The response of the carbon sinks to recent climate change, and current and expected emissions in the short term from fossil fuel burning and land use

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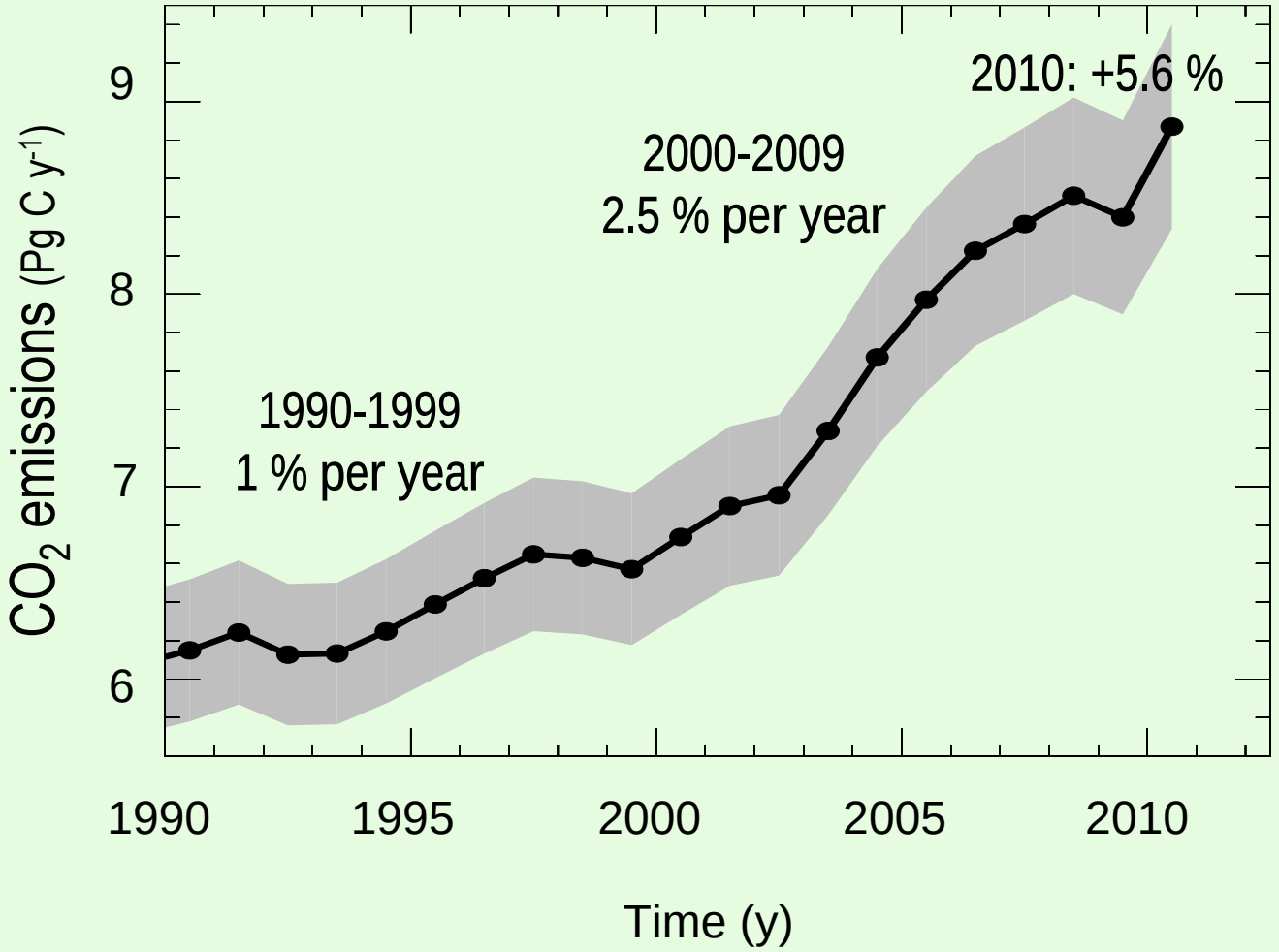
Earth System Science Partnership ESSP

DIVERSITAS IGBP IHDP WCRP

Global Carbon Project

Tyndall Centre for Climate Change Research

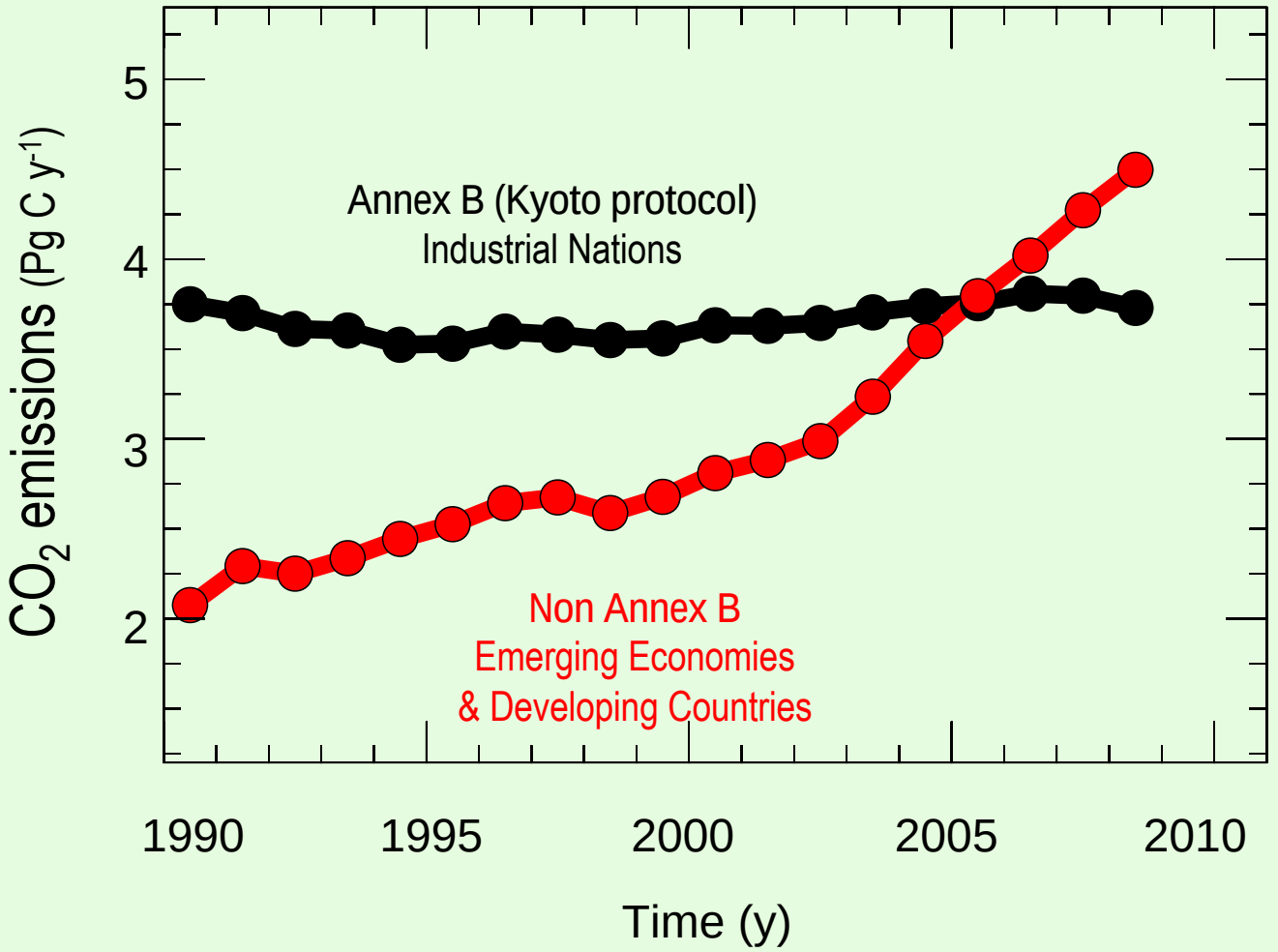
Fossil Fuel CO_2 Emissions



2010:
Emissions: 8.9 PgC
(32.5 Gt CO_2)
includes cement emissions

CDIAC data based on UN, BP & IEA statistics; updated from Friedlingstein et al. Nature Geoscience 2010

