The Global Burden of Disease Due to Air Pollution and Its Major Sources: Estimates from the GBD 2013 Study

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on behalf of the GBD Air Pollution Core Analytic Team: Richard Burnett, H Ross Anderson, Mohammad Forouzanfar, Joseph Frostad and the Global Burden of Disease Collaboration

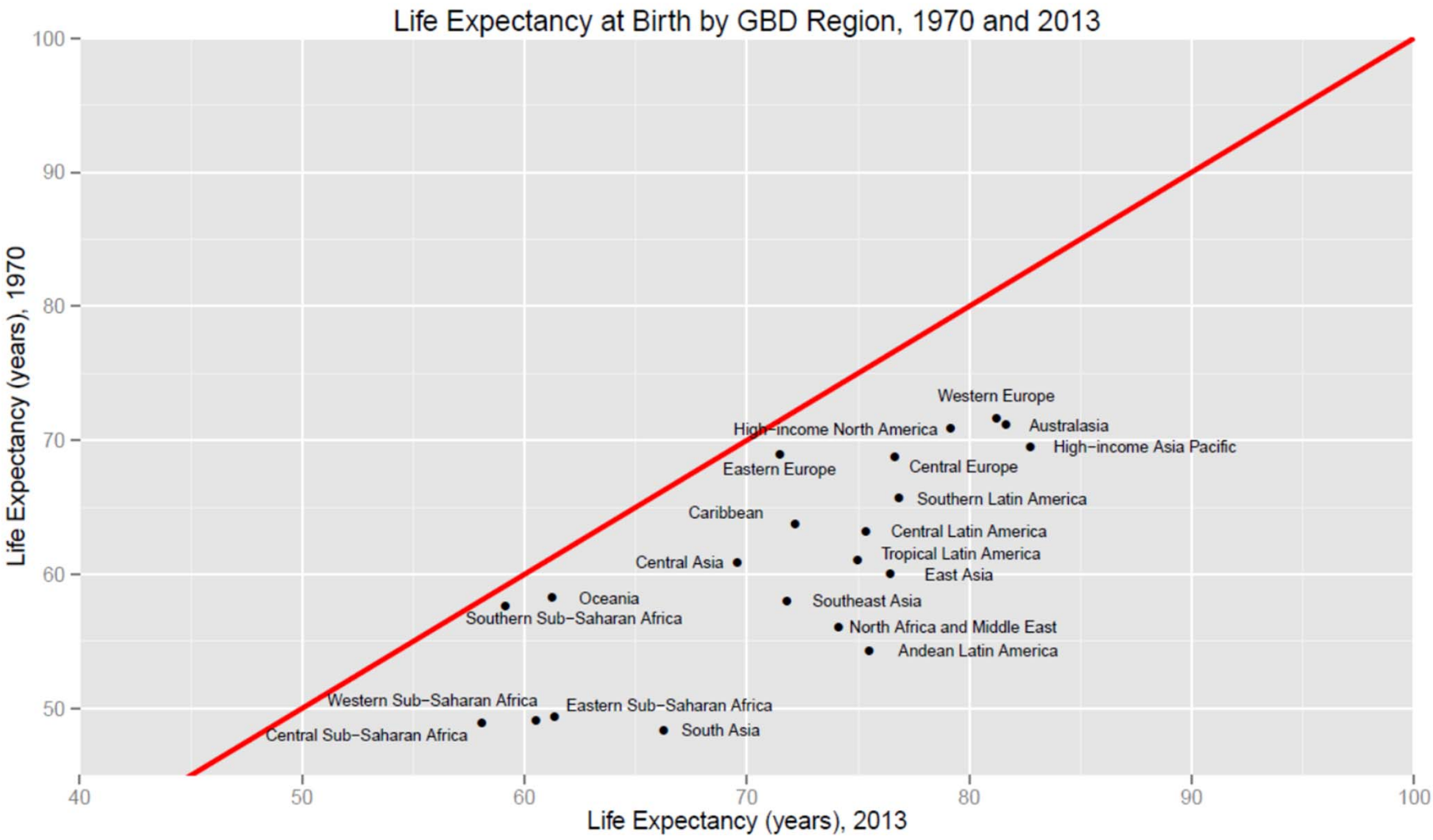
- **The Global Burden of Disease (GBD) project**
- **Global health patterns that underlie burden due to the ambient air pollution**
- **Estimating the burden of disease attributable to air pollution**
- **Global burden of disease attributable to ambient air pollution 1990-2013**
- **GBD MAPS Estimating the burden of disease from specific air pollution sources**

What is the Global Burden of Disease?

