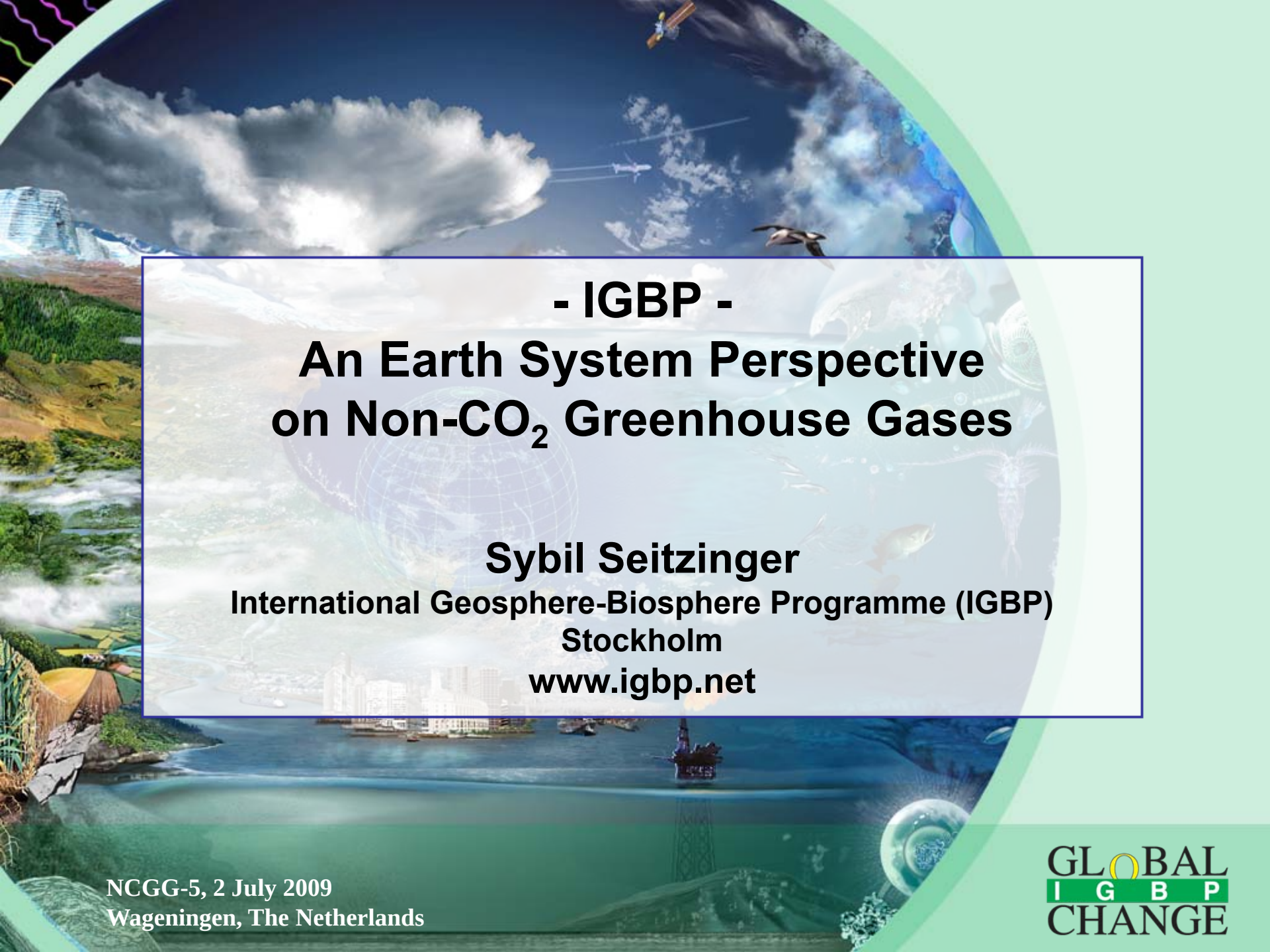

- IGBP -
An Earth System Perspective on Non-CO_2 Greenhouse Gases

Sybil Seitzinger
International Geosphere-Biosphere Programme (IGBP)
Stockholm
www.igbp.net

NCGG-5, 2 July 2009
Wageningen, The Netherlands

GLOBAL CHANGE IGBP

Studying the Earth System

Disciplinary research needed to understand the pieces of the puzzle

Some of the pieces lack detail, others are missing entirely - but…

GLOBAL IGBP CHANGE

Studying the Earth System

We need
to put together
the puzzle

Earth System
functions

Address policy
relevant questions

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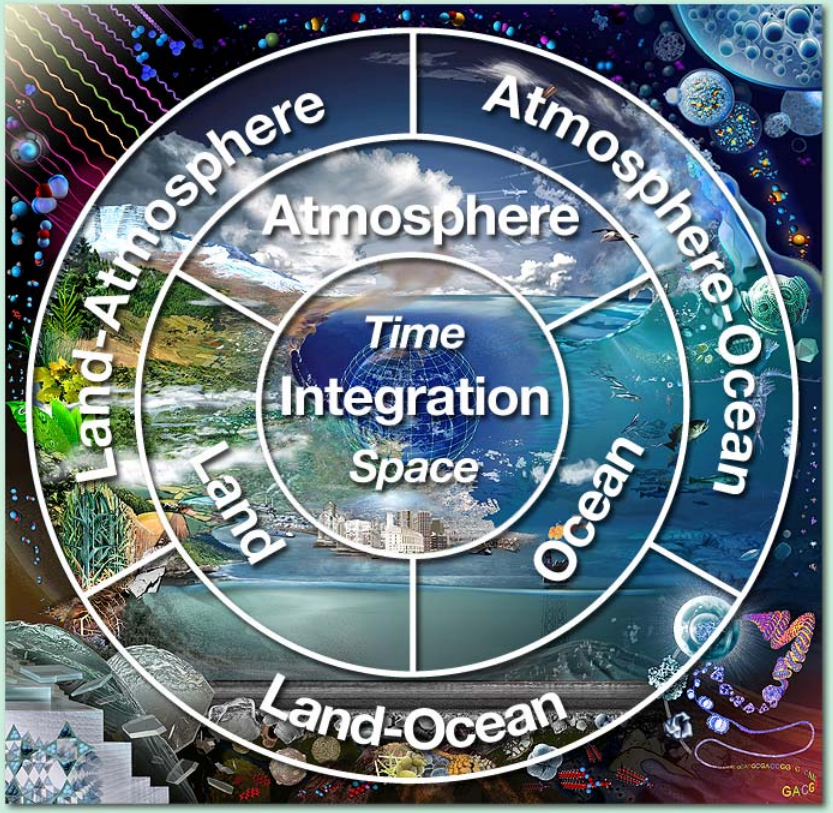
International Geosphere Biosphere Program
IGBP

- Interactions among biological, chemical, and physical processes and human systems
- Issues relevant to society
- Interdisciplinary
- Earth System context



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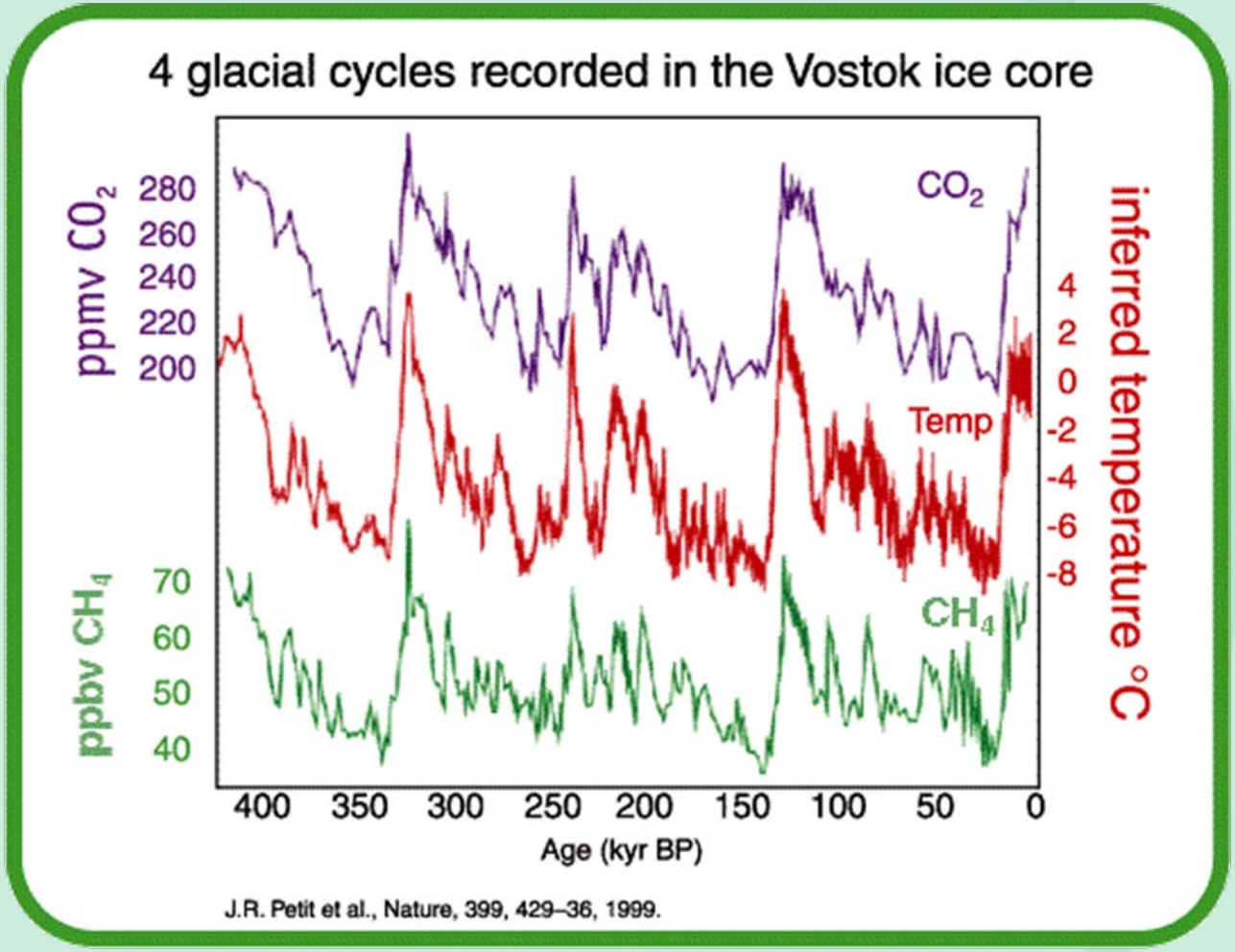
IGBP Core Projects

