Identifying Signatures for Idling Vehicle Emission Detection to Promote Smart Air Quality Behaviors

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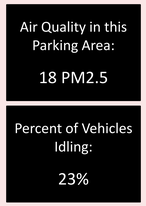
Motivation and Project Goal

Vehicle emissions contribute to air pollution, and engine idling can cause microenvironments of poor air quality. Some individuals spend a significant amount of time working and staying In these microenvironments (e.g. parking valets, commercial drive-through staff, before/after school drop-off monitors and students). Is it possible to use social norm messaging to reduce vehicle idling?

The project aims to develop a Smart Air system that integrates air quality sensors and idling vehicle detection with cloud infrastructure to allow real-time feedback through a Dynamic Air Quality Display.



Display Example

Study Objectives

Collecting preliminary air-quality concentrations in the vicinity of idling vehicles to:

- Determine the sensitivity and ranges required from the prospective low-cost air quality sensors for use in the Smart Air system.
- Generate expected pollution signatures from idling engines.

Experimental Set-up

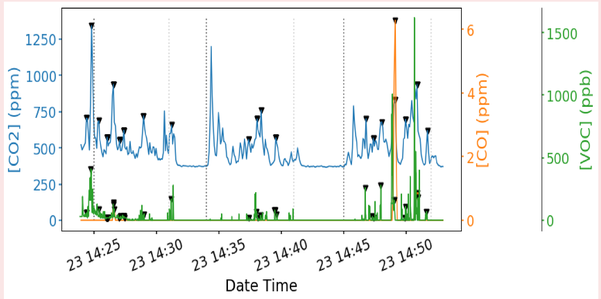
Air Quality Instruments:

- CO_2 / CO concentration - TSI Q-Track 7575 with probe 982
- VOC concentration - TSI Q-Track 7575 with probe 984

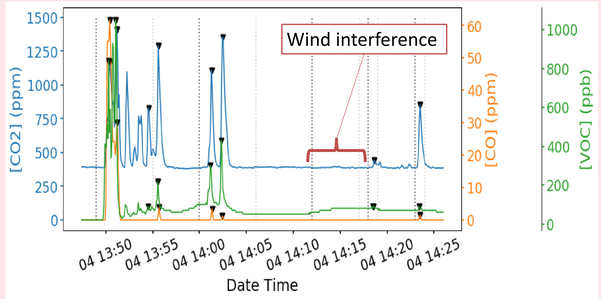
Results

Dotted line - idling event
Black marker - corresponding peaks (+/- 10 seconds)

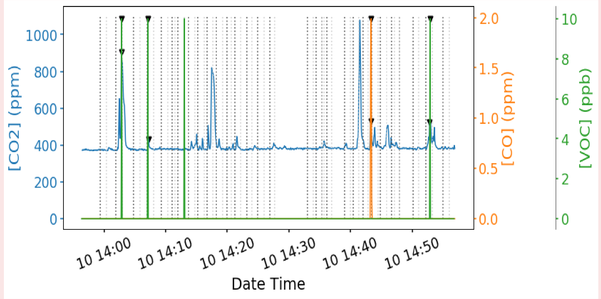
Three idling events:
- 6.3-minute average idle time.
- 42-inch average source distance from sensors.
- Wind - very erratic.



Five idling events:
- 3.8-minute average idle time.
- 36-inch average source distance from sensors.
- Wind - somewhat erratic.



31 idling events:
- 51-second average idle time.
- 60-inch average source distance from sensors.
- Wind - mainly toward sensors.



Peak Time Correlation (%)	Corresponding CO_2	Corresponding CO	Corresponding VOC
CO_2 peak	-	14%	63%
CO peak	100%	-	80%
VOC peak	39%	9%	-

Challenges

- Weather - wind can carry pollutant emissions away from the air quality sensors.
- Source (tailpipe) distance - tailpipe location varies with vehicle model and the ability to measure tailpipe distance depends on field collection location.
- Vehicle Make/Model/Year/Condition/Operation - Engine and pollution control system design, age, condition, and operation all affect emissions.

Conclusion

Vehicle emissions were detected by the air quality sensors in each of the three field collections:

- CO_2 and VOC concentrations were detected more frequently than CO and show moderate correlation.
- All emission species show a decrease in concentration as distance from source increases.
- CO emissions are low and become undetectable at approximately five feet from the source.

Further work is needed to analyze correlations in emission concentrations.

Future Work

- Collect pollutant concentration measurements in realistic settings with individuals present to determine potential interference with CO_2 concentrations.
- Determine if correlations exit between vehicle emission to allow the development of vehicle pollution signatures.
- Include particulate matter concentrations in the field collection using Plantower PMS 3003 sensors.

Acknowledgements

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Dr. Kerry Kelly has an interest in the company Tetrad: Sensor Network Solutions, LCC, which commercializes solutions for environmental monitoring.