Evaluation of Developmental CMAQ Ozone Forecasts

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CMAQ Model Performance

AQ Model Forecasts Interpolated to Station Locations

vs.

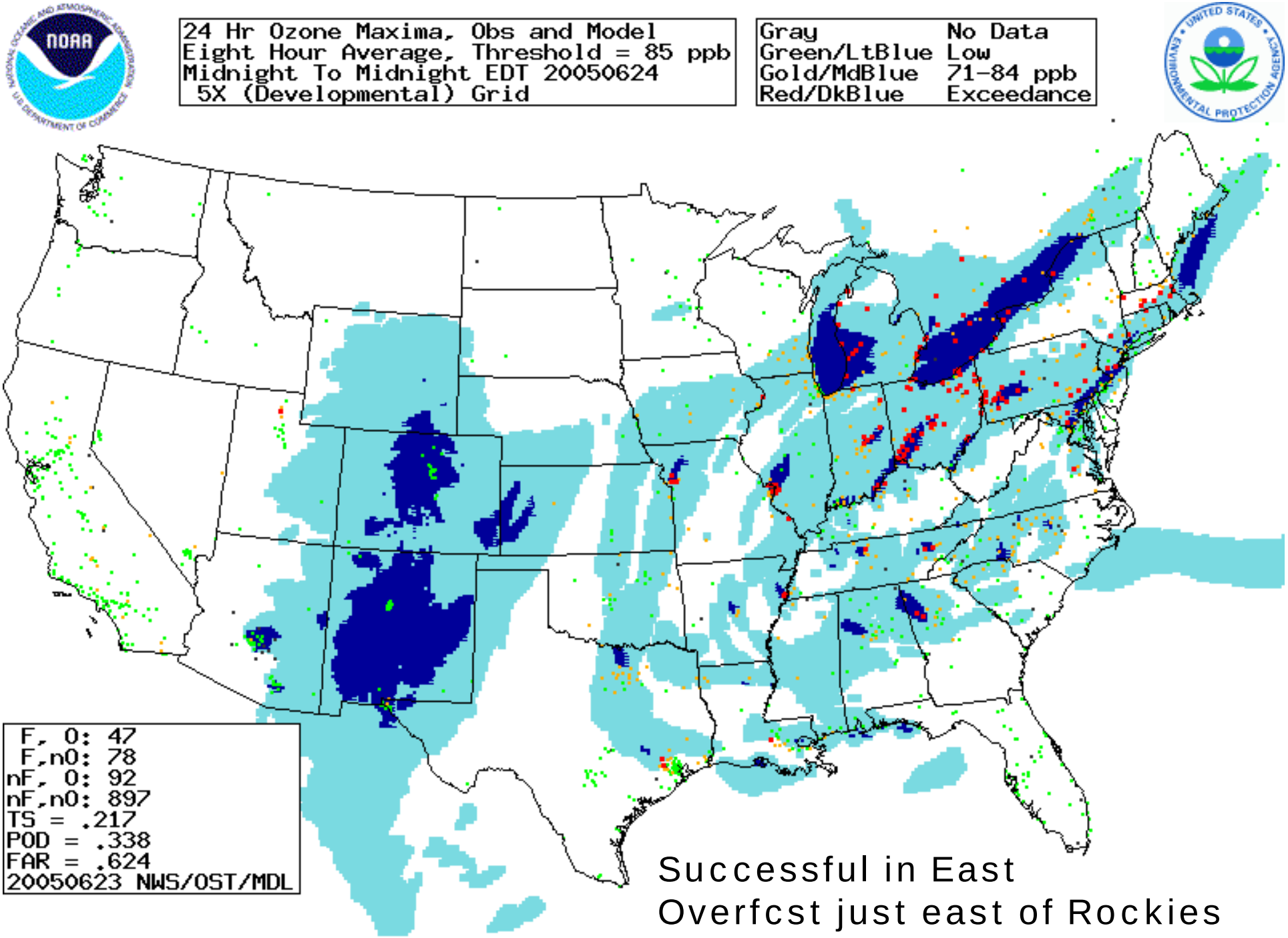
Observations

CMAQ Model Performance

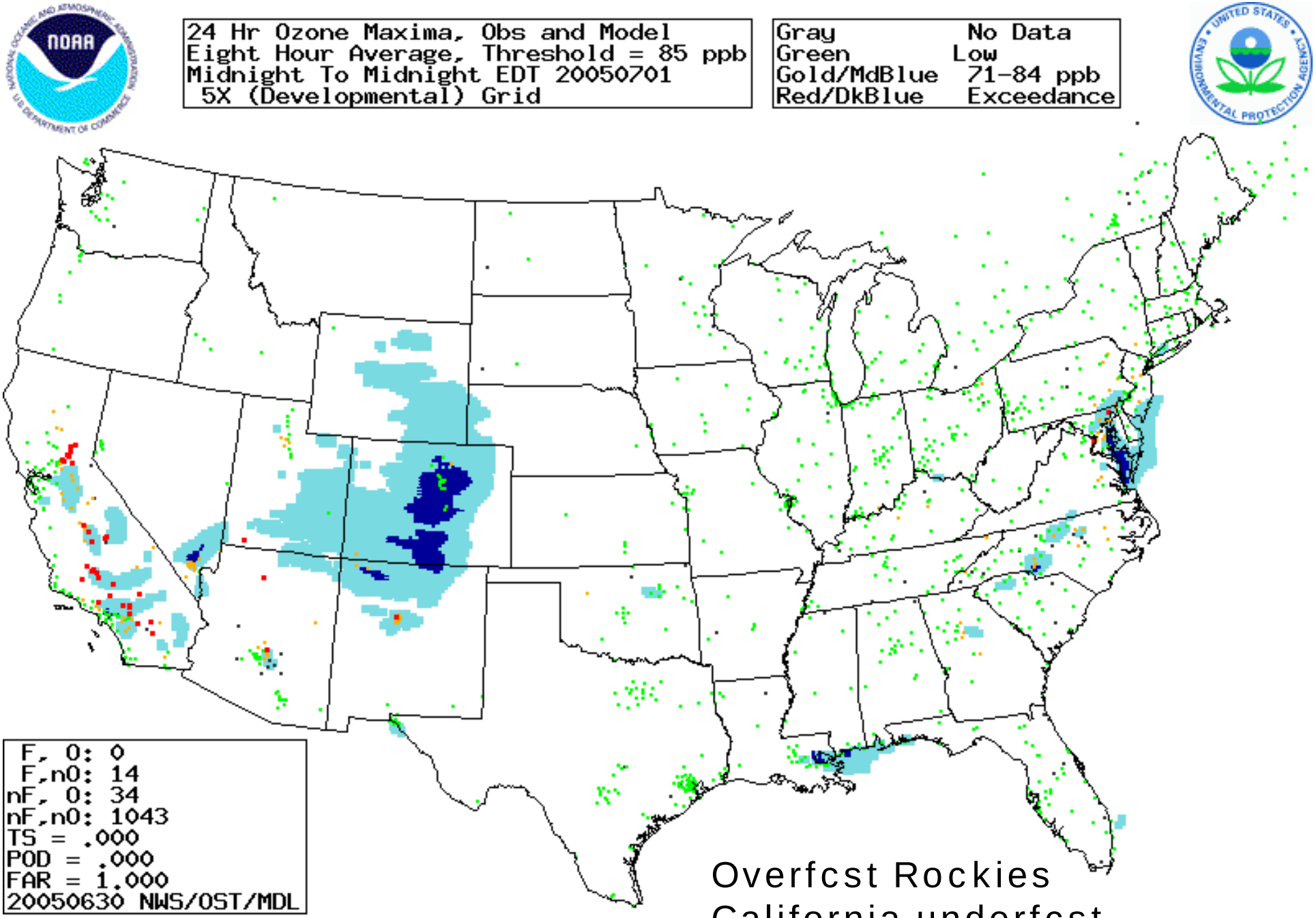
How do the 3x and the 5x models compare?

CMAQ Model Performance

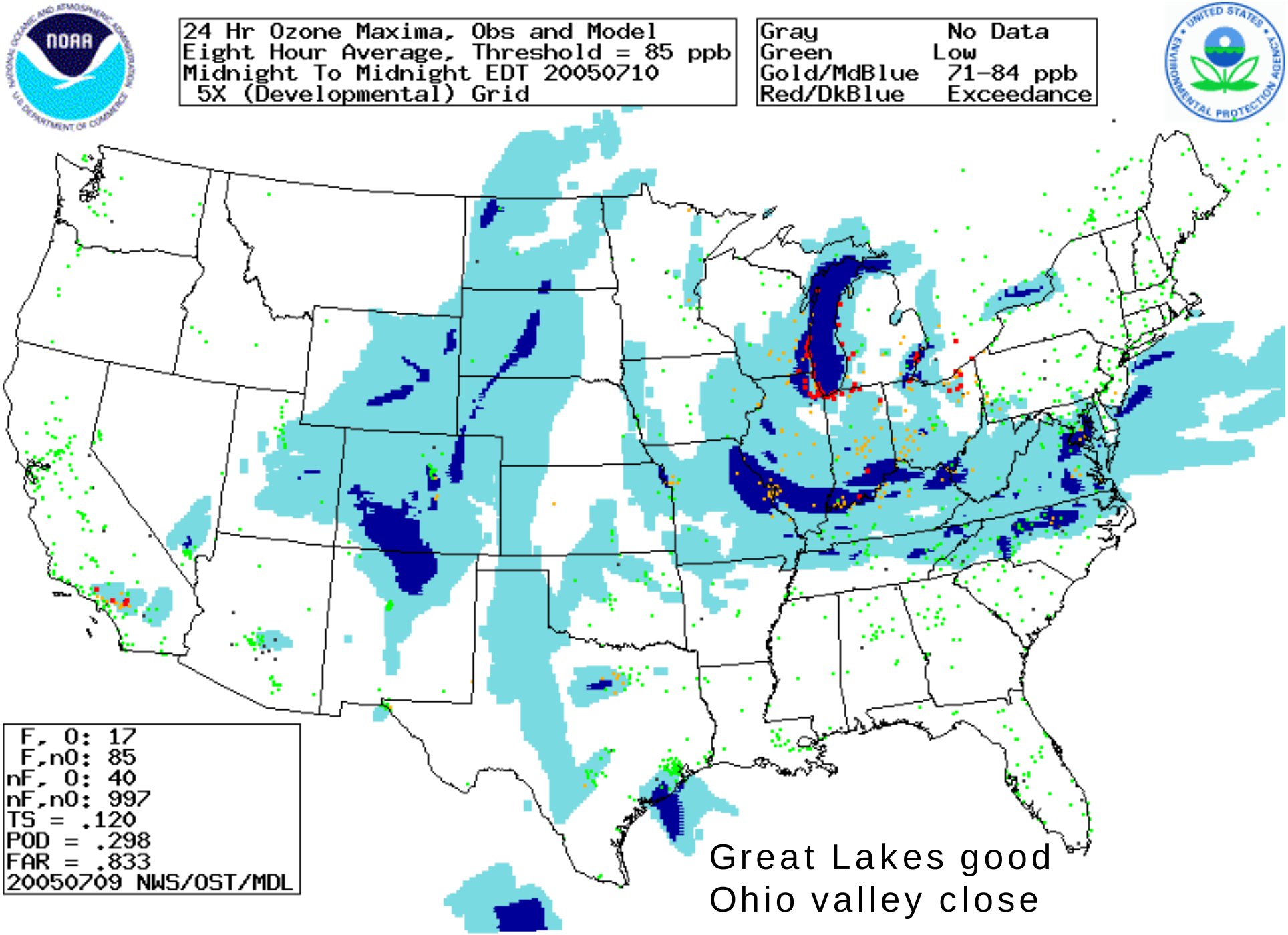
Maps of Model-Predicted Exceedences vs. Observations

