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Tracing the relative significance of primary versus secondary organic aerosols over a Coastal Ocean based on stable carbon isotopes and anhydrosugars

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Abstract

Organic aerosols (OA), a ubiquitous component of ambient particulate matter (accounting for a mass fraction as high as 90%)[1] can have multiple effects on Earth's system, including those "direct" (scattering/absorption properties) and "indirect" ones (for example, their ability to act as cloud condensation nuclei: CCN or influence the hygroscopic properties, cloud albedo)[1,2]. Understanding the sources and formation pathways of OA is an essential prerequisite for reducing their associated uncertainties in the predicted climate effects. These impacts could be more severe for the tropical regions with intense anthropogenic activities such as S. Asia. Our study here focuses on characterizing the OA in the S. and SE. Asian outflow to a coastal Ocean, the Bay of Bengal (BoB).

We demonstrate the simultaneous use of stable carbon isotopic composition of total carbon ($\delta^{13}C_{TC}$) and anhydrosugars, tracers of biomass burning (BB) emissions, to elucidate the relative significance of primary (POA) versus secondary organic aerosols (SOA). We assessed the concentrations of anhydrosugars (levoglucosan: *Lev*, mannosan: *Man* and galactosan: *Gal*) and $\delta^{13}C_{TC}$ over the BoB, influenced by the continental outflow from the Indo-Gangetic Plain (IGP) and forest fires in South-East Asia (SEA). We observed notable differences in the molecular distributions and diagnostic mass ratios of anhydrosugars between IGP- (*Lev* $>$ *Gal* $>$ *Man; Lev/Gal: 5.5*) and SEA-outflow (*Lev* $>$ *Man* $>$ *Gal; Lev/Gal: 26*). The positive linear/nonlinear relationship of $\delta^{13}C_{TC}$ with Lev, K^+, and total carbon (TC) in the wintertime SEA-outflow are in sharp contrast to those in summer from Mt. Tai, China, and Rondônia, Brazil. A negative linear relationship of reciprocal values of mass concentrations of TC, water-soluble organic carbon (WSOC), and Lev with $\delta^{13}C_{TC}$in the SEA-outflow suggests a mixing of ^{13}C-enriched POA of BB origin and "fresh or less-aged SOA" formed by the oxidation of ^{13}C-depleted volatile organic compounds.

References

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