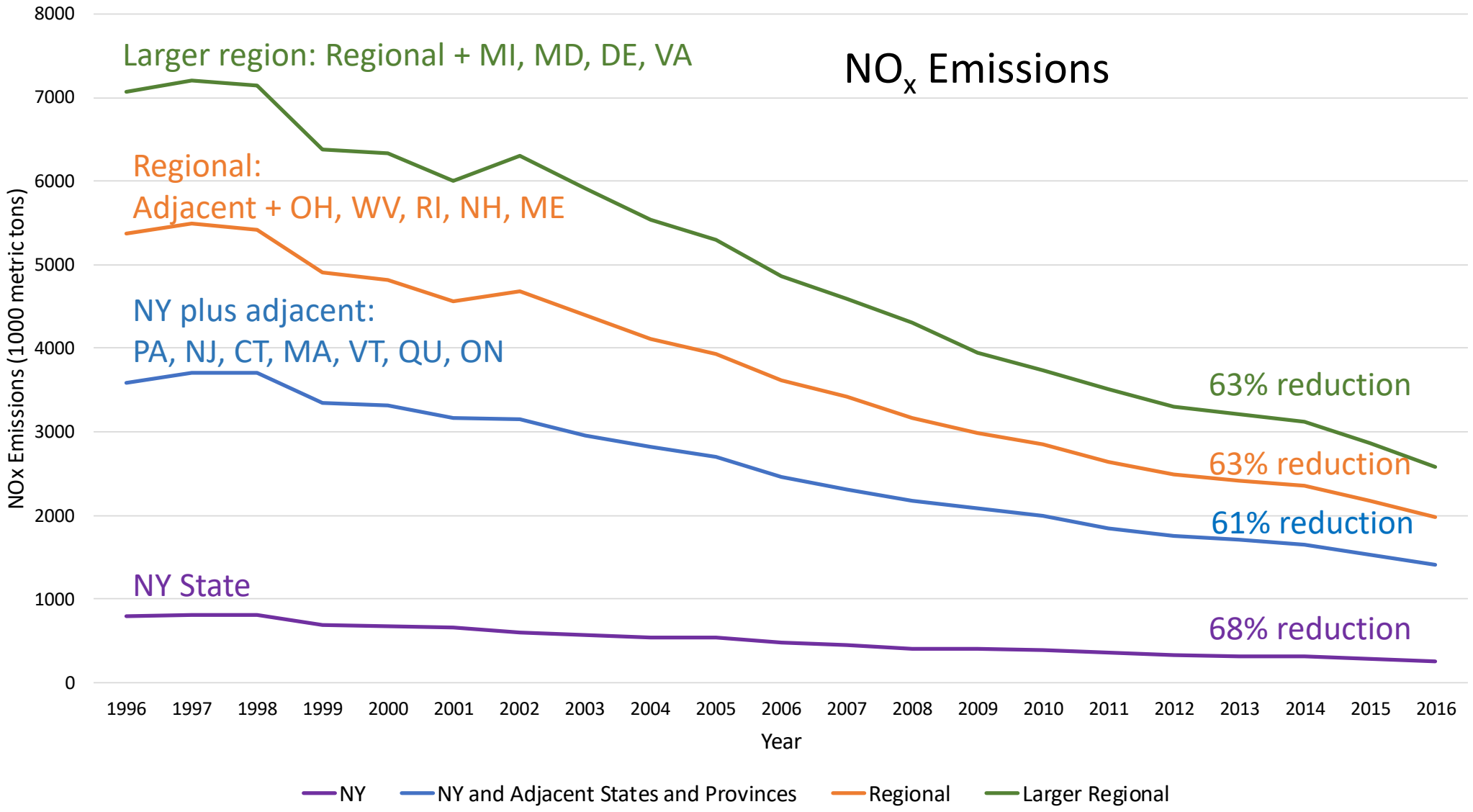
Emission Reductions Improve Air Quality

Charles Blanchard, Stephanie Shaw, Eric Edgerton, James Schwab

Energy-Related Air Quality and Health Effects Research Workshop
April 9 – 10, 2019

NYSERDA PON 2981

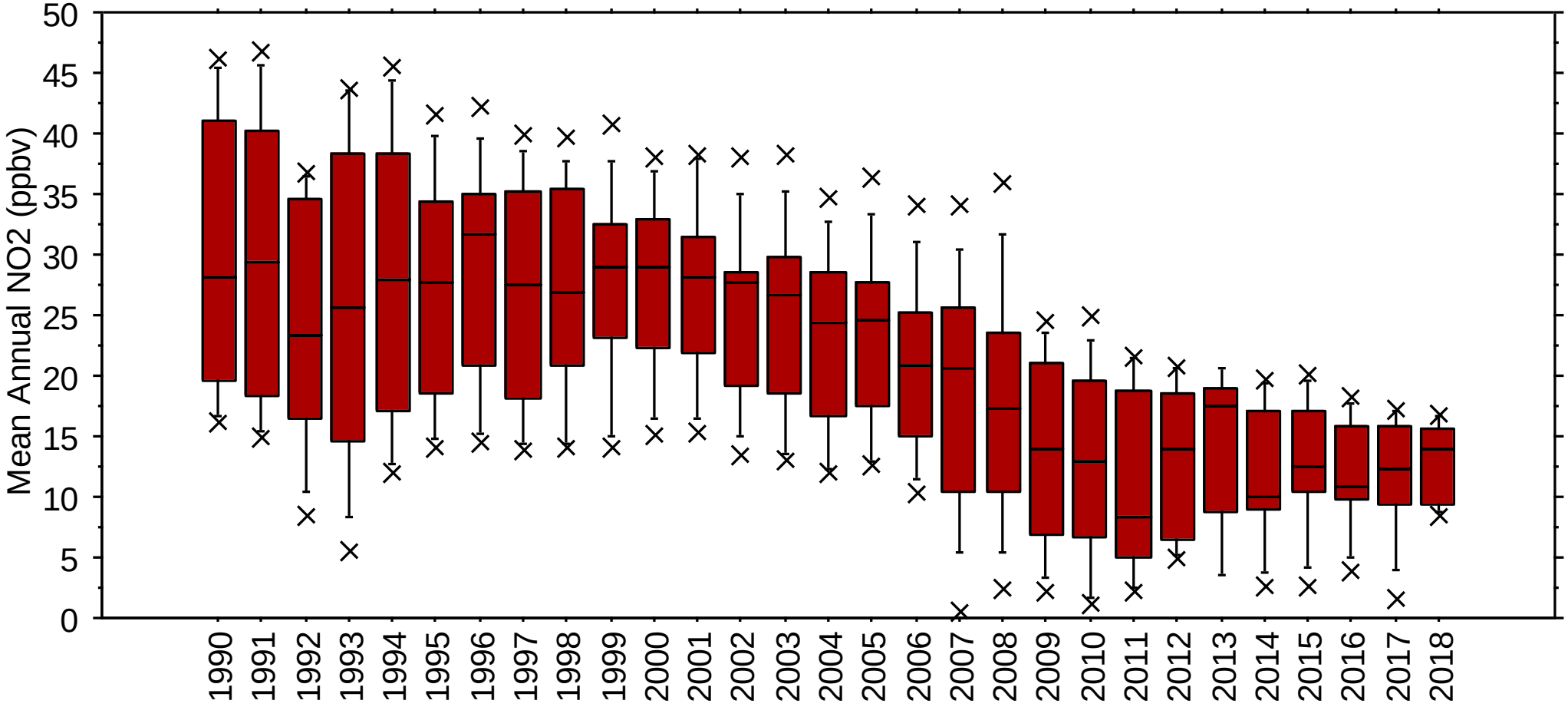
Large, Widespread Emission Reductions, 1996 – 2016



Source: U.S. EPA trends inventory; Environment and Climate Change Canada air pollutant emission inventory

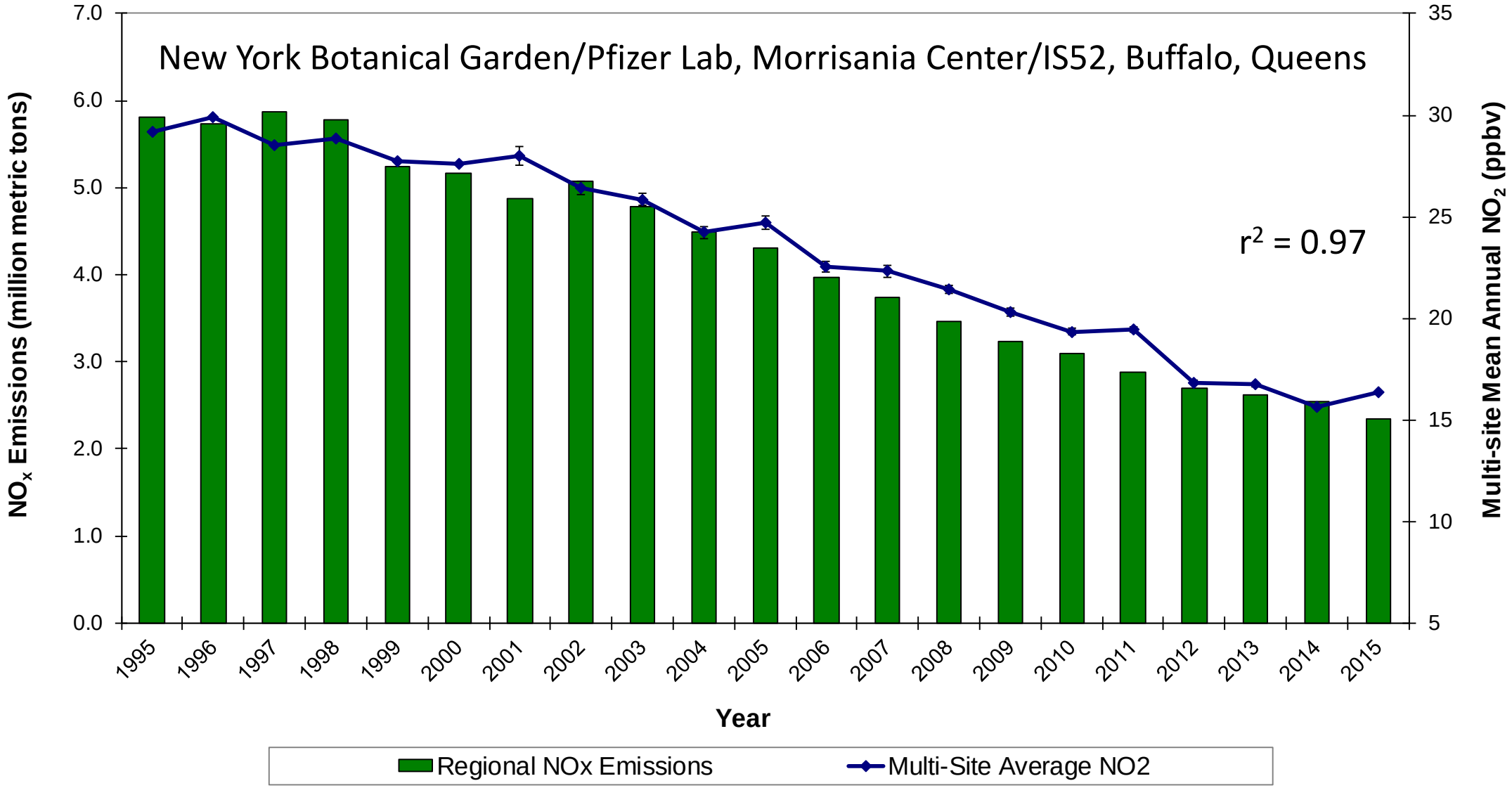
Mean Annual Ambient NO_2 Declined at NY Sites

All NY State NO_2 monitoring sites (N = 5 – 12 sites per year, ≥ 7 sites except 2012 & 2013)



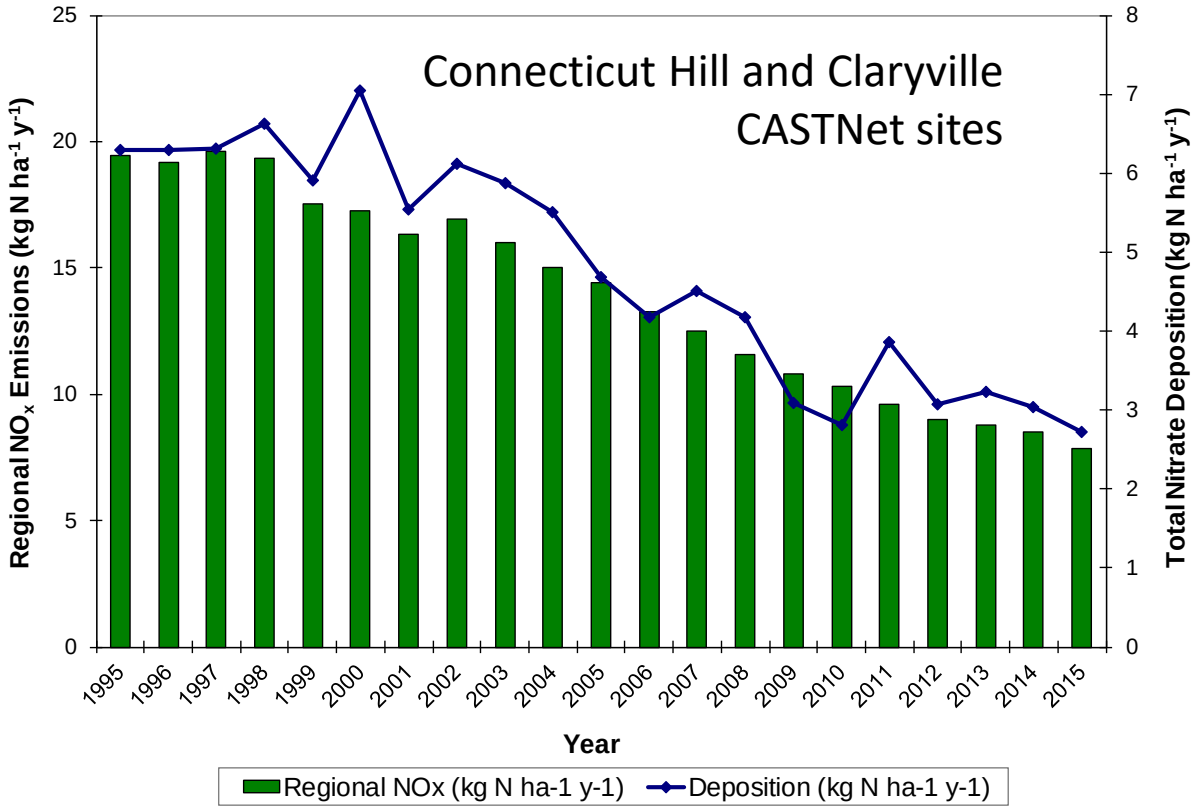
Source: U.S. EPA Air Quality System (AQS) pre-generated data files

