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Development of a spatially-resolved mobile source carbon dioxide emission inventory for Bogota, Colombia

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As a result of the rapid urbanization process experienced during the last 60 years, 75% of the Colombian population now lives in cities. Urban areas are net sources of greenhouse gases (GHG) and contribute significantly to the national GHG emission inventory.

Scientifically-sound GHG mitigation strategies require accurate and detailed estimations of GHG sources and sinks. Spatially-resolved inventories are effective mitigation decision-making tools as they allow visualizing the distribution of emissions and support the assessment of social and economically sound mitigation alternatives. Additionally, spatially resolving a bulk a priori inventory is essential for the optimal definition of sites for GHG flux monitoring with advanced direct measurement (eddy covariance) and inverse modeling techniques.

Fossil fuel use in transportation is a major source of carbon dioxide in Bogota. Here we present estimates of CO2 emissions from mobile sources in Bogota using the Intergovernmental Panel on Climate Change (IPCC) recommended methodology, and using an aggregation method, which allows for time and space distribution of emissions. The total CO2 emissions from mobile sources were estimated from monthly and annual consumption statistics of gasoline (regular and premium), diesel and compressed natural gas (CNG). We also estimated CO2 emissions from combustion of bioethanol and biodiesel. While these emissions are considered balanced on an annual (or multi-annual) agricultural cycle, the CO2 generated by their combustion would be measurable by an eventual (instantaneous) net flux CO2 monitoring system.

For the aggregation methodology, we used available information on a) Bogota's road network classified by type and flow of vehicles, b) average travel speeds, and c) mean travel length (activity factor) for each vehicle category and road type (derived from traffic counts at strategic intersections). We used COPERT IV for the estimation of appropriate emission factors for Bogota's vehicle fleet. These calculations were validated with published CO2 emissions factors measured in situ in Bogota. We selected vehicle categories in COPERT IV (European fleet) similar Bogota's fleet (classified by fuel type, technology and engine size). A major difficulty was the estimation of emission factors for gasoline vehicles locally converted to CNG.

This research allowed estimating the relative contribution of fuel and vehicle categories to CO2 emissions along with city zones and times of day of high emission. The analysis of the fuel consumption time series revealed a near-stabilization trend on energy consumption for transportation, which is unexpected taking into account the sustained economic and vehicle fleet growth in Bogota. Finally, the comparison of the aggregation methodology with the IPCC methodology contributes to the analysis of possible error sources on activity factor estimations. This information is very useful for uncertainty estimation and adjustment of primary air pollutant emissions inventories.