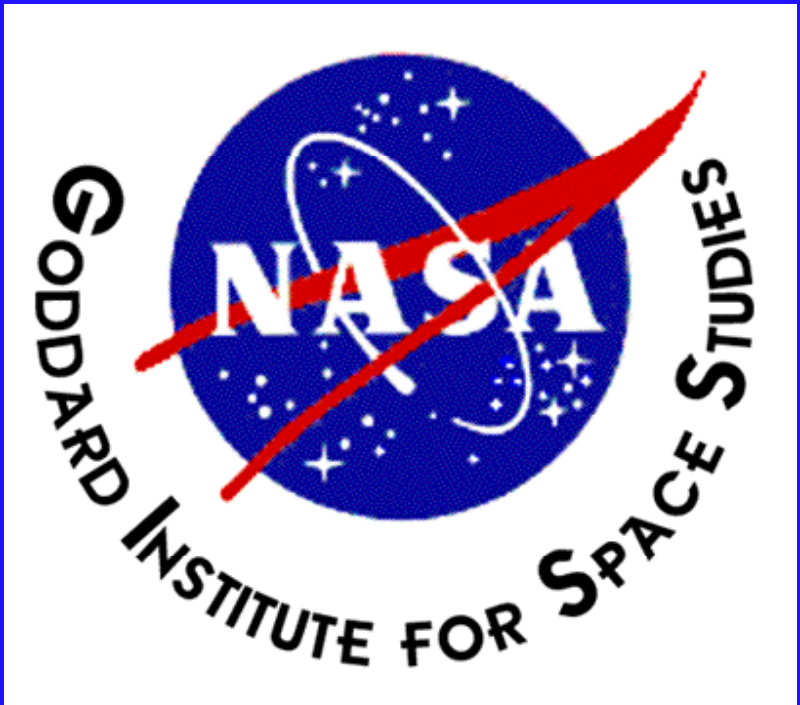
Methane and Climate Change



Drew Shindell

Carbon Dioxide and Climate

Emissions

emissions from fossil fuel combustion, in many cases equipment with large capital cost and long turnover time

