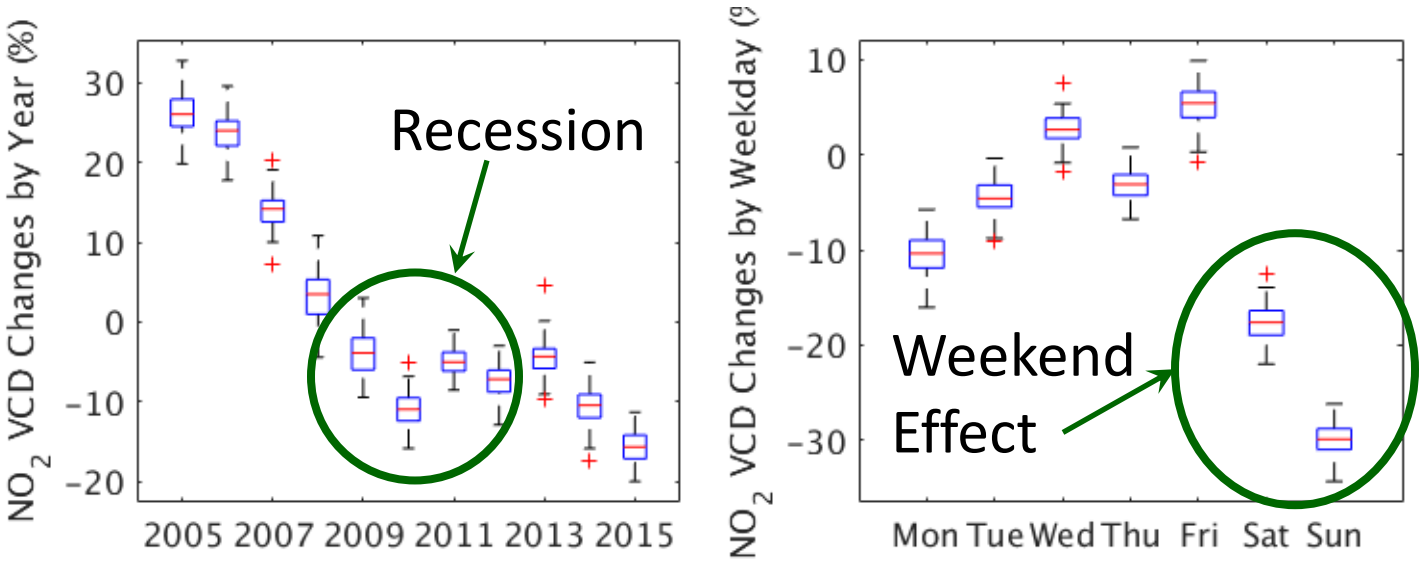
Using Monitoring Data to Improve Emissions Inventories

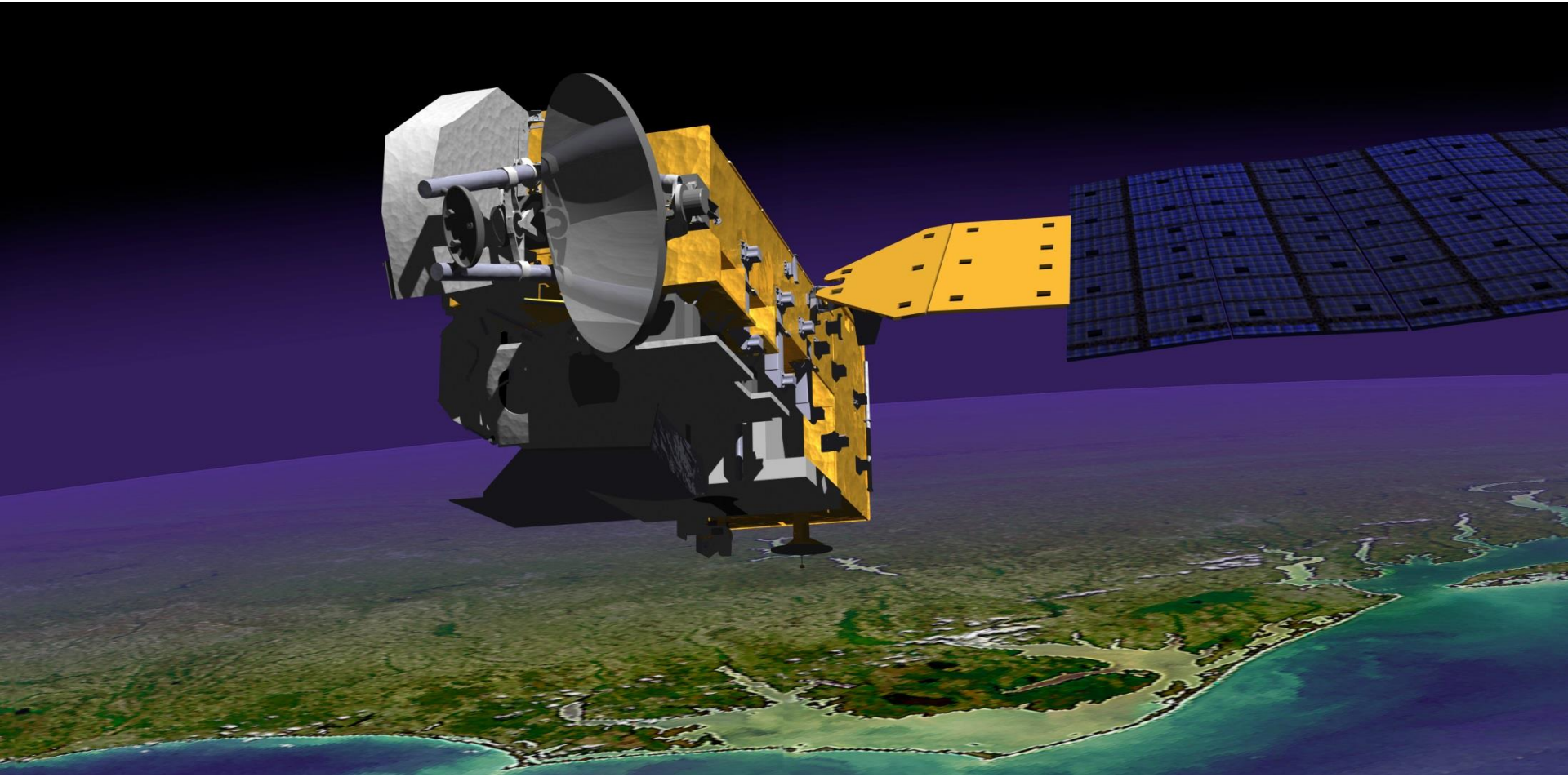
Benjamin de Foy, Saint Louis University

STL Area Monitoring Agencies Meeting, 23 May 2017



de Foy, B., Lu, Z. and Streets, D.G., 2016. Impacts of control strategies, the Great Recession and weekday variations on NO_2 columns above North American cities. *Atmospheric Environment*.

OMI NO_2 Columns for Emission Inventory Development



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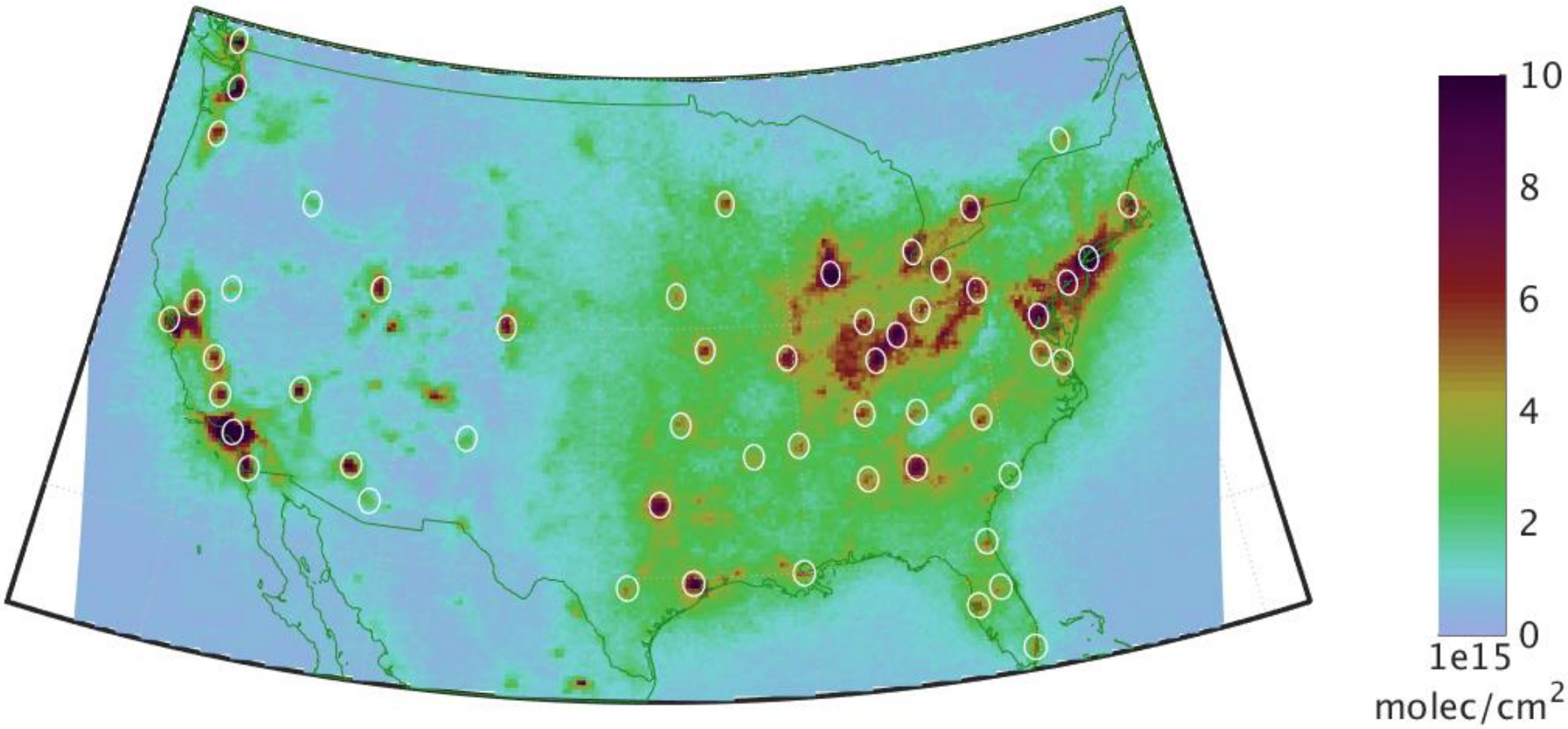
OMI NO_2 over the USA - 2005



