Estimating the value of GeoXO ACX data for public health and environmental justice

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May 7, 2024

GeoXO ACX Science Team meeting

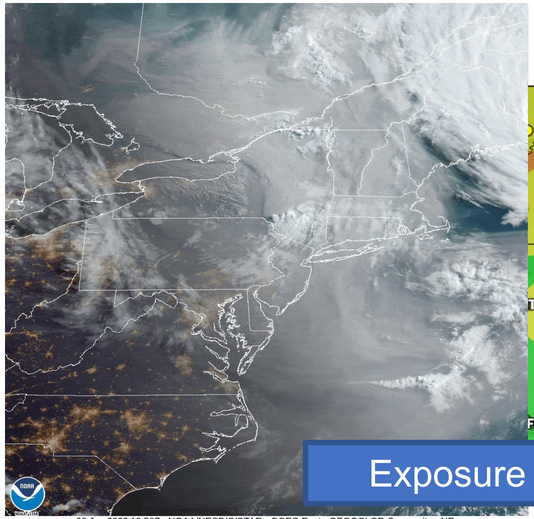
College Park, MD

Milken Institute School of Public Health
THE GEORGE WASHINGTON UNIVERSITY

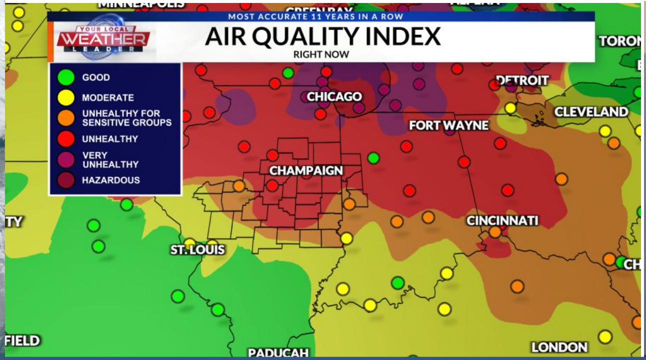
Motivation

Can we estimate public health benefits from improved identification of severe air pollution events with geostationary satellite data?

- $PM_{2.5}$ air quality alert days
- Urban NO_2 and air pollution injustice



06 Jun 2023 10:56Z - NOAA/NESDIS/STAR - GOES-East - GEOCOLOR Composite - NE



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Exposure → Health Outcomes

GeoHealth

Research Article | Open Access

Public Health Benefits From Improved Identification of Severe Air Pollution Events With Geostationary Satellite Data

Katelyn O'Dell, Shobha Kondragunta, Hai Zhang, Daniel L. Goldberg, Gaige Hunter Kerr, Zigang Wei, Barron H. Henderson, Susan C. Anenberg

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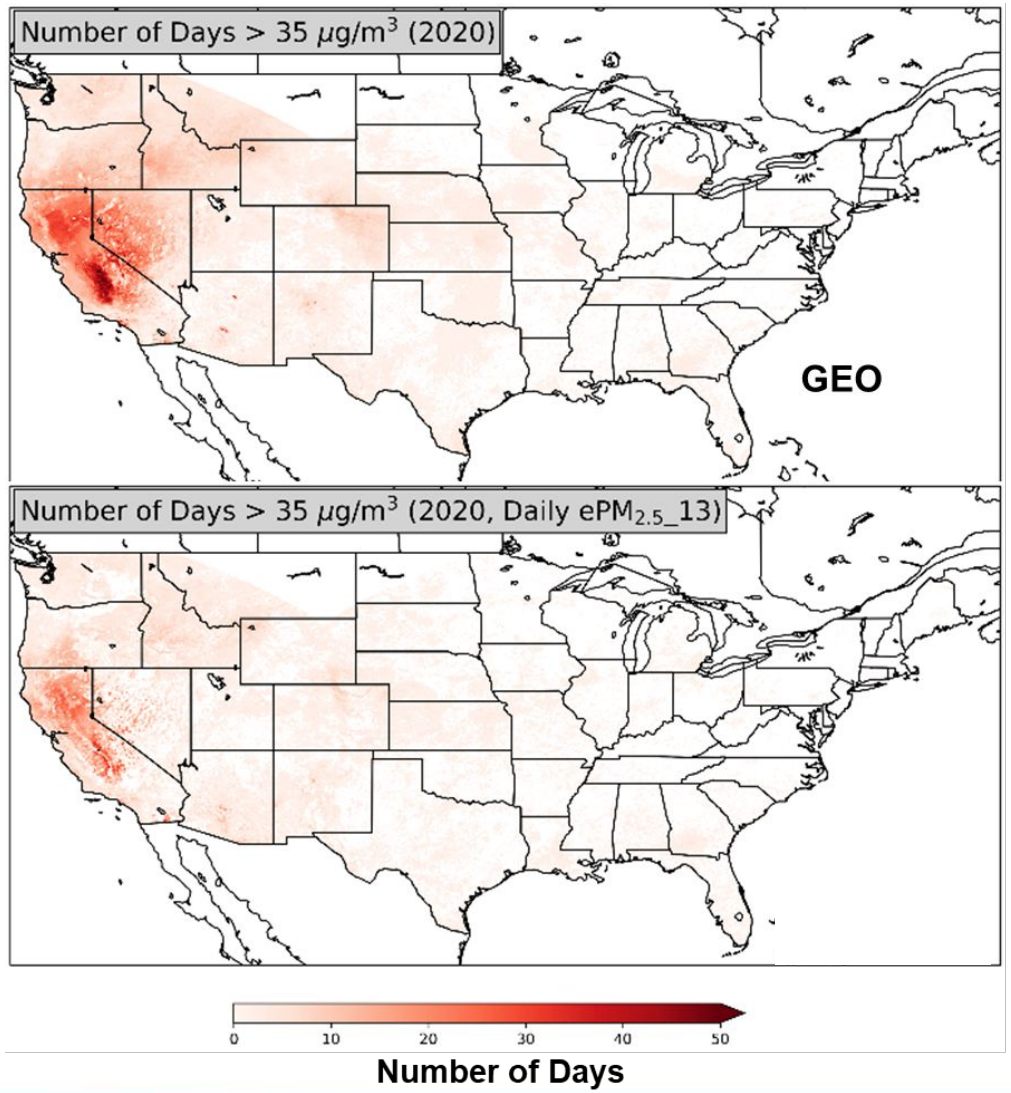

Zhang et al., W&F, 2022

Led by Dr. Kate O'Dell

National Environmental Satellite Data and Information Service
DEPARTMENT OF COMMERCE

