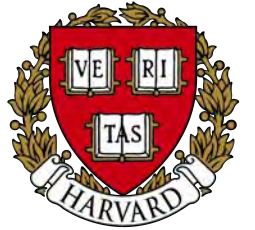


Global premature mortality due to exposure to air pollution from fossil fuels

Karn Vohra, Alina Vodonos, Joel Schwartz, Eloise A. Marais,
Melissa P. Sulprizio, Loretta J. Mickley



UNIVERSITY OF
BIRMINGHAM

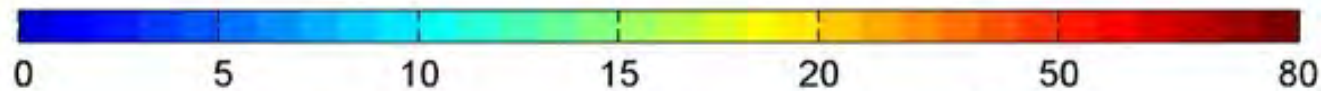
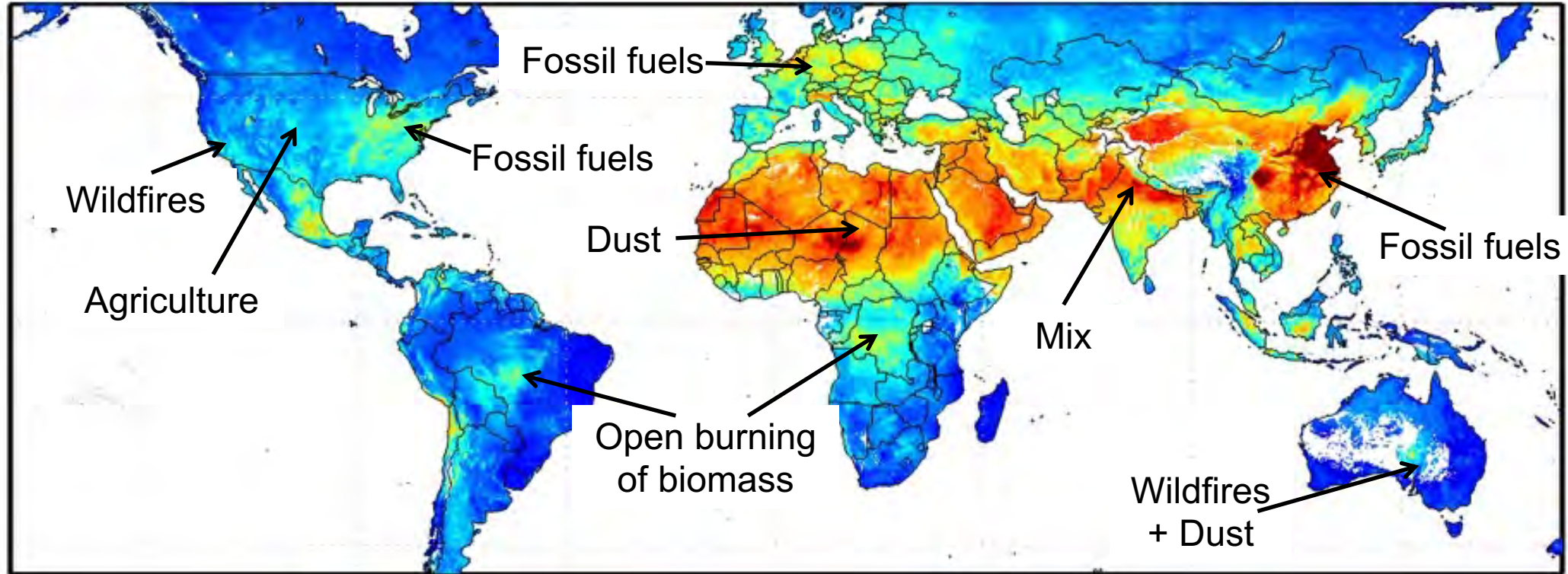
WALLACE
GLOBAL FUND

Vohra et al.: <https://www.sciencedirect.com/science/article/pii/S0013935121000487>
Research Group website: <https://maraisresearchgroup.co.uk/>

18 May 2021

Global distribution of fine particles (PM_{2.5})

PM_{2.5} derived with satellite observations and a model



Satellite-Derived PM_{2.5} [$\mu\text{g}/\text{m}^3$]

Source: van Donkelaar et al., EHP [2010]

Dominant sources can be natural or anthropogenic and vary spatially and seasonally

PM_{2.5} from burning fossil fuels

PM_{2.5} precursors emitted from a range of activities that combust fossil fuels

Combustion for transport, industry, energy generation, and domestic heating, lighting and cooking



PM_{2.5} is a mix of primary and secondary components

Direct emission
of PM_{2.5}
(primary PM_{2.5})

Emission of gas-phase
precursors
(secondary PM_{2.5})



