# Estimating Neighborhood-scale $PM_{2.5}$ Gradients in NYC by Integrating Satellite Data and Non-regulatory Measurements


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# $PM_{2.5}$ Prediction at 100-m Resolution in NYC

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- Background
  - Regulatory monitors are often too sparse to assess $PM_{2.5}$ gradients at the neighborhood scale
  - Satellite models (1-10 km resolution) often do not have the necessary resolution either
  - Non-regulatory / low-cost sensors can form dense networks but data are often noisy
- Objectives
  - Estimate daily $PM_{2.5}$ concentrations by combining NASA satellite data, regulatory and non-regulatory measurements
  - Evaluate the impact of integrating non-regulatory measurements into satellite-based models

# A Random Forest Model for Daily $PM_{2.5}$ Concentrations

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***Daily PM2.5 Conc. = f(MAIAC AOD, weather parameters, NDVI, traffic volume, road lengths, point emission sources, population density)***

| | EPA model | EPA+NYCCAS model |
|---|---|---|
| Sample size | 5788 | 9257 |
| CV $R^2$ | 0.85 | 0.73 |
| RMSE | 1.98 μg/m3 | 2.35 μg/m3 |
| Slope | 1.07 | 1.10 |

# Patterns of Predicted $PM_{2.5}$ Concentrations

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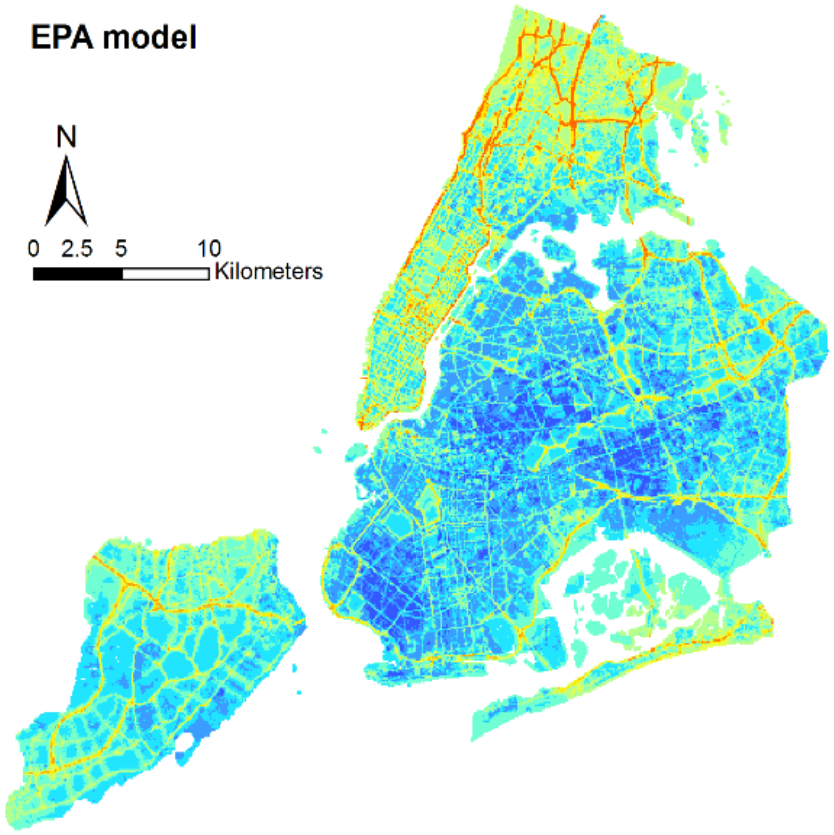


