Role of Sensors and Data in an Integrated Transportation and One Health Approach

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Deputy Assistant Administrator for Science Policy
Office of Research and Development

11th Annual International PEMS Conference
Riverside, CA

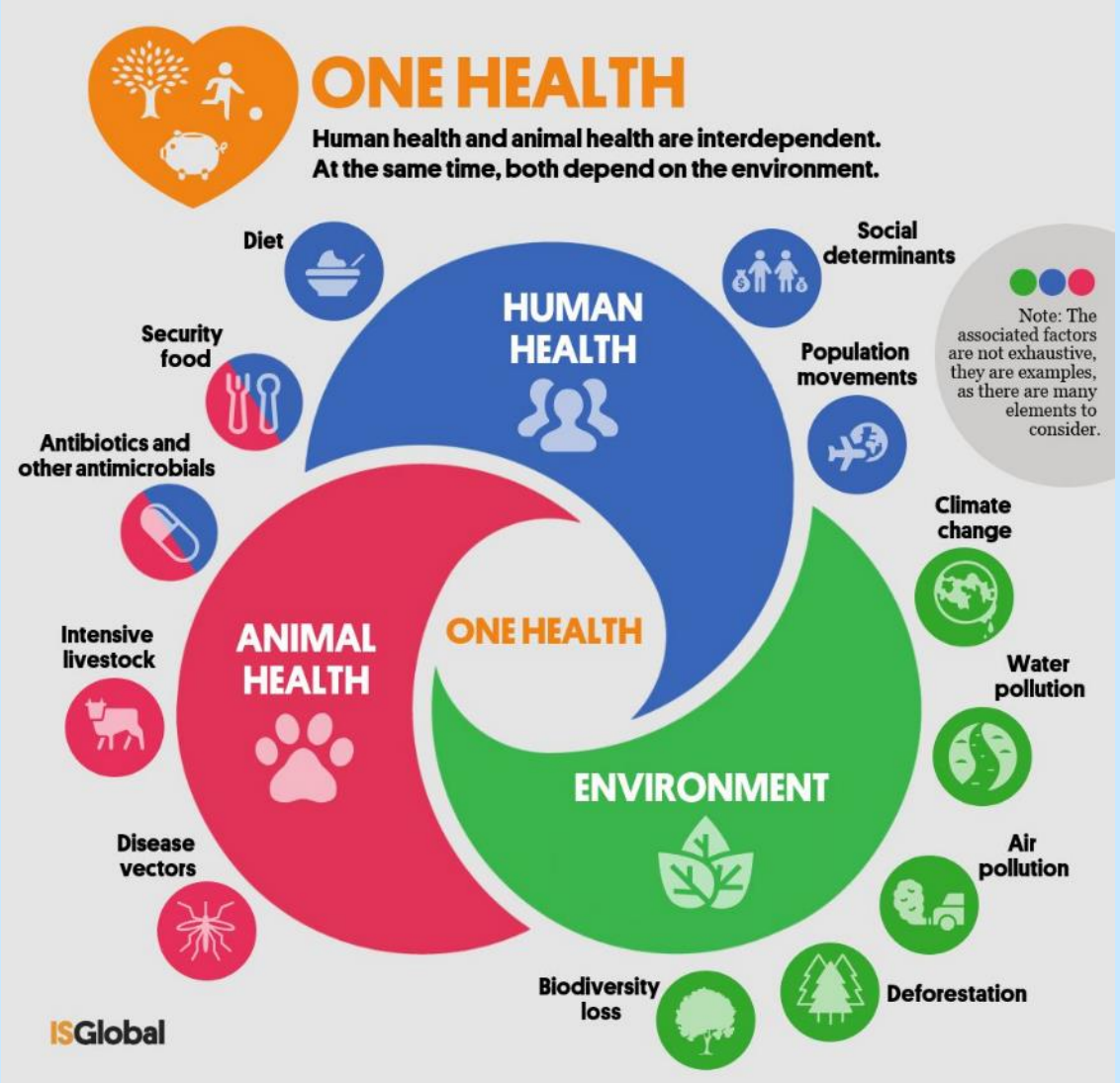
March 17, 2022

- Over-Arching Contexts
- Office of Research and Development
- ORD Research on Source to Impact Continuum
- High Resolution Data
- Opportunities

One Health

Thompson, 2013, Int J Parasitol. 43(12):1079-1088
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7126848/

One Health & Environmental Contaminants



Barcelona Institute of Global Health
https://www.isglobal.org/en/-/one-health-una-sola-salud-

EPA's Mission

To protect human health and the environment.

One Health Actions by EPA

Laws

- Clean Air Act
- Clean Water Act
- TSCA
- RCRA
- Superfund (CERCLA)
- FIFRA
- ESA

More Law Summaries

Regulated Topics

- Asbestos
- Certifications (608, etc.)
- Mold
- Drinking Water
- Lead
- Waste
- Per- and Polyfluoroalkyl Substances (PFAS)

Find more topics

Regulated Sectors

- Agriculture
- Automotive
- Construction
- Electric Utilities
- Oil & Gas Extraction
- Transportation

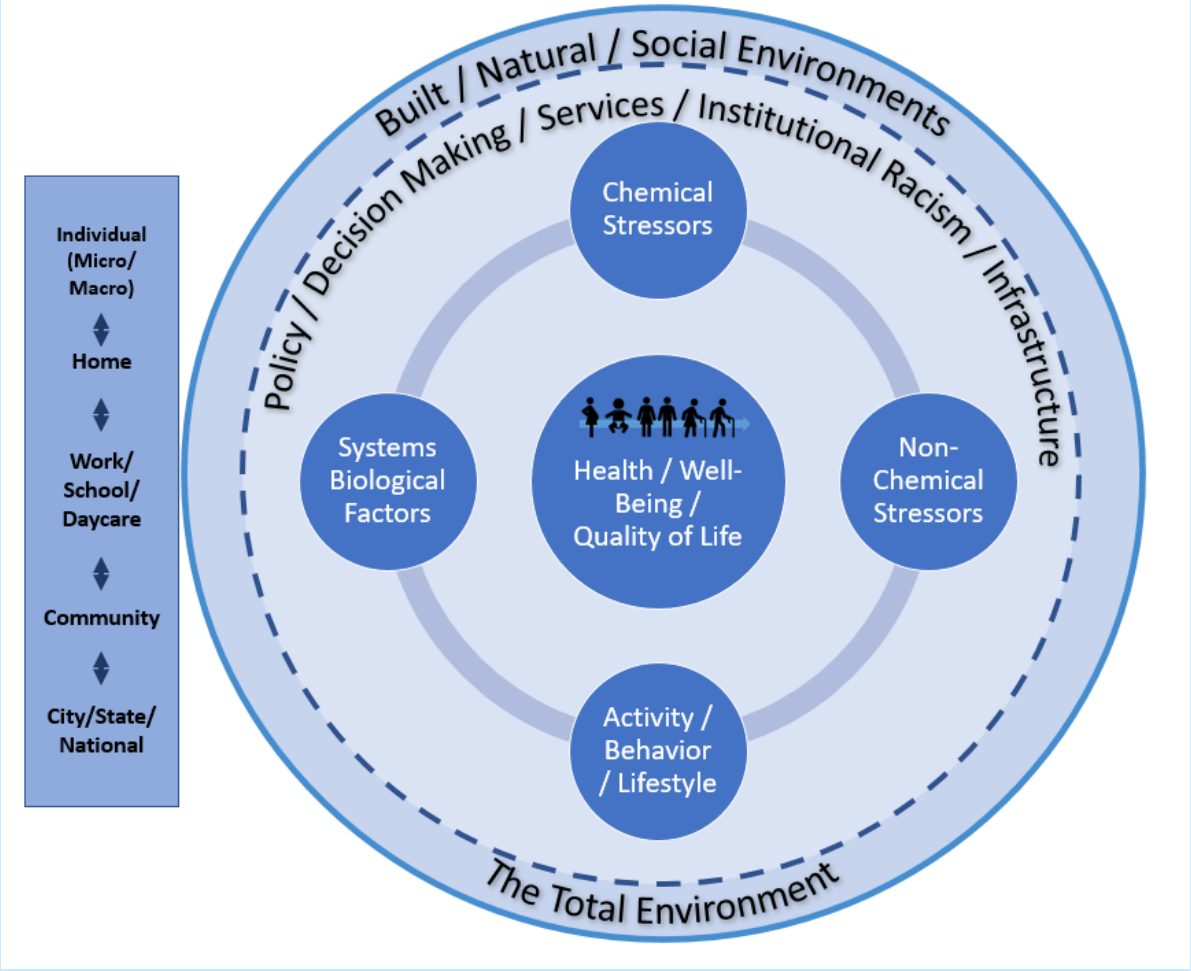
Find more sectors

https://www.epa.gov/laws-regulations

One Health and Transportation

- Transportation systems interact not just with humans, but also modify the natural environment.
- Holistic approaches to improving community health and wellbeing via transportation improvements can address One Health.
- The work that the PEMS community does is an important contributor to characterizing the spatial and temporal distribution of chemical stressors.

Positive/Neutral/Negative Influences of the Total Environment (Built, Natural, Social)



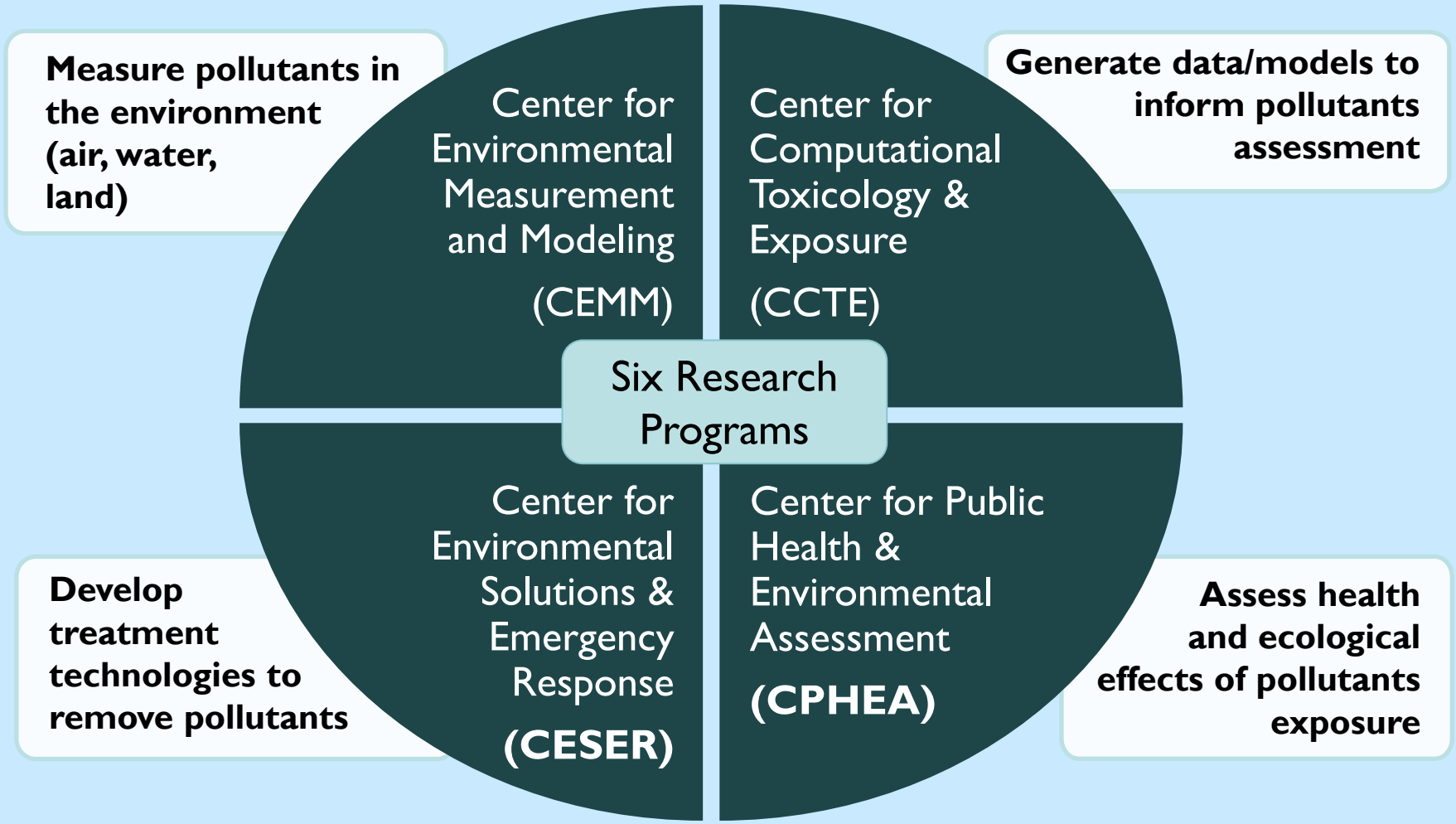
Adapted from Tulve, N. S., Ruiz, J. D. C., Lichtveld, K., Darney, S. P., & Quackenboss, J. J. (2016). Development of a Conceptual Framework Depicting a Child's Total (Built, Natural, Social) Environment in Order to Optimize Health and Well-Being. Journal of Environment and Health Science, 2 (2), 1-8.

