

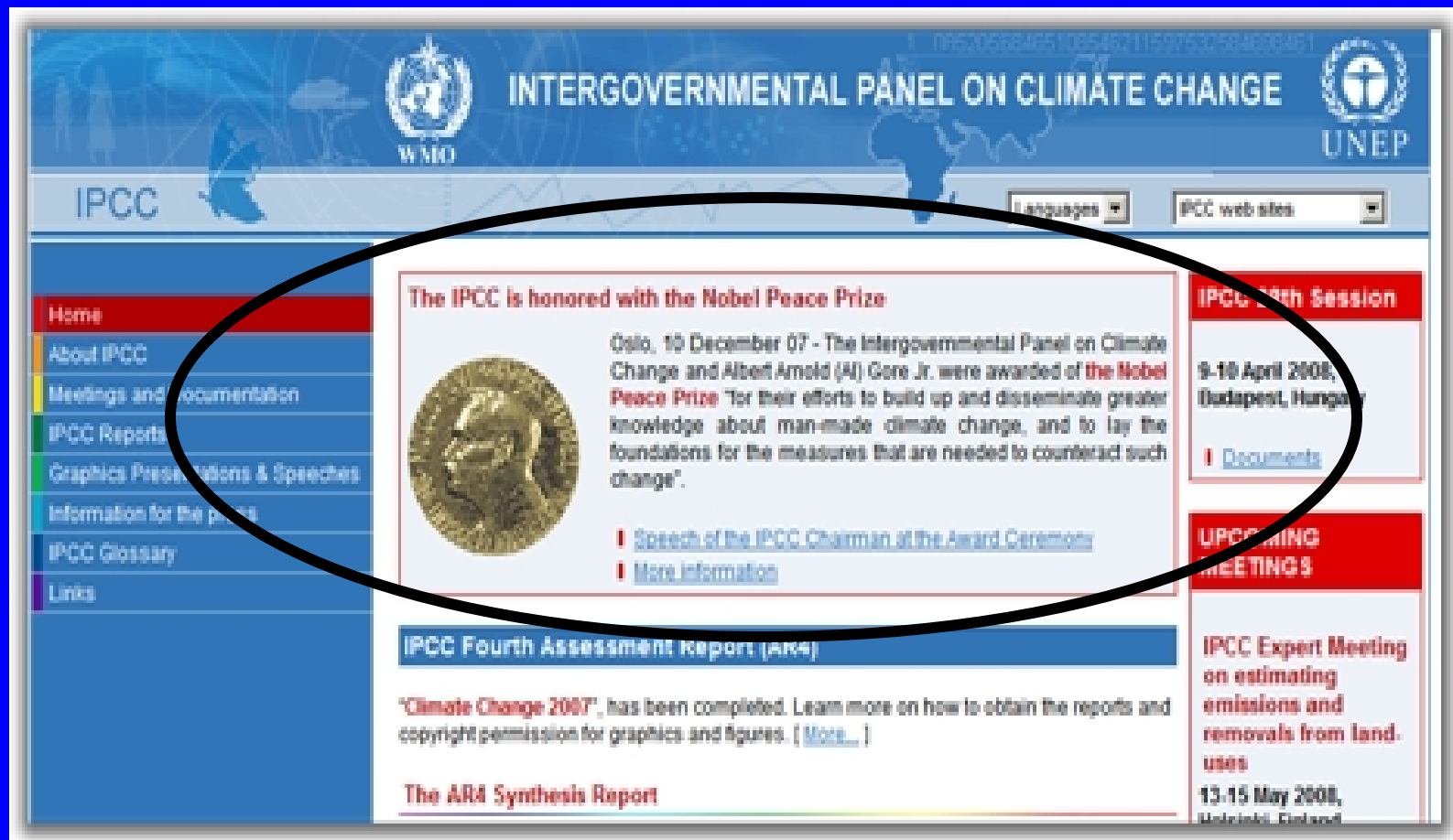
Challenges for Health and Climate Time and Morality

Royal Melbourne Institute of Technology
July 18, 2008

At the 0.03% level

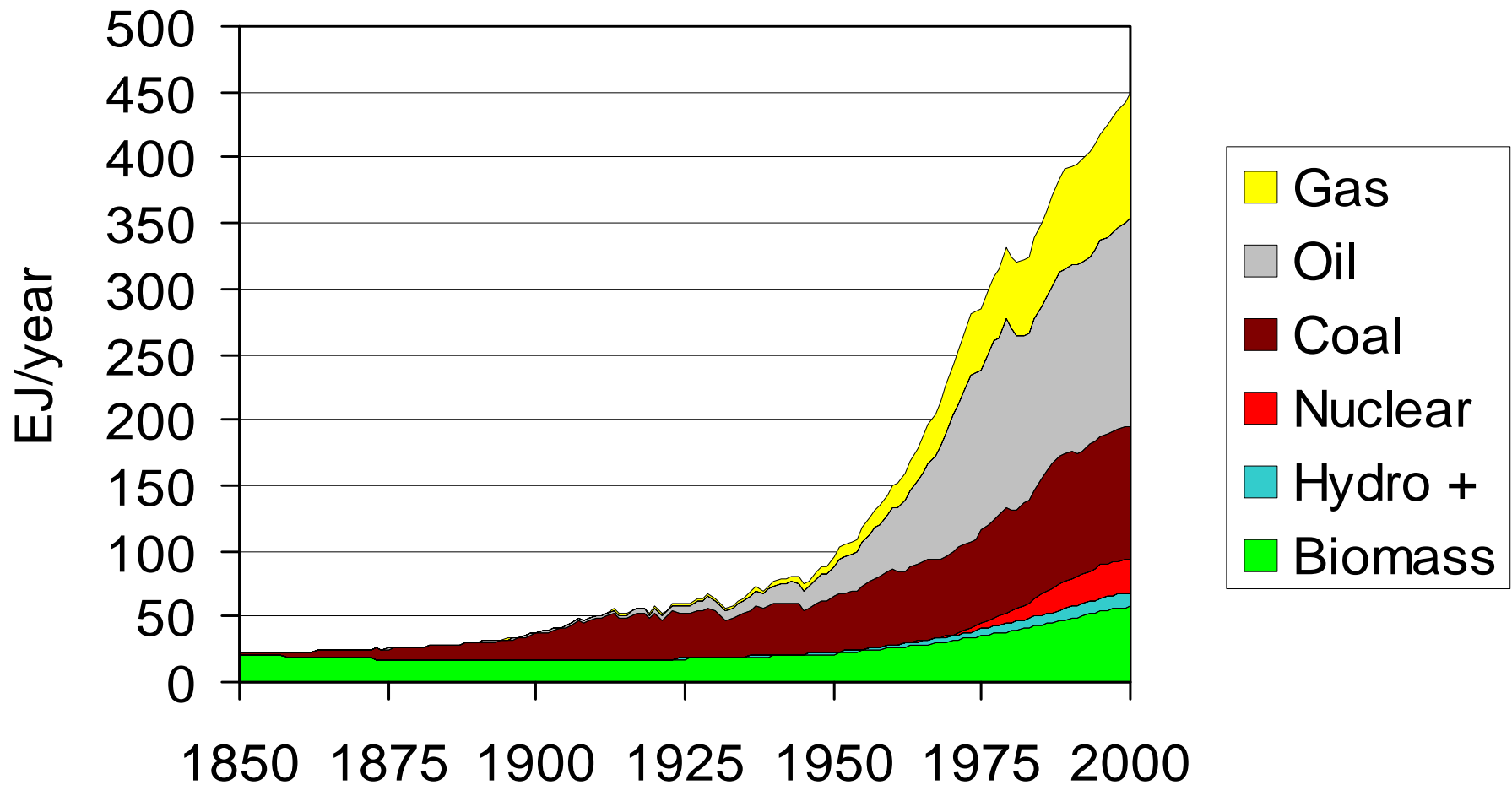
Kirk R. Smith
Professor of Global Environmental Health
Nobel Laureate 2007
University of California, Berkeley





2000 Scientists Involved Worldwide

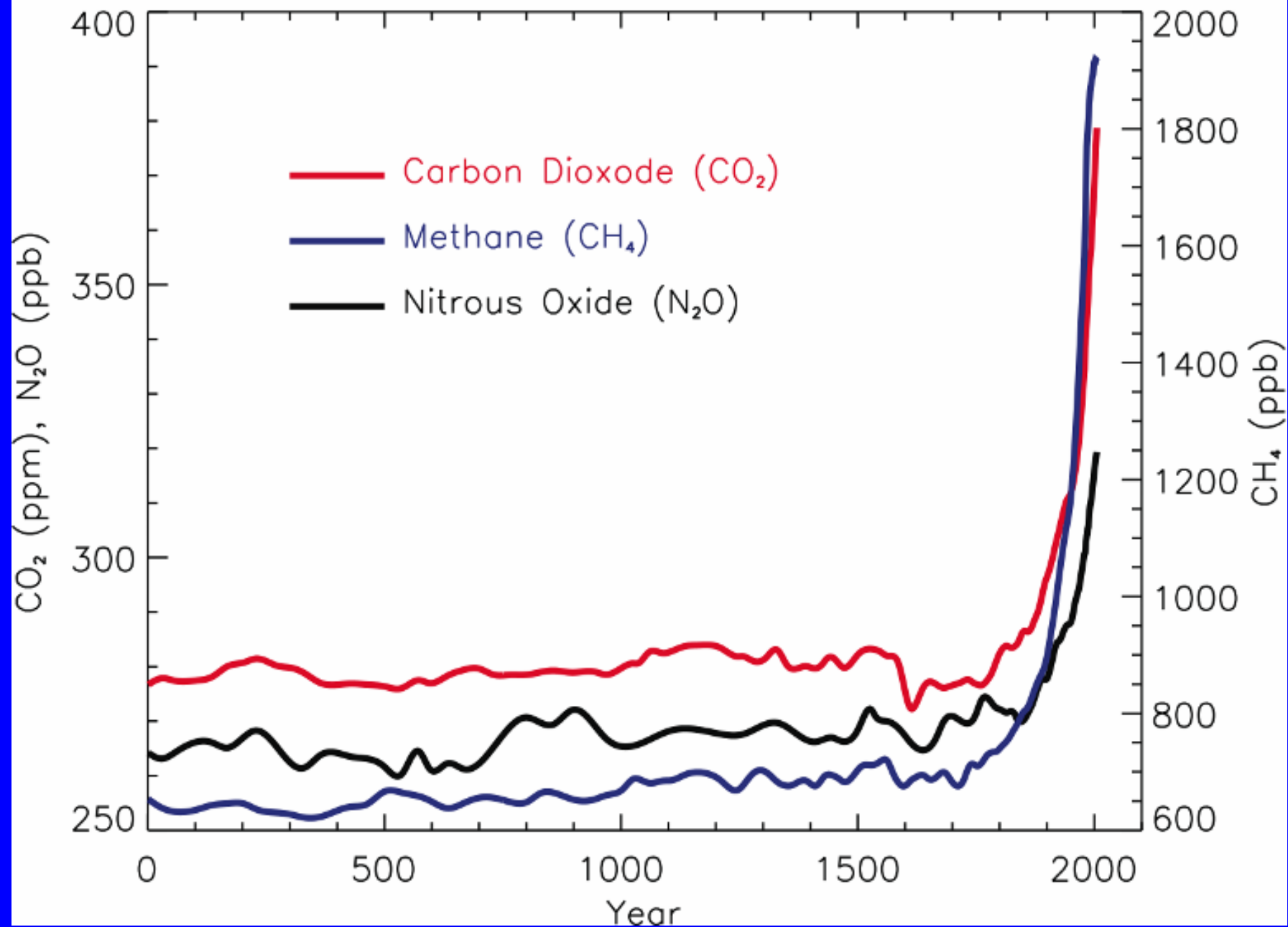
Growth of world population & affluence since 1850 brought 20-fold increase in energy use, the principal source of CO₂ emissions



1850-1950 was 1.45%/yr, driven mainly by coal

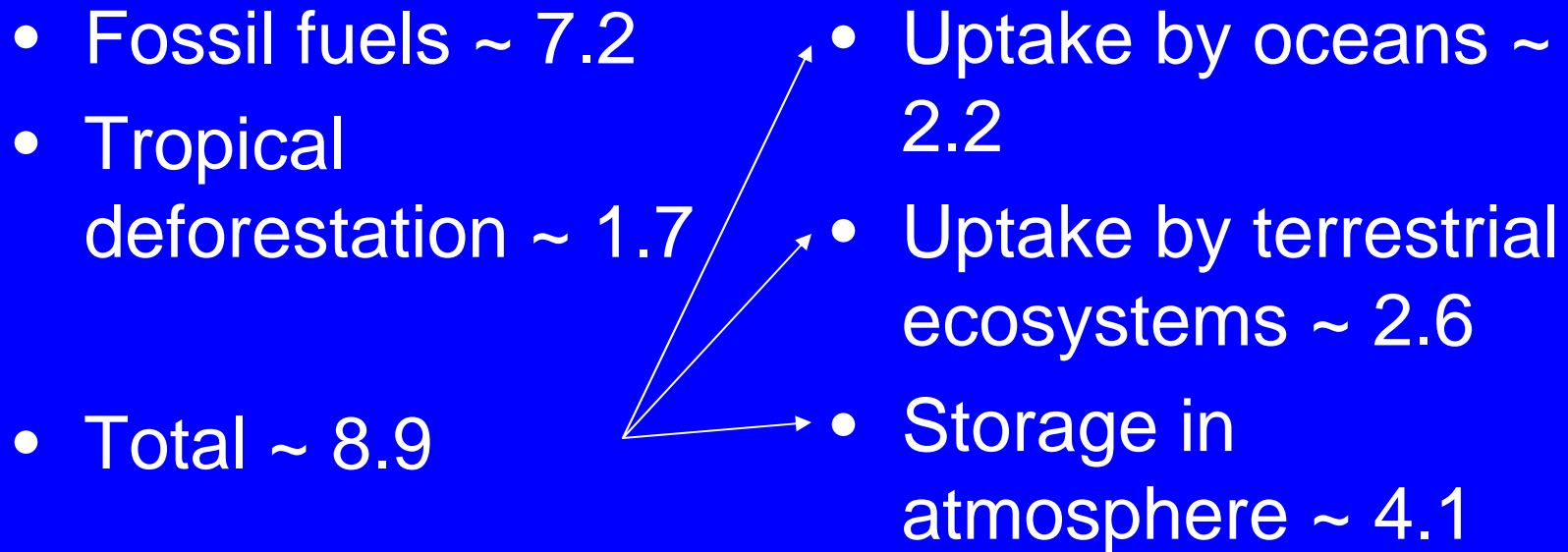
1950-2000 was 3.15%/yr, driven mainly by oil & natural gas.

Concentrations of Greenhouse Gases from 0 to 2005



Sources and Fates of Human Carbon Emissions – Billion Tons of Carbon

Annual Mean: 2000-2005



What is climate?

Climate consists of averages and extremes of

- hot & cold
- wet & dry
- snowpack & snowmelt
- winds & storm tracks
- ocean currents & upwellings

and not just how much & where, but also when.

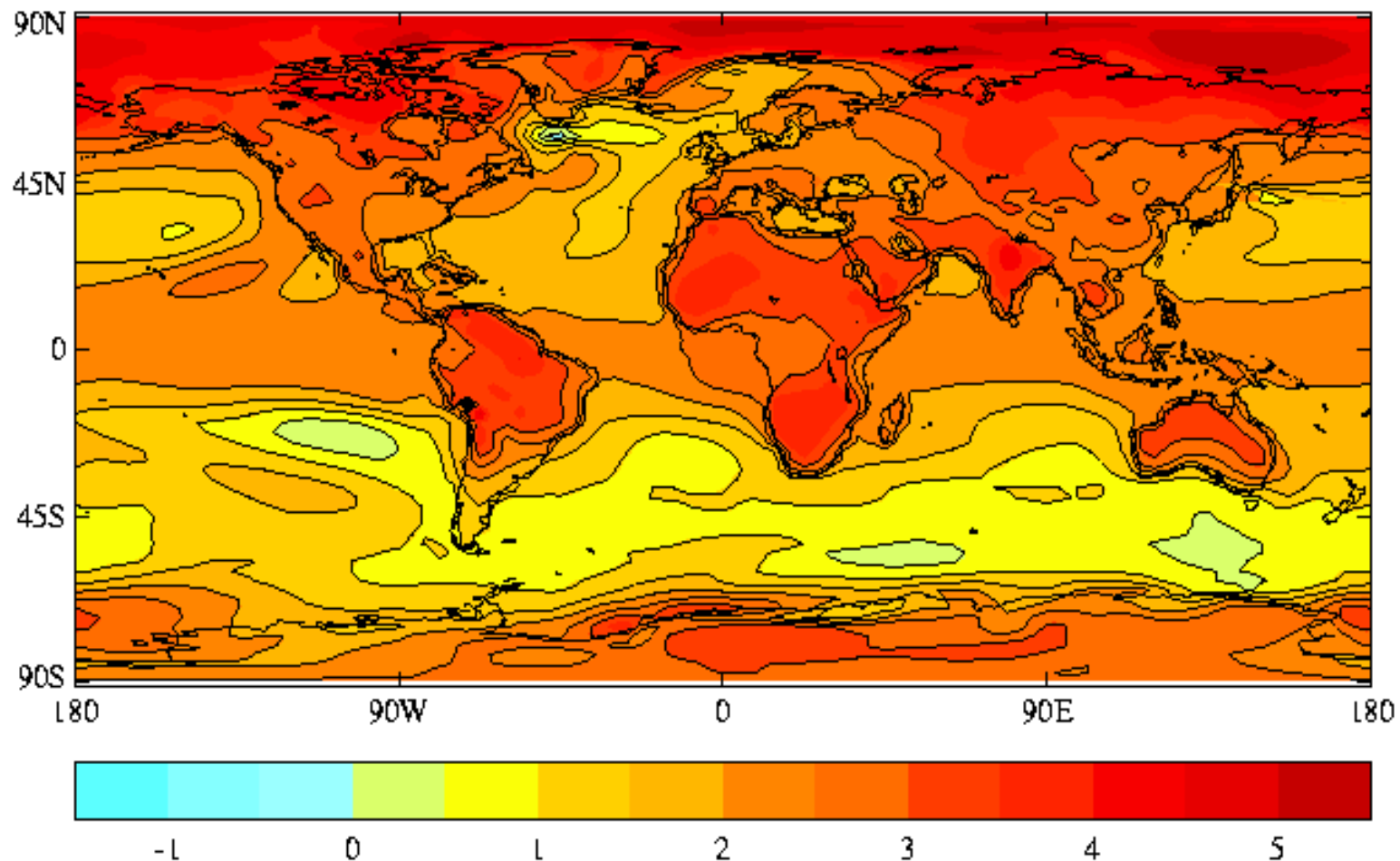
Why does climate matter?

