

*A COMPARATIVE STUDY OF CLEVELAND'S URBAN
DRIVING PATTERNS WITH STANDARD URBAN DRIVING
CYCLES USING HOUSEHOLD TRAVEL SURVEY DATA*

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Outline

- Cleveland Household Travel Survey (HHTS)
- Selection of Study Corridors
- Data Characteristics & Sample Reliability
- Comparisons with Standard Driving Schedules
- Application in emissions analysis
- Conclusions

Household Travel Survey

- GPS based survey
- Purpose:
 - To provide data reflecting travel behavior patterns in the region.
 - To provide supporting data for the travel forecasting model



HHTS as Datasource

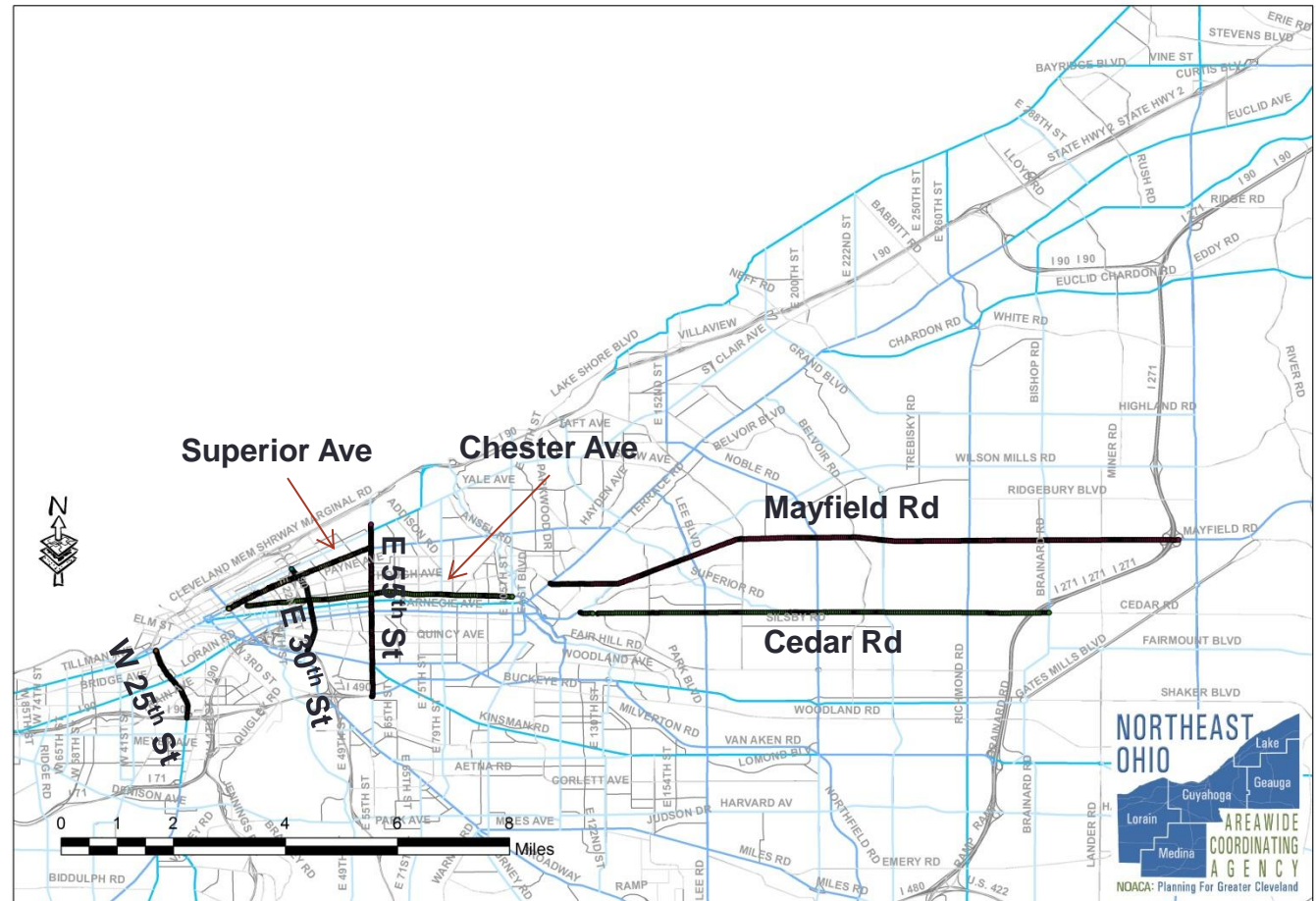
- Large dataset spanning the region – over 13 million GPS data points
- Saves costs of additional data collection
- A reliable and accurate passive probe
- Imputation techniques allow mode recognition and trip characterization
- Impact of real-world driving characteristics on vehicular emissions can be analyzed
- Vehicle dynamics and travel behavior parameters can be analyzed
- Localized driving cycles and link driving schedules can be analyzed

