Why care about $PM_{10-2.5}$?

Eur Respir J 2005; 26: 309–318
DOI: 10.1183/09031936.05.00001805

REVIEW

Epidemiological evidence of effects of coarse airborne particles on health

B. Brunekreef* and B. Forsberg#

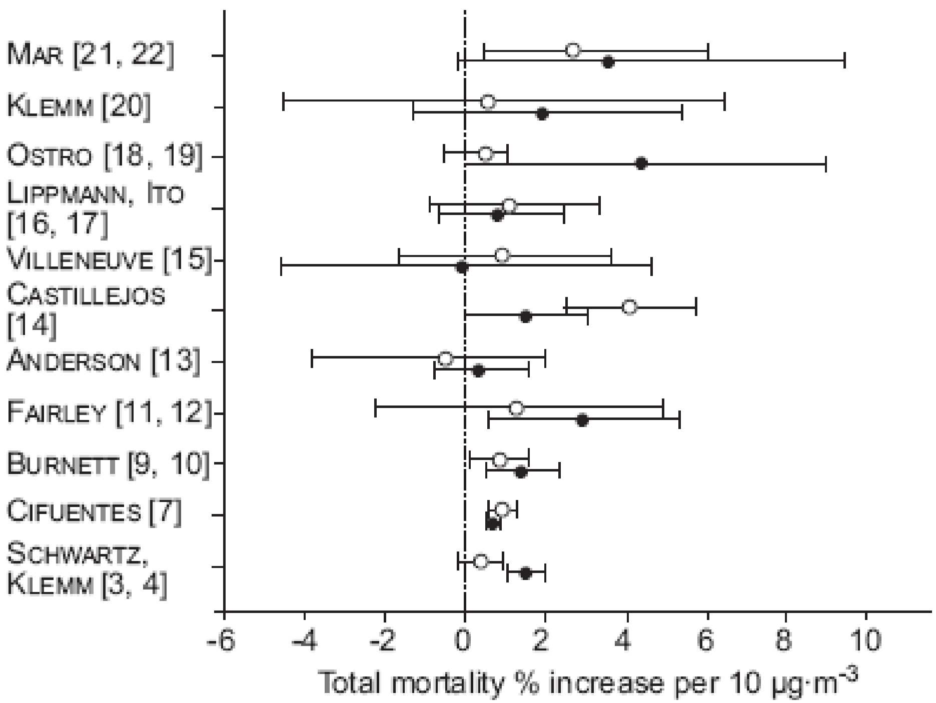


FIGURE 1. Effect of fine (●) and coarse (○) particles on total mortality published time series studies.

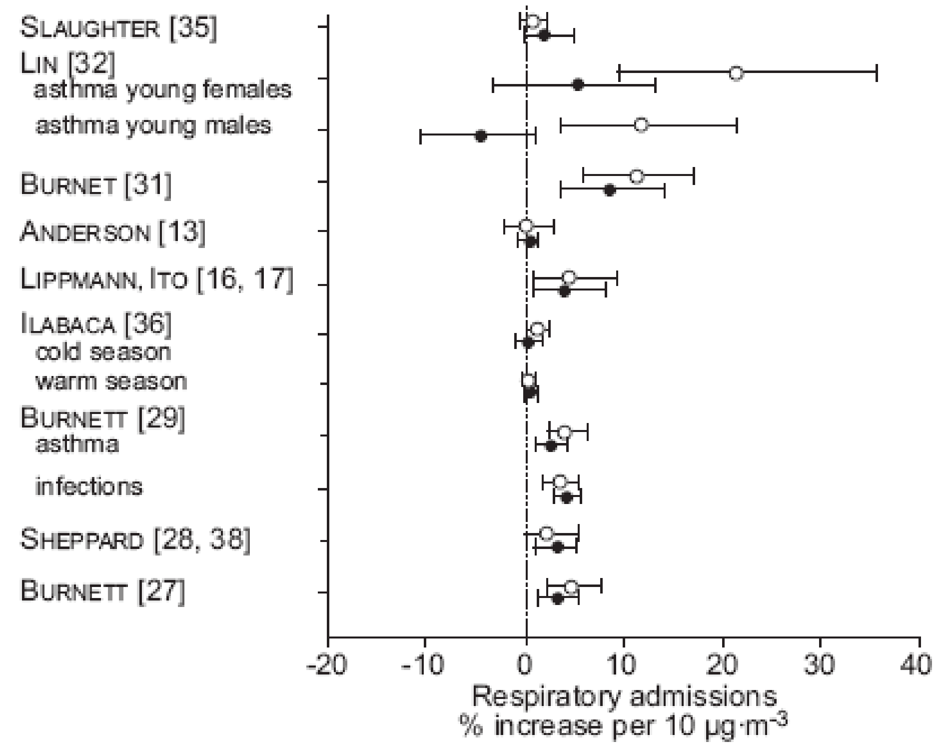


FIGURE 2. Effect of fine (●) and coarse (○) particles on respiratory admissions in published time series studies.

Team:

Noah Fierer (CU)

Mike Hannigan (CU)

Christine Wiedinmyer (NCAR)

Leverages CRUSH

Coarse Rural Urban Sources and Health Study

Hannigan, Peel, Milford, Miller, Navidi, Schauer

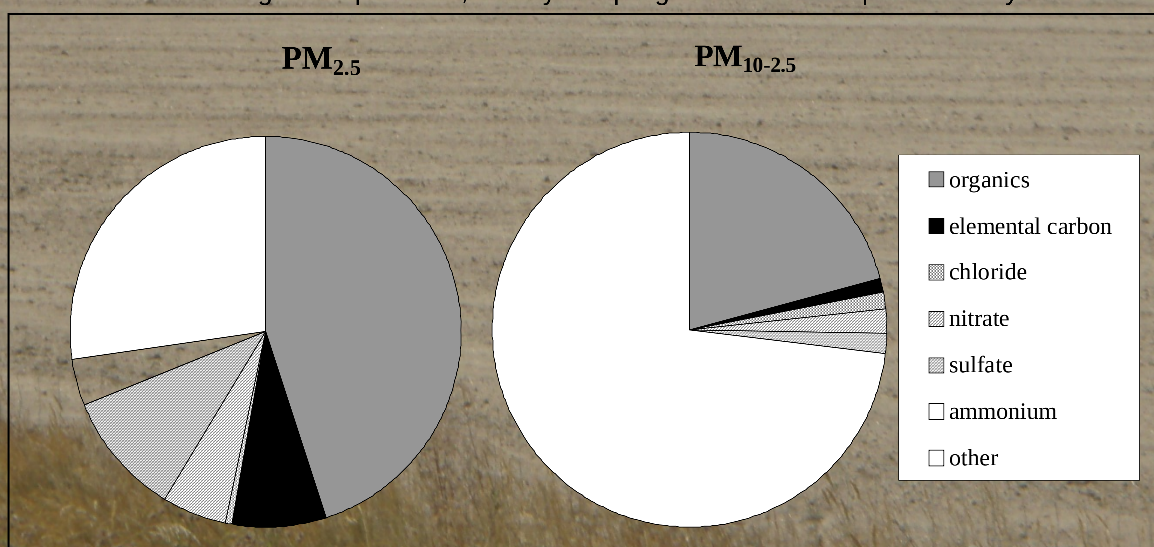
EPA funded effort

Goal

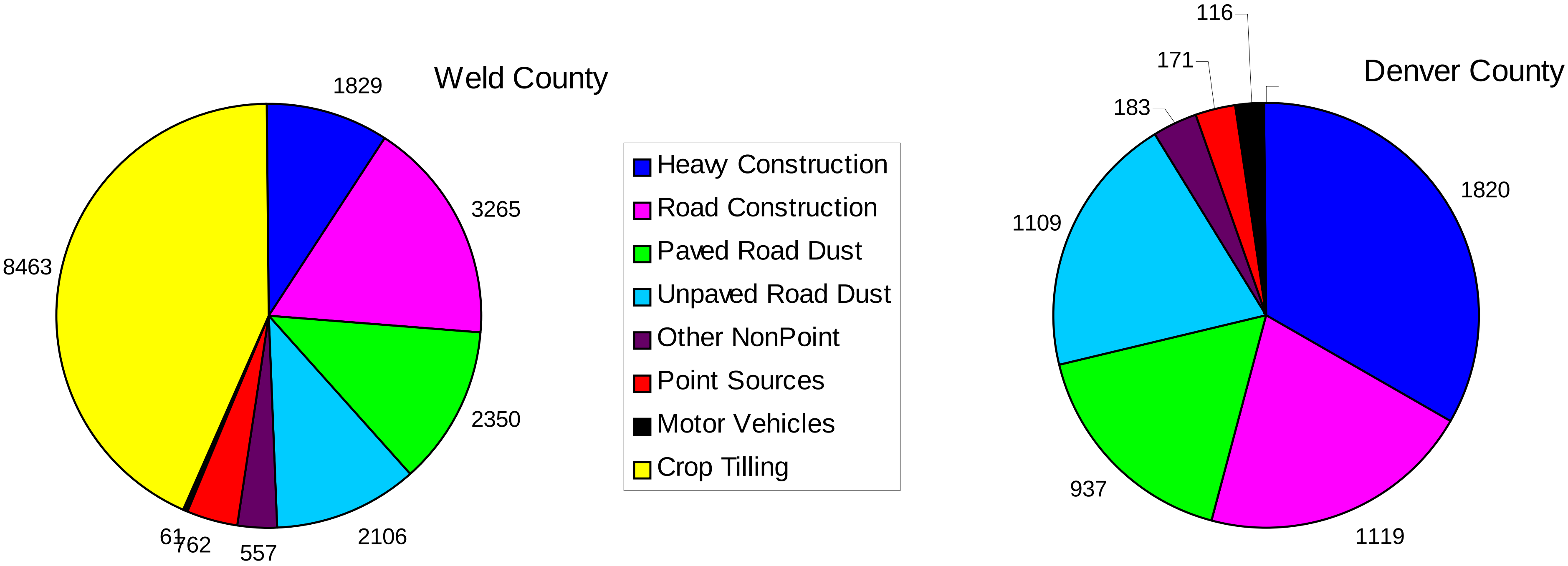
Accurate $PM_{10\text{-}2.5}$ emissions inventories

- ✓ Include all important sources
- ✓ Include realistic temporal cycles
- ✓ Include links with other important environmental variables

Denver annual average PM specaition, 6th day sampling for 2001 at Alsup Elementary School

