

Fossil-fuel related PM_{2.5} pollution global mortality estimates using GEOS-Chem

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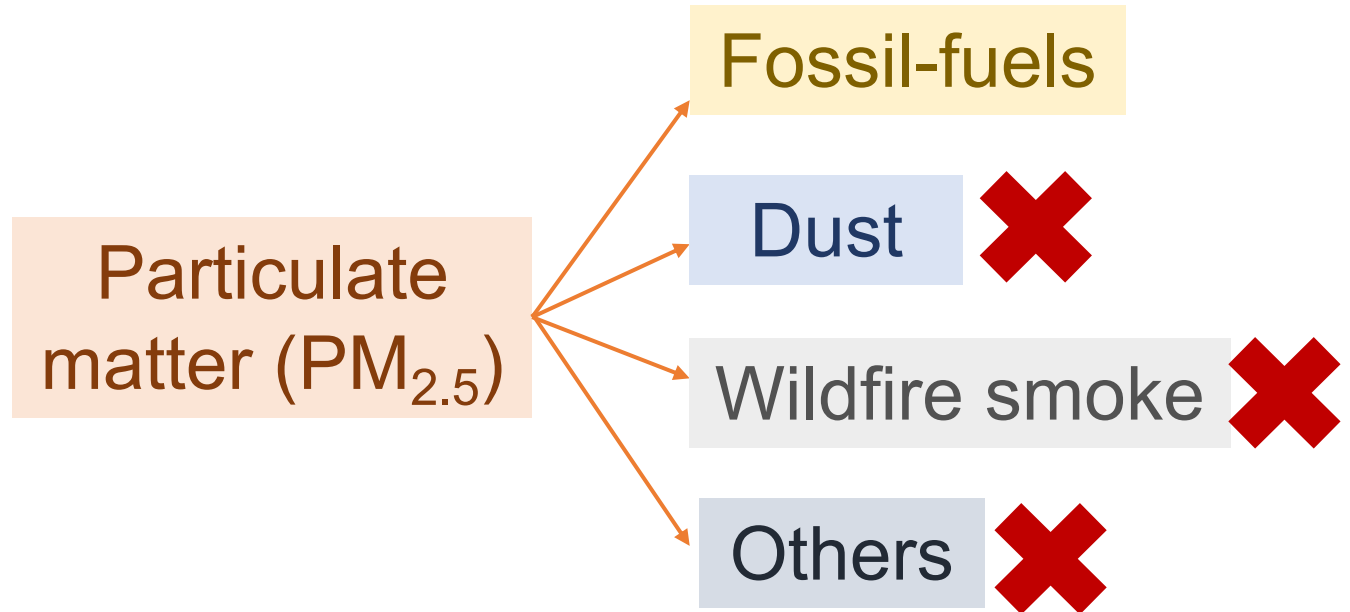
Why fossil-fuel related PM_{2.5}?



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

[Cohen et al. 2017]

Dominant anthropogenic source;
Can be easily controlled

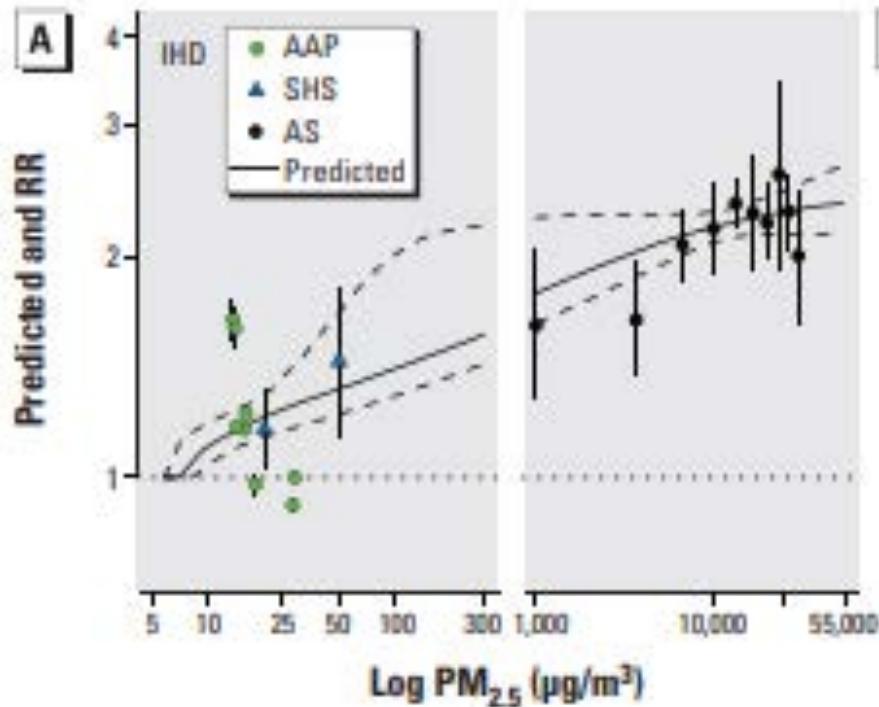


In this study, we use a chemical transport model GEOS-Chem
to estimate PM_{2.5} contribution from fossil-fuel combustion

