Real-time Mapping of $PM_{2.5}$ Using the Mid-point 24-hour Average

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Reporting Real-time $PM_{2.5}$ Information

Today, I will discuss:

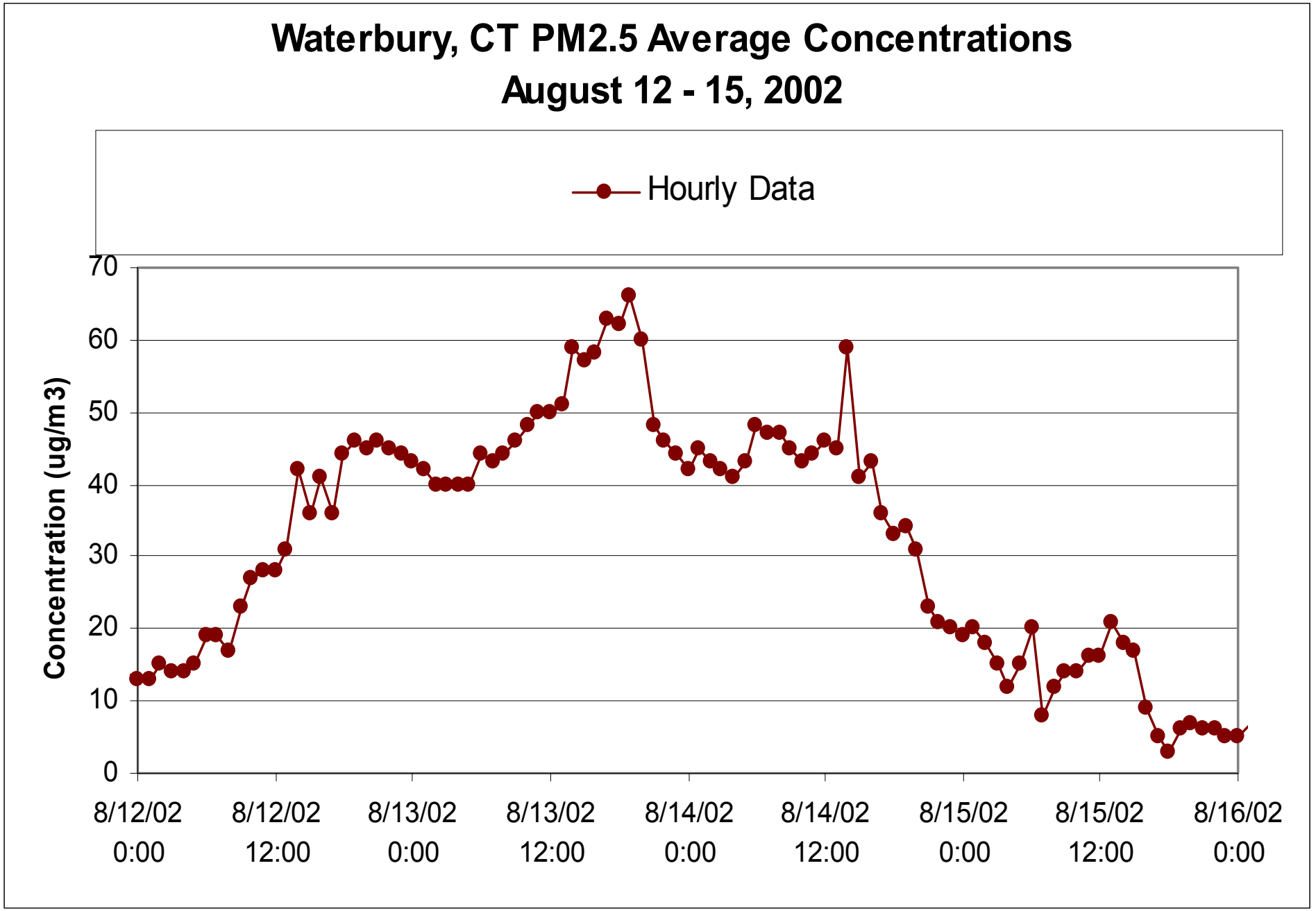
1. Issues with reporting the Air Quality Index (AQI) for $PM_{2.5}$ as the previously measured 24-hour average.
2. The benefits of using the mid-point 24-hour average for reporting the AQI.
3. A technique for predicting the mid-point 24-hour average based on both historical data and real-time data at upwind monitors.

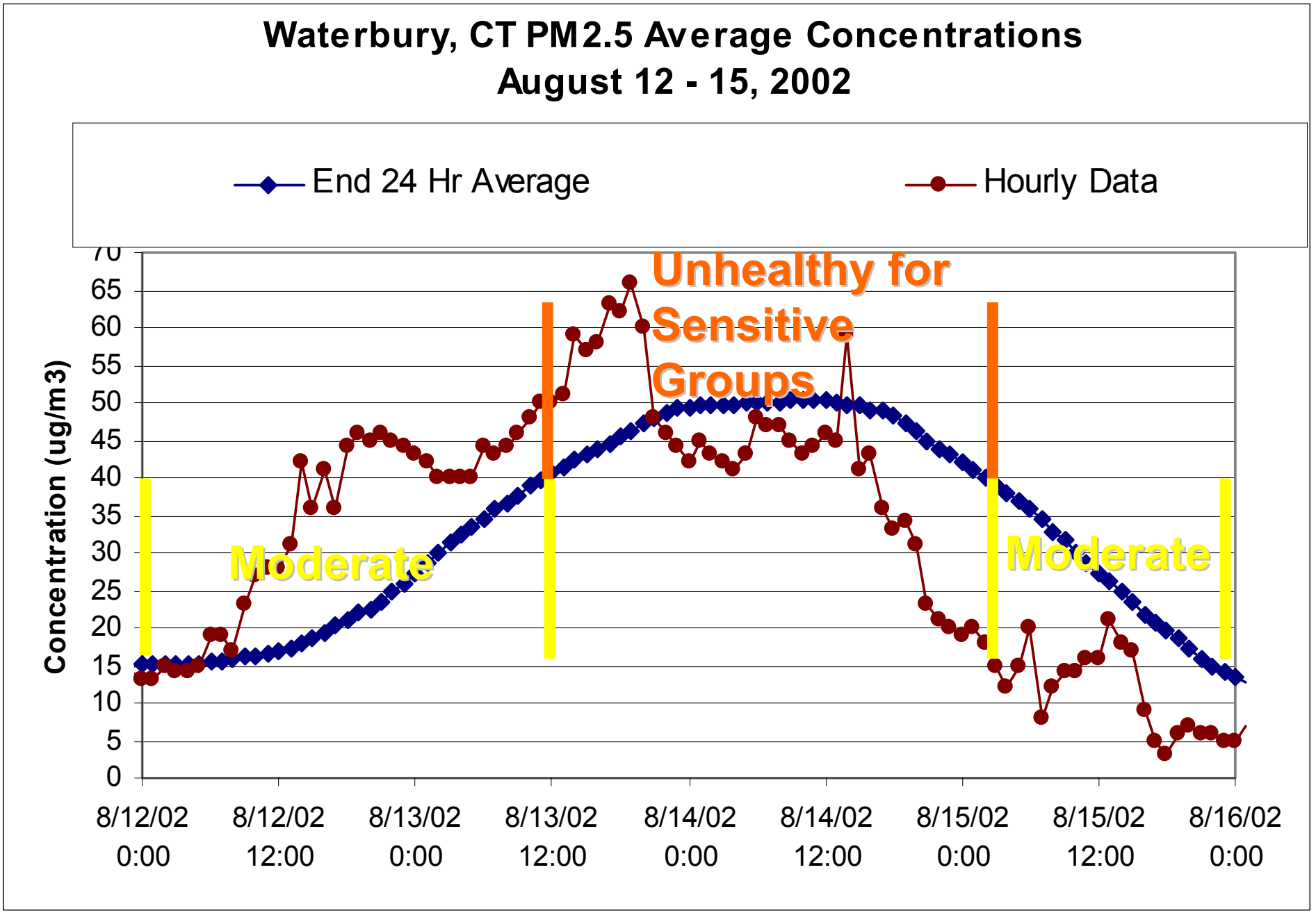
Reporting the AQI for $PM_{2.5}$ as the Previously Measured 24-hour Average

- When real-time $PM_{2.5}$ data is reported as the average for the previous 24-hour period, the reported AQI may may be out of sync with the hourly values currently being measured.
- For real-time reporting to be useful, it needs to be able to represent unhealthy air while it's occurring; not after a high 24-hour average has occurred.
- Similarly, when hourly values drop dramatically due to a change in meteorology (e.g., a front came through), reporting the AQI as the previous 24-hour average may significantly overestimate current and near-future air quality levels.

