O_3 and $PM_{2.5}$ Forecasts with Hi-Res Air Quality Modeling System: Evaluation of 2008 & Outlook for 2009

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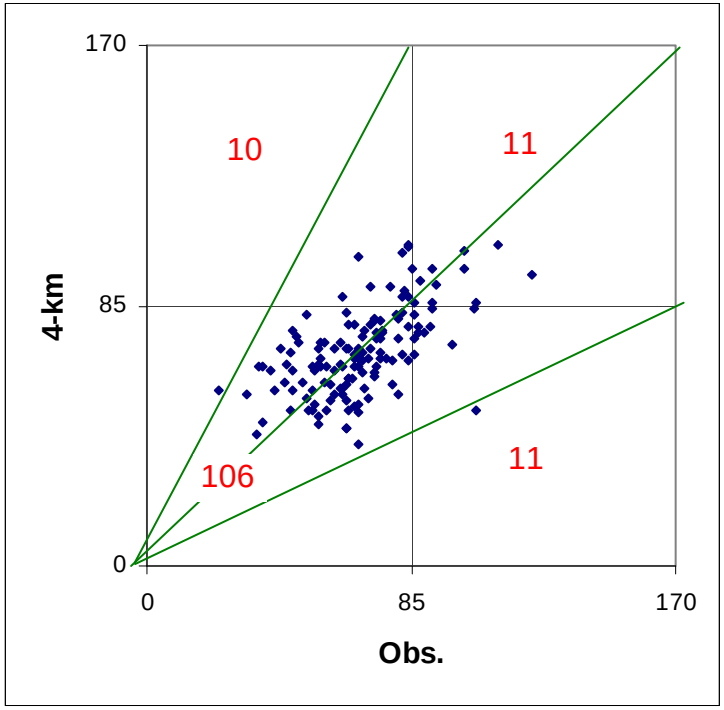
GA EPD, Air Protection Branch

Our 2008 Forecasting

- Most important difference from 2007 is 48-hr forecasts and updates every 12-hr
- New web site (http://forecast.ce.gatech.edu)
- Meteorological forecasts added
  - More locations (e.g., Fort Benning)
- Models did not change much
  - WRF version 3.0
  - Tested Georgia Tech's new SOA module in CMAQ 4.6
    - New SOA pathways: Isoprene→ SOA, Sesquiterpenes→SOA
    - This reduced underestimation of summertime PM
    - Enthalpy of vaporization for SOA was reduced
    - This helped reduce overestimation of wintertime PM

