

US EPA ARCHIVE DOCUMENT

Spatial and Compositional Relationships of Indoor Aerosols in the Detroit Exposure and Aerosol Research Study (DEARS)

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DEARS Objectives

- *Determine contribution of specific ambient sources to residential and personal exposures*
- *Determine relationship between community monitor and personal exposures to PM components and air toxics*

DEARS Monitoring Design

- 3 year study - July '04 to Feb. '07
- 120 homes - 5 days in winter and summer
- Concurrent monitoring
 - Personal
 - Residential indoor & outdoor
 - Ambient

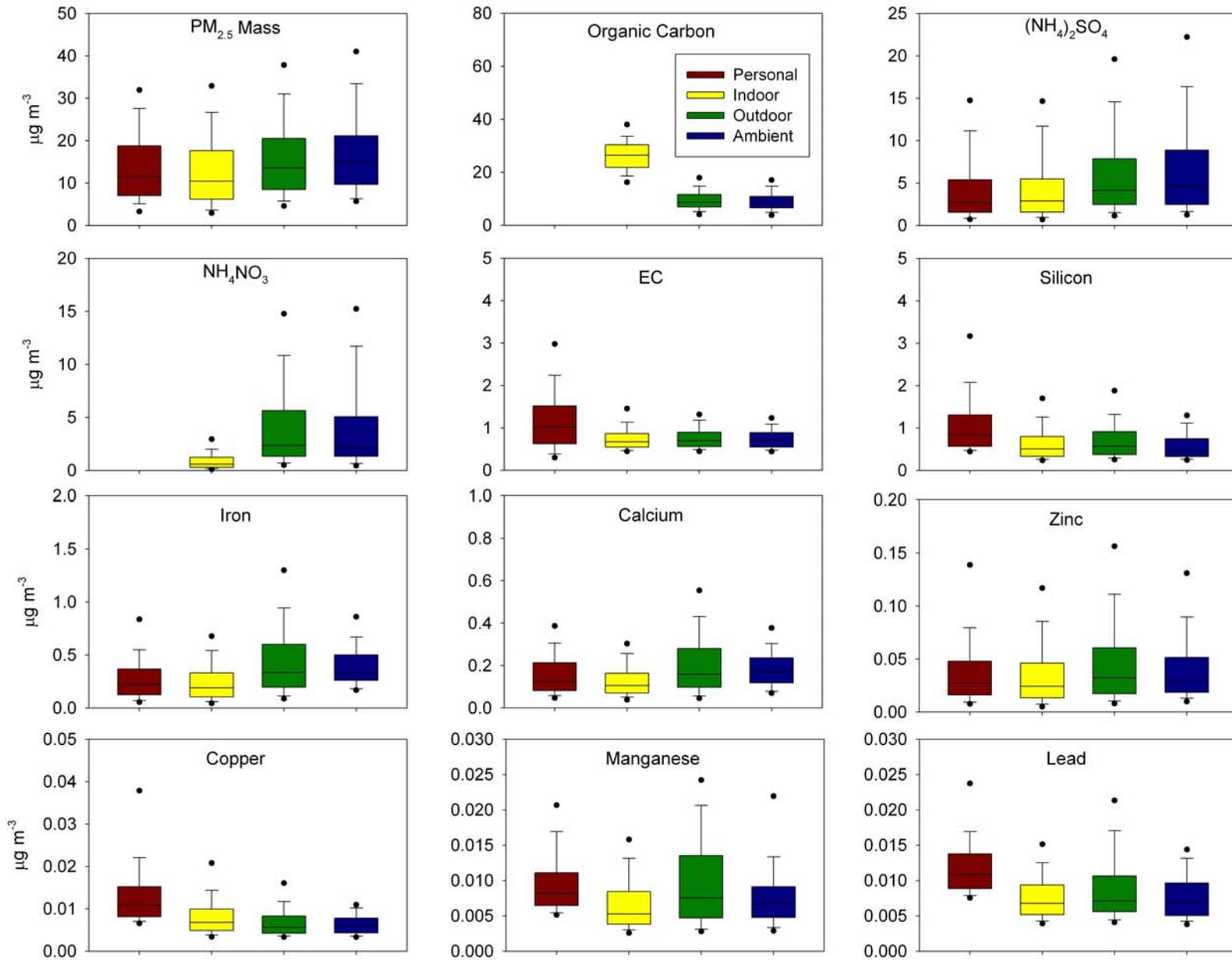


DEARS Measurements

| <u>Parameter</u> | <u>Personal</u> | <u>Indoor</u> | <u>Outdoor</u> | <u>Ambient</u> |
|--|-----------------|---------------|------------------|----------------|
| PM_{2.5} (mass, elements) | X | X | X | X |
| PM_{coarse} (mass, elements) | -- | X | X | X |
| EC-OC (PM_{2.5}) | -- | X | X | X |
| EC (PM_{2.5}) | X | X | X | X |
| Nitrate | -- | X | X | X |
| Gases (O₃, NO₂, SO₂) | X | -- | -NO ₂ | X |
| Aldehydes | X | X | X | X |
| VOCs | X | X | X | X |
| SVOCs | -- | X | X | X |
| PAHs | -- | X | X | X |
| Air Exchange Rate | -- | X | -- | -- |

Data Description

- Participants randomly identified and recruited
- Excluded smokers
