

Air Toxics in El Paso, Texas: Implications for Cross-Border Transport

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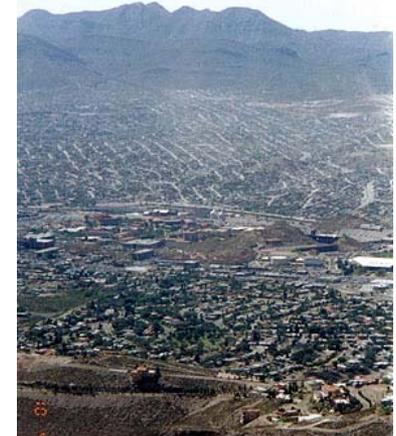
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Introduction

- **The Paso del Norte (PdN) Region**
 - Formed by mountains that surround El Paso, TX, and Sunland Park, NM, in the US, and Ciudad Juárez, Chihuahua, Mexico
 - One of the largest metropolitan areas along U.S.-Mexico border (2 Million residents)
- **Emissions**
 - Cross border traffic is 18 million vehicles yearly
 - Other sources
 - **Cooking**
 - **Heating**
 - **Brick manufacturing**
 - **Petrochemical**
 - **Waste burning**
 - Different standards between US and Mexico
- **Has some of the highest acetaldehyde and formaldehyde concentrations in the US**



Introduction - 2

- **Previous Studies**

- GIS epidemiological

- Strong correlations between mobile source emissions and children's pulmonary functions
 - Chemical composition of and community exposure to these emissions have not been quantified
 - How air toxics levels could be assessed using existing indicators (e.g., criteria pollutants) is unclear

- Studies focusing on VOC and PM

- Limited to 1-2 receptors in downtown El Paso
 - Did not look at acute short-term exposure near sources or spatial gradients

- Currently available information on air toxics and emission sources insufficient to adequately apportion community exposure to sources in region

Introduction - 3

- **Pilot Study Objectives**

- Characterize levels of selected air toxics
 - Urban residential areas influence by cross-border pollution
 - Specific local sources
 - Cross-border traffic
 - Waste burning
- Associate air toxics levels to major environmental indicators and/or criteria pollutant concentrations
- Determine and document air toxics emission factors

- **Cooperative Effort**

- City of El Paso – administration and logistics
- UTEP – logistics, sampling locations and personnel
- DRI – equipment, sampling, and laboratory analysis



El Paso Monitoring Sites

UTEP



12/10-14/08

Border-Crossing to Highway Ramp



12/19-22/08

Bowie H.S.



12/15-18/08



Trash Burning at DRI



12/23/08, 1/7-9/09



El Paso Monitoring Sites - 2

- **Ambient Monitoring Sites**
 - UTEP – next to TCEQ CAMS
 - Bowie HS - ~1 block from TCEQ Chamizal CAMS/PAMS
- **Source Oriented Monitoring Sites**
 - Cross-Border Mobile Sources
 - Behind El Paso Zoo
 - Location where both cars and trucks coming from Mexico pass by to get to other parts of El Paso or IH-10 and other parts of the US
 - Waste Burning
 - Originally to be at dump in Juarez
 - Had to be abandoned due to safety concerns
 - Eventually used household garbage from El Paso landfill
 - Added PVC and tire scraps
 - Burned at DRI facility in Reno, NV