HHTS as Datasource

- Choose the **study area**
 - CMS measures, functional classification, AADT etc.,
- Understand the **data characteristics**
 - Modes, trips, speeds, spatial characteristics etc.,
- Choose a **reliable sample** from population dataset
 - Apply statistical measures of reliability
- Analyze a few **travel behavior parameters**
 - Trip-based, speed-based, and vehicle-based
- Estimate the **emissions**

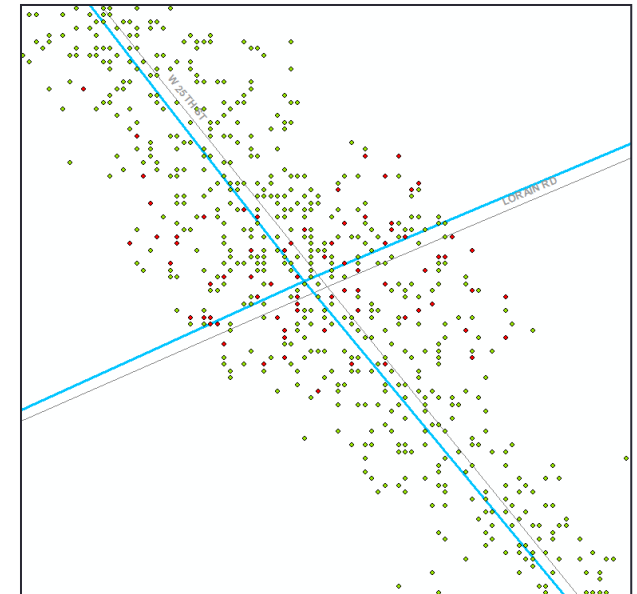
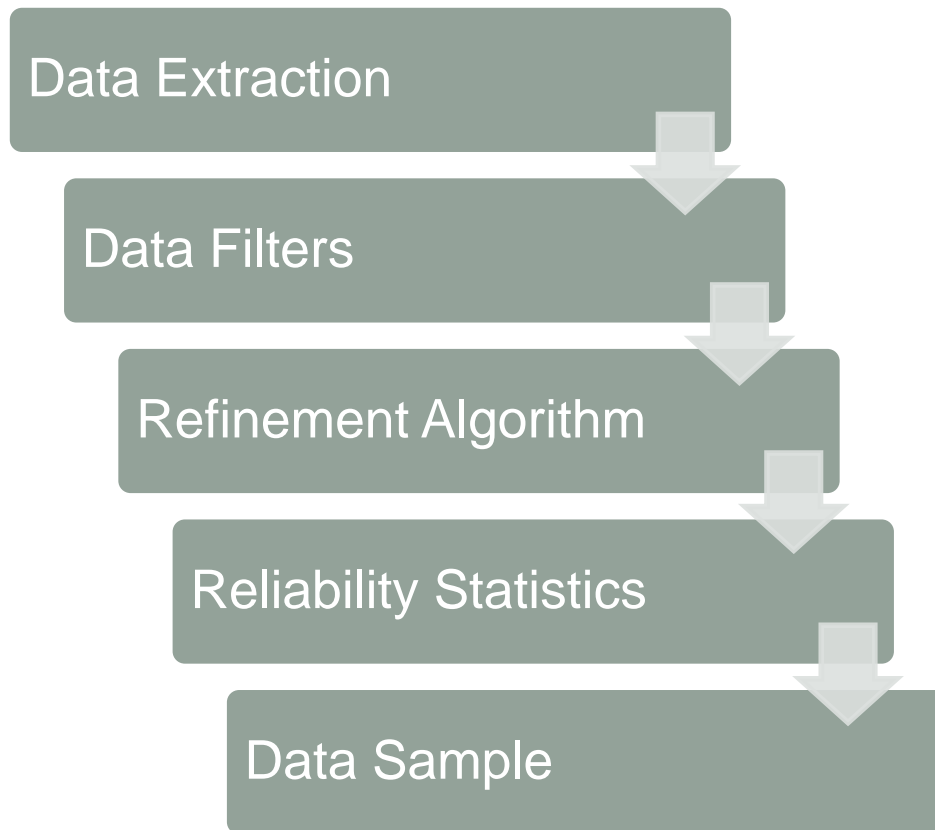
Study Corridors

