

Aethalometer: Two major issues:

1. Excessive short term thermal stability problems

5-minute data are extremely noisy with even modest temperature cycling  
(quick-fix: styrofoam cooler solution)

1-hour data are “ok”

2a. Large (~2x, more for DC) spot loading effect for “fresh soot”

==> results in under-measurement of BC and variable short term measurements (poor correlation of collocated instruments)

2b. Moderate change in response to non-BC composition of aerosol

==> under certain conditions: “sample matrix effects”  
-- enhanced response to BC



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# A Simple Procedure for Correcting Loading Effects of Aethalometer Data (IAC/AAAR Sept. 2006, St. Paul MN)

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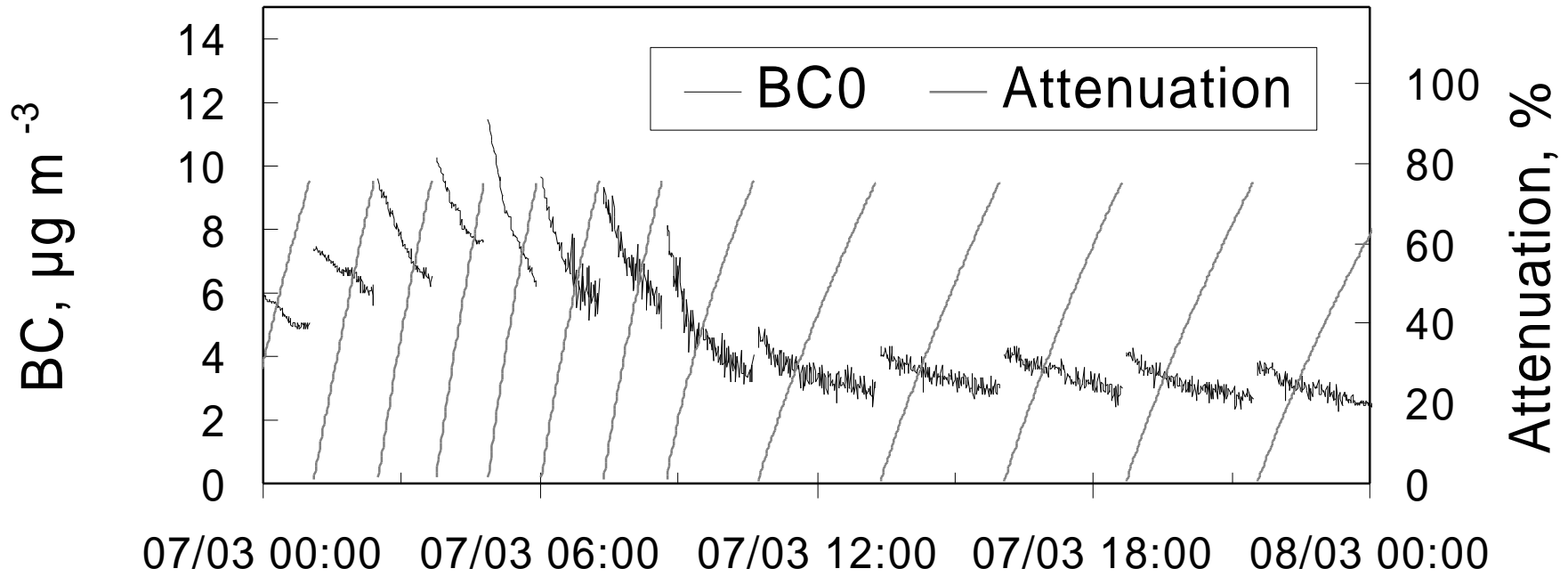
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## Motivation for the work





Aethalometer calculates BC concentration ( $\mu\text{g m}^{-3}$ ) from

$$BC = \frac{\mathbf{s}_{abs}}{\mathbf{a}_{abs}} = \frac{1}{\mathbf{a}_{abs}} \frac{A}{Q} \frac{\Delta ATN}{\Delta t}$$

$\sigma_{abs}$  = absorption coefficient ( $\text{m}^{-1}$ )

$\alpha_{abs}$  = mass absorption efficiency ( $\text{m}^2 \text{g}^{-1}$ ) - not discussed here

