Spatial Patterns and Spatial Modeling of Primary Organic Aerosol Concentrations in Three North American Cities

Provat Saha¹, Ellis Robinson², Wenwen Zhang³, Steven Hankey⁴, Allen Robinson⁵, and Albert Presto⁶

¹Carnegie Mellon University, Mechanical Engineering, Pittsburgh, United States of America (psaha@andrew.cmu.edu)
²Carnegie Mellon University, Mechanical Engineering, Pittsburgh, United States of America (esrobins@andrew.cmu.edu)
³Virginia Tech, Urban affairs and Planning, School of Public and International Affairs, Blacksburg, United States of America (wenwenz3@vt.edu)
⁴Virginia Tech, Urban affairs and Planning, School of Public and International Affairs, Blacksburg, United States of America (hankey@vt.edu)
⁵Carnegie Mellon University, Mechanical Engineering, Pittsburgh, United States of America (alr@andrew.cmu.edu)
⁶Carnegie Mellon University, Mechanical Engineering, Pittsburgh, United States of America (apresto@andrew.cmu.edu)

We measure highly spatially resolved primary organic aerosol (POA) concentrations in three North American cities (Oakland, Pittsburgh, and Baltimore) using an aerosol mass spectrometer deployed on a mobile laboratory. We conduct between 10 and 20 days of repeated mobile sampling in each city, covering a wide range of urban land use attributes. We derive two POA factors using positive matrix factorization of the measured organic mass spectra: cooking OA (COA) and traffic-related OA (hydrocarbon-like OA; HOA). Both the COA and HOA concentrations vary substantially within and between cities. The COA and HOA concentrations in Oakland are about a factor of 2-4 higher than Pittsburgh and Baltimore. Within a city, the concentrations vary by a factor of 2-5. The COA concentrations are higher than the HOA in each city, indicating that cooking is an important POA source in the US. In each city, the concentrations are higher in the downtown and near large sources, showing the linkage between land-use activities and POA concentrations. We develop land-use regression (LUR) models for COA and HOA using the measured concentrations and available land-use covariates. We find that a similar set of land-use covariates explain the variability of measured POA in each city. The LUR models are moderately transferable between sampling cities. An external validation effort using literature data shows that our models predict the previous point measurements in six North American cities reasonably well. We are applying our LUR models for a national prediction of the concentration surfaces of COA and HOA. We plan to apply the national estimates for the epidemiologic and environmental justice analysis of POA in the United States.