Benjamin de Foy, Zifeng Lu, David G. Streets:
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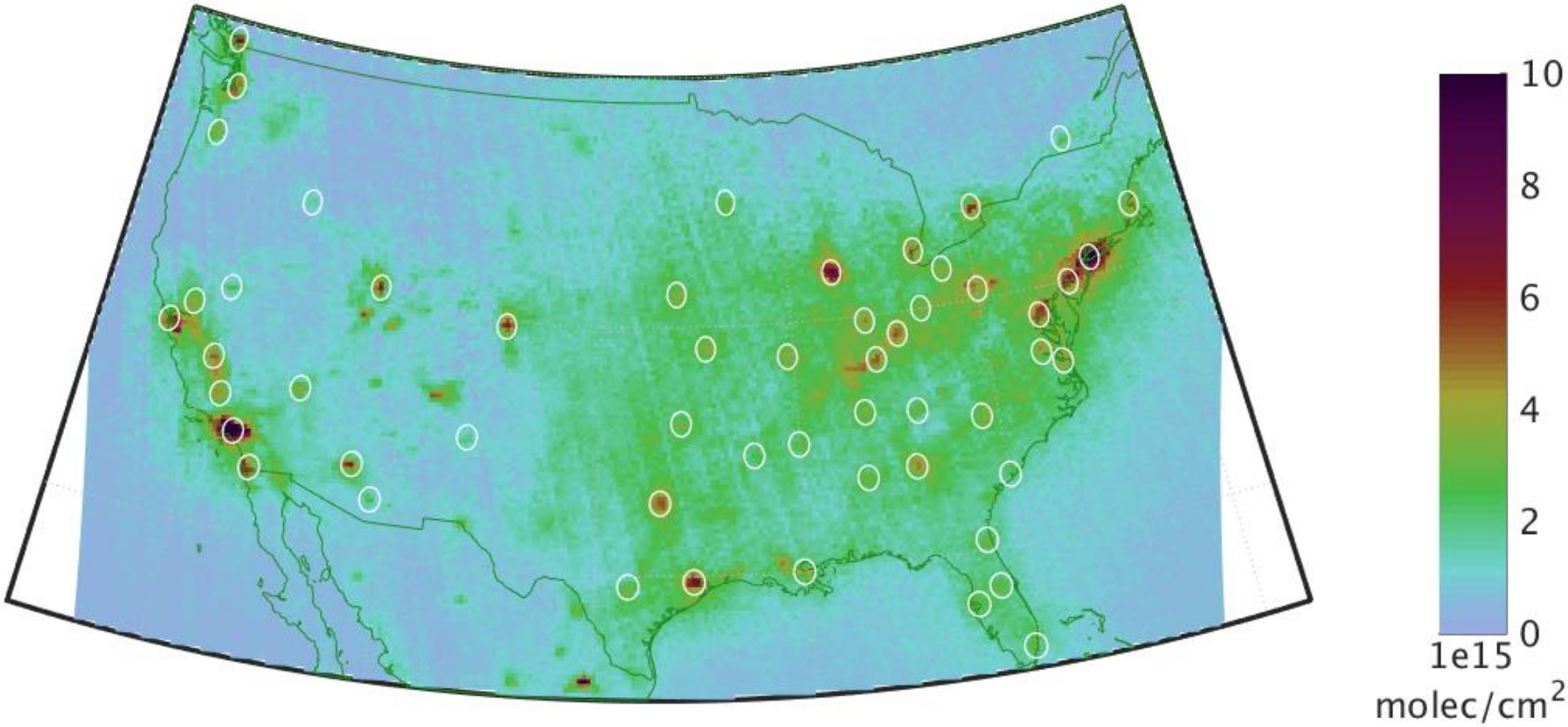

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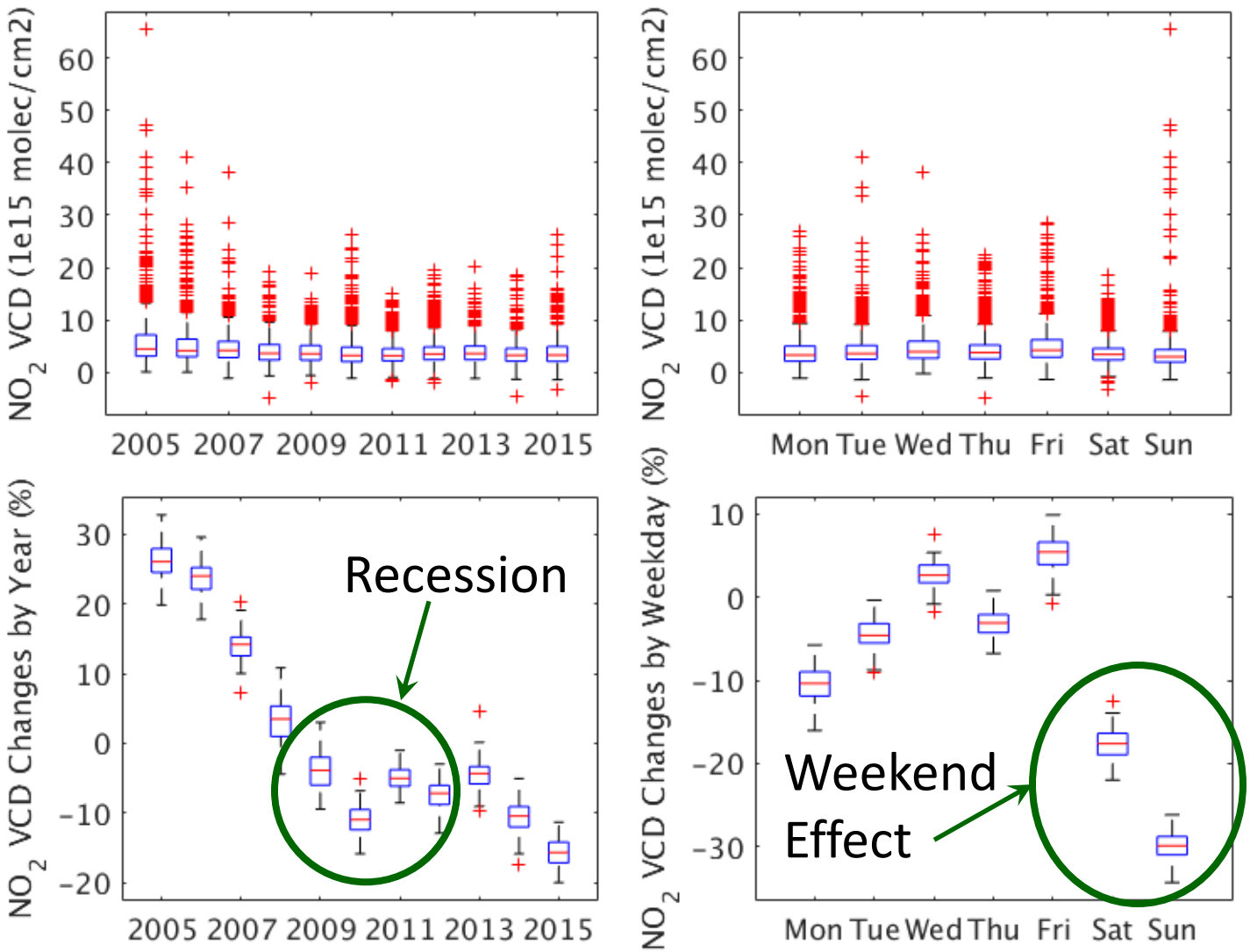
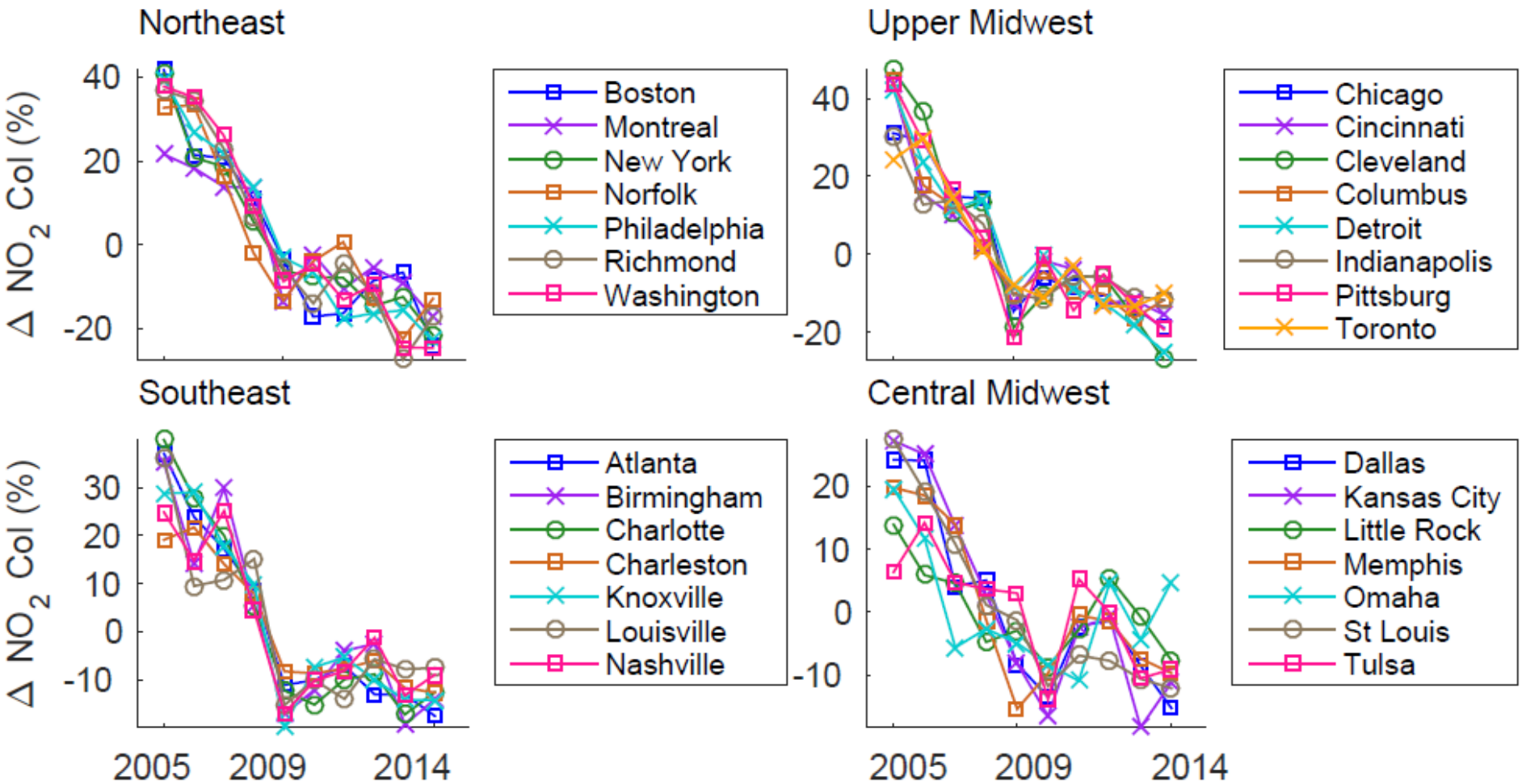
Multiple Linear Regression yields cleaner annual and weekly signals than simple averaging – St. Louis

