Spatial patterns and spatial modeling of primary organic aerosol concentrations in three North American cities

Provat Saha[1], Ellis Robinson[1], Wenwen Zhang[2], Steven Hankey[2], Allen Robinson[1], Albert Presto[1]

[1]Carnegie Mellon University, [2]Virginia Tech

CAPS Center for Atmospheric Particle Studies

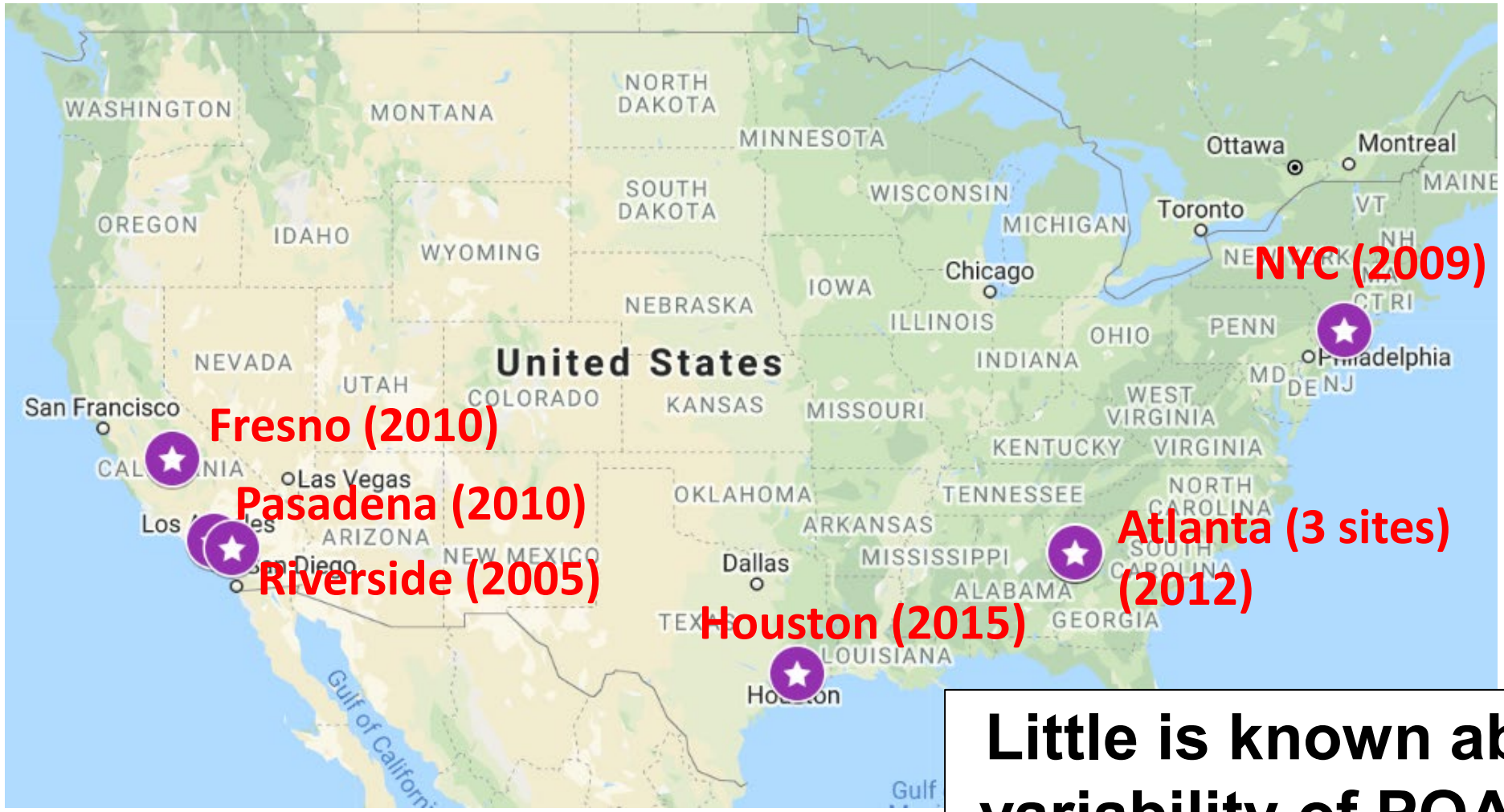
CACES

Carnegie Mellon University

Important questions about POA exposures

- **Concentrations and spatial trends**
  - What are typical concentrations?
  - What are the inter- and intra-city spatial patterns?
- **POA sources**
  - What are the major sources, and how do they drive spatial patterns?
- **POA exposure assessment**
  - What would be needed to improve exposure estimates?

