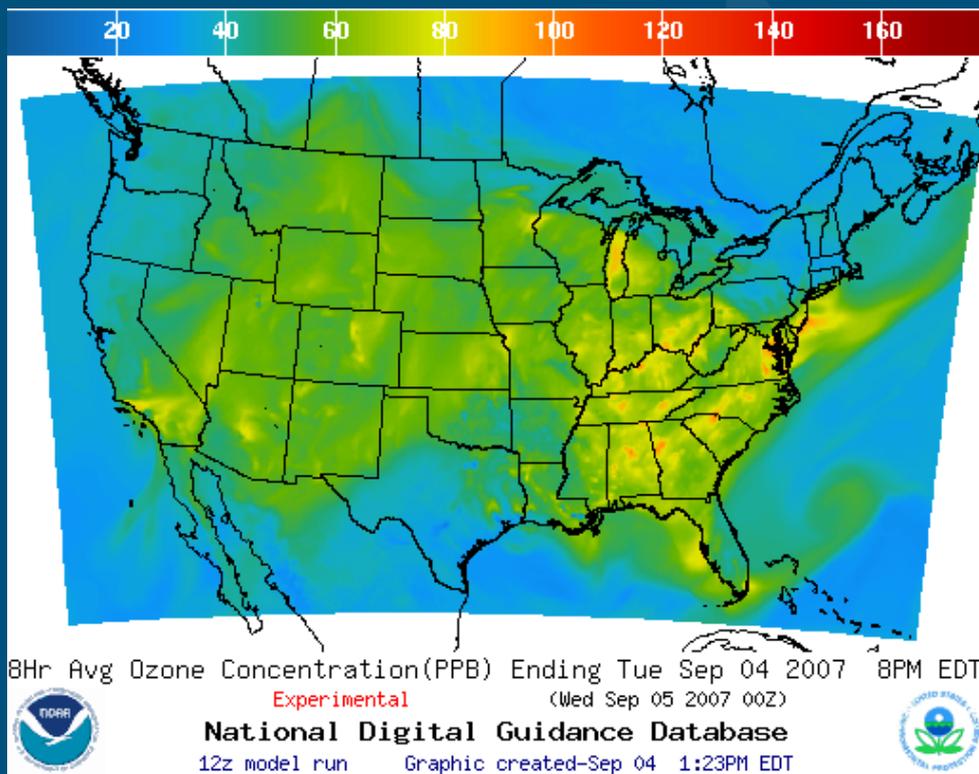


An Evaluation of the Experimental 5x WRF-CMAQ Air Quality Forecast Model for the Summer of 2007



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Spatial Evaluation

- CONUS
- Regions: NE, SE, UM, LM, RM, PC
- California: NMB, SFB, CVB, CC, SC, DB



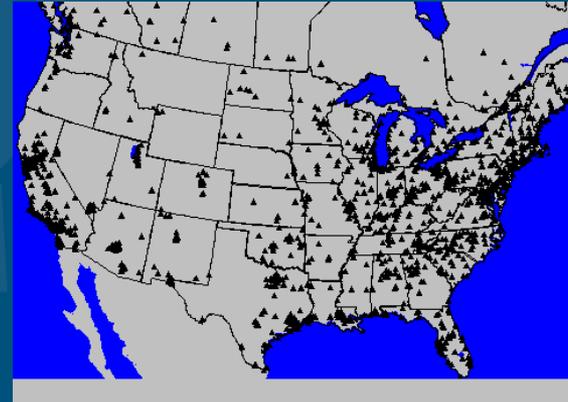
Temporal Evaluation

- Summer Season (J, J, A)
- Monthly Summaries: M, J, J, A, S
- Daily: 1 May – 8 September, 2007

This evaluation used:

*Hourly O₃ concentrations (ppb) from
EPA's AIRNOW network*

> 1090 stations



Observations were matched/compared directly to grid cells

- i.e. no interpolation/smoothing was used

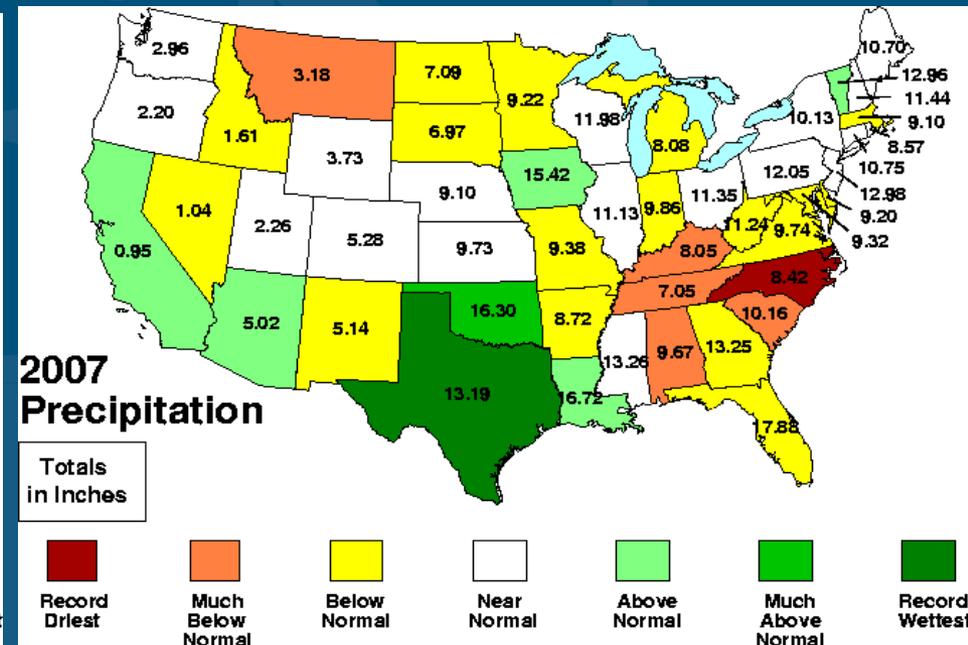
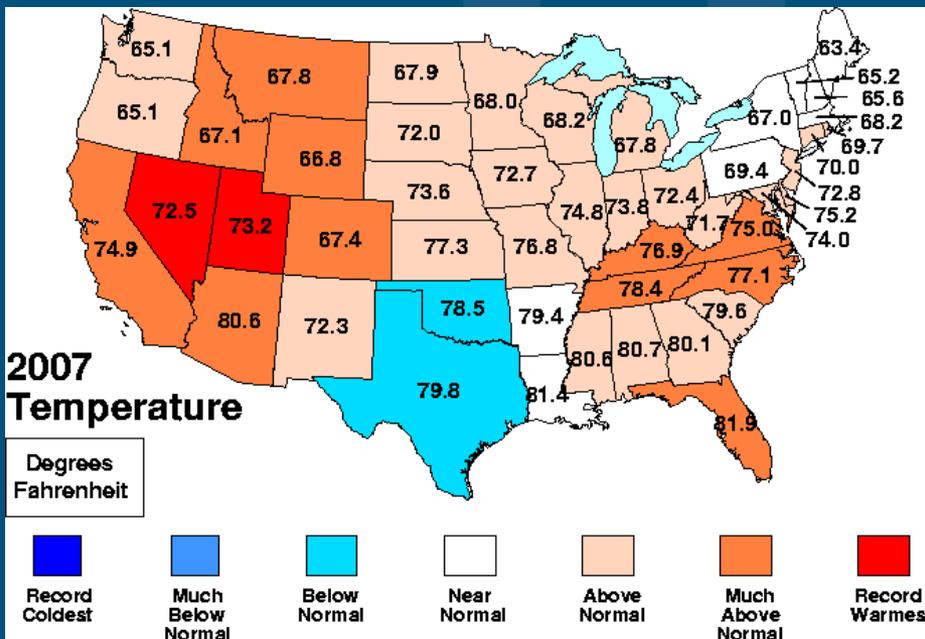
A suite of statistical metrics for both:

discrete forecasts and categorical forecasts

for the hourly, maximum 1-hour, maximum 8-hour O₃ simulations

Summer Weather

The summer was considerable warmer than normal, the exception being the Northeast, which was near normal and lower Midwest, where record rainfall kept temperatures down.