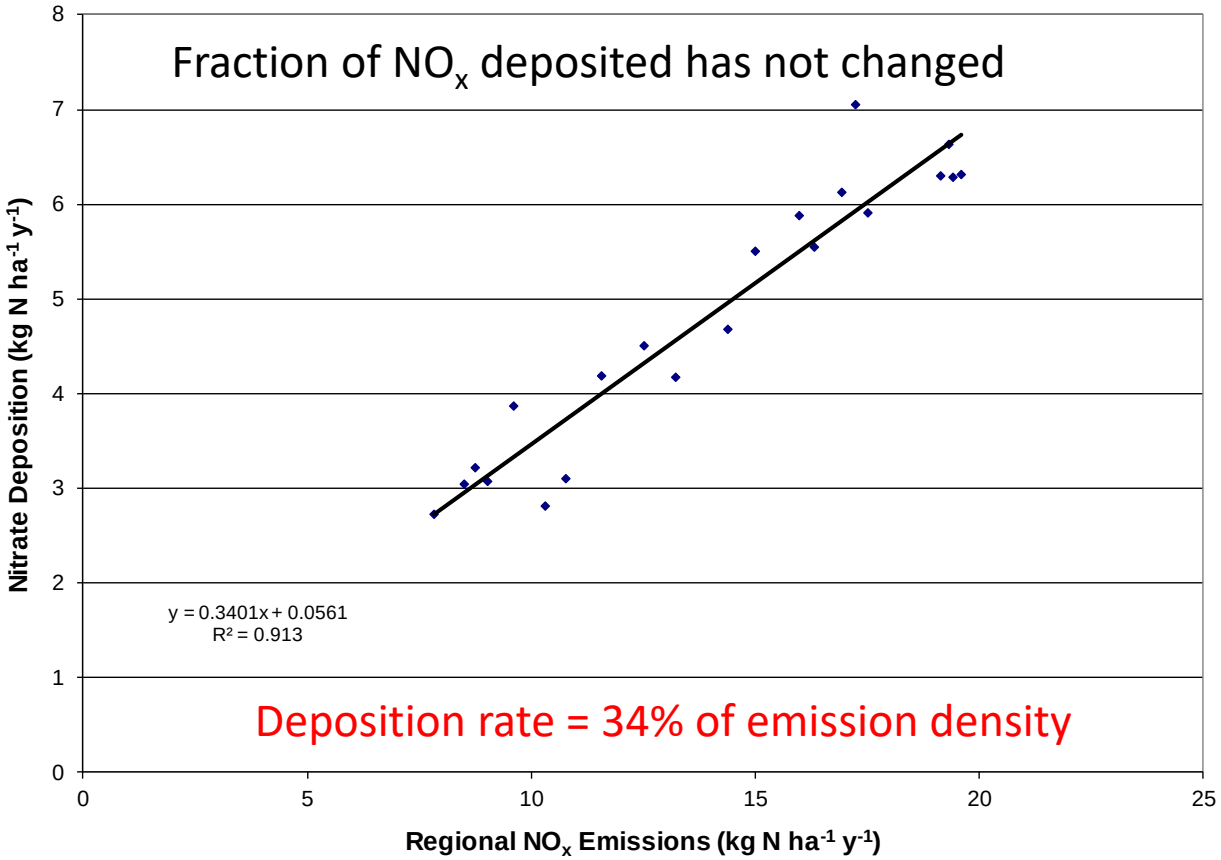
Ambient NO_2 Decline Tracked NO_x Emissions



Source: U.S. EPA Air Quality System (AQS) pre-generated data files

Nitrate Deposition (wet NO_3 + dry HNO_3 + dry pNO_3) Deposition Tracked Regional NO_x Emissions

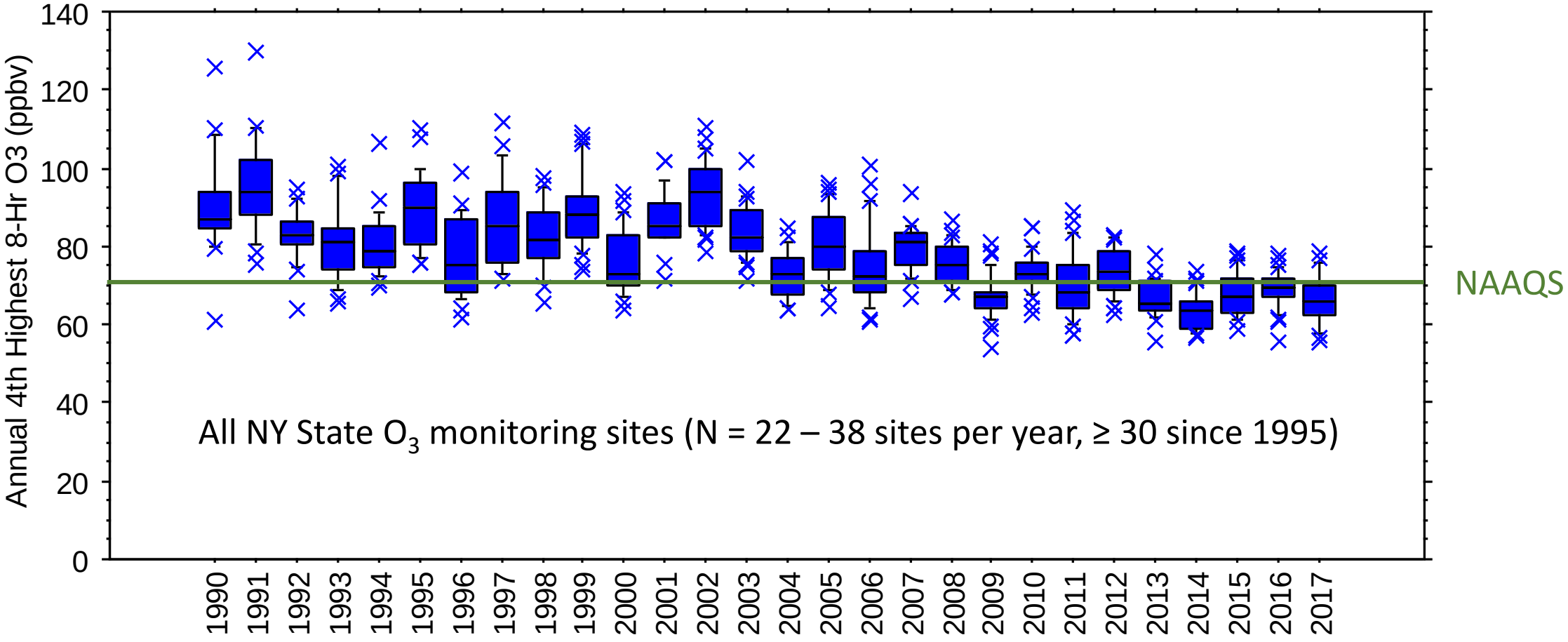




Source: U.S. EPA Clean Air Status and Trends Network data

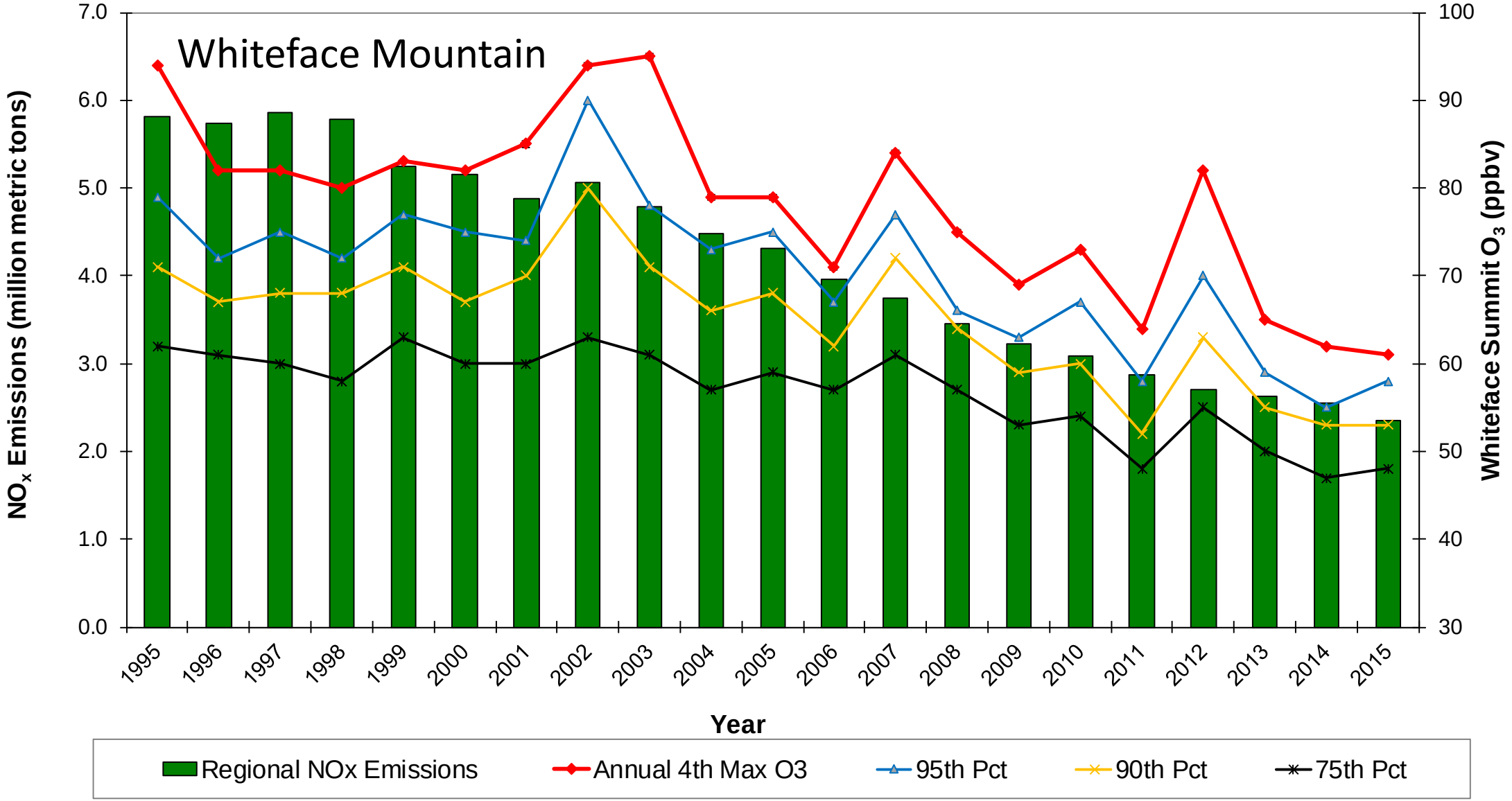
Implication: NO_x sink is proportional to NO_x emissions

Annual 4th-Highest Daily Peak 8-Hour O_3 Declined Rate of Decline ~ 1 ppbv per Year

