Climate Change Decision Making: The Co-benefits Story

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International Colloquium on
The Grand Scientific Challenges of
Combating Climate Change
Unversidad Autotnoma Metropolitana
Mexico City, November 9, 2011

Climate Change Health Impacts

1) **Direct impacts** through changing weather patterns (e.g., storms, floods, temperature extremes)
2) **Indirect impacts** through natural systems including changes in water supply and quality, air pollution, and ecosystems leading to shifts in disease vectors.
3) **Systemic impacts** operating through human systems including shifts in food supplies, refugee patterns, coastal and agricultural livelihoods, and the health impacts of society's responses to climate change, such as geo-engineering, carbon taxes, biofuel production, etc.
4) **Low-probability high-consequence impacts** such as extremely rapid climate change or sea level rise due to threshold phenomena in Earth's systems, e.g., runaway methane emissions from the tundra or rapid loss of parts of the Antarctic ice sheet.

Louisiana Diaspora

The number of people displaced by Hurricane Katrina is staggering. Using information collected by the Federal Emergency Management Agency, the map below depicts the evacuated location (by ZIP code) of approximately 800,000 Louisiana citizens requesting federal assistance as of September 20, 2005 (FEMA, 2005).

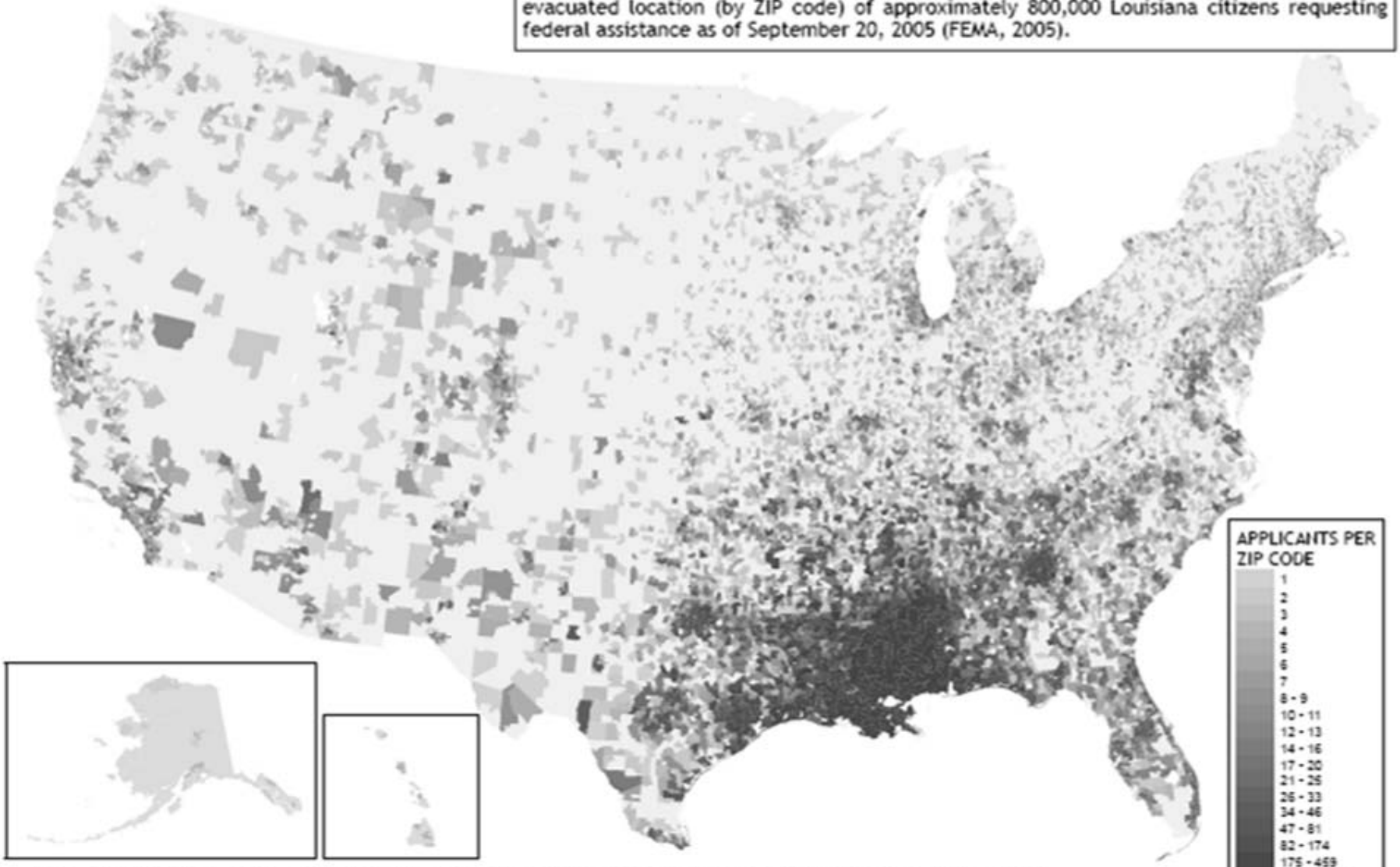
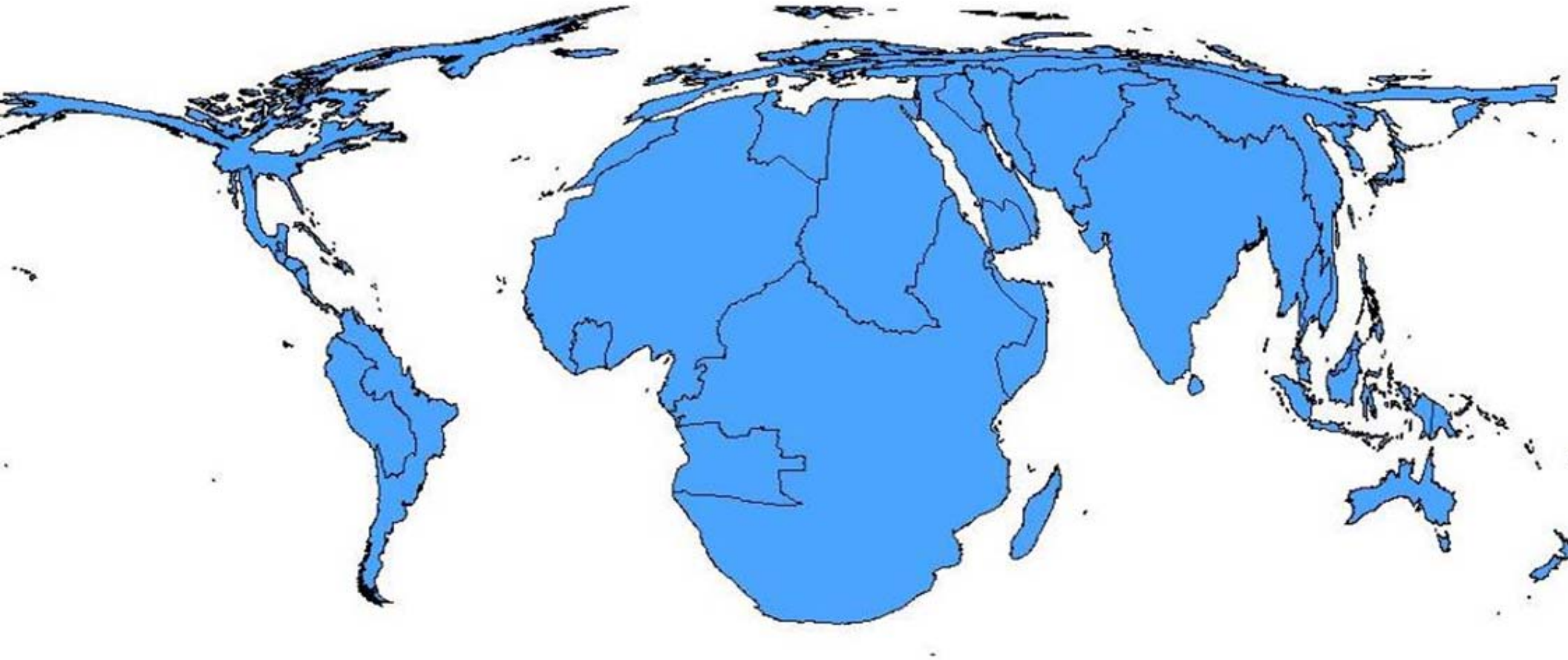


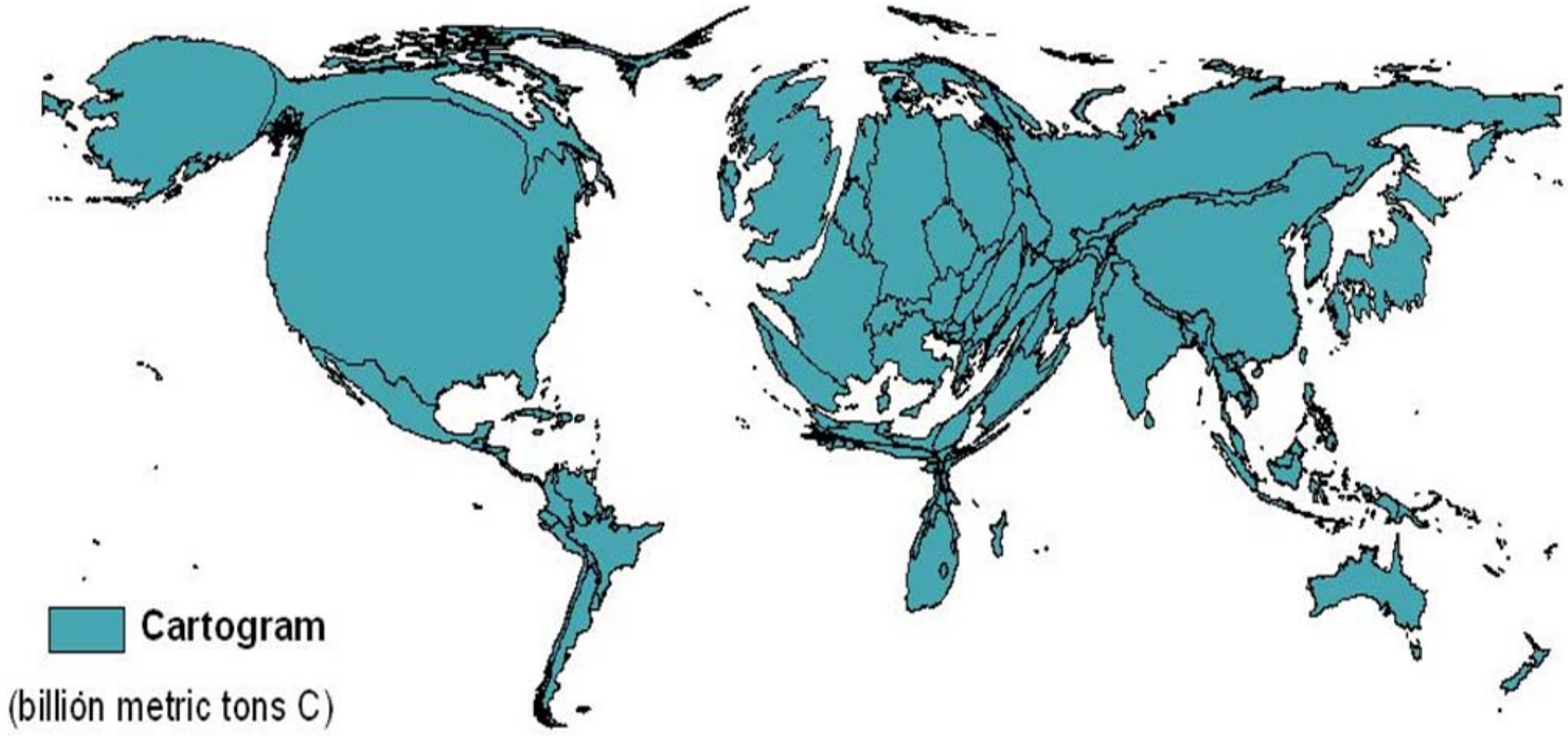
Figure 12: Hurricane Diaspora: Location of 800,000 Displaced Louisiana Residents Requesting Federal Assistance (FEMA, 2005).

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: Quantifying a growing ethical crisis** *EcoHealth* 4(4): 397–405, 2007

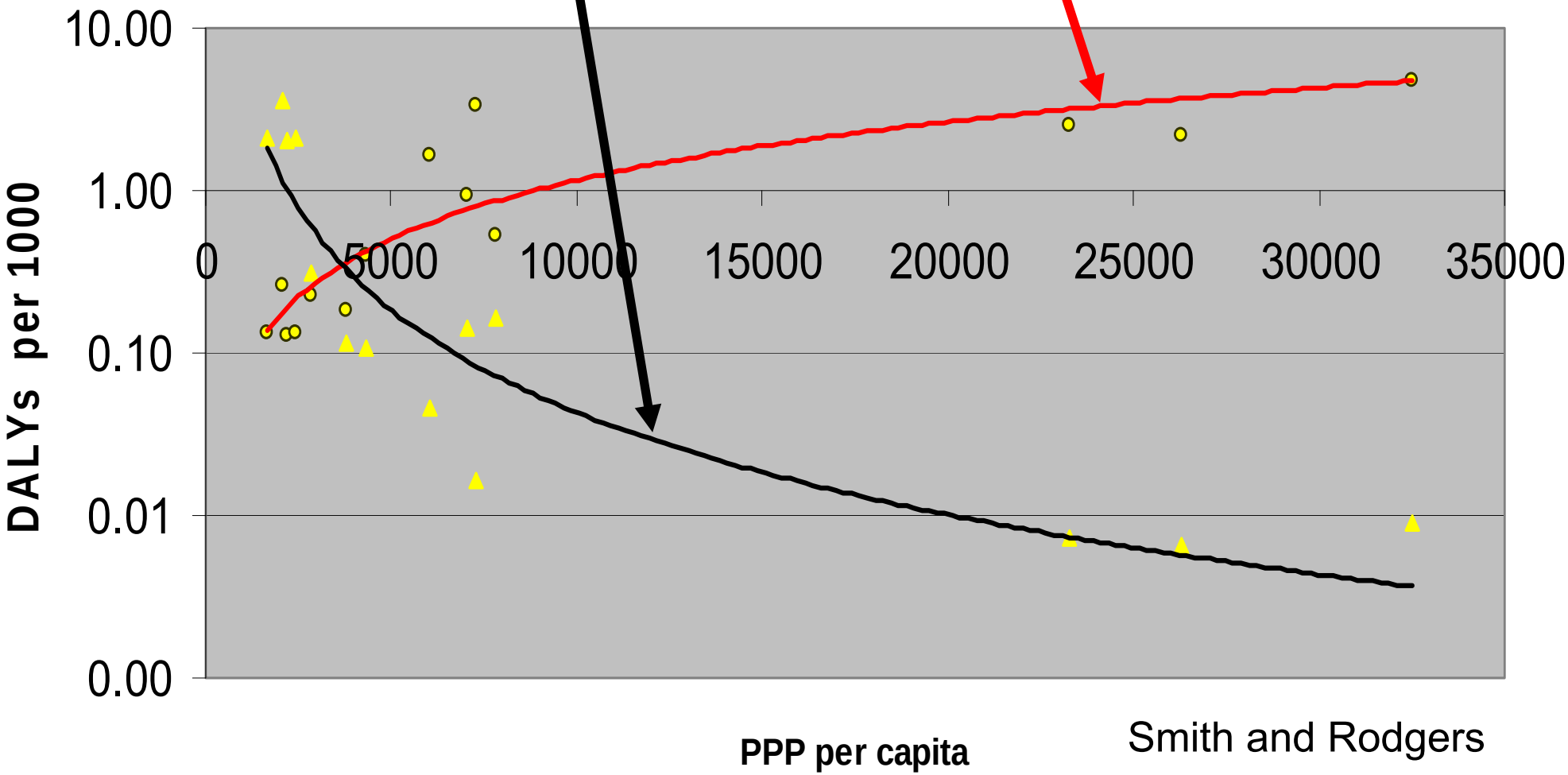
Cumulative CO_2 emissions from fossil fuels (as depleted by natural processes)