EPA's Office of Research and Development

- ORD conducts research, providing the foundation for credible decision making to protect human health and the environment

- ORD's Mission: To provide the best available environmental science and technology to inform and support human health and environmental decision making at the federal, state, tribal, and local levels, addressing critical environmental challenges and anticipating future needs through leading edge research.

ORD's research is carried out by four Centers



ORD's Research Programs

ORD's work is focused into six research programs

Air, Climate, & Energy

Chemical Safety for Sustainability

Homeland Security

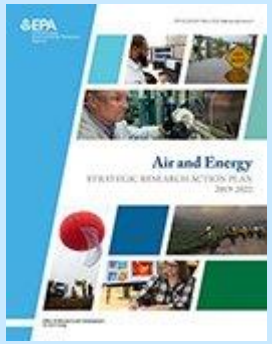
Health & Environmental Risk Assessment

Safe & Sustainable Water Resources

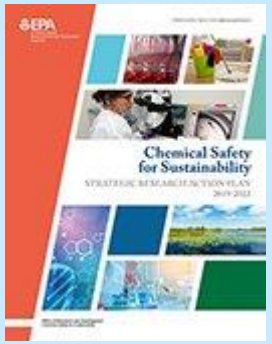
Sustainable & Healthy Communities

ORD Research Planning

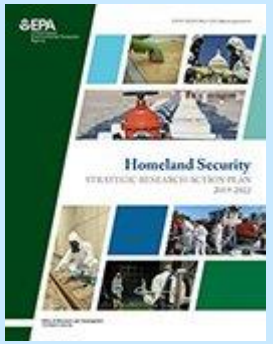
ORD is in the middle of a long-term research planning cycle, developing Strategic Research Action Plans (StRAPs) for FY23-FY26.



Air, Climate, & Energy

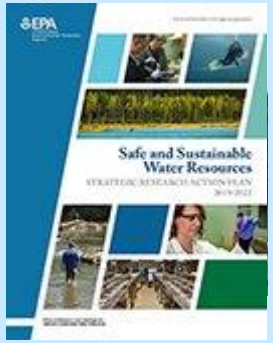


Chemical Safety for Sustainability

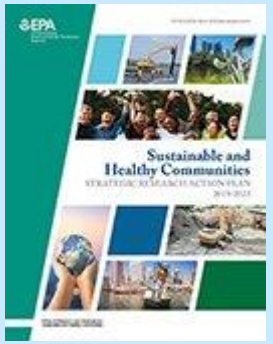


Homeland Security

Health & Environmental Risk Assessment



Safe & Sustainable Water Resources



Sustainable & Healthy Communities

ORD Cross-Cutting Research Priorities

Environmental Justice

Cumulative Impacts

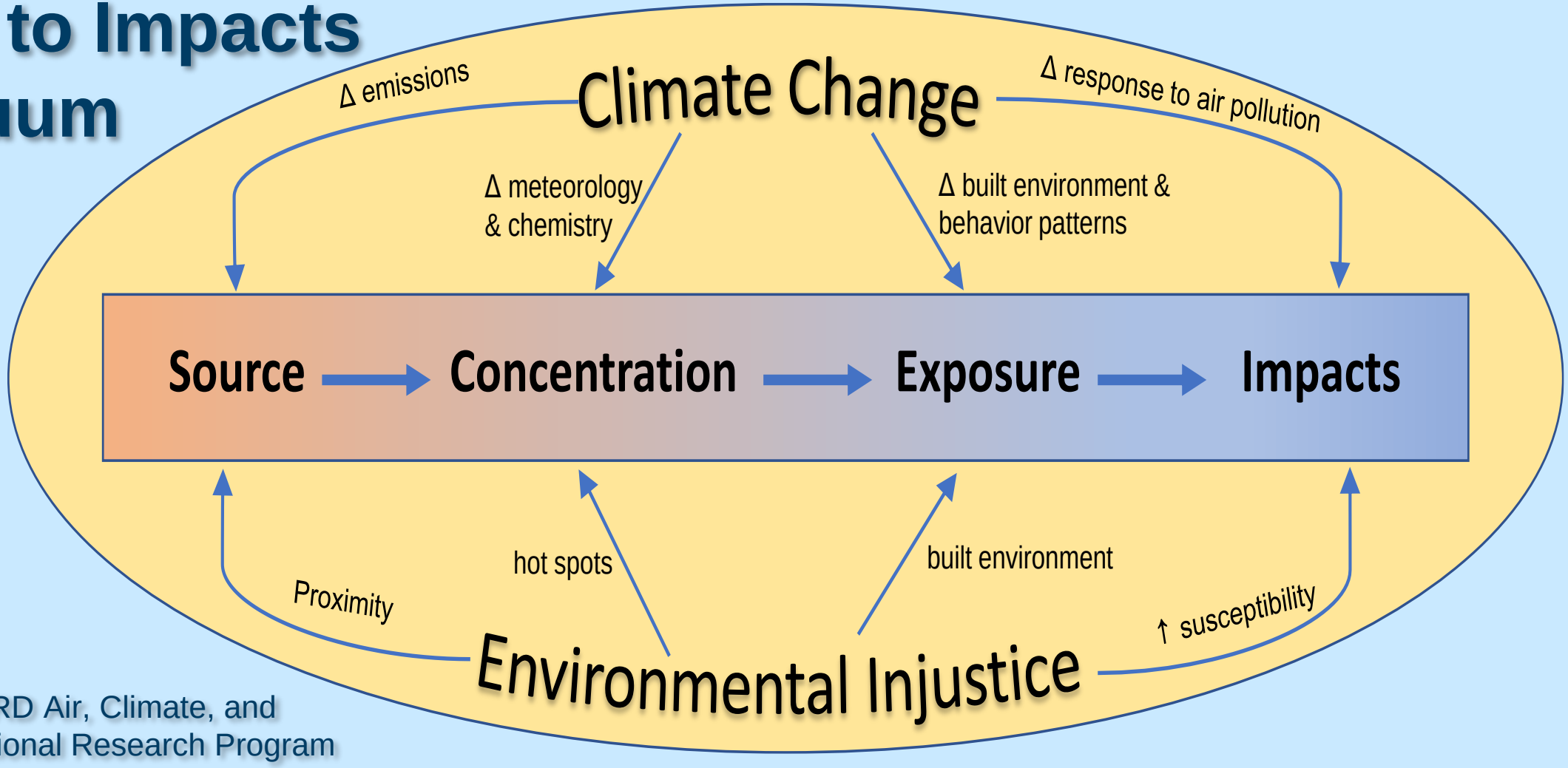
Climate Change

Community Resiliency

Children's Environmental Health

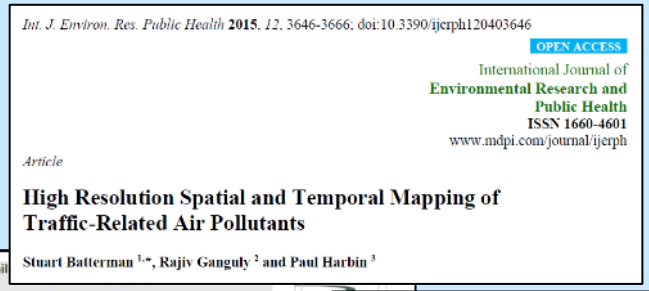
Contaminants of Immediate and Emerging Concern

Source to Impacts Continuum



Source: ORD Air, Climate, and Energy National Research Program

Environmental Justice Considerations (examples)



Int. J. Environ. Res. Public Health 2015, 12, 3646-3666; doi:10.3390/ijerph120403646

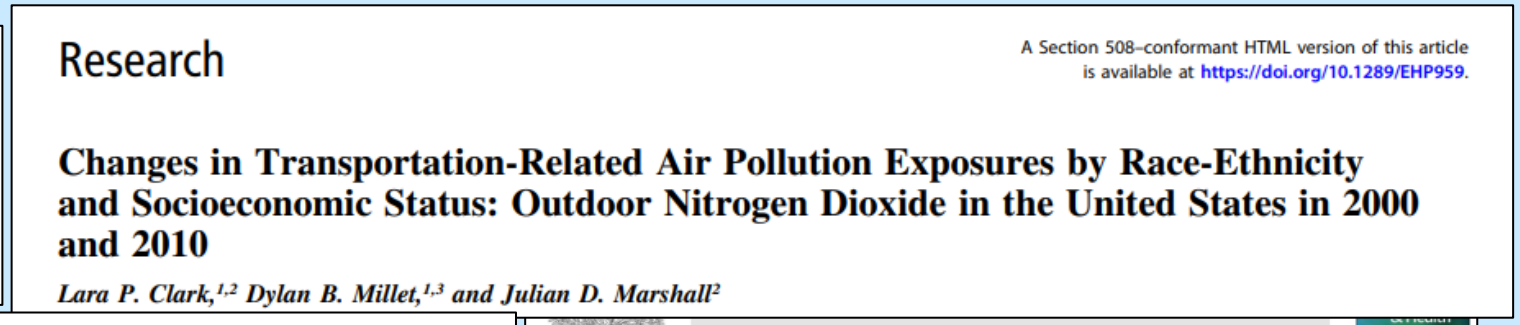
OPEN ACCESS

International Journal of Environmental Research and Public Health
ISSN 1660-4601
www.mdpi.com/journal/ijerph

Article

High Resolution Spatial and Temporal Mapping of Traffic-Related Air Pollutants

Stuart Batterman [1,*], Rajiv Ganguly [2] and Paul Harbin [3]

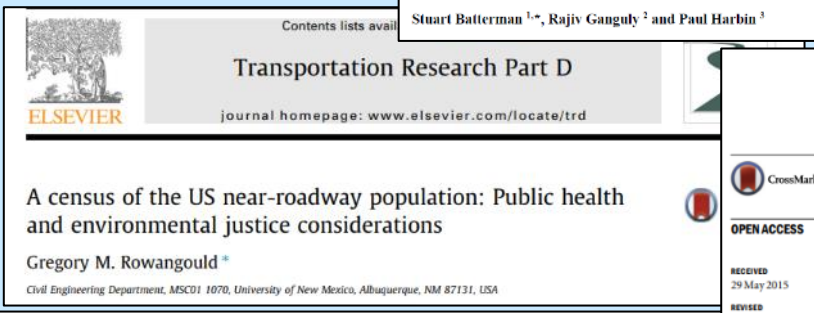


Research

A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP959.

Changes in Transportation-Related Air Pollution Exposures by Race-Ethnicity and Socioeconomic Status: Outdoor Nitrogen Dioxide in the United States in 2000 and 2010

Lara P. Clark,[1,2] Dylan B. Millet,[1,3] and Julian D. Marshall[2]



Contents lists avail

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

ELSEVIER

A census of the US near-roadway population: Public health and environmental justice considerations

Gregory M. Rowangould *

Civil Engineering Department, MSC01 1070, University of New Mexico, Albuquerque, NM 87131, USA

Environmental Research Letters

CrossMark

LETTER

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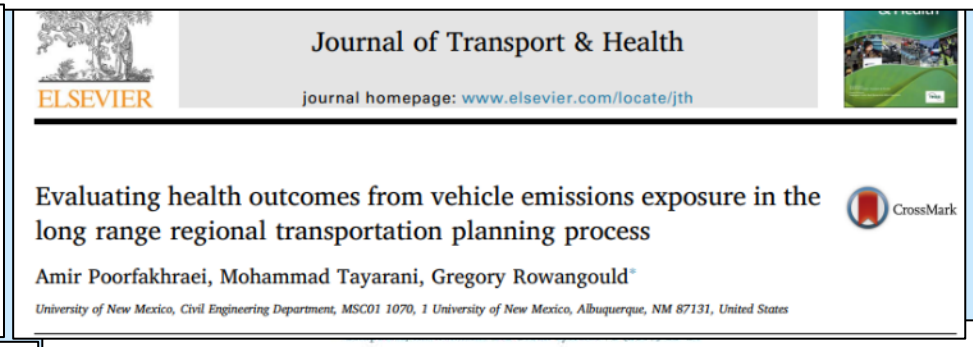
Household-level disparities in cancer risks from vehicular air pollution in Miami

Timothy W Collins, Sara E Grineski and Jayajit Chakraborty

Department of Sociology and Anthropology; University of Texas at El Paso; El Paso, TX 79968, USA

E-mail: twcollins@utep.edu, segrineski@utep.edu and jchakraborty@utep.edu

Keywords: air pollution, environmental justice, generalized estimating equations, health risk disparities, race/ethnicity



Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

ELSEVIER

Evaluating health outcomes from vehicle emissions exposure in the long range regional transportation planning process

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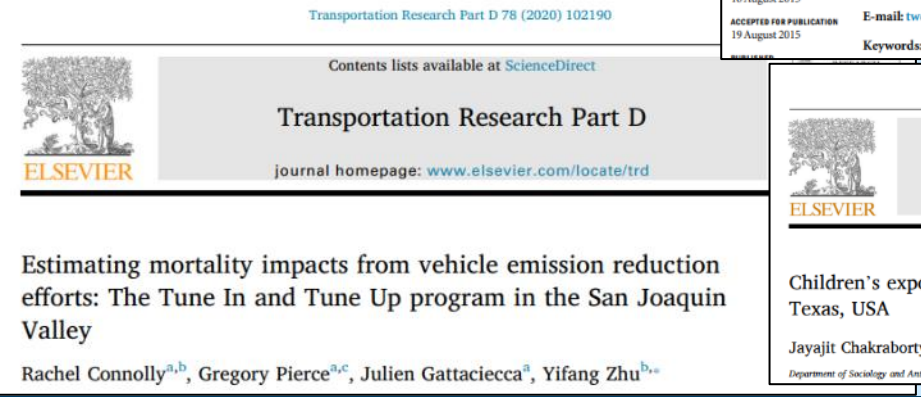
Amir Poorfakhraei, Mohammad Tayarani, Gregory Rowangould*

