Public Health Co-Benefits of Reducing Short-Lived Climate Forcers

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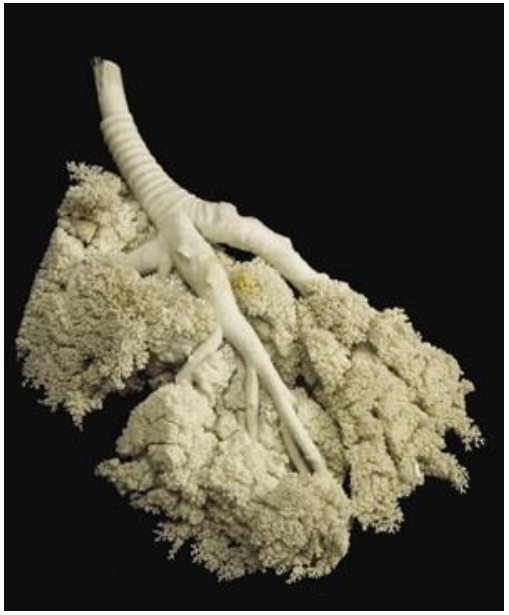
Reasons for Reducing Short-Lived Climate Forcers

- Avoid rapid near-term climate change and slow melting of ice, snow and glaciers
- **Provide large, certain public health and environmental co-benefits**

Linking SLCF to Air Pollution

- Methane contributes to the formation of **ground-level ozone** (O_3), the main component of smog
  - Ozone is not emitted directly into the air but forms when emissions of precursors, including methane, carbon monoxide, nitrogen oxides (NOx) and volatile organic compounds (VOCs), "cook" in the sun
- Black Carbon (BC) is part of the pollution mixture known as **particulate matter** (PM)
  - BC is predominantly found in the fine particle ($PM_{2.5}$) fraction, which is most strongly linked to adverse health effects

Health Effects of Ground-level Ozone

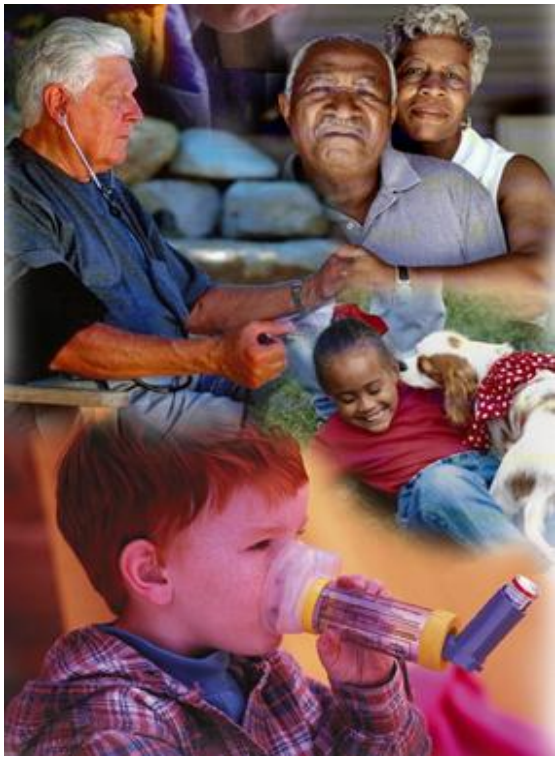


Ozone affects healthy people as well as those who are already sick

- Aggravates lung disease, including asthma, emphysema and bronchitis
- Increases the frequency of asthma attacks
- Reduces lung function, making it harder to breathe
- Causes coughing, sore or scratchy throat
- Makes it difficult to take a deep breath
- Inflames and damages the airways

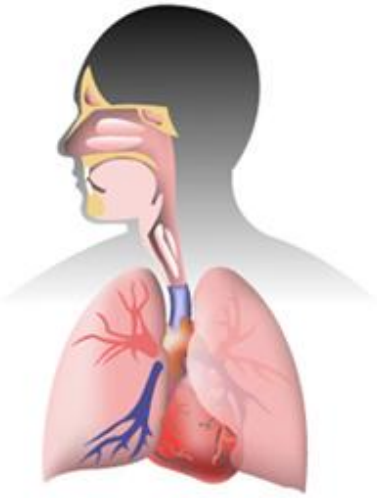
Health Effects of Ground-Level Ozone (cont.)