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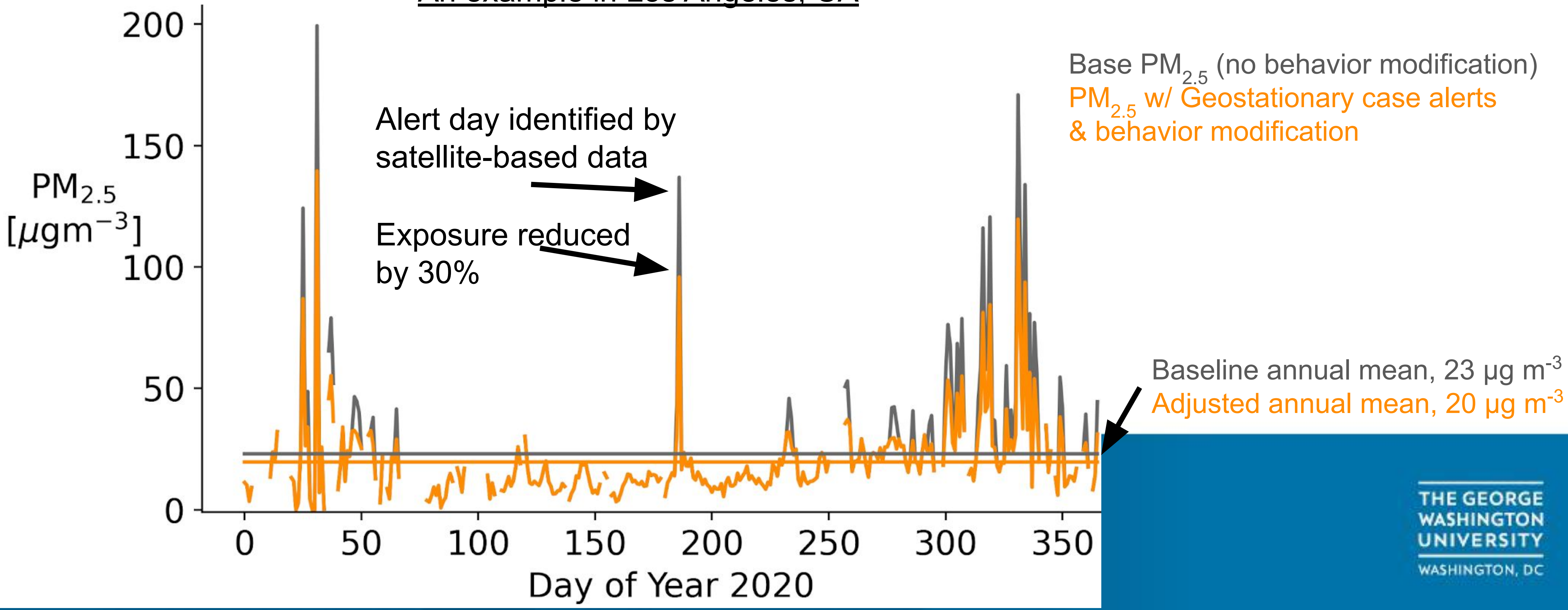
Reduction in annual average $PM_{2.5}$ exposure from avoidance behavior

Assumption: 30% reduction in exposure, accounting for fraction of population taking exposure-reducing actions and the effectiveness of the actions (EPA CAIF Report, 2021).