Fossil Fuel CO_2 Emissions

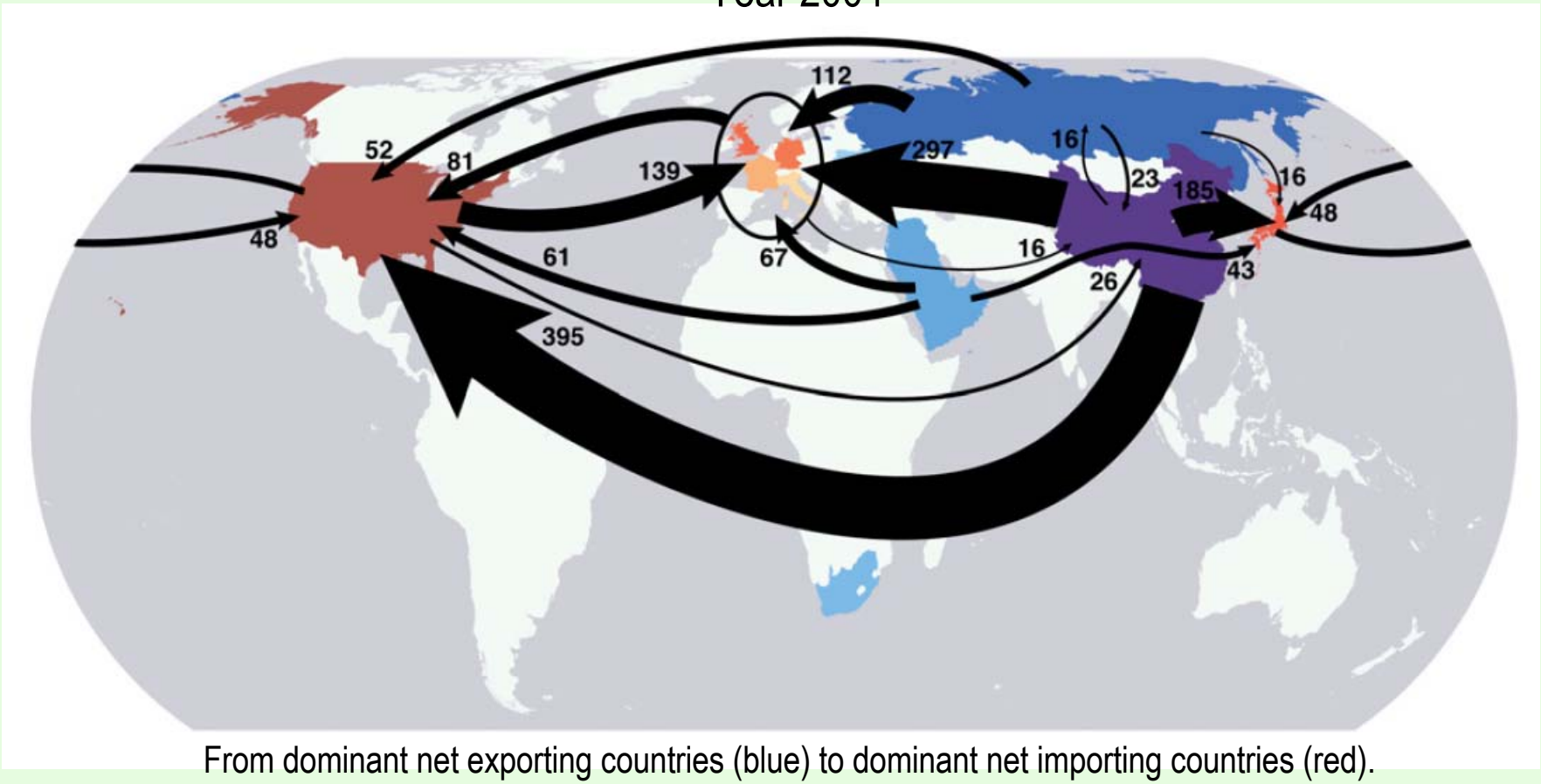


most of the growth in global emissions originates from emerging economies

CDIAC data; updated from Le Quéré et al. Nature Geoscience 2009

Fluxed of Emissions Embodied in Trade (Mt CO_2/y)

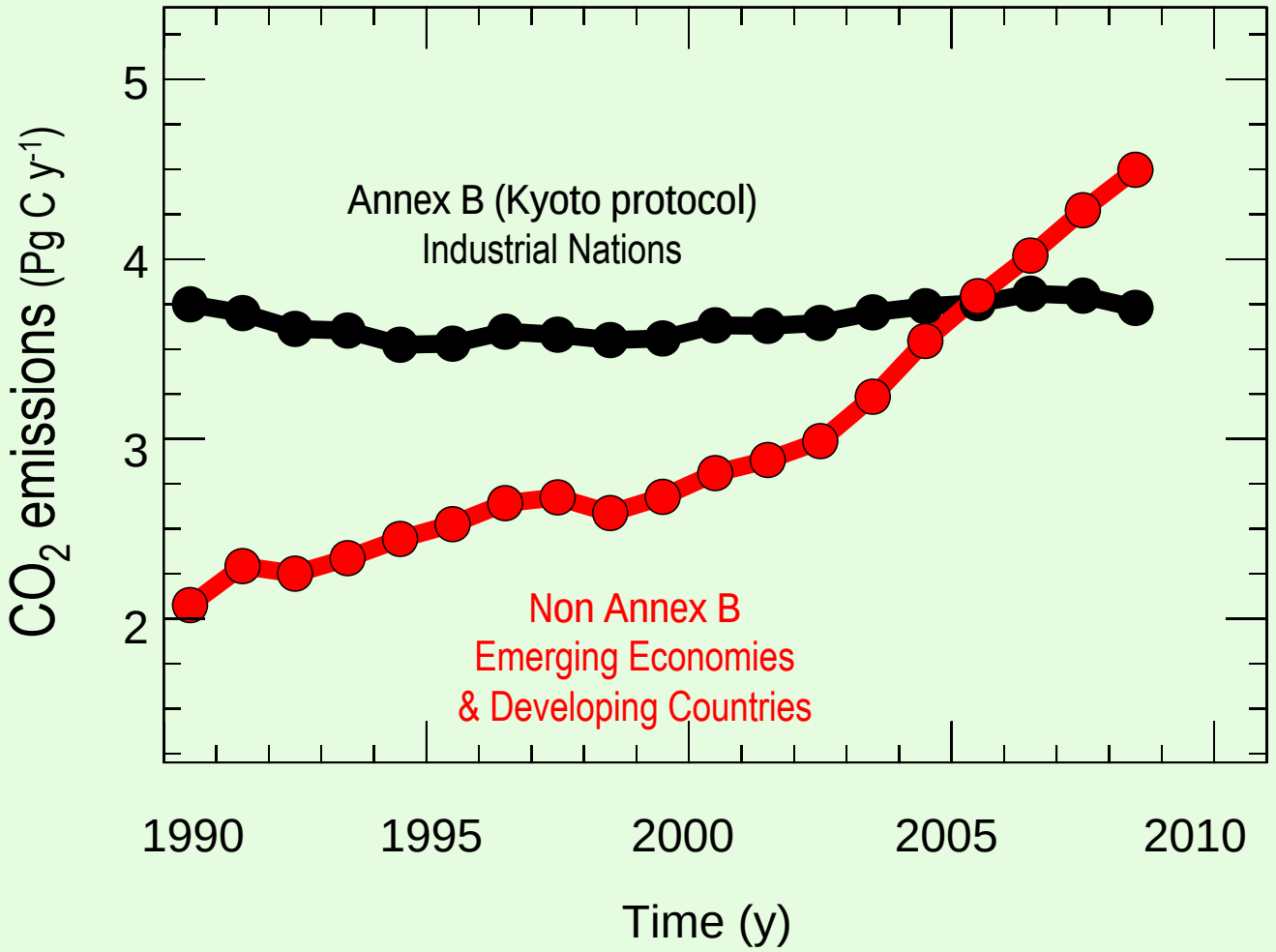
Year 2004



From dominant net exporting countries (blue) to dominant net importing countries (red).