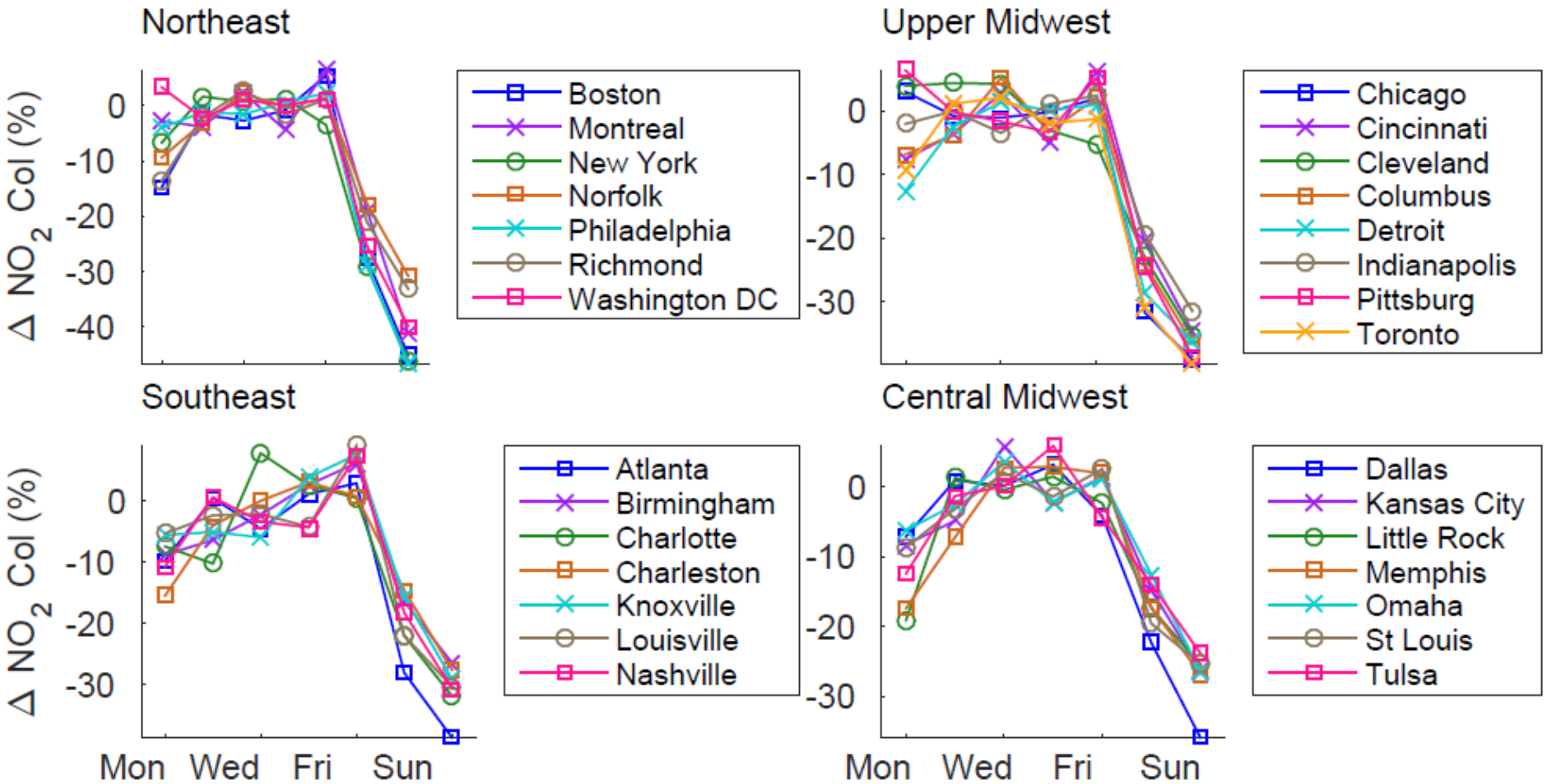


Uncertainty Analysis of Regression Model using Bootstrapping Algorithm

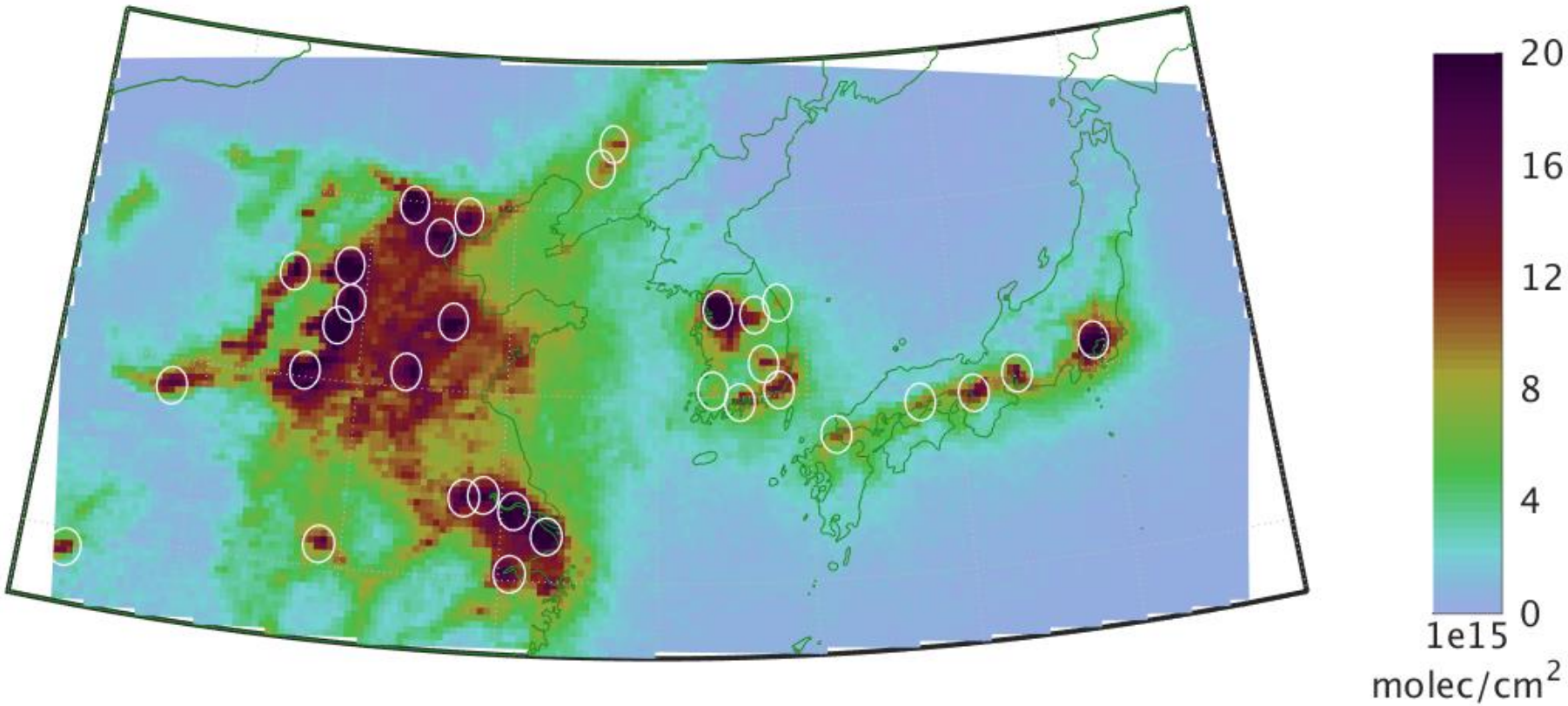
North American Metropolitan Areas: Strong long-term reductions, temporary recession impacts



