Using satellite-derived air quality datasets for health applications: Disease burdens and environmental justice

Susan Anenberg, PhD

NOAA GEO-XO Town Hall

April 29, 2021

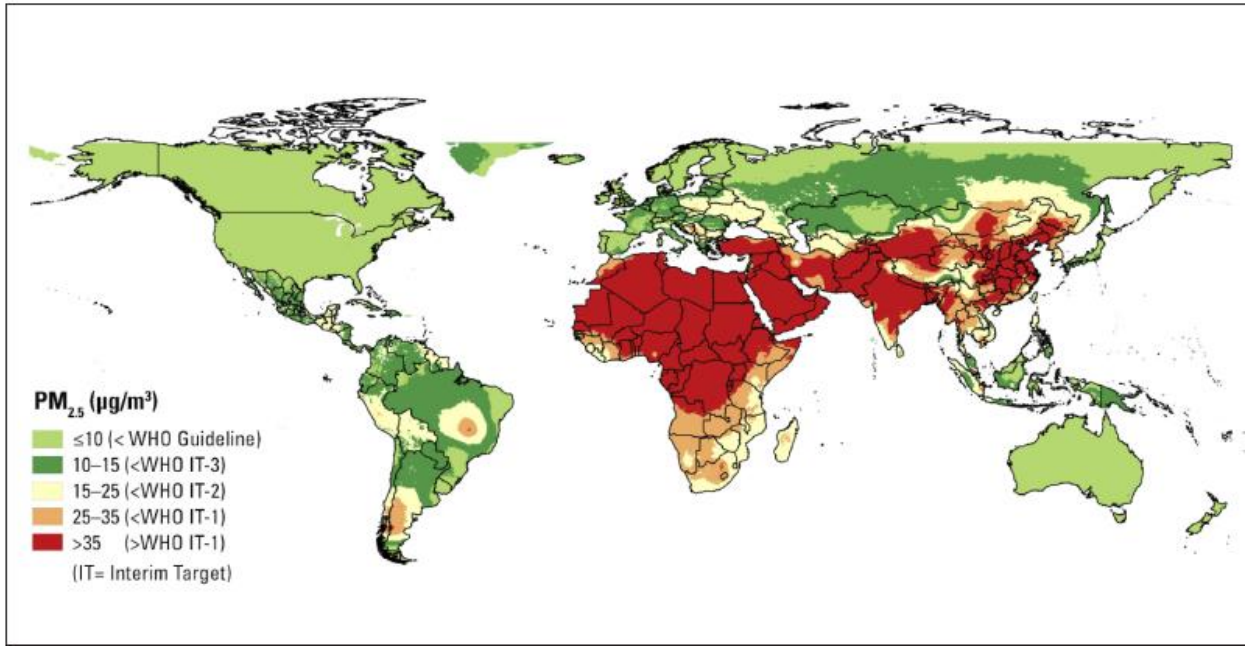
Many collaborators, some named throughout talk

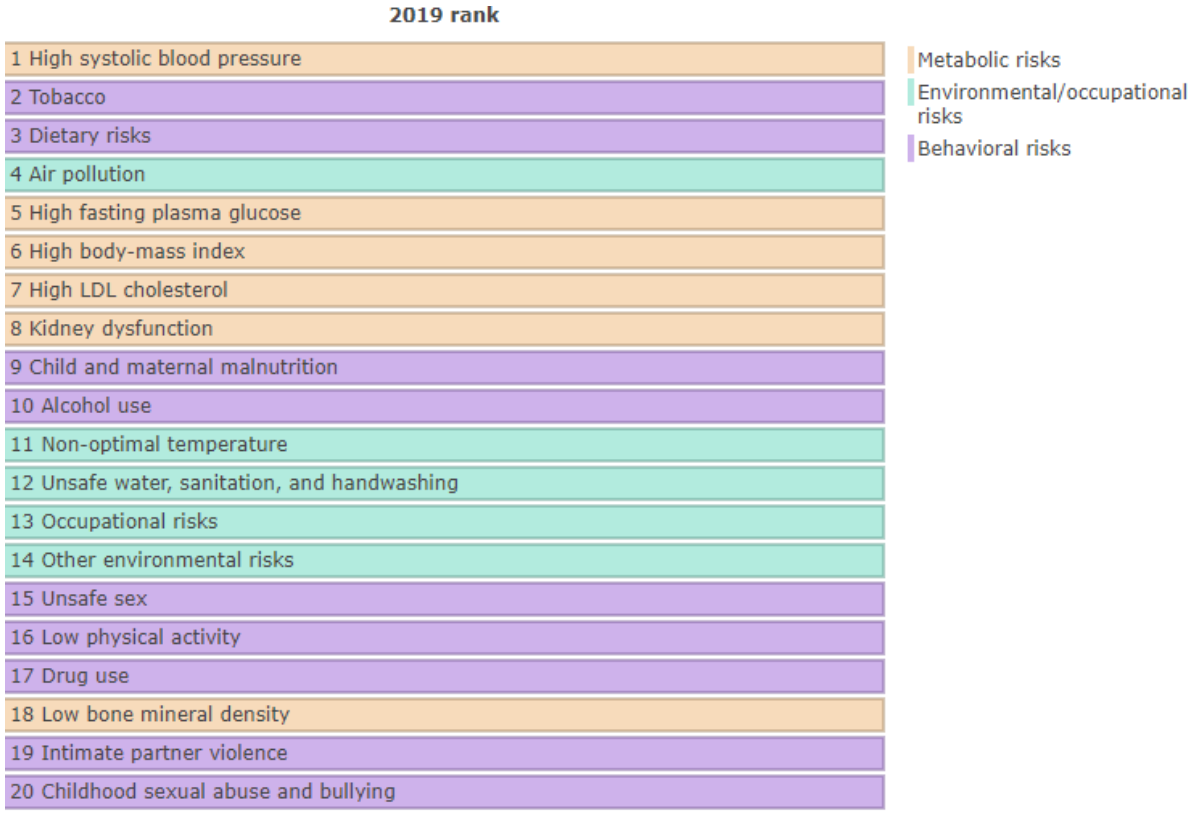
Support from: NASA, Health Effects Institute, Environmental Defense Fund