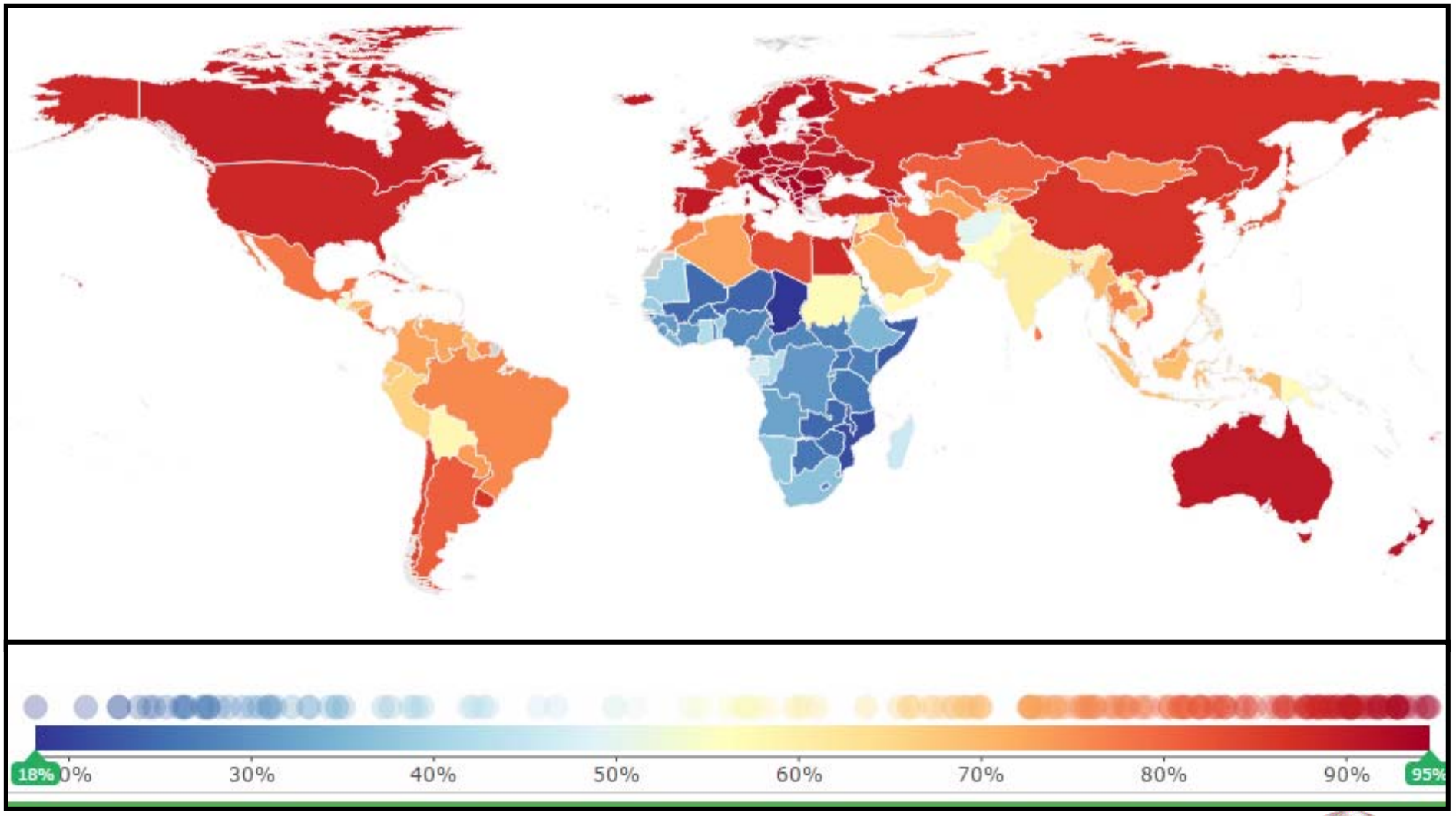
- Systematic quantification of health loss due to diseases, injuries and risk factors
- Disease, injury, & risk burden estimates for 1990 – 2013 using comparable methods for 188 countries (+ sub-country analyses)
  - incidence and prevalence of 301 diseases and injuries and 2,337 relevant disabling sequelae, stratified by sex and 20 age groups
  - Role of 79 modifiable risk factors
  - Burden measured as "Disability Adjusted Life Years" (DALYs) – lost years of healthy life; premature deaths in a given year
- Global collaboration coordinated by Institute for Health Metrics and Evaluation and involves > 1,600 collaborators
- GBD 2013 updates previous GBD estimates with new data, methods
- Major GBD 2013 results for Mortality, Healthy Life Expectancy and Years Lived with Disability , and Risk Factor burden published in *The Lancet* 2014-2015
- Annual updates beginning in 2016

http://www.healthdata.org/gbd

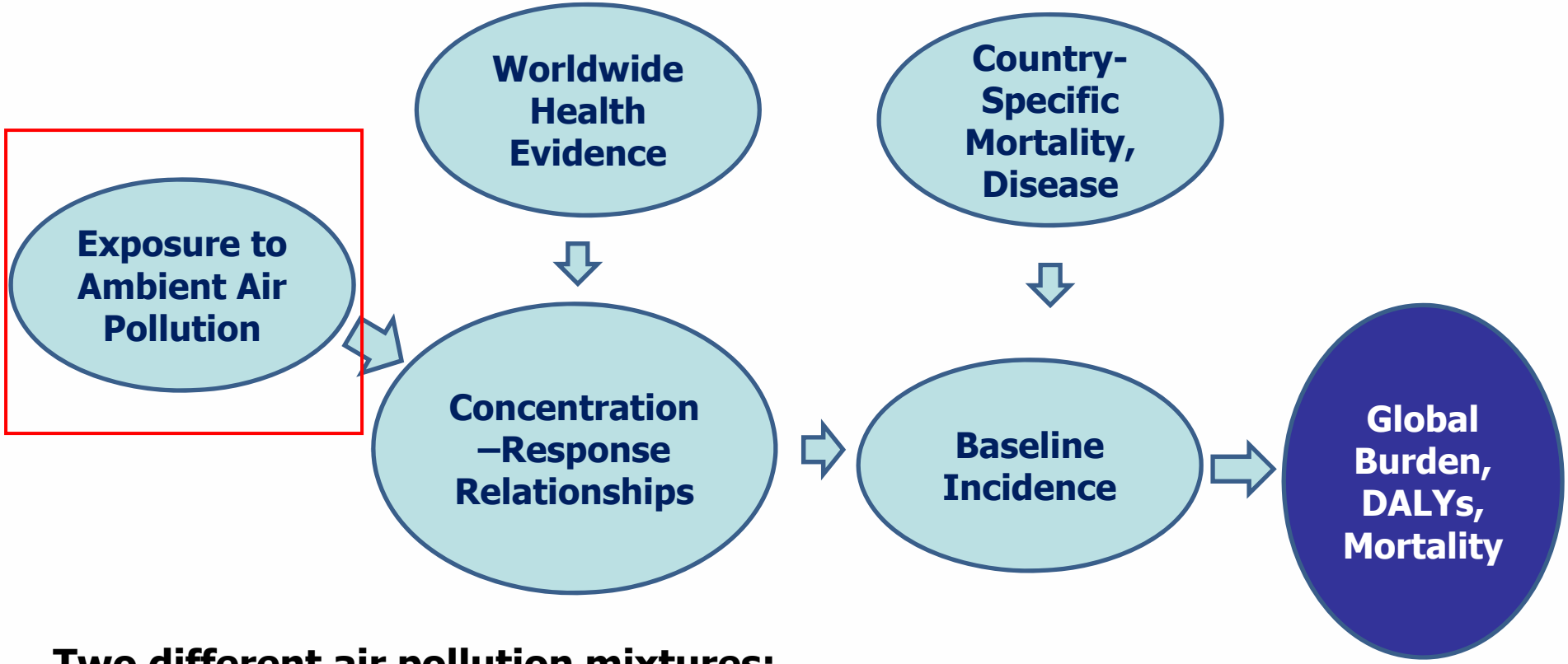
Changes in Life-Expectancy at Birth 1970-2013



Percent of DALYs from Non-Communicable Diseases in 2013



General approach

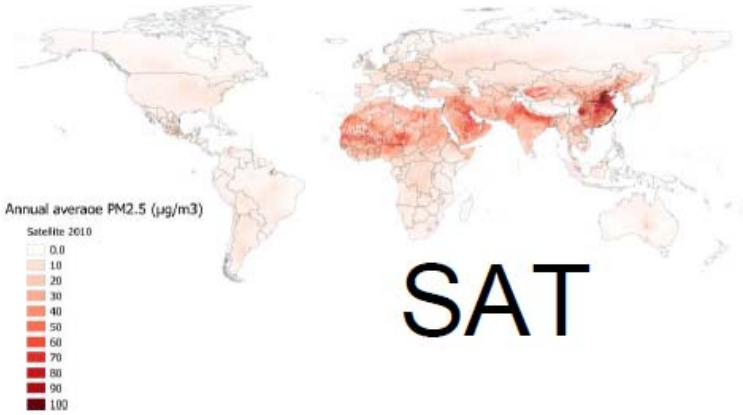


Two different air pollution mixtures:

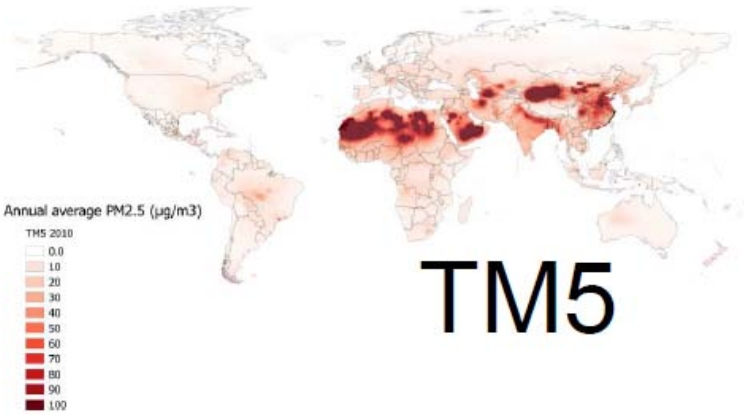
$PM_{2.5}$

Ozone

Estimating Global Exposure to $PM_{2.5}$

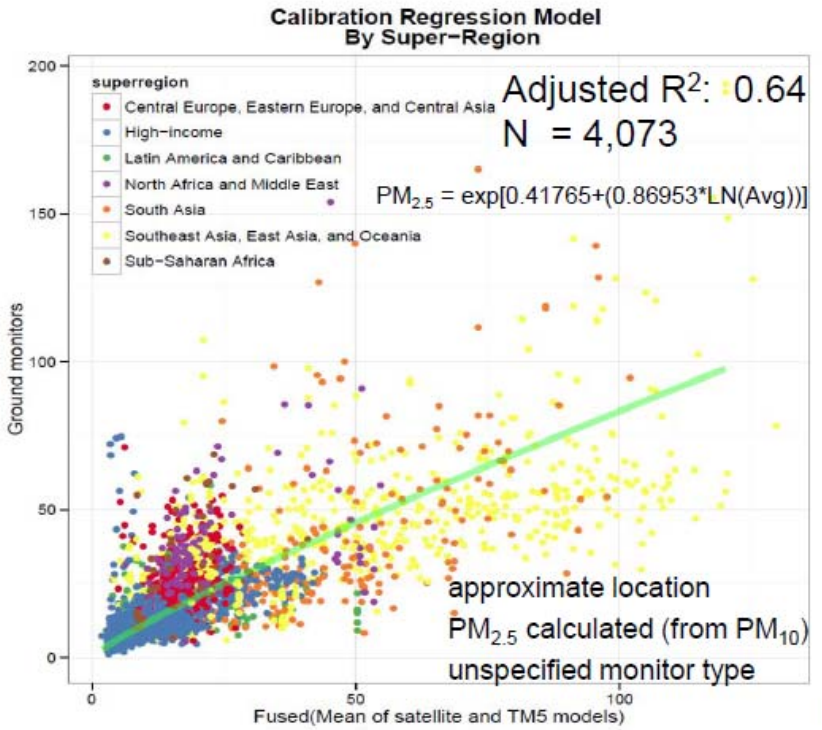


SAT



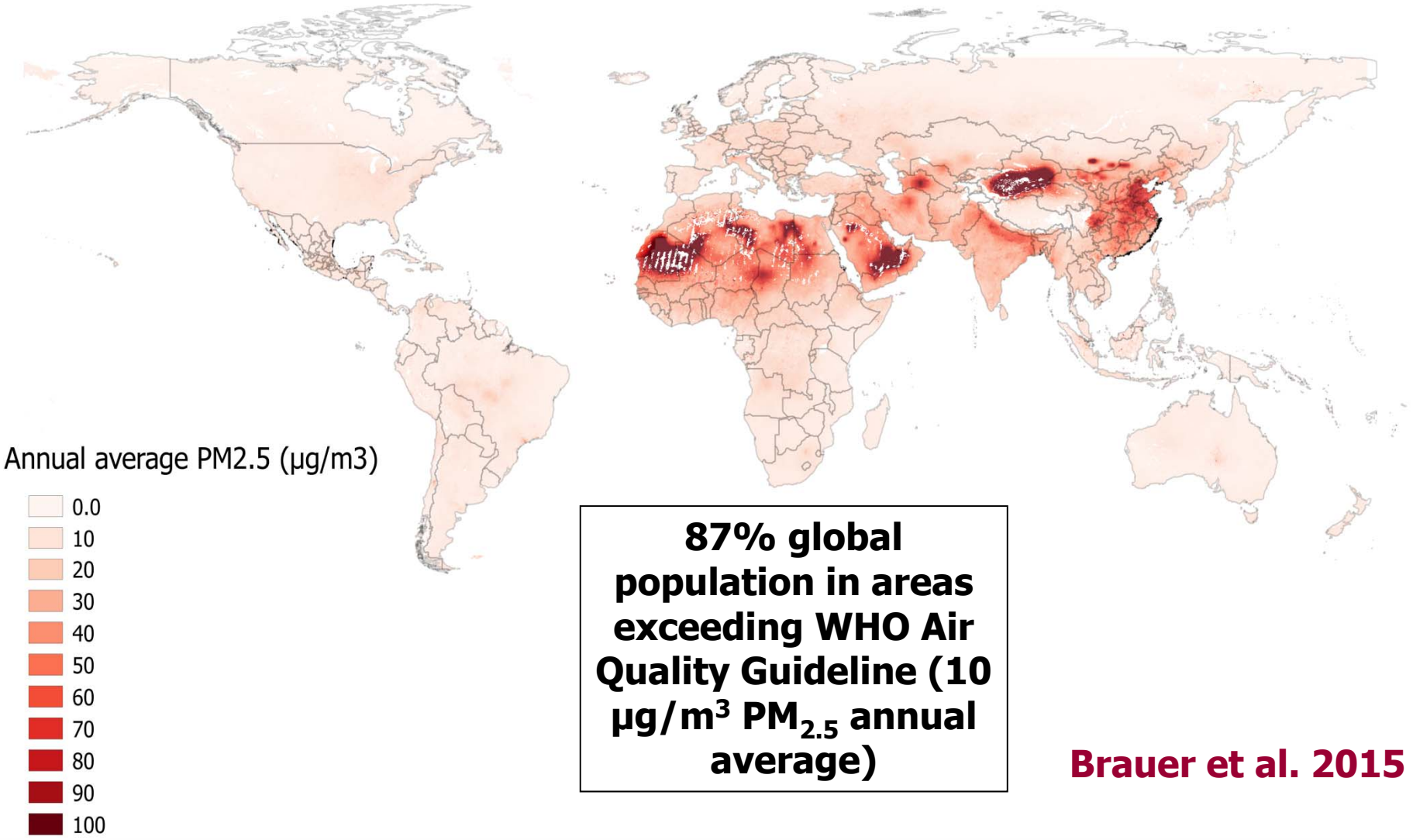
TM5

- Final estimates based on average of (1.4 million) grid cell values (SAT, TM5) and calibrated (regression model) with measurements
  - 0.1° x 0.1° resolution
  - extrapolated to 2013 using 2010-2011 trend in SAT
- Incorporate variance between two estimates and measurements in uncertainty assessment
- Unique contributions from each approach