El Paso Monitoring Sites - 3



Views at the El Paso Zoo site monitoring border-crossing vehicle emissions

Measurements

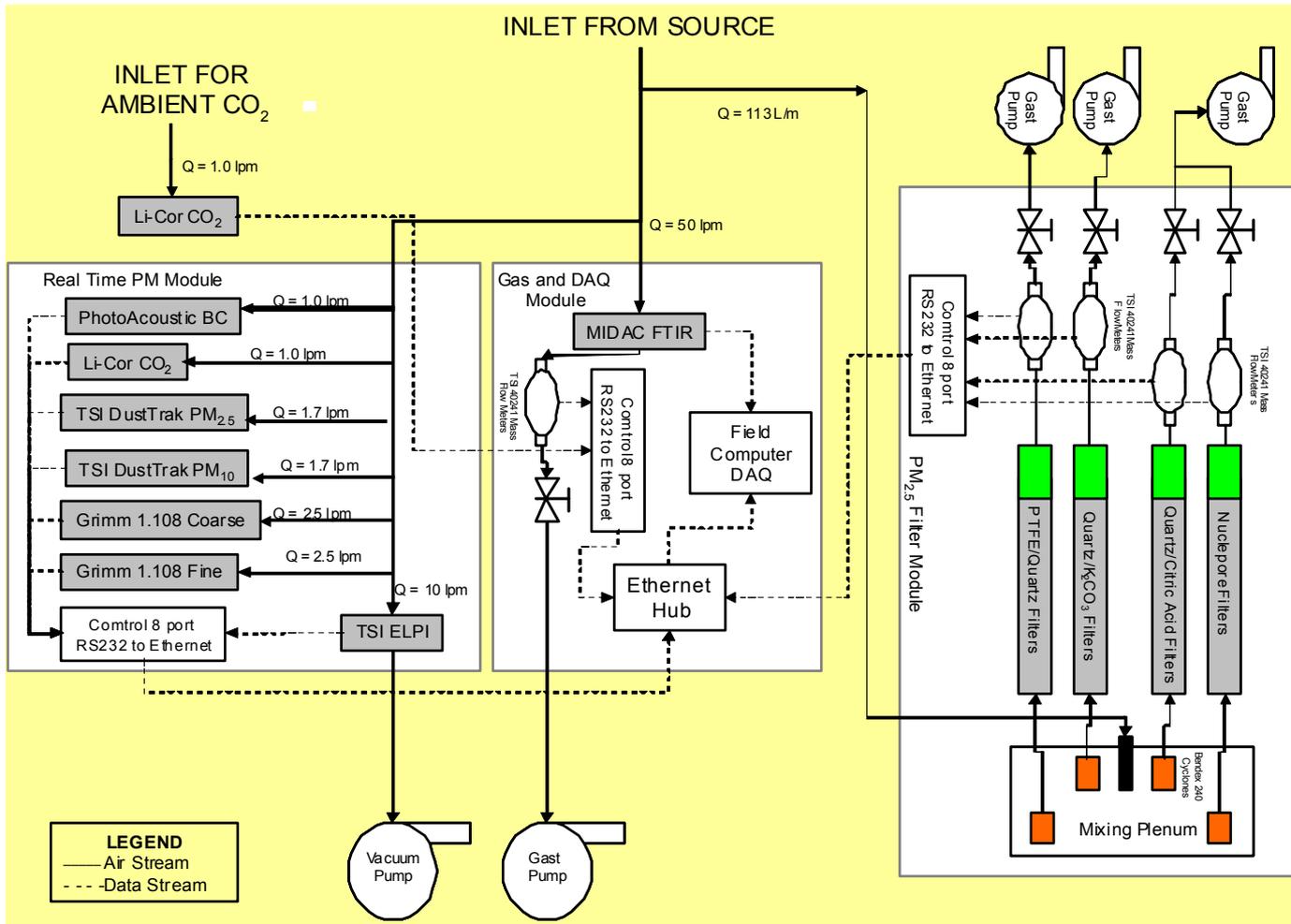
- **Spectrum of Measurements**
 - **Continuous (≤ 5 min)**
 - **Gaseous**
 - CO, CO₂, NO-NO₂-NO_x, SO₂
 - Aldehydes, VOC,
 - **Particulate**
 - PM₁₀ & PM_{2.5}
 - PAH, BC
 - PSD (10nm – 10 μ m)
 - **Integrated (~1-9 hrs)**
 - **Gaseous**
 - Auto-GC - VOCs
 - DNPH/HPLC – Aldehydes, carbonyls
 - Canisters/GCMS – VOCs
 - **Particulate**
 - Teflon filter – mass & elements by XRF
 - Quartz filter – non-polar HCs by TD-GC/MS

Measurements - 2

Method	Target Pollutants ^a	Avg. Time	Frequency
Fourier Transform Infrared Spectrometer (FTIR, Illuminator series, Midac, Costa Mesa, CA)	acetaldehyde, acrylonitrile, formaldehyde, hydrazine, methylene chloride, perchloroethylene, vinyl chloride, carbon monoxide, carbon dioxide, nitrogen oxides	2 sec	Continuous throughout experiment
Auto-GC (TO-14 Air Sampling GC, SRI Instruments)	acrylonitrile, benzene, carbon tetrachloride, chloroform, 1, 3-dichloropropene, methylene chloride, perchloroethylene, propylene dichloride, 1, 1, 2, 2-tetrachloroethane, trichloroethylene, vinyl chloride, other VOC source markers	10 – 40 min	Hourly throughout experiment
DNPH/HPLC (2,4-dinitrophenyl-hydrazine derivatization cartridge sampling followed by High Performance Liquid Chromatography analysis)	acetaldehyde, acrolein, formaldehyde, other carbonyls	10 – 40 min	Overlap with auto-GC measurement; 10 – 15 per sampling location decided by the field operator for a total of 45 samples
Teflon Filter/XRF (Teflon membrane filter sampling followed by X-ray Florescence analysis)	arsenic, beryllium, cadmium, chromium, lead, manganese, mercury, nickel; and PM _{2.5} mass (by gravimetry)	10 – 40 min	Overlap with DNPH/HPLC measurement for a total of 45 samples
Quartz Filter/TD-GC/MS (Quartz-fiber filter sampling followed by Thermal Desorption-GC/MS analysis)	ethylene dibromide, ethylene dichloride, ethylene oxide, polychlorinated biphenyls, polycyclic organic matter*, quinoline*; and OC/EC (by Thermal/Optical Reflectance method)	10 – 40 min	Overlap with DNPH/HPLC measurement for a total of 45 samples
Canister/GCMS (Canister sampling followed by Gas Chromatography Mass Spectrometry analysis)	acrylonitrile, benzene, 1, 3-butadiene, carbon tetrachloride, chloroform, 1, 3-dichloropropene, methylene chloride, perchloroethylene, propylene dichloride, 1, 1, 2, 2-tetrachloroethane, trichloroethylene, vinyl chloride, other VOC source markers	10 – 40 min	Overlap with DNPH/HPLC measurement; 2 – 3 per sampling location decided by the field operator for a total of 10 samples
Photoelectric Aerosol Sensor (PAS, EcoChem Analytics PAS2000)	diesel particulate matter [†] , polycyclic aromatic hydrocarbons	1 min	Continuous throughout experiment
CO ₂ /H ₂ O Gas Monitor (LiCor-840)	carbon dioxide, water vapor	1 sec	Continuous throughout experiment
DustTrak™ (Model 8520, TSI)	PM ₁₀ , PM _{2.5} by light scattering	1 sec	Continuous throughout experiment
Electric Low Pressure Impactor (Dekati ELPI)	Particle size distribution (10 nm – 10 μm) [‡]	5 sec	Continuous throughout experiment
Aethalometer (Magee AE14U) ^b	PM _{2.5} black carbon [†] by light absorption	5 min	Continuous throughout experiment

^a Detection limits vary (see SOPs); * Primarily for particle-phase fractions; [†] measure surrogate; [‡] aerodynamic diameter (12 size bins); ^b Not part of the In-Plume system and will be installed upon availability.

