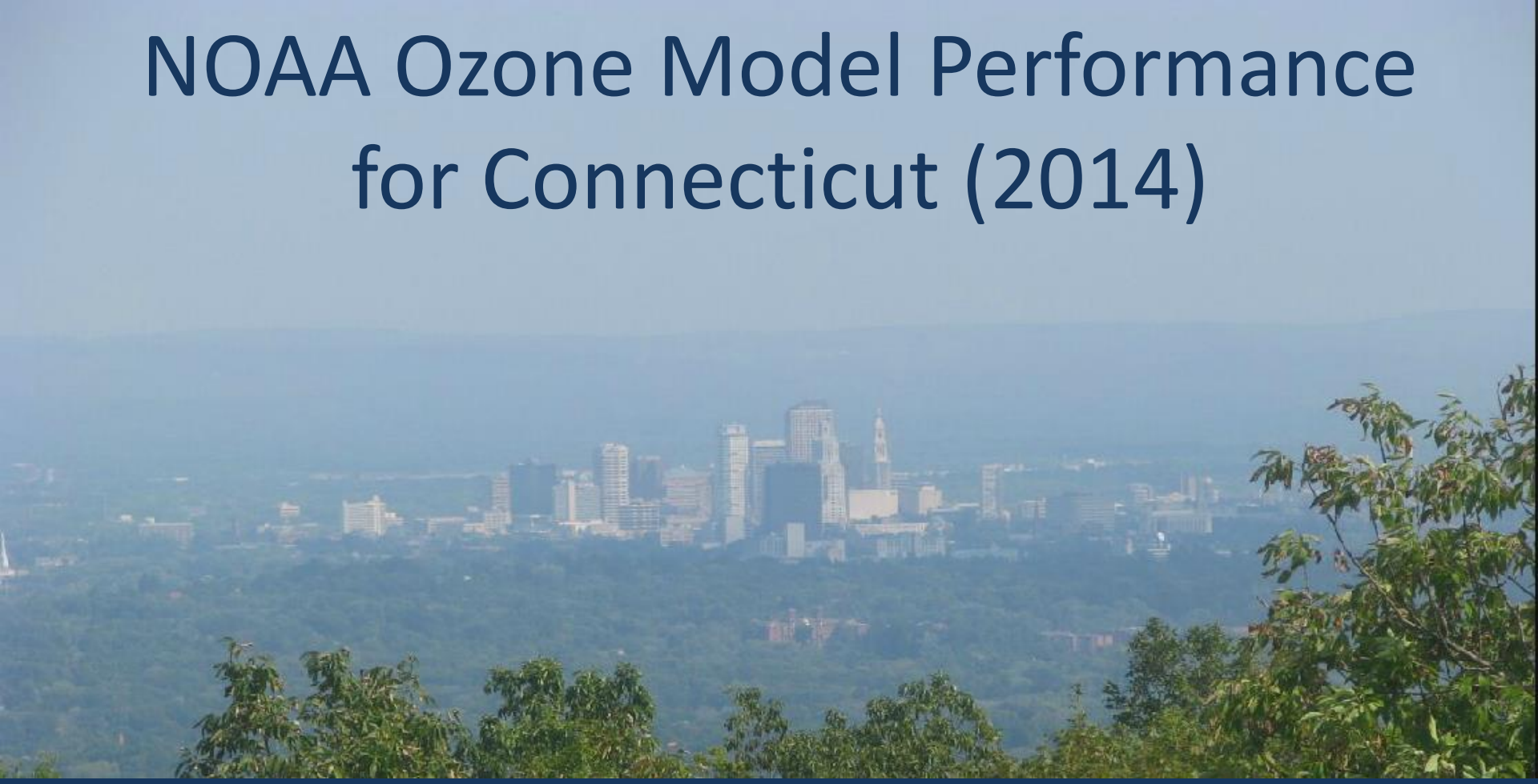
Connecticut Department of Energy and Environmental Protection

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

NOAA Ozone Model Performance for Connecticut (2014)



September 9, 2014

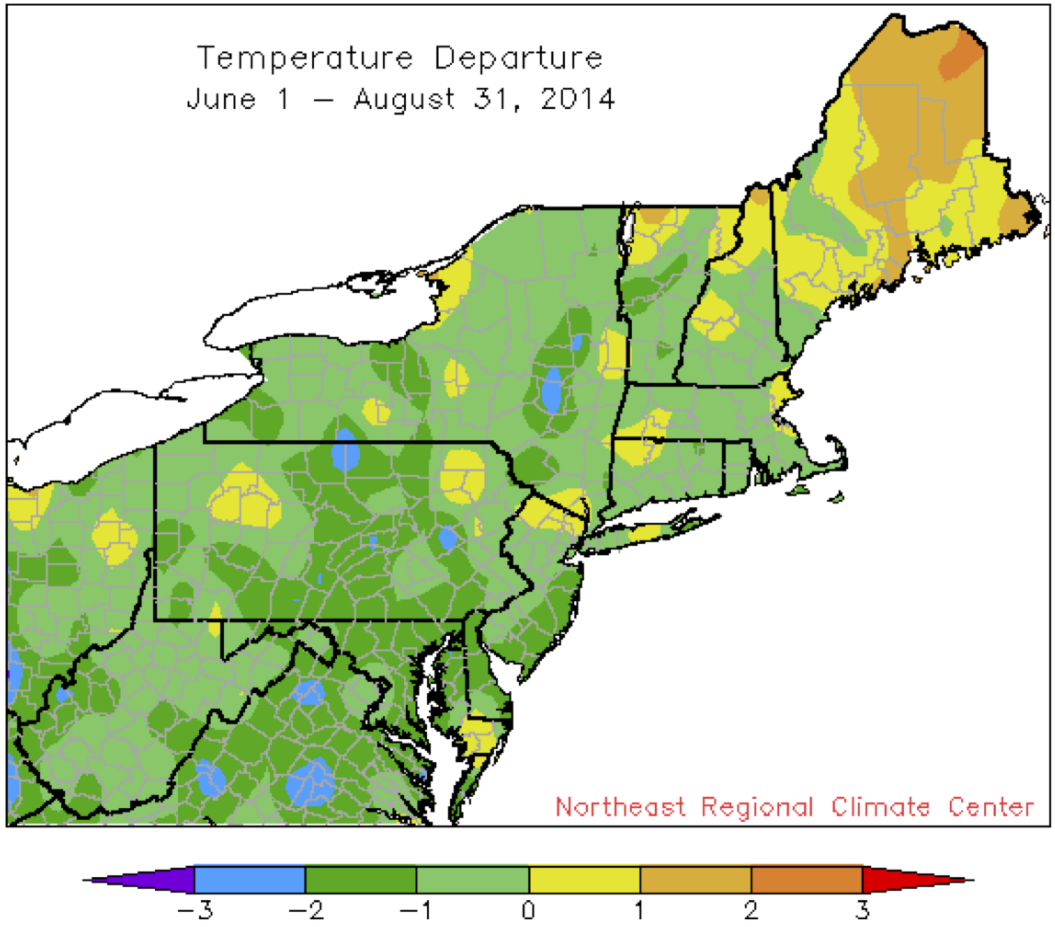
Michael Geigert
Air Quality Forecaster Focus Group Workshop/ Silverspring MD

Connecticut Department of Energy and Environmental Protection

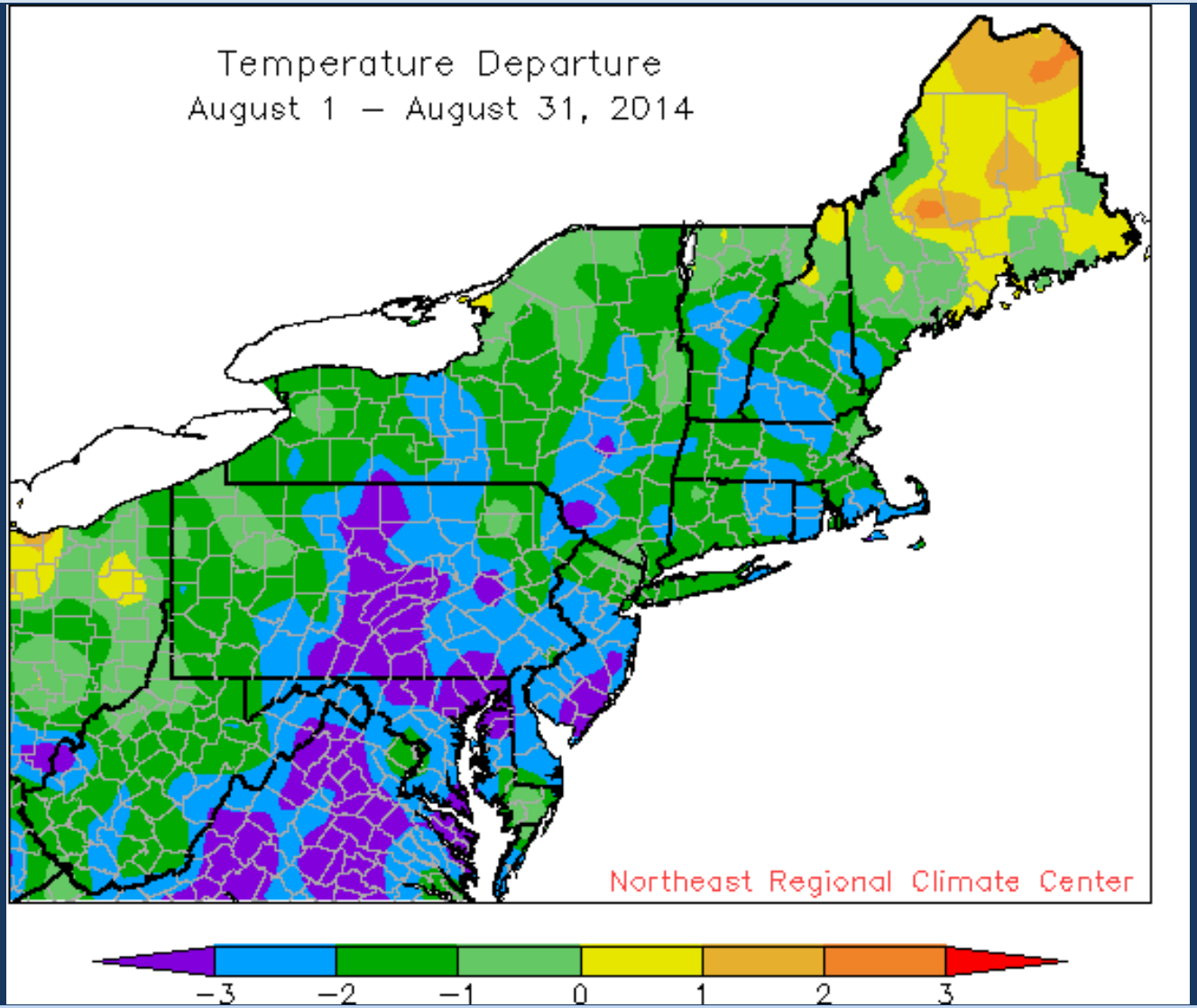
Slightly cooler Summer overall

- Less ozone exceedance days in CT
- 8 days in 2014 vs. 18 in 2013

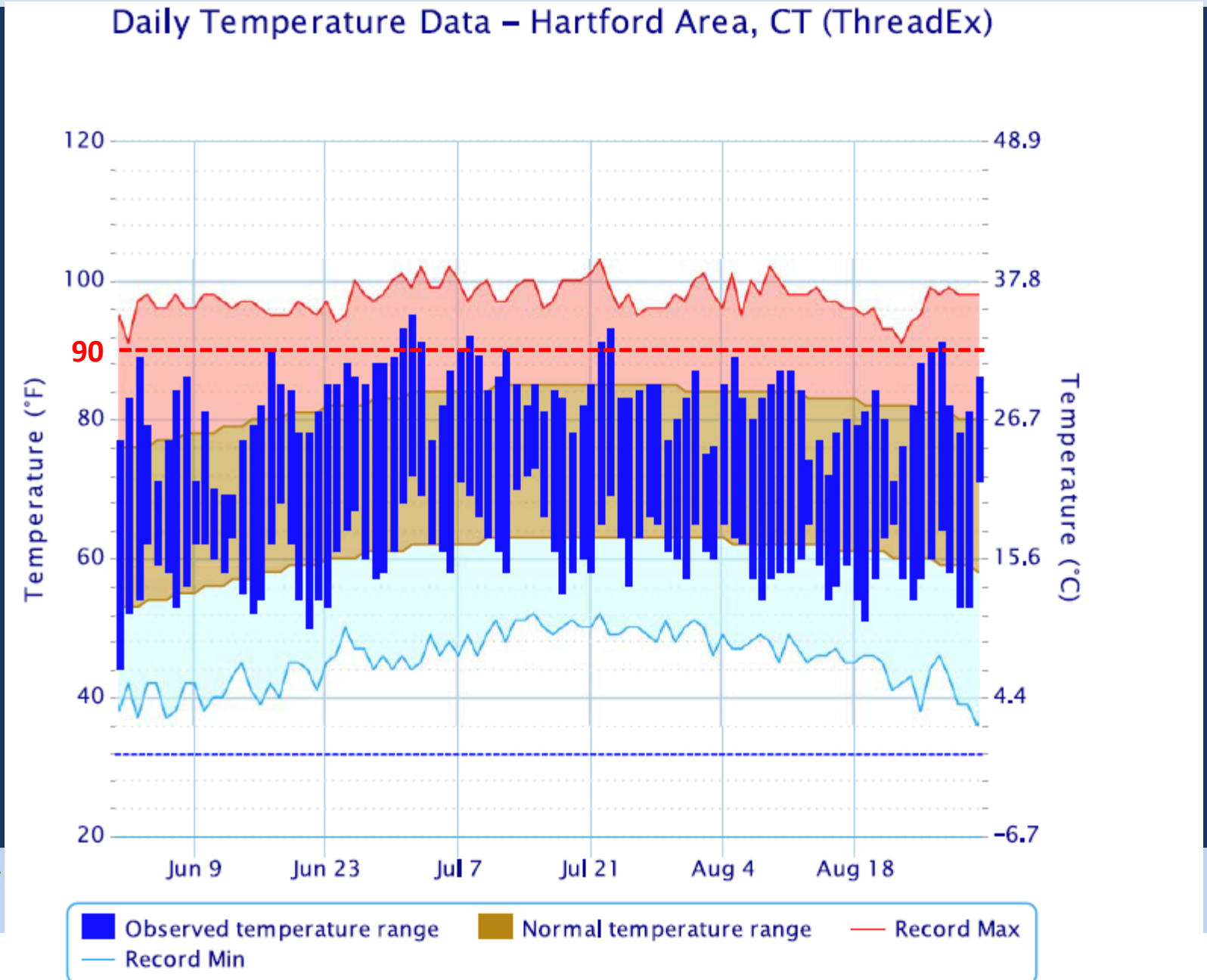
Location	Summer 2014	Normal	Departure	Rank
Dulles Ap, VA	72.8	74.9	-2.1	10 coolest
Atlantic City, NJ	71.9	73.9	-2.0	
Huntington, WV	72.6	74.2	-1.6	19 coolest
Baltimore, MD	73.8	74.9	-1.1	18 coolest
Wilmington, DE	73.8	74.8	-1.0	
Charleston, WV	73.3	73.9	-0.6	
Pittsburgh, PA	70.4	71.0	-0.6	
Concord, NH	67.3	67.8	-0.5	
Providence, RI	70.8	71.3	-0.5	
Binghamton, NY	66.5	66.9	-0.4	
Newark, NJ	74.8	75.2	-0.4	
Erie, PA	69.4	69.8	-0.4	
LaGuardia Ap, NY	74.9	75.3	-0.4	
Philadelphia, PA	75.7	76.0	-0.3	
Buffalo, NY	68.8	69.0	-0.2	
Williamsport, PA	70.7	70.9	-0.2	
Worcester, MA	67.9	68.1	-0.2	
Beckley, WV	69.2	69.3	-0.1	
Elkins, WV	68.4	68.5	-0.1	
Boston, MA	71.1	71.1	0.0	
Central Park, NY	74.4	74.4	0.0	
Harrisburg, PA	73.8	73.8	0.0	
Hartford, CT	71.4	71.4	0.0	
Kennedy Ap, NY	73.7	73.7	0.0	
Portland, ME	66.9	66.9	0.0	
Rochester, NY	68.8	68.8	0.0	
Bridgeport, CT	72.4	72.2	0.2	
Allentown, PA	71.7	71.4	0.3	
Washington, DC	78.1	77.7	0.4	
Albany, NY	70.3	69.8	0.5	
Syracuse, NY	69.8	69.3	0.5	
Islip, NY	72.5	71.7	0.8	16 warmest
Scranton, PA	70.5	69.4	1.1	
Burlington, VT	69.6	68.4	1.2	
Caribou, ME	65.7	63.3	2.4	3 warmest

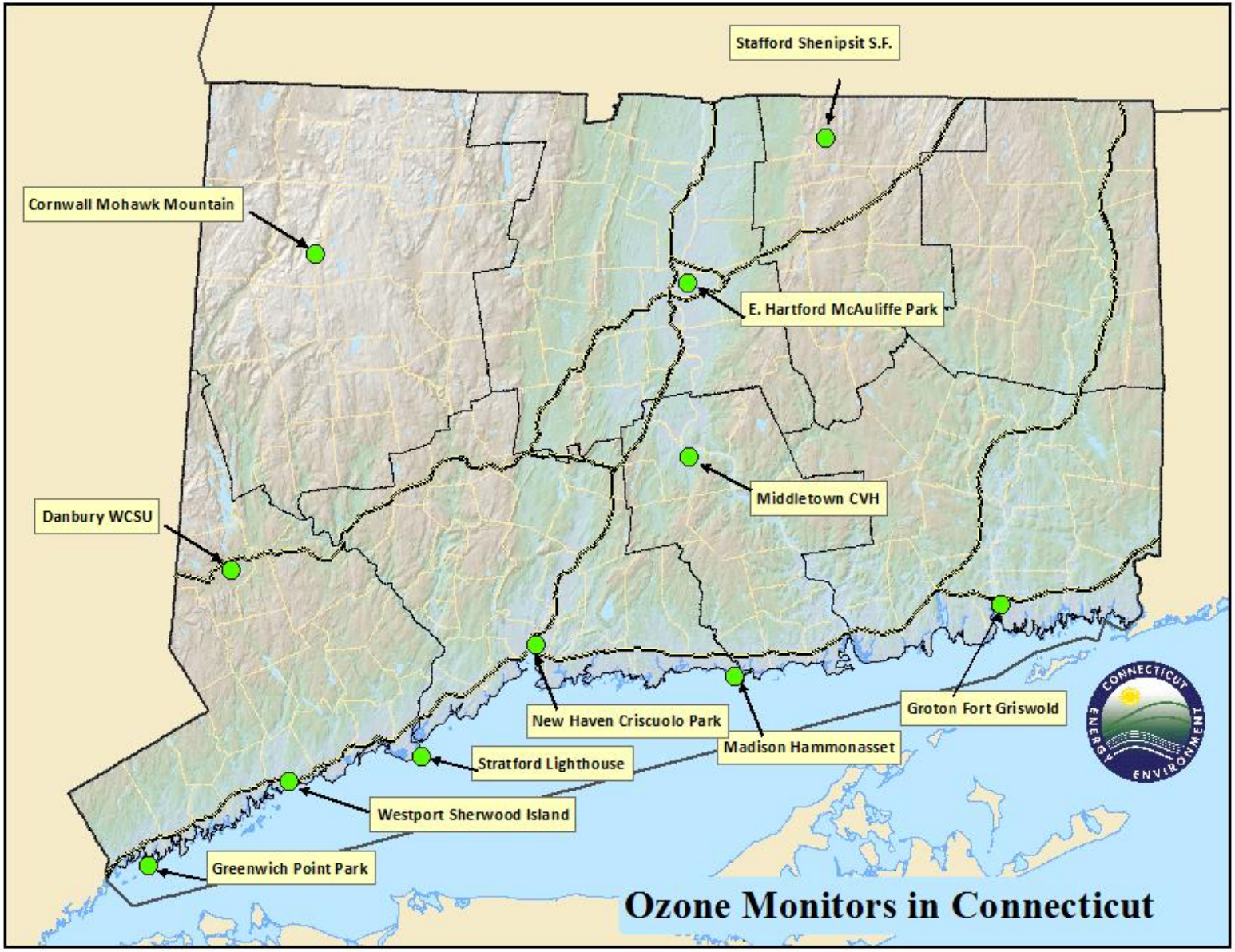


Only 1 Ozone Exceedance day in August



Only 10 days 90 degrees or above (Hartford)




Stafford Shenipsit S.F.
Cornwall Mohawk Mountain
E. Hartford McAuliffe Park
Middletown CVH
Danbury WCSU
New Haven Criscuolo Park
Groton Fort Griswold
Madison Hammonasset
Stratford Lighthouse
Westport Sherwood Island
Greenwich Point Park
Ozone Monitors in Connecticut

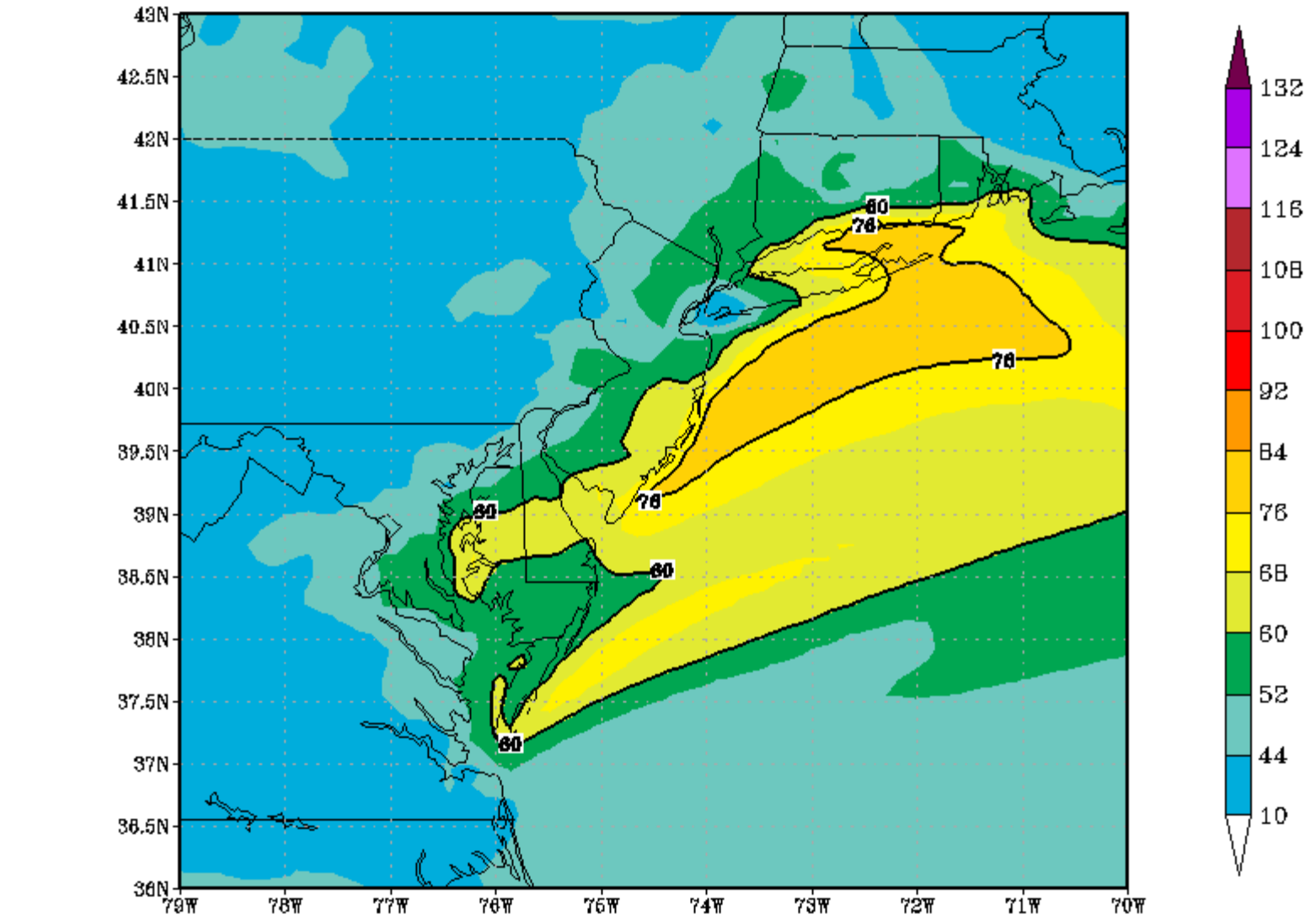
Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
May 2014