Brauer et al., 2015

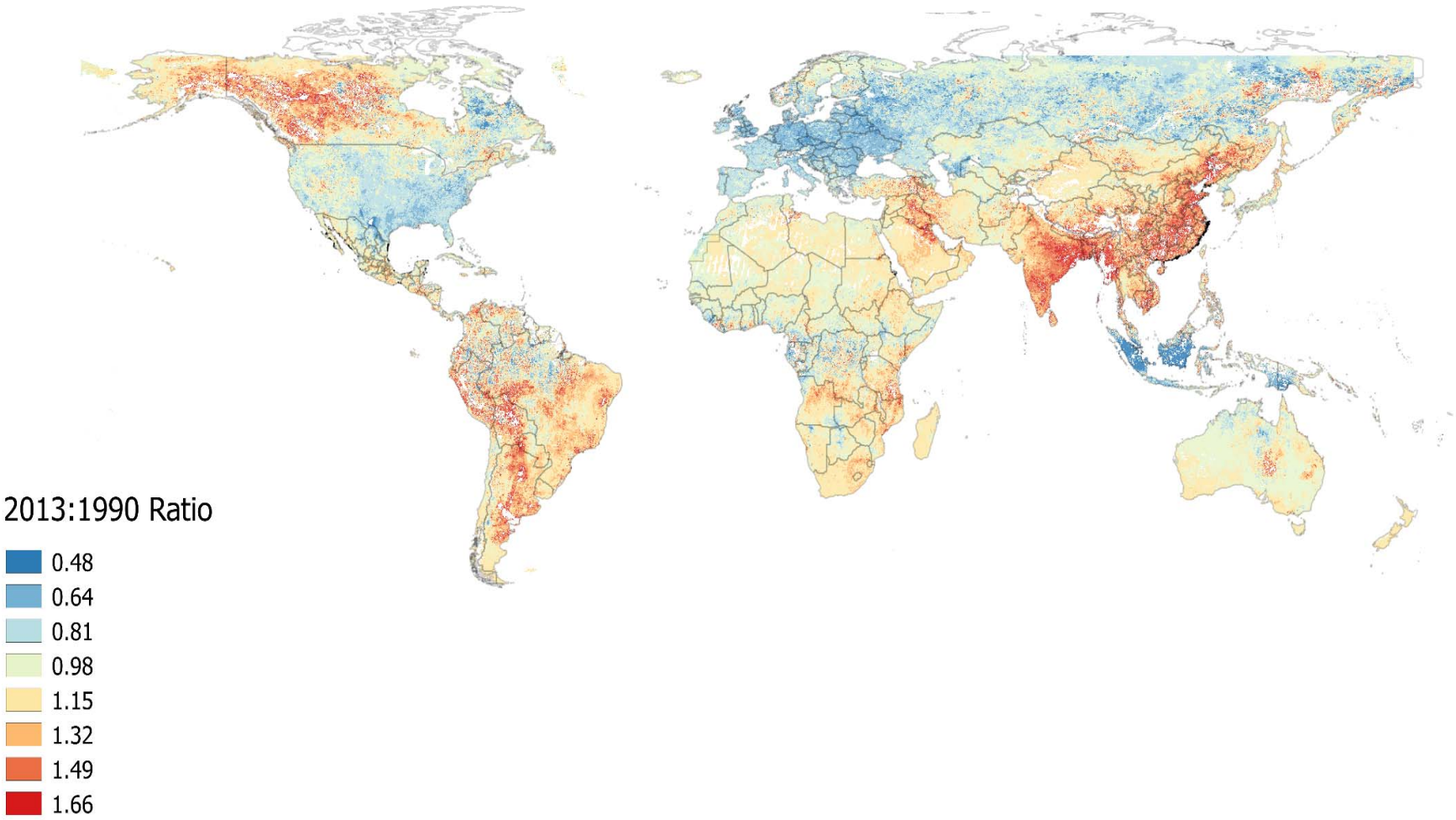
2013 Annual Average $PM_{2.5}$



87% global population in areas exceeding WHO Air Quality Guideline (10 µg/m³ $PM_{2.5}$ annual average)

