Detroit Near-Road Cooperative Exposure-Health Study

Near-road EXposures and effects from Urban air pollutants Study (NEXUS)

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- University of Michigan – Stuart Batterman, Toby Lewis, Tom Robbins, Laprisha Berry-Vaughn
- Community Action Against Asthma

Health Effects Institute
Comprehensive Review of Traffic Research (2010)

Traffic-related exposures are extensive and associated with adverse health outcomes

30-45% of people living in large North American cities live in traffic exposure areas

Conclusion: Traffic-related pollution may cause a range of health outcomes including cardiovascular and respiratory effects

Children are Especially Vulnerable to the Effects of Traffic

Children who lived within 500 m of a freeway had substantial deficits in lung growth from 10-18 years of age (Gauderman et al. 2007)

Children exposed to higher levels of traffic-related air pollution at school and home are at increased risk of developing asthma (McConnell et al. 2010)

NEXUS Looks at Effect of Traffic on Asthmatic Children in Detroit

Near-road **EX**posures and effects from **U**rban air pollutants **S**tudy (NEXUS)

Asthma prevalence rate for children in Detroit is 29% - three times the national average

Research funded through EPA's Science To Achieve Results (STAR) program

Partnership between ORD, University of Michigan and Community Action Against Asthma

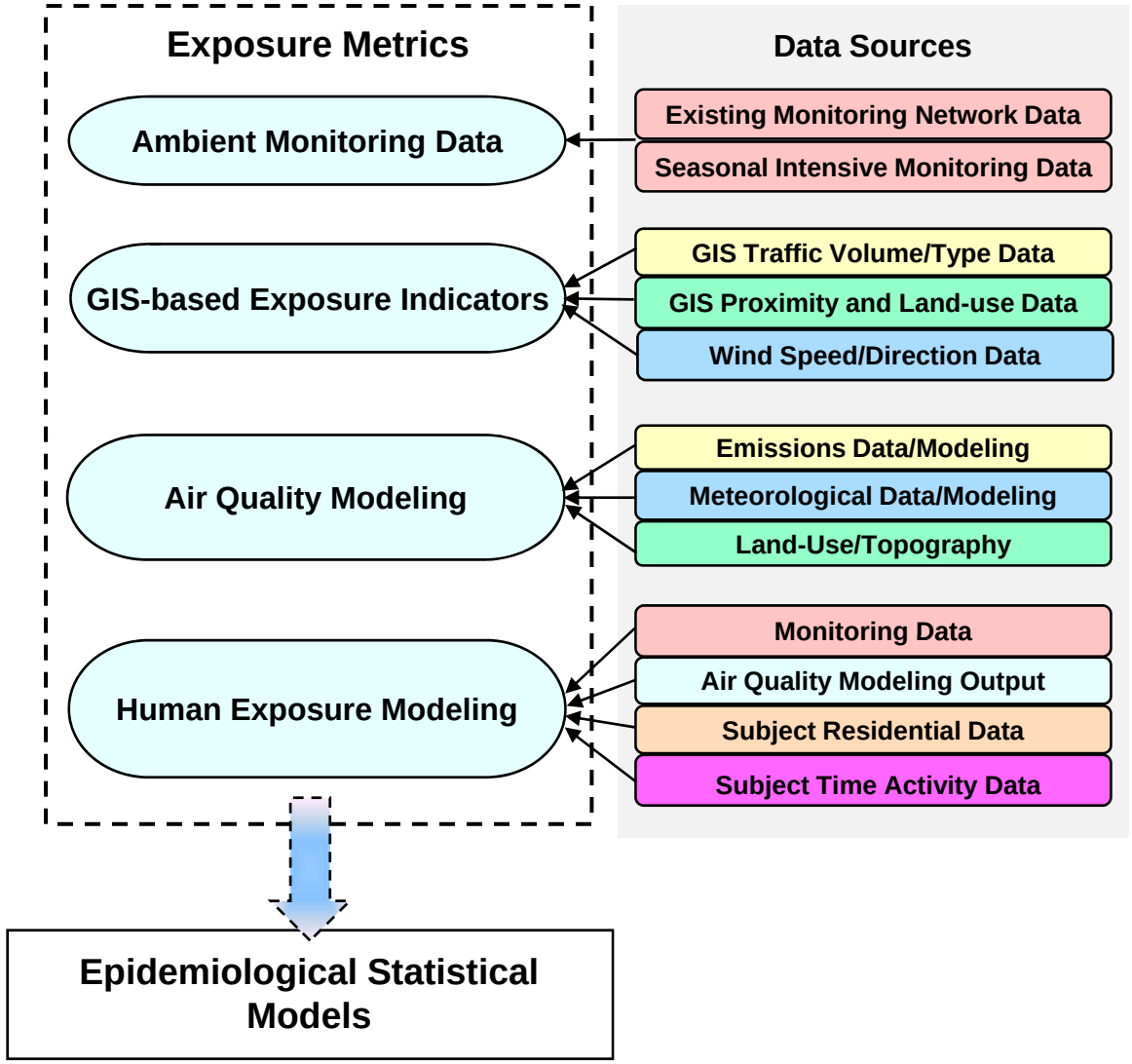
NEXUS Focuses on Three Research Questions

Which measures of traffic-related air pollution are most closely associated with aggravated asthma?