University of New Mexico, Civil Engineering Department, MSC01 1070, 1 University of New Mexico, Albuquerque, NM 87131, United States



Transportation Research Part D 78 (2020) 102190

Contents lists available at ScienceDirect

Transportation Research Part D

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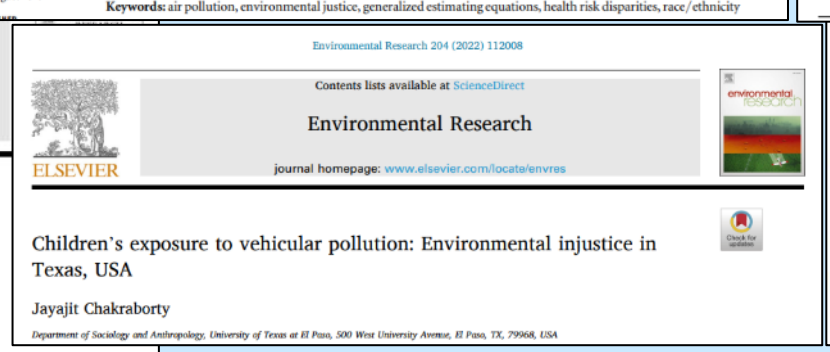
ELSEVIER

Estimating mortality impacts from vehicle emission reduction efforts: The Tune In and Tune Up program in the San Joaquin Valley

Rachel Connolly[a,b], Gregory Pierce[a,c], Julien Gattaciecca[a], Yifang Zhu[b,*]



Environmental Research 204 (2022) 112008

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ELSEVIER

Children's exposure to vehicular pollution: Environmental injustice in Texas, USA

Jayajit Chakraborty

Department of Sociology and Anthropology, University of Texas at El Paso, 500 West University Avenue, El Paso, TX, 79968, USA

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journal homepage: www.elsevier.com/locate/ceus

ELSEVIER

Agent-based modeling to estimate exposures to urban air pollution from transportation: Exposure disparities and impacts of high-resolution data

Sashikanth Gurram[a,d], Amy Lynette Stuart[a,b,*], Abdul Rawoof Pinjari[c]

What common questions do community members have?

Should I be concerned about air pollution in my community?

How do air pollution concentrations change from place to place in my community?

What are the causes of air pollution in my community?

Supplementing data collected in national air monitoring networks, a variety of monitoring strategies exist to provide answers to these common questions. Models can provide important complementary information. This presentation is primarily about monitoring.

Measurement considerations for these questions

Should I be concerned about air pollution in my community?	Measure air pollutant types of concern using methods that are accurate enough to compare against benchmark values
How do air pollution concentrations change from place to place in my community?	Measurements should be precise enough to determine changes in concentrations and support multi-location measurement
What are the causes of air pollution in my community?	Measurement strategy is needed, which could involve complementary modeling and combining ancillary data to explore local and distributed source contributions to air pollution concentrations

Common measurement research strategies to isolate local-scale impacts

Note: These two strategies can be used in combination

Strategy 1: Evaluate whether spatial differences exist for pollutant types of interest

Known source of interest → Measure here → Measure here → Measure here

Distance from source

C_{loc} estimated by the difference between locations (downwind – upwind; near – far)

Conducted with:
Instruments onboard mobile platform
or
Multiple fixed monitoring stations

Strategy 2: Measure quickly to assess how pollutant concentrations change with wind

Known or unknown source → Measure here, quickly → Known or unknown source

Source location and C_{loc} estimated using wind and air pollutant data; supporting information if available (e.g., source activity data)

Conducted with:
One or multiple fixed monitoring stations; includes meteorological measurements

Community-Focused Research Needs

- Environmental Justice
- Community stakeholder perspective: science-informed action to solve problems
- EPA's National Environmental Justice Advisory Committee (NEJAC) (2004):
  - Promote a paradigm shift to community-based approaches, particularly community-based participatory research and intervention
  - Develop and implement efficient screening and targeting methods/tools to identify communities needing immediate intervention

Decision-Makers

Individuals

Communities

Companies

Local Government (City, County)

State Government

Federal Government

Health Impact Assessment (HIA)

is one method of accounting for combinations of chemical and non-chemical stressors in a decision-focused manner.

HIA's rely on extensive collaboration between community members, scientists, and government

Courtesy of Tim Barzyk, ORD

Impacts
Air/water/soil quality
Community/household economics
Education
Exposure to hazards
Healthcare access/insurance
Housing
Infectious disease
Land use
Traffic Safety
Mental health
Access to goods and services
Noise pollution
Nutrition
Parks and recreation
Physical activity
Water Resources
Safety and security
Social capital
Soil quality

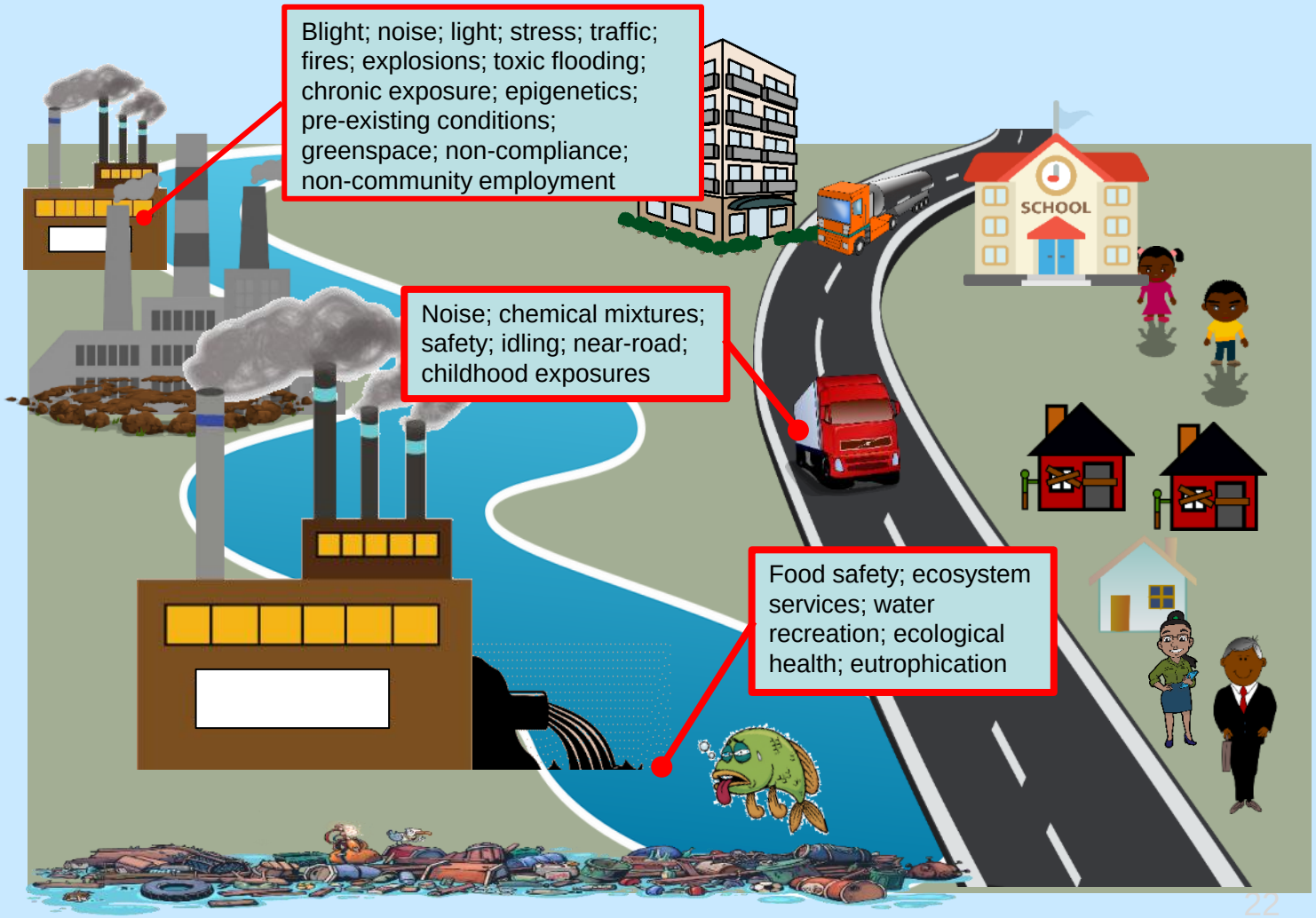
Health Effects

- attention deficit disorder (ADD)/attention deficit hyperactivity disorder (ADHD) - alcoholism/substance abuse - allergies - anemia - anxiety - arthritis - asthma - behavioral health/development - birth defects - bronchitis - cancer - carbon monoxide poisoning - cardiovascular/circulatory health - central nervous system function - childhood growth/development - cholesterol - chronic disease - chronic obstructive pulmonary disease (COPD) - cognitive function - communicable disease - depression - diabetes - diarrhea - disability - dyslipidemia - emphysema	- endocrine disorders - eye/nose/throat/lung irritation - fatigue - food-borne illness - gallbladder disease - genotoxicity - gynecological/reproductive health - headaches - hearing loss/impairment - heart attack - heart disease - heat/cold related illnesses - hypertension/high blood pressure - immune system/function - infection - infectious disease - inflammation/inflammatory response - injury - irregular heart beat - kidney disease/disorder - lead poisoning - learning disabilities/reduced learning - life expectancy - liver disease/health - low birth weight - lung disease/health	- malnutrition - mental health - metabolic disorder/disease - morbidity - mortality/death/fatality - musculoskeletal/bone & joint - myocardial infarction - nausea - neurological health - nutrition - obesity/weight - osteoporosis - overall/general health - physical health - physiological health - pneumonia - psychological health - rape - respiratory health - sexually transmitted disease - sick building syndrome - sleep apnea - sleep disturbance - stress - stroke - suicide - ulcers - vector borne illness - water borne illness/water toxics exposure

Rhodus et al. 2012. A Review of Health Impact Assessments in the U.S.: Current State-of-Science, Best Practices, and Areas for Improvement.

Cumulative Impacts

- EPA-regulated pollutants are one of many issues of concern for communities
- While EPA cannot address all health risks in communities, understanding these interactions is important for decision-making



Courtesy of Tim Barzyk, ORD

Cumulative Impacts

ORD will integrate efforts across research programs to improve understanding of cumulative impacts and develop and apply the necessary models, methods, and tools to conduct real-world assessments that result in both adverse and beneficial health and environmental effects.

- Addressing the cumulative impacts of exposure to multiple chemical and non-chemical stressors is necessary with the best available science.
- Internal and external partners can make informed, scientifically credible decisions to protect and promote individual, community, and environmental health.

Cumulative Impacts White Paper: Recommendations for ORD Research

Cumulative Impacts

Summary of Recommendations

Establish the Decision Context and Stakeholder Engagement

Identify partners, policies, decisions and tools; engage partners to translate research into action; and establish trust and true partnerships with communities.

Address Scientific Considerations for Meeting Partner Needs

Develop fit-for-purpose approaches to characterize exposures; evaluate health disparities and well-being impacts; identify intervention points; and evaluate impacts of policies and interventions.

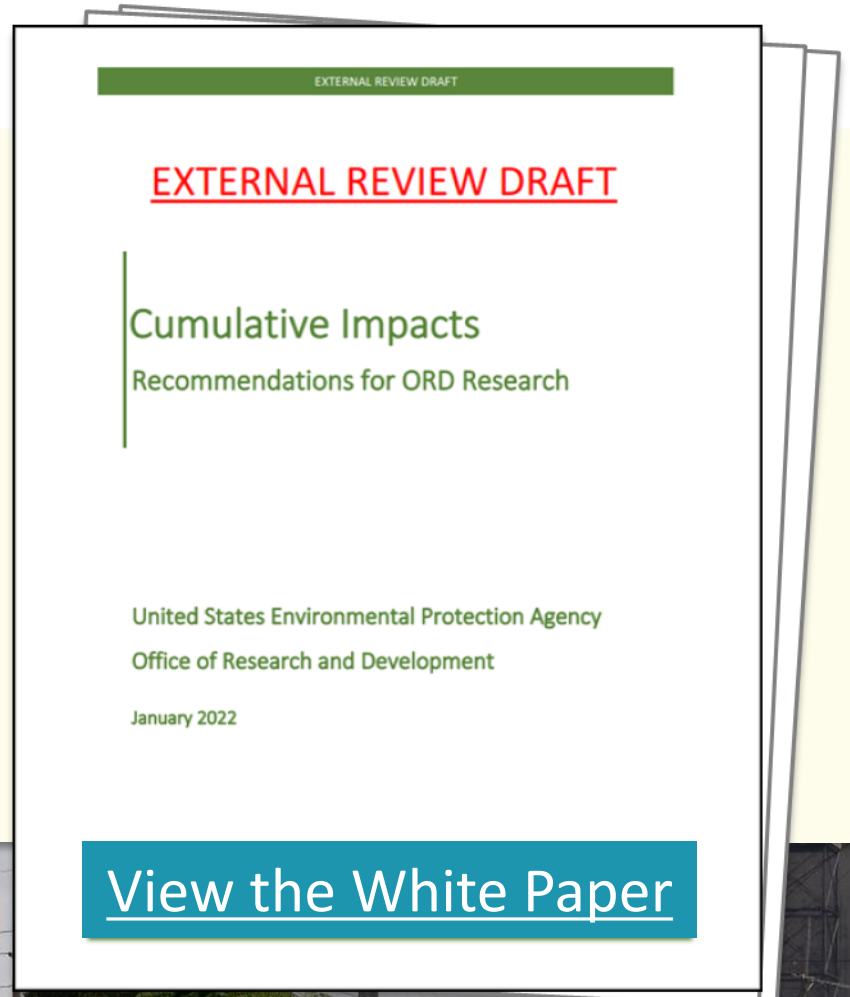
Empower Local Decisions and Actions

Support fit-for-purpose use of community-generated data; provide access to transparent data; offer training and technical support on EPA methods, guidance, and tools for cumulative impact assessment.