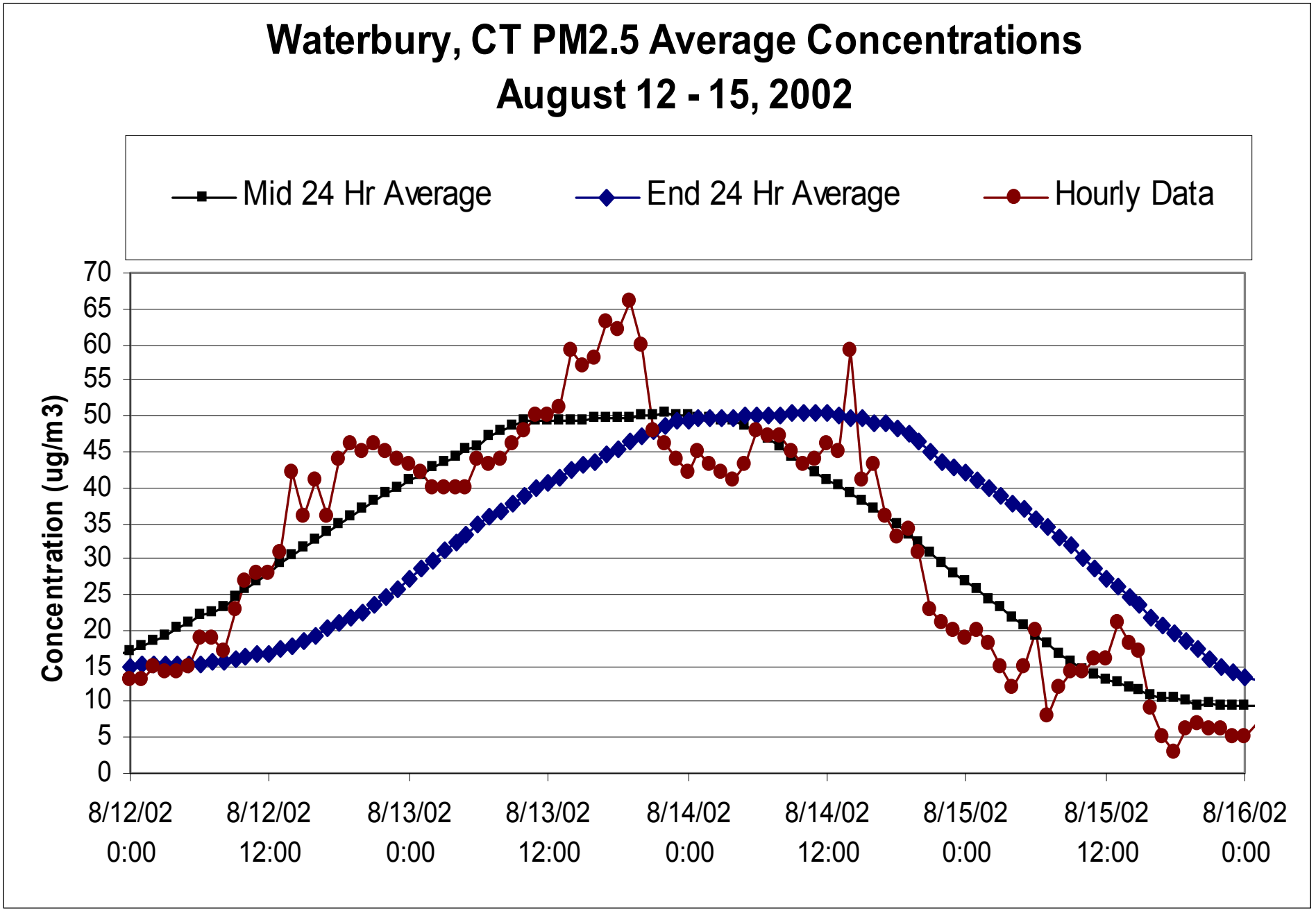
EPA's AQI for PM-2.5

AQI Index Values	AQI Descriptor	Concentration range (24-hour ave.)	Color
0 to 50	Good	0 $\mu g/m^3$ to 15.4 $\mu g/m^3$	Green
51 to 100	Moderate	15.5 $\mu g/m^3$ to 40.4 $\mu g/m^3$	Yellow
101 to 150	Unhealthy for Sensitive Groups	40.5 $\mu g/m^3$ to 65.4 $\mu g/m^3$	Orange
151 to 200	Unhealthy	65.5 $\mu g/m^3$ to 150.4 $\mu g/m^3$	Red
201 to 300	Very Unhealthy	150.5 $\mu g/m^3$ to 250.4 $\mu g/m^3$	Purple

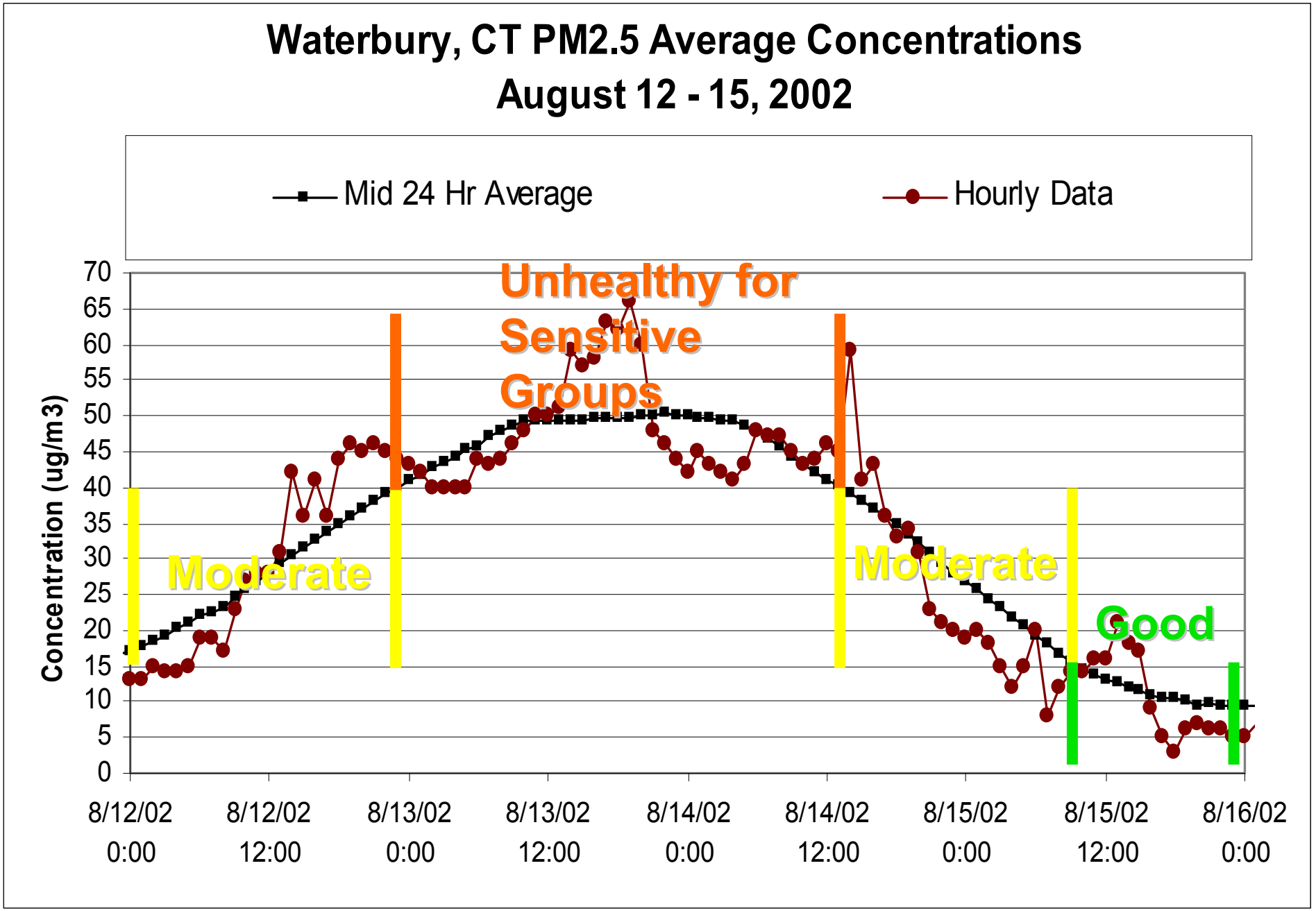

Waterbury, CT PM2.5 Average Concentrations
August 12 - 15, 2002
Hourly Data
Concentration (ug/m3)
70
60
50
40
30
20
10
0
8/12/02 0:00
8/12/02 12:00
8/13/02 0:00
8/13/02 12:00
8/14/02 0:00
8/14/02 12:00
8/15/02 0:00
8/15/02 12:00
8/16/02 0:00

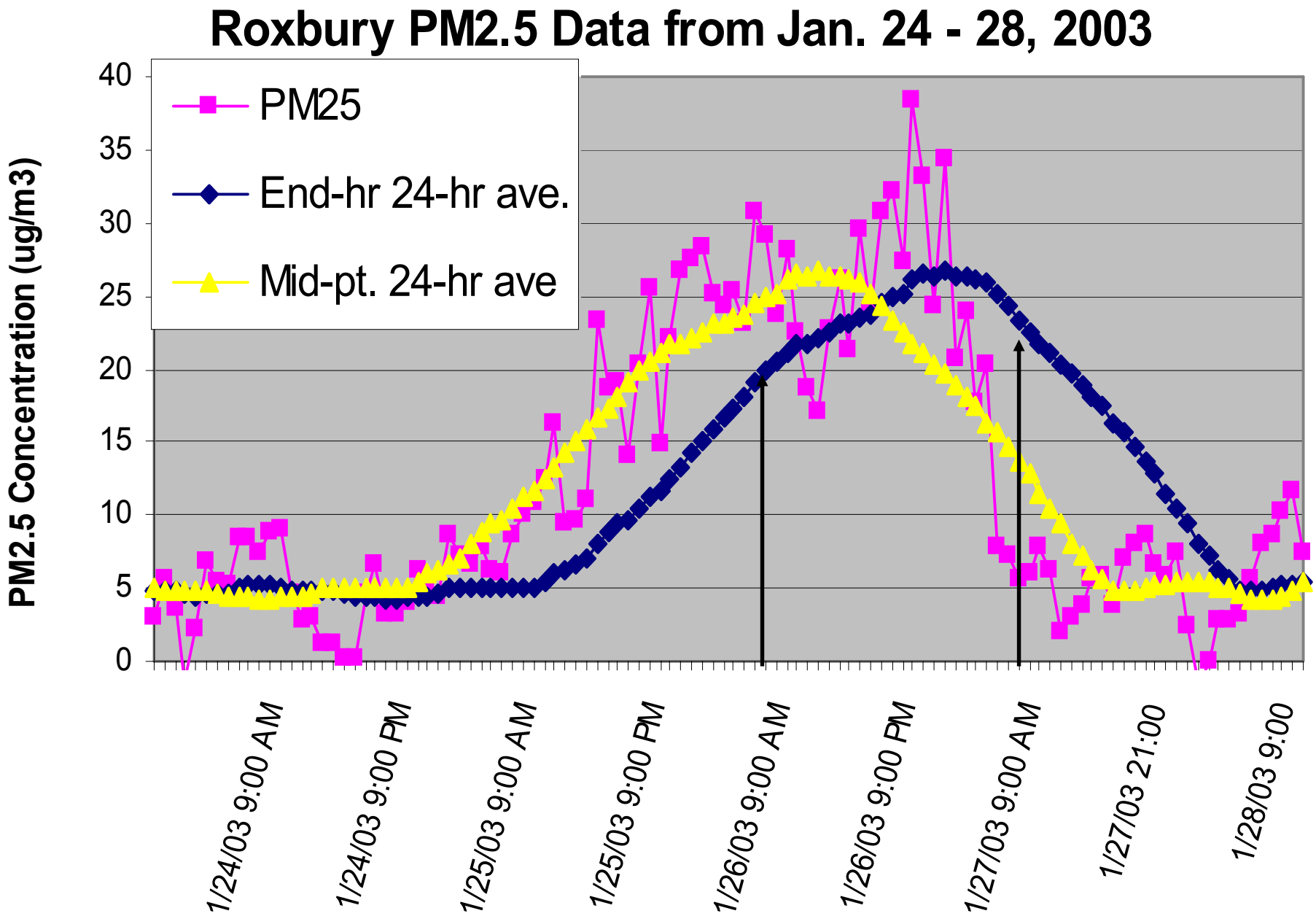

Waterbury, CT PM2.5 Average Concentrations
August 12 - 15, 2002
End 24 Hr Average
Hourly Data
Concentration (ug/m3)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Unhealthy for Sensitive Groups
Moderate
Moderate
8/12/02 0:00
8/12/02 12:00
8/13/02 0:00
8/13/02 12:00
8/14/02 0:00
8/14/02 12:00
8/15/02 0:00
8/15/02 12:00
8/16/02 0:00

Ideal Way for Reporting Would be by Mid-hour 24-hr Average



Ideal Way for Reporting Would be by Mid-hour 24-hr Average




Roxbury PM2.5 Data from Jan. 24 - 28, 2003
PM2.5 Concentration (ug/m3)
PM25
End-hr 24-hr ave.
Mid-pt. 24-hr ave
40
35
30
25
20
15
10
5
0
1/24/03 9:00 AM
1/24/03 9:00 PM
1/25/03 9:00 AM
1/25/03 9:00 PM
1/26/03 9:00 AM
1/26/03 9:00 PM
1/27/03 9:00 AM
1/27/03 21:00
1/28/03 9:00

Are you sensitive to AIR POLLUTION?

