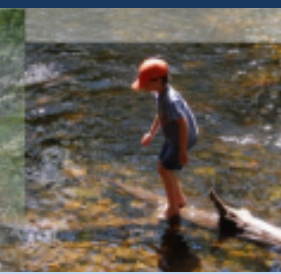




Connecticut Department of Energy and Environmental Protection



Connecticut Department of
**ENERGY &
ENVIRONMENTAL
PROTECTION**

2014 Ozone Season Forecasting Summary

October 9, 2014
Sam Sampieri
Michael Geigert
SIPRAC Meeting



Connecticut Department of Energy and Environmental Protection

2014 Ozone Season Re-Cap

Only 8 Days over the 8-Hour Ozone NAAQS

Lowest since 2009 (6)

Last Year 18 Days

15 Days $\geq 90^\circ$ at BDL This Summer



How did we do this past year?

Actual Exceedences Days = 8

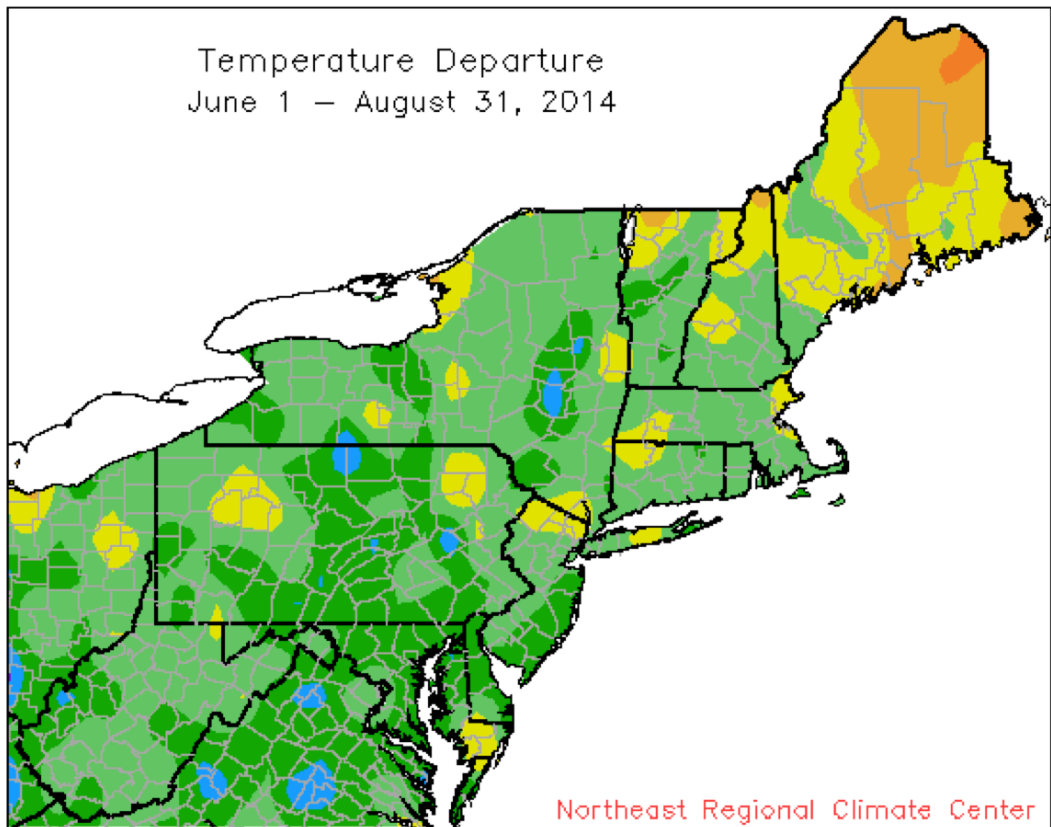
Forecast Exceedences Days = 4

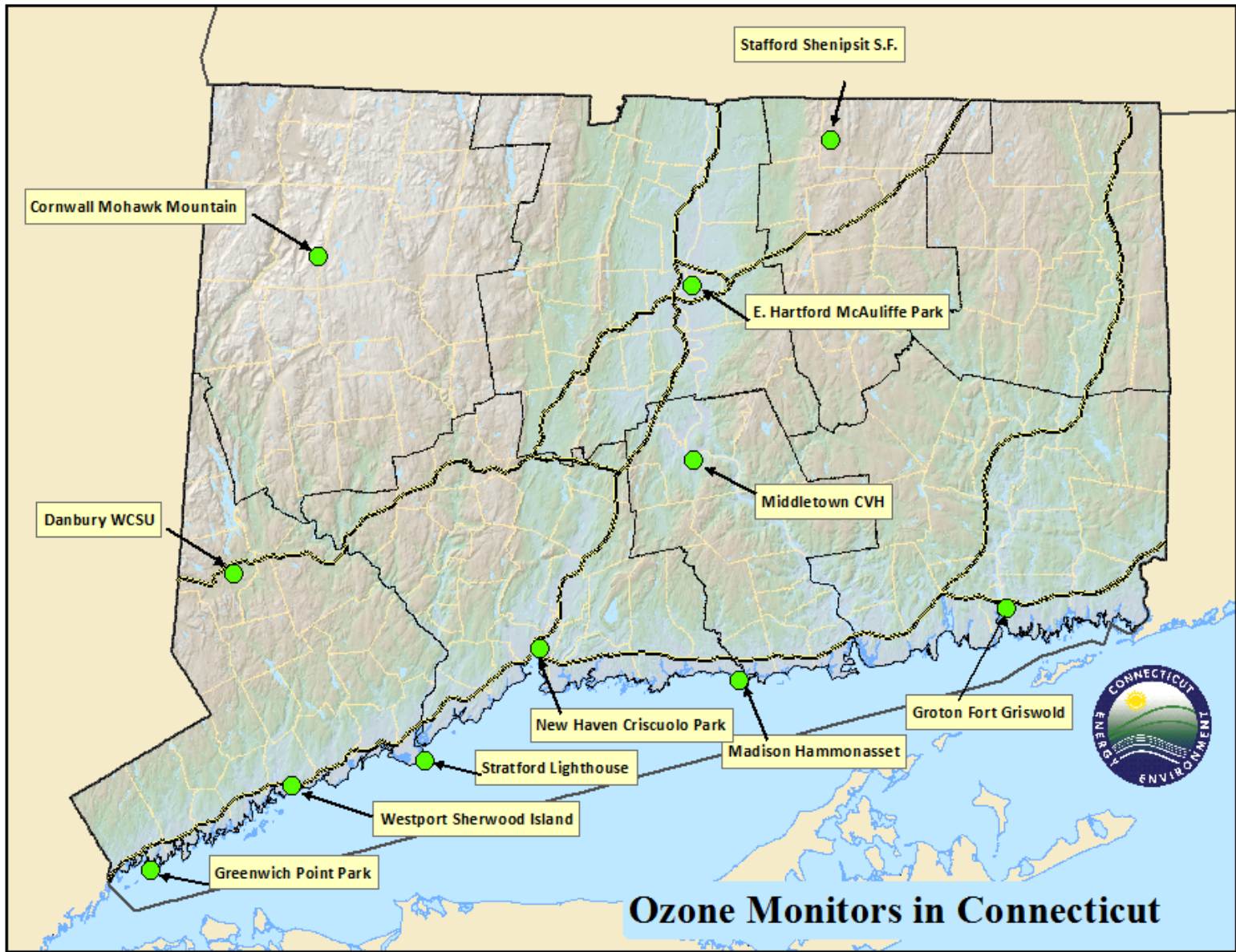
Month	Actual Dates	Forecast Dates
May	27	
June	2, 17	17
July	7, 8, 22	22
August	27	27
September	2	2*
Total	8	4