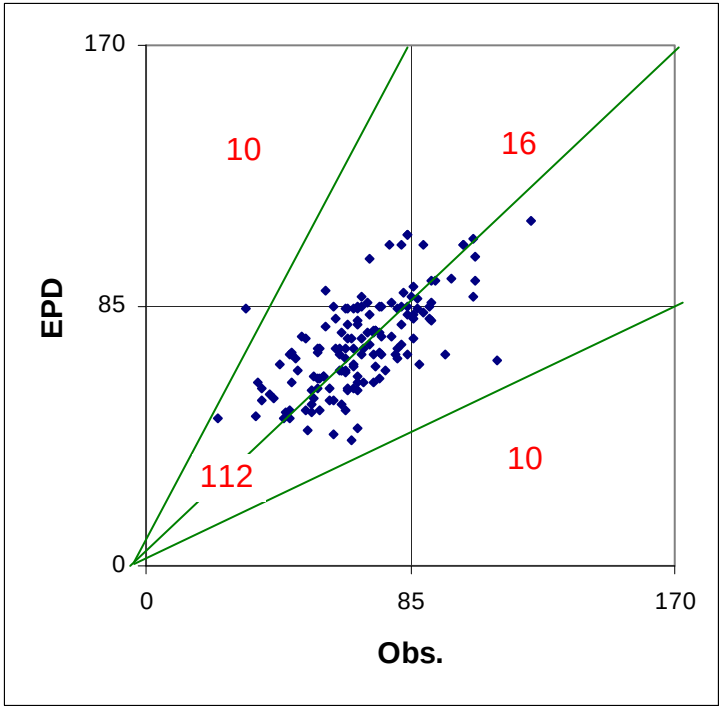
2007 O_3 Performance: 4-km vs. EPD's

Our 4-km Forecast



MNB	8.5%
MNE	19%

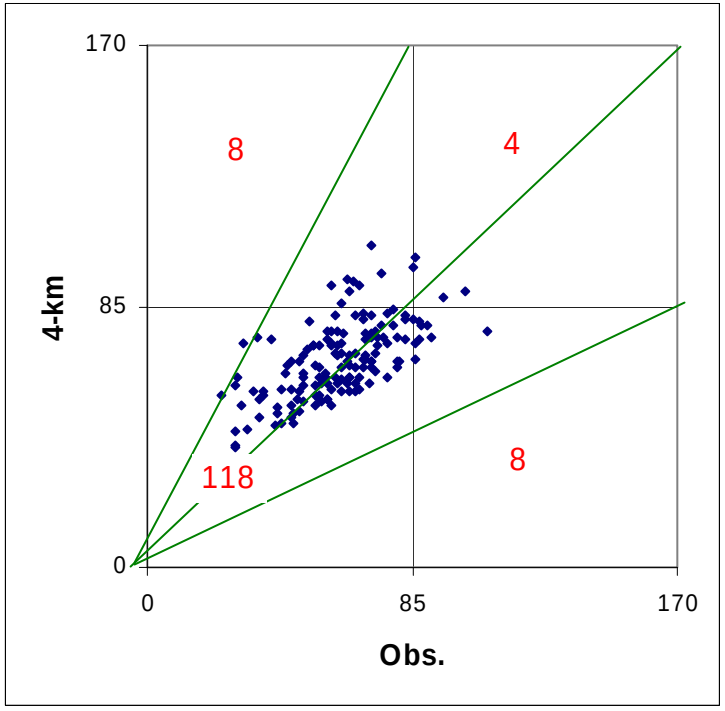
EPD Ensemble Forecast



MNB	9.0%
MNE	18%

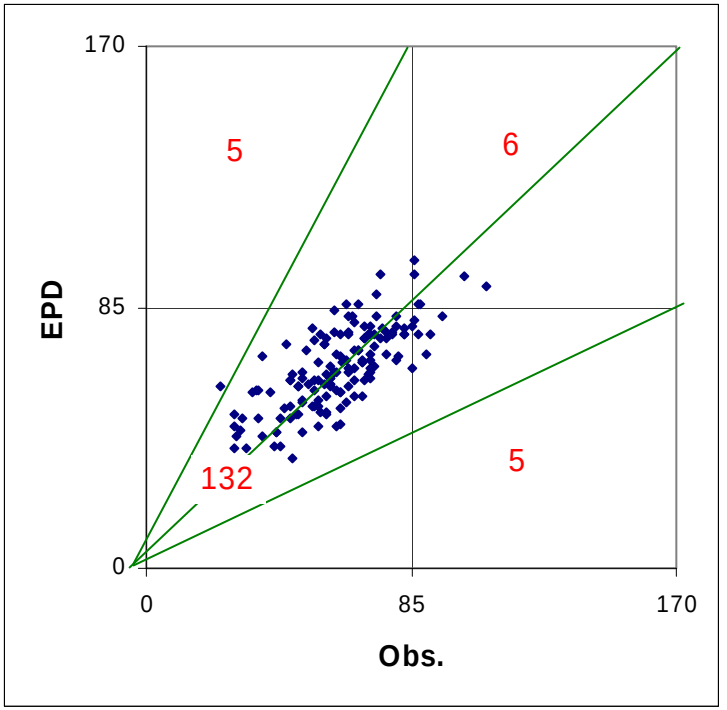
2008 O_3 Performance: 4-km vs. EPD's

Our 4-km Forecast