A = spot area ( $\text{cm}^2$ )

Q = flow rate (LPM)

$\Delta ATN$  = change of attenuation in time  $\Delta t$

However:

It is well known, that the relationship between *ATN* change and BC concentration is not linear (e.g., Weingartner *et al.*, 2003; Arnott *et al.*, 2005)



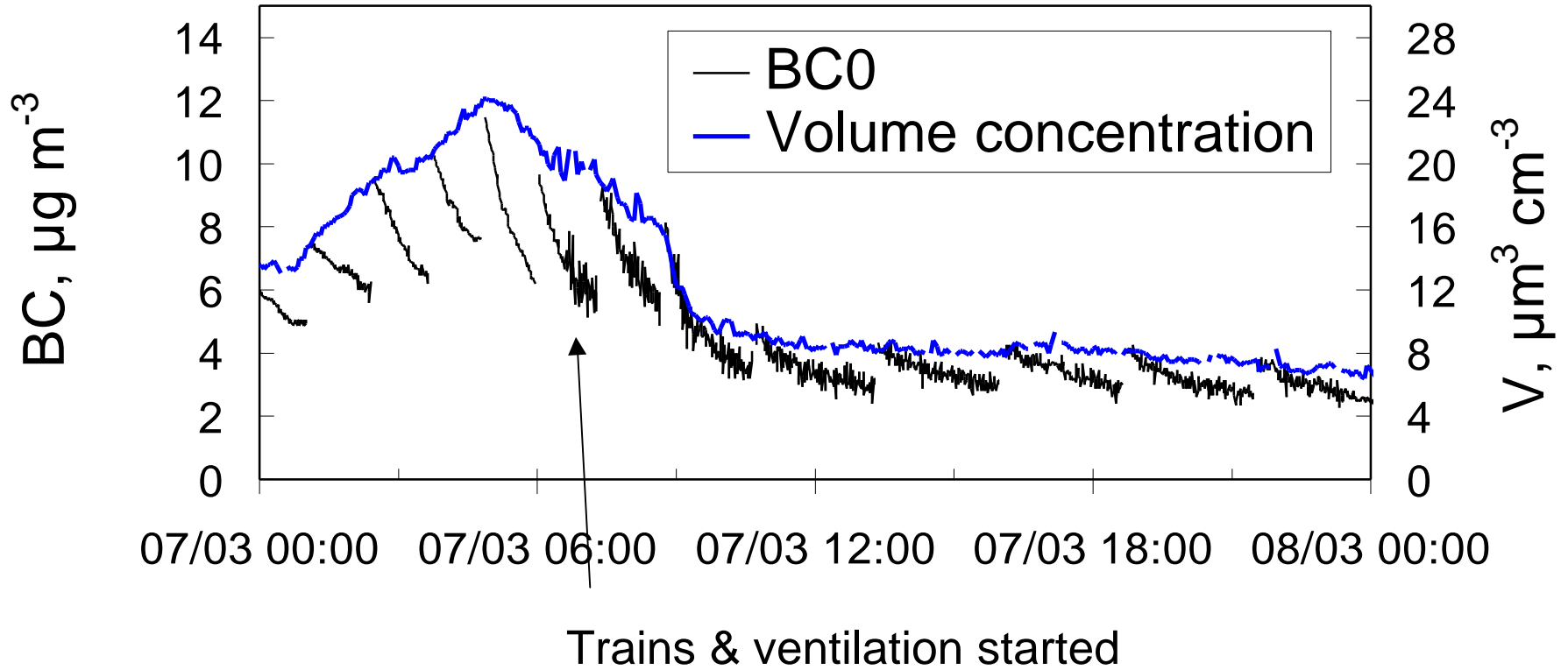
After the filter spot has been changed the first  $ATN \sim 0$  so