GLOBAL CHANGE
IGBP

An Integrated Earth System



The natural cycling of the planet

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An Integrated Earth System

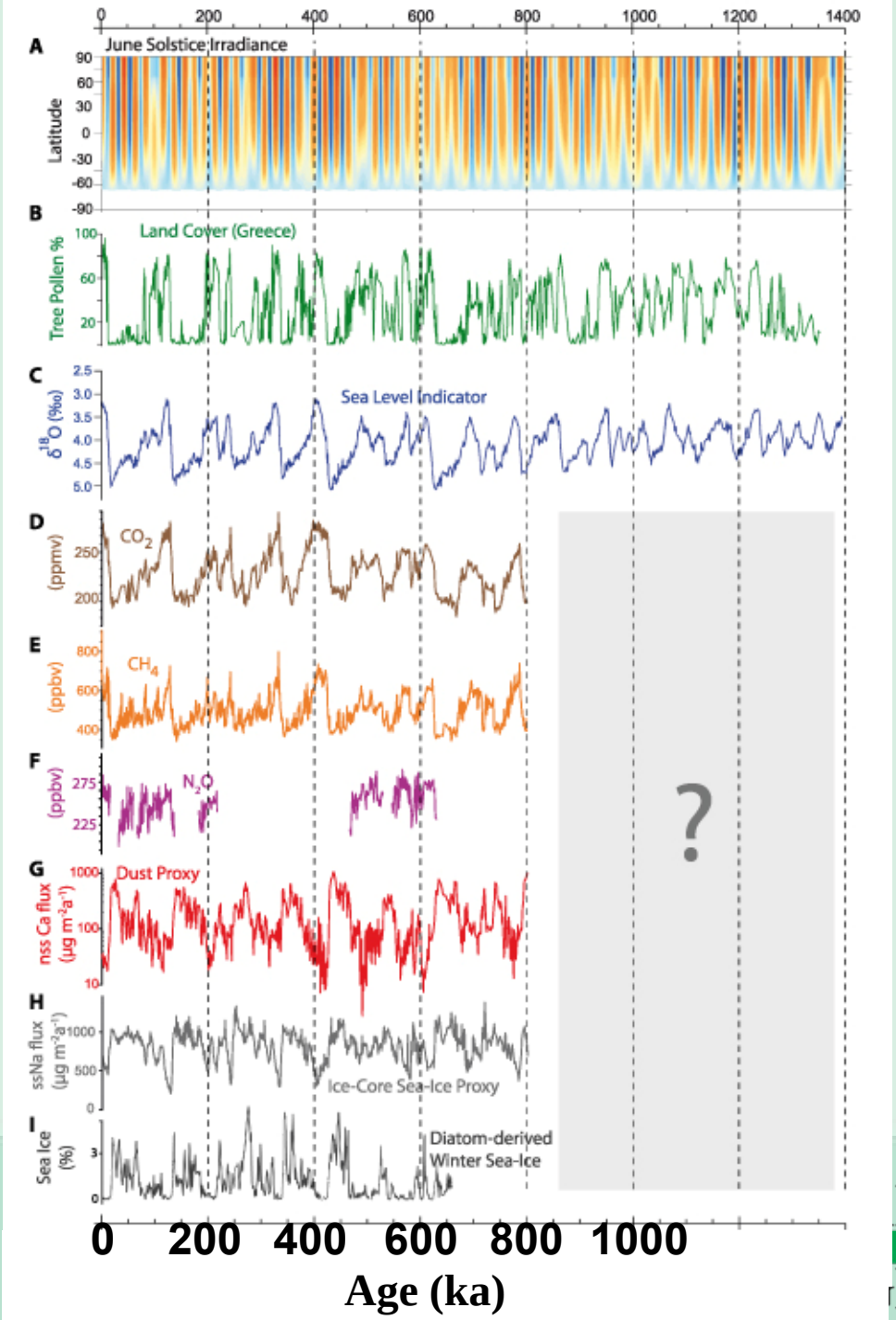
Sea Level Indicator del ^{18}O

CO_2, ppm

CH_4, ppb

N_2O, ppb

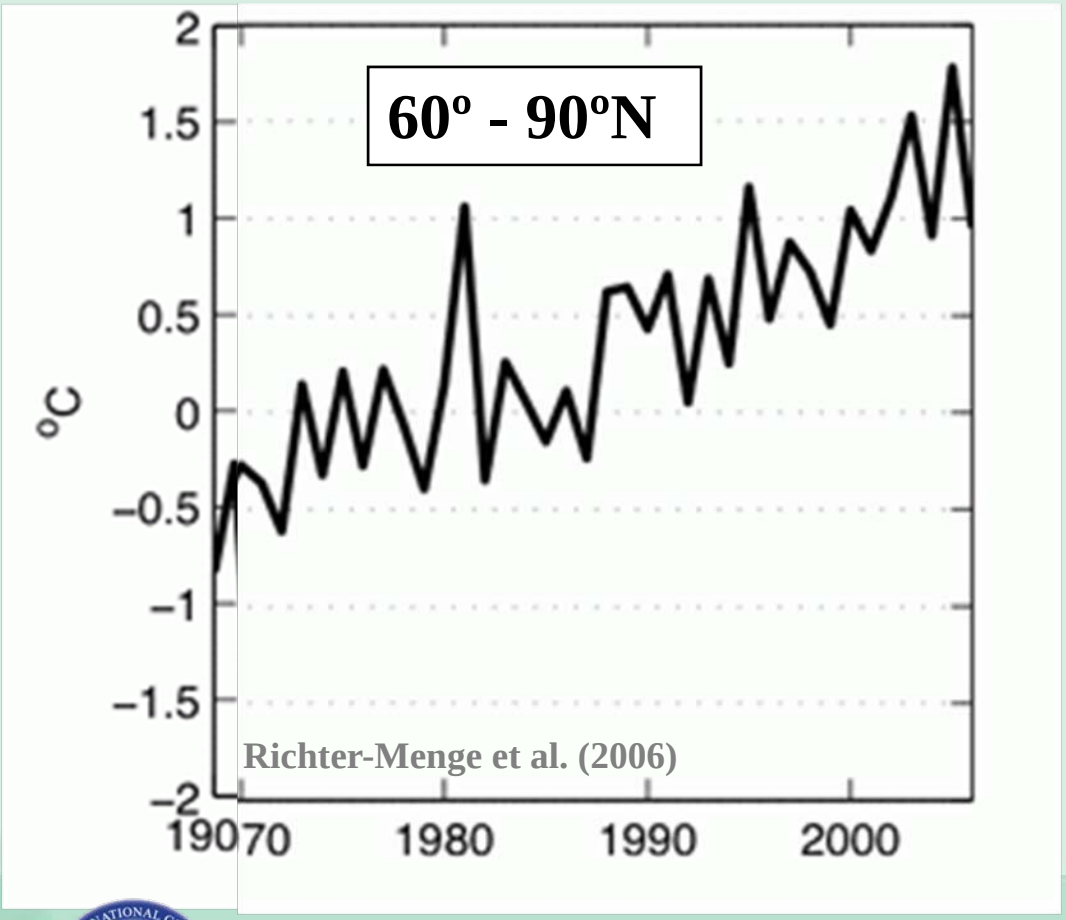
Dust Proxy



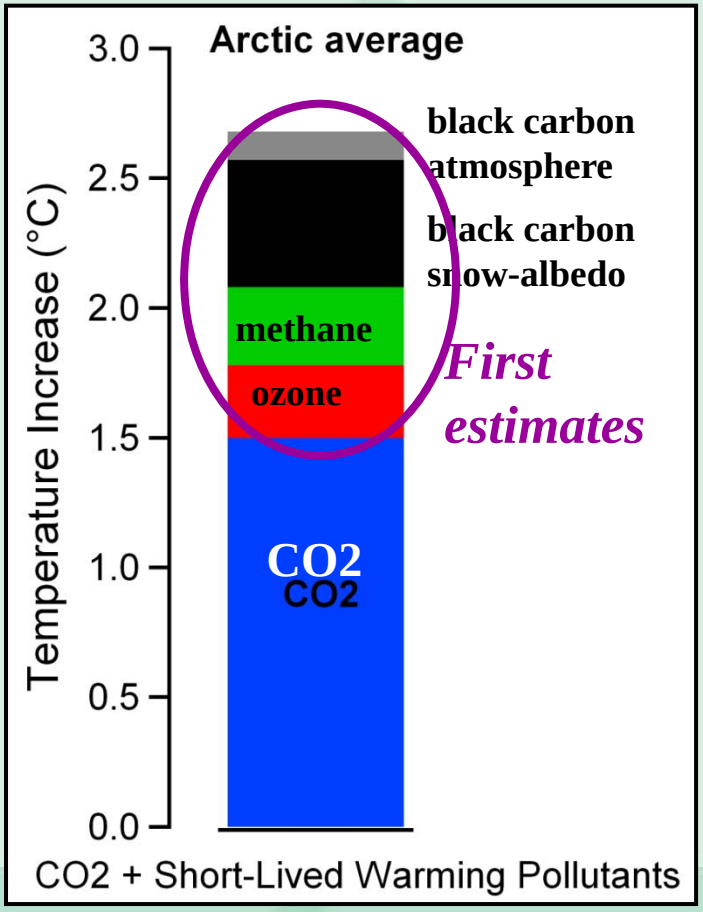
Lisiecki and Raymo 2005
Luthi et al. 2008
Loulergue et al. 2008
Spahni et al. 2005
Wolff et al. 2006, others

PAGES
PAST GLOBAL CHANGES

Annually aver. surface air temperature anomalies (1900 – 2006)