- W 25th St
- E 30th St
- E 55th St
- Chester Ave
- Superior Ave
- Cedar Rd
- Mayfield Rd



HHTS Data Characteristics

- GPS Point Database: time, speed, location, unique id



Sample Reliability

A representative sample is selected from population data such that the sample mean is within the 95% confidence interval of population mean.

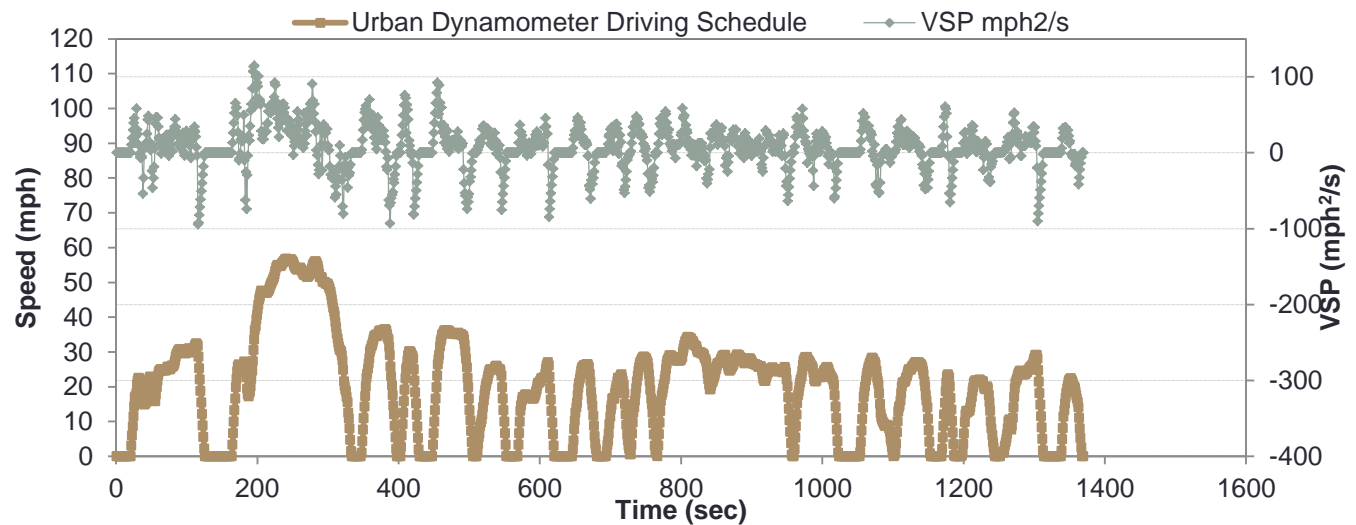
	W 25th	E 30th	E 55th
Population Mean	19.3	17.2	21.4
Sample Mean	15.2	19.8	19.5

