Research connecting air quality, climate change, energy, policy and health

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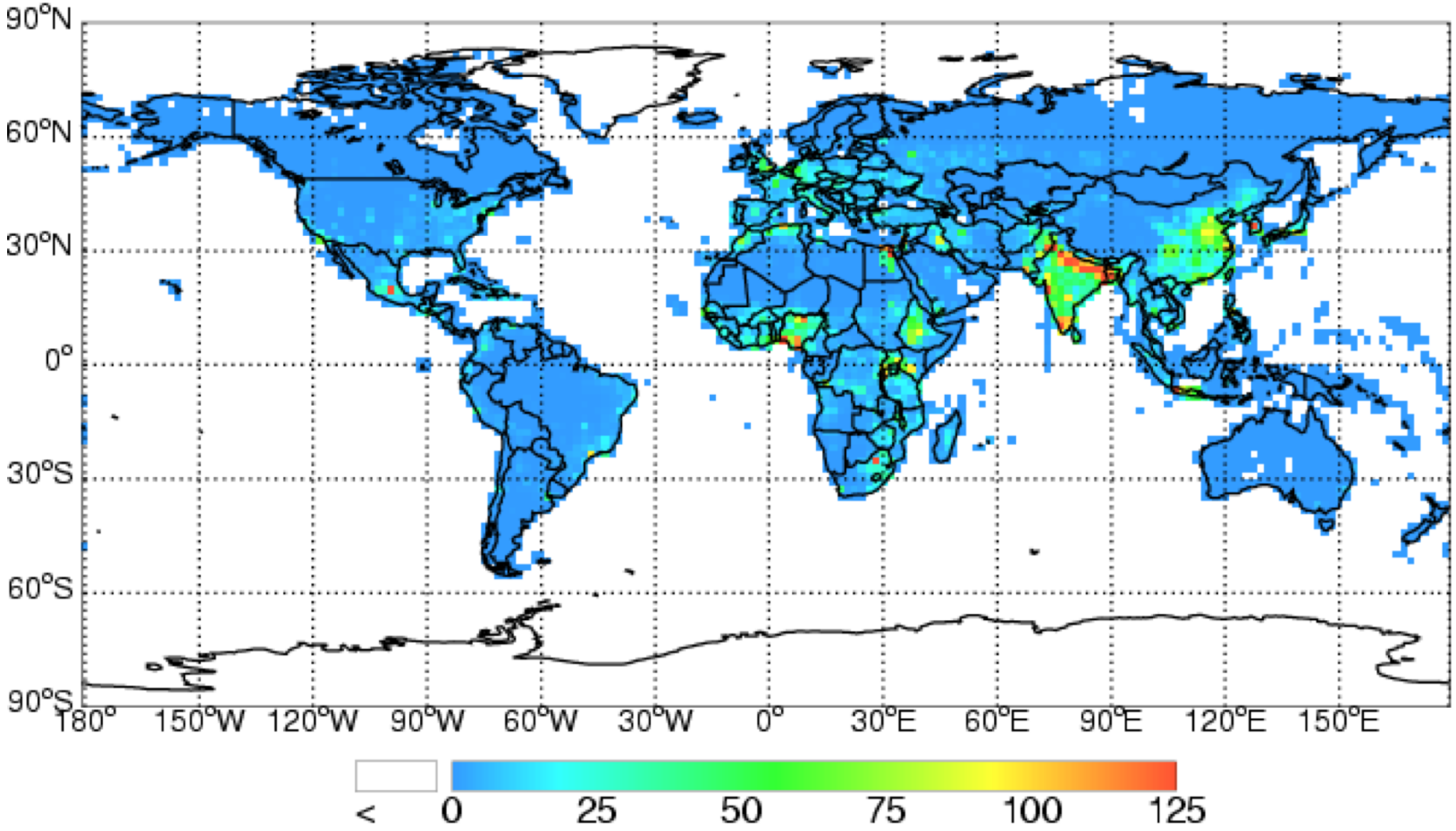
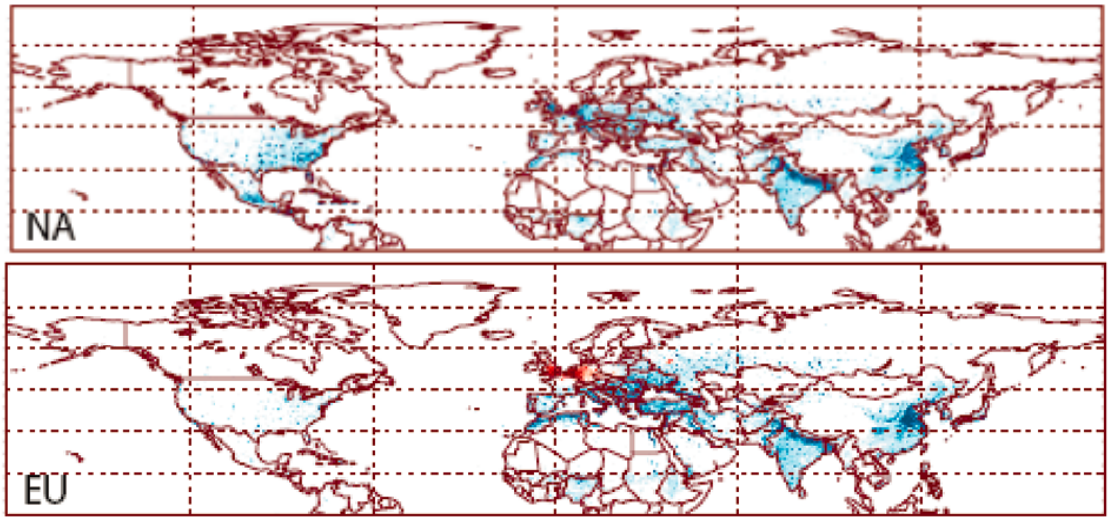
-20% Global Anthrop. Methane Emissions: 30,200 avoided premature deaths in 2030 due to reduced ozone