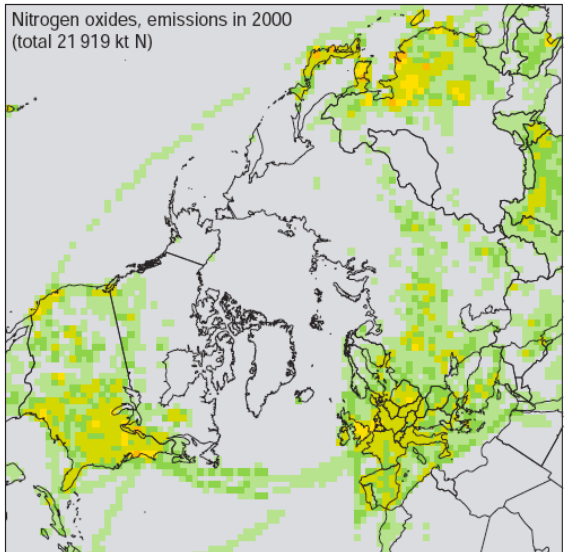
Annually aver. surface air temperature increase due to CO_2 + *short-lived pollutants (lifetimes of weeks to years)*

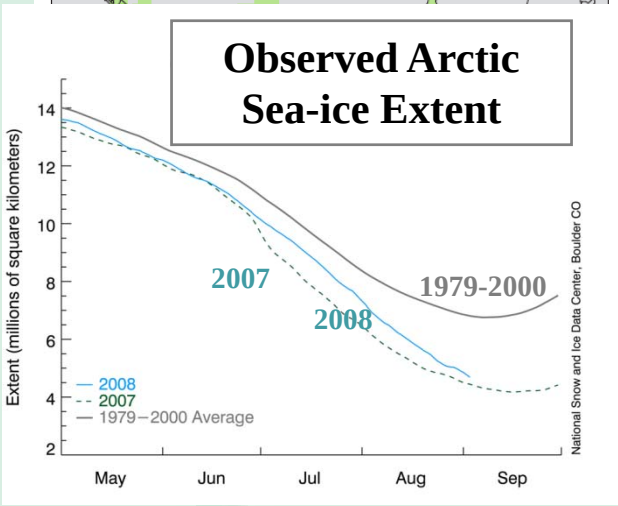


Quinn et al. (2007)
Arctic Council Declaration, April 2009

Black Carbon - Snow/Ice Albedo Feedback

BC Sources

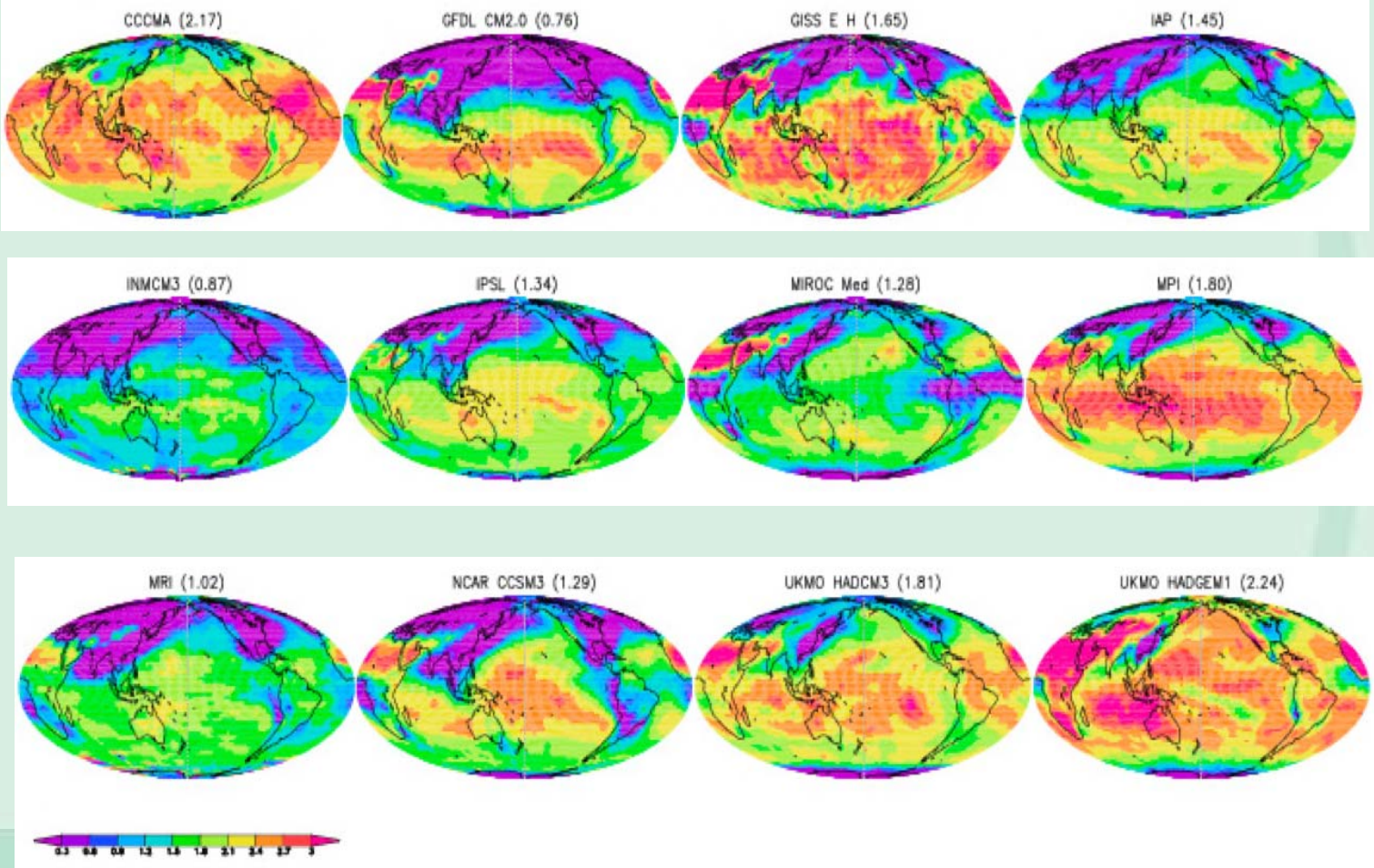




Soot deposition darkens surface ⇨ more solar energy absorbed ⇨ increases surface temperature ⇨ snow melts ⇨ more solar energy absorbed ⇨ increases surface temperature (same effect GHGs)

Variation in Radiative Forcing among GCMs (AR4)

Contribution from Aerosols, Ozone and NCGG??



Shindell et al. 2009 IGAC Newsletter & B. Soden, pers. comm.

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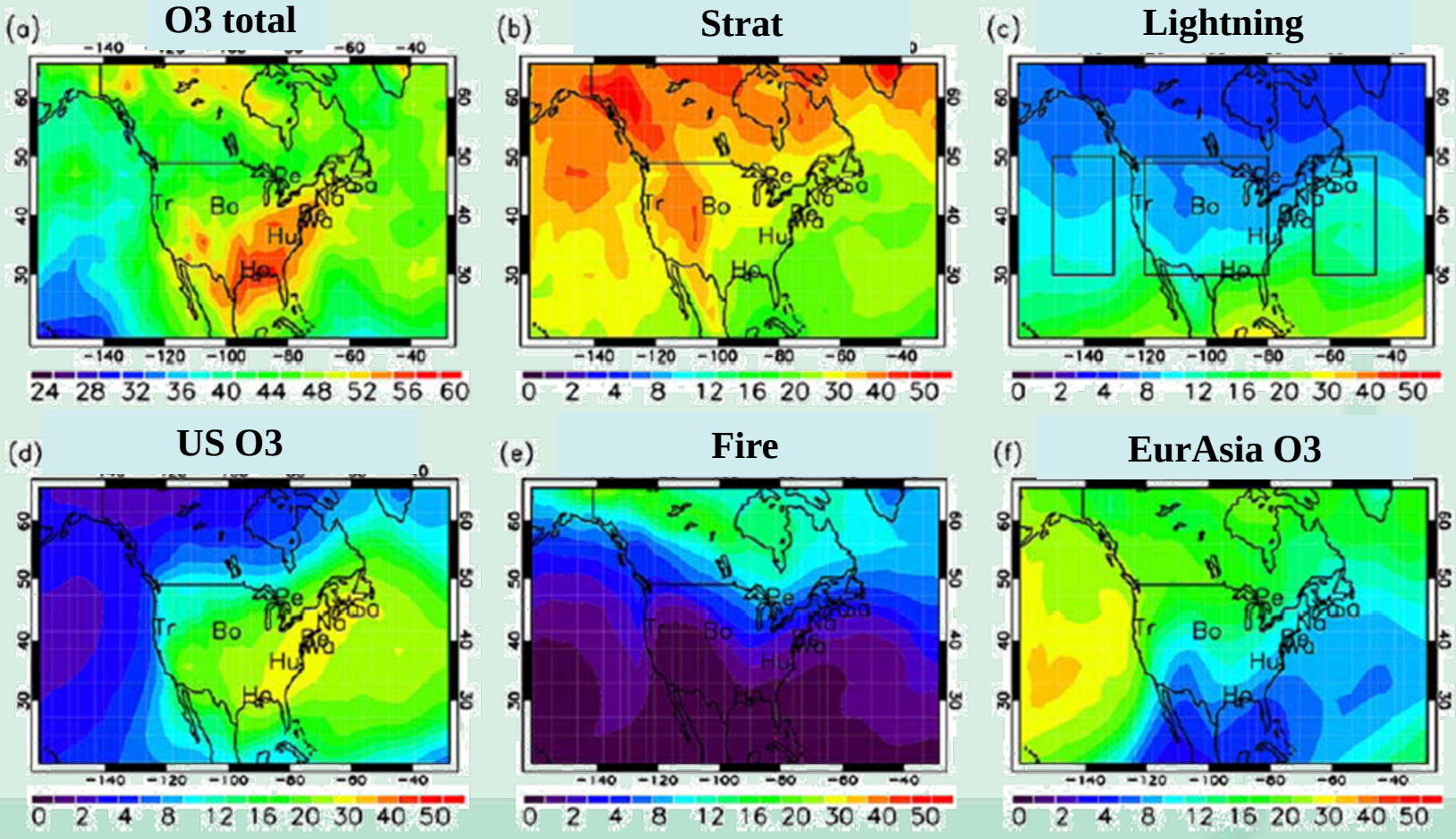
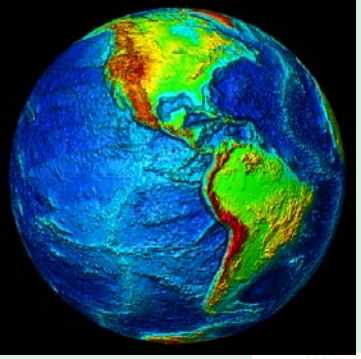
Model Intercomparison
Model – Data Comparison
Hindcasting
Aerosols, Ozone and NCGG