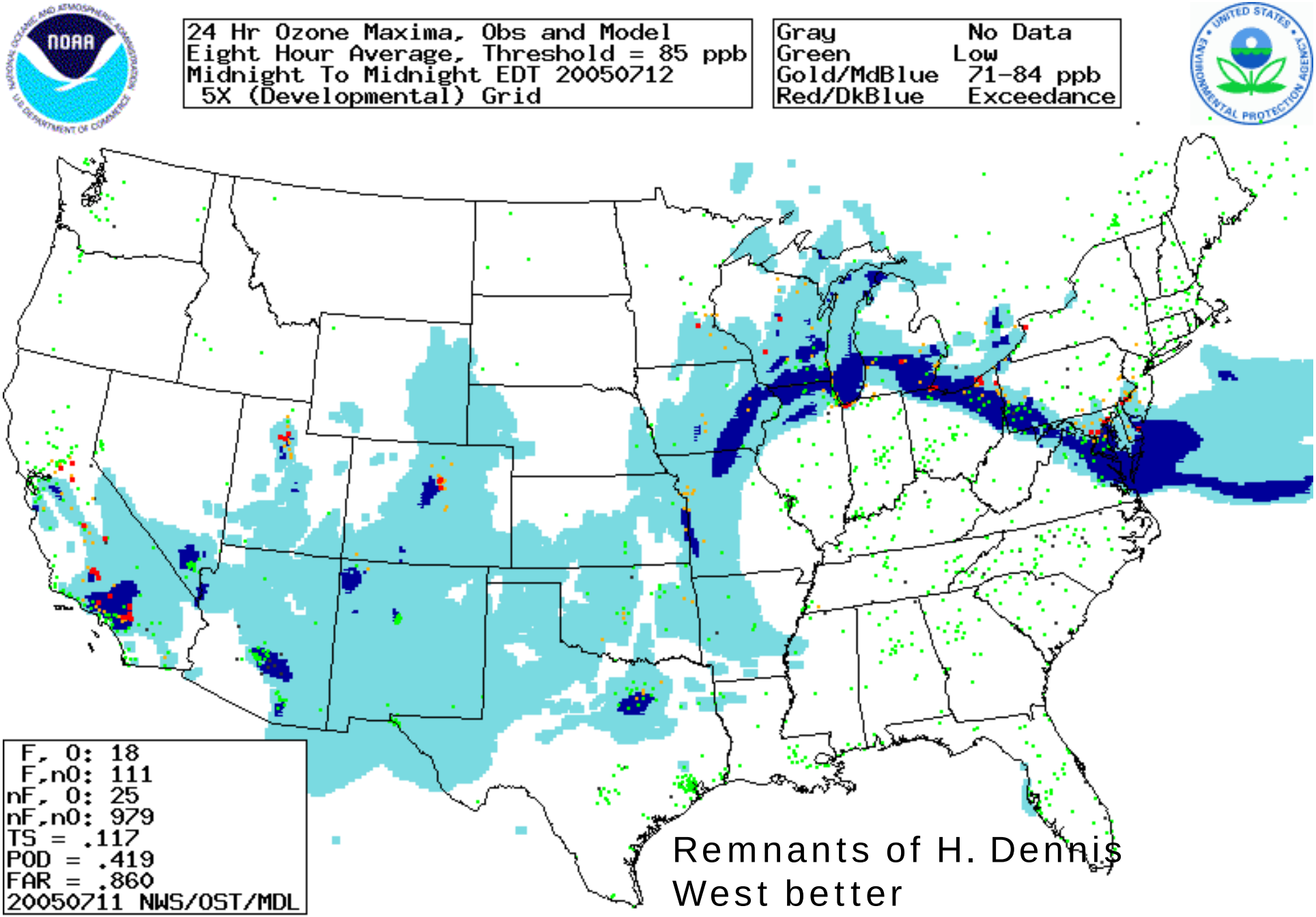


Successful in East
Overfcst just east of Rockies

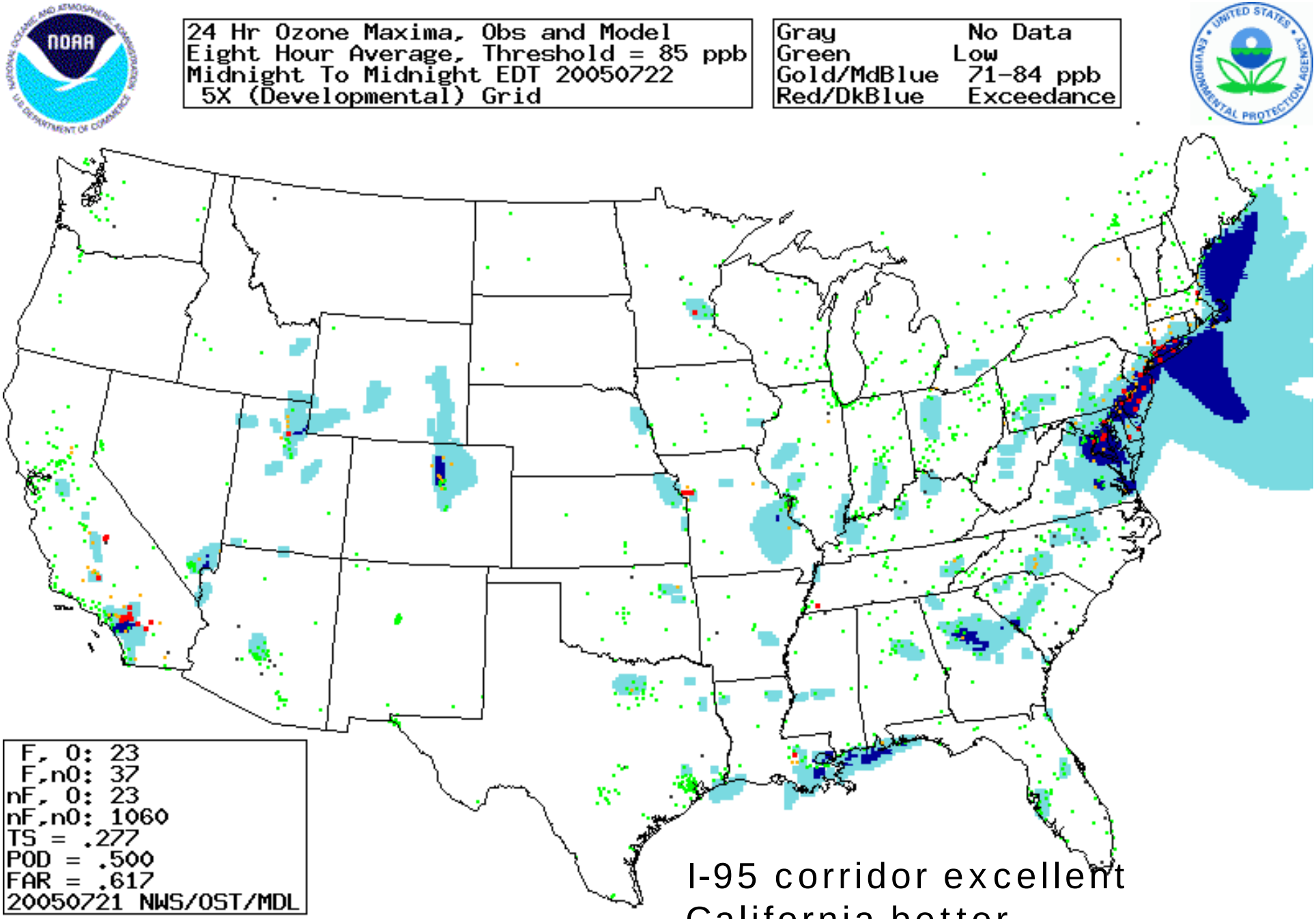


Overfcst Rockies
California underfcst

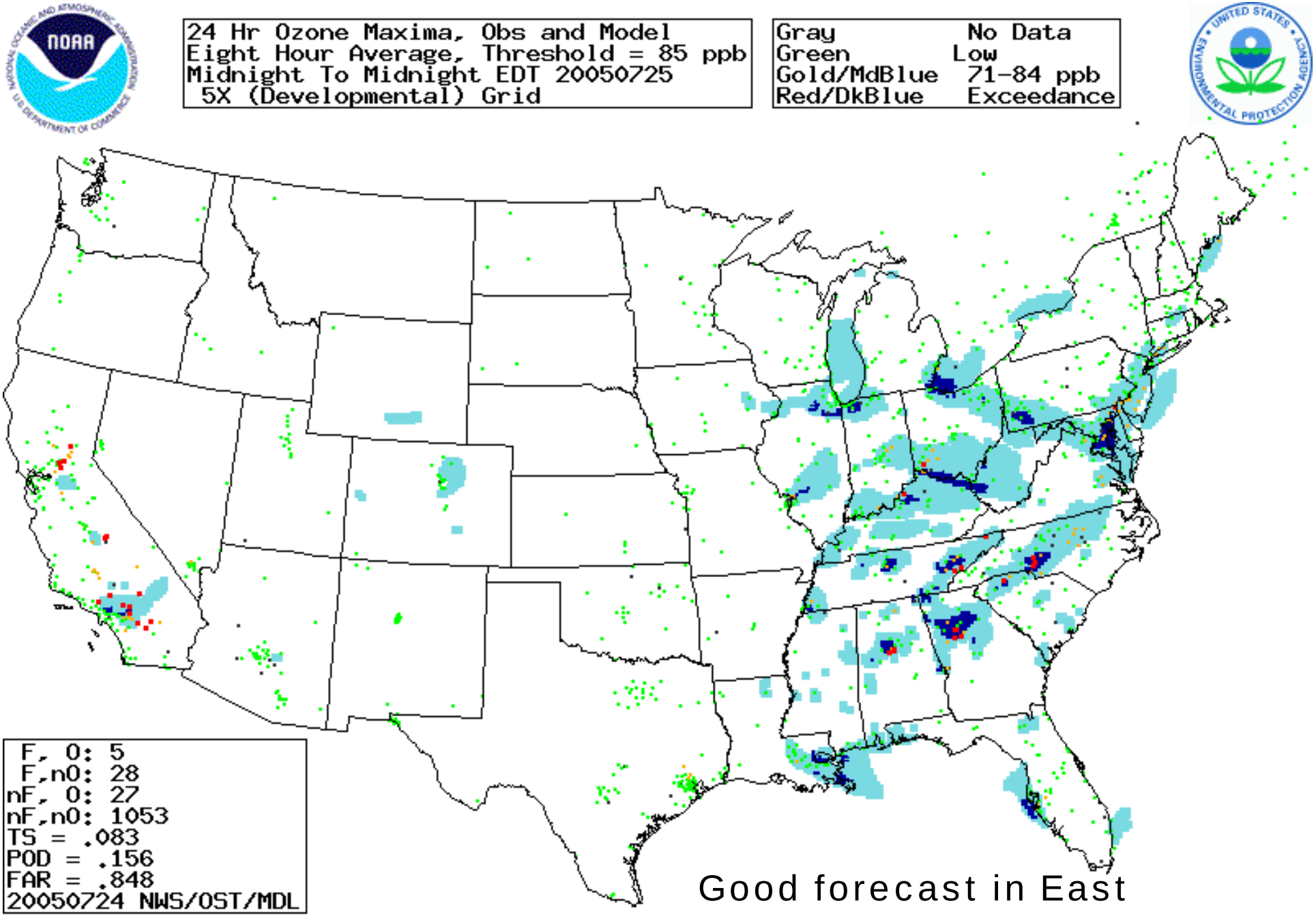

24 Hr Ozone Maxima, Obs and Model
Eight Hour Average, Threshold = 85 ppb
Midnight To Midnight EDT 20050710
5X (Developmental) Grid
Gray No Data
Green Low
Gold/MdBlue 71-84 ppb
