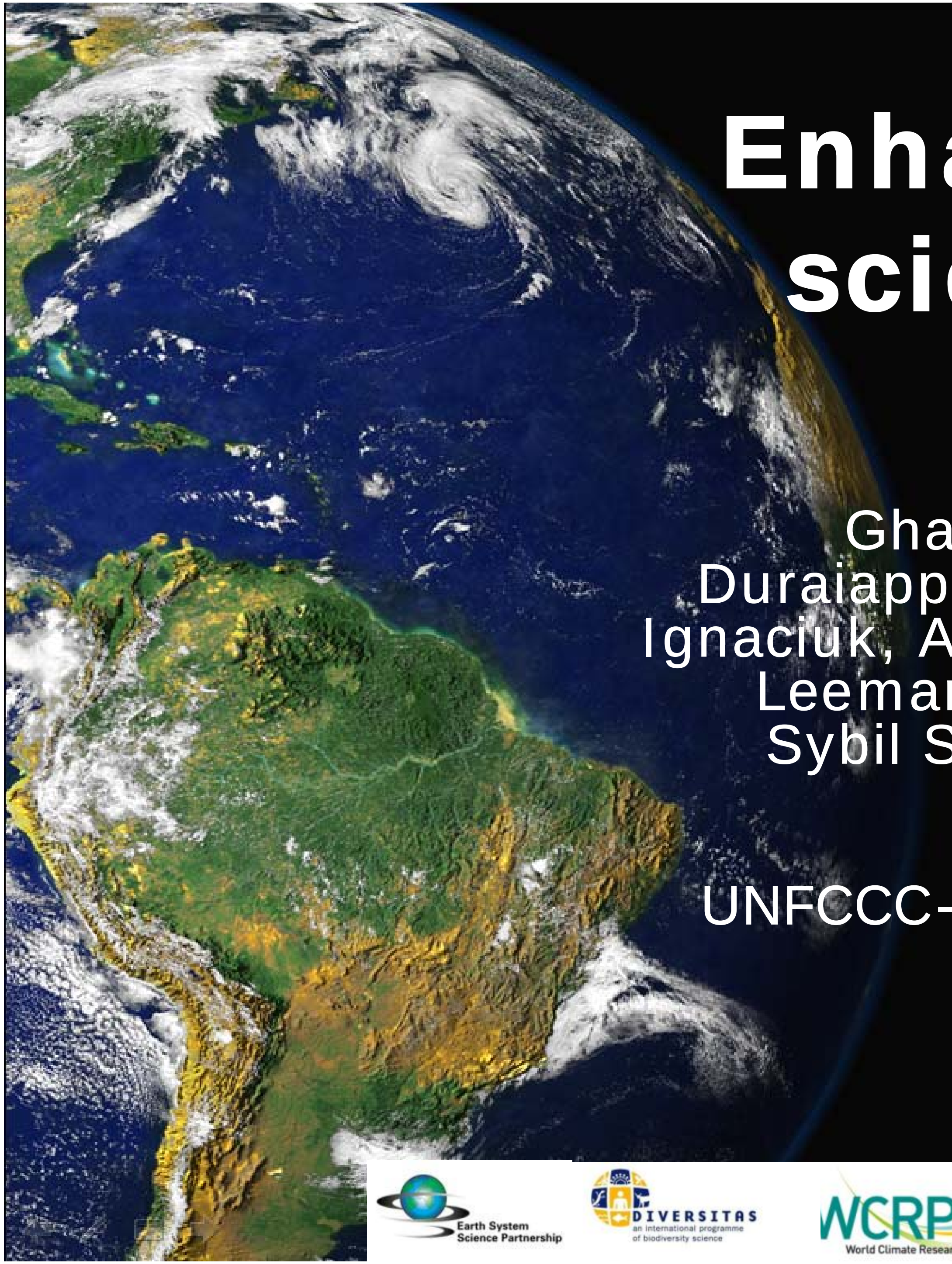

Enhancing the science basis

Guy Midgley,
Ghassem Asnar, Anantha Duraiappah, Andy Haines, Ada Ignaciuk, Anne Larigauderie, Rik Leemans, Corinne Le Quéré, Sybil Seitzinger and Charles Vorosmarty

UNFCCC-SBSTA meeting Bonn
8-6-2011

Earth System Science Partnership
DIVERSITAS an international programme of biodiversity science
WCRP World Climate Research Programme
GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme
IHDP International Human Dimensions Pro[gramme] on Global Environmental Change

Earth System Science Partnership (ESSP)




ESSP facilitates the study of the Earth's environment as an integrated system in order to understand how and why it is changing, and to explore the implications of these changes for global and regional sustainability.




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IHDP

DIVERSITAS - an integrated programme of biodiversity science

Integrative biodiversity science and its societal relevance. www.diversitas-international.org

IGBP - International Geosphere-Biosphere Programme

Science for Earth's sustainability, understanding biological, chemical, physical processes & mutual relationships with human systems. www.igbp.net

IHDP - International Human Dimensions Programme on Global Environmental Change

Multidisciplinary science in the human dimensions of global change, and interface between science and practice. www.ihdp.unu.edu

WCRP - World Climate Research Programme

Predictive scientific understanding of the climate system, and human influence on climate. www.wcrp-climate.org

Crosscutting projects (joint projects): Global Carbon Project; Global Water System Project; Global Environmental Change and Human Health; Global Environmental Change and Food Systems; Climate Change, Agriculture and Food Security; Monsoon Asia Integrated Regional Study

Earth System Science Partnership

Recent scientific findings: topics covered

- Carbon cycle – emissions and sinks
- Climate modelling
- Impacts, projections, responses
  - Land cover change, oceans, biodiversity
  - Human health co-benefits of mitigation

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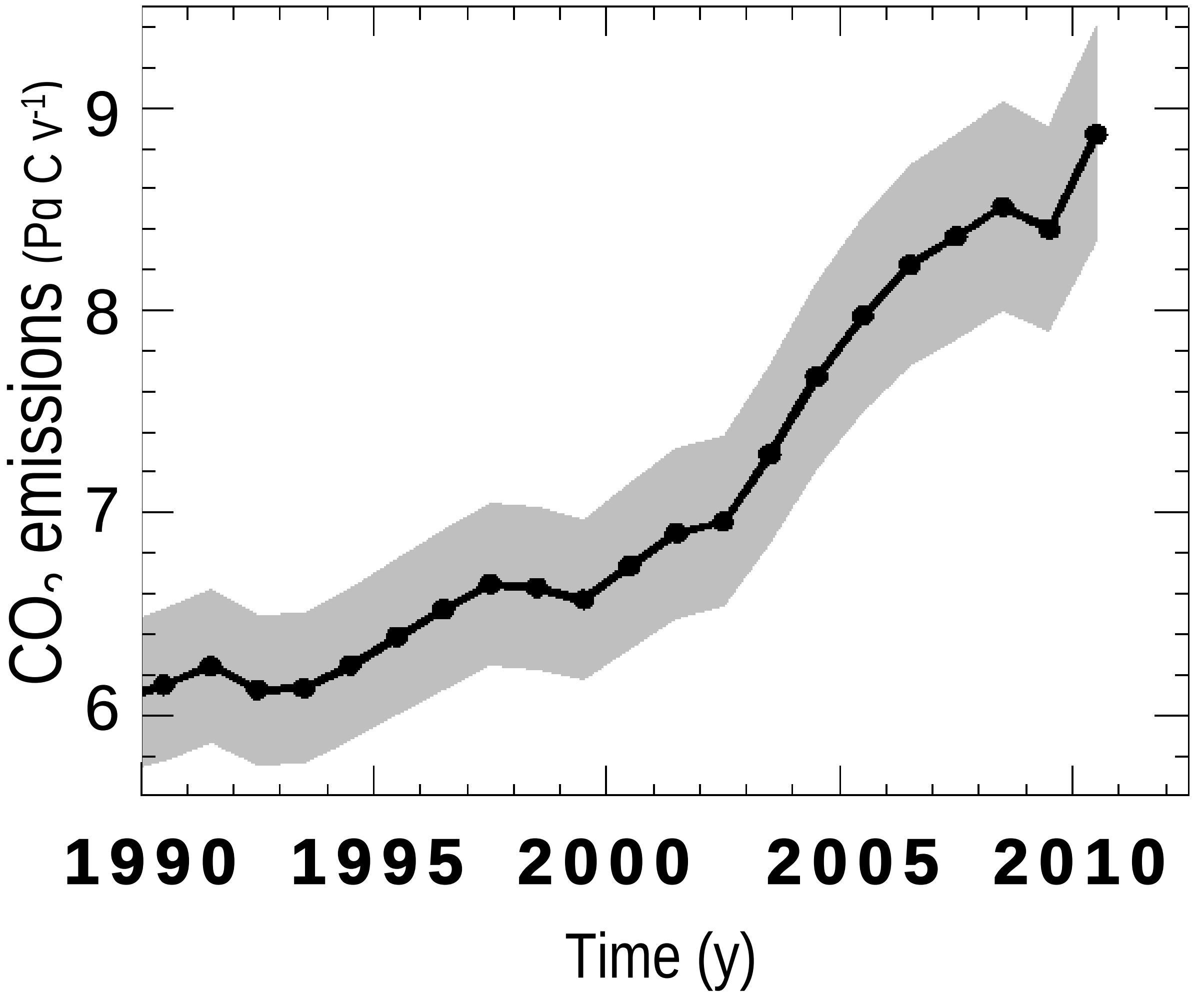
Fossil Fuel CO_2 Emissions