Black carbon **primary**

Sulfate

Nitrate

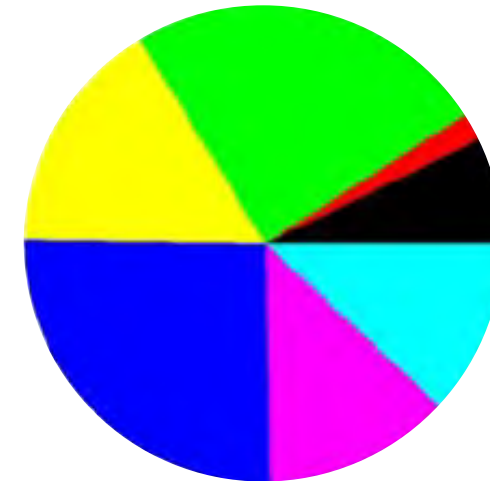
Ammonium

secondary

Other inorganics

Organic aerosols

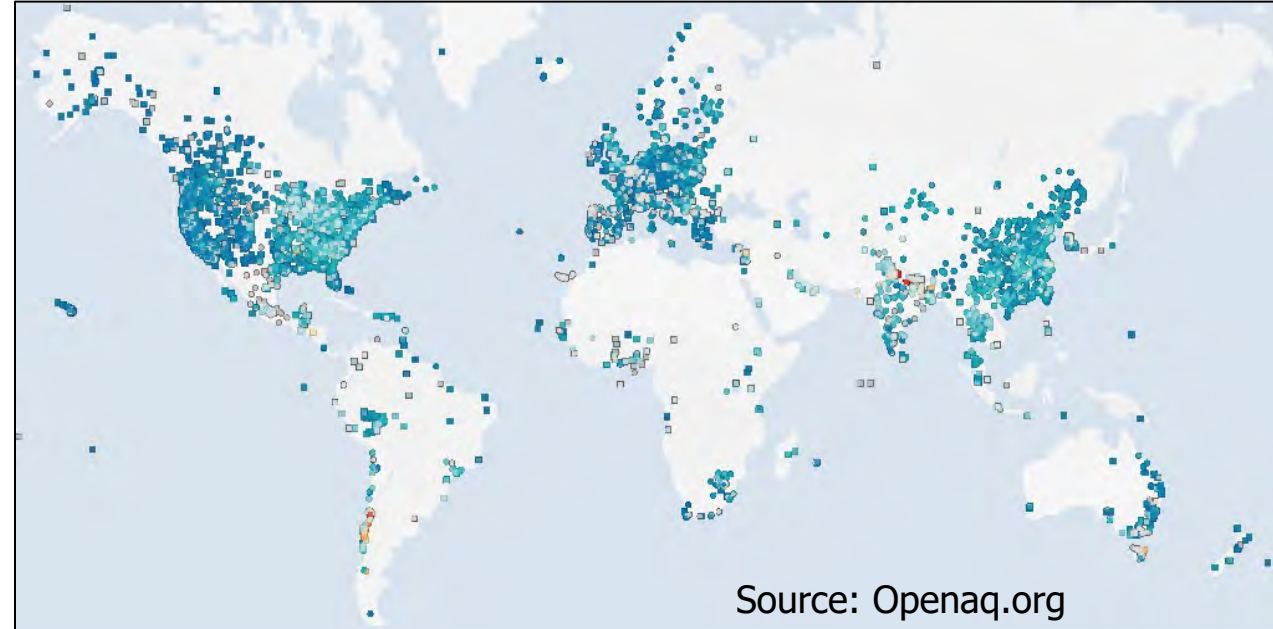
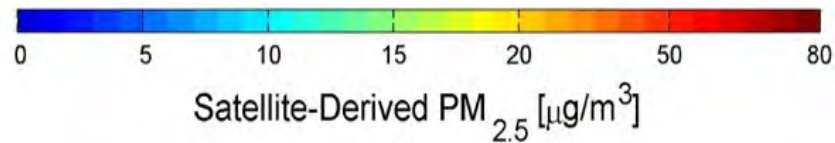
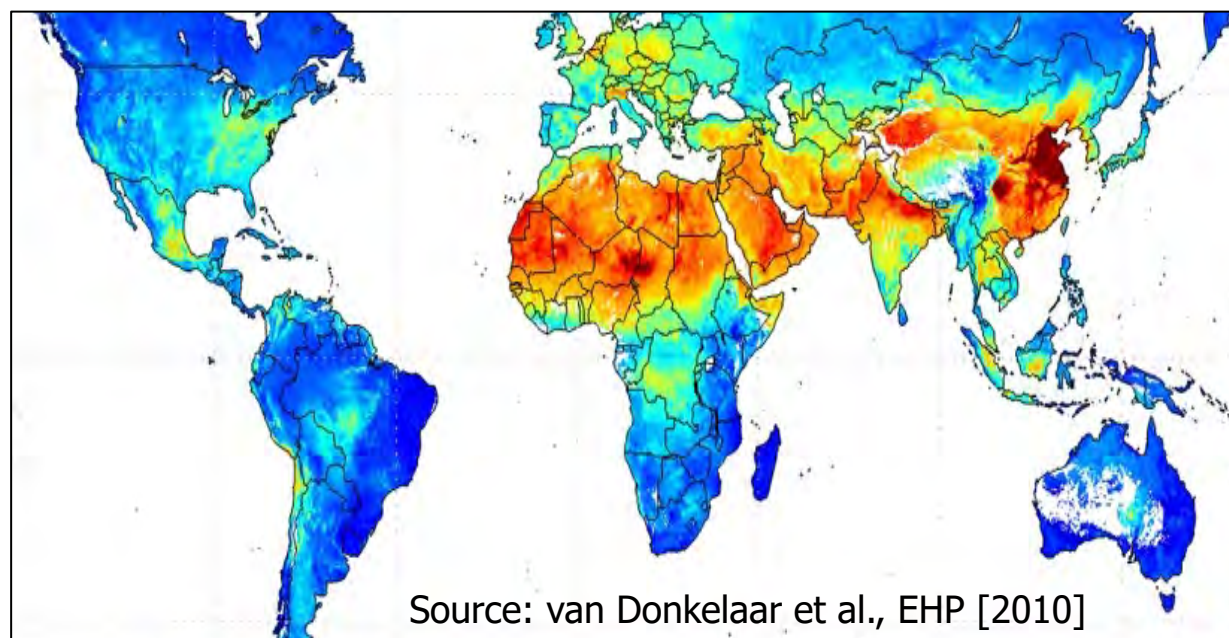
primary+secondary



PM_{2.5} includes a mix
of components

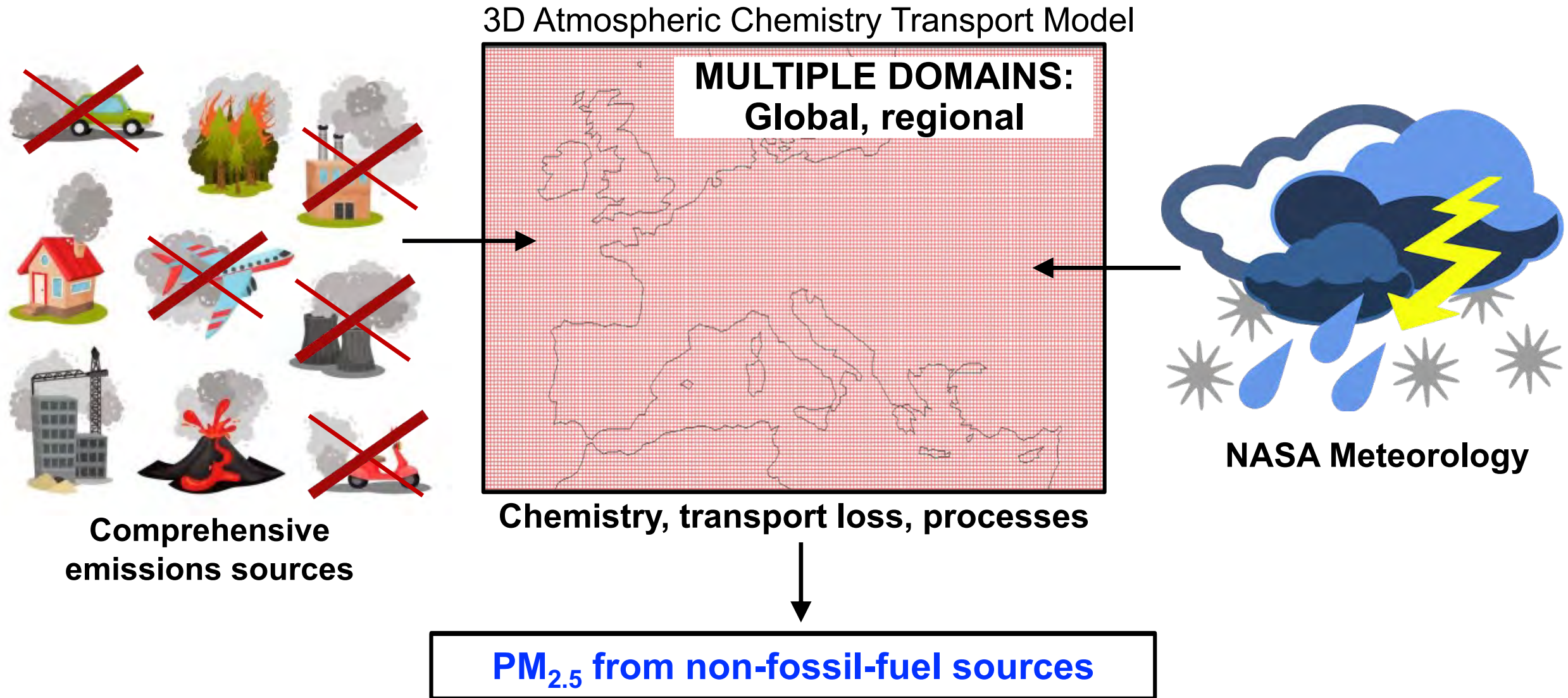
Challenging to isolate fossil-fuel PM_{2.5} using observations