Red/DkBlue Exceedance
F, 0: 17
F,n0: 85
nF, 0: 40
nF,n0: 997
TS = .120
POD = .298
FAR = .833
20050709 NWS/OST/MDL
Great Lakes good
Ohio valley close



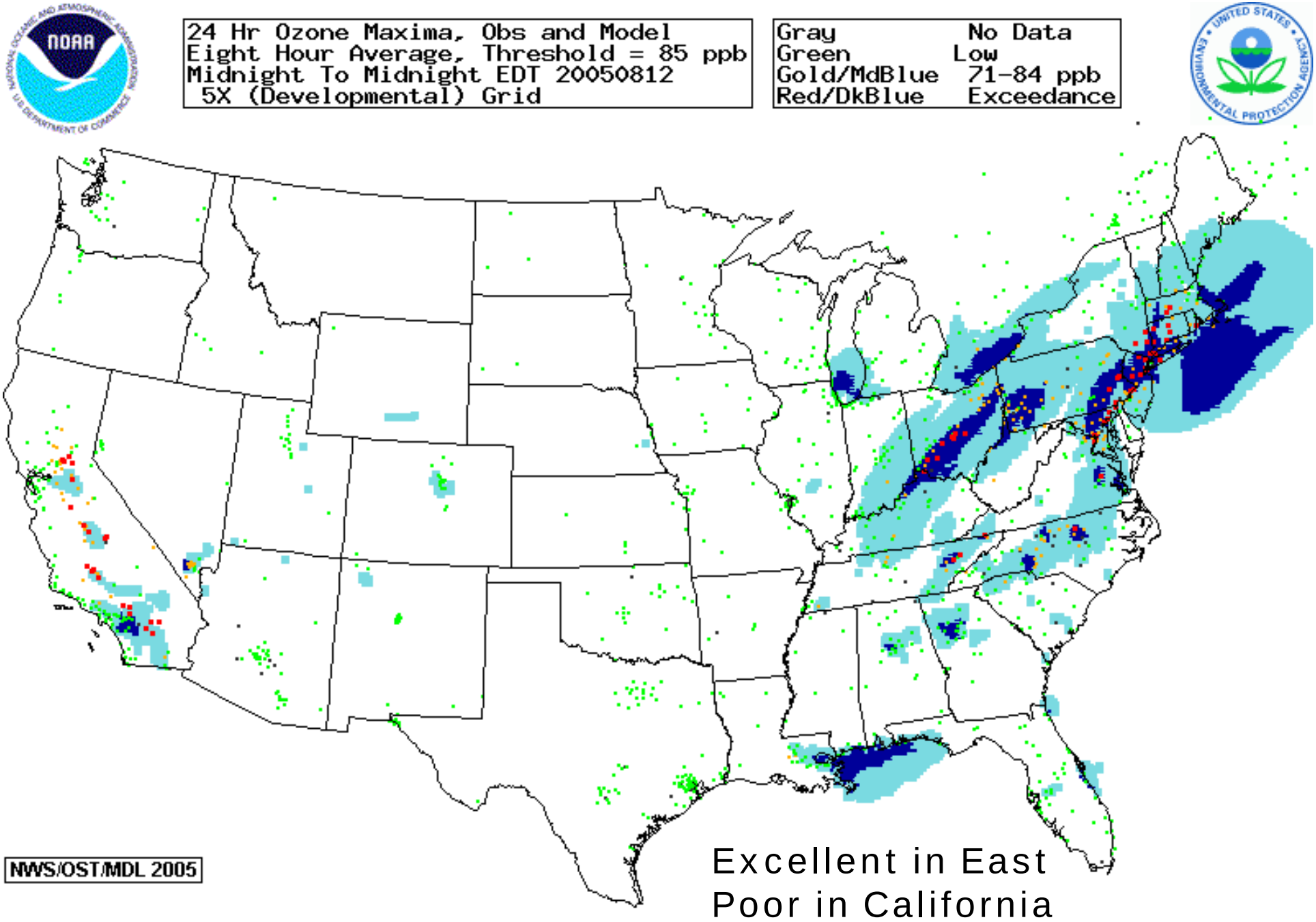
Remnants of H. Dennis
West better
Thunderstorms Pittsburgh, PA



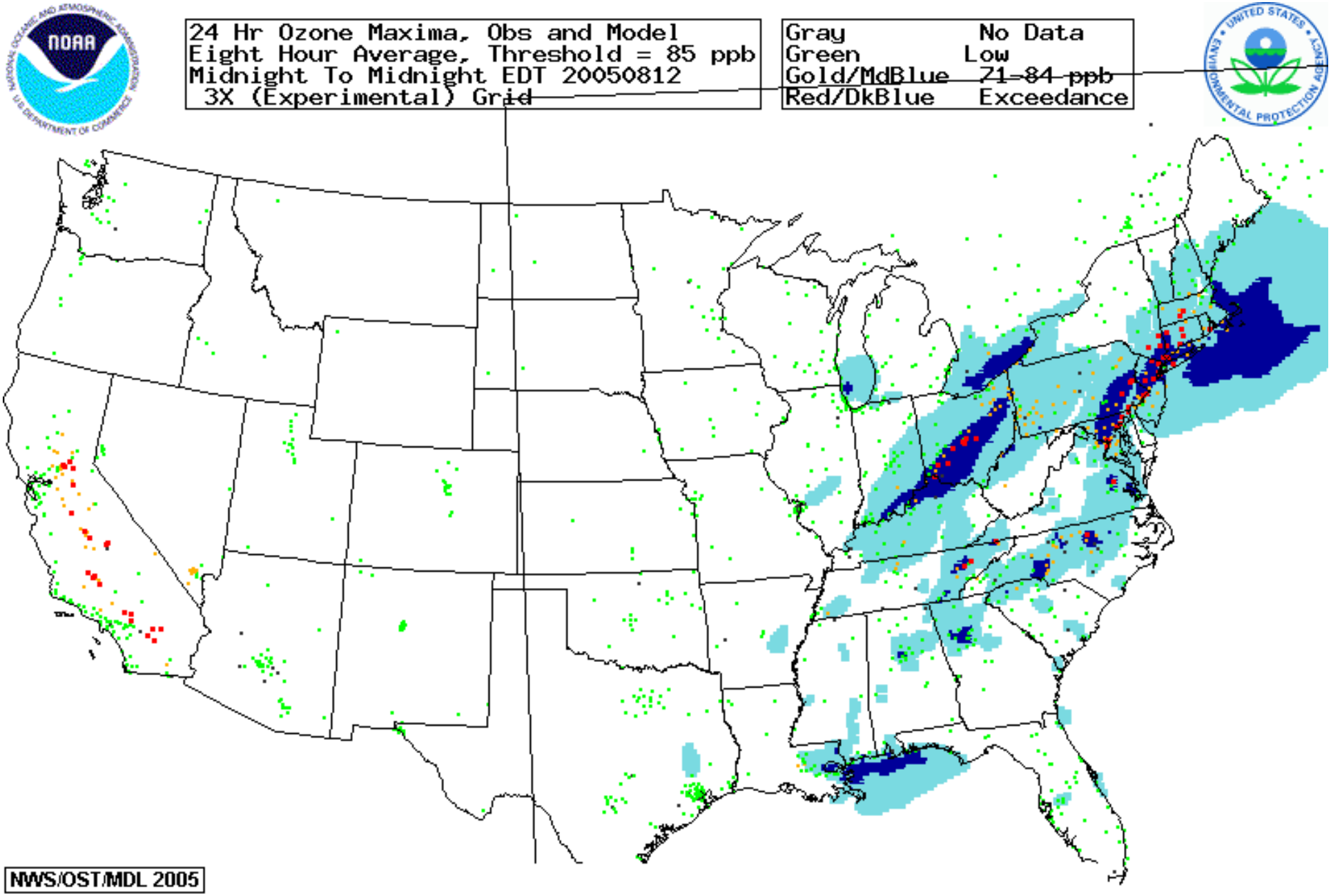
I-95 corridor excellent
California better
Rockies – overfcst corrected