Summary of Recommendations

Support Science Translation and Delivery

Deliver solutions that improve community health and well-being and translate approaches and results for broader contexts.



View the White Paper

Provide Research Mgmt Support for Cumulative Impact Assessment

Integrate cumulative impact research into ORD's portfolio; address technological, workforce and culture issues; build partnerships to advance cumulative impact research and policy.

Science Advisory Board Consultation

ORD collaborated with program and regional offices on a ‘OneEPA’ joint SAB Consultation on cumulative impact assessment.

Consultation occurred on March 2&7, 2022

Consultation sought advice on the following:

1. Understanding and accounting for uncertainties in the use of cumulative impact assessment for a range of both near- and long-term Agency decision-making contexts, including regulatory, permitting, land-use decisions, and more.
2. Contents and recommendations in the Cumulative Impacts White Paper, including research directions to develop the science to support these cumulative impact assessments.

Transportation-Related ORD Research

Emissions Characterization

- Chassis Dynamometers
- On-board Measurements (PEMS)
- Analytical Laboratories

Air Quality and Exposure Assessments

- Mobile Monitoring
- Fixed-site Sampling
- Portable Sensors
- Wind Tunnel
- CFD Modeling

Health Effects

- Epidemiological
- Toxicological

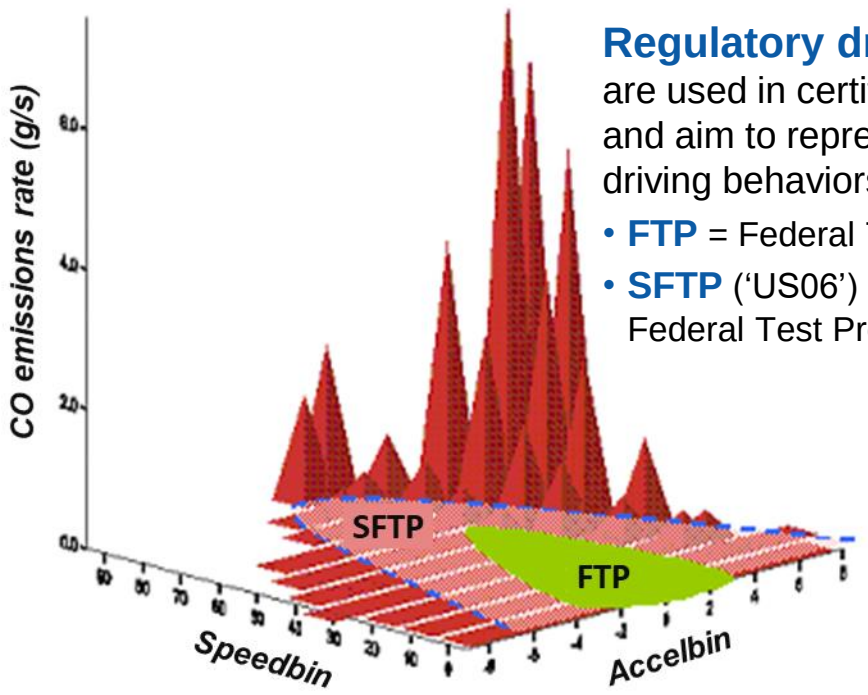
Courtesy of Rich Baldauf

Emissions Examples

- Motor vehicle emissions while operating on alternative and renewable fuels
  - Ethanol-blends with gasoline
  - Biodiesel
- Current and new technology vehicle emissions
  - Understand deterioration and future benefits from new technologies
  - Tier 2 and 3 Light-Duty and GDI vehicles
  - 2010 compliant Heavy-Duty trucks
- Effects of cold temperature and cold start conditions
- Brake and tire wear (including nano-materials)
- Influence of driving activity on emission changes
- Projects in US and internationally

Courtesy of Rich Baldauf

On-Board Measurements



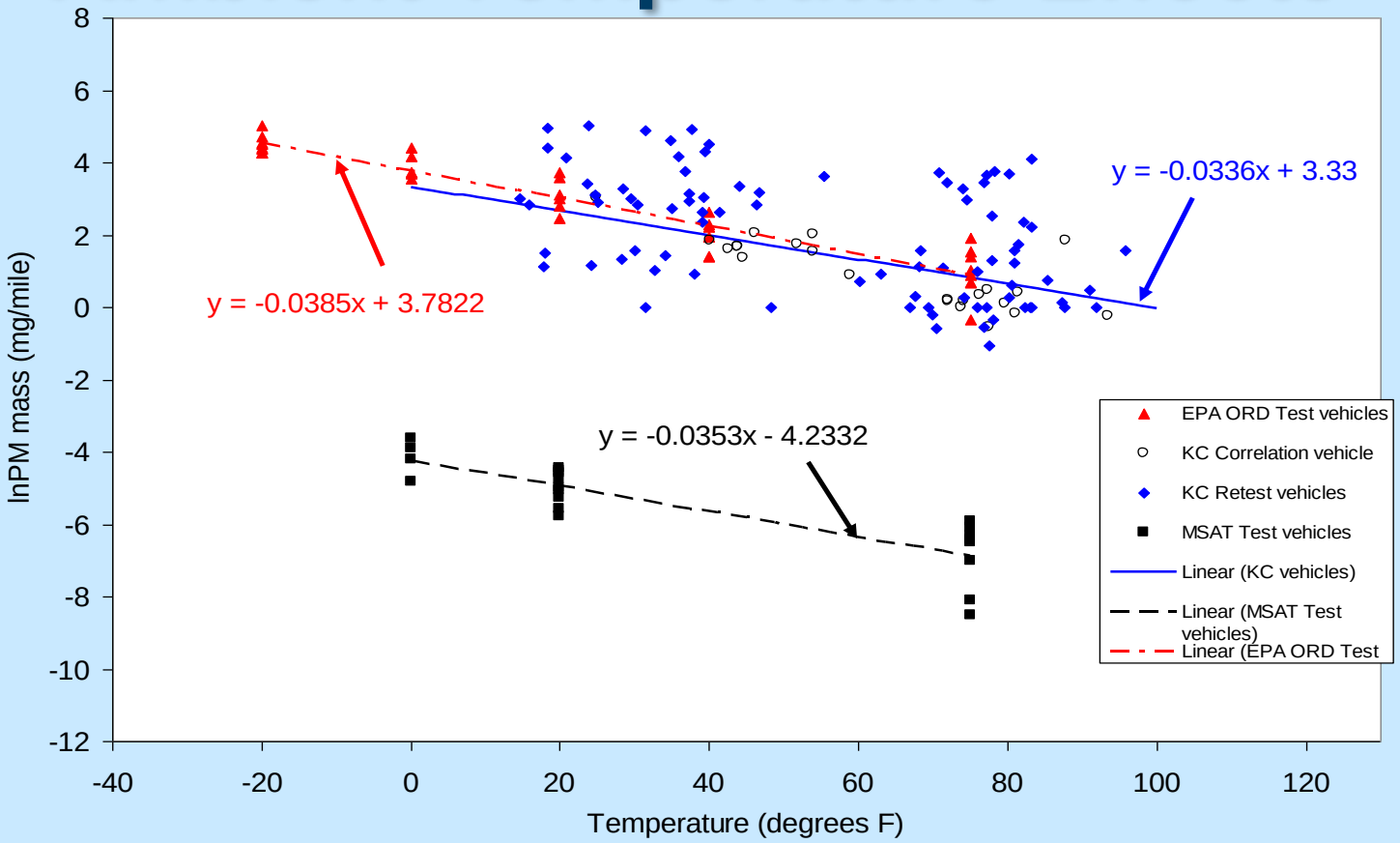
Regulatory driving cycles are used in certification tests and aim to represent vehicle driving behaviors

- **FTP** = Federal Test Procedure
- **SFTP** ('US06') = Supplemental Federal Test Procedure

Emissions can greatly increase when driving conditions fall outside our federal test methods, notably at high speed/acceleration

Courtesy of Rich Baldauf

Ambient Temperature Effects



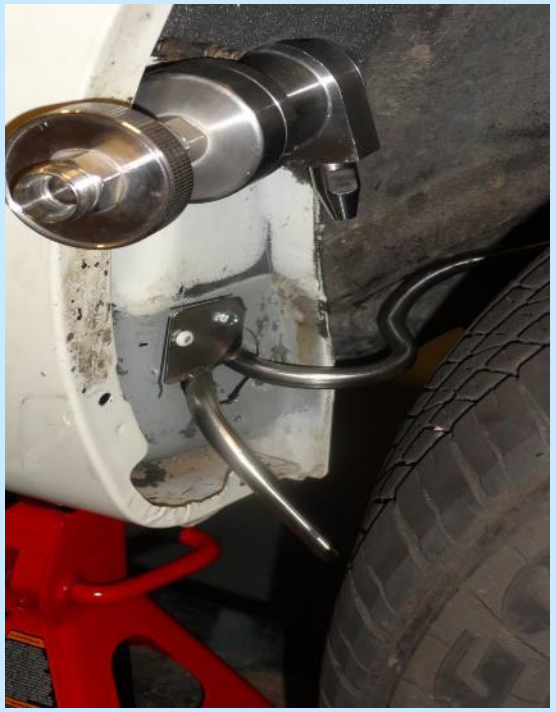
EPA's MOVES emissions model now accounts for ambient temperature effects on PM emissions

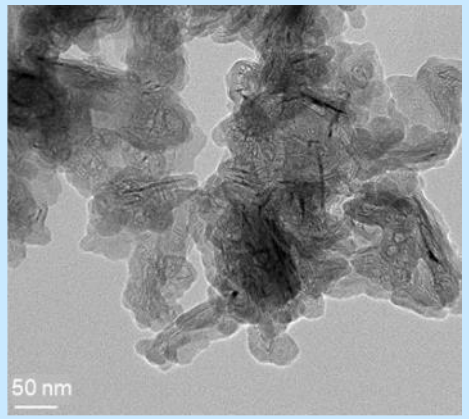
Courtesy of Rich Baldauf

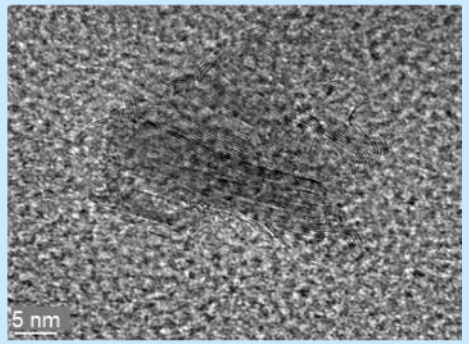
Lab and field studies show that emissions increase with decreasing temperature for running and start (used in MOVES)

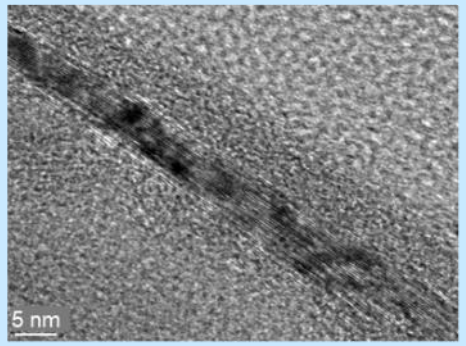
Brake and Tire Wear

- Focus on PM emissions brake and tire include coarse, fine and ultrafine particles
- Especially Nano-materials used in manufacturing





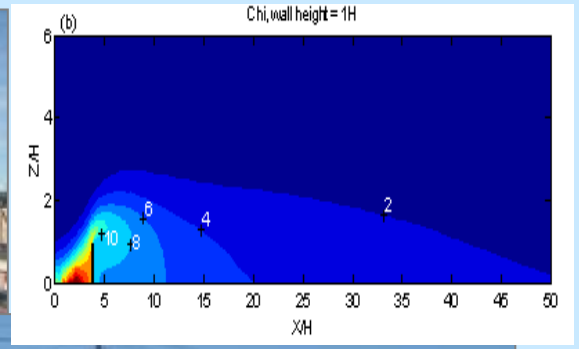




Deshmukh, Bang, Kumbhar, and Baldauf, 2010, Health Effects Institute Annual Conference