Satellite products (left) and surface measurements (right) provide total PM_{2.5}



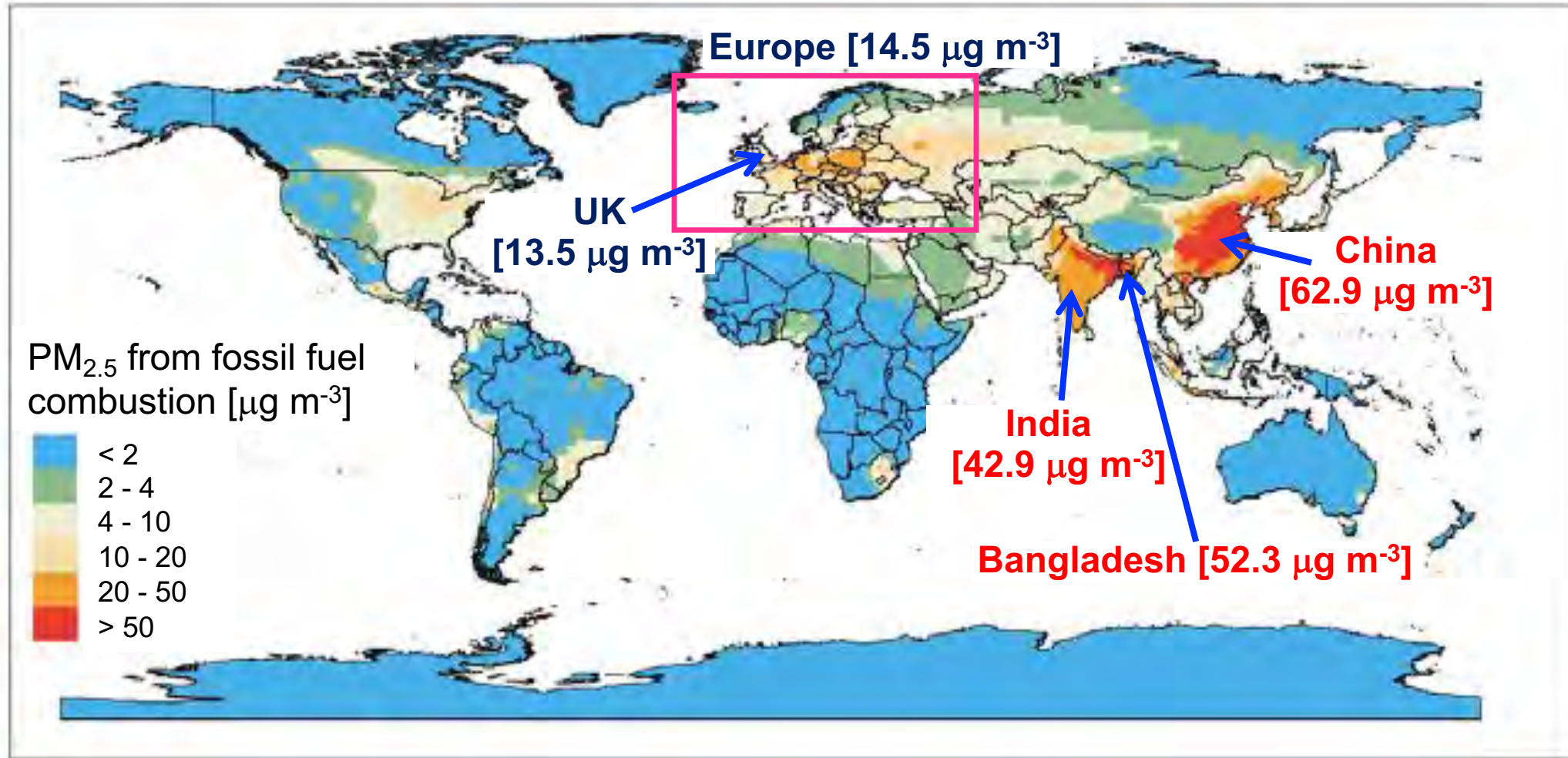
Even with measurements of the individual PM_{2.5} components, it is challenging to tease out the contribution from fossil fuels, **so we use a model.**

Simulate surface $\text{PM}_{2.5}$ using the GEOS-Chem model



Model estimate of fossil fuel PM_{2.5}

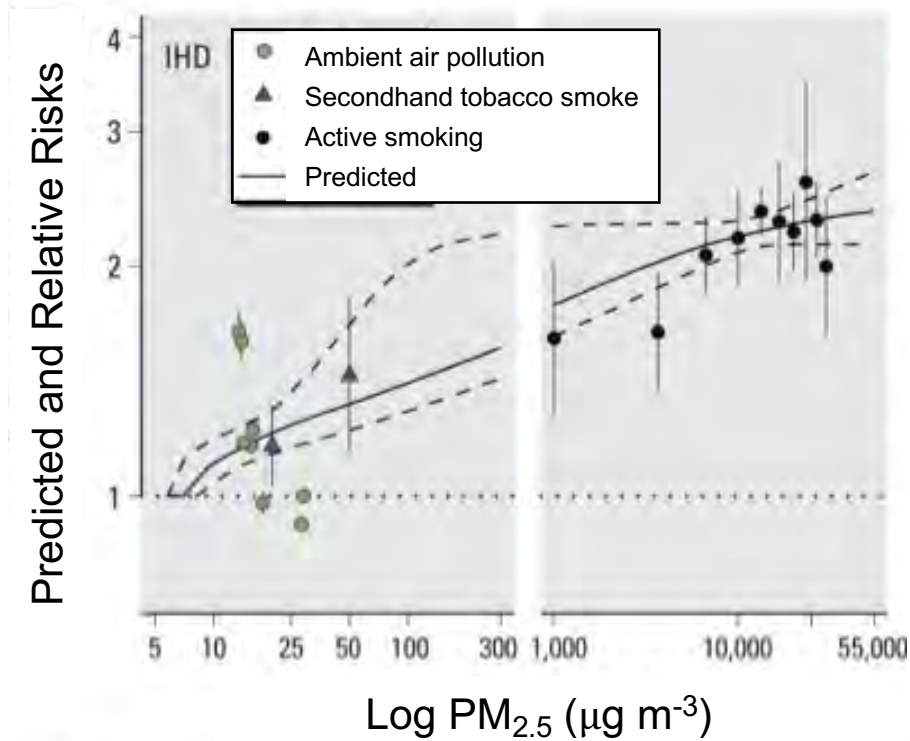
Difference between model simulations with and without fossil fuel PM_{2.5}