Do children with asthma who live near major highways show more inflammation and other biological responses?

Does traffic exposure influence the likelihood of respiratory viral infections in children with asthma?

Tiered Exposure Metrics



Hypothesis –

Refined exposure estimates will provide greater power to detect epidemiologic associations

Study Design

Health Measures

- Health Assessment Fall 2010
  - Health Measures 2 weeks for each subject
- Health Assessment Winter 2010/11
  - Health Measures 2 weeks for each subject
- Health Assessment Spring 2011
  - Health Measures 2 weeks for each subject
- Health Assessment Summer 2011
  - Health Measures 2 weeks for each subject

Measurements

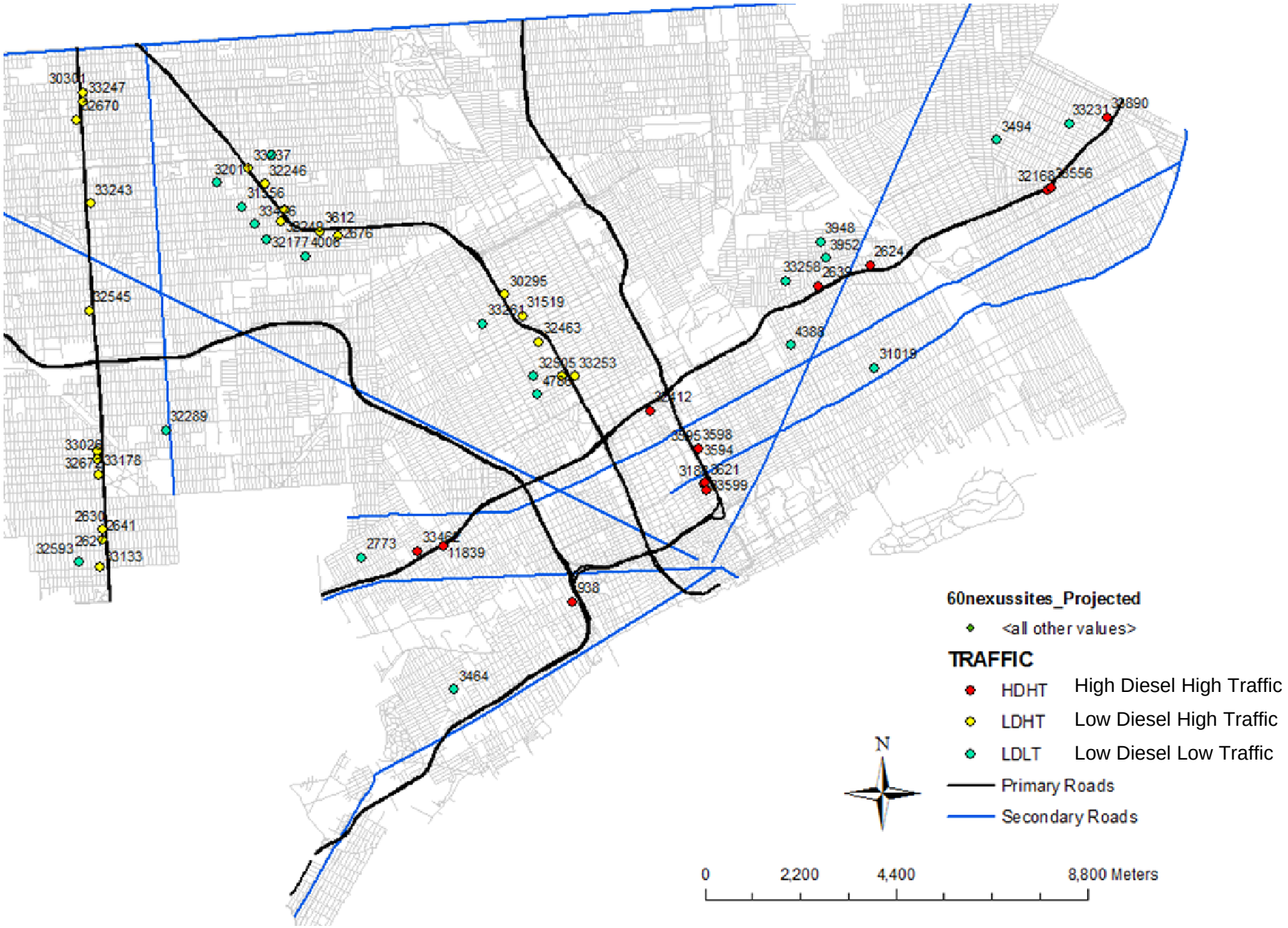
- MDEQ Monitoring
- I96 Measurements
- I96 Supplemental Measurements
- School Measurements
- Residential Measurements
  - 5 subjects per week
- I96 Supplemental Measurements
- School Measurements
- Residential Measurements
  - 4 subjects per week