- Environmental tobacco smoke (ETS) impacts were prevalent despite best efforts to minimize
 - ETS measured optically
 - ETS levels $> 1.5 \mu\text{g m}^{-3}$ removed for these analyses
 - About 25% of indoor obs. (221) over two years of data
- Only $\text{PM}_{2.5}$ mass and components included in these analyses
- Data largely not normally distributed
 - Non-parametric tests on original data
 - Log-transformed data for parametric tests



Differences Among Residential and Ambient PM_{2.5} Components

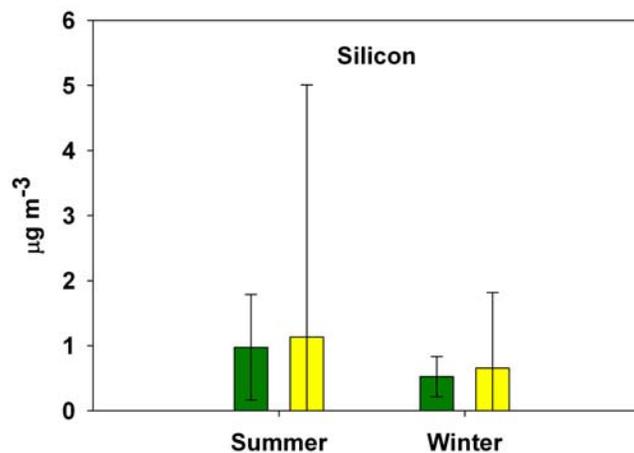
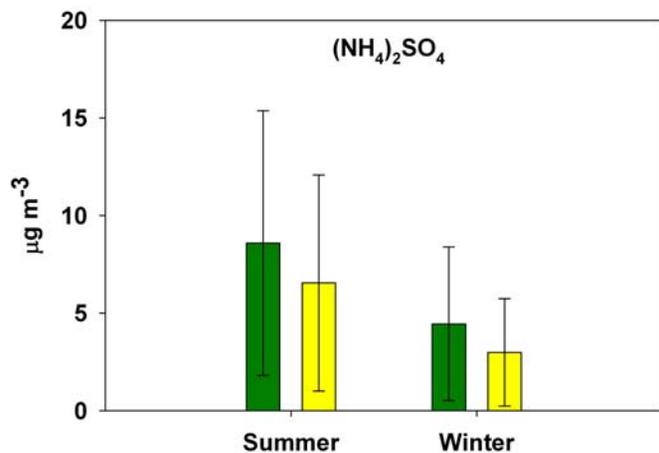
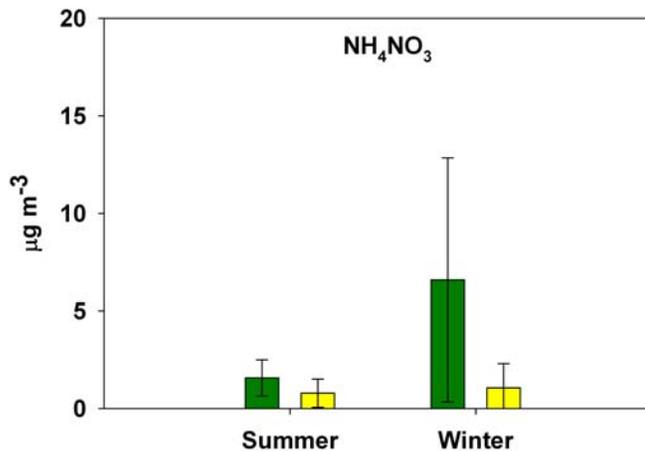
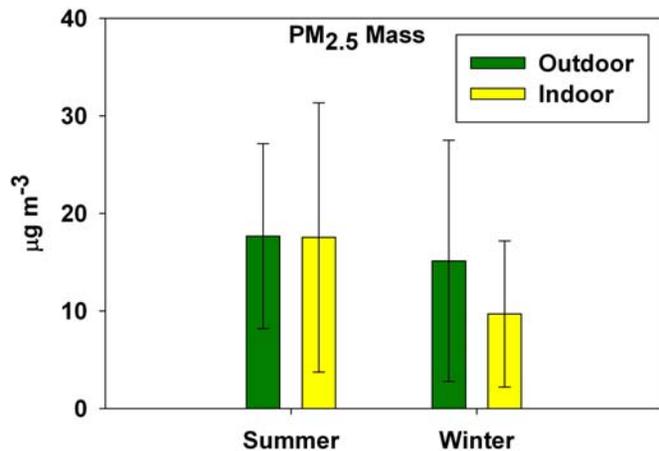
| Component | <i>Personal vs. Indoor</i> | | <i>Indoor vs. Outdoor</i> | | <i>Outdoor vs. Ambient</i> | |
|------------------------|----------------------------|--------|---------------------------|--------|----------------------------|--------|
| | Summer | Winter | Summer | Winter | Summer | Winter |
| PM _{2.5} Mass | | | | O | | |
| Organic carbon | | | | | | O* |
| Sulfate | | | O | O | | |
| Nitrate | | | O | O | A | |
| Elemental carbon | | | | | A | O |
| Silicon | | P | | | | |
| Iron | | | O | O | | O* |
| Calcium | P | | O | | O* | |
| Potassium | P | P | O | O | | |
| Zinc | | | | O | | O* |
| Manganese | P | P | O | O | O* | O |
| Lead | P | P | | O | | O |
| Copper | P | P | I | I | | |

