Connecticut Department of Energy and Environmental Protection

Connecticut Department of
ENERGY & ENVIRONMENTAL PROTECTION

2017 NOAA Model Performance for Connecticut

September 27, 2017

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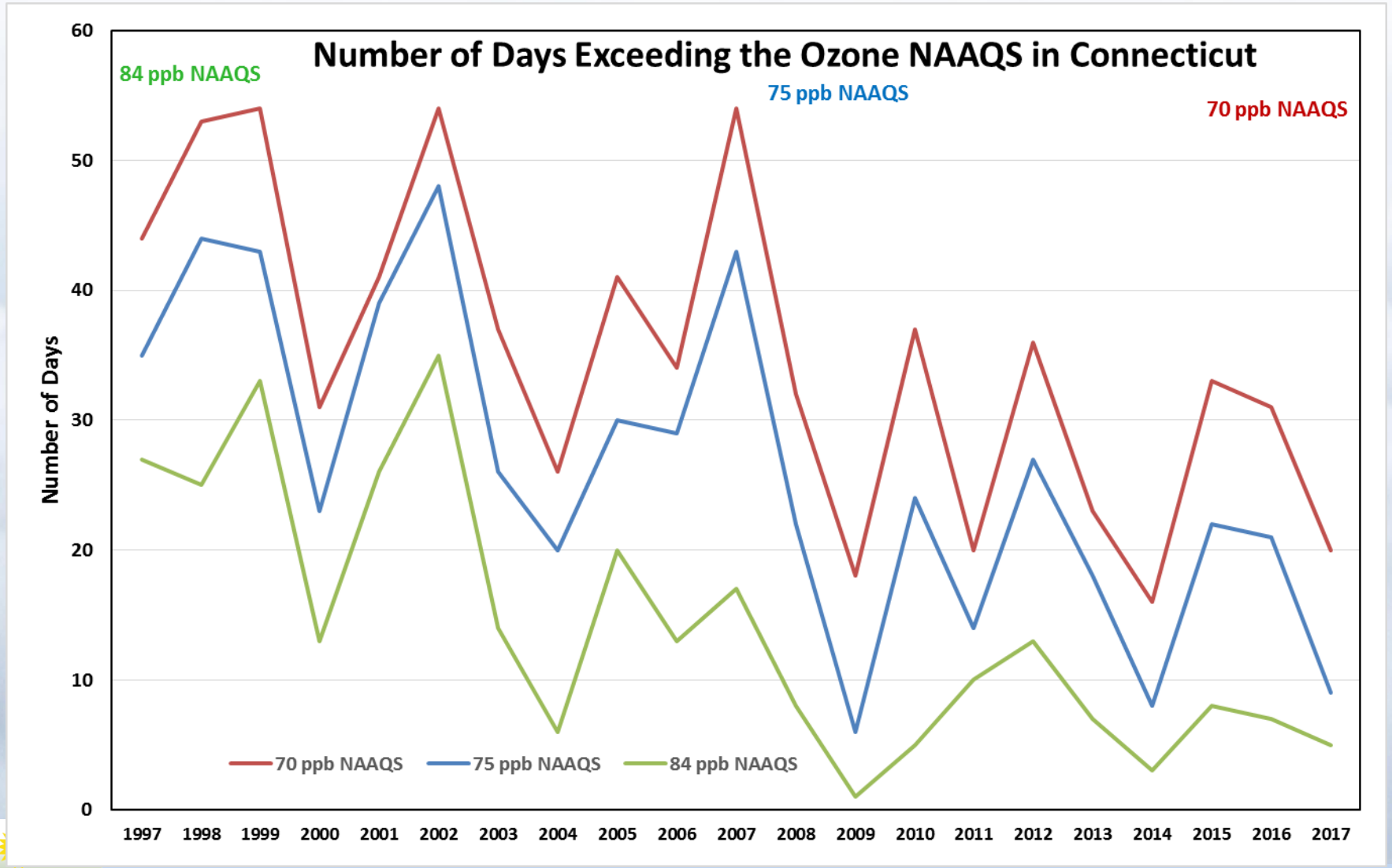
Connecticut Department of Energy and Environmental Protection

Ozone in Connecticut 2017

- 20 exceedance days in 2017 through September 18.

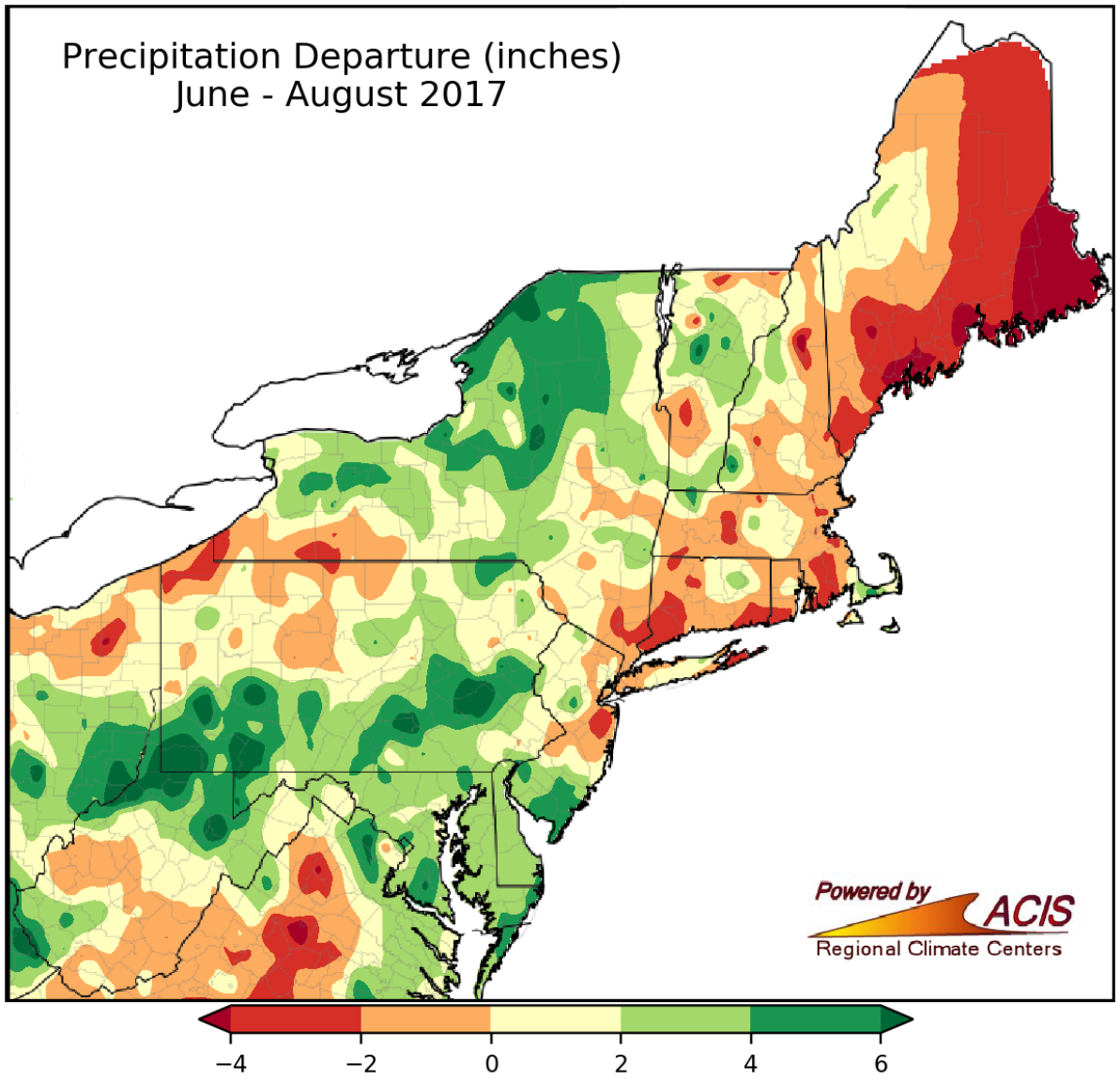
2017 Exceedances	May			June							July							August		
Site	17	18	19	10	11	12	13	21	22	30	3	8	11	12	18	19	20	3	10	22
Abington	82	79	56	69	75	79	66	56	54	59	47	59	51	52	48	60	59	52	53	50
Cornwall	77	67	54	69	62	67	61	51	64	64	41	50	44	49	59	54	56	63	58	65
Danbury	78	72	58	72	63	71	66	54	72	74	50	54	55	53	72	60	65	75	61	72
East Hartford	78	75	52	72	64	65	60	52	59	71	44	56	46	64	62	56	56	62	56	62
Greenwich	74	86	58	70	72	90	74	61	65	66	57	58	60	66	57	68	84	68	69	54
Groton	67	90	76	71	78	81	90	69	50	47	63	65	67	75	44	61	72	43	57	44
Madison	70	90	76	70	80	97	95	75	58	54	71	71	74	86	48	76	76	52	67	49
Middletown	81	86	59	76	79	85	71	57	69	69	51	64	57	68	58	72	76	58	56	58
New Haven	65	85	60	62	75	89	47	57	43	49	53	M	56	67	46	74	79	52	66	M
Stafford	84	77	54	72	63	68	59	53	63	70	44	56	43	56	51	54	56	60	53	62
Stratford	71	91	70	72	80	95	88	74	65	61	66	66	68	77	54	76	81	65	73	58
Westport	73	90	64	75	79	97	81	64	70	63	56	62	63	70	59	73	90	68	75	58
# days > Federal Standard	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Trend Graph


Number of Days Exceeding the Ozone NAAQS in Connecticut
84 ppb NAAQS
75 ppb NAAQS
70 ppb NAAQS
Number of Days
60
50
40
30
20
10
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
70 ppb NAAQS
75 ppb NAAQS
84 ppb NAAQS

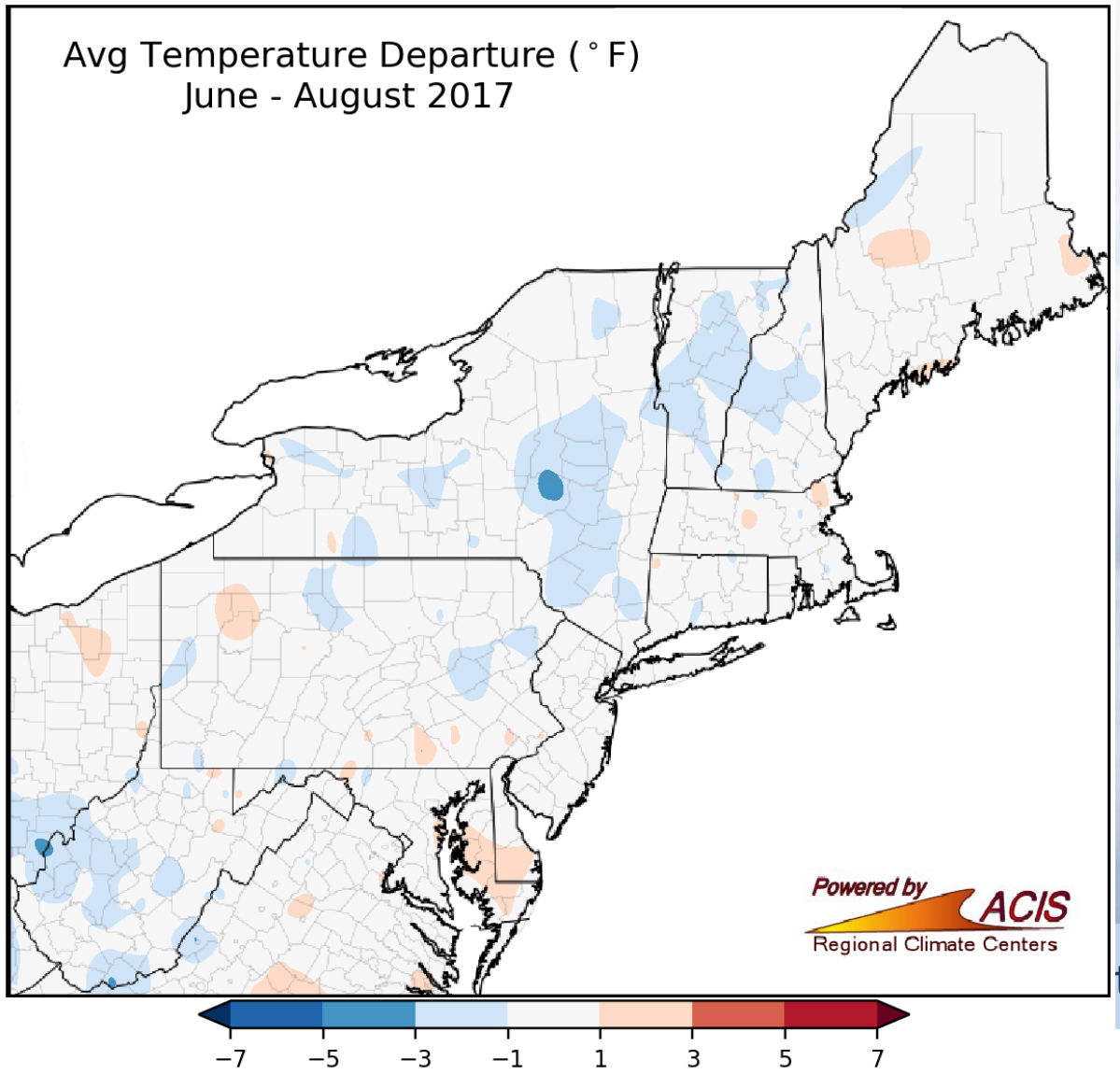
Summer Precipitation Summary

- Overall a drier summer for southern New England.

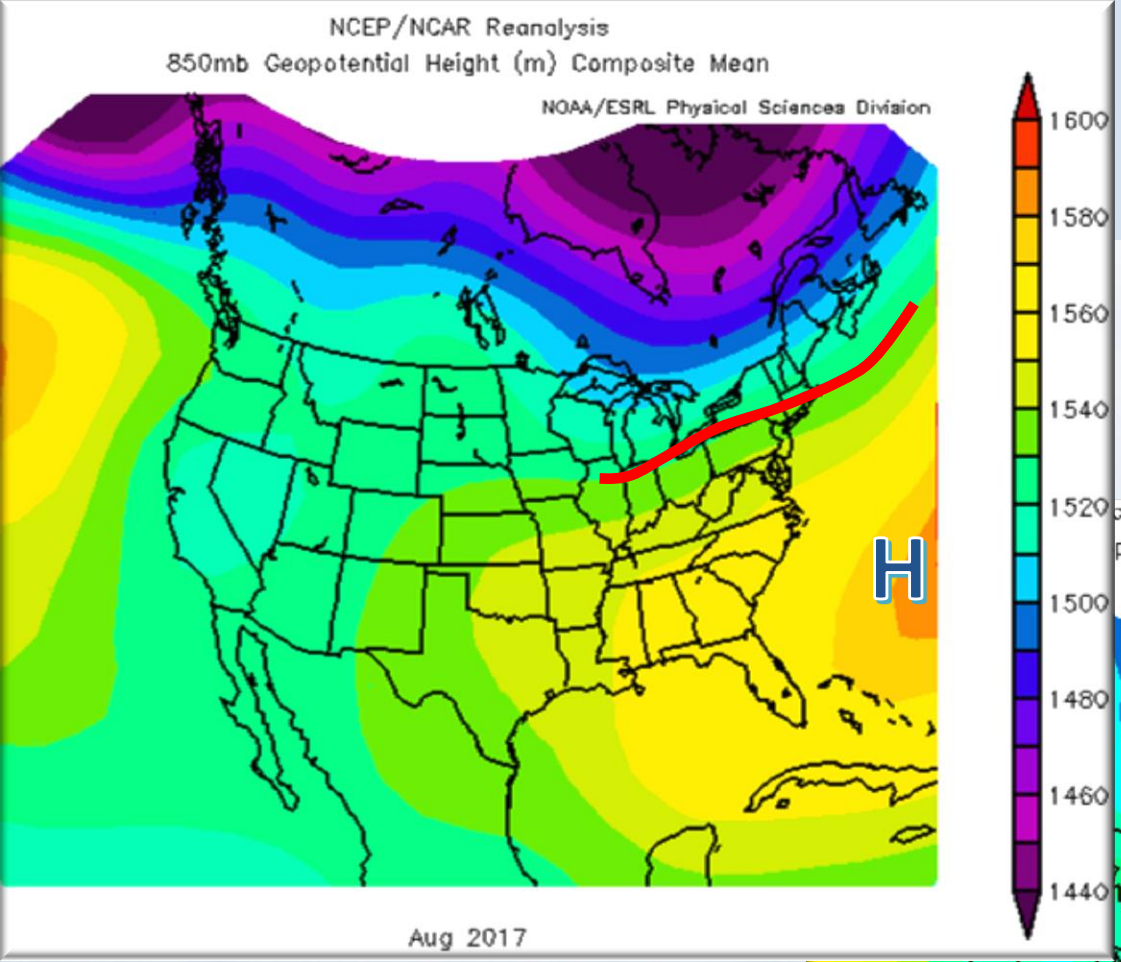


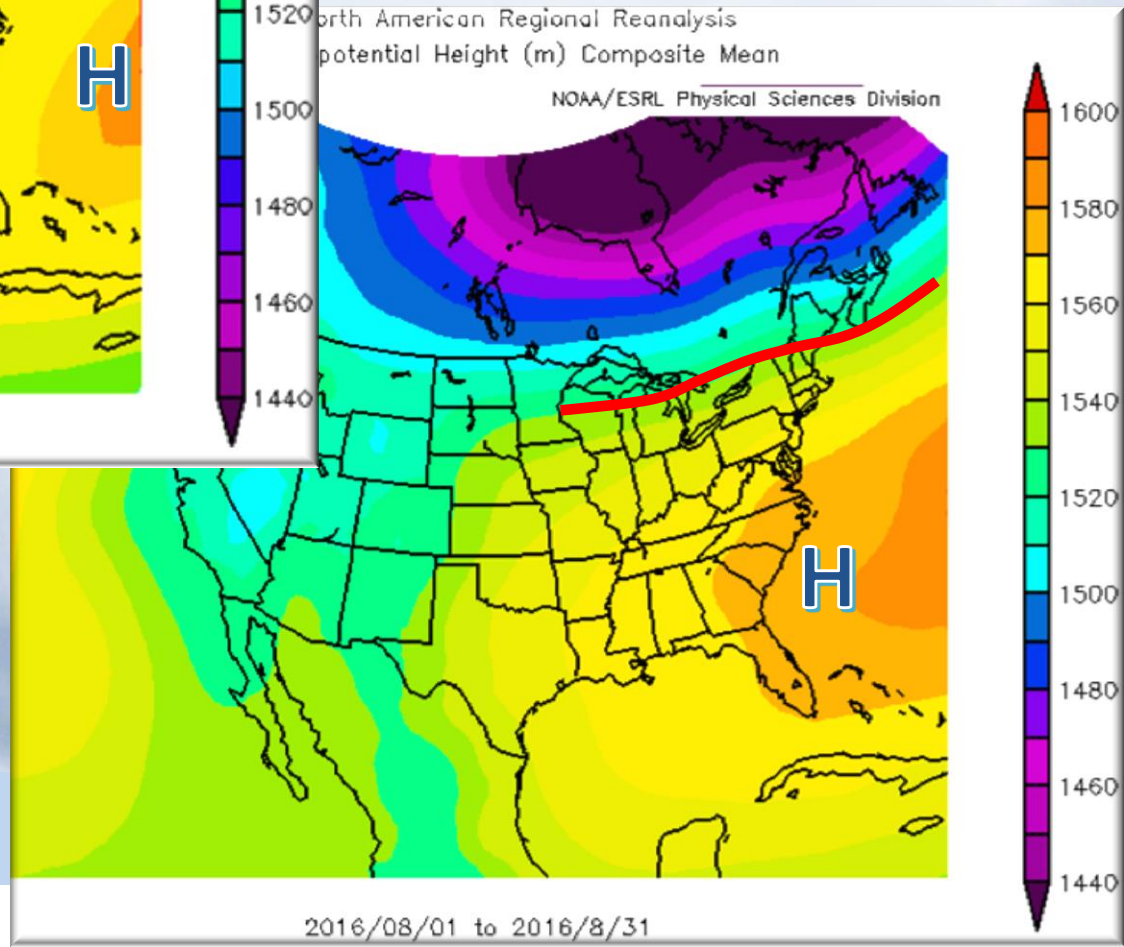
Summer Temperature summary

- Near normal for summer, but below average August;



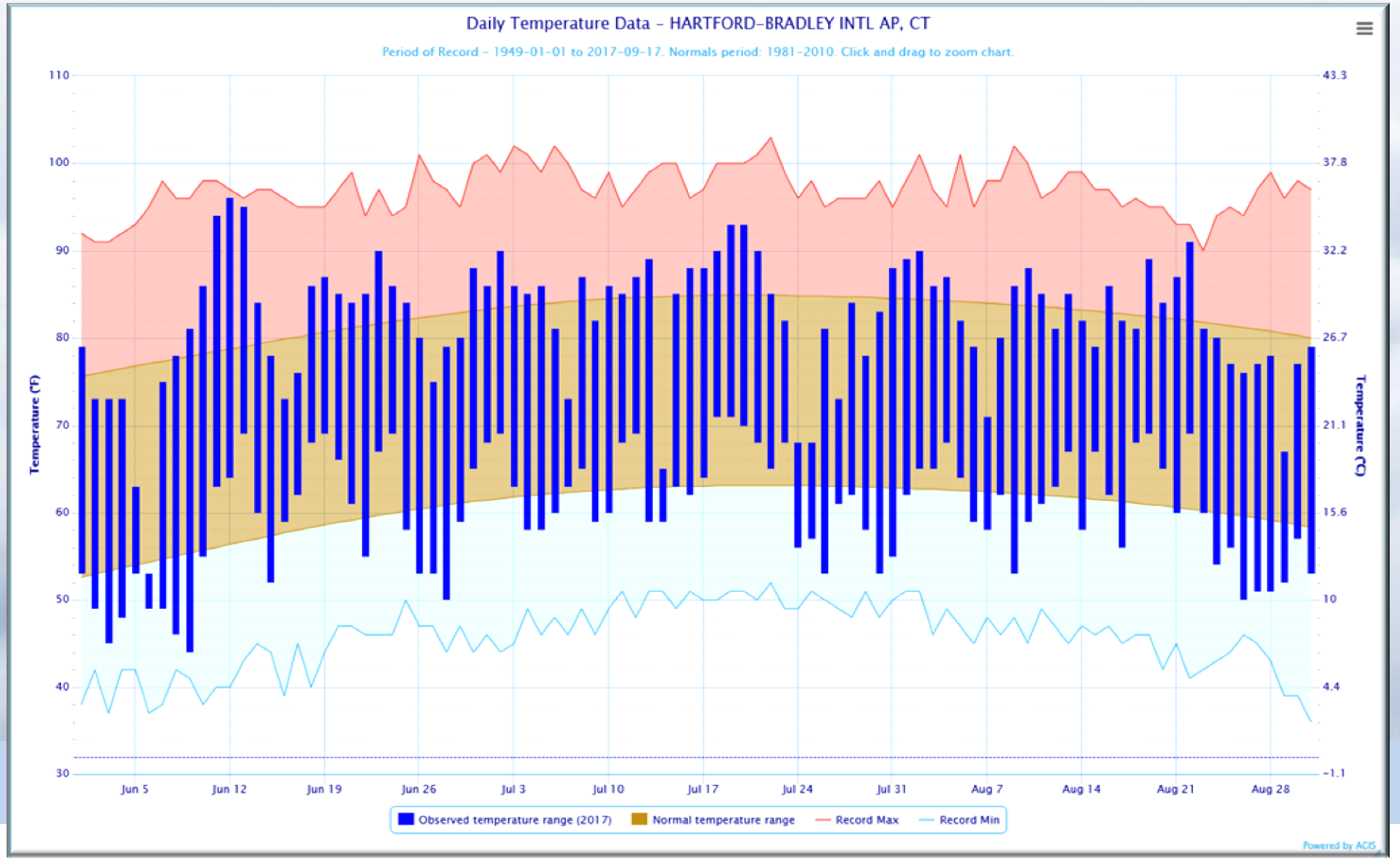
August 2016 vs. 2017 850mb pattern



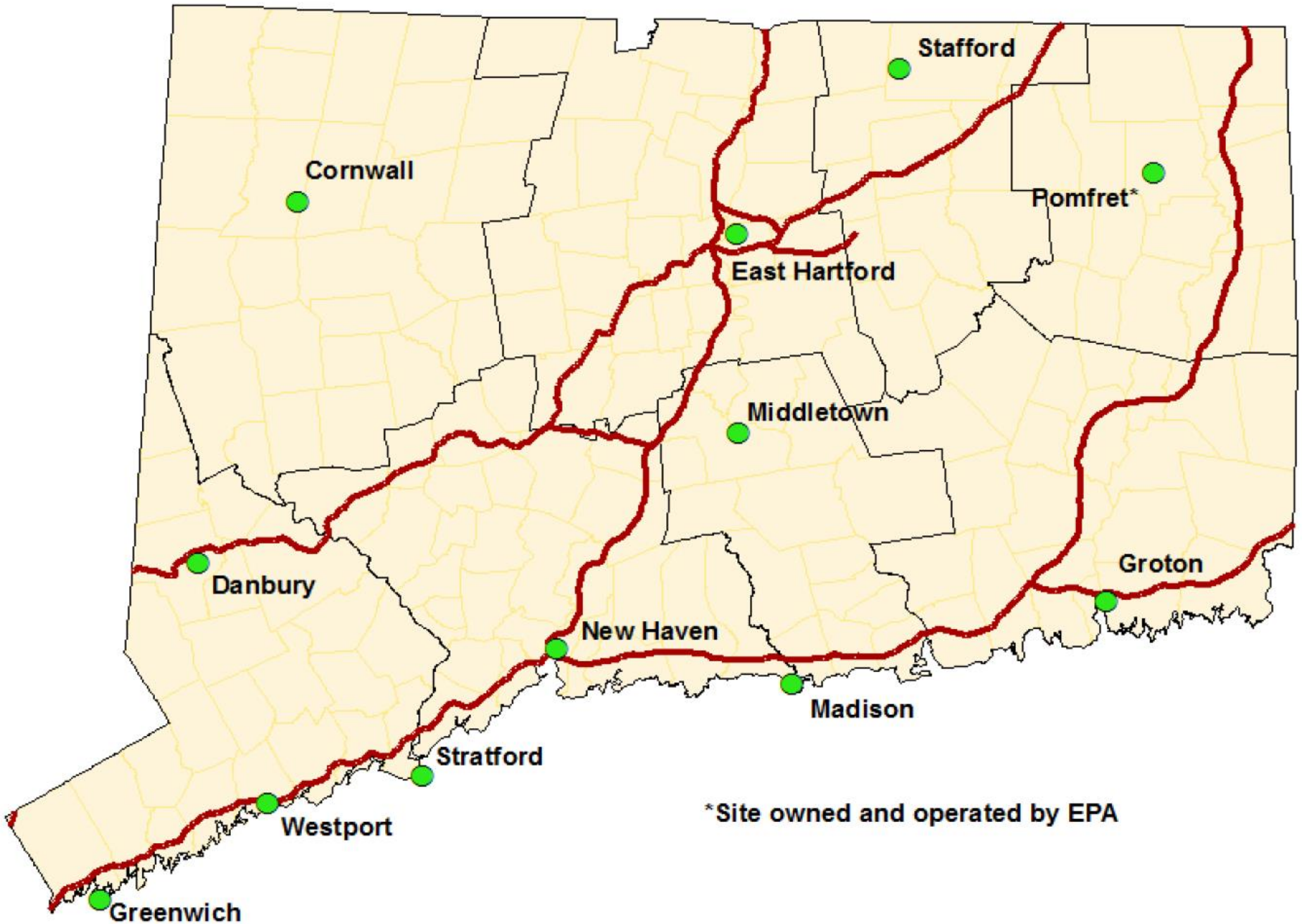


Note the distinct 850mb trough in 2017 with the 1530 dm depressed to the south of New England. The 850 mb high is also further east in the Atlantic. This allowed for a cooler weather pattern in August 2017.