Exposure Estimates

- GIS Exposure Indicators
- GIS Exposure Indicators
- GIS Exposure Indicators
- GIS Exposure Indicators
- AERLINE Residential and School Outdoor Estimates
- Exposure Model Residential Indoor and Personal Exposure Estimates

Methods

- Cohort description:
  - 60+ children ages 6-16 with persistent asthma
  - 3 groups each living within 150 m of
    - High traffic/high diesel (>90K/>6K),
    - High traffic/low diesel (>90K/<4.5K)
    - Low traffic (<25K; >300 m from roadway)
- Health measures and biomarkers (collected seasonally and when colds reported):
  - Nasal lavage, respiratory tract infections, lung function FeNO



Timeline

- Sept, Oct, Nov 2010
  - Fall AQ/exposure measurement campaign
  - Seasonal health assessment
- Dec 2010, Jan, Feb 2011
  - Seasonal health assessment
  - Long-term measurements at I-96 site
- March, April, May 2011 –
  - Spring AQ/exposure measurement campaign
  - Seasonal health assessment

Residential/School Measurements

~ 30 homes – indoor and outdoor

2 schools (outdoor)

Fall and Spring (~7 weeks each)

- $PM_{2.5}$ (daily)
- PM_{coarse} (weekly)
- Black carbon
- CO
- NOx
- Particle number
- Meteorology

} Continuous

- Home floor dust (mold)

School Measurements

Determine relative impact of mobile and industrial sources

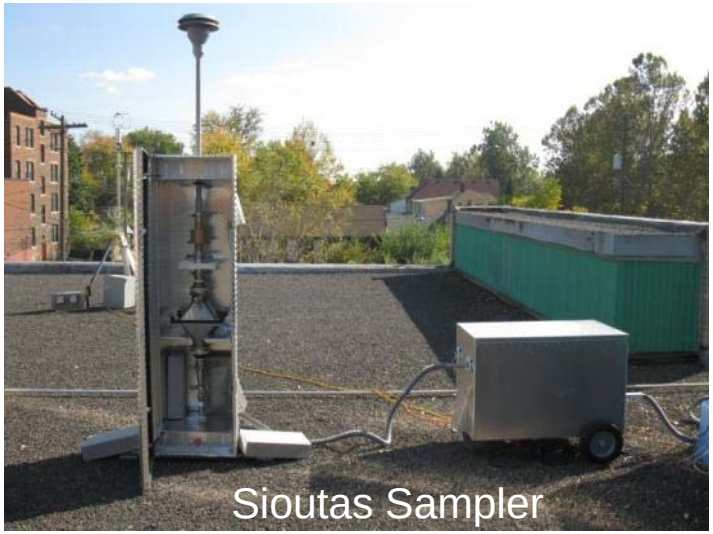
Toxicology – link with epidemiological associations

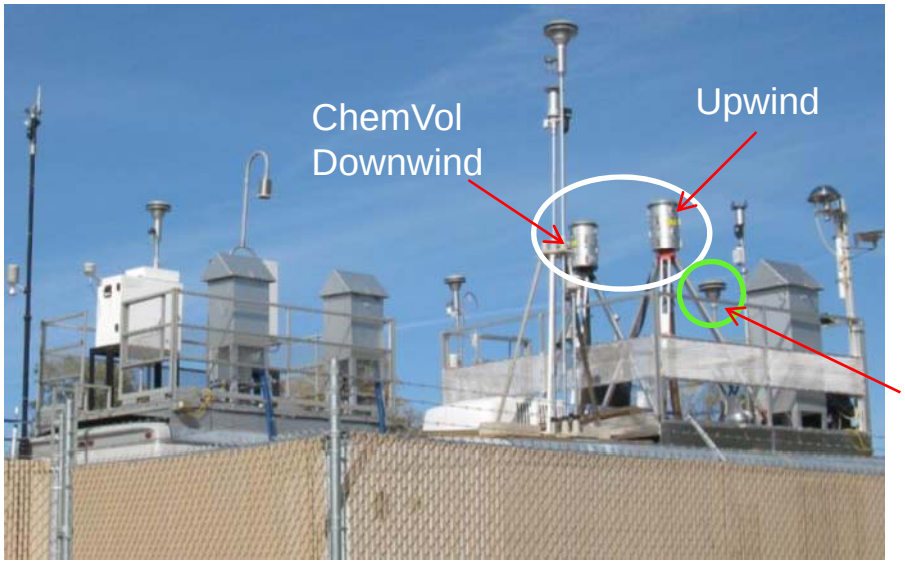
2 schools – Maybury & Ludington

Fall and Spring (~7 weeks each)

- Volatile organic compounds
  - 1-in-2 day
  - 6–10 am
- $PM_{2.5}$
  - Organic and elemental composition
  - 1-in-2 day frequency
  - 3 samples: 6–10 am; 10 am–4 pm; 4 pm–6 am
- PM_{coarse}, $PM_{2.5}$, $PM_{0.18}$
  - 2-in-3 day frequency
  - Toxicology studies
- PM_{coarse}
  - SEM stubs
  - Weekly
- PM size/speciation
  - DRUM sampler
  - 3-hr resolution