Limited point POA data in US from atmospheric field campaigns



Little is known about spatial variability of POA exposures

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

We investigate POA exposures in three US cities using Mobile AMS measurements and LUR modeling

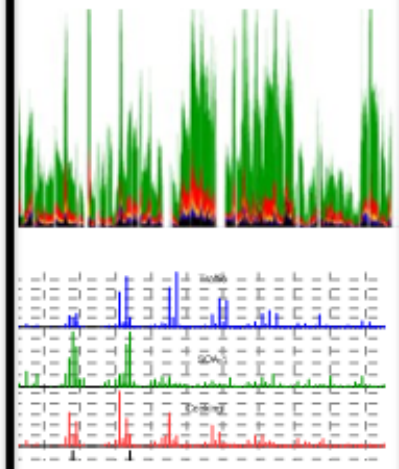
CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

Our approach:

1. Mobile sampling

2. PMF

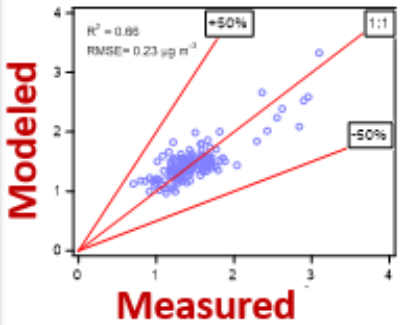


HOA

COA

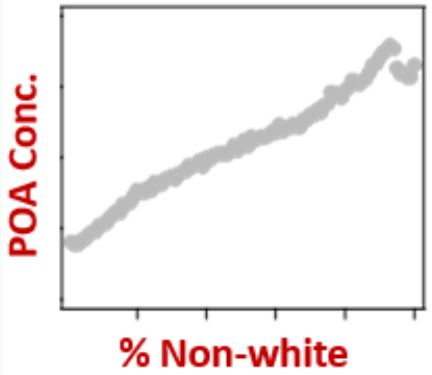
