Traffic-Related Air Pollution (TRAP) – Modeling, Monitoring and Health Effects

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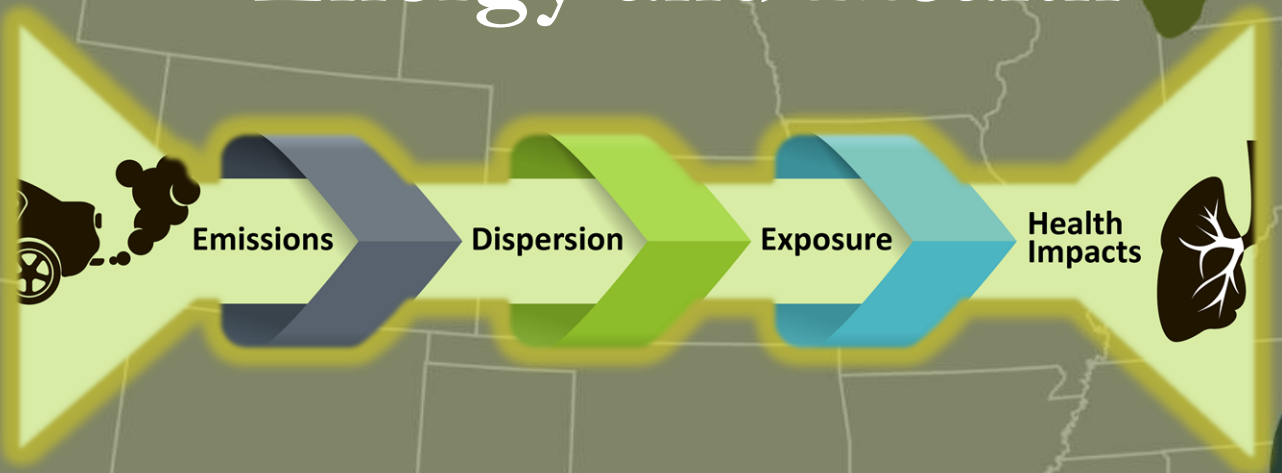

UC Riverside

UTEP

Texas A&M Transportation Institute

Georgia Tech

Johns Hopkins University

Need for an Integrated and Holistic Approach

- In recent years, the need for a holistic and integrated approach to understand transportation externalities has increased
- Shift from single-disciplinary to multi-disciplinary approach
- Methods and models to address gaps between traditionally evolved domains
- Map out the entire “Tailpipe to Lungs” Spectrum
- Understand environmental implications for Emerging Technologies (Electric Vehicles, Connected Automated Vehicles, Shared Mobility etc.)