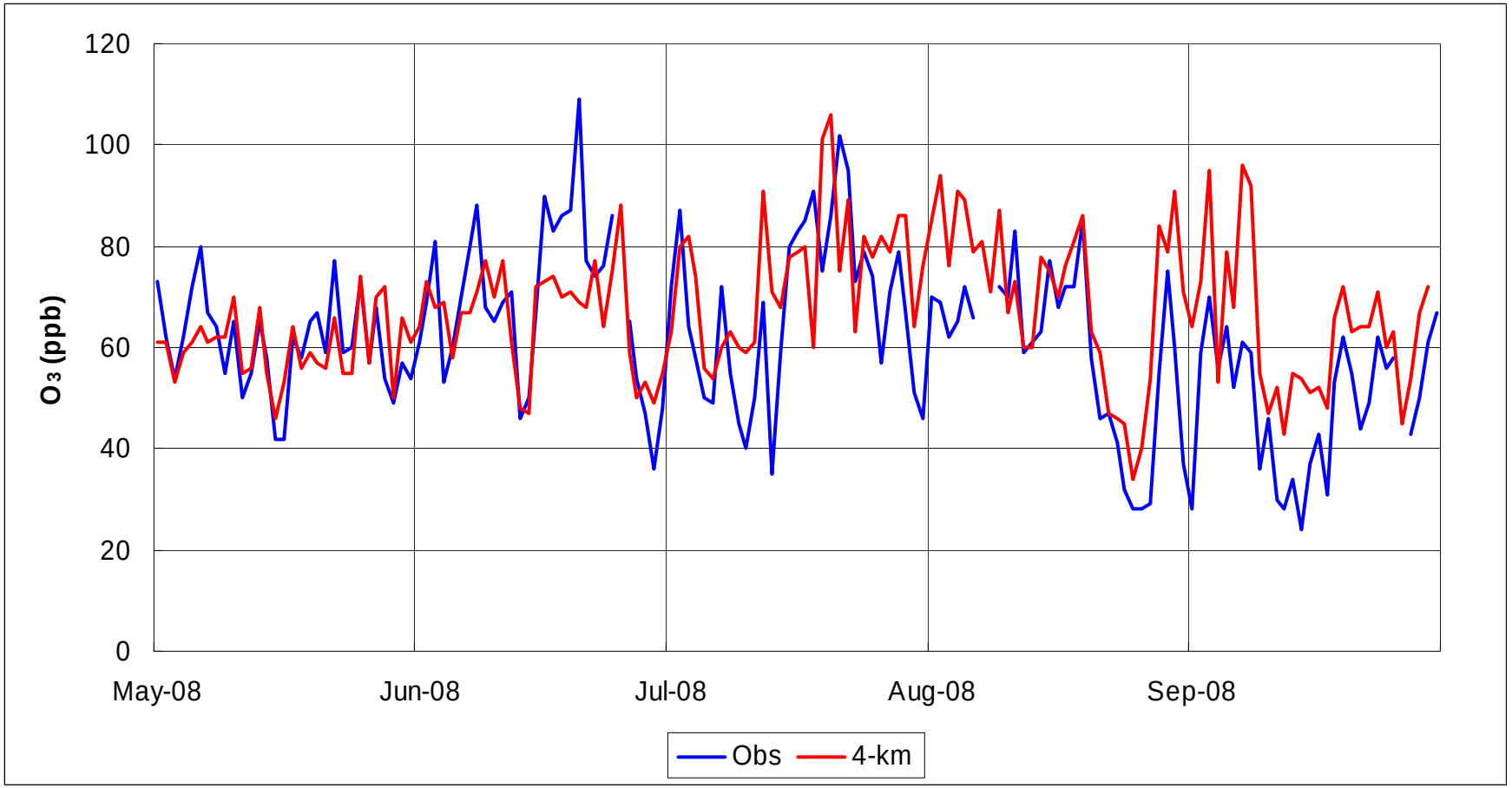
MNB	14%
MNE	24%

EPD Ensemble Forecast

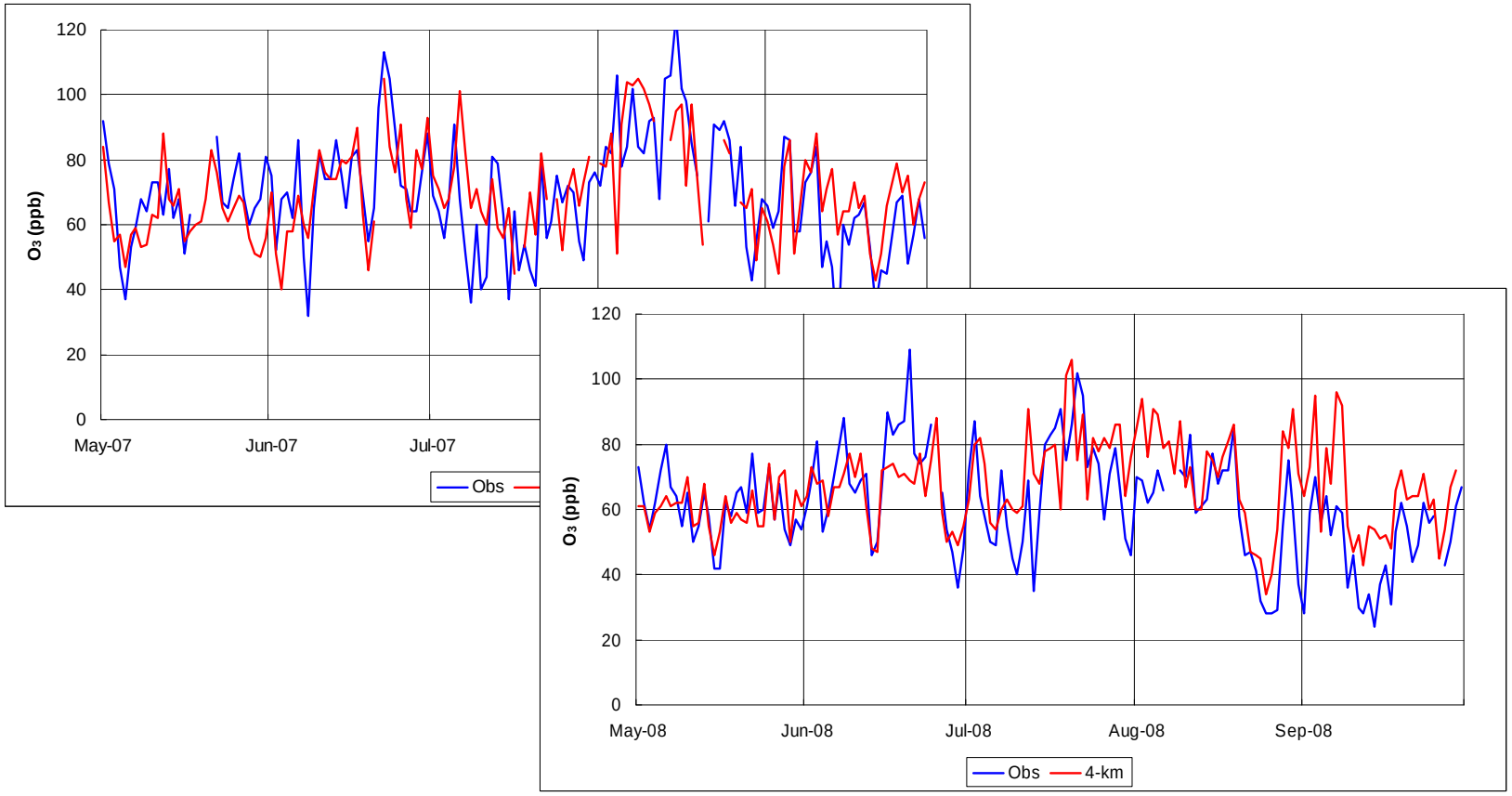


MNB	11%
MNE	19%

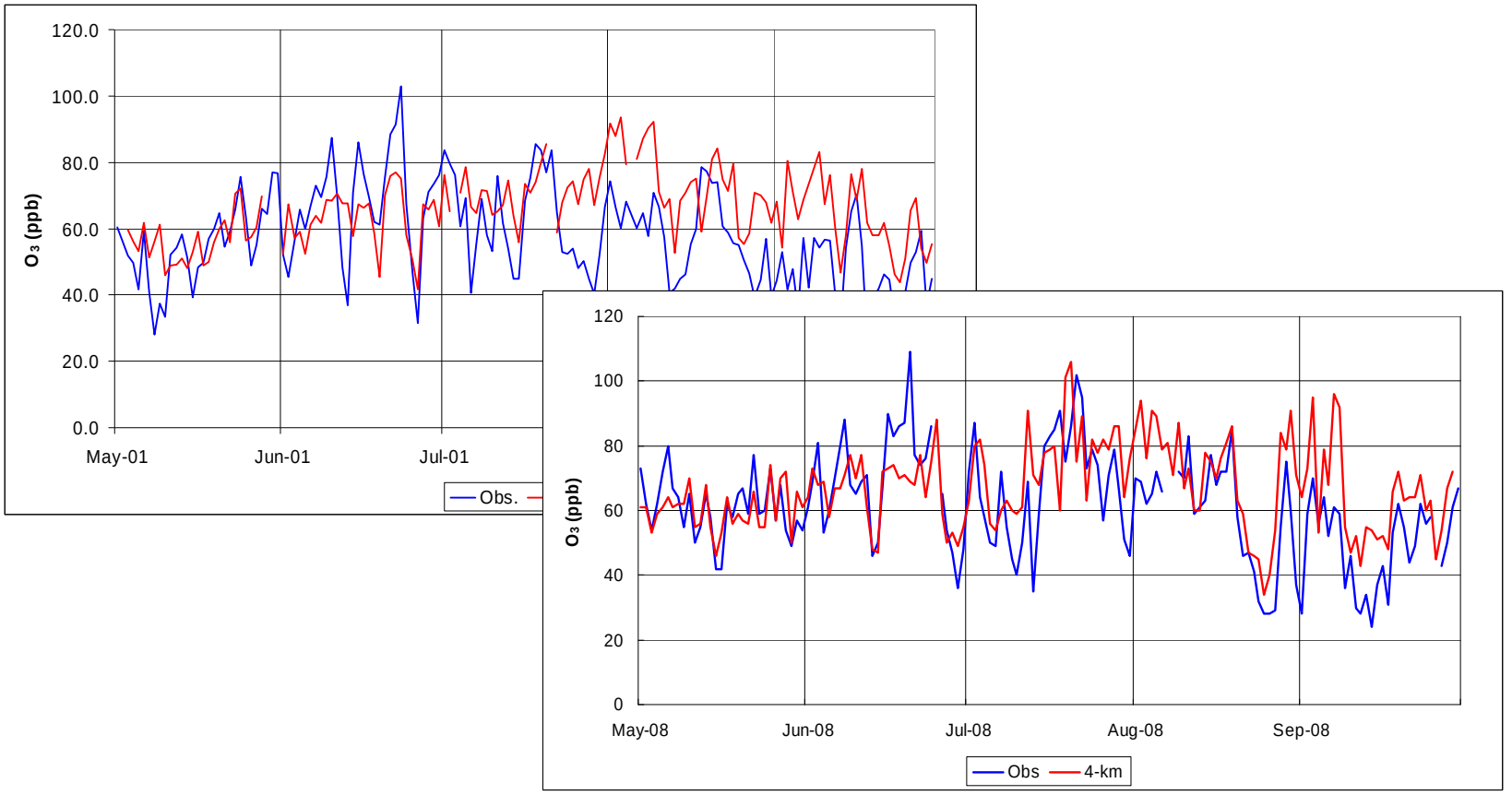
Forecast vs. Observed O_3



Ozone Season 2008 vs. 2007

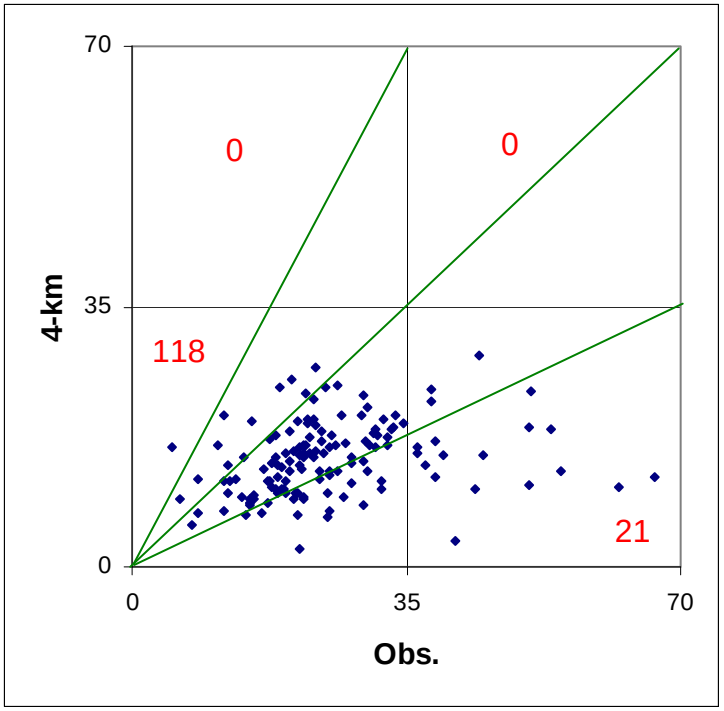


Ozone Season 2008 vs. 2006



