APPENDIX XIII

MATES V

FINAL REPORT

Black Carbon and Elemental Carbon Comparison

Appendix XIII

Black Carbon and Elemental Carbon Comparison

XIII.1 Introduction

During MATES V, continuous black carbon (BC) monitors (i.e. AE33 Aethalometers) and 24-hr integrated speciation samplers (i.e. SASS; used to collect the particle samples that were then analyzed for EC and other major components of $PM_{2.5}$) were operated at all sites. Both samplers were operated in air-conditioned trailers through $PM_{2.5}$ inlets, approximately 10 m above the ground level and subsequently, the quartz-fiber filters were analyzed for organic carbon (OC) and elemental carbon (EC). More information about sampling procedures is available in Appendix VI.

BC concentrations are derived through a light absorption process correlated with the deposited soot particles on the filter while EC represents a thermally refractory portion of the carbon measured based on the preferential oxidation. Although EC and BC are operationally defined based on the measurement method used and are not considered measurements of the same species, they are generally highly correlated (Lack et al., 2014). A few studies have directly compared BC and EC measurements and investigated the relationship between them (Cesari et al., 2018; Jeong et al., 2004; Mousavi et al., 2018; Sharma et al., 2004). Such comparisons usually indicate satisfactory correlation coefficients but various degrees of bias (slope). This is probably related to the choice of the coefficients used to convert absorption measurements to BC estimates or to assumptions inherent in the thermal-optical methods used to measure EC and different instruments used in each study. In this appendix, the results from simultaneous EC and BC measurements are compared with each other and their correlation is investigated.

XIII.2 Results

As shown in Figure XIII-1, a comparison between the 24-hr average BC concentrations and the corresponding EC levels for all MATES V sites shows a good correlation (r^2 = 0.88). The plot also shows that there is an intercept of 365 nm/m^3 on the fitted line which shows that when the filter-based EC measurements are zero or near zero, aethalometers are measuring higher BC values. This might be due to the fact that Aethalometers are continuous monitors and have higher sensitivity at low concentrations compared to filter-based EC measurements.

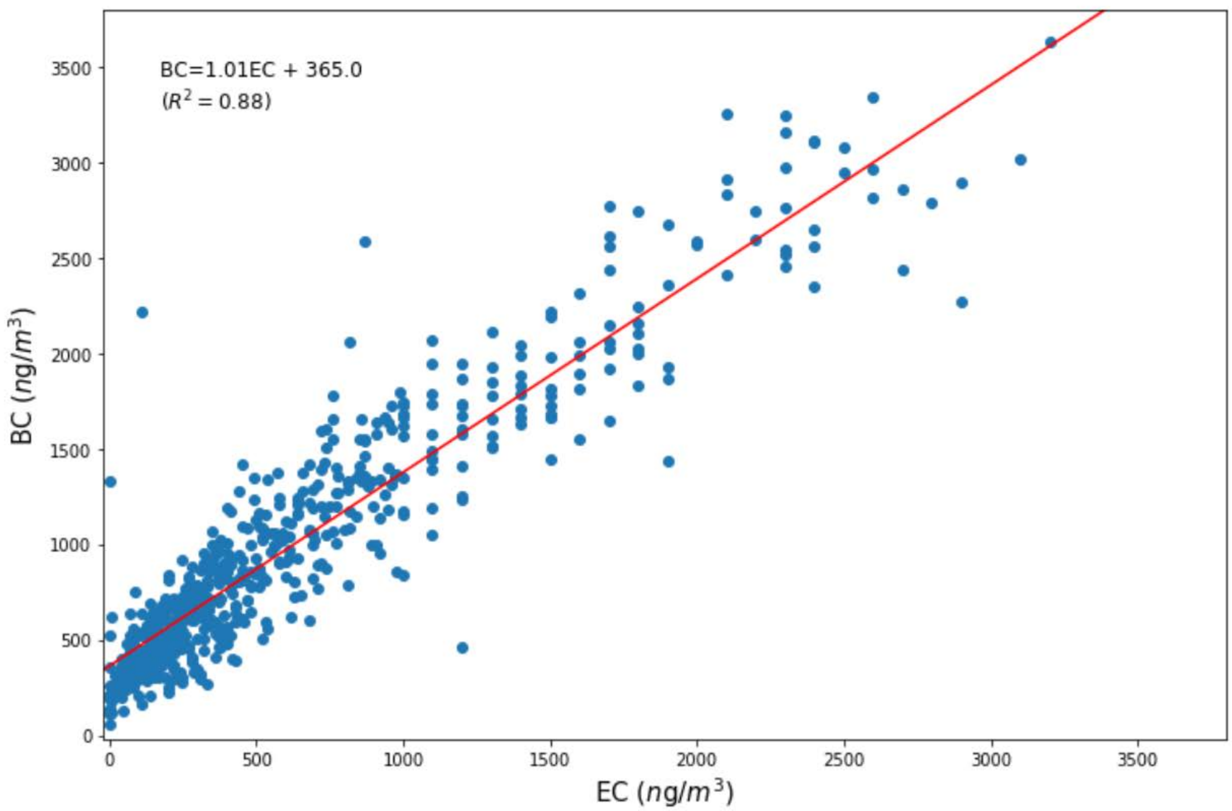

Figure XIII-1. Comparison of daily average BC and EC concentrations, measured at all stations during MATES V