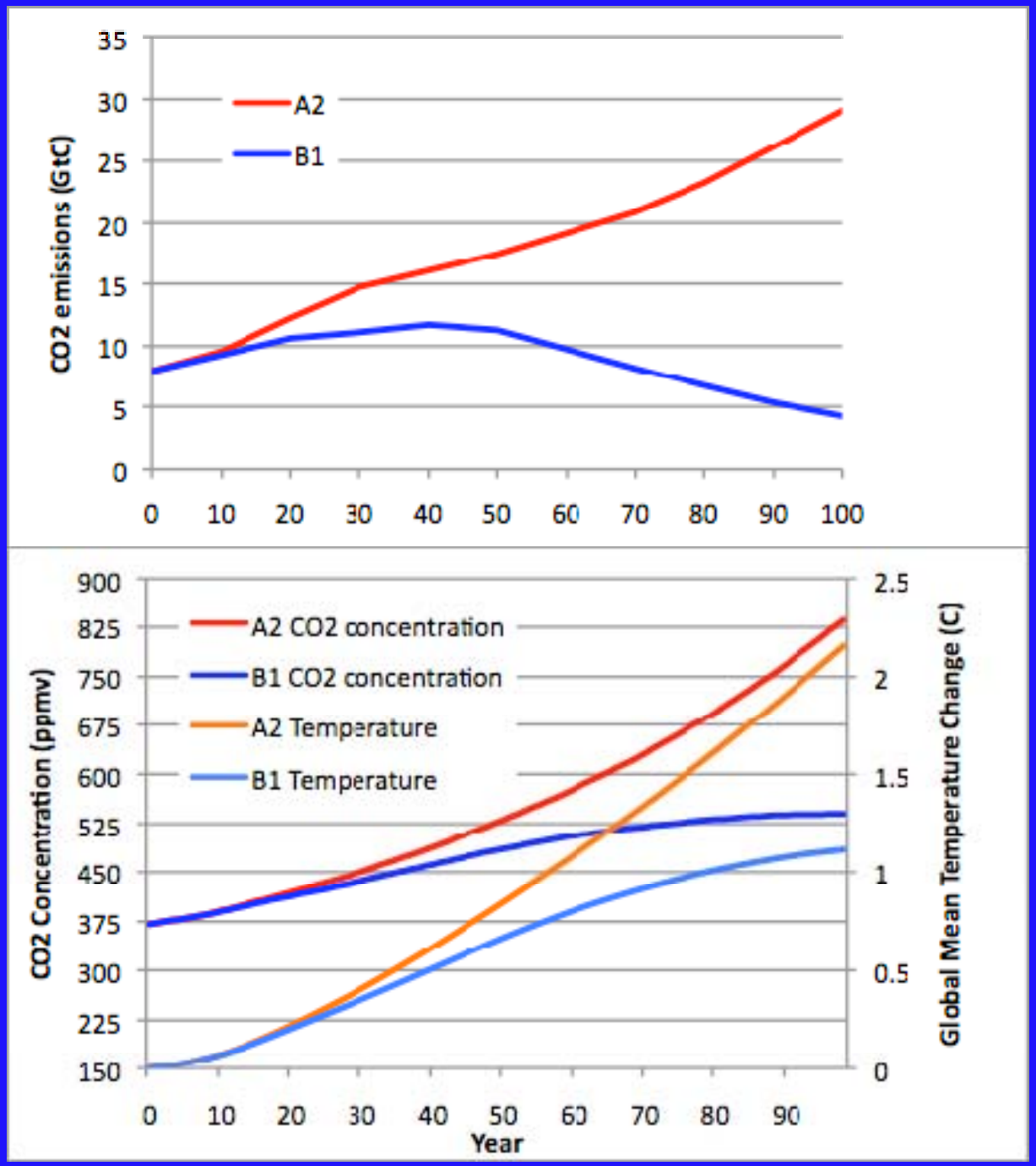
Atmospheric Concentration

atmospheric concentration adjusts slowly via biosphere and ocean

Climate Response

deeper ocean requires decades to adjust to changes in energy

Response to CO_2 Emissions Changes



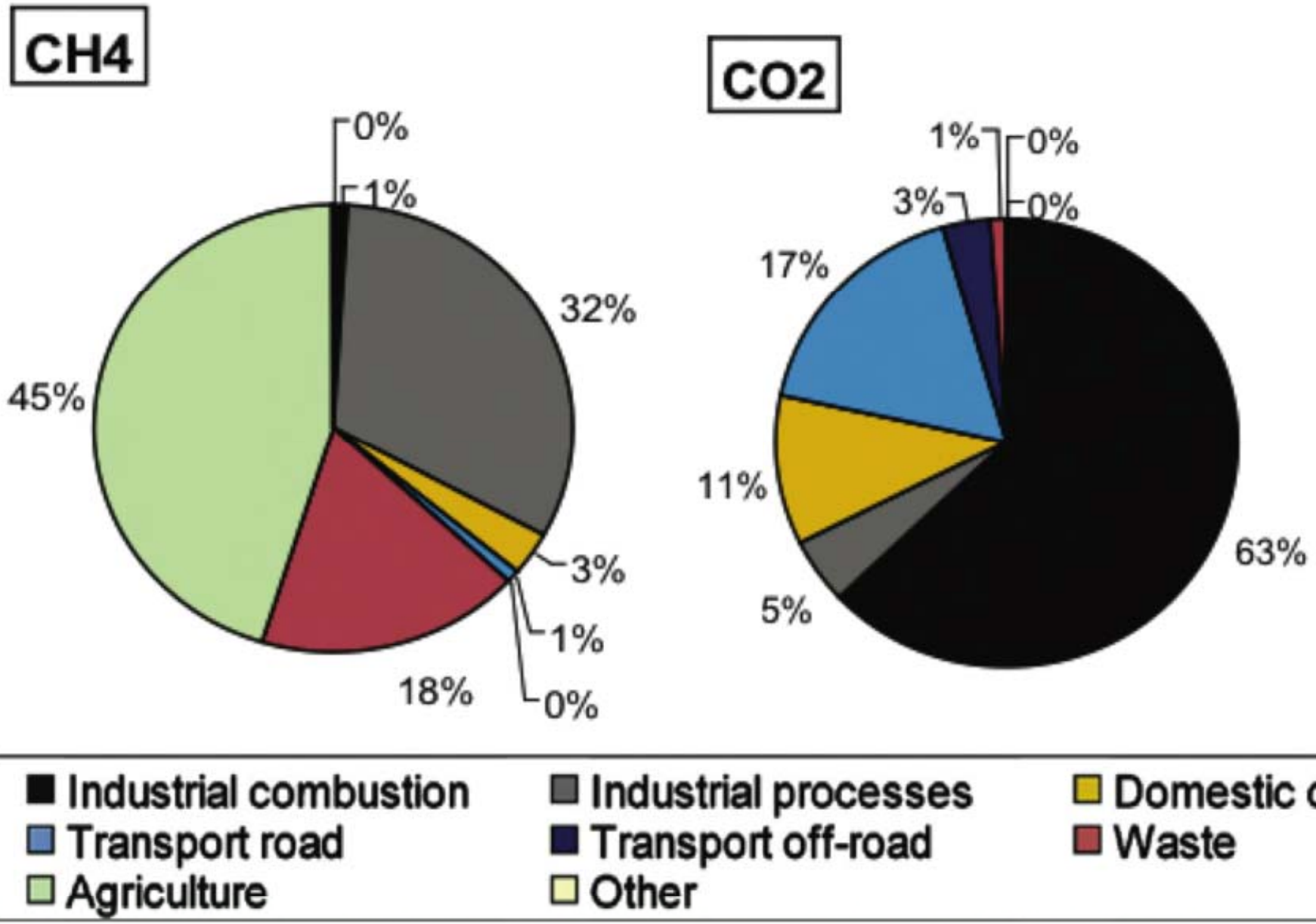
High and Low SRES scenarios