<u>An example in Los Angeles, CA</u>



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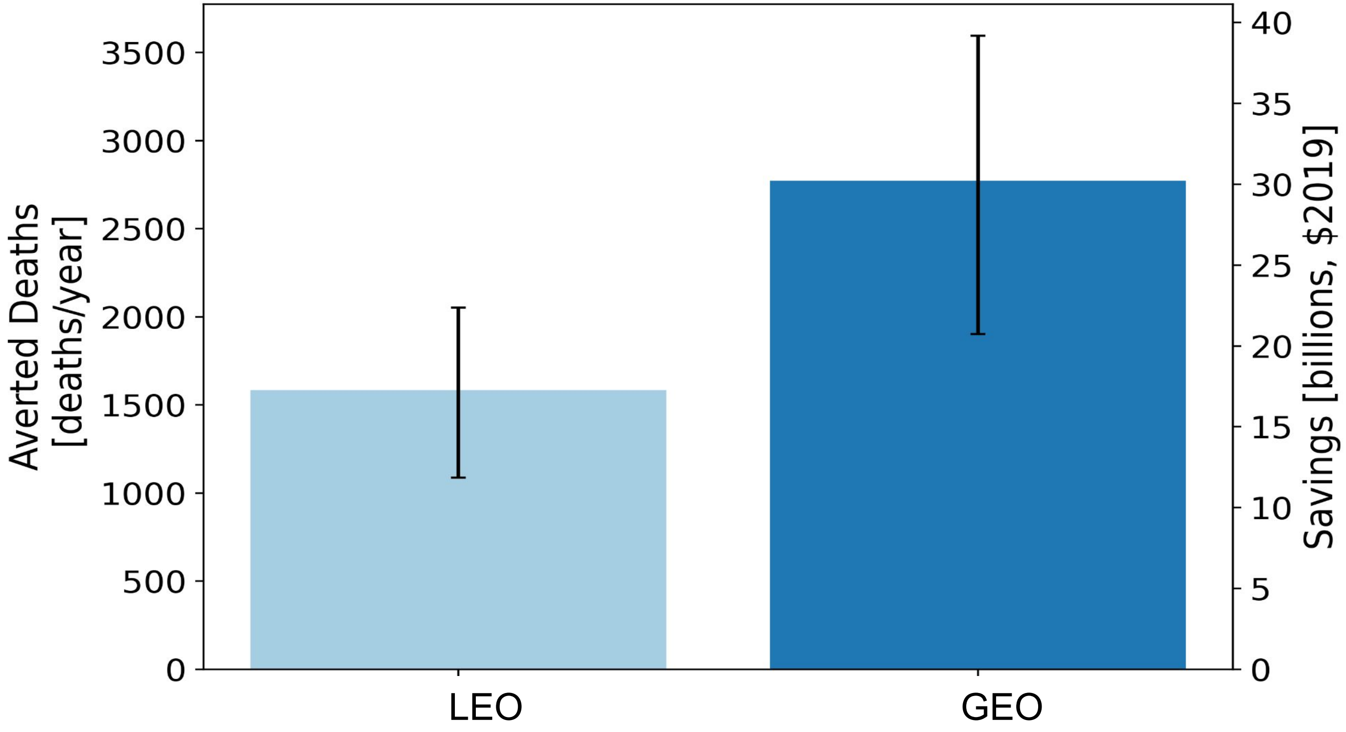
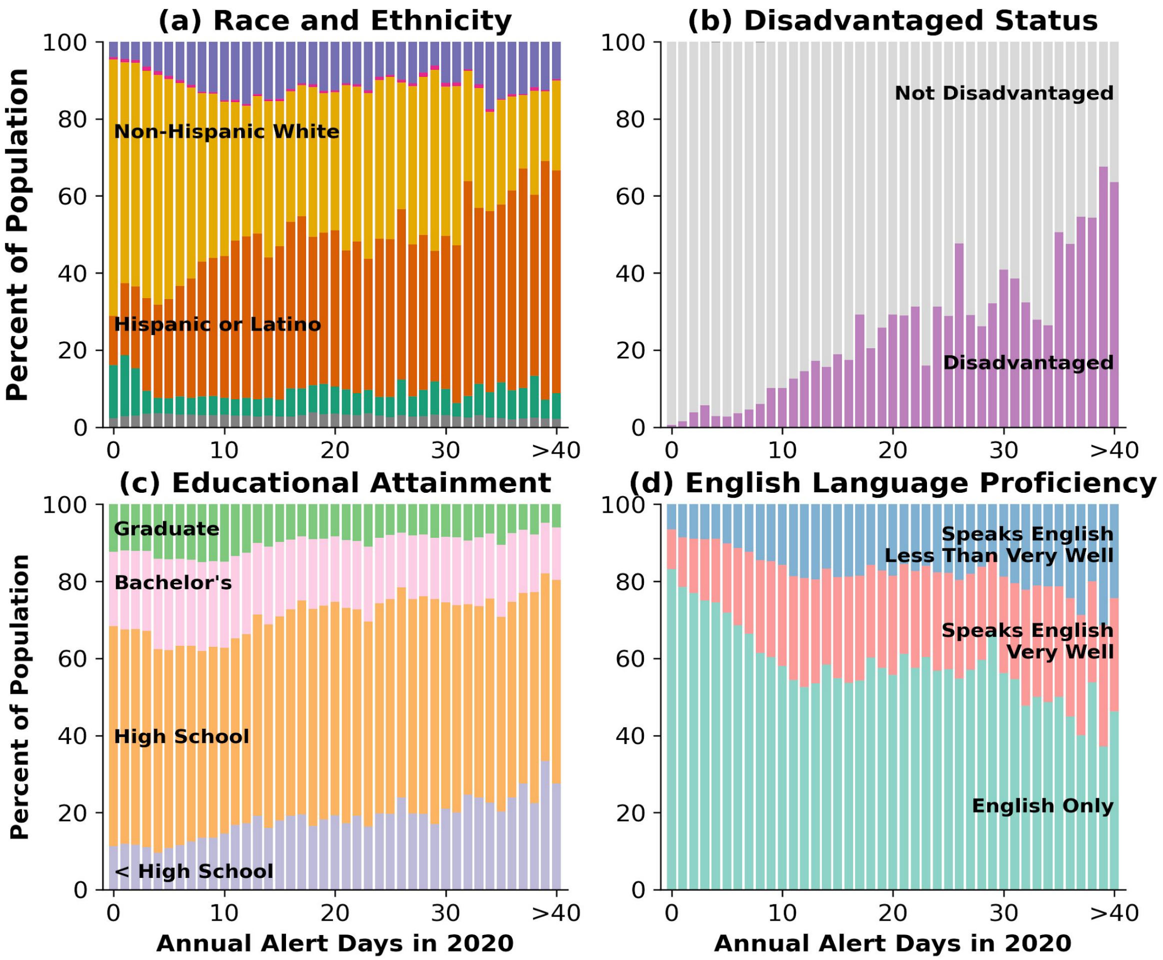
Air quality alerts based on geostationary satellite data compared to polar-orbiting satellite data could lead to 1200 premature deaths averted with ~$13B savings annually



Communities exposed to more alert days in 2020 were more likely to:

- Identify as Hispanic or Latino
- Identify as Asian or Pacific Islander, report to speak English less than “very well”
- Have less than a high school education
- Be classified as disadvantaged by the US government



Development of a Land-Use Regression of Hourly Surface NO_2 in preparation for GeoXO Atmospheric Composition Data