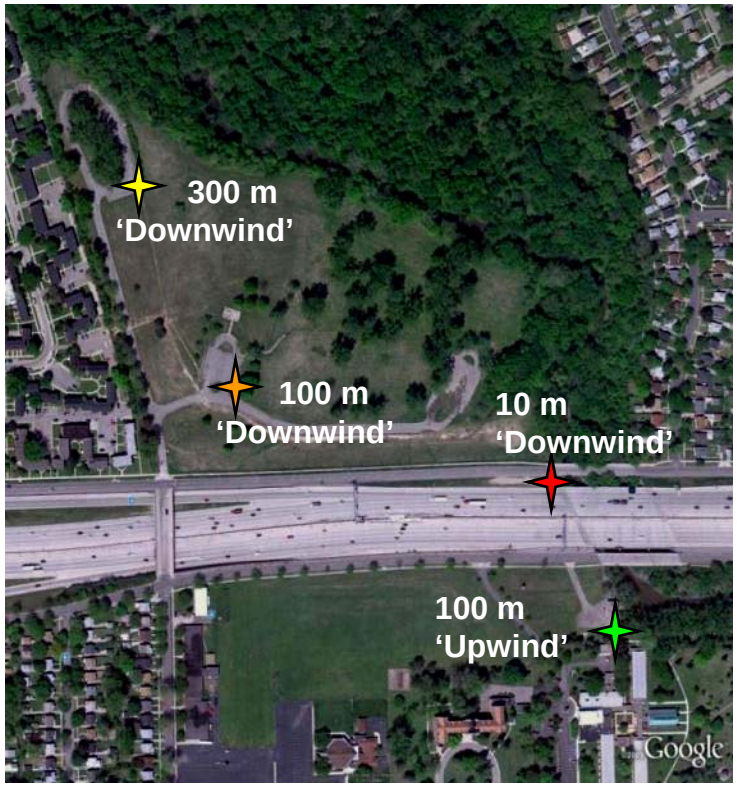
Particle Toxicology Studies





- Coarse, fine and ultrafine particles collected near-road
- Extracted particles:
  - Chemically analyzed
  - Instilled in mice
- Pulmonary and cardiac responses evaluated
- Evaluating portable sampler to for toxicology studies

I-96 Spatial Transect Study
Seasonal Intensives



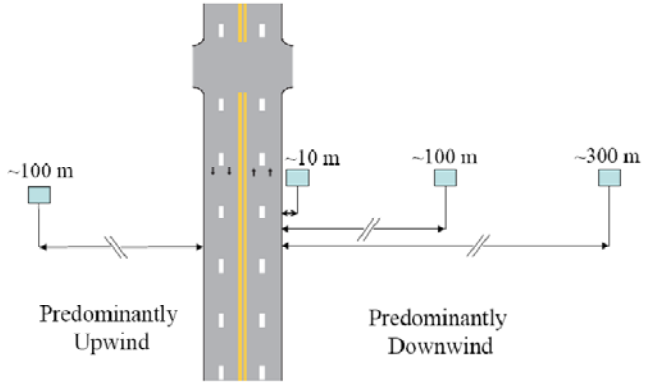
- BC, NO/NO_2, CO
- Particle size distribution
- VOCs
- Toxicology (PM_{coarse}, $PM_{2.5}$, $PM_{0.1}$)
- $PM_{2.5}$ speciation (organics & metals)

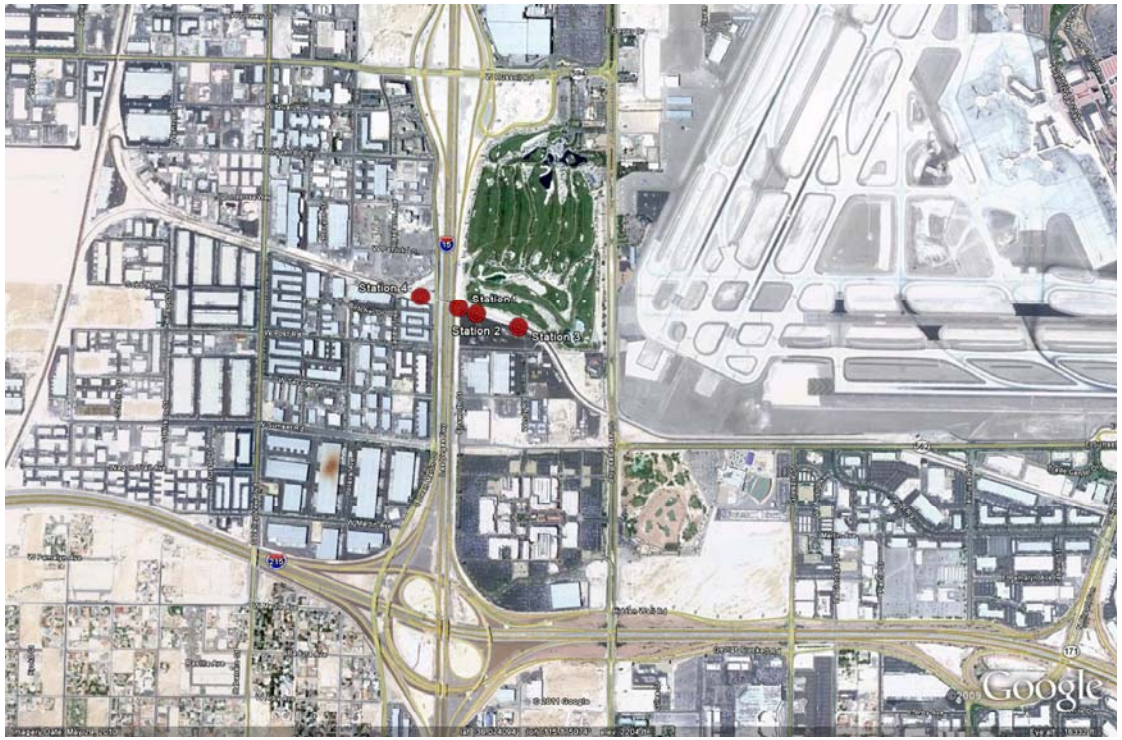
- PM_{coarse}
- $PM_{2.5}/PM_{coarse}$
- DRUM sampler
- FHWA Protocol Measurements