3. LUR

$$Conc = \beta_0 + \sum \beta_i \times x_i + \varepsilon$$



4. Conc map

5.Exposure analysis

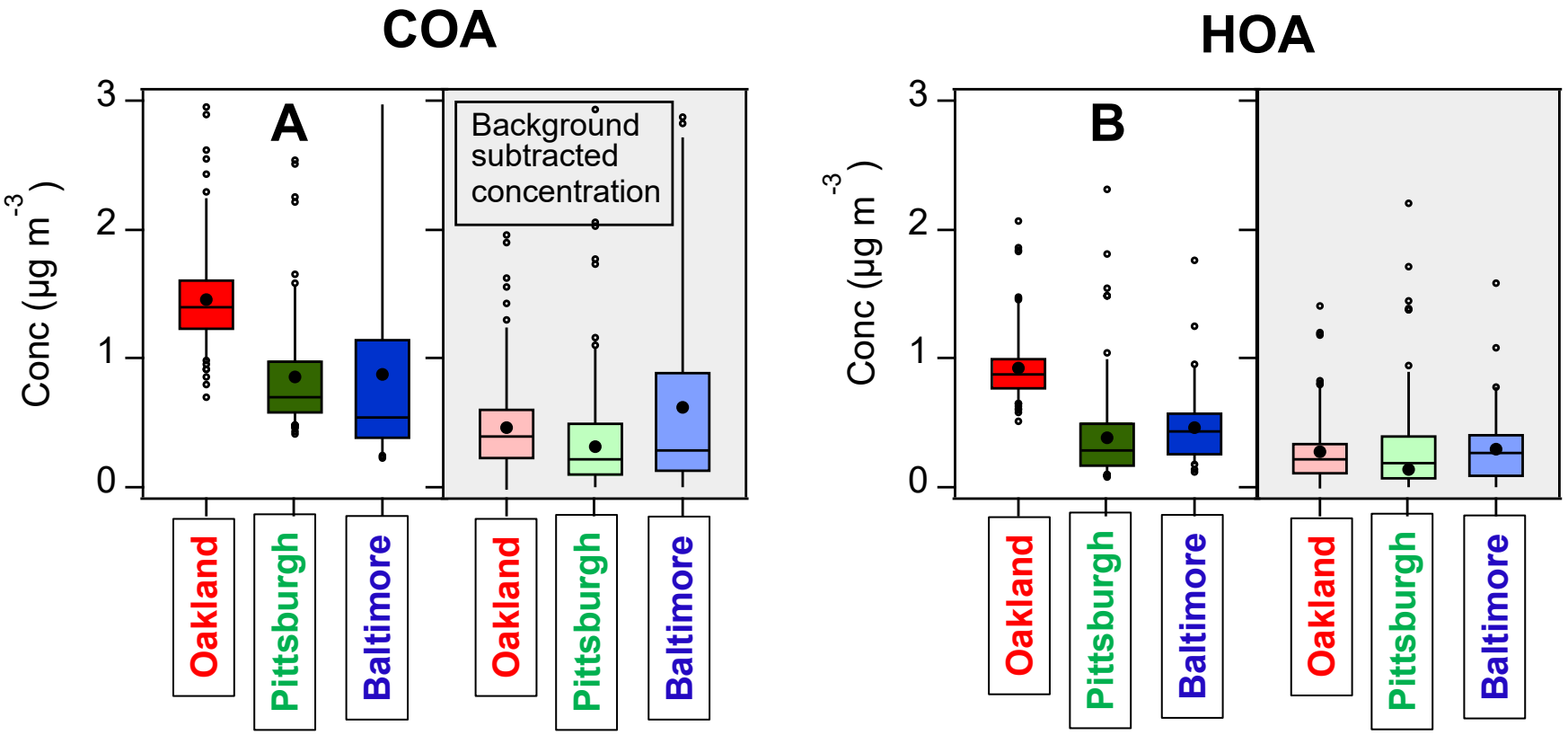


EJ

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

Both HOA and COA vary substantially within and between cities



Spatial variability

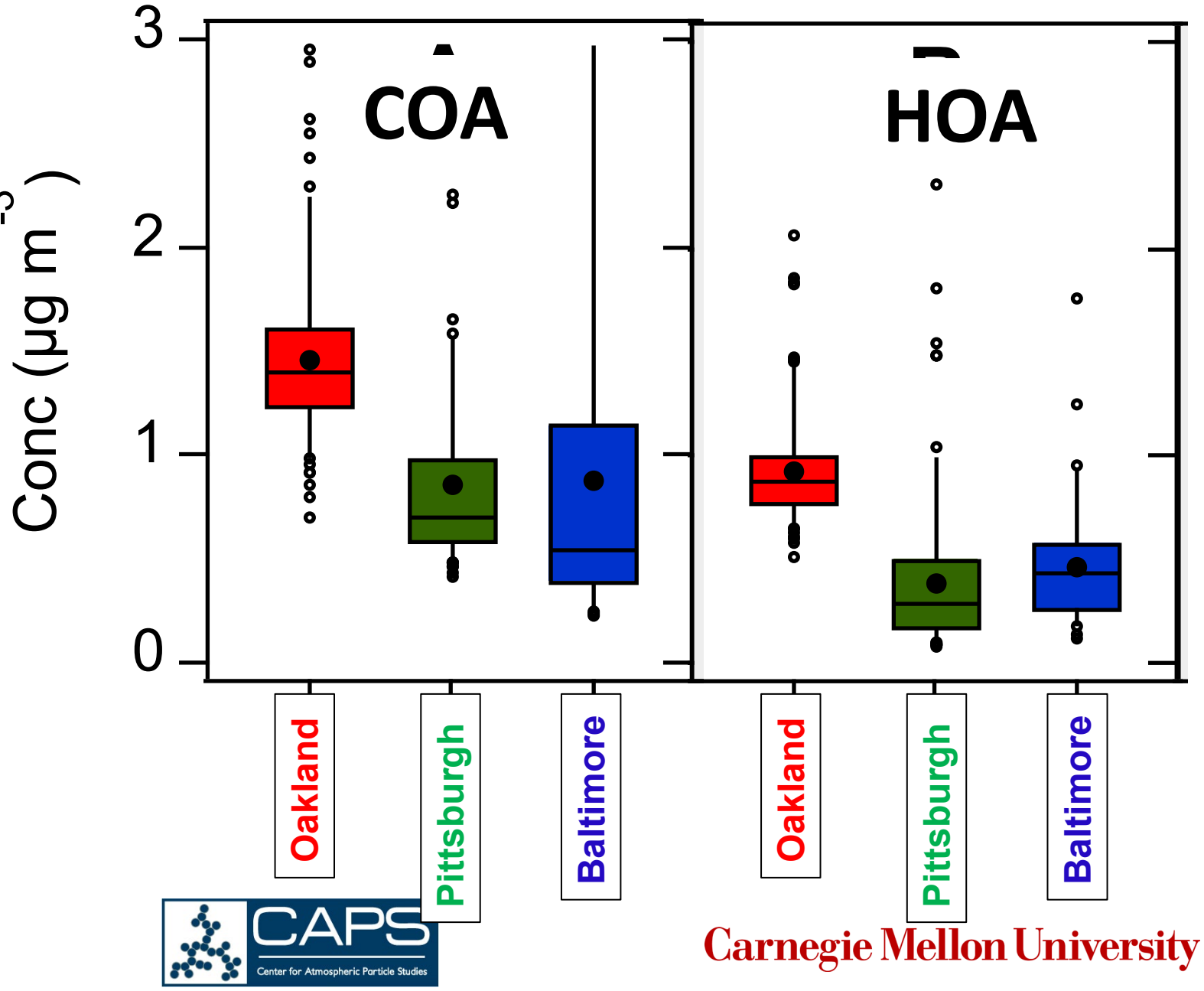
Within-city: 2-6x

Between-city: 2X

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

COA is an important POA source in cities



In each city:

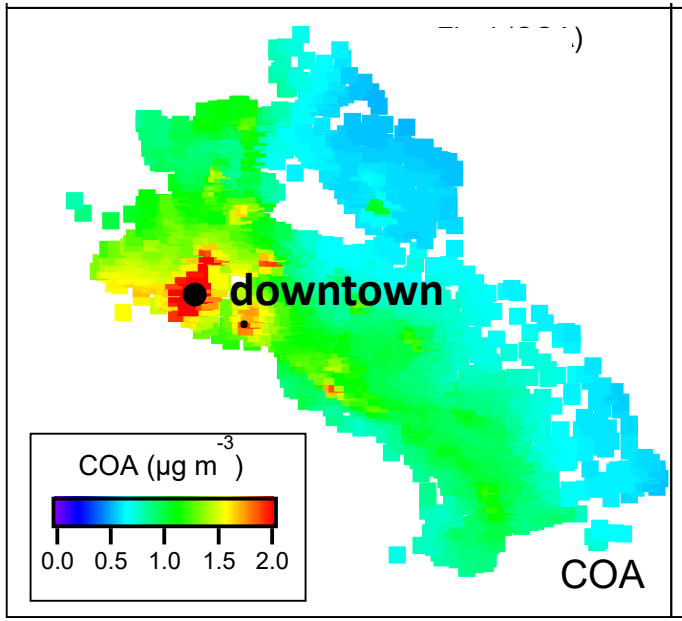
COA> POA

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

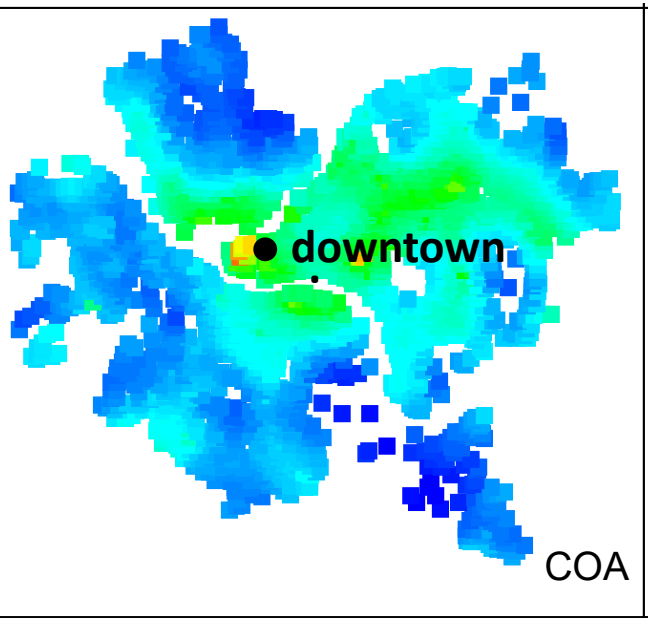
Good linkage between COA concentrations and physically relevant land-use covariates

Oakland



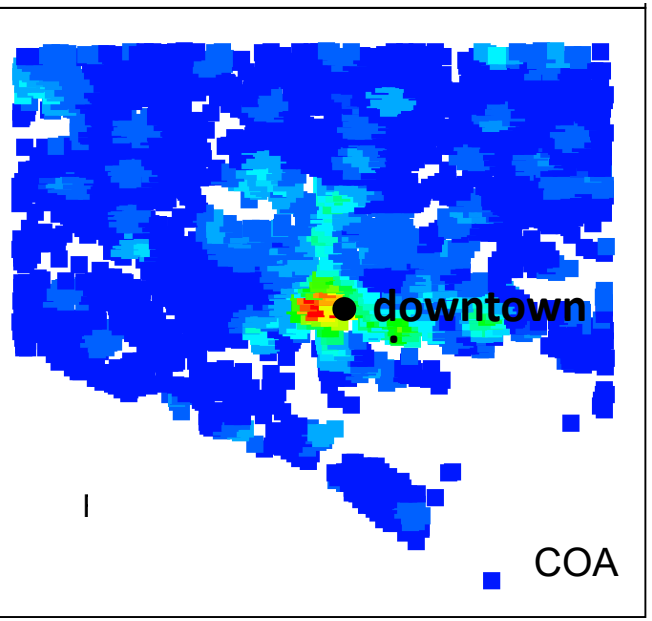
(1) Restaurant density (250 m)
(2) Population density (500 m)
(3) Commercial land use (1000 m)

Pittsburgh



(1) Restaurant density (250 m)
(2) Commercial land use (400 m)
(3) Impervious surface (1000 m)