	Chester Ave	Superior Ave	Cedar Rd	Mayfield Rd
Population Mean	24.4	17.2	24.7	24.2
Sample Mean	25.1	18.3	25.2	24.3

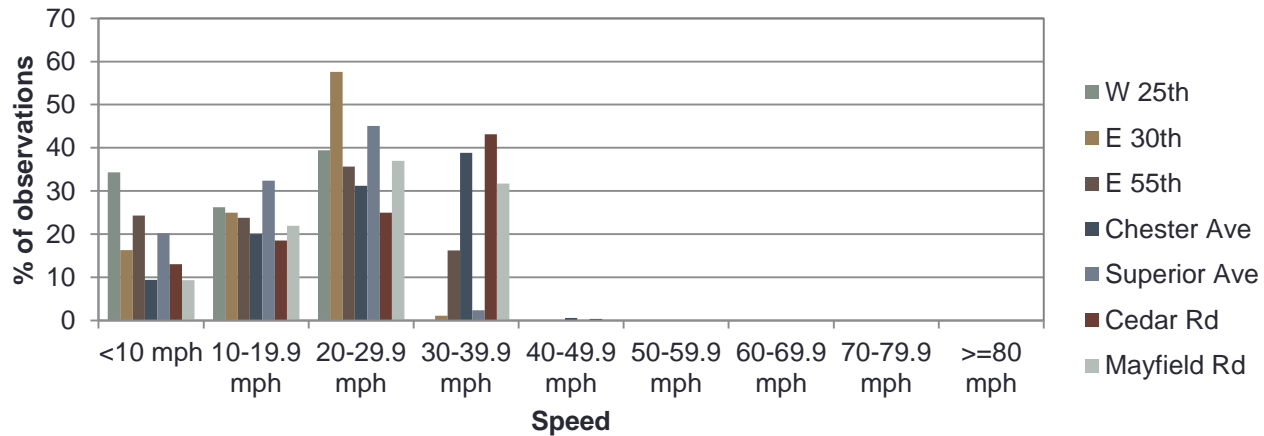
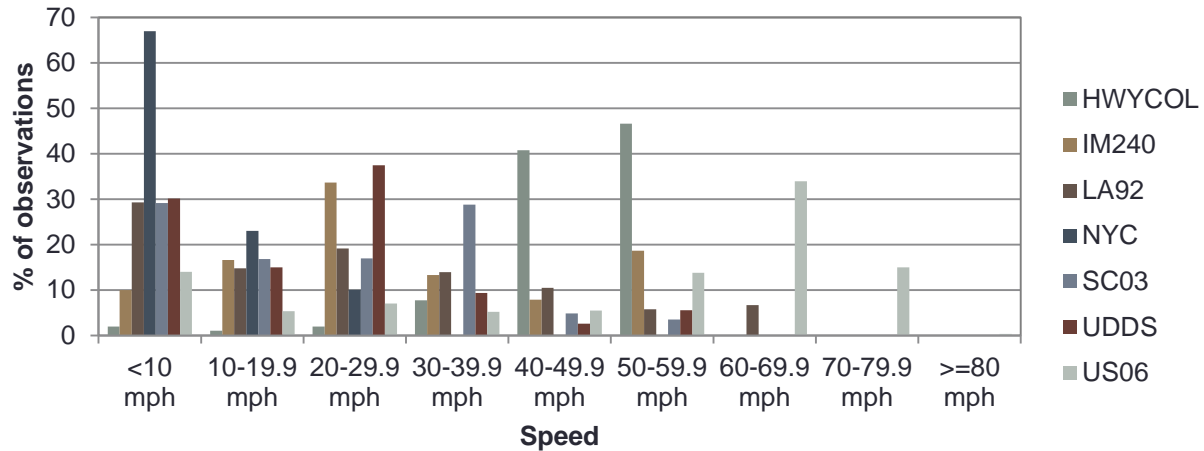
Some Standard Driving Schedules

- IM240
- UDDS
- FTP
- HWFET
- NYCC
- US06
- SC03
- LA92

The standard vehicle dynamometer driving schedules will help characterize the real world driving behavior.

