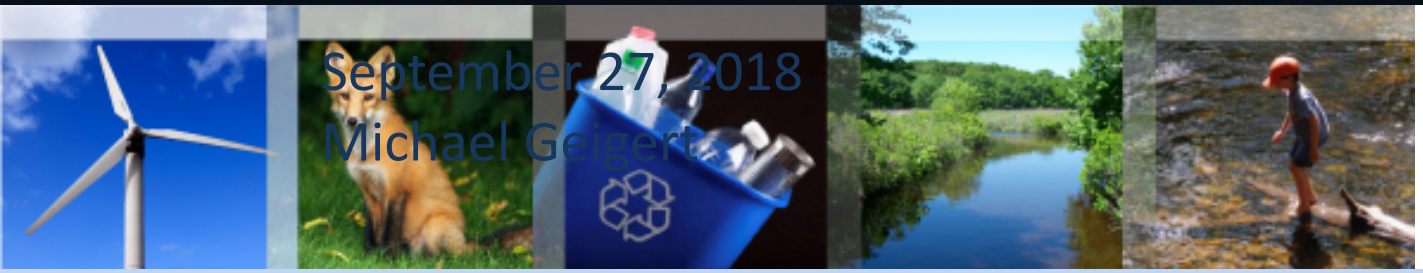
Connecticut Department of Energy and Environmental Protection



September 27, 2018
Michael Geigert

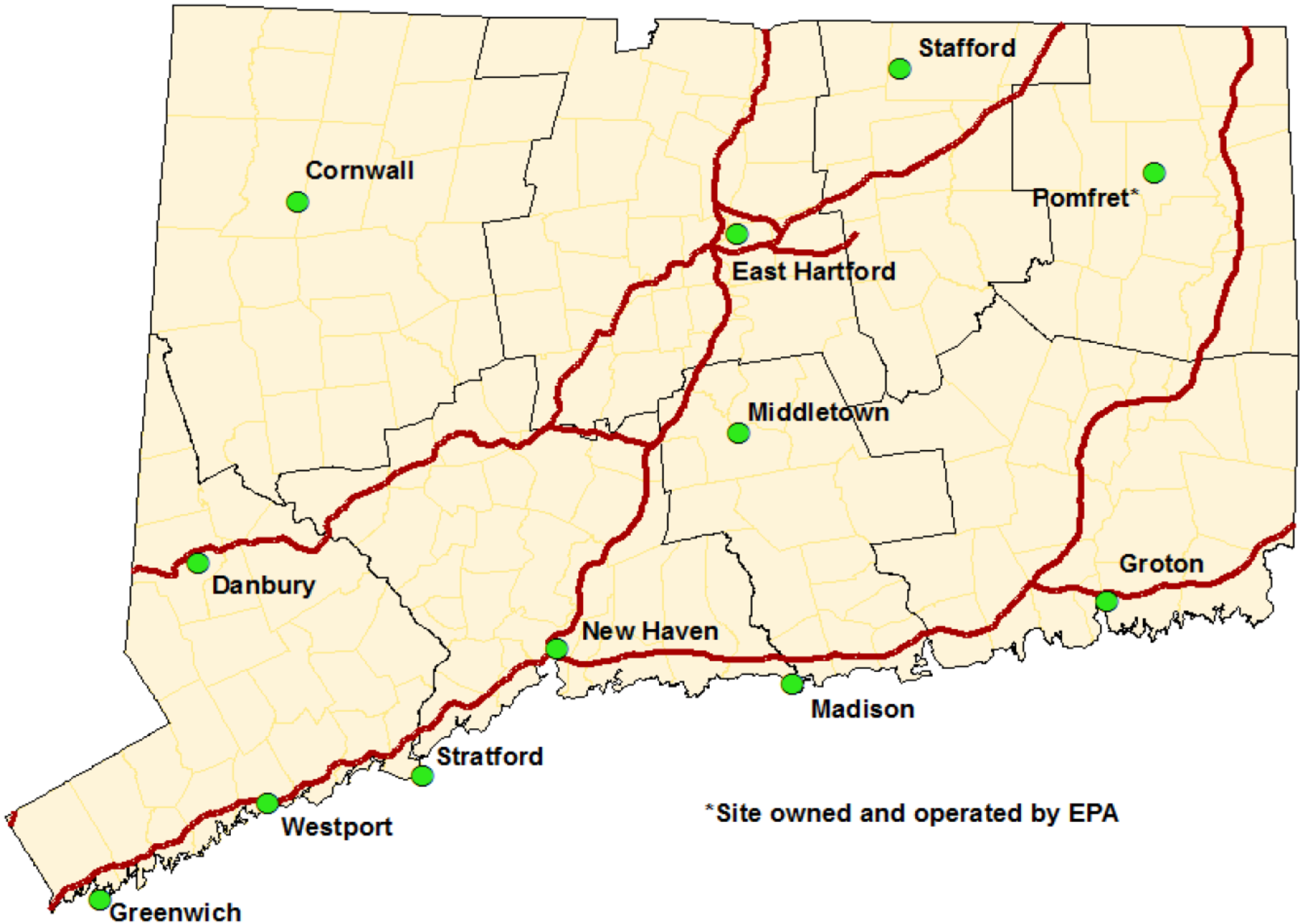
Connecticut Department of
ENERGY & ENVIRONMENTAL PROTECTION

2019 Ozone Season Summary

21 Exceedance Days
Last Year (2018): 23 Days

December 12, 2019
Sam Sampieri
Kristen Salimeno
Daniella Lopez
Michael Geigert

CT Ozone Monitors



How Did We Do This Year?

Actual Exceedance Days = 21
Forecast Exceedance Days = 10

Month	Actual Dates	Forecast Dates
May	None	None
June	5, 26, 27, 28 & 29	None
July	4, 10, 16, 17, 19, 20 27, 28, 29, 30 & 31	6, 10, 19, 20, 21, 27, 28, 29, & 30
August	8, 19 & 30	19
September	22 & 23	None
Total	21	10

Ozone in Connecticut 2019

- 21 exceedance days this year

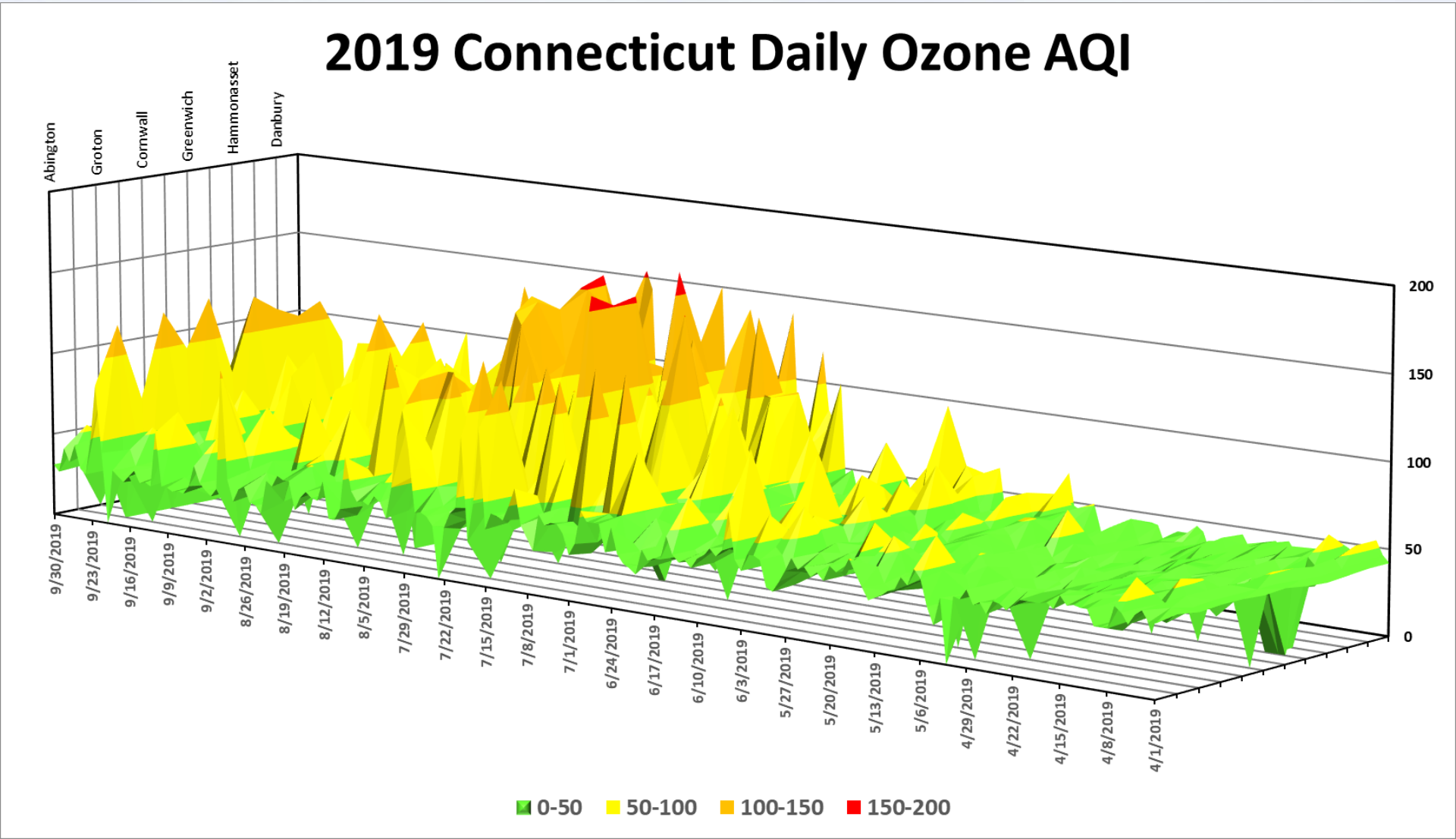
Connecticut Department of Environmental Protection
2019 8-Hour Ozone Daily Maximums*

	June					July											August			Sept.		Total
Site	5	26	27	28	29	4	10	16	17	19	20	27	28	29	30	31	8	19	30	22	23	Count
Abington	60	52	52	52	56	48	58	68	52	66	47	M	M	69	64	56	59	47	72	64	54	**1**
Cornwall	67	53	46	M	M	56	52	62	42	45	43	58	54	62	66	41	51	47	51	69	59	**0**
Danbury	71	55	46	59	56	65	58	75	53	66	50	72	61	64	75	51	60	59	60	74	71	**6**
East Hartford	59	55	49	53	54	60	54	77	52	77	45	52	61	61	72	51	58	64	57	77	72	**5**
Greenwich	61	70	62	72	64	86	72	86	69	64	54	63	71	84	84	76	66	66	65	63	62	**8**
Groton	51	53	67	62	79	79	75	59	58	59	65	31	75	74	73	59	76	44	62	61	47	**7**
Madison	51	63	72	71	84	77	79	66	60	58	73	40	84	86	77	69	84	60	67	74	54	**11**
Middletown	58	58	53	58	60	64	60	87	60	77	53	48	73	82	76	60	65	70	76	76	64	**7**
New Haven	48	63	60	54	57	72	60	89	57	71	60	50	81	83	66	70	66	71	64	78	49	**7**
Stafford	70	54	50	54	54	44	55	75	51	78	44	53	61	62	73	56	55	54	56	75	72	**5**
Stratford	57	71	64	65	76	82	64	84	69	67	67	53	83	87	77	70	80	72	71	65	56	**10**
Westport	60	71	63	68	72	84	67	90	74	72	58	61	81	88	79	69	70	68	73	72	60	**11**
# days > Federal Standard	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	

Good (0-54 ppb)
Moderate (55-70 ppb)
Unhealthy for Sensitive Groups (71-85 ppb)
Unhealthy (86-105 ppb)
Very Unhealthy (>106 ppb)

Ozone in Connecticut 2019

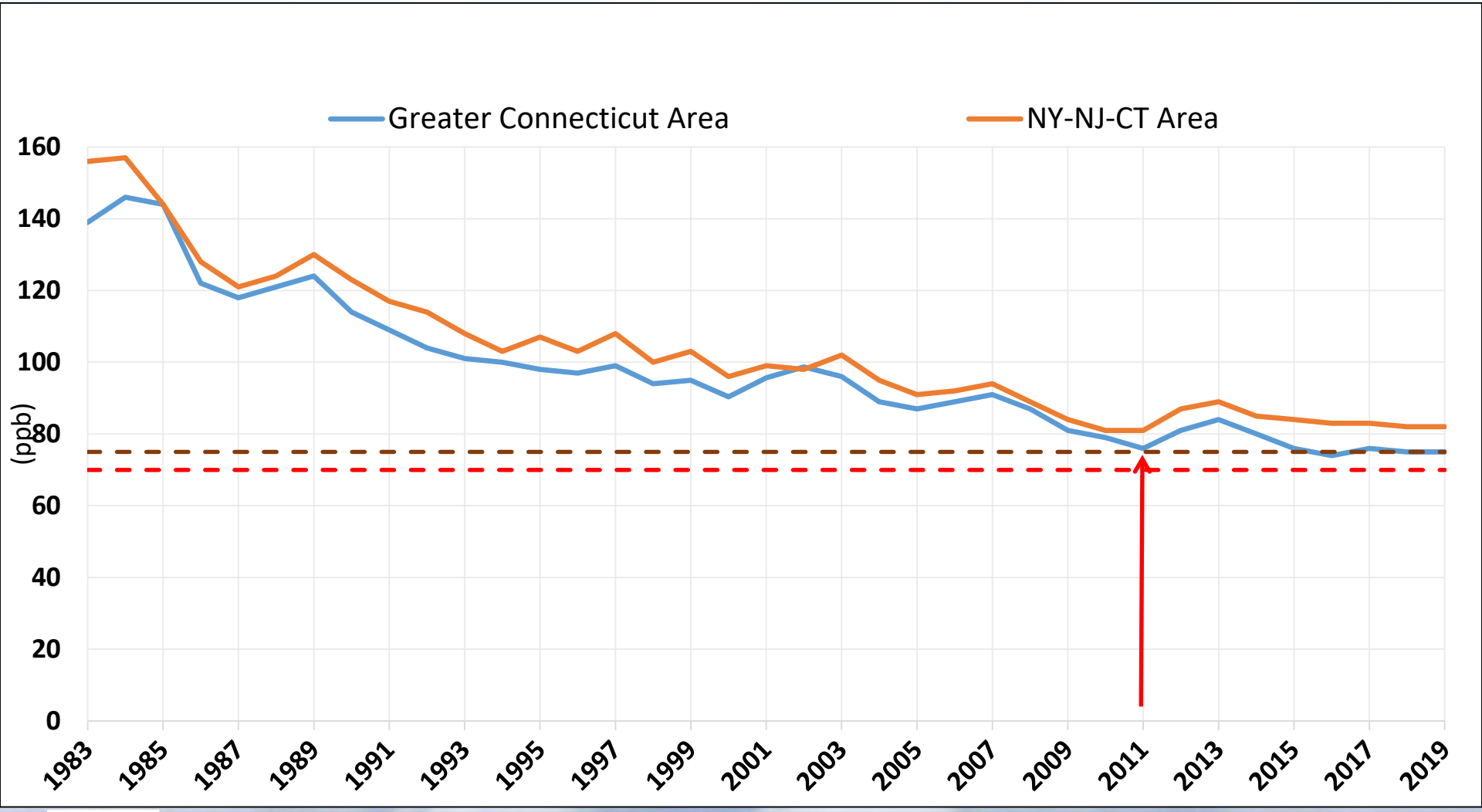
- 21 exceedance days this year



2019 Preliminary Design Values

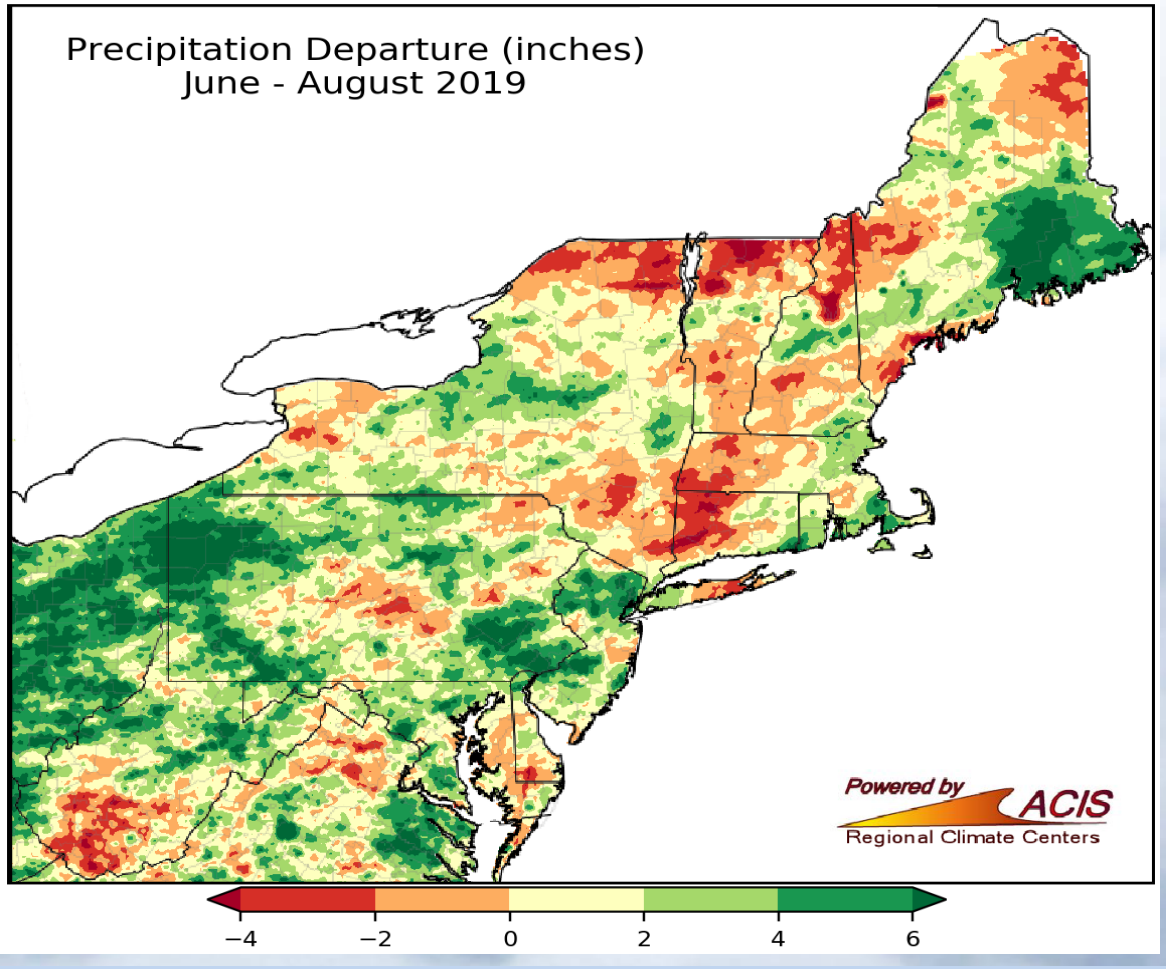
	Site Name	To Date: Prelim 2019 DV	2019 Compliance Status x = Violating NAAQS: 2015 NAAQS	2008 NAAQS	1997 NAAQS	# Needed to Next NAAQS in Violation (key monitors in each NA are highlighted in RED)
SWCT Portion of NYC Area	Danbury	73	X			4 more days > 80 ppb day(s) violate the 2008 NAAQS
	Greenwich	81	X	X		4 more days > 94 ppb day(s) violate the 1997 NAAQS
	Madison	80	X	X		4 more days > 91 ppb day(s) violate the 1997 NAAQS
	Middletown	77	X	X		4 more days > 98 ppb day(s) violate the 1997 NAAQS
	New Haven	75	X			1 more days > 80 ppb day(s) violate the 2008 NAAQS
	Stratford	82	X	X		4 more days > 90 ppb day(s) violate the 1997 NAAQS
	Westport	82	X	X		3 more days > 89 ppb day(s) violate the 1997 NAAQS
Greater CT	Cornwall	66				4 more days > 72 ppb day(s) violate the 2015 NAAQS
	East Hartford	70				1 more days > 75 ppb day(s) violate the 2015 NAAQS
	Groton	75	X			1 more days > 75 ppb day(s) violate the 2008 NAAQS
	Stafford	71	X			4 more days > 86 ppb day(s) violate the 2008 NAAQS
	Abington	70				1 more days > 66 ppb day(s) violate the 2015 NAAQS
Number of Exceedance Days to Date			21			The 1997 standard was repealed with the 2008 Implementation rule. Effective April 6, 2015

Ozone Design Values (ppb)



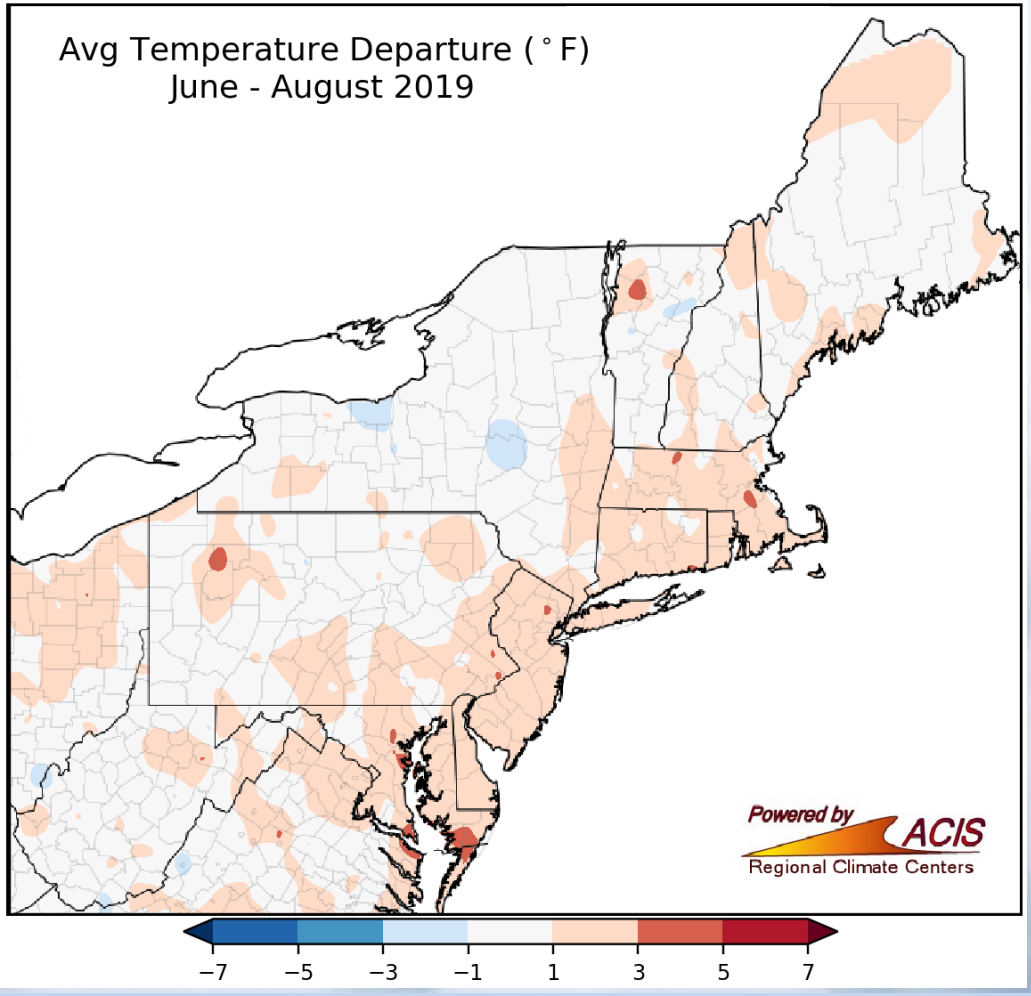
Summer Precipitation Summary

Overall, a drier summer for Connecticut



Summer Temperature Summary

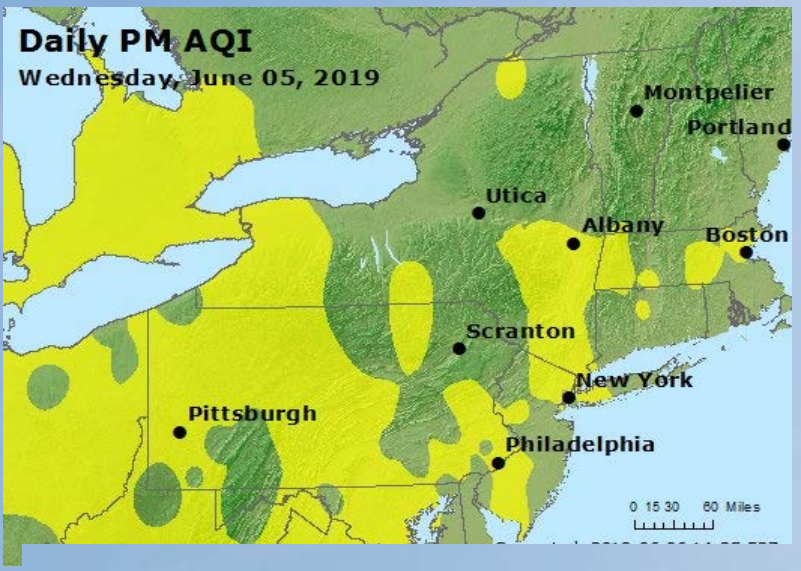
Slightly above normal temperatures for Connecticut

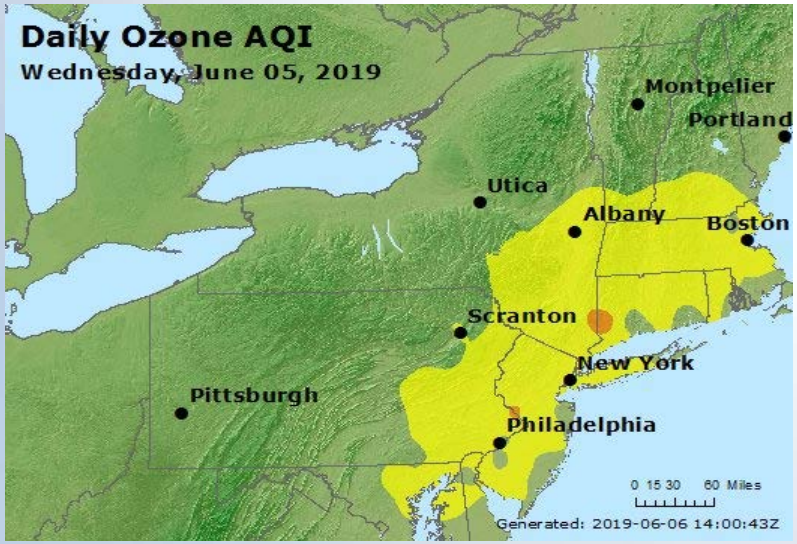


2019 Select Event Analysis

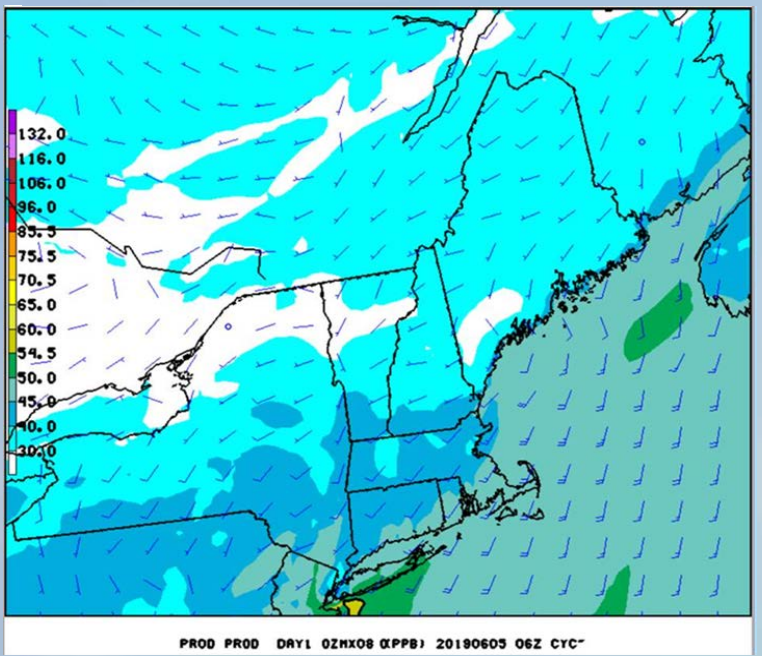
- June 5
- June 27-29
- July 4
- July 16
- August 30
- September 22-23