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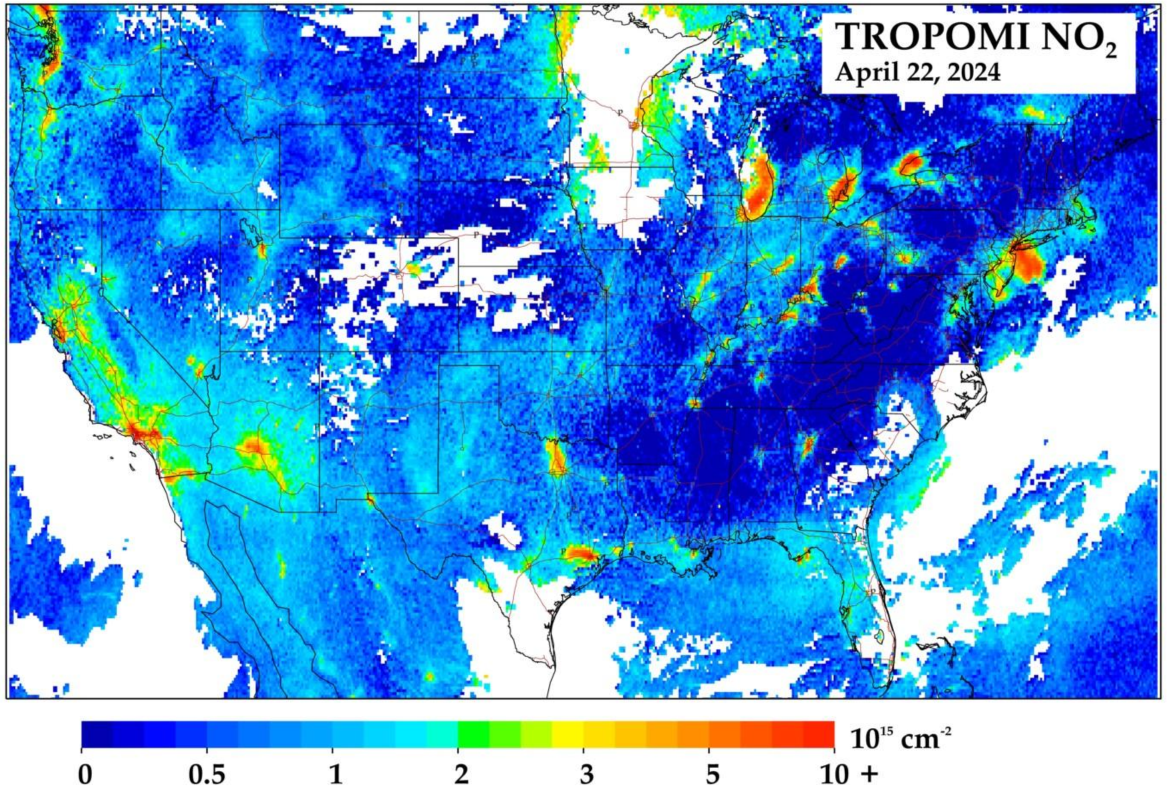
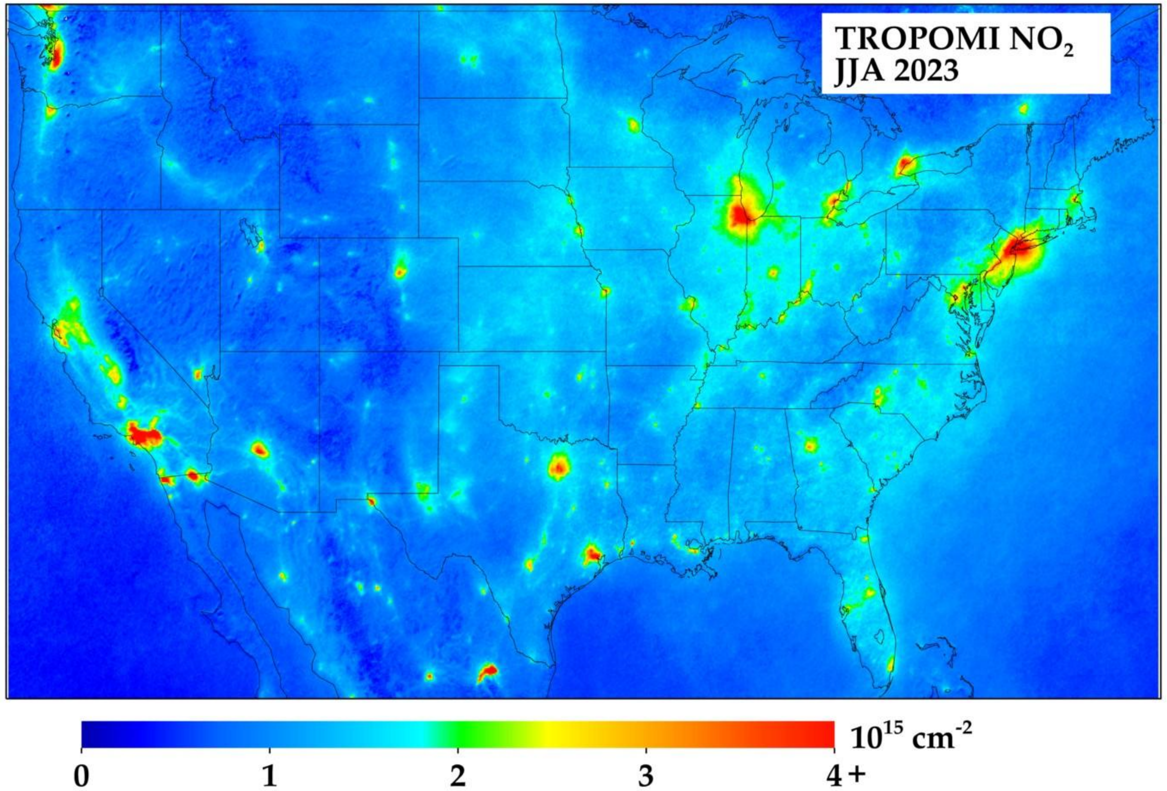
[1]George Washington University, [2]NOAA NESDIS Center for Satellite Applications and Research

Led by Dr. Omar Nawaz

NO_2 pollution from TROPOMI

tropomino2.us





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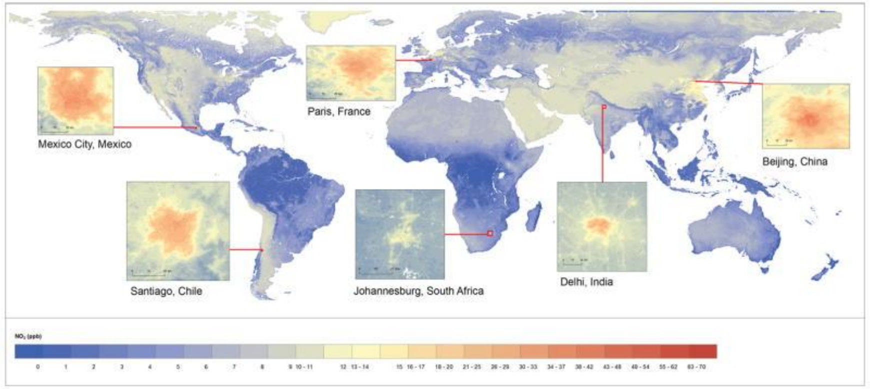
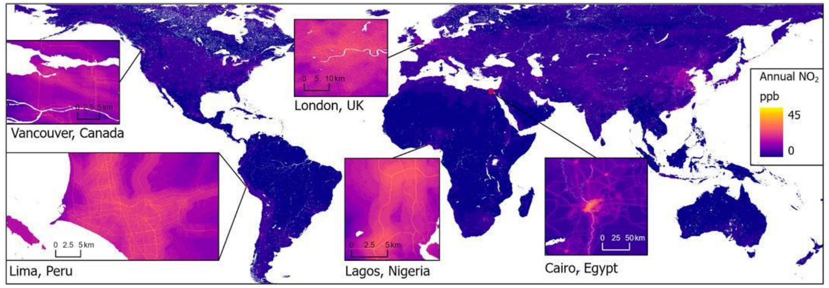
Motivation

In the past, large-scale LUR models have used **OMI** data:

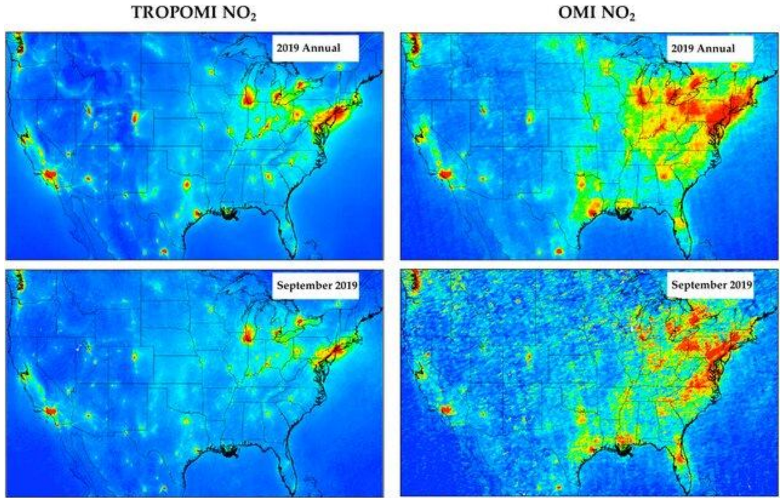


Larkin et al. 2017



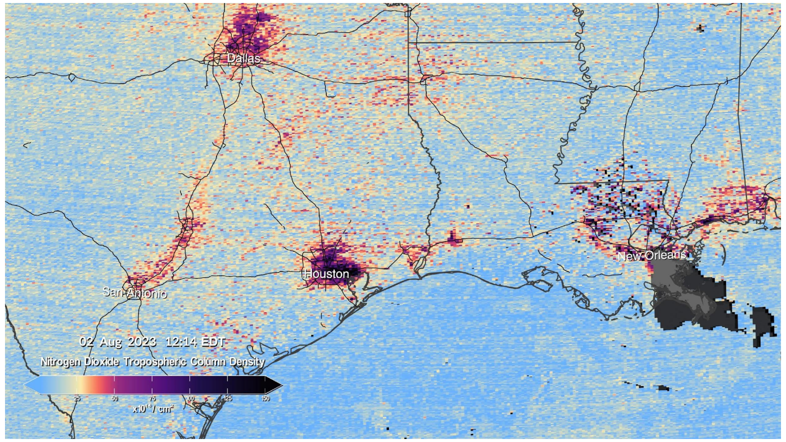
Larkin et al. 2023

We have much finer resolution data from **TROPOMI:**



Goldberg et al. 2021

In the US, soon we will have finer resolution *and* hourly data from **TEMPO:**



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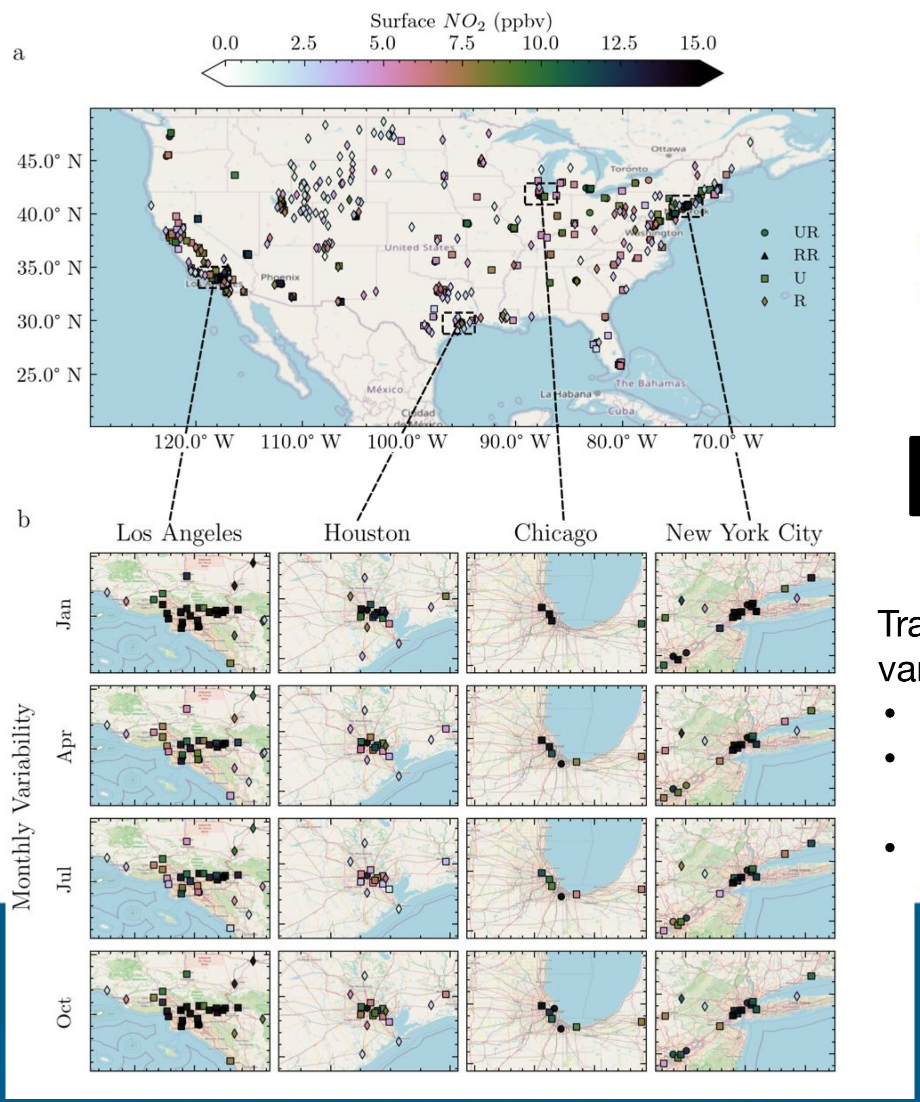
Predicting surface-level NO_2 from a TROPOMI-derived Land Use Regression