Slightly cooler Summer overall

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

Location	Summer		Departure	Rank
	2014	Normal		
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





A Few 2014 Events

May 27

June 17, 22

July 1, 6, 7, 22

August 27

September 2



May Maximum 8-Hour Ozone Concentration

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					

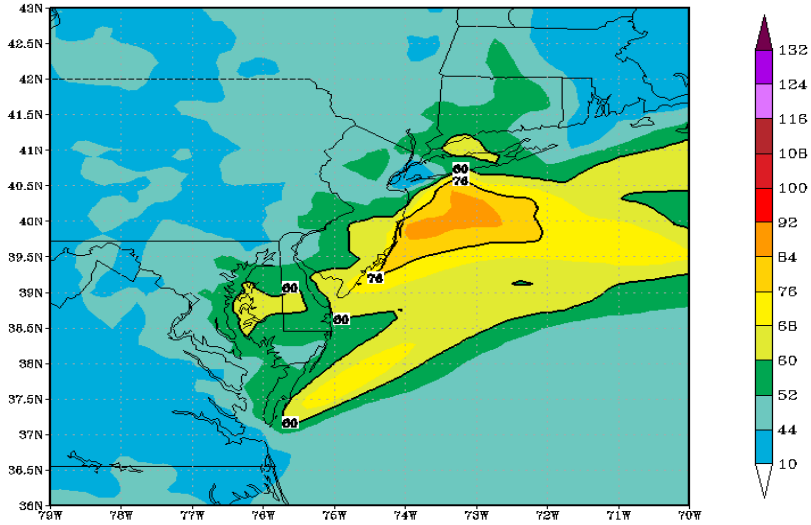
Good (0-59 ppb)
Moderate (60-75 ppb)
Unhealthy for Sensitive Groups (76-95 ppb)
Unhealthy (96-115 ppb)
Very Unhealthy (116 > ppb)

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

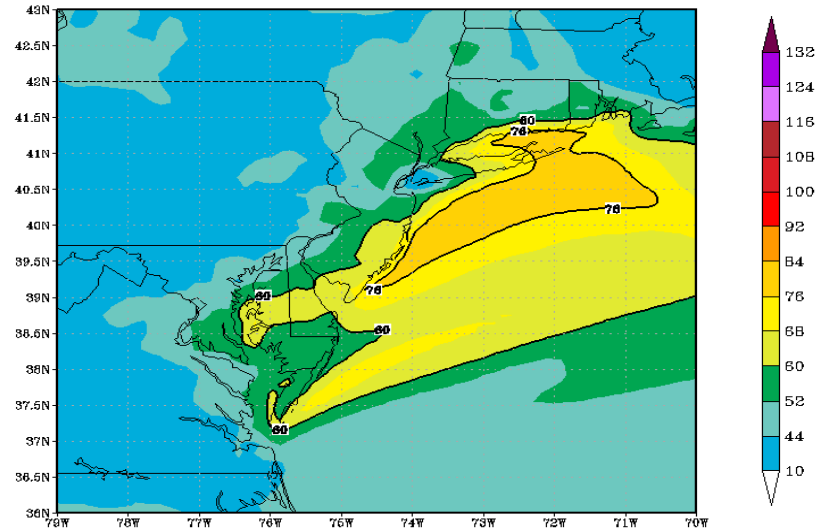


May 27 Analysis

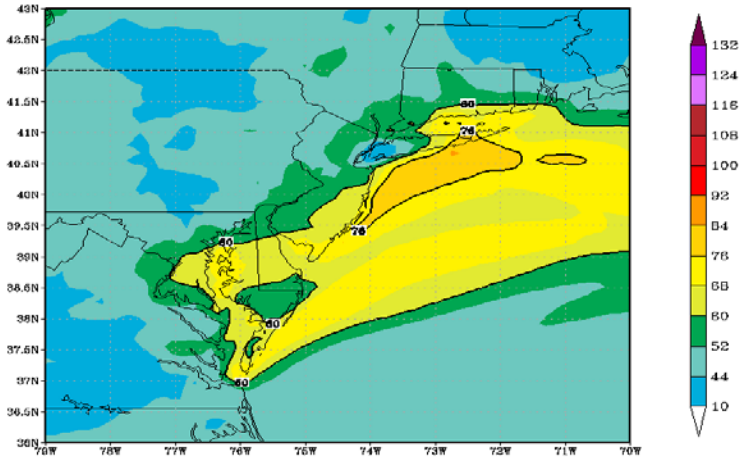
(prd) 06Z 31H-48H 2 day 8h max sf O₃ (ppbv) Valid 27 MAY 2014



(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 27 MAY 2014



(prd) 06Z 7H-30H 1st d 8h max sf O₃ (ppbv) Valid 27 MAY 2014



June Maximum 8-Hour Ozone Concentrations

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)

Unhealthy for Sensitive Groups (76-95 ppb)

Unhealthy (96-115 ppb)

Very Unhealthy (116 > ppb)

Units - parts per billion (ppb)