Previous health impact models have been useful but have had certain limitations

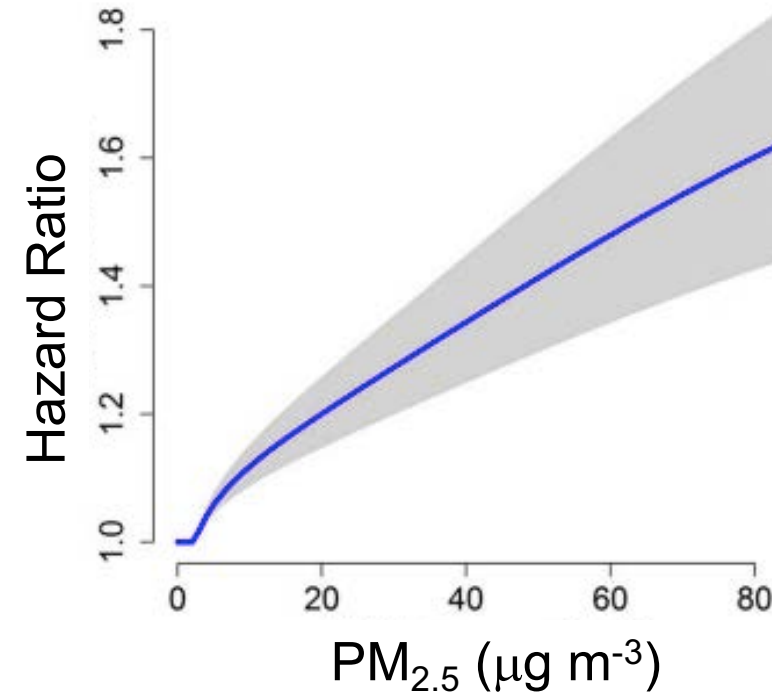
Integrated Exposure-Response (IER)

Global Exposure Mortality Model (GEMM)



[Burnett et al., 2014]

