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Building a scientific foundation for sound environmental decisions

The Detroit Exposure and Aerosol Research Study (DEARS):

Study Overview

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Understanding Exposure Research

- Individuals experience adverse health effects from particulate matter (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 often use ambient monitoring data as a surrogate of **true personal exposure** to a regulated source

Personal Exposure Research

- Provide the link between source/regulatory monitoring and health outcomes
- Goal: Evaluate/model the relationship between PM at ambient sites and personal exposure

•Outdoor sources
•Indoor sources
•Personal sources
•Physical factors
•Environmental factors

Personal Exposure – Key Questions

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

Detroit Was Selected Because…

- Was an non-attainment area 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
- Potential for pollutant spatial variability
- Possibility of summer and winter season variability
- Historic Speciation Trends Network site and National Air Toxics Network Site data
- State and local interest
- Existing community partnerships

DEARS- GOALS

- Describe 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
  - PM and gaseous copollutants

DEARS Emphasis

Understanding the 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

Planned 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
  - Land Use Regression (DCHS and WOEAS)
- Air quality modeling
  - Urban-scale modeling of key sources: impact on residential monitoring locations
  - Regional-scale modeling for transport into airshed
  - CMAQ-AERMOD and ConCEPT
- 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
  - PM-SHEDS and associated

Source Apportionment

- Use of data collected at central site, indoors, and outdoors (greatest extent possible)
- 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 ultimately using the latest approaches (e.g., multilinear engine, positive matrix factorization) that incorporate exposure, human activity and environmental survey information

Detroit Study – Other Elements

- Mobile Source Characterization-near road emphasis-Ambassador Bridge
- Detroit Children's Health Study, including MICA
- Detroit Healthy Heart
- Detroit Tox Study (Hi Vol Trailer)
- Evaluation of biogenic markers for PM (carbon - 14)
- Secondary Organics data collections
- Health Canada and Environment Canada collaborations (including collocation and mobile monitoring

DEARS Monitoring Design

- 3 year field study initiated in July 2004 and completed on February 25, 2007
- Randomize household purposeful study design
- Non-smoking with no health or vocational exclusion
- Each year (winter/summer) had 40 enrollees
- Households were monitored for 5 days in winter and 5 days in summer (~1200 total sampling days)
- Concurrent monitoring at:
  - Central community site
  - Residential – outdoors and indoors
  - Personal level

Exposure Monitoring Approach

- Measure concentrations PM/components/ gases
  - Ambient
  - Outdoors
  - Indoors
  - Personal
- Collect data on personal activities/locations, house characteristics, and indoor/personal sources
- Characterize the relationships
- Evaluate the factors that influence these relationships

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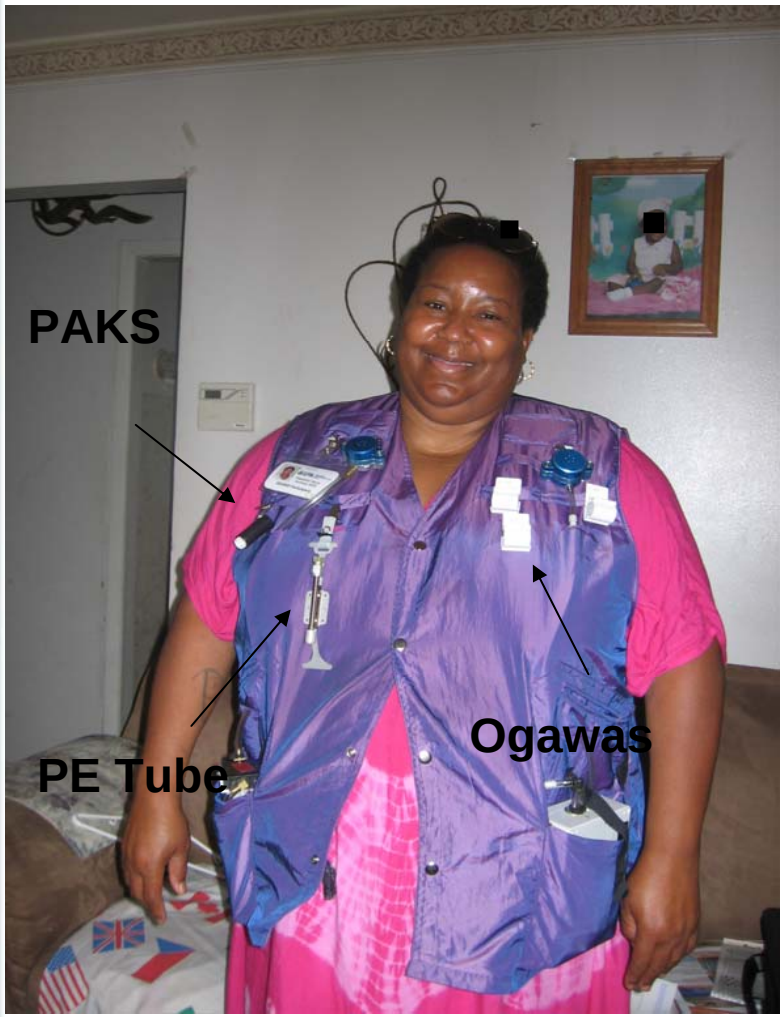
DEARS Measurements