Climate governs

- Productivity of farms, forests, & fisheries
- Geography of disease
- Livability of cities in summer
- Damages from storms, floods, wildfires
- Property losses from sea-level rise
- Expenditures on engineered environments
- Distribution & abundance of species

Where we're headed without any serious mitigation.

HADCM2 GHG ensemble (2041-70)–(1961-90) Annual Mean Temperature ($^{\circ}\text{C}$)



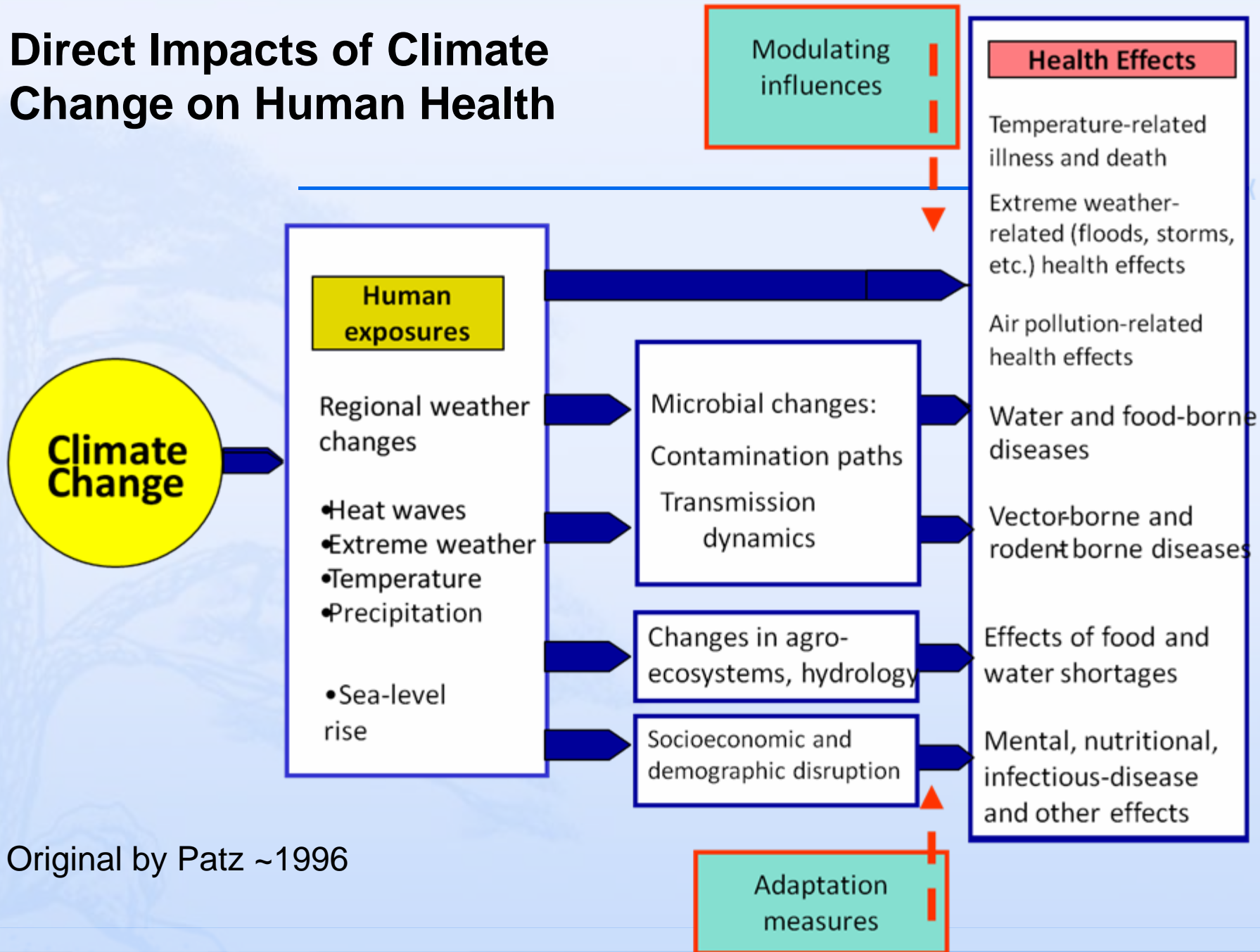
Hadley Centre for Climate Prediction and Research

Computer simulation of mid-21st-century
warming under Business as Usual

Four short briefings

- What are the implications of climate for public health?
- Co-benefits: how can we achieve both climate and health protection with energy policy?
- Why is methane under-rated as a GHG and what are the implications?
- What is the potential for moral co-benefits?

Direct Impacts of Climate Change on Human Health



Original by Patz ~1996










	Negative impact	Positive impact
Very high confidence		
Malaria: contraction and expansion, changes in transmission season		
High confidence		
Increase in malnutrition		
Increase in the number of people suffering from deaths, disease and injuries from extreme weather events		
Increase in the frequency of cardio-respiratory diseases from changes in air quality		
Change in the range of infectious disease vectors		
Reduction of cold-related deaths		
Medium confidence		
Increase in the burden of diarrhoeal diseases		

Figure 8.3. *Direction and magnitude of change of selected health impacts of climate change (confidence levels are assigned based on the IPCC guidelines on uncertainty, see <http://www.ipcc.ch/activity/uncertaintyguidancenote.pdf>).*

COMPARATIVE QUANTIFICATION OF HEALTH RISKS

GLOBAL AND REGIONAL BURDEN OF DISEASE
ATTRIBUTABLE TO SELECTED MAJOR
RISK FACTORS

VOLUME 1

EDITED BY

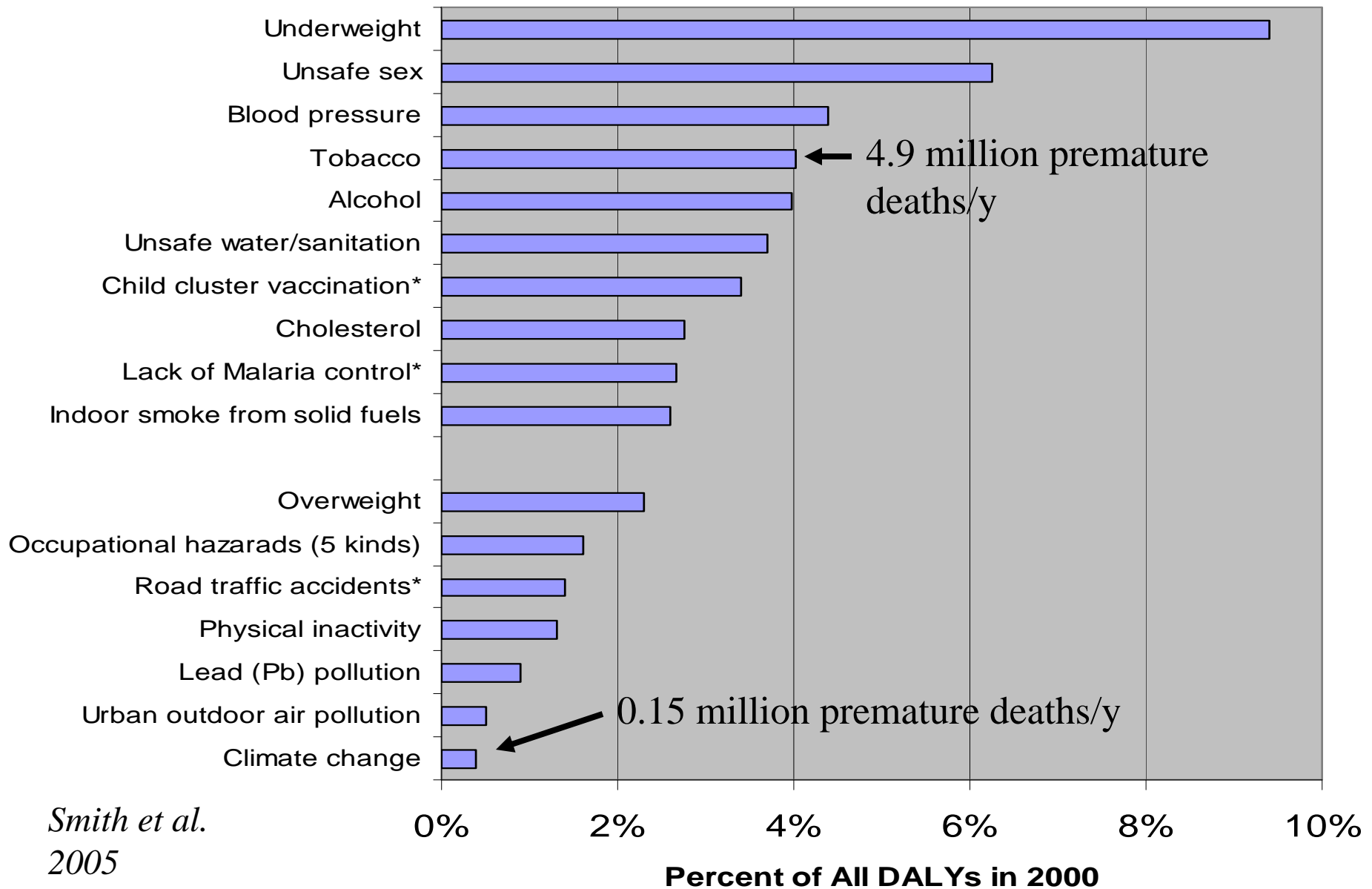
MAJID EZZATI, ALAN D. LOPEZ, ANTHONY RODGERS
AND CHRISTOPHER J.L. MURRAY



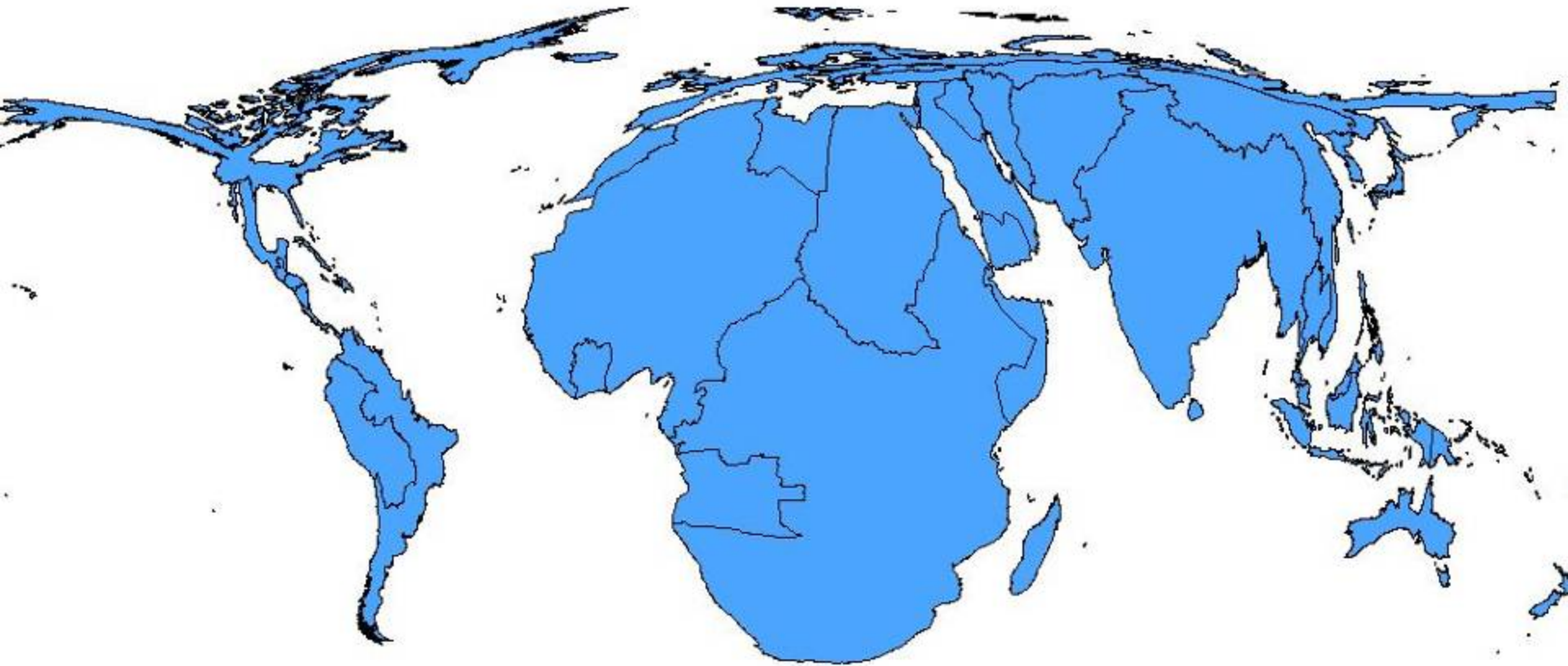
World Health Organization
Geneva

Published in 2004, 2 vols, ~2500 pp
(available on WHO CRA website)

Global Burden of Disease from Top 10 Risk Factors plus selected other risk factors

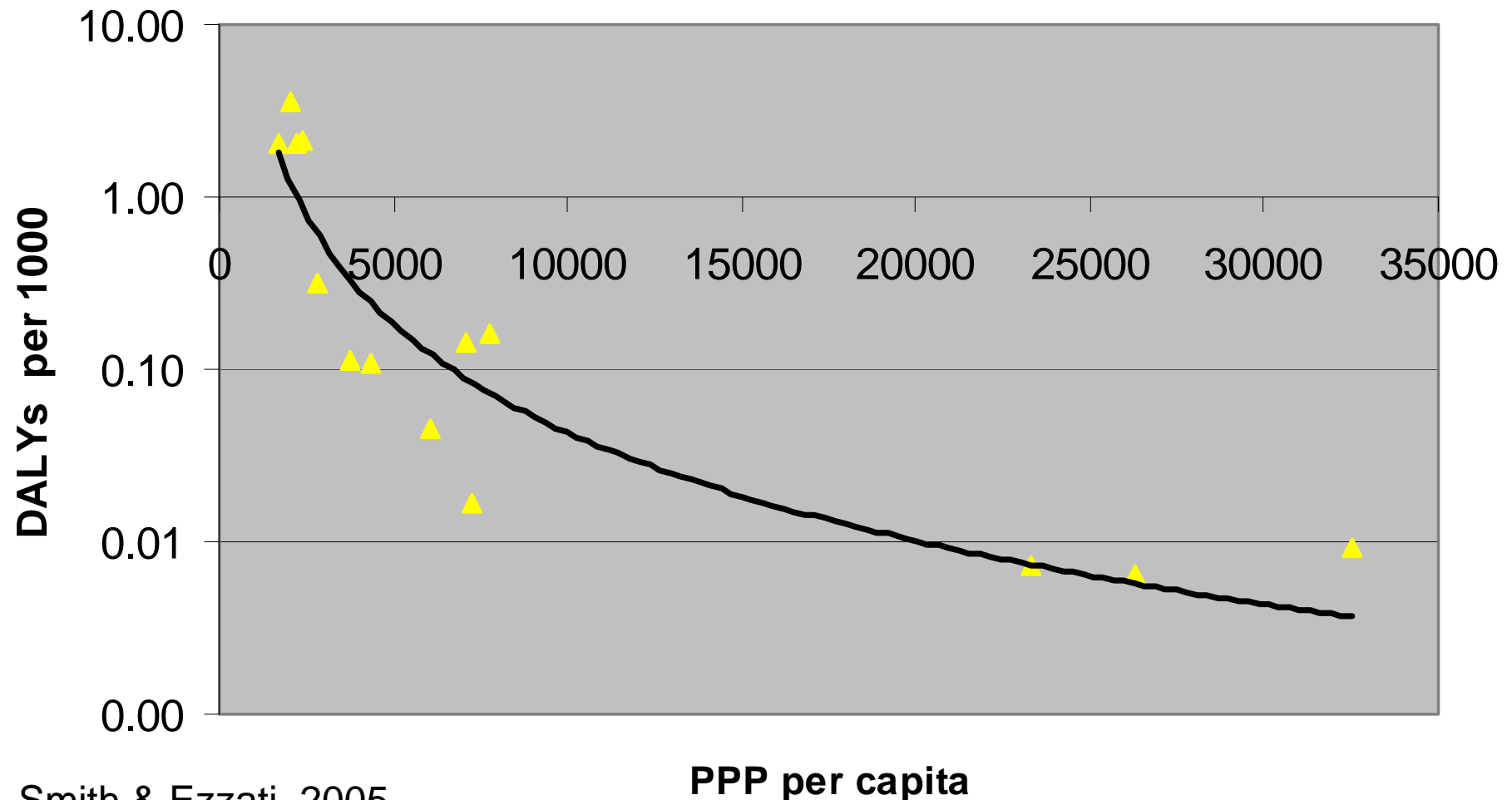


Cartogram of Climate-related Mortality (per million pop) yr. 2000



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

Health Impacts from Climate Change by Income Level across the World



Smith & Ezzati, 2005

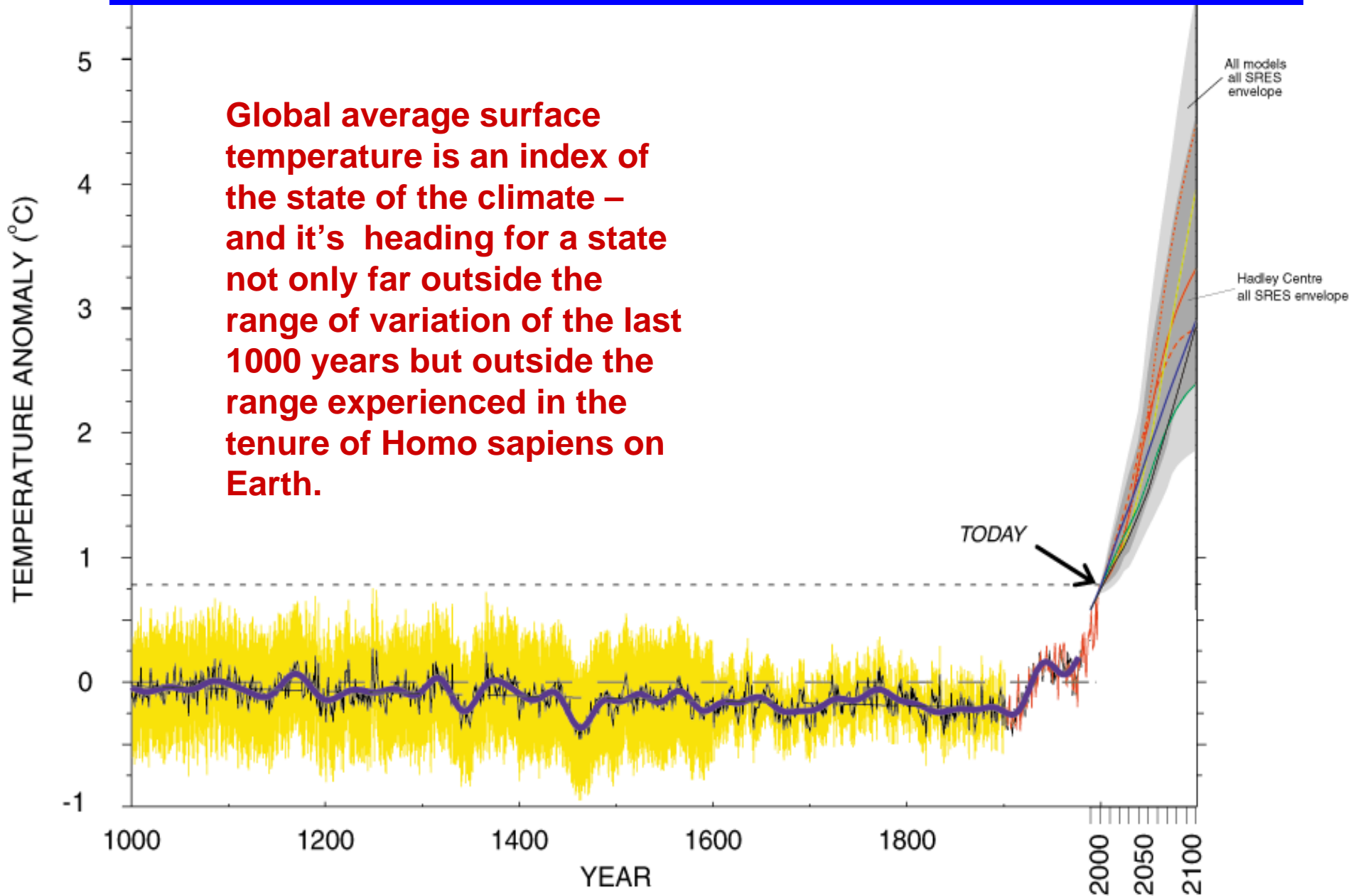
WHO Comparative Risk Assessment

Climate Change Health Impacts as of 2000

- Diarrhea – 2.4% of global burden
- Malaria – 2%; 6% in some regions
- 17% of protein-energy malnutrition
- 7% of dengue fever in some rich countries
- 150,000 deaths, 99% in poor countries (46% in South Asia)
- 0.4% of all DALYs (lost healthy life years)
- Most (88%) of impact in children under 5
- Not large today, but growing rapidly.
- It is not what is attributable today, but avoidable today that is the concern.

