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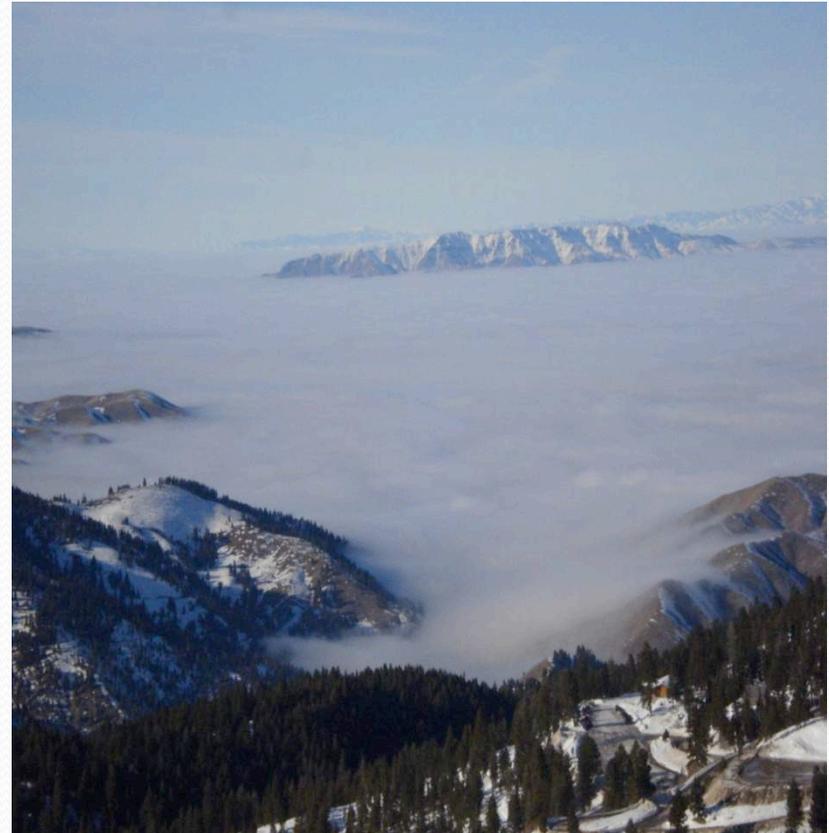
Evaluation of Wintertime CO and NO_x Emissions Inventories from the Treasure Valley PM_{2.5} Precursor Study

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Treasure Valley PM_{2.5} Precursor Study

- Goal: To characterize atmospheric PM_{2.5}, precursor gases, and the relevant meteorology during typical wintertime conditions.
- Two month study in Boise, ID.
 - Dec. 2008 - Jan. 2009
- Success!
 - >90% Data completeness for all but two instruments.
 - Sampled a significant wintertime stagnation event.



MACL Instrumentation

Aerosol

Particle Size Distribution

nano SMPS (3-60 nm) (Assembled in house with TSI components)

long SMPS (40-700nm) (Assembled in house with TSI components)

APS (0.6-20 um) (TSI)

Bulk Soluble Composition

Particle-Into-Liquid Sampler -PILS (Brechtel)

Inorganics (SO_4 , NO_3 , Cl, NH_4 , Na, Mg, ...) by Ion Chromatography (Metrohm-Peak)

Water soluble organic carbon by TOC analysis (Sievers / GE Analytical)

Cloud Condensation Nuclei (DMT)

Aerosol Spatial Variability and Optical Depth (Leosphere Aerosol Lidar)

Meteorology

P, T, RH, Wind speed & direction, Precip (Vaisala WXT)

Boundary Layer Height (Leosphere Aerosol Lidar)

Trace Gases

Ozone (Dasibi)

Carbon Monoxide (Aerolaser)

NO_x / NO_y (Air Quality Design)

SO_2 (Teledyne)

Time Resolved VOCs (PTR-MS, Ionicon)

Speciated VOCs (not deployed in Boise)

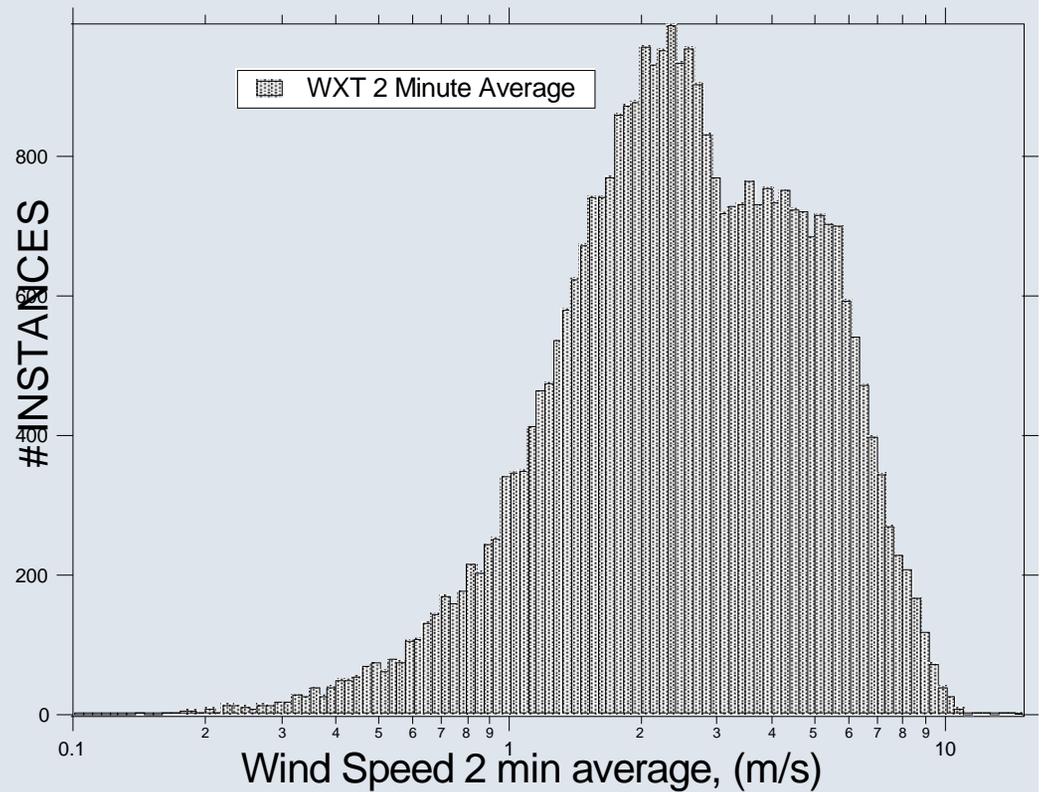
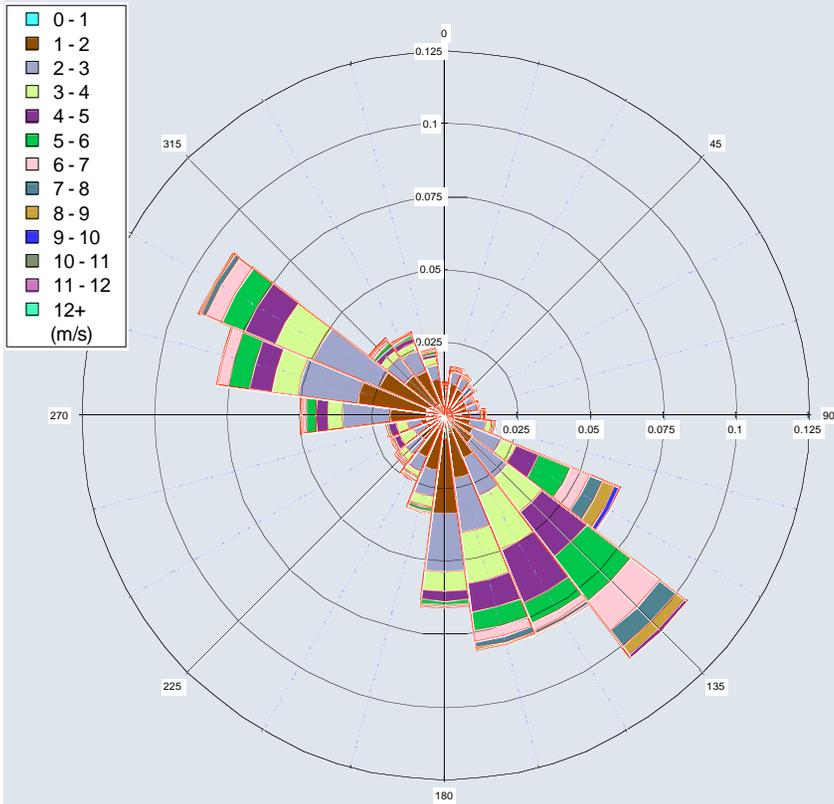
Varian GC-MS

