Why?

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

Epidemiological evidence of effects of coarse airborne particles on health

B. Brunekreef* and B. Forsberg#

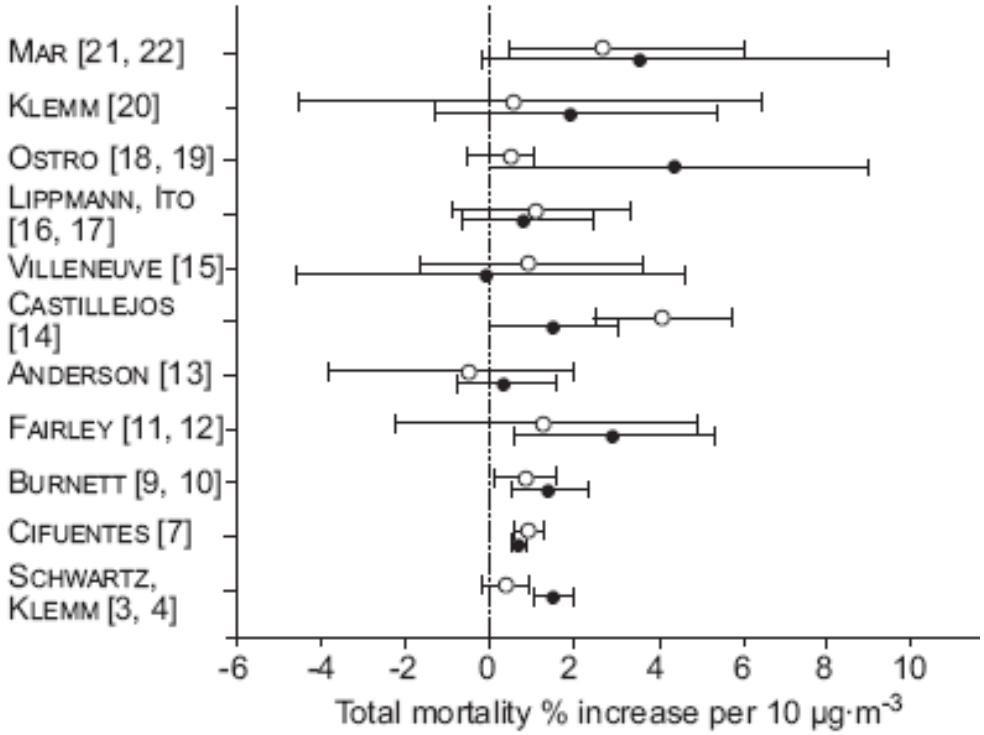


FIGURE 1. Effect of fine (●) and coarse (○) particles on total mortality published time series studies.

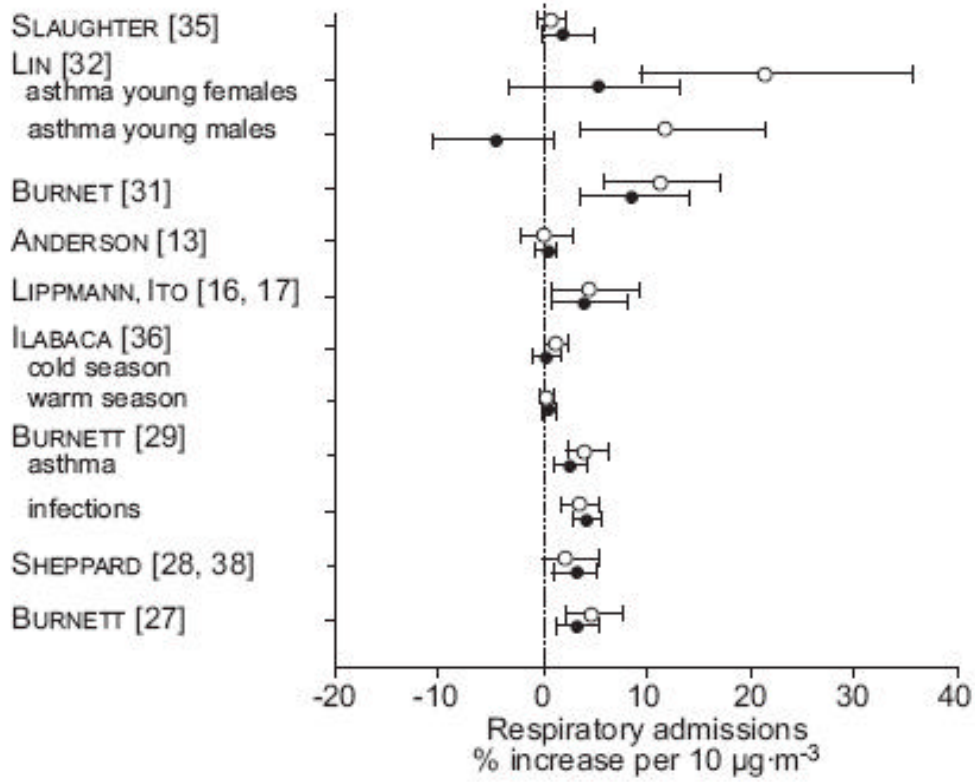


FIGURE 2. Effect of fine (●) and coarse (○) particles on respiratory admissions in published time series studies.

Challenges

- Reproducible effect?
- Urban effect only?
- Spatial heterogeneity?

Health Effects & Characterization of Urban and Rural PM_{coarse} in NE Colorado

CU – M. Hannigan, J. Milford, S. Miller

CSU – J. Peel

Mines – W. Navidi

UWisc – J. Schauer

UWash – S. Vedal

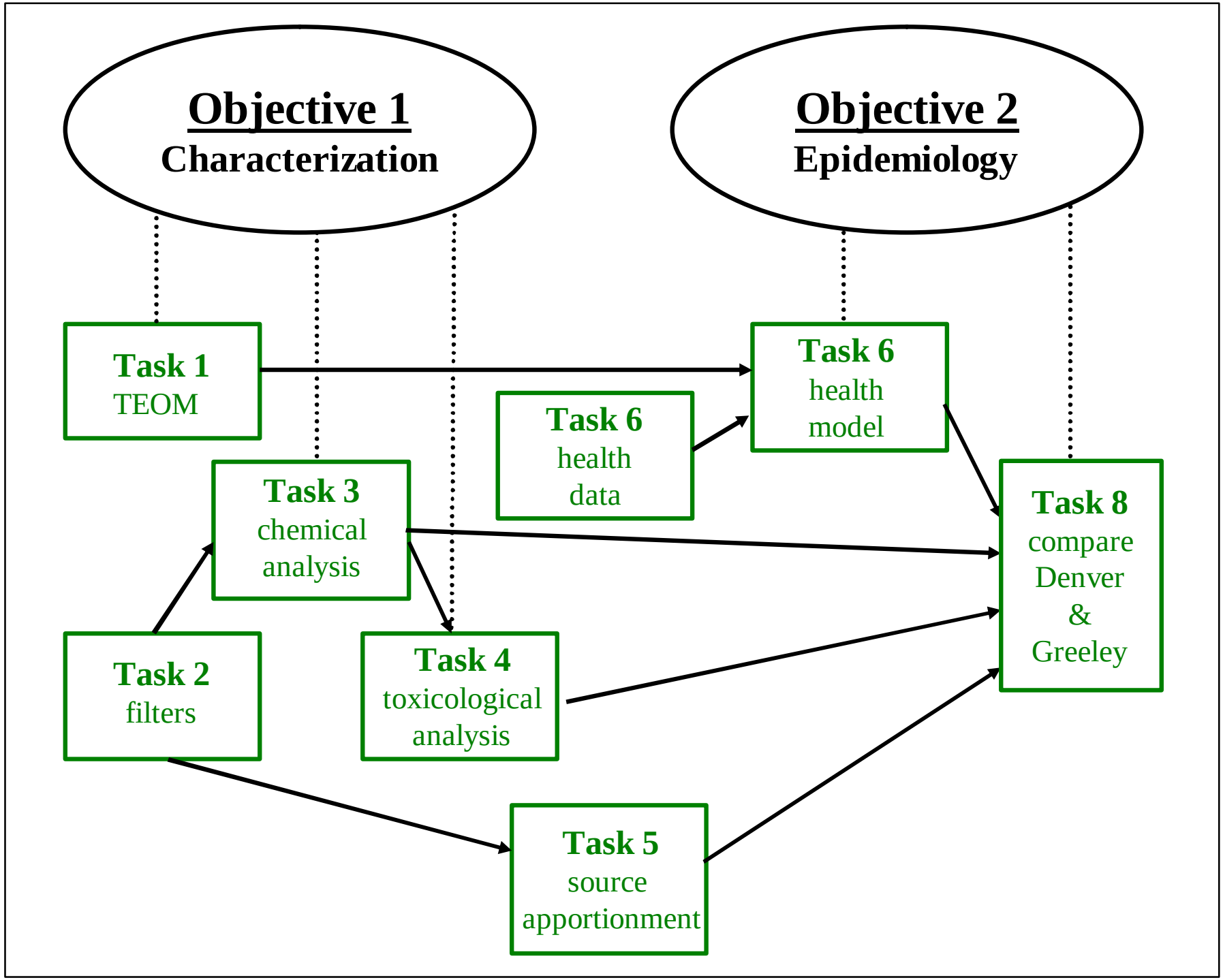
What are we going to do?