BERN carbon cycle concentrations

GTP response

dT=0.81 C in 2100,
dT=0.10 C in 2050

Different Sources



Isaksen et al., Atm. Env., 2009

Near-term and Long-term Climate Change

Problems that occur over different timescales

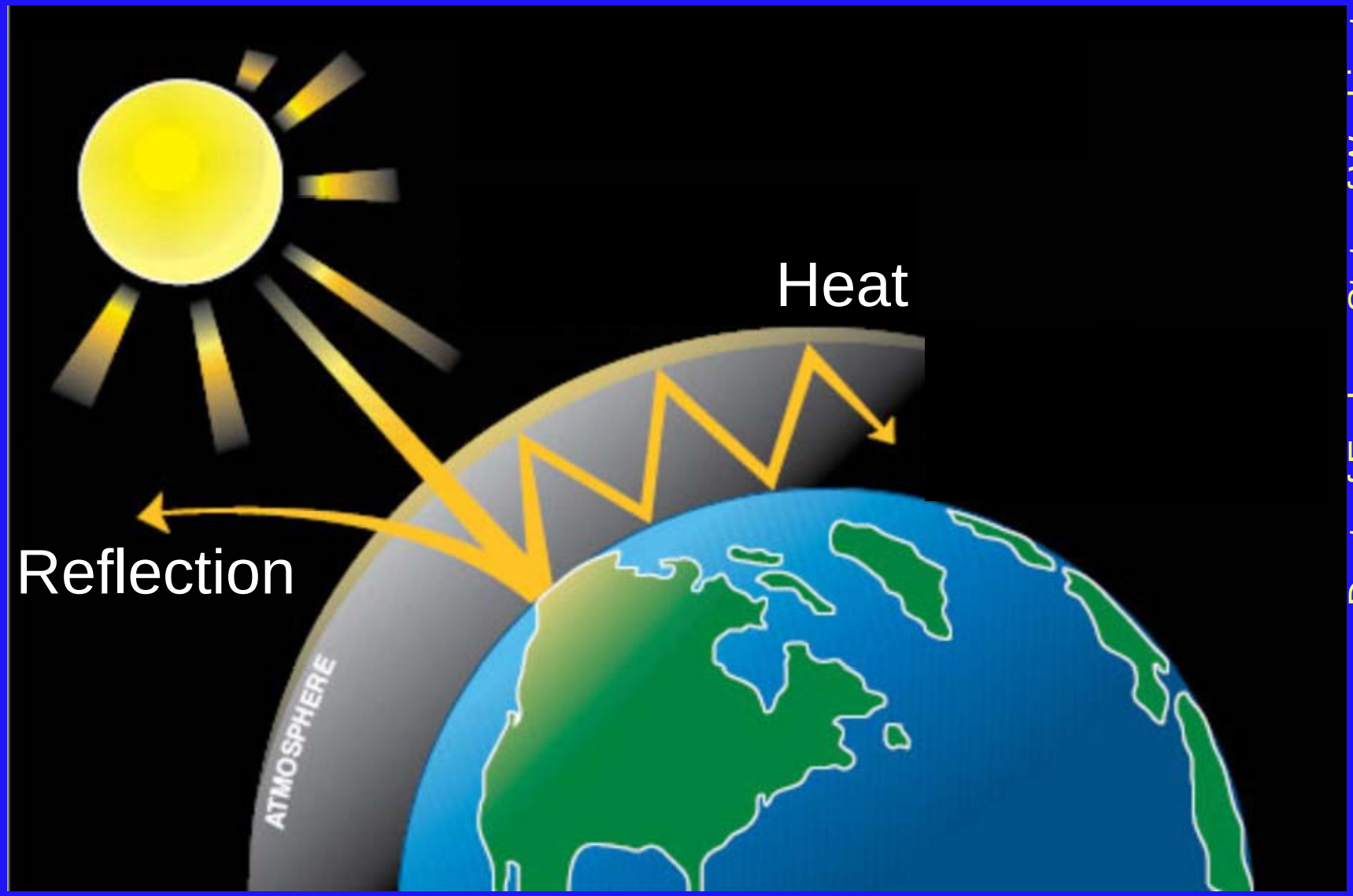
Problems with different causes!

