

A Framework for Linking Urban Traffic and Vehicle Emissions in Smart Cities



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Introduction

- Urban traffic flows are complex phenomena influenced by a variety of factors and are responsible for excessive vehicle exhaust emissions [1]
- Exploring the relationship between emissions and traffic requires comprehensive models to relate and analyze diverse data
- In exploring this problem, we
 - develop a **methodology** to understand the **relationship** between traffic patterns and emissions, and
 - use **analysis and visualization techniques** to study traffic emissions

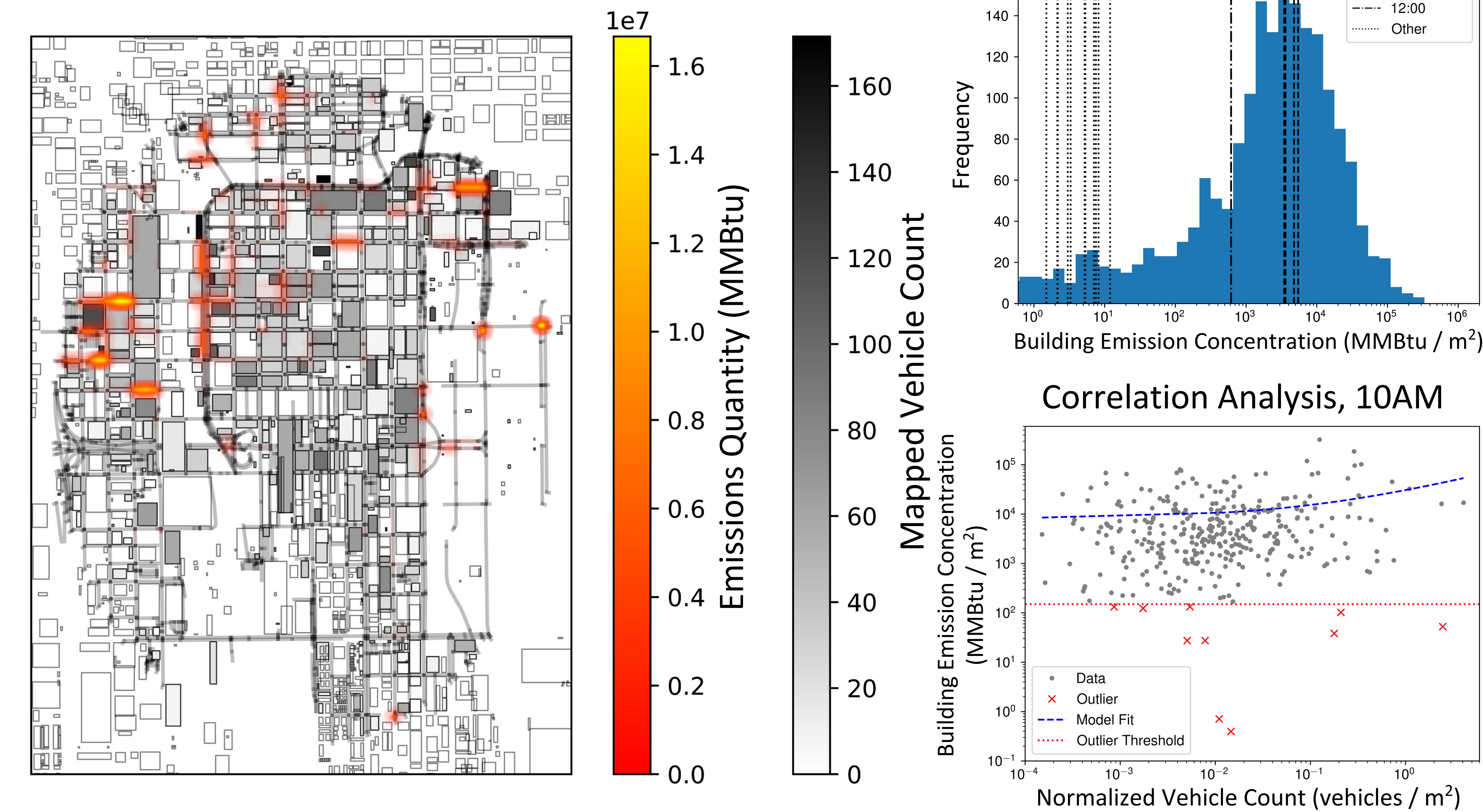
Our Framework

- Extrapolates** and **transforms** non-spatial data into **spatial data**
- Fuses** these new data with urban layout data
- Visualizes** the distribution of traffic and emissions across time and space
- Allows us to extract **meaningful correlations** from these fused datasets
- Is **portable** across many platforms, including Power9 systems

