2016 MARAMA Region Ozone Season Review

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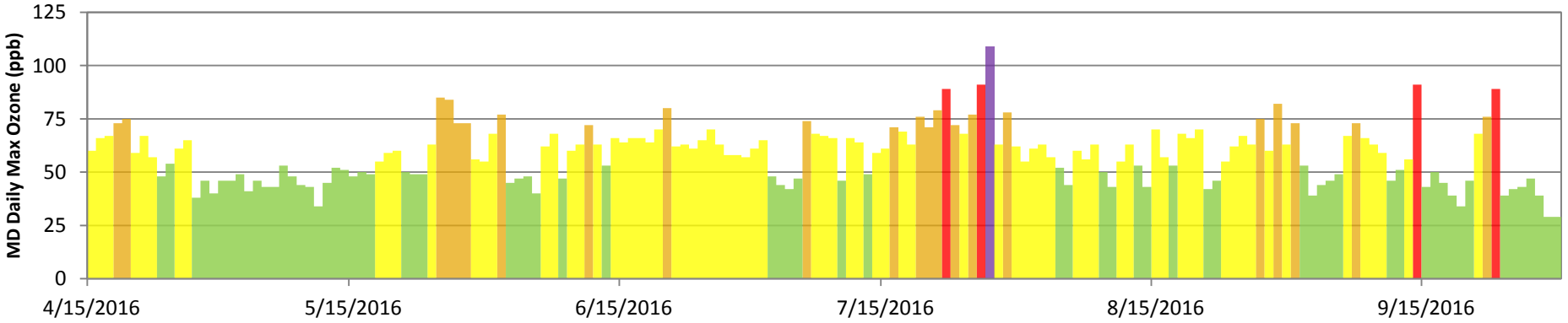
MARAMA Air Quality Monitoring Workshop

December 6, 2016

2016 MD Ozone Season

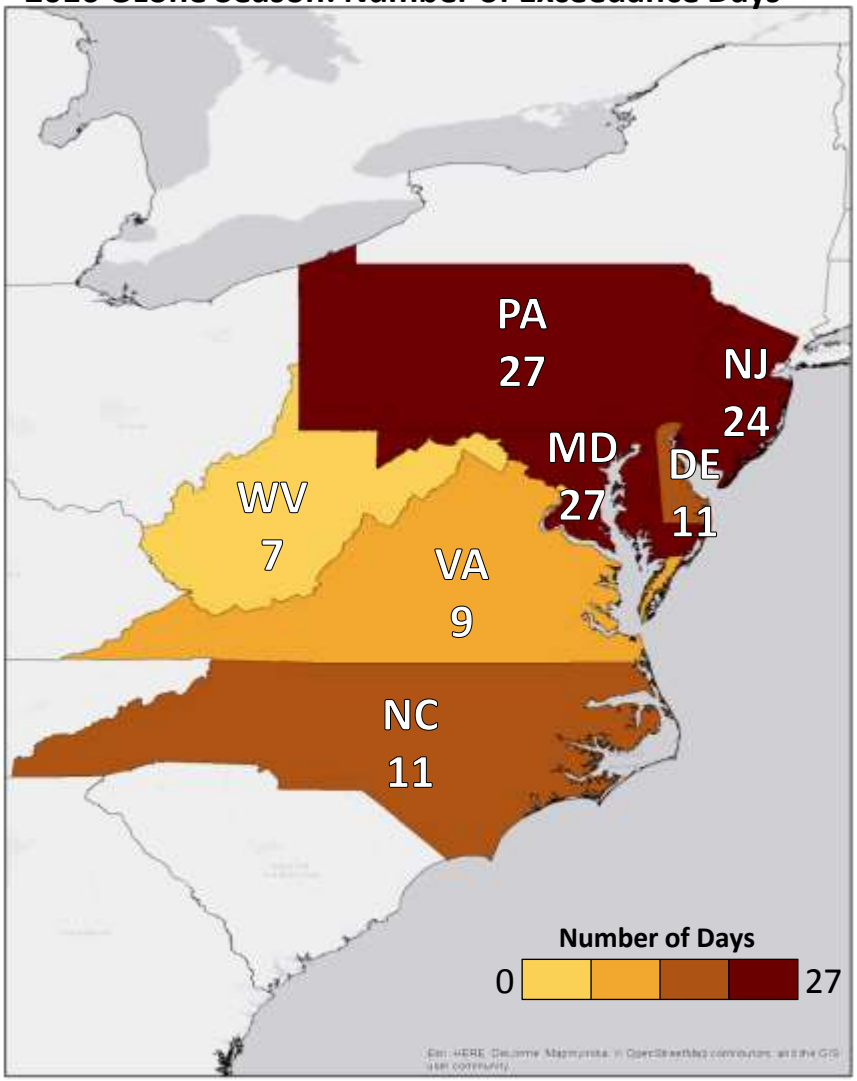
- 27 Maryland exceedance days, > 70 ppb 8-hour daily max
  - 22 Unhealthy for Sensitive Groups (USG), or code Orange days
  - 4 Unhealthy, or code Red days
  - 1 Very Unhealthy, or code Purple day
- July 27th Very Unhealthy day was the first in Maryland since June 2012.

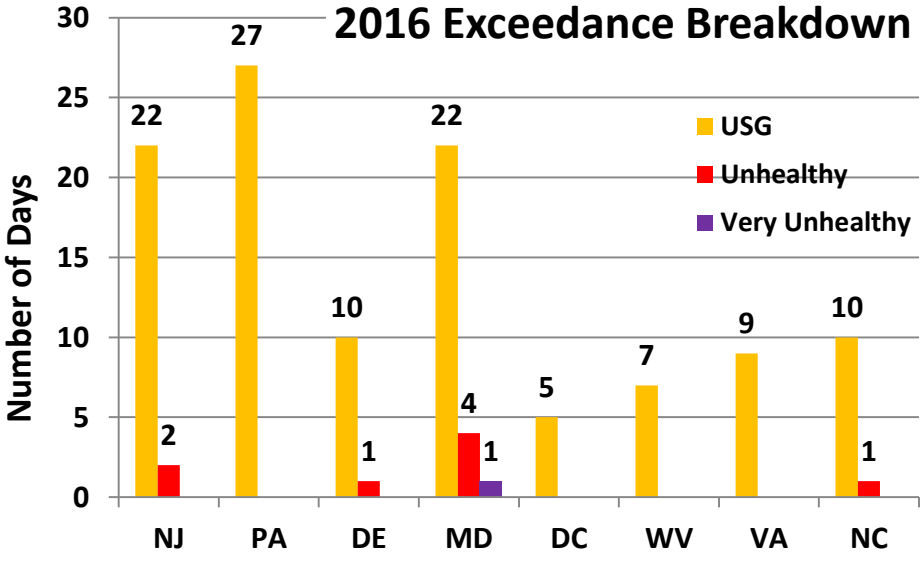


*2016 Data is preliminary.

MARAMA Region Ozone Season

2016 Ozone Season: Number of Exceedance Days





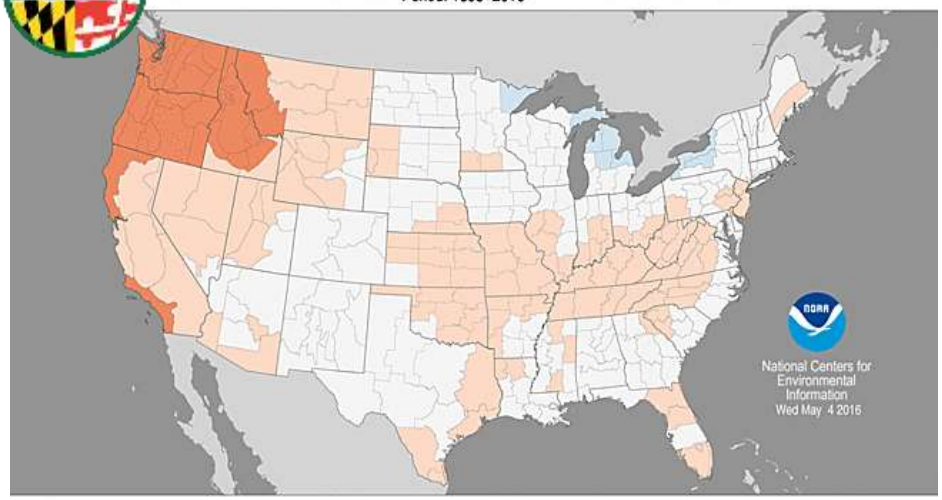
*2016 Data is preliminary.

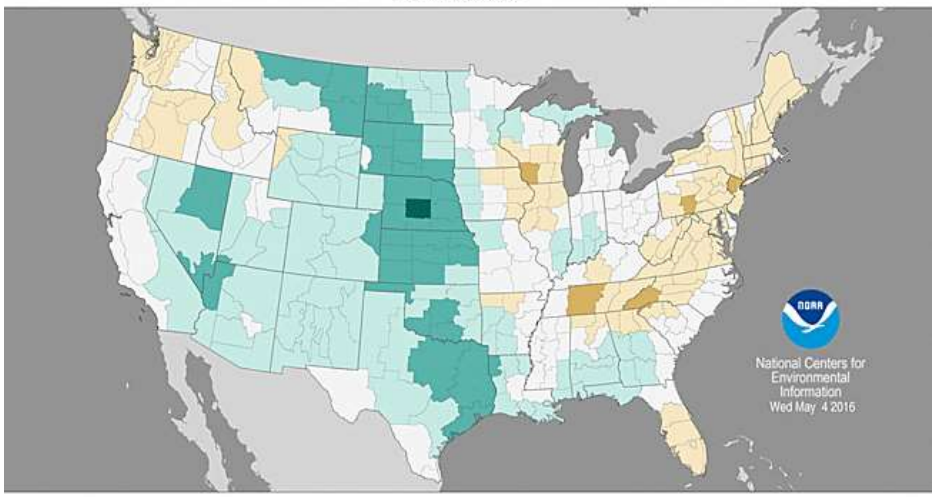
New EPA Standard

AQI Category	AQI Range	2015 *Breakpoints* 8-hr O_3 *ppb*	2016 Updated Breakpoints 8-hr O_3 *ppb*
Good	0 - 50	0 - 59	0 – 54
Moderate	51 - 100	60 - 75	55 – 70
USG	101 - 150	76 - 95	71 – 85
Unhealthy	151 - 200	96 - 115	86 - 105
Very Unhealthy	201 - 300	116 - 374	106 – 200
Hazardous	301 - 500	* 2-hr: 375-600*	* 2-hr: 201-600*

*See 40 CFT Appendix G to Part 58 for more detail on Hazardous and other AQI. Not all categories follow this noted temporal averaging

APRIL





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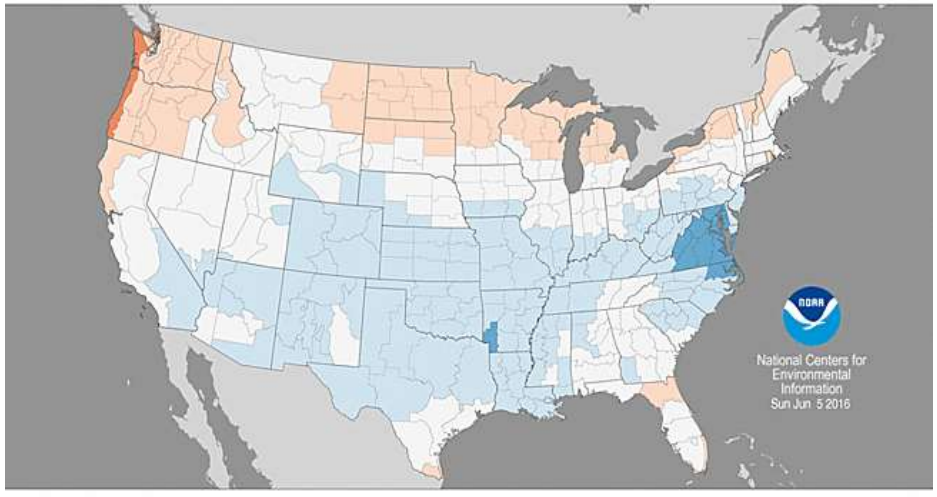

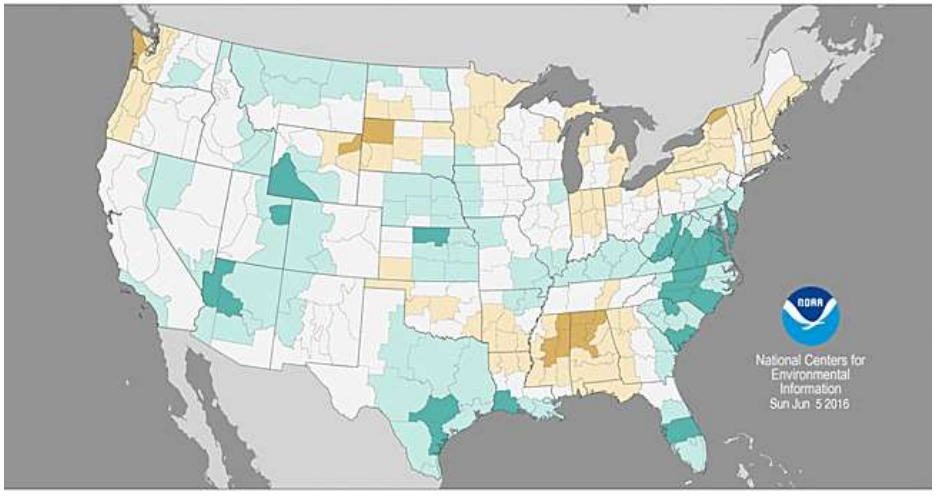

Source: [NCDC Temperature and Precipitation Maps]

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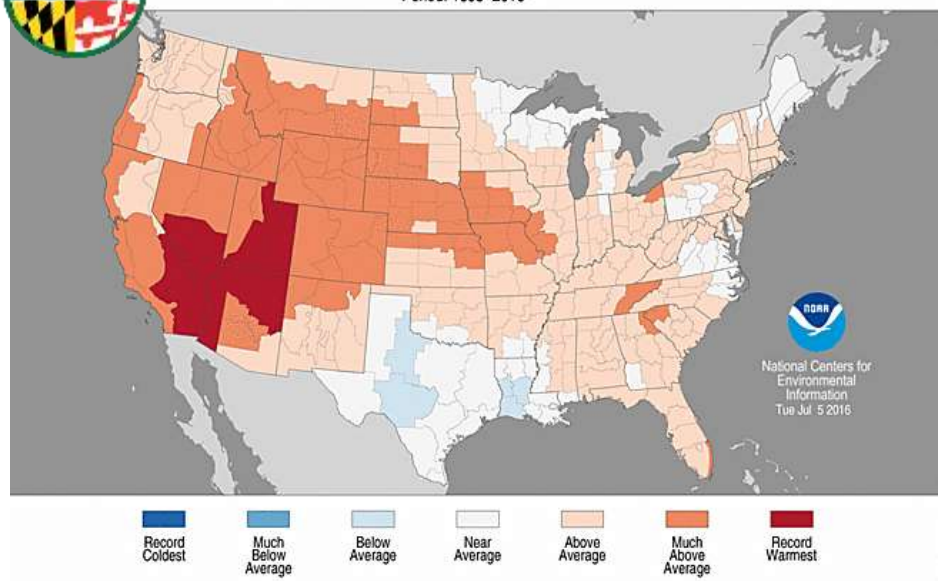