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Cornwall	54	51	50	45	41	45	54	51	52	54	55	69	48	48	39	41	48	50	53	54	61	52	40	36	45	59	68	28	49	48	41
Danbury	48	48	49	45	36	44	52	36	43	51	M	71	43	M	41	38	49	48	51	50	57	53	40	35	43	58	80	21	46	43	40
East Hartford	35	49	50	43	35	43	51	45	49	51	54	69	40	41	42	40	48	50	51	48	55	41	40	34	43	52	74	27	42	44	40
Greenwich	40	52	50	46	44	47	43	48	45	54	57	51	38	33	36	37	52	49	56	54	51	53	37	33	45	55	75	34	46	54	43
Groton	44	54	53	48	36	45	50	43	51	56	59	64	37	33	44	47	53	52	53	51	50	40	36	32	35	64	69	28	39	43	49
Madison	44	53	53	48	38	46	49	47	54	55	60	59	34	33	42	45	56	52	52	52	53	44	35	35	40	67	71	28	44	48	51
Middletown	41	50	54	46	37	45	53	48	52	57	56	69	38	40	43	42	51	51	52	48	54	48	49	37	45	60	86	26	46	47	45
New Haven	29	35	40	44	38	46	44	47	51	51	47	47	37	34	41	42	37	51	50	50	54	49	42	34	43	48	72	M	44	46	48
Stafford	41	50	53	43	32	44	53	51	50	55	56	73	37	50	44	43	47	49	50	49	56	47	44	34	44	52	65	27	45	49	43
Stratford	39	50	51	47	41	46	46	52	53	54	57	55	38	36	43	46	56	51	55	54	53	62	39	41	47	60	84	29	47	52	47
Westport	34	50	48	45	38	44	46	40	38	50	56	54	34	30	35	36	M	48	51	50	48	46	30	36	46	58	76	28	45	53	41
# days > Federal Standard																											1				

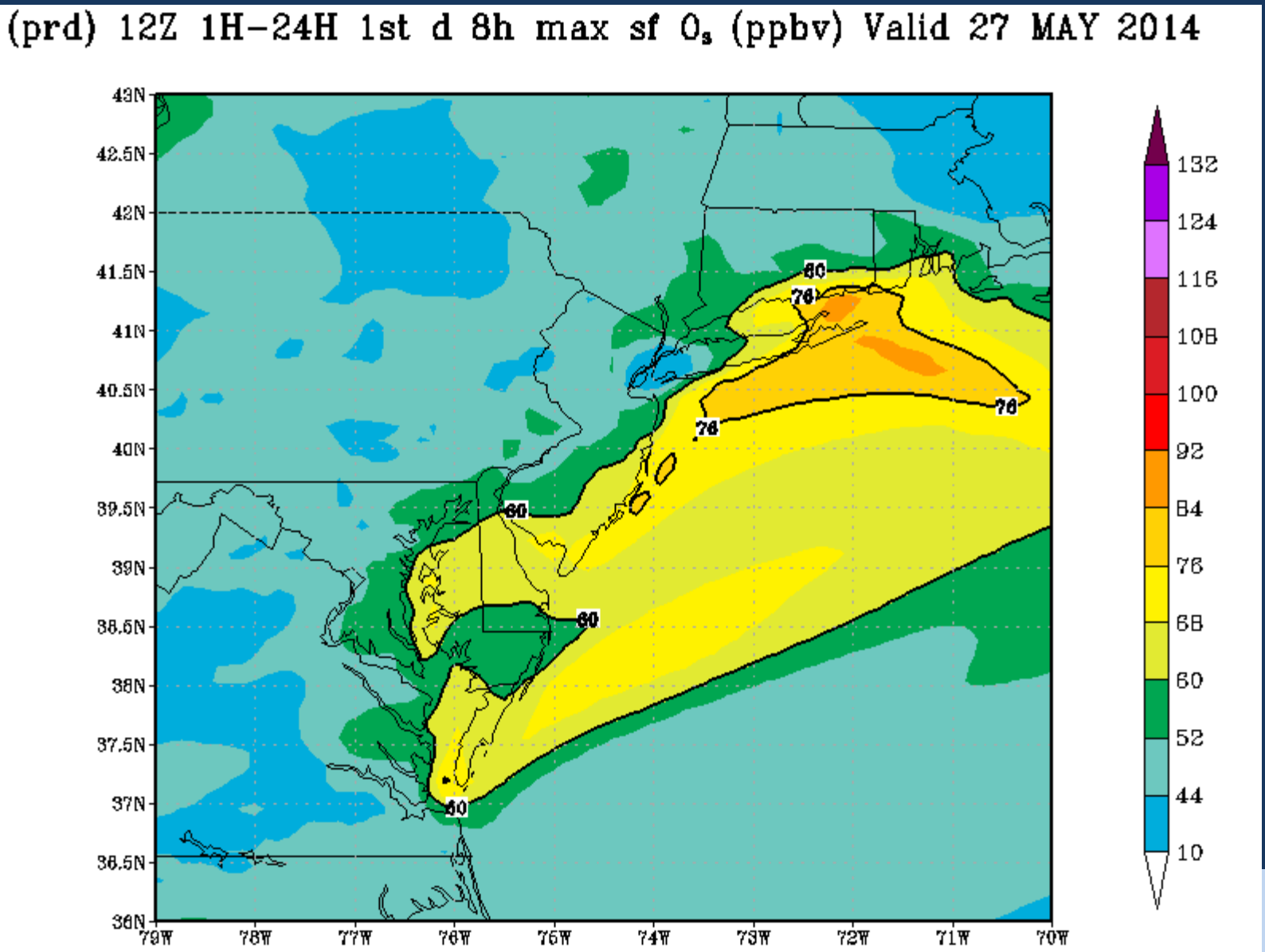
Good (0-59 ppb)
Moderate (60-75 ppb)
Unhealthy for Sensitive Groups (76-95 ppb)
Unhealthy (96-115 ppb)
Very Unhealthy (116 > ppb)

Units - parts per billion (ppb)
Federal Standard = 75 ppb
M = missing data
* Data is preliminary and has not been quality assured

May 26th 12z PROD run



May 27th 12z PROD run



Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
June 2014

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cornwall	53	66	66	43	41	21	39	52	43	37	34	32	41	38	32	52	79	51	40	37	37	50	59	55	52	34	42	57	60	56
Danbury	64	66	74	43	38	20	32	57	36	38	36	28	36	34	27	54	84	45	33	35	36	55	62	53	52	34	43	62	66	54
East Hartford	53	76	70	47	37	21	32	49	35	M	33	28	27	35	32	55	77	44	39	37	35	37	53	51	52	36	39	49	57	70
Greenwich	52	46	68	48	43	24	36	59	44	38	38	36	36	39	34	49	83	52	38	43	49	57	55	45	41	39	49	70	58	51
Groton	50	59	54	38	34	28	41	62	38	31	42	35	31	37	36	36	50	49	44	41	37	41	47	48	34	46	39	50	37	45
Madison	51	55	54	37	39	27	44	54	43	34	41	37	34	39	34	44	59	49	47	40	38	45	54	51	34	47	45	58	45	50
Middletown	53	76	71	47	40	24	35	55	42	M	39	34	28	39	32	52	77	49	43	39	44	45	57	47	48	39	43	54	54	68
New Haven	45	54	69	43	38	22	37	44	39	34	37	31	29	39	34	43	78	48	37	39	35	48	67	48	34	37	47	66	52	47
Stafford	56	81	73	50	36	21	33	52	45	44	34	29	27	32	32	57	77	45	36	37	37	41	50	52	53	32	39	46	57	70
Stratford	50	56	61	42	44	23	43	62	49	41	42	39	36	39	32	49	76	50	45	40	43	51	65	49	36	38	51	69	54	49
Westport	53	57	61	41	39	21	37	55	37	39	37	29	32	39	30	47	84	50	38	40	44	54	55	47	41	37	50	70	58	52
# days > Federal Standard		2															3													

Good (0-59 ppb)
Moderate (60-75 ppb)
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Unhealthy (96-115 ppb)
Very Unhealthy (116 > ppb)

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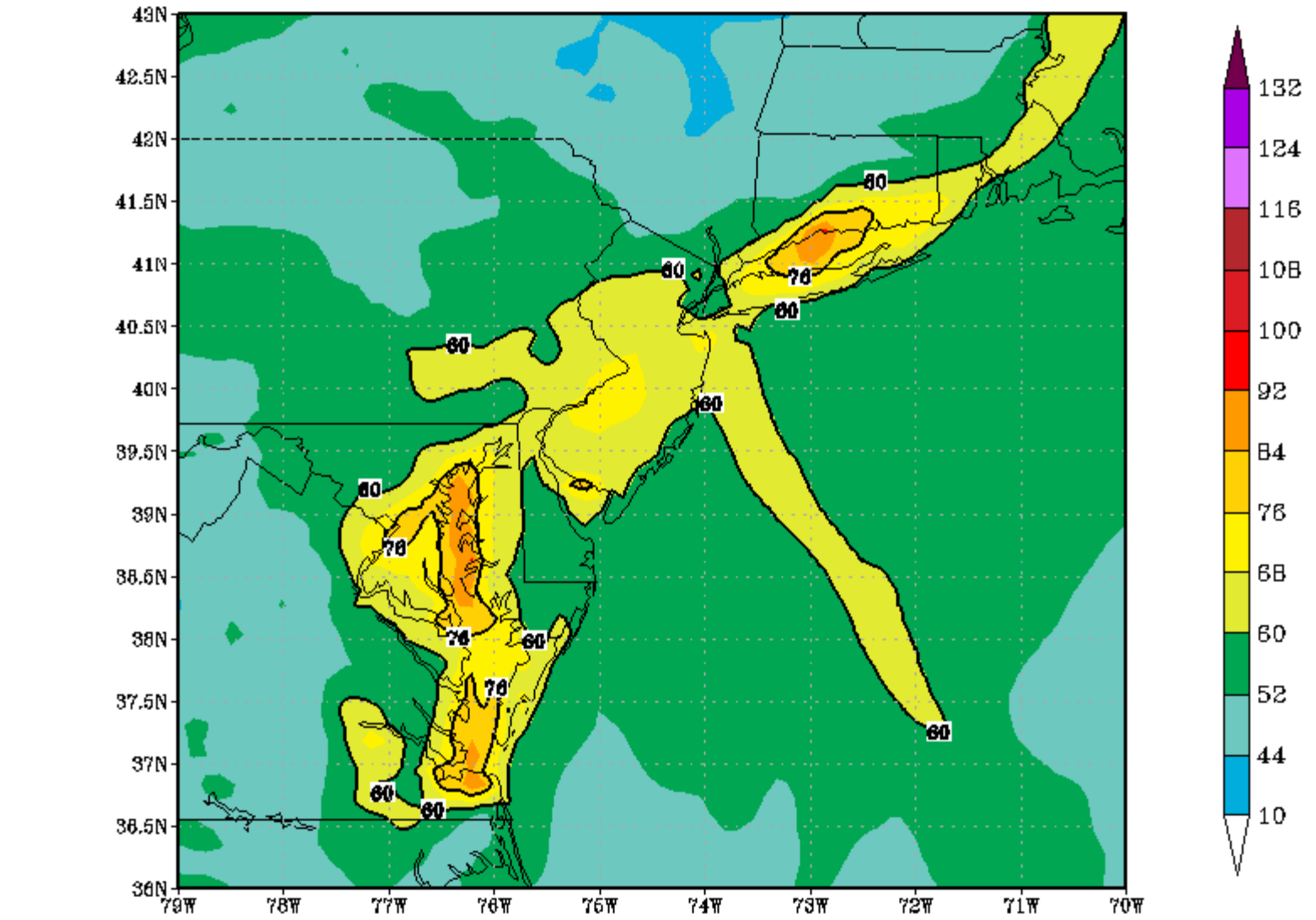
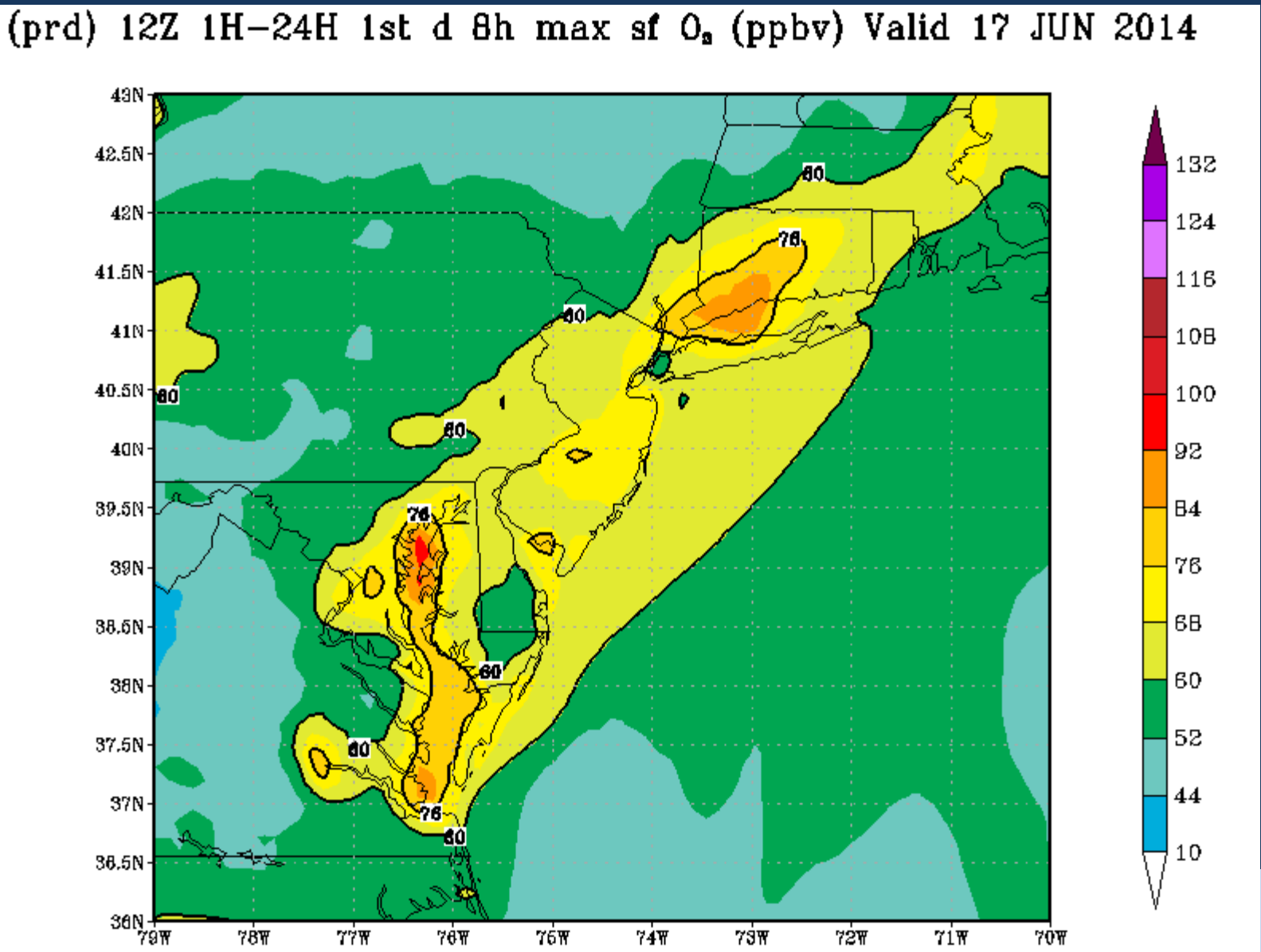
June 16th 12z Model Run



June 17th 12z Model Run



Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
July 2014

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Abington	49	46	53	35	28	55	63	63	61	40	44	58	42	42	35	36	39	33	34	39	52	70	51	29	36	58	46	53	27	37	57
Cornwall	60	49	57	35	34	52	64	64	50	38	45	62	48	45	45	40	36	48	42	50	50	57	74	31	41	50	46	46	20	40	60
Danbury	53	47	66	31	30	51	72	72	66	39	43	74	51	37	50	39	48	39	49	48	58	72	74	35	34	59	61	50	28	35	69
East Hartford	59	48	59	33	29	52	83	77	65	40	45	70	48	37	43	41	39	38	38	45	53	68	74	36	33	59	56	56	24	29	69
Greenwich	54	56	69	33	33	61	91	78	57	54	54	62	47	56	51	59	53	46	49	47	62	70	54	39	52	57	65	59	30	51	64
Groton	42	36	45	37	32	57	57	57	57	48	50	48	40	49	36	37	41	43	35	38	47	63	44	28	46	65	46	61	36	38	56
Madison	44	41	48	34	35	62	61	63	64	55	59	55	44	48	42	51	48	51	42	42	49	74	52	40	50	61	53	69	41	45	70
Middletown	57	51	59	36	31	61	78	82	73	53	56	73	47	47	42	46	48	45	40	43	53	82	65	42	42	65	59	65	28	43	70
New Haven	52	42	56	30	32	58	65	76	55	50	54	64	48	43	39	42	53	38	43	45	57	72	50	32	45	56	46	56	29	37	66
Stafford	60	46	54	32	M		82	77	69	41	44	66	46	42	45	39	39	37	37	48	41	77	75	27	34	60	55	56	26	31	69
Stratford	53	50	63	34	33	66	74	70	60	65	58	70	50	50	45	55	59	47	50	53	65	78	56	34	52	58	65	68	40	52	72
Westport	56	49	70	32	34	68	81	82	63	56	57	72	50	53	46	51	58	42	49	47	63	80	61	36	52	64	69	65	33	52	72
# days > Federal Standard							4	5														6									