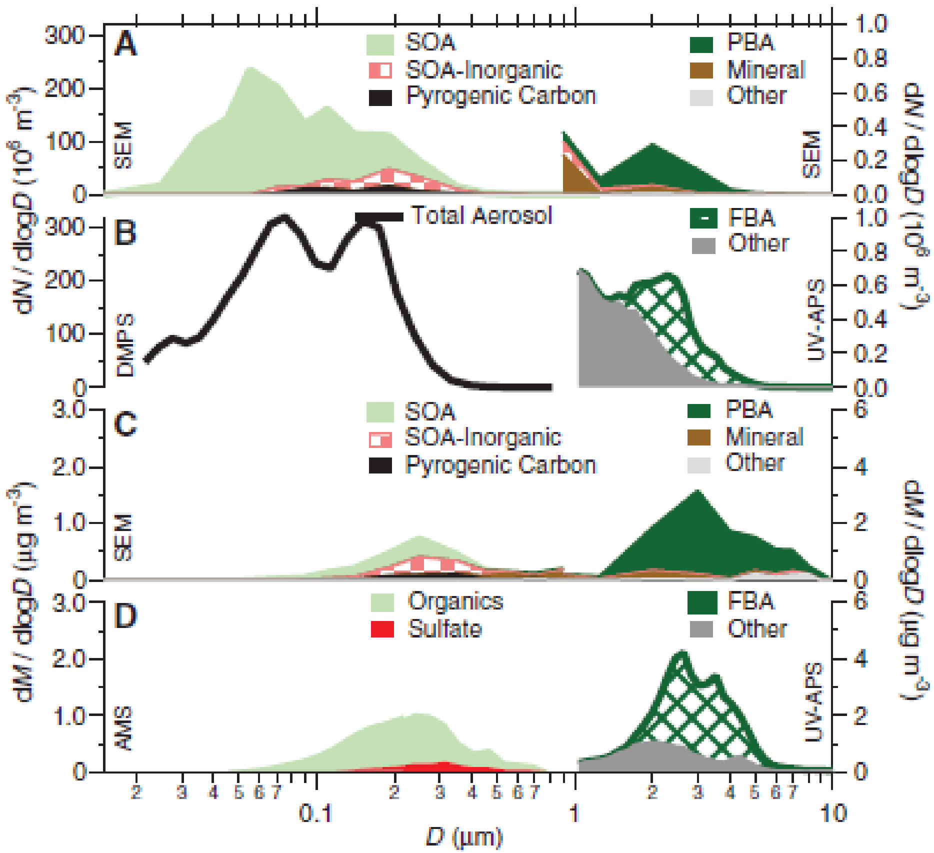


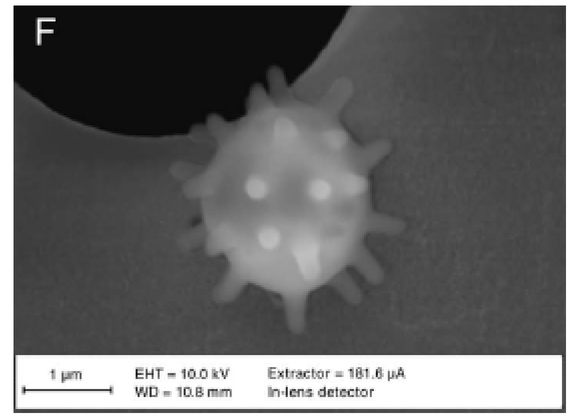
$PM_{10-2.5}$ Annual Emissions Inventory



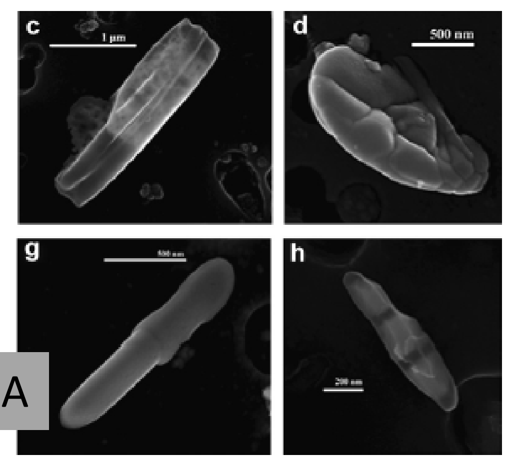
Not enough organics in the emissions inventory

Primary Biological Aerosols (PBA)





Pöschl et al, Science, 2010

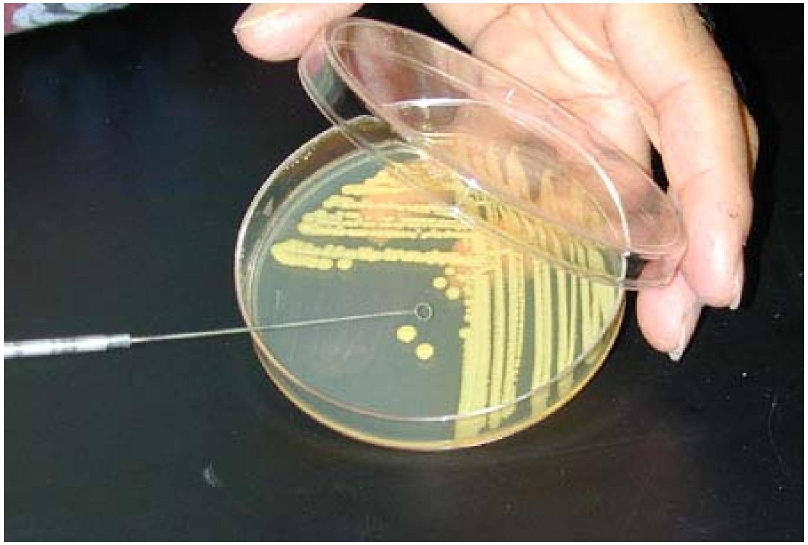


~3-7% of $PM_{2.5}$ was BPA

Coz et al, Atm Env, 2010

10^5 to 10^7 bacterial cells m^{-3} in the atmosphere

Bacteria may represent ≈ 40% of atmospheric organic C in PM_{10}
(Wiedinmyer et al. 2009)

>99% of bacteria are resistant to culturing, but we can use DNA analyses to survey bacterial diversity

Advances in DNA sequencing technologies (e.g. pyrosequencing) have revolutionized the field of microbial ecology.

In 2006:

$10,000 = 100 bacteria identified in each of 30 samples

In 2010:

$10,000 = 10,000 bacteria identified in each of 100 samples

Our Project – $PM_{10\text{-}2.5}$ Emissions Inventory

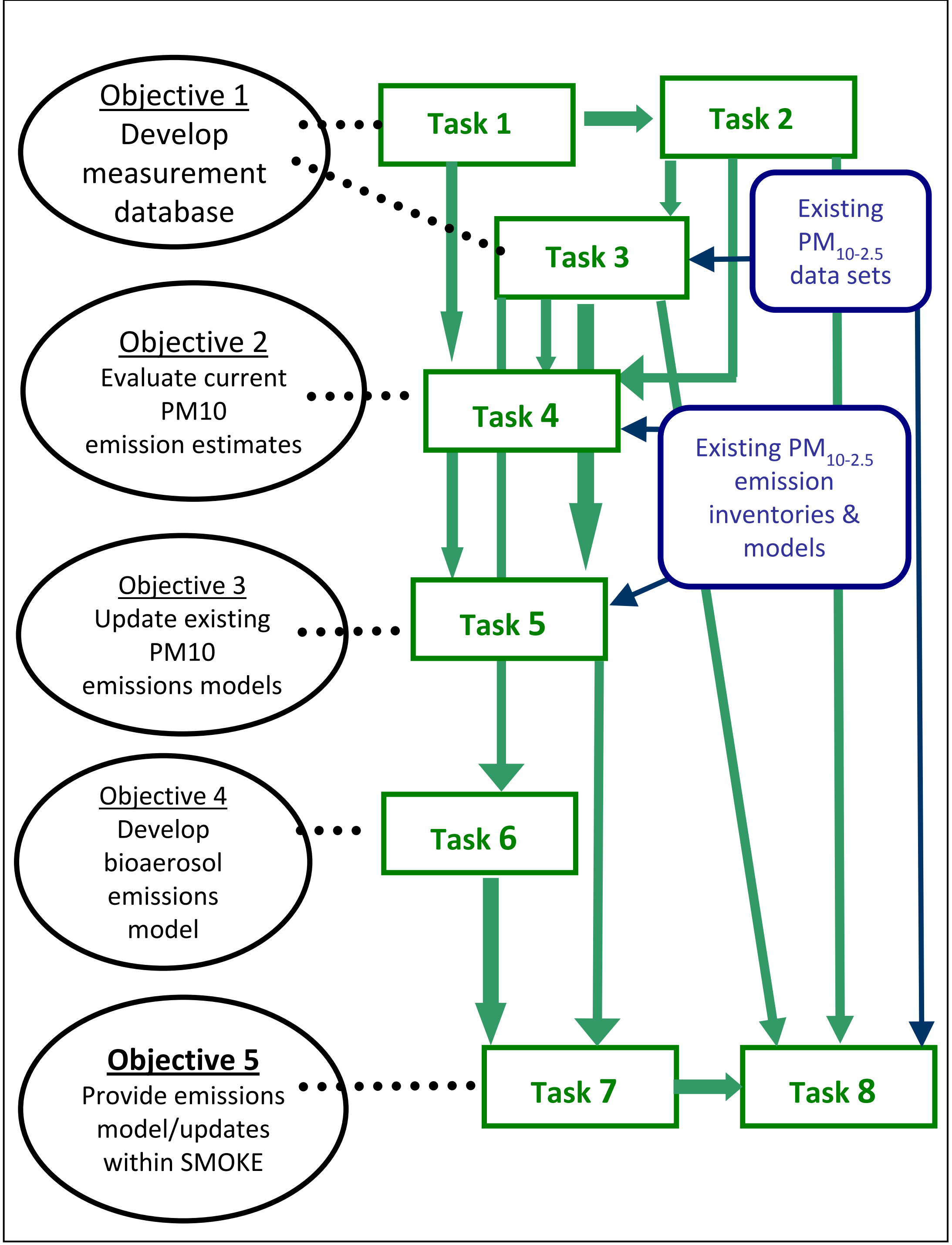
Objective 1. Develop a robust measurement database that will provide highly detailed information about $PM_{10\text{-}2.5}$ sources and controlling variables.

Objective 2. Evaluate current PM_{10} emissions models and identify informational gaps

Objective 3. Update existing PM_{10} emissions models to include more detailed controlling factors.

Objective 4. Develop an emissions module for direct biological particle emissions.

Objective 5. Package all updates and new models for use with the SMOKE emissions processing system.



