Modeling Committee Update

OTC Committee Meeting

April 4th, 2012

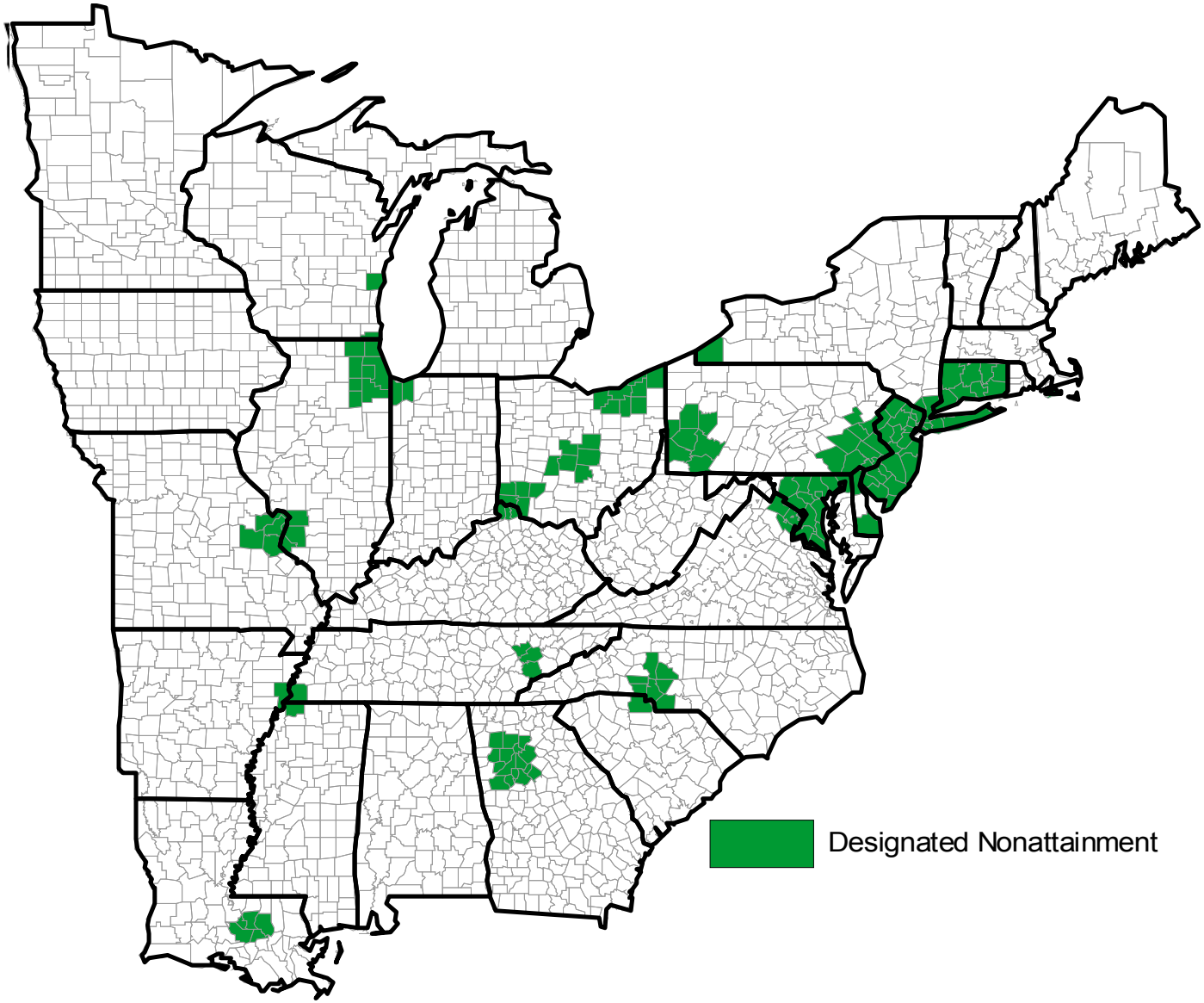
Washington, DC

Overview

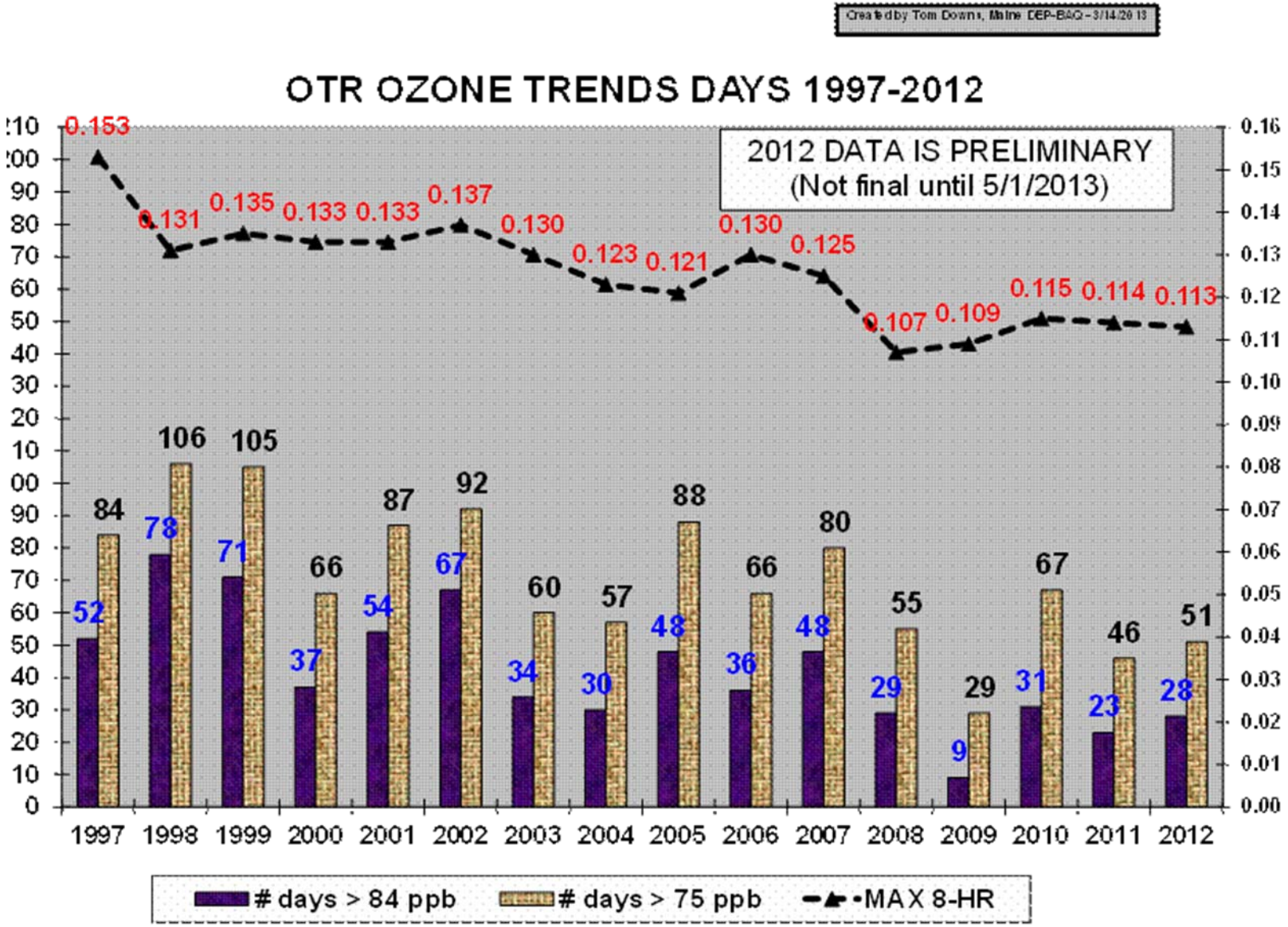
1. Ozone Design Value Update
2. Level 3 Screening
    1. 2007 Base Case Inventories
    2. 2007 Base Case Model Performance
    3. Level 3A Results
    4. Next Steps

OZONE DESIGN VALUE UPDATE

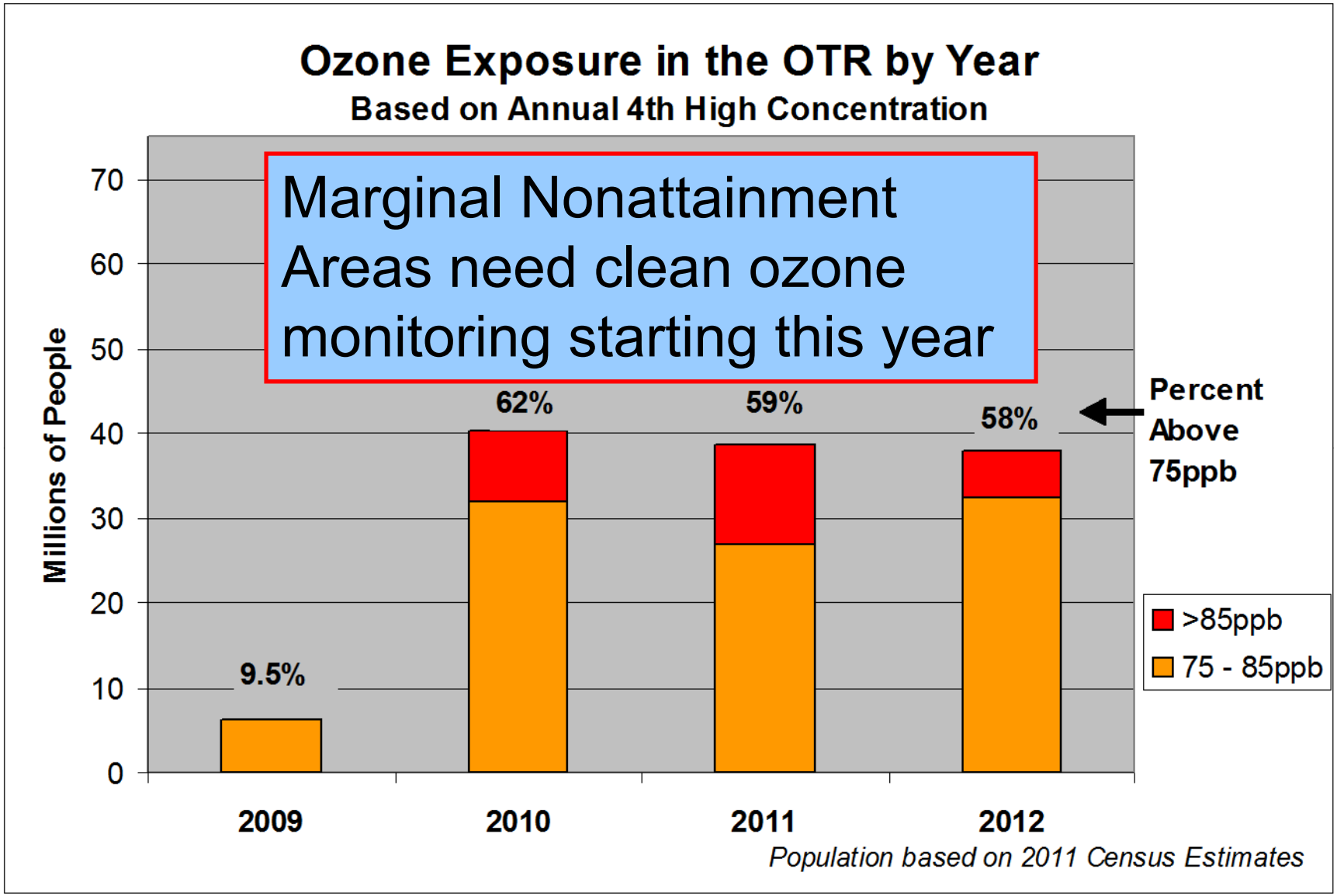
Ozone Nonattainment (2008 NAAQS)