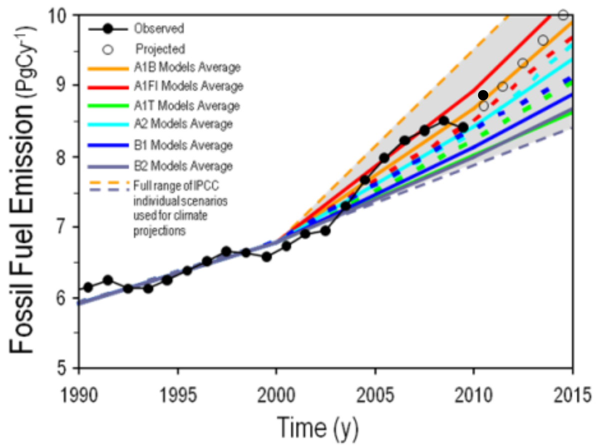
2009:
Emissions:8.4±0.5 PgC
Growth rate: -1.3%
1990 level: +37%

2000-2008
Growth rate: +3.2%

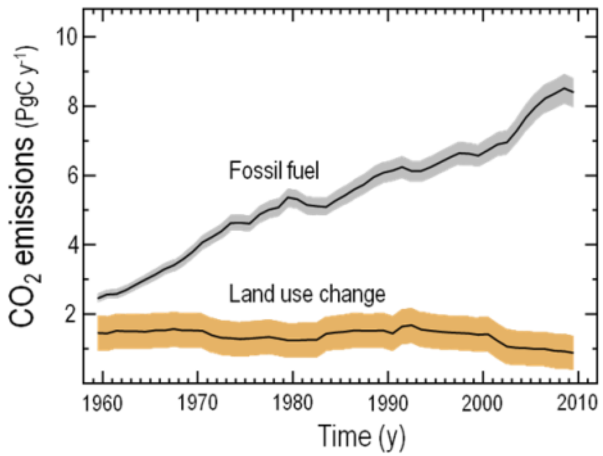
2010 (projected):
Growth rate: >3%
"measured"
+5.6%

"Unpacking" CO_2 Emissions

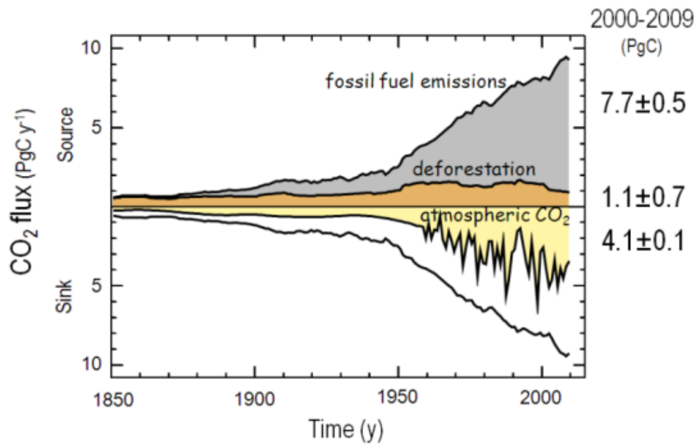
Fossil Fuel Emissions: Actual vs. IPCC Scenarios



CO_2 Emissions from FF and LUC (1960-2009)



Human Perturbation of the Global Carbon Budget



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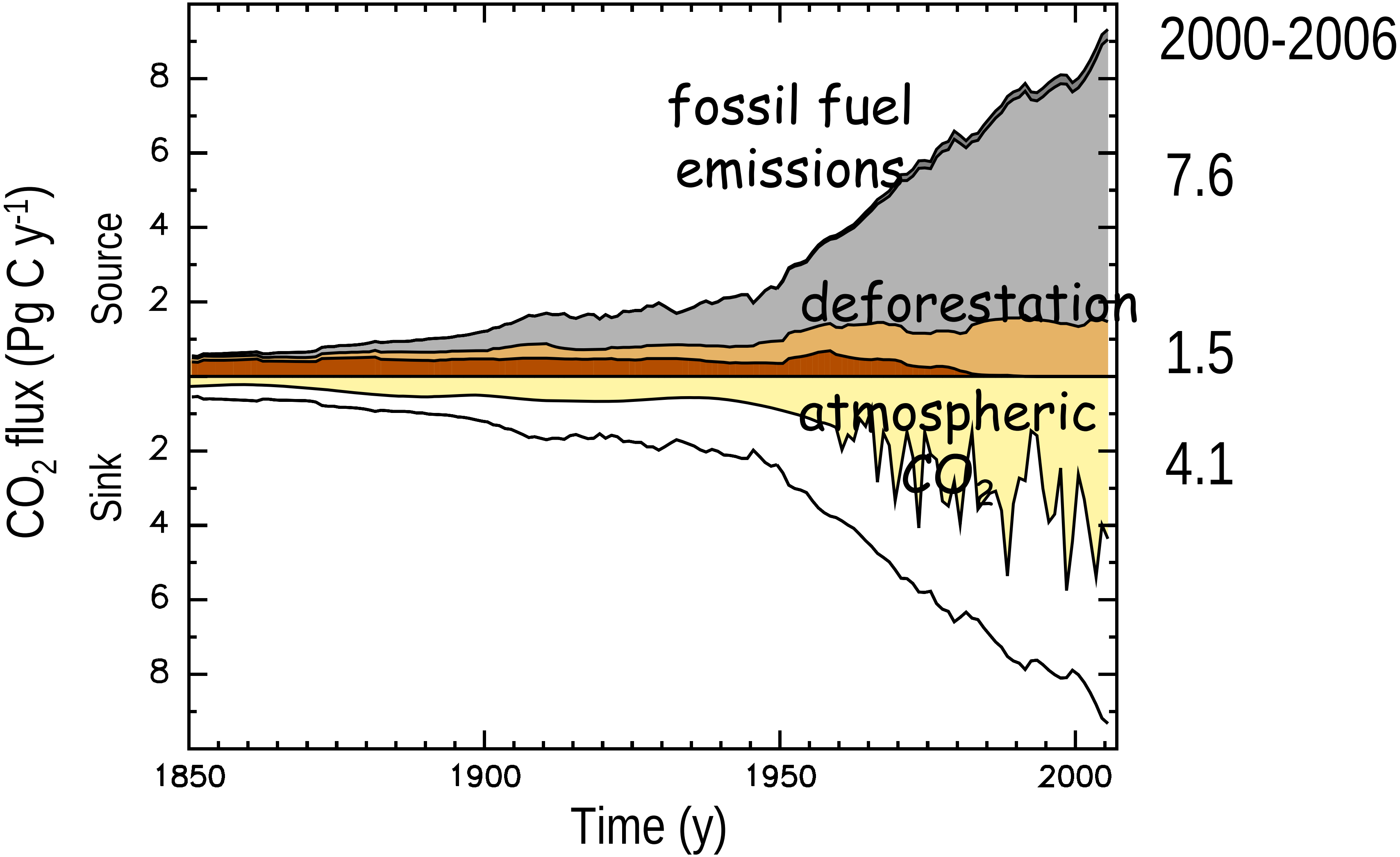
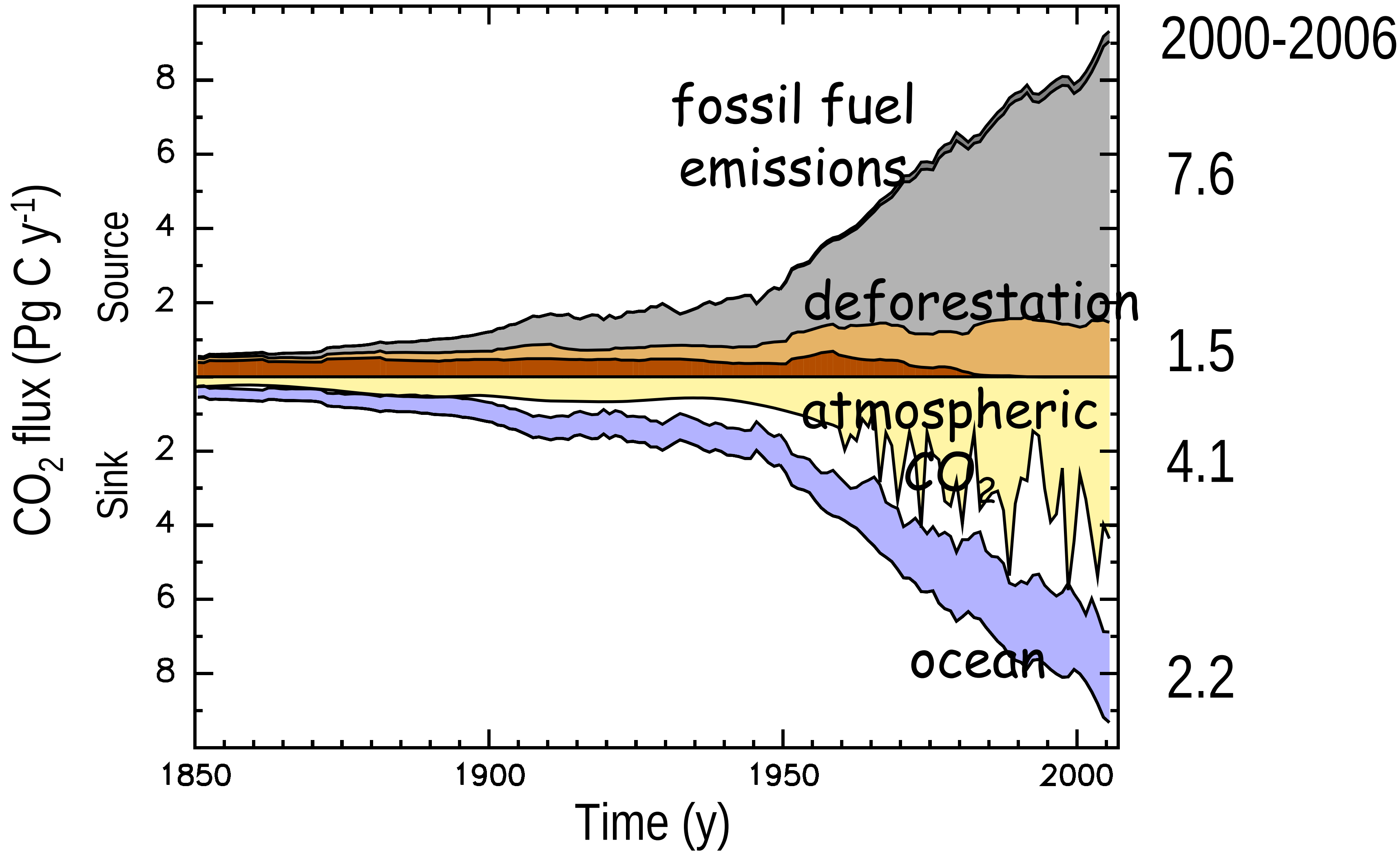
Perturbation of Global Carbon Budget (1850-2006)



