

Elemental and Organic Carbon Measurements in Fine PM from Urban to Rural to Background Air Over Canada: Understanding Human Impacts on Atmospheric Compositions

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Quantifying human induced CO₂ and other air pollutants in ambient air is important in air quality and climate change research, particularly in addressing the issue of the continued increase of atmospheric CO₂. Elemental and organic carbon (EC & OC) components in fine carbonaceous particulate matter (PM) are key air pollutants, existing in urban, rural and remote environments. It is known that they are released from various emission sources (e.g., fossil fuel combustion, biomass burning, primary biological matter) and also produced in the atmosphere from photochemical oxidation of 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 for constraining their emission strength and propagation mechanisms, assessing the impact of human induced emissions on current ambient concentrations or deposition rates, as well as in evaluating the effectiveness mitigation actions of these pollutants.

Quartz filter samples were collected for one year (2006-2007) at five sites in Canada (see the map), from Toronto (a typical urban site), Egbert (a rural site, ~ 80 km northwest of Toronto), to Fraserdale, and Berm-TT (both are continental boreal forest sites), to Alert (an Arctic baseline site). EC/OC concentrations were determined using a thermal/optical method. The magnitude of pyrolyzed organic carbon (POC), 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 $\delta^{13}\text{C}$ measurements in each carbon fraction (i.e., OC, POC and EC). The EC & OC measurements have been co-located with measurements of aerosol optical properties and greenhouse gas concentrations. It is anticipated that these measurements will continue to be part of long-term measurement program in Environment Canada's GHGs & Aerosol Observation Network allowing an integrative approach to track and assess the human impact on climate change.

The spatial and temporal distributions, including annual means and the seasonal variations of EC, OC, POC and their related ratios (e.g. OC/EC, POC/OC), were derived. Combined with the $\delta^{13}\text{C}$ information, it was found that the spatial gradients of EC and OC (shown on the map) during different seasons from urban, rural and background air over Canada were mainly due to the propagation of human induced emissions for the period of observation. However, biomass burning and biogenic emissions, as primary sources, and atmospheric photochemical oxidation processes play important roles in influencing seasonal variations at the different sites.

Similar measurements for the same period of time from Beijing, a mega-city in China, and the average value for a two-month (April-May, 2006) at Whistler Mountain on the west coast of Canada, will also be shown to provide insight on the impact of long-range Asian-Pacific transport on the ambient levels of EC/OC over Canada.

