

USING EPA'S MOVES MODEL TO EXPLORE AIR QUALITY
EMISSIONS FROM HIGHWAY TRAFFIC

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RESEARCH QUESTIONS

- How does the level of congestion and vehicle speeds on a freeway affect the emitted level of air pollutants and greenhouse gases?
- Can we customize the Environmental Protection Agency's (EPA) MOVES3 emissions model in such a way to produce better and more informed estimates of air pollutants and greenhouse gas emissions at a corridor level?

PROJECT BACKGROUND

- Highway US 26 in Washington County, OR study area
- Partnered with PSU to do near-highway concentration monitoring



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- Highway US 26 in Washington County, OR study area
- Partnered with PSU to do near-highway concentration monitoring
- Modeling emissions using EPA MOVES3
- Dispersion modeling using AERMOD/RLINE





FULL STUDY AREA

Key

★ Monitoring Trailer

Roadway Links

— Highway

— Heavy Traffic

— Medium Traffic

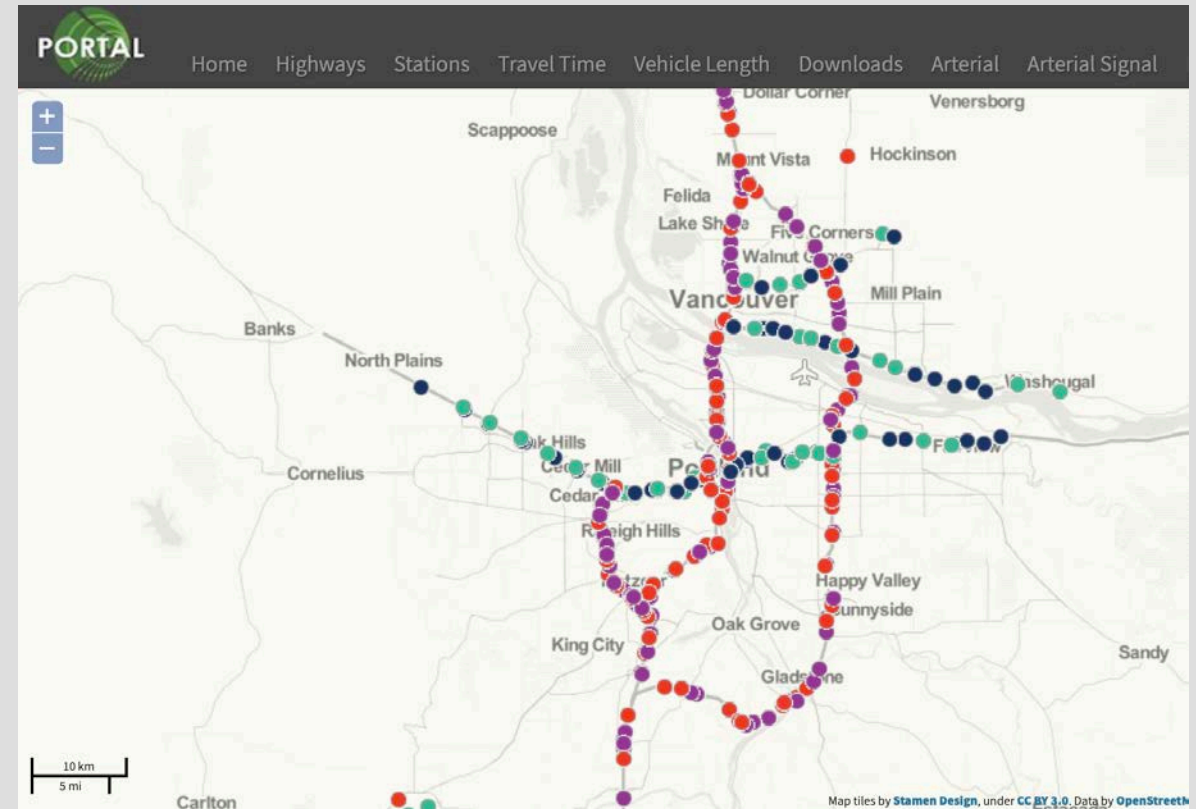
METHODS

- Classify lanes and roads into 4 categories of links:
 - Highway
 - Non-highway
 - Heavy traffic
 - Medium traffic
 - Light traffic