1000 years of Earth temperature history...and 100 years of projection

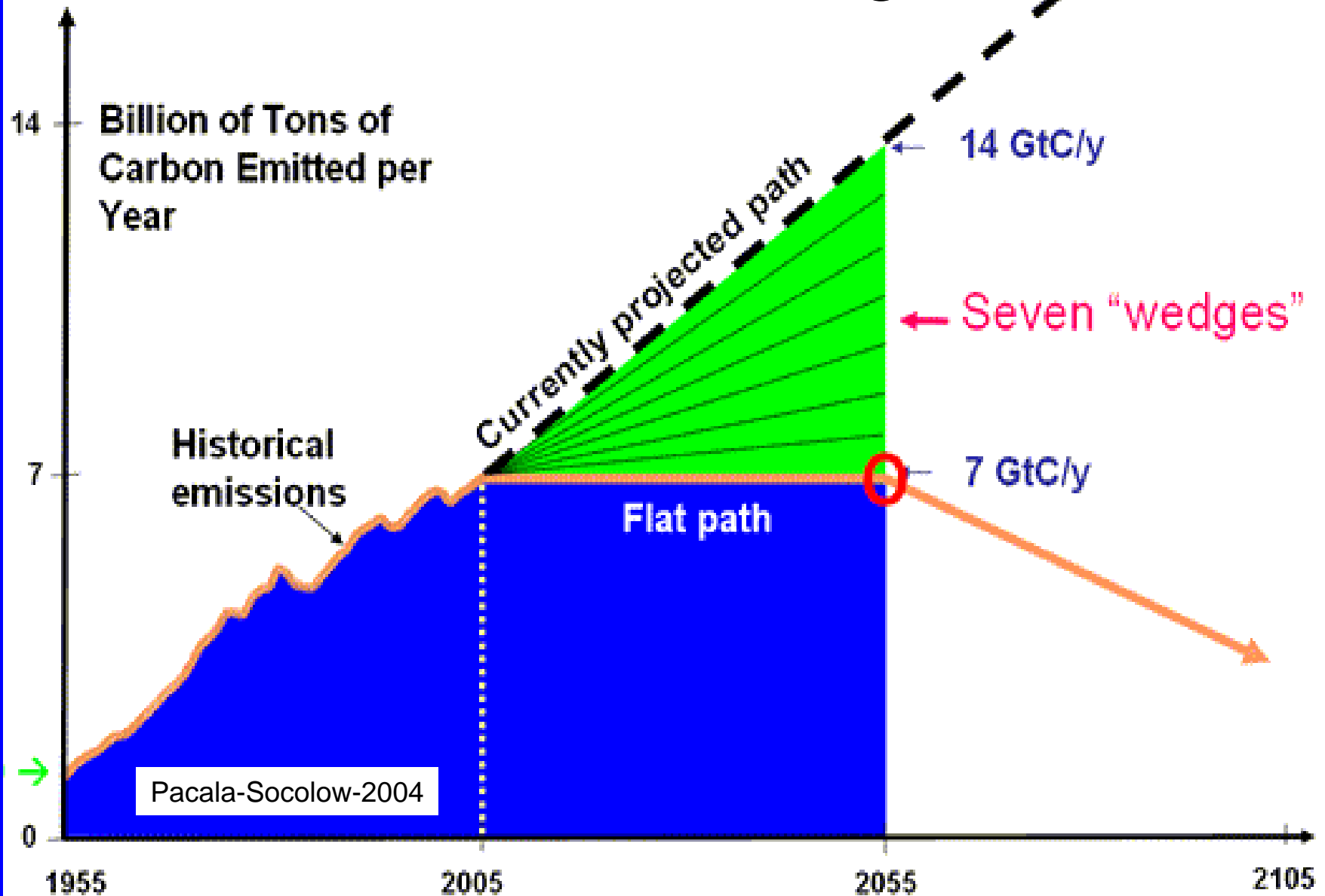
Global average surface temperature is an index of the state of the climate – and it's heading for a state not only far outside the range of variation of the last 1000 years but outside the range experienced in the tenure of Homo sapiens on Earth.

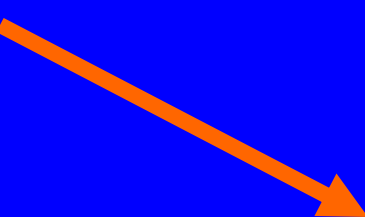


Society has three basic options for responding to human-caused climate change

- **Mitigate** by working to reduce greenhouse gas (GHG) emissions from energy and land use or to capture them from the atmosphere in order to slow or, perhaps, reverse warming
- **Adapt** by reducing the negative effects of climate change through protecting coastlines, moving populations away from impacted areas, increasing efforts to control climate-related vectorborne diseases, insulating cities from heat stress, and so on.
- **Suffer**, i.e., given that efforts in the first two arenas above are moving slowly, there is very likely to be suffering, perhaps considerable in poorer parts of the world, because of the climate change committed already
- We will be doing all three, but can reduce the third if we put more effort into the first two.

“Stabilization Wedges”



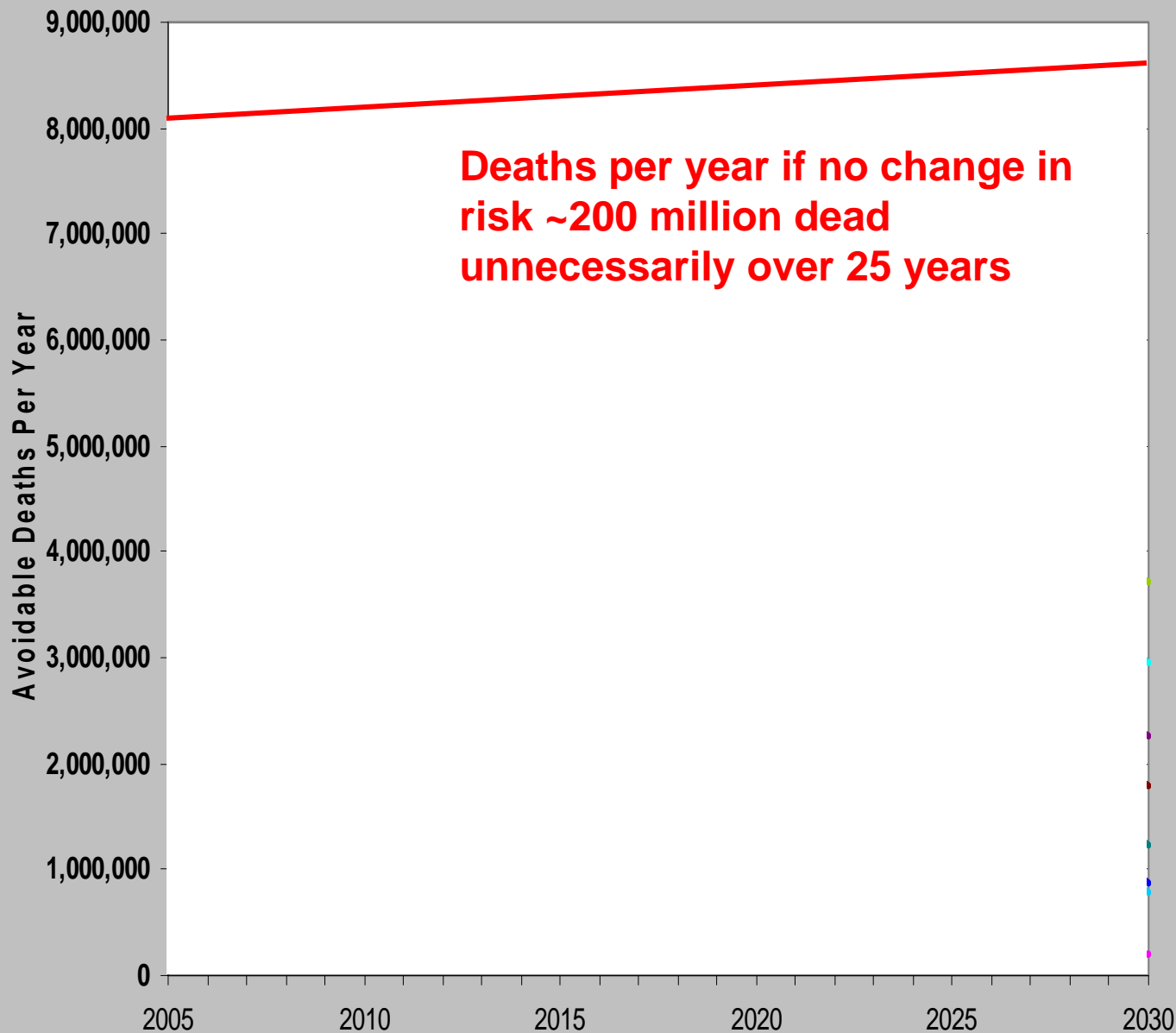
- 
1. Efficient vehicles
 2. Reduced use of vehicles
 3. Efficient buildings
 4. Efficient coal power plants
 5. Gas instead of coal power plants
 6. Capture CO₂ at baseload power plant
 7. Nuclear power for coal power
 8. Wind power for coal power
 9. PV power for coal power
 10. Capture CO₂ at H₂ plant
 11. Capture CO₂ at coal-to-synfuels plant
 12. Wind H₂ in fuel-cell car for gasoline in hybrid car
 13. Biomass fuel for fossil fuel
 14. Reduced deforestation, plus reforestation, afforestation, and new plantations.
 15. Conservation tillage for soil management

Ten Million Excess Child Deaths: The World's Greatest Scandal

- Because it is so damaging and so avoidable
- Damaging well beyond death
 - Lower child mortality necessary part of reducing birth rates
 - Reducing child mortality is a population control measure
 - For every child who dies, several others suffer life-long impacts
 - Lower cognitive capacity (ability to learn)
 - Chronic disease of many kinds
- Whatever your goal (economic growth, stable population, democratic institutions, global equity, art, literature, science, an educated electorate, etc.), it is impaired by excess child mortality

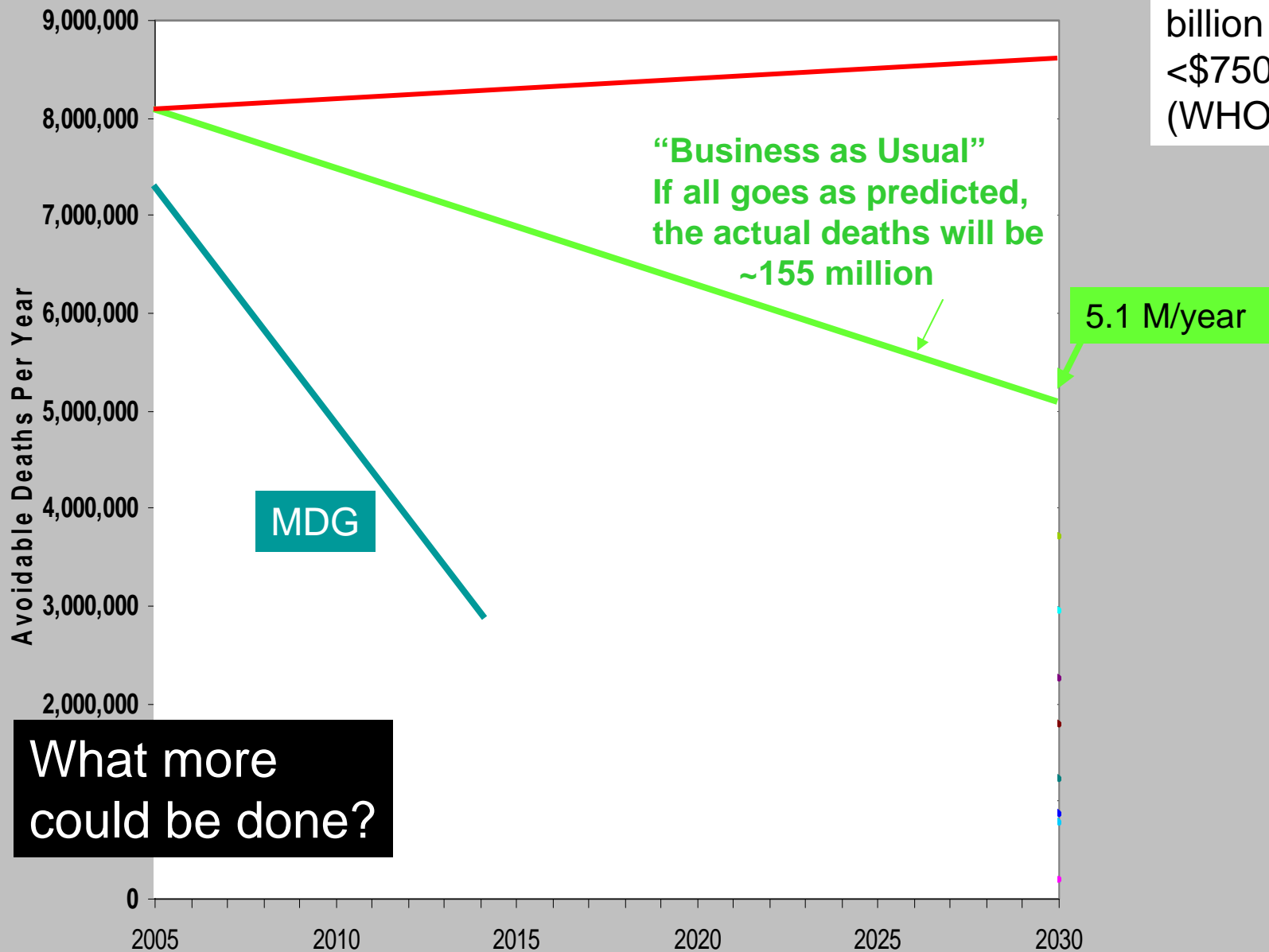
Child Mortality Wedges: 2005-2030

Children in the poorest nations with 2.7 billion people: <\$750/year-person (WHO databases)



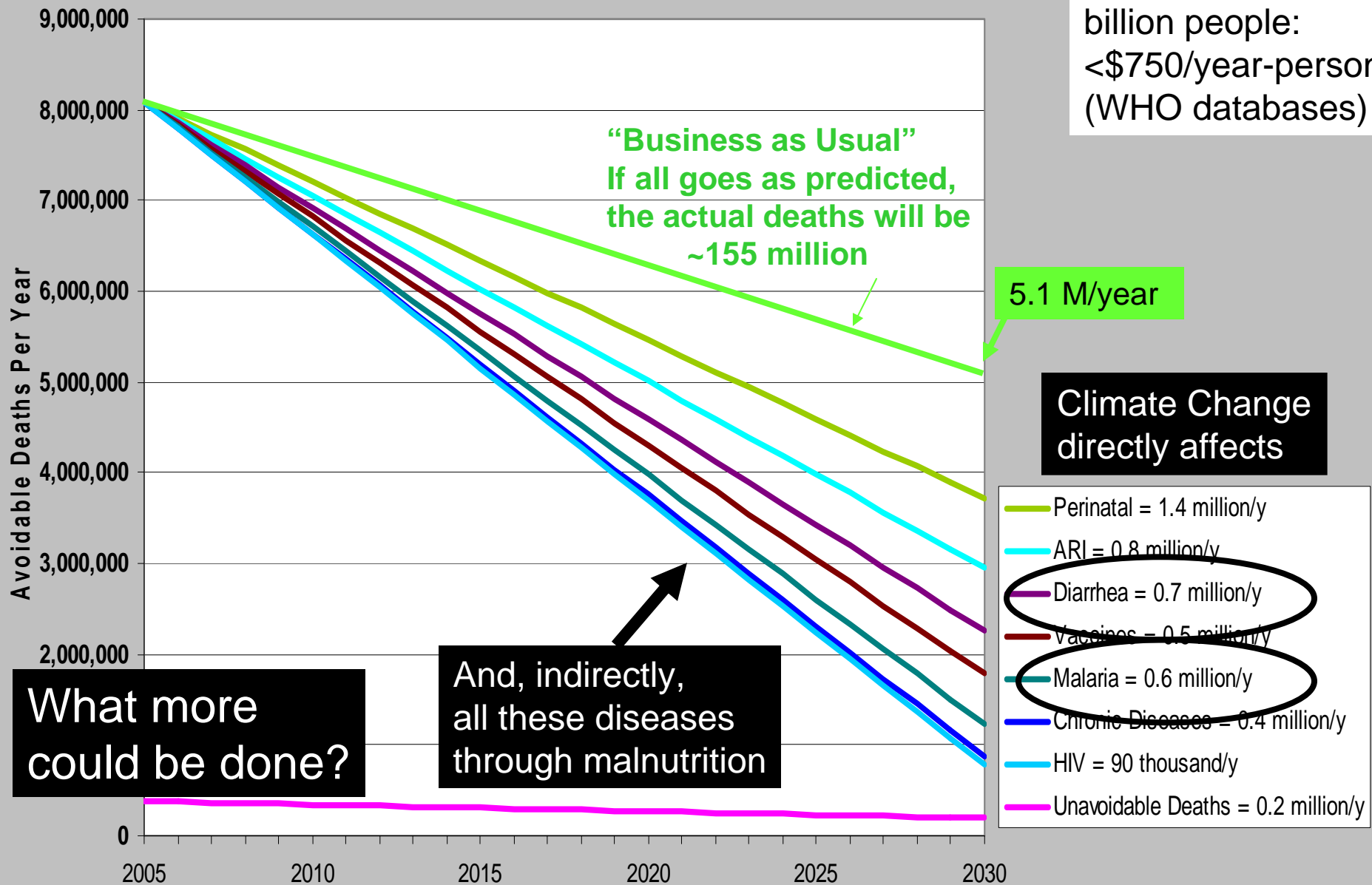
Child Mortality Wedges: 2005-2030

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Child Mortality Wedges: 2005-2030