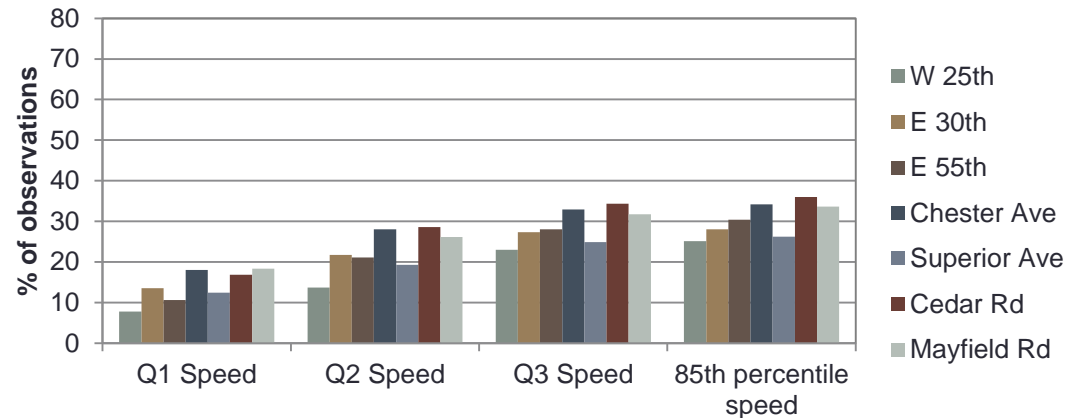
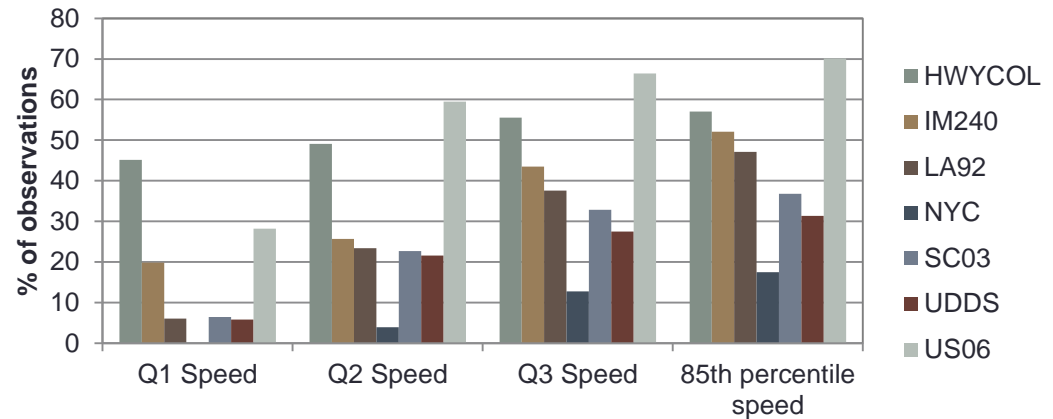