The BEAT: Realtime Air Quality Data

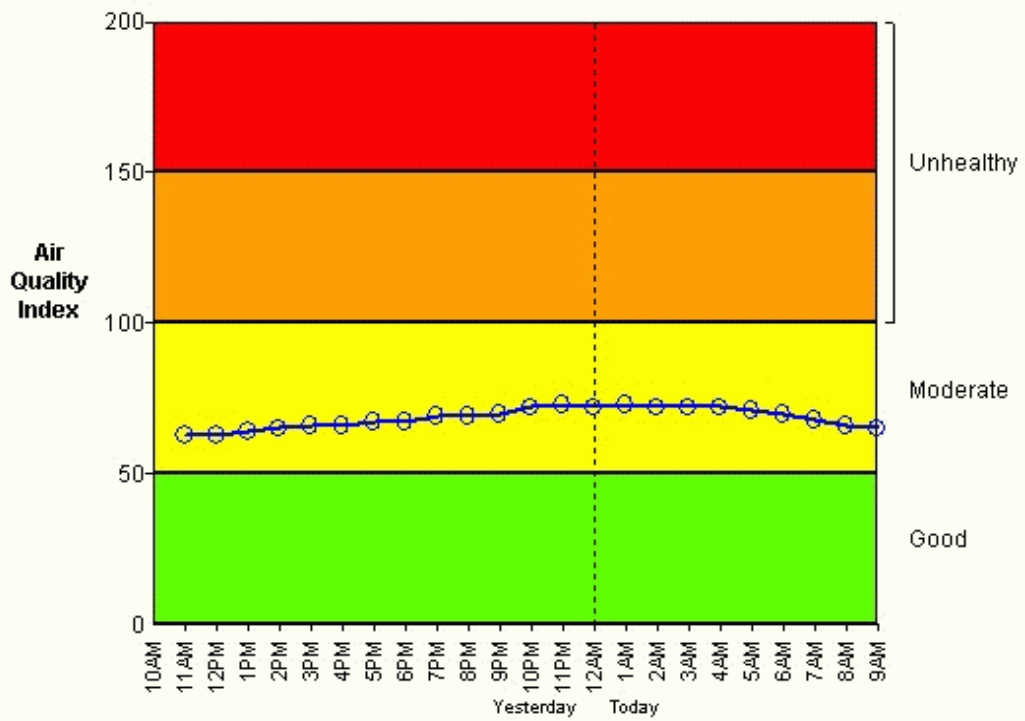
As of 9:00 AM
1/27/03

Current Air Quality: Moderate

Overall Air Quality: Today This Week This Month
Specific Pollutants: Today This Week This Month

Explanation of Terms

Today's Air Pollution



Boston Photographs from CAMNET

Photograph at 8 a.m. on 1-26-03

$PM_{2.5}$ concentration at this time was 29.1 μg/m^3.

Reported AQI was 60.

Photograph at 8 a.m. on 1-27-03

$PM_{2.5}$ concentration at this time was 5.7 μg/m^3

Reported AQI was 66.

Photographs from CAMNET web site (http://hazecam.net)

AirBeat
Roxbury Air Monitoring

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YOUR HEALTH

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617-427-9500

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AIR POLLUTION?

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As of 12:00 PM
1/27/03

Current Air Quality:
Moderate

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Student Projects
Links
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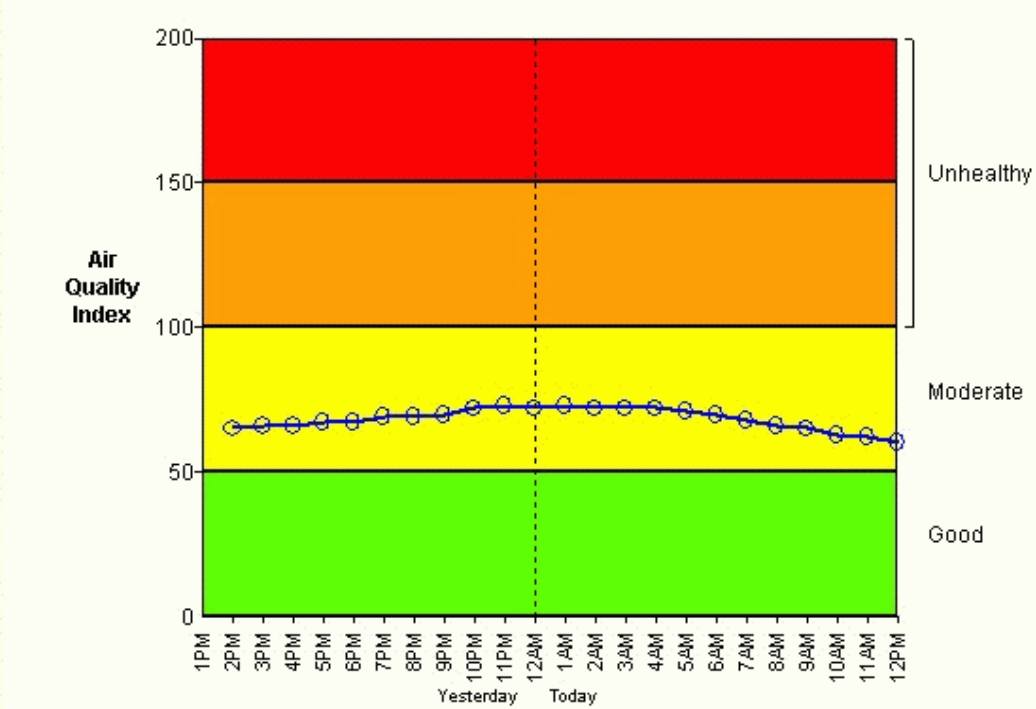
Text Only

Overall Air Quality: Today This Week This Month
Specific Pollutants: Today This Week This Month

Explanation of Terms

Today's Air Pollution



Are you sensitive to AIR POLLUTION?

The BEAT: Realtime Air Quality Data

Pollution Levels | Ozone Movies | Ozone Forecast | Boston Skyline | Pollution Alerts

As of 3:00 PM
1/27/03

Current Air Quality: Moderate

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Student Projects
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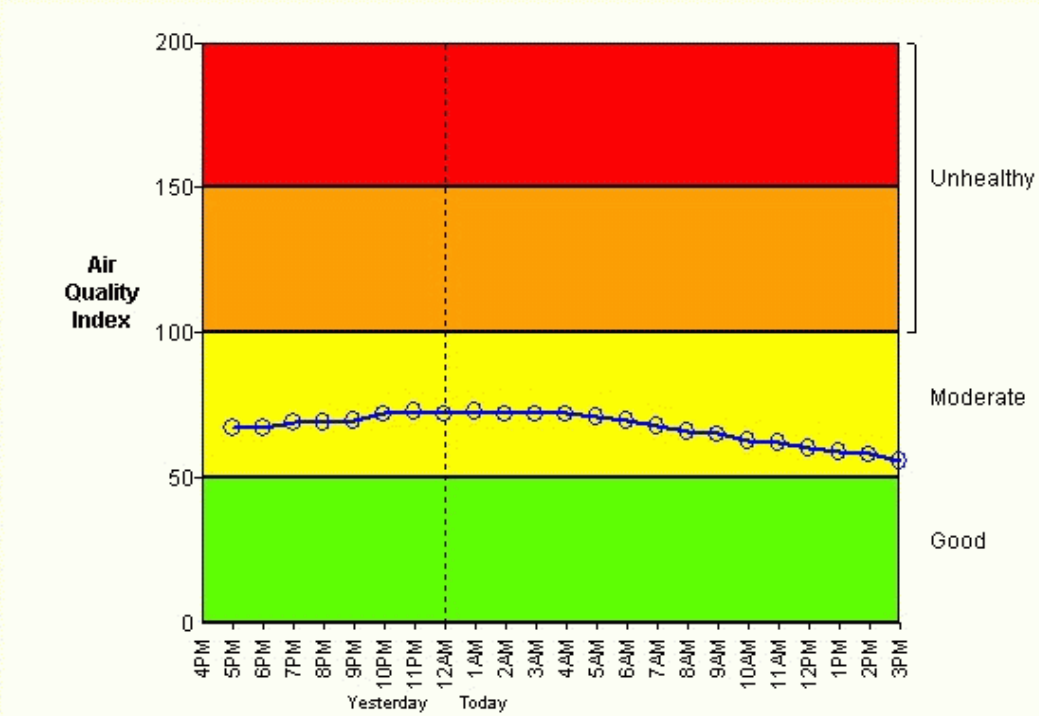
Overall Air Quality: Today This Week This Month
Specific Pollutants: Today This Week This Month

Explanation of Terms

Today's Air Pollution



Are you sensitive to AIR POLLUTION?

The BEAT: Realtime Air Quality Data

Pollution Levels | Ozone Movies | Ozone Forecast | Boston Skyline | Pollution Alerts

As of 10:00 PM
1/27/03

Current Air Quality: Good

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Student Projects
Links
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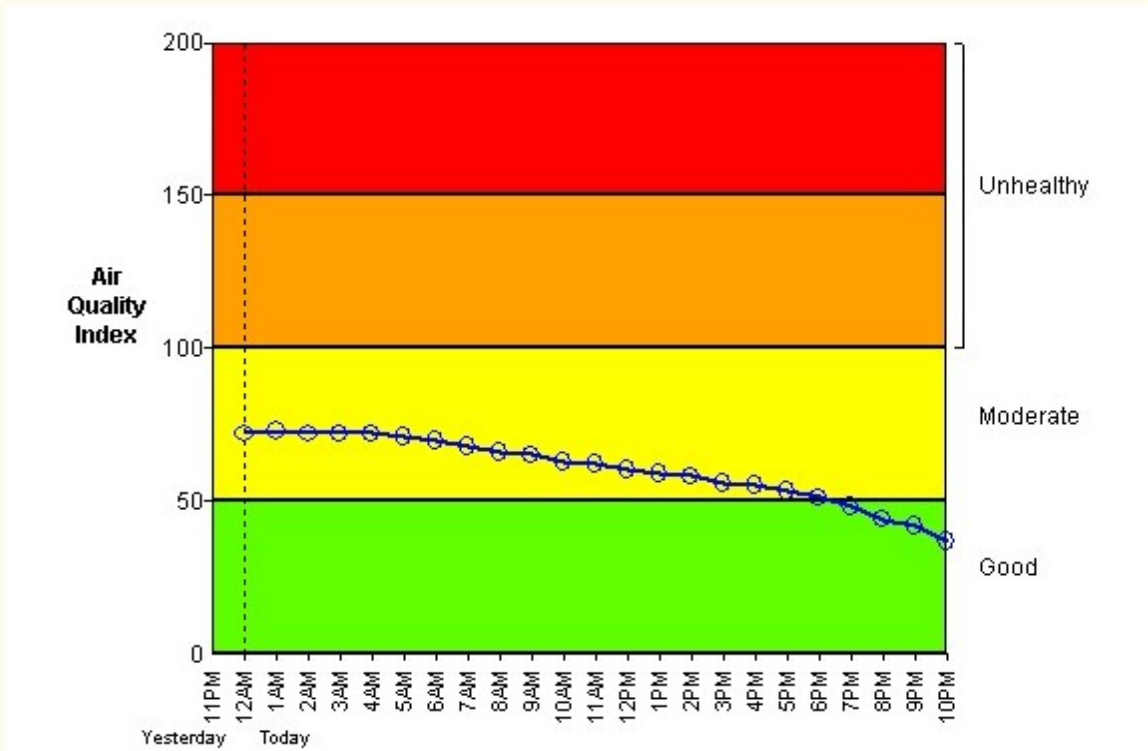
Contact Us
Text Only

Overall Air Quality: Today This Week This Month
Specific Pollutants: Today This Week This Month