Milken Institute School of Public Health
THE GEORGE WASHINGTON UNIVERSITY

Air pollution continues to be a leading health risk factor in nearly all countries

>90% of people worldwide live with $PM_{2.5}$ concentrations above the World Health Organization guideline

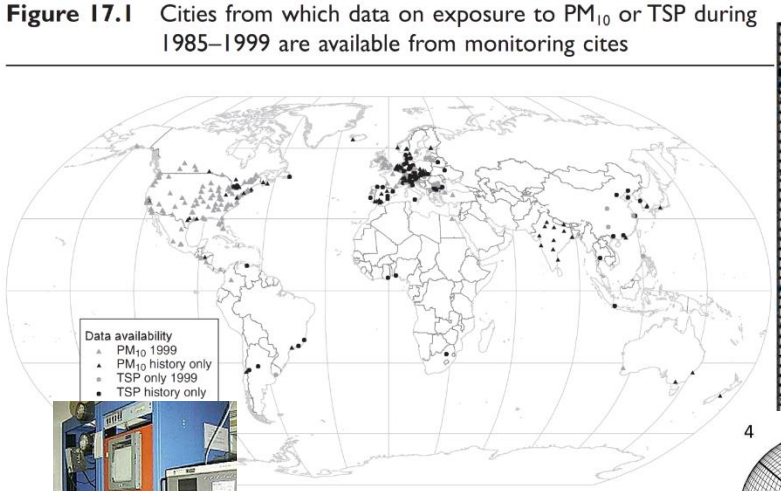


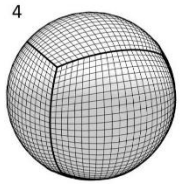


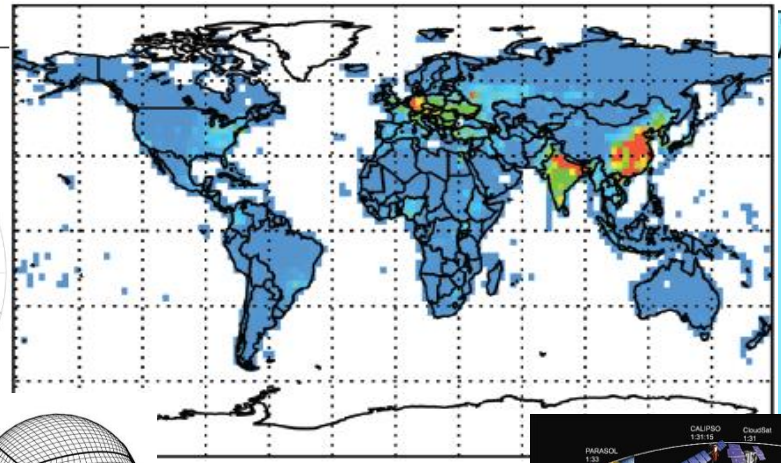
Health Effects Institute, State of Global Air 2019 Report (2019)

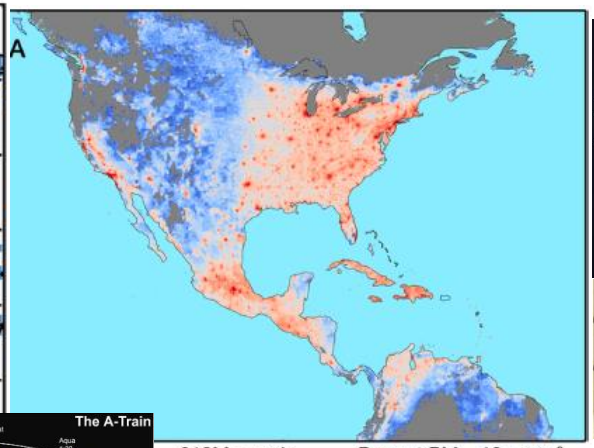
GBD 2019 Study
https://vizhub.healthdata.org/gbd-compare/

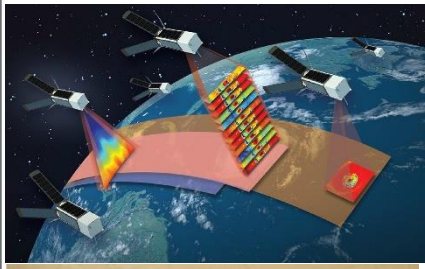
Satellite remote sensing has transformed our ability to understand air pollution disease burdens globally

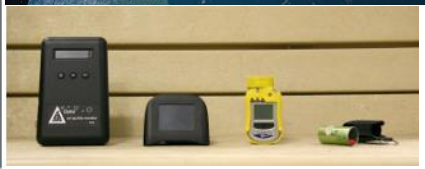












2004: **Surface air quality monitors**, 800,000 premature deaths associated with urban $PM_{2.5}$ (Cohen et al. 2004)

