Partitioning Sources of CO_2 Atmospheric Signal in an Urban Site Using Carbon Monoxide as a Tracer

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The uncertainty associated with atmospheric measurements of fossil fuel CO_2 (CO_{2foss}) in an urban environment is mainly attributed to the presence of high spatiotemporal variability, atmospheric complexity, complicated underlying processes governing gas mixing and flux dynamics, and influence by local emission patterns. Despite the associated uncertainties, the partitioning of mixing ratios into anthropogenic CO_2 (CO_{2An}), background CO_2 (CO_{2bac}), and biospheric CO_2 (CO_{2bio}) in an urban CO_2 signal are essential in carbon cycle and air quality regulations. In this research, we present and evaluate a CO:CO_2 ratio technique, based on measurements obtained using a wavelength-scanned cavity ring down spectrometry technology, as a direct method of identifying the source of urban CO_2 signals in Cookeville (36.1628° N, 85.5016° W), a medium-sized city located within the Eastern Highland Rim region of the United States. The NOAA HYSPLIT model is used to construct backward trajectories of the CO_2 and CO to determine the origin of the air masses contributing to the consistent diurnal and seasonal mixing ratio cycles that are accompanied by distinct seasonal CO:CO_2 ratios (β). In contrast to the spring and summer seasons, β values for the winter season are reasonably high, which is an indication of a strong CO:CO_2 correlation that corresponds to a reduced biospheric influence. The reduced biospheric influence is suggestive of a local or regional CO_2 signal that is driven by human-induced combustion processes at a time when photosynthesis is weak. For the year 2017, β values (ppb:ppm^{-1}) of 9.7 ±0.4, 5.3 ±0.4, and 2.0 ±0.2 were obtained for the winter, spring, and summer seasons, respectively. In 2018, a similar trend in the β ratios was obtained with values of 8.9 ±0.5, 7.4 ±0.7, and 2.6 ±0.5 for winter, spring, and summer seasons, respectively.

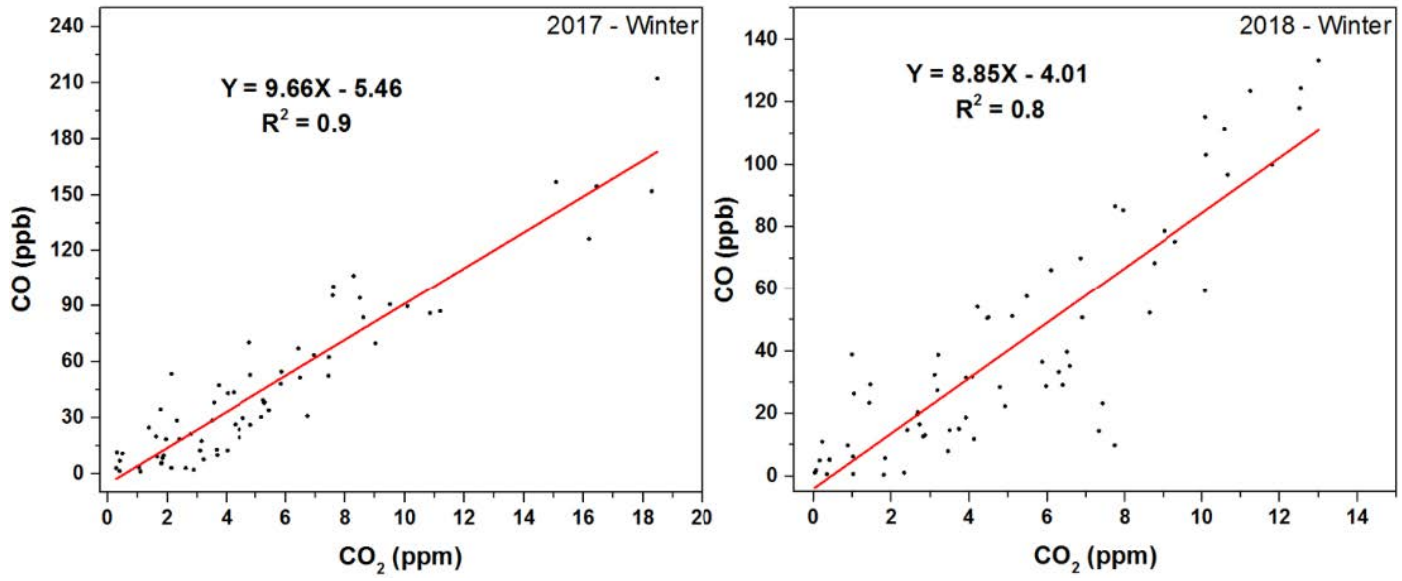

Figure 1. CO:CO_2 correlation plots obtained using CO and CO_2 mixing ratios above background levels.