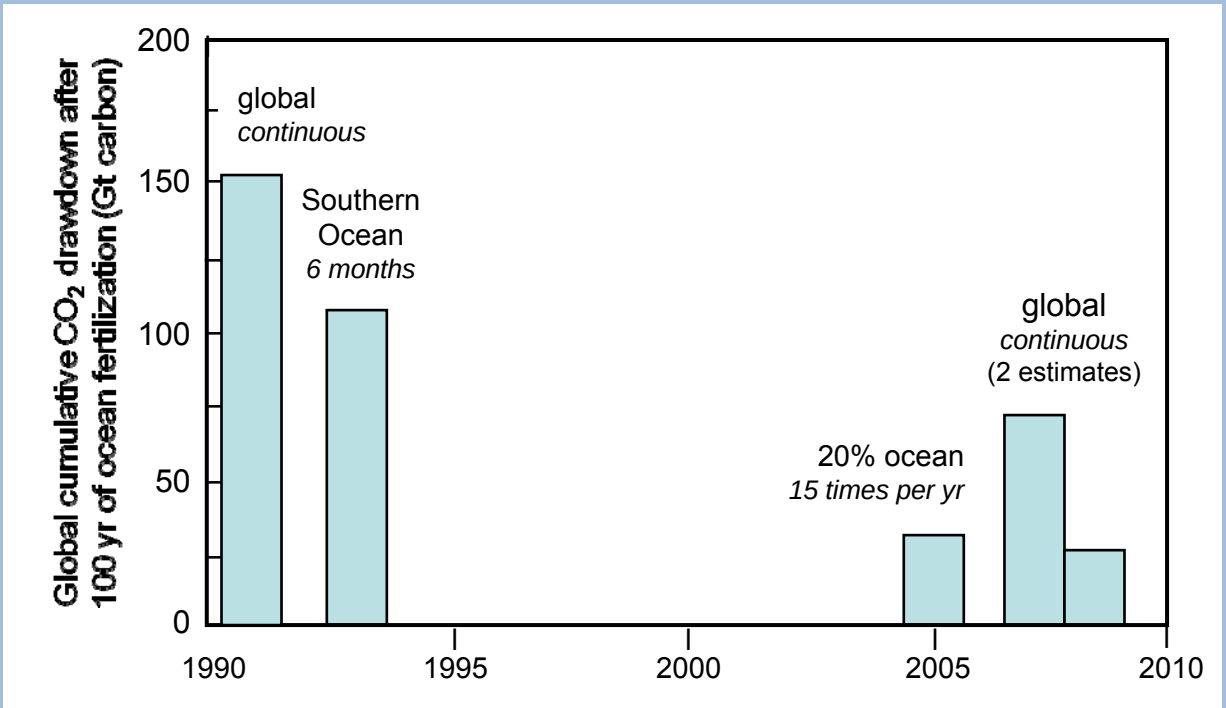
- **No ocean fertilization except legitimate scientific research**
- **LC/LP will develop regulatory mechanism, including framework for assessment**

LC/LP COP, Oct 2008

Modelling studies are still possible...



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- Greatest effect in Southern Ocean
- If Southern Ocean excluded, maximum benefit <0.2 Pg C pa
- Does not take account of possible increased release of CH_4 and N_2O