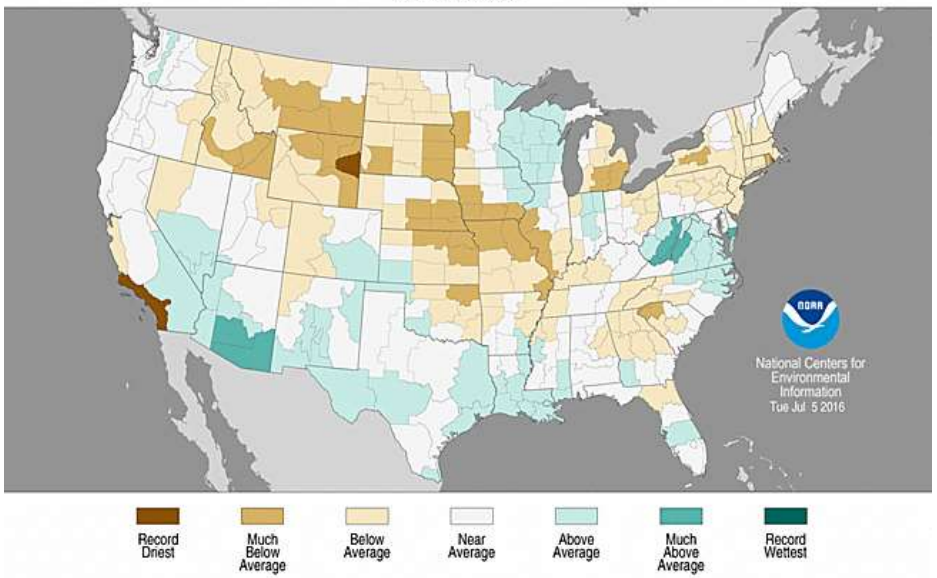

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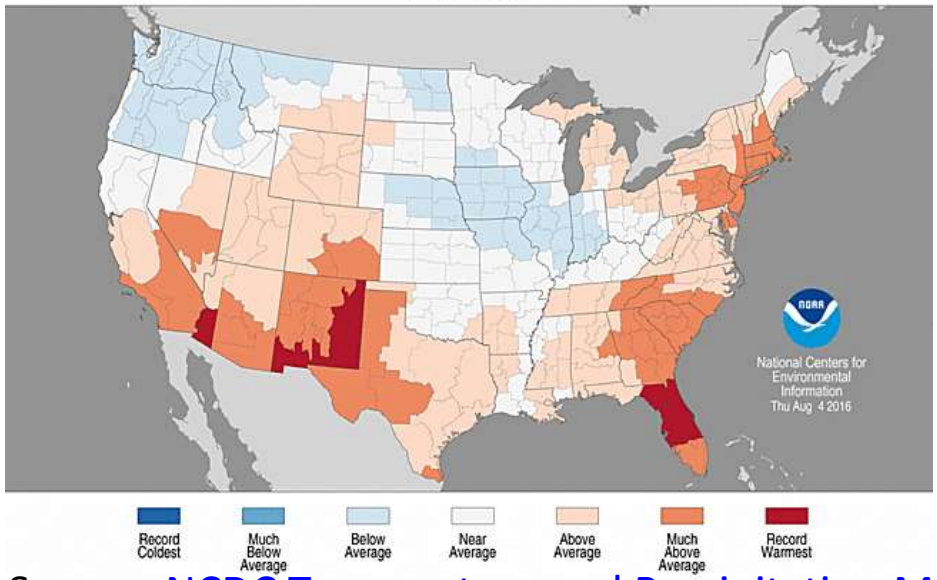

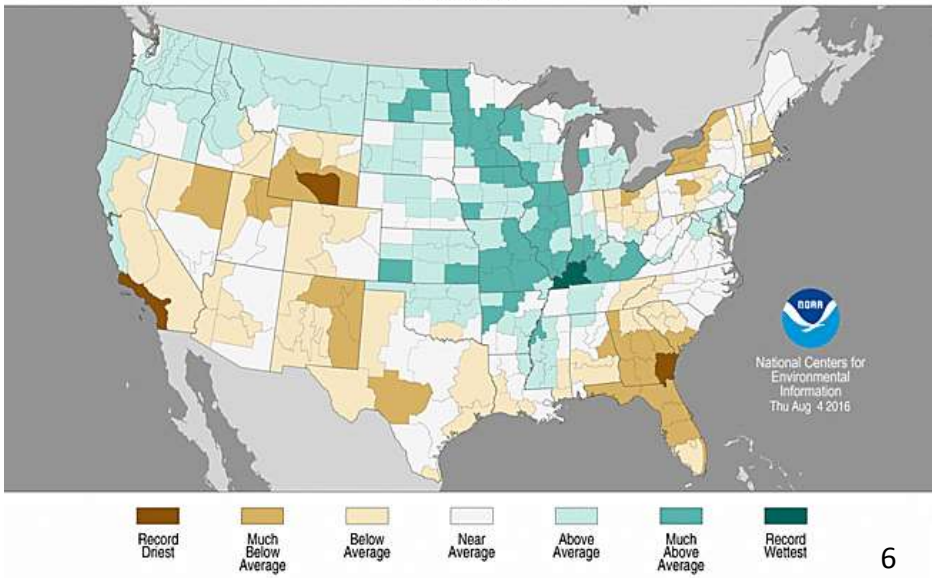

Source: [NCDC Temperature and Precipitation Maps]

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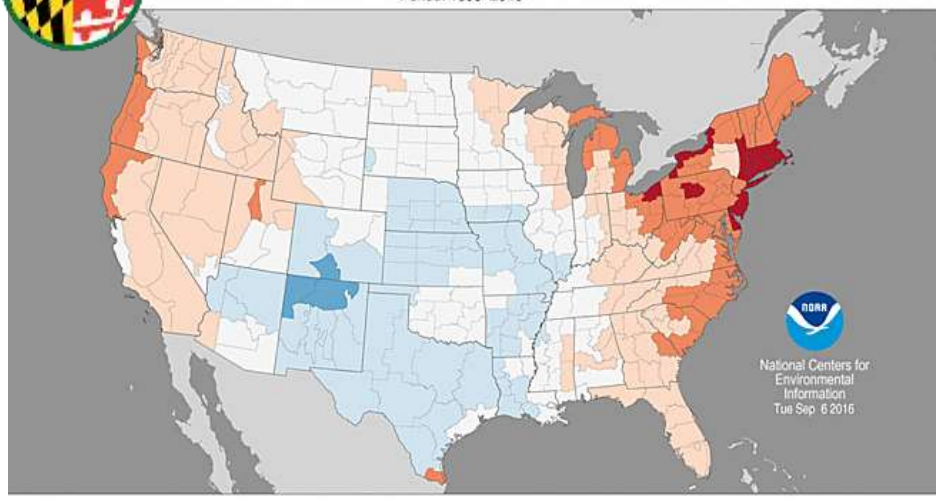
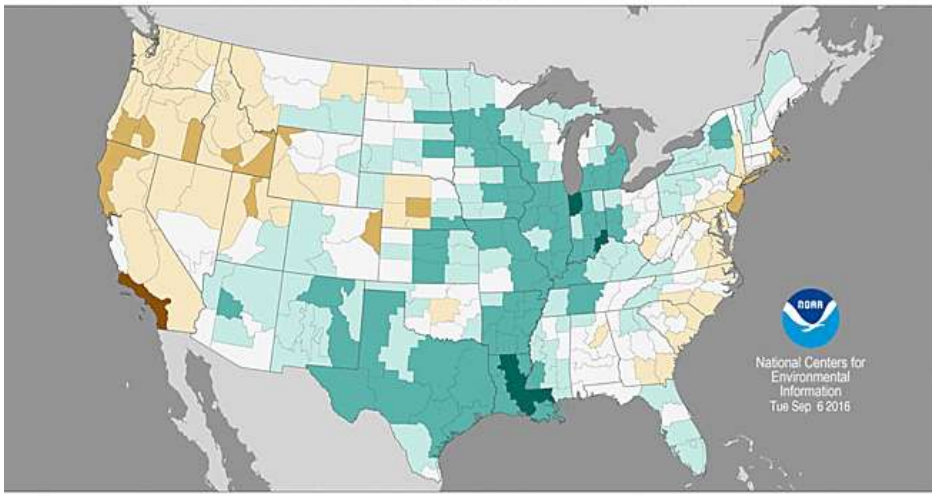
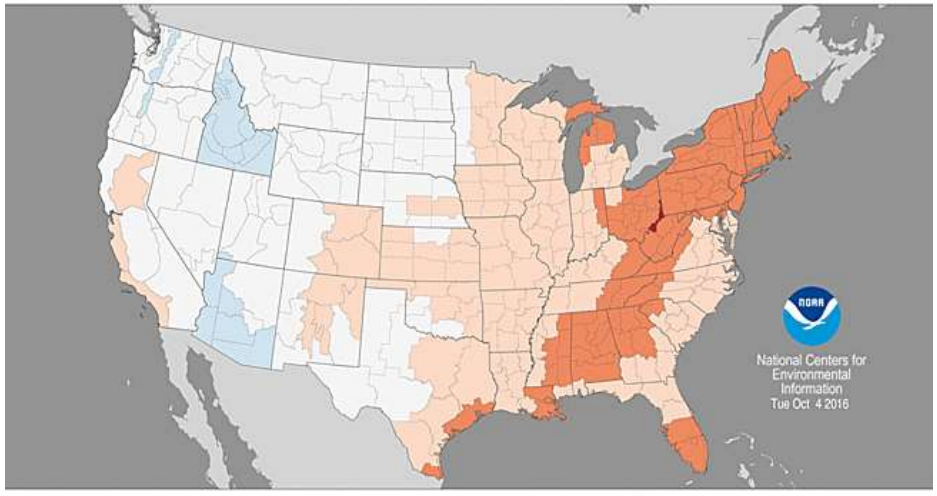
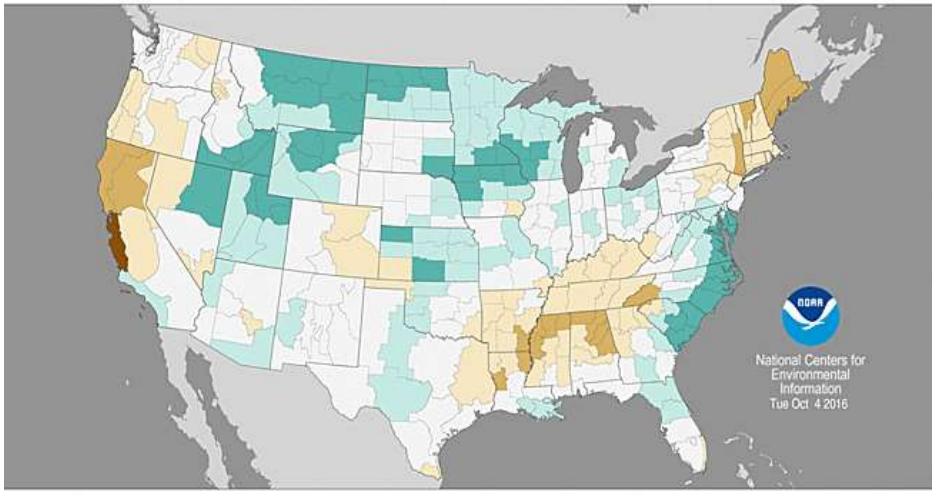




SEPTEMBER



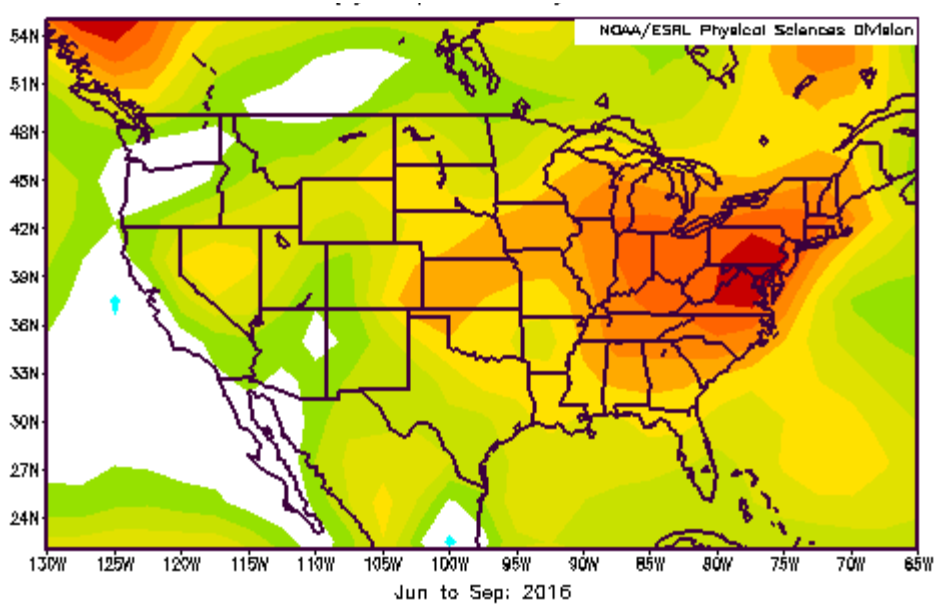


Source: [NCDC Temperature and Precipitation Maps]

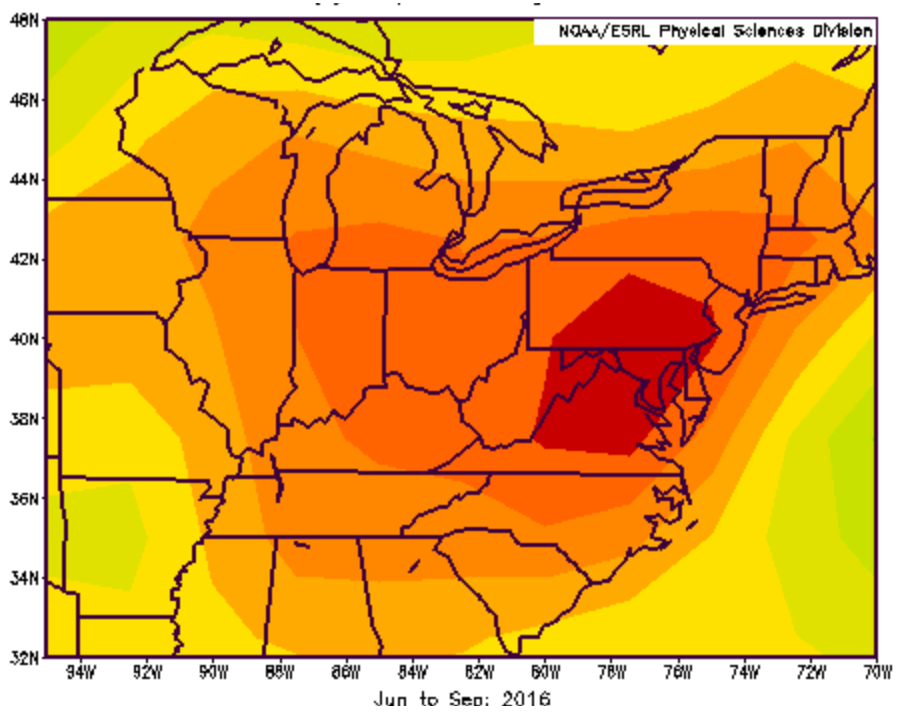
JJAS Surface Temp Anomalies

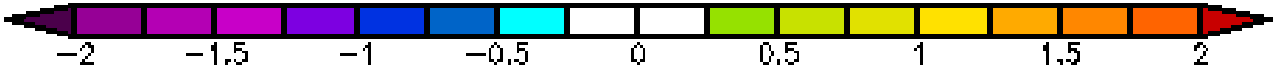
- Much hotter than normal summer suggests a very strong ozone season