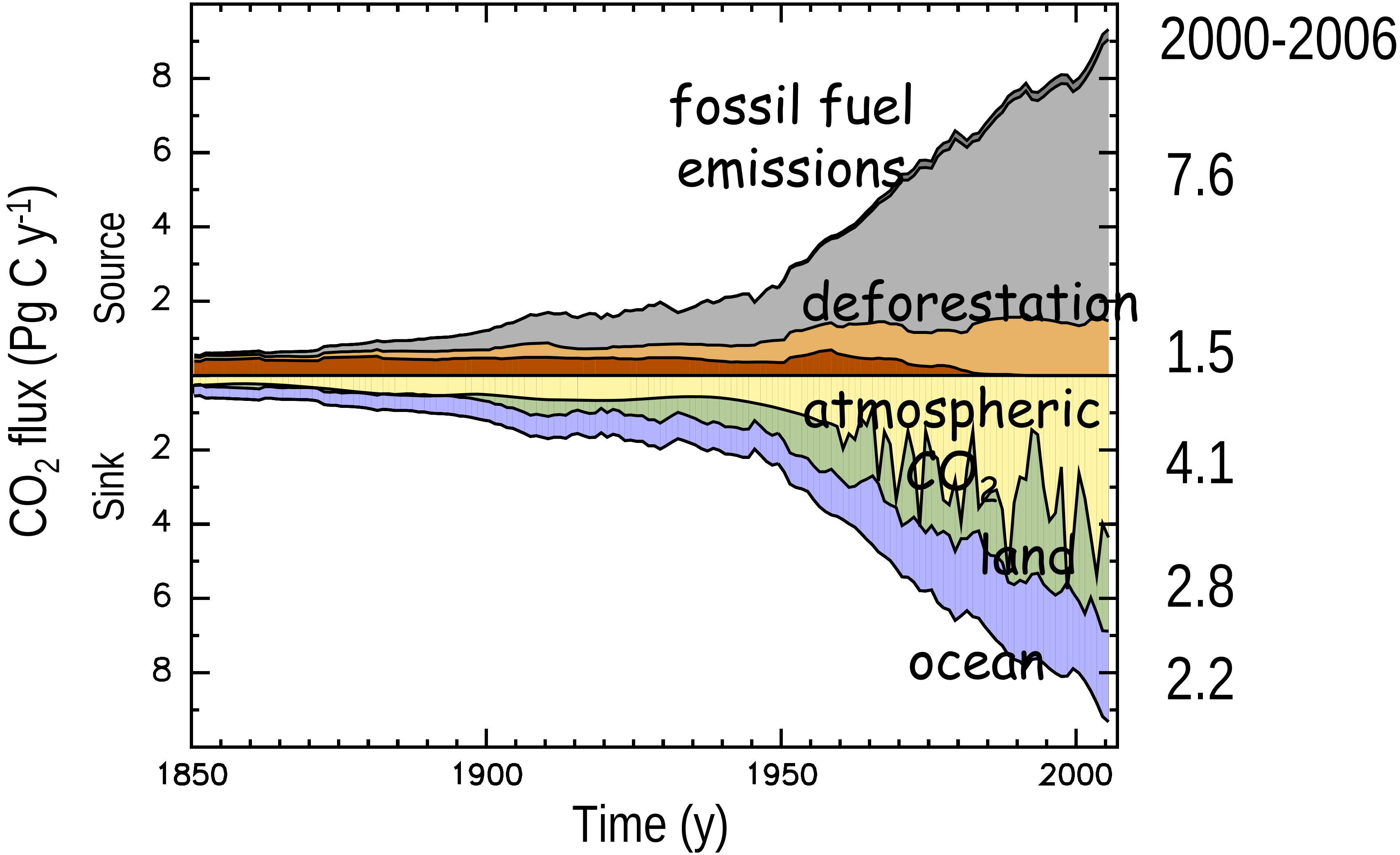
Le Quéré, unpublished; Canadell et al. 2007, PNAS

Perturbation of Global Carbon Budget (1850-2006)



Le Quéré, unpublished; Canadell et al. 2007, PNAS

Perturbation of Global Carbon Budget (1850-2006)



Le Quéré, unpublished; Canadell et al. 2007, PNAS

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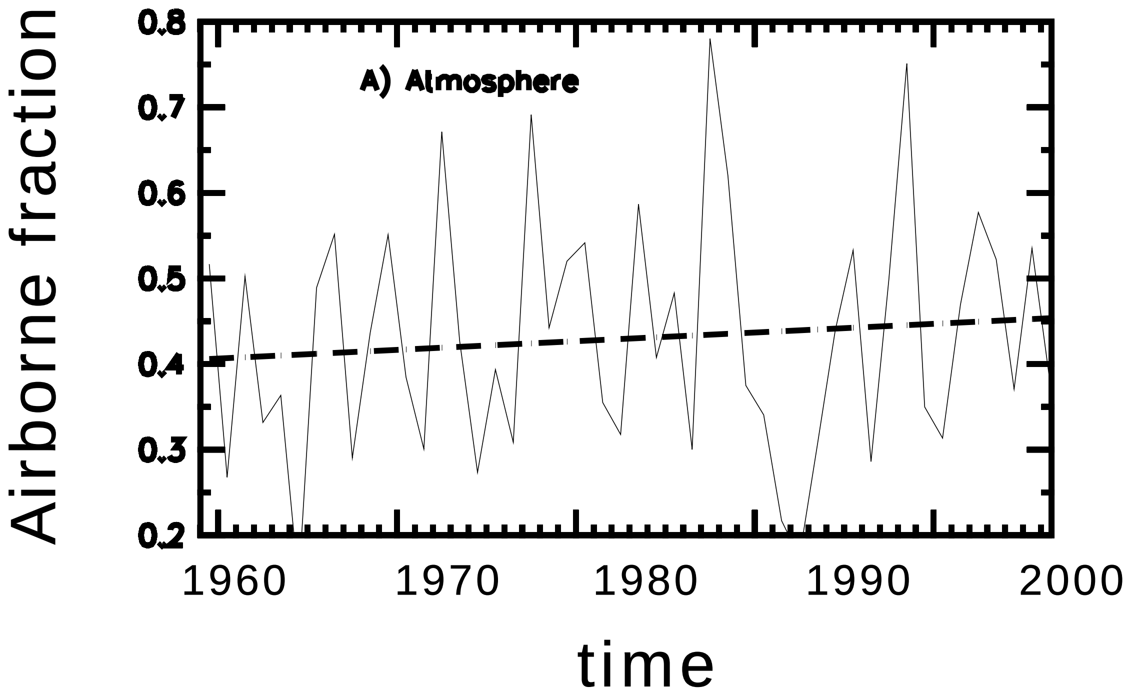
Time Dynamics of the Airborne Fraction Shows ~10% decline in the efficiency of natural sinks