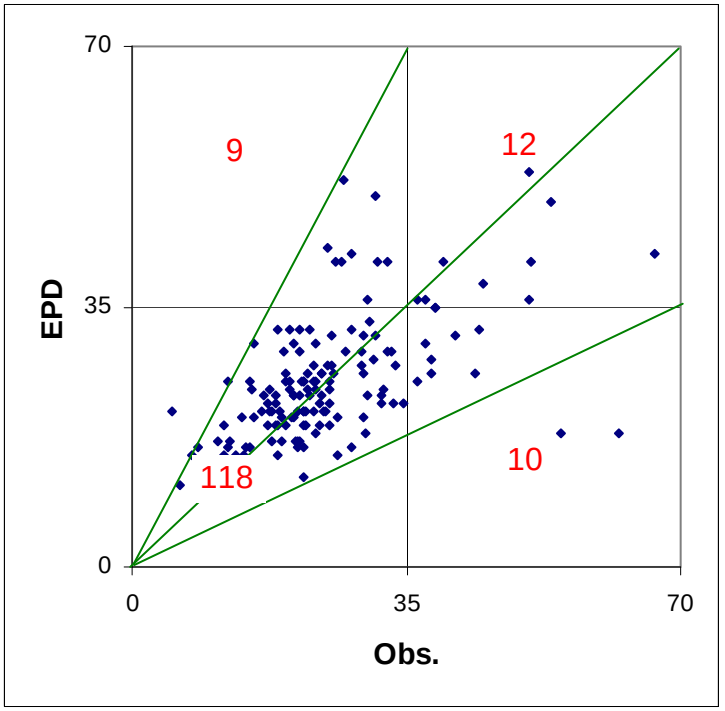
2007 $PM_{2.5}$ Performance: 4-km vs. EPD's

Our 4-km Forecast



MNB	-37%
MNE	44%

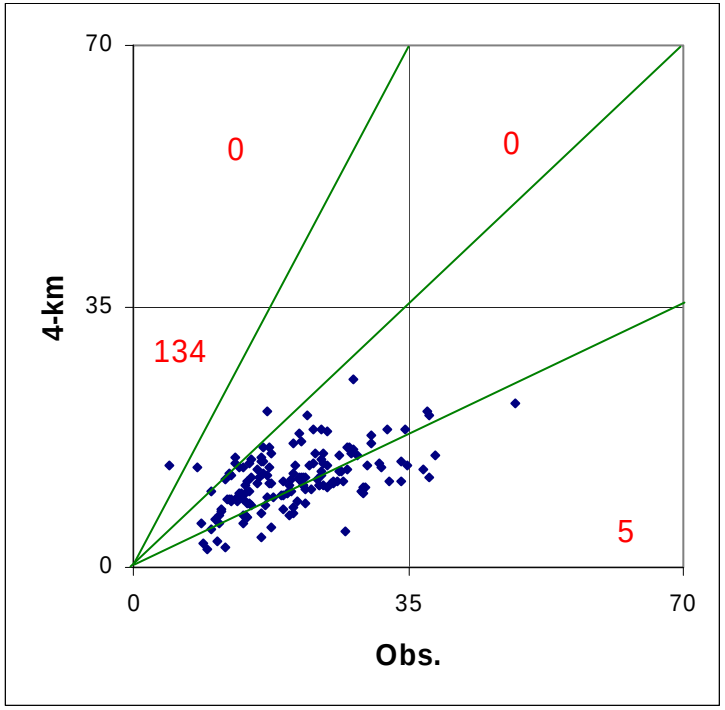
EPD Ensemble Forecast



MNB	8.6%
MNE	28%

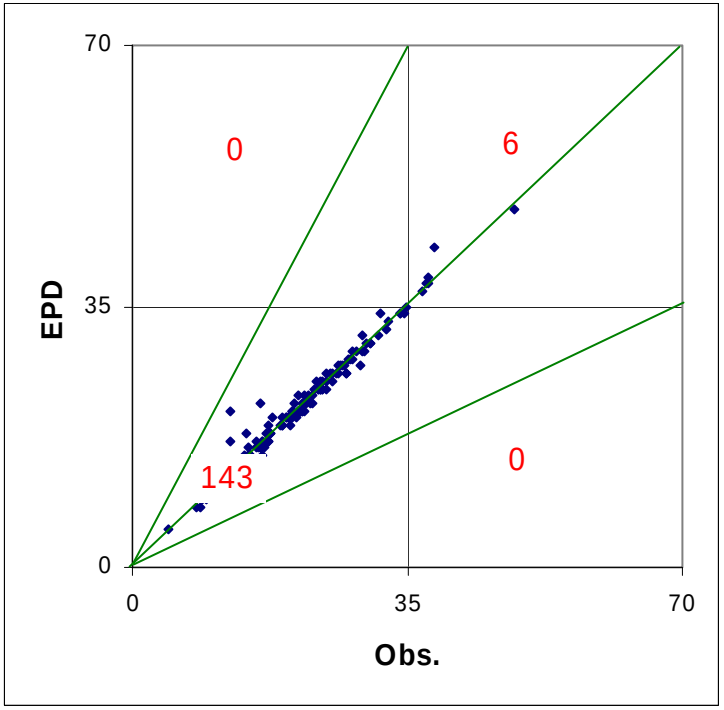
2008 $PM_{2.5}$ Performance: 4-km vs. EPD's