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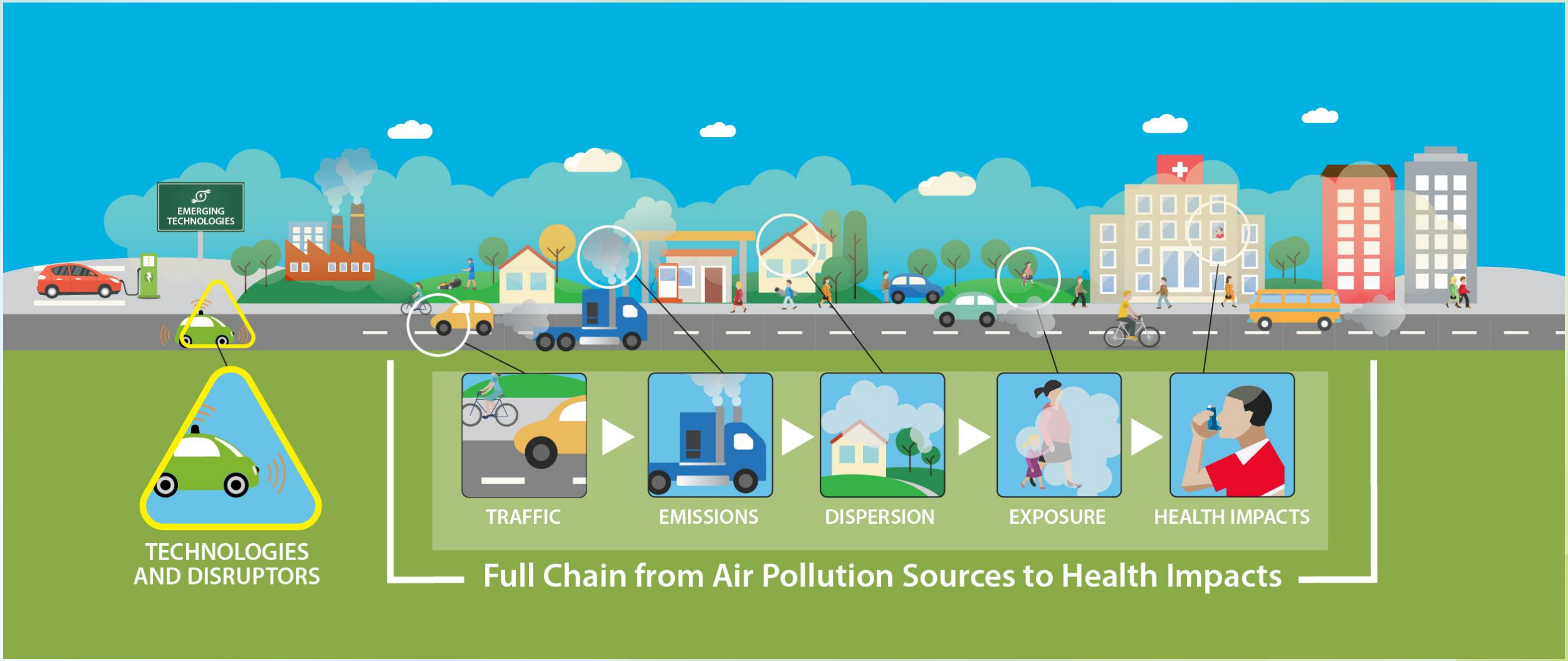
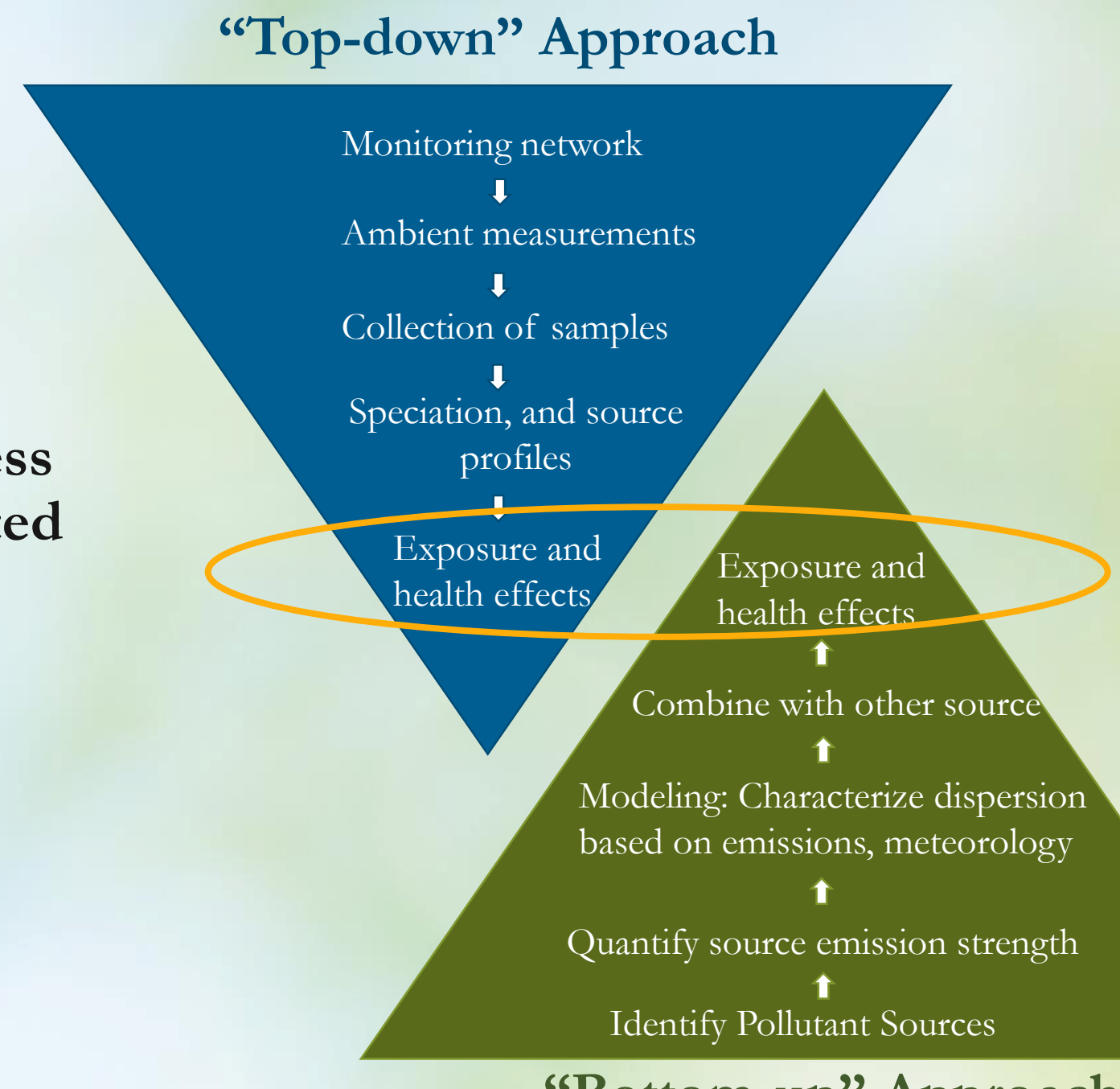
Transportation Emissions and Health Spectrum