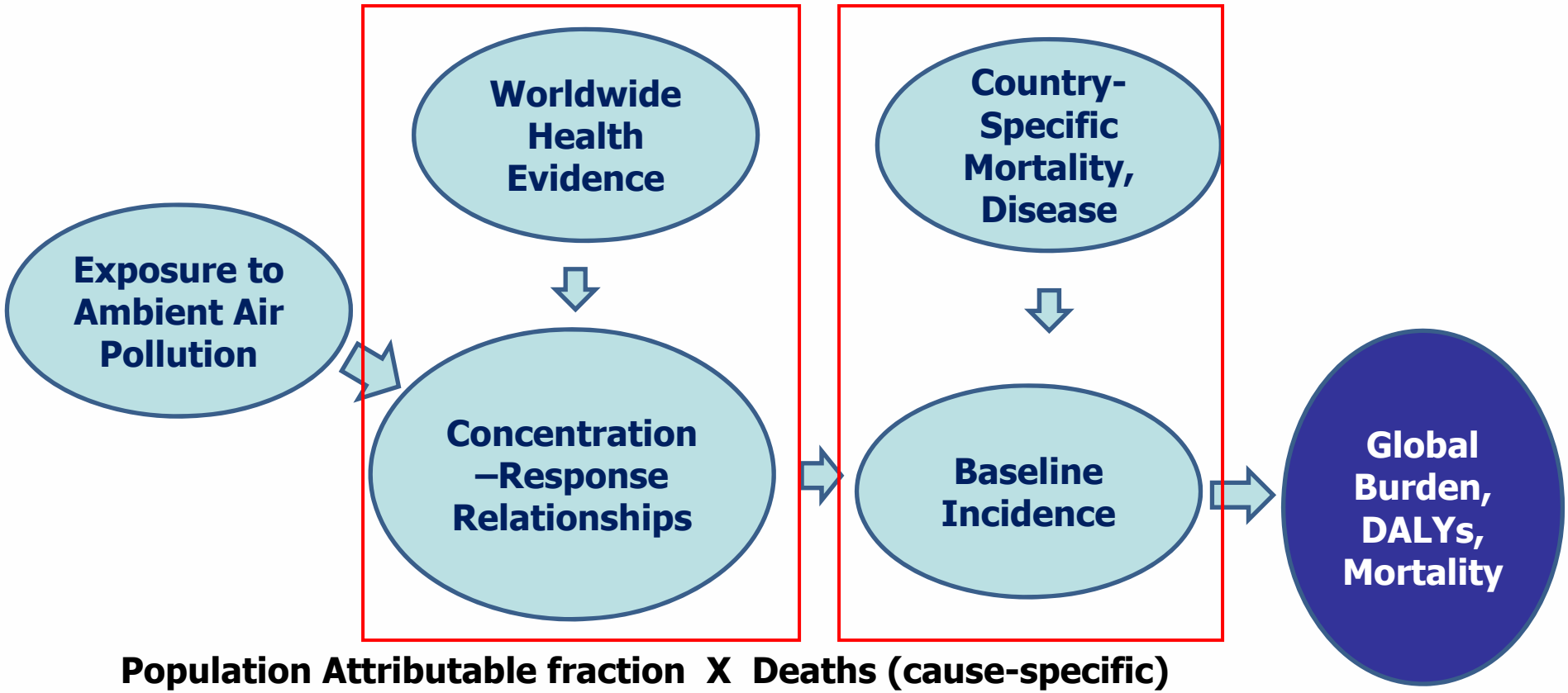
Brauer et al. 2015

1990 – 2013 Change in Annual Average $PM_{2.5}$



Brauer et al. 2015

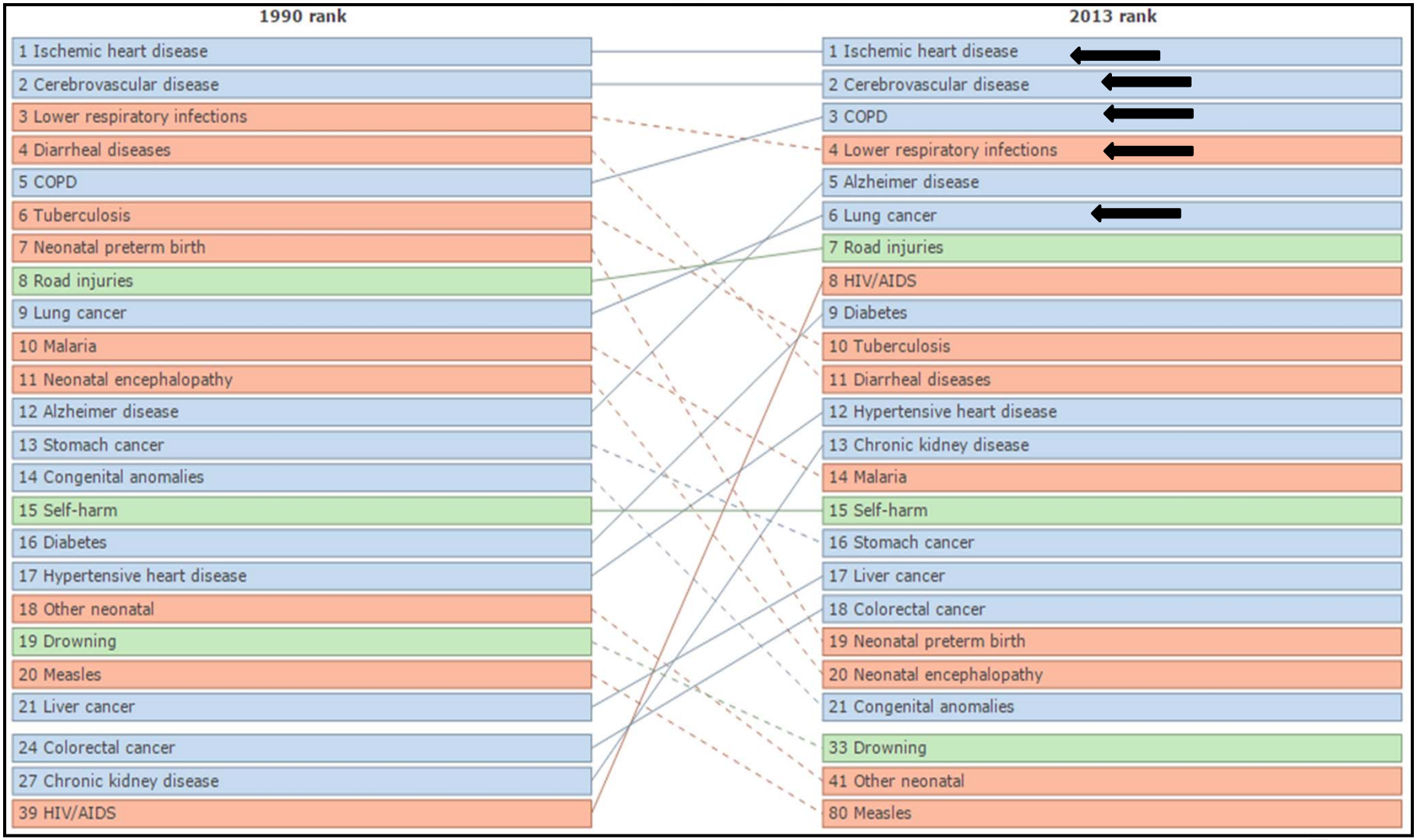
General approach



Population Attributable fraction X Deaths (cause-specific)
Population Attributable fraction X DALYs (cause-specific)

Cause-specific mortality/incidence at national and subnational level (China, Mexico, UK)

Diseases affected by air pollution: 4 of the top 5 causes of the global burden of disease in 2013