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

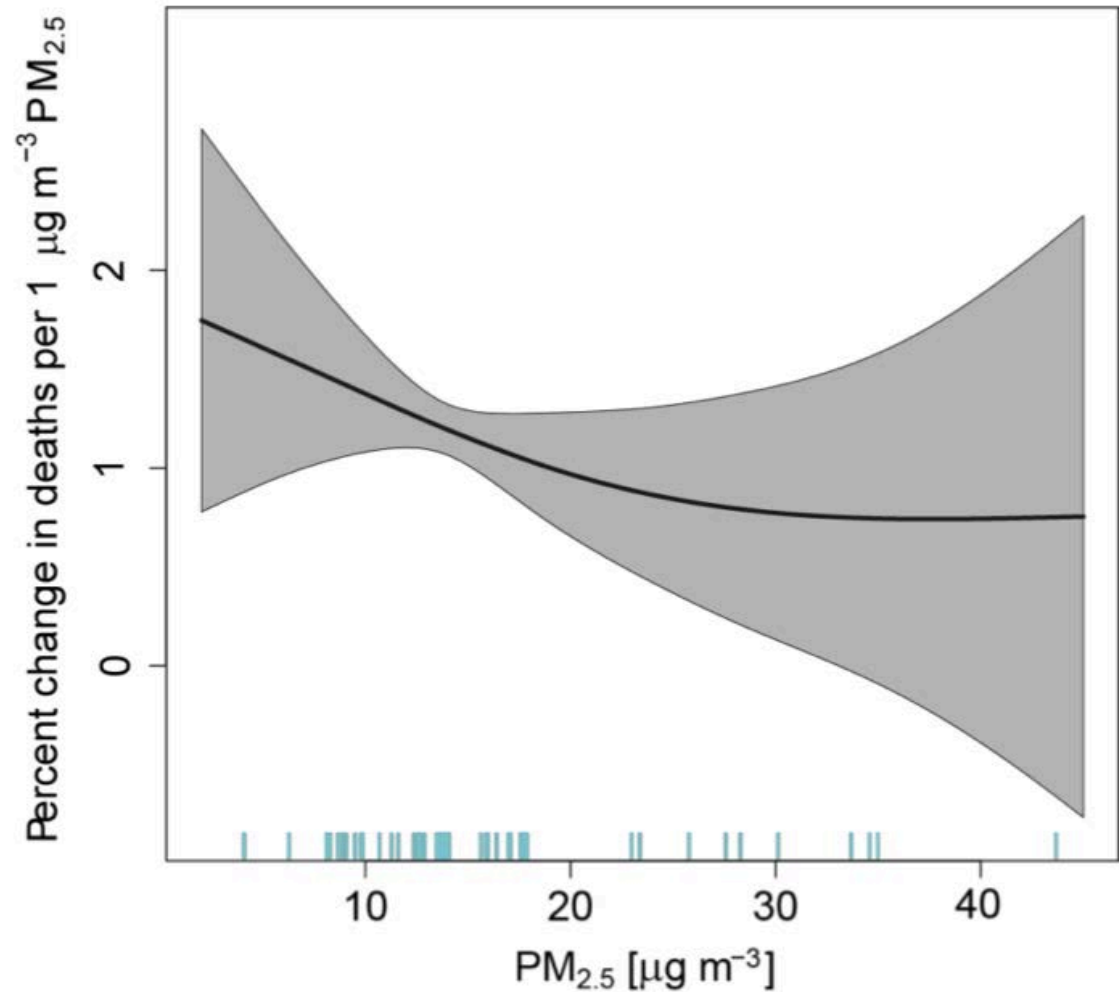


[Burnett et al., 2018]

41 cohort studies and model
constrained using 4 parameters

We use concentration-response-function (CRF) from the meta-analysis of 53 studies

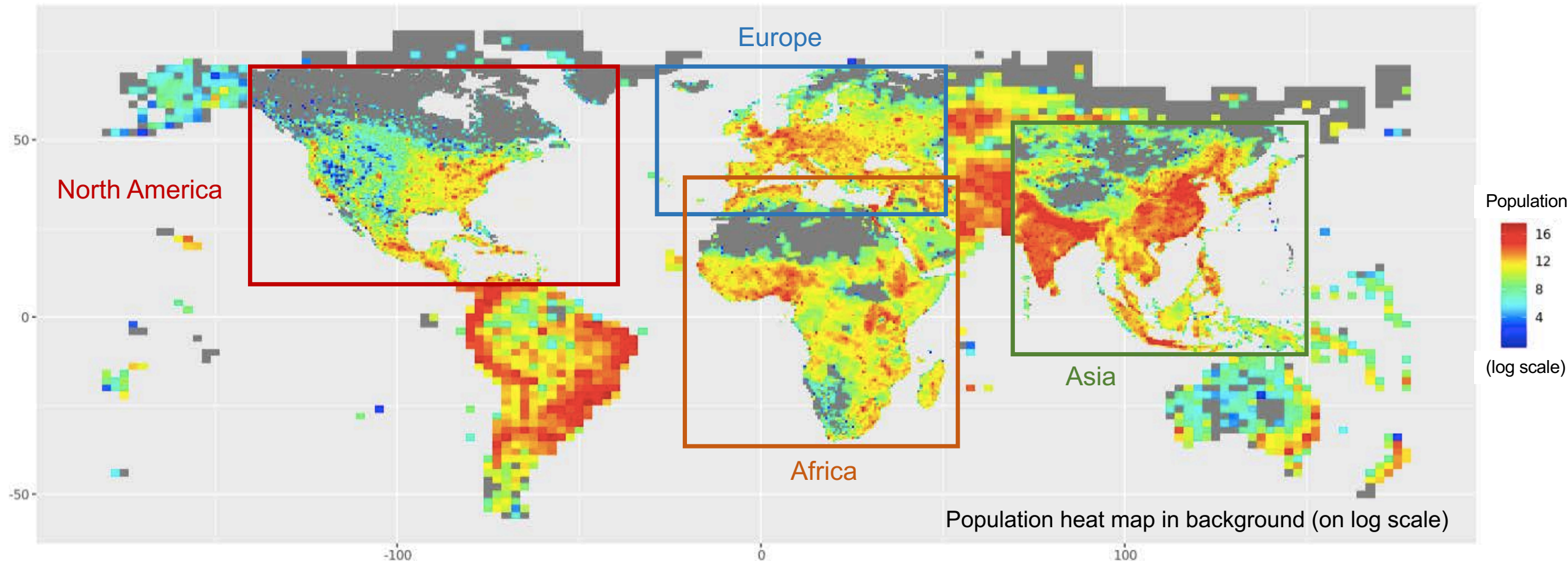
- Flexible shape of CRF
- Incorporates more studies
- Wider concentration and population age range
- Includes death from all-causes



[Vodonos et al., 2018]