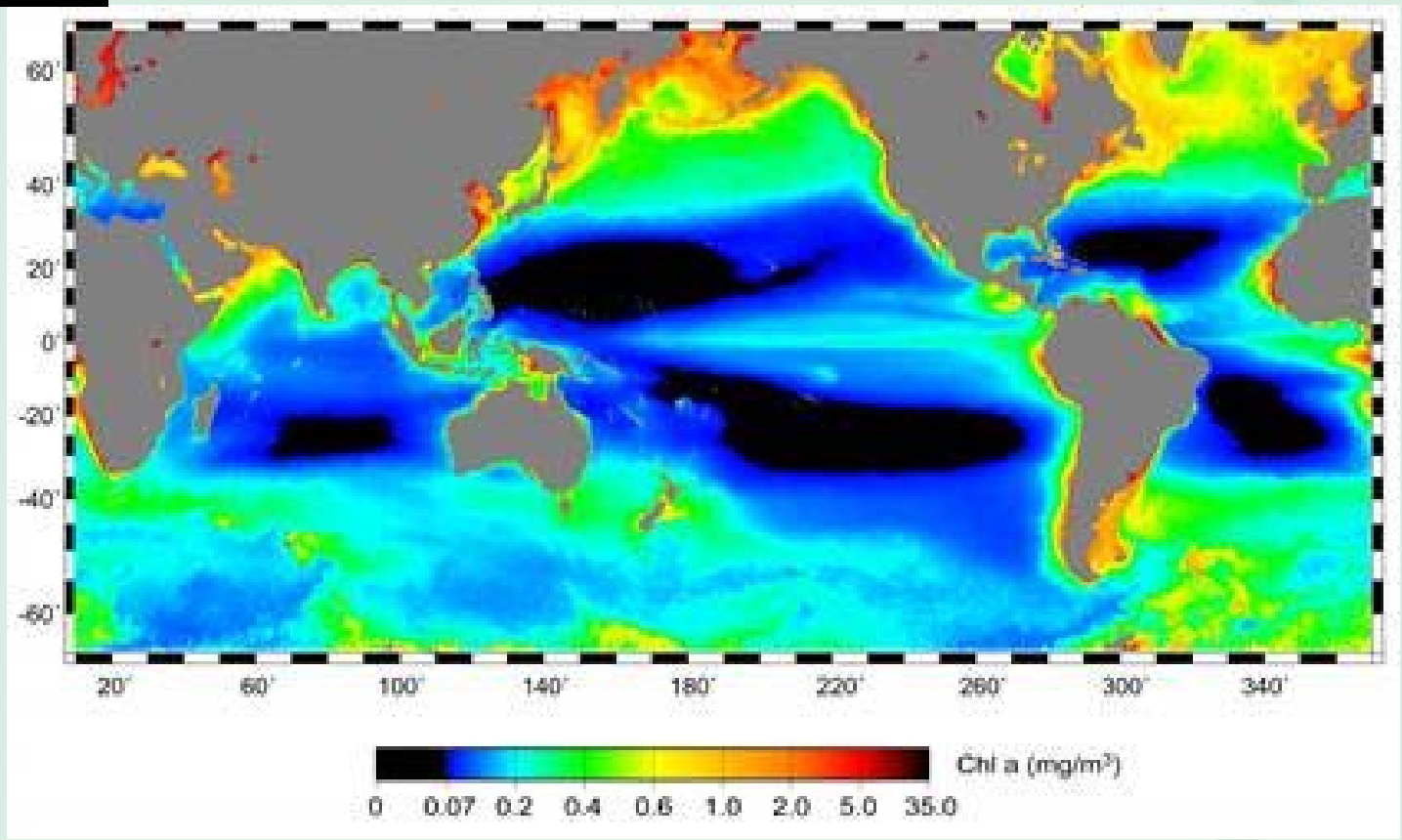


Contribution to Tropospheric O_3 columns - % of total

Pfister et al. 2008 JGR MOZART-4



Oceans Cover 71% of Earth's Surface



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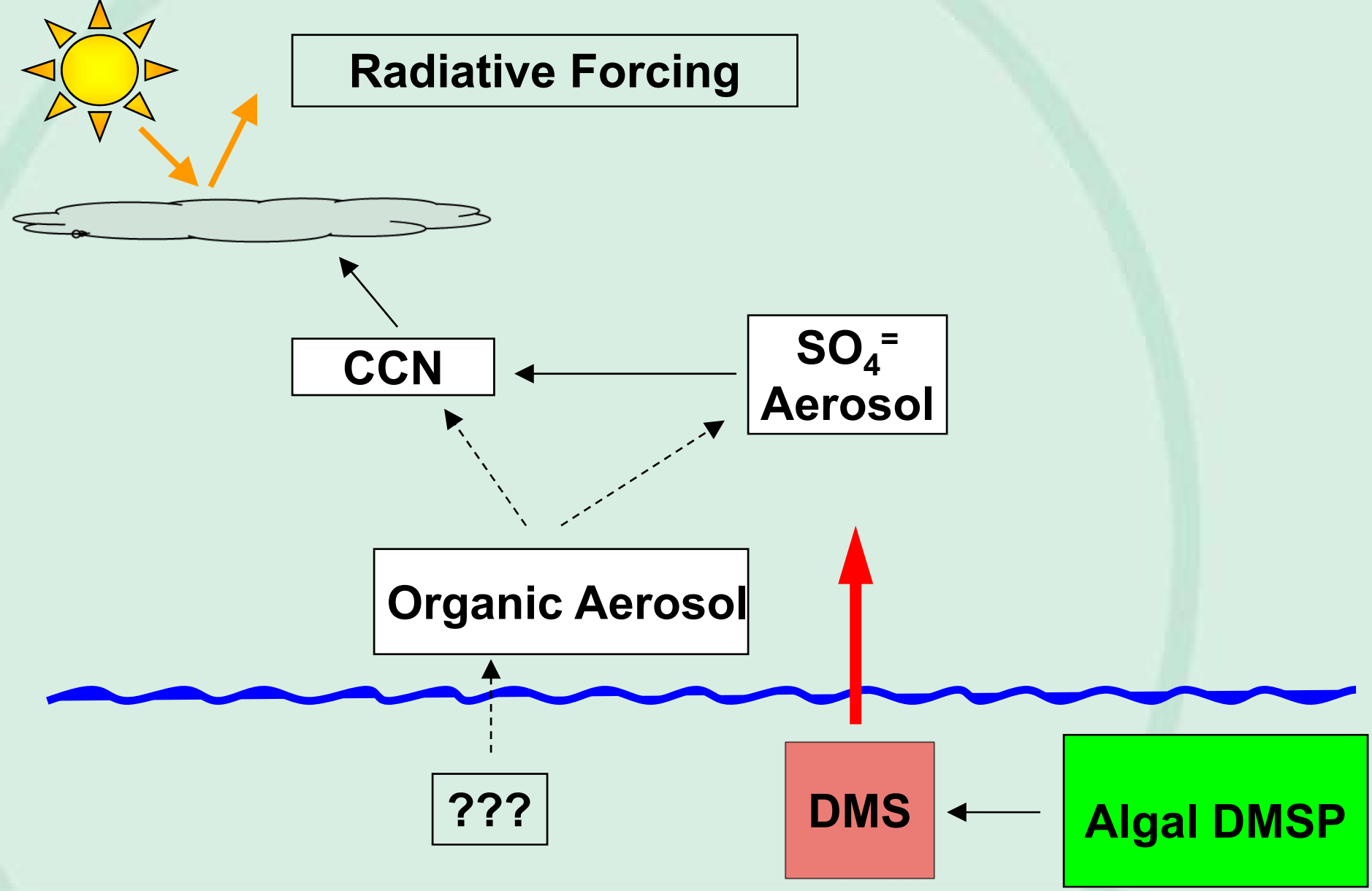
Ocean-Derived Organic Aerosols: Production and Impact