Davis & Caldeira PNAS 2010

Fossil Fuel CO_2 Emissions



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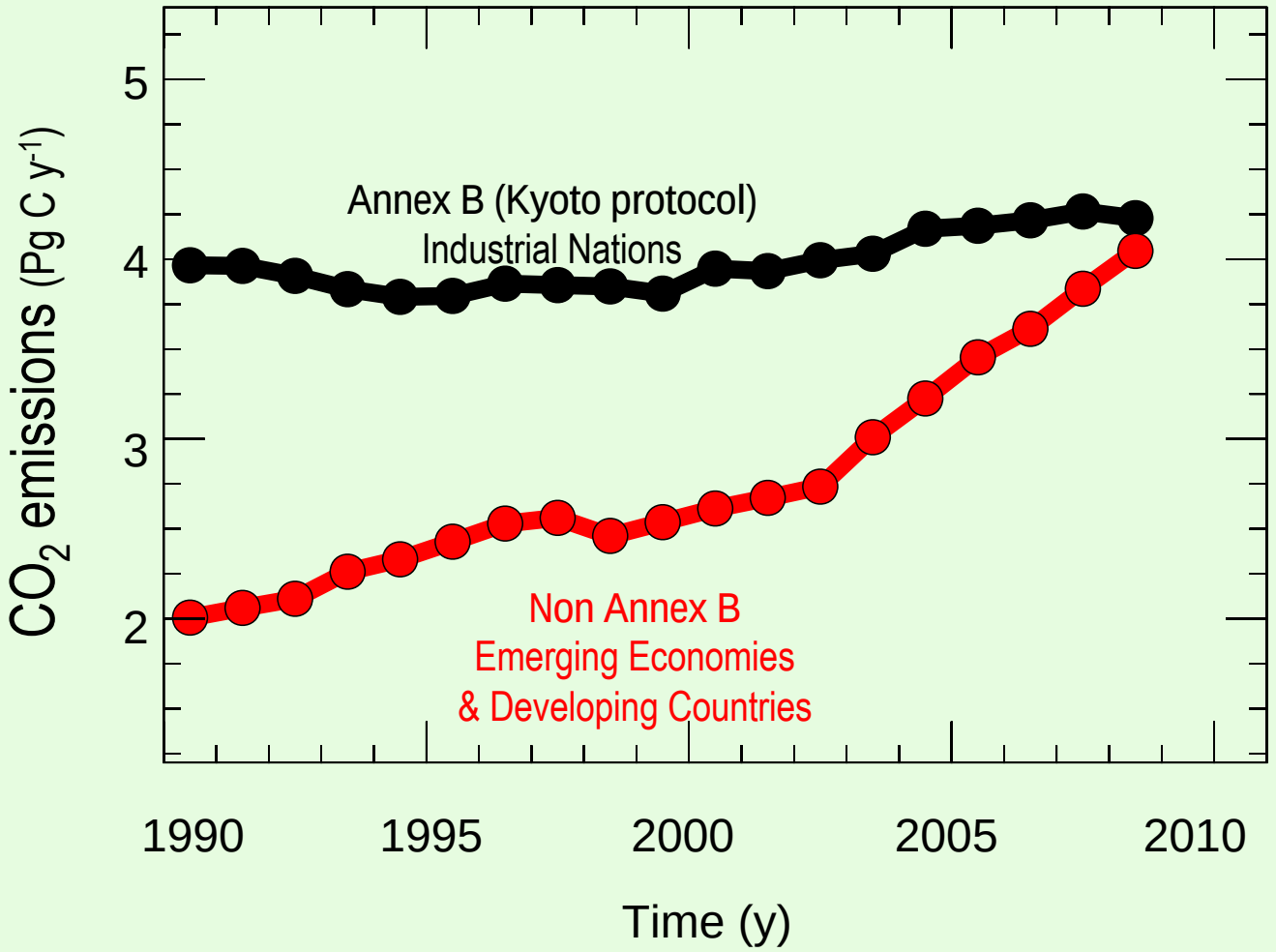
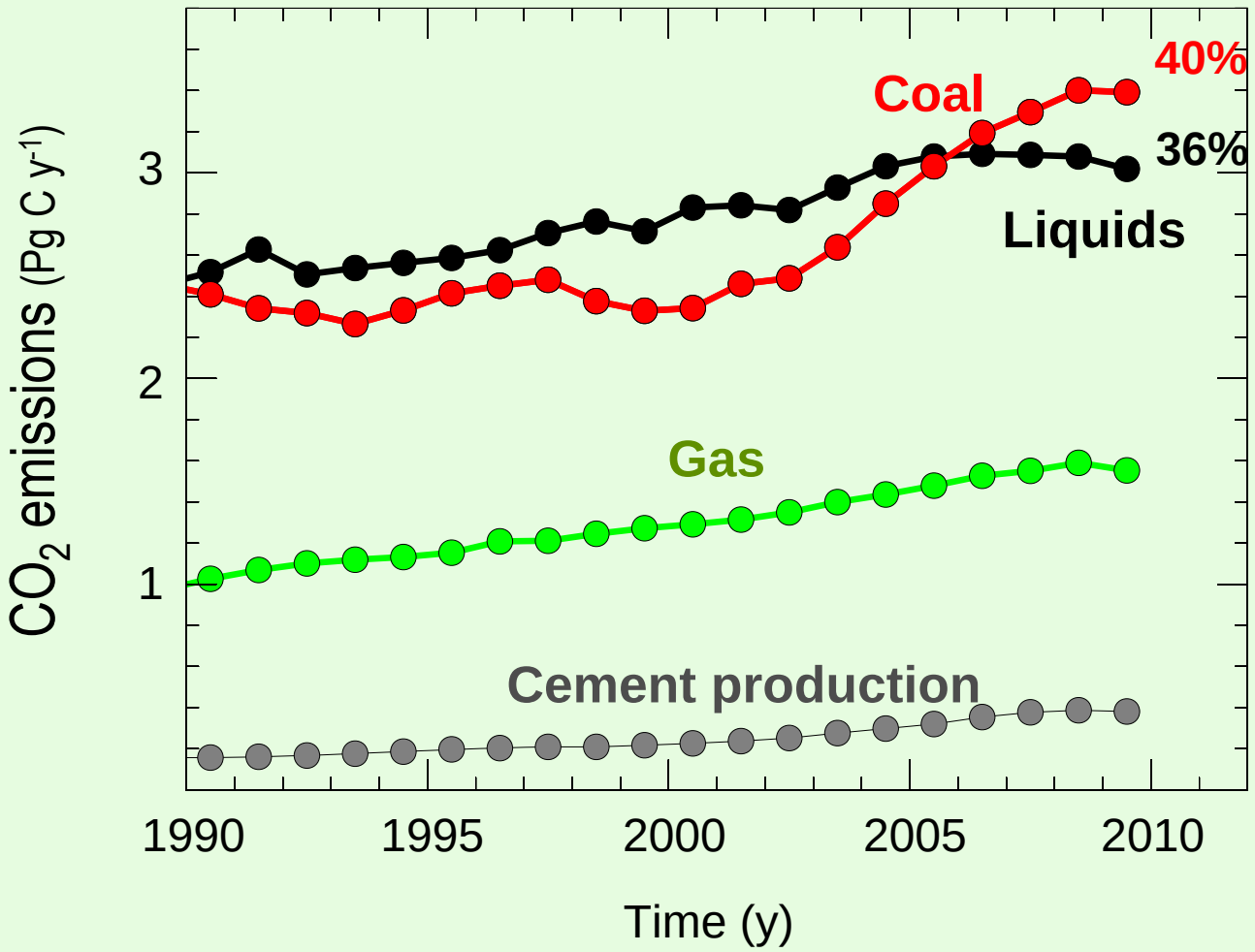