Federal Standard = 75 ppb

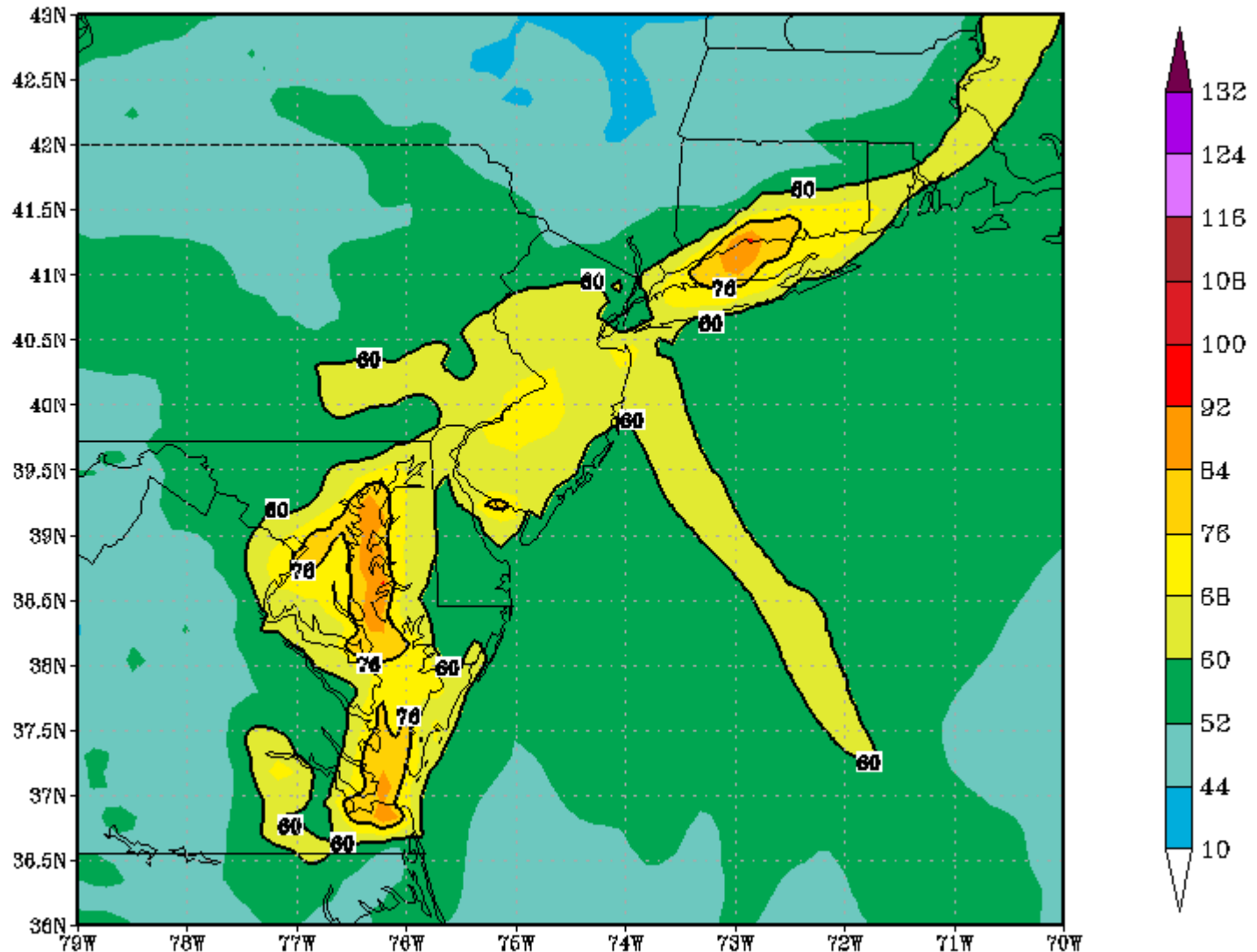
M = missing data

* Data is preliminary and has not been quality assured



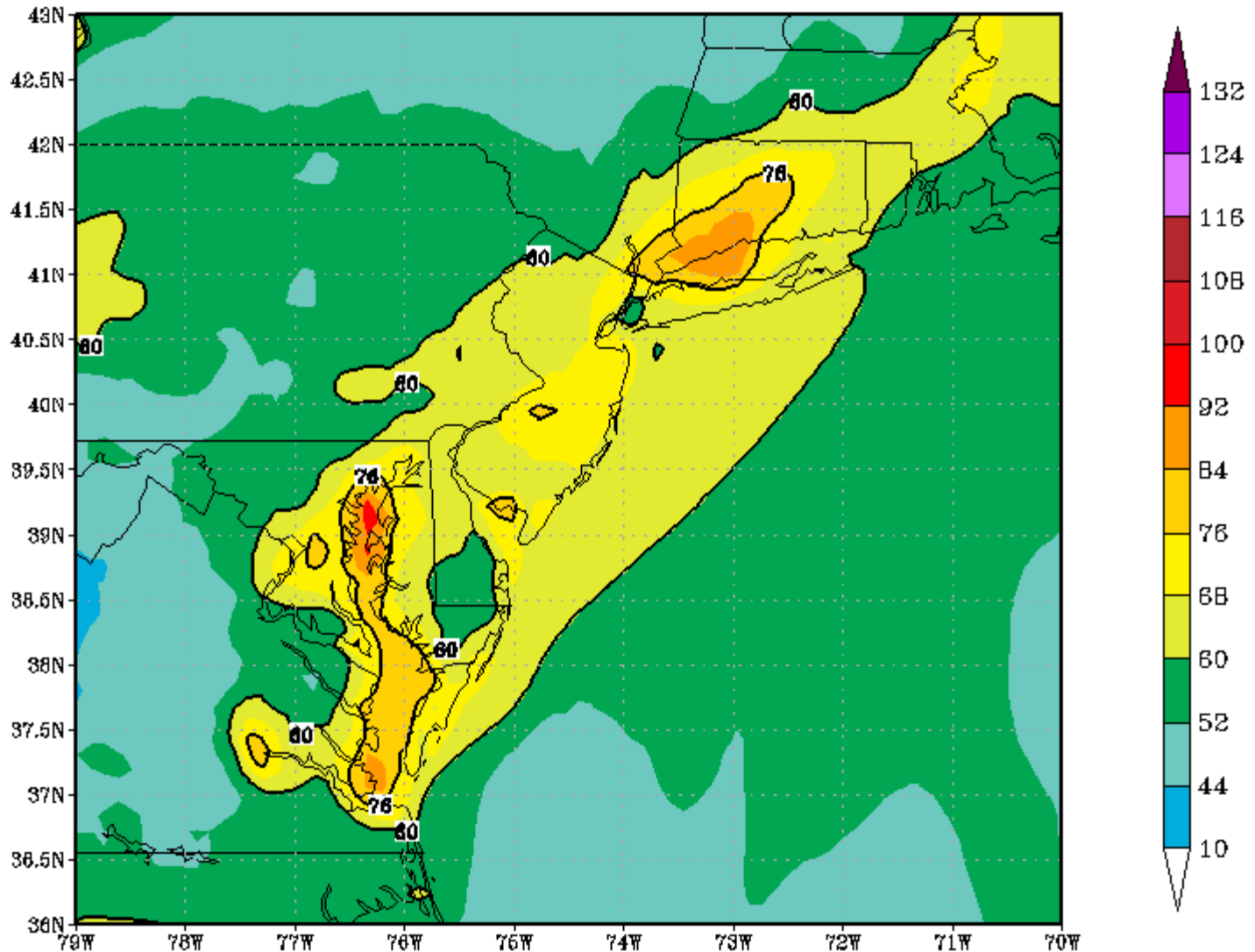
June 16th 12z Model Run