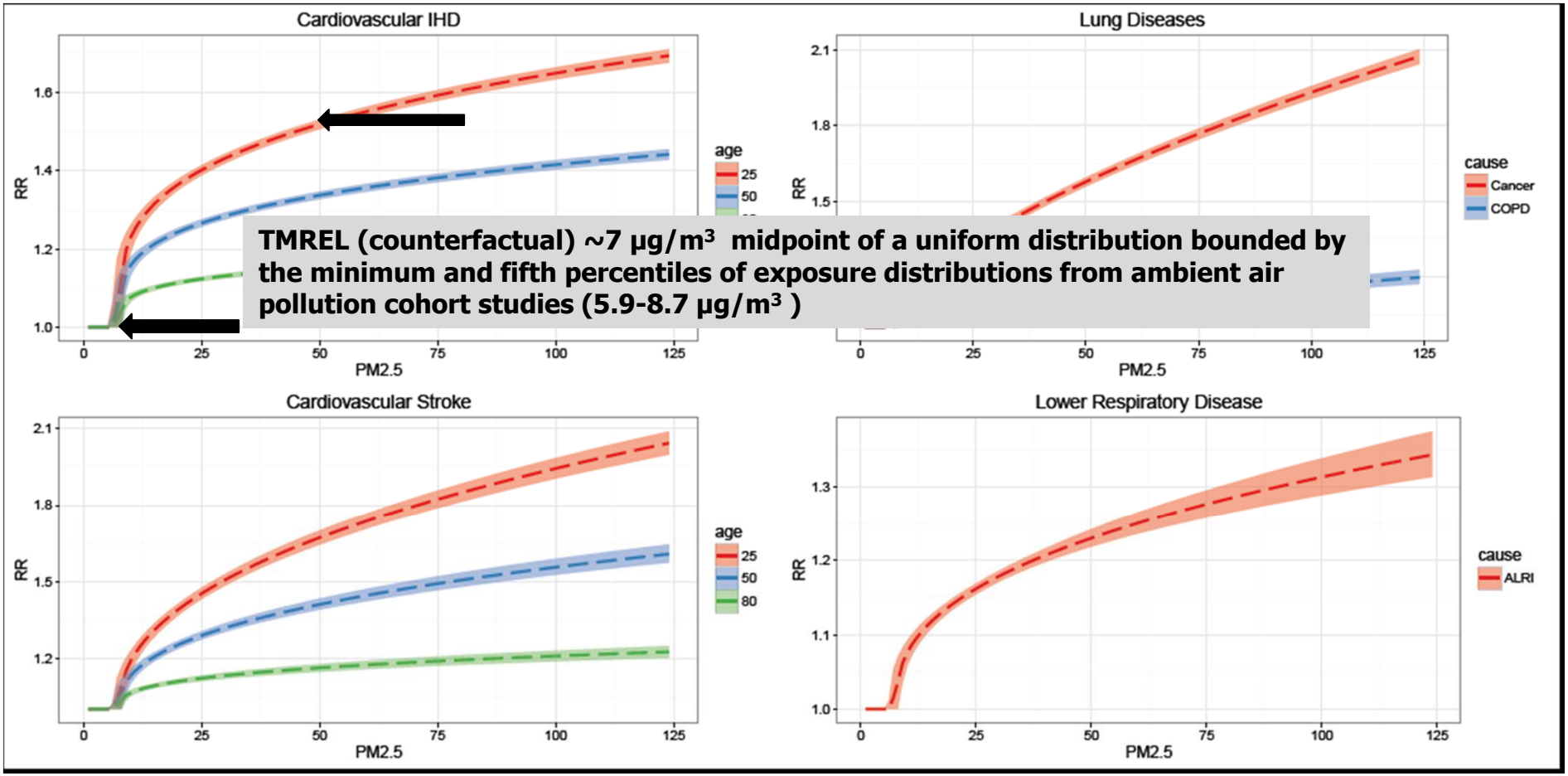


GBD 2013 Mortality and Causes of Death Collaborators *The Lancet 2014*

A Mortality Risk Model for the Global Burden of Ambient $PM_{2.5}$

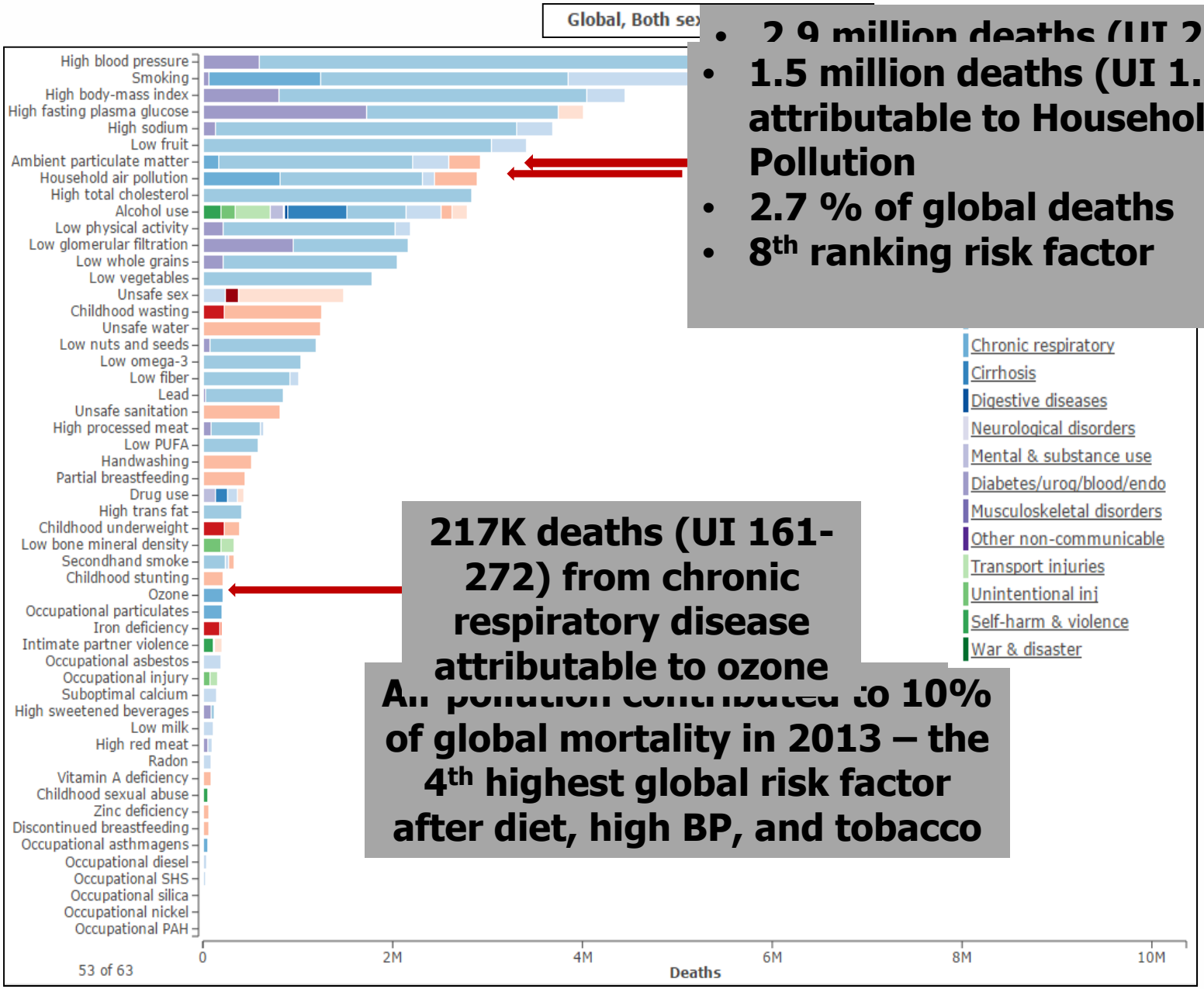
- All cohort studies of $PM_{2.5}$ and mortality from chronic disease have been conducted in the US and Western Europe at $PM_{2.5}$ 5µg/m^3 to 30µg/m^3
- Need new models to estimate risk over the entire global range up with annual average $PM_{2.5}$ greater than 100 µg/m^3in East and South Asia and other regions
- Estimate risk across the full global range of $PM_{2.5}$ concentrations by integrating epidemiologic evidence on risk of mortality from major sources of exposure to $PM_{2.5}$ (Burnett et al. 2014)
    - active smoking
    - second-hand smoke
    - household burning of solid fuels
    - ambient $PM_{2.5}$
- Key assumption: risk is a function of $PM_{2.5}$ inhaled dose regardless of PM source

