

Delaware's Experience with Continuous PM2.5 Monitoring – ThermoFisher SHARP

OR

*In Search of a (Statistically)
Meaningful Relationship*

Betsy Frey, Delaware Air Quality Mgmt
MARAMA Monitoring Meeting
November 18, 2008

Delaware's Experience with Continuous PM2.5 Monitors

- 2003 Thermo Andersen BAMs at four sites
 - VSSC PM2.5 inlet, 35° C temp
- 2006 incorporated “smart” heater firmware upgrade, seasonal adjustment
- July 2007 installed SHARP Model 5030 hybrid nephelometer/BAM at urban Wilmington site (MLK)

Other monitors on site

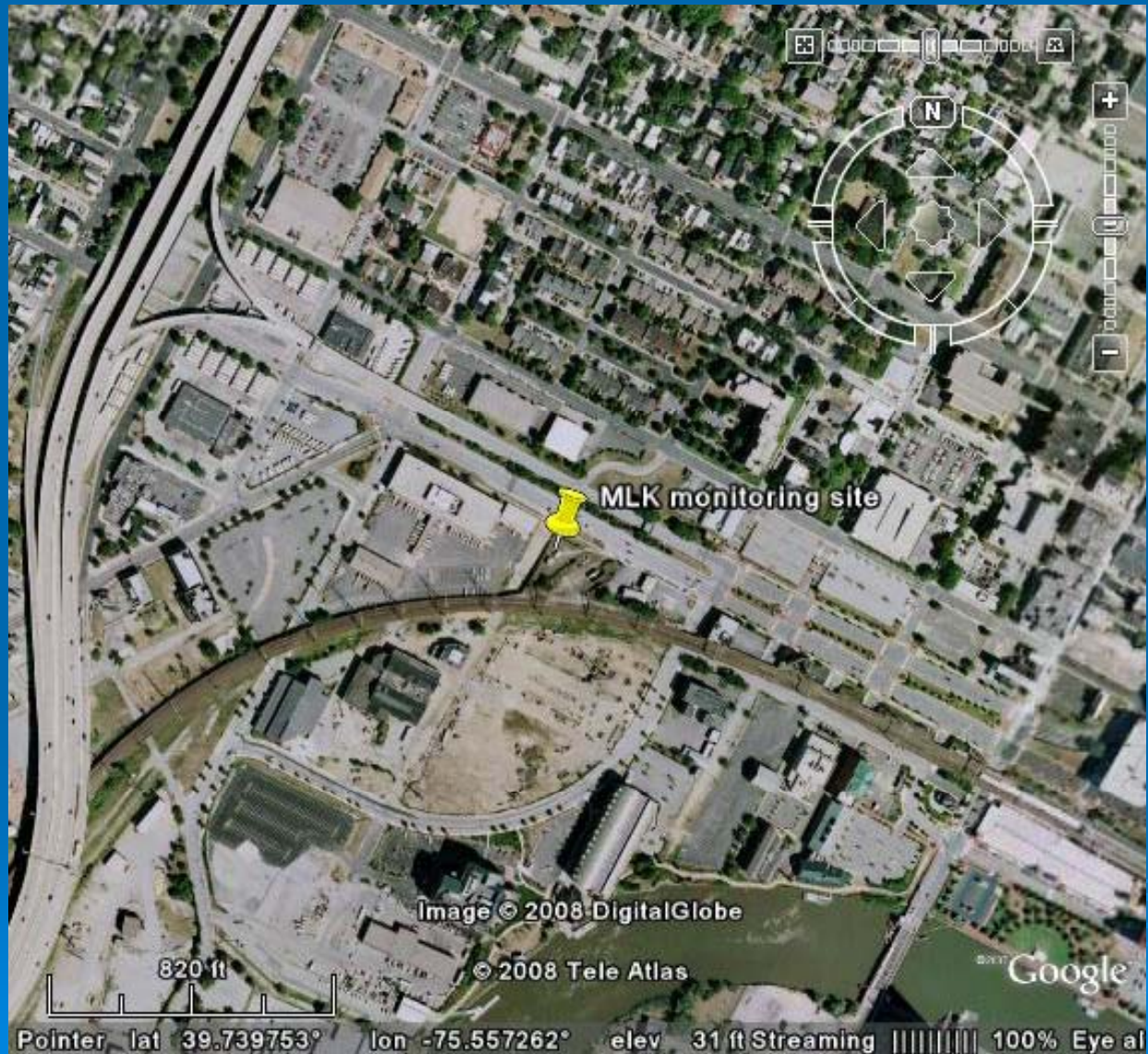
- MLK PM2.5 monitors collocated with:
 - PM2.5 FRM (every day and 1-in-6 collocate)
 - TEOM PM10
 - Aethalometer
 - Other continuous NAAQS monitors (SO₂, CO, NO/NO_x)

Synchronized Hybrid Ambient Real-Time Particulate Monitor (SHARP)

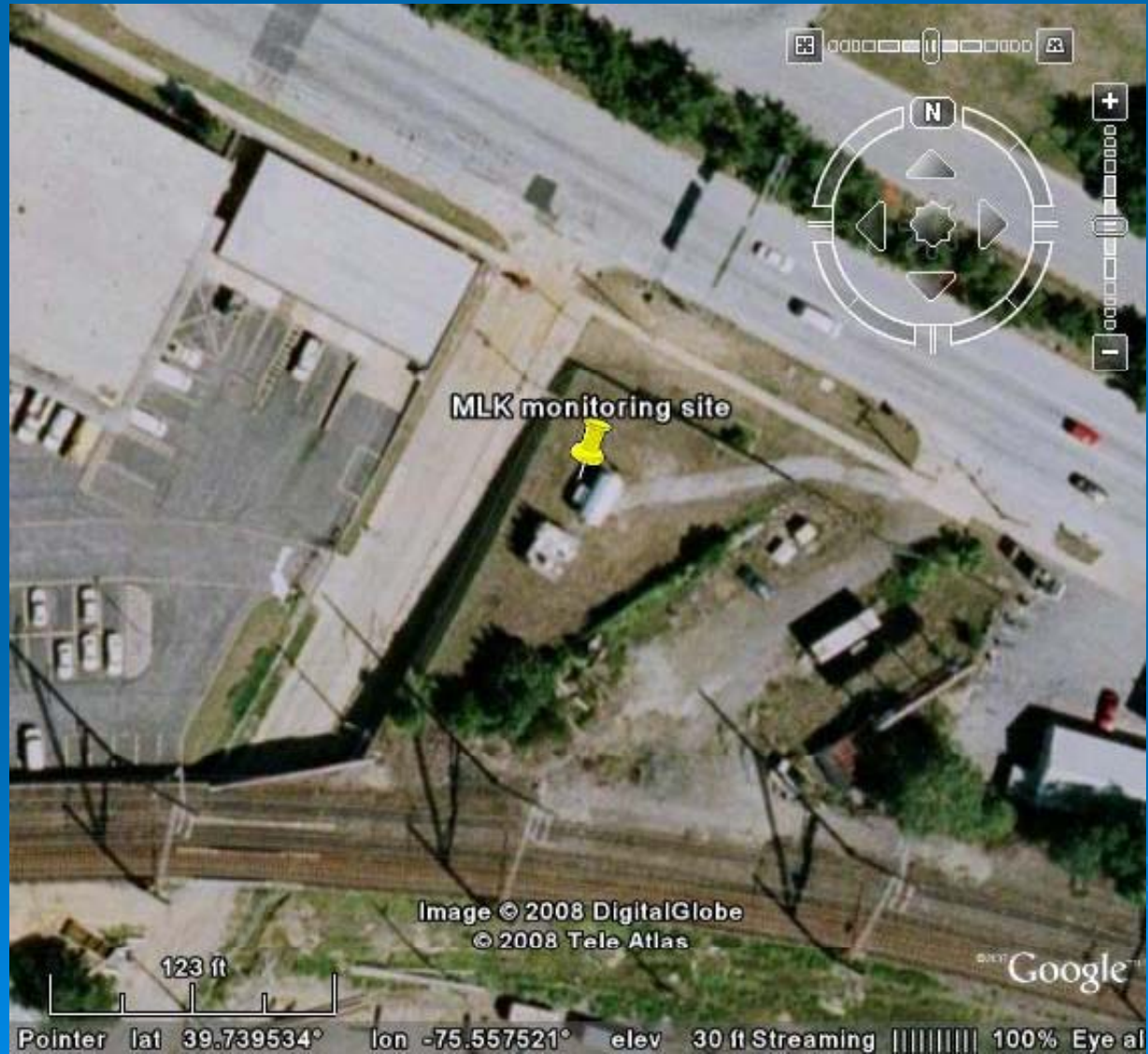
- Nephelometer and beta gauge in series
 - Accuracy of a beta gauge with high time resolution of a nephelometer
- Heater on the inlet line for moisture control
- Dynamic digital filtering of both data streams
 - Continuously adjust the nephelometer response using the beta gauge response

Condensed From: Jay Turner, Washington University in St. Louis

Wilmington MLK monitoring site



Wilmington MLK monitoring site





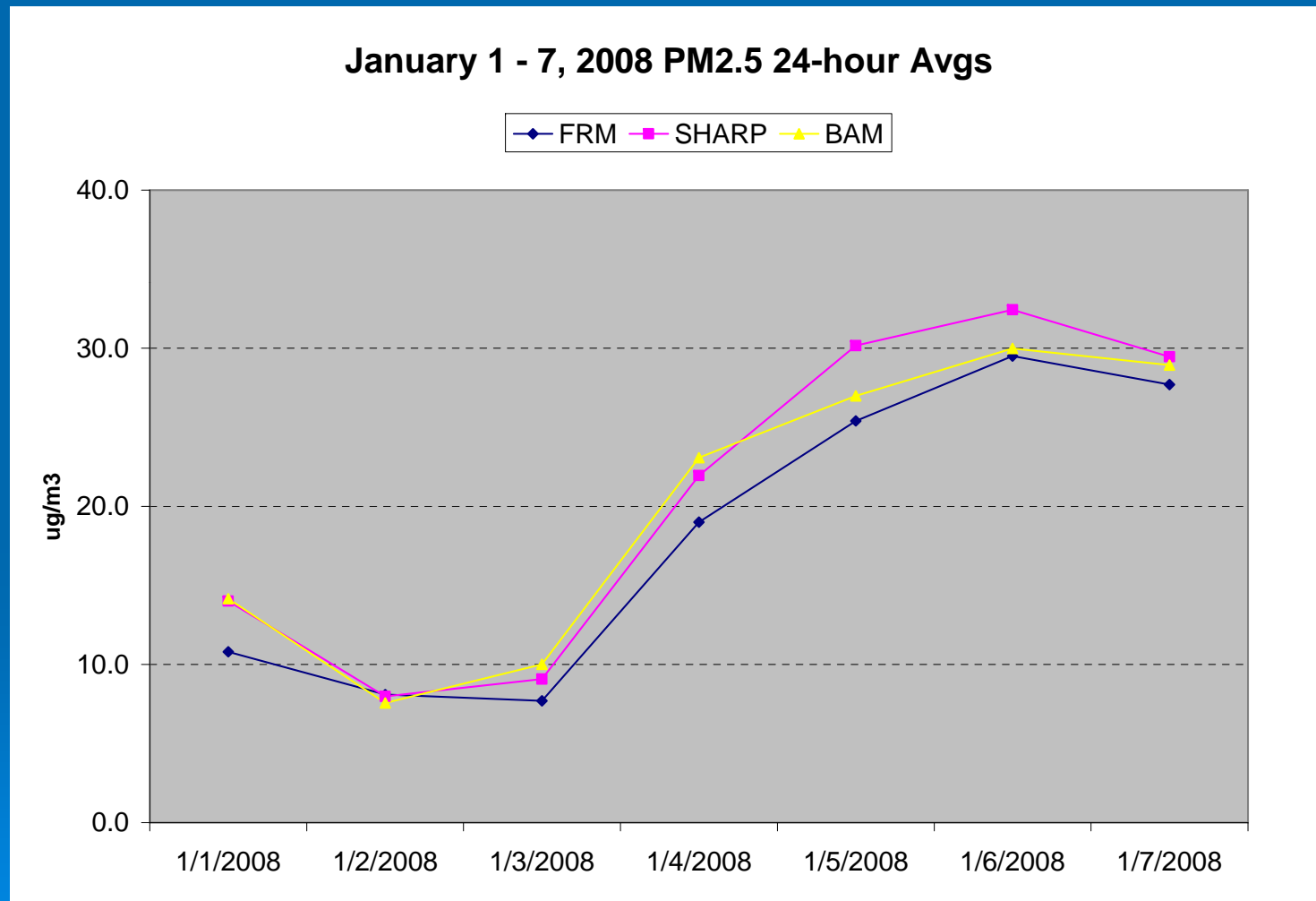


Operational information

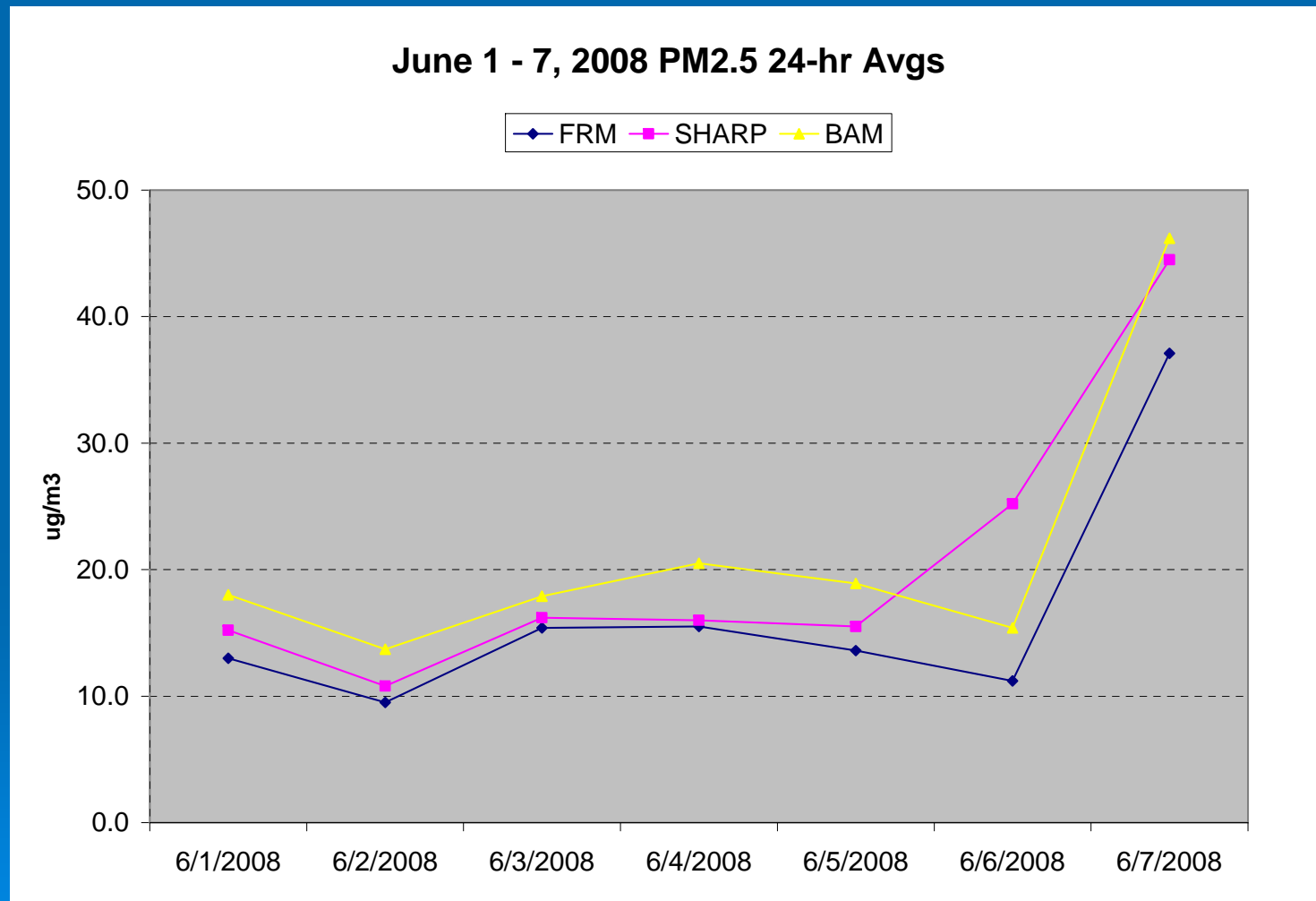
- Monitor checks, records
 - Bi-weekly checks (temp, press, flow)
 - Annual/semi-annual checks (zero/span foil)
 - Monthly Maintenance – heated inlet checks/cleaning, filter tape checks
- Issues, problems?
 - Nothing to report so far (knock on wood)

Now the good stuff – Data!

Winter 24-hr Averages



Summer 24-hr Averages



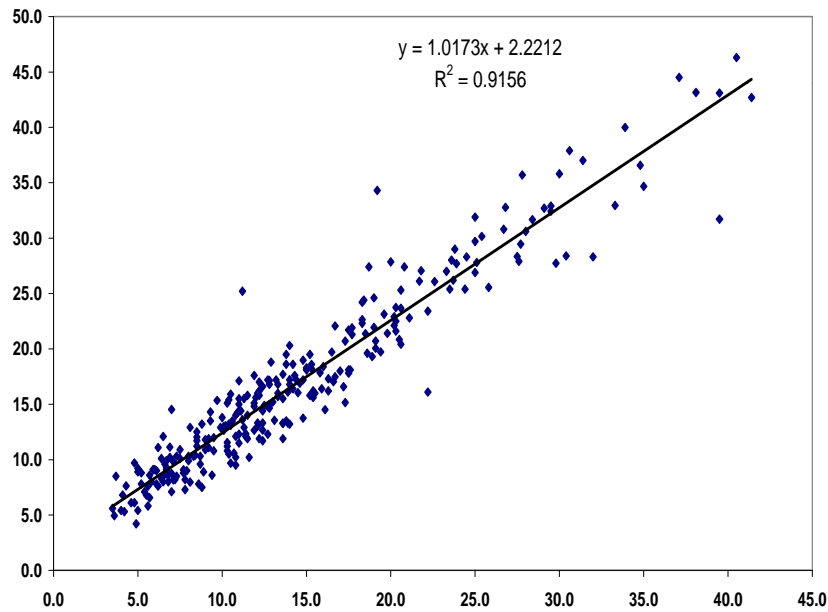
Compare 24-hour averages:

- SHARP correlates well with FRM
 - $R^2 = 0.9156$
 - 24-hour Average higher by 2 – 3 ug
- BAM correlates fairly well with FRM
 - More noise than SHARP, $R^2 = 0.7716$
 - 24-hour Average higher by 4 - 5 ug

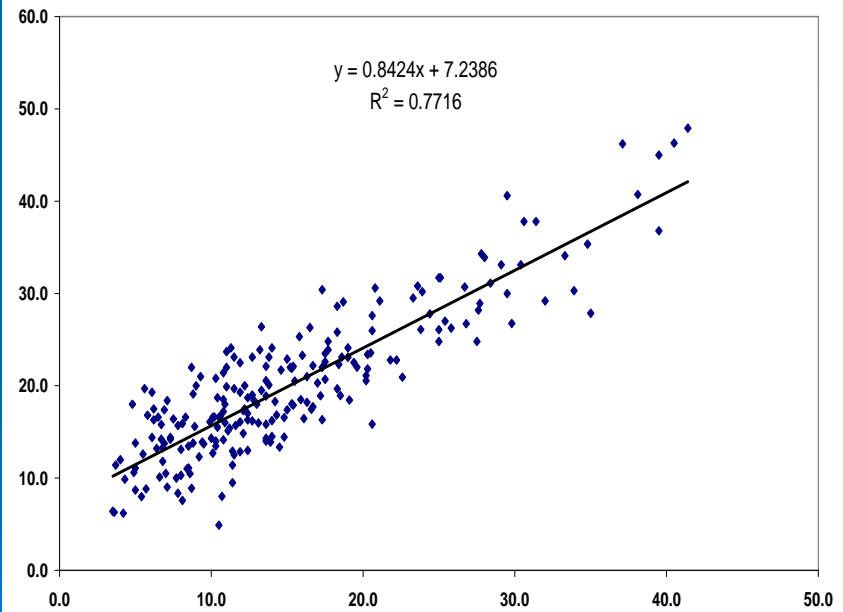
BUT both BAM and SHARP can differ from the FRM by more than ± 10 ug on any day

Data correlation with FRM: SHARP and BAM 24-hr averages

SHARP vs FRM



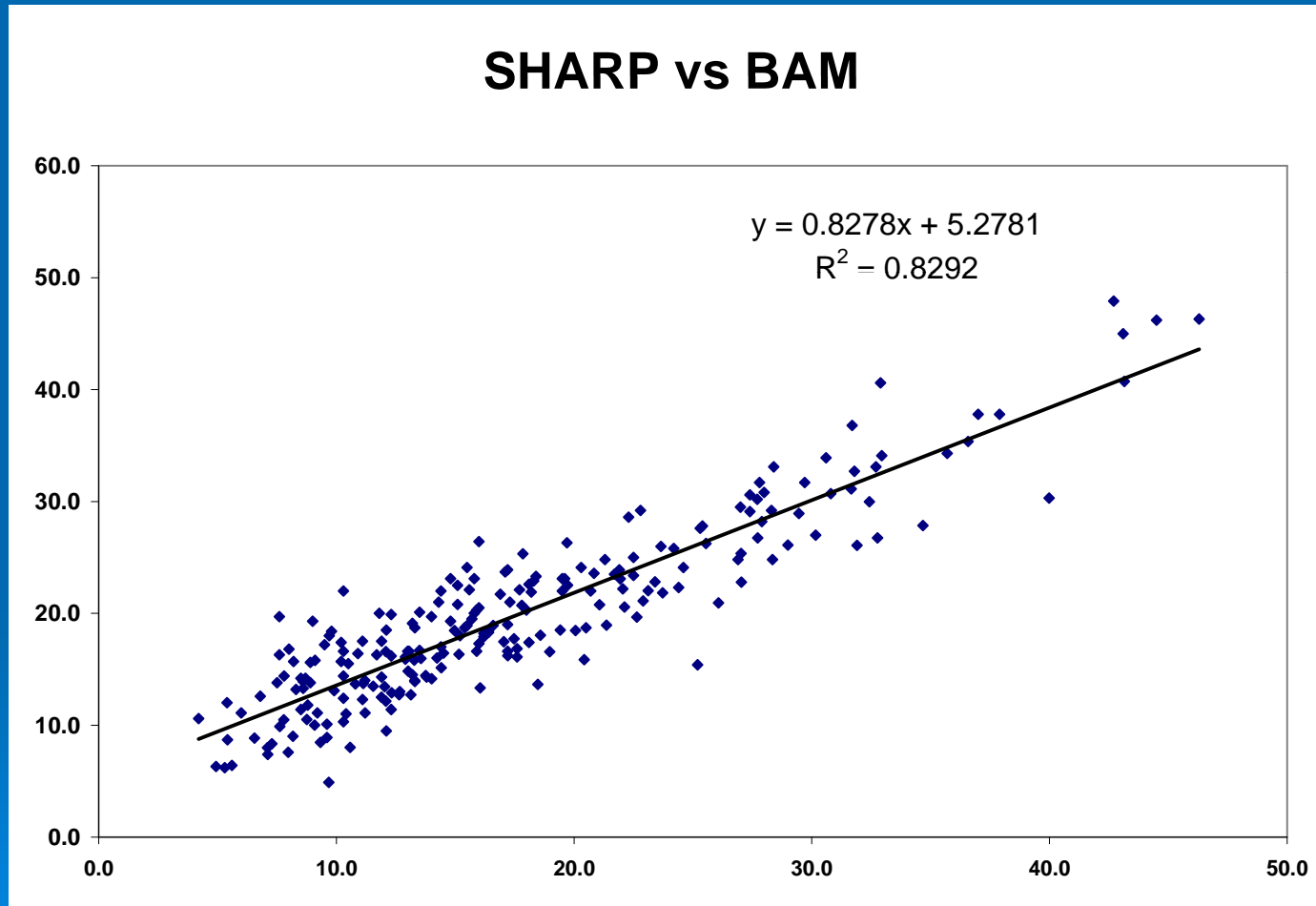
BAM vs FRM



How do continuous methods compare to each other?

