Preliminary Constraints on Fossil-fuel CO_2: Comparison of Tracers $^{14}CO_2$, CO, and SF_6

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CO_2 derived from the combustion of fossil fuels is a significant component of the atmospheric carbon budget. Accurate estimates of the fossil fuel source are essential to determining the biological CO_2 flux accurately. However, traditional estimates based on economic inventories are unlikely to be accurate on the sub-continental spatial scales and sub-annual time scales of interest in biological flux studies.

We compare three fossil fuel CO_2 tracer methods ($^{14}CO_2$, CO, and SF_6) at two North American locations (Niwot Ridge, Colorado, and New England) as shown in Figure 1. We derive the boundary layer biological CO_2 contribution (C_{bio}) from the boundary layer – free troposphere CO_2 gradient, correcting for the fossil fuel CO_2 contribution. The direct tracer $^{14}CO_2$ does not suffer from the potential biases associated with the indirect tracers CO and SF_6 and is expected to provide accurate detection capability. In comparison, the SF_6 method shows significant variability at these sites. The CO method is more consistent, but shows a seasonally coherent bias, underestimating fossil fuel CO_2 emissions in winter and overestimating in summer. The bias in the CO-based approach has implications for its planned use as a fossil-fuel tracer in the atmospheric components of the North American Carbon Program.

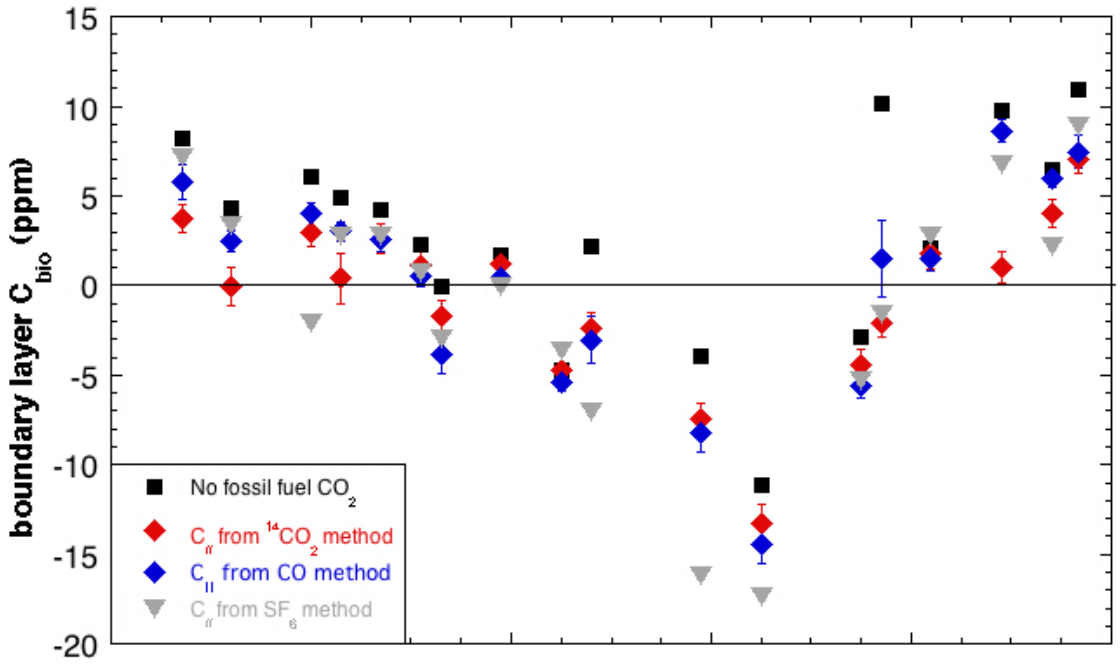

Figure 1. Biological CO_2 contribution in the boundary layer over Massachusetts, as determined using fossil fuel CO_2 (C_{ff}) estimates derived from each tracer method.