Explanation of Terms

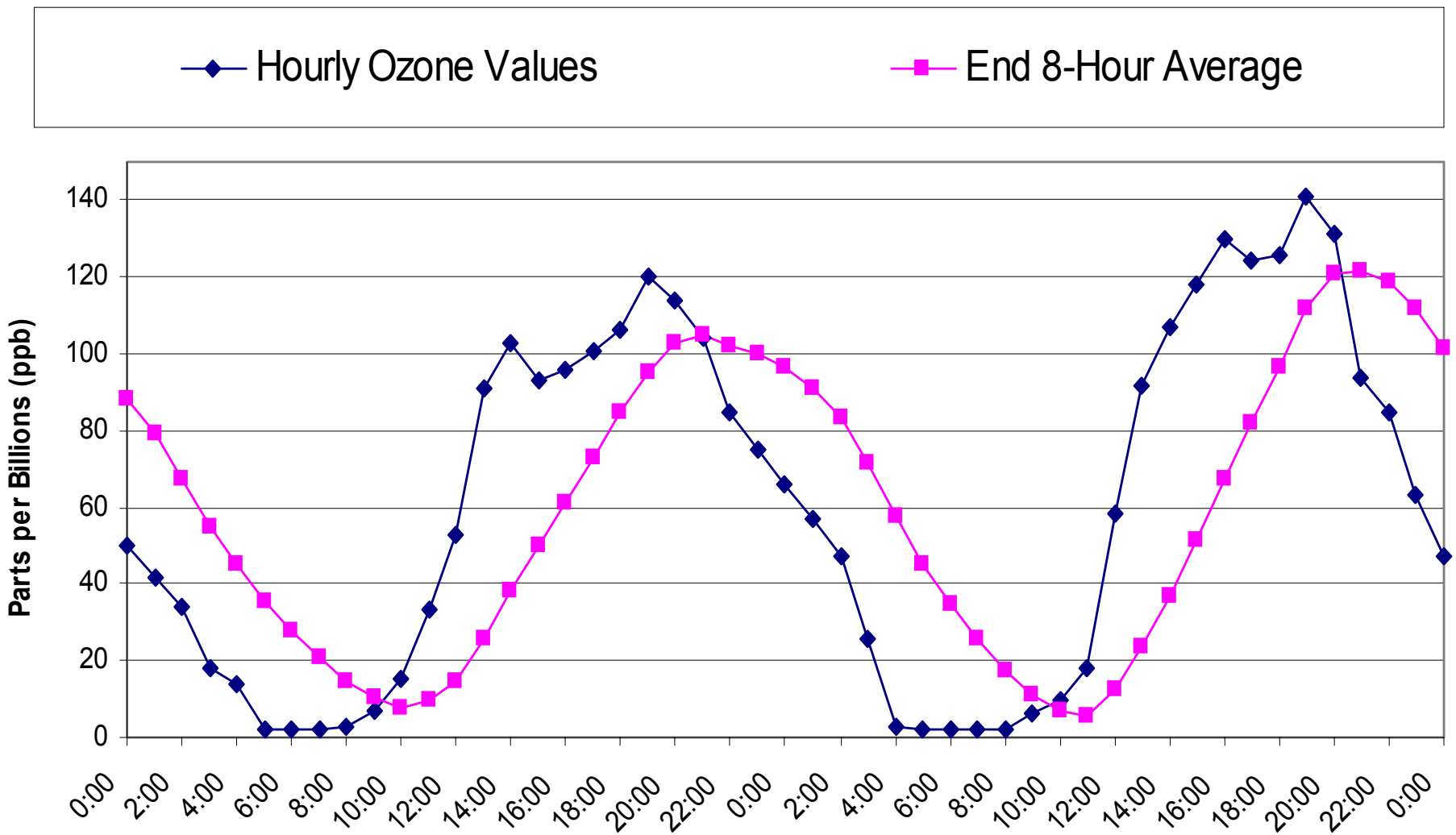
Today's Air Pollution



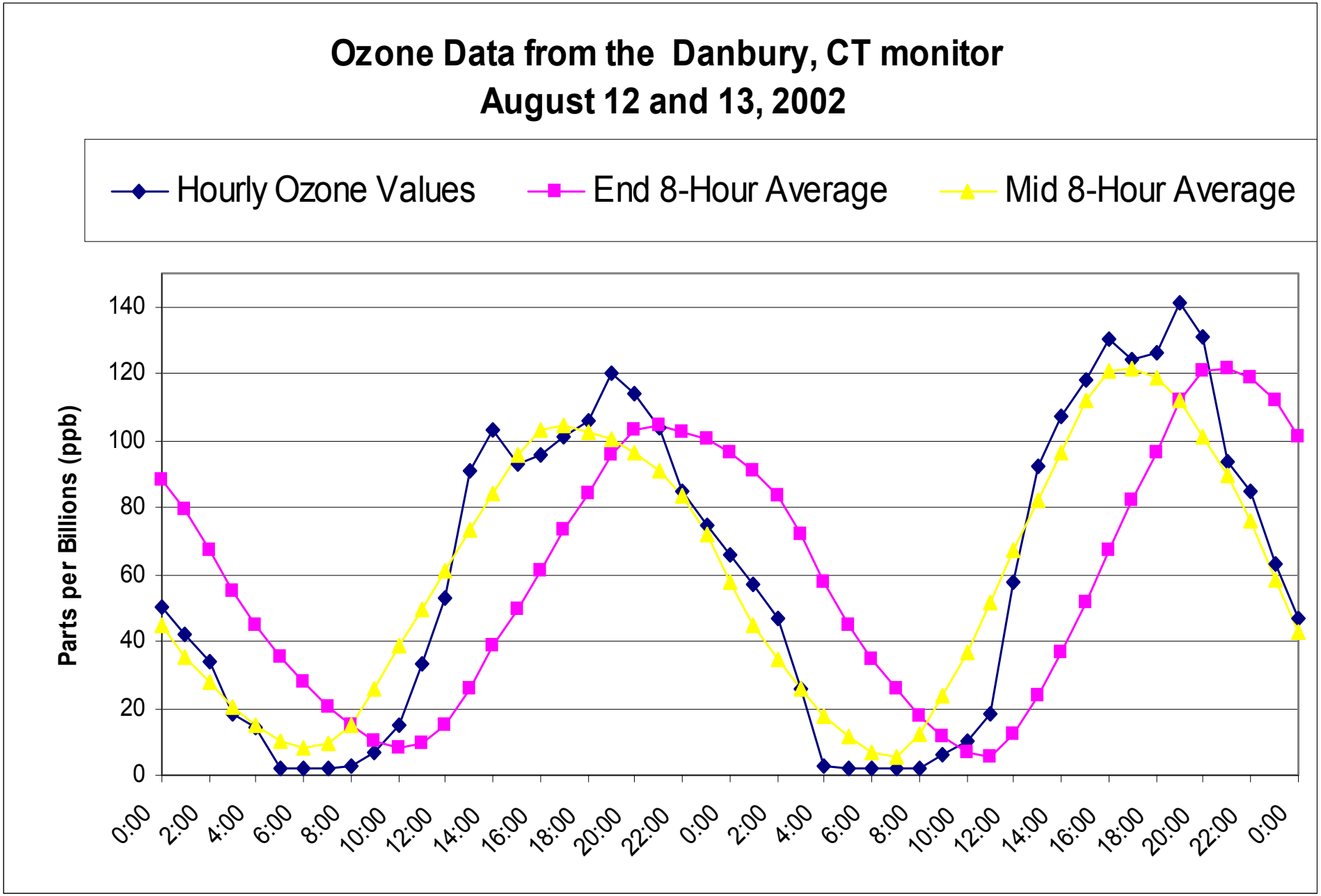
Advantages with Reporting Mid-Hour 24-hr Averages for $PM_{2.5}$

- The reported AQI will be in sync with the hourly values currently being measured (e.g., unhealthy air reports will be when maximum hourly values are being measured, not after the fact).
- The reported AQI will generally not be inconsistent with current visible conditions.
- Maintains consistency with the Air Quality Index scale and the cautionary statements for $PM_{2.5}$.
- Consistent with how real-time ozone mapping is done.

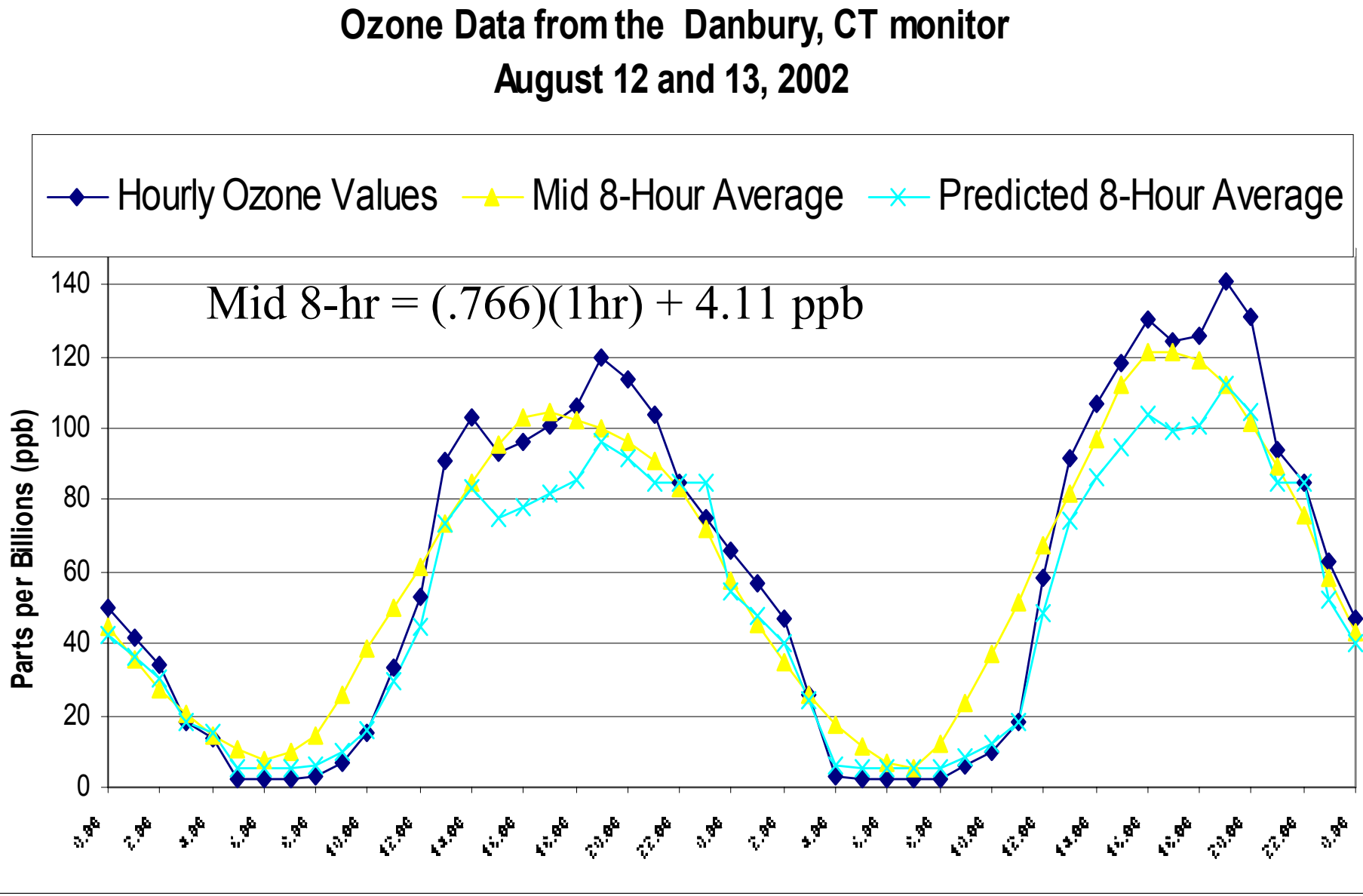
Some Problem Was Dealt with for Reporting Real-time Ozone



Ideal Way to Report Real-time Ozone is by Mid 8-Hour Average



Based on the relationship between peak 1-hr and peak 8-hr values, a method was developed to predict mid 8-hr averages



How Do We Report Mid Hour 24-hr Averages on a Real-time Basis?

