

# AIRPACT-5 : PM<sub>2.5</sub> and O<sub>3</sub> Evaluation

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# Simulation time periods

- Different episodes considered
  - July 2012
  - August 2012
  - August 2015
    - Large wildfire season, monitors across the domain impacted
- $O_3$  and total  $PM_{2.5}$  - We compare the model results w.r.t. AIRNow / AQS data for the urban sites
- $PM_{2.5}$  species – Model comparison w.r.t. IMPROVE / CSN sites

## AIRPACT-5: Key differences w.r.t. AIRPACT-4

- Emissions – primary aerosol emissions are divided into many more species
- Gas phase mechanism – CB05 (AIRPACT-4 used SAPRC99)
- Aerosol treatment – AERO6 module (AIRPACT-4 used AERO5)
- Corrects for the plume rise error for fires (now considers fire emissions above 1<sup>st</sup> layer)
  - Thus, more PM emissions from fires
  - Doesn't affect any gas phase species
- Currently AIRPACT-5 uses 37 vertical layers.
  - All results shown here based on 21 MCIP layers
  - Possible impacts on O<sub>3</sub> performance

# Performance Evaluation at Urban sites

PM<sub>2.5</sub> and O<sub>3</sub>

## Some large fires in August 2015

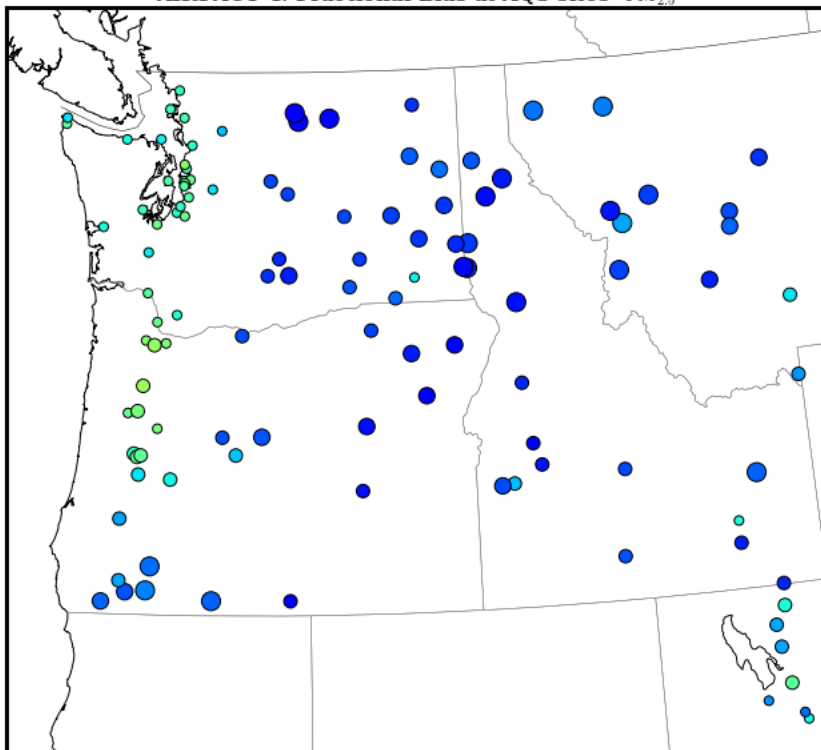
<b>Fire name</b>	<b>SMARTFIRE2 acres</b>	<b>Burn reports acres</b>
North Star Fire	147,096	218,138
Tunk Block Fire	194,578	165,947
Okanogan Complex (Lime Belt Fire)	133,728	133,707
Chelan Complex Fire	57,226	88,985
Grizzly Bear Complex Fire	22,494	83,148
Kettle Complex Fires	49,404	76,549
Wolverine Fire	80,692	65,512
Carpenter Road Fire	47,610	63,972
Cougar Creek Fire	62,330	53,534
Highway 8 Fire	7,900	33,100
Tower Fire (Kaniksu Complex)	22,218	24,711
Colville Complex Fire	966	11,522
Twisp River Fire	7,184	11,222

## Performance evaluation summary: August 2015

<b>statistic</b>	<b>AIRPACT-4</b>	<b>AIRPACT-5</b>
mean observed ( $\mu\text{g}/\text{m}^3$ )	18.5	
# obs	3389	
mean modeled ( $\mu\text{g}/\text{m}^3$ )	4.3	10.4
Bias ( $\mu\text{g}/\text{m}^3$ )	-14.2	-8.1
Error ( $\mu\text{g}/\text{m}^3$ )	14.5	9.6
Fractional bias (%)	-83.5	-49.4
Fractional error (%)	92.1	63.1
Normalized bias (%)	-48.4	-28.7
Normalized error (%)	60.9	49.1
RMSE	29.3	20.6

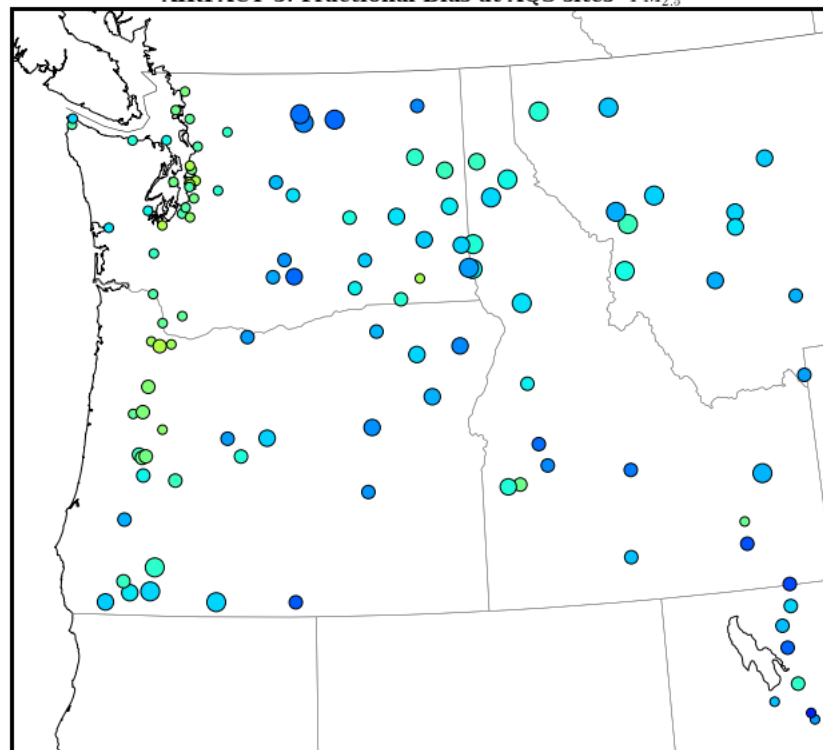
# Spatial Distribution of FB

AIRPACT-4: Fractional Bias at AQS sites-  $PM_{2.5}$



•  $[PM_{2.5}] < 10$    ●  $10 < [PM_{2.5}] \leq 20$    ●  $20 < [PM_{2.5}] \leq 30$    ●  $[PM_{2.5}] > 30$

