Burden of disease from rising coal emissions in Asia

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Coal use is expanding rapidly in Asia

2014 Population
1. China = 1369.5 million
2. India = 1270 million
4. Indonesia = 255 million

Coal SO$_2$ Emissions (Present Day ~2011)

Lu et al., 2011; EPA Annual ARP report 2013
Coal use is expanding rapidly in Asia

If all projected plants become operational, Asian coal emissions of SO$_2$ and NO$_x$ could triple by 2030. Indonesia and Vietnam together account for 67% of this projected increase, as well as an additional 35 million people by 2030.

Lu et al., 2011; EPA Annual ARP report 2013
Project Objectives

1. Calculate surface PM and ozone concentrations due to both 2011 and estimated 2030 coal emissions in East and Southeast Asia (excluding emissions from China and India).

2. Estimate the human health burden of this rising coal pollution.

Approach

1. Implement three 1-year emission scenarios of coal SO$_2$, NO$_x$, and primary PM$_{2.5}$ (as fine mode dust) into v9-02 of GEOS-Chem at 0.5° x 0.666° resolution over Asia:
   
   a. **Present Day (2011)** – Replace EDGAR v4.2 emissions over Asia with 2011 reported emissions
   
   b. **2030** – Add emissions for all Asian coal plants in the developmental pipeline
   
   c. **No Coal** – Remove contribution of Asian coal emissions from EDGAR v4.2

2. Apply concentration-response relationships following Krewski *et al.*, 2009 (PM) and Anenberg *et al.*, 2010 (ozone) to estimate the premature mortality due to coal-related pollution.
Regional PM enhancements are mostly from sulfate.

PM enhancements correlate spatially with population density. Total exposure is third highest in China, due to high population levels in southern China near Vietnamese emissions.
We estimate 16,000 deaths annually from current coal.

Including a 10% population increase by 2030 in both Indonesia and Vietnam, we estimate 45,600 deaths annually by 2030 if all projected plants become operational.
Global changes in PM are small and driven by NO\textsubscript{x}.

Leibensperger et al., 2011:

\[ \Delta \text{PM}_{2.5} \text{ from Asian } \text{SO}_2 \]

\[ \Delta \text{PM}_{2.5} \text{ from Asian } \text{NO}_x \]

\[ \Delta \text{PM}_{2.5} \text{ from 2030 Coal (this work)} \]

Intercontinental enhancements in surface PM reflect the influence of NO\textsubscript{x} emissions on oxidant chemistry. Greater influence over Europe compared to U.S. is likely due to higher domestic PM sources there (SO\textsubscript{2}, NO\textsubscript{x}, NH\textsubscript{3}).