Objective 1 (Characterization)

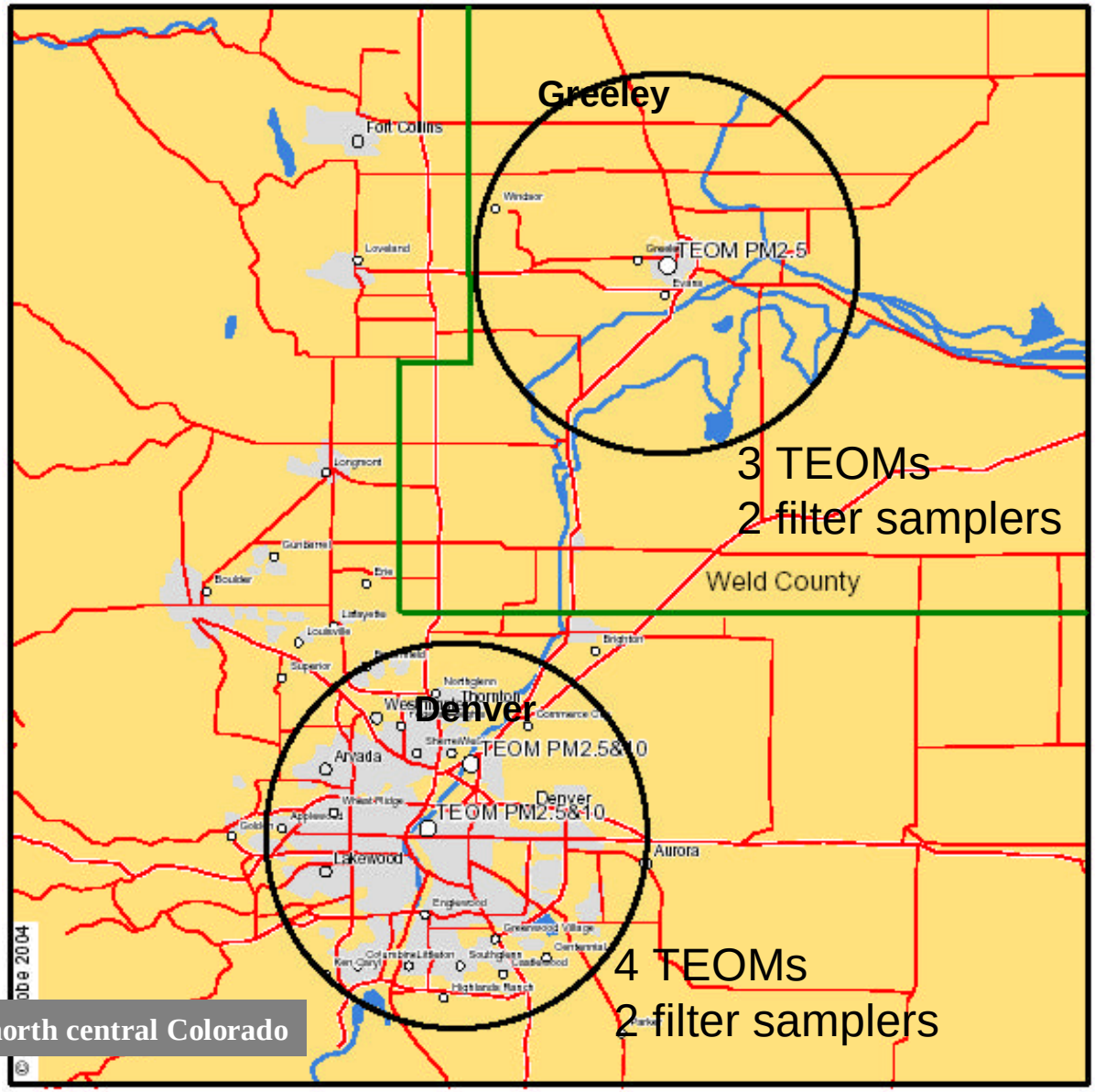
Characterize PM_{coarse} mass, composition, toxicity, and origin in Denver and Greeley

Objective 2 (Health Effects)

Evaluate the association of PM_{coarse} mass and several health outcomes in Denver & Greeley

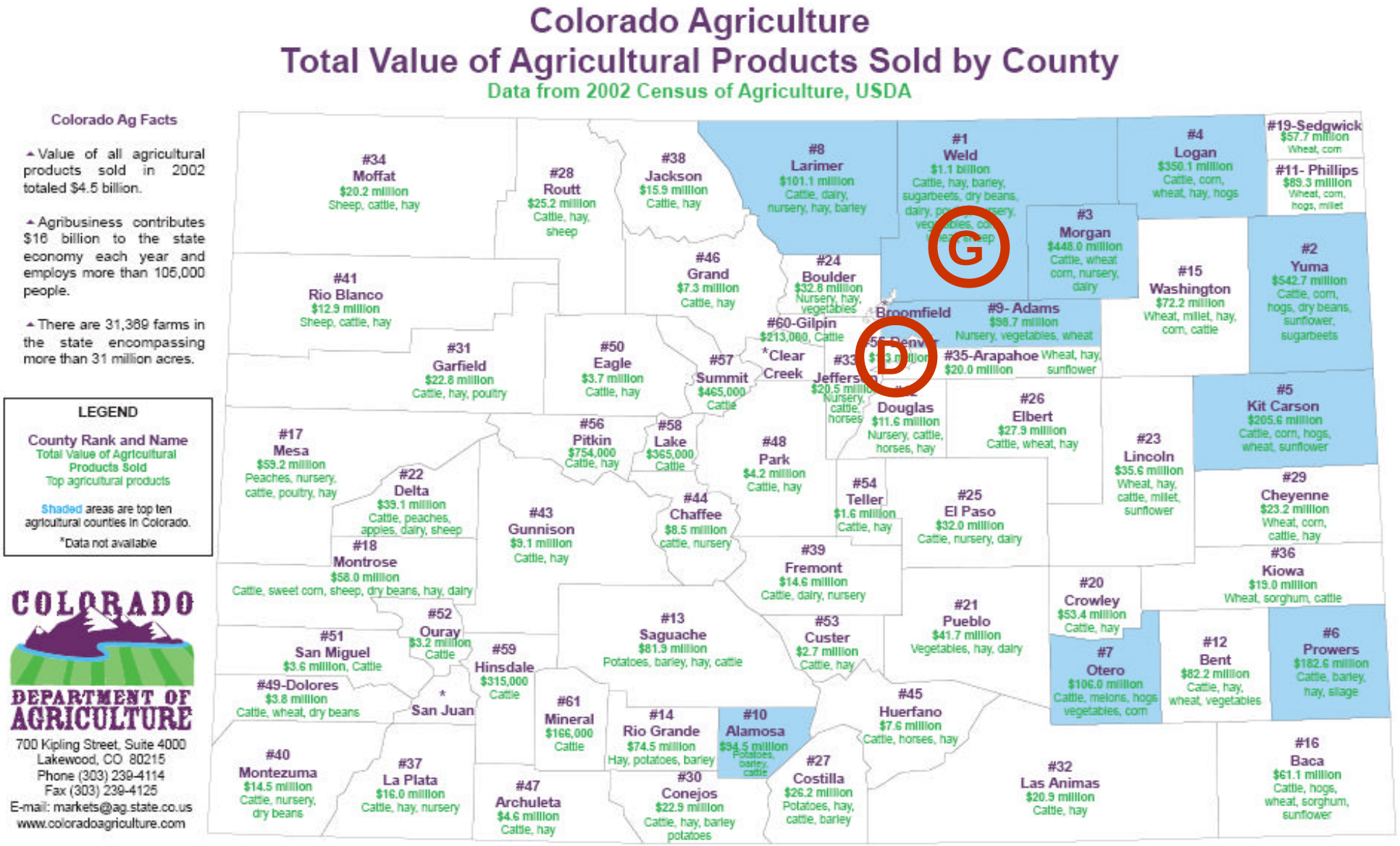

Objective 1
Characterization
Objective 2
Epidemiology
Task 1
TEOM
Task 6
health
model
Task 6
health
data
Task 3
chemical
analysis
Task 8
compare
Denver
&
Greeley
Task 2
filters
Task 4
toxicological
analysis
Task 5
source
apportionment