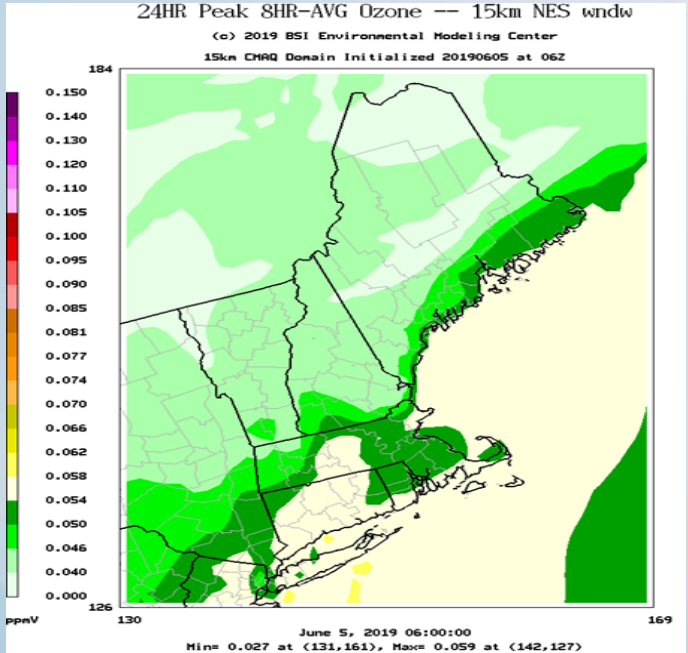
June 5, 2019: Peak 8-hour and Ozone AQI



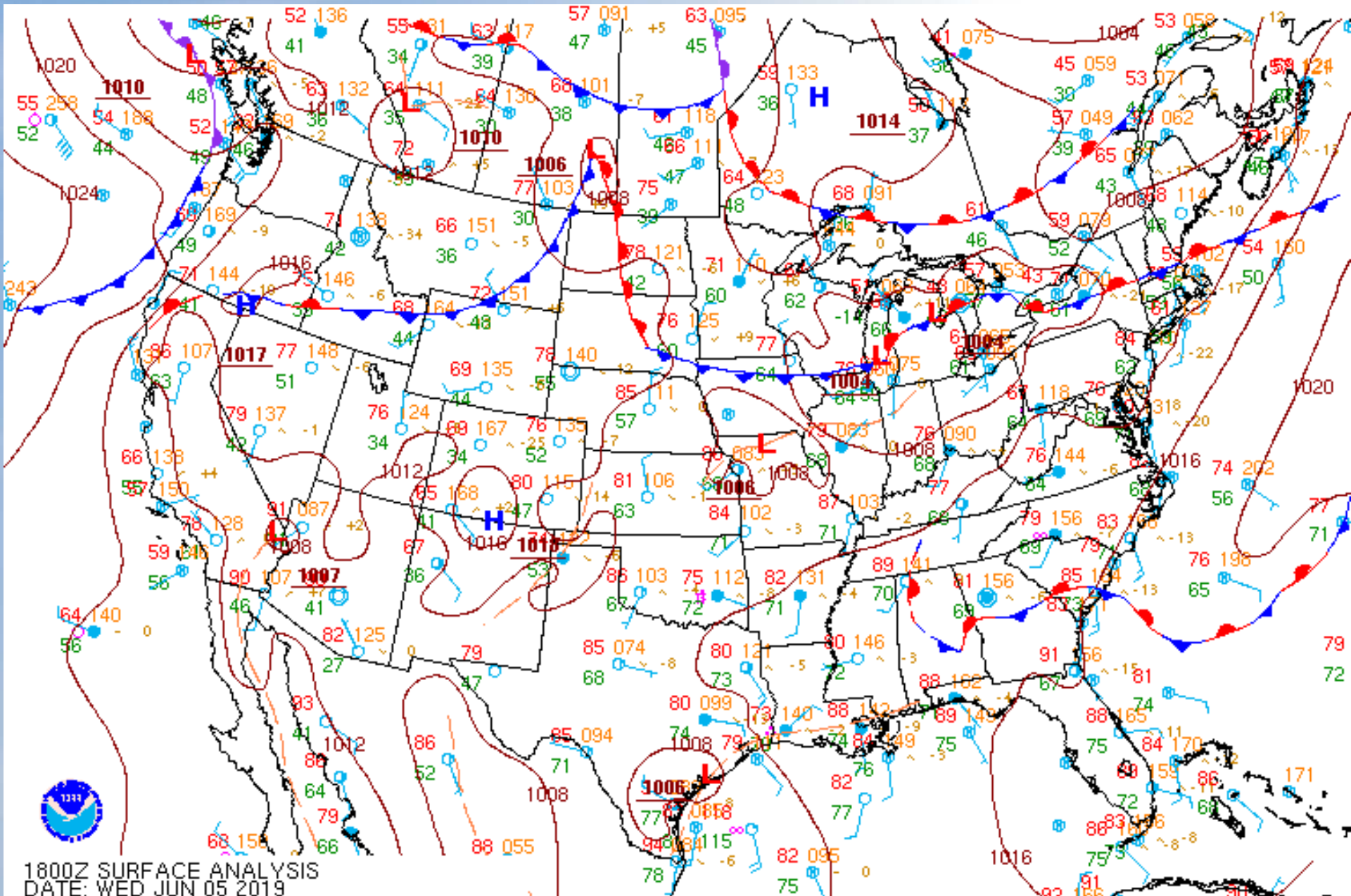


NOAA and BARONS Modeling



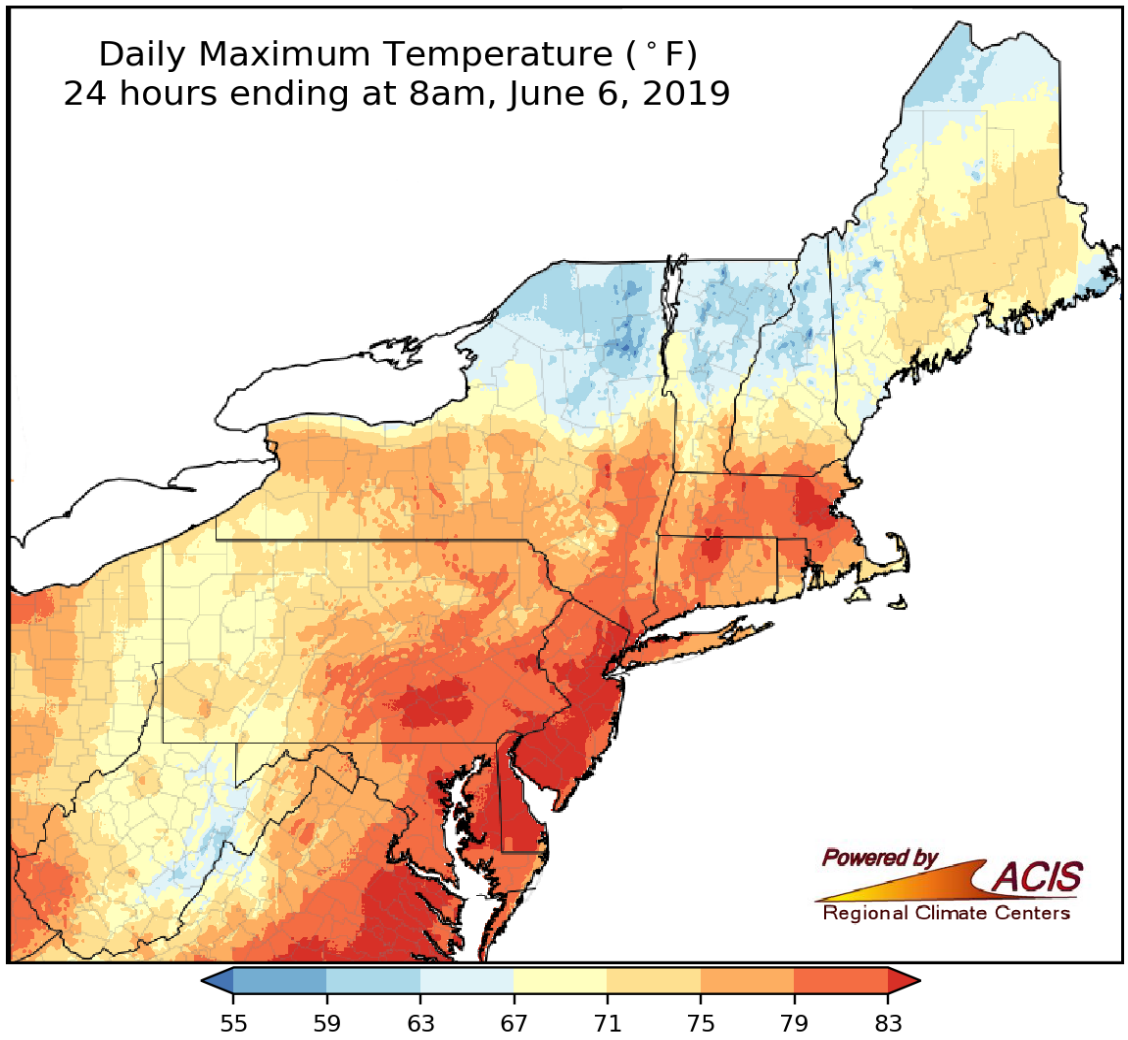


18z Surface Analysis

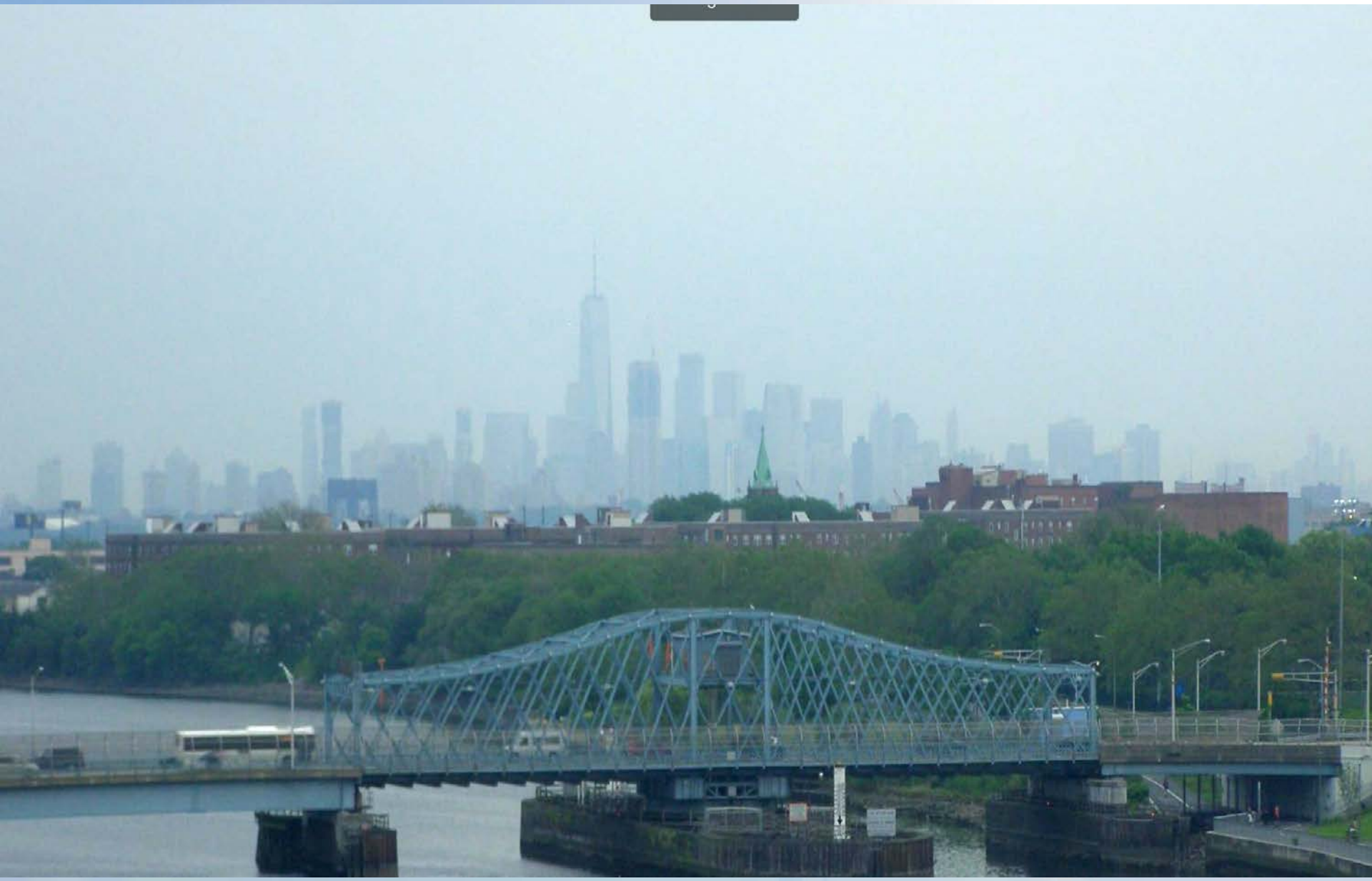


Daily Maximum Temperature

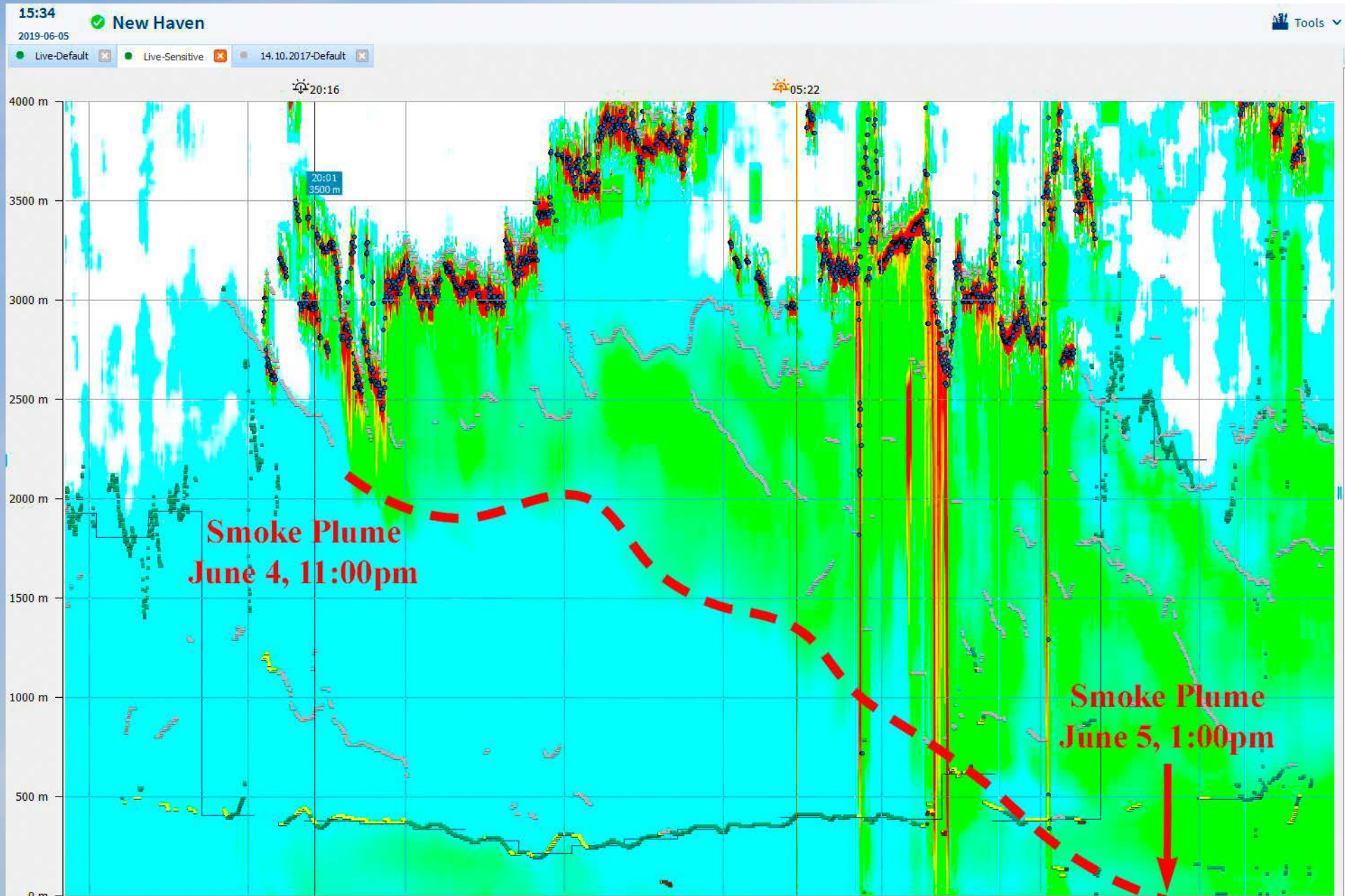
Temperatures barely exceeded 80 degrees over southern New England.



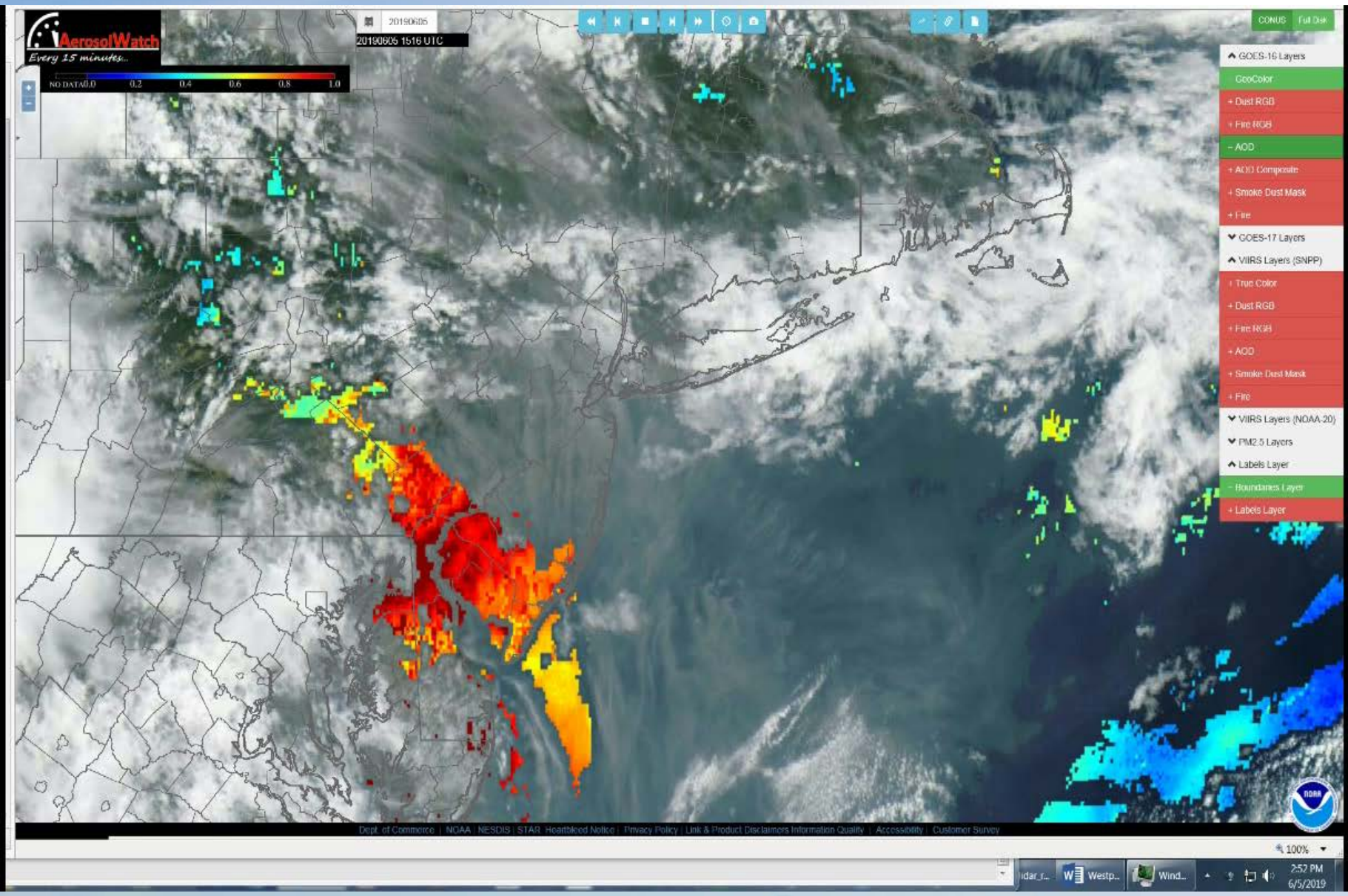
Newark NJ Haze Cam 18:41 pm



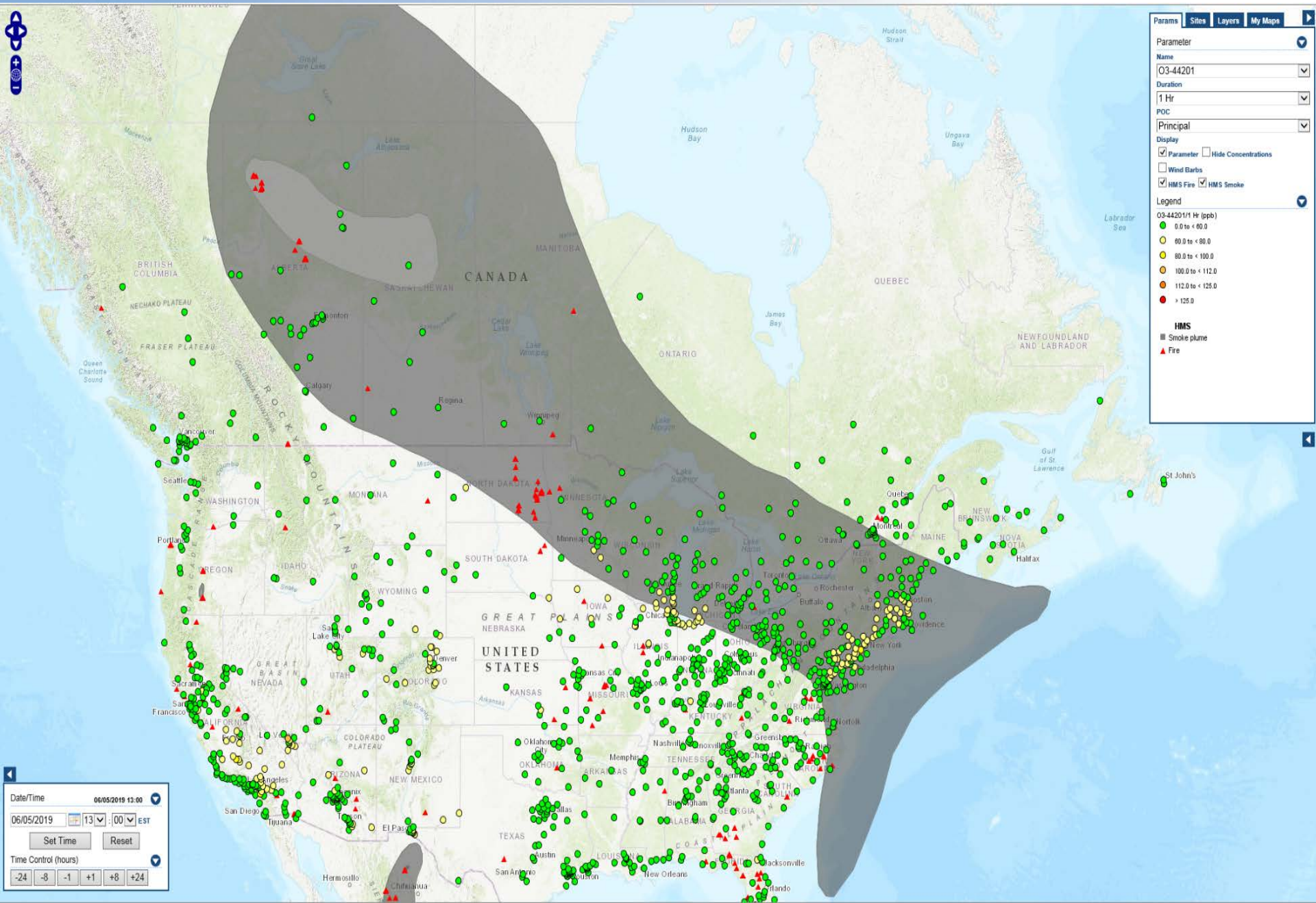
New Haven Ceilometer with Smoke Plume Layer