Speed Distribution



Speed Distribution

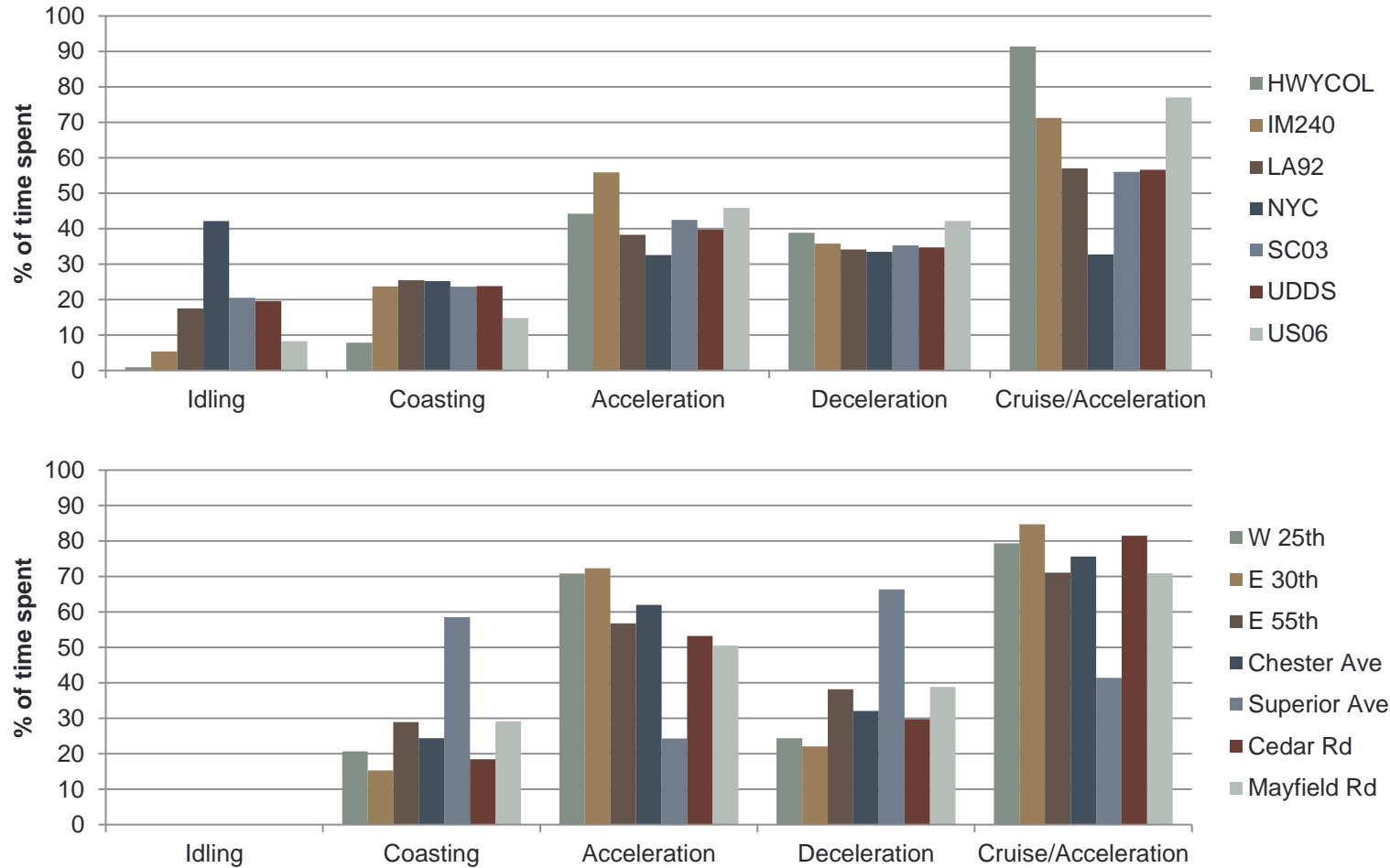
- The correlation coefficients clearly indicated strong relationships in speed distribution



Aggressiveness

- For the standard driving schedules considered,
 - the first quartile acceleration/deceleration range was -0.2 to -0.6 mph/s
 - the third quartile acceleration/deceleration range was 0.3 to 0.8 mph/s
- In the samples considered for our analysis,
 - the first quartile acceleration/deceleration range was -0.4 to -1.03 mph/s
 - the third quartile acceleration/deceleration range was 0.43 to 1.03 mph/s