GBD 2013 Integrated Exposure Response Functions



GBD Risk Factor Collaborators 2015; Cohen/Brauer et al. 2016 Submitted

GBD 2013 Mortality Risk Factors



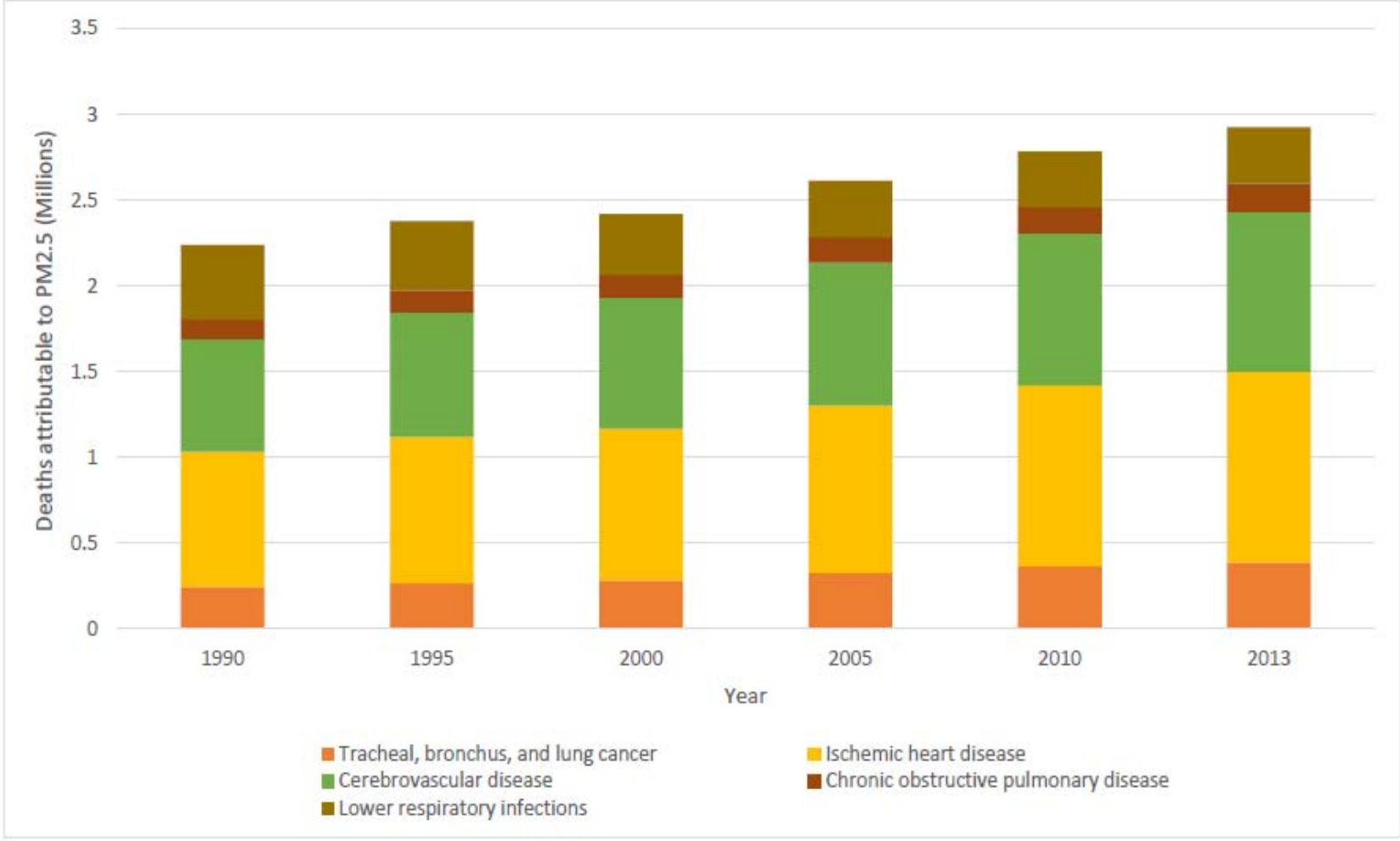
- 2.9 million deaths (UI 2.7-3.1)
- 1.5 million deaths (UI 1.3-1.7) attributable to Household Air Pollution
- 2.7 % of global deaths
- 8th ranking risk factor

217K deaths (UI 161-272) from chronic respiratory disease attributable to ozone

Air pollution contributed to 10% of global mortality in 2013 – the 4th highest global risk factor after diet, high BP, and tobacco

