

Introduction

Although lots of attention has recently been paid to Black Carbon (BC) due to its important role in climate system, there are still large knowledge gaps in quantifying their emission sources and estimating their climate impacts at regional and global scale. Because of the short atmospheric lifetime of BC, thus, changes in its atmospheric concentrations could reflect the corresponding changes in its source emissions. In this work, we are going to show using long-term atmospheric observations of elemental carbon (EC), as BC mass concentrations, to potentially constrain its regional emission sources in North America.

Observation sites

- An observation network of EC has been strategically established across Canada since 2006. The sites represent different geographic regions with various continental source influences, including urban (Toronto, ON), rural (Egbert, ON), boreal forest (Fraserdale, ON, East Trout Lake, SK), high elevation (Whistler Mt., BC), and a remote Arctic region (Alert, NU).

- Weekly integrated quartz filter samples collected at the sites have been analysed for EC concentrations over the period of 2006 to 2015 via a thermal method, i.e., EC-CAN 900 (Huang et al., 2006).

Results

- Downwards trends (2006-2015) are observed in both annual & seasonal means at sites (e.g., Toronto & Egbert) in eastern Canada.

- Upwards trends (2006-2015) in summertime are observed at a boreal forest site (East Trout Lake, SK) in western Canada.

- Seasonal patterns, with relatively higher concentrations in summer-fall months and relatively lower concentrations in winter-spring months, were observed at all sites except for Alert (the Arctic site).

- Mann-Kendall Test confirmed the trend analysis (suitable to small datasets with no normal distribution required).

Constraining Regional Sources

- In comparison with BC emission inventories (van Marle et al., 2017; Hosulya et al., 2018), it is shown that the trends observed in eastern Canada (e.g., Toronto, and Egbert, ON) are dominated by the changes anthropogenic emissions over the same period and the influence of US emissions on the trends may be more significant than Canadian emissions.

- Whereas the seasonal pattern and inter-annual variability observed in eastern Canada have been influenced much more by biomass burning events.

- The decreasing trends (2006-2015) in eastern Canada would imply beneficial effects from clean air policies both in the US (Clean Air Act) and Canada (Clean Air Regulations); supporting by the correlations between the fossil fuel emissions and BC mass in annual averages (see plots below).

- However, there are inconsistencies in seasonal profiles / patterns between the observations and the regional emission inventories in Eastern North America. That raises questions and suggests a possible approach on constraining the seasonal profile of BC emissions in North America via atmospheric observations.

References

