Supplemental section for paper, An Evaluation of three methods for measuring black carbon at Alert, Canada by Sharma et al.

Calculation of Aerosol Angstrom Absorption Exponent:

The aerosol Ångström absorption exponent (AAE) was calculated from the PSAP absorption measurements. The AAE is defined as

$$AAE = \frac{\ln(\frac{\sigma_{ap}(\lambda_1)}{\sigma_{ap}(\lambda_2)}}{\ln(\frac{\lambda_1}{\lambda_2})} \qquad 1$$

where λ_1=467 nm and λ_2=660 nm and $\sigma_{ap}(\lambda_1)$ is absorption at 467 nm and $\sigma_{ap}(\lambda_2)$ is absorption at 660 nm.

Uncertainty in AAE

Standard techniques were applied to determine combined uncertainties in the Aerosol Absorption Exponent calculated at two wavelengths; λ_1=467 nm and λ_2=660 nm. The uncertainty in AAE is determined by Eq. 2 has also been used in Sherman et al. (2015).

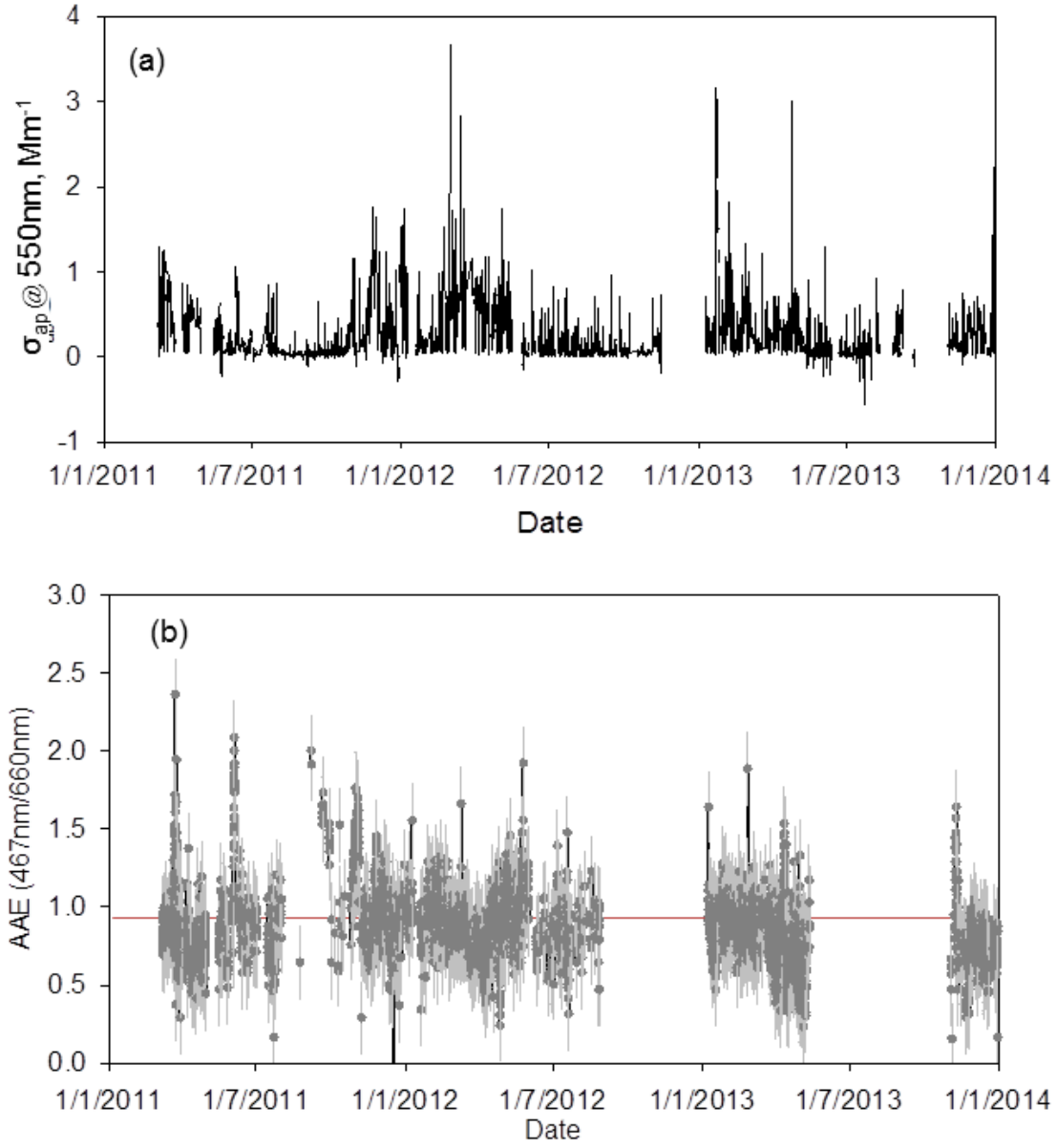
$$\Delta AAE\left(\frac{467nm}{660nm}\right) = \left(\left(\frac{\partial AAE}{\partial \sigma_{ap,467}}\right)^2 \Delta\sigma_{ap,467}{}^2 + \left(\frac{\partial AAE}{\partial \sigma_{ap,660}}\right)^2 \Delta\sigma_{ap,660}{}^2 + 2 * corr\left(\sigma_{ap,467}, \sigma_{ap,660}\right) * \left(\frac{\partial AAE}{\partial \sigma_{ap,467}}\right) * \left(\frac{\partial AAE}{\partial \sigma_{ap,660}}\right) * \Delta\sigma_{ap,467} * \Delta\sigma_{ap,660}\right)^{1/2} \qquad (2)$$