Source: https://www.carteeh.org/

Approaches to assess TRAP and associated health effects



TRAP and the Burden of Childhood Asthma

"Top-down" Approach

- Estimate the number and percentage of childhood asthma cases attributable to traffic-related air pollution (TRAP)
- Two years (2000 and 2010)
- Study Setting
  - 48 states and District of Columbia
  - TRAP: NO_2, $PM_{2.5}$ and PM_{10}
  - Census block level
- Combination of population counts, monitoring data, land-use regression, spatial interpolation and burden of disease estimates

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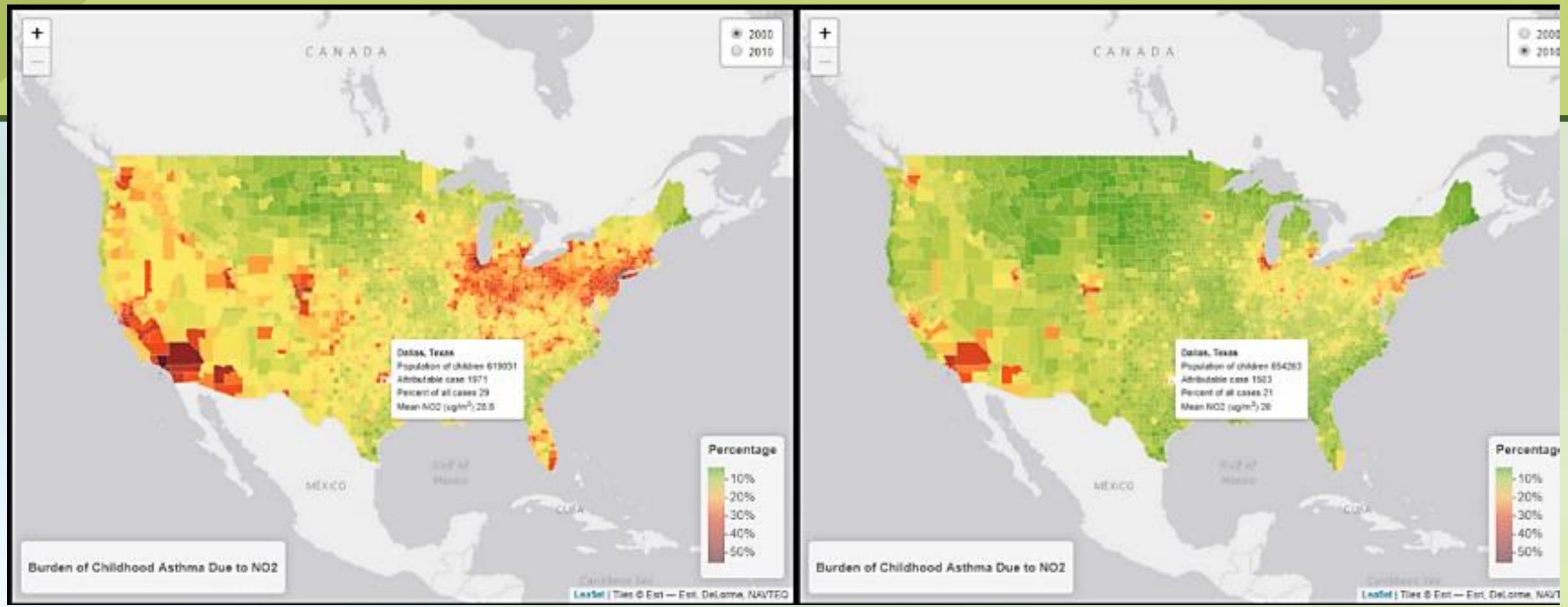
Alotaibi, R; Bechle, M; Marshall, J; Ramani, T; Zietsman, J; Nieuwenhuijsen, M; Khreis, H, 2019, "Traffic related air pollution and the burden of childhood asthma in the contiguous United States in 2000 and 2010". Environment international, 127, pp.858-867.