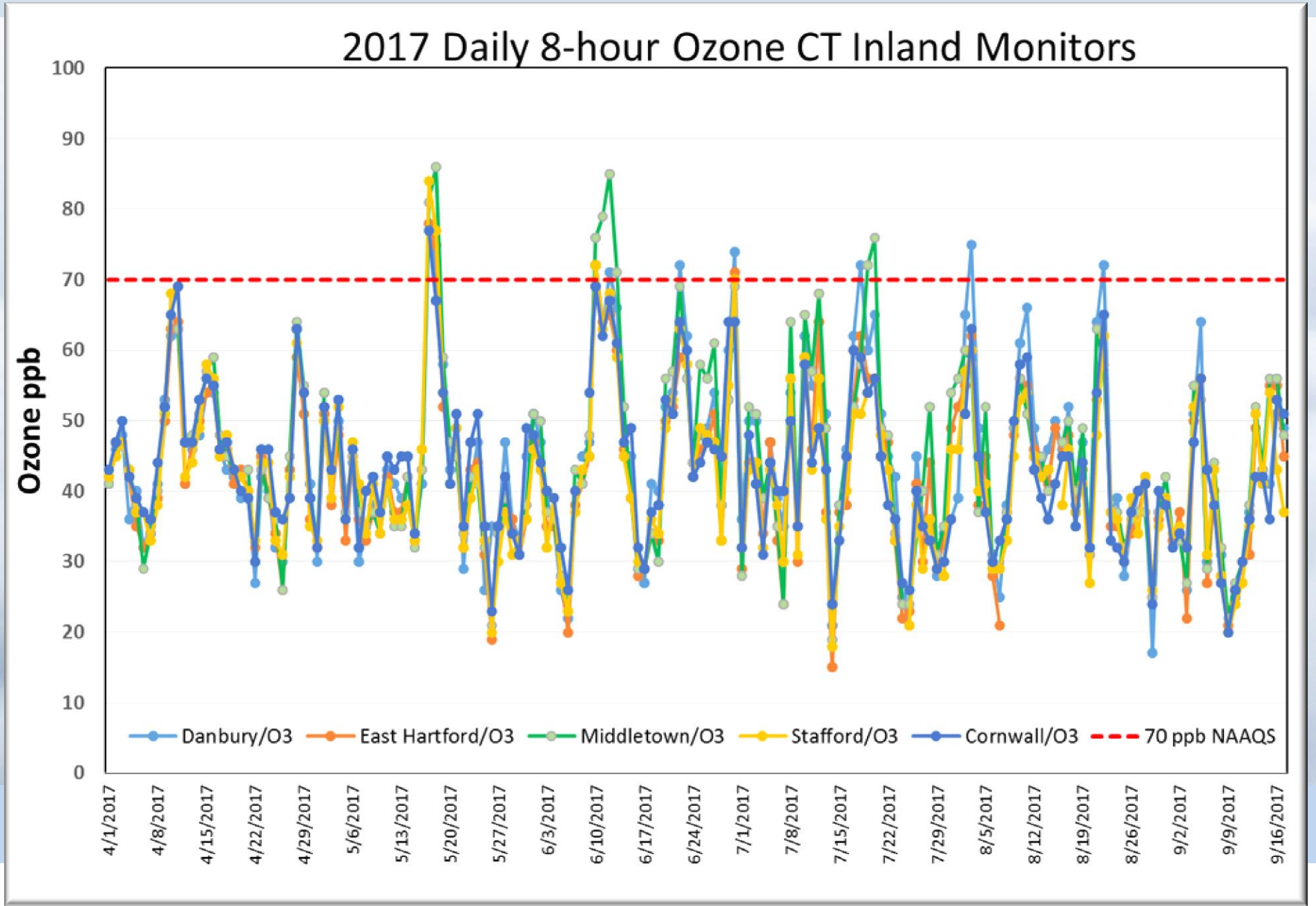
14 Days 90+ degrees at BDL Hartford



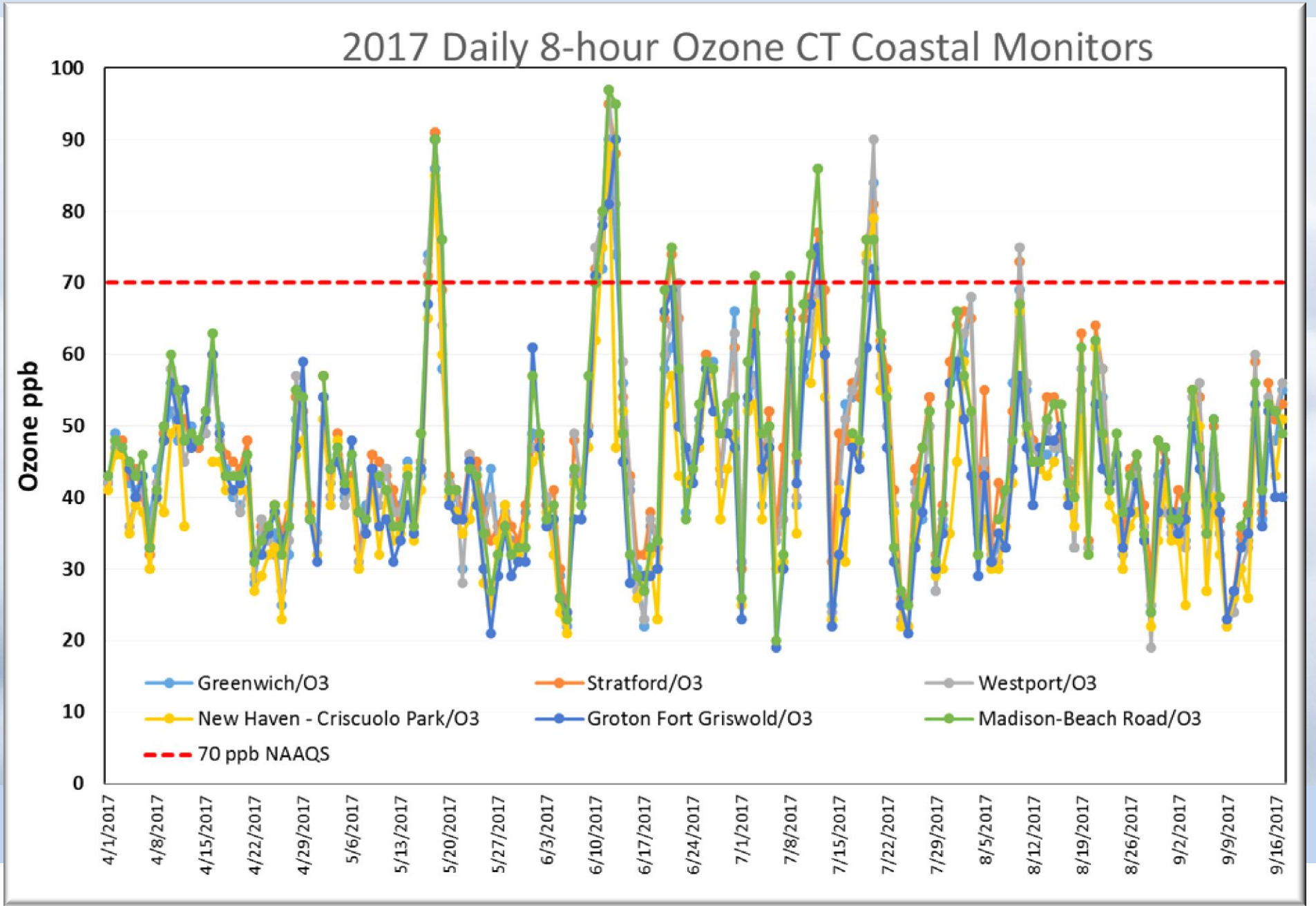
CT ozone Monitors



Inland Monitors



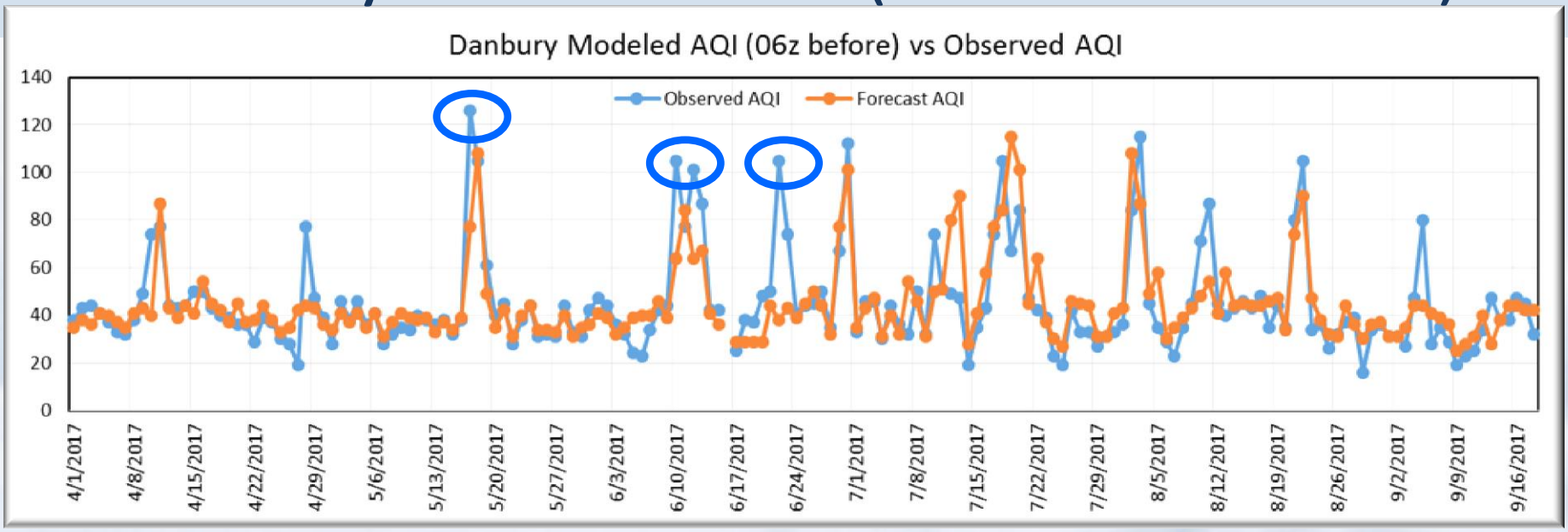
Coastal Monitors



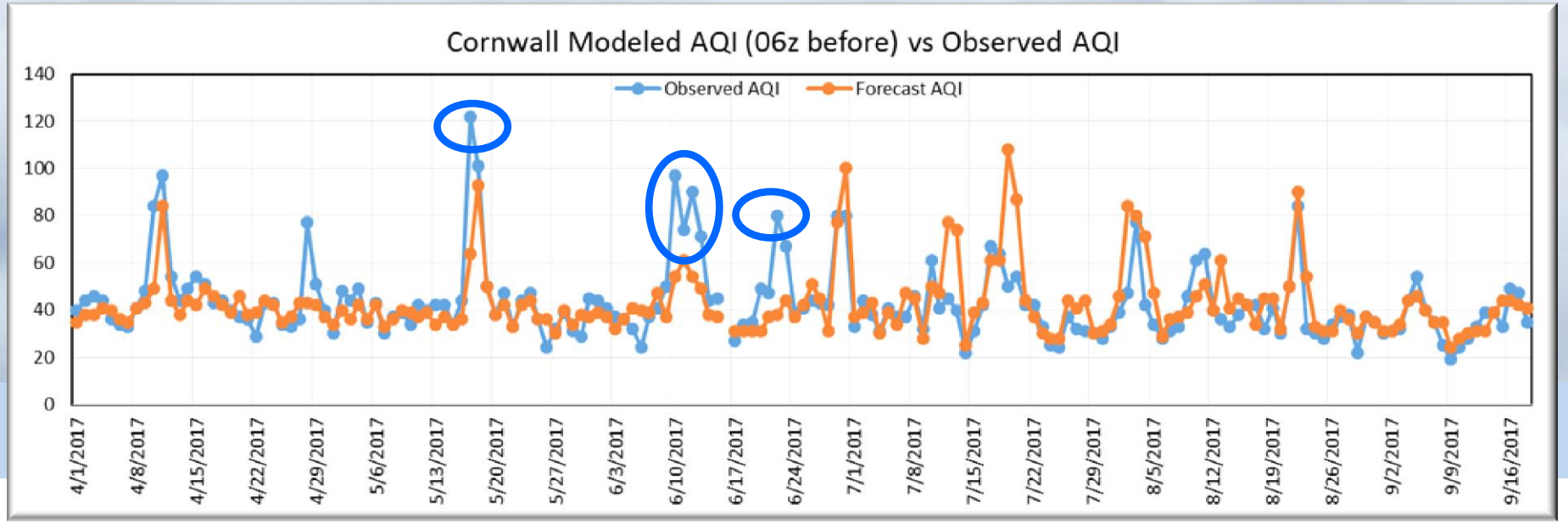
NOAA Model Performance

- The following charts were produced from AQI data from Airnowtech;
- The NOAA 06z Day 2 model run was plotted against the observed AQI values;
- The early season events of May 17-19 and June 10-13, 22 were generally under-predicted;
- July 22 was a notable over-prediction for the coastal sites.

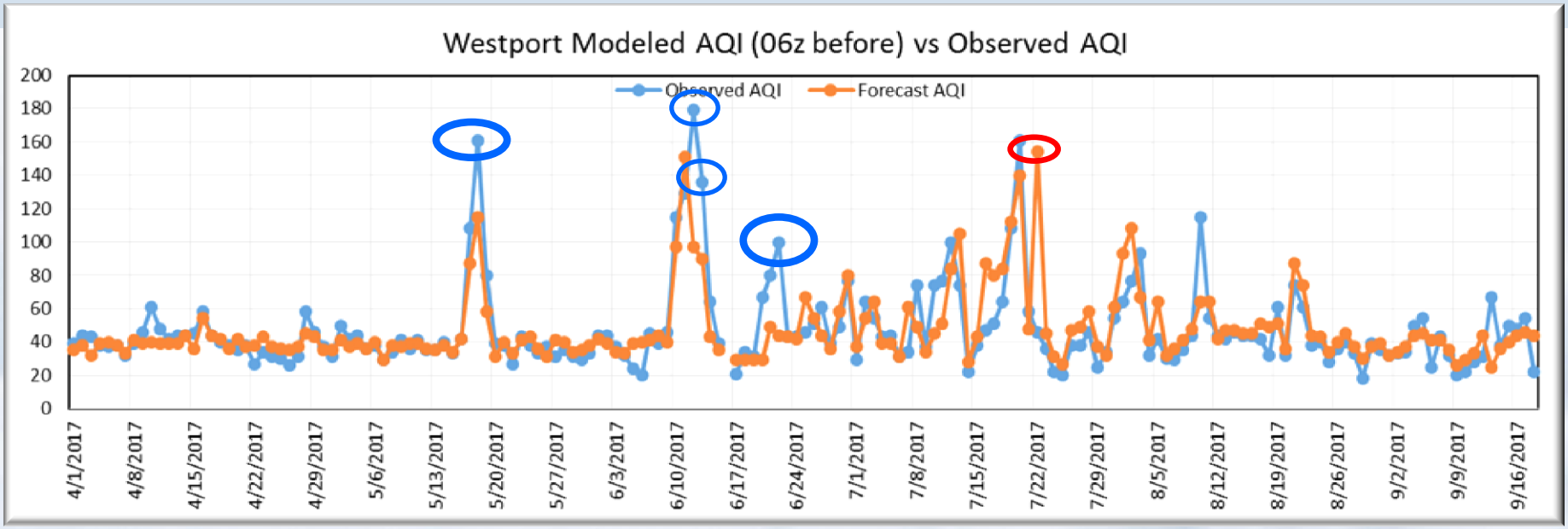
Danbury and Cornwall (Western Interior)



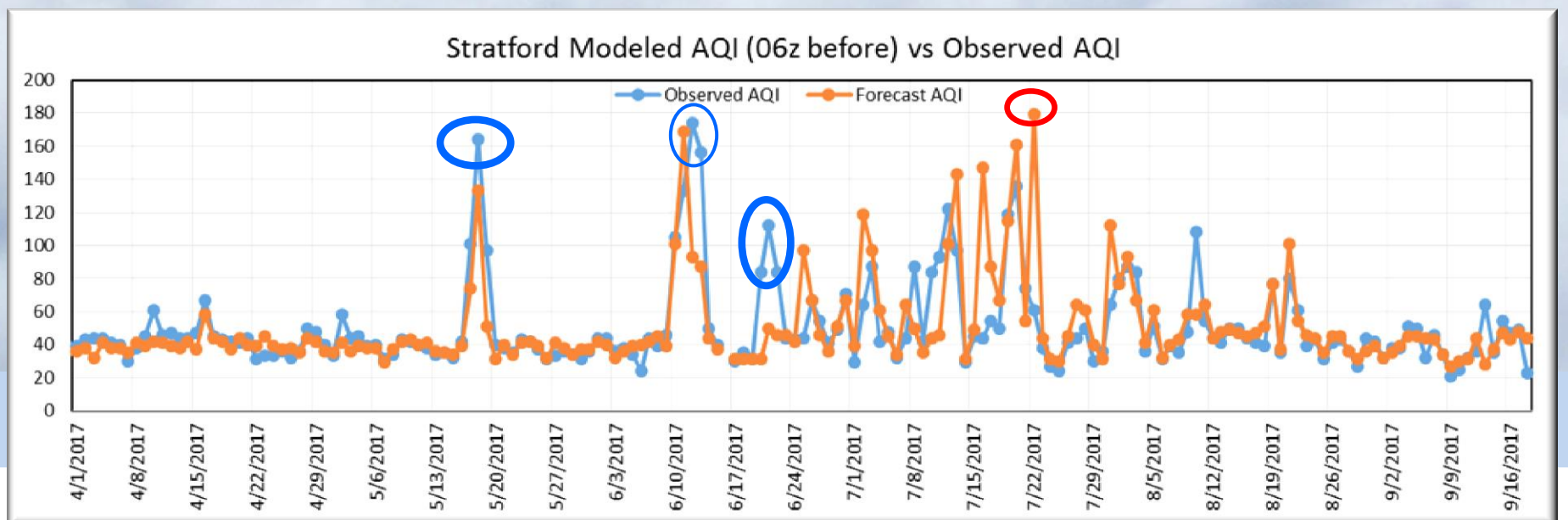
- The May and June events were under-predicted.



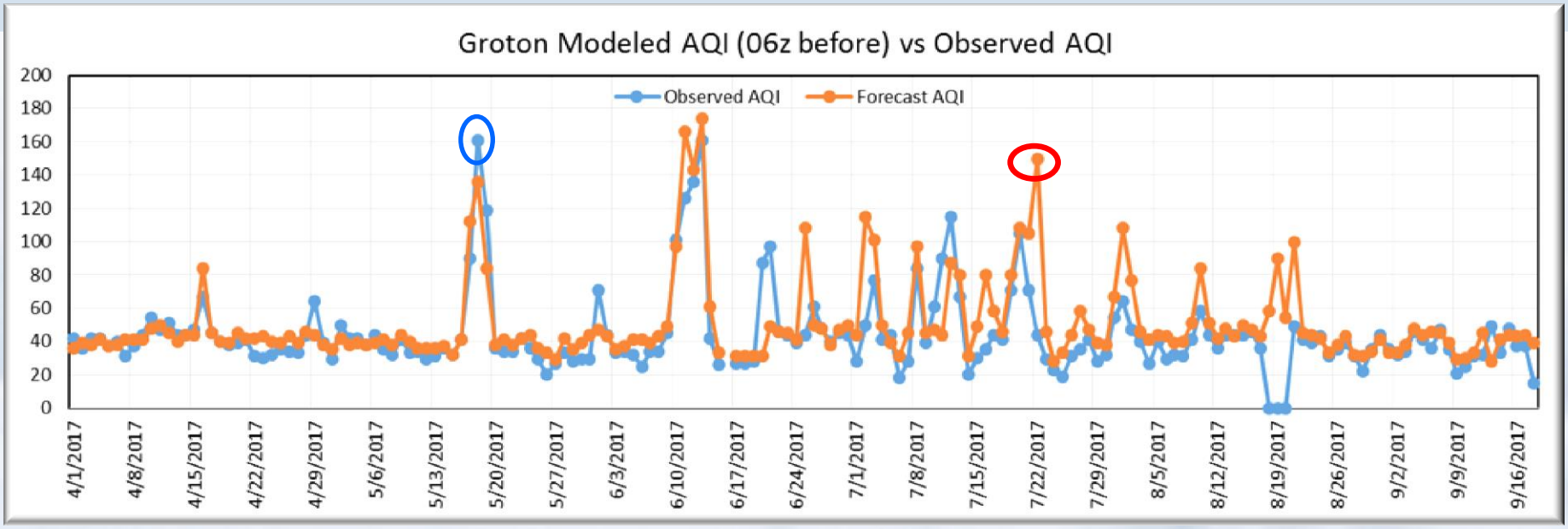
Westport and Stratford (West Coastal)



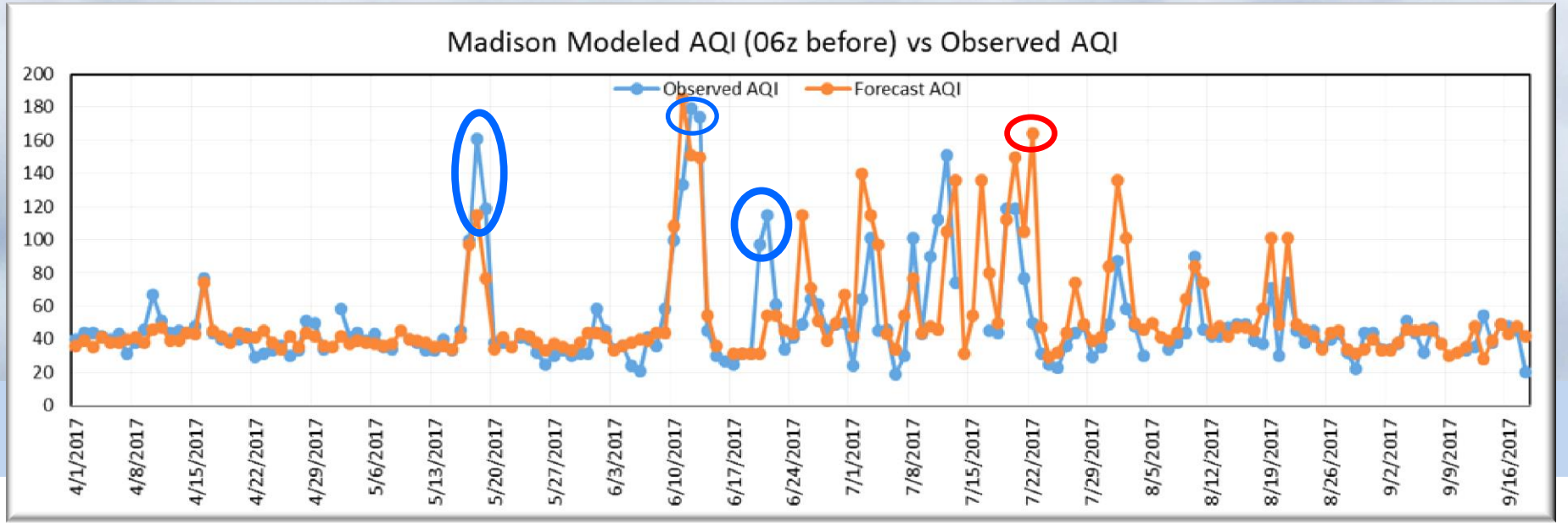
The May and June events were mostly under predicted.