1/3 of growth in emerging economies for products consumed in the west

Peters et al. PNAS 2011

CO_2 Emissions by Fossil Fuel Type

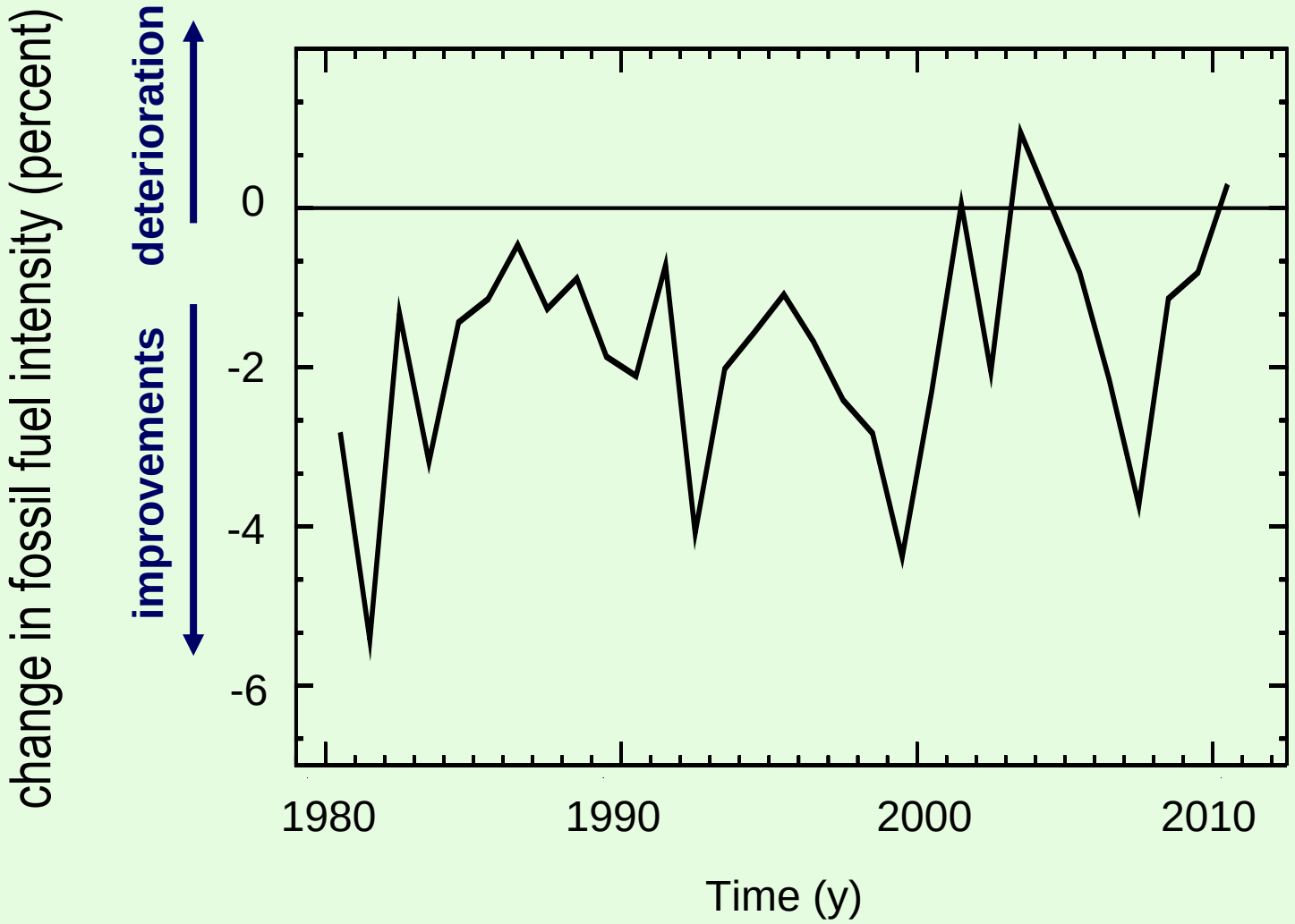


Global CO_2 emissions now dominated by coal

Coal emits more CO_2 than liquids or gas

CDIAC; Le Quéré et al. 2009, Nature Geoscience

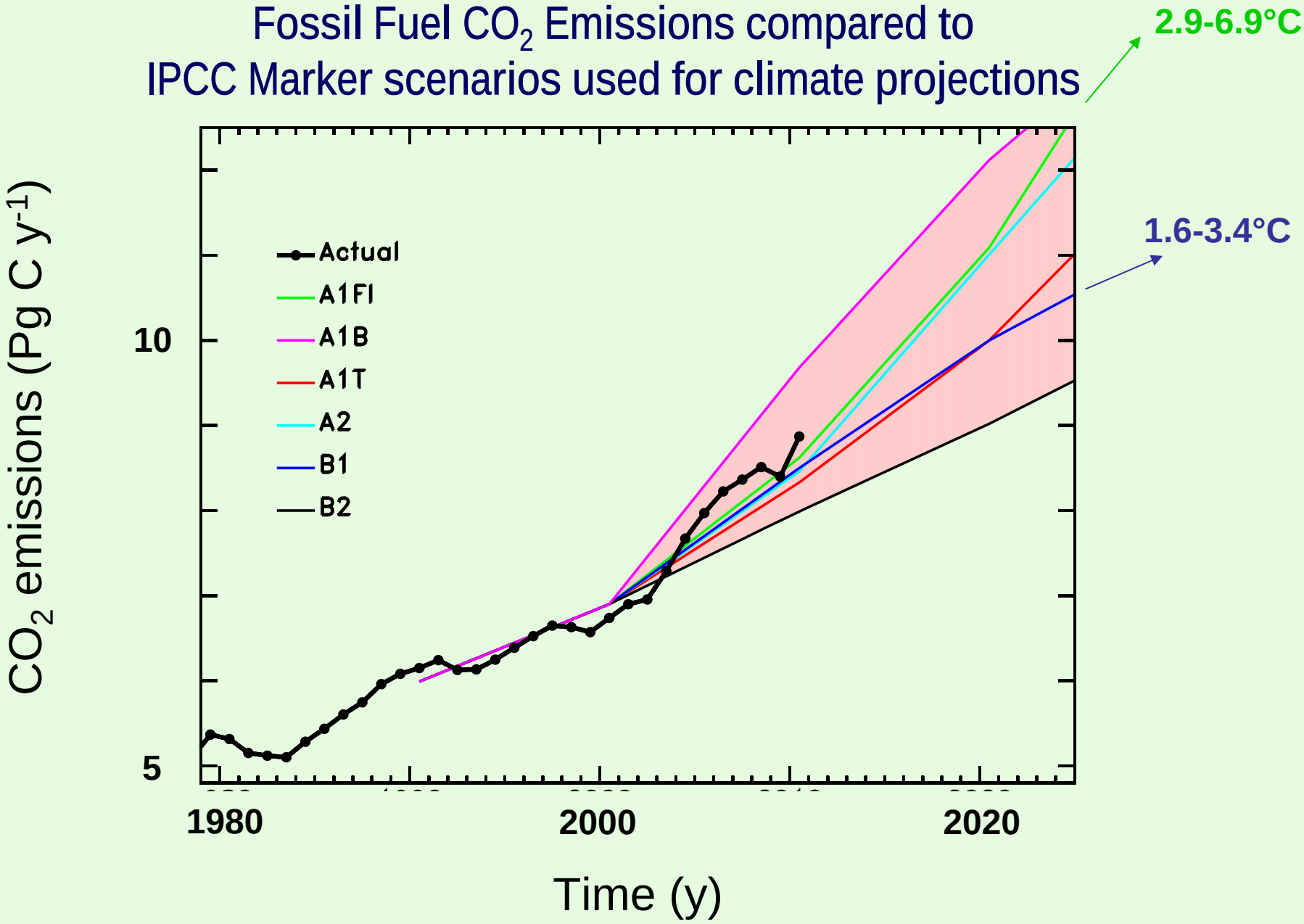
Change in Fossil Fuel intensity of the economy



Improvements in the fossil fuel intensity of the economy are slowing down because of coal use

CDIAC CO_2 emissions growth - IMF GDP growth

Fossil Fuel CO_2 Emissions compared to IPCC Marker scenarios used for climate projections



Updated from Le Quéré et al (2009) Nature Geoscience, using Marker scenarios modified from Raupach et al. PNAS (2007)

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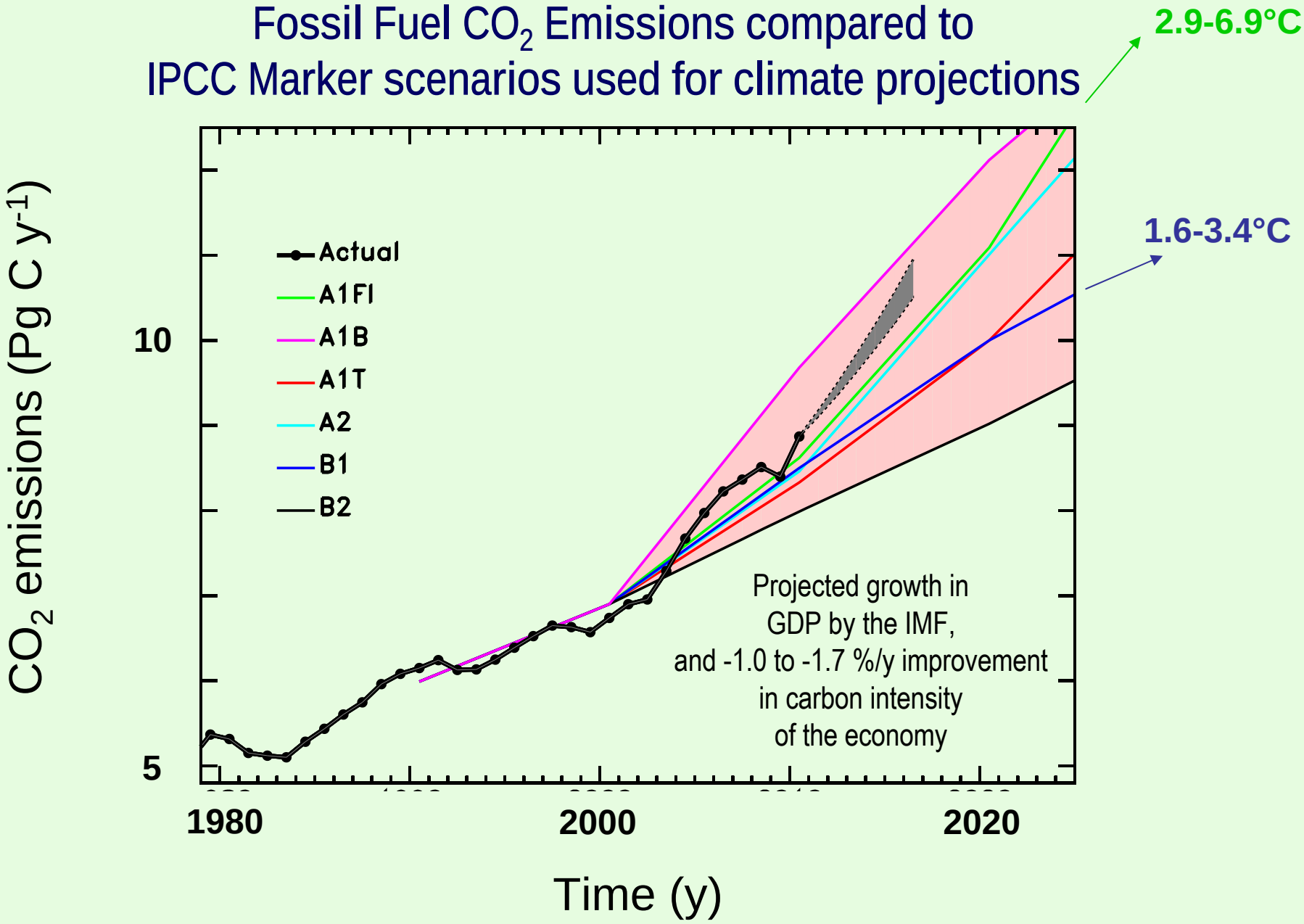

