Air pollution from fossil fuels is responsible for nearly 1 in 5 premature deaths worldwide

Karn Vohra (kxv745@bham.ac.uk), Alina Vodonos, Joel Schwartz, Eloise A. Marais, Melissa P. Sulprizio, Loretta J. Mickley

BEAR Conference 8 September 2021

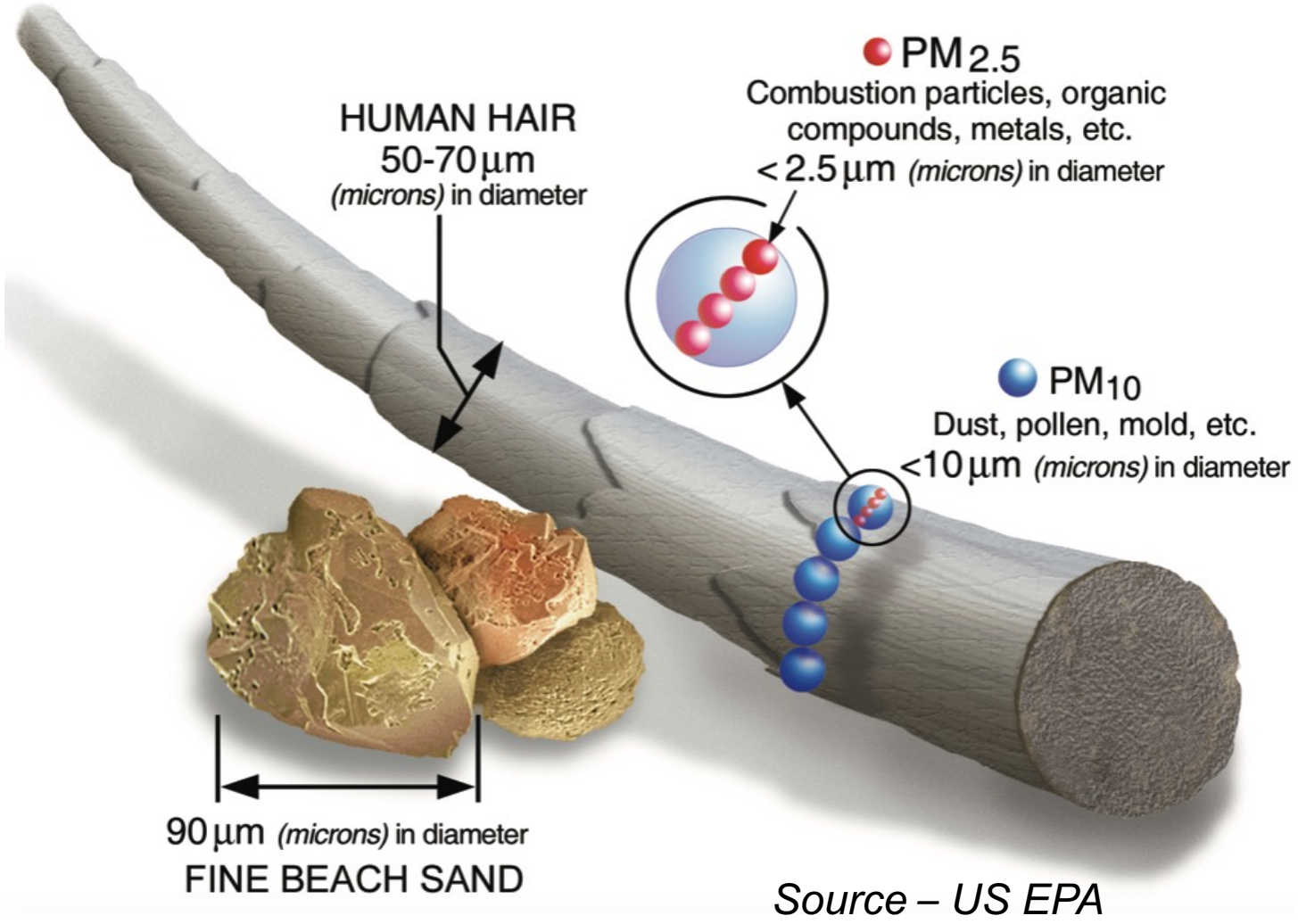
UNIVERSITY OF BIRMINGHAM

UCL

WALLACE GLOBAL FUND

What is PM?

Particulate Matter (PM) – solid particles or liquid droplets suspended in air



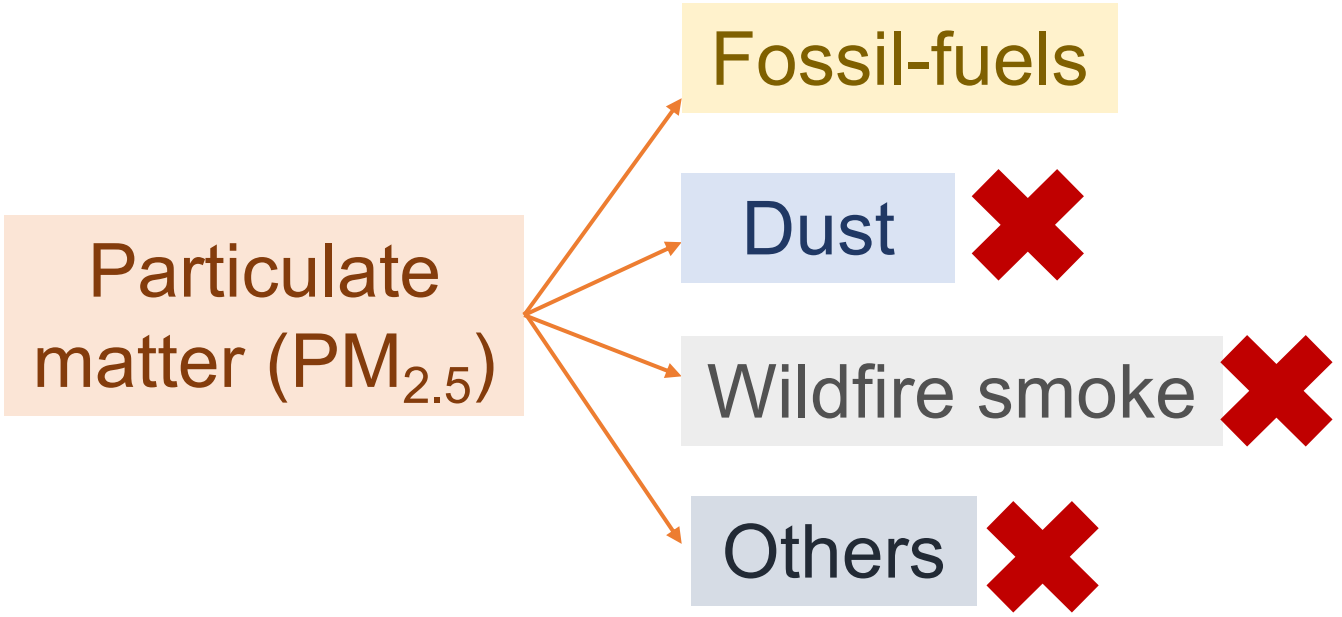
Source – US EPA

Why fossil-fuel related $PM_{2.5}$?