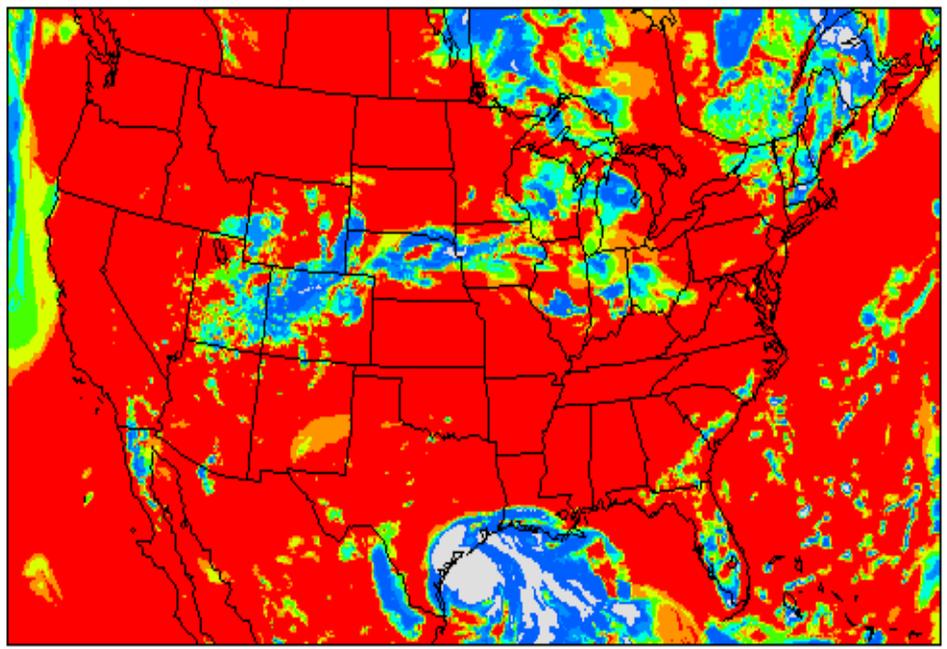
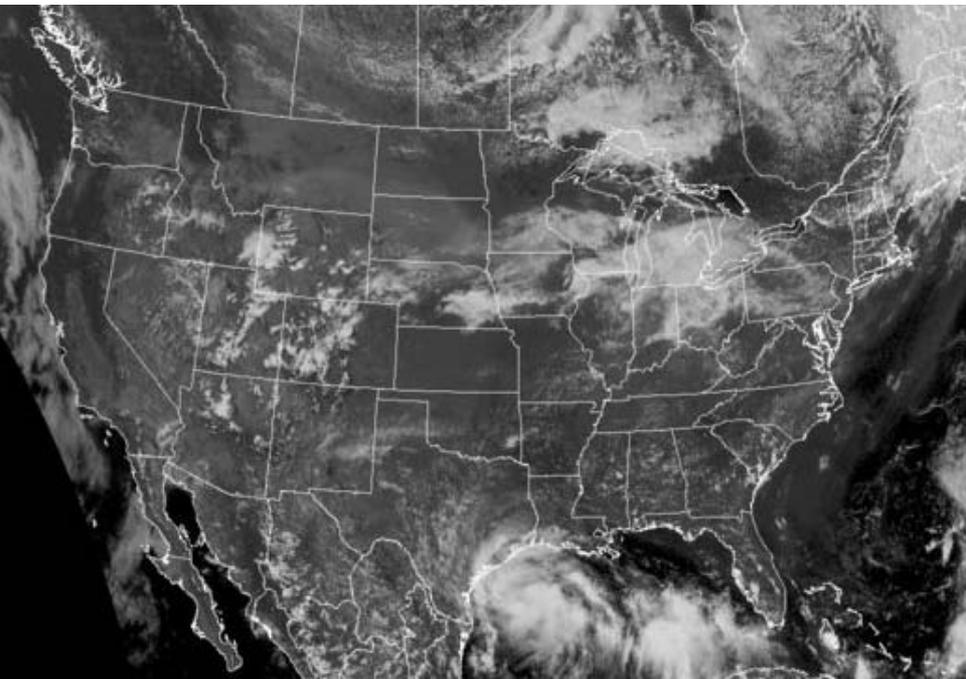
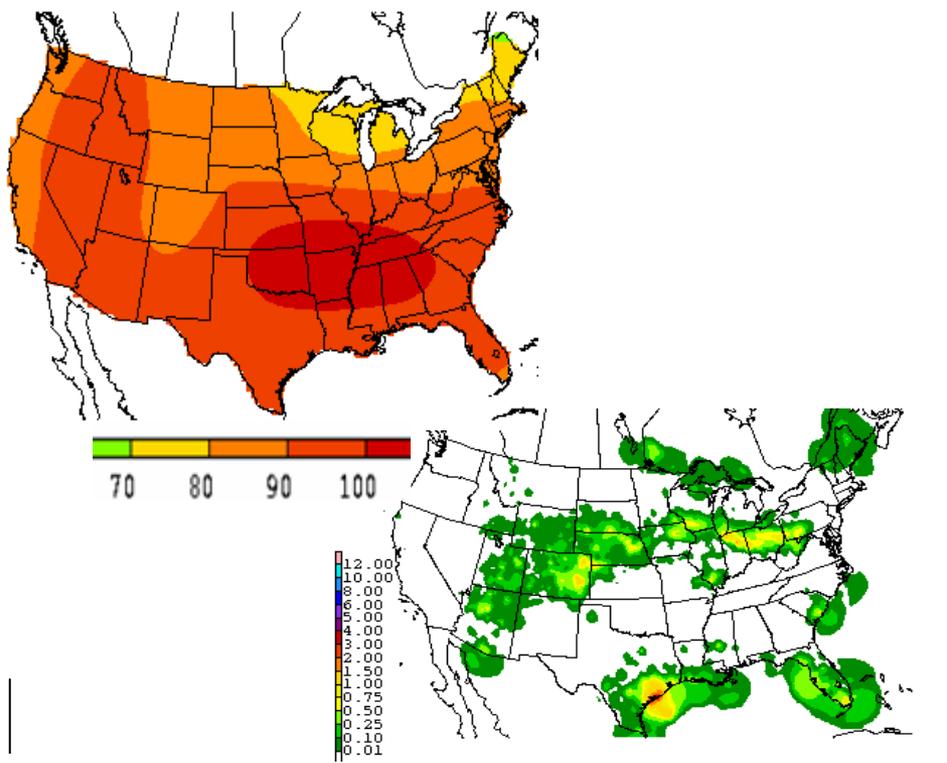
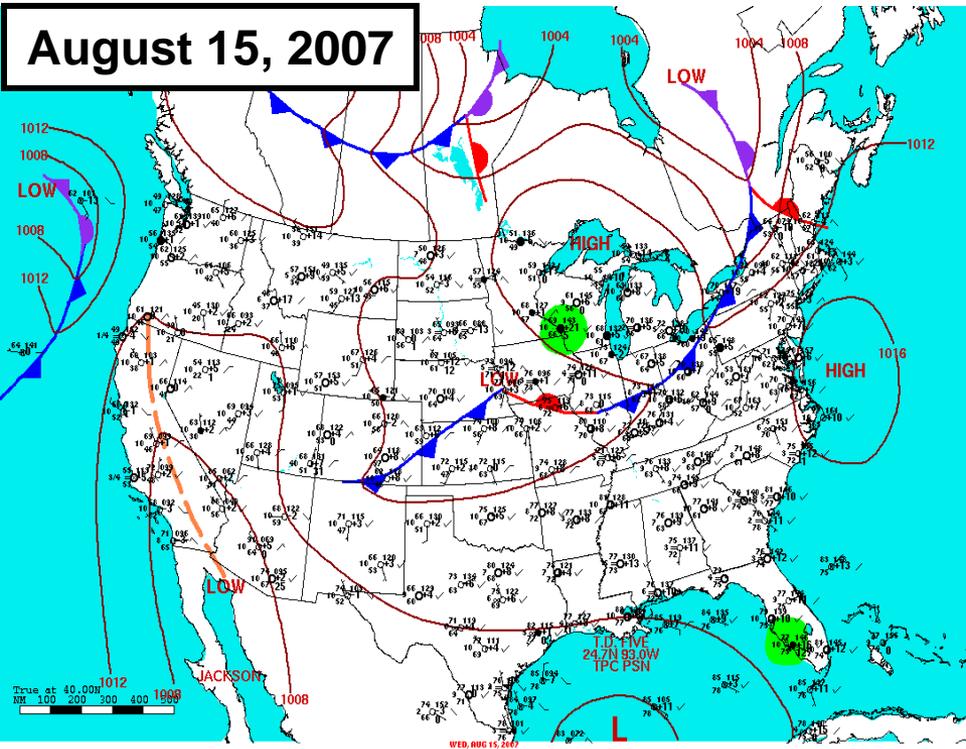
The model's performance was closely scrutinized and summarized on a daily basis from the first of May through the middle of September.

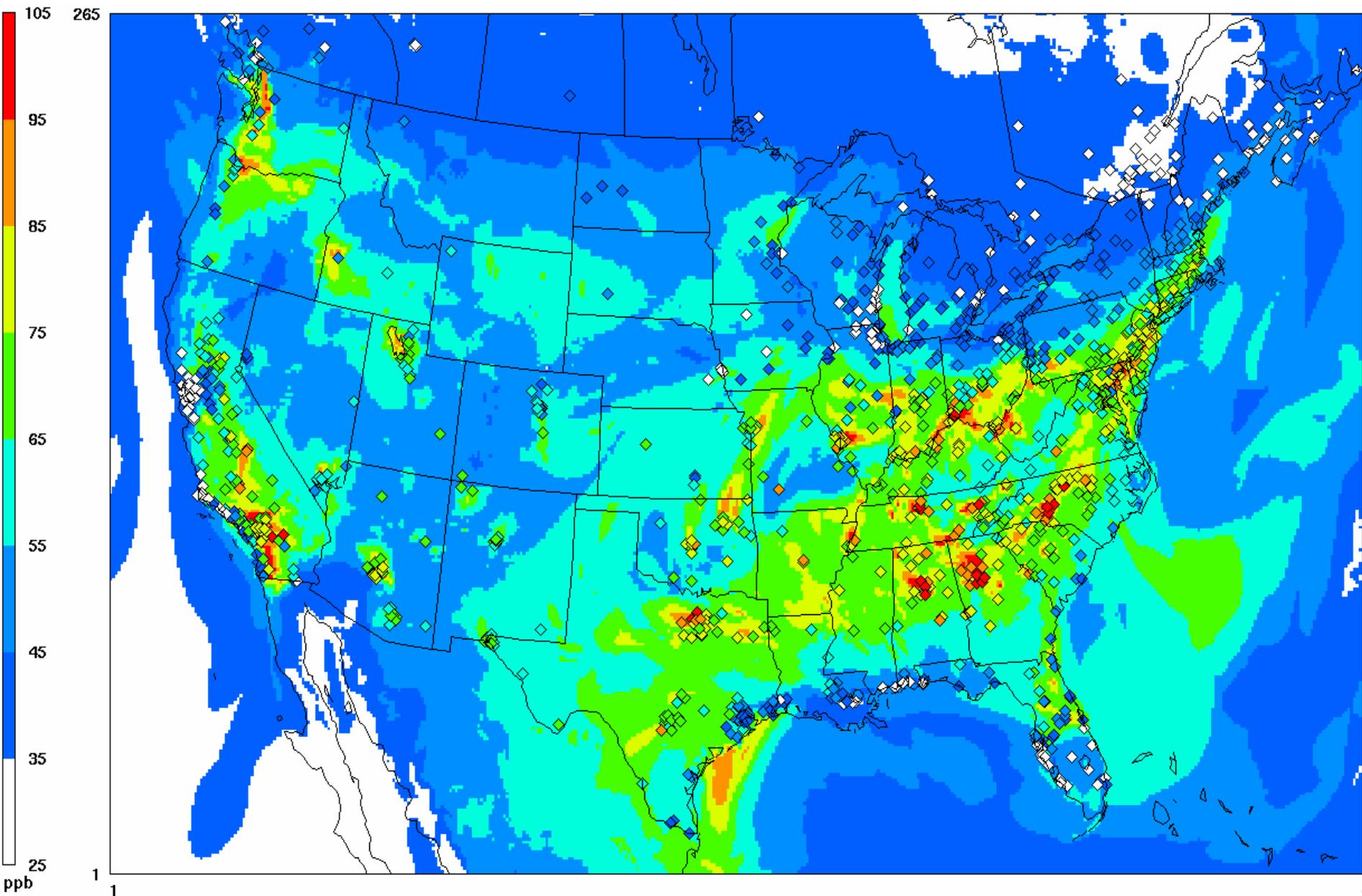
- An example for 15 August is provided.