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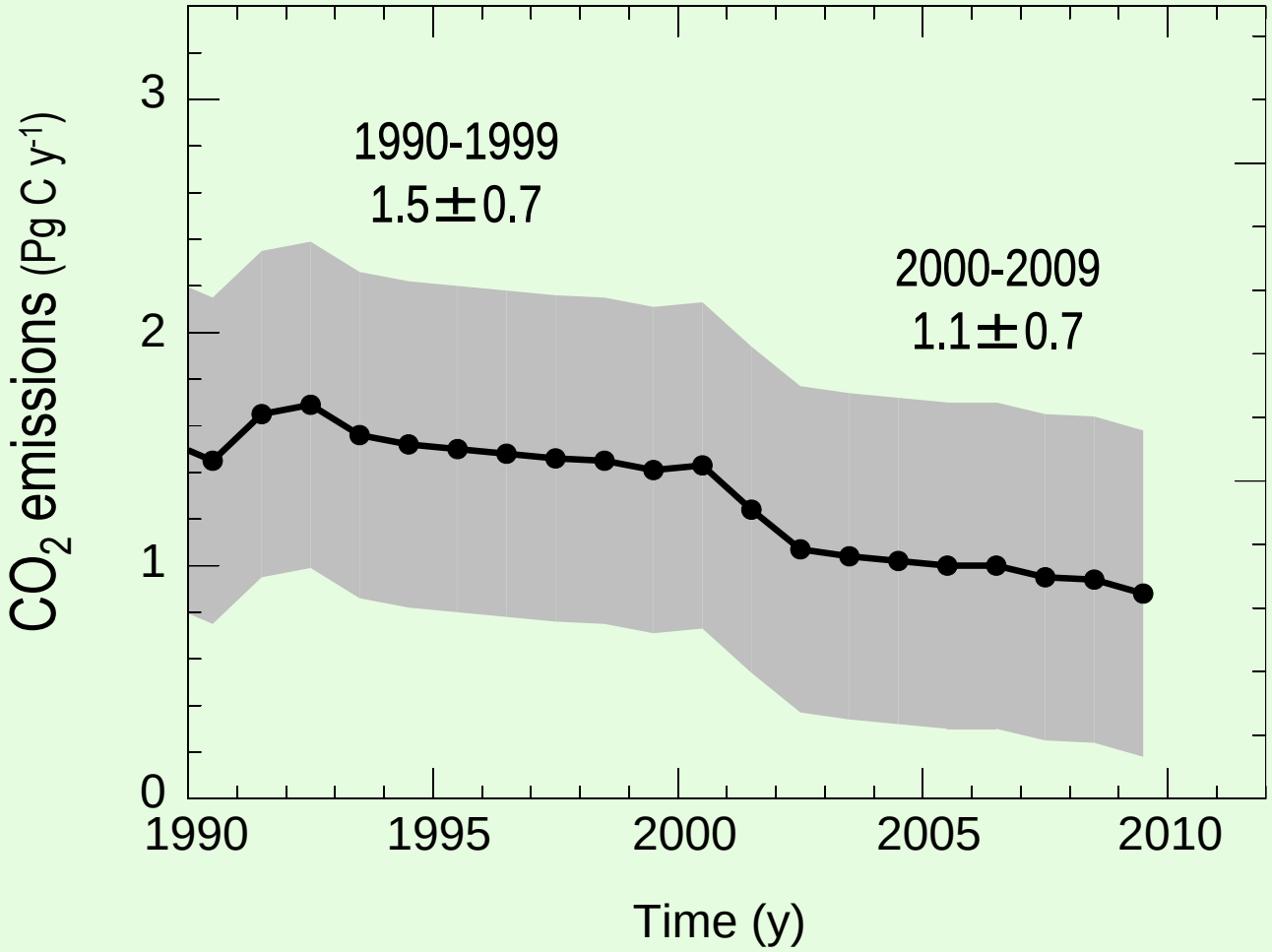
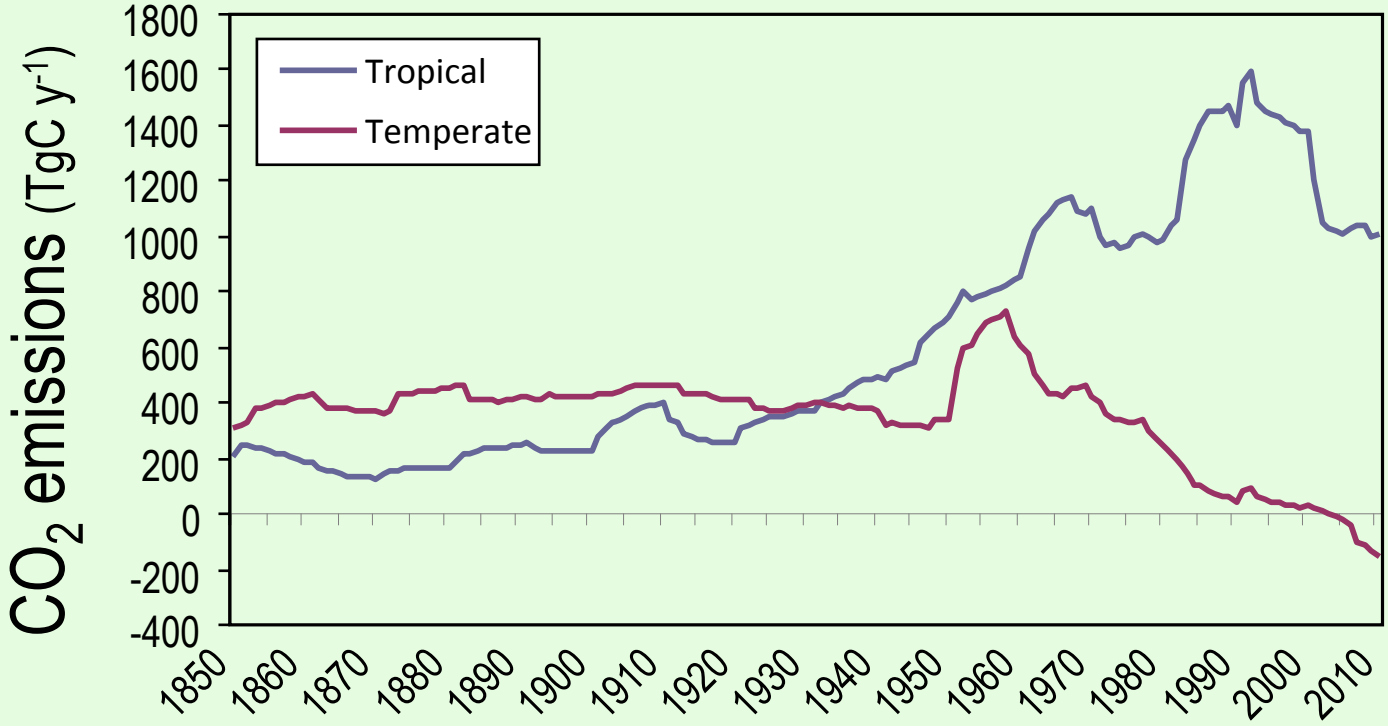
CO_2 Emissions from deforestation and other Land Use Change



Estimated ~25% decrease between the two decades with large uncertainty

WHRC; Friedlingstein et al. 2010, Nature Geoscience; FAO 2010 Forest report

Regional Emissions from Land Use Change



Both tropical and temperate LUC recently decreasing

Temperate LUC could now be a small CO_2 sink

R.A. Houghton 2010, personal communication

Fate of anthropogenic CO_2 emissions (2000-2009)