TRAP and the Burden of Childhood Asthma

Online Interactive Maps

Results

Attributable Cases and Percentage of Childhood Asthma Cases by Year

Pollutant	Attributable to TRAP		% of all cases		Change (%)	
	2000	2010	2000	2010	AC	% of all cases
NO_2	210,000	140,000	27%	18%	-32%	-33%
$PM_{2.5}$	25,000	190,000	31%	24%	-23%	-24%
PM_{10}	330,000	290,000	42%	36%	-13%	-14%

Percentage of cases attributable to air pollution were higher

1. In urban areas than rural areas, and
2. In block groups with lowest median household income
3. Number and Percentage of cases (NO_2)

   209,068 → 141,931 (attributable cases)
   27% → 18% (% of all asthma cases)

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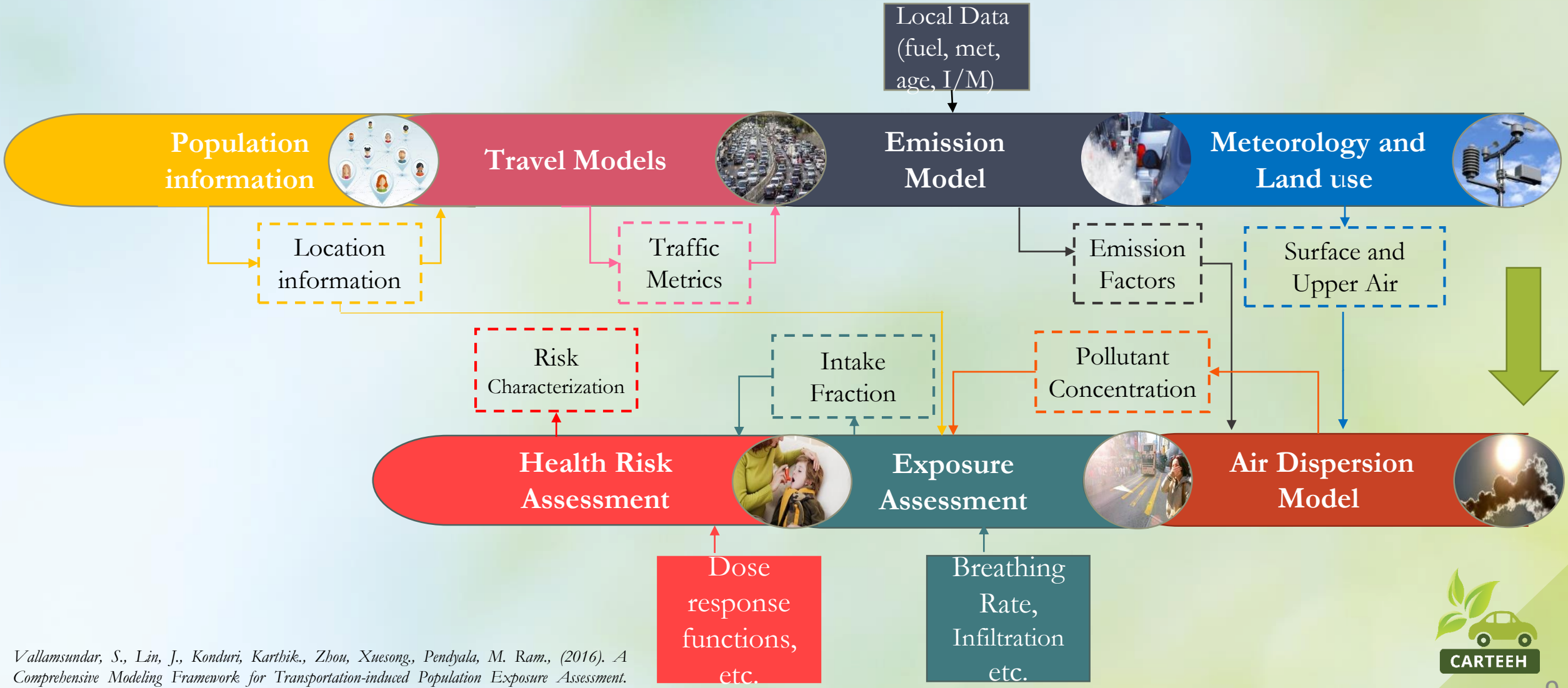
Integrated Modeling Framework

"Bottom-up" Approach



Vallamsundar, S., Lin, J., Konduri, Karthik., Zhou, Xuesong., Pendyala, M. Ram., (2016). A Comprehensive Modeling Framework for Transportation-induced Population Exposure Assessment. Transportation Research Part D: Transport and Environment. Vol. 46, 94-113.