Results

We test our framework using traffic and emissions data from the Chicago Loop:

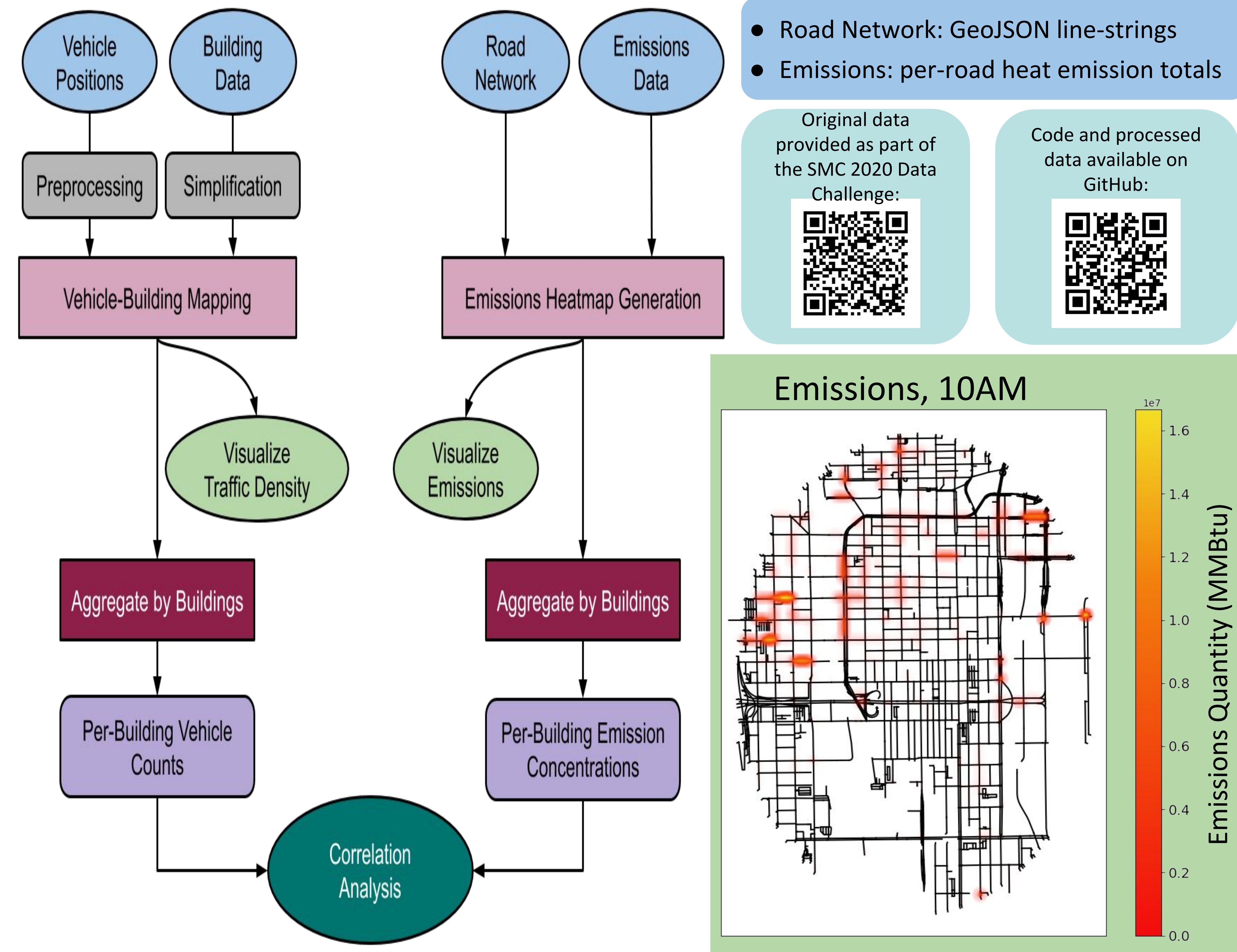
City-Wide Emissions / Traffic Correlation, 10AM



