Development of Long-term Emission Inventories in the United States from 1990 to 2010

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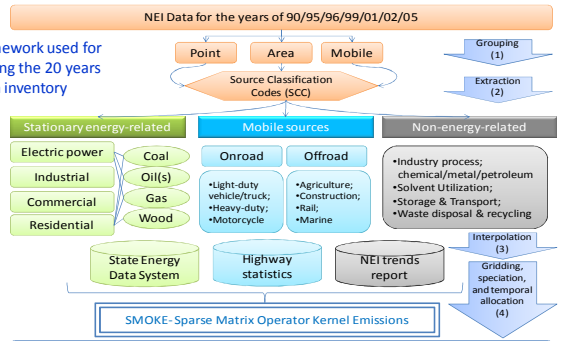
Background

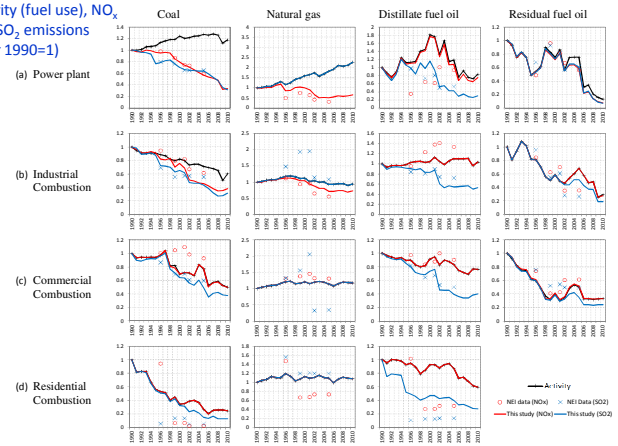
An accurate description of emissions is crucial for model simulations to reproduce and interpret observed phenomena over extended time periods. A consistent series of spatially resolved anthropogenic emissions of SO_2, NO_x, CO, NMVOC, NH_3, PM_{10} and $PM_{2.5}$ in the United States from 1990 to 2010 was developed by using an approach based on several long-term databases containing information about changes in activity data and emission controls. The state-level anthropogenic emissions for three major sectors (incl. 49 sub-sectors) were estimated based on several long-term databases containing information about changes in activity data and emission controls. Activity data for energy-related stationary sources were derived from the State Energy Data System. Corresponding emission factors reflecting implemented emission controls were calculated back from the national emission inventory (NEI) for seven years (i.e., 1990, 1995, 1996, 1999, 2001, 2002 and 2005), and constrained by the AP-42 (US EPA's Compilation of Air Pollutant Emissions Factors) dataset. Activity data for mobile sources including all types of highway vehicles and non-highway equipments was obtained from the highway statistics reported by Federal Highway Administration. The trends in emission factors for highway mobile source were informed by the 2011 National Transportation Statistics. Emissions for all non-energy related source were either scaled by the growth ratio of activity indicators or adjusted based on the NEI trends report and EDGAR (Emissions Database for Global Atmospheric Research) dataset.

The 36km-CONUS WRF-CMAQ simulations (us36) driven by the newly-developed emission inventory provide an excellent basis for the evaluation of the newly-developed historical inventory. Trends in air quality across the northern hemisphere were also simulated using internally consistent historical emission inventories obtained from EDGAR (nh108). Thorough comparison against available observations from ground monitors will be conducted. Gaseous and aerosol measurements taken from several routine monitoring networks including the Clean Air Status and Trends Network (CASTNET), the Interagency Monitoring of Protected Visual Environments (IMPROVE), the Aerometric Information Retrieval System (AIRS)-Air Quality System (AQS) are used to validate and improve the current understanding of emissions. Improvements of the newly-developed inventories are suggested.

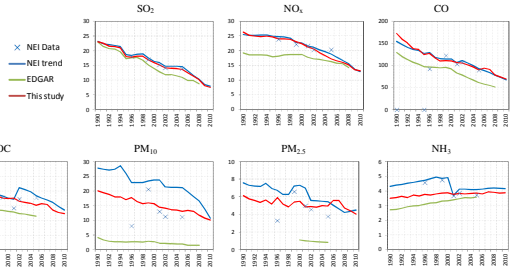
The framework used for developing the 20 years emission inventory