Weekly compilations were then created and openly discussed in weekly briefings held every Tuesday at ARL/NOAA.

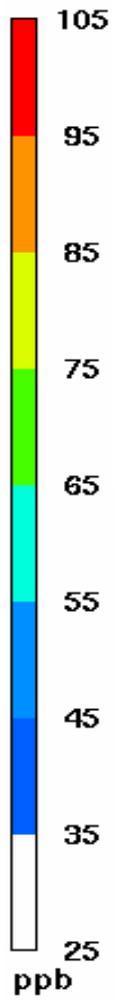
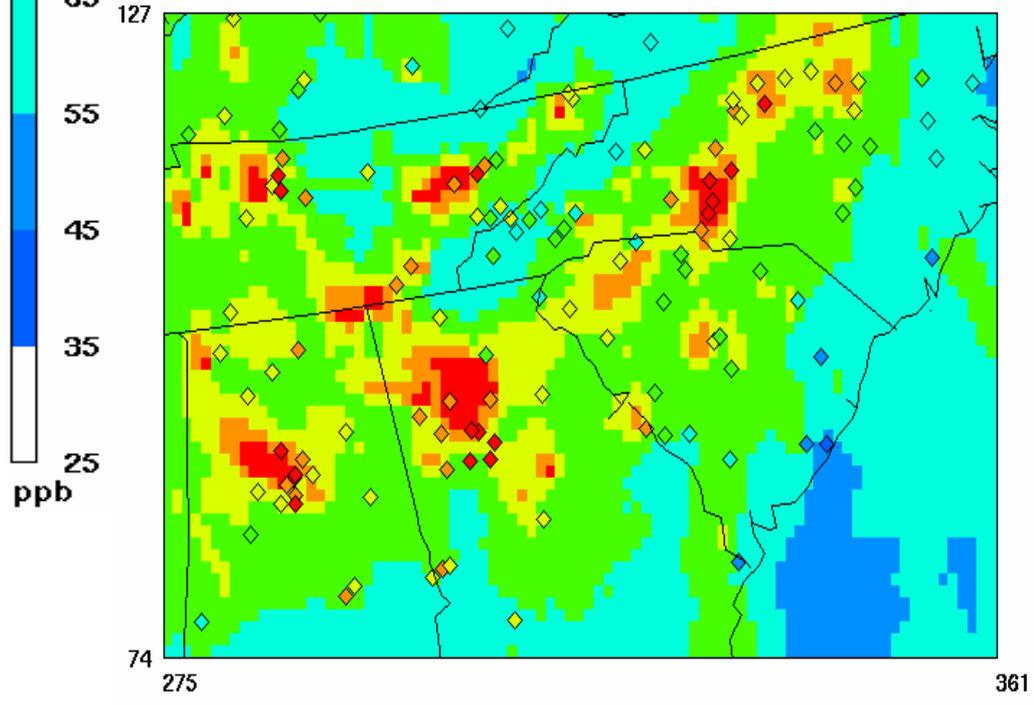
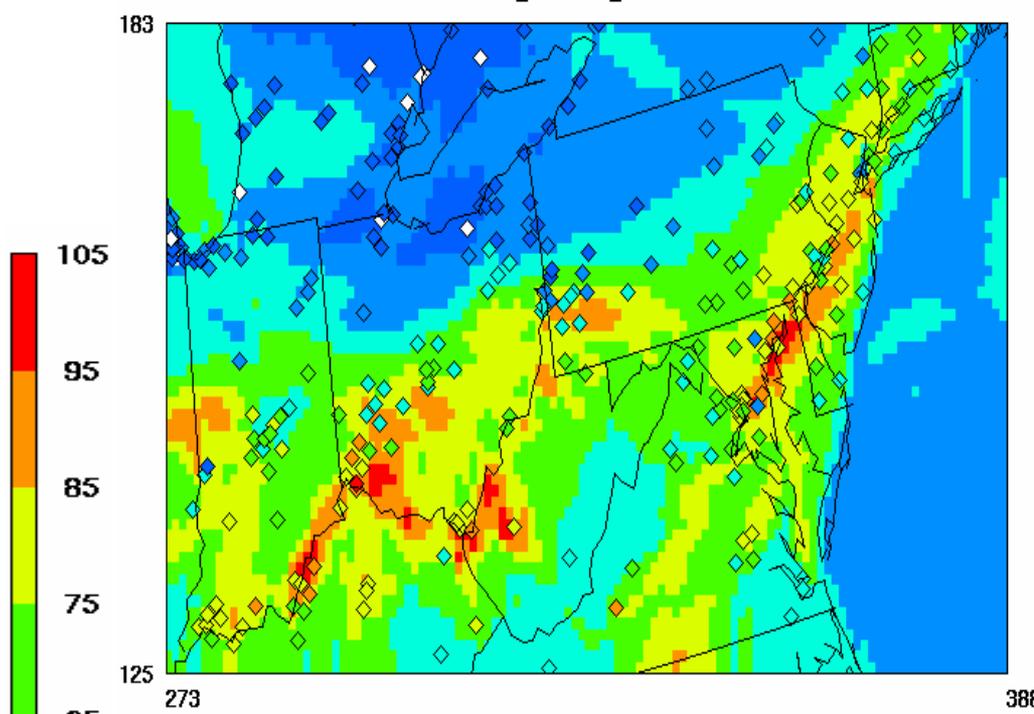
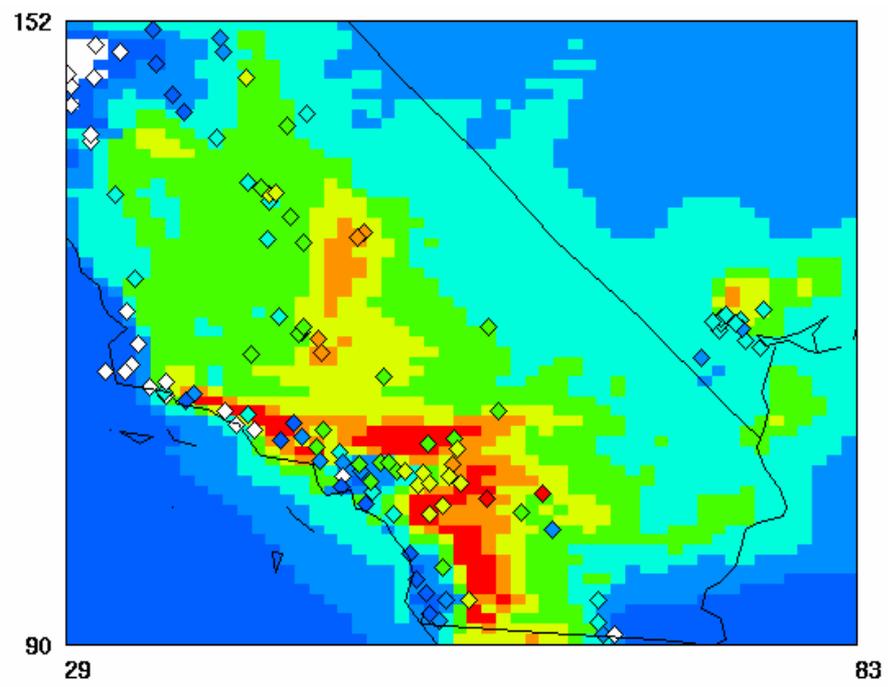
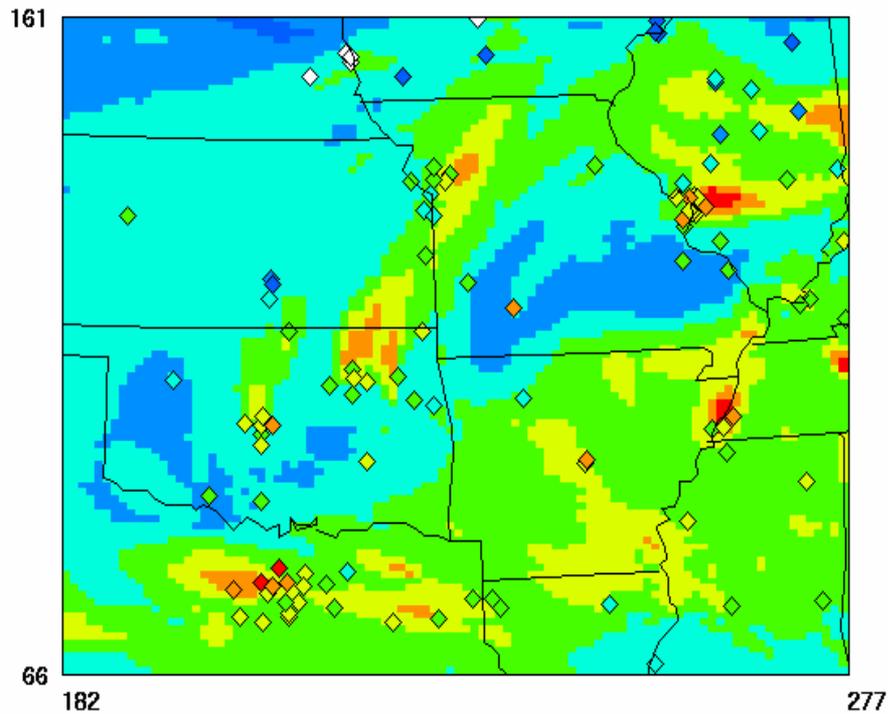
- These are available for dissemination, contact information available on last slide.

August 15, 2007

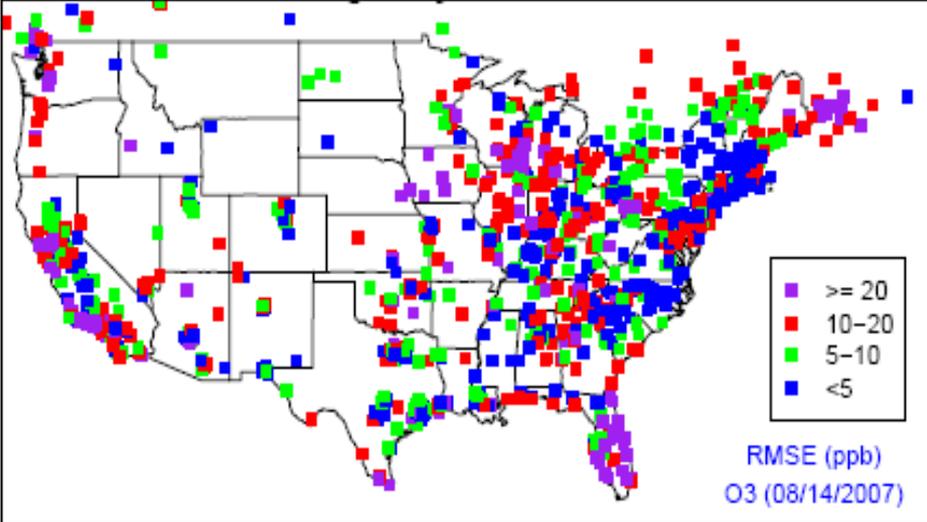




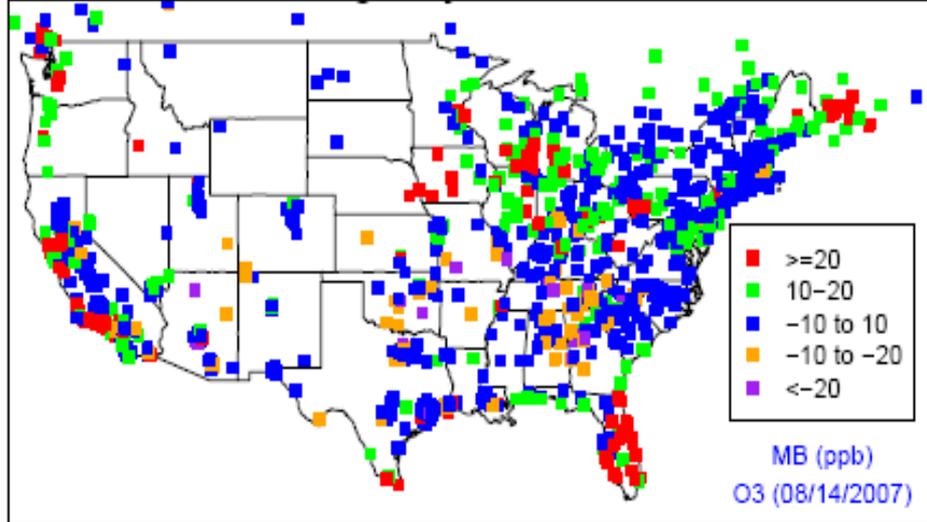
August 15, 2007 0:00:00
Min= 20 at (28,149), Max= 117 at (306,94)



