Scientists develop new model to measure vehicle emissions

February 27 2013

(Phys.org)—A team of researchers in Boston University's Department of Earth and Environment have developed a new, bottom-up model for measuring on-road vehicle emissions. The model will be used in Massachusetts to more accurately analyze roadway-level traffic data obtained from the Highway Performance Monitoring System (HPMS). Their findings have been published online in the journal *Environmental Science and Technology*

Because on-road transportation is responsible for 28 percent of all U.S. fossil-fuel carbon dioxide (CO_2) emissions, accurate measurement of such emissions is critical for effective regional planning. Using methods currently available, which are based on spatial proxies such as population and road density to downscale national or state-level data, planners have been unable to effectively measure vehicle emissions at regional scales because of data limitations. (Such procedures introduce errors where the proxy variables and actual emissions are weakly correlated.)

The new, BU-developed model makes use of a broad, temporal dataset that permitted the construction of a time series of highly detailed emissions estimates (high spatial resolution). The time-series estimates allowed the researchers to analyze trends in on-road emissions across space and time and to compare their results with other inventories. Because these estimates do not rely on spatial proxies such as population or road density, the BU team was able to conduct a full cross-section/time-series panel regression of population density on vehicle emissions at the scale of local towns. This approach offers urban planners a valuable new tool, because the intensity of emissions is likely to be strongly correlated with characteristics of the built environment such as household and population density, jobs-housing balance, and the diversity of land uses. Another advantage of this approach is that it allows researchers to investigate the interrelation of emissions, population, income, and land uses.

The researchers compared their results with on-road emissions estimates from the Emissions Database for Global Atmospheric Research (EDGAR), with the Vulcan Product, and with estimates derived from state fuel consumption statistics reported by the Federal Highway Administration (FHWA). They found that their model differs from FHWA estimates by less than 8.5 percent on average, and is within 5 percent of Vulcan estimates. (EDGAR estimates systematically exceed FHWA by an average of 22.8 percent.)

This new approach may help resolve key issues in debates over how to reduce on-road CO_2, which have centered on the nature of the relationships between emissions and vehicle miles traveled (VMT), and between VMT and other features of the built environment such as the density of roads, residences, and commercial activity.

Using their new model, the BU researchers found that, in Massachusetts, population density is positively correlated with vehicle emissions at densities less than 2,000 persons per square kilometer (km–2). However, above this level the correlation becomes negative, and emissions decline slowly until densities exceed 4,000 persons per km–2, and then more rapidly thereafter. These results suggest that it is only at the higher population densities associated with dense, urban-core towns that we would expect to see on-road emissions decline with rising density. For lower-density towns, increasing population density is more likely to result in an increase rather than a decrease in vehicle emissions occurring within the town. This result may be a consequence of adding new resident-drivers to the roads, or an indirect effect of denser development drawing more travelers into the area from neighboring towns.

"These results highlight the value of using an emissions inventory with high spatial and temporal resolution," says Lucy Hutyra, assisistant professor of earth and environment and study co-author. "At coarser spatial scales, much of the variation in population density and on-road emissions between towns is lost in the aggregation to larger grid cells. By preserving this local variation, and by generating emissions estimates that did not rely on population density as a proxy for spatial allocation, we were able to highlight the shape of the response surface between on-road CO_2 emissions and population density at the scale of local municipalities in Massachusetts."

As a result of finding a highly nonlinear relationship between its bottom-up emission estimates and the spatially varying proxy variable used in prior studies, the study highlights the potential pitfalls of relying on linear predictors in the construction of downscaled emission inventories.

More information: pubs.acs.org/doi/full/10.1021/es304238v

Provided by Boston University

Citation: Scientists develop new model to measure vehicle emissions (2013, February 27) retrieved 26 April 2024 from https://phys.org/news/2013-02-scientists-vehicle-emissions.html