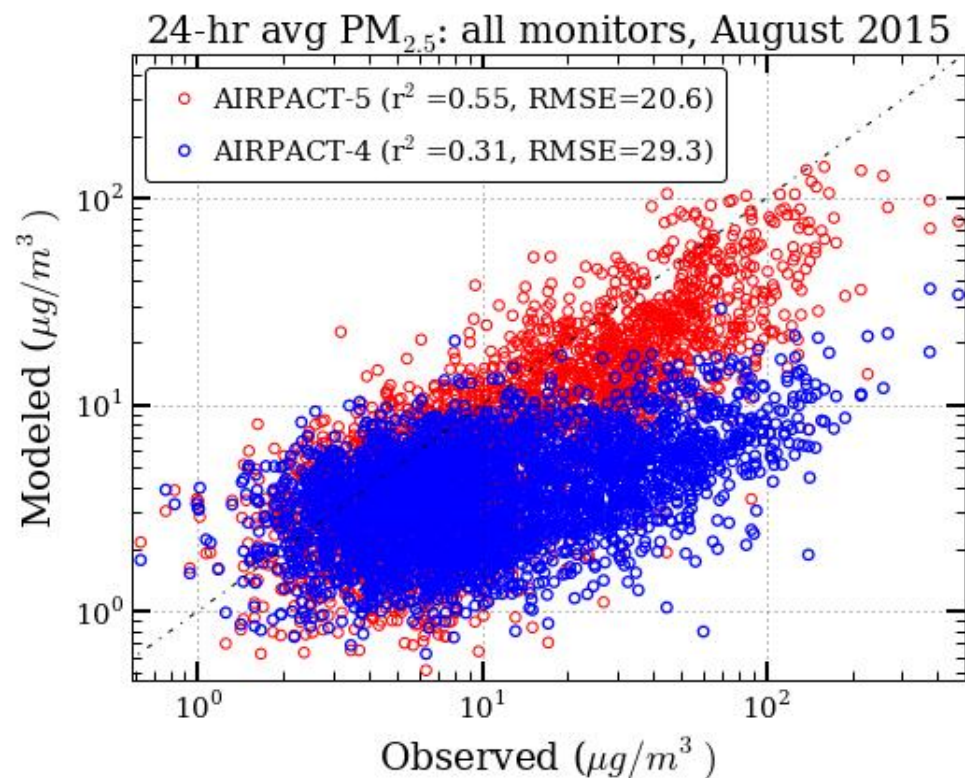
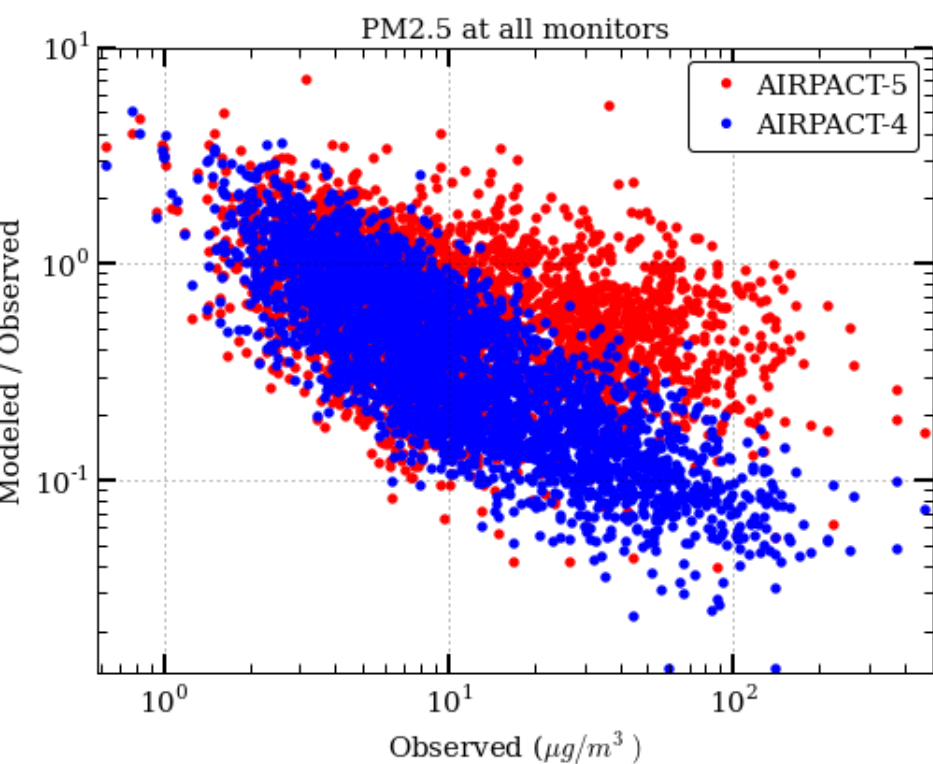
AIRPACT-5: Fractional Bias at AQS sites-  $PM_{2.5}$



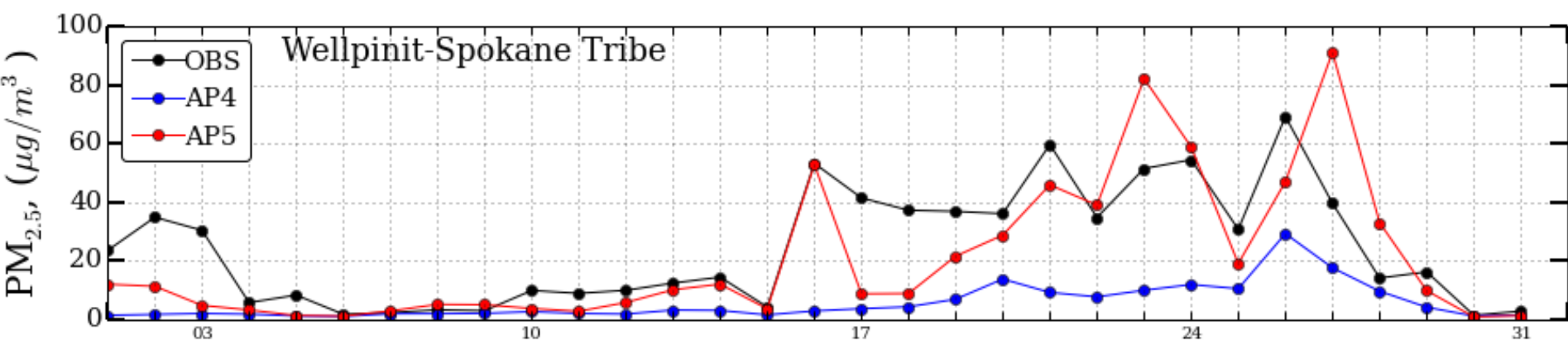
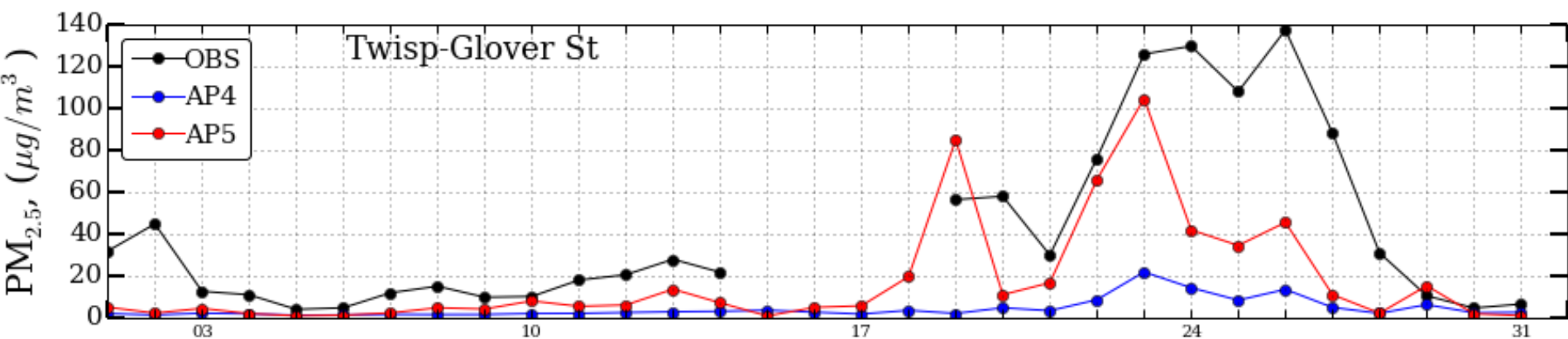
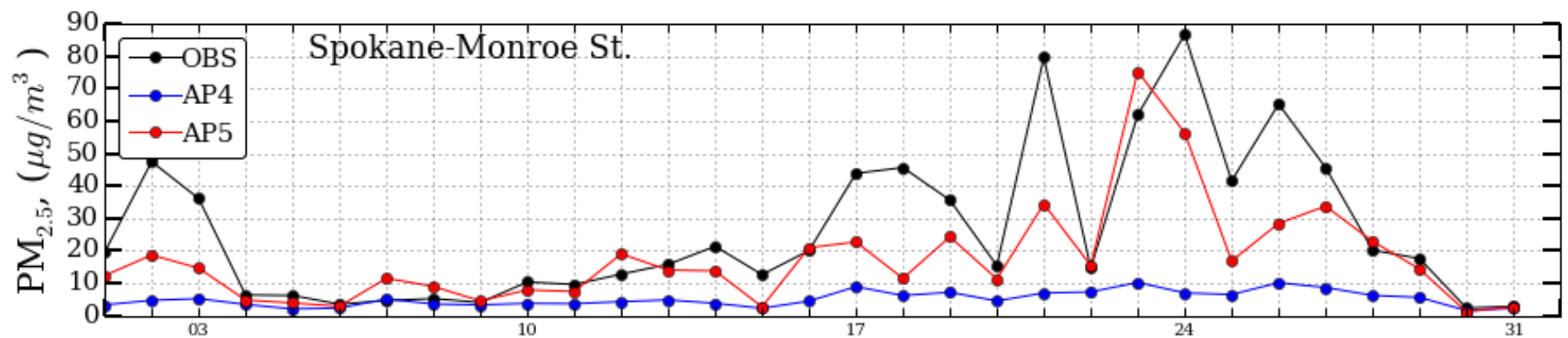
•  $[PM_{2.5}] < 10$    ●  $10 < [PM_{2.5}] \leq 20$    ●  $20 < [PM_{2.5}] \leq 30$    ●  $[PM_{2.5}] > 30$

# AIRPACT-5 PM<sub>2.5</sub> performance at AIRNow sites: August 2015

- Plume error correction significantly improves AIRPACT-5 performance
- Specially true at higher observed concentrations