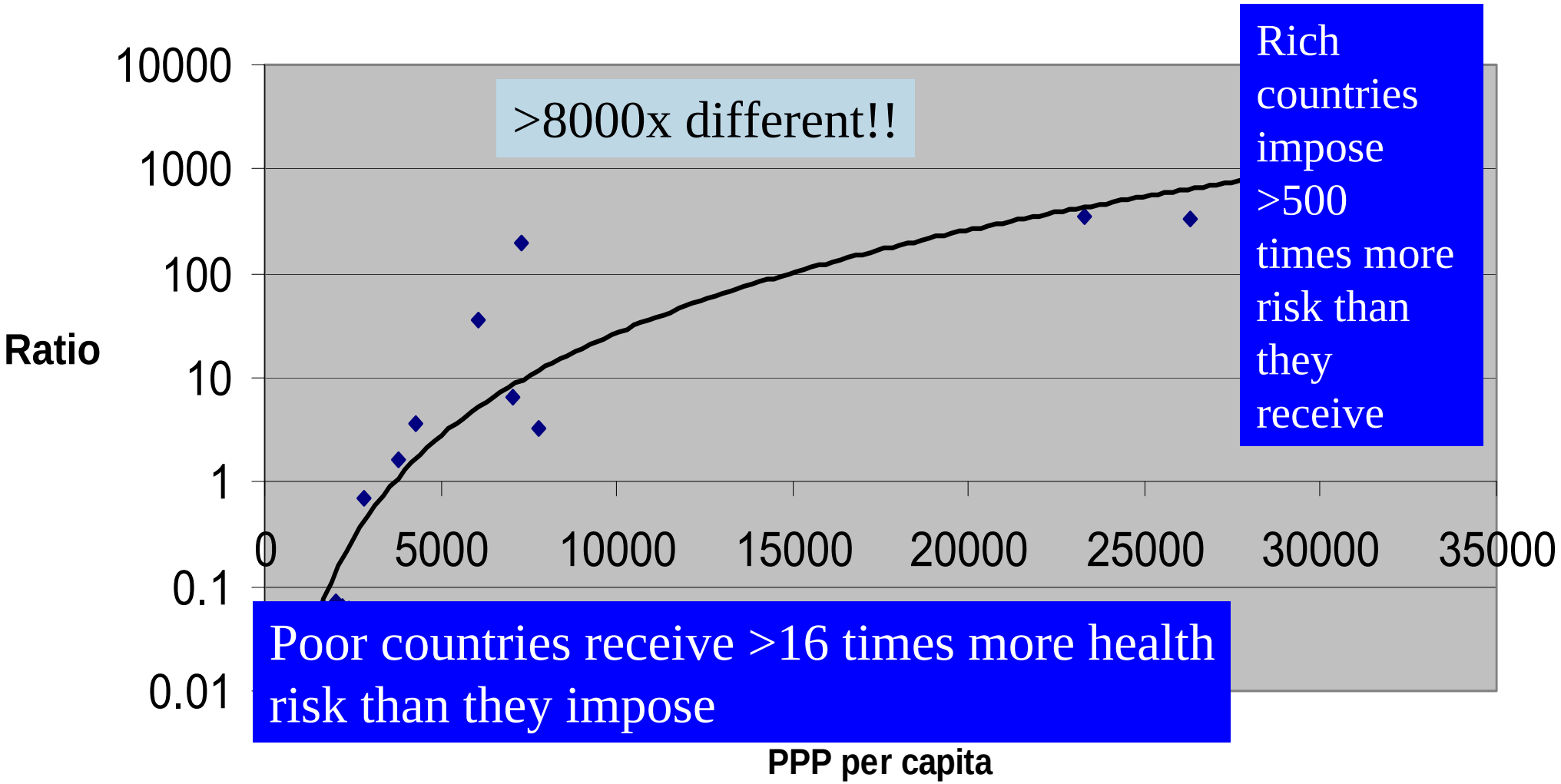
Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global: Quantifying a growing ethical crisis** *EcoHealth* 4(4): 397–405, 2007

Distribution of Health Impacts from Climate Change

(Experiencing versus Imposing)



Distribution of Health Impacts from Climate Change (Ratio: Imposing/Experiencing)



CC Health Effects, cont.

5) Co-benefits: Achieving health- and climate-protection benefits with the same policies and projects

Proposed IPCC Definition of Co-Benefits

- Co-benefit actions are those taken to mitigate climate change that have significant benefits of other types for society.
- Although there is no mitigation action that does not have at least some influence on other sectors, co-benefits activities are those in which there is sufficient impact to be considered an intervention in their own right for those sectors.

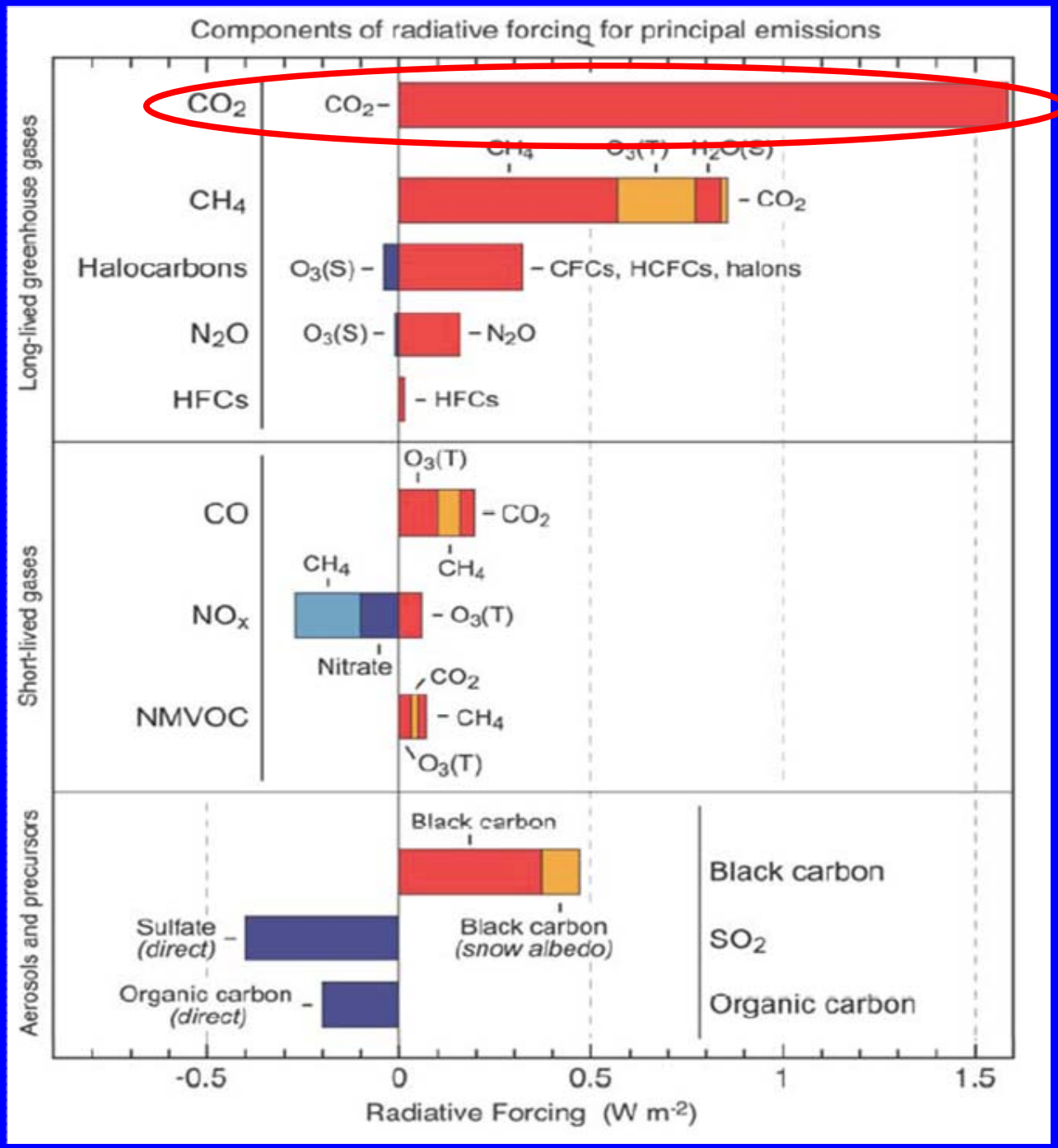
Being Smart about Mitigation

- **Co-benefits**: Guide mitigation measures so they help achieve other societal goals, including health protection.
- **No-regrets:** providing a short-term more certain return (health) on a long-term more uncertain investment (climate protection)
- **Win-win:** Double return on single investment

Why Worry about Co-benefits?

- Helps reduce the cost of mitigation by sharing cost with other sectors.
- Recognizes that society still has major goals besides avoiding climate change, such as providing acceptable levels of health protection
- Potentially **bridge political gap** between developed and developing countries in international climate negotiations – early achievement of more certain benefits that directly relate to development needs

Global warming in 2005 due to all human emissions since 1750

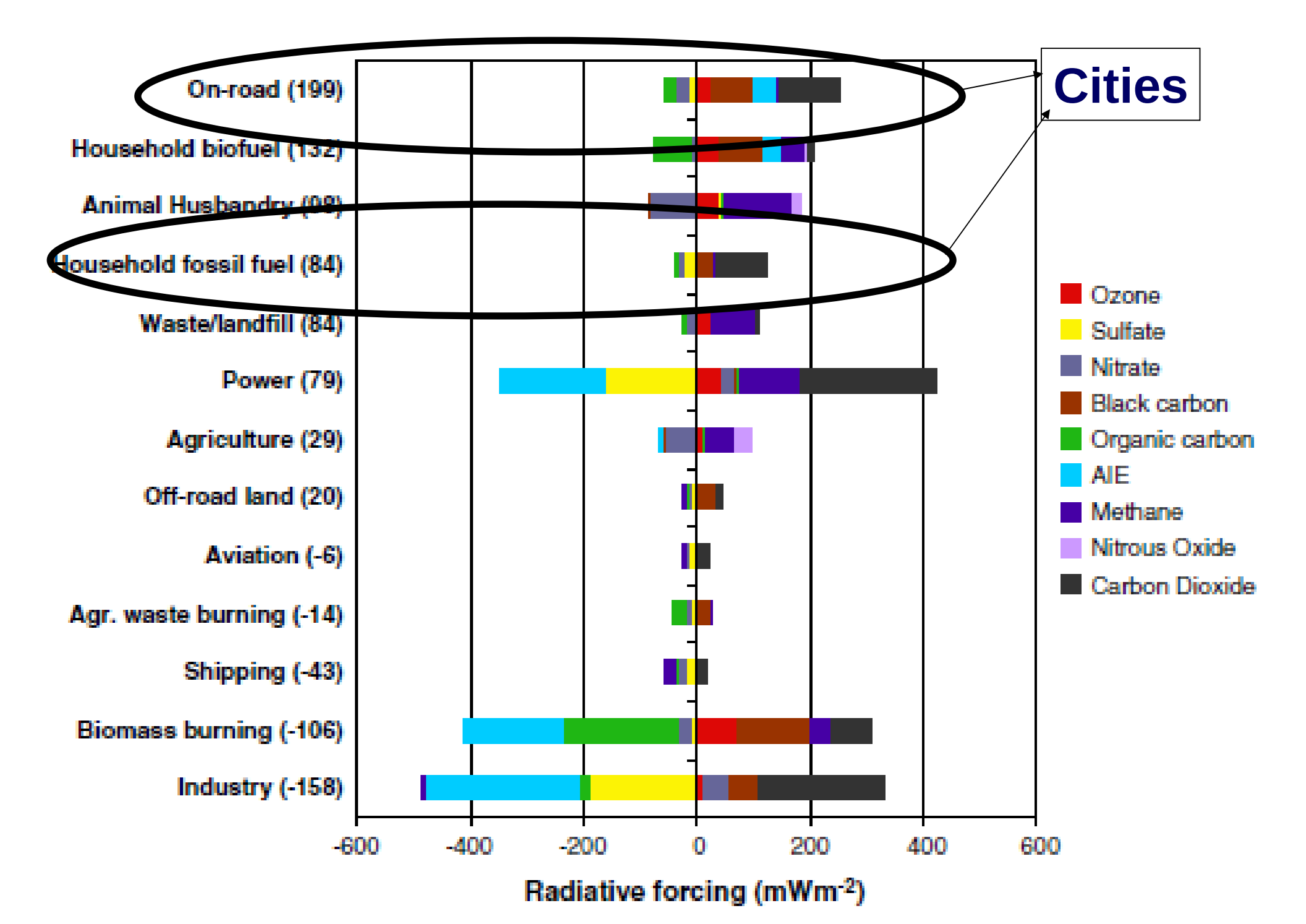


CO2 is the most important Greenhouse Gas Mostly from fuel combustion

IPCC, 2007

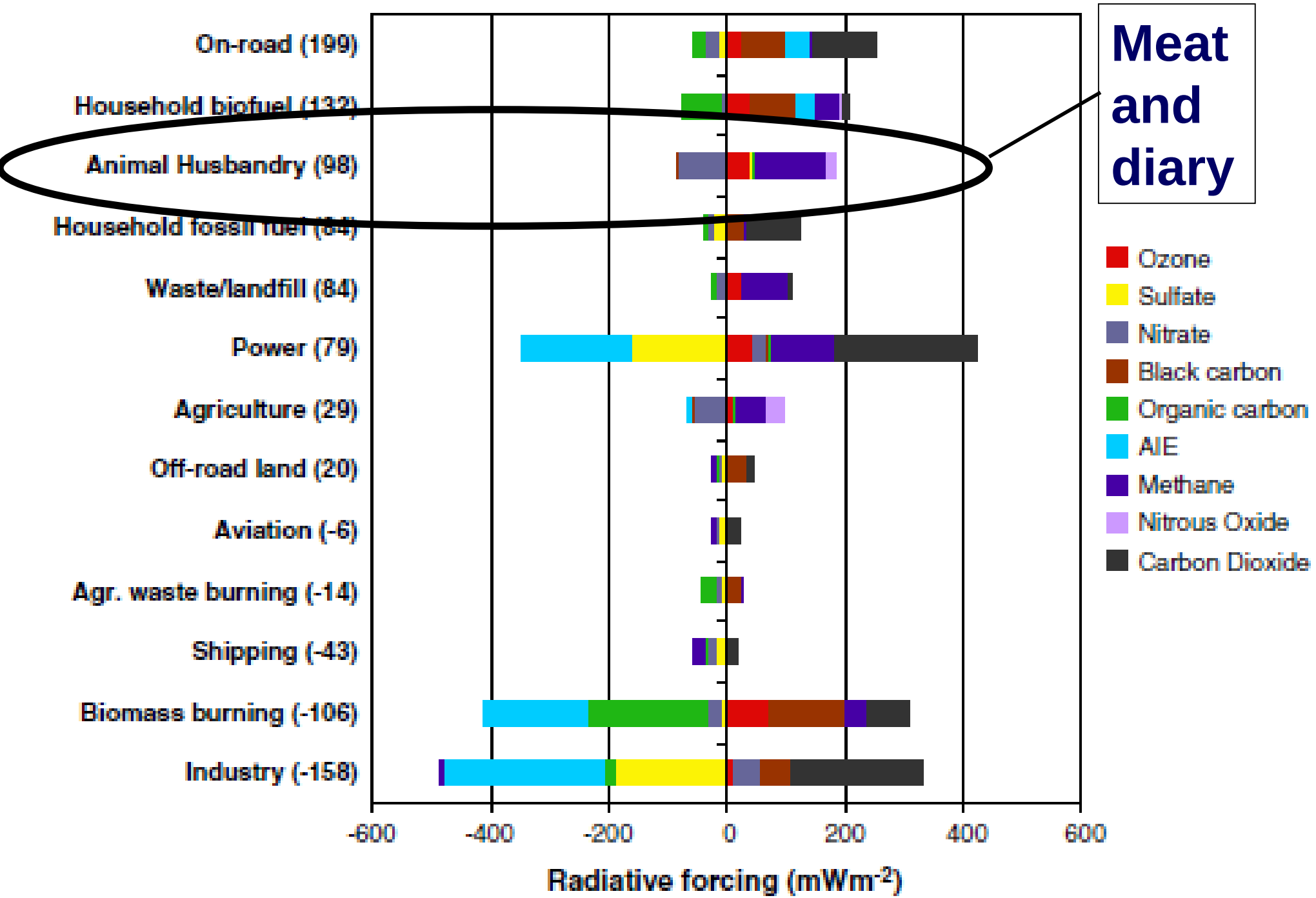
Air Pollution from Energy Use

- Outdoor emissions from energy systems
  - 1 million premature deaths around the world
  - Most well documented benefits, climate and health
- Energy efficiency, fuel shifting lead to less climate impact and less ill-health
- Some difficult issues related to relative climate impacts of different aerosols, e.g., black carbon, sulfates, organic carbon


Cities
On-road (199)
Household biofuel (132)
Animal Husbandry (98)
Household fossil fuel (84)
Waste/landfill (84)
Power (79)
Agriculture (29)
Off-road land (20)
Aviation (-6)
Agr. waste burning (-14)
Shipping (-43)
Biomass burning (-106)
Industry (-158)
Ozone
Sulfate
Nitrate
Black carbon
Organic carbon
AIE
Methane
Nitrous Oxide
Carbon Dioxide
-600
-400
-200
0
200
400
600
Radiative forcing (mWm-2)