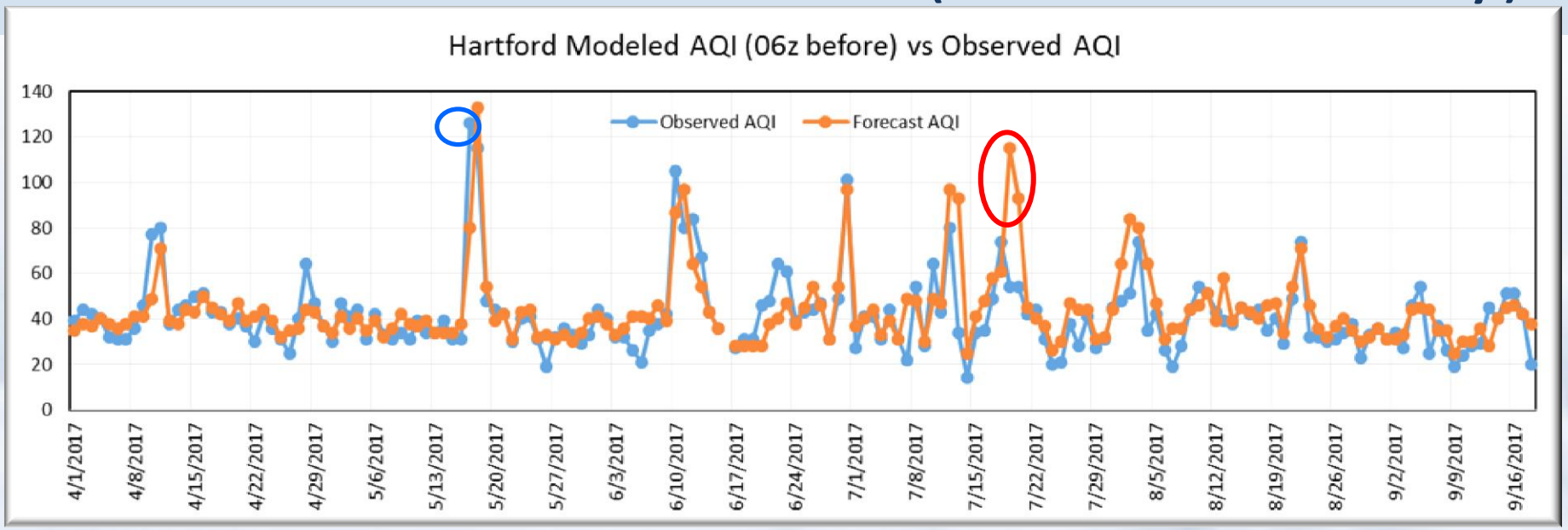
Groton and Madison (East Coastal)



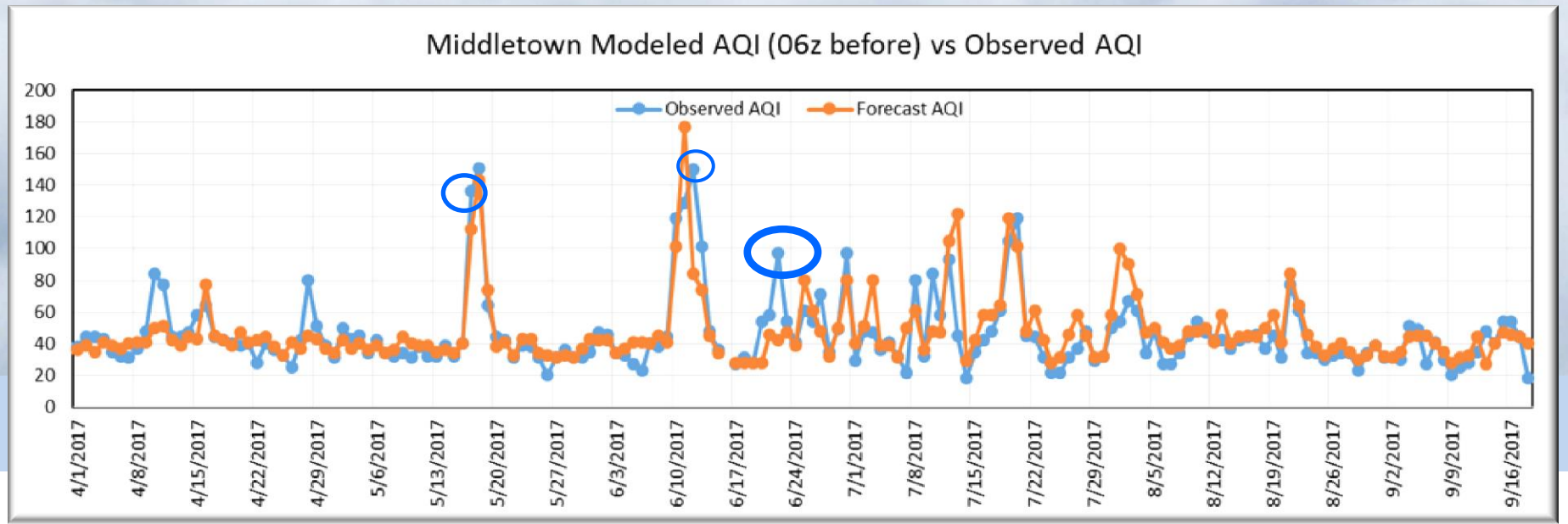
The May and June events were better for Groton but missed Madison in May.



Hartford and Middletown (Central CT Valley)



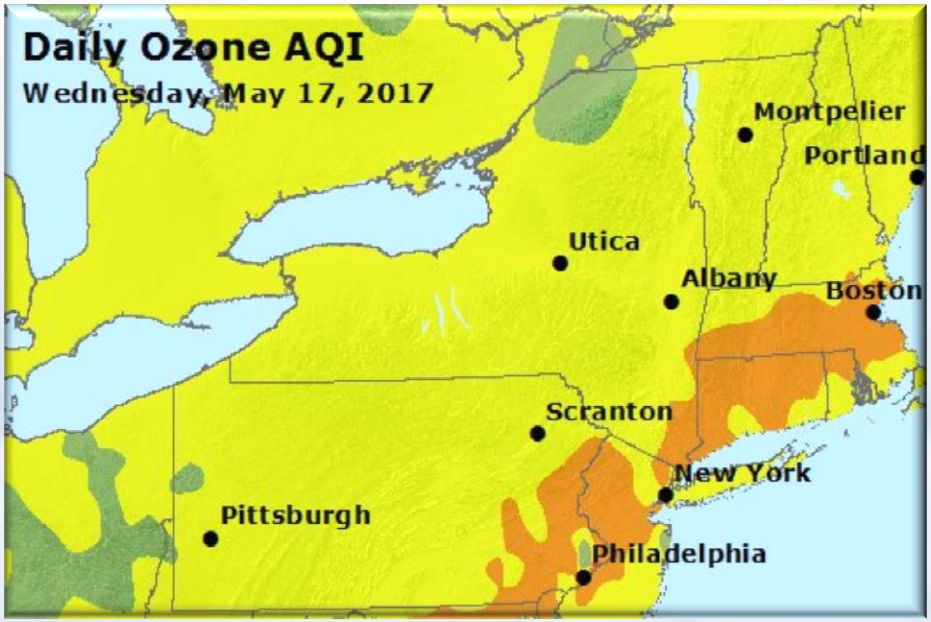
The May 17th event was under-predicted with over-prediction on July 19-20 in Hartford.

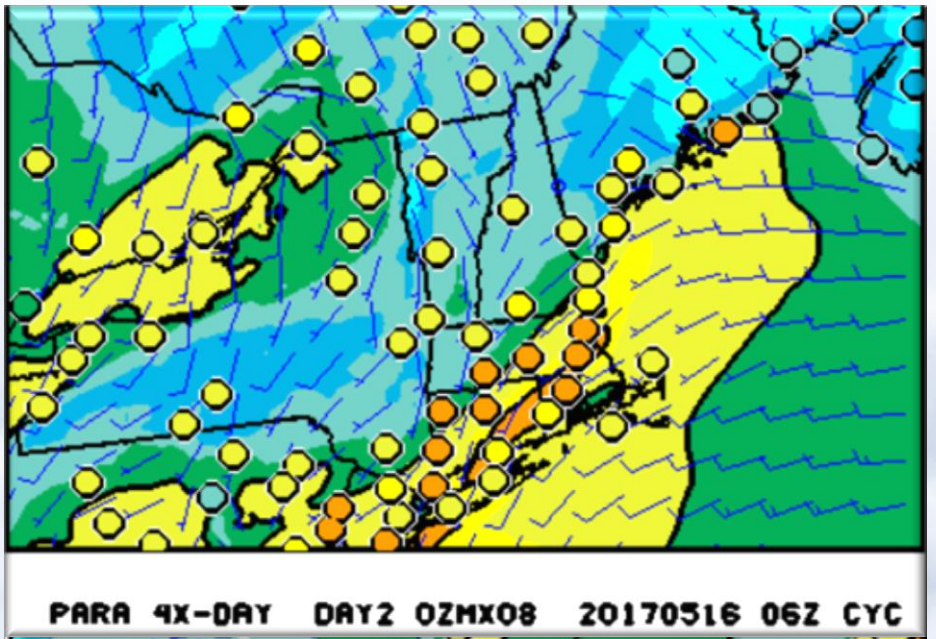


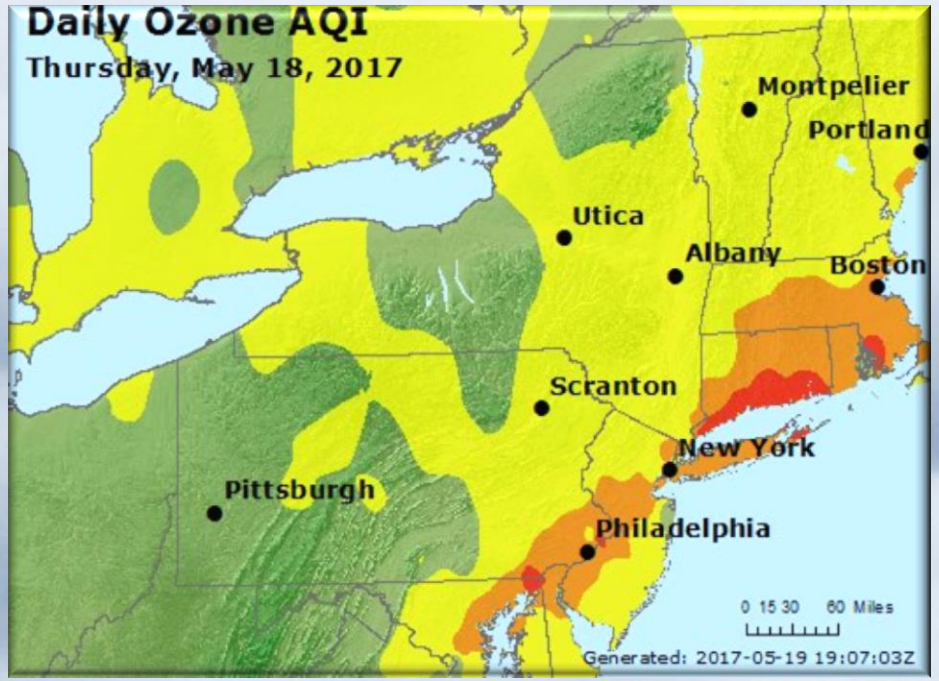
Connecticut Ozone Event May 17-19, 2017

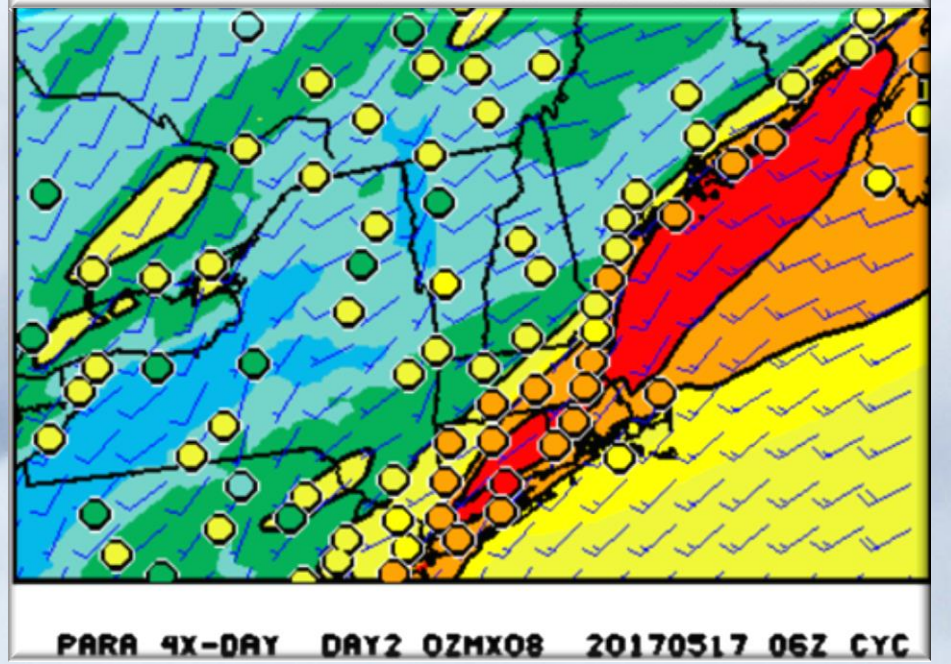
- This was a classic and widespread 3-day event for the I-95 corridor that quickly developed from a Bermuda high that setup off the east coast.
- All models correctly forecasted a USG event for the region but underestimated the areal extent, as the ozone plume pushed much further inland.
- The NOAA model doesn't assimilate gaseous smoke emissions into their ozone model, so that may have been responsible for some of the under predictions.
- Inland areas commonly have higher ozone levels earlier in the season than the coast, possibly because the sea breeze has a greater effect of pushing the plume inland than later in the season. A finer grid model resolution would be useful here.