Seasonal Differences in PM_{2.5} Components

| Component | Personal | Indoor | Outdoor | Ambient |
|------------------------|----------|----------|---------|---------|
| PM _{2.5} Mass | | | | |
| Organic carbon | n/a | artifact | | |
| Sulfate | | | | |
| Nitrate | n/a | | | |
| Elemental carbon | | | | |
| Silicon | | | | |
| Iron | | | | |
| Calcium | | | | |
| Potassium | | | | * |
| Zinc | * | | | * |
| Manganese | | | | |
| Lead | | | | |
| Copper | | * | | |

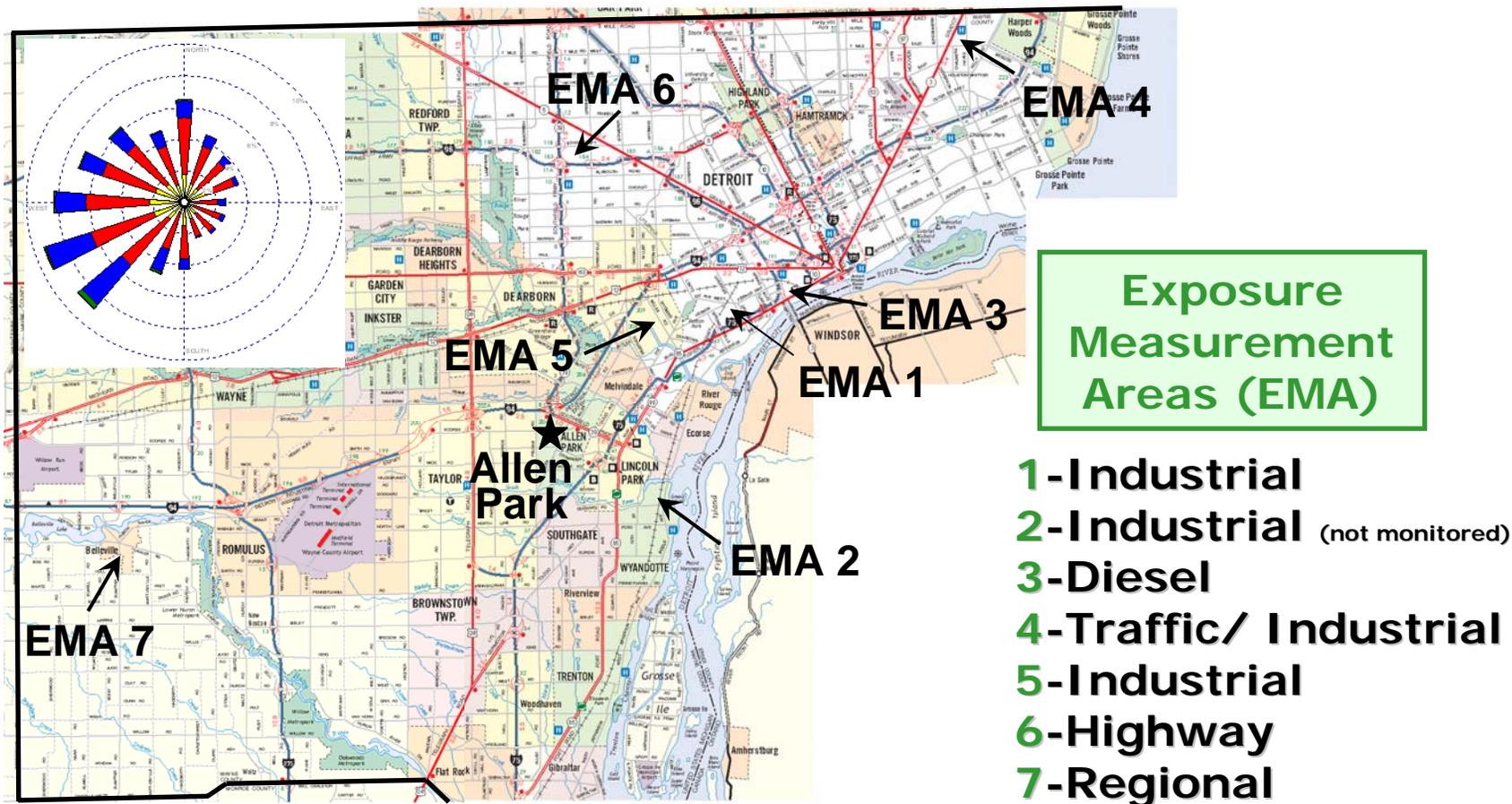
 = higher during Summer
  = higher during Winter
 *p<0.10