Modifying the Built Environment

- Obesity, traffic accidents, and lack of physical activity responsible for 3+ million additional premature deaths annually
- Reduce vehicle use (air pollution, obesity, safety, etc)
- Change urban design to increase physical activity (obesity, air pollution, safety)
- Improve energy efficiency of buildings (avoid health risks of energy poverty)

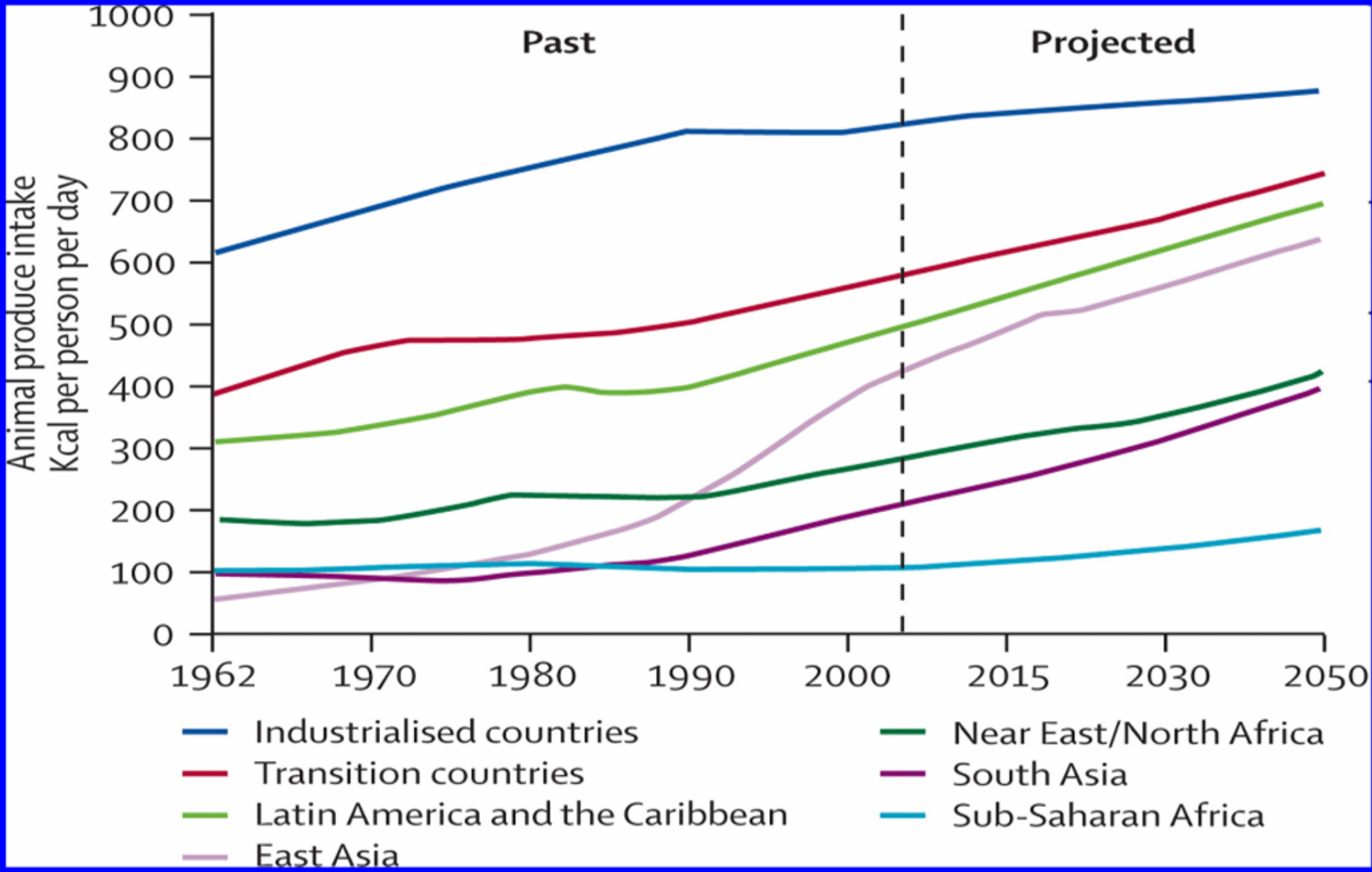

Meat and diary
On-road (199)
Household biofuel (132)
Animal Husbandry (98)
Household fossil fuel (64)
Waste/landfill (84)
Power (79)
Agriculture (29)
Off-road land (20)
Aviation (-6)
Agr. waste burning (-14)
Shipping (-43)
Biomass burning (-106)
Industry (-158)
Ozone
Sulfate
Nitrate
Black carbon
Organic carbon
AIE
Methane
Nitrous Oxide
Carbon Dioxide
-600
-400
-200
0
200
400
600
Radiative forcing (mWm-2)

Redirecting Diet Preferences

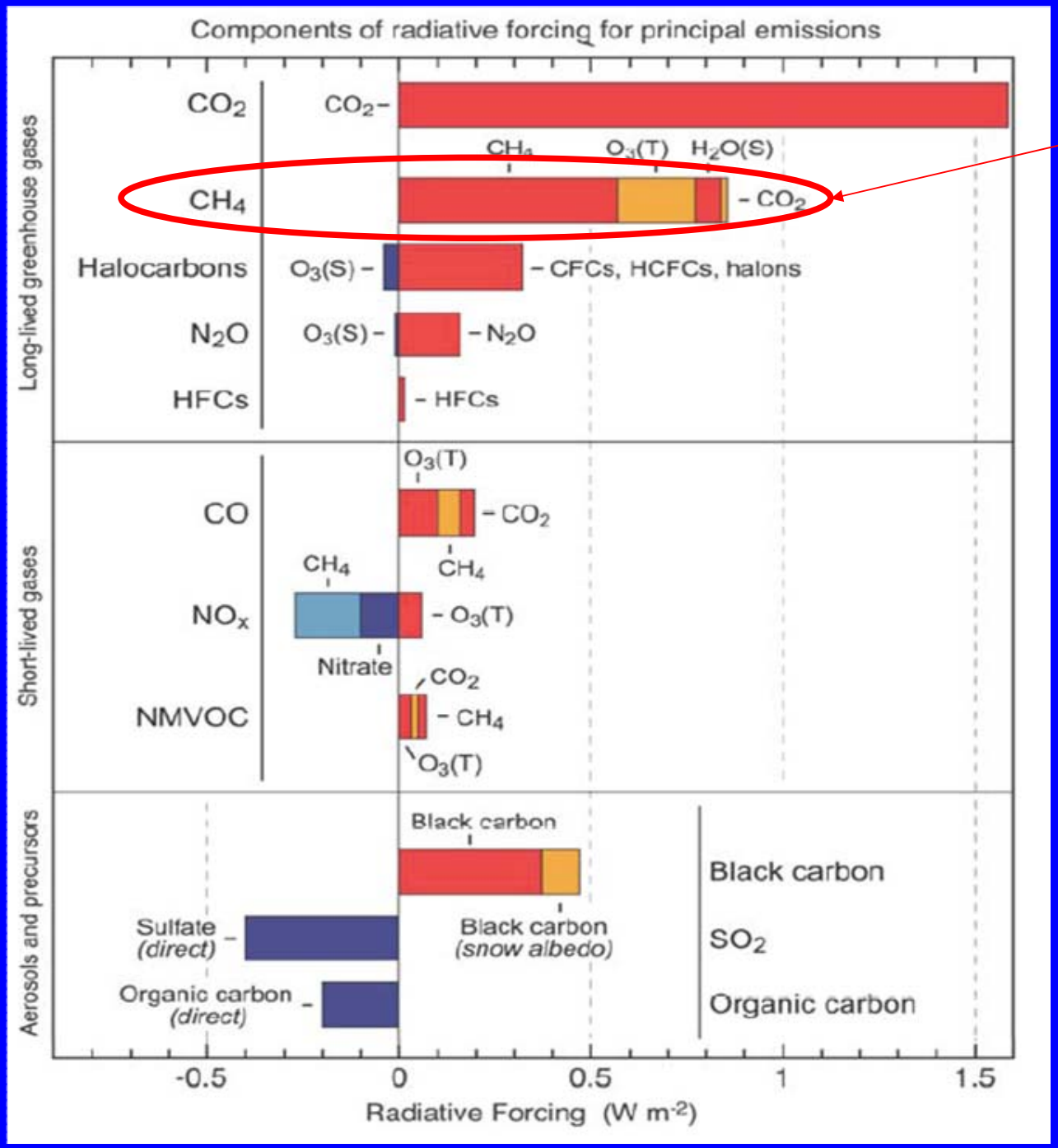
- Livestock responsible for 20+% of global greenhouse emissions – methane from animal digestion plus operation of meat/dairy feed/supply systems
- Converge on lower mean global red meat consumption with health benefits in rich countries in heart disease, diabetes, and colon cancer
- Similar benefits to convergence in global dairy consumption
- China/India have the major global growth potential

Trends in consumption of livestock products per person

FAO

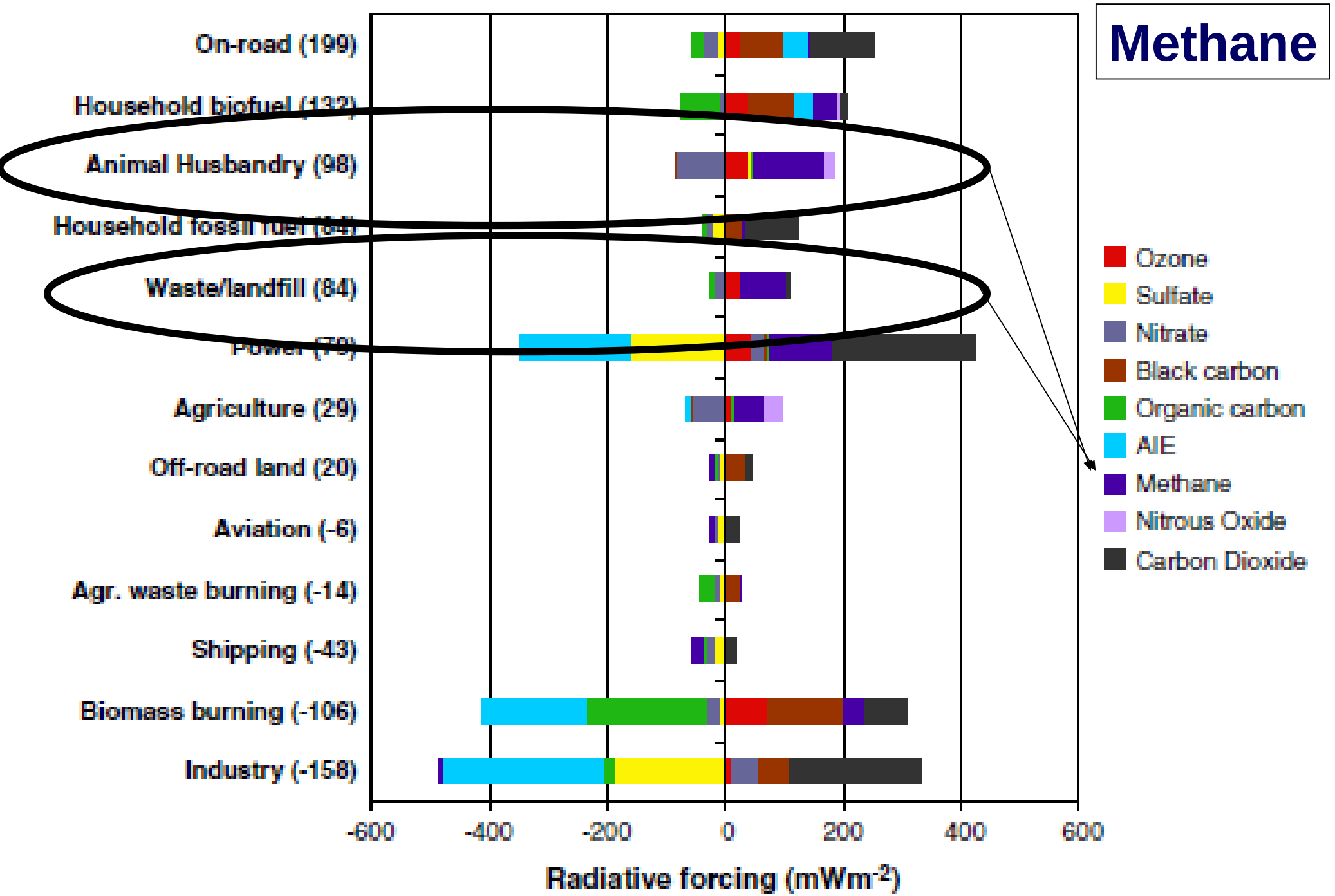


Global warming in 2005 due to all human emissions since 1750



Methane is second most important Greenhouse Gas

IPCC, 2007


Methane
On-road (199)
Household biofuel (132)
Animal Husbandry (98)
Household fossil fuel (64)
Waste/landfill (84)
Power (79)
Agriculture (29)
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Aviation (-6)
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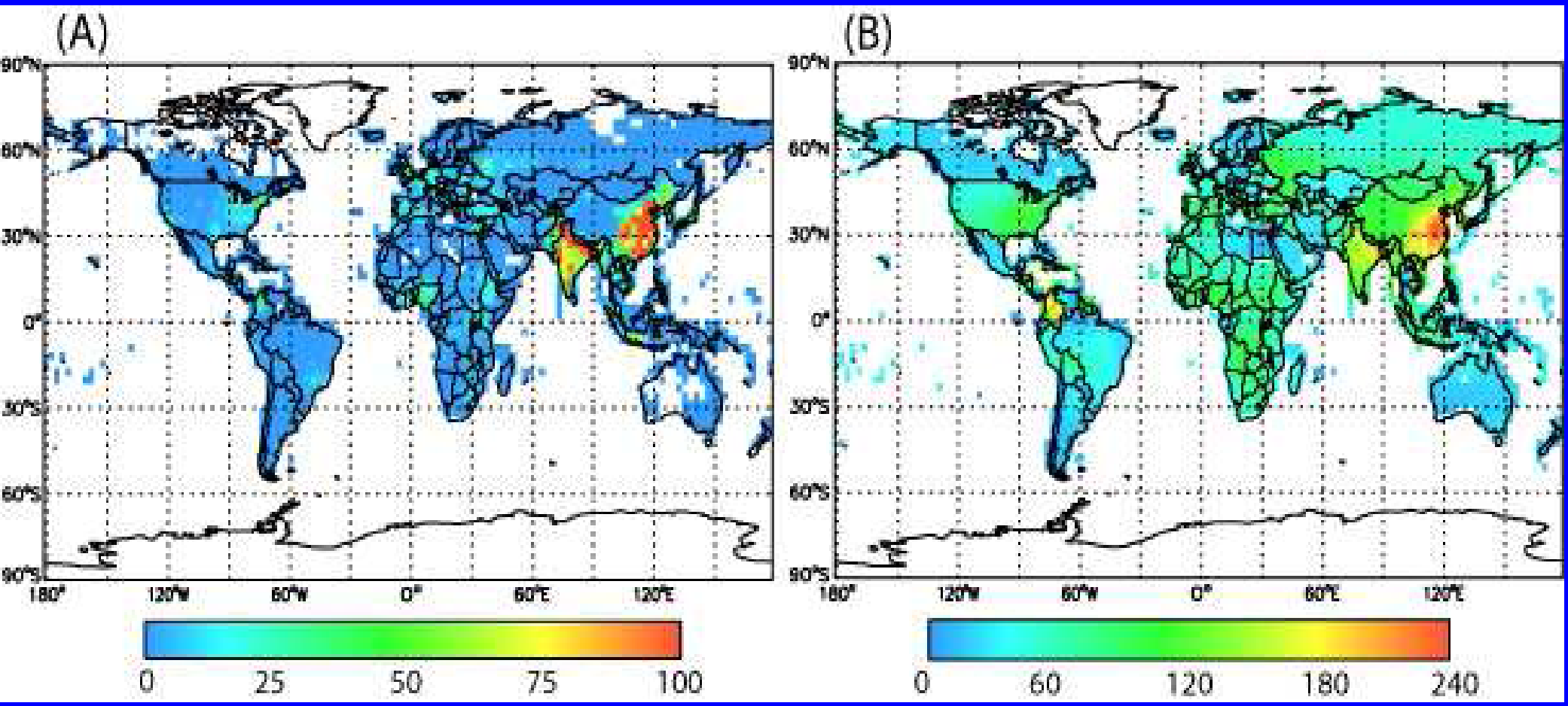
Methane
Nitrous Oxide
Carbon Dioxide
-600
-400
-200
0
200
400
600
Radiative forcing (mWm-2)