May 17-19, 2017 Ozone Event

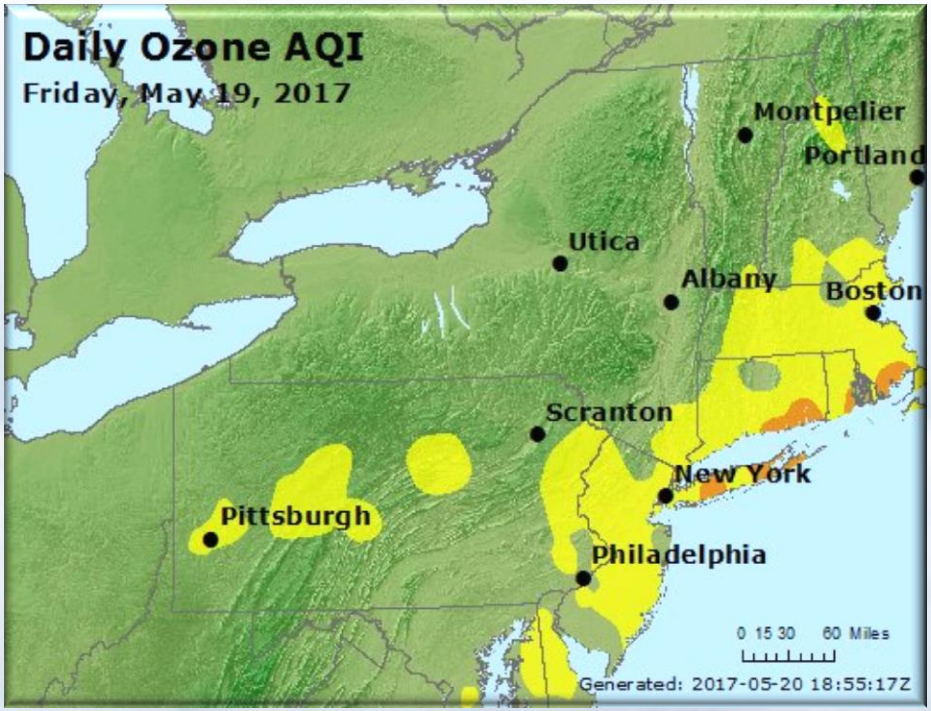


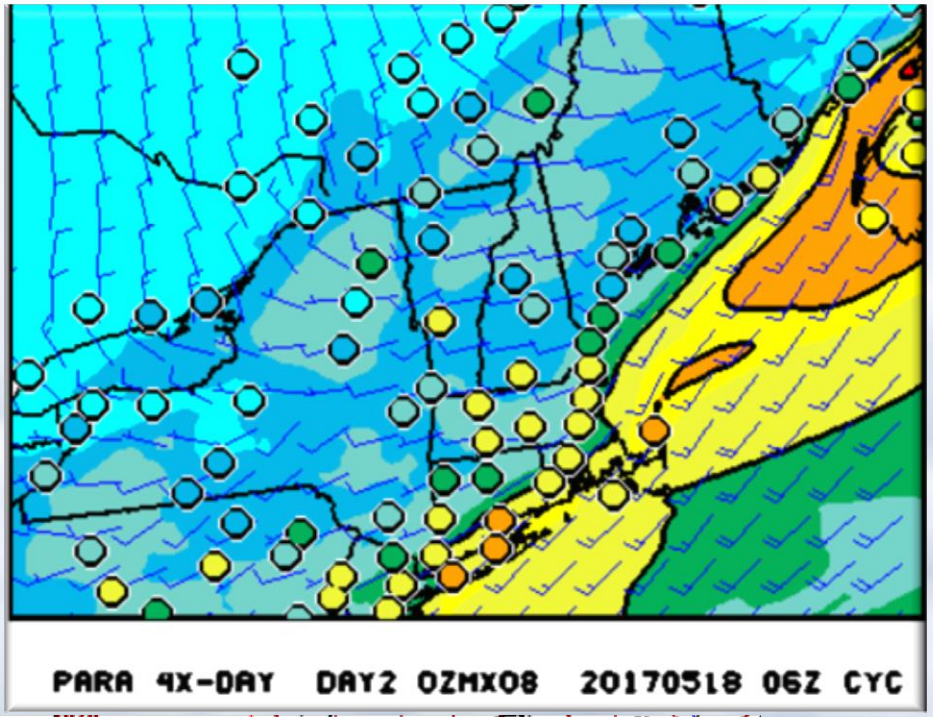


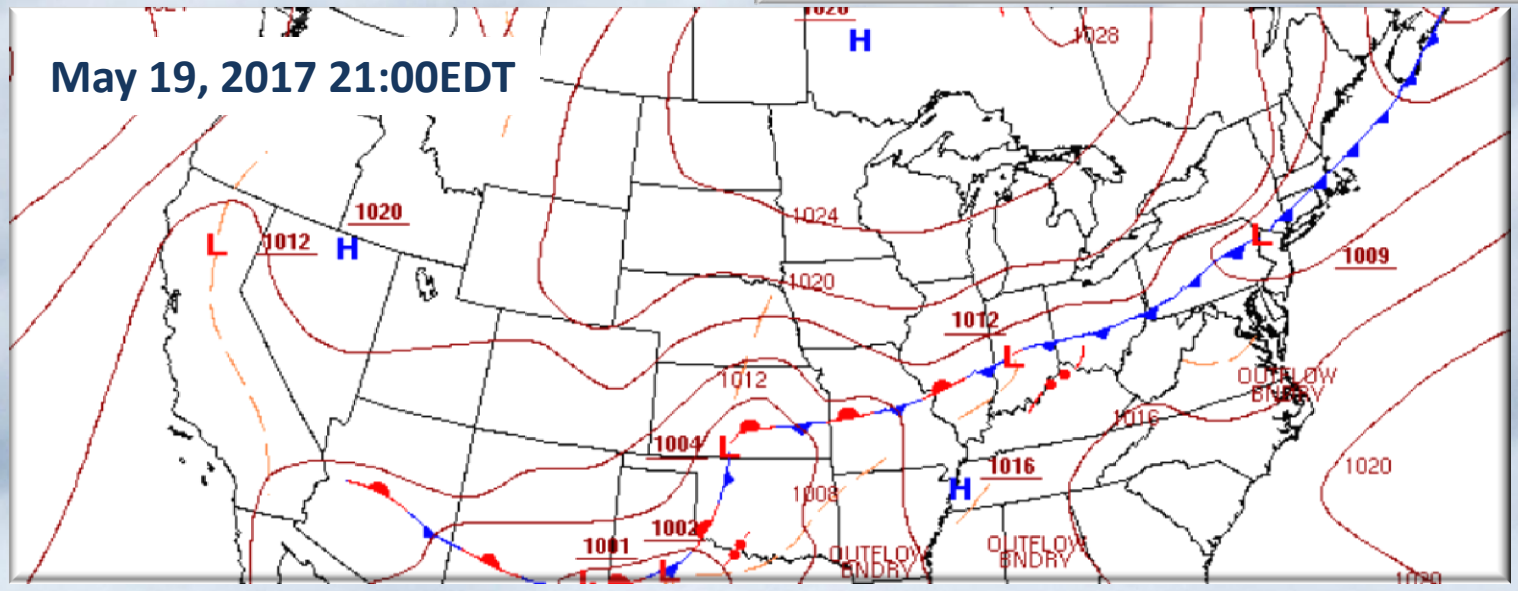




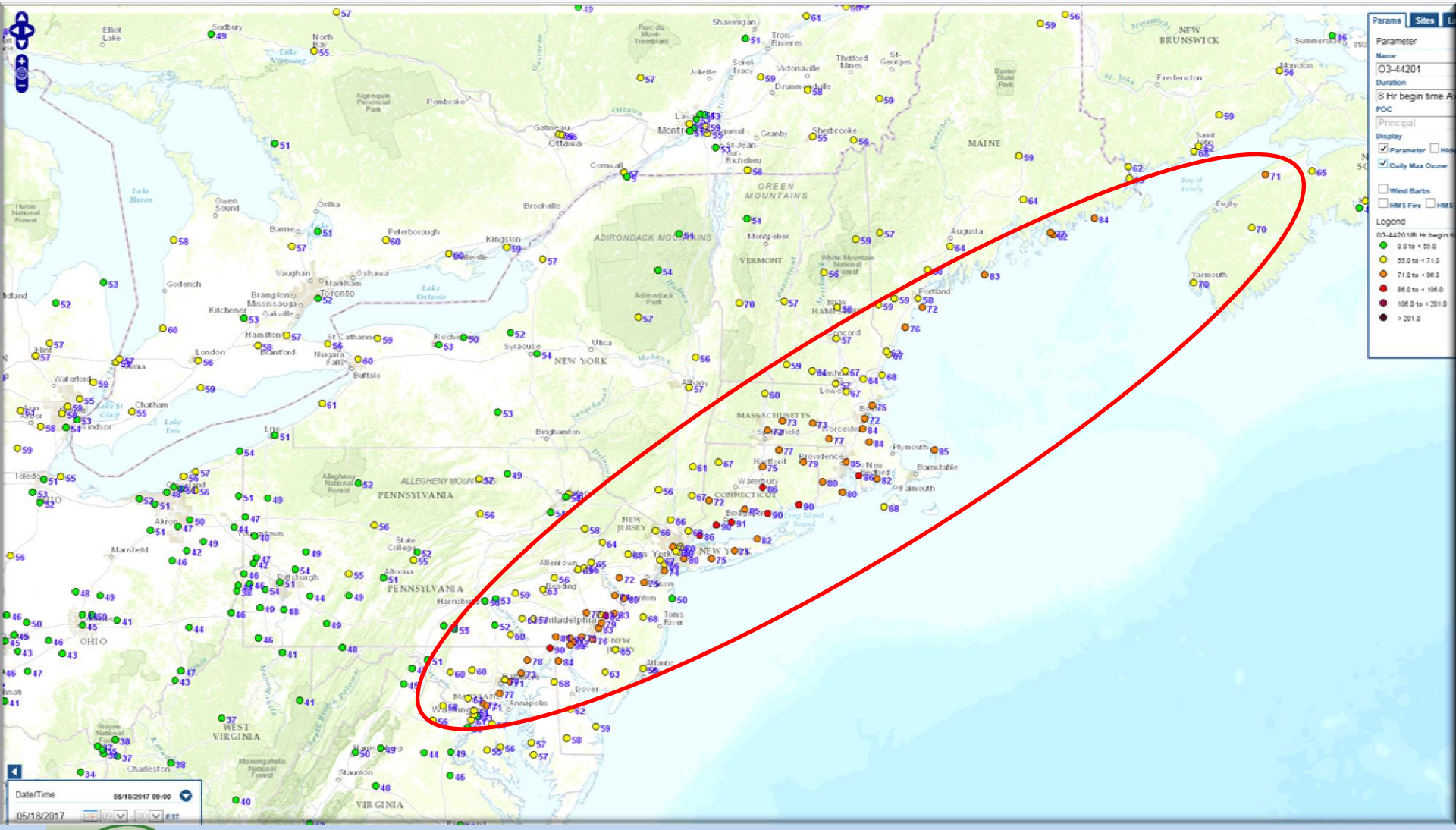
May 17-19, 2017 Ozone Event





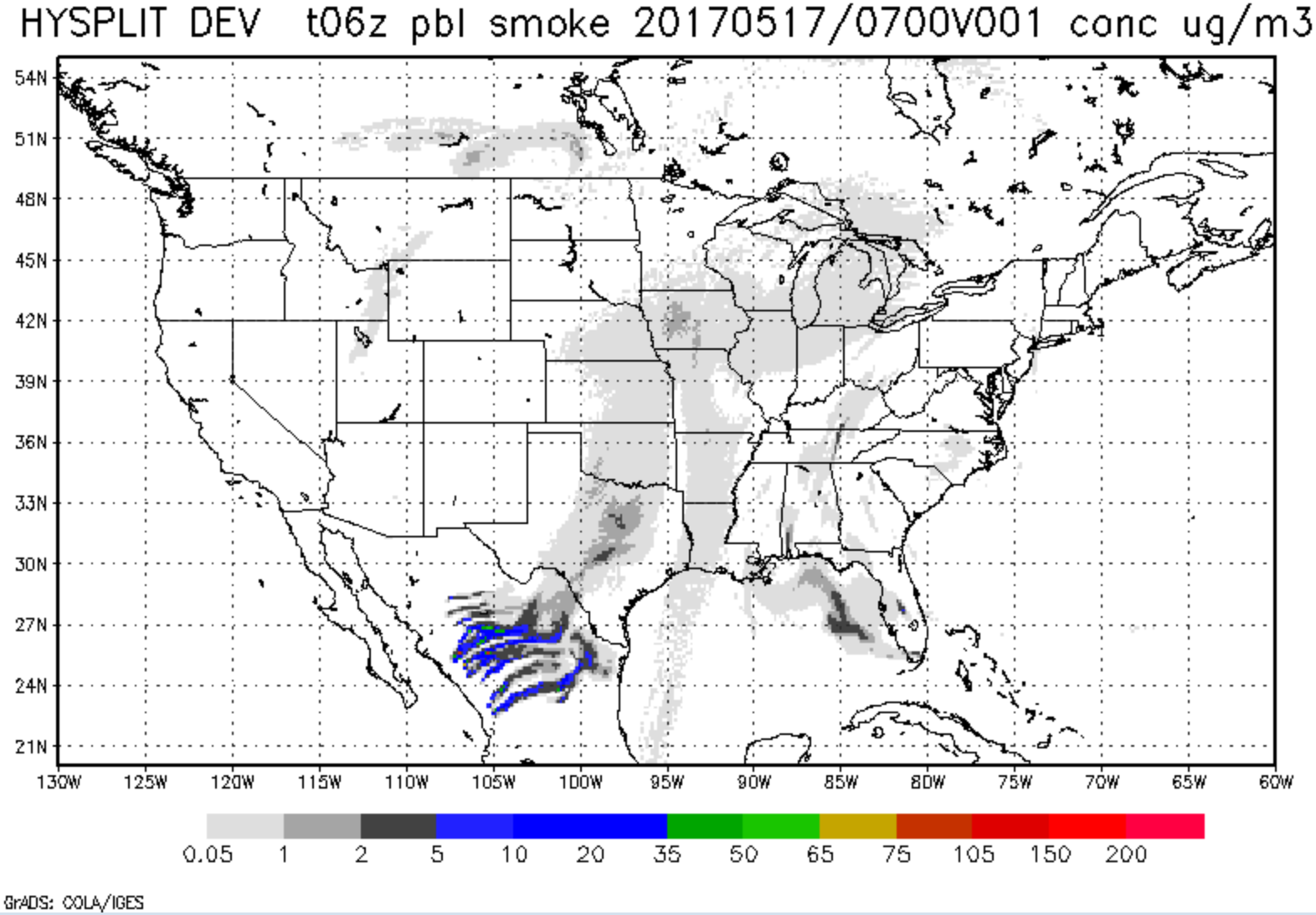


2nd Day of Classic I-95 Corridor Episode



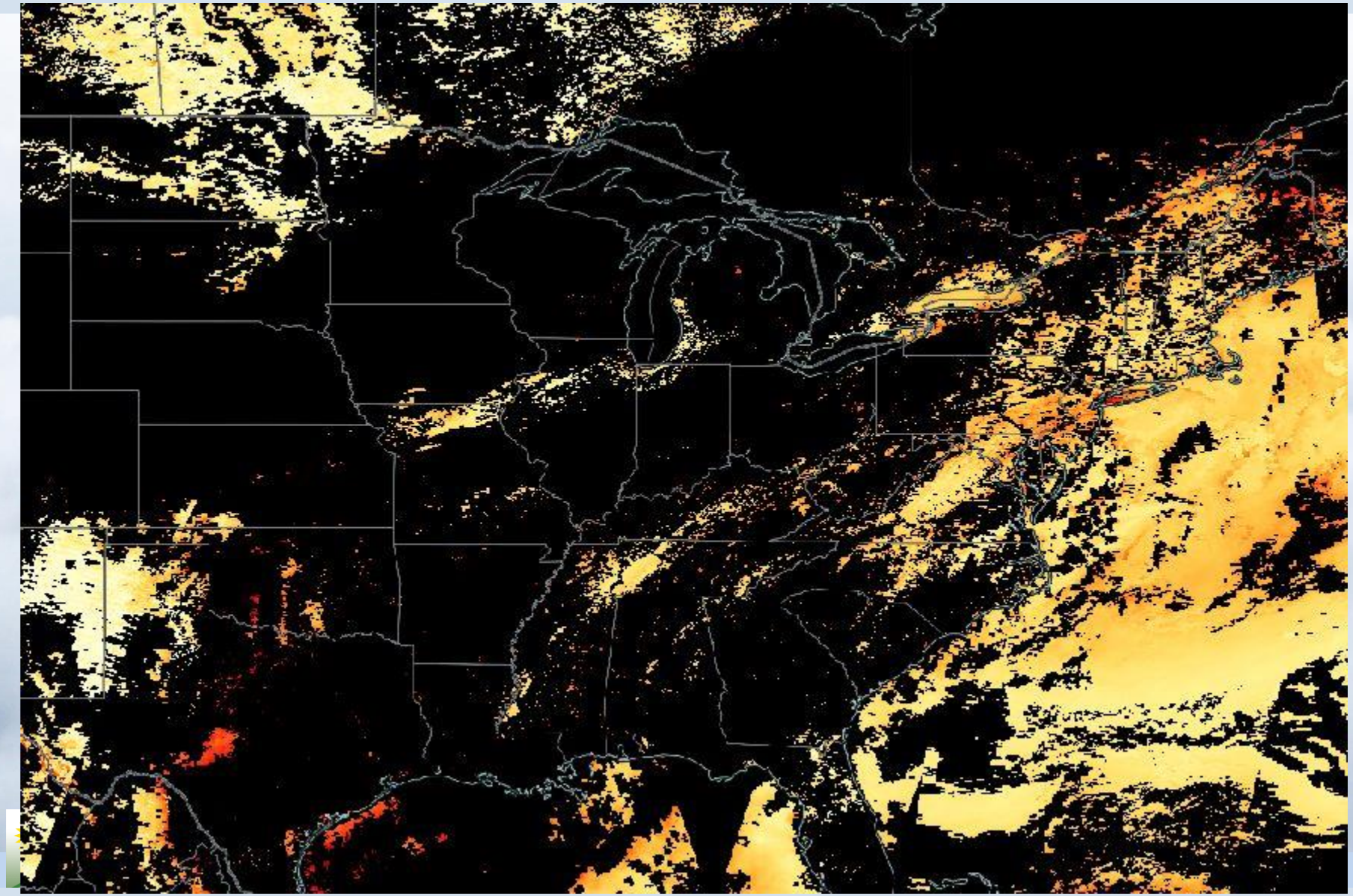
May 18, 2017 Map of Ozone Monitors

May 17, 2017 Hysplit Smoke Animation



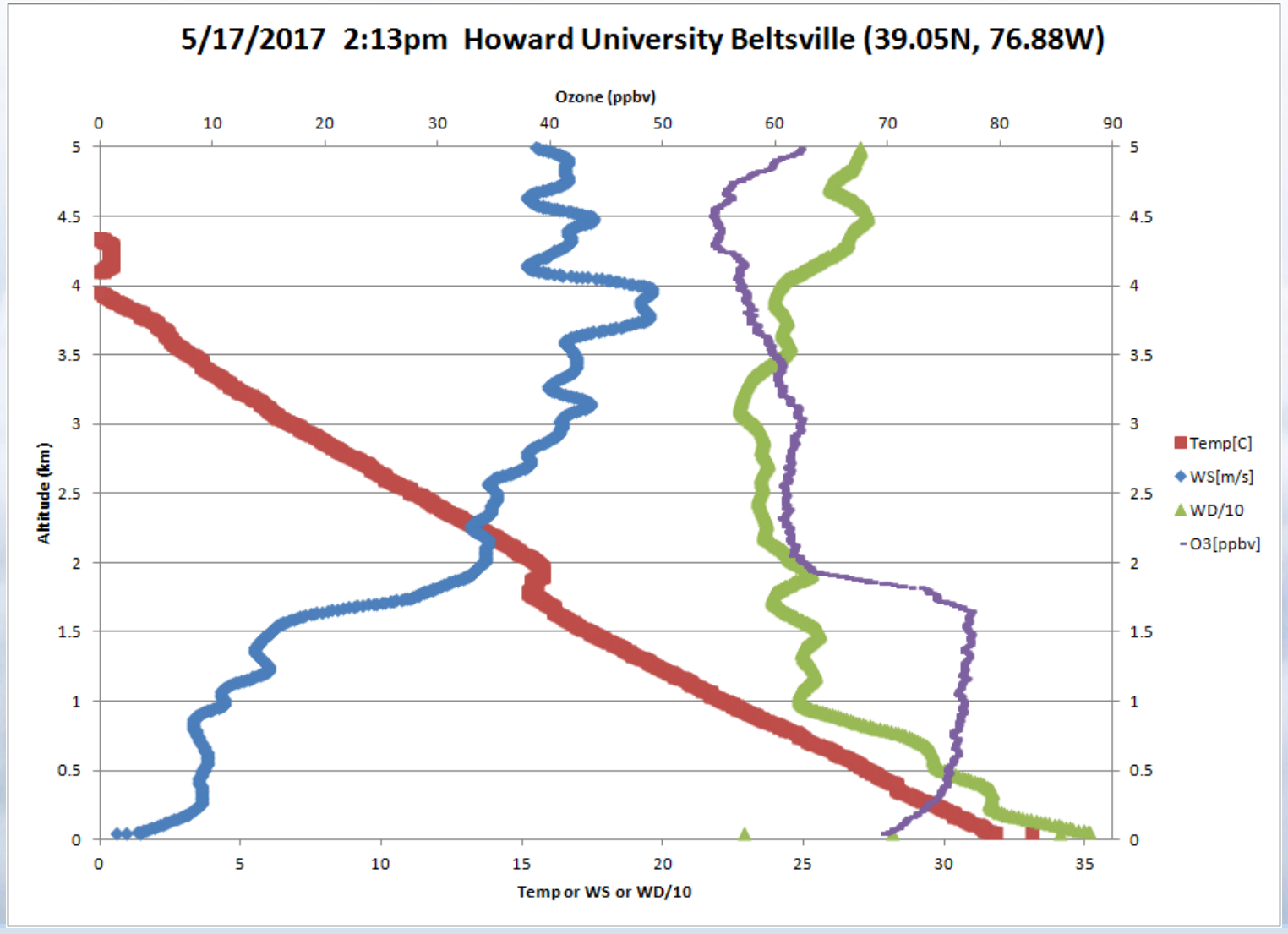
Agricultural burning from Mexico and the southeast States was advecting smoke towards the Mid-Atlantic States and New England

May 18, 2017 Satellite and AOD



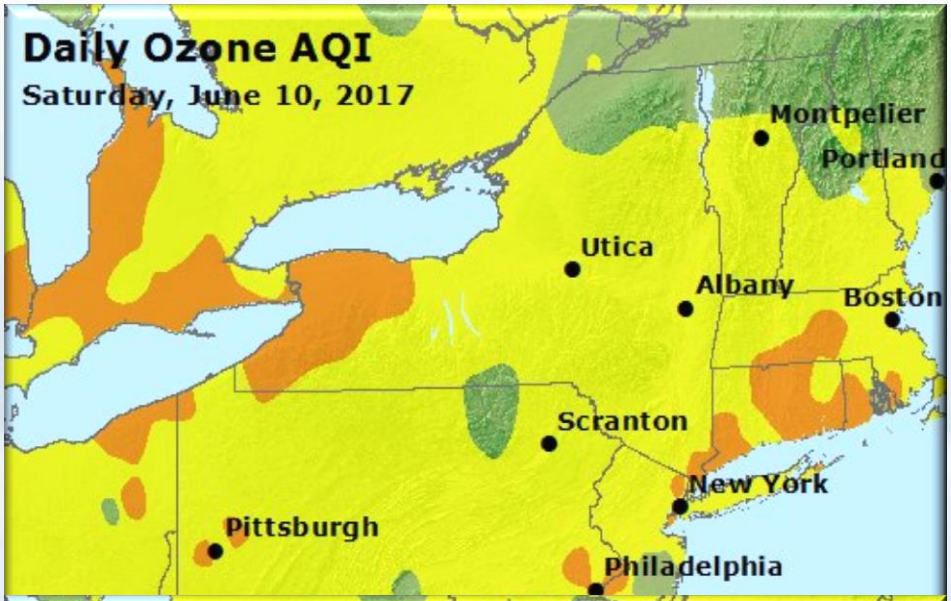
Residual aerosols from agricultural burning may have contributed to an increase in regional ozone.

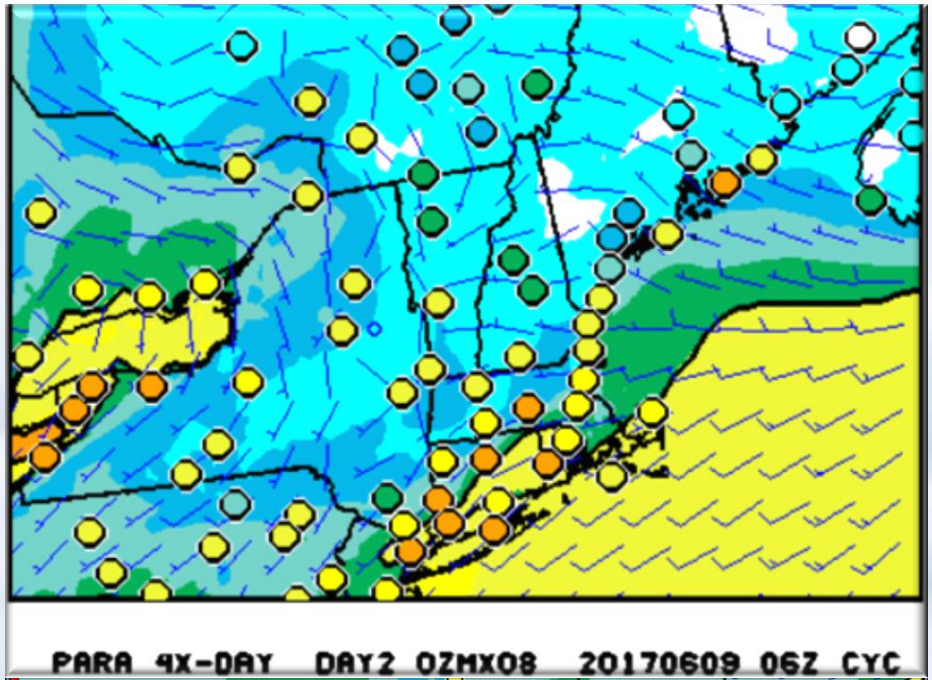
Ozonesonde from Beltsville, MD on May 17, 2017

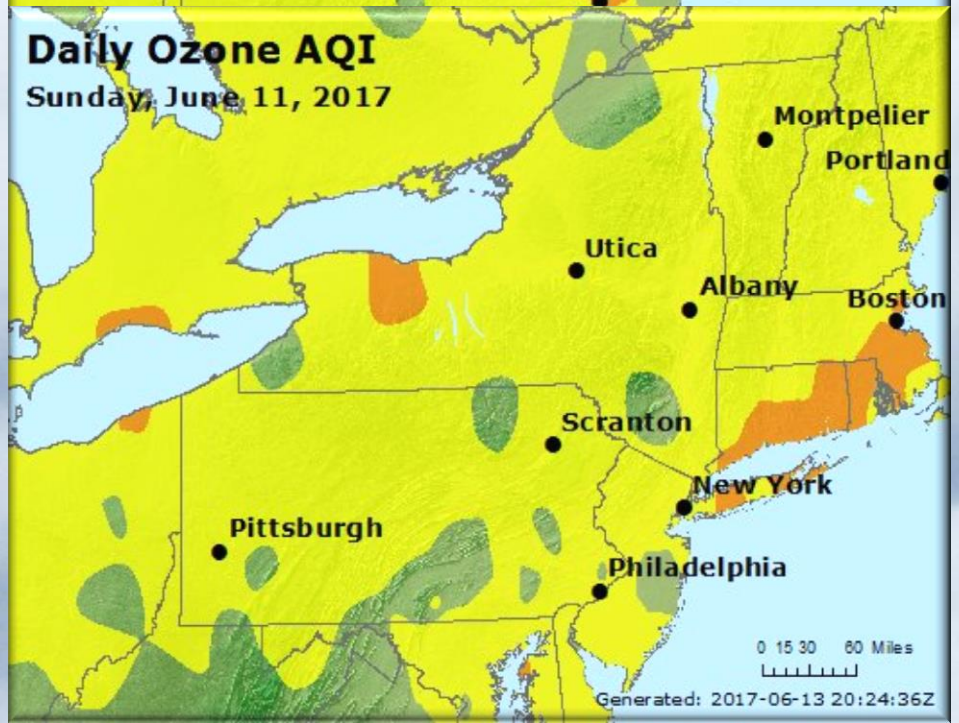


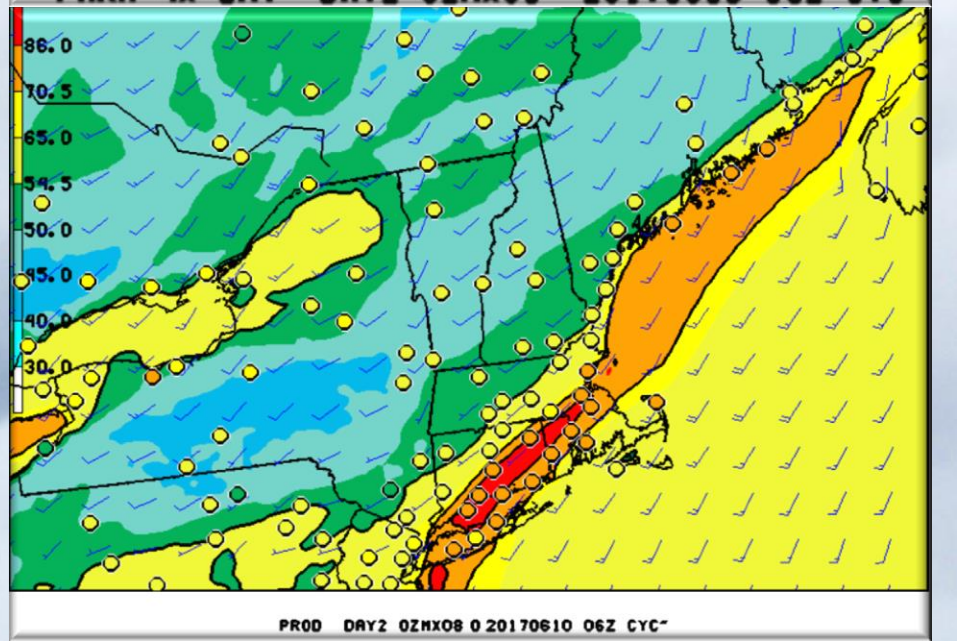
Ozonesonde shows an elevated reservoir of ozone between 500-1800 meters above the surface from a wind direction of about 250 degrees (west-southwest)