Seasonal Differences in PM Components

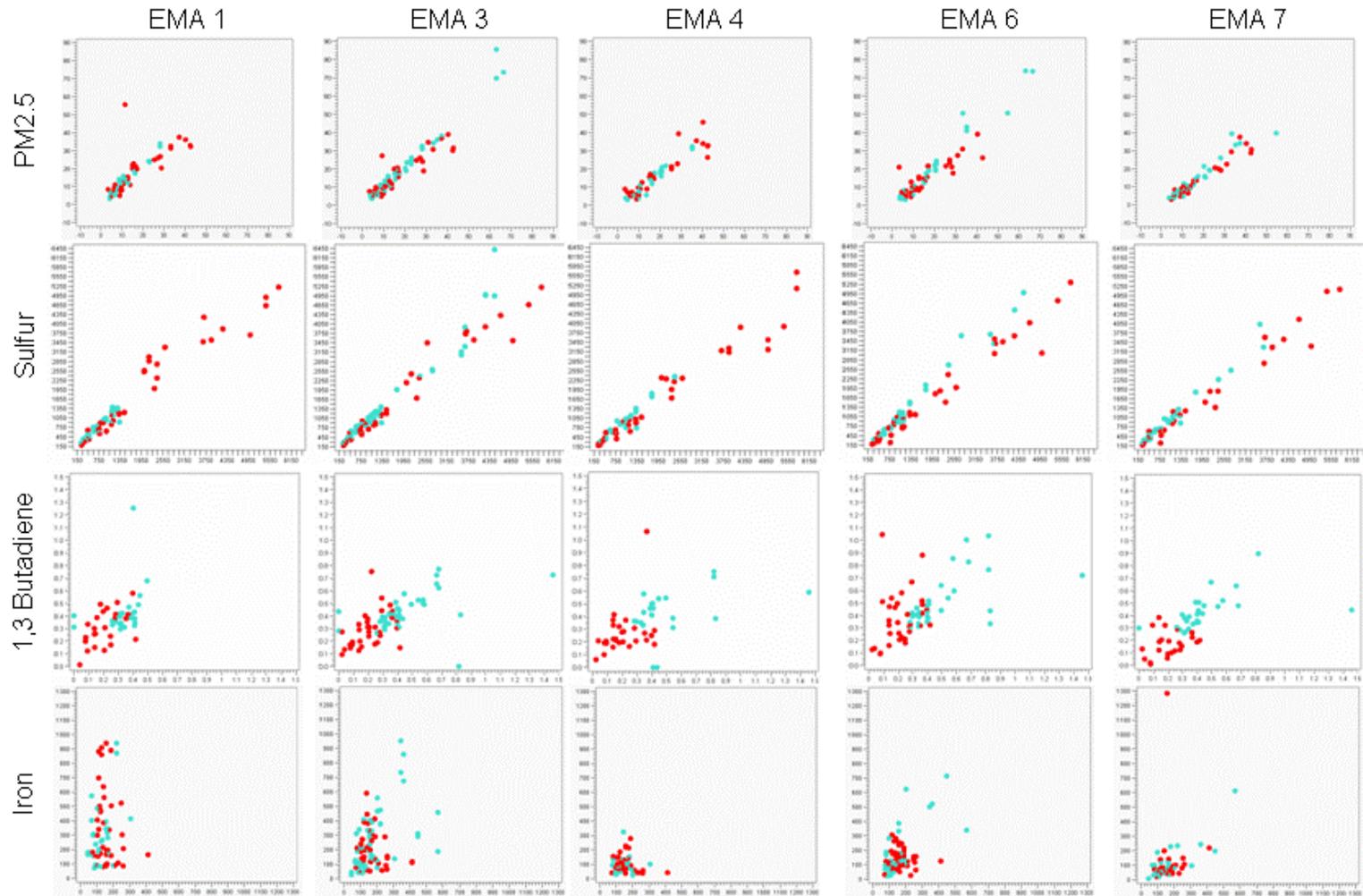


DEARS Study Sites

(Emphasis on Proximity to Sources)