Work Plan

Leverages CRUSH

Task 1. $PM_{10-2.5}$ collection

Task 2. $PM_{10-2.5}$ analysis

Task 3. $PM_{10-2.5}$ source apportionment

Task 4. Existing inventory evaluation

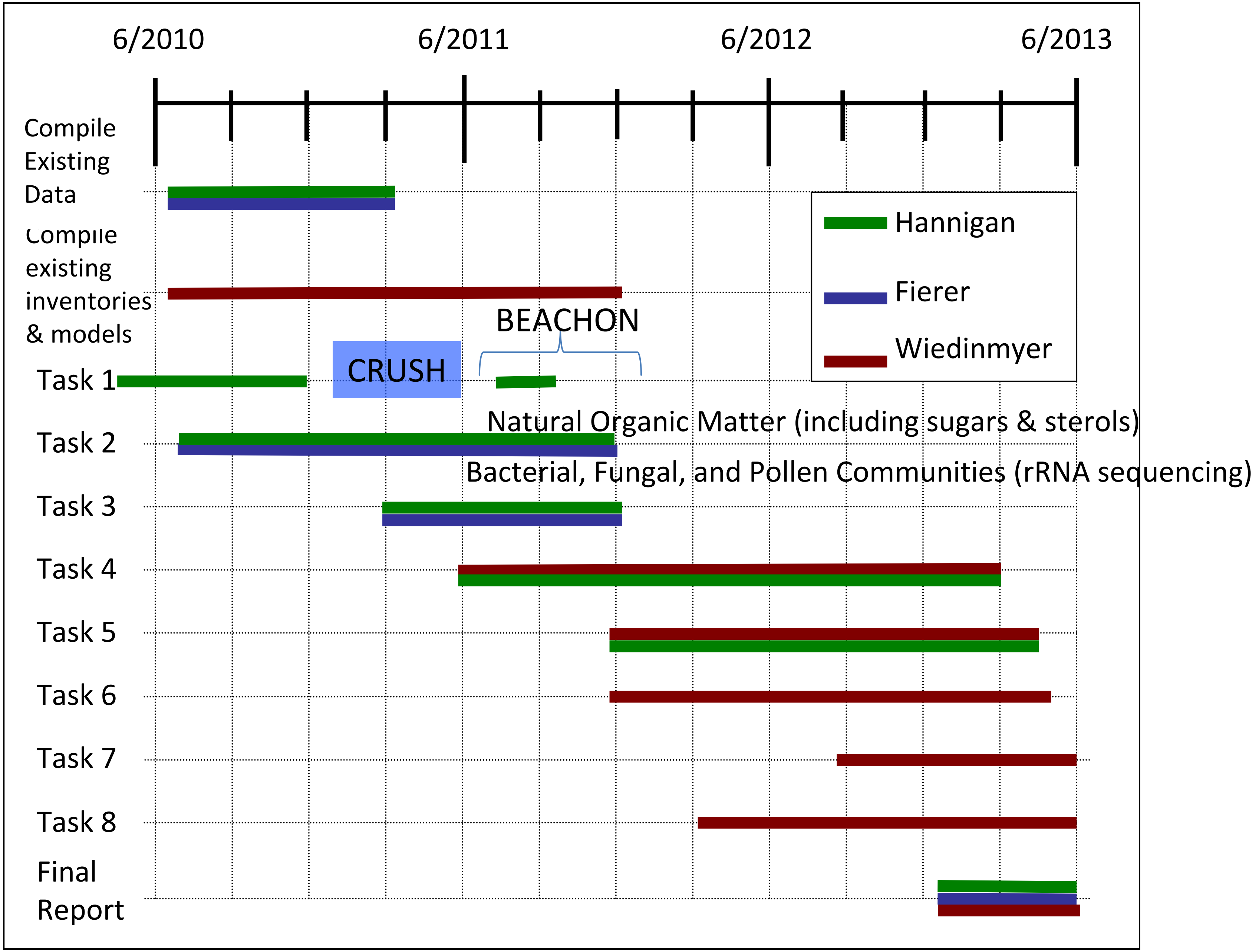
Task 5. Refine existing inventories

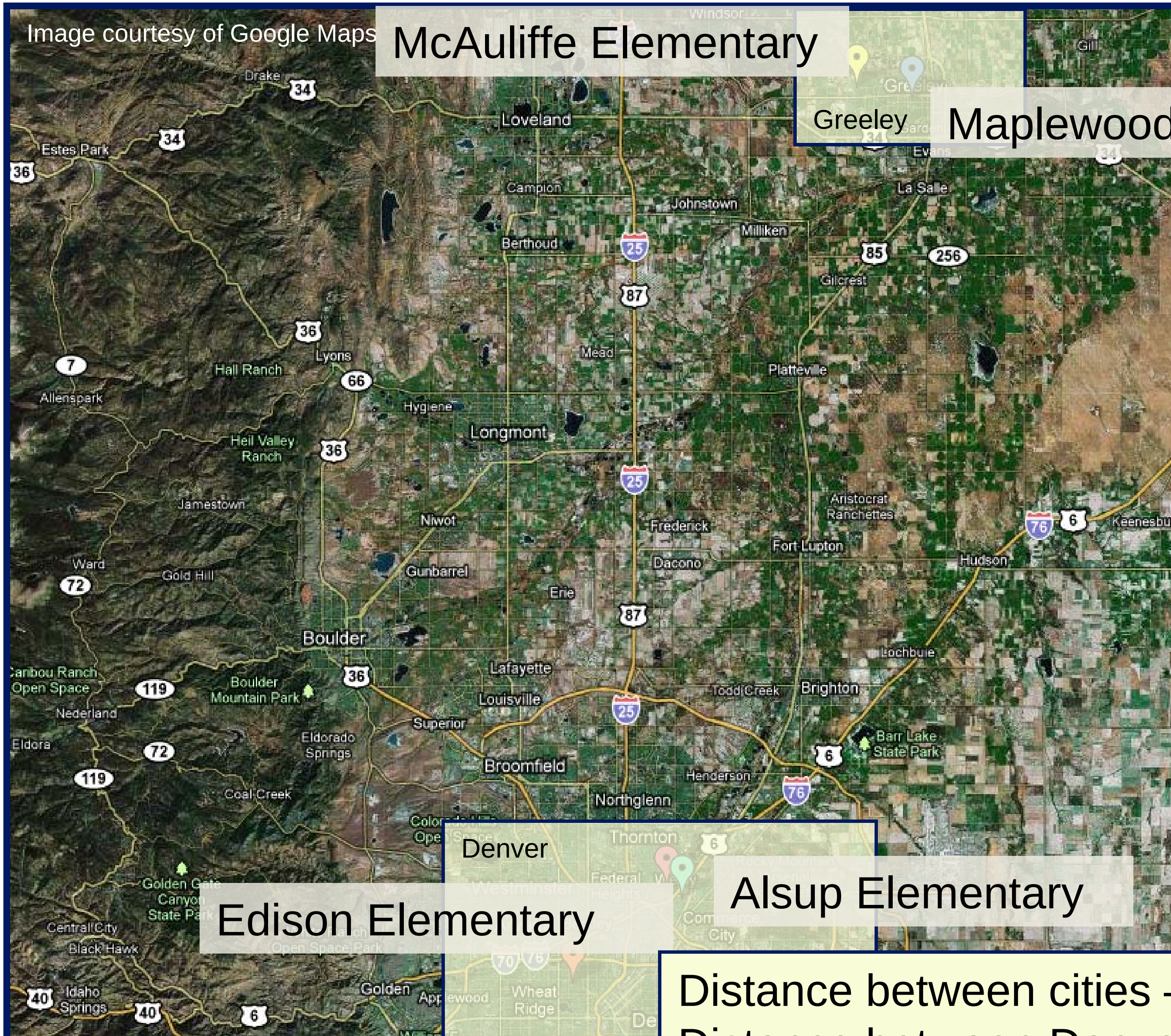
Task 6. Develop bioaerosol inventory

Task 7. Adapt inventories in SMOKE

Task 8. Assess new inventories

Task timeline with responsible person indicated





Distance between cities – 50 miles
Distance between Denver sites – 6 miles
Distance between Greeley sites – 3 miles

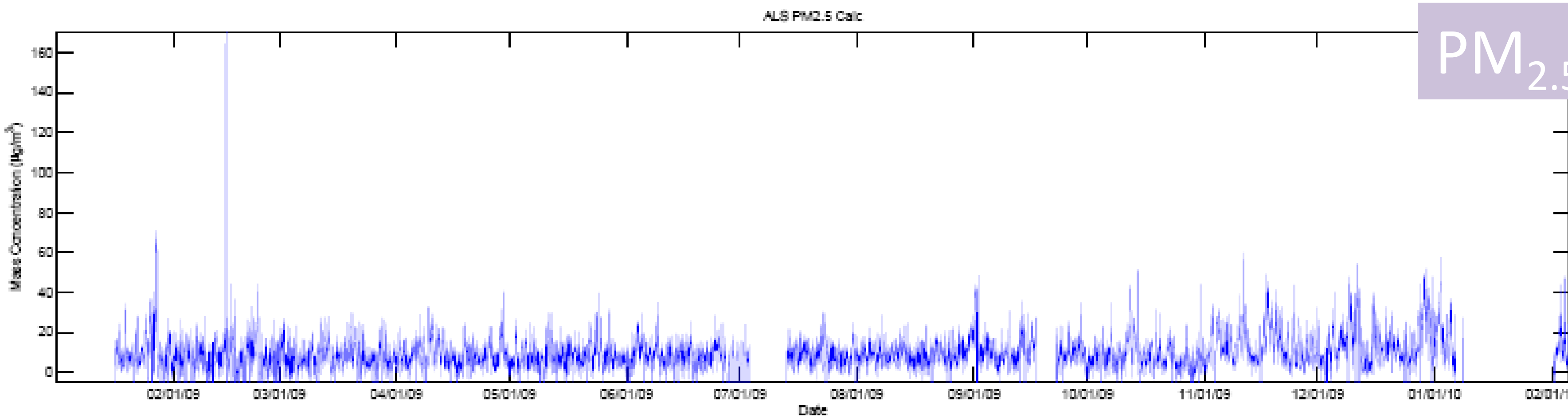
Monitoring/Collection Tools

TEOM 1405-DF

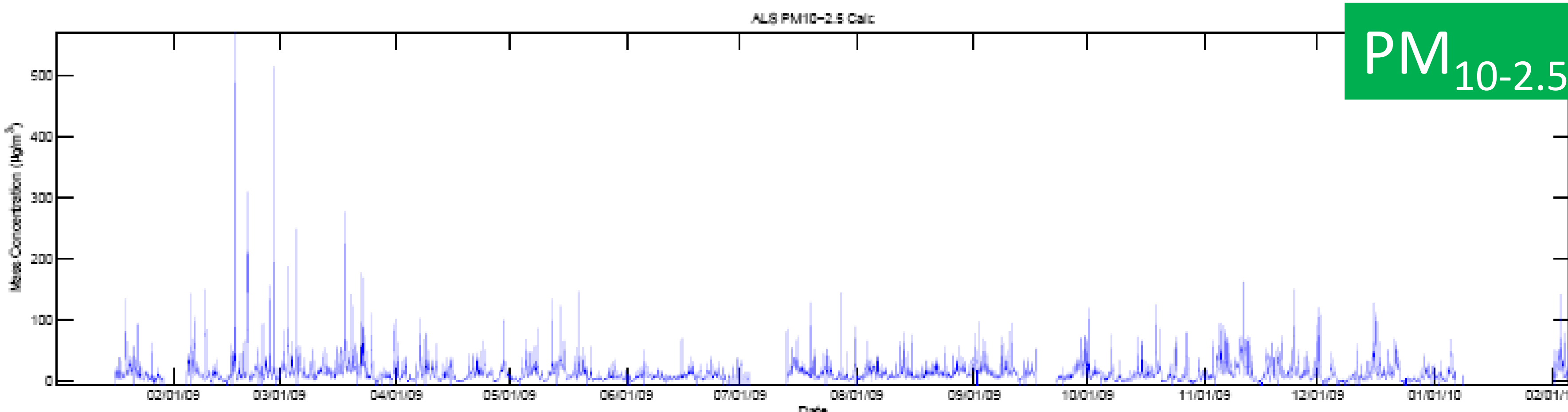
Mass Monitoring

Filter Collection

Time Series (hourly)