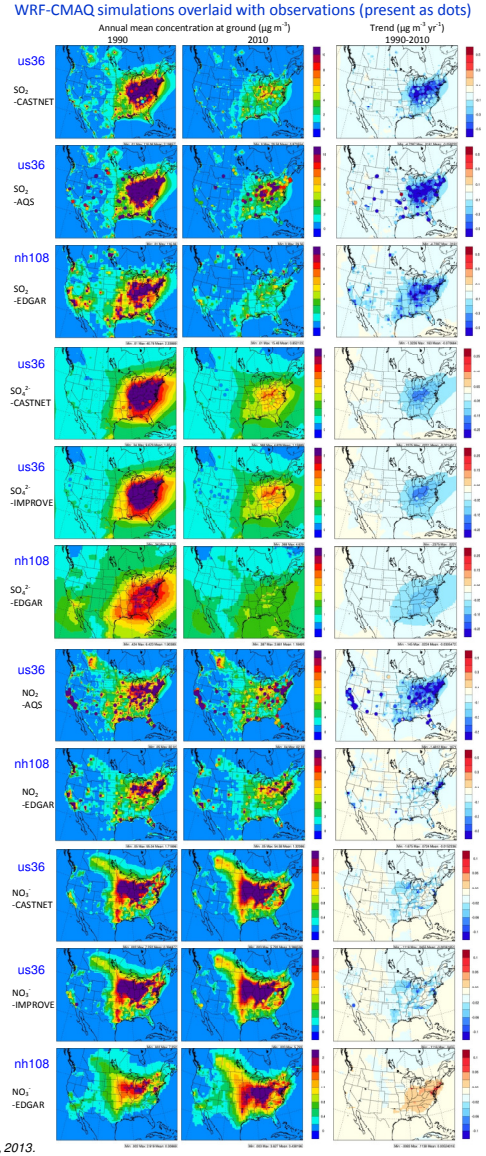
Activity (fuel use), NO_x and SO_2 emissions (Year 1990=1)



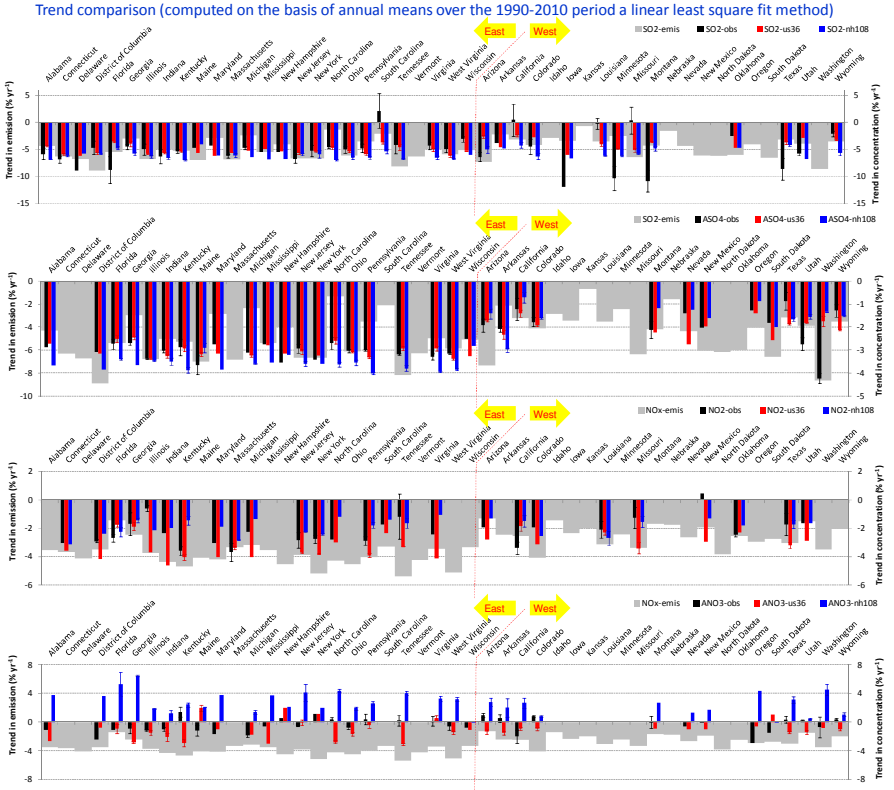
National emission estimates (unit: Tg•year-1)



WRF-CMAQ simulations overlaid with observations (present as dots)



Trend comparison (computed on the basis of annual means over the 1990-2010 period a linear least square fit method)



Major findings

1. A WRF-CMAQ simulation driven by the newly-developed inventory shows similar spatial distributions but higher concentration levels for all pollutants-compared to a simulation driven by EDGAR.
2. Both simulations captured the decreasing trends of SO_2, NO_2 and SO_4^{2-} concentrations over eastern US but the simulation driven by EDGAR tends to overestimate the rate of SO_4^{2-} decreases in most of states.
3. The simulation driven by the newly-developed inventory captured the slightly decreasing trends of NO_3^- in most states, whereas the simulation driven by EDGAR exhibits significant opposite trends which might be caused by an underestimation of the decreasing trend of NO_x emissions as well as an overestimation of the increasing trend of NH_3 emissions.
4. Discrepancies between simulated and observed trends are found. Future work is needed to further investigate these discrepancies.

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More details can be found at :

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