

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

Students: Clark Hathaway¹ and Sebastian Mobo¹

Mentors: Silvina Caíno-Lores¹, Travis Johnston², Michela Taufer¹



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

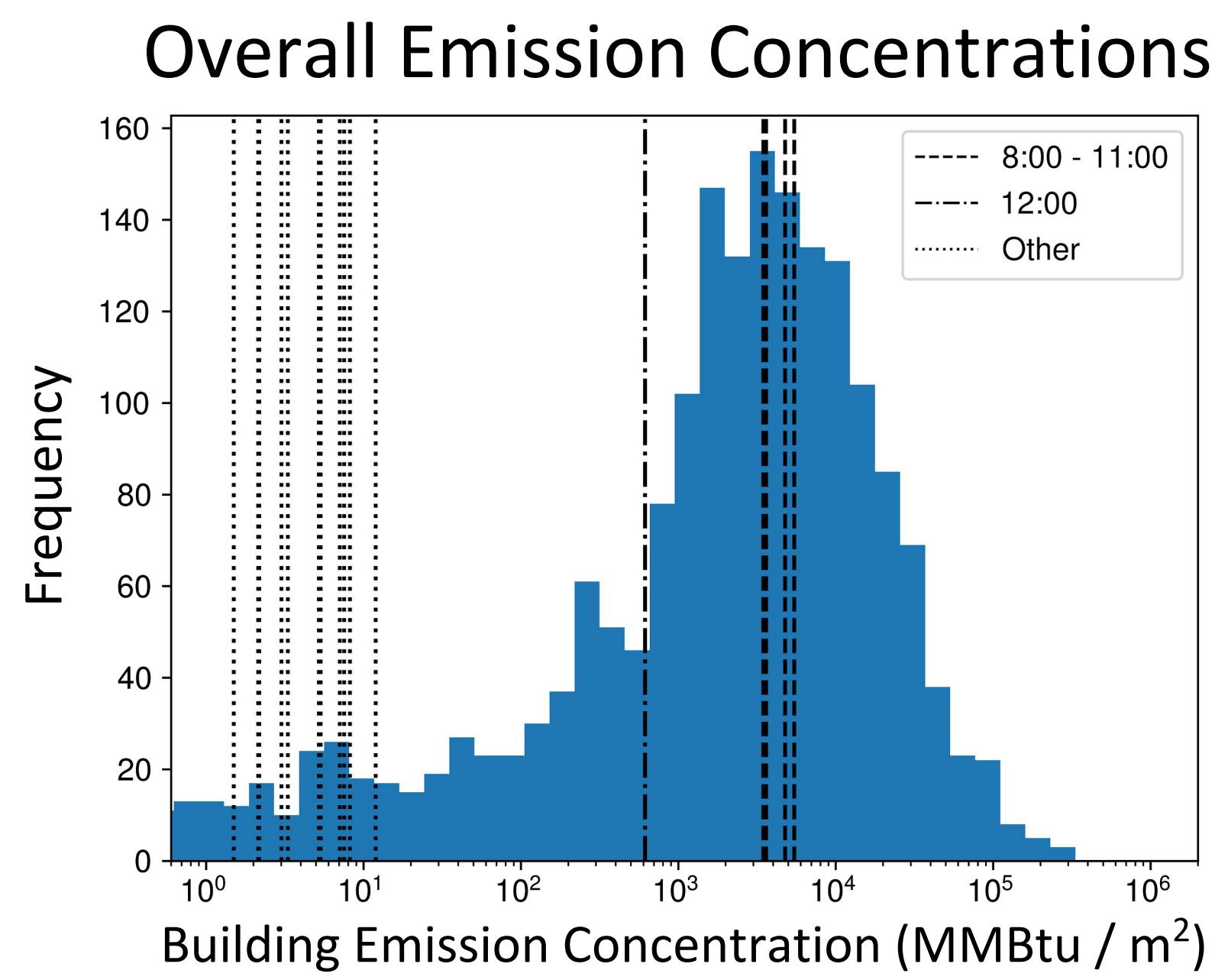
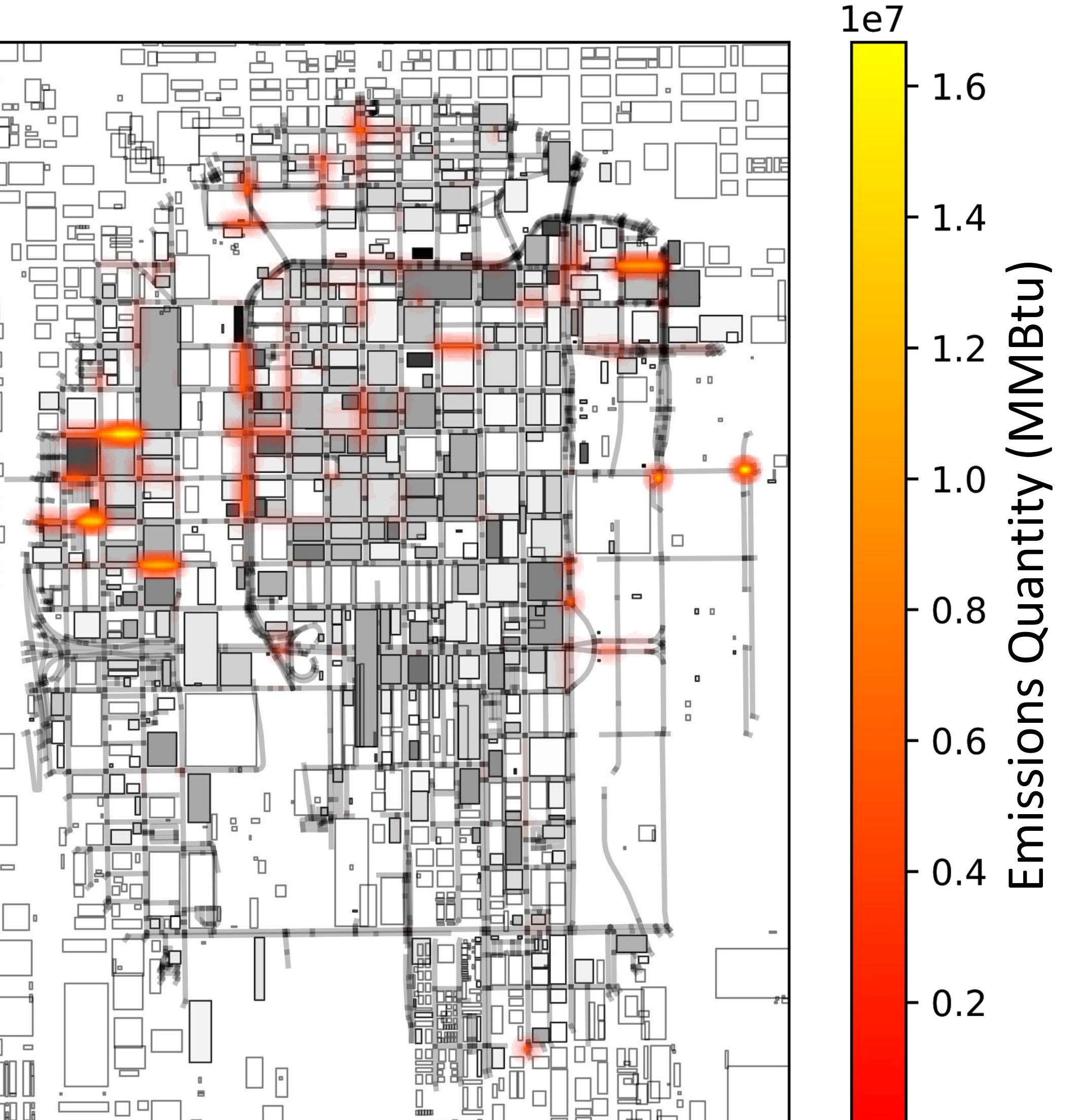
Our Framework