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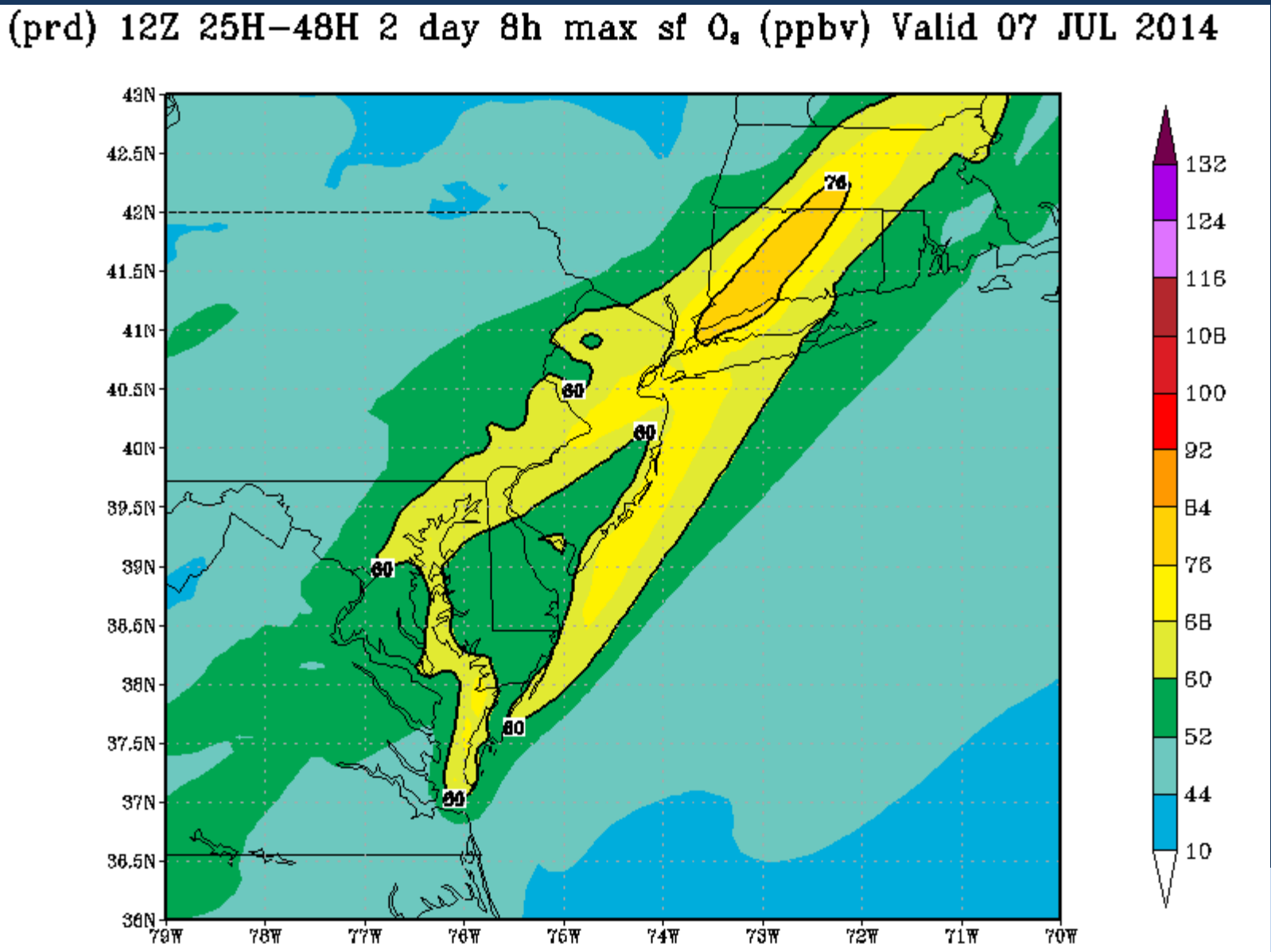
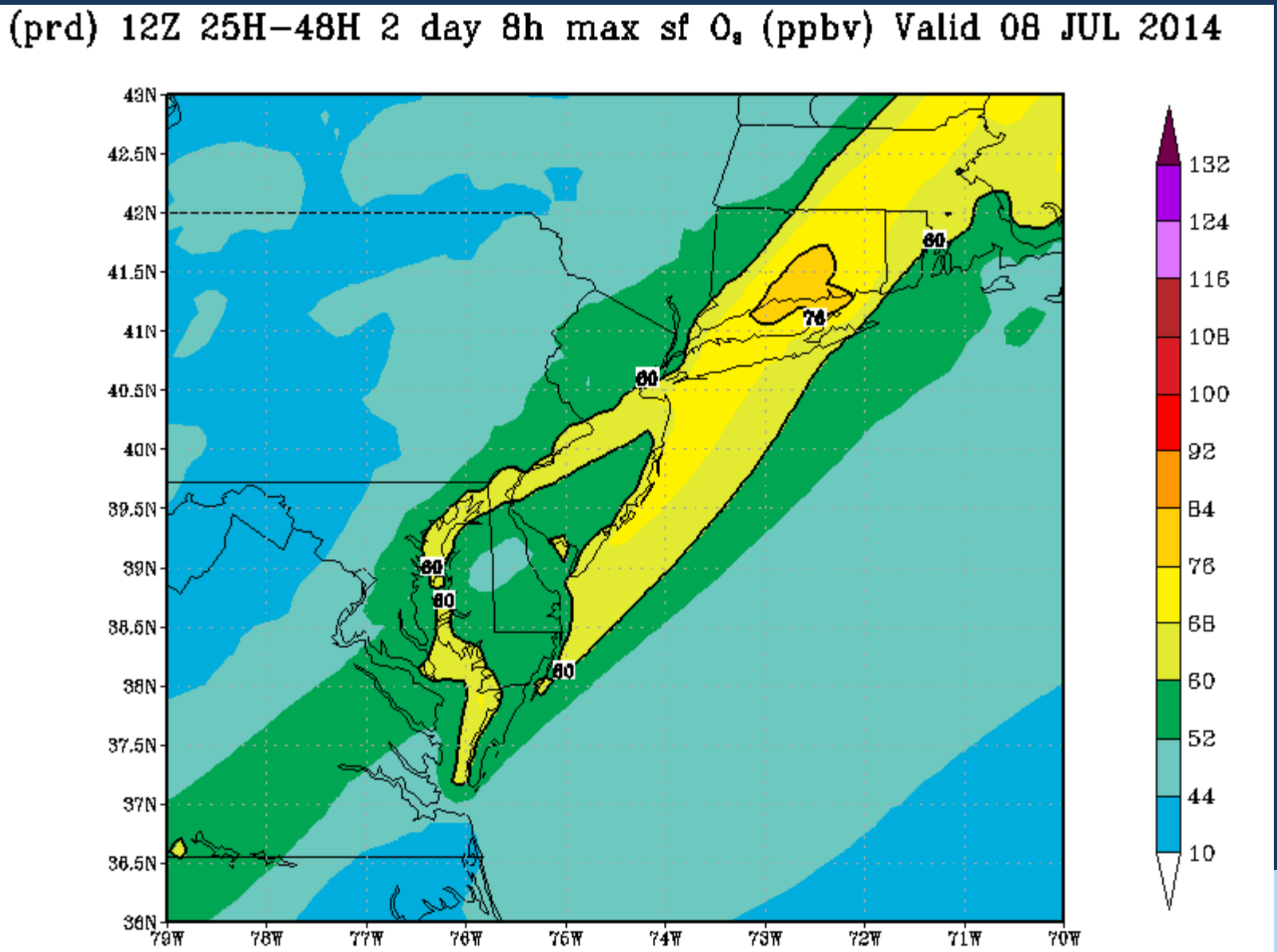
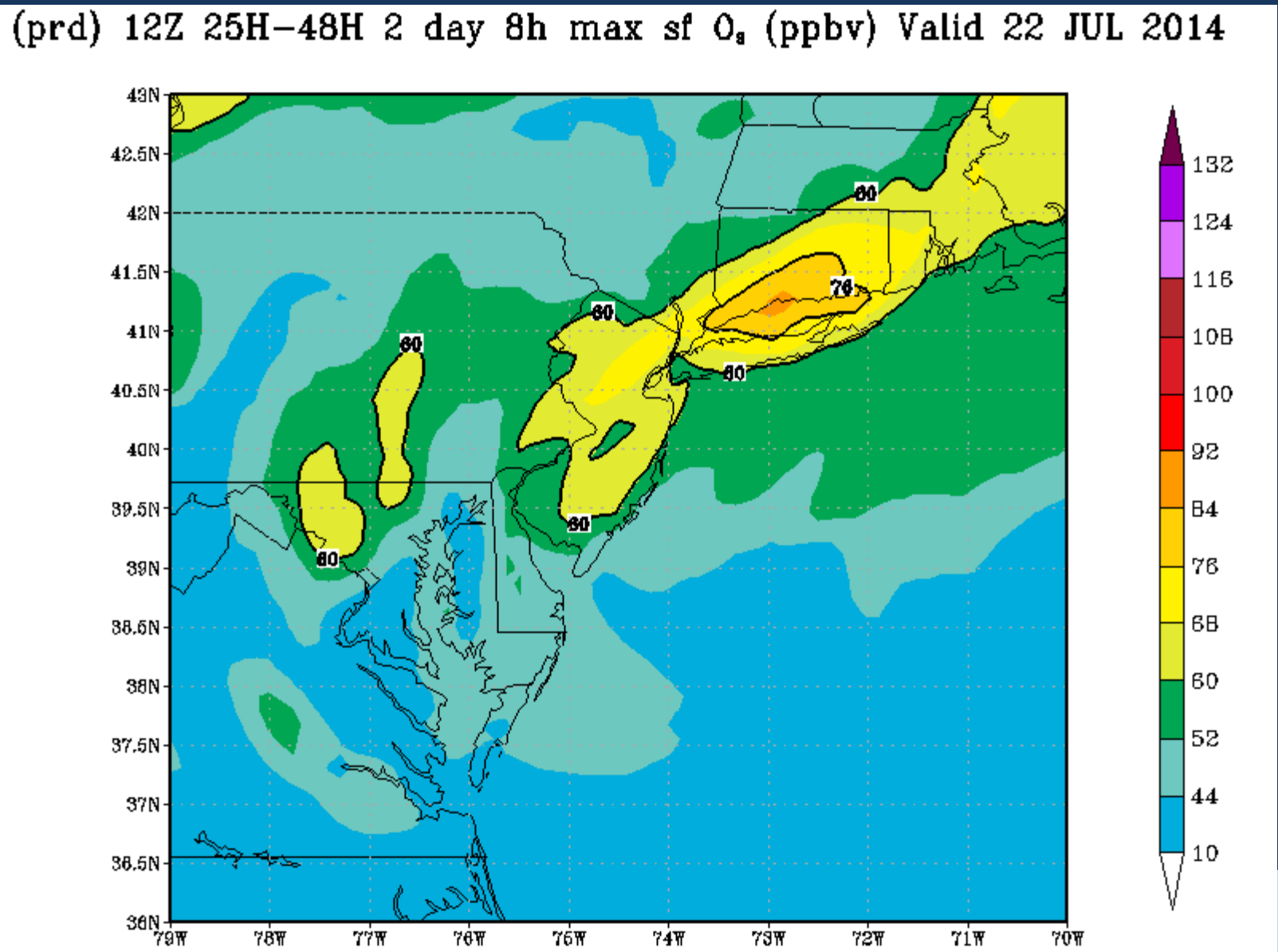
July 6th 12z Model Run



July 7th 12z Model Run

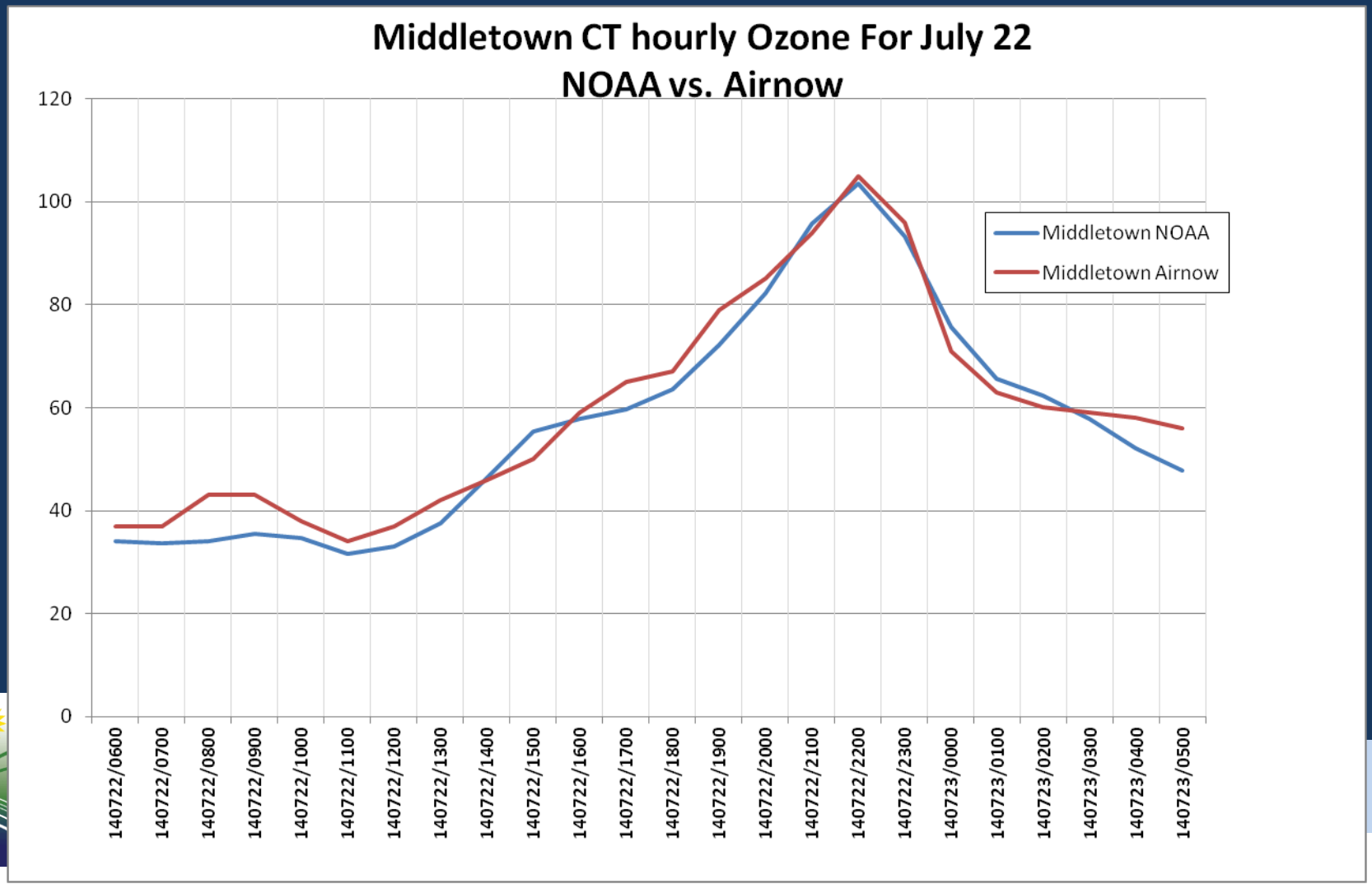


July 21st 12z Model Run



July 21st 12z EXP for Middletown

Although overall EXP plume was “hotter” , the Middletown forecast was correct!



Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
August 2014

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Abington	53	M	M	49	56	38	35	29	26	36	46	32	30	47	31	55	43	32	43	50	37	24	26	32	41	39	66				
Cornwall	55	51	43	50	50	35	32	32	32	43	55	37	39	60	27	57	53	34	44	58	47	29	25	30	31	43	51				
Danbury	63	48	48	56	62	36	34	29	30	33	61	39	38	51	30	56	46	32	54	70	58	31	31	32	28	53	82				
East Hartford	62	48	39	58	67	38	35	30	32	40	58	35	34	50	27	47	41	34	52	55	45	22	28	28	43	54	82				
Greenwich	56	56	49	66	69	50	39	37	41	37	59	39	40	55	35	67	50	38	52	58	54	37	31	39	42	63	81				
Groton	48	46	36	48	65	49	39	36	32	42	41	32	37	69	37	63	60	33	41	52	37	28	27	33	49	35	59				
Madison	56	52	46	56	62	51	39	41	47	45	53	38	39	75	38	65	68	32	47	56	41	34	30	37	63	43	68				
Middletown	60	49	36	61	65	45	39	35	36	44	57	38	38	55	32	61	50	37	53	55	42	26	31	33	44	48	80				
New Haven	55	46	45	53	57	39	35	34	37	43	57	38	38	57	30	60	51	30	47	46	44	29	28	34	39	49	75				
Stafford	61	48	40	56	63	37	35	29	27	34	55	34	35	48	28	49	41	33	44	52	36	24	27	30	26	48	74				
Stratford	61	60	52	66	66	48	39	34	46	45	66	44	44	69	38	71	61	43	54	60	50	36	33	37	51	64	73				
Westport	62	54	49	67	62	46	40	33	43	42	61	40	38	58	35	69	52	35	52	57	49	35	31	38	51	66	88				
# days > Federal Standard																											7				

Good (0-59 ppb)
Moderate (60-75 ppb)
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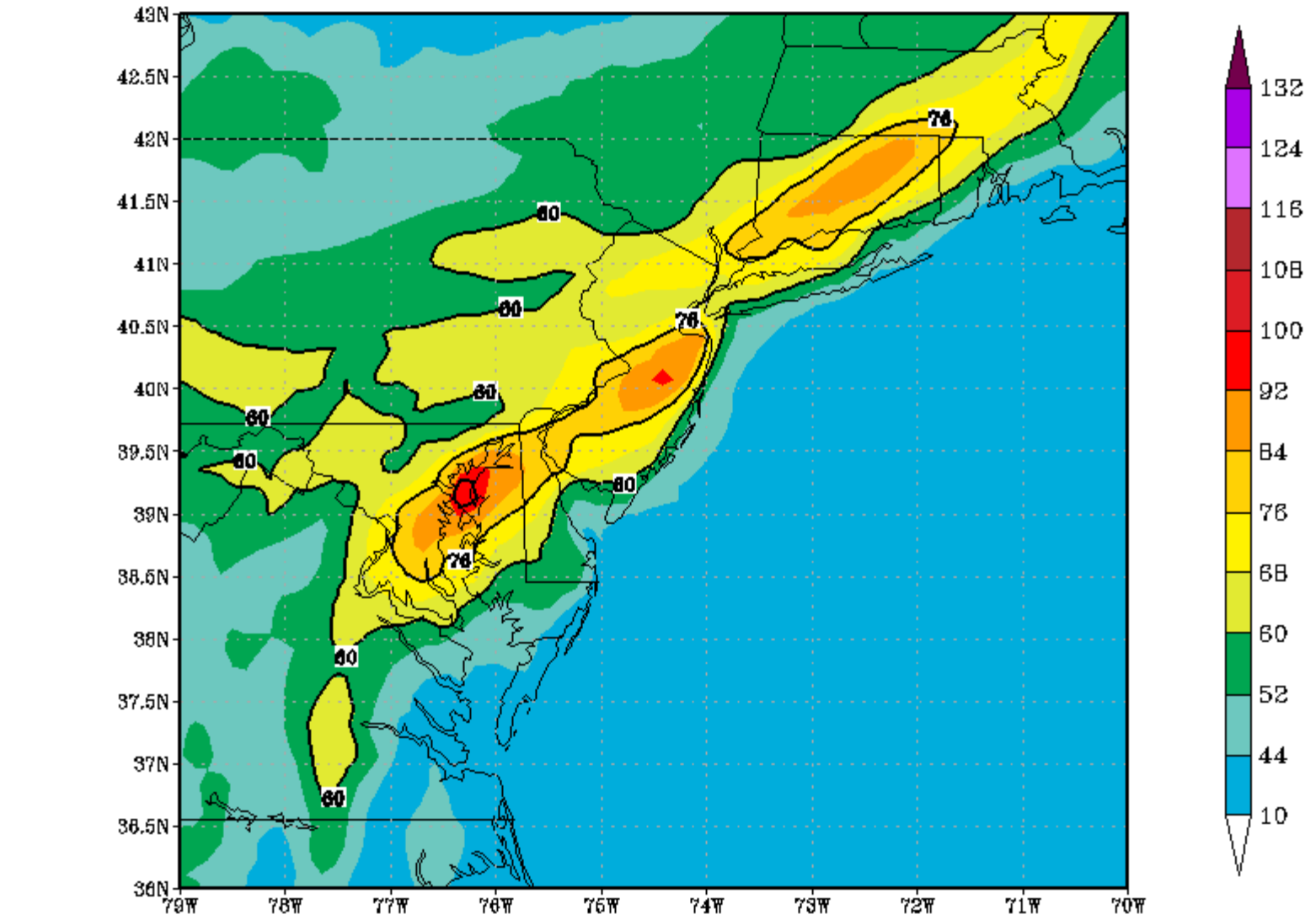
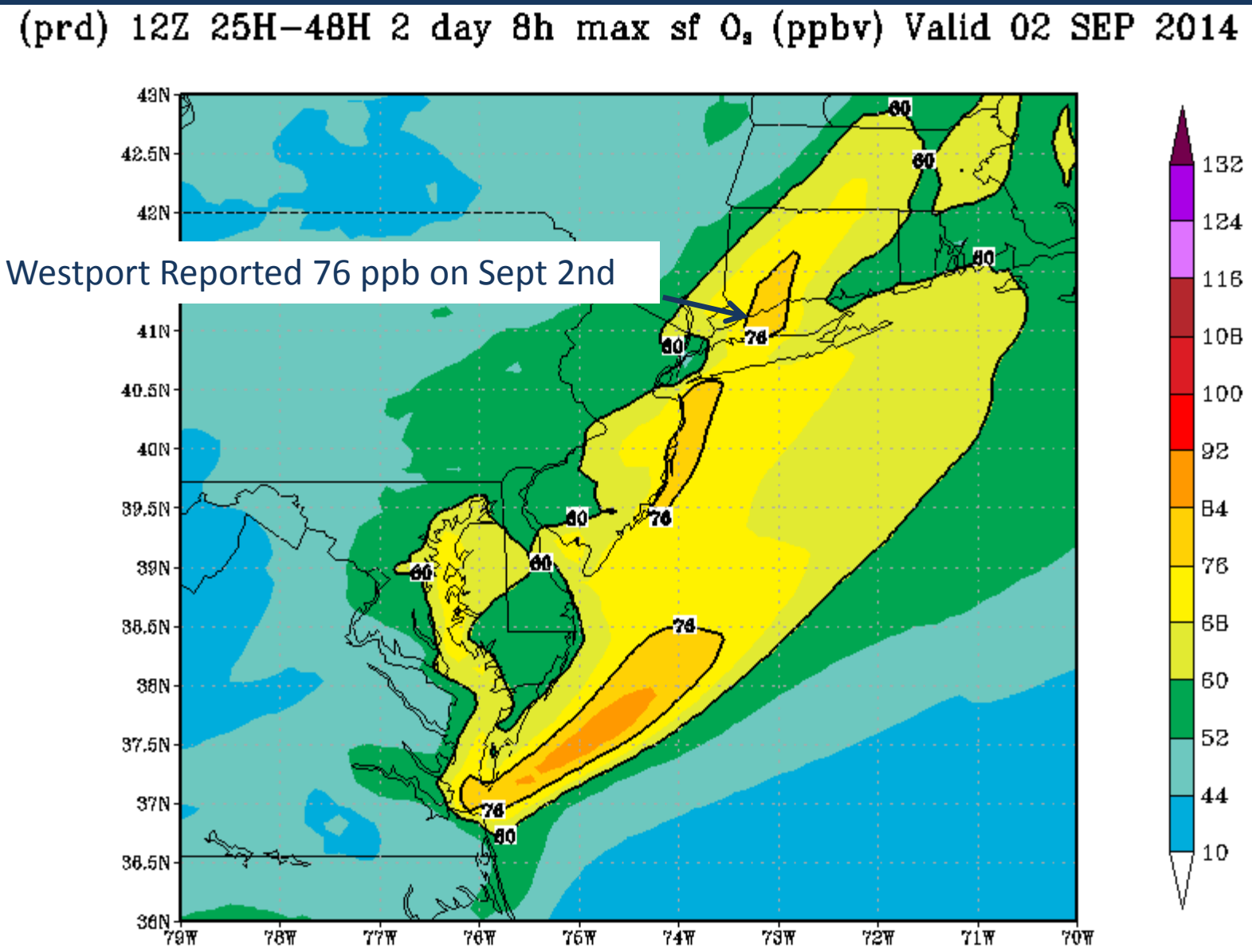
August 26th 12z Model Run