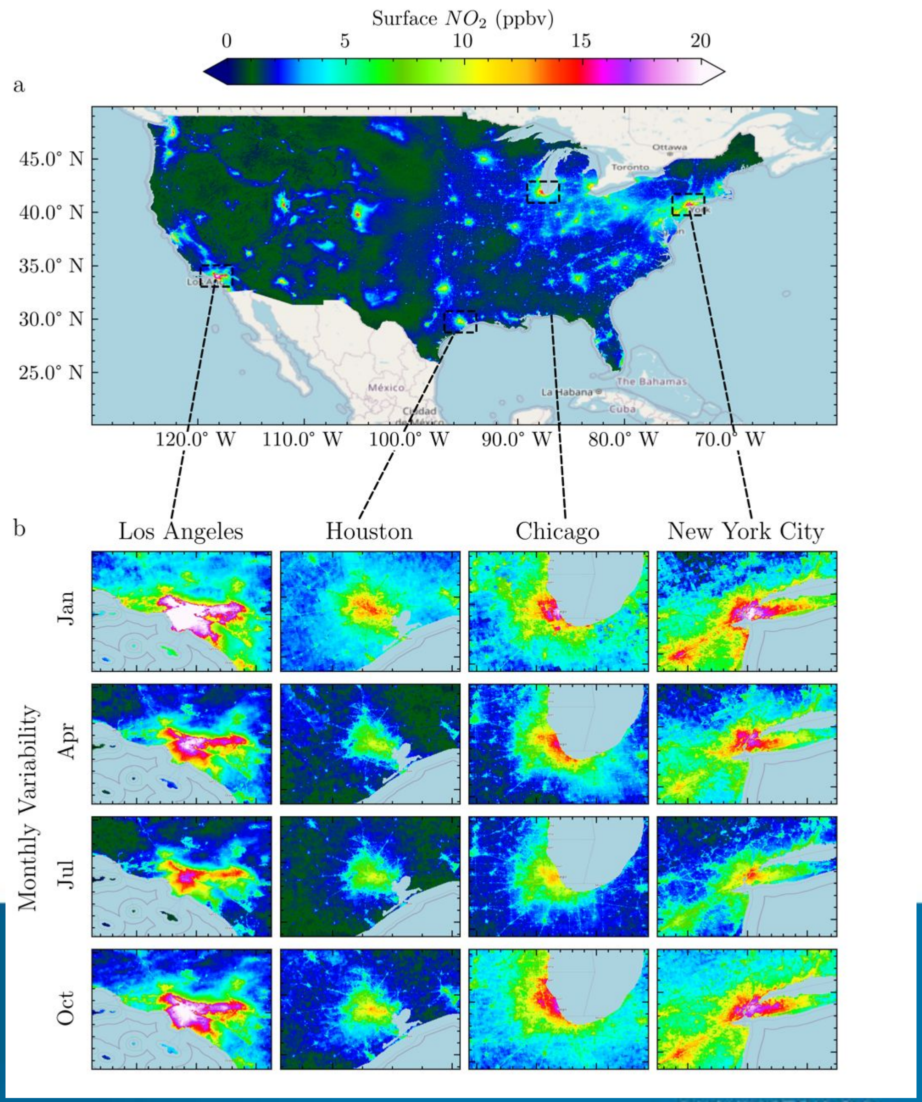


Minimize Lasso MSE

$$\sum_{i=1}^{n}(y_i - \sum_{j} x_{ij}\beta_j)^2 + \lambda \sum_{j=1}^{p} |\beta_j|$$

Train model using predictor variables:

- Land-use characteristics
- Remote-sensing observations (TROPOMI)
- Meteorological data (ERA-5)



Nawaz et al. *in prep*

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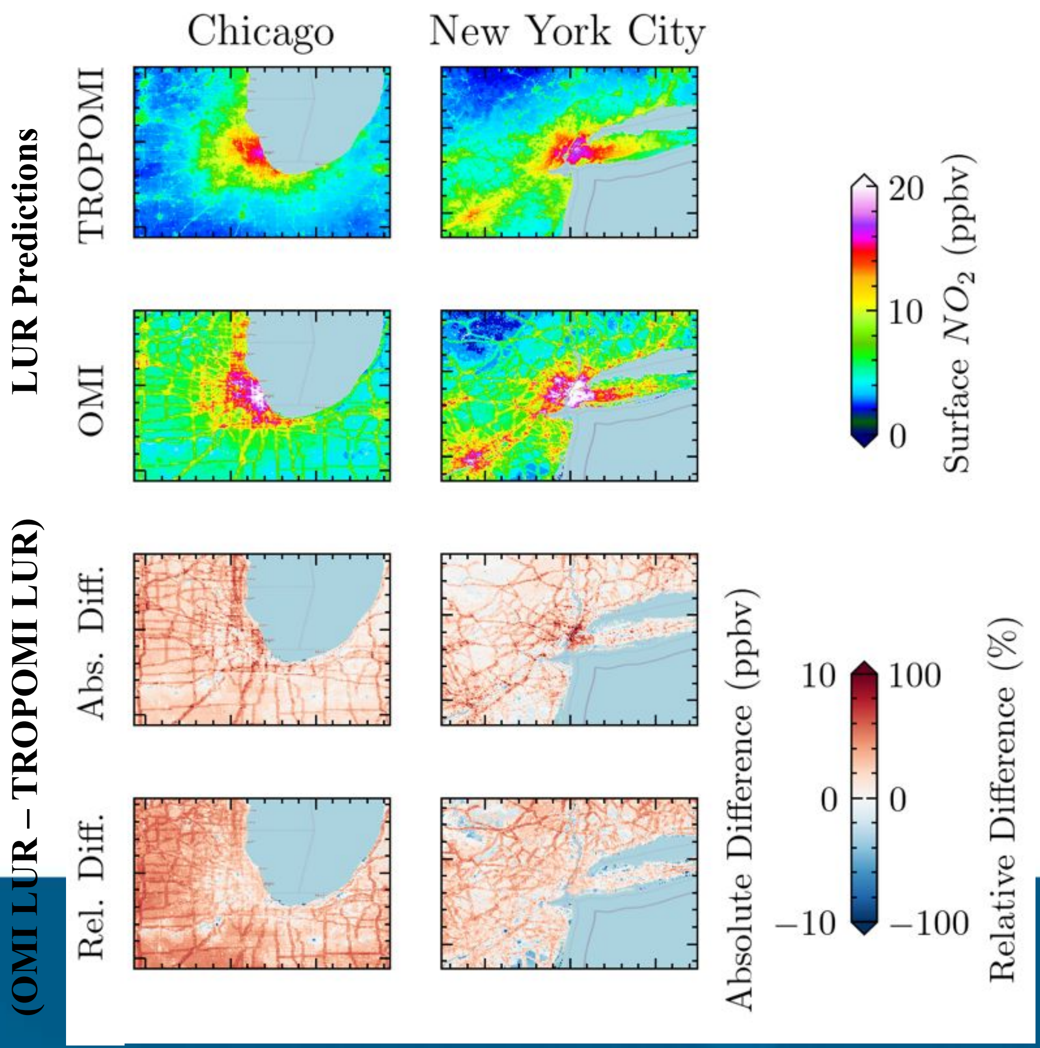
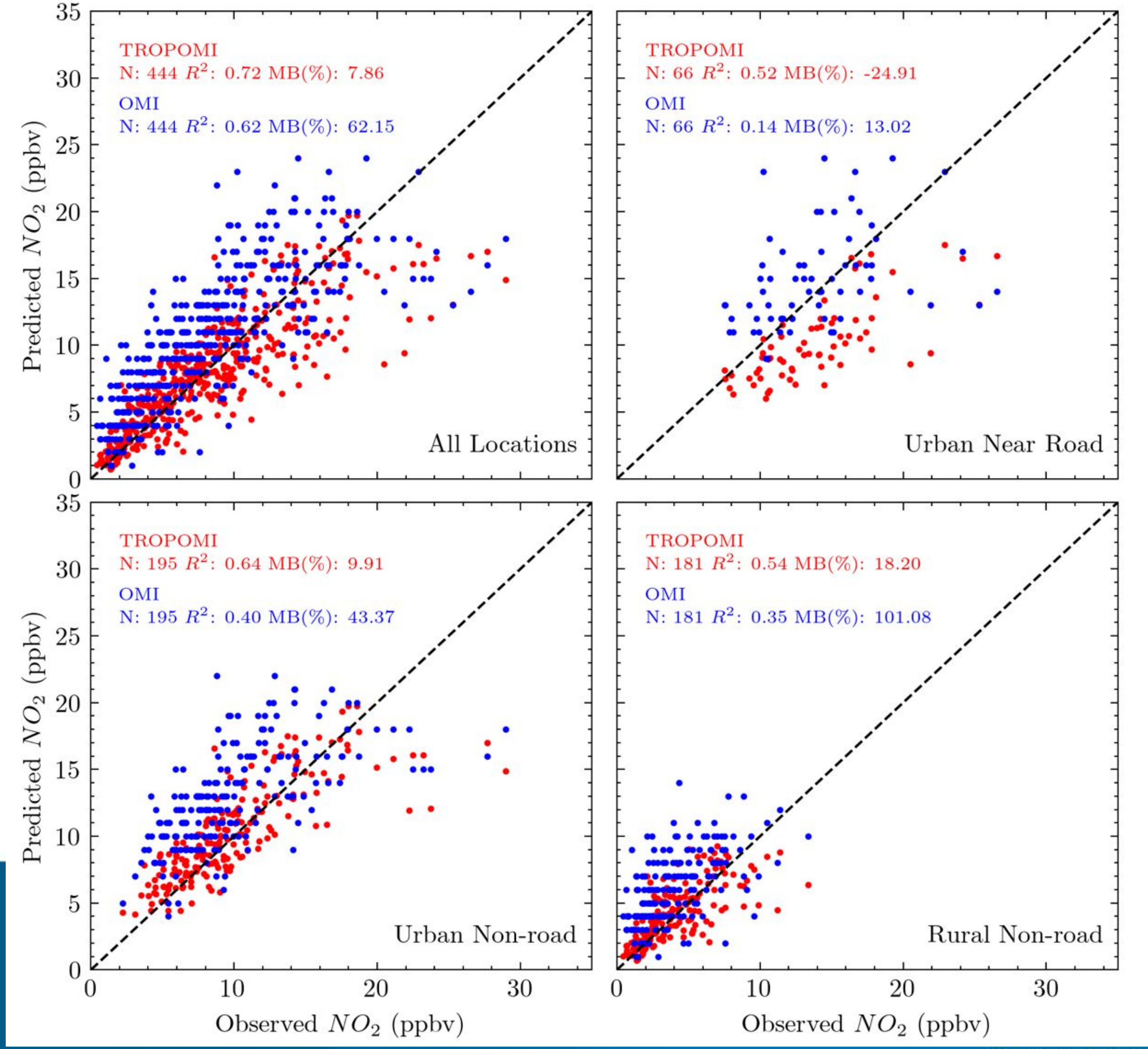
TROPOMI improves the predictive power of a surface-level NO_2 LUR





