

Diagnostic and Operational Evaluation of 2002 and 2005 Estimated 8-hr Ozone to Support Model Attainment Demonstrations

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Background

- State Implementation Plans will include modeling the impacts of emission control scenarios with 3-D Eulerian photochemical transport models
- Model performance is typically evaluated on an operational basis and rarely to support a diagnostic assessment

Model Evaluation

- **Operational** evaluations for ozone modeling purposes include matching model estimates with observation data for ozone, nitrogen oxides (NOX), and total volatile organic compounds (VOC)
- A **diagnostic** (dynamic) evaluation assesses how appropriately the modeling system responds to emissions adjustments

Diagnostic Evaluation

- A comparison between observed and estimated ozone for the summers of 2002 and 2005 is useful for a diagnostic assessment
 - High quality emission inventories were developed for each year
 - A large NOX emissions reduction occurred between these years due in part to NOX SIP Call compliance
- Emissions decrease from weekday to weekend and having two full summers provides enough days with high ozone on each day of the week to make this type of evaluation useful
- Just a few of many potential approaches to diagnostic evaluation

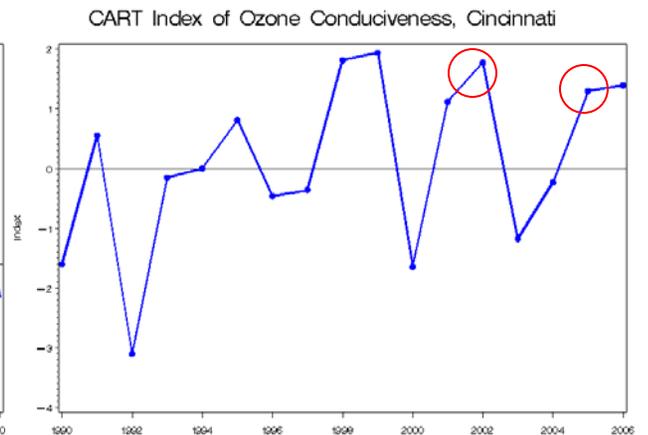
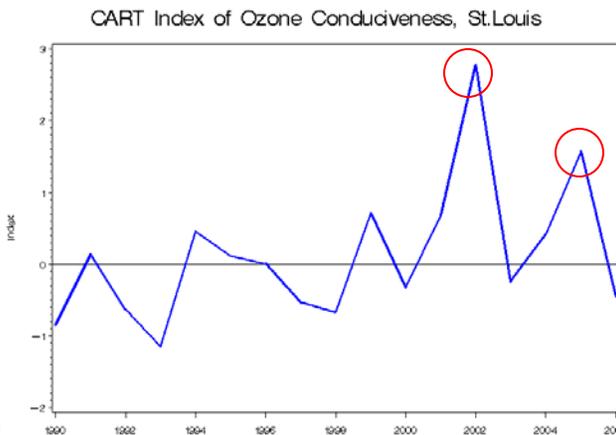
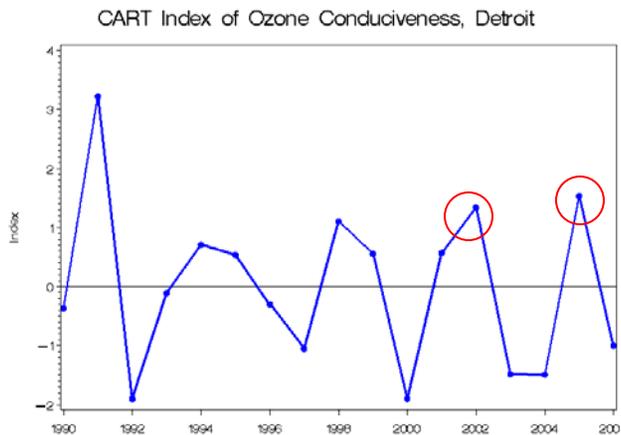
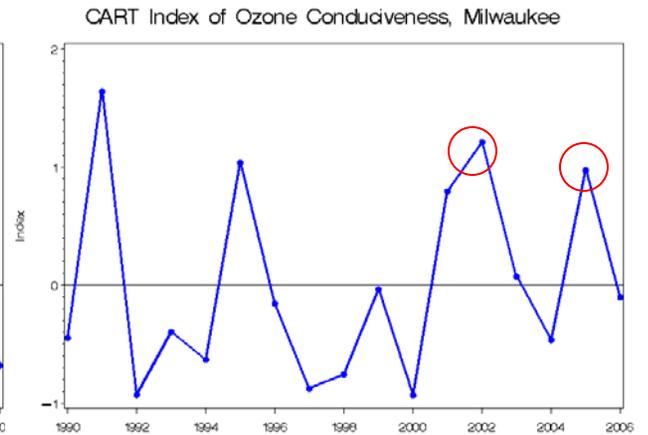
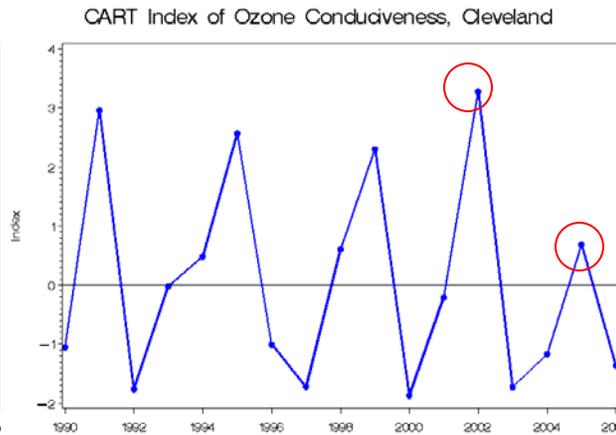
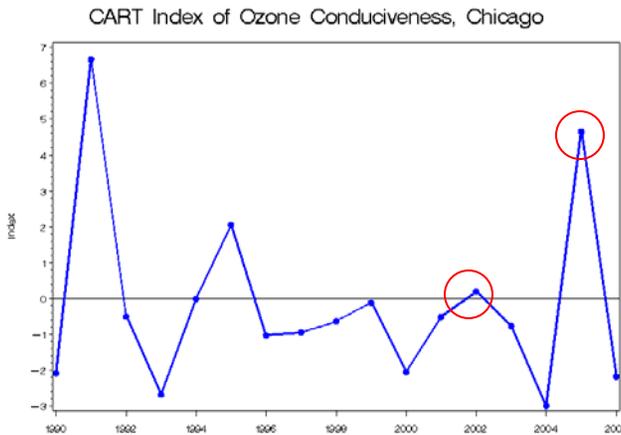
Typical July weekday emissions (tpd) for 2002 and 2005