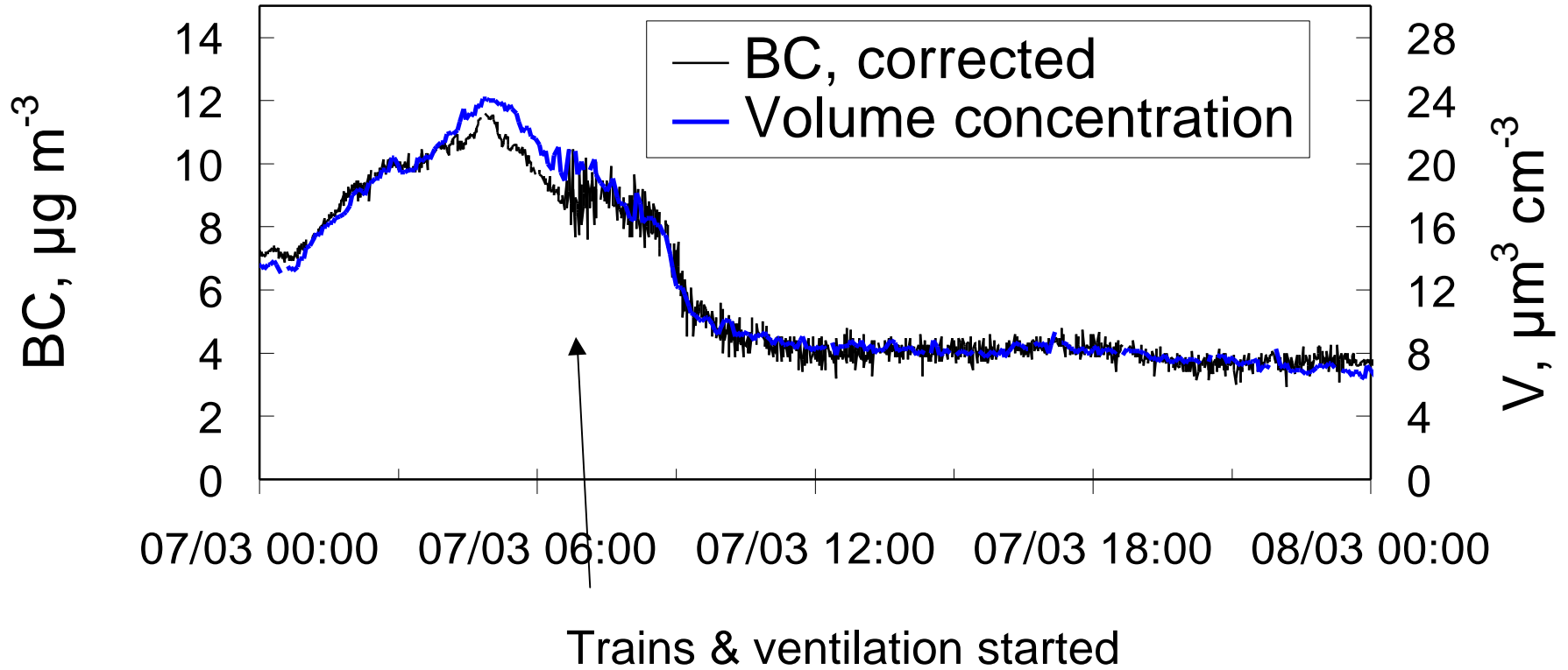
$$BC_{CORRECTED}(t_{i,last}) = BC_{NON-CORRECTED}(t_{i+1,first})$$

and we can solve

$$k_i = \frac{1}{ATN(t_{i,last})} \left( \frac{BC_{NON-CORRECTED}(t_{i+1,first})}{BC_{NON-CORRECTED}(t_{i,last})} - 1 \right)$$