Baltimore



(1) Food density (250 m)*
(2) Restaurant density (500m)
(3) Major road density (500 m)
(4) Impervious surface (150 m)

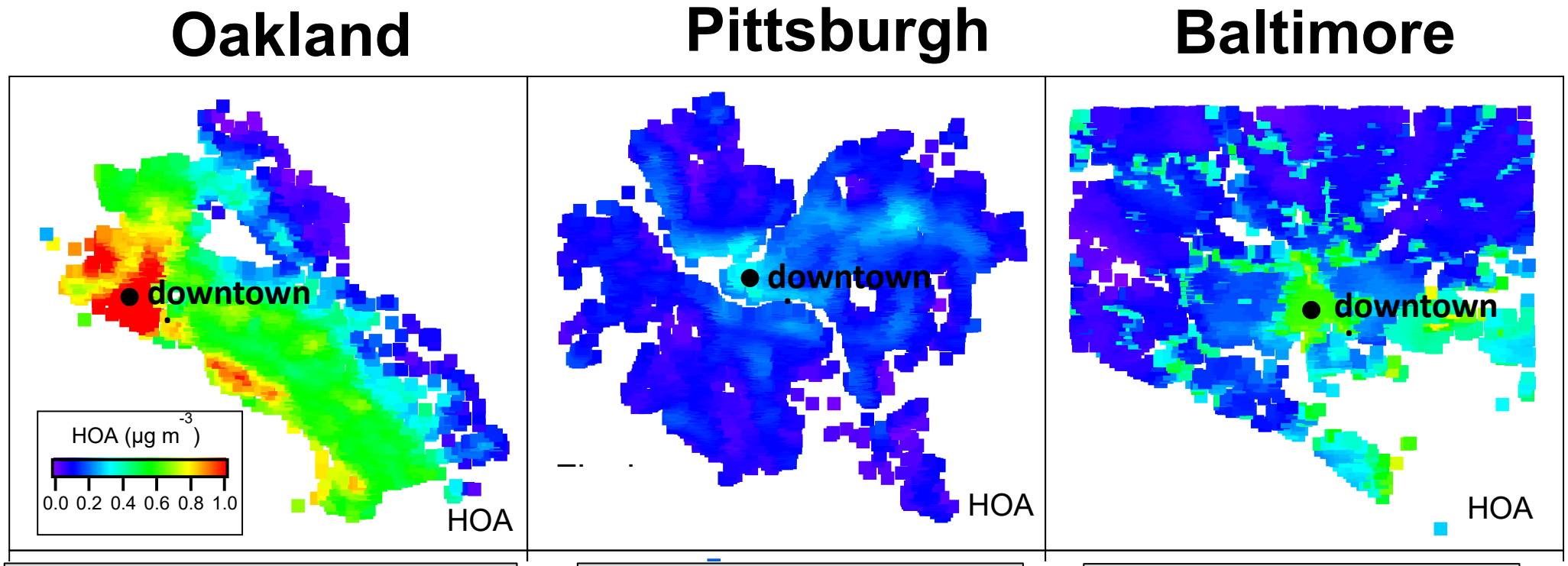
COA

*Food = restaurant+ other food shops

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

Good linkage between HOA concentrations and physically relevant land-use covariates



HOA

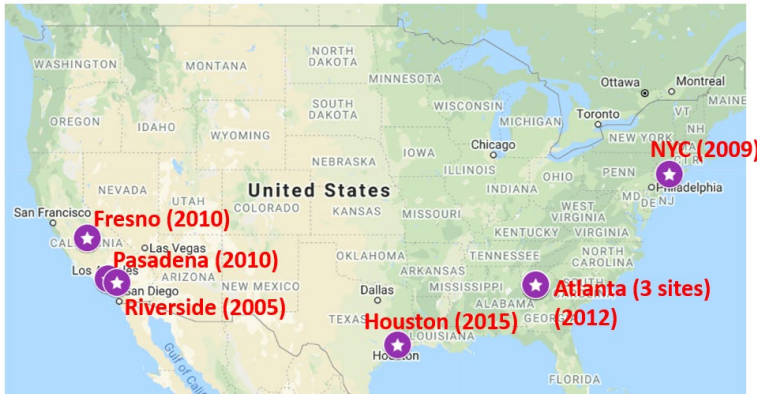
Oakland	Pittsburgh	Baltimore
(1) Road intersection density (1000 m) (2) Commercial landuse (500 m) (3) Impervious surface (500 m)	(1) Arterial road density (500 m) (2) Inv. dist to major intersection (3) Impervious surface (500m)	(1) Transport land use (400 m) (2) Commericla landuse (100 m) (3) Impervious surface (750 m)