Previous research has indicated that the correlation between EC and BC can be site-specific (Jeong et al., 2004). Figure XIII-2 shows the regression analysis between BC and EC measurements at each site. High correlation coefficients ($0.77 < r^2 < 0.94$) show good agreement between the two measurements at each site. The slope changes from 0.86 to 1.13 while a positive intercept is observed at each site between 231 to 493 ng/m^3. A site-specific correction factor is calculated based on actual measurements to convert the optical BC measurements to thermal-optical EC equivalents. EC is a required PM component in an attainment regional modeling approach in an Air Quality Management Plan/State Implementation Plan. However, EC measurements require a time-consuming and relatively expensive method, whereas BC measurements can be performed relatively cheaply, continuously (i.e. higher time resolution), and with much less required maintenance. Therefore, such conversions are useful information to substitute EC or to use as supporting data to substantiate EC measurements.

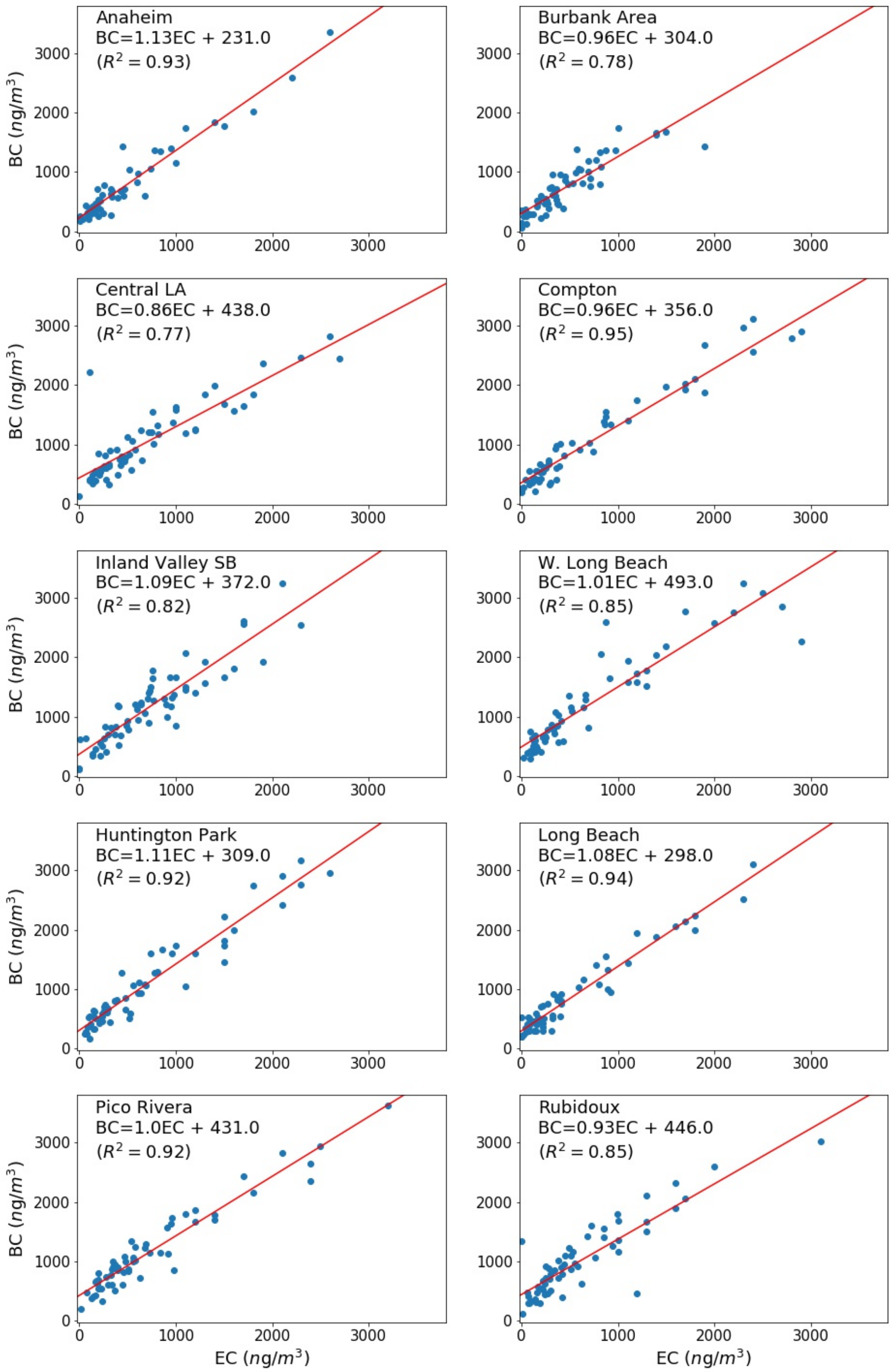

Figure XIII-2. Comparison of daily average BC and EC concentration at each MATES V site