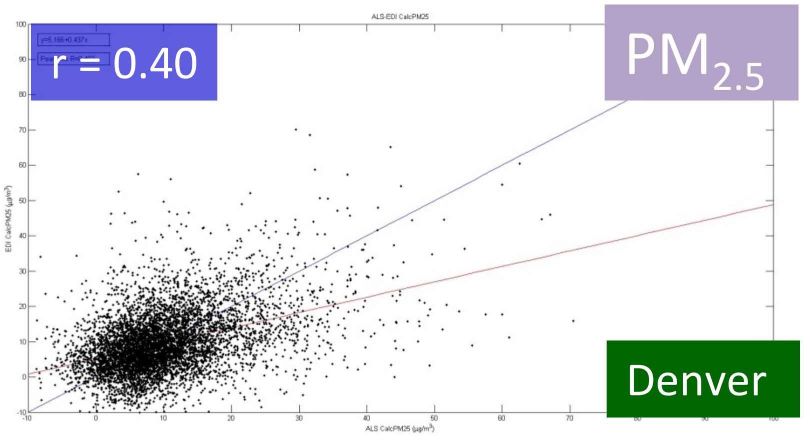
$PM_{2.5}$

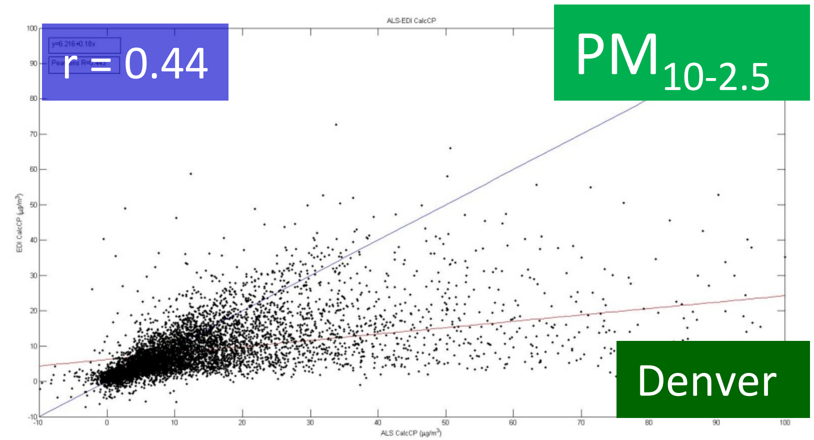


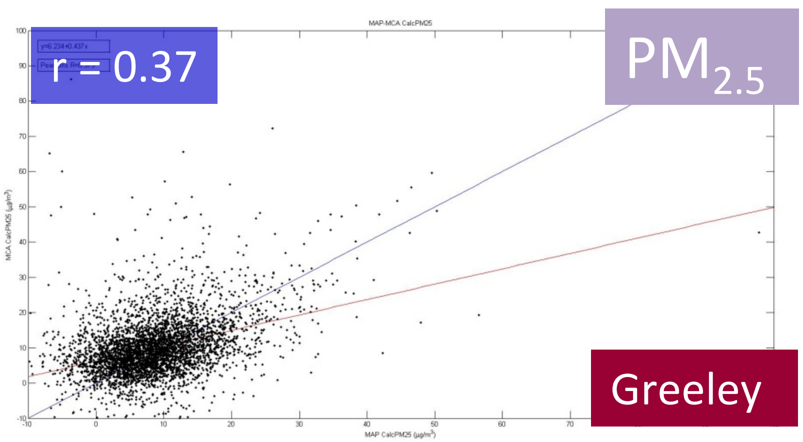
$PM_{10-2.5}$

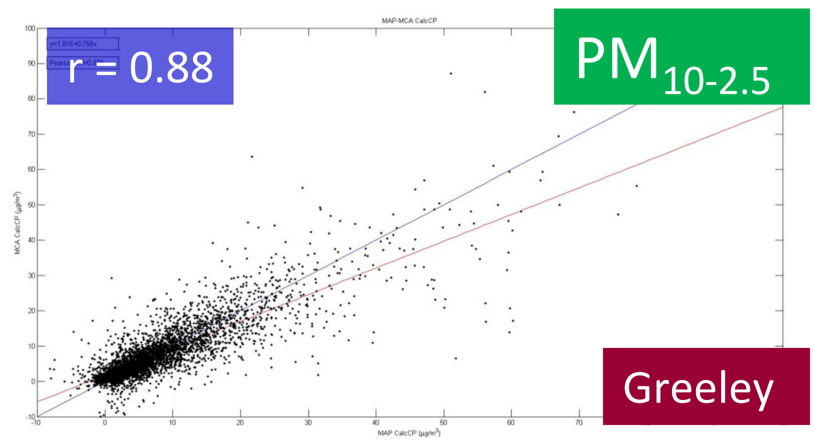
Alsup Elementary, Denver CSN site

Spatial Variability (hourly)