OTR Trend Days 1997-2012



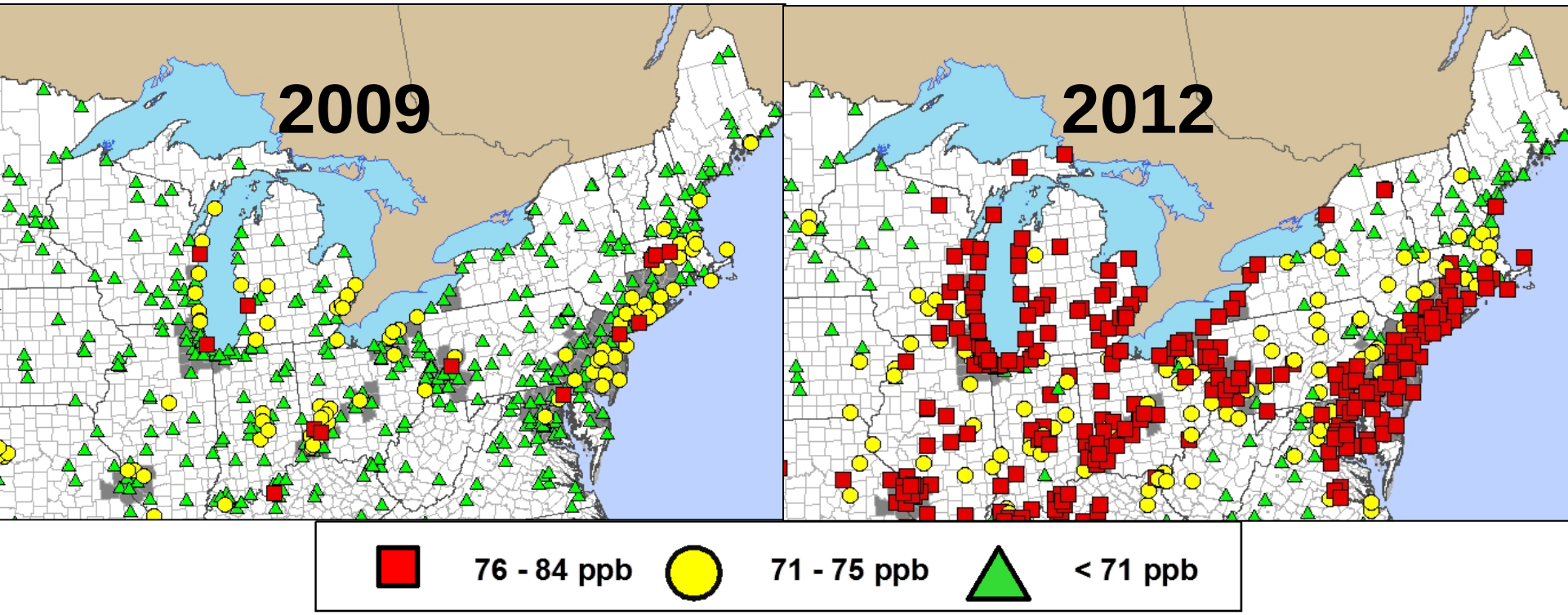
Ozone Exposure in the OTR



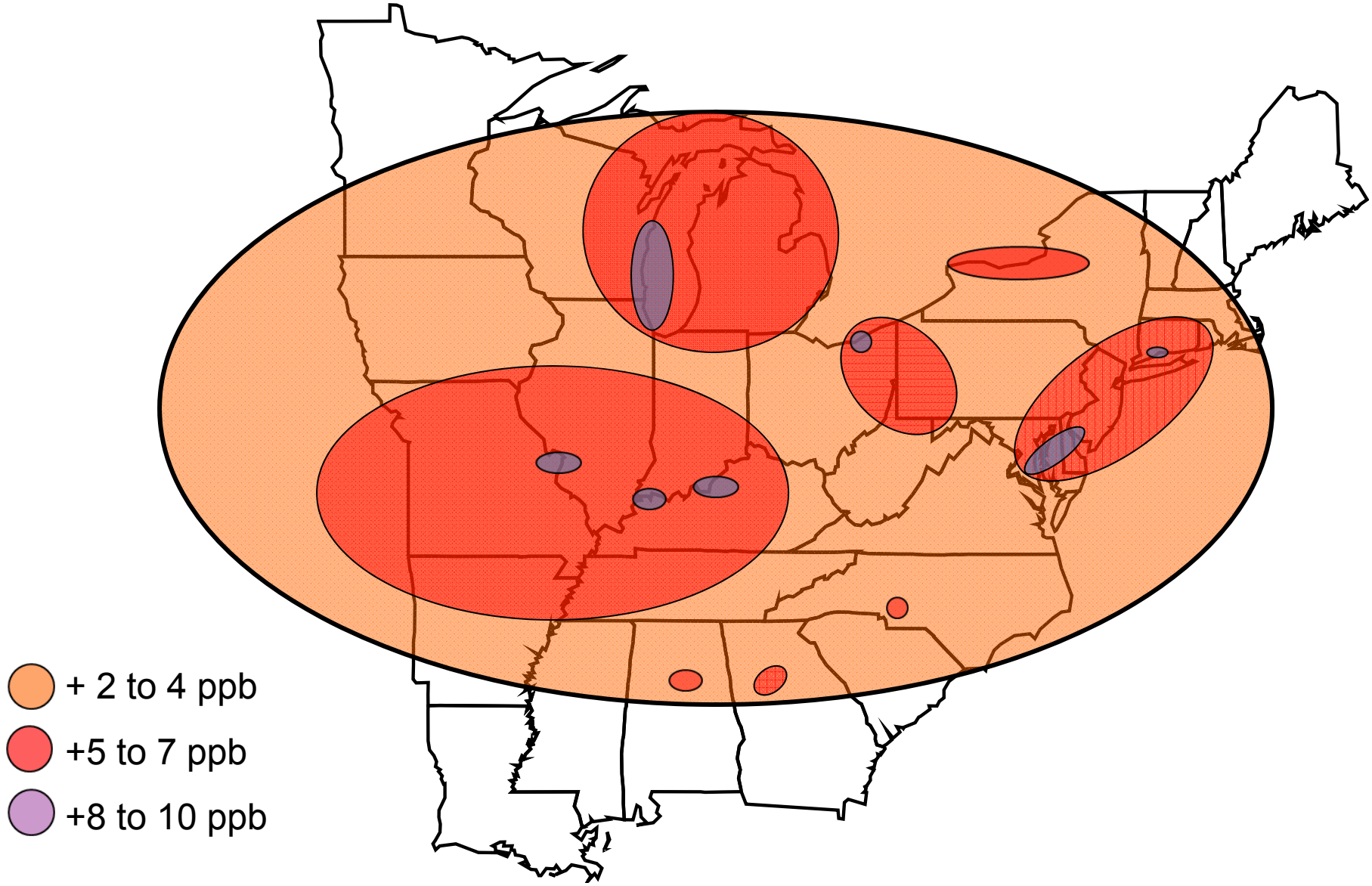
Ozone Design Value Update

Design values are a 3-year average of the 4th highest 8-hour values by monitor. This value is compared to the standard.

This year we dropped 2009 and added 2012 to the calculation.

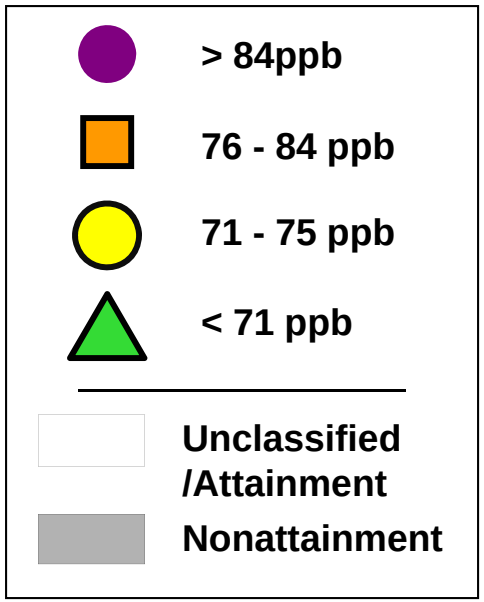


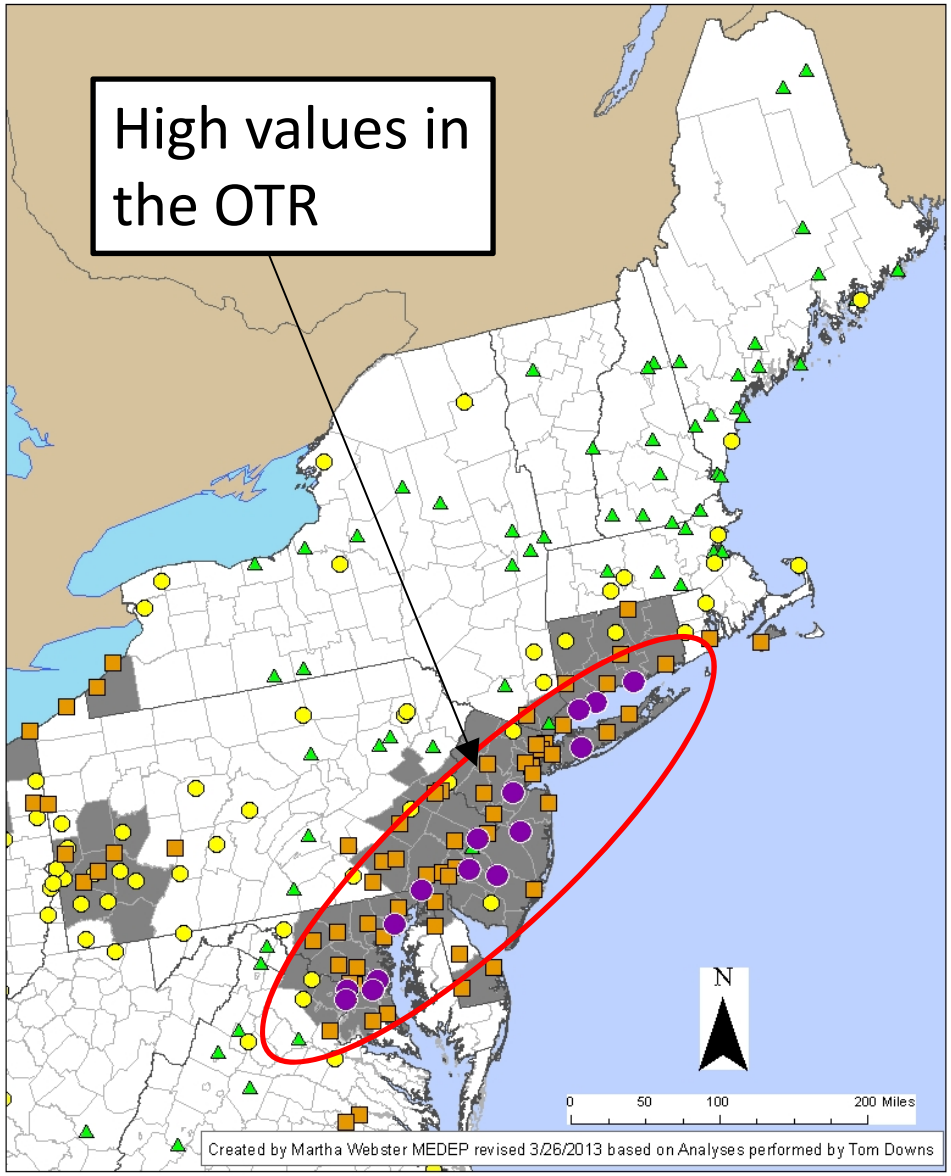
Differences Between 2009-2011 and 2010-2012 Design Values