	VOC 2002	VOC 2005	NO _x 2002	NO _x 2005
Nonroad Mobile	1,167	1,558	1,875	1,843
Other Area	2,555	2,637	255	283
Onroad Mobile	2,185	1,829	4,035	3,402
EGU Point	35	28	3,422	1,712
Non-EGU Point	751	635	1,085	1,021
5 State Total	6,693	6,687	10,672	8,260

Ozone Conduciveness

- A Classification and Regression Tree (CART) analysis was done examining meteorological data at certain locations in the Midwest United States to characterize how ozone conducive the summers of 2002 and 2005 were compared to other recent summers
- At each of these locations the summers of 2002 and 2005 are at least typical in terms of ozone conduciveness
- These locations often have meteorological characteristics that are more conducive to ozone formation than a typical summer
- This increases confidence that model estimates will largely be a response to differences in emissions rather than meteorology

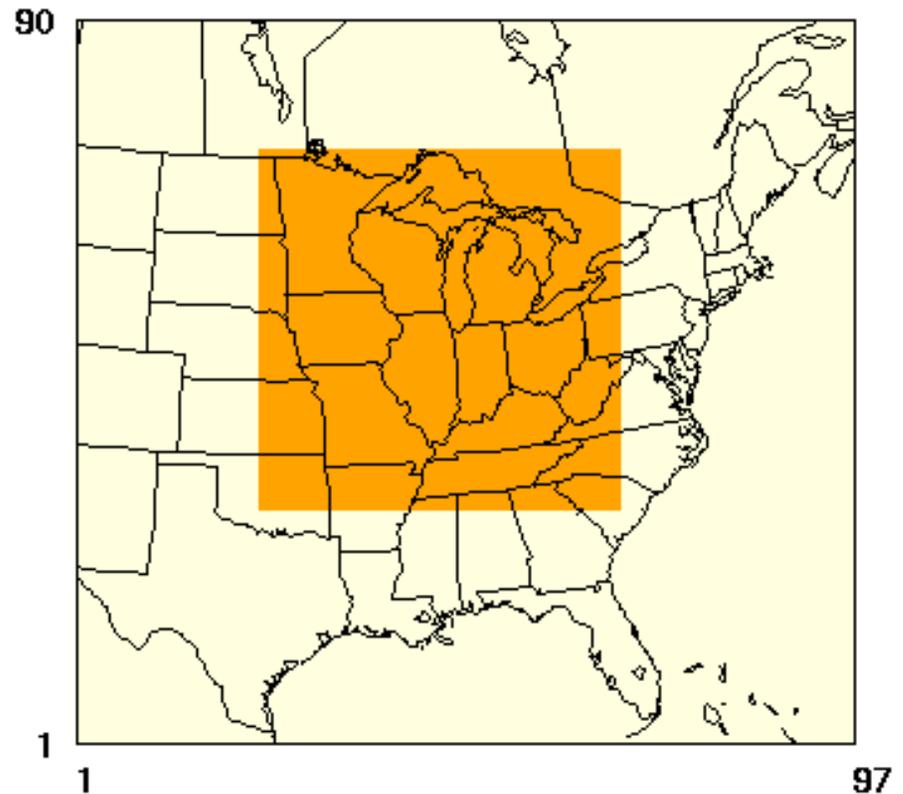
CART ozone conducive index



**plots courtesy of Donna Kenski*

Photochemical Modeling

- 36 km (large box) and 12 km (small dark box) modeling domain
- CAMx version 4.5
- MM5v3.6.x
- CB05 gas phase chemistry
- MEGAN biogenic emissions both years
- Anthropogenic emissions based on 2002 and 2005 State submitted inventories



Operational Evaluation

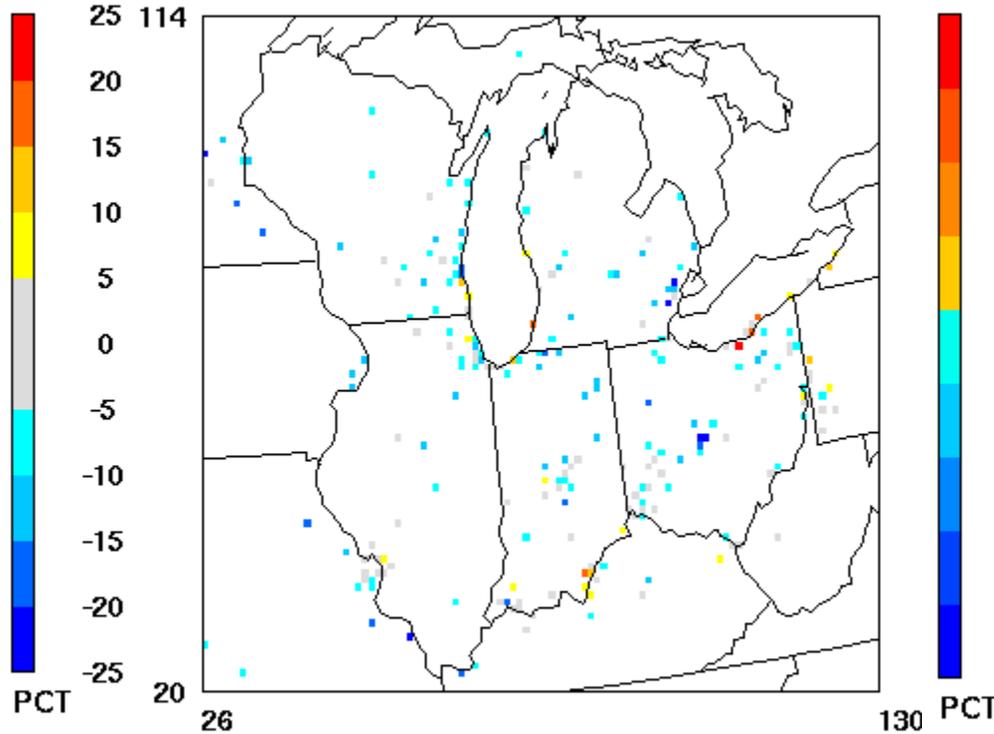
- The ozone design value is the 4th highest maximum 8-hr ozone concentration over a summer averaged over 3 consecutive summers
- Examined 8hr ozone daily maximum concentrations > 95th percentile value
- Model performance criteria distributions eliminate data points above the 95th percentile where error > 30 ppb