June 10-13, 2017 Ozone Event

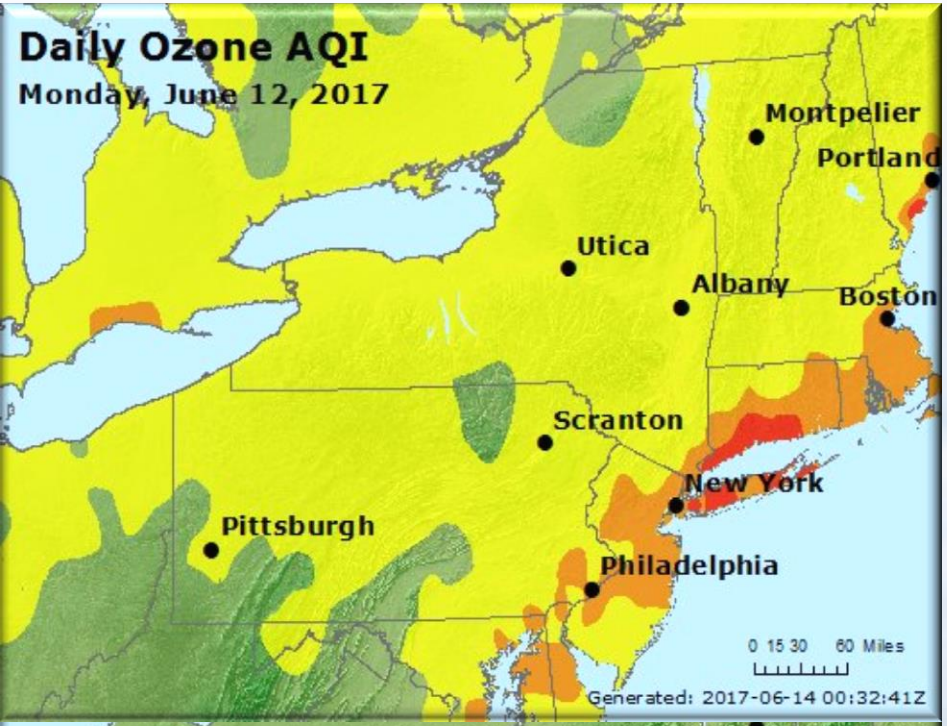


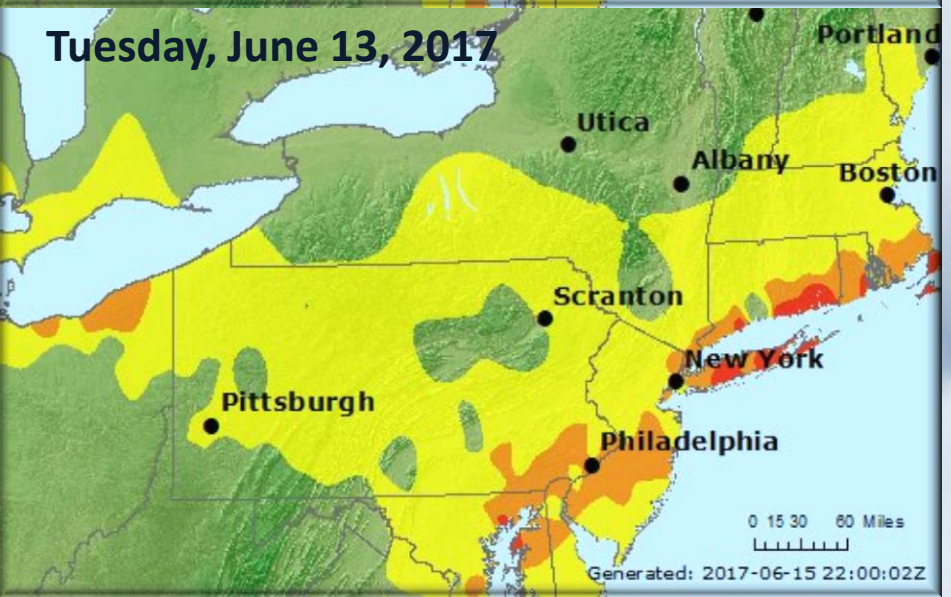


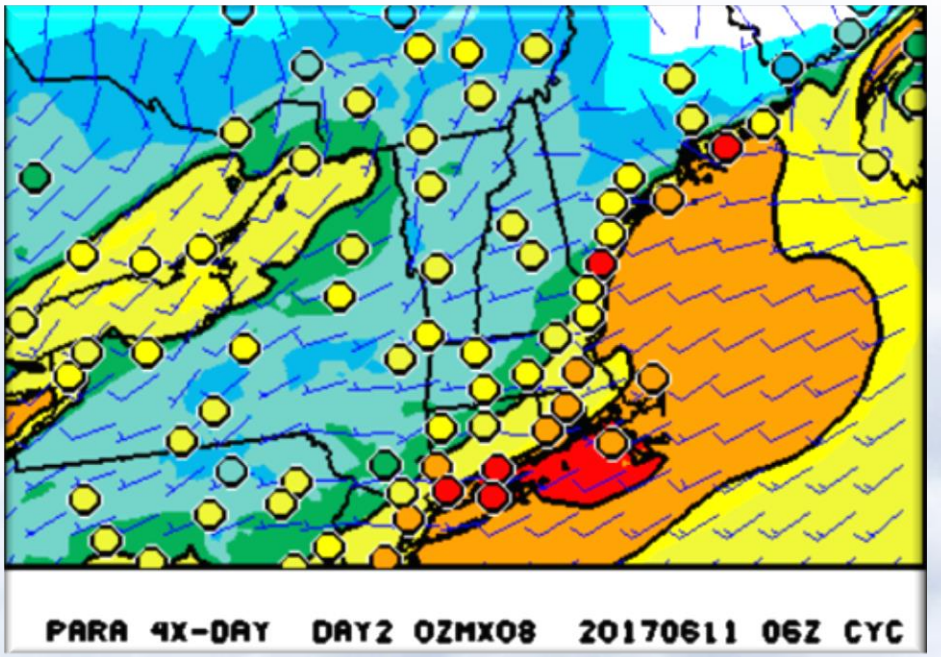


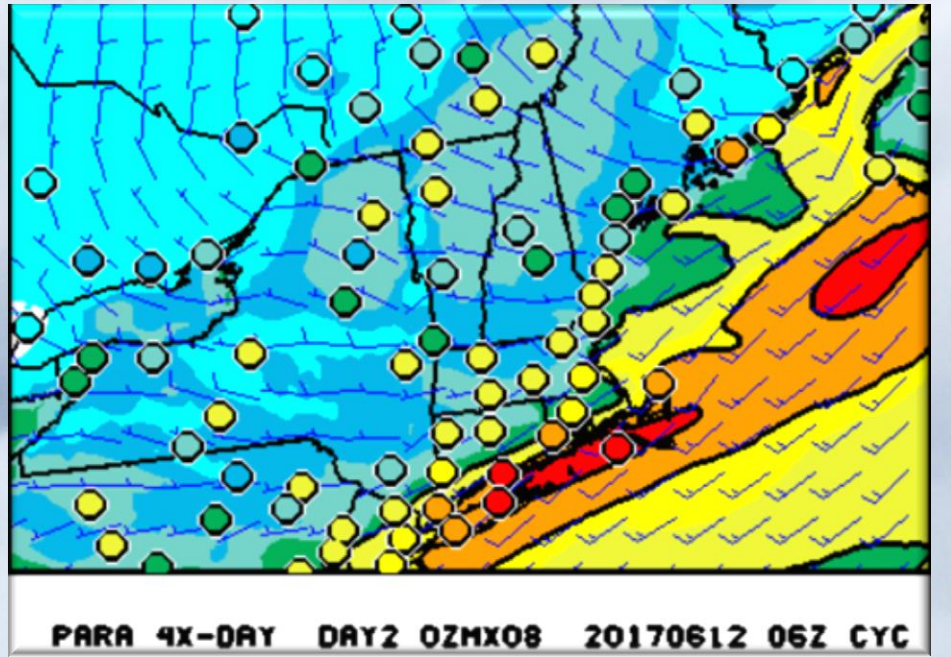


June 10-13, 2017 Ozone Event

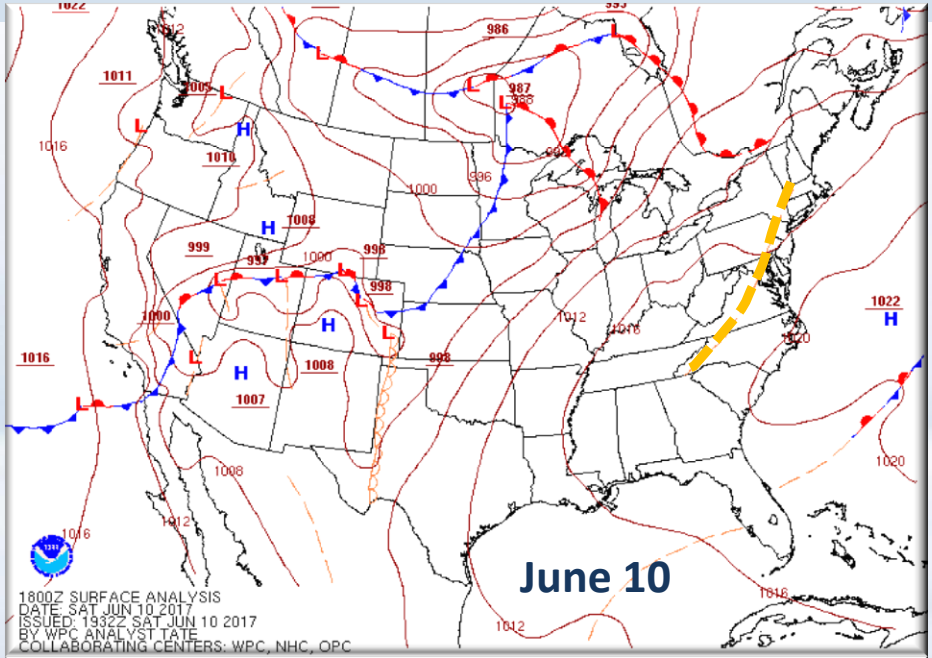


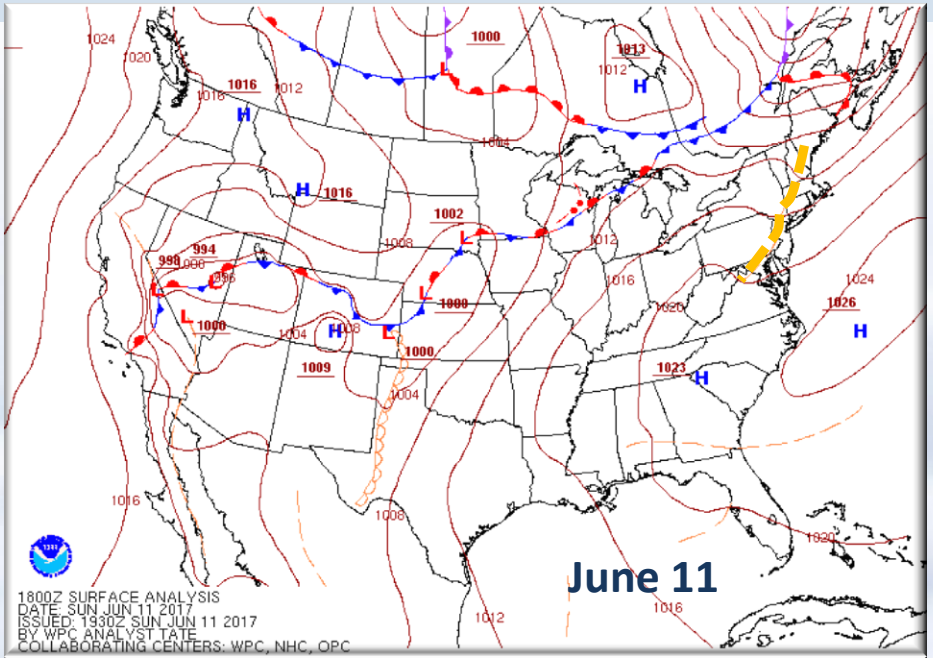


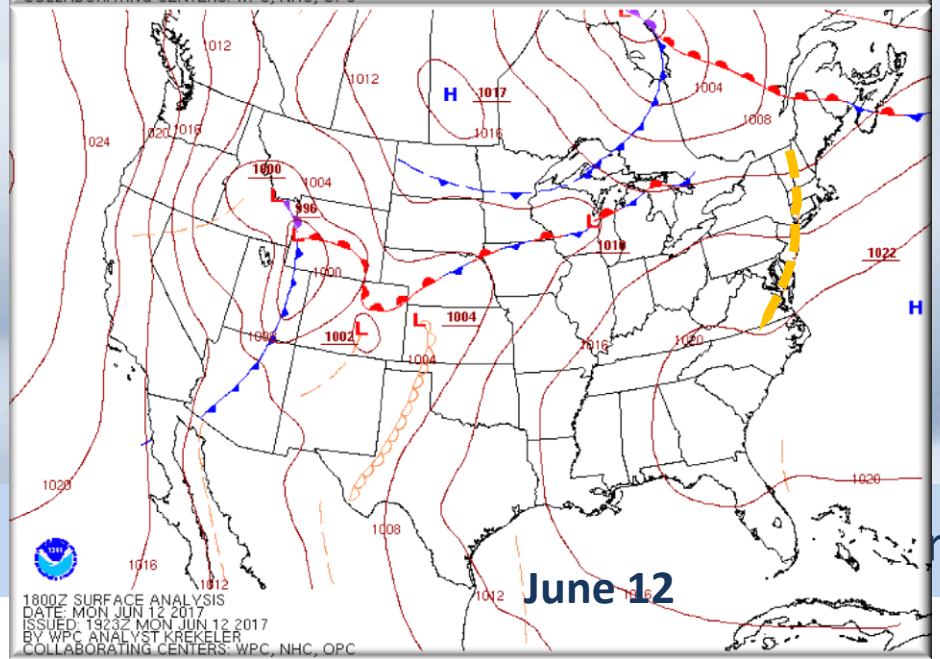


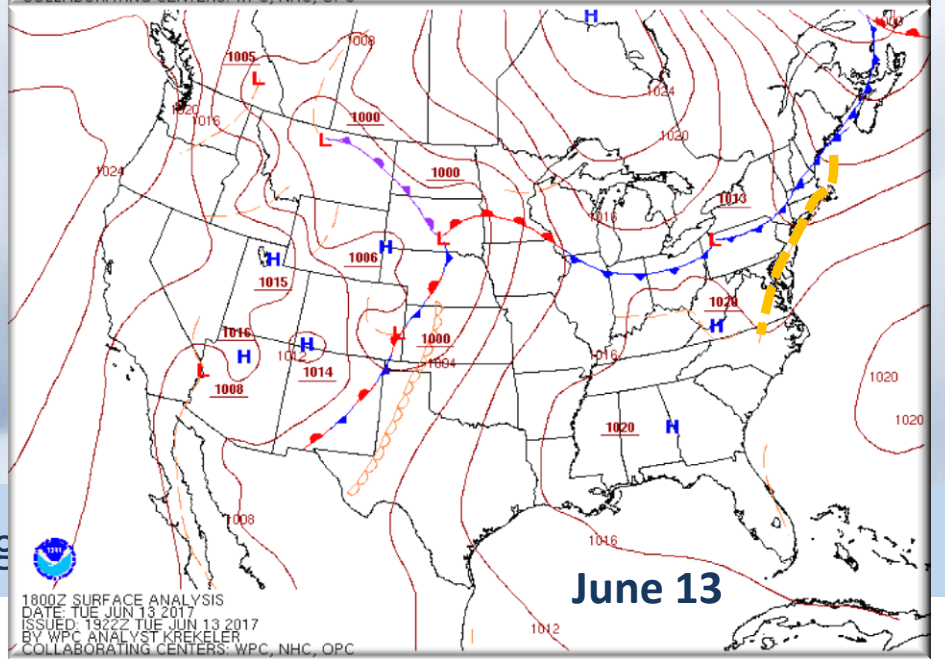


18z Surface Maps with Lee Troughs

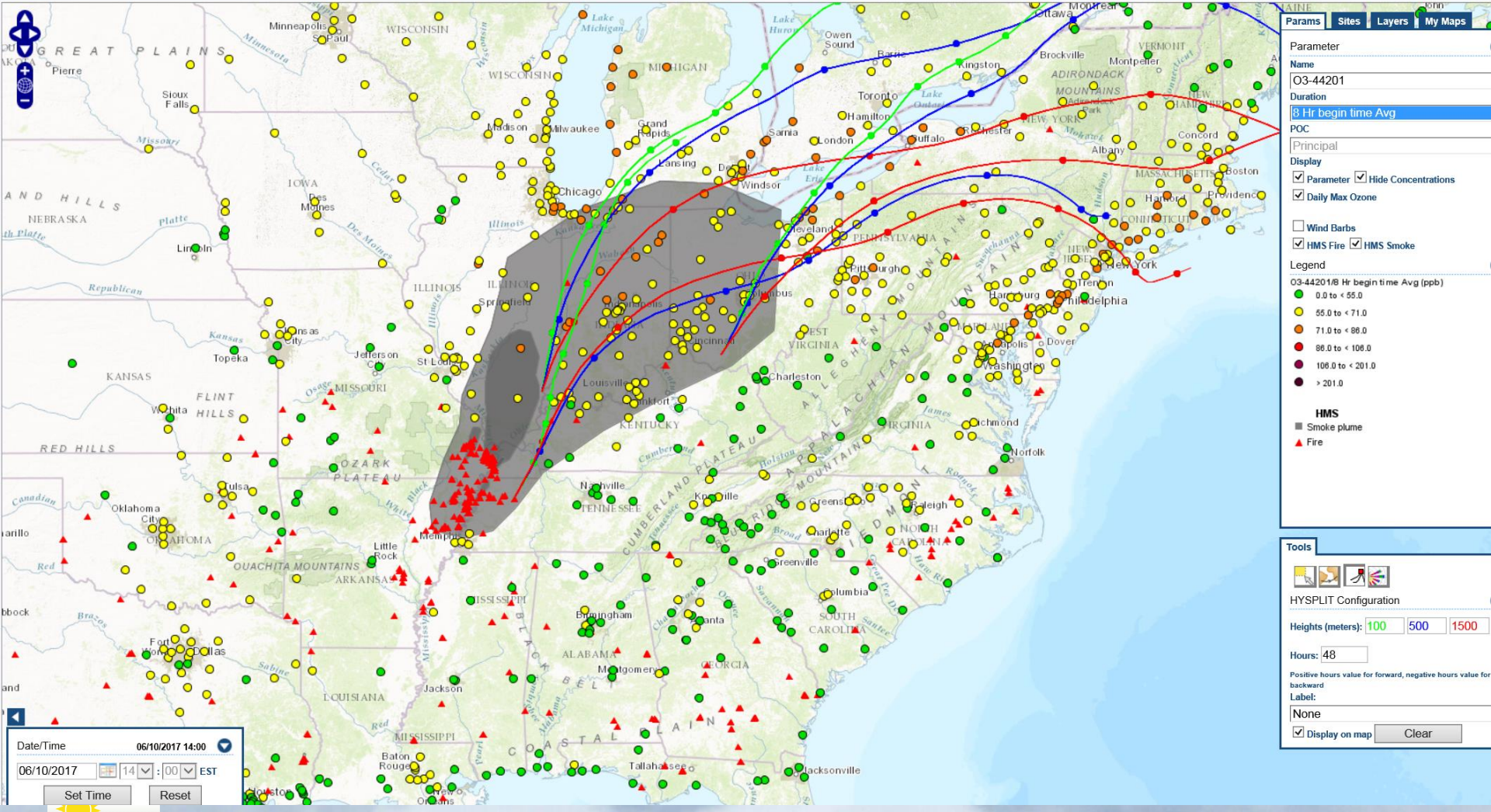








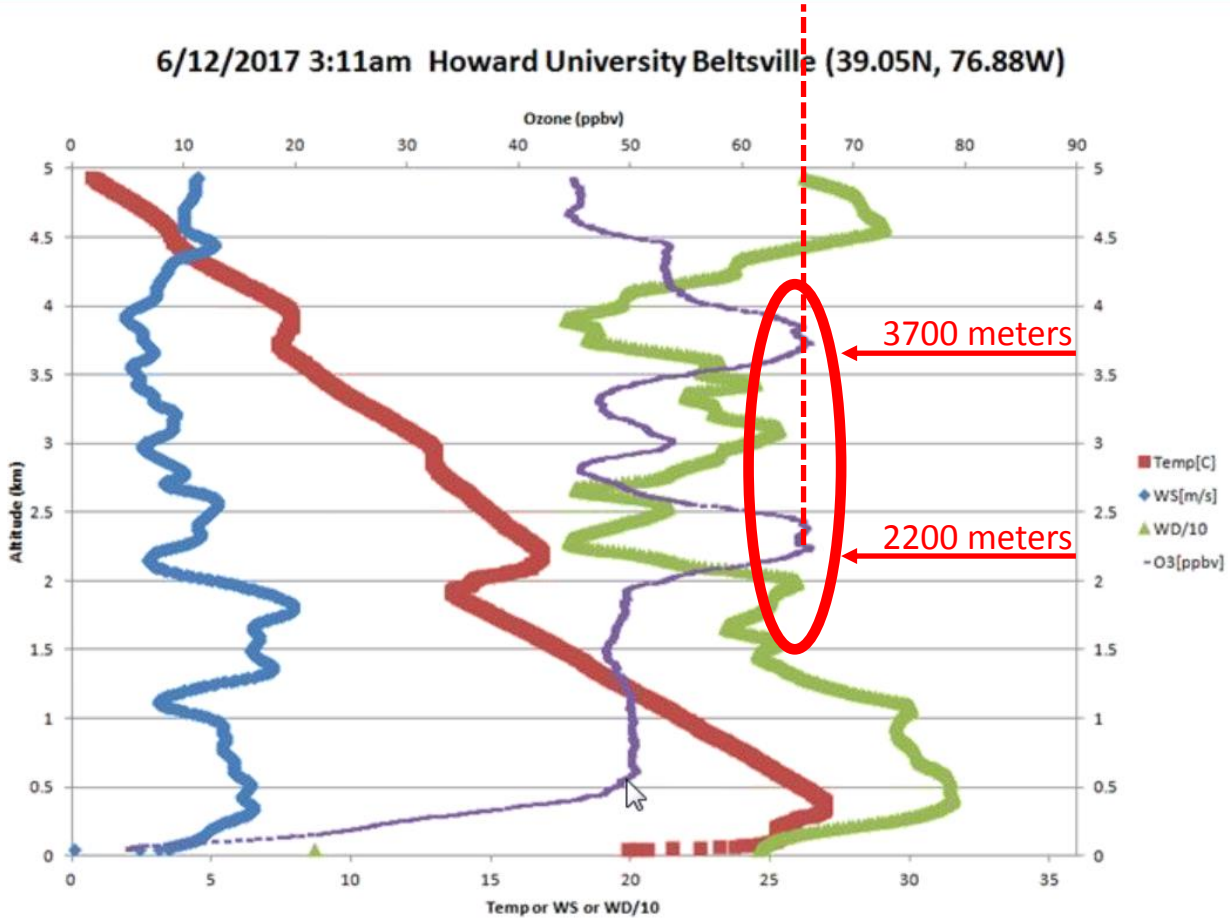
Trajectory Analysis June 10, 2017



Fires from that same area were producing a sizable plume and 48 hour trajectories were entering New England from the west and northwest.

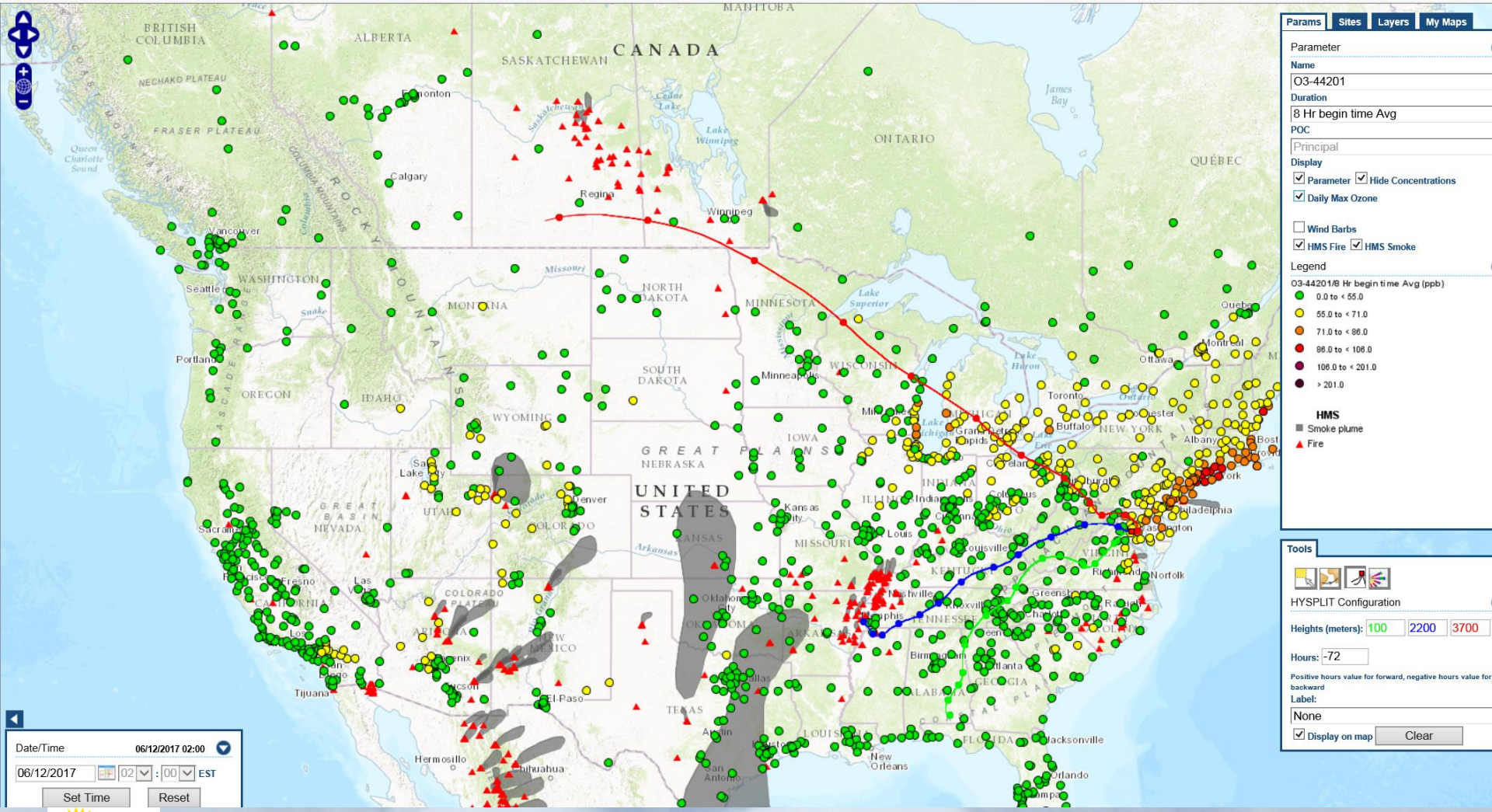
June 12, 2017 Maryland Ozonesonde

Early Morning Ozonesonde



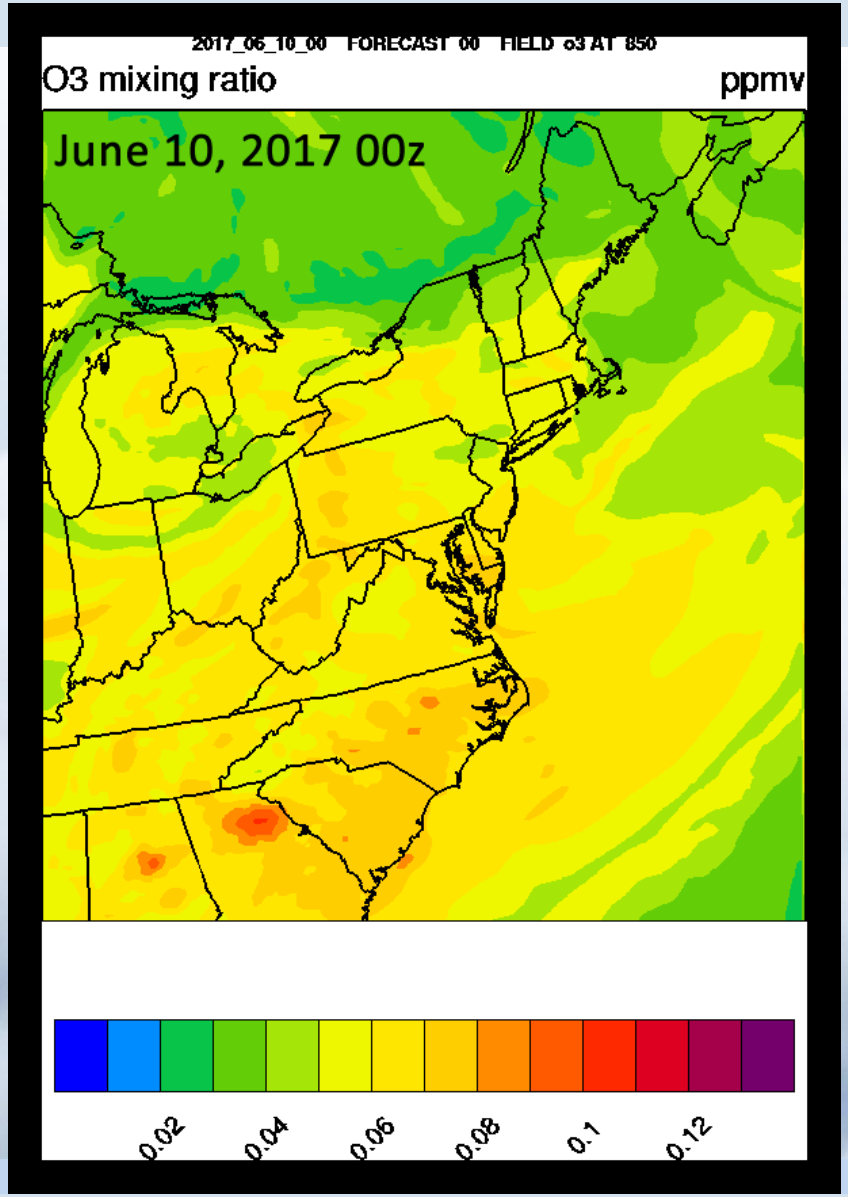
Note the elevated ozone levels of 65 ppb measured at layers 2200 and 3700 meters above the surface.

