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Detroit Exposure Aerosol Research Study (DEARS)

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Personal Exposure Research - Issue

- Individuals experience adverse health effects from PM in the air they breath (personal exposure)
- EPA regulations to protect human health are based on ambient monitoring data
- Epidemiological studies that show adverse health effects to PM use ambient monitoring data as an estimate of personal exposure

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Personal Exposure – Key Questions

- What are the relationships between PM concentrations measured at ambient sites and indoor, outdoor, personal exposure
- Can PM measurements at central sites adequately represent exposures to ambient PM?
- Do the relationships differ for toxic components of PM? For PM from sources

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Personal Exposure – Key Questions

- Can models be used to improve estimates of exposure from ambient site measurements?
- Can models be used to better understand the relationships between PM sources, ambient air concentrations, and personal exposure?

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- Where have we been?
  - NRC 1: Understanding the relationship for PM mass, short-term exposures
- Where are we going?
  - NRC 2: PM for toxic components
  - PM from sources
  - Spatial Variability
  - Chronic exposures
  - Integrating information from source to health effects

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Findings from Previous Studies

- For fine PM and sulfates correlations between ambient sites and indoor air or personal exposure is relatively good
  - **For community-based epi studies, the ambient monitor should be adequate exposure surrogate**
- Attenuation factor ranges from <0.2 to 1.0
  - **Strength of the health impact may be underestimated**
- Use of personal exposure data in health studies shows greater health impacts

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Findings from Previous Studies

- Attenuation factor varies by city and season
  - **A single nationwide standard may provide a different level of protection for different populations**
- Housing type and ventilation are key factors for attenuation.
- Poor correlations for several species; ultrafine, nitrates, EC, organics
  - **Epi studies using ambient monitors may not be able to show health effects**
- Criteria gases correlate with fine PM at ambient site but not at person
  - **Criteria gases are surrogates not confounders of exposure in epi studies**

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What's Next?

- In 10 years, EPA's regulations will dramatically reduce fine particle sulfate
- These species are well-behaved; exposure and health effects can be reasonably predicted from ambient monitoring data
- What about the species that are left in the air **and all of the species measured at Supersites??** Research is needed to
  - **Describe the relationship between ambient levels and exposure**
  - **Determine if epidemiological studies can be used to evaluate health impacts (can ambient monitoring data with or without modeling be used as surrogates)**
  - **Improve exposure and risk assessments**

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DEARS- GOAL

- Describe/model the relationship between concentrations at a central site and residential/personal concentrations for
  - PM constituents,
  - PM characteristics
  - PM from specific sources (mobile and point)
  - Air toxics

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Emphasis placed on understanding impact of:

- Local sources (mobile and point) on outdoor residential concentrations,
- Housing type and house operation on indoor concentrations
- Locations and activities on personal exposure

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Why Detroit?

- Currently in non-attainment for $PM_{2.5}$
- Projected non-attainment status after sulfur reductions in 2010
- Large number of industrial point sources
- Heavy mobile source impact including diesel
- Should be spatial distribution of concentrations
- Summer and winter seasons
- Speciation Trends Network site and National Air Toxics Network Site
- State and local interest
- Existing community partnerships

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Field Monitoring Design

- 3 to 4 year study starting in Summer 2004
- Collect data in 120 homes for 5 days in winter and 5 days in summer (1200 sampling days
- Concurrent monitoring at
  - Central site
  - Residential – outdoors and indoors
  - Person
- Survey data
  - Residential characteristics, participant characteristics, time/activity, source usage.

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Study Design

Physical/chemical factors that impact spatial variability and outdoor/ indoor concentrations

- residential location relative to sources and central site monitor
- composition and strength of source emissions
- meteorology
- regional concentrations
- air exchange rates
- housing characteristics/HVAC operations

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Parameter	Personal	Indoor	Outdoor	Ambient
$PM_{2.5}$ (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	x	--	--	x
Carbonyls	x	x	x	x
VOCs	x	x	x	x
SVOCs	--	x	x	x
PAHs	--	x	x	x
Air Exchange	--	x	--	--