		2002	2005
MP Criteria	Error	12.46	11.08
	Bias	-10.35	-8.77
	N	1392	1880
No MP Criteria	Error	15.32	11.82
	Bias	-13.45	-9.36
	N	1565	1935

Operational 8hr Ozone > 80 ppb by Station

BIAS

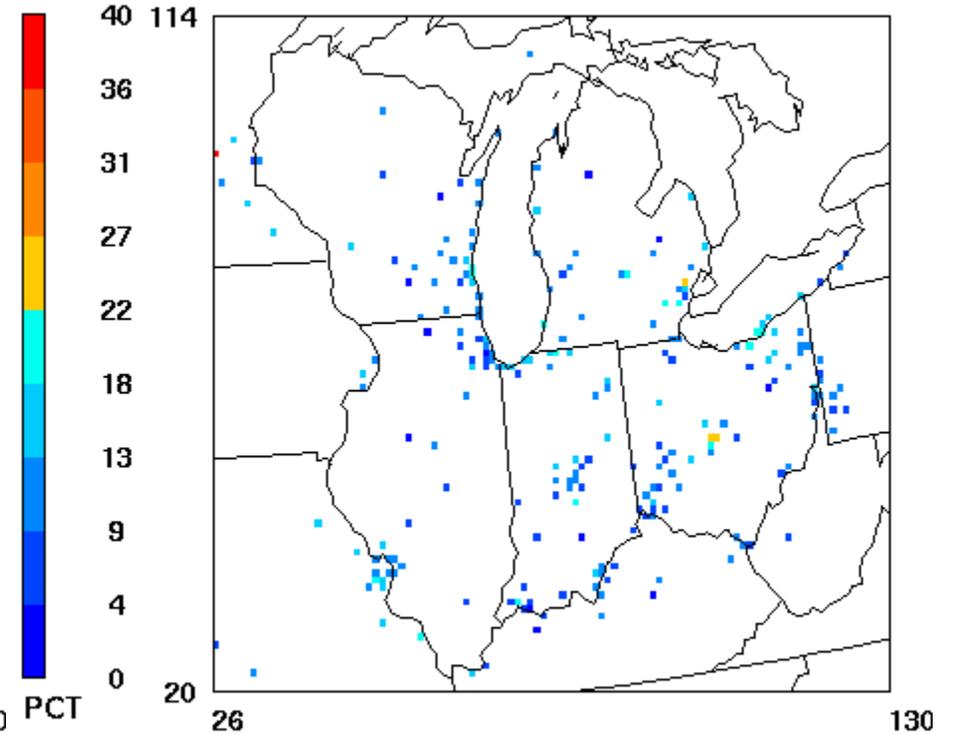
Cutoff 80
MRPO:BAKER



December 31, 1999 0:00:00
Min= -52 at (26,95), Max= 21 at (109,68)