U.S. Surface Temp Anomaly JJAS

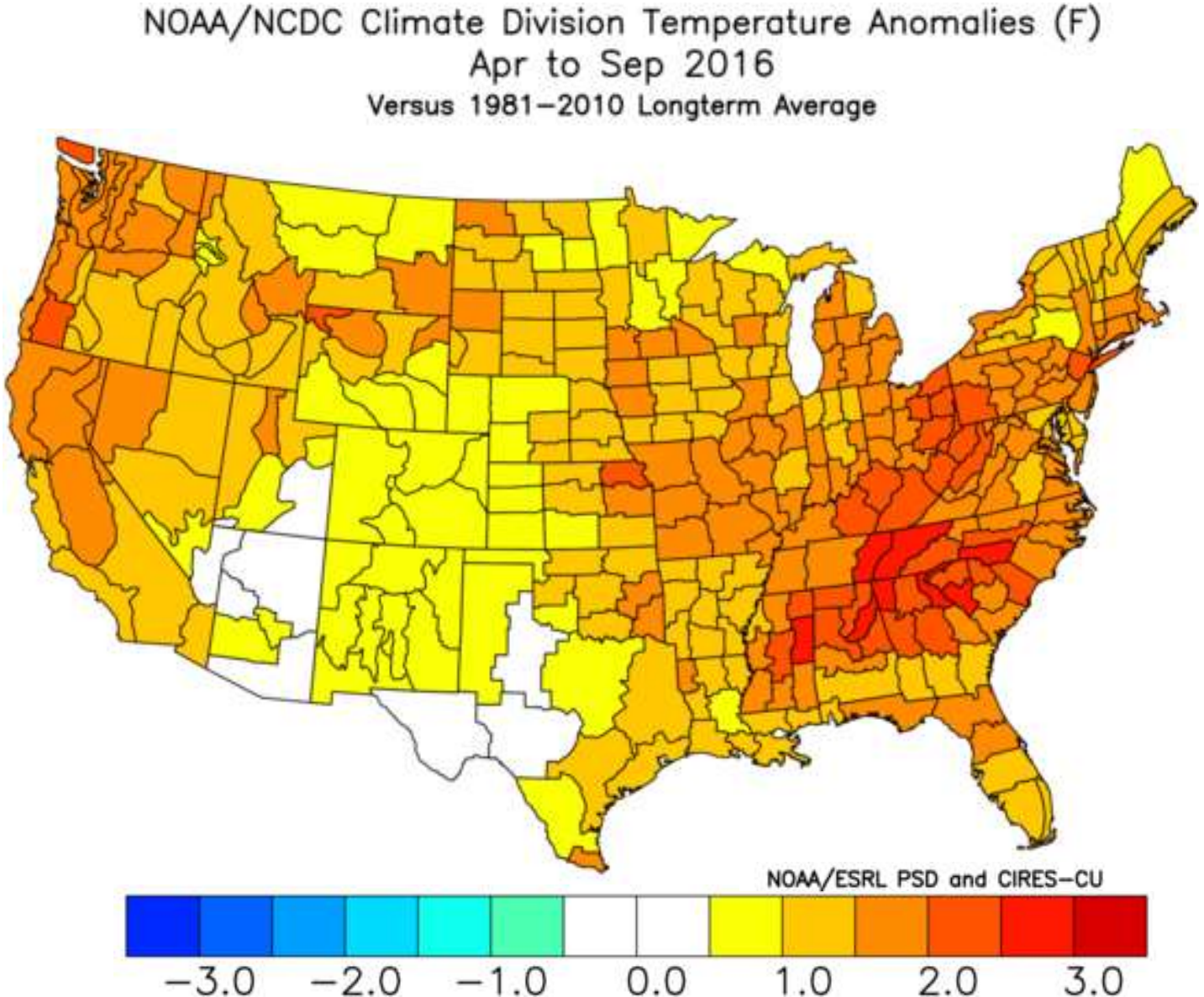


Mid-Atlantic Temp Anomaly JJAS





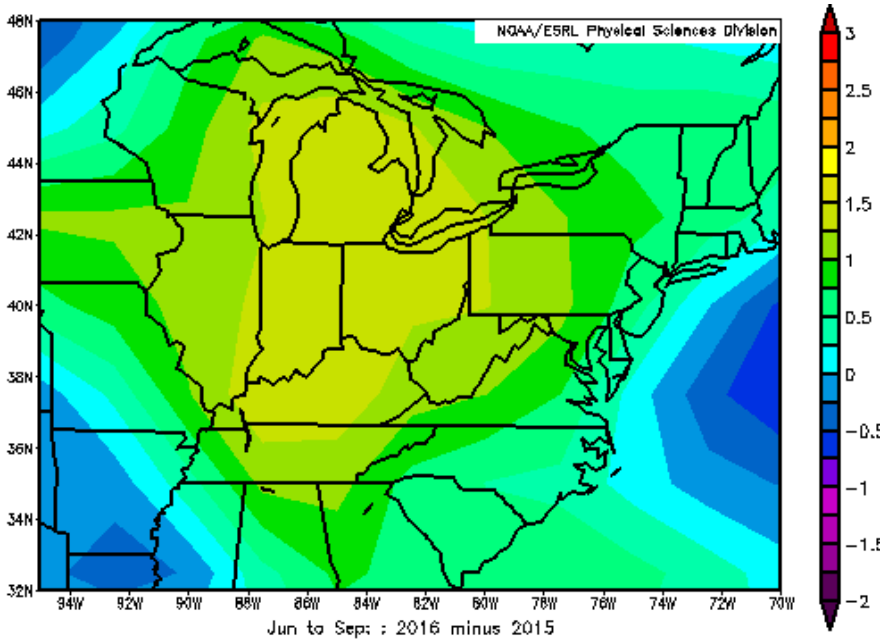
Ozone Season Surface Temp Anomalies



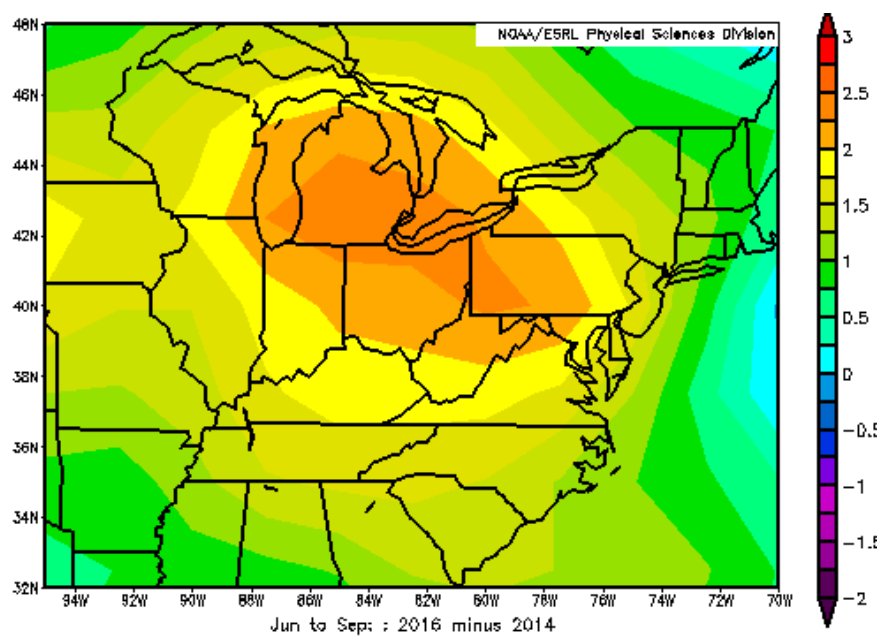
Surface Temp Yearly Comparison

- 2016 was much warmer across Mid-Atlantic and Mid-West vs 2015 and 2014.

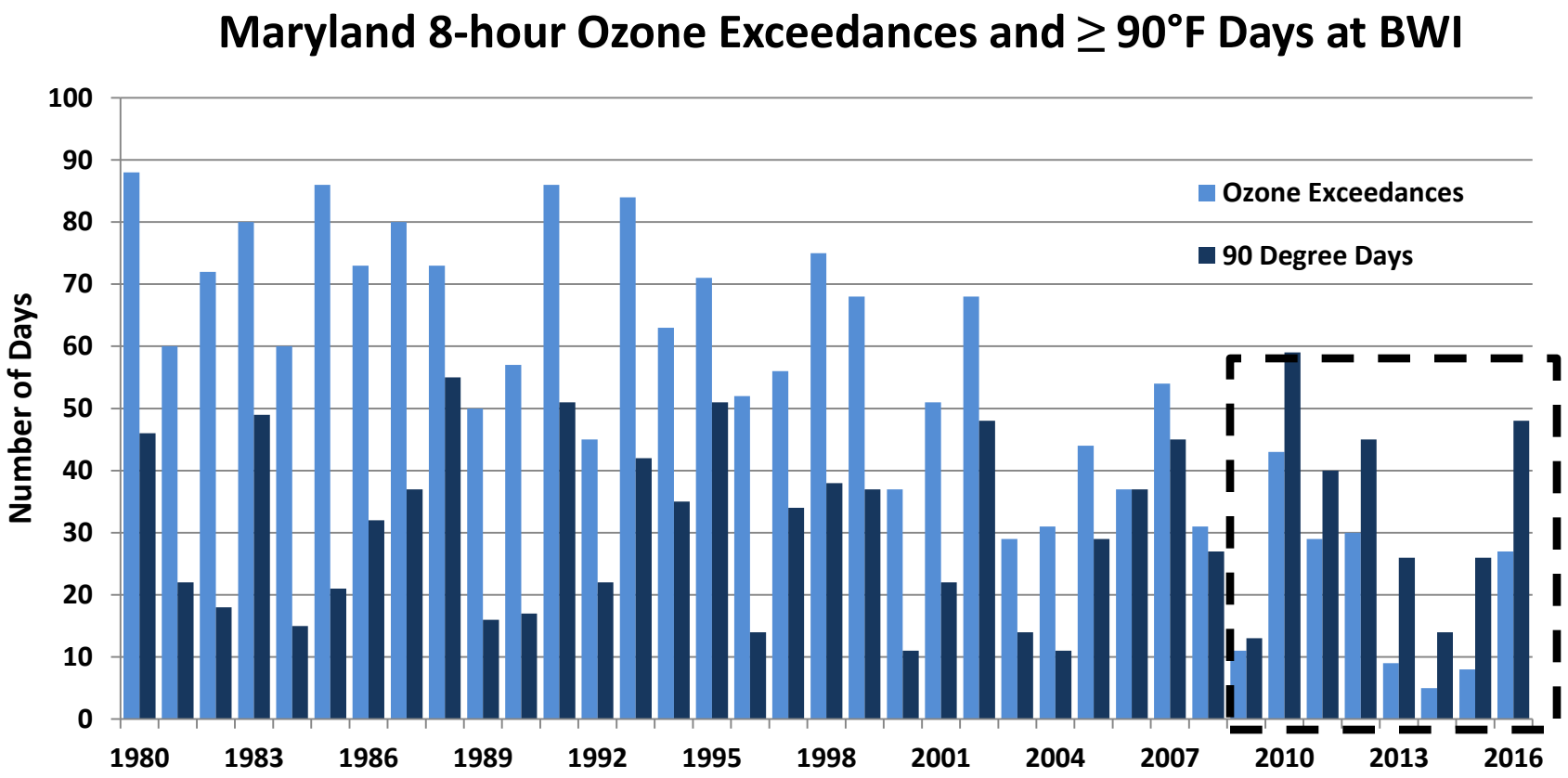
2016 – 2015 Surface Temps JJAS



2016 – 2014 Surface Temps JJAS

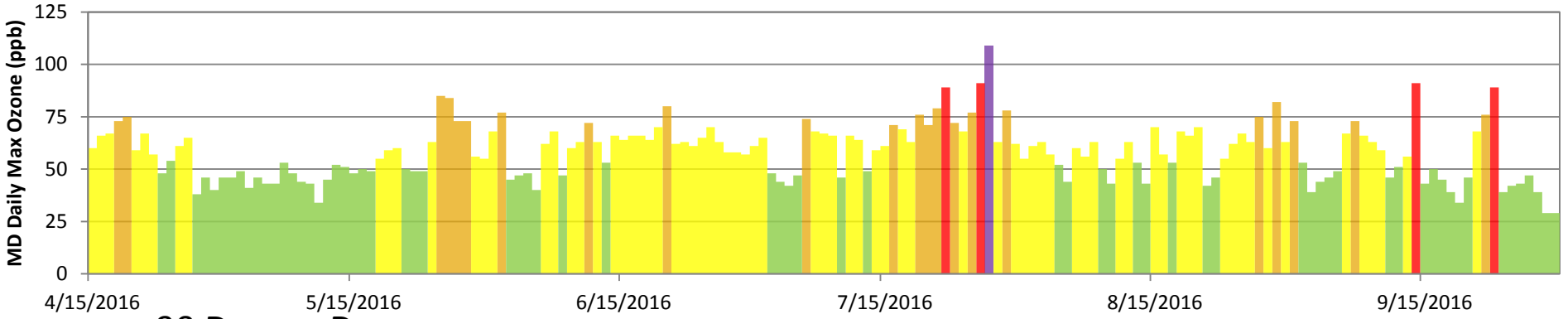


Ozone Exceedances vs. 90 Degree Days



*2016 Data is preliminary.

2016 MD SEASON AT A GLANCE



90 Degree Days

YEAR	No. Days	Avg. T_{max} (^{o}F)
2016*	48	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°F : 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*	27	14	5
2015	20	8	2
2014	11	5	1
2013	19	9	0
2012	42	30	13
2011	46	29	16
2010	61	43	21

*Preliminary Data

2016 vs. 2015

- Despite temperatures being much warmer, exceedance day numbers were near 2015 levels.
- In fact, many states saw exceedance numbers drop!

Exceedance Days (Using 70 ppb)

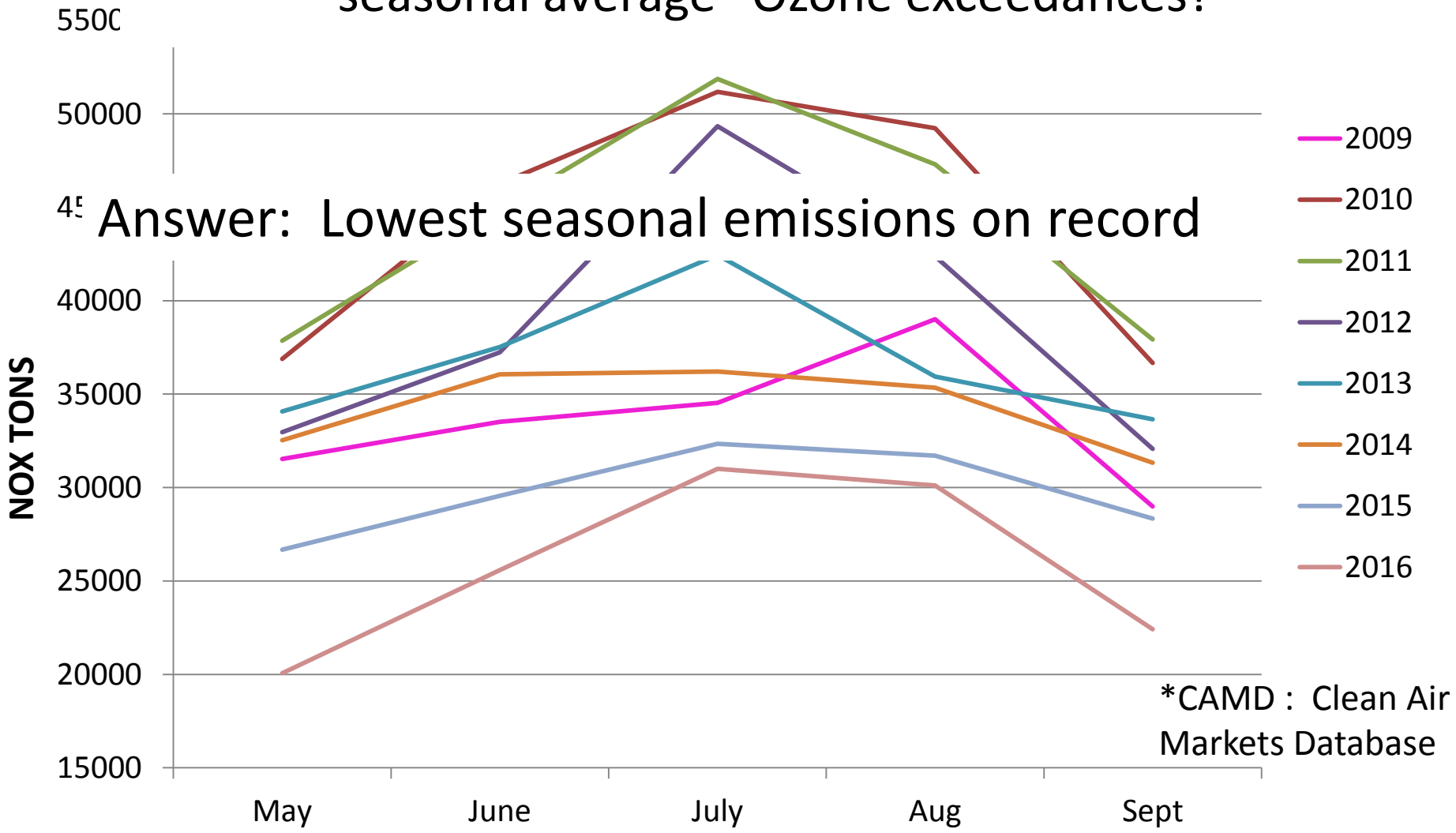
State	2015	2016	Diff
DC	5	5	0
NJ	31	24	-7
PA	33	27	-6
DE	10	11	+1
MD	20	27	+7
WV	7	7	0
VA	13	9	-4
NC	14	11	-3

*Data is preliminary

Monthly CAMD Emissions from:

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

Answer: Lowest seasonal emissions on record

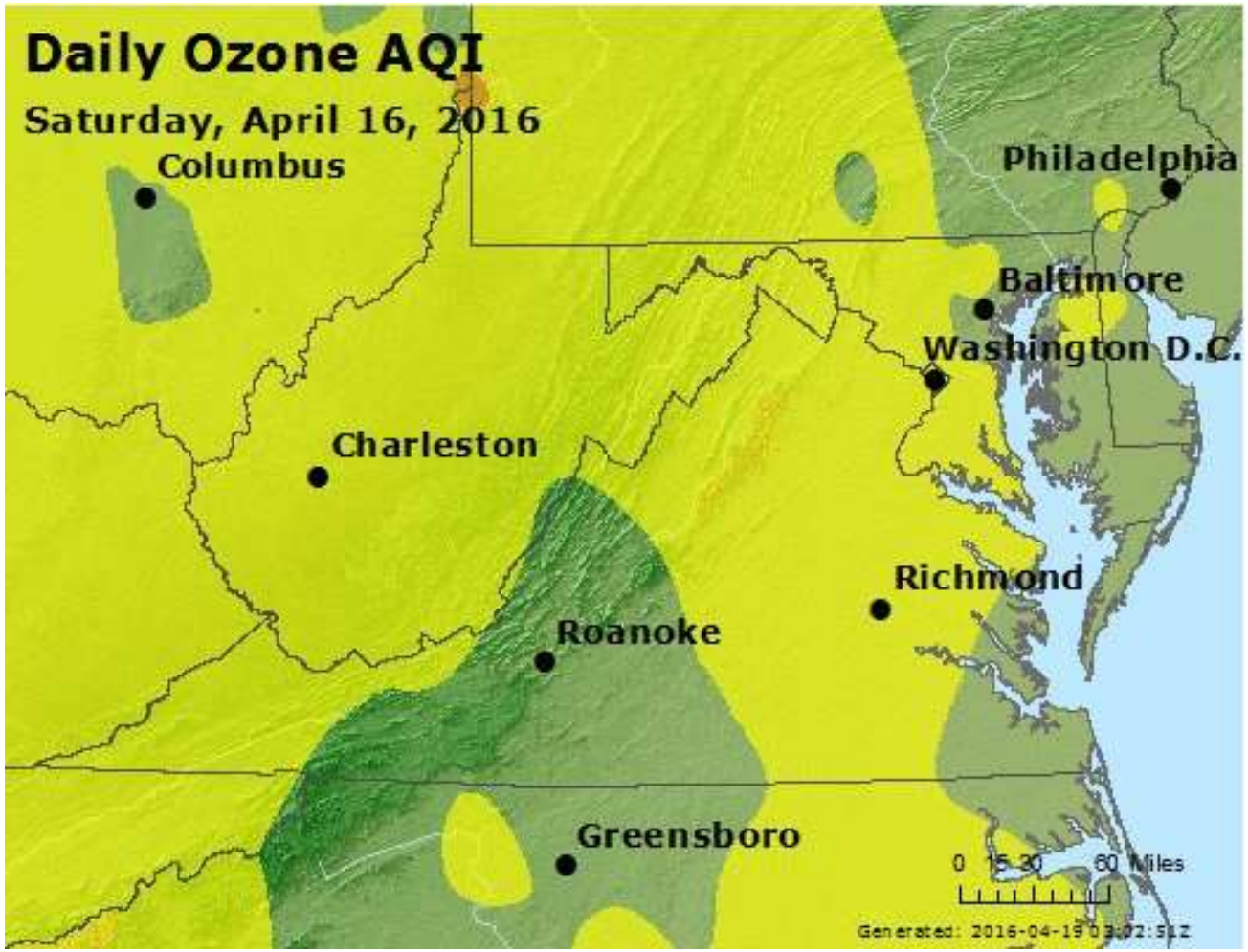


*CAMD : Clean Air Markets Database

Emissions of Indiana, Ohio, West Virginia, Virginia, Pennsylvania, Maryland and the District of Columbia were summed together on a monthly basis

Synoptic Vs Mesoscale

- With less regional support, exceedances are becoming more isolated and in turn more difficult to forecast



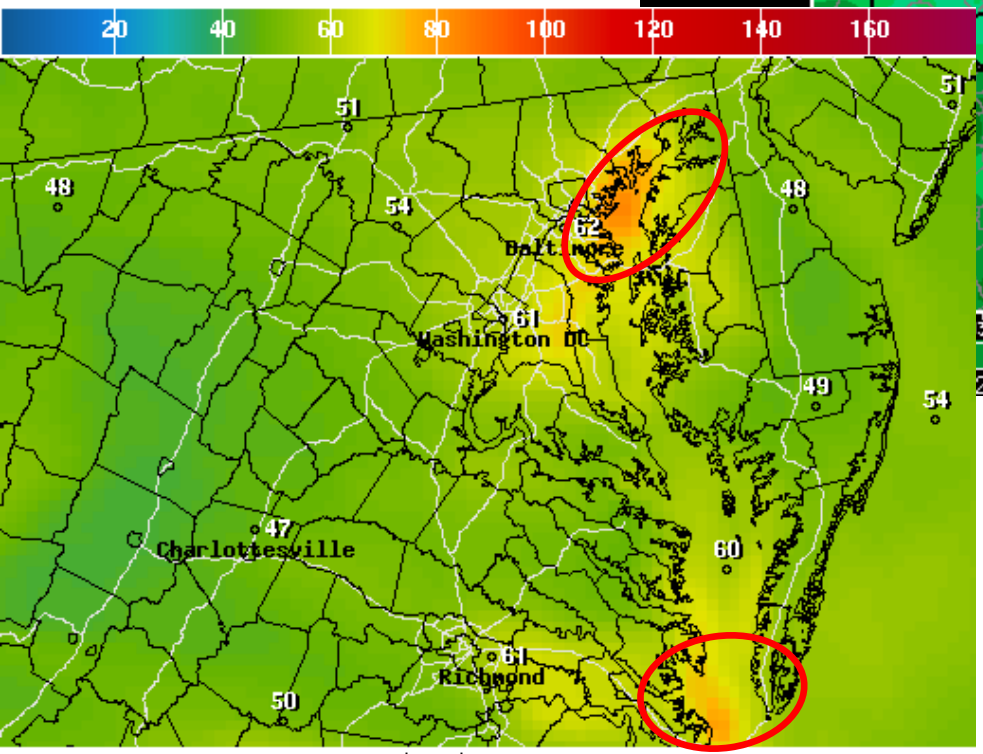
Maryland's Ozone Max 8-Hour Avg 2016

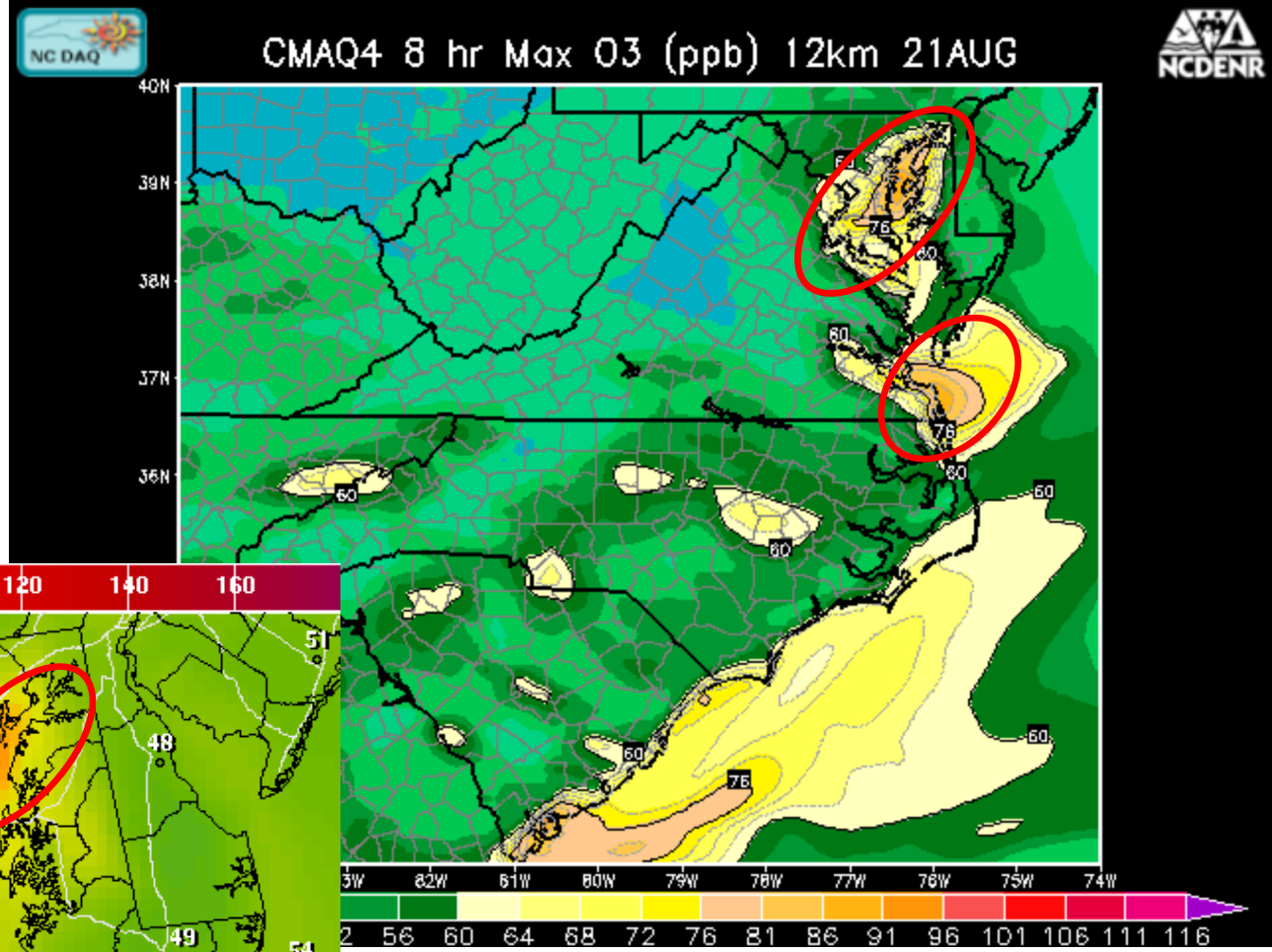
	Metropolitan Statistical Area (Group Number)																					Daily max 8-hour ozone conc. (ppb)	Daily number of sites with an occurrence
	1								2							3	4			5	6		
	Aldino	Edgewood	Essex	Furley	Hart Miller Island	Glen Burnie	Padonia	South Carroll	Calvert	PG Equest. Ctr.	Frederick Airport	Howard U.	Beltsville*	Rockville	So. Maryland	Fair Hill	Blackwater NWR	Millington	Horn Point	Hagerstown	Piney Run		
04/18/2016															73							73	1
04/19/2016									74	73					75		74					75	4
05/25/2016	77	79	78	75		75	74	72		74		74	76			83		85	71			85	13
05/26/2016	79	80	81	78		76	84	75	75			74	72		73	76	76	76	77			84	15
05/27/2016	73																					73	1
05/28/2016							73															73	1
06/01/2016			72				72	77			77									72		77	5
06/11/2016																71		72				72	2
06/20/2016	76	79	73							79						80						80	5
07/06/2016			74																			74	1
07/16/2016			71																			71	1
07/19/2016			75		75																	75	2
07/20/2016			71																			71	1
07/21/2016	77	72	75	74	72	76	73				75	78	78							74		78	11
07/22/2016	72	82	72		88					76						87						88	6
07/23/2016					72																	72	1
07/25/2016	77	76	77			77										74						77	5
07/26/2016			73		91					72					74							91	4
07/27/2016		79	99	88	109	74	73		73	78					80							109	9
07/29/2016			72		78	71																78	3
08/27/2016					71											75						75	2
08/29/2016			74		74	82																82	3
08/31/2016	72						73															73	2
09/07/2016			71		73																	73	2
09/14/2016		77	78		91											72						91	4
09/22/2016	74				71		71									76						76	4
09/23/2016	87	80	80	76	88	77	78	75		77	73				71	81		73		74		88	14
Number of occurrence days																							
2016: 27	10	9	18	5	13	8	9	4	3	7	3	3	3	0	6	10	2	4	2	3	0		
2015: 8																							

Synoptic Vs Mesoscale

- It is more important than ever to understand the mesoscale and even microscale effects that impact ozone concentrations
  - Appalachian Lee-Side troughing
  - Sea/Bay Breezes
  - Land Breezes
  - Local Convection
  - Urban Heat Island/Country Breezes

Operational models tend to over predict surface ozone





STUDY AREA

Fair Hill

Aldino

Aberdeen

Edgewood

Furley

Essex

Millington

Baltimore

RT-MILLER
SLAND

• OZONE MONITORS

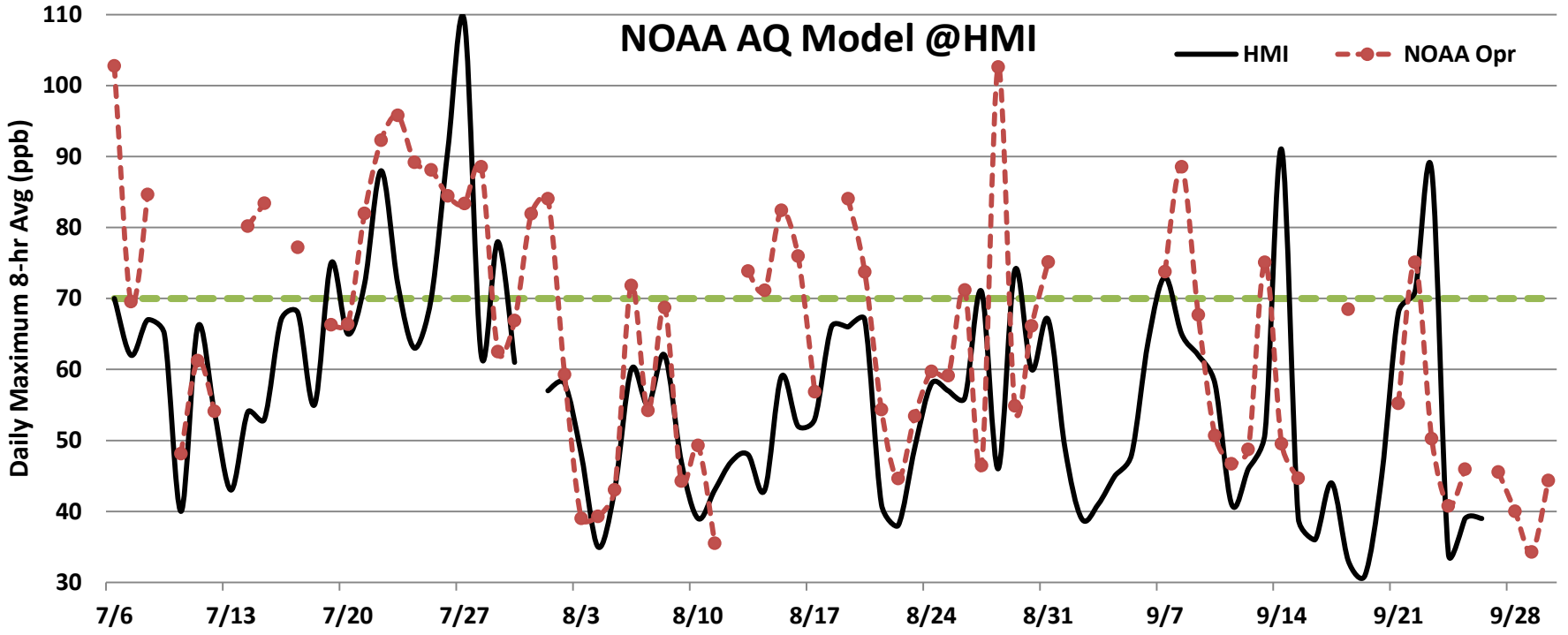
N

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Hart Miller Island Project

- Purpose
  - To have observations within the bay to prove or debunk the ozone forecast models
  - To better understand the complex land/bay interactions
- Island was in perfect location with monitor site on far eastern side to provide the most realistic bay conditions.
- Monitor became operational July 6th

Hart-Miller Island



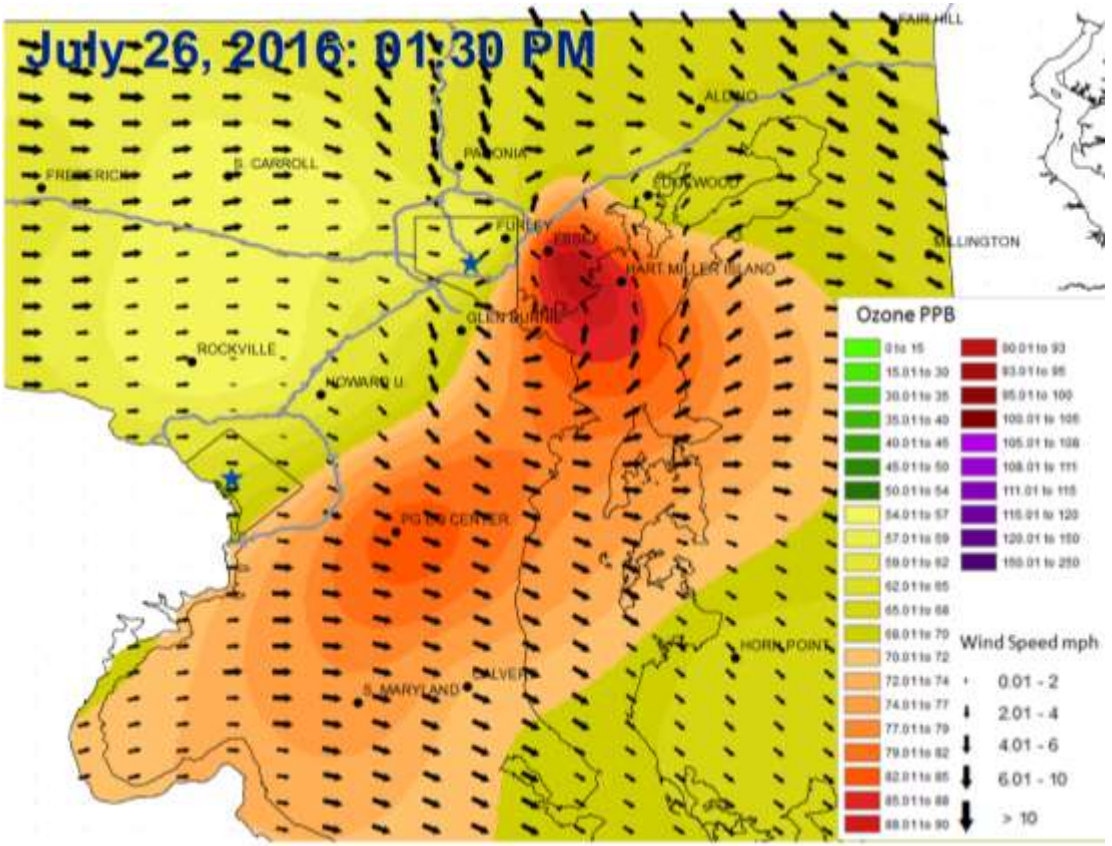
- 8 USG Days, 4 Unhealthy , 1 Very Unhealthy
- 5 of the 7 highest daily 8-hour maximum ozone concentrations in MARAMA were at HMI
- Highest: 109 ppb
- Certainly some truth, however NOAA model still over predicted
- Much more to learn…

5-Minute Ozone Plots

- A script was created to plot ozone, wind speed and wind direction data from Envista at 5-minute intervals for particular days of interest.
- These images can then be looped to better show fine details that may have been missed previously.

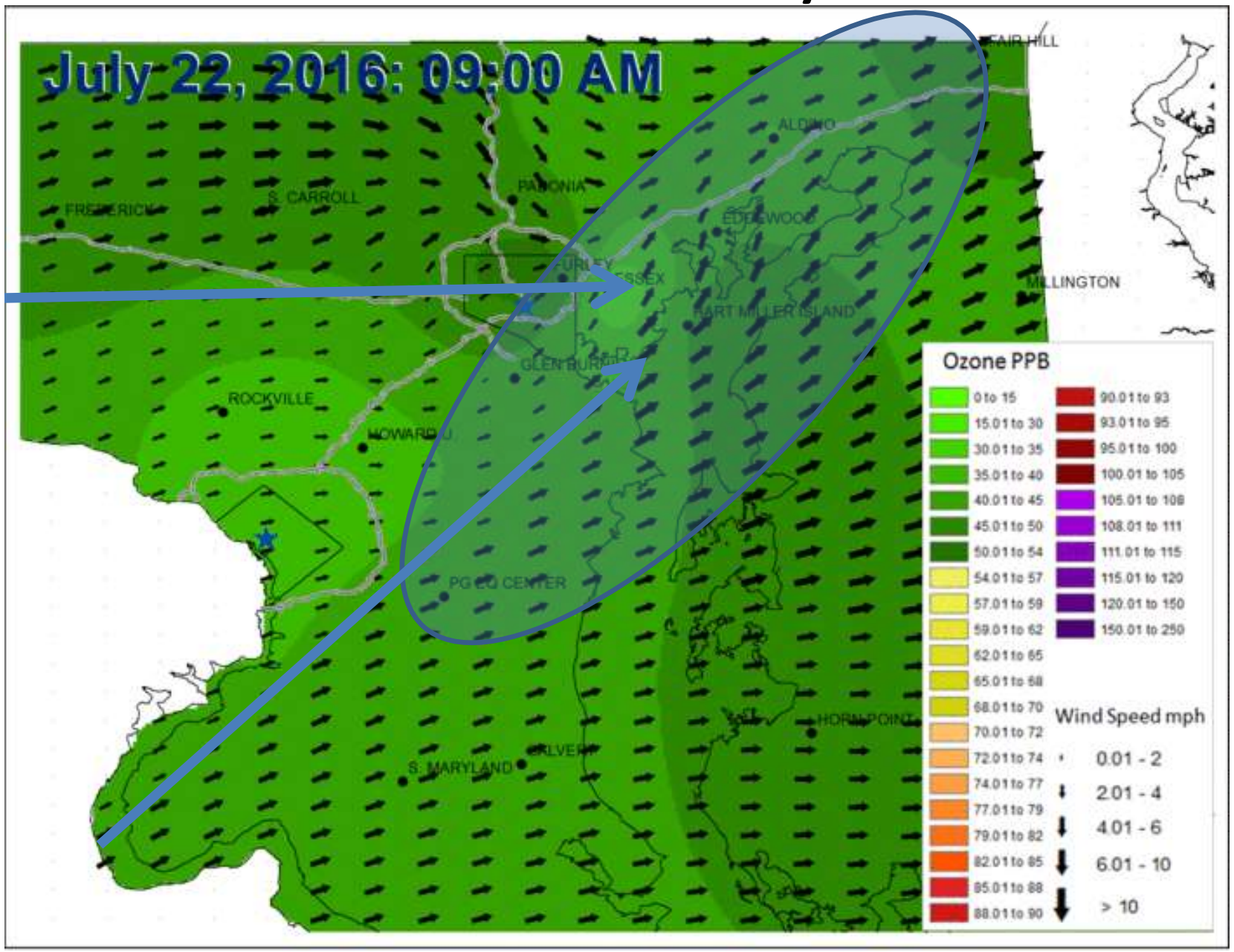
Sample Output

- Focused on bay region
  - DC and BAL Starred
- Major highways included
- Monitor sites included
- Color coded AQI
- Wind vectors computed
- Legend incorporated to show scaling



- Note: Computed wind vectors and AQI values are based off 5-minute averages

Animation – July 22nd

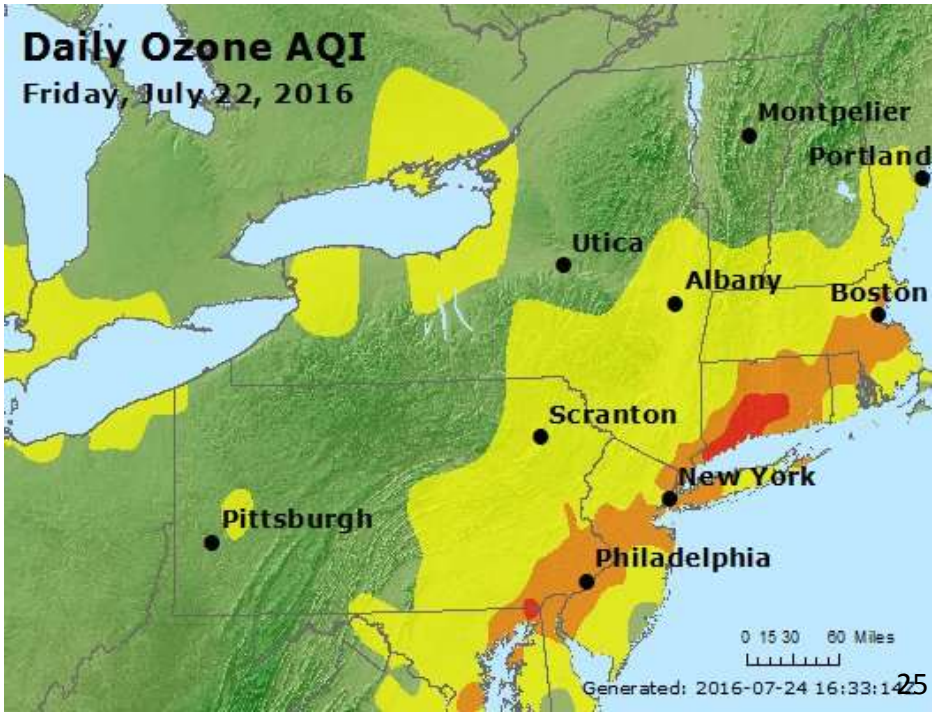


18Z July 22nd 2016

Convergence

MET

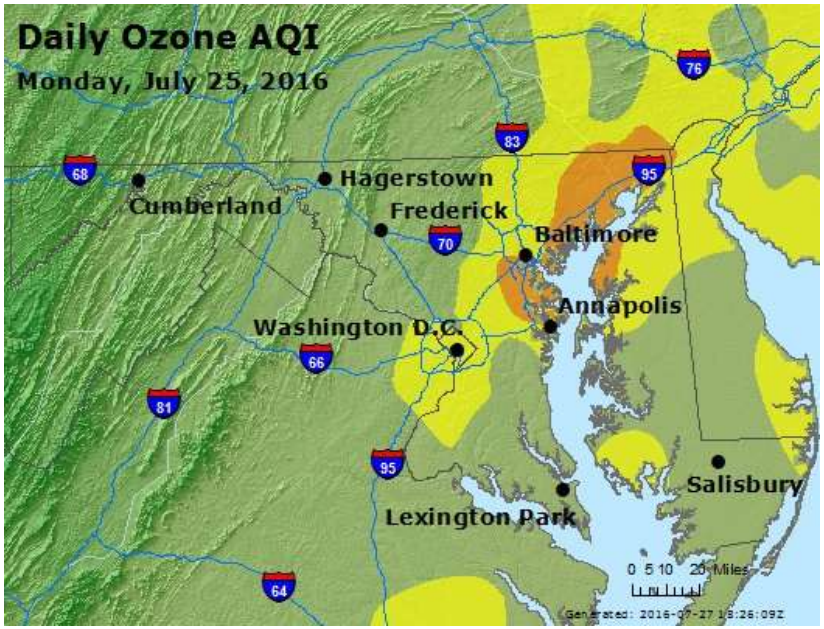
- Warm temps, generally clear skies
- Classic lee-side trough



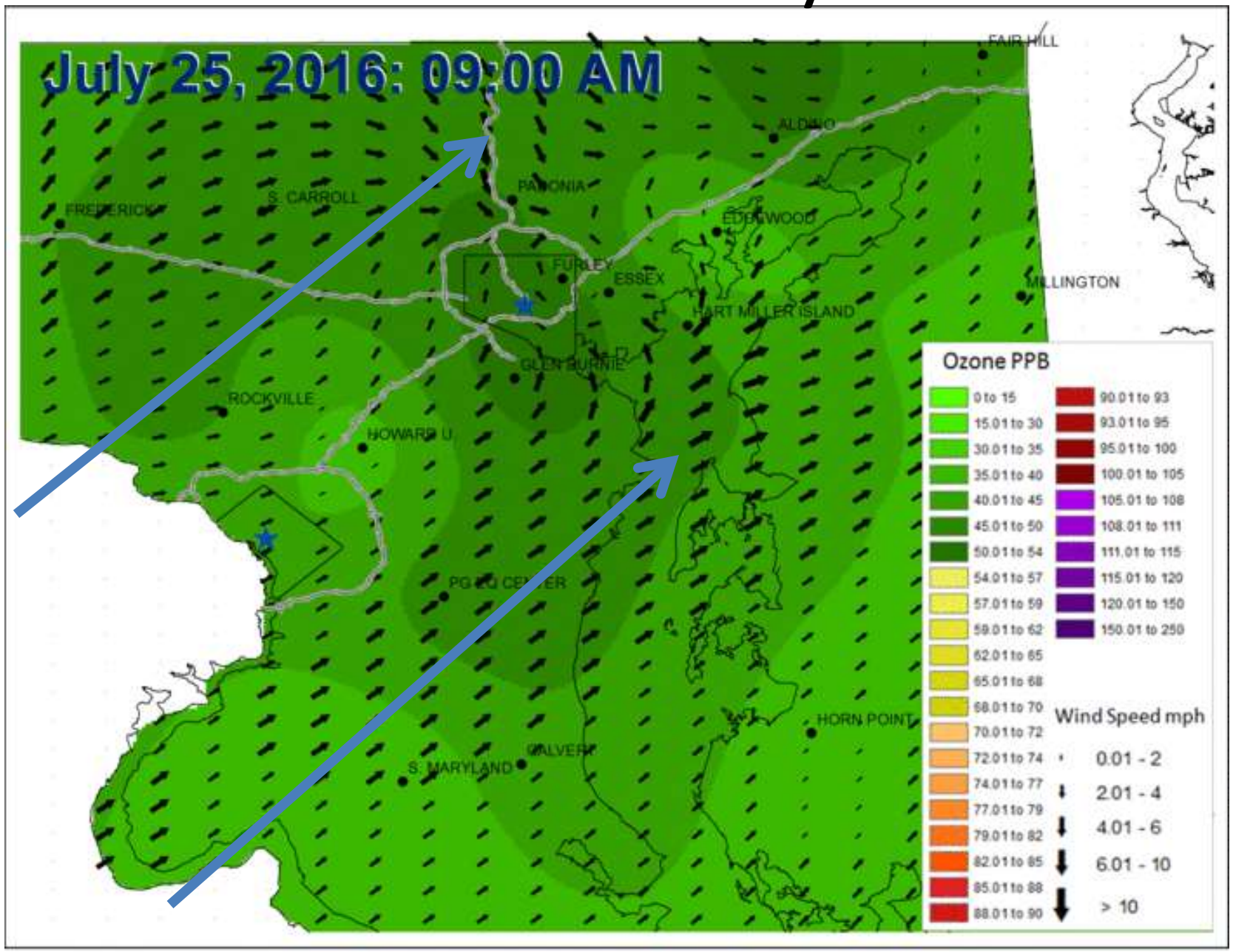
15Z July 25th 2016

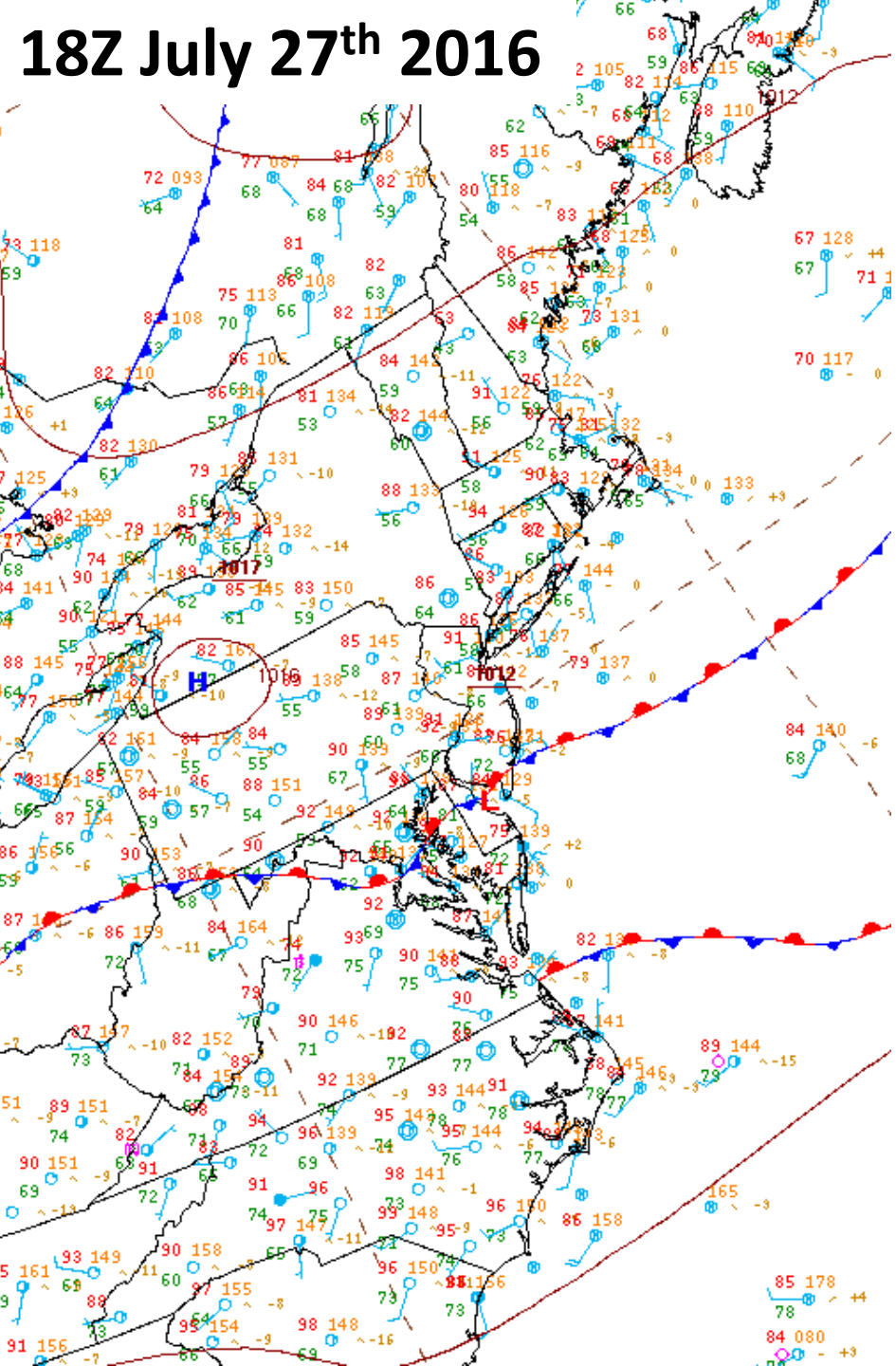
MET

- Warm sectored
- Hot/humid conditions
- Persistent SW flow



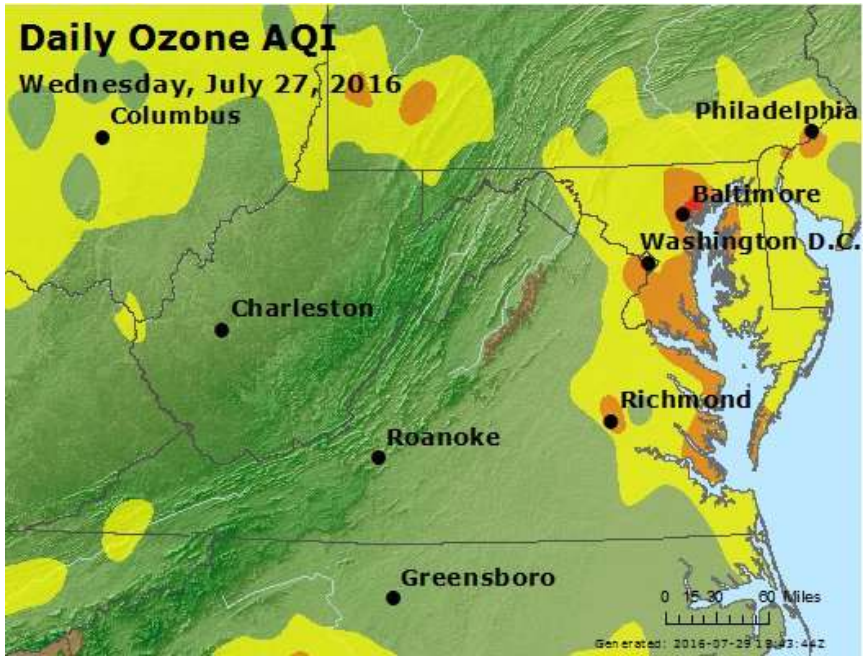
Animation – July 25th



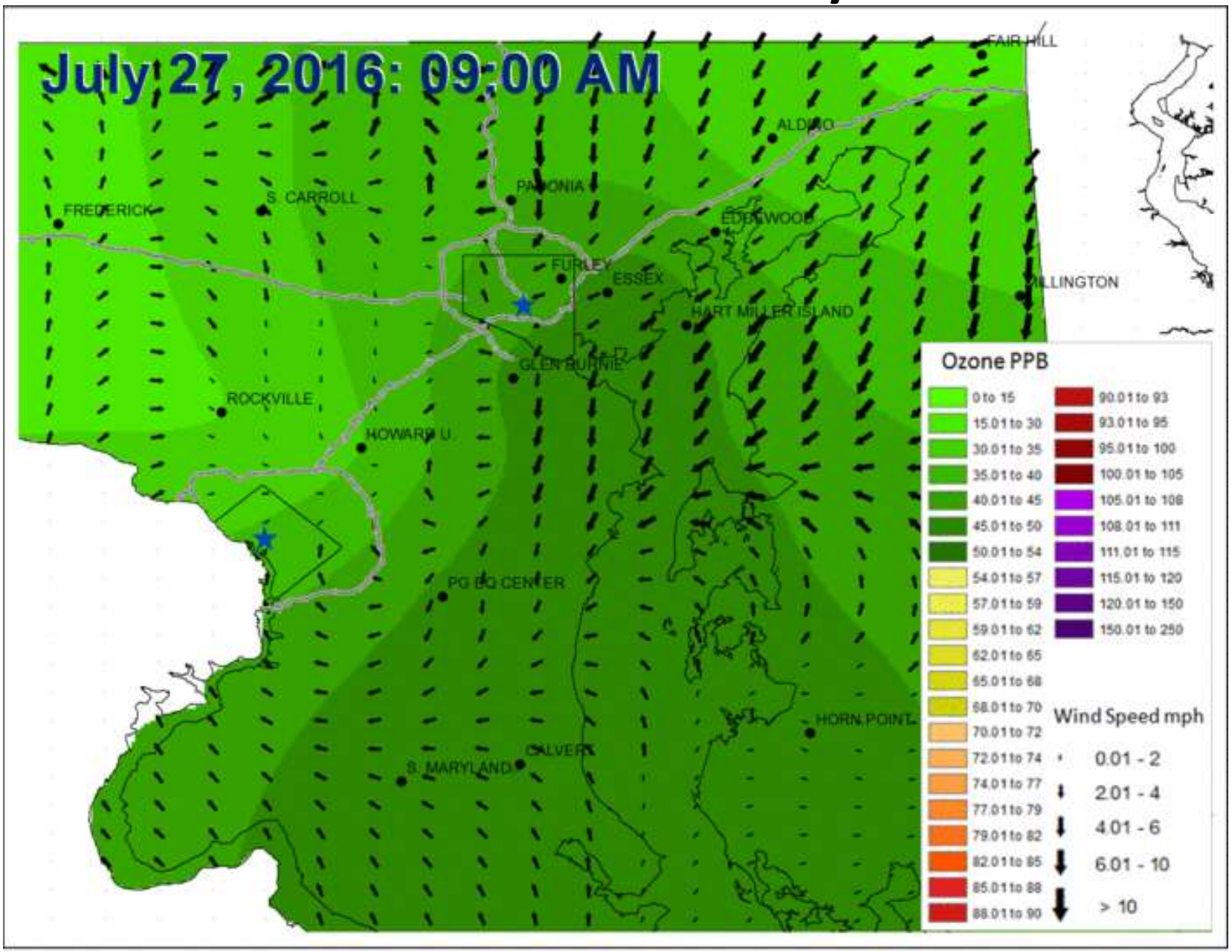


MET

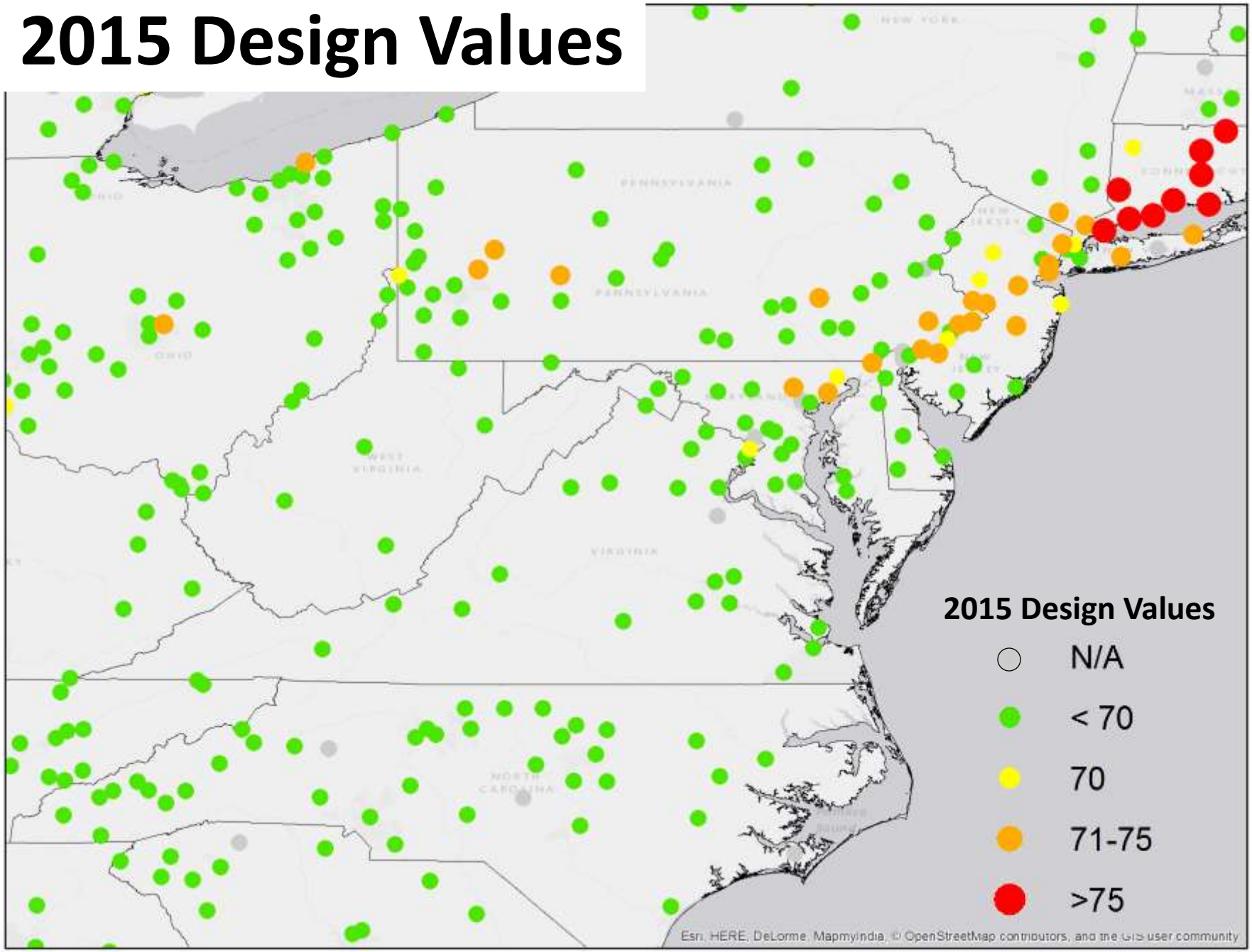
- Cold front weakens/stalls
- Continued hot/humid
- Weak/Variable flow
- Allows for local winds to dominate



Animation – July 27th



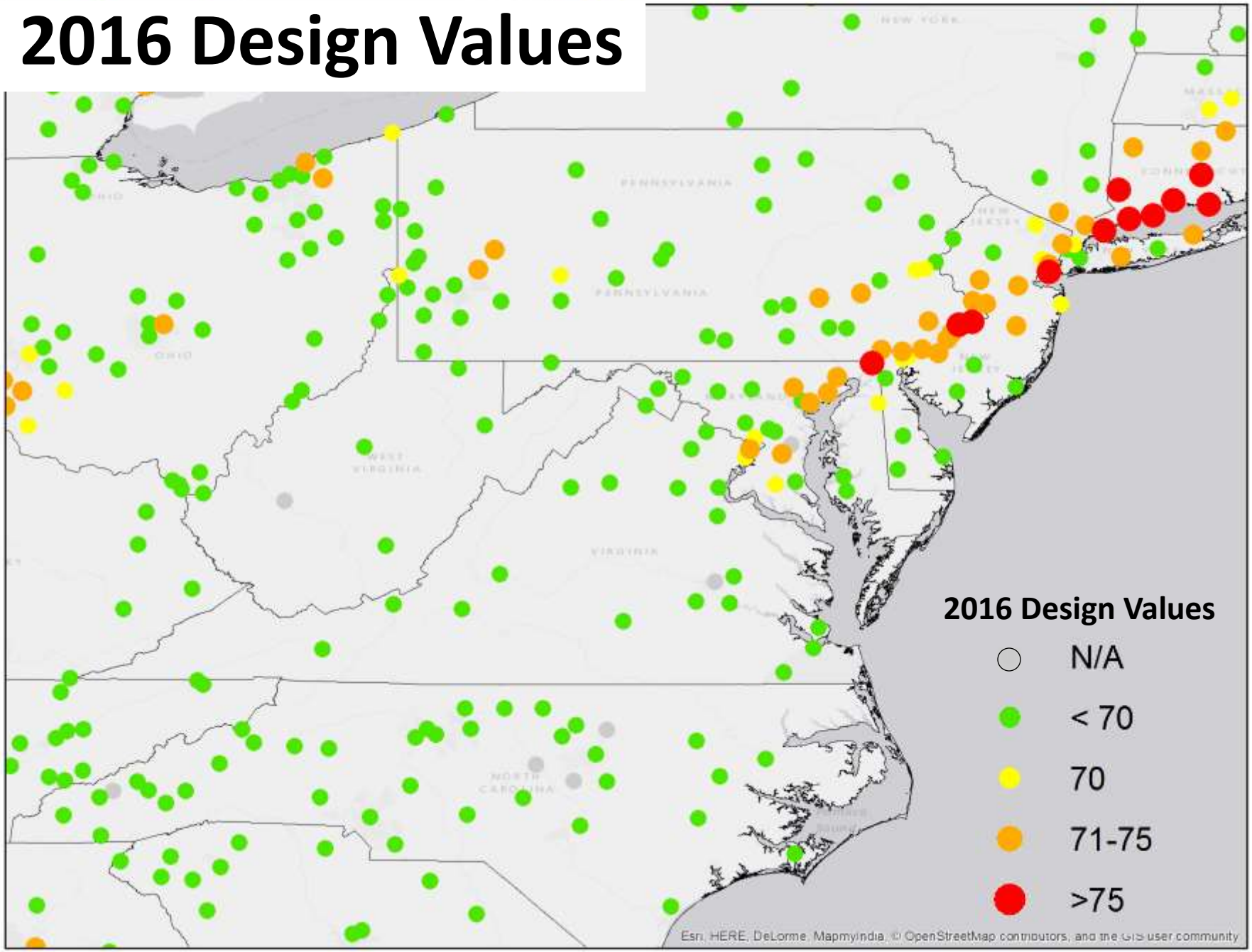
2015 Design Values



*Data Source: Tom Downs (ME)

*Data is preliminary

2016 Design Values



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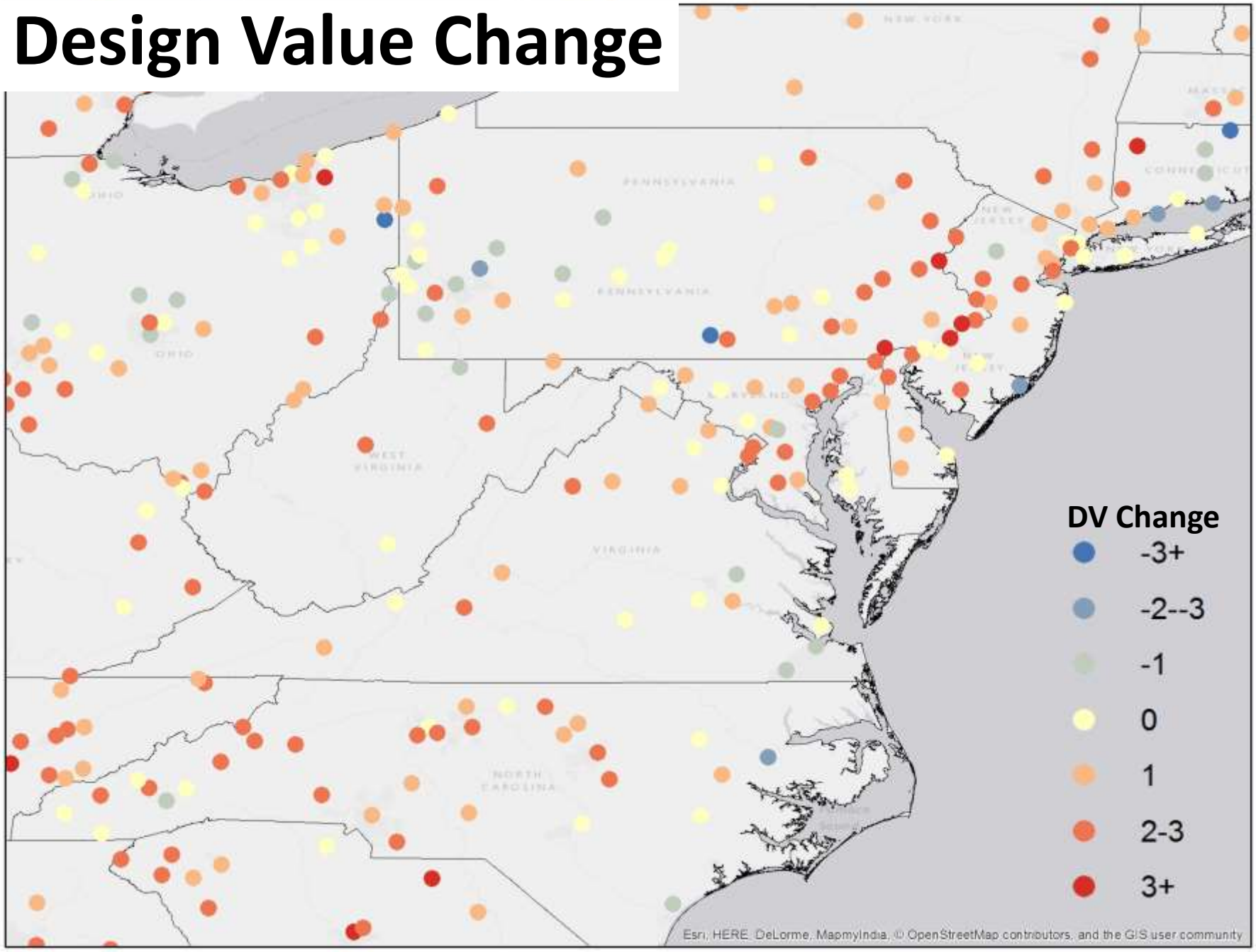
Design Value Change



*Data Source: Tom Downs (ME)

*Data is preliminary

Summary

- As expected, ozone exceedance numbers increased in 2016 given the new, lower EPA standard
- However when comparing similar exceedance thresholds, 2016 was near or in some instances below previous years despite well above normal temperatures.
- Local and regional emission reductions have clearly made an impact on exceedance days
- It is more important than ever that power plants operate their controls every day during ozone season

Summary cont.

- The classic model for high ozone in the Mid-Atlantic not sufficient
  - Exceedances becoming more isolated relying heavily on meso/microscale conditions
- Bay readings from the Hart Miller Island monitor showed some validity to model forecasts
  - Still overestimations

Contact Info

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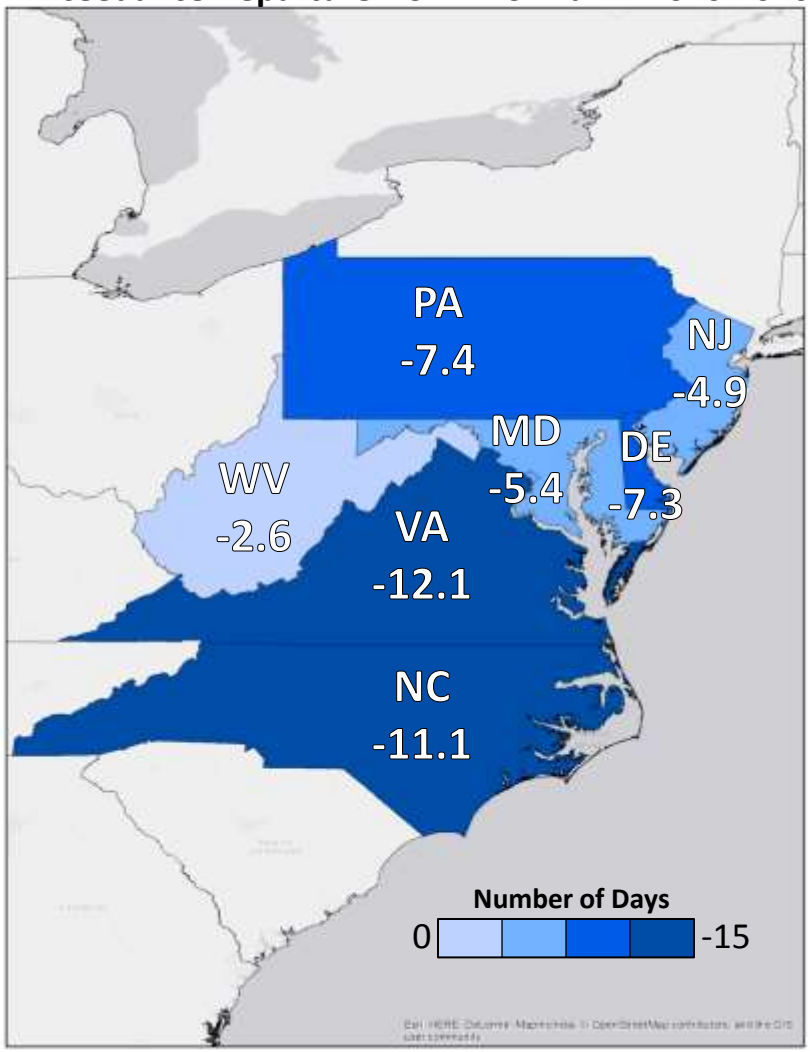
410-537-3871
james.boyle@maryland.gov

Air Monitoring Program
Air and Radiation Management Administration

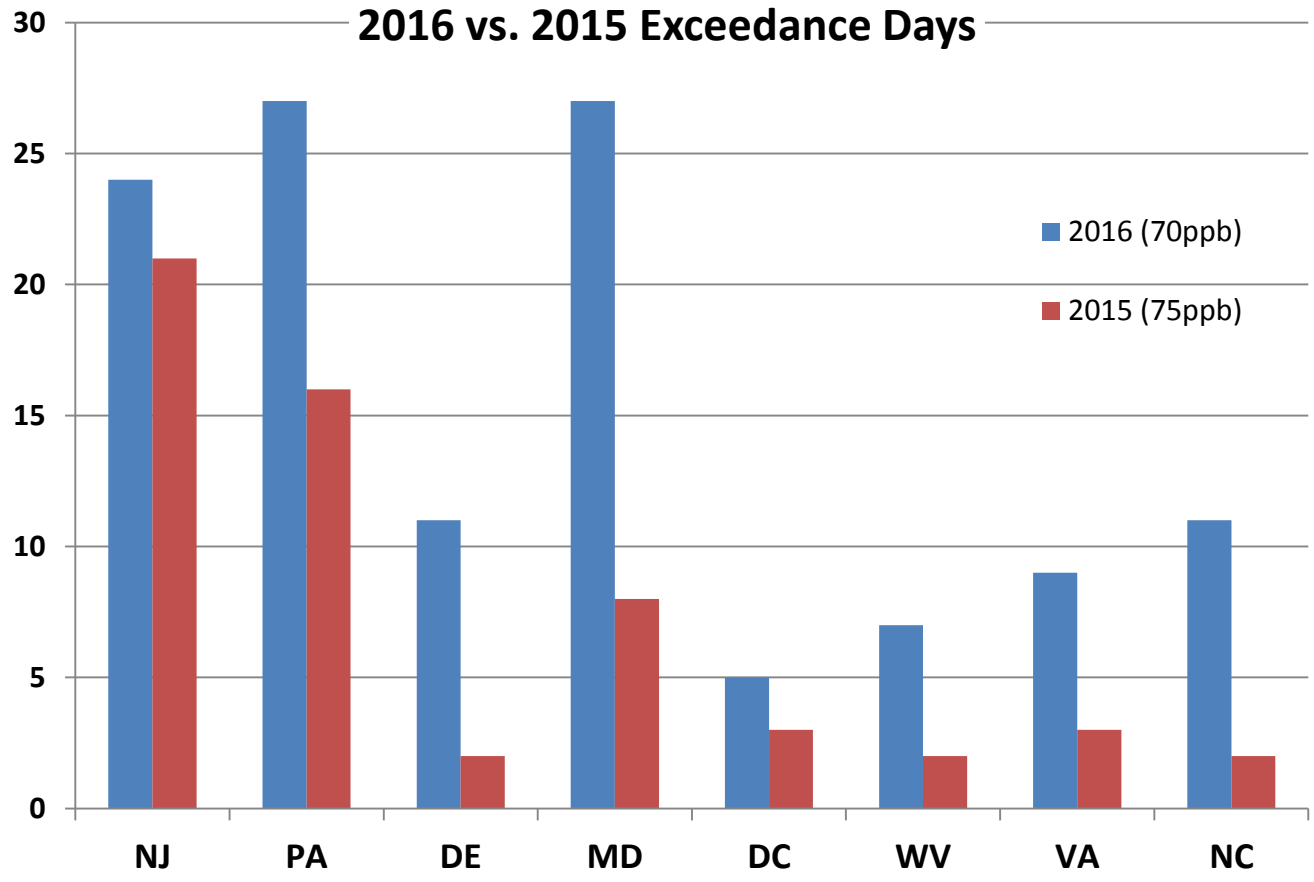
MARYLAND
DEPARTMENT OF THE ENVIRONMENT

Extra Material

2016 Ozone Season:
Exceedance Departure from "Normal" – 2010-2016

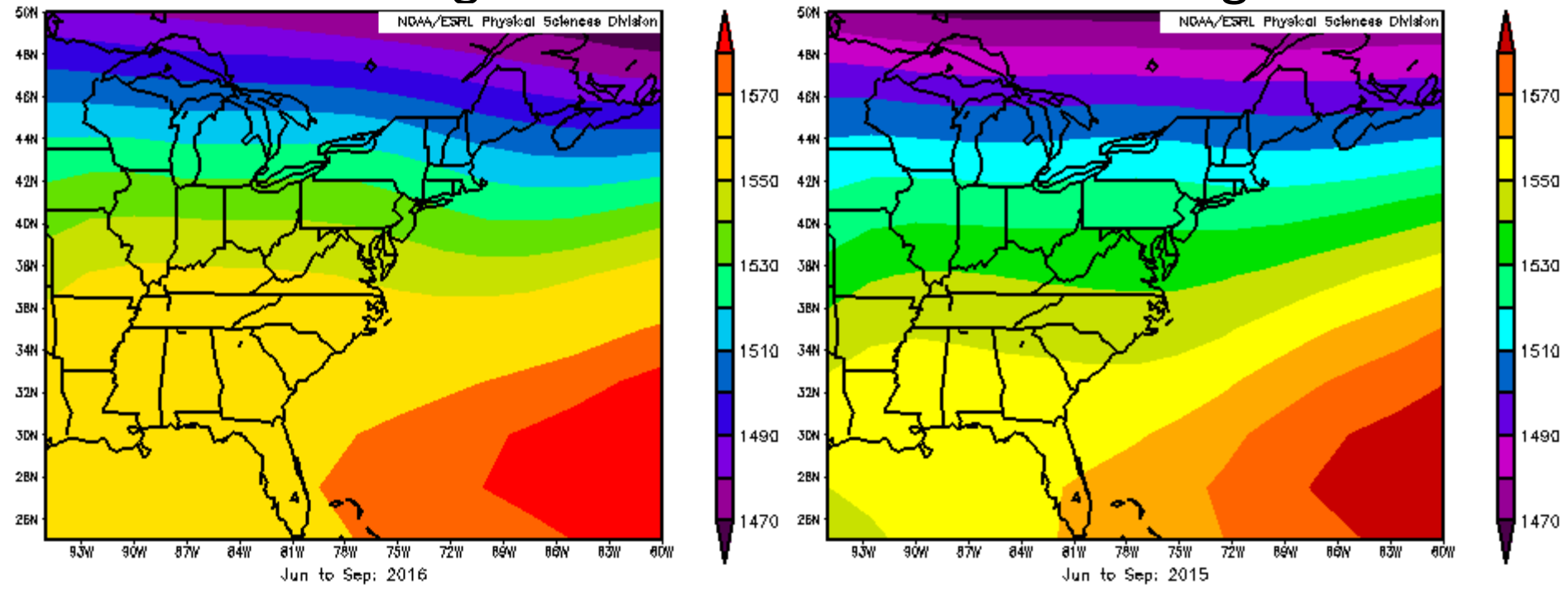


*2016 Data is preliminary.


2016 vs. 2015 Exceedance Days
30
25
20
15
10
5
0
2016 (70ppb)
2015 (75ppb)
NJ
PA
DE
MD
DC
WV
VA
NC