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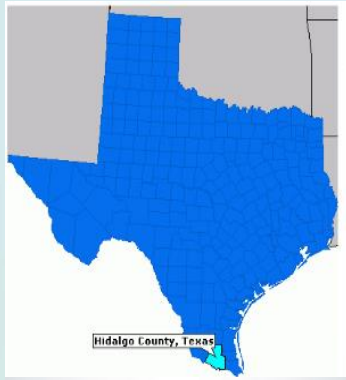
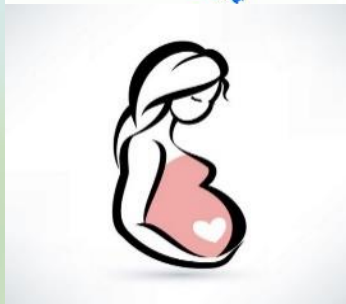
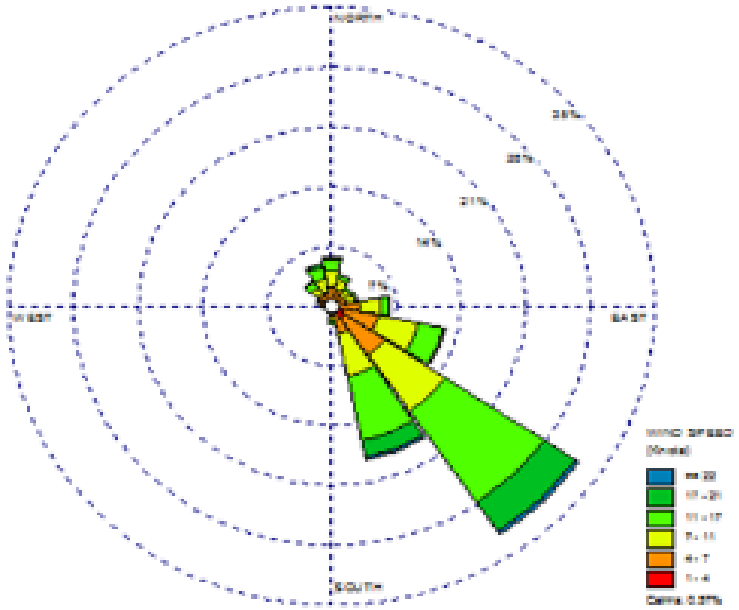
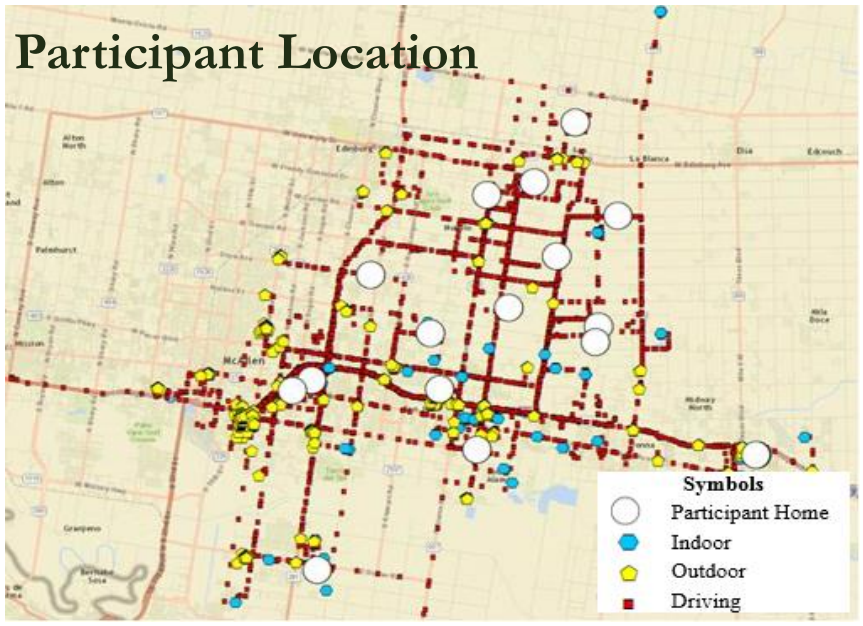
Maternal Exposure to TRAP

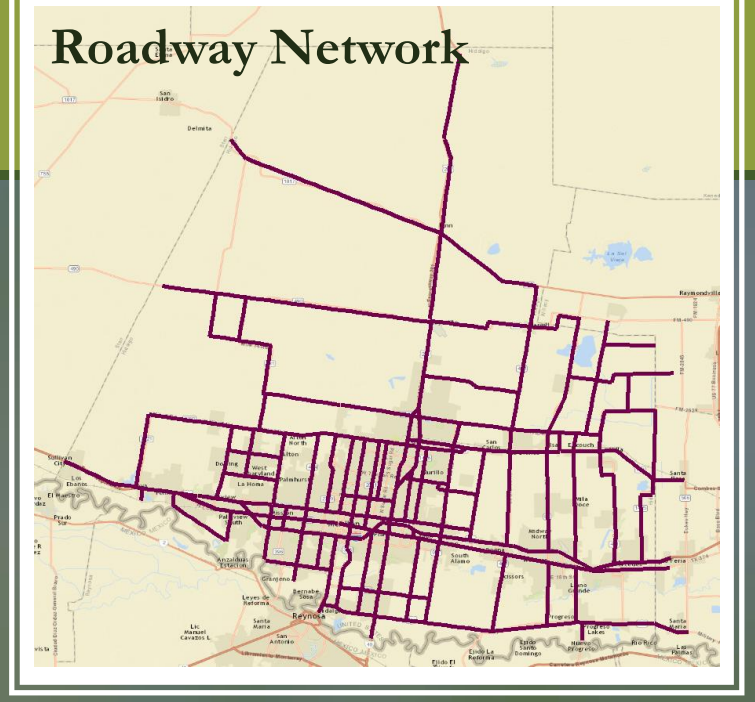
- Assess in-utero exposure to TRAP ($PM_{2.5}$, black carbon), and association between prenatal exposure and increased susceptibility to Asthma
- One of the early studies focusing on a group of pregnant women in South Texas
- Personal Monitoring, Modeling and biological sample (blood, hair and urine) collection
- Collaborative Study conducted with Johns Hopkins University, and TAMU Health Science Center