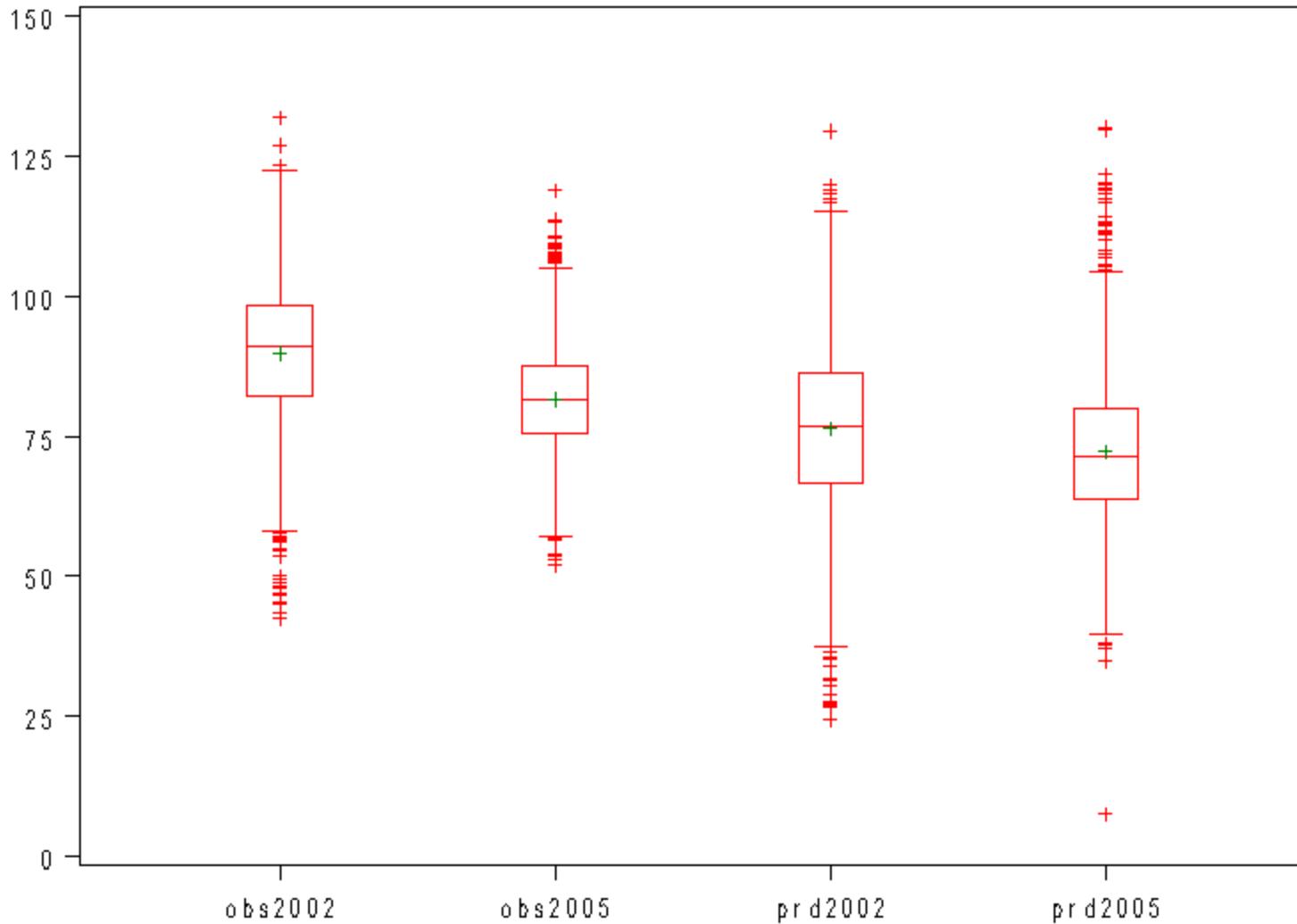
ERROR

Cutoff 80
MRPO:BAKER



December 31, 1999 0:00:00
Min= 1 at (68,67), Max= 52 at (26,95)