Our Lab
Urban – Rural Comparison

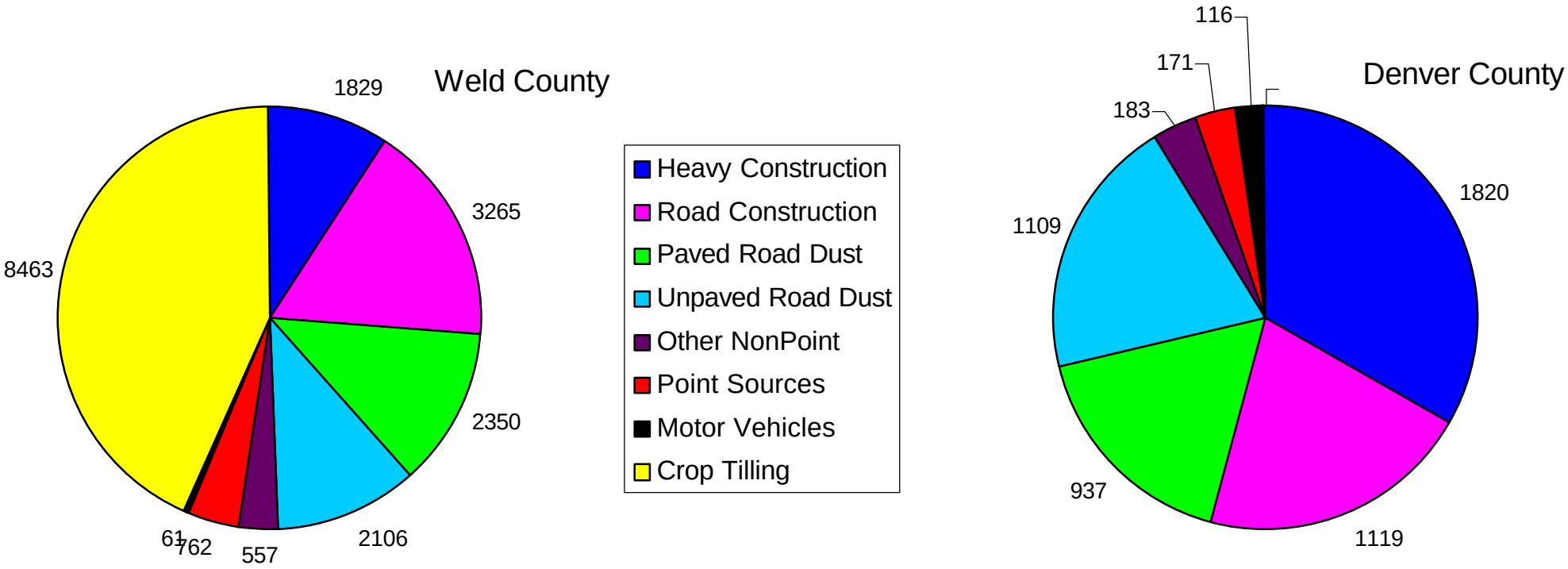


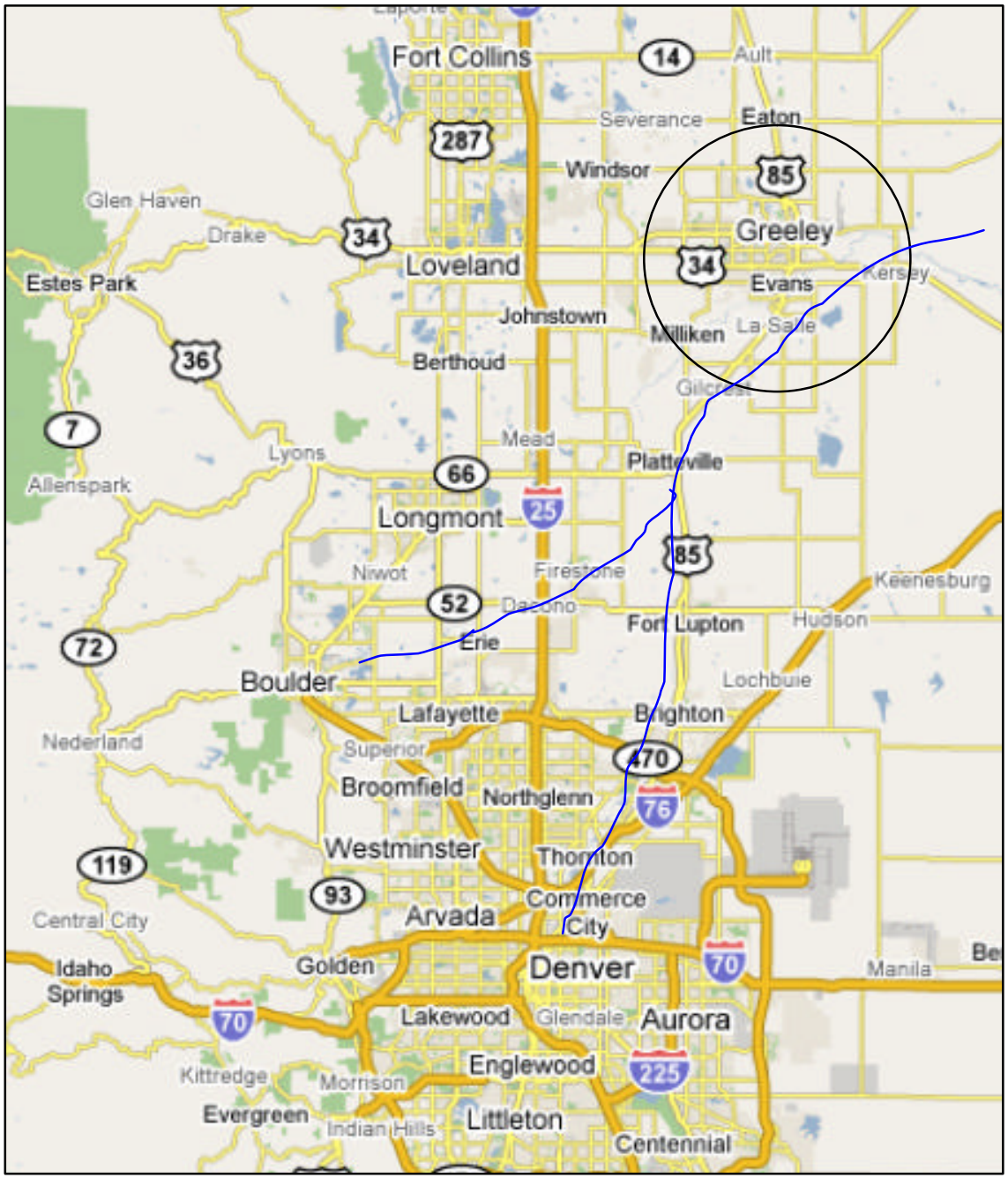
Map of study areas in north central Colorado

Greeley is the Weld County seat.
Weld County is the #1 agricultural county in Colorado and #8 in the US.
Ranks 2nd in the US in cattle and sheep inventory & sales ($ 0.9 billion)