$k_i$  is then used for correcting all data obtained for filter spot  $i$





**Table 1. Linear least squares slope of hourly BC vs SUNSET EC at the South Bronx.**

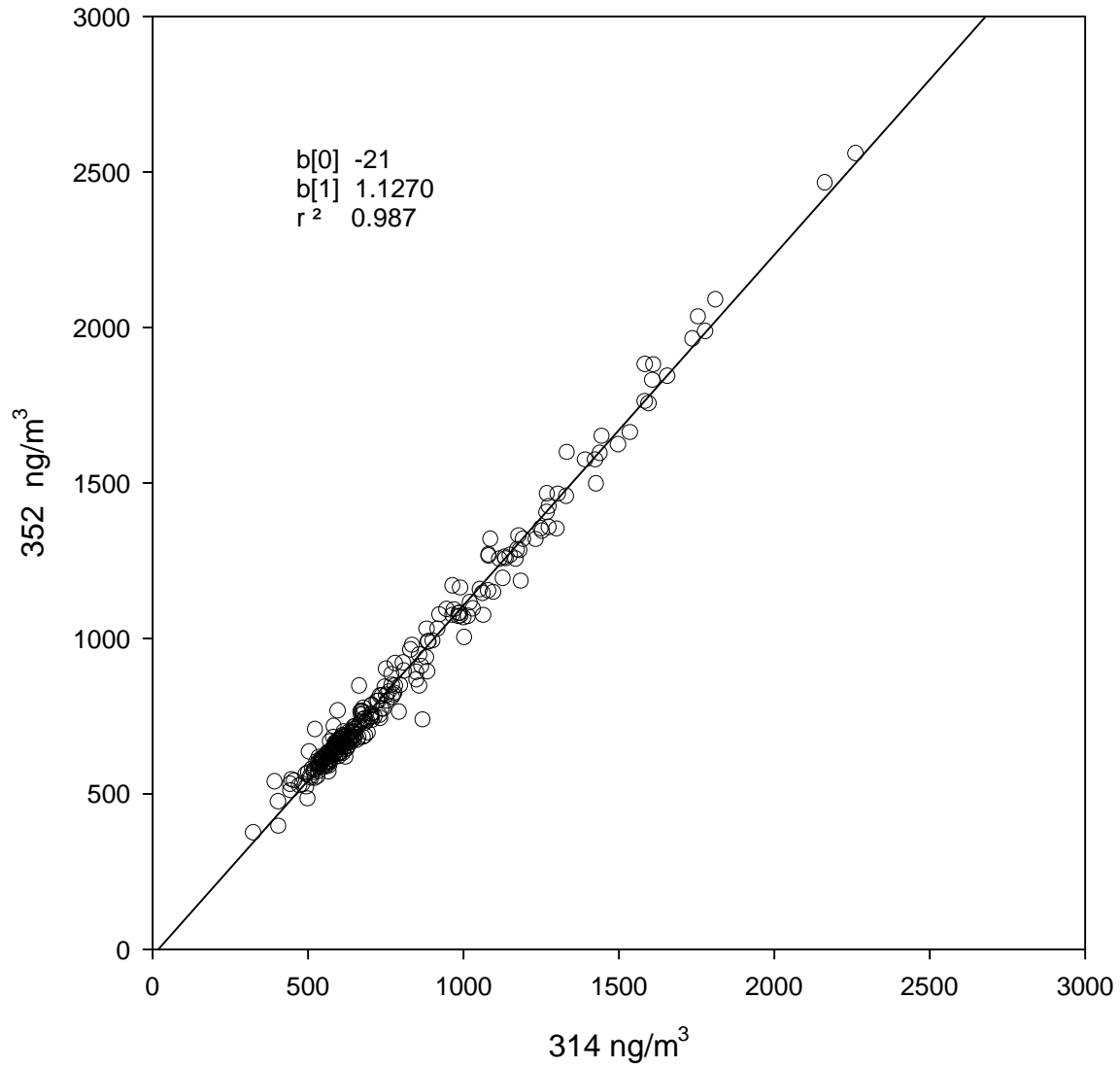
Hourly Aethalometer BC is highly correlated with Sunset EC with  $R^2 > 0.7$ . However, from April to October BC is biased approx. 30% higher than EC whereas, from November to March BC is equal or lower than EC.