Custom 2-channel VOC preconcentrator

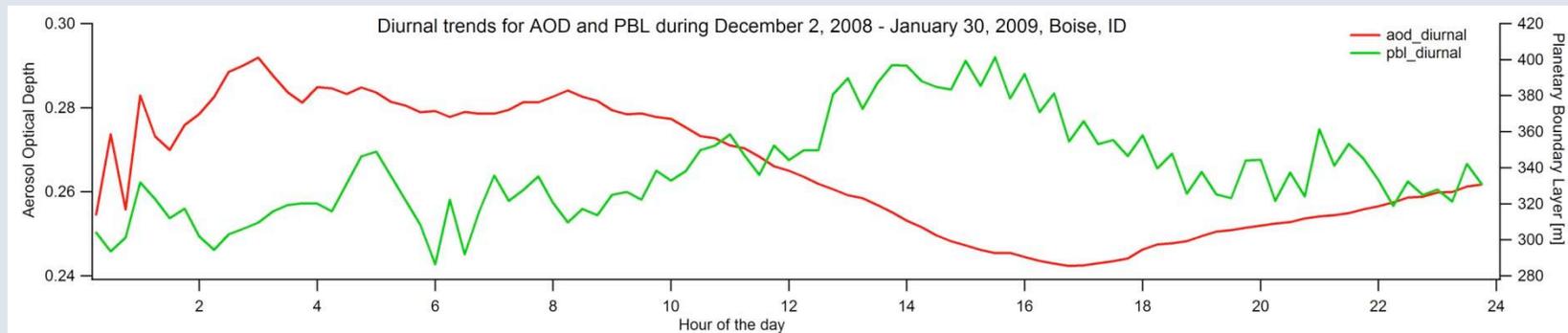
Boise Winds

Wind Rose Plot:

Wind Speed Log Histogram:

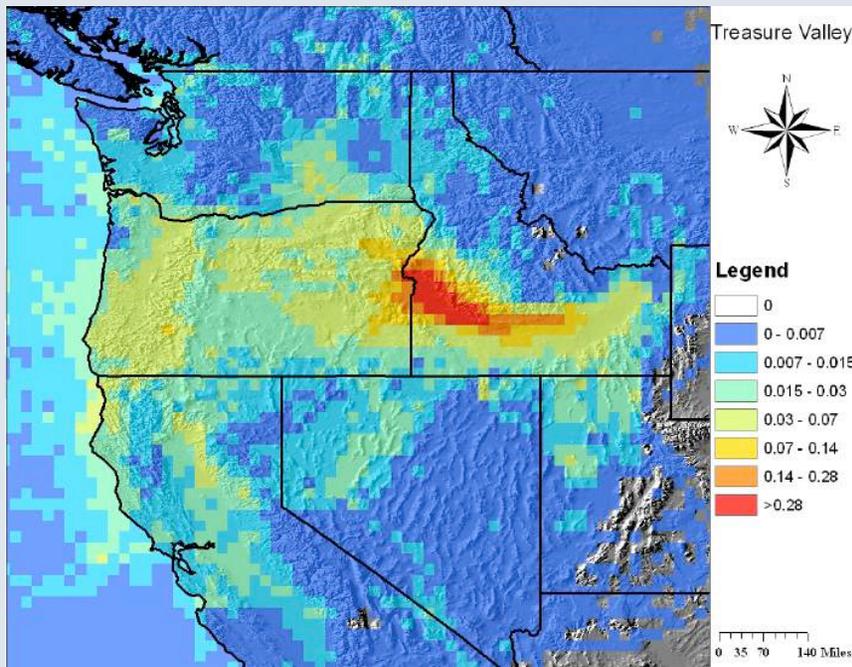


Diurnal Average Profile of PBL Height and Aerosol Optical Depth, Dec-Jan

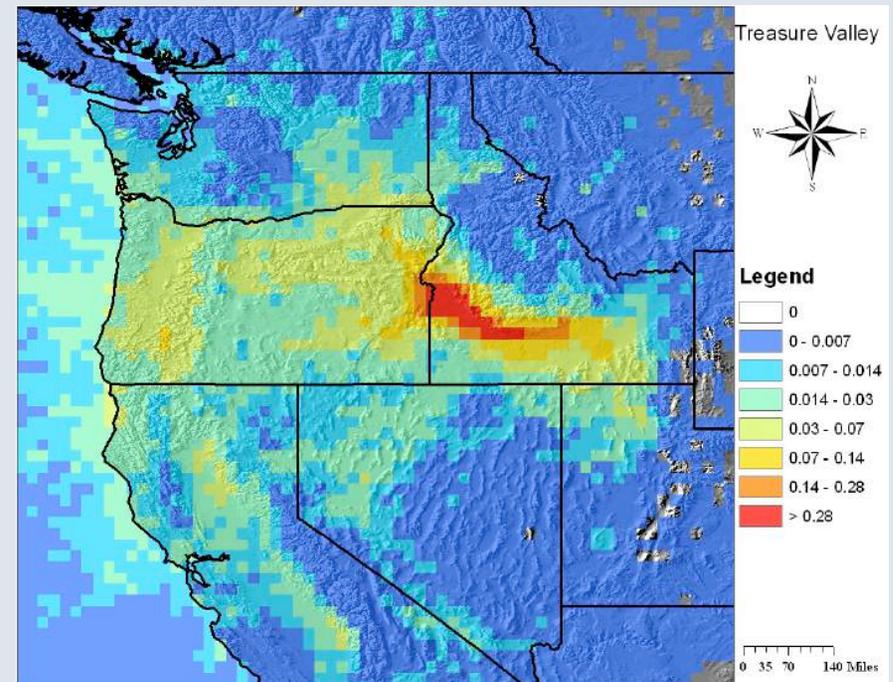


Normalized residence time for Treasure Valley air masses

10 meter height



50 meter height



Graphics courtesy of Ilias Kavouras of The Desert Research Institute and Idaho Department of Environmental Quality.

Use high resolution CO and NO_x observations to evaluate emissions

- Parish et al. (2006) compared measured ratios of CO to NO_x to emissions inventories.
- Measured CO to NO_x ratios are much lower than emissions inventories.
- What is the situation in Boise?