Preliminary 2012 Ozone Design Values

3-Year average of the 4th high concentration for 2010, 2011, 2012





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LEVEL 3 SCREENING

OTC Level 3 Modeling Platform

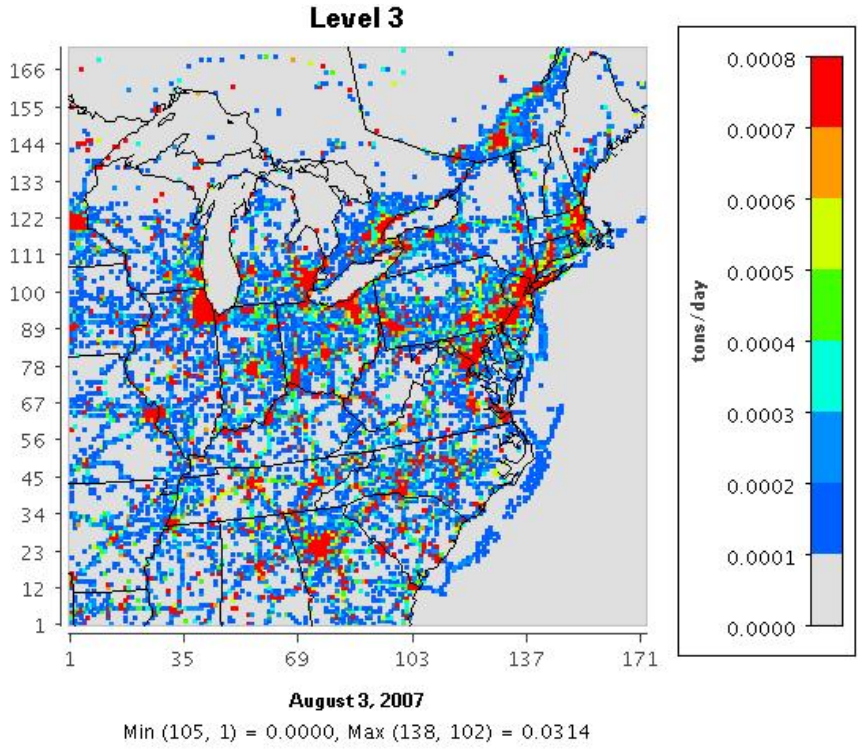
- CMAQ 4.71 with CB05 chemistry aero5 aerosol module
- MARAMA/OTC Level 3 emission inventories
- WRF 2007 Meteorology
- Time-variant boundary conditions of Eastern US 12 km domain using ConUS 36 km simulations

2007 Base Case
Emission Inventory Summaries

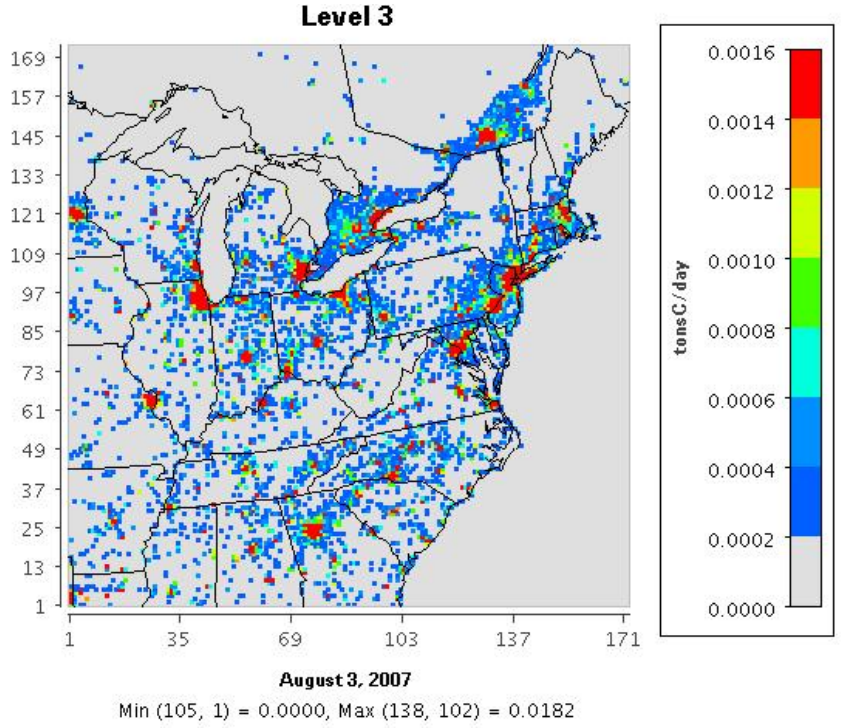
Level 3: Total Anthropogenic Emissions

August 3, 2007

NO_X



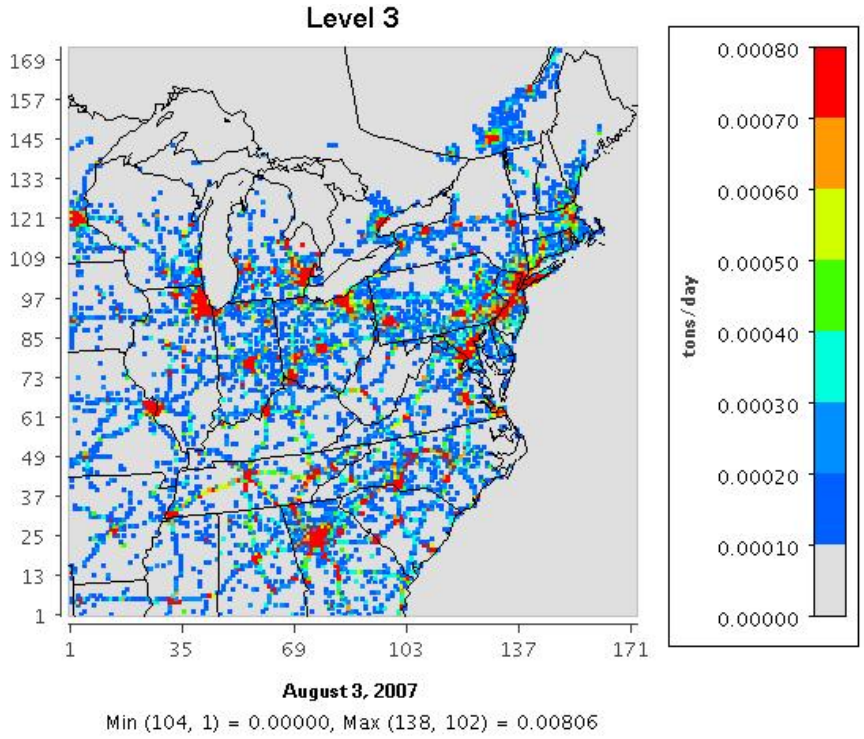
VOC



Level 3: Onroad Mobile Emissions

August 3, 2007

NO_X



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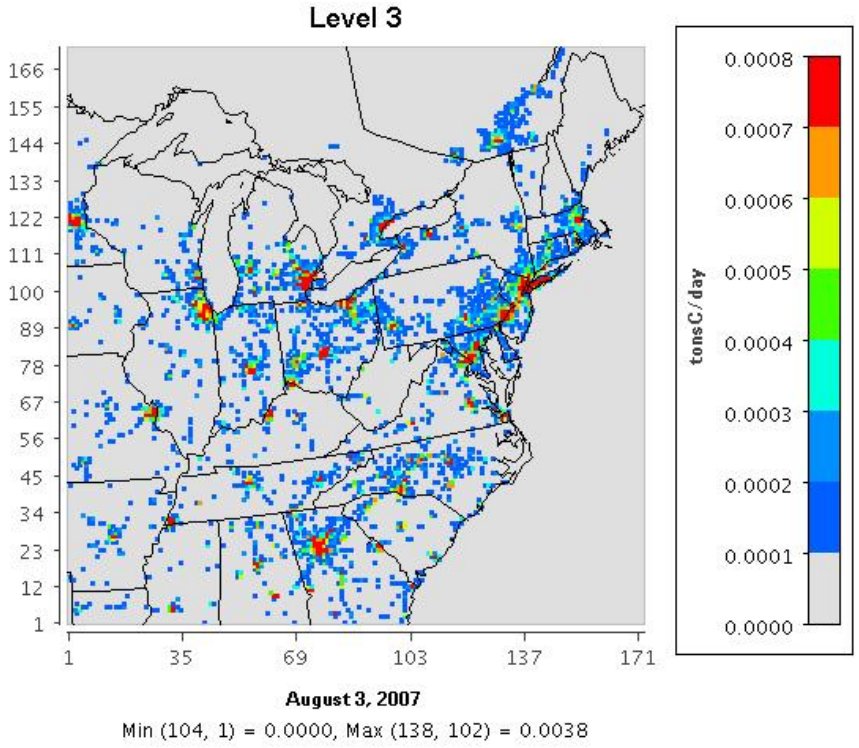
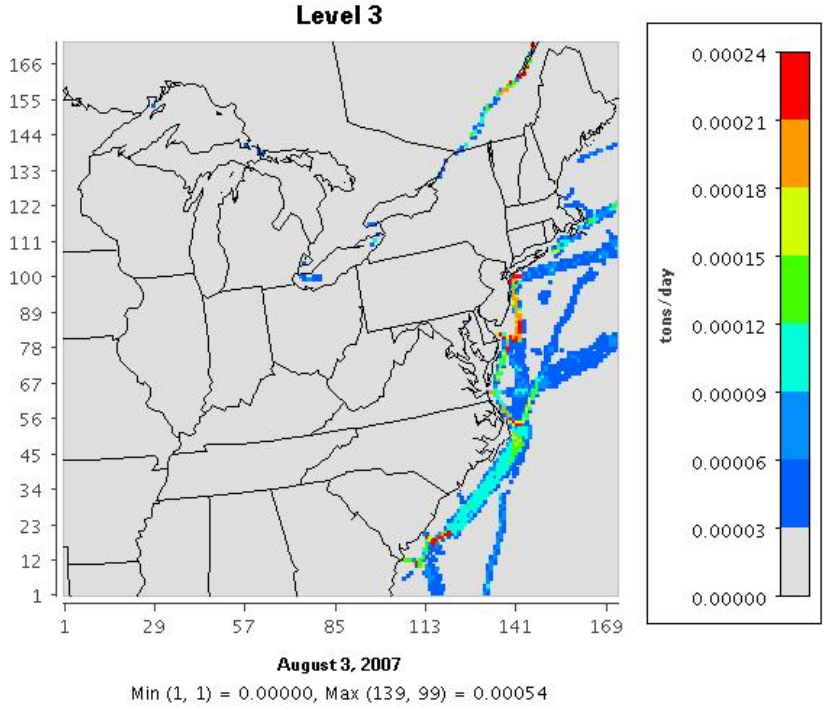