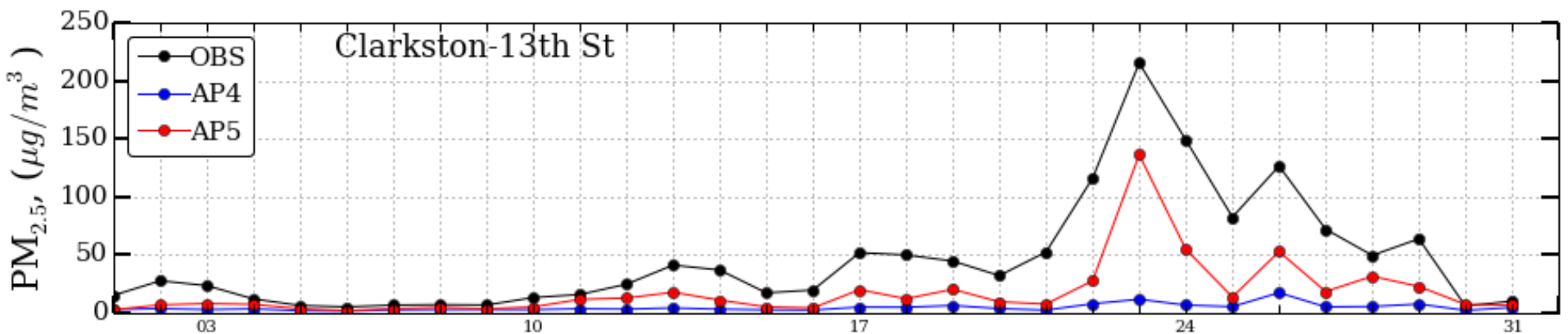
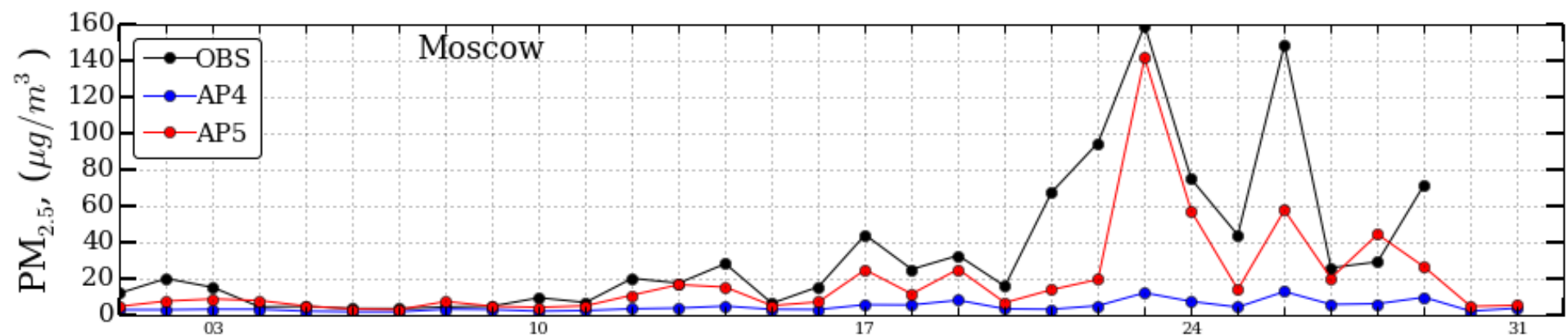
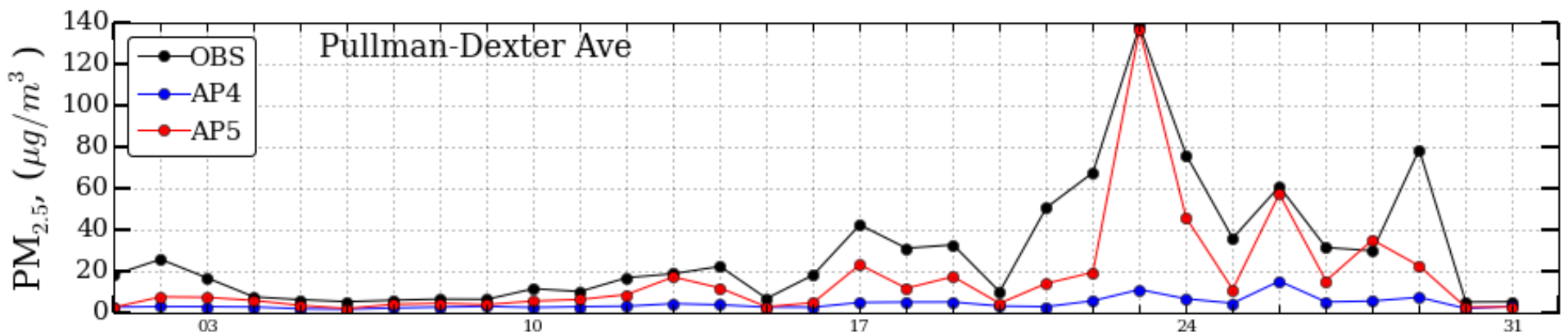






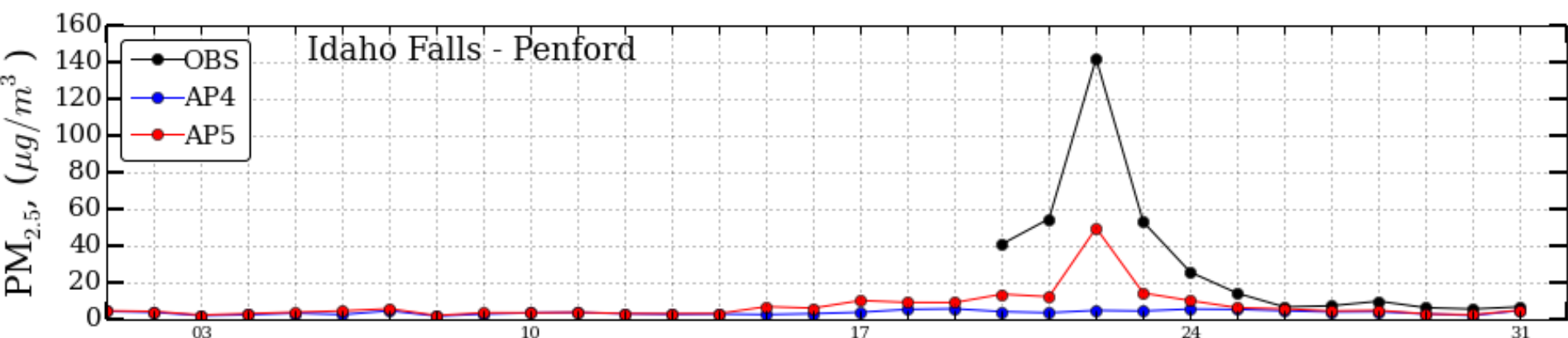
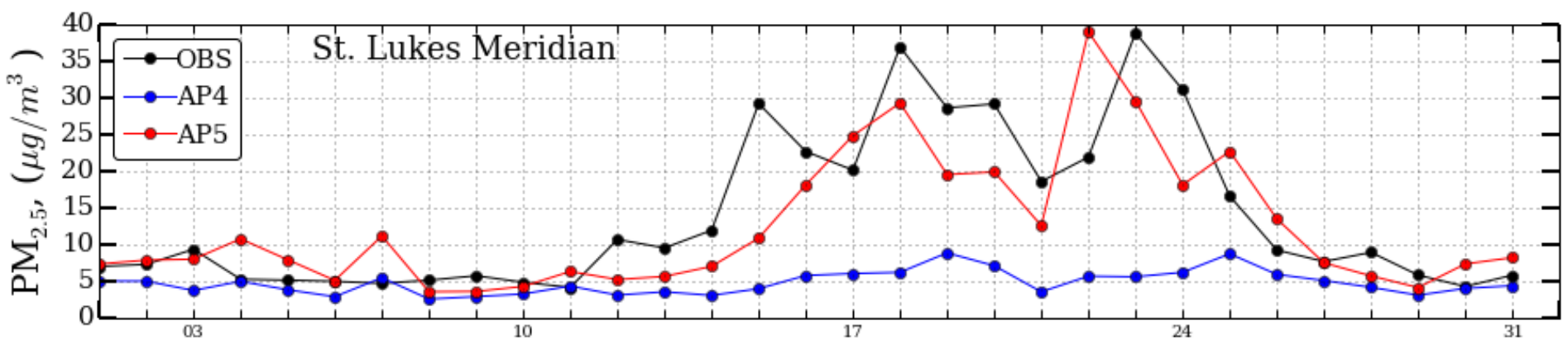
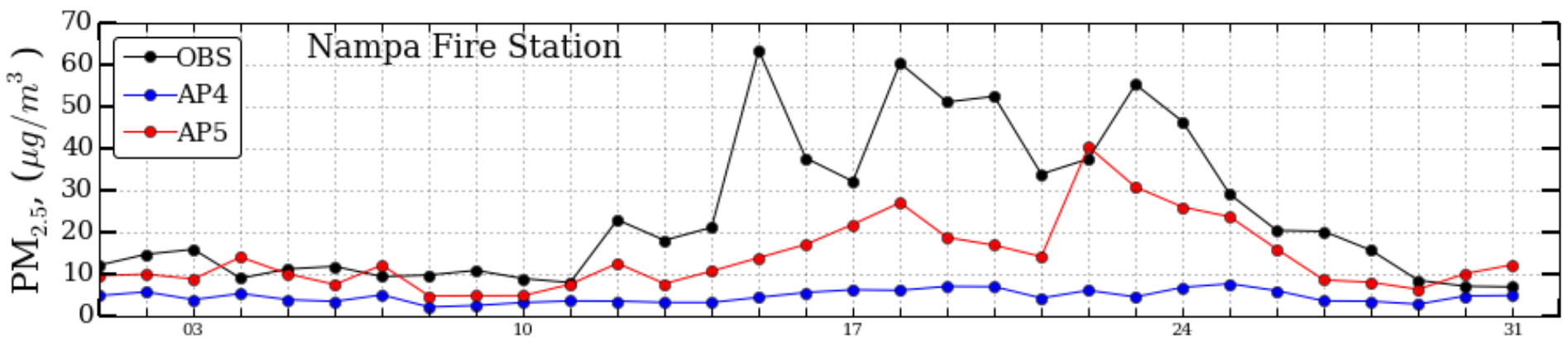
Aug  
2015