Measurements - 3

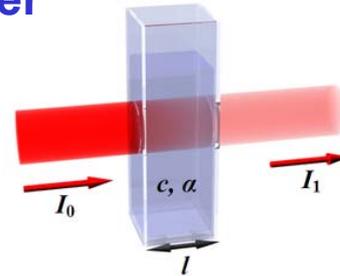


Measurements - 4

Fourier Transform Infra-Red Spectrometer



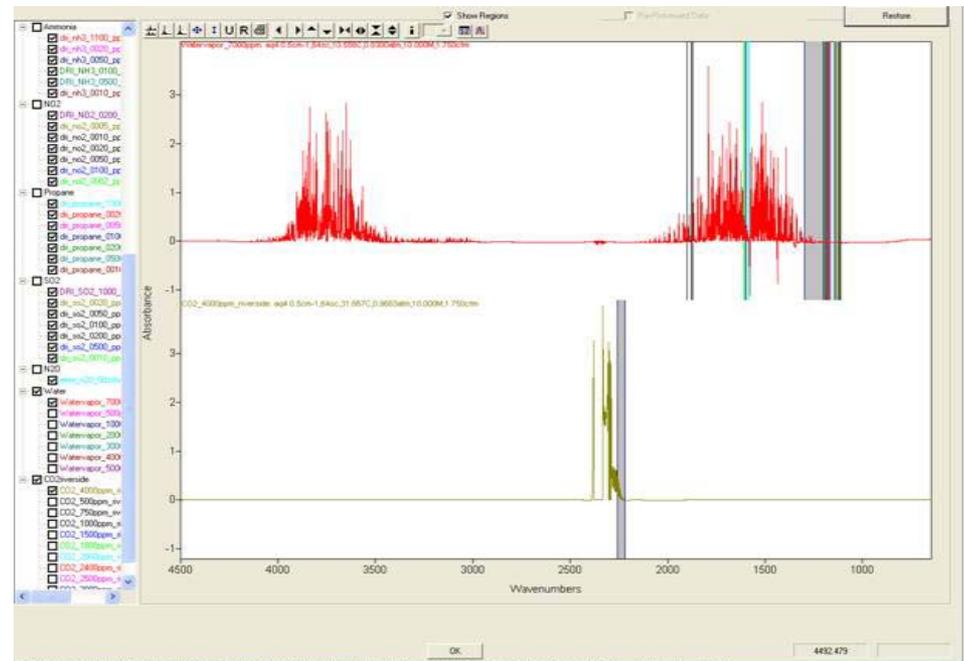
Source
Radiation



Detector

$$A_i = \alpha_i C_i l$$

- Beer-Lambert law:
 - $\log_{10}(1/T) = A$ absorbance
 - α is absorption coefficient
 - C is concentration
 - L is the distance that the radiation travel through the sample l
 - $I_1 = I_0 \exp(-\alpha l)$
- 0.5 cm^{-1} resolution, 10 m folded optic length, 2 L custom cell, 50 LPM flow, sample frequency once per 1.5 seconds.



H₂O and CO₂ FTIR Spectra

Measurement - 5

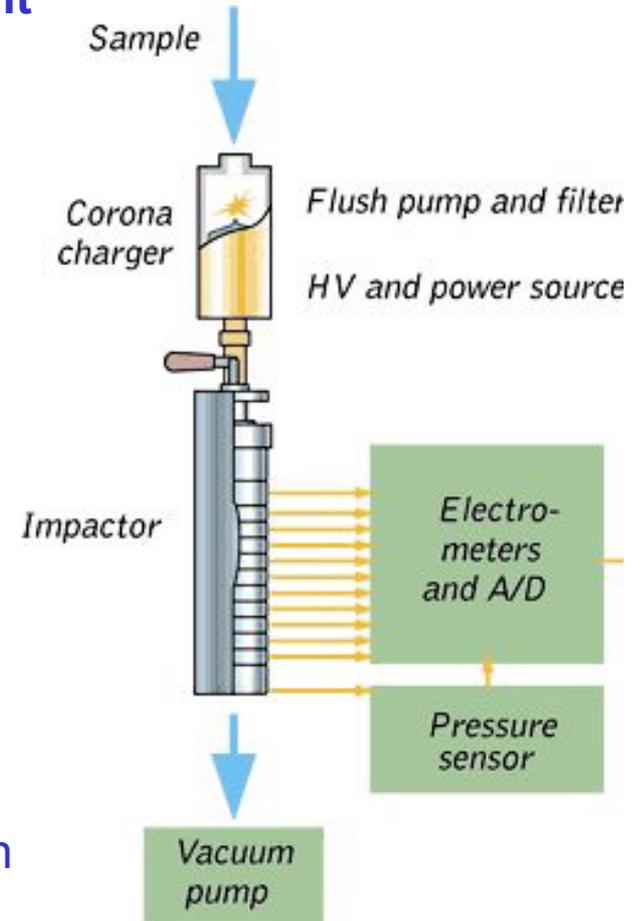
Real-Time Continuous Particle Measurement