Level 3: Category 3 Marine Emissions

August 3, 2007

NO_X



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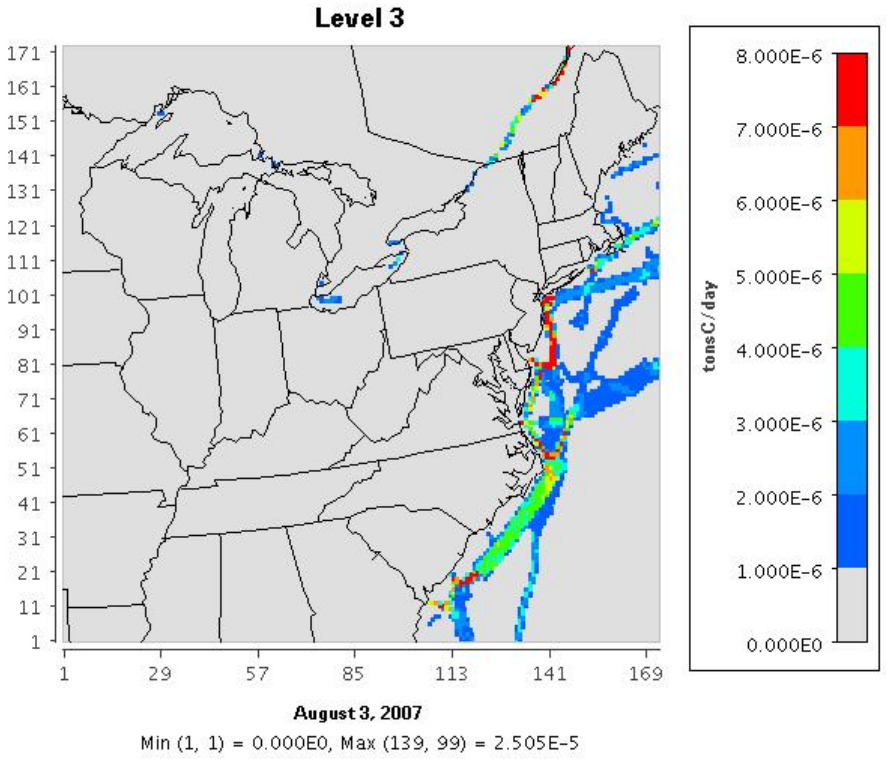
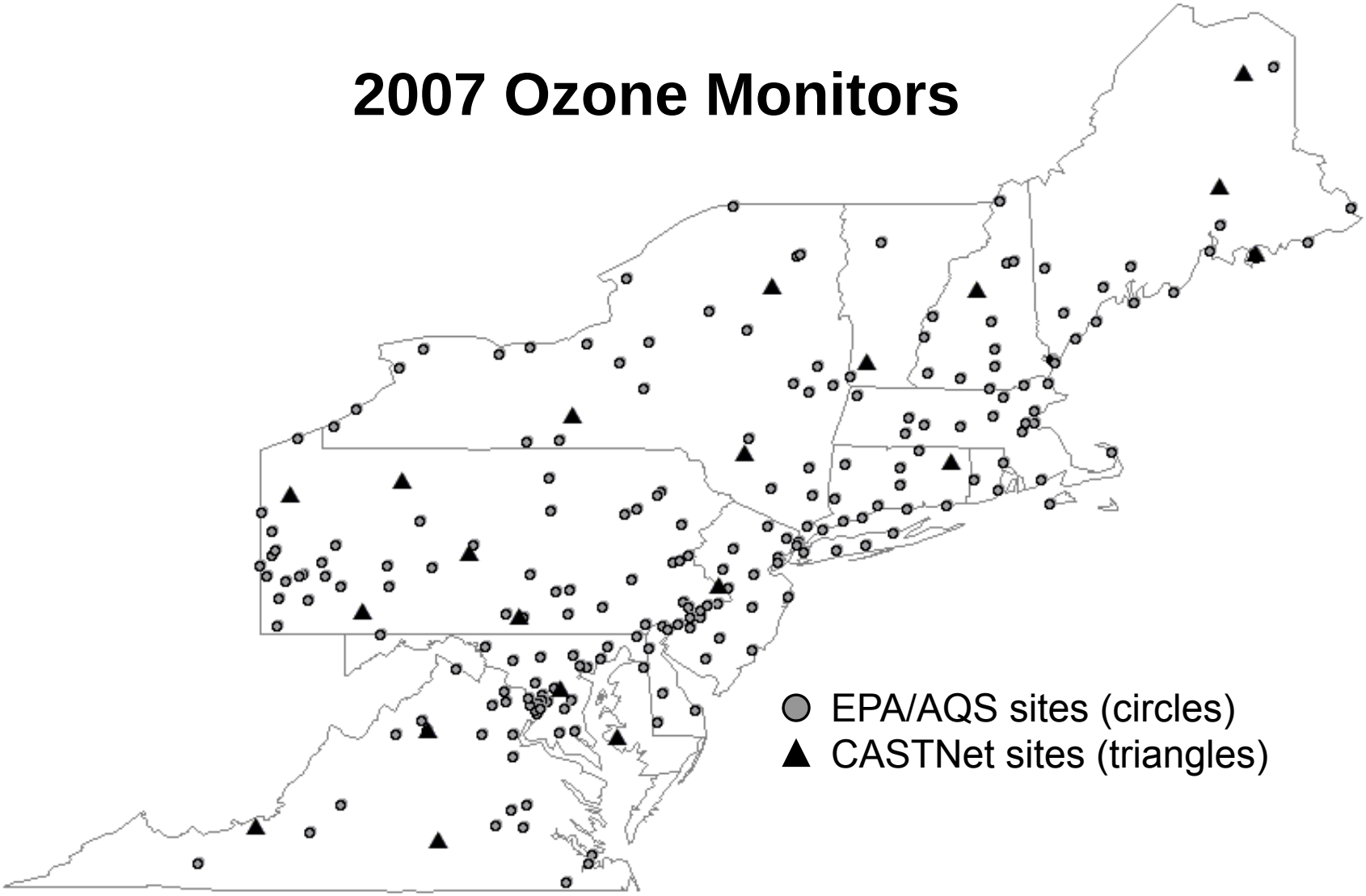


2007 Base Case
Model Performance Analyses

CMAQ O_3 Model Performance Evaluation

- OTR region plus all of VA
  - EPA/AQS (S/L/T), 210 sites
  - CASTNet, 20 sites
- Focus on 2007 O_3 season (April-October)
  - 1-hour O_3 – diurnal variations
  - Daily-maximum 8-hour O_3 – model bias and error, in space and time

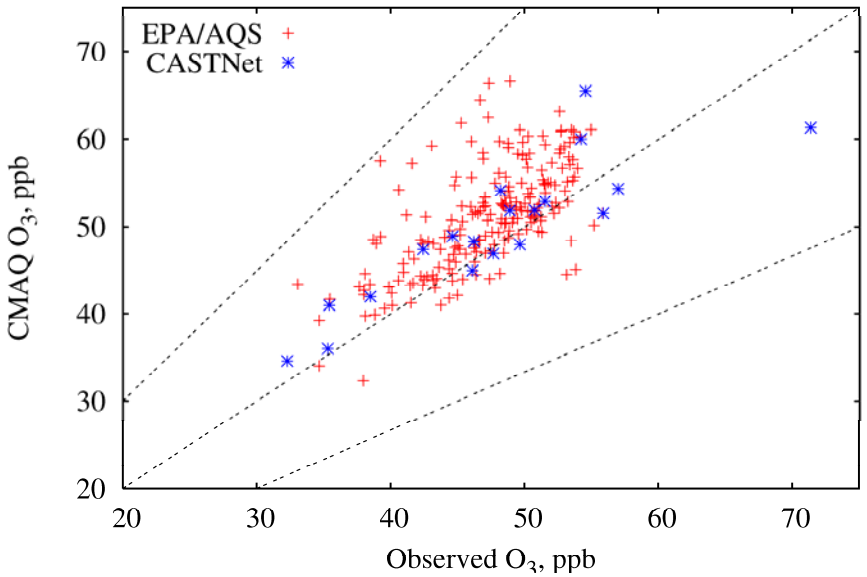
Locations of O_3 Monitors in the Region



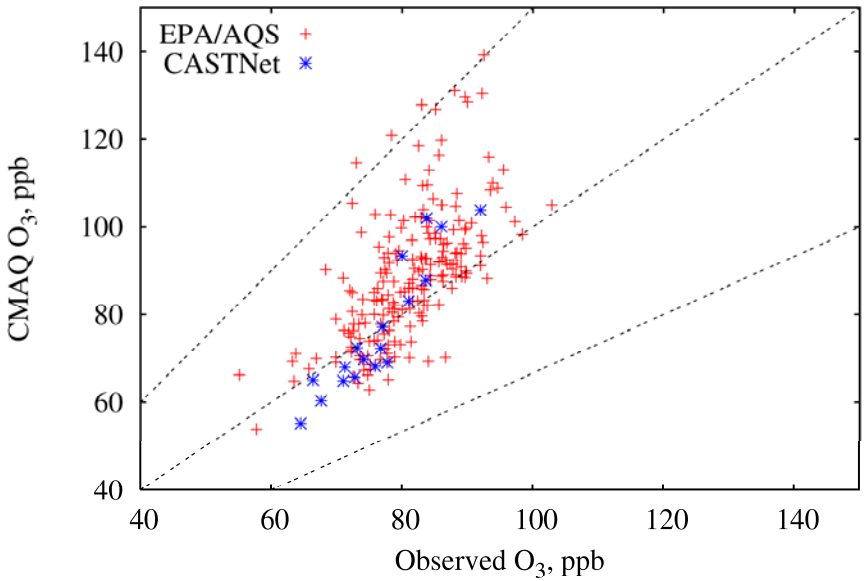
2007 Base

Daily Max 8-hr O_3

Avg. Daily Maximum 8-Hour Ozone



Daily 4th Maximum 8-Hour Ozone



Correlations of CMAQ vs Monitored values

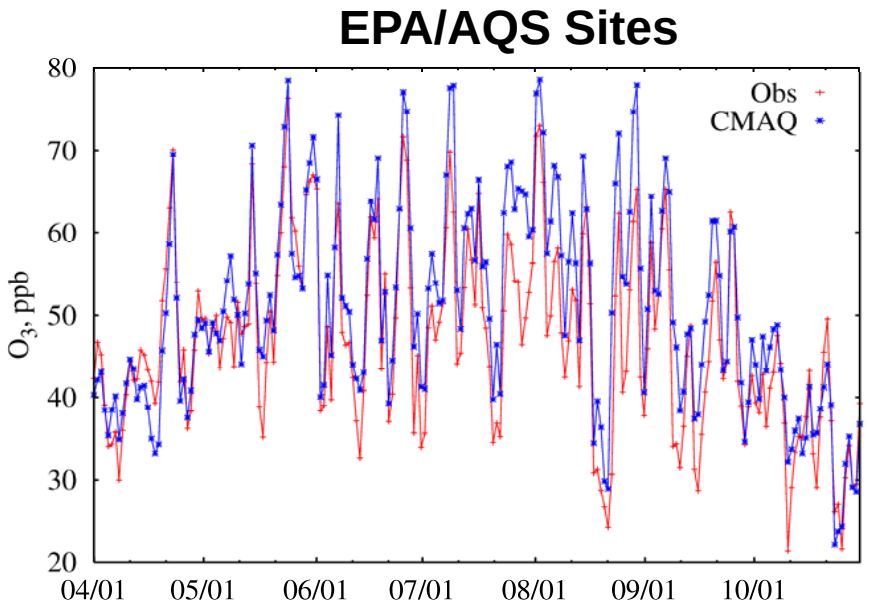
Dashed lines denote correlation patterns of 1 to 1.5, 1 to 1, and 1.5 to 1