The observed trend in Airborne Fraction was +0.25% per year (p = 0.89) from 1959-to 2006, implying a decline in the efficiency of natural sinks of 10%

Canadell et al. 2007, PNAS

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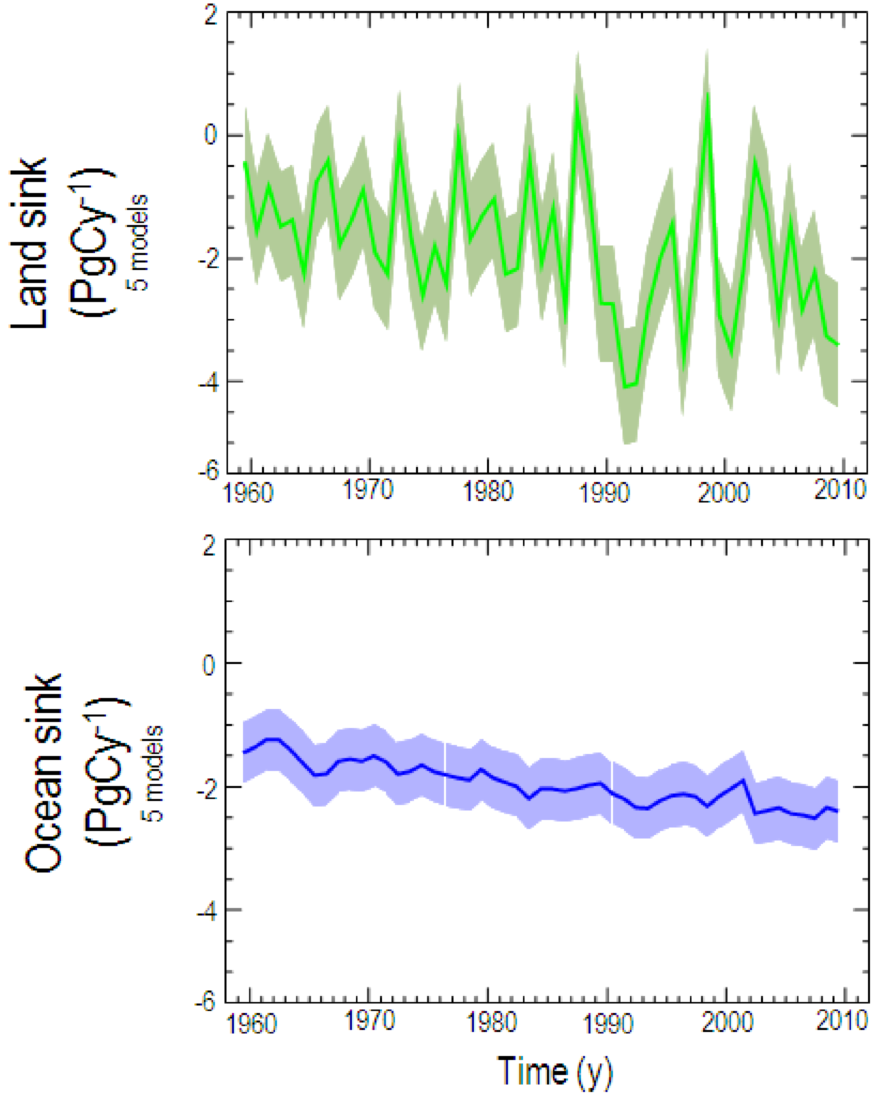
Quantifying the Biosphere's Carbon Sink Activity

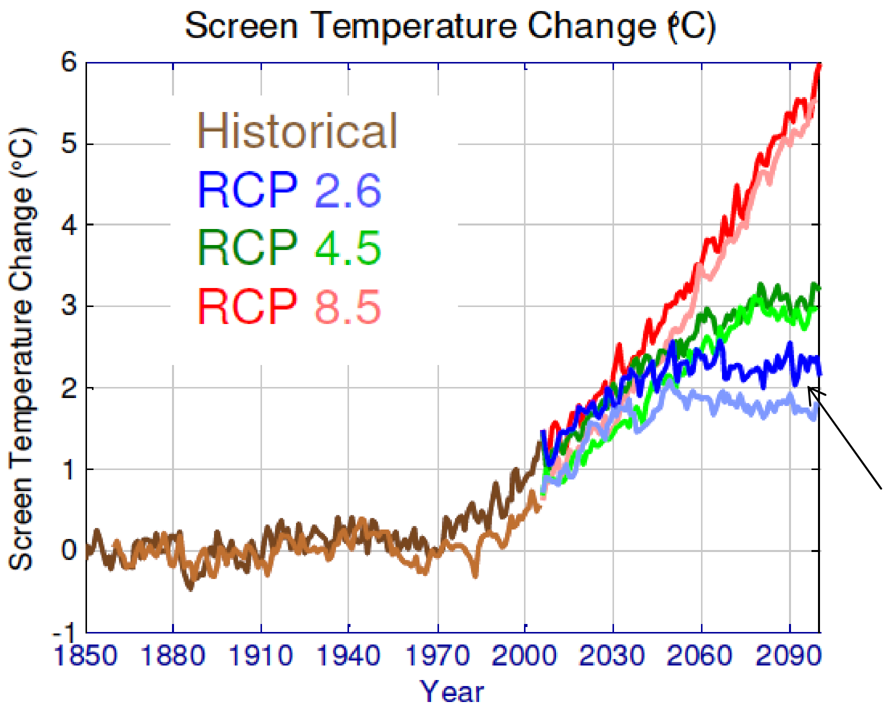


Decadal and Century-scale Projections (CMIP5)

Earth System Science Partnership

- 21 global modelling teams
- Full set of forcing (20st and 21st century)
- Earth System Grid – free access to simulation runs
- More results to be available at:

WCRP Open Science Conference
24-28 October 2011, Denver, Colorado, USA
http://conference2011.wcrp-climate.org



2°

Dark colour – CCCma
Light colour - Hadley

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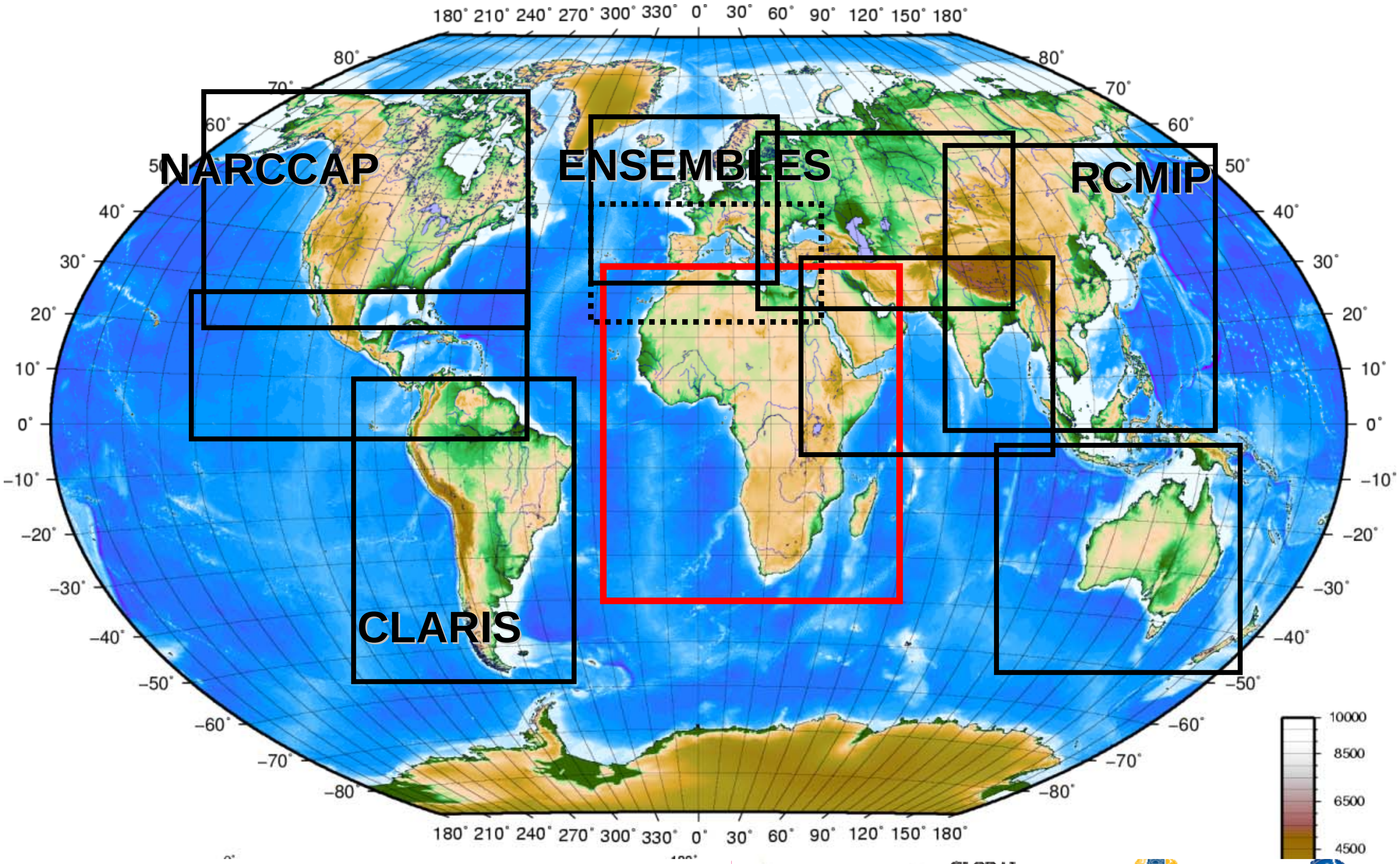
Downscaling the Decadal Predictions (CORDEX)