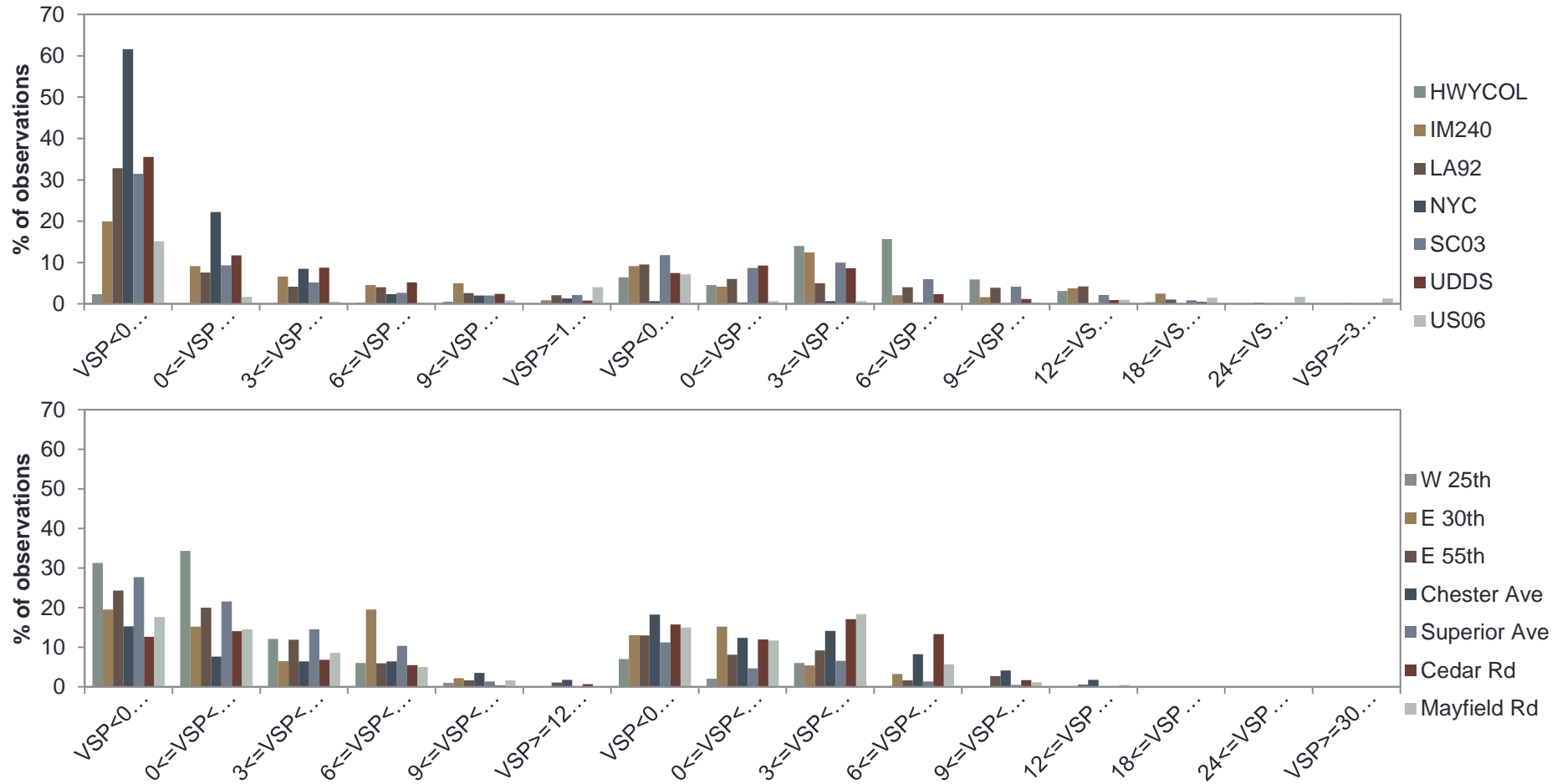
Mode Distribution



Mode Distribution

- HHTS data has a time interval of 3 seconds between successive observations.
- Very few data points have recorded speeds <1 mph, which was considered as idling mode in our analysis.
 - Use of processed data is the likely cause.
 - It was observed that data in this range is lacking though out the dataset.
 - This is likely to impact idling emissions during emisisions modeling at project level.
- Operating modes play a vital role in emissions generation.

MOVES based VSP Bin Distribution



Correlations

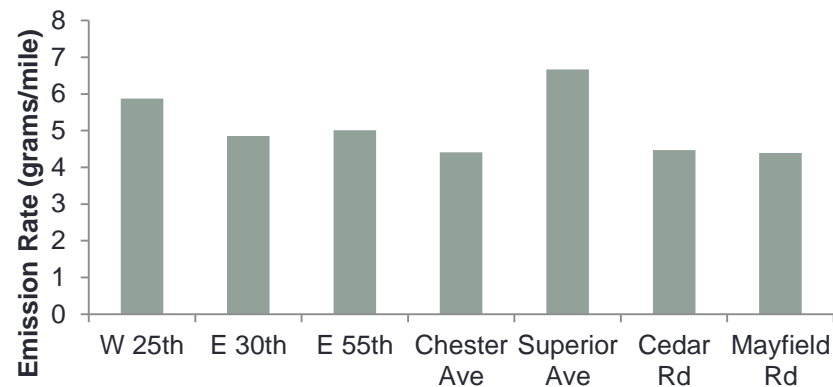
	Speed Distribution	VSP Distribution
W 25 th St	LA92, UDDS	NYC, SC03, UDDS
E 30 th St	IM240, UDDS	UDDS
E 55 th St	IM240, LA92, UDDS	IM240, LA92, NYC, SC03, UDDS
Chester Ave	SC03	SC03