Hotspots are in China, Bangladesh, India, and central Europe

Standard and widely used risk assessment models

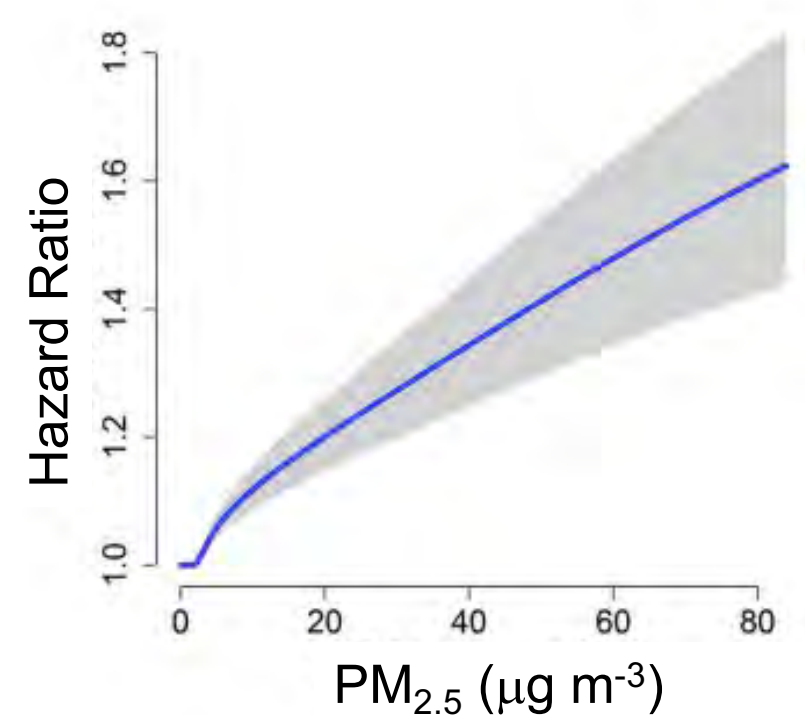
Integrated Exposure-Response (IER)



[Burnett et al., 2014]

Data includes active and passive smoking
to address outdoor PM_{2.5} > 40 μg m⁻³

Global Exposure Mortality Model (GEMM)

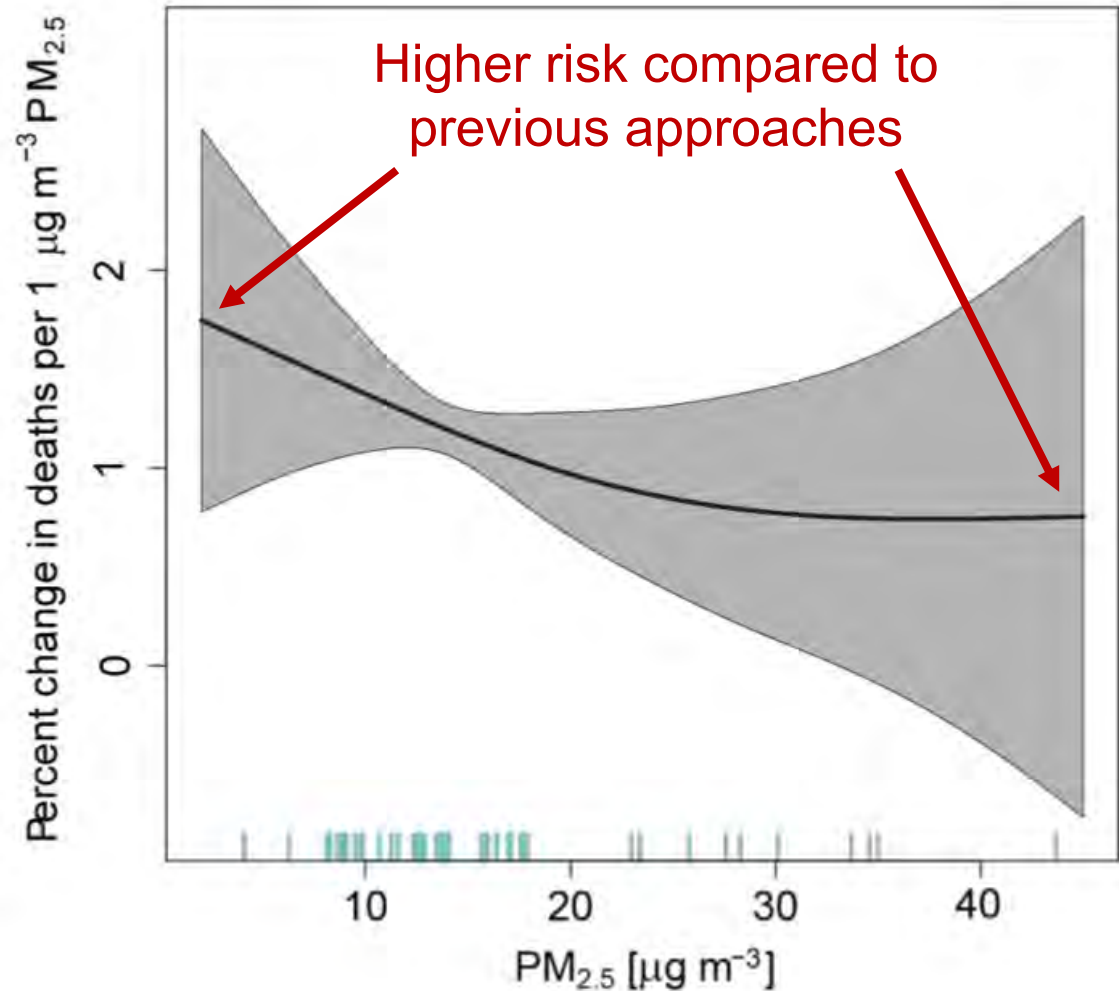


[Burnett et al., 2018]