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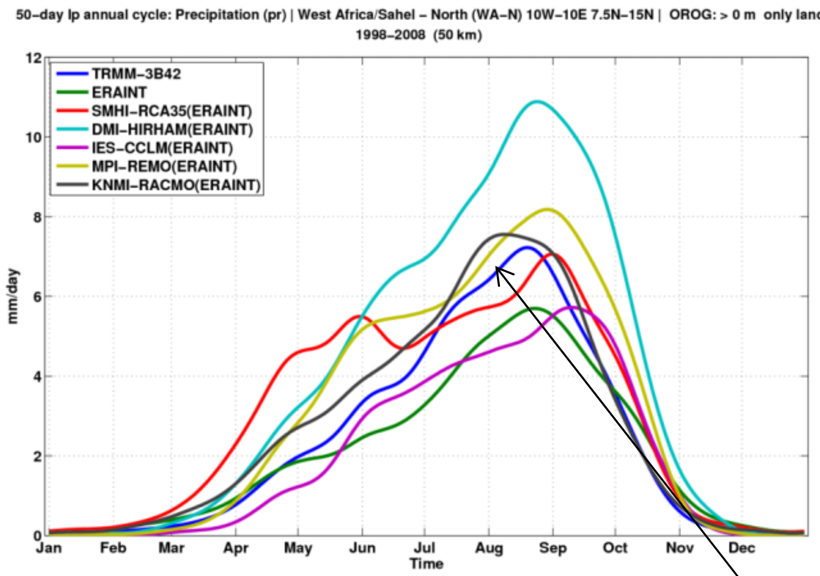
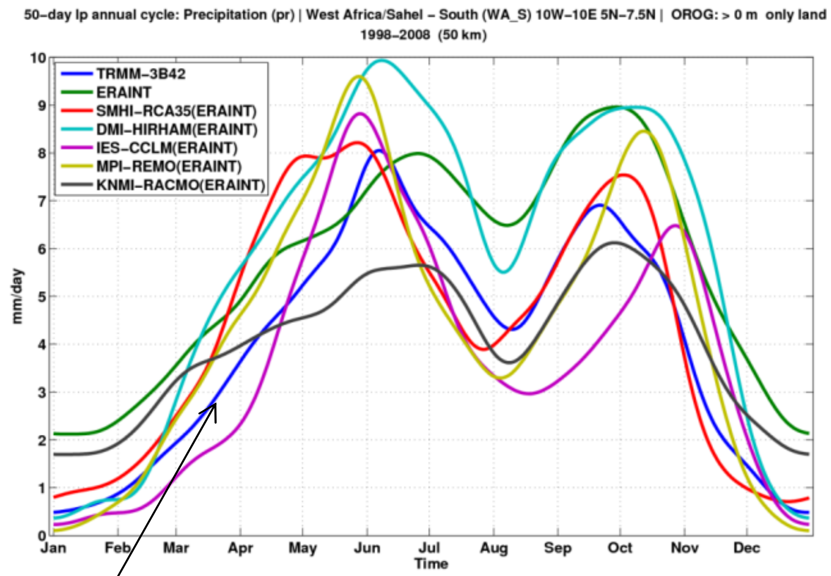
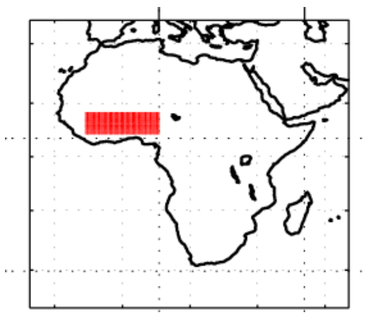
Downscaling the Decadal Simulations

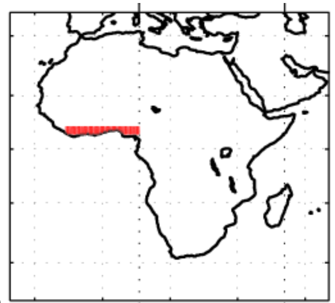
(Annual precipitation cycle Examples for Africa)







Observations



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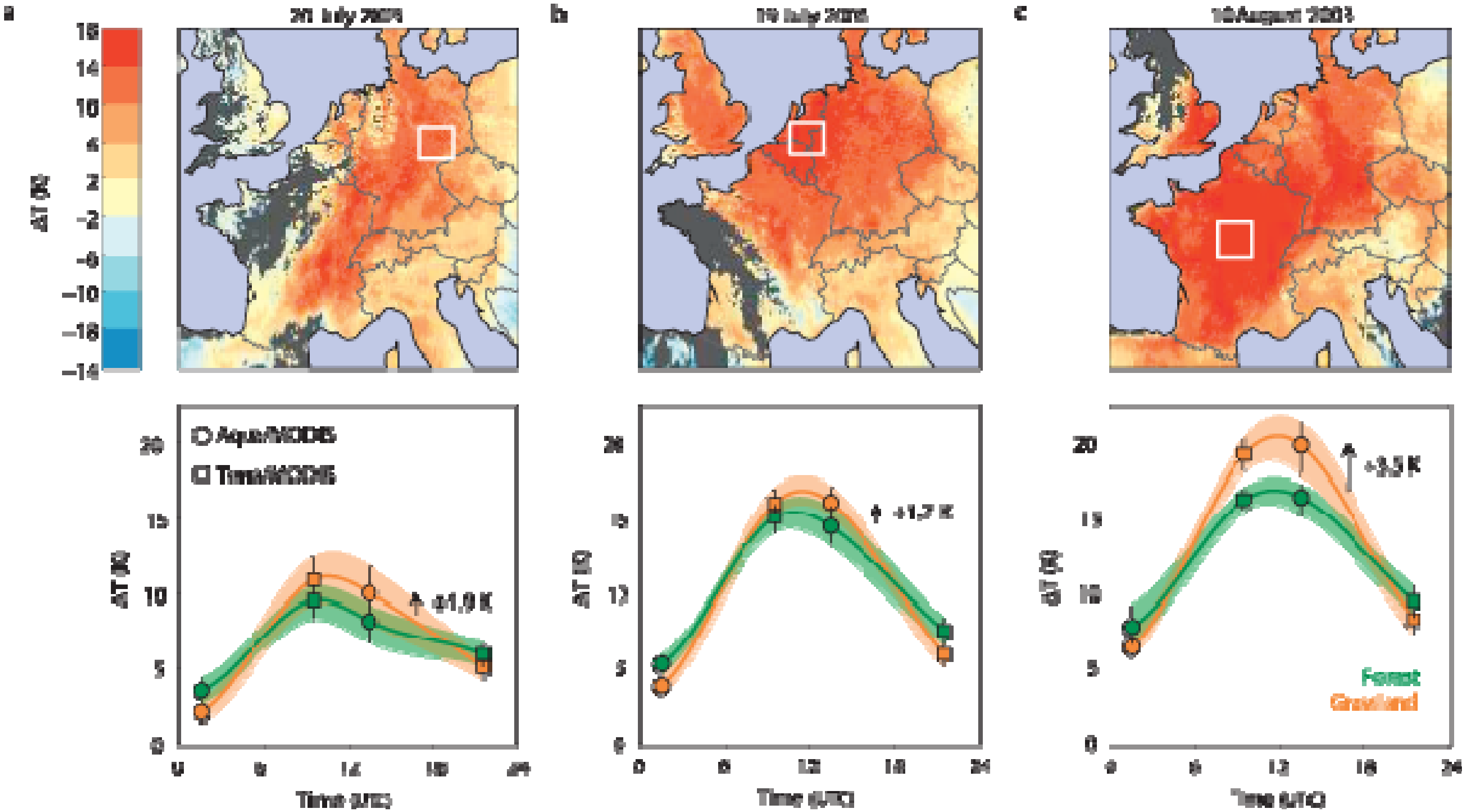
Land cover matters! Forest and Grassland Response to European Heat Waves



Teuling AJ et al. (2010) Nature Geoscience 3: 722-727.