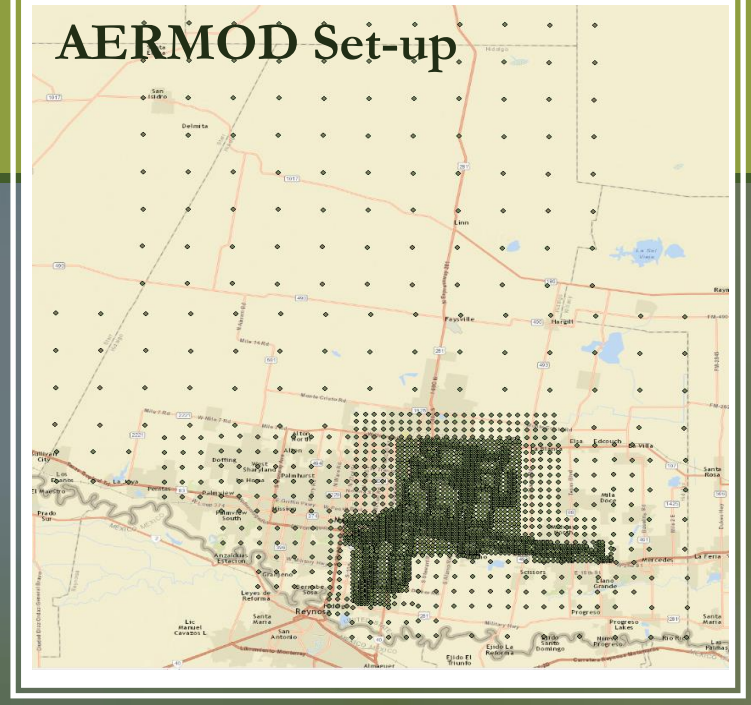












Maternal Exposure to Air Pollution

- *Askariyeh, M.H., Vallamsundar, S., Zietsman, J., Ramani, T (2019). Assessment of Traffic-related Air Pollution: Case Study of Pregnant Women in South Texas. International Journal of Environmental Research and Public Health 16(13).*
- *Zamora, M.L., Pulczinski, J.C., Johnson, N., Garcia-Hernandez, R., Rule, A., Carrillo, G., Zietsman, J., Sandragorsian, B., Vallamsundar, S., and Askariyeh, M.H., Koehler, K. (2018). Maternal exposure to PM2.5 in south Texas, a pilot study. Science of Total Environment. Vol. 628, 1497–1507.*