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

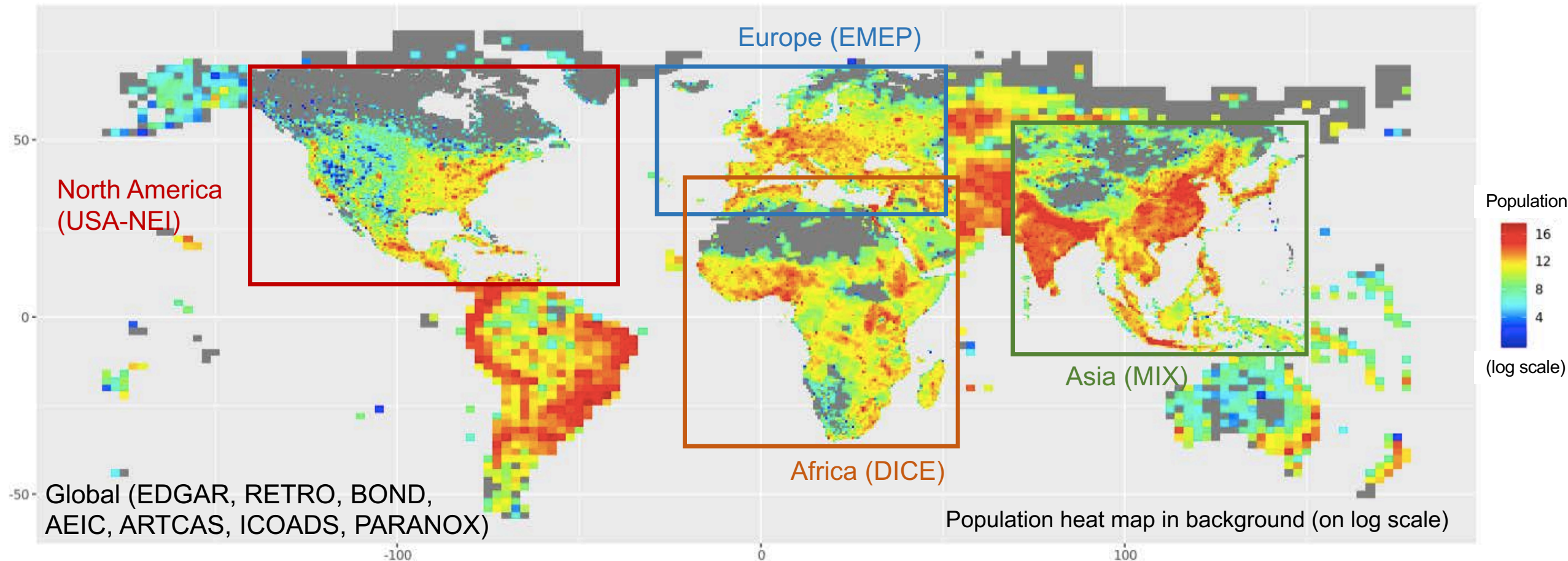


Global (coarse grid resolution : $2^\circ \times 2.5^\circ$)
Regional (fine grid resolution : $0.5^\circ \times 0.67^\circ$)