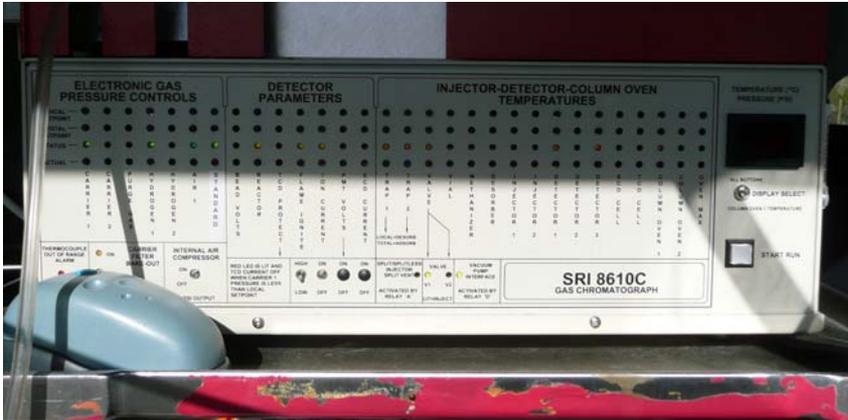
ELPI

Electrical Low Pressure Impactor

Measures particle number concentration and aerodynamic size (between 7 nm and 10 μm with filter stage)



Measurements - 6



SRI Auto-GC



DustTrak for PM by light scattering

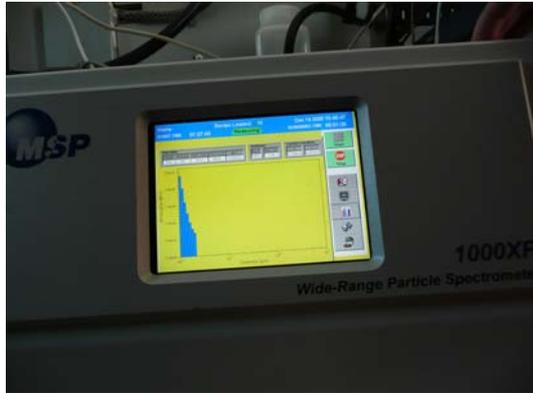


Andersen Aethalometer for BC



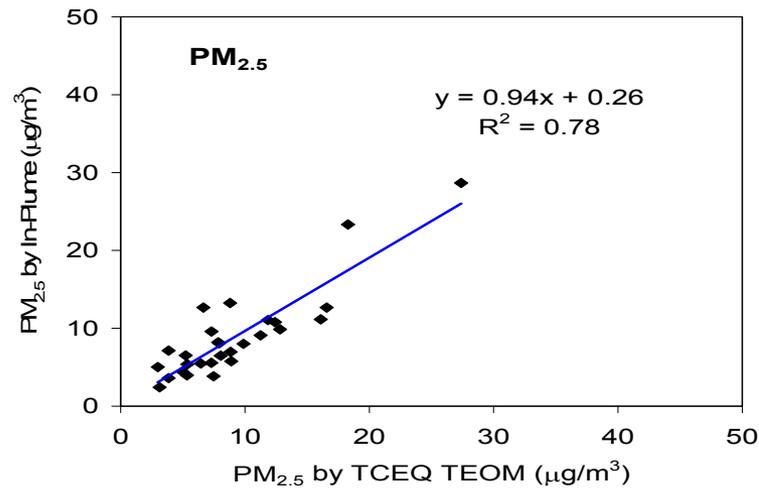
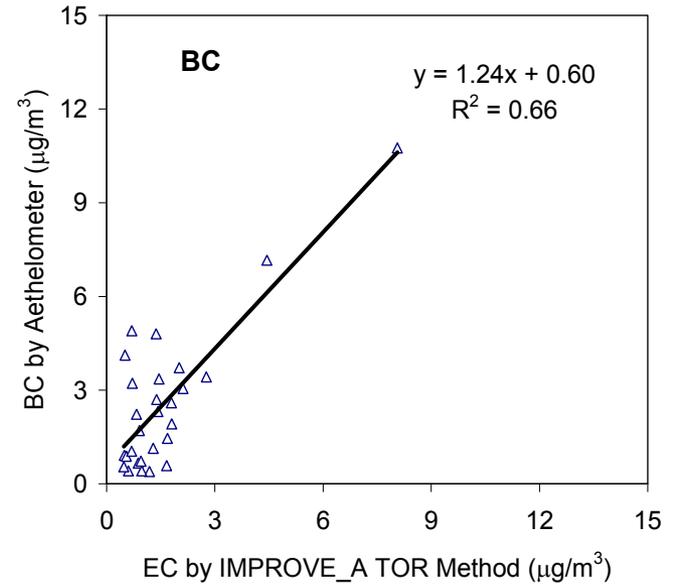
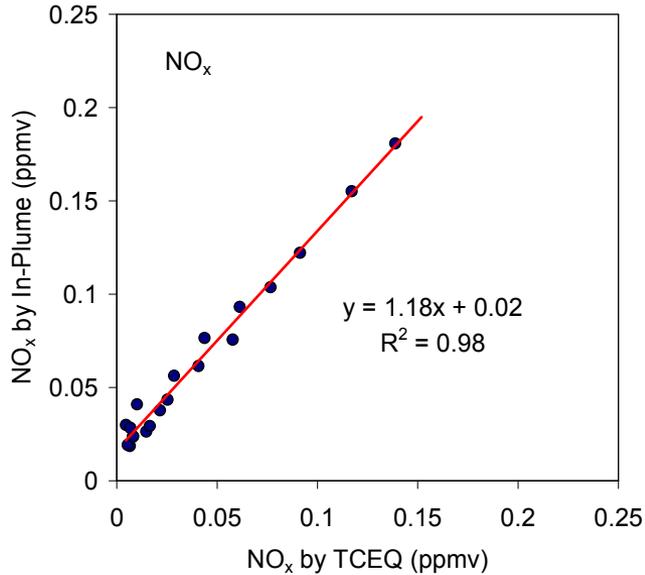
EchoChem PAS for PAH, DPM