Methane, as well as some emissions of other short-lived pollutants that influence climate, from different activities

Problems with different ancillary considerations

Methane is a precursor of tropospheric ozone, so impacts human health, agricultural and forestry yields, and CO_2

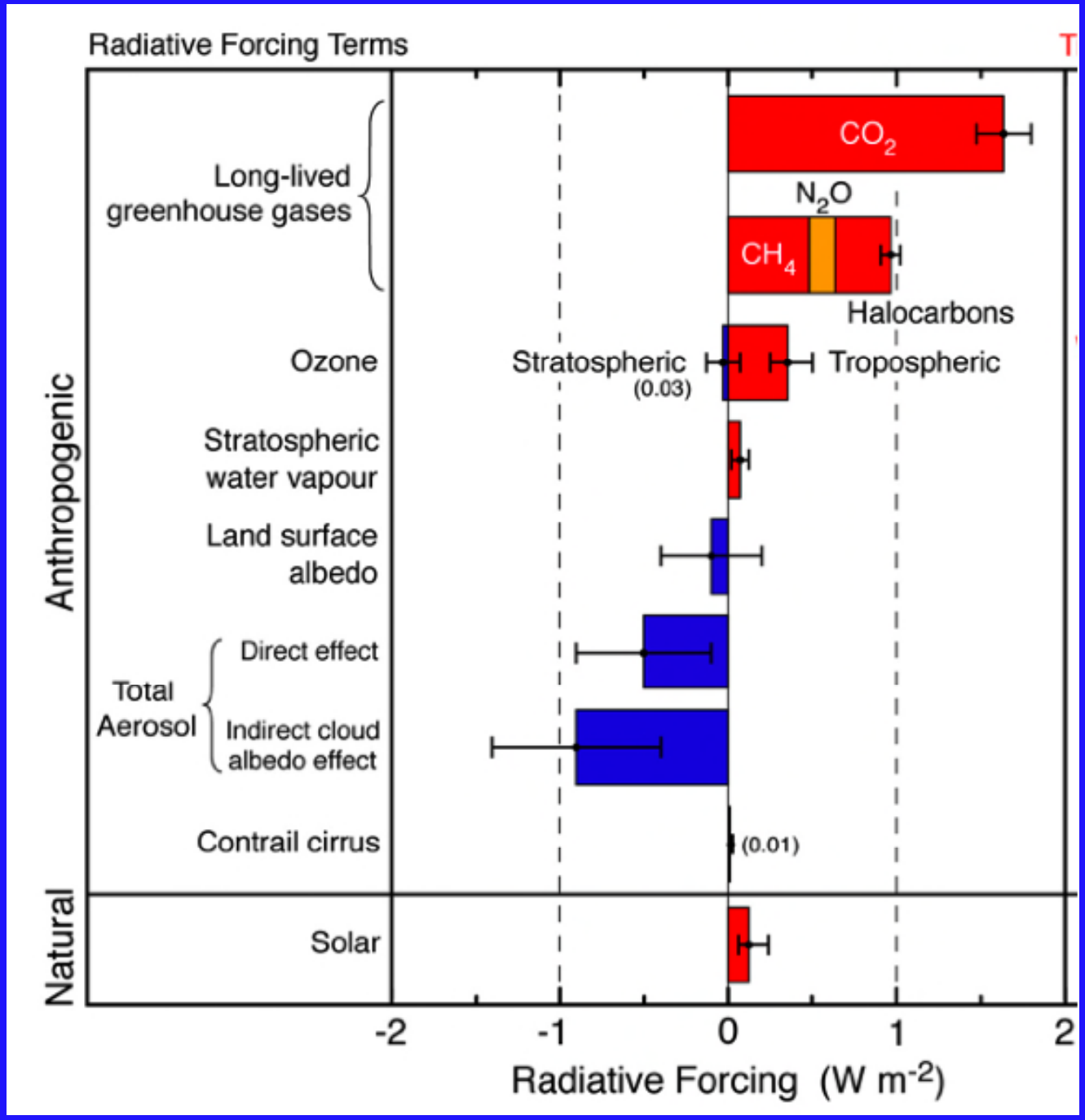
The Earth's Energy Balance



Dept. of Ecology, State of Washington

Greenhouse gases absorb outgoing heat, changing radiative energy balance. Evaluate as 'radiative forcing'