(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 17 JUN 2014



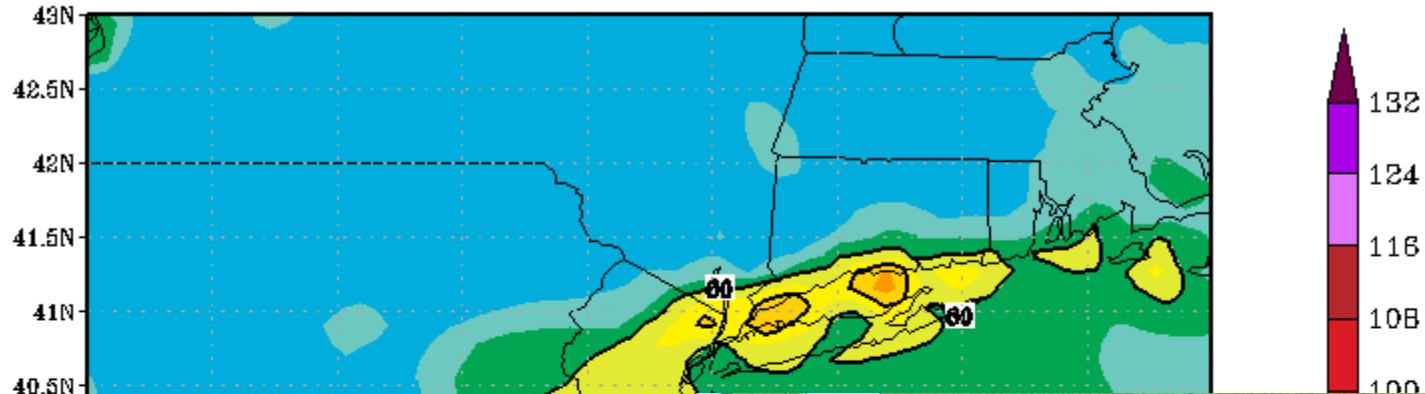
June 17th 12z Model Run

(prd) 12Z 1H-24H 1st d 8h max sf O₃ (ppbv) Valid 17 JUN 2014

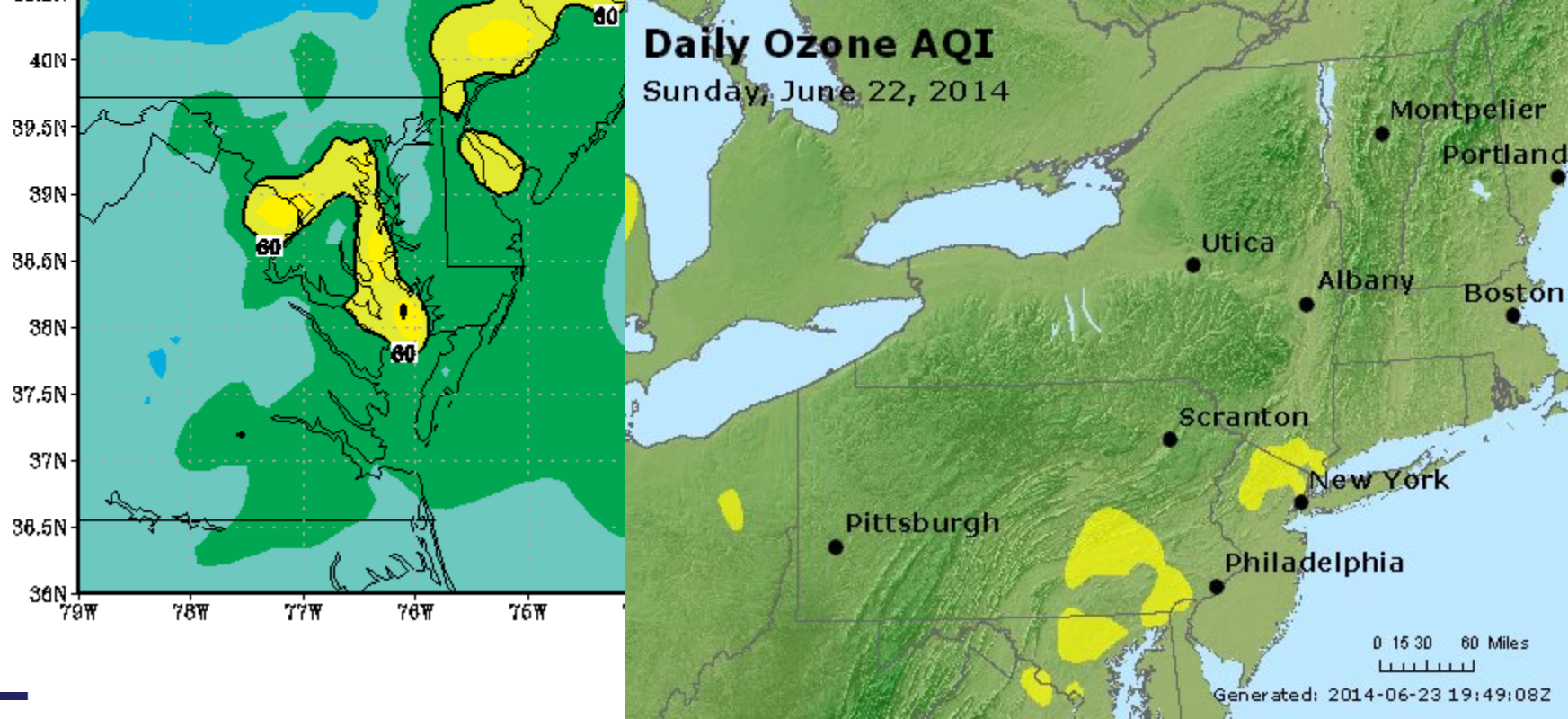


LIS Plume Over Done?