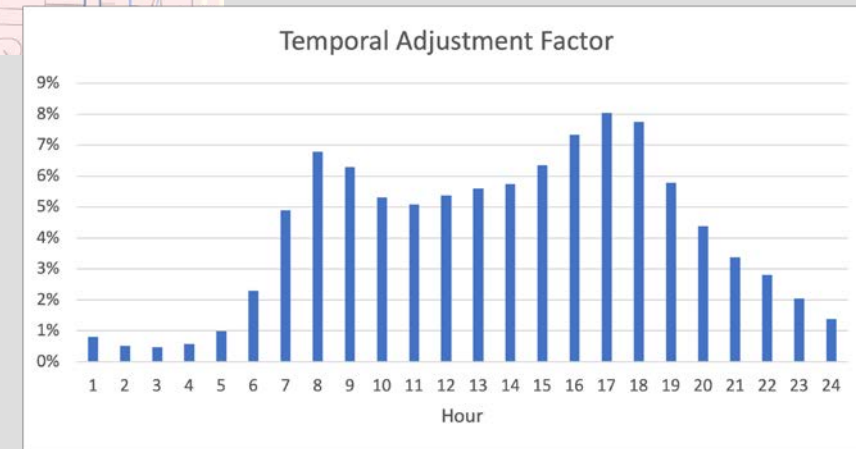
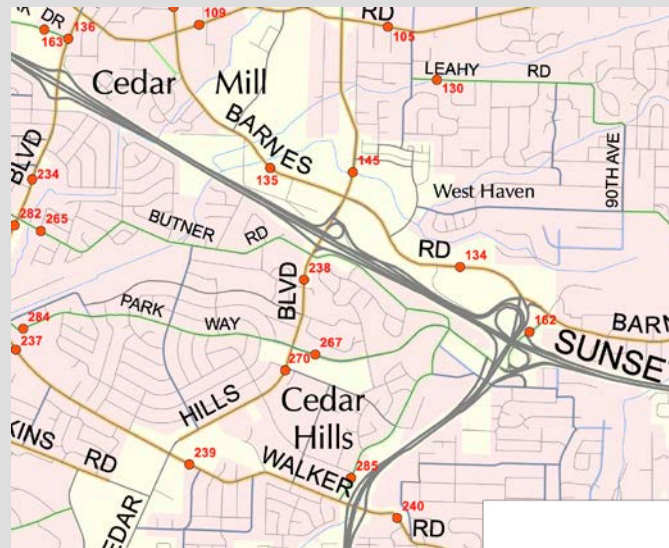
CHARACTERIZATION OF TRAFFIC

- Highway Lane Data: PORTAL website
 - Vehicle volumes
 - Average speed
 - % HD vehicles



CHARACTERIZATION OF TRAFFIC

- Highway Data: PORTAL website
 - Vehicle volumes
 - Average speed
 - Individual lane info
 - % HD vehicles
- Off-highway roads:
 - Washington County Traffic Counts
 - Daily vehicle counts
 - Identified a few traffic count locations within the model boundary
 - Used TAF to disperse traffic for each hour
 - Used Google Maps to estimate speeds



MOVES SET-UP

- Run in Emission Rate Mode
- Created a custom input database
- Speed distribution and VMT are necessary to run the model but do not affect emission rates