Our 4-km Forecast



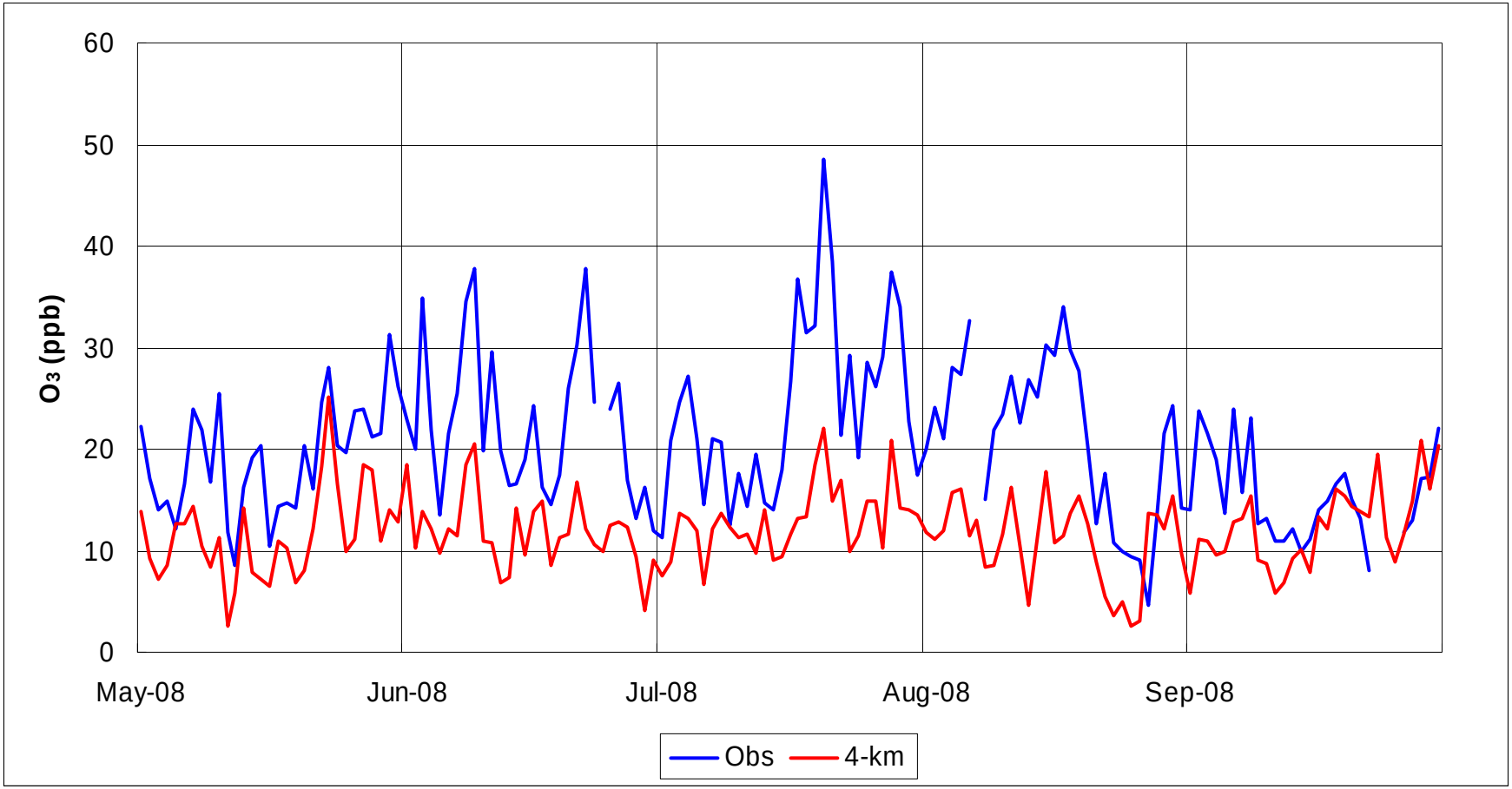
MNB	-41%
MNE	45%

EPD Ensemble Forecast

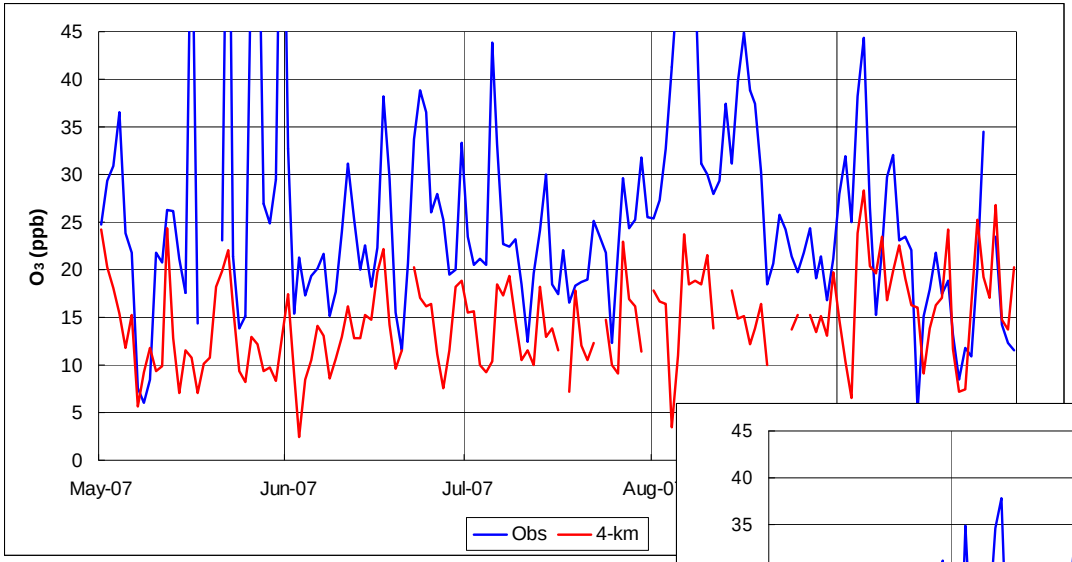


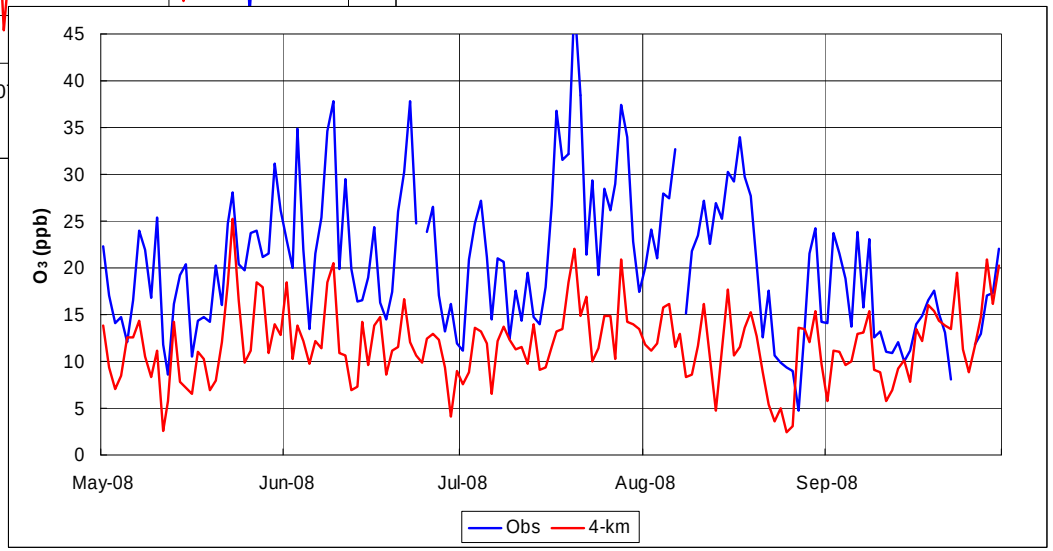
MNB	1.8%
MNE	3.6%

Forecasted vs. Observed $PM_{2.5}$

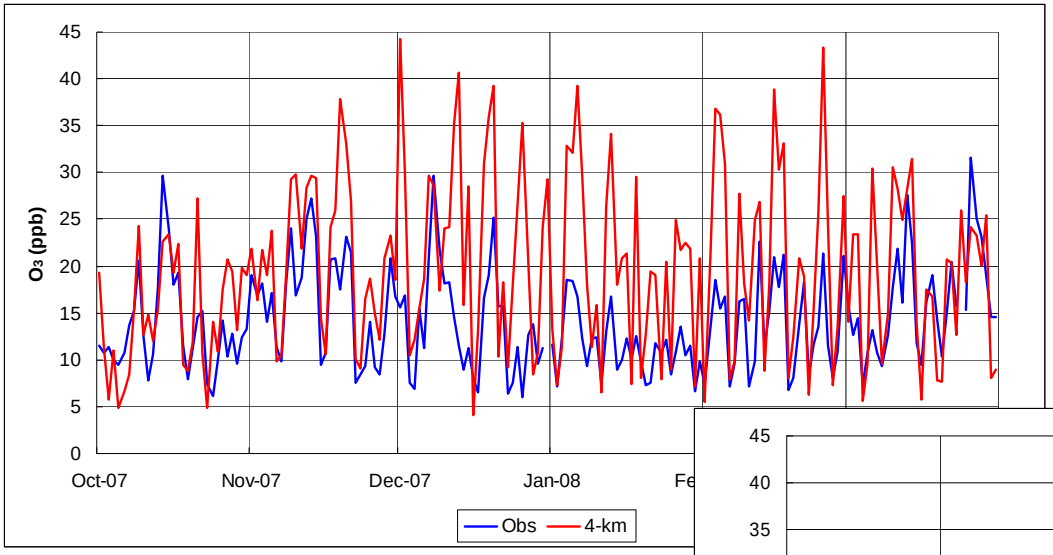


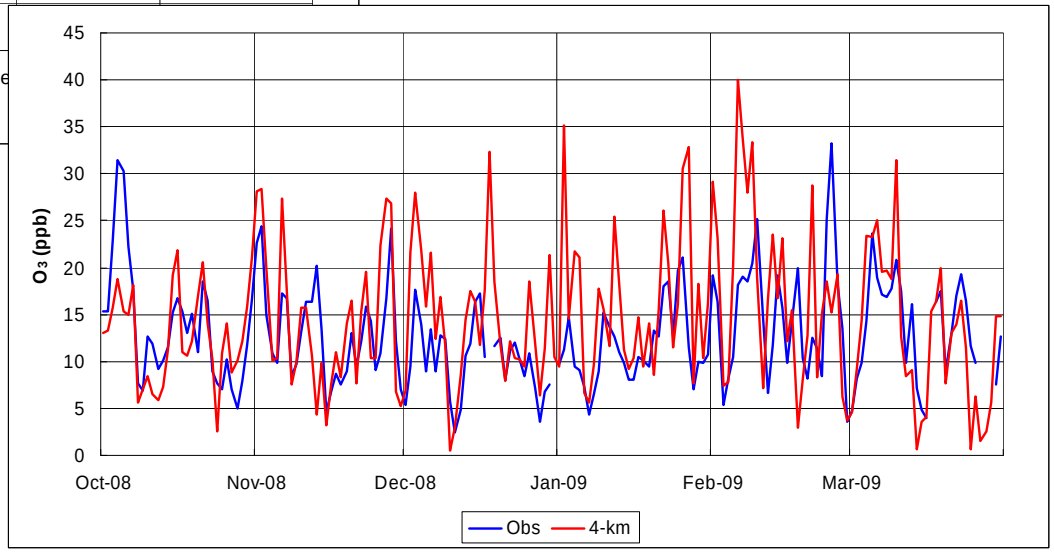
Summer 2008 vs. 2007





Winter 2008 vs. 2007



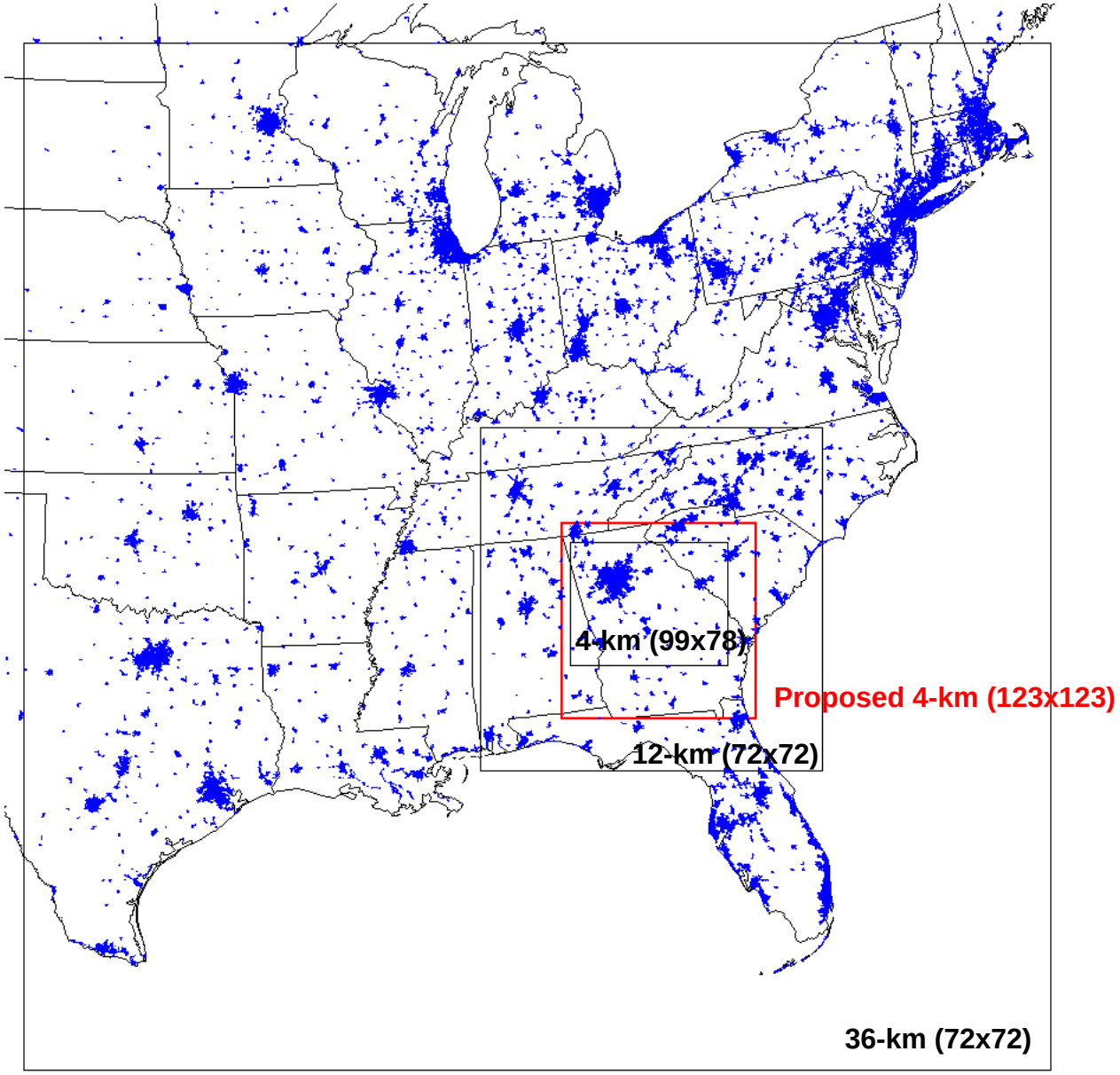


Summary

- Ozone forecasts not as good as 2007
  - Overall bias is +14% and error is 25%
  - Degradation is most likely due to weather