4.2 million deaths attributed to ambient $PM_{2.5}$ in 2015

[Cohen et al. 2017]

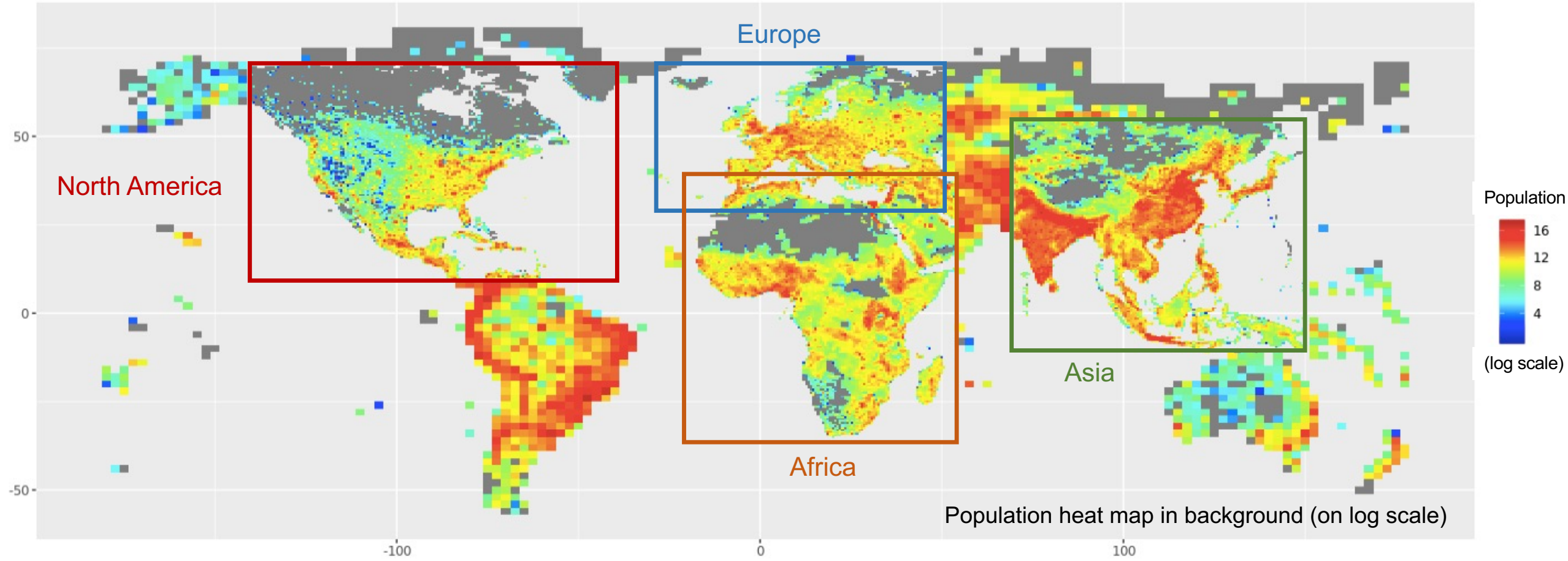
Dominant anthropogenic source;
Can be easily controlled



In this study, we use a chemical transport model GEOS-Chem to estimate $PM_{2.5}$ contribution from fossil-fuel combustion

We carry both global and regional scale GEOS-Chem simulations replicating 2012 pollution conditions

GEOS-Chem v10-01, driven by 2012 GEOS-5 offline assimilated meteorology



Global (coarse grid resolution : 2° × 2.5°)

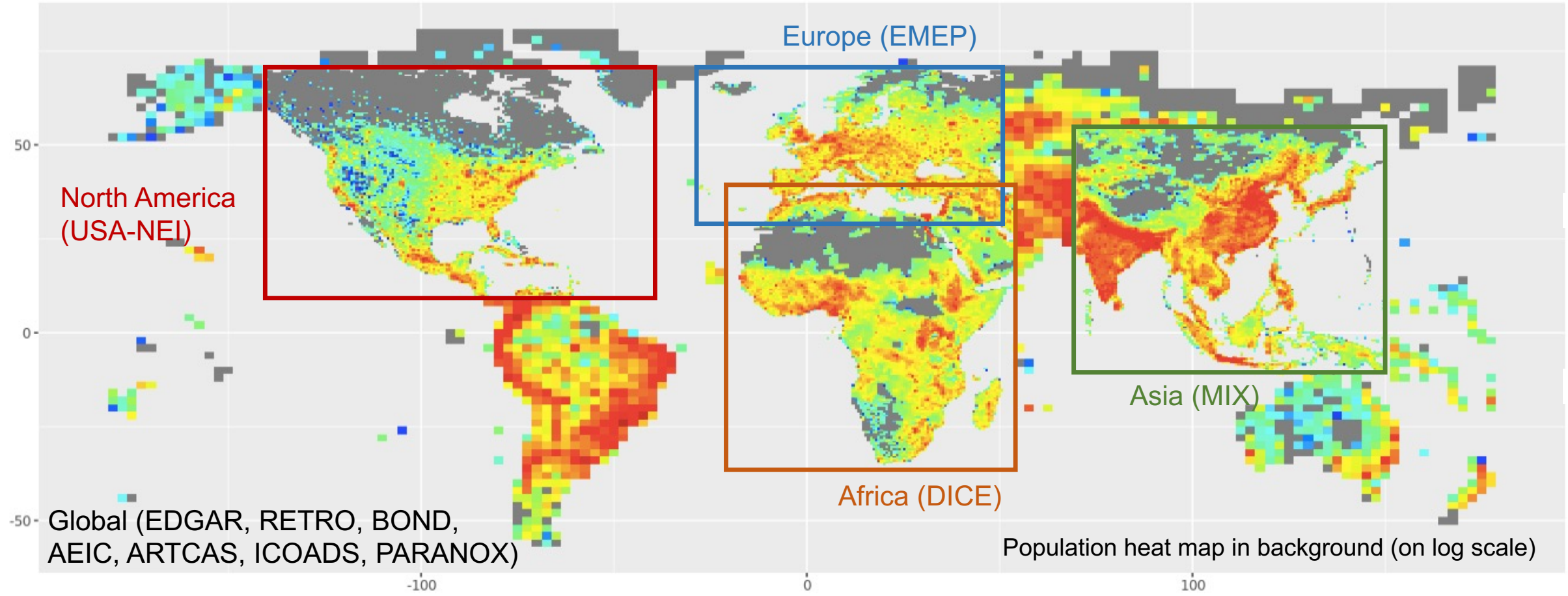
Regional (fine grid resolution : 0.5° × 0.67°)

