Impact of large emissions reductions on fine particulate matter sensitivities to precursors

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A dramatic decrease in US emissions occurred within the last decade.

How has this changed the response of surface PM to future reductions?

What do these changes mean for future policy?

EPA national emissions trends
www.epa.gov/ttnchie1/trends/
We used GEOS-Chem to estimate the **sensitivity** of surface PM to emissions

- Created an input menu to readily scale national, total anthropogenic emissions
- Varied emissions around two base cases
  - Year 2005: Standard NEI05 emissions
  - Year “2012”: NEI05 scaled to match reported reductions

- Model specifics:
  - GEOS-Chem v9-02 with GEOS5 meteorology for Jan, Jul 2005
  - NA 0.5° × 0.66° nested grid with 2° × 2.5° boundary conditions

\[
\Delta SO_2 \text{ sensitivity}
\]
Winter PM is now more nitrate-limited

Jan sensitivities, ng m\(^{-3}\) kt\(^{-1}\)

Different magnitudes

Changes correlated (\(r^2=94\%\))
Winter PM is now more nitrate-limited

Isorropia output with temperature, humidity, and sulfate concentrations from the northern Midwest
Sensitivity to SO$_2$ emissions has (mostly) increased

Except Northeast in winter
The increased SO$_2$ sensitivity is driven by more aqueous (H$_2$O$_2$) oxidation.

Change in fraction (%) of SO$_2$ oxidation done by H$_2$O$_2$
The sensitivity approach can also be applied to aerosol direct radiative effects

- Change in SO$_2$ oxidation path changes horizontal, vertical distribution of aerosol
- Change in composition, hygroscopicity changes aerosol radiative properties
- Sensitivity of DRE to emissions has been explored for CO$_2$, O$_3$ but not for aerosols