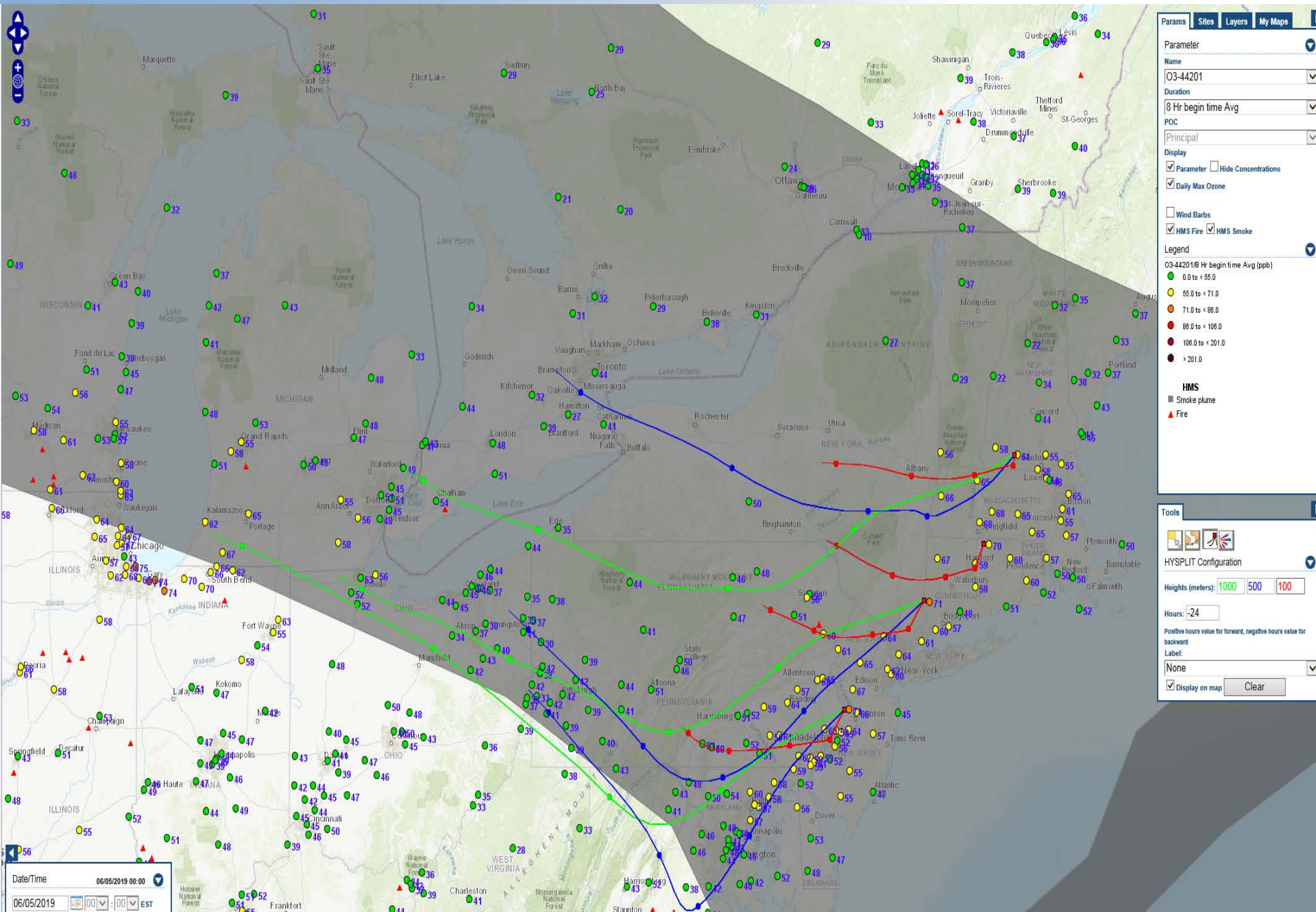
GOES16 Animation with AOD



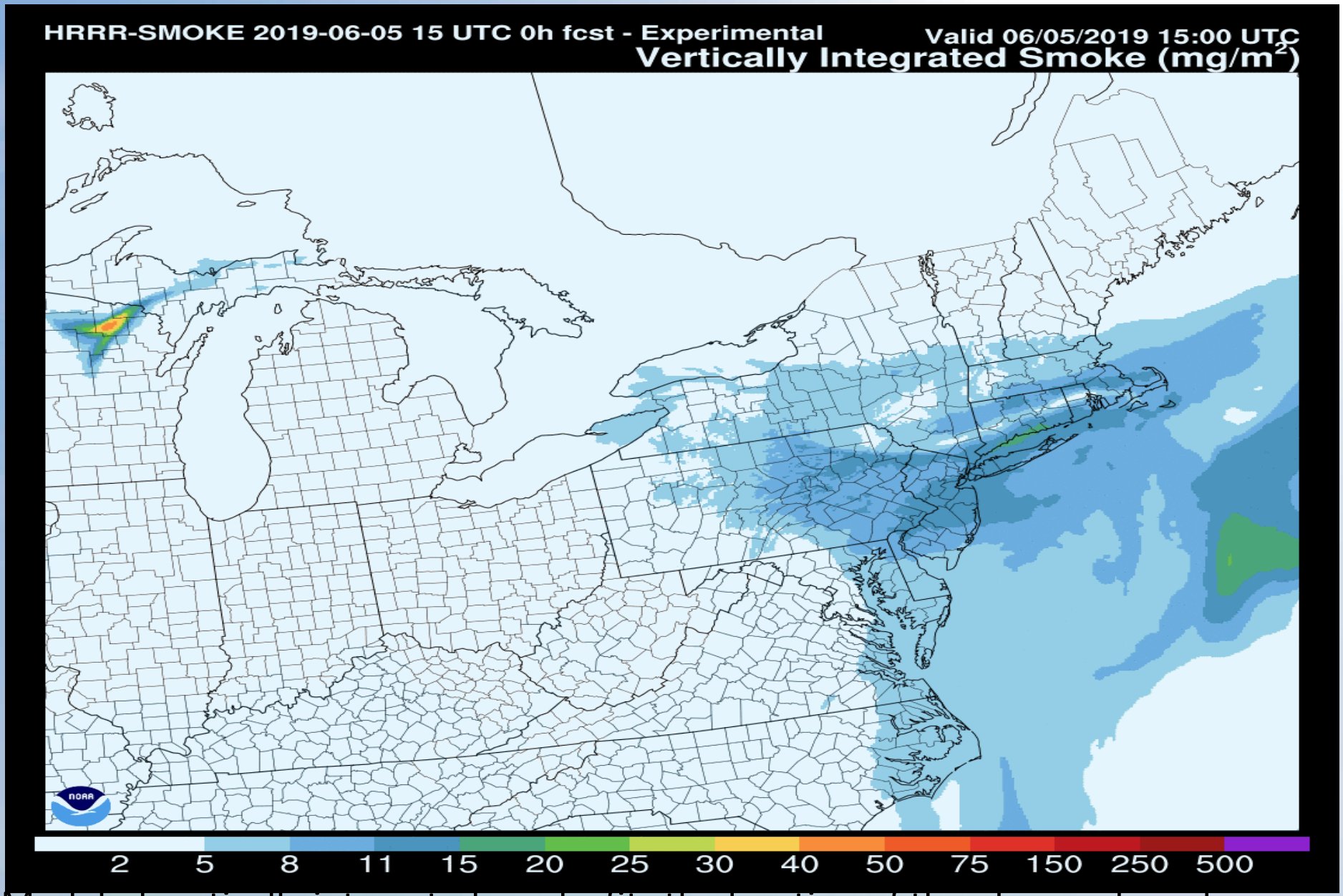
24-hour HMS Smoke



24-hour Back Trajectories



HRRR Smoke Model



Modeled vertically integrated smoke fits the location of the observed smoke.

Conclusions

- Southerly wind flow, combined with temperatures barely over 80 degrees, is not the usual pattern for an ozone exceedance;
- Although a smoke plume from western Canada had been meandering across the country during recent days, it had not yet reached the ground and affected air quality;
- Ozone levels were forecast to be borderline MODERATE for this day;
- The image from the New Haven ceilometer, illustrates aerosols from smoke at upper levels of the atmosphere, which descended to the surface by 1:00pm;
- Back trajectories at 3 levels, show air originating from within the analyzed smoke plume.
- Since the NOAA model had actually decreased the ozone forecast, it was the preferred model - but it did not include smoke chemistry!

Date (LST)	6/27/2019	Date (LST)	6/28/2019	Date (LST)	6/29/2019
Essex	85	Leonia	85	**Madison-Beach Road**	**84**
Edgewood	80	Essex	82	**Groton Fort Griswold**	**79**
Furley	76	NEA	81	Riverhead	78
Lancaster	75	Reading Airport	81	Babylon	77
AURORA HILLS	74	CCNY	81	**Stratford**	**76**
McMillan NCORE	73	Edgewood	79	Narragansett	73
BELLFNT2	72	Norristown	79	Queens	72
Madison-Beach Road	**72**	LABP	78	**Westport**	**72**
Millville	72	Furley	78	Holtsville	71
Babylon	72	Beltsville	76	Edgewood	69
Ancora State Hosptial	72	Bronx - IS52	75	Colliers Mills	69
Lancaster DW	71	New Garden	75	Dunkirk	67
Horn Point	71	Padonia	75	M.K. Goddard	65
NEA	70	Pfizer Lab	75	NEA	64
Reading Airport	70	Chester	73	Greenwich	64
New Garden	70	Flemington	73	Millville	64
Brigantine	70	PG Equestrian Center	73	Wampanoag Laborato	64
Clarksboro	70	**Greenwich**	**72**	LABP	63
Holtsville	70	BELLFNT2	72	BELLFNT2	63
Beltsville	69	Bristol	72	Millington	63
Chester	69	NEW	72	Ancora State Hosptial	63
FRANCONIA	69	Rutgers University	72	W Greenwich	63
TakomaRec	69	Fair Hill	72	Bronx - IS52	62
Fair Hill	68	Brigantine	72	KILLENS	62
York	68	**Madison-Beach Road**	**71**	Fall River	62
LABP	67	Millville	71	Leonia	61
Bristol	67	Camden Spruce St	71	Essex	61
Camden Spruce St	67	HU-Beltsville	71	New Garden	61
HU-Beltsville	67	Queens	70	Bristol	61

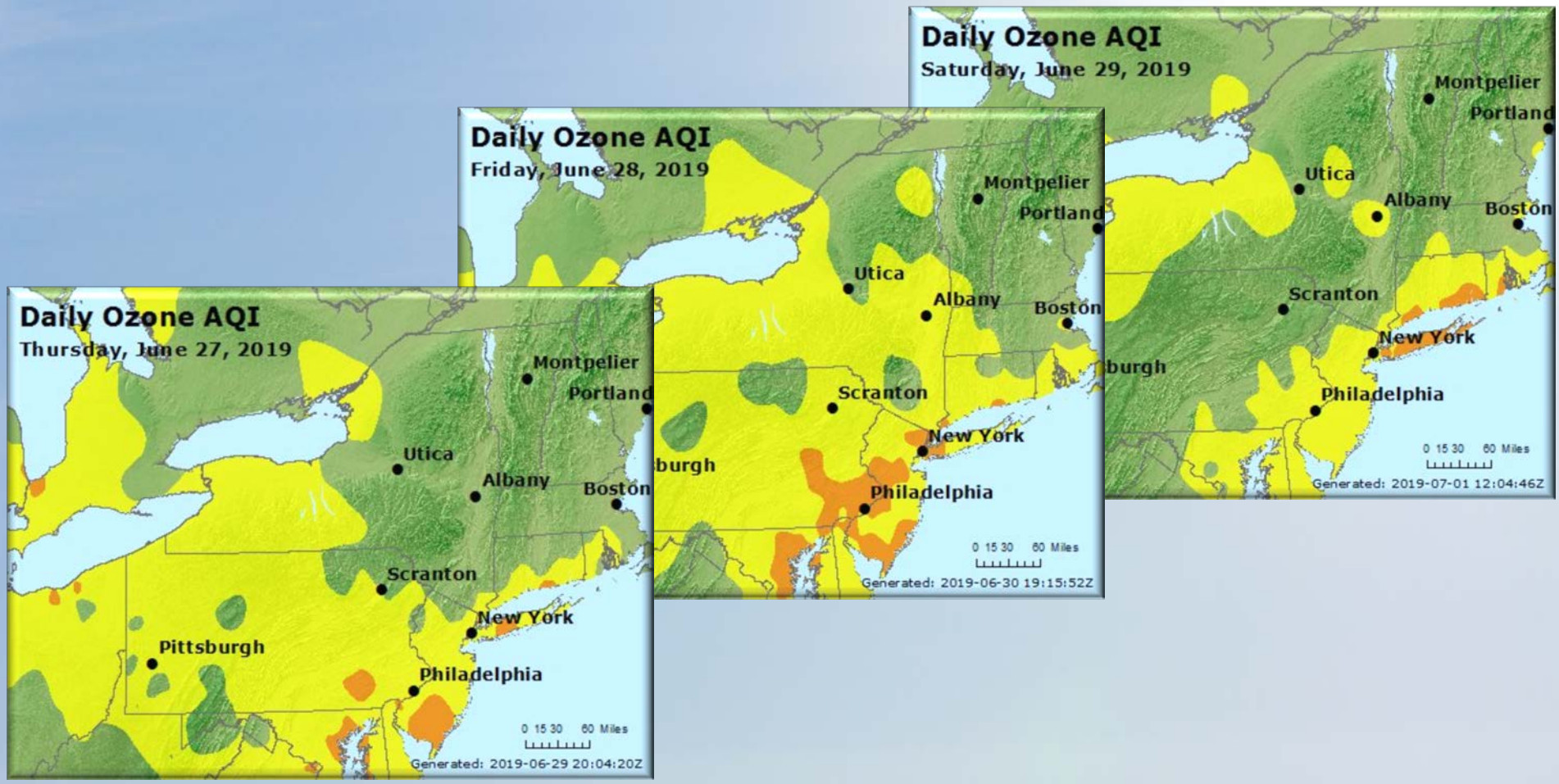
Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Ozone Event Analysis: June 27-29, 2019

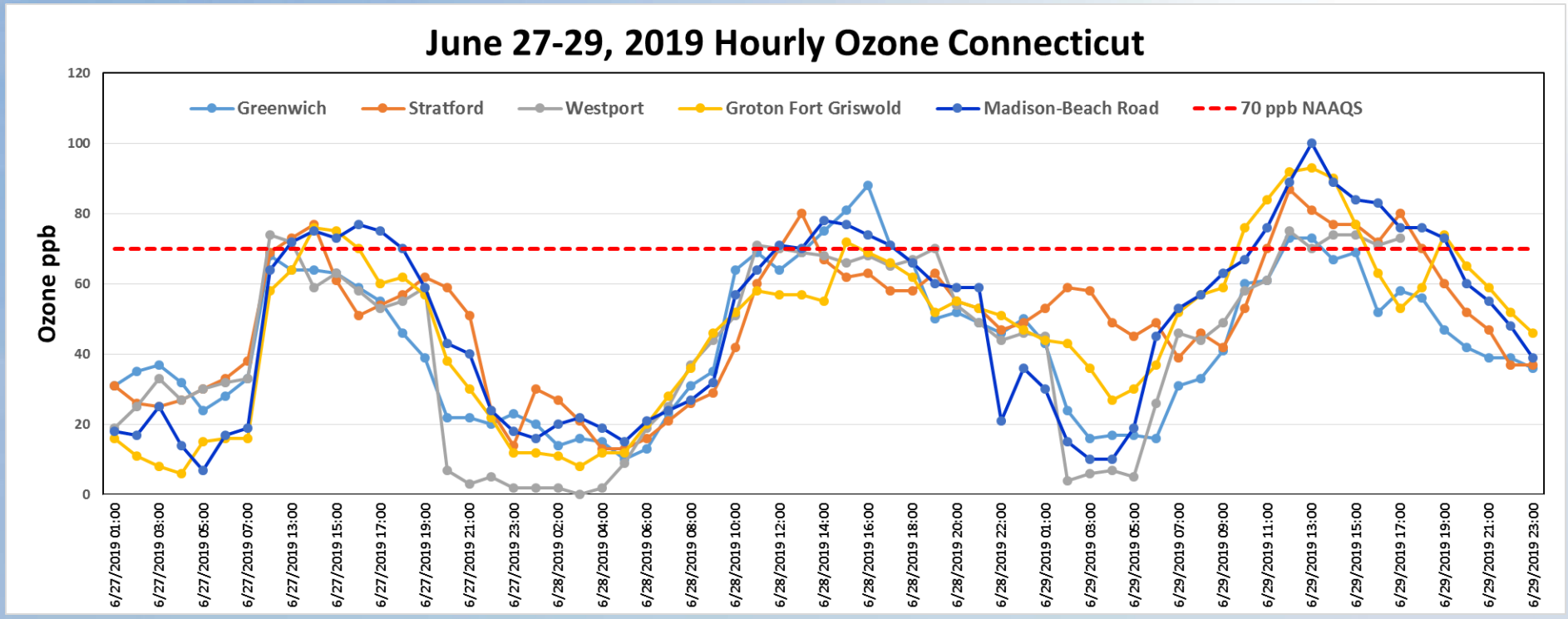
Michael Geigert

CONNECTICUT WORKING TOGETHER FOR CLEAN AIR

June 27-29, 2019: 8-hour Ozone Maximums



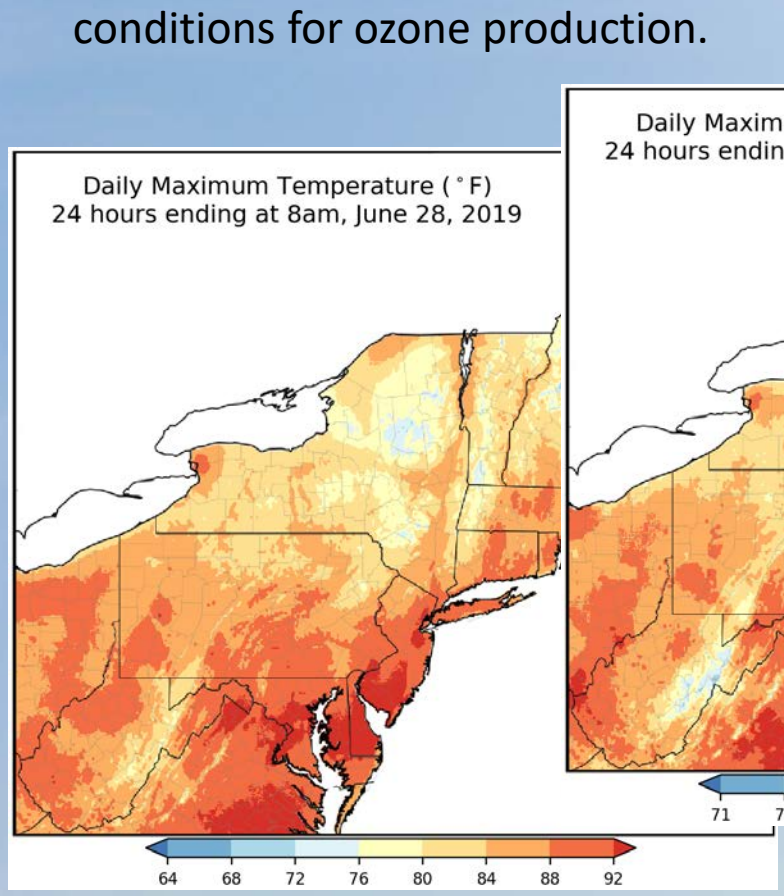
June 27-29, 2019 Hourly Ozone

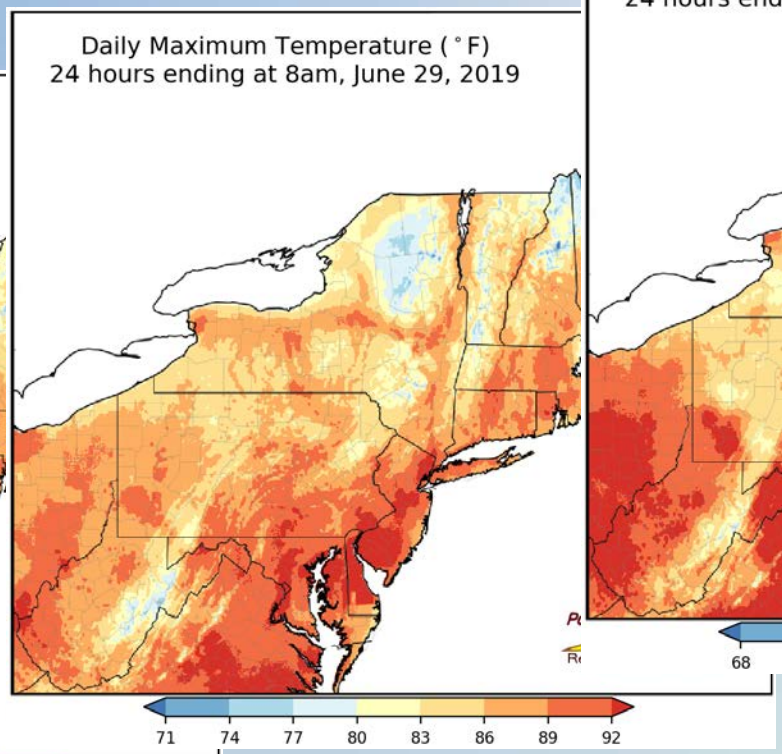


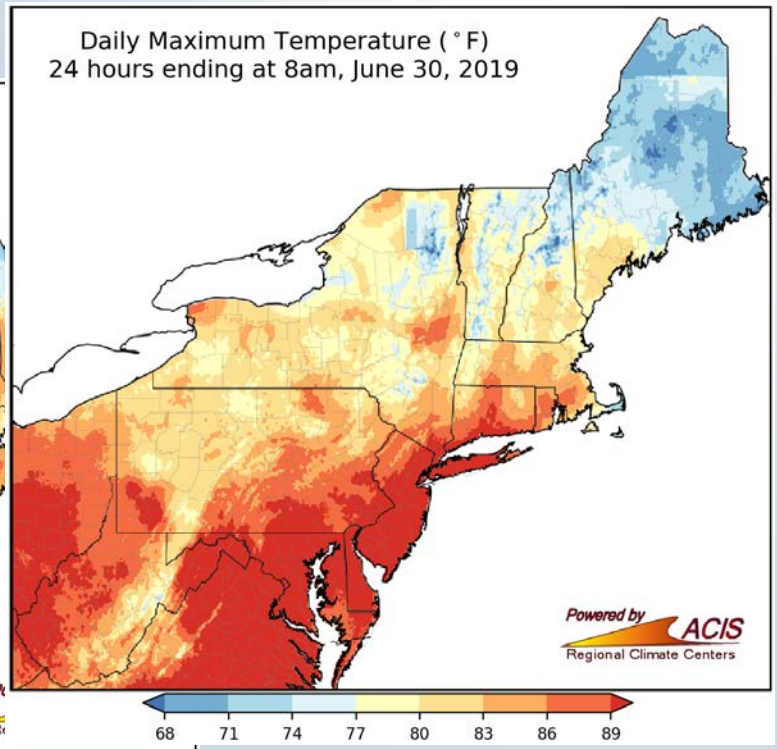
- Only the coastal monitors had exceedances, with Madison peaking on June 29th.

Maximum 24-hr Temperature

- Temperatures reached the upper 80's to low 90's along the I-95 corridor, which provided conditions for ozone production.

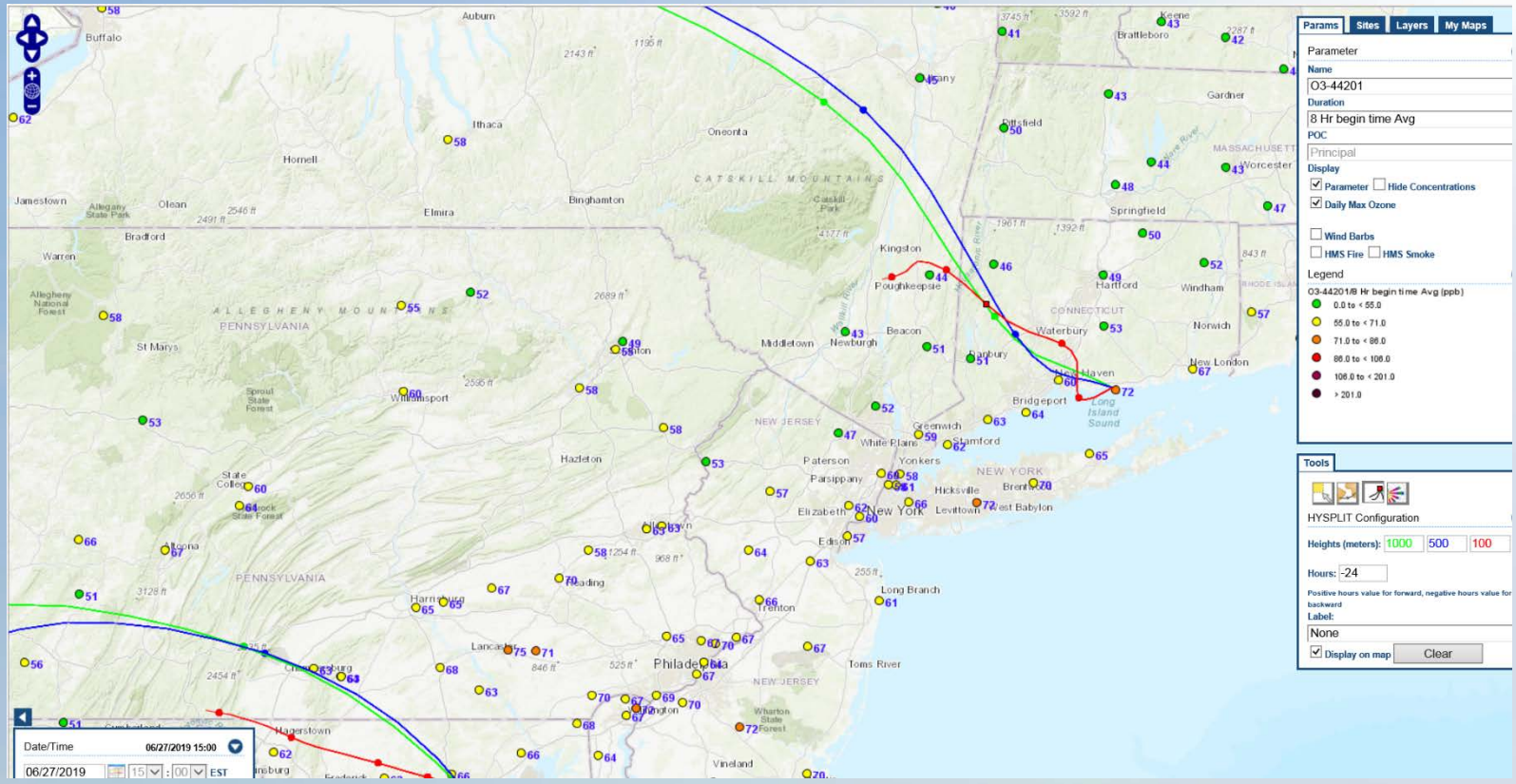






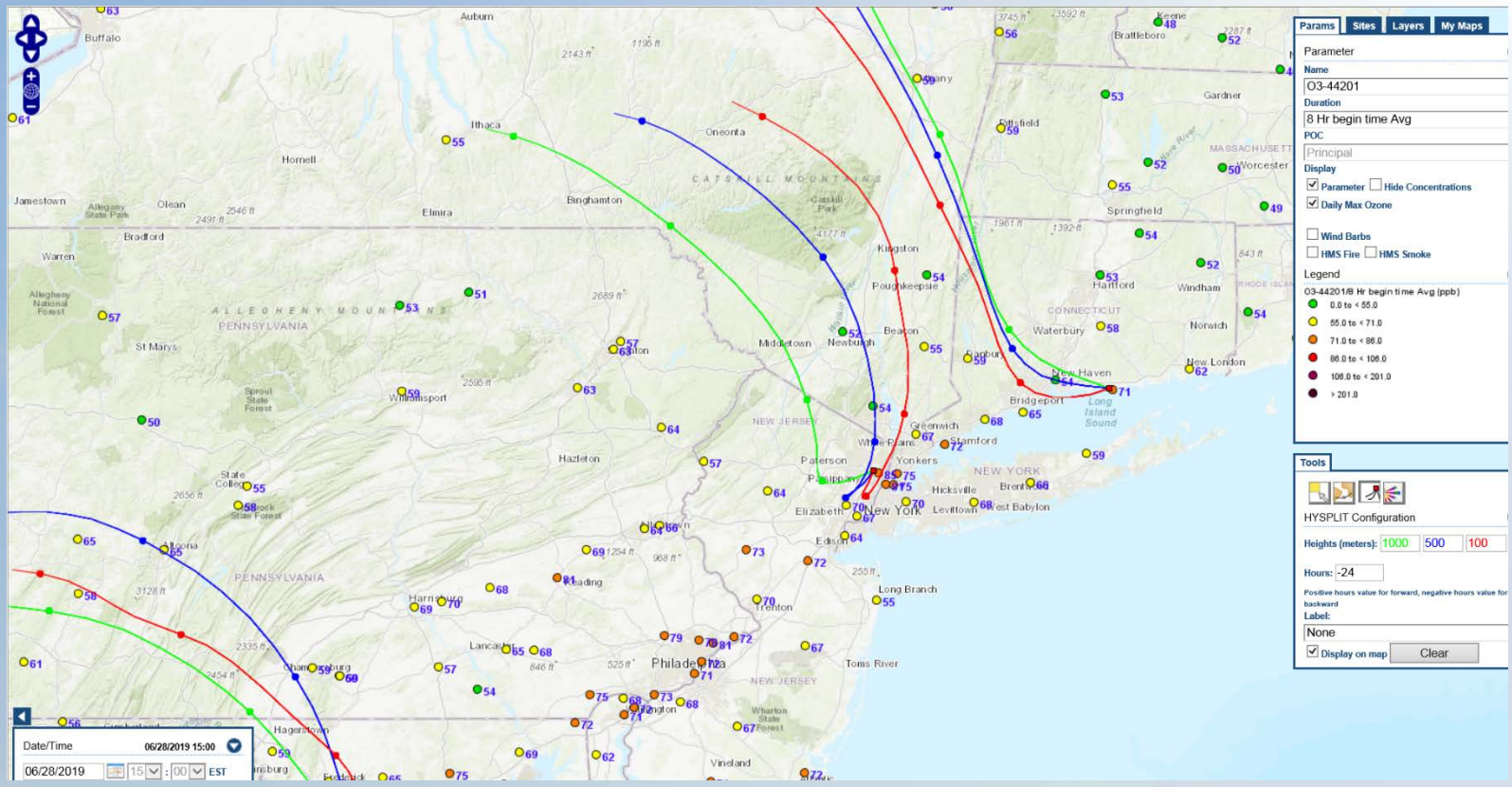
June 27, 2019 Back Trajectories

- Surface winds were light from the north but turned southwest late in the day. This advected ozone from LIS into coastal Connecticut. Upper air winds were from the northwest.