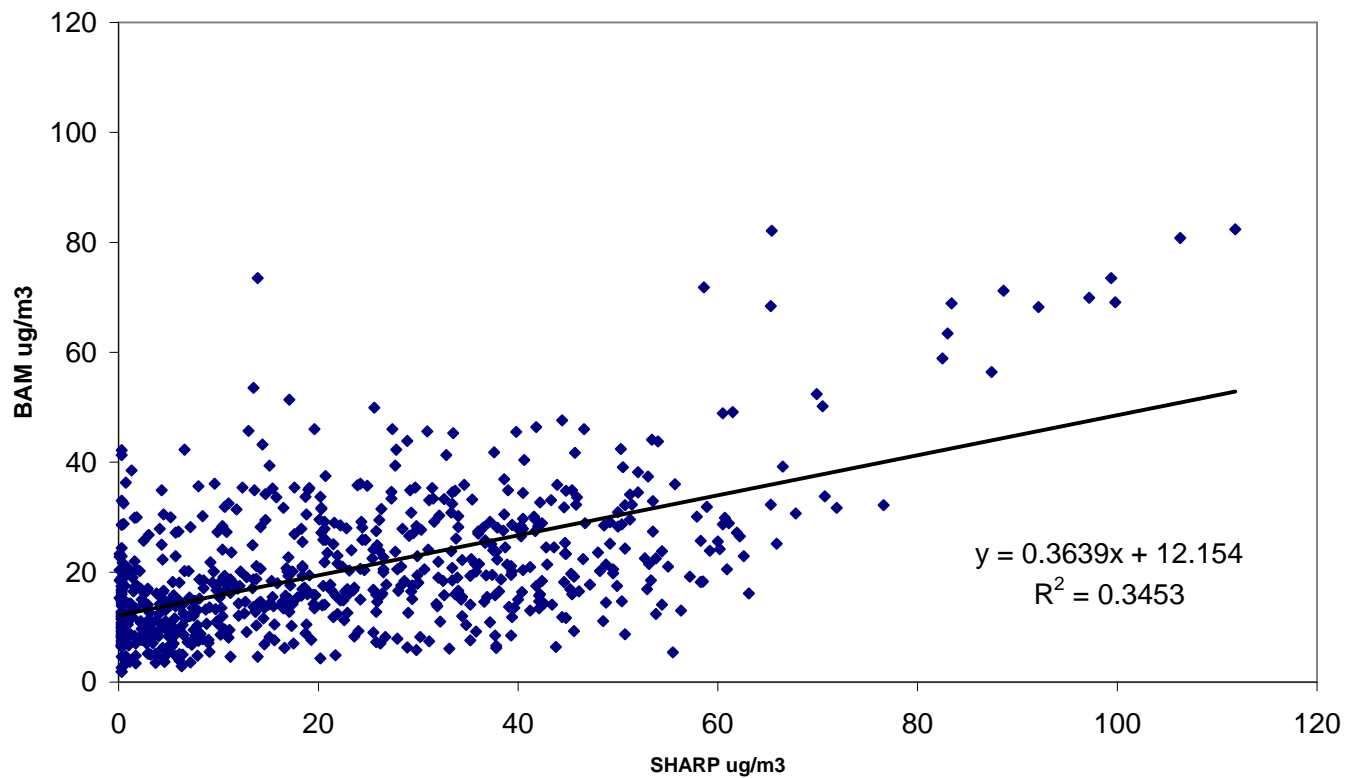
- Compare SHARP with BAM - Regression correlation
- 24-hour averages correlate fairly well
- But hourly averages do not

Compare continuous SHARP vs BAM 24-hr Avg.



Compare BAM vs SHARP Hourly data

BAM vs SHARP June 2008

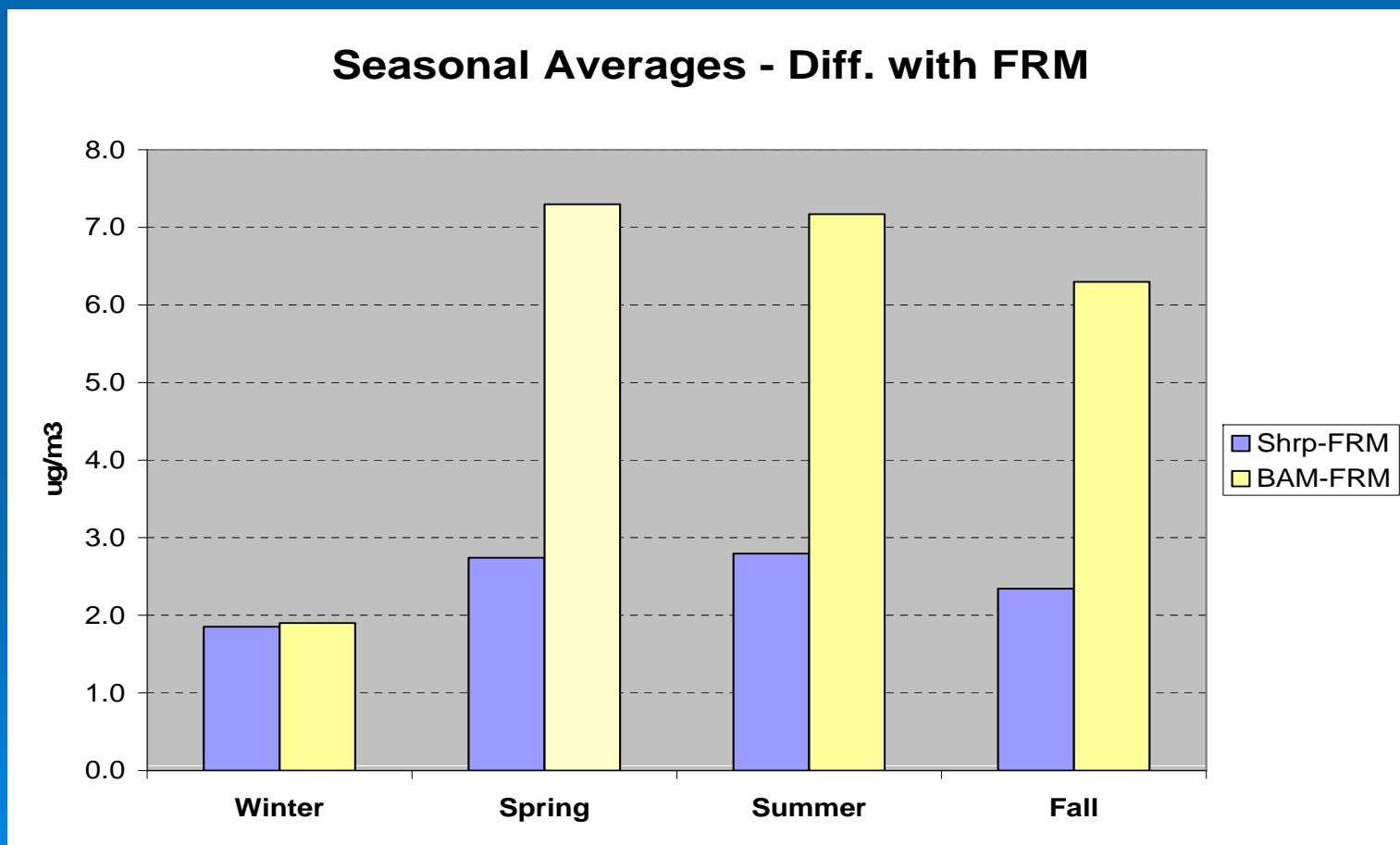


Other Issues BAM, SHARP, FRM

- Seasonal differences? Between BAM and SHARP, between BAM/SHARP and FRM?
- Time series of hourly data – patterns?

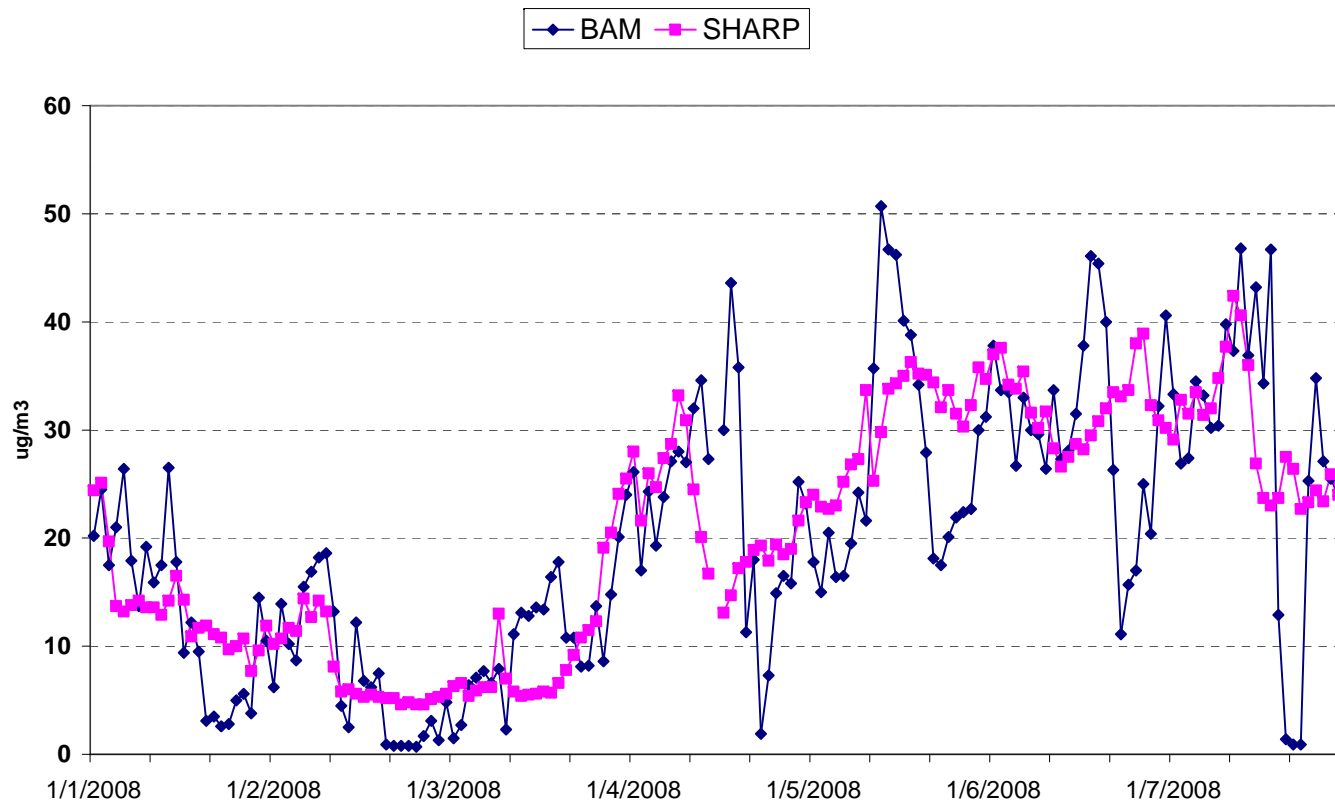
Seasonal Diff. in ug

Both SHARP and BAM measure more mass than FRM, especially in warmer months (FRM not good at capturing volatiles)

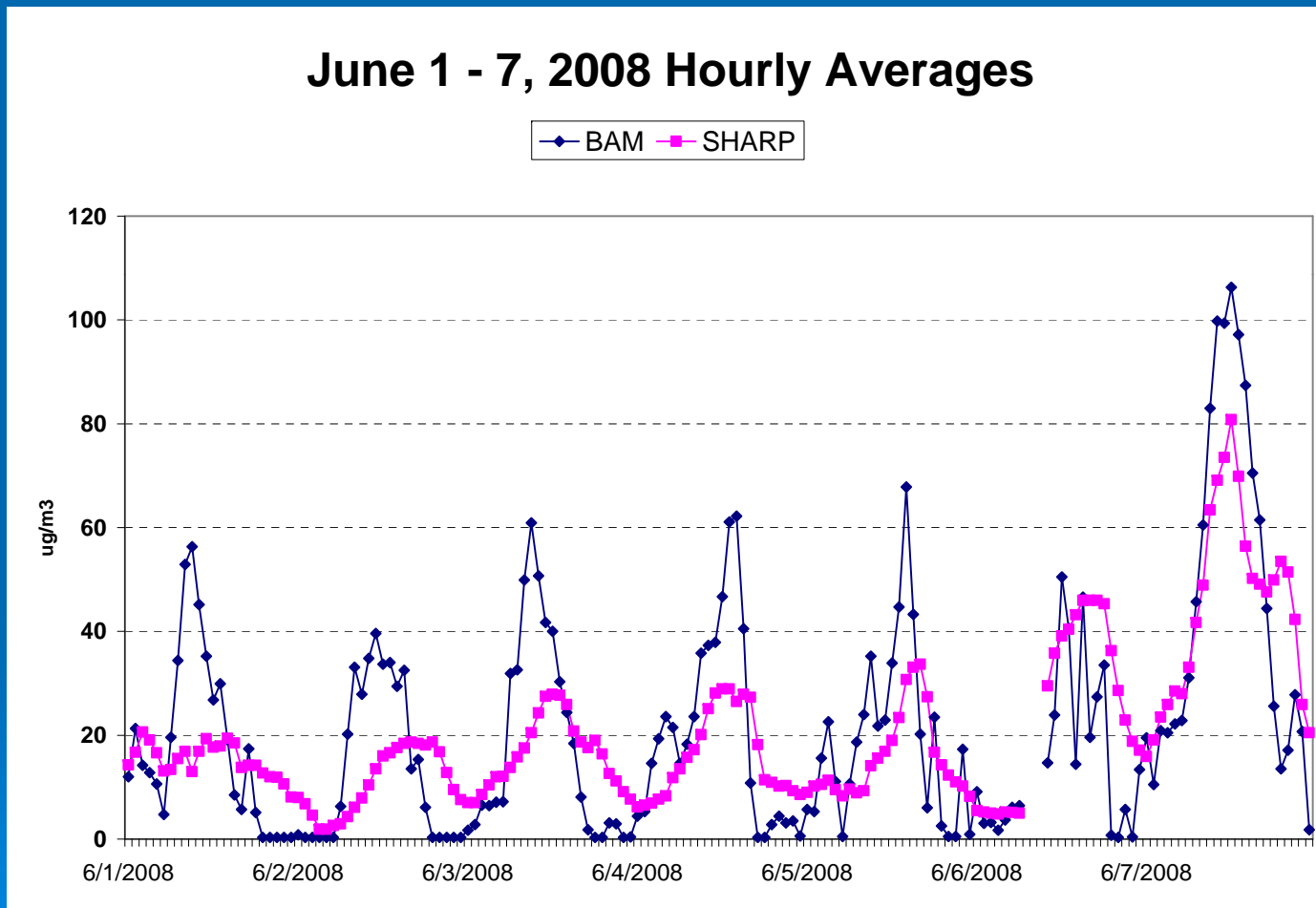


Times series collocated hourly BAM & SHARP - Winter

January 1 - 7, 2008 Hourly Data



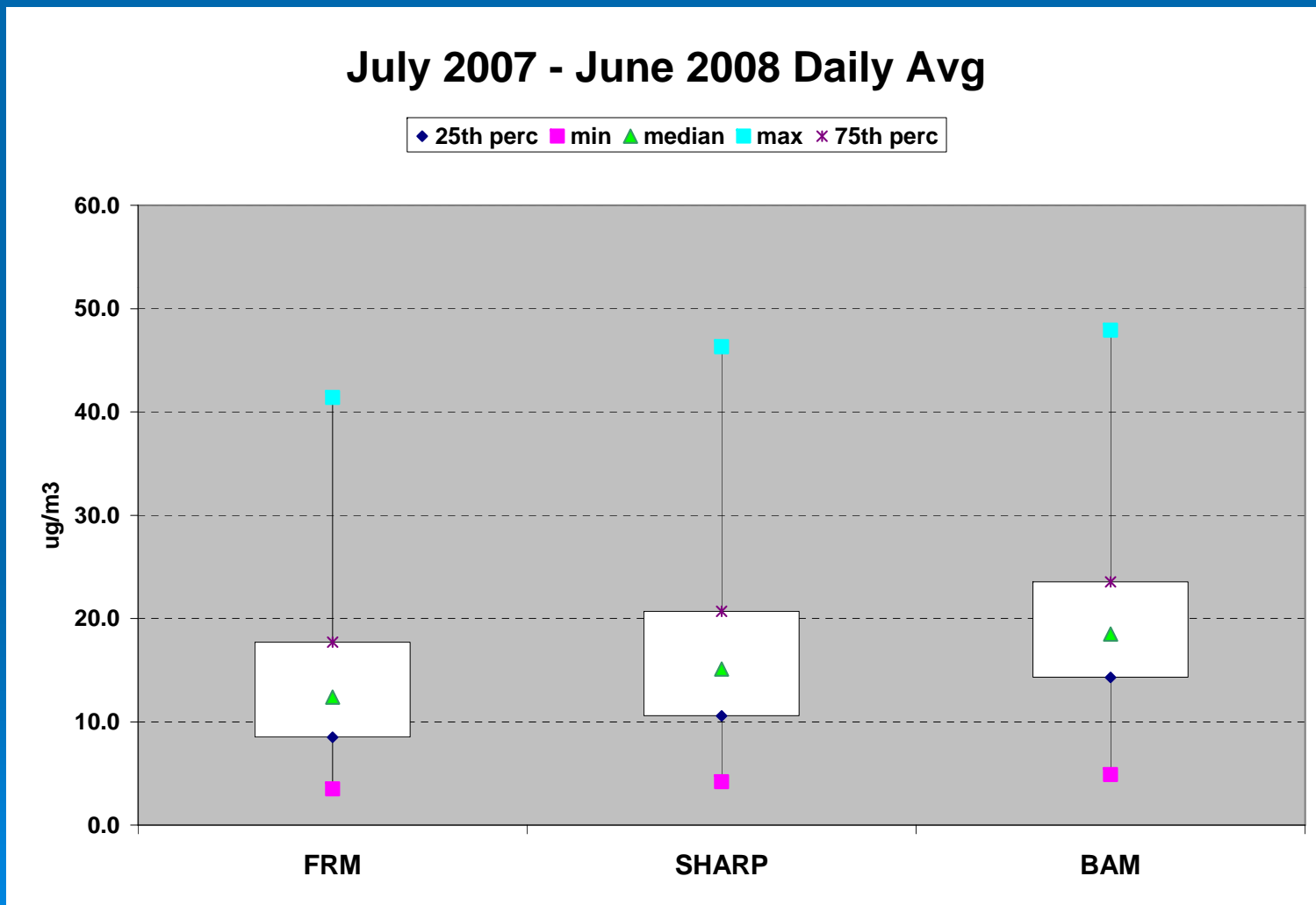
Times series collocated hourly BAM & SHARP - Summer



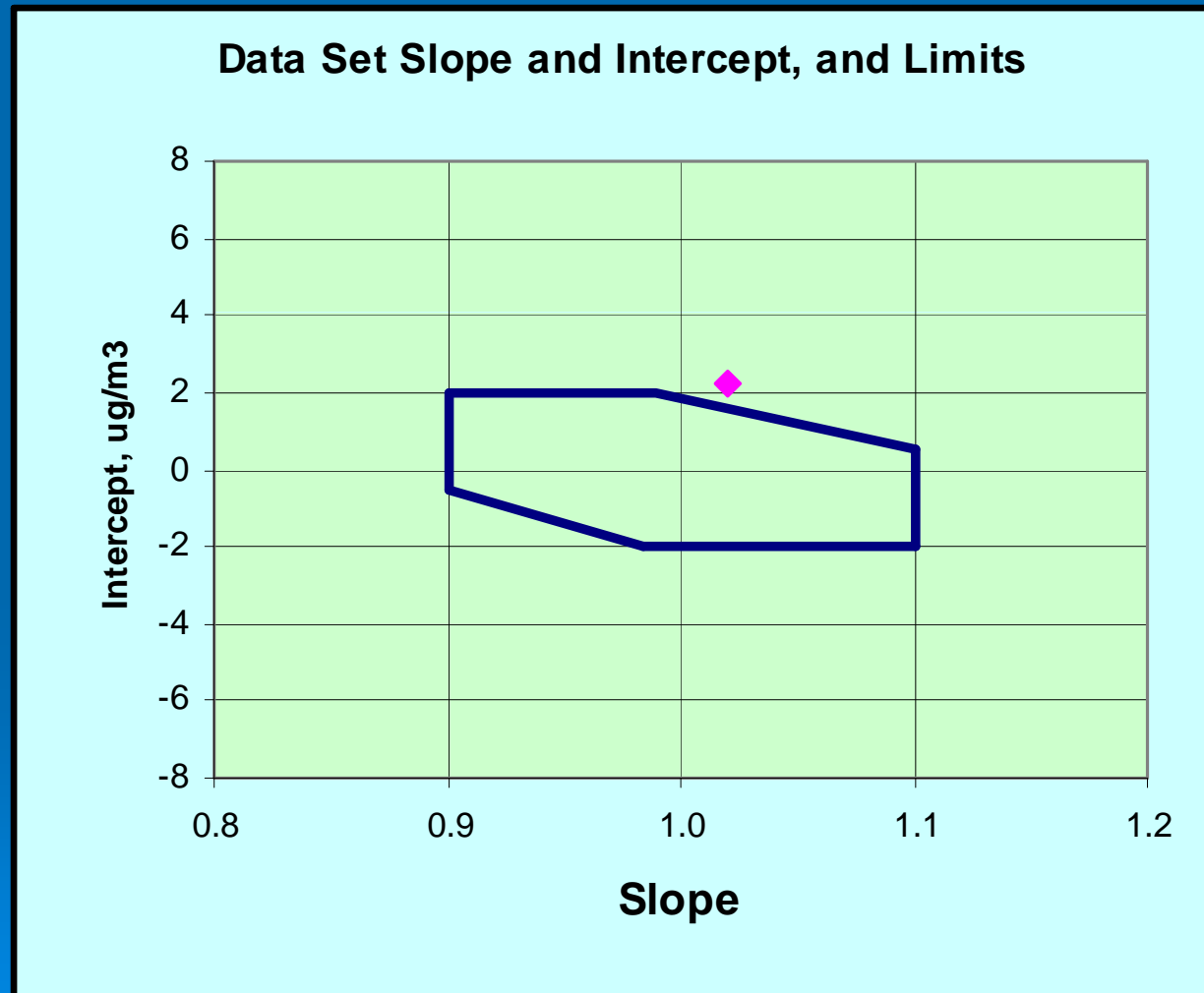
Method Comparison Statistics

- Compare 24-hour average summary stats (median, range, etc.)
- Apply EPA's FEM guidance