It should be noted that the calculated fitted lines for all stations are close to the overall fitted line shown in figure VI-7 which allows applying a universal correction factor, without causing a significant deviation from unity as is shown in Figure XIII-3.

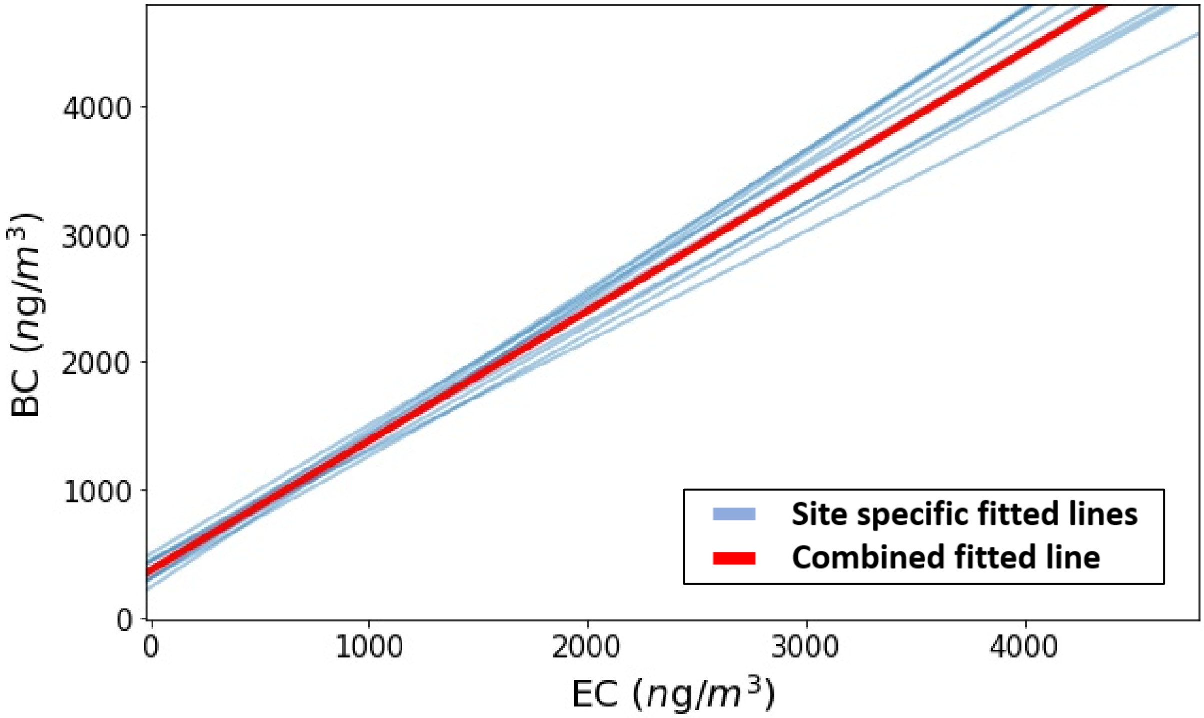

Figure XIII-3. Comparison of fitted lines between site-specific analysis (blue) and all the combined data (red) for MATES V BC and EC data correlations

Generally, particulate BC measured by the Aethalometer is a reliable surrogate for particulate EC measured by subsequent chemical analysis on the filter, especially in cases where the trends and changes of ambient BC concentrations are of interest, or in large air quality monitoring networks. The concurrent measurement of BC and EC with both optical and thermal-optical methods, however, provides additional information for identifying emission sources.

XIII.3 Summary

One of the major areas of interest in air monitoring is to evaluate continuous monitoring technologies in order to reduce the frequency and amount of filter-based technologies that are expensive and time-consuming. Aethalometers offer a tremendous opportunity to move towards more desired continuous, higher time resolution sampling (as short as 1-minute) and supplement or reduce the need for more expensive, time-consuming filter-based sampling. The comparison between filter-based EC and continuous BC concentrations measured by Aethalometer shows good agreement between the two measurements at each site and suggests that continuous BC measurement can be a reliable surrogate for particulate filter-based EC while providing higher temporal resolution and better detection limits at lower concentrations.

XIII.4 References

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