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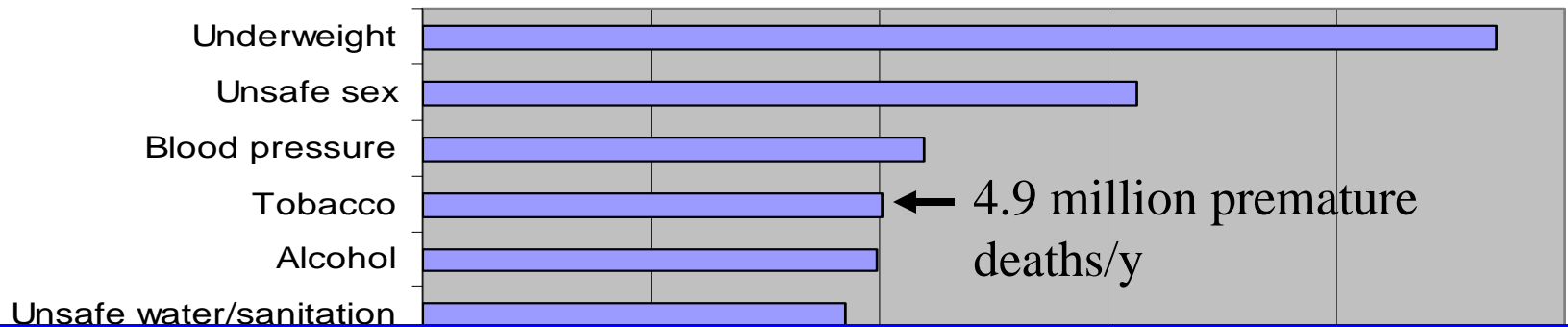
Health Effects Determined by Several Factors

- Stress imposed,
 - For example environmental changes due to climate change
- Susceptibility to those stresses,
 - For example., how much climate change will produce a doubling of diarrhea deaths in a particular place
- Background disease rate,
 - For example, doubling diarrhea death rates in Melbourne does not have the same impact as doubling them in Mozambique
- Background nutrition, health surveillance, emergency preparedness, health care delivery, etc.
 - For example, the same strength hurricane in Florida may kill 50 people, but in Bangladesh it will kill 5000

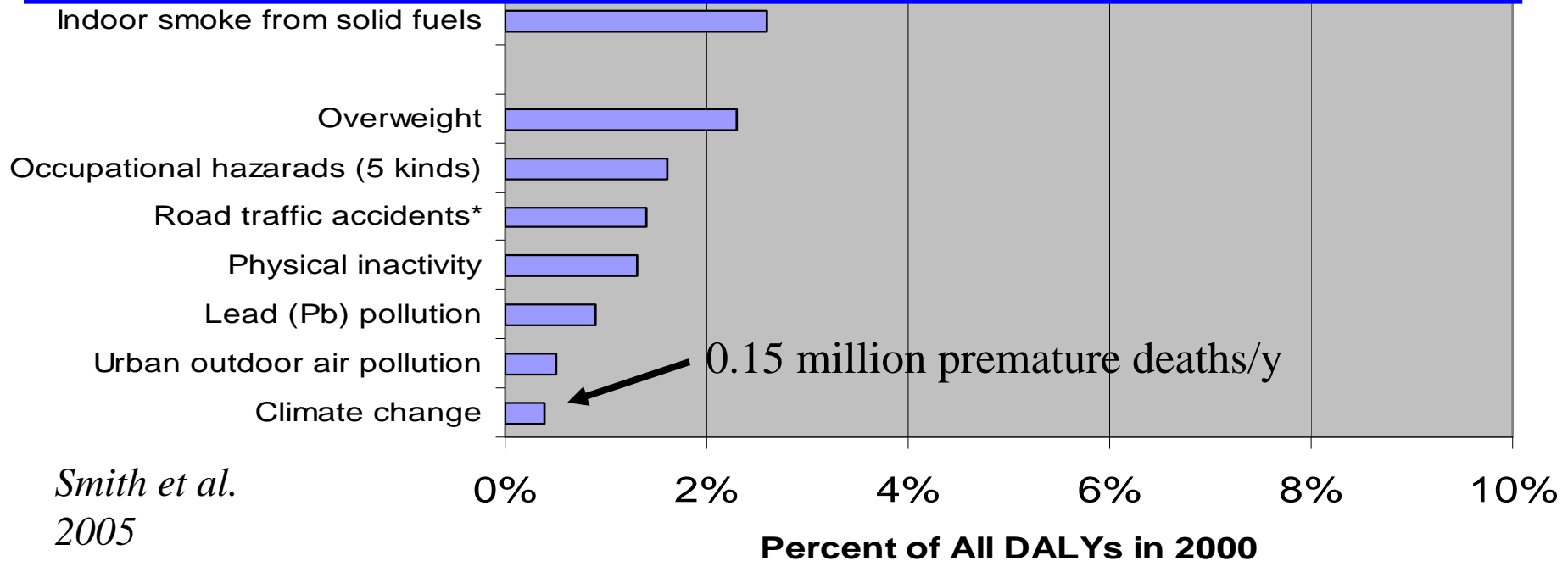
Bottom Line on Climate Health Effects

- Mostly affect the most vulnerable populations in the world – esp. children in poor countries
- This population already highly impacted ~ 10 million avoidable deaths each year
- Progress is slow in reducing this toll and is threatened by climate change
- Not all diseases affected equally
- Has implications for altering our plans to take climate change into account by both
 - accelerating efforts to do what we should be doing anyway
 - Shifting our priorities among diseases

Global Burden of Disease from Top 10 Risk Factors plus selected other risk factors

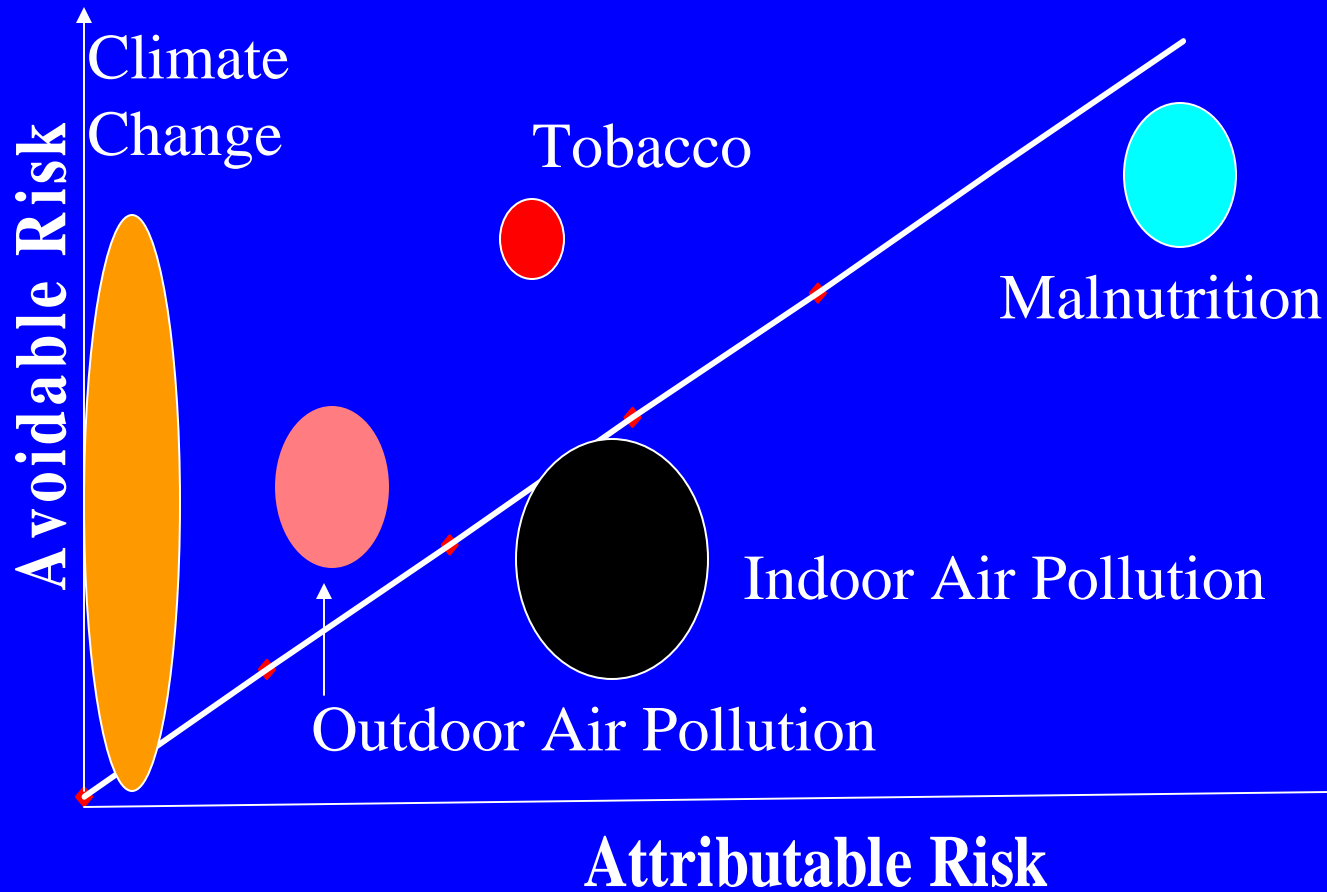


It is not the attributable risk that matters,
but the avoidable risk – a very different kettle of fish



Smith et al.
2005

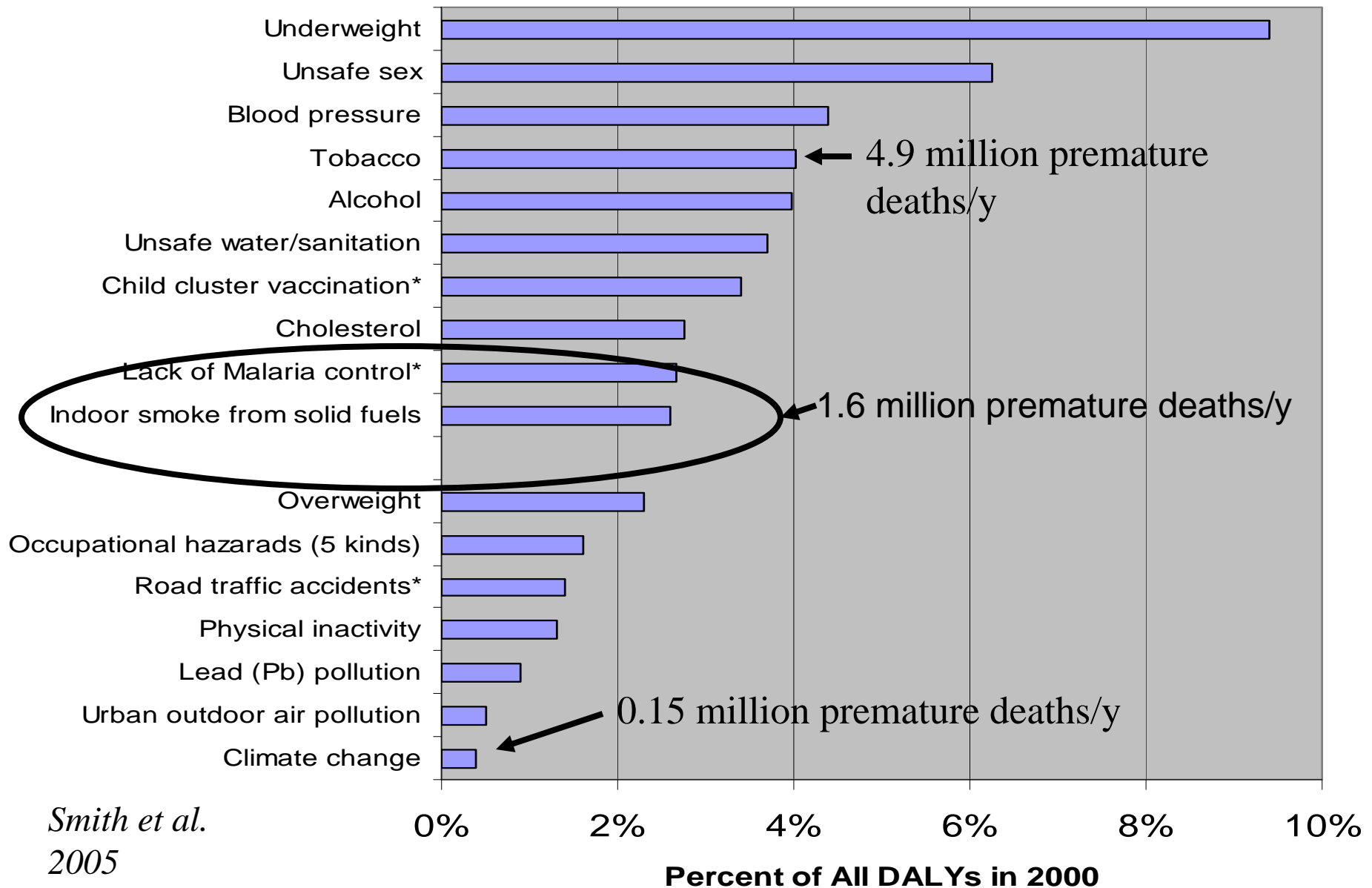
Risk and Uncertainty



Implications for Climate Change Health Intervention Strategy

- To date, the attributable burden of diseases from climate change for which evidence is available has been modest by comparison to the traditional threats to public health
- Over time, however, the burden will rise, even with major additional efforts at mitigation and adaptation.
- Most of this increase will be in the form of enhancing existing health risks (malnutrition, adverse weather, vectorborne disease, poor water supplies, etc.)
- But since $\text{Burden} = f(\text{Exposure, Exposure/Response and Vulnerability} \text{ -- i.e., background disease})$
- Efforts to work on Vulnerability are just as important as those for Exposure and Exp/Resp
- This implies that public health efforts to reduce background disease rates for these traditional hazards be granted even greater urgency so their enhancement by climate change in future years will be less serious

Global Burden of Disease from Top 10 Risk Factors plus selected other risk factors