1.1 PgC y^{-1}

7.7 PgC y^{-1} +

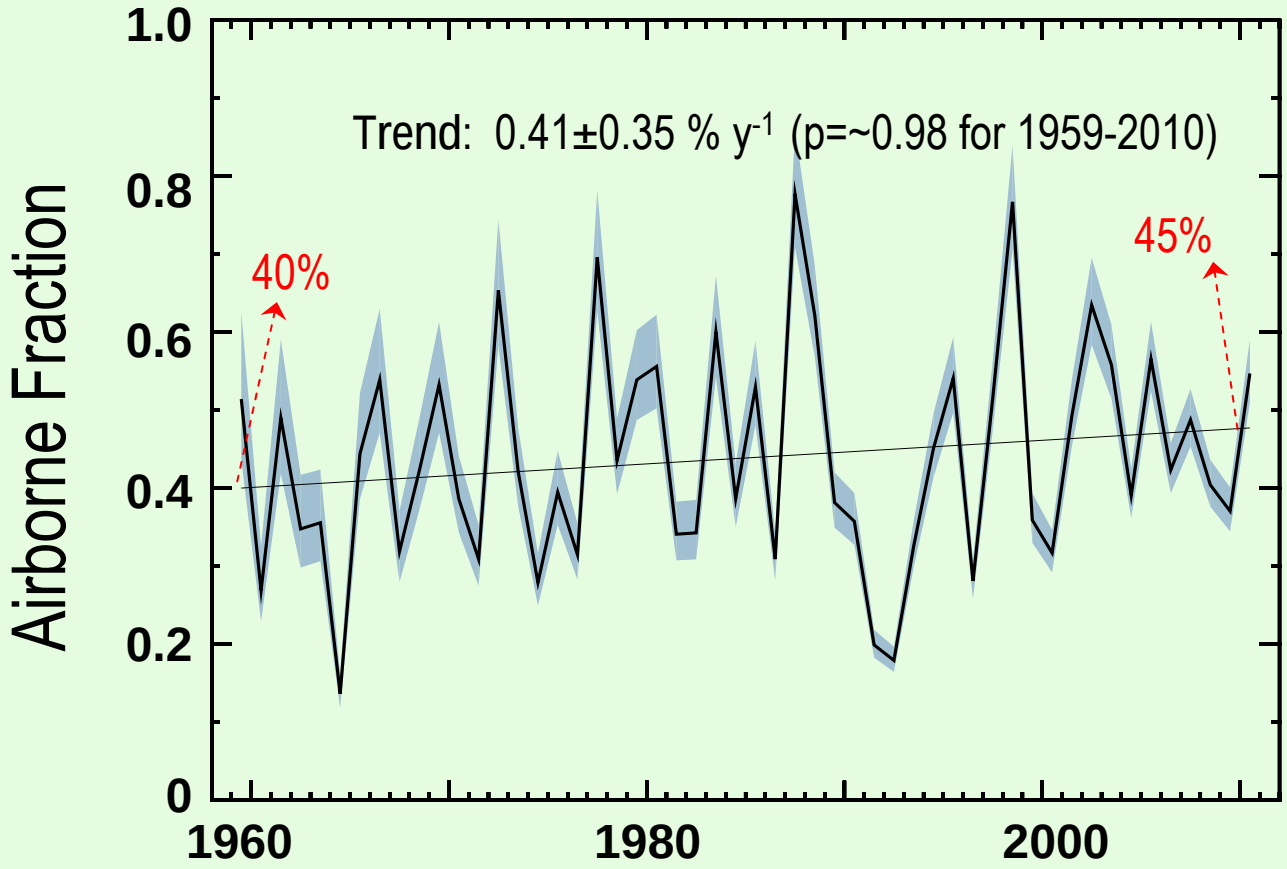
4.1 PgC y^{-1}
47%

2.4 PgC y^{-1}
27%

26%
2.3 PgC y^{-1}

Updated from Le Quéré et al. 2009, Nature Geoscience; Canadell et al. 2007, PNAS

Evolution of the airborne fraction



Raupach et al., Nature Geoscience, under review; Canadell et al. PNAS 2007

Possible Reasons for a Positive Trend in Airborne Fraction:

- Accidental (p=0.98; errors in land use)
- Emissions are rising too fast
- Sinks are saturating because of high CO_2
- Sinks/reservoirs are responding to climate change and variability

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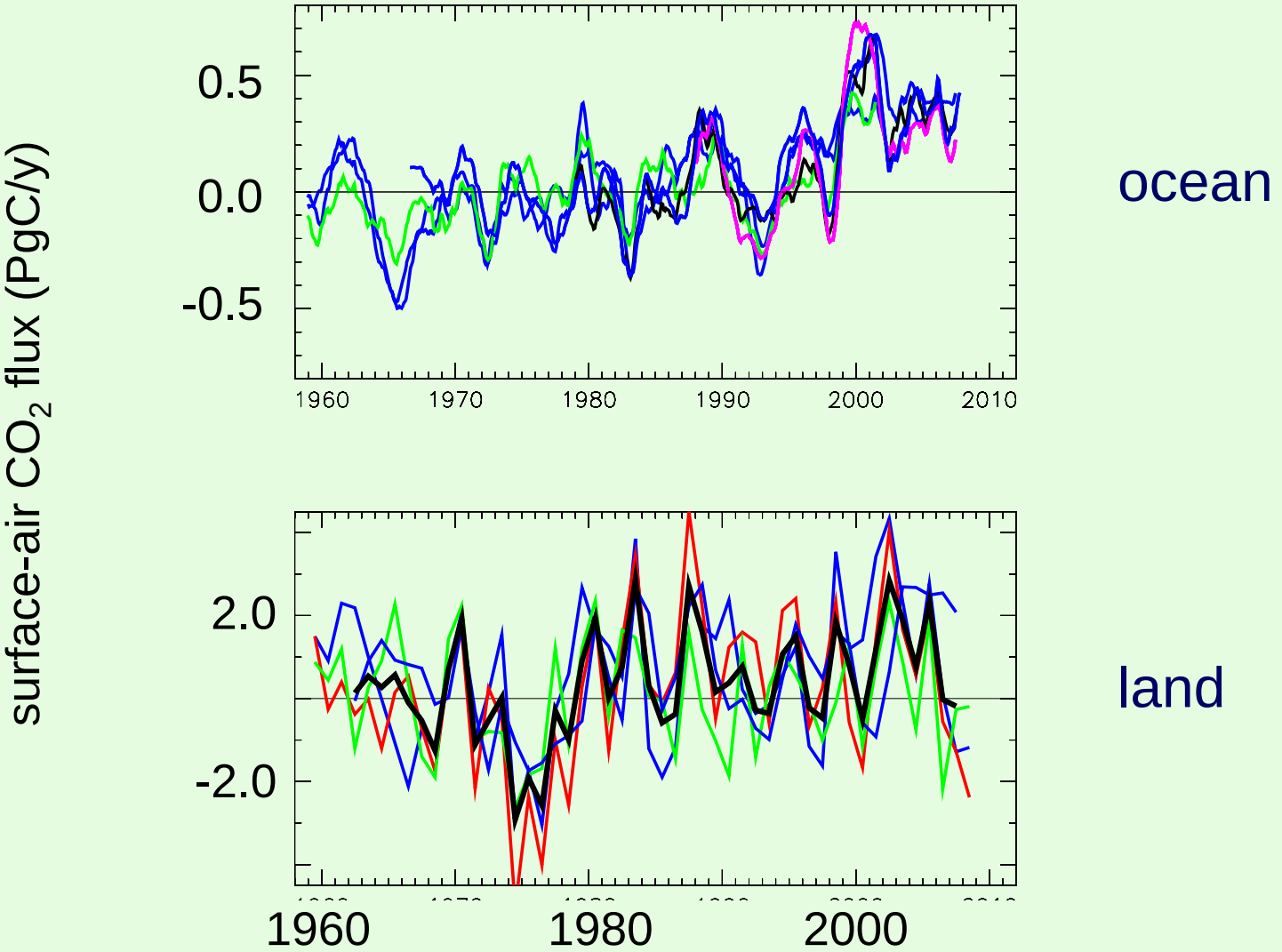
1959-2008 Trend in Airborne Fraction (% per year):

Observations:	+ 0.41 ± 0.35
Models (without changes in climate)	- 0.8

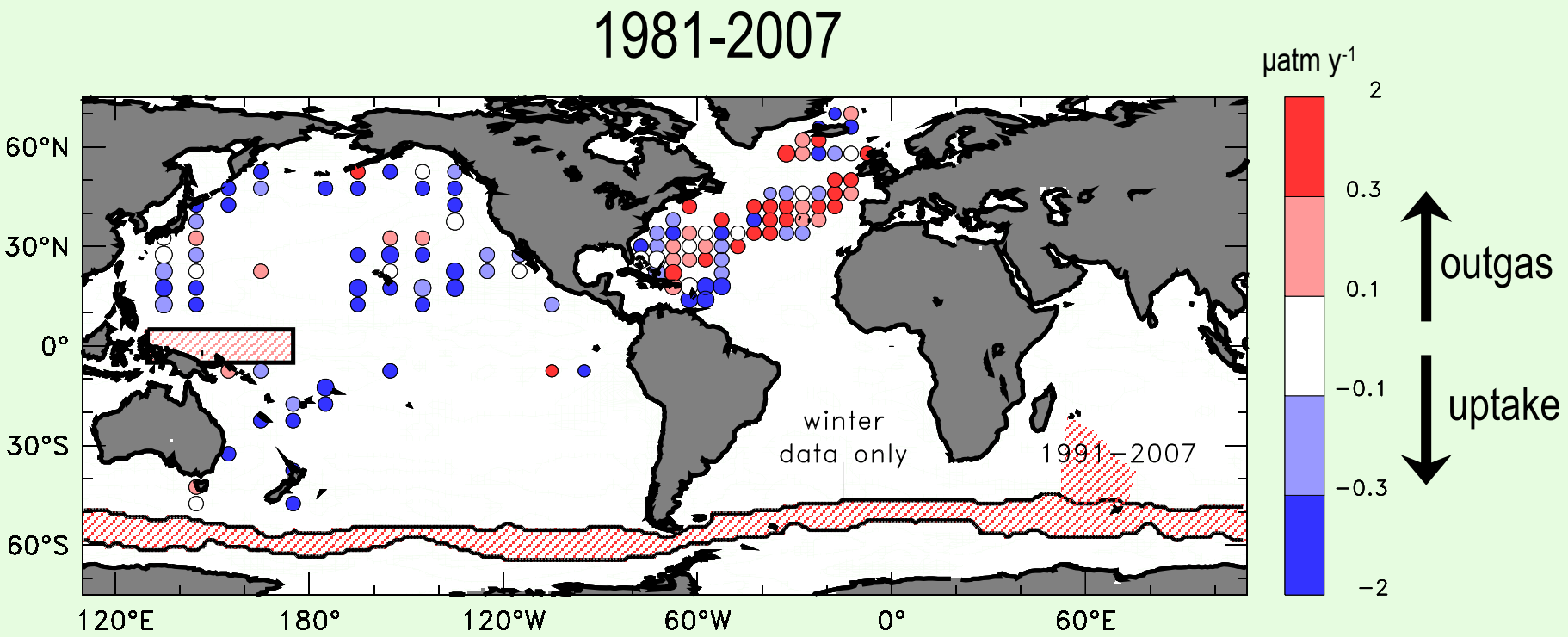
Le Quéré et al. 2009, Nature Geoscience

Impact of climate change and variability on the CO_2 sinks (from models)



