EMS Annual Meeting Abstracts
Vol. 22, EMS2025-318, 2025, updated on 02 Apr 2026
https://doi.org/10.5194/ems2025-318
EMS Annual Meeting 2025
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Tracing CO□ sources during biomass burning seasons (2020-2023) using δ¹³C-CO□ and air pollutants in São Paulo, Brazil

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The stable isotopic composition of carbon, such as δ¹³C-CO□, is a valuable tool for tracing the sources of atmospheric CO□. Within this framework, the METROCLIMA project (www.metroclima.iag.usp.br) aims to develop and evaluate methodologies for quantifying urban greenhouse gas emissions and distinguishing between biogenic and anthropogenic sources. We analyzed data from a METROCLIMA station equipped with a cavity ring-down spectroscopy instrument (Picarro), which continuously measures δ¹³C-CO□ and CO□ in real time. The station is located in a partially vegetated urban area at the Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG), University of São Paulo (USP) (-23.559478, -46.733533). This study focuses on characterizing total urban CO□ and identifying potential CO□ sources during the wildfire seasons (August and September) across four years (2020–2023). Additionally, we analyzed PM□□, PM□.□, O□, and NO□ data from the CETESB monitoring station in Pinheiros (São Paulo's Environmental Protection Agency).

The isotopic signatures observed during the spring seasons indicate a predominant influence of biomass burning (δ¹³C-CO□ = −22‰ to -25‰) and fossil fuel combustion (δ¹³C-CO□ = −30‰ to -37‰), as revealed by Keeling plot analyses (based on intercepts from δ¹³C-CO□ versus 1/CO□). HYSPLIT backward trajectory analyses suggest that some of the air masses were likely influenced by plumes originating from the Pantanal and the Atlantic Forest (Mata Atlântica) regions. Other identified source was local wood burning, contributing to a lesser extent each year. Moreover, the temporal behavior of isotopic signals was consistent with CO□ concentrations and CETESB pollutant data, indicating a strong influence of wildfire plumes on CO□ levels and air pollutants such as PM□□, PM□.□, O□, and CO. Notably, the 2022 wildfire season presented the highest CO□ concentrations and pollutant levels among the years analyzed.

Here, we provide an initial assessment of CO□ sources during biomass burning seasons in São Paulo, offering valuable insights that could support future greenhouse gas mitigation strategies.