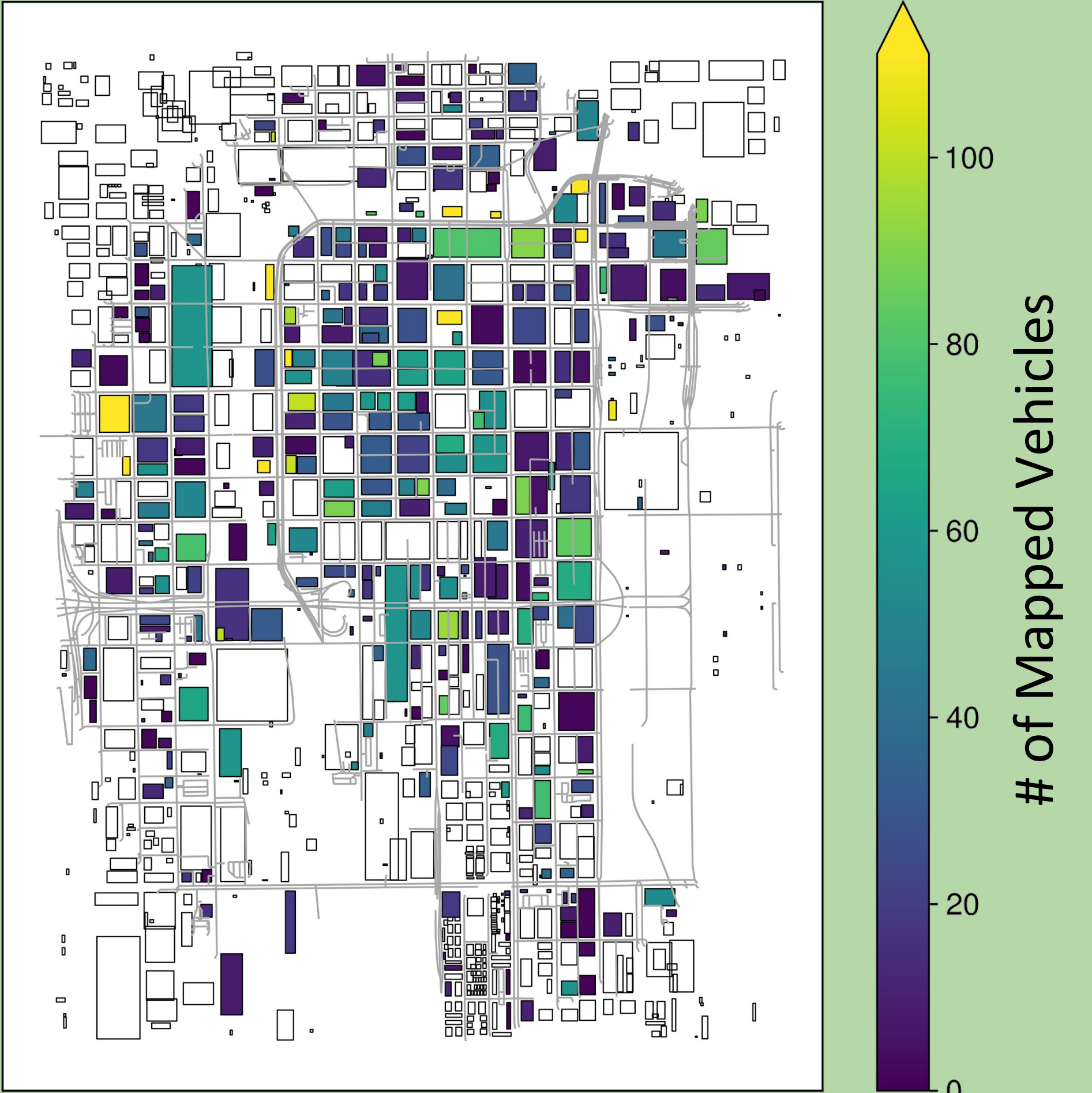
Methods

- Vehicle Positions: UTM coordinates and road IDs
- Building Footprint Data: GeoJSON polygons