Historical Radiative Forcing



IPCC AR4

2007

Indirect effects of methane emissions

Methane leads to ozone formation

Methane is oxidized into water in the stratosphere

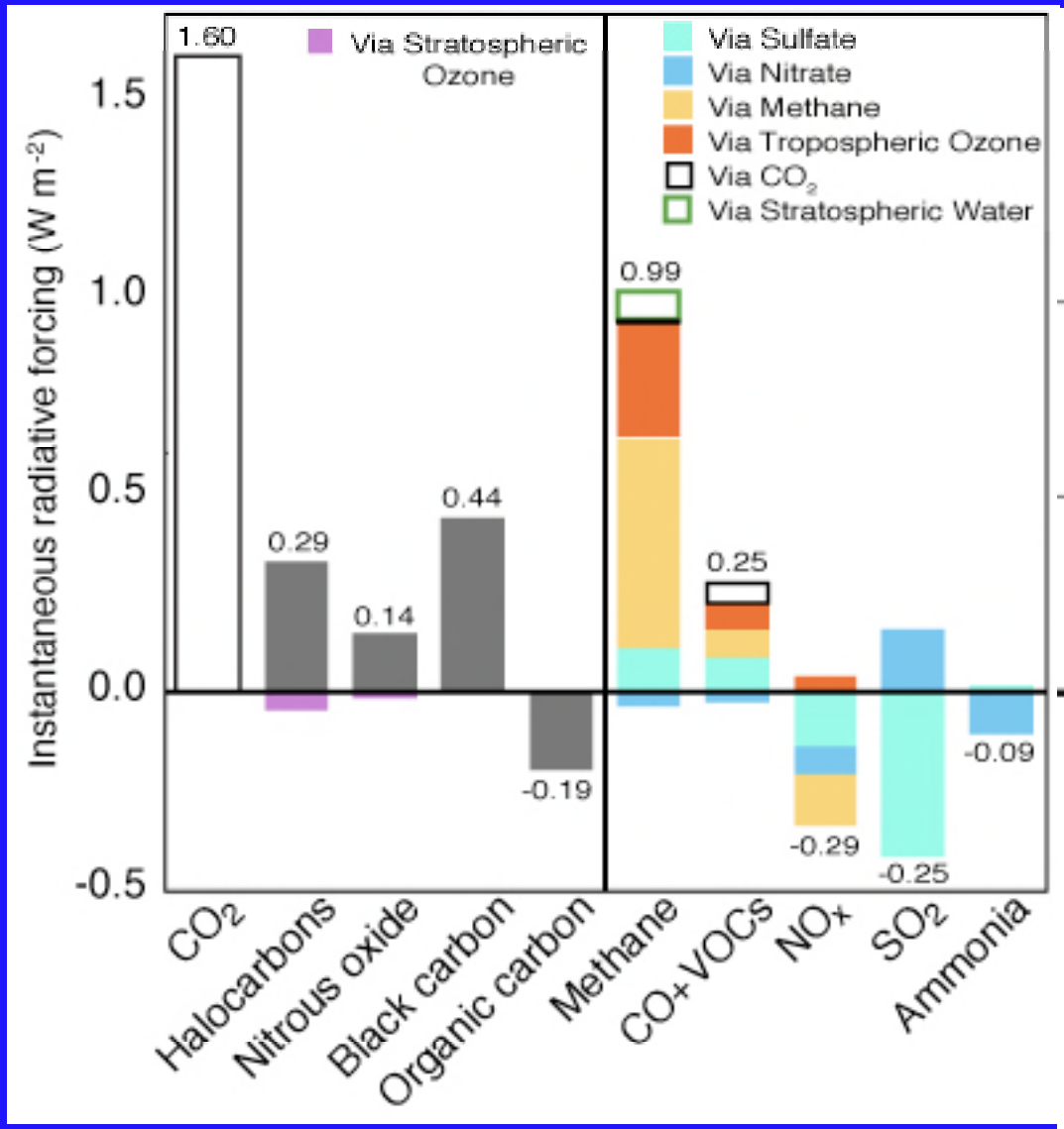
Methane is oxidized into CO_2 in the troposphere