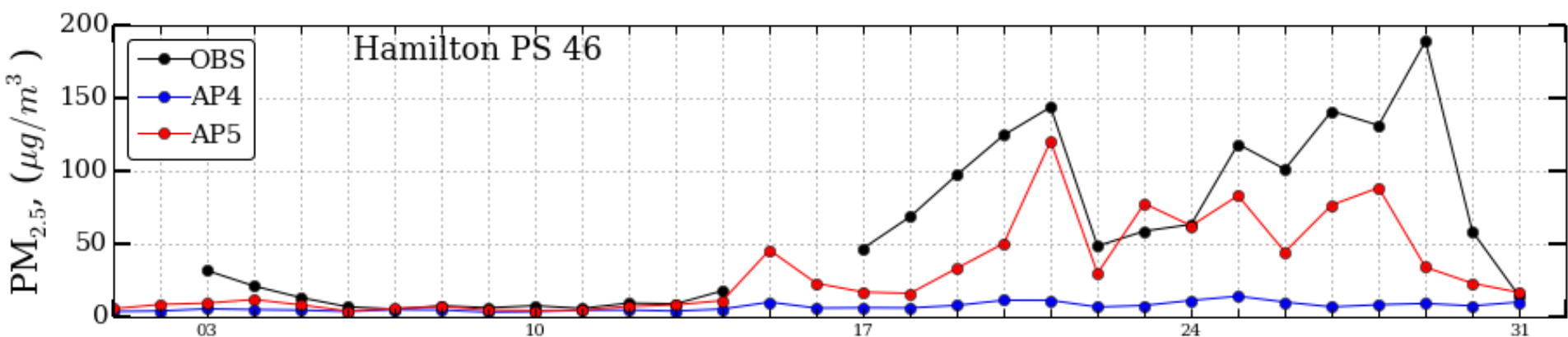
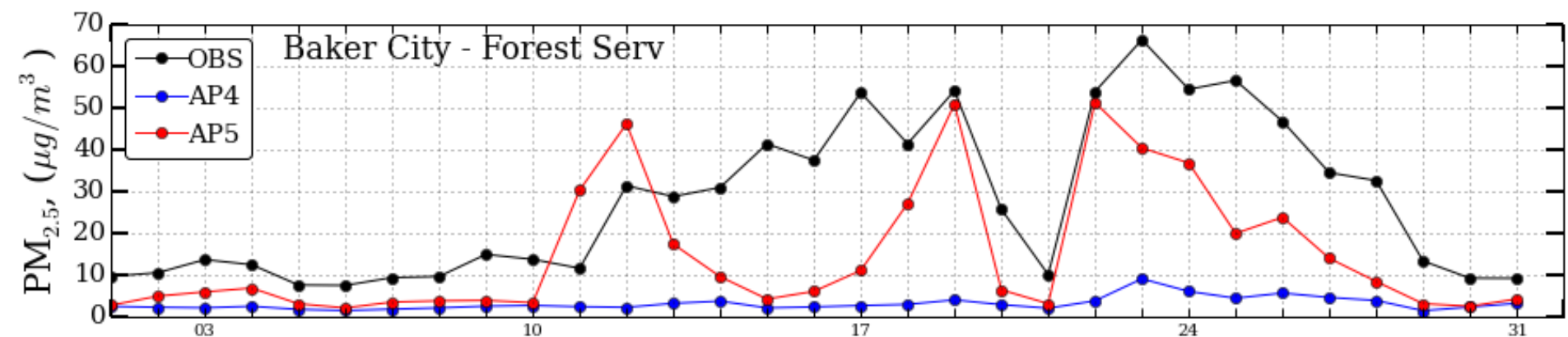
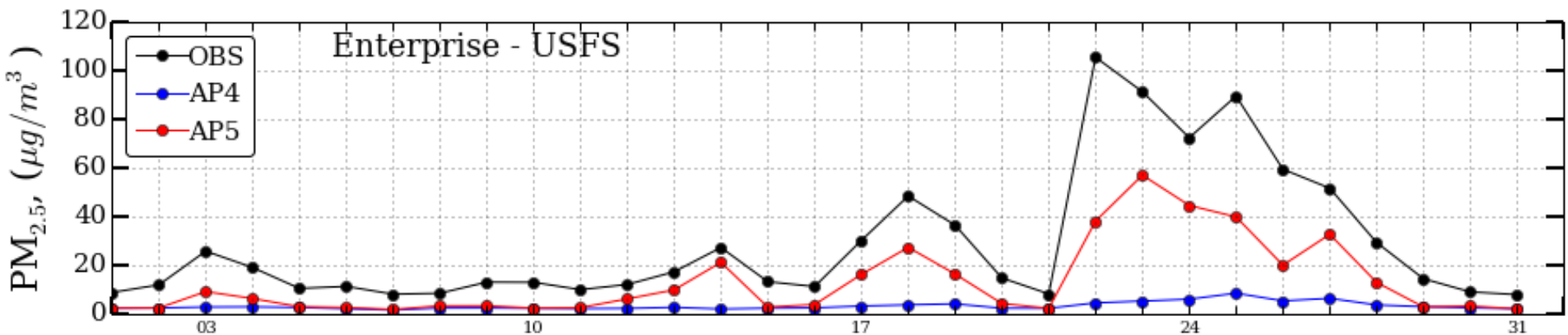
Sep



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2015

Sep





# O<sub>3</sub>: Performance statistics

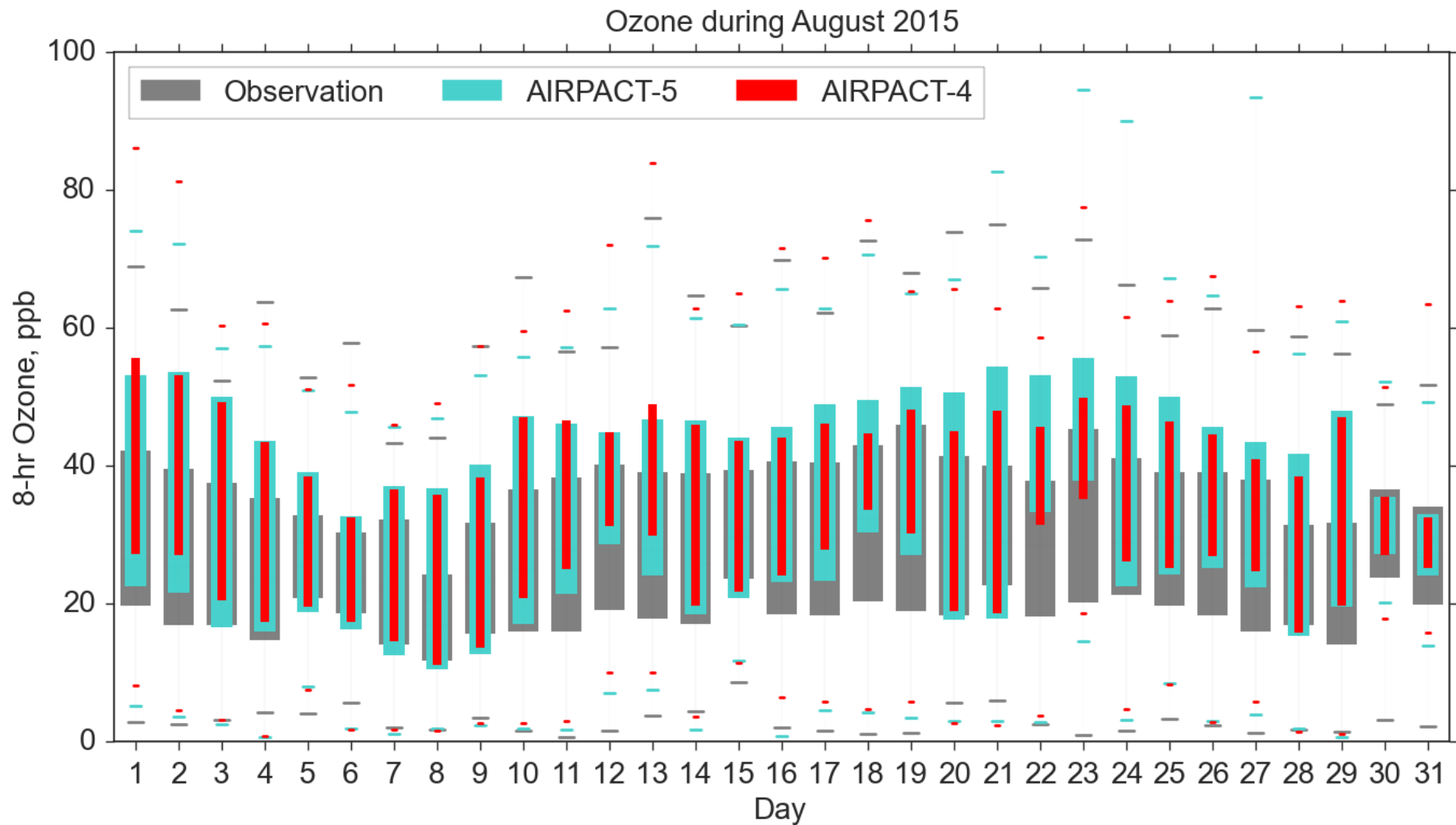
	July 2-14, 2012		August 2-18, 2012		July 28 – August 3, 2015	
	AP4	AP5	AP4	AP5	AP4	AP5
MB (ppb)	6.4	2.4	7.5	3.4	7.9	5.2
ME (ppb)	10.2	8.0	11.1	8.8	10.7	9.6
FB (%)	15.0	5.7	21.9	11.9	23.4	16.5
FE (%)	32.8	28.3	34.0	29.7	33.5	31.5
NB (%)	32.4	19.0	46.3	29.2	44.9	35.8
NE (%)	46.2	37.1	56.2	43.7	53.2	48.2
RMSE	13.1	10.4	14.5	11.5	13.8	12.7
# pairs approx.	10700		16600		7000	