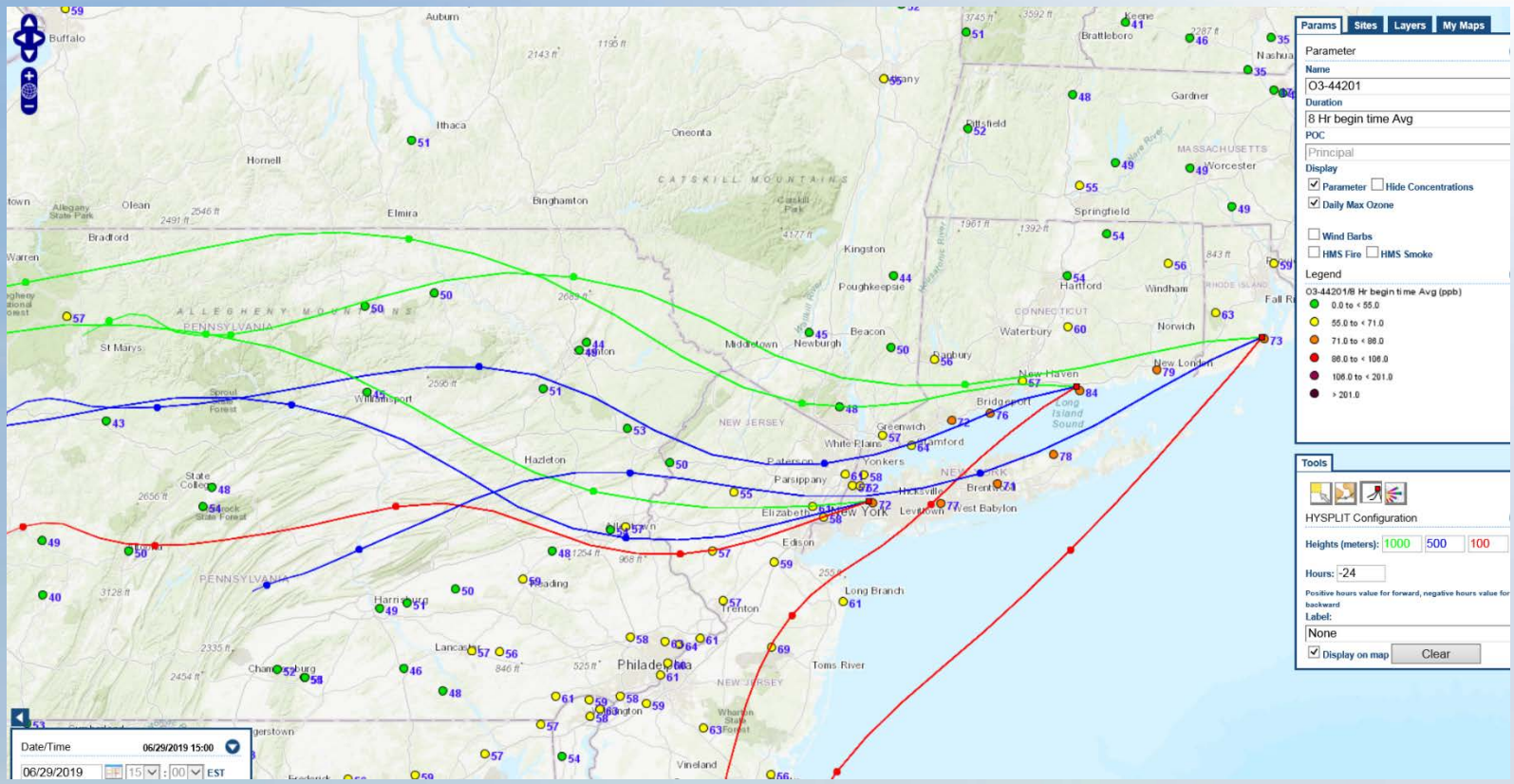
June 28, 2019 Back Trajectories

- Winds started out from the northwest, from a usually clean air region, but turned southwest, which advected ozone into coastal CT.



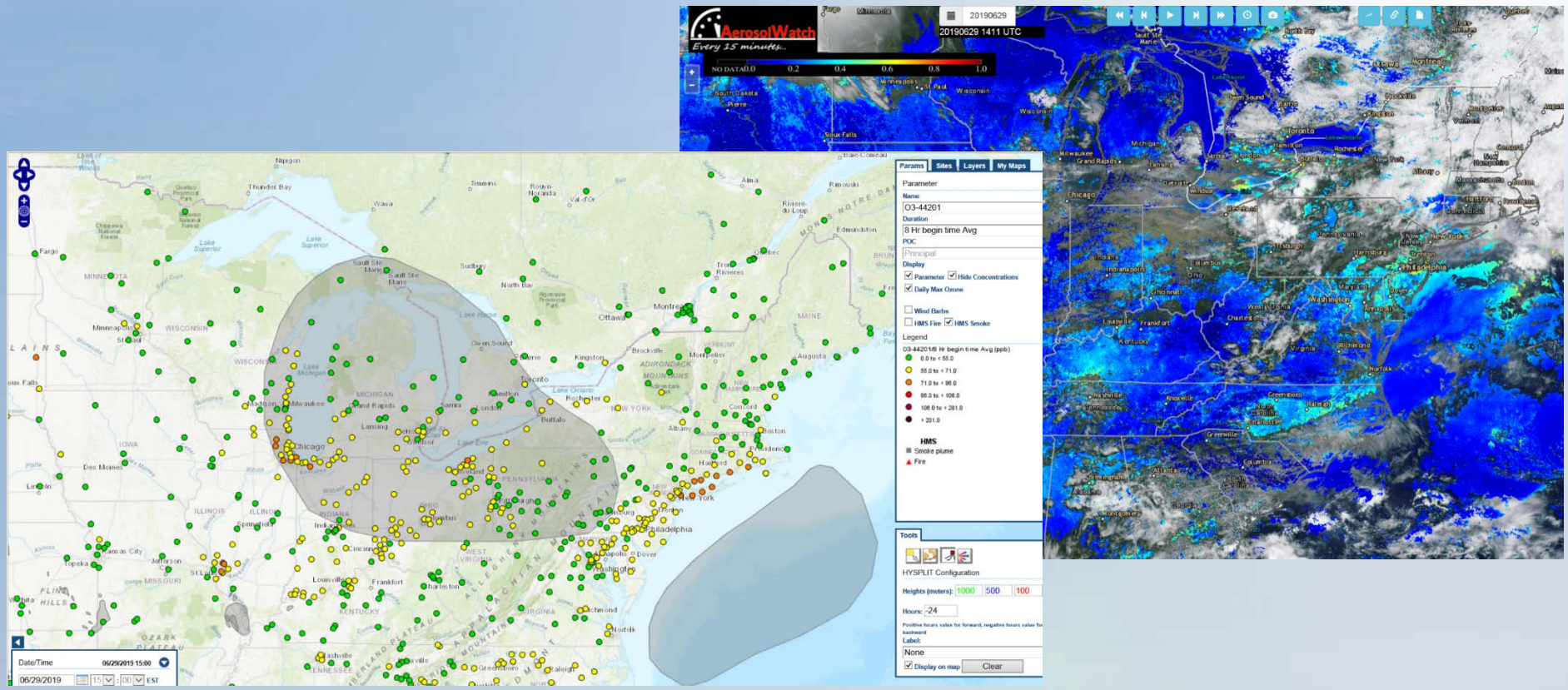
June 29, 2019 Back Trajectories

- By June 29th, a general west/southwest wind flow allowed pollutants from NYC and northern New Jersey to affect coastal CT.



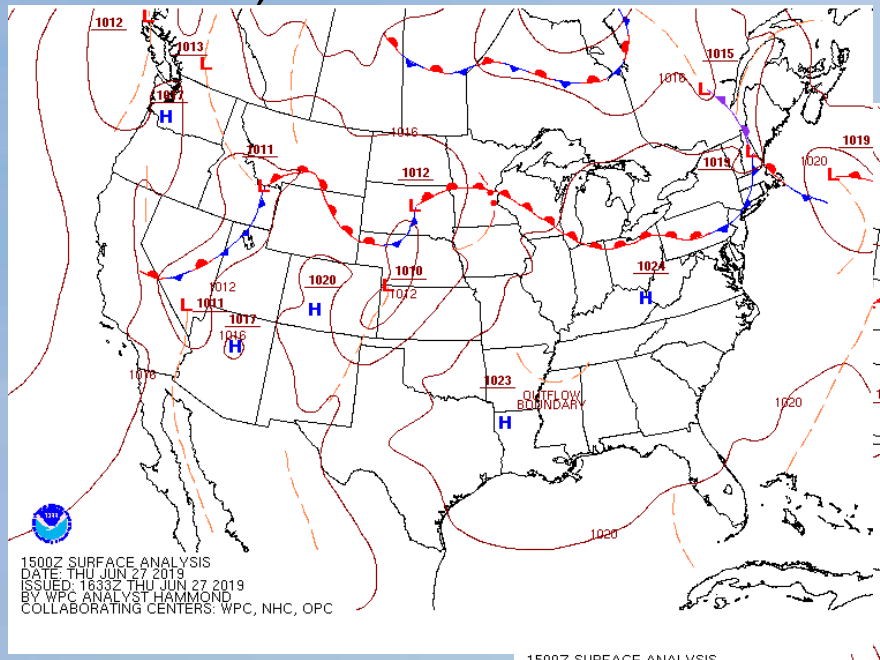
Aerosols detected by the Satellites

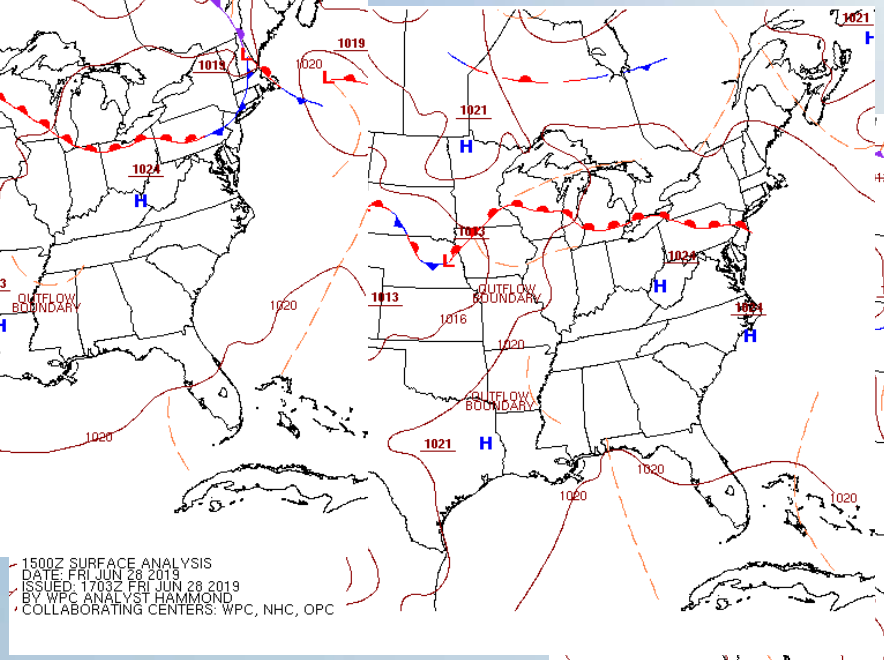
- A diffuse smoke plume was detected on June 29th, which may have elevated ozone levels during the event.

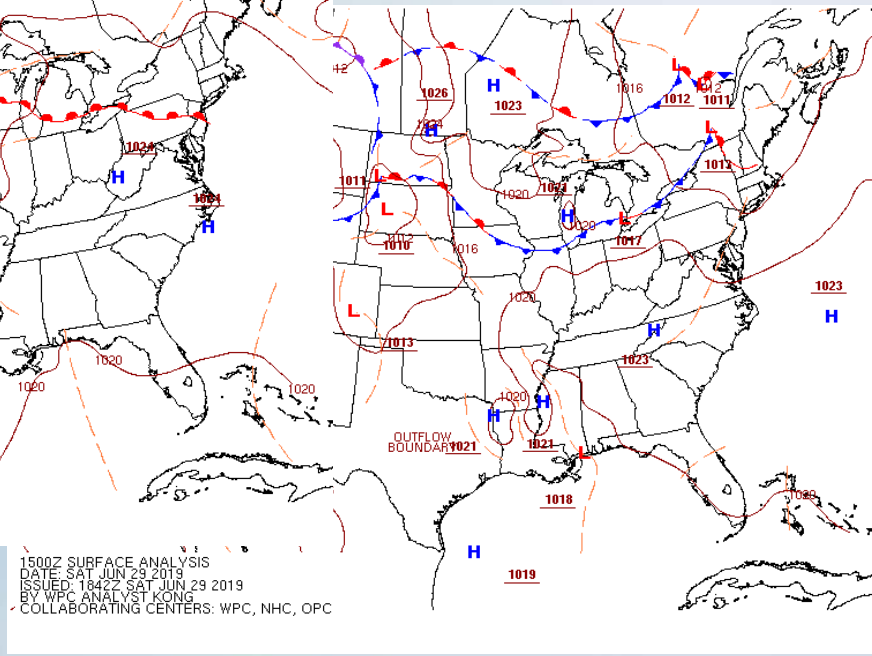


June 27-29, 2019 15z Surface Analysis

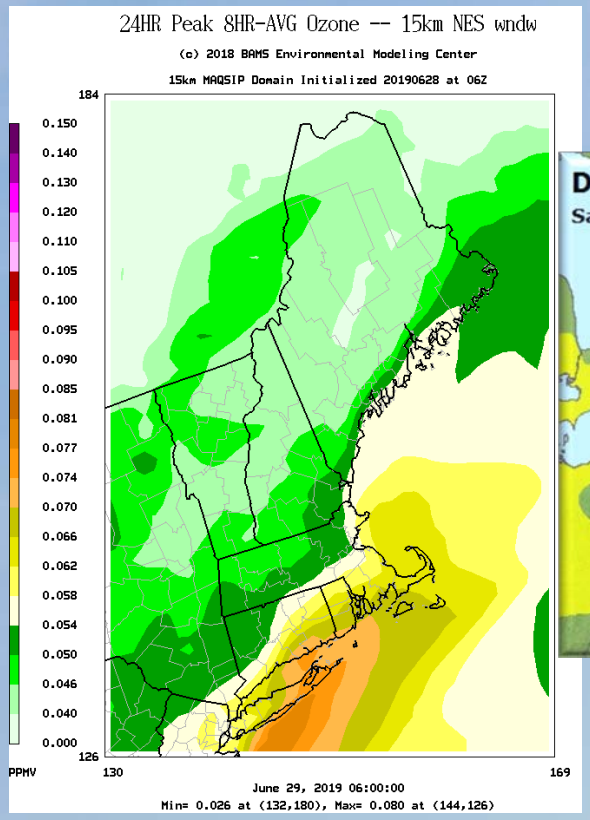
- Weak pressure gradients produced light surface winds. A ‘lee’ trough developed by June 29th, which allowed more southwest flow along the I-95 corridor.

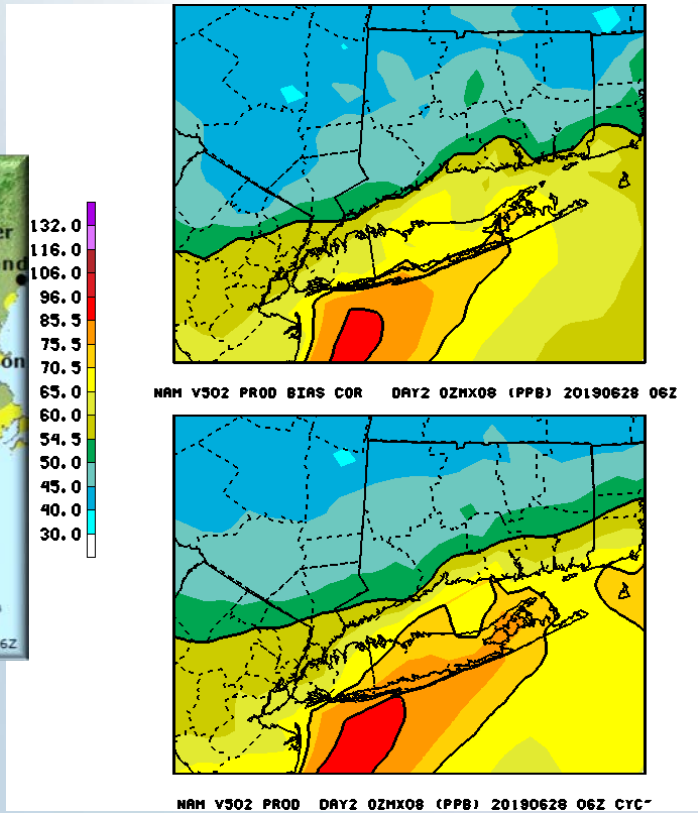






June 29, 2019 Ozone Model runs





- The NOAA June 28th day 2 model runs showed only moderate ozone (right), but the MAQSIP pushed the USG ozone into southeast CT.

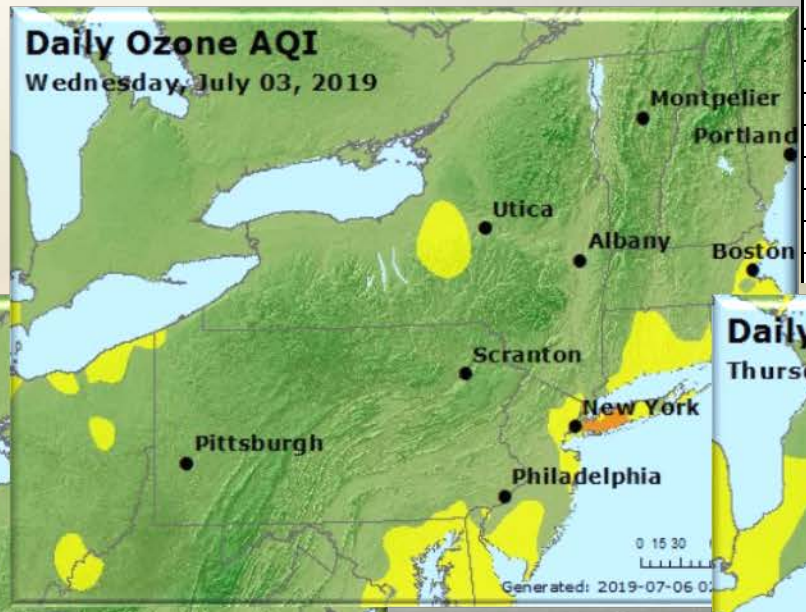
Conclusion

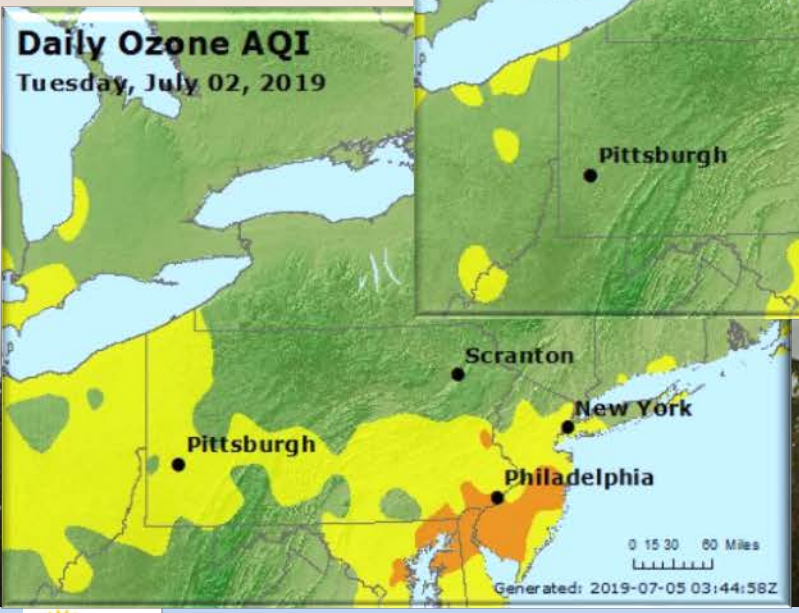
- The NOAA production model generally performed better than the other models, but still tended to under-predict the ozone. The usually reliable NOAA bias-corrected version, under-predicted the ozone.

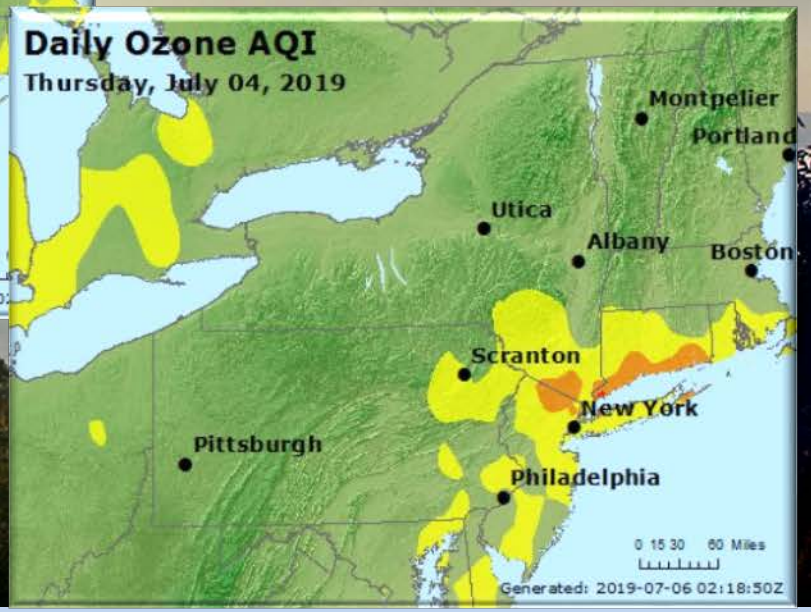
- Although smoke never appeared to be a factor at the time, it is possible that a diffuse plume was present that was difficult to detect from satellite images.

- Model differences, especially for June 29th, made it hard to forecast the magnitude of the event for Connecticut.

Date (LST)	Site AQS	Site	Max 8hr Ozone ppb
7/4/2019	90010017	**Greenwich**	**86**
7/4/2019	90019003	**Westport**	**84**
7/4/2019	90013007	**Stratford**	**82**
7/4/2019	90110124	**Groton Fort Gri**	**79**
7/4/2019	90099002	**Madison-Beach R**	**77**
7/4/2019	340315001	Ramapo	77
7/4/2019	360870005	Rockland Cty	74
7/4/2019	90090027	**New Haven - Cri**	**72**
7/4/2019	340030006	Leonia	71
7/4/2019	360050133	Pfizer Lab	69
7/4/2019	360050110	Bronx - IS52	68
7/4/2019	361192004	White Plains	68
7/4/2019	440090007	Narragansett	66
7/4/2019	90011123	**Danbury**	**65**
7/4/2019	90079007	**Middletown-CVH-**	**64**
7/4/2019	361030004	Riverhead	64
7/4/2019	360810124	Queens	63
7/4/2019	360610135	CCNY	62







Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

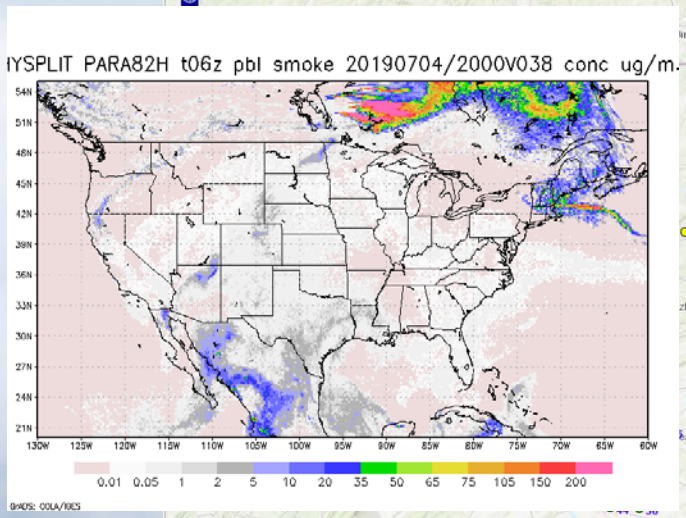
Ozone Event Analysis: July 4, 2019

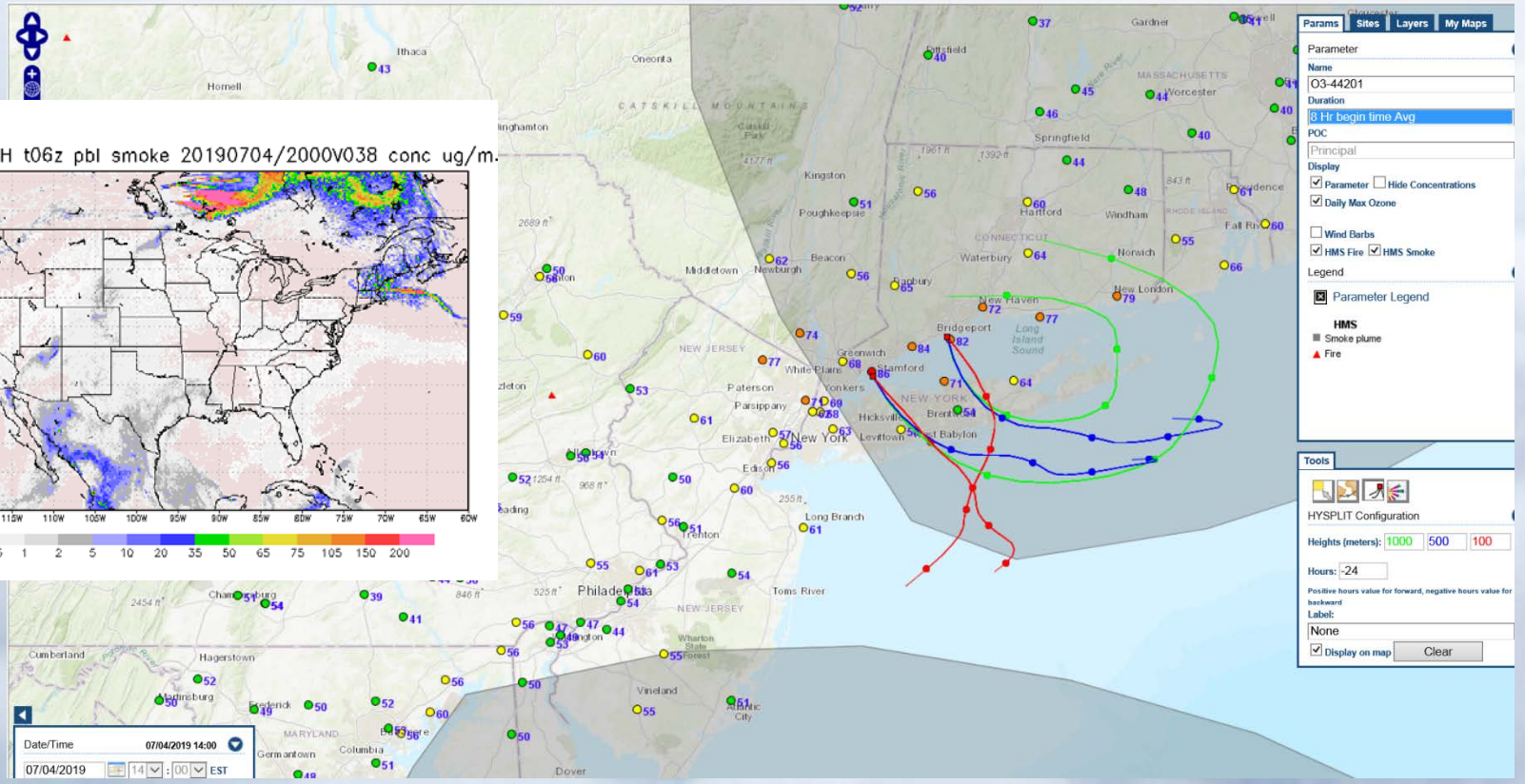
Michael Geigert

CONNECTICUT WORKING TOGETHER FOR CLEAN AIR

July 4, 2019 Back Trajectories

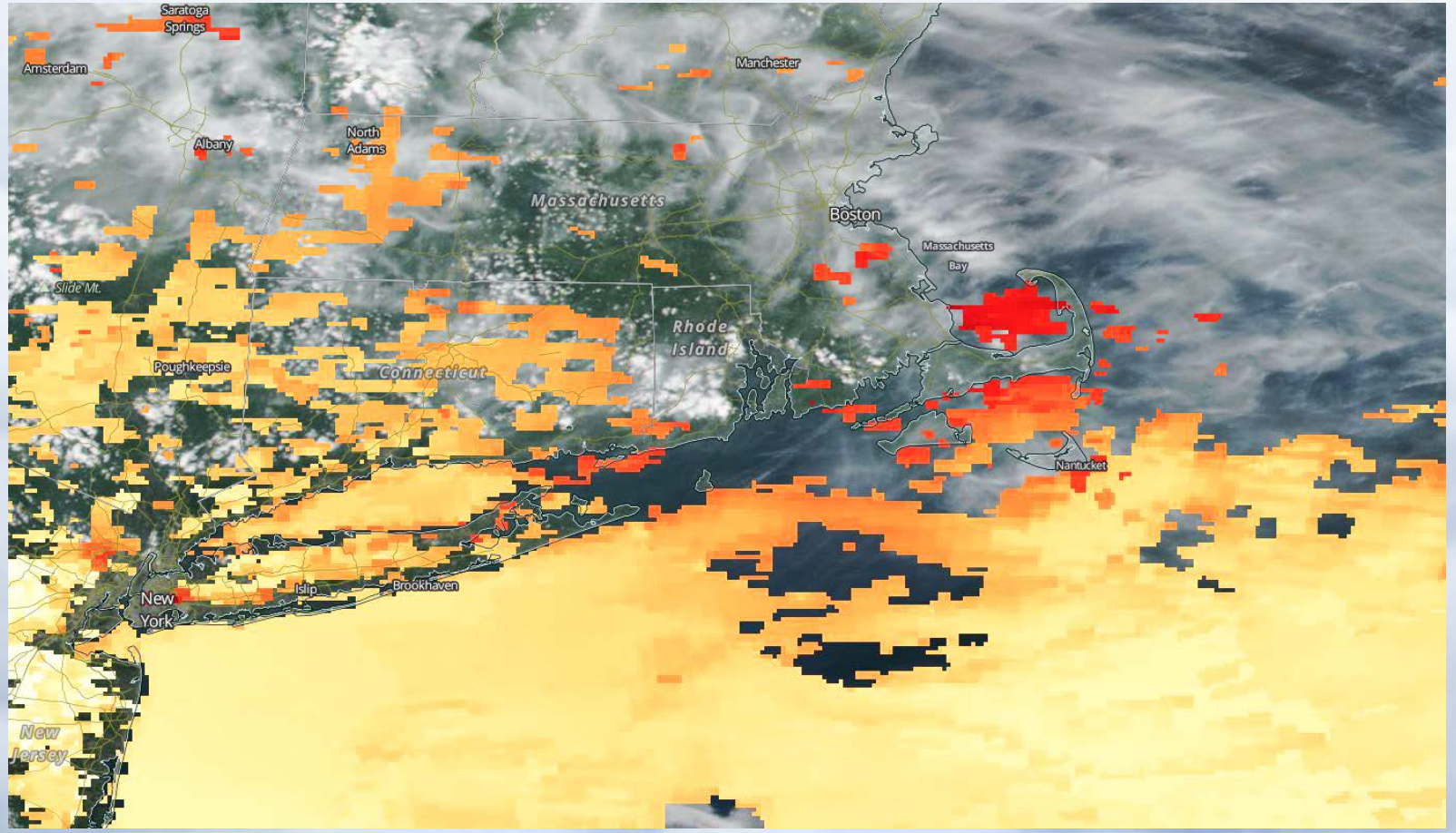
- Surface winds were light from the northwest but recirculated late in the day. Smoke was modeled to stay to our north, but it appears that the 1000 meter winds may have transported this smoke back to the coast.





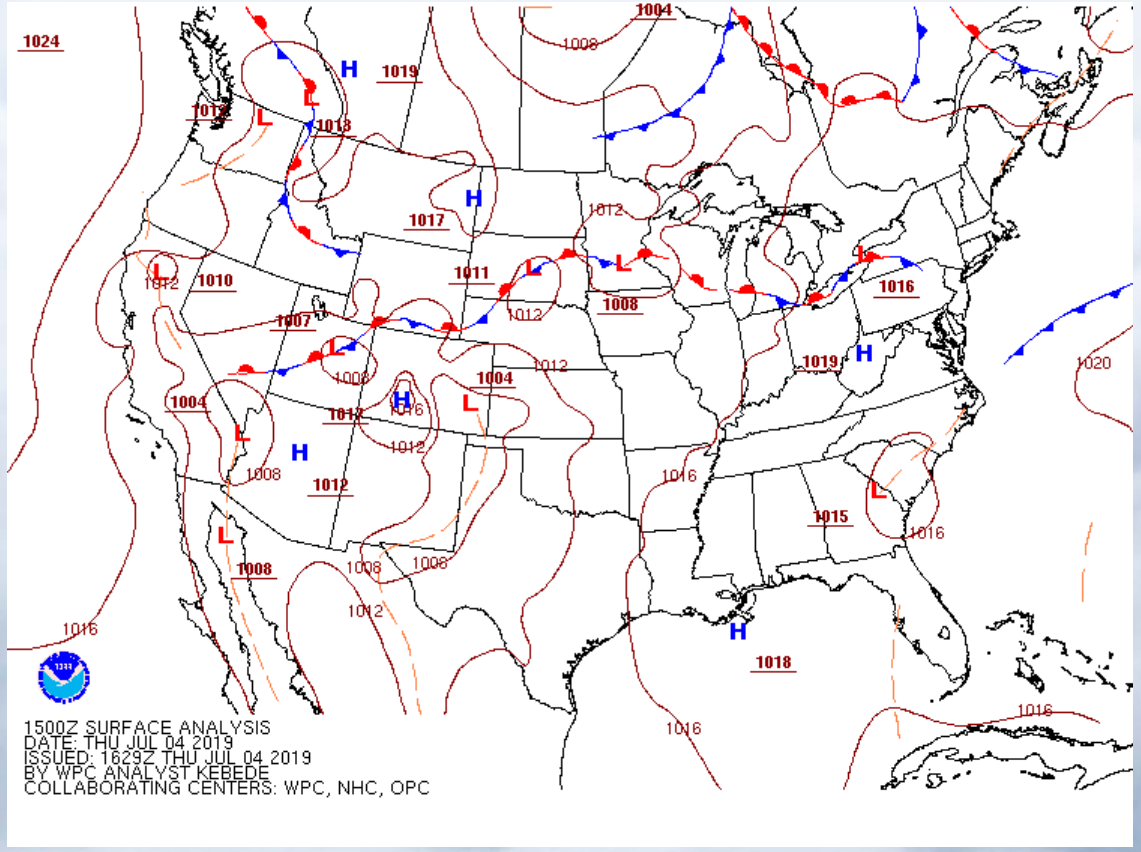
Aerosols detected by the Satellite

- A diffuse smoke plume was detected on July 4th, which may have elevated ozone levels during the event.

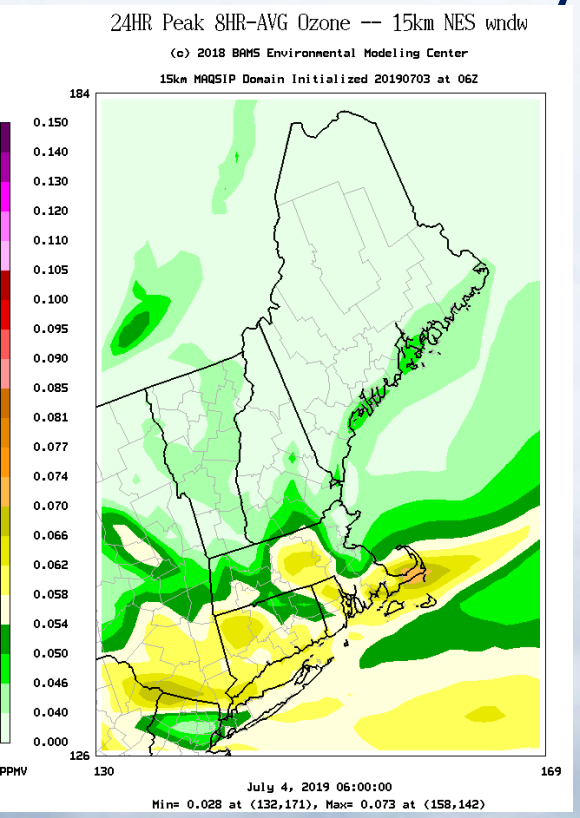


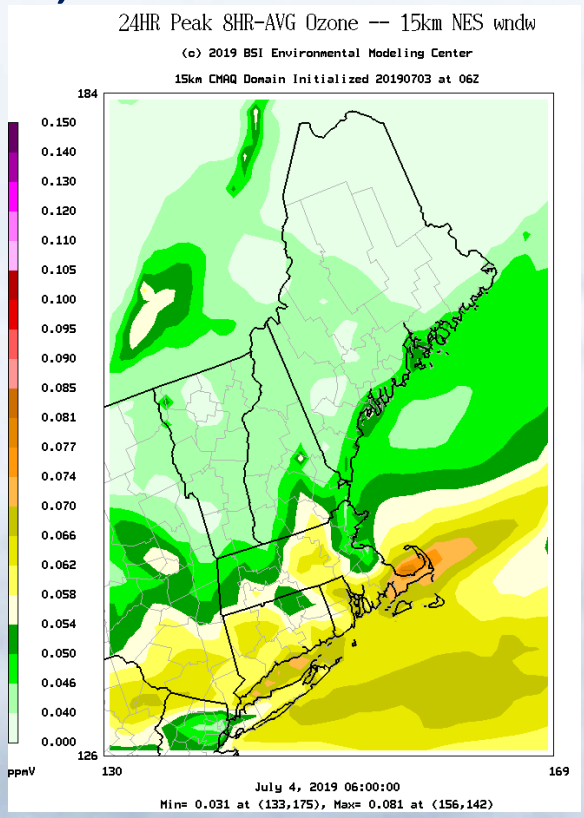
July 4, 2019 15z Surface Analysis

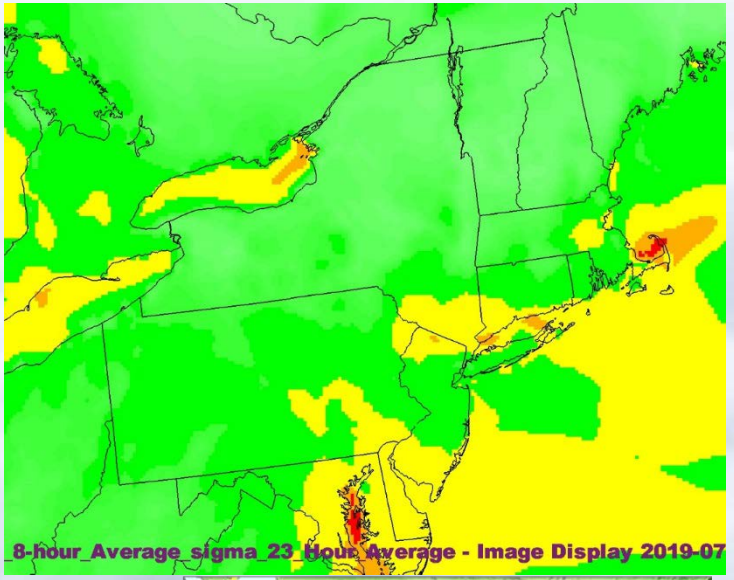
- Weak pressure gradients produced light surface winds.

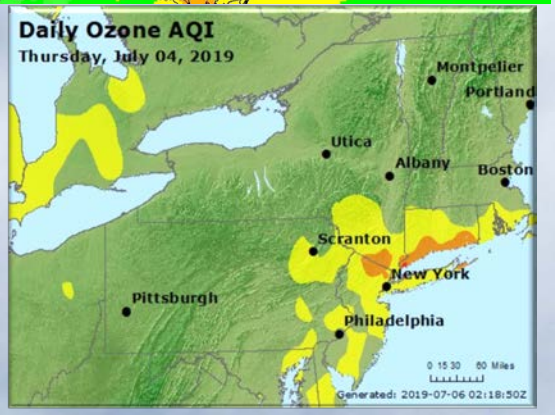


July 3, 2019 Ozone Model runs







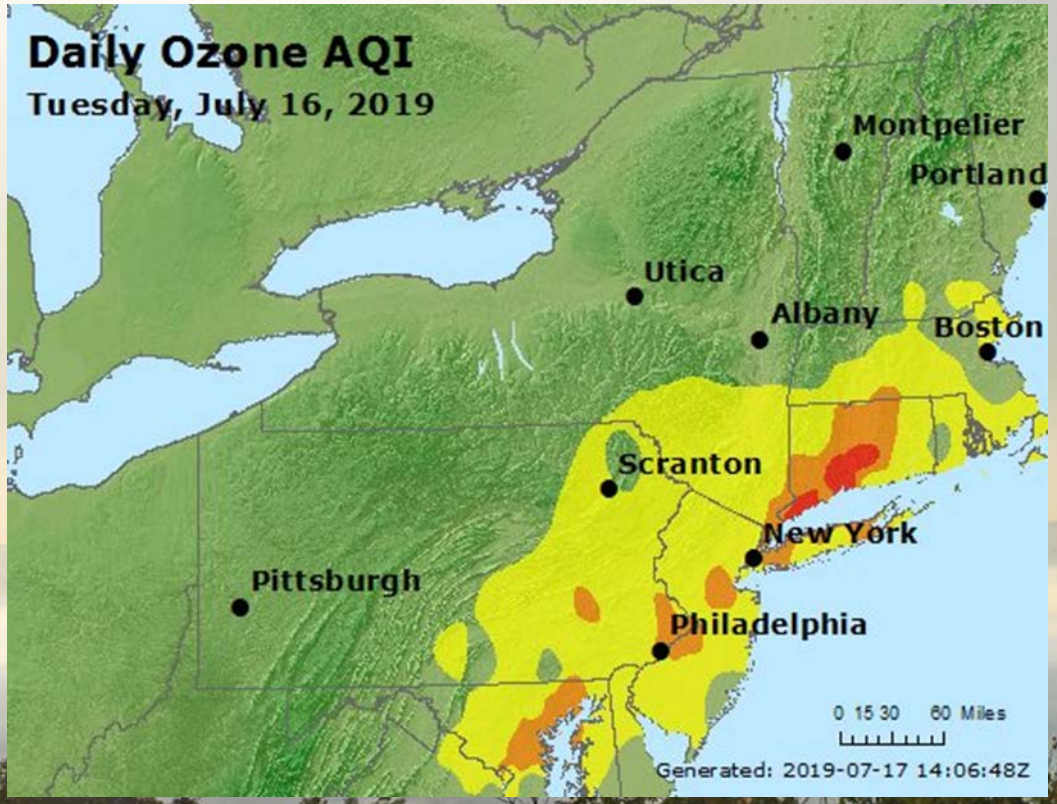


- The NOAA July 3, day 2 model run showed USG near the coast, as did the Barons CMAQ (center) but the MAQSIP (left) was only moderate. It is evident that the models under-predicted USG areas by 5-10+ ppb.

Conclusion

- Although the models suggested that a few coastal sites may have reached USG, they once again under-predicted the event.
- Although smoke was modeled to stay to our north, it appears likely that a diffuse plume was present and was recirculated into our coastal sites.
- It is sometimes the case that ozone levels can be lower on holidays with less commuting, so it was initially thought that the models may be on the high side. The models did not take any smoke emissions into account, which likely biased the predicted ozone concentrations too low.

- Eight Connecticut monitors exceeded the 70 ppb NAAQS
- Four monitors had Unhealthy Air Quality



Date (LST)	Site AQS	Site	Max 8hr Ozone ppb
7/16/2019	90019003	**Westport**	90
7/16/2019	90090027	**New Haven**	89
7/16/2019	90079007	**Middletown**	87
7/16/2019	90010017	**Greenwich**	86
7/16/2019	90013007	**Stratford**	84
7/16/2019	421010024	NEA	82
7/16/2019	420170012	Bristol	81
7/16/2019	361030044	Flax Pond	79
7/16/2019	90031003	**East Hartford**	77
7/16/2019	240259001	Aldino	77
7/16/2019	245100054	Furley	77
7/16/2019	421010004	LABP	76
7/16/2019	421010048	NEW	76
7/16/2019	240031003	Glen Burnie	76
7/16/2019	90011123	**Danbury**	75
7/16/2019	90131001	**Stafford**	75
7/16/2019	340230011	Rutgers University	75
7/16/2019	240053001	Essex	74
7/16/2019	240330030	HU-Beltsville	74
7/16/2019	240251001	Edgewood	73
7/16/2019	360050110	Bronx - IS52	72
7/16/2019	360810124	Queens	72
7/16/2019	420110011	Reading Airport	72
7/16/2019	361030004	Riverhead	71
7/16/2019	110010044	McMillan NCORE	71
7/16/2019	110010050	TakomaRec	71
7/16/2019	360050133	Pfizer Lab	70
7/16/2019	361192004	White Plains	70
7/16/2019	420950025	Freemansburg	70
7/16/2019	340030006	Leonia	70
7/16/2019	360850111	Fresh Kills	69

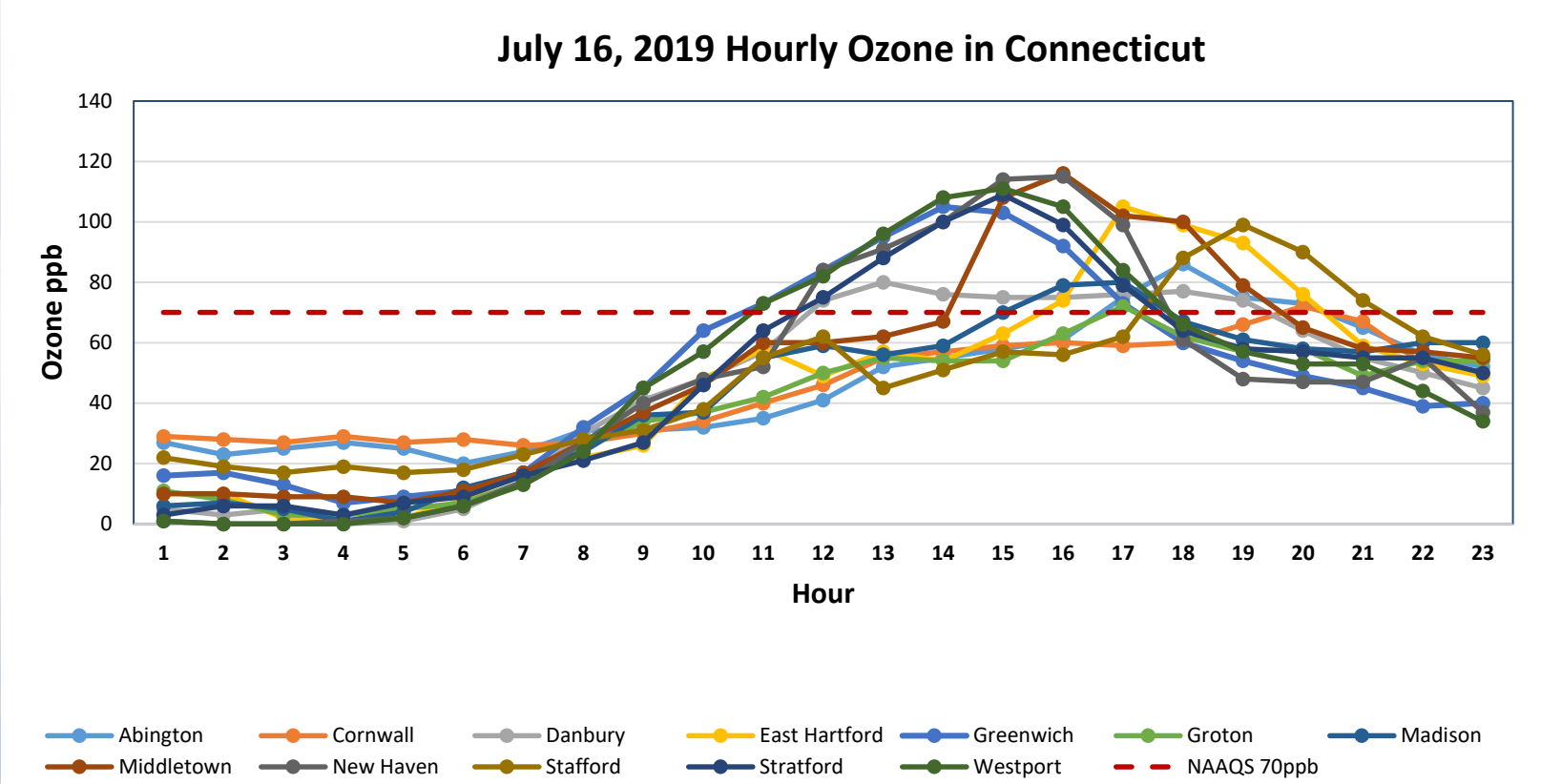
Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Ozone Event Analysis: July 16, 2019

Daniella Lopez

CONNECTICUT WORKING TOGETHER FOR CLEAN AIR

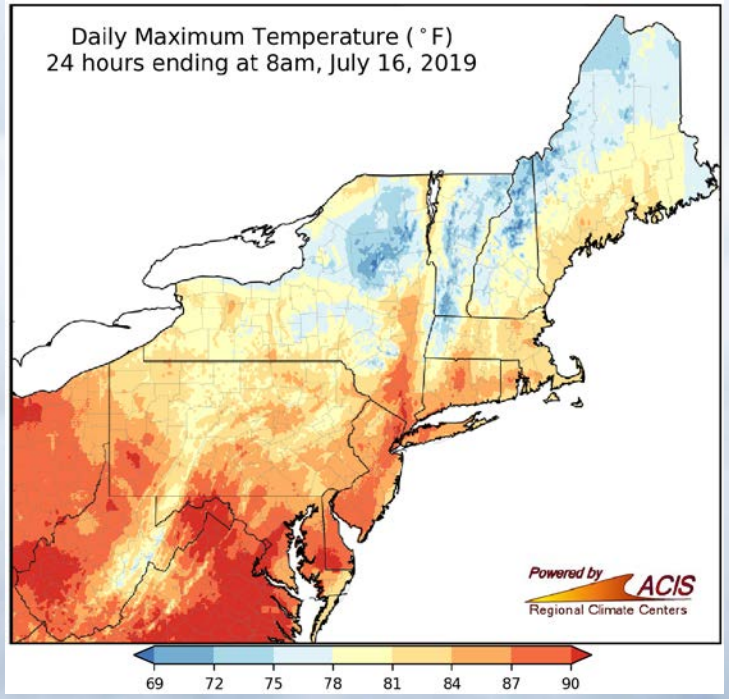
July 16, 2019 Hourly Ozone

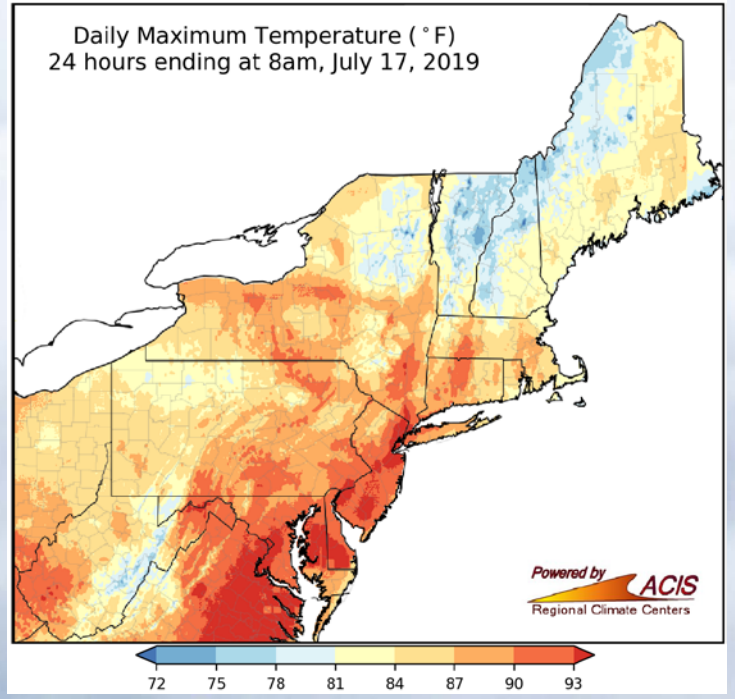


- Eight monitors exceeded the NAAQS 70 ppb standard, with Middletown reaching a high of 116 ppb.

Maximum 24-hr Temperature

- From 8 AM on July 16 to 8 AM on July 17, maximum temperatures reached 94 degrees in parts of the state.