North American Metropolitan Areas: Weekend Effects: Strong, but Variable

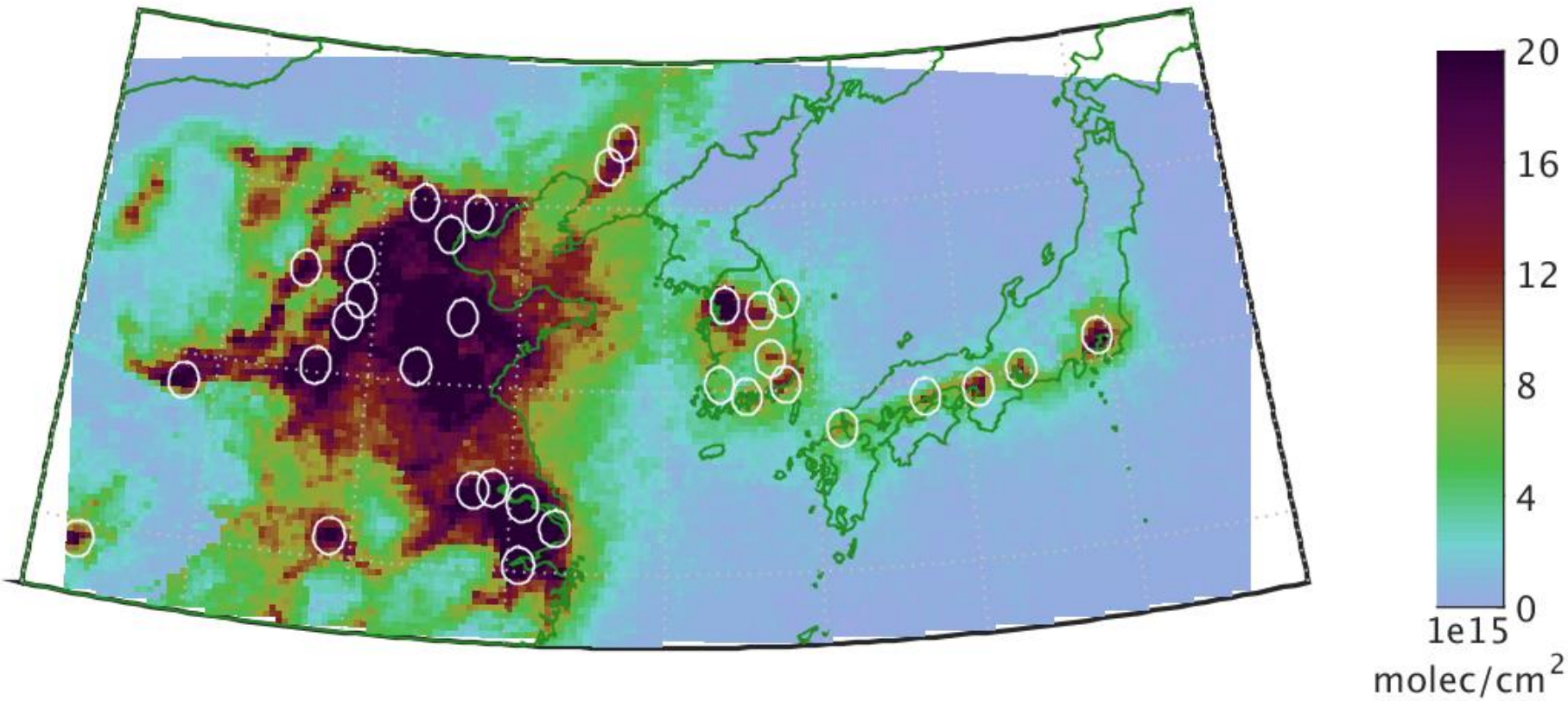


OMI NO_2 over NE Asia - 2005



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



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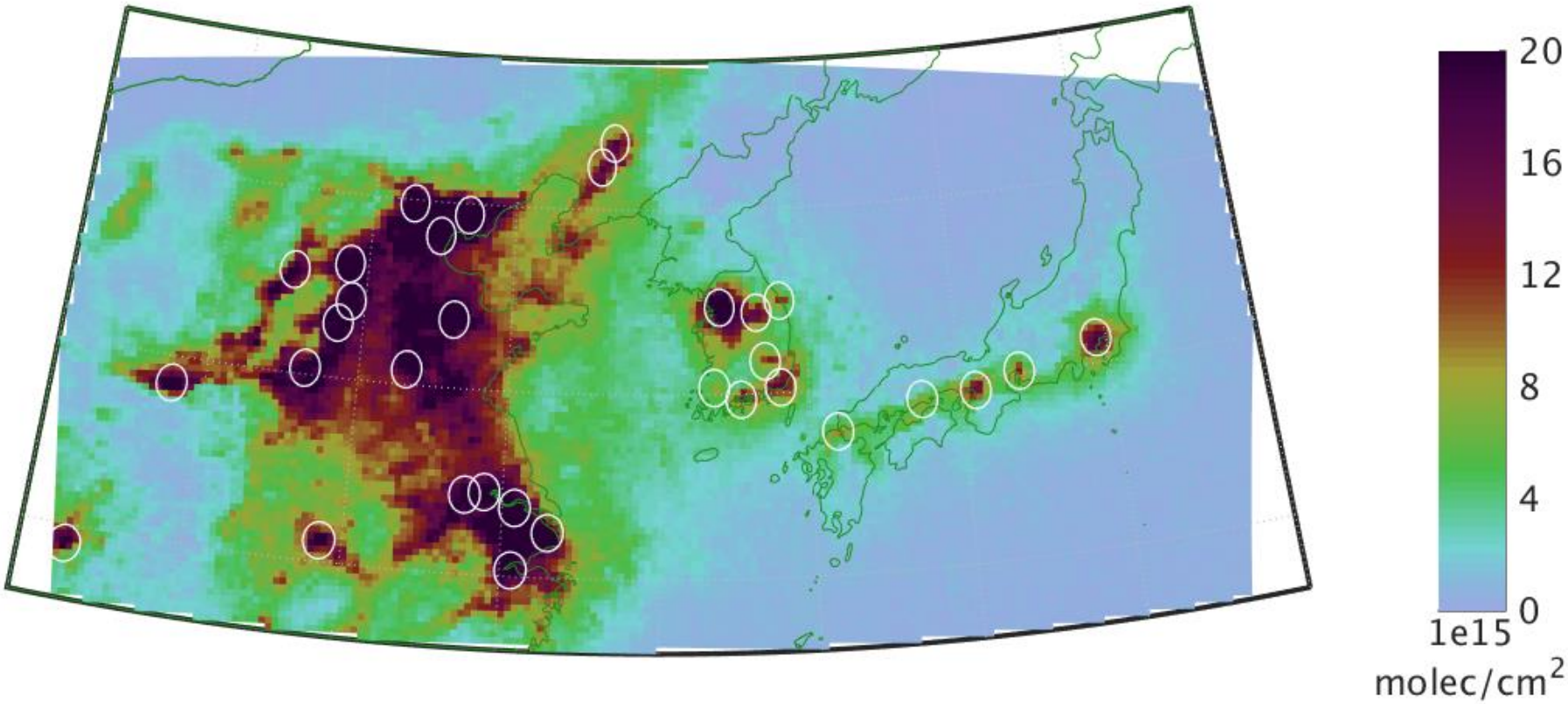

