Black Carbon Mass Observations across Canada (2006-2015): Constraining on Regional Emissions in North America

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Black carbon (BC) plays an important role in Earth's climate system from regional to global scales. To contribute to the evaluation of models, which may help constrain regional and global emissions, an observation network of aerosol elemental carbon (EC) as BC mass 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). Because of its short atmospheric lifetime, changes in atmospheric EC concentration (specifically those observed in seasonal and inter-annual variability) largely reflect the changes of emission source influences at regional scales; although, the impacts of long-range transport should not be underestimated.

Weekly integrated quartz filter samples collected at these sites have been analyzed for EC concentrations over the period of 2006 to 2015. Seasonal patterns and inter-annual variability of BC mass have been observed. In comparison with several recently-published emission inventories, including the historic Intergovernmental Panel on Climate Change (IPCC) emissions of BC for Coupled Model Intercomparison Project 6th phase (CMIP6) and Canada /U.S. particulate matter 2.5 (PM2.5) emissions, it is shown that the trends observed at the sites in eastern Canada (e.g., Toronto, and Egbert, ON) are dominated by anthropogenic emission changes and the influence of U.S. emissions on the trends may be more significant than Canadian emissions. Whereas that the seasonal pattern and inter-annual variability observed at the sites in western 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 U.S. (Clean Air Act) and Canada (Clean Air Regulatory Agenda). However, there are inconsistencies in seasonal patterns between the observations in eastern Canada and the regional emissions inventories in North America. That raises questions and may suggest a possible pathway on constraining the seasonal profile of BC emissions in North America via observations.

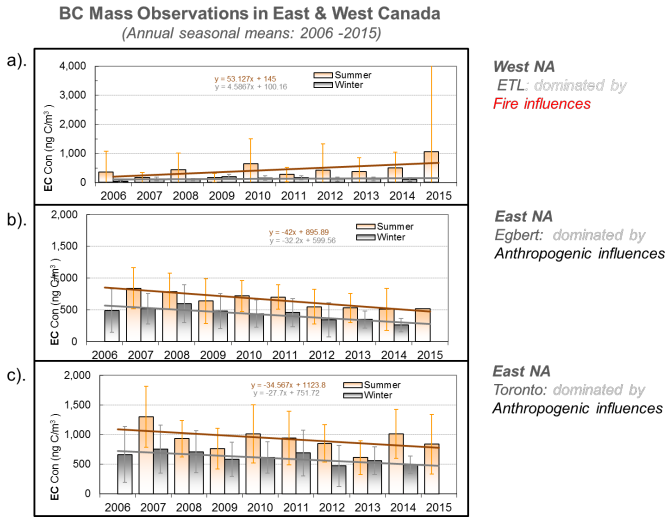

Figure 1. BC mass observations at representative sites in East and West Canada (2005-2016). Orange bars: warm seasons (May-Oct); Gray bars: cold seasons (Nov-Apr). a) East Trout Lake (ETL), SK; b) Egbert, ON; c) Toronto, ON

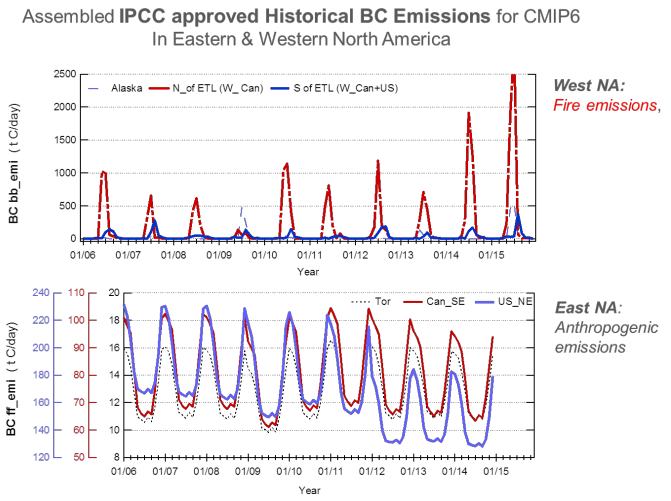

Figure 2. Regional assembled BC emissions (IPCC approved for CMIP6) in Eastern & Western North America (NA). Top panel: BC emissions from fires in Western NA; bottom panel: BC emission from anthropogenic emission in Eastern NA.