- 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

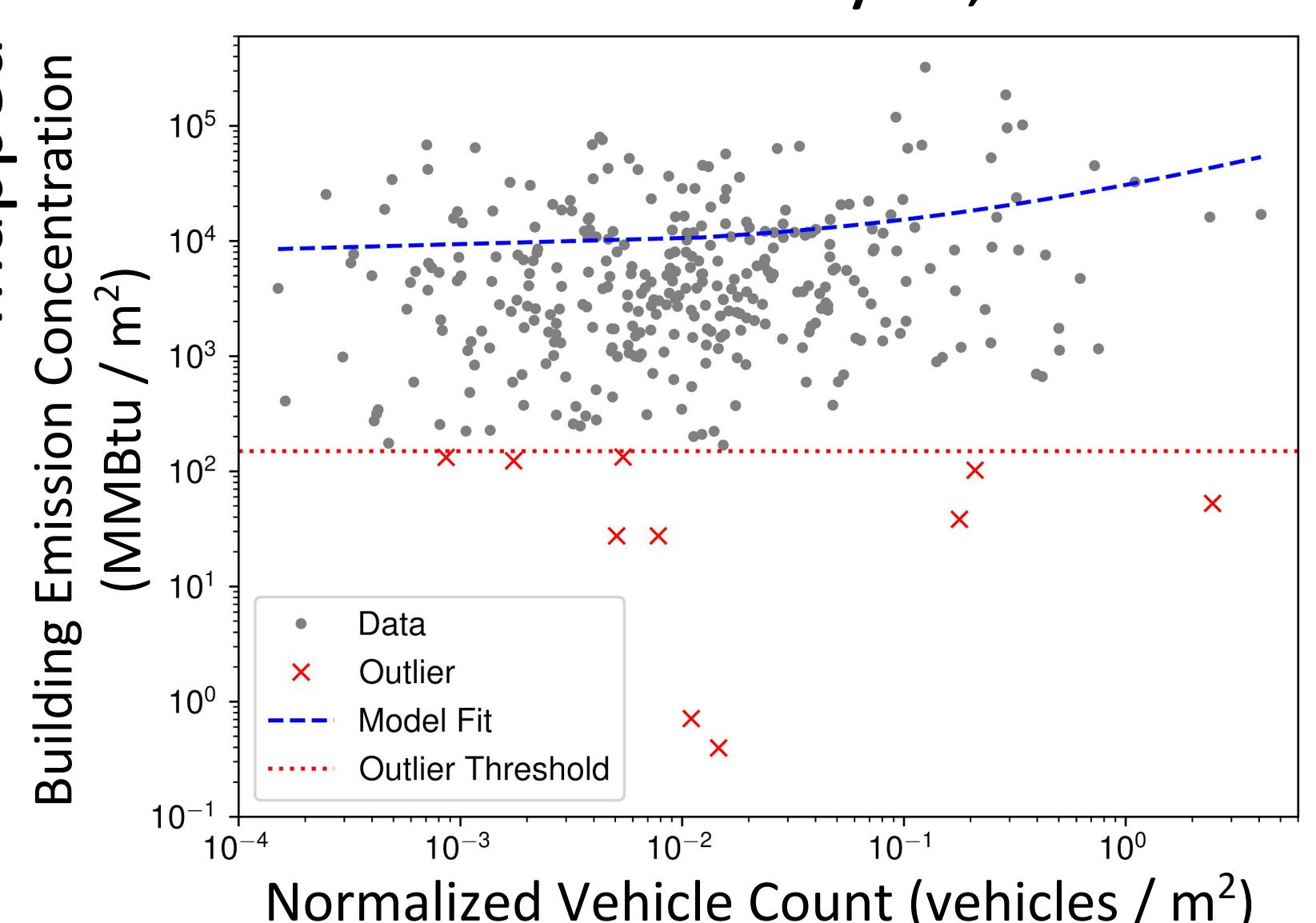
Results

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

City-Wide Emissions / Traffic Correlation, 10AM



Correlation Analysis, 10AM



- A weak positive correlation exists between mapped vehicle counts and emission concentrations from 08:00 to 11:00 ($r = 0.151$ to 0.220 , $p < 0.01$)
- At 12:00, this correlation is weaker but still significant ($r = 0.119$, $p = 0.032$)
- Emissions levels drop by several orders of magnitude after 12:00