- $PM_{2.5}$ forecasts are still not very accurate.
  - May-September bias is -41% and error is 45%
  - Secondary organic aerosol is underestimated in Summer
  - Performance is much better in Fall and Spring
  - Wintertime $PM_{2.5}$ has improved

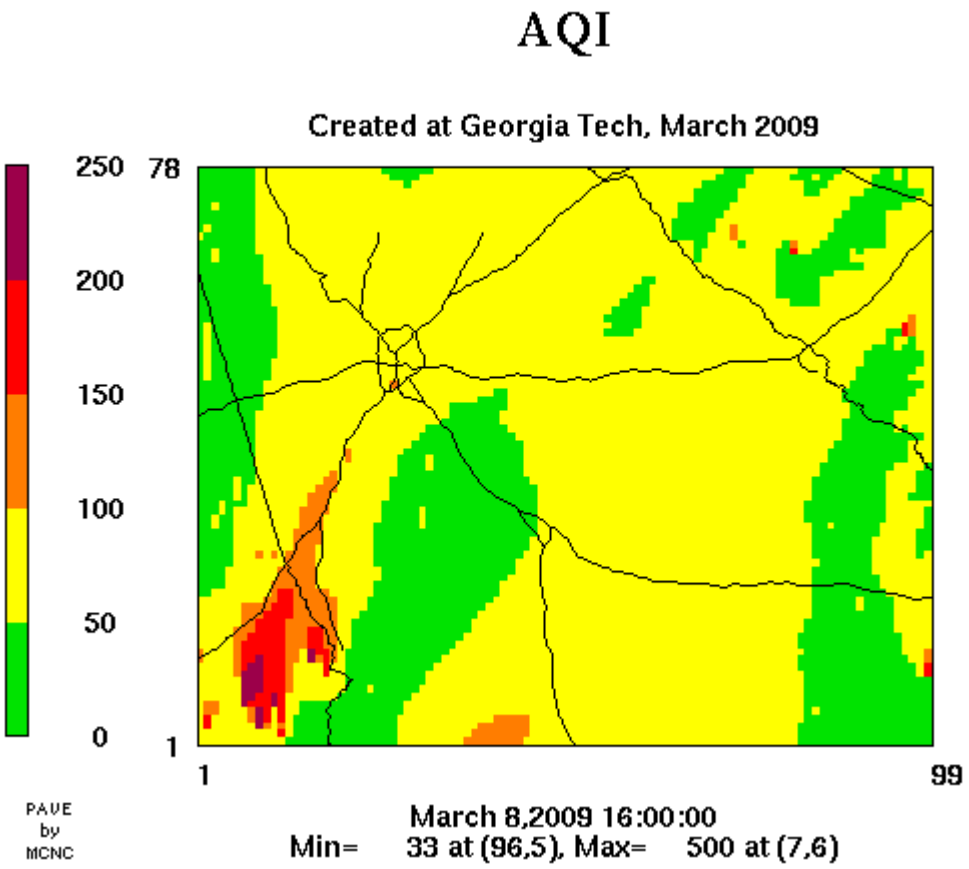
New in 2009

- Enlarge 4-km domain to include all of Georgia
- Model Updates:
  - Newly released WRF version 3.1
  - Georgia Tech's new SOA module in CMAQ 4.6
    - Detailed monoterpenes → SOA, additional isoprene & sesquiterpenes → SOA, N-generations of SOA (N>=2)
- Emissions:
  - BEIS 3.12 for SOA precursor emissions
  - Remove fire emissions from the projected 2009 inventory
- Website:
  - Redesign presentation of forecast products
    - Comments by Rebecca Watts Hull of Georgia Conservancy
  - Spatial plots of AQI
    - Found an error in Feb 2009 Technical Assistance document and reported to EPA
- Evaluation:
  - Add AMET as a tool for evaluation of air quality and meteorology


4-km (99x78)
Proposed 4-km (123x123)
12-km (72x72)
36-km (72x72)