Quantifying Traffic Contribution

- Detailed chemical characterization of PM and VOCs analyzed with source-receptor models
  - PMF, Unmix
  - Differentiate combustion/non-combustion and diesel/gasoline
- High time-resolution measurements used to identify local-scale impacts (traffic, industry)
  - APTR (Air Pollutant Transport to Receptor)
  - NTA (Non-parametric Trajectory Analysis)

Separating the Air Quality Impact of a Major Highway and Nearby Sources by Nonparametric Trajectory Analysis

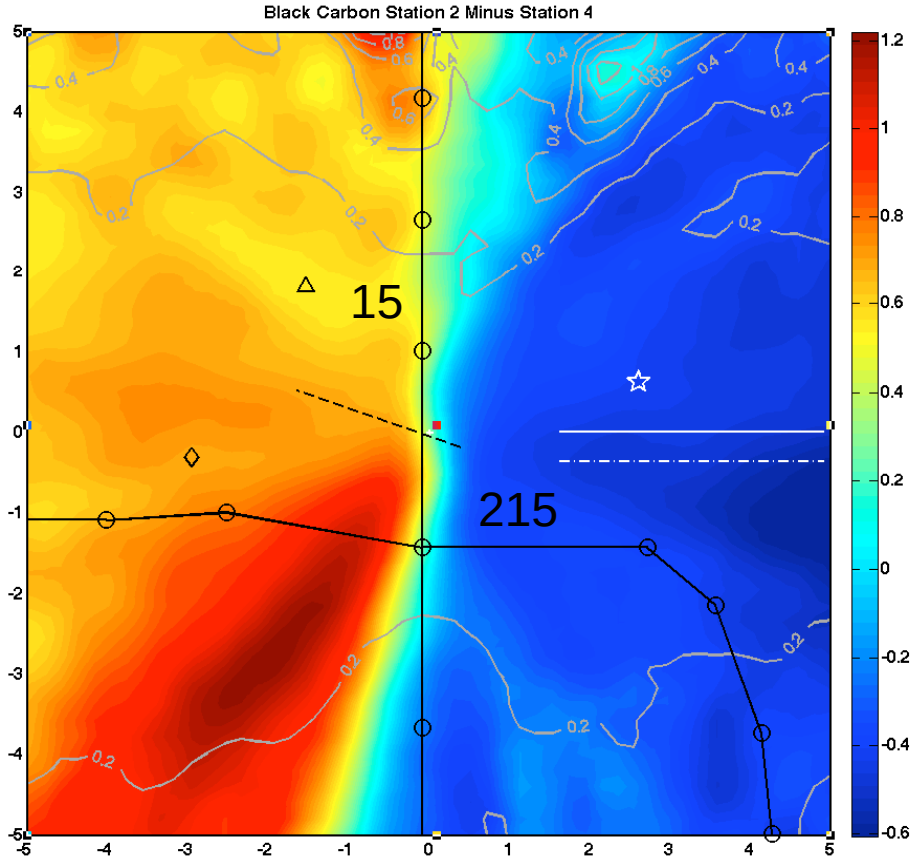