Simulation 1 : All emissions
Simulation 2 : Fossil-fuel turned OFF

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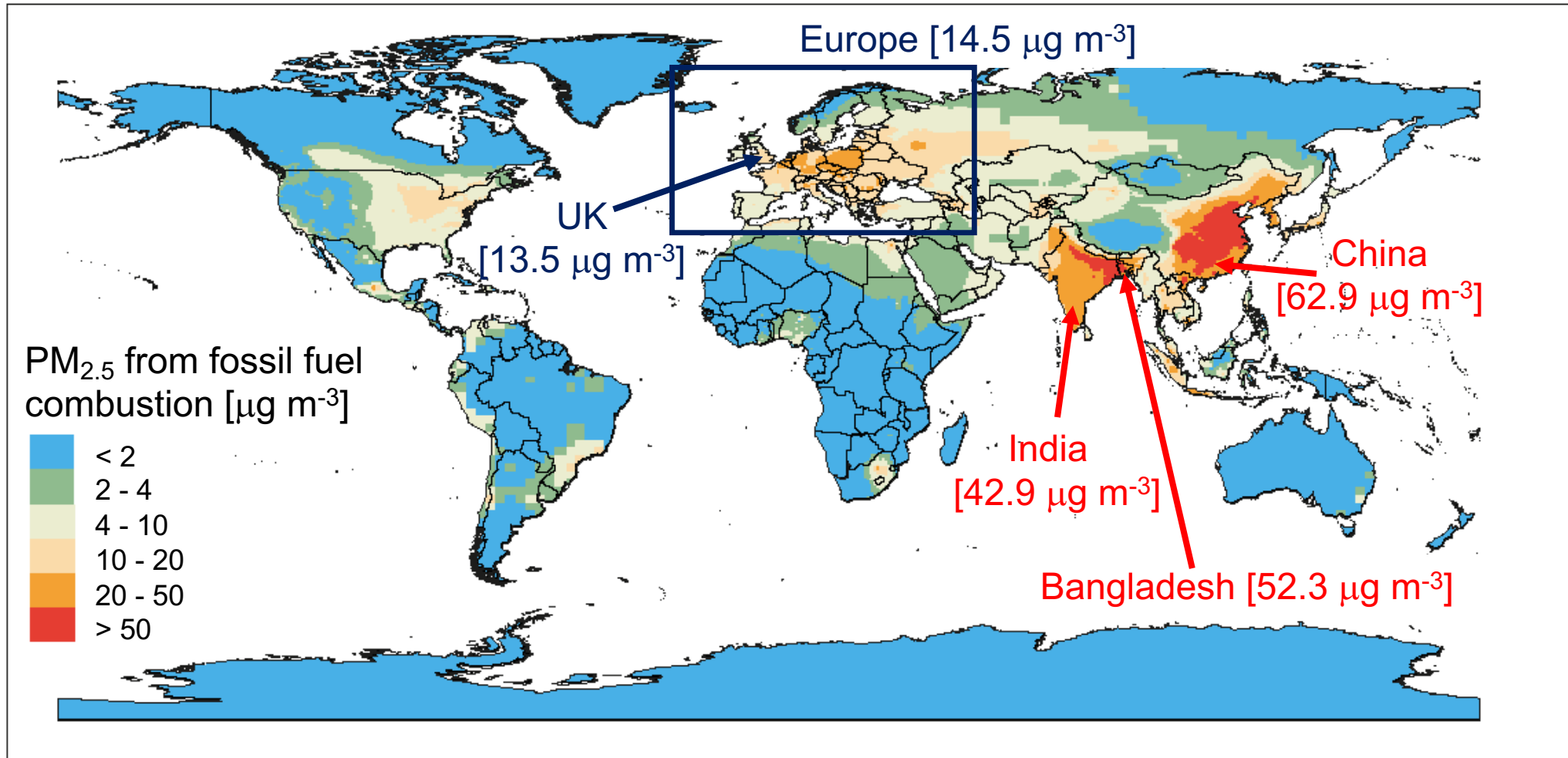
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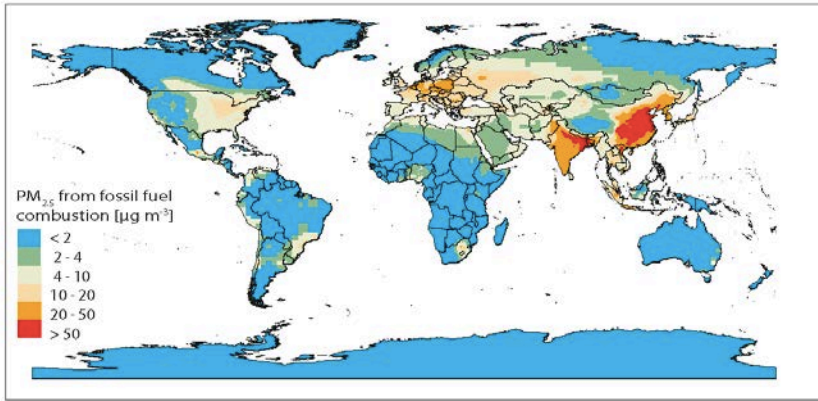
Fossil-fuel estimates from GEOS-Chem simulations



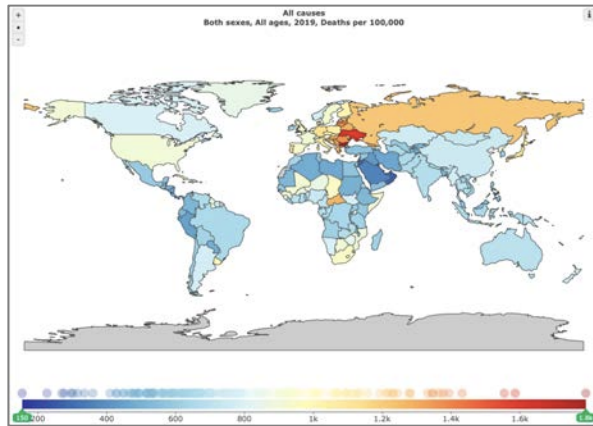
China, Bangladesh and India have the highest annual mean fossil-fuel $\text{PM}_{2.5}$ in 2012

[Vohra et al., in review, *Environ. Res.*]

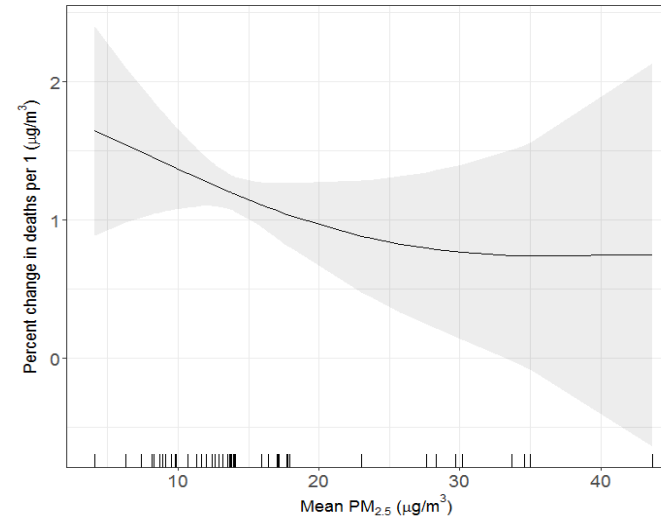
Methodology for health impact calculation