Measurements - 7

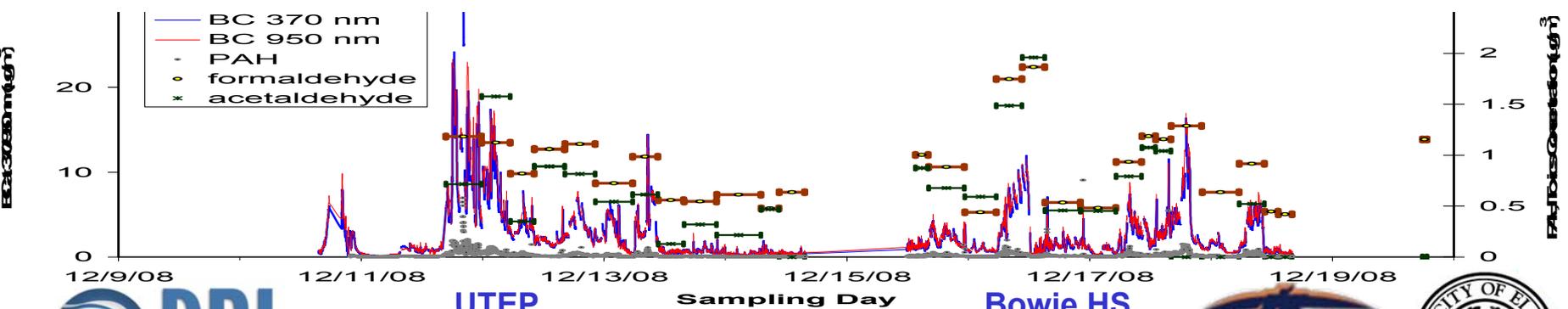
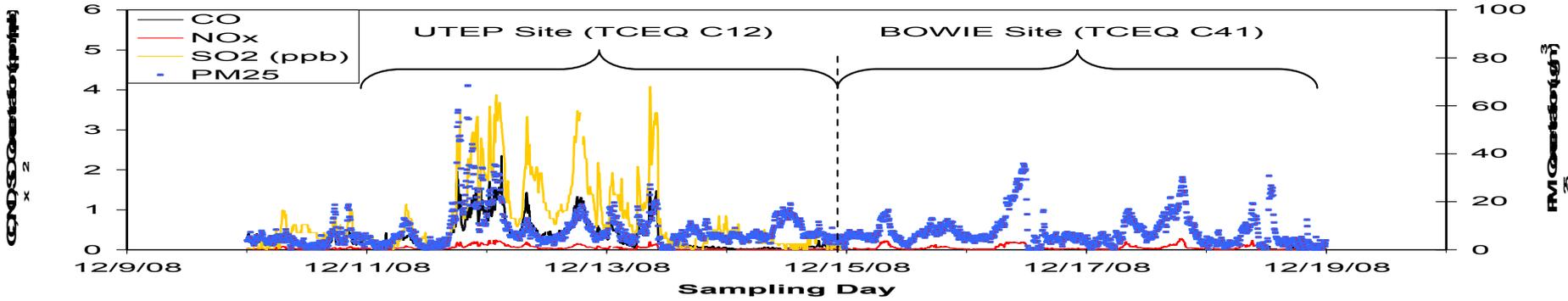
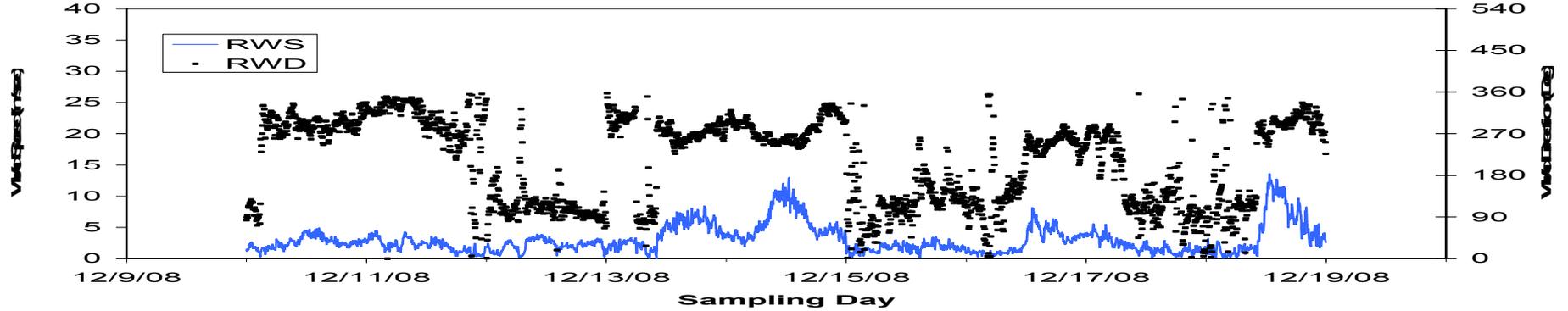