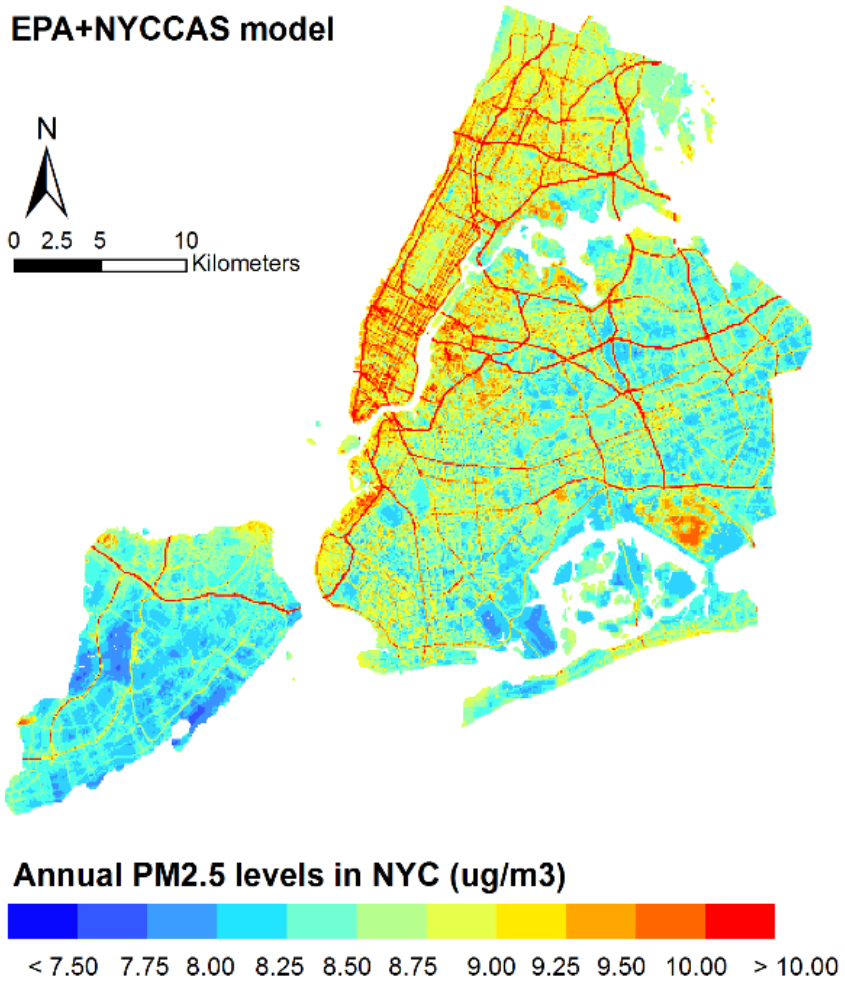

# Neighborhood-scale $PM_{2.5}$ gradients

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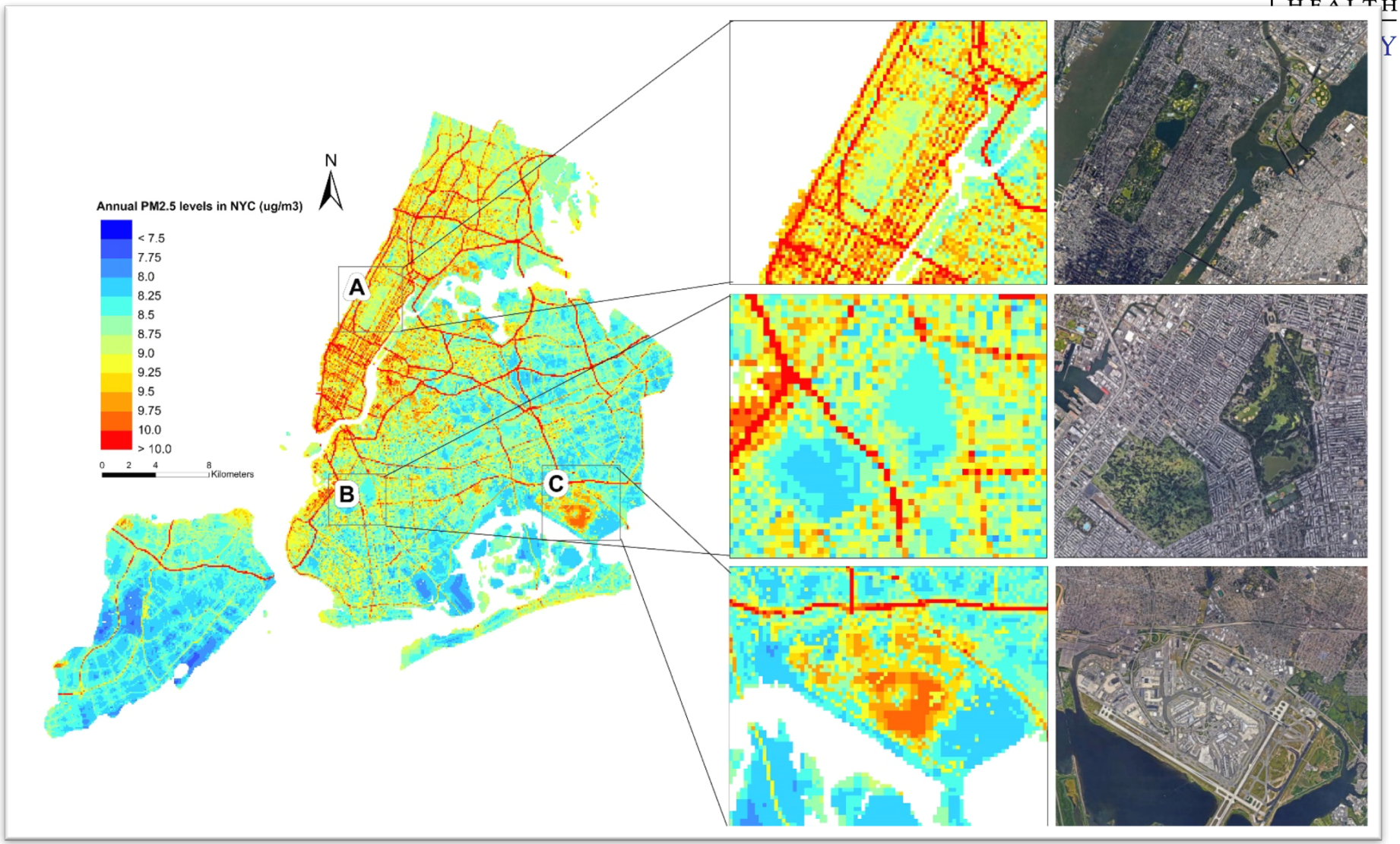