Nawaz et al. *in prep*

LUR built on TROPOMI data is less dependent on other land-use predictor variables

	% Reduction in R^2	
	TROPOMI	OMI
Built Environment	5.6	1.6
All Major Road	0.0	8.6
All Residential Road	0.1	0.8
Major Rail	0.0	N/A
Boundary Layer Height	0.0	N/A
UV Backscatter	1.2	N/A
Surface Pressure	3.7	0.1
Remote Sensing Observations	27.6	6.2
Population Density	N/A	1.5
Tree Cover	N/A	1.1
Water Body	N/A	0.7
Temperature	N/A	0.5

Nawaz et al. *in prep*

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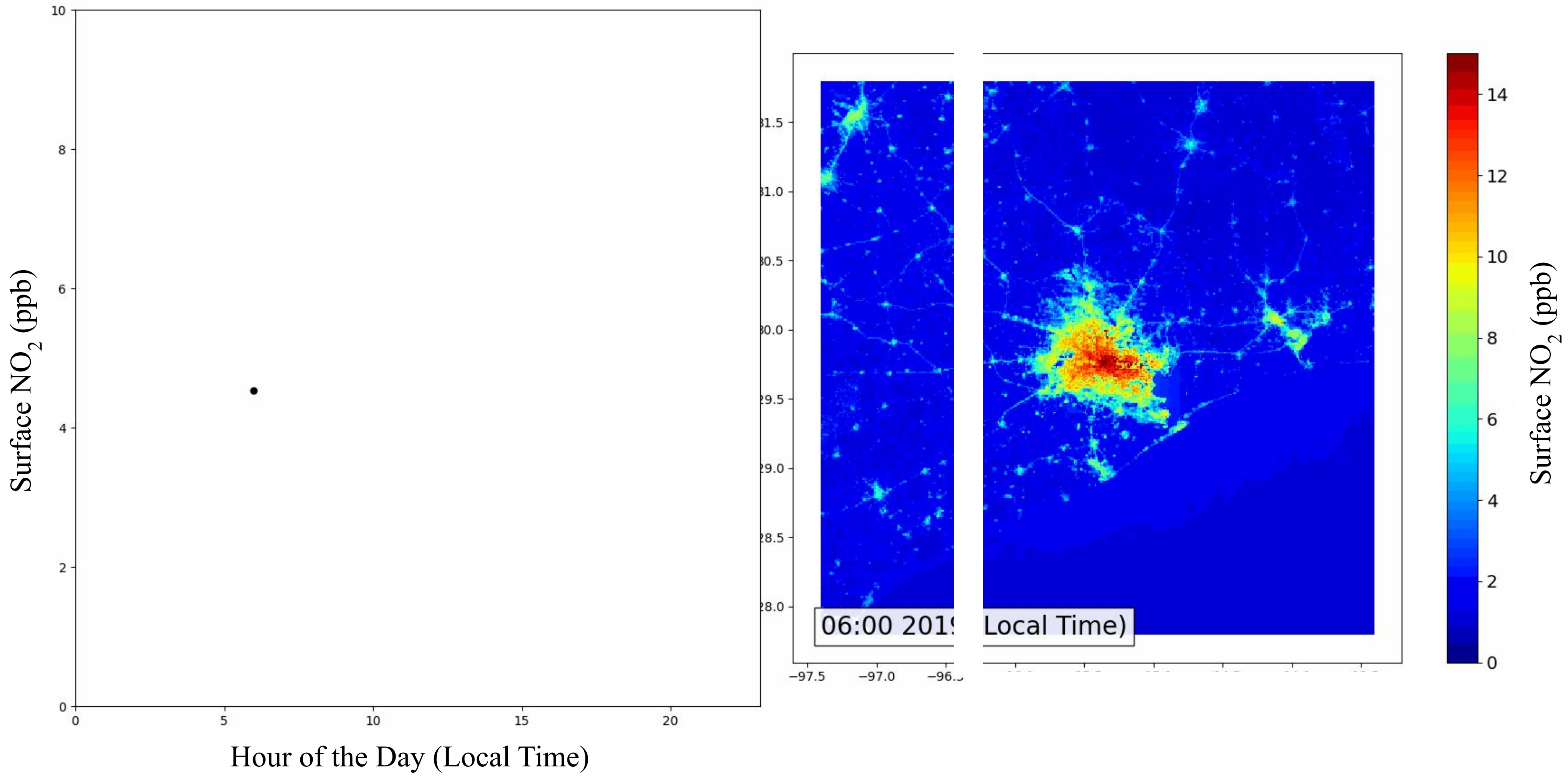
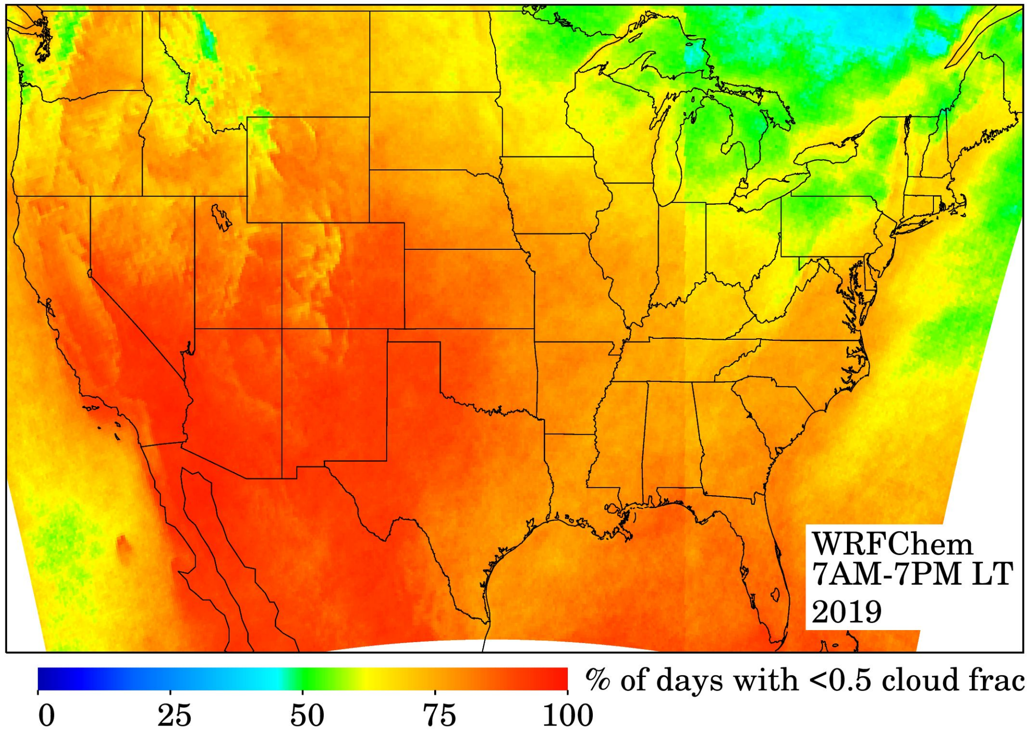
Preparing for TEMPO: Hourly NO_2 predictions in Houston in 2019