CAPS Center for Atmospheric Particle Studies

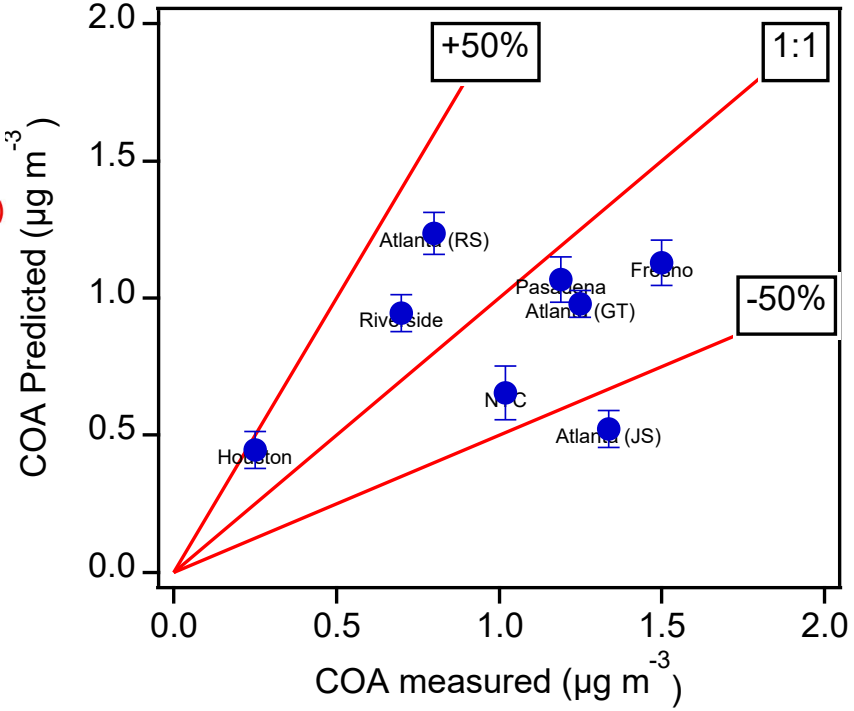
Carnegie Mellon University

Our models explain past atmospheric field studies data reasonably well

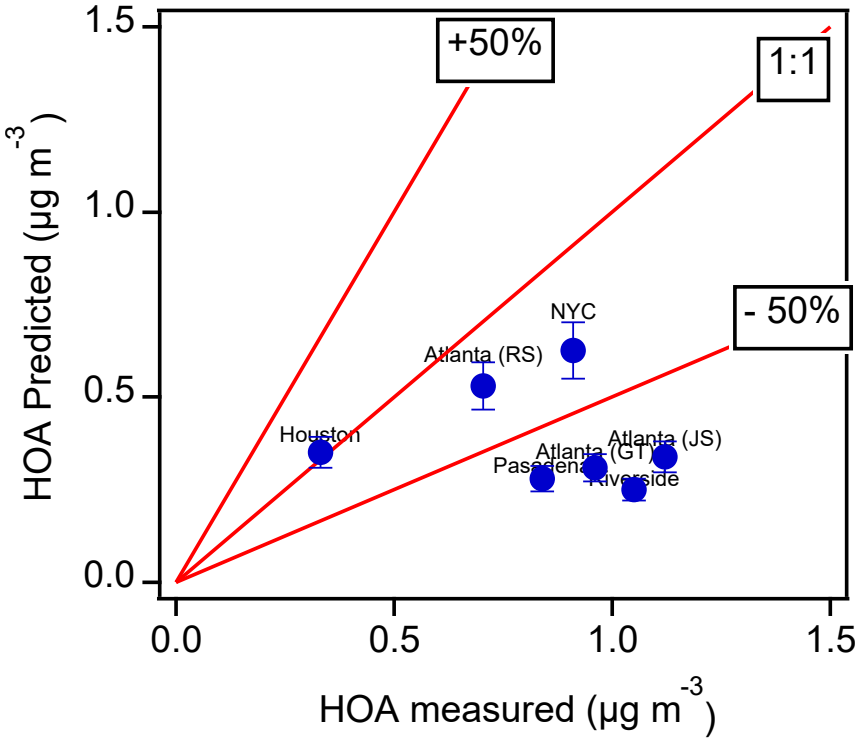
Point POA data from atmospheric field campaigns