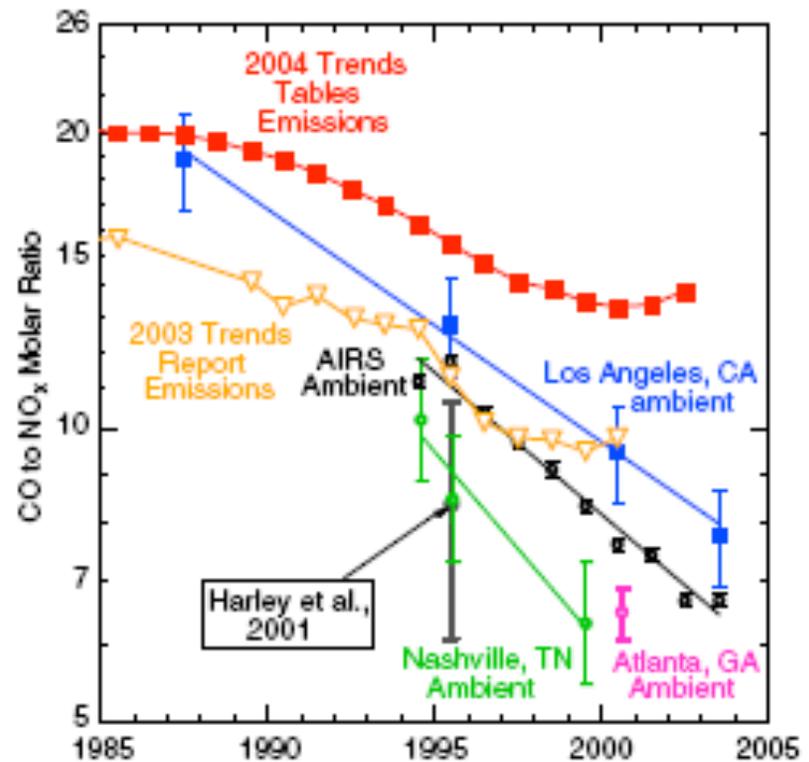
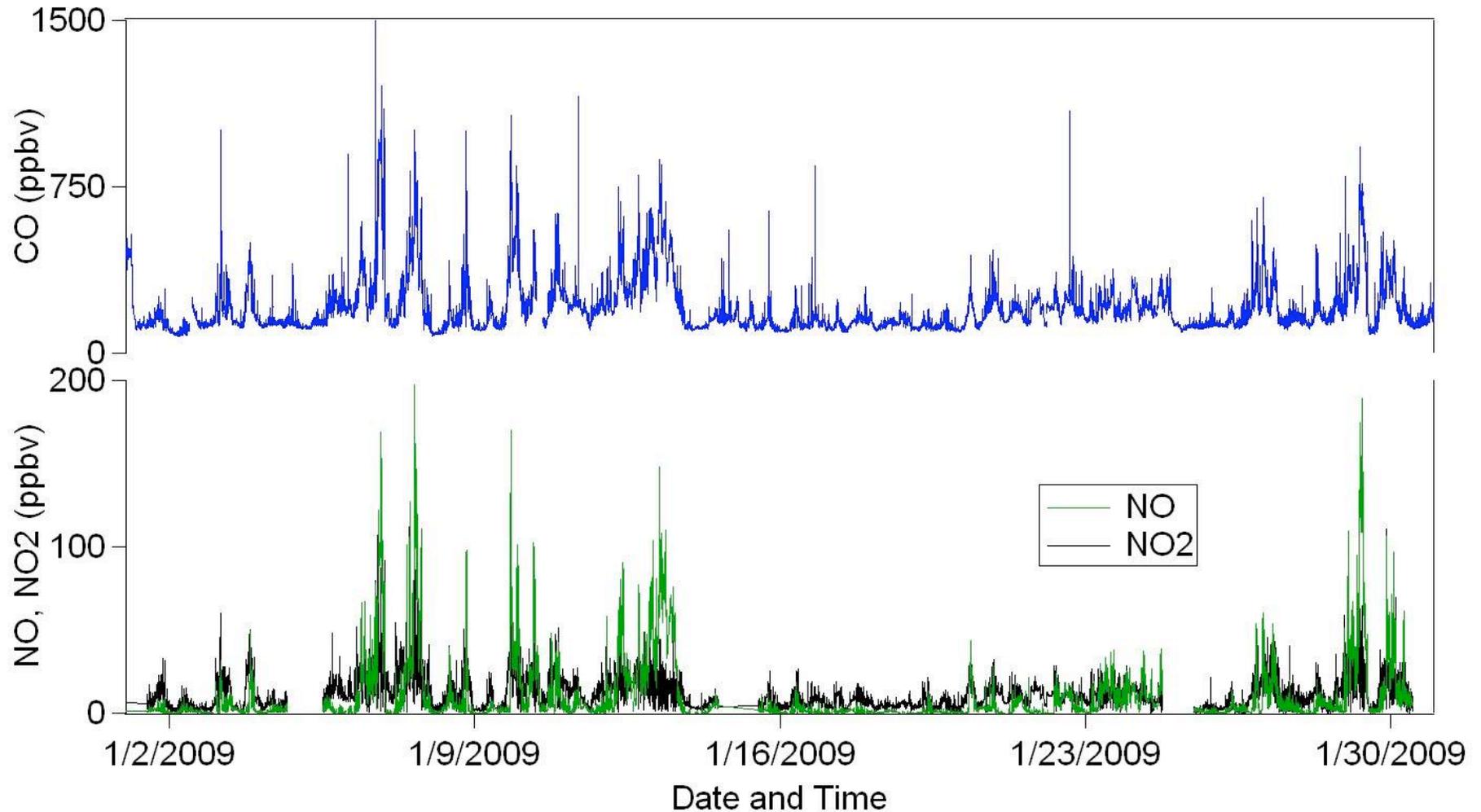
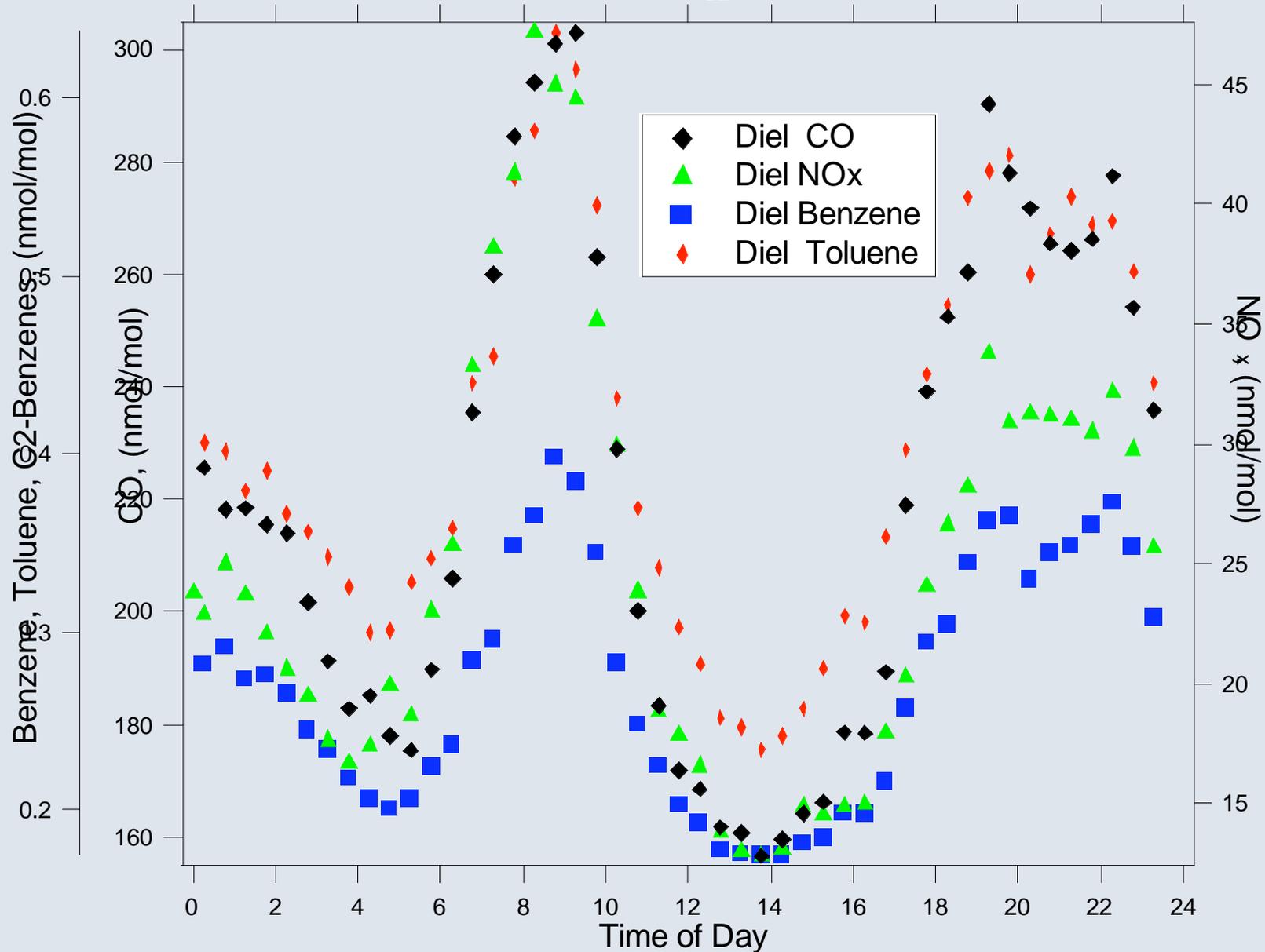


Fig. 3. Semi-log plot of temporal trends of observed urban ambient CO to NO_x ratios compared to ratios from on-road vehicle emission estimates.

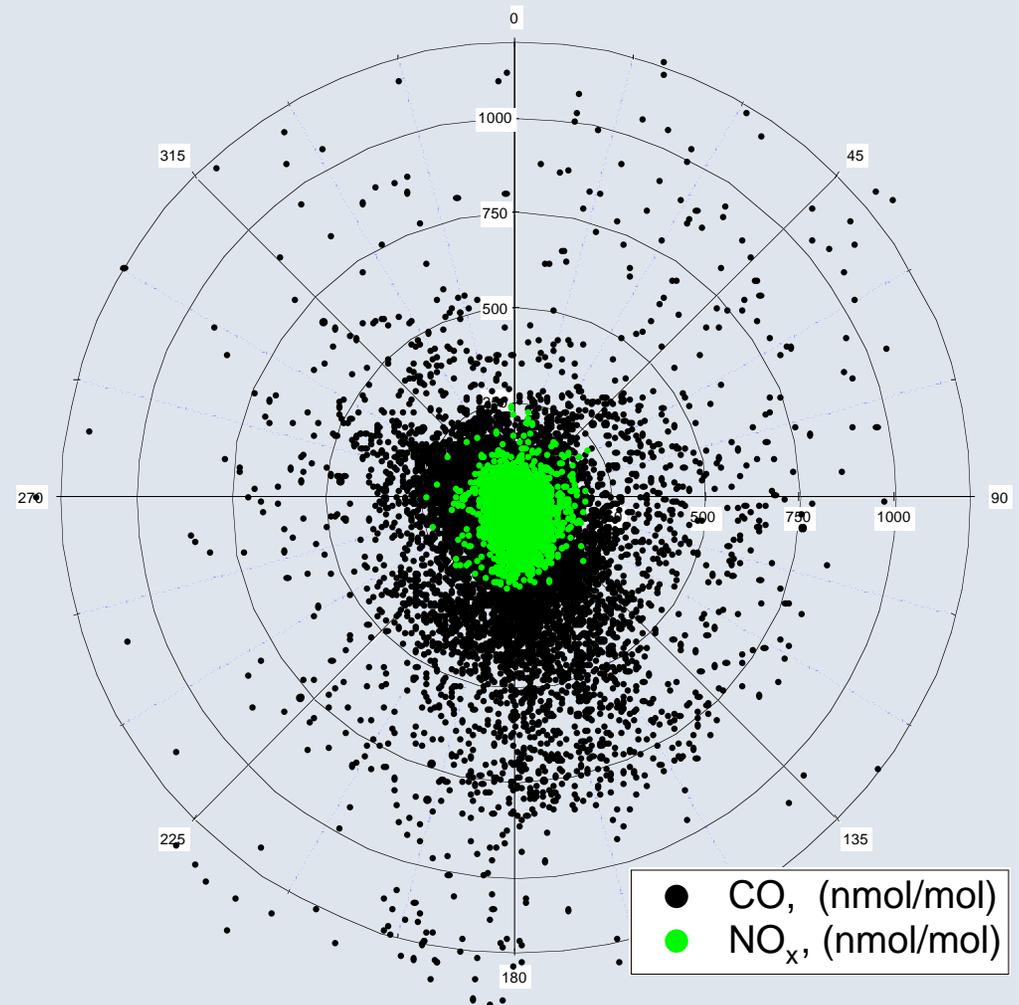
Time series of CO and NO_x during January 2009