West et al., *PNAS*, 2006



Ozone from N. American and European emissions causes more deaths outside of those regions than within

	receptor region				
source region	NA	EA	SA	EU	NH
NA	**9 (4 – 13)** 9 (4 – 14)	**7 (3 – 10)** 4 (2 – 6)	**6 (3 – 9)** 5 (3 – 8)	**11 (5 – 17)** 6 (3 – 9)	**36 (18 – 55)** 27 (13 – 41)
EA	**2 (1 – 3)** 1 (1 – 2)	**43 (21 – 66)** 40 (19 – 61)	**6 (3 – 9)** 5 (2 – 8)	**5 (3 – 8)** 3 (1 – 4)	**59 (29 – 91)** 49 (24 – 76)
SA	**1 (0 – 1)** 0 (0 – 1)	**4 (2 – 6)** 3 (1 – 4)	**76 (37 – 117)** 66 (32 – 101)	**2 (1 – 3)** 1 (0 – 2)	**85 (41 – 130)** 71 (34 – 108)
EU	**2 (1 – 3)** 1 (0 – 1)	**8 (4 – 12)** 6 (3 – 8)	**6 (3 – 10)** 6 (3 – 9)	**17 (8 – 26)** 25 (12 – 38)	**38 (18 – 58)** 40 (19 – 61)

