CARBON ISOTOPIC COMPOSITION OF ANTHROPOGENIC AEROSOLS IN ATMOSPHERIC POLLUTION RESEARCH

Durre Nayab Habib[1], Andrius Garbaras[1], Ulrike Dusek[2], Agne Masalaite[1]

[1]Center for Physical Sciences and Technology, Department of Nuclear Research, Lithuania
[2]University of Groningen, Groningen,9747 AG, The Netherlands
durre.nayab@ftmc.lt

Carbonaceous aerosols from anthropogenic sources, including biomass burning (BB) and vehicular emissions, are a major component of fine particulate matter and play an important role in air quality, climate forcing, and human health [1]. However, uncertainties remain in identifying their sources and understanding how their chemical signatures evolve during atmospheric processing. Stable carbon isotopic composition ($\delta^{13}C$) of organic carbon (OC) offers a promising tracer to address these challenges. This study investigates the applicability of $\delta^{13}C$ in anthropogenic atmospheric pollution research through two independent experimental approaches.

Firstly, laboratory aging experiments were conducted on aerosols produced from the combustion of six different biomass fuels to examine isotopic changes during photochemical processing. $\delta^{13}C$ of OC was measured across three thermal fractions (200 °C, 350 °C, and 650 °C). OH-aged samples showed minimal isotopic change, in contrast to consistent ^{13}C depletion following UV aging. The intermediate-temperature OC fraction (350 °C) was generally enriched in ^{13}C compared to other fractions after UV aging. For example, wood-pellet emissions showed $\delta^{13}C$ values of −25.3 ‰, −25.1 ‰, and −25.0 ‰ for the 200 °C, 350 °C, and 650 °C fractions, respectively, compared to −25.6 ‰, −25.7 ‰, and −25.4 ‰ in un-aged samples.

Secondly, $\delta^{13}C$ of three-step OC was characterized for vehicle exhaust aerosols(un-aged) collected from eleven in-use vehicles. Substantial variability in isotopic composition was observed among vehicles and thermal fractions, with most values clustering between −26 ‰ and −28 ‰, alongside notable deviations in specific samples.

Overall, the results demonstrate that $\delta^{13}C$ of OC is sensitive to both photochemical aging and source-specific emission characteristics, supporting its use as a tracer for anthropogenic aerosol source apportionment and atmospheric pollution studies.

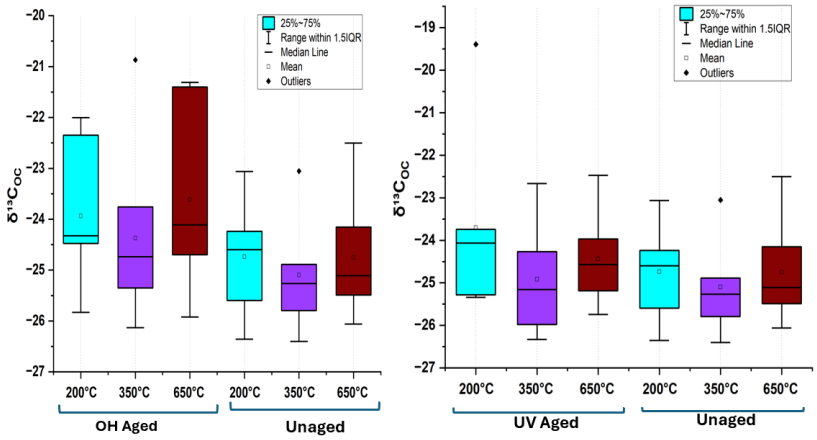

Fig. 1. Comparison of OH and UV aged biomass burning aerosol emissions samples with their respective un-aged samples

[1] H. Huang, Y. Jin, W. Sun, Y. Gao, P. Sun, and W. Ding, “Biomass Burning in Northeast China over Two Decades: Temporal Trends and Geographic Patterns,” Remote Sensing, vol. 16, no. 11, p. 1911, May 2024, doi: 10.3390/rs16111911.