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Assessing real-world vehicle emission factors with a low-cost sensor network

MECH 493 Project Description

Background

Air pollution is a leading cause of premature mortality and is associated with over 7 million deaths per year. Among air pollution sources, the transportation sector is a large contributor; in North America, the transportation sector accounted for approximately 20% of total particulate matter pollution in recent years. To date, high-cost regulatory-grade instruments have been the primary tool for assessing air pollutant emissions from vehicles. Recently, low-cost sensors have been increasingly used in ambient air quality studies. Operation of low-cost sensor systems is far less complex than traditional instruments and these tools are typically small and portable, creating potential for wide-spread networked deployment in urban areas where traffic-related pollution is substantial. One potential application of widespread low-cost sensor deployment is using these systems as a remote sensing tool for measurement of fleet-based vehicle emission factors (emissions normalized to activity, i.e., fuel burned or distance travelled). If these tools could be used for this purpose, low-cost sensor systems could be deployed at hundreds of locations to capture a broad range of vehicle operating conditions and environments, generating millions of vehicle plumes for analysis and optimization within Smart Cities. However, it remains uncertain if the measurement sensitivity of low-cost sensor systems are capable of such measurements.

To address this question, the Zimmerman group previously assessed the suitability of low-cost sensor systems for determining vehicle emission factors using a remote-sensing-type approach in 3 parking garages on the UBC campus, which is a traffic-rich, but highly controlled environment. Our results demonstrated that low-cost sensors are a promising tool for the calculation of real-world emission factors, but their performance in complex near-road environments remains unknown.

The Project

The student will use low-cost sensor data from 16 monitors co-located at the Clark Drive Monitoring Station in Vancouver to assess the suitability of these tools for emission factor determination. The Clark Drive Monitoring Station is located at Clark Drive and 11th Ave, which experiences high traffic volumes and a mixed diesel and gasoline vehicle fleet. As part of this, the student will develop computational tools to isolate the vehicle-specific component of the air pollution signal, and algorithms for automatically identifying vehicle exhaust plumes. The student will then validate their method against data collected in parallel by Metro Vancouver, the local regulatory agency that operates the Clark Drive Monitoring Station.

Students applying for this position should be interested in environmental sustainability, comfortable working with large and complex data sets, and be interested in developing their coding and data analysis skills. Communicating science in a policy context is also an important interest, as we anticipate presenting our findings to the Air Quality and Climate Group at Metro Vancouver, the regulatory authority in the region. Depending on progress, the student may also have the opportunity to publish their results in a peer-reviewed academic journal.

Facilities and Resources

The student will work from home with a computer to perform these computational assessments using Matlab/Python. The student will meet weekly with Prof. Zimmerman and will also have the opportunity to interact with graduate students within her group on a regular basis.