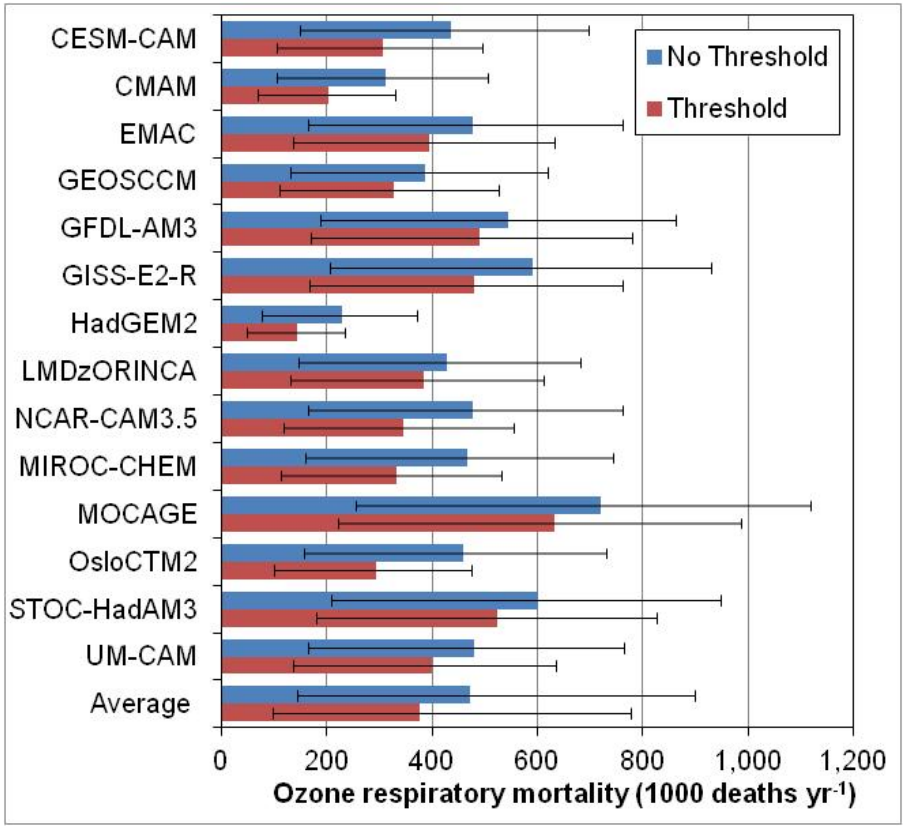
Avoided deaths (hundreds) from 20% regional ozone precursor reductions, based on HTAP simulations.

Anenberg et al., *ES&T*, 2009

Global mortality burden – ACCMIP ensemble

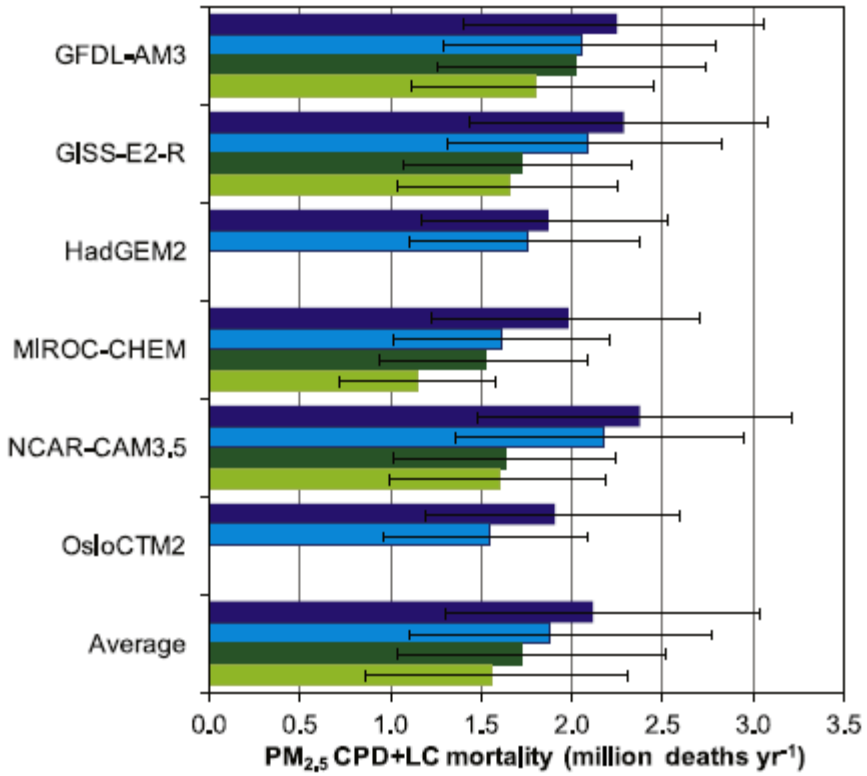
Ozone-related mortality

470,000 (95% CI: 140,000 - 900,000)



$PM_{2.5}$-related mortality(*)