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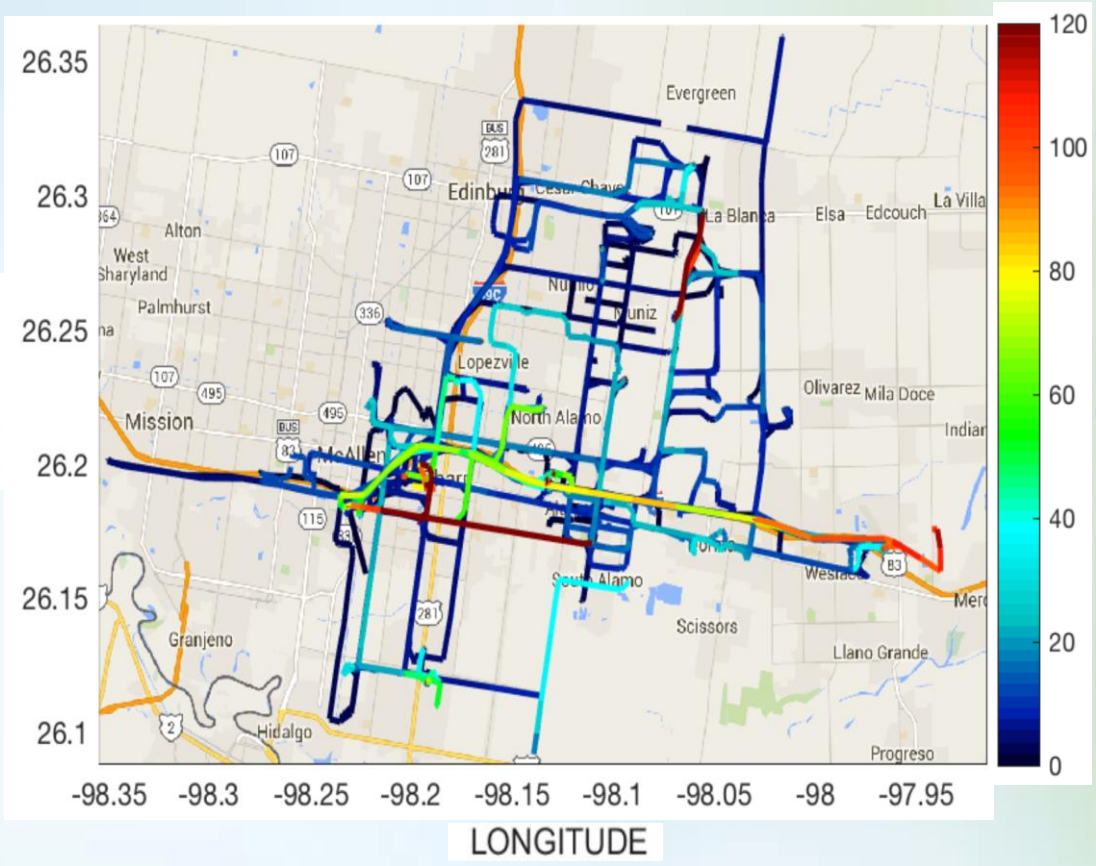
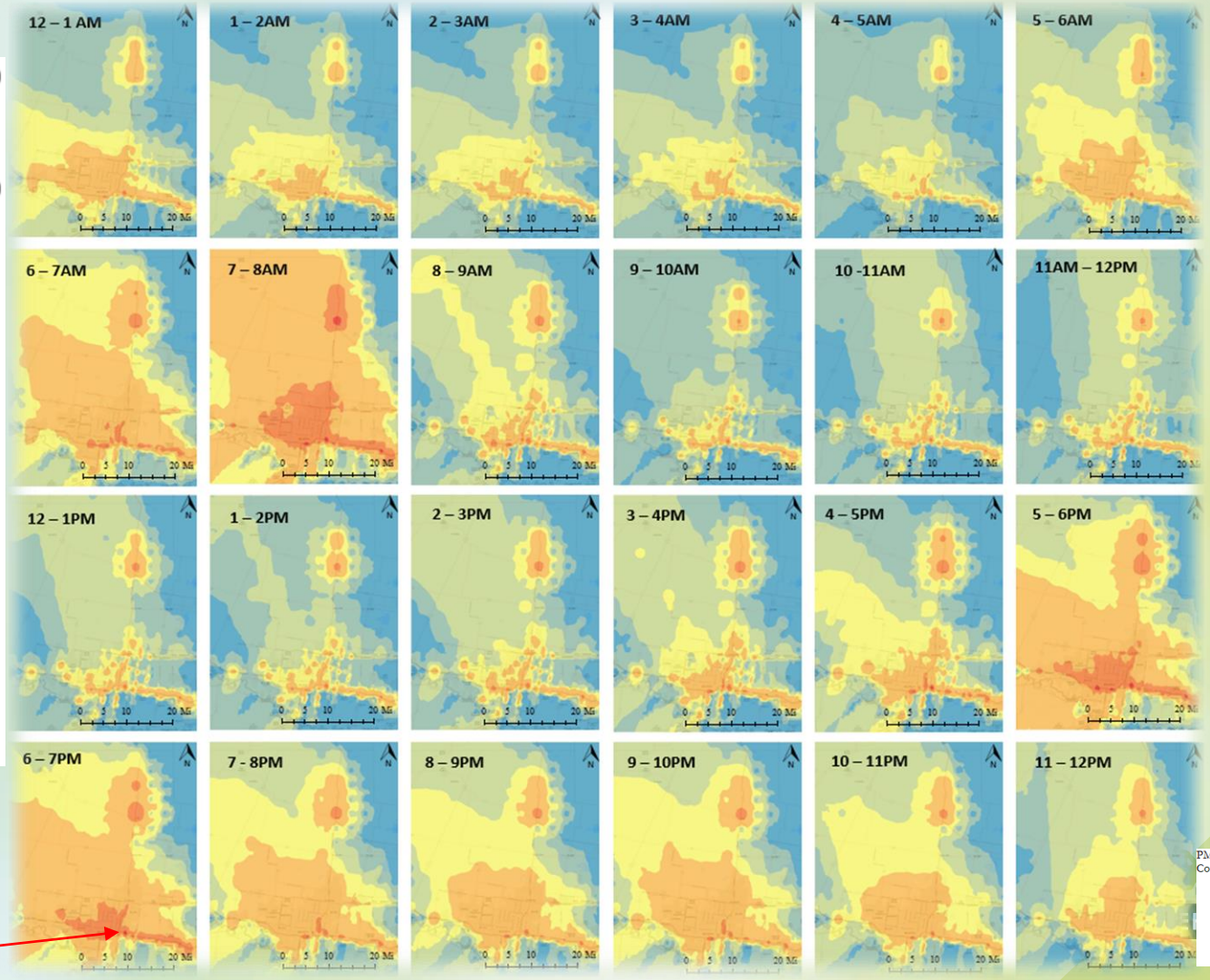
Maternal Exposure to Air Pollution