Measurements - 8

In-Plume System Measurement Comparisons



Results



UTEP

Bowie HS

Sampling Day

Ambient Monitoring Sites



Results - 2

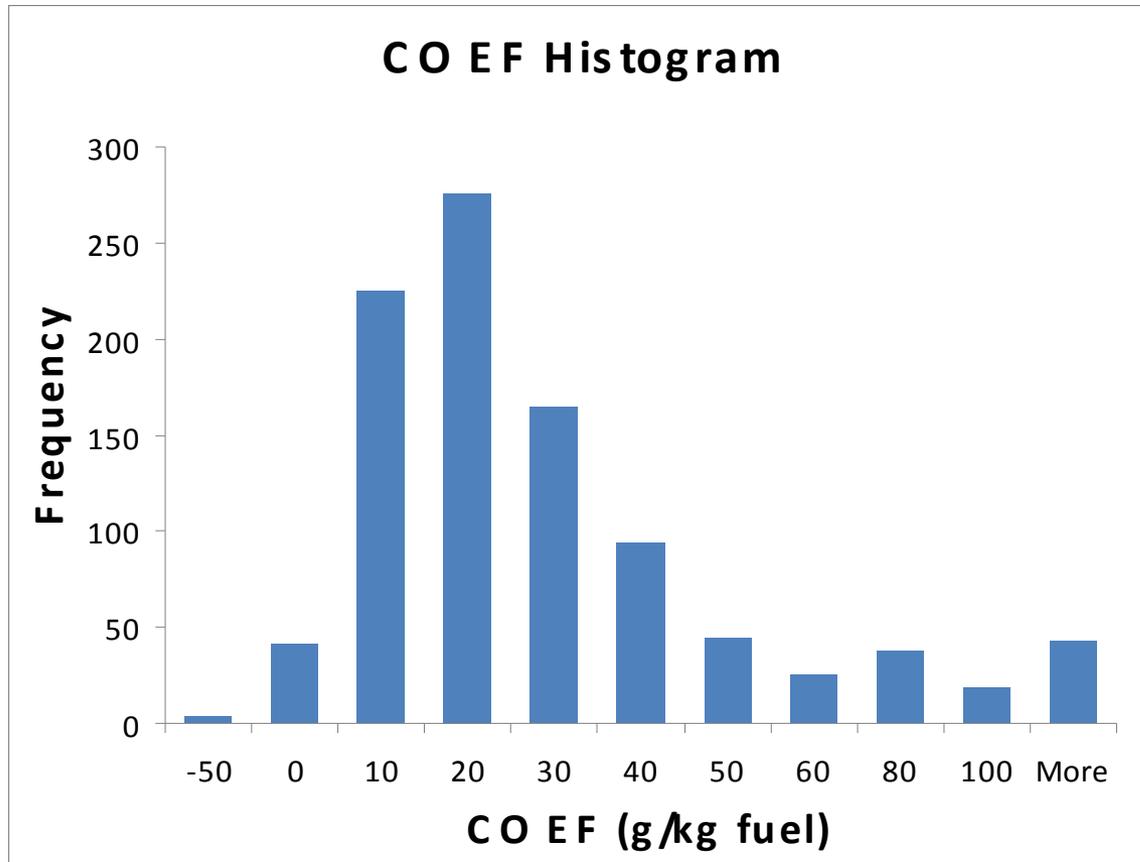
On-Road Mobile Source Sampling

Fleet average Emission Factor (g/kg fuel)

	CO	NO	HC	PM
Fleet Average	28.32	17.15	26.89	0.91
Standard Deviation	48.52	7.17	36.06	1.20
Sampled Vehicle Passes	971	971	971	296