Good forecast in East
Poor in California



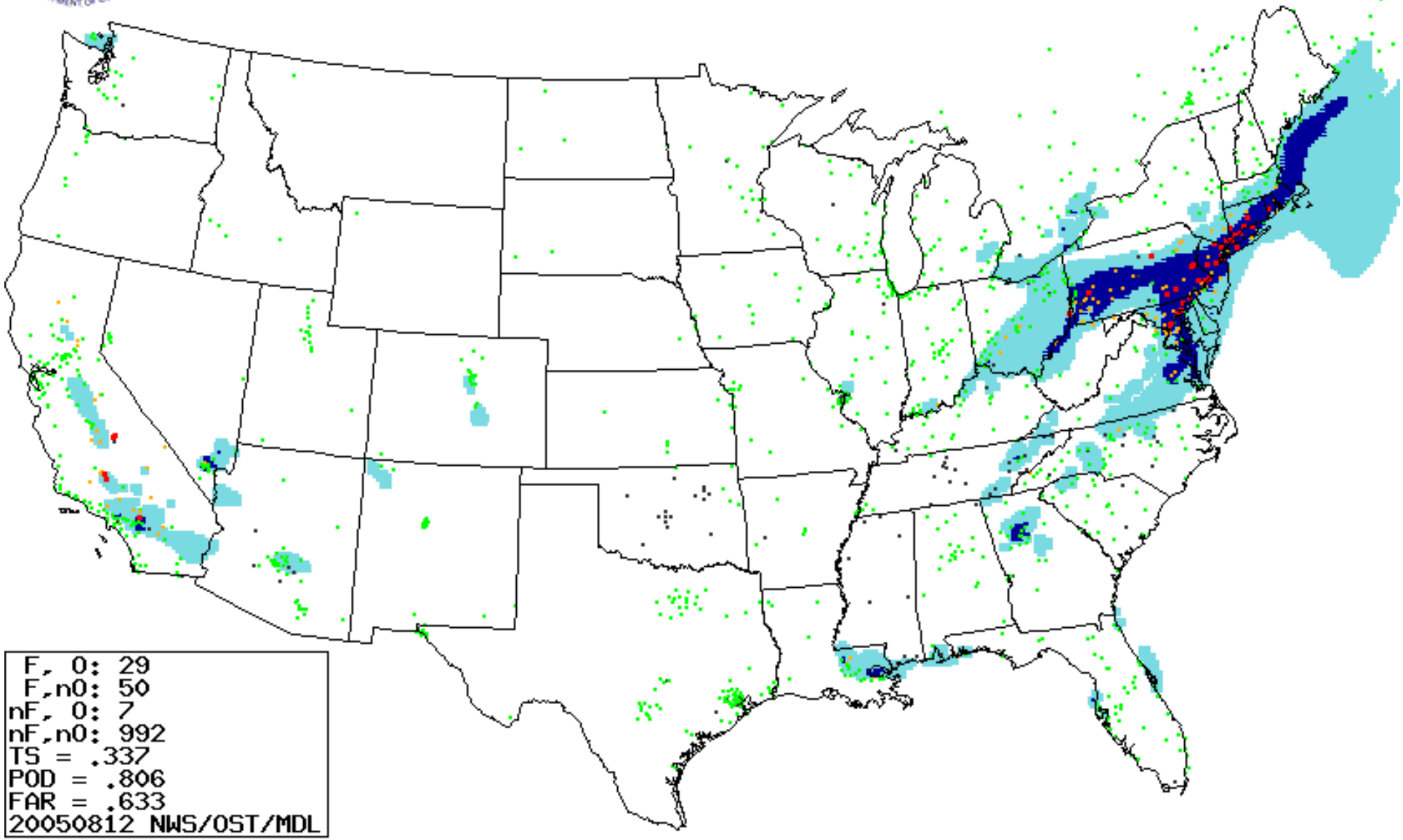
Excellent in East
Poor in California


24 Hr Ozone Maxima, Obs and Model
Eight Hour Average, Threshold = 85 ppb
Midnight To Midnight EDT 20050812
3X (Experimental) Grid
Gray No Data
Green Low
Gold/MdBlue 71-84 ppb
Red/DkBlue Exceedance
NWS/OST/MDL 2005

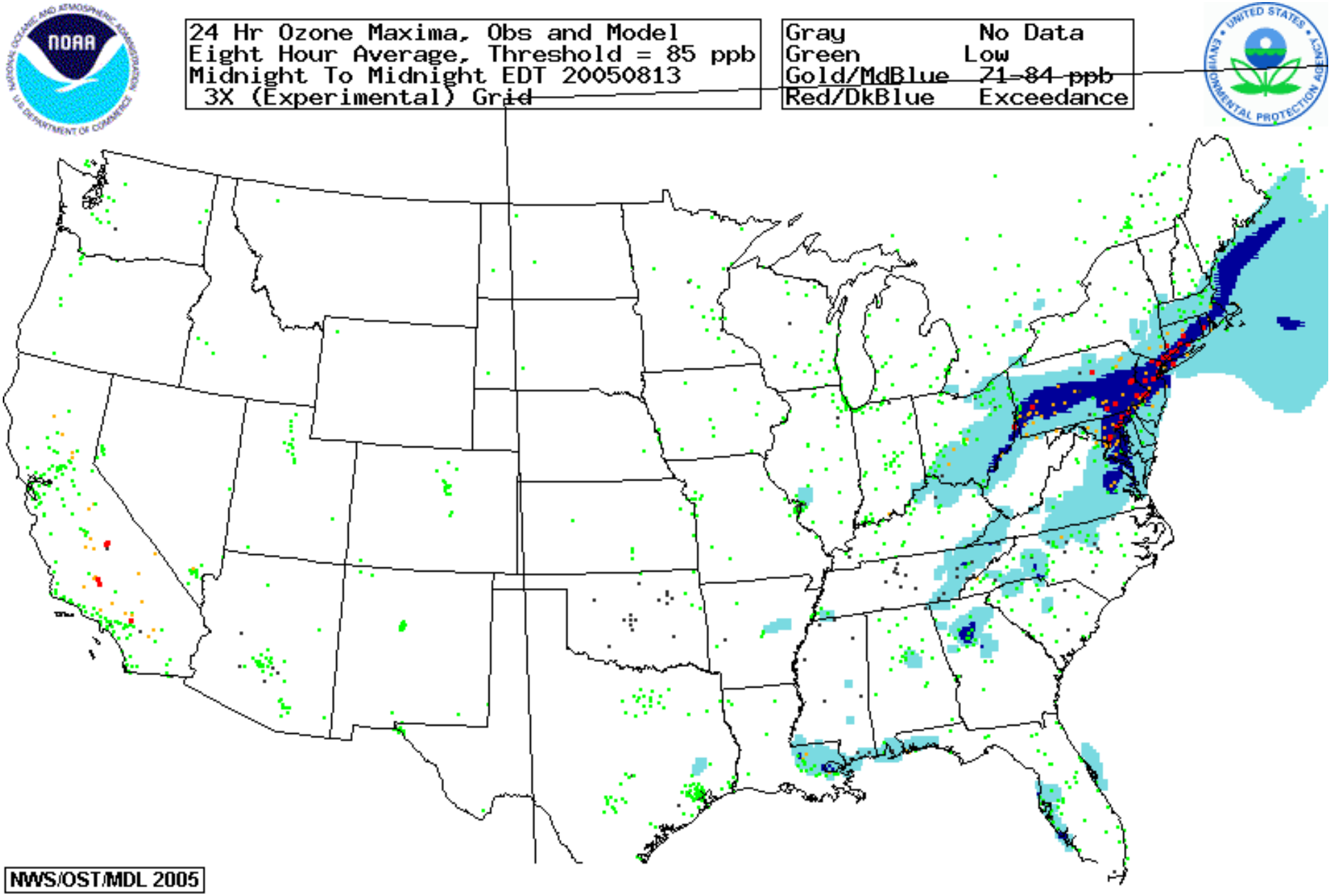
3X AQ Model

24 Hr Ozone Maxima, Obs and Model
Eight Hour Average, Threshold = 85 ppb
Midnight To Midnight EDT 20050813
5X (Developmental) Grid

Gray	No Data
Green	Low
Gold/MdBlue	71-84 ppb
Red/DkBlue	Exceedance



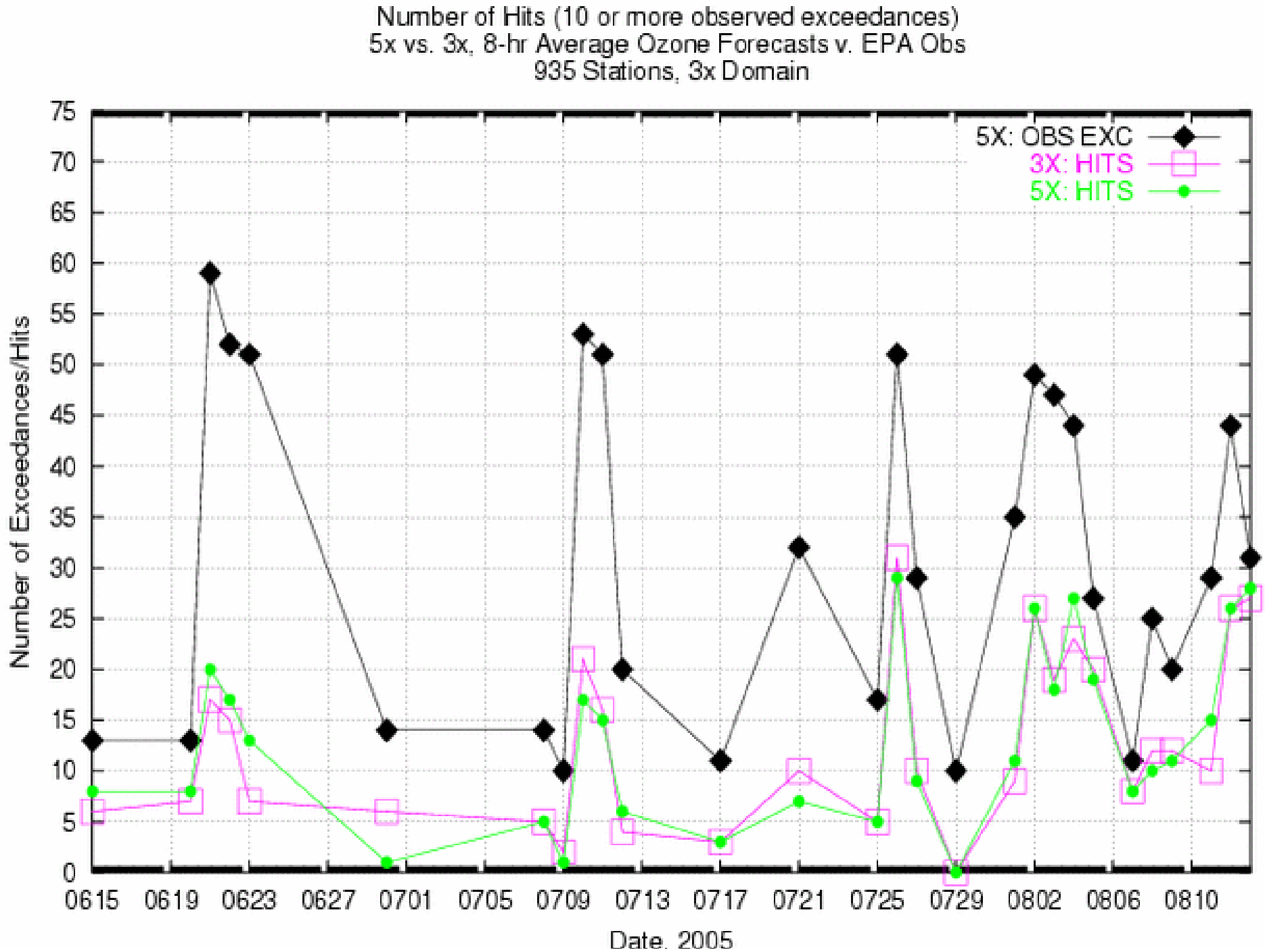
F, 0: 29
F,n0: 50
nF, 0: 7
nF,n0: 992
TS = .337
POD = .806
FAR = .633
20050812 NWS/OST/MDL

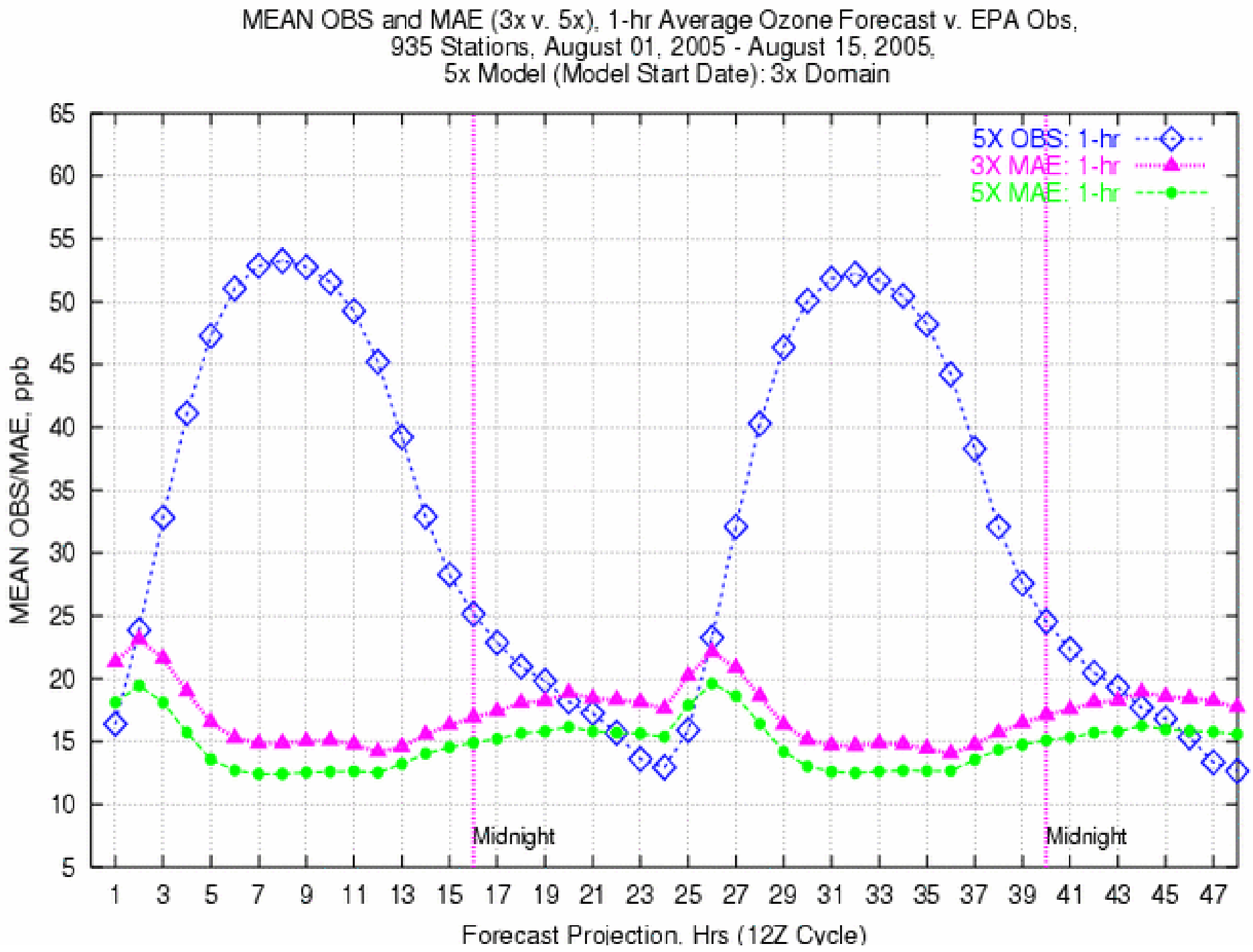

24 Hr Ozone Maxima, Obs and Model
Eight Hour Average, Threshold = 85 ppb
Midnight To Midnight EDT 20050813
3X (Experimental) Grid
Gray No Data
Green Low
Gold/MdBlue 71-84 ppb
Red/DkBlue Exceedance
NWS/OST/MDL 2005

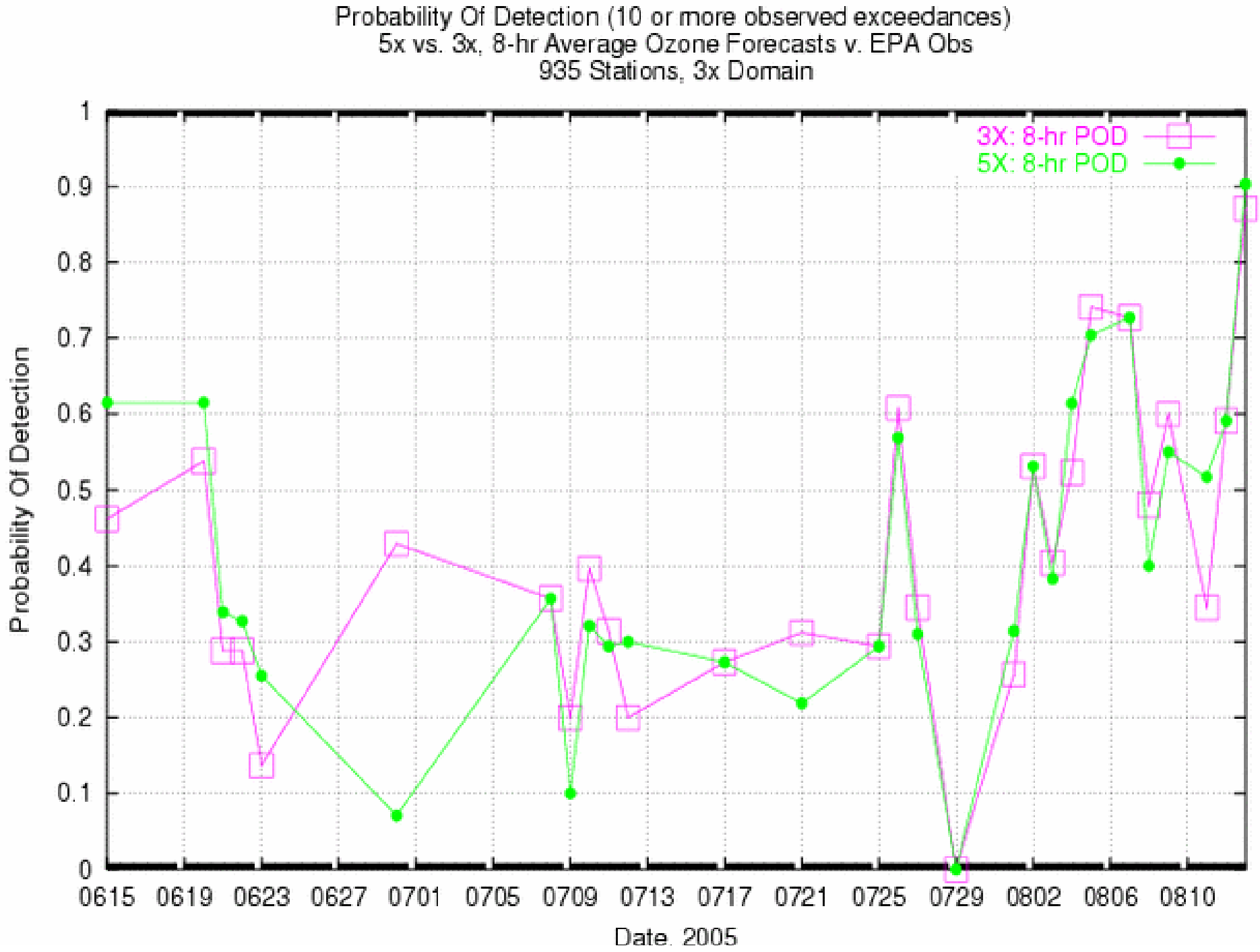
3X AQ Model

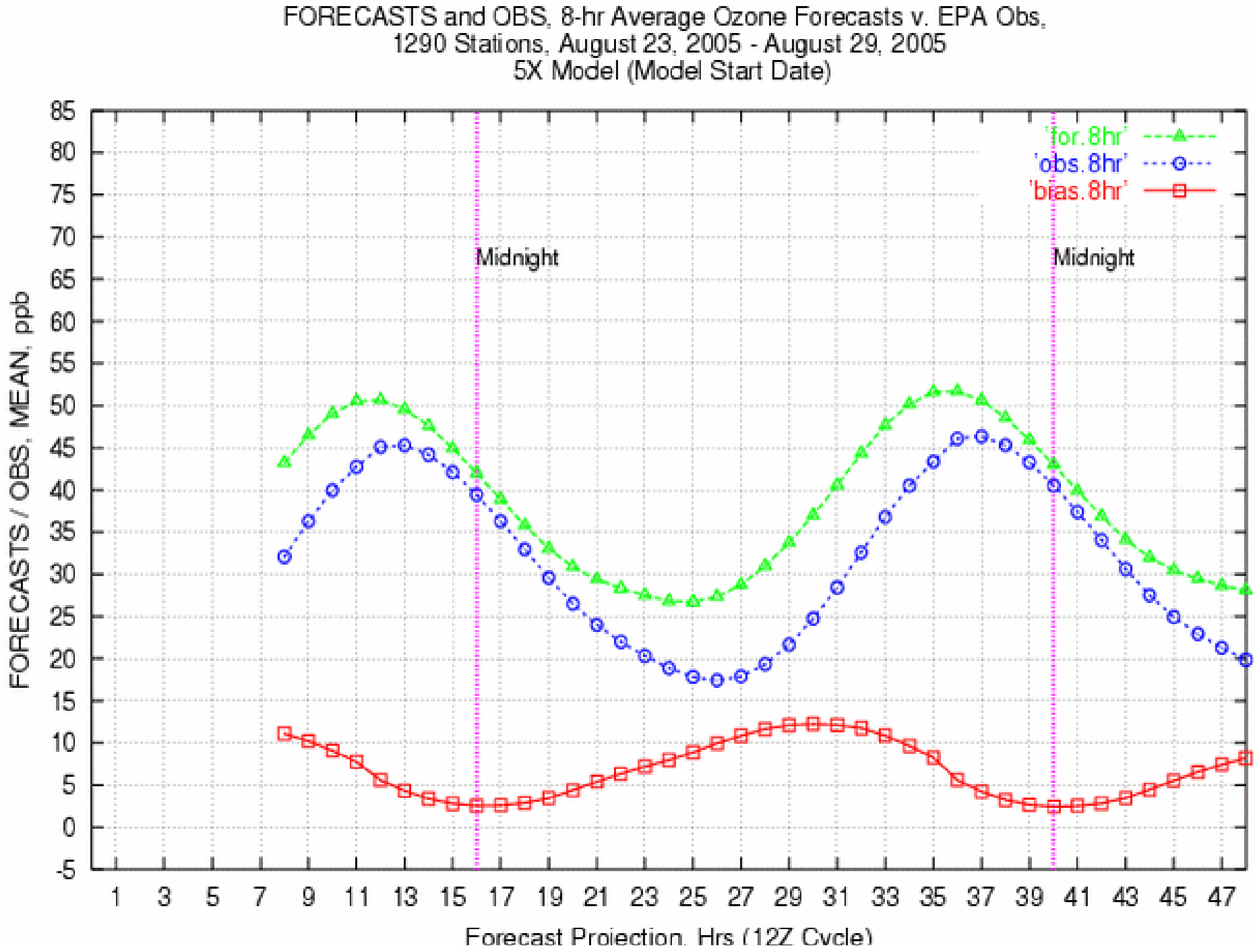
Model Statistics:

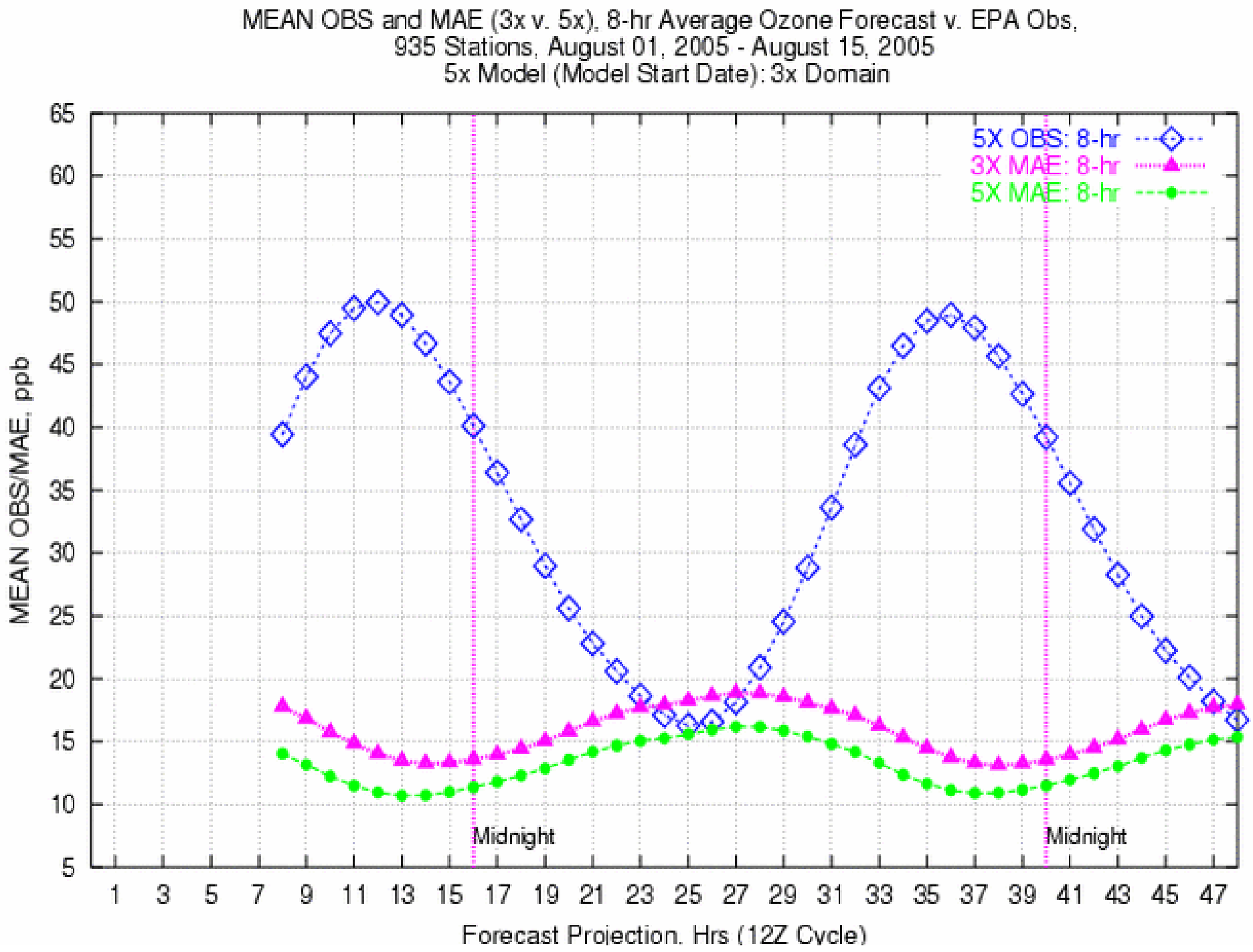
Bias
Mean Absolute Error
Scatter Plot

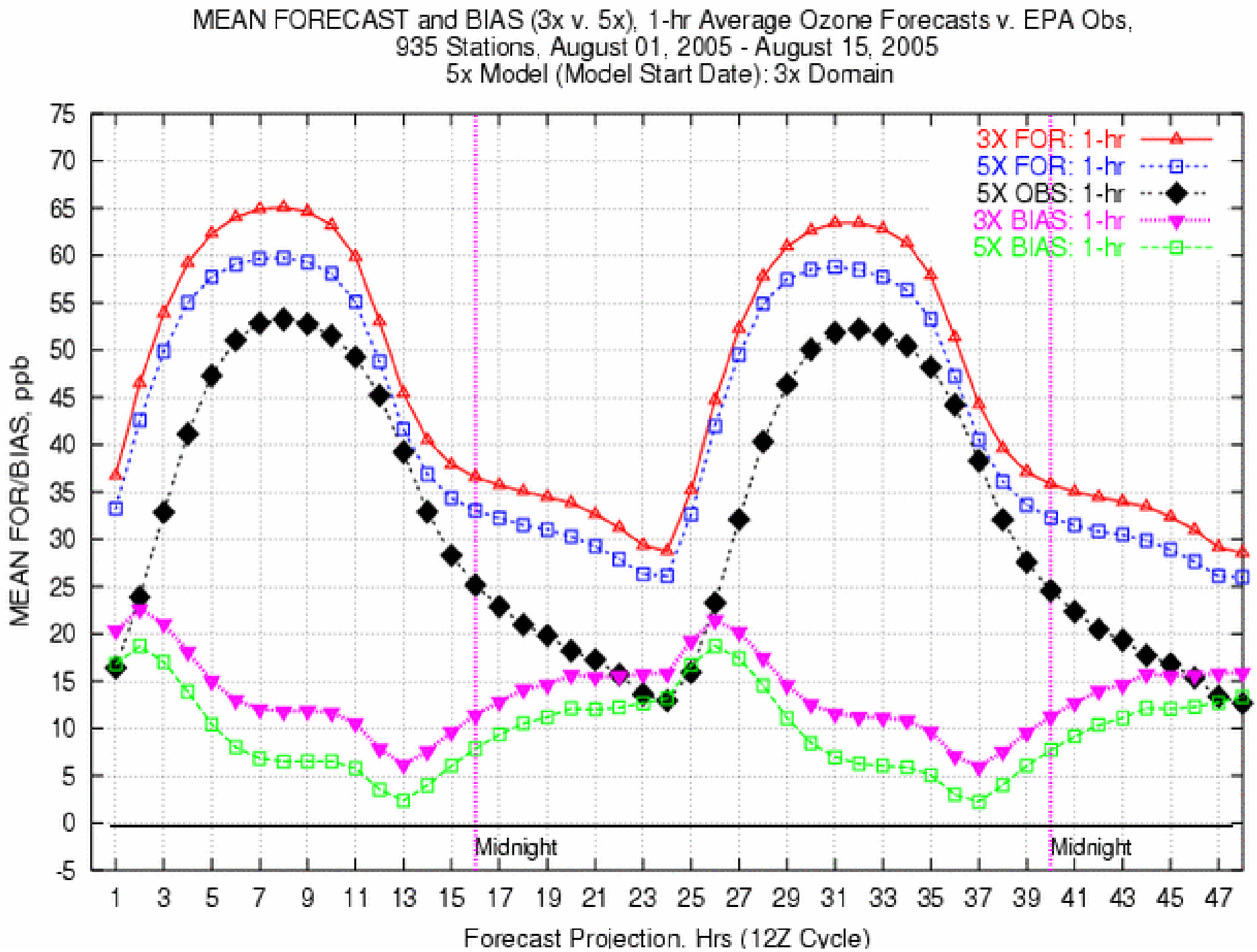

Number of Hits (10 or more observed exceedances)
5x vs. 3x, 8-hr Average Ozone Forecasts v. EPA Obs
935 Stations, 3x Domain
5X: OBS EXC
3X: HITS
5X: HITS
Number of Exceedances/Hits
Date, 2005
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
0615
0619
0623
0627
0701
0705
0709
0713
0717
0721
0725
0729
0802
0806
0810