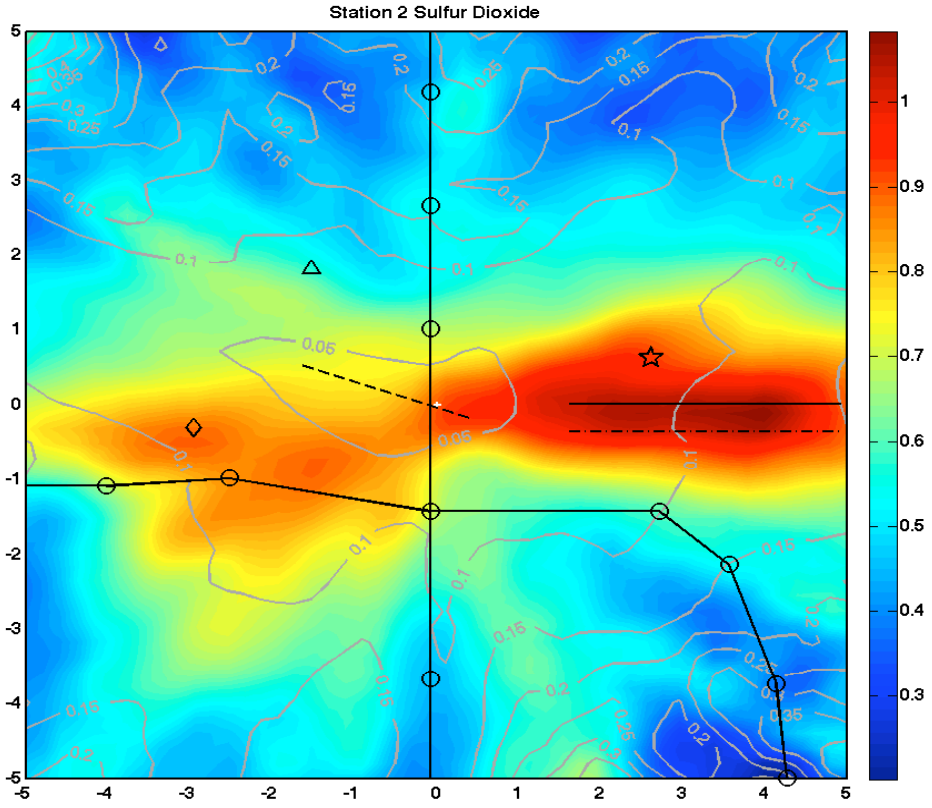
Location and distances of monitoring stations to evaluate concentrations of mobile source related air pollutants adjacent to the I-15 freeway. Stations 1 – 3 are at increasing downwind distances; station 4 is upwind.

Ron Henry, Alan Vette, Gary Norris, Ram Vendantham, Sue Kimbrough, Richard Shores

The impact of the I-15 highway shown by Station 2 - Station 4. Station 2 is at the origin.



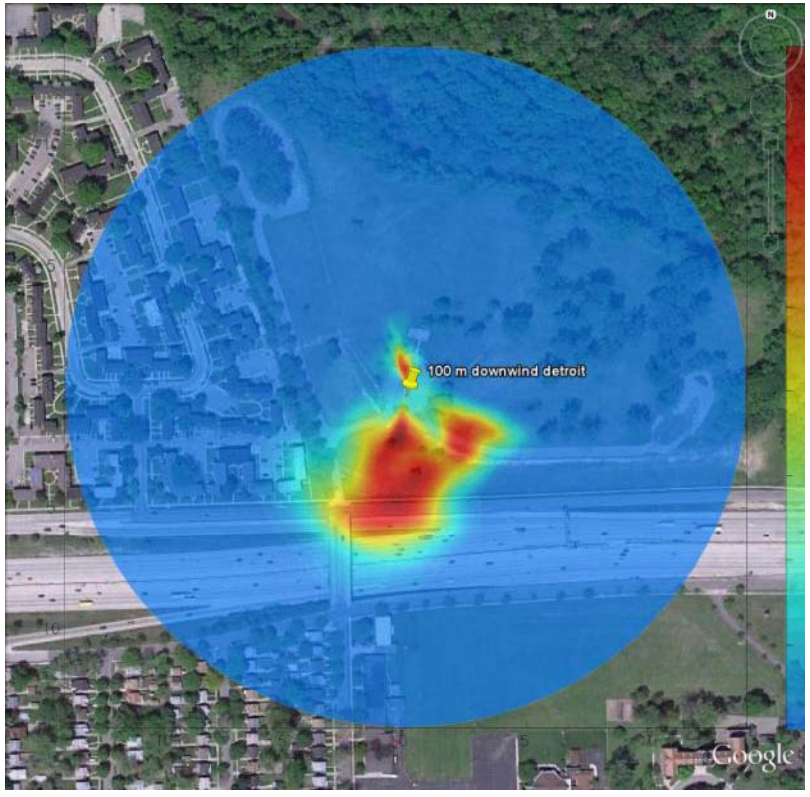
NTA map of sulfur dioxide in ppb at station 2.