PM_{coarse} Emissions Inventory



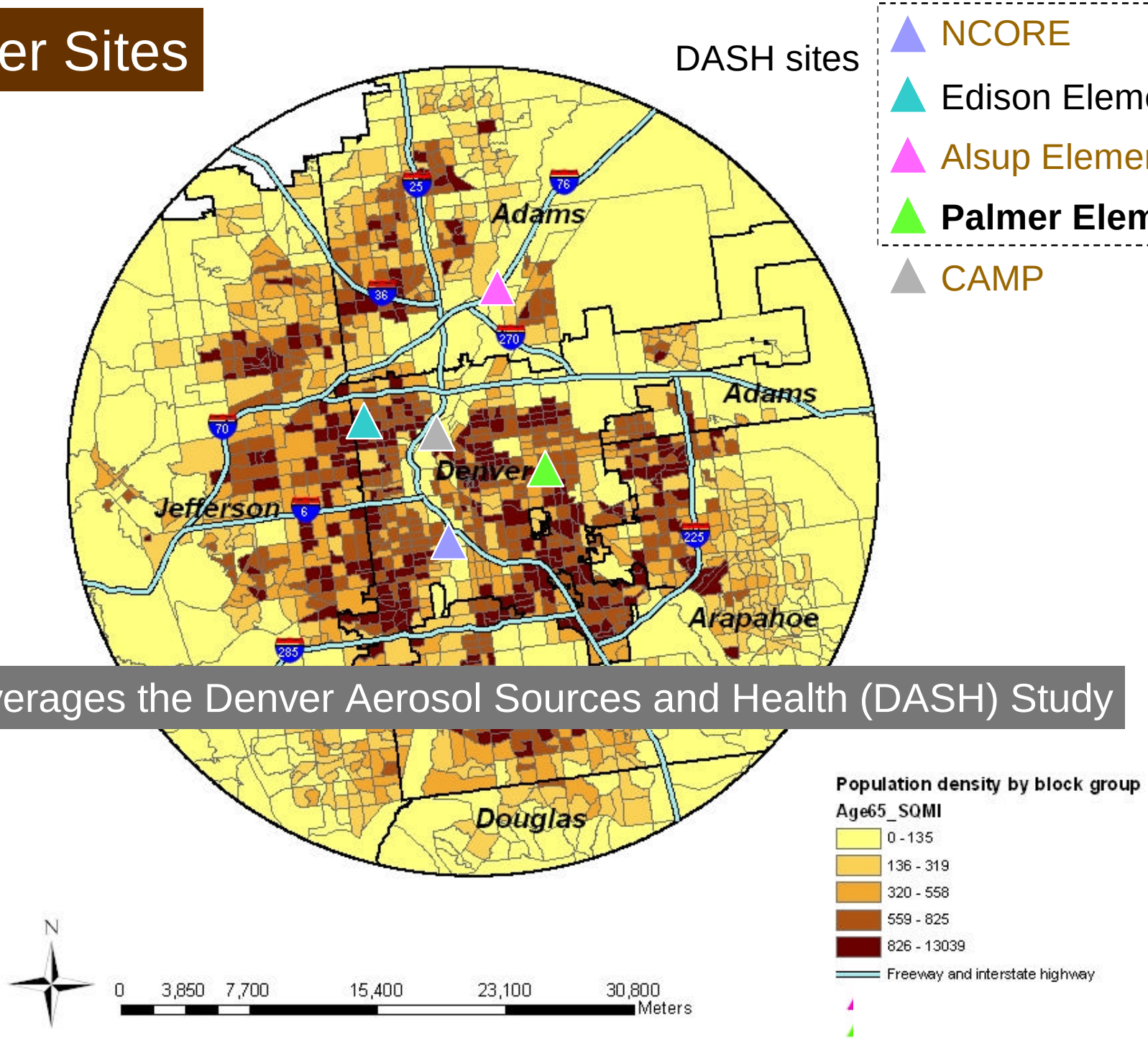


Greeley to Denver = 50 miles

<u>Greeley demographics:</u>
Population (2005): 88,249
Pop. change: +14.7% since 2000
Median income: $36,400
Pop. = 65 yrs old: 10%
African American: < 1%
Hispanic: 29.5%

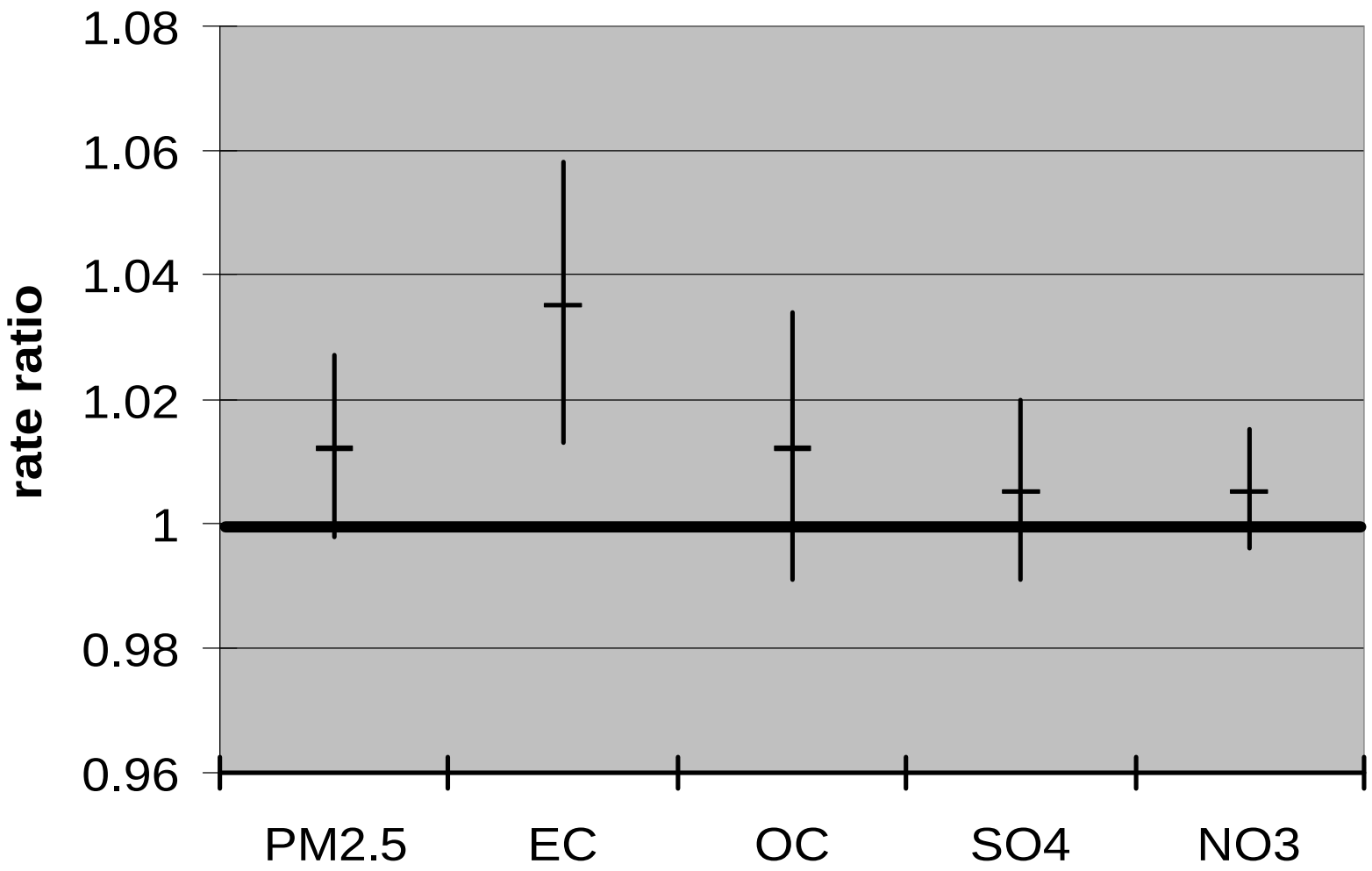
<u>Denver demographics:</u>
Population (2005): 557,917
Metro area pop.: 2.2 million
Median income: $39,500
Pop. = 65 yrs old: 11%
African American: 11%
Hispanic: 32%

Denver Sites



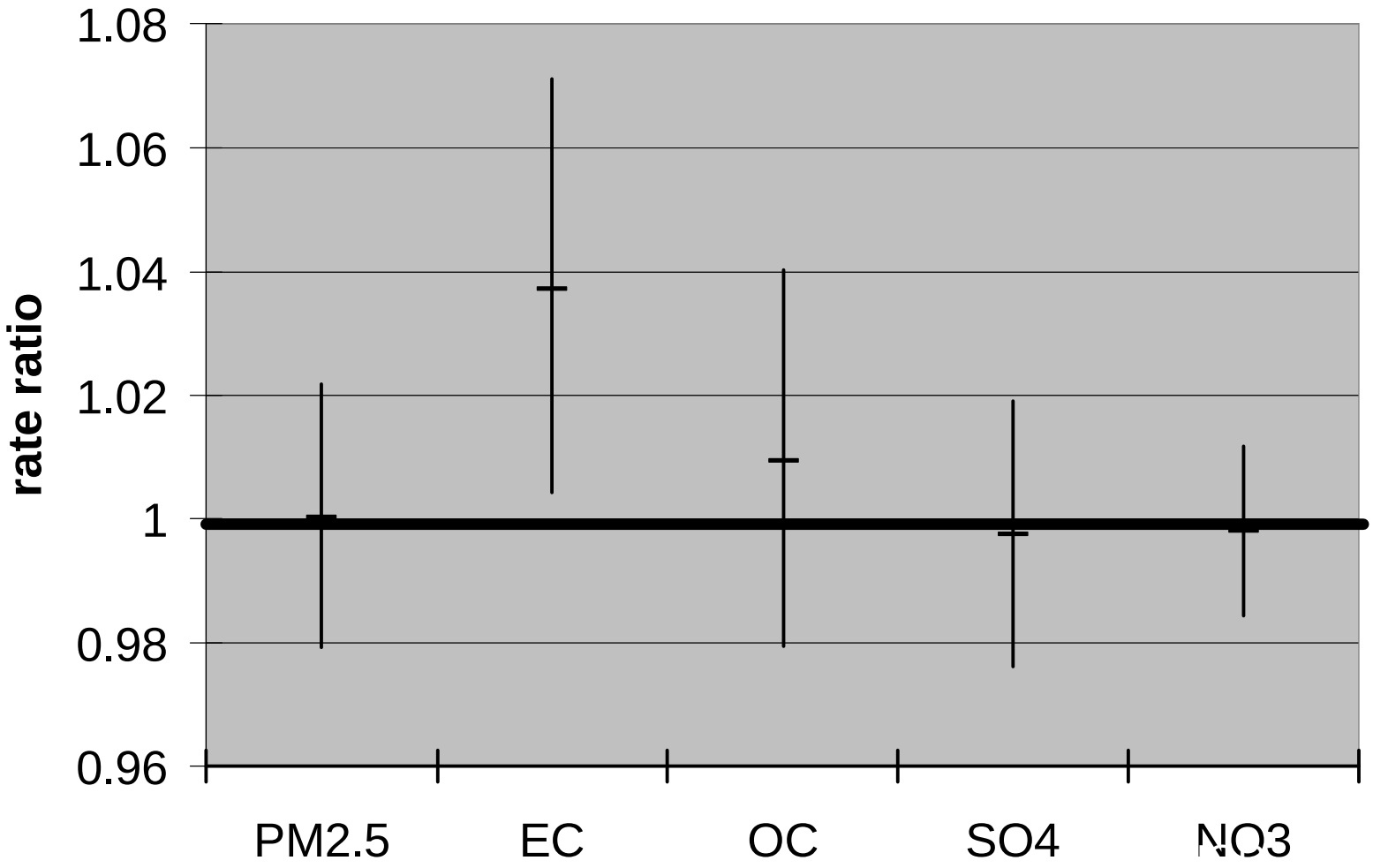
Leverages the Denver Aerosol Sources and Health (DASH) Study