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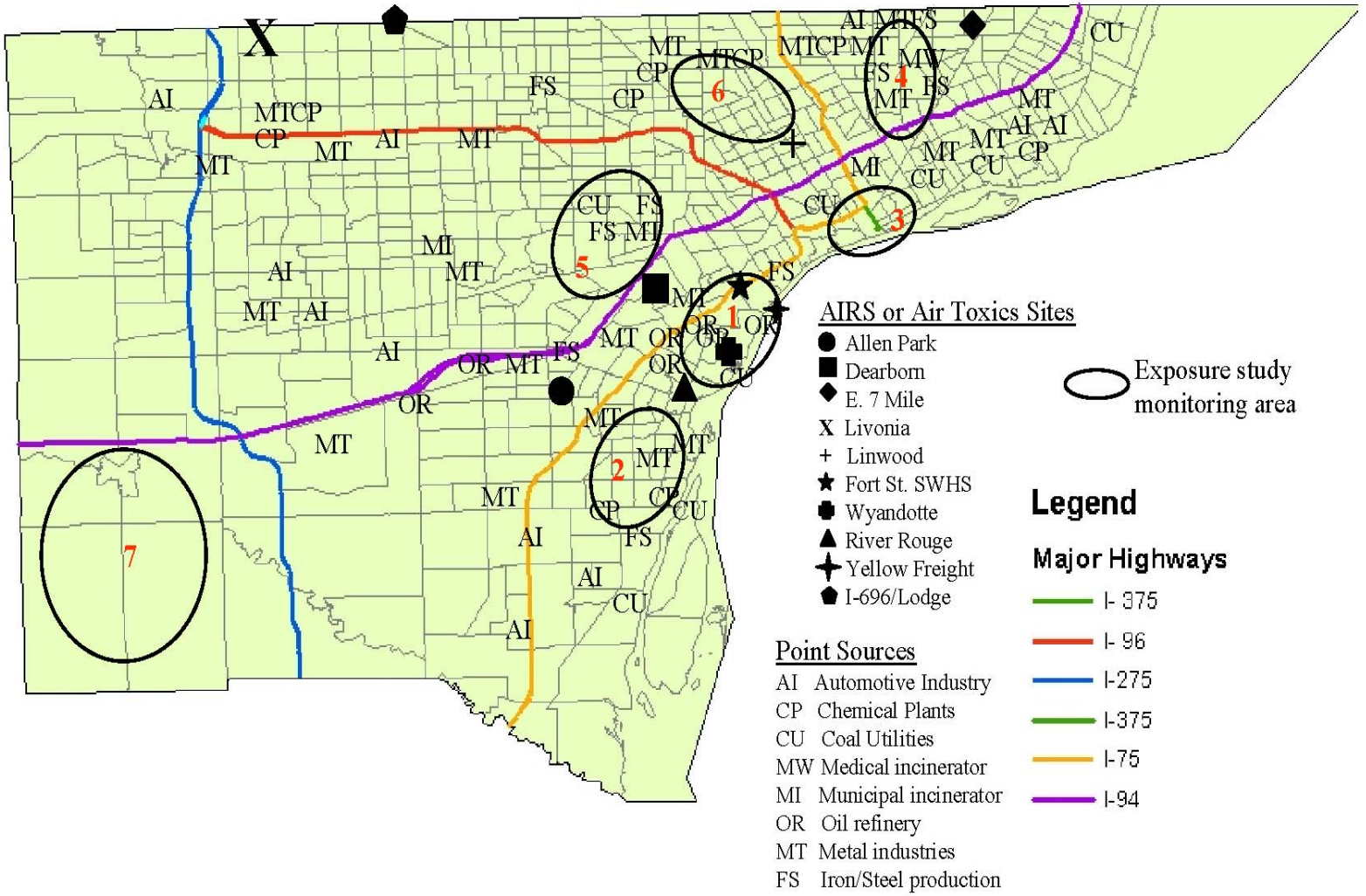
Monitoring locations- 7 selected based on proximity to sources



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Source Apportionment

- Conducted at central site, indoors, and outdoors
- Detailed analysis for source markers
  - elements, EC/OC, sulfate, nitrate, carbonyls (e.g. acrolein), VOCs (e.g., 1,3 butadiene), Hopanes, alkanes, PAHs, and levoglucosan
- Source apportionment using the latest approaches (e.g., multilinear engine, positive matrix factorization) that incorporate exposure, human activity and environmental survey information

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Modeling

- Spatial analysis
  - Spatial variability in concentrations
  - Relationship between residential and source location
  - Combine monitoring data with air quality model output to improve spatial analysis
- Air quality modeling
  - Urban-scale modeling of key sources: impact on residential monitoring locations
  - Regional-scale modeling for transport into airshed
- Exposure modeling
  - Links concentrations with population and the activities that impact exposures
  - Predict population exposures due to time spent in residential locations, work/school locations, vehicles

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Detroit Study – Other Elements

- Mobile Source Characterization
- Toxicity Studies of PM from major sources
- Detroit Asthma Study
- EPRI Health Study
- Field evaluation of PM_{coarse} sampler
- Evaluation of biogenic markers for PM
- Intensive ambient sit monitoring

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Progress to Date-September 2004

- Formal OMB, IRB and EPA approval of DEARS
- Development of community and collaborative support
- Initiation of DEARS field monitoring
- Completion of first season of DEARS field measurements

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Summary

- A well-characterized air shed
- Extensive exposure data, including source apportionment
- Modeling to describe exposure variability
- We are looking for more partners to model data and conduct health studies
- COME ON DOWN