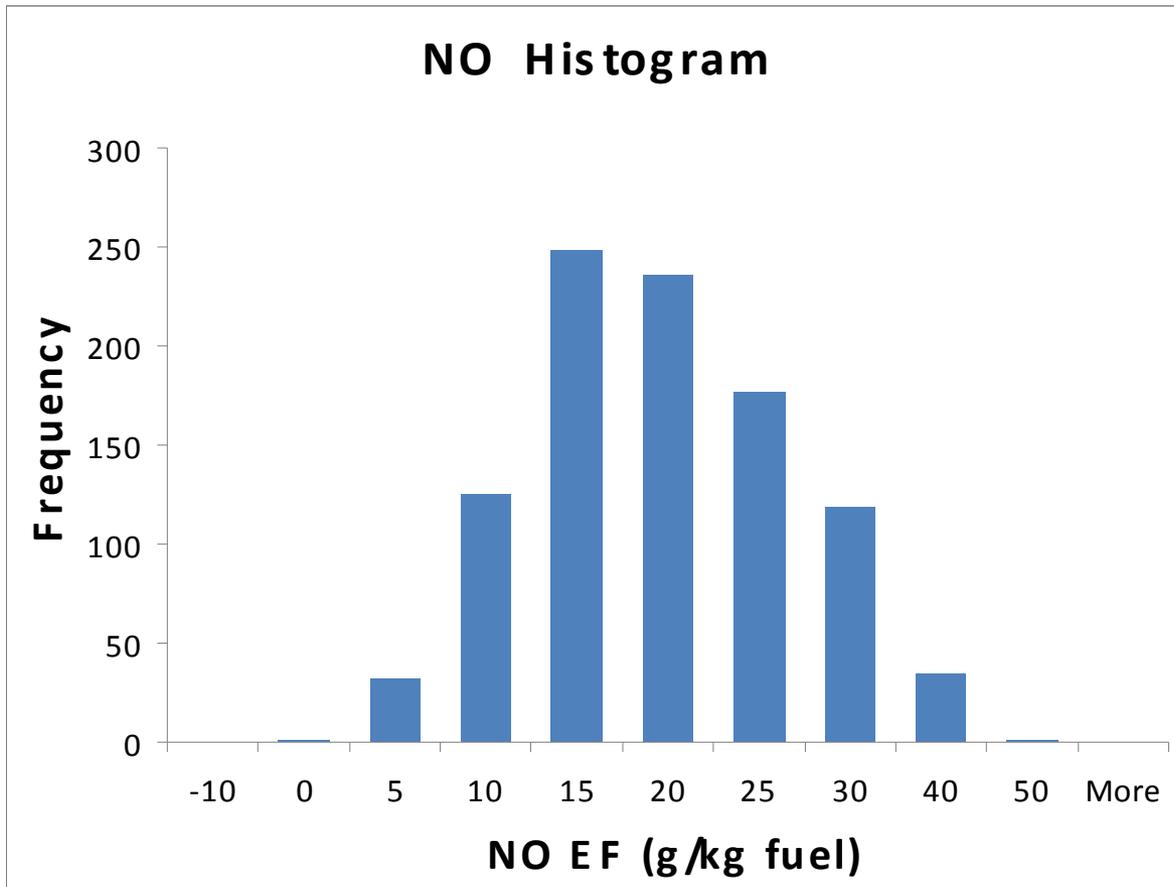
Results - 3

Mobile Source CO Emission Factors



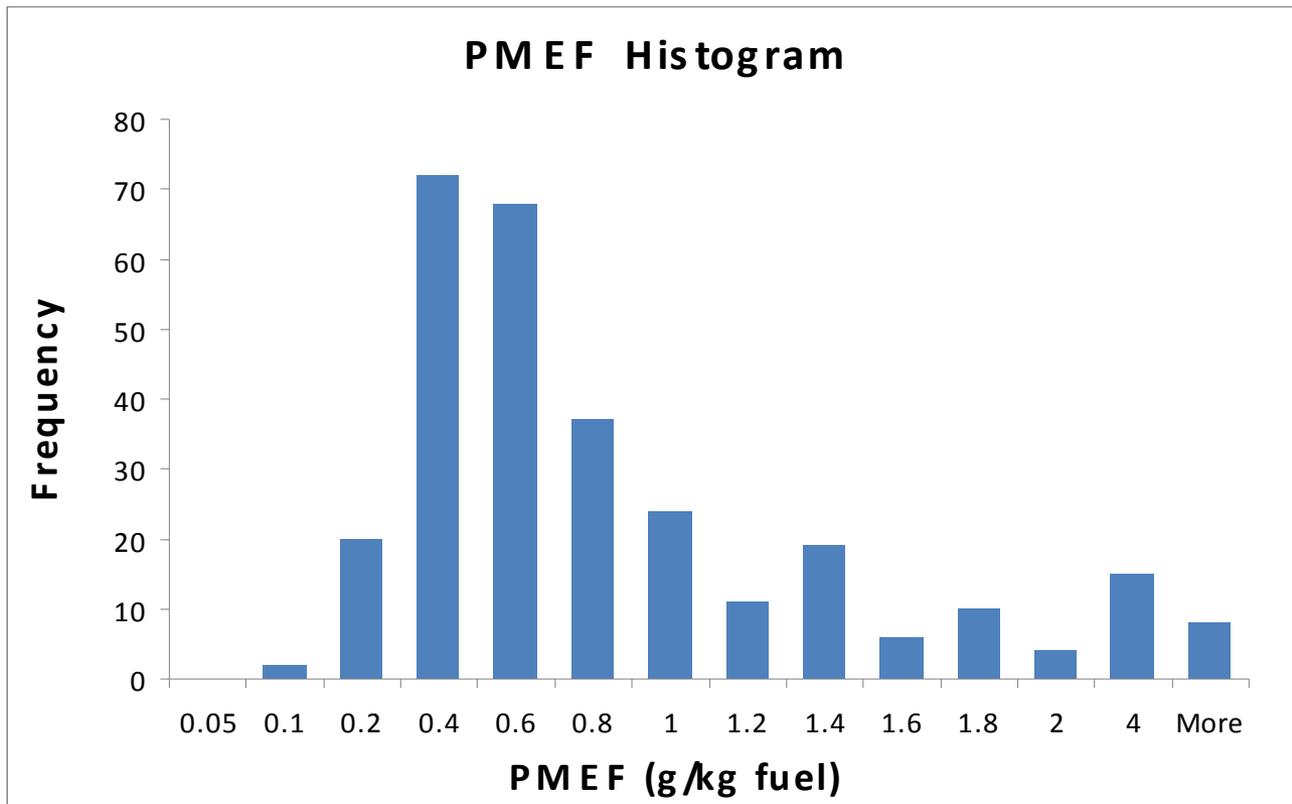
Results - 4

Mobile Source NO Emission Factors

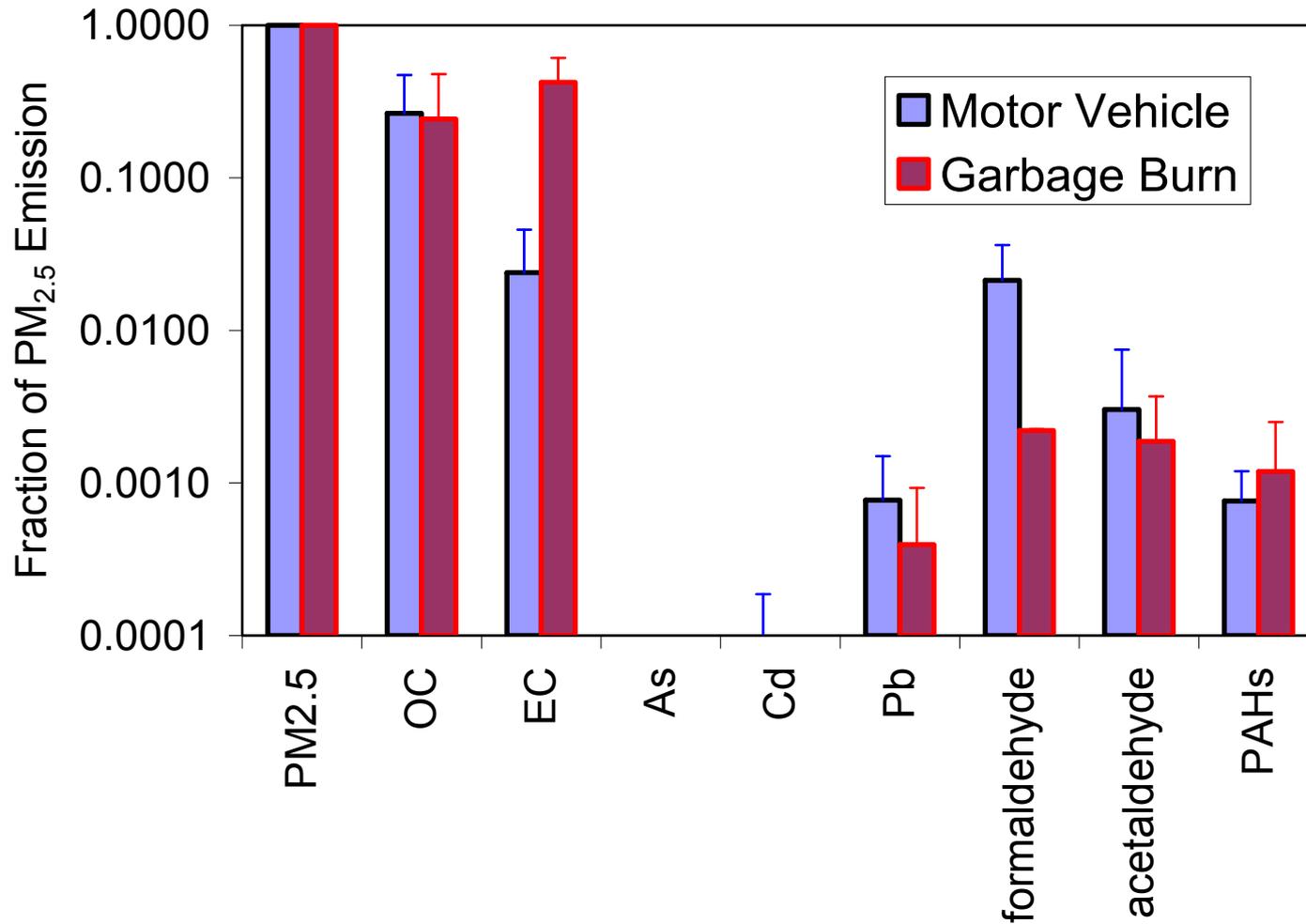


Results - 5

Mobile Source PM Emission Factors



Results - 6



Differences in Source Composition



Conclusions

- Results are very preliminary
- Aerosol and air toxics levels highly influenced by wind direction, signifying cross-border transport
- Good correlation between $PM_{2.5}$ and CO and NO_x
Suggests on-road traffic as the dominant source of PM and polycyclic aromatic hydrocarbons (PAHs)
- Emission profiles indicate strong emissions
 - Formaldehyde from motor vehicles
 - Black Carbon from unregulated domestic garbage burning
- Missing Auto-GC data making task of finding surrogates difficult

Future Work

- **Analysis for specific compounds**
- **Adjustments for time lags**
- **Adjustments for missing data**
- **Source-receptor modeling**

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