COA



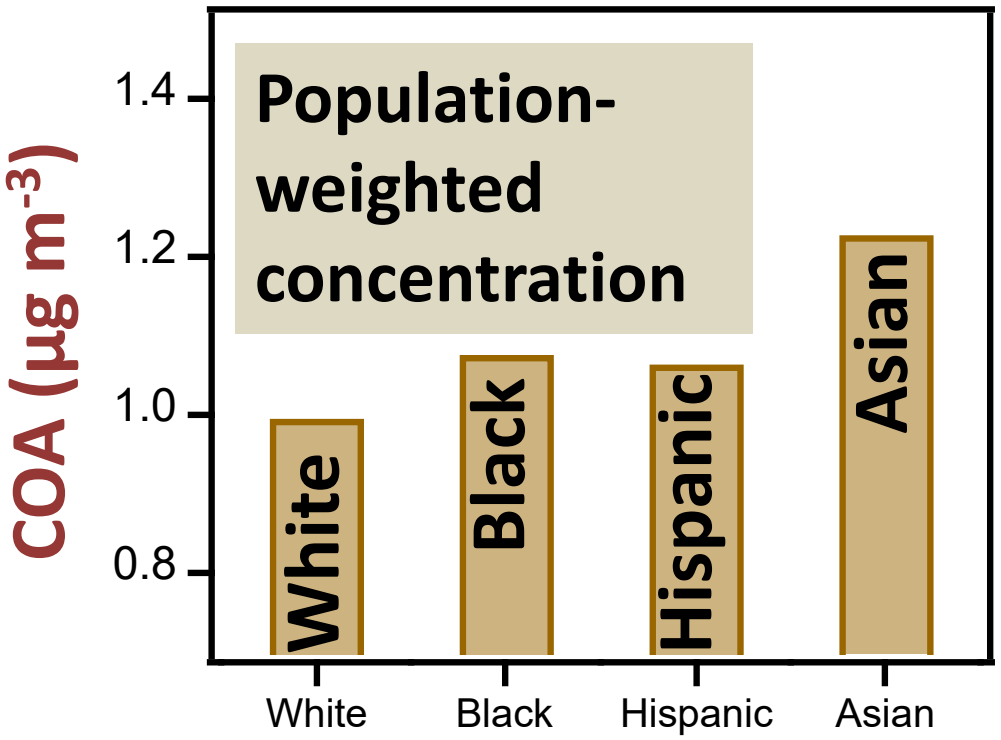
HOA

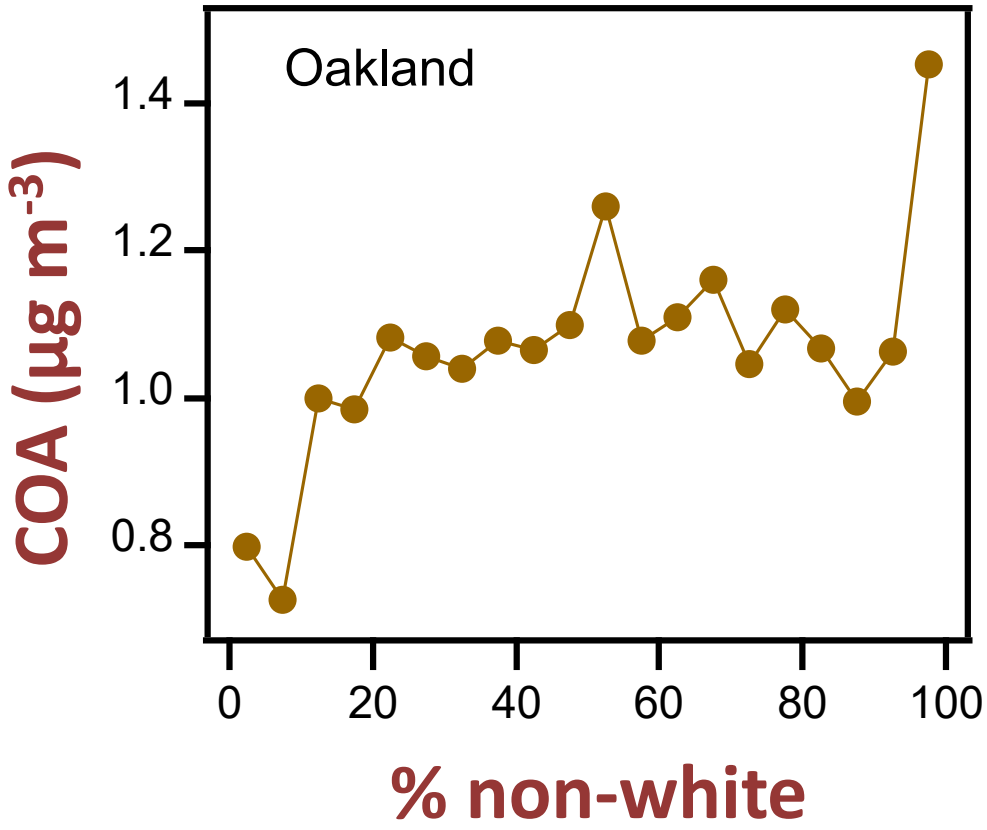


CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

Application: High spatial resolution data and model help exposure analysis



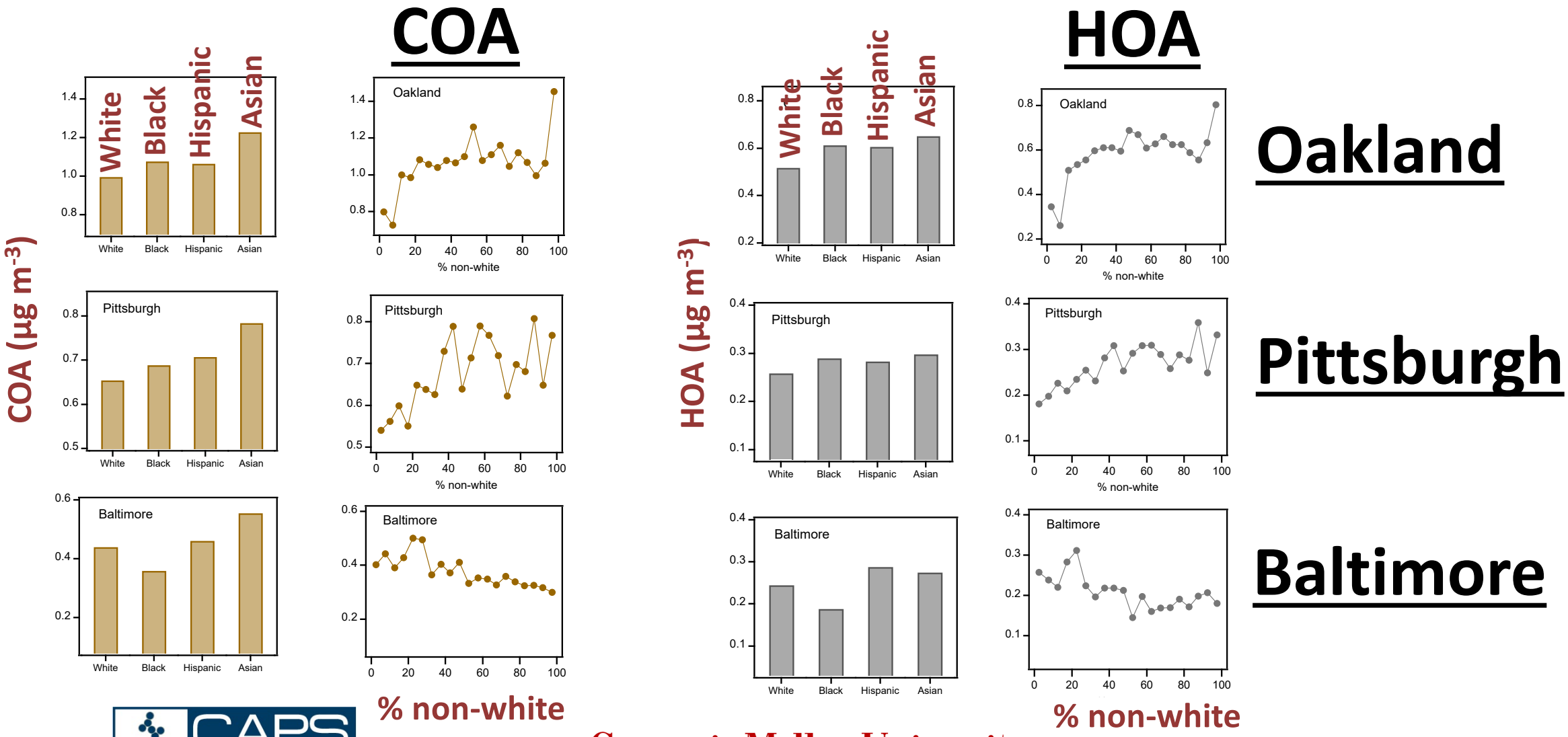


Exposure to COA in Oakland by Race

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

Application: High spatial resolution data and models help exposure analysis



Carnegie Mellon University

CAPS Center for Atmospheric Particle Studies

Summary:

Important questions about POA exposures

- **Concentrations and spatial trends**
  - What are typical concentrations? ~ 1-3 μg m^{-3} (in urban area)
  - What are the inter- and intra-city spatial patterns?
    - Intra-urban: factor of 2-5; Inter-urban: factor of 2
- **POA sources**
  - What are the major sources, and how do they drive spatial patterns?
    - Both Cooking and Traffic
- **POA exposure assessment**
  - What would be needed to improve exposure estimates?
    - High spatial resolution data and model help exposure estimates
    - More data is needed in more locations

Acknowledgments

- Data collection and reduction:
- Peishi Gu
- Rishabh U. Shah
- Qing Ye
- Hugh Z. Li
- CAPS

Funding: CACES

U.S. Environmental Protection Agency (US EPA)

Grant # RD83587301: Center for Air, Climate and Energy Solutions (CACES)

CAPS Center for Atmospheric Particle Studies

Carnegie Mellon University

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant #