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

George Allen, NESCAUM
gallen@nescaum.org

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Introduction.

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

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

- Boston: long history of BC data (1999)
  Multiple sites (MassDEP, HSPH)

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

- Newer Q: trends of urban BC 1999-present
  Effect of diesel control programs?
2003 Diurnal Plot of Seven Core Sites.

**Workday** \( N = 230 - 250 \) days

- N.End
- Joy St.
- Roxbury
- Brigham Circle-CWay
- Brighton
- Waltham
- Stow

4 Core Urban Sites

Least Urban Site (Stow)

**Non-workday** \( N = 115 \) days

Note: 2 sites have partial year data.

- Stow: Dec-Sept
- N.End: July-Dec

BC, \( \mu g/m^3 \)

Hour of day, EST
Updated Boston Diurnal Plots: 2009-2012

Weekday 2009-2012

Weekend 2009-2012

Very local diesel emergency Genset weekly test (timer on EST all year)
South St. Boston very local BC source Sat. 11am EST:

Next-Door Genset exhaust:
Trends

2 Qs: Why South St. highest? -and- Why no/little trend since 2004/2005?
South St. 1-hour BC Pollutant Rose
< 4 µg/m³

Clear null to SSE
(wind seldom from that direction)
South St. BC times Hour by Wind Direction.

Direction of source that dominates average BC concentration.
Nonparametric Wind Regression for Source Identification Analysis:

10° weighted window is slid across the wind direction coordinates

**Boston - South Street Aethalometer BC, May 2009 - May 2013**

*smoothing parameter = 10 degrees*

*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 HDD locos)
165 Degrees: South Station Garage wall - Loco Soot
Why no long-term trend – post-HDD cleanup?

2013 update:
Roxbury and N.End flat
South St. BC comes down to N.End
Countway/HSPH has local source influence
P = .004; adjusted R² = 0.74
BC Trend Regressions, 2005-2012 Annual Means

Roxbury

North End

Why no trend at these sites?
(Story to be continued...)
Conclusions.

- City transit bus and school bus retrofit programs: dramatic BC drop 2002-2004

- BC trends since then: mostly flat
  Why?

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

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

- Point sources of BC: emergency diesel gensets large short-term spikes of BC
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EPA AMTIC Link to Full Report:
http://www.epa.gov/ttn/amtic/20072008_CSATAM.html

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