2.1 million (95% CI: 1.3 - 3.0 million)



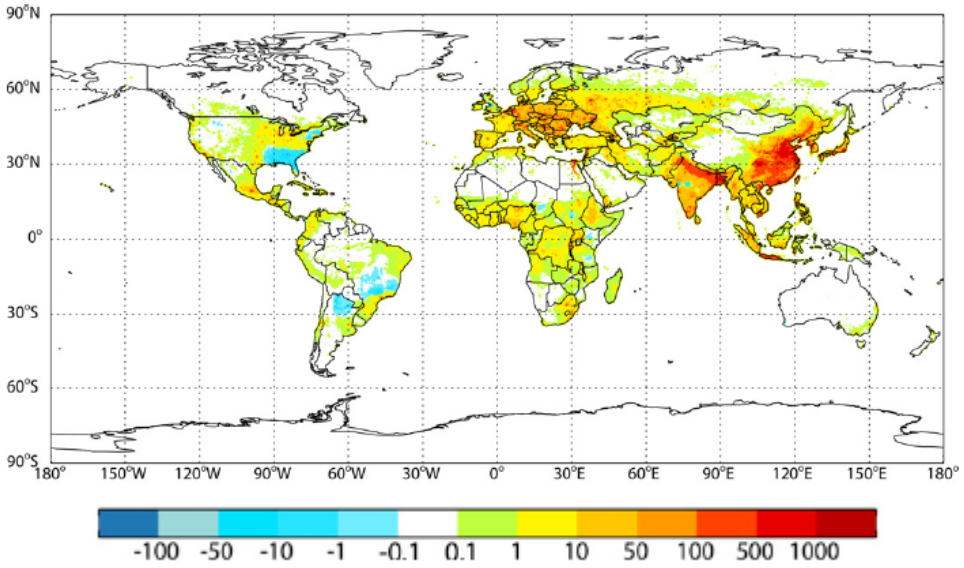
(*) $PM_{2.5}$ calculated as a sum of species (dark blue)
$PM_{2.5}$ as reported by 4 models (dark green)
Light-colored bars - low-concentration threshold (5.8 μg m^{-3})

Global Burden: $PM_{2.5}$-related mortality

Global and regional mortality per year

Regions	Total deaths	Deaths per million people (*)
North America	43,000	152
Europe	154,000	448
Former Soviet Union	128,000	793
Middle East	88,700	371
India	397,000	715
East Asia	1,049,000	1,191
Southeast Asia	158,000	564
South America	16,800	92
Africa	77,500	327
Australia	1,250	78
Global	2,110,000	665

(*) Exposed population (age 30 and older)

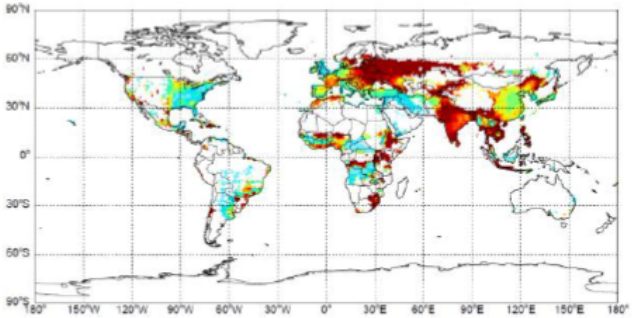


CPD+LC mortality , deaths yr^{-1} $(1000\ km^2)^{-1}$,
multi-model mean in each grid cell , 6 models

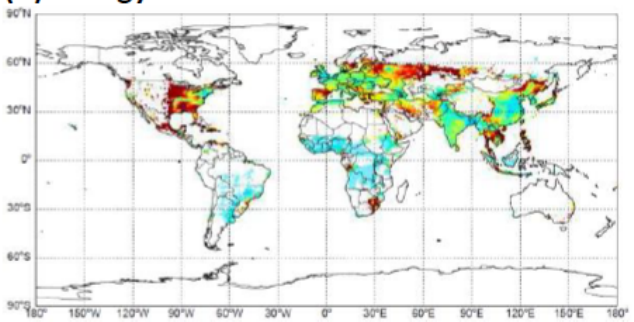
Silva et al. (ERL, 2013)