Methane Reduction

- Second most important greenhouse gas
- Major cause of rise in global tropospheric ozone concentrations – important health-damaging and crop-damaging pollutant
- Livestock a major source
- Leaks: Coal mines, gas pipelines, etc.
- Waste management: Landfills, wastewater
- Incomplete combustion: biomass and coal

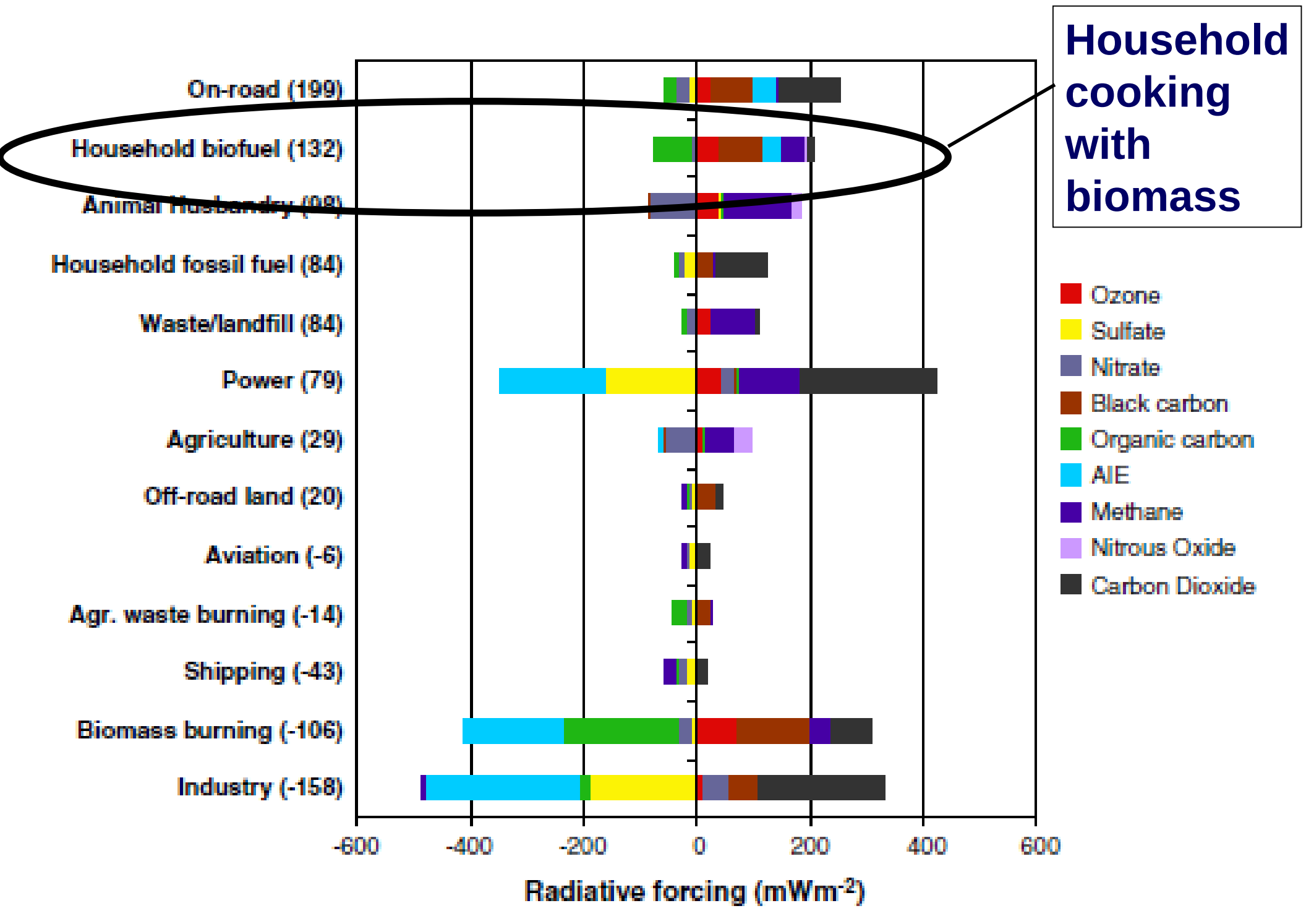


Mortality from ozone per 1000 km2 and per million people

Annenberg et al., 2010

Methane

- Way to reduce warming in the next generation is to put more attention on methane (and other shorter lived GHGs)
- The **rate** of warming is as important as the total amount
- Way to slow the rate is to immediately reduce methane emissions
- Need to start working soon to lower rate in order to give us time to deal with CO2, a more difficult issue


Household cooking with biomass
On-road (199)
Household biofuel (132)
Animal Husbandry (98)
Household fossil fuel (84)
Waste/landfill (84)
Power (79)
Agriculture (29)
Off-road land (20)
Aviation (-6)
Agr. waste burning (-14)
Shipping (-43)
Biomass burning (-106)
Industry (-158)
Ozone
Sulfate
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Methane
Nitrous Oxide
Carbon Dioxide
-600
-400
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0
200
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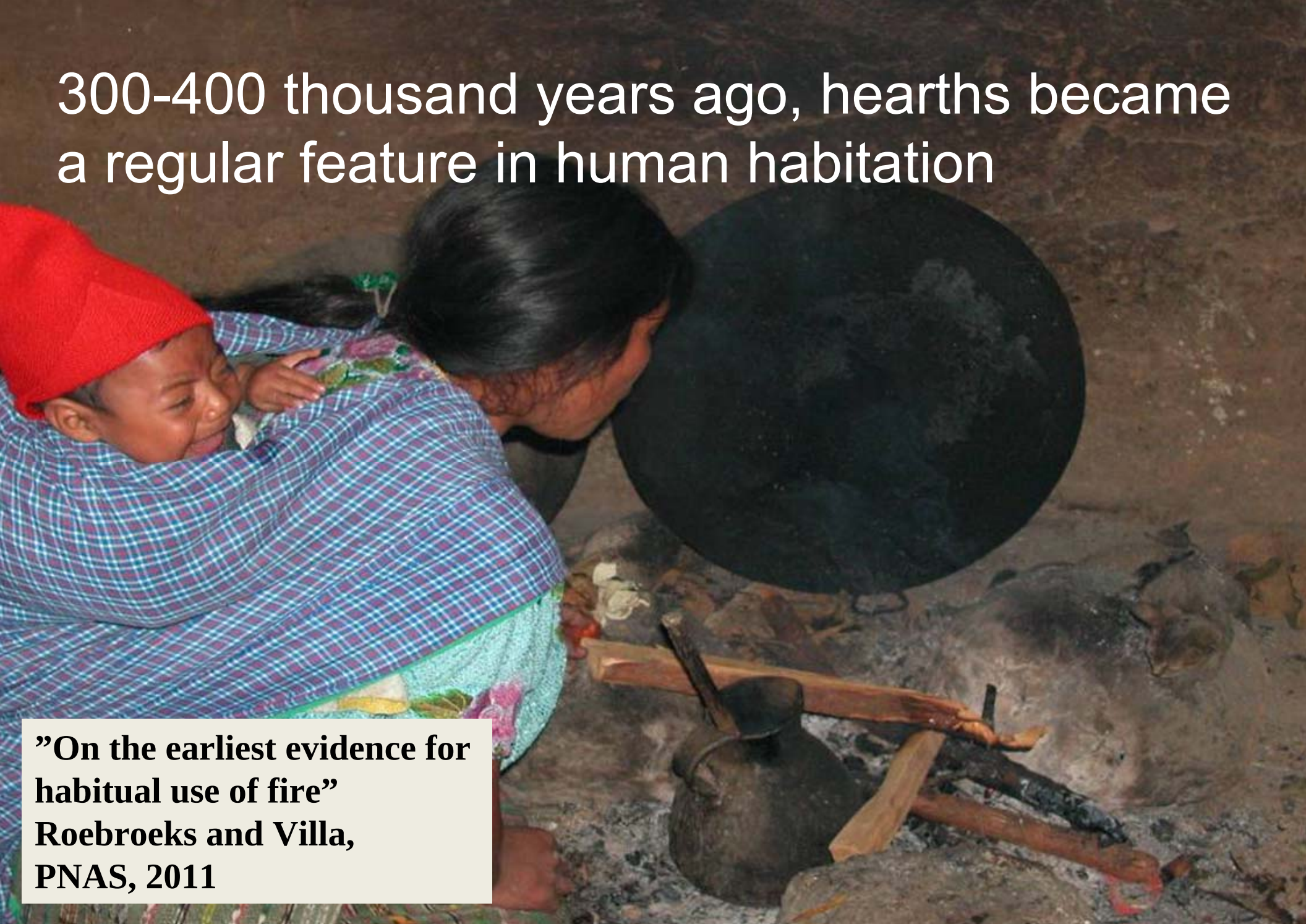
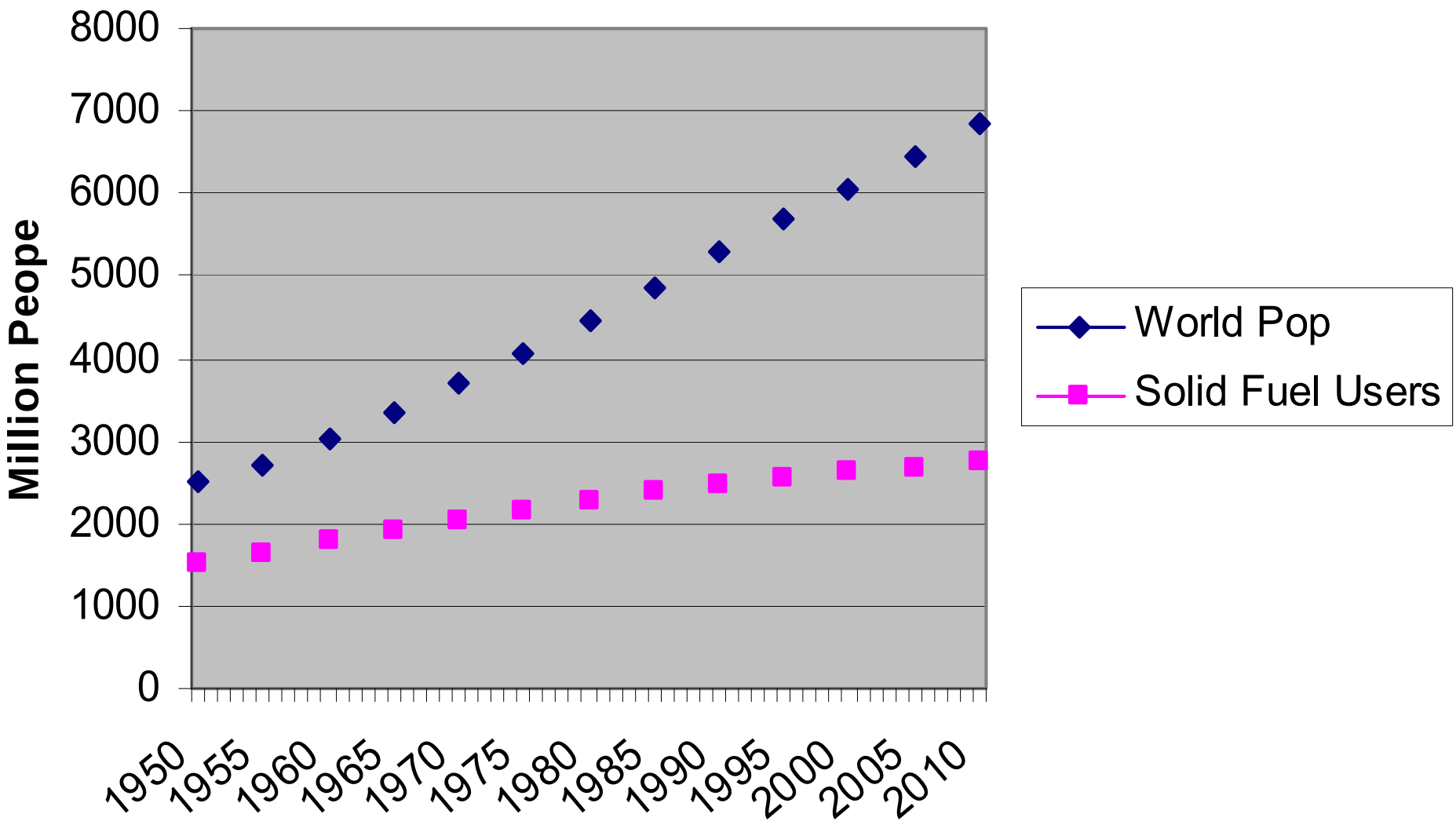
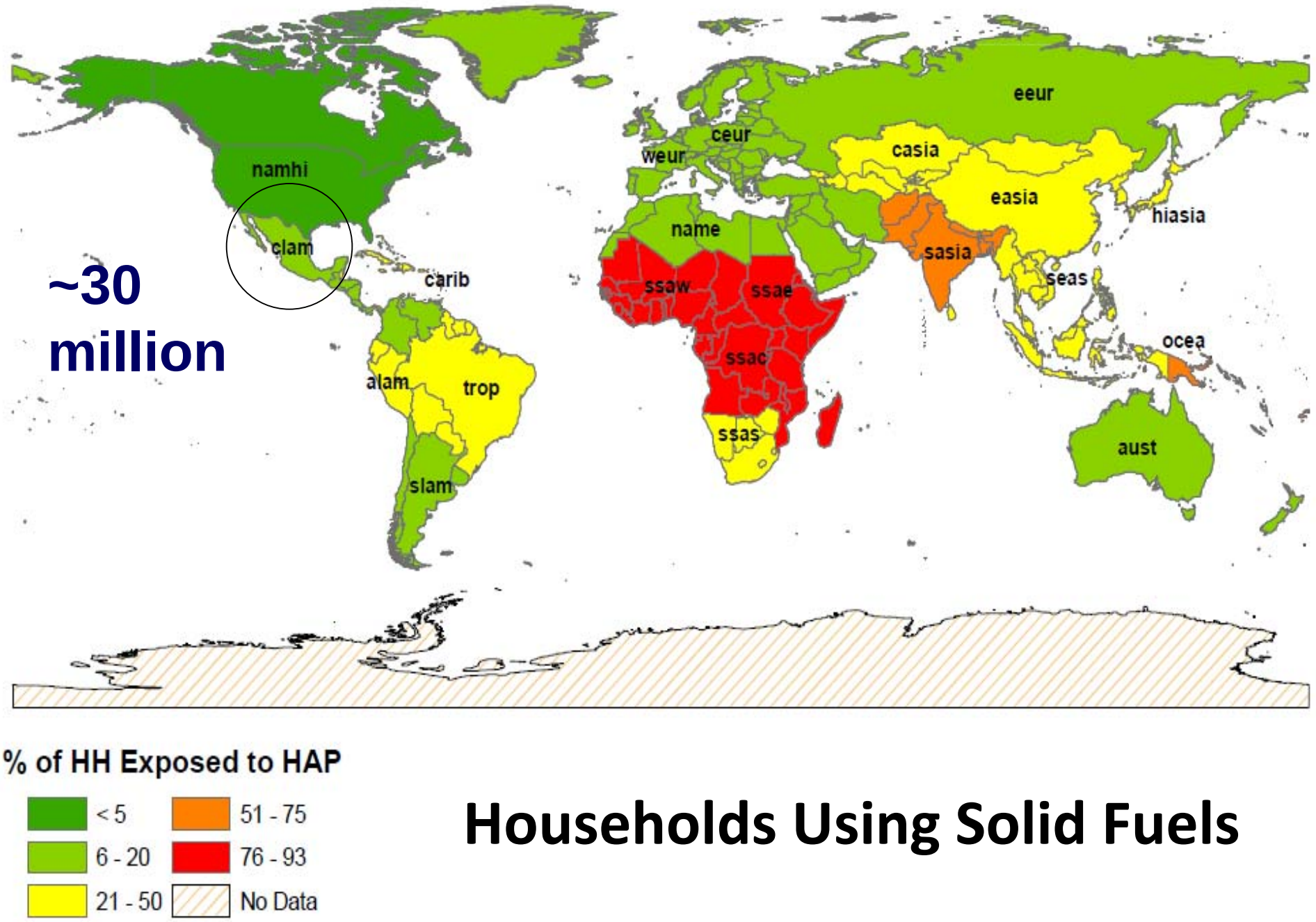
Radiative forcing (mWm-2)


300-400 thousand years ago, hearths became a regular feature in human habitation
”On the earliest evidence for habitual use of fire”
Roebroeks and Villa,
PNAS, 2011