Input Data

Age Distribution

Fuel

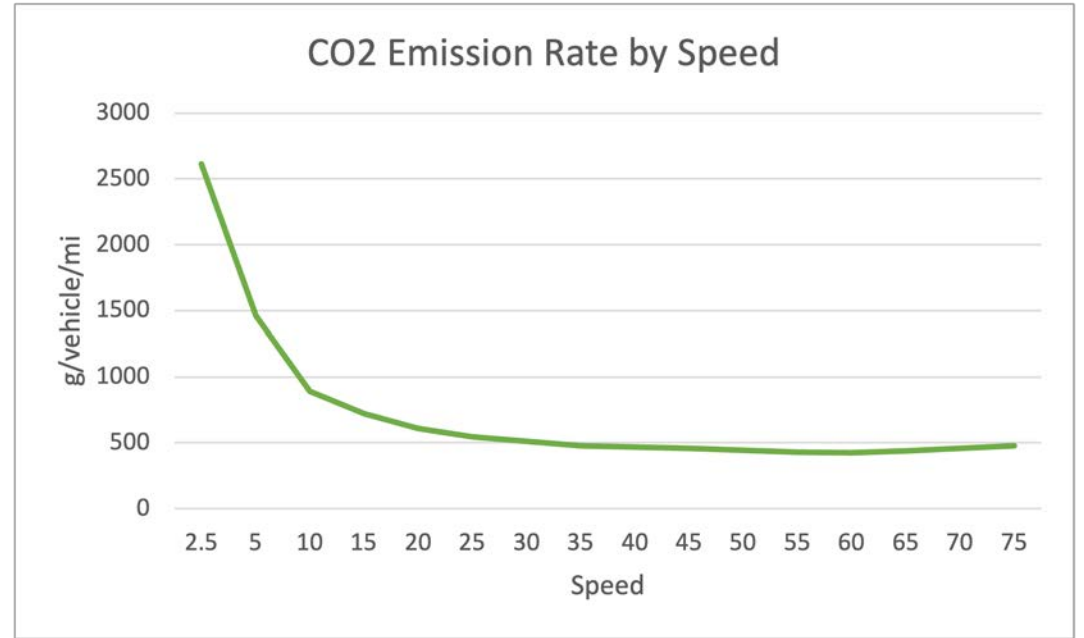
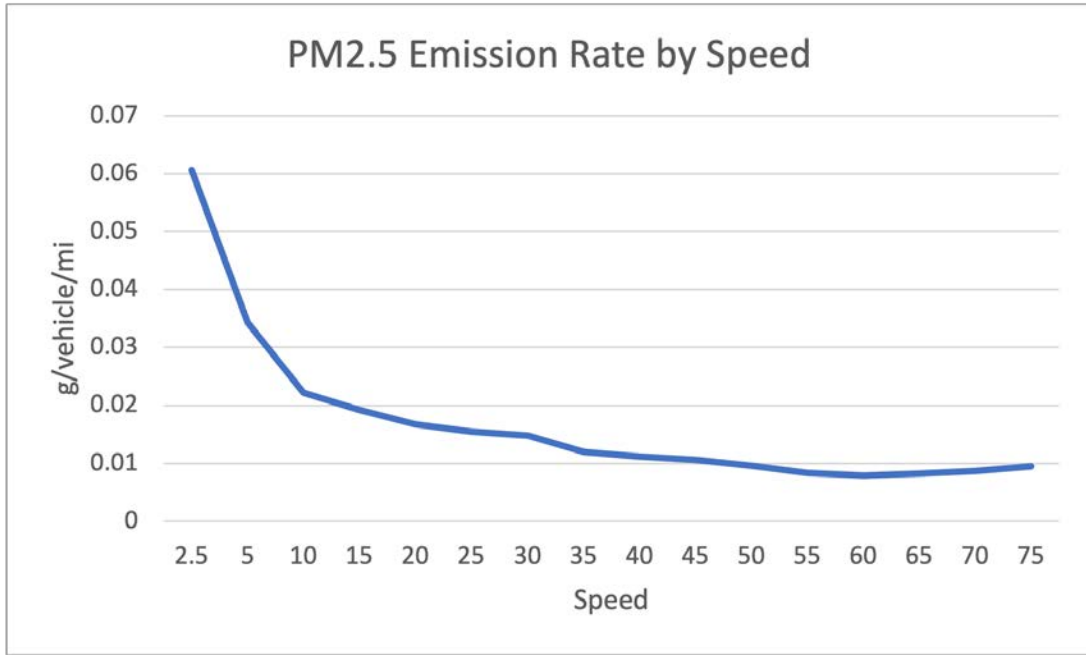
I/M Program

Met - Temperature & Humidity

Road Type Distribution

Source Use Type

Starts



Emissions Rate (g/vehicle/mi)