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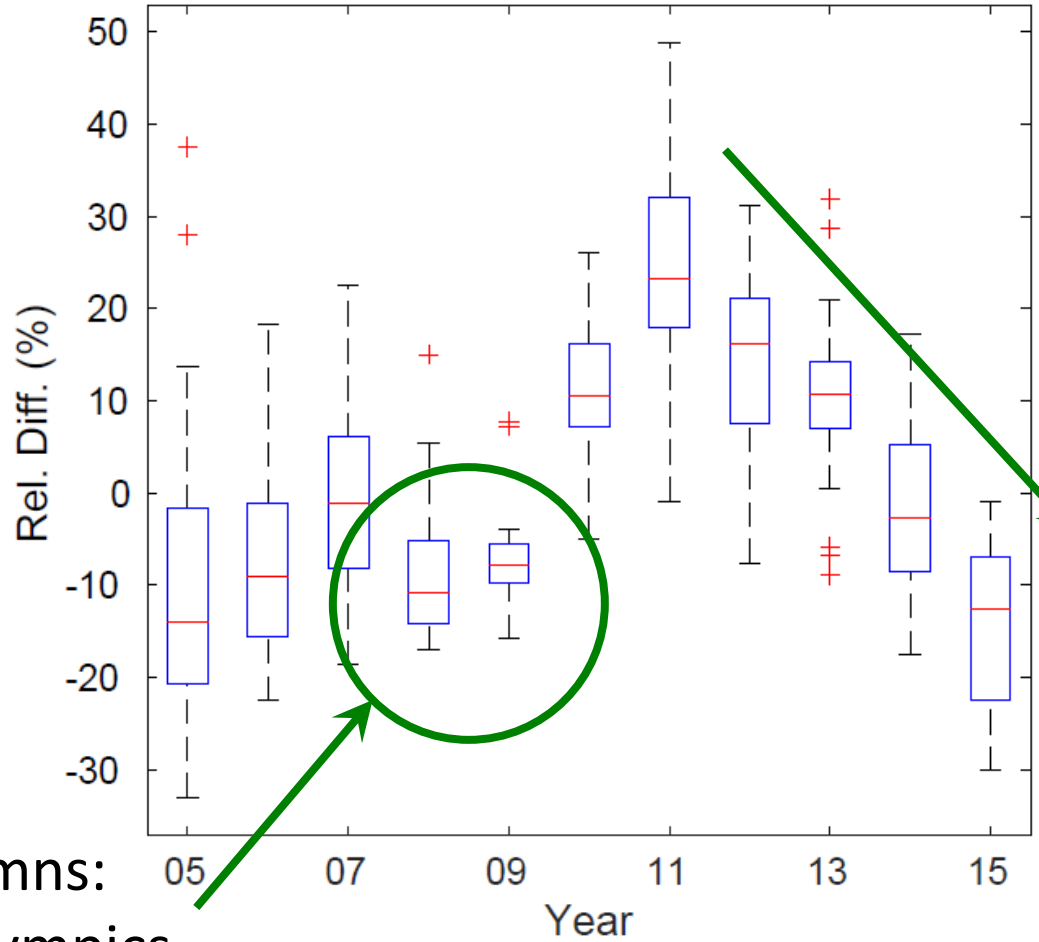
OMI NO_2 over Multiple Sites in China

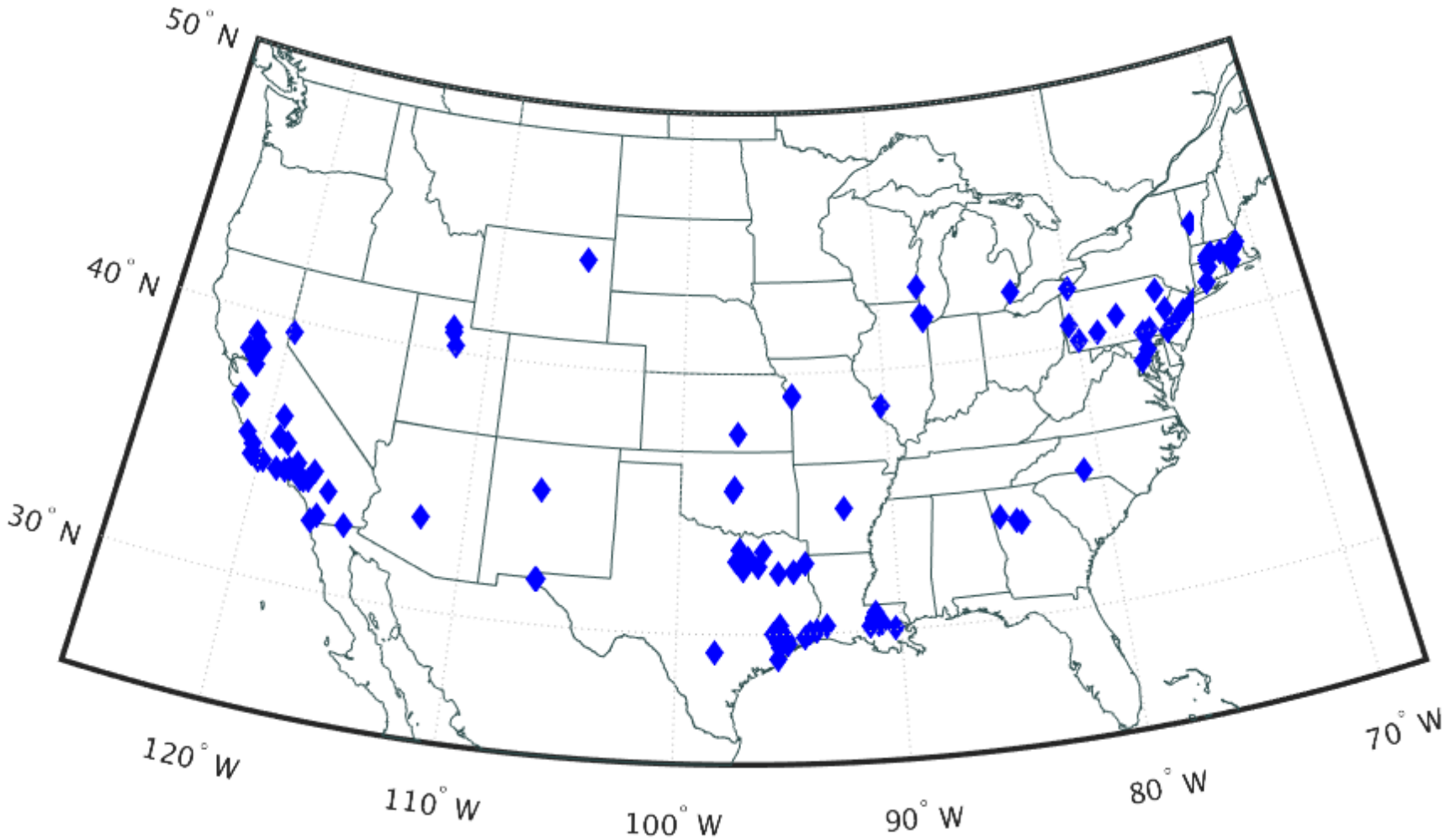


Reduced Columns since 2011 as a result of the 12th Five Year Plan

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_x Concentrations 2005-2015, 90% data completeness