Reporting AQI

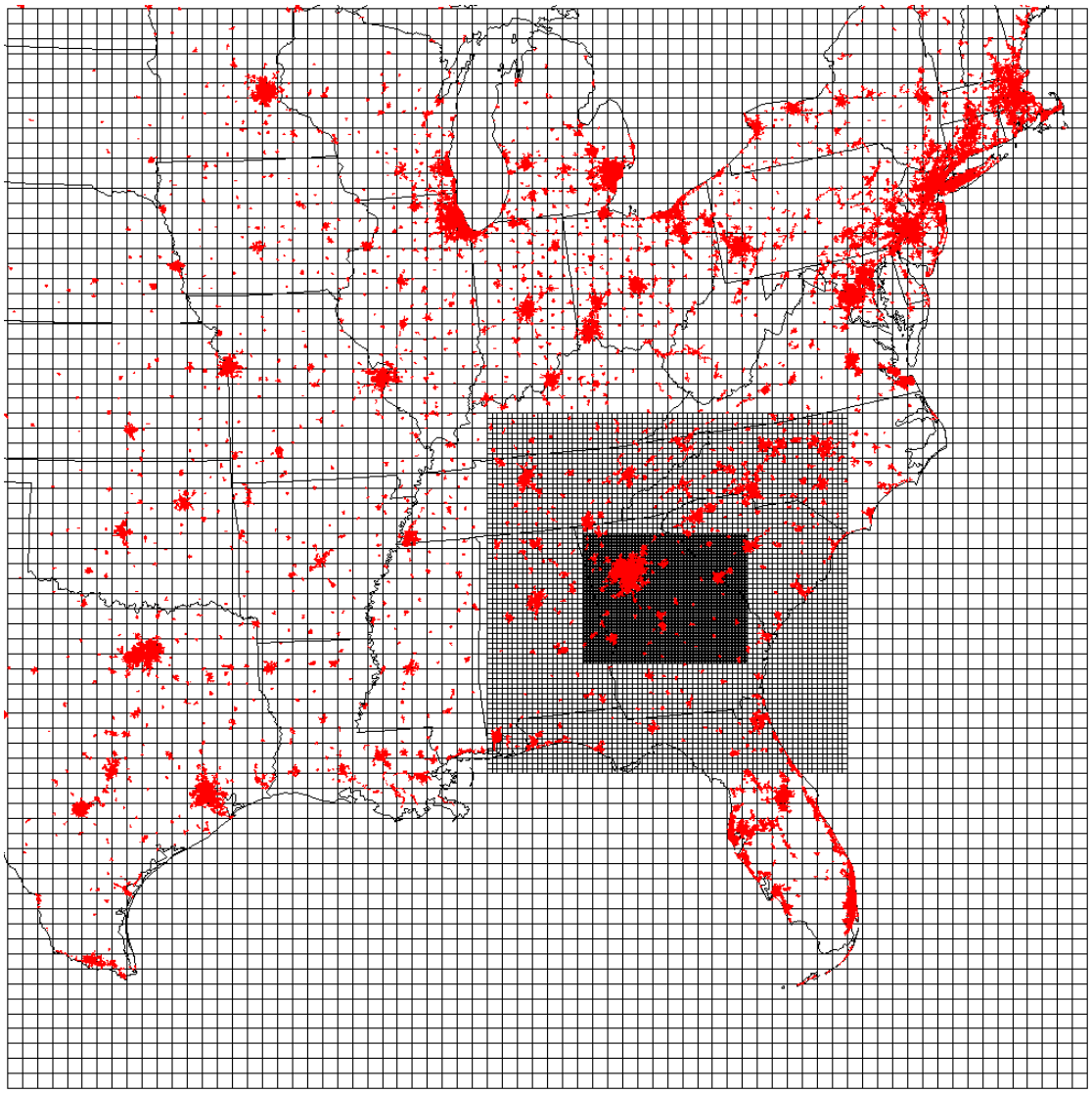
- How to report AQI pollutant?



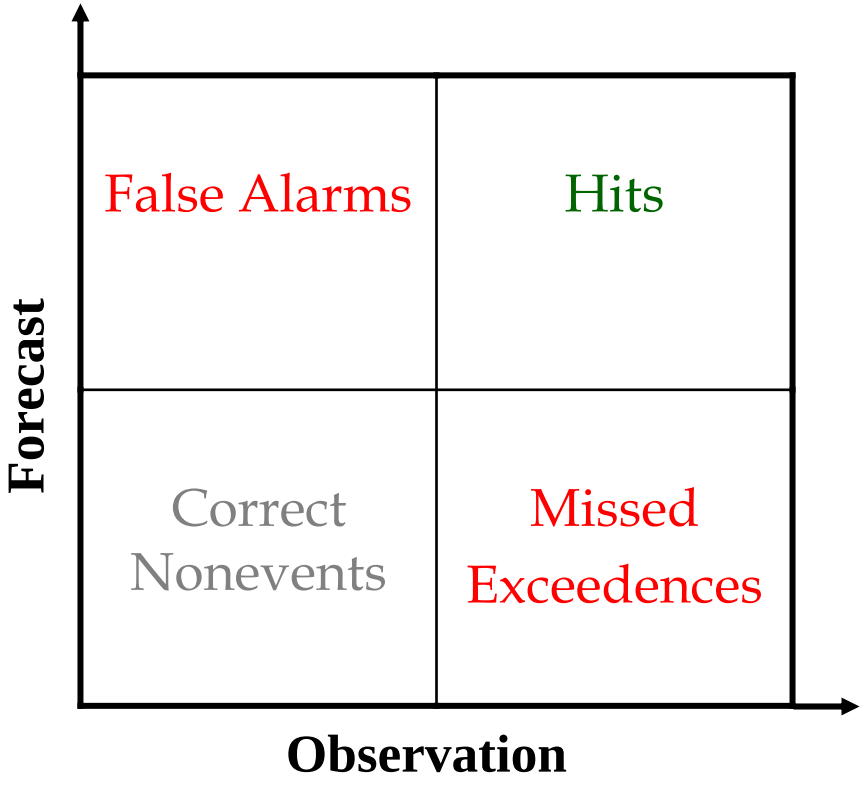
THE END

Modeling Domain and Grids

- Three grids:
  - 36-km (72x72)
  - 12-km (72x72)
  - 4-km (99x78)
- 34 vertical layers used in WRF
- 13 layers in CMAQ



Performance Metrics



$$\text{NMB} = \frac{1}{N}\sum_{k=1}^{N}\frac{c_k^m - c_k^o}{c_k^o}$$

$$\text{NME} = \frac{1}{N}\sum_{k=1}^{N}\frac{\left|c_k^m - c_k^o\right|}{c_k^o}$$