DASH – Total Mortality



Daily PM2.5 – July 1, 2002 to present

DASH – Cardio-Respiratory Mortality



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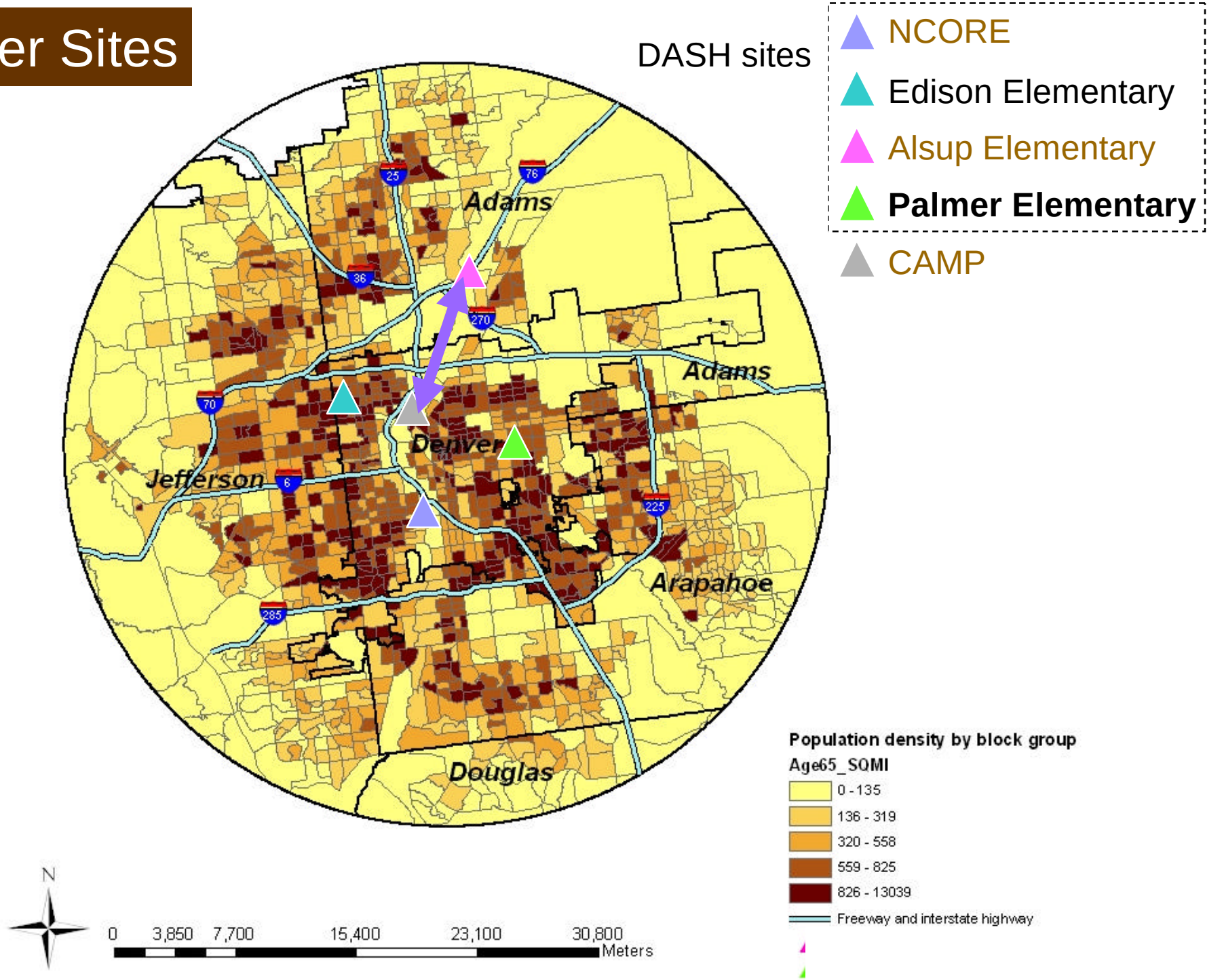

What do we know?

2005 concentrations

	CAMP		Commerce City		Greeley	
	PM2.5	PMcoarse	PM2.5	PMcoarse	PM2.5	PMcoarse
mean	10.50	14.82	8.28	21.18	7.58	14.50
stdev	5.88	8.44	4.76	12.22	4.13	8.47

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2005 concentration correlations

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		PM2.5	PMcoarse	PM2.5	PMcoarse	PM2.5	PMcoarse
CAMP	PM2.5						
	PMcoarse	-0.09					
Commerce City	PM2.5	0.44					
	PMcoarse		0.63	-0.02			
Greeley	PM2.5	0.60		0.60			
	PMcoarse		0.48		0.65	0.14	