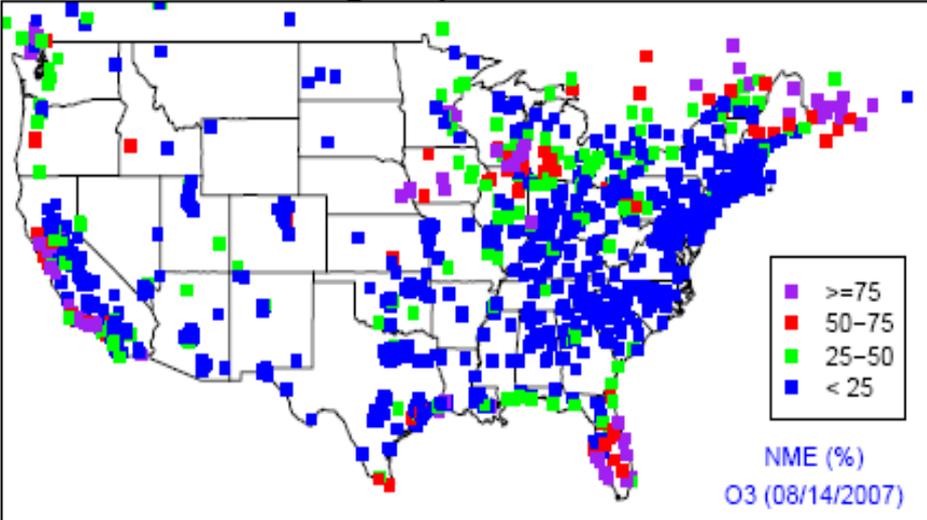
Target Day Max 8-hr O3



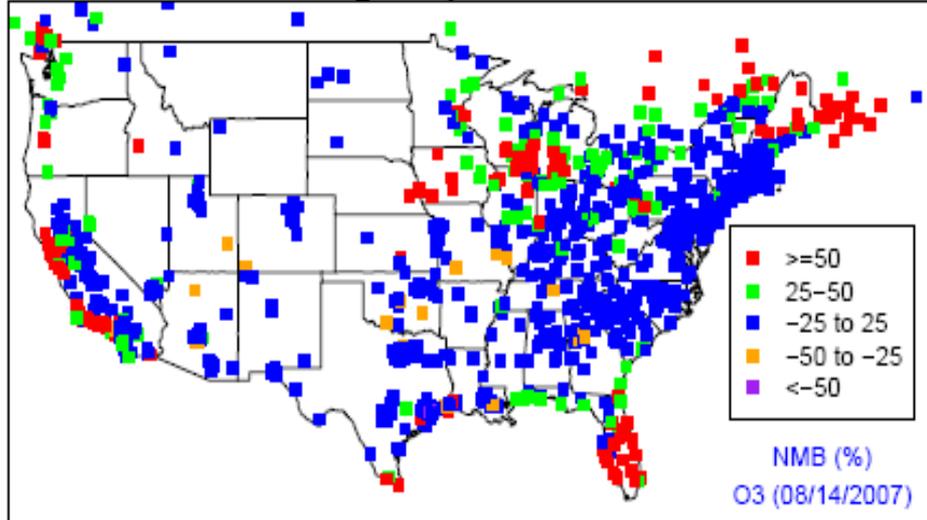
Target Day Max 8-hr O3



Target Day Max 8-hr O3



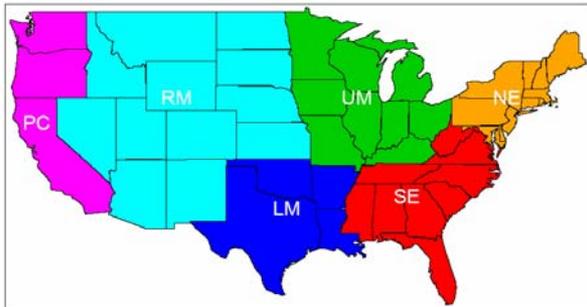
Target Day Max 8-hr O3



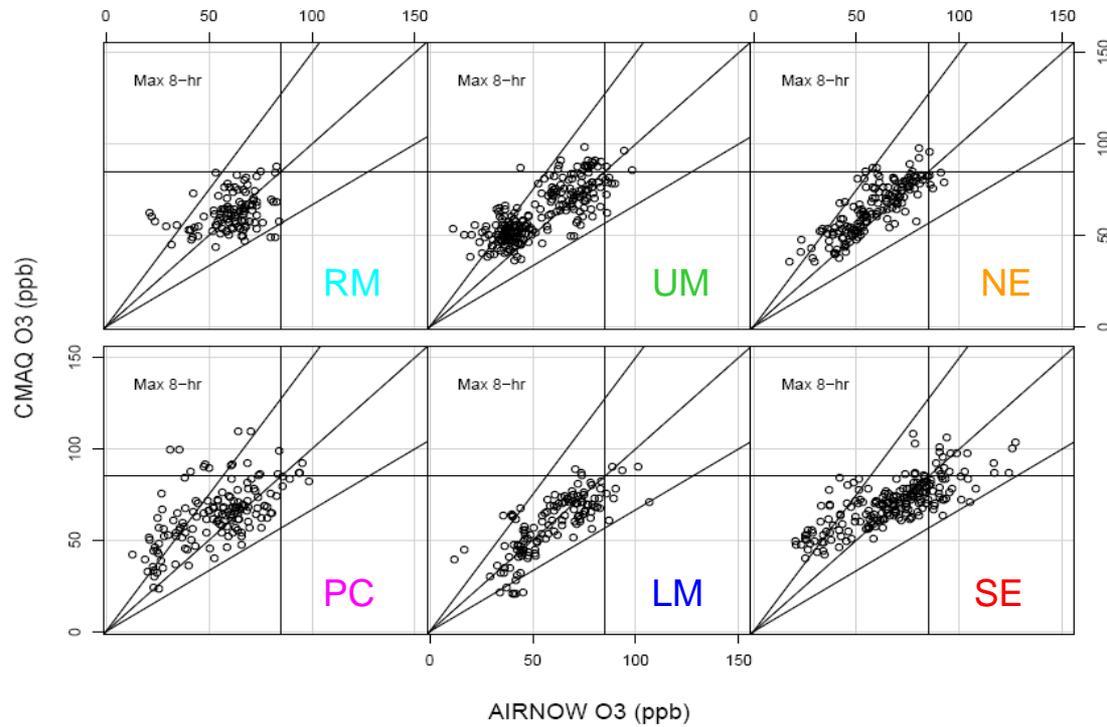
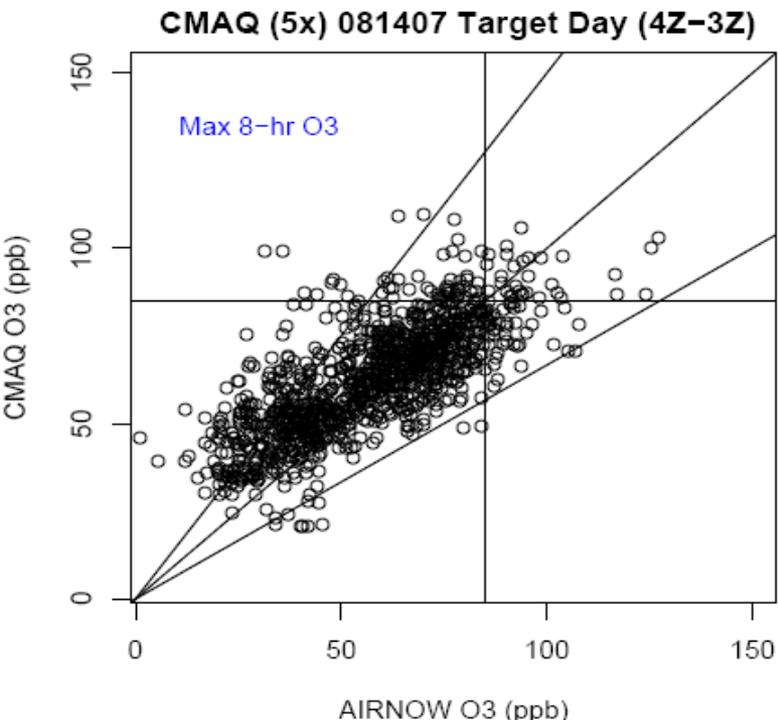
Max. 8-Hr Ozone Forecast

Init: 14 August (12 Z)

Valid: 15 August (04 Z to 03 Z)

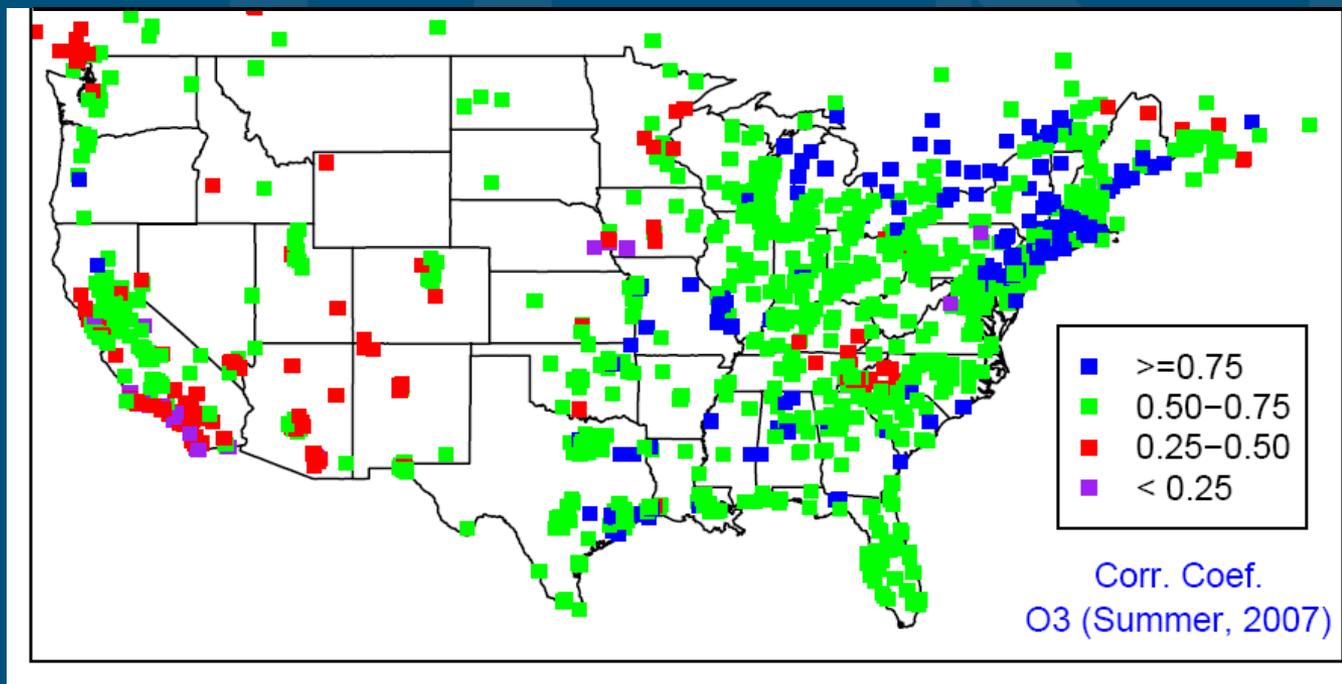


	N	Obs Mean	Model Mean	RMSE (ppb)	NME (%)	MB (ppb)	NMB (%)	r
CONUS	1094	56.62	62.29	14.54	19.73	5.66	10.00	0.75
NE	160	58.67	64.71	10.87	13.97	6.05	10.31	0.82
SE	213	67.84	70.41	15.04	16.88	2.57	3.79	0.76
UM	239	53.67	62.01	14.04	21.38	8.34	15.55	0.79
LM	134	59.69	58.58	11.25	14.60	-1.11	-1.86	0.78
RM	109	60.92	62.15	13.27	16.72	1.23	2.02	0.33
PC	148	53.81	64.01	19.33	27.32	10.20	18.96	0.59
CA	134	53.99	63.49	19.40	26.72	9.49	17.58	0.59



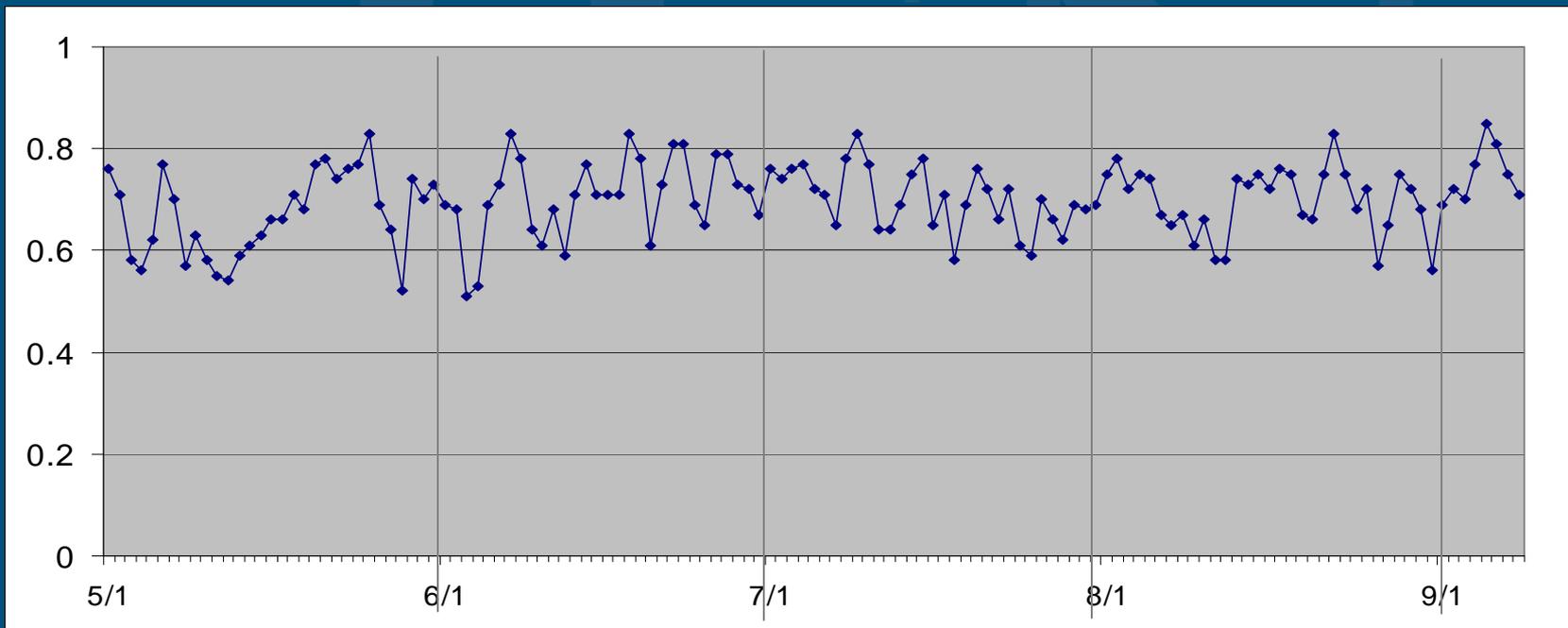
Summer Discrete Statistics CONUS Analysis - Max. 8-hour Ozone *Correlation*

n	OBS (ppb)	MOD (ppb)	RMSE (ppb)	NME (%)	MB (ppb)	NMB (%)	r
99132	48.96	53.21	13.00	20.43	4.25	8.67	0.70