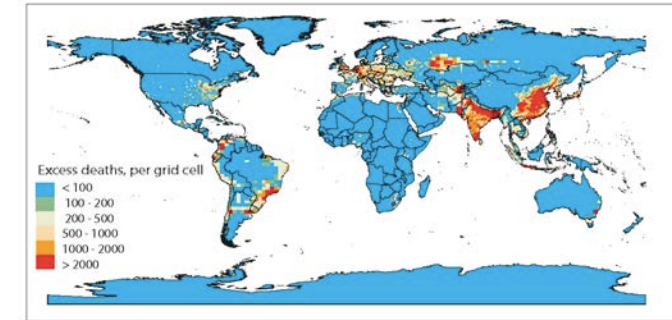
Fossil-fuel PM_{2.5} from GEOS-Chem



Baseline mortality from GBD



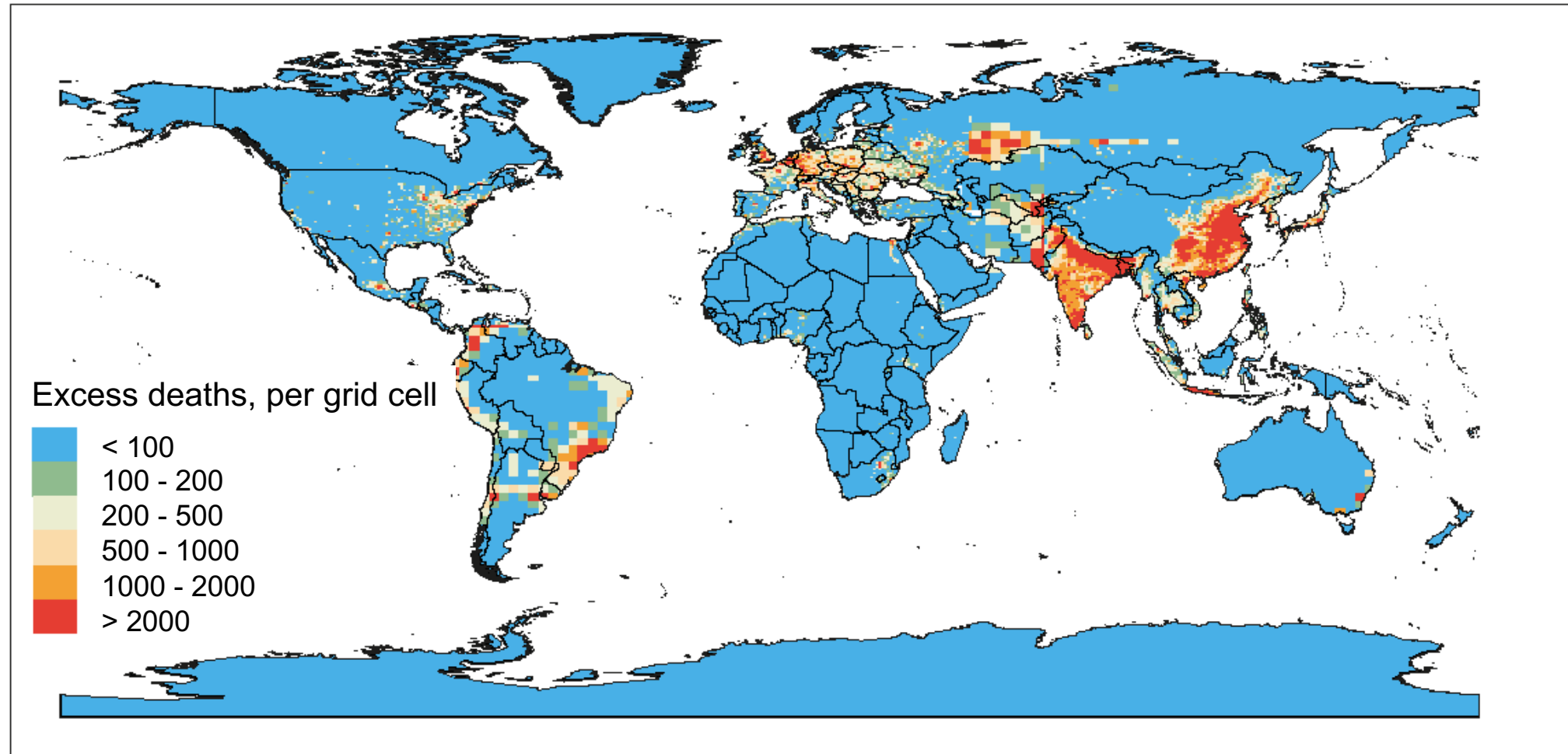
Meta-analysis CRF from cohort studies



Global mortality estimates