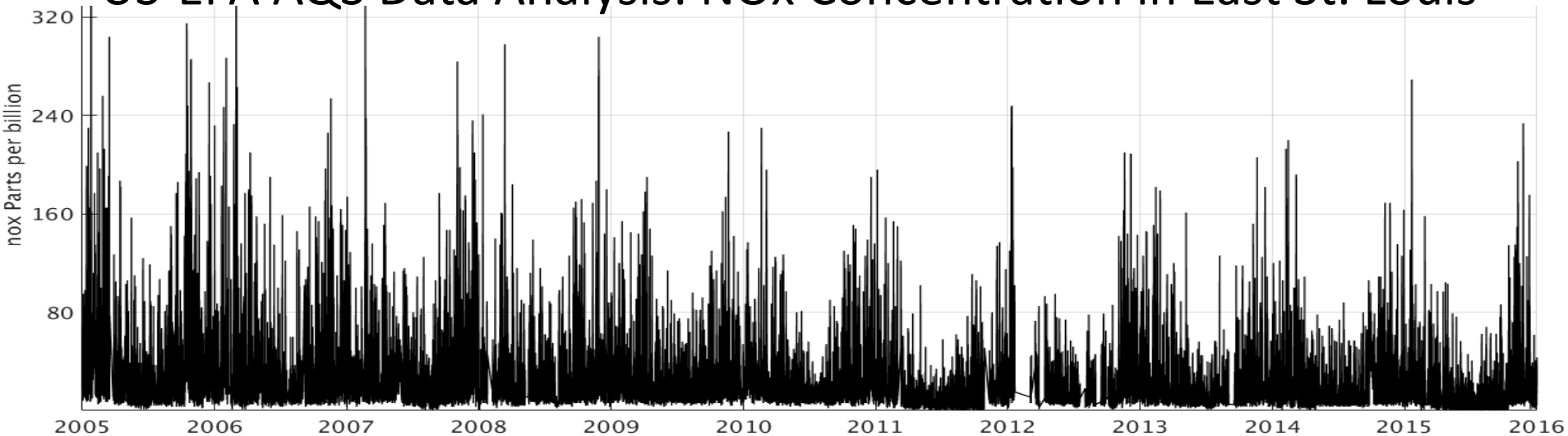


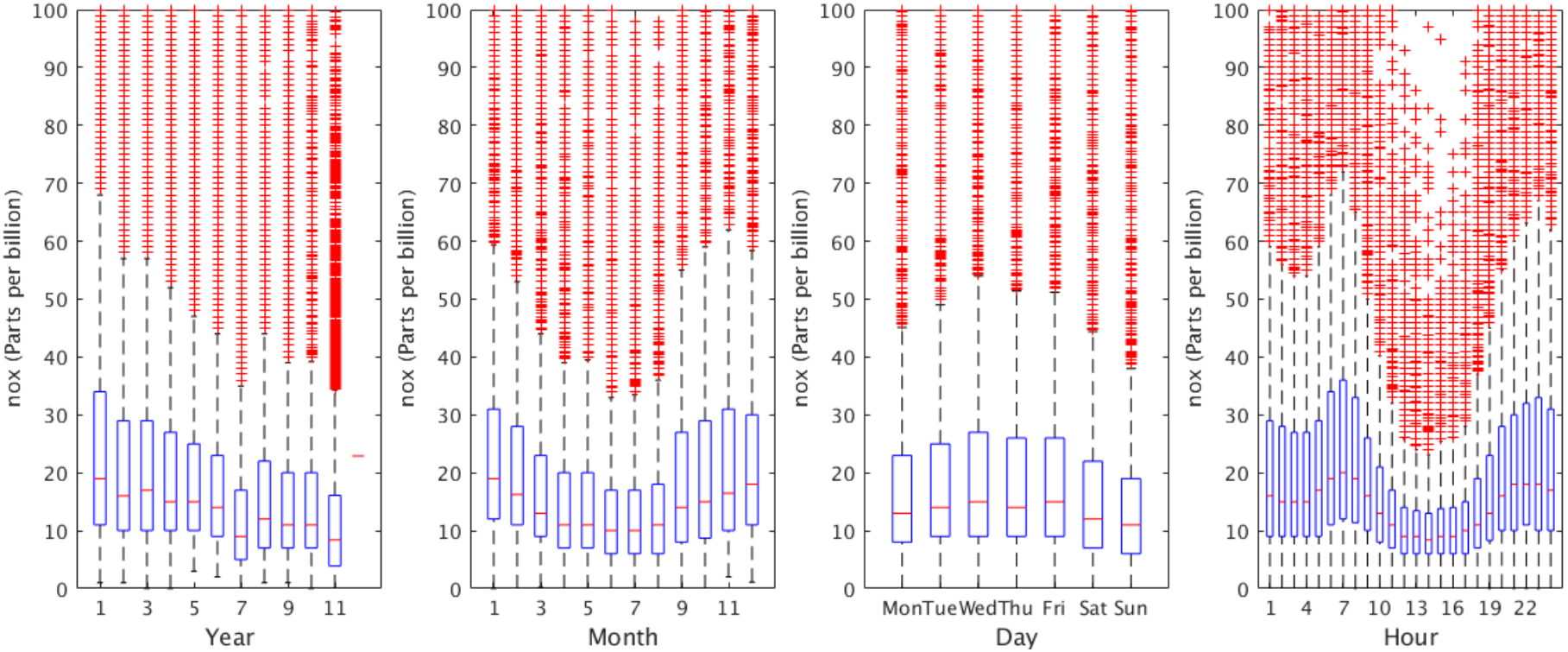
US-EPA AQS Data Analysis: Hourly NO_x Concentrations 2005-2015, 90% data completeness

Factors Contributing to NO_x Surface Concentrations:

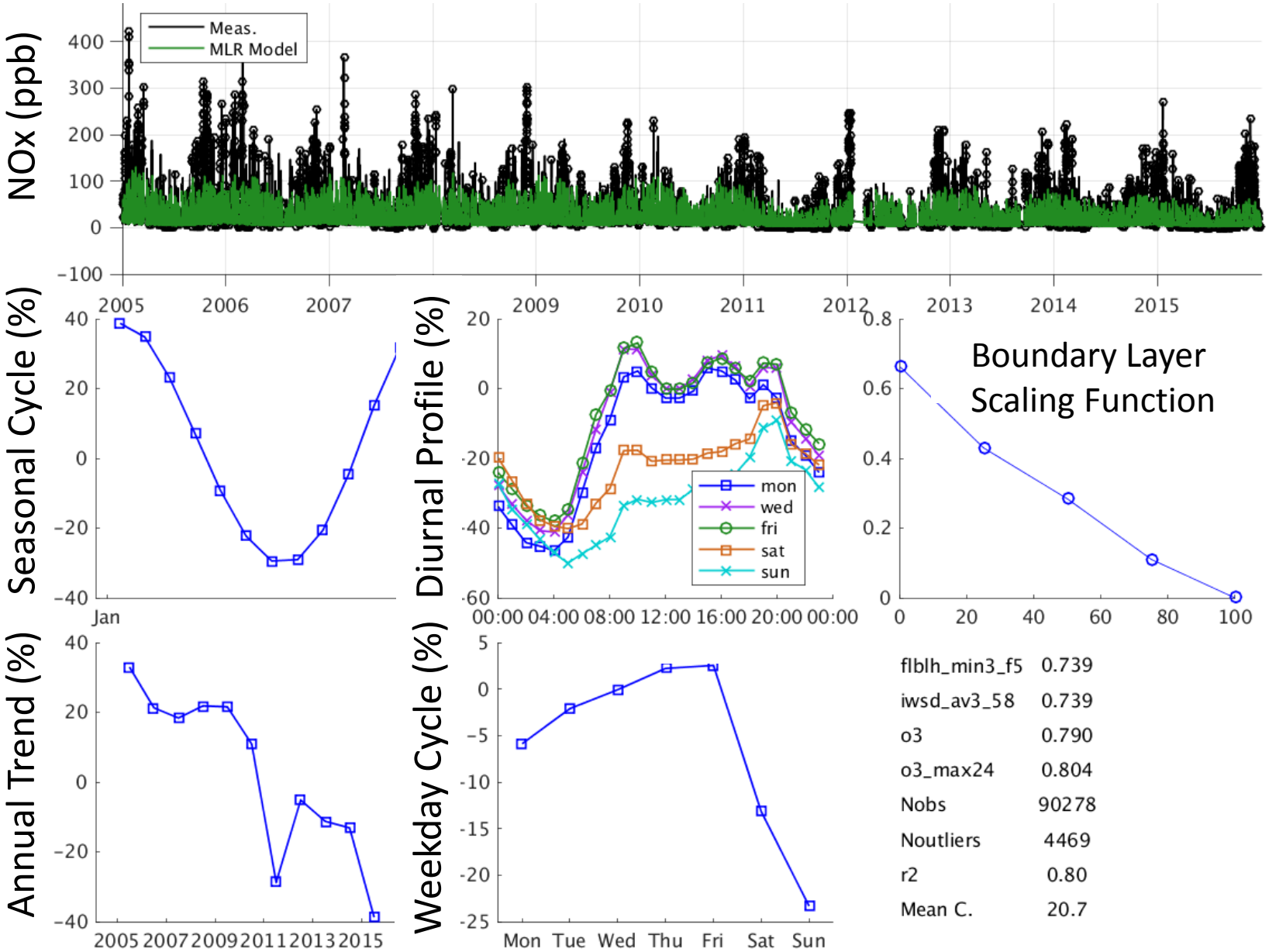
- **Emissions:** diurnal, weekly, seasonal, long-term signals
- **Transport:** wind speed and direction, boundary layer height
- **Chemistry:** NO_x lifetime: rough proxies: ozone, ultraviolet radiation, temperature, humidity

