Preliminary Results from the Philadelphia Forecast Area

William F. Ryan
Amy Huff
Department of Meteorology
The Pennsylvania State University

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Summer Weather in PHL

- Average temperature at PHL for summer season (JJA) ~ +1.4 F above average.
- Precipitation was +4.4” but all due to 4.7” excess in June.
- 33 days of measurable precipitation, 29 was 1997-2005 average.
- 25 days ≥ 90º F. This less than 2005 (27) and slightly higher (23) than 1997-2005 average.

2006 Ozone in PHL

- Two days reached Code Red (≥ 105 ppbv) and 17 days reached Code Orange.
- Average for 1997-2005 is 8 and 22 respectively.
- Only two monitors reached Code Red during season. 12 of 17 Code Orange days were two monitors or less.
- Regional O_3 falling?

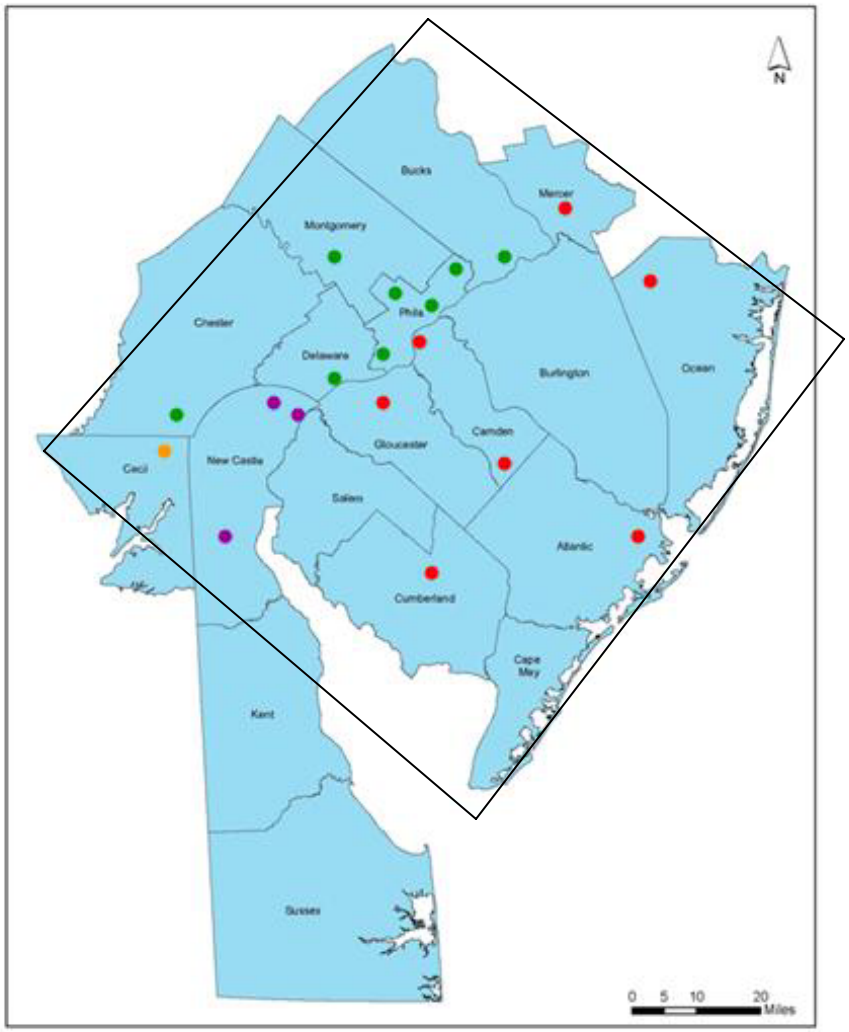
Areas of Investigation

- Operational Model: Can the 0600 UTC run be relied on for forecast guidance?
- Experimental Model: How well does it perform in the higher O_3 cases? Does it show any overall bias?
- $PM_{2.5}$ Model: In the ballpark?

Operational 0600 UTC Run

- Looked at 9 “problem” monitors in PHL and determined daily 8-hour maximum O_3 forecast using NOAA website point data.
- Used peak of 9 monitors as a proxy for domain wide peak O_3.
- 85 of 106 days collected full data set and used in forecast preparation.

PHL Air Quality Forecast Area



9 of 19 monitors used
For verification:

2 Southwest
3 Along I-95
1 Northwest
1 Southeast
2 Northeast

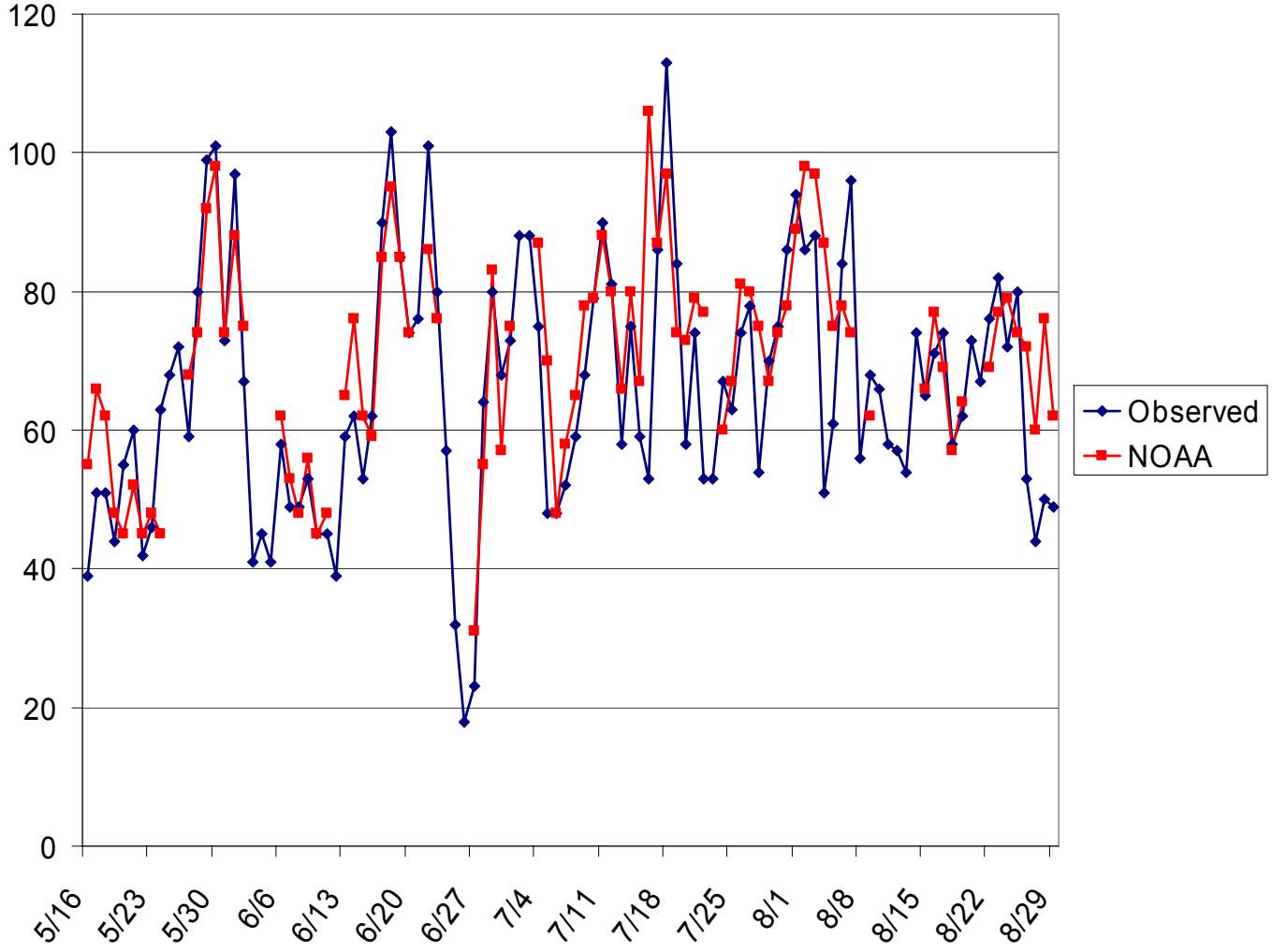
Basic Verification: PHL Domain Maximum O_3

- Bias + 3.1 ppbv
- Mean absolute error 8.5 ppbv and median absolute error 6.0 ppbv.
- Best statistical model for same days: Bias = +4.9 ppbv, Mean AE = 9.1 ppbv, Median AE = 7.7 ppbv.

Performance in High O_3 Cases

- Model results not available for two cases.
- Correctly forecast Code Orange cases on 14 of 17 days (Consensus forecast 13/17).
- Cost of only 3 False Alarms (convection an issue in one case).
- Under-predicted 2 Code Red cases but did not wildly over-predict during heat wave of July 31-August 3.

Domain Maximum Ozone: PHL



Monitor Specific Forecasts

- For set of 9 monitors:
  - Range of Bias: - 2 to + 6.8 ppbv
    - Underpredicted at PNE (urban) and overpredicted at Collier's Mills (exurban)
  - Range of Mean AE: 8.6-11.7 ppbv
    - Best at Fair Hill (MD) and worst at PNE.
  - Range of Median AE: 6-8 ppbv
    - Best at Rider, NJ along I-95 Corridor.

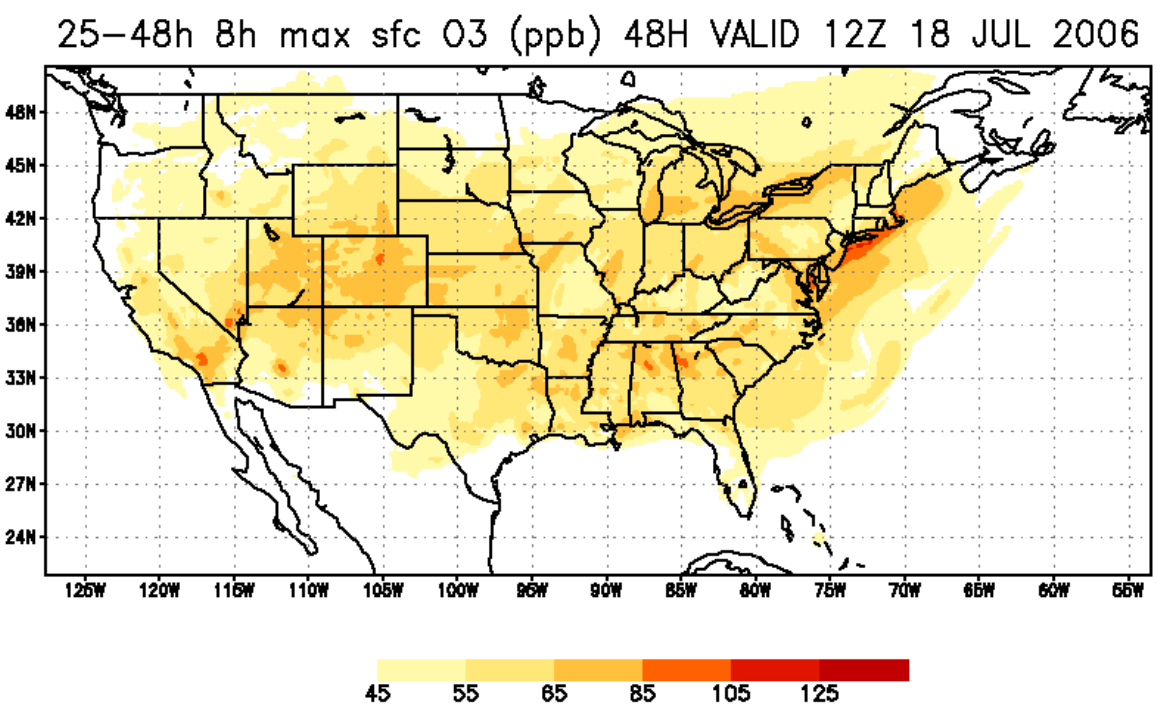
Experimental Forecast Model: Domain Maximum

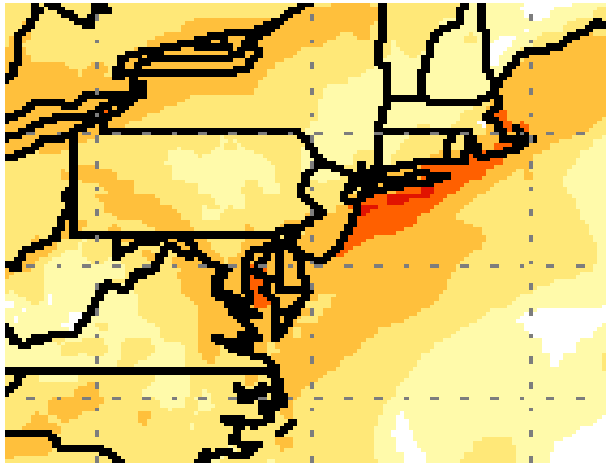
- Data Collected July 24-August 30. Full data for 34 of 38 cases.
- Only one period of high O_3 (July 31-August 3)
- Overall Statistics
  - Bias: 1-hour: -2.8 ppbv, 8-hour: +1.7 ppbv
  - Mean AE: 1-hour: 11 ppbv, 8-hour: 8.8 ppbv
  - Median AE: 1-hour: 8.8 ppbv, 8-hour: 5.0 ppbv

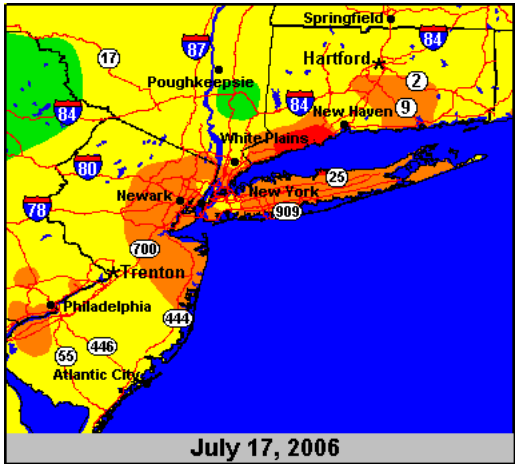
Experimental Model: High Ozone Cases

- Domain maximum as determined from posted or archived forecast images on NCEP site.
- 16 of 19 cases had 1200 UTC model runs.
- Model did not predict ≥ 85 ppbv O_3 for any of the 16 cases.
- Typically highest O_3 was found just offshore of forecast area.

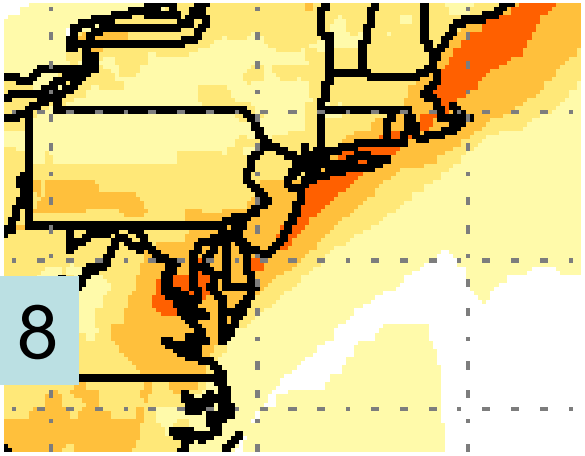
Example: July 17, 2006

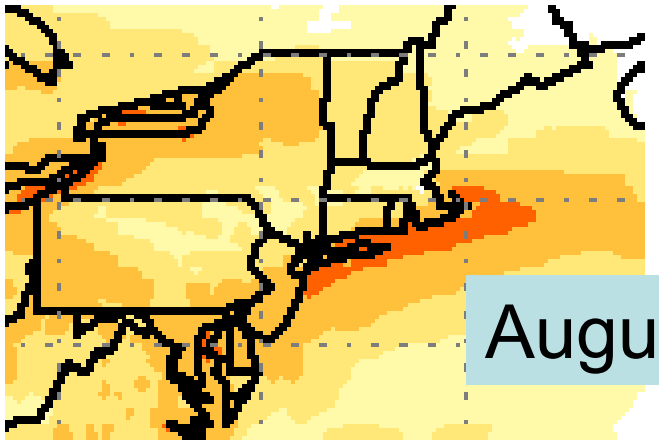


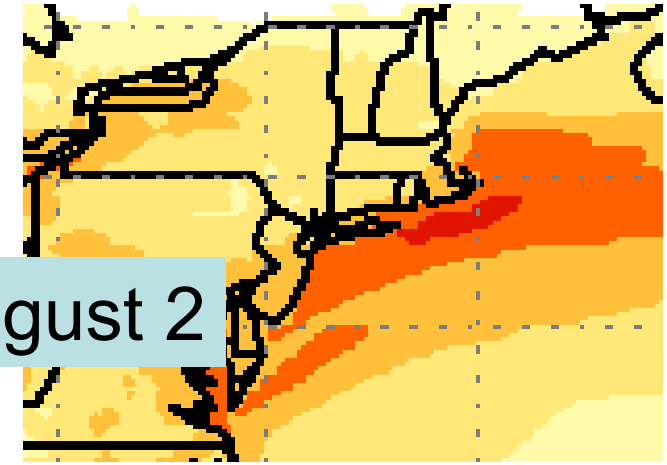


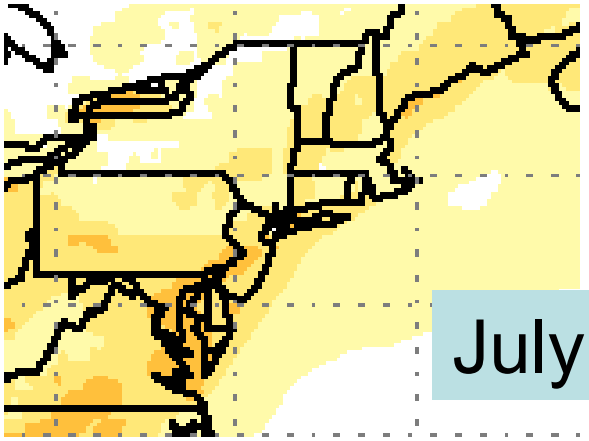


A Common Occurrence







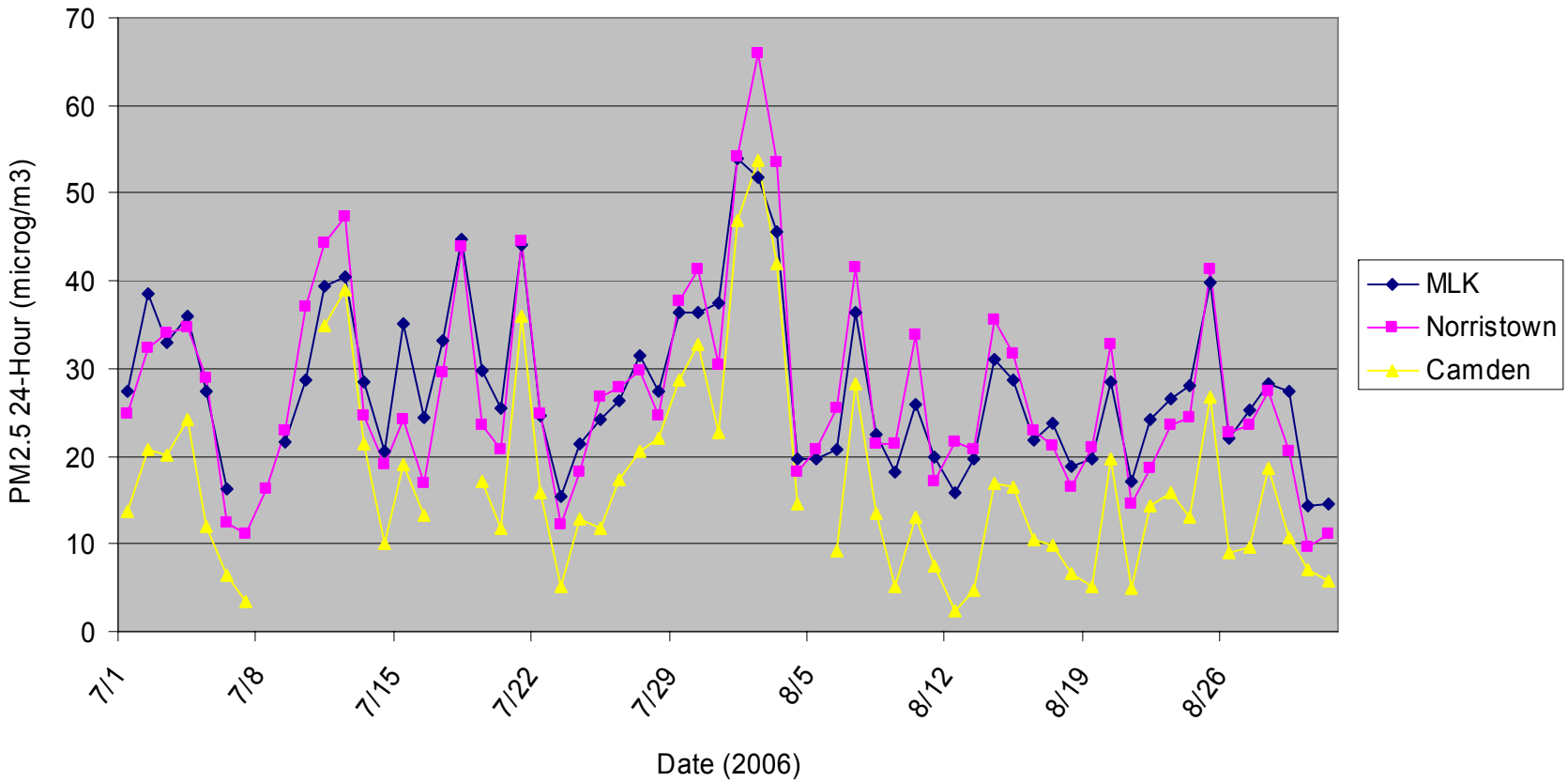


But not always……..

$PM_{2.5}$ Forecasts

- Not possible to accurately verify model performance.
- Continuous monitors often out of service or “noisy” data.
- A variety of $PM_{2.5}$ measurement techniques in PHL area including:
  - TEOM (Camden, Millville, Flemington)
  - TEOM-FDMS (Norristown)
  - BAMS (Delaware)

Different Techniques – Different Results

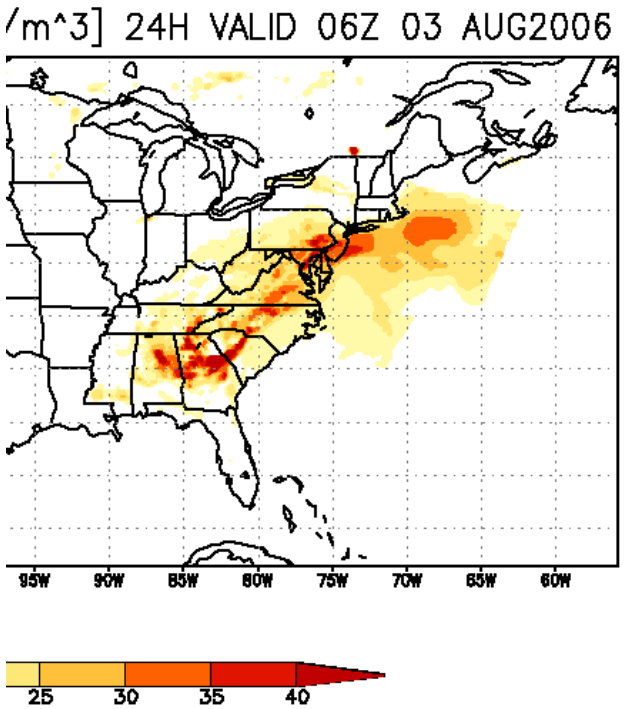


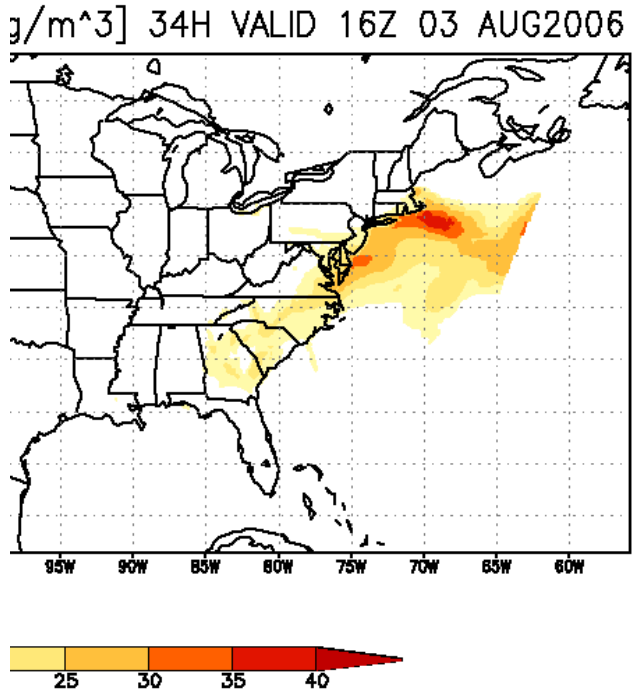
In general, an average of these three monitors most closely approximates FRM $PM_{2.5}$. But is FRM accounting for all semi-volatile $PM_{2.5}$?

Rough Verification

- In the same “ballpark”: Forecast range overlaps observed range by 5 microg/m^3.
- High $PM_{2.5}$ cases always under-predicted.
- For 36 cases from late July to late August
  - Over-predict: 2 cases
  - About right: 19 cases
  - Under-predict: 15 cases

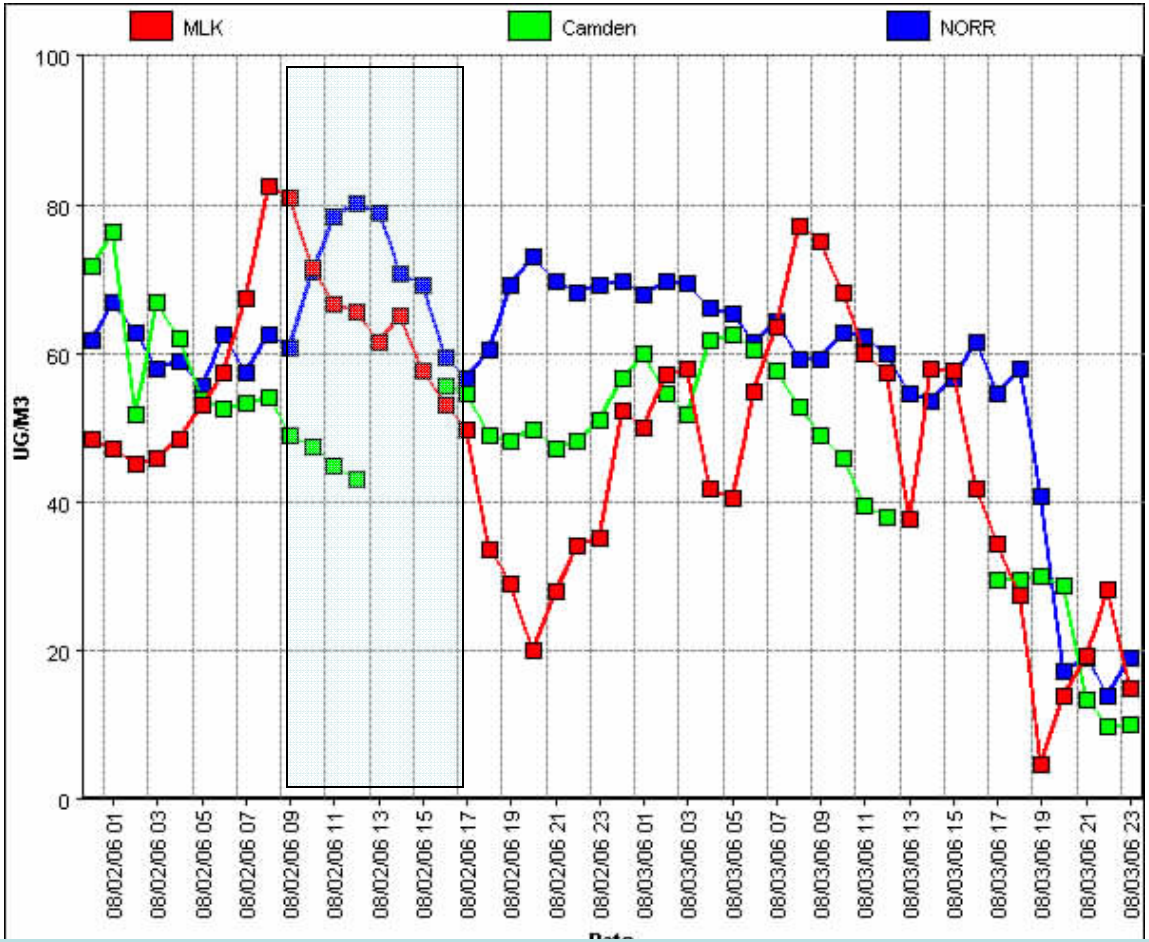
Diurnal Pattern in High $PM_{2.5}$ Cases





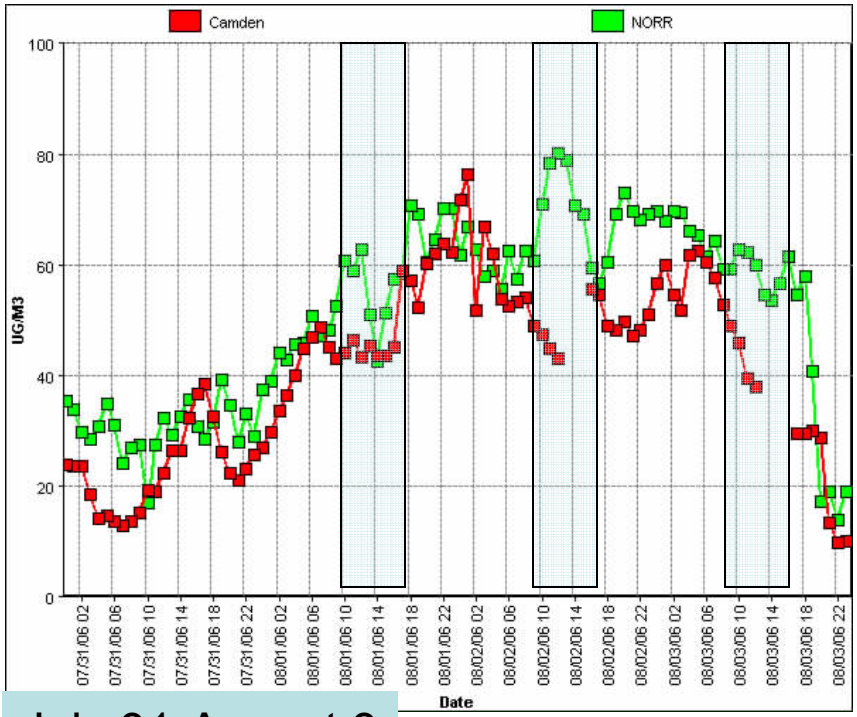
In many cases, early morning $PM_{2.5}$ close to observations but concentrations collapse as mixing occurs in afternoon.

Observed $PM_{2.5}$

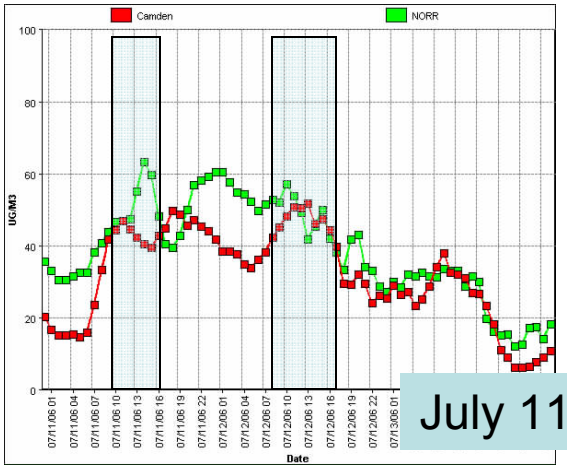


Particularly on high $PM_{2.5}$ cases (regional influences?), mid-day or well-mixed conditions do not show rapid fall in concentrations.

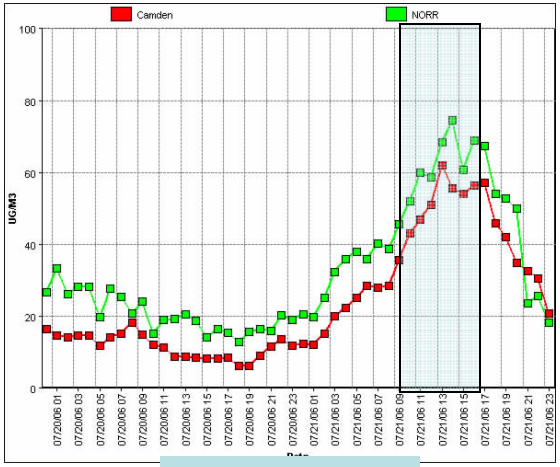
Other Examples



July 31-August 3



July 11-13



July 20-21

Conclusions for PHL Area

- Operational 0600 UTC forecasts are excellent guidance products.
- Experimental model good in average conditions but fails to resolve high O_3 cases.
- $PM_{2.5}$ forecasts, to the extent they can be fairly verified, tend to under-predict, particularly in high end cases. Regional PM limits decrease during well-mixed afternoon hours?