1.006 Modelling urban δ13C variations in the Greater Toronto Area.

Early Career Scientist

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Abstract:

Even in urbanized regions, carbon dioxide (CO_2) emissions are derived from a variety of biogenic and anthropogenic sources and are influenced by atmospheric transport across borders. As policies are introduced to reduce the emissions of CO_2, there is a need for independent verification of emissions reporting. In this work, we use carbon isotope ($^{13}CO_2$ and $^{12}CO_2$) simulations in combination with atmospheric measurements to distinguish between CO_2 sources in the Greater Toronto Area (GTA), Canada. This is being done by developing an urban $\delta^{13}C$ framework based on existing CO_2 emissions data and forward modelling. We first developed a CO_2 inventory for the GTA at a very fine spatial and temporal resolution (0.02^ox0.02^o and hourly, respectively). We compared the outputs from the Lagrangian dispersion model FLEXPART (at 0.1^ox0.1^o) and the chemistry transport model GEM-MACH (at 0.02^ox0.02^o) to evaluate the impact of model resolution on the produced simulations. These model results are used in our framework in combination with region-specific $\delta^{13}C$ signatures of the dominant CO_2 sources; the product is compared against highly accurate $^{13}CO_2$ and $^{12}CO_2$ ambient data. Locally, anthropogenic CO-$_2$ in urban areas is often derived from natural gas combustion (for heating) and gasoline/diesel combustion (for transportation); the isotopic signatures of these processes were measured to be significantly different (approximately $\delta13C_{VPDB}$ = -44 ‰ and -29 ‰ respectively) in the GTA and can be used to infer their relative contributions. Utilizing our $\delta^{13}C$ framework and differences in sectoral isotopic signatures, we quantify the relative contribution of CO_2 sources on the overall measured concentration and assess the ability of this framework as a tool for tracing the evolution of sector-specific emissions.