- Mid hour 24-hour averages **cannot** be reported on a real-time basis based on a full 24 hours of collected data.
- However, mid hour 24-hour averages can be used as the standard to judge methodologies that attempt to predict the "current AQI" using a combination recently collected data (e.g., the most 12 hours) and other parameters.

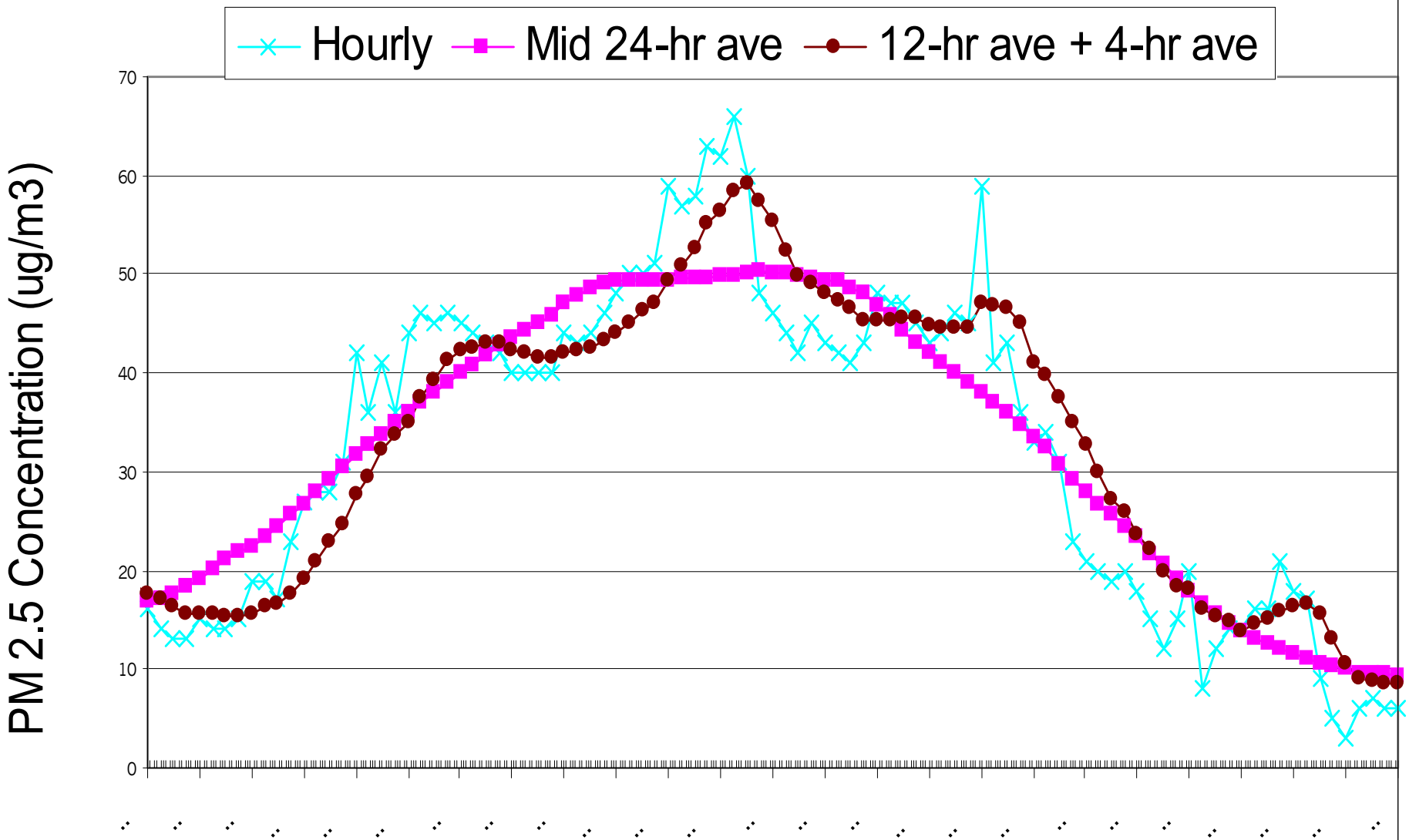
Reporting Mid Hour 24-hr Averages on a Real-time Basis

- The method we developed previously used the most recent period of data (i.e., the most recent 4 hour average) as a predictor of future values.
- The general rule of thumb for calculating the mid hour 24-hour average was:

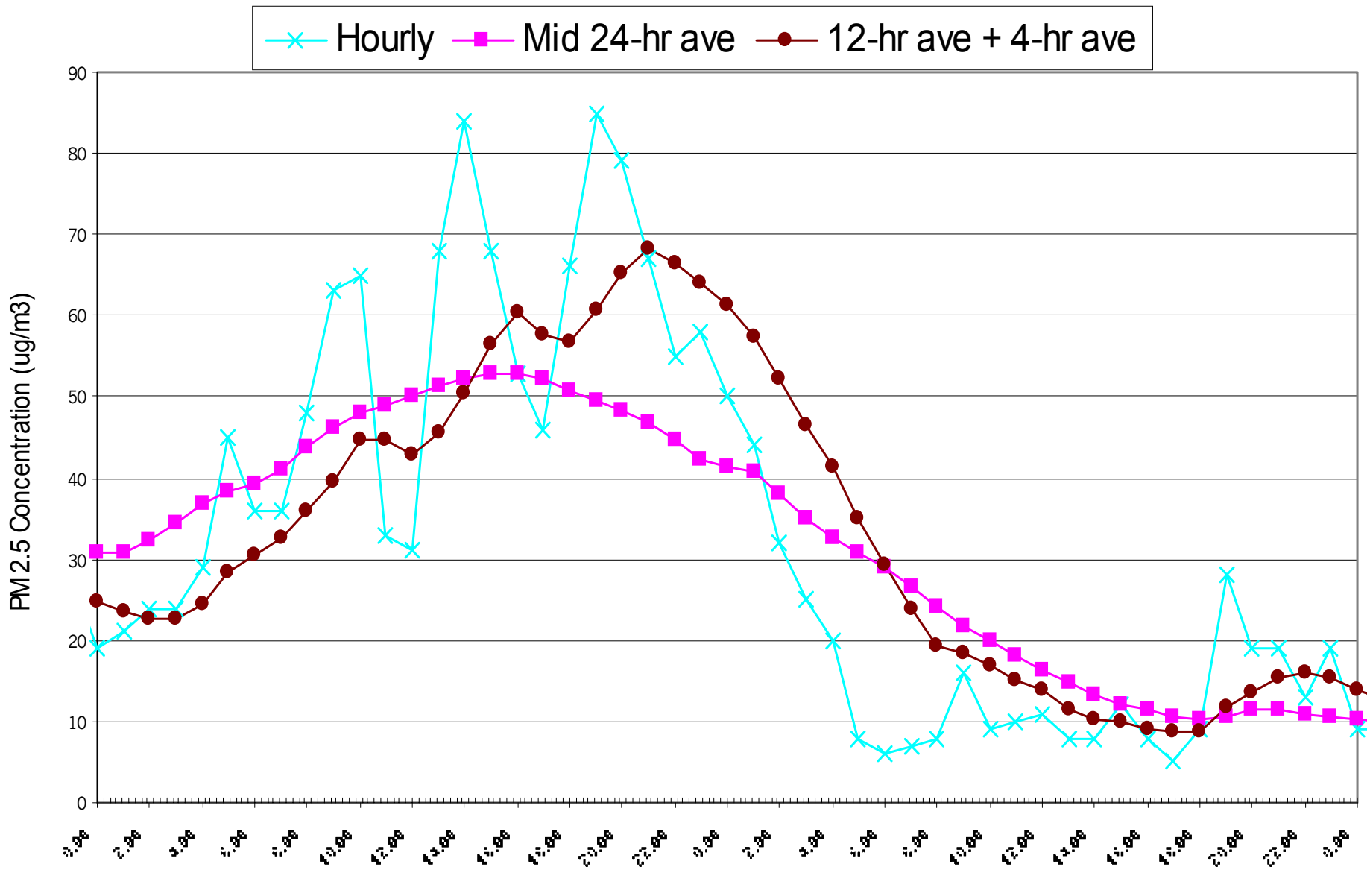
Mid 24-hr ave. = (12*(12-hr ave.) + 12*(4-hr ave.))/24

- Since the most recent period of data is heavily weighted in the calculation of a "predicted" mid hour 24-hour average, the resulting AQI is responsive to the hourly data.

Waterbury, CT PM2.5 Concentrations
August 12 - August 15, 2002



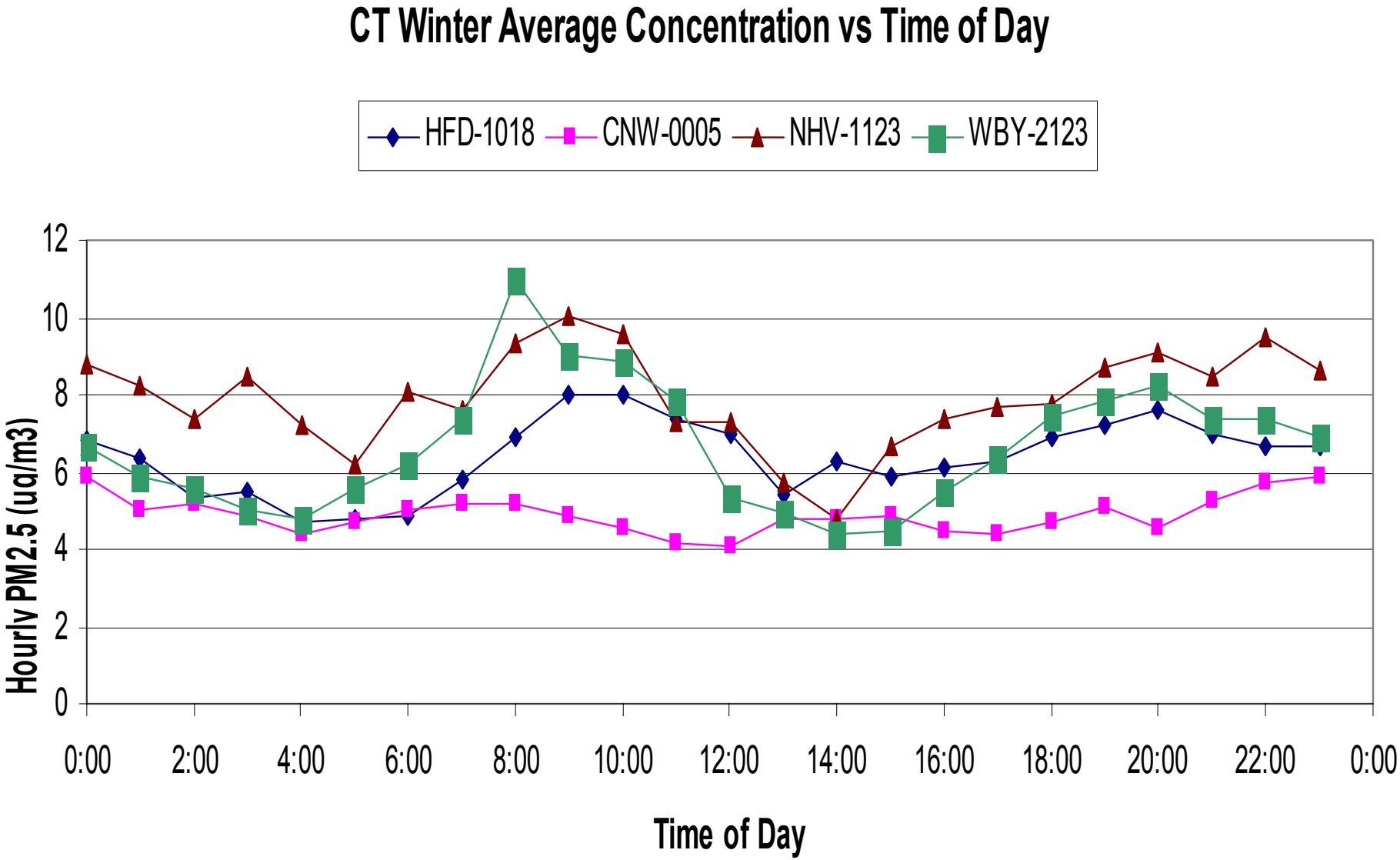
Boston, MA PM2.5 Concentrations
November 21 and 22, 2002