BC vs EC	slope	R2
Jul-05	1.3	0.9
Aug-05	1.2	0.86
Sep-05	1.2	0.86
Oct-05	1.19	0.7
Nov-05	1.02	0.78
Dec-05	0.82	0.78
Jan-06	0.98	0.81
Feb-06	1.05	0.88
Mar-06	1.03	0.83
Apr-06	1.4	0.76
May-06	1.31	0.85
Jun-06	1.31	0.85
Jul-06	1.39	0.85

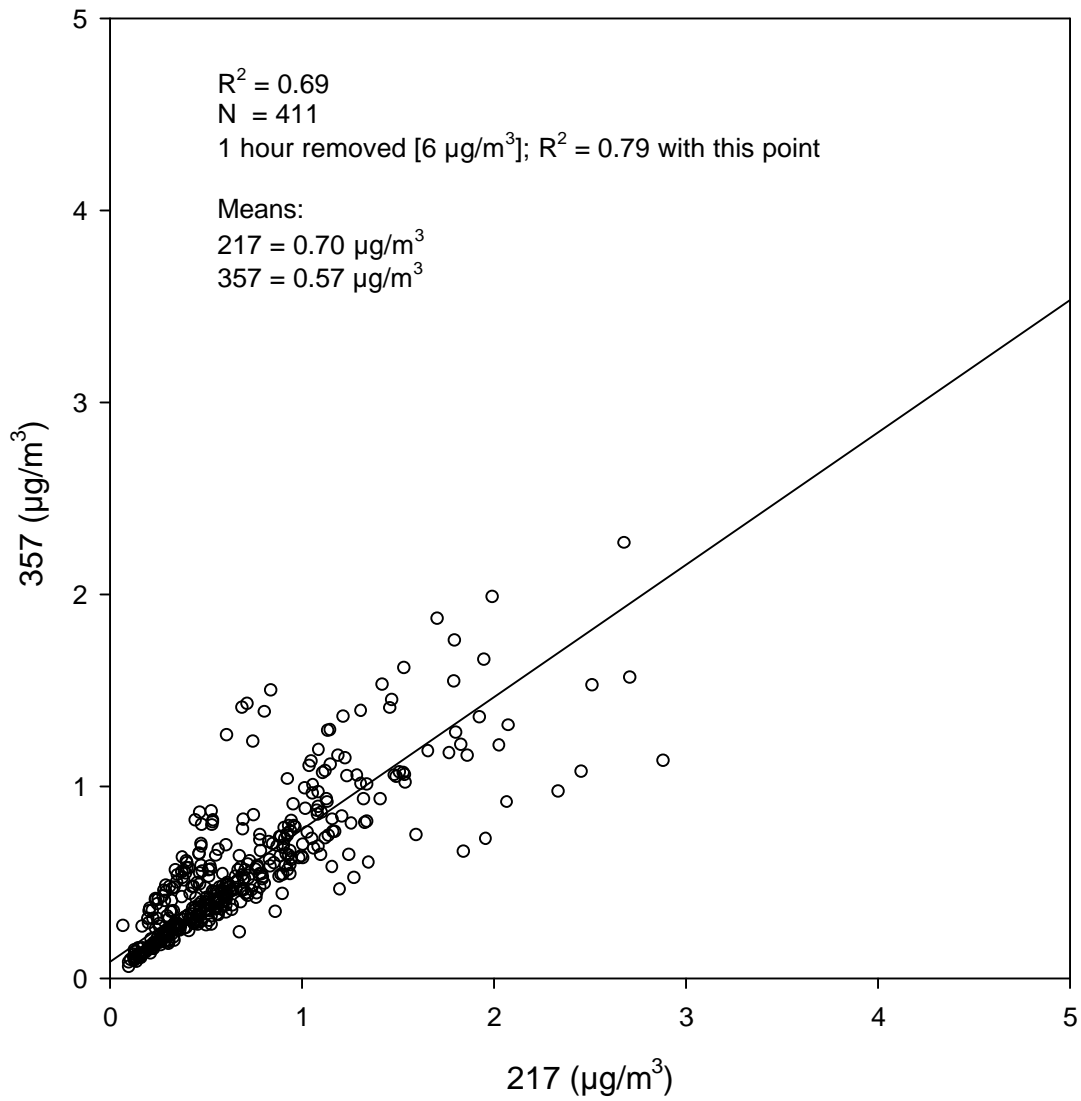
Source: Oliver Rattigan, NY-DEC



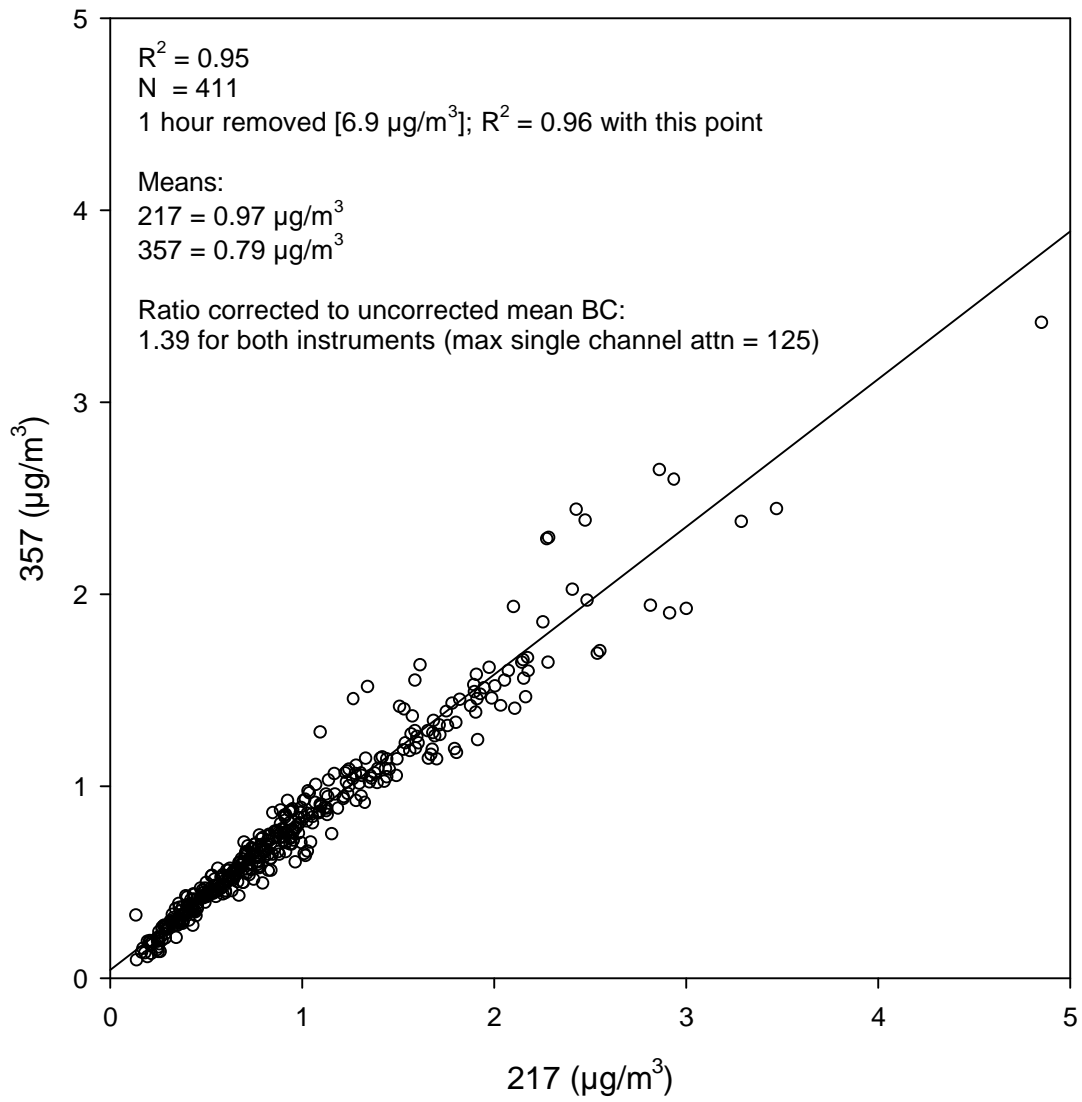
352 vs 314, 5-min data  
May 2002, suburban Boston