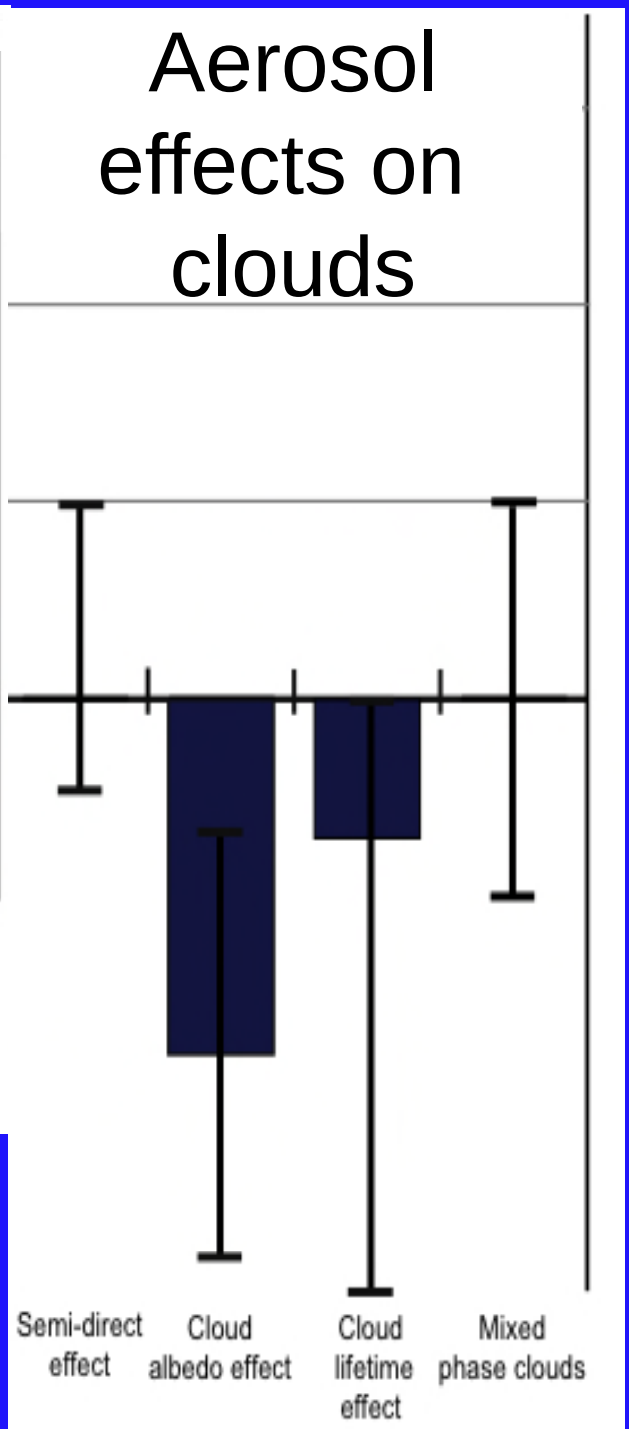
Methane alters tropospheric oxidation, affecting sulfate and nitrate aerosols

The ozone produces by methane inhibits CO_2-uptake by plants

GWP: 20-yr ~100xCO_2, 100-yr ~33xCO_2

Historical Forcing by Emitted Species





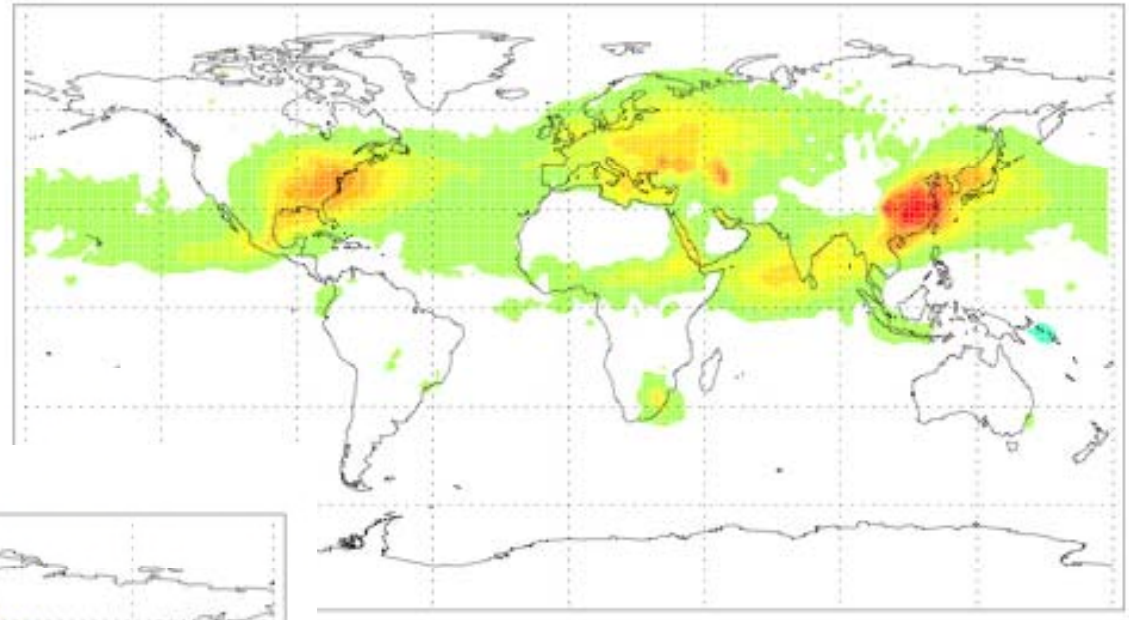
Shindell et al., Science, 2009;