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

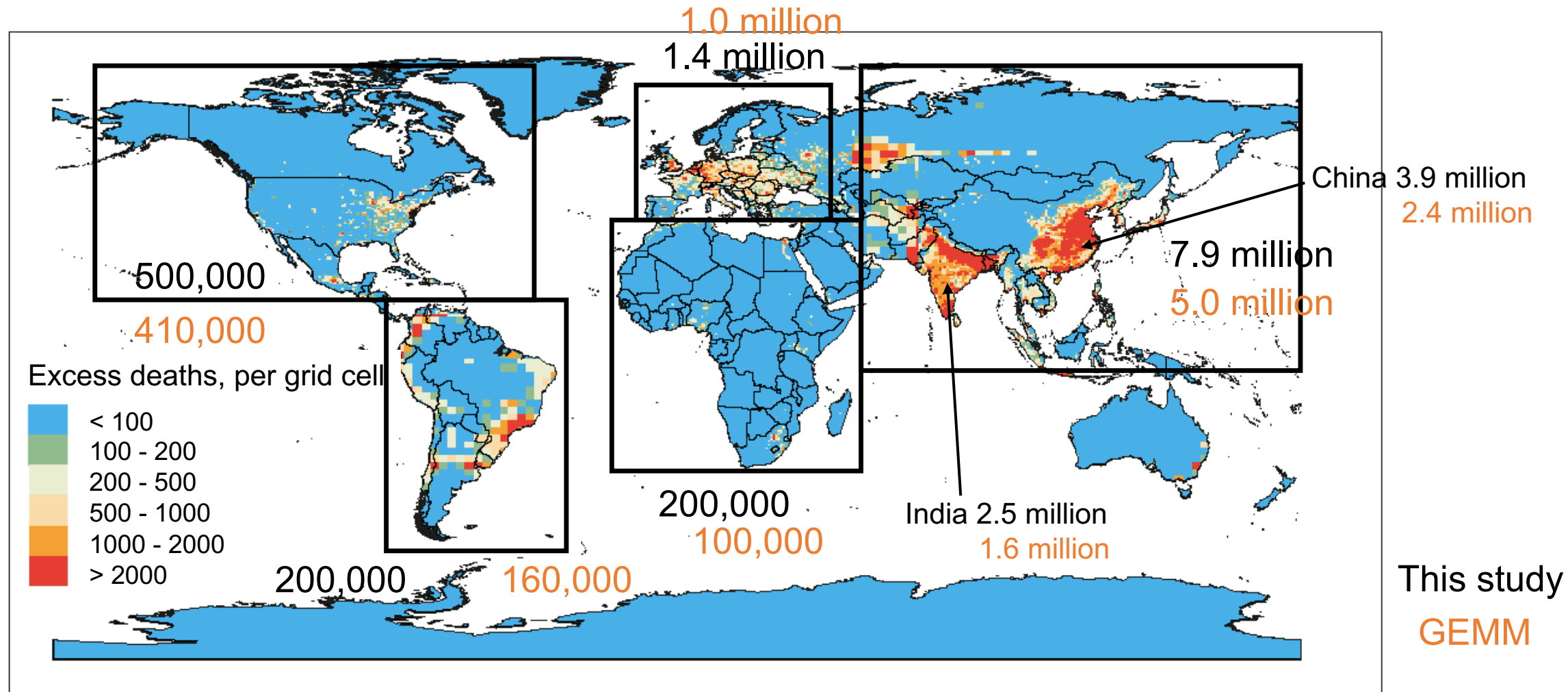
Estimated global mortality from fossil-fuel combustion



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

[Vohra et al., in review, *Environ. Res.*]

