Real-World Gas-Phase Emissions from Hybrid and Conventional Vehicles in Cold Weather Climate under Variable Terrain

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Exhaust emissions from motor vehicles contribute significantly to environmental issues and human health concerns. More stringent standards have encouraged manufacturers to seek alternatives to the internal combustion engine for propulsion of on-road vehicles. Increasing proportions of the vehicle fleet are hybrid vehicles, driven by various combinations of the conventional internal combustion engine coupled with electric motors and battery power sources. Though fuel consumption is a known and advertised advantage of the hybrid vehicles on the market, the possible emissions benefits from these vehicles has not been fully characterized. This research aims to (a) examine the transient effects of real-world driving on tailpipe emissions by collecting vehicle and emissions parameters on a second-by-second basis; (b) investigate the influence of cold weather climate on the performance and emissions output of the hybrid vehicle; (c) speciate gas-phase emissions from a baseline (conventional) and an experimental (hybrid) vehicle beyond the regulated exhaust emissions constituents; (d) help to inform current emissions modeling frameworks on how to account for alternative vehicles and unregulated emissions. Fourier Transform Infrared Spectroscopy (FTIR) technology, specifically the MKS MultiGas 2030 High-Speed Gas Analyzer, quantified the gas-phase species emitted from the vehicle tailpipe at one-second temporal resolution. The FTIR measured constituents of hybrid and conventional vehicle exhaust during real-world travel on a fixed route over hilly Chittenden County terrain. With second-by-second detection of the gaseous exhaust emission species, the data obtained in this study will identify the driving modes and other significant inputs suitable for predicting emissions from these low-emitting, alternative vehicles.