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.

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)

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(**) 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$^{-3}$)

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Silva et al. (ERL, 2013)
## Global Burden: PM$_{2.5}$-related mortality

### Global and regional mortality per year

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

(*) 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

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: $0.5 \pm 0.2$ million yr$^{-1}$
- 2050: $1.3 \pm 0.5$
- 2100: $2.2 \pm 0.8$

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.

- PM$_{2.5}$: 0.35 µg/m$^3$ (domestic) and 0.12 µg/m$^3$ (foreign)
- Ozone: 0.86 ppb (domestic) and 2.69 ppb (foreign)

Zhang et al. ACP, 2016