- Tens of millions of people are affected by ozone pollution worldwide. **At-risk groups** include:
  - Children
  - Older adults
  - People with lung disease such as asthma or chronic obstructive pulmonary disease (COPD)
  - People who are active outdoors
- Breathing ozone can lead to:
  - Increased medication use for people with asthma
  - Doctors visits
  - Missed school days
  - Missed work days
  - Emergency room visits and hospital admissions
  - Increased risk of premature death



Benefits of Reducing Global Methane Emissions

- West et al. (2006) estimated that a 20% reduction in global anthropogenic methane emissions would:
  - Reduce mean global 8-hr ozone concentrations by 1 ppb
  - **Prevent 30,000 premature deaths globally in 2030**
  - **Prevent 370,000 premature deaths from 2010-2030 (global cumulative)**
  - **Avoid other damages to health, agriculture, and forestry, valued at ~$5 billion per year**
  - Reduce global radiative forcing by 0.14 W/m^2
  - Provide 2% of global natural gas production
- These reductions can be achieved at a net cost-savings (~$1.9 billion per year) using identified technologies



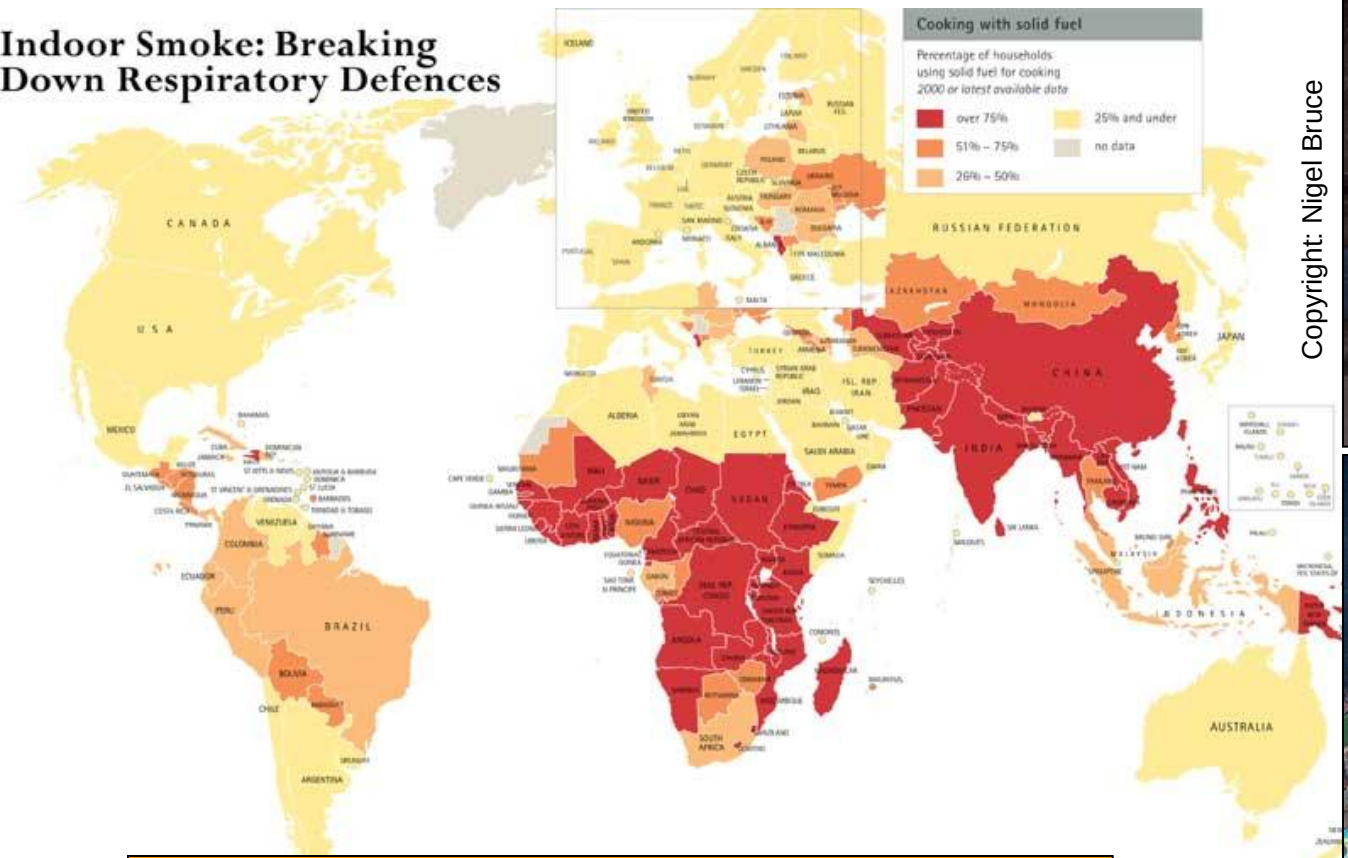
Health Effects of Fine Particles ($PM_{2.5}$)