AP5 generally shows improvement

Improvement also seen for MDA8hr O<sub>3</sub> MFB (based on July 2012 simulations)

Model	FB (%)	FE (%)
AP4	13	21
AP5	-1	15

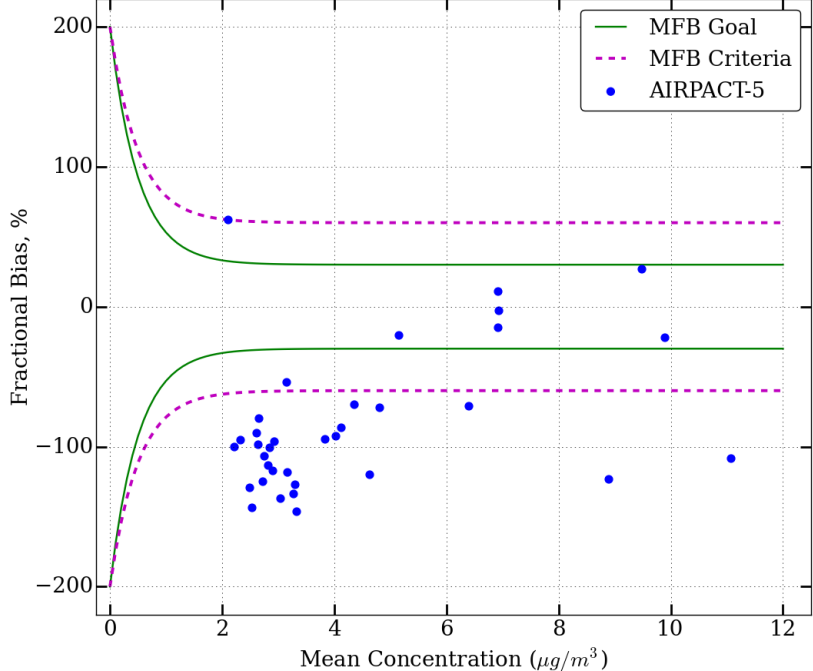
# Ozone: August 2015



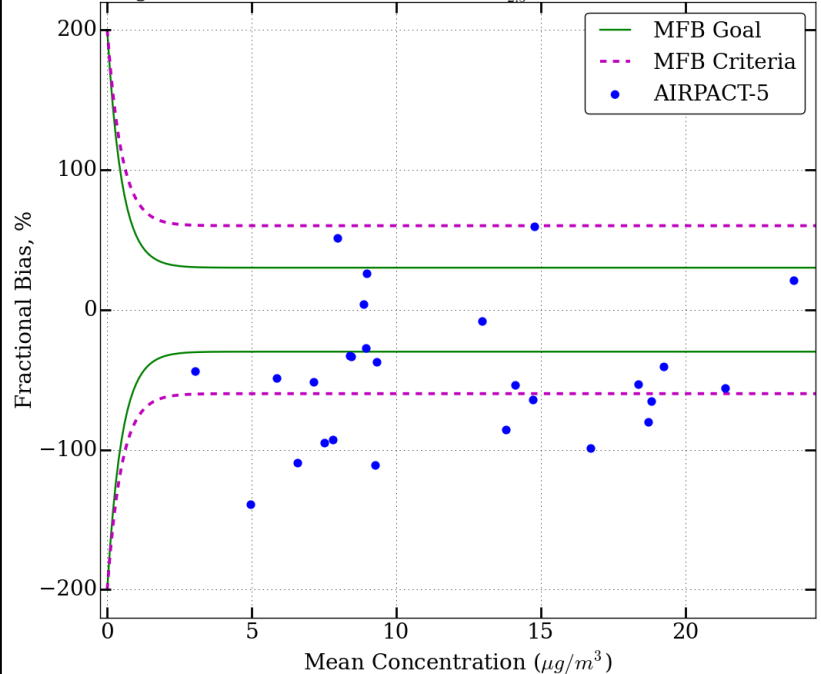
# PM performance evaluation at IMPROVE and CSN sites

PM<sub>2.5</sub>, OC, EC, SO<sub>4</sub>, NO<sub>3</sub>, NH<sub>4</sub>

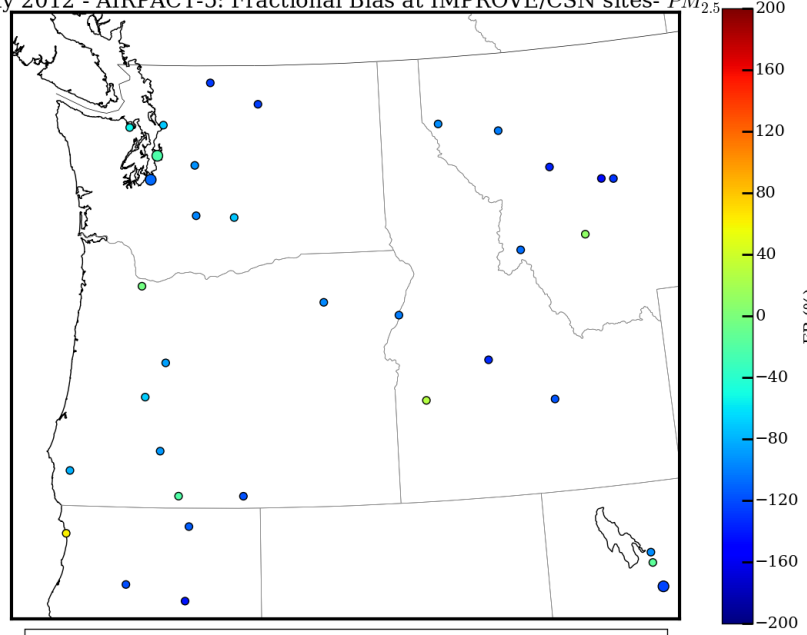
July 2012 - Fractional Bias for  $PM_{2.5}$  at IMPROVE/CSN sites



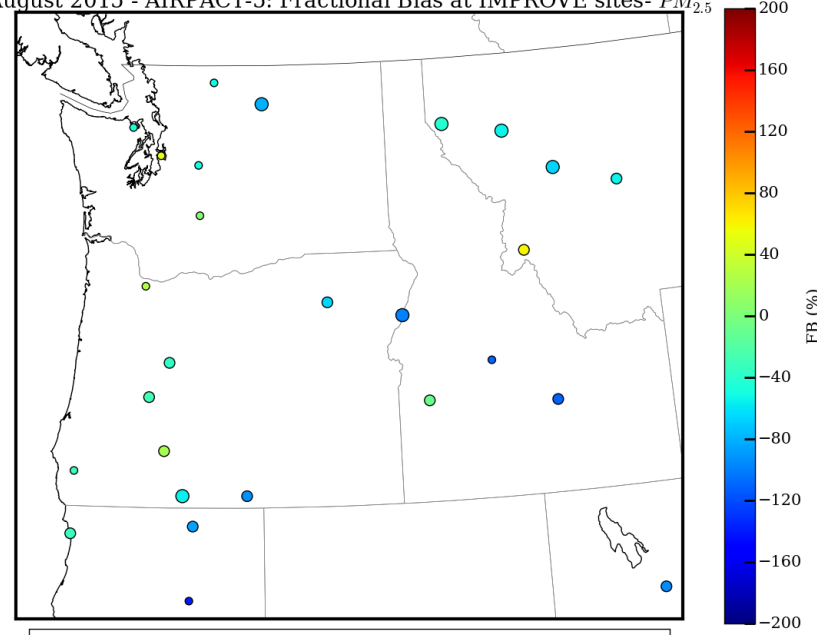
August 2015 - Fractional Bias for  $PM_{2.5}$  at all IMPROVE/CSN sites