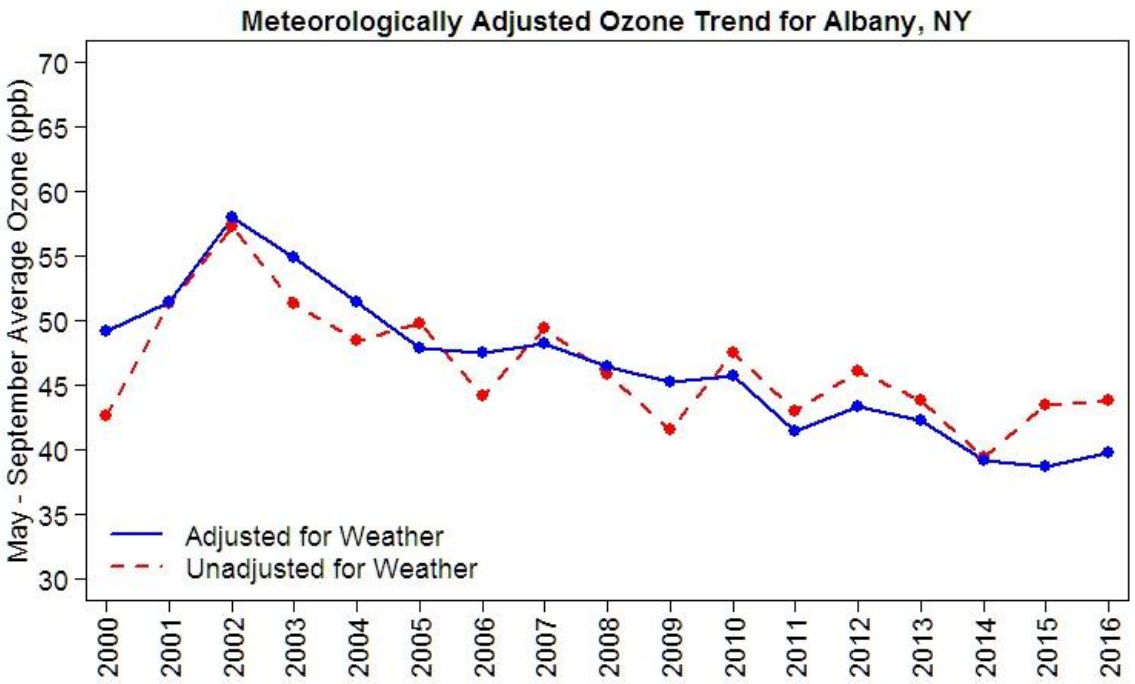


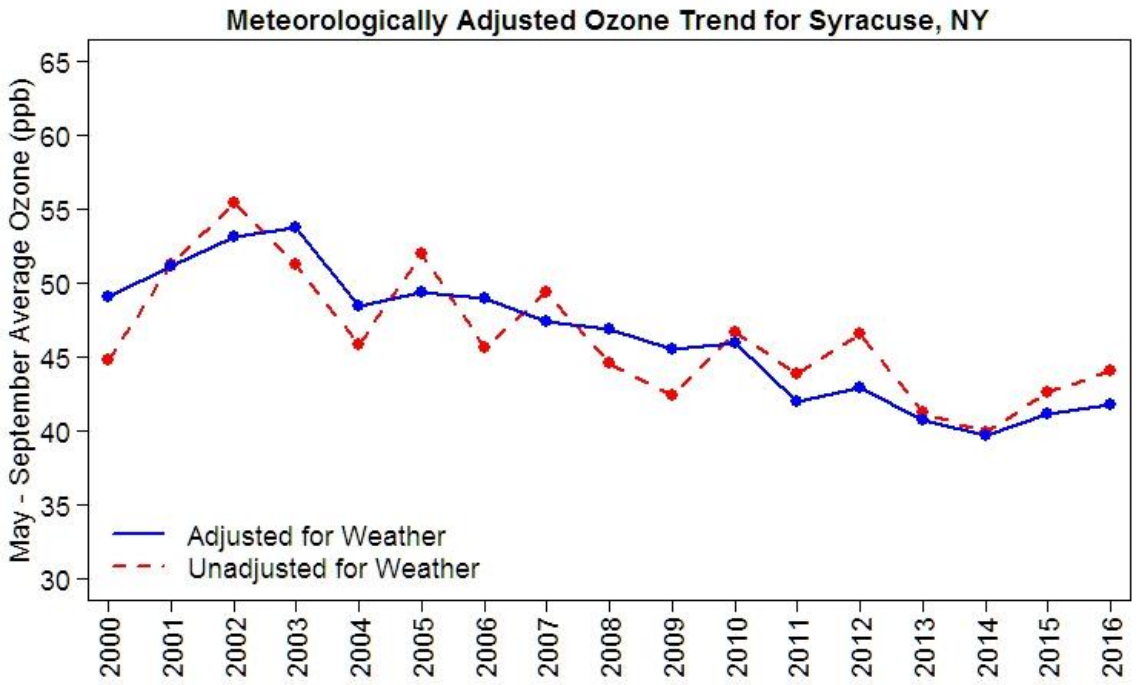
Source: U.S. EPA Air Quality System (AQS) pre-generated data files

Max O_3 Values Declined Along with 75th – 95th Percentiles (Declining Toward ~40 – 50 ppbv)



O_3 Trends are Due to Emission Changes (Not to Trends in Weather)





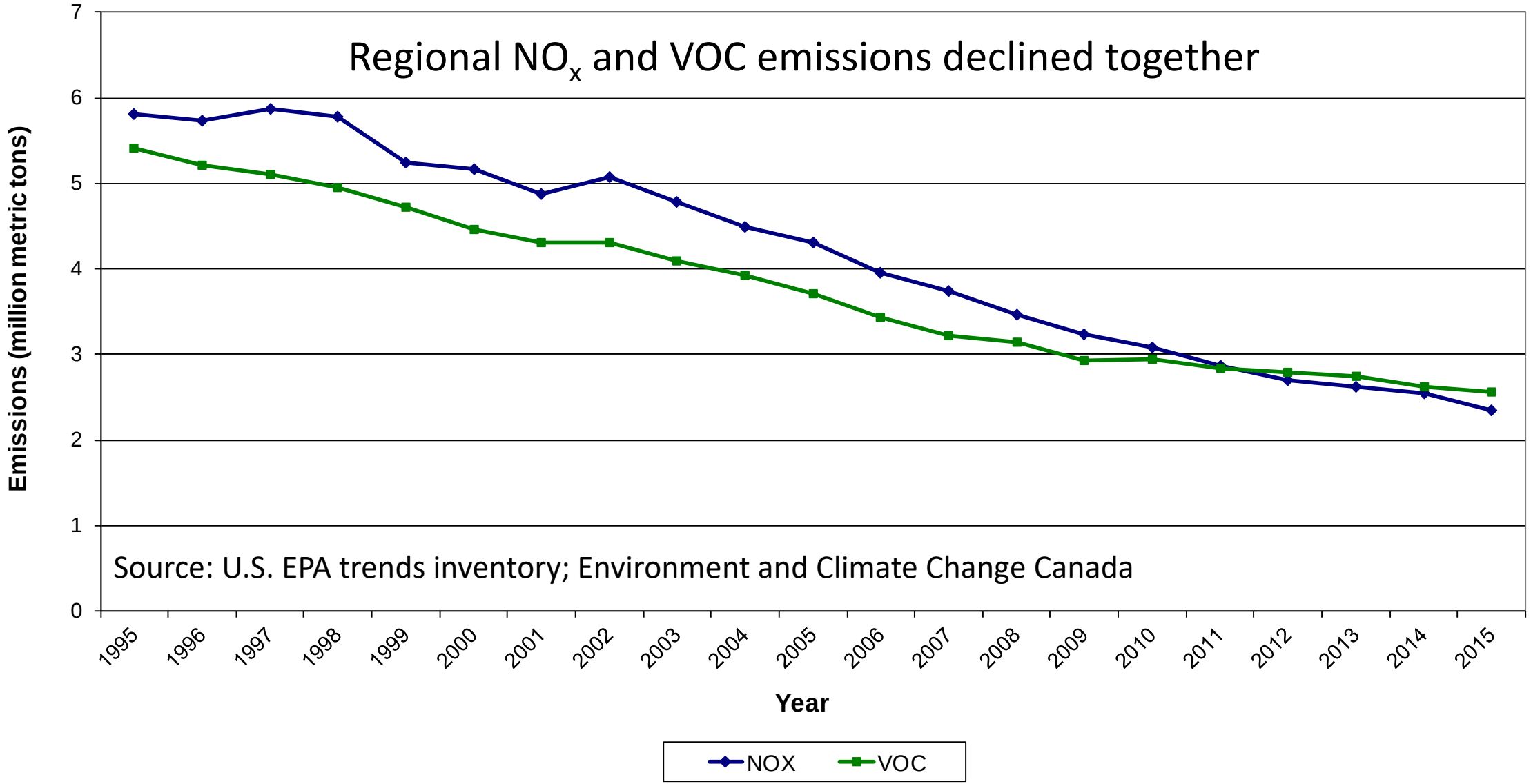
https://www.epa.gov/air-trends/trends-ozone-adjusted-weather-conditions

Atmospheric Environment 41 (2007) 7127–7137

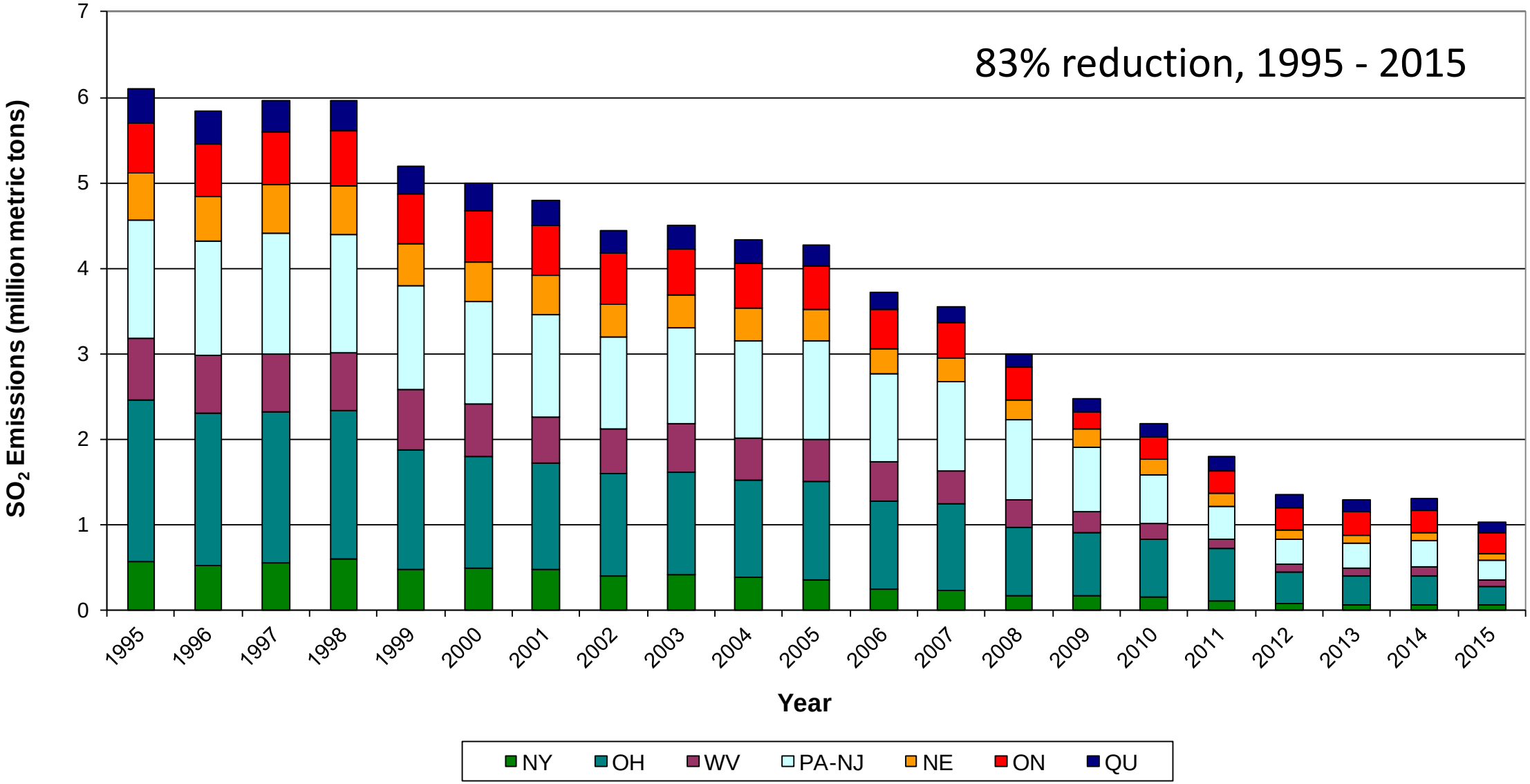
The effects of meteorology on ozone in urban areas and their use in assessing ozone trends

Louise Camalier, William Cox, Pat Dolwick

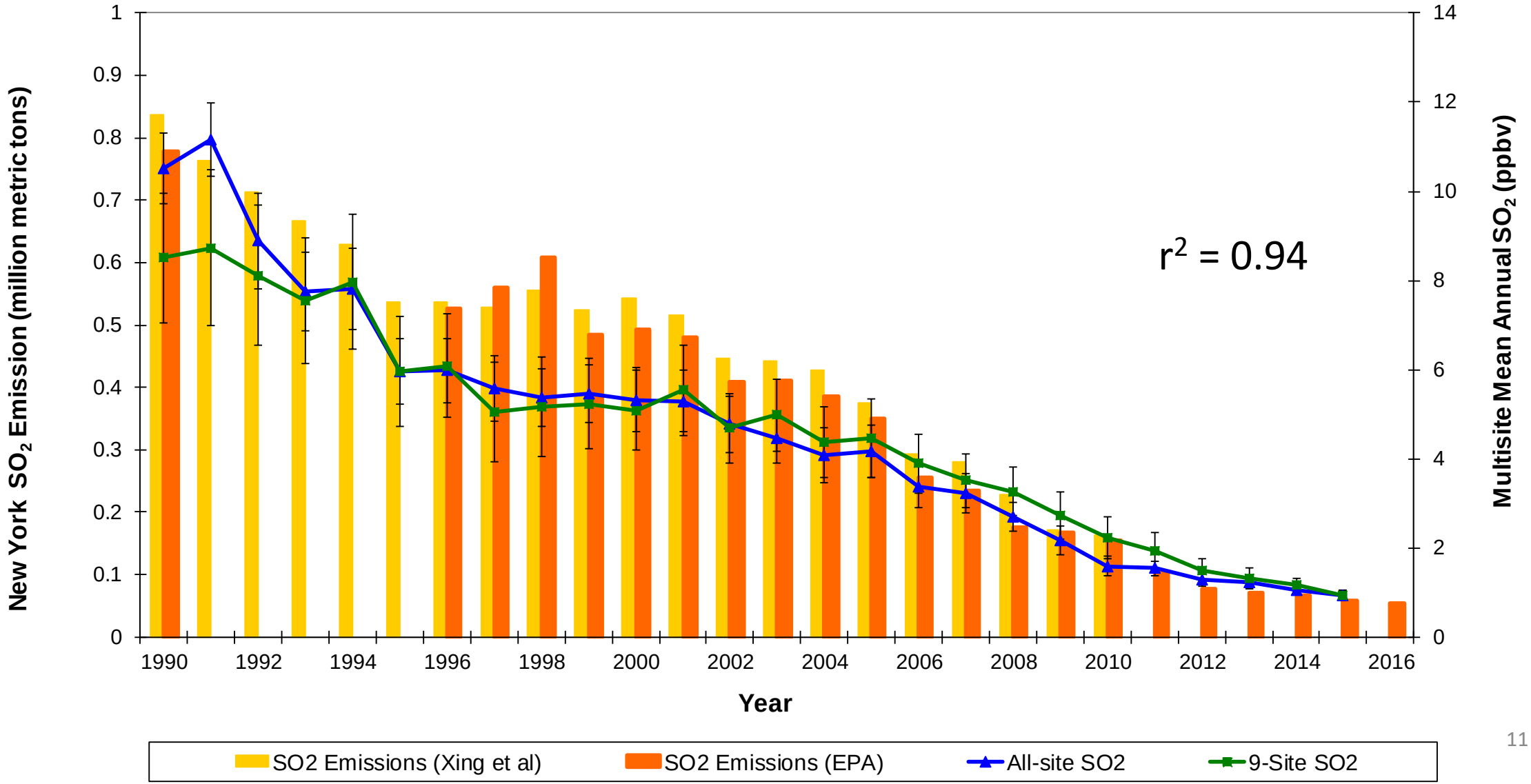
O_3 Trends are Modulated by Atmospheric Chemistry (Discussed in Next Presentation)



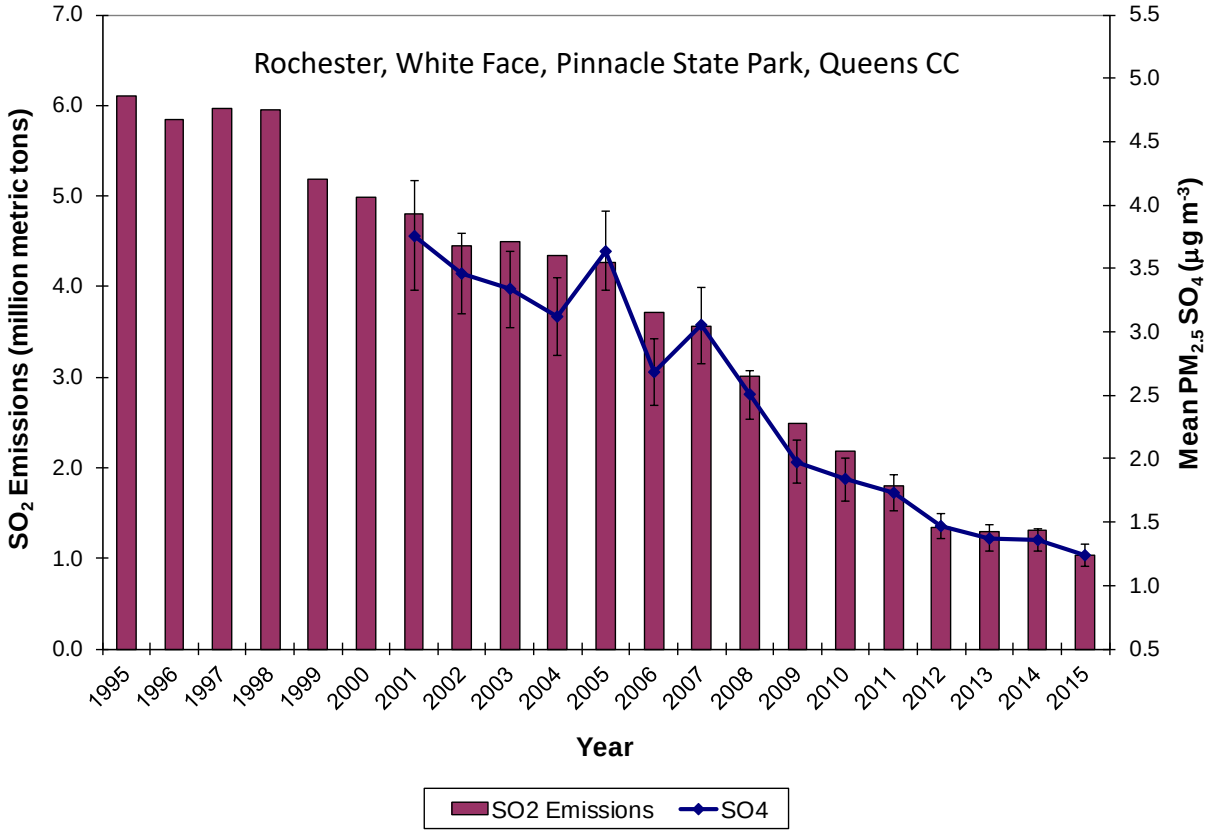
Large, Widespread SO_2 Emission Reductions

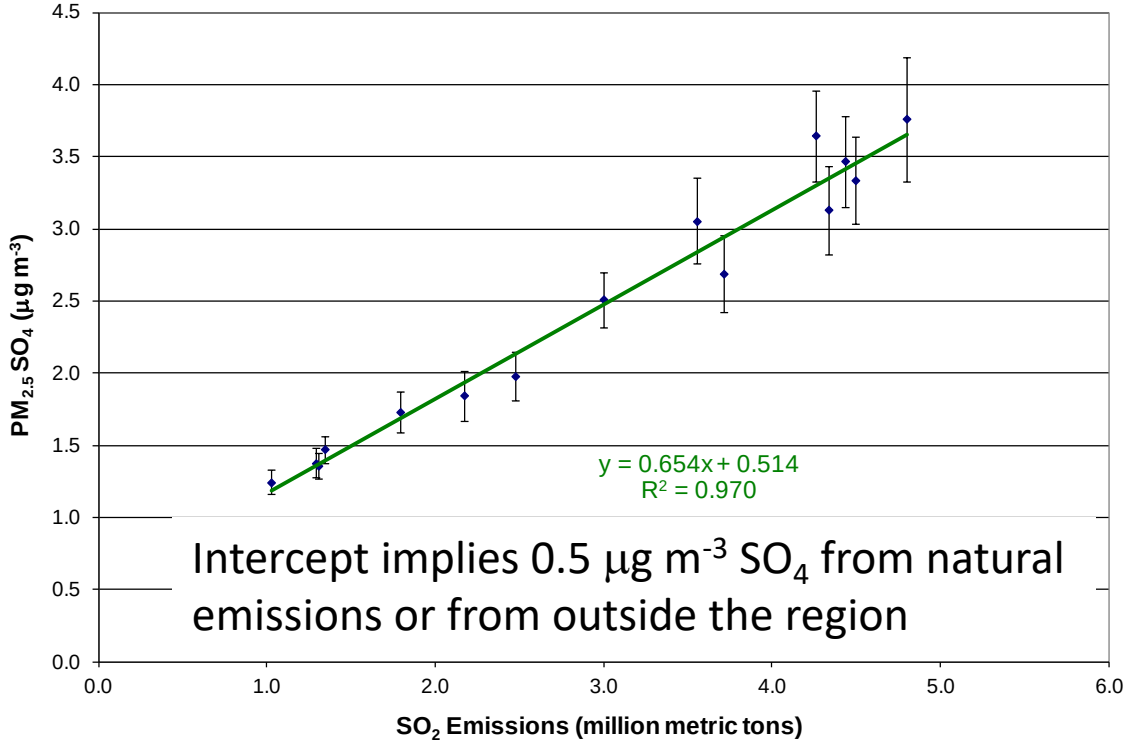


Ambient SO_2 Declined with Regional and NY State SO_2 Emission Reductions



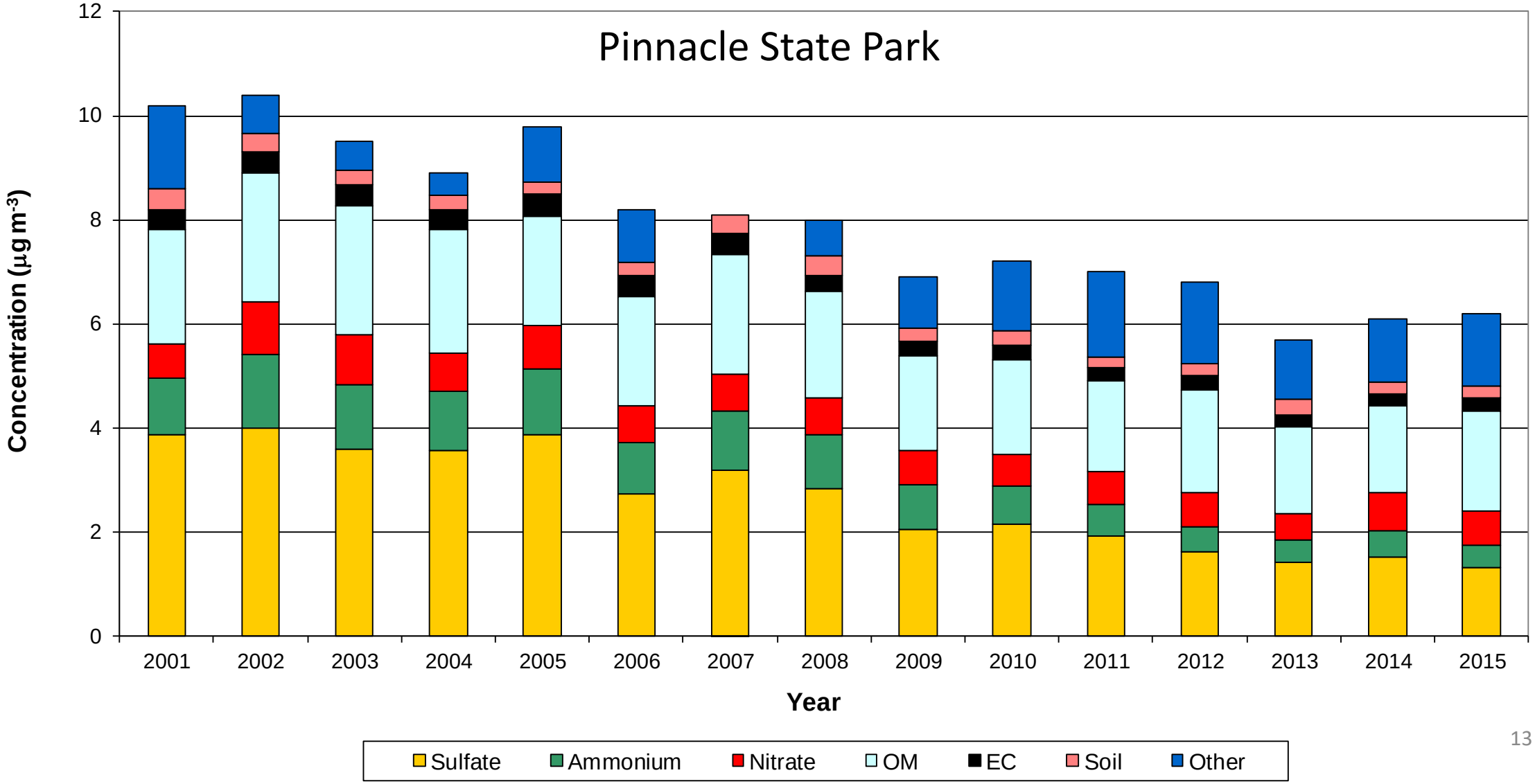
Multi-site Mean $PM_{2.5}$ SO_4 Tracked Regional (and NY) SO_2 Emissions



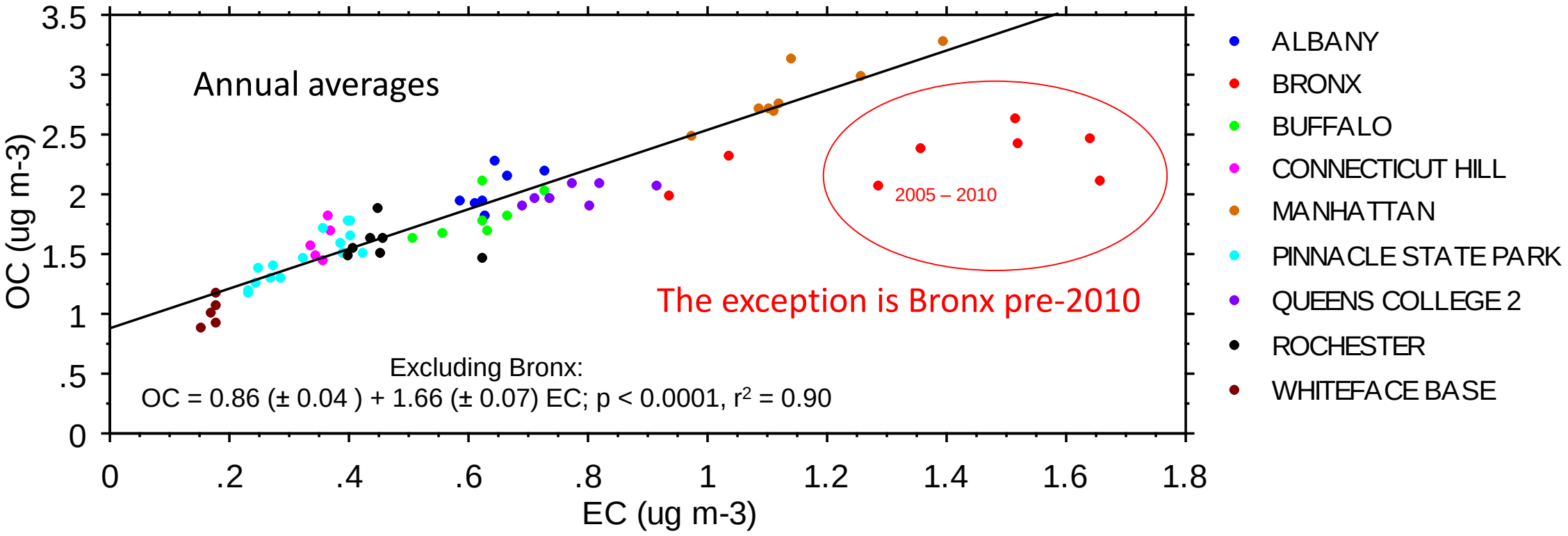


As a result of SO_2 emission reductions and ambient PM SO_4 decreases, aerosol composition and ion balance have changed

Organic Matter (OM) and Elemental Carbon (EC) are Now a Larger Fraction of $PM_{2.5}$ Mass (OM = scaled OC)

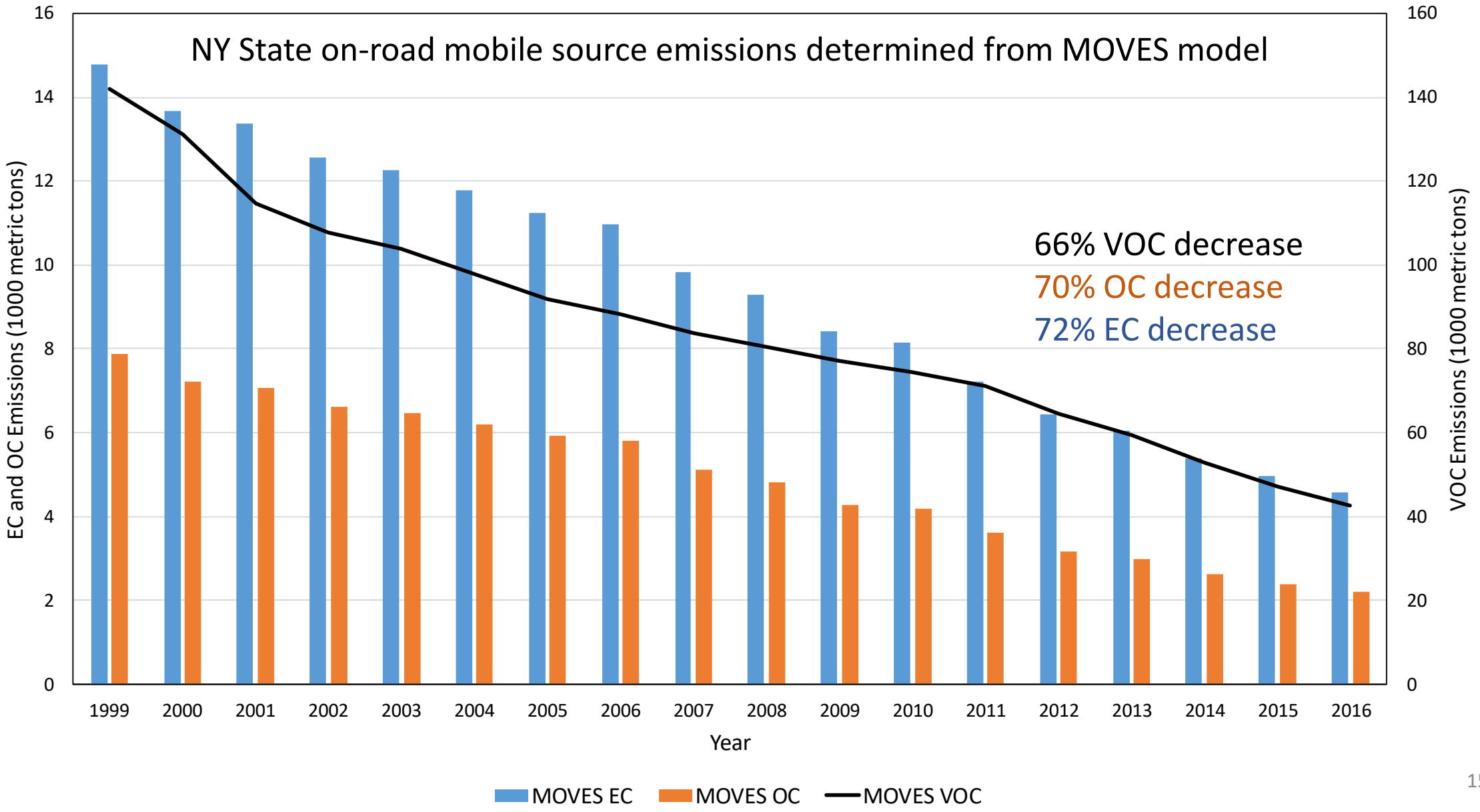


Consistent Ratio of Organic Carbon (OC) to Elemental Carbon (EC) Over Time and Space

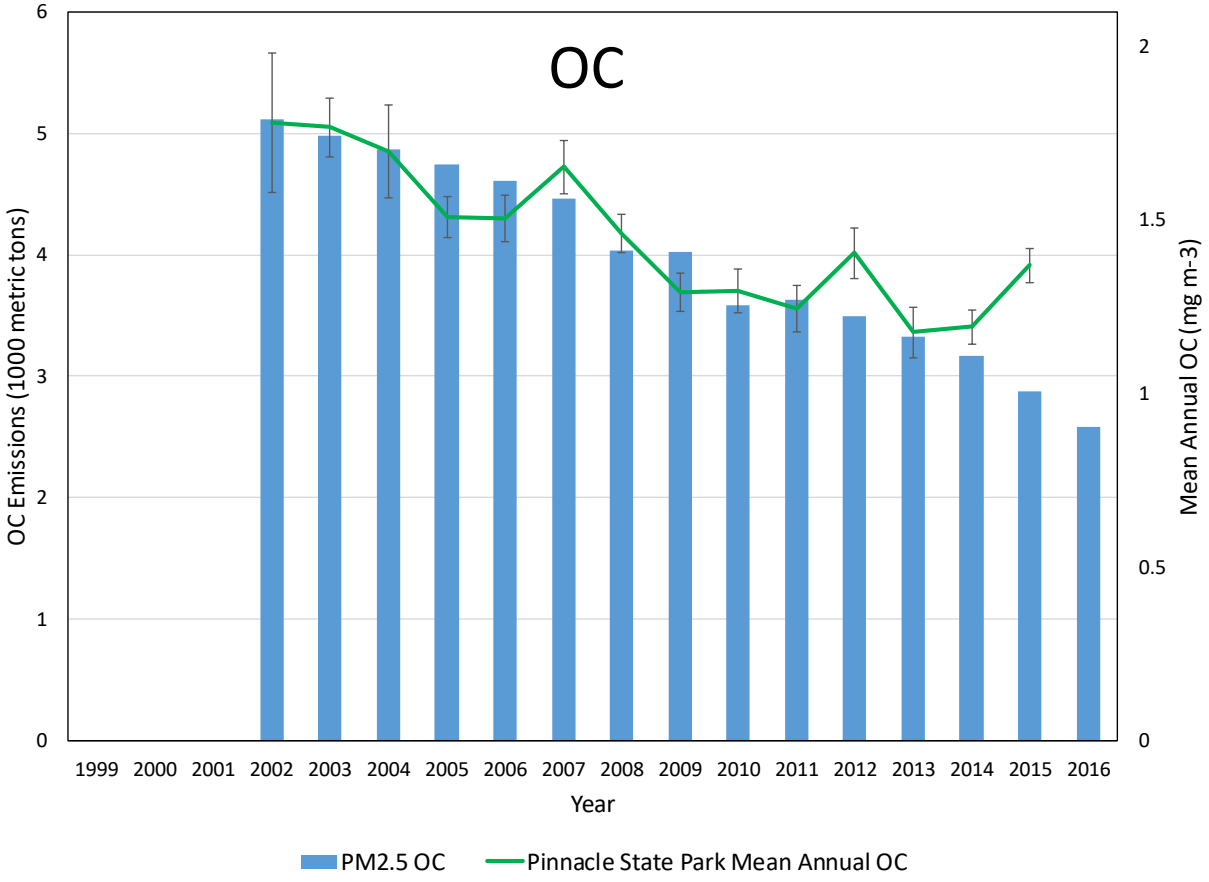


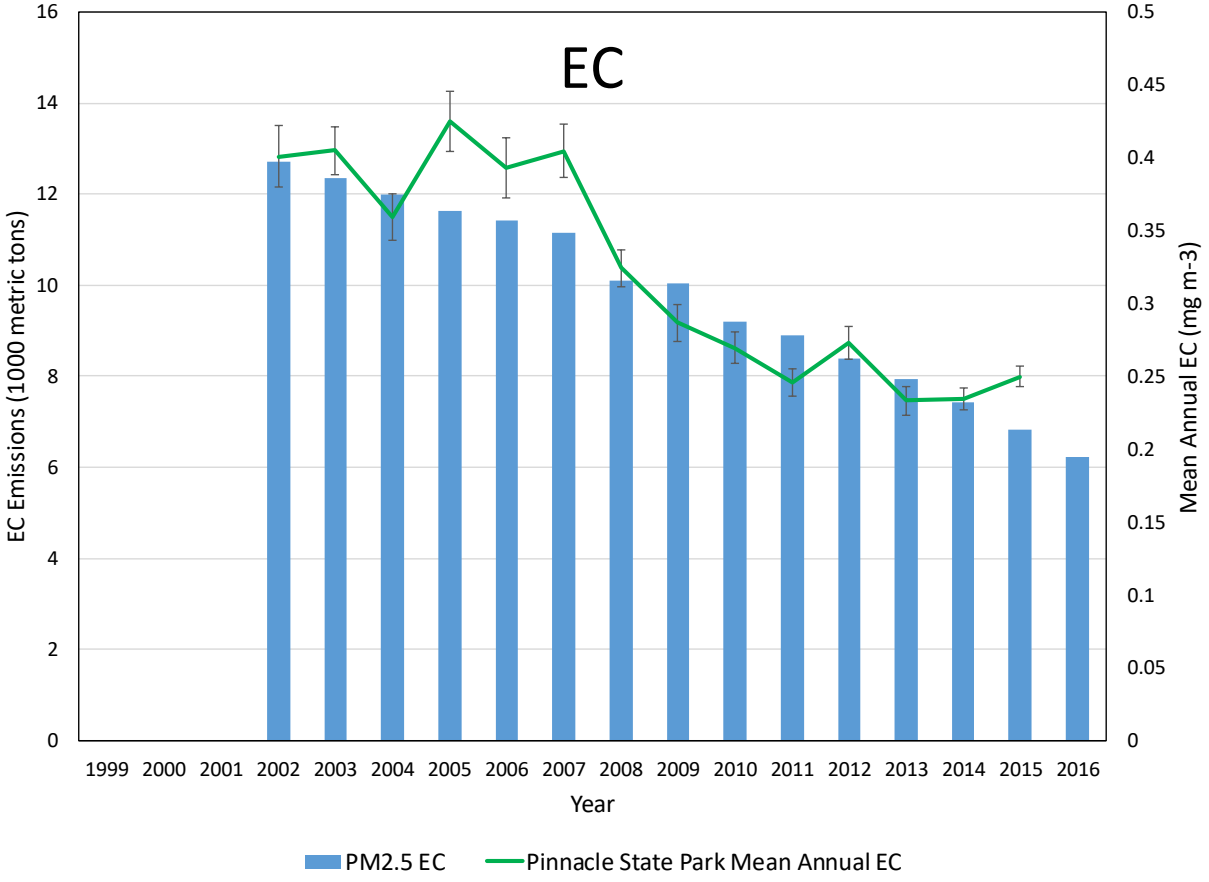
Consistent OC/EC suggests similar sources and processes affect all sites

Mobile-Source PM and VOC Emissions Decreased



PSP OC and EC Trends are (Sort of) Consistent with Mobile-Source $PM_{2.5}$ OC and EC Emission Reductions

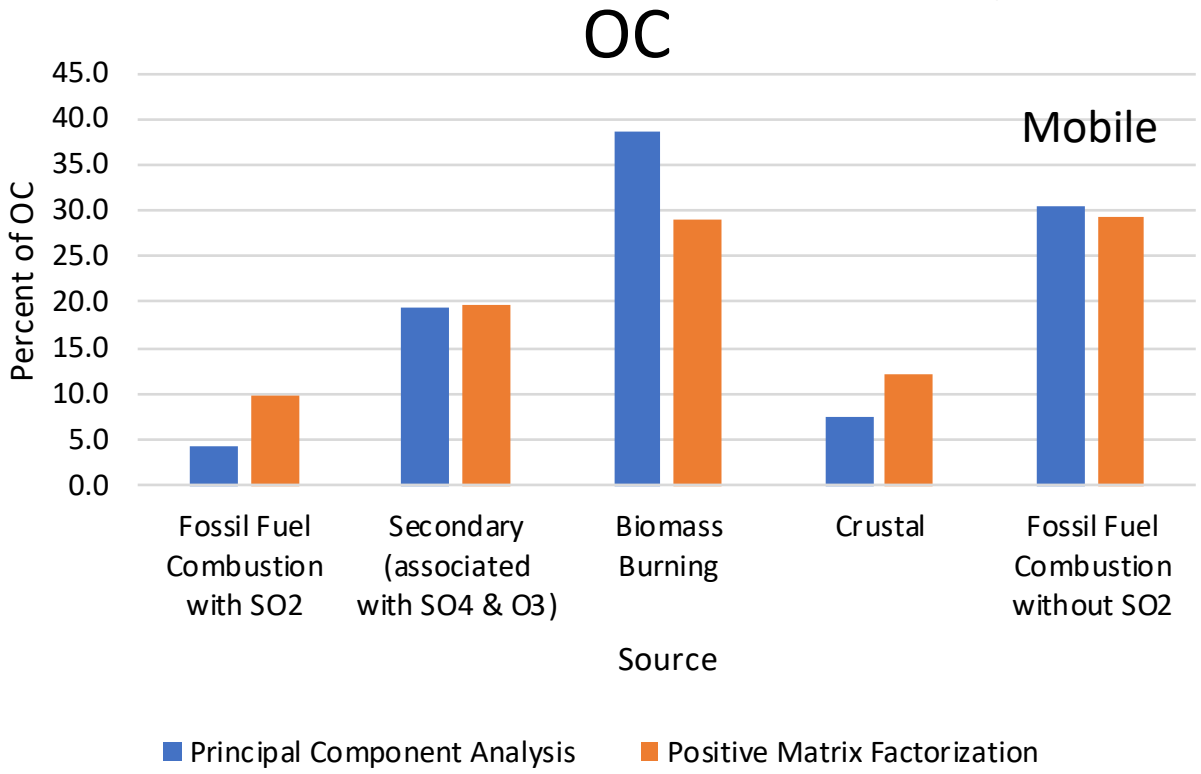


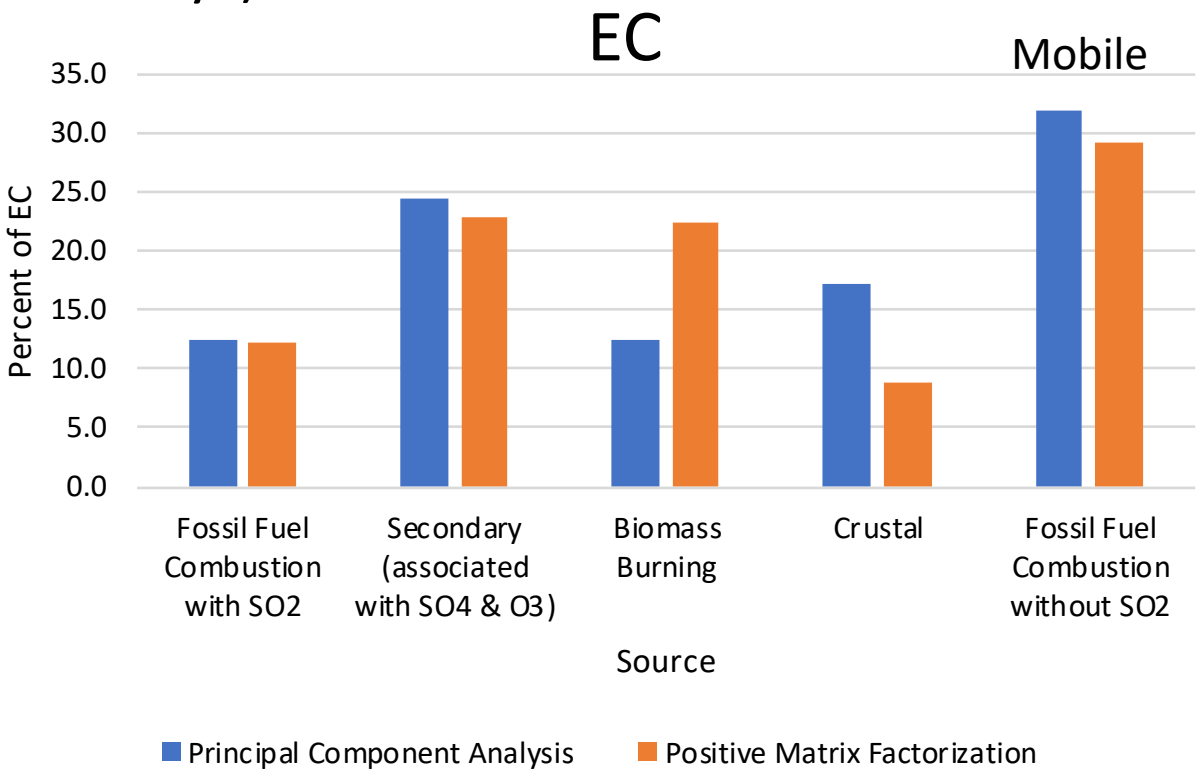


Source: EPA trends inventory highway vehicles plus non-highway vehicles $PM_{2.5}$ emissions scaled by MOVES and SPECIATE ratios of OC and EC to $PM_{2.5}$ mass

Multiple Sources Contribute to $PM_{2.5}$ OC and EC (Biomass Burning, Mobile, Secondary, Fossil Fuel, Crustal)

Receptor model source apportionment of data from Pinnacle State Park, 2001 – 2015 (means of 1087 days)

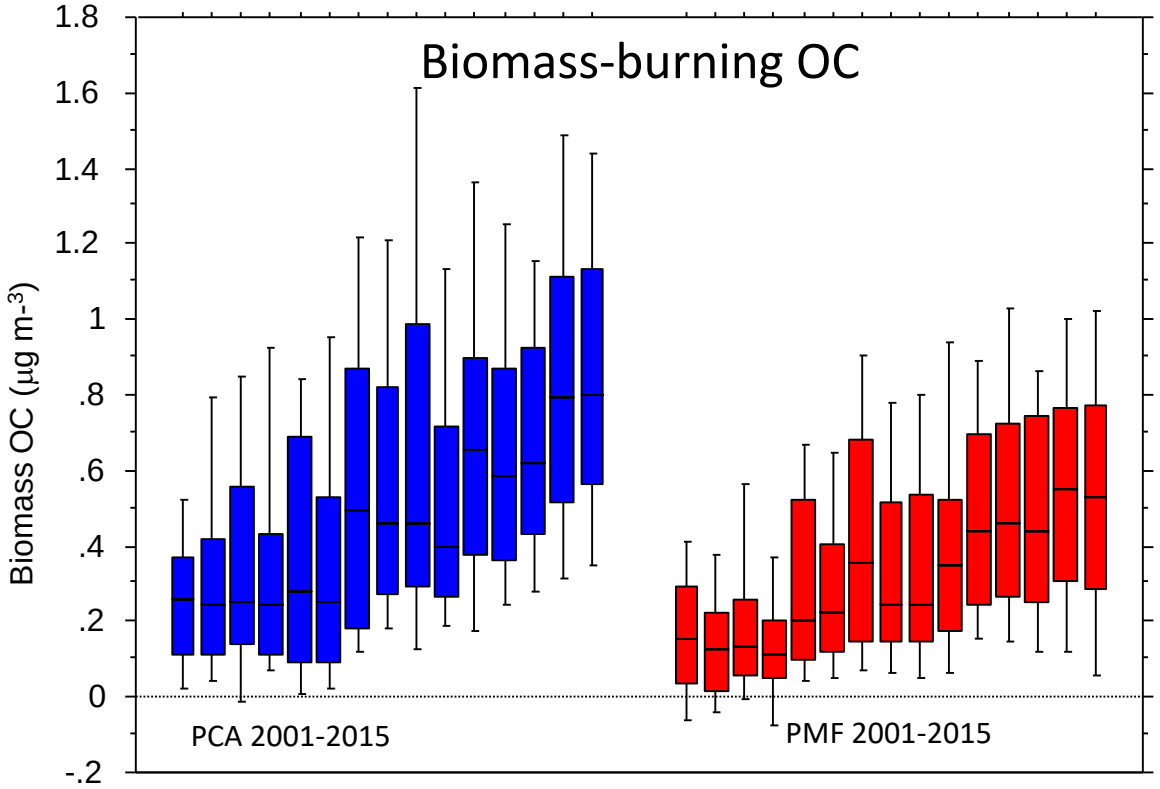


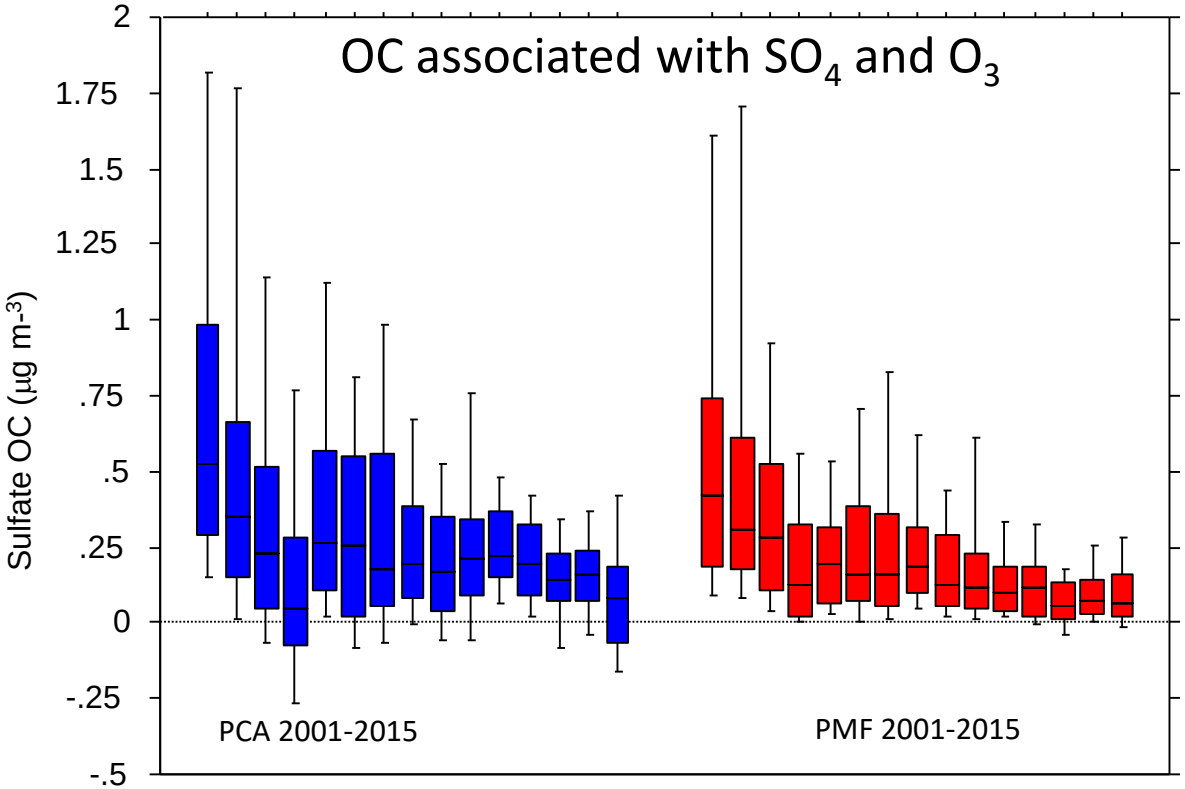


OC source contributions include secondary as well as primary components

Consistent PM Trends from Two Receptor Models

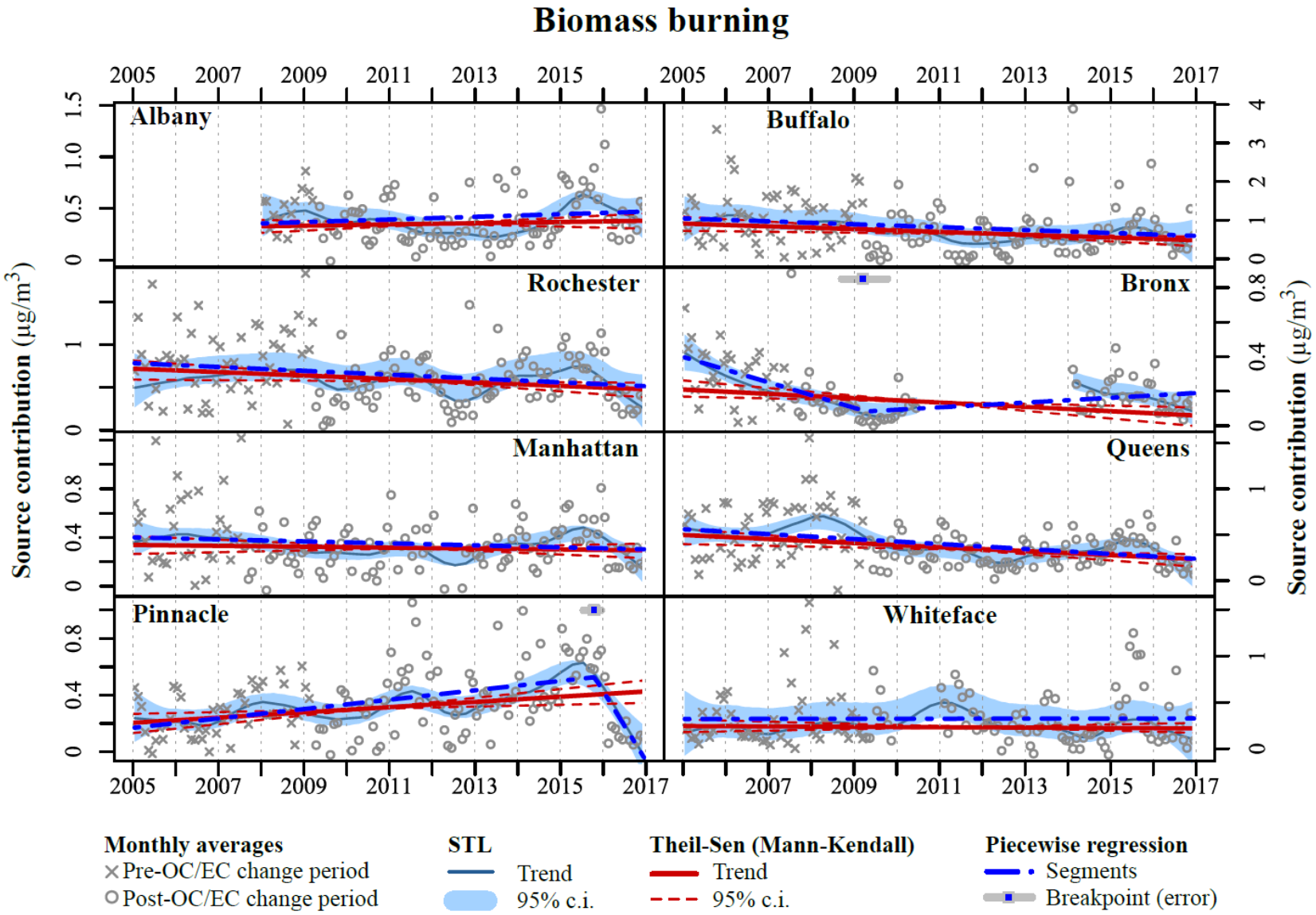
At Pinnacle State Park (PSP), biomass burning OC and EC increased as SO_4-associated OC decreased



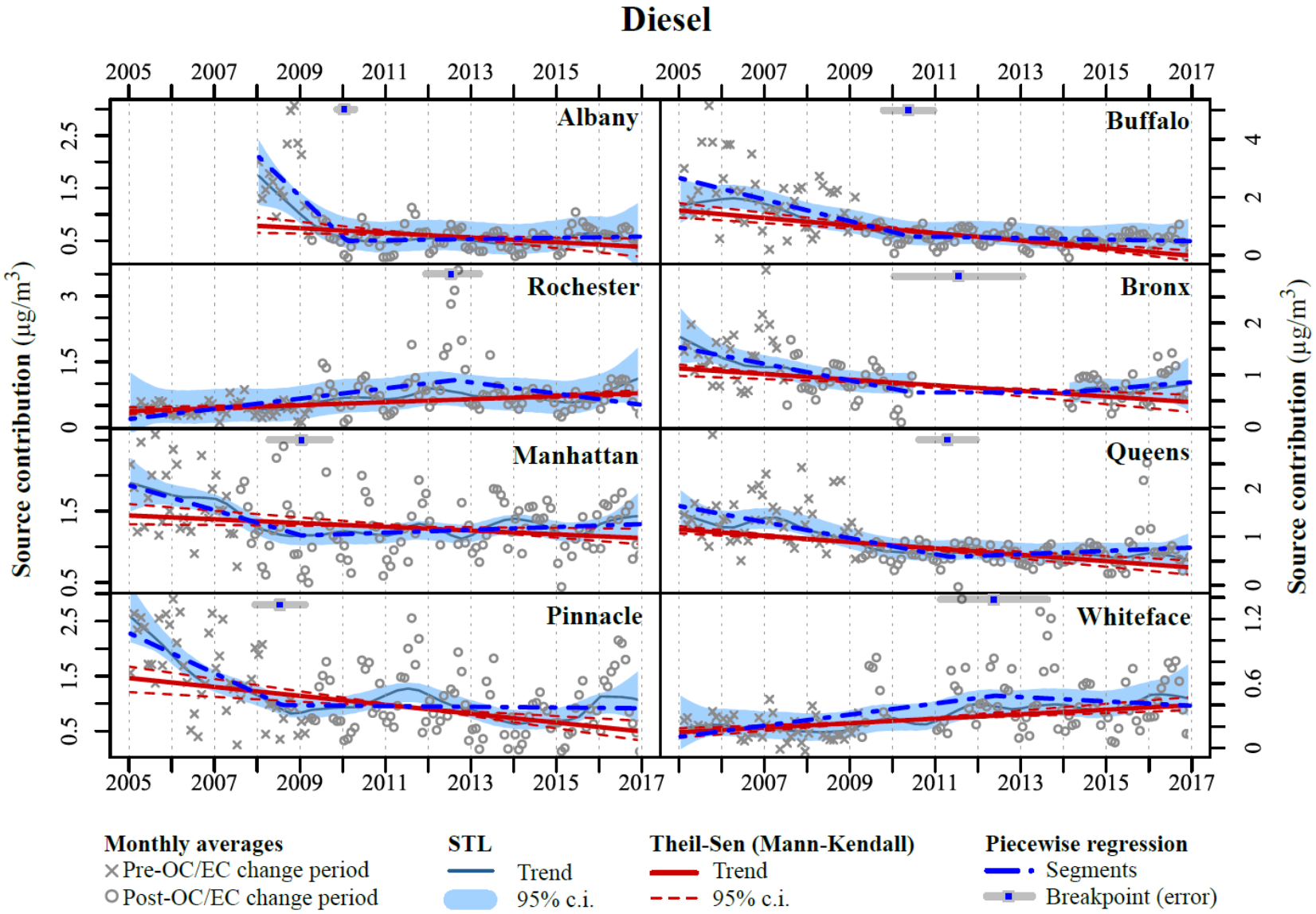


PCA = Principal Component Analysis PMF = Positive Matrix Factorization

Biomass Burning PM Increases at PSP are Not Seen at Other Sites (Massiol et al., Atmos. Environ., 2019)



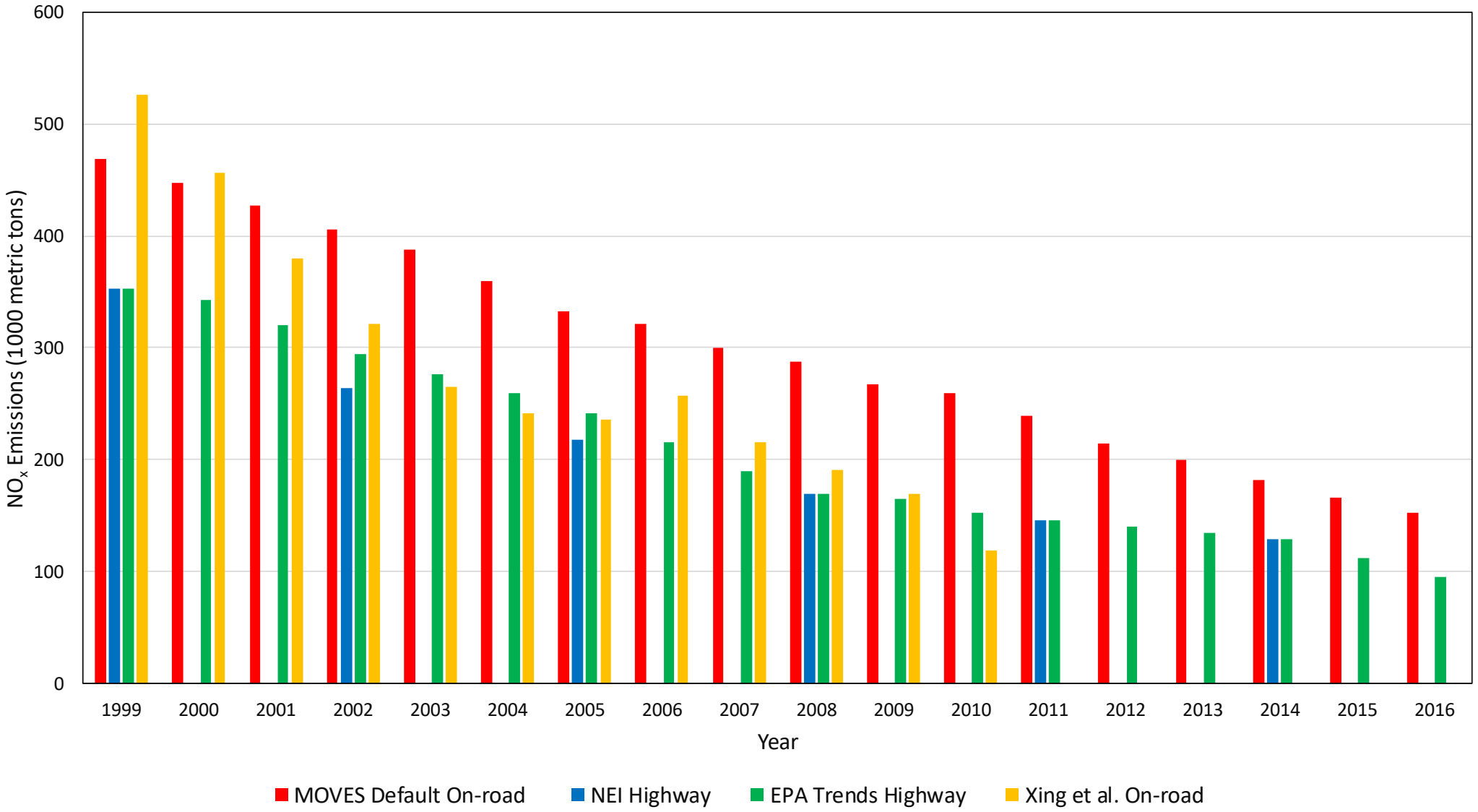
Diesel PM Contributions Decreased at Most Sites (Massiol et al., Atmos. Environ., 2019)



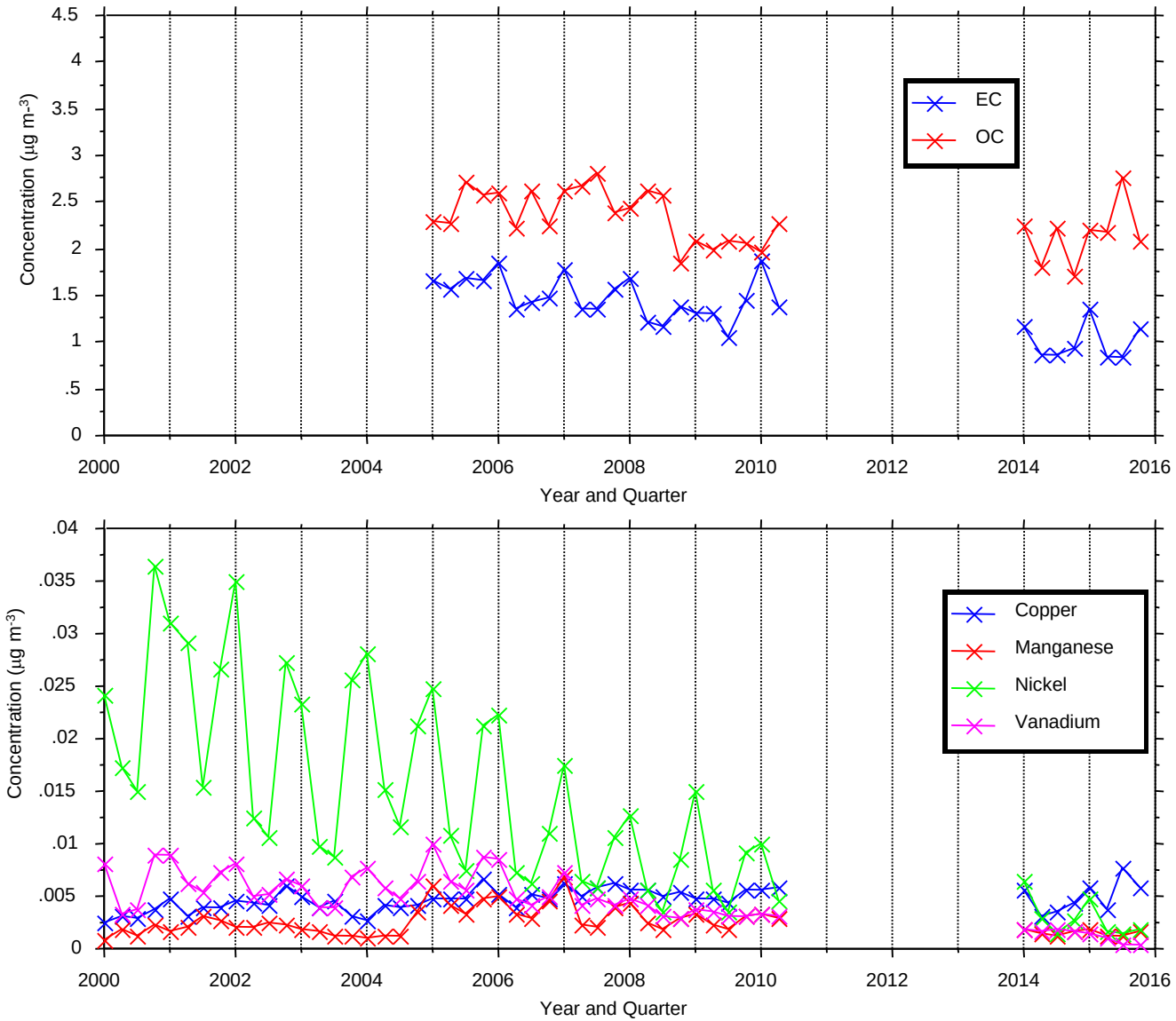
Questions?

Extra Slides

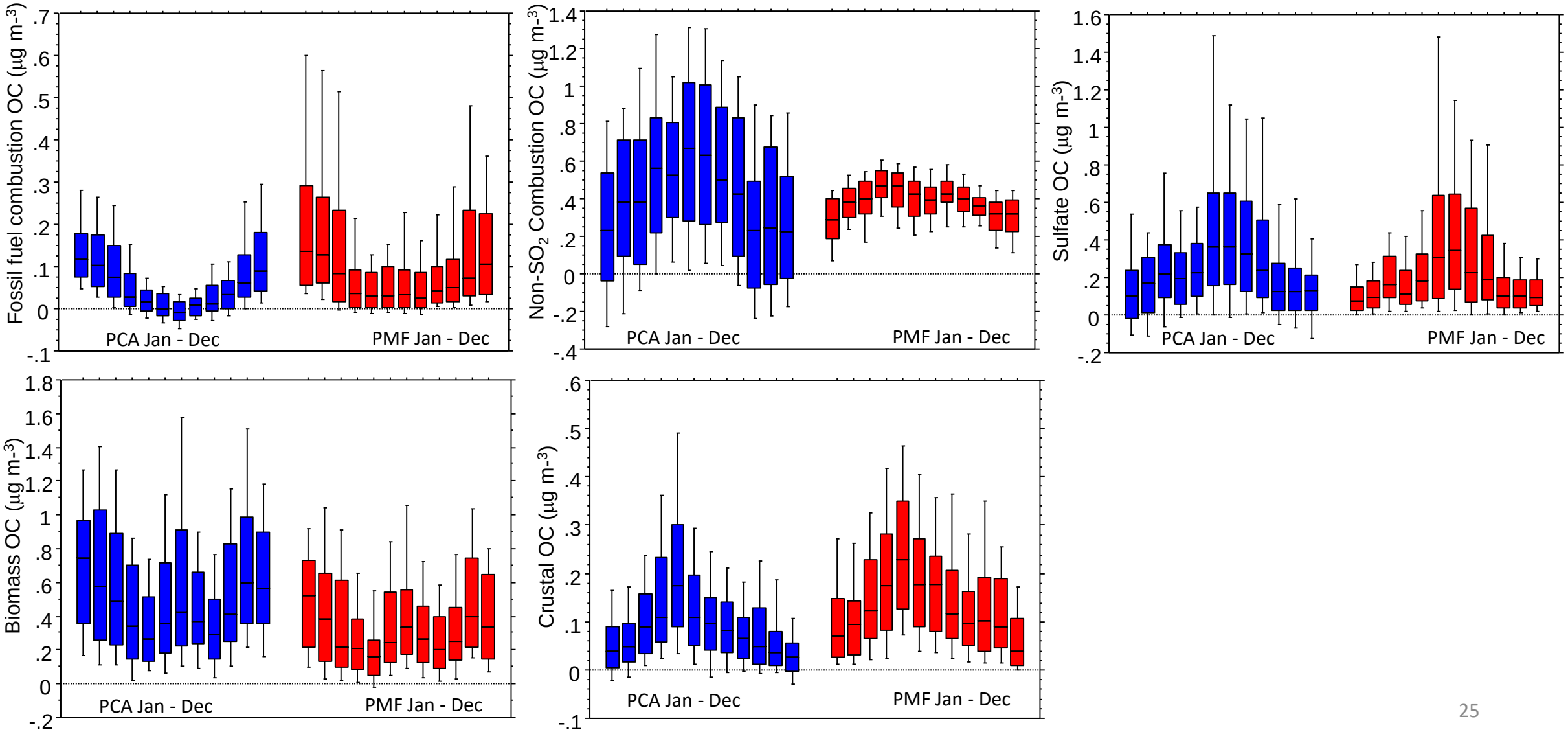
Comparison of NO_x Emissions



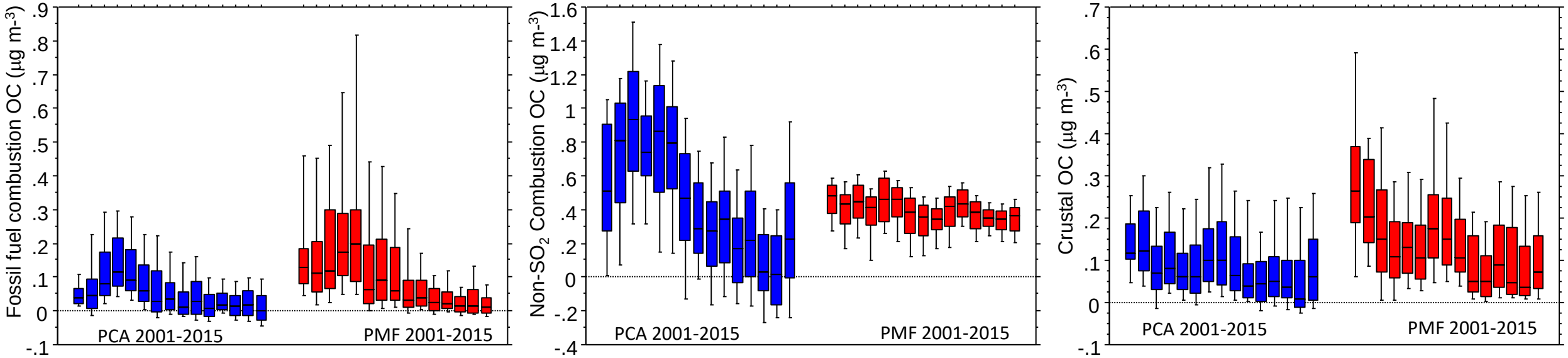
Bronx EC Decline Compared with Ni Trends



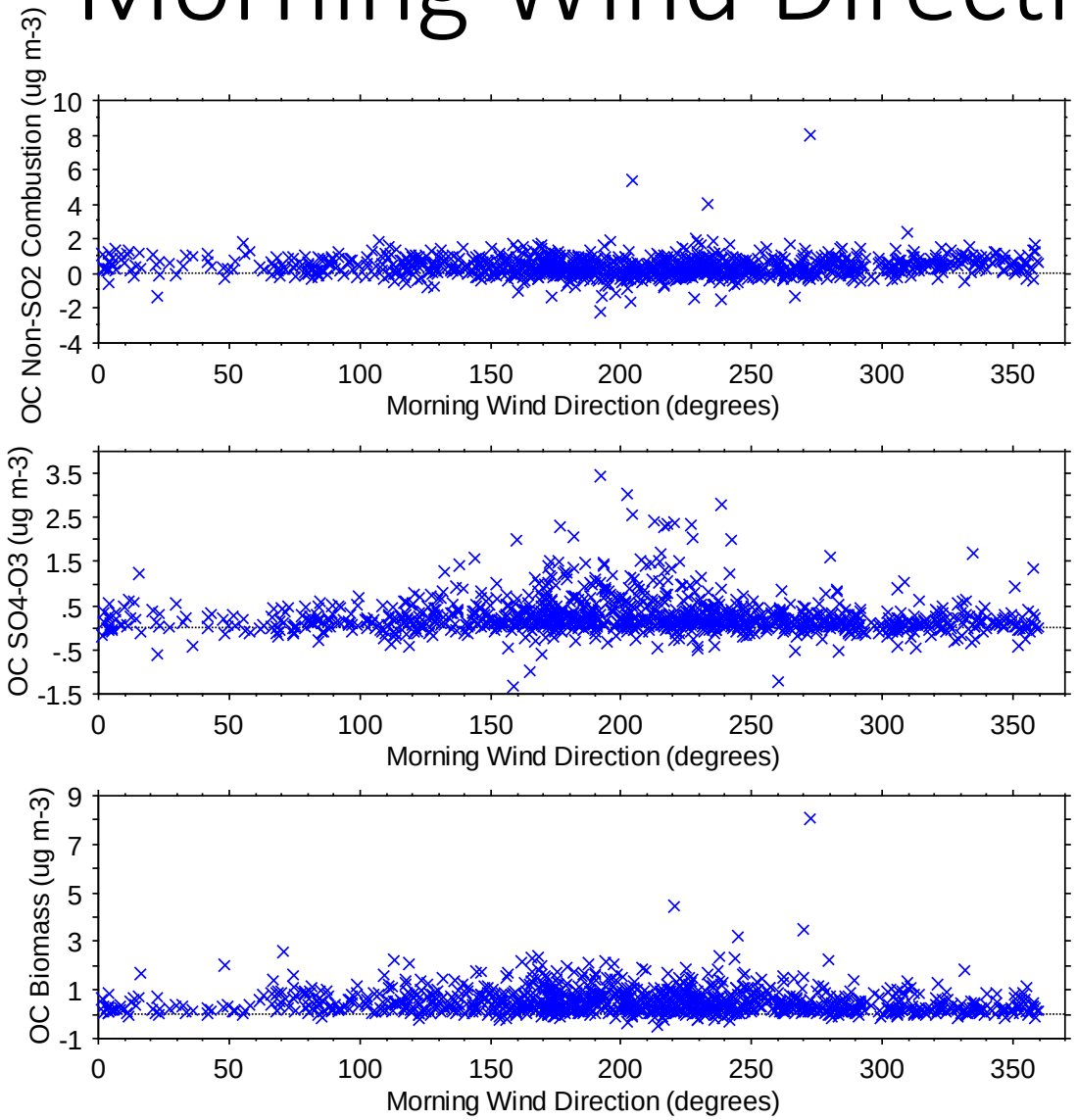
Seasonal Variations of PCA and PMF Factors at PSP

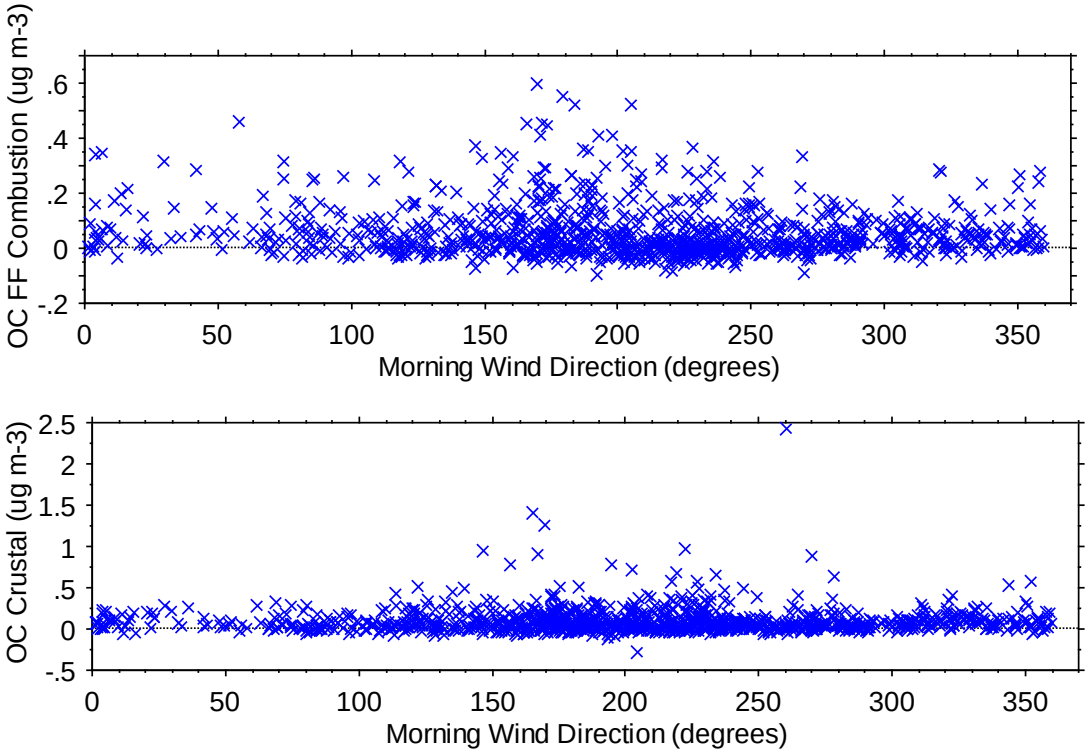


Trends in OC Source Contributions at PSP

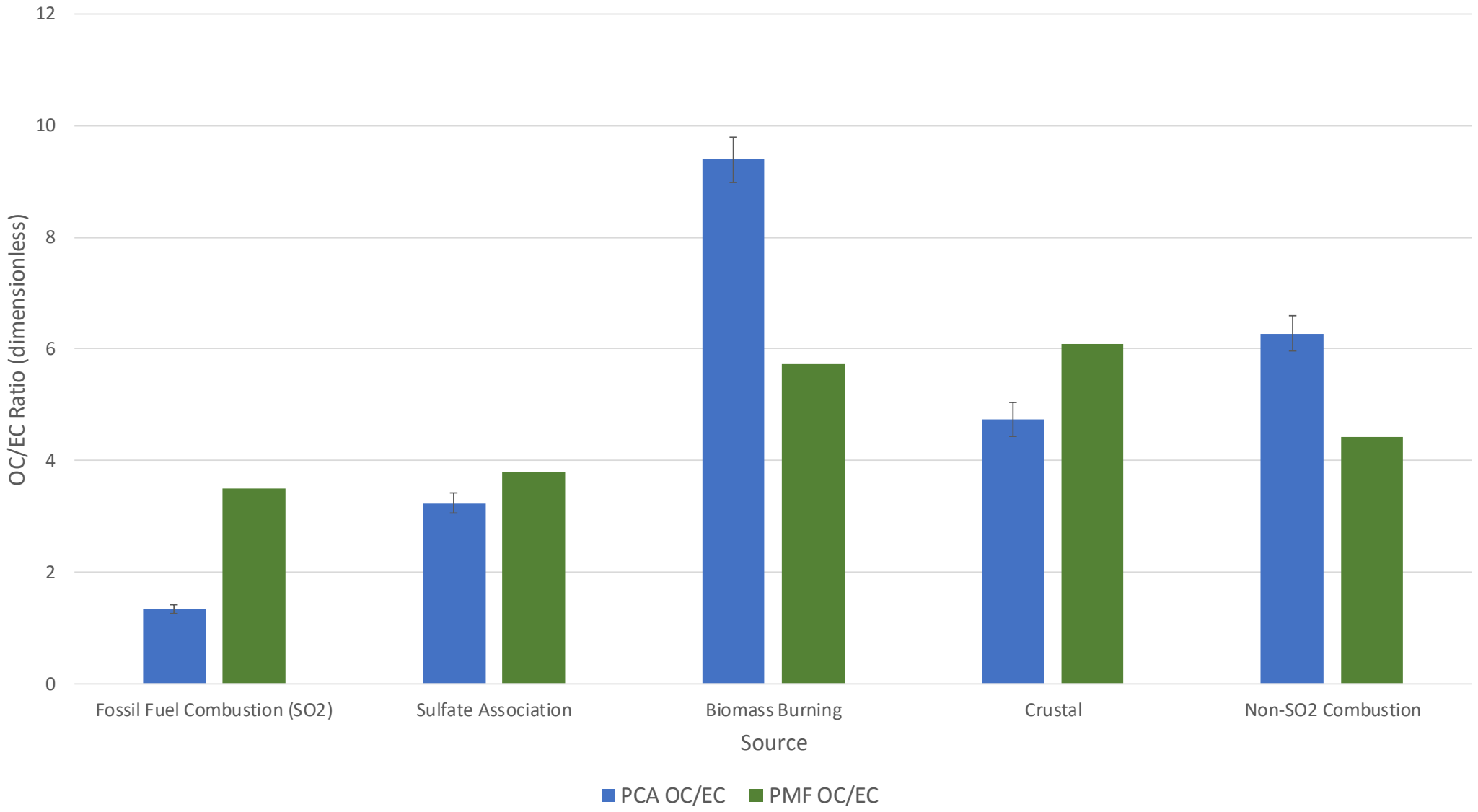


Variation of OC Source Contributions with Morning Wind Direction





Source Differences in Mean OC/EC Ratios at PSP



PMF fixes the OC/EC ratio for each factor so there is no standard error of the mean