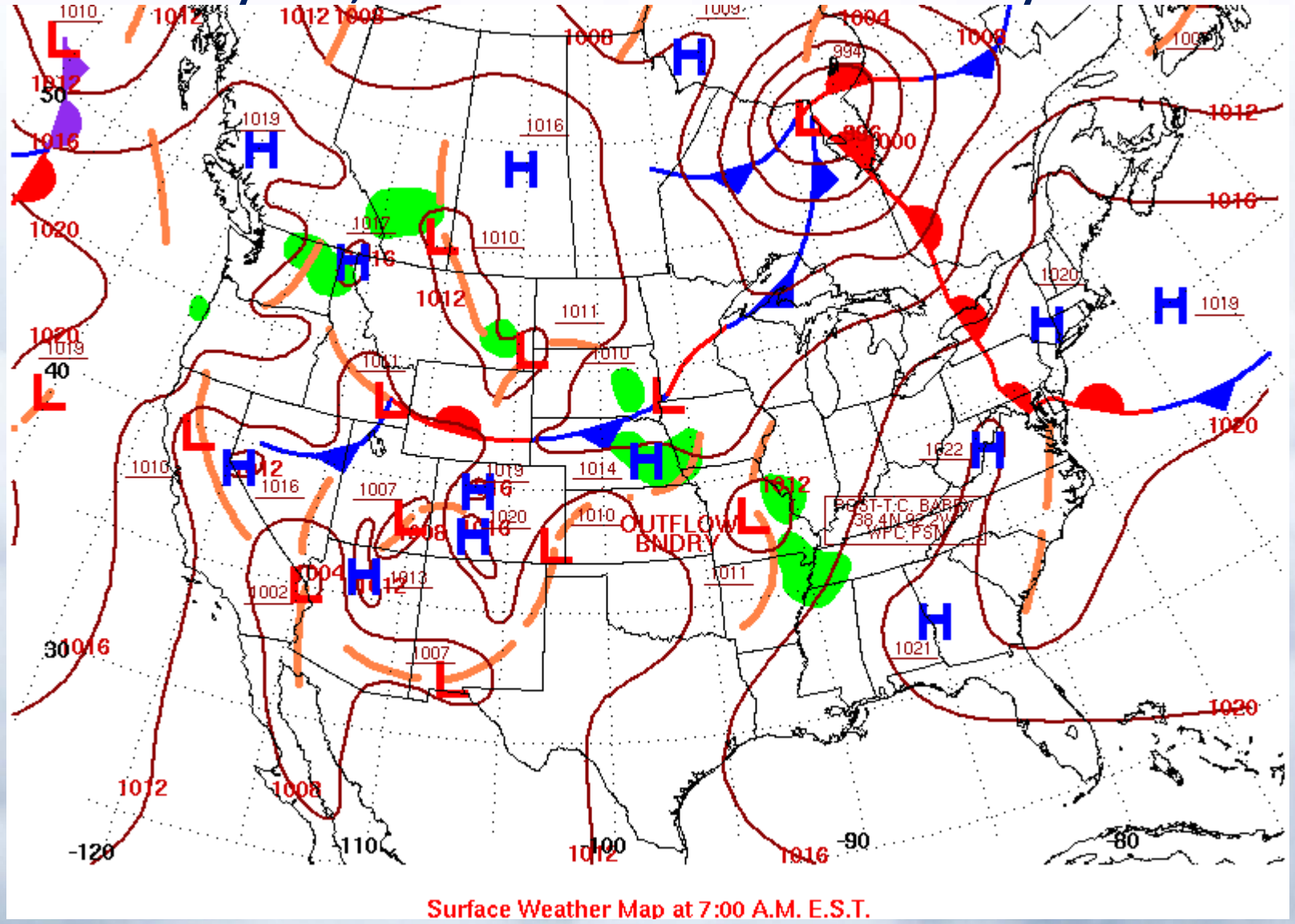


- These warmer temps were conducive to ozone production.

July 16, 2019 Back Trajectories

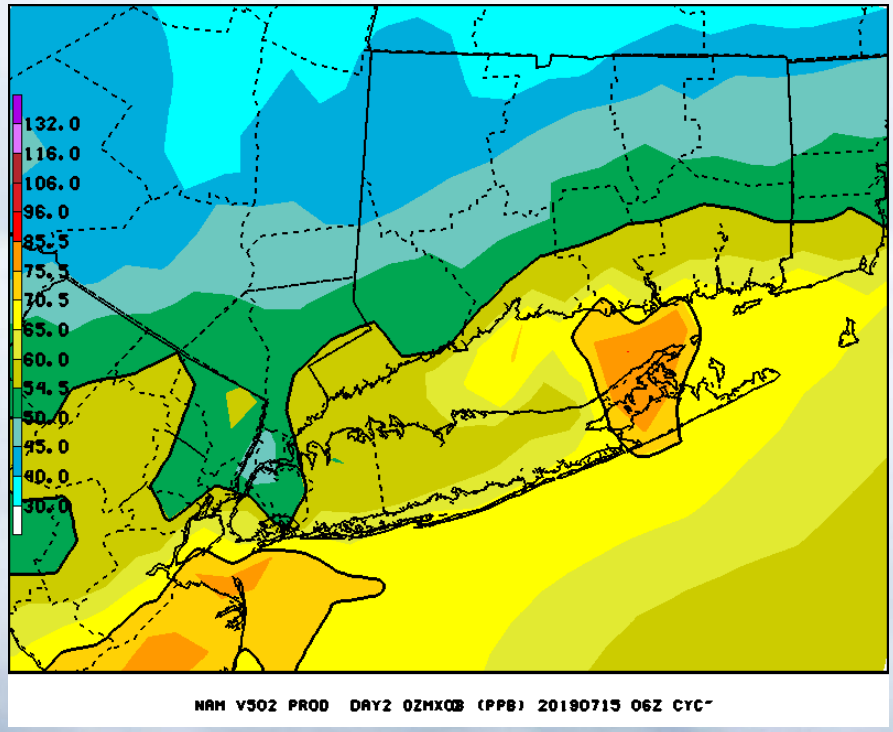
- 24 hour back trajectories from 4:00 PM EST
- The lowest back trajectory (red) goes over the Long Island Sound, which provided precursors for ozone production from the New York Metropolitan area and Long Island.

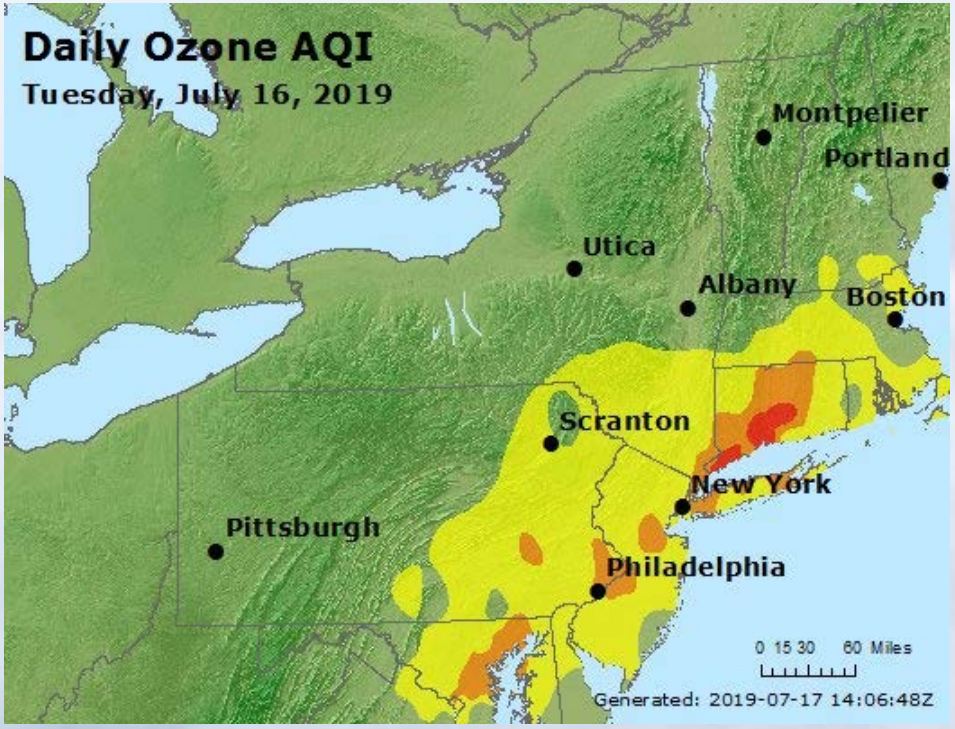
July 16, 2019 12z Surface Analysis



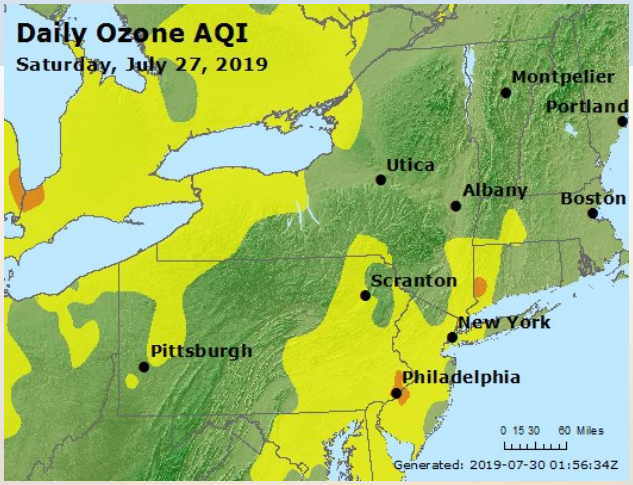
- High pressure was present over CT which contributed to calm winds.

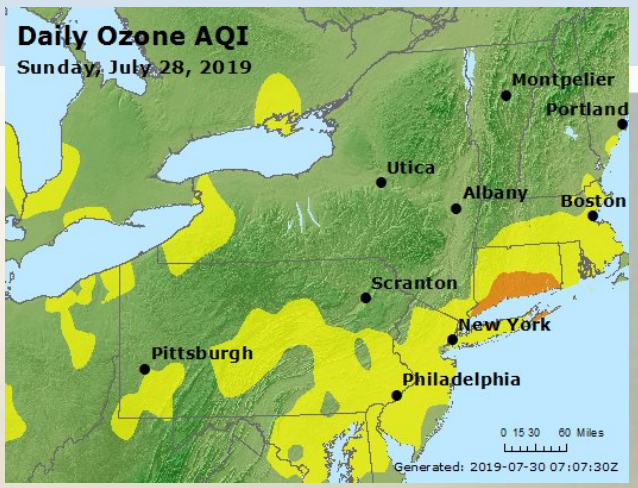
July 15, 2019 Ozone Model Runs (NOAA)

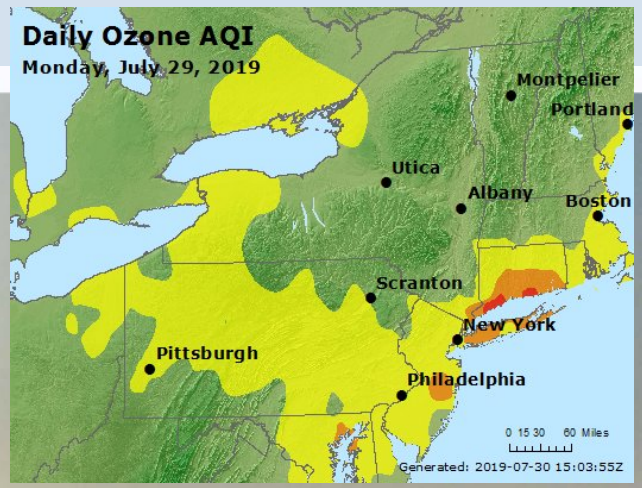


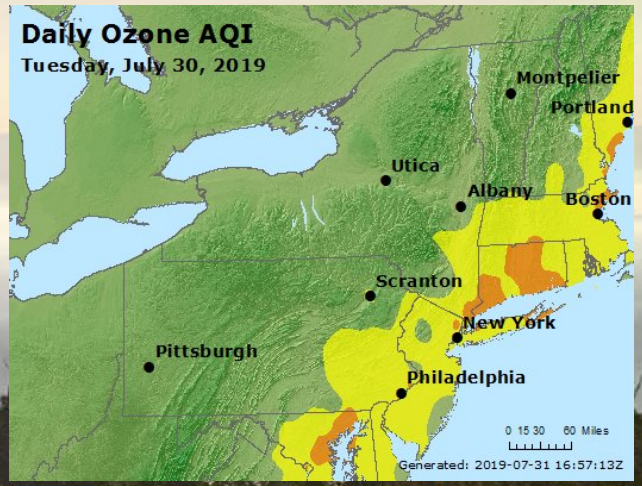


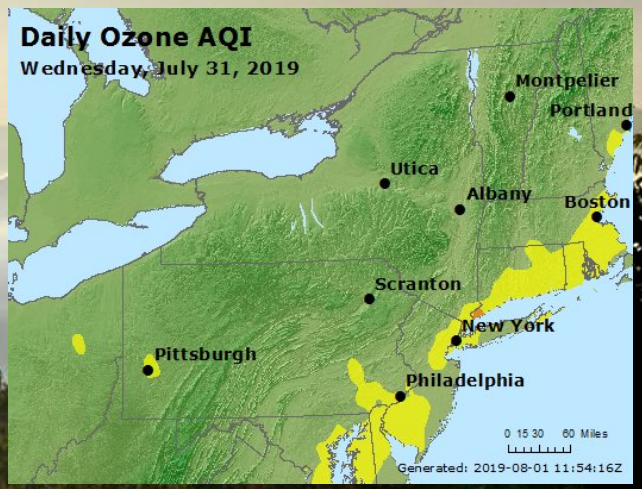
- The NAM-CMAQ July 15 day 2 model run shows good ozone levels in most of the state and moderate levels across the coastal regions.











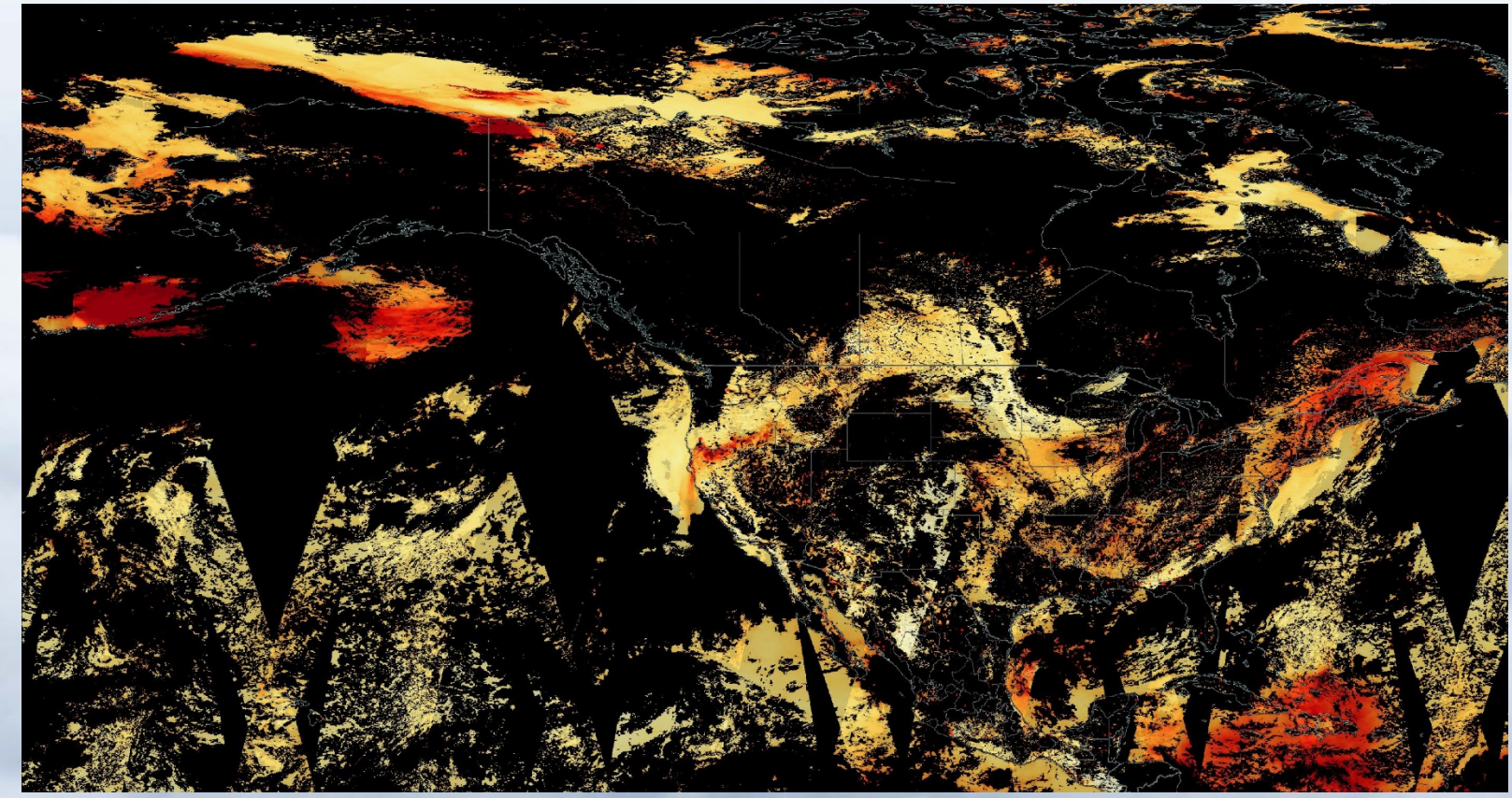
Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Ozone Event Analysis: July 27-31, 2019

Kristin Salimeno

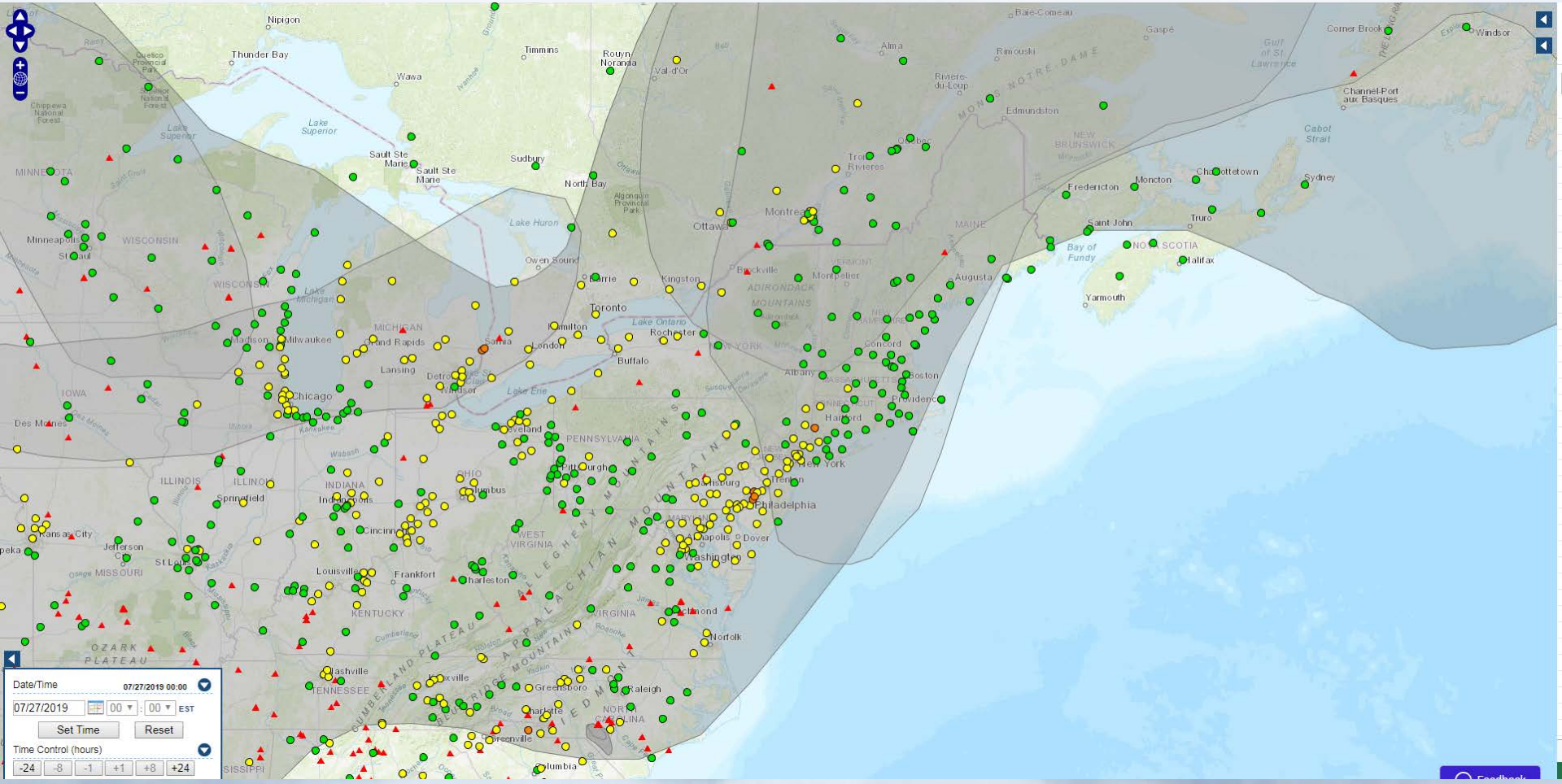
CONNECTICUT WORKING TOGETHER FOR CLEAN AIR

July 27, 2019 Satellite Aerosols

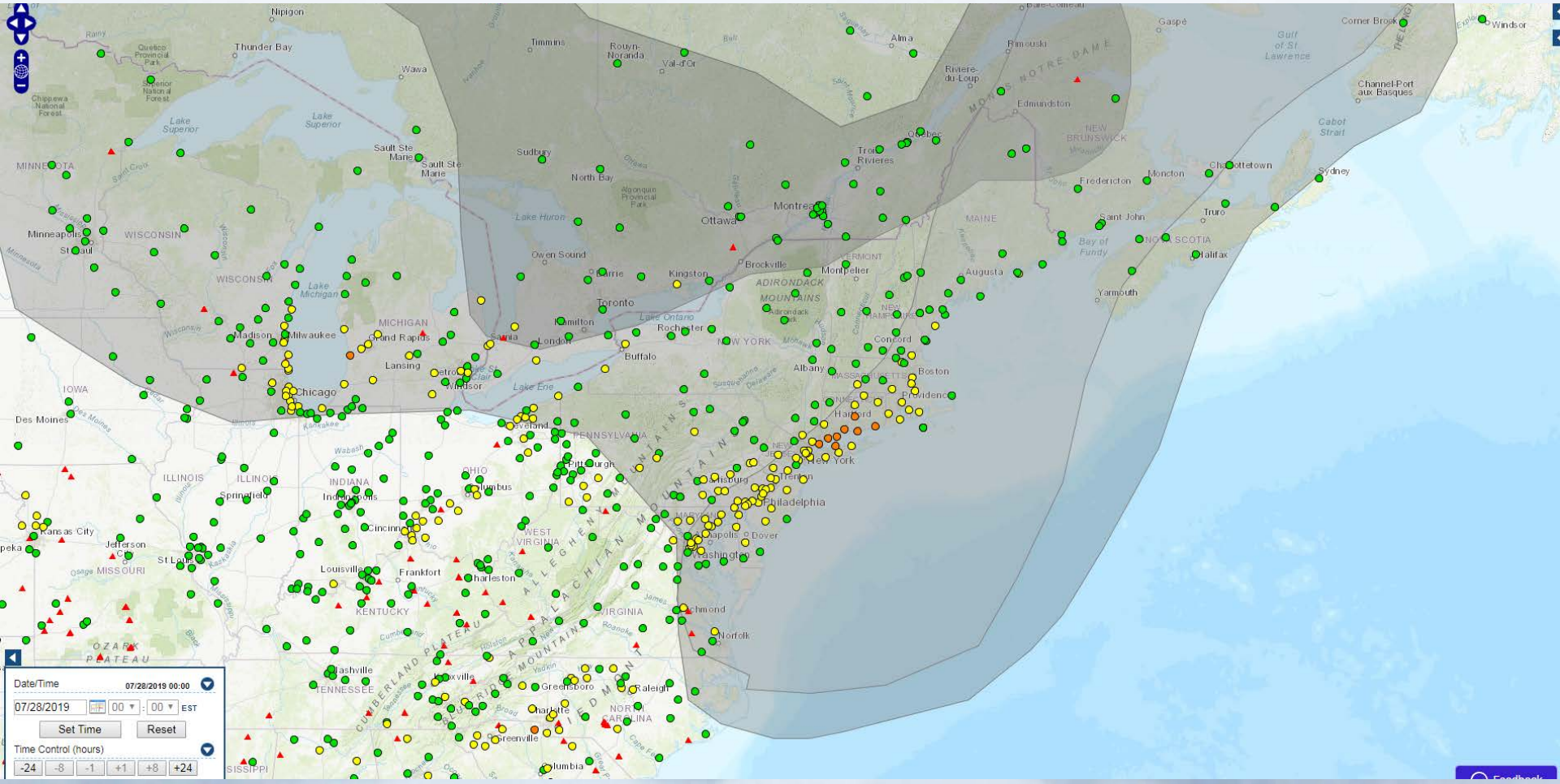


- Satellite aerosols suggest smoke from the Siberian fires reached North America.

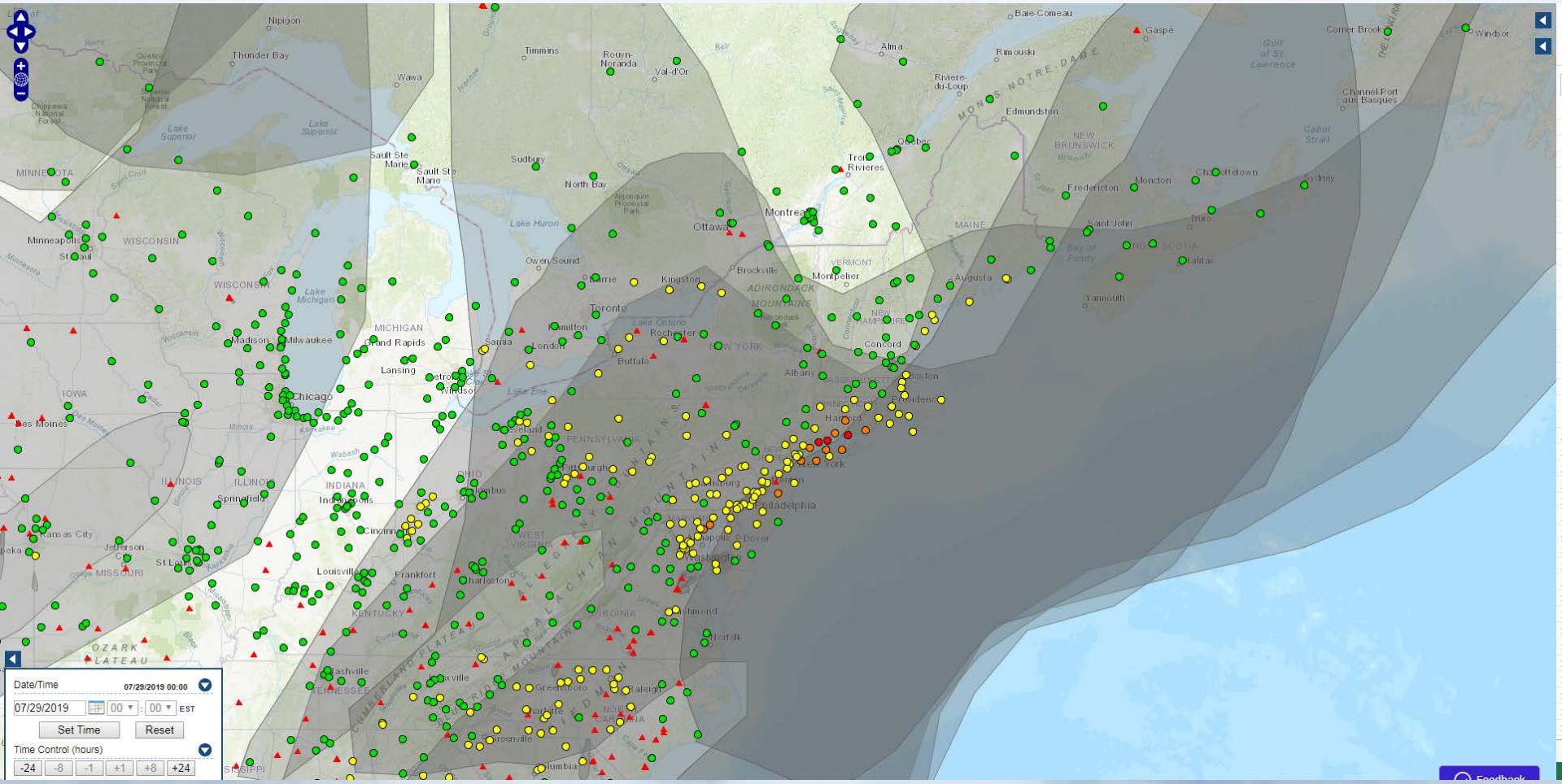
AirNow Smoke Data July 27, 2019



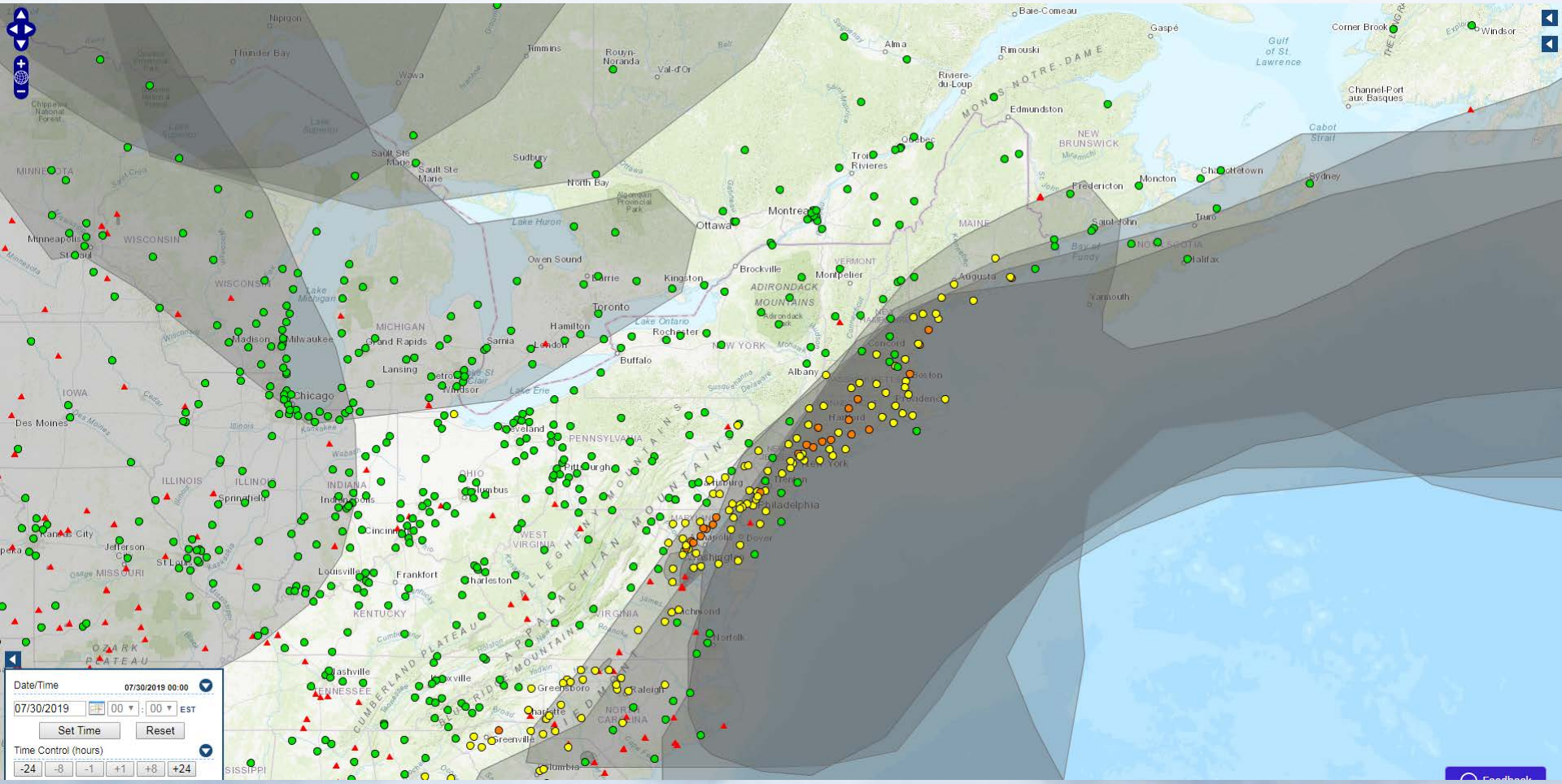
AirNow Smoke Data July 28, 2019



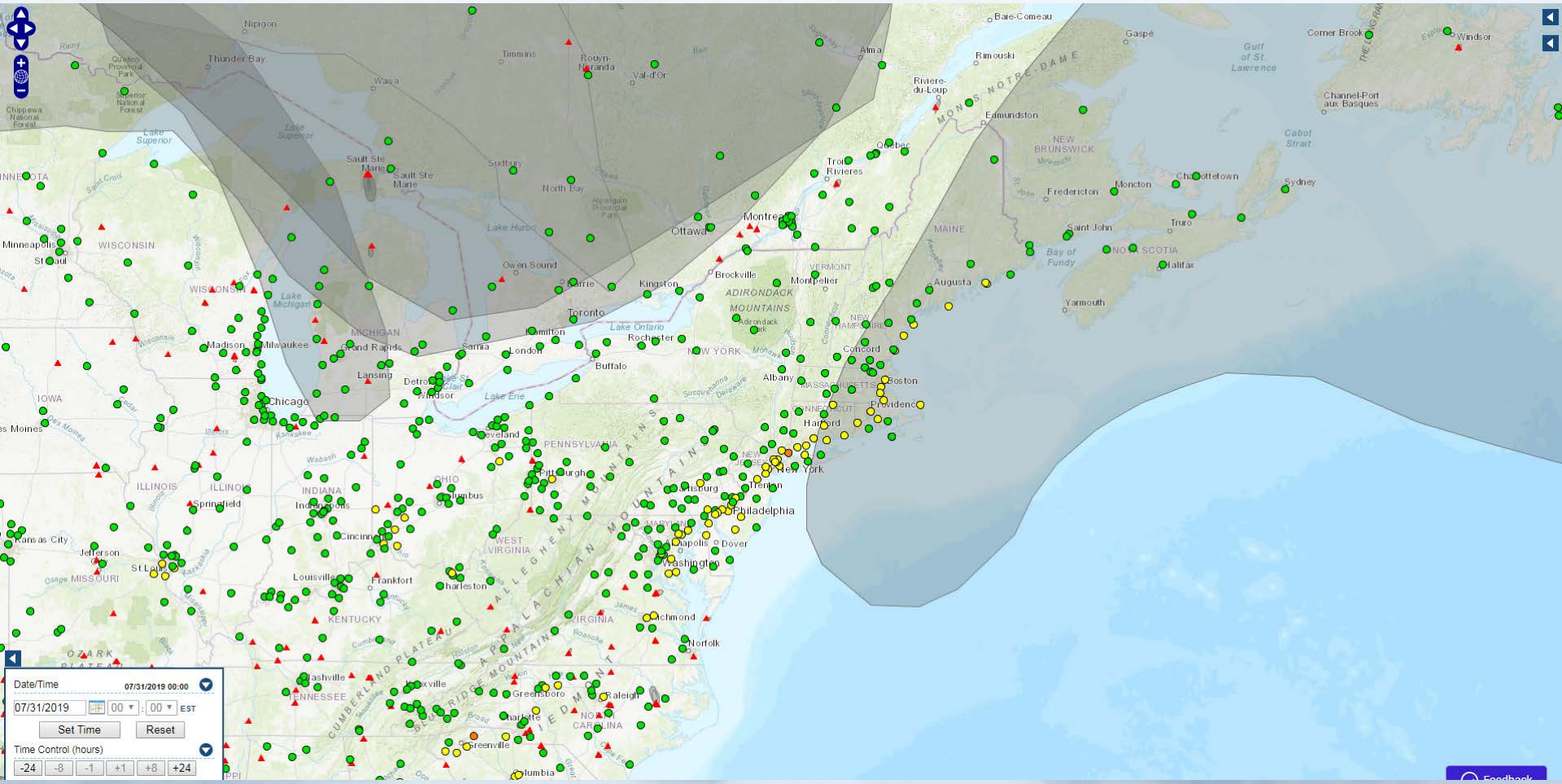
AirNow Smoke Data July 29, 2019

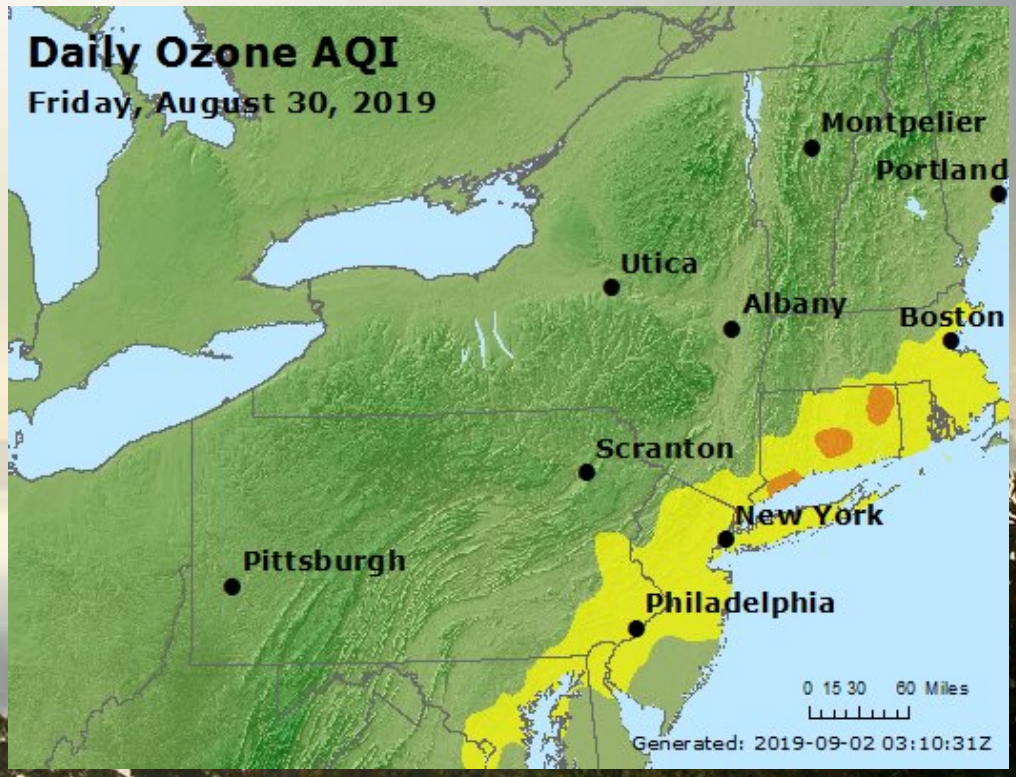


AirNow Smoke Data on July 30, 2019



AirNow Smoke Data on July 31, 2019





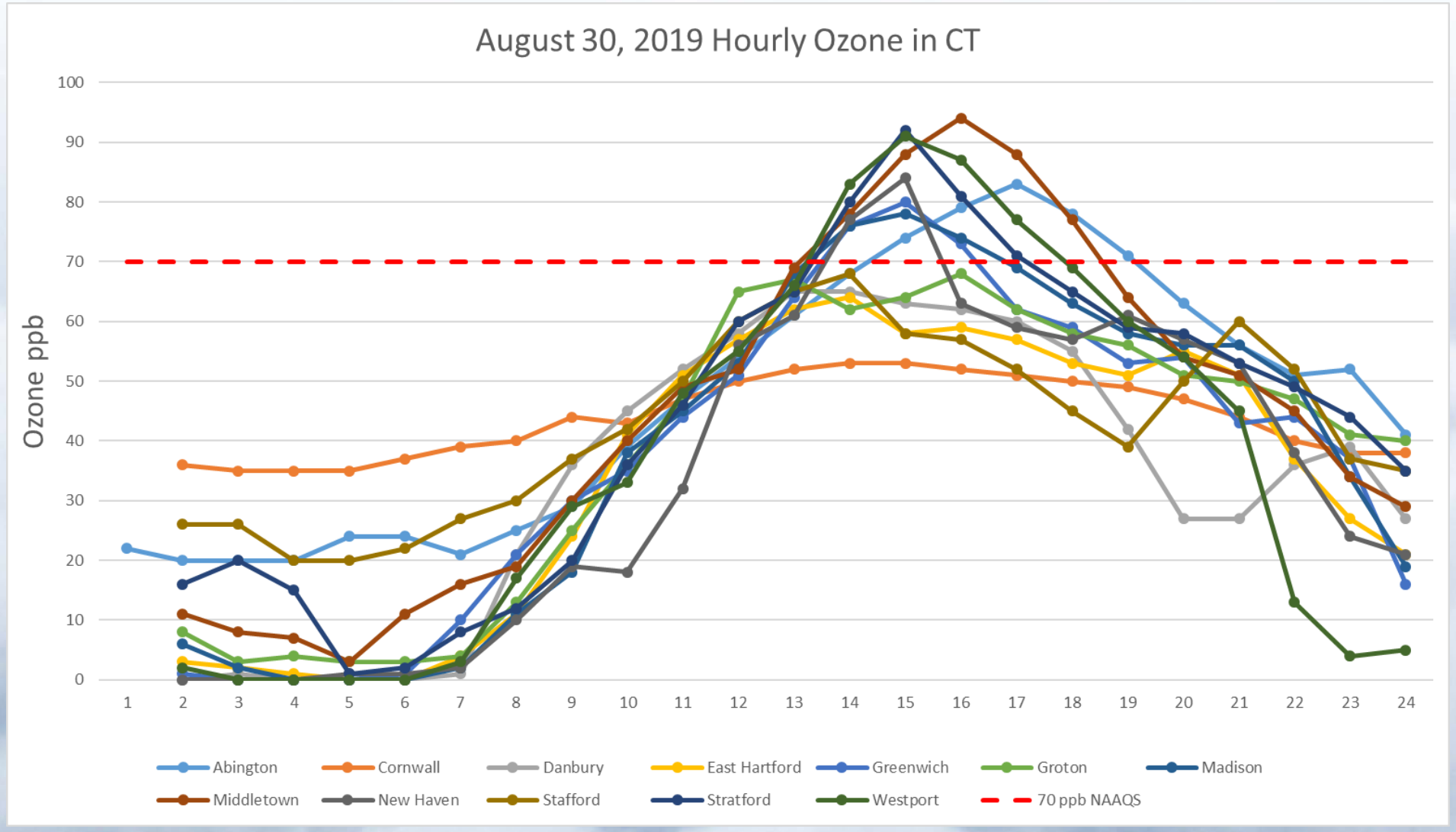
Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Ozone Event Analysis: August 30, 2019

Daniella Lopez

CONNECTICUT WORKING TOGETHER FOR CLEAN AIR

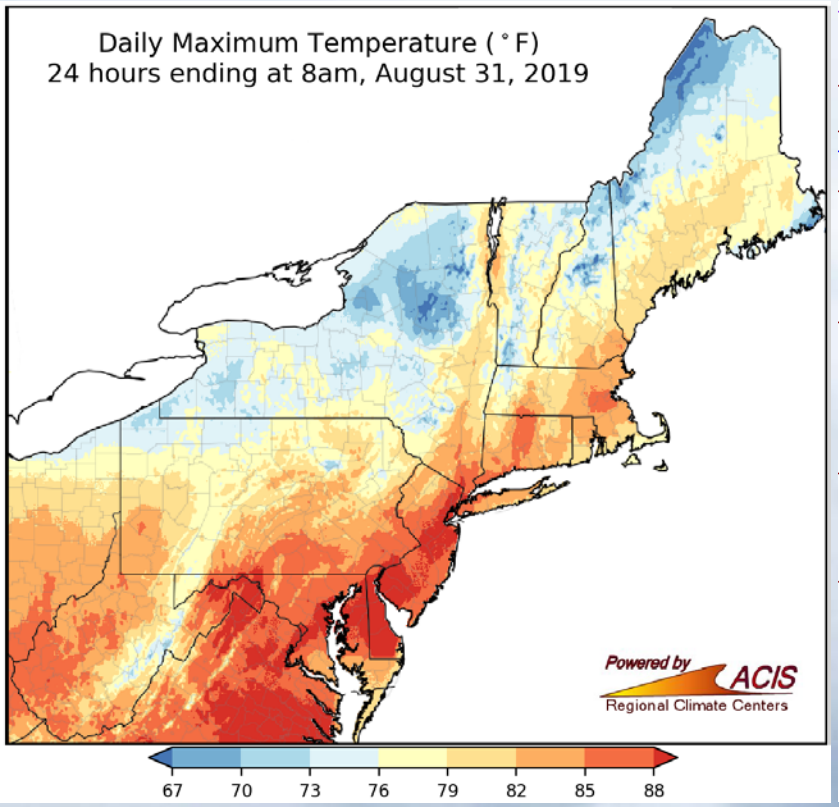
August 30 Hourly Ozone in CT

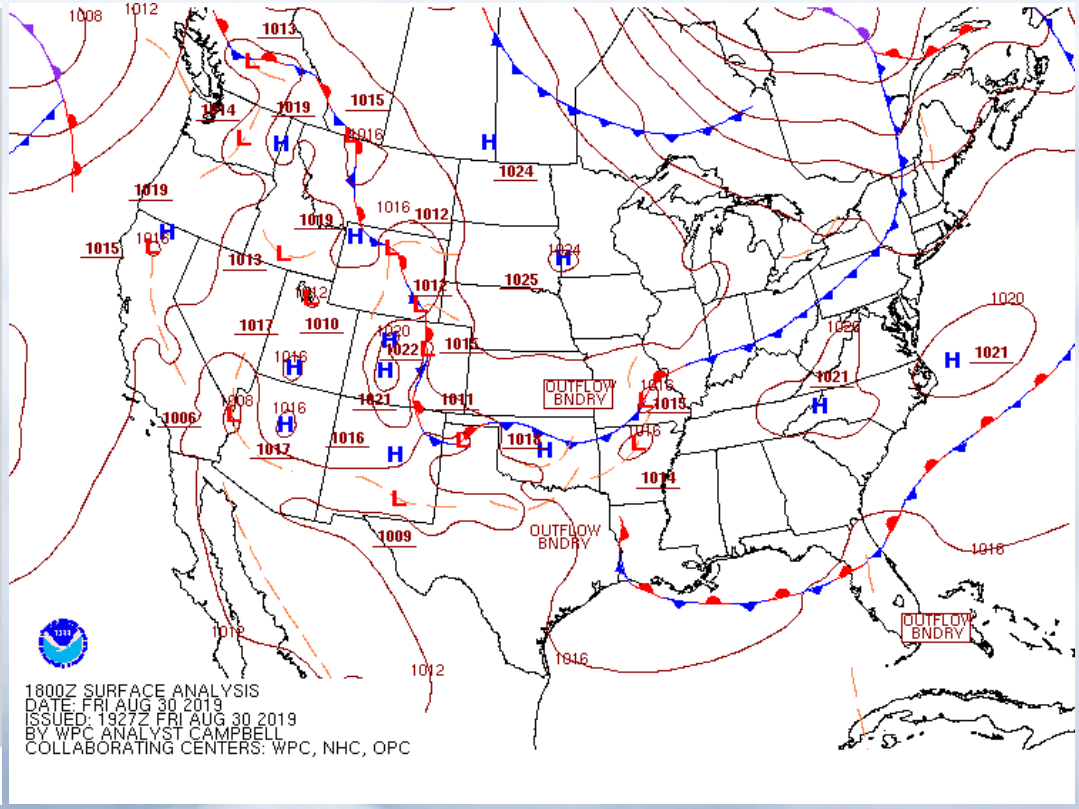


- Seven monitors exceeded the 70 ppb NAAQs.
- Middletown peaked at 94 ppb, being the highest hourly ozone value for the day.

August 30 Maximum 24-hr Temperature

- Most of CT reached temps in the mid 80's with the max being 86°F



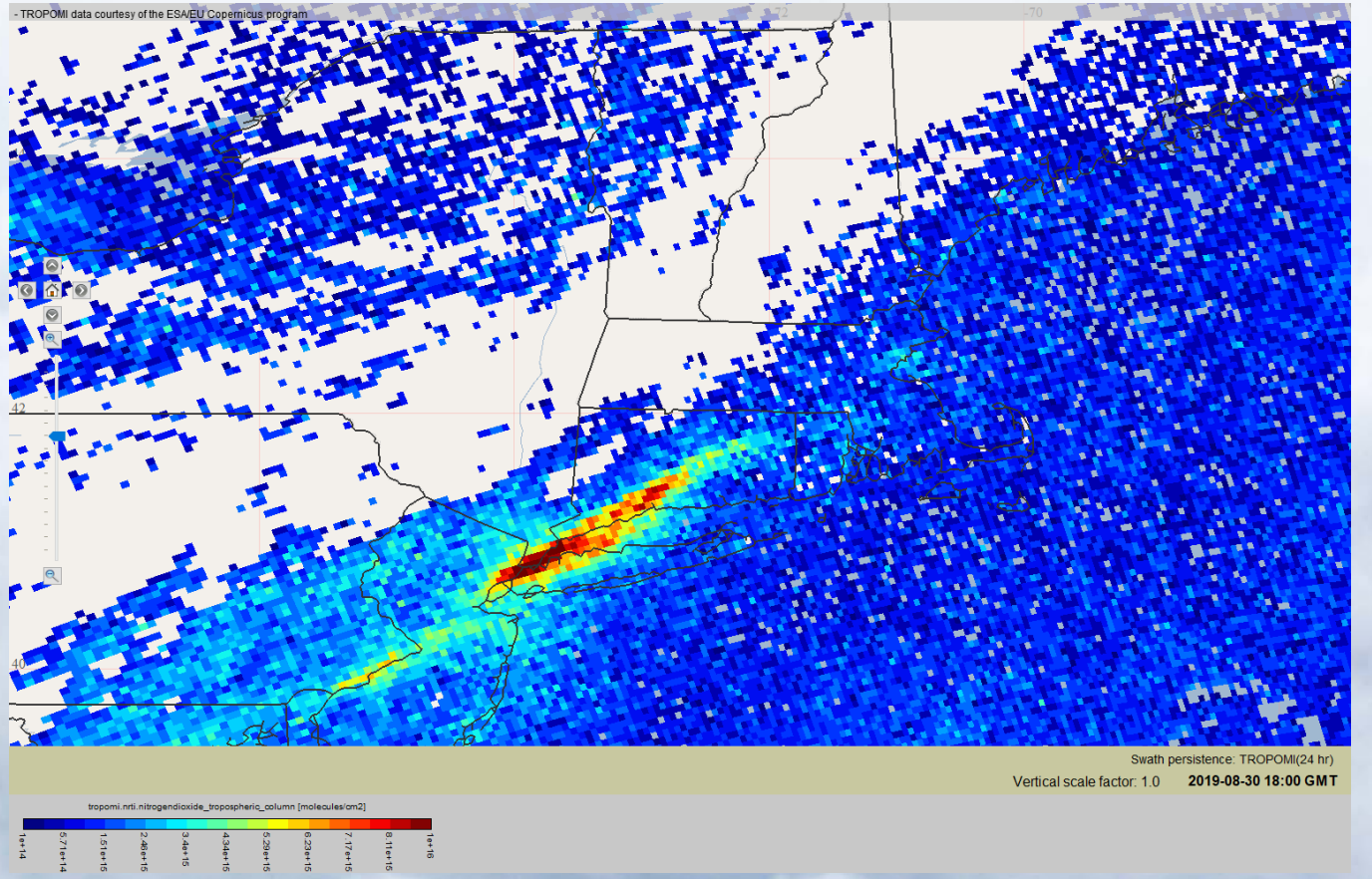


August 30, 2019 18z (2:00 pm EST) Surface Analysis

August 30, 2019 Back Trajectories

- 24 hour back trajectories for the Middletown monitor show air coming from the NYMA and LIS.

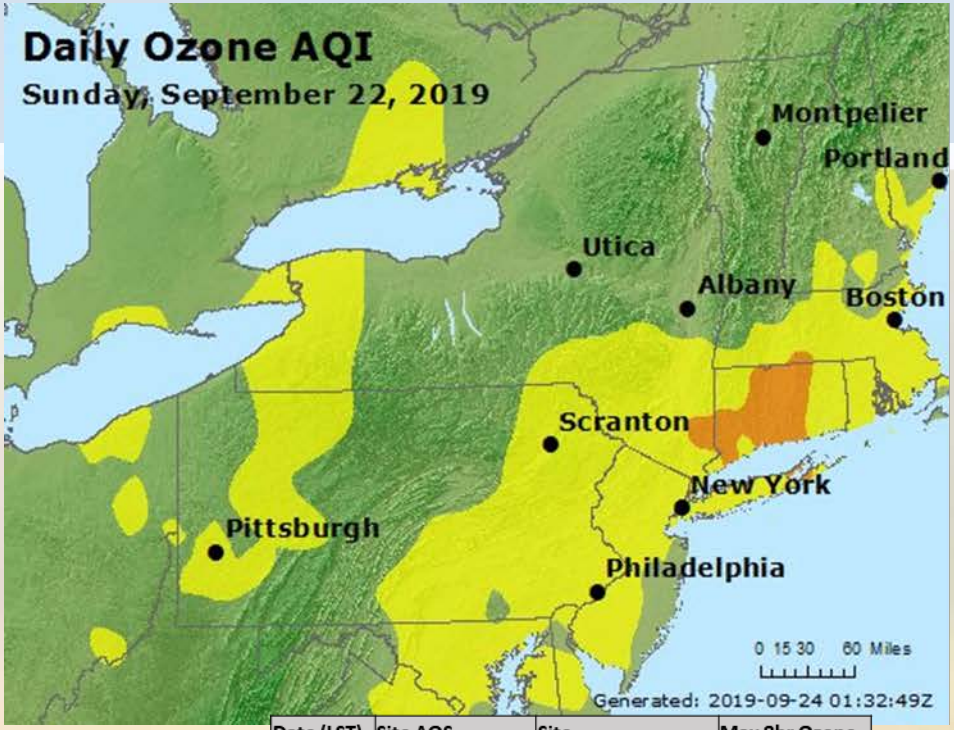
August 30, 2019: NO_2 18GMT (2pm)

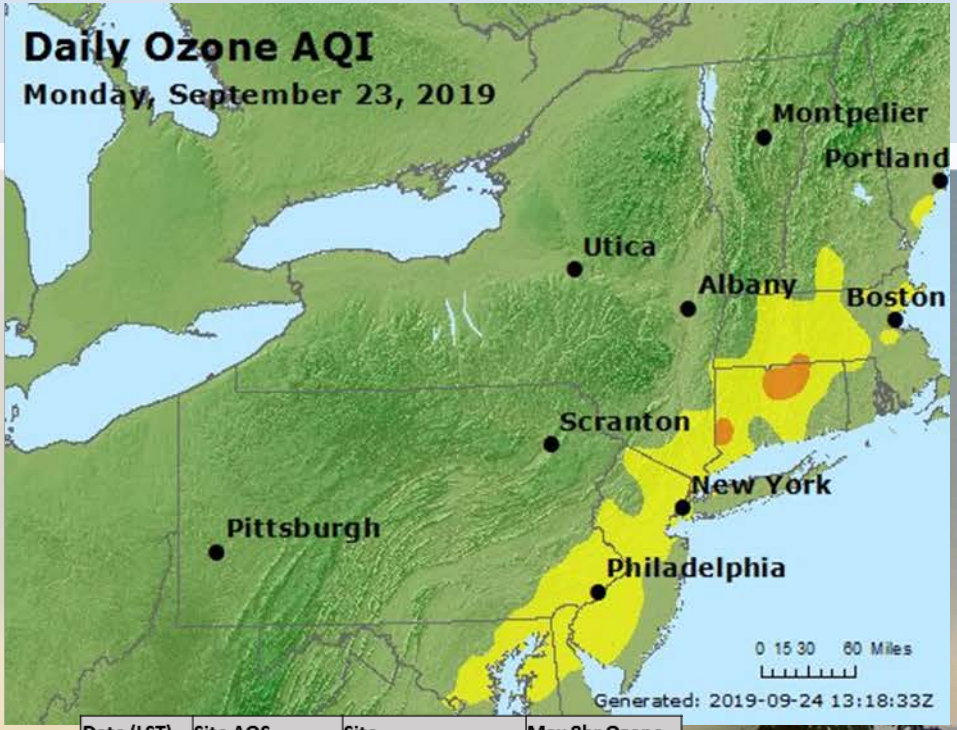


- A highly concentrated plume of NO_2 can be seen over the NYMA extending to the exceeding monitors. The plume is transported into CT along the SW winds.