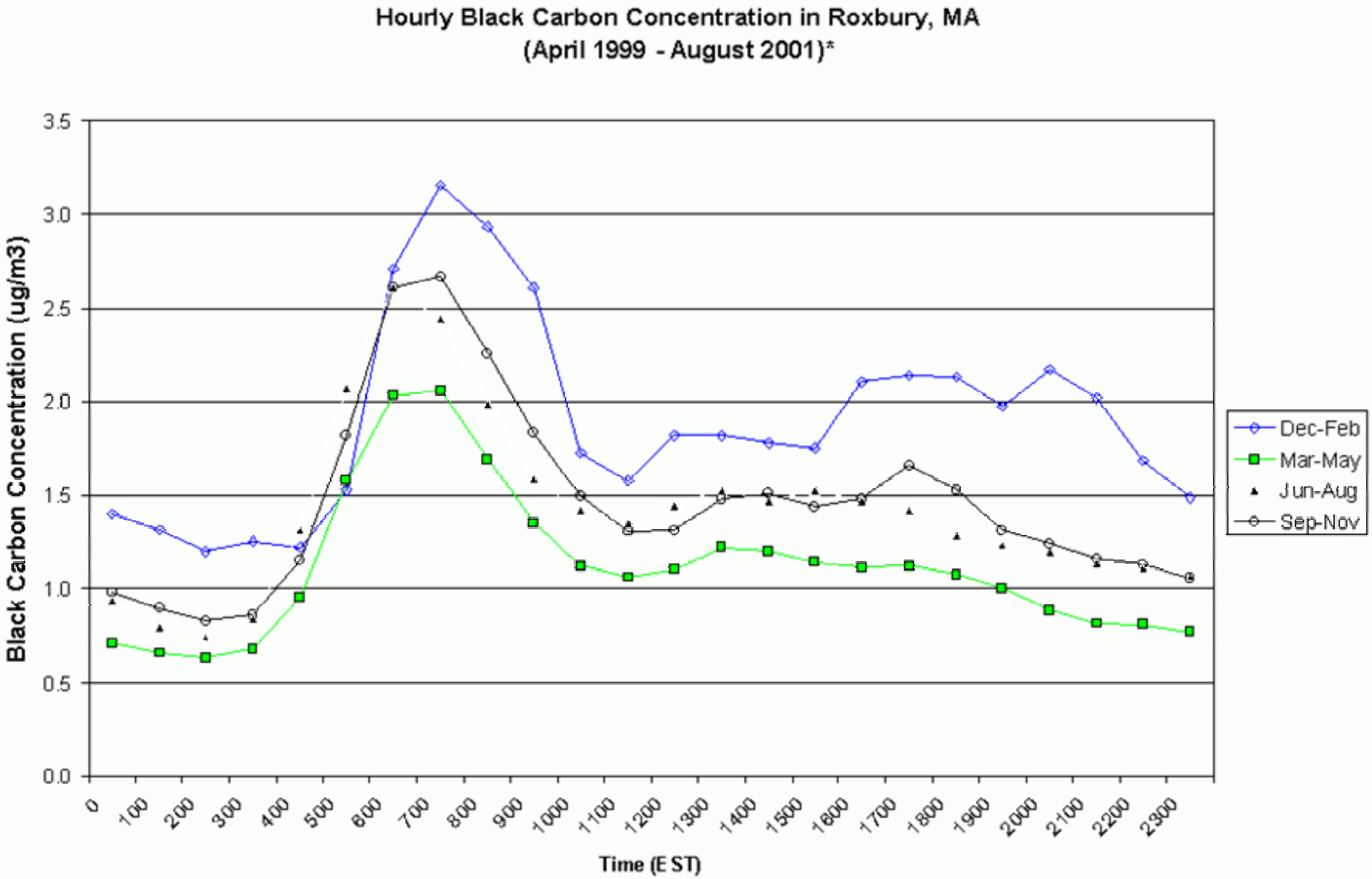
Dealing With Peak Hourly Values

- One way to deal with the over prediction is to look closely at time of day trends and don't weight data as much during the typical peak periods (e.g., 6 a.m. to 11 a.m.).
- This especially important in the winter at urban monitors.

Urban Monitors Typically Show a Diurnal Pattern in Winter

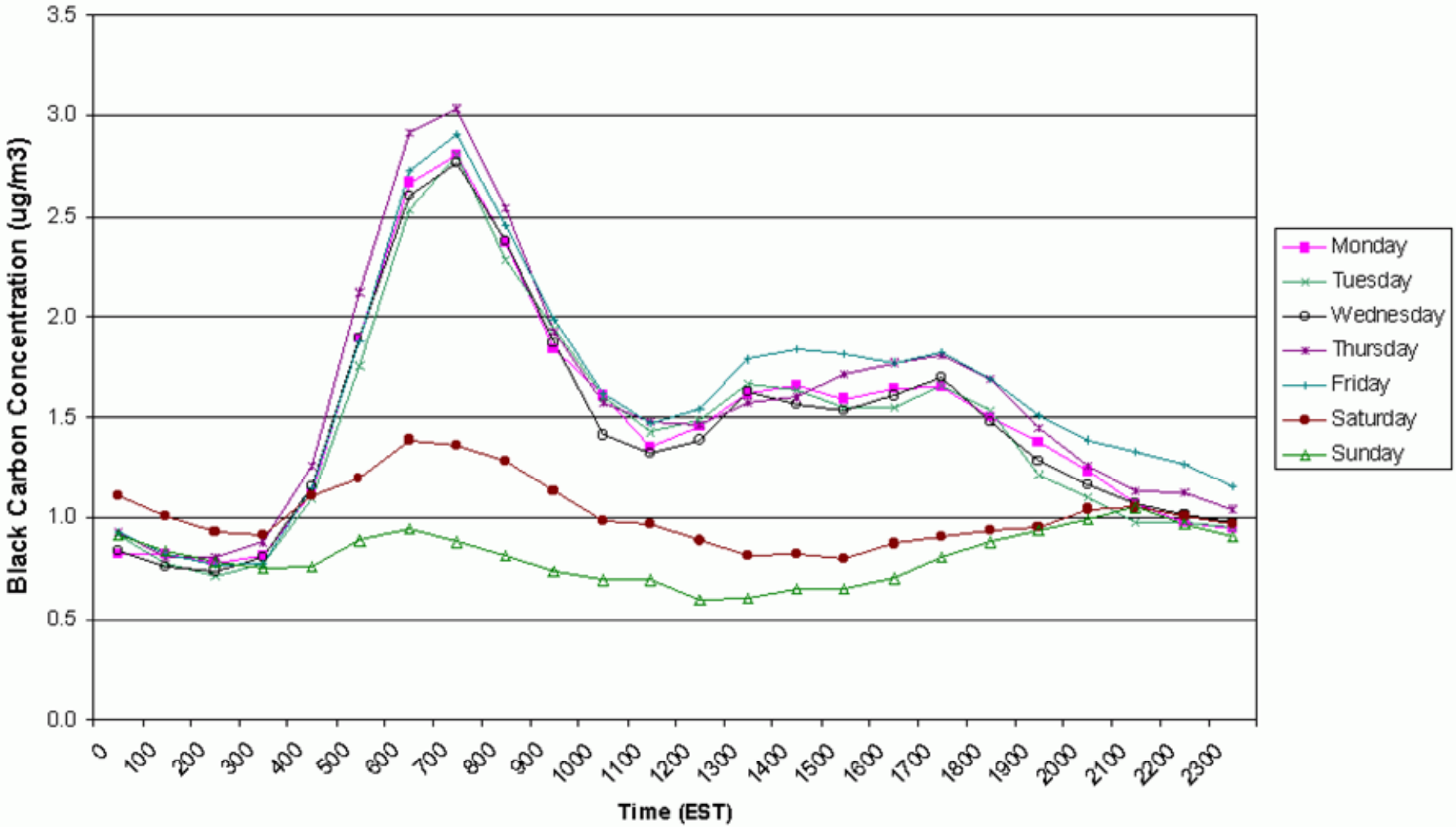


The Black Carbon Fraction Related to Transportation Emissions



* July 2000 and July 2001 not included due to poor data capture.