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 (O_3, NO_2, SO_2)	X	--	X*	X
Aldehydes	X	X	X	X
VOCs	X	X	X	X
SVOCs	--	X	X	X
PAHs	--	X	X	X
Air Exchange Rate	--	X	--	--

* NO2 only

Use of Novel Passive or Active Samplers

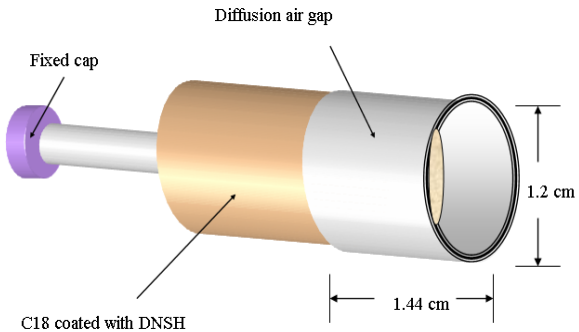


- 25VOCs (aromatics/HCs (9) + halogenated HCs (16))
- 3 carbonyls
- Continuous $PM_{2.5}$
- O_3, NO_2, SO_2

Passive Badges

PE Tube-Carbopack X

Ogawa



PAKS

Additional Novel Exposure Monitoring

- Coarse particle PM Exposure Monitoring (CPEM)
- Active PM2.5 Personal Nephelometer
- Canadian “CRUISER” monitoring at DEARS study areas.