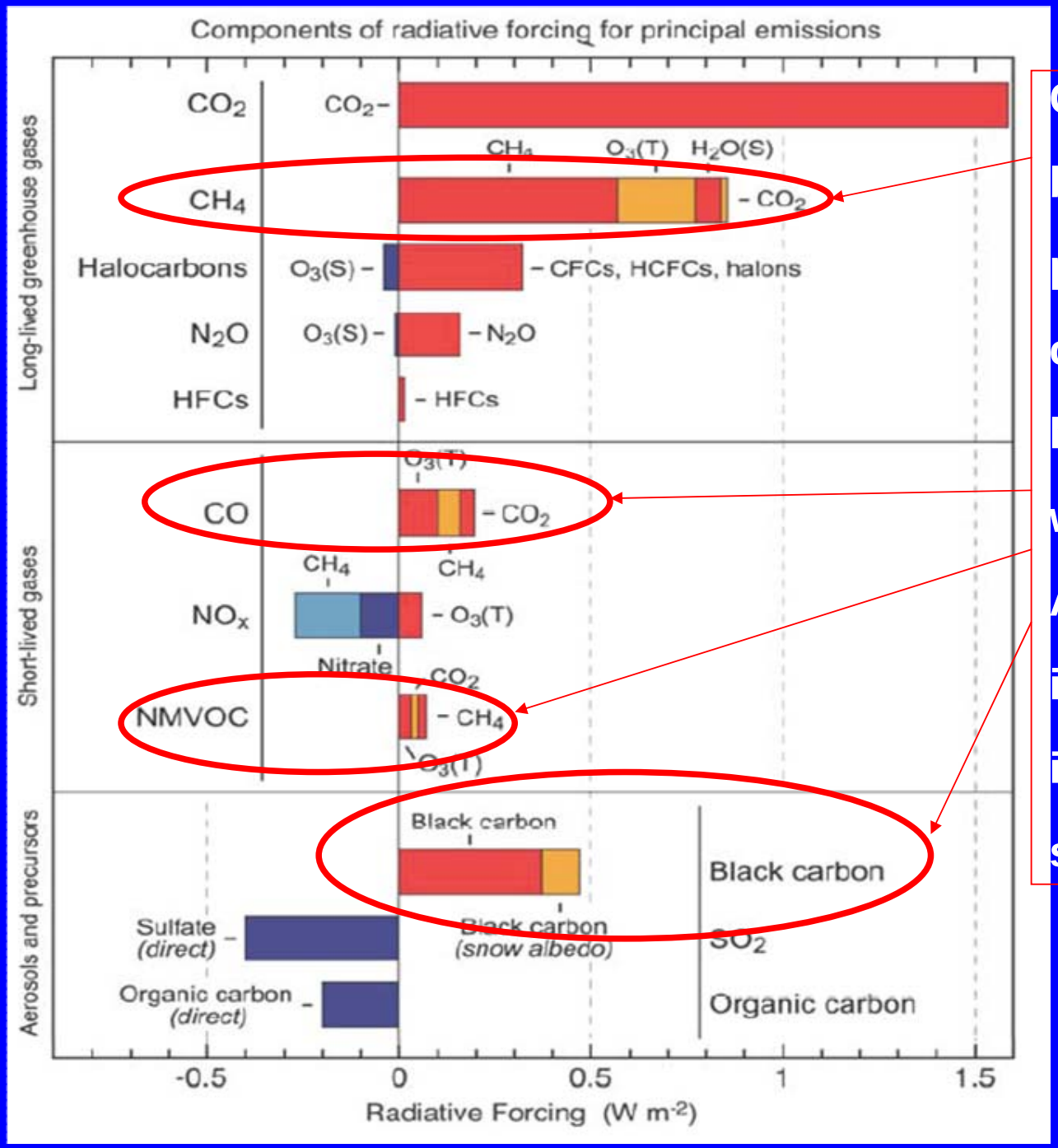
World Population Using Solid Fuels





Households Using Solid Fuels

Global warming in 2005 due to all human emissions since 1750



CO_2 is important for climate, but so are many other pollutants, including the ones circled that, unlike CO_2, also have significant health as well as climate impacts.

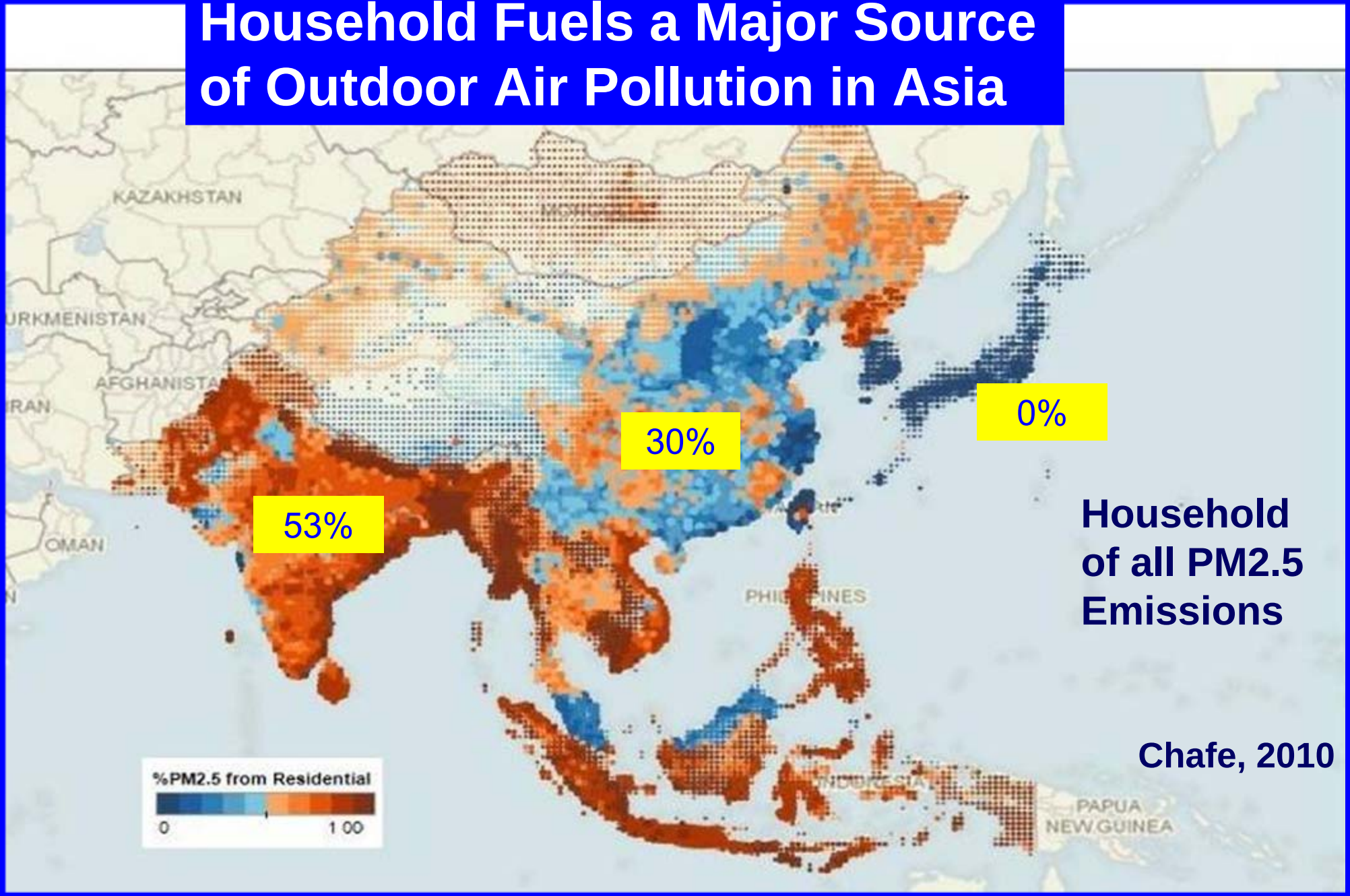
All these are produced by incomplete combustion in household stoves using simple solid fuels

IPCC, 2007

Household Fuels: where the most rubber hits the co-benefits road

- Large source of ill-health worldwide in poorest populations ~ 2 million premature deaths annually
- Non-renewable biomass and coal fuels produce net CO2 emissions
- Poor combustion leads to non-CO2 greenhouse-related emissions

Household Fuels a Major Source of Outdoor Air Pollution in Asia



Household of all PM2.5 Emissions

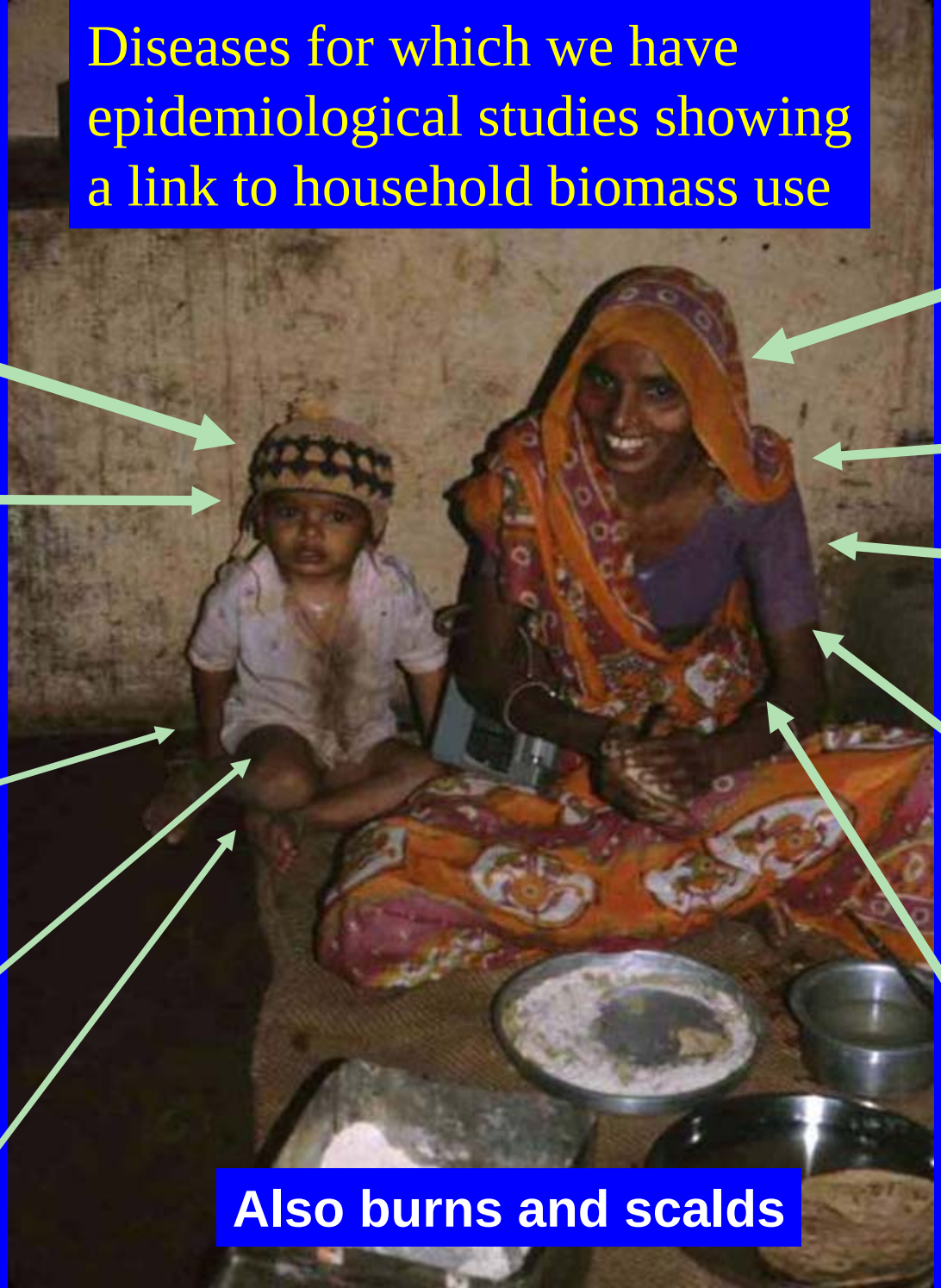
Chafe, 2010

Source: Asian Emission Inventory for NASA INTEX_B 2006 (accessed 2010)

Household combustion only a cause of outdoor air pollution in Asia?

- Small particles, PM2.5, are the most important for health
- According to the World Health Organization, Mexican cities have PM2.5 levels averaging 25-30 ug/m3 -- worst at 50 (Mex standard – 15)
- Villages in Michoacán, just for comparison, have 24-h outdoor levels of 60-90 ug/m3 (Zuk et al., 2006)
- Nearly all from household combustion

Diseases for which we have epidemiological studies showing a link to household biomass use



ALRI/ Pneumonia

Low birth weight

Asthma?

Birth defects

Cognitive Impairment

Chronic obstructive lung disease

Cataracts

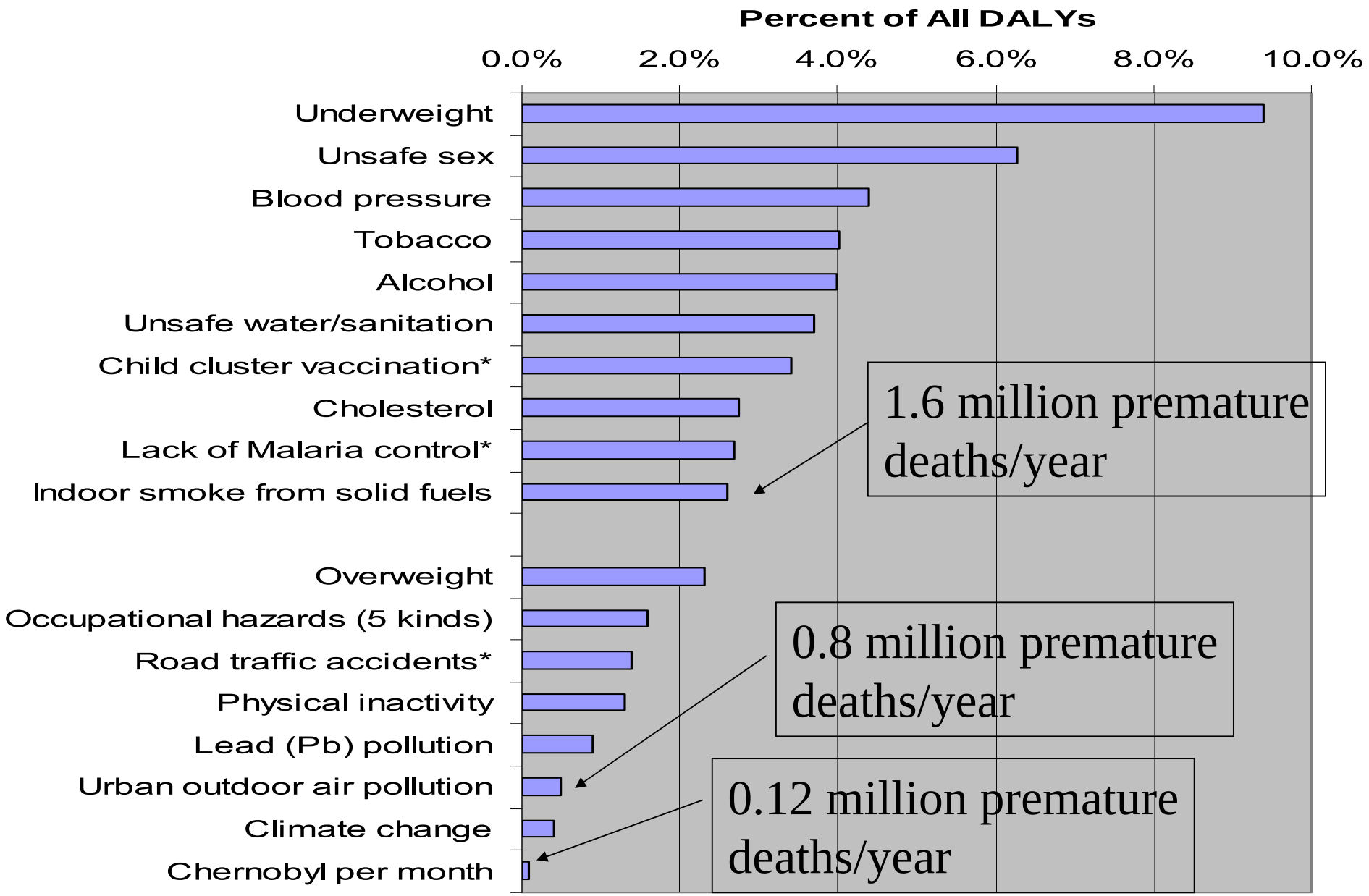
Lung cancer (cervical, aero-digestive?)