Isaksen et al., Atm. Env., 2009

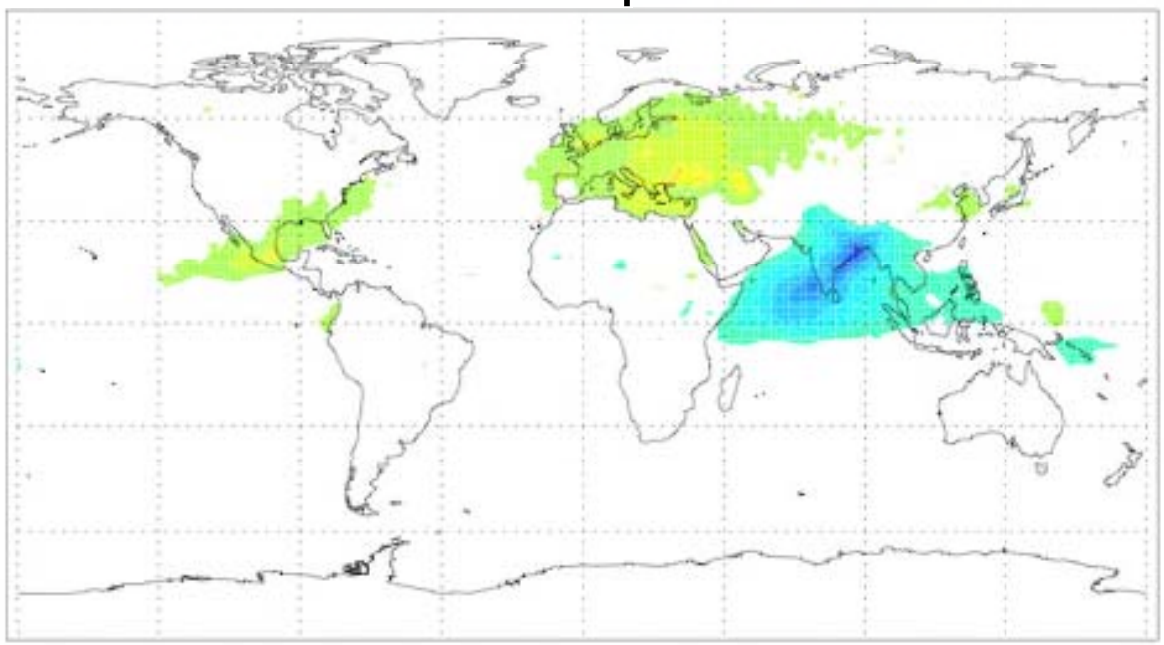
Actual Measures

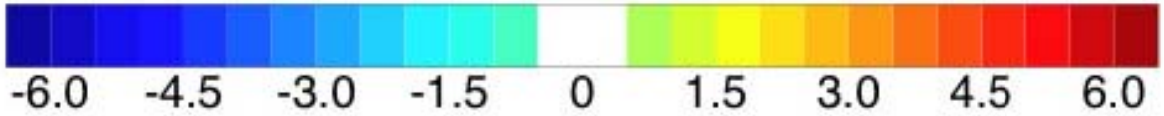
Maximum Feasible Technological Reductions 2030 vs 2000

Industry and Power



Residential and Transport





Forcing (W/m^2)

Kloster et al., ACP, 2008

Physical Science of Methane

Large forcing

Baed on emissions, ~1 W/m^2 (total anthro 1.6 W/m^2)

Small uncertainties

Forcing is not residual of offsetting terms, indirect impacts additive, total uncertainty ~15%