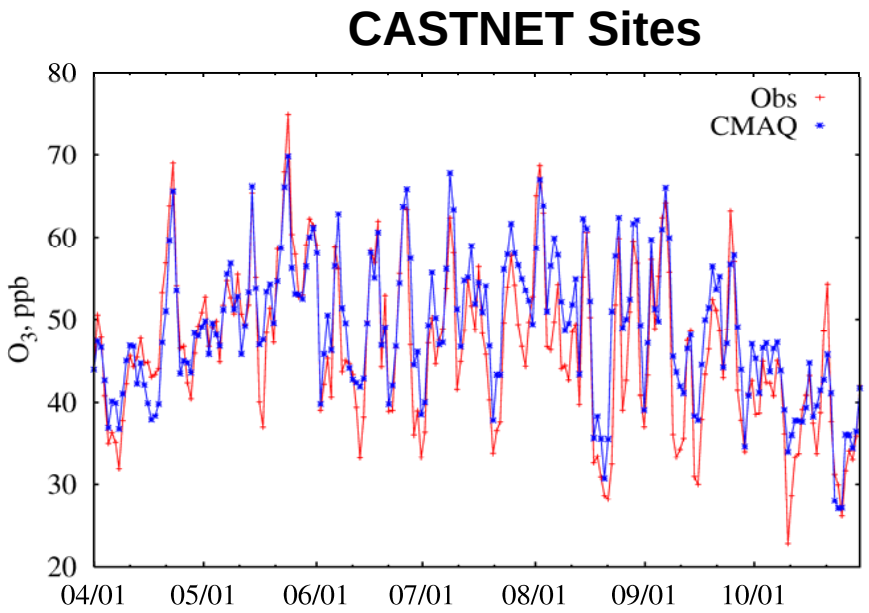
- All sites fall within the 1 to 1.5 and 1.5 to 1 lines for <u>average</u> daily maximum O_3
- CMAQ tends to overestimate both average and daily maximum O_3

Comparison of observed and predicted average daily maximum 8-hour O_3 (top panel) and 4th highest daily maximum 8-hour O_3 at EPA/AQS and CASTNet sites across the OTR+VA, April-October 2007

2007 Base

Daily Max 8-hr O_3





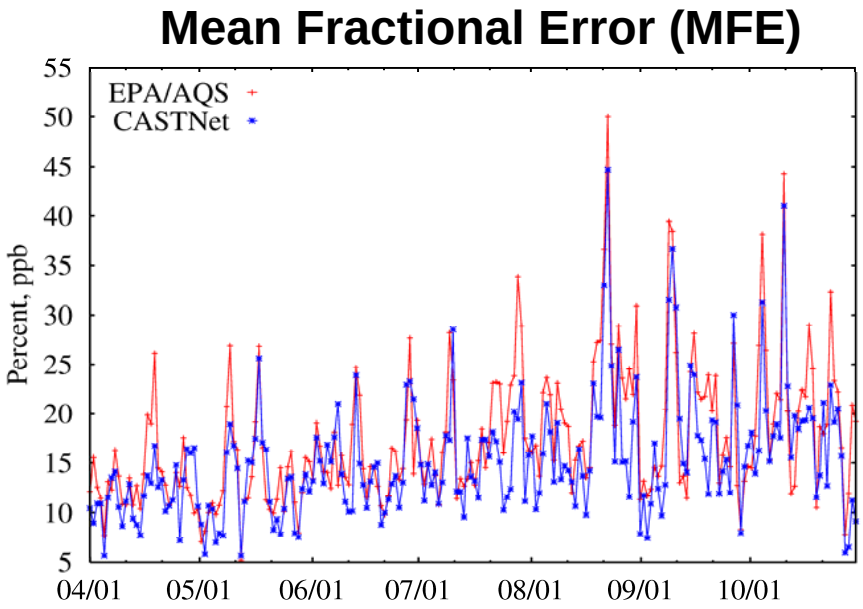
Running Daily Maximum For CMAQ and Monitors

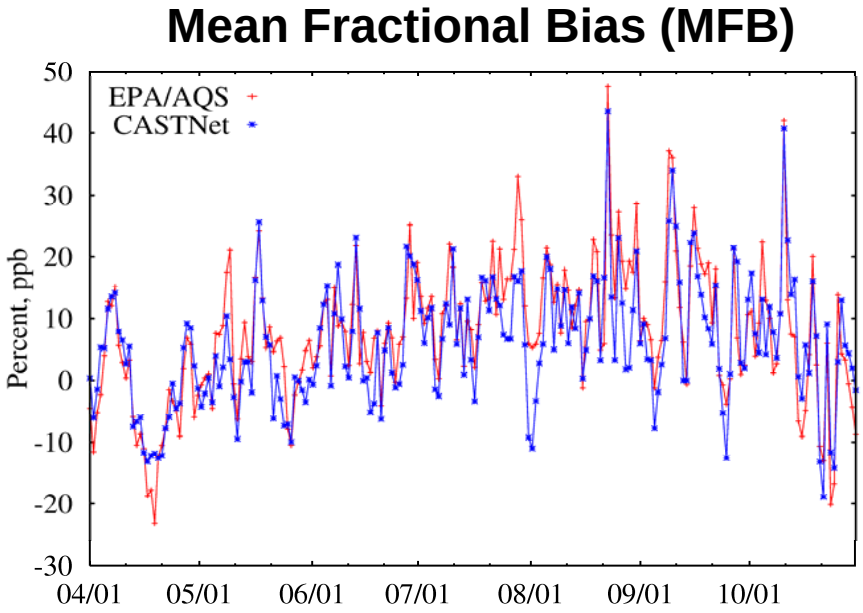
- CMAQ generally captures the seasonality in daily maximum O_3 levels
- There is a tendency to over-predict O_3 especially at EPA/AQS sites from about mid-May to mid-September

Daily maximum 8-hour O_3 aggregated across EPA/AQS (top panel) and CASTNet (bottom panel) sites across the OTR+VA

2007 Base

Daily Max 8-hr O_3





Running Daily Maximum Mean Fractional Error & Mean Fractional Bias

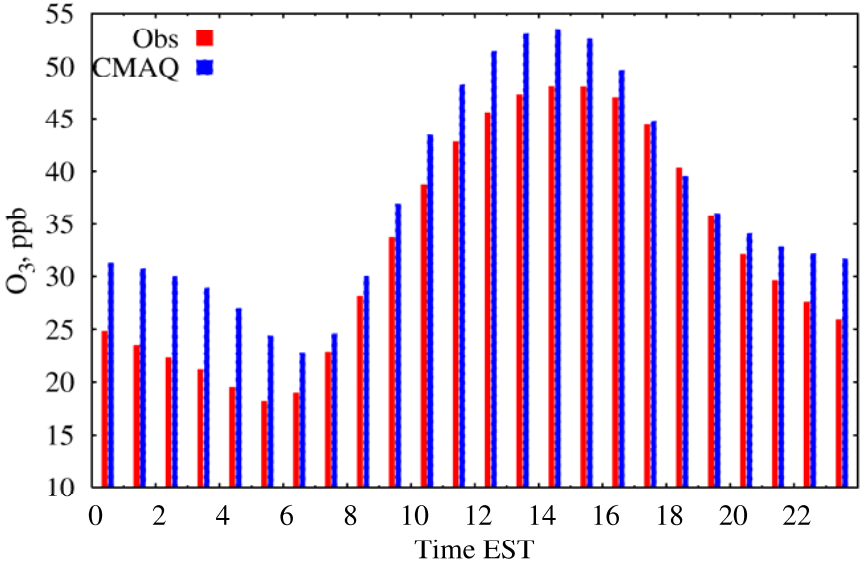
- MFE and MFB tend to be higher at EPA/AQS sites compare to CASTNet

Mean fractional error (top panel) and mean fractional bias (bottom panel) in daily max 8-hr O_3 aggregated across the OTR+VA

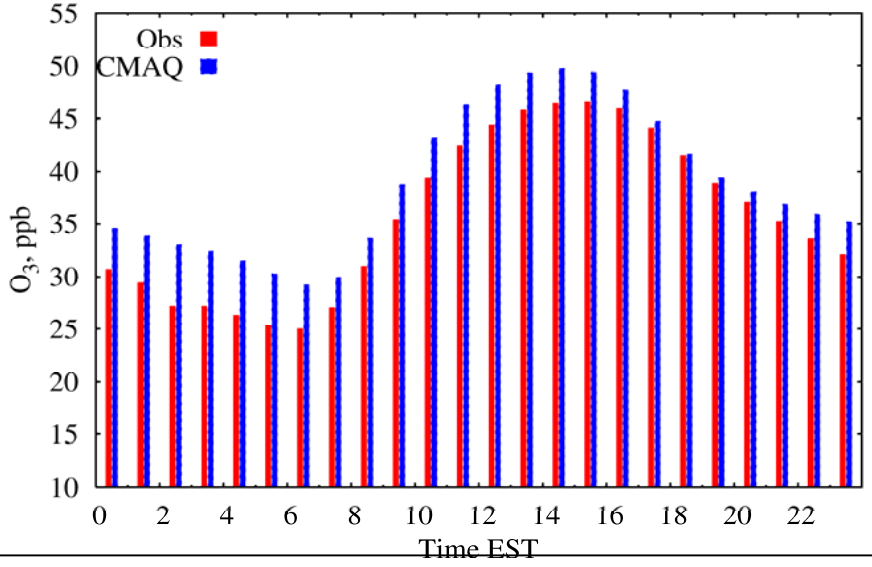
2007 Base

O_3 Diurnal Variations

EPA/AQS Sites



CASTNET Sites



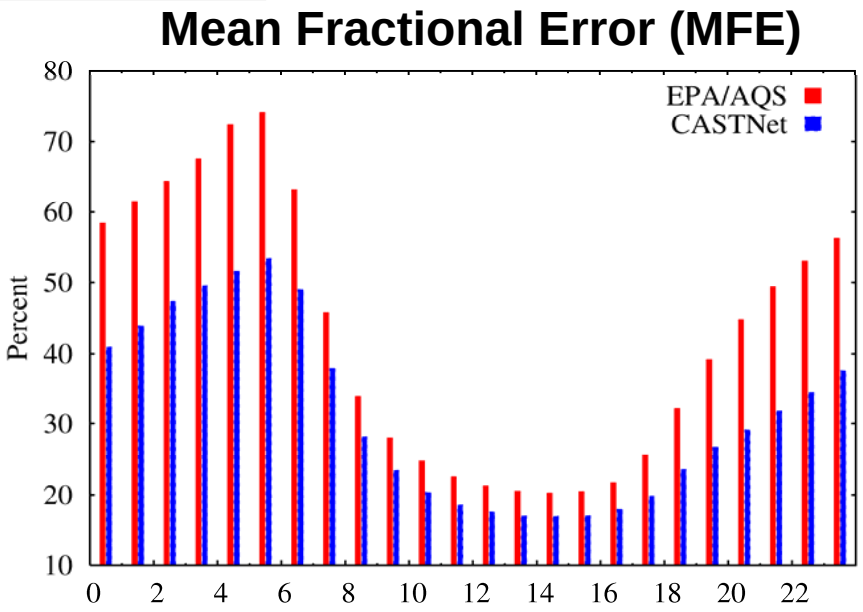
Hourly Comparisons of CMAQ vs Monitored values