Contributions of different sectors to $PM_{2.5}$ mortality

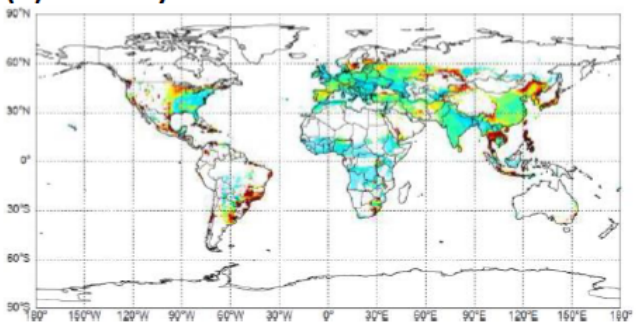
(A) Residential & Commercial



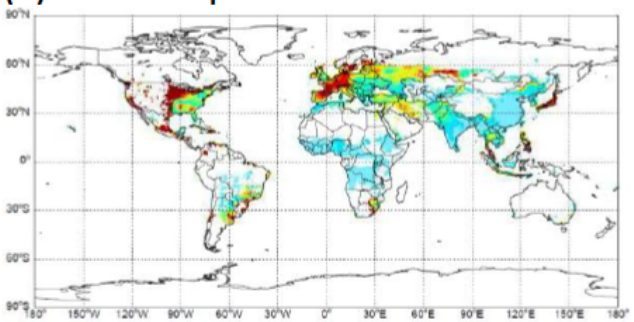
(B) Energy



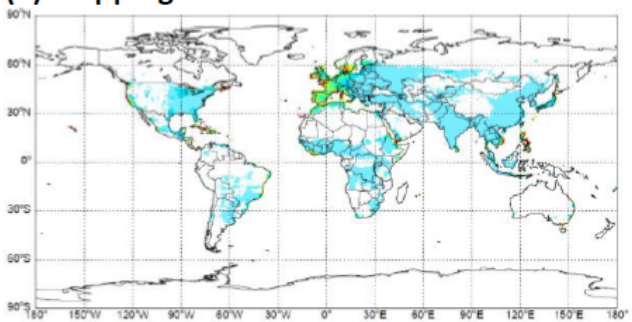
(C) Industry



(D) Land Transportation



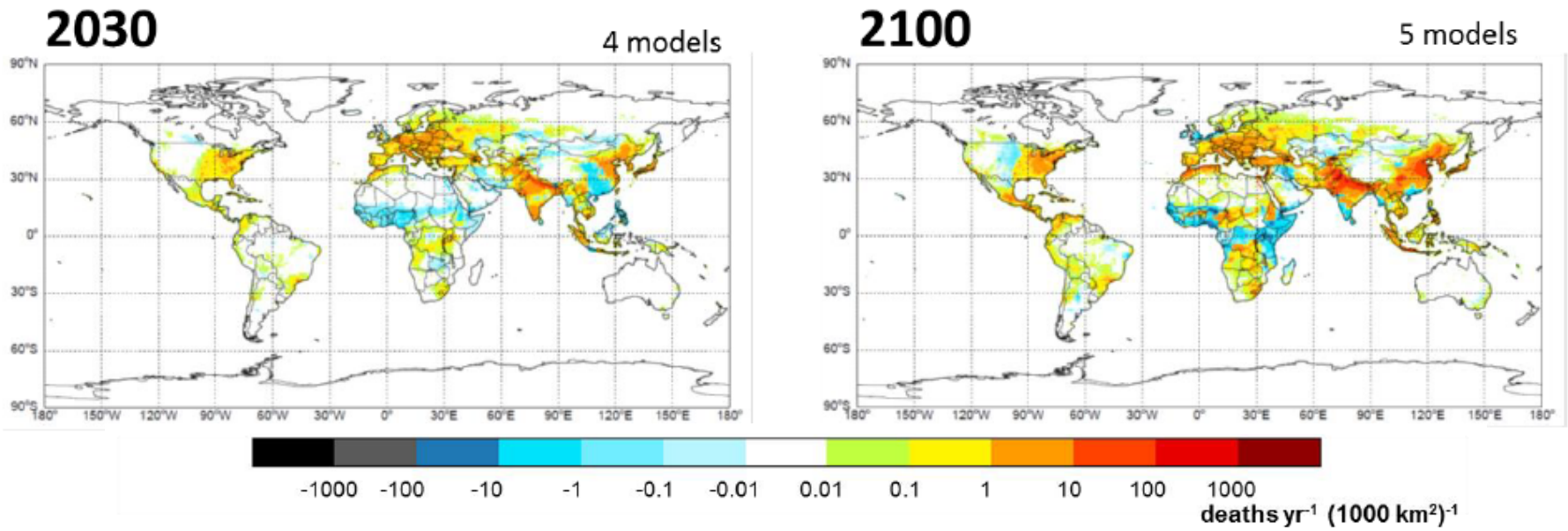