July 2012 - AIRPACT-5: Fractional Bias at IMPROVE/CSN sites -  $PM_{2.5}$



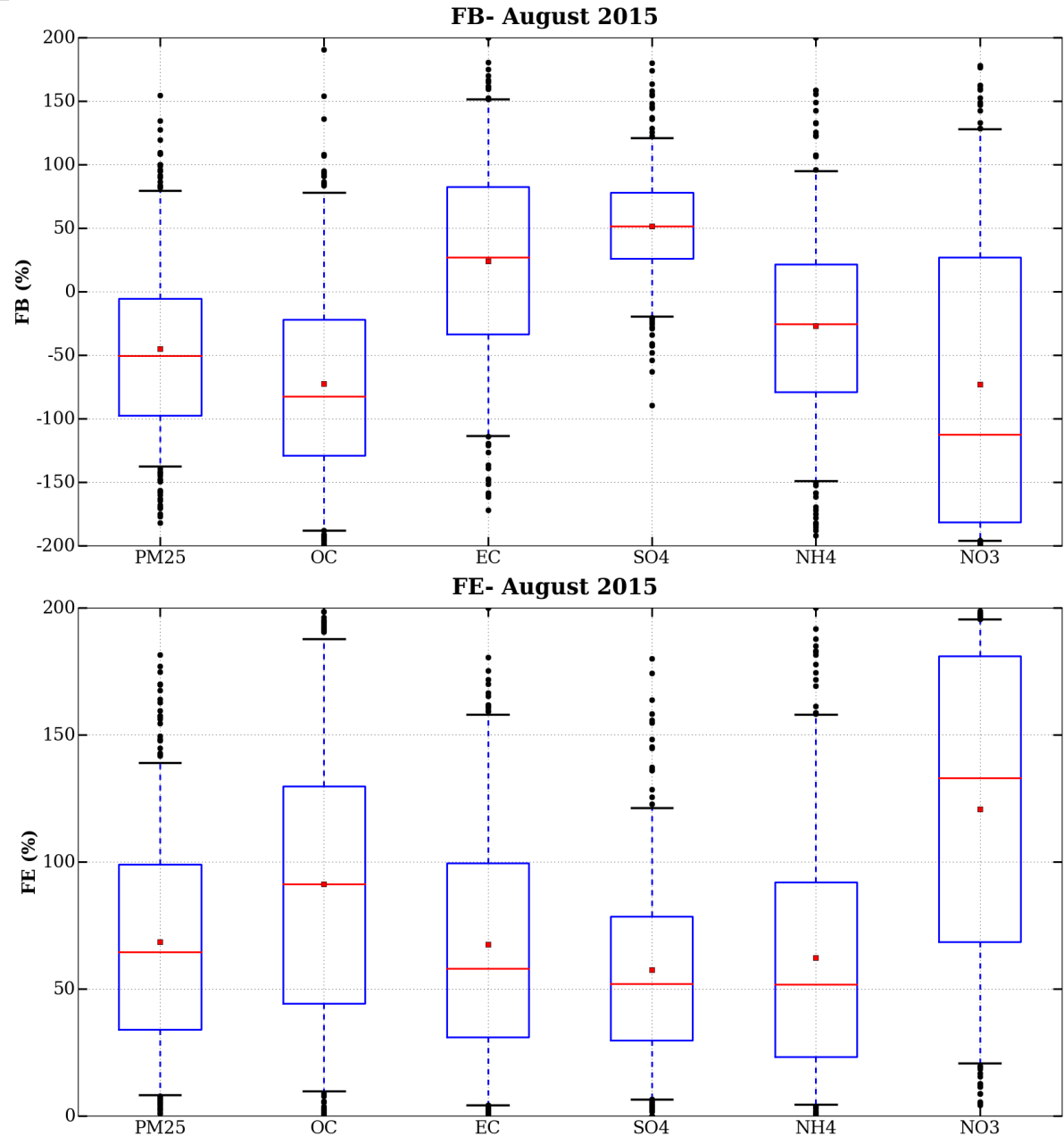
August 2015 - AIRPACT-5: Fractional Bias at IMPROVE sites -  $PM_{2.5}$





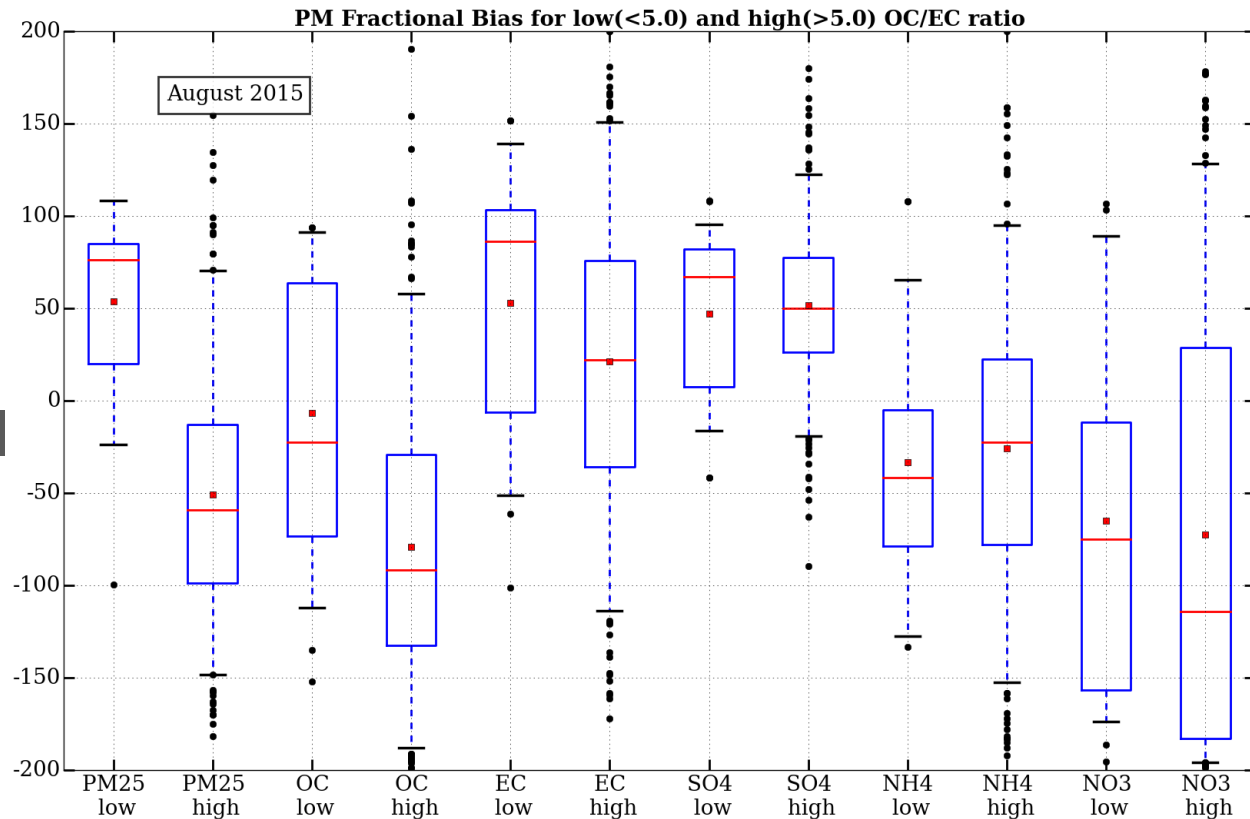
# Fractional Bias and Error

- EC, SO<sub>4</sub> and NH<sub>4</sub> are fairly well predicted
- Underprediction of PM<sub>2.5</sub> and OC
- Also underpredicts NO<sub>3</sub>, but concentrations are very small