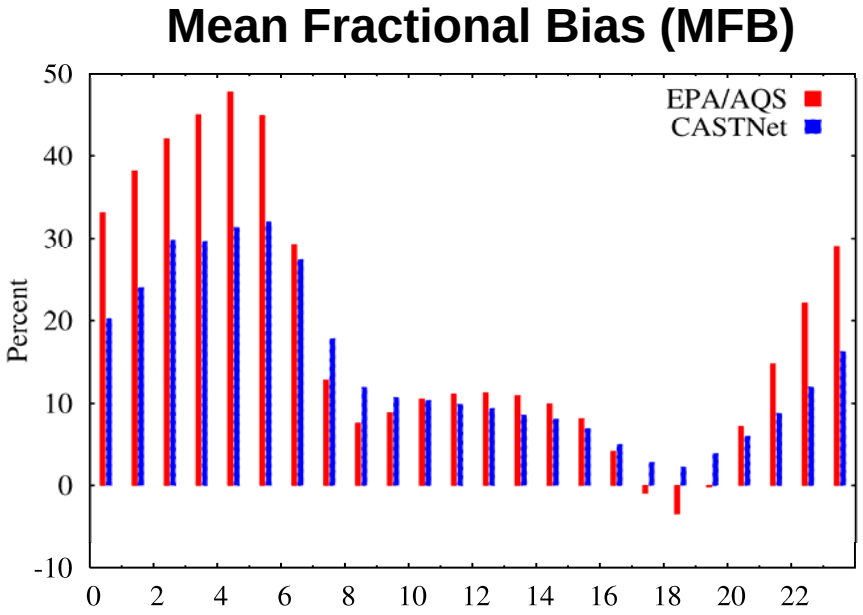
- Good qualitative agreement between observed and predicted O_3
- Largest over-prediction during nighttime/early morning hours
- Better agreement during the late afternoon hours
- For most hours of the day, CMAQ over-predictions are ~1-2 ppb larger at EPA/AQS sites compared to CASTNet sites

Average diurnal variation of O_3 aggregated across EPA/AQS (top panel) and CASTNet (bottom panel) sites across the OTR+VA

2007 Base

Diurnal Variations





Mean Fractional Error & Mean Fractional Bias

- Largest MFE and MFB tend to occur during the nighttime and early morning hours
- MFE and MFB tend to be larger at the EPA/AQS sites compared to CASTNet
- Overall, MFE was lower than 25% and MFB was lower than 10% during the late morning and afternoon hours

Mean fractional error (top panel) and mean fractional bias (bottom panel) across the OTR+VA

Maximum 8-Hour CMAQ and Monitor Comparison

Observed daily
1st maximum 8-hour O_3

CMAQ over-predicts along the coast/urban corridor

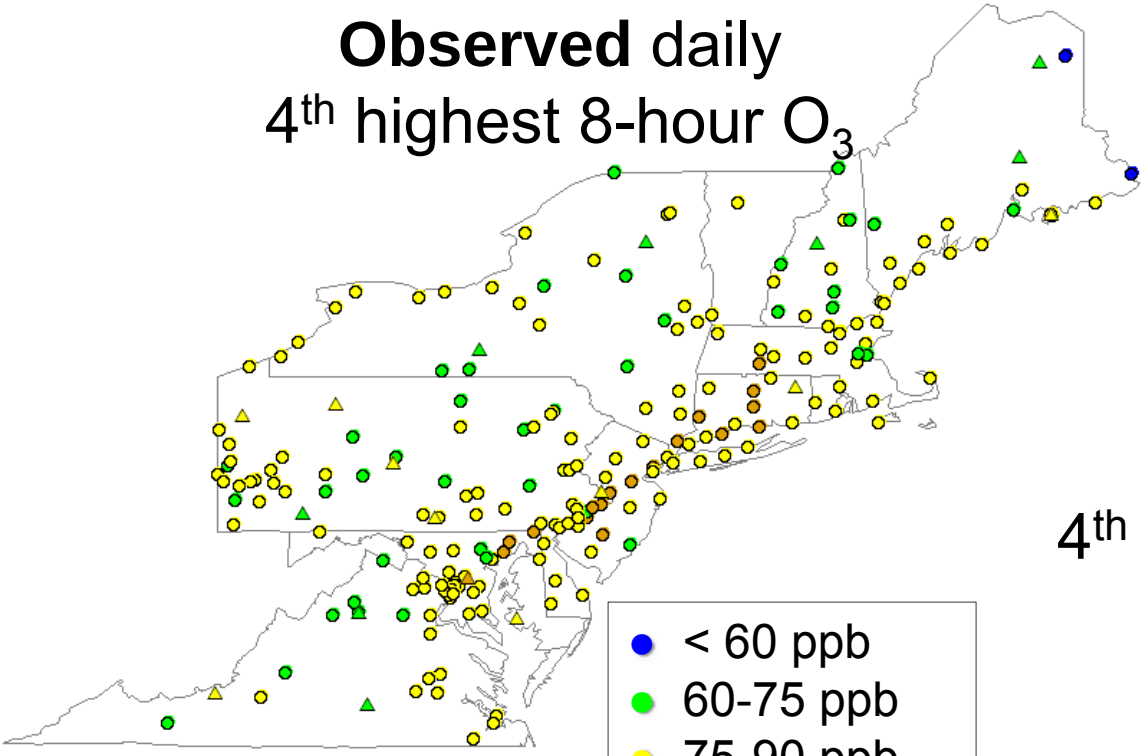
CMAQ daily
1st maximum 8-hour O_3

< 60 ppb
60-75 ppb
75-90 ppb
90-105 ppb
105-120 ppb
> 120 ppb

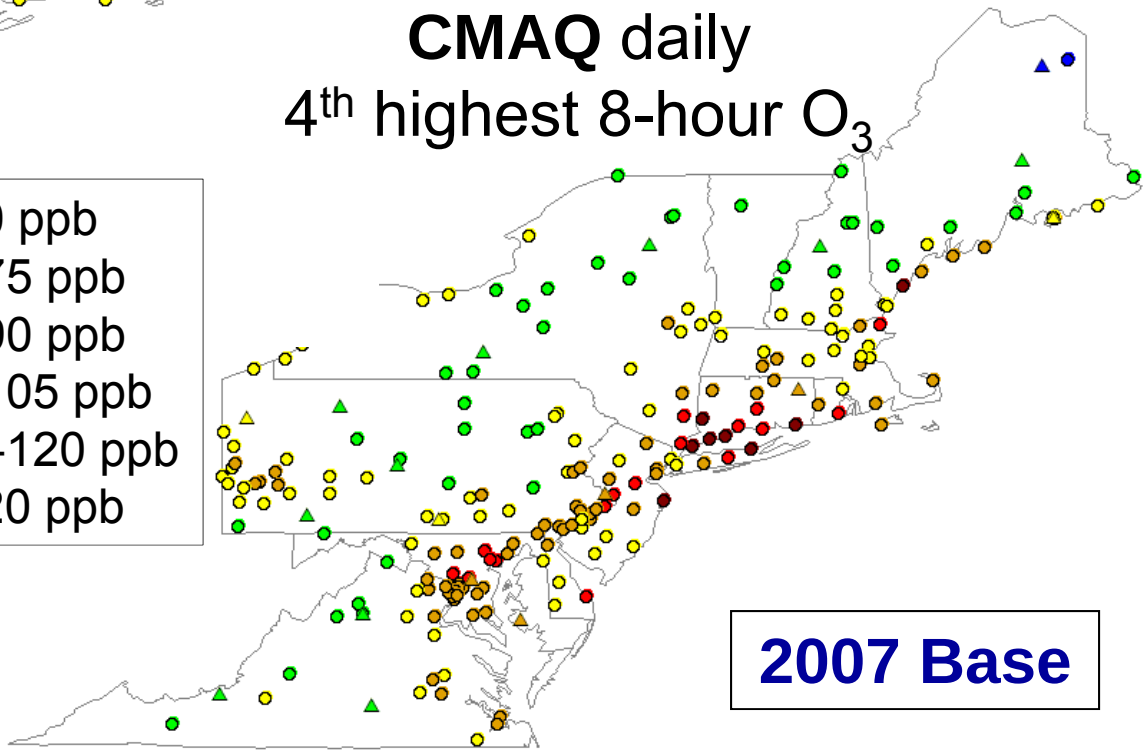
EPA/AQS sites (circles)
CASTNet sites (triangles)

2007 Base

4th High 8-Hour CMAQ and Monitor Comparison



CMAQ over-predicts along the coast/urban corridor



- < 60 ppb
- 60-75 ppb
- 75-90 ppb
- 90-105 ppb
- 105-120 ppb
- > 120 ppb

EPA/AQS sites (circles)
CASTNet sites (triangles)