Simulation 1 : All emissions

Simulation 2 : Fossil-fuel turned OFF

We carry both global and regional scale GEOS-Chem simulations replicating 2012 pollution conditions

GEOS-Chem v10-01, driven by 2012 GEOS-5 offline assimilated meteorology



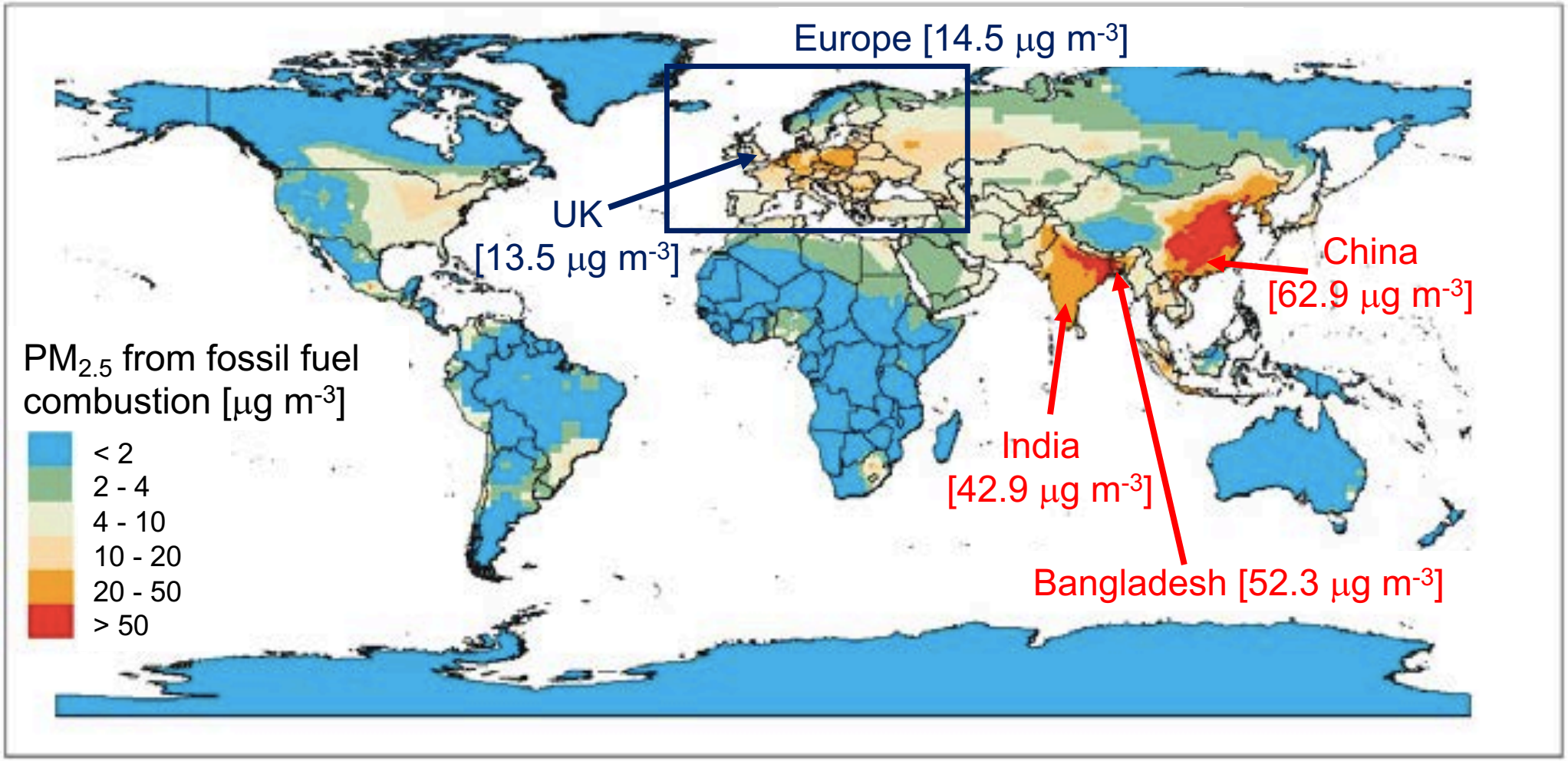
Global (coarse grid resolution : 2° × 2.5°)

Regional (fine grid resolution : 0.5° × 0.67°)

Simulation 1 : All emissions

Simulation 2 : Fossil-fuel turned OFF

Fossil-fuel estimates from GEOS-Chem simulations



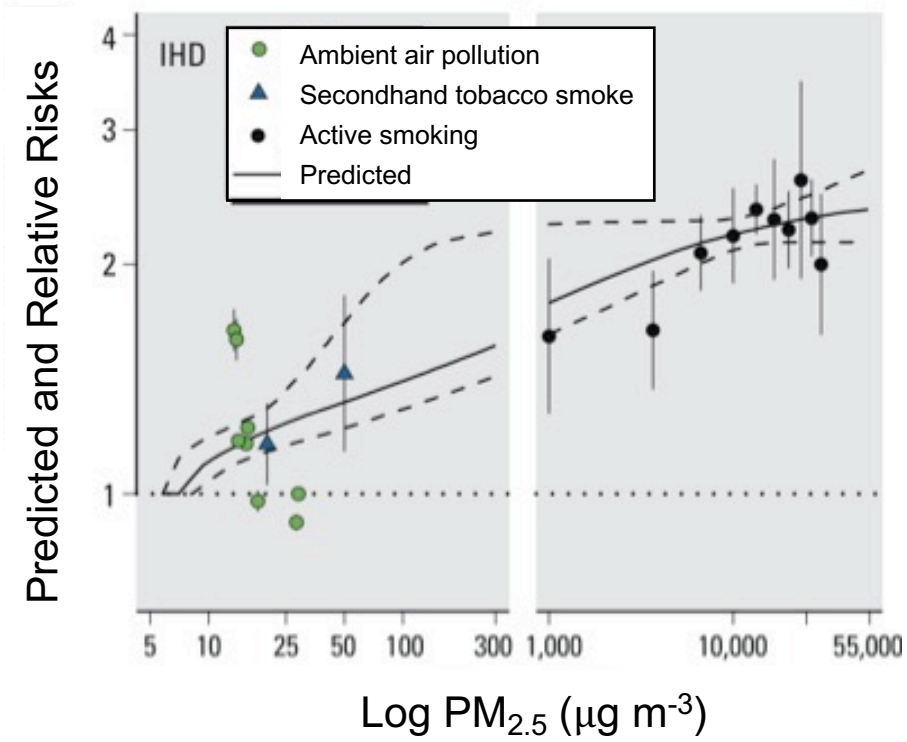
WHO guideline [10 μg m-3]