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Global Biodiversity Outlook 3

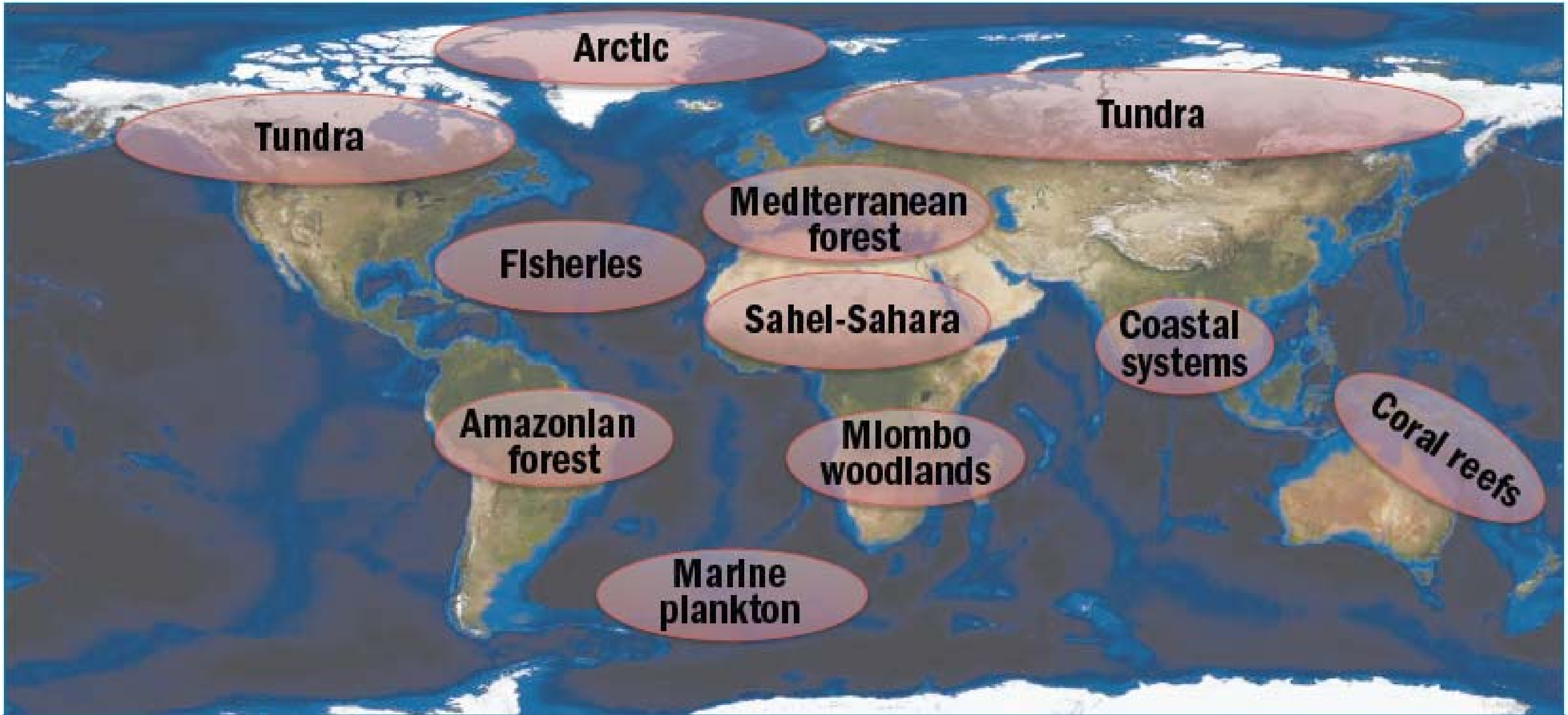

FIGURE 1 MAP OF THE DISTRIBUTION OF TIPPING POINTS OF GLOBAL IMPORTANCE.

Base map is the NASA Blue Marble Next Generation, a MODIS-derived 500m true color earth dataset. Source: onearth.jpl.nasa.gov/.

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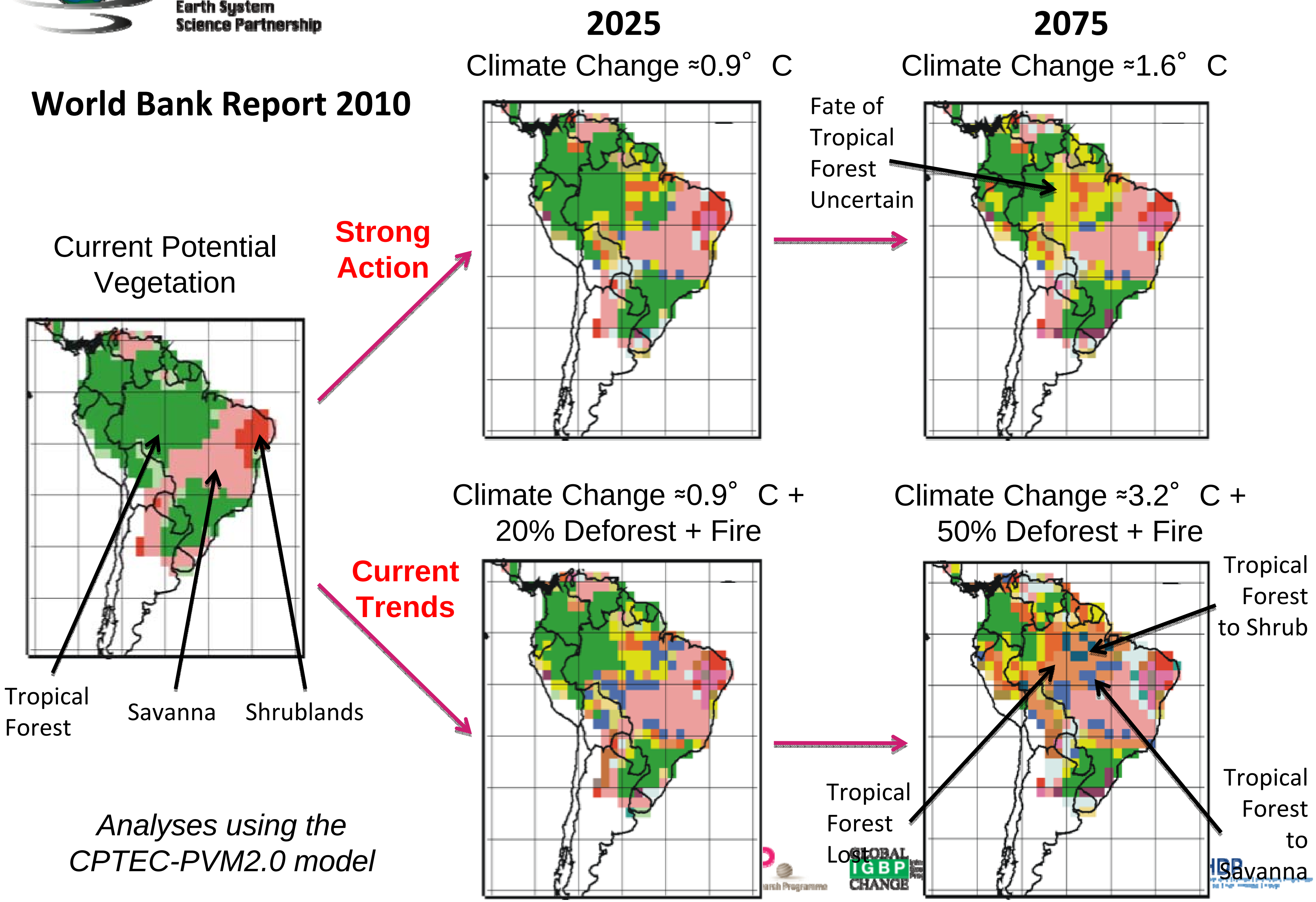
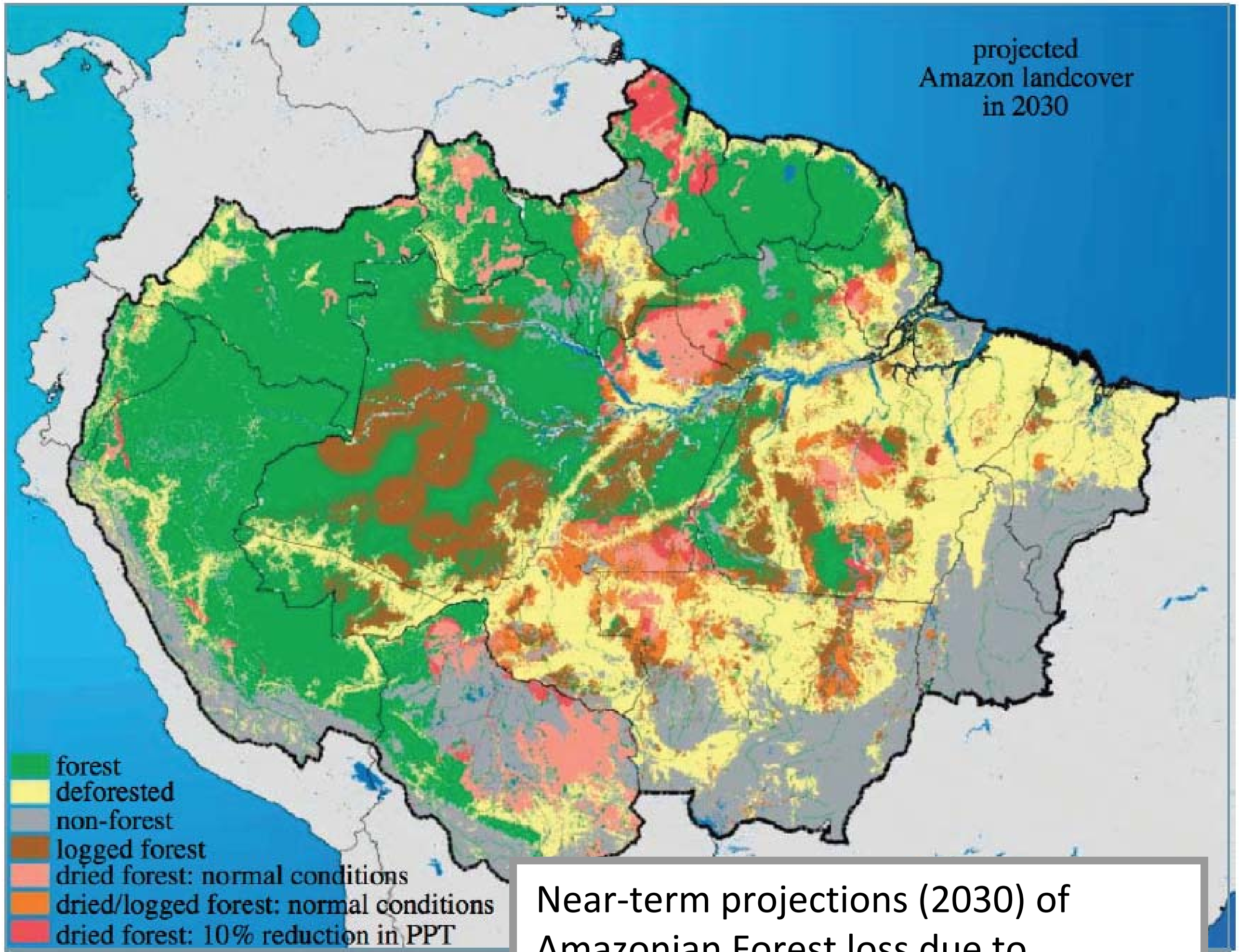
World Bank Report 2010



Analyses using the CPTEC-PVM2.0 model

Amazonian Forest Dieback Due to Climate Change, Deforestation & Fire



Near-term projections (2030) of Amazonian Forest loss due to deforestation and forest degradation due to logging, climate change and fire (Nepstad et al. 2008)

If trends of recent past continue over the next several decades:

- **≈ 15–26 Pg of carbon contained in forests released to the atmosphere by 2030 ≈1.5–2.6 years of current worldwide, human-induced carbon emissions (Nepstad et al. 2008).**
- **Loss of 1/3 of >10000 tree species (Hubbell et al. 2008).**

Private-sector related land use trends in Africa

- Trans-national investment in agriculture and farmland
- Access provided through long-term leases or purchases
- International vs national and local needs for resources in an increasingly connected world

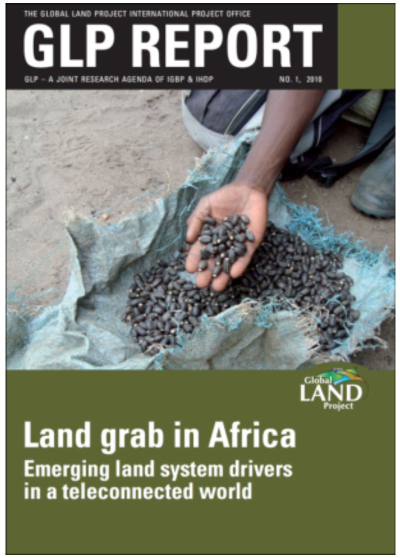


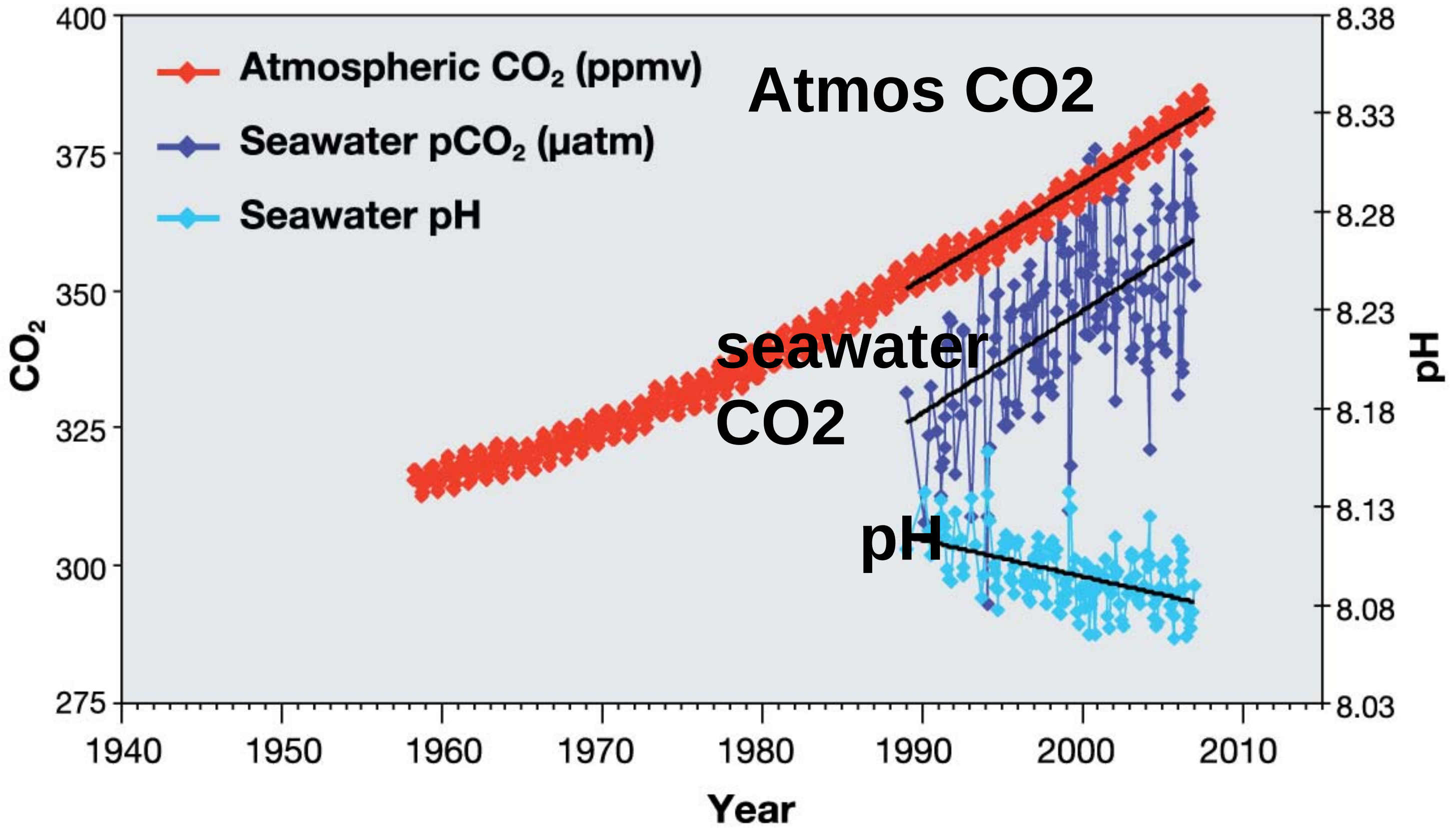
Table 3. Purpose of the land deals

	Food production	Biofuels	Industrial production
Ethiopia	8	15	1
Madagascar	3	16	3
Sudan	11	2	

Ocean acidification

Arctic ocean carbonate under-saturation
Current CO2 emission rate –
2018 - 10%
2050 – 50%
2100 – 100%