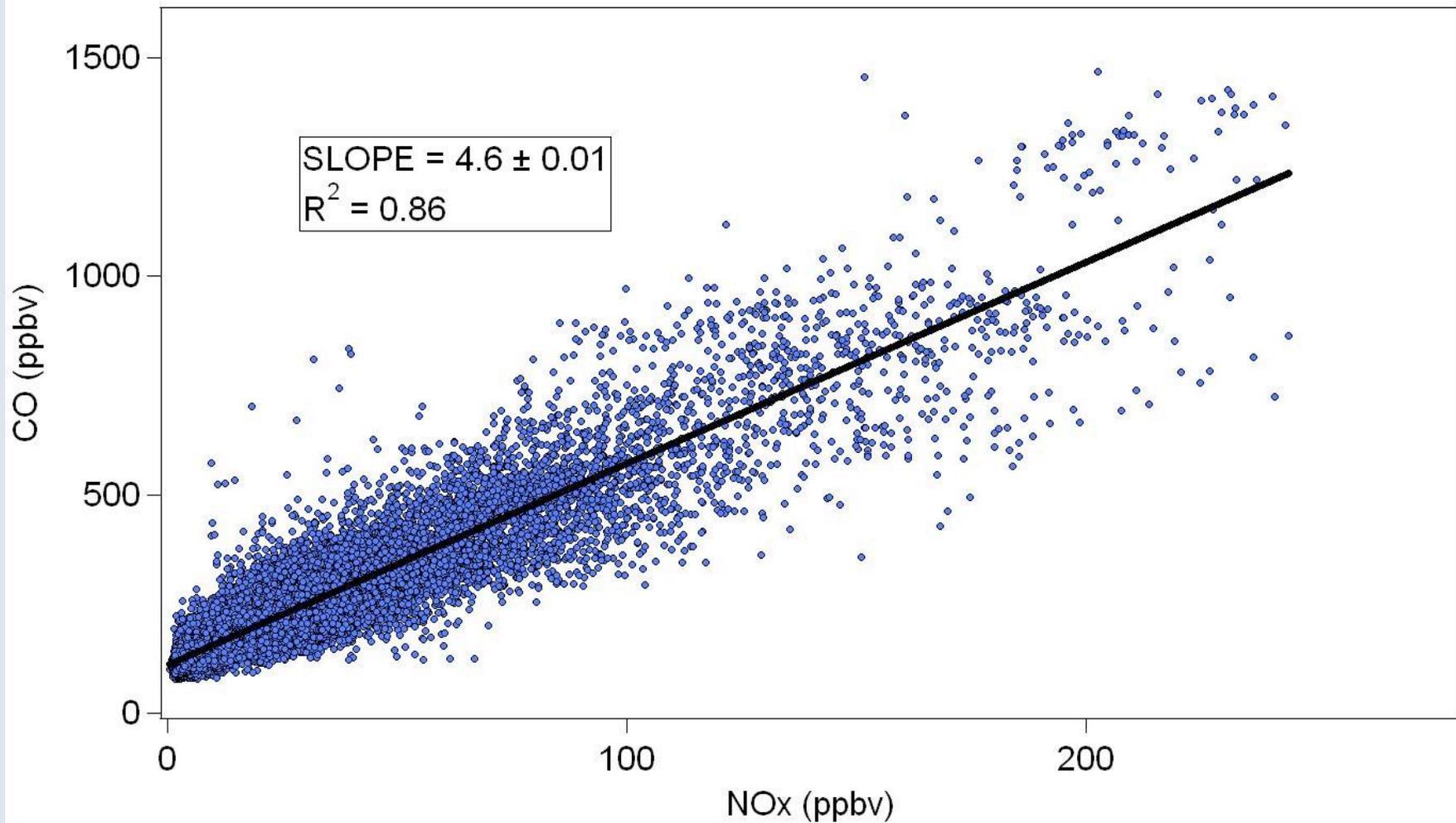
Diurnal concentrations of automobile exhaust tracers and NO_x



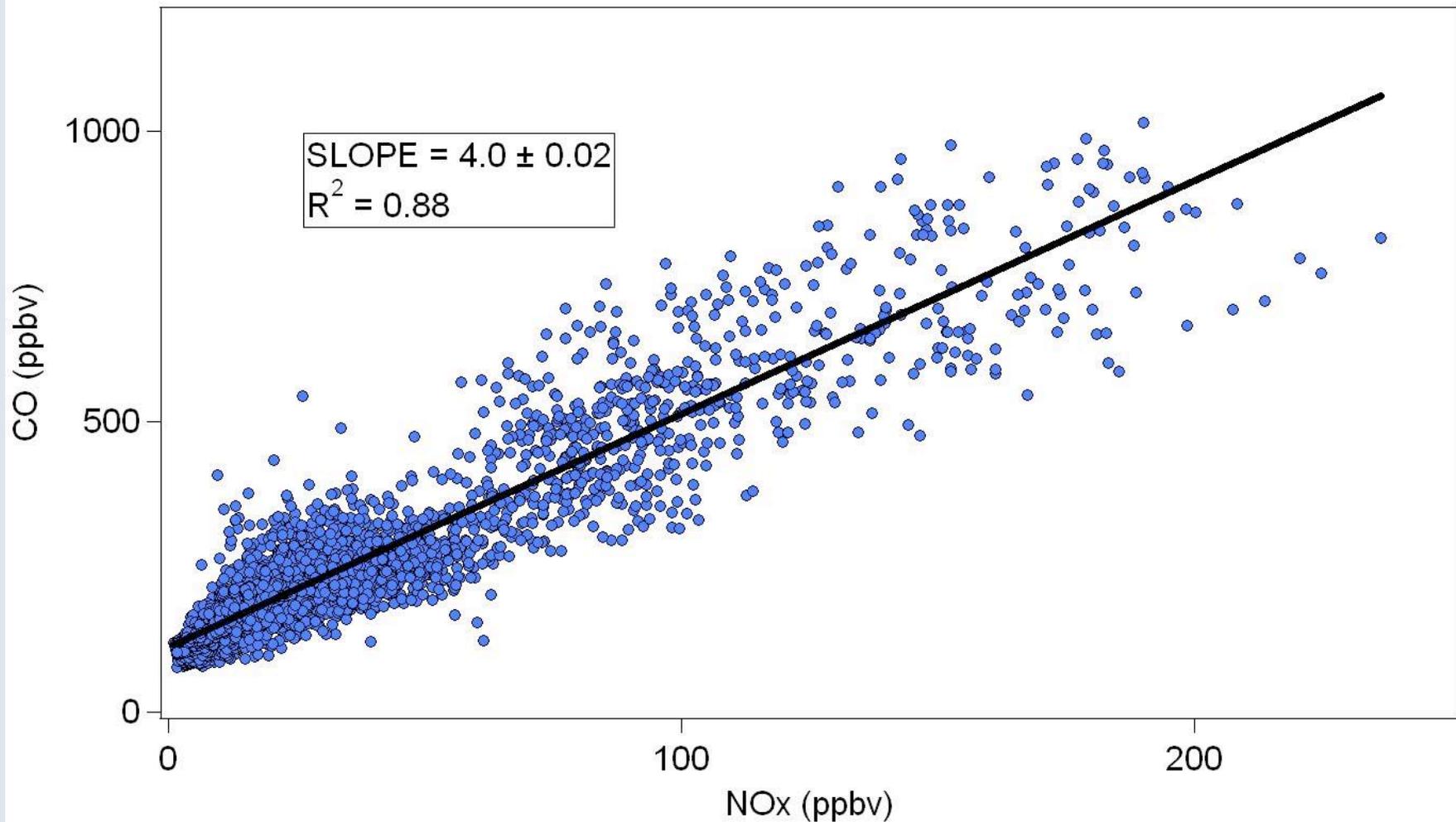
- CO and NO_x levels displayed little wind direction dependence.
- CO/NO_x ratios were also not dependent on wind direction