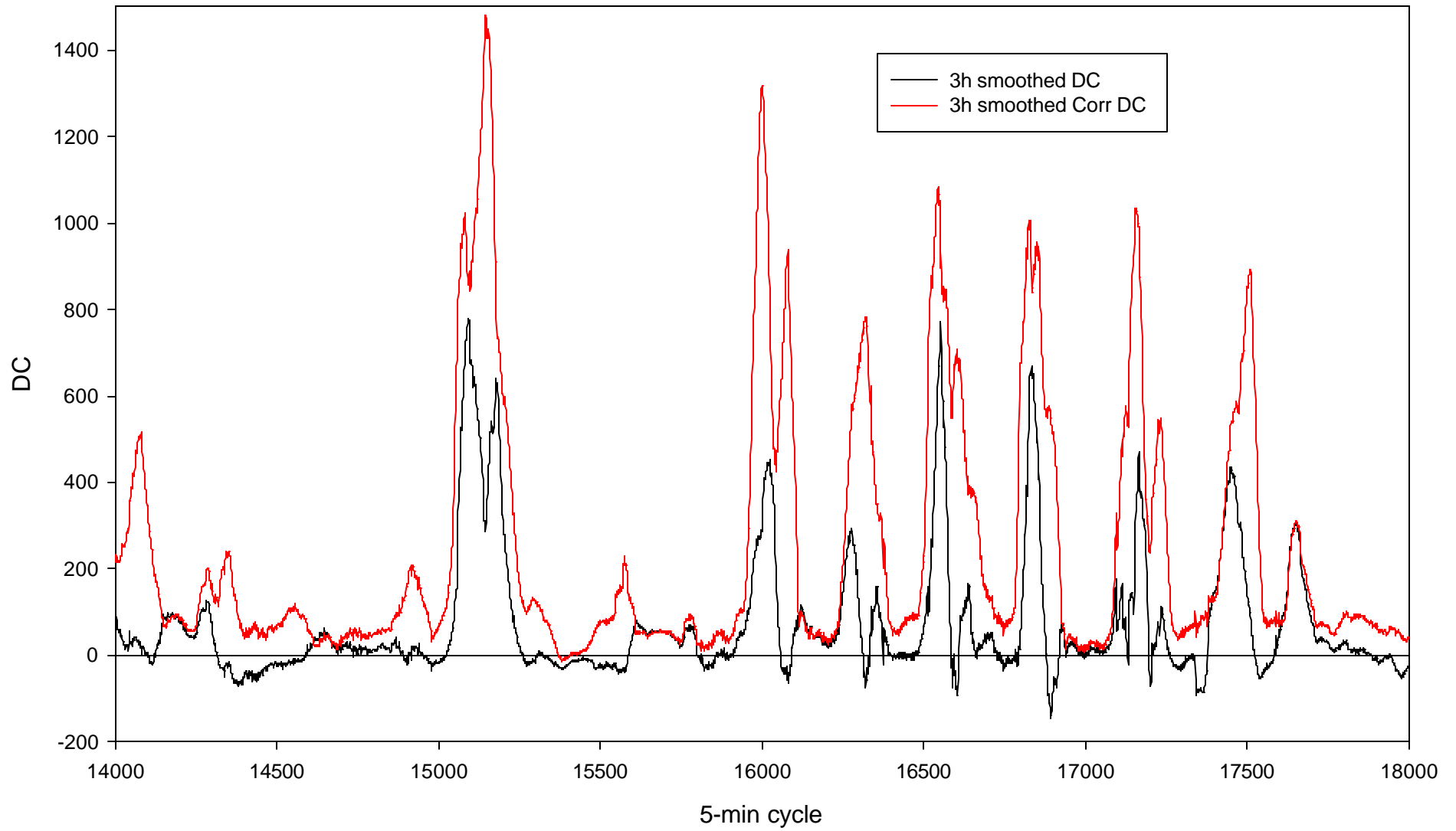
BC Collo, AMC Boston Site, Dec-Jan 03-04 1-hour means  
No Correction for filter spot saturation



BC Collo, AMC Boston Site, Dec-Jan 03-04 1-hour means  
With Fixed-Value Virkkula Correction



# Rutland, Winter-Spring 2004



How much can these Aethalometer measurement matrix effects be reduced while keeping the method reasonably simple?

1. Completely eliminated if the aerosol is fresh and mostly black
- 2a. Partially eliminated if the aerosol has lots of white-ish particles (BC is over-estimated from enhanced scattering)
- 2b. Drying the sample when ambient dewpoint is high should reduce the over-estimate.

Details: Las Vegas Presentation at

<http://tinyurl.com/22fcub>