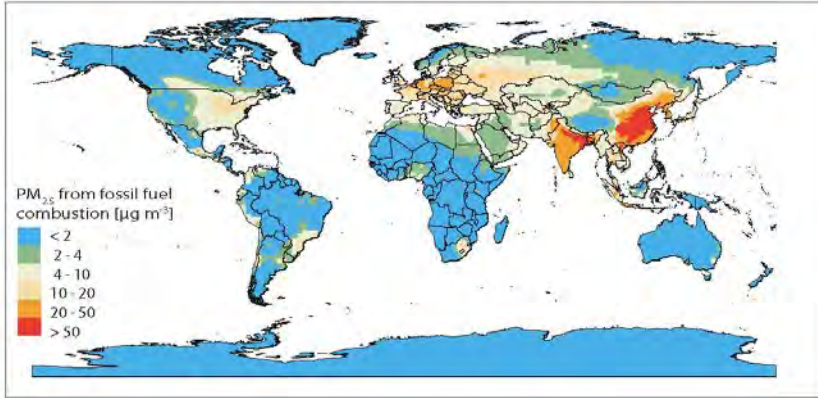
41 cohort studies and model
constrained using 4 parameters

Updated risk assessment model used in our study

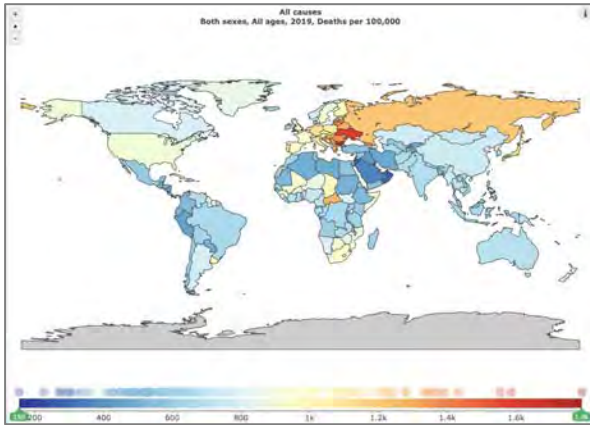
- Flexible shape of concentration-response function
- More cohort studies, and wider concentration and age range than previous approaches
- Includes death from all-causes



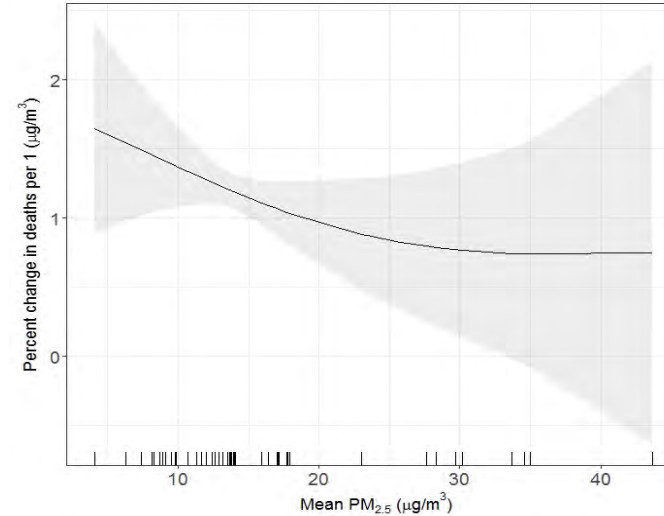
Methodology for health impact calculation



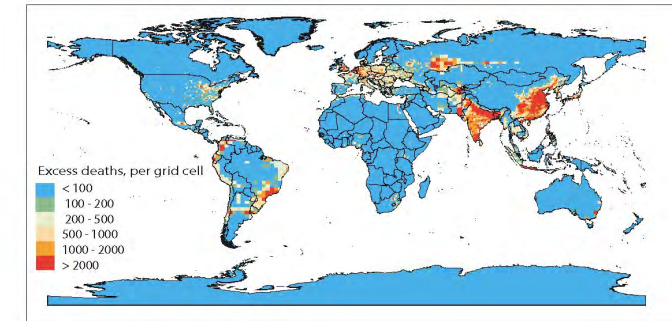
Fossil-fuel PM_{2.5} from GEOS-Chem



Baseline mortality from Global Burden of Disease



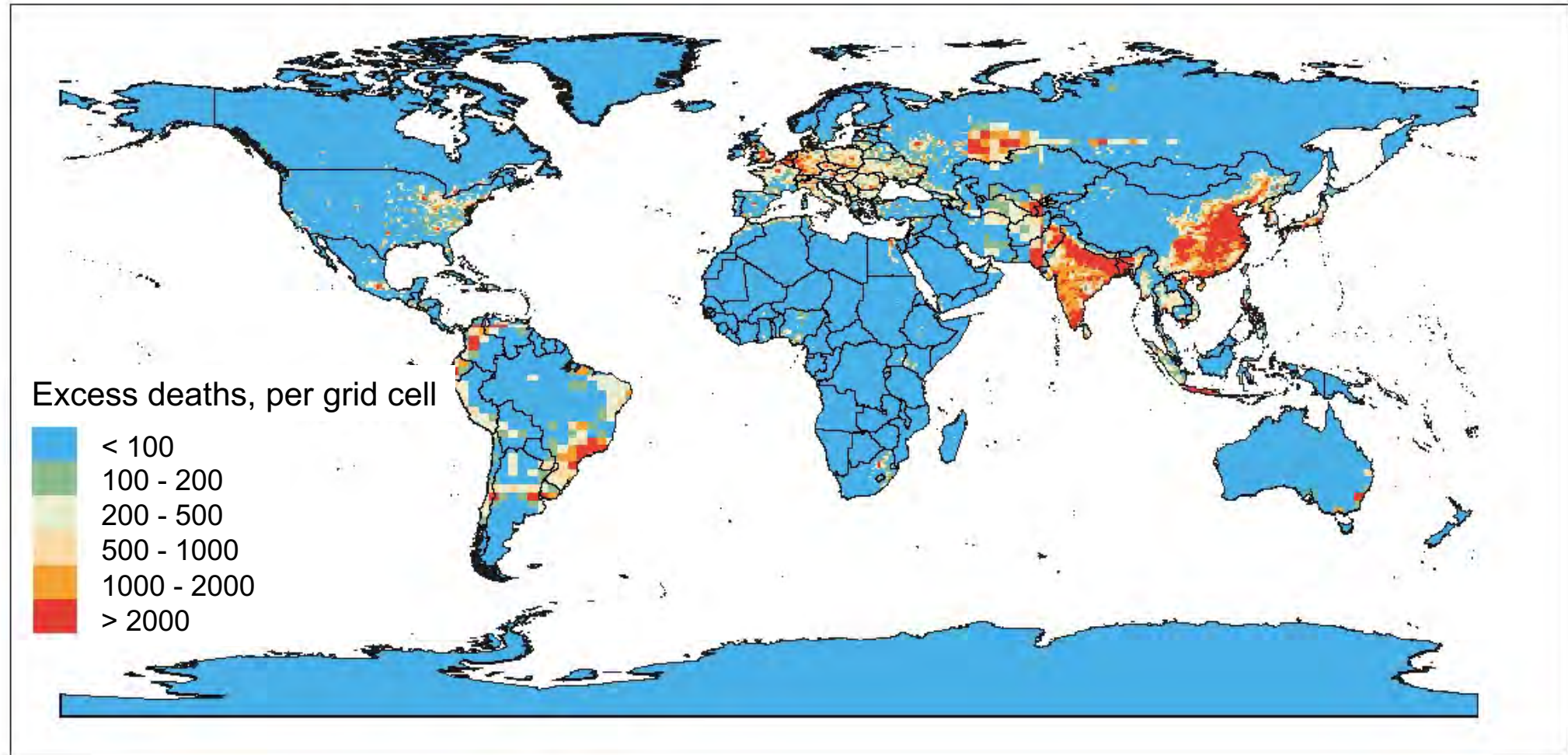
Meta-analysis concentration-response function from cohort studies