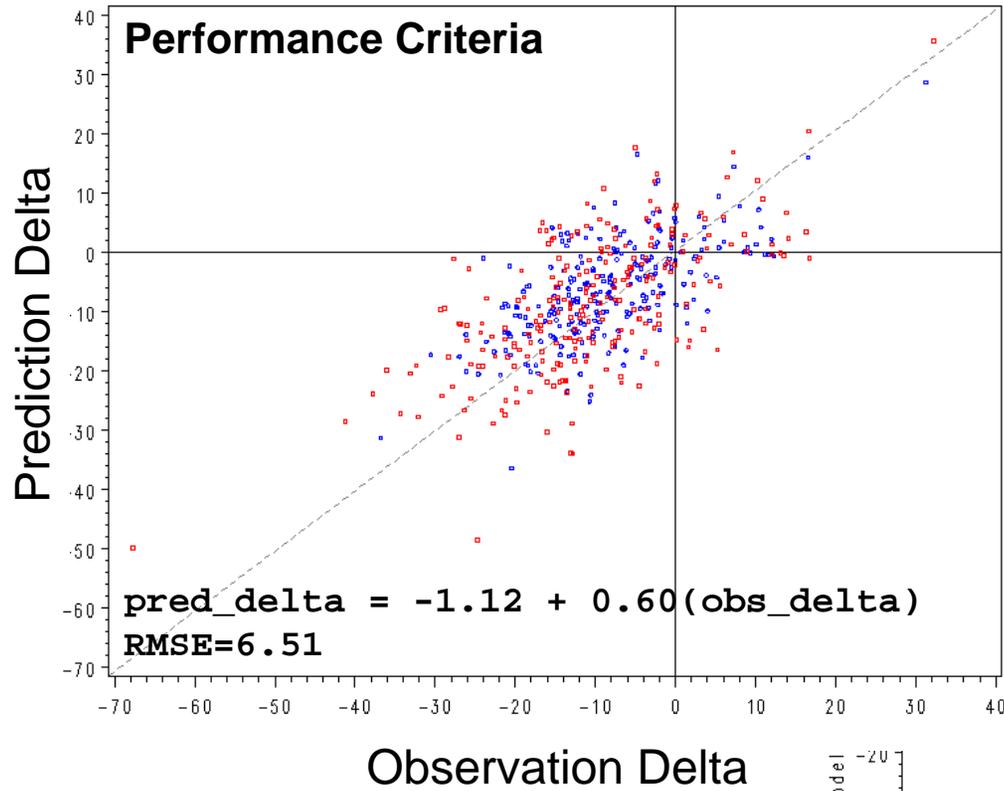
Observation and Model Prediction Distributions (obs. daily 8hr max>95%tile)