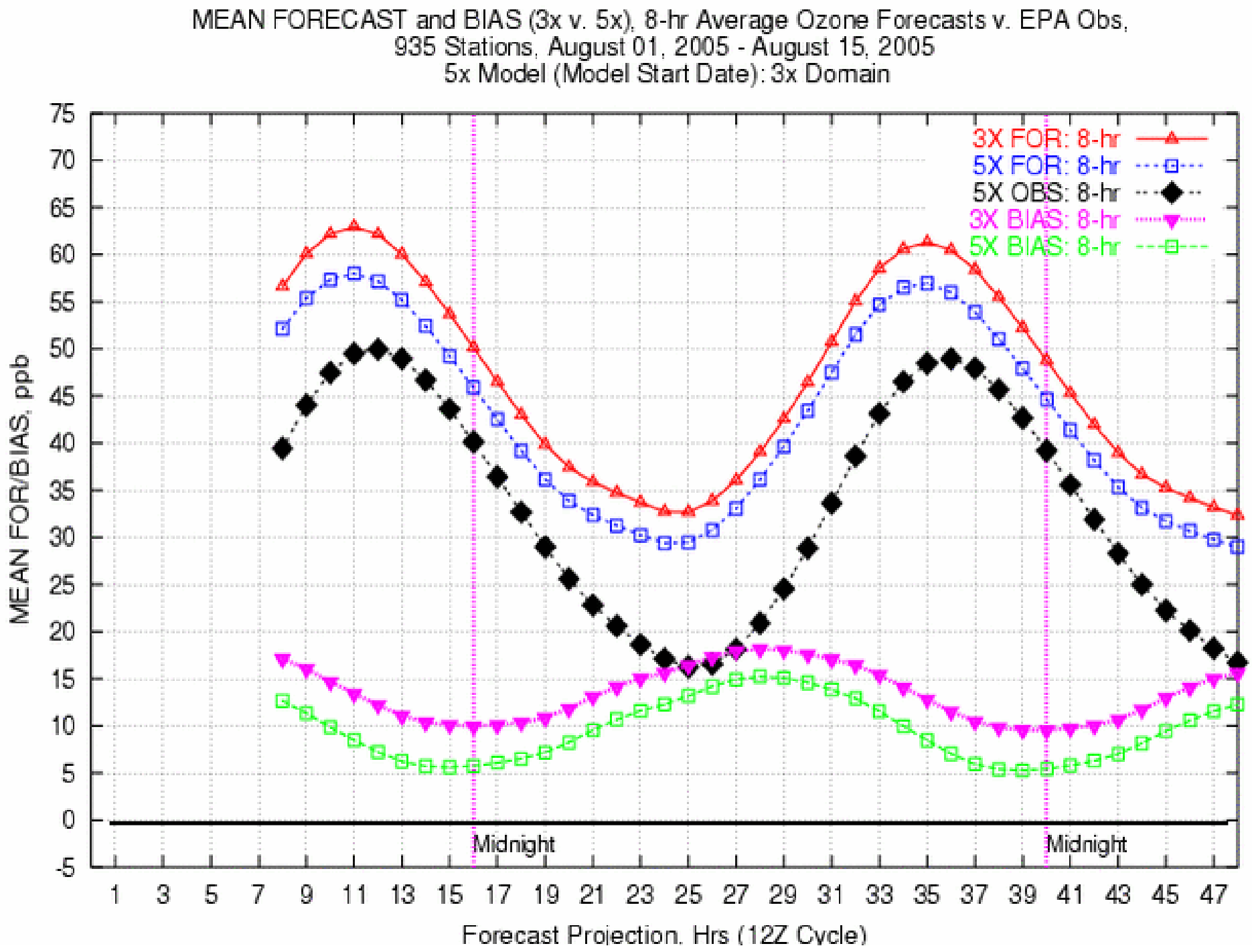

MEAN OBS and MAE (3x v. 5x), 1-hr Average Ozone Forecast v. EPA Obs,
935 Stations, August 01, 2005 - August 15, 2005,
5x Model (Model Start Date): 3x Domain
5X OBS: 1-hr
3X MAE: 1-hr
5X MAE: 1-hr
MEAN OBS/MAE, ppb
65
60
55
50
45
40
35
30
25
20
15
10
5
Midnight
Midnight
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47
Forecast Projection, Hrs (12Z Cycle)

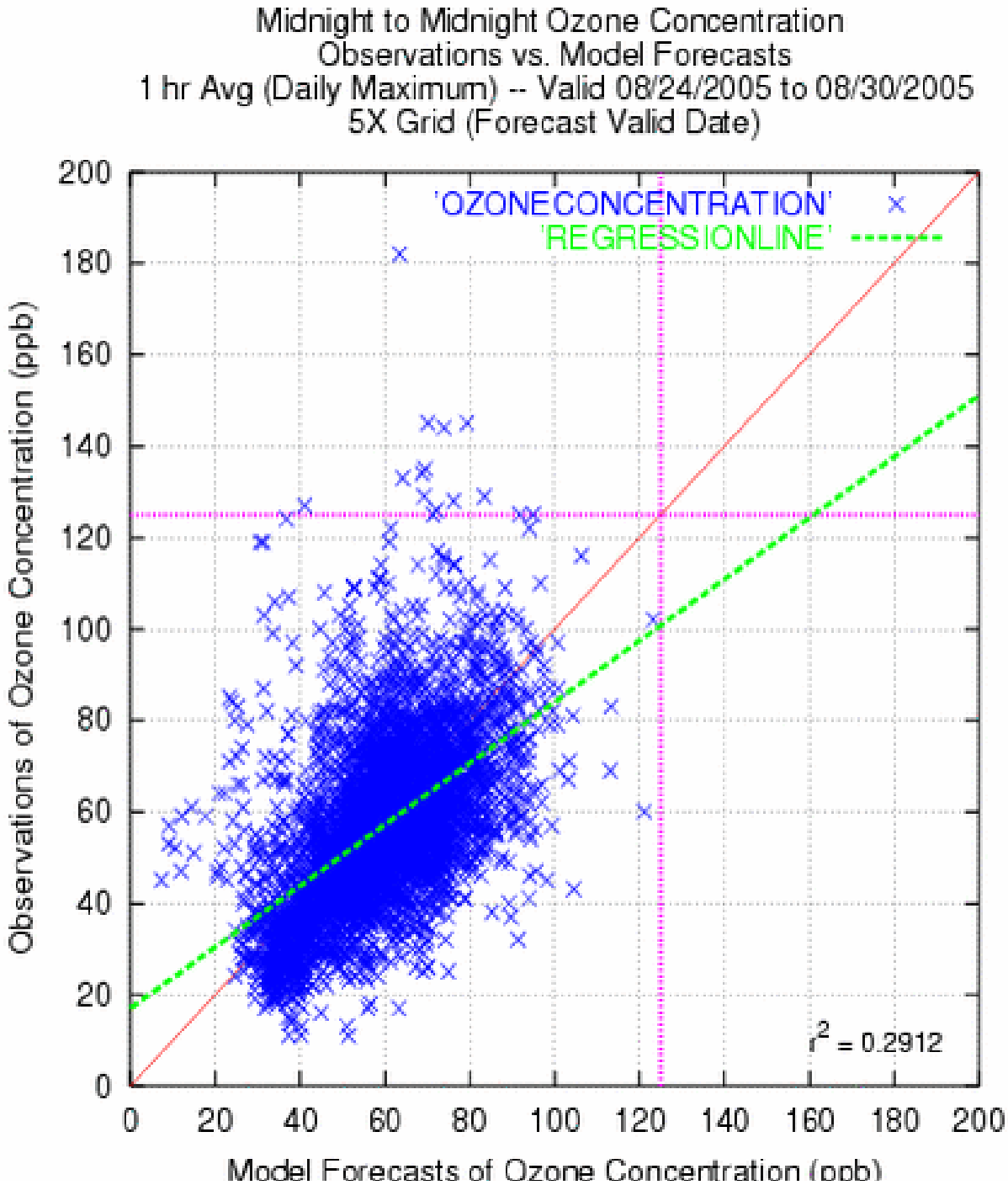

Probability Of Detection (10 or more observed exceedances)
5x vs. 3x, 8-hr Average Ozone Forecasts v. EPA Obs
935 Stations, 3x Domain
3X: 8-hr POD
5X: 8-hr POD
Probability Of Detection
Date, 2005
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0615
0619
0623
0627
0701
0705
0709
0713
0717
0721
0725
0729
0802
0806
0810

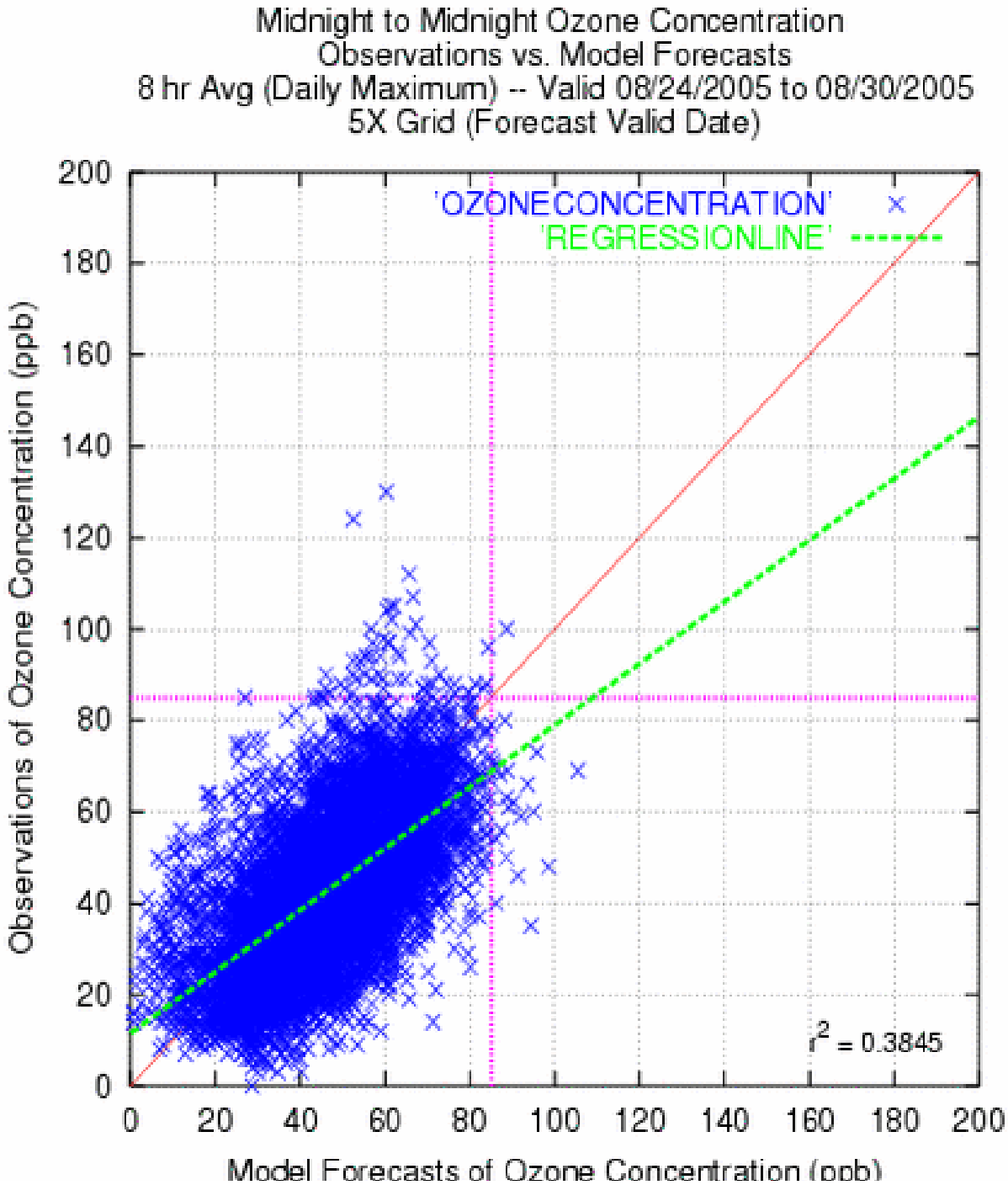

FORECASTS and OBS, 8-hr Average Ozone Forecasts v. EPA Obs,
1290 Stations, August 23, 2005 - August 29, 2005
5X Model (Model Start Date)
'for.8hr'
'obs.8hr'
'bias.8hr'
Midnight
Midnight
FORECASTS / OBS, MEAN, ppb
Forecast Projection, Hrs (12Z Cycle)
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47