China, Bangladesh and India have the highest annual mean fossil-fuel $PM_{2.5}$ in 2012

[Vohra et al., 2021]

Standard and widely used risk assessment models

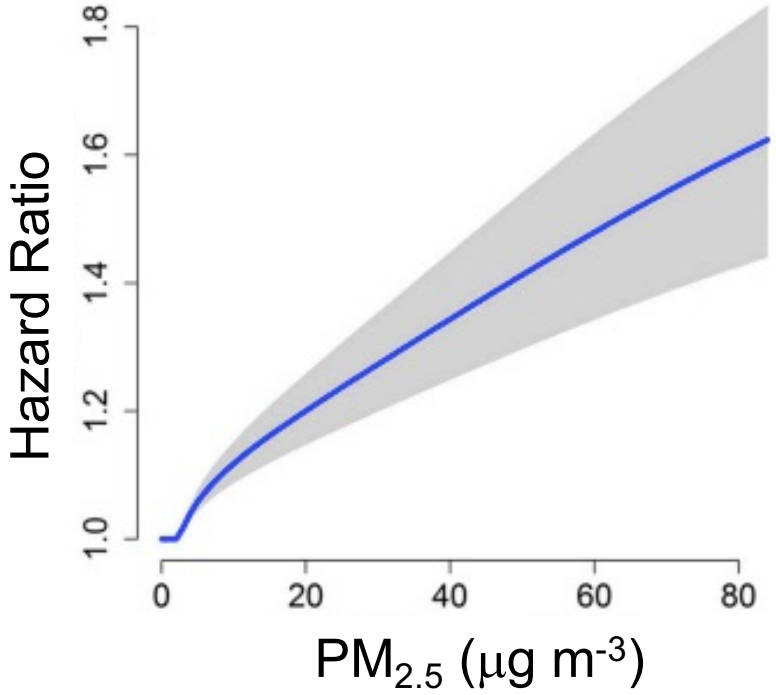
Integrated Exposure-Response (IER)



[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)

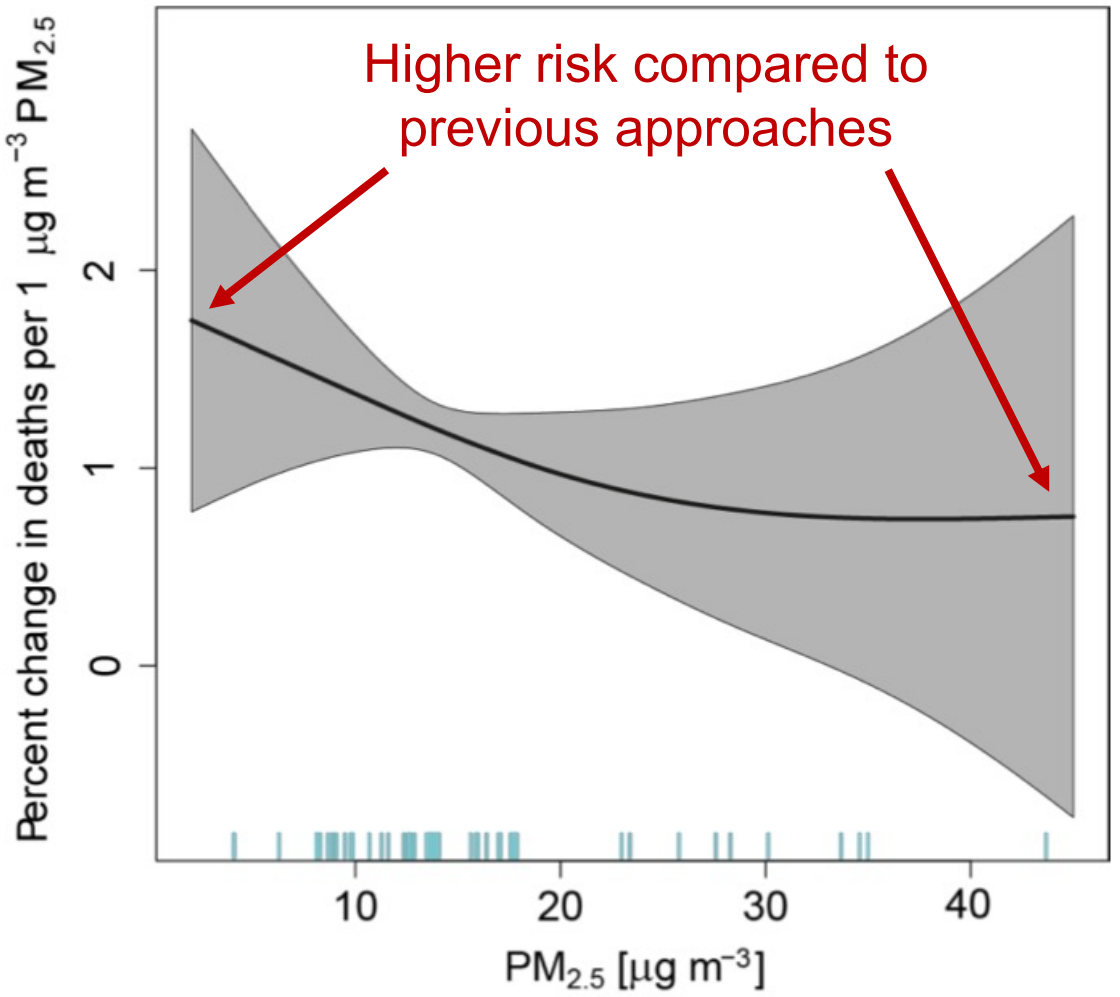


[Burnett et al., 2018]

41 cohort studies and model constrained using 4 parameters

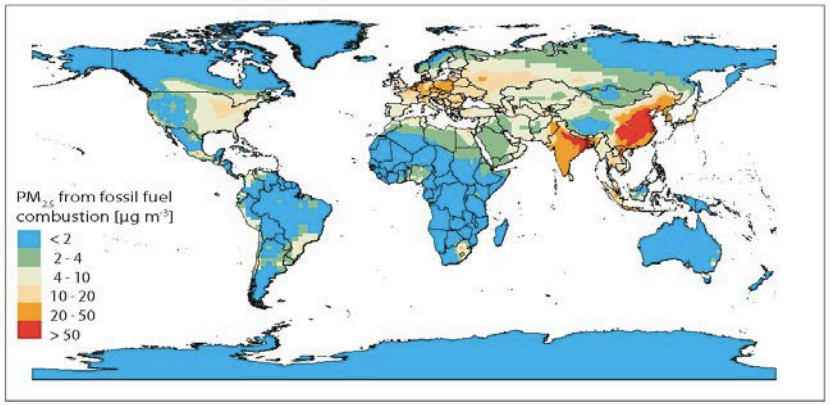
Updated risk assessment model used in our study