Global premature mortality estimates

We use the derived fossil-fuel PM_{2.5} with baseline mortality in the meta-analysis concentration-response function to estimate global premature mortality

Estimated global premature mortality from fossil fuel combustion

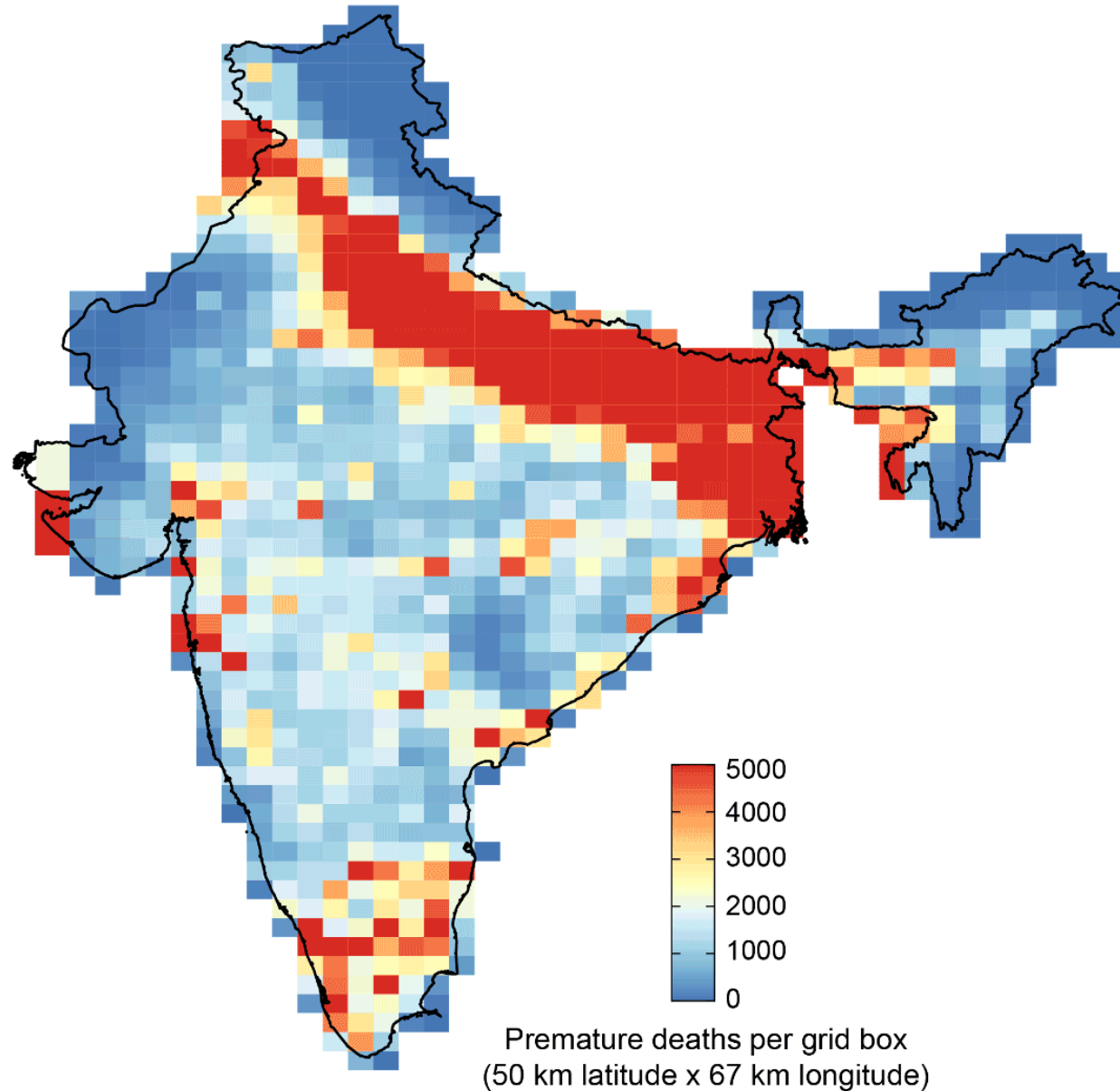


10.2 million premature deaths attributed to fossil-fuel $\text{PM}_{2.5}$ in 2012
[-47 million, 17 million]

[Vohra et al., 2021]