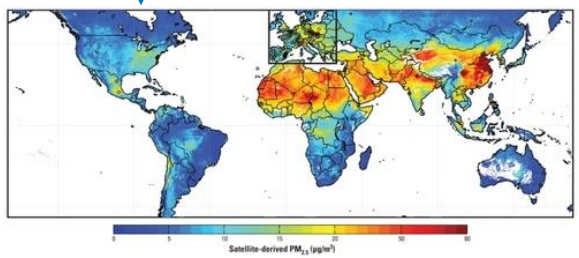
2010: **Global chemical transport model**, 3.7 million $PM_{2.5}$ and 700,000 ozone deaths globally (Anenberg et al. 2010)

2012: **Satellite observations, global chemical transport model, and ground observations combined,** 3.2 million $PM_{2.5}$ and 152,000 ozone deaths (Lim et al. 2012)

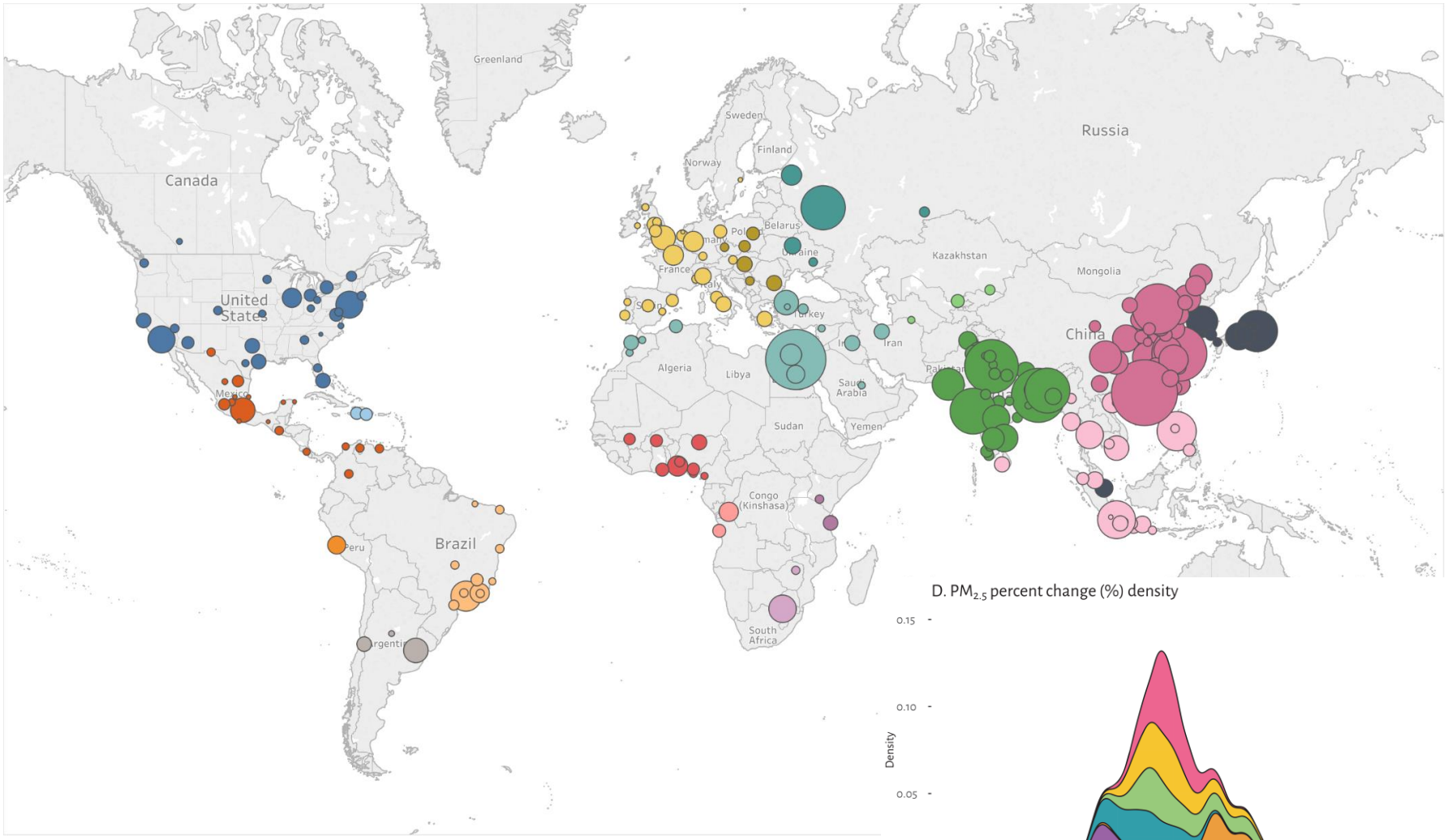
2016-2020: **methods refined,** ~4 million $PM_{2.5}$ and 200,000 ozone deaths (Forouzanfar et al. 2016, etc.)

Future: geostationary satellites, low-cost sensors, mobile monitoring, ???

2010: **Global $PM_{2.5}$ concentrations from satellite AOD** (van Donkelaar et al. 2010)



$PM_{2.5}$ mortality in cities worldwide



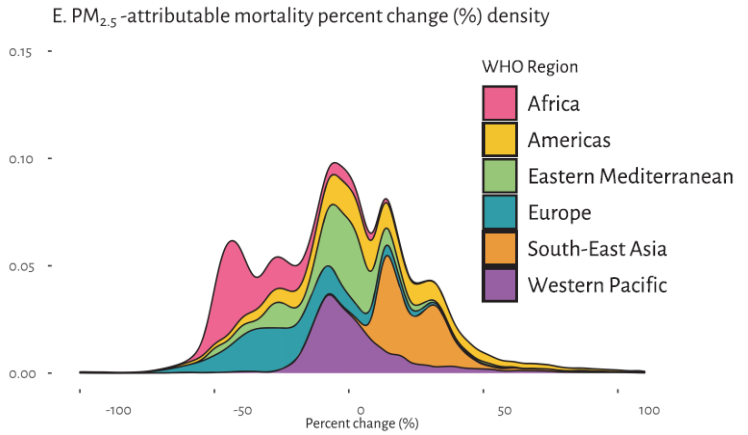
SCIENTIFIC REPORTS
nature research

OPEN

Particulate matter-attributable mortality and relationships with carbon dioxide in 250 urban areas worldwide

119
19
August 2019

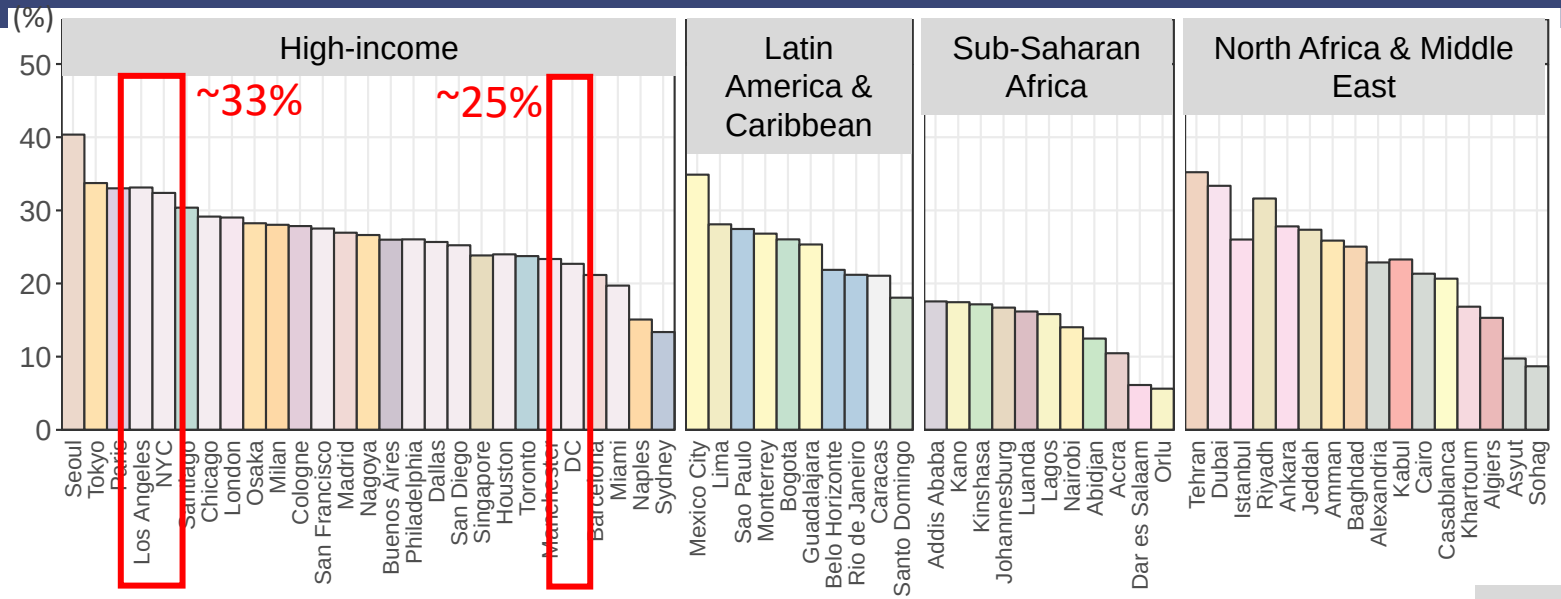
Susan C. Anenberg[1], Pattanun Achakulwisut[1,7], Michael Brauer[2,3], Daniel Moran[4], Joshua S. Apte[5] & Daven K. Henze[6]

