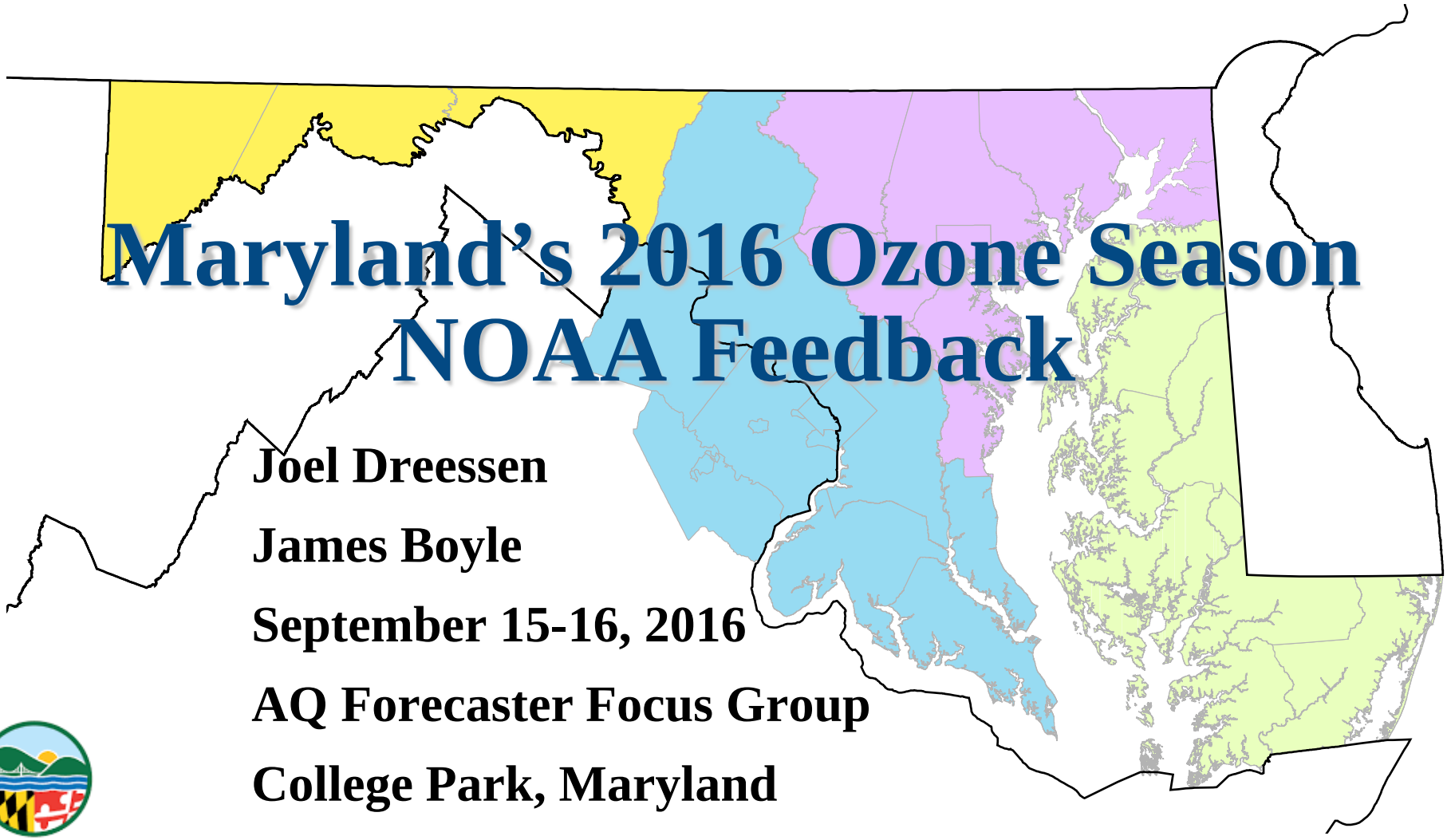
MARYLAND
DEPARTMENT OF THE ENVIRONMENT



Maryland's 2016 Ozone Season NOAA Feedback

Joel Dreessen

James Boyle

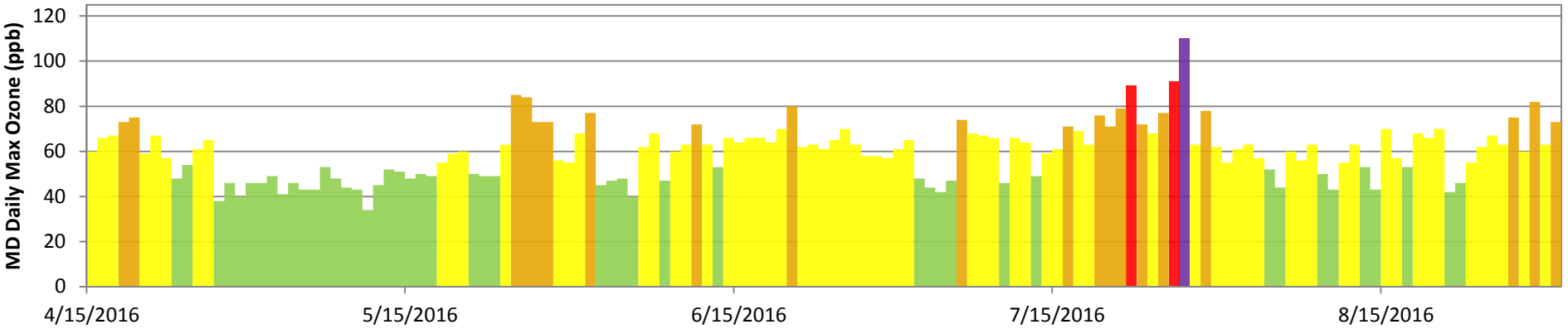
September 15-16, 2016

AQ Forecaster Focus Group

College Park, Maryland

Maryland
Department of
the Environment

2016 SEASON AT A GLANCE



90 Degree Days

YEAR	No. Days	Avg. T_{max} (^{o}F)
2016*	41	85.3
2015	26	83.6
2014	14	82.5
2013	27	83.1
2012	45	85.6
2011	40	86.6
2010	59	87.7

Average No. of days >90 : 31

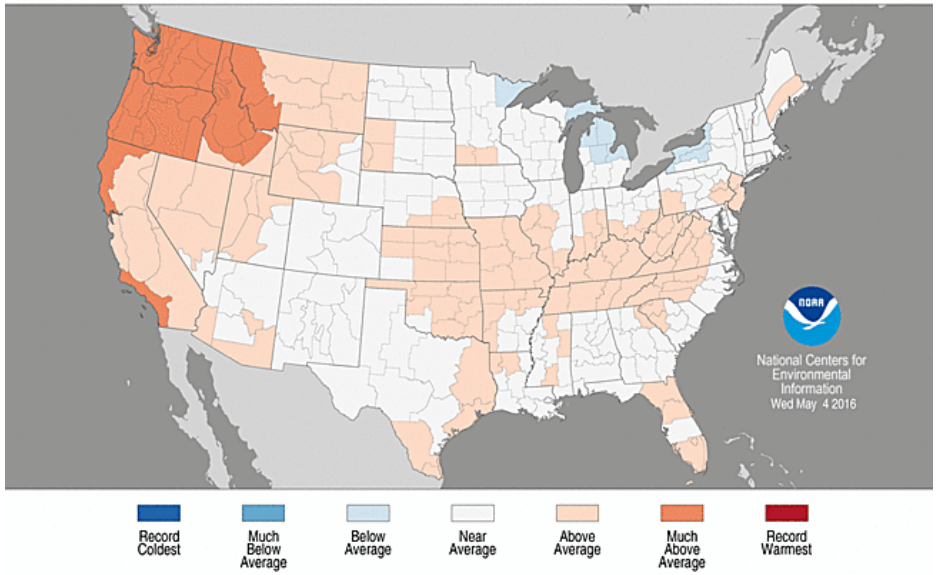
The summer of 2016 was *warmer* than normal and *SIGNIFICANTLY warmer* than the past 3 years. However, Maryland had only marginally more exceedance days than the past 3 years.

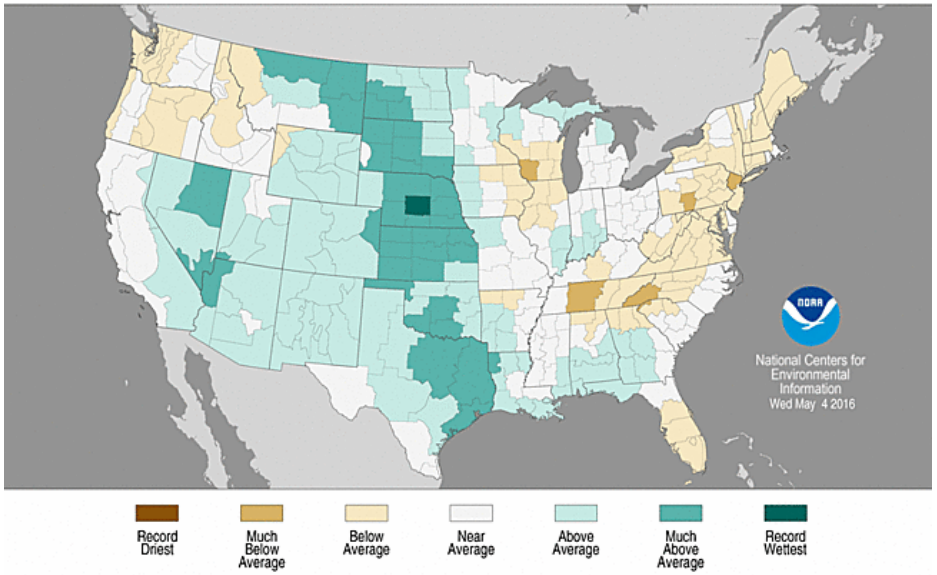
Exceedance Days

YEAR	70ppb	75ppb	84ppb
2016*	23	11	3
2015	19	8	2
2014	11	5	1
2013	19	9	0
2012	42	30	13
2011	46	29	16
2010	61	43	21

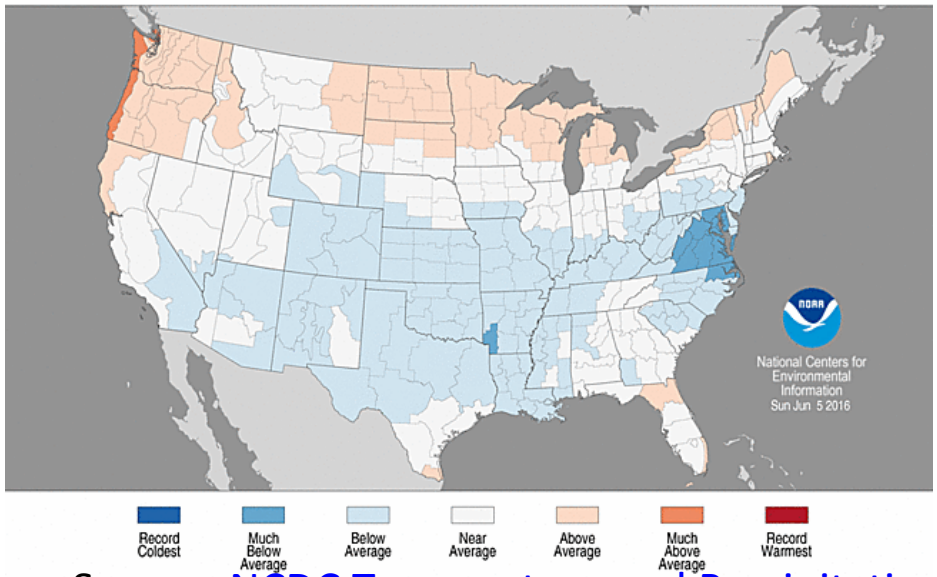
*Through August 31; Preliminary Data

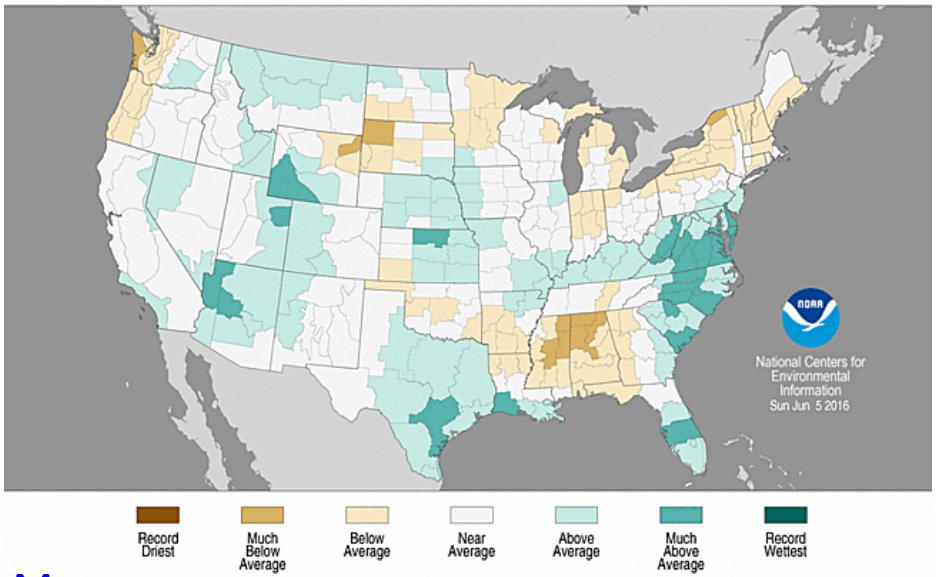
APRIL





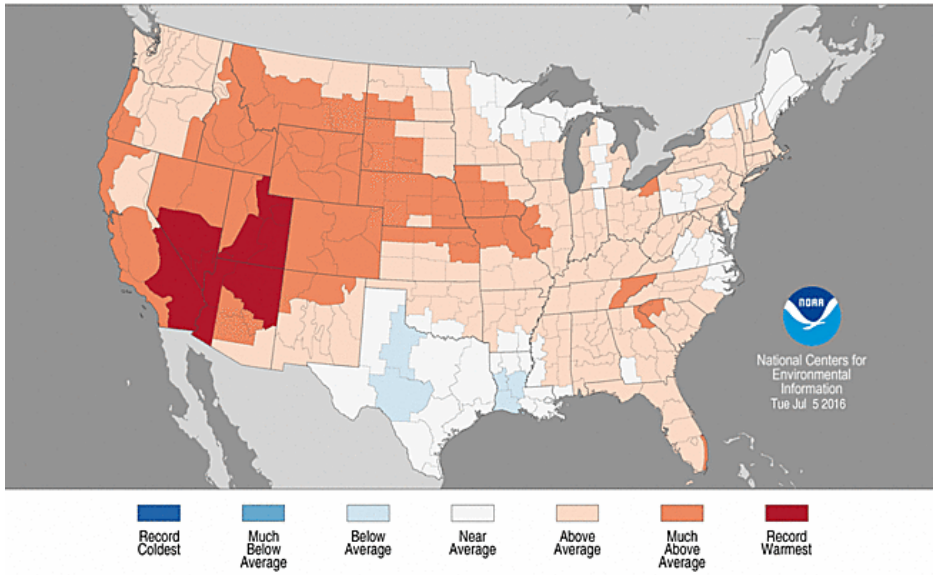
MAY

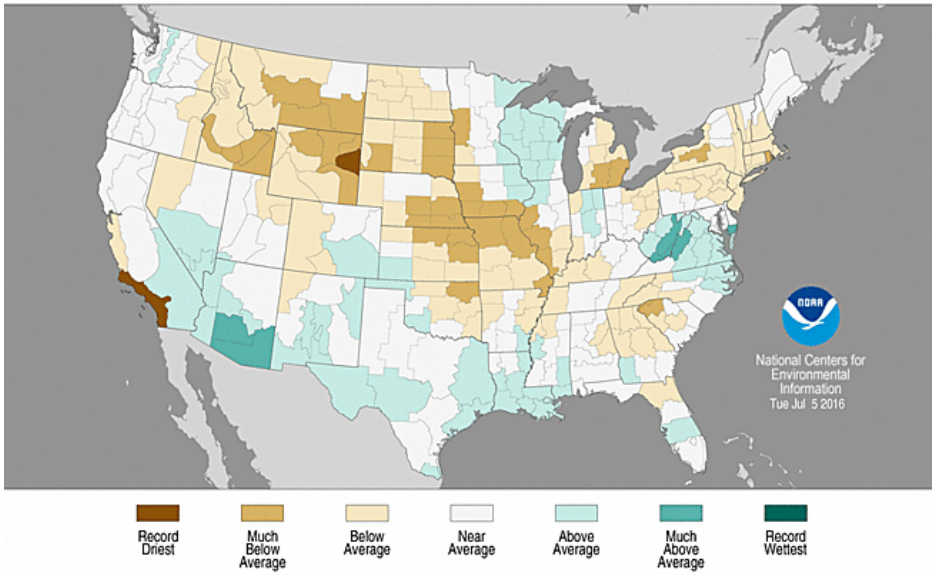




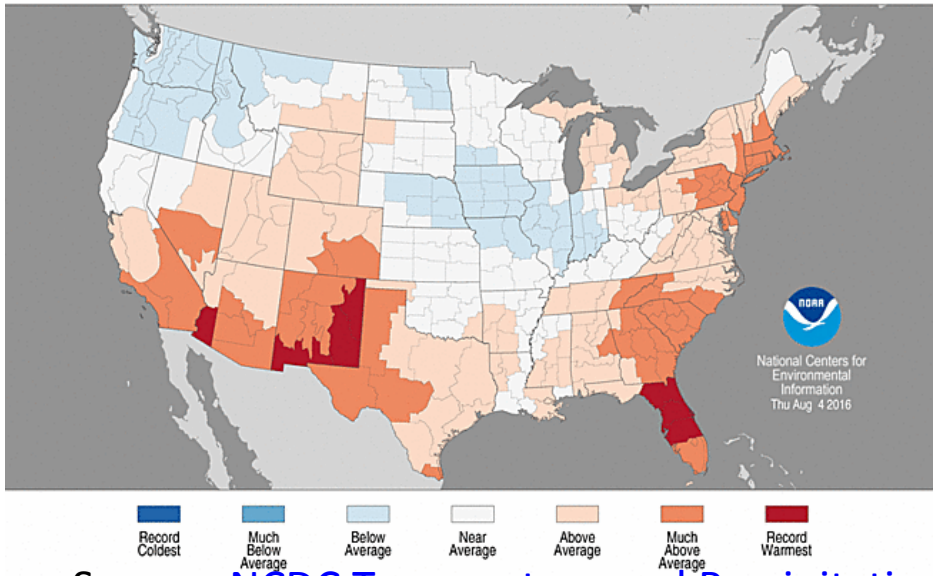
Source: [NCDC Temperature and Precipitation Maps]

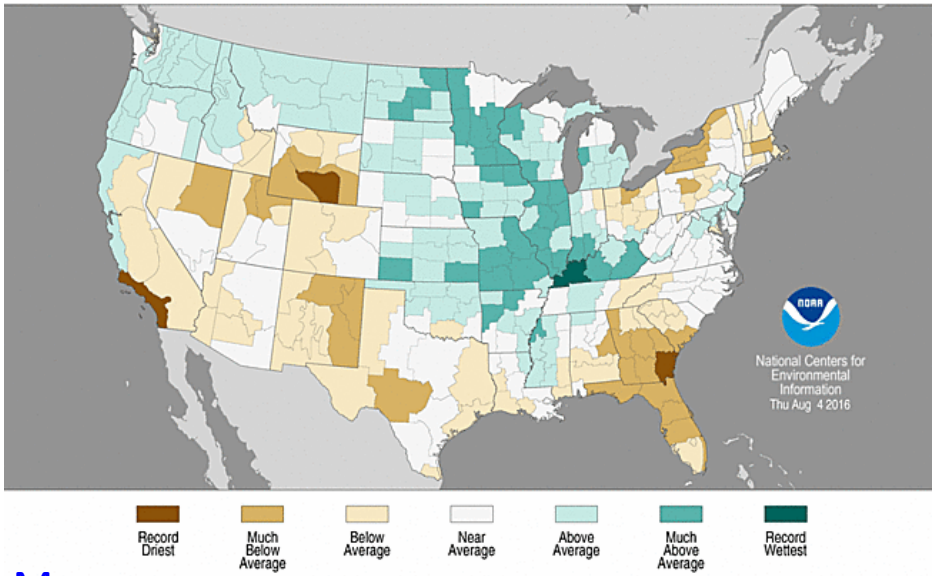
JUNE





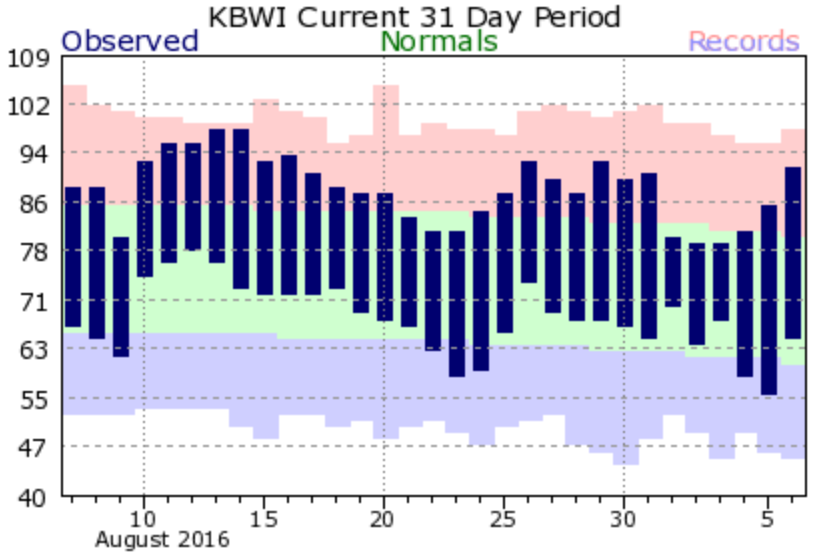
JULY





Source: [NCDC Temperature and Precipitation Maps]

AUGUST



Aug. Avg. Max T: 89.1
Normal: 85.1
Departure +4.0

Days >= 90: 14
Normal: 6.5
Departure: +7.5

THE MONTHLY AVERAGE TEMPERATURE WAS WELL ABOVE NORMAL...AND RANKED AS THE **SIXTH WARMEST AUGUST ON RECORD**

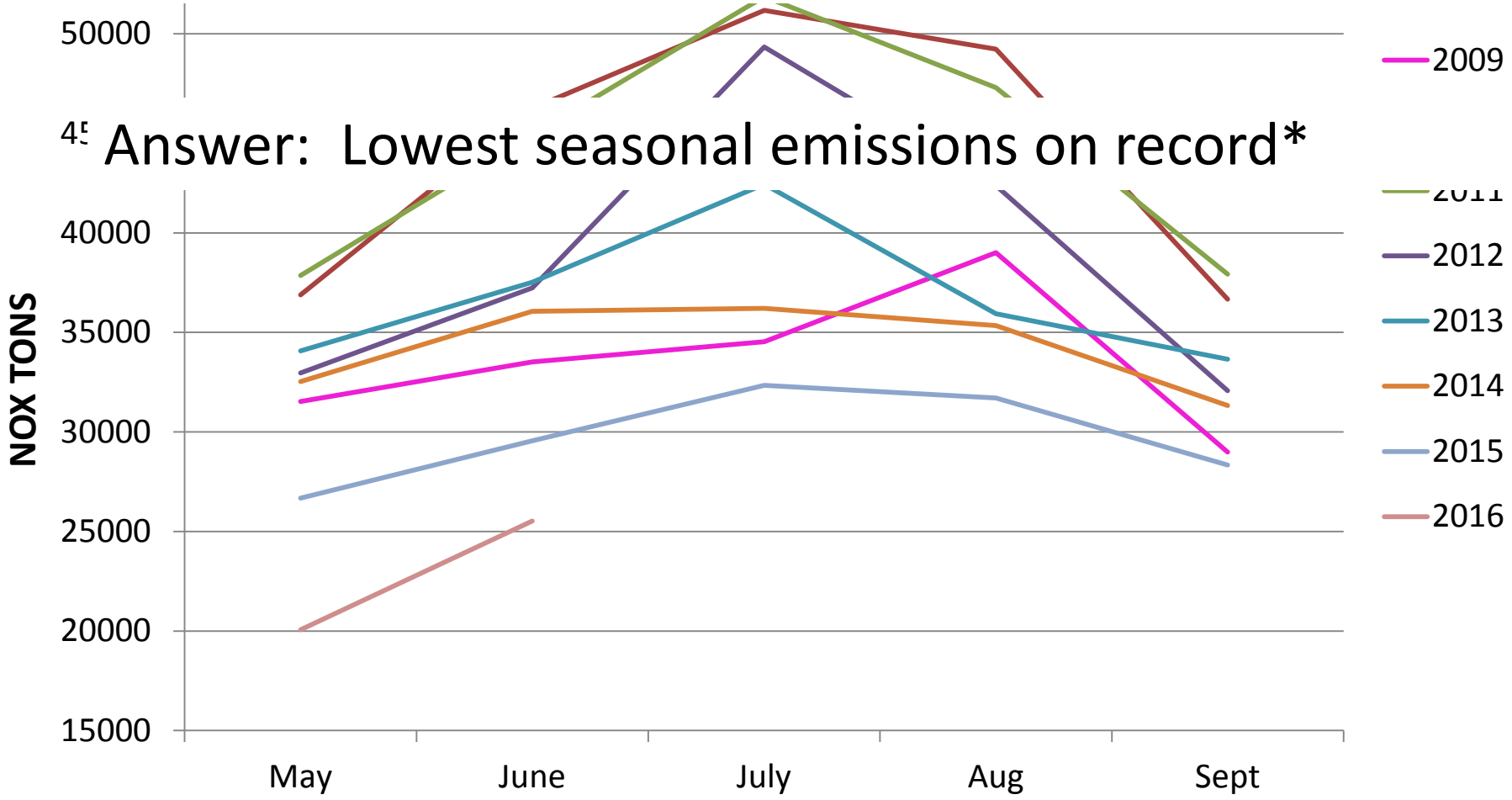
	Metropolitan Statistical Area (Group Number)																				Daily max 8-hour ozone conc. (ppb)
	1								2							3	4			5	6	
	Aldino	Edgewood	Essex	Furley	Hart Miller Island	Glen Burnie	Padonia	South Carroll	Calvert	PG Equest. Ctr.	Frederick Airport	Howard U.	Beltsville*	Rockville	So. Maryland	Fair Hill	Blackwater NWR*	Millington	Horn Point	Hagerstown	Piney Run	
2015 Design Value	70	71	68	65			71	67	68	69	67	68	69	68	66	73	66	69	64	65	64	
08/27/2016					**71**											**75**						**75**
08/29/2016			**74**		**74**	**82**																**82**
08/31/2016	**72**						**73**															**73**

Source: NCDC Temperature and Precipitation Maps, NWS Sterling

Monthly CAMD Emissions from:

Why did a warmer than normal season not translate to "seasonal average" Ozone exceedances?

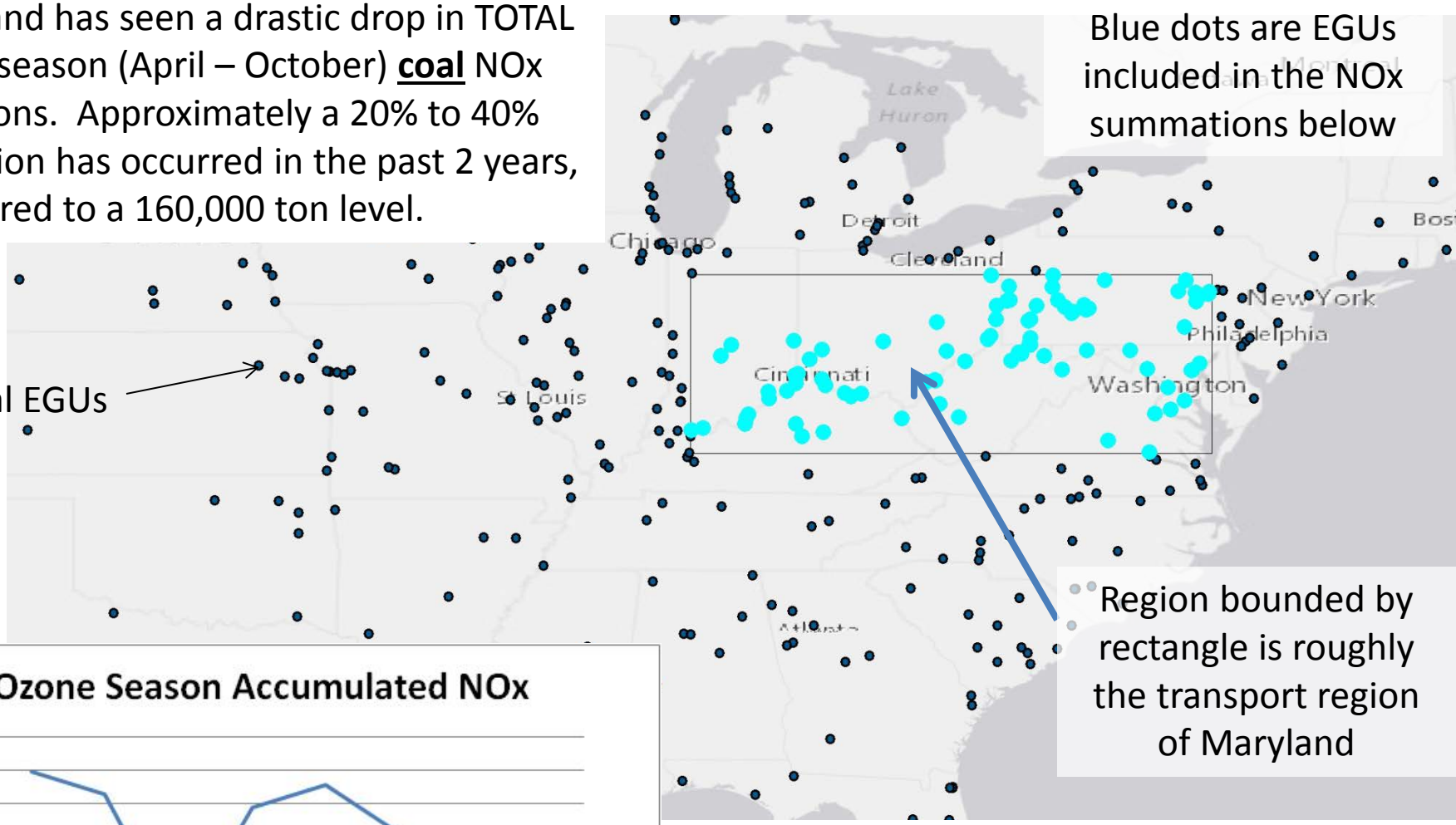
Answer: Lowest seasonal emissions on record*

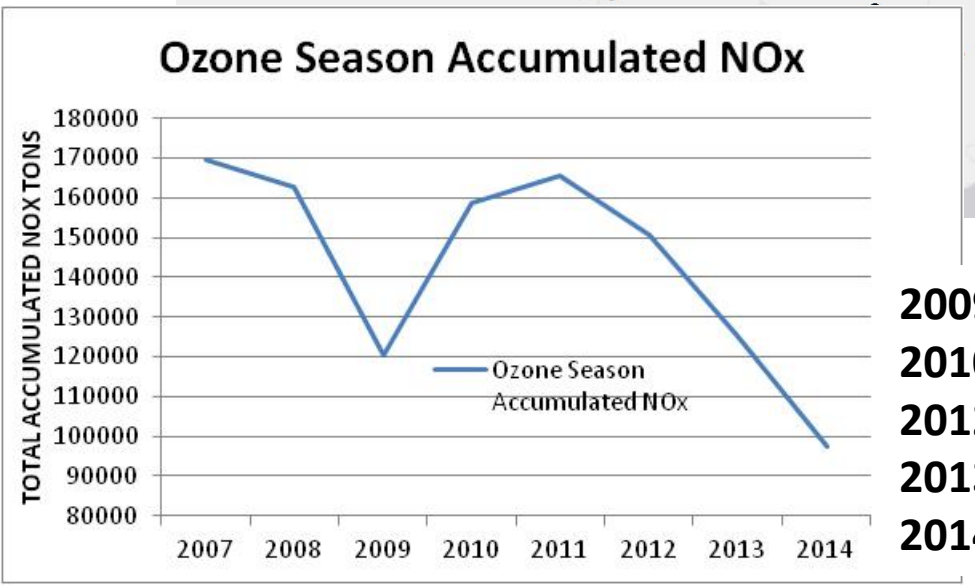


Emissions of Indiana, Ohio, West Virginia, Virginia, Pennsylvania, Maryland and

*Based on available emissions from May and June, 2016

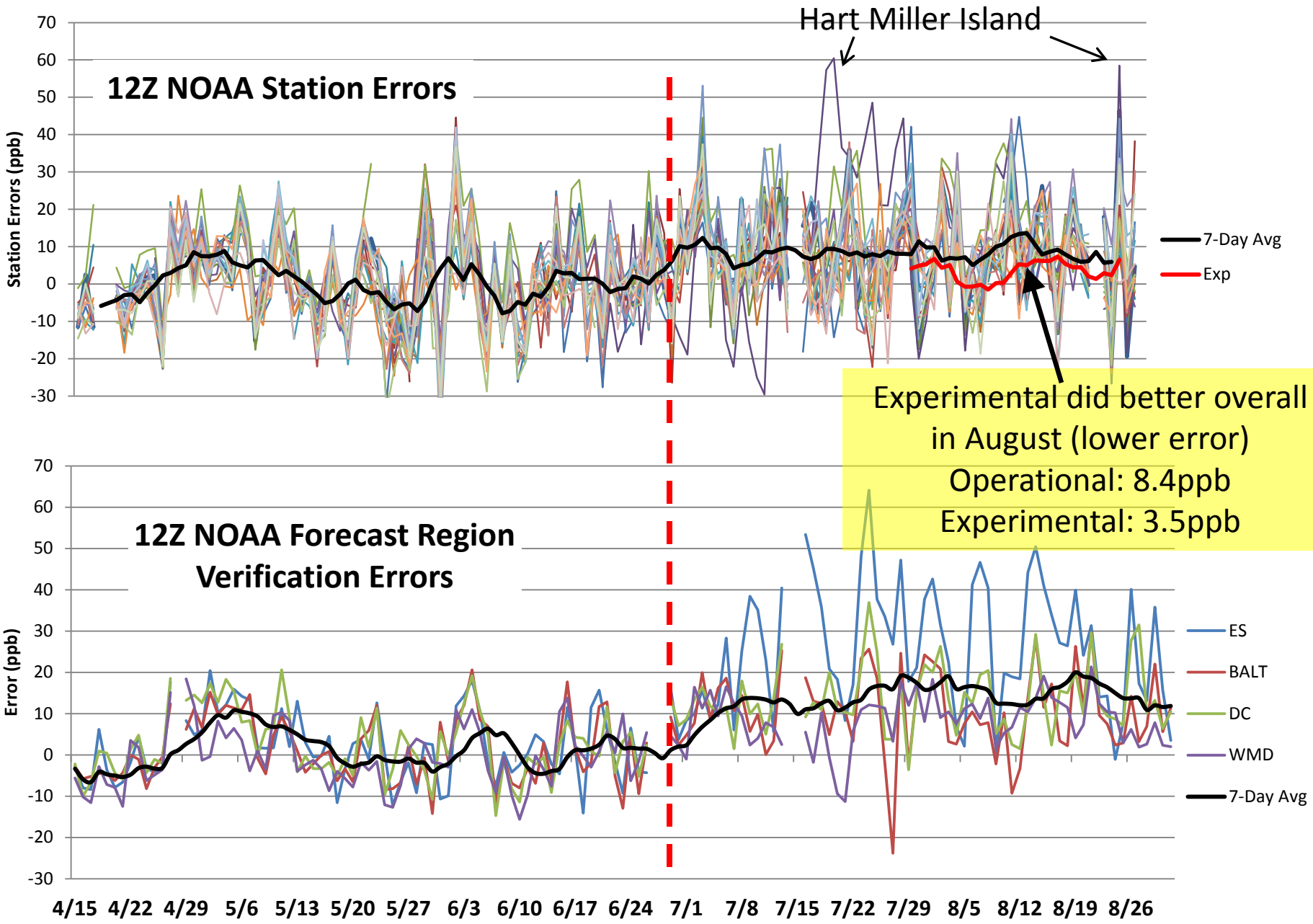
Source region for NOx transport in to Maryland has seen a drastic drop in TOTAL ozone season (April – October) **coal** NOx emissions. Approximately a 20% to 40% reduction has occurred in the past 2 years, compared to a 160,000 ton level.



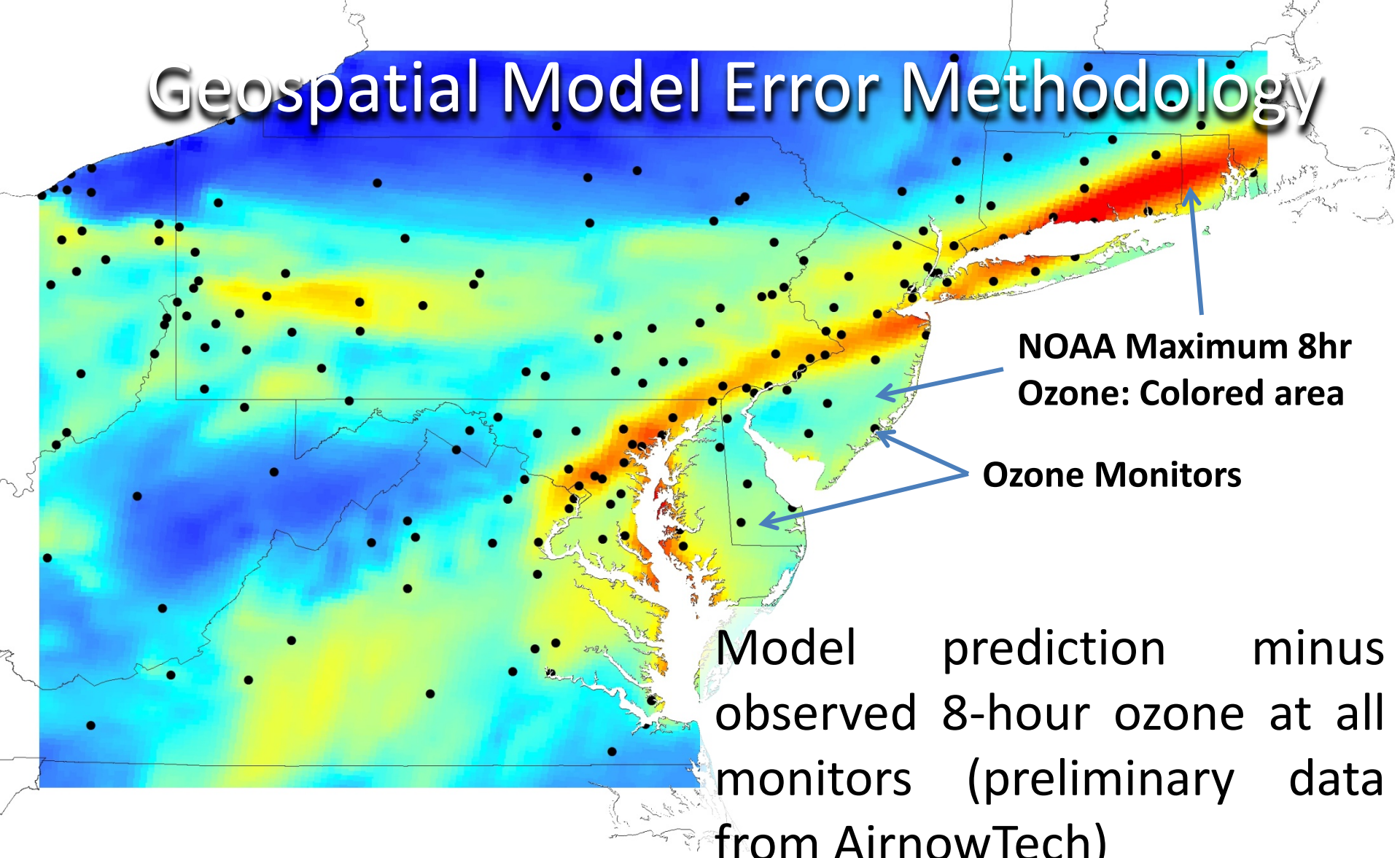


2009: 45135 fewer NOx tons emitted than in 2011
2010: 7011 fewer NOx tons emitted than in 2011
2012: 14830 fewer NOx tons emitted than in 2011
2013: 40462 fewer NOx tons emitted than in 2011
2014: 67983 fewer NOx tons emitted than in 2011

NOAA DAY-2 MARYLAND ERRORS (Model - Observations)



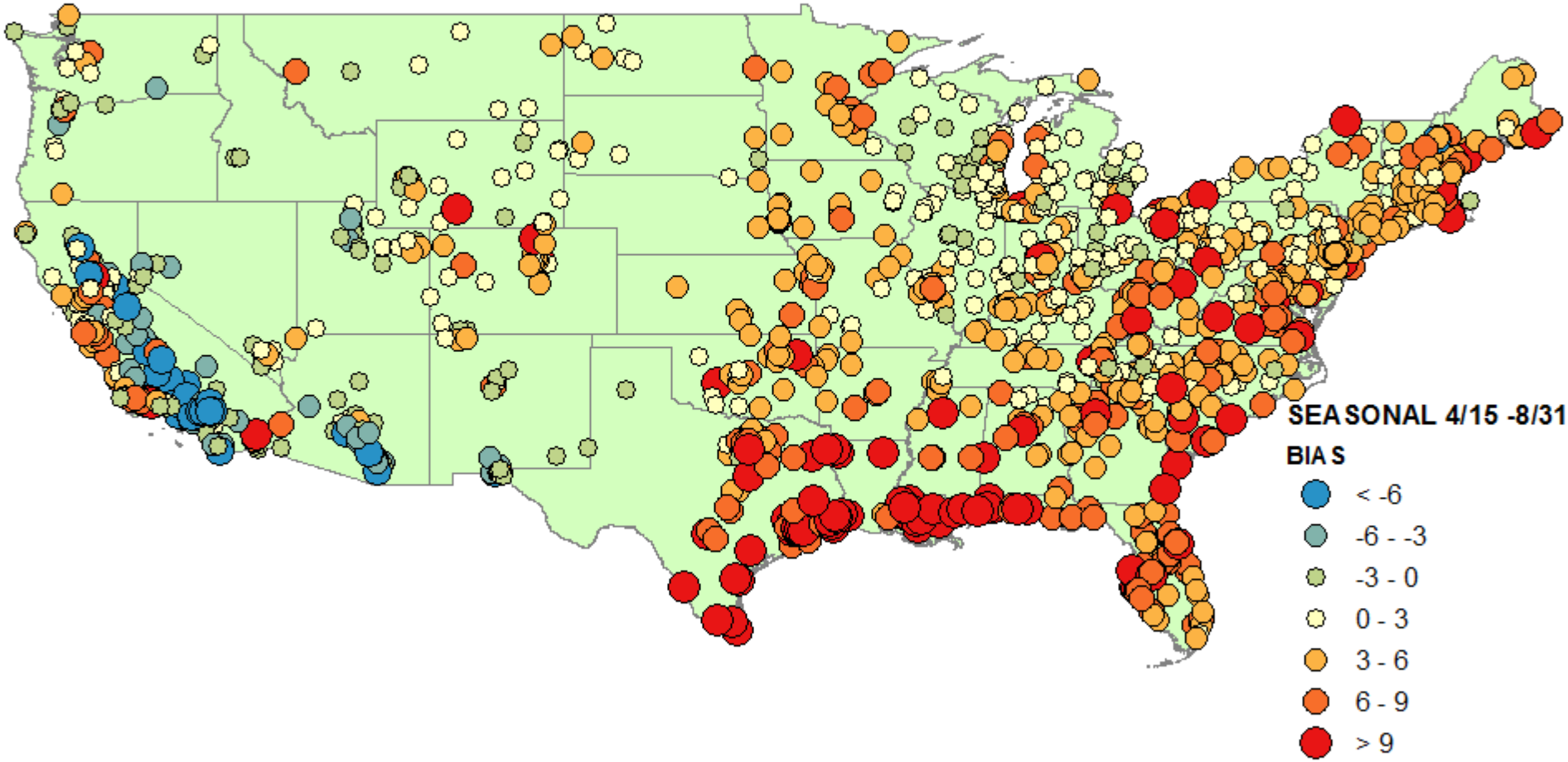
Geospatial Model Error Methodology



Model prediction minus observed 8-hour ozone at all monitors (preliminary data from AirnowTech)

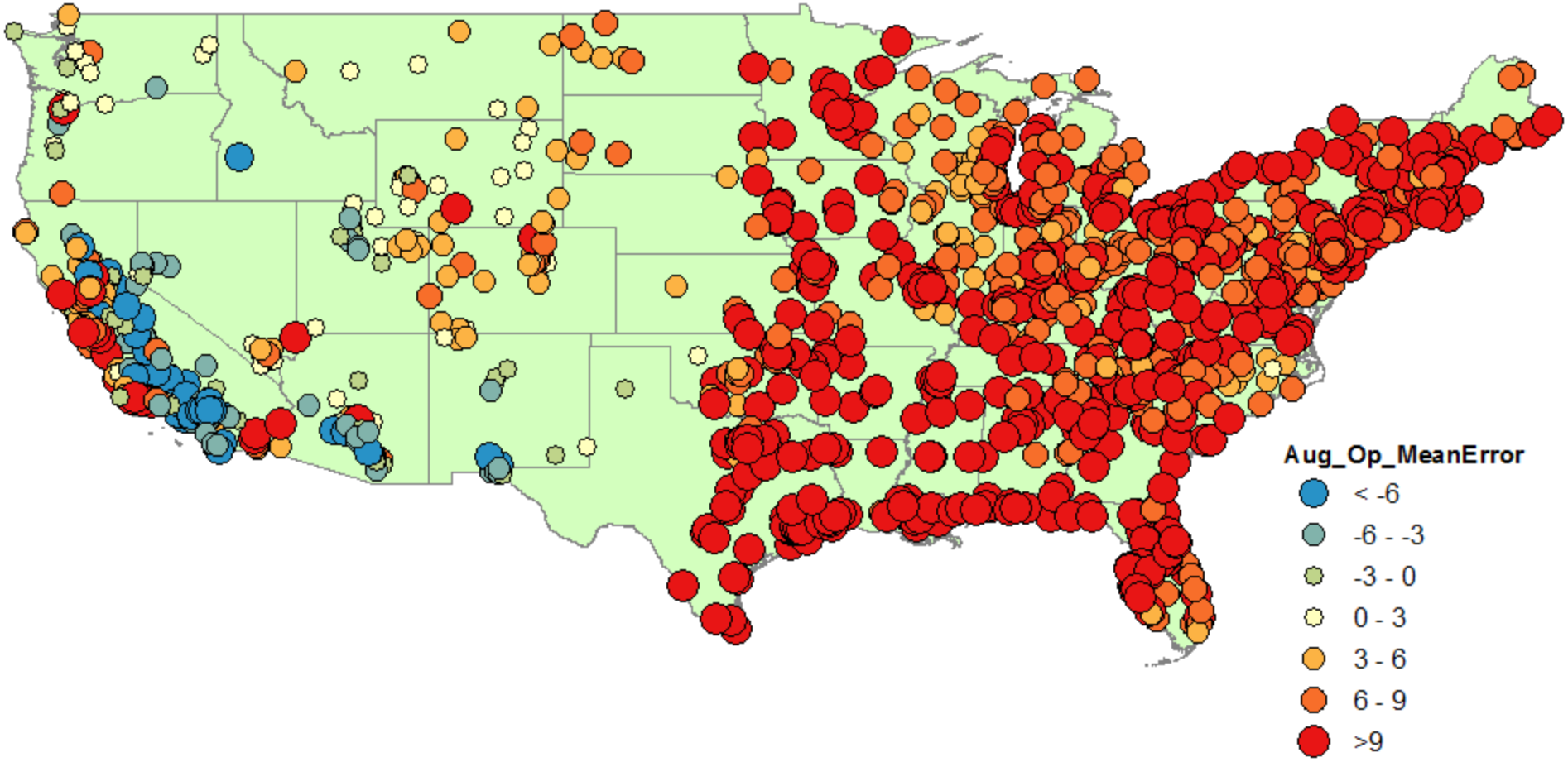
Seasonal BIAS – 8hr Ozone

Operational



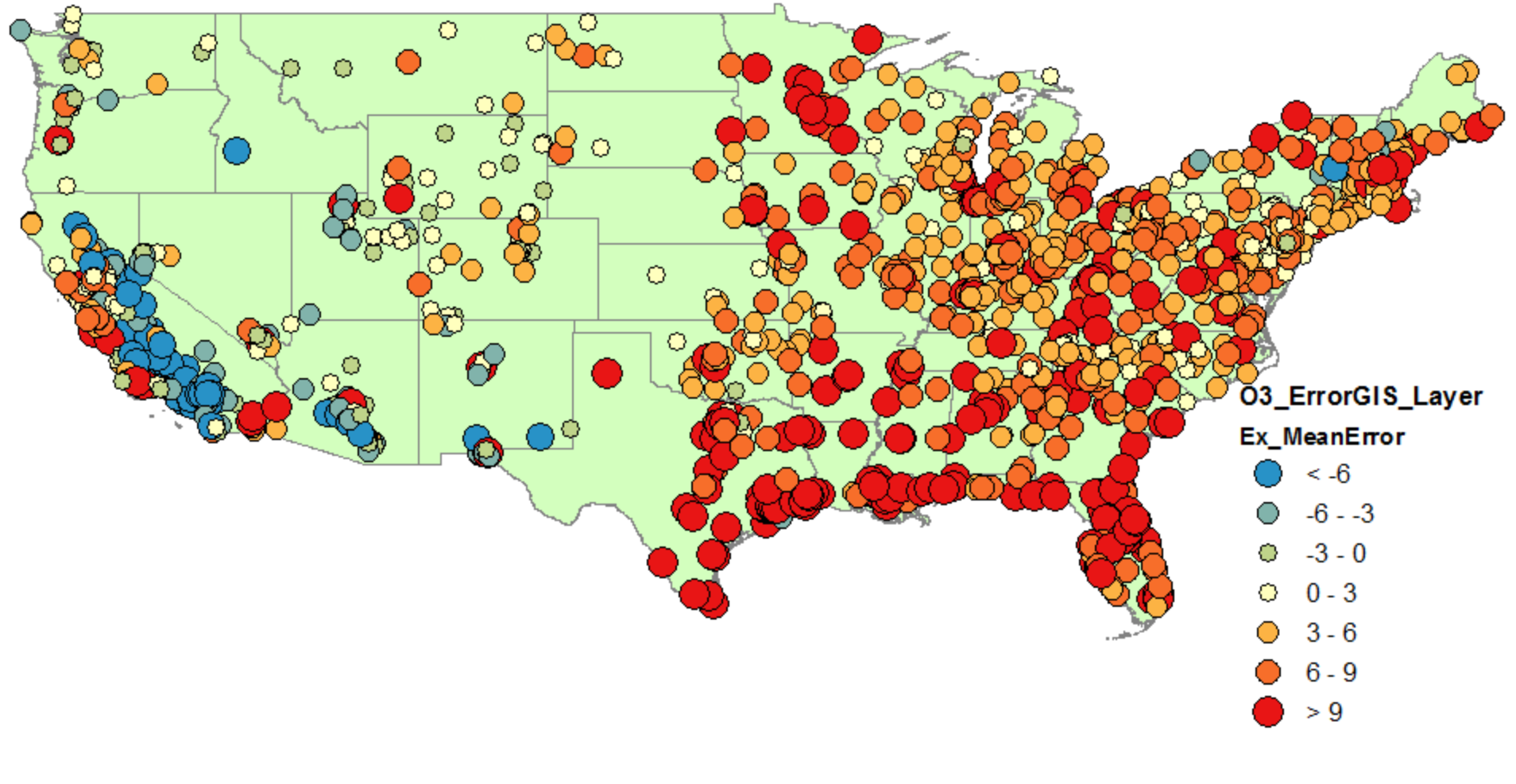
August BIAS – 8hr Ozone

Operational



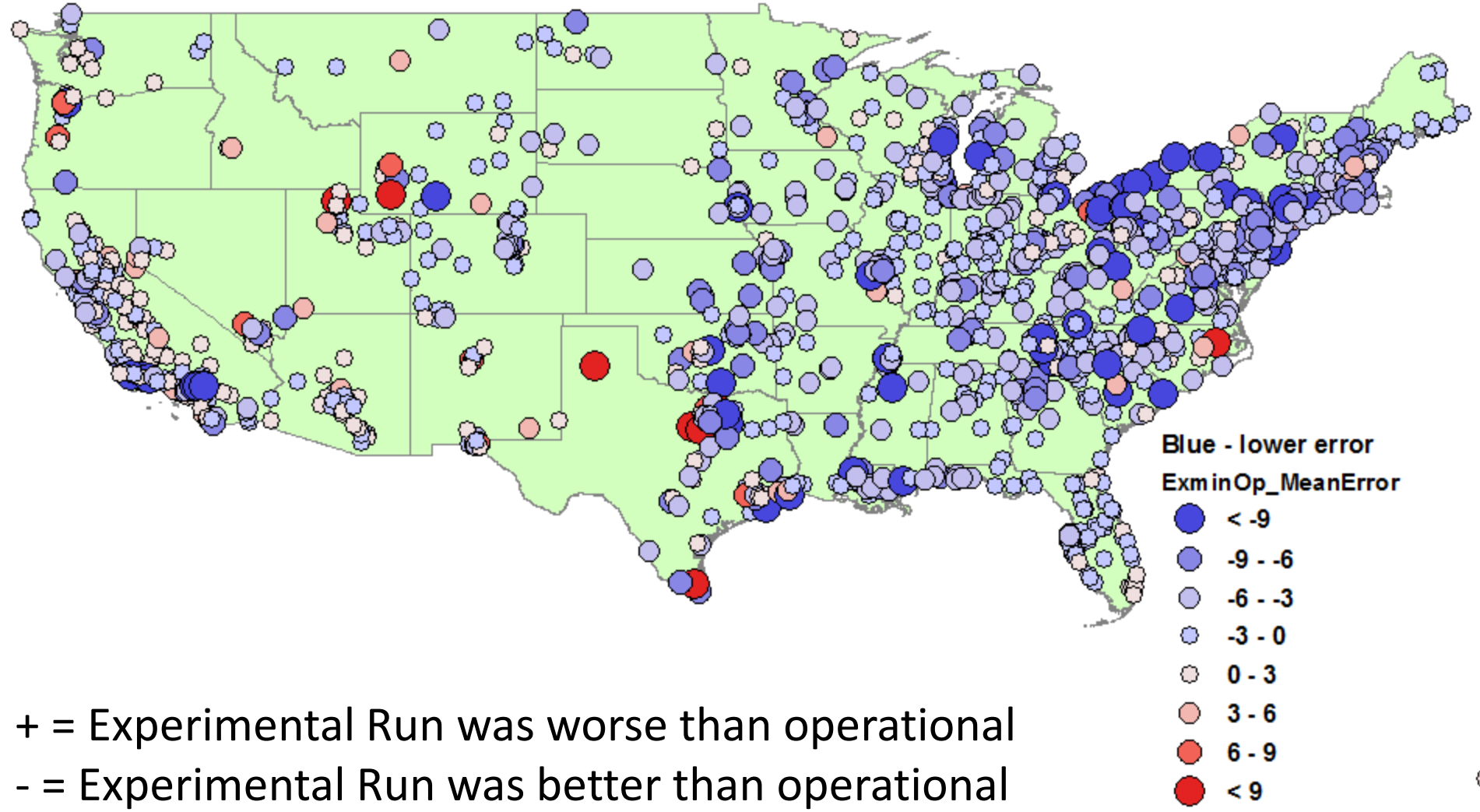
August BIAS – 8hr Ozone

Experimental



August BIAS – 8hr Ozone

Improvement between Experimental & Operational

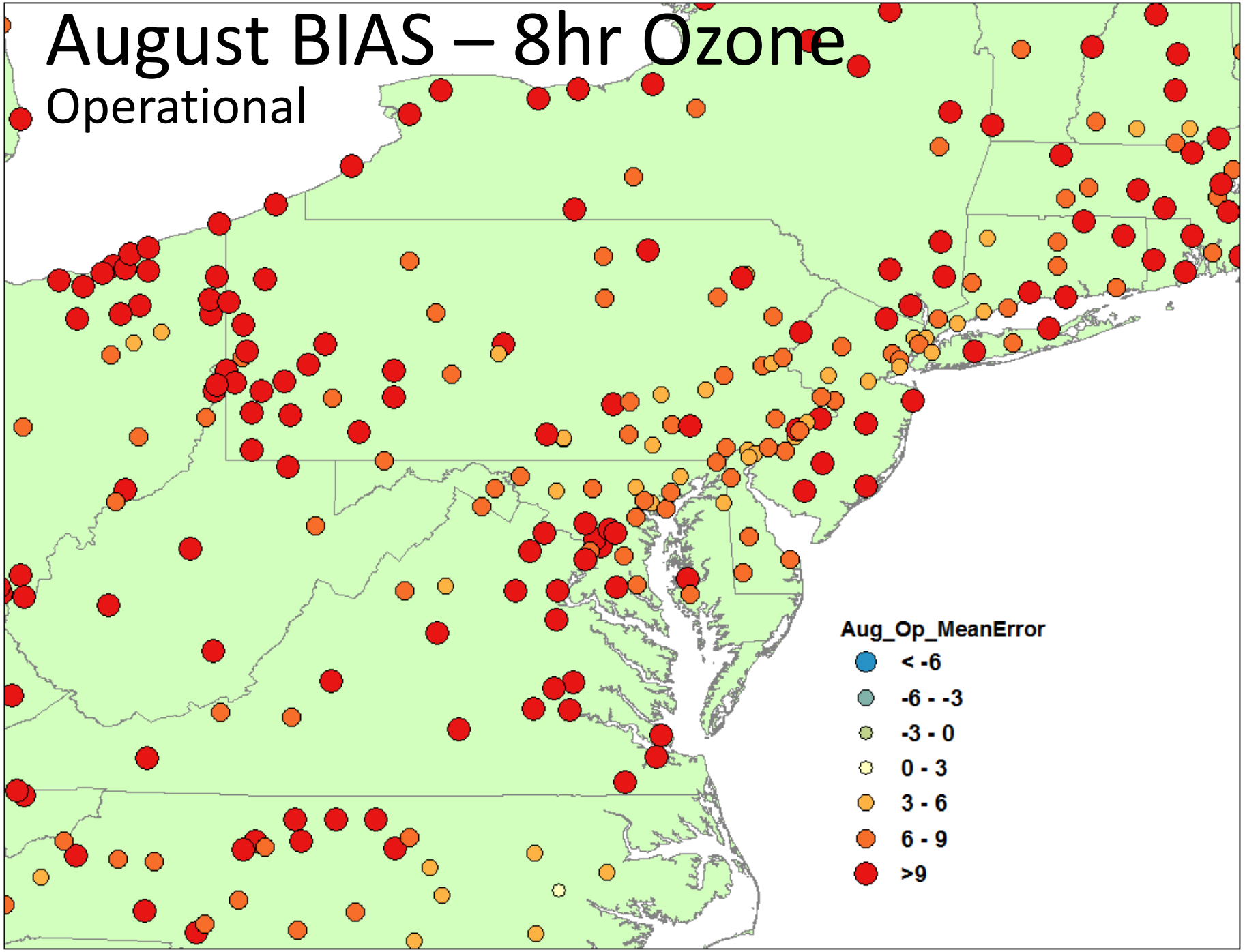


+ = Experimental Run was worse than operational

- = Experimental Run was better than operational

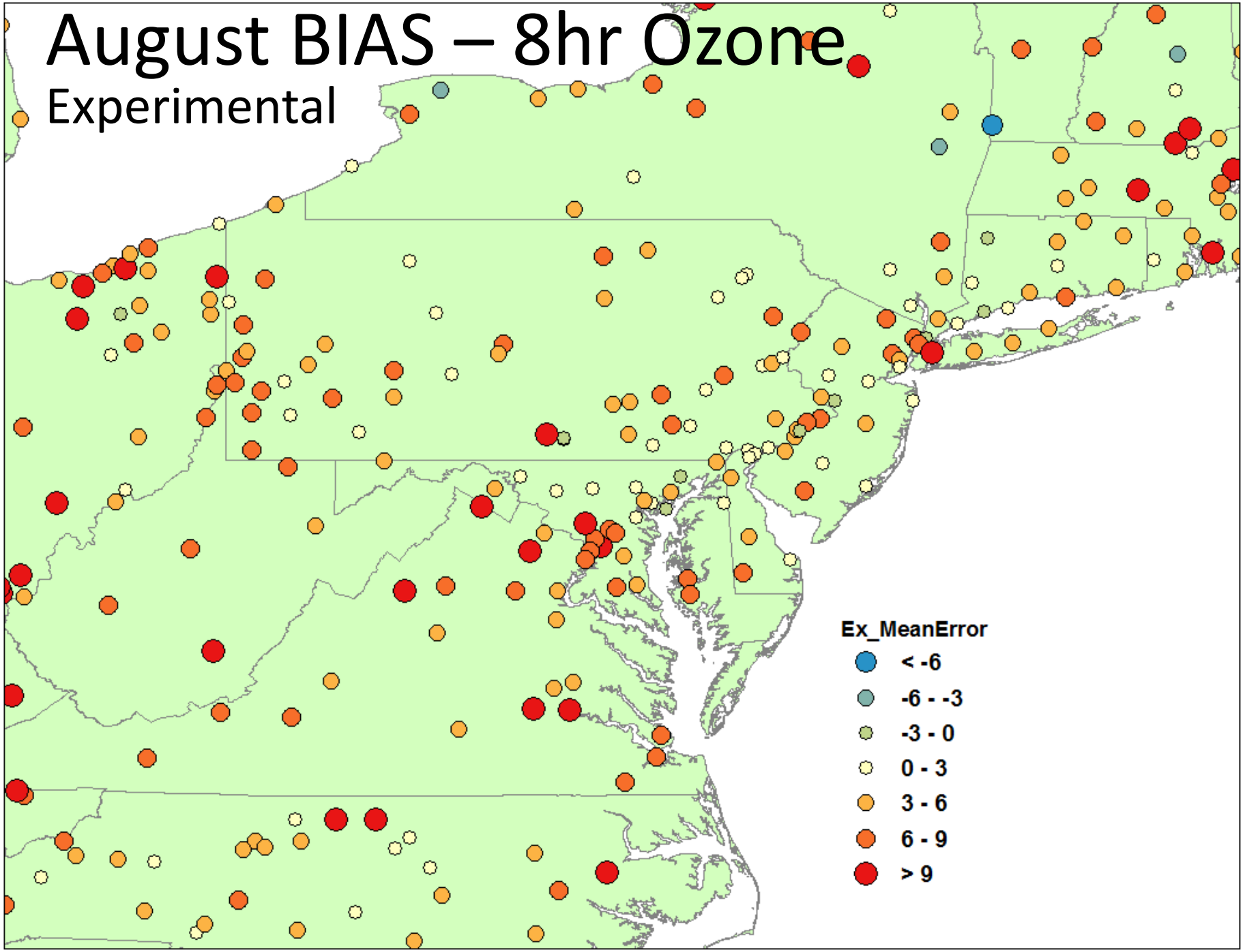
August BIAS – 8hr Ozone

Operational



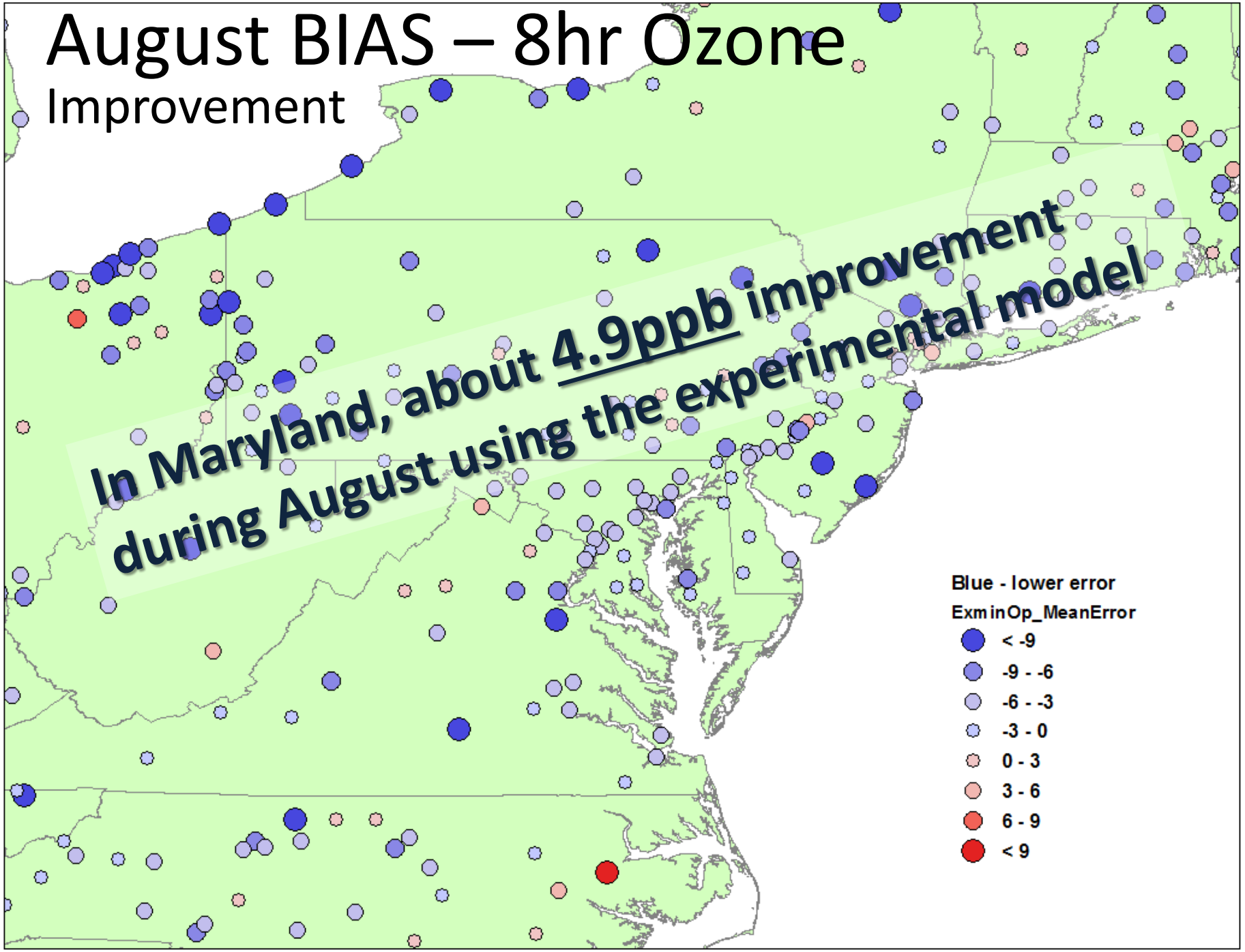
August BIAS – 8hr Ozone

Experimental



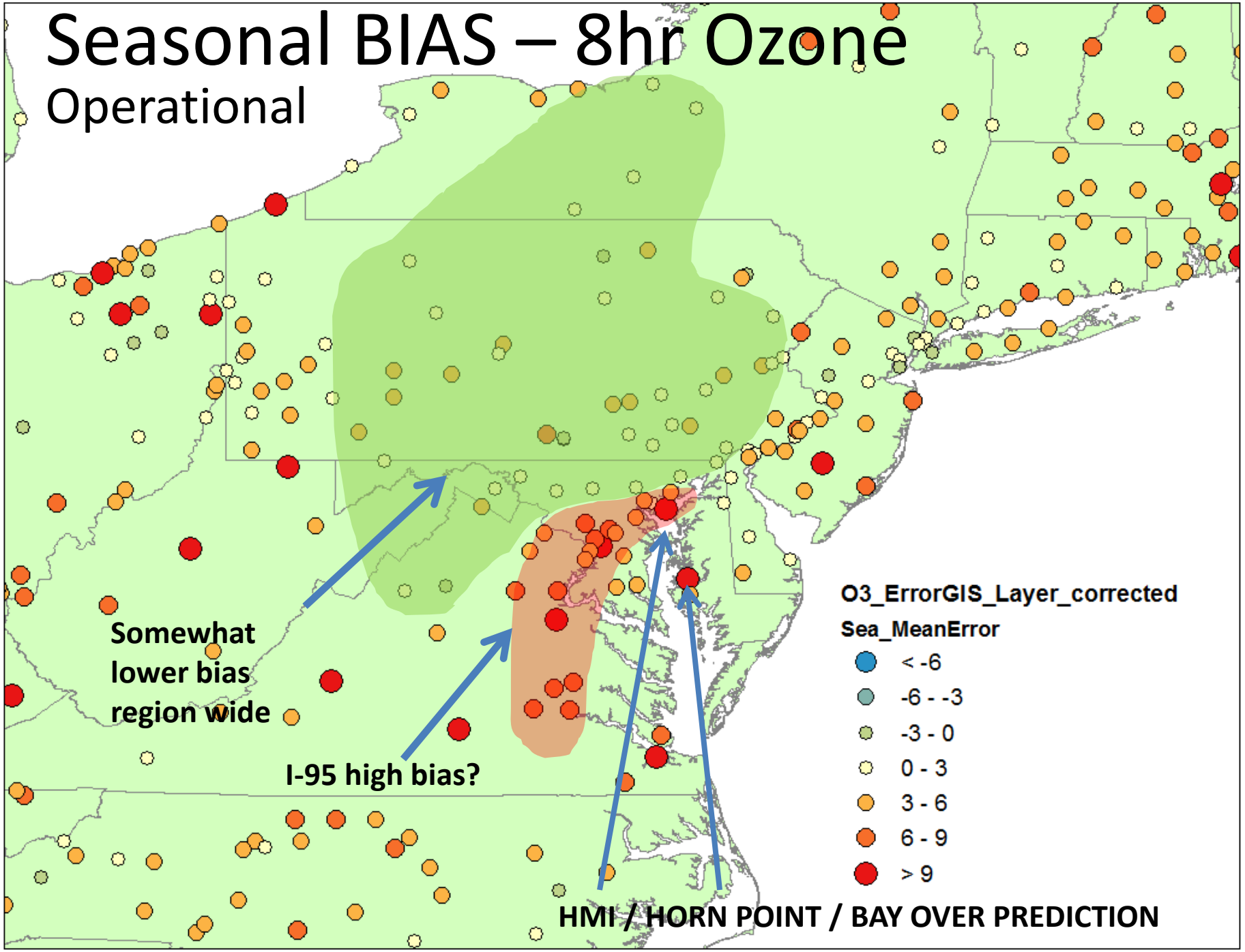
August BIAS – 8hr Ozone

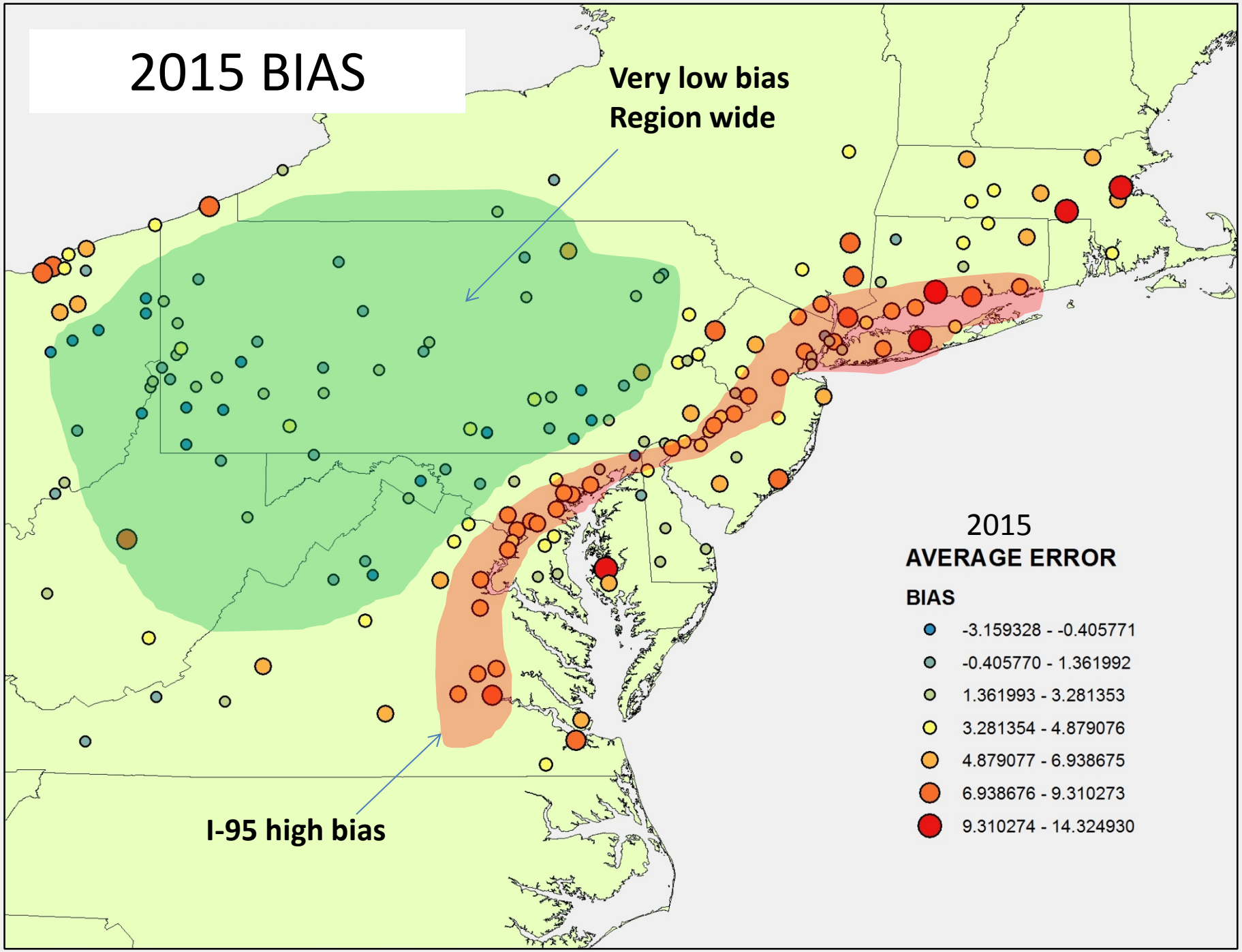
Improvement



Seasonal BIAS – 8hr Ozone

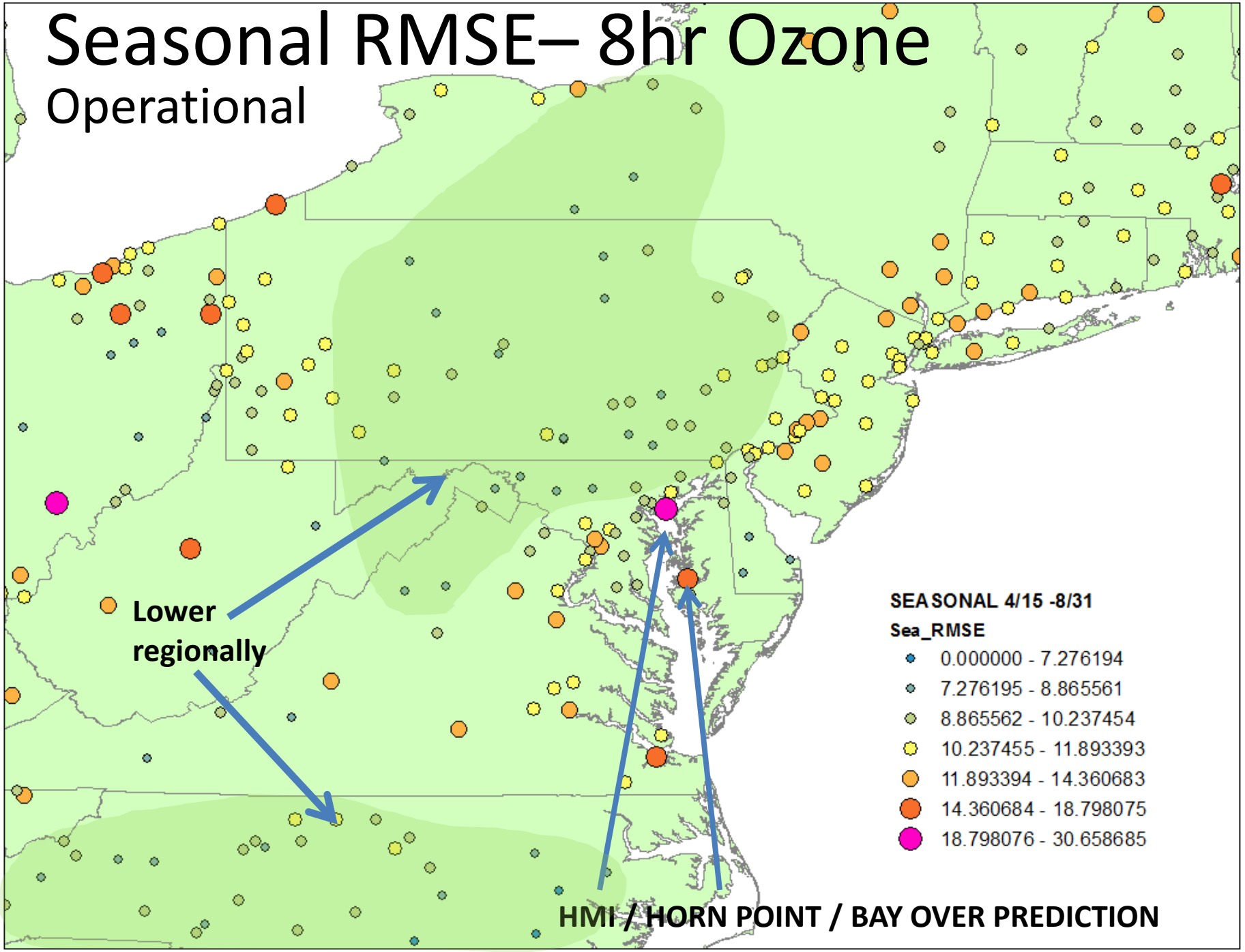
Operational



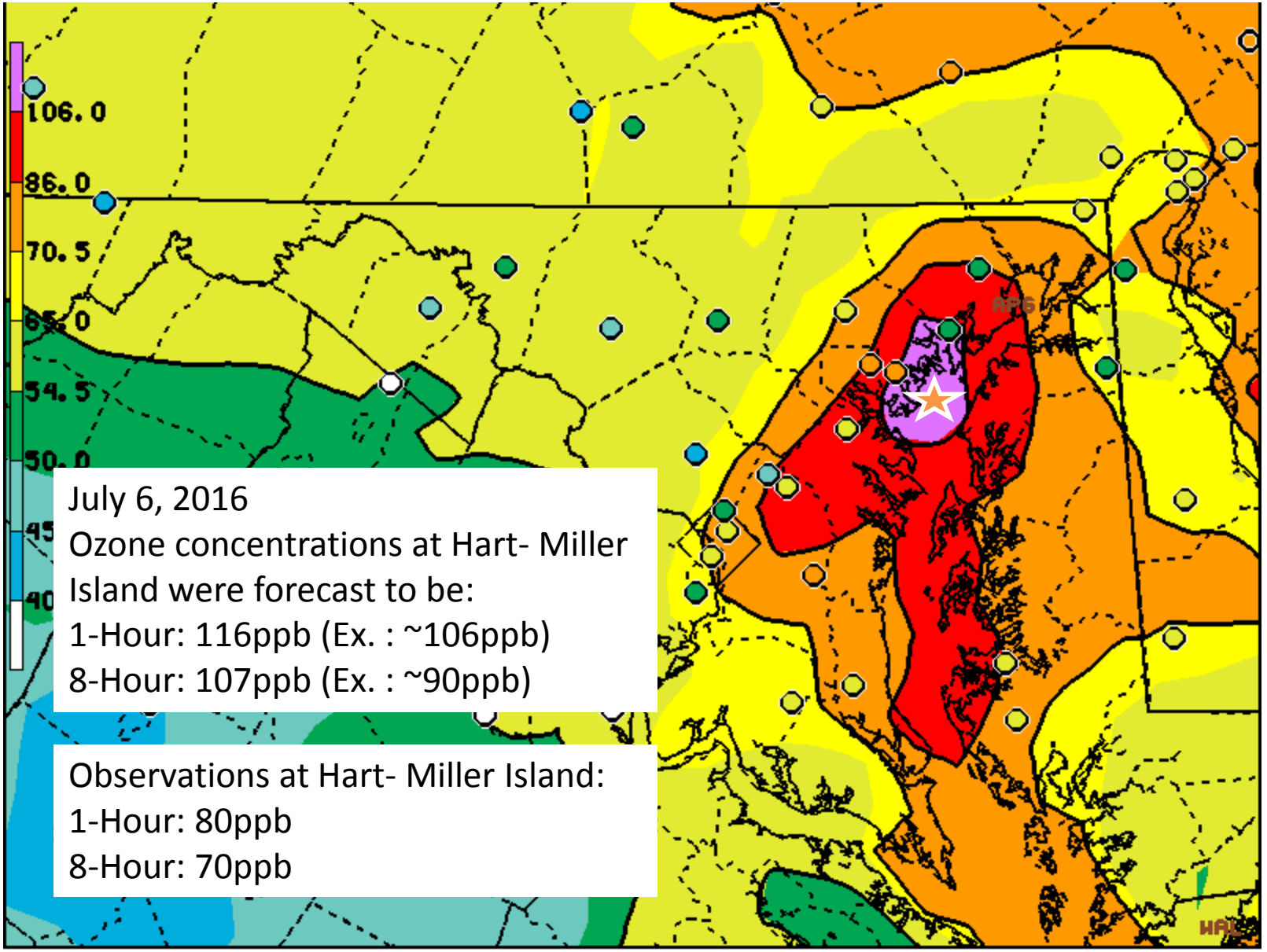

2015 BIAS
Very low bias
Region wide
I-95 high bias
2015
AVERAGE ERROR
BIAS
-3.159328 - -0.405771
-0.405770 - 1.361992
1.361993 - 3.281353
3.281354 - 4.879076
4.879077 - 6.938675
6.938676 - 9.310273
9.310274 - 14.324930

Seasonal RMSE– 8hr Ozone

Operational

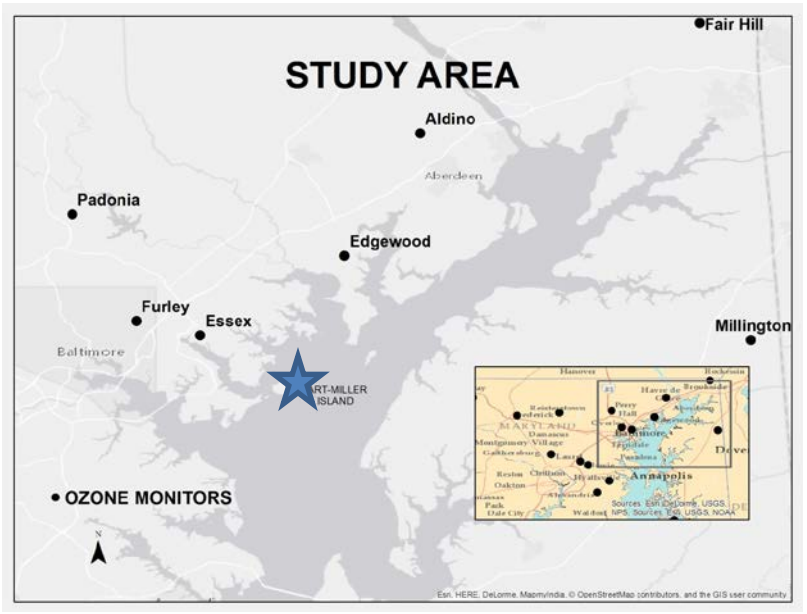


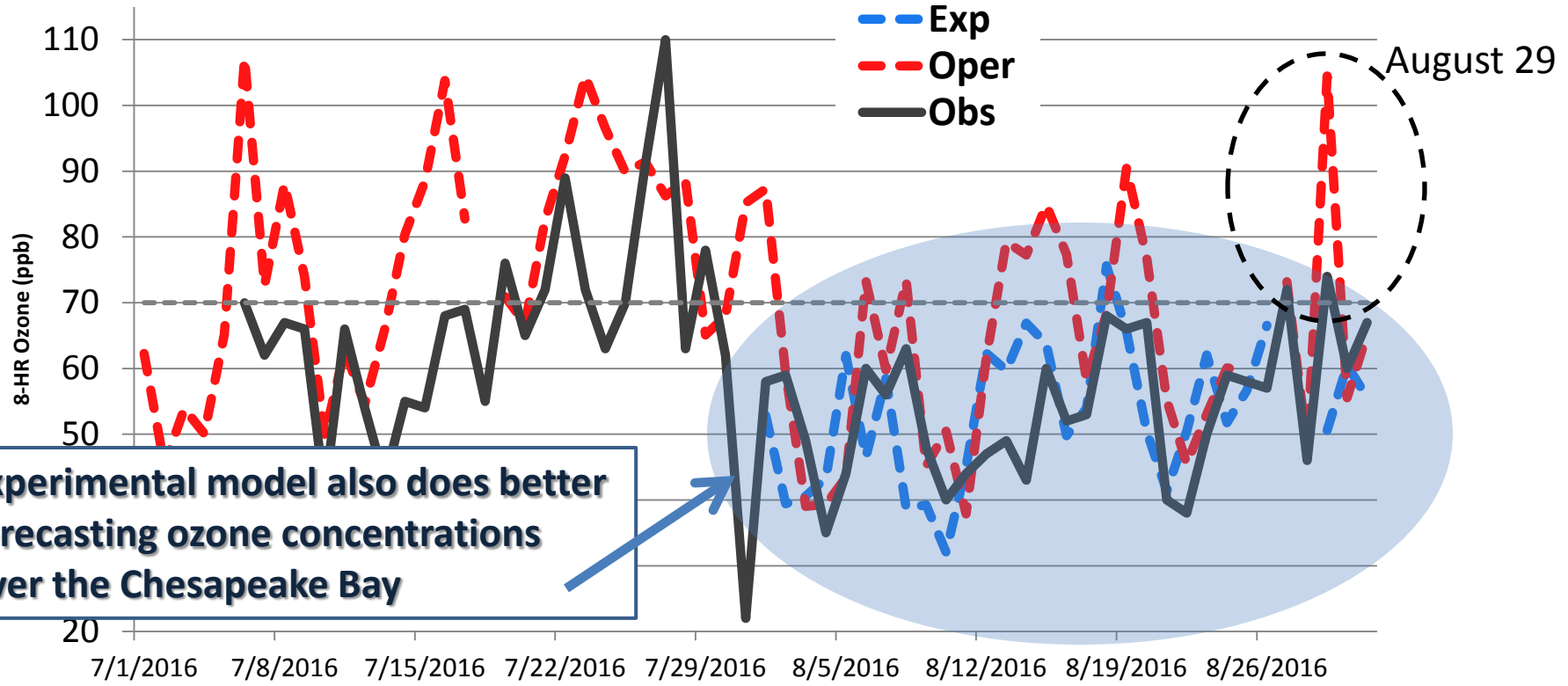
HART-MILLER ISLAND[1]



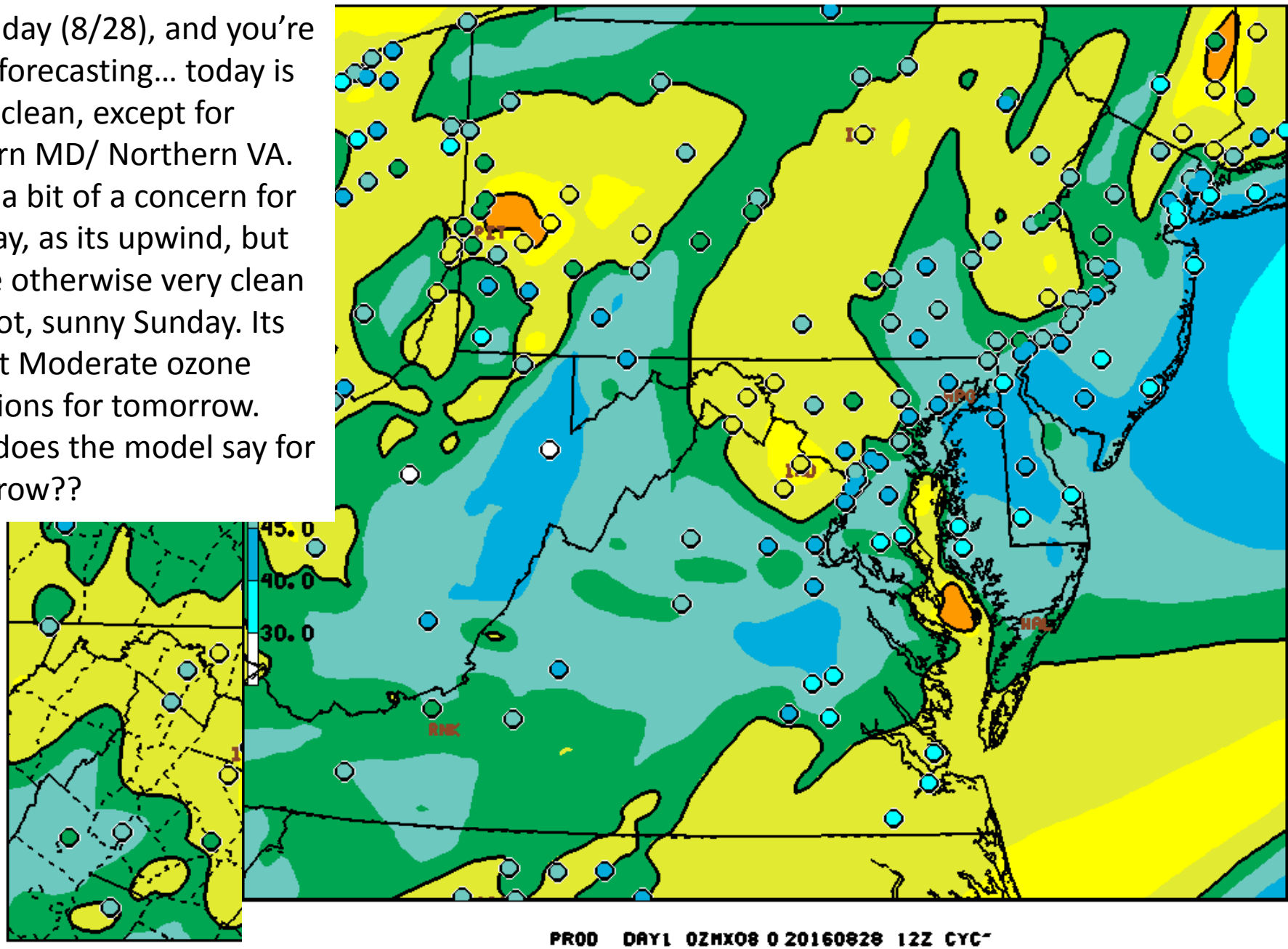
[1]This was a special purpose monitor

Hart-Miller Island





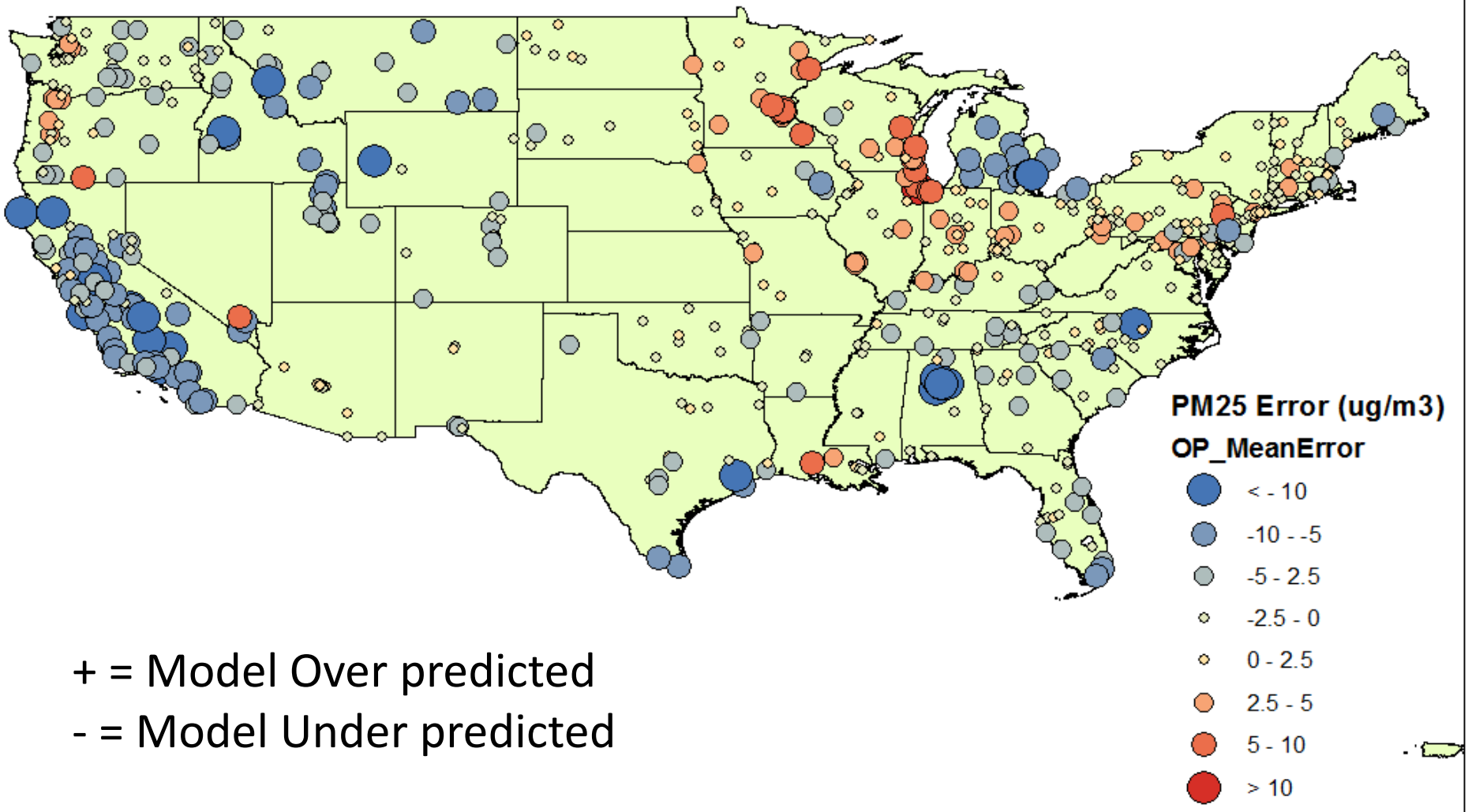
Its Sunday (8/28), and you're home forecasting… today is pretty clean, except for Western MD/ Northern VA. This is a bit of a concern for Monday, as its upwind, but we are otherwise very clean on a hot, sunny Sunday. Its at least Moderate ozone conditions for tomorrow. What does the model say for tomorrow??



* Through Aug 31 PROD DAY1 OZMX

August BIAS – 24hr PM2.5

Operational

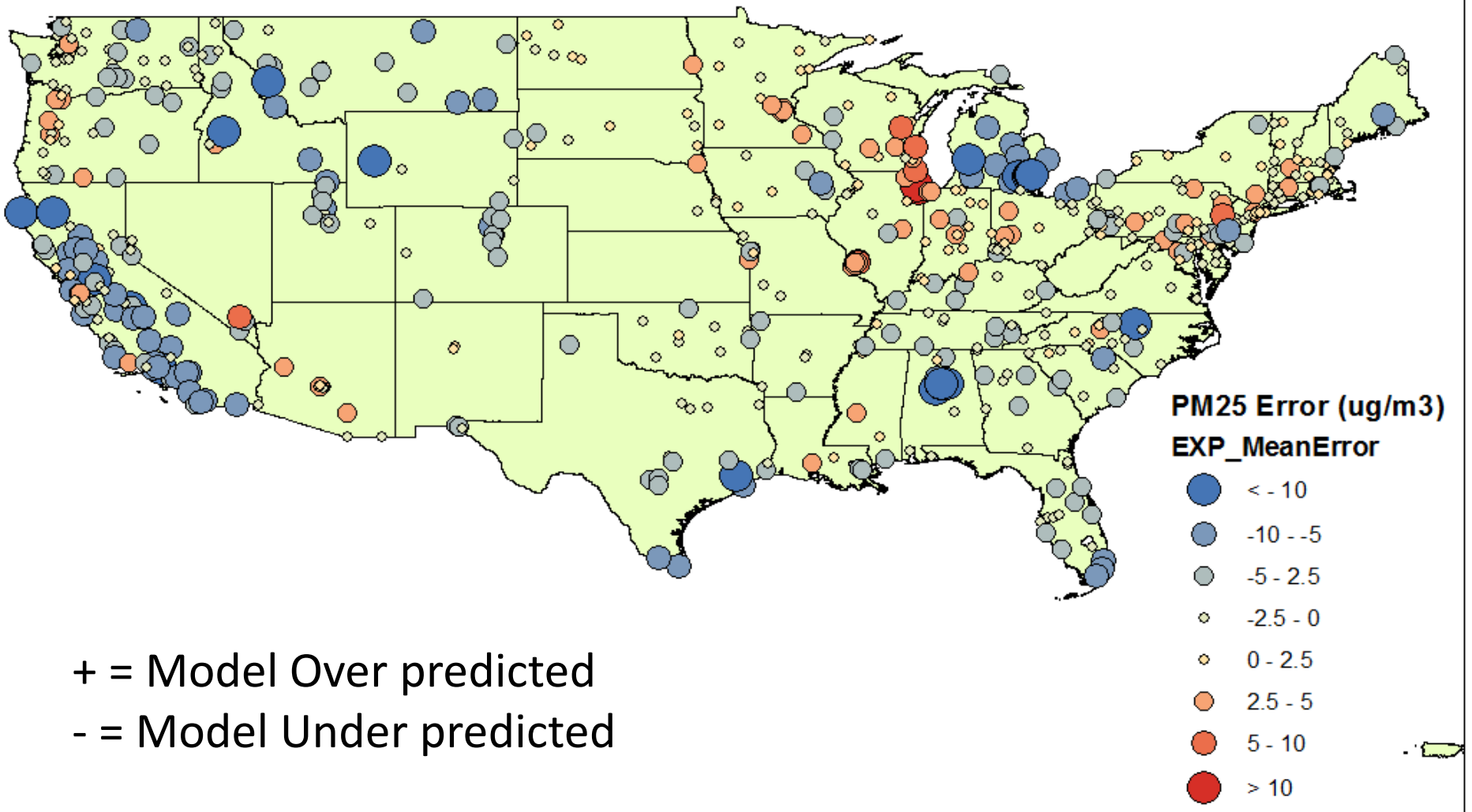


+ = Model Over predicted

- = Model Under predicted

August BIAS – 24hr PM2.5

Experimental



+ = Model Over predicted

- = Model Under predicted

August BIAS – 24hr PM2.5

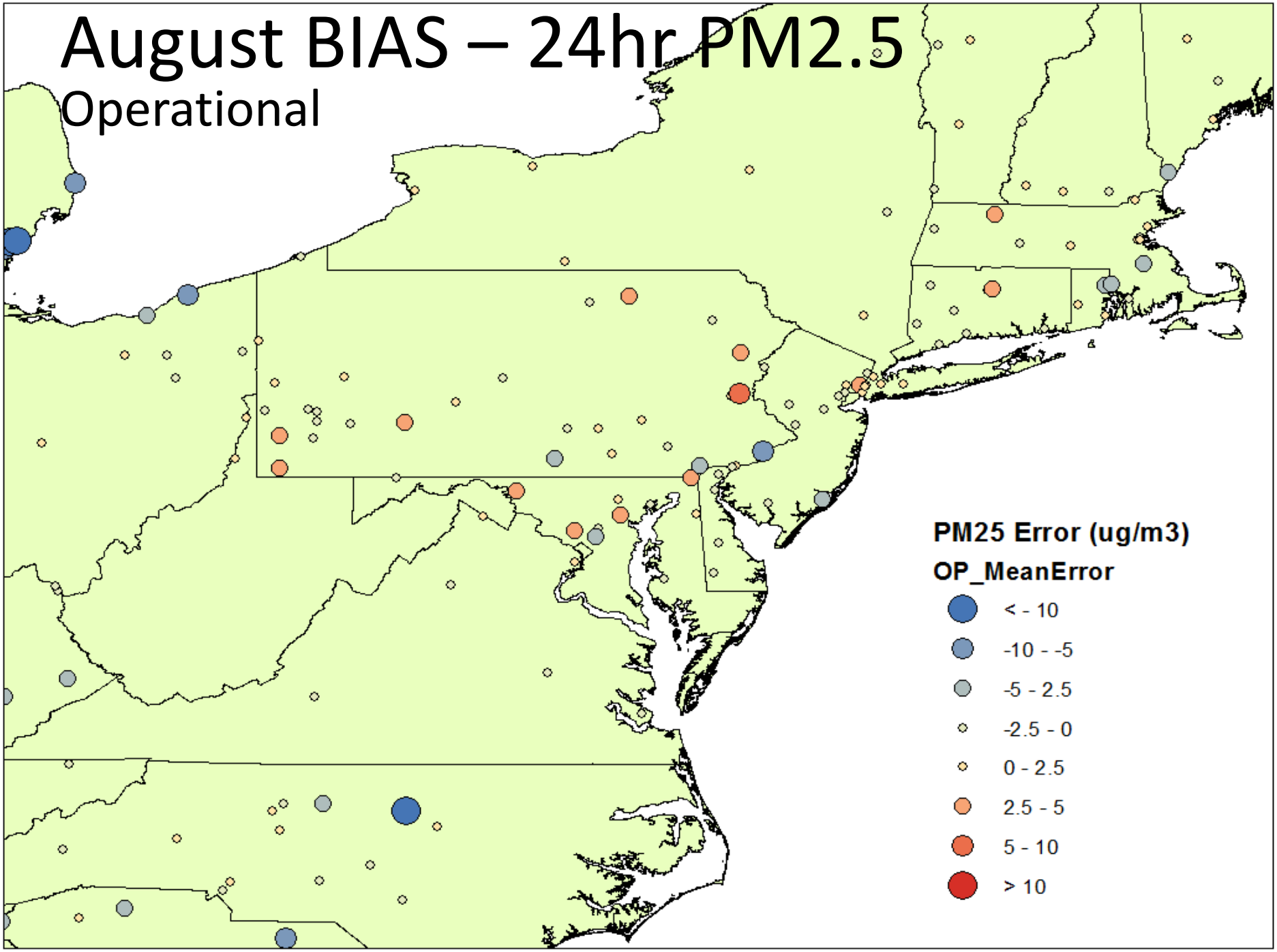
Improvement between Experimental & Operational

\+ = Experimental Run Was Worse than Operational

\- = Experimental Run was Better than Operational

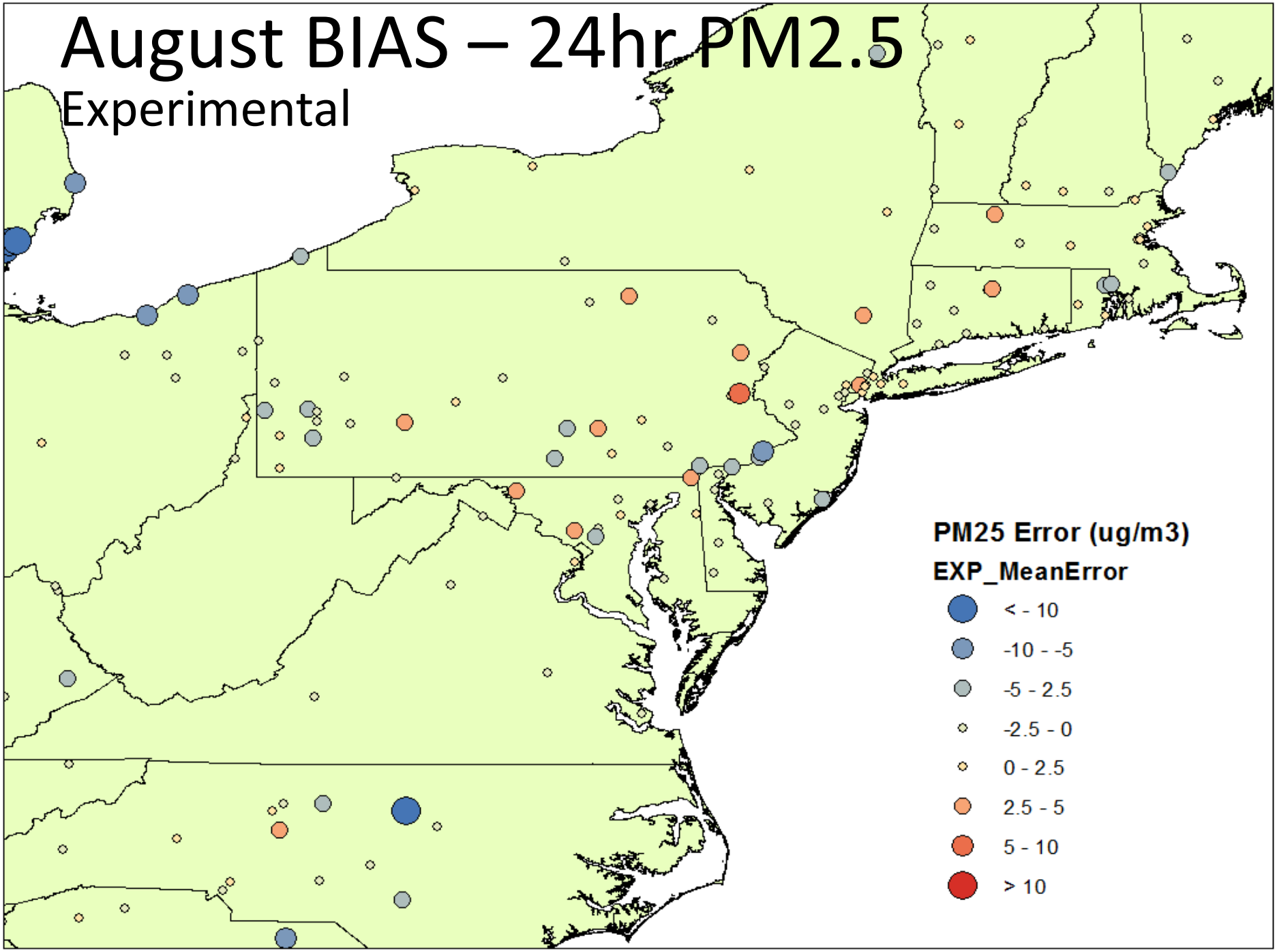
August BIAS – 24hr PM2.5

Operational



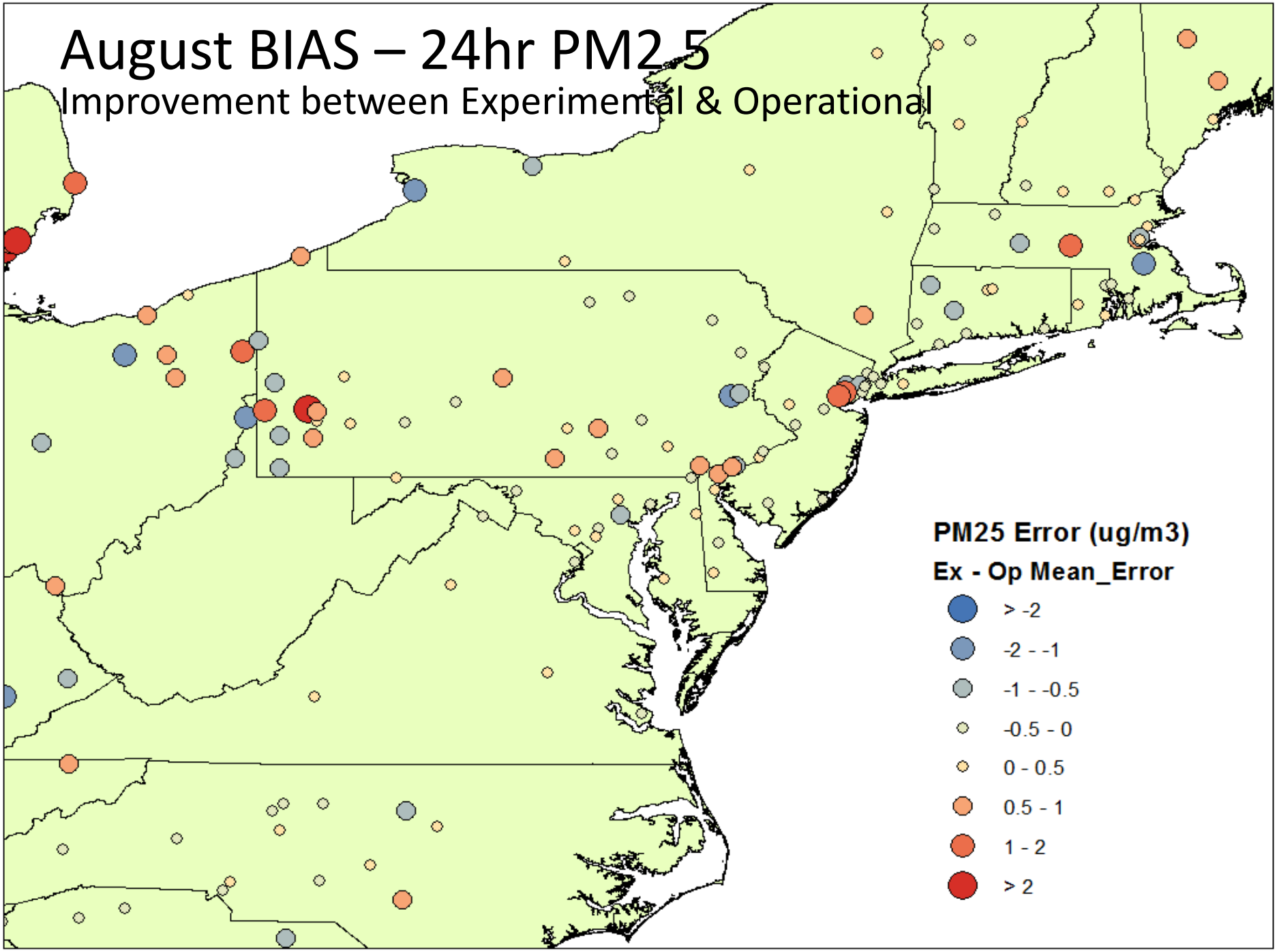
August BIAS – 24hr PM2.5

Experimental



August BIAS – 24hr PM2.5

Improvement between Experimental & Operational



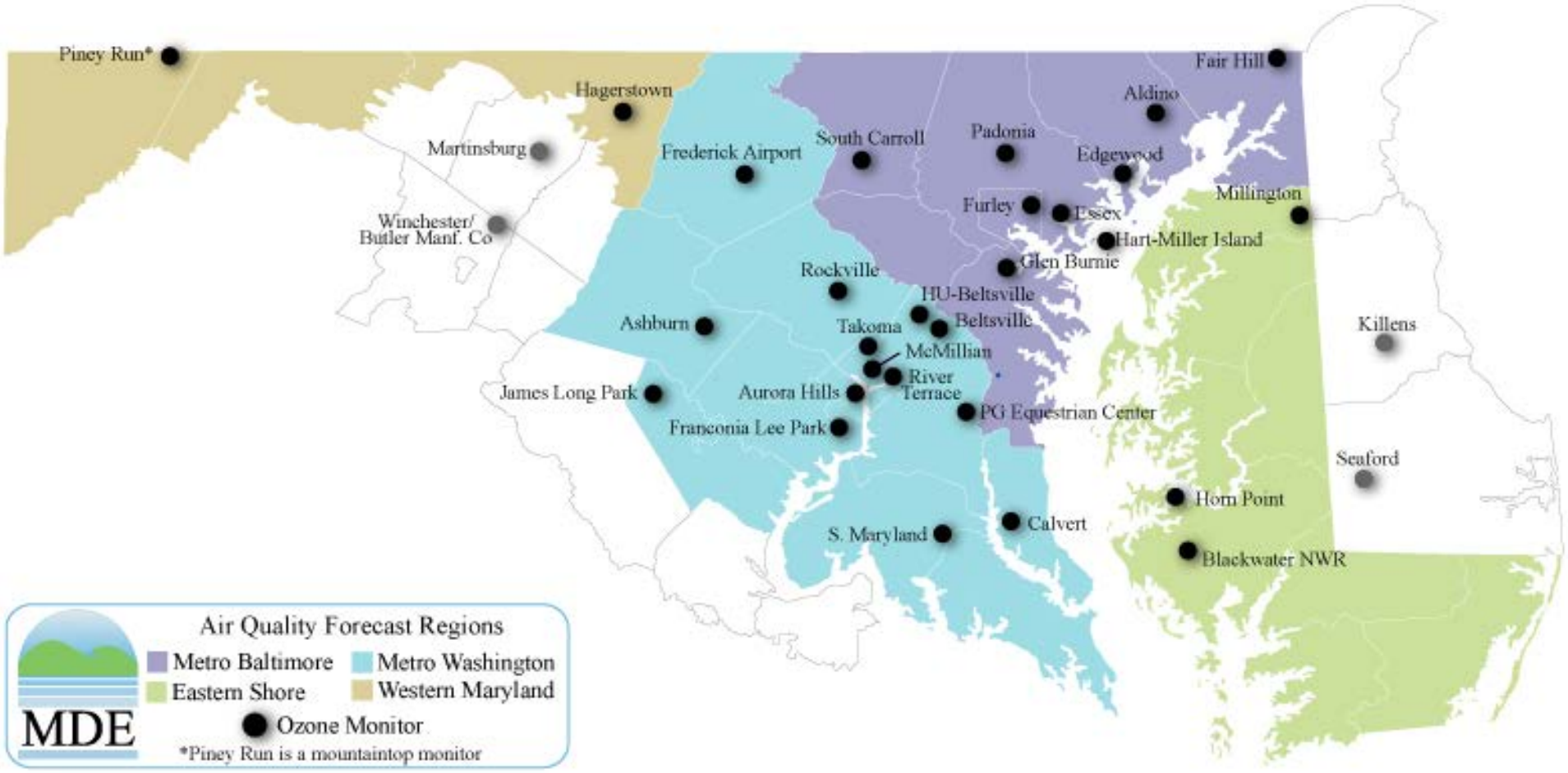
Conclusions

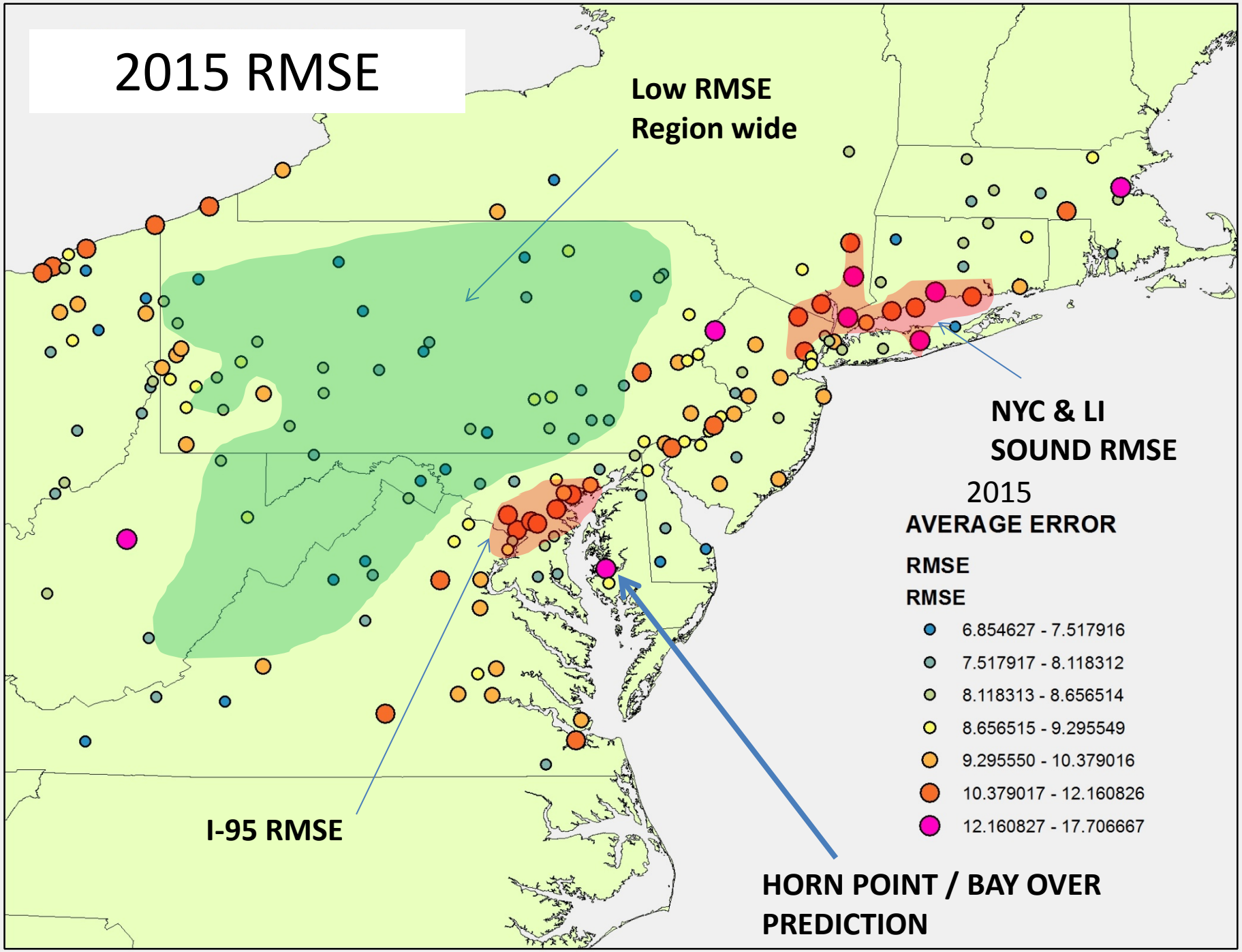
1. The experimental outperforms current operational model based on an August evaluation
   a. There was a dramatic reduction in the number of false alarms, though also a decrease in the number of hits, however the number of available hits (exceedances) was small for August (7)
   b. The **bias** of the experimental model **decreased** by about 5ppb in Maryland. Favorable for forecasting.
2. The experimental model does better over the Chesapeake Bay, but still over-predicts, particularly on exceedance days and/or days with hot temperatures.
3. The current operational continues to have a high bias with significant false alarms, most notable on the eastern shore and southeast of Baltimore
   a. False alarms and high bias were noted starting July 1 this year – after an outage of the model.
4. Both the operational and experimental models in general underestimate PM2.5 concentrations on average across the CONUS
   a. Both models perform fairly well across the Mid-Atlantic (slight overestimation)
   b. Experimental model has shown general improvement, particularly in CA
   c. No significant improvement in Maryland

A webmap of the data is located here:
http://geodata.md.gov/imapwab/?appid=a689c6f3873a4b71889c94a65fb0c75f

APPENDIX

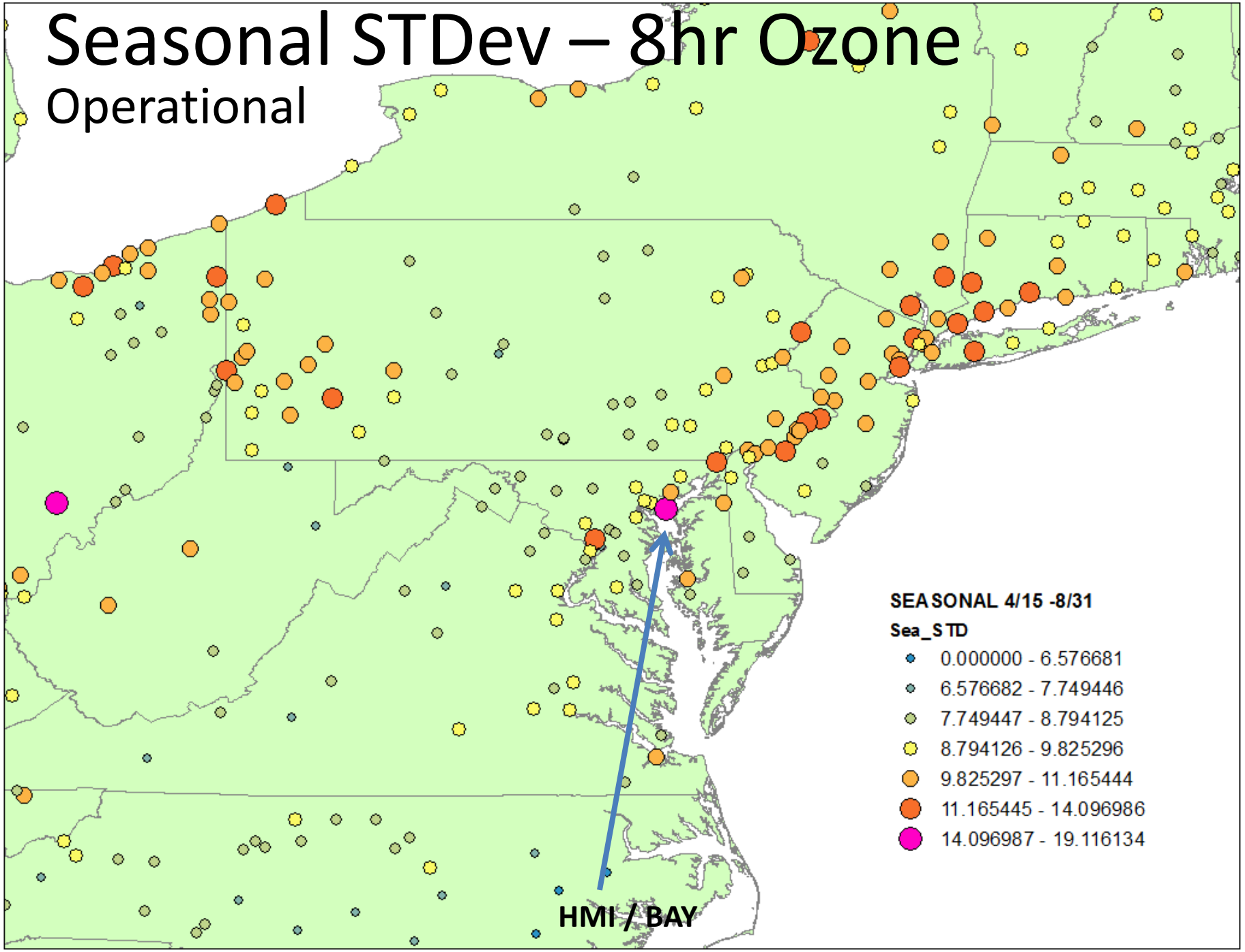
Forecast Regions & Monitors




2015 RMSE
Low RMSE
Region wide
NYC & LI
SOUND RMSE
2015
AVERAGE ERROR
RMSE
RMSE
6.854627 - 7.517916
7.517917 - 8.118312
8.118313 - 8.656514
8.656515 - 9.295549
9.295550 - 10.379016
10.379017 - 12.160826
12.160827 - 17.706667
I-95 RMSE
HORN POINT / BAY OVER
PREDICTION

Seasonal STDev – 8hr Ozone

Operational



2015 ERROR STDEV