Regional premature mortality from fossil fuel combustion

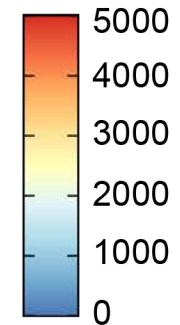
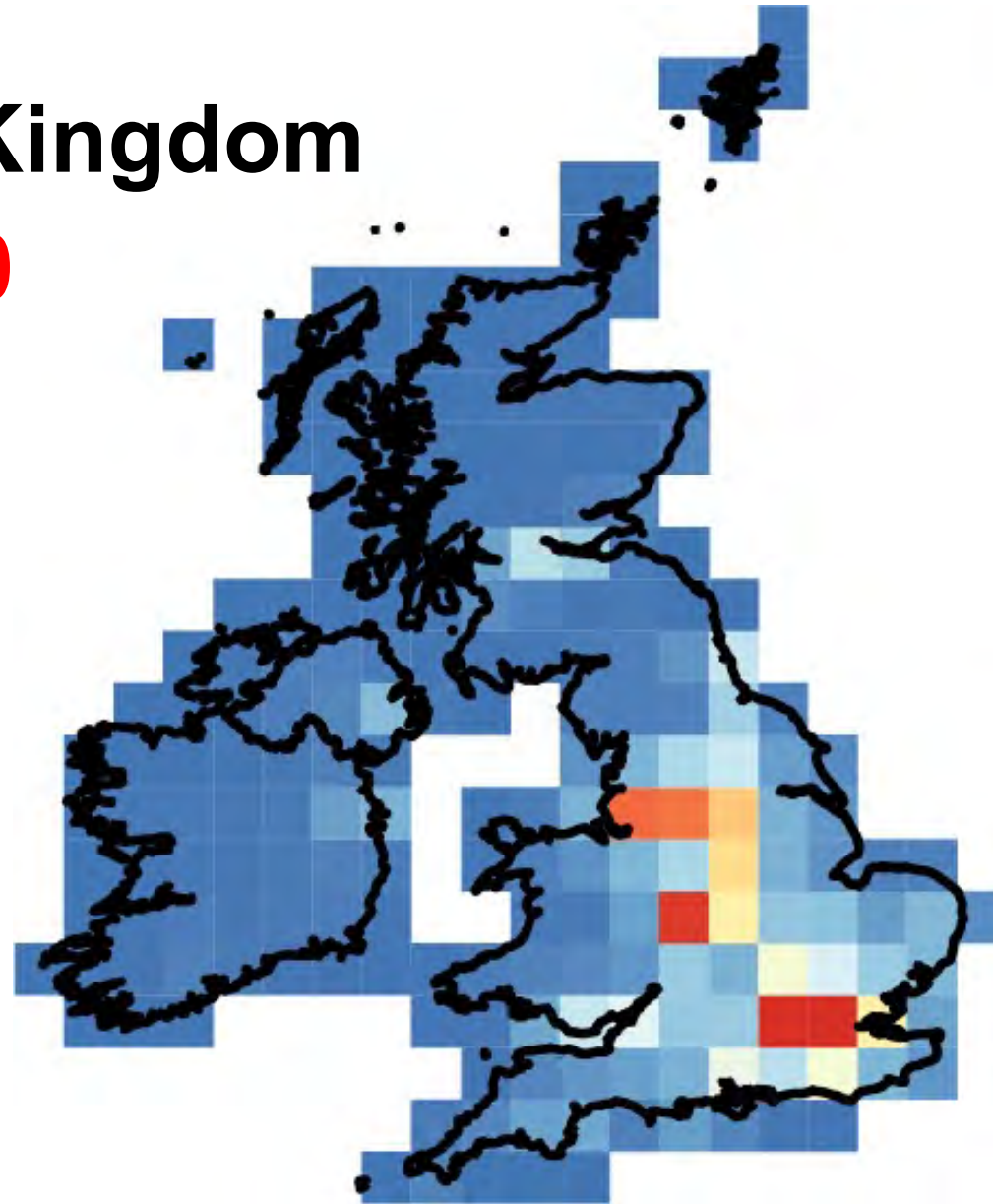
India
2,500,000



Regional premature mortality from fossil fuel combustion

United Kingdom

99,000

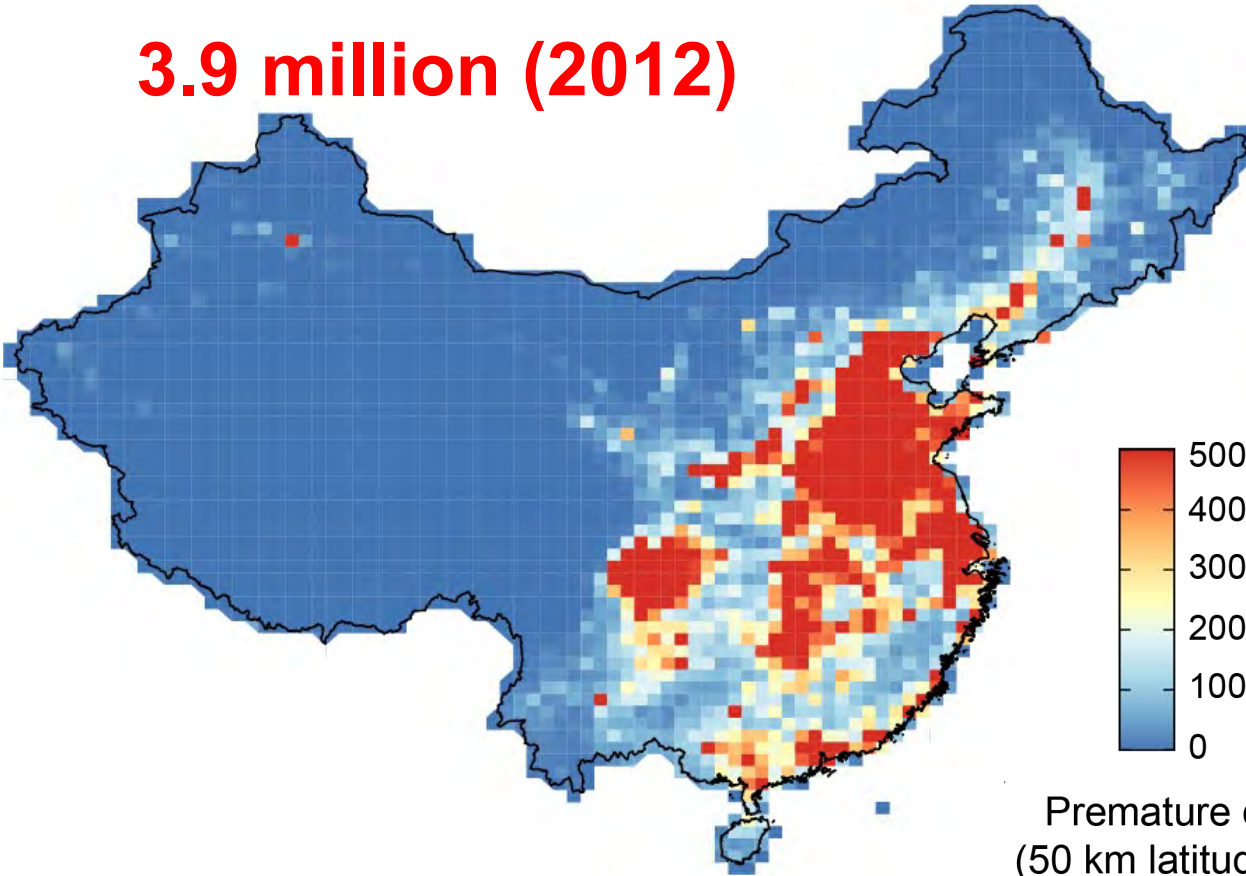


Premature deaths per grid box
(50 km latitude x 67 km longitude)

