

## **Tailpipe Emissions: Real-World, On-Road Data versus MOVES2010 Modeling in Conventional & Hybrid-Electric Vehicles by Operating Mode**

### **Research Goal:**

Determine whether the Environmental Protection Agency (EPA) mobile source emissions model, MOtor Vehicle Emission Simulator (MOVES), is accurately estimating tailpipe emissions for modern technology conventional and hybrid-electric cars on a second-by-second (SbS) basis.

### **Motivation:**

- The EPA regulates tailpipe emissions to reduce the damage that pollutants have on the environment and human health. Tailpipe emissions are linked to climate change, contain carcinogens, and are associated with damage to the immune system. They also contribute to neurological, reproductive, developmental, and respiratory problems along with cardiovascular disease and asthma.<sup>1,2,3</sup>
- The EPA developed MOVES to estimate vehicle emissions of criteria pollutants, greenhouse gases, air toxics, and particulate matter emissions in addition to energy consumption.<sup>4</sup>
- Validation of the MOVES model when compared to real-world, on-road data will lead to better estimates for vehicle emissions estimates for the late-model passenger vehicles that dominate today's on-road fleet.

### **Data & Methods**

Real-world data from UVM's Total On-Board Tailpipe Emissions Measurement System (TOTEMS) collected vehicle activity including speed, acceleration, grade, and vehicle specific power (VSP). Data was collected from two 2010 Toyota Camry vehicles, one conventional (CV) & one hybrid-electric (HEV), for three road links of different grade, (downhill, flat, and uphill) in Chittenden County, Vermont. TOTEMS data was input to MOVES, version 2010b, at the project-level to estimate emission rates on 12 pollutants for 2010 light-duty vehicles.

### **Results**

MOVES overestimated emission rates for criteria gases such as carbon monoxide (CO) and underestimated emission rates for mobile source air toxics (MSATs) such as benzene. The magnitude of the difference between the real and modeled emission rates was found to vary by operating mode and time of year.