(E) Shipping & Aviation

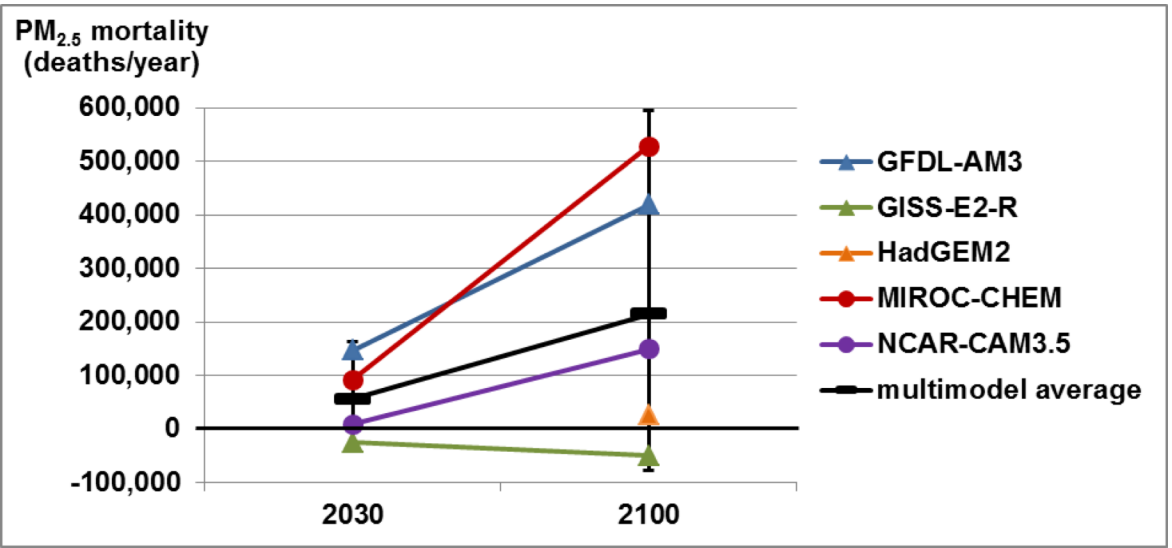


Residential & commercial emissions are most important globally (30% of deaths).

Silva et al., EHP, 2016

Impact of Future Climate Change on $PM_{2.5}$ mortality





Total deaths attributable to climate change:

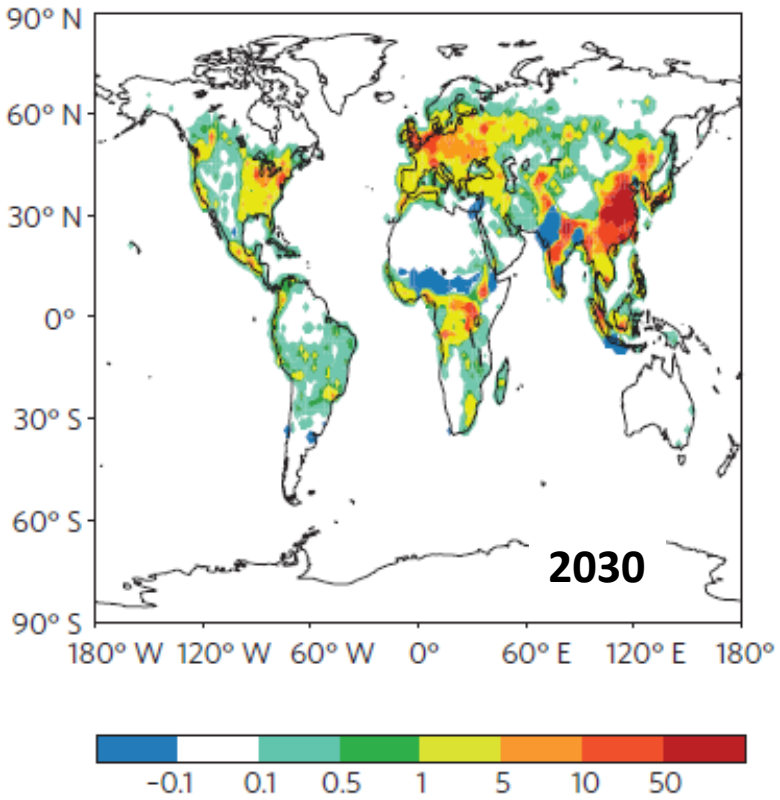
2030: 55,600 (-34,300 to 164,000)

2100: 215,000 (-76,100 to 595,000)

Silva et al. (in prep.)

Co-benefits of global GHG mitigation for air quality and health

Avoided air pollution-related deaths from global GHG reductions:

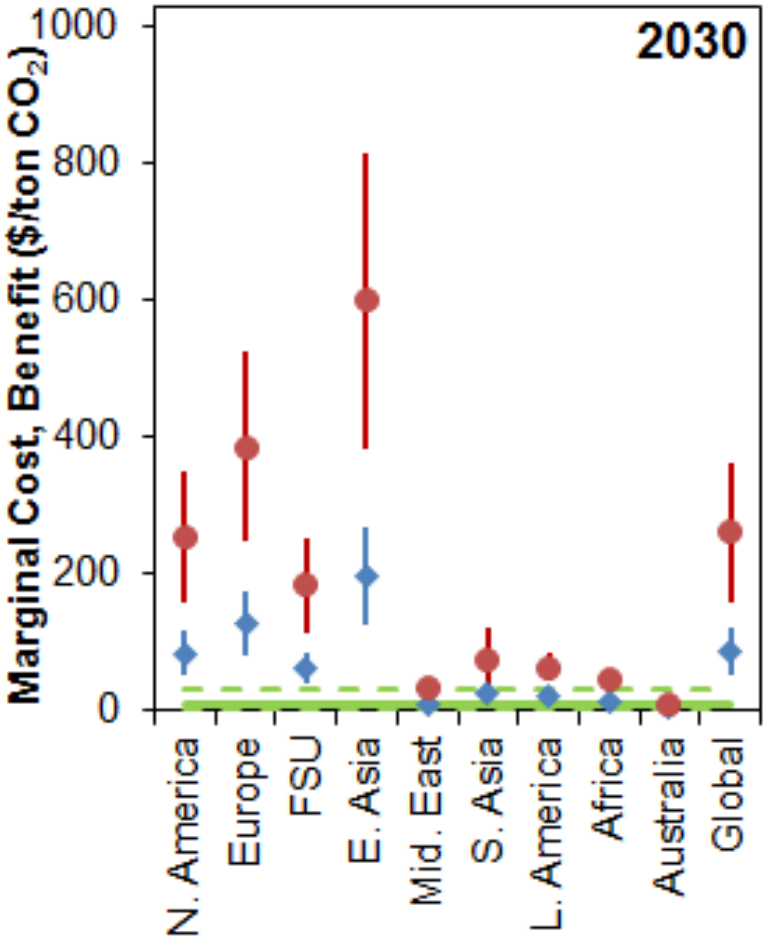


2030: 0.5 ± 0.2 million yr^{-1}

2050: 1.3 ± 0.5

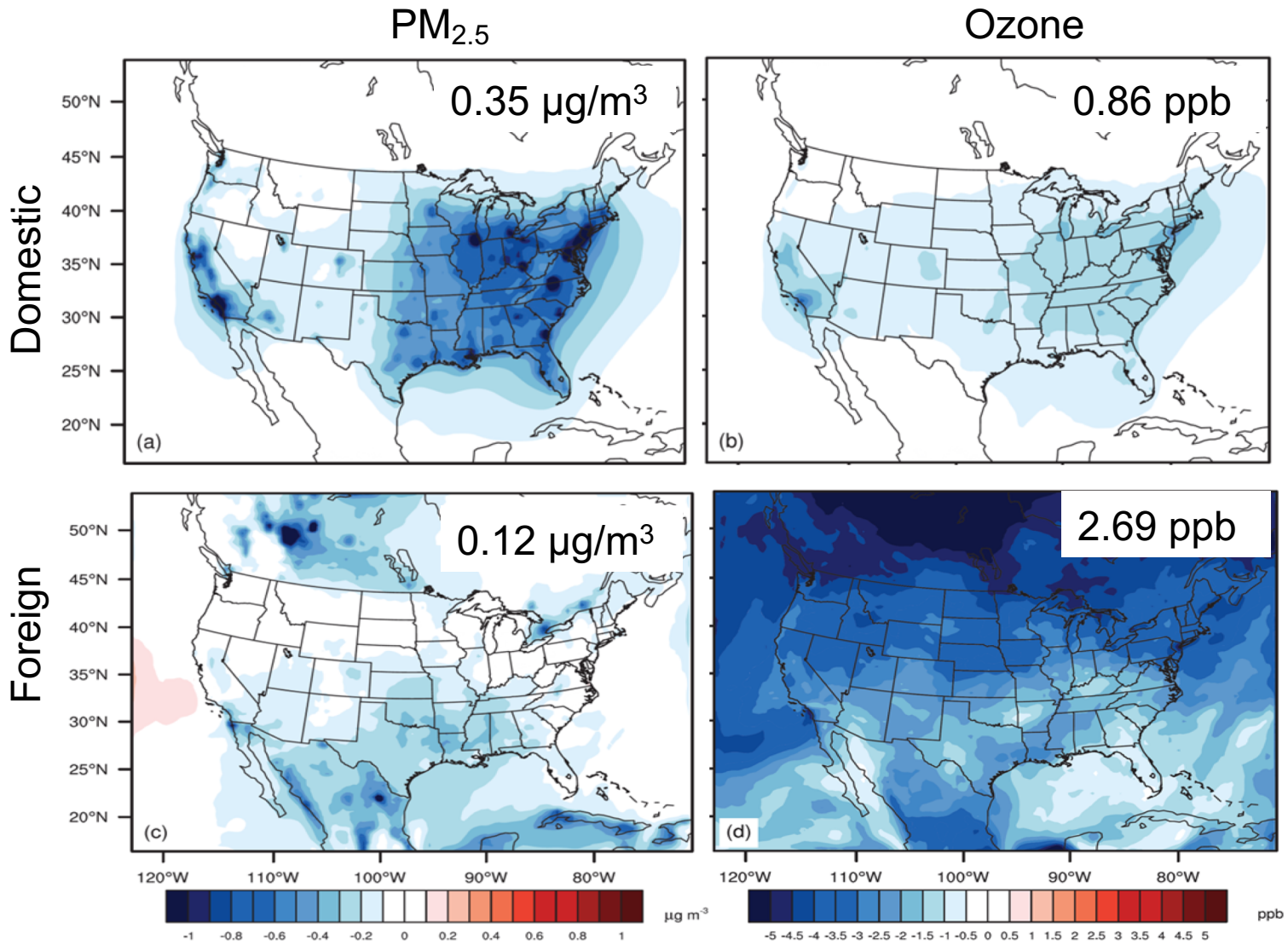
2100: 2.2 ± 0.8

Monetized health co-benefits (blue & red) vs. cost of GHG reduction (green):



West et al., NCC, 2013

Downscaling Co-benefits to USA (2050)



Most $PM_{2.5}$ co-benefits from **domestic** reductions.

Most ozone co-benefits from **foreign** and **methane** reductions.

Zhang et al. ACP, 2016