September 1st 12z Model Run

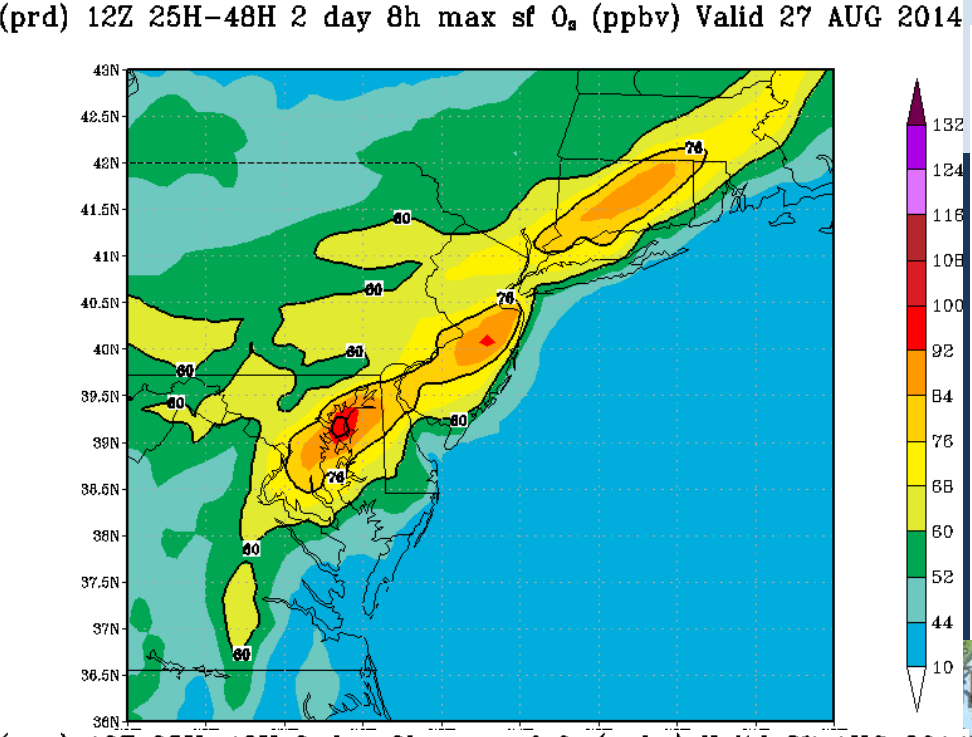


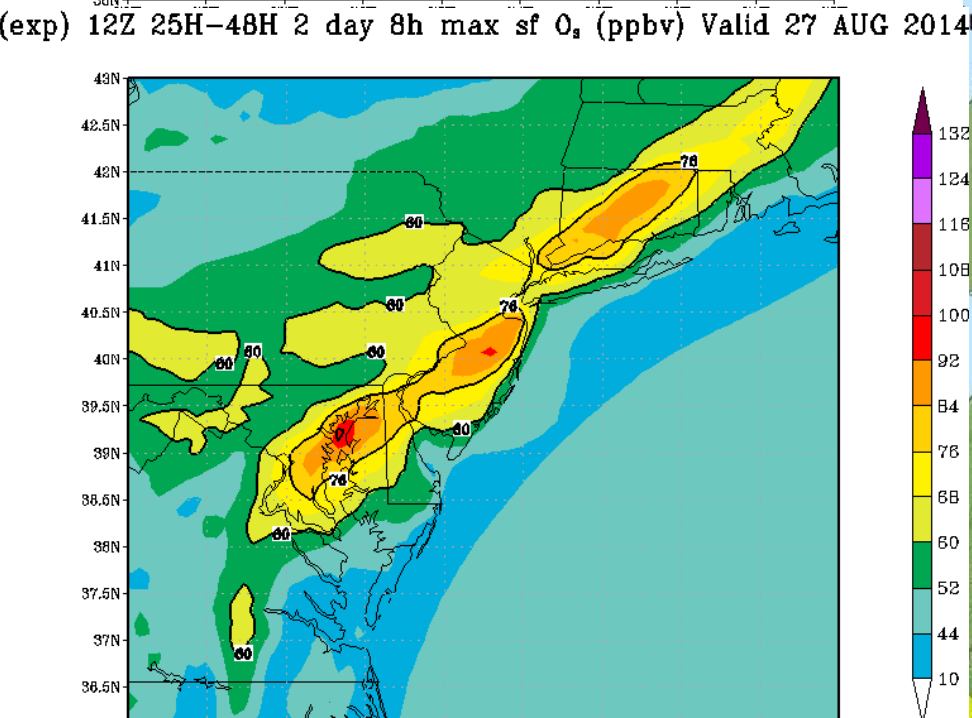
NOAA Model Performance

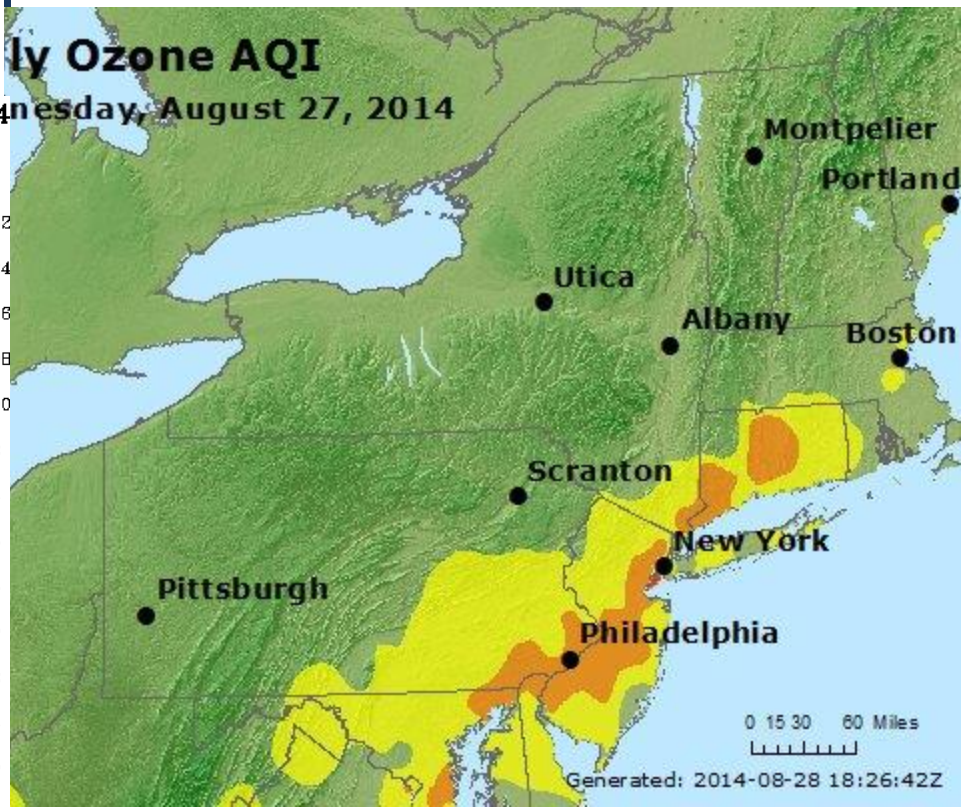
- Note that the PROD 12z day before model run correctly predicted all seven exceedance days for Connecticut.
- Conducted further model analysis for the last 2 exceedance days: August 27th and September 2nd
- Had access to hourly PROD and EXP data (8/27)

August 27th Ozone Event

Both the PROD and EXP accurately predicted the plume, 12z the day before.



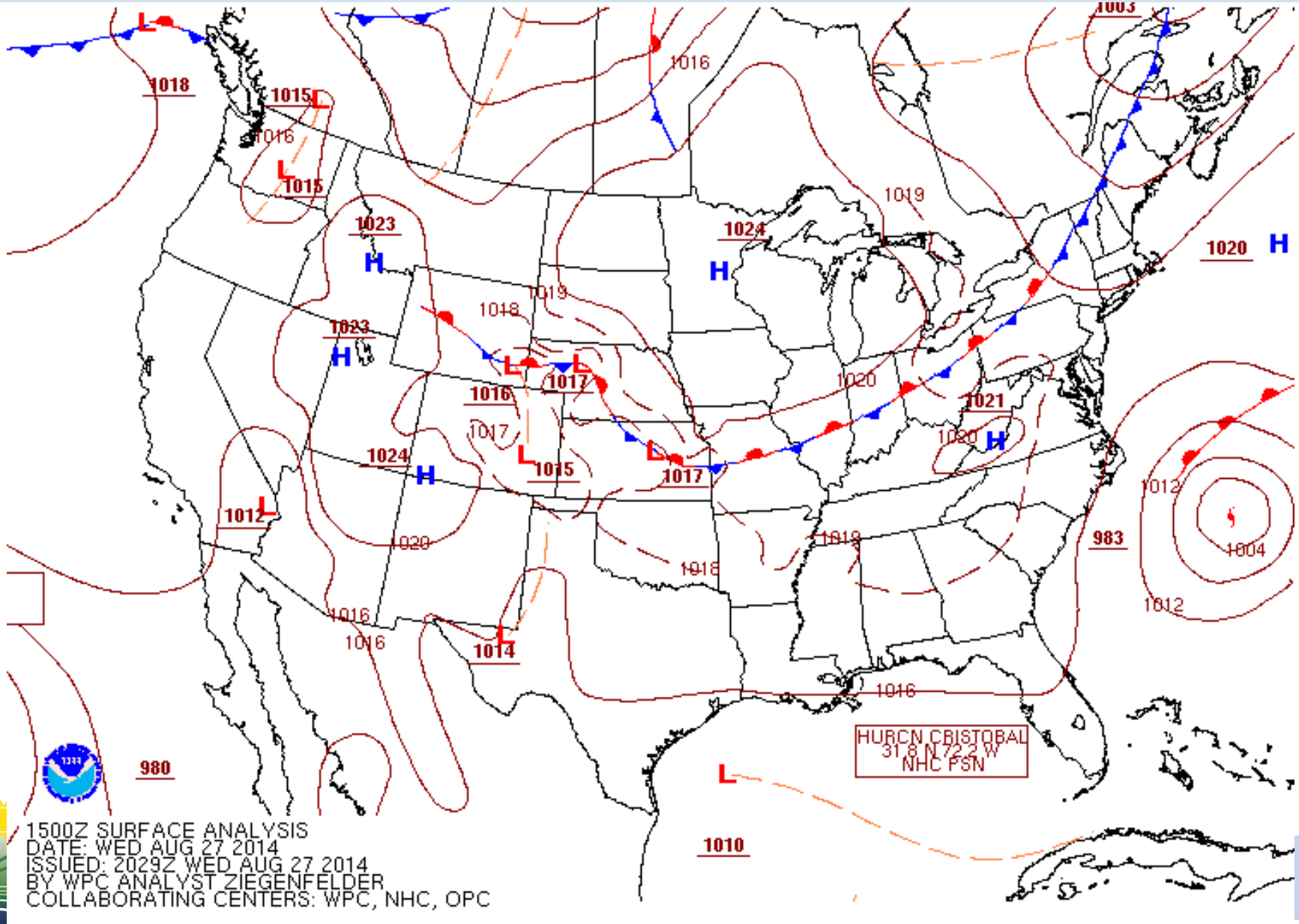




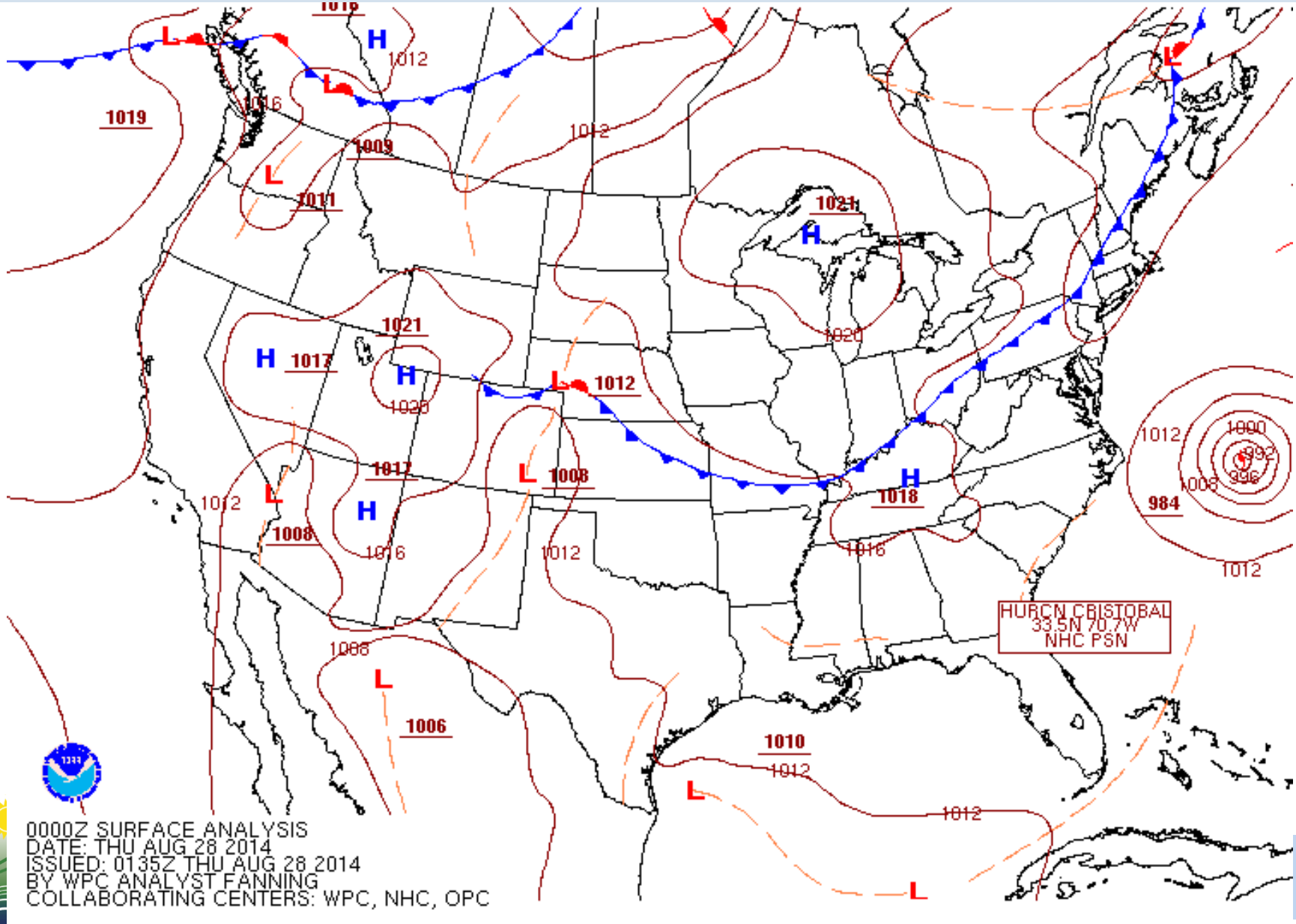
August 27th, 2014 Ozone Event

Site/Site AQS	Date	Max 8-hour Ozone ppb	8/26/2014 EXP 12z ppb	8/26/2014 PROD 12z ppb
Cornwall/090050005	9/2/2014	51	59	60
Danbury/090011123	9/2/2014	82	75	78
East Hartford/090031003	9/2/2014	82	87	85
Greenwich/090010017	9/2/2014	81	--	--
Groton Fort Gri/090110124	9/2/2014	59	58	58
Madison-Beach /090099002	9/2/2014	68	69	68
Middletown/090070007	9/2/2014	80	86	86
New Haven - Cri/090090027	9/2/2014	75	85	82
Stafford/090131001	9/2/2014	74	81	81
Stratford/090013007	9/2/2014	73	79	78
Westport/090019003	9/2/2014	88	80	76

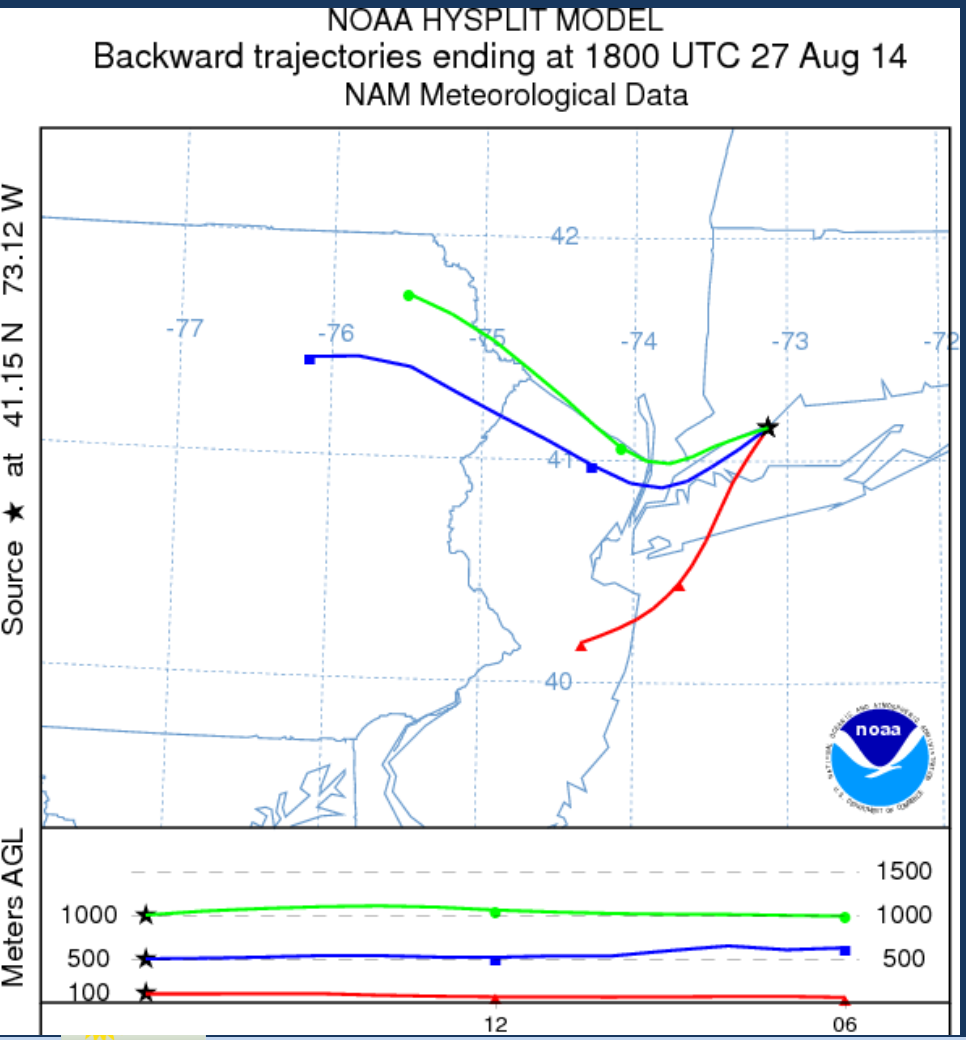
August 27th, 2014 (15z)

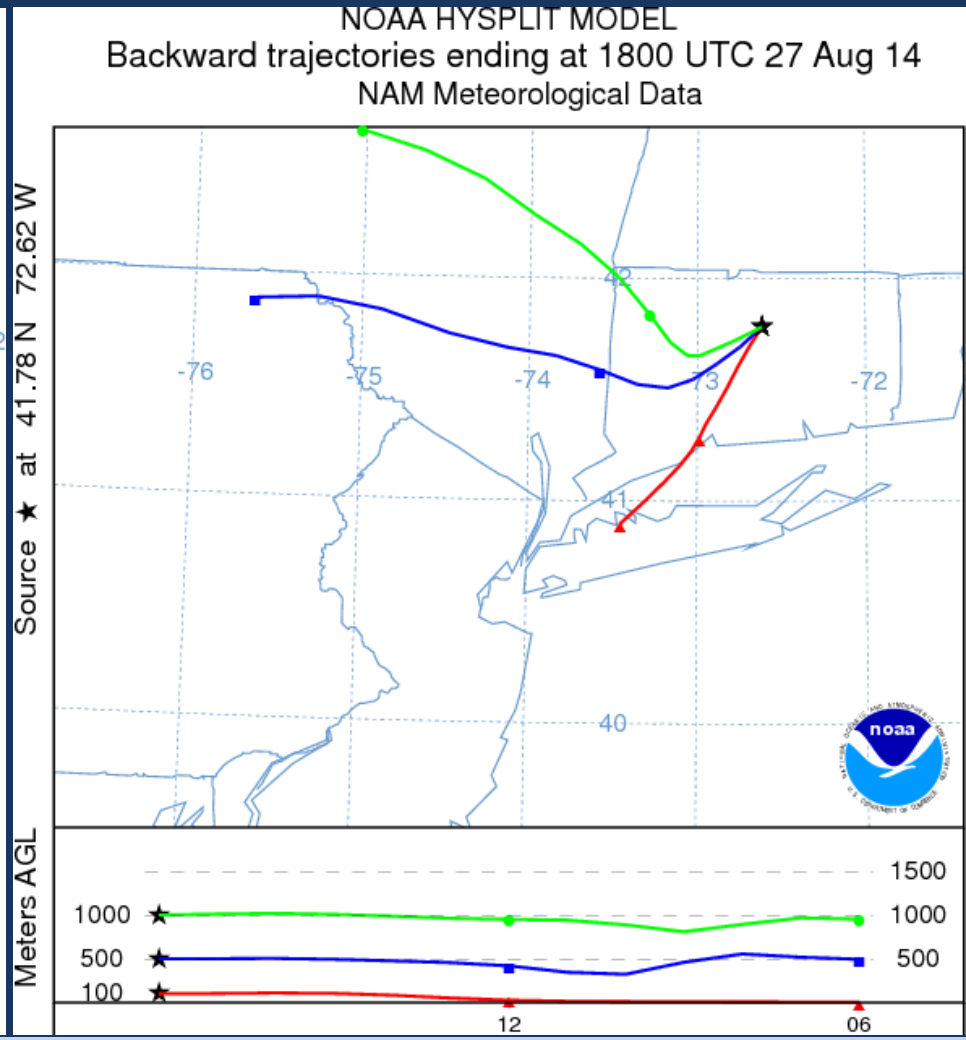


August 28th, 2014 (00z)