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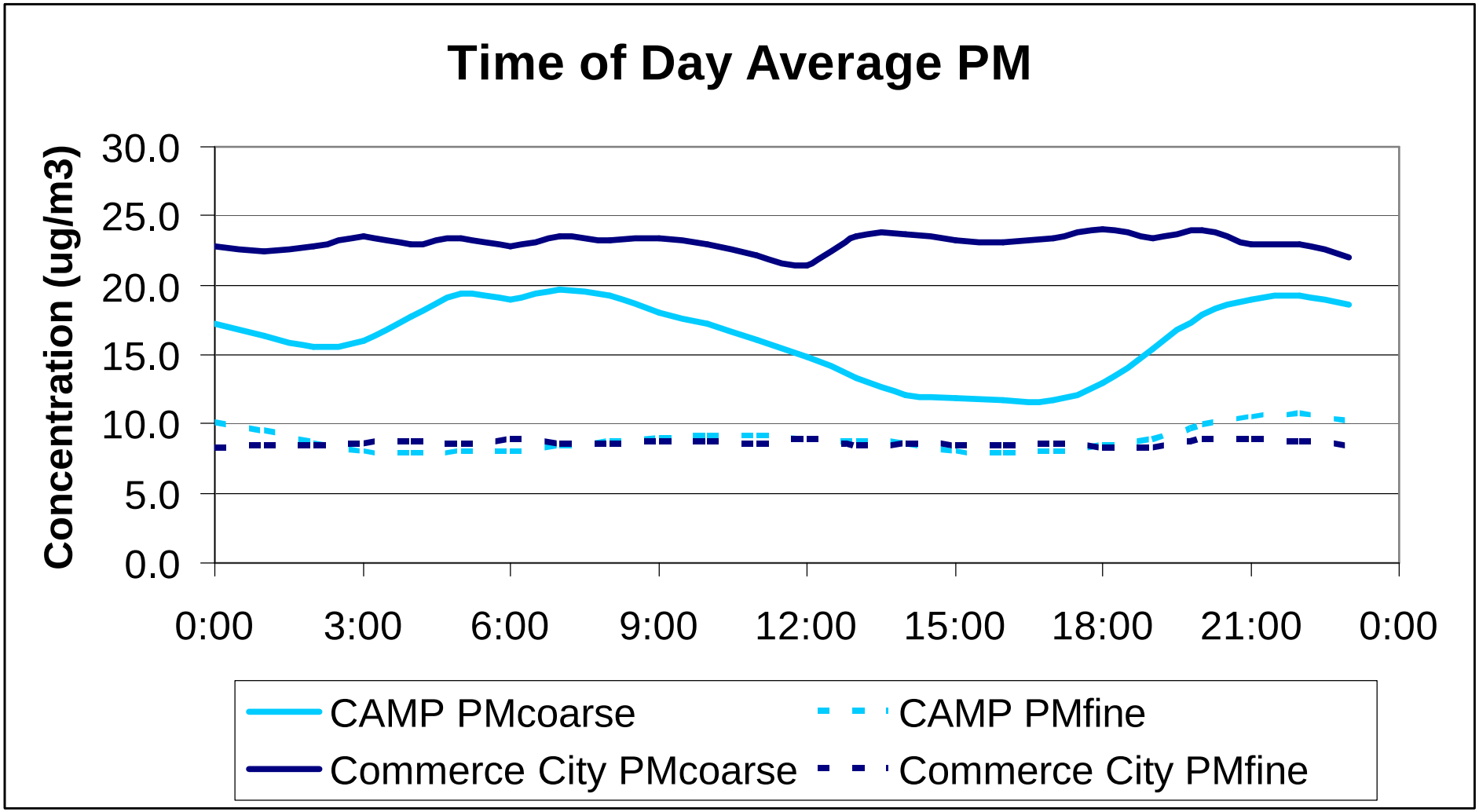
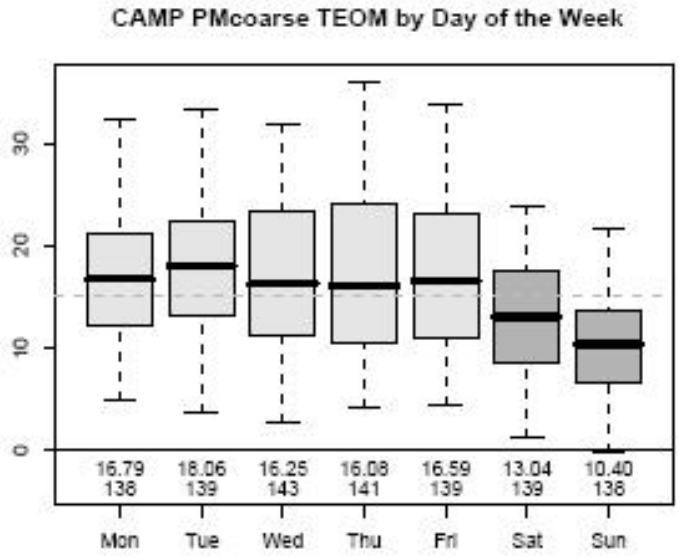
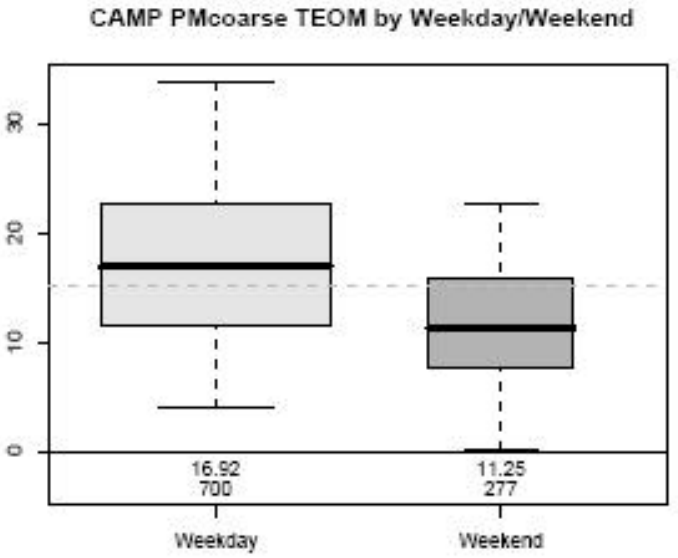
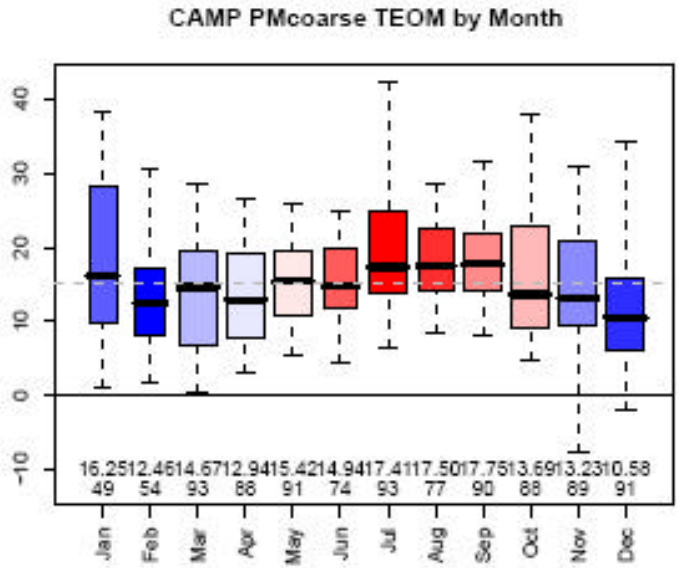
Data Analysis Examples

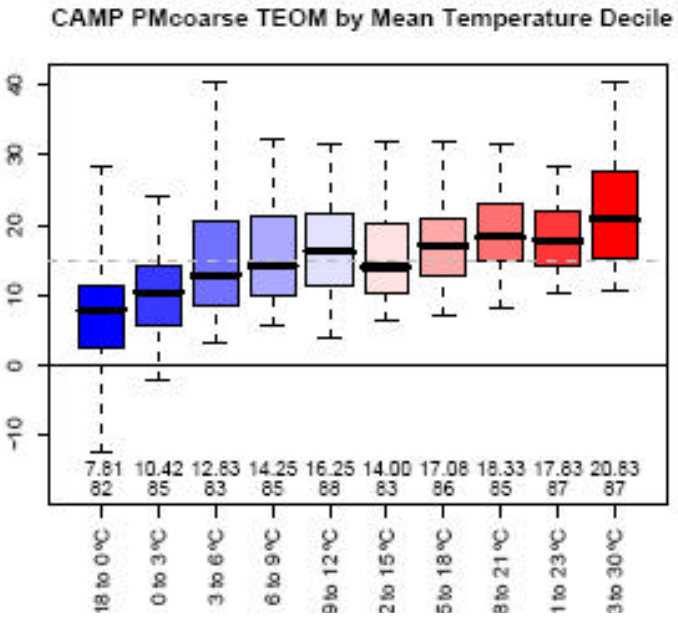


Trends

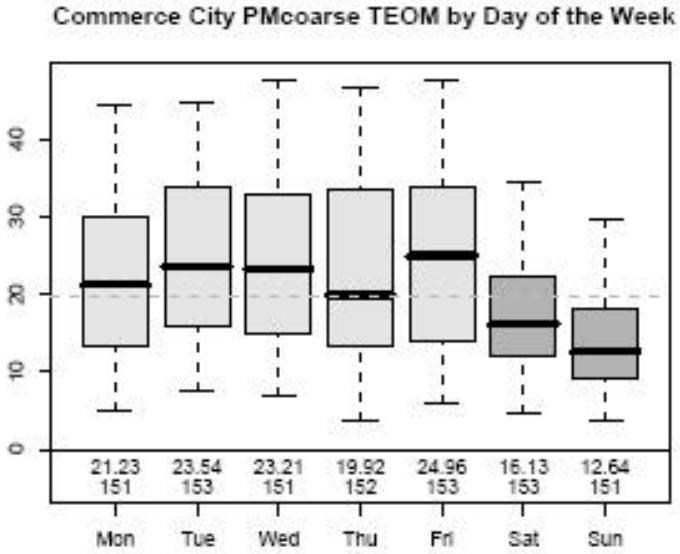

CAMP PMcoarse TEOM by Day of the Week
0
10
20
30
16.79
138
18.06
139
16.25
143
16.08
141
16.59
139
13.04
139
10.40
136
Mon
Tue
Wed
Thu
Fri
Sat
Sun

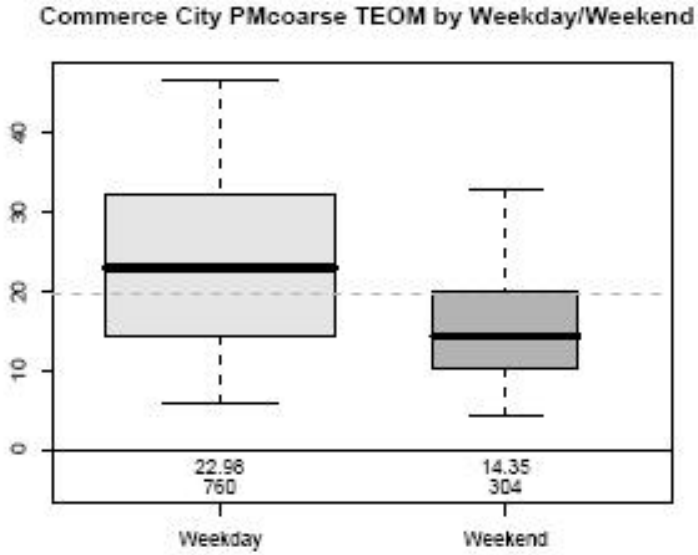

CAMP PMcoarse TEOM by Weekday/Weekend
0
10
20
30
16.92
700
11.25
277
Weekday
Weekend