Summer Discrete Statistics CONUS Analysis - Max. 8-hour Ozone *Correlation*

	Summer	May	June	July	August
r	0.71	0.69	0.71	0.71	0.72

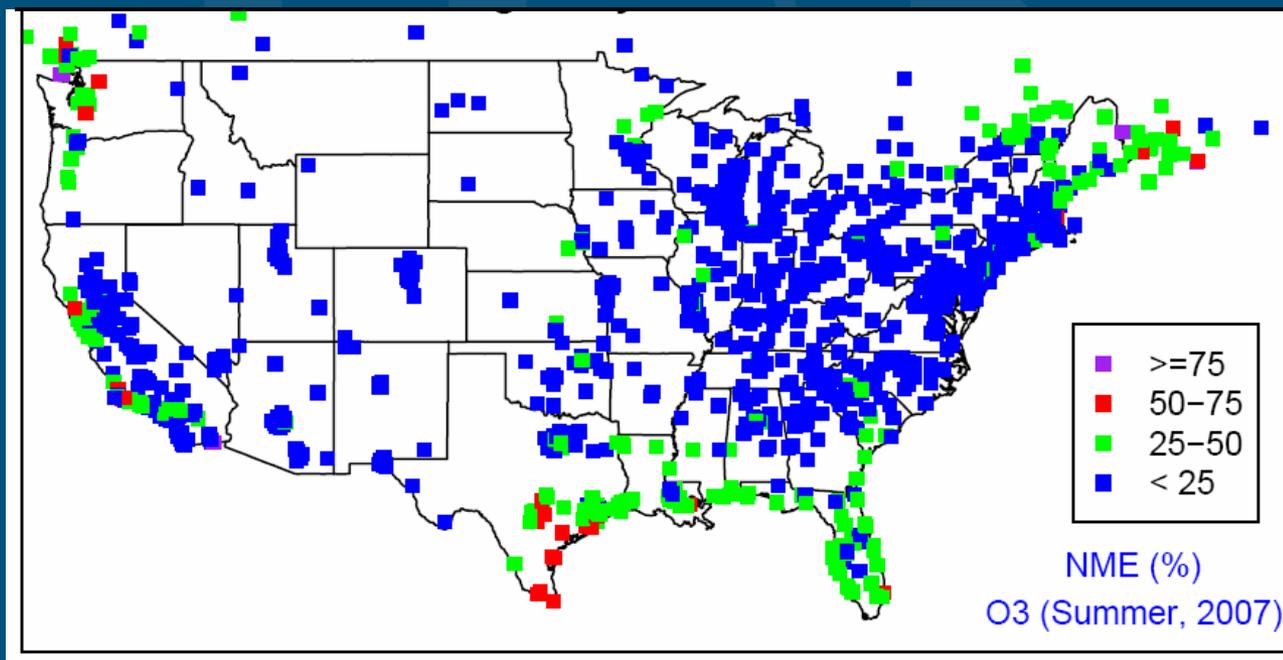


Summer Discrete Statistics

CONUS Analysis - Max. 8-hour Ozone

Normalized Mean Error

n	OBS (ppb)	MOD (ppb)	RMSE (ppb)	NME (%)	MB (ppb)	NMB (%)	r
99132	48.96	53.21	13.00	20.43	4.25	8.67	0.70

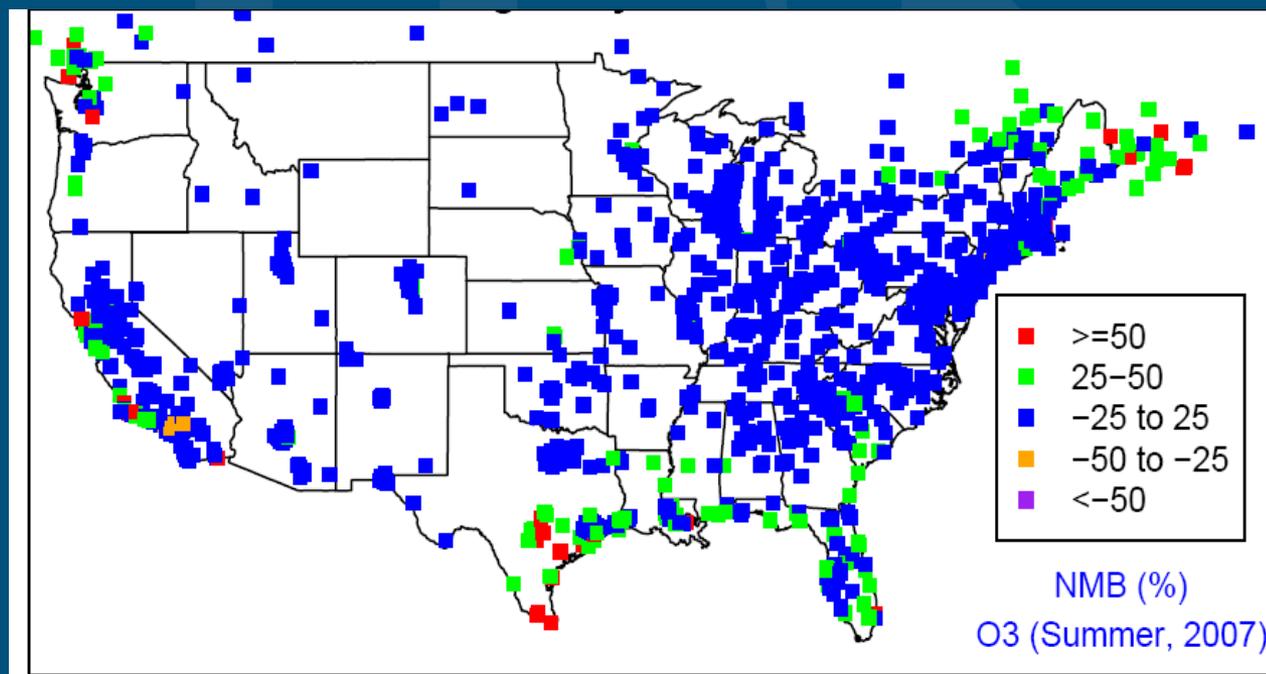


Summer Discrete Statistics

CONUS Analysis - Max. 8-hour Ozone

Normalized Mean Bias

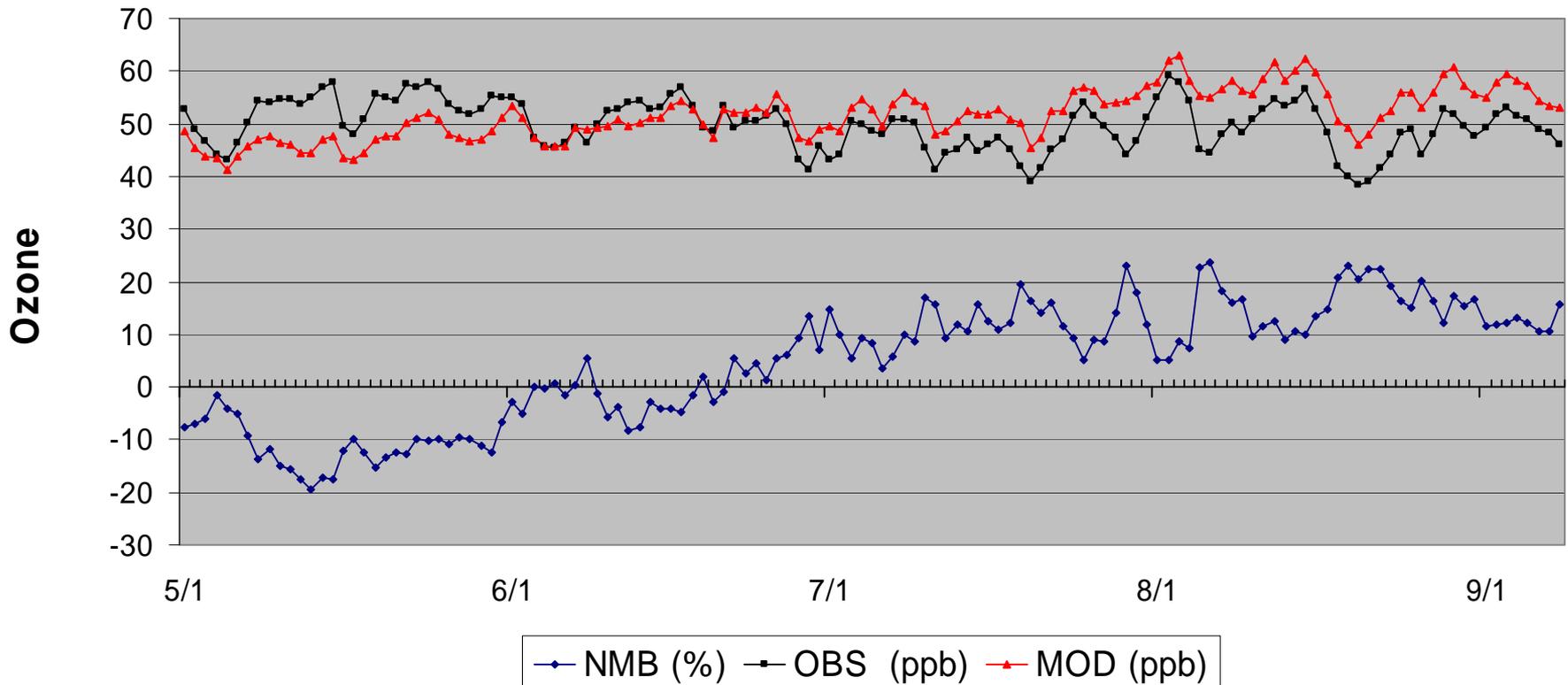
n	OBS (ppb)	MOD (ppb)	RMSE (ppb)	NME (%)	MB (ppb)	NMB (%)	r
99132	48.96	53.21	13.00	20.43	4.25	8.67	0.70