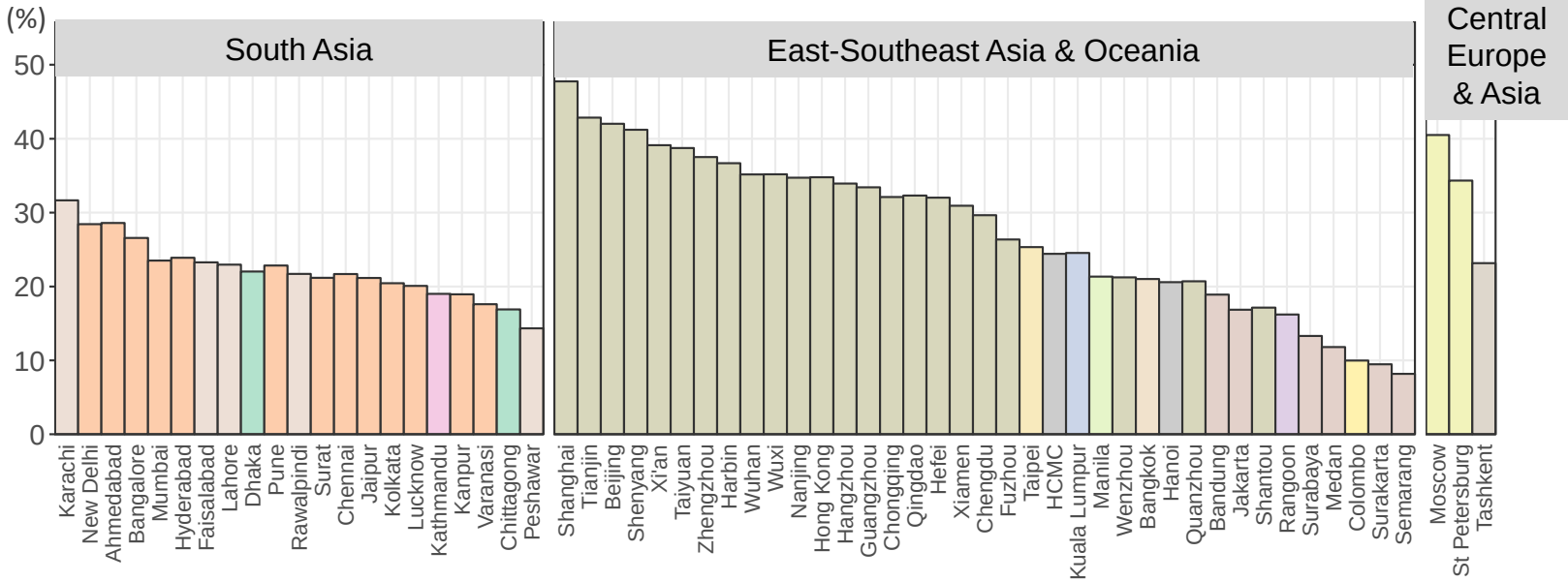


Southerland et al. in prep

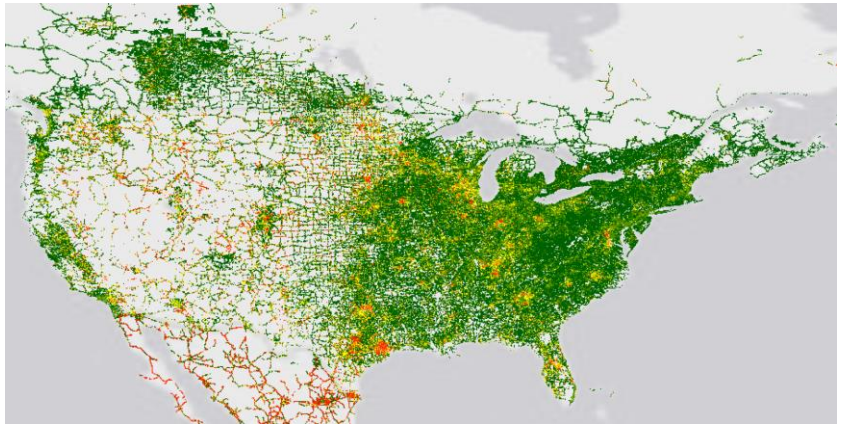
NO_2 pollution is an important risk factor for pediatric asthma incidence

Ploy Achakulwisut Arash Mohegh





- % of new pediatric asthma cases attributable to NO_2 >20% in cities in both developed and developing countries.
- Despite substantial declines, NO_2-attributable pediatric asthma incidence increased from 2000 to 2019 in many areas of the U.S.

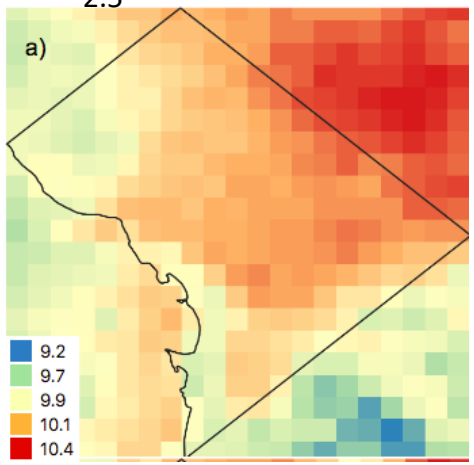


Achakulwisut et al., 2019, *Lancet Planetary Health (2019)*
Anenberg, Mohegh, et al. in prep,
https://www.essoar.org/pdfjs/10.1002/essoar.10506660.1

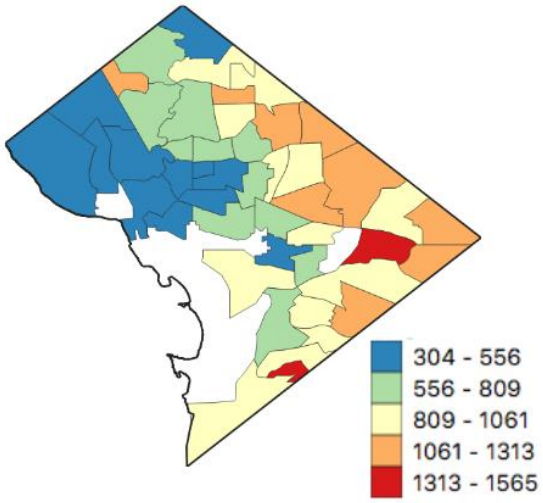
Identifying inequities in air pollution health risks challenged by coarsely resolved data inputs for exposure estimation

