Outdoor air pollution has increased significantly due to anthropogenic emissions of air pollutants and their precursors. Exposure to air pollution from ozone and fine particulate matter (PM$_{2.5}$) can cause adverse health effects, particularly cardiovascular and respiratory morbidity and mortality. We previously estimated 2.1 million PM$_{2.5}$-related deaths annually from cardiopulmonary diseases and lung cancer, and 470,000 ozone-related deaths annually from respiratory diseases, at a global scale (Silva et al. 2013). This and other recent studies have quantified global air pollution mortality but they do not estimate the contribution of different emission sectors (Anenberg et al. 2010; Lim et al. 2012; Evans et al. 2013) or they focus on a specific emissions sector—shipping (Corbett et al. 2007) and aircraft (Barrett et al. 2010).

**Studies**

- Use a global chemical-transport model (CTM) at a fine horizontal resolution to estimate:
  - Total global burden of present-day anthropogenic ozone and PM$_{2.5}$ on human mortality.
  - The contributions of five anthropogenic emissions sectors (energy, residential & commercial, industry, land transportation, all transportation) to current ozone and PM$_{2.5}$ concentrations and premature human mortality.

**Materials and Methods**

- Modeling ozone and PM$_{2.5}$ concentrations
  - Meteorology: GEOS-5 meteorological fields, 2005 0.05° x 0.05° resolution and 72 vertical hybrid levels.
  - Emissions: IPCC’s AR4 RCP5.8 global emissions inventory, 2005 0.05° x 0.05° resolution.
  - MOZART-4 (Gravili et al. 2010) Chemistry, Transport and Deposition

**Emissions:**

- Add seasonality, specification of NBVOCs and grid to 0.05° x 0.05° resolution.

**Applications:**

- Applying an impact function to estimate air pollution-related premature mortality (ΔMort):

  \[ \Delta \text{Mort} = \mu \times AF \times Pop \]

  \( \mu = \text{baseline mortality rate} \)

  \( AF = \frac{\text{exposed population}}{\text{baseline population}} \)

  \( \text{Exposed Population} = \frac{\text{Population} \times \text{PM}_2.5 \text{concentration}}{\text{Baseline PM}_2.5 \text{concentration}} \)

- Since 2010, 25% of all deaths from premature respiratory mortality are attributable to increased ozone and particulate matter concentrations. Long-term epidemiological studies have shown a clear relationship between long-term exposure to ozone and increased mortality from respiratory and cardiovascular diseases. Linear models are used to quantify the attributable fraction and exposure-response function: a function that describes the expected change in a health effect when the dose of a pollutant changes.

**Conclusions:**

- Ozone-related mortality: 205,000 deaths/year globally, mostly in East Asia (41%) and India (30%);
- The Transportation sector has the greatest impact globally (33% of total premature mortality), but Energy and Residential & Commercial have strong impact in India and East Asia and Industry has strong impact in East Asia. Globally, these sectors contribute about 80% of total ozone respiratory mortality.

- PM$_{2.5}$-related mortality: 1.6 million deaths/year globally, mostly in East Asia (45%), India (17%), Europe (12%) and FSU (9%). The Residential & Commercial sector has the greatest impact globally (31% of total excess mortality), especially in East Asia, India, Europe and FSU;
- Globally, these sectors contribute about 70% of total PM$_{2.5}$ mortality.

**Future work**

- Evaluate these results with coarse resolution simulations.

**References**

- Anenberg et al. 2013, Environ Health Perspect. 121, 57-63
- Barrett et al. 2010, Atmos. Environ. 44, 2480-2491
- Burnett et al. 2011, Environ. Health Perspect. 119, 417-432
- Corbett et al. 2007, Environ. Health Perspect. 115, 123-128
- Emmons et al. 2007, Atmos. Environ. 41, 6667-6680
- Evans et al. 2013, Environ. Health Perspect. 121, 57-63
- Evans et al. 2013, Environ. Health Perspect. 121, 57-63
- Hoek et al. 2007, Environ. Health Perspect. 115, 123-128
- Izcat et al. 2013, Environ. Health Perspect. 121, 57-63

- City of New York, www.airquality.city.ny.us/about/levels.html