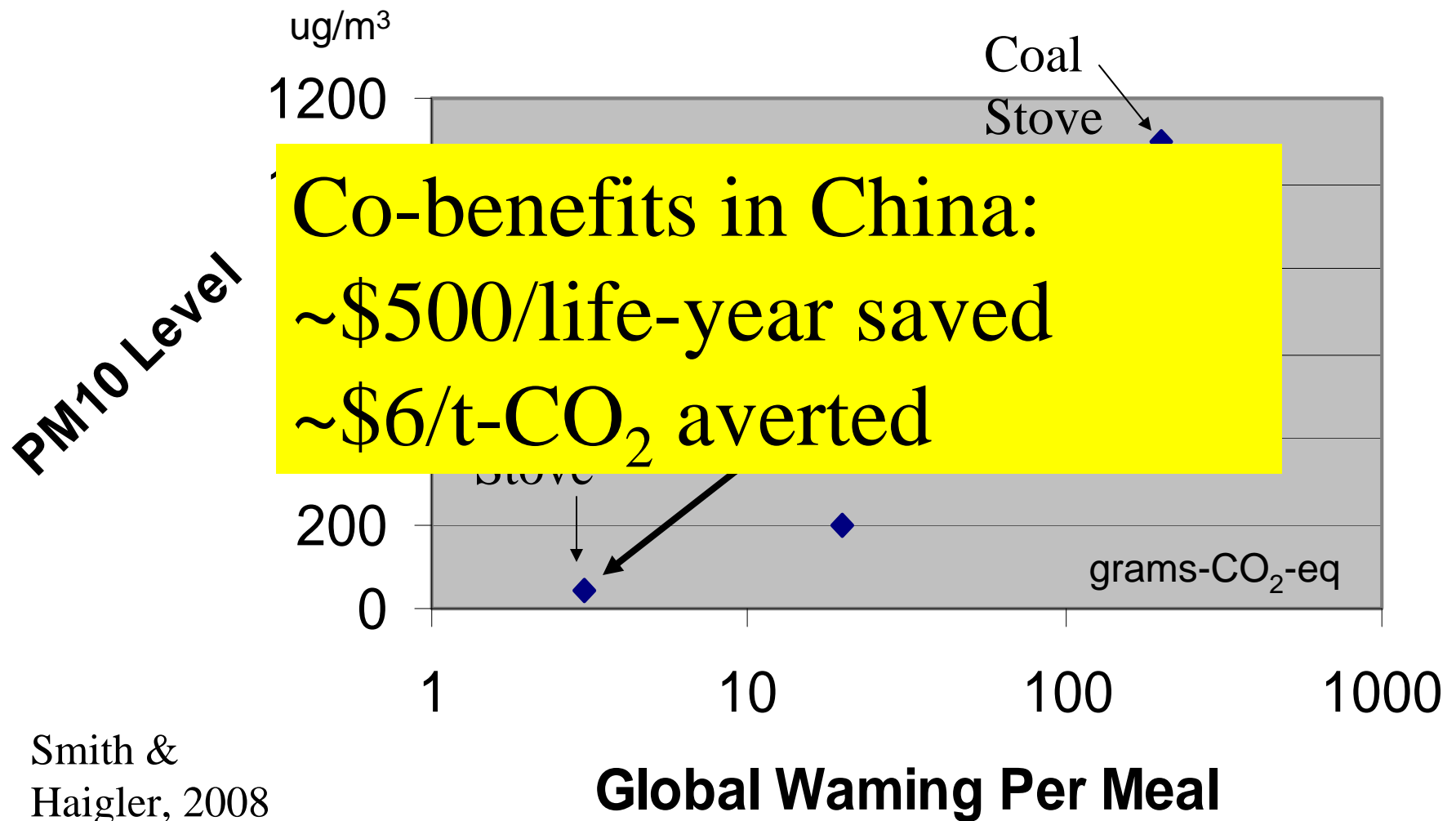


A Chinese Biomass Gasifier Stove

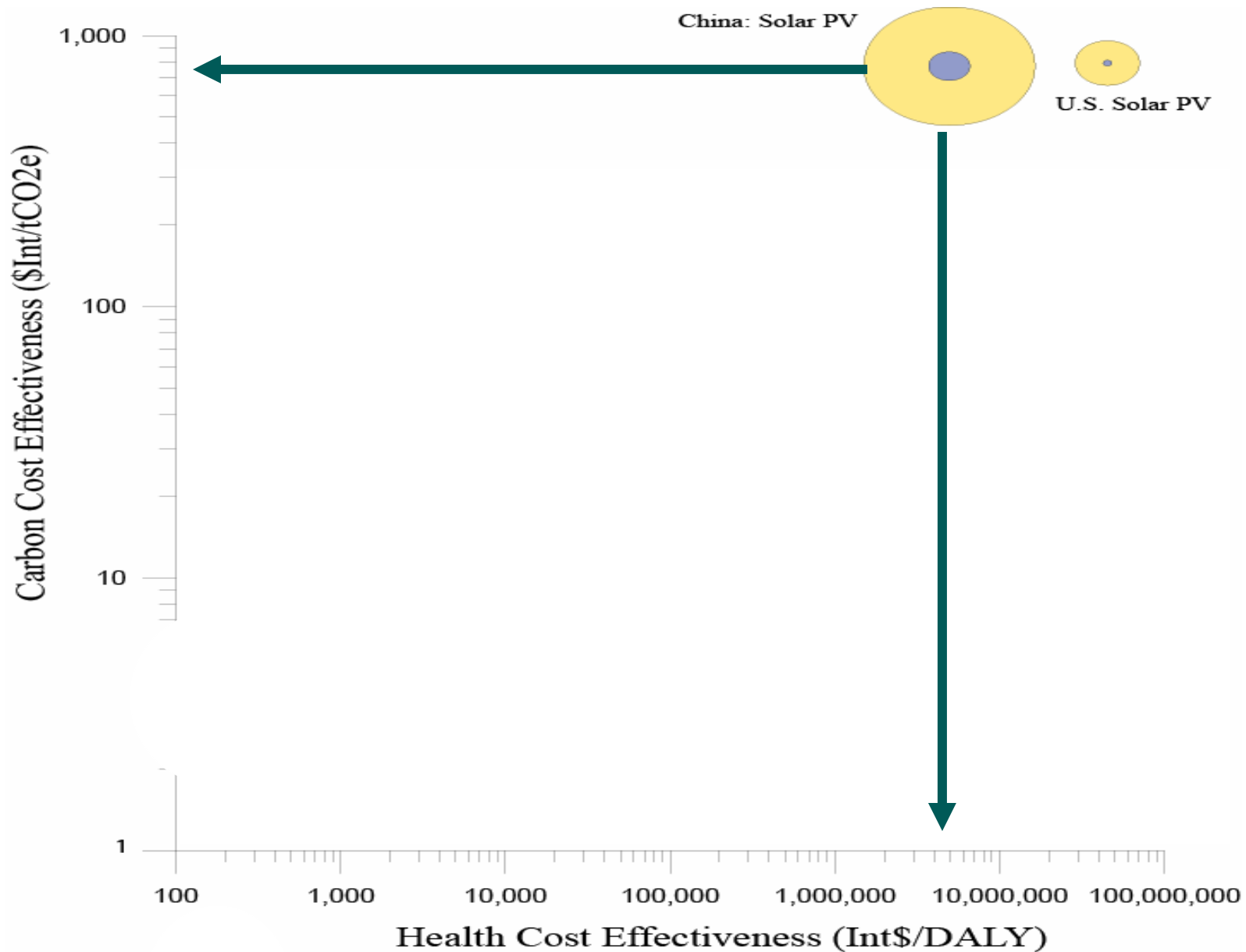
Tests show emissions nearly at LPG levels:
Low health risk and essentially no greenhouse emissions



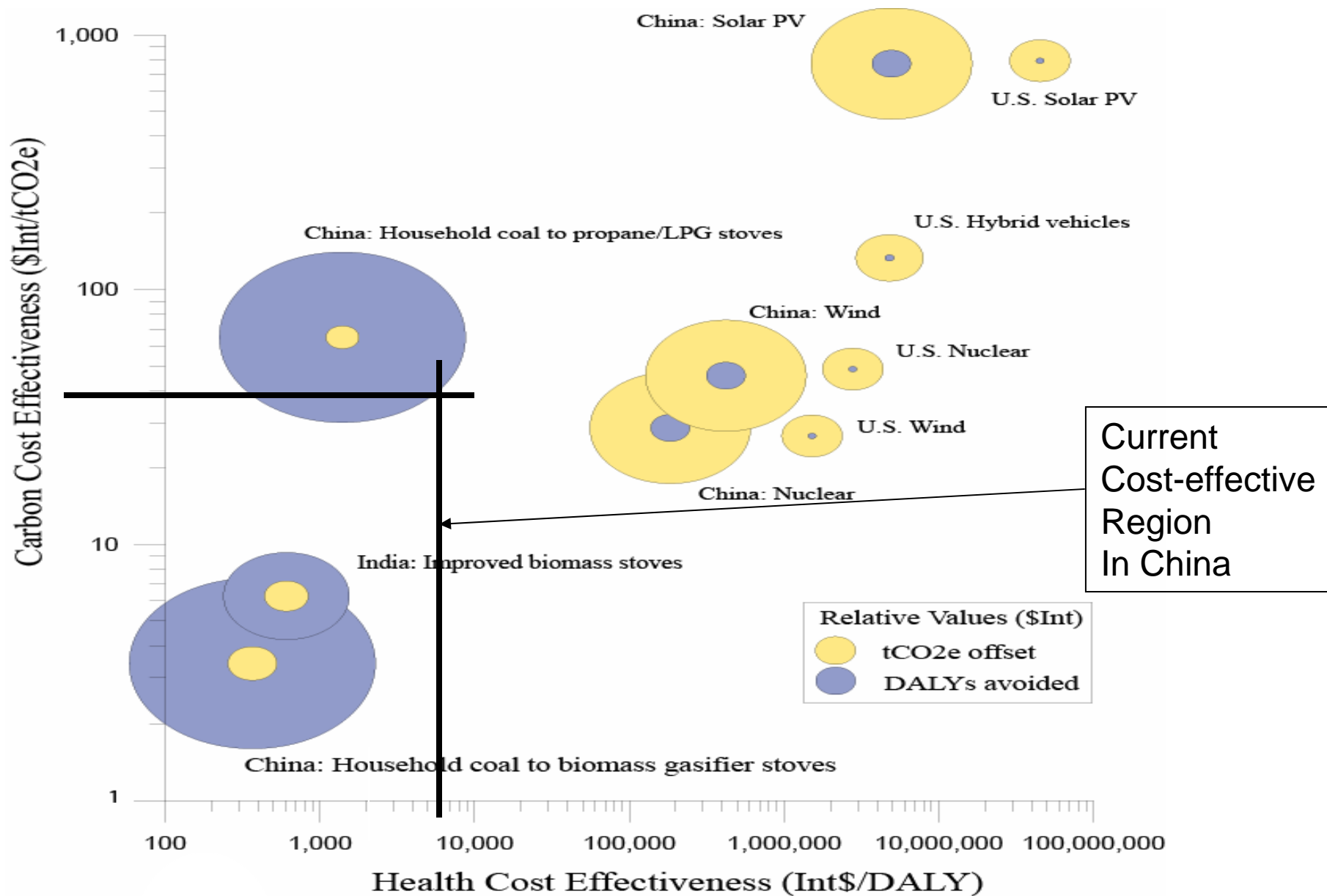
Health and Greenhouse Gas Benefits of Biomass Stove Options



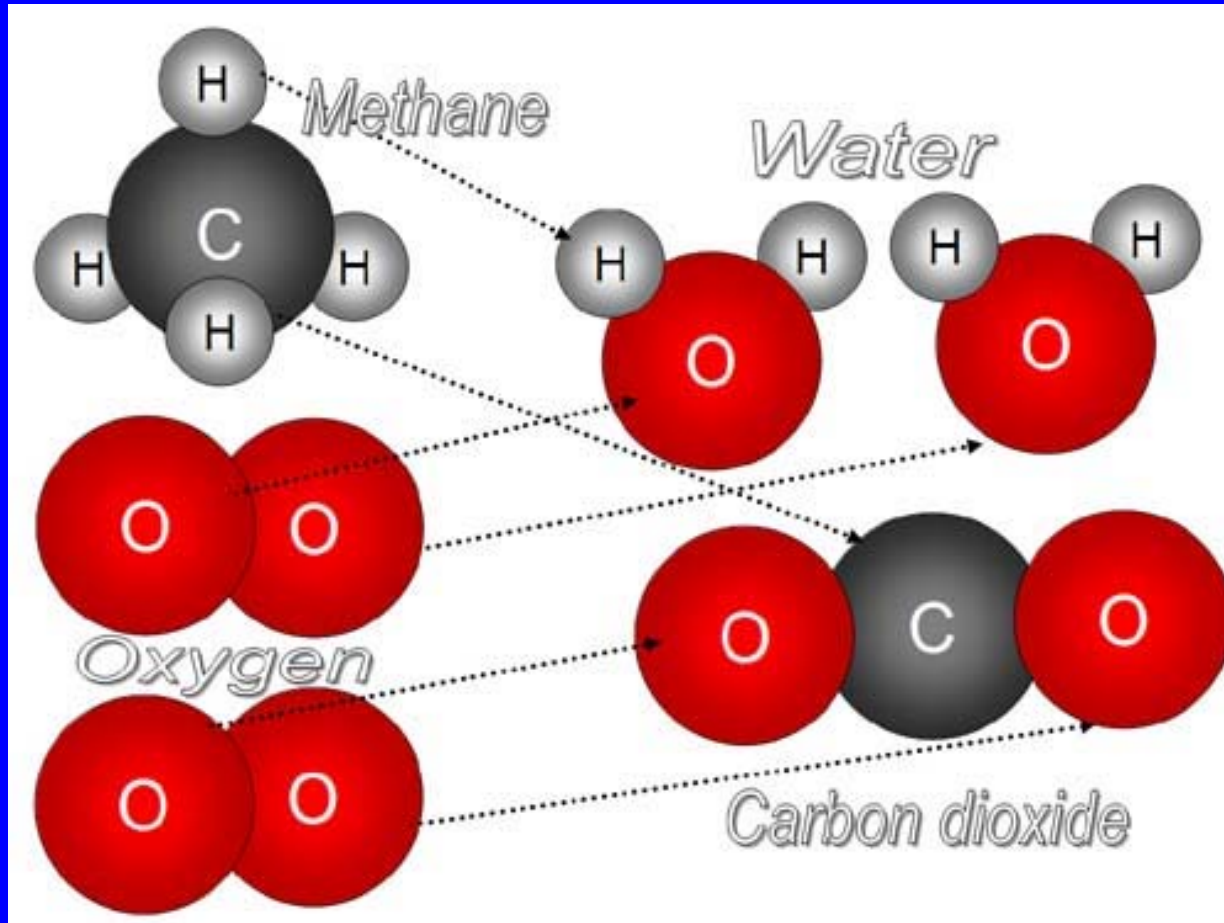
Smith &
Haigler, 2008



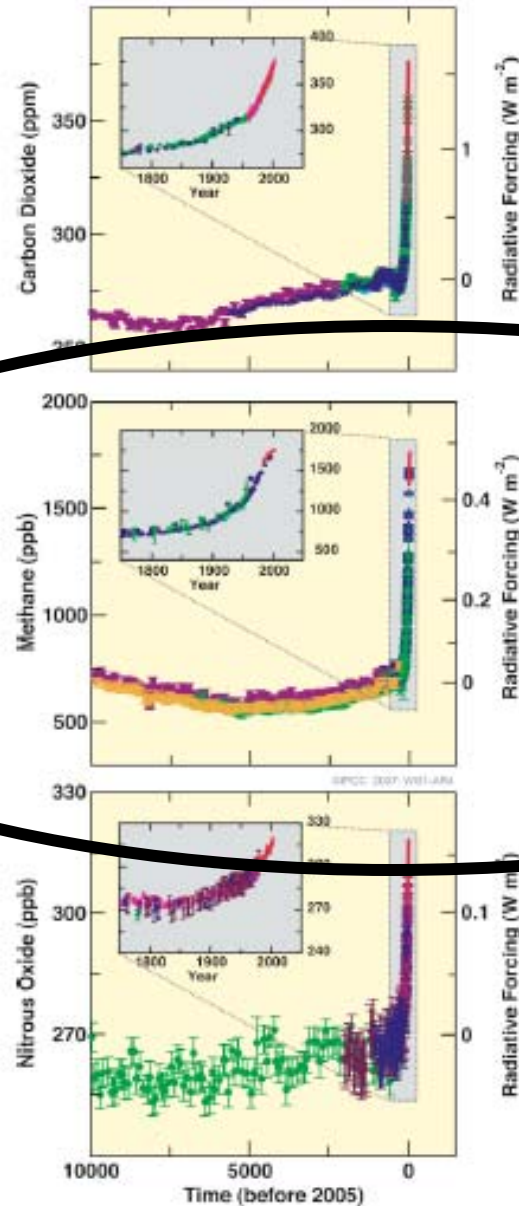
Smith & Haigler, 2008



The Methane Story: CH_4



Atmospheric Greenhouse gas concentrations



Anthropogenic Sources

CO₂

Fossil fuels
Land use change
Cement manufacturing

Methane

Landfills
Rice
Livestock
Waste management
Fossil recovery

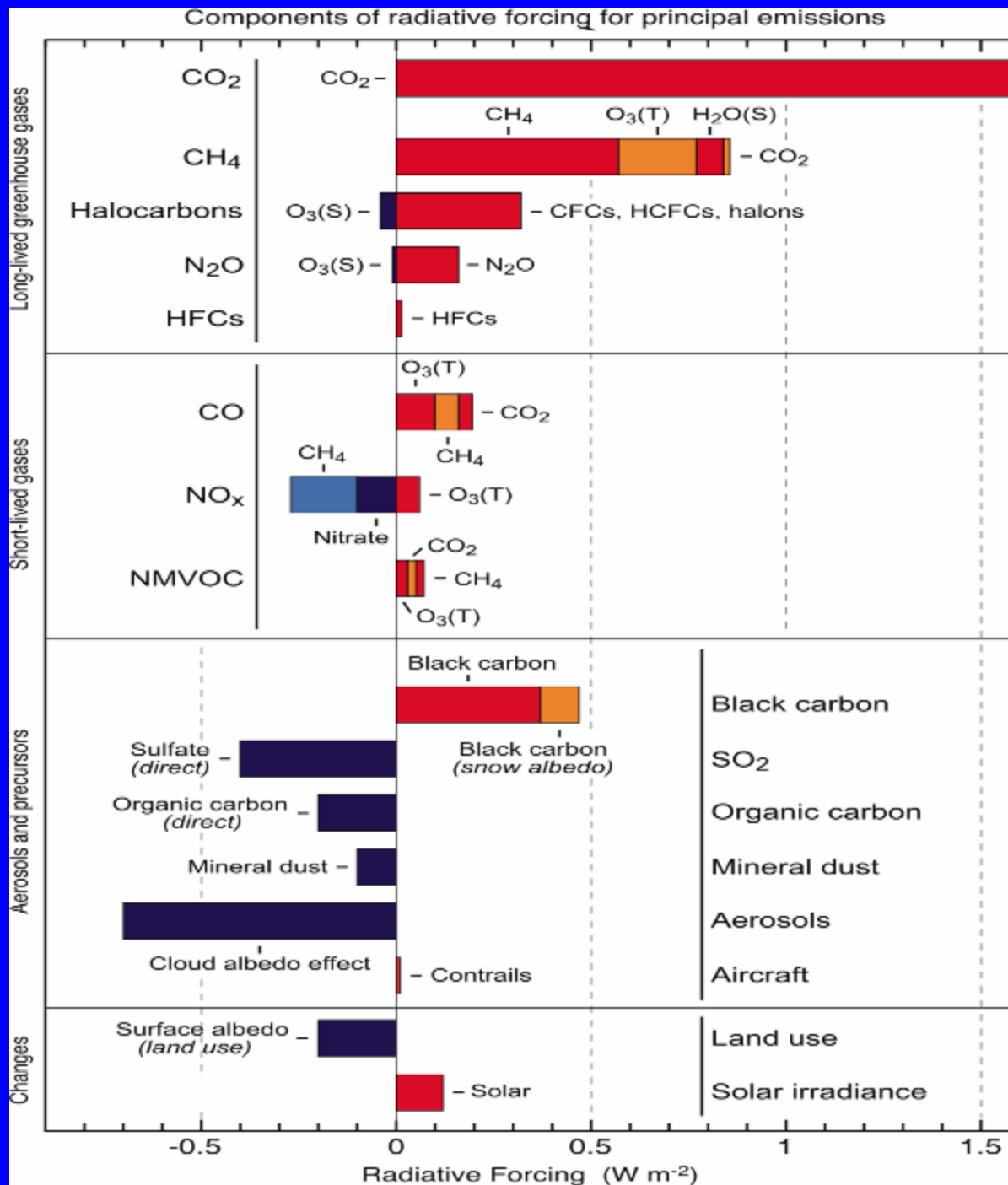
N₂O

Fertilizer
Planted N-fixers
Combustion

Figure SPM.1
IPCC 2007

Methane

- A much more powerful greenhouse gas (GHG) than CO₂
- Partly due to its direct effect, but also because it creates ozone (O₃), another powerful GHG
- About 100 times more per ton than CO₂ at any one time
- Eventually turns to 2.75 times as much CO₂ by mass
- Methane has thus contributed a significant amount to global warming,
- But has a much shorter atmospheric lifetime compared to CO₂
- Thus, changes in emission rates will have a much faster impact to lower warming



Warming in 2005
from emissions
since 1750

More than half
due to methane

IPCC, 2007

Methane (cont.)