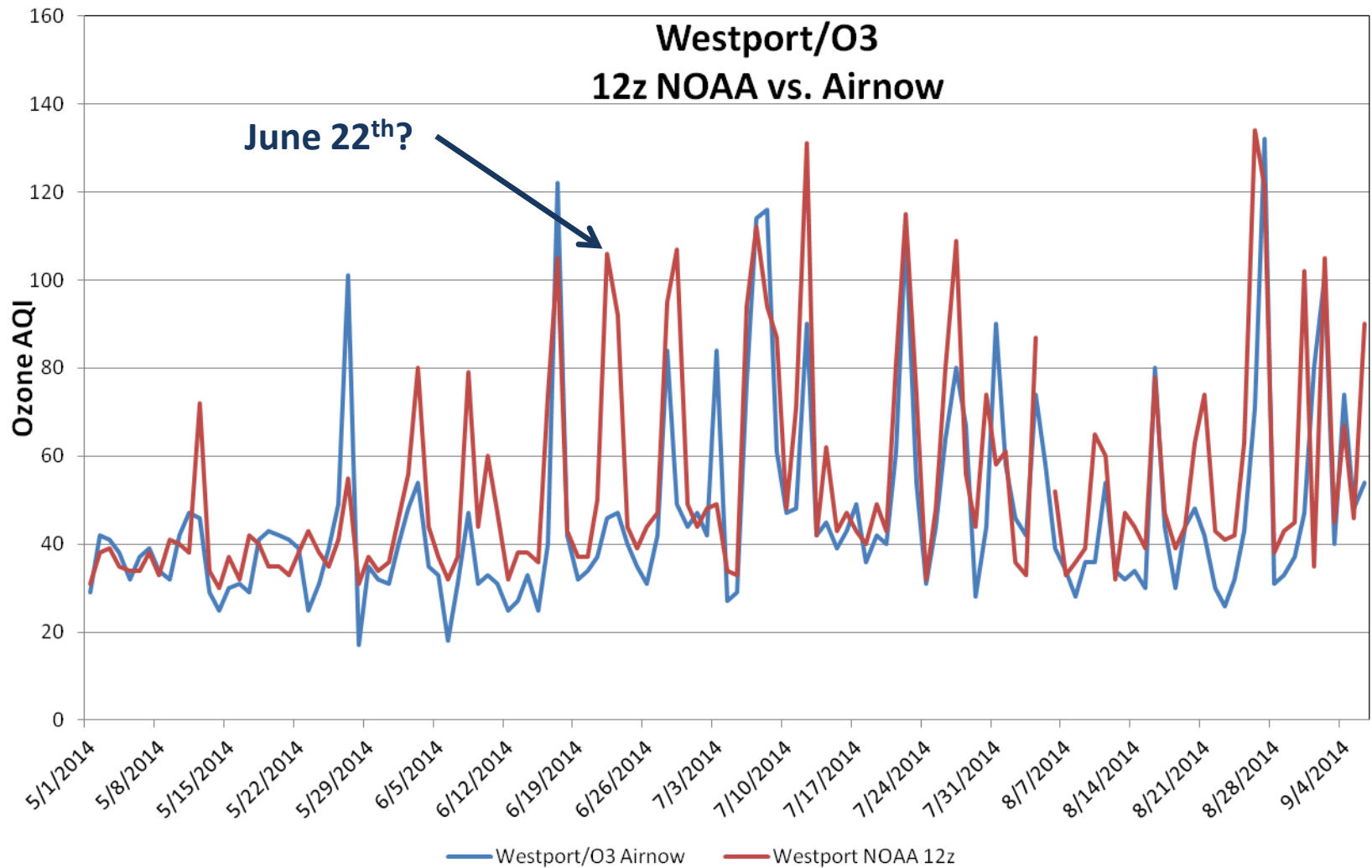
(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 22 JUN 2014