Air Quality and Exposure

- Field measurements of traffic, meteorology and air quality
  - Fixed and
  - Mobile monitoring that include
  - Reference and lower cost sensors
- Wind tunnel assessments
  - General road configurations
  - Simulations of field sites
- Modeling assessments
  - Computational Fluid Dynamics (CFD)
  - Research dispersion model (R-LINE)
  - EPA regulatory emissions (MOVES) and dispersion (AERMOD) models
  - EPA mapping software (*e.g.*, EnviroAtlas)



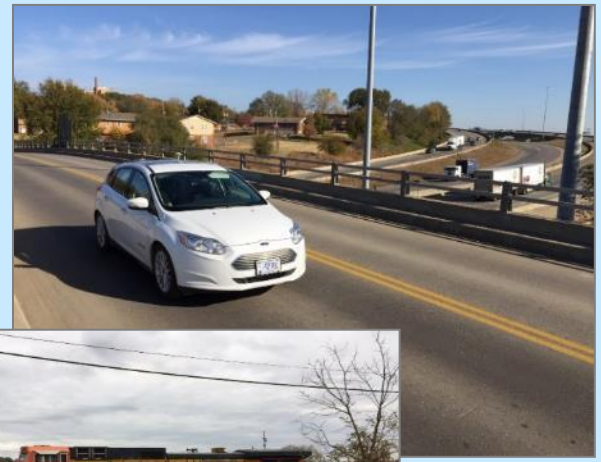
Courtesy of Rich Baldauf

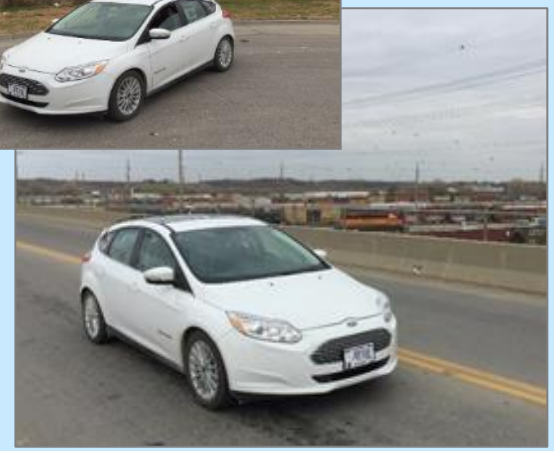
Mobile Air Quality Measurements

Mobile can be with EV or walk/bike

(Match fixed monitors)

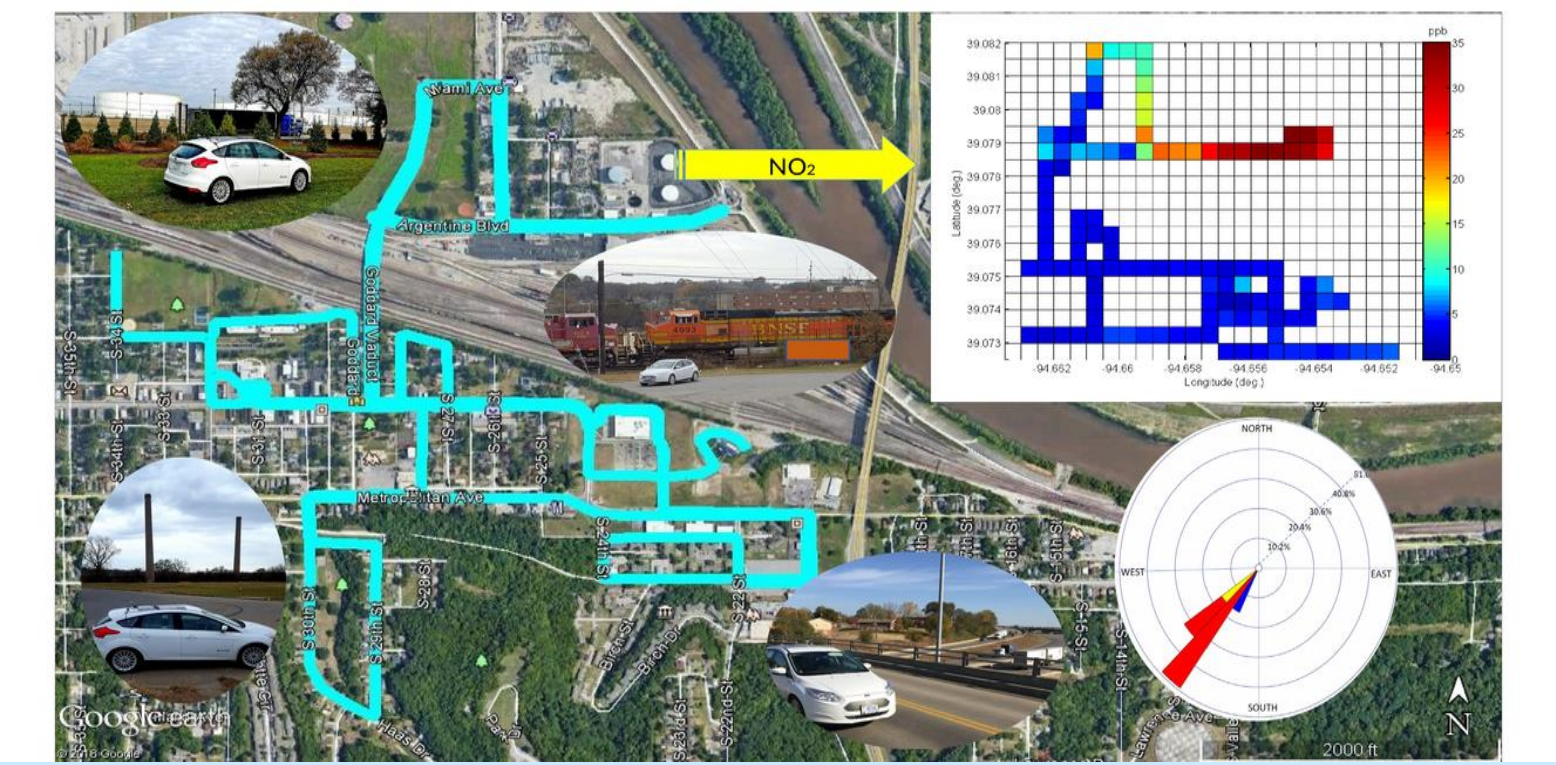
- Particulate Matter ($PM_{2.5}$)
- Ultrafine Particles (UFP)
- Black Carbon (BC)
- Nitrogen Dioxide (NO_2)
- Carbon Dioxide (CO_2)
- GPS
- Video
- Met Data (remote)
  - Wind Speed
  - Wind Direction





Courtesy of Rich Baldauf

Source Impacts on Community Air Quality



Mobile monitoring for railyard, highways, industrial
Integrate with fixed for spatial and temporal resolution

Courtesy of Rich Baldauf

FWHA/EPA Near-Road Collaboration

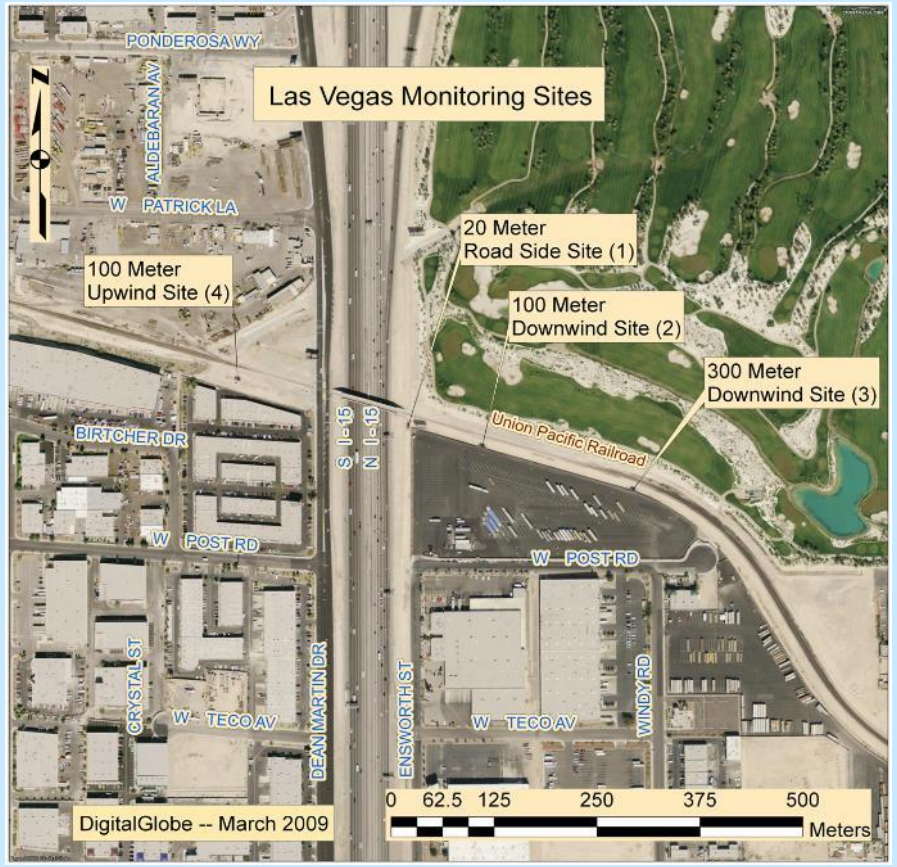
Long-term near-road studies

- Highlight sharp gradients

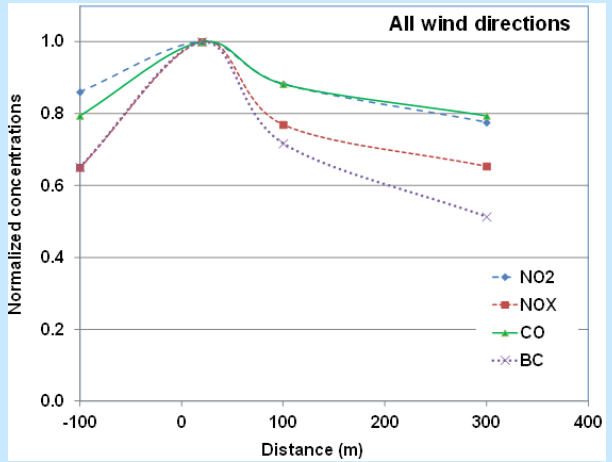
Near roads

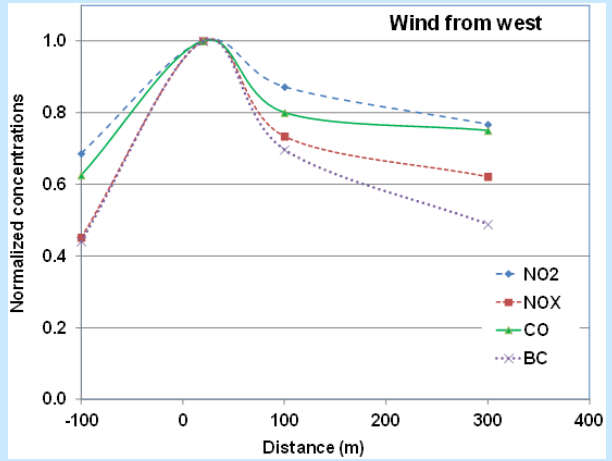
- Las Vegas
- Detroit
- Raleigh

- Multiple monitoring locations
  - 100 m upwind
  - 20, 100, 300 m downwind
- Multiple pollutants
  - PM (mass, number, BC)
  - Gases (CO, NO/NO_2/NO_x)
  - Speciation (VOC, PM)



Las Vegas





Courtesy of Rich Baldauf

Health Effects Research

- Which chemical components of air pollution (either single or in combination) cause health effects?
- What are the likely sources? Do production conditions (*e.g.*, engine type, combustion efficiency, fuel, etc) and atmospheric transformation change toxicity?
- How air pollution exacerbates diseases and if so, how?