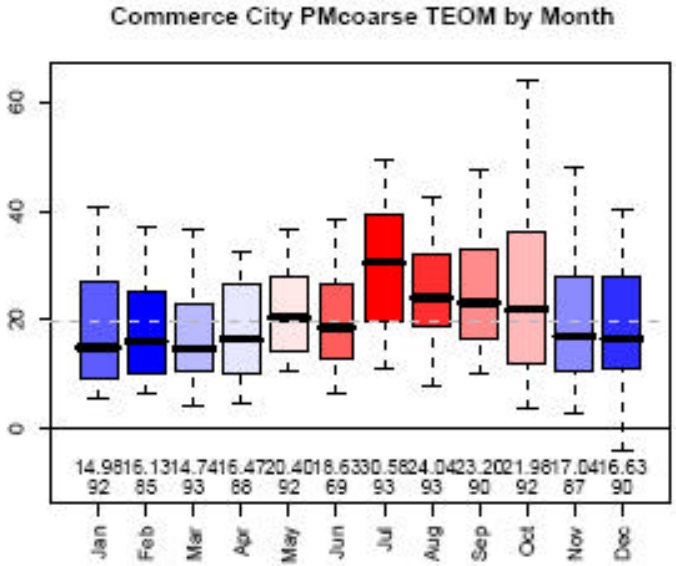

CAMP PMcoarse TEOM by Month
-10
0
10
20
30
40
16.25 12.46 14.67 12.94 15.42 14.94 17.41 17.50 17.75 13.69 13.23 10.58
49 54 93 88 91 74 93 77 90 88 89 91
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

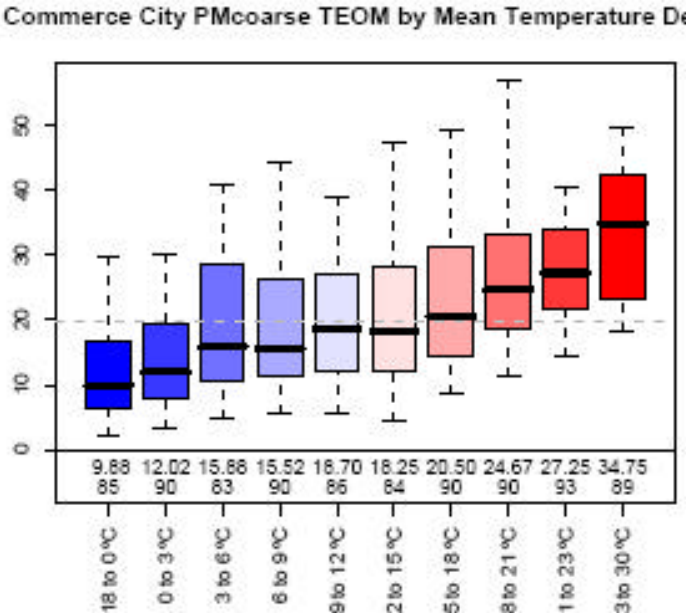

CAMP PMcoarse TEOM by Mean Temperature Decile
-10
0
10
20
30
40
7.81 10.42 12.83 14.25 16.25 14.00 17.08 18.33 17.63 20.83
82 85 83 85 88 83 86 85 87 87
-18 to 0°C
0 to 3°C
3 to 6°C
6 to 9°C
9 to 12°C
12 to 15°C
15 to 18°C
18 to 21°C
21 to 23°C
23 to 30°C

Trends

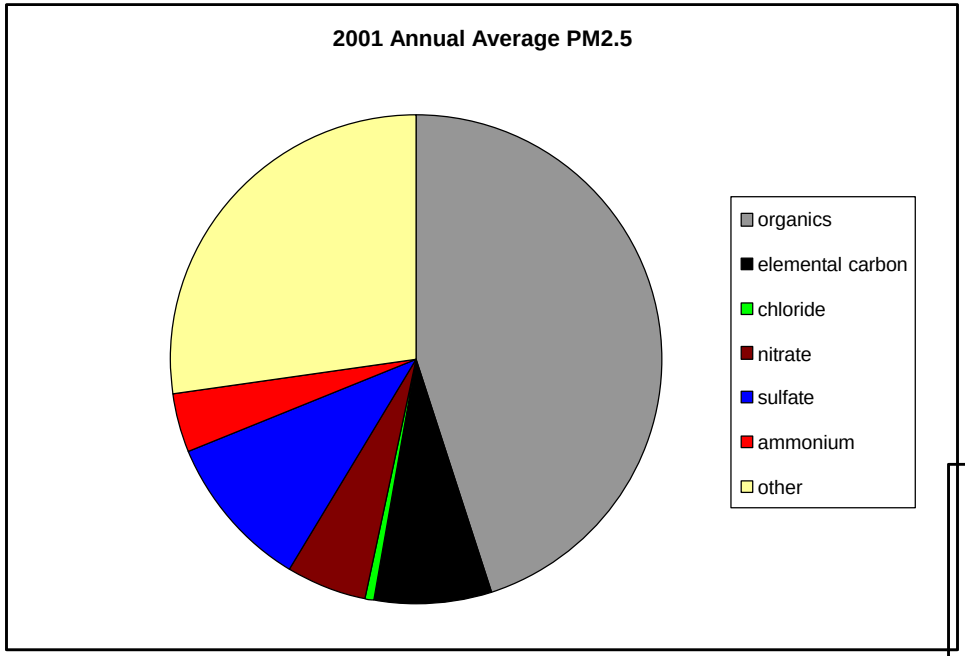

Commerce City PMcoarse TEOM by Day of the Week
0
10
20
30
40
21.23
151
23.54
153
23.21
151
19.92
152
24.96
153
16.13
153
12.64
151
Mon
Tue
Wed
Thu
Fri
Sat
Sun


Commerce City PMcoarse TEOM by Weekday/Weekend
0
10
20
30
40
22.96
760
14.35
304
Weekday
Weekend

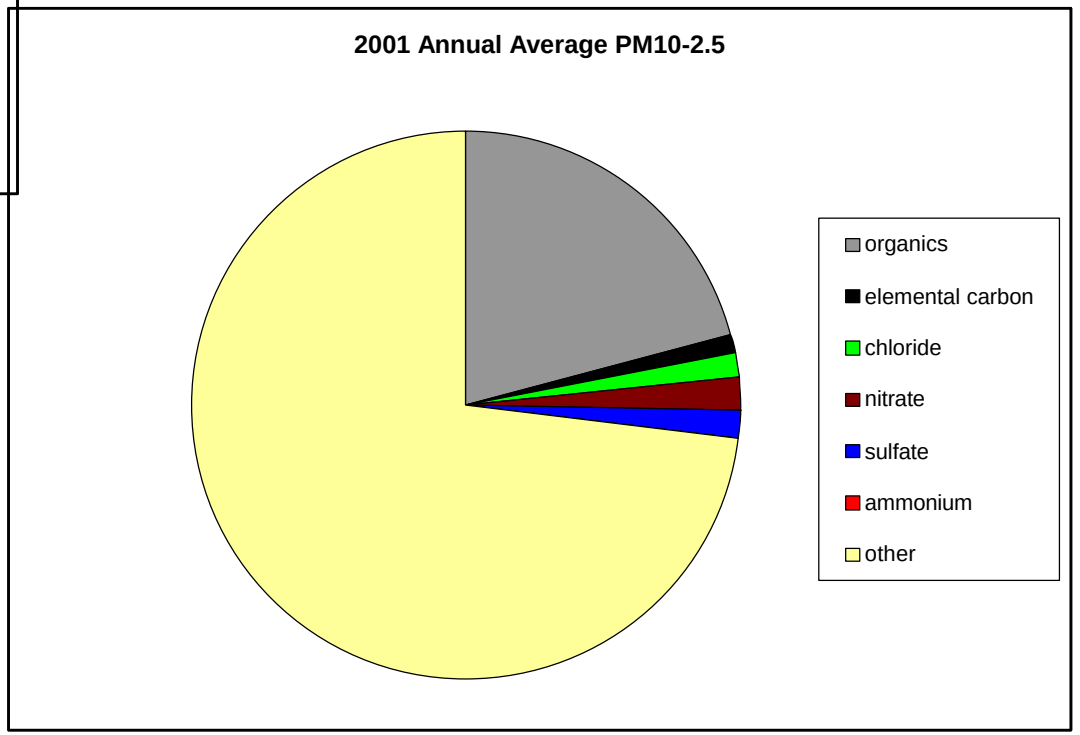

Commerce City PMcoarse TEOM by Month
0
20
40
60
14.98 16.13 14.74 16.47 20.40 18.63 30.58 24.04 23.20 21.98 17.04 16.63
92 85 93 88 92 69 93 93 90 92 87 90
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Commerce City PMcoarse TEOM by Mean Temperature Dec
0
10
20
30
40
50
9.88 12.02 15.86 15.52 16.70 18.25 20.50 24.67 27.25 34.75
85 90 83 90 86 84 90 90 93 89
18 to 0°C
0 to 3°C
3 to 6°C
6 to 9°C
9 to 12°C
12 to 15°C
15 to 18°C
18 to 21°C
21 to 23°C
23 to 30°C

