Triple Isotopes ($\delta^{13}C$, $\delta^{2}H$, and $\Delta^{14}C$) Compositions and Source Apportionment of Atmospheric Naphthalene: A Key Surrogate of Intermediate-Volatility Organic Compounds (IVOCs)

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Widely occurring in the atmosphere, naphthalene (NAP) is worth concern not only owing to its carcinogenicity, but also as an important precursor of atmospheric SOA [1]. However, its source attributions are not explicit. We conducted source apportionment of atmospheric NAP using a triple-isotope ($\delta^{13}C$, $\delta^{2}H$, and $\Delta^{14}C$) technique combined with a Bayesian model in the Beijing-Tianjin-Hebei (BTH) region, China [2].

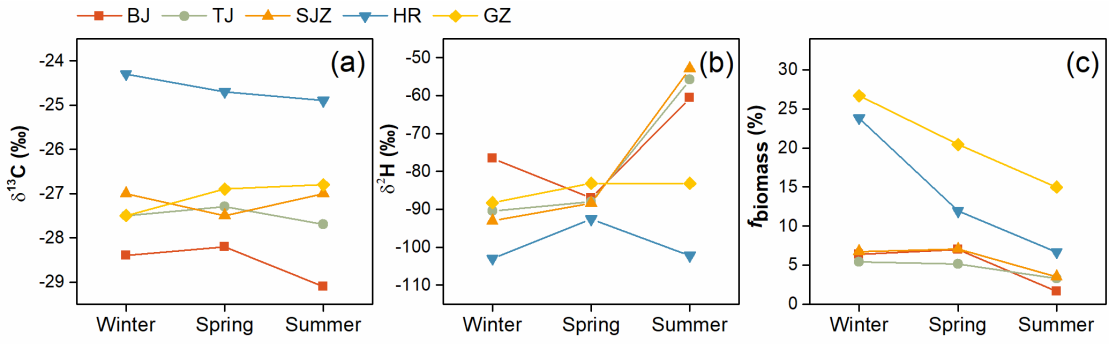

Figure 1. Temporal-spatial distribution of stable carbon (a), hydrogen (b) isotope compositions and fraction modern (c) of atmospheric vapor-phase naphthalene. Beijing (BJ), Tianjin (TJ), Shijiazhuang (SJZ), Huairou (HR) and Guangzhou (GZ).

At the urban sites (BJ, TJ, and SJZ), stable carbon (–27.7 ± 0.7 ‰) and radiocarbon (–944.0 ± 20.4‰) isotope compositions of NAP did not exhibit significant seasonal variation, but the deuterium system showed a relatively more ^{2}H-depleted signature in winter (–86.7 ± 8.9 ‰) compared to that in summer (–56.4 % ± 3.9 ‰). Radiocarbon signatures indicated that 95.1 ± 1.8 % of NAP was emitted from fossil sources in these cities. The Bayesian model results indicated that the source contribution of the BTH urban sites had a similar pattern. The contribution of liquid fossil combustion was highest (46.7 ± 2.6%), followed by coal high-temperature combustion (26.8 ± 7.1%), coal low-temperature combustion (18.9 ± 6.4%) and biomass burning (7.6 ± 3.1%). At the suburban site, the contribution of coal low-temperature combustion could reach 70.1 ± 6.4 %. The triple-isotopes based approach provides a top-down constraint on the sources of atmospheric NAP, and could be further applied to other IVOCs in the ambient atmosphere.

[1] Huang *et al.* (2019) Environ. Sci. Technol. 53, (3), 1235-1244.

[2] Bosch *et al*. (2015) Environ. Sci. Technol. 49, (13), 7657-7665.