- Breathing fine particles ($PM_{2.5}$) causes adverse effects on the cardiovascular and respiratory systems
  - **Ambient** (outdoor) $PM_{2.5}$ exposures are linked to
    - Premature death
    - Heart attacks
    - Strokes
    - Hospital and emergency room visits
    - Acute and chronic bronchitis
    - Asthma-related effects
    - $PM_{2.5}$ may also be associated with infant mortality low birth weight, and cancer

  - **Indoor** $PM_{2.5}$ exposures are associated with:
    - Respiratory impacts, including acute lower respiratory infections (ALRI) in children and chronic obstructive pulmonary disease (COPD) in women
    - Other studies indicate link to cardiovascular impacts such as high blood pressure, and to adverse birth outcomes (low birth weight and stillbirth)

Indoor Smoke from Cookstoves is among the Leading Health Risk Factors Globally

WHO (2009) estimates that indoor smoke from cookstoves leads to <u>2 million</u> premature deaths each year, mainly among women and children



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Half the world cooks with solid fuels such as wood, dung, charcoal, coal, or crop residues.

Global Health Burden of Indoor Smoke from Solid Fuels

- Indoor smoke contains a range of pollutants, including PM, CO, CO_2, methane, and carcinogens
- WHO (2009) estimates that in 2004, exposure to indoor smoke worldwide led to:
  - 21% of lower respiratory infection deaths
  - 35% of COPD deaths
  - 3% of lung cancer deaths
- About 64% of these deaths occur in low-income countries
- Along with diarrheal disease, lower respiratory infections are leading cause of death and illness among children < 5 years of age

Global Health Burden of Ambient (Outdoor) $PM_{2.5}$

- WHO (2009) estimates that in 2004, ambient $PM_{2.5}$ in urban areas alone was associated with **800,000 premature deaths each year**
  - This underestimates total global mortality burden because it excludes rural areas (~70% of global population)
- Anenberg et al. (2010) estimate that exposure to ambient $PM_{2.5}$ leads to approximately **3.7 million premature deaths** annually (including rural areas)
- Note: next Global Burden of Disease study is underway; expected to produce updated estimates for both indoor and outdoor $PM_{2.5}$ exposures

Estimated Impacts of $PM_{2.5}$ in the U.S.

- **$PM_{2.5}$ associated with 130,000 - 320,000 premature deaths in the U.S. in 2005** (5.4% of all deaths nationwide) (Fann et al., 2011)
  - Reductions in directly emitted $PM_{2.5}$ (including BC) estimated to provide $227,000-$887,000 in health benefits per ton reduced (2010$) (Fann at al., 2009)
  - This is 7 to 300 times greater than the benefits per ton estimated for reductions of other PM precursors, indicating that controls on direct $PM_{2.5}$ may be particularly effective for protecting public health