GLOBAL CHANGE IGBP



Charlson et al. 1987

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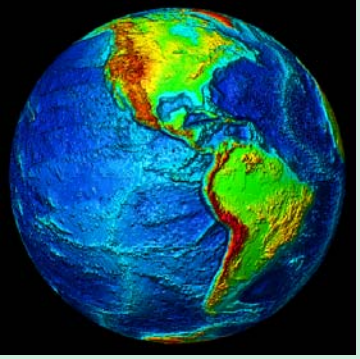
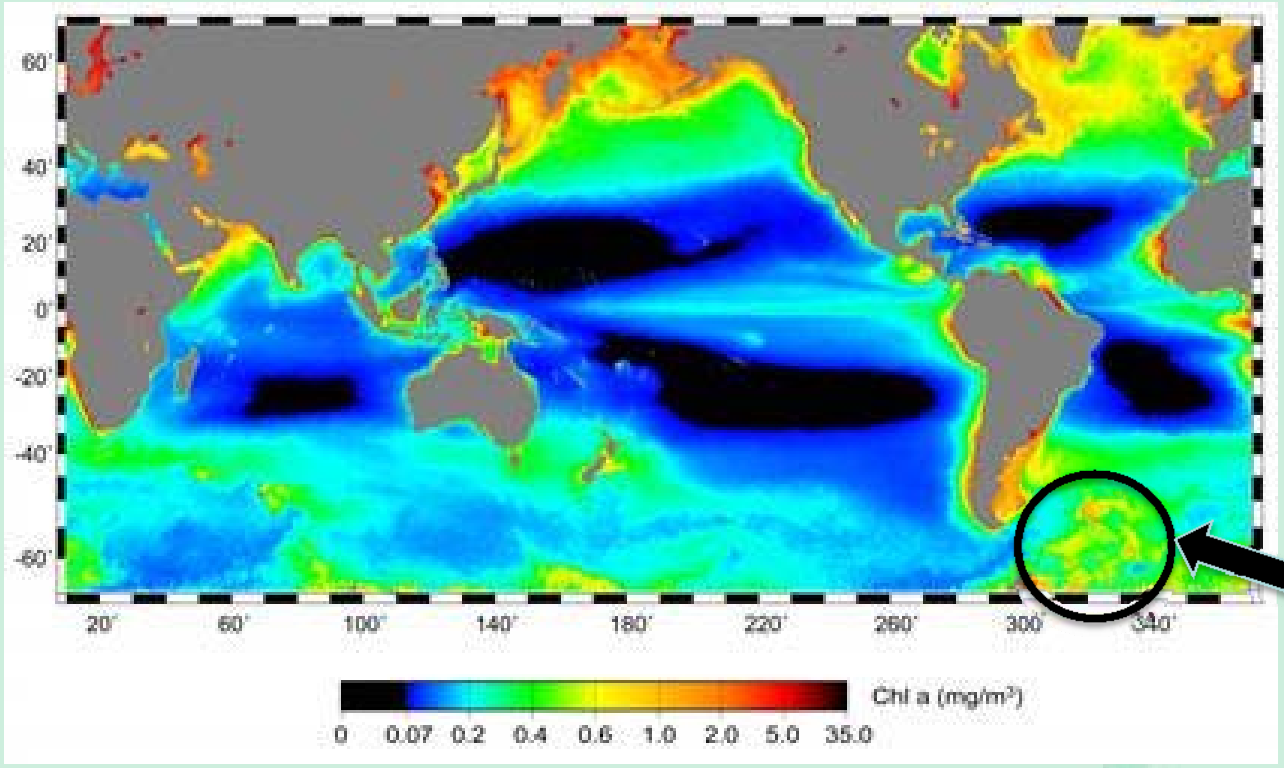


Oceans Cover 71% of Earth's Surface



Study Site

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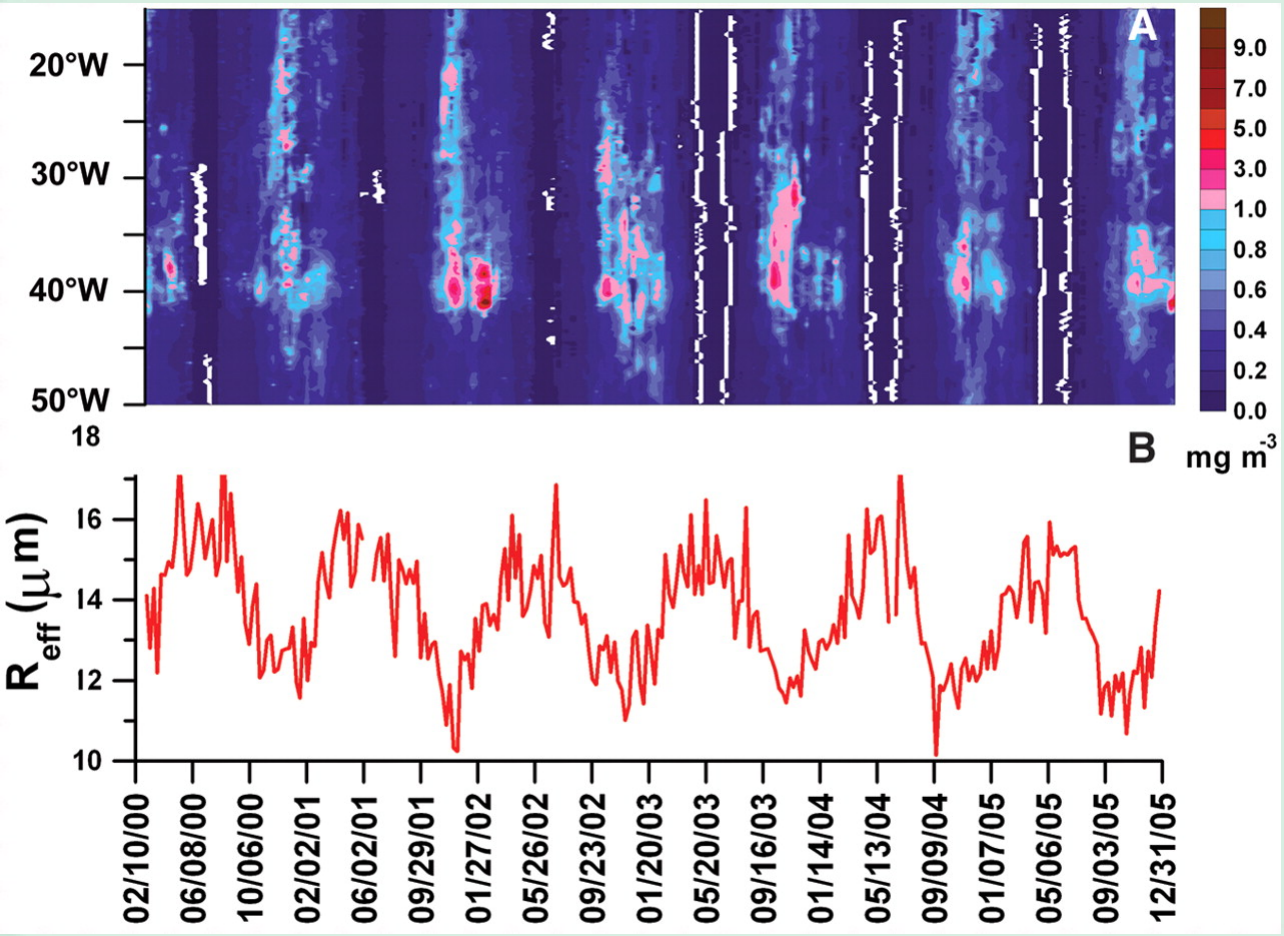
Phytoplankton and Cloudiness in the Southern Ocean

Marine Aerosol Formation



Chlorophyll a (SeaWiFS)

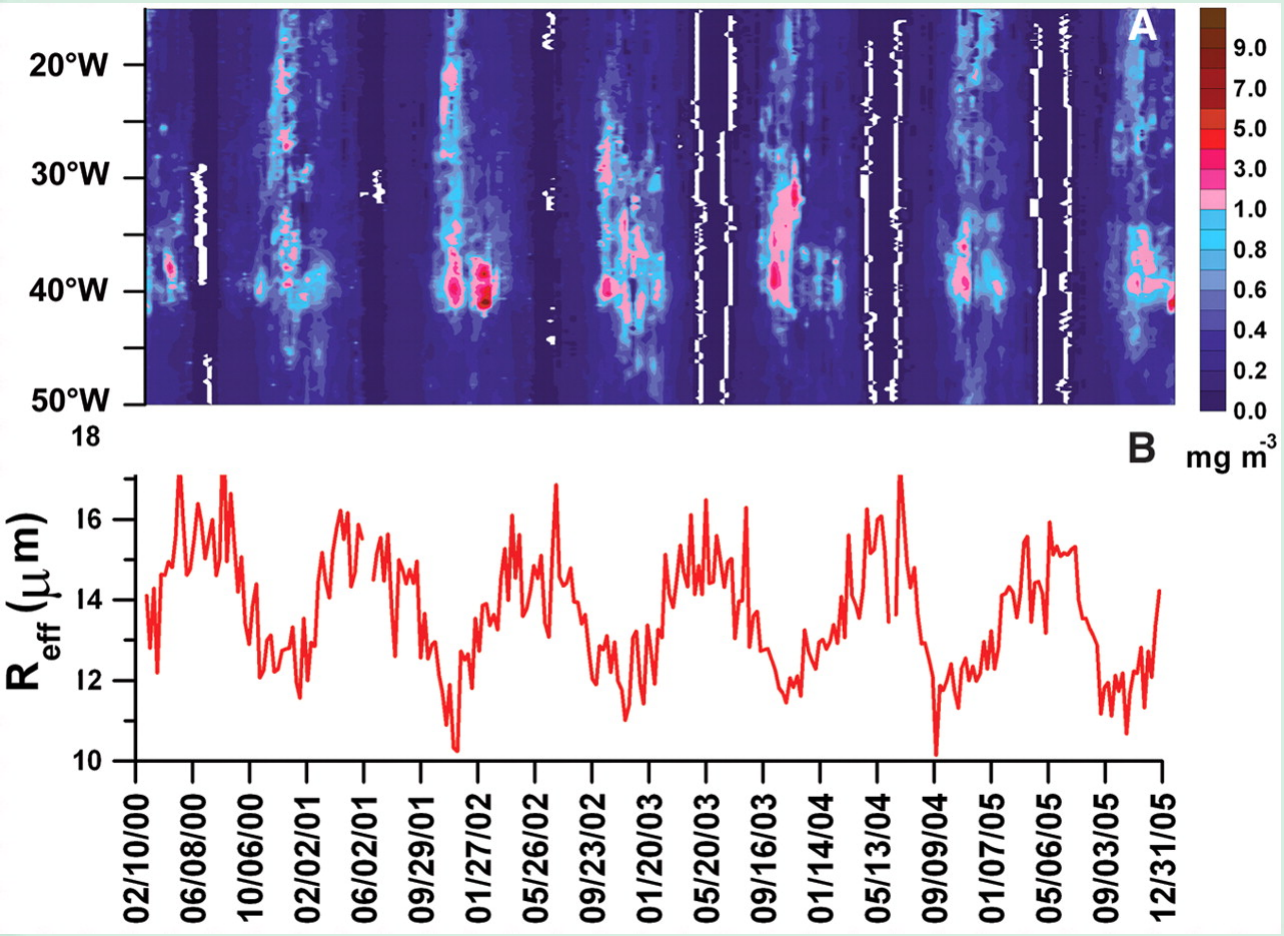
Cloud Effective Radius

Meskhidze & Nenes 2006 *Science*

Phytoplankton and Cloudiness in the Southern Ocean

Marine Aerosol Formation

Decrease short wave radiation flux top of atmosphere -15 Watts/m2



Chlorophyll a (SeaWiFS)