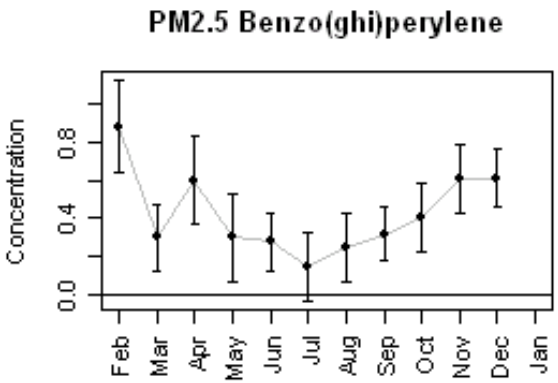
Chemical Characterization

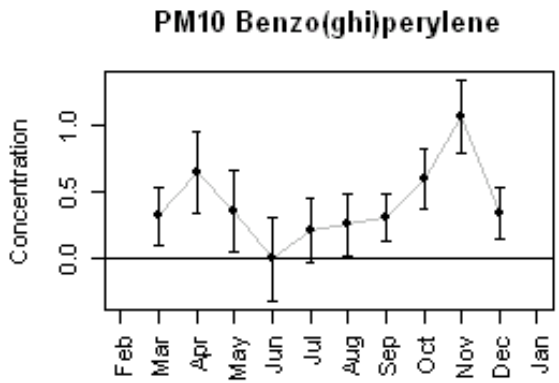


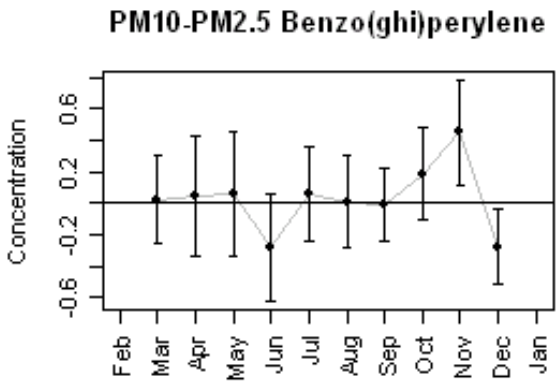
6th day sampling for 2001 at Alsup Elem.

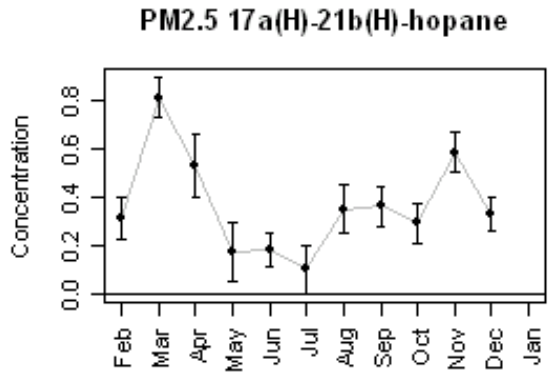


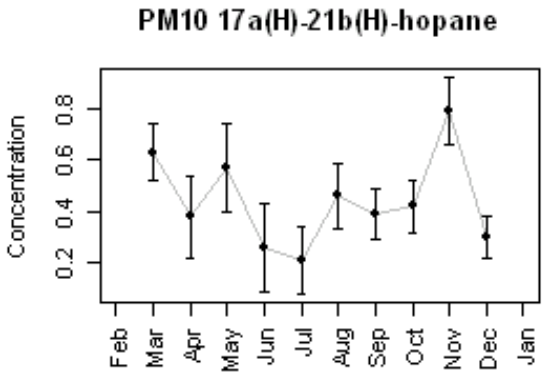
Organics Origins?

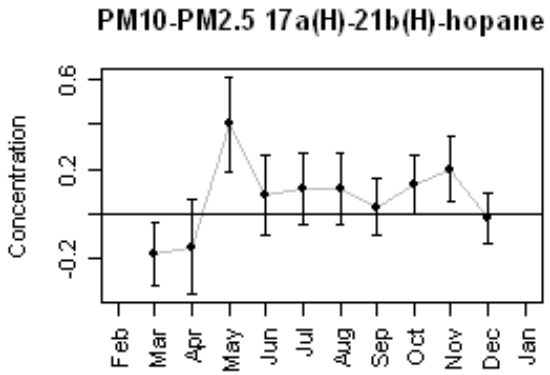






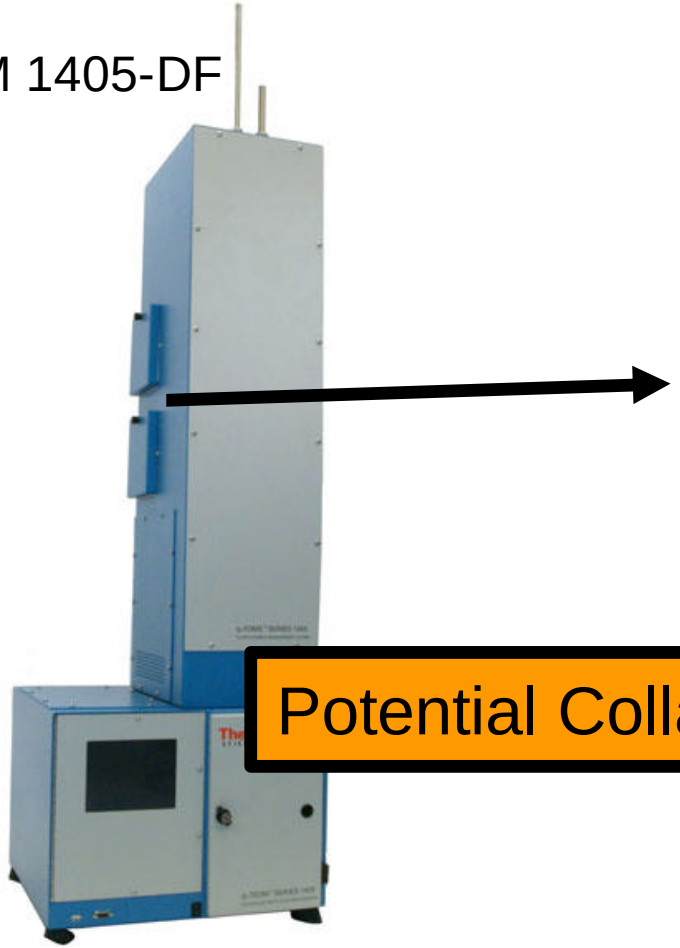






Monitoring/Collection Tools

TEOM 1405-DF



Potential Collaboration with OAQPS

Mass Monitoring

Filter Collection

Resultant Data

PM_{coarse} Characterization

1. Mass

3 years

2. Ions (IC)
3. Bulk carbon (NIOSH 5040)
4. Water soluble C & N
5. Trace metals
6. Endotoxin
7. Total carbohydrates
8. Total proteins
9. Macrophage assays

   ROS production & cytotoxicity

Health Endpoints

1. Arrhythmic events

   ICD patients
2. Respiratory ED visits
3. Cardiovascular ED visits
4. Preterm births
5. Intrauterine growth retardation

Filter measurements (200)

Power Estimates

Outcome	Denver Number	OR/RR*	Power	Greeley Number	OR/RR*	Power
Arrhythmic events	1,200 event-days	1.05	0.98	600 event-days	1.05	0.89
		1.10	0.99		1.10	0.99
		1.20	0.99		1.20	0.99
Respiratory ED visits	50 visits / day	1.02	0.95	14 visits / day	1.02	0.64
		1.05	0.99		1.05	0.99
		1.10	0.99		1.10	0.99
Cardiovascular ED visits	20 visits / day	1.02	0.62	6 visits /day	1.02	0.32
		1.05	0.99		1.05	0.96
		1.10	0.99		1.10	0.99
Preterm births†	3,000	1.05	0.16	1,200	1.05	0.12
		1.10	0.48		1.10	0.36
		1.50	0.99		1.50	0.99

*OR and RR per 10 μg/m^3 increase in coarse PM
† Approximately 10% of all births; IUGR will have similar power.

Resulting Data Analysis

Models to be evaluated

1. Source apportionment
2. Exposure assignment
3. Health outcome

50 sets

set = 2 Greeley vs 2 Denver

Urban/Rural Comparison

1. Mass
2. Ions
3. Bulk carbon
4. Water soluble C & N
5. Trace metals
6. Endotoxin
7. Total carbohydrates
8. Total proteins
9. Macrophage bioassays
10. **Sources**
11. **CP mass effect estimate**