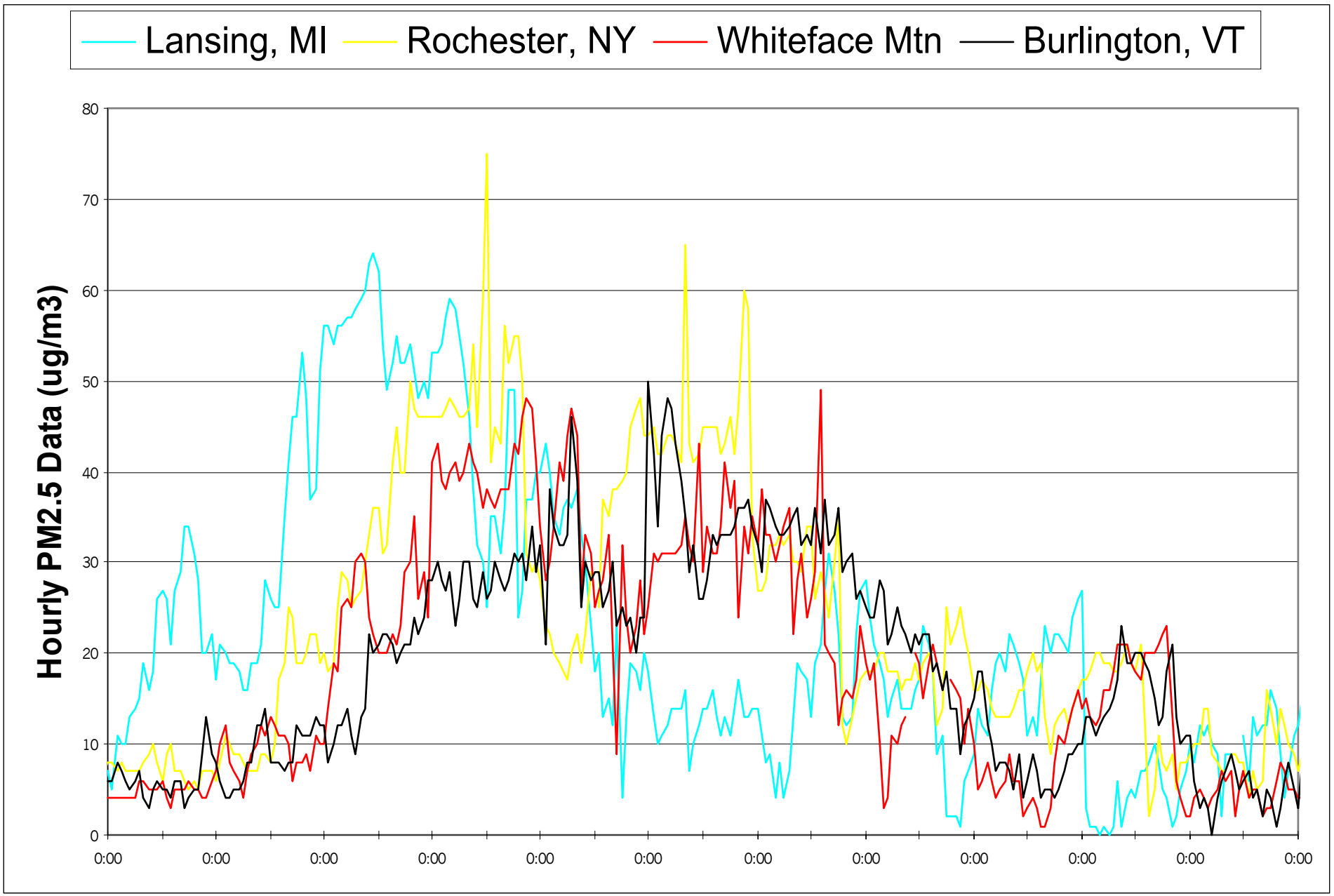
Day-of-Week Black Carbon Concentrations in Roxbury, MA (April 1999 - August 2001)*

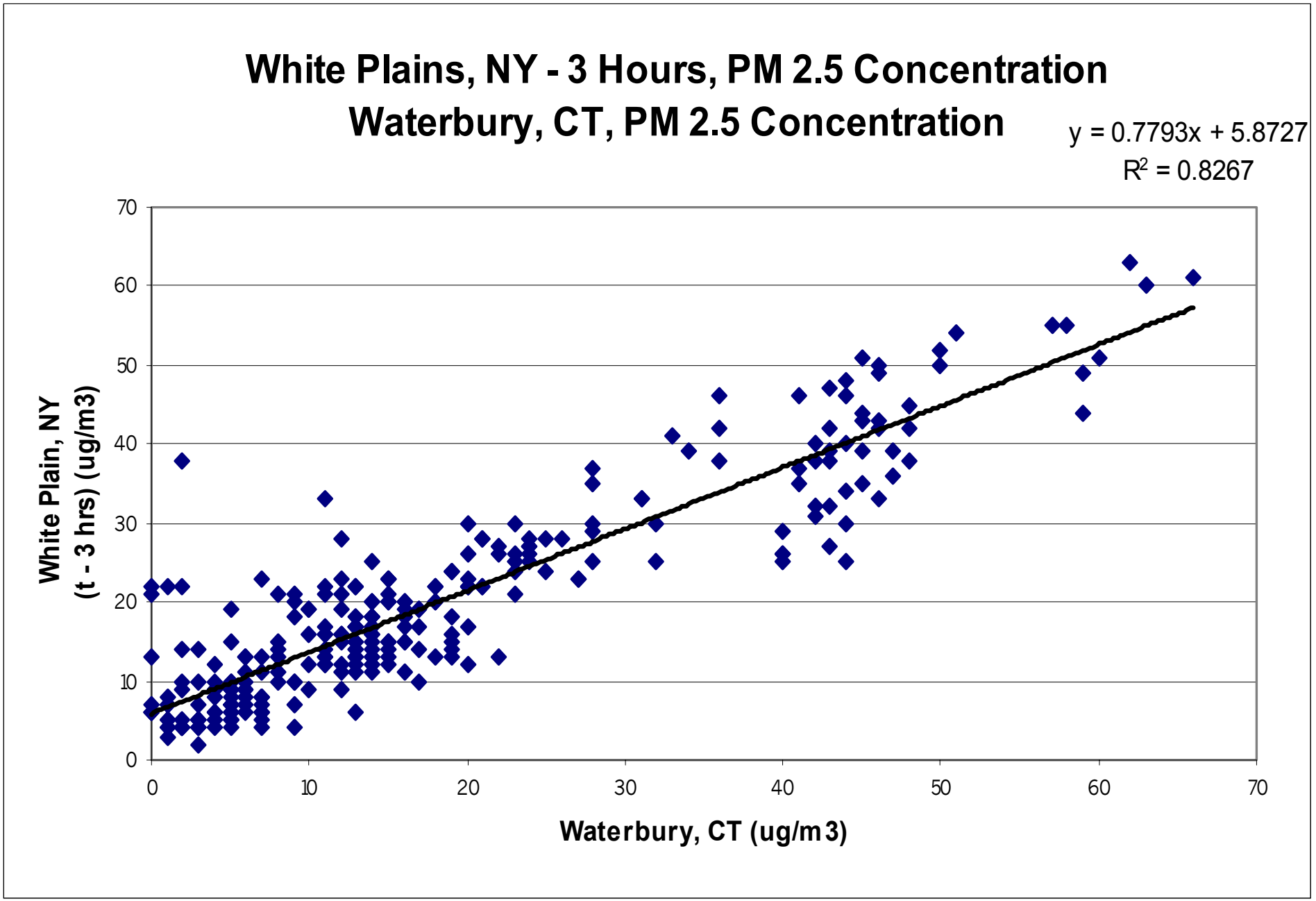


* July 2000 and July 2001 not included due to poor data capture.

Dealing With Peak Hourly Values

- Another way to deal with the over prediction is to look at upwind data and don't weight data as much when upwind data is falling.
- Important in eastern U.S. where transport is an issue.

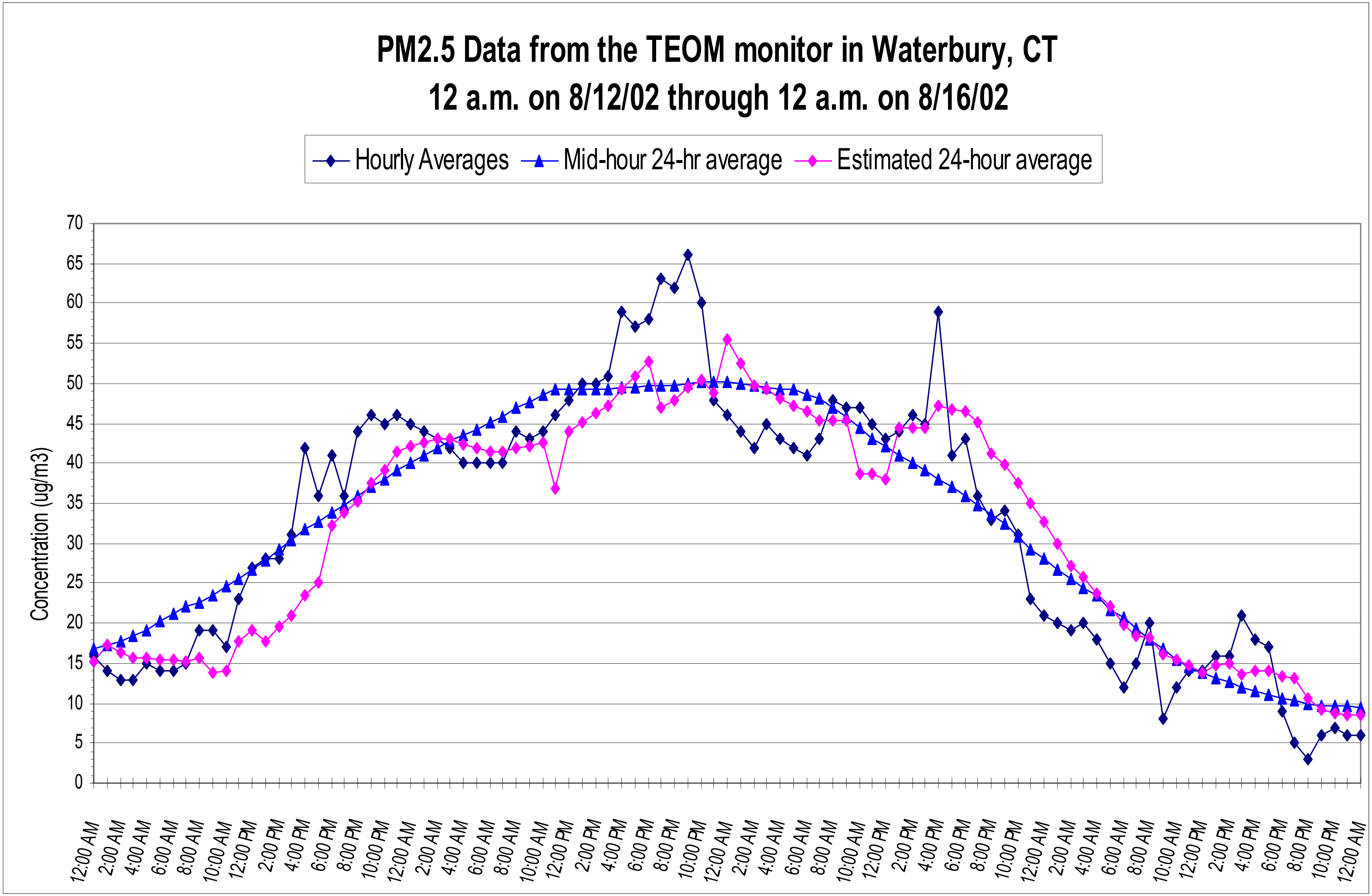

Lansing, MI
Rochester, NY
Whiteface Mtn
Burlington, VT
Hourly PM2.5 Data (ug/m3)
80
70
60
50
40
30
20
10
0
0:00
0:00
0:00
0:00
0:00
0:00
0:00
0:00
0:00
0:00
0:00
0:00


White Plains, NY - 3 Hours, PM 2.5 Concentration
Waterbury, CT, PM 2.5 Concentration
y = 0.7793x + 5.8727
R2 = 0.8267
White Plain, NY
(t - 3 hrs) (ug/m3)
Waterbury, CT (ug/m3)
0
10
20
30
40
50
60
70

