Analysis of Spatial and Temporal Trends of Black Carbon in Boston

A 2008 Community-Scale Air Toxics Ambient Monitoring Grant Project
In Cooperation with MassDEP

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Introduction

Black Carbon Soot (BC): indicator of urban diesel PM

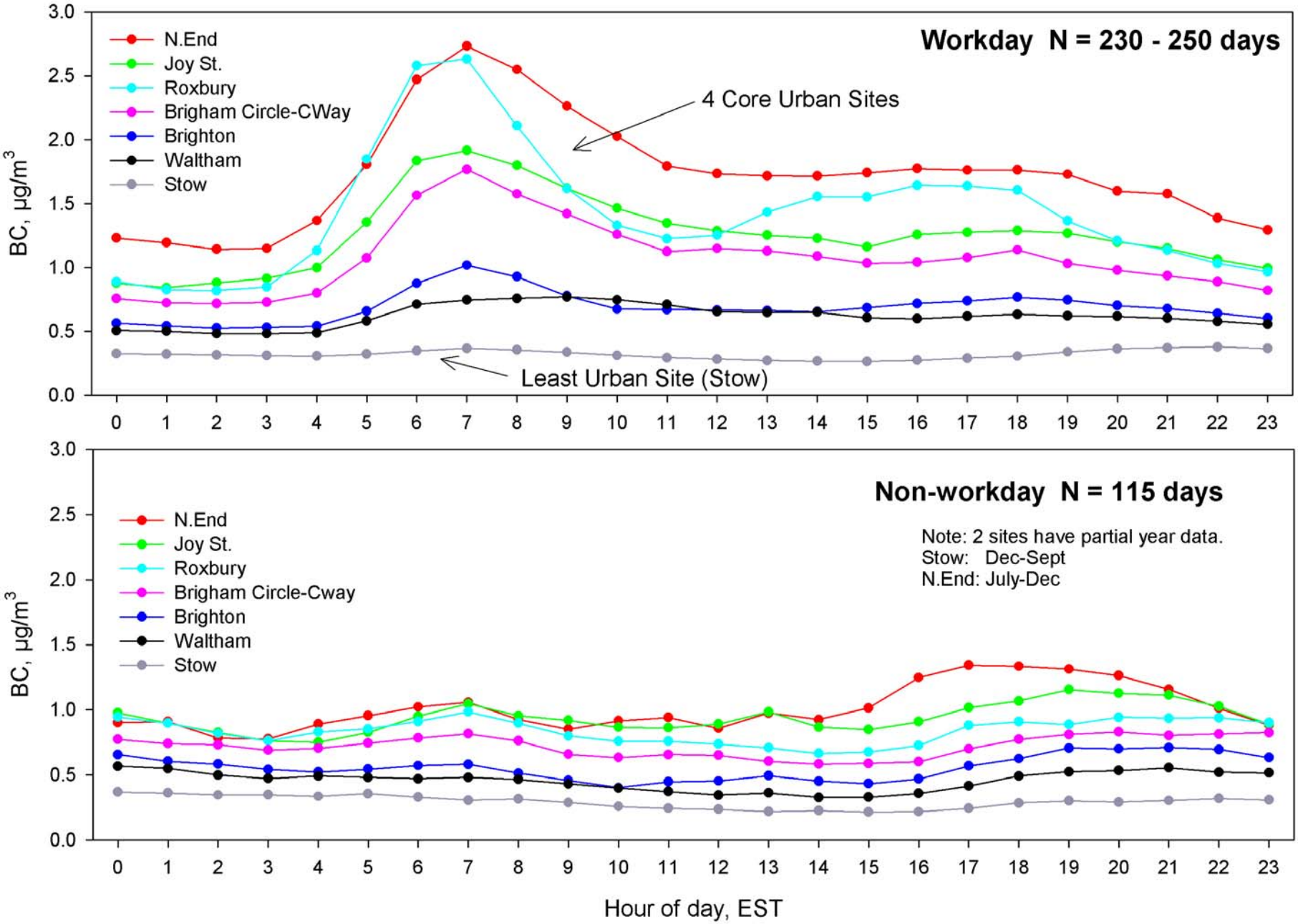
Easily measured with optical methods (Aethalometer)
- High time resolution (1 to 5 minutes)

Boston, MA: long history of BC data (1999)
- Multiple sites (MassDEP, Harvard-Chan School of Public Health)

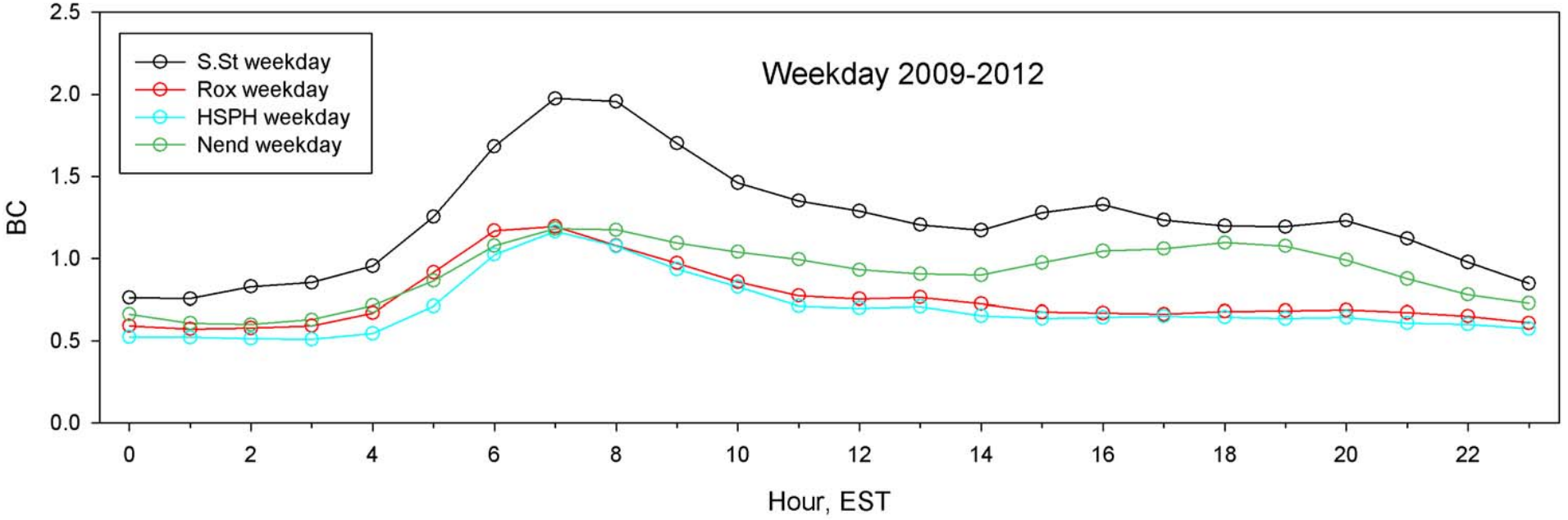
Original work: assess spatial scale of urban BC “bubble”
- 2003 7-site study
- Reprocess data with current methods (spot loading correction)

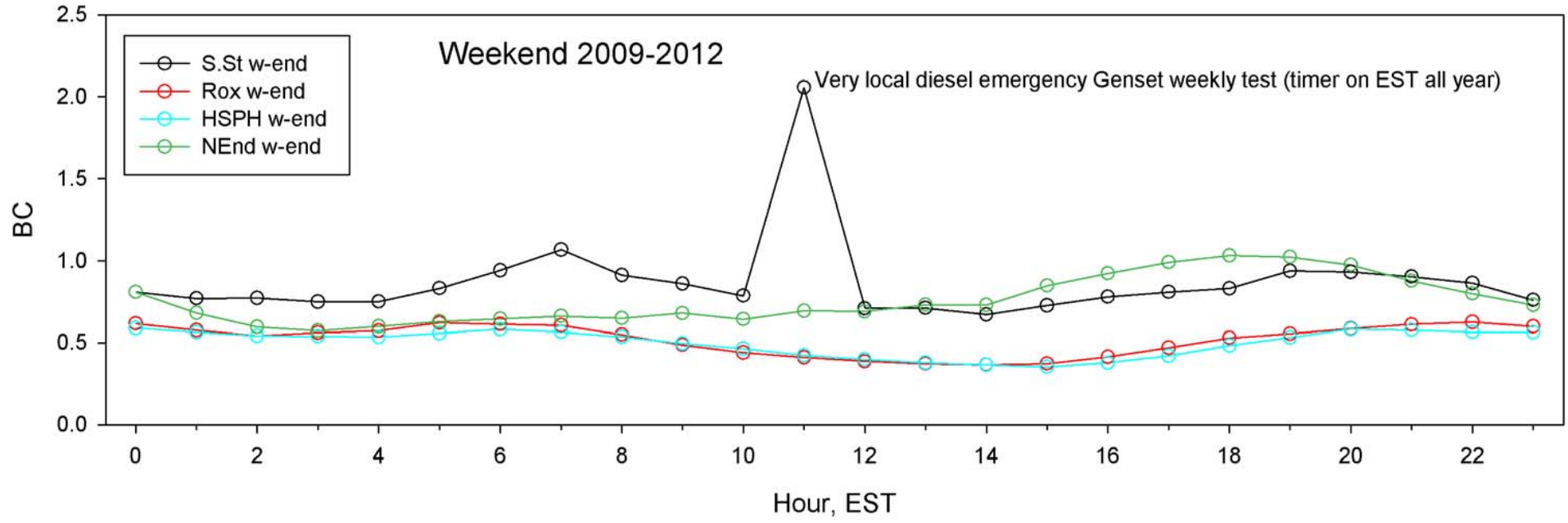
New work: trends of urban Boston BC 1999-present
- Effect of diesel control programs?

2003 Diurnal Plot of BC at Seven Core Sites (reprocessed)



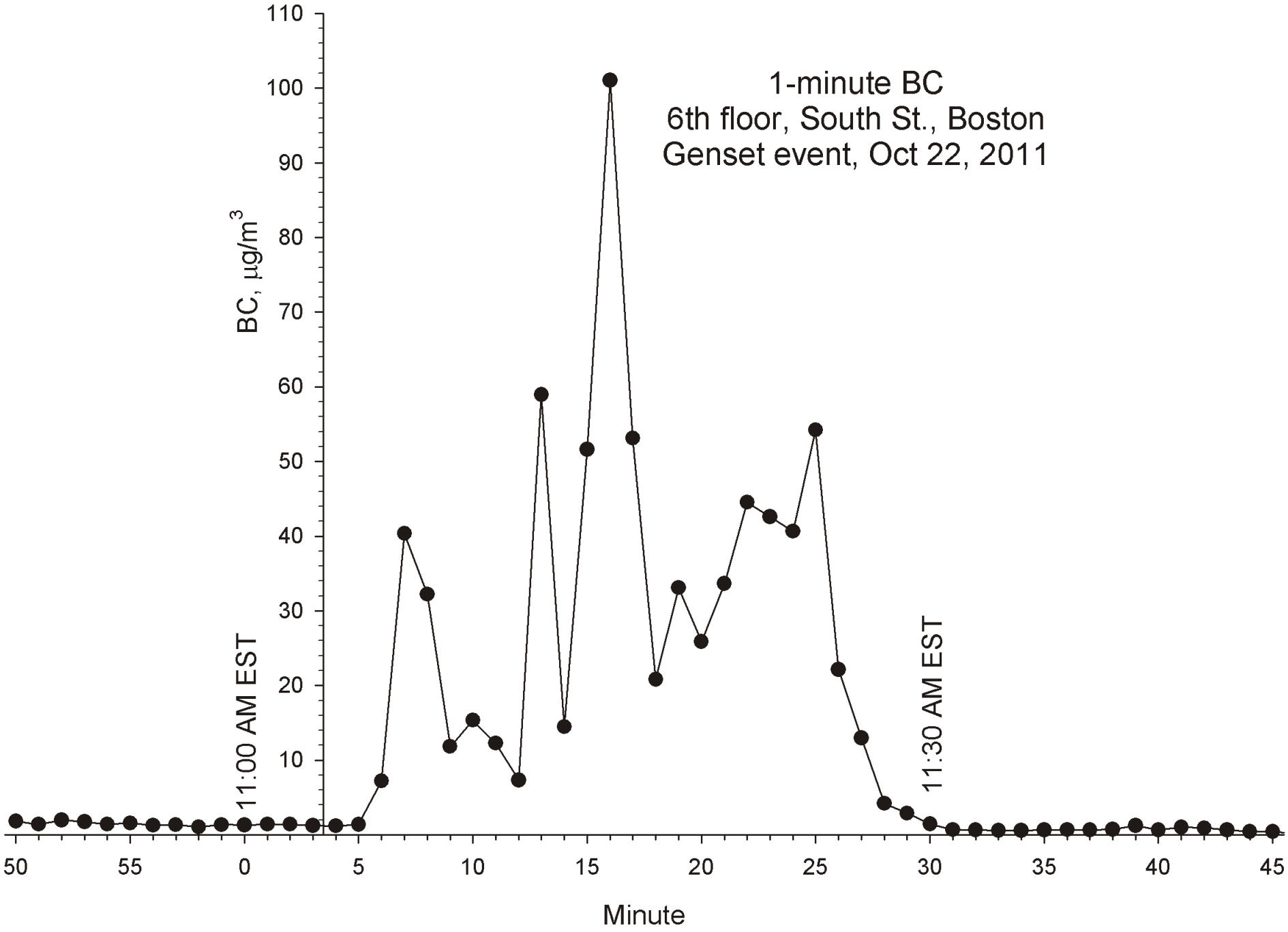
Updated Boston Diurnal Plots: 2009-2012





South St. Boston: very local BC source Sat. 11am EST:

Emergency Genset BC Event (South St. Site)

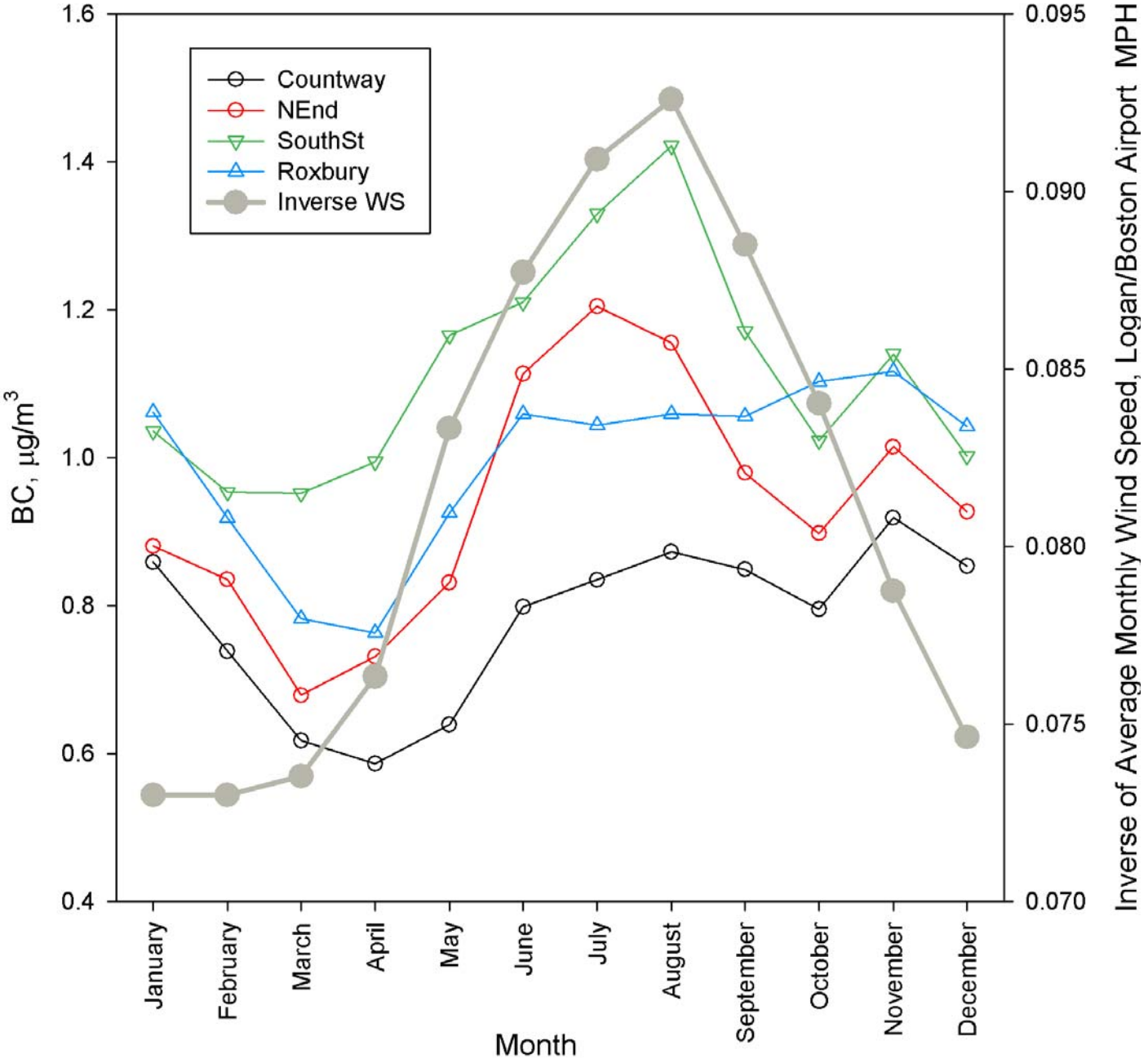


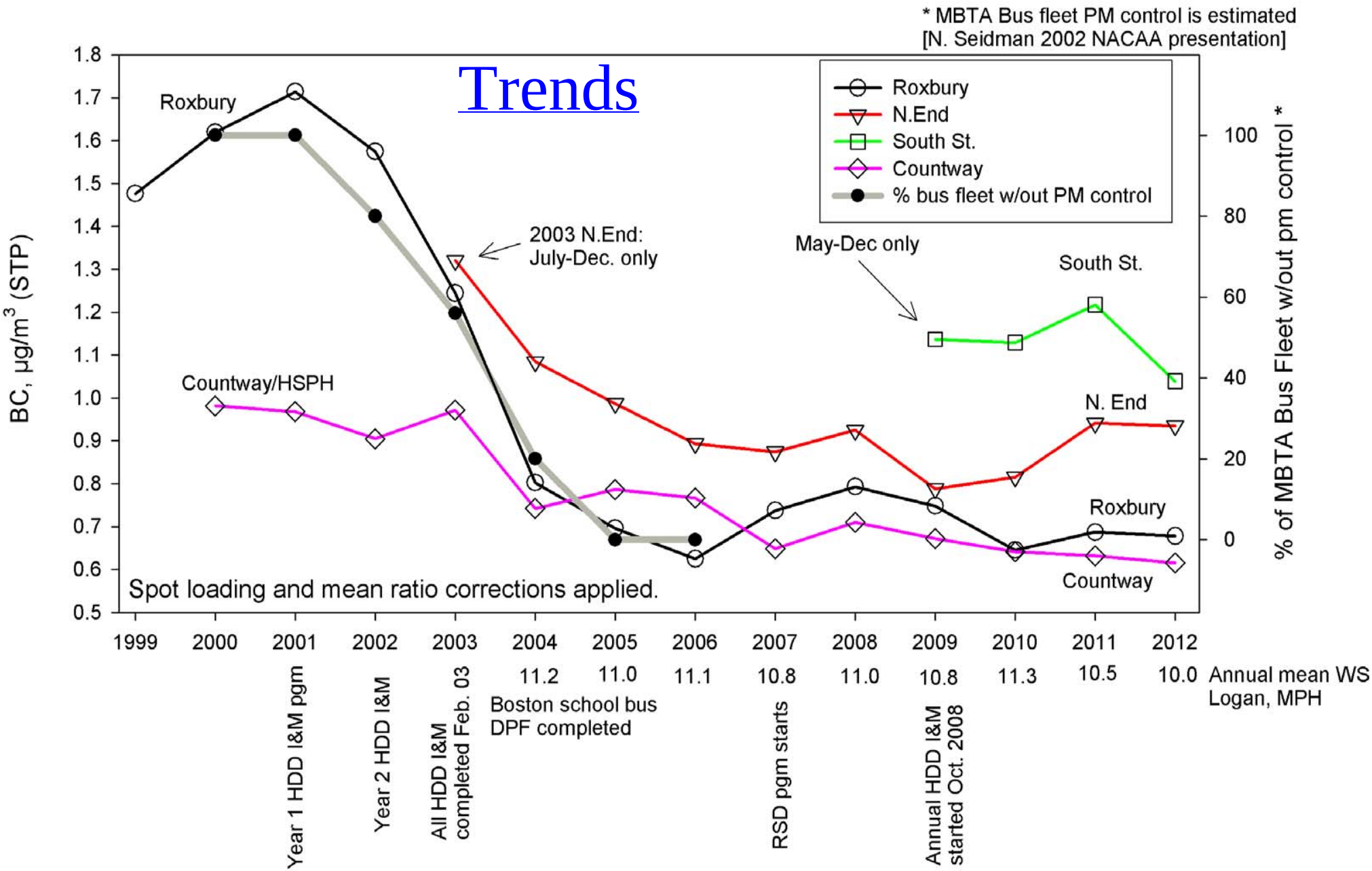
Boston Seasonal BC Patterns

BC higher in Summer! (conventional wisdom says winter)

Seasonal pattern apparently driven by wind speed

Lower WS in summer: poorer dispersion





Dramatic 2002 to 2004 BC decrease: huge school and city bus fleet cleanup

2 Qs: Why South St. highest? -and- Why no/little trend since 2005?

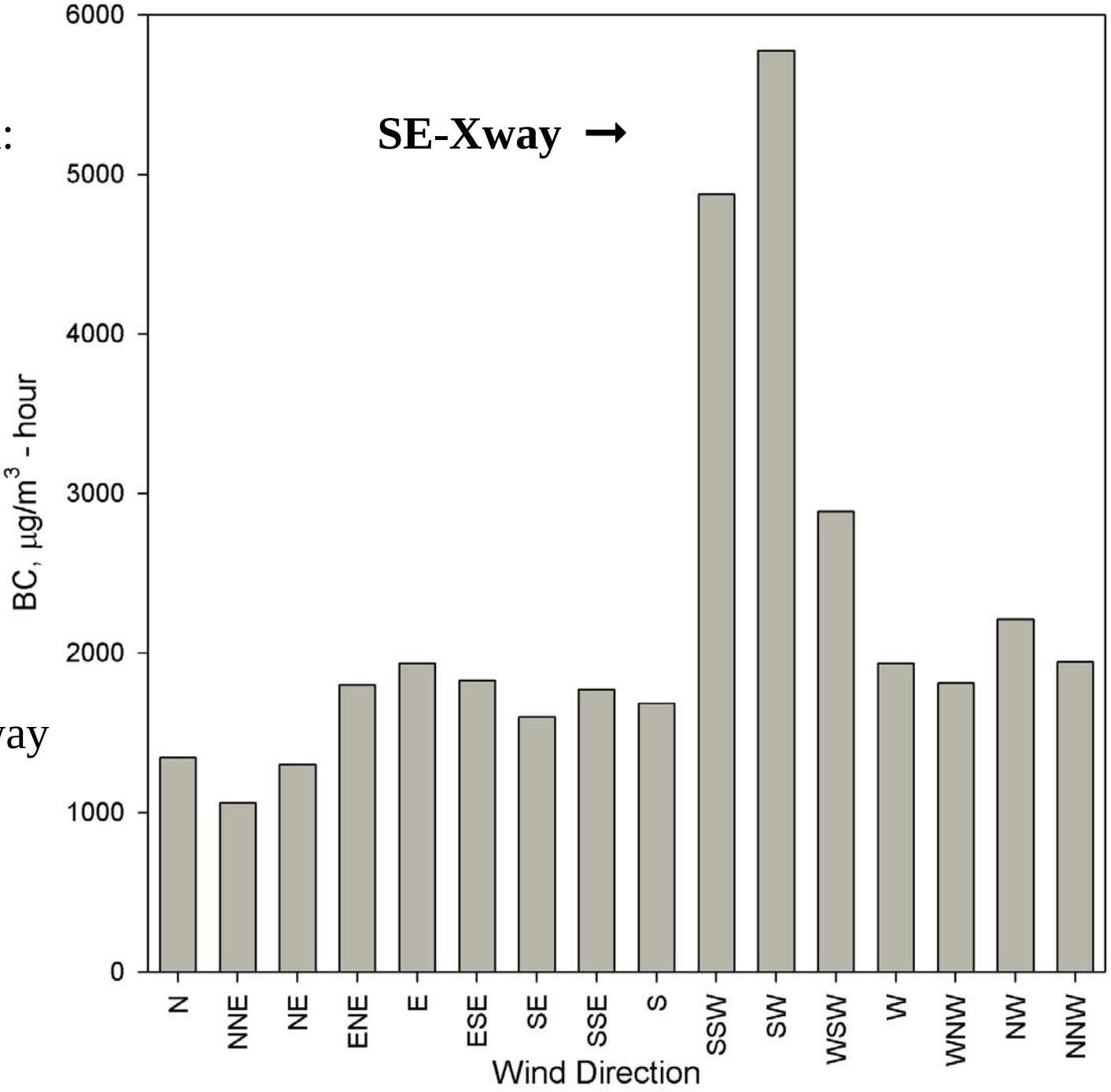
Why is South St. BC Highest?

Direction that dominates average BC concentration:
SSW to SW

Prevailing winds:
SSW to SW

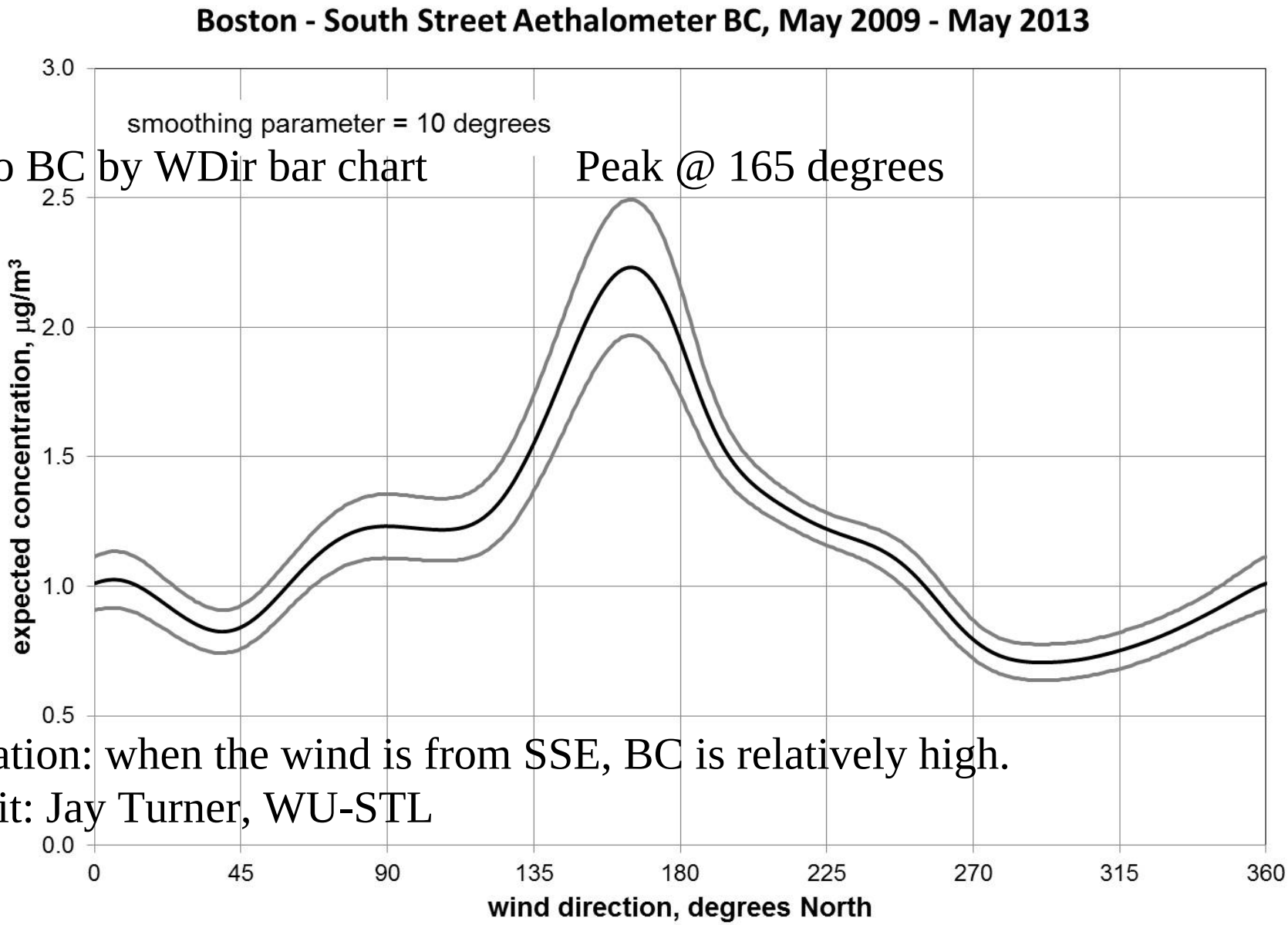
I-93 / Southeast Expressway
180,000 AADT

South St. BC * Hour
By Wind Direction



Nonparametric Wind Regression: Source Identification Analysis:

10° weighted window is slid across the wind direction coordinates



Similar to BC by WDir bar chart Peak @ 165 degrees

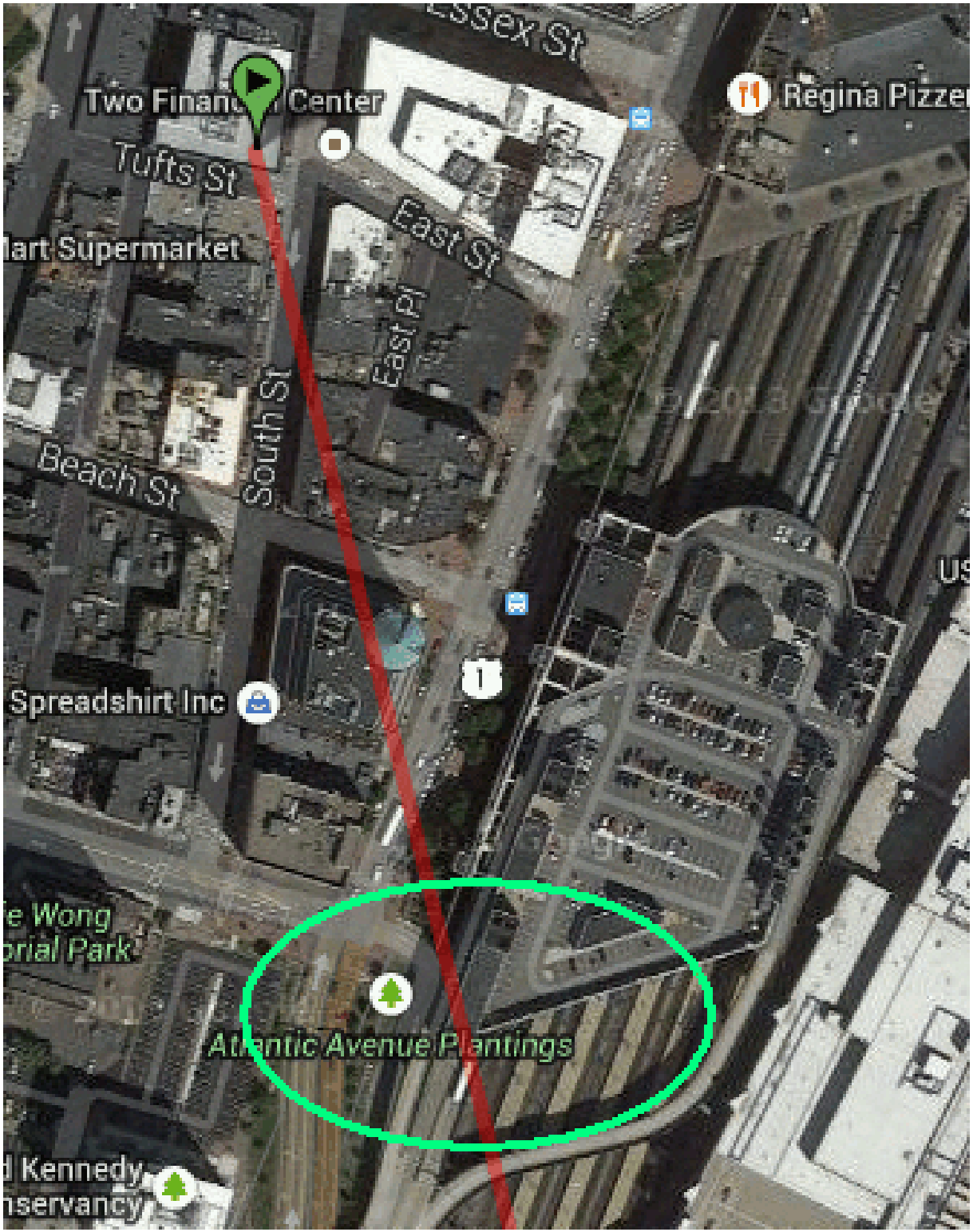
Interpretation: when the wind is from SSE, BC is relatively high.

Credit: Jay Turner, WU-STL

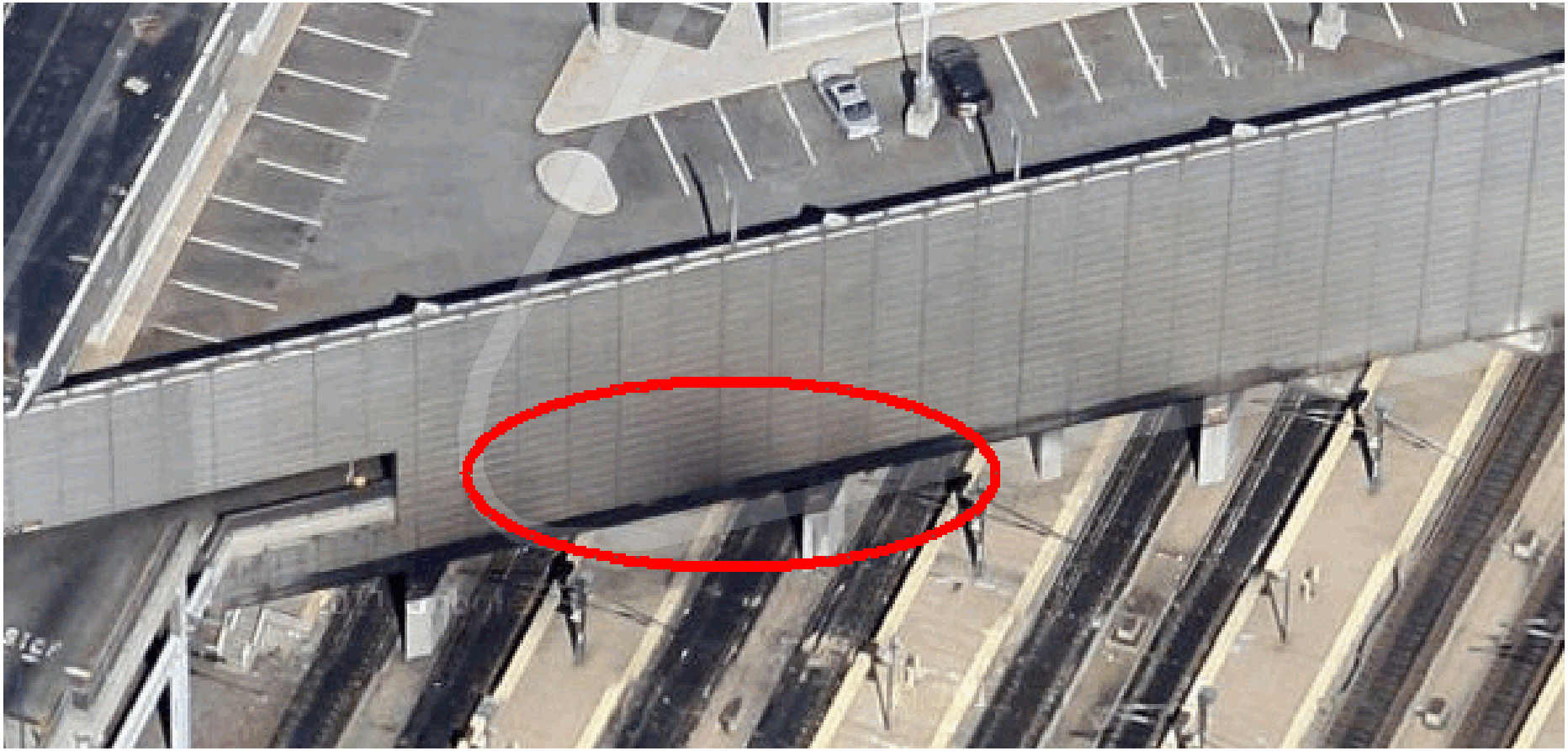
What's 165 deg.
from this site
(my office)?

South Station garage / soot vacuum cleaner

Inter-city buses and commuter rail 2-cycle HDD locos

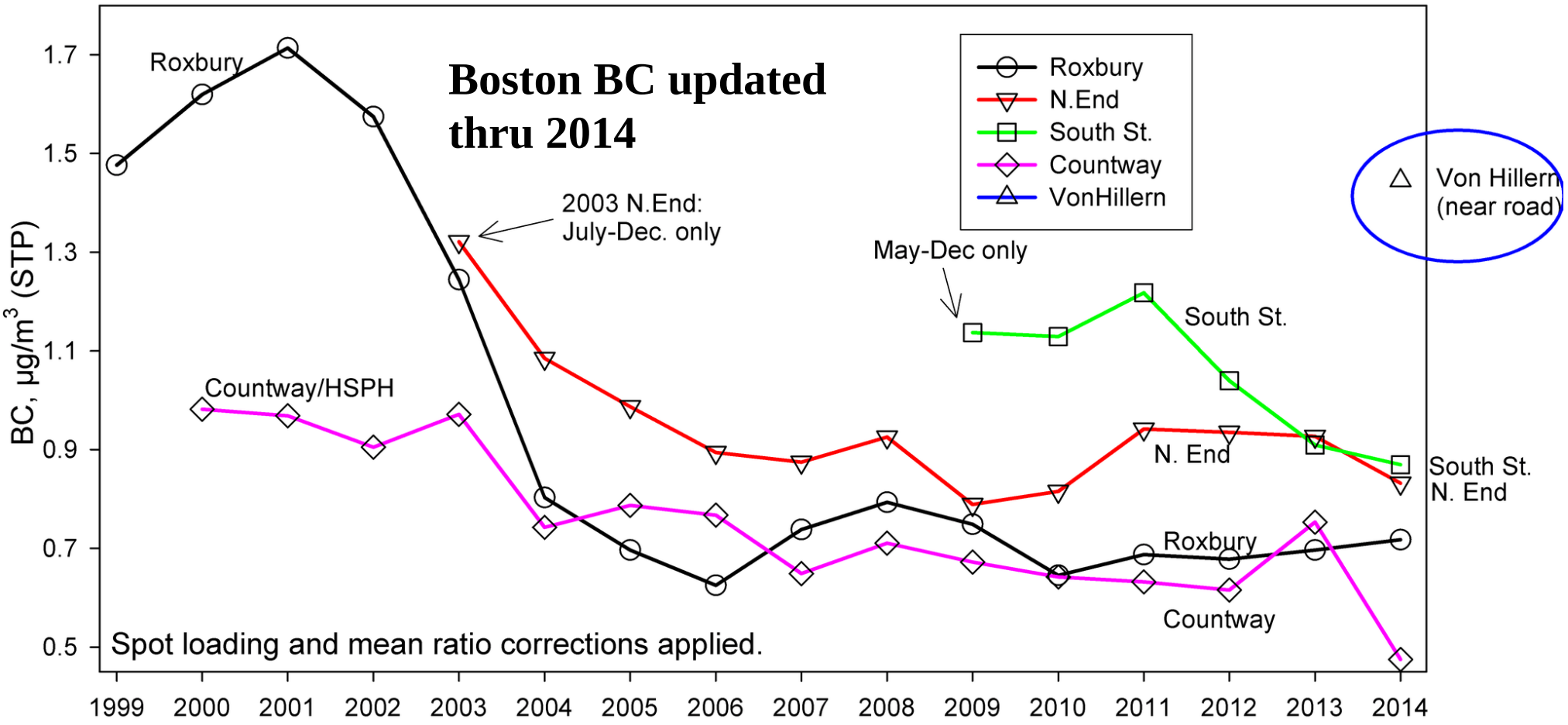


165 Degrees: South Station Garage wall - Loco Soot



Close up of wall, taken Summer 2014:

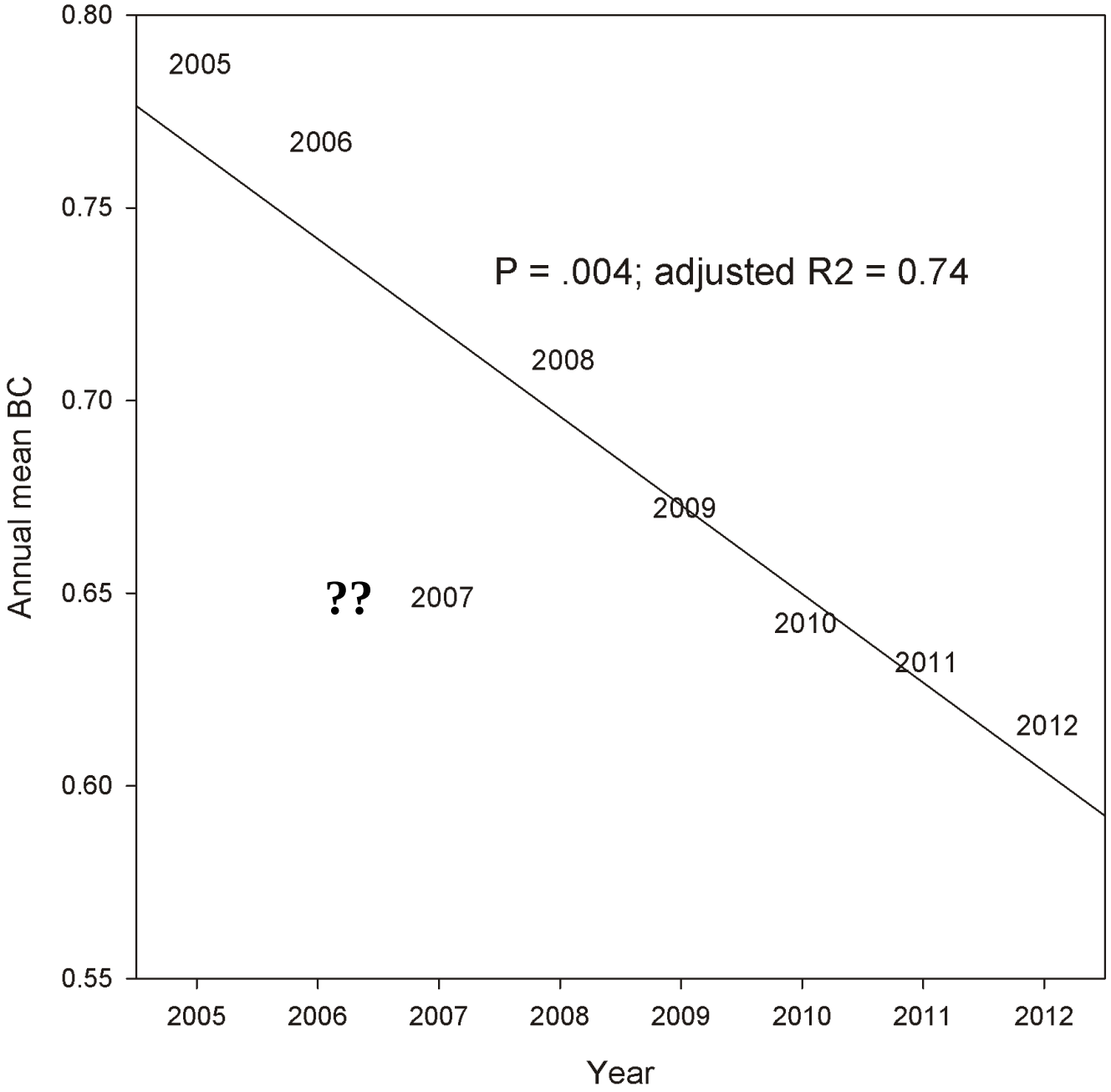
Q. #2: Why no long-term trend post-bus cleanup?



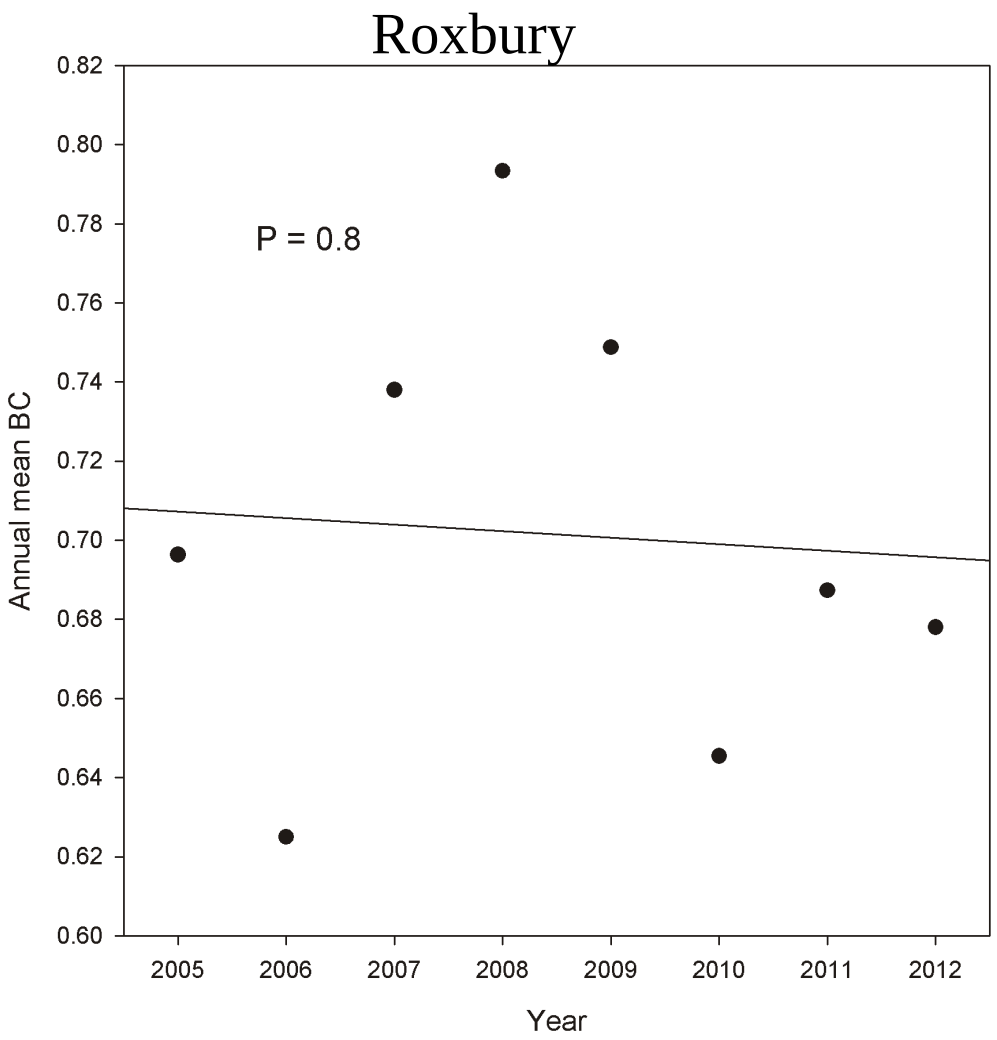
2014 update:

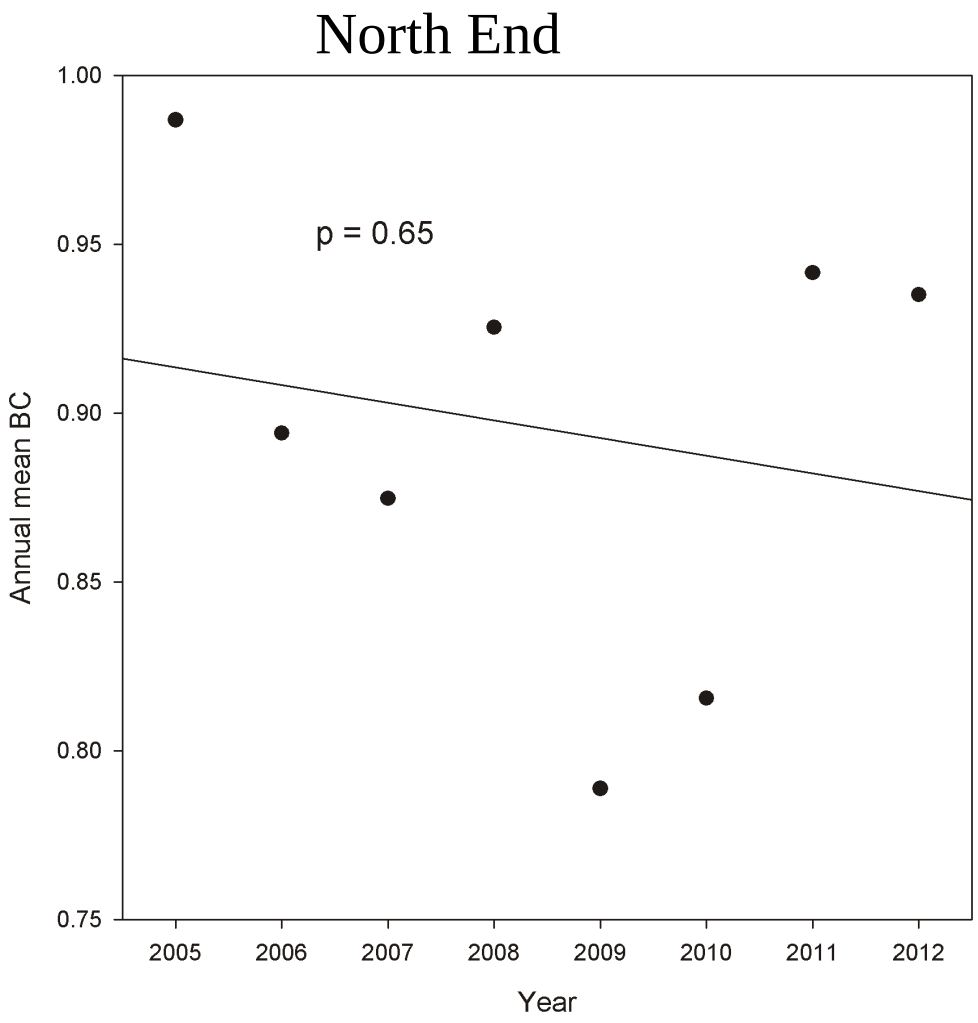
- Roxbury and N.End still flat
- South St. BC comes down to N.End
- Countway/HSPH has 2013 local source influence
- Von Hillern (near-road site) similar to Roxbury 15 years ago

HSPH/Countway BC Trend 2005 - 2012 (after 2002 - 2004 retrofit cleanup)



BC Trend Regressions, 2005-2012 Annual Means





Very different trend pattern compared to HSPH

1.8 km apart, both urban scale sites with similar mean BC (0.7 µg/m3)

Summary:

Substantial BC spatial gradient from core urban to background
    on average: 4x higher (2003 data)

City transit bus and City school bus retrofit programs:
    Dramatic BC drop 2002-2004
    Effective control strategy / accountability demonstration

BC trends since then: mostly flat
    Why? 5-site urban BC monitoring continues...

Urban BC: associated with time of day / day of week traffic patterns
    Sources: commuter rail, highway, local traffic

Large point sources of BC: emergency diesel gensets
    large short-term spikes of BC

Acknowledgments.

- US EPA and MassDEP for funding
- MassDEP for Roxbury, N.End, and Von Hillern BC data
- Harvard-Chan School of Public Health for Countway BC data

EPA AMTIC Link to Full Report:
http://www.epa.gov/ttn/amtic/files/20072008csatam/bostonbcreport.pdf

Got Soot? Rollin' Coal...
(Prius Repellant)