Residential Outdoor Concentration



Ambient Concentration at Central Site Monitor

Season 1 (Summer) ●

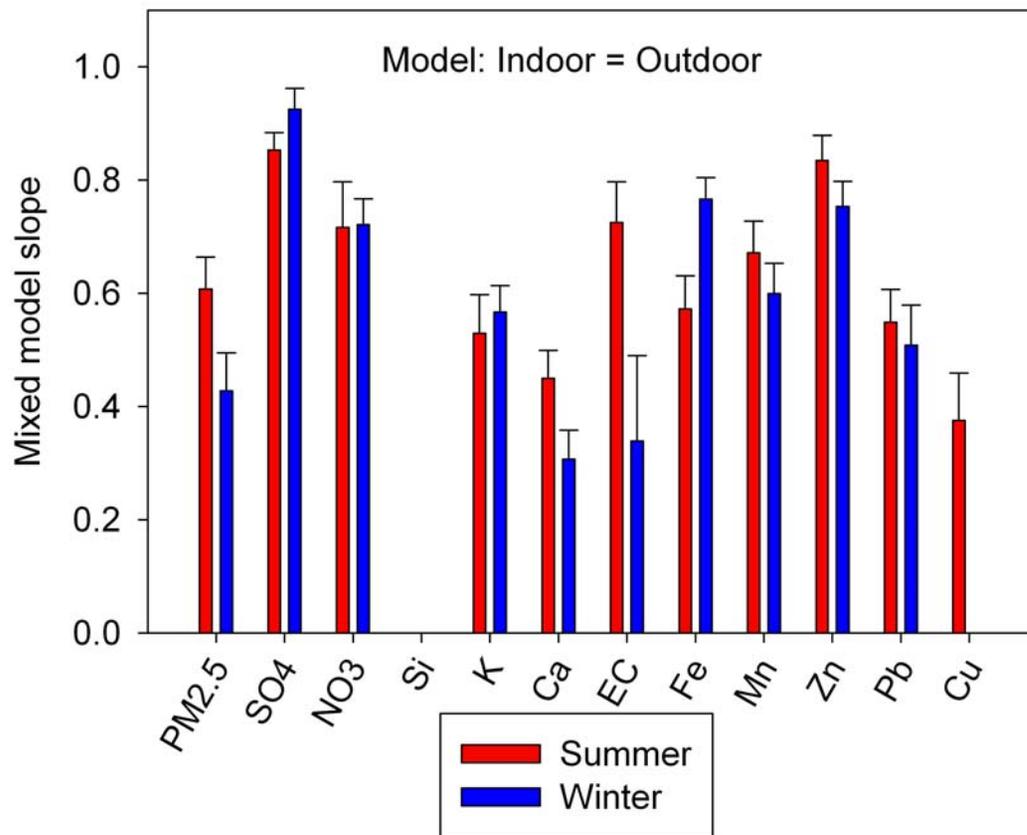
Season 2 (Winter) ●

Spatial Differences in PM_{2.5} Components

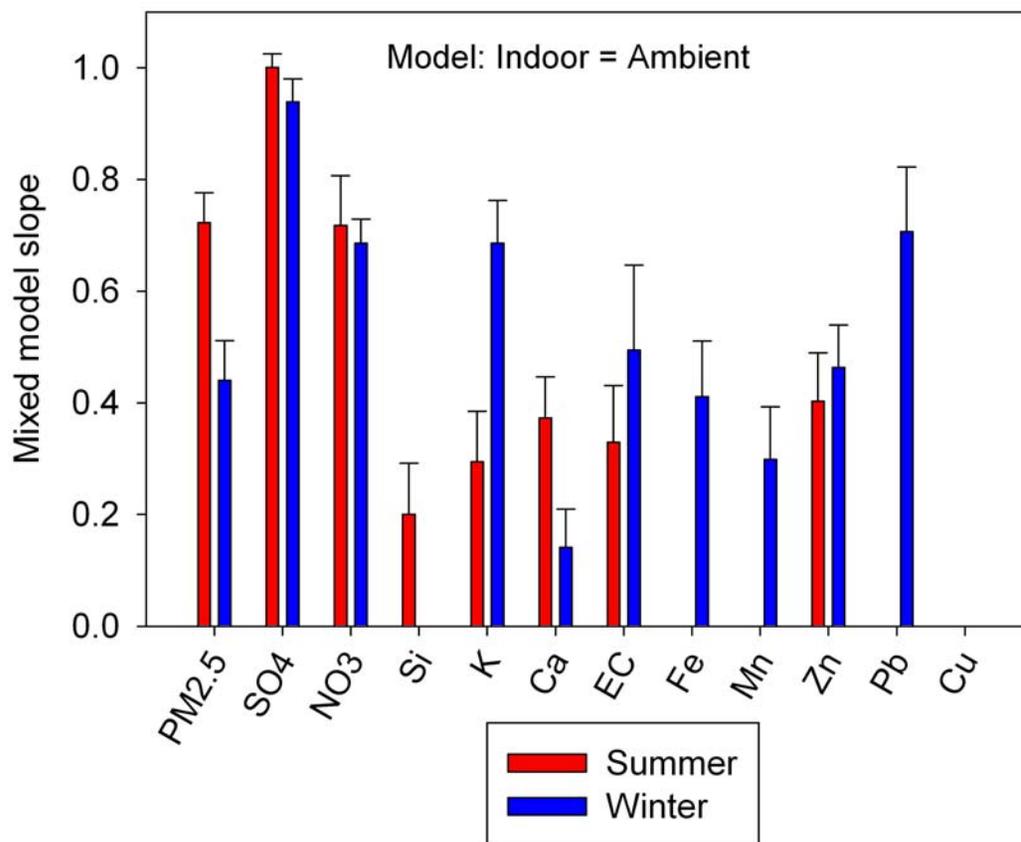
| Component | 1 | 3 | 4 | 5 | 6 | 7 |
|------------------------|-------|-------|-----|-------|---|---|
| PM _{2.5} Mass | P I | | P I | P I | I | |
| Organic carbon | | | | | | |
| Sulfate | | | | | | |
| Nitrate | | | | | | |
| Elemental carbon | O | O | | O | | |
| Silicon | | | | O | | |
| Iron | P I O | P I O | | P I O | | |
| Calcium | P I O | O | | O | O | |
| Potassium | P I | I | | I O | | |
| Zinc | P I O | I O | | P I O | | |
| Manganese | P I O | P I O | | P I O | | |
| Lead | | | | | | |
| Copper | | | | | | |

p<0.05; p<0.10

Indoor PM Components – Relationships with Outdoor



Indoor PM Components – Relationships with Ambient



Conclusions

- Environmental tobacco smoke prevalent and impacted indoor data
 - Data stratified accordingly
- Composition of indoor PM similar to outdoor – lower indoor levels of many PM components
- PM composition varied with season – summer generally higher
 - Summer = sulfate
 - Winter = nitrate
- Local sources impacted outdoor levels of many components
 - Impacts seen in indoor and personal PM
- Strong relationships between indoor and outdoor PM components
- Weaker associations between indoor and ambient PM components
- DEARS study design was successful and allows us to examine residential exposure relationships