Maria Castillo

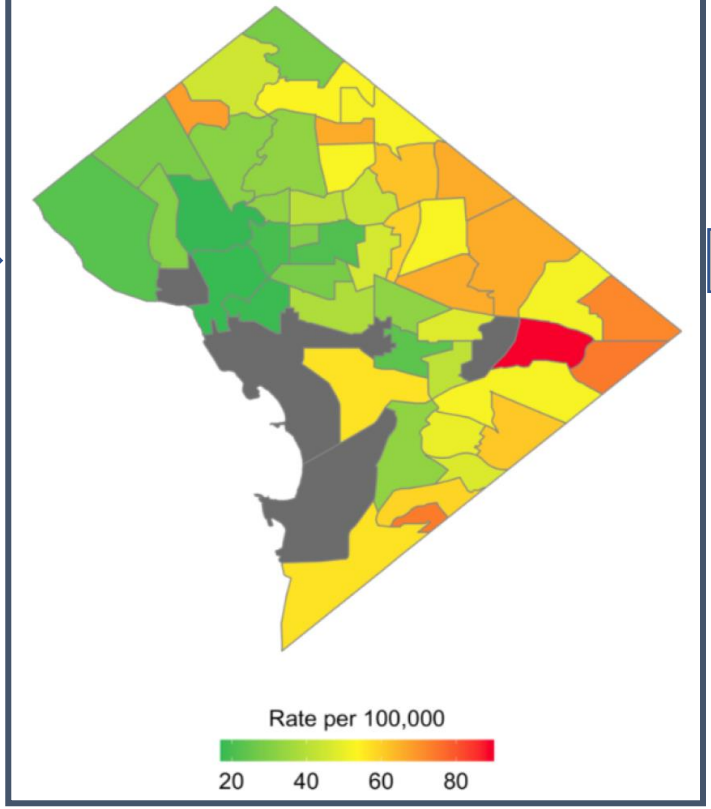
$PM_{2.5}$ concentrations



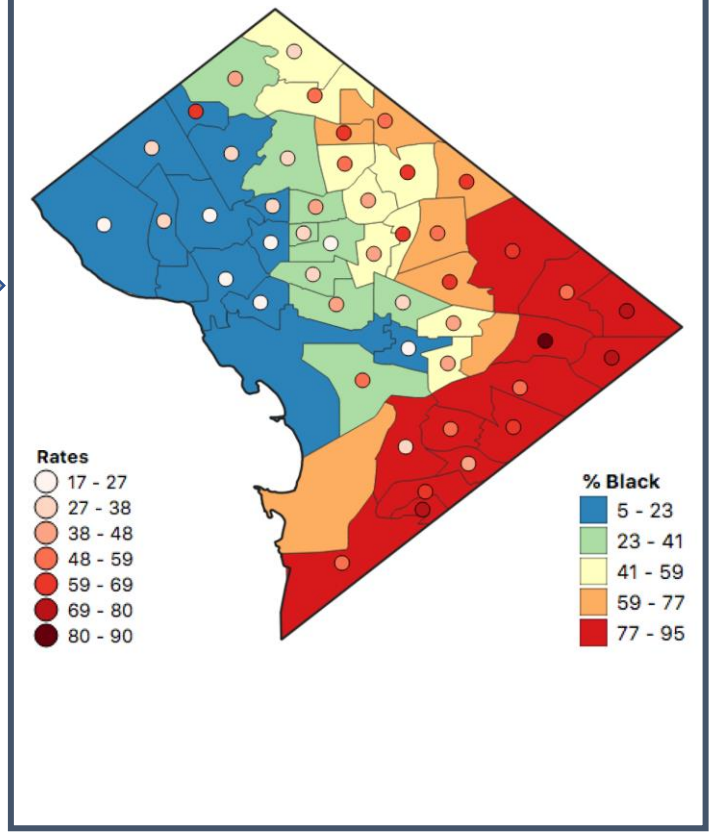
All-cause mortality rates



$PM_{2.5}$-attributable mortality rates…

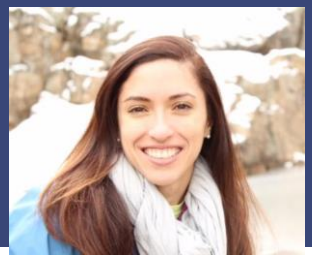


… similar spatial pattern as % Black



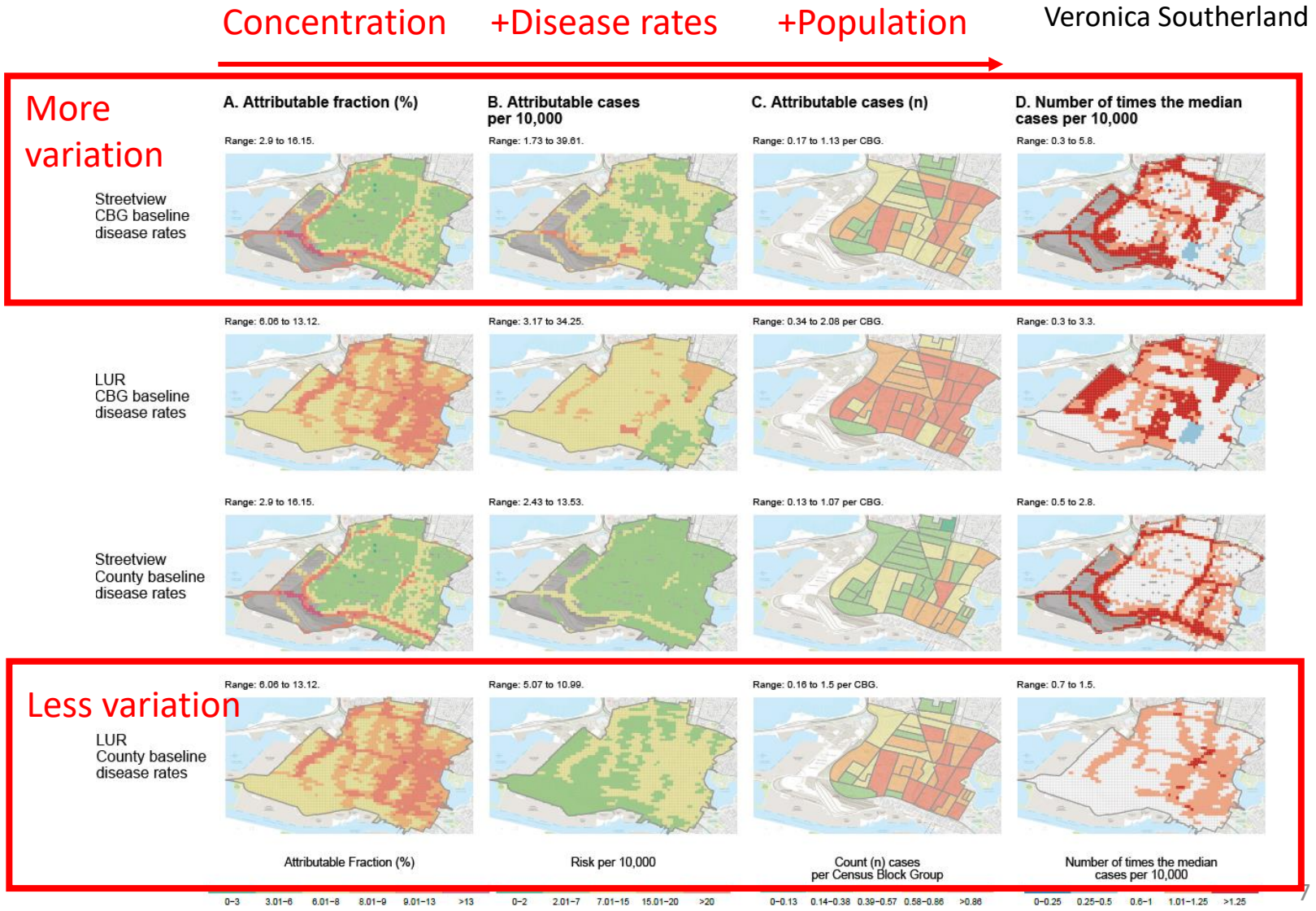
Castillo et al. submitted, https://www.essoar.org/doi/abs/10.1002/essoar.10506837.1