MOVES OUTPUT

MOVES POST-PROCESSING

Data Frame 1: MOVES emission rates

- Emission rates by
 - Hour (temperature and humidity dependent)
 - Speed
 - Road type

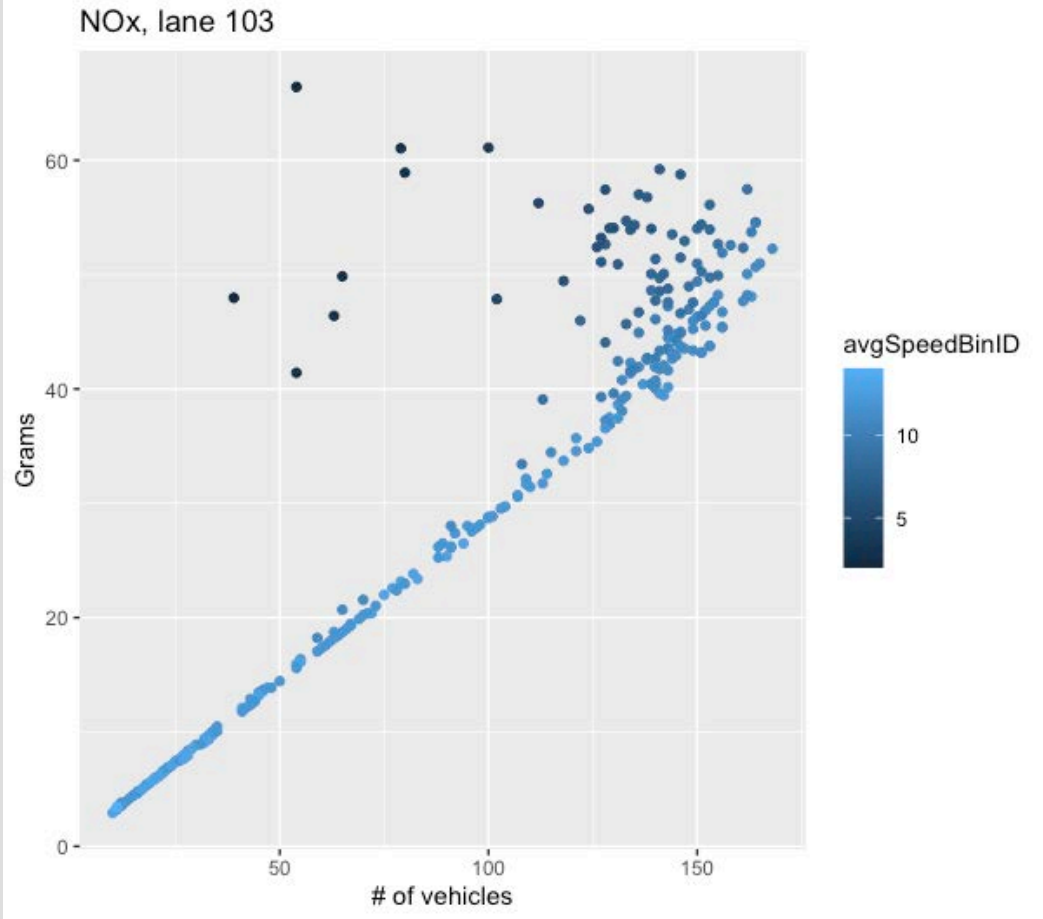
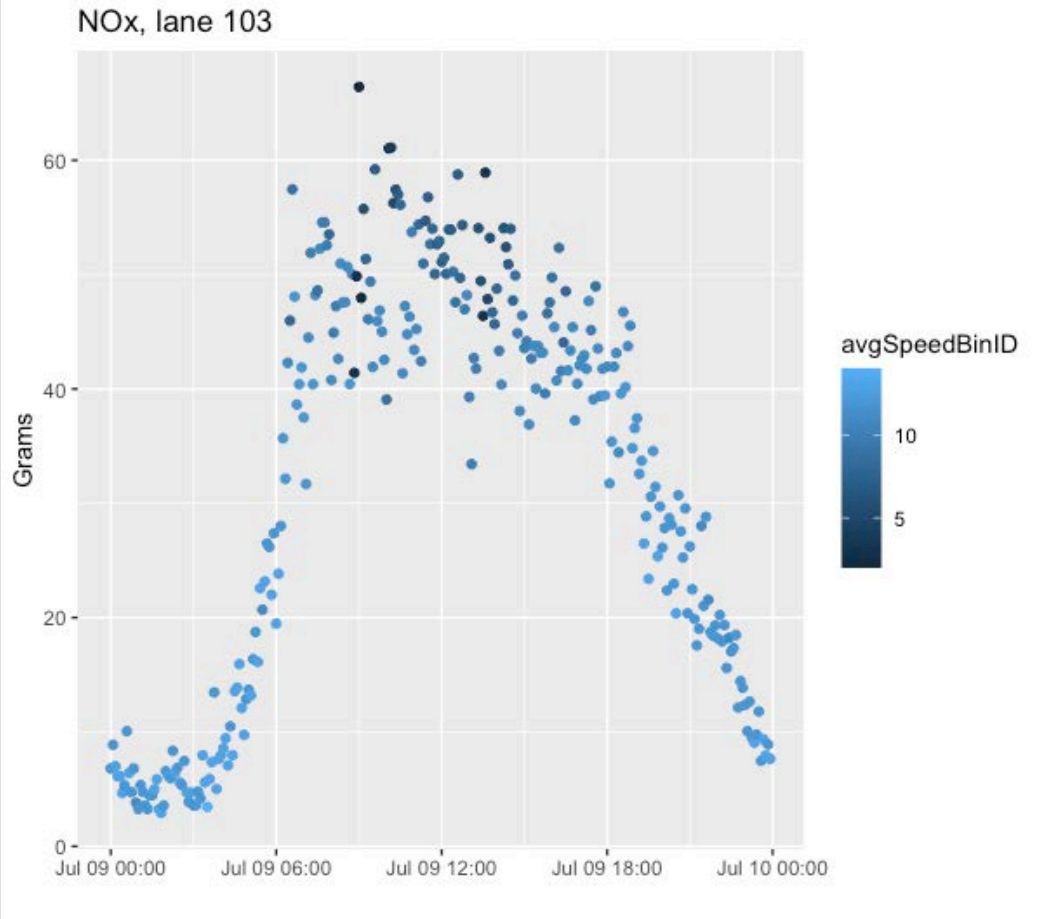