US-EPA AQS Data Analysis: NOx Concentration in East St. Louis



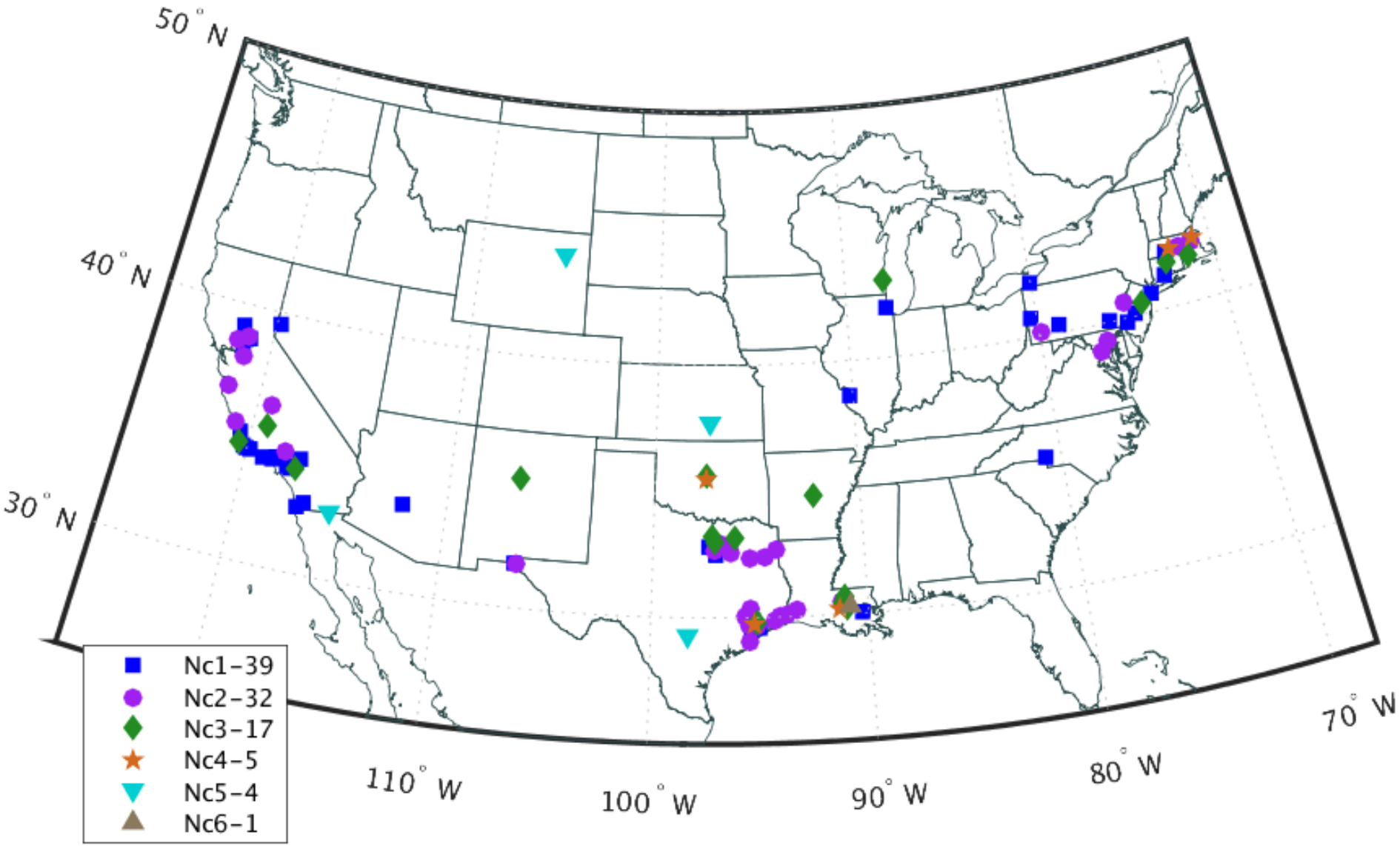


AQS Multi-Linear Regression for East St. Louis

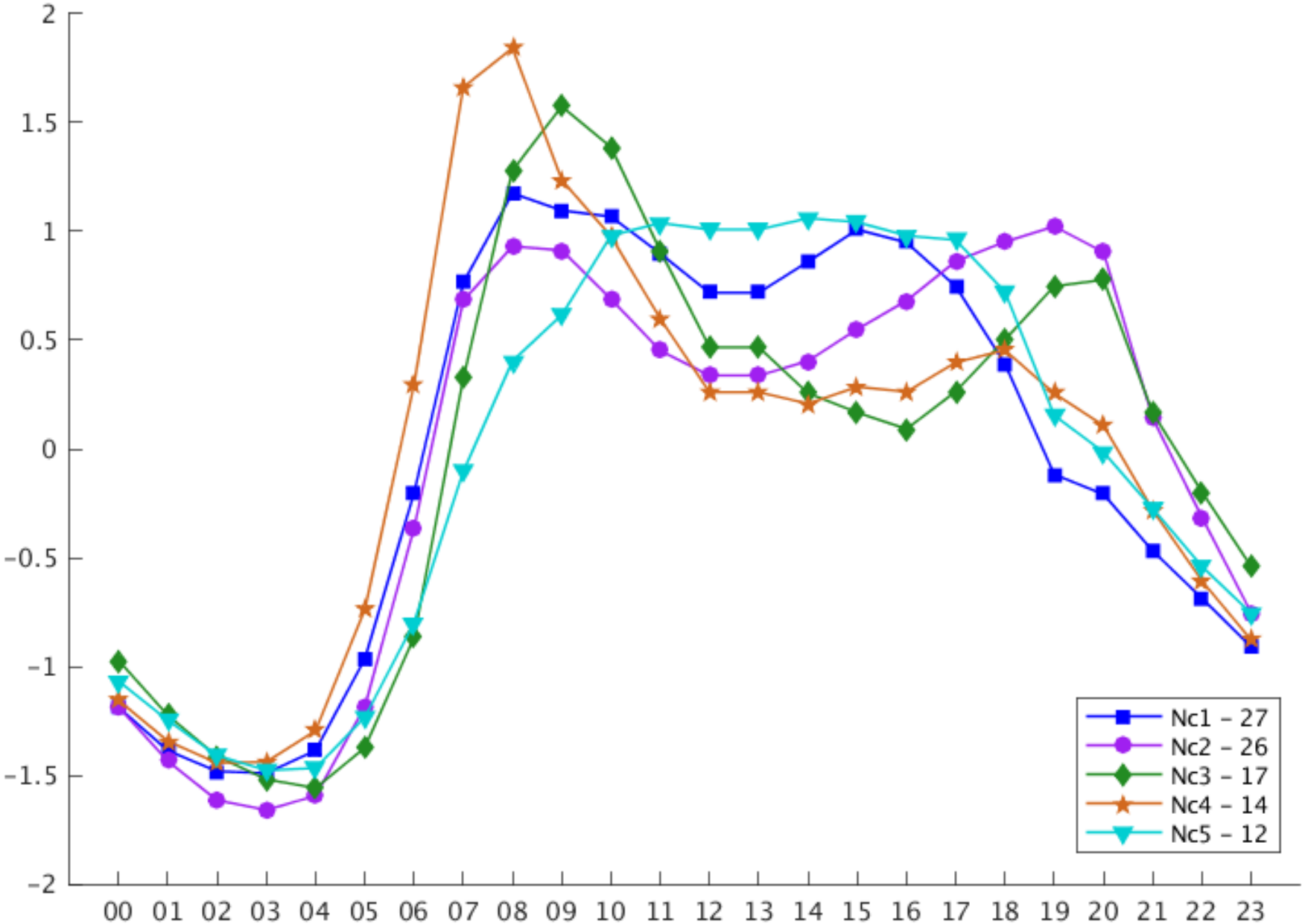


Top 3 Clusters of Annual Patterns for 110 US sites