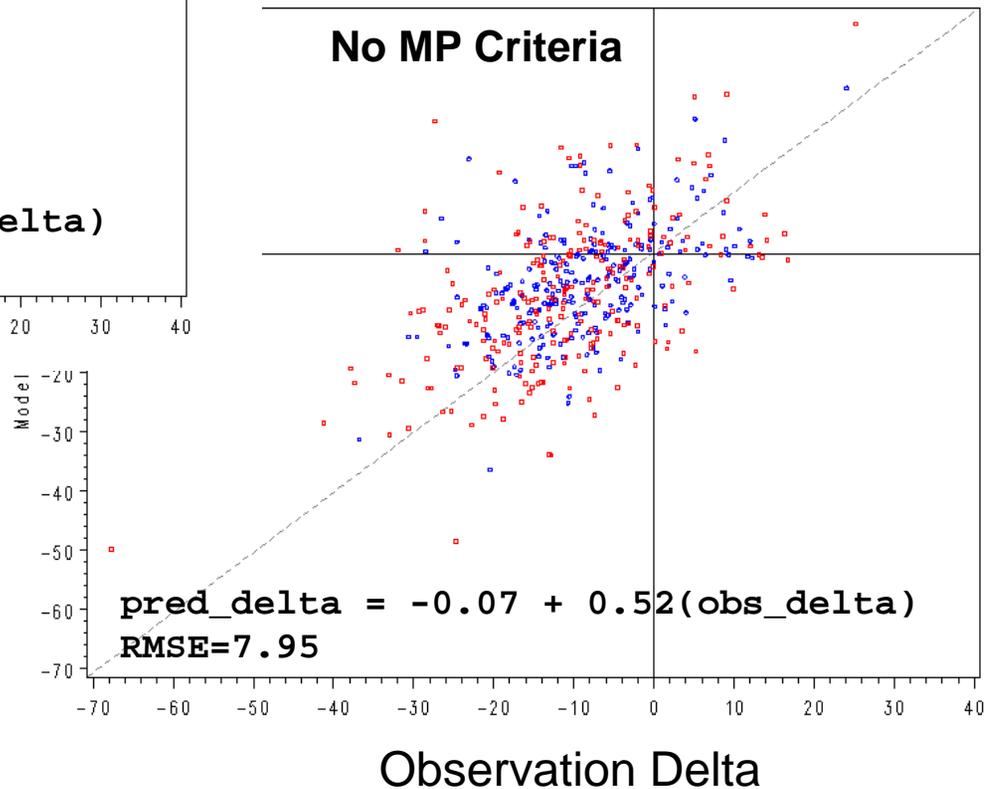
Diagnostic Evaluation

- The correlation coefficient is estimated to determine the relationship between the change in 95th (and greater) percentile observations between 2002 and 2005 and the change in the paired model predictions between the same years
- This approach is designed to determine if the change in high ozone observed at each monitor location between 2002 and 2005 is similar to the model estimates of high ozone in 2002 and 2005 at the same location
- If observed ozone decreases but the modeling system predicts no change or an increase between years then the relationship would be weak
- However, if the model predictions change similarly to the observed values then the relationship would be strong
- The relationship in bias between 2005 and 2002 observations and the bias between paired predictions is mixed ($r=.64$, $r^2=.41$, $N=240$)