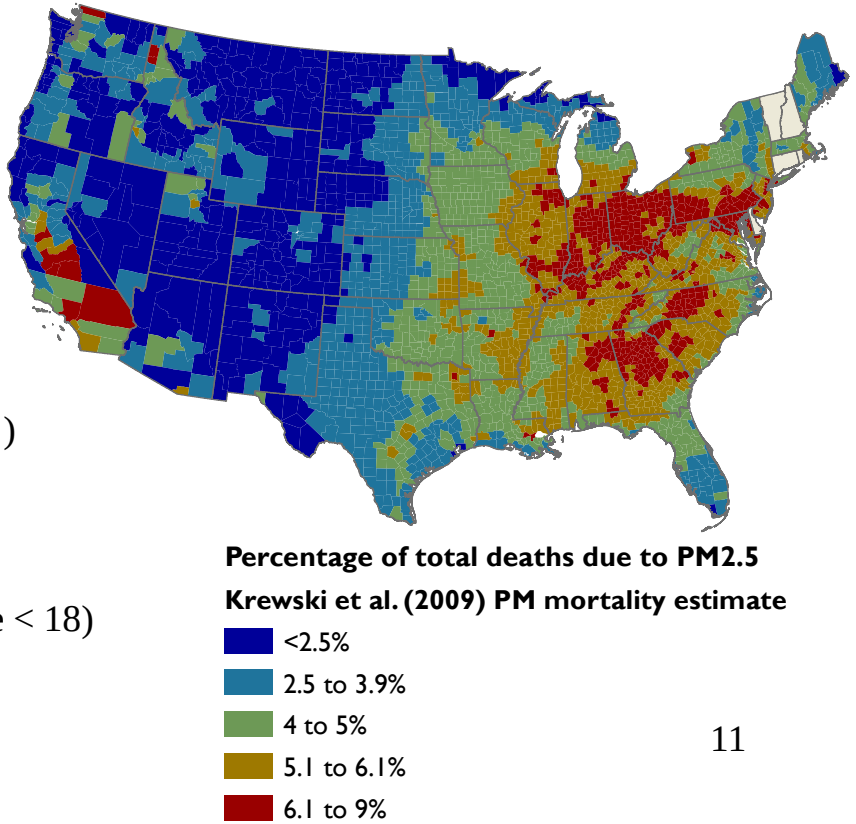
- Other Effects in 2005 (Fann et al., 2011):

Adults:

- 18,000,000 lost work days (age 18-65)
- 180,000 heart attacks (age ≥ 17)
- 83,000 cases of chronic bronchitis (age ≥ 26)
- 62,000 hospitalizations for cardiovascular effects (age ≥ 17)
- 30,000 hospitalizations for respiratory effects (all ages)

Children:

- 110,000 emergency department visits related to asthma (age < 18)
- 200,000 cases of acute bronchitis (age 8-12)
- 2,500,000 cases of exacerbation of asthma (age 6-18)



A Little Perspective on Poor Air Quality

($PM_{2.5}$ as an indicator)

		
Chicago, IL: August 16, 2000 **$PM_{2.5}$ < 10 µg/m³**	**Chicago, IL: August 26, 2000** **$PM_{2.5}$ = 34 µg/m³**	**Home with Open Fire (Guatemala)** **Peak $PM_{2.5}$ = 8670 µg/m³** **Typical 24-hr : 100s-1000s µg/m³**

Some Pollutants in Indoor Smoke	**Criteria Pollutants:** $PM_{2.5}$, CO, NO_2, **Toxics:** formaldehyde, benzene, 1-3 butadiene, benzo[α]pyrene **Climate Forcers:** CO_2 (partial), CH_4, CO, NMHCs, BC, OC **For Coal:** CO_2 (full), SO_2, As, Pb, Hg, & F

	Annual		24-hour	
	EPA Standard	**WHO Guideline**	**EPA Standard**	**WHO Guideline**
$PM_{2.5}$	**15.0 µg/m³**	**10.0 µg/m³**	35 µg/m³	25.0 µg/m³