Cloud Effective Radius

→ **isoprene** → **SOA** → **CCN**

Meskhidze & Nenes 2006 *Science*

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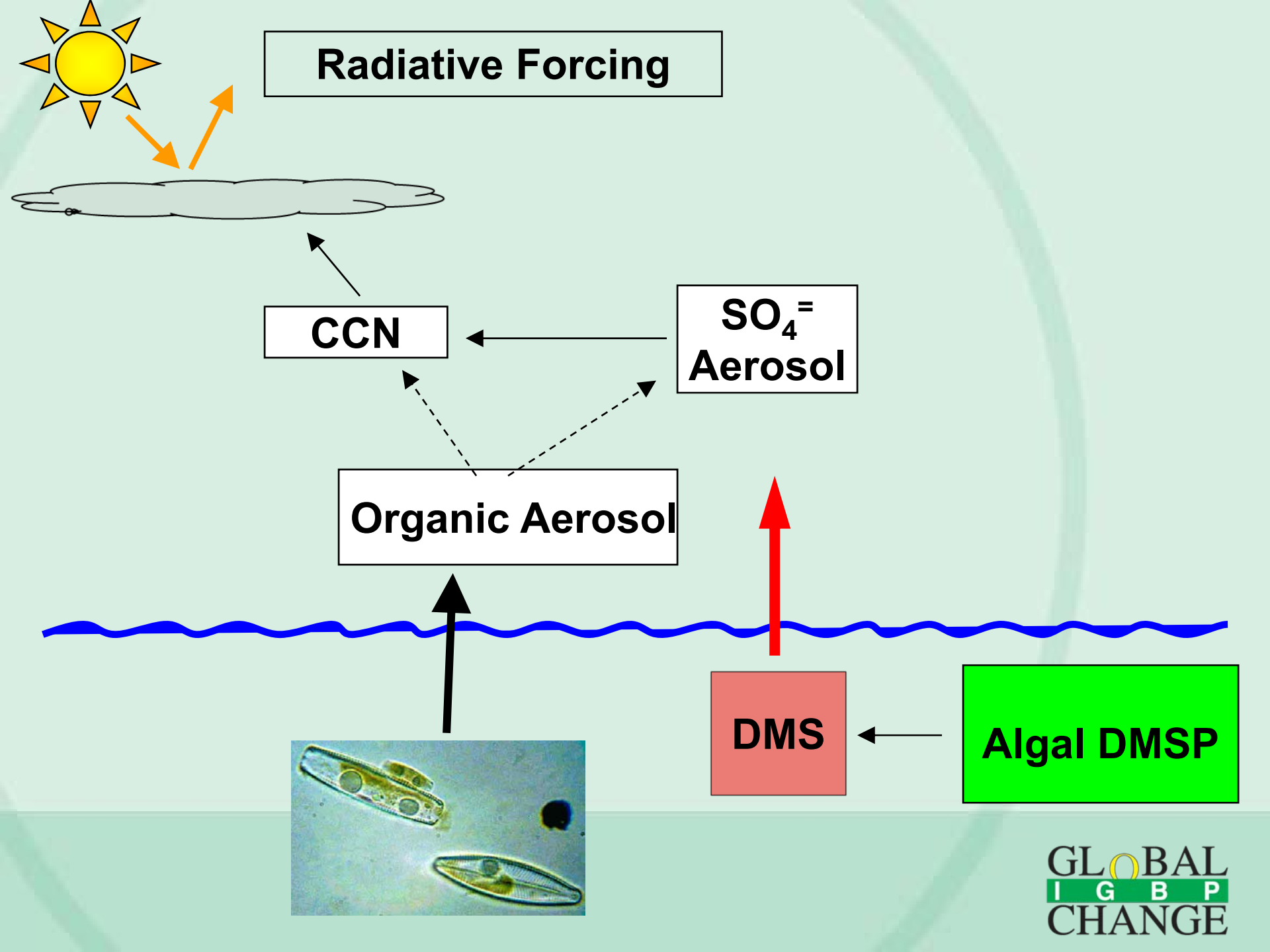
Radiative Forcing
CCN
$SO_4^=$ Aerosol
Organic Aerosol
DMS
Algal DMSP
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CHANGE

Production of Food & Energy

- have >2x input of fixed N to terrestrial ecosystems

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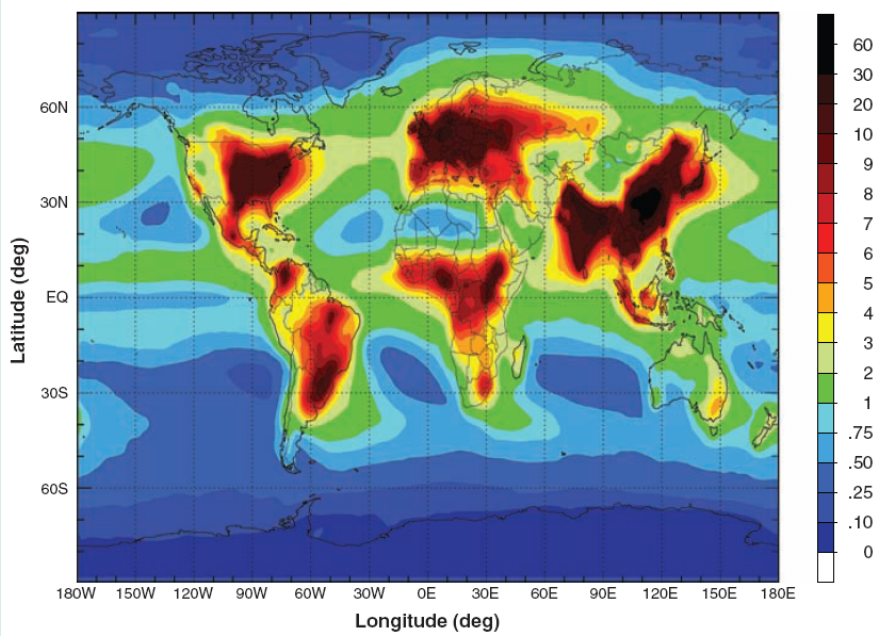
Nitrogen Atmospheric Deposition

from:fossil fuel combustion, agriculture and natural sources



Galloway, J.N. et al., 2008. Science 320, 889-892.

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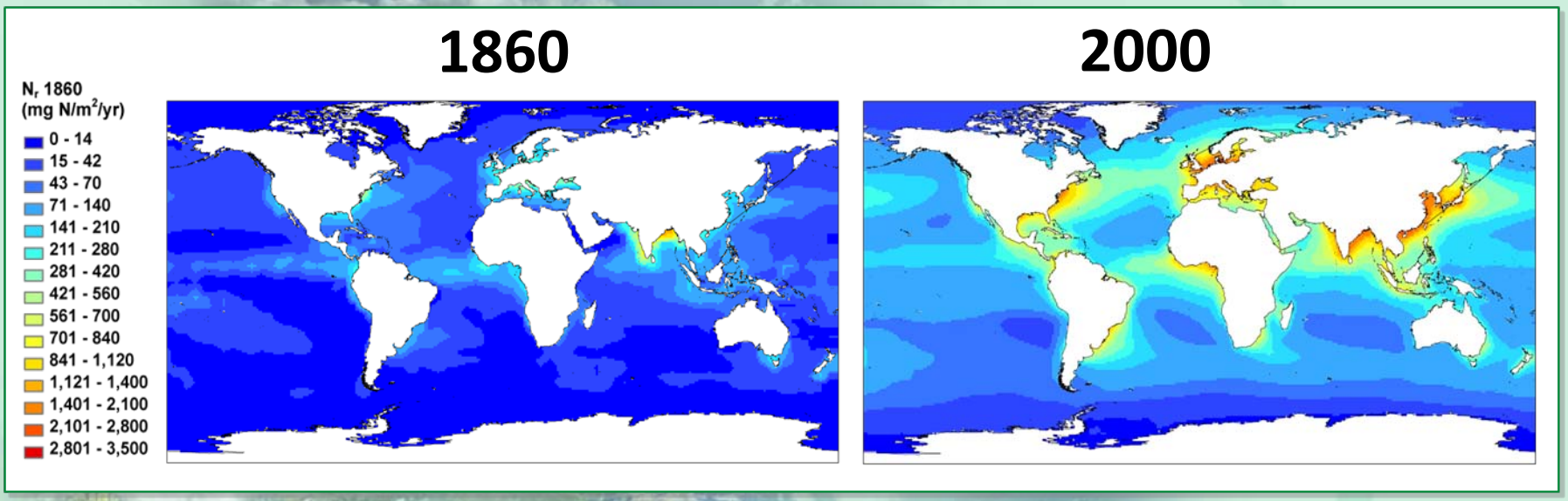
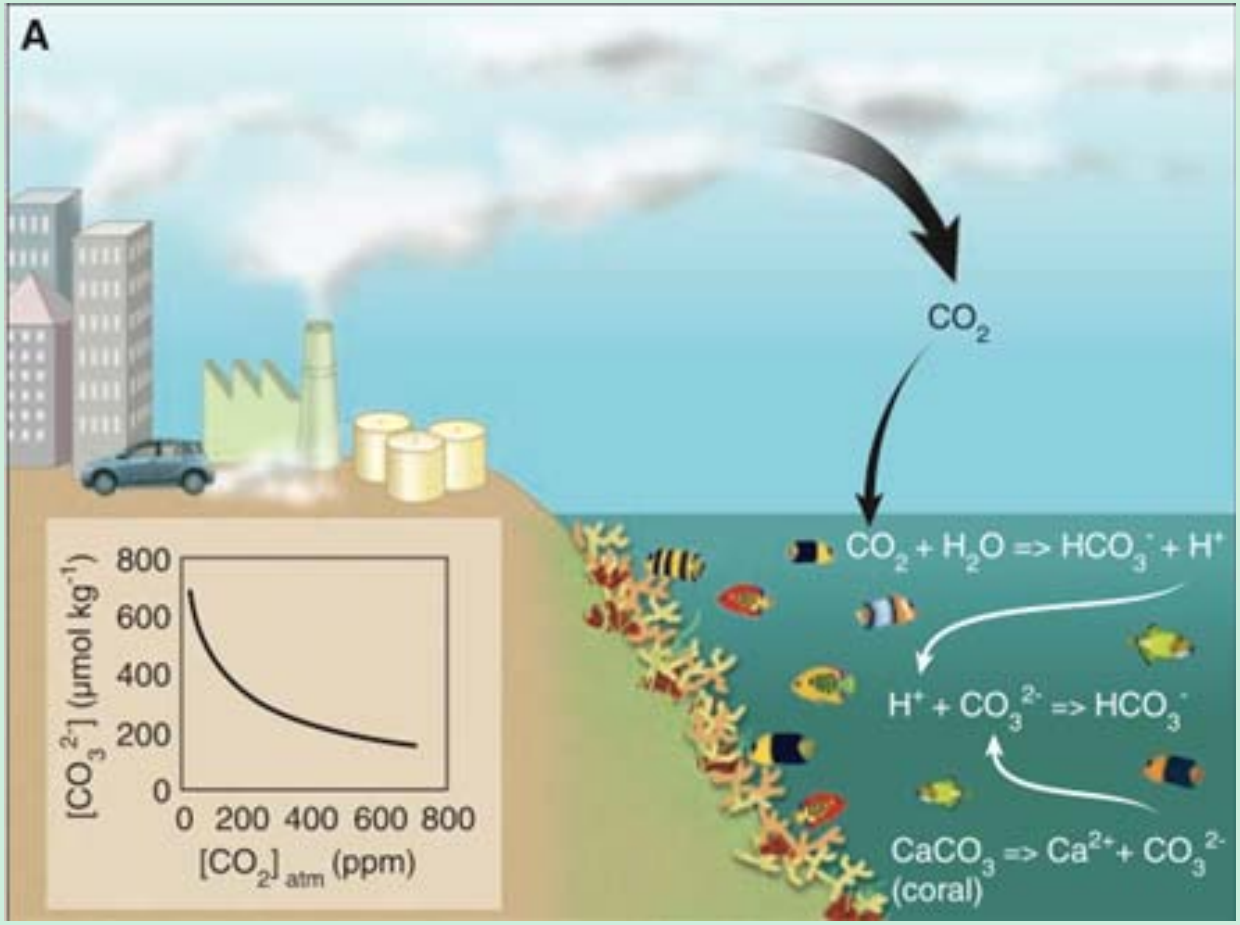
Impacts of Atmospheric Nitrogen Deposition on the Ocean