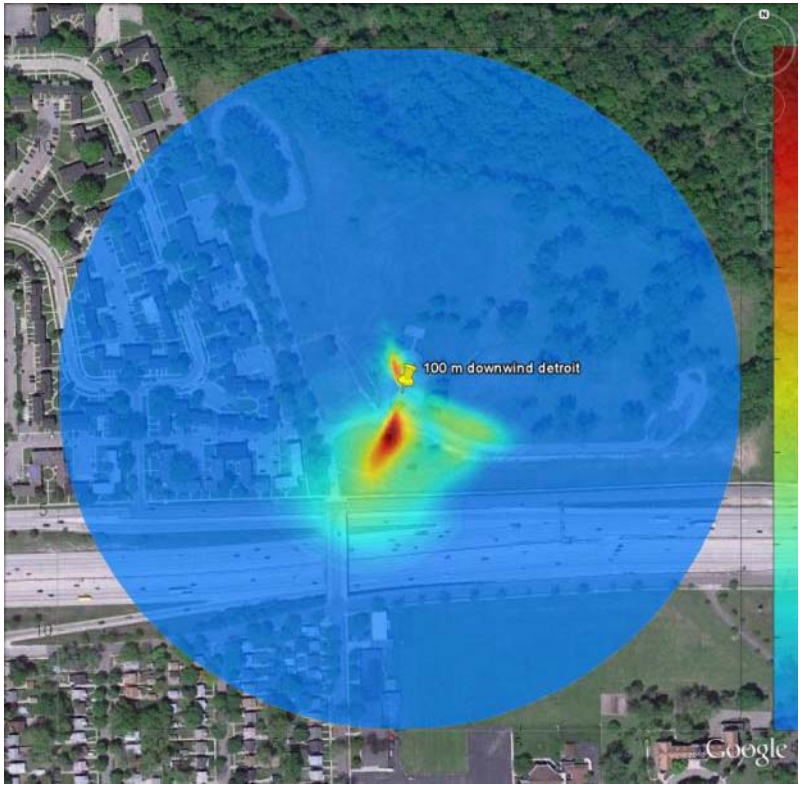
NEXUS Initial Results

Sustained Wind Incidence Method (SWIM)

SHARP 5 minute $PM_{2.5}$



NOx

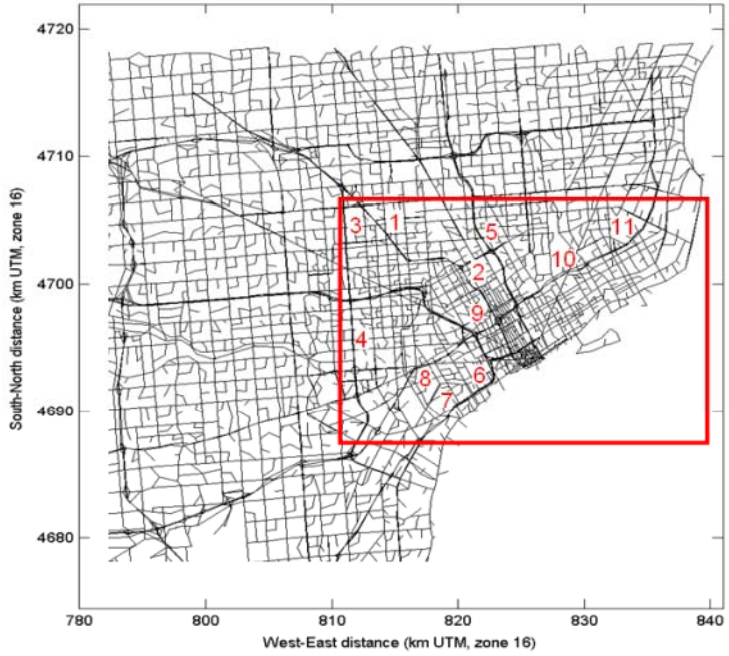


Air Pollution Dispersion Modeling

- Modeled concentrations used as a primary input to epidemiologic analysis
- 2-step hybrid modeling process to reduce uncertainty

1. Screening level modeling

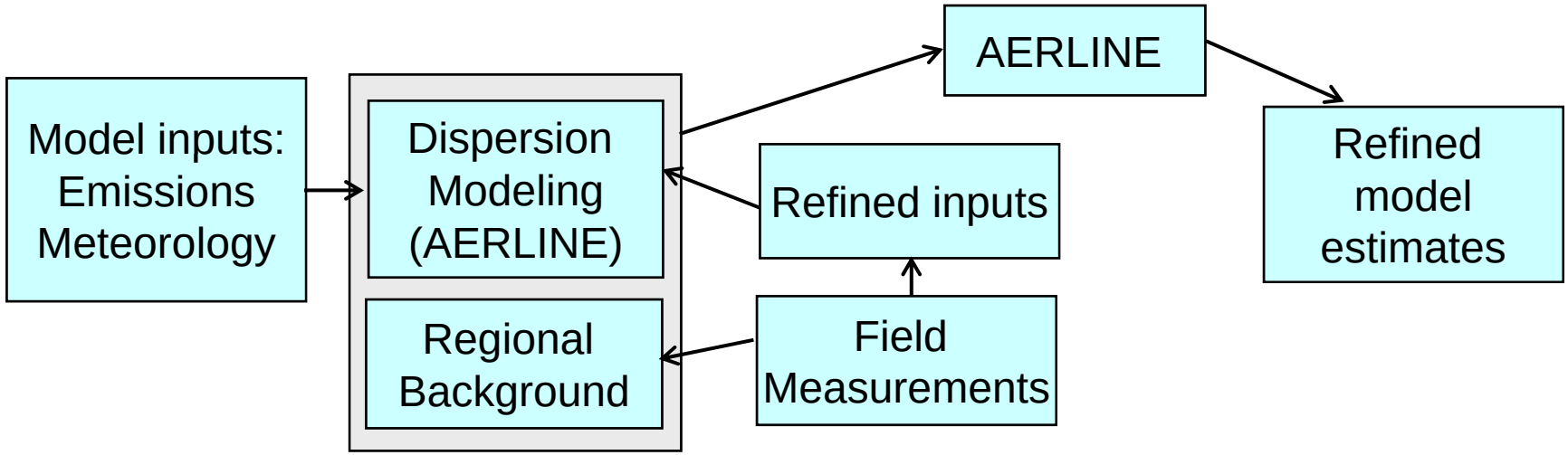
- Existing emissions and met. data
- Capture spatial gradients (near-road and other sources)
- Identify complex configurations for wind tunnel simulations
- Typical approach used to determine roadway impacts.