Summary – 24-hour averages



EPA FEM Limits – DE data



Potential Data Use

- Air Quality Index
- NAAQS comparisons
- Diurnal profiles, correlations with other parameters/pollutants

AQI Calculations

- Not currently submitted to AirNow
- Less variability compared to BAMS, closer to FRM especially in summer

Comparison with NAAQS

Both SHARP and BAM measure more mass than FRM, especially in warmer months

98th percentile

- FRM = 35 ug/m³
- SHARP = 38 ug/m³
- BAM = 38 ug/m³

“Annual” Average

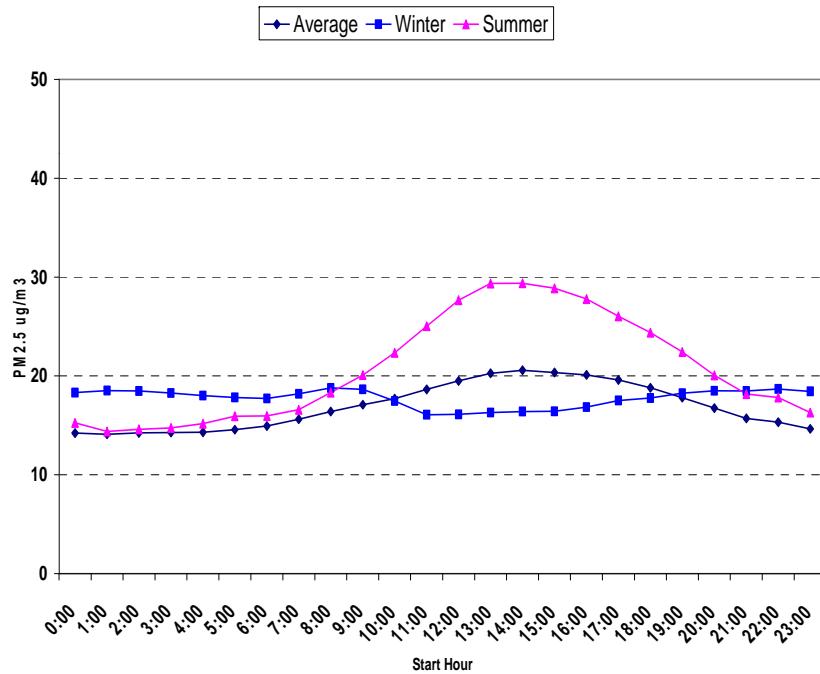
- FRM = 14.2 ug/m³
- SHARP = 16.7 ug/m³
- BAM = 19.8 ug/m

Correlations with other parameters

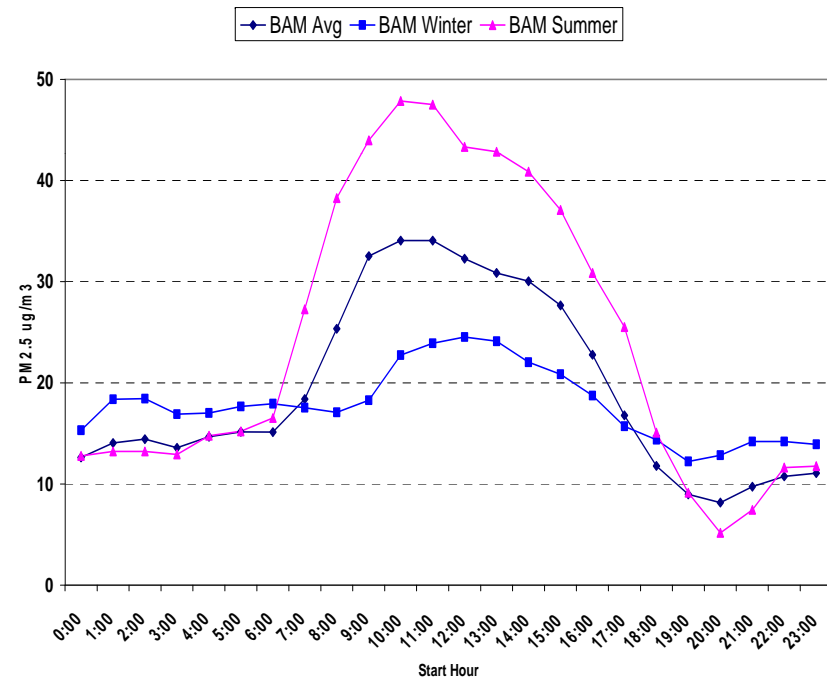
- Identify patterns that can't be found with FRM (ex. temporal relationships, diurnal patterns)
- Correlations with other pollutants (BC, etc.)
- Correlations with wind direction or other meteorological conditions

