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What do we learn from EC (black carbon), OC and their Isotope Measurements in Fine Airborne PM over Canada?

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Elemental carbon and organic carbon (EC & OC) components in fine airborne carbonaceous particulate matter (PM) are major air pollutants existing in urban, rural and remote environments as well as key players in climate change (via radiative forcing). It is known that both EC (also called as black carbon or soot) and OC are released from various emission sources (e.g., fossil fuel combustion, biomass burning) and OC is also produced in the atmosphere through photochemical oxidations from gas phase organics. Tracking their spatial (e.g., from urban to rural to background air or latitudinal) and temporal (e.g. seasonal and inter-annual) distributions will provide valuable information to constraining emission sources and atmospheric transport/transformation mechanisms as well as to assessing effectiveness of mitigation for these pollutants.

Sources/processes detecting and attributing are key aspects in both air quality and climate change research. Isotope measurements, as independent tools, can provide valuable insight to constrain those aspects. Duo to its inert nature, it is expected that the δ^{13}C of EC won't be changed after emitting to the atmosphere, reflecting the signature of source, whereas the δ^{13}Cof OC will have a various degree of changes through photochemical processes, depending on the history of the air mass. Therefore, an isotopic profile of δ^{13}C in carbon components released at different temperature ranges can provide useful insight to the emission sources and formation processes in ambient PM.

Quartz filter samples were collected at the five sites over Canada, from Toronto (a typical urban site), Egbert (a rural site, $\sim$ 80 km northwest of Toronto), to Fraserdale, and Berm-TT (both are continental boreal forest sites), to Alert (an Arctic baseline site). EC and OC concentrations for those samples collected during the period (2006 - 2007) were determined using a thermal method (Totoal_900_EnCan) developed in Toronto lab at Environment Canada, which is different from IMPROVE and NIOSH. The magnitude of POC (pyrolized organic carbon), which is produced in the analysis and proportional to oxygenated OC on the filters, was also obtained from these measurements. A subset of the samples was selected for δ^{13}C measurements in each carbon fraction (i.e., OC, POC and EC). Due to the collocated filter sampling with the *in situ* measurements of aerosol optical properties and CO_2 concentrations, the relationship between the annual mean EC/OC concentrations and aerosol light absorption and scattering as well as between the EC and excess CO_2 (i.e. CO_2 difference relative to a background value) on a regional scale have been also investigated.

Combining the isotopic measurements, it is found that the spatial gradients of EC and OC during different seasons from urban, rural to background air over Canada were mainly due to the transport of human induced emissions although biomass burning and biogenic emissions, as primary sources, and atmospheric photochemical oxidations, as secondary sources, play important roles in influencing seasonal variations at the different sites. EC and OC are major components contributing to the aerosols optical properties on a regional scale. Integrating EC/OC in fine PM with CO_2 and their δ^{13}C measurements will be a powerful tool to study human-induced impact on climate change.