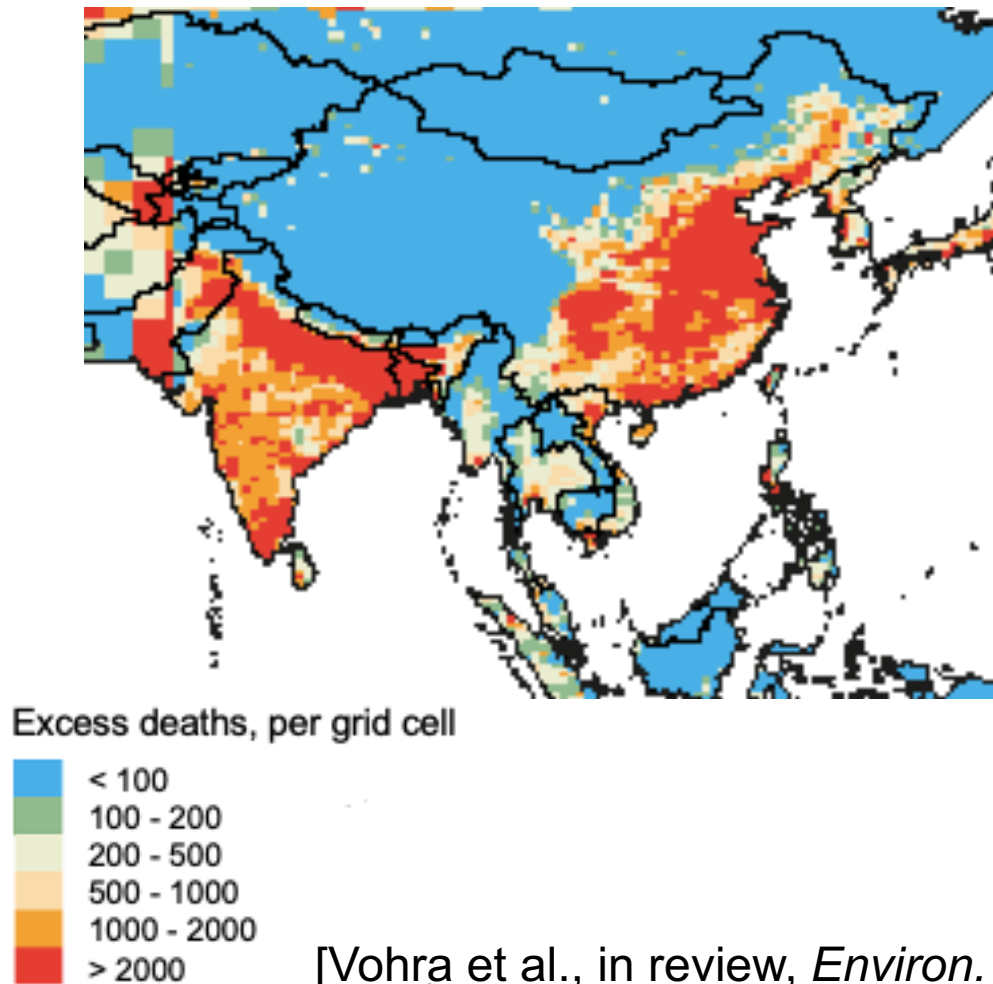
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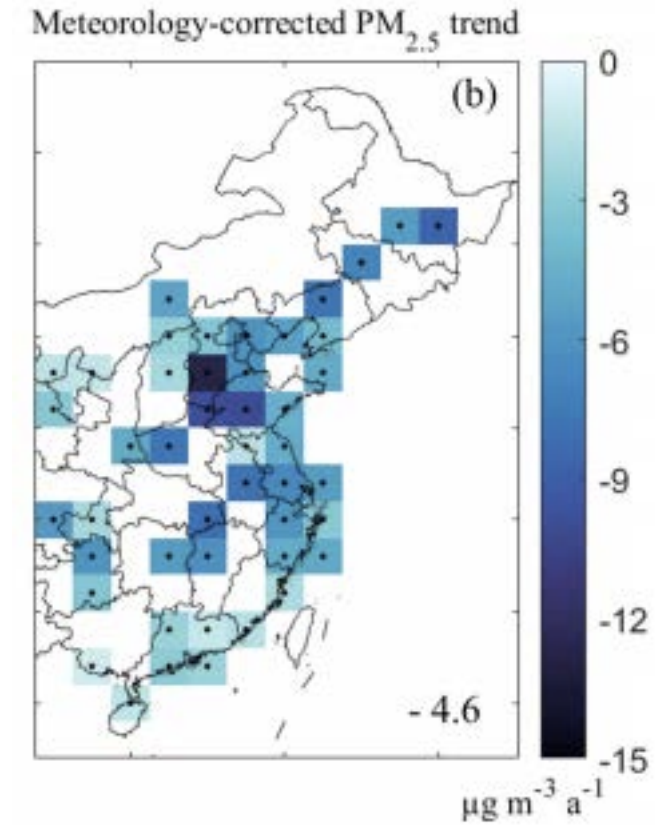


2012
China : 3.9 million
Global : 10.2 million

43.7% reduction in
PM_{2.5} across China

2018
China : 2.4 million
Global : 8.7 million

PM_{2.5} trends (2013-2018)



30-50% decline in China

[Zhai et al., 2019]

Dramatic reduction in PM_{2.5} levels in China decreases premature deaths by 1.5 million; no evidence observed for India yet

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 of the choice of CRF

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