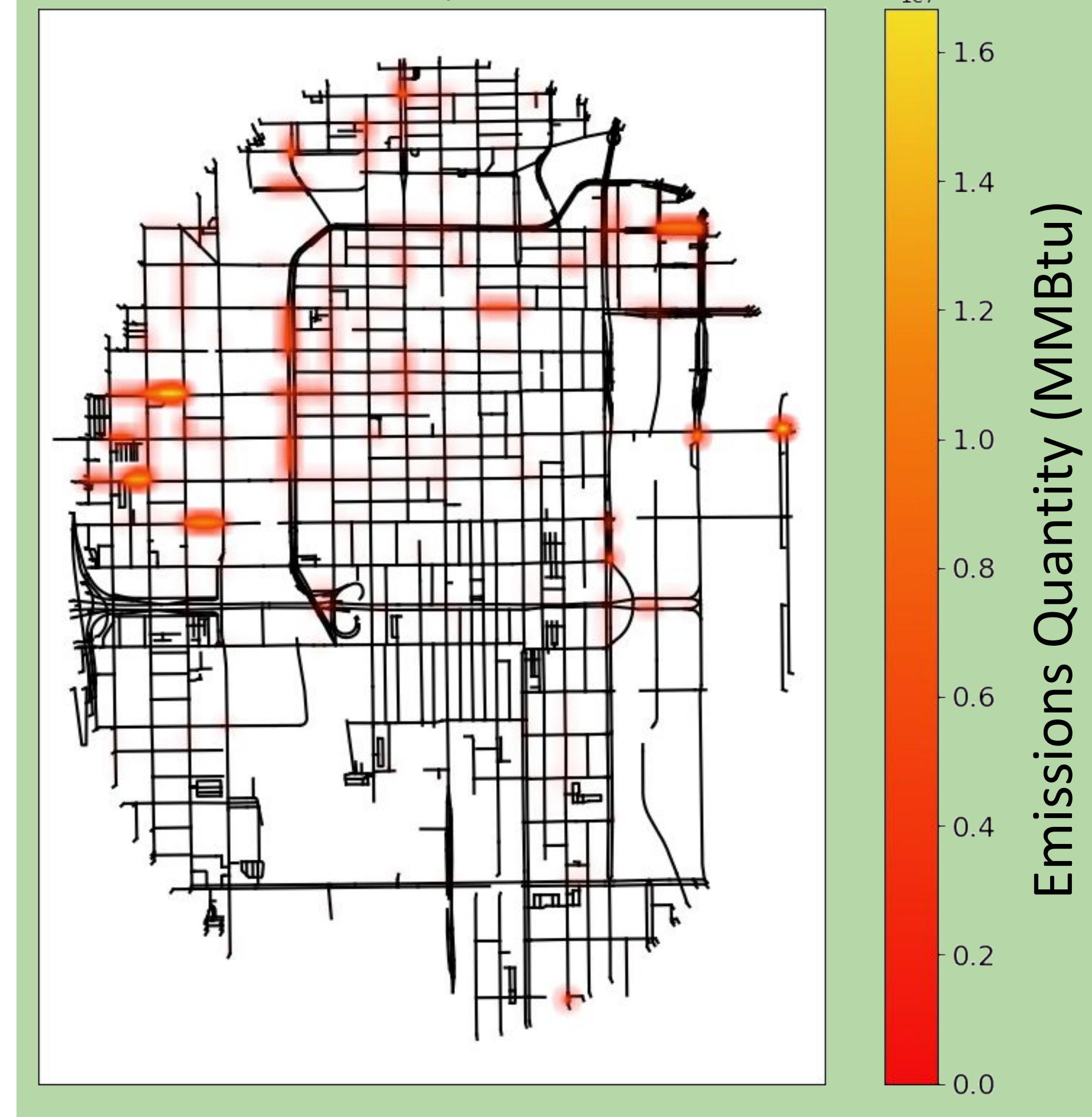
- Correction of inaccurate vehicle positions by inference from road network layout
- Simplification of building footprint polygons into bounding boxes and centroids to reduce computational load



Mapping Density, 10AM



Emissions, 10AM



- Vehicles are mapped to nearby buildings using a *k-d* tree structure and aggregated into per-building vehicle counts
- Spread of heat emissions from road sources is modelled using a cell-based heatmap, then aggregated into per-building emission concentration levels

- Correlation between vehicle counts and emission concentrations is then analyzed with linear regression

Lessons Learned

In our analysis of the Chicago Loop, we

- apply methods for **characterizing**, **cleaning**, and **fusing** data about traffic and emissions;
- find a weak **correlation** between traffic and emissions during morning commute hours; and
- observe both **spatial** and **temporal** patterns in traffic emissions throughout the area of interest

Future Work

- Model other variables that affect emissions:
 - Building height
 - Vehicle types
 - Weather
- Develop other mapping methods:
 - For example, map vehicles to multiple buildings, based on a distance threshold