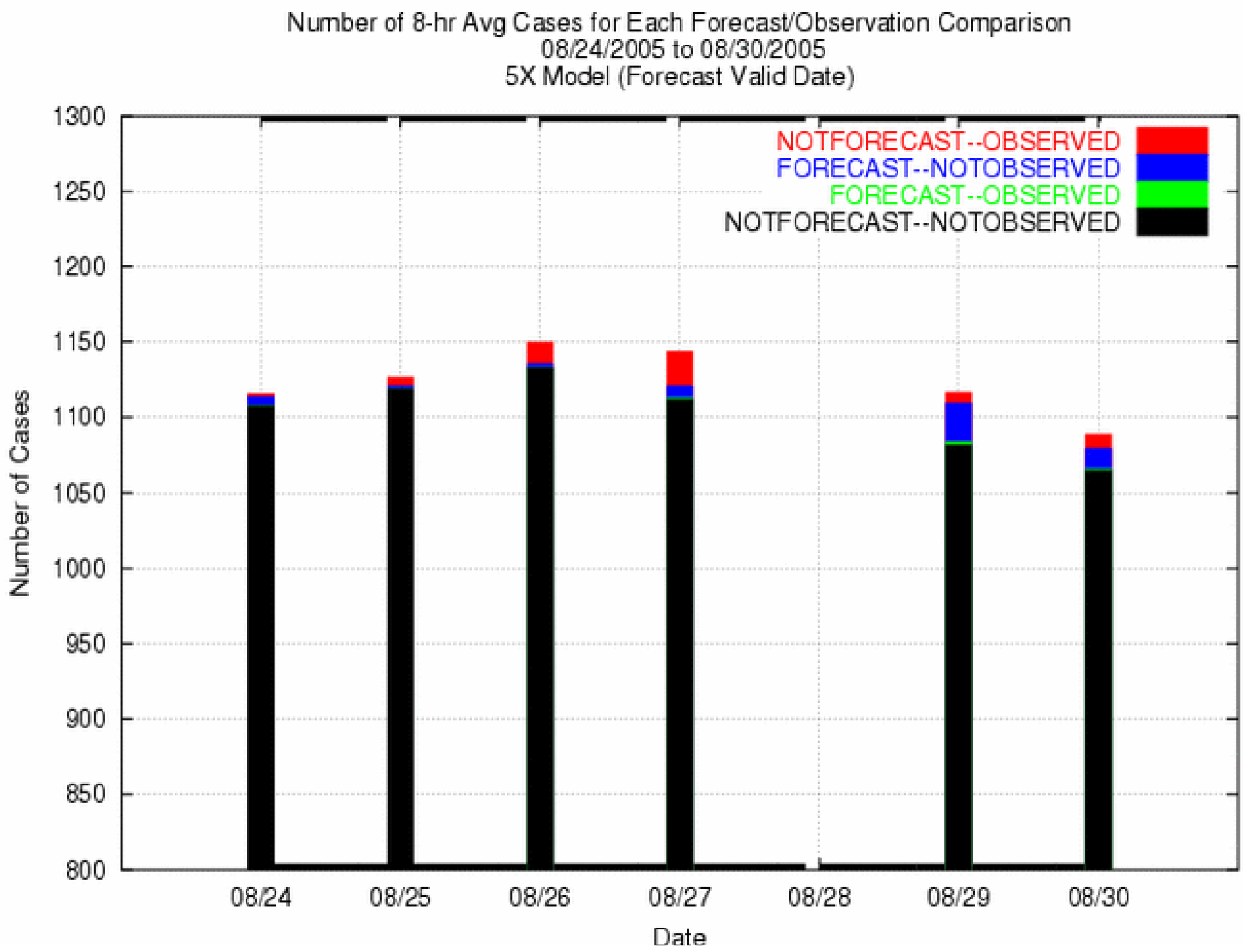

MEAN OBS and MAE (3x v. 5x), 8-hr Average Ozone Forecast v. EPA Obs,
935 Stations, August 01, 2005 - August 15, 2005
5x Model (Model Start Date): 3x Domain
5X OBS: 8-hr
3X MAE: 8-hr
5X MAE: 8-hr
MEAN OBS/MAE, ppb
65
60
55
50
45
40
35
30
25
20
15
10
5
Midnight
Midnight
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47
Forecast Projection, Hrs (12Z Cycle)

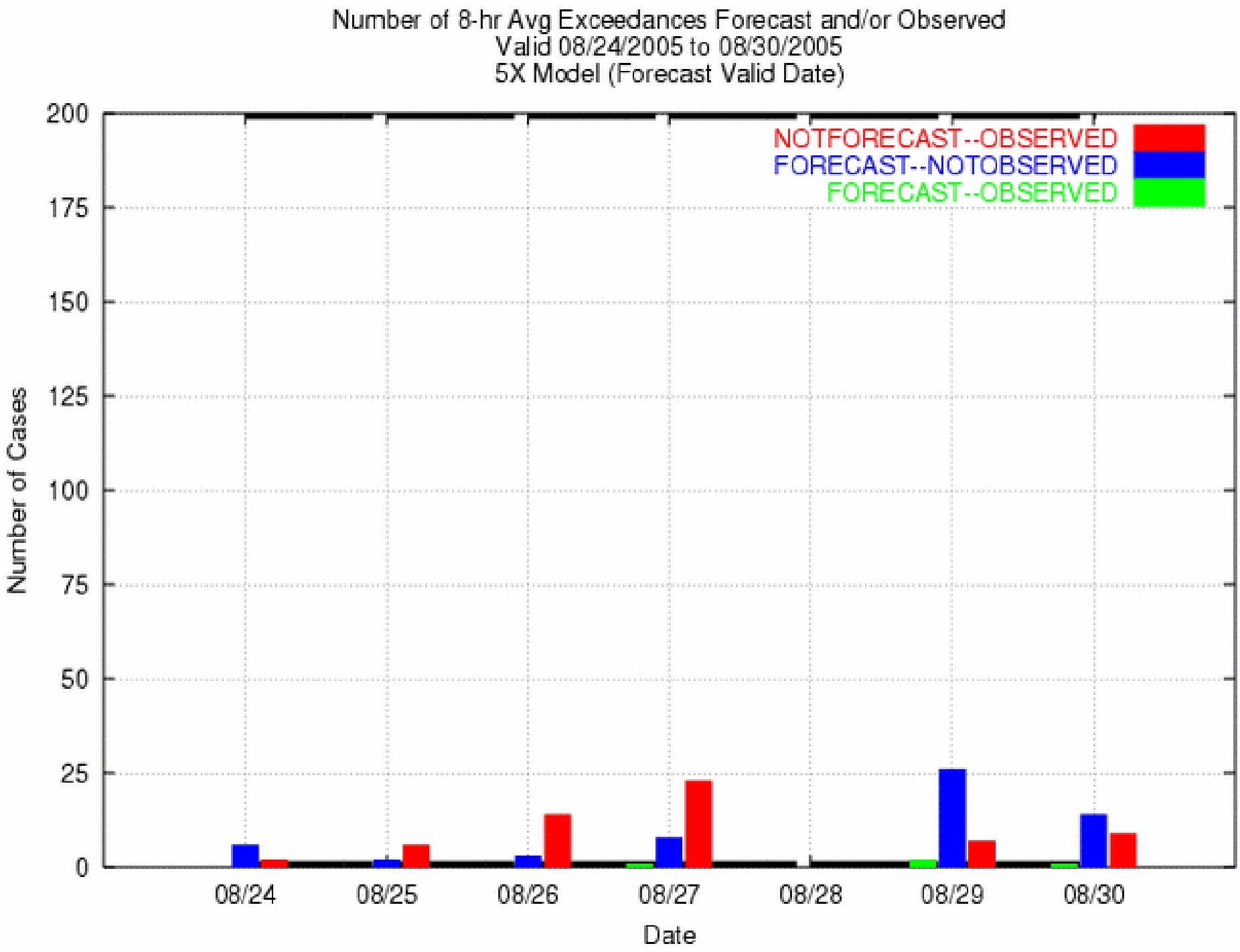

MEAN FORECAST and BIAS (3x v. 5x), 1-hr Average Ozone Forecasts v. EPA Obs,
935 Stations, August 01, 2005 - August 15, 2005
5x Model (Model Start Date): 3x Domain
3X FOR: 1-hr
5X FOR: 1-hr
5X OBS: 1-hr
3X BIAS: 1-hr
5X BIAS: 1-hr
MEAN FOR/BIAS, ppb
Forecast Projection, Hrs (12Z Cycle)
Midnight
Midnight
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47


MEAN FORECAST and BIAS (3x v. 5x), 8-hr Average Ozone Forecasts v. EPA Obs,
935 Stations, August 01, 2005 - August 15, 2005
5x Model (Model Start Date): 3x Domain
3X FOR: 8-hr
5X FOR: 8-hr
5X OBS: 8-hr
3X BIAS: 8-hr
5X BIAS: 8-hr
MEAN FOR/BIAS, ppb
Forecast Projection, Hrs (12Z Cycle)
Midnight
Midnight
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47


Midnight to Midnight Ozone Concentration
Observations vs. Model Forecasts
1 hr Avg (Daily Maximum) -- Valid 08/24/2005 to 08/30/2005
5X Grid (Forecast Valid Date)
'OZONECONCENTRATION'
'REGRESSIONLINE'
r^2 = 0.2912
Observations of Ozone Concentration (ppb)
Model Forecasts of Ozone Concentration (ppb)
0
20
40
60
80
100
120
140
160
180
200


Midnight to Midnight Ozone Concentration
Observations vs. Model Forecasts
8 hr Avg (Daily Maximum) -- Valid 08/24/2005 to 08/30/2005
5X Grid (Forecast Valid Date)
'OZONECONCENTRATION'
'REGRESSIONLINE'
r^2 = 0.3845
Observations of Ozone Concentration (ppb)
Model Forecasts of Ozone Concentration (ppb)
0
20
40
60
80
100
120
140
160
180
200


Number of 8-hr Avg Cases for Each Forecast/Observation Comparison
08/24/2005 to 08/30/2005
5X Model (Forecast Valid Date)
NOTFORECAST--OBSERVED
FORECAST--NOTOBSERVED
FORECAST--OBSERVED
NOTFORECAST--NOTOBSERVED
Number of Cases
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
08/24
08/25
08/26
08/27
08/28
08/29
08/30
Date


Number of 8-hr Avg Exceedances Forecast and/or Observed
Valid 08/24/2005 to 08/30/2005
5X Model (Forecast Valid Date)
NOTFORECAST--OBSERVED
FORECAST--NOTOBSERVED
FORECAST--OBSERVED
Number of Cases
200
175
150
125
100
75
50
25
0
08/24
08/25
08/26
08/27
08/28
08/29
08/30
Date

Definitions of Statistical Terms

		OBSERVED	
		Y	N
FORECAST	Y	a	b
	N	c	d

a - Forecast and Observed (YY)

b - Forecast, but Not Observed (YN)

c - Not Forecast, but Observed (NY)

d - Not Forecast and Not Observed (NN)

(Following the convention of Wilkes, 1995)

Definitions of Statistical Terms

		OBSERVED	
		Y	N
FORECAST	Y	a	b
	N	c	d

FRACTION CORRECT = (a+d) / (a+b+c+d)

THREAT SCORE = a / (a+b+c)

POD = a / (a+c)

FAR = b / (a+b)

BIAS BY CATEGORY (a+b) / (a+c) (c+d) / (b+d)