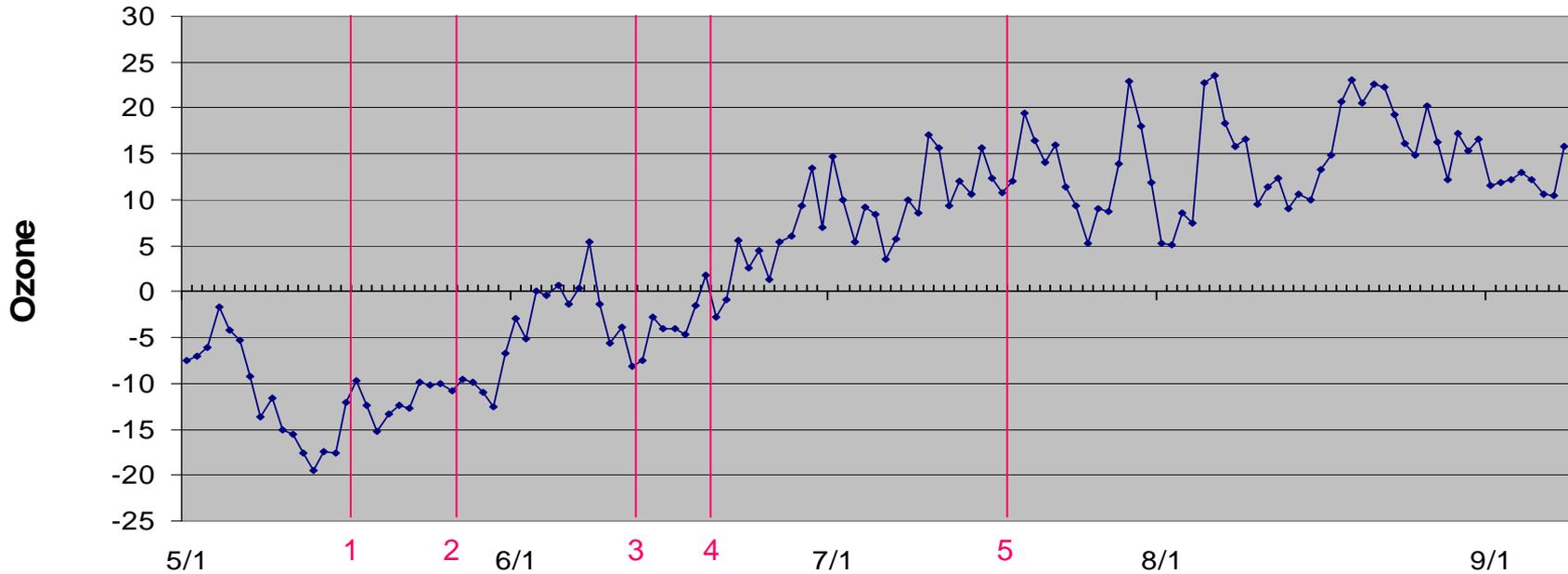
Summer Discrete Statistics

CONUS Analysis - Max. 8-hour Ozone

Normalized Mean Bias



Summer Discrete Statistics CONUS Analysis - Max. 8-hour Ozone *Normalized Mean Bias*



- 1 Mobile emissions added (5/16)
- 2 PBL change - TKE (5/25)
- 3 PBL change - ACM-2 (6/12)
- 4 NAM resistance change (6/19)
- 5 Dry deposition, plume rise correction (7/18)

Summer Discrete Statistics

Max. 8-hour Ozone

Regional Analysis



Domain	n	OBS (ppb)	MOD (ppb)	RMSE (ppb)	NME (%)	MB (ppb)	NMB (%)	r
CONUS	99132	48.96	53.21	13.00	20.43	4.25	8.67	0.70
NE	14520	49.10	53.14	12.33	19.19	4.03	8.21	0.74
SE	19296	52.19	57.96	12.79	19.26	5.77	11.05	0.69
UM	21837	51.35	53.79	11.22	17.05	2.44	4.74	0.67
LM	11756	40.03	46.21	14.61	28.95	6.18	15.43	0.67
RM	9909	55.50	58.55	11.40	15.71	3.04	5.48	0.56
PC	13594	51.74	54.04	16.02	23.07	2.31	4.46	0.61
CA	12280	53.54	55.24	16.39	22.70	1.70	3.17	0.58



Summer Discrete Statistics

Max. 8-hour Ozone



California Analysis

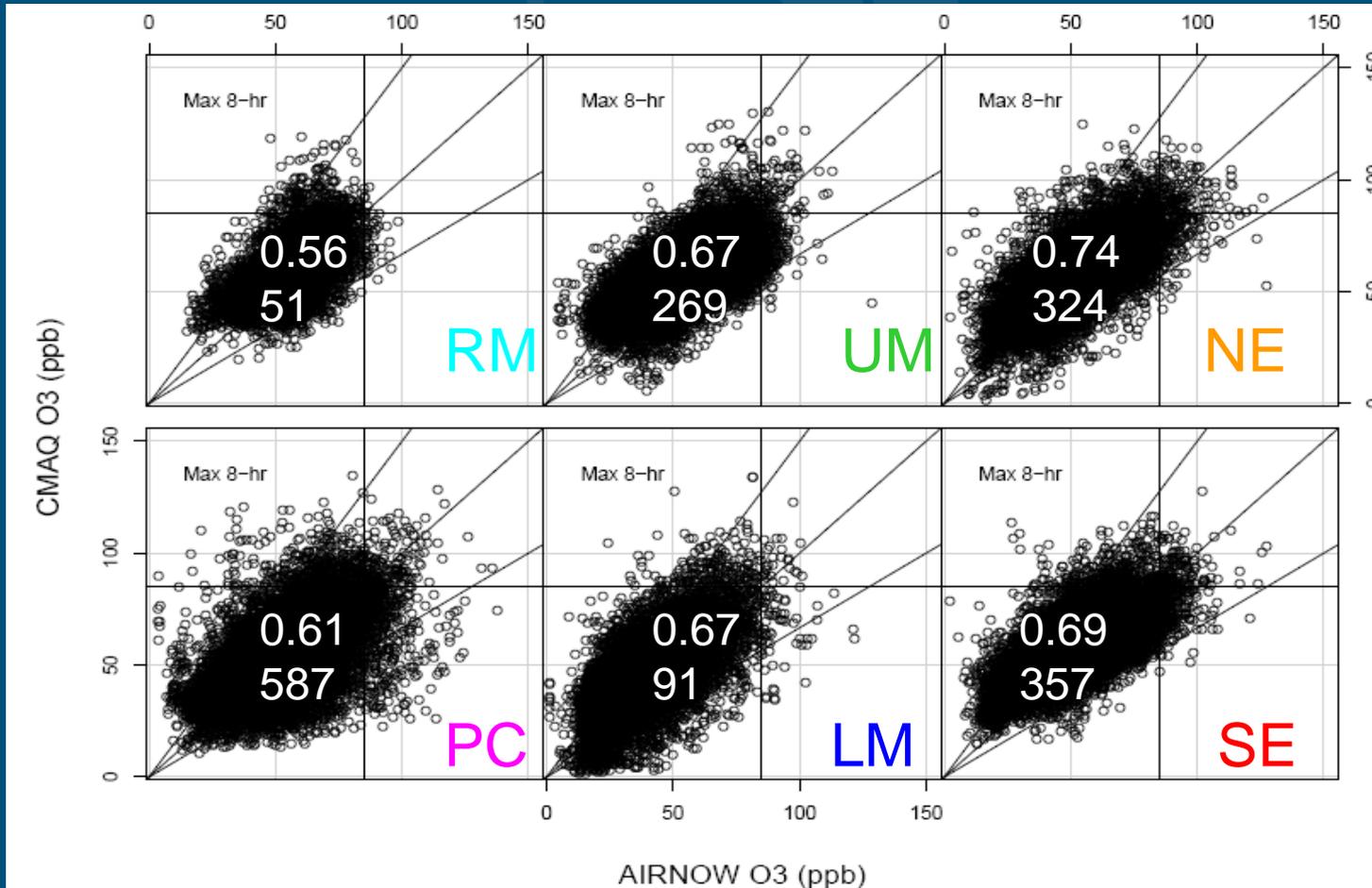
Domain	n	OBS (ppb)	MOD (ppb)	RMSE (ppb)	NME (%)	MB (ppb)	NMB (%)	r
CA	12280	53.54	55.24	16.39	22.70	1.70	3.17	0.58
NMB	1100	60.05	64.83	13.12	16.26	4.78	7.96	0.53
SFB	1638	33.51	39.38	12.24	28.80	5.87	17.52	0.50
CVB	3431	59.29	62.82	11.78	15.41	3.52	5.94	0.66
CCB	1902	43.65	55.62	18.79	32.27	11.97	27.43	0.52
SCB	3110	58.08	48.86	20.20	26.48	-9.22	-15.87	0.52
DSB	1099	63.22	63.03	20.19	24.10	-0.19	-0.30	0.45