Diurnal peaks different heights, different times of day

July 2007 - June 2008 Sharp PM2.5

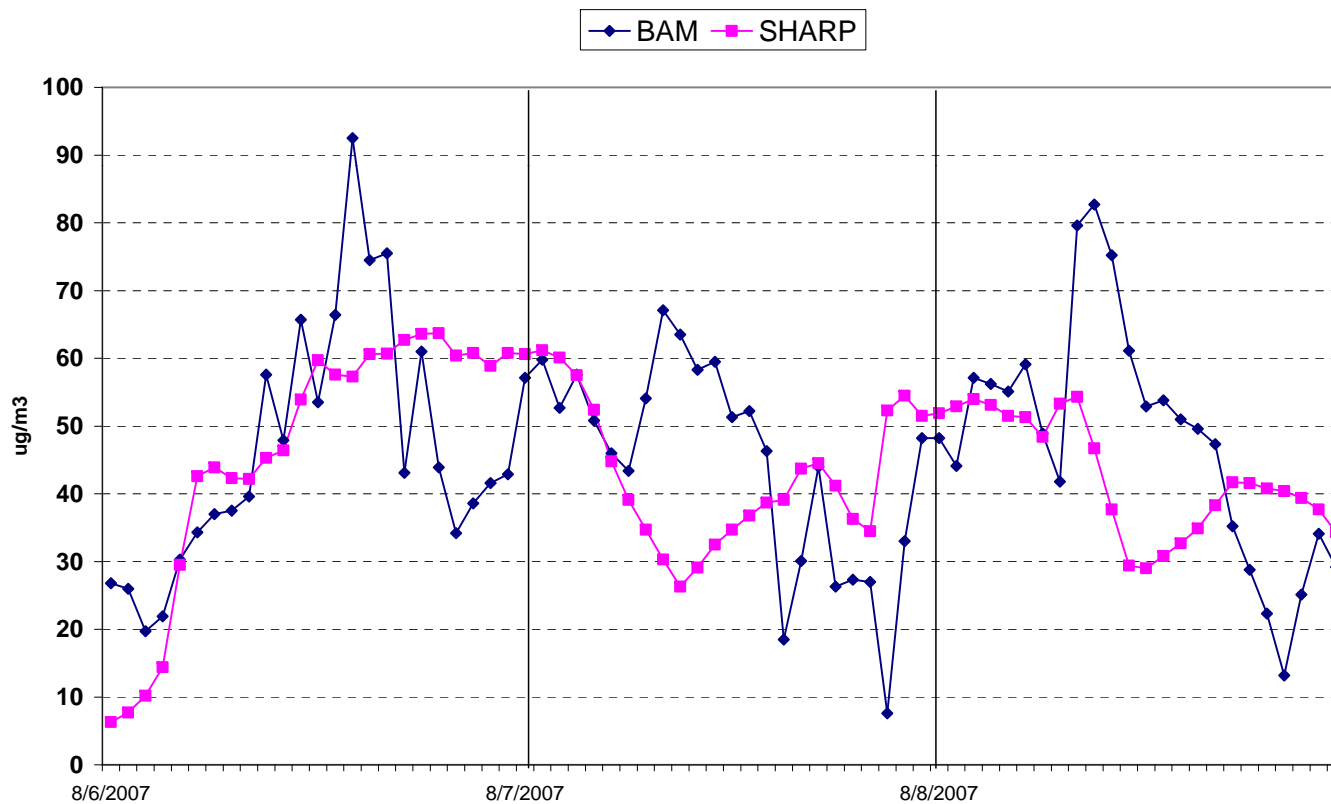


July 2007 - June 2008 BAM 2.5



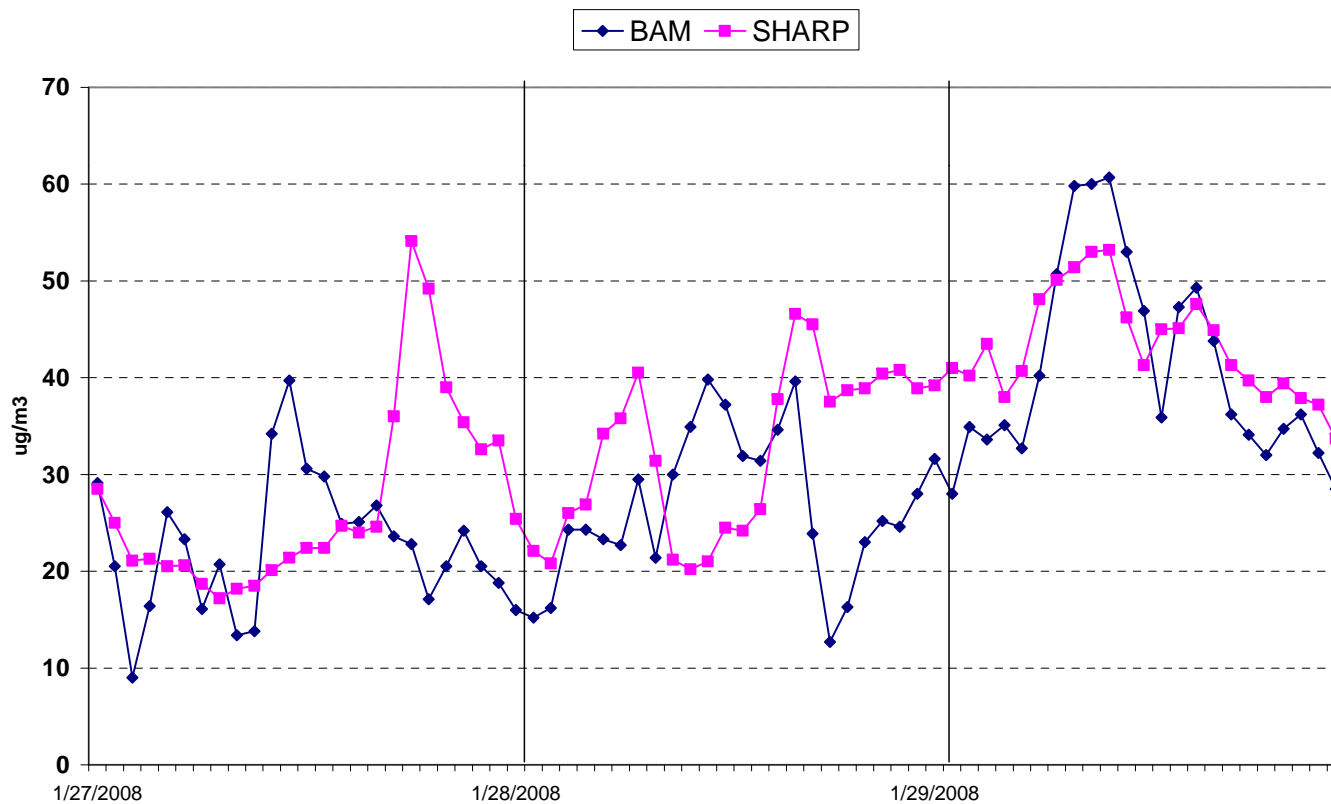
High concentration days - summer

High concentration episode: July 6-8, 2007



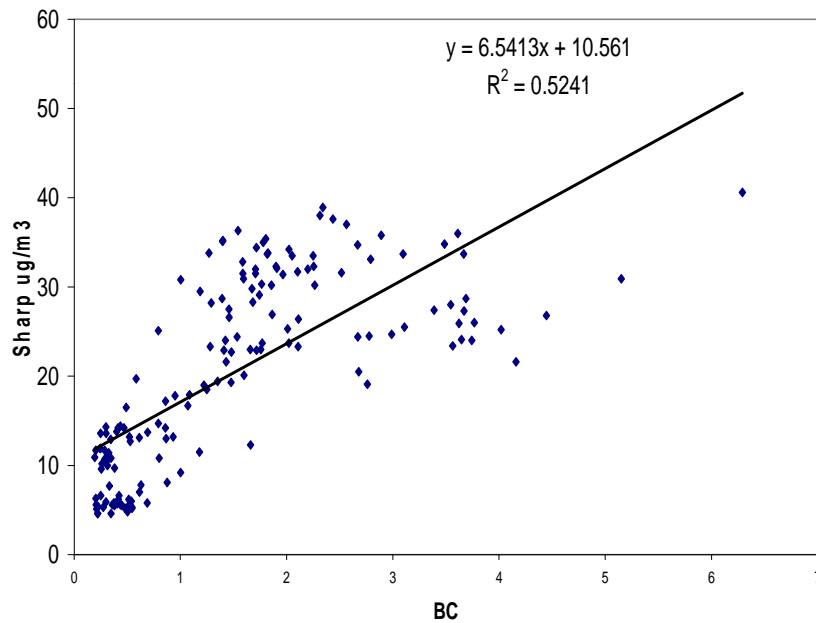
High concentration days - winter

High Concentration episode: January 27-29, 2008

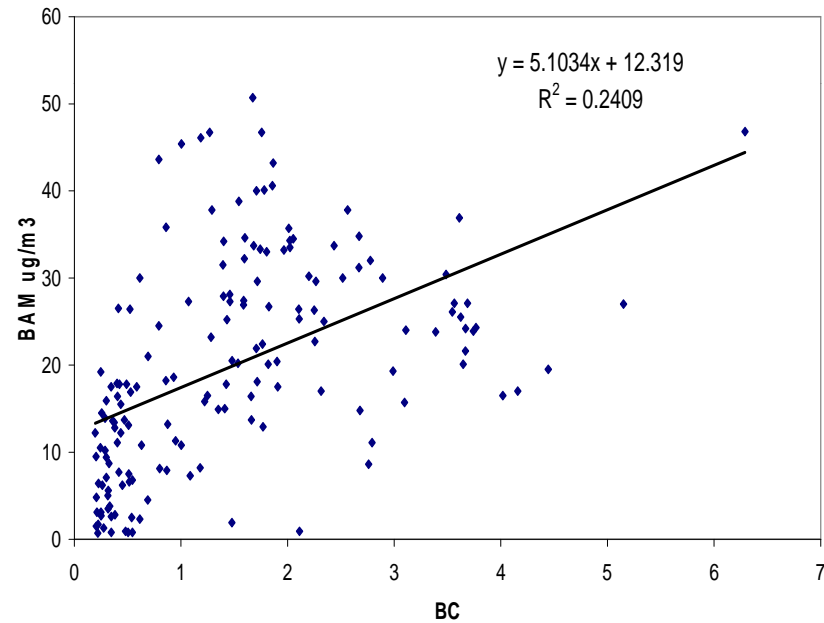


PM2.5 hourly averages vs Black Carbon

Jan. 1-7 Hourly Data: BC and SHARP



Jan. 1-7 Hourly Data: BC and BAM



Summary – SHARP

- Very good correlation with FRM
 - *BUT* still measures higher concentrations than FRM due to volatiles
 - Not appropriate for NAAQS compliance in areas close to the NAAQS (i.e., all of Delaware)
- AQI calculations - more consistent than BAM
- Other parameters - easier to correlate with other parameters/pollutants

Questions?