Heart disease/ stroke

Tuberculosis

Also burns and scalds

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



THELANCET-D-09-06268R3

S0140-6736(11)60921-5

Embargo: [add date when known]

Effect of reduction in household air pollution on childhood pneumonia in Guatemala (RESPIRE): a randomised controlled trial

Kirk R Smith, John P McCracken, Martin W Weber, Alan Hubbard, Alisa Jenny, Lisa M Thompson, John Balmes, Anaite Diaz, Byron Arana, Nigel Bruce

To be published Nov 11, 2011

RESPIRE – Randomized trial (n=518)

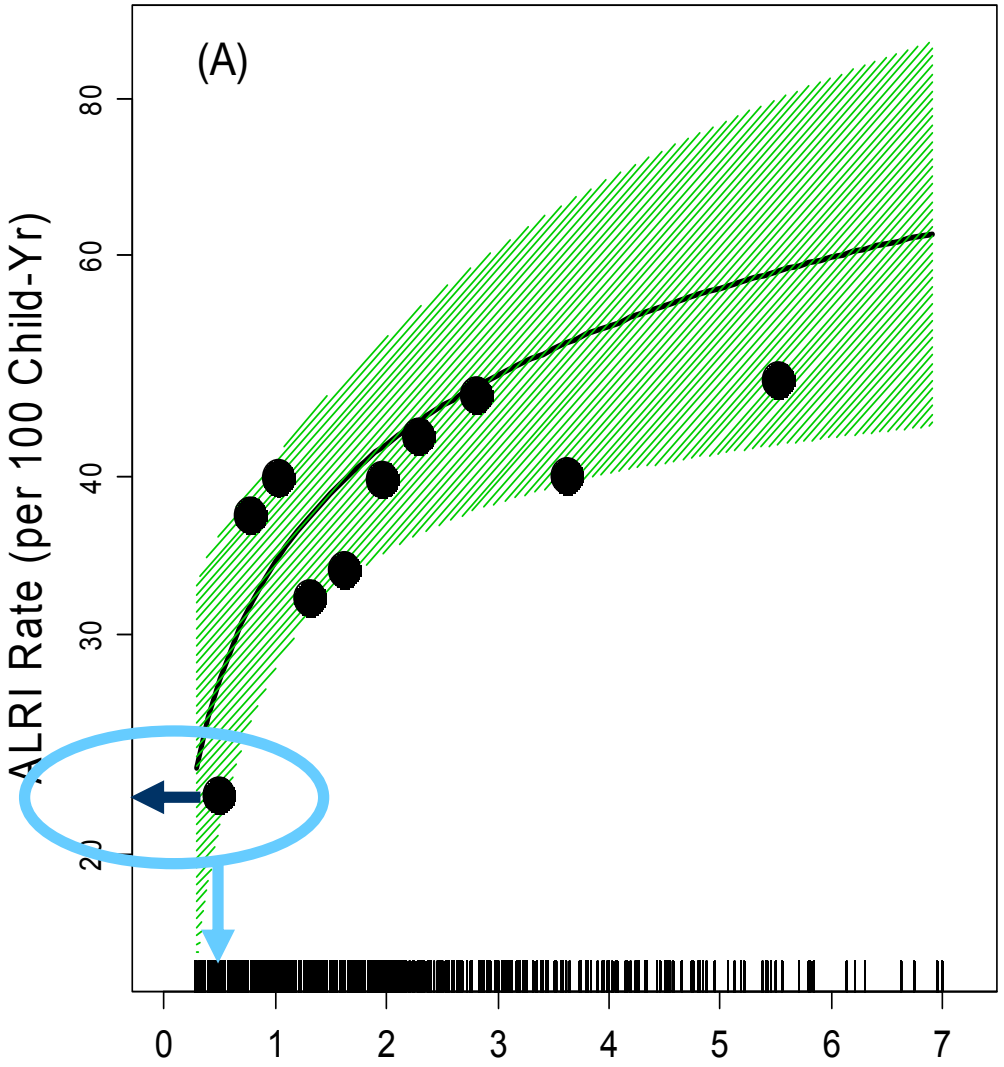
Impact on pneumonia up to 18 months of age

Traditional open 3-stone fire: kitchen 48-hour $PM_{2.5}$ levels of 600 - 1200 $\mu g/m^3$

Chimney wood stove, locally made and popular with households


CO monitor
CO monitor

MD-diagnosed Acute Lower Respiratory Infection



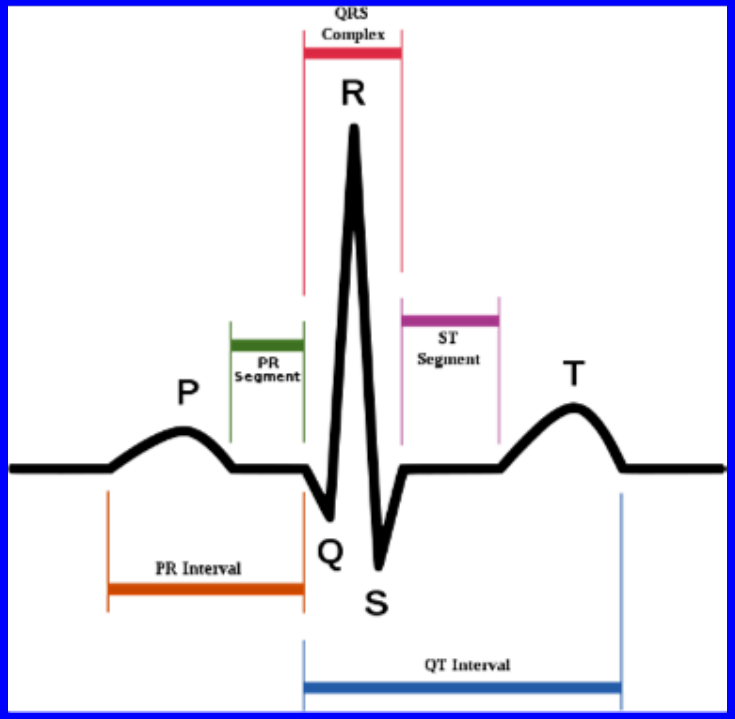
Where we Want to Be!

RESPIRE-Guatemala

Intervention to Lower Household Wood Smoke Exposure in Guatemala Reduces ST-Segment Depression on Electrocardiograms

John McCracken,[1,2] Kirk R. Smith,[2] Peter Stone,[3] Anaité Díaz,[4] Byron Arana,[4] and Joel Schwartz[1]

[1]Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, USA; [2]Environmental Sciences Division, University of California, Berkeley, California, USA; [3]Brigham and Women's Hospital, Boston, Massachusetts, USA; [4]Center for Health Studies, Universidad del Valle, Guatemala City, Guatemala



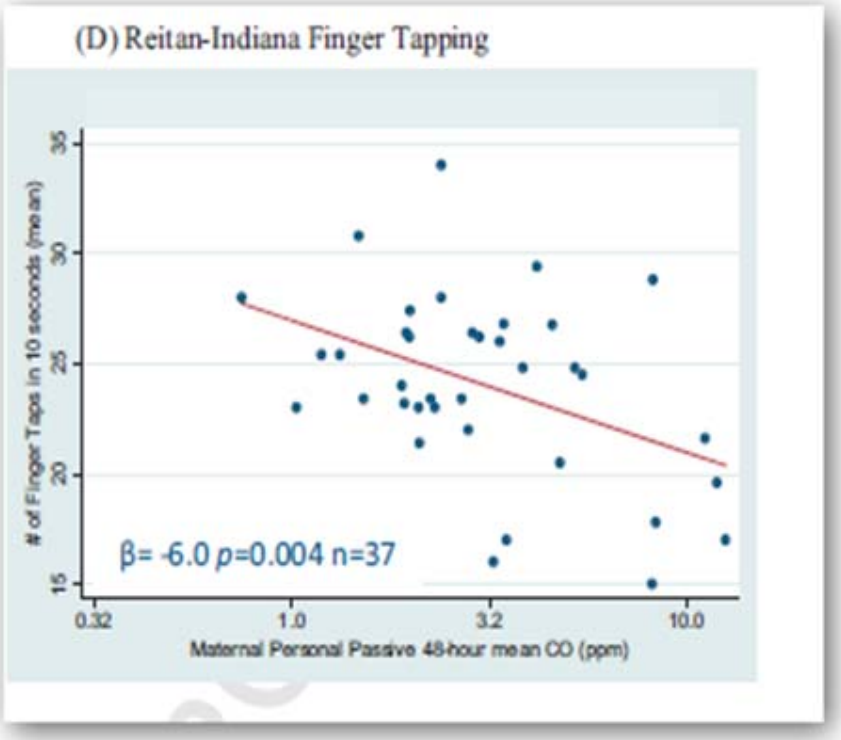
Environmental Health Perspectives
Nov, 2011

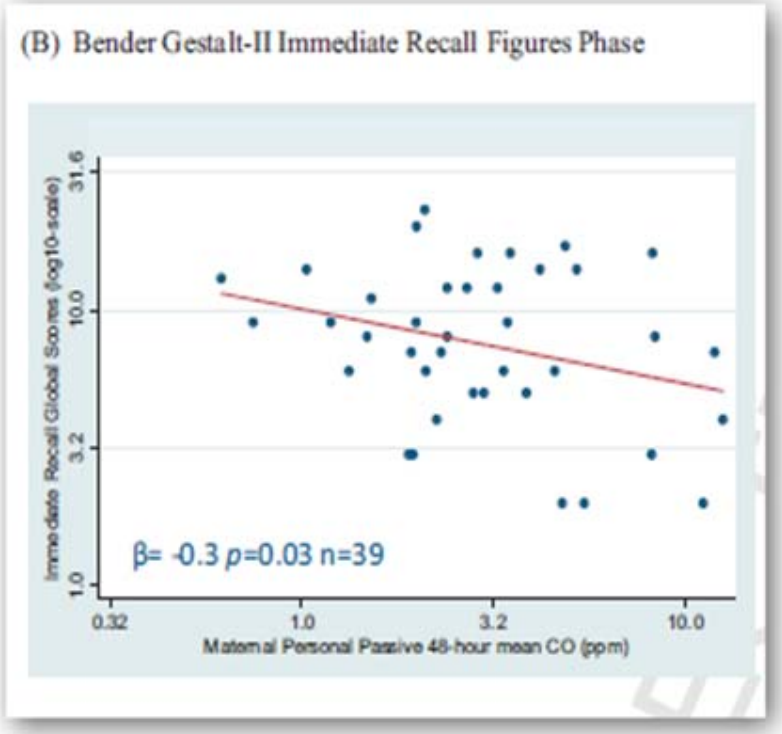
Contents lists available at SciVerse ScienceDirect

NeuroToxicology

Neurodevelopmental performance among school age children in rural Guatemala is associated with prenatal and postnatal exposure to carbon monoxide, a marker for exposure to woodsmoke

Linda Dix-Cooper[a], Brenda Eskenazi[b], Carolina Romero[c], John Balmes[a,d], Kirk R. Smith[a,*]





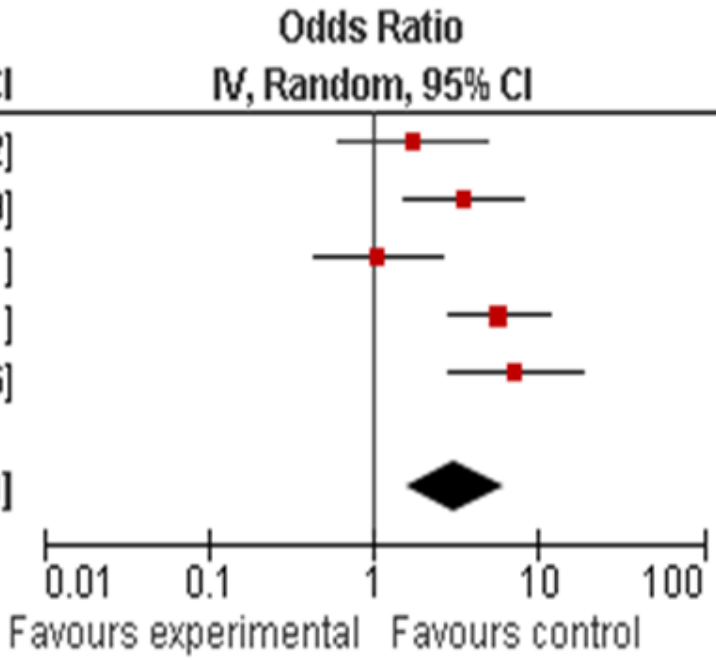
October 2011

Cervical Cancer and Household Air Pollution

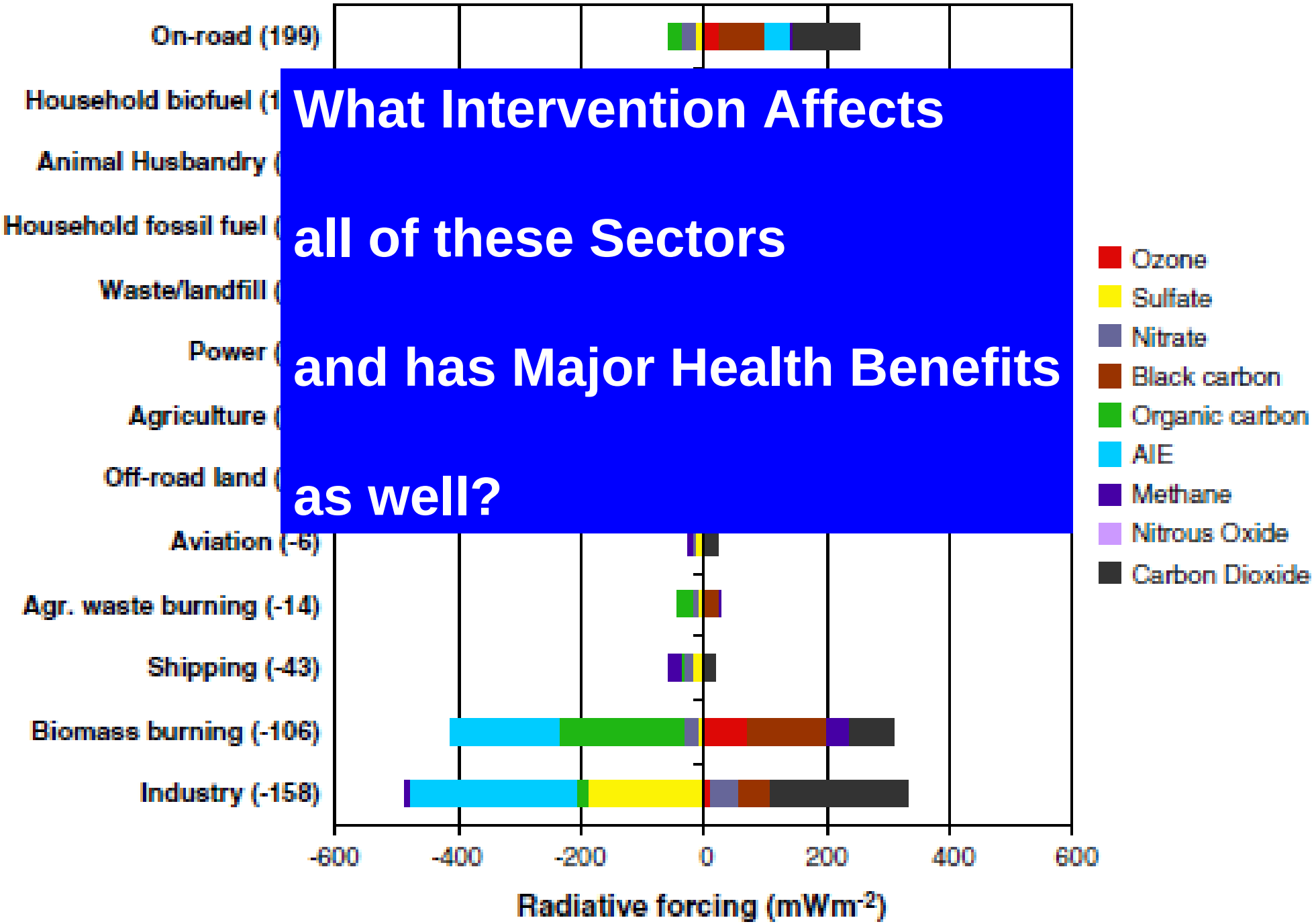
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Ferrera 2000(a)	0.54232429	0.53624989	17.6%	1.72 [0.60, 4.92]
Ferrera 2000(b)	1.24990174	0.41614175	20.9%	3.49 [1.54, 7.89]
Velema 2002(a)	0.06765865	0.45514155	19.8%	1.07 [0.44, 2.61]
Velema 2002(b)	1.75093748	0.36626585	22.4%	5.76 [2.81, 11.81]
Sierra Torres 2006	1.98787435	0.47618897	19.2%	7.30 [2.87, 18.56]
Total (95% CI)			**100.0%**	**3.14 [1.57, 6.30]**

Heterogeneity: $Tau^2 = 0.43$; $Chi^2 = 12.71$, df = 4 (P = 0.01); $I^2 = 69\%$

Test for overall effect: Z = 3.23 (P = 0.001)



