Sensitivity of Global PM2.5-related Mortality to Precursor Emissions

Colin Lee
PhD Candidate, Dalhousie University

Randall V. Martin, Daven K. Henze, Aaron van Donkelaar, Richard T. Burnett, Aaron Cohen, Haidong Wang, Raphael Lozano, Christopher J.L. Murray, Michael Brauer
PM$_{2.5}$ and Mortality

- Long-known relationship between fine PM and health effects; E.G. Dockery et al., 1993
  - Many limitations in knowledge

- GBD project estimated cause-specific mortality for 235 causes globally
  - Rigorous constraints and uncertainty assessment
Global Mortality

\[ M = \sum_i \sum_j \text{Pop}_i \cdot M_{i,j} \cdot \left(1 - \frac{1}{\text{RR}_{i,j}}\right) \]

- \( M \) = total global mortality
- \( M_{i,j} \) = baseline mortality for cause \( j \) in country \( i \)
- \( \text{Pop}_i \) = population of country \( i \)
- \( \text{RR}_{i,j} \) = \( f(\text{PM}_{2.5}) \); relative risk for cause \( j \) in country \( i \)

GBD global estimate of premature mortality attributable to PM2.5 in 2010:
Global Mortality

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GBD global estimate of premature mortality attributable to PM2.5 in 2010:

3.2 million people
What can we do about it?

Primary → $\text{PM}_{2.5}$ → Chem → Precursors
What can we do about it?

Primary ➔ PM$_{2.5}$ ➔ Chem ➔ Precursors

- NO$_x$
- SO$_2$
- NH$_3$
How we answered that

GEOS-Chem

Emis → Chem → Trans → Concs → HIF → M

GEOS-Chem Adjoint

∂/∂Emis ← Chem ← Trans ← ∂/∂Concs
How we answered that

- Local
- By source
Sensitivity to $\text{SO}_2$ Emissions

$\Delta M_{\text{global}} / 10\% \Delta \text{Emis}$
Sensitivity to NO\textsubscript{x} Emissions

\[ \Delta M_{\text{global}} / 10\% \Delta \text{Emis} \]
Sensitivity to NH$_3$ Emissions

\[\Delta M_{\text{global}} / 10\% \Delta \text{Emis}\]
Summary

- Strong SO2 sensitivity in northern India and eastern China
- Strong NOx sensitivity in eastern China and Europe
- Weak NH3 sensitivity in India compared to population
- Results at actionable policy scales