A: New York Central Park; B: NY-27 state highway; C: JFK airport

# Relative Difference Between EPA Model and EPA+NYCCAS Model

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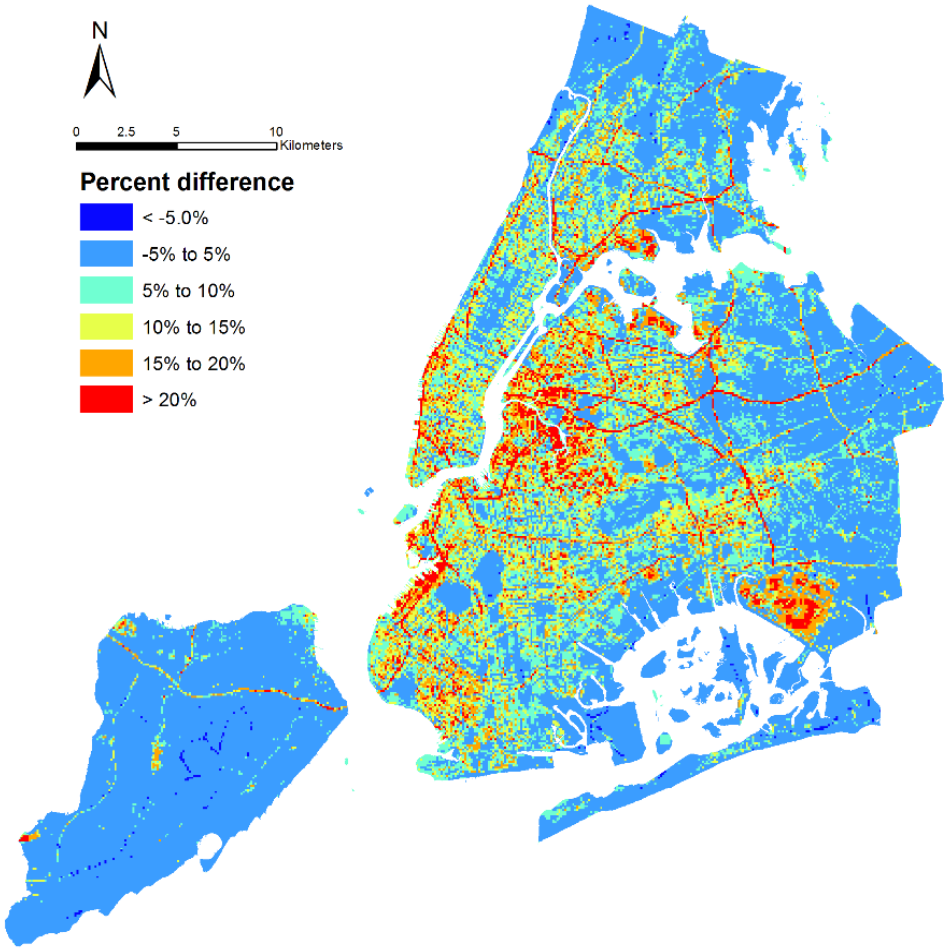
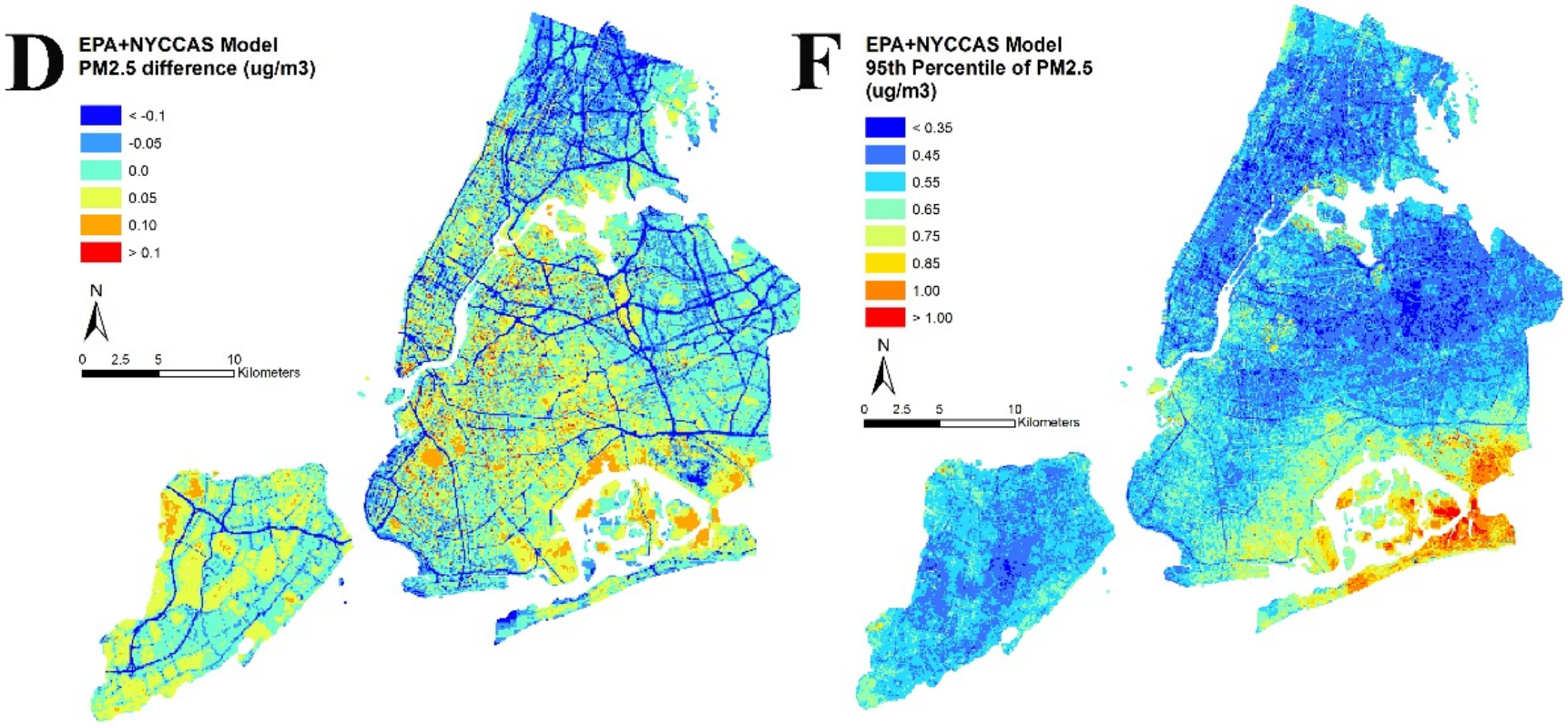



In suburban areas, forests and parks, two models are comparable.

Along major roads and in more densely populated neighborhoods, EPA+NYCCAS model predictions are 15% higher than EPA model. Health burden due to $PM_{2.5}$ pollution in the city may have been underestimated.

# EPA+NYCCAS Model With and Without AOD




D: Mean difference between the model with and without satellite AOD is negligible.

F: 95$^{th}$ percentile (~15 days each year) difference can be much larger in south of the city – AOD model higher

# Conclusions

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- Satellite-based $PM_{2.5}$ models are trained by ground monitoring data.
  - Number and spatial allocation of monitors influence results
  - $R^2$ is not the only indicator for model performance
- Non-regulatory measurements and AOD can be fused together to estimate neighborhood-scale PM2.5.
- Previous studies may underestimate the disease burden due to PM2.5 and exposure disparities in NYC.