where

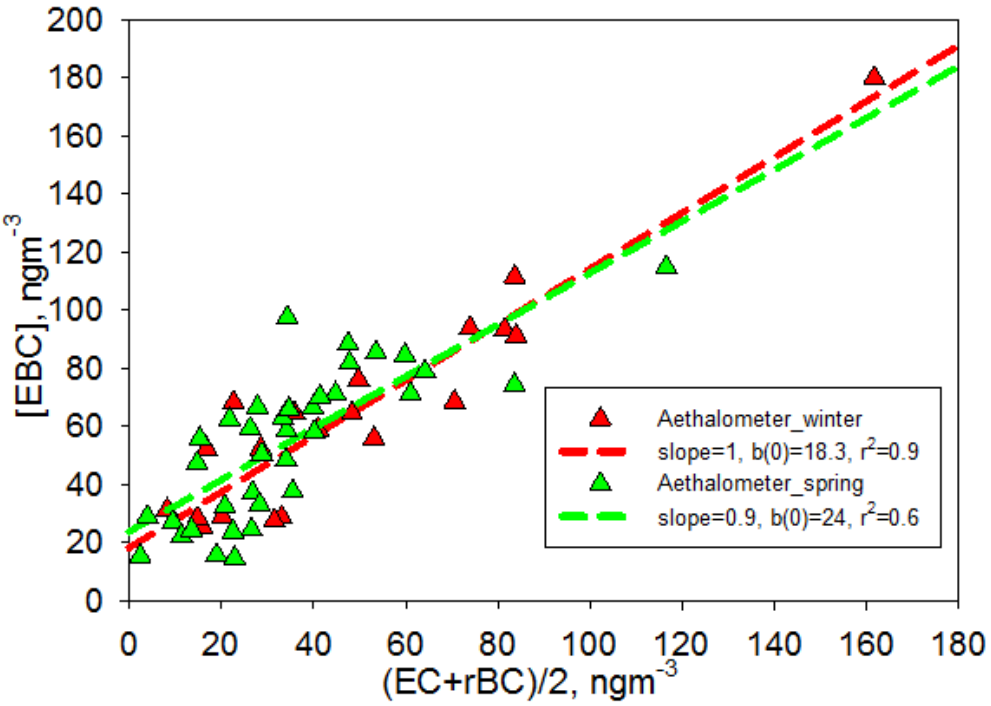
$$\left(\frac{\partial AAE}{\partial \sigma_{ap,467}}\right) = \frac{2.26}{\sigma_{ap,467}} \; and \; \left(\frac{\partial AAE}{\partial \sigma_{ap,660}}\right) = \frac{-2.26}{\sigma_{ap,660}}$$

The time series of hourly light absorption measurements from the PSAP at Alert at 550 nm wavelength is shown in Fig_Supplemental_1a. The light absorption has been corrected according to Bond et al. (1999) and also Ogren (2010) for loading and scattering interferences. Episodic increases in absorption during winter/spring reach as high as 4 Mm^{-1} and overall lower values are measured during the summer and fall. Dust and brown carbon each have strong wavelength dependences, but BC does not. The impact of non-BC light absorbing species will

appear as deviations from near unity (1.1±0.3) in the Ångstrom Absorption exponent (AAE) if the non-BC light absorbing species make up more than 40% of the BC (Lack and Langridge, 2013). At Alert, non-BC light absorbing species may include brown carbon and dust. At Alert, absorbing OC (POC, i.e. brown carbon) is more than 40% of the total absorbing carbon for most of the time. The hourly averaged AAE values between March 2011 and December 2013 are shown in Fig._Supplemental_1b. Values of AAE between 0.5 and 1.5 represent absorption primarily due to fossil fuel BC. A value near 1.0 is considered to be an example of graphitic carbon particles (Petzold et al., 2009), values between 1 and 1.5 are due to total carbon, while AAE values close to 0.5 may reflect different absorption characteristics of pure elemental carbon and increase with varying amounts of OC (Bahadur et al., 2012). There are brief episodic increases in AAE where values over two are reached, indicating the presence of non-BC absorbing aerosol, but most of the fine mode absorption measurements fall within 0.5-1.5, suggesting that EBC is the primary absorbing component with episodic influences of non-BC absorbing components. Mineral dust gives AAE values of three and larger at visible wavelengths (Petzold et al., 2009), which are not evident in Fig._Supplemental_1b.



Supplemental_Fig1: (a) Hourly aerosol light absorption measurements, σ_{ap}, at 550 nm at Alert; (b) hourly averaged Aerosol Angstrom Exponent (AAE) with uncertainty (light gray) calculated from $AAE=-\ln(\sigma_{ap}(\lambda_1)/\sigma_{ap}(\lambda_2))/\ln(\lambda_1/\lambda_2)$ where λ_1=467 nm and λ_2=660 nm and $\sigma_{ap}(\lambda_1)$ is absorption at 467 nm and $\sigma_{ap}(\lambda_2)$ is absorption at 660 nm. A value of AAE=1 is for graphite aerosol.



Supplemental_Fig-2: Improved agreements were obtained between the best estimated black carbon mass and masses obtained by optical technique such as Aethalometer (green and red triangles are for data during spring and winter). EBC Aethalometer and rBC data were averaged to EC sampling times.