Summer Discrete Statistics

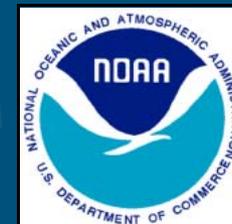
Max. 8-hour Ozone

Regional Analysis



Summer Categorical Statistics

Max. 8-hour Ozone



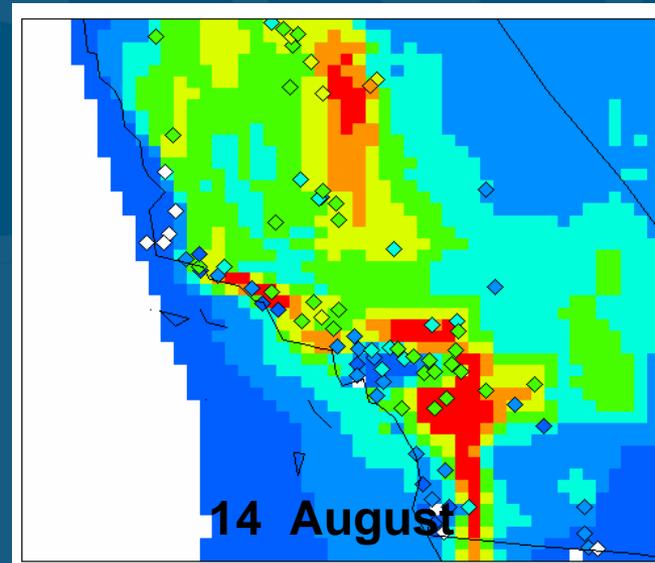
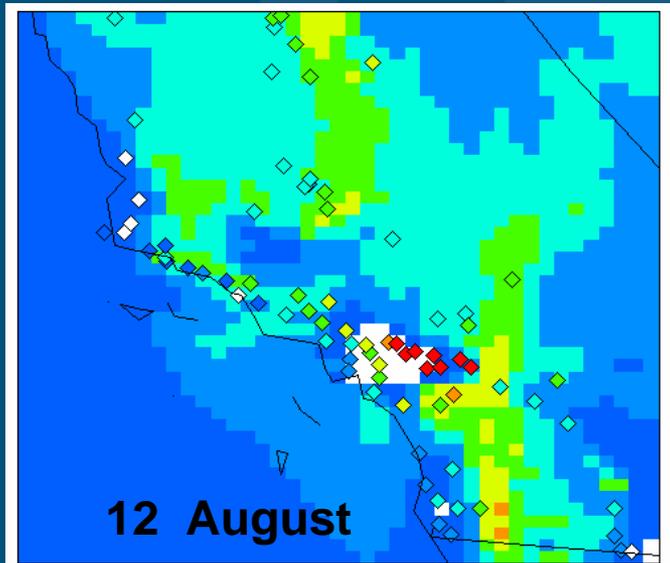
Regional Analysis

Domain	A	B	FAR	CSI	H	W	> 85 ppb
CONUS	96.91	1.44	77.64	15.21	32.22	54.15	1679
NE	96.40	1.45	71.22	20.52	41.67	65.82	324
SE	96.97	1.44	72.18	19.64	40.06	59.35	357
UM	97.96	1.17	78.03	13.42	25.65	57.51	269
LM	97.72	2.54	88.31	9.15	29.67	44.53	91
RM	97.00	5.10	97.31	2.30	13.73	40.40	51
PC	93.36	1.09	74.65	15.23	27.60	48.24	587
CA	92.71	1.08	74.45	15.33	27.69	48.47	585

Future Case Study Research

Simulations for areas east of LA have been, on occasion, very poor.....why?

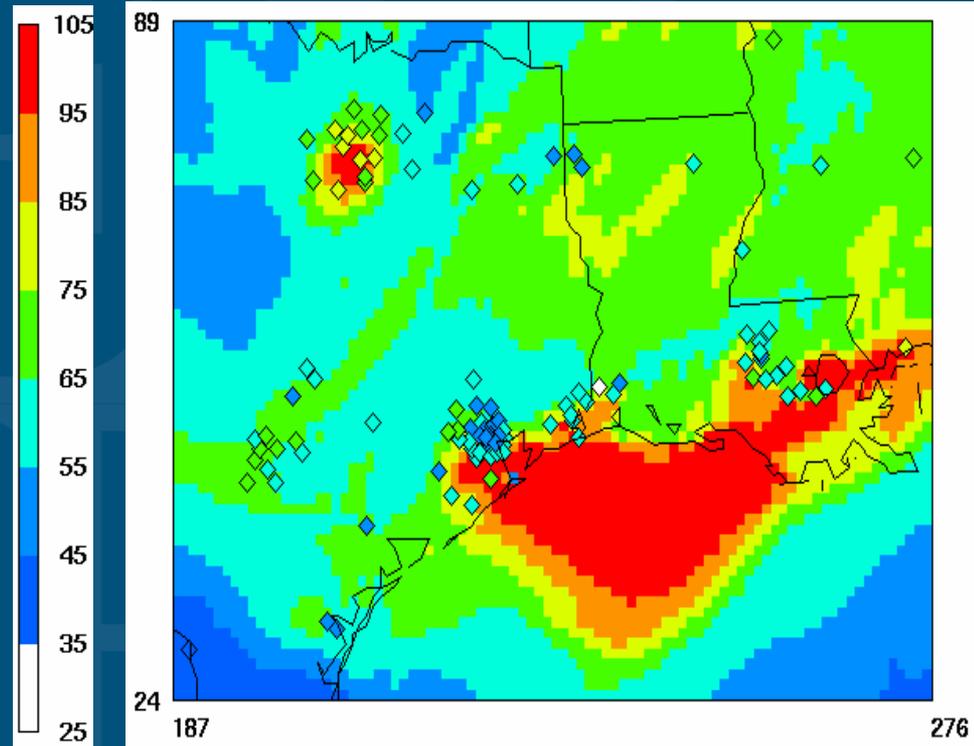
- Inadequate spatial resolution in complex terrain?
- PBL height errors?
- Wind errors?
- Emission errors?



Future Case Study Research

Simulations for near / offshore areas of the Gulf Coast States have been too high on occasion.....why?

- Inadequate spatial resolution to simulate sea / land breeze?
- PBL height errors?
- Emission errors?

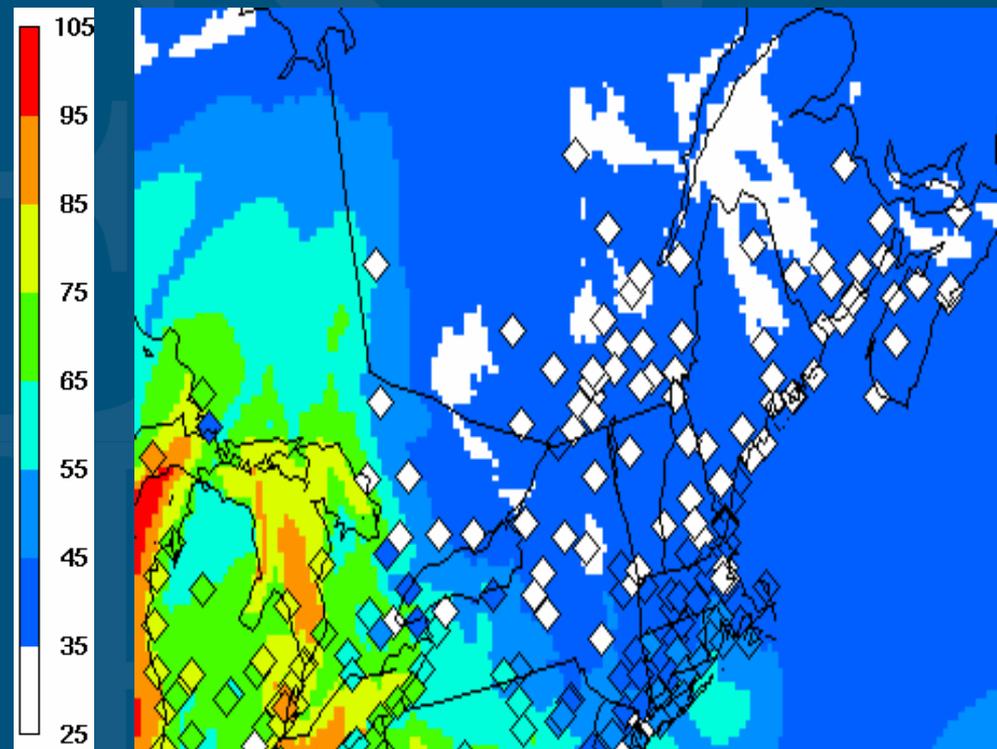


Future Case Study Research



Simulations in “clean” air masses have been too high....why?

- Boundary concentrations set too high?



Summary



The experimental 5x WRF-CMAQ Air Quality Forecast Model performed quite well over the Summer of 2007.

CONUS:	r	=	0.70
	NMB	=	8.7%
	NME	=	20.4%

Systematic underprediction was observed from May through mid-June, at which time numerous changes were made, resulting in systematic overprediction.

Future research will focus on eliminating this overprediction as well as other scenarios where the simulations were poor.



Acknowledgements

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Tanya Otte*, Anne-Marie Carlton*, Jerry Herwehe*.

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