Conclusion

- A large NO_2 plume was present over NYMA and extended into CT aligning with the exceeding monitors.
- NO_2, warm temperatures (86°F) and a SW wind for most of the afternoon were conducive to ozone formation and transport.
- The models for August 30, 2019, did not forecast USG within CT.
- The Barons CMAQ and MAQSIP models under-predicted USG, however, the moderate levels were accurate in both.
- The NAM-CMAQ model predicted USG close to the coast of CT. This model was the most accurate.





Date (LST)	Site AQS	Site	Max 8hr Ozone
9/22/2019	90090027	**New Haven**	**78**
9/22/2019	90031003	**East Hartford**	**77**
9/22/2019	90079007	**Middletown**	**76**
9/22/2019	90131001	**Stafford**	**75**
9/22/2019	90011123	**Danbury**	**74**
9/22/2019	90099002	**Madison**	**74**
9/22/2019	90019003	**Westport**	**72**
9/22/2019	360790005	Mt Ninham	71
9/22/2019	340190001	Flemington	70
9/22/2019	90050005	**Cornwall**	**69**
9/22/2019	361192004	White Plains	69
9/22/2019	420430401	Harrisburg	68
9/22/2019	340030006	Leonia	67
9/22/2019	250154002	WARE	67
9/22/2019	340219991	Wash. Crossing	67
9/22/2019	250130008	CHICOPEE	66
9/22/2019	340273001	Chester	66

Date (LST)	Site AQS	Site	Max 8hr Ozone
9/23/2019	900310031	**East Hartford**	**72**
9/23/2019	901310011	**Stafford**	**72**
9/23/2019	900111231	**Danbury**	**71**
9/23/2019	3402300111	Rutgers Univers	70
9/23/2019	4210100241	NEA	68
9/23/2019	2402590011	Aldino	67
9/23/2019	1000310131	BELLFNT2	67
9/23/2019	2501300081	CHICOPEE	67
9/23/2019	2401500031	Fair Hill	67
9/23/2019	1000320041	MLK	67
9/23/2019	2400310032	Glen Burnie	66
9/23/2019	4202901001	New Garden	66
9/23/2019	3402100051	Rider Universit	66
9/23/2019	2501540021	WARE	66
9/23/2019	3402199911	Wash. Crossing	66
9/23/2019	3401700061	Bayonne	65
9/23/2019	4201700121	Bristol	65

Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

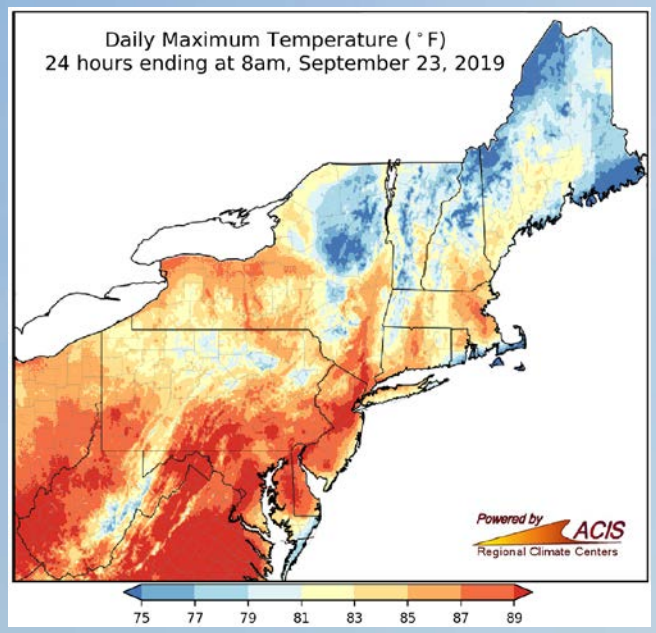
Ozone Event Analysis: September 22-23, 2019

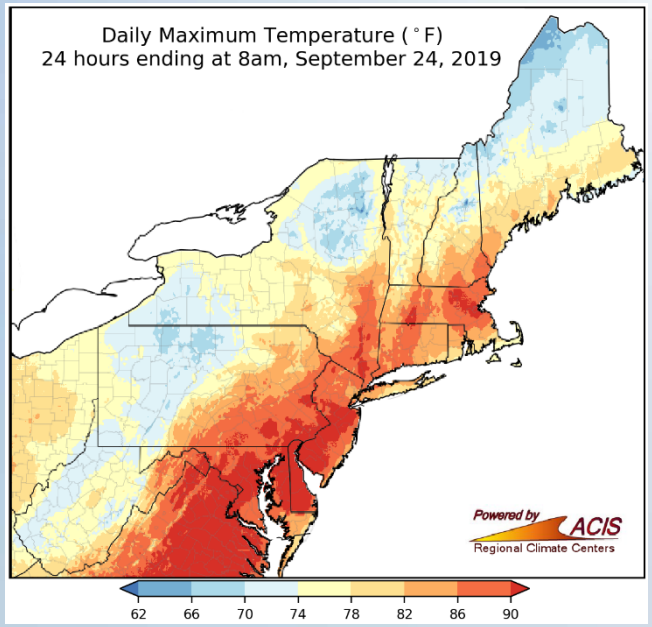
Kristin Salimeno

CONNECTICUT WORKING TOGETHER FOR CLEAN AIR

September 22-23 Maximum 24-hr Temperature

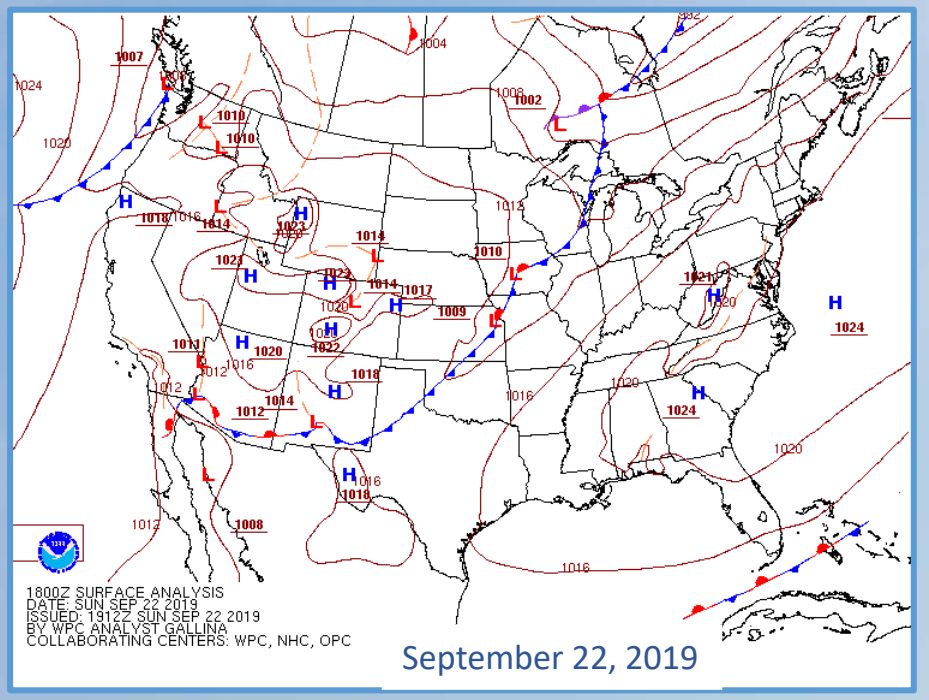
- On September 22 (left), temperatures in the 80's were measured along the SW coastline and up through the middle of the state. Lower temps were measured in the NW and NE corners of the state.



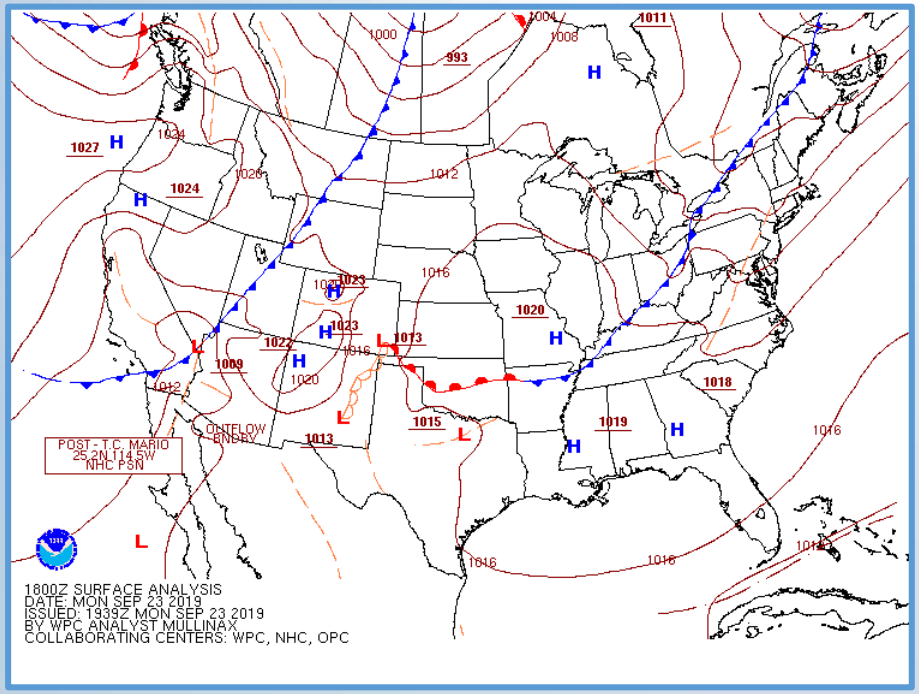


- On September 23 (right), temperatures increased across the state, with the middle portion of CT reaching close to 90. The lowest temperatures were recorded in the SE corner of the state.

September 22-23, 2019 18z Surface Analysis



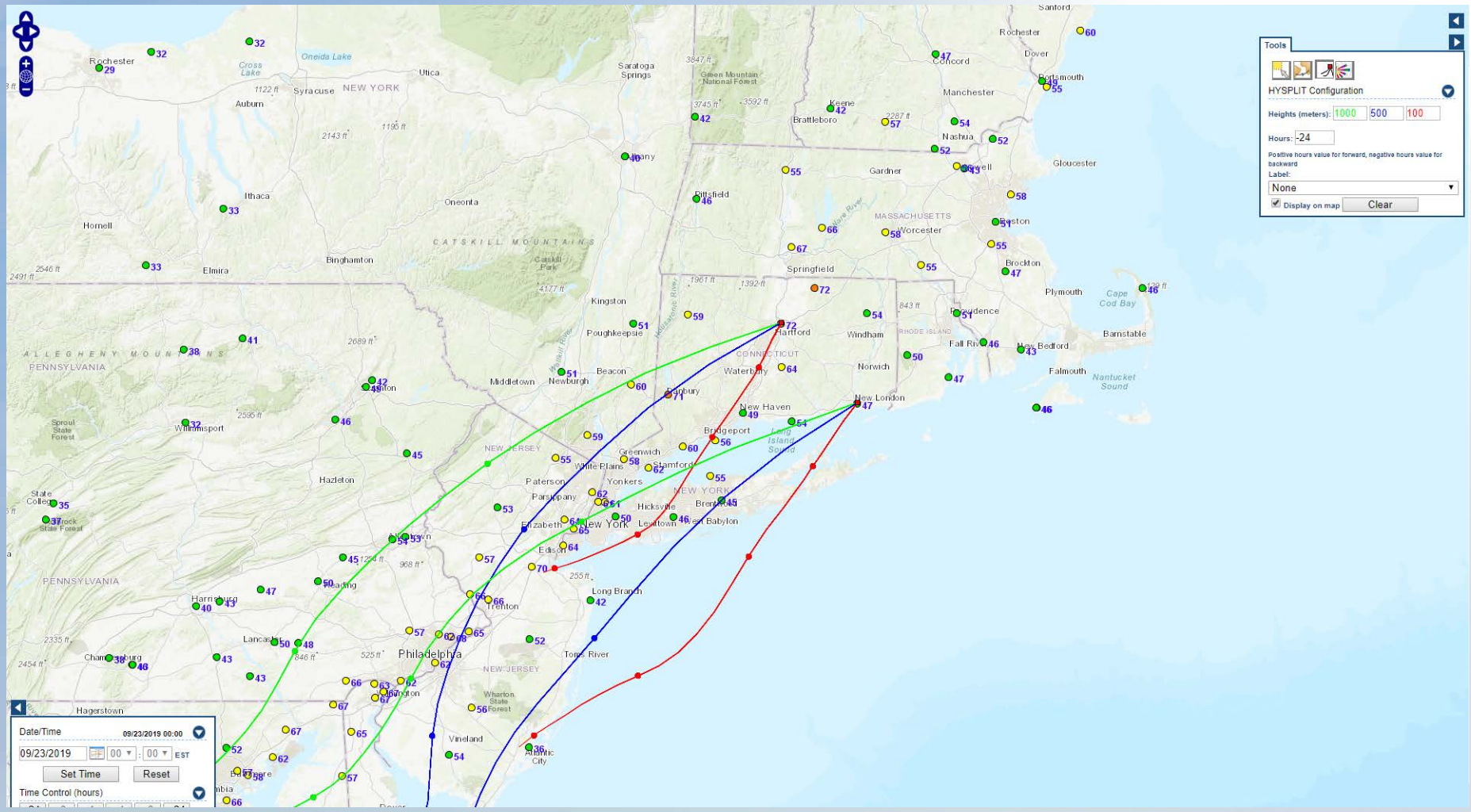
September 22, 2019



- Conditions over CT were calm and clear for September 22 and 23.

September 23, 2019 Back Trajectories

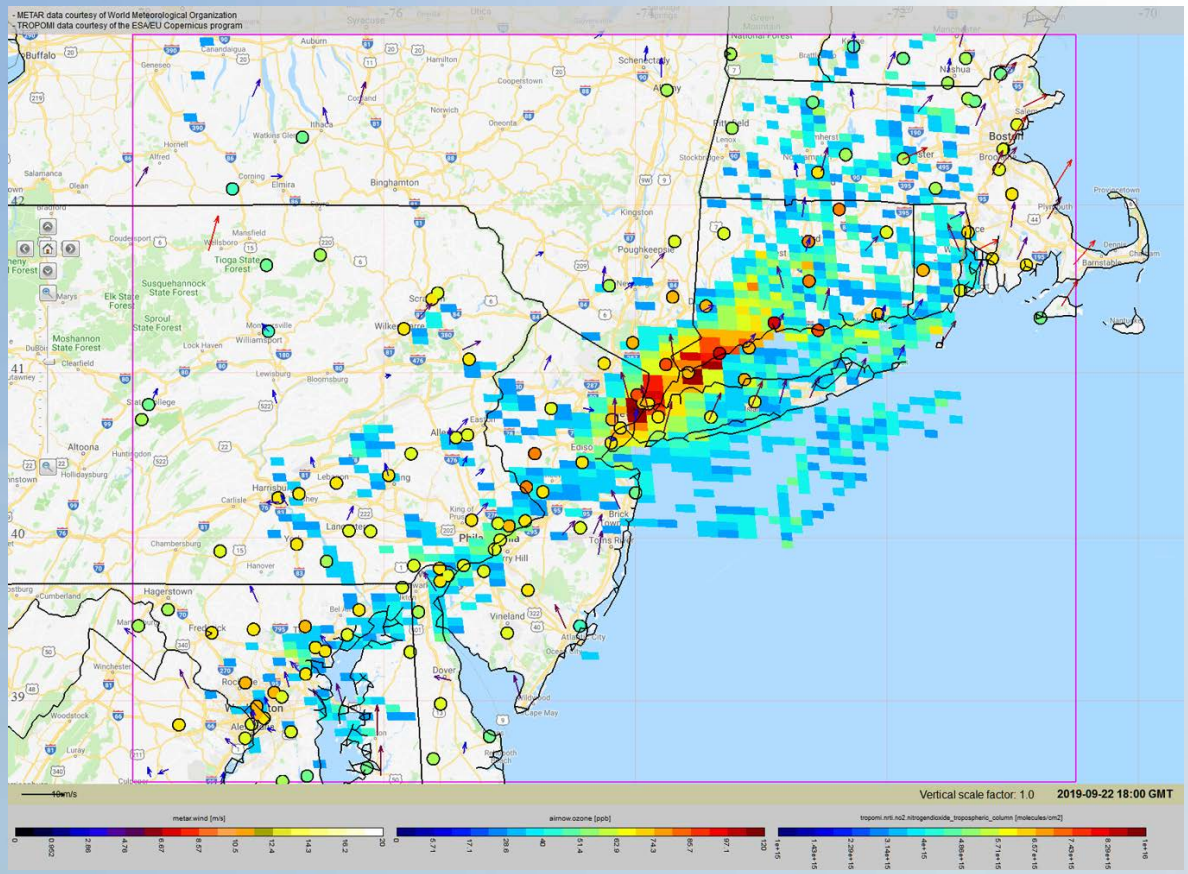
- 24 hour back trajectories for the East Hartford monitor show air coming from over the NYMA.



- 24 hour back trajectories for the Groton monitor show air passed over Long Island and LIS.

September 22, 2019: TROPOMI NO_2, METAR Wind Vectors, and AirNow Ozone Data 18GMT

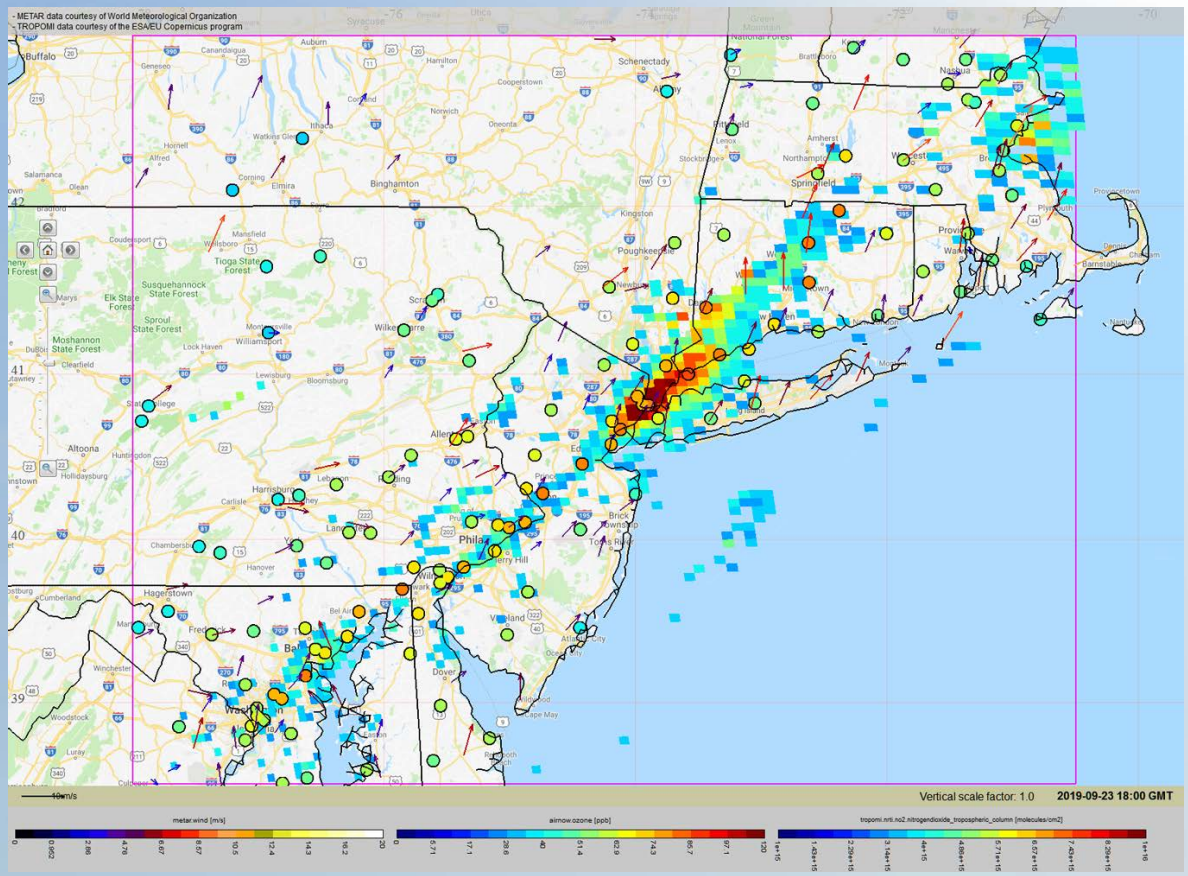
(2:00 pm EST)



- The NO2 plume is transported along the SW coast of CT and into the middle portion of the state.
- Wind vectors show a SW wind.

September 23, 2019: TROPOMI NO_2, METAR Wind Vectors, and AirNow Ozone Data 18GMT

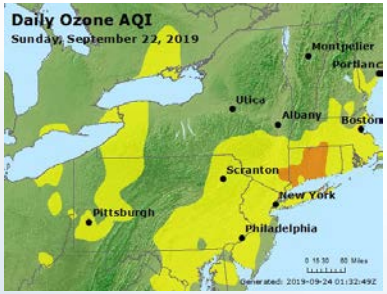
(2:00 pm EST)

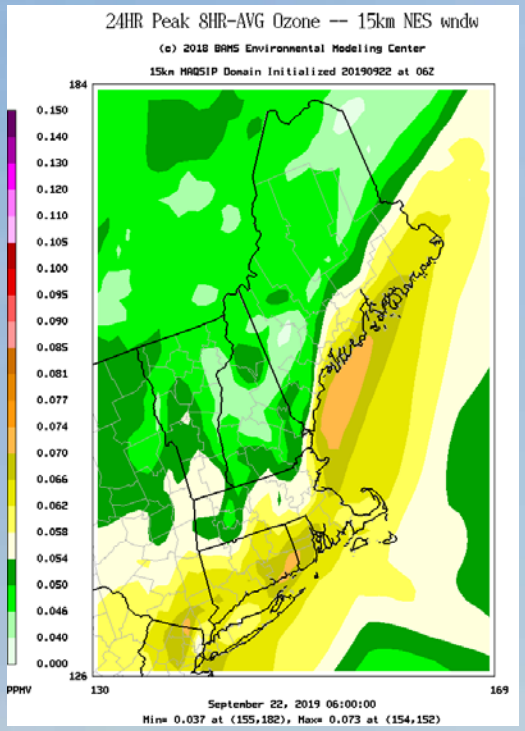


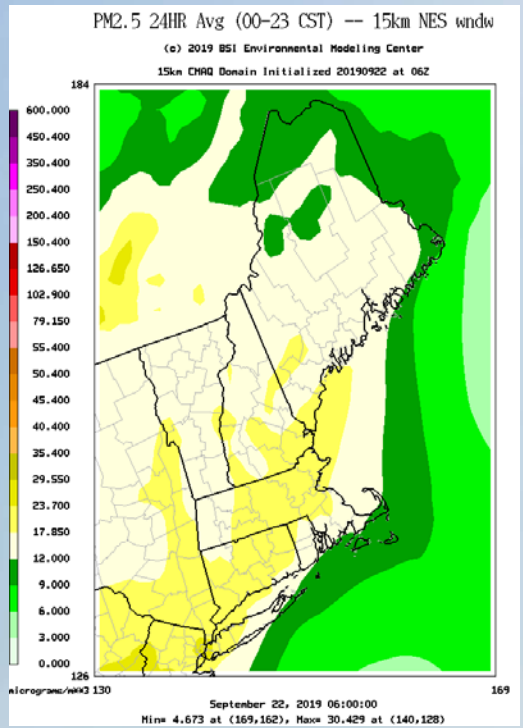
- The SW wind transports the NO2 plume into CT.

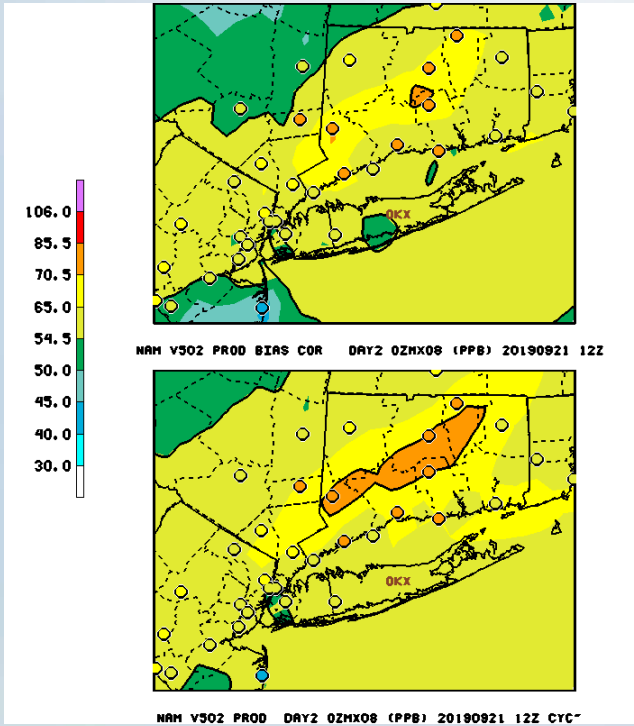
September 22, 2019 Model Performance

- The NAM-CMAQ (right) and the Baron's MAQSIP (right) model forecasted spots of USG. The NAM-CMAQ non-biased corrected model forecasted the largest area of USG.









2019 Conclusions

•21 exceedance days in 2019, compared with 23 in 2018;

• Typical warm, dry, summer weather pattern set up from late June through August, pushed the highest ozone levels from high NOX and VOC emissions along the I-95 corridor and NYC into Connecticut because of SW wind pattern in 2019 (25 days of 90+ degrees) vs. 2018's South wind pattern (32 days of 90+ degrees);

•The NOAA & Barons models generally under predicted in May and early June, and again in September, and

• Some over predictions began in late June and continued into late August, however there were some days of under predictions as well.

2019 Conclusions

- When we know that NOAA/BARONS models are over predicting, we generally lower the ozone levels by as much as 10-20 ppb; however in some instances we predicted a bit to low (an additional 3-5ppb) forecasting ozone levels below the NAAQS (USG AQI);
- We also under-predicted when smoke was present for a few events this summer based on the modeling. Smoke may have hindered the model performance due to solar attenuation; therefore models may have under-predicted an additional 5-10ppbs, and
- On-going but limited Long Island Sound Ozone Study (LISTOS) continue to provide more insight and tools to Forecasters for increasing the forecast skill in future.