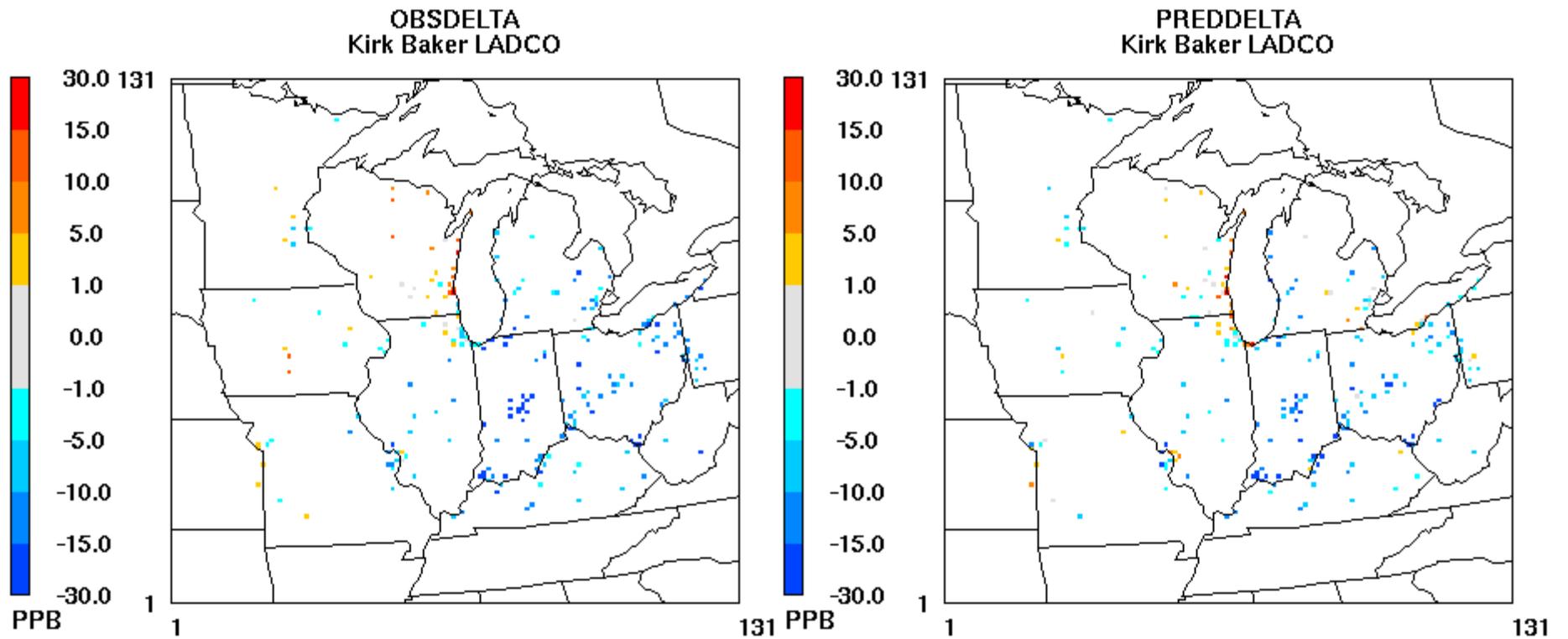
Paired observation delta with predicted delta (absolute and percentage)



	MP Criteria	No MP Cr.
Obs_abs_delta	-8.4	-8.8
Pred_abs_delta	-6.2	-4.6
Obs_pct_delta	-10.5	-10.9
Pred_pct_delta	-8.7	-6.7
r	0.64	0.51
r ²	0.41	0.26