- Flexible shape of concentration-response function
- More cohort studies, and wider concentration and age range than previous approaches
- Includes more health endpoints

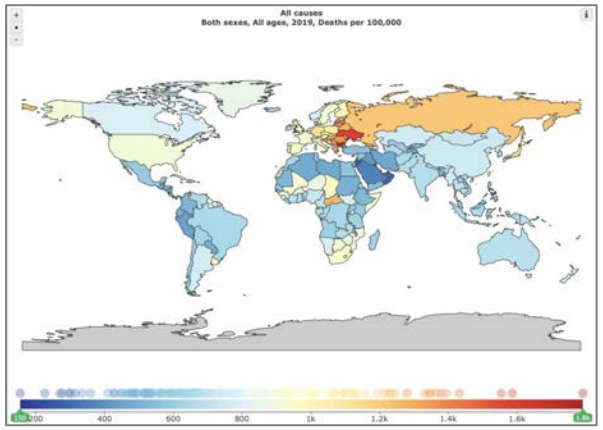


[Vodonos et al., 2018]

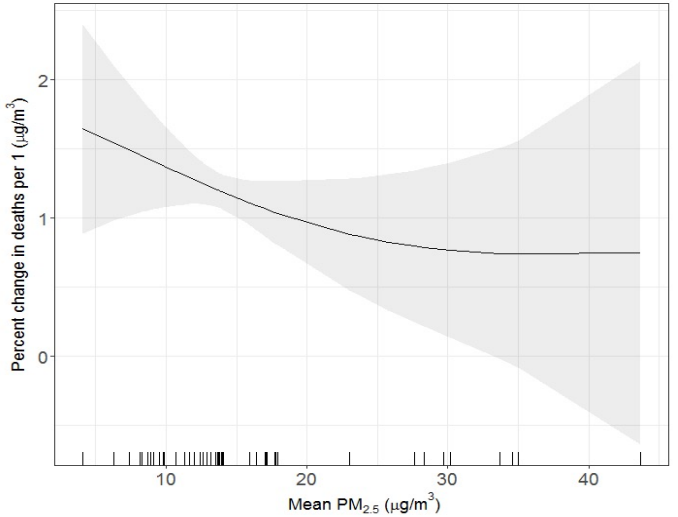
Methodology for health impact calculation



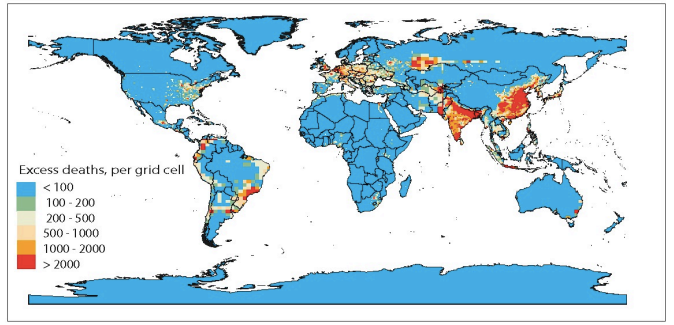
Fossil-fuel $PM_{2.5}$ from GEOS-Chem



Baseline mortality from Global Burden of Disease



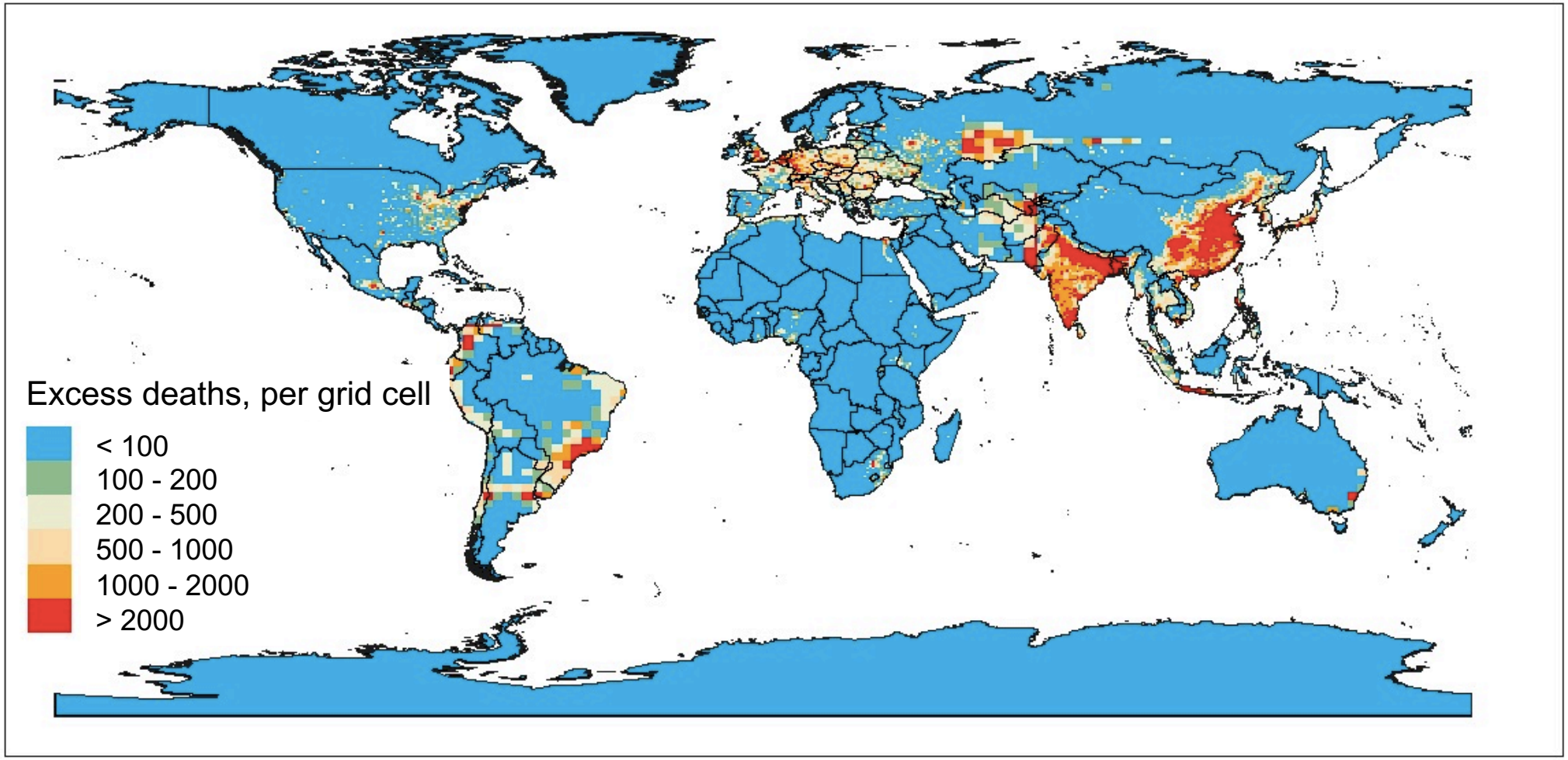
Meta-analysis concentration-response function from cohort studies