Within-city heterogeneity in air pollution health risks: Importance of picking up traffic



Veronica Southerland

- 38-fold variation in mortality attributable to NO_2 across Bay Area, CA
- Mobile monitoring led to more spatial variation in air pollution health risks
- Hourly measurements from geostationary satellites should improve estimation of traffic-related air pollution health risks



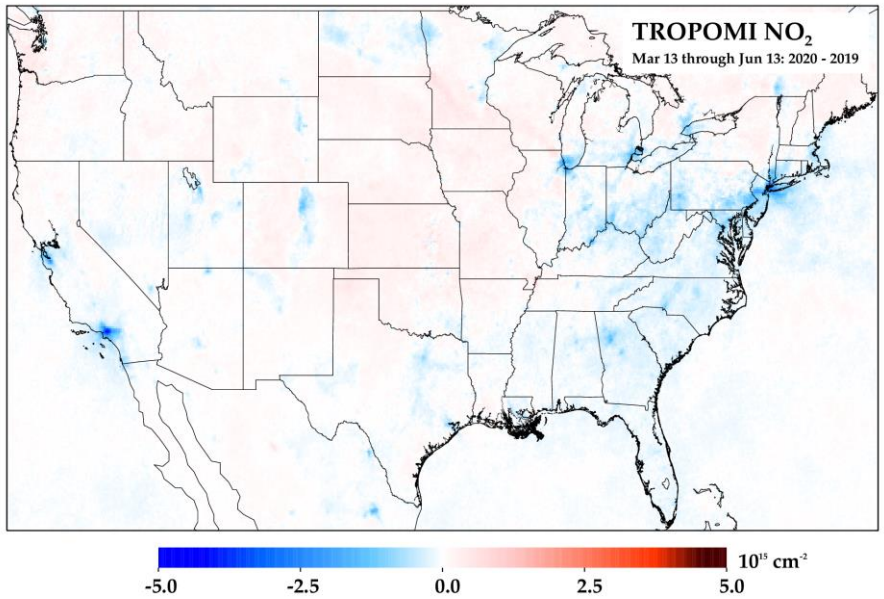
Southerland et al. EHP, 2021

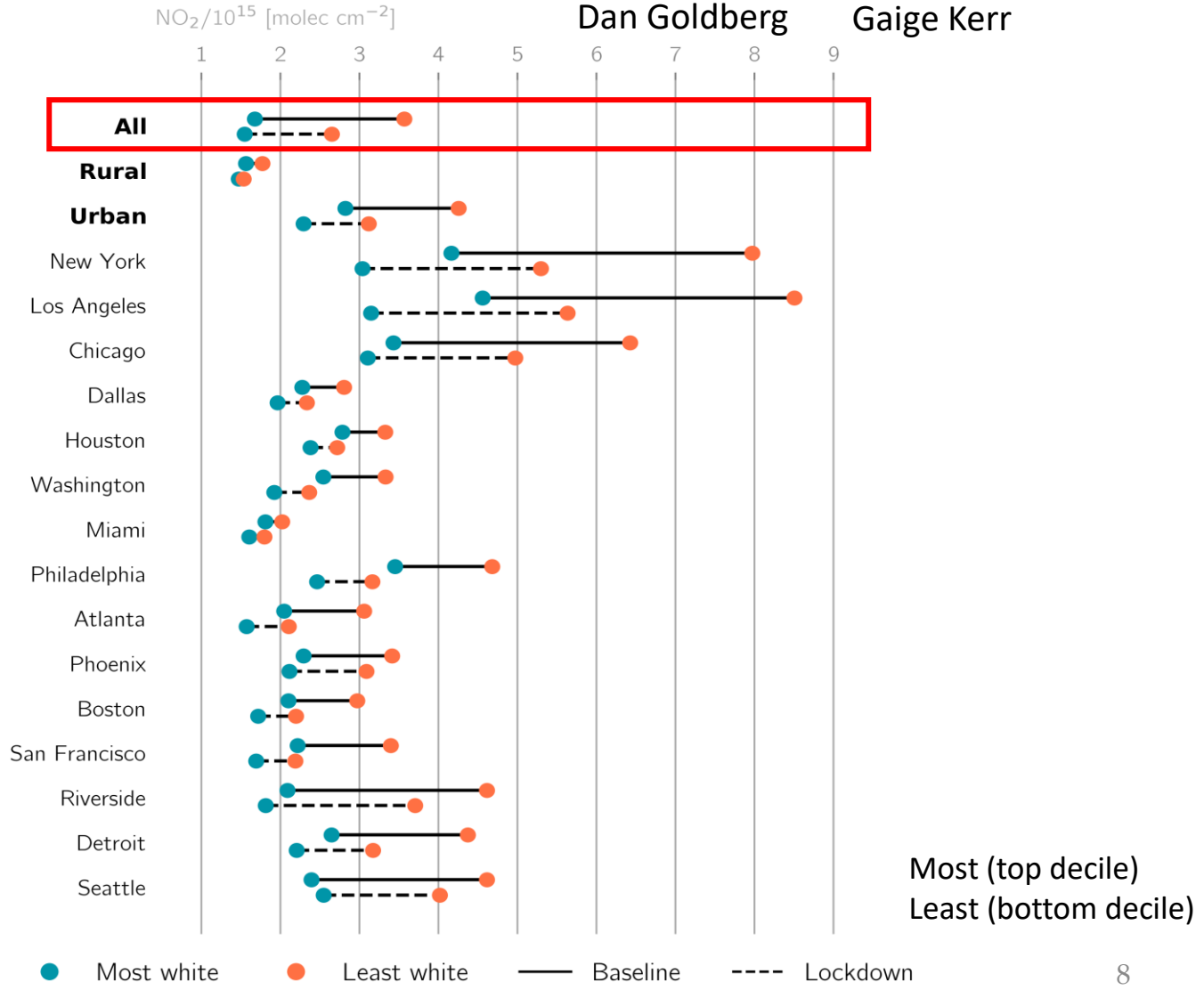
COVID-19 pandemic reveals persistent disparities in NO_2 pollution

Dan Goldberg

Gaige Kerr

In many cities, the post-lockdown NO_2 amounts in the least white communities are still ~50% larger than the pre-lockdown NO_2 amounts in the most white communities



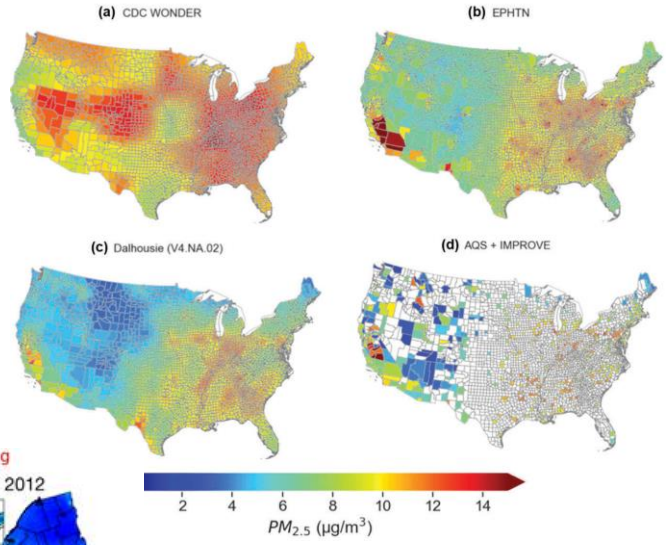