Le Quéré et al. 2009, Nature Geoscience

Estimated Trends in Sea-Air pCO_2



Le Quéré et al. Nature Geoscience 2009 based on data from Takahashi et al DSR 2009

Trend in Airborne Fraction (% per year):

Observations:	+ 0.41 ± 0.35
Models (without changes in climate)	- 0.8
Models (with changes in climate)	+ 0.1

Le Quéré et al. 2009, Nature Geoscience

Conclusions:

- persistent growth in fossil fuel emissions of ~3% y^{-1} since 2000
- embodied emissions affect Annex B share
- CO_2 intensity of the economy improving more slowly
- recent decrease in land use emissions
- CO_2 sinks could be responding to climate change and variability

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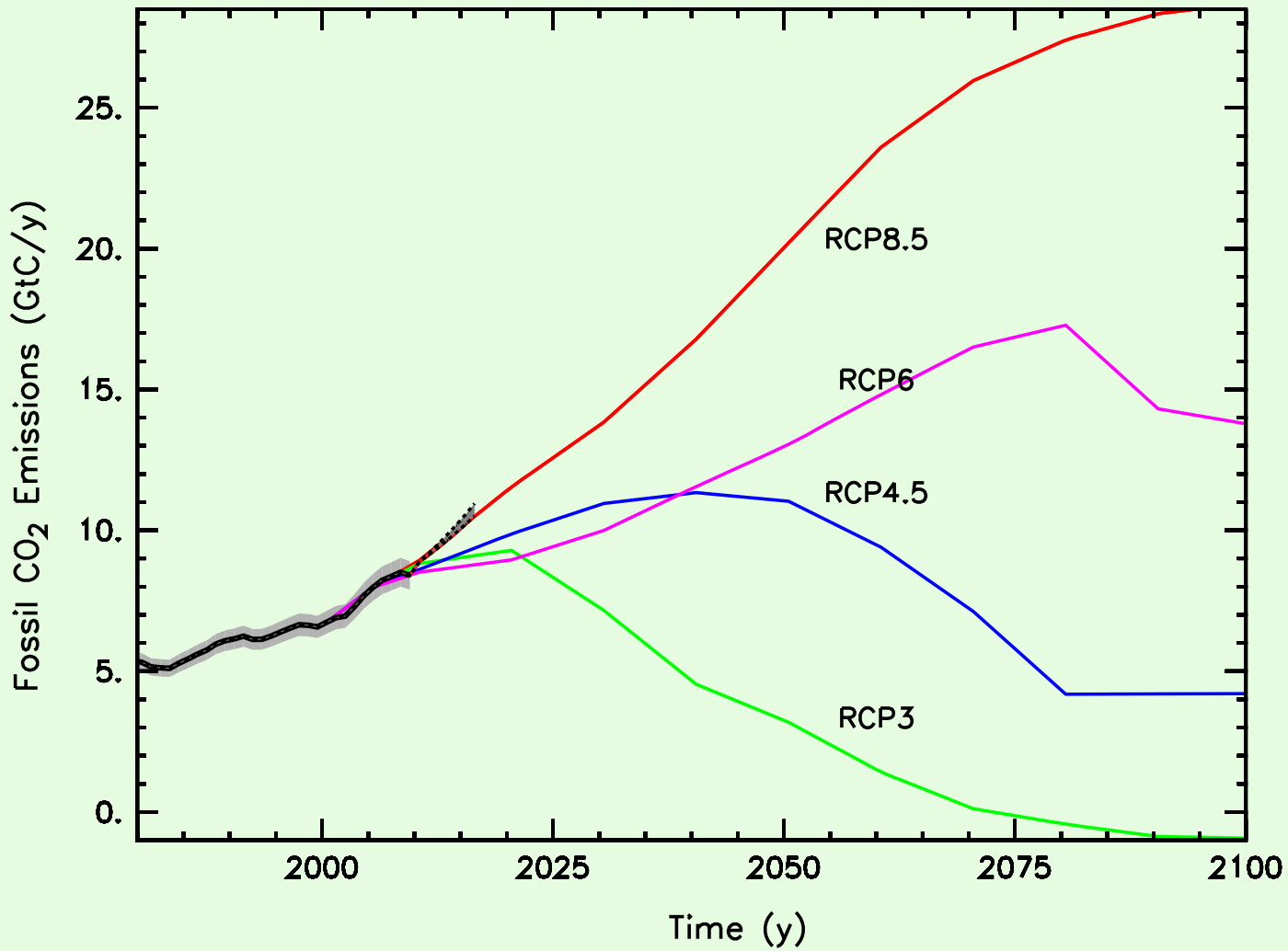
Current Opinion in
Environmental
Sustainability

An International Carbon Office to assist policy-based science

Corinne Le Quéré[1,2], Josep G Canadell[3], Philippe Ciais[4], Shobhakar Dhakal[5], Anand Patwardhan[6], Michael R Raupach[3] and Oran R Young[7]

RCP scenarios



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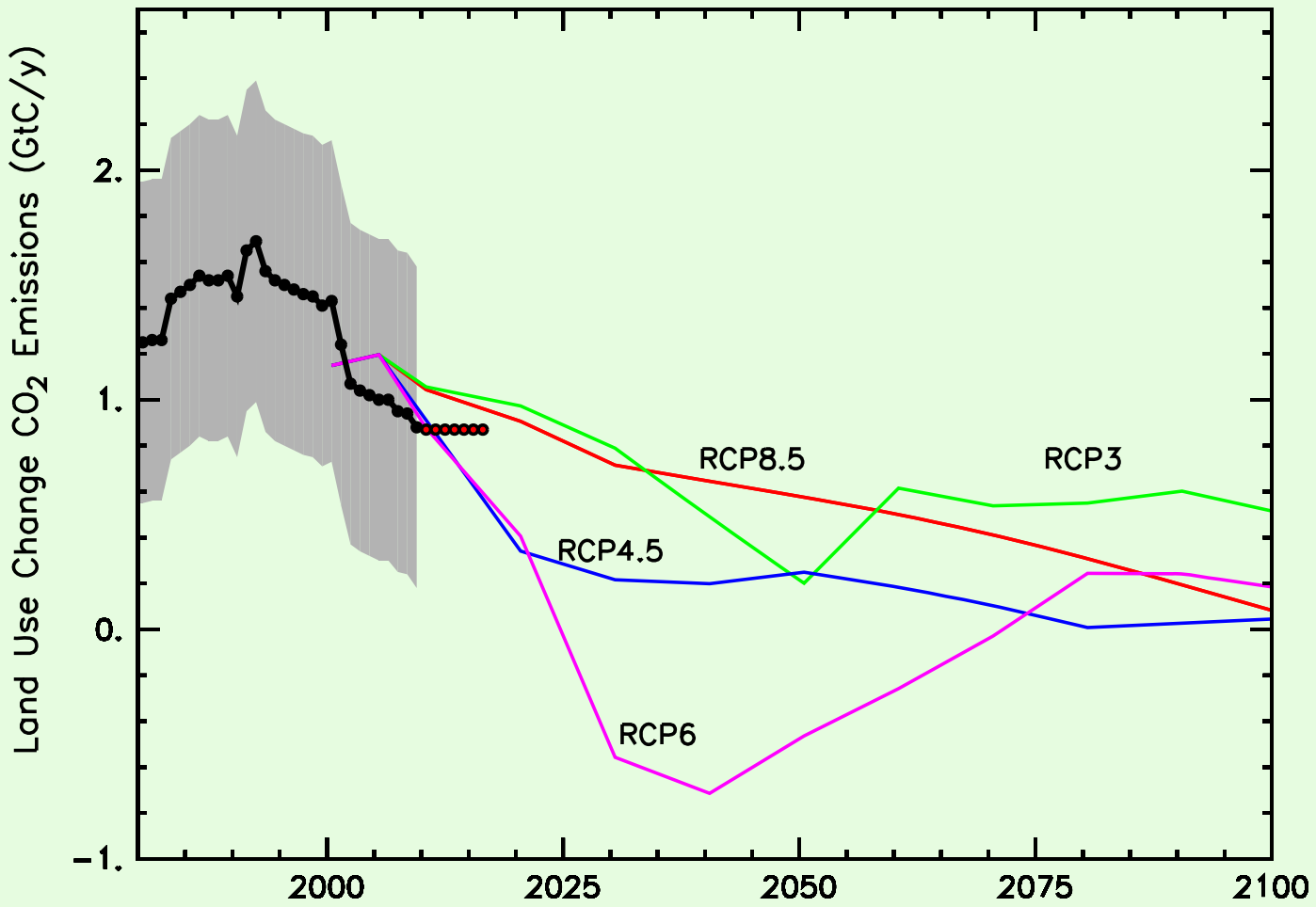
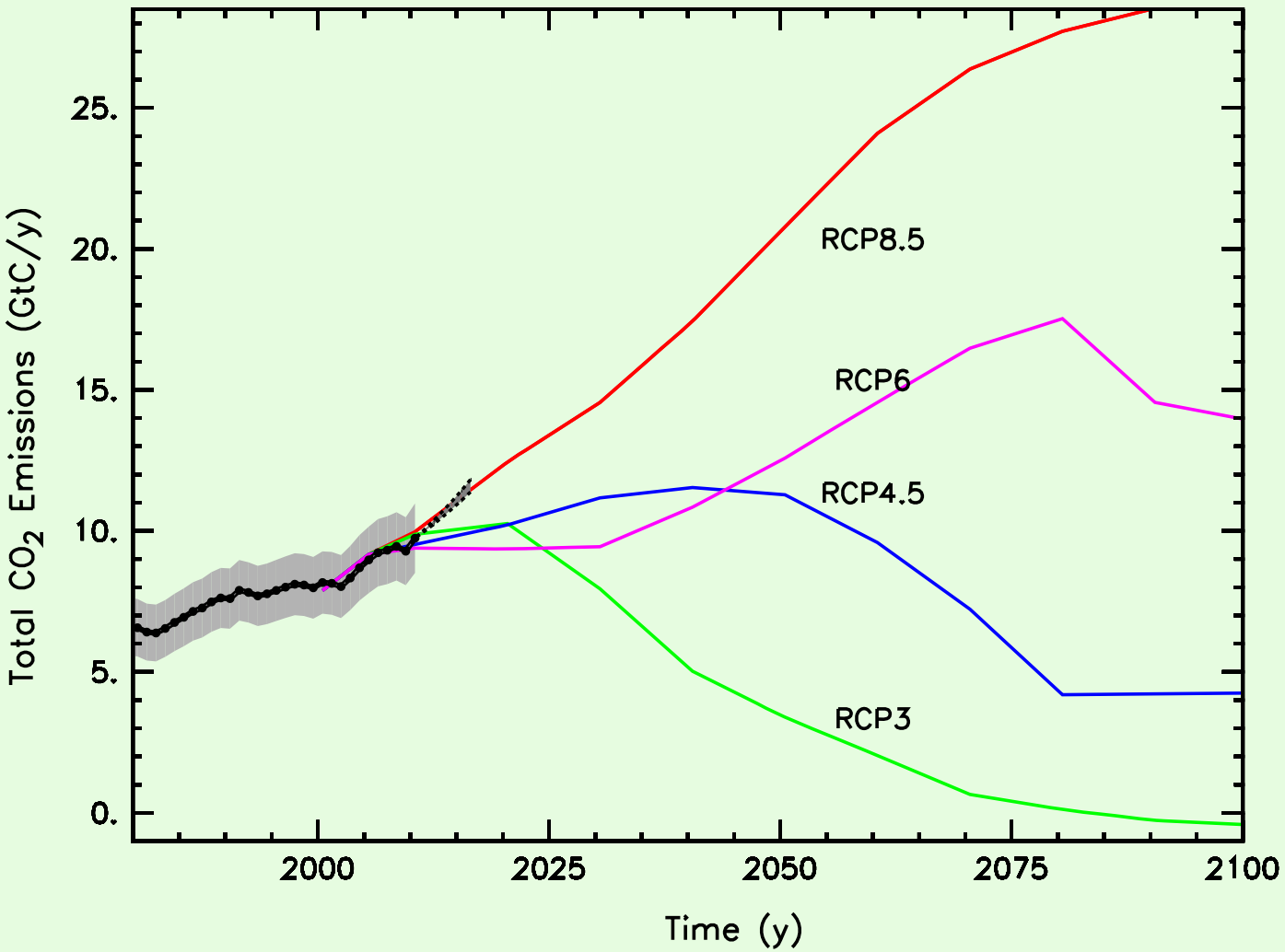
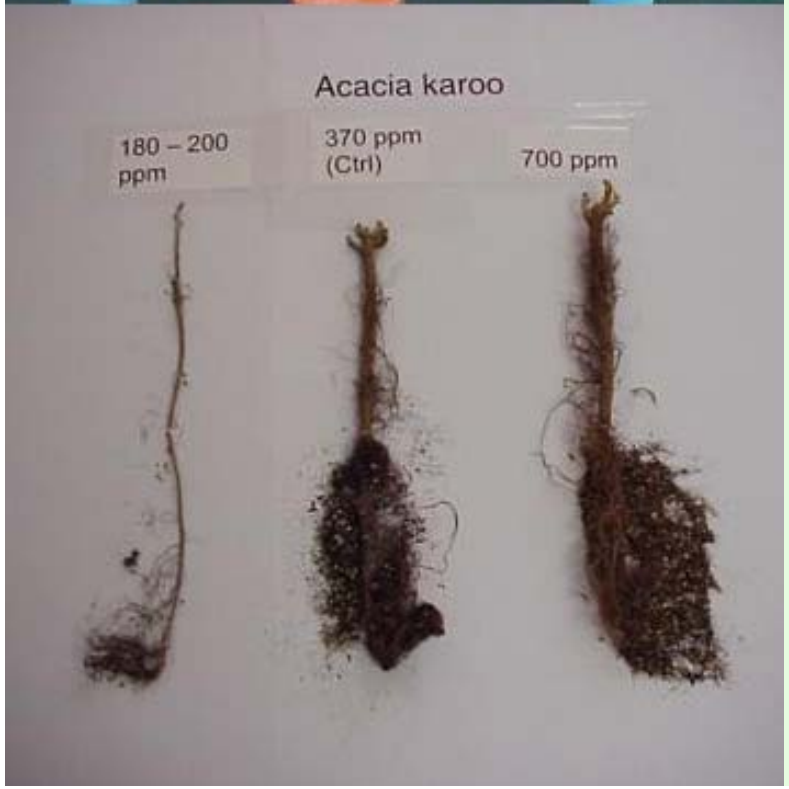


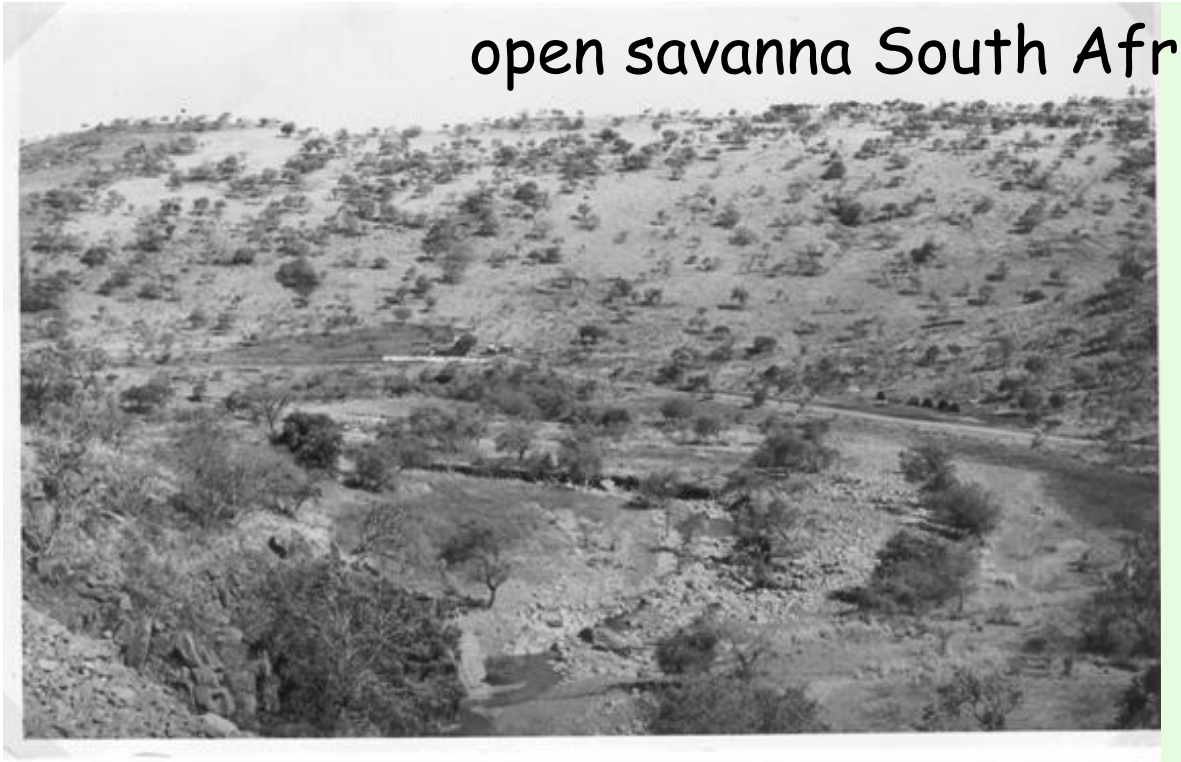
RCP scenarios





Guy Mingley and Barney Kgope (SANBI), William Bond (UCT)

open savanna South Africa



1955

1998

Guy Mingley (SANBI)
Photo: Timm Hoffmann , IPC, UCT