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 $PM_{2.5}$ in 2012

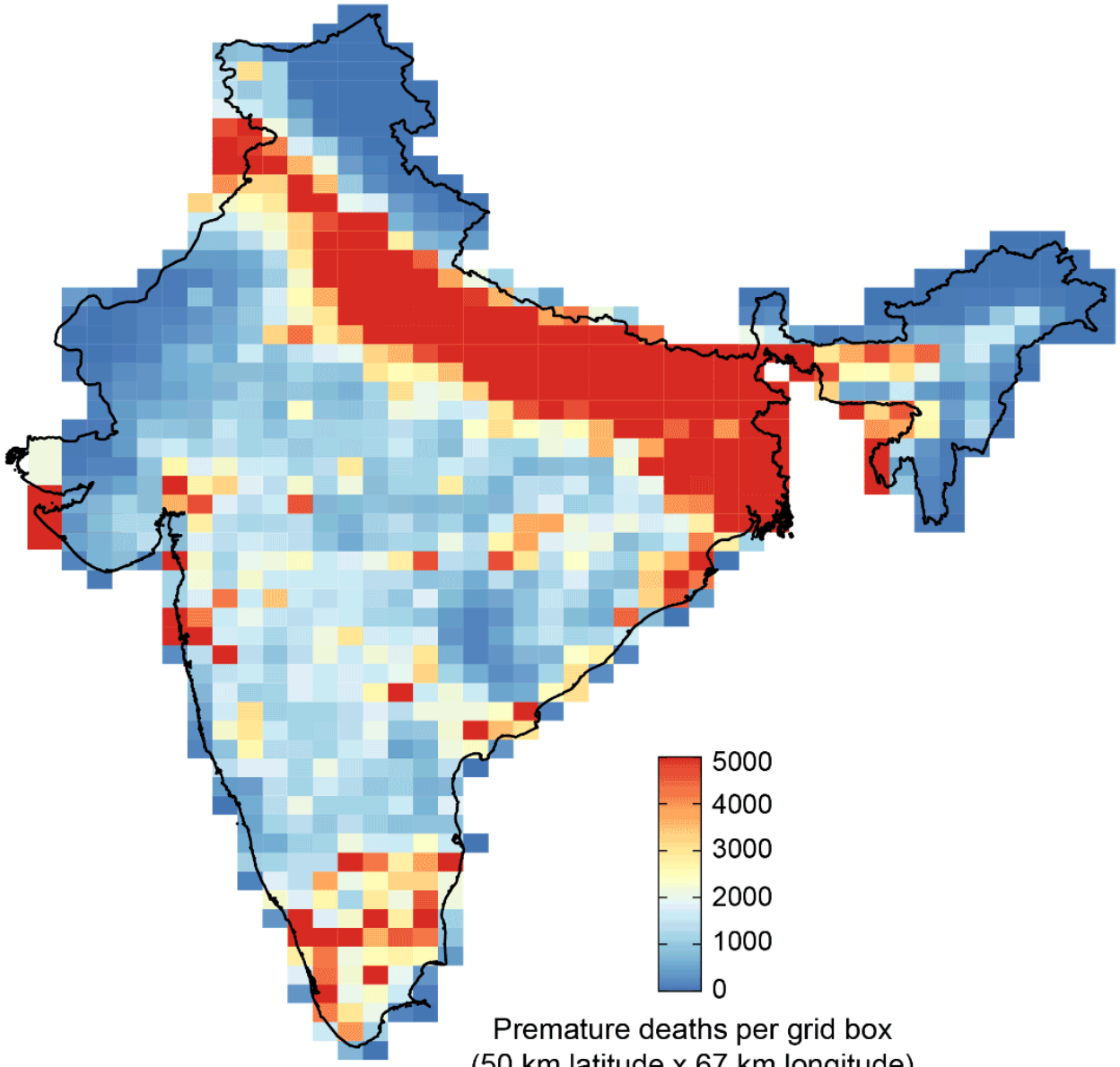
[-47 million, 17 million]

[Vohra et al., 2021]