Daily Ozone AQI
Sunday, June 22, 2014

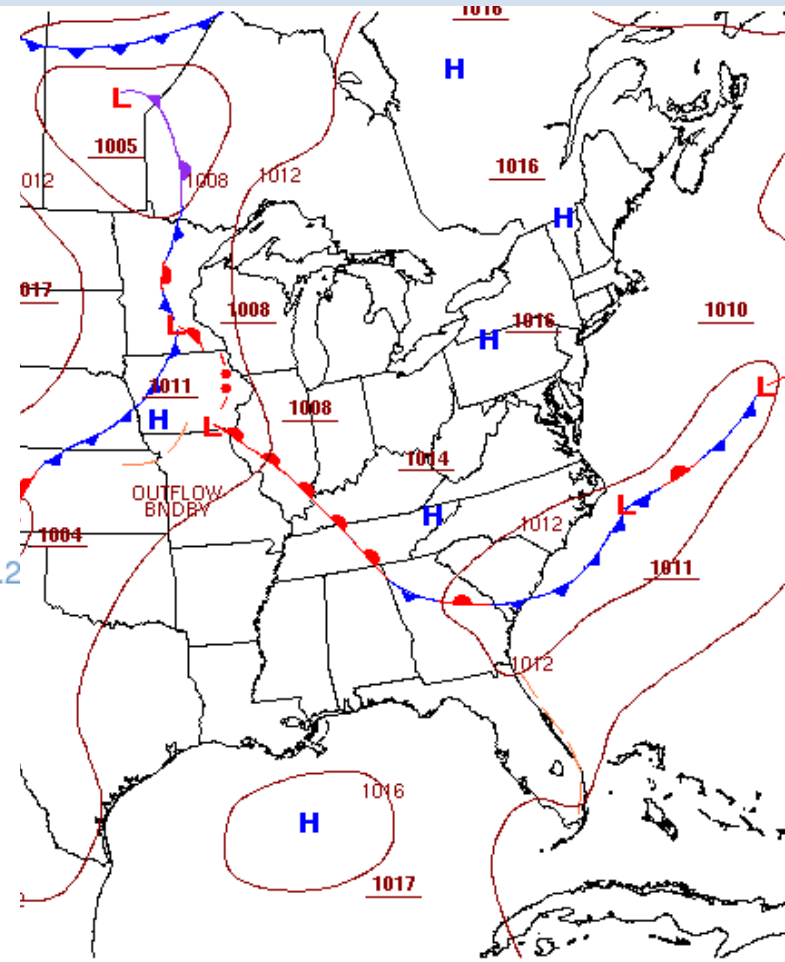
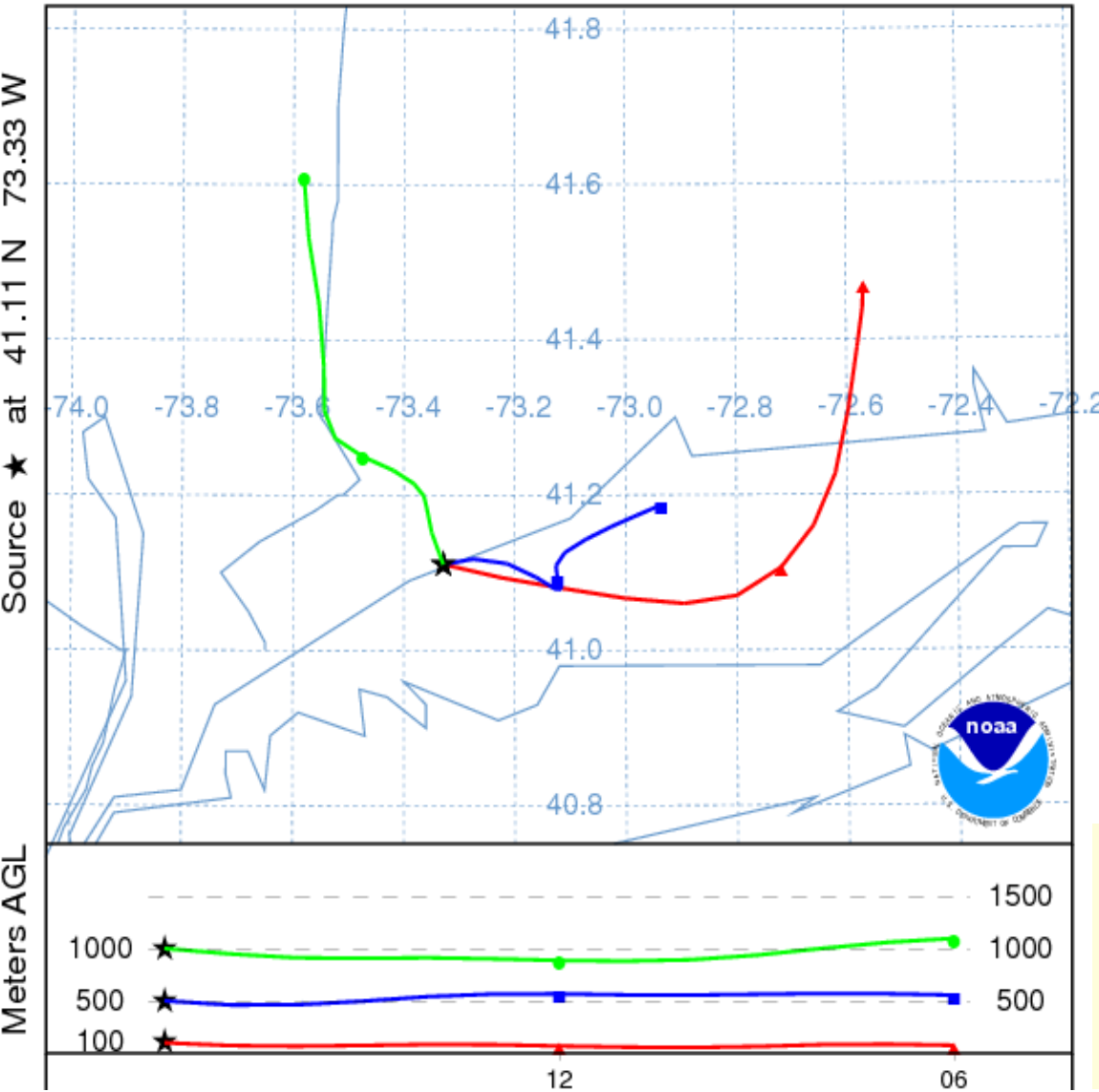


What about Over-Prediction?



Light Wind Conditions

NOAA HYSPLIT MODEL
Backward trajectories ending at 1800 UTC 22 Jun 14
NAM Meteorological Data



- Over-prediction during certain meteorological conditions only?
- May point to mobile-source emissions too high.

July Maximum 8-Hour Ozone Concentrations

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										

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)