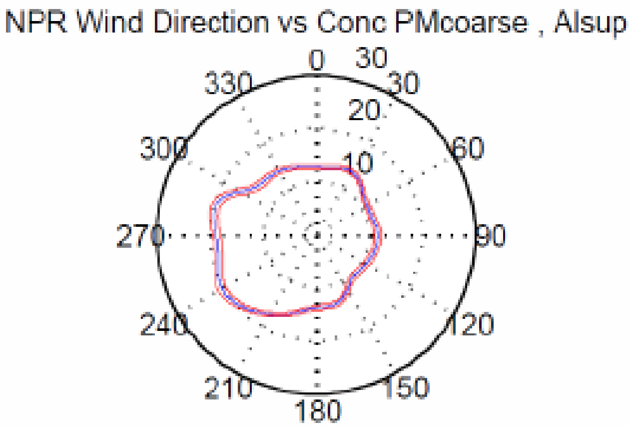


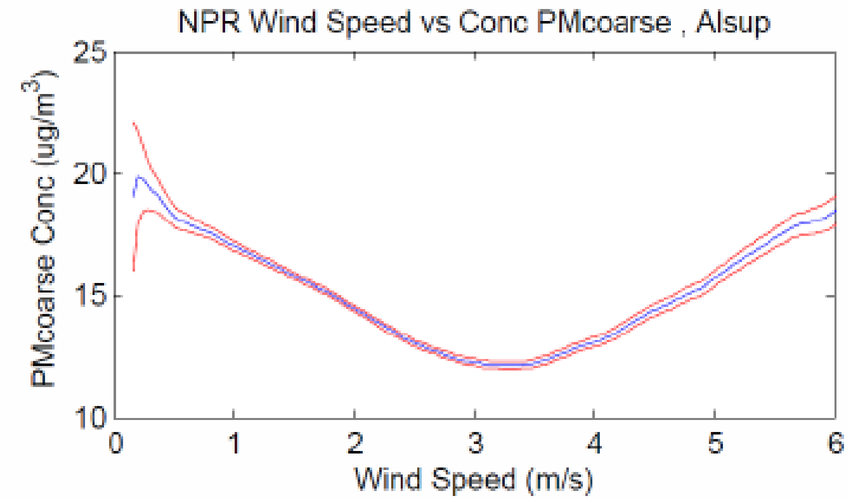




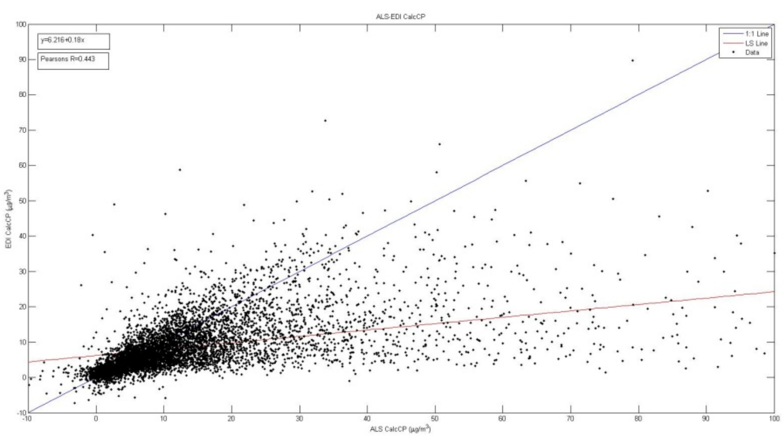


Denver $PM_{10-2.5}$

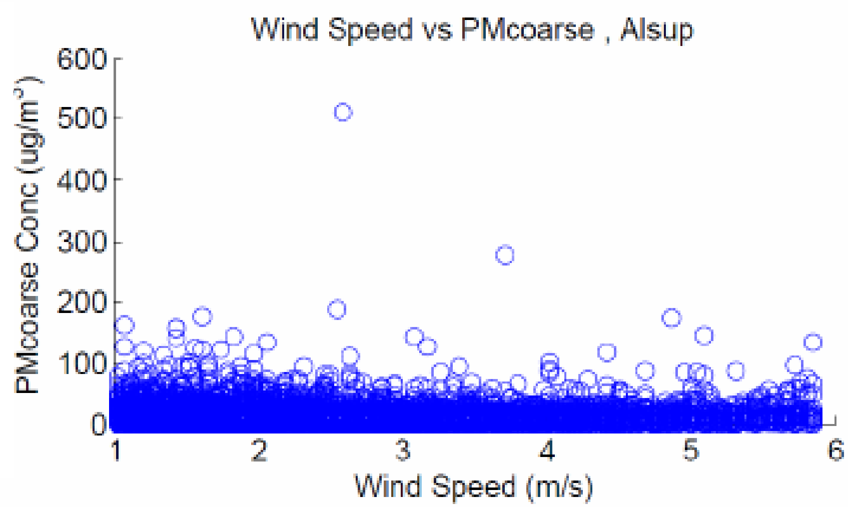




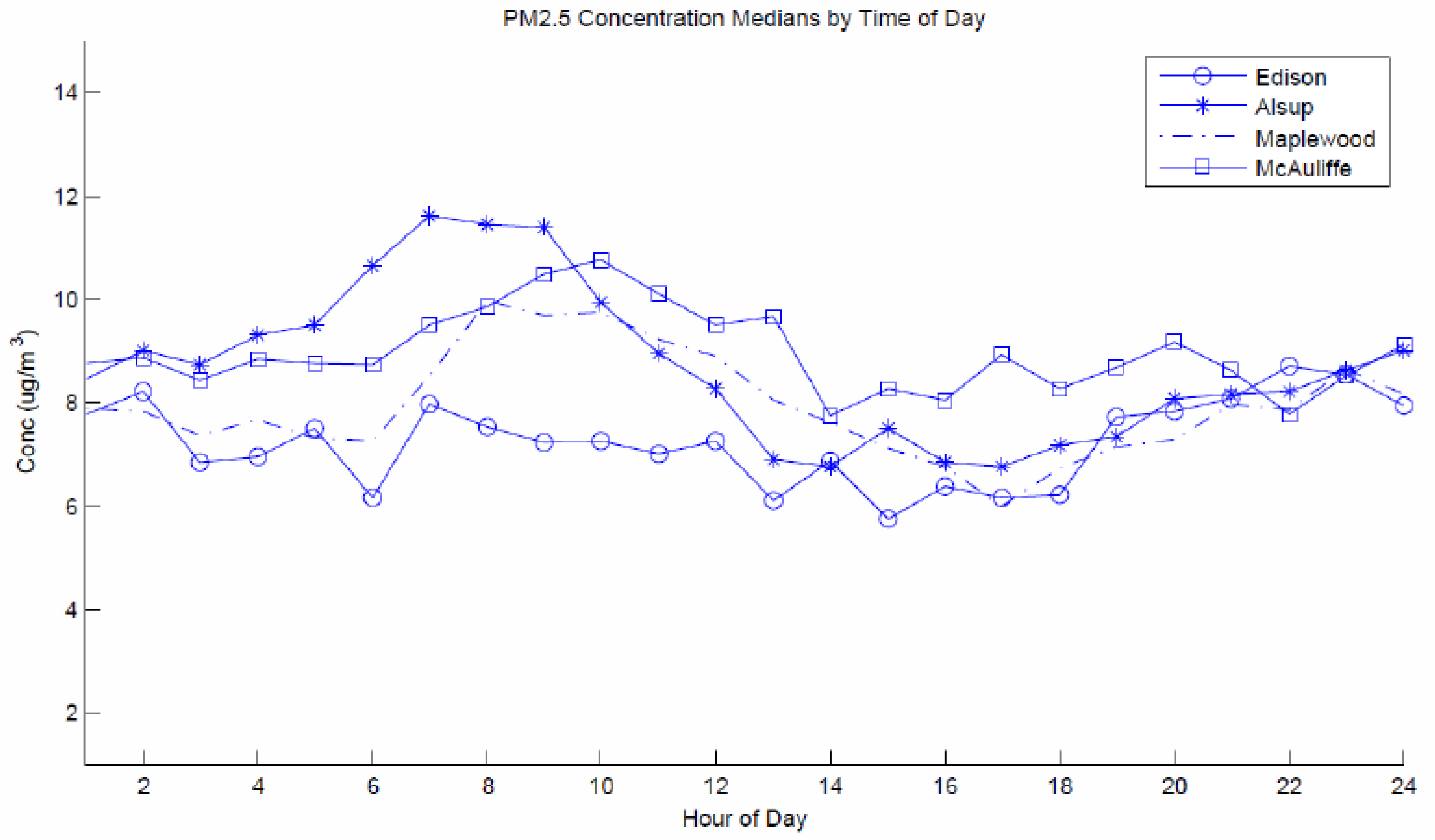
Edison Elementary



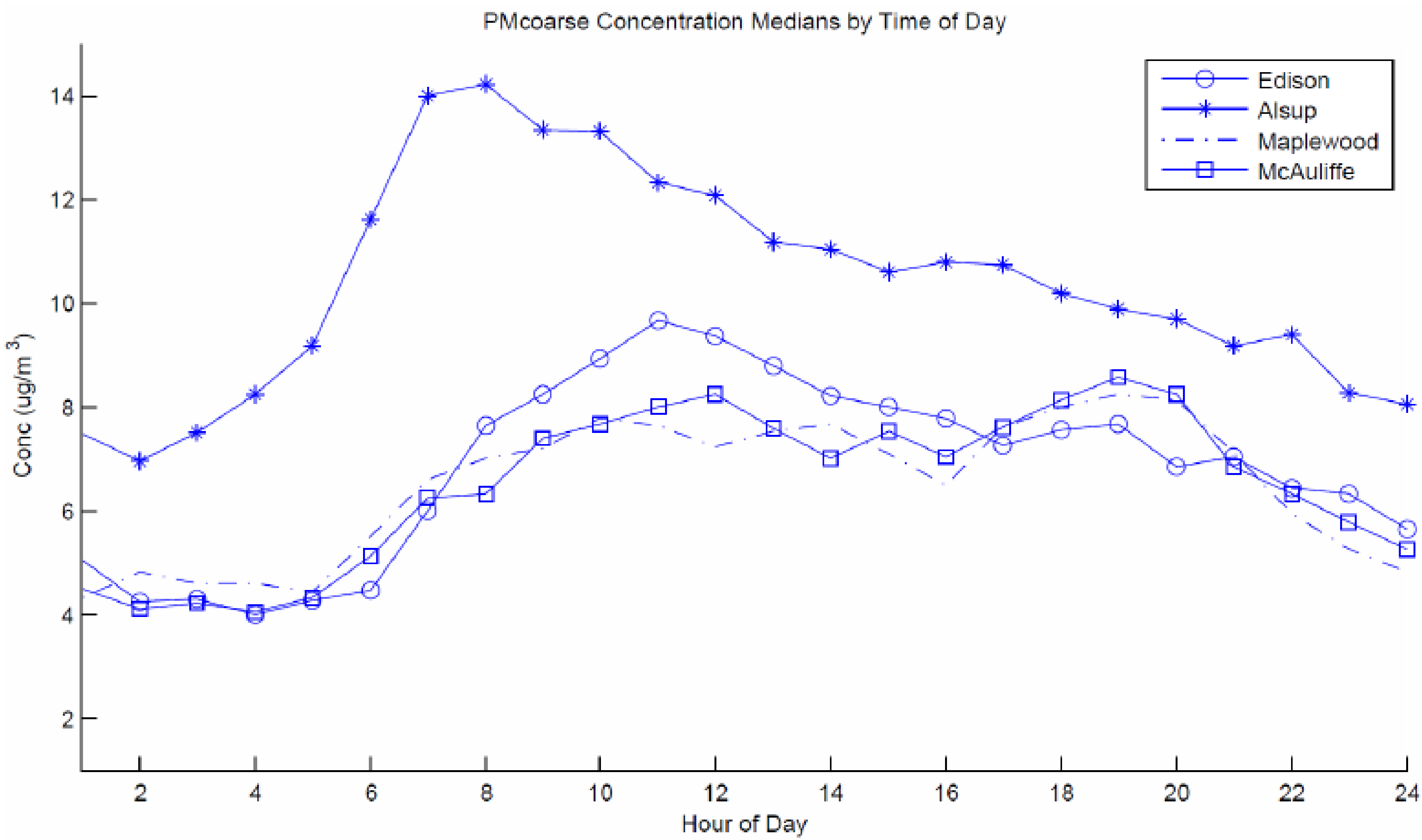
Alsup Elementary



Diurnal Variability, $PM_{2.5}$

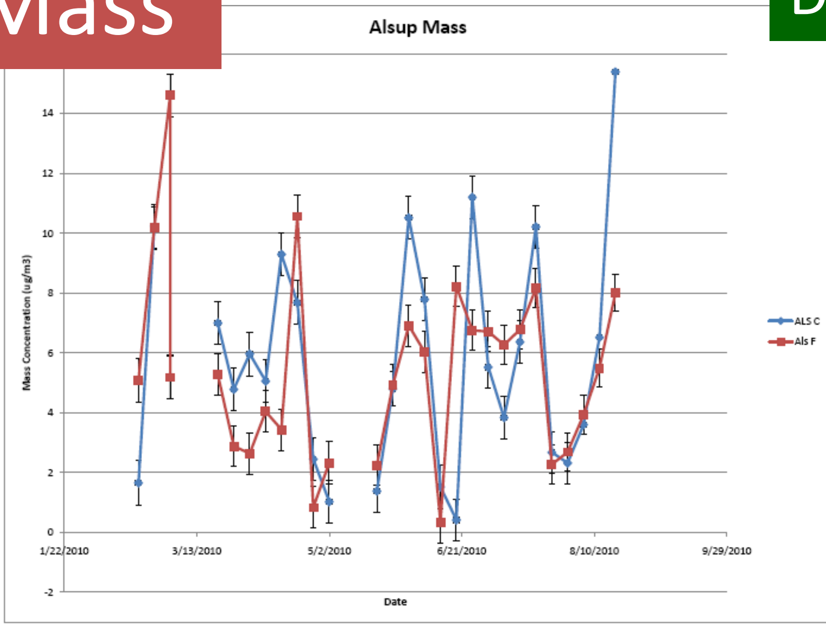