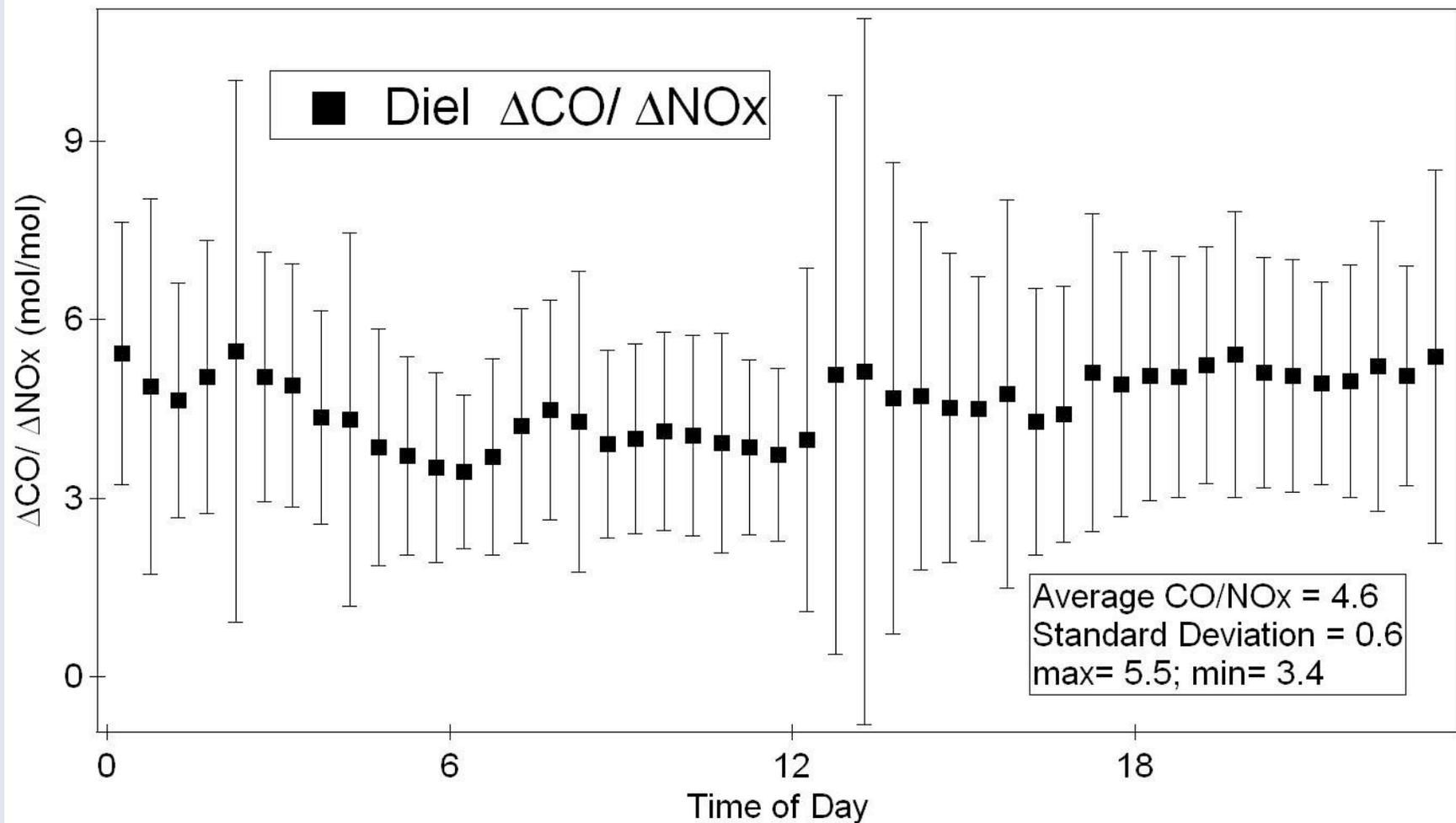
Observed CO vs. NO_x ratio for the entire monitoring period (90s data)



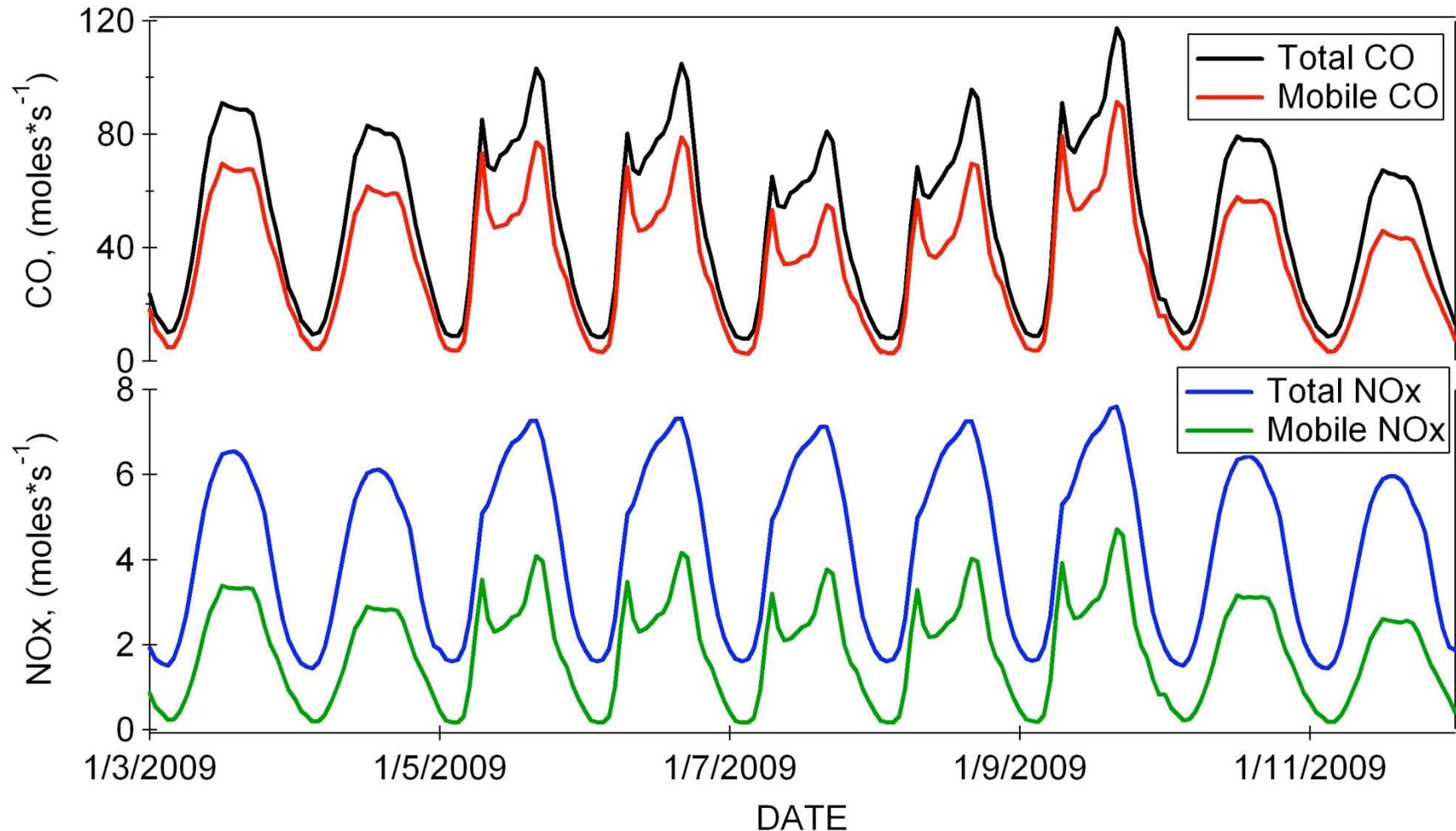
Observed CO vs. NO_x ratio during morning rush hour (5:00 am to 9:00 am)



Diel variation of $\Delta\text{CO}/\Delta\text{NO}_x$ from Dec 2, 2008 to Jan 31, 2009