Fast response

main influence ~5-15 years after emission

~Equal impact from emissions anywhere

makes valuation across regions simple

Co-benefits of Methane Emissions Reductions

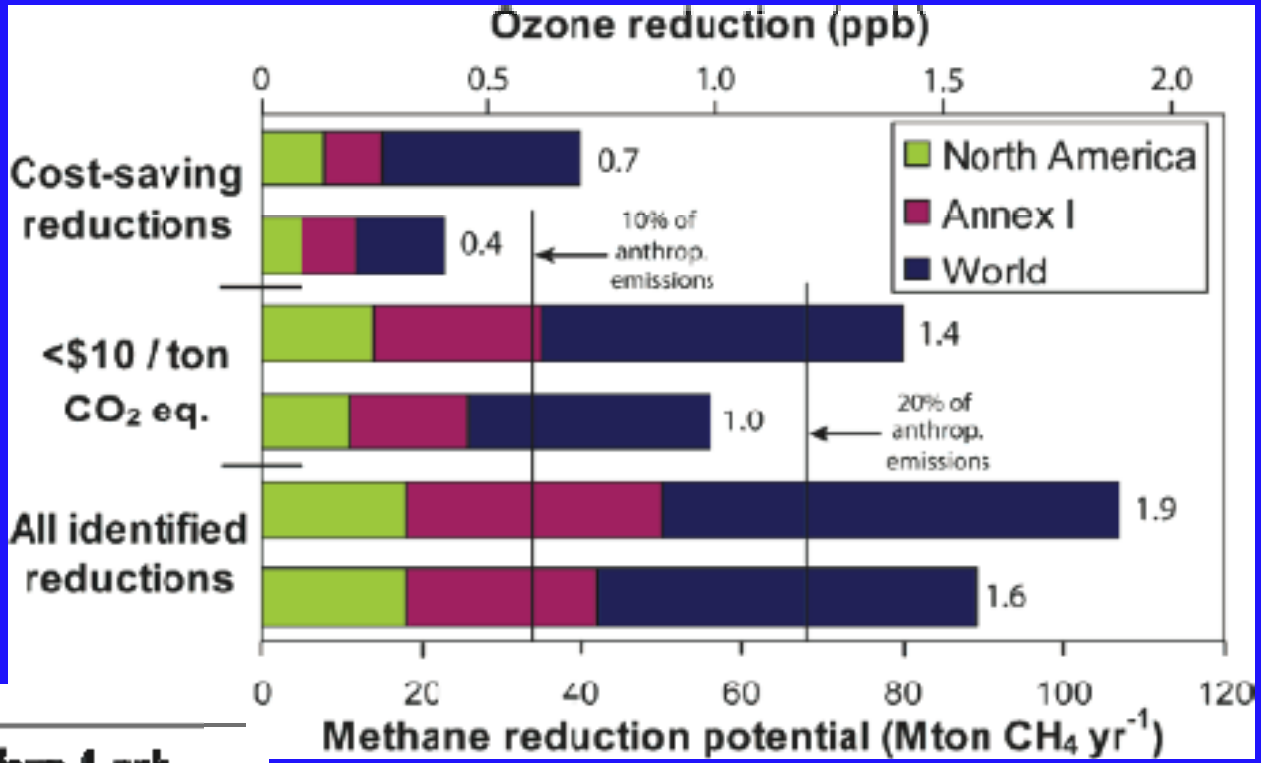


TABLE 1. Annual Nonmortality Benefits of a Uniform 1 ppb Ozone Reduction (in $Billion yr^{-1} ppb^{-1})[a]

	United States	EU-15	East Asia	global[b]
agriculture	0.40	0.51	0.42	2.8 (0.34–5.6)
forestry	0.44			1.7 (0.5–2.9)
human health (nonmortality)	0.59	0.60		3.0 (2.3–4.1)
total	1.4	>1.1	>0.4	7.5 (4.4–10.7)

[a] Derived from regional studies (29–33). [b] Global benefits extrapolated from regional studies with estimated uncertainty (in parentheses, 90% confidence interval from EPA (30) applied proportionally to the central estimates).

Annual avoided mortalities in the NH due to 20% reduction in methane 141,000 to 401,000

West and Fiore, ES&T, 2005 ; Anen et al., ES&T, 2009

Integrated Assessment Activity of UNEP (2010)

Looking at short-lived warming agents (black carbon and tropospheric ozone precursors, including methane)

Assessing state of knowledge on emissions, atmospheric processes, impacts on climate, health, ecosystems, & economics, and policy responses (technological & structural measures and implementation)

Questions to be addressed

What are the impacts of black carbon and tropospheric ozone and how significant are they? (warming and air pollution)

Can measures be designed that will definitely produce win-win solutions to reduce these impacts?

Can policies to apply these measures be implemented in different parts of the world?

What are the key uncertainties that require attention and what do they mean for the conclusions?

What are the implications for global governance and finance?