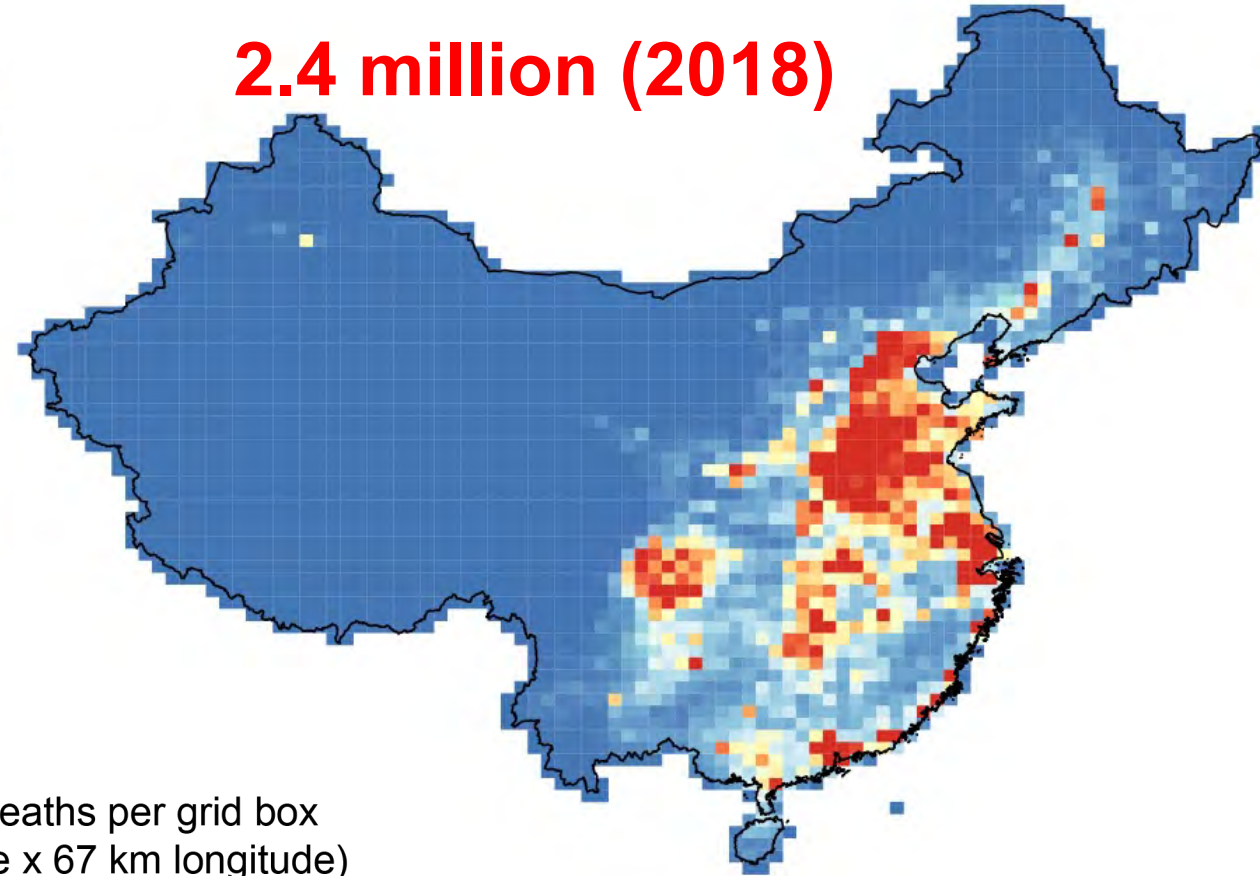
Policies can help mitigate these premature deaths

China

3.9 million (2012)



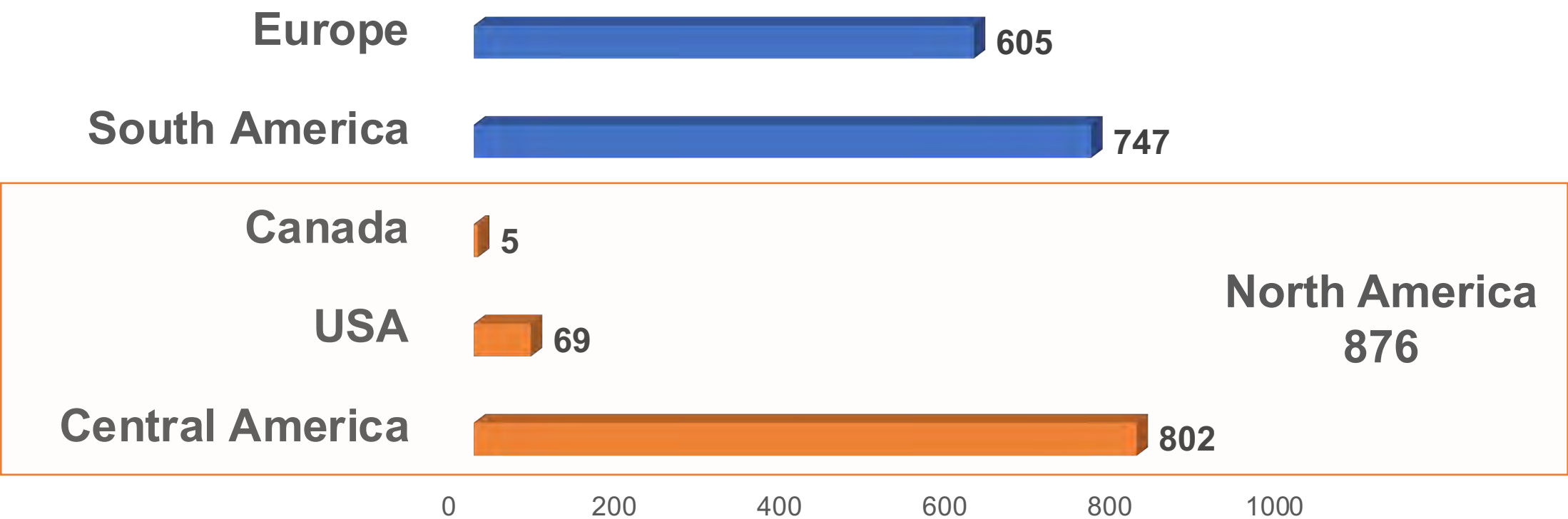
2.4 million (2018)



Premature deaths per grid box
(50 km latitude x 67 km longitude)

Dramatic reduction in PM_{2.5} in China from 2012 to 2018 decreases premature deaths by 1.5 million

Children are also affected by air pollution from fossil fuels



More than 2000 premature deaths from lower respiratory infection alone
for children < 5 years old

Implications of and response to our findings

We calculate global premature mortality that is much greater than previous estimates (updated risk assessment model, higher spatial resolution PM_{2.5})

Swell of media attention from leading news agencies and advocacy groups



<https://www.theguardian.com/environment/2021/feb/09/fossil-fuels-pollution-deaths-research>

Translated into **many languages** for audiences in France, Spain, India, Canada, China, Central and South America

Heightened immediate urgency to transition to cleaner and more sustainable energy sources

