



## Urban Atmospheric Monitoring and Modeling System (Urban-AMMS): A Top-Down Approach to Investigate Sources and Variability of an Inert Tracer in the Washington, DC, and Baltimore, MD, Metropolitan Area

**Miguel Cahuich-Lopez**<sup>1,2</sup>, Christopher Loughner<sup>1</sup>, Fong Ngan<sup>1,2</sup>, Anna Karion<sup>3</sup>, Lei Hu<sup>4</sup>, Israel Lopez-Coto<sup>3,5</sup>, Kimberly Mueller<sup>3</sup>, Julia Marrs<sup>3</sup>, John Miller<sup>4</sup>, Brian McDonald<sup>6</sup>, Colin Harkins<sup>6,7</sup>, Congmeng Lyu<sup>6,7</sup>, Meng Li<sup>6,7</sup>, Kevin Gurney<sup>8</sup>, Sonny Zinn<sup>1</sup>, Xinrong Ren<sup>1</sup>, Mark Cohen<sup>1</sup>, Howard Diamond<sup>1</sup>, Ariel Stein<sup>1</sup>, and James Whetstone<sup>3</sup>

<sup>1</sup>National Oceanic and Atmospheric Administration, Air Resources Laboratory, College Park, MD, USA

<sup>2</sup>Earth System Science Interdisciplinary Center/Cooperative Institute for Satellite Earth System Studies, University of Maryland, United States of America (mcahuich@umd.edu)

<sup>3</sup>National Institute of Standards and Technology, Gaithersburg, MD, USA

<sup>4</sup>National Oceanic and Atmospheric Administration, Global Monitoring Laboratory, Boulder, CO, USA

<sup>5</sup>School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY, USA

<sup>6</sup>National Oceanic and Atmospheric Administration, Chemical Sciences Laboratory, Boulder, CO, USA

<sup>7</sup>Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, CO, USA

<sup>8</sup>Northern Arizona University, Flagstaff, AZ, USA

Accurate quantification of the sources and sinks of long-lived air pollutants is fundamental for effective emissions management, particularly in urban areas where emissions are generally more intense. Stakeholders commonly use so-called bottom-up methods to estimate emissions for urban areas. This type of emission accounting is typically carried out for annual totals, often with a latency of one or more years. Alternative methods that provide estimates with higher temporal resolution and lower latency could be helpful for stakeholders seeking targeted strategies to reduce emissions. A top-down urban emissions estimation system for the Washington, DC, and Baltimore, MD, metropolitan area, called the Urban Atmospheric Monitoring and Modeling System (Urban-AMMS), is being developed to provide accurate, up-to-date urban emissions data. Urban-AMMS has several components, including tower-based, aircraft, and mobile van measurements platforms, whose data are assimilated by the CarbonTracker-Lagrange analytical inverse model; an ensemble of HYSPLIT backward dispersion simulations driven by in-house high-resolution WRF simulations (spatial resolution of 1 km) enhanced with urban meteorological observations; biospheric models; and bottom-up inventories used for a prior estimate of emissions in the domain. The inversion system is tailored to account for the underlying variability in urban fluxes of an inert tracer (CO<sub>2</sub>) by solving for hourly fluxes and incorporating explicit spatiotemporal covariance of prior errors, as well as high-resolution source-receptor sensitivities estimated by WRF-HYSPLIT. Here, we present an overview of Urban-AMMS, including initial results and sensitivity analyses to investigate the effects of prior spatial aggregation, background handling,

and the temporal covariance of prior errors. Numerical experiments show improvements in estimates of urban surface fluxes at both the city and grid cell scales. Still, the reliability of inverse fluxes depends on prior uncertainty, as observed in previous studies. These findings provide critical insights for the inverse estimation of long-lived air pollutants in complex urban environments.