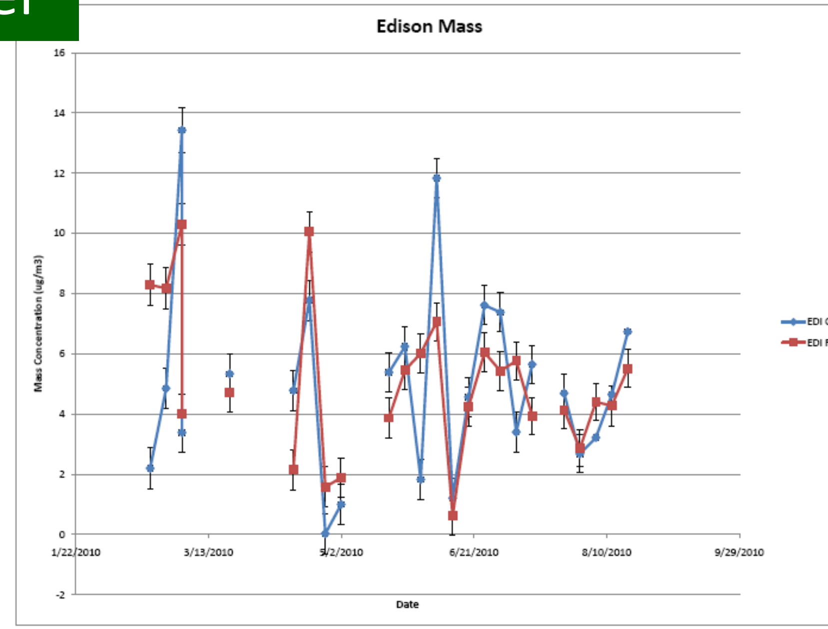
Diurnal Variability, $PM_{10-2.5}$



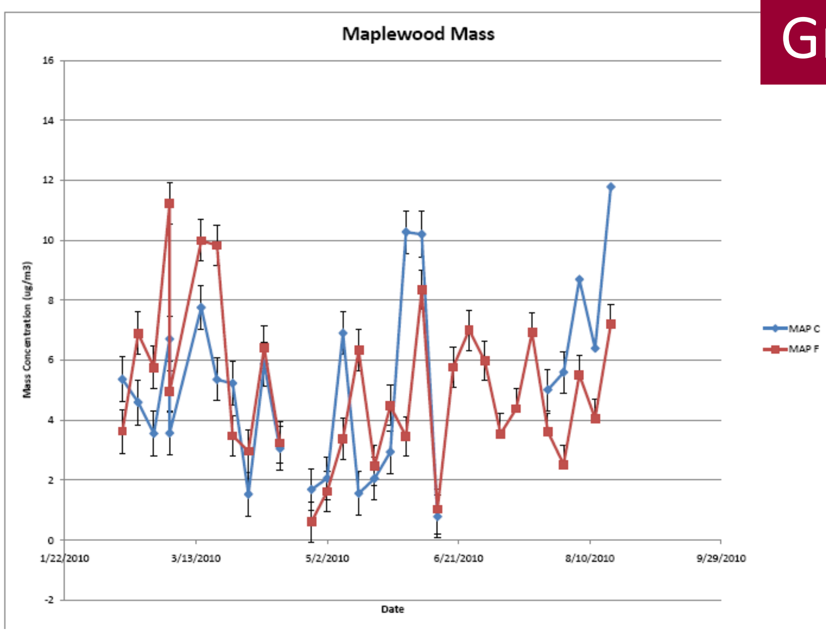
Mass

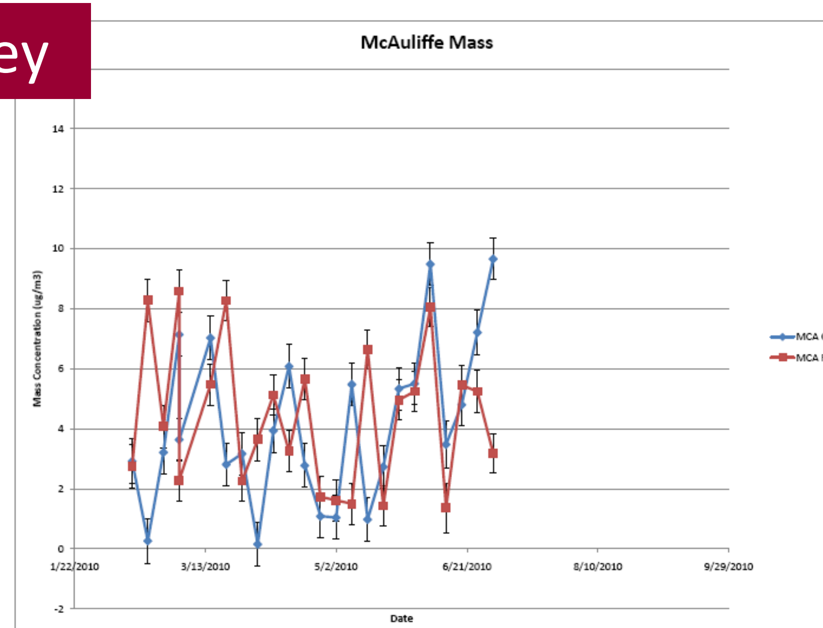
Denver



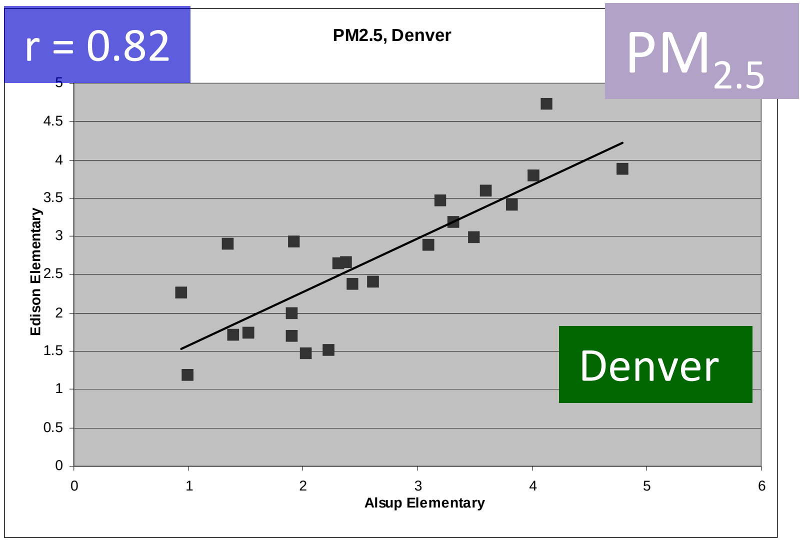


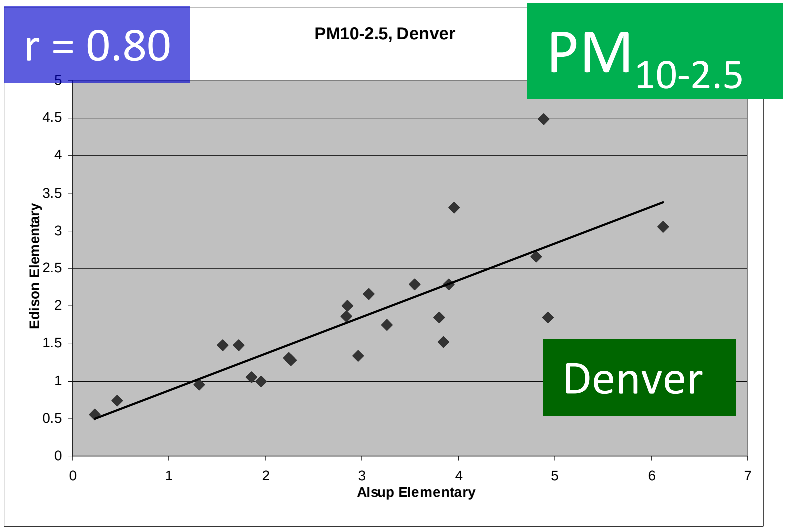
Greeley

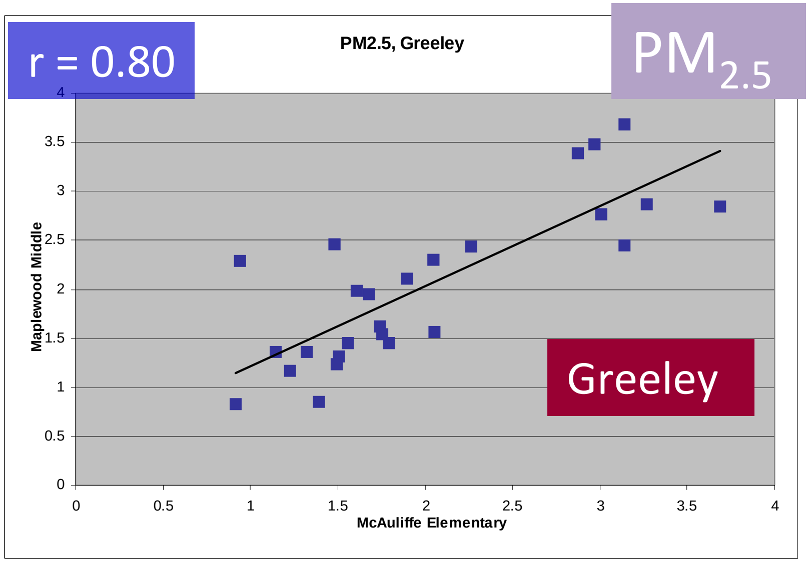


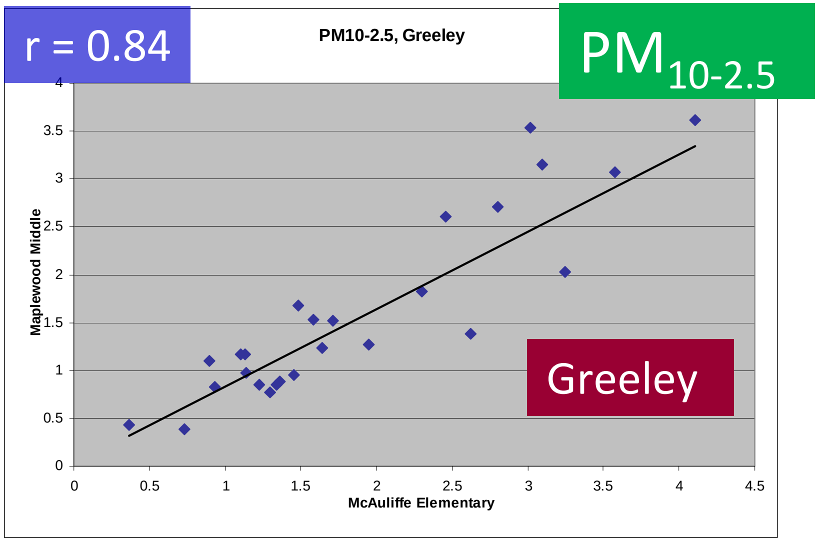


OC Spatial Variability (daily)