Three papers; two done in Honduras, one in Columbia


What Intervention Affects
all of these Sectors
and has Major Health Benefits
as well?
On-road (199)
Household biofuel (1
Animal Husbandry (
Household fossil fuel (
Waste/landfill (
Power (
Agriculture (
Off-road land (
Aviation (-6)
Agr. waste burning (-14)
Shipping (-43)
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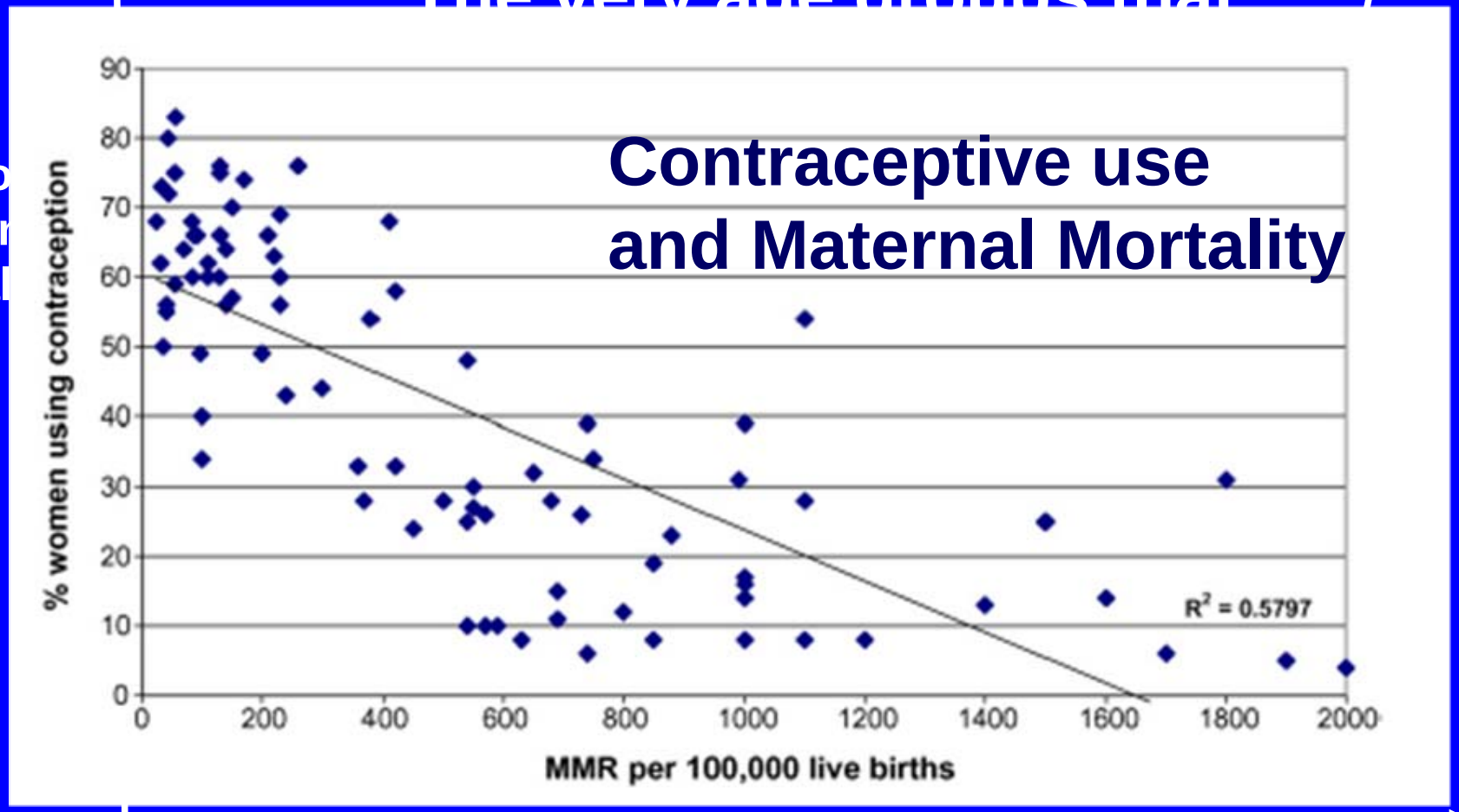
600
Radiative forcing (mWm-2)
Ozone
Sulfate
Nitrate
Black carbon
Organic carbon
AIE
Methane
Nitrous Oxide
Carbon Dioxide

Most cost-effective GHG control device is probably a condom

- Many tens of millions of women wish to have fewer children, but do not have access to contraceptives
- Giving them access could mean ~2 billion fewer people by 2100 – a major reduction of stress on the Earth
- Many health benefits, particularly child and maternal mortality, to smaller, more planned families

The very age groups that

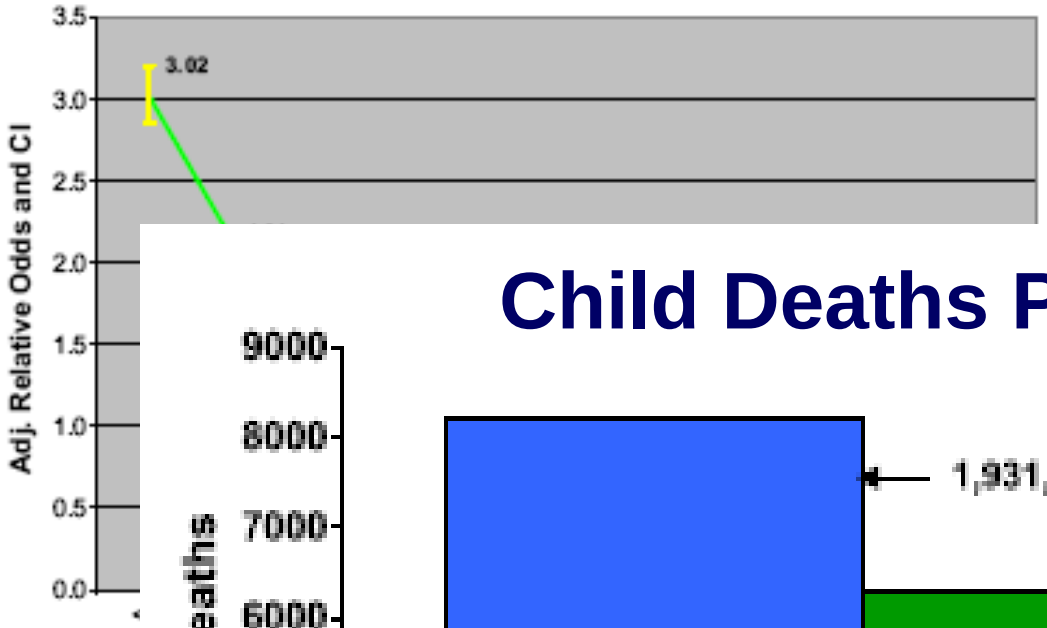
Risk o
Materr
Mortal



13

Age of Mother

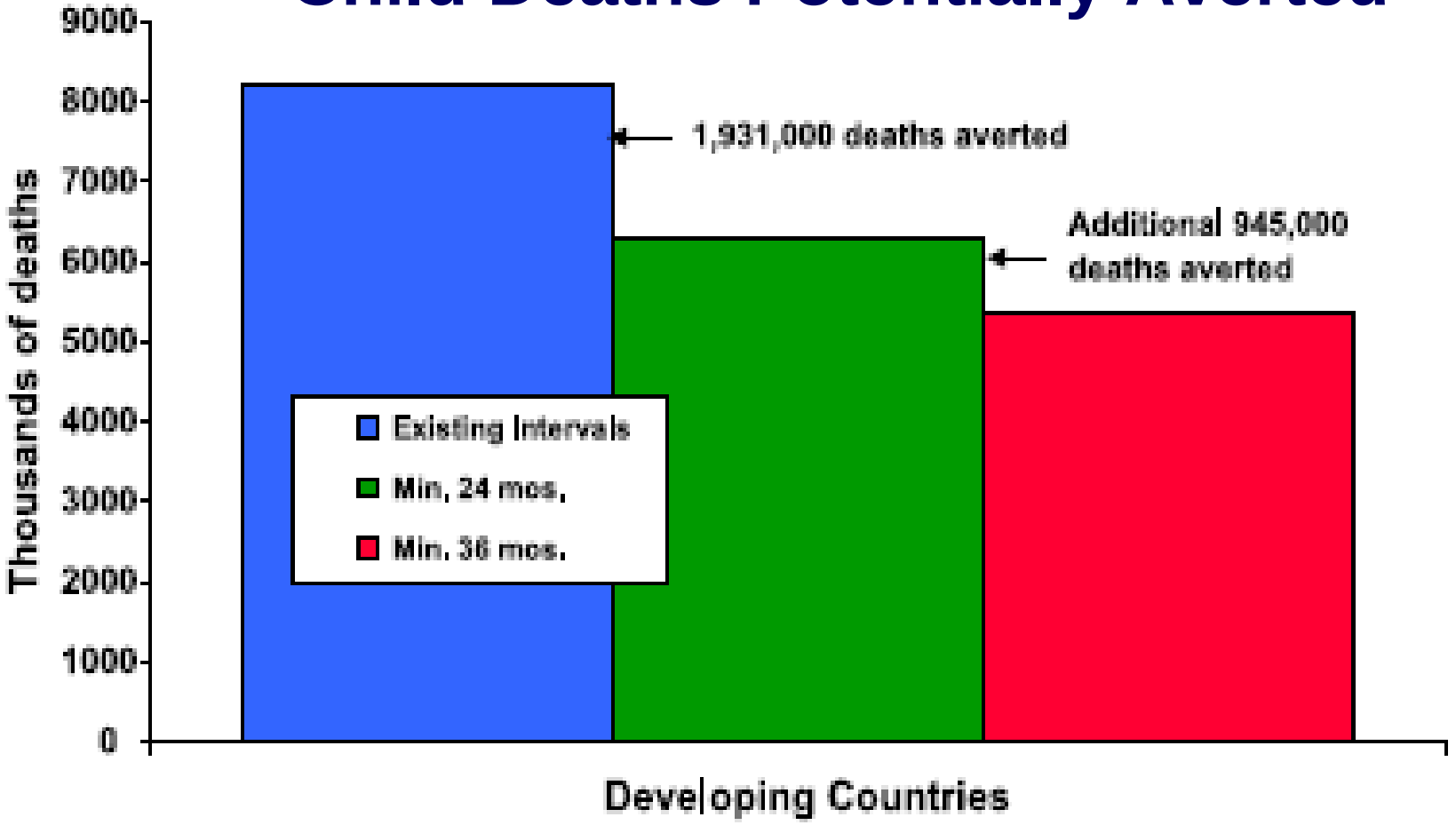
45



Figure

Inter

Child Deaths Potentially Averted



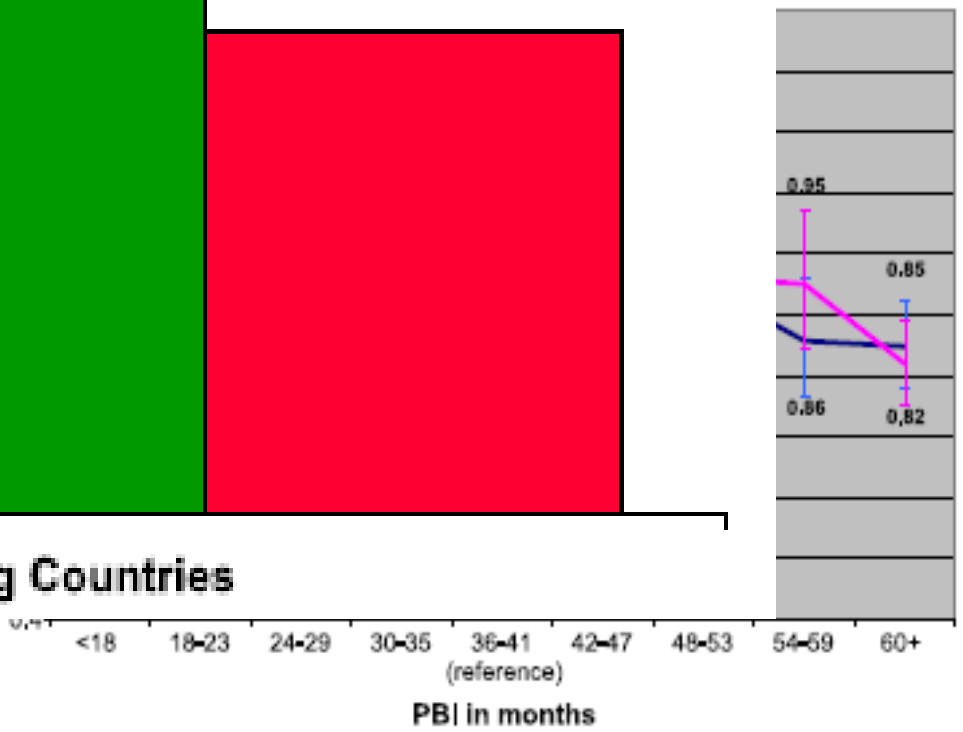


Figure 5 Child malnutrition by birth interval.

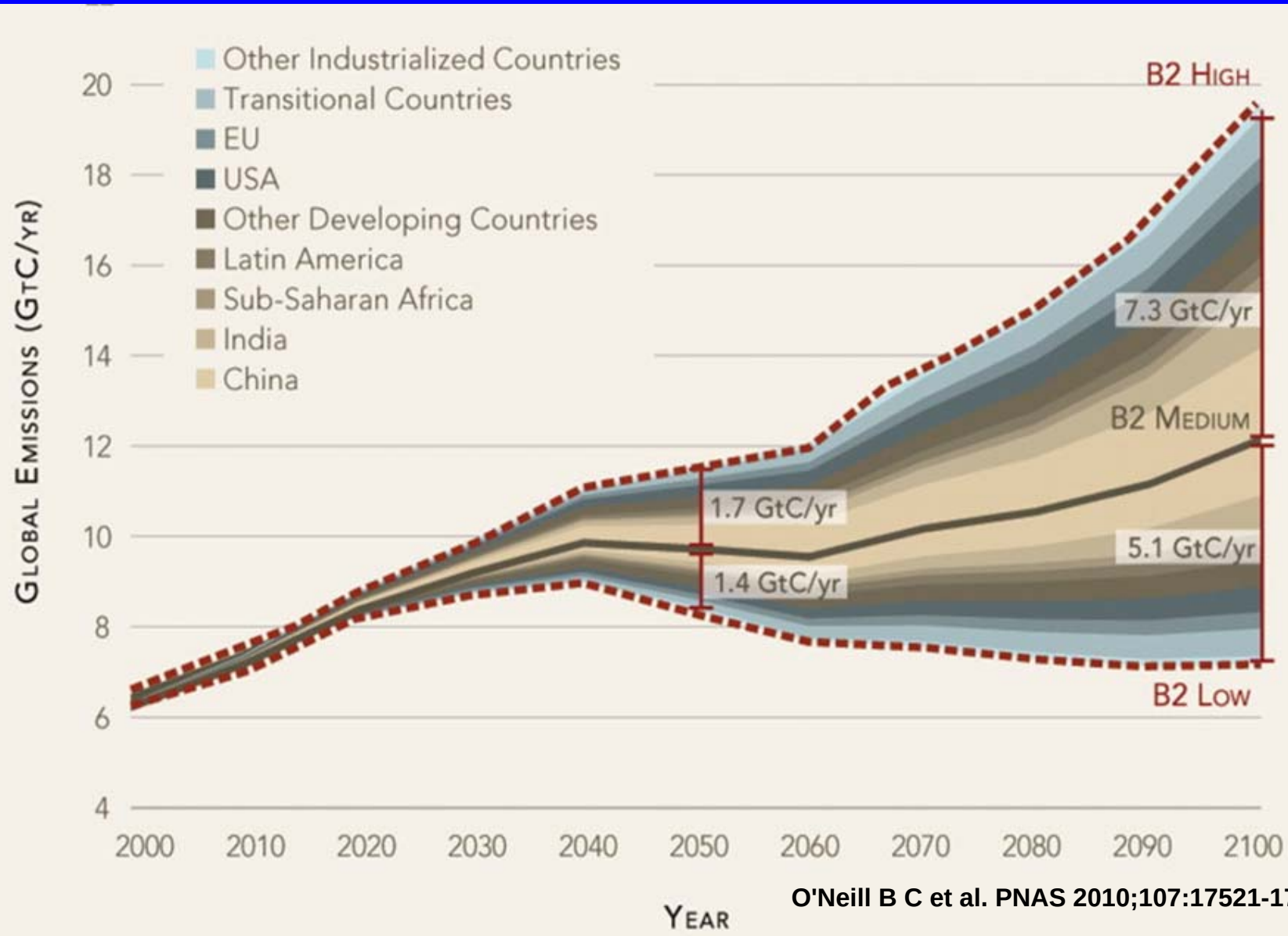
Global demographic trends and future carbon emissions