Most (top decile)
Least (bottom decile)

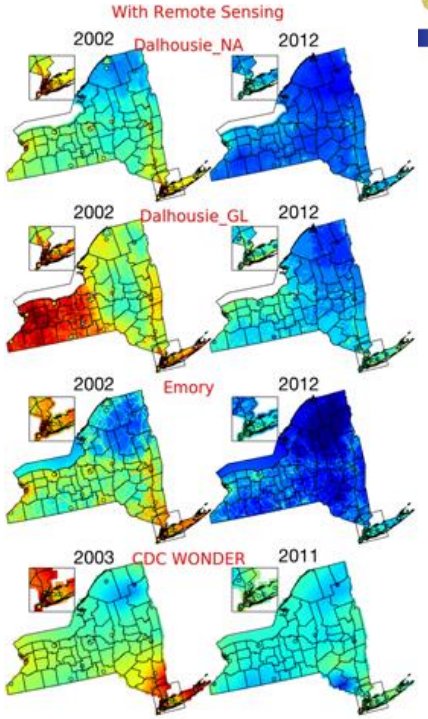
Kerr, Goldberg, and Anenberg, submitted
https://www.essoar.org/doi/pdf/10.1002/essoar.10504561.3

Concluding thoughts

- Satellite remote sensing has transformed environmental health surveillance capabilities
- Limitations of satellite data for health applications
  - Temporal coverage/flyover time
  - Spatial resolution
  - Ability to discern components/mixtures
  - There is still disagreement between surface concentration estimates from different methods
- Some thoughts for future directions
  - Important to have continuous record of satellite datasets
  - Use satellite data to identify areas for locating ground monitors
  - Integrate multiple concentration datasets to leverage strengths of each



Diao et al. 2019



Jin et al. 2019