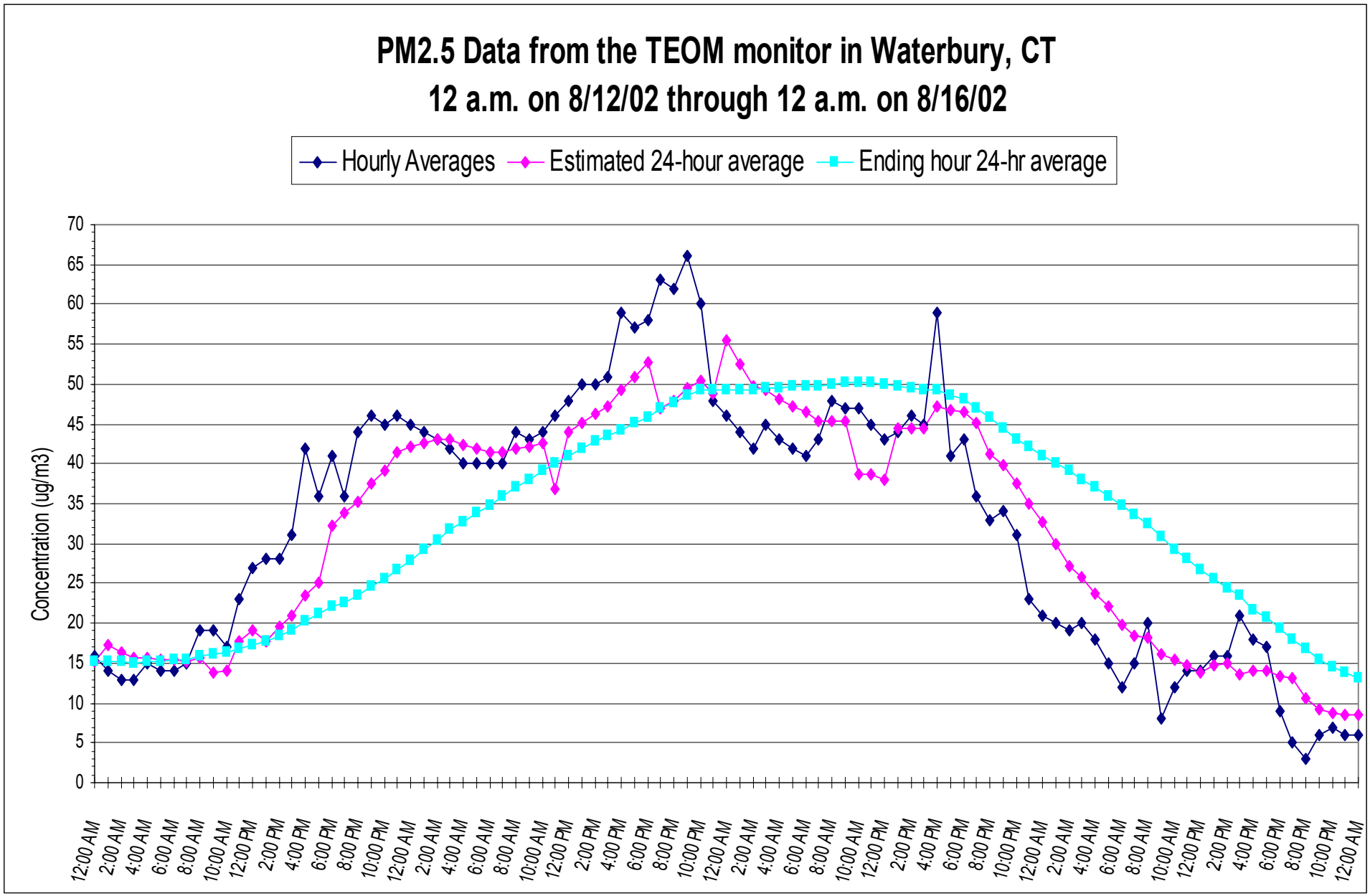
Predicting future data using "upwind" data

- When the most recent 4-hour average is elevated compared to most the recent 12-hour average, look at the trend in upwind data.
- If the upwind data trend is upwards, keep weighting at the downward site as is.
- When upwind data is downward, do not count the most recent 4-hour average as heavily in the prediction calculations.

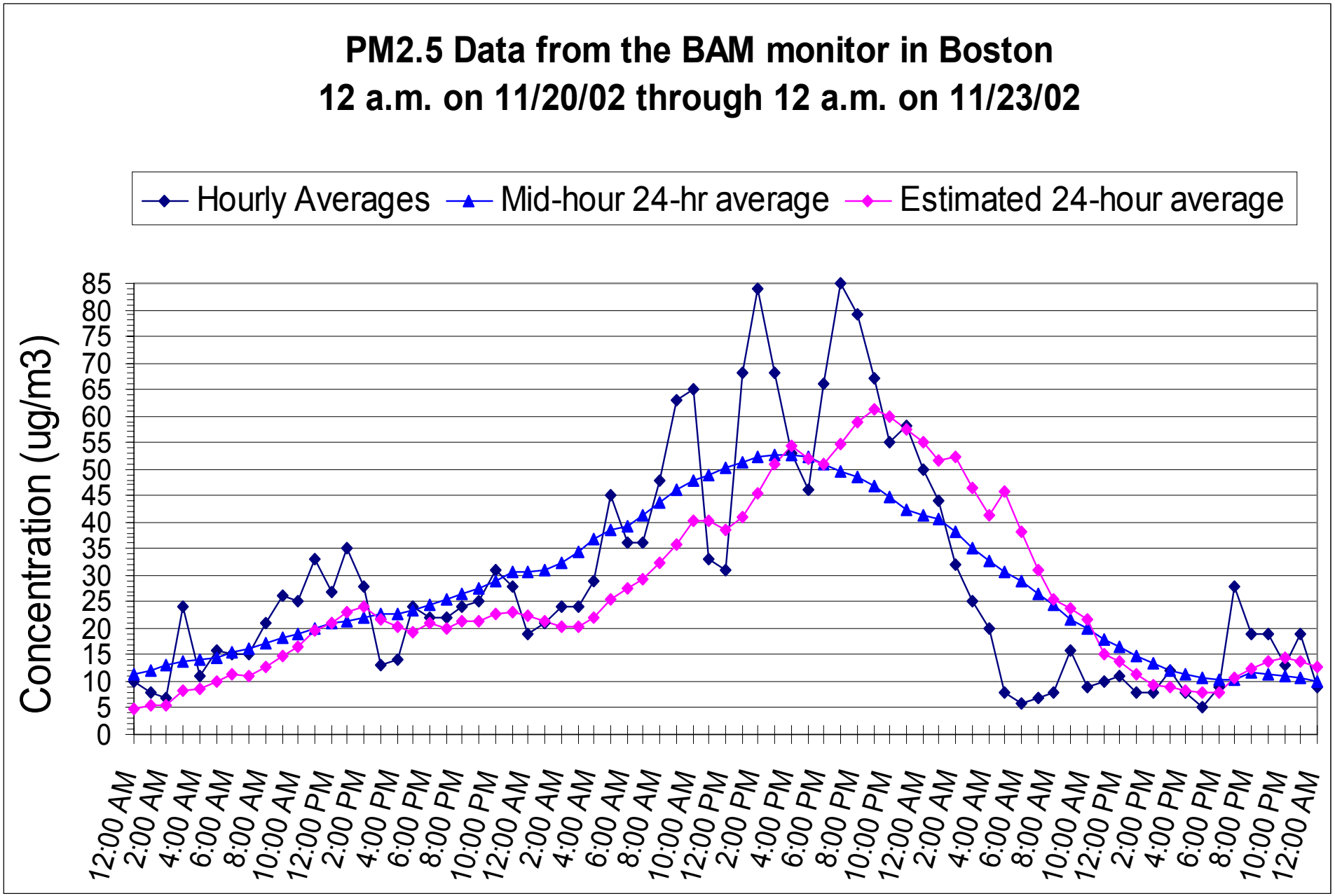
Predicted versus Mid-hour in the Summer



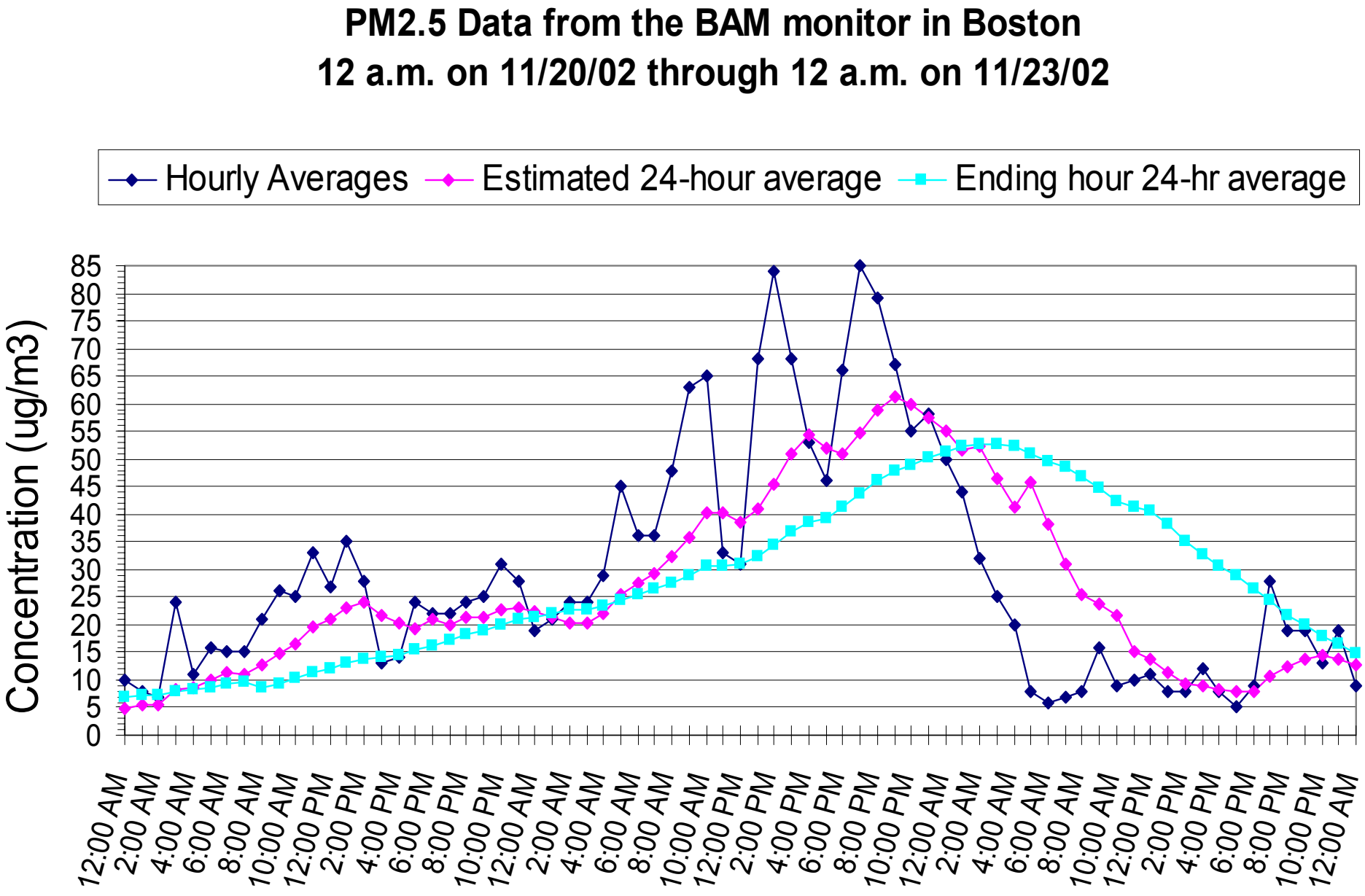
Predicted versus End-hour in the Summer



Predicted versus Mid-hour in the Winter



Predicted versus End-hour in the Winter



Conclusion

- Reporting the AQI based on mid 24-hour average will result in an AQI that is sync with the hourly values currently being measured.
- Methodologies can be developed to estimate mid 24-hour averages and used in PM2.5 mapping.
- Such an approach will maintain consistency with the Air Quality Index scale and associated cautionary statements for $PM_{2.5}$.