CO_2 and pH time series in the North Pacific Ocean



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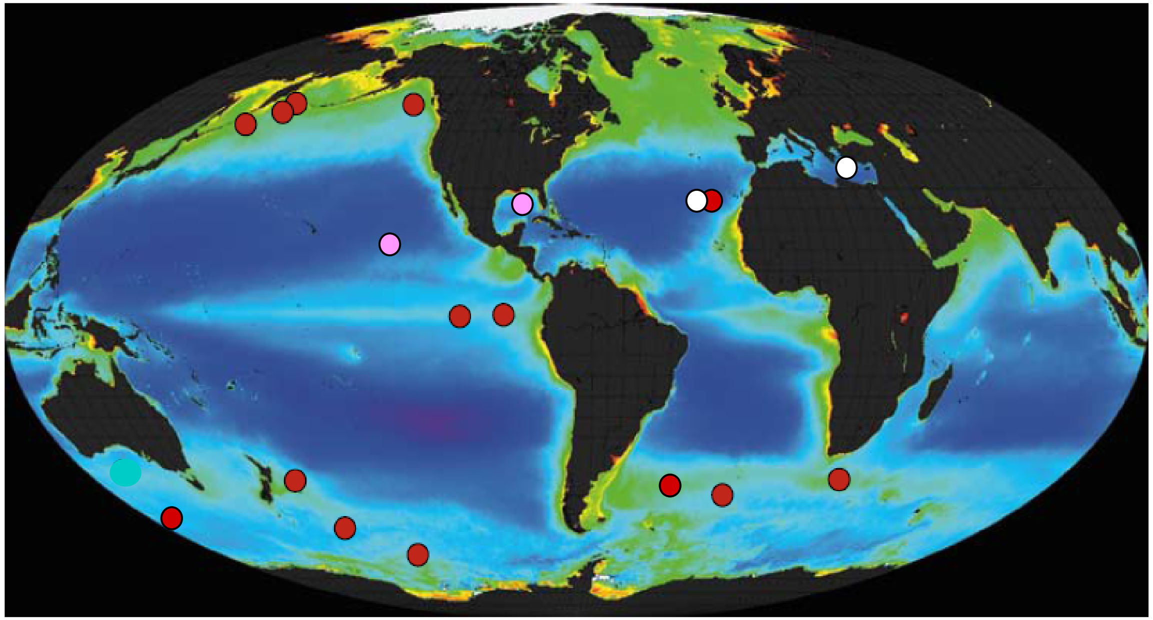
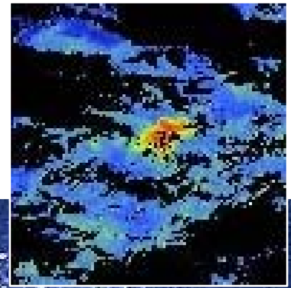
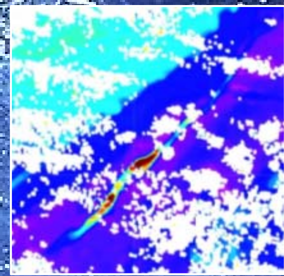
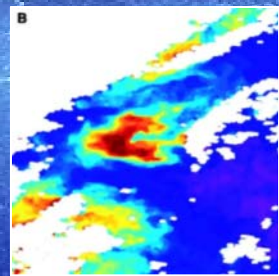
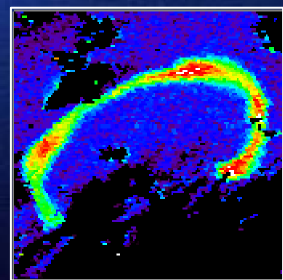
Large-scale biophysical interventions knowledge for feasibility and risk assessment











13 iron addition experiments ( ), two commercial trials ( ) and two phosphate addition experiments ( ) have been carried out to date. Most induced a phytoplankton bloom, but only three conclusively demonstrated carbon sequestration.

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.

Ocean Fertilization

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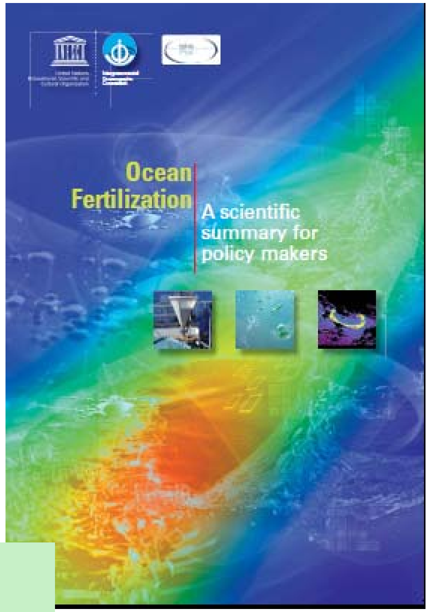

- **Effectiveness:** field experiments (at scale of 10-100 km^2) show CO_2 uptake can be enha
- **Perr** upta a few mon

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

- **Verification:** it will be challenging (=expensive) to quantify carbon sequestration, and hence net climatic benefit
- **Political acceptability:** concerns on unintended impacts currently limit research. Large scale deployment likely to fail 'precautionary principle'

Health co-benefits of action

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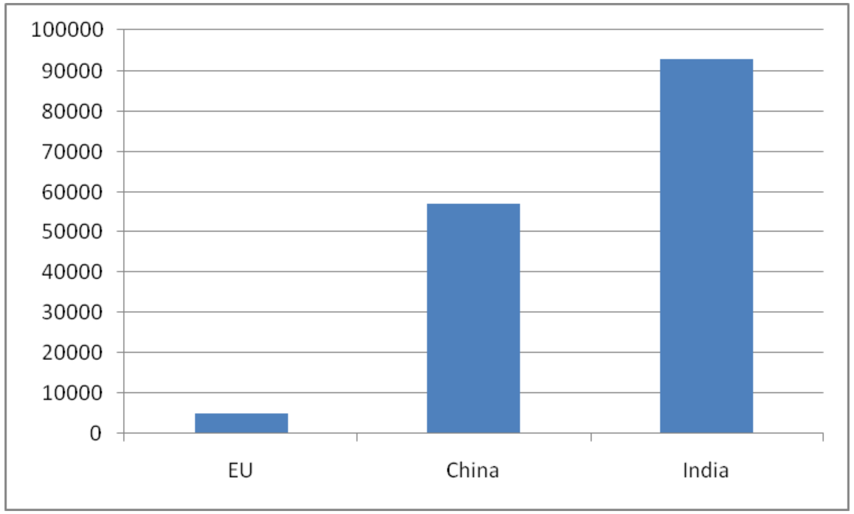
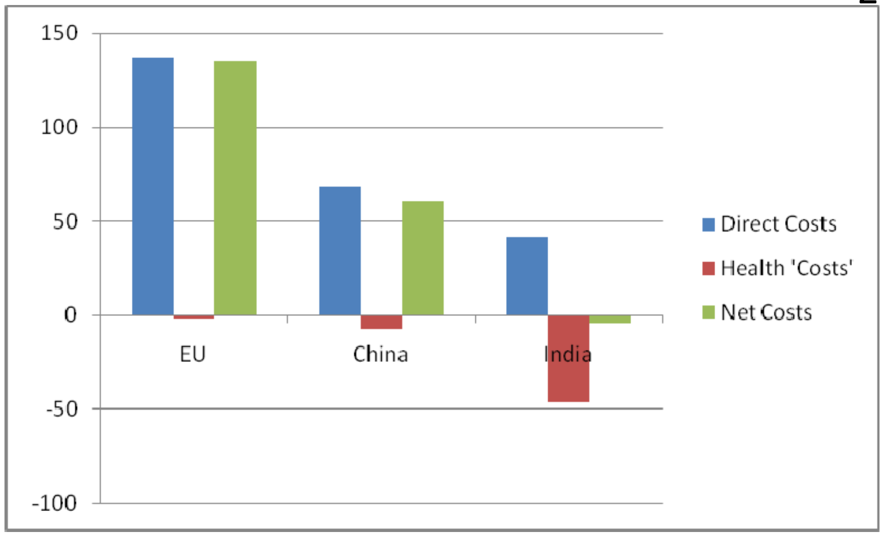
Haines et al 2009 Lancet 374 December 19/26 pp 2104-14

Premature Deaths Avoided in 2030



- Many climate change mitigation strategies can result in major benefits for public health
- Co-benefits can significantly offset mitigation costs, additional to other benefits of limiting extent of climate

Costs of Mitigation US$/Tonne CO_2



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Conclusions

- Very close links between changes in socio-economic activity and carbon cycle, direct (emissions) and indirect (market signals)
- Ecosystems/biodiversity important. Natural ocean and land ecosystem sinks for CO_2 emissions are large, but sensitive to climate variability, and currently probably showing reduced efficiency
- Local/regional land management options appear important for mitigation, adaptation and local livelihoods
- Knowledge on trends, projections and potential responses for land-based systems improving, indicates risks in key regions, some more manageable than others
- Predictive understanding of impacts on oceans is advancing, confirms IPCC AR4 concerns, more knowledge needed to assess response options
- Co-benefits of mitigation may be significant but are currently under-appreciated

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Thank you for your attention!

More information can be obtained at:
www.essp.org
www.diversitas-international.org
www.igbp.net
www.ihdp.unu.edu
www.wcrp-climate.org