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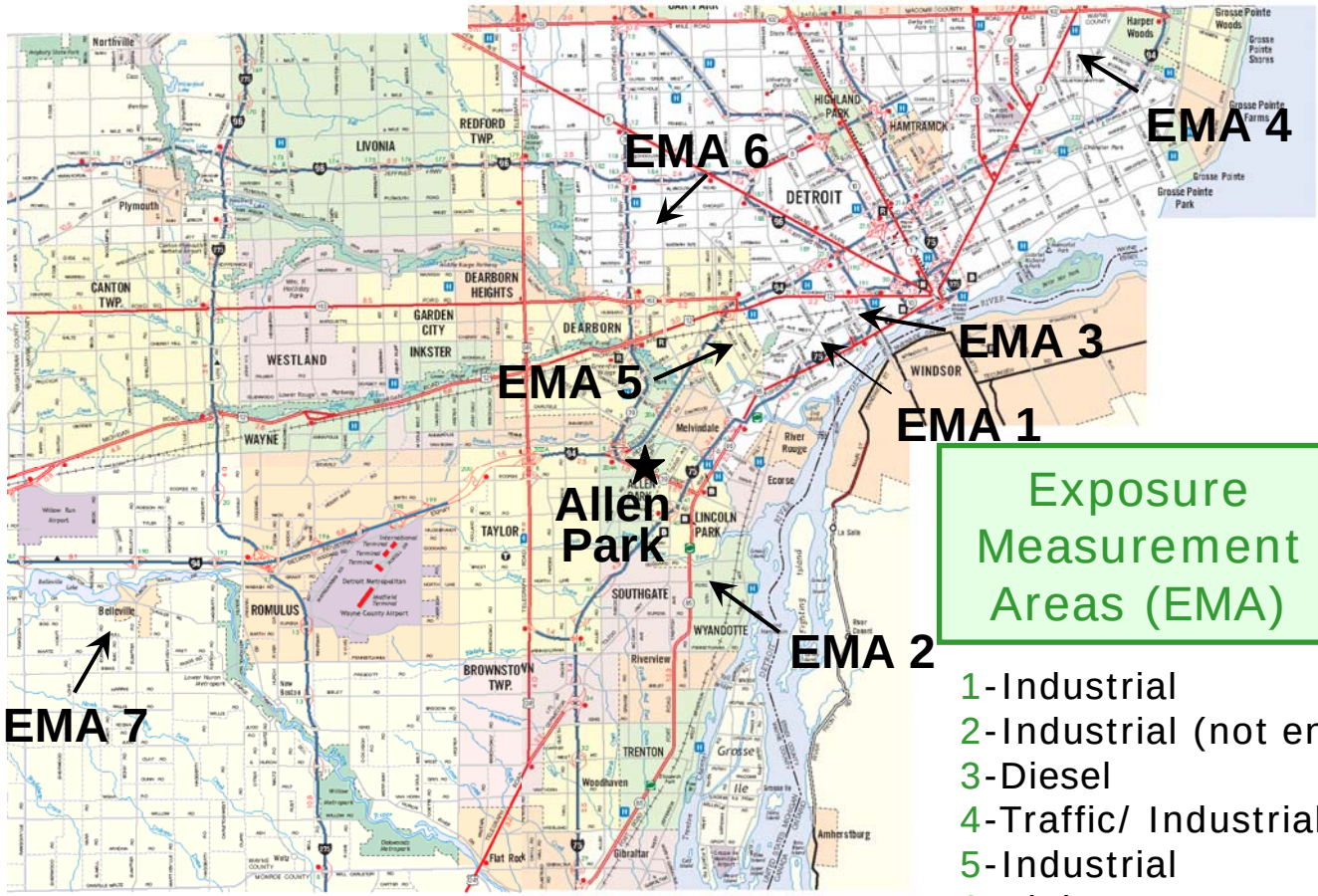
DEARS Study Sites



Exposure Measurement Areas (EMA)

1-Industrial
2-Industrial (not enrolled)
3-Diesel
4-Traffic/ Industrial
5-Industrial
6-Highway
7-Regional

Sampling Vest

- Personal monitoring vest
- Time Activity Diary
- 5 days, 2 seasons

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Indoor & Outdoor Monitoring

- Matched to personal and ambient instrumentation

Central Community Site Monitoring

- Community-based monitoring at Allen Park, an MDEQ air site central to the study area

Study Initiated- July 2004

Field Deployment Rates (%)

Metric	~Nominal attempts	Summer '04	Winter '05	Summer '05
PM	800-1930	97	98	96
EC-OC	470-560	93	96	99
Nitrate	460-560	93	93	94
Gases	820-1020	100	99	99
Carbonyl	680-770	99	99	98
VOC	720-870	99	99	98
MIE	600-660	> 90	92	96
SVOC	450-540	95	94	97
PFT	190-210	100	100	98

The DEARS performed data collection at a very high rate. In addition, a very high rate of valid data collection was typical (> 90%).

Completion of Field Monitoring

- Approximately 36,000 total individual daily records of individual pollutant or survey data
- Completion of formal interactions with human participants. Close out of Dearborn field office

Progress to Date

- Recovery of raw data from seasons 1-6 (SVOC, elemental exceptions)
- Validation of all primary seasons 1-4 datasets. Continued work secondary measures
- Development of integrated internal datasets for seasons 1- 4
- Ongoing validation of season 5-6 primary measures.
- Preliminary analyses on select objective goals using data from first four seasons

Future Efforts

- Full recovery and validation of remaining raw data (2008- most measures)
- Primary database development inclusive of all seasons (2008-most measures)
- Full integration of DEARS data within the NERL and associated modeling/source apportionment (select datasets by 2008)
- Development of peer review journal articles (some drafts already in progress). Many in 2008
- Development of public version of database (after 2010) and highly dependent upon funding

Today's Discussion

- Current data findings by study area leads on the areas most advanced
- Please ask questions
- Will include updates on related or non-DEARS associated studies involving the Detroit area