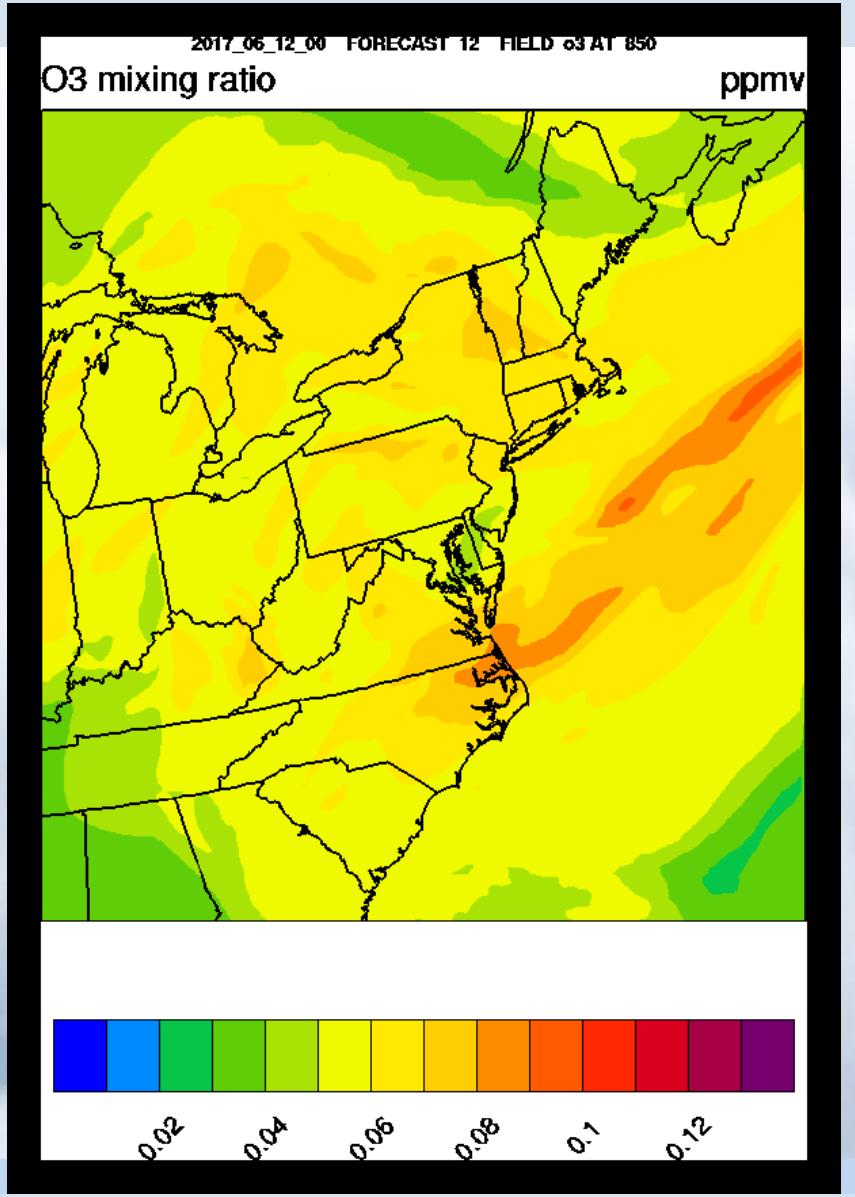
Beltsville Back Trajectory Analysis, June 12, 2017



The 2200 meter 72 hour back trajectory are from the region over the fires, while the 3700 meter back trajectory could have originated from fires in southern Canada.

WRFCHEM 850 mb Ozone



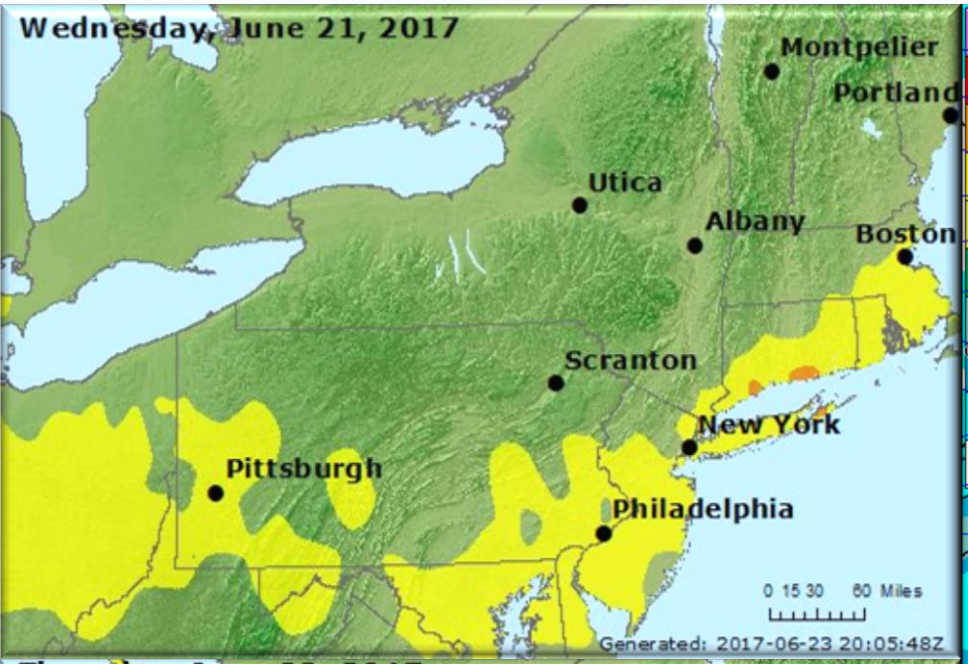


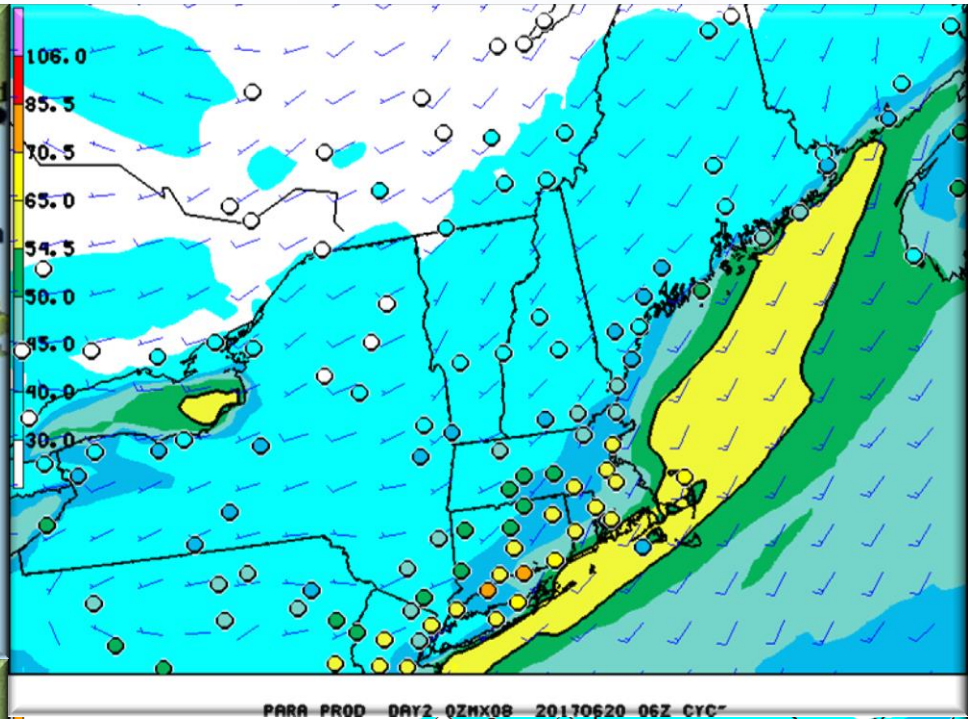
WRFCHEM was predicting a reservoir of 70+ ppb ozone residing above the eastern States at 850mb (~1500m). At 12z on June 12th, elevated ozone of 60-80 ppb was modeled just west of Beltsville, MD.

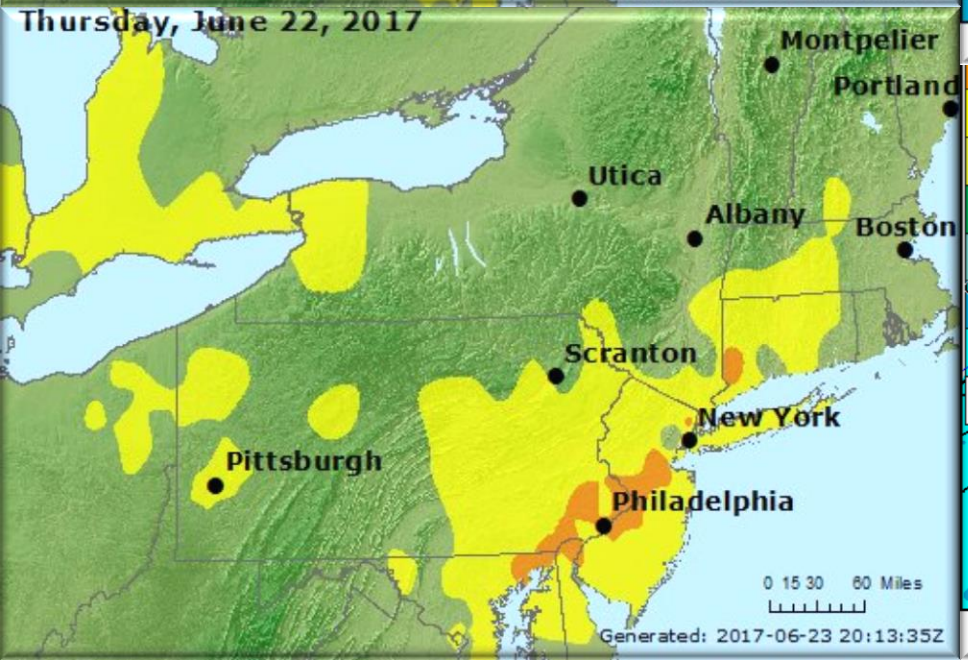
June 10-13, 2017 Ozone Event

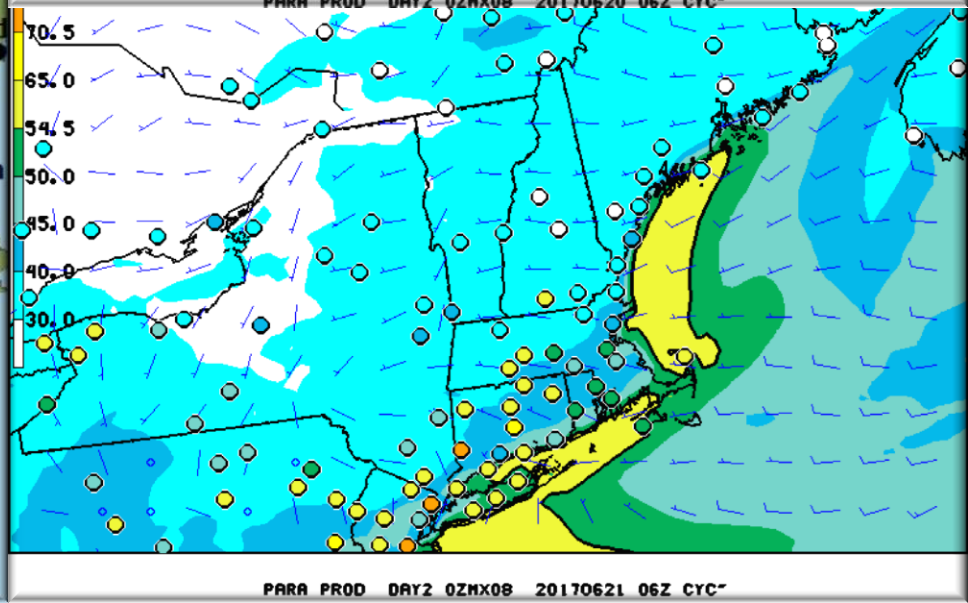
- 2nd ozone event of the season in CT was driven by the Bermuda High circulation over the I-95 corridor with higher level transport from the west;
- Exceedances occurred from Maryland to Maine, with Cadillac Mountain monitoring the highest 8-hour ozone average of 98 ppb;
- NOAA ozone models provided good guidance and CT forecasters correctly forecasted exceedances on June 11-13th;
- NOAA model under prediction, especially on June 10th, likely due to smoke enhancement.

June 21-22, 2017 Ozone Event

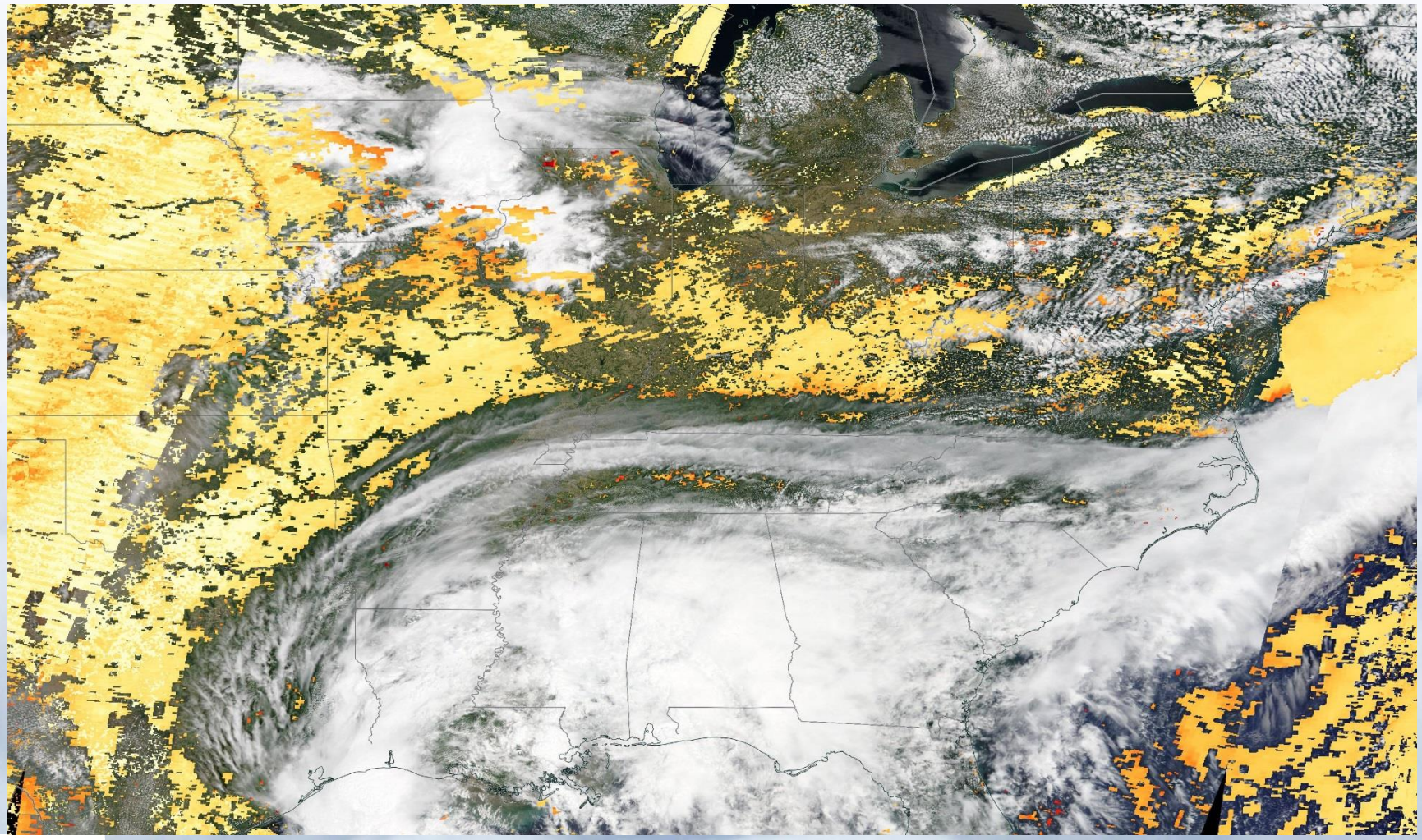






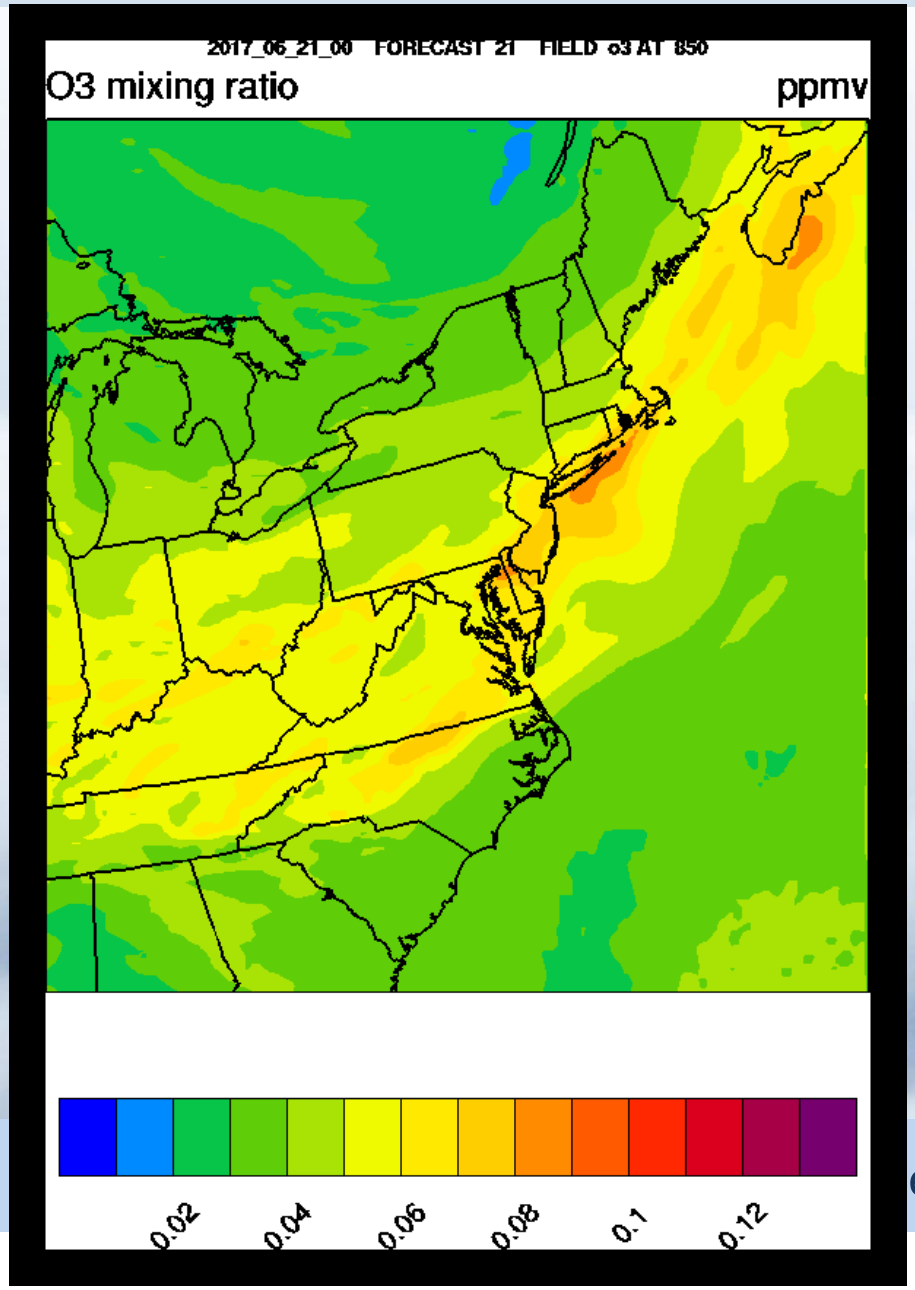


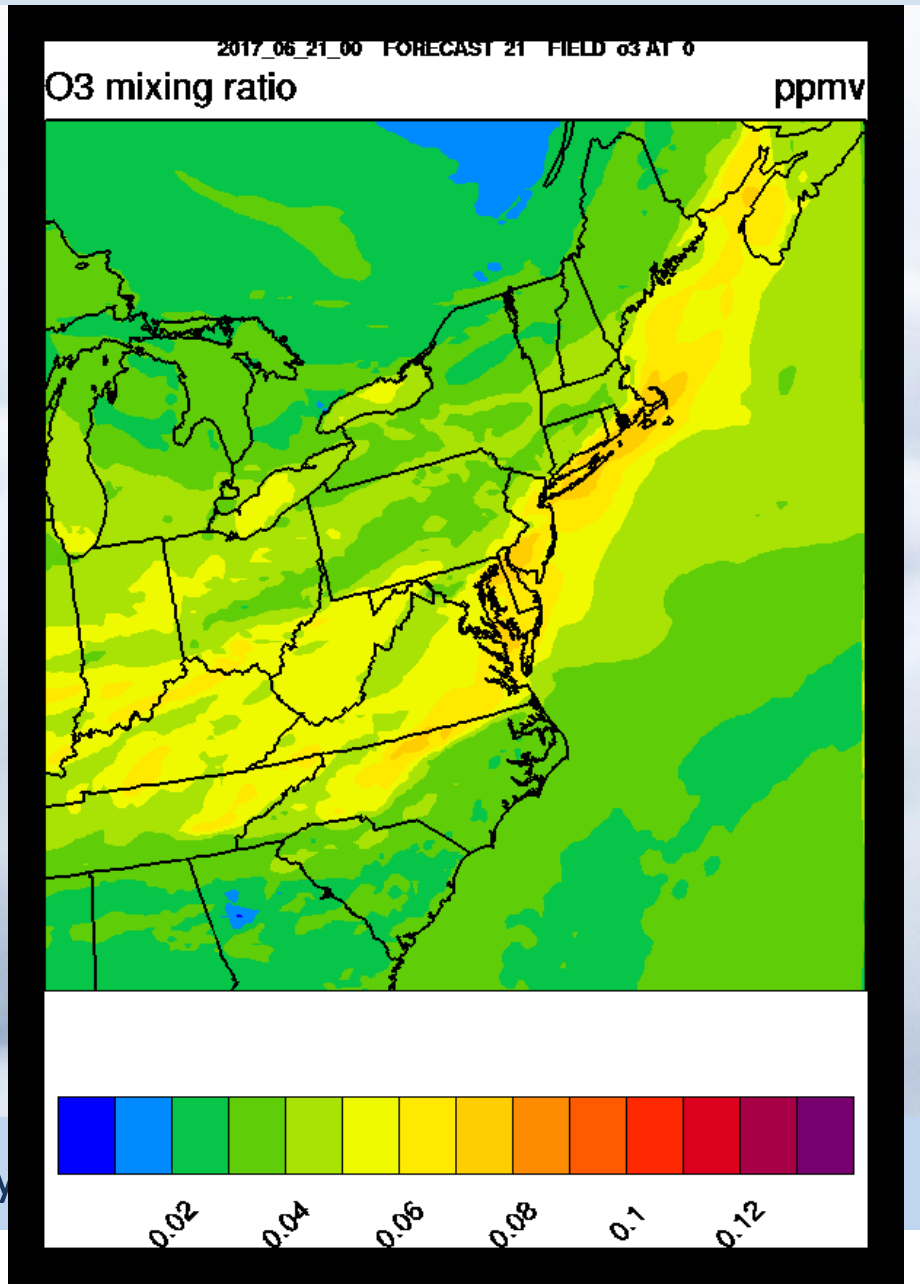
June 21, 2017 Satellite AOD



The satellite AOD analalysis shows elevated PM2.5 levels in the atmosphere, likely due to smoke emissions.