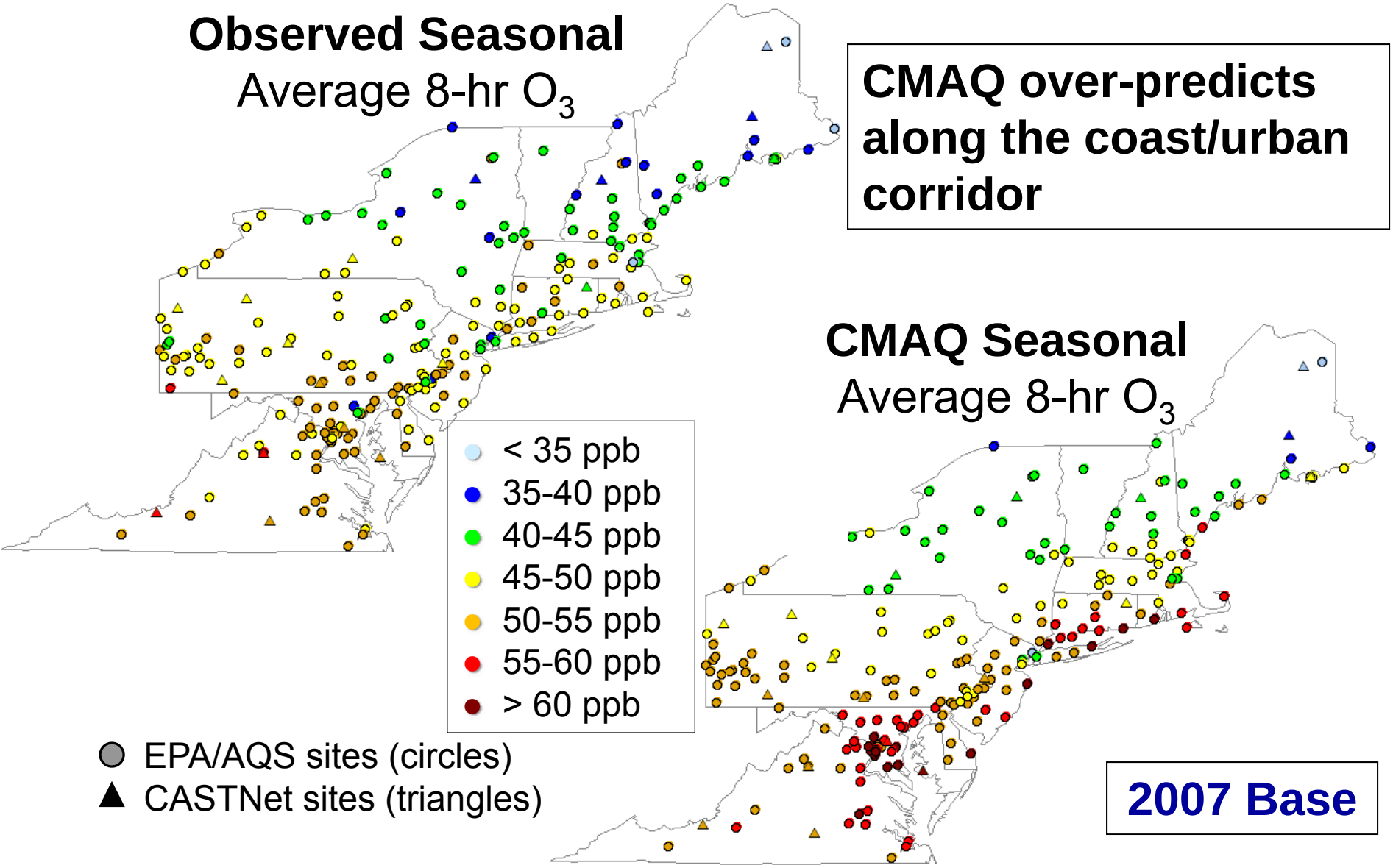
2007 Base

Seasonal Average CMAQ and Monitor Comparison

Observed Seasonal
Average 8-hr O_3

CMAQ over-predicts along the coast/urban corridor

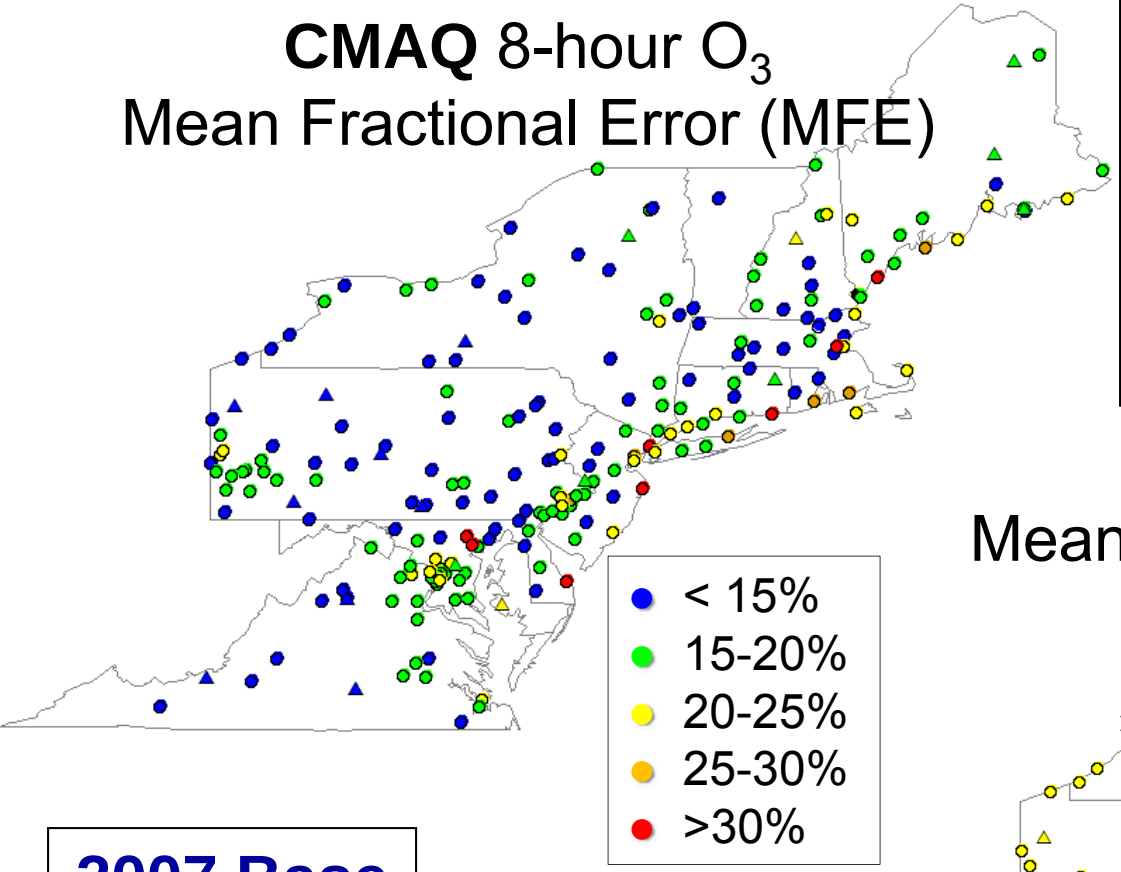
CMAQ Seasonal
Average 8-hr O_3



2007 Base

Seasonal Mean Fractional Error and Bias

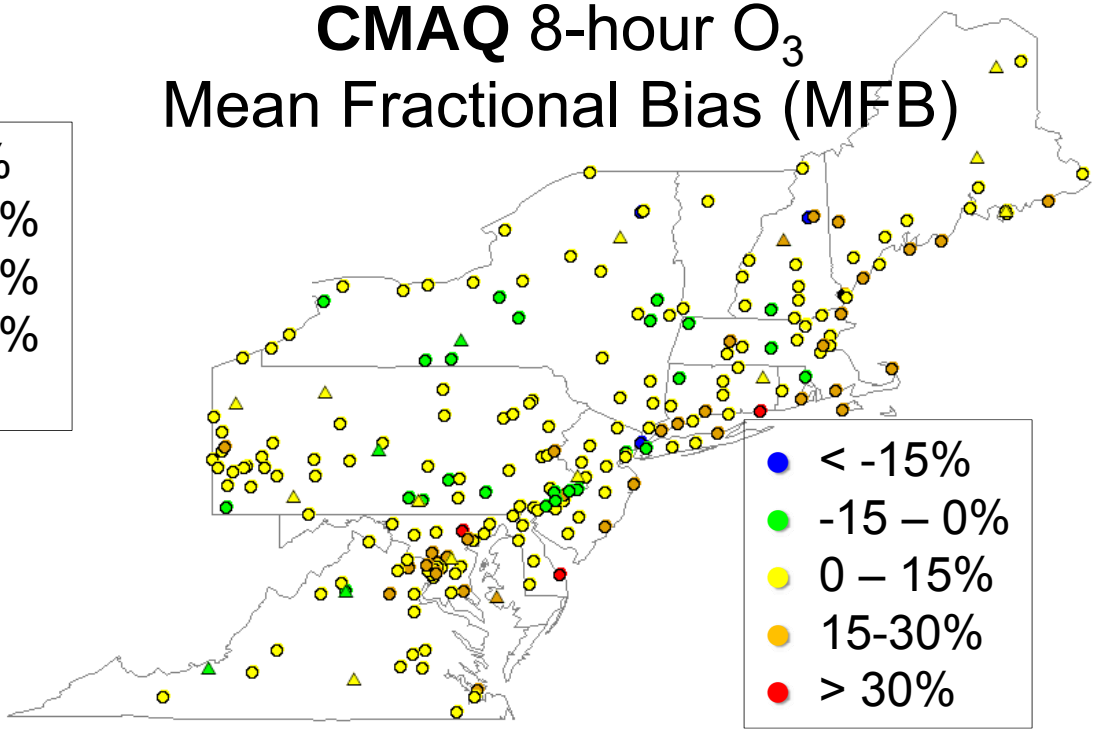
CMAQ 8-hour O_3
Mean Fractional Error (MFE)



Most sites perform well

Largest errors/bias occur along coast and downwind of some urban areas

CMAQ 8-hour O_3
Mean Fractional Bias (MFB)



2007 Base

- EPA/AQS sites (circles)
- CASTNet sites (triangles)

Model Performance Summary

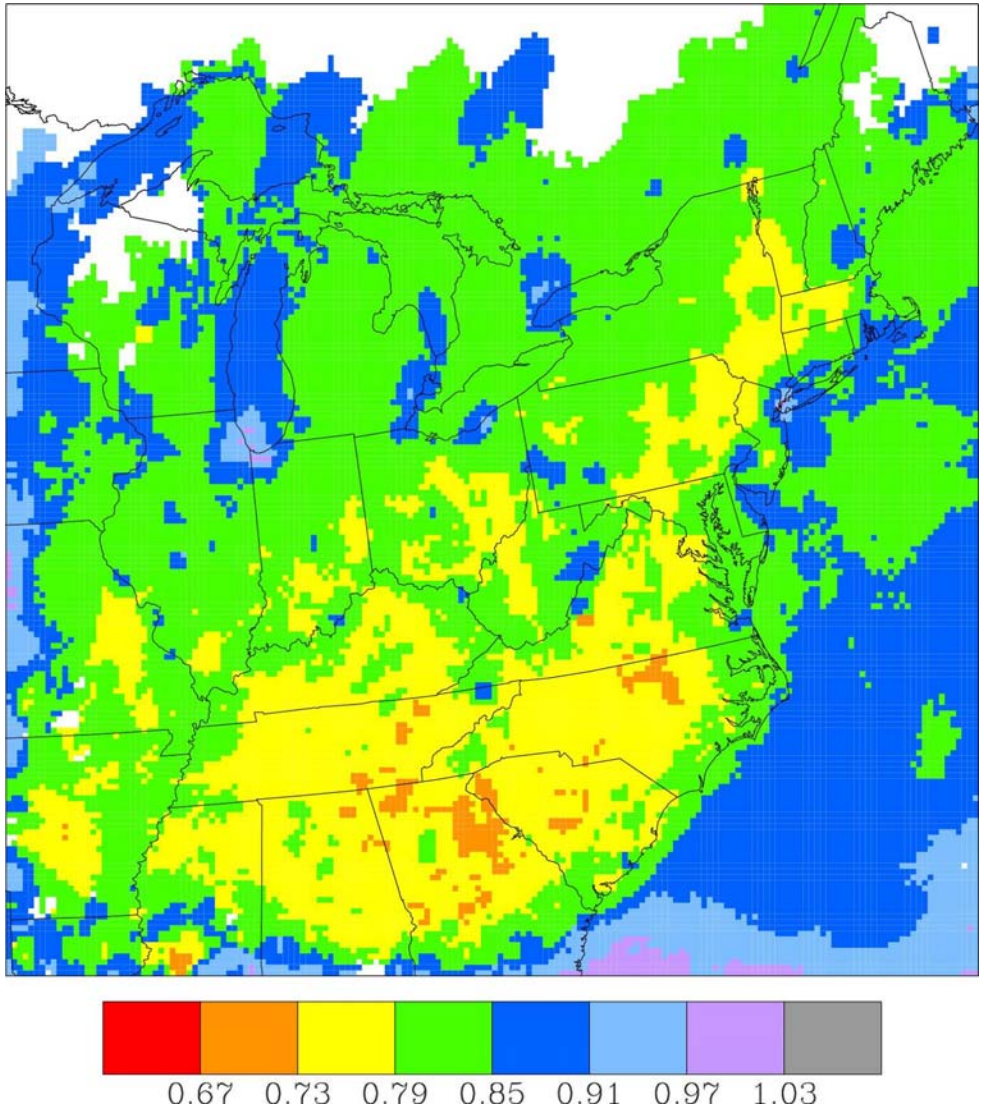
- CMAQ performed within performance criteria
  - Annual average MFE and MBE were lower than 30% and 15% respectively
  - Did well in capturing the observed diurnal and temporal patterns
  - Nighttime ozone over-prediction may be due to excessive vertical mixing resulting in lower NO_X scavenging
  - CMAQ tended to perform better with rural monitors (CASTNet) than urban monitors (EPA/AQS)
  - Model performance was weakest near coastal areas

Level 3A Screening Results

Relative Reduction Factors (RFF)

- EPA Modeling guidance recommends use of photochemical models in a relative way to demonstrate attainment
- Relative reduction factors (RRFs) are determined for each monitor based on the relative change produced by modeling from a base case
- RRF factors for each monitor are multiplied by the base period design value to predict a future case design value
- If there are biases in the future year, those biases are accounted for by being relative to those same biases in the base year