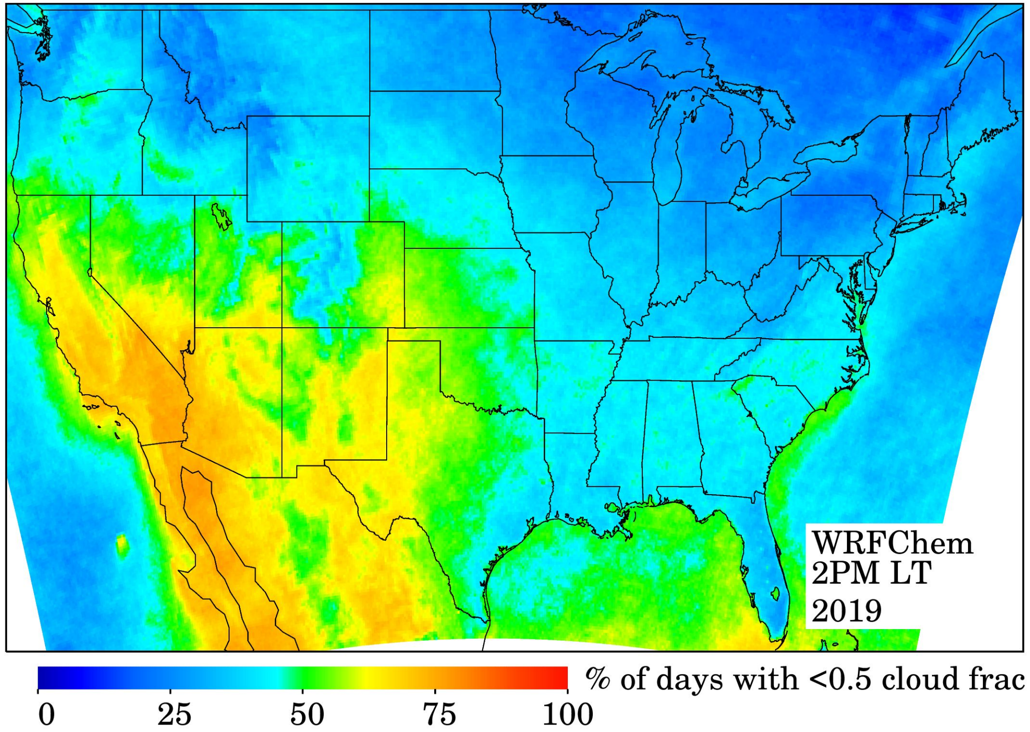
Many more days of observations from TEMPO

CONUS cloud patterns: GEO-like vs. LEO-like

WRF-Chem: Cloud-free *any time* during 7 AM – 7 PM



WRF-Chem: Cloud-free during 1 PM



City	% at 2 PM	% at 7AM-7PM
NYC	34.7	70.9
TOR	27.5	61.9
DMV	39.3	74.5
CHI	34.6	67.9
ATL	42.3	72.7
DEN	44.2	86.3
DFW	50.1	84.4
SEA	32.2	64.6
LA	69.1	89.9
PHX	69.5	92.5

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Conclusions

- Air quality alerts based on geostationary satellite data could lead to health benefits with an associated economic value of 13 (8.8-17) billion dollars ($2019) per year.
- TROPOMI NO_2 columns improve surface NO_2 land use regression predictions in the US
  - Predictive power
  - Less reliance on other data like land use variables
  - Expect even more value from hourly measurements from TEMPO and GeoXO
- Results highlight many potential applications of atmospheric composition data from geostationary satellites for improving public health