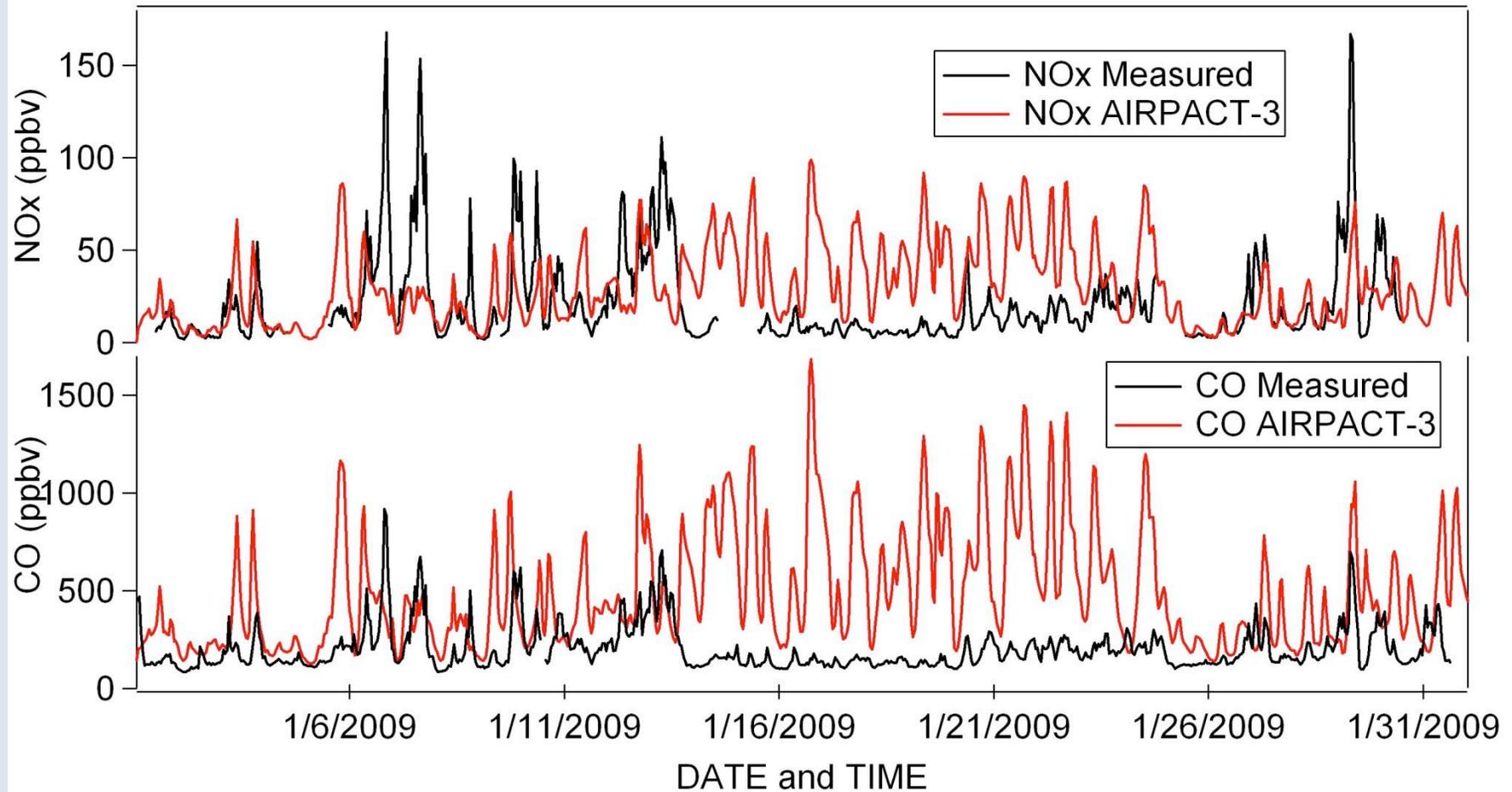


Emissions generated for AIRPACT-3

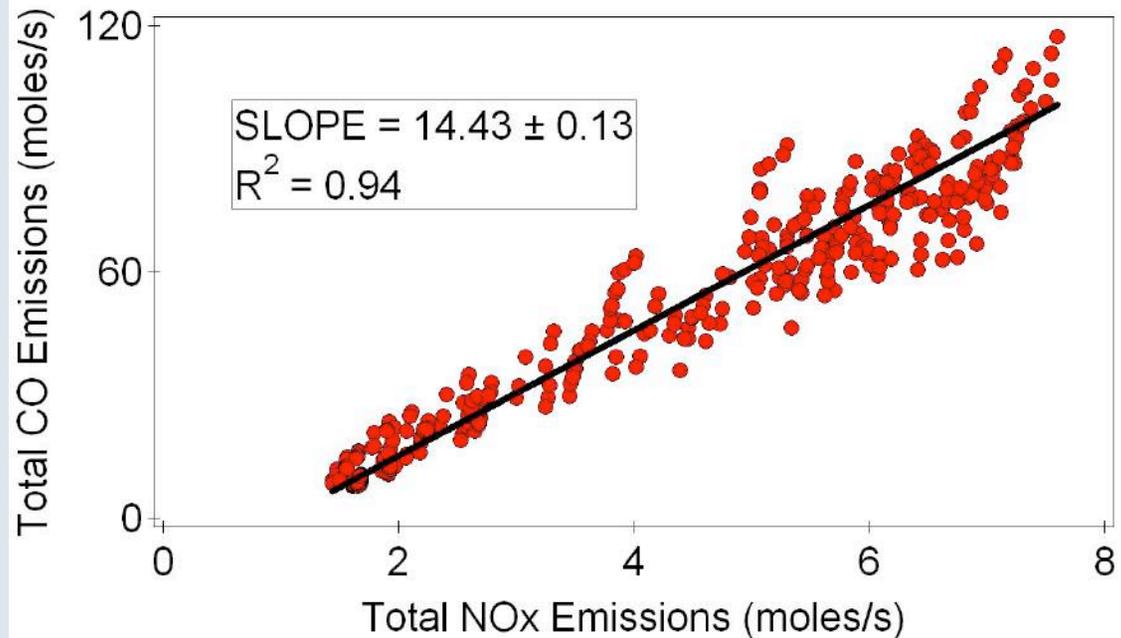


- 76% CO emissions mobile
- 57% NOx emissions mobile

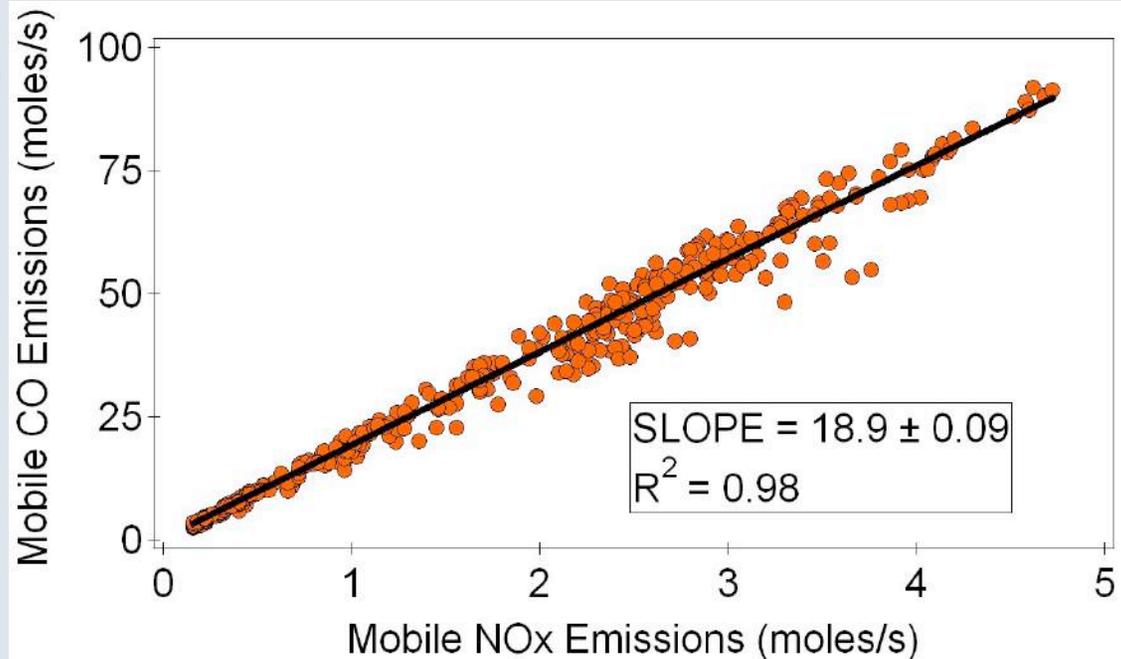
Measurement and AIRPACT-3 results for January 2009