850 Geopotential Heights

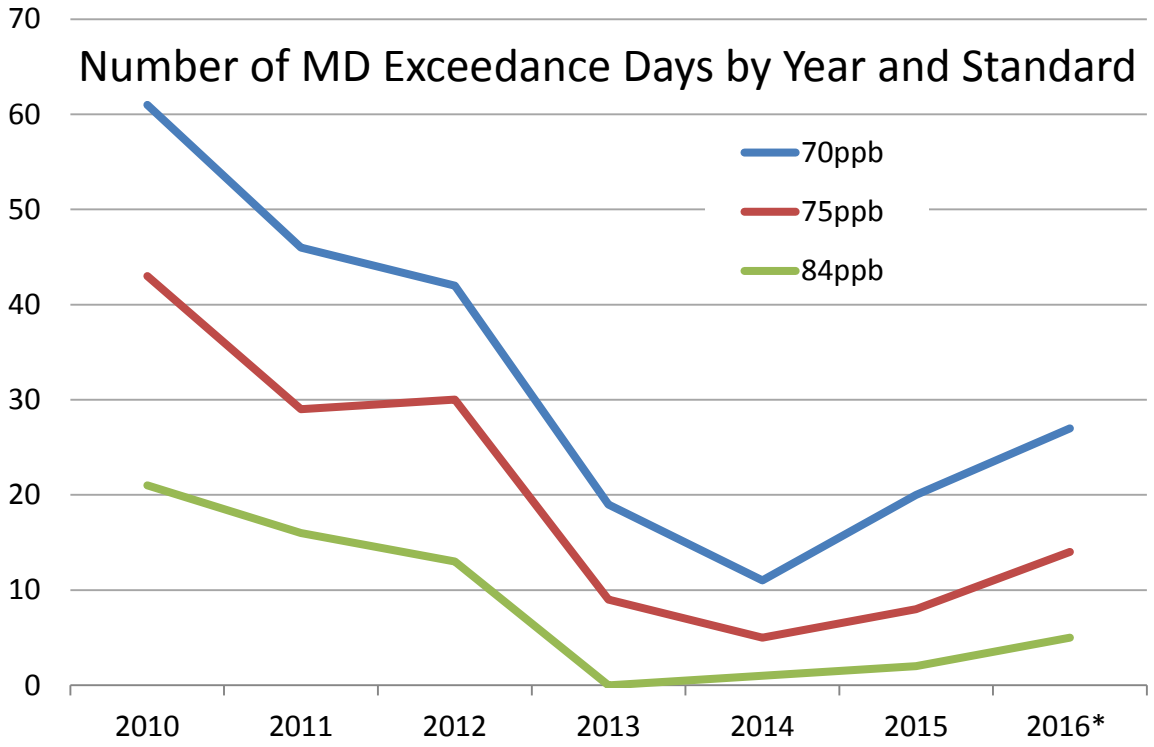
2016 JJAS Average



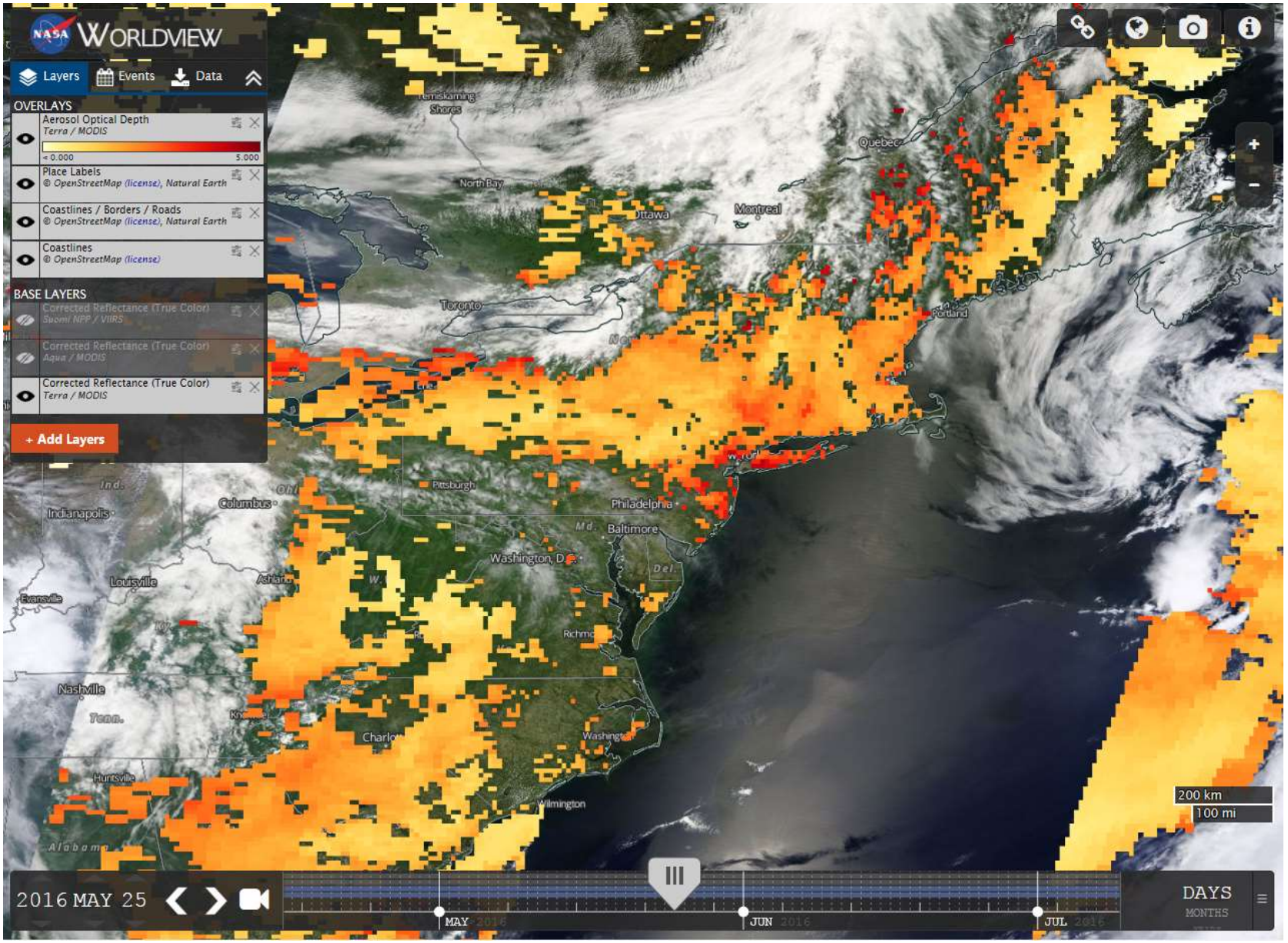
2015 JJAS Average

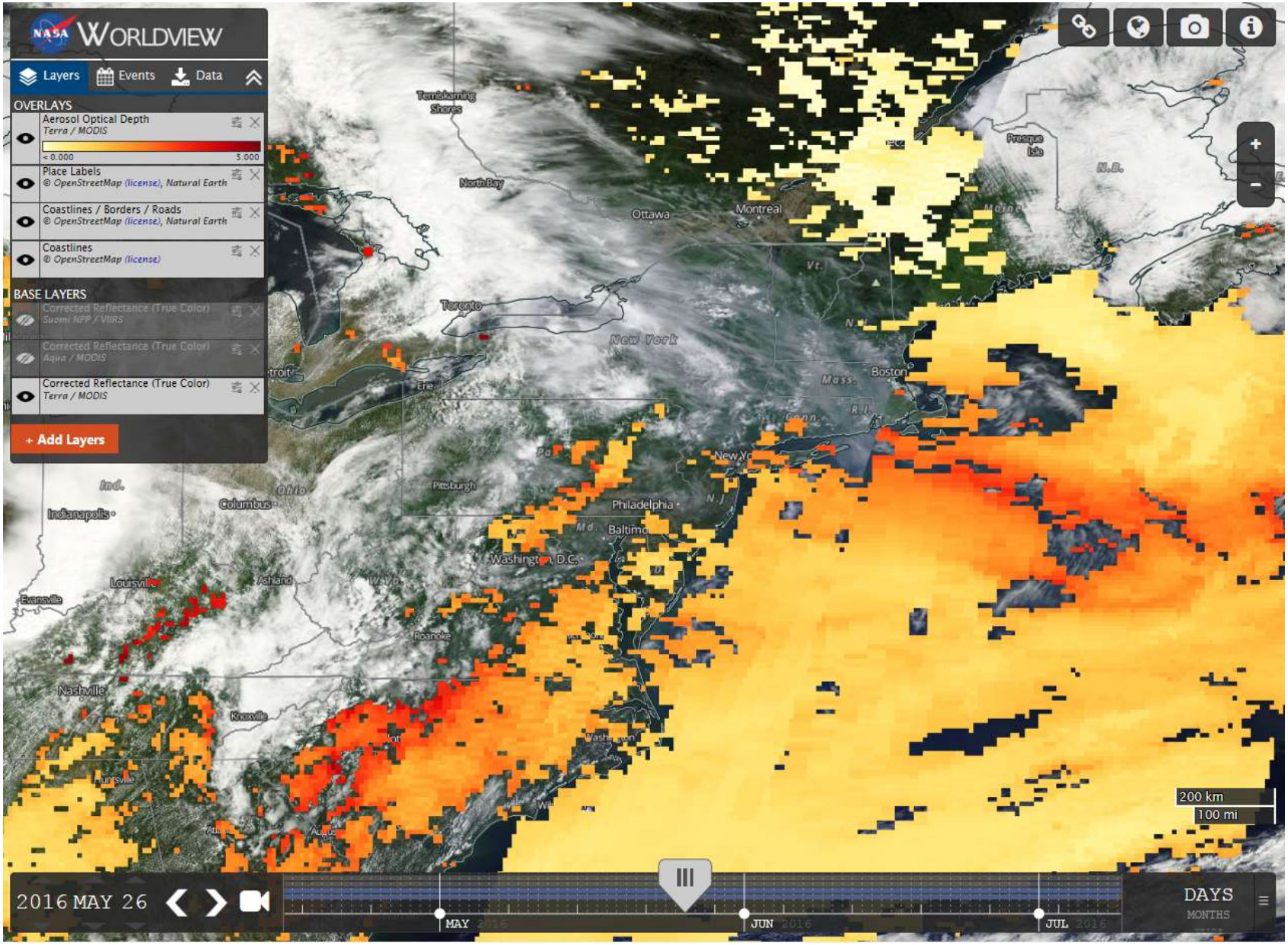
2016 Overview

- Much hotter than normal summer suggests a very strong ozone season
- Maryland saw only modest increases in ozone in 2016 over the past few years despite higher temperatures
- Most states actually saw a decrease from 2015



Why not a similar number to 2011 or 2012?


WORLDVIEW
Layers
Events
Data
OVERLAYS
Aerosol Optical Depth
Terra / MODIS
< 0.000
5.000
Place Labels
© OpenStreetMap (license), Natural Earth
Coastlines / Borders / Roads
© OpenStreetMap (license), Natural Earth
Coastlines
© OpenStreetMap (license)
BASE LAYERS
Corrected Reflectance (True Color)
Suomi NPP / VIIRS
Corrected Reflectance (True Color)
Aqua / MODIS
Corrected Reflectance (True Color)
Terra / MODIS
+ Add Layers
Temiskaming Shores
North Bay
Ottawa
Montreal
Quebec
Toronto
Portland
Pittsburgh
Philadelphia
Baltimore
Washington, D.C.
Columbus
Indianapolis
Louisville
Evansville
Nashville
Huntsville
Wilmington
200 km
100 mi
2016 MAY 25
MAY 2016
JUN 2016
JUL 2016
DAYS
MONTHS


NASA WORLDVIEW
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Events
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Aerosol Optical Depth
Terra / MODIS
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Place Labels
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North Bay
Ottawa
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Philadelphia
Baltimore
Washington, D.C.
Columbus
Indianapolis
Louisville
Evansville
Ashland
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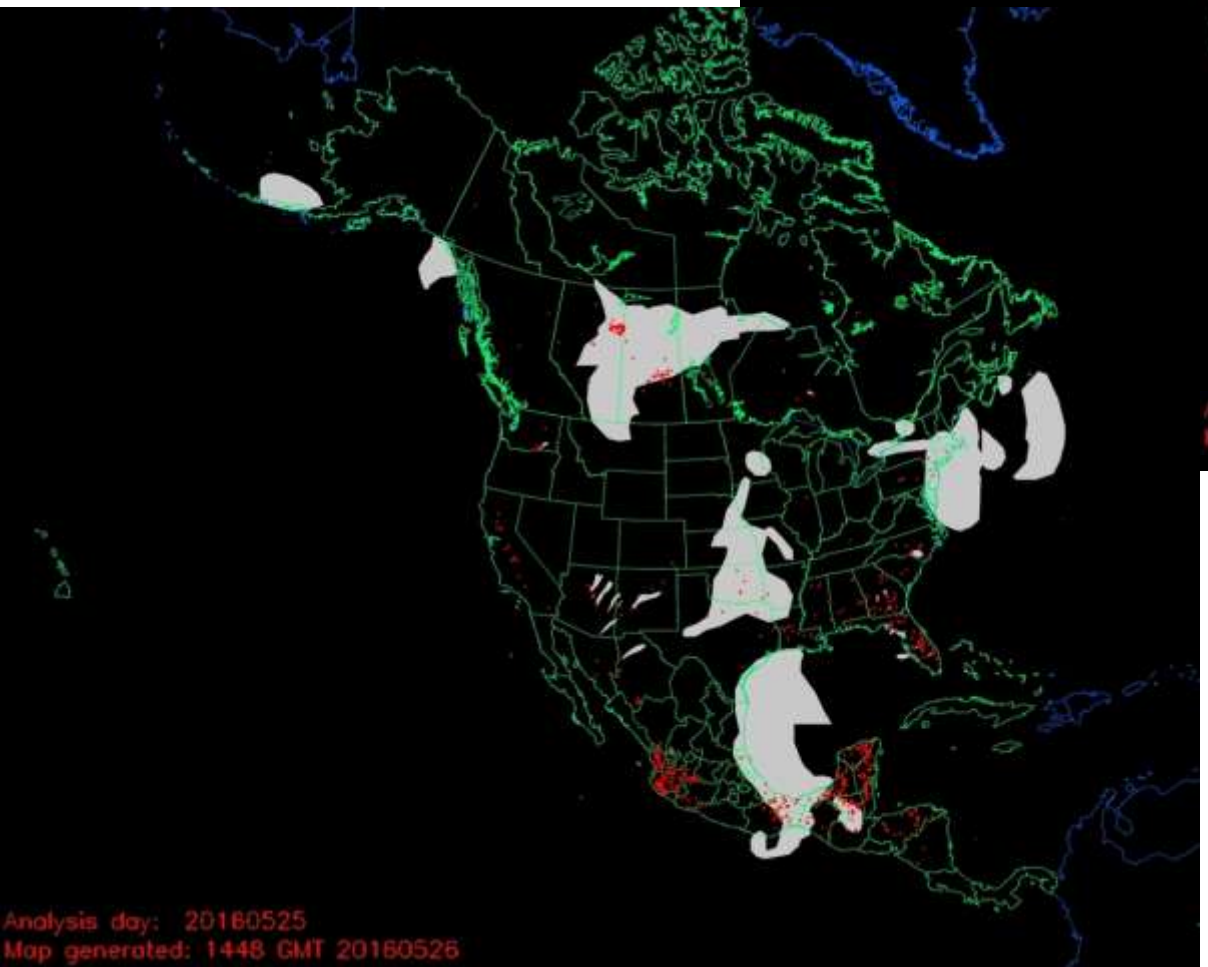
Nashville
Knoxville
200 km
100 mi
2016 MAY 26
MAY 2016
JUN 2016
JUL 2016
DAYS
MONTHS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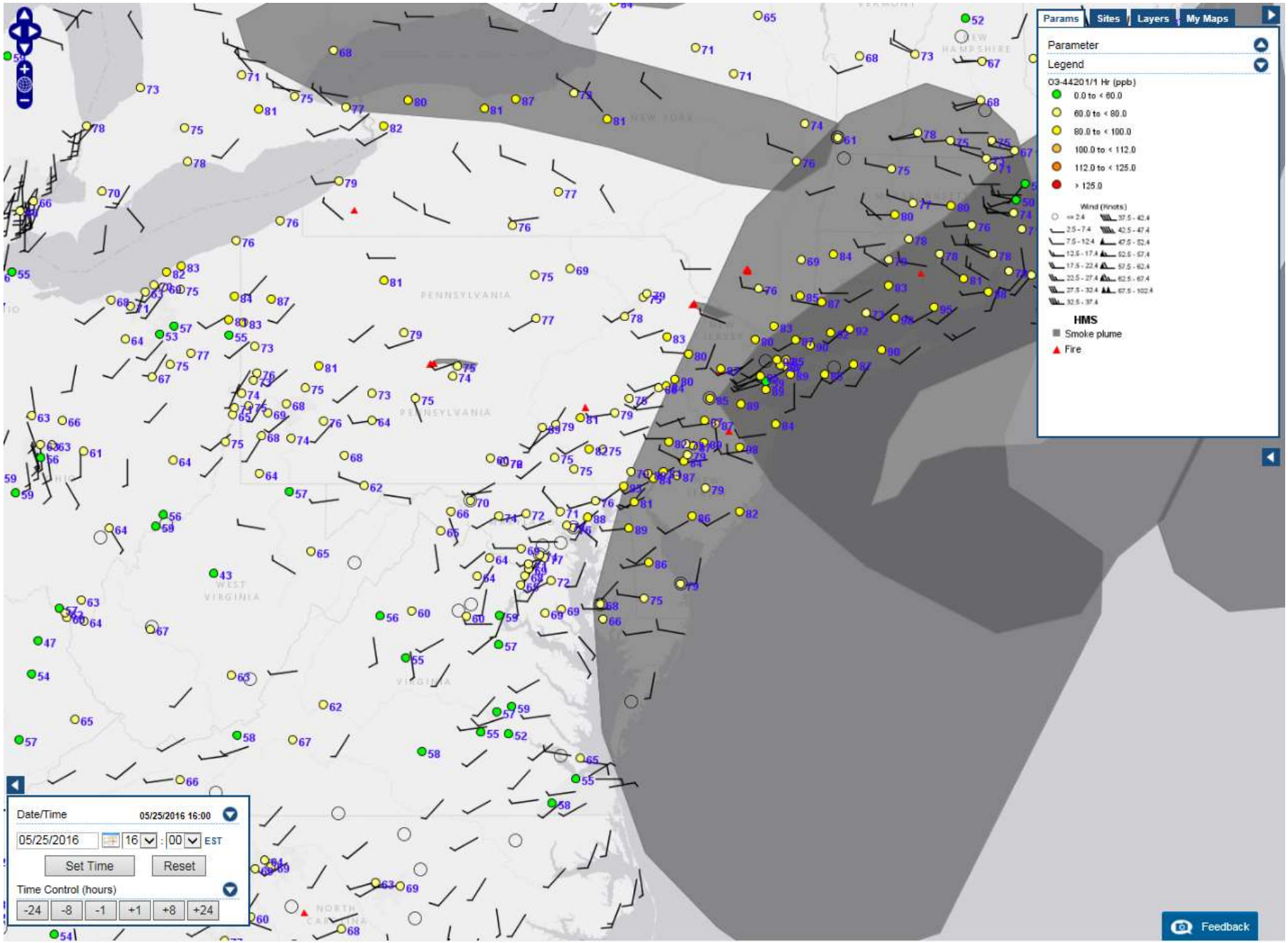
Map generated: 1448 GMT 20160526

Analysis day: 20160526
Map generated: 1517 GMT 20160527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Legend
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60.0 to < 80.0
80.0 to < 100.0
100.0 to < 112.0
112.0 to < 125.0
> 125.0
Wind (Knots)
HMS
Smoke plume
Fire
Date/Time
05/25/2016 16:00
05/25/2016
16
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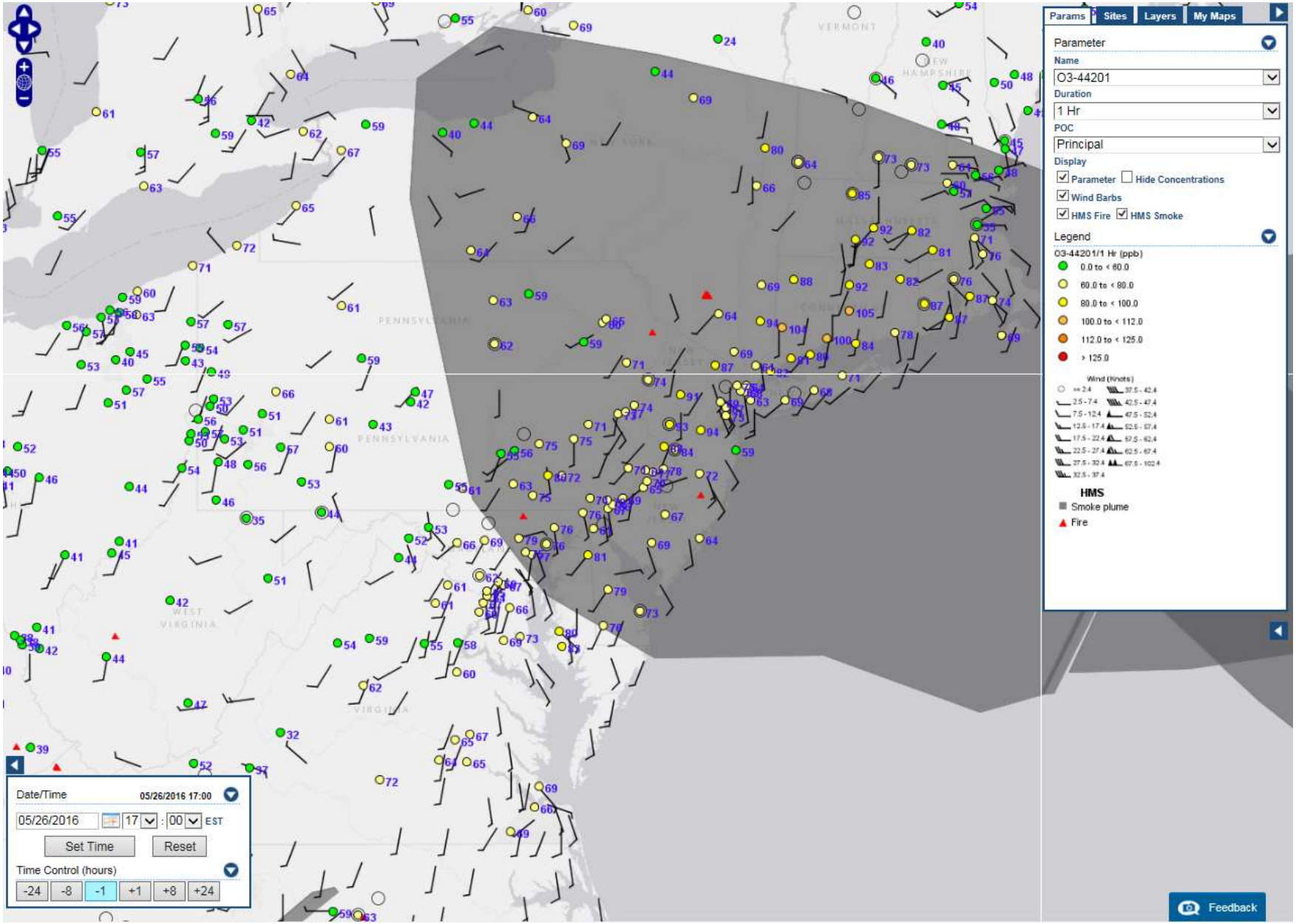
EST
Set Time
Reset
Time Control (hours)
-24
-8
-1
+1
+8
+24
Feedback
PENNSYLVANIA
WEST VIRGINIA
VIRGINIA
NEW YORK
NEW HAMPSHIRE
NORTH CAROLINA


Params
Sites
Layers
My Maps
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Name
O3-44201
Duration
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POC
Principal
Display
Parameter
Hide Concentrations
Wind Barbs
HMS Fire
HMS Smoke
Legend
O3-44201/1 Hr (ppb)
0.0 to < 60.0
60.0 to < 80.0
80.0 to < 100.0
100.0 to < 112.0
112.0 to < 125.0
> 125.0
Wind (Knots)
HMS
Smoke plume
Fire
Date/Time
05/26/2016 17:00
05/26/2016
17
00
EST
Set Time
Reset
Time Control (hours)
-24
-8
-1
+1
+8
+24
Feedback