Superior Ave	IM240, UDDS	IM240, LA92, NYC, SC03, UDDS
Cedar Rd	SC03	-
Mayfield Rd	IM240	IM240, SC03

Correlation coefficient >0.75

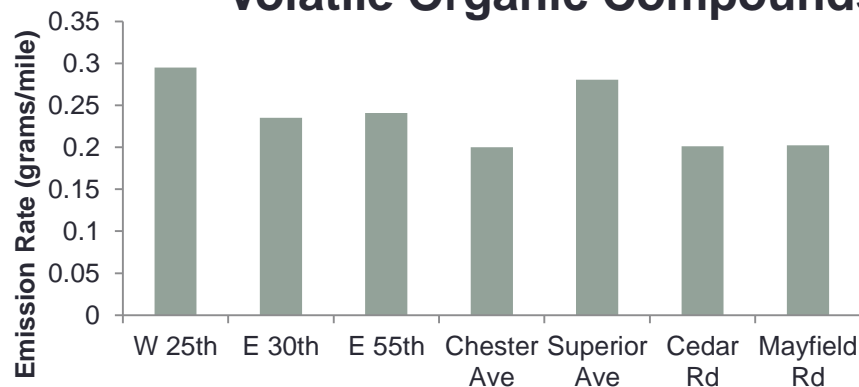
Emissions

- The resultant emissions are specific to each driving schedule.
- Lower speeds resulted in higher emissions.
- The time interval between successive data points is 3 sec for the HHTS data. The impacts of time intervals needs to be studied.

Carbon Monoxide



Volatile Organic Compounds



Conclusions

- HHTS data is a reliable source of information to infer driver behavior characteristics .
- Vehicle dynamics can be imputed at a varied geographic scales.
- Data is very useful in project level emissions modeling. Saves costs of data collection. However, users must be knowledgeable about the limitations.

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