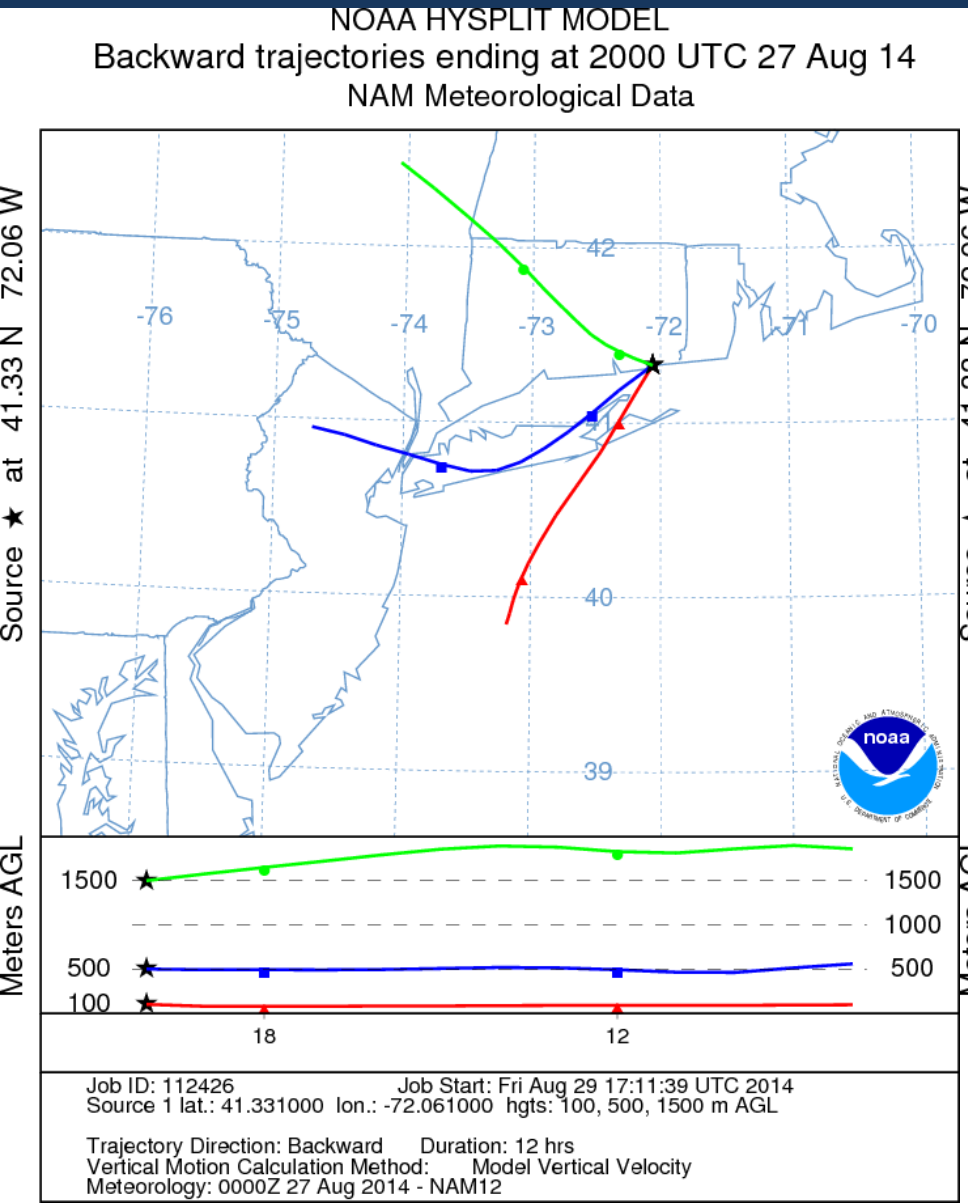


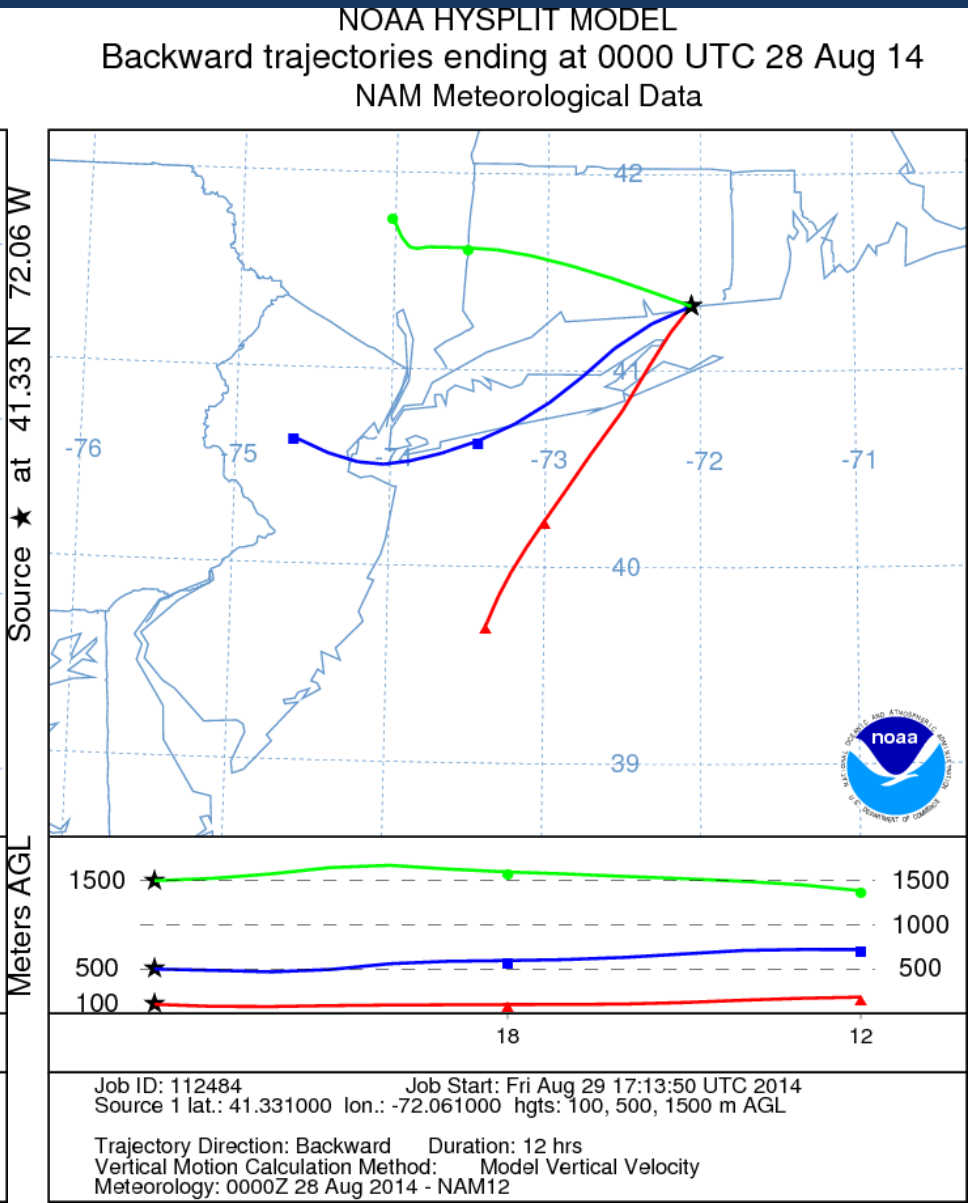
Low level trajectories- NYC Plume

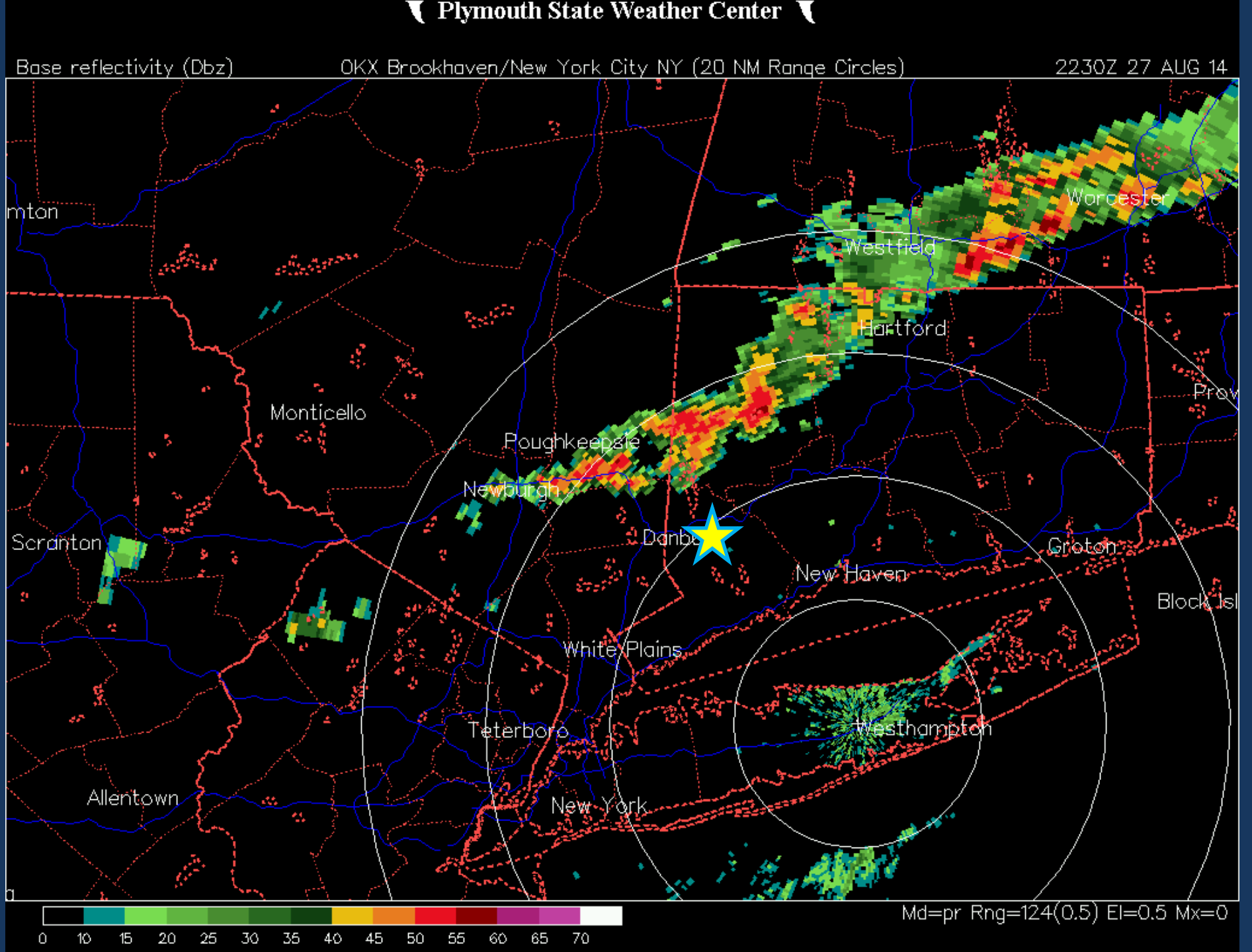


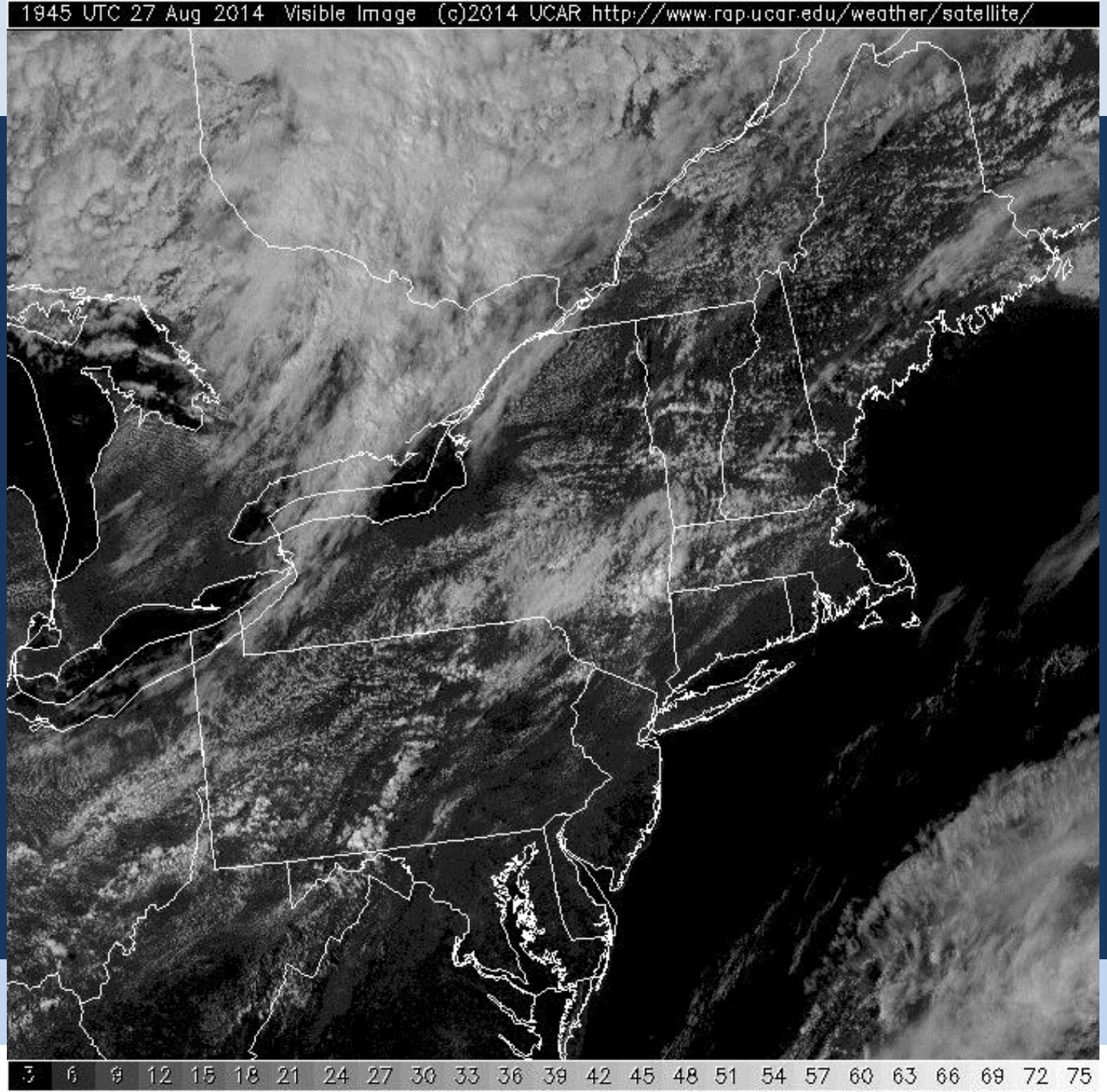


Groton Trajectories more Maritime

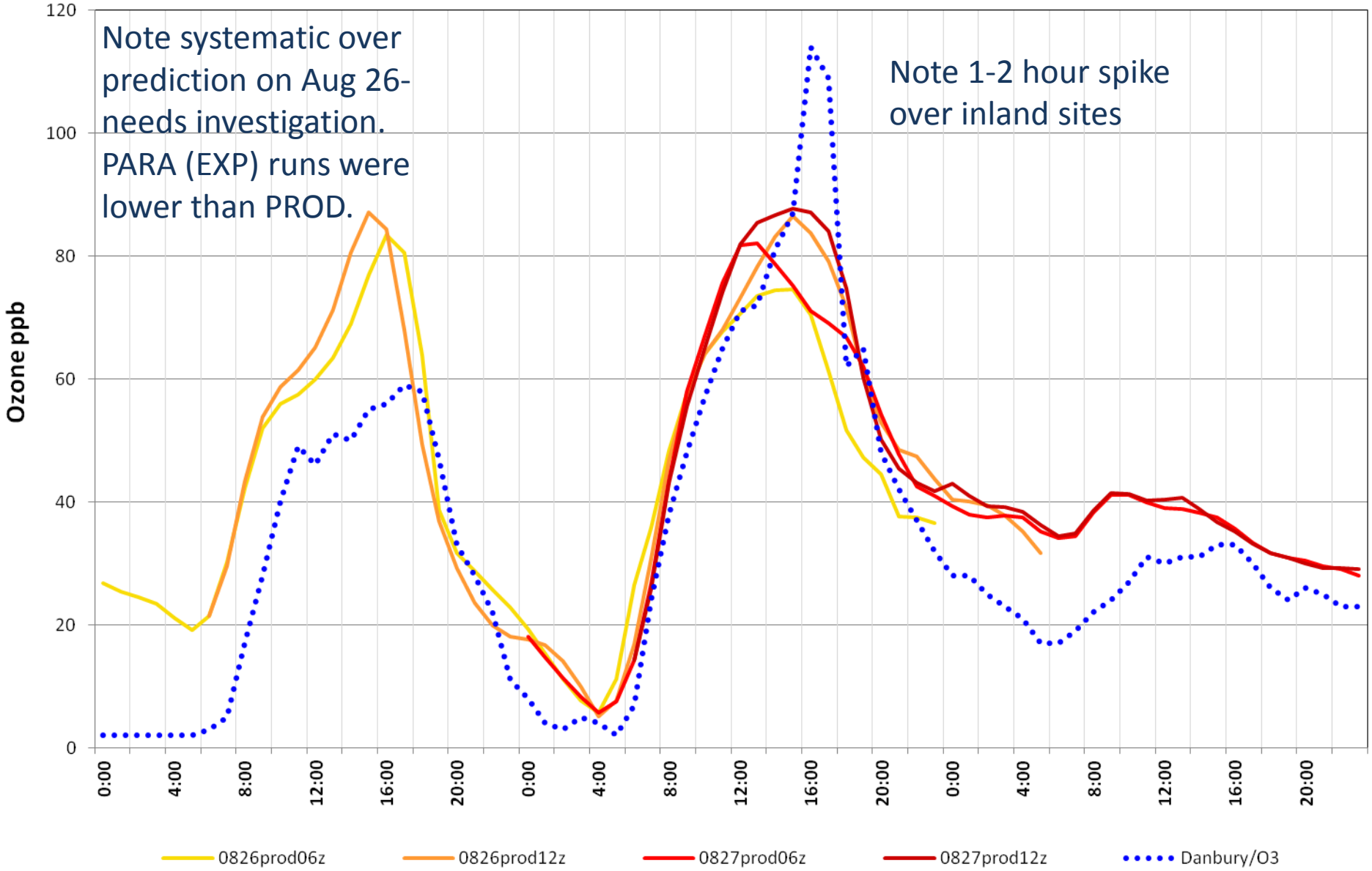


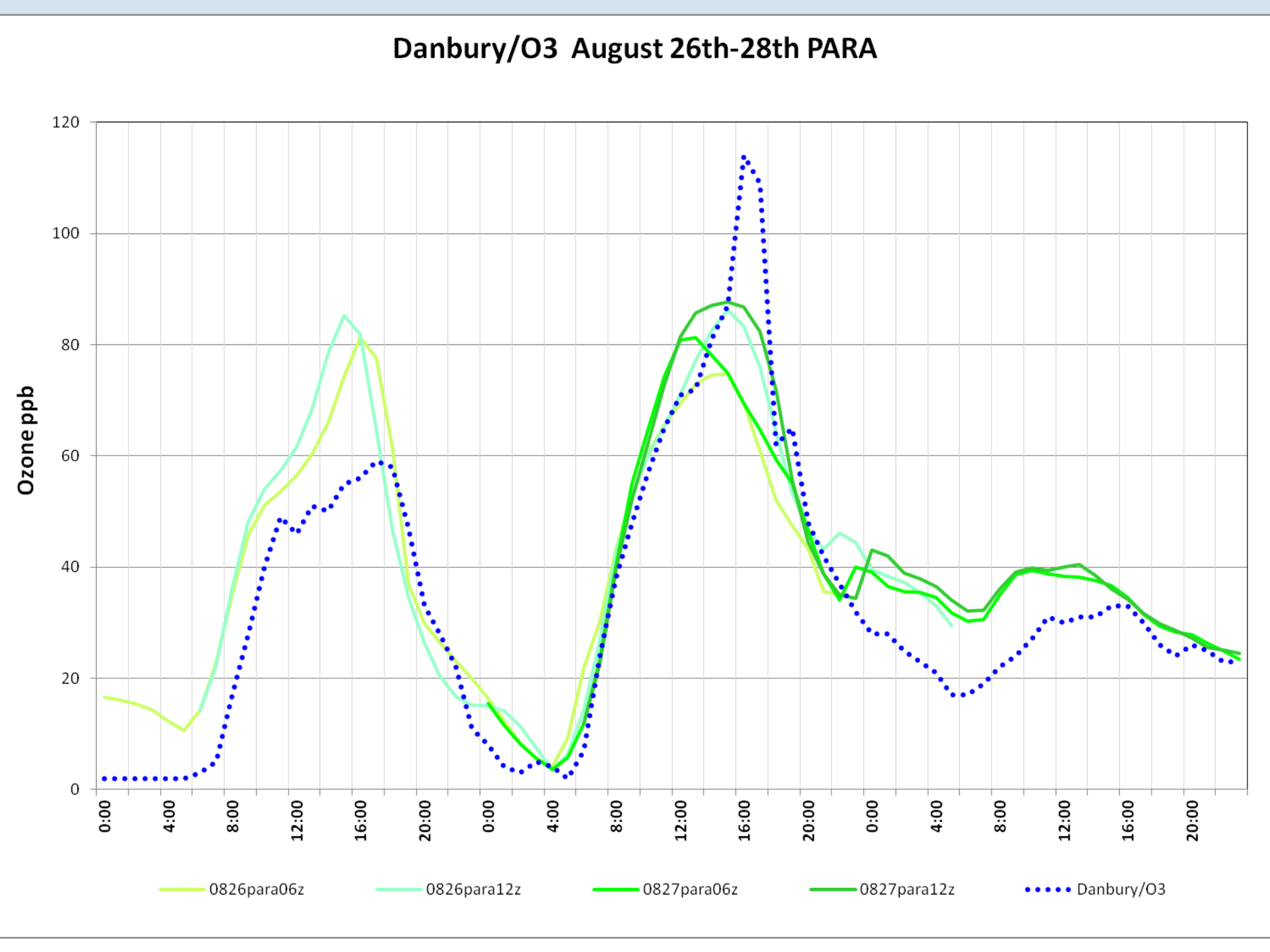


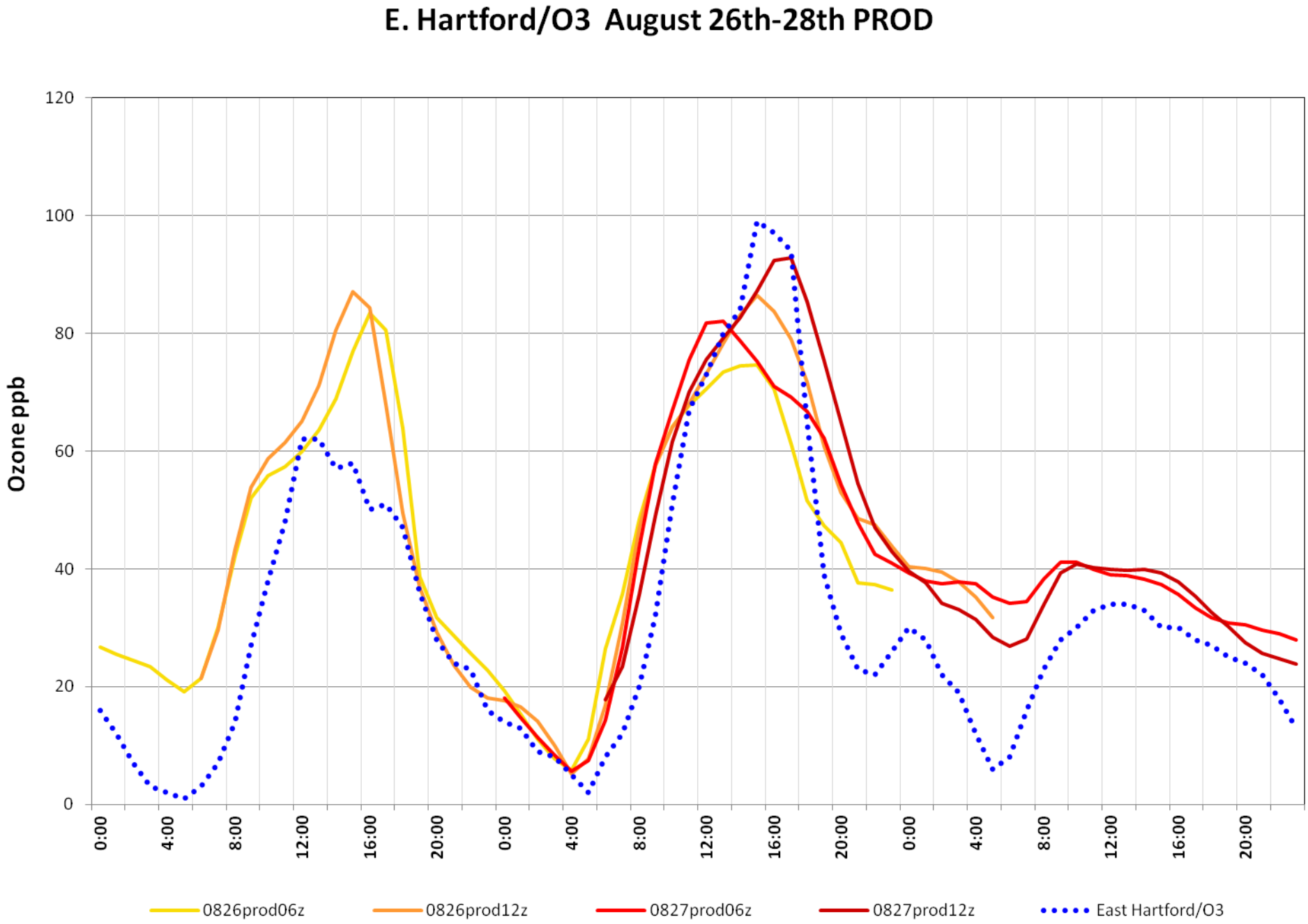

Plymouth State Weather Center
Base reflectivity (Dbz)
OKX Brookhaven/New York City NY (20 NM Range Circles)
2230Z 27 AUG 14
mton
Worcester
Westfield
Hartford
Prov
Monticello
Poughkeepsie
Newburgh
Scranton
Danbu
Groton
New Haven
Block Isl
White Plains
Teterboro
Westhampton
Allentown
New York
0 10 15 20 25 30 35 40 45 50 55 60 65 70
Md=pr Rng=124(0.5) El=0.5 Mx=0