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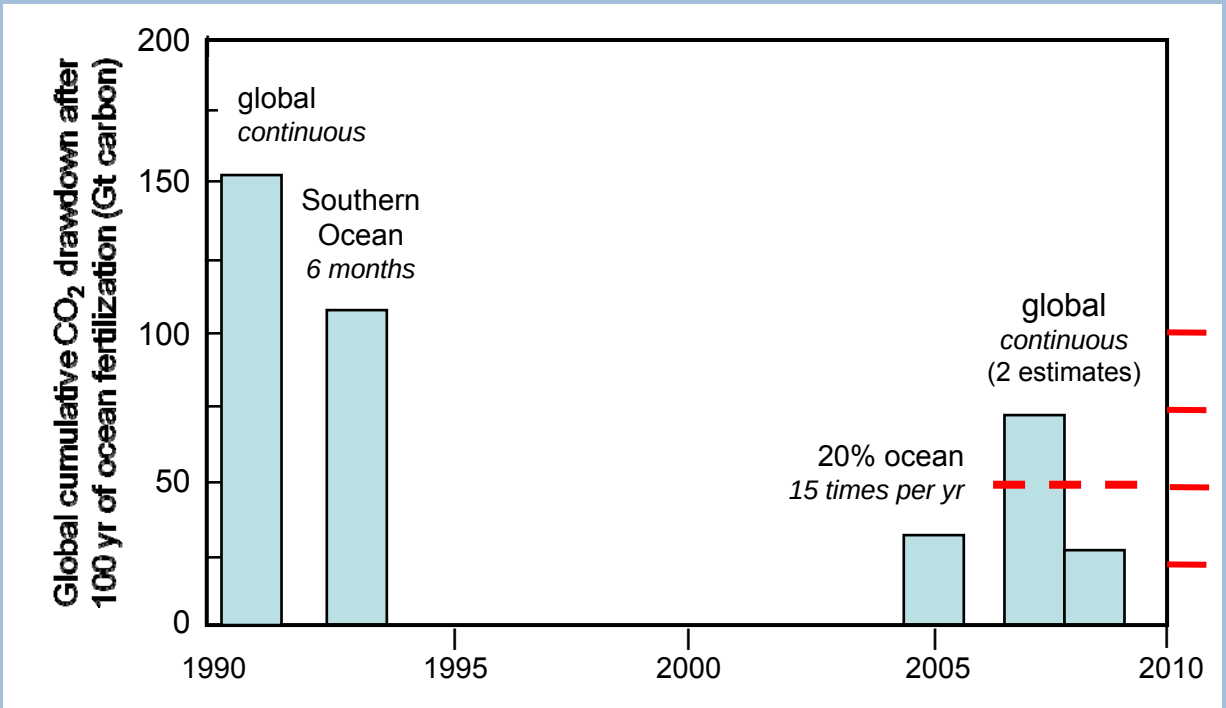

Estimated max. global carbon drawdown over 100 years

1.0 Pg C pa

0.5 Pg C pa

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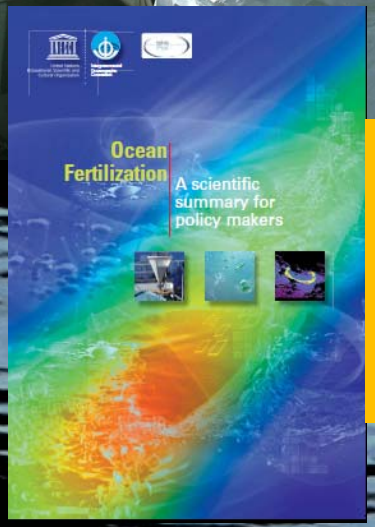

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Scientific Summary for Policymakers by IOC/UNESCO (Intergovernmental Oceanographic Commission) and SOLAS/IGBP (Surface Ocean - Lower Atmosphere Study/International Geosphere-Biosphere Programme)
Wallace et al. 2011

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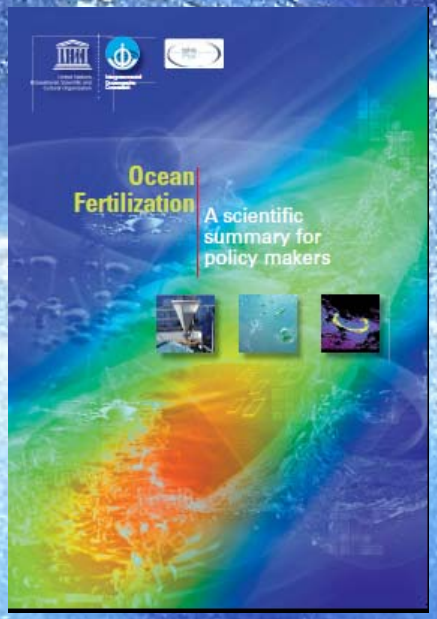

Ocean fertilization: a scientific summary for policy makers

The geoengineering technique we know most about – but still with many uncertainties

- **Effectiveness:** field experiments (at scale of 10-100 km^2) show CO_2 uptake can be enhanced – but with high variability
- **Permanence:** most of the extra carbon uptake will be returned to the atmosphere within a few months. Global net maximum < 0.5 Pg C pa?
- **Verification:** it will be challenging (=expensive) to quantify carbon sequestration and unintended impacts, and hence net climatic benefit
- **Political acceptability:** concerns on unintended impacts currently limit research. Large scale studies may fail 'precautionary principle'