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Combustion inputs into a terrestrial archive over 265 years as evidenced by BPCA molecular markers

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Pyrogenic organic matter (PyOM) such as char and soot is produced during the incomplete combustion of biomass and fossil fuel. It is composed of condensed aromatic structures and can resist degradation processes, maybe over long periods of time. Land-use changes, industrial activity and its transport by wind and water affect the fluxes of PyOM from the source to its sedimentary archive. Investigating environmental PyOM with the molecular marker benzene polycarboxylic acid (BPCA) method provides various information about quantity, quality (BPCA distribution pattern) and about its isotopic composition (13C and 14C). Assessing PyOM quality can indicate whether it is mostly combustion condensate (soot) or combustion residue (charcoal) and potentially allow source apportionment.

Our study area is the Pettaquamscutt River catchment area (35 km2), Rhode Island, U.S.A. It is located down-wind of industrial areas recording deposition of long-distance atmospheric transport as well as local catchment inputs, both from natural and anthropogenic sources. We investigated 50 samples of a sediment record over a time span of 265 years (1733-1998 AD). Previous investigations provided information on the age of deposition, the content of polycyclic aromatic hydrocarbons (PAH) as well as of the radiocarbon contents of total organic carbon (TOC) and PAH (Lima, 2004). We used the BPCA molecular marker method to quantify and characterize PyOM in the same record.

First results show that quantity and quality of PyOM change over 265 years. Our investigation aims at understanding how different sources of PyOM are reflected in terrestrial archives by comparing the results of BPCA with radiocarbon-dated TOC and PAH records. Among other aspects, the PAH record reflects the Great Depression and the 1970s oil embargo in North America. We interpret the BPCA distribution patterns regarding the simultaneous shift of dominant fuels including wood, coal, petroleum and gas. Future work will include compound-specific radiocarbon analysis of BPCA molecular markers to improve our understanding of the sources and residence time of PyOM.

References

Lima, A.L.C., 2004. Molecular and Isotopic Records of Combustion Inputs to the Environment Over the Last 250 Years, doctoral dissertation, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution (MIT/WHOI).