Courtesy of Rich Baldauf

Recent Health Effects Projects

- Epidemiological studies identifying associations focus on roadway proximity and air quality exposure measurements
- Animal toxicity studies linking exposures to adverse health effects
  - Diesel/biodiesel exhaust, Including comparison of “fresh” vs. “aged”
  - Near-road
  - Ethanol and ethanol-blend gasoline vapors
- Human toxicity studies comparing effects of diesel/biodiesel exhaust to ambient air exposures

Courtesy of Rich Baldauf

Elements of Real-World Measurements

Purpose

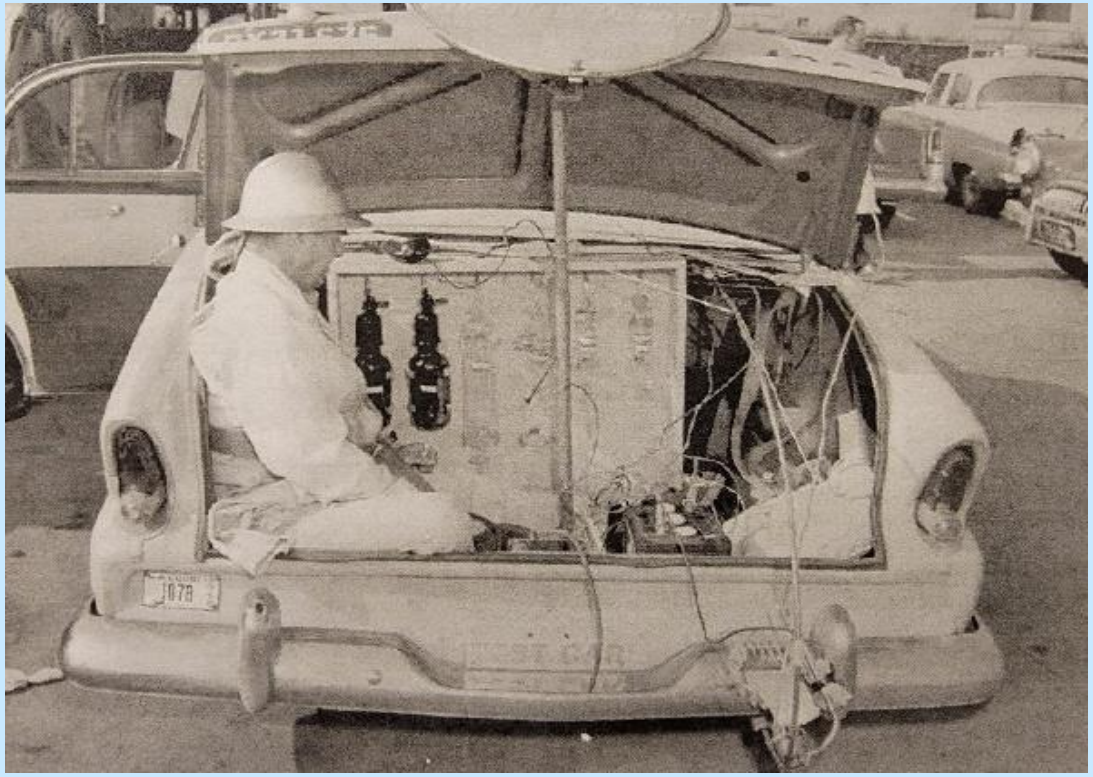
- How will the data be used?
- What data are needed?

Study Design

- Controllable
- Observable but not controllable
- Not observable

Instruments	Data collection
Calibration	QA/QC
Maintenance	Data analysis
Repair	People
Deployment	Training

PEMS Have Come A Long Way…



Examples of Portable Emission Measurement Systems

SEMTECH-DS
CFR 1065 Compliant
NDIR: CO_2, CO, HC
FID: THC
NDUV: NO, NO_2
Heated Sample Line
~50 lbs
High Power Demand

ParSYNC
"micro-PEMS"
Electrochemical:
CO_2, NO, NO_2
PM: light-scattering, opacity, ionization
Water separation
~10 lbs
Low Power Demand

Axion ("simplified")
NDIR: CO_2, CO, HC
Electrochemical: NO, O_2
Light-scattering: PM
Water separation bowl
~30 lbs
Low Power Demand

Tailor Study Design to Purpose: Examples for Onroad Vehicle Tailpipe Emissions

- Real-world effectiveness of
  - Emission standards
  - Emissions controls
- Trends over time
- Source categories
- Fuels
- Operating modes (e.g., cold starts)
- Road functional class
- Level of service, congestion
- Effect of road grade
- Identification of emissions hotspots
- Roundabout vs. signalized intersections
- Signal timing and coordination
- Idle reduction
- Driver behavior and driving cycles
- Alternative routes for an Origin/Destination pair
- Siting of remote sensing locations
- Comparison of transport modes (e.g., rail vs. passenger car)

Environmental Justice and High-Resolution Data

High Resolution spatial data support environmental justice research areas, including:

- Integrating chemical and nonchemical stressor data to characterize cumulative health impacts
- Characterizing environmental conditions and pollution exposure to support community decision-making

Mapping and Environmental Justice

- Map communities in terms of a variety of characteristics simultaneously, including social factors (such as race and income) along with likely exposure risks
- EJ mapping tools can help address cumulative impacts
- An EJ tool should be:
  - –Science-based
  - –Informed by community experience
  - –Endorsed and utilized by government
  - –Available for all to use
  - –Informed by public participation
  - –Available as a third-party validator for local issues

Lee, 2020

Challenges

- Ammonia slip
- Formaldehyde
- Ethylene oxide
- Cold Start
- High Altitude
- Other emissions processes: evaporative, running losses, brake and tire wear

International Considerations

Regions:
U.S., Europe, China, Australia
Latin America
Africa

Vehicle life cycle:
new vehicle markets
used vehicle markets

Variations in:
Fuel quality
Fuel type
Vehicle type/fleet
Road type
Land use patterns
OBD
I/M
(etc.)

Fit-for-Purpose Mobility & Transport Solutions

- Personal passenger transport – urban centers, inter-city
- Local goods transport and delivery
- Long-haul transport
- Vehicle sharing
- Autonomous vehicles
- Intermodal travel
- Work from home

Related Issues

Supply chain

Energy Transitions (e.g., more electrification)

- Critical mineral availability or substitutability
- Environmental and other implications

Spatial Variation in Real-World Light Duty Vehicle Exhaust Emission Rates

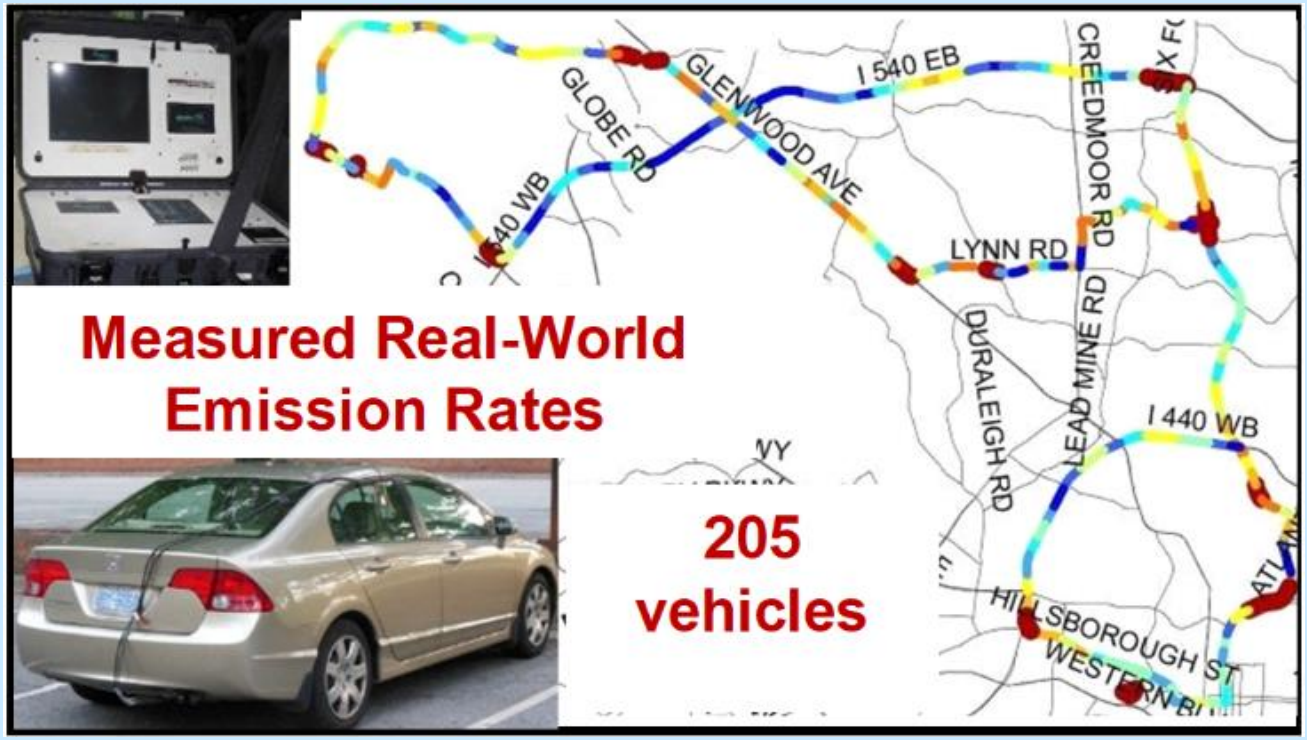
Environmental Science & Technology

pubs.acs.org/est Article

Geospatial Variation of Real-World Tailpipe Emission Rates for Light-Duty Gasoline Vehicles

Tanzila Khan, H. Christopher Frey,* Nikhil Rastogi, and Tongchuan Wei

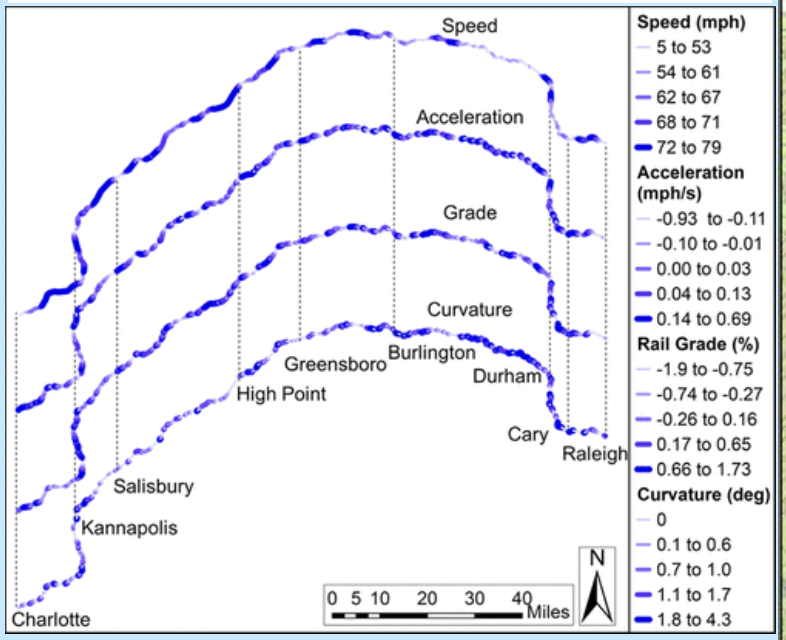
Cite This: *Environ. Sci. Technol.* 2020, 54, 8968–8979 Read Online



Environmental Science & Technology
Get e-Alerts

Characterizing Fuel Use and Emission Hotspots for a Diesel-Operated Passenger Rail Service

Nikhil Rastogi and H. Christopher Frey*



Air Pollution Mapping

Environmental Science & Technology

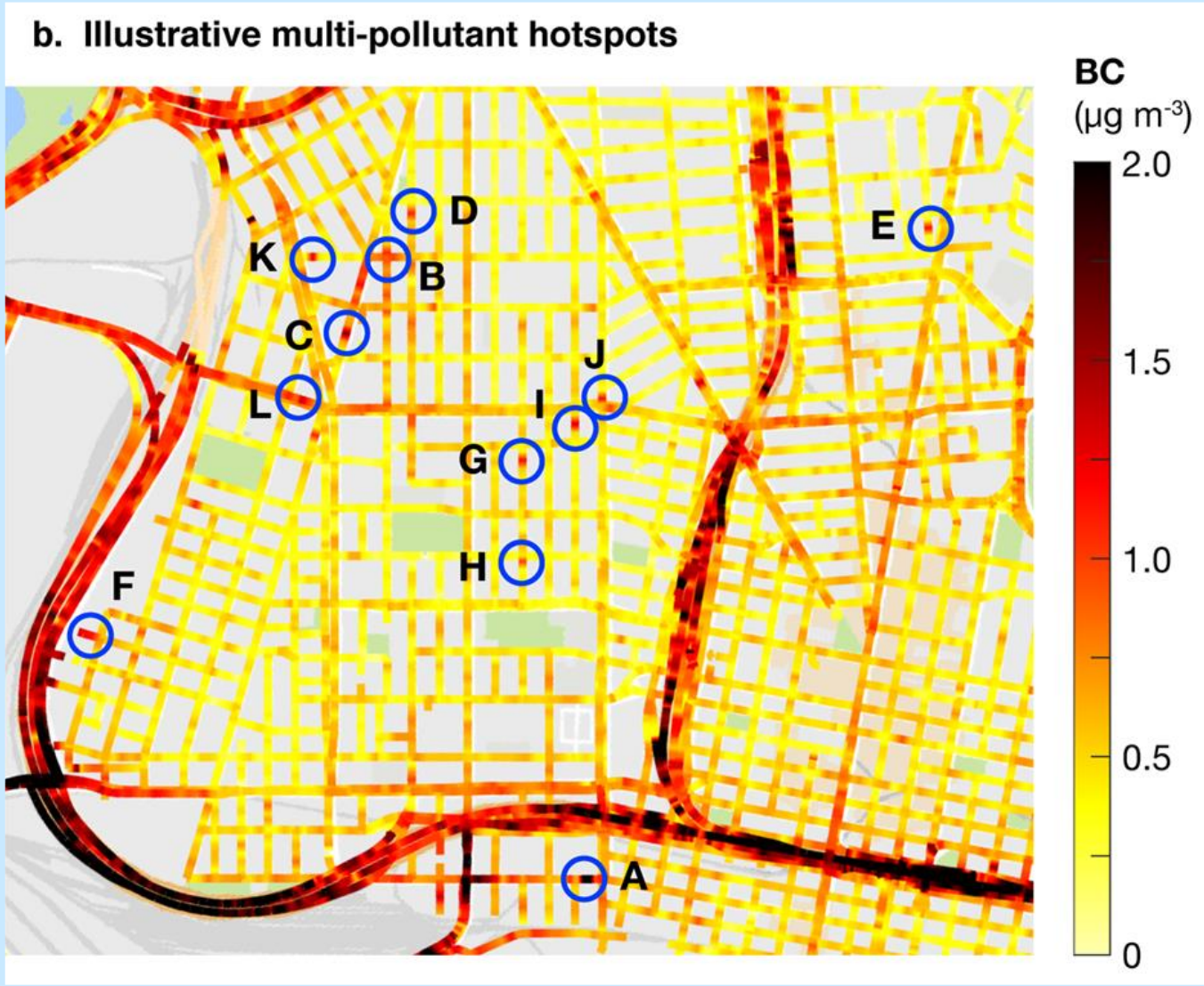
ACS AuthorChoice

Article

pubs.acs.org/est

High-Resolution Air Pollution Mapping with Google Street View Cars: Exploiting Big Data