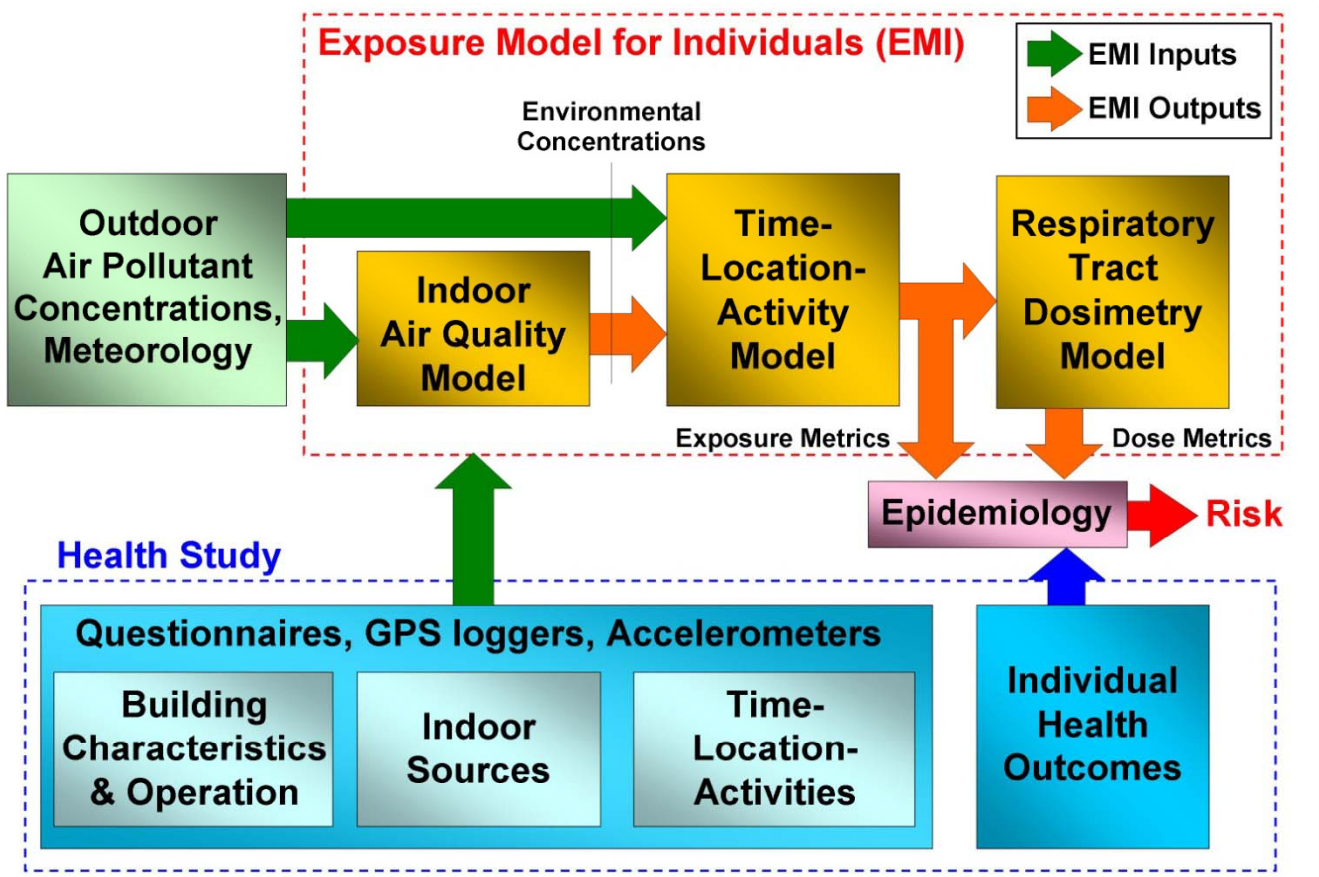
Air Pollution Dispersion Modeling

2. Refined modeling

- Emissions and met. data contemporaneous with field study
- Primary emissions from mobile sources superimposed on "background" levels
- Evaluated with outdoor measurement data
- Provide pollutant surface (spatial and temporal) across health study domain
- Primary $PM_{2.5}$ EC/OC and EC from diesel, NOx, CO, and MSAT (benzene)



Exposure Model for Individuals



EMI Web site: www.epa.gov/heasd/emi