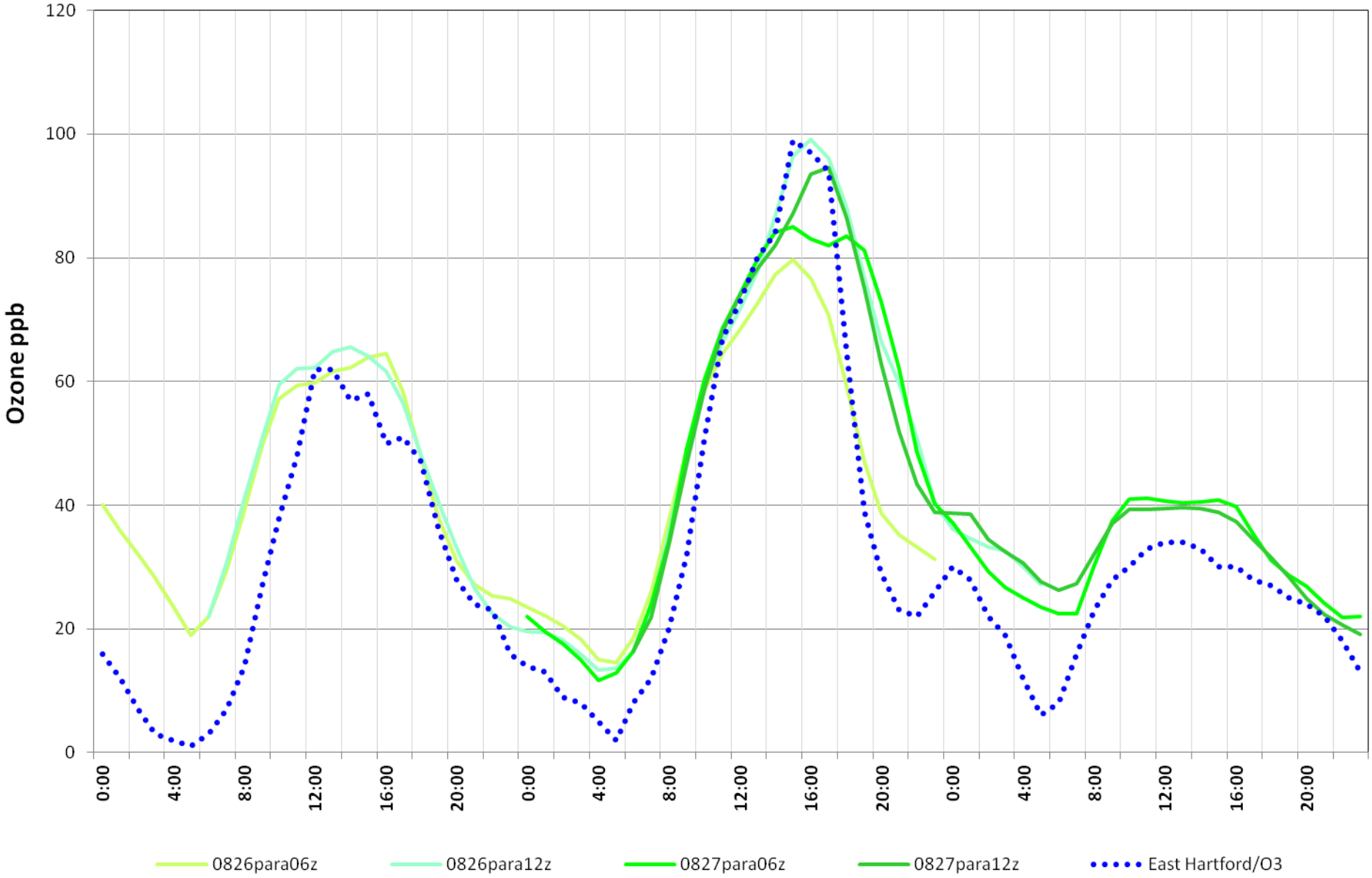

1945 UTC 27 Aug 2014 Visible Image (c)2014 UCAR http://www.rap.ucar.edu/weather/satellite/
3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75

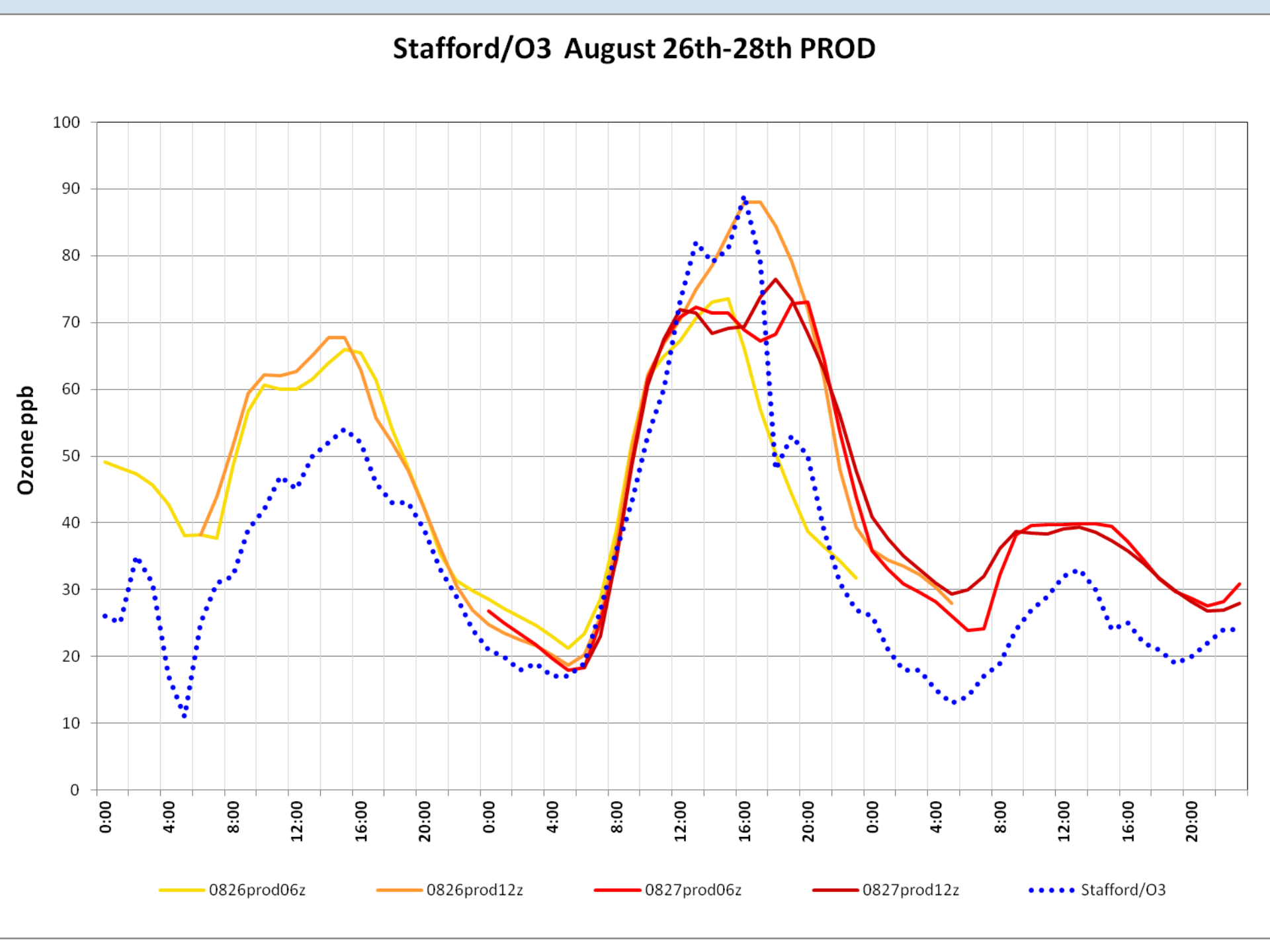
Danbury/O3 August 26th-28th PROD

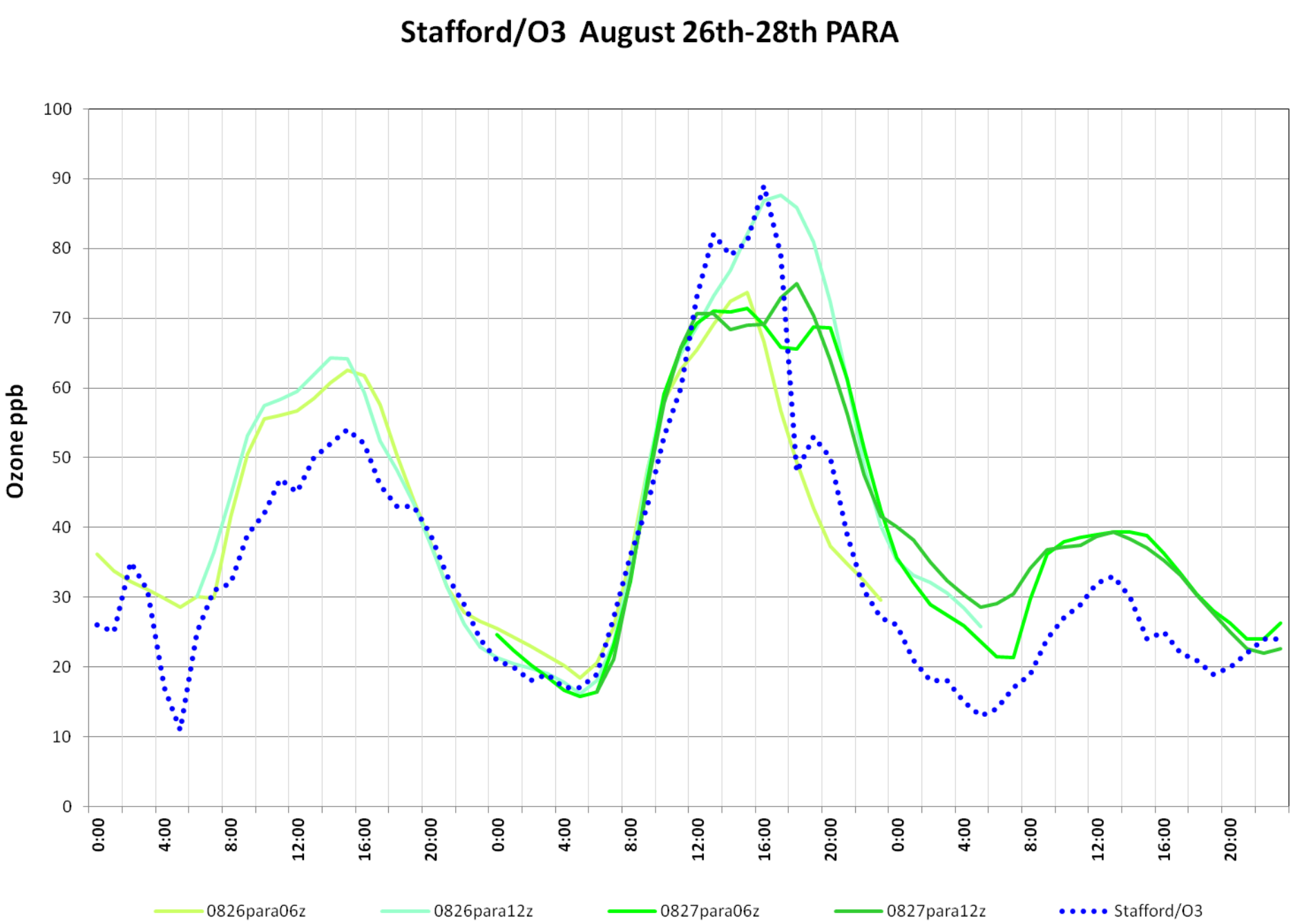


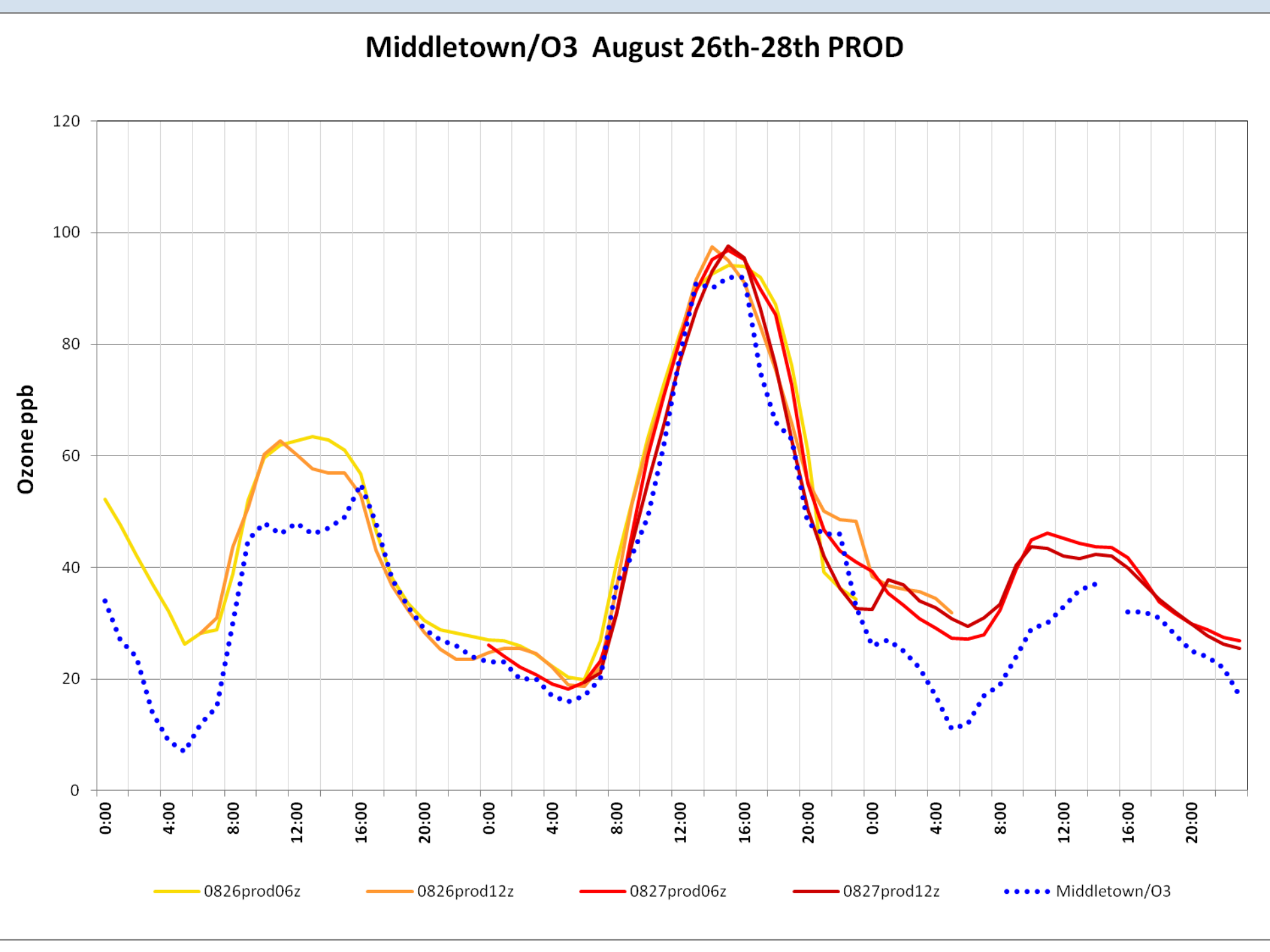

Danbury/O3 August 26th-28th PARA
Ozone ppb
120
100
80
60
40
20
0
0:00
4:00
8:00
12:00
16:00
20:00
0826para06z
0826para12z
0827para06z
0827para12z
Danbury/O3


E. Hartford/O3 August 26th-28th PROD
Ozone ppb
120
100
80
60
40
20
0
0:00
4:00
8:00
12:00
16:00
20:00
0826prod06z
0826prod12z
0827prod06z
0827prod12z
East Hartford/O3

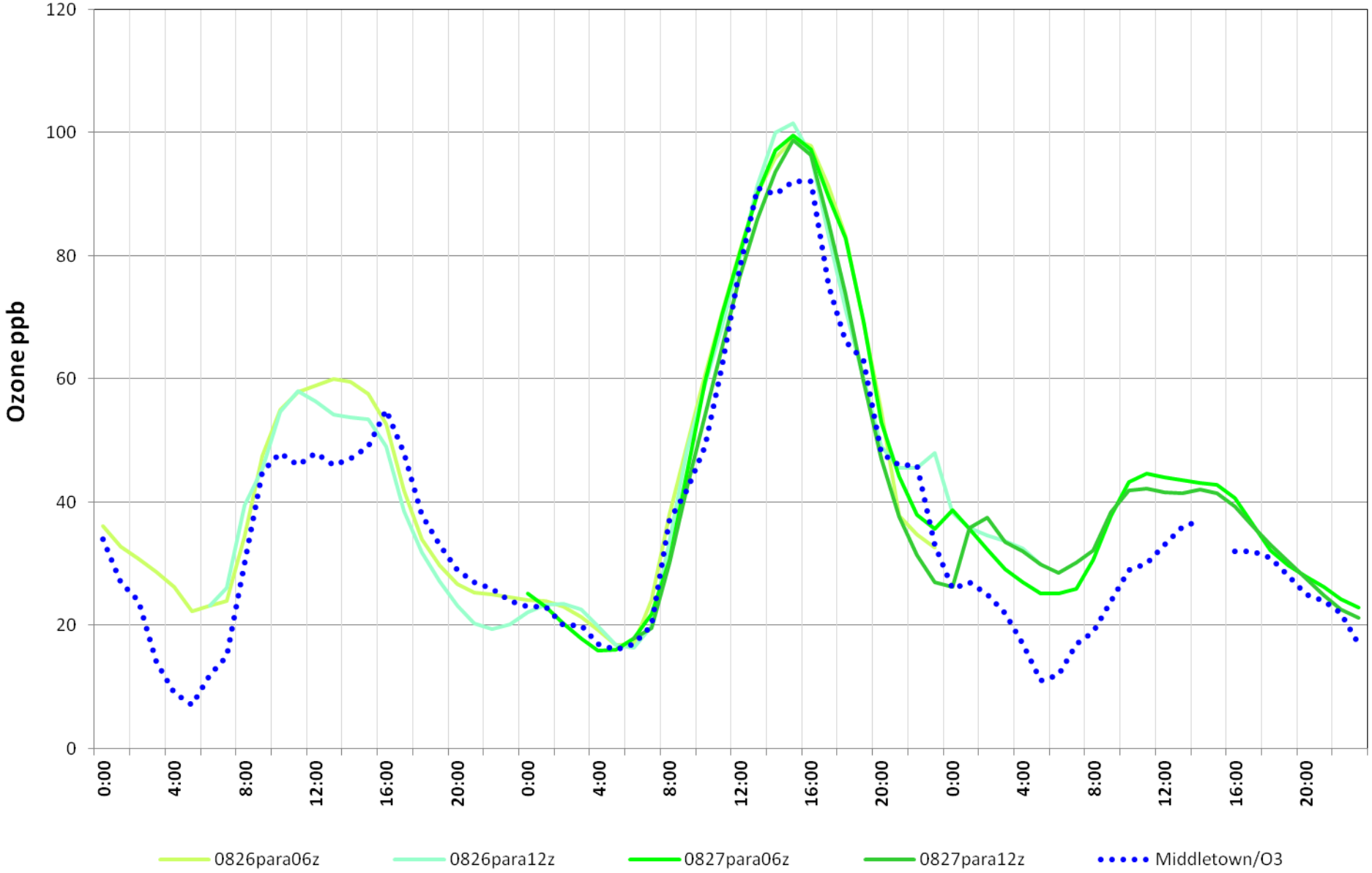

E. Hartford/O3 August 26th-28th PARA
Ozone ppb
120
100
80
60
40
20
0
0:00
4:00
8:00
12:00
16:00
20:00
0826para06z
0826para12z
0827para06z
0827para12z
East Hartford/O3

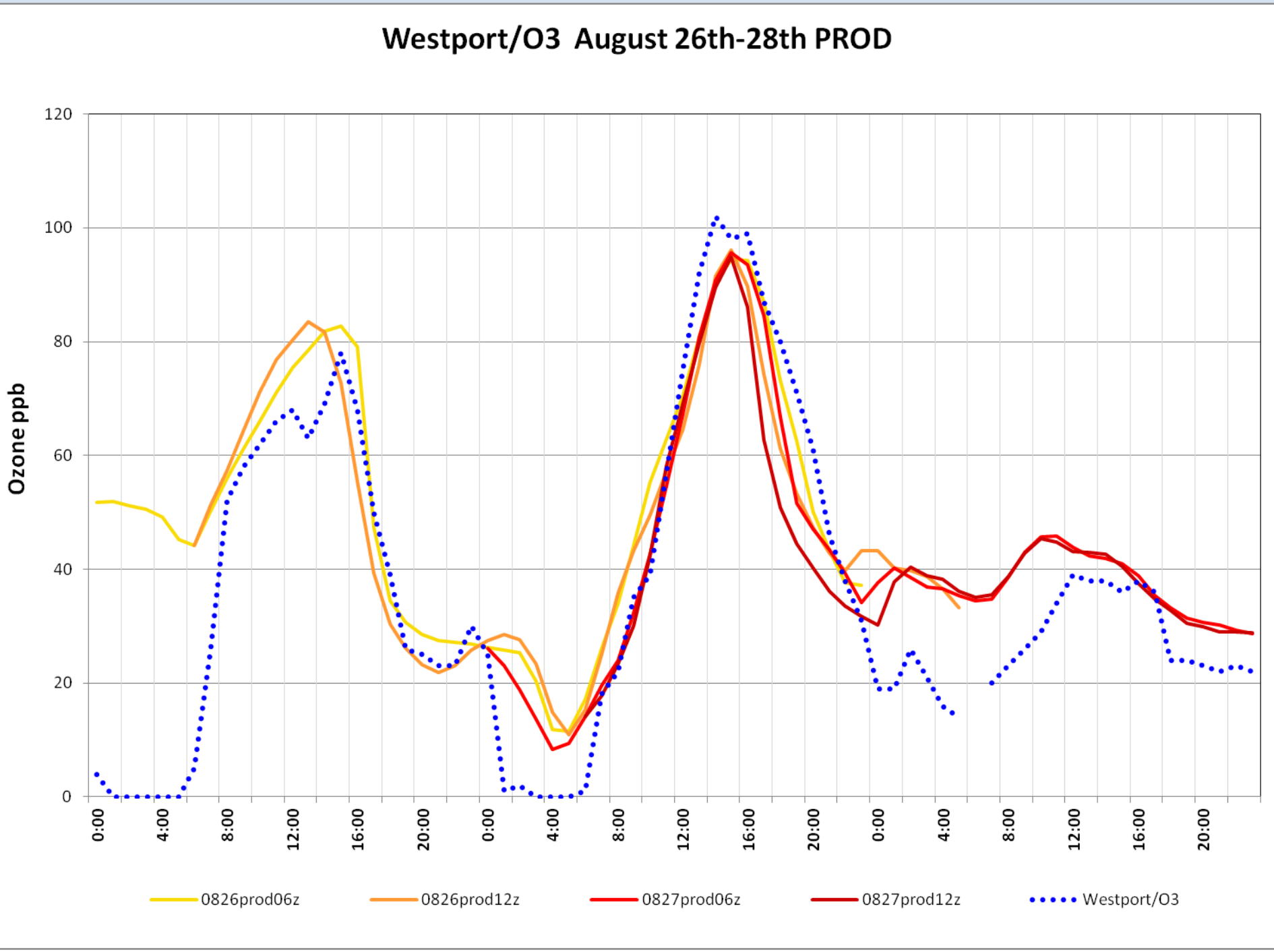

Stafford/O3 August 26th-28th PROD
Ozone ppb
100
90
80
70
60
50
40
30
20
10
0
0:00
4:00
8:00
12:00
16:00
20:00
0826prod06z
0826prod12z
0827prod06z
0827prod12z
Stafford/O3