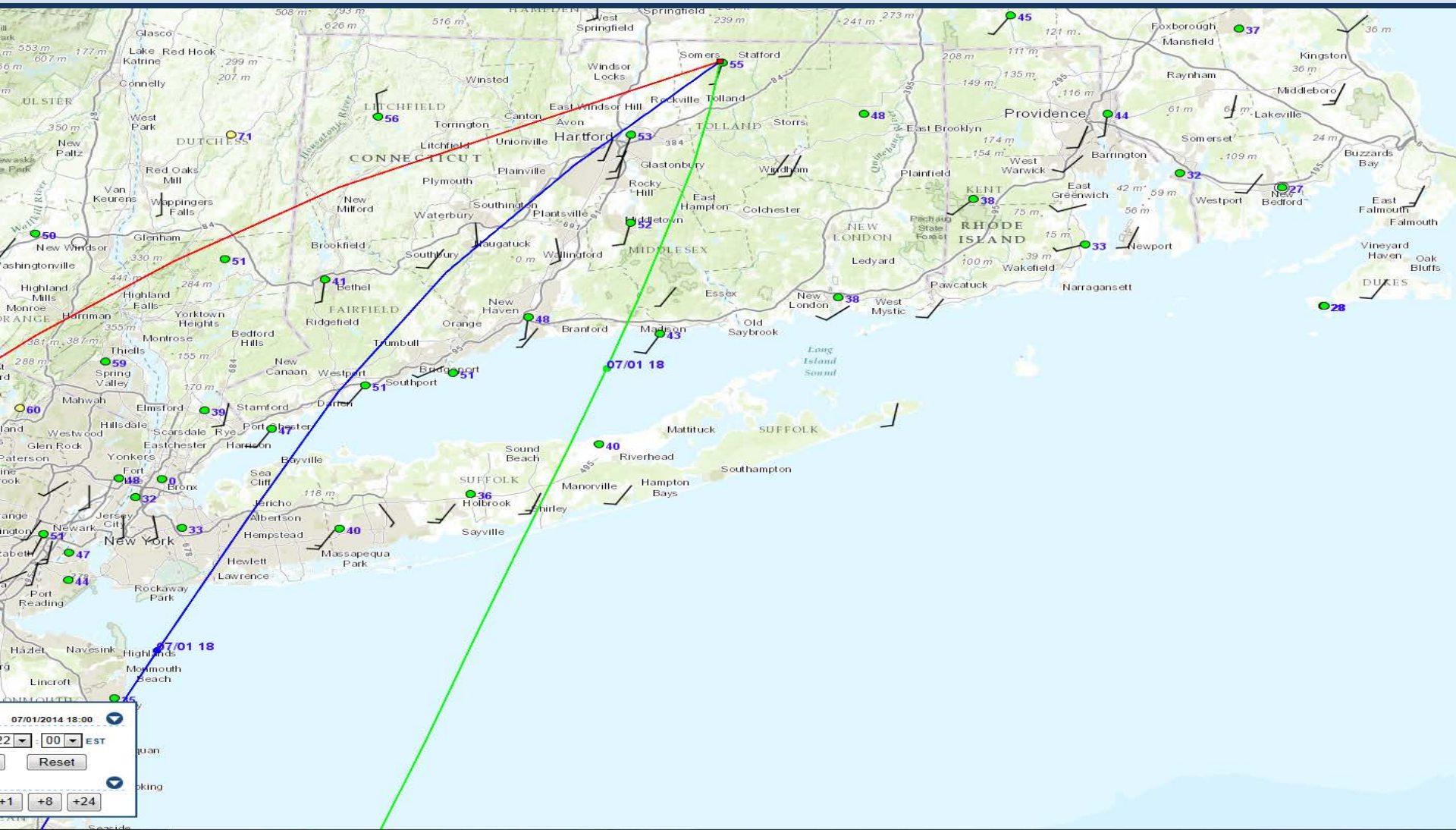
Federal Standard = 75 ppb

M = missing data

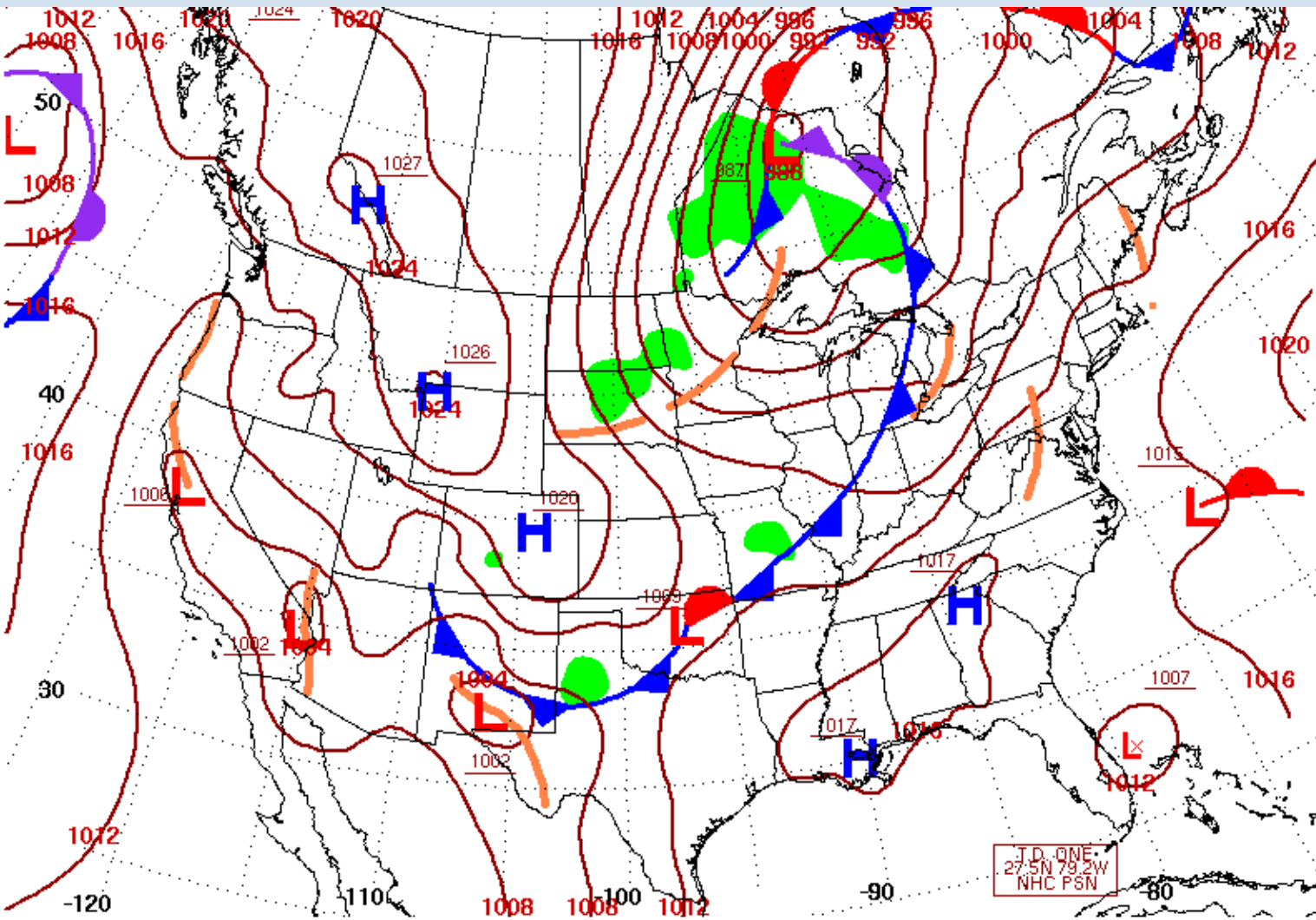
* Data is preliminary and has not been quality assured