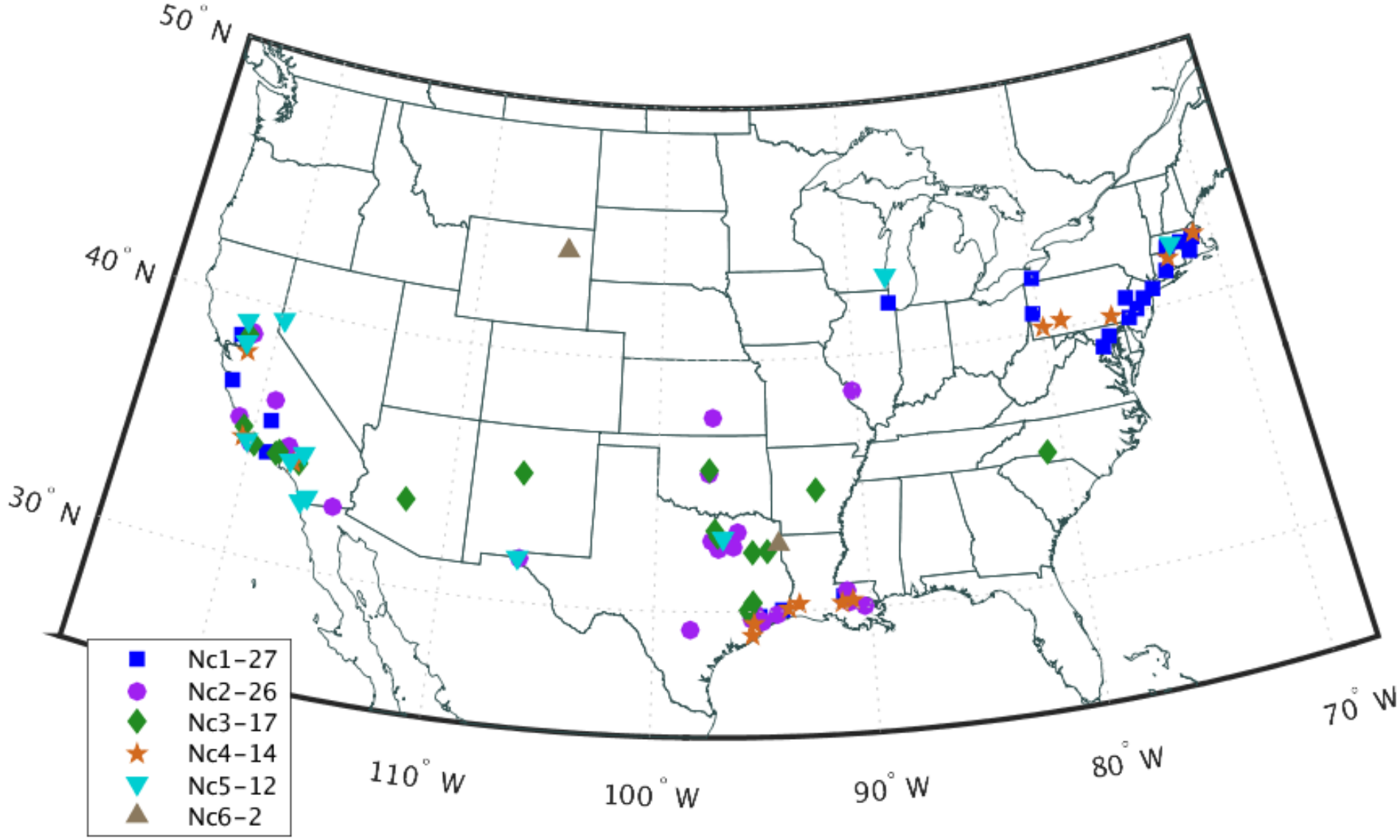
Clusters of Annual Patterns



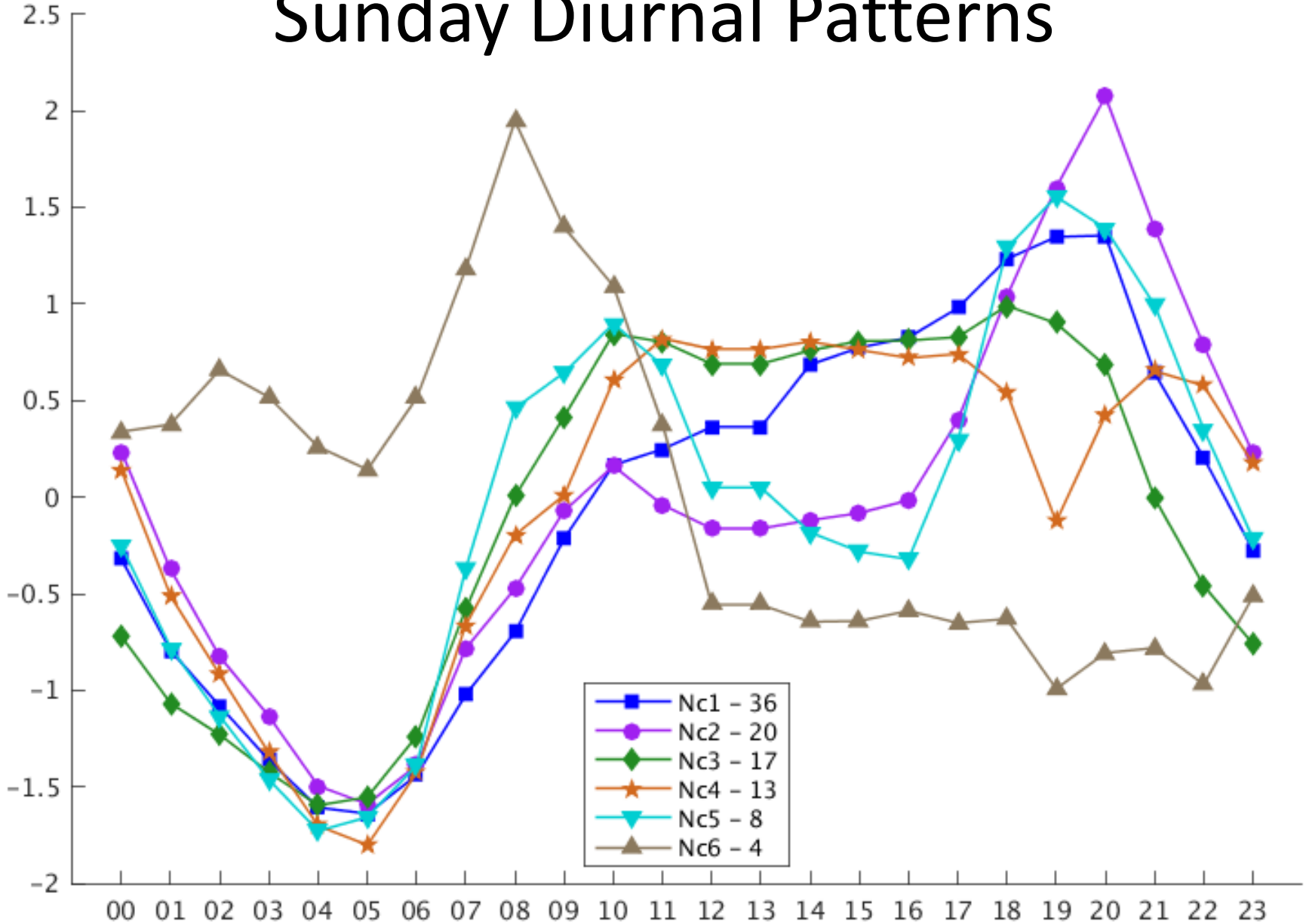
Mid-Week Diurnal Patterns



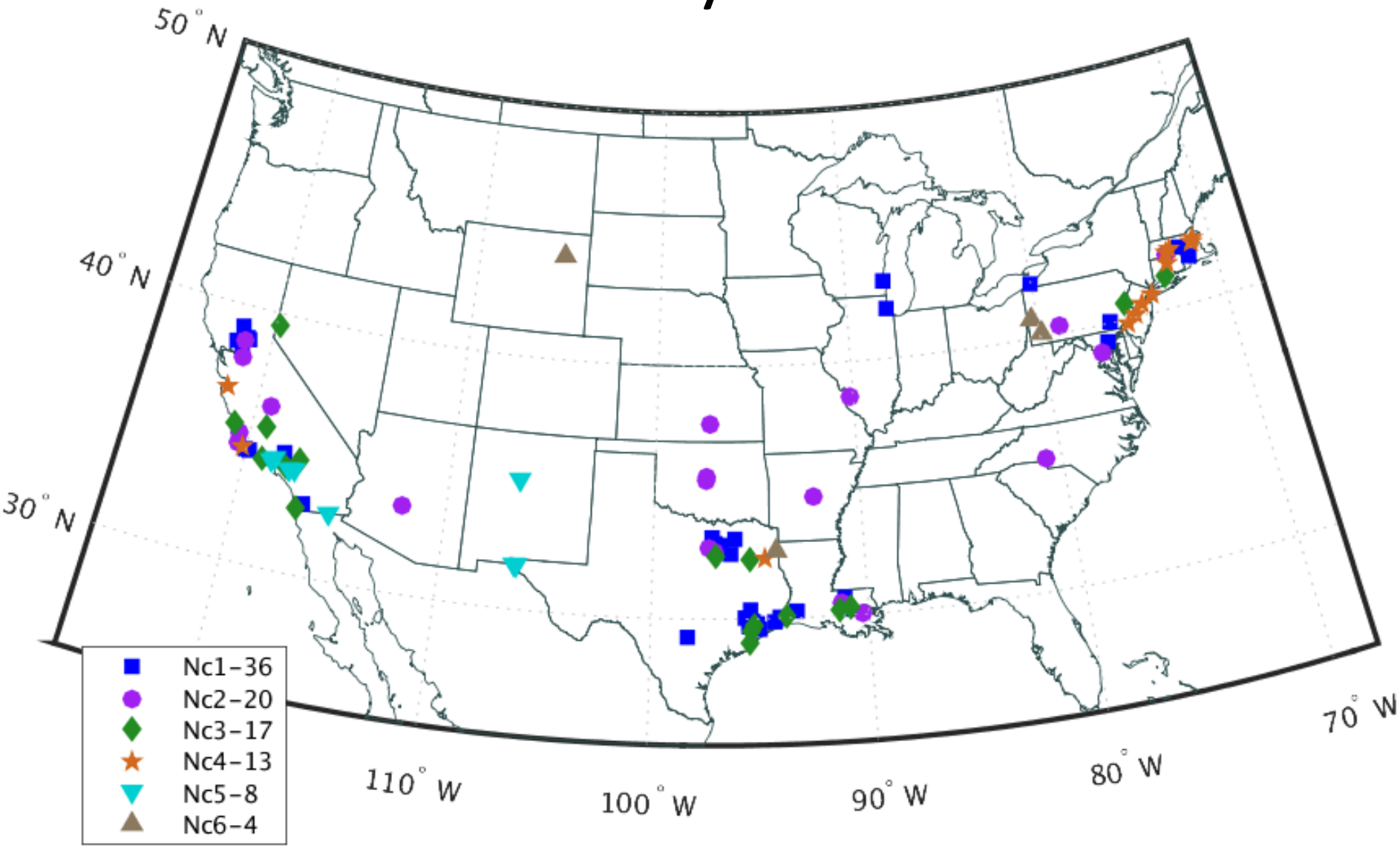
Clusters of Mid-Week Diurnal Patterns



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