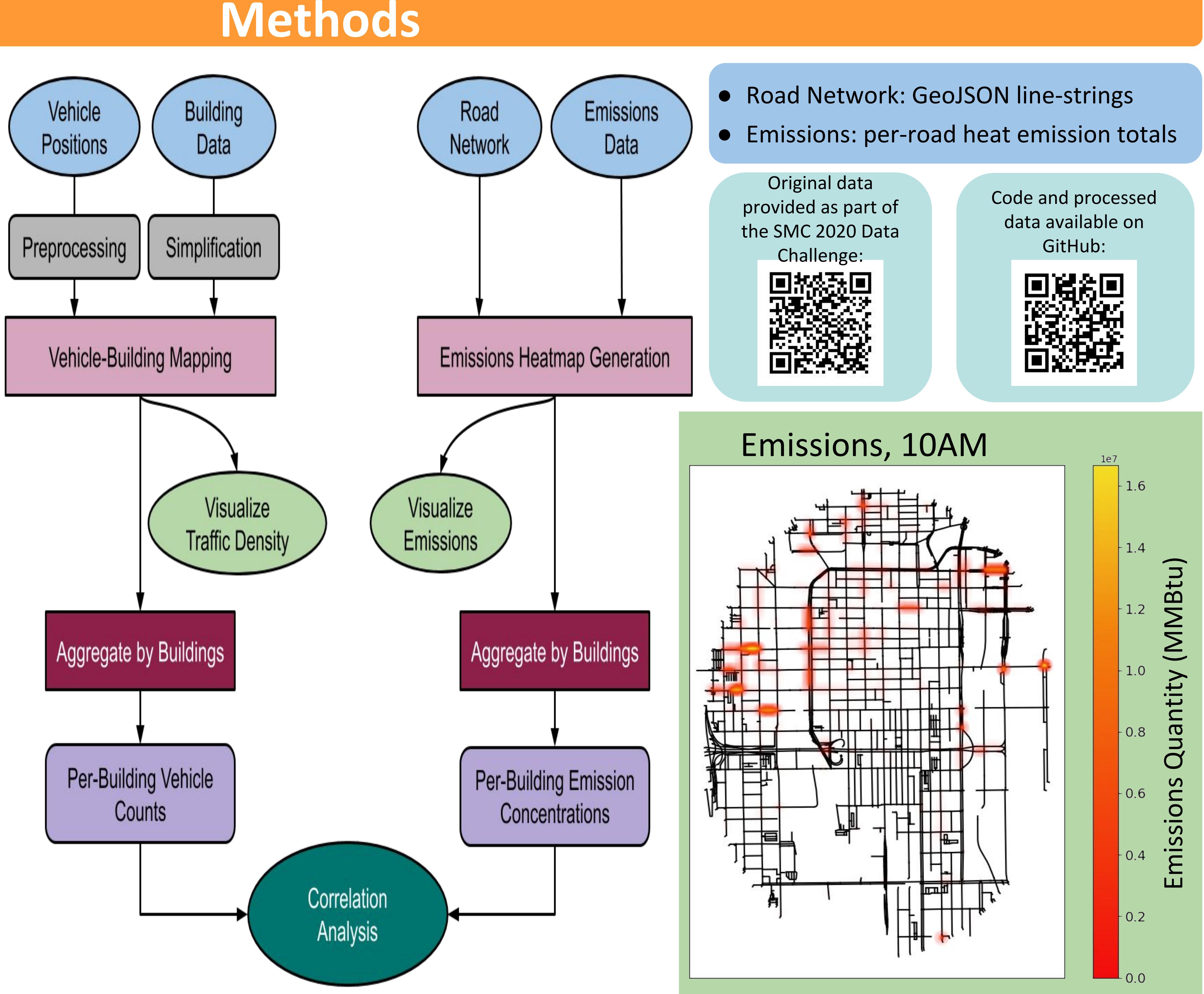
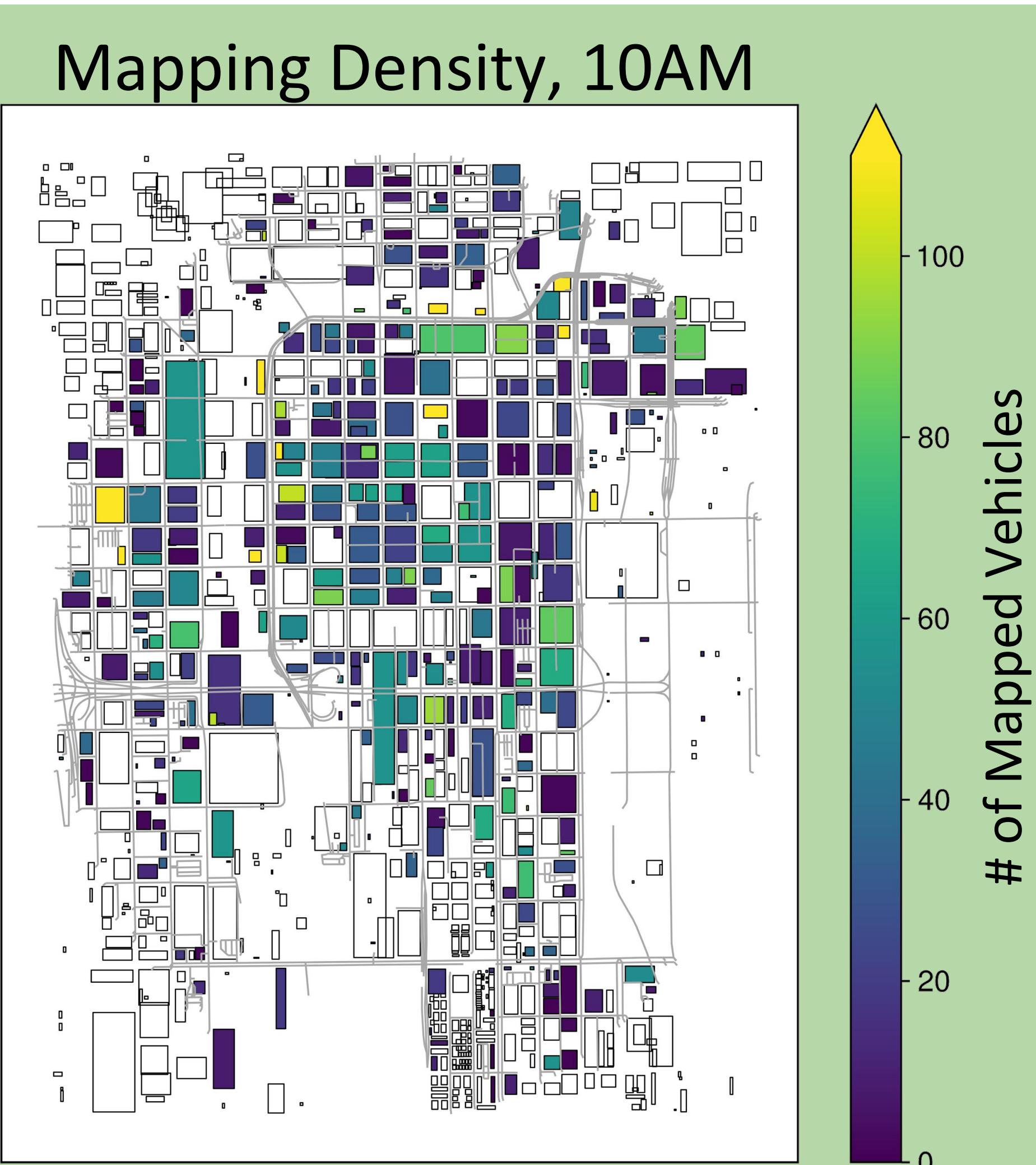
Lessons Learned

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



- 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