- Low level ocean fertilization
  ~1/3 of ocean's external nitrogen
- ~10% of anthropogenic CO_2 drawdown
- Increased N_2O emissions (up to 1.2 Tg N/yr)

Duce et al. 2008 Science

Rising CO_2 Conc. Increases Ocean Acidity



Non-climate change effect of rising CO_2

$$[H^+] = \frac{HCO_3^-}{CO_3^{2-}}$$

Hoegh-Guldberg et al. 2007 Science

GLOBAL IGBP CHANGE

The Ocean in a High-CO_2 World Symposia

October 2008, Monaco

220 participants from 32 countries

www.ocean-acidification.net

International Council for Science ICSU SCOR Scientific Committee on Oceanic Research

IAEA.org International Atomic Energy Agency

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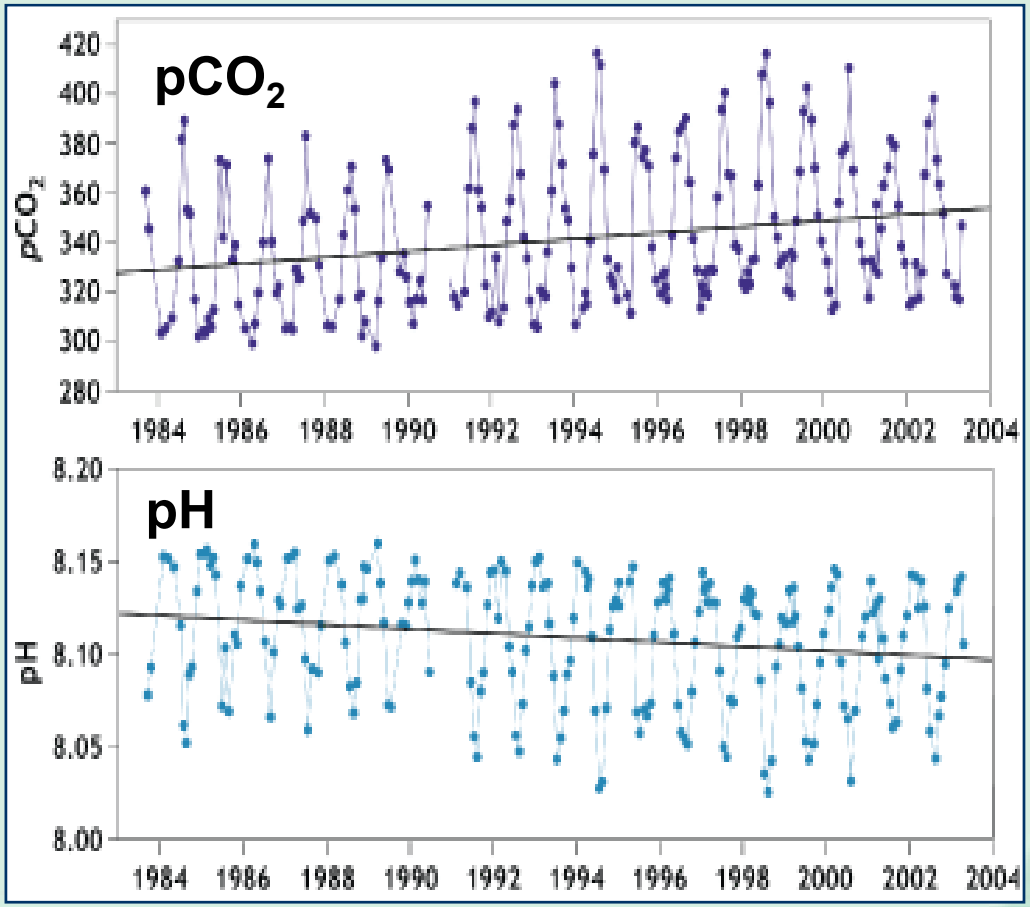
Ocean Acidification is Happening Now and is Measurable

0.1 pH
30%



David Karl, University of Hawaii

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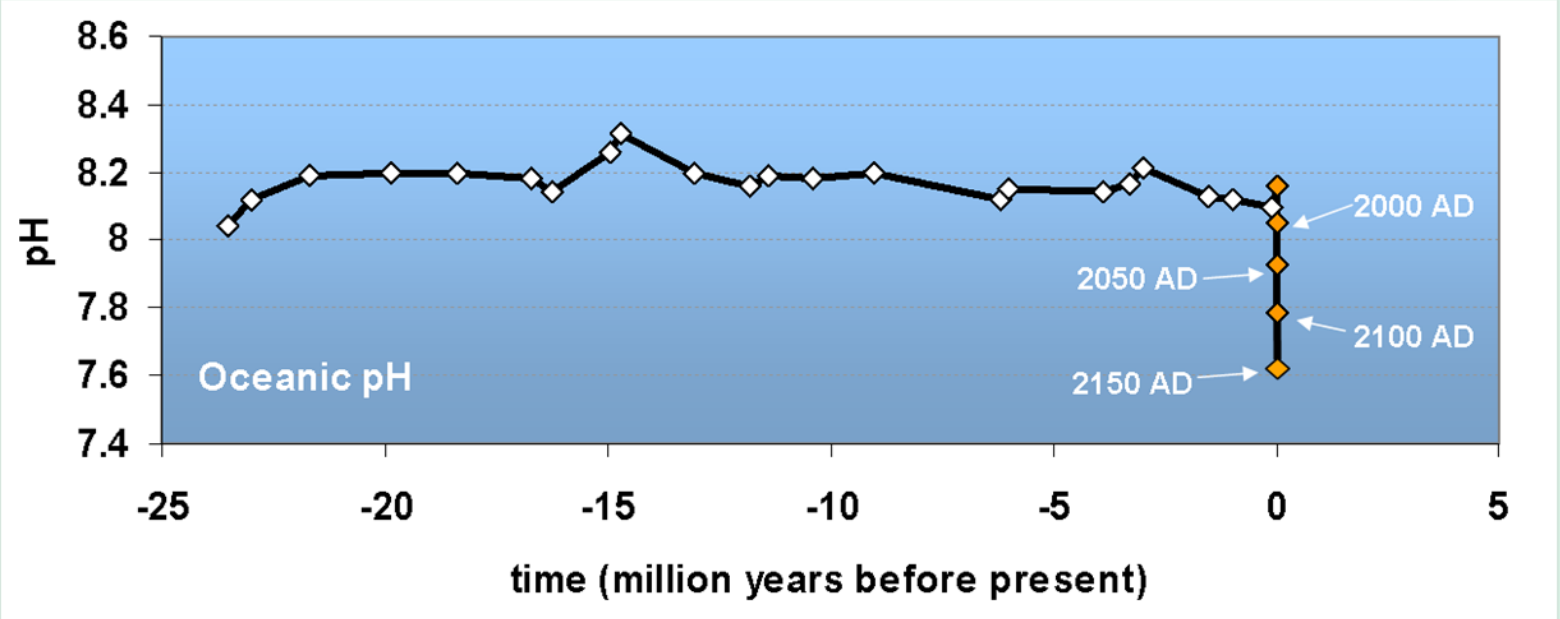
The Oceans are Acidifying Fast

at a rate and to a level not experienced by marine organisms for at least 20MY



Avoiding Dangerous Climate Change (Turley et al 2006)