Data Frame 2: Traffic data

- Datetime (5-min increments)
- Links
- VMT
- Avg. Speed

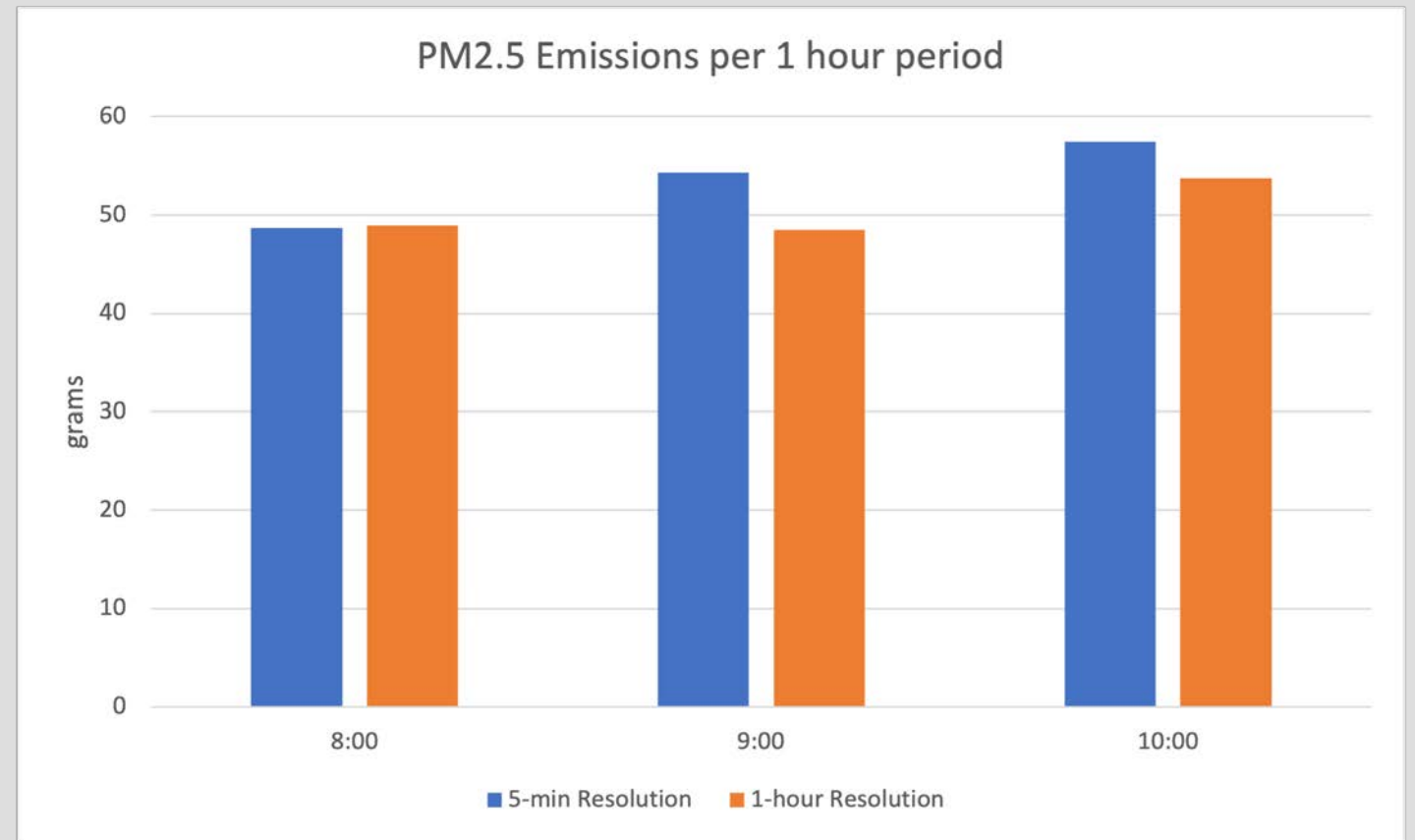
$$\text{Emissions (g/link)} = \text{Vehicle Population (vehicles/link)} \times \text{Link Length (mi)} \times \text{Emission Rate (g/vehicle mi)}$$

IMPACT OF VEHICLE VOLUME VS SPEED



IMPACT OF TIME RESOLUTION

- Finer time resolution is more impactful for hours with congestion
- The 9:00 hour emissions were 11% less when averaging speeds for the hour versus calculating emissions every 5-min



AERMOD ANALYSIS

- 11 model run iterations
 - Initial
 - “Urban” model option, accounts for urban heat island effects
 - “Flat” source type
 - Model receptor at 3m from ground
 - Non-adjusted surface friction velocity
 - Use R-LINE source type
 - **R-LINE + 3m + Urban**

FINDINGS & SUMMARY

- Vehicle volume is the primary driver of highway emissions, however, congestion is important to capture for short-term analyses
- Using a finer time resolution allows for more conservative emissions estimates for congestion periods
- Heavy duty vehicle distribution can greatly impact emissions
- Using RLINE with the URBAN AERMOD setting is found to yield the best results yet when comparing to modeled concentrations
- PM2.5 and NOx are more sensitive to speed changes than CO2e

REFINEMENTS TO BE MADE

- Continue calibrating AERMOD
 - Boundary layer mixing height
- Run a more traditional Hot Spot Analysis using EPA's MOVES2AERMOD tool
 - Requires running a longer time span
- MOVES op mode distribution
 - Getting detailed information of vehicle operation mode behavior could be impactful to emissions
 - Vehicle Specific Power: Estimate of Power Demand on Engine

APPLICATIONS

- Short-term emissions modeling and hot spot analyses are less common and documented in the literature
- Refine modelling approaches to inform planning purposes
 - Understanding which parameters emissions are most sensitive to can help prioritize data
- Community projects interested in understanding near highway air quality

THANK YOU!

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