Brian C. O'Neill[a,1,2], Michael Dalton[b], Regina Fuchs[c], Leiwen Jiang[a], Shonali Pachauri[c], and Katarina Zigova[d,2]

[a]Climate and Global Dynamics Division and Integrated Science Program, National Center for Atmospheric Research, Boulder, CO 80307; [b]Alaska Fisheries Science Center, National Oceanographic and Atmospheric Administration, Seattle, WA 98115; [c]International Institute for Applied Systems Analysis, A-2361 Laxenburg, Austria; and [d]Department of Economics, University of Konstanz, 78457 Konstanz, Germany

Proceedings of the National Academy of Sciences
October 12, 2010 | vol. 107 | no. 41 | 17521–17526

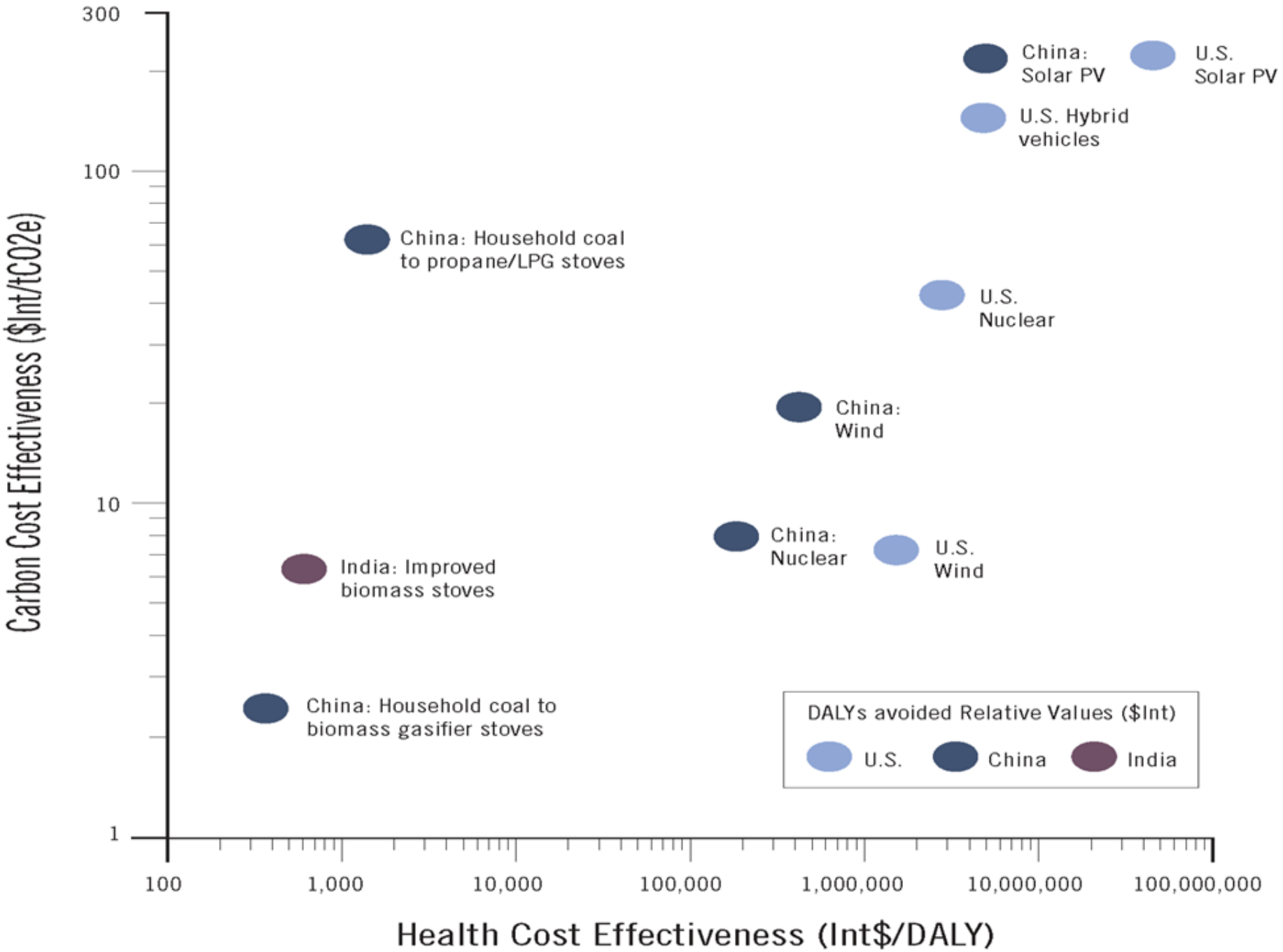
Global CO2 Emissions Under different Fertility Scenarios



O'Neill B C et al. PNAS 2010;107:17521-17526

Access to Reproductive Services

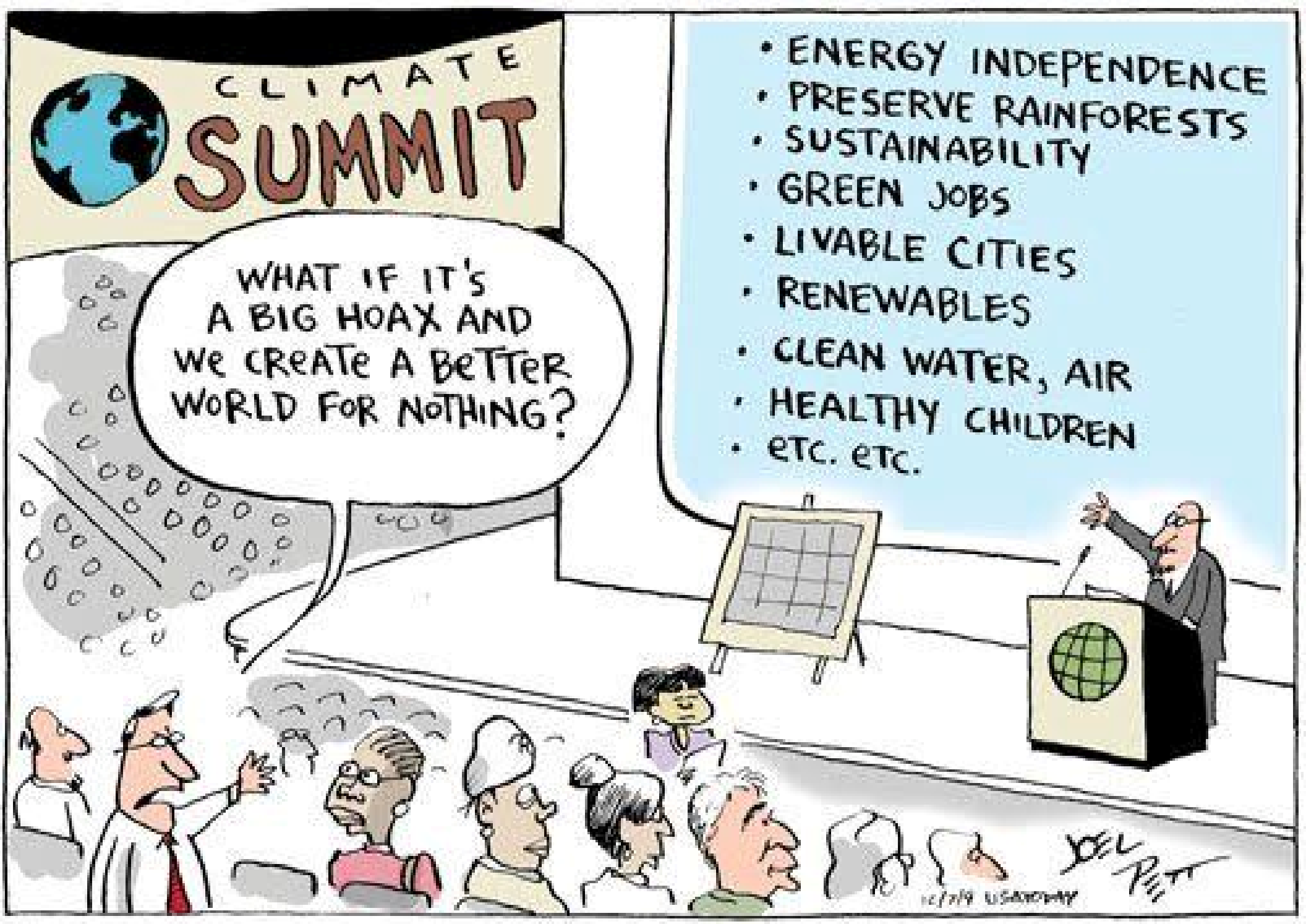
- Not population control, but reproductive rights
- All countries on the way to replacement fertility this century
- Just a matter of making it possible to happen sooner rather than later in the century
- Large health benefits can be accrued



Smith and Haigler, Ann Rev of Public Health, 2008

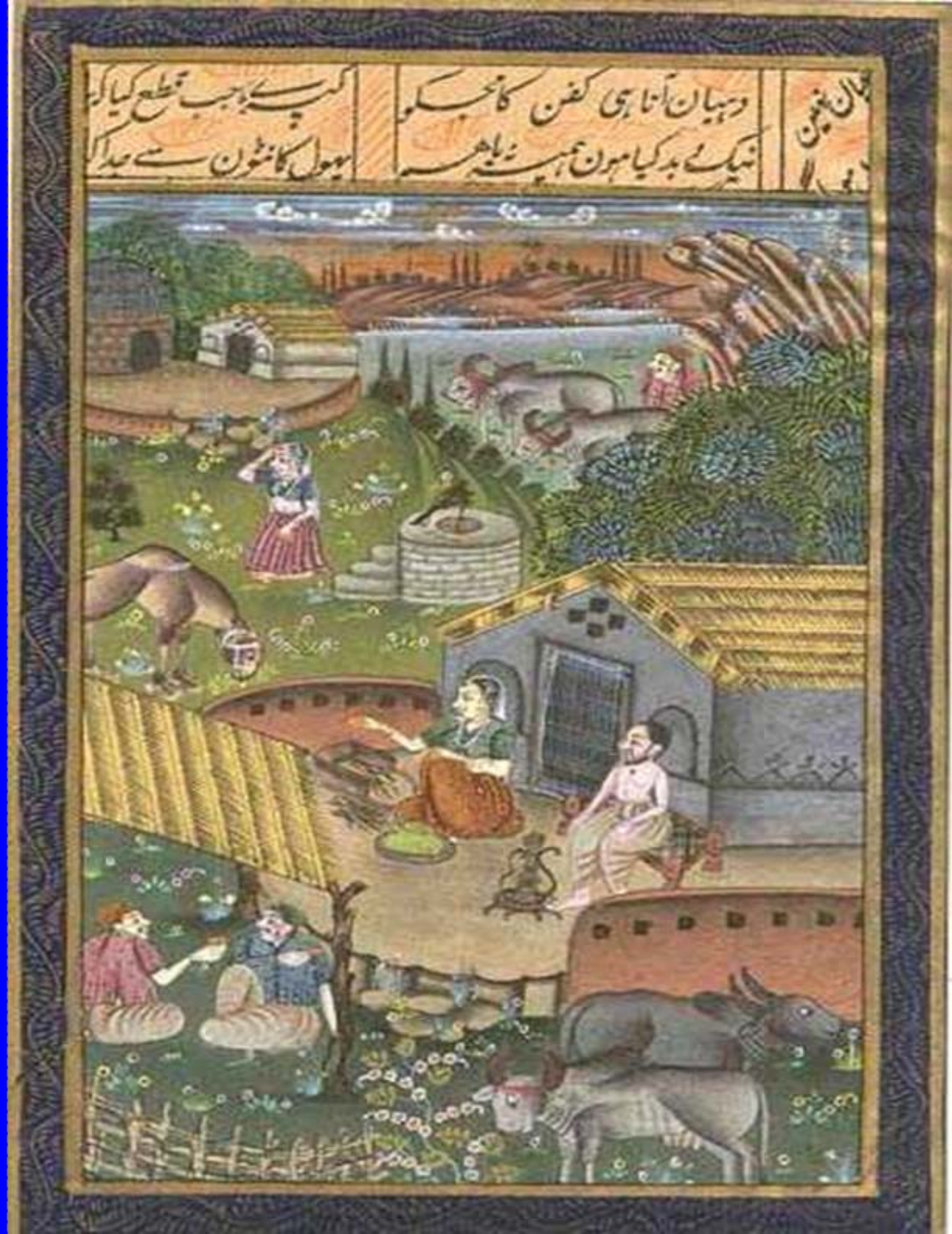
Summary

- Carbon dioxide controls absolutely needed to blunt climate change impacts
- Considerable health co-benefits in doing so if projects are targeted
- Even greater health co-benefits can achieved by focusing on other climate-altering pollutants (CAPs: methane, black carbon, etc.)
- These mostly have an impact on rate of warming, not total
- But rate is also important for impacts

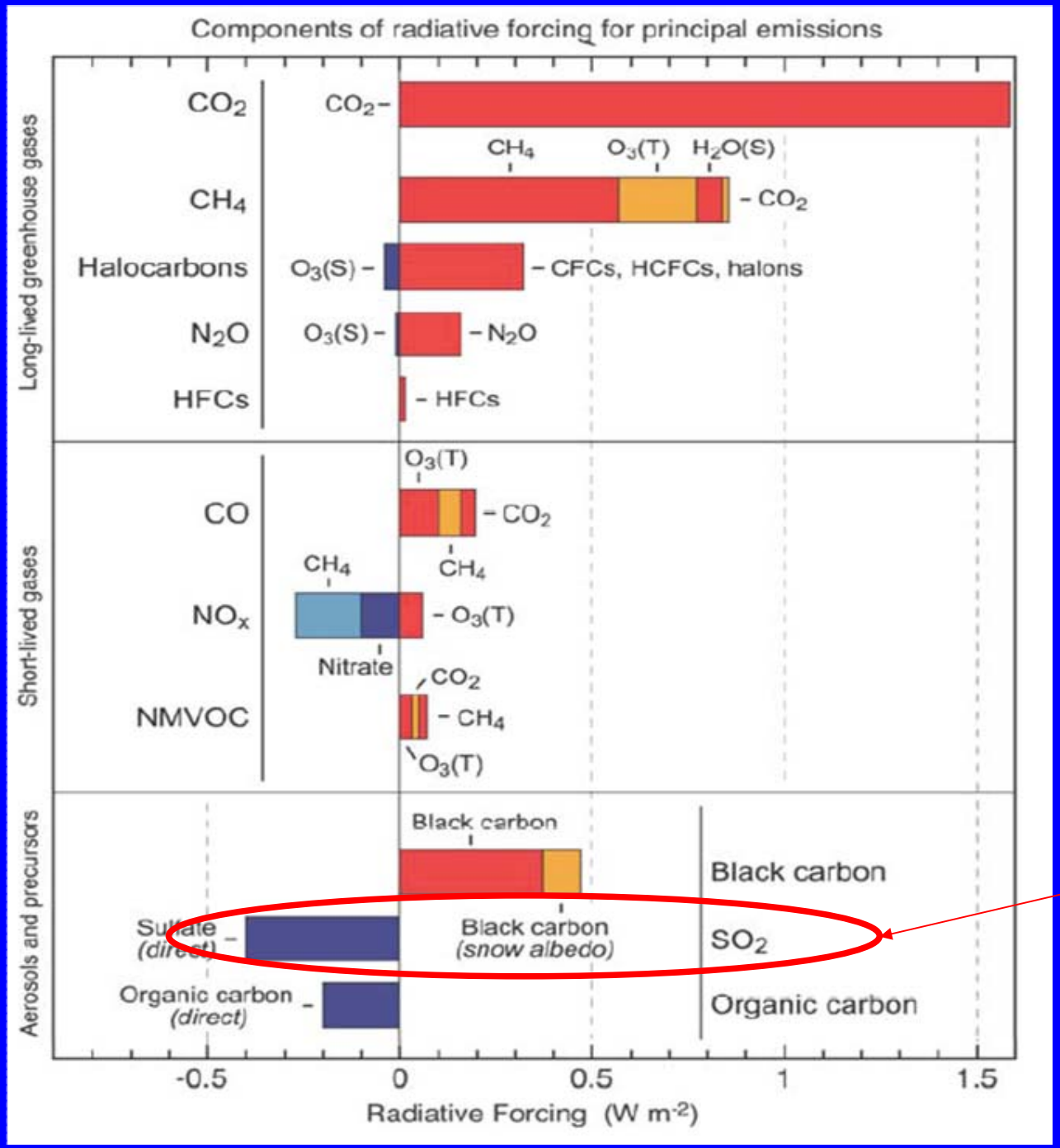

CLIMATE
SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
JOEL PETT

Gracias

Publications and presentations on website – easiest to just “google” Kirk R. Smith



Global warming in 2005 due to all human emissions since 1750



Sulfate is cooling for climate, but damaging to health

IPCC, 2007