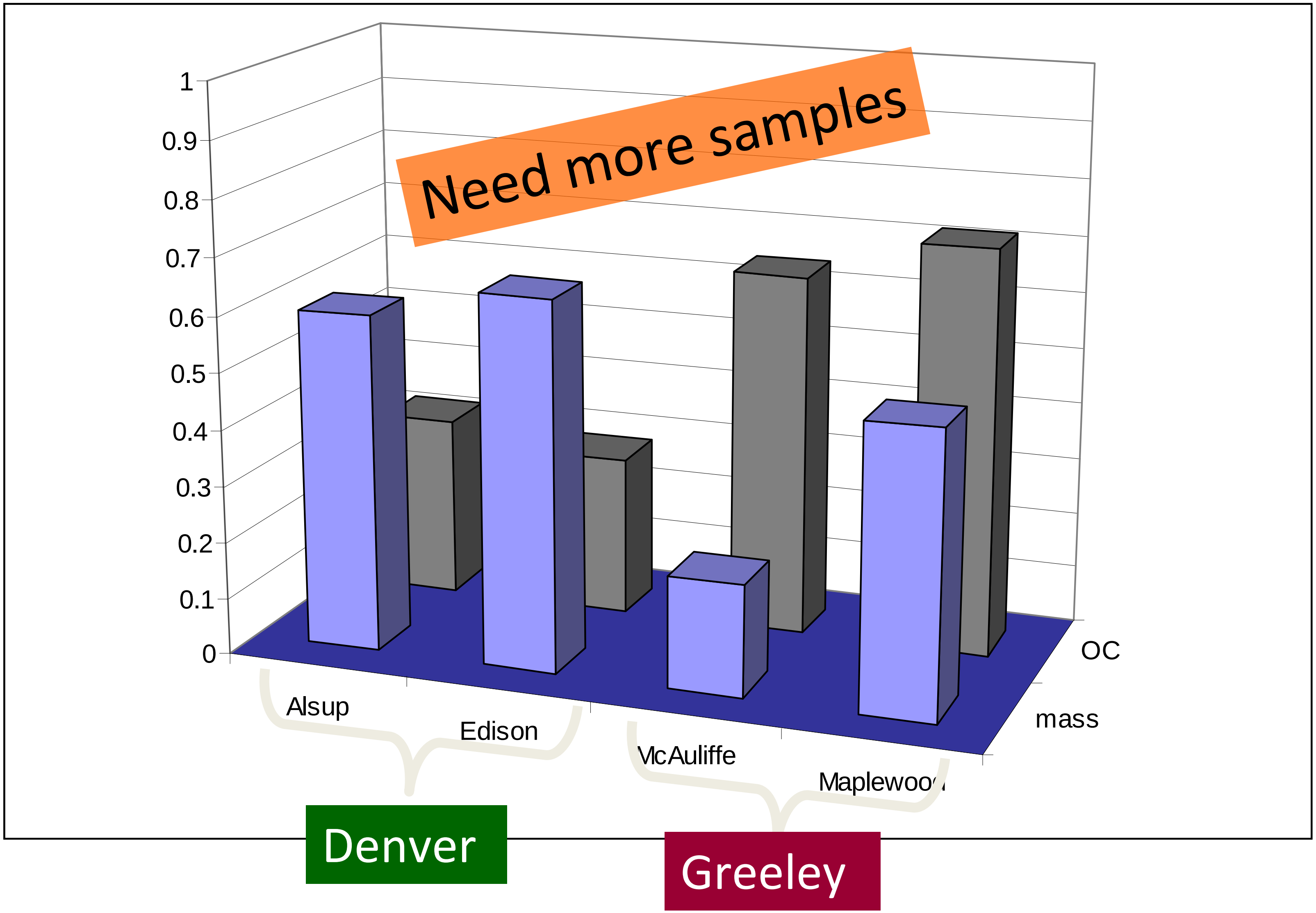




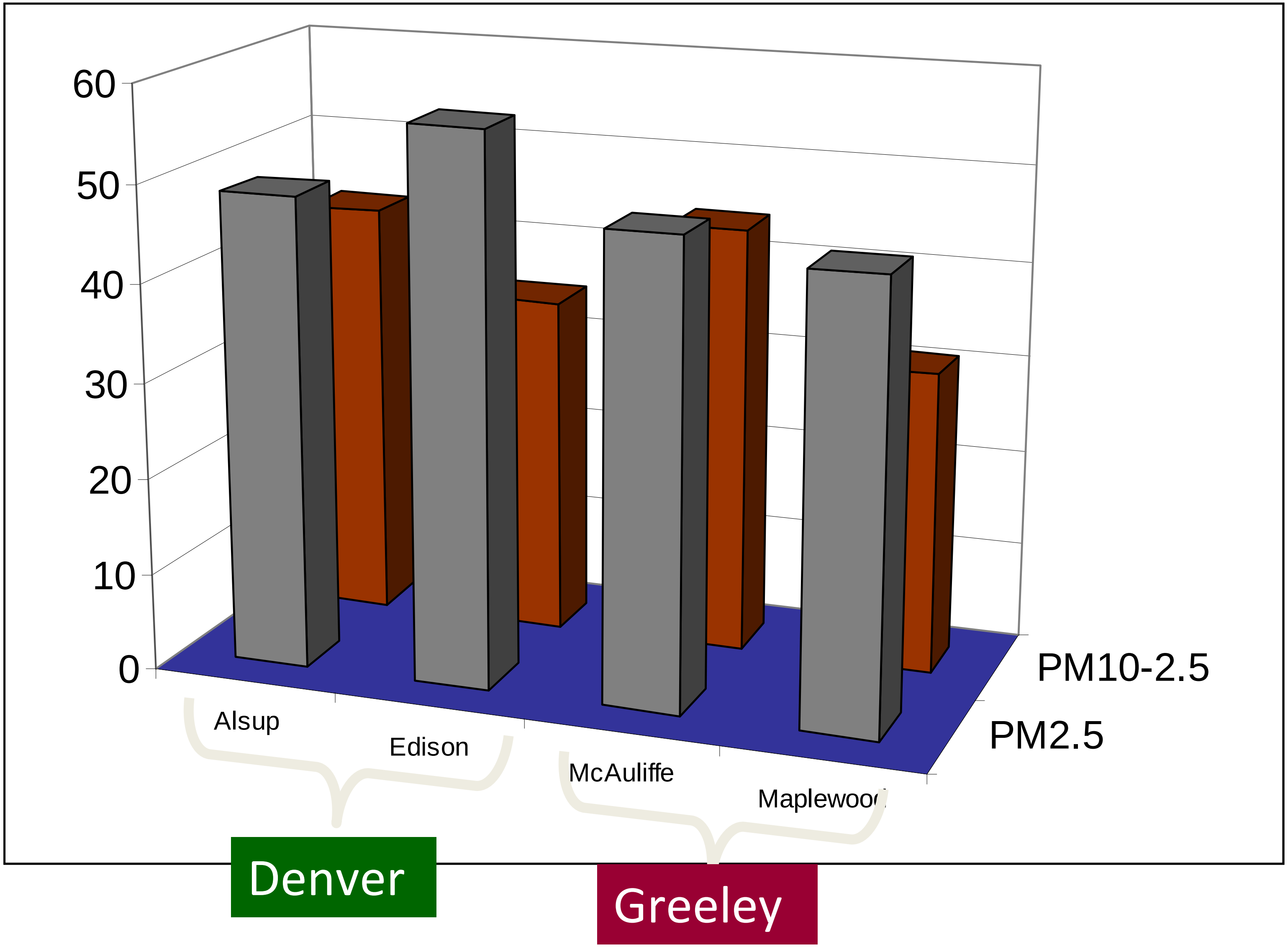




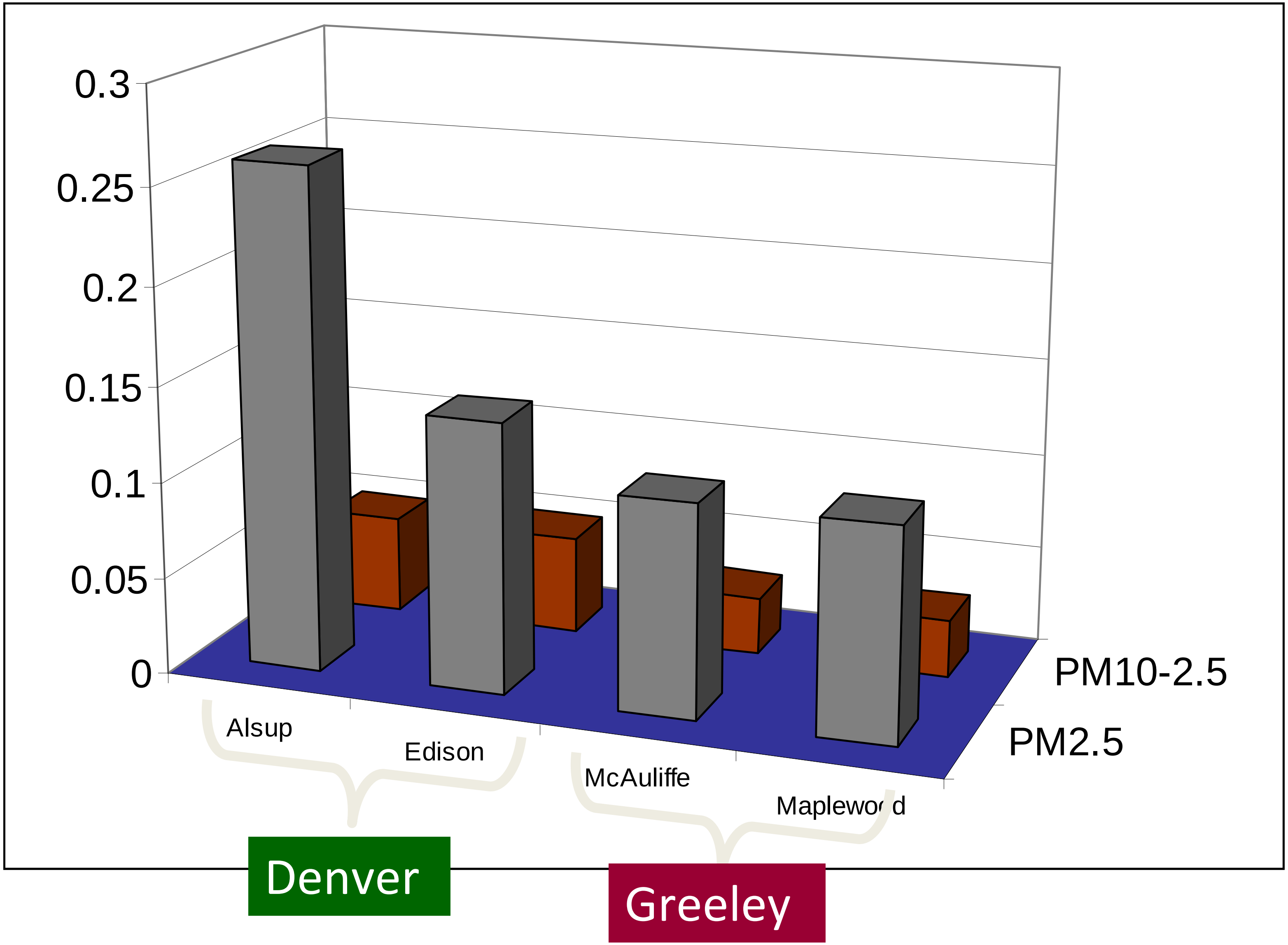
Correlation between sizes



OC as % of Total Mass

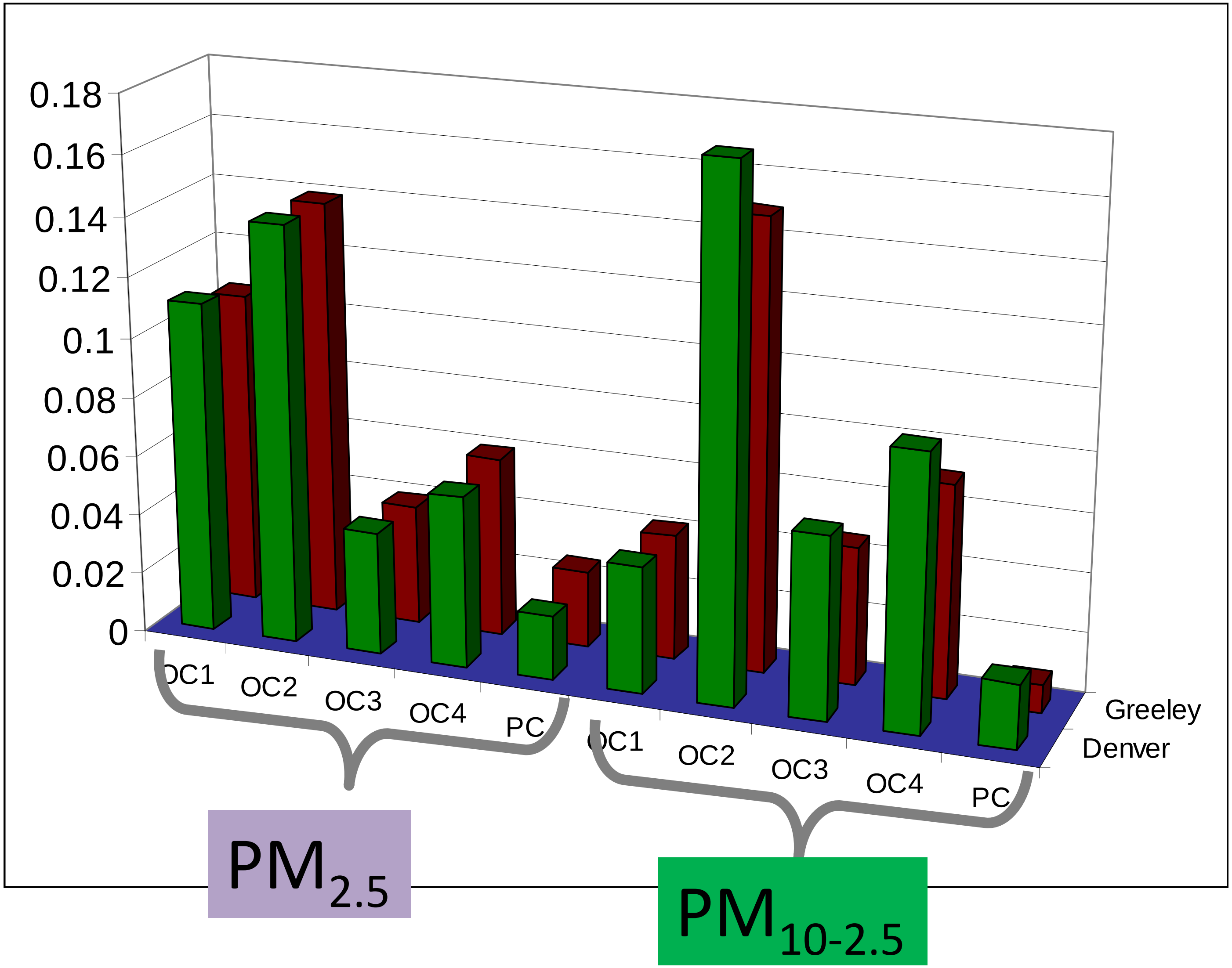


EC/OC

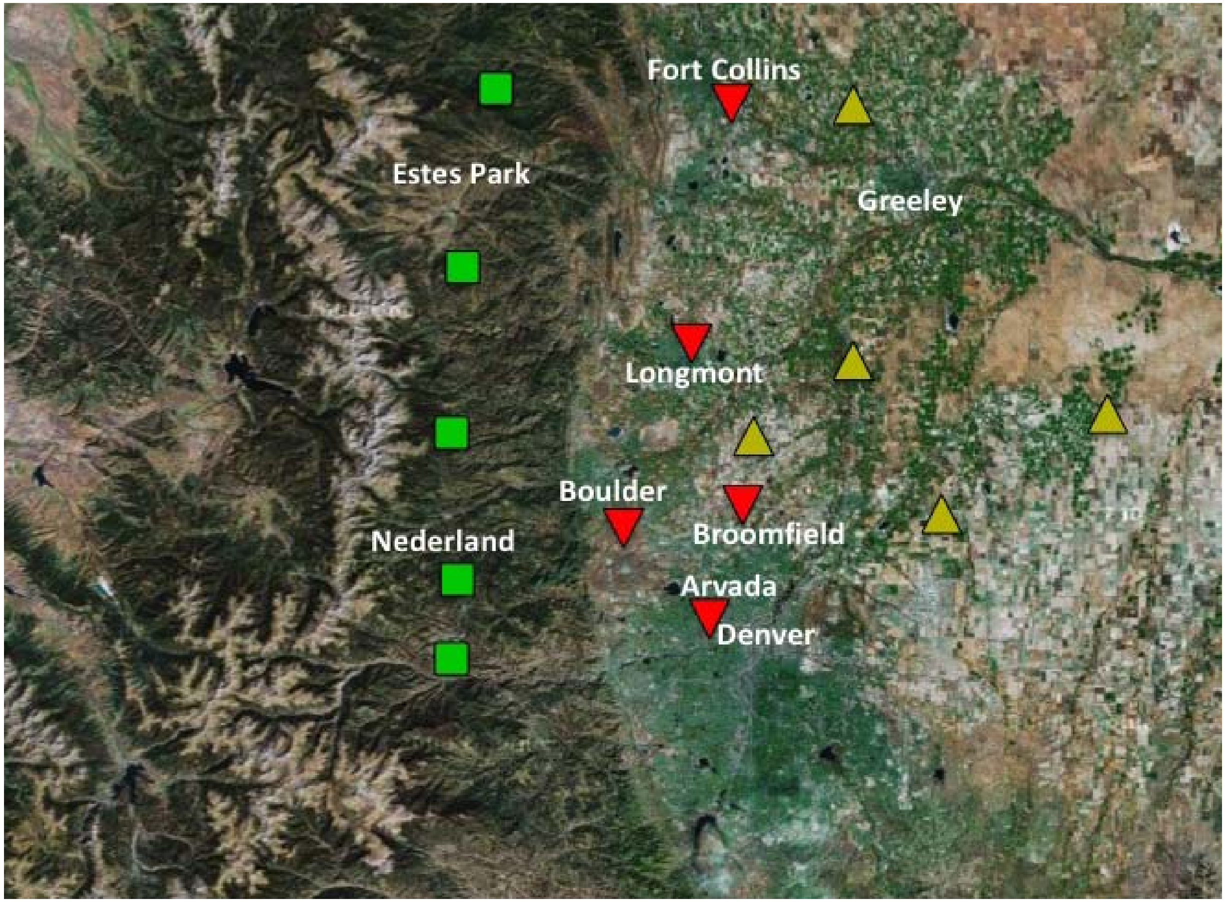


0.3
0.25
0.2
0.15
0.1
0.05
0
PM10-2.5
PM2.5
Alsup
Edison
McAuliffe
Maplewood
Denver
Greeley

OC Volatility

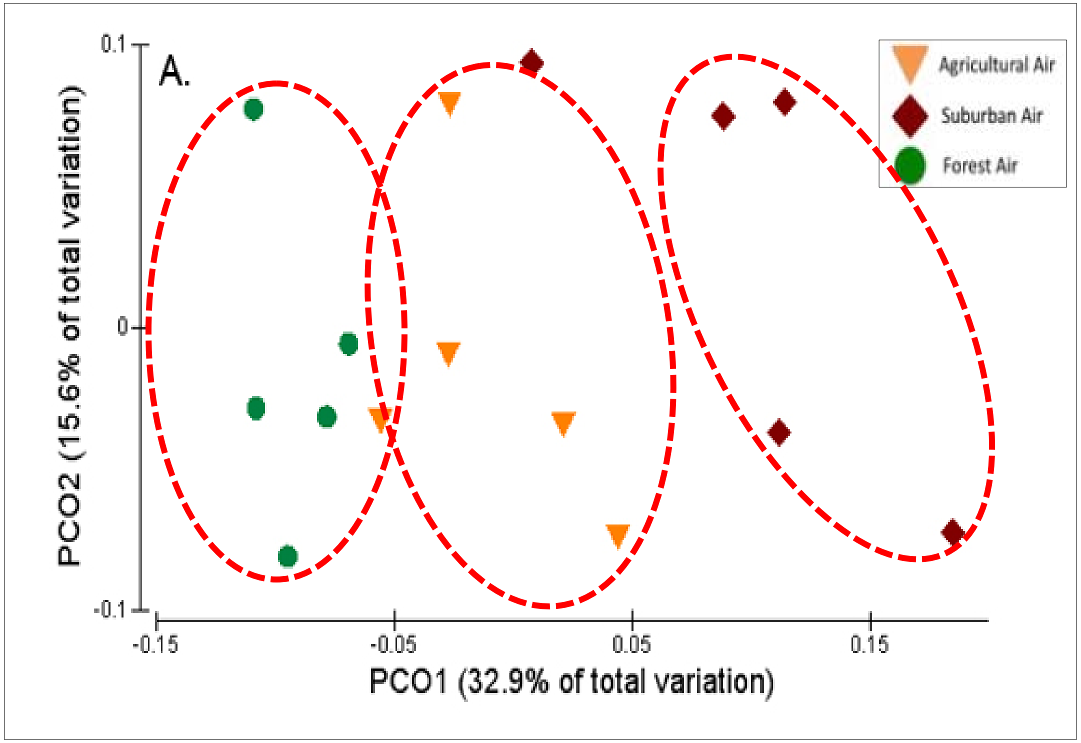


Land-Use Effects on Airborne Bacterial Communities (a snapshot during the summer)