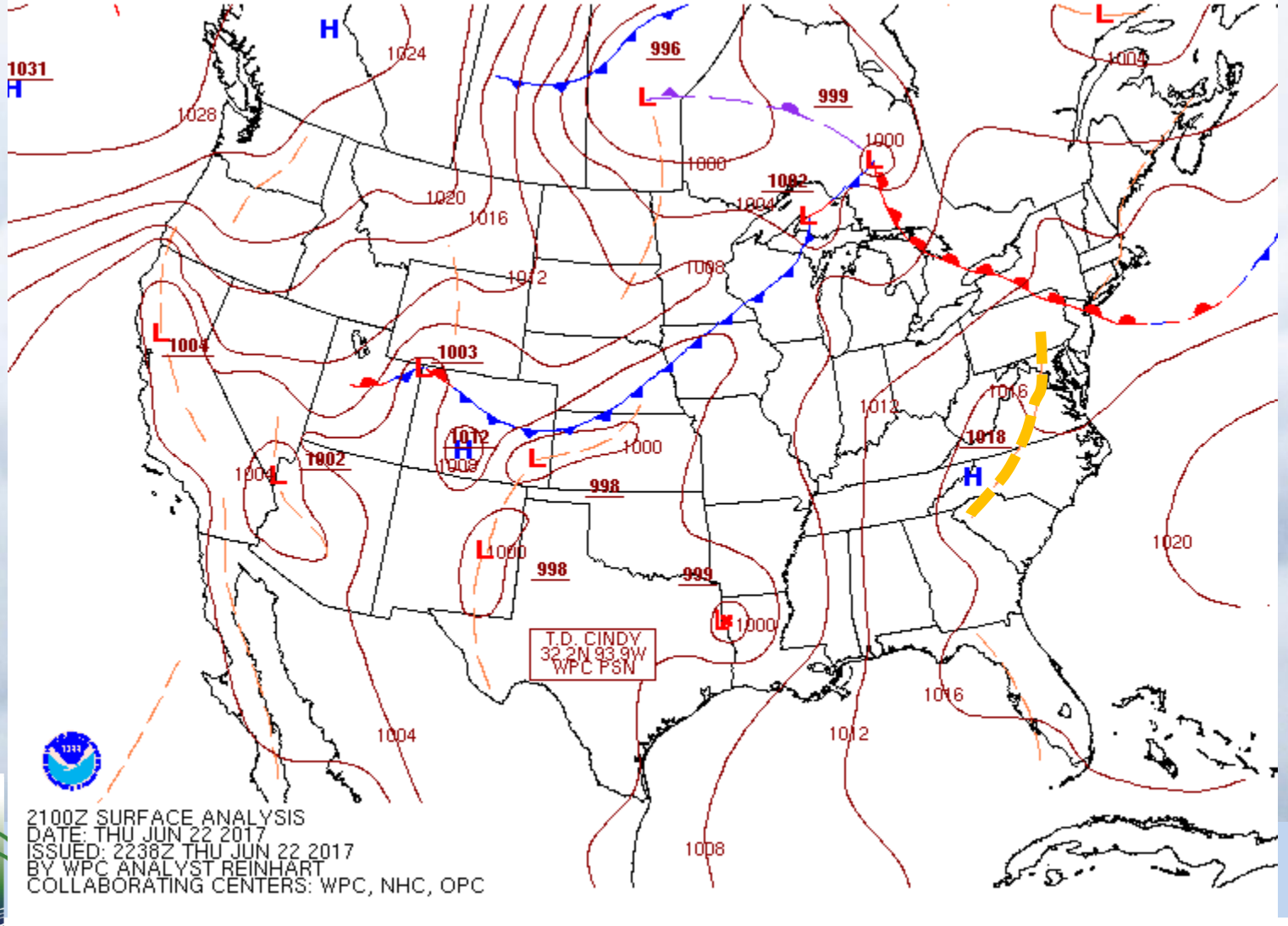
WRCHEM June 21, 2017 21z 850mb vs. Sfc





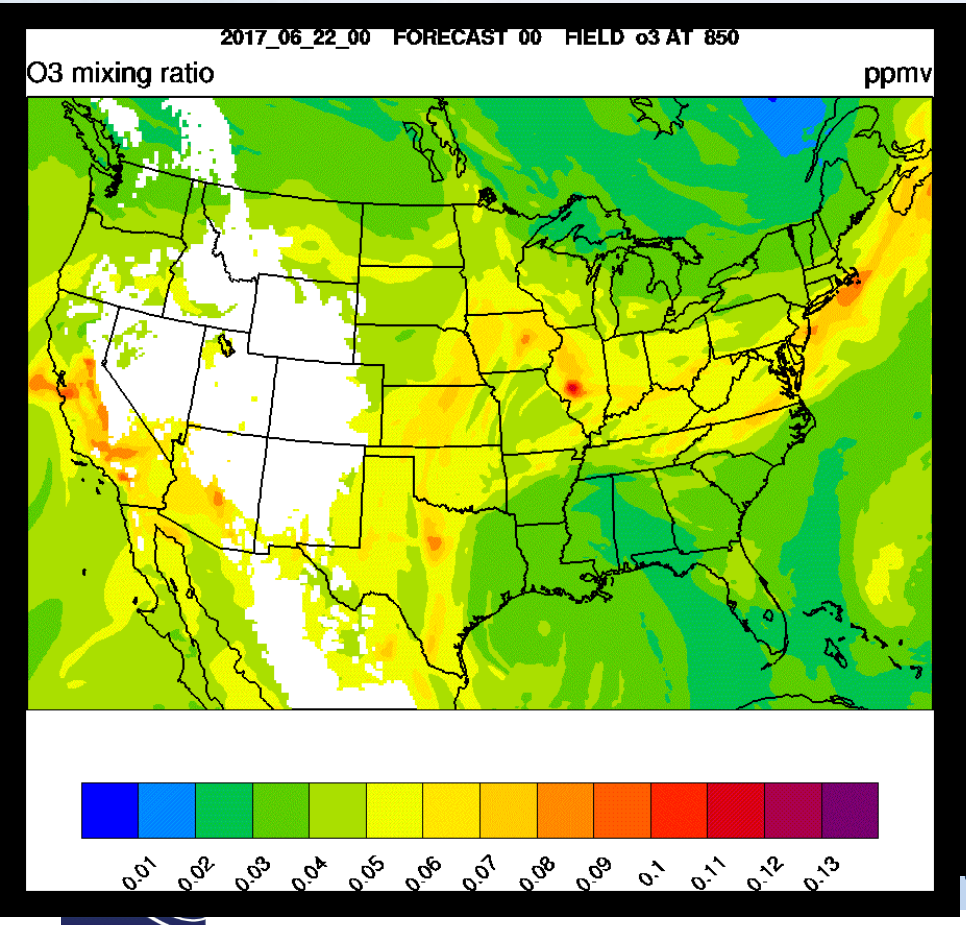
June 22, 2017 Surface Analysis 5:00pm

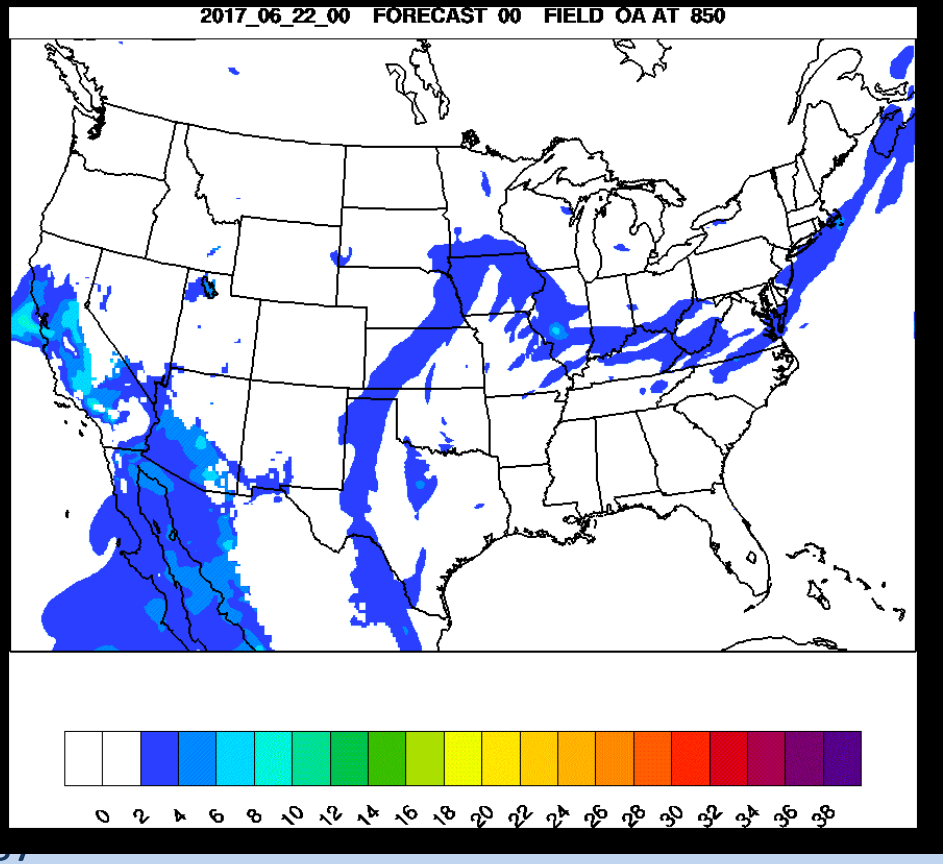
- Warm front was analyzed to the south of CT but lee-trough to our south may have created a southwest wind flow at the surface that allowed ozone to be transported from NYC into southwest CT.



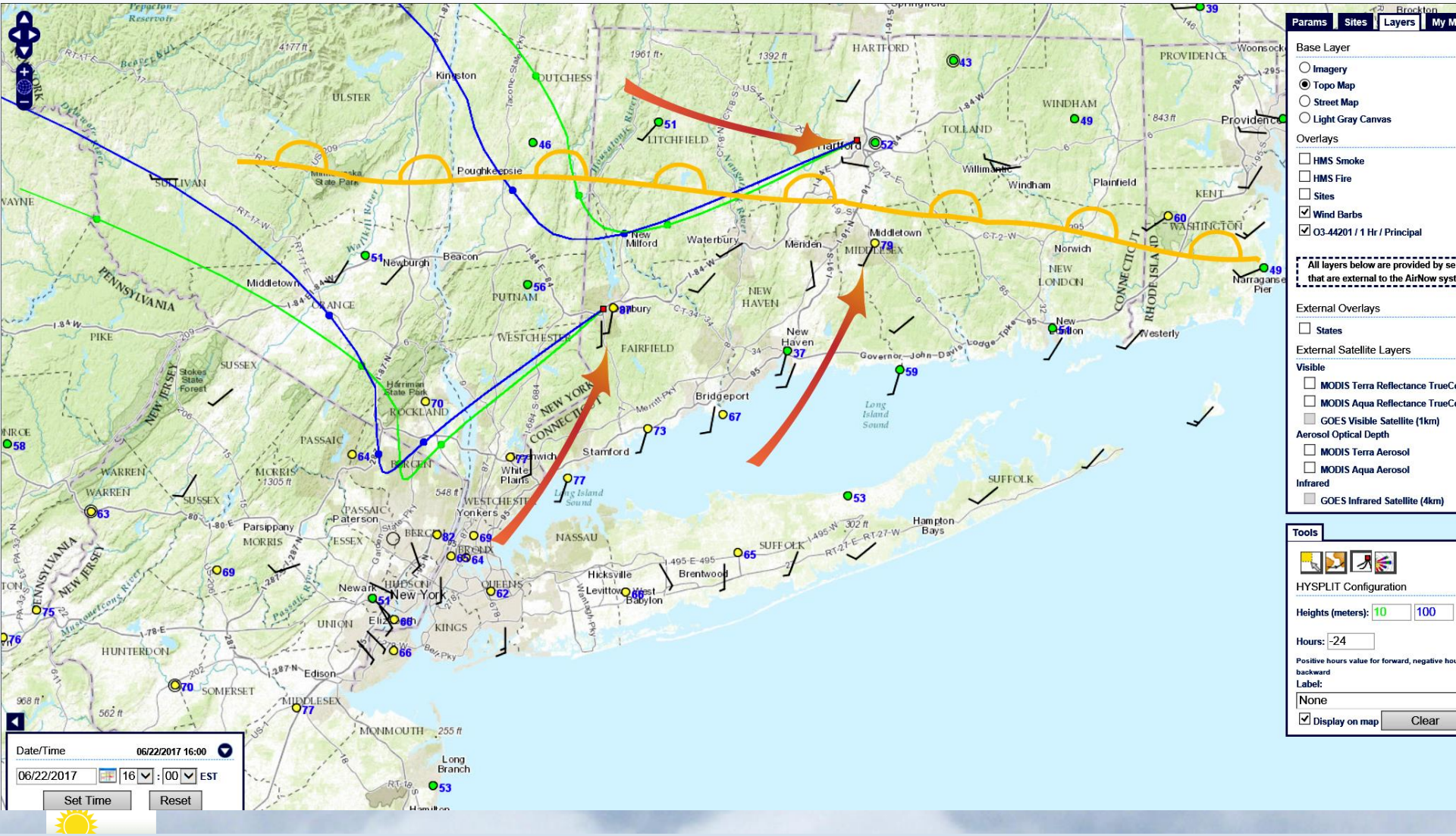
June 22, 2017 WRFCHEM 850 mb Animation

- 850mb (~1500m) ozone (left) and 850mb organic aerosol (right) model animations show a clear connection with the transport of ozone with the aerosols from fires to our west.
- Note that tropical storm Cindy can be seen in the ozone circulation in east Texas.



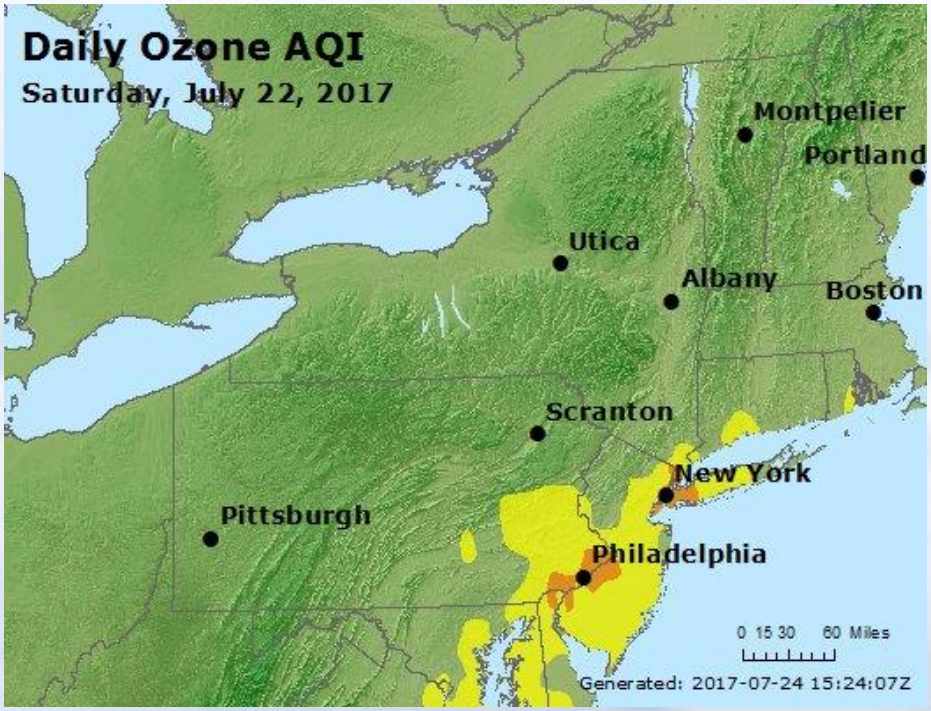


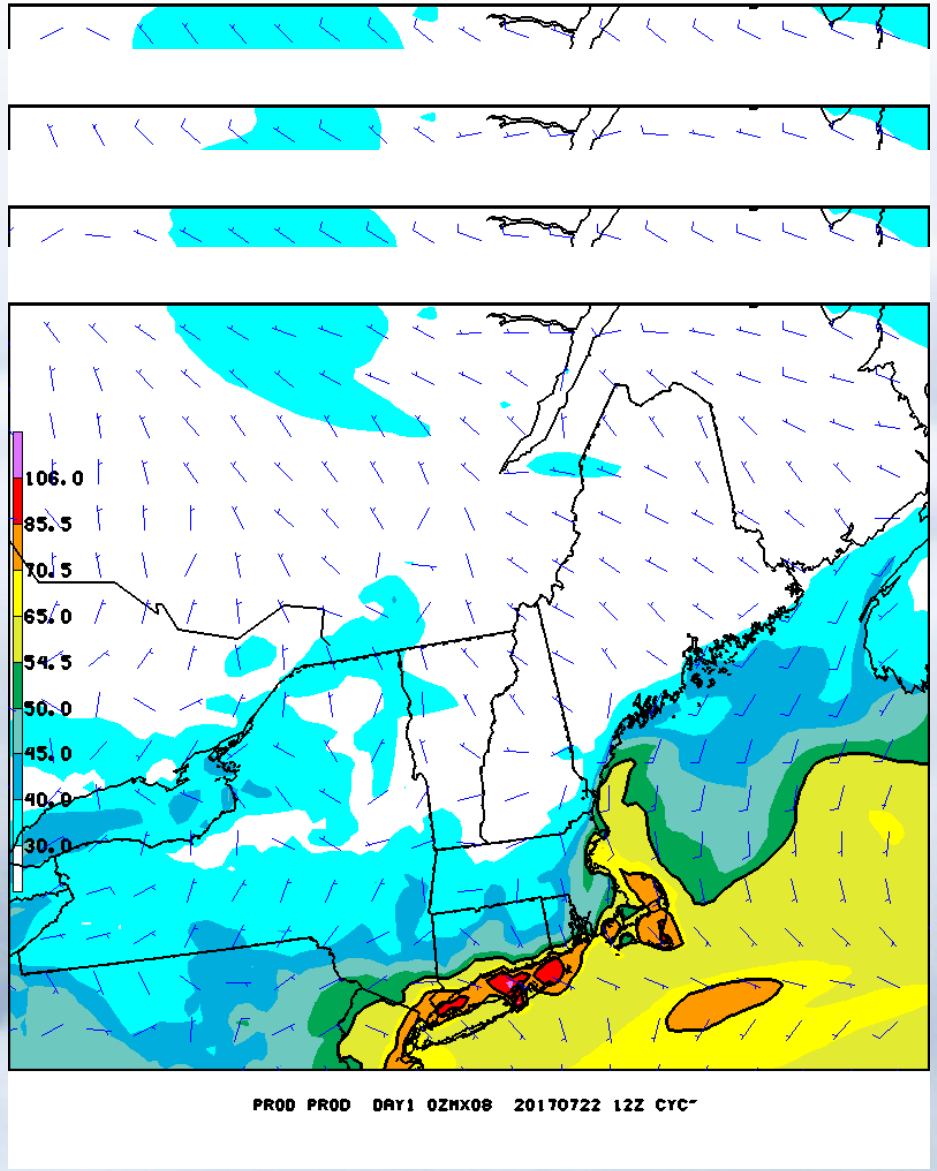
June 22, 2017 24-hour Back Trajectories 4:00pm EST



Low level winds (10-100 meters) were southwesterly over southern CT, traveling over the metro NYC area, which had the greatest impact on our Danbury monitor. It appears that the warm front had penetrated into CT sooner than the models predicted.