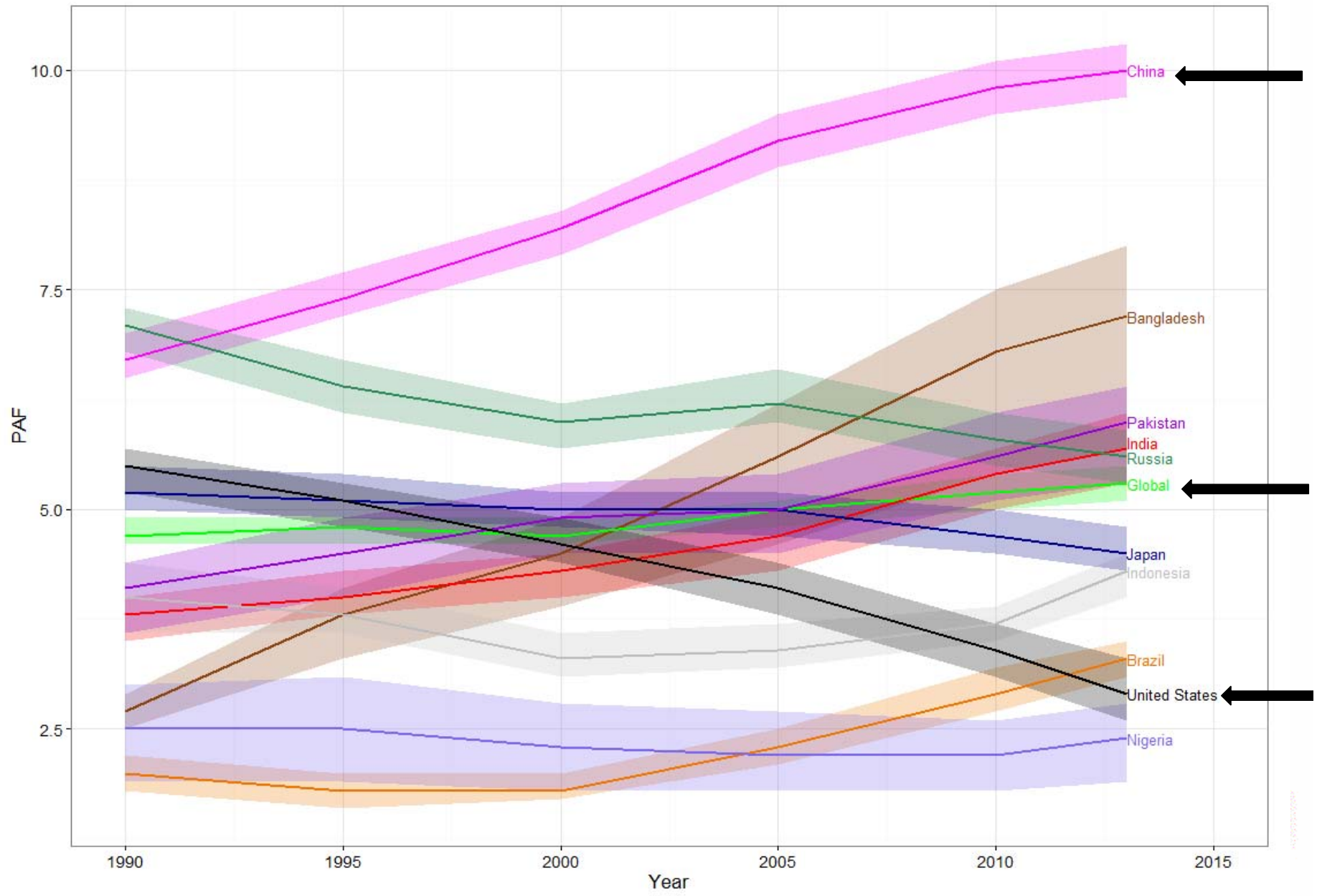
GBD Risk Factor Collaborators 2015; http://vizhub.healthdata.org/gbd-compare

Global Deaths Attributable to Ambient $PM_{2.5}$ by Cause 1990-2013



http://vizhub.healthdata.org/gbd-compare/, Cohen/Brauer et al. 2016 Submitted

Proportion of deaths due to ambient $PM_{2.5}$ 1990-2013 in world's ten most populous countries



Conclusions, Implications & Challenges

- Ambient air pollution contributed substantially to the global burden of disease in 2013 and the burden has increased over the past 23 years

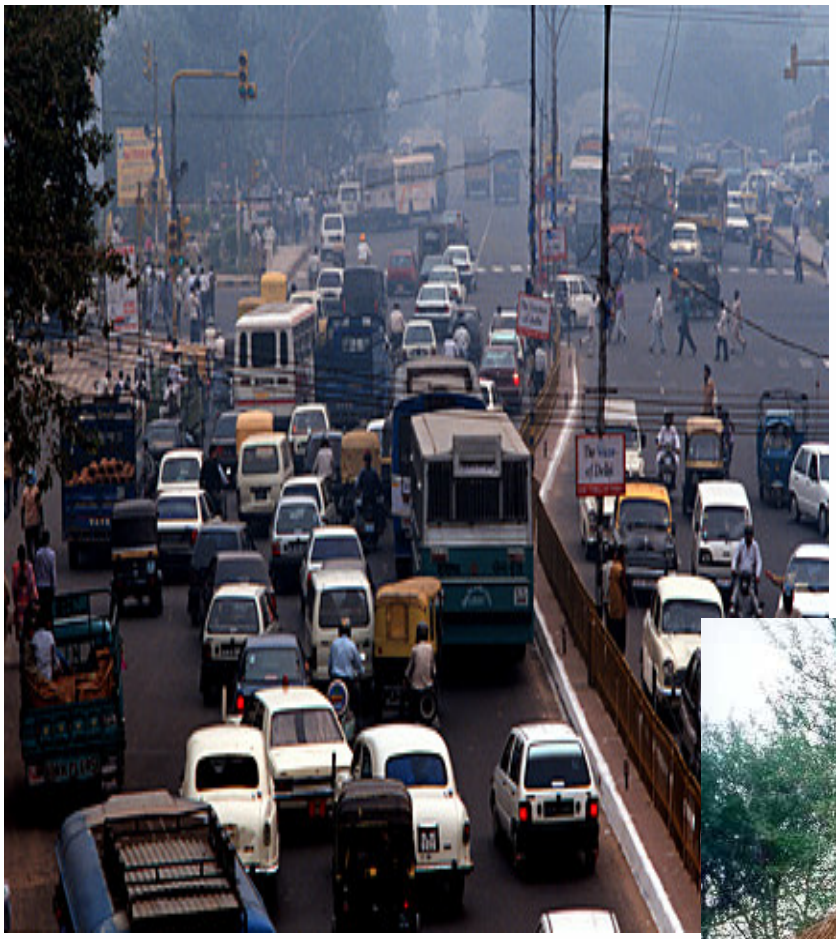
- This increase reflects both trends in population aging and non-communicable disease rates and increasing levels of air pollution in low and middle-income countries

- Demographic trends suggest that burdens will likely increase even if air pollution levels decrease

- Nonlinear exposure-response functions suggest relatively modest reductions in burden in the most polluted countries unless $PM_{2.5}$ levels are substantially decreased

- Despite these challenges, there is the potential for considerable health benefits because reductions in exposure affect the entire population

Reducing disease burden requires control of emissions from all major sources



GBD MAPS – Global Burden of Disease from Major Air Pollution Sources

- Multi-year collaboration between the Health Effects Institute (HEI), the Institute for Health Metrics and Evaluation (IHME), Tsinghua University, IIT Mumbai, University of British Columbia and other leading academic centers

- GBDMAPS will estimate:
  - Disease burden due to ambient air pollution from coal burning and other major sources in China (nationally and by province), India and Eastern Europe using Global Burden of Disease (GBD) framework

  - Disease burden due to coal burning overall and for major sectors (power generation, industrial, domestic), as well as burden attributable to other source sectors, (transportation, domestic biomass, open biomass, solvent use, etc.)

  - Coal and other major source contributions to ambient $PM_{2.5}$ and their associated disease burdens under current conditions and future policy scenarios

- China report release June 2016, India report expected 2017

GBD MAPS International Steering Committee

Dan Greenbaum / Bob O'Keefe	Health Effects Institute
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GBD MAPS methodology