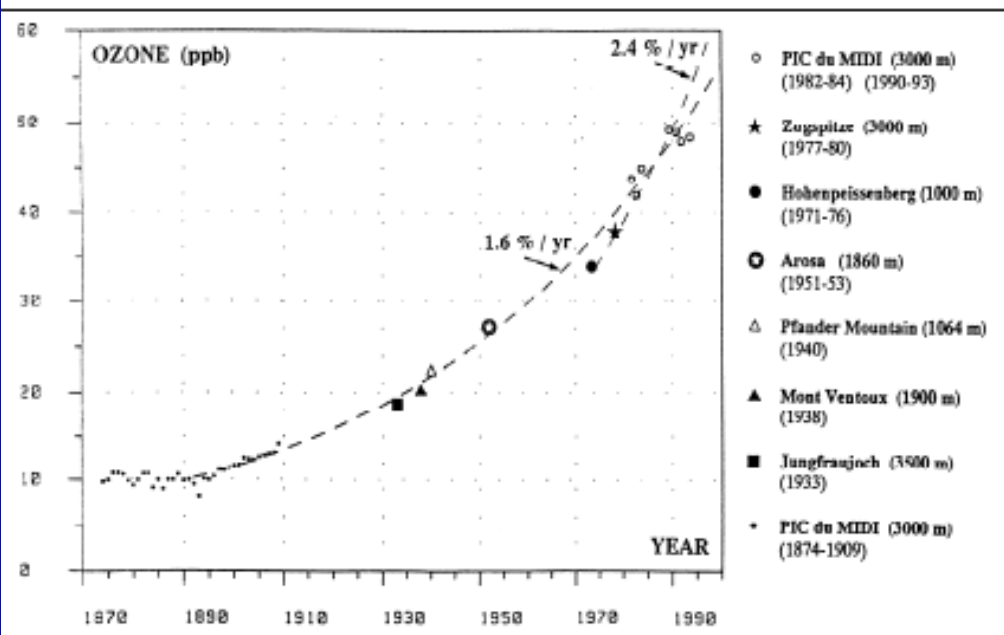
- Way to reduce warming in the next generation is to put more attention on methane (and other shorter lived GHGs)
- Once the heat enters Earth's systems, it does not matter where it came from
- The **rate** of warming is as important as the total amount
- Way to slow the rate is to immediately reduce methane emissions
- While working to stop CO₂ in the long run

Methane, cont.

- Increases of wide-scale ground-level ozone is becoming a major world problem
- A significant health-damaging pollutant
- Methane emissions are one of its causes
- Reduction of methane emissions, therefore, will help protect health worldwide in the short term

Background Ozone is Growing ...

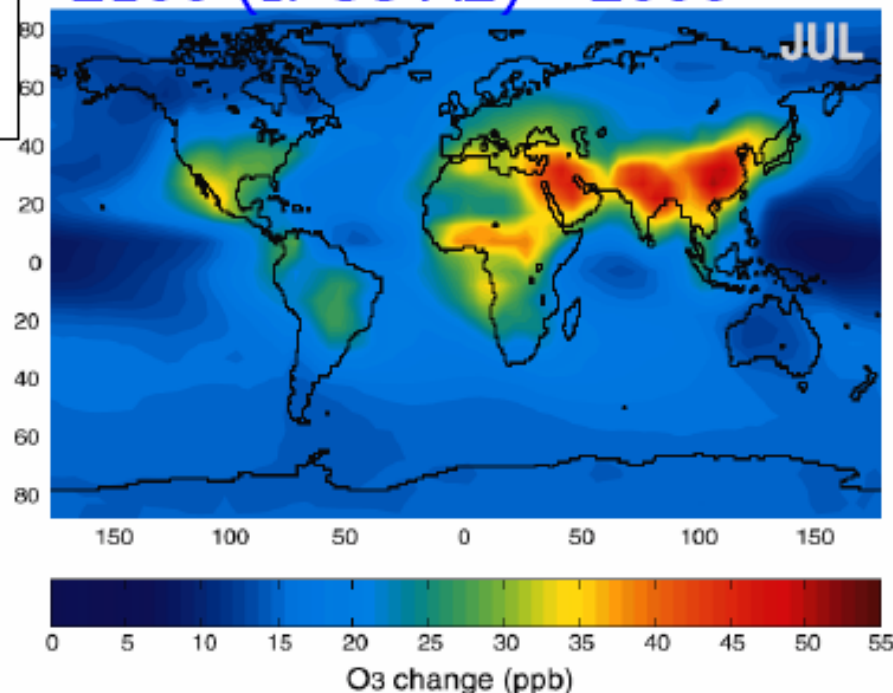
... and Will Continue to Grow!



Ozone trend at European mountain sites, 1870-1990 (Marenco et al., 1994).

Historic and future increases in background ozone are due mainly to **increased methane and NO_x emissions** (Wang *et al.*, 1998; Prather et al., 2003).

2100 (IPCC A2) - 2000



Multiple Benefits of Reducing Methane

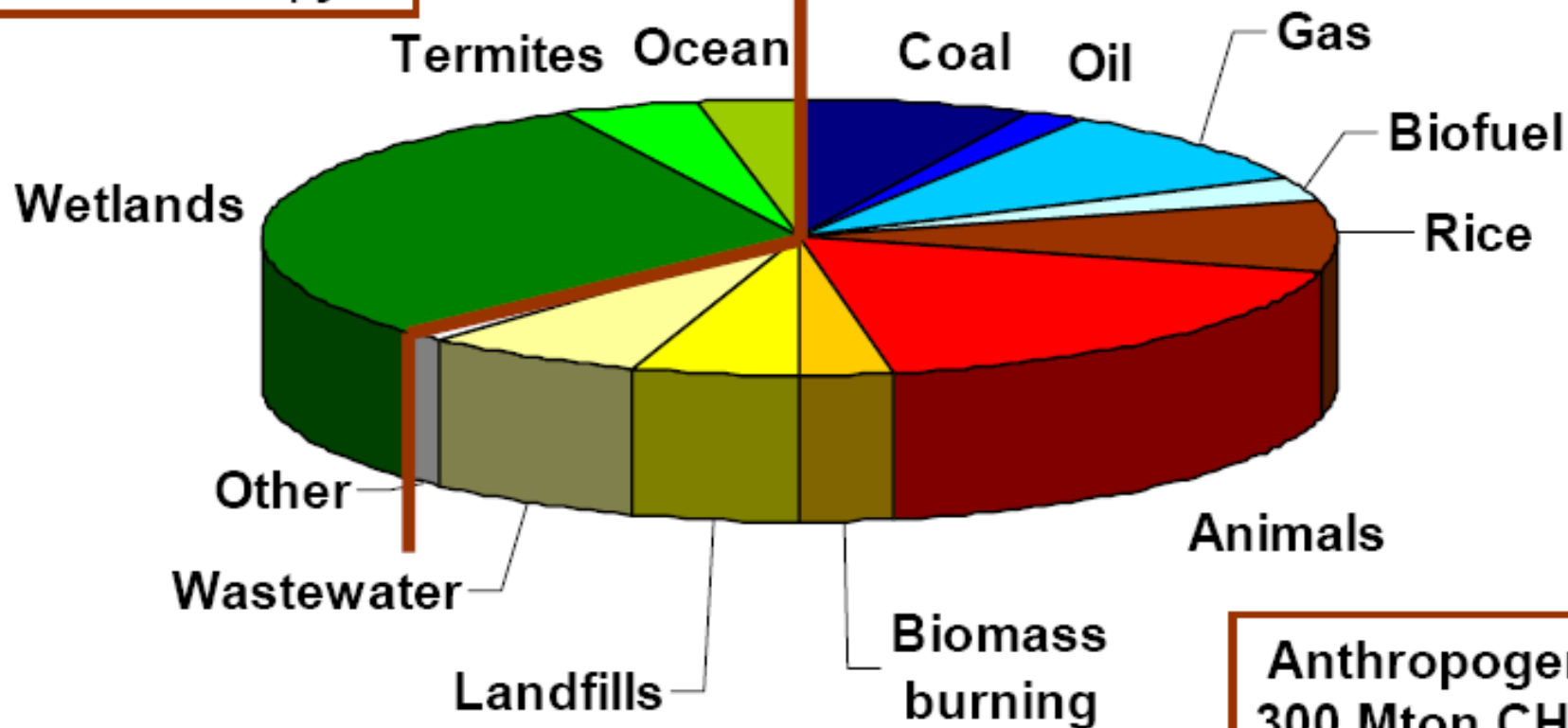
Reducing **~20% of anthropogenic methane emissions** will:

- Be possible at a **net cost-savings**.
- Reduce 8-hr. average ozone globally by **~1 ppb**.
- Reduce global radiative forcing by **~0.14 W m⁻²**.
- Provide **~2%** of global natural gas production.
- Prevent **~30,000** premature deaths globally in 2030, **~370,000** from 2010-2030.

Mauzerall, 2007

Global Methane Emissions

Natural:
180 Mton CH₄ yr⁻¹

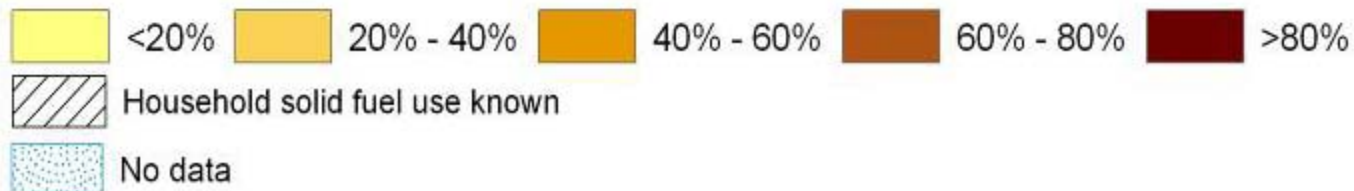
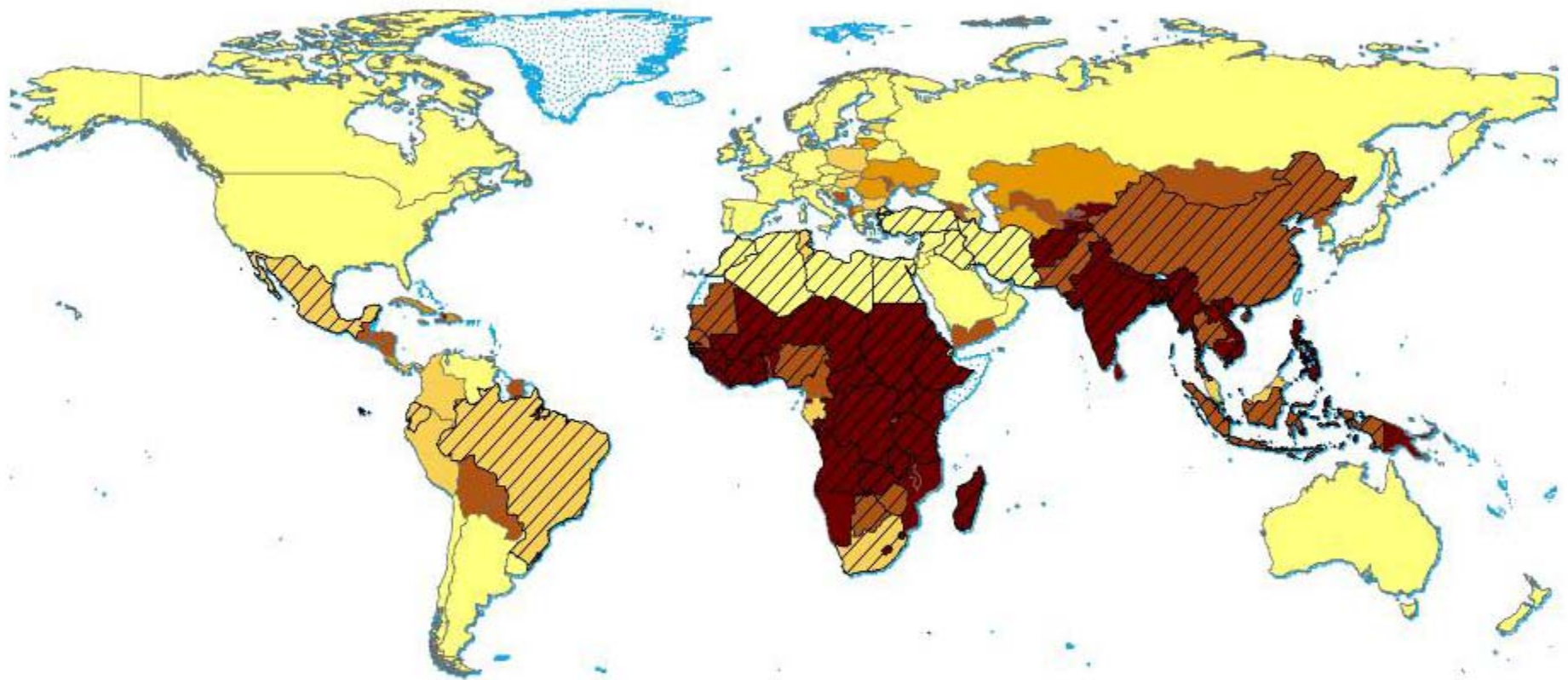


Anthropogenic:
300 Mton CH₄ yr⁻¹

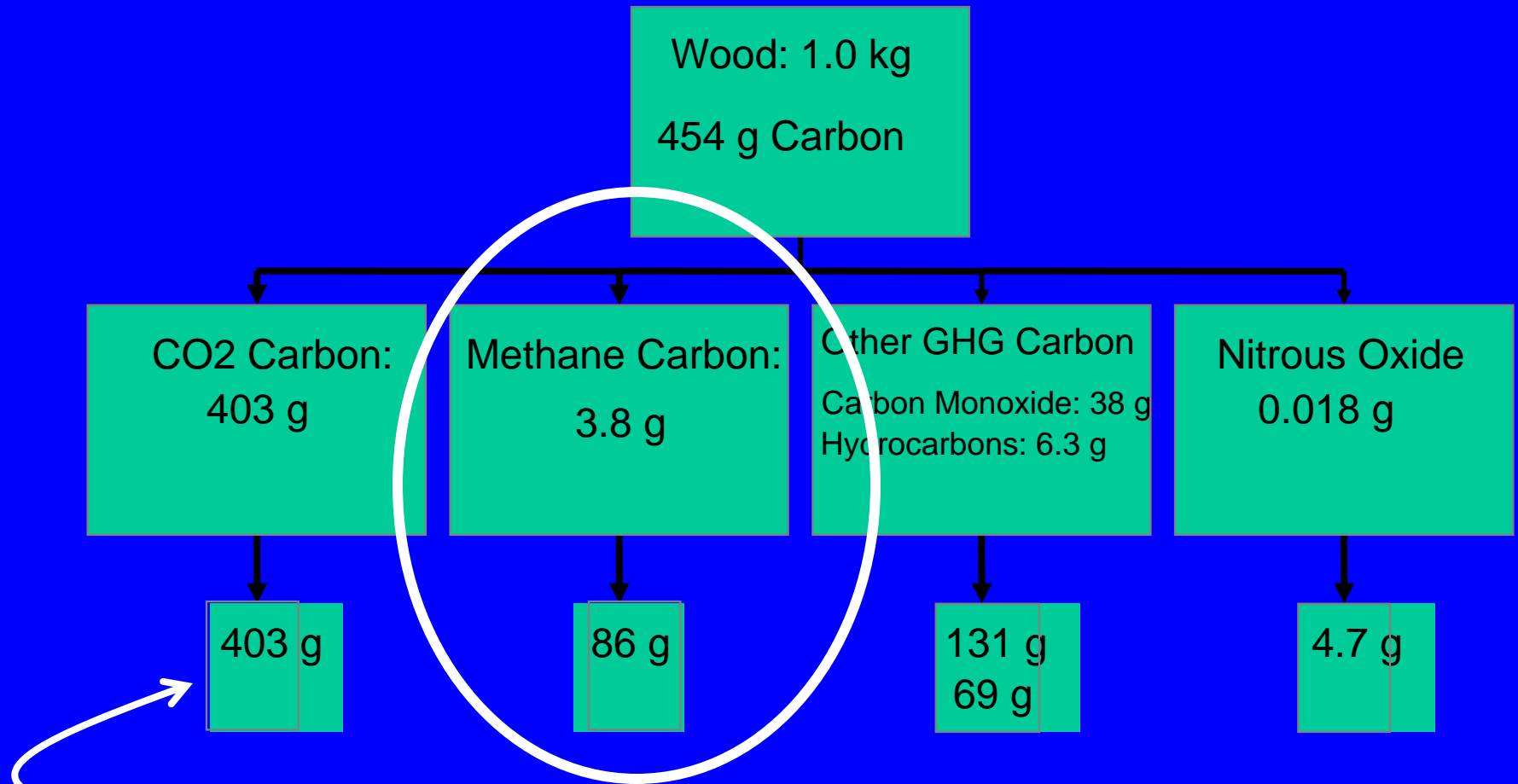
* USA is ~9% of global anthropogenic emissions.

EDGAR3.2 &
Houweling *et al.*, 1999

National Household Solid Fuel Use, 2000



Greenhouse warming commitment per meal for typical wood-fired cookstove in India



Global warming commitments of each of the gases as CO₂ equivalents

Source:
Smith,
et al.,
2000

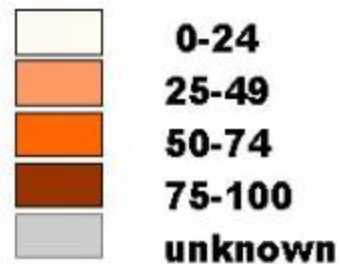
Indian Households Using Biomass Fuels



2 million tons methane
per year of 300 Mt
total human emissions

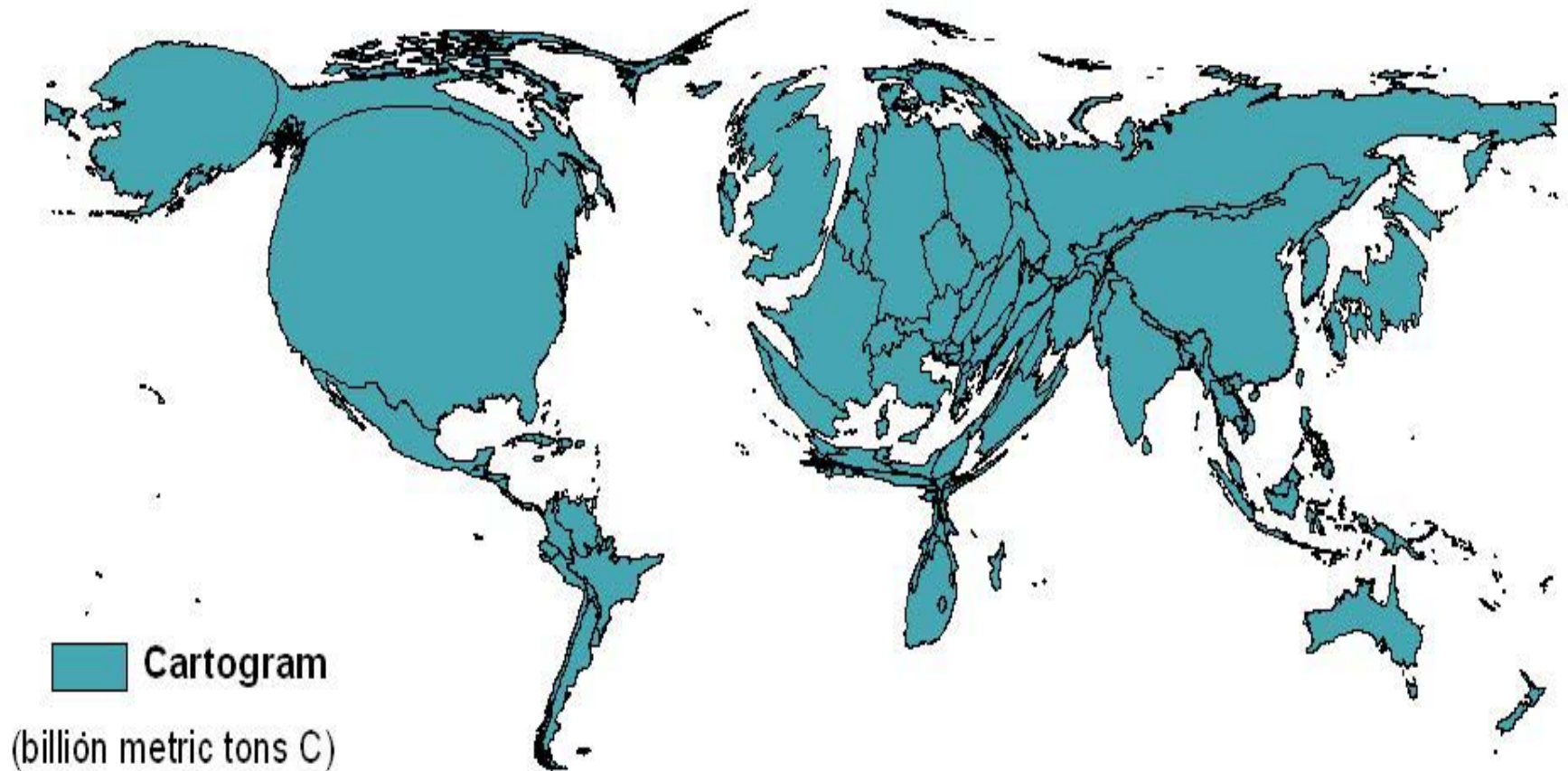
Smith,
et al.
2000

Percentage of Households



*Source: Census of India 1991

National Natural Debts: Cumulative CO2 emissions, depleted by natural processes



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

Total CUMULATIVE Greenhouse Gas Emissions in the Year 2002, by Country

Ratio of largest to smallest emitting countries ~ 500x

This kind of calculation, however is based only on CO₂ emissions:

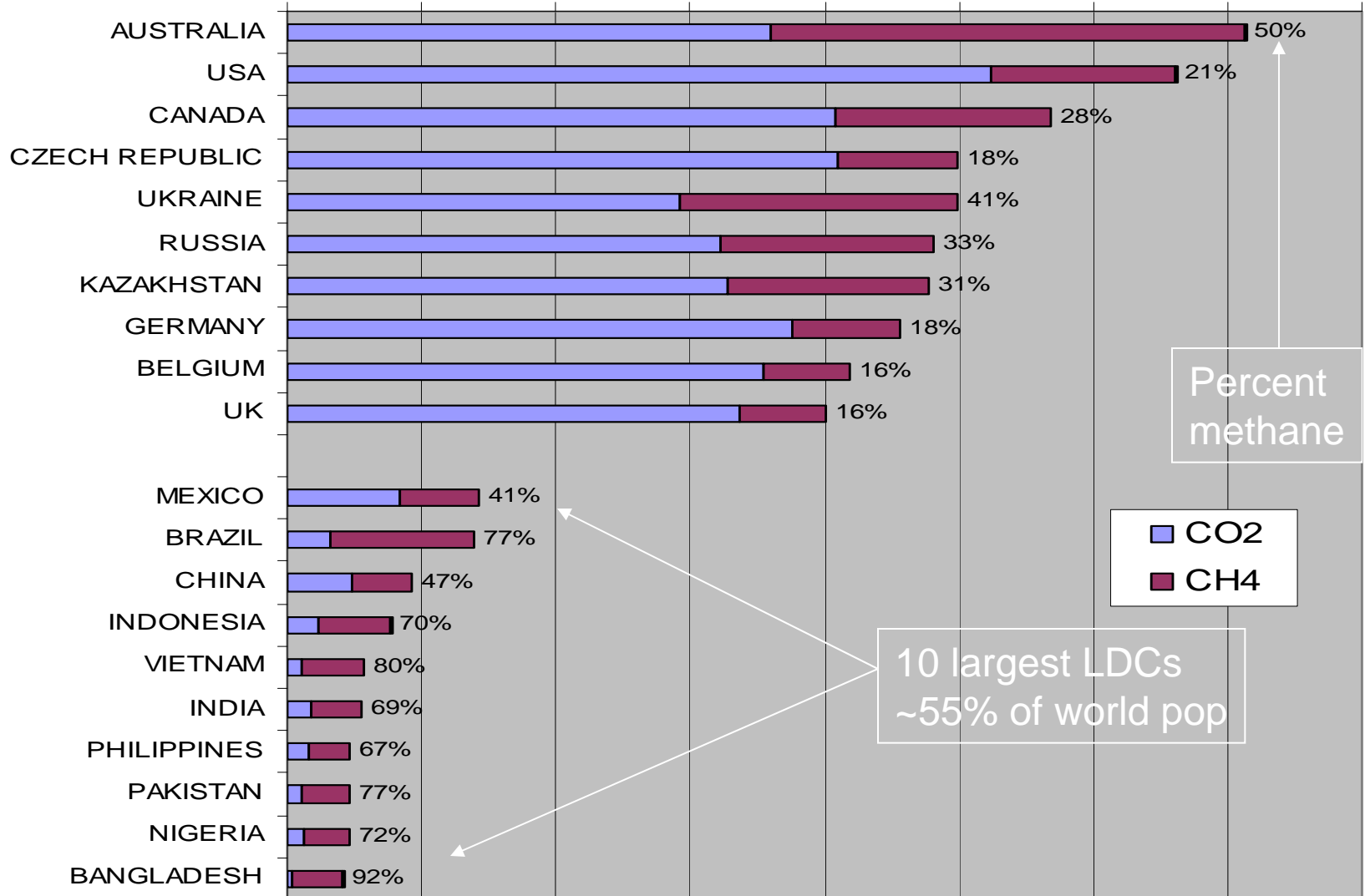
(billión metric tons C)

Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

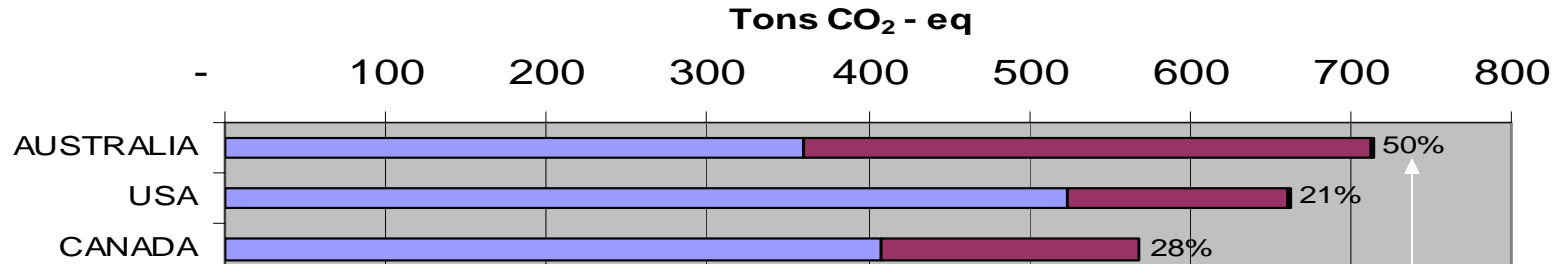
International Natural Debt Per Capita

Tons CO₂ - eq

- 100 200 300 400 500 600 700 800



International Natural Debt Per Capita



Ratio of largest to smallest emitters considering both CO₂ and methane ~ 40x

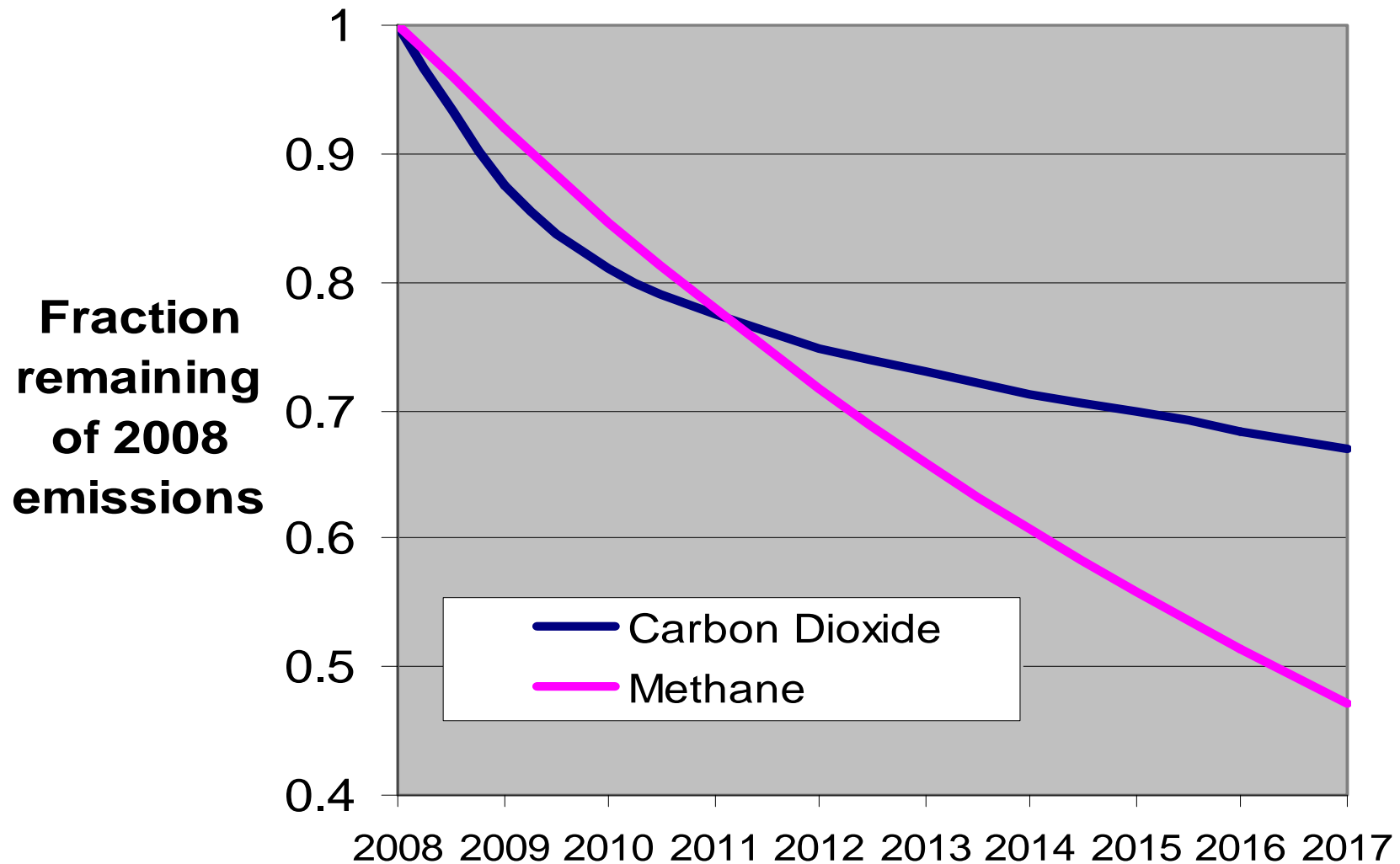


Math of GHG Decay (4AR)

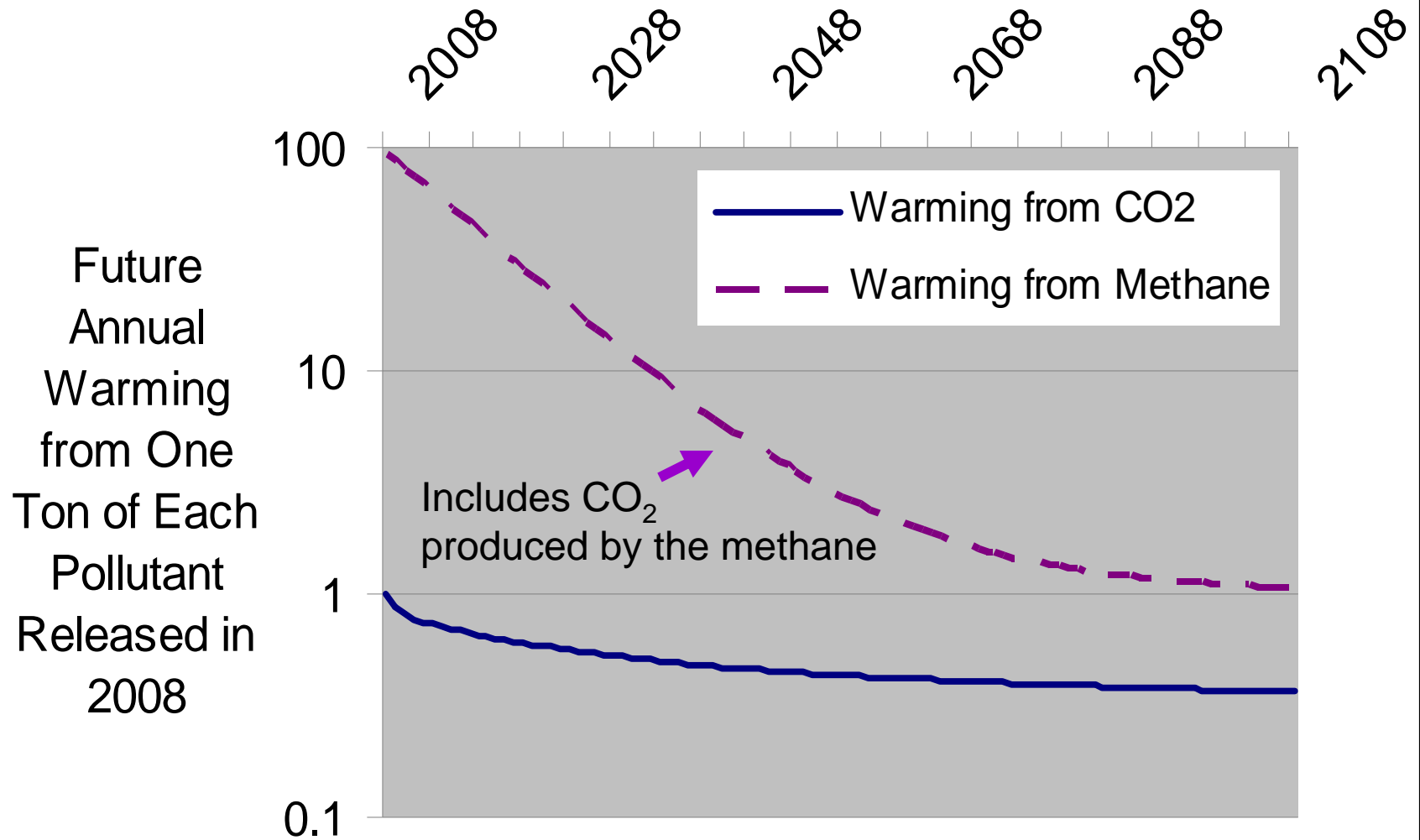
- CO₂ goes into four compartments:
 - 19% of total with a lifetime* of 1.2 years
 - 34% at 18.5 y
 - 26% at 173 y
 - 21% with “infinite” lifetime
- Methane has a 12 y lifetime,
 - but oxidizes to CO₂
 - and water

*Lifetime refers to the time to reach 1/e (37%) of the original amount

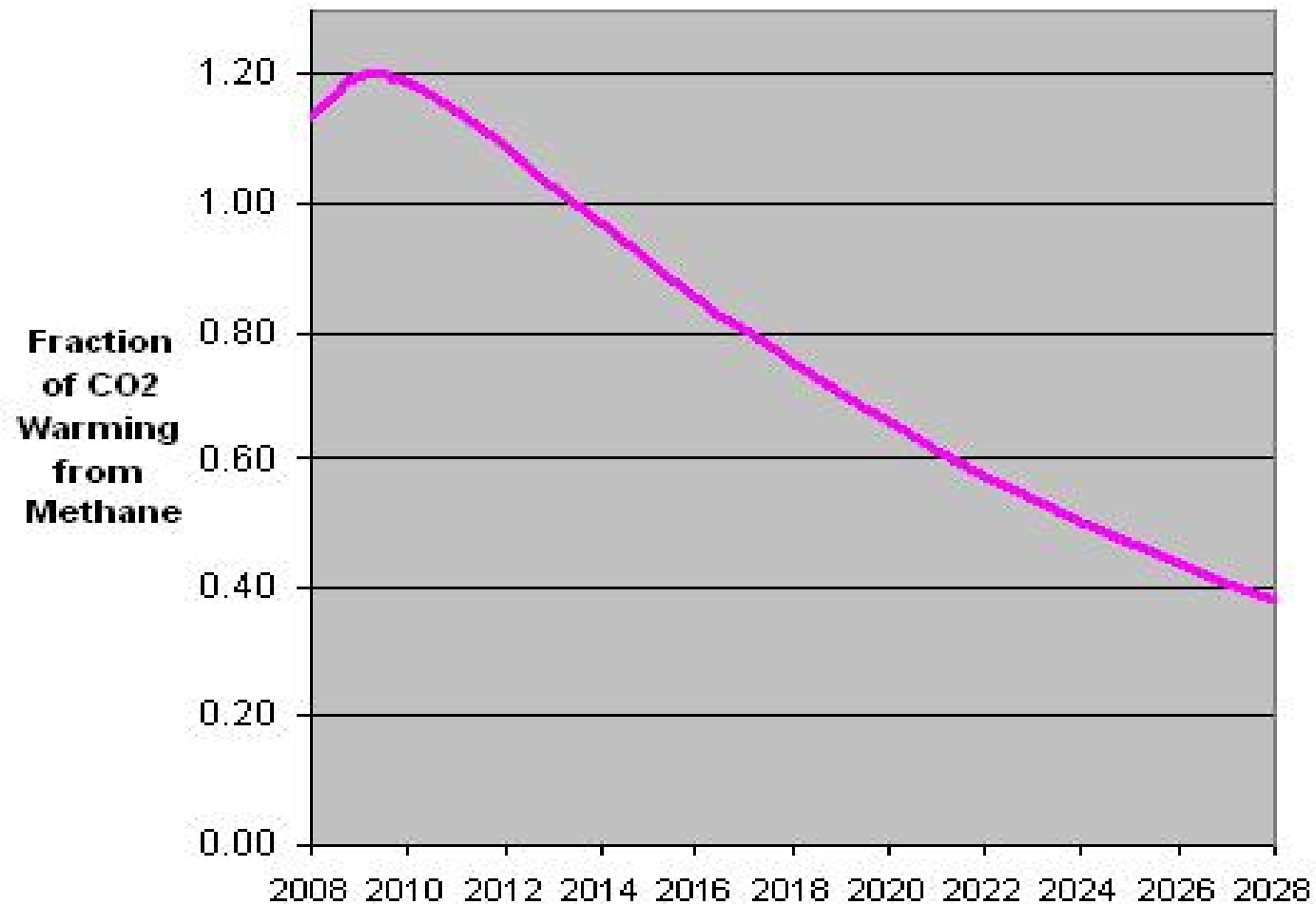
Natural CO2 and CH4 Depletion - first 10 years