Joshua S. Apte,[*,†] Kyle P. Messier,[†,‡] Shahzad Gani,[†] Michael Brauer,[§] Thomas W. Kirchstetter,[∥] Melissa M. Lunden,[⊥] Julian D. Marshall,[#] Christopher J. Portier,[‡] Roel C.H. Vermeulen,[▽] and Steven P. Hamburg[‡]



Median Organic Aerosol Concentration from a Mobile Aerosol Mass Spectrometer

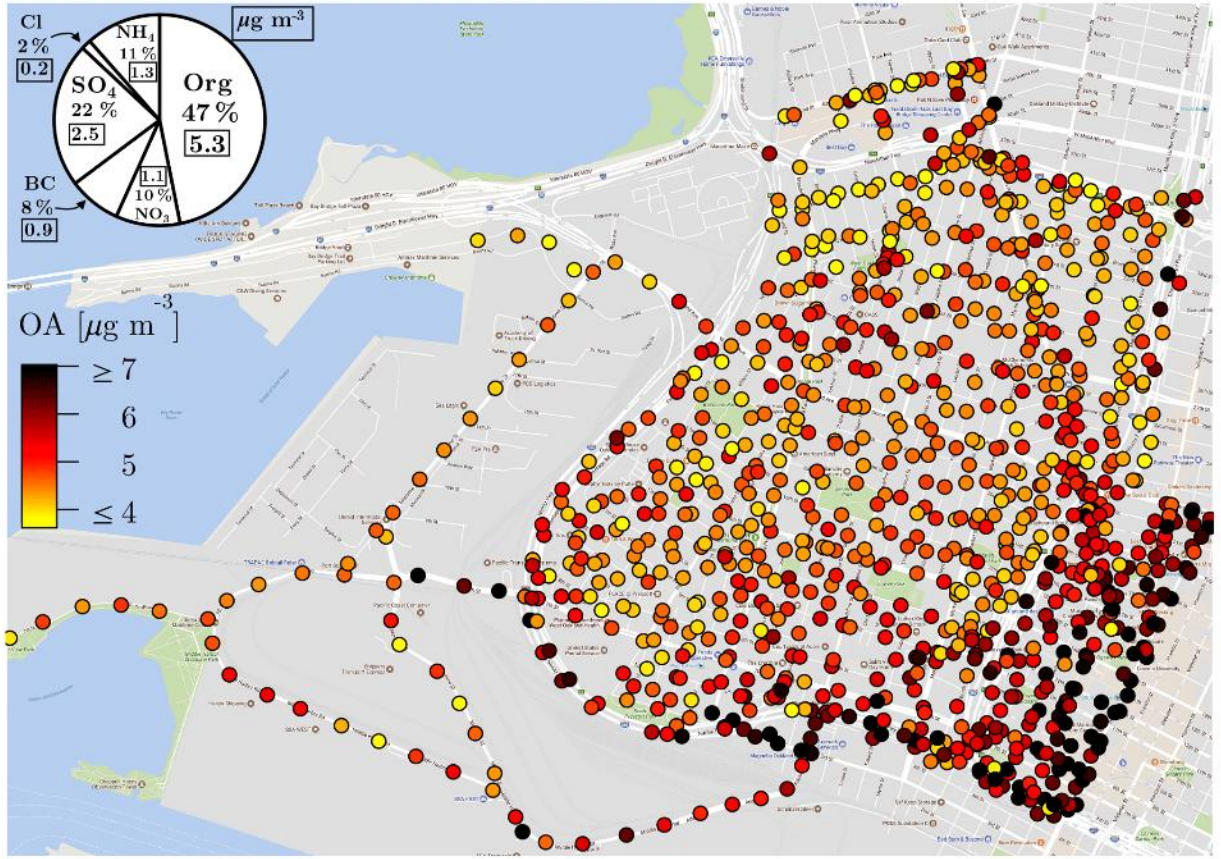
Atmos. Chem. Phys., 18, 16325–16344, 2018
https://doi.org/10.5194/acp-18-16325-2018

Atmospheric Chemistry and Physics
Open Access
EGU

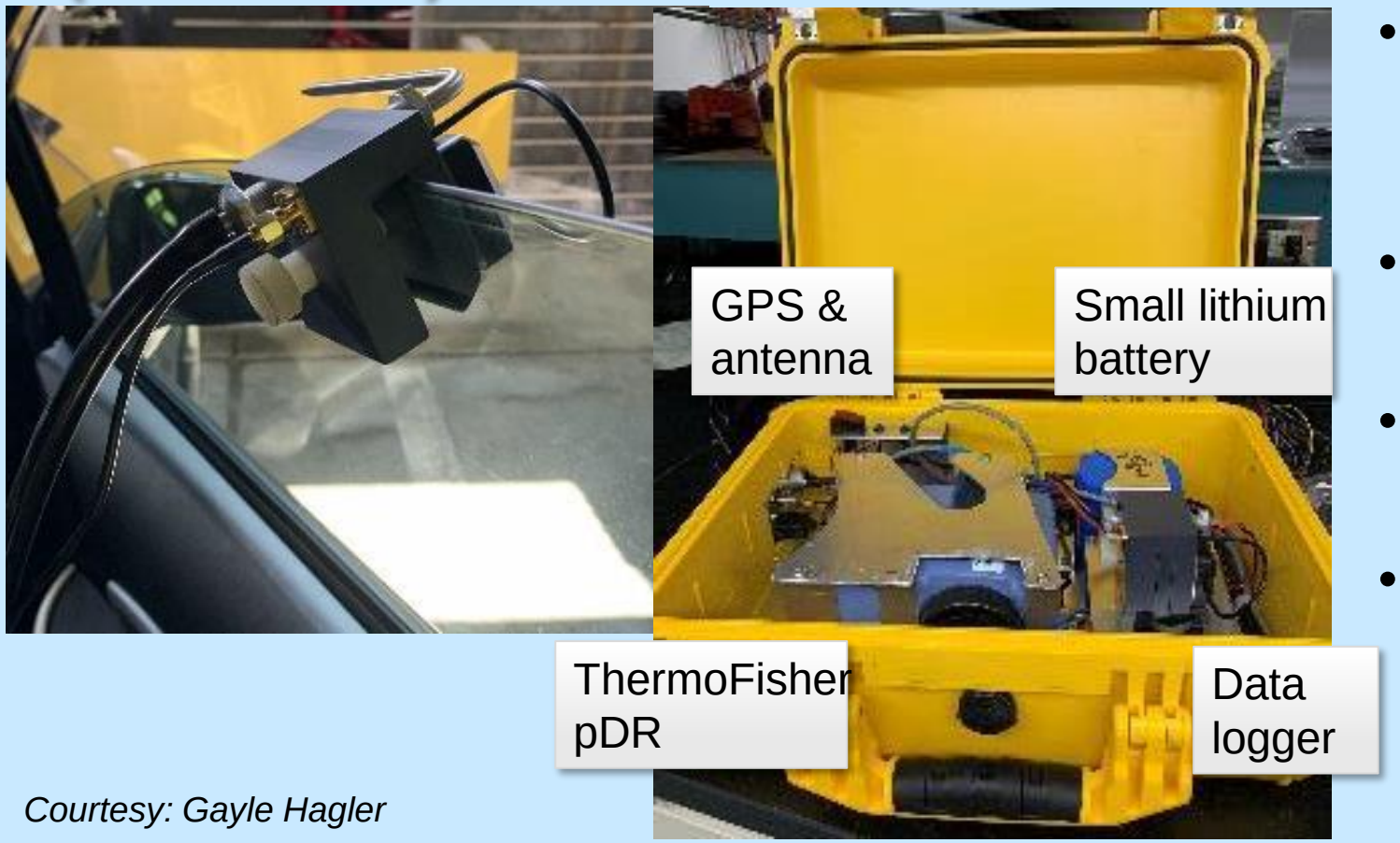
High-spatial-resolution mapping and source apportionment of aerosol composition in Oakland, California, using mobile aerosol mass spectrometry

Rishabh U. Shah[1,2], Ellis S. Robinson[1,2], Peishi Gu[1,2], Allen L. Robinson[1,2], Joshua S. Apte[3], and Albert A. Presto[1,2]

[1]Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA, USA
[2]Center for Atmospheric Particle Studies, Carnegie Mellon University, Pittsburgh, PA, USA
[3]Department of Civil, Architectural and Environmental Engineering, University of Texas at Austin, Austin, TX, USA



Vehicle Add on Mobile Monitoring Systems (VAMMS) for Wildfire Smoke

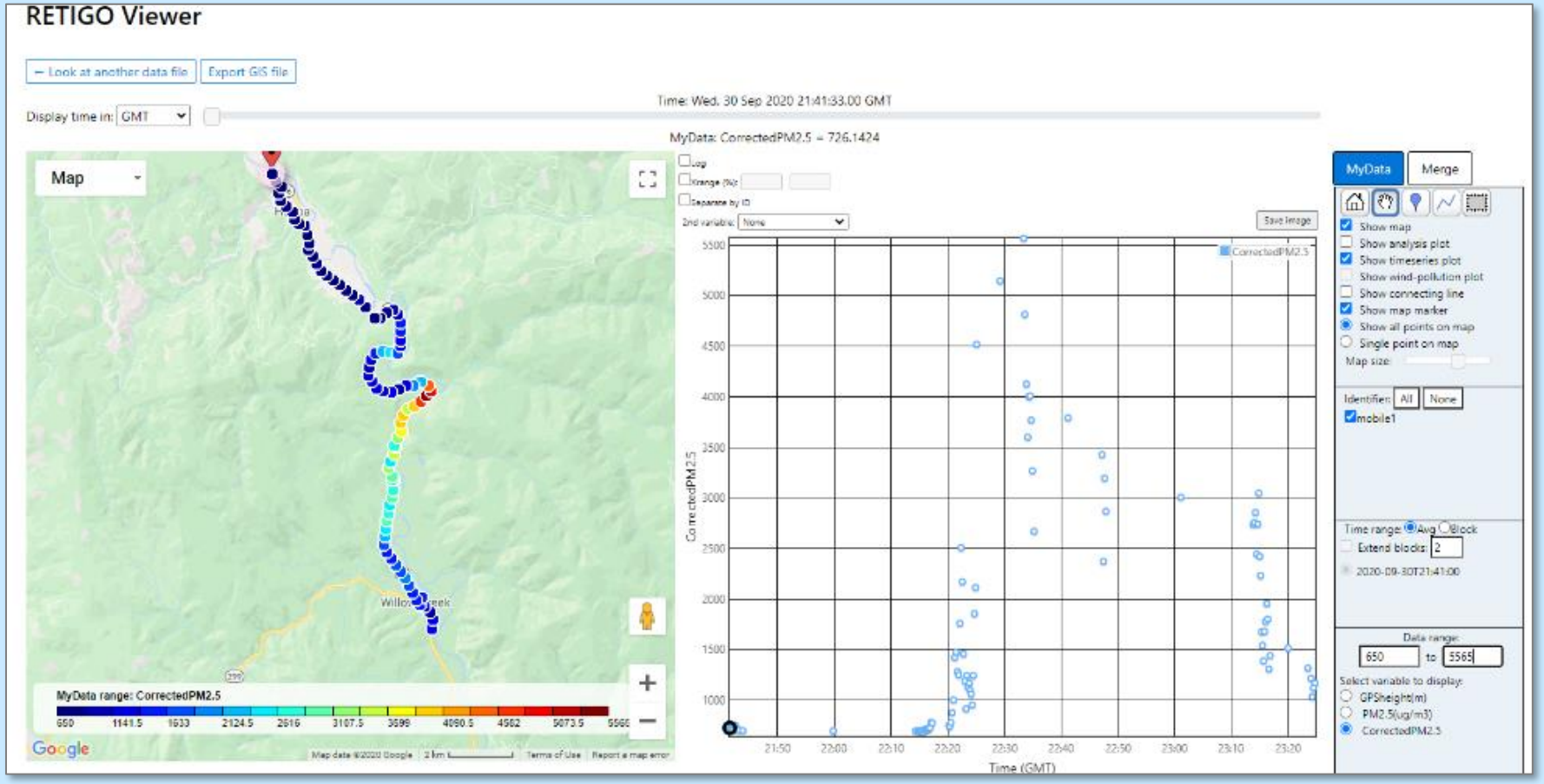


Courtesy: Gayle Hagler

- Ambient PM is sampled through an external isokinetic probe (@ 35 mph)
- Window mount provides an easy install on any vehicle
- High resolution GPS data (<3m accuracy)
- System cost is currently high (about $9k), but EPA is developing lower-cost solutions