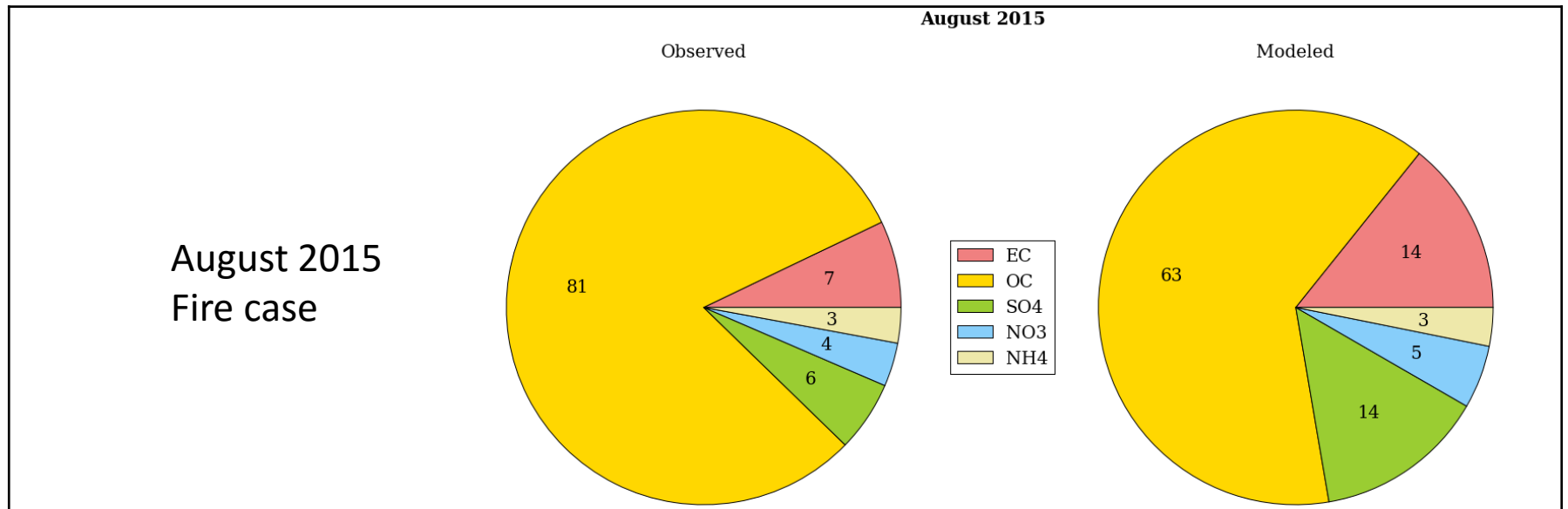
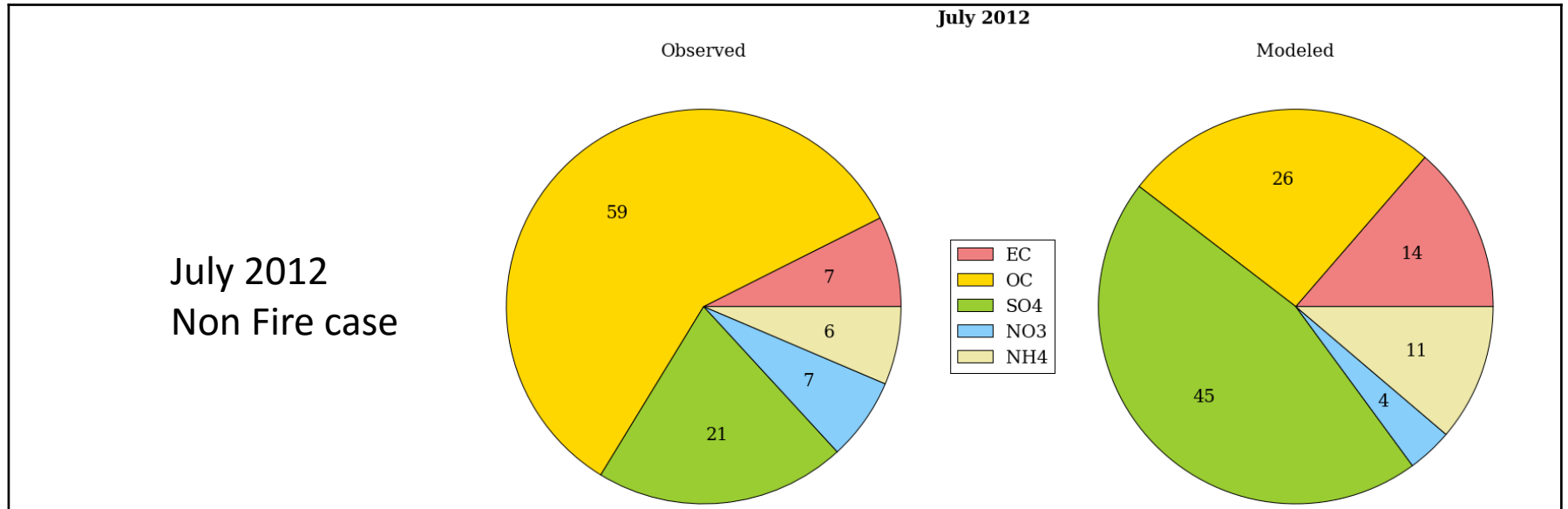


# FB as a function of OC/EC ratio

- Similar behavior for  $PM_{2.5}$  and OC (which form bulk of  $PM_{2.5}$ )
- Little variability in FB for  $SO_4$  indicating model robustness for  $SO_4$
- Variability also small for  $NH_4$  and  $NO_3$



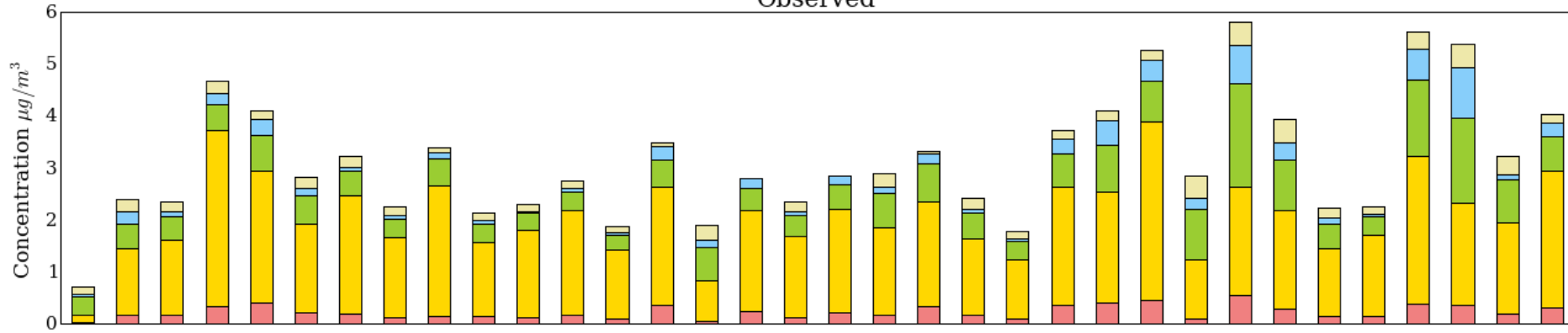
# Relative contribution of PM species – modeled vs observed



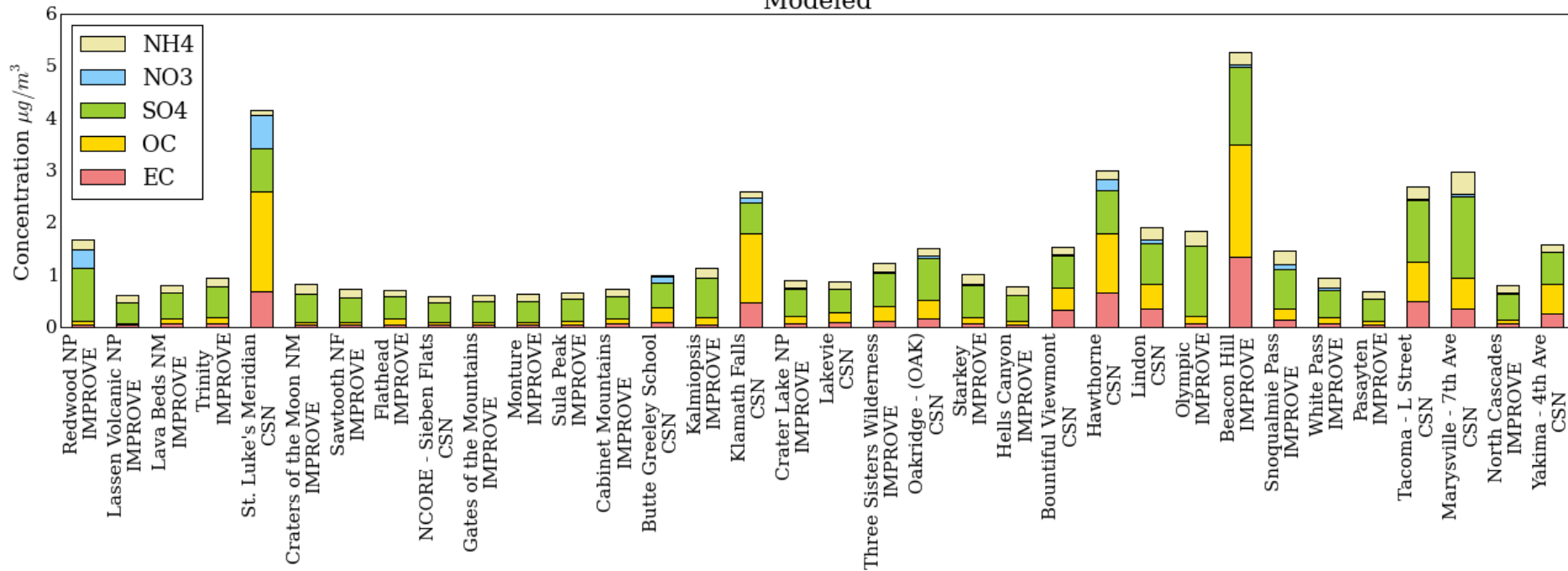
# Distribution at different IMPROVE/CSN sites