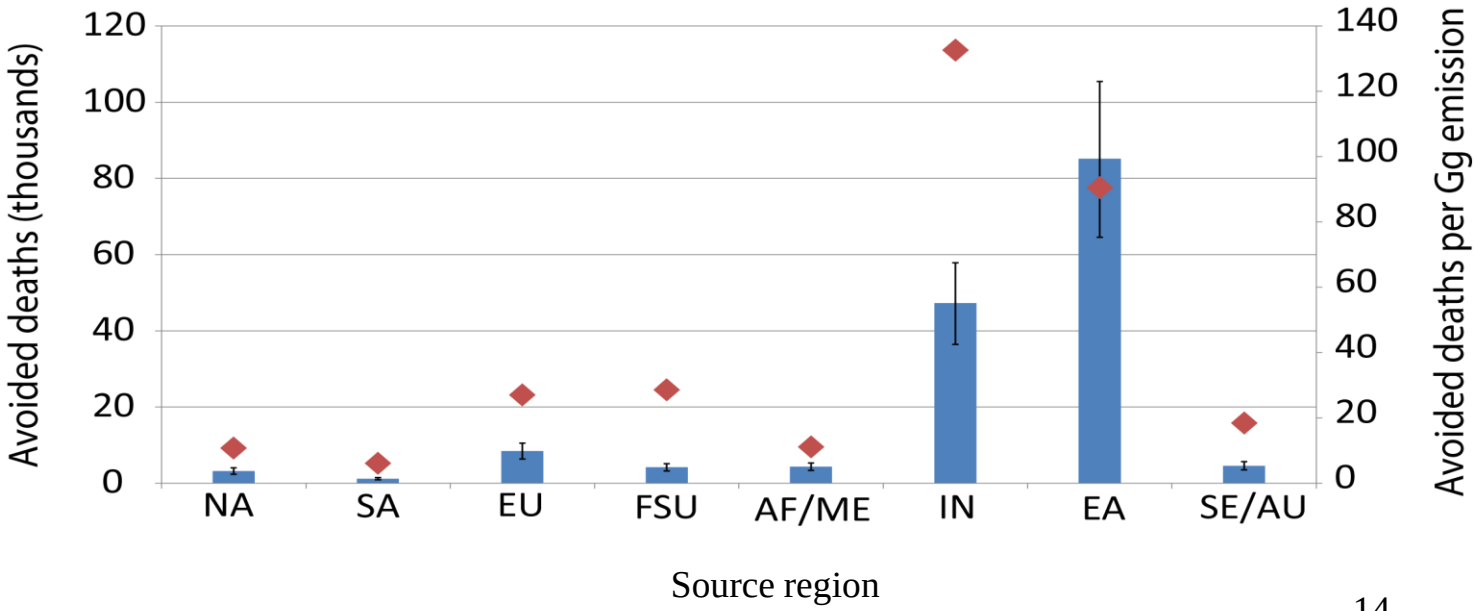
Potential Public Health Co-Benefits of Reducing BC

- Available studies indicate that reducing $PM_{2.5}$ prolongs life and promotes health:
  - Wilkinson, et al. (2009) estimate that cookstove replacements in India (150,000 stoves/year for 10 years) could substantially reduce $PM_{2.5}$-related mortality in 2020 associated with ALRI (30%), COPD (28%) and ischaemic heart disease (6%)
  - Saikawa et al. (2009) modeled numerous scenarios for future PM emissions in China and found that a maximum feasible reduction scenario (including BC, OC, and sulfate) reduced $PM_{2.5}$-related premature mortality in China by 50% in 2030
  - Pope et al. (2009) indicate that decreases in ambient $PM_{2.5}$ concentrations in the U.S. between 1980 and 2000 increased average life expectancy at birth by 7 months
- Health and environmental co-benefits accrue locally (in the region where emissions are reduced)

Public Health Co-Benefits of Reducing BC (cont.)

- Anenberg et al. (2011) indicate that reducing global BC emissions from key sectors (residential, industry and transportation) by 50% would provide substantial health benefits globally through improved air quality
  - Found that 50% reduction in BC alone could prevent 157,000 premature deaths per year
  - 50% reduction in BC + OC estimated to prevent 1.2 million premature deaths per year

Region	
NA	North America
SA	South America
EU	Europe
FSU	Former Soviet Union
AF/ME	Africa/Middle East
IN	South Asia (India)
EA	East Asia (China)
SE/AU	Southeast Asia/Australia



Benefits of Reducing Vehicle Emissions

- Global vehicle emissions are growing rapidly. Controlling these emissions can provide substantial climate and health benefits, even as vehicle ownership grows.
- Shindell et al. (2011) estimate adopting European vehicle standards in China, Latin America, Africa, and the Middle East could lead to:
  - 120,000-280,000 avoided premature deaths in 2030 (valued at $0.6-2.4 trillion in 2006 USD)
  - 6.1-19.7 million metric tons of avoided ozone-related crop yield losses
  - Mitigation of 0.2° C (+0.14° C/-0.17° C) Northern Hemisphere extratropical warming during 2040-2070

Key Messages

- Robust scientific evidence links ground-level ozone and $PM_{2.5}$ to adverse health effects
- Reductions in SLCF (methane, BC, and HFC) will provide sizable public health benefits through reductions in ozone and $PM_{2.5}$
  - Hundreds of thousands of premature deaths and millions of illnesses can be prevented each year through SLCF mitigation efforts that reduce indoor and outdoor pollution
  - Public health benefits of reductions in $PM_{2.5}$ and ozone are certain, will occur soon after emissions are reduced, and will benefit local populations
  - The public health benefits alone may be large enough to justify SLCF mitigation in many regions and sectors
- More work is needed to design strategies that are tailored to individual countries' situations, and to promote the health benefits of SLCF reductions

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