Stafford/O3 August 26th-28th PARA
Ozone ppb
100
90
80
70
60
50
40
30
20
10
0
0:00
4:00
8:00
12:00
16:00
20:00
0826para06z
0826para12z
0827para06z
0827para12z
Stafford/O3


Middletown/O3 August 26th-28th PROD
Ozone ppb
120
100
80
60
40
20
0
0:00
4:00
8:00
12:00
16:00
20:00
0826prod06z
0826prod12z
0827prod06z
0827prod12z
Middletown/O3

Middletown/O3 August 26th-28th PARA




Westport/O3 August 26th-28th PROD
Ozone ppb
120
100
80
60
40
20
0
0:00
4:00
8:00
12:00
16:00
20:00
0:00
4:00
8:00
12:00
16:00
20:00
0:00
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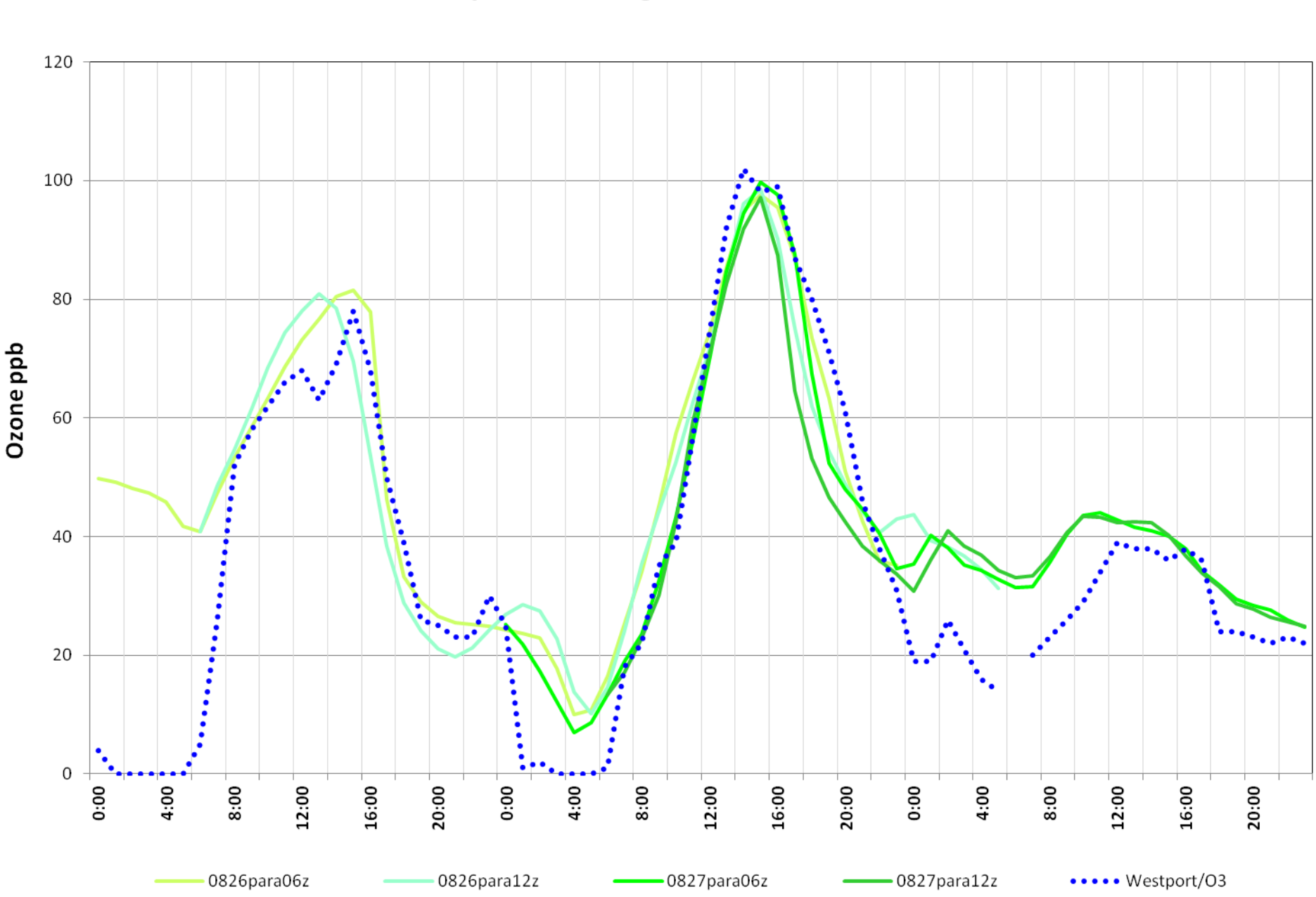
0826prod12z
0827prod06z
0827prod12z
Westport/O3


Westport/O3 August 26th-28th PARA
Ozone ppb
120
100
80
60
40
20
0
0:00
4:00
8:00
12:00
16:00
20:00
0826para06z
0826para12z
0827para06z
0827para12z
Westport/O3

August 27th Ozone Event for Connecticut Model comparison

Focus group members were asked to evaluate the current experimental CB05, Aero-IV ozone model that is scheduled to become operational in October 2014, depending on results for the rest of the summer and user feedback.

Changes to the CB05 (EXP) model this year have markedly improved the ozone predictions in Connecticut.

V4.6.3 CB05/AERO-4 CMAQ EMC para run (June 13th):
Previously NTR, organic nitrate, biased high, which influenced ozone production. It is now photolyzed and removed quicker (Dickerson et al., 2014) by shortening NTR lifetime by a factor of 10.

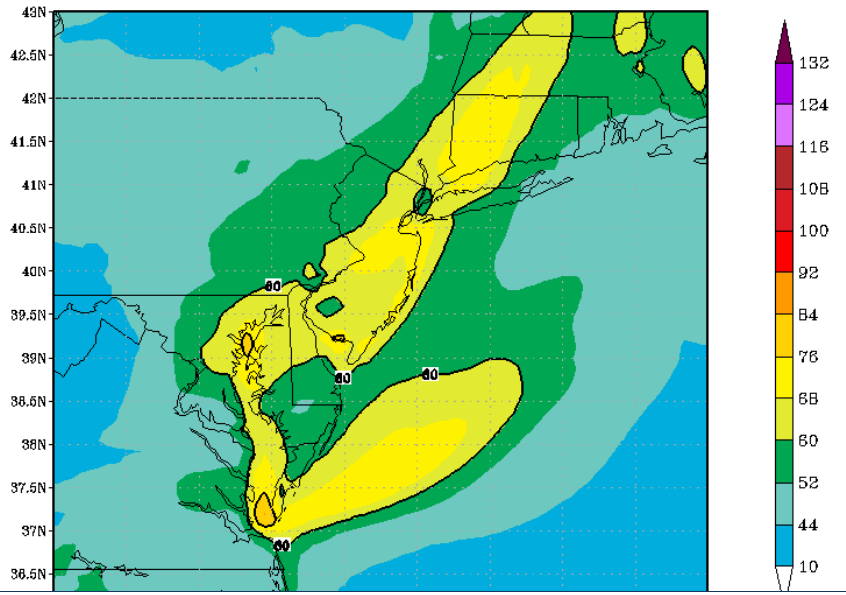
NAM Upgraded (August 12th) amongst other things:
•Added a new version of the Betts-Miller-Janjic (BMJ) convective parameterization scheme, with moister convective profiles and less convective triggering, which improves the QPF bias on the 12-km NAM parent domain during the warm season;
•Reduced the roughness length for 5 vegetation types, with the target of improving the 10-m wind bias in the eastern CONUS:

September 2, 2014 Ozone Event

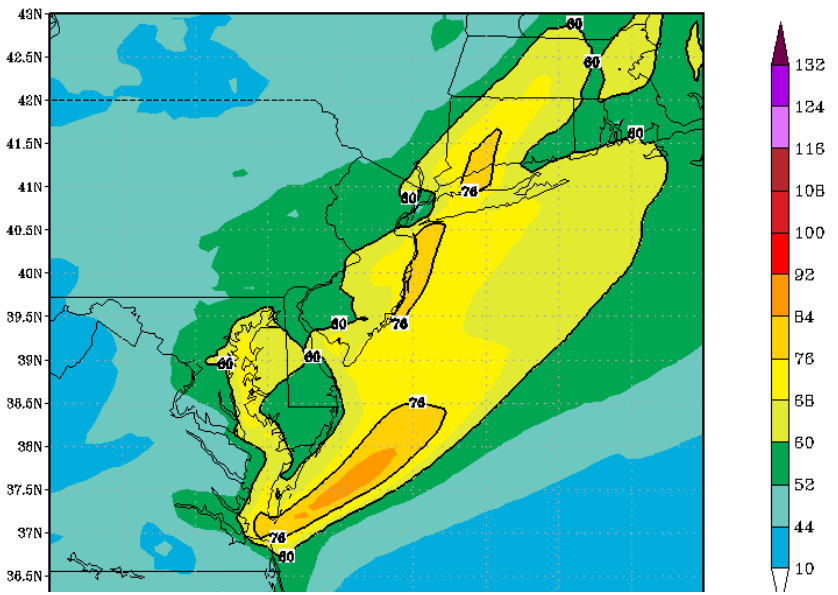
Site/Site AQS/Param/POC	Date (LST)	Max 8-hour Ozone ppb	9/2/2014 PROD 12z ppb
Cornwall/090050005/O3/1	9/2/2014	49	60
Danbury/090011123/O3/1	9/2/2014	59	62
East Hartford/090031003/O3/1	9/2/2014	73	68
Greenwich/090010017/O3/1	9/2/2014	69	--
Groton Fort Gri/090110124/O3/1	9/2/2014	53	60
Madison-Beach R/090099002/O3/1	9/2/2014	59	67
Middletown/090070007/O3/1	9/2/2014	70	74
New Haven - Cri/090090027/O3/1	9/2/2014	65	78
Stafford/090131001/O3/1	9/2/2014	62	67
Stratford/090013007/O3/1	9/2/2014	73	78
Westport/090019003/O3/1	9/2/2014	76	75

September 2, 2014 event PROD model

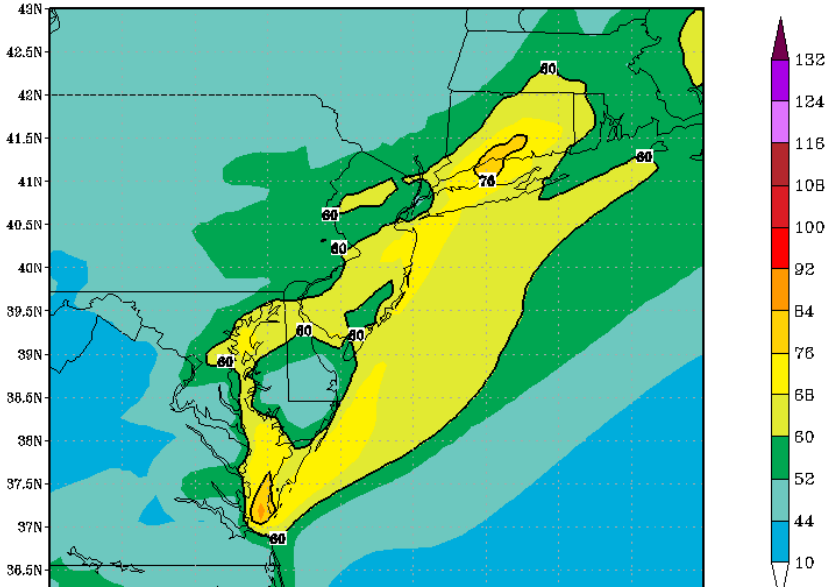
(prd) 06Z 31H-48H 2 day 8h max sf O_3 (ppbv) Valid 02 SEP 2014



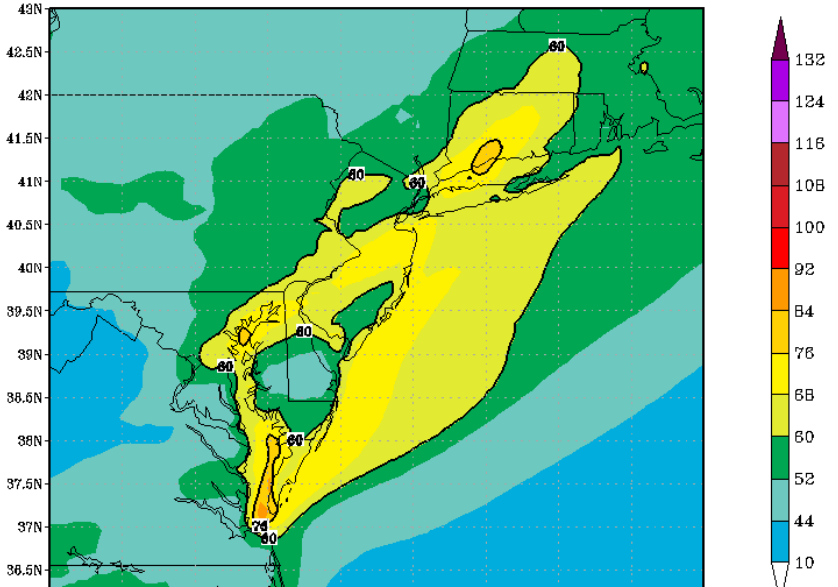
(prd) 12Z 25H-48H 2 day 8h max sf O_3 (ppbv) Valid 02 SEP 2014



(prd) 06Z 7H-30H 1st d 8h max sf O_3 (ppbv) Valid 02 SEP 2014



(prd) 12Z 1H-24H 1st d 8h max sf O_3 (ppbv) Valid 02 SEP 2014



September 2, 2014 event EXP model

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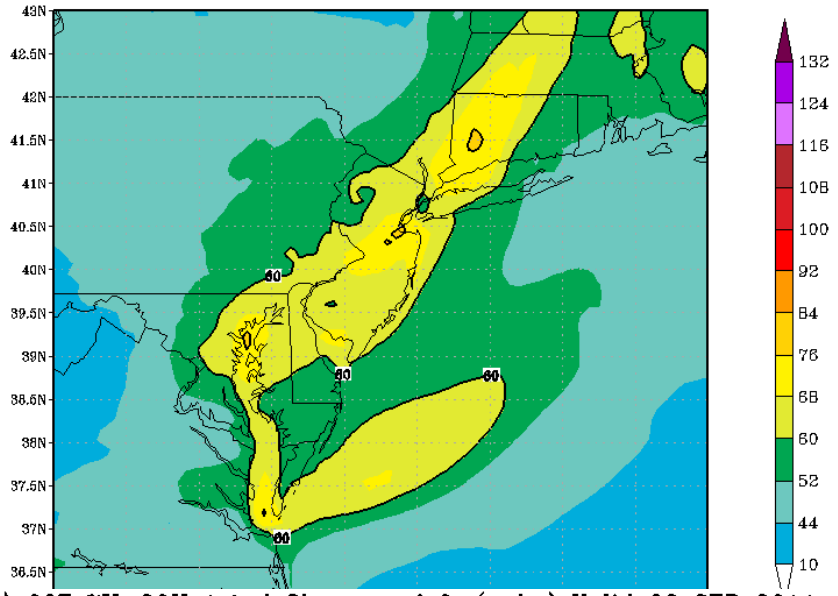
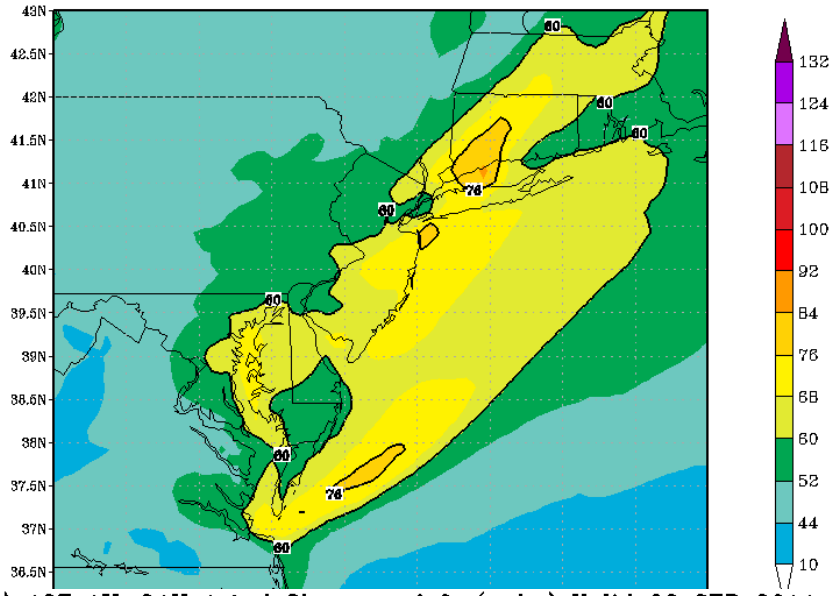


(exp) 12Z 25H-48H 2 day 8h max sf O_3 (ppbv) Valid 02 SEP 2014



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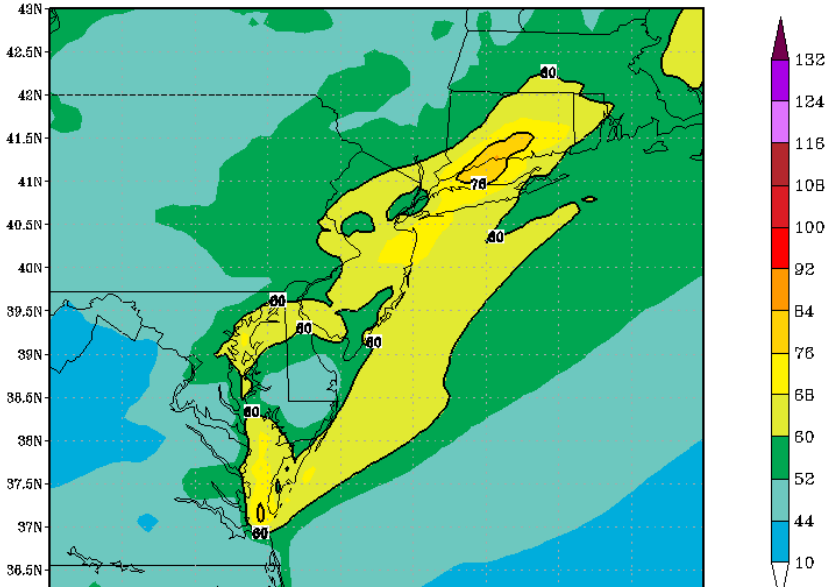
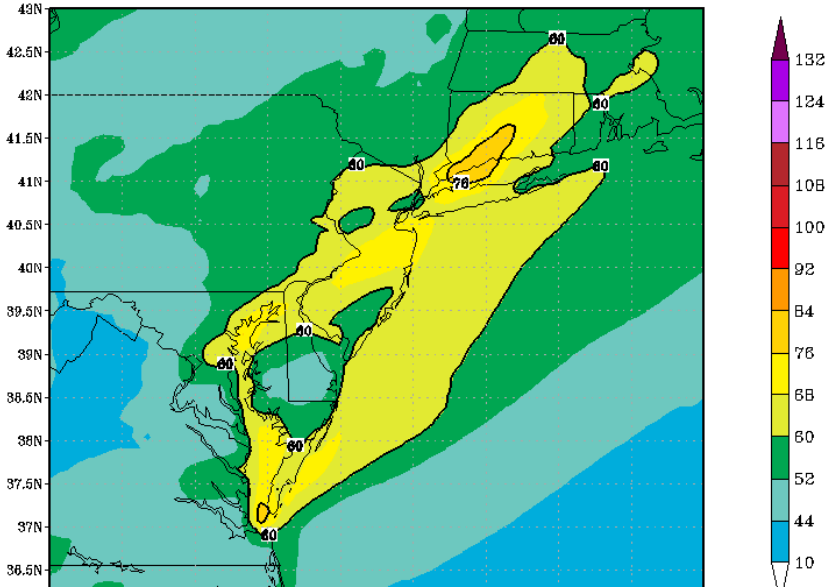
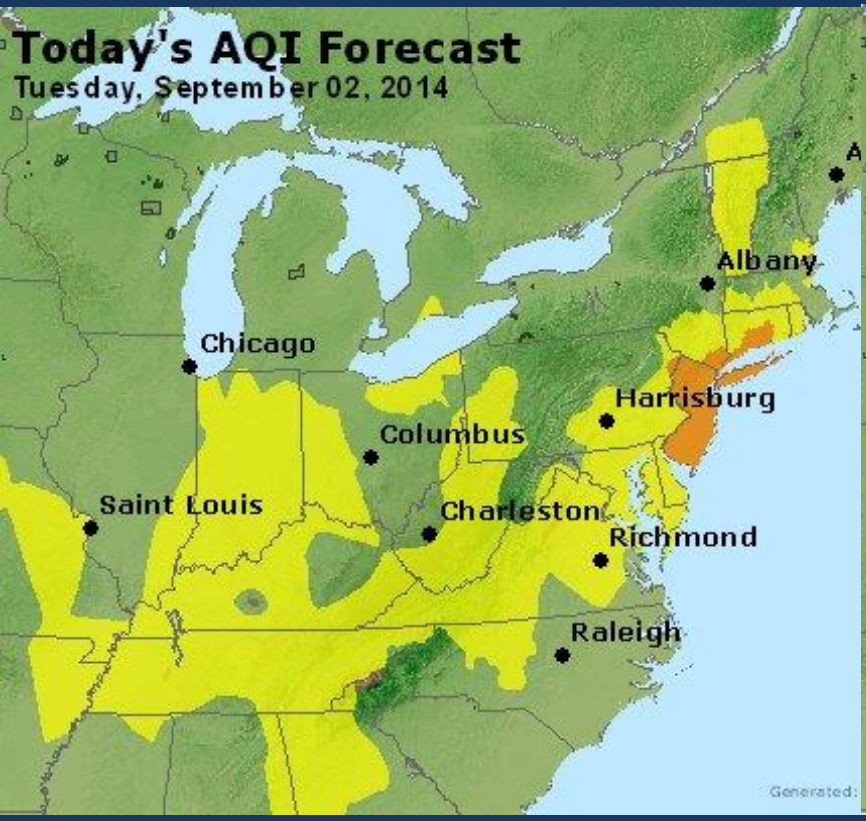