Relative Reduction Factors
2020 vs. 2007 Level3 Base



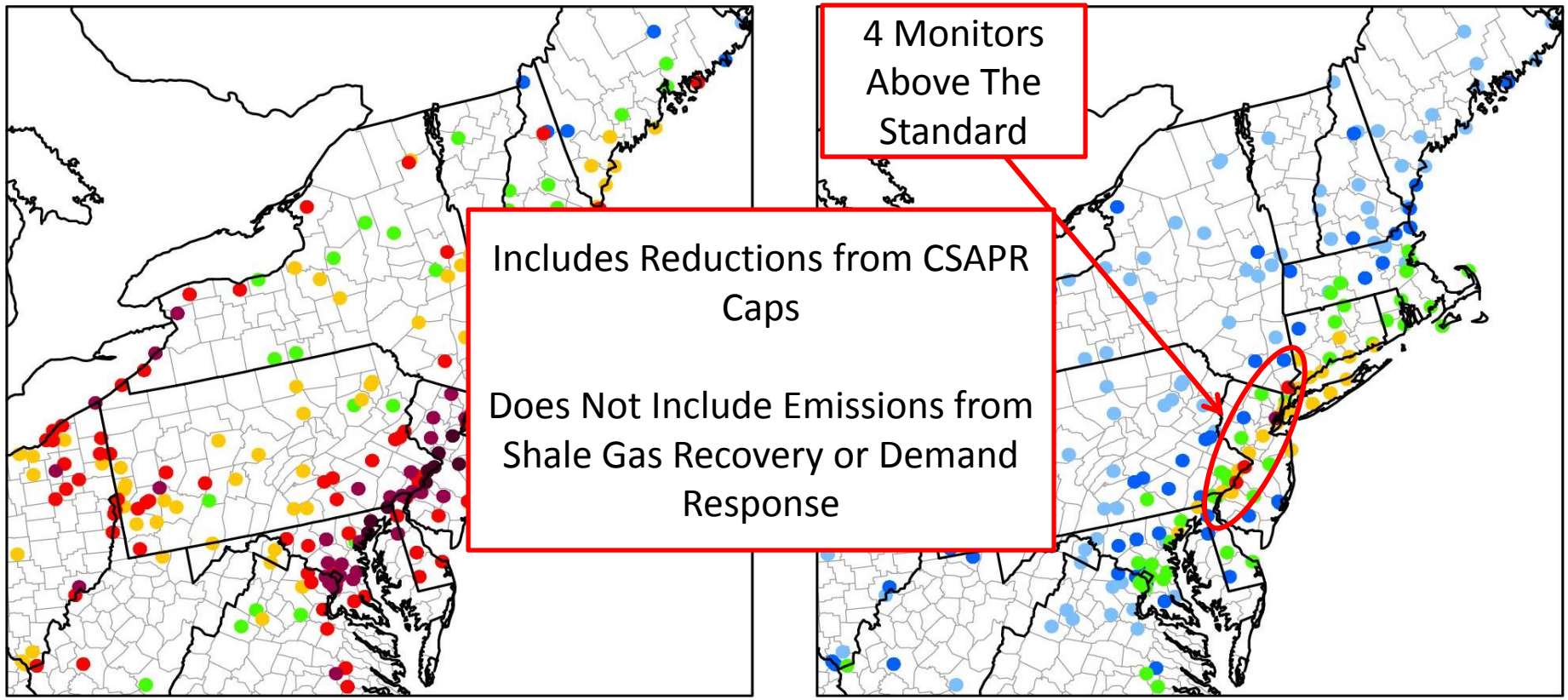
Daily Max 8-hr Ozone April 15 – October 30

2007 Base Case Design Values

2020 CMAQ Predicted Design Values

Observed 8-Hr Daily Maximum Ozone DVC (Average of 05-07, 06-08, and 07-09 DV)

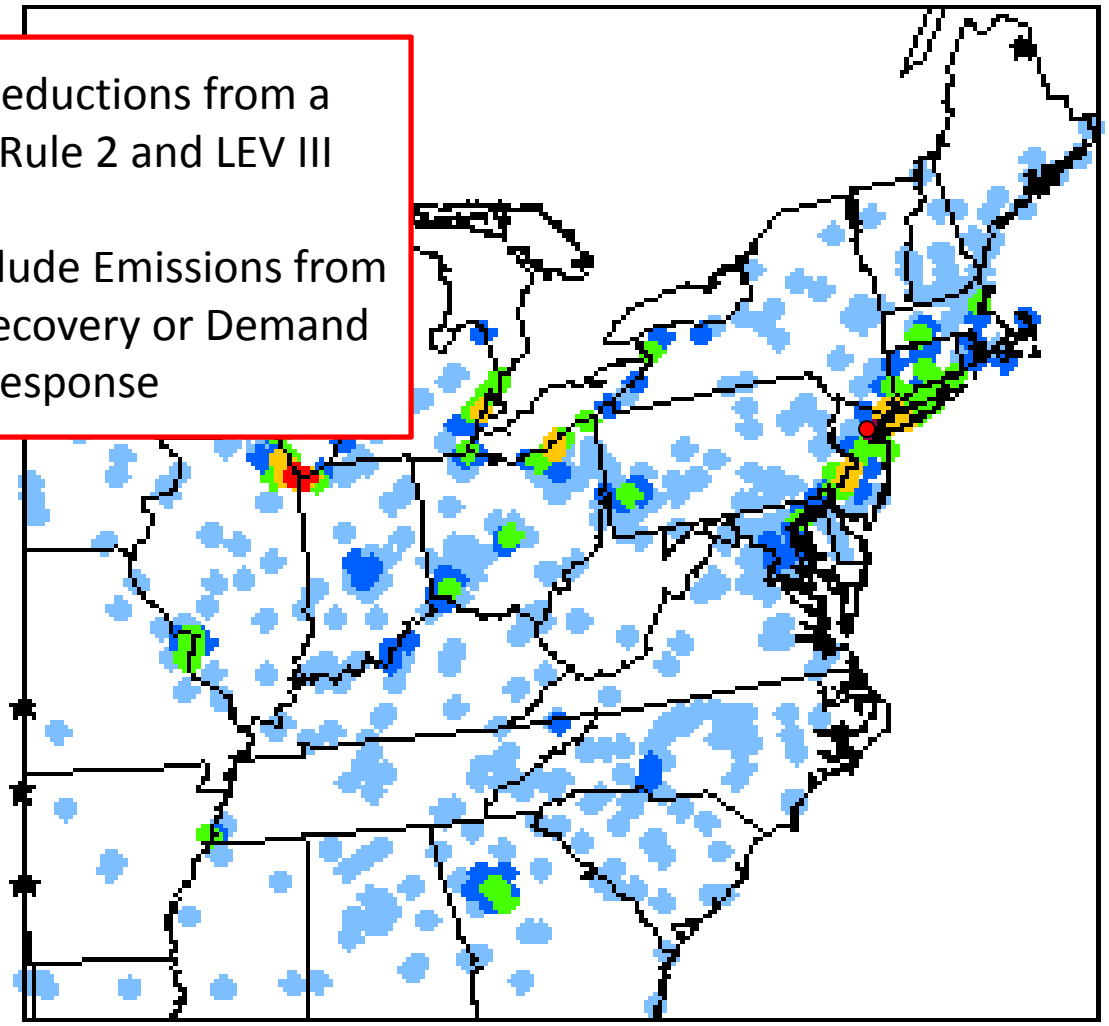
Estimated 2020 Future Design Value based on 2007 Level 3 platform



Level 2 - Scenario 4
CMAQ Predicted 2020 Design Values

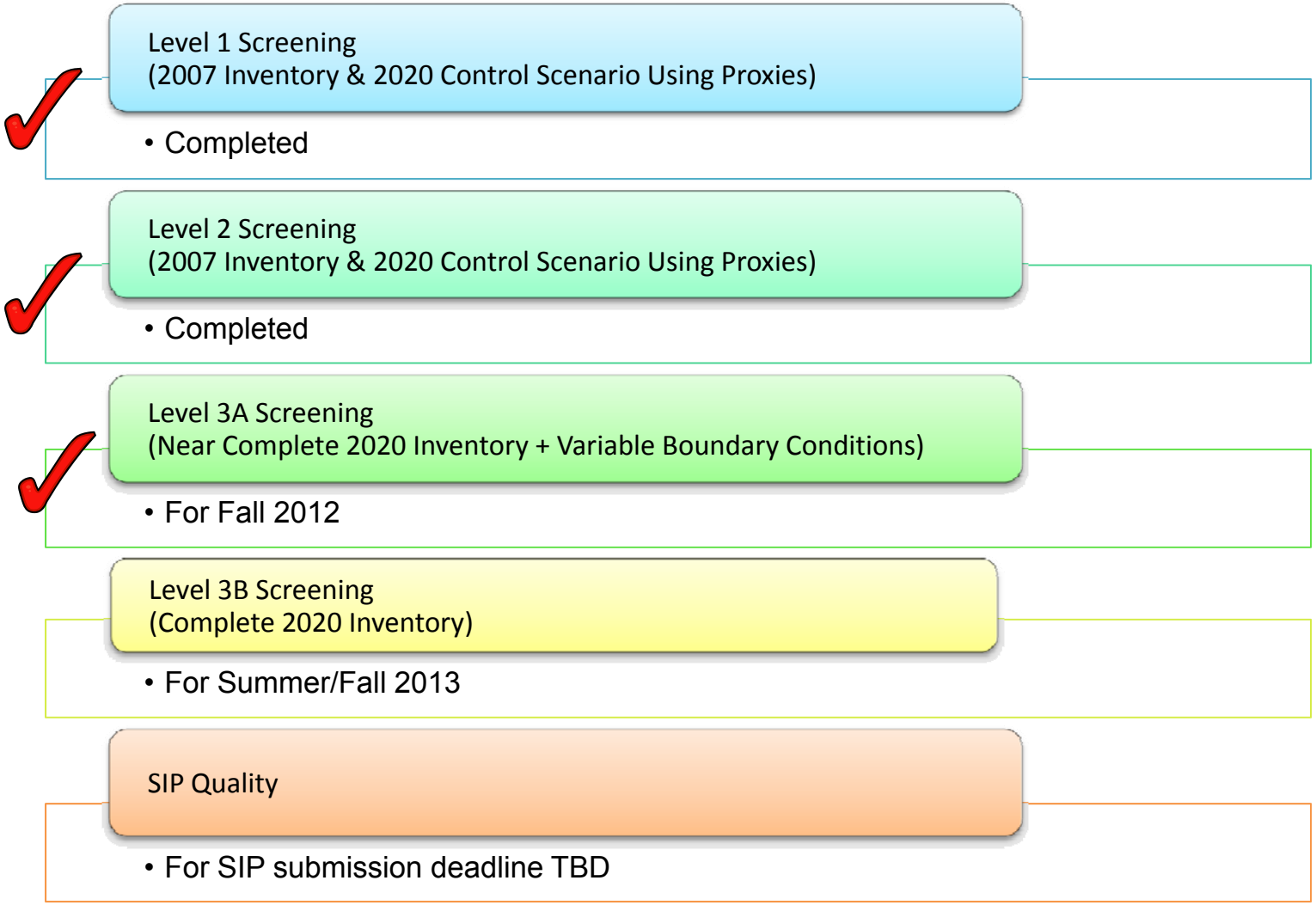
Includes Reductions from a Transport Rule 2 and LEV III

Does Not Include Emissions from Shale Gas Recovery or Demand Response



Next Steps

Screening Modeling Schedule



Level 3B Screening Activities

Goal: Improved 2020 base for performance assessment

- Include draft ERTAC EGU emission inventory
  Annual Meeting

Goal: Improved projection of 2018 attainment status

- CMAQ Base Case 2018
  Annual Meeting

Summary

- Emission inventories are improving
- Model performs within a target criteria
- Air quality improving but still much to be done
  - Design Values starting to level-out
  - Model projections do not show full attainment
  - Model may be optimistic (uses CSAPR caps and does not include shale gas recovery or demand response)

Questions

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