Agriculture
City
Forest

Bowers et al. *In Press*. ISME Journal



Groups	F or t-stat	P	Den. Df
Main Effect	2.999	0.001	12
Ag, City	1.5064	0.02	8
Ag, Forest	1.3723	0.015	8
City, Forest	2.1423	0.009	8

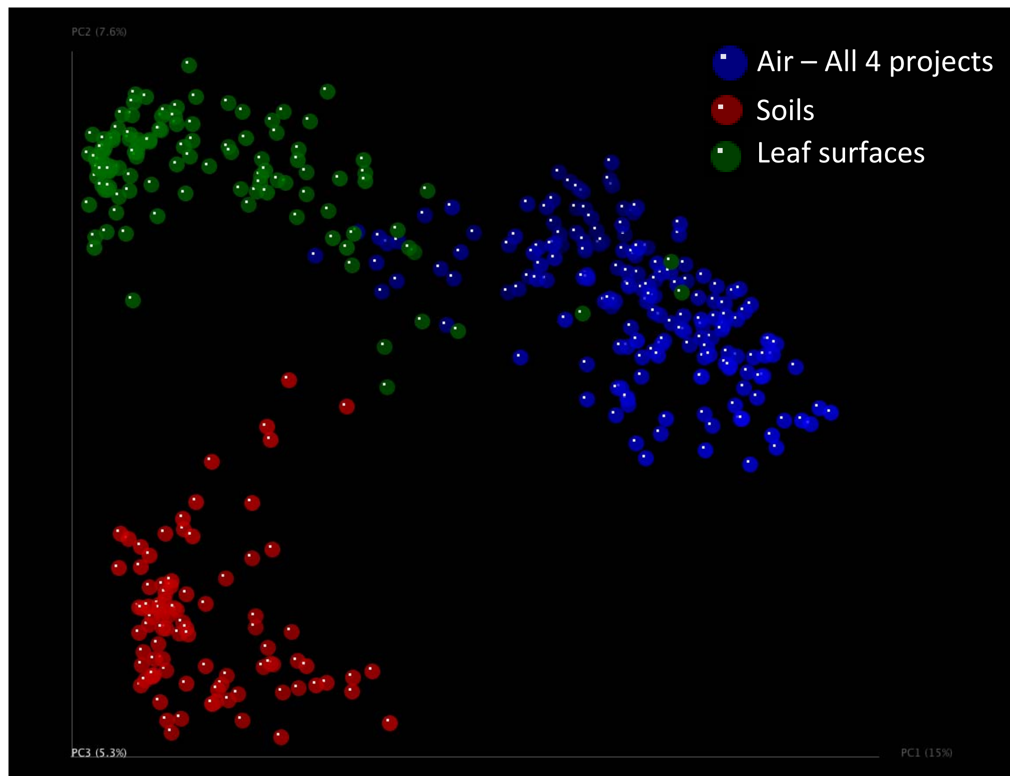
Agriculture ▲
City ▼
Forest ■

Atmosphere

Soil (dust)

Leaf surfaces

Source tracking via analysis of airborne bacterial communities



Modeling Coarse Particles & Biological Components

Use existing models of fugitive dust from agricultural activities from CARB, EPA, WRAP…