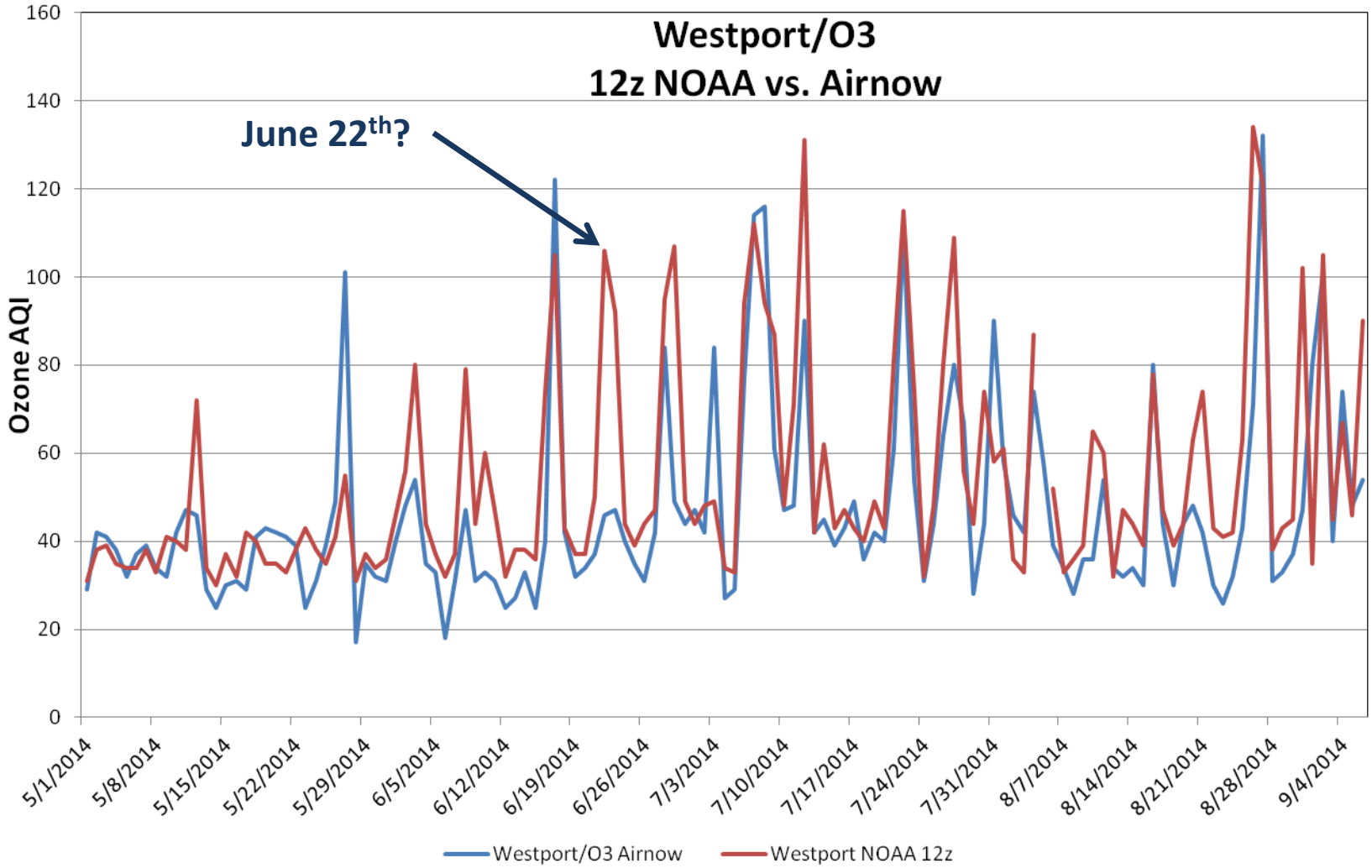
(exp) 12Z 1H-24H 1st d 8h max sf O_3 (ppbv) Valid 02 SEP 2014



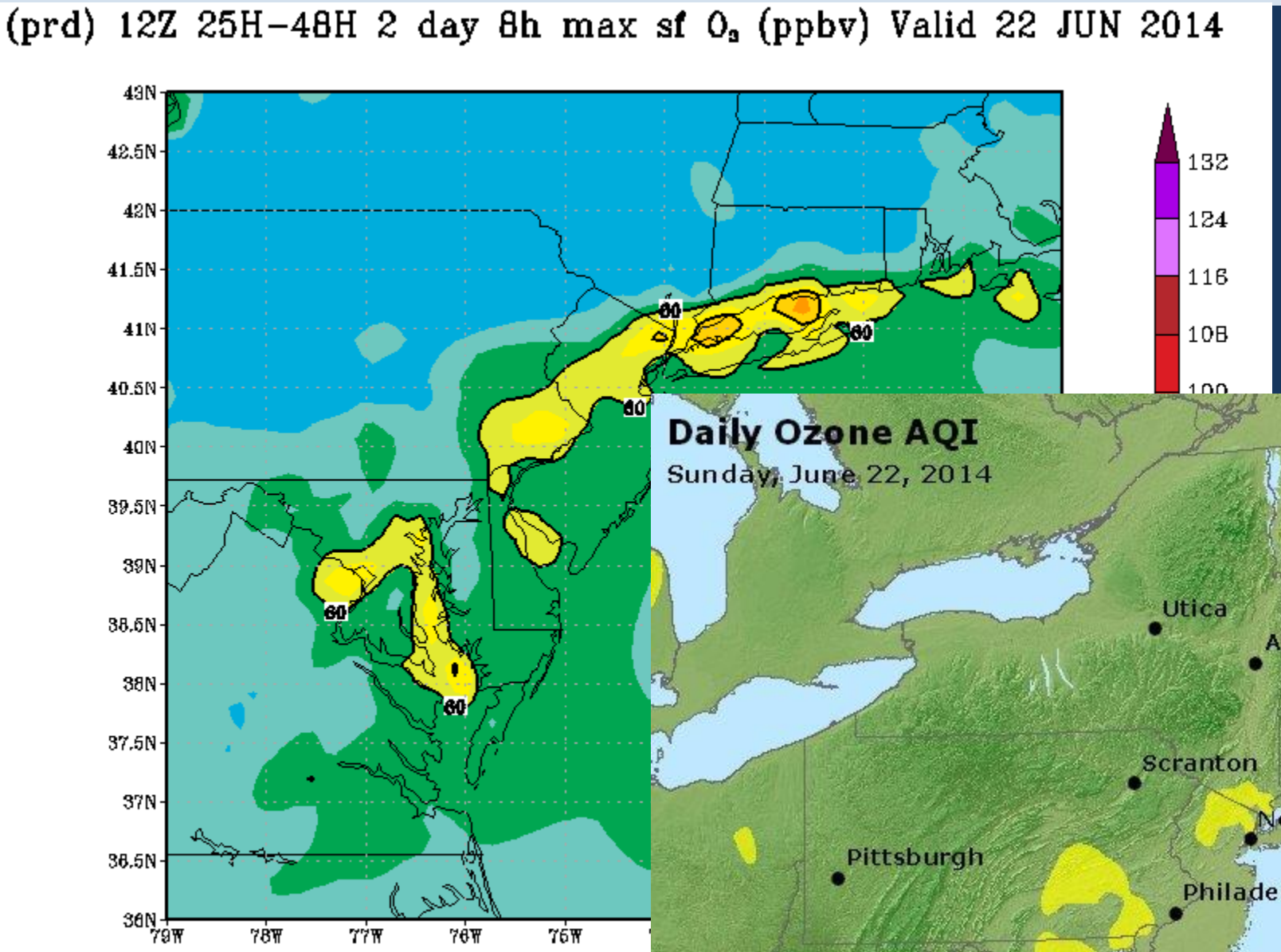
September 2nd AQI Maps



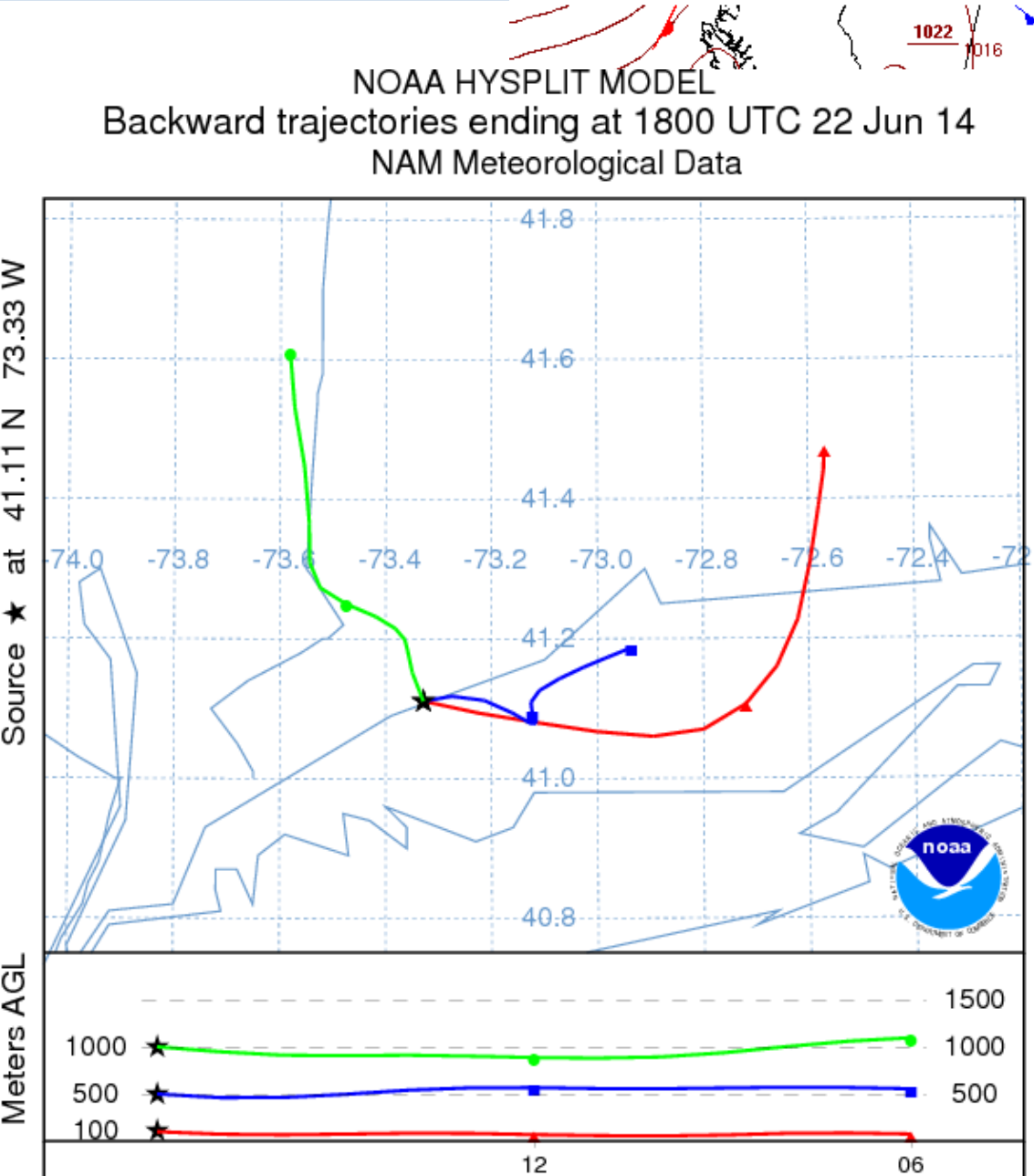
What about Over-Prediction?

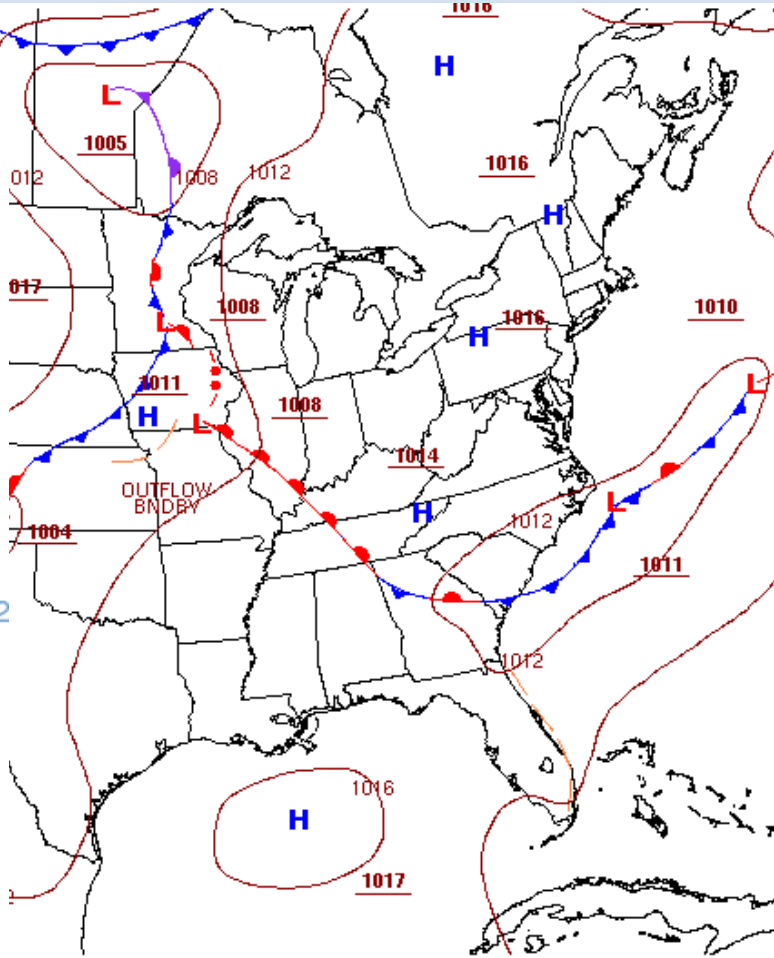


LIS Plume Over Done?



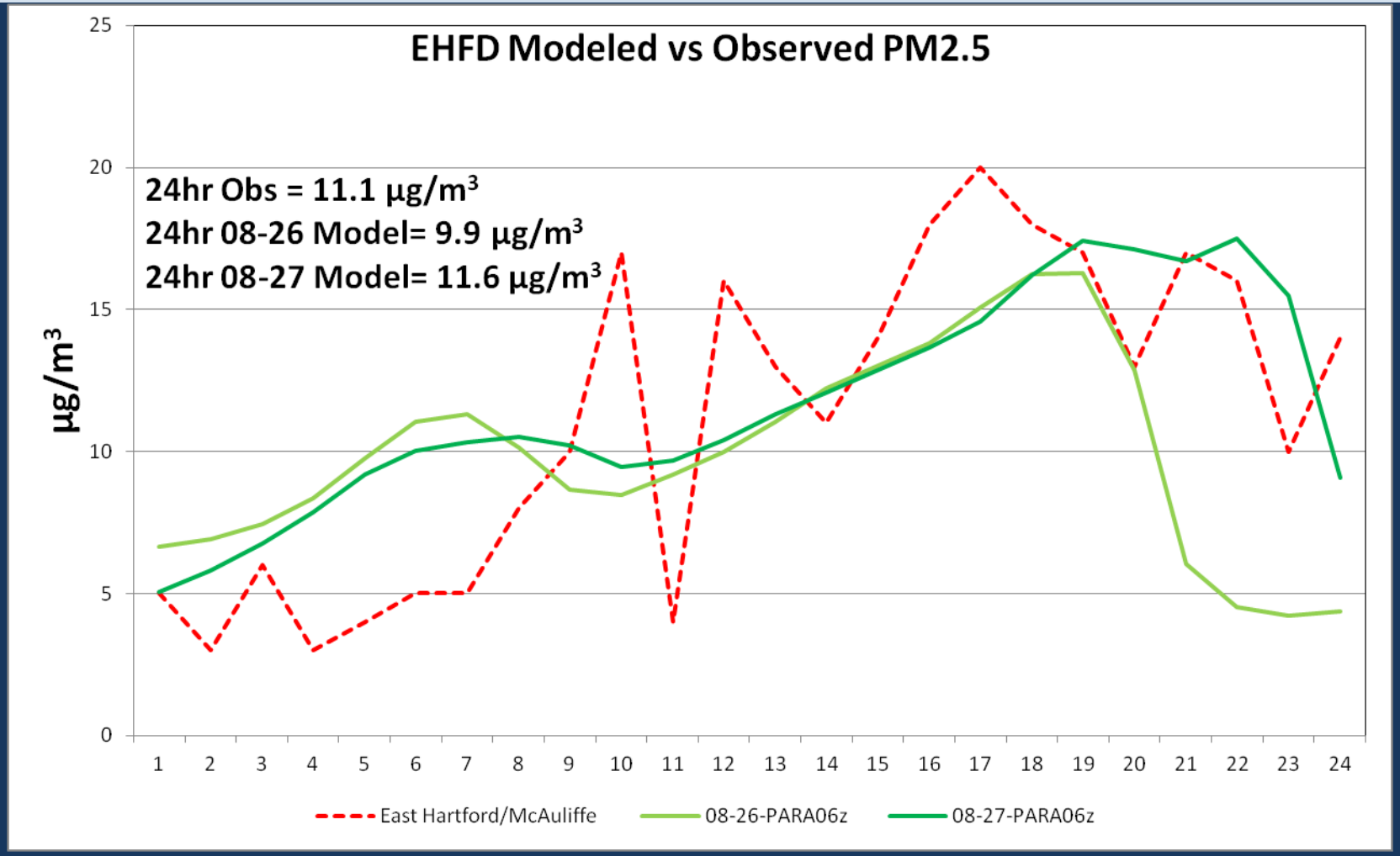
Light wind Conditions





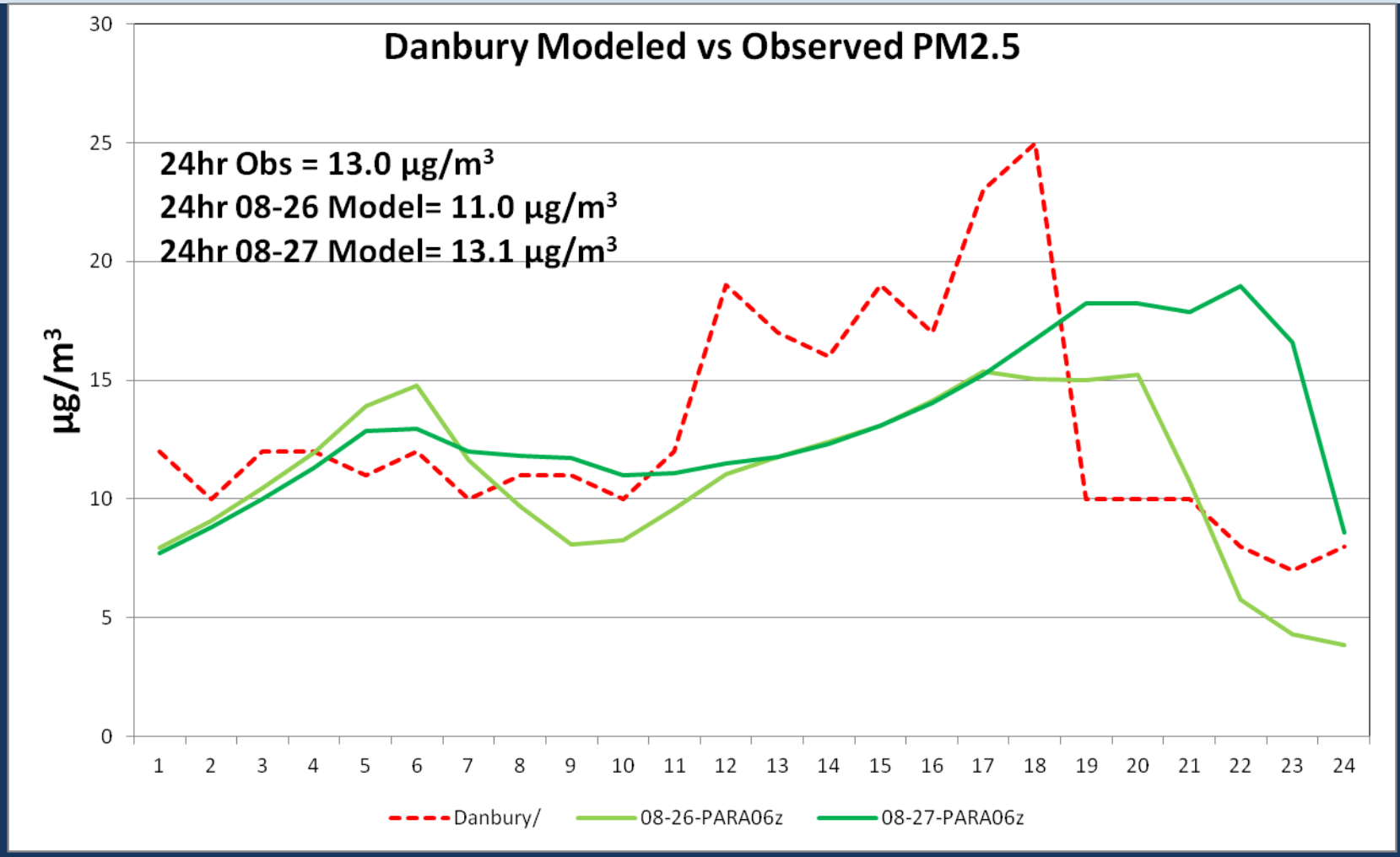
- **Over-prediction during certain meteorological conditions only?**

What about PM2.5?



Model does not catch sharp fluctuations

PM2.5 not an issue in the summer



Same-day 24hr averages more accurate on this day

Conclusions

- Recent model improvements has allowed CT forecasters to increasingly trust the model output.
- Day before forecasts have become nearly as reliable as the same day model runs.
- The late summer over-prediction has been nearly eliminated.
- The CB05/AERO-4 model looks good for production.

Questions?

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Michael.Geigert@ct.gov
806-424-3509