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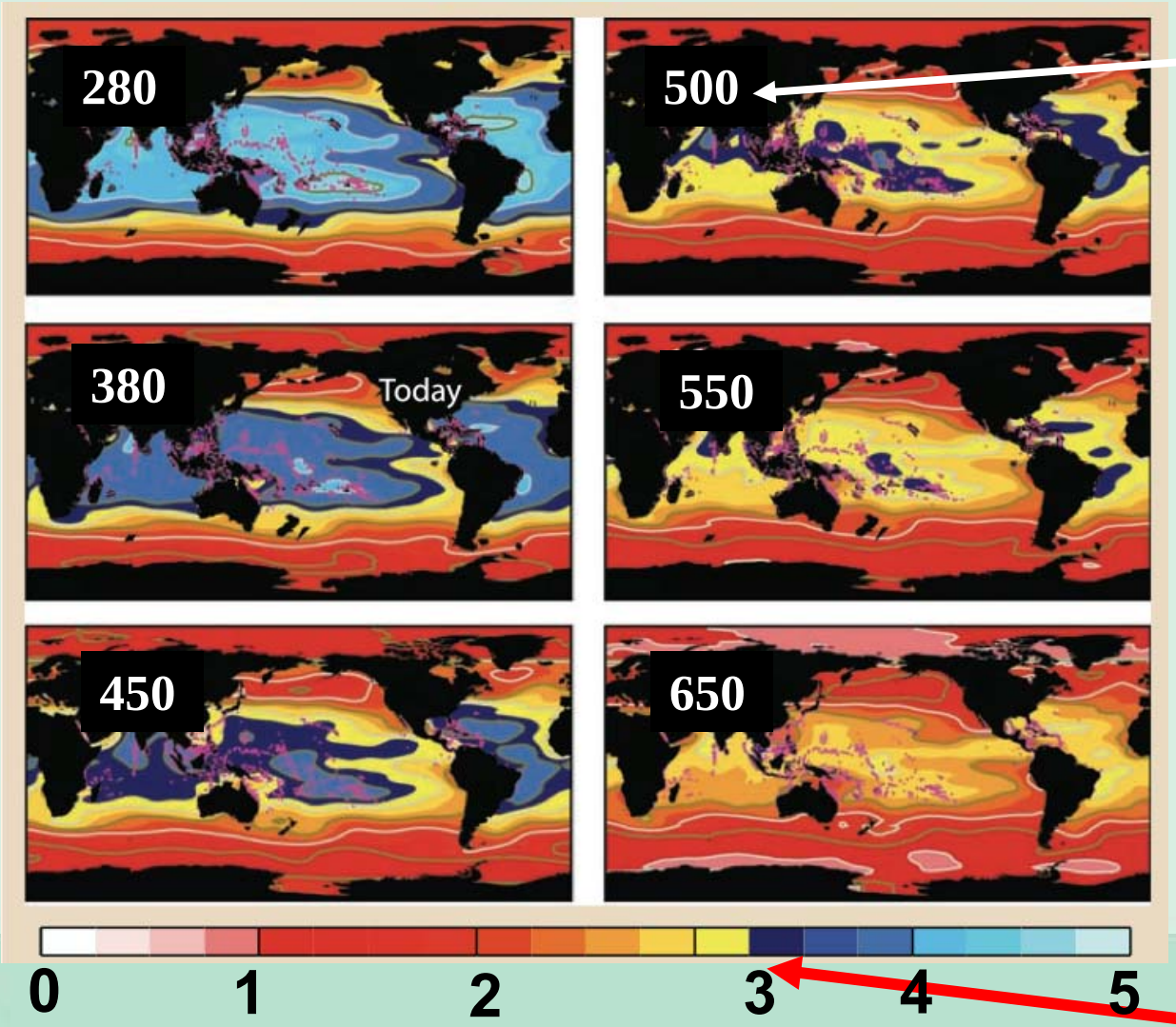
Effects of Rising Atmospheric CO_2 on Coral Reefs



Atmospheric CO_2 concentration

Models of ocean chemistry suggest that hard corals will be unable to build reefs (aragonite) or that coral reefs may even begin to dissolve due to ocean acidification within next 40 years.

Level below which hard corals cannot build reefs

Hoegh-Guldberg et al. 2007 Science

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Climate Change and Rising CO_2 Impacts on Coral Reefs

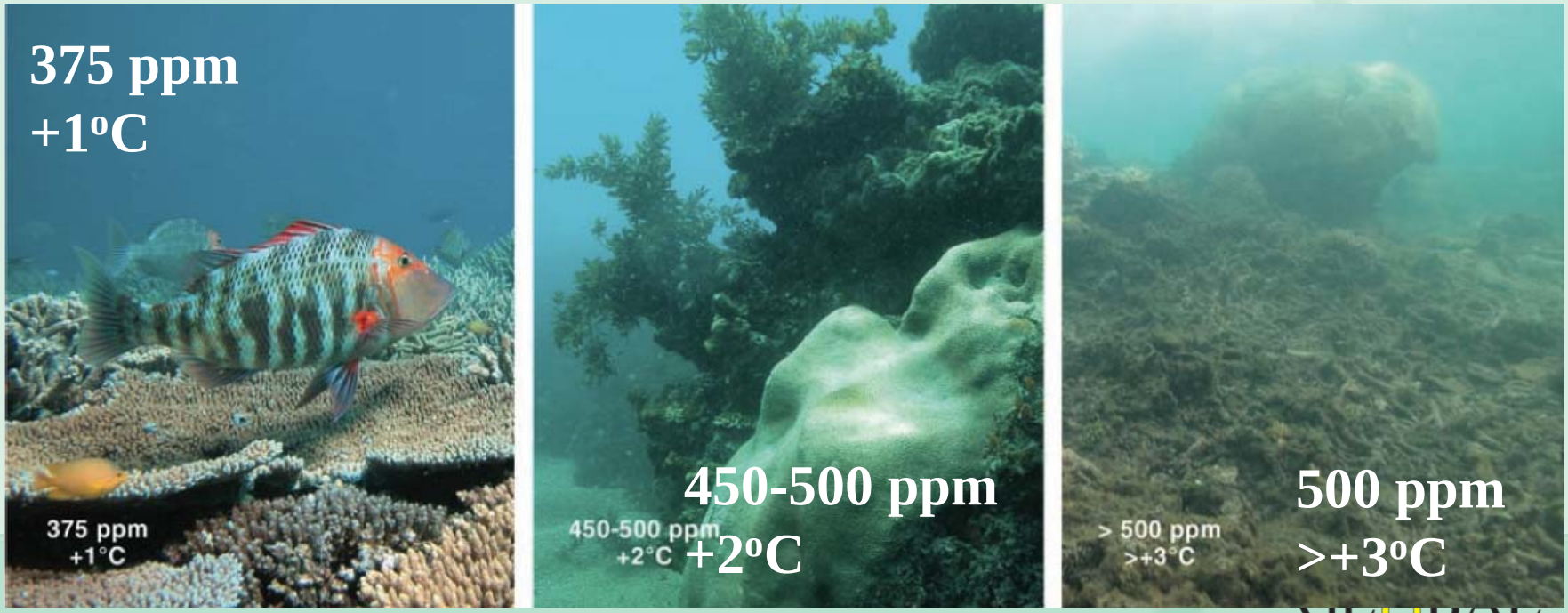
Examples of what the future might look like

(photos from the Great Barrier Reef)

"Healthy" Coral reef

"Bleached" coral reef large areas already, most coral reefs in the next few decades

"Dead" reef middle to end of the 21st century



Hoegh-Guldberg et al. 2007 Science

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Second Symposium on The Ocean in a High-CO_2 World

October 2008, Monaco

- Press Releases, media reports, Monaco Declaration
- Fact Sheet on Ocean Acidification
- Special Issue of Biogeosciences
- Research Priorities Report
- Oceanography Magazine article
- Summary for Policymakers

www.ocean-acidification.net

International Council for Science ICSU SCOR Scientific Committee on Oceanic Research

IAEA.org International Atomic Energy Agency

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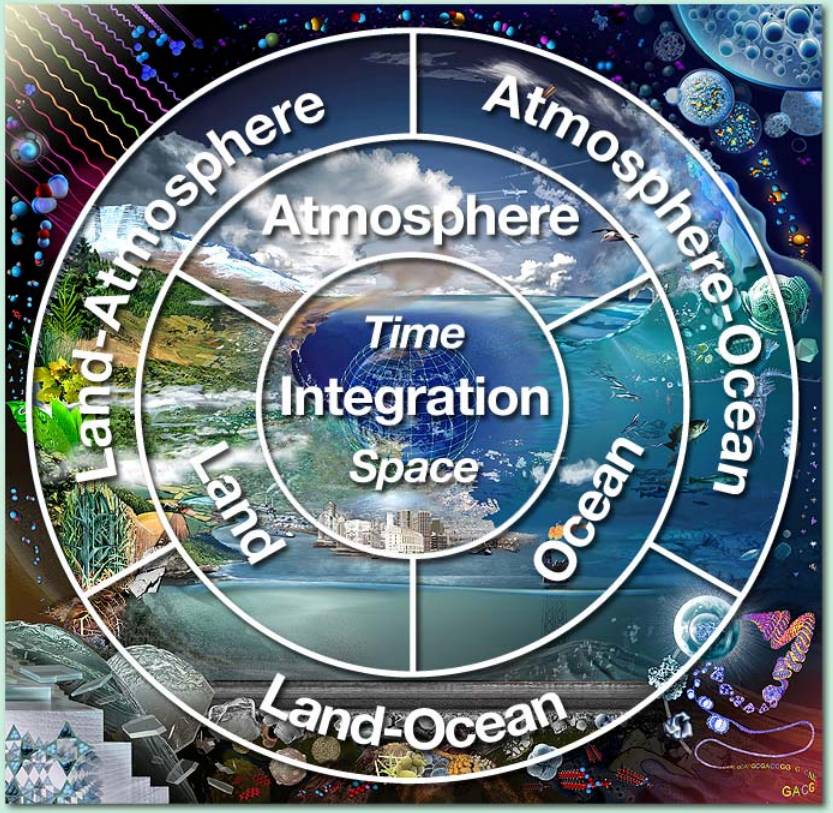
IGBP

Network of scientists around the world

- **Interactions among biological, chemical, and physical processes and human systems**
- **Issues relevant to society**
- **Interdisciplinary and integration**
- **Earth System context**



www.IGBP.net

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