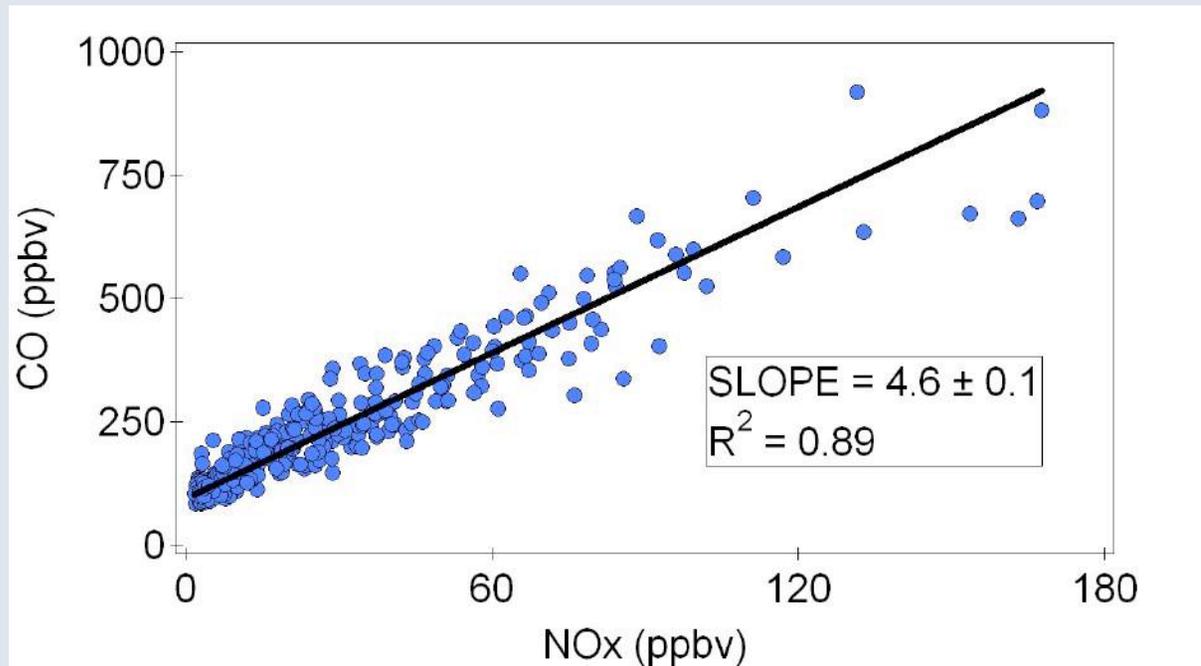
AIRPACT-3 Total Emissions



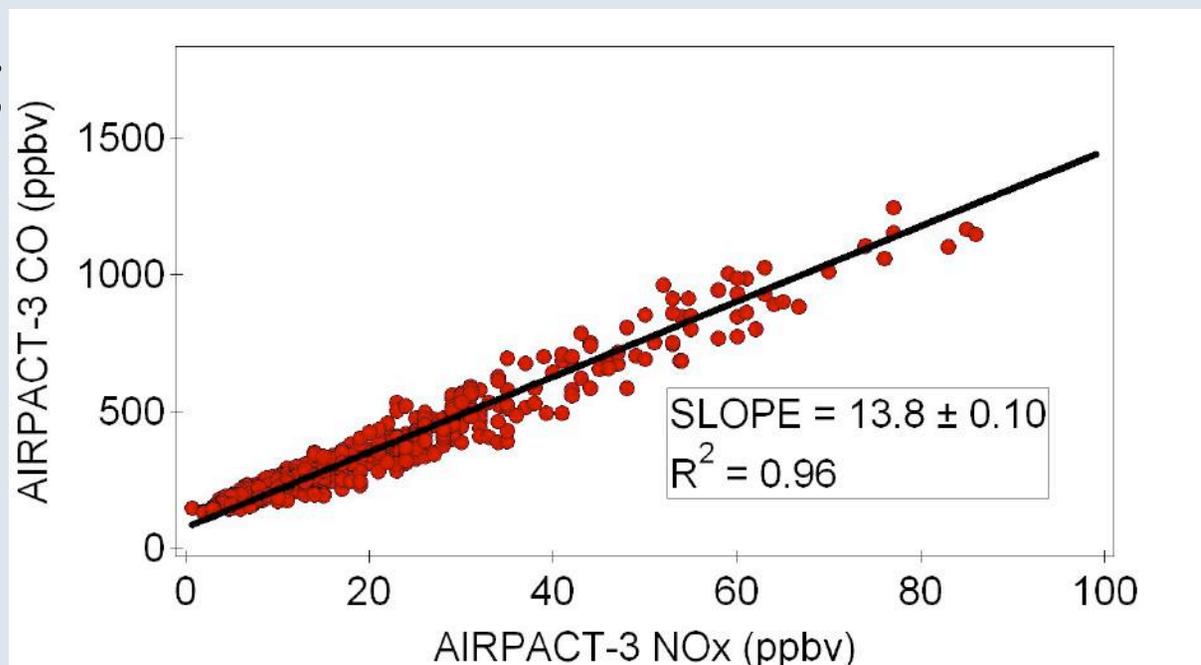
AIRPACT-3 Mobile Emissions



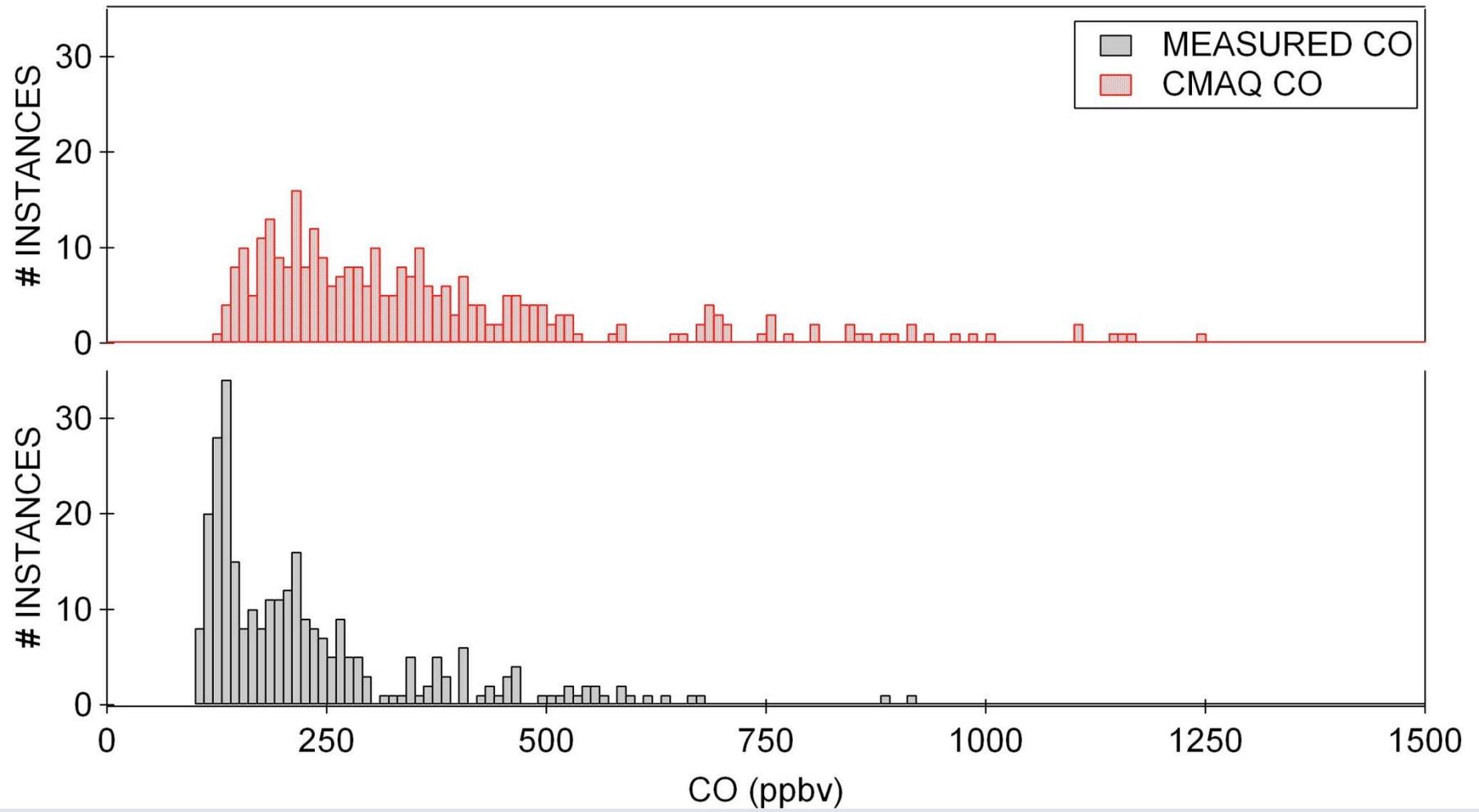
Measured mixing ratios



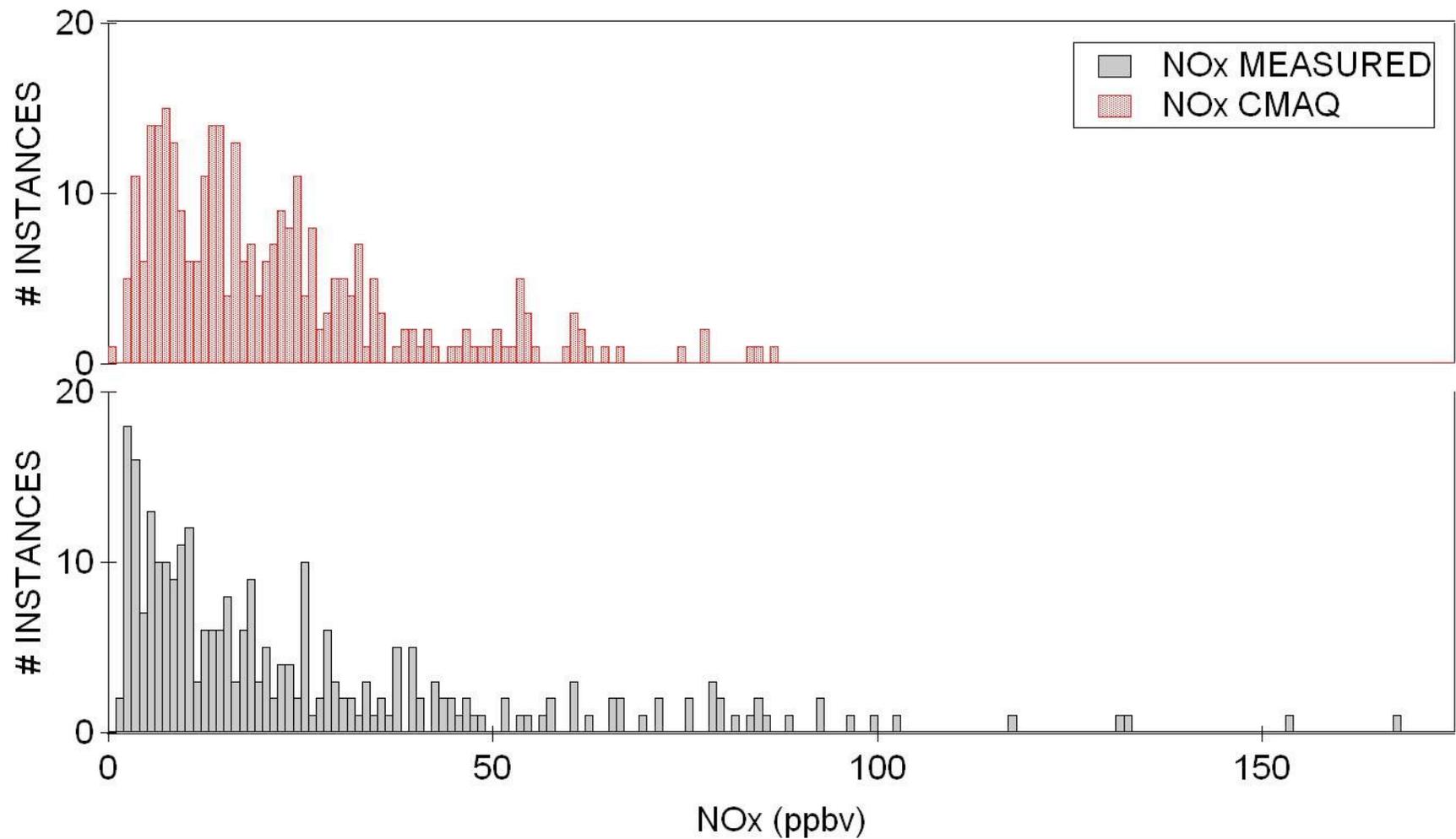
AIRPACT-3 mixing ratios



Histogram of AIRPACT-3 and measured CO mixing ratios



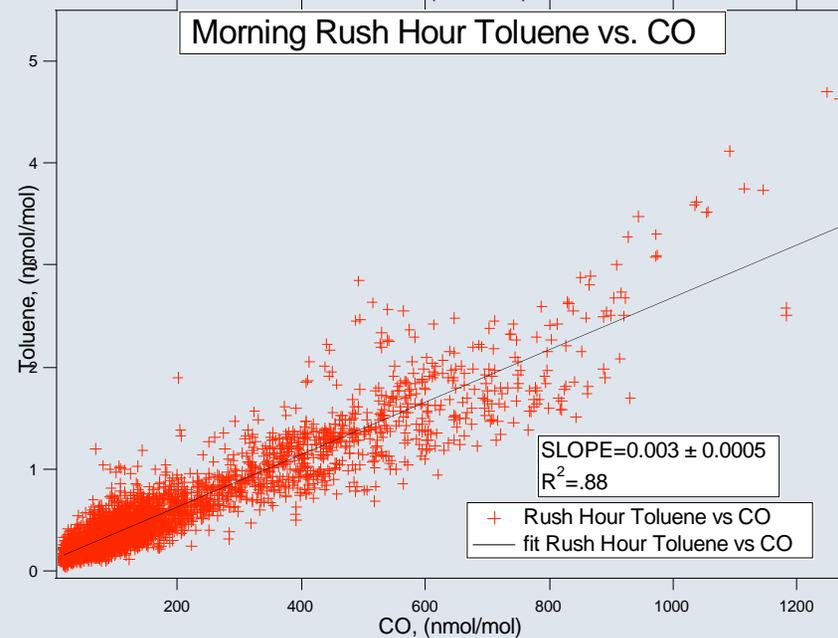
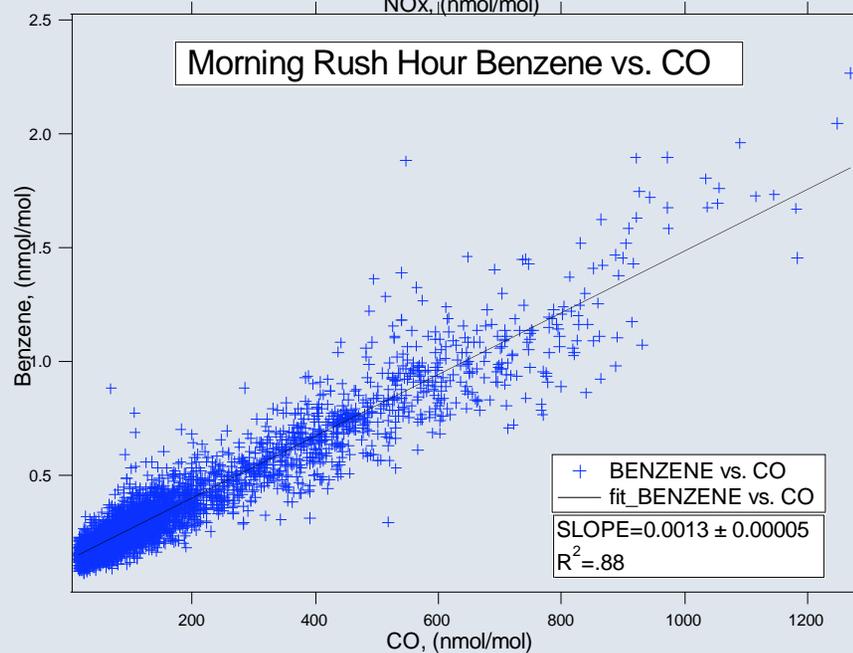
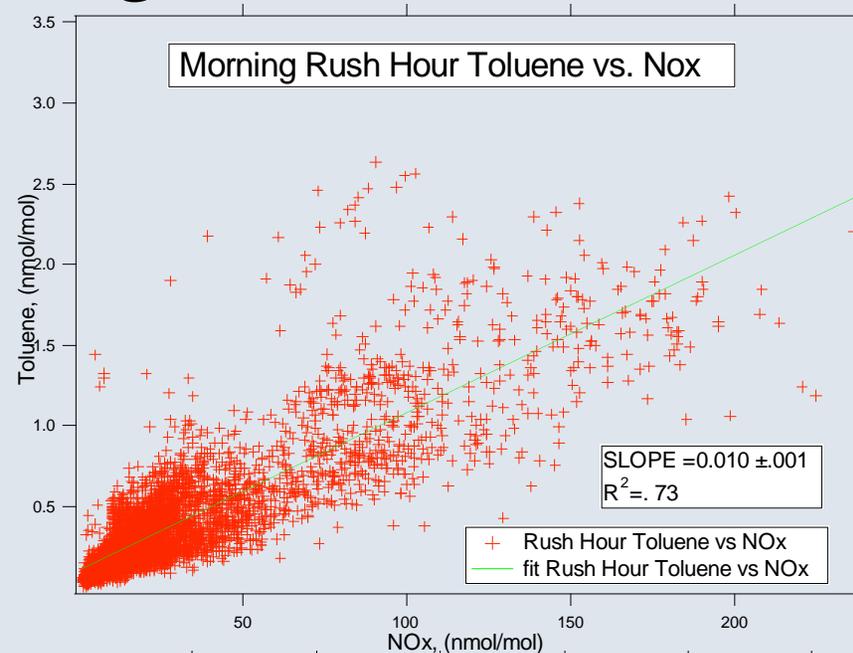
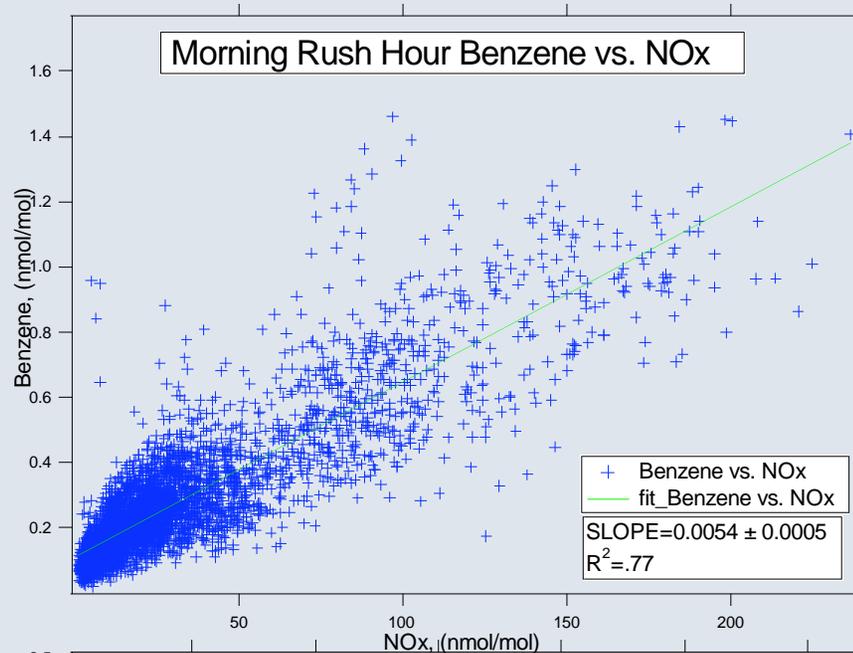
Histogram of AIRPACT-3 and measured NO_x mixing ratios



Emissions Ratio Summary:

Source	$\Delta\text{CO}/\Delta\text{NO}_x$
Measurement	(mol/mol)
Entire campaign high res.	4.6
Rush hour high res.	4.0
Rush hour median	3.6
Entire campaign 1hr avg.	4.6
IDEQ 1 hr	3.3
Model	
Mixing ratio results	13.8
Mobile emissions	18.9
Total Emissions	14.4

VOC Ratios for morning rush hour



Conclusions:

- Model CO/NO_x ratios are 3 to 4 times higher than observed
- Histograms suggest that the emissions inventory captures NO_x emissions better than CO emissions.
- How will this change with a new EI and/or with the new MOtor Vehicle Emissions Simulator 2010 (MOVES2010)?
- How do model ratios compare to observations for other species (VOC/NO_x)?

Acknowledgements: We would like to thank IDEQ for support, NSF for funding the Mobile Atmospheric Chemistry Lab and NW-AIRQUEST for support of the AIRPACT forecast system.

Instrumentation:

NO_x:

- Air Quality Design, Inc. two channel, high sensitivity, chemiluminescent NO detector.
- Molybdenum oxide catalytic converter on channel 1 (NO_y).
- Solid state photolytic NO₂ converter on channel 2 (NO_x).
- Calibration in zero air with 5.03 ppmv ± 1.0% EPA NO standard from Scott Marrin, Inc.
- 90 second average

CO:

- Aero Laser AL5002 Fast CO Monitor.
- Span calibration with 0.250% ± 2% NIST traceable.
- 90 second average