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New approach to characterize CO_2 and CH_4 emissions over Sacramento, California using an airborne aircraft measurement

Ju-Mee Ryoo (1,2), Laura Iraci (1), Tomoaki Tanaka (3), Josette Marrero (1,2), Emma Yates (3), Warren Gore (1), Inez Fung (4,5), and Ira Leifer (6)

(1) NASA Ames Research Center, Moffett Field, CA, USA, (2) Oak Ridge Associated Universities, Oak Ridge, TN, USA, (3) Bay Area Environmental Research Institute, Moffett Field, CA, USA, (4) Department of Earth and Planetary Sciences, University of California, Berkeley, Berkeley, CA, USA , (5) Department of Environmental Sciences, Policy and Management, University of California, Berkeley, Berkeley, CA, USA, (6) Bubbleology Research International, CA, USA

The CO_2 and CH_4 emission fluxes over Sacramento, California, USA, are estimated using an aircraft equipped with a greenhouse gas sensor through Alpha Jet Atmospheric eXperiment (AJAX). To better quantify the emission fluxes over the entire city and two small point sources within the area, we designed flight patterns in cylindrical loops, and computed the emission fluxes from 4 flights in 2015 using the Kriging interpolation method based on Gauss's divergence theorem. The mean emission rates of CO_2 (CH_4) were 1.5x10^5–6.5 x10^5 (0–70) g s^{-1}. The concentrations at the downwind side of Sacramento show somewhat persistent patterns among the 4 flights, but the magnitudes and locations of the fluxes vary depending on the individual flight condition and seasonality. For example, on September 24, 2015, the maximum fluxes of CO_2 and CH_4 were 5.7 mmol $m^{-2}s^{-1}$ and 62.5 μmol $m^{-2}s^{-1}$, while those of CO_2 and CH_4 were 2.3 mmol $m^{-2}s^{-1}$ and 49.8 μmol $m^{-2}s^{-1}$ on November 17, 2005, respectively. Furthermore, the emission fluxes tend to be smaller in summer (July) than winter (November). Both the CO_2 and CH_4 concentrations, the wind speed and direction show high spatial variability both horizontally and vertically. The local maximum emission flux over a landfill and a rice field measured on July 29, 2015, was 2–3 times lower than the maximum measured over the entire city area due to seasonality, low CO_2 concentration and light wind conditions, suggesting that the wind and seasonal variation in CO_2 and CH_4 have a strong effect on the flux estimation of the both local emissions and city-size emissions. Our results demonstrate that the aircraft-based approach is effective and useful for capturing city-size emission fluxes and estimating the greenhouse gas emissions and its sources.