July 1 Trajectory Analysis



July 1 Non-Event

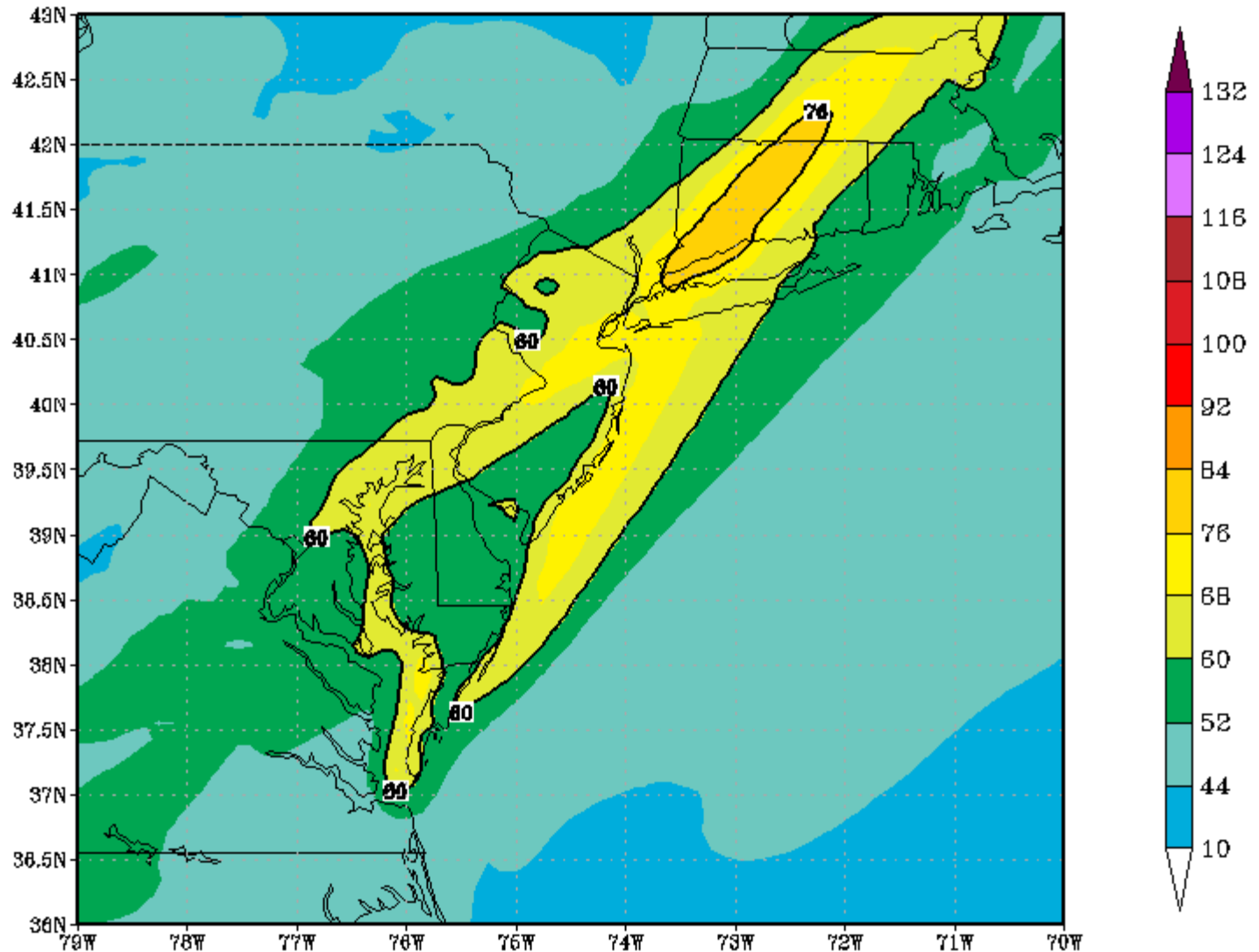


Surface Weather Map at 7:00 A.M. E.S.T.



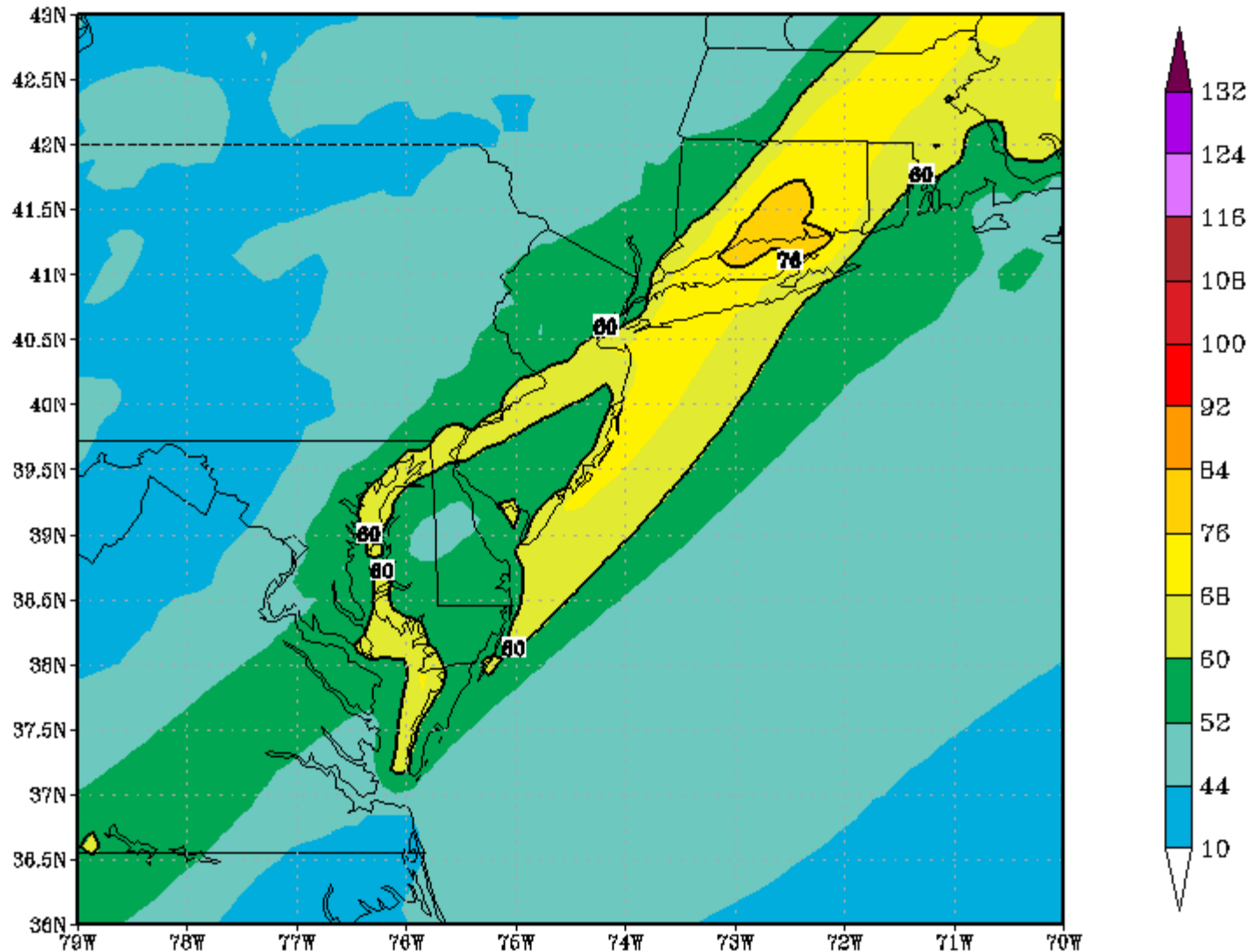
July 6th 12z Model Run

(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 07 JUL 2014