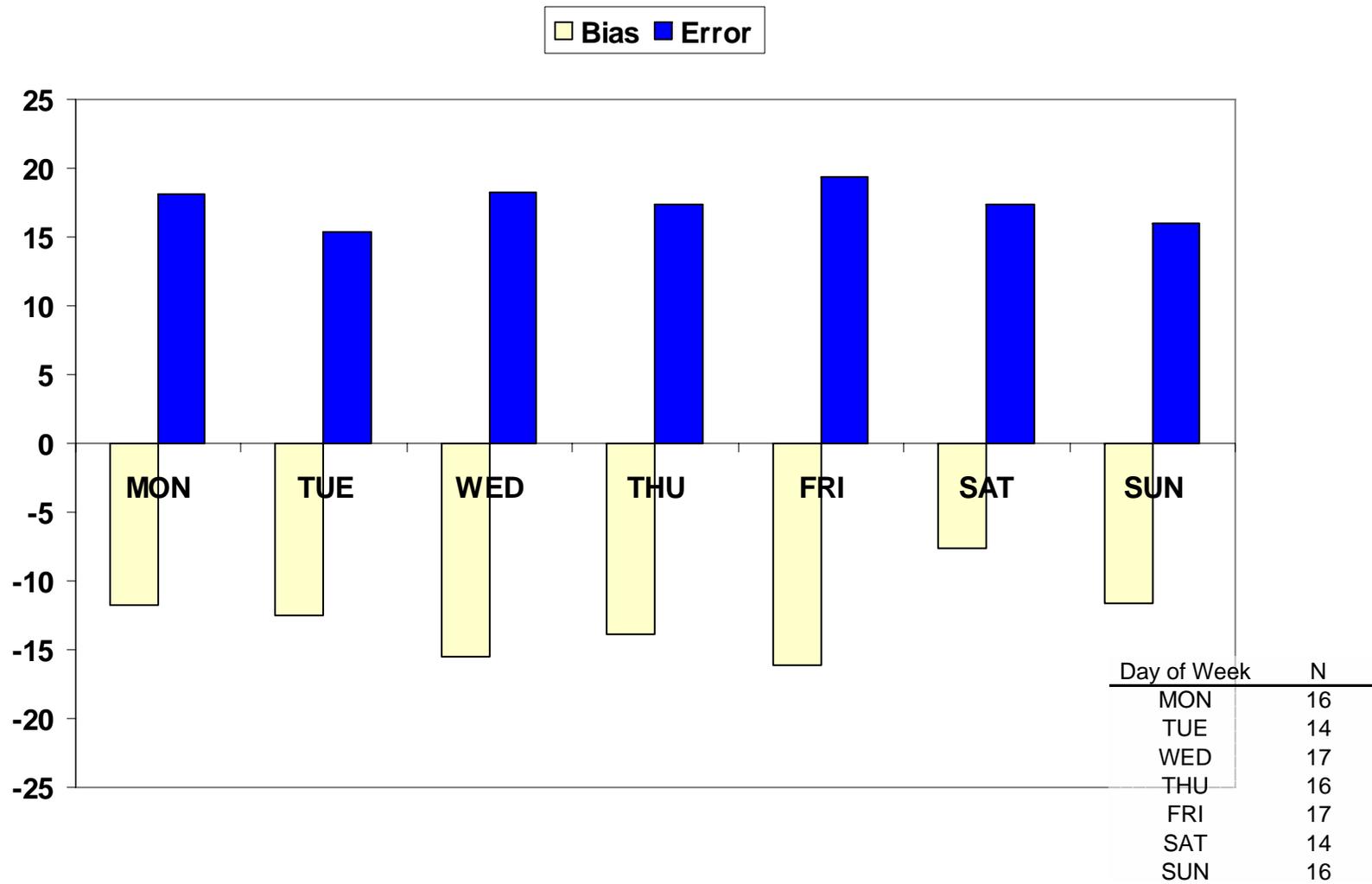
Absolute Delta (2005-2002)



Day of the Week Evaluation

- The benefit of simulating 2 summer seasons is that there are enough days with high ozone to assess model performance by day of the week
- The results show consistent model performance by day of the week
- The weekend days clearly do not perform any worse than weekday days

Mean bias and mean error of days with 8-hr ozone > 80 ppb in 2002 and 2005



Conclusions

- The operational evaluation suggests high ozone is slightly under-predicted in both summers
- The diagnostic approaches used in this study suggests the modeling system will appropriately respond to emissions adjustments
- This is important since a relative modeling approach is required to estimate future year ozone values for ozone attainment demonstrations
- Many different approaches may provide information useful to assess how appropriately the modeling system responds to emissions adjustments