Monitored Exposure



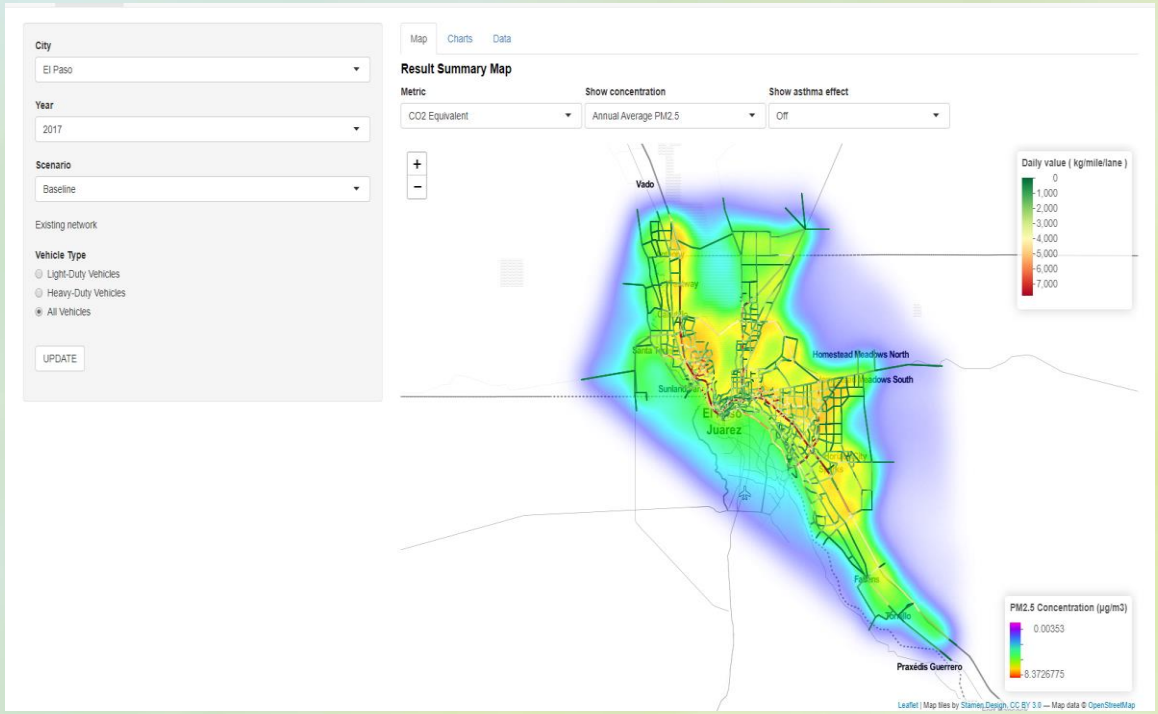
Modeled Exposure



U.S-Mexico border highway

Integrated Modeling Platform, TEMPO-H

- **TEMPO-H**
  - An integrated **transportation** and **emissions modeling platform** for **optimization** in **health**
- Interface based on an automated pipeline deployed in the cloud
- Several Metrics
- For more details, refer to the link below
  - https://tempo-dashboard.io/



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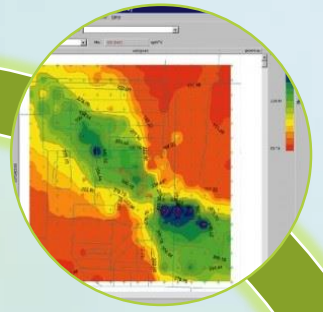
Low-Cost Sensors Initiative

Sparse Ambient Monitoring Network

Use data to inform models



Air Quality Maps

Crowdsourced Information

Calibration

Low-Cost Sensors

Expensive

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Future Research

- **Expand Network of AQ Measurements**
  - Strengthen and expand the current monitoring network
  - Emerging low-cost sensors (both field and wearables)
  - Understand existing trends, and assess effectiveness of control measures
- **Integrated Modeling Platforms**
  - Assess the complete chain from source to impacts
  - Critical as we prepare for revolutionary change in form of transportation disruptors
- **Combination of "top-down" and "bottom-up" approaches**
  - Identifying hot-spots for monitoring via dispersion modeling
  - Validating models, and identifying missing pieces using measurements

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Thank you!

Contact Information

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