RETIGO (Real-Time Geospatial Data Viewer)

- Web-based data visualization tool available to the public
- Plug and play visualization of VAMMS data:
  - Mapping
  - Time series
  - Toggle between parameters
  - Import data from other sources (e.g,. AirNow, WMO)



Courtesy: Gayle Hagler

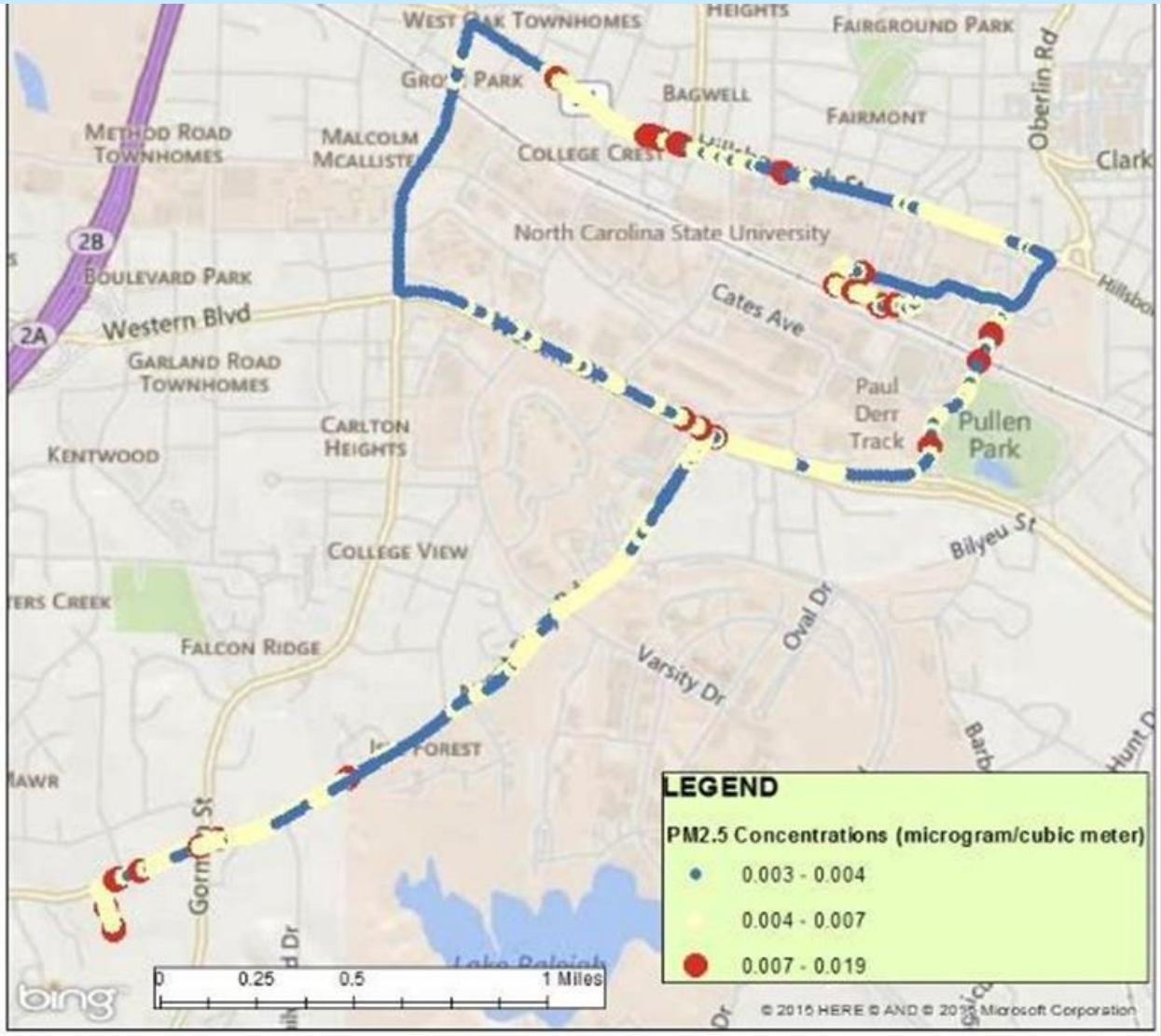
https://www.epa.gov/hesc/real-time-geospatial-data-viewer-retigo

Quantification of Sources of Variability of Air Pollutant Exposure Concentrations among Selected Transportation Microenvironments

Transportation Research Record
2020, Vol. 2674(9) 395–411

DOI: 10.1177/0361198120929336
journals.sagepub.com/home/trr
SAGE

H. Christopher Frey[1], Disha Gadre[2], Sanjam Singh[3], and Prashant Kumar[4]



Community Engaged Participatory Air Monitoring

Partnership of a university and community-based organization

Trained local youth

Incorporated community members into data collection

Temporal as well as spatial variability

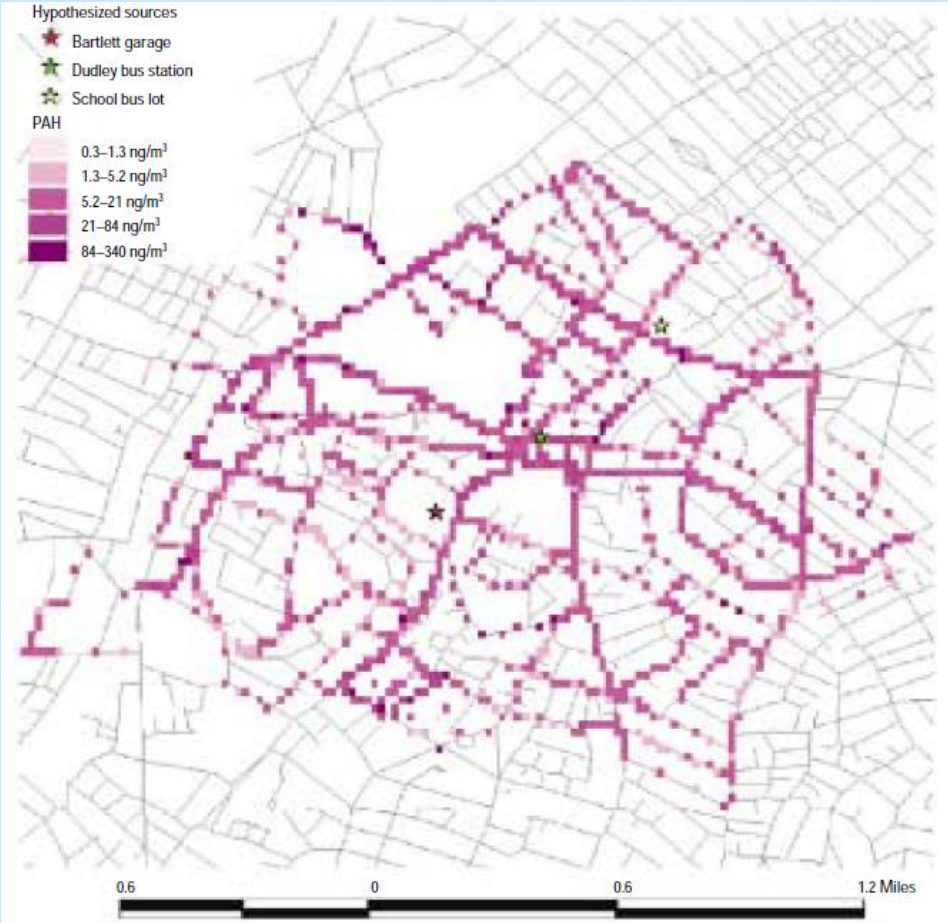


Figure 4. GIS representation of cell-averaged, 1-min average PAH concentrations near Dudley Square, derived from mobile PAS 2000CE monitoring in July/August 1999 (ng/m³).

Articles

Fine Particulate Matter and Polycyclic Aromatic Hydrocarbon Concentration Patterns in Roxbury, Massachusetts: A Community-Based GIS Analysis

Jonathan I. Levy,[1] E. Andres Houseman,[2] John D. Spengler,[1] Penn Loh,[3] and Louise Ryan[2]

Youth Engaged Participatory Air Monitoring

"With all of this new information, I want to educate my community on how harmful these particulates are, and how change should begin with personal choices people make throughout their day"

International Journal of *Environmental Research and Public Health*

MDPI

Article

Youth Engaged Participatory Air Monitoring: A 'Day in the Life' in Urban Environmental Justice Communities

Jill E. Johnston [1,*], Zully Juarez [1], Sandy Navarro [2], Ashley Hernandez [3] and Wendy Gutschow [1]

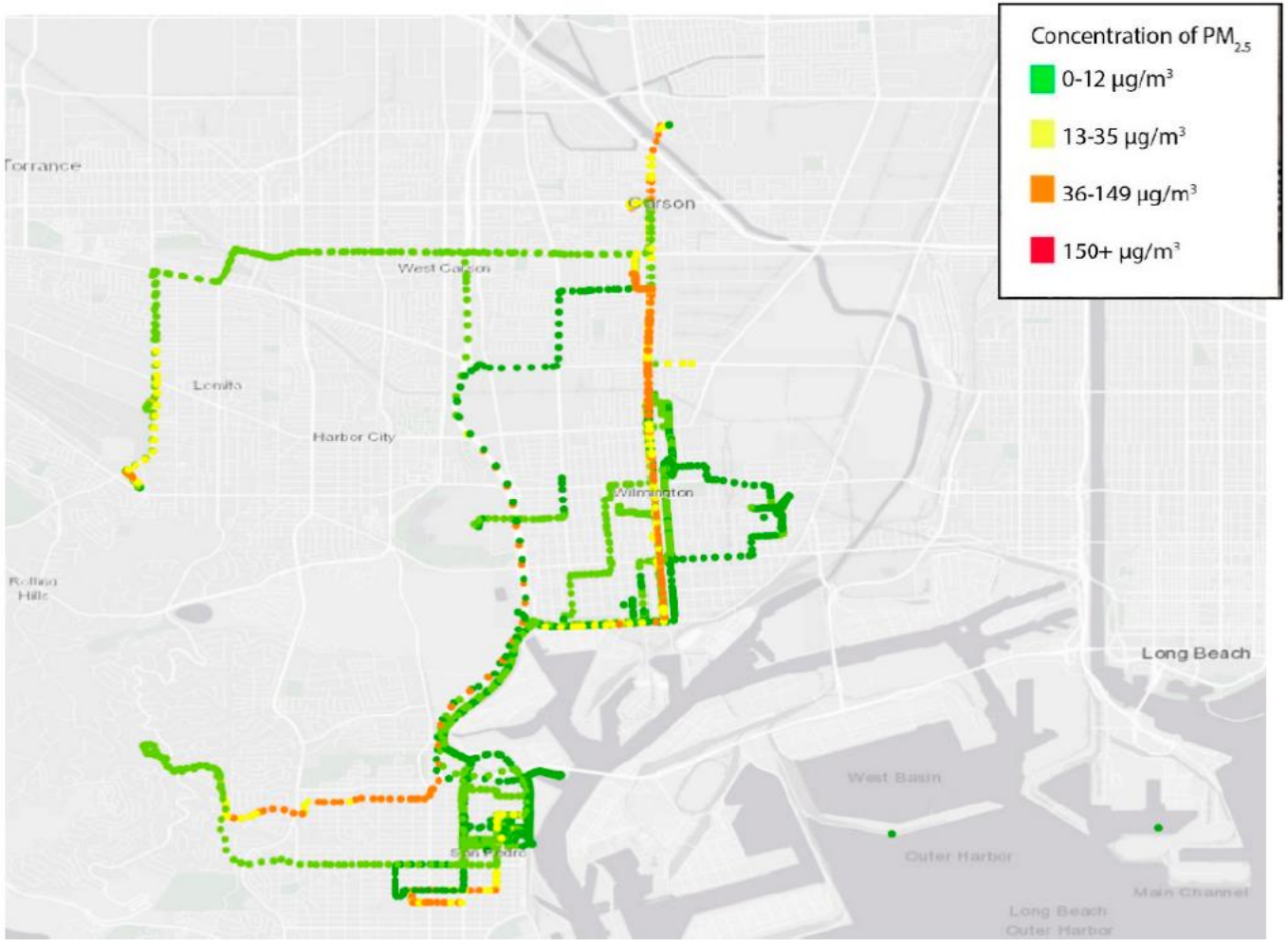


Figure 2. Map of $PM_{2.5}$ air monitoring exposure measurements from all CBE youth participants.

Data Challenges and Opportunities

- Large datasets
- Participatory Science
- Study design (purpose)
- Space
- Time
- Instruments
- Quality Assurance Project Plan (QAPP)
- Applications: Policy, Planning, Operations, Evaluation

Opportunities

- Vehicle emissions measurements are part of multiple frameworks
  - One Health
  - Health Impact Assessment
  - Cumulative Impacts
  - Others: energy life cycle, materials life cycle (critical minerals), etc.
- Evidence-based approach to inform decisions at multiple scales: international, national, regional, community
- Integration with other scientific, technical, research, policy, planning, operations, and evaluation communities

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3DATX
David Miller

* Retired