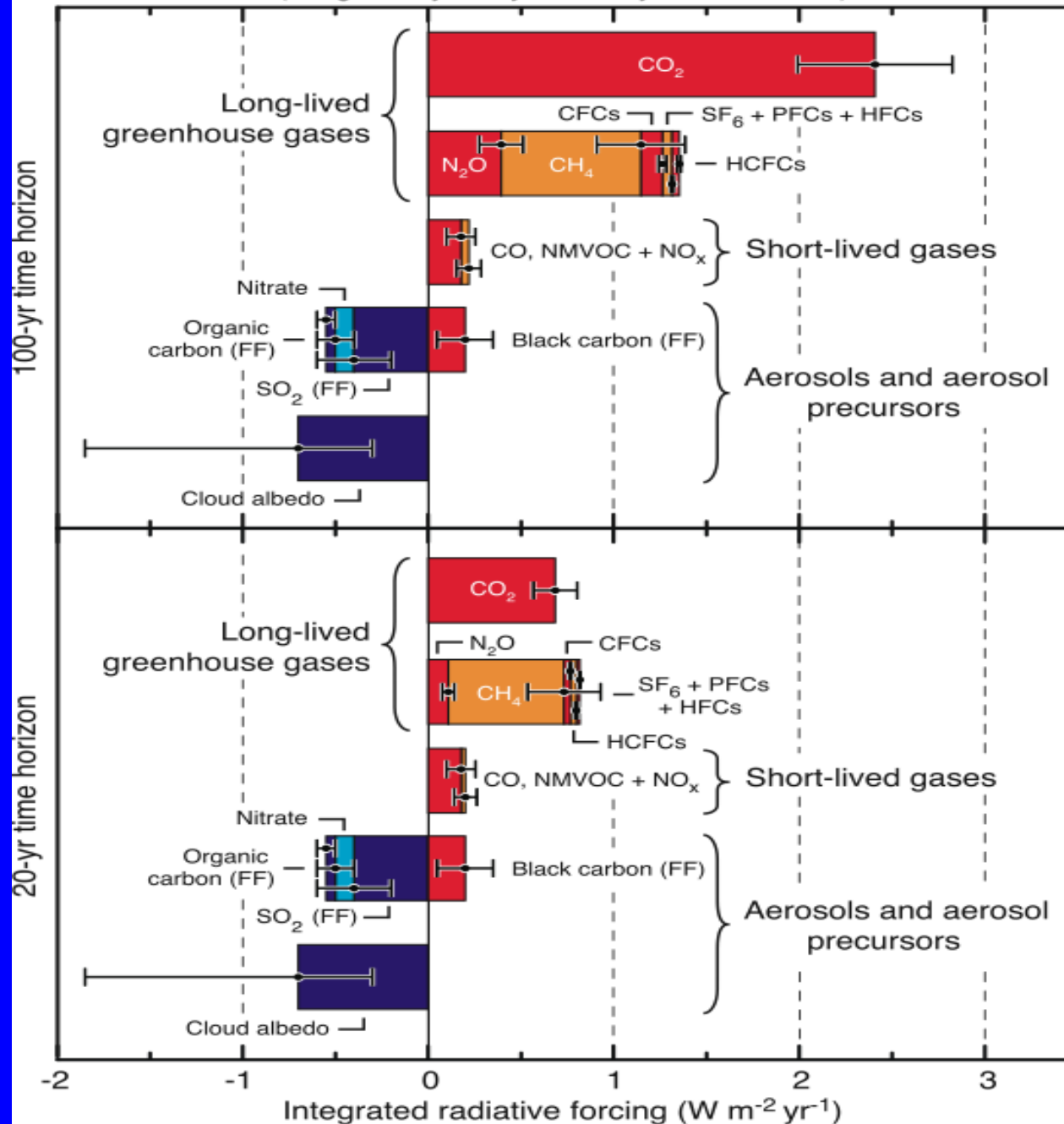
Relative Warming of Methane and CO₂ from Emissions in 2008



Warming Contribution of Total ~2008 Emissions of Methane Compared to Total CO2 Emissions



Integrated Radiative Forcing for Year 2000 Global Emissions
(Weighted by 100-yr and 20-yr time horizons)



100-y
horizon

Time
perspective
makes a
difference

20-y
horizon

Methane and Time

- The current official GWPs are based on 100-year time horizons
 - Methane is 21 x CO₂ by weight
 - Equivalent to ~0.7% discount rate
- For making decisions on how to spend resources when impacts are upon us, 1% is too low.
- The other GWP published by IPCC, has a 20-year time horizon
 - Methane is 72 x CO₂ by weight
 - Equivalent to ~ 8% discount rate
 - More compatible with financial investments
- International health investments use a 3% discount rate, which is a GWP of ~50

Conclusion on Methane

- Methane emissions are more important than current official weighting factors indicate because of its large effect over the next generation
- Likely to increase in “value”, perhaps during the post-Kyoto deliberations now starting
- Ways to control are quite different from CO₂
- Developing countries have a bigger role
- Methane is emitted as part of the poor combustion process of solid fuels, which also produce much health-damaging pollution
- Improving this combustion offers substantial GHG as well as health benefits in a cost-effective manner

Tapping Moral Energy

- Among the most important problems in the world are the huge and mostly growing inequities in human society
- This dominates both ends of the climate change spectrum
 - Emissions are highly unevenly distributed
 - Impacts will make current health inequities worse
 - Responses may act this way also – biofuels
- Remember, however, that even the most extreme estimate of the health effects of climate change does not come close to the hundreds of millions of children slated to die already because of our inaction in the next generation.

Food for a Week, Germany

© 2005 PETER MENZEL PHOTOGRAPHY



ALLEMAGNE 1500 sortes de saucisses, 1200 restaurants McDonald's, 750 millions de kebabs

avalés chaque année... Plus de la moitié des Allemands sont en surpoids ou obèses.

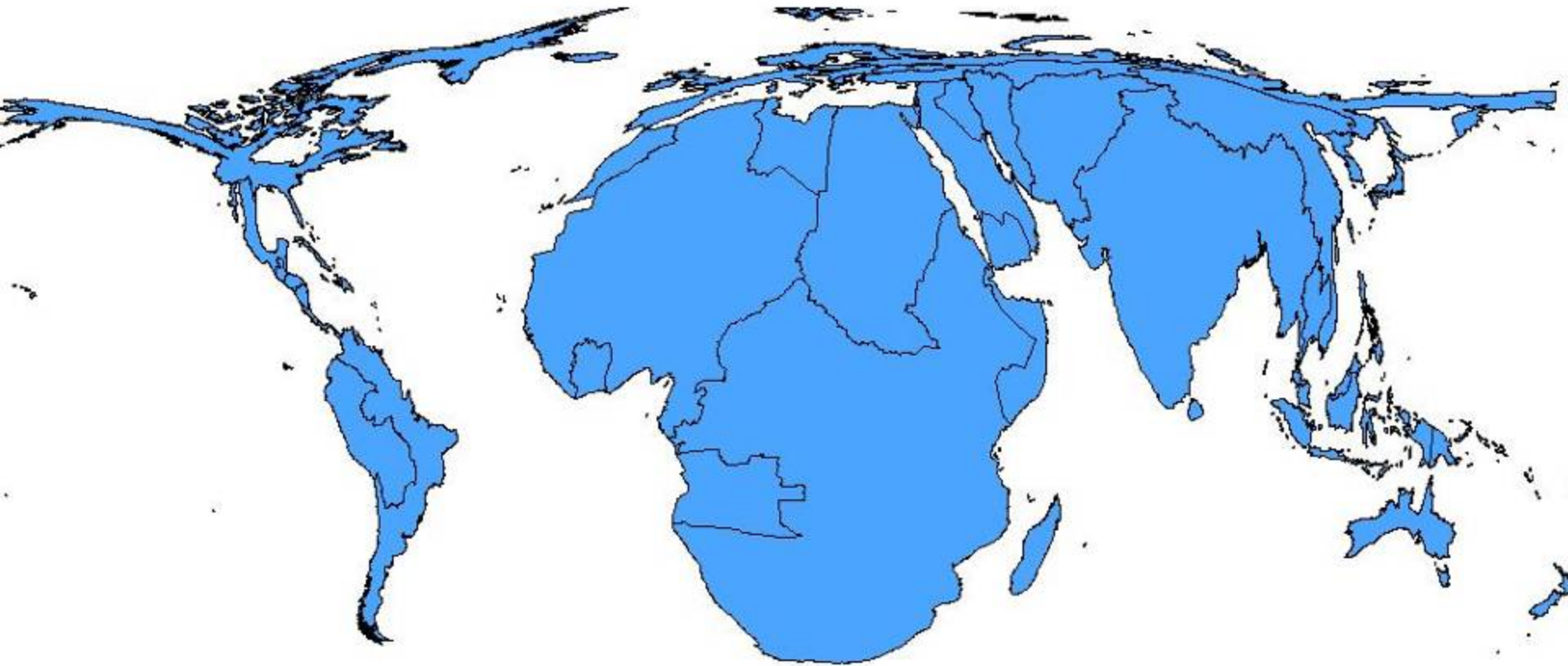
Food for a Week, Darfur Refugees, Chad

© 2007 PETER MENZEL PHOTOGRAPHY



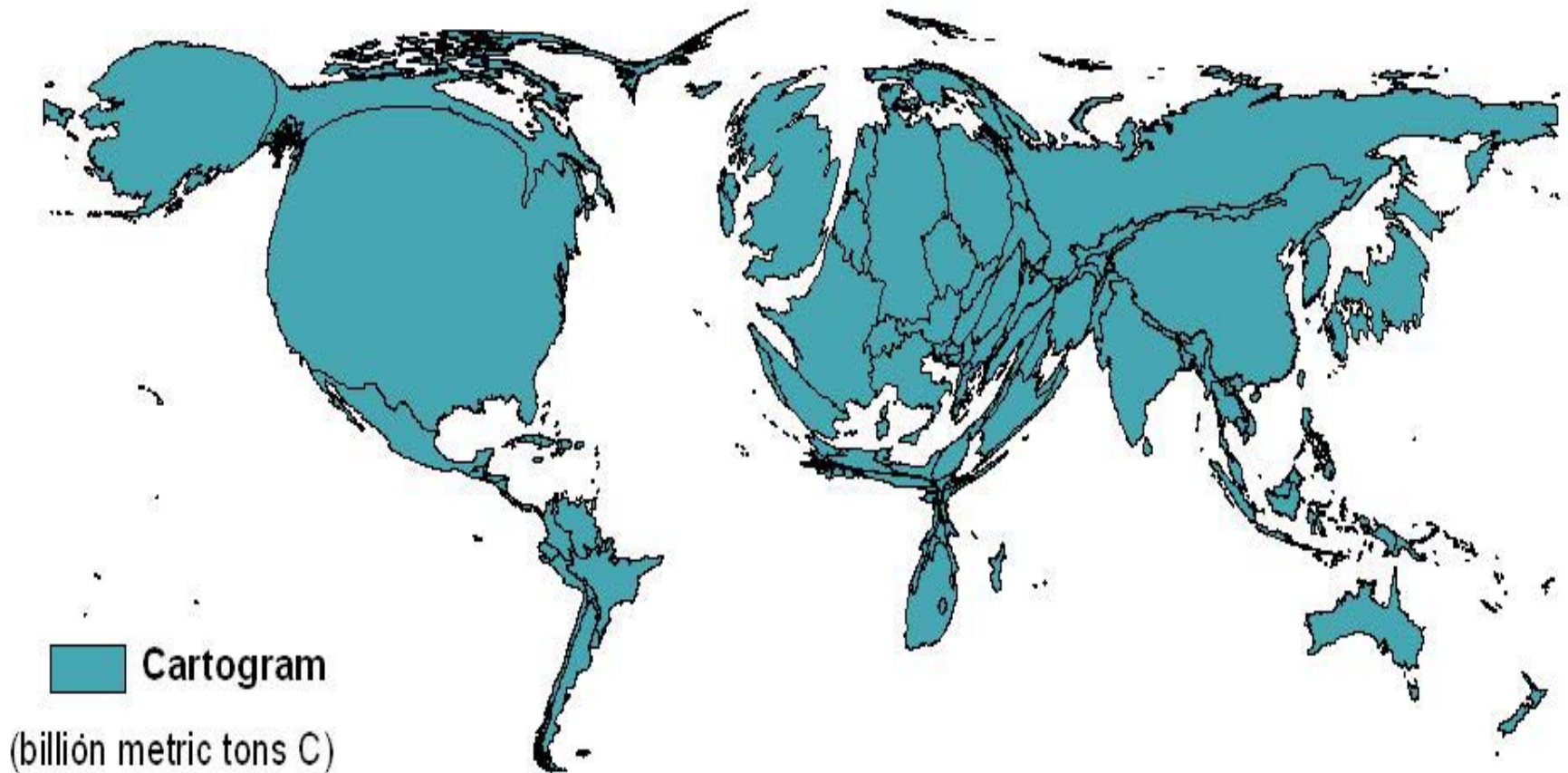
TCHAD 230 000 réfugiés de guerre soudanais vivent dans les camps de l'Onu. Chacun a droit à 2100 Cal par jour: céréales, sucre, sel, huile, légumes secs et farine vitaminée.

Cartogram of Climate-related Mortality (per million pop) yr. 2000



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

Cumulative CO₂ emissions from fossil fuels (as depleted by natural processes)



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

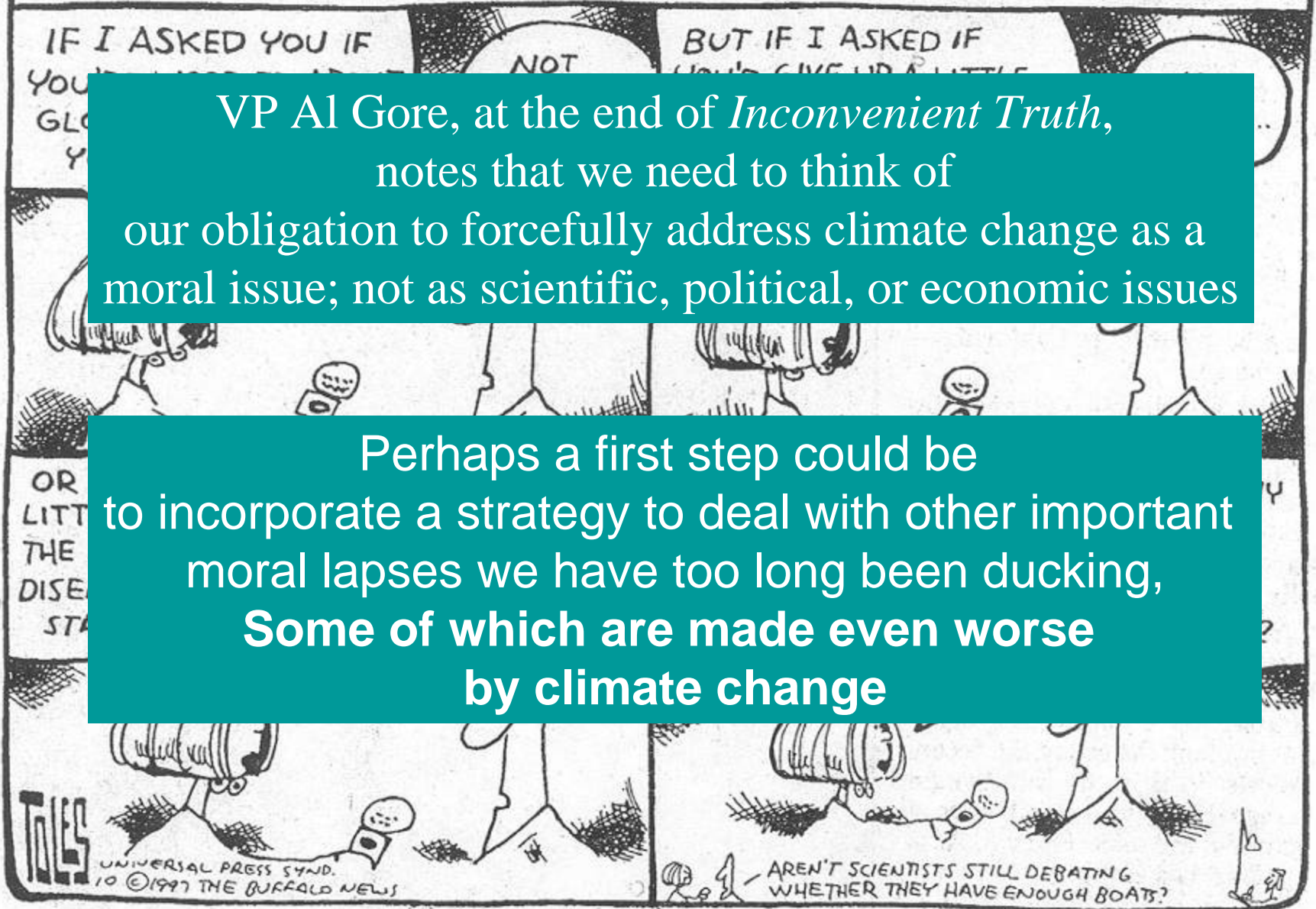
Sins of Omission and Commission

- That children die unnecessarily in poor countries is mostly seen as a Sin of Omission – we do not cause it and our lapse is just in not doing more to stop it.
- Awareness of climate change has the effect of shifting it more to a Sin of Commission, i.e., at least in part directly due to our actions.

Hard questions about climate change

VP Al Gore, at the end of *Inconvenient Truth*, notes that we need to think of our obligation to forcefully address climate change as a moral issue; not as scientific, political, or economic issues

Perhaps a first step could be to incorporate a strategy to deal with other important moral lapses we have too long been ducking,
Some of which are made even worse by climate change



Operating Planet Earth Sustainably

- This is our goal – climate change is the latest and perhaps largest symptom of us not doing so
- In addition to being climate neutral, no matter how one might define sustainability, it does not include 100s of millions of children dying unnecessarily in the next generation.
- We need to find ways to bring ourselves to sustainability in ways that push us jointly toward a spectrum of goals, some with us already and others just now coming into prominence
- The co-benefits of moral energy

The Silver Lining

- One of the few positive sides of the climate change crisis is that the global village is no longer just an intellectual construct
- That we have one planet, one atmosphere, one set of mutual responsibilities, and one fate – these are now clear

References

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For discussion re adaptation

- Choice of discount rate (time horizon), whether explicit or not, drives balance of adaptation and other approaches
- “To believe that market forces can be used to fix climate change is to believe in magic”
- What is the climate equivalent of the “ozone hole” – the trigger that takes climate issues across the divide from controversial analytics to concerted action?

Publications available at
<http://ehs.sph.berkeley.edu/krsmith/>

Thank you