Regional premature mortality from fossil fuel combustion

India

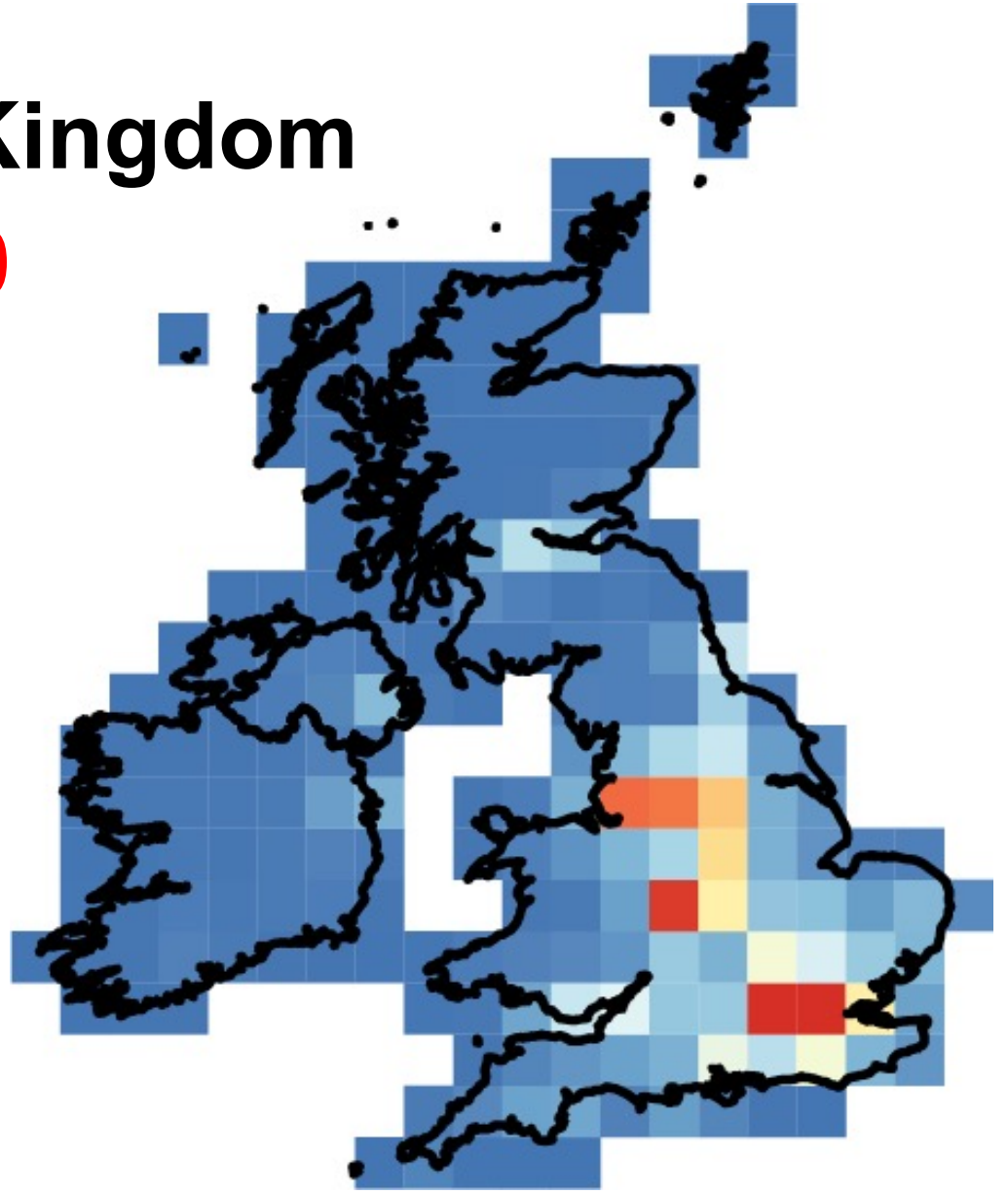
2,500,000

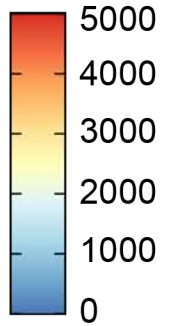


Regional premature mortality from fossil fuel combustion

United Kingdom

99,000



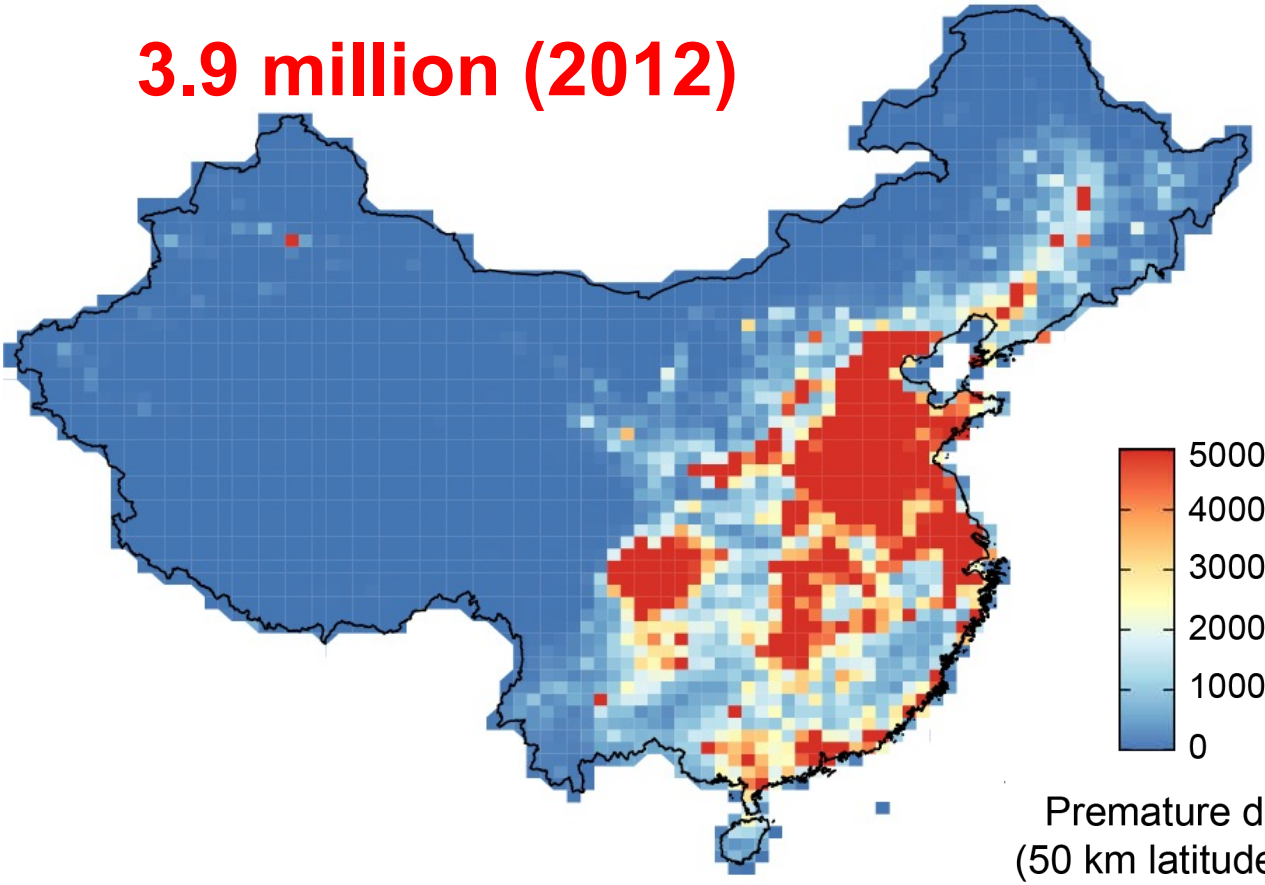


Premature deaths per grid box
(50 km latitude x 67 km longitude)