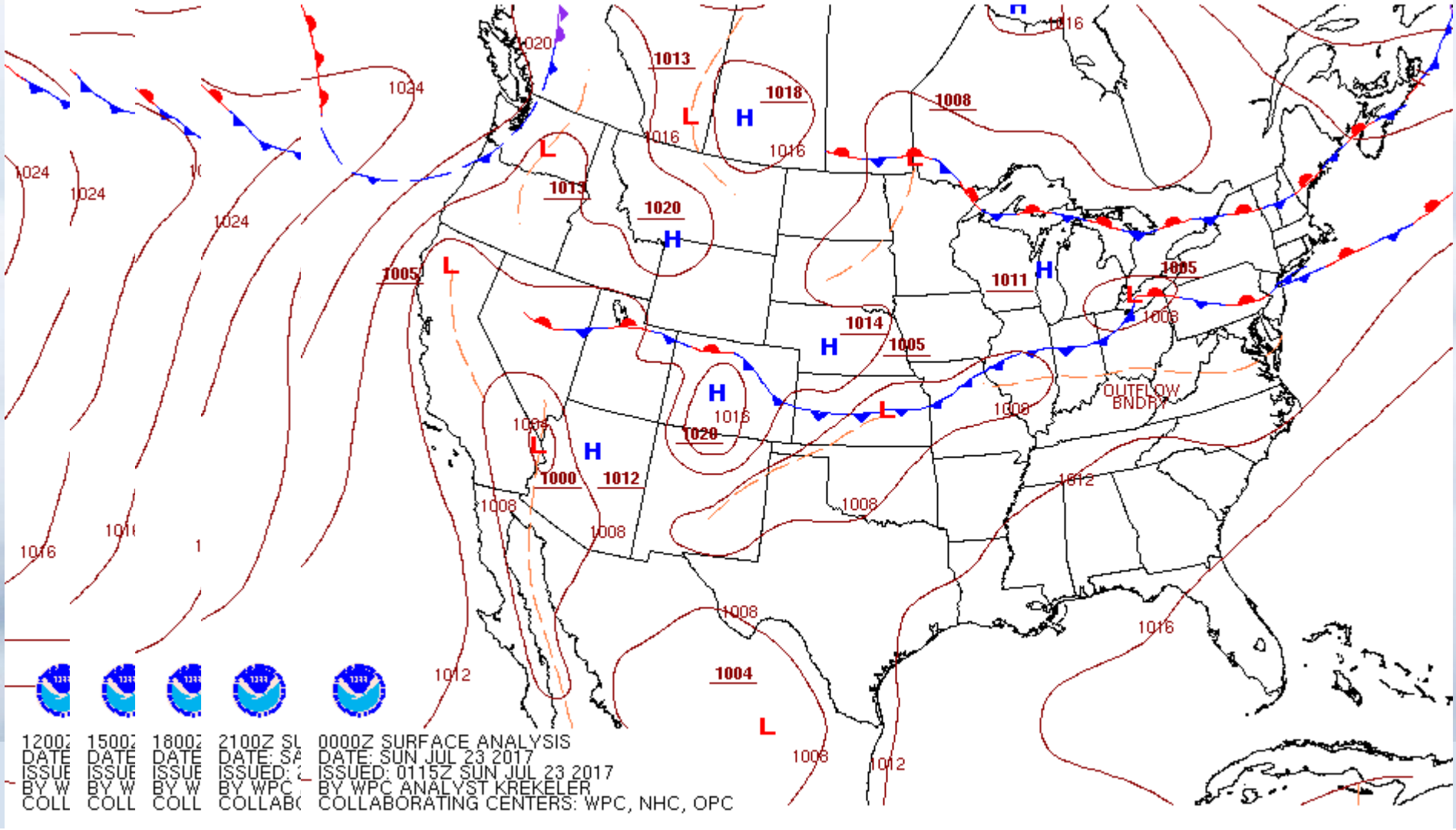
July 22, 2017 Ozone Over Prediction



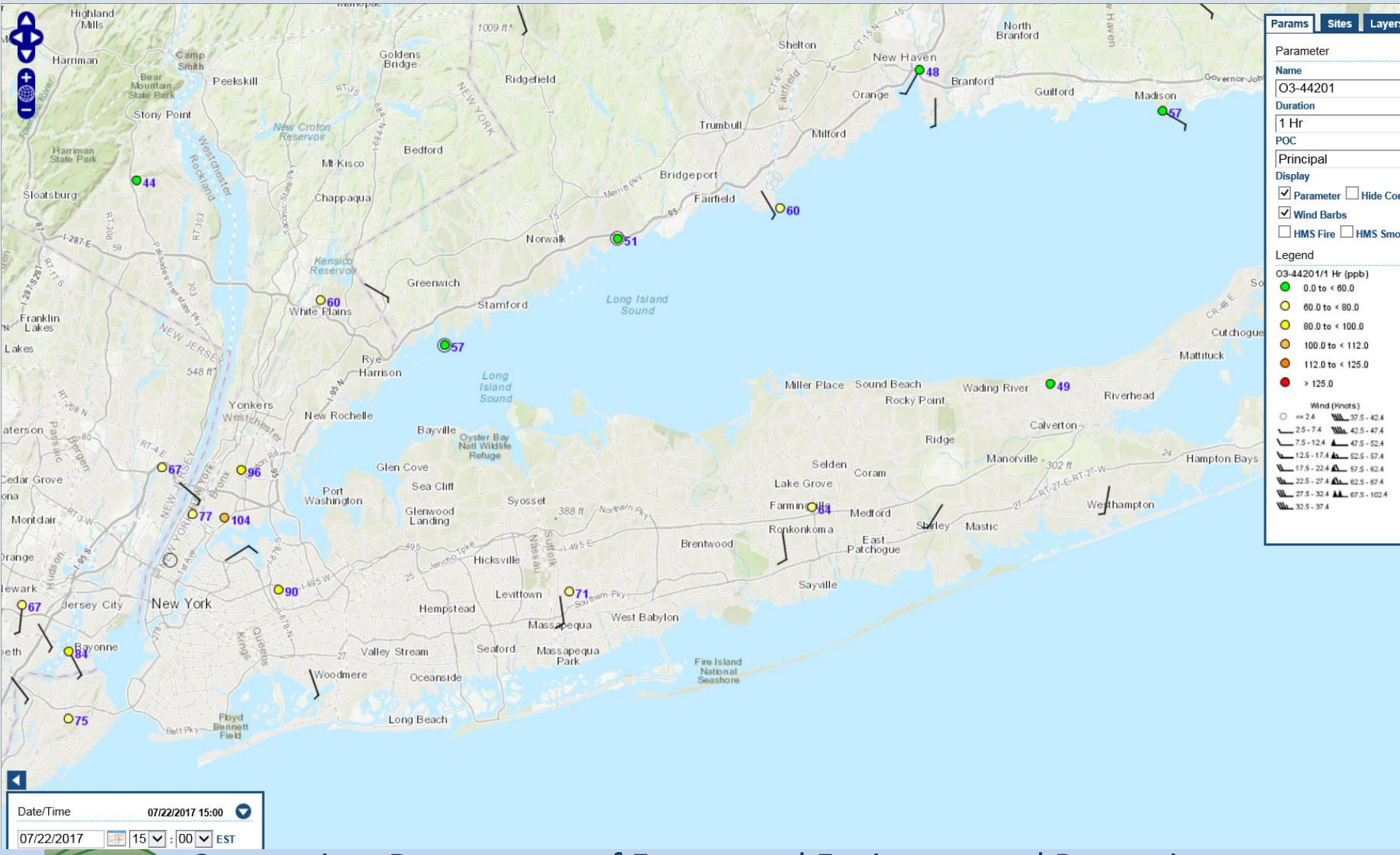


July 22 , 2017 Surface Analysis

- Cold front stalled just south of Connecticut which prohibited a LIS plume to develop.

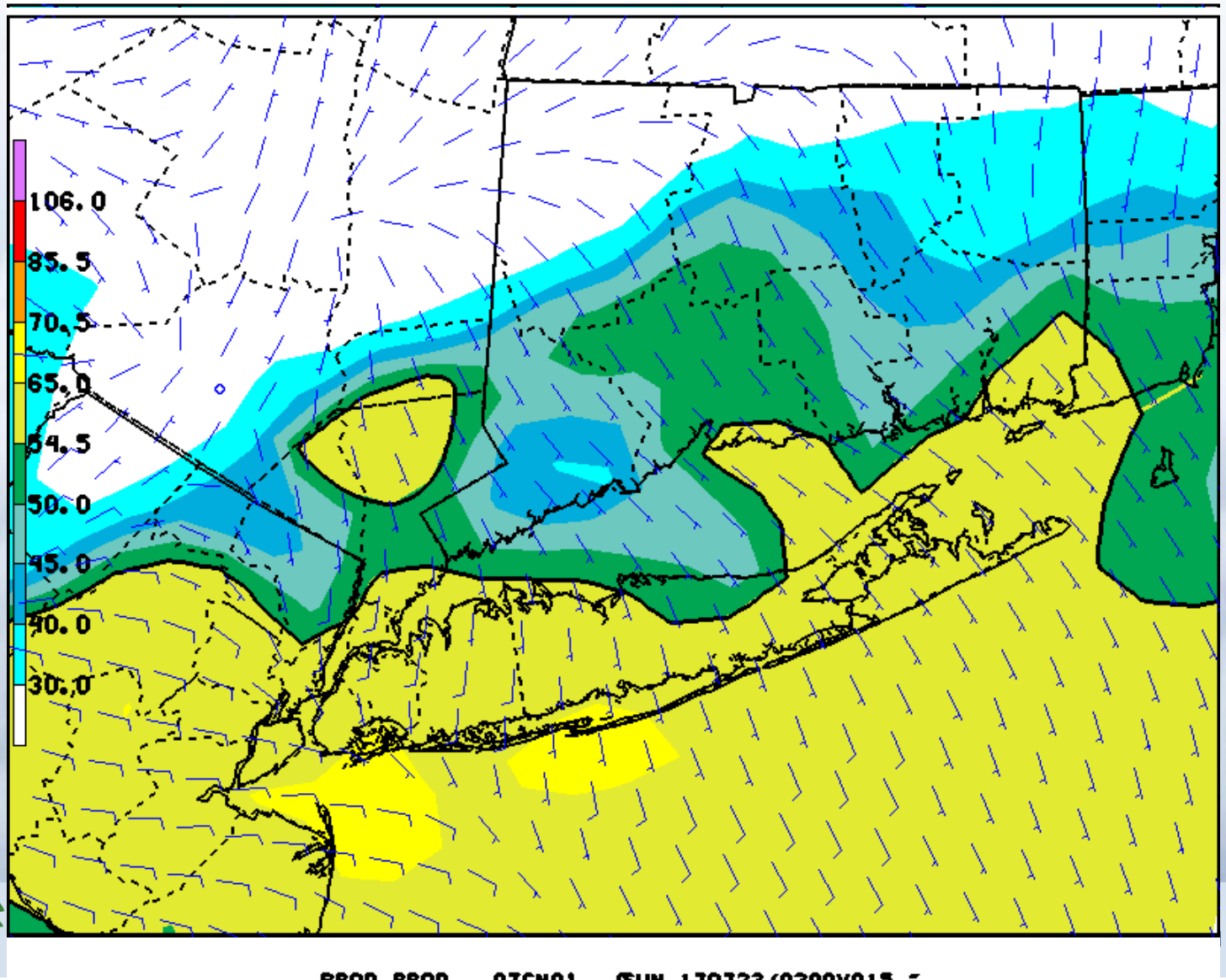


July 22 , 2017 1500EST Ozone

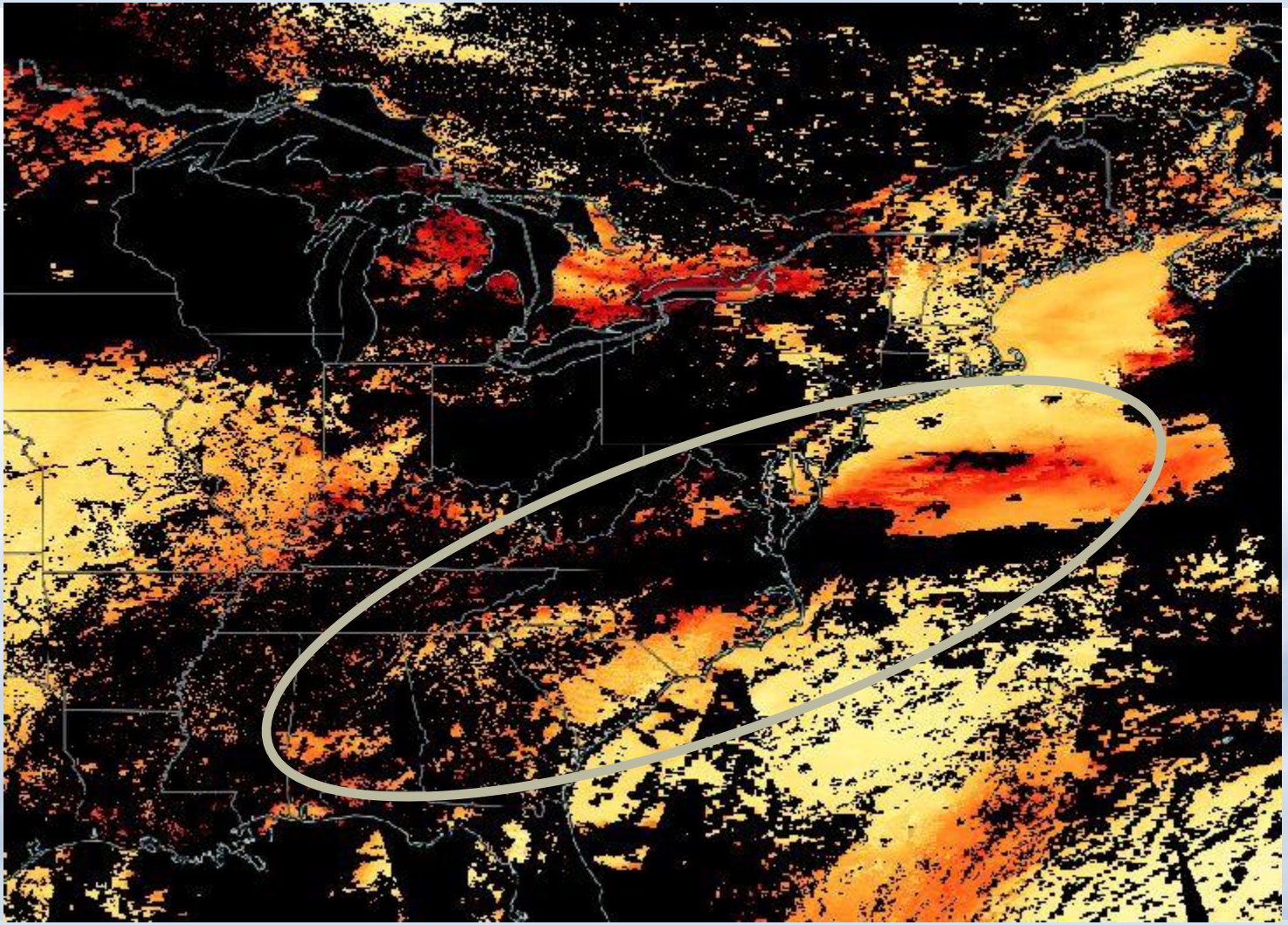


Connecticut Department of Energy and Environmental Protection

July 22, 2017 NOAA Model

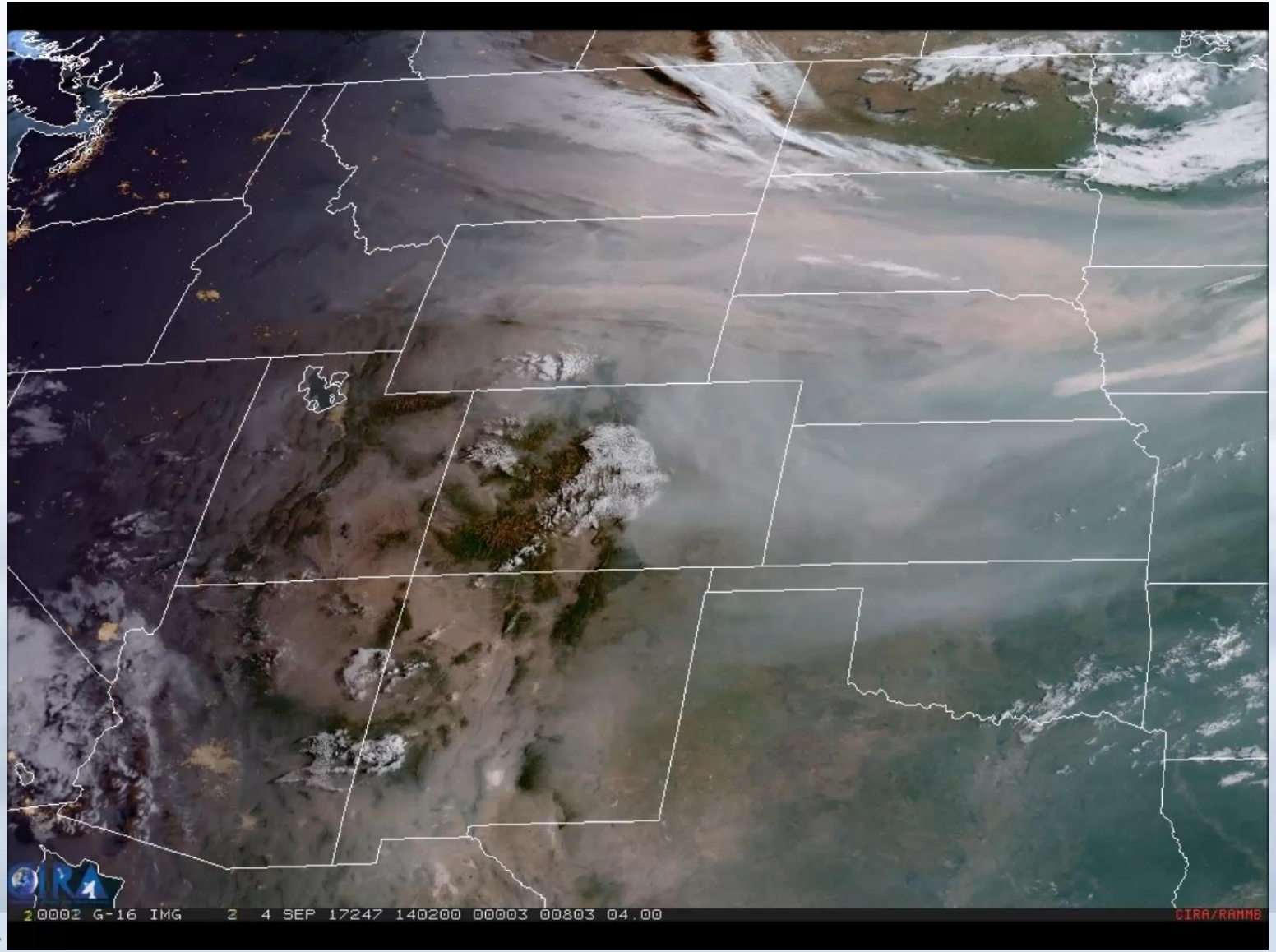


July 21, 2017 AOD



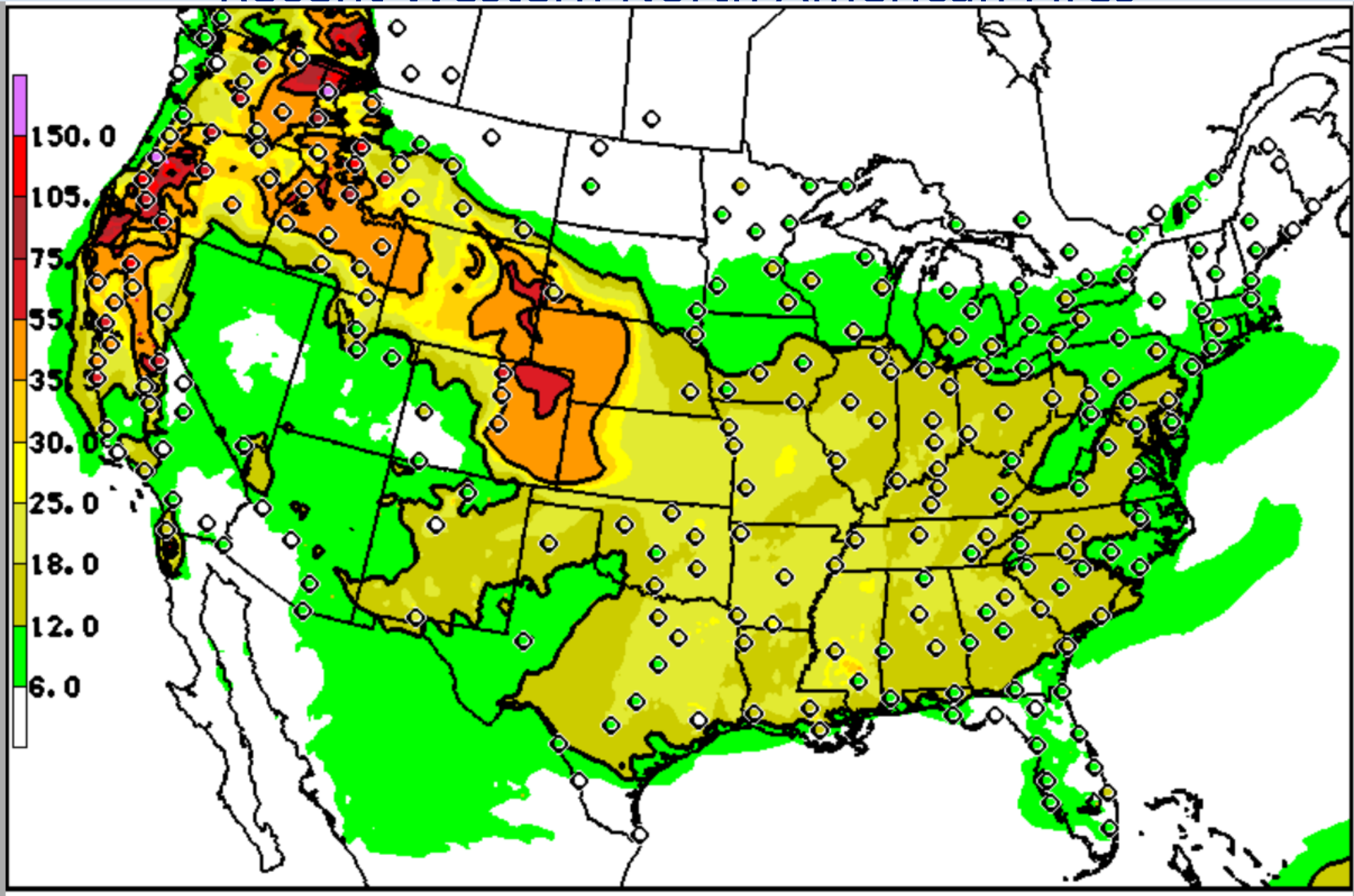
There appears to have been a smoke plume riding up the East Coast the day. Is it possible that the NOAA Model used the particulates to produce a plume of ozone over the Atlantic?

Western Fire Plumes (GOES-16)

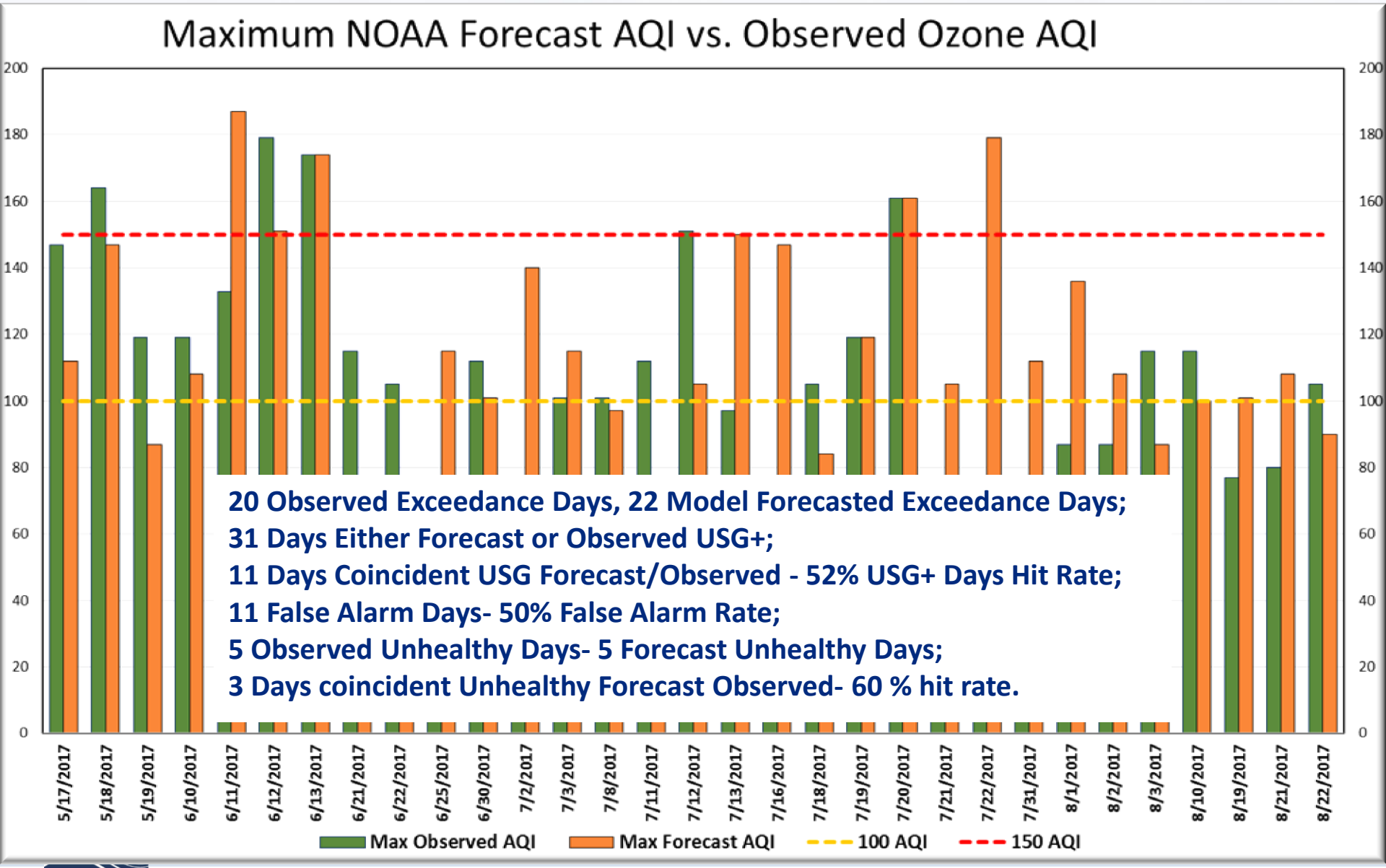


- Western Fires created impressive plume on September 4, 2017.

Recent Western North American Fires



Maximum Observed vs. Forecast AQI



Conclusions

- 20 exceedance days in 2017, compared with 31 in 2016;
- Highest ozone levels occurred in May-June this year, because of weather pattern changing in July;
- The NOAA model generally under predicted the May- June events, possibly due to smoke from agricultural fires;
- Some over predictions in July may have been due to over development of Mid-Atlantic plume over the ocean.
- The NOAA model is generally a reliable tool for forecasters and would benefit from a high resolution nested area over Long Island Sound.