Using Monitoring Data to Improve Emissions Inventories

Benjamin de Foy, Saint Louis University
STL Area Monitoring Agencies Meeting, 23 May 2017


OMI NO₂ over the USA - 2005

Benjamin de Foy, Zifeng Lu, David G. Streets:
Impacts of control strategies, the Great Recession and weekday variations on NO2 columns above North American cities, Atmospheric Environment, 2016
OMI NO$_2$ over the USA - 2014

Benjamin de Foy, Zifeng Lu, David G. Streets:
Impacts of control strategies, the Great Recession and weekday variations on NO2 columns above North American cities, Atmospheric Environment, 2016
Multiple Linear Regression yields cleaner annual and weekly signals than simple averaging – St. Louis

Uncertainty Analysis of Regression Model using Bootstrapping Algorithm
North American Metropolitan Areas: Strong long-term reductions, temporary recession impacts
North American Metropolitan Areas: Weekend Effects: Strong, but Variable
OMI NO$_2$ over NE Asia - 2005

de Foy, Lu, Streets: Satellite NO$_2$ retrievals suggest China has exceeded its NO$_x$ reduction goals from the twelfth Five-Year Plan, Scientific Reports, 2016.
OMI NO$_2$ over NE Asia - 2011

de Foy, Lu, Streets: Satellite NO$_2$ retrievals suggest China has exceeded its NO$_x$ reduction goals from the twelfth Five-Year Plan, Scientific Reports, 2016.
OMI NO$_2$ over NE Asia - 2014

de Foy, Lu, Streets: Satellite NO$_2$ retrievals suggest China has exceeded its NO$_x$ reduction goals from the twelfth Five-Year Plan, Scientific Reports, 2016.
OMI NO$_2$ over Multiple Sites in China

Reduced Columns since 2011 as a result of the 12$^{th}$ Five Year Plan

Reduced Columns: Recession / Olympics

de Foy, Lu, Streets: Satellite NO$_2$ retrievals suggest China has exceeded its NO$_x$ reduction goals from the twelfth Five-Year Plan, Scientific Reports, 2016.
US-EPA AQS Data Analysis: Hourly NO\textsubscript{x} Concentrations 2005-2015, 90\% data completeness
Factors Contributing to NO$_x$ Surface Concentrations:

- **Emissions**: diurnal, weekly, seasonal, long-term signals

- **Transport**: wind speed and direction, boundary layer height

- **Chemistry**: NO$_x$ lifetime: rough proxies: ozone, ultraviolet radiation, temperature, humidity
US-EPA AQS Data Analysis: NOx Concentration in East St. Louis
AQS Multi-Linear Regression for East St. Louis

- **NOx (ppb)**
- **Seasonal Cycle (%)**
- **Annual Trend (%)**
- **Weekday Cycle (%)**
- **Diurnal Profile (%)**
- **Boundary Layer Scaling Function**

Graphs showing trends and cycles over time with specific data points and measurements.
Top 3 Clusters of Annual Patterns for 110 US sites
Mid-Week Diurnal Patterns
Clusters of Mid-Week Diurnal Patterns
Sunday Diurnal Patterns
Clusters of Sunday Diurnal Patterns
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• There have been strong reductions in NOx emissions in the last 10 years
• The recession had a significant temporary impact on emissions
• The week-end effect is stronger in larger cities
• Diurnal emission profiles vary by region in the US

• Multiple Linear Regression Analysis accounts for variations from multiple factors and hence gives clearer estimates of temporal signals in the data