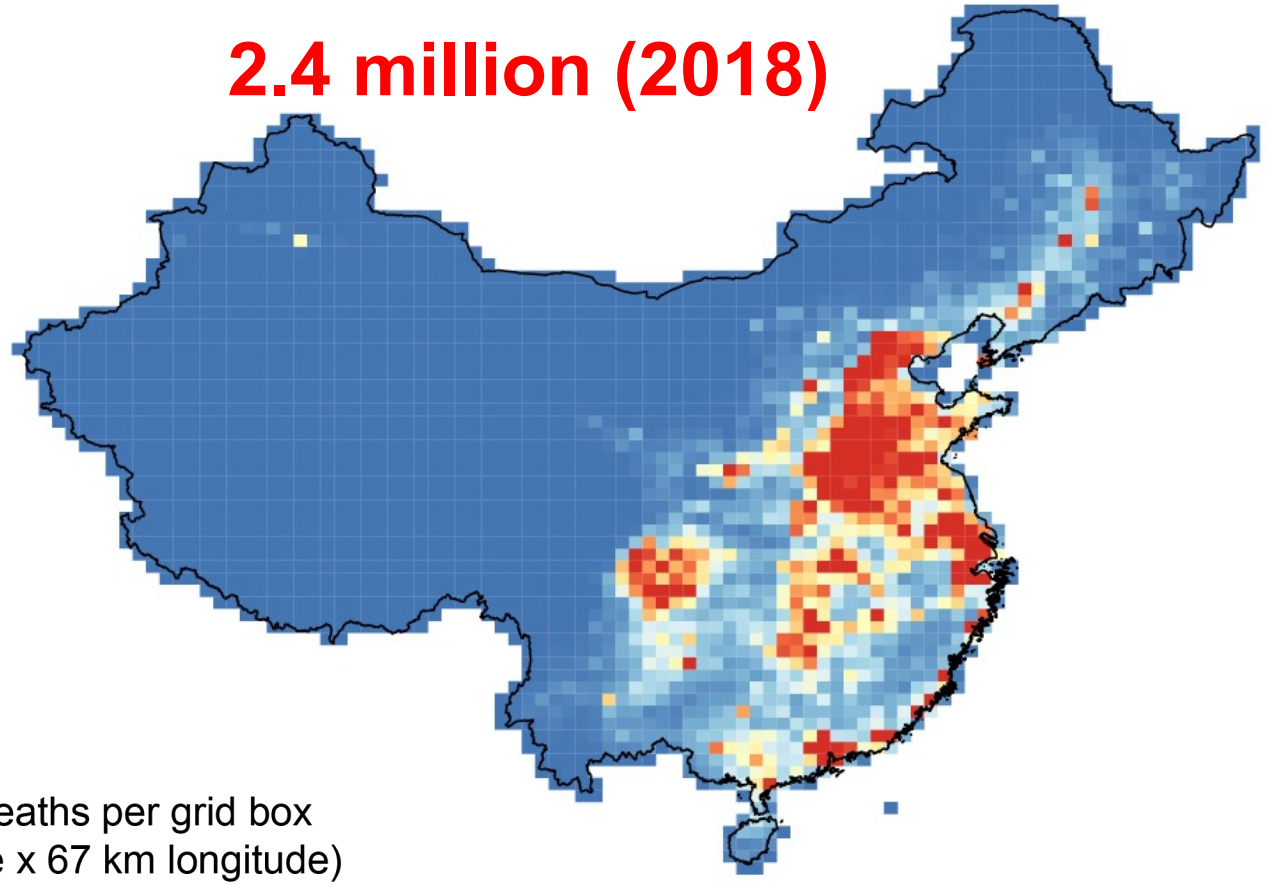
Policies can help mitigate these premature deaths

China

3.9 million (2012)



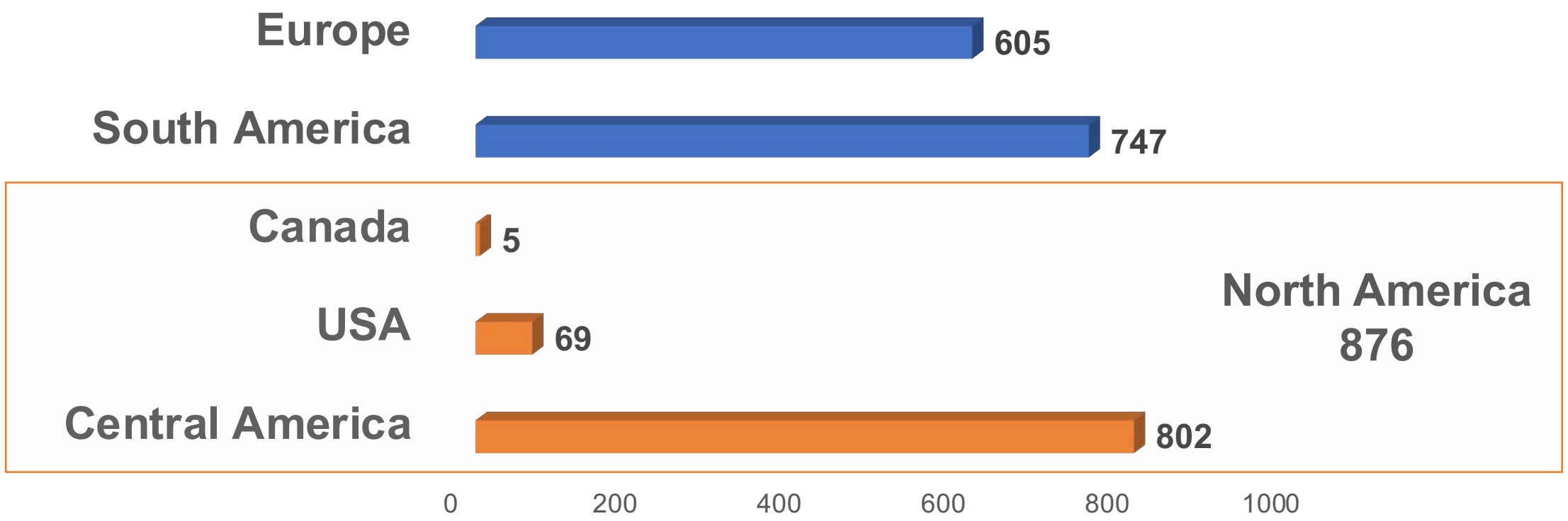
2.4 million (2018)



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

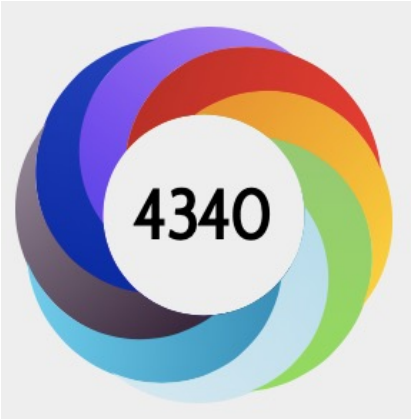
Implications of and response to our findings

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



Altmetric Score

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

Link to publication:
https://doi.org/10.1016/j.envres.2021.110754

Conclusions

- We estimate global mortality of **10.2 million** in 2012 from fossil-fuel $PM_{2.5}$ derived using a chemical transport model GEOS-Chem and meta-analysis CRF
- Greatest mortality impact is estimated for regions with substantial fossil-fuel $PM_{2.5}$, notably China (**~3.9 million**) and India (**~2.5 million**) in 2012. Estimates for China decrease to ~2.4 million in 2018 because of decline in fossil fuel emissions
- Our estimates for fossil-fuel related $PM_{2.5}$ are higher than premature mortality estimates from total $PM_{2.5}$ mainly because we use an updated CRF

Any questions? kxv745@bham.ac.uk @kohra_thefog