July 2012

Observed



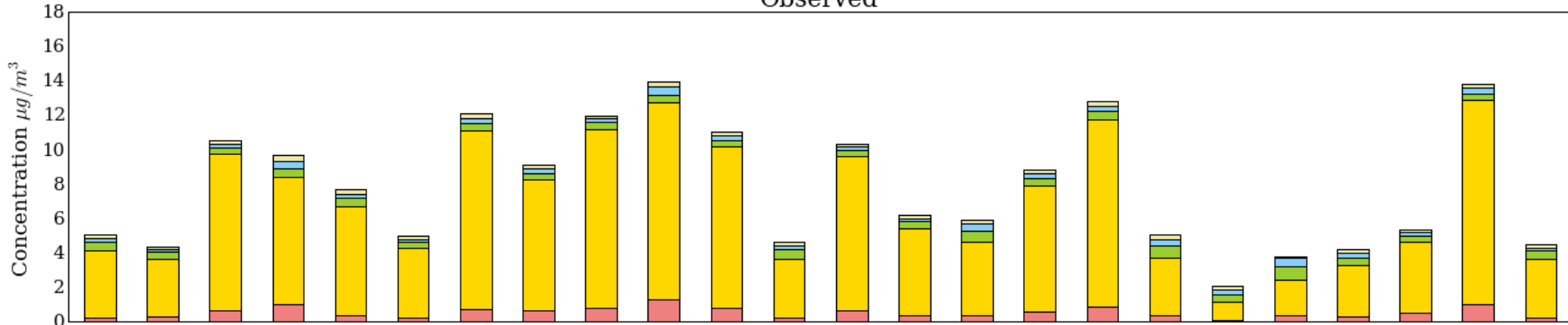
Modeled



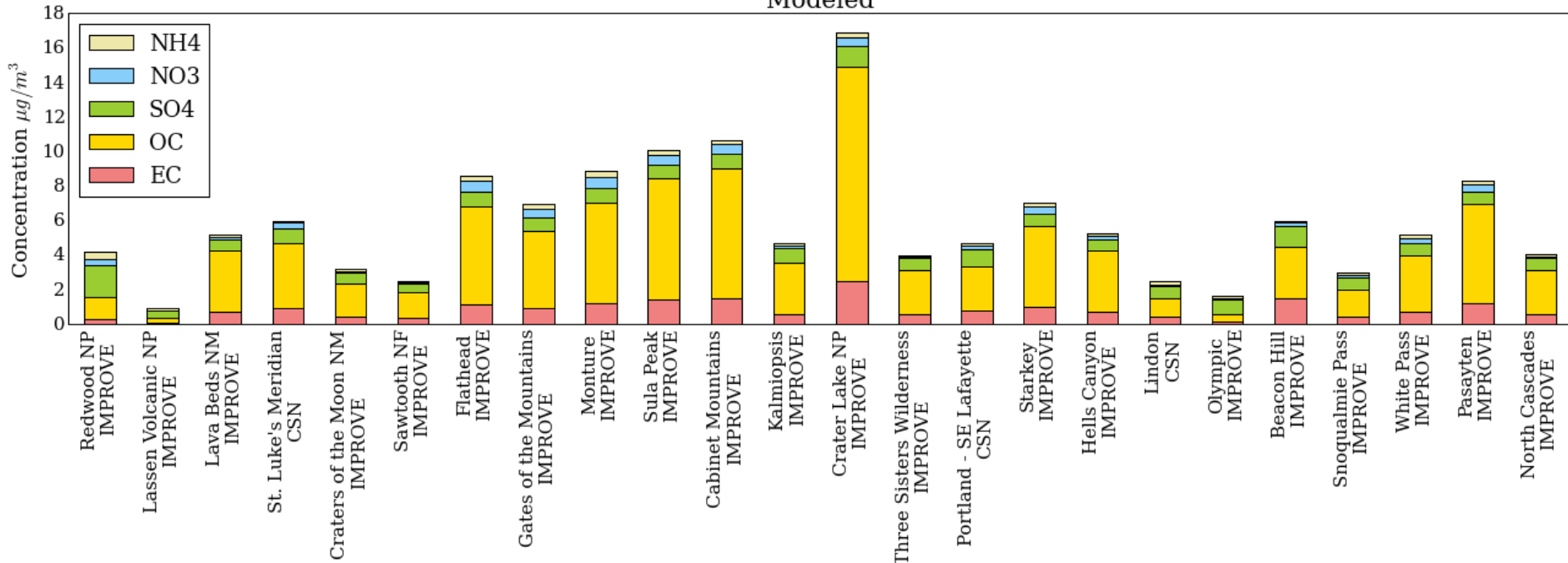
# Distribution at different IMPROVE/CSN sites

August 2015

Observed



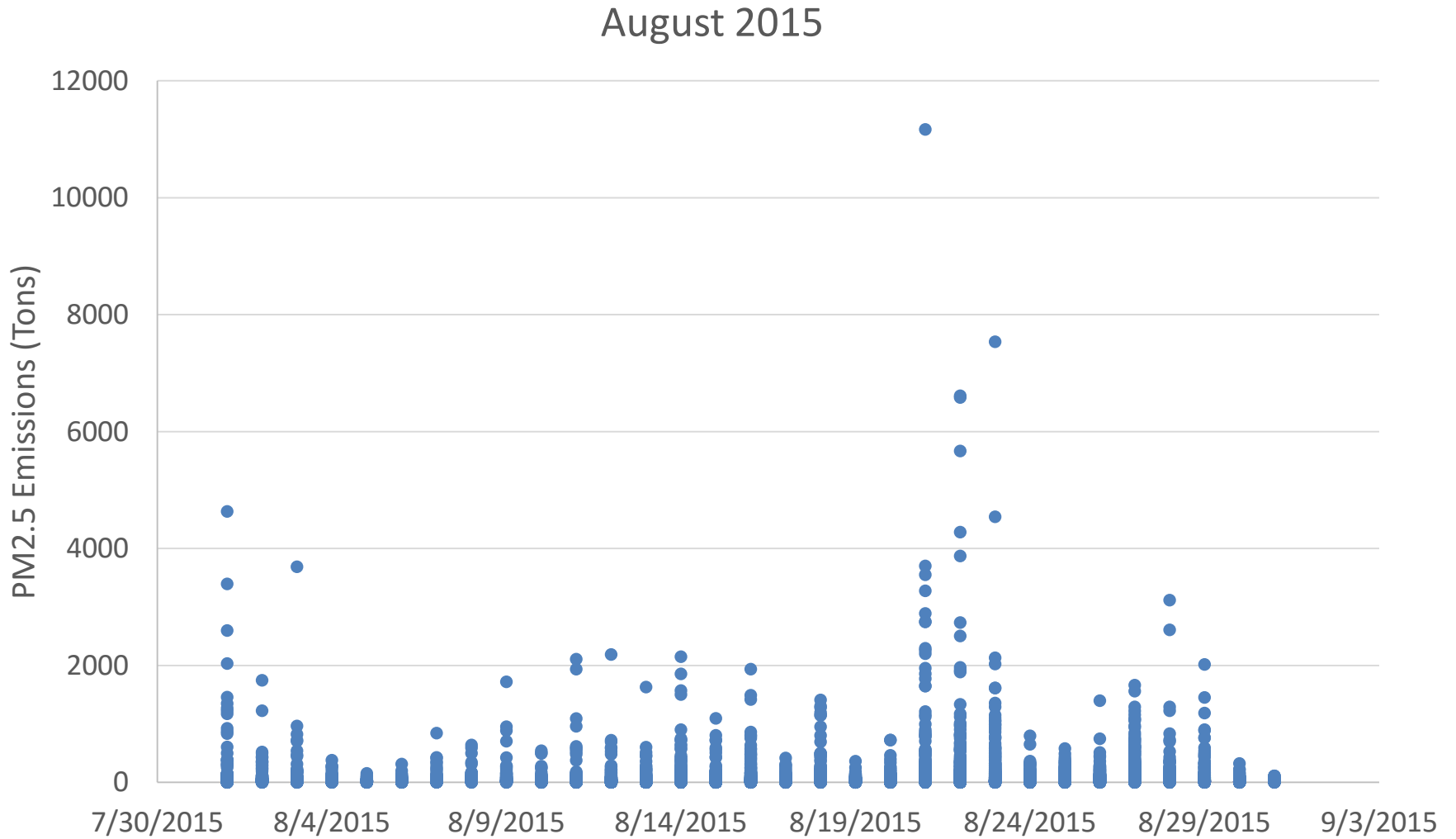
Modeled



## Summary

- Correction to fire emissions has significantly improved the performance for  $PM_{2.5}$  compared to AIRPACT-4
- AIRPACT-5 performance has improved for ozone episodes considered
- Comparison with IMPROVE / CSN sites show that we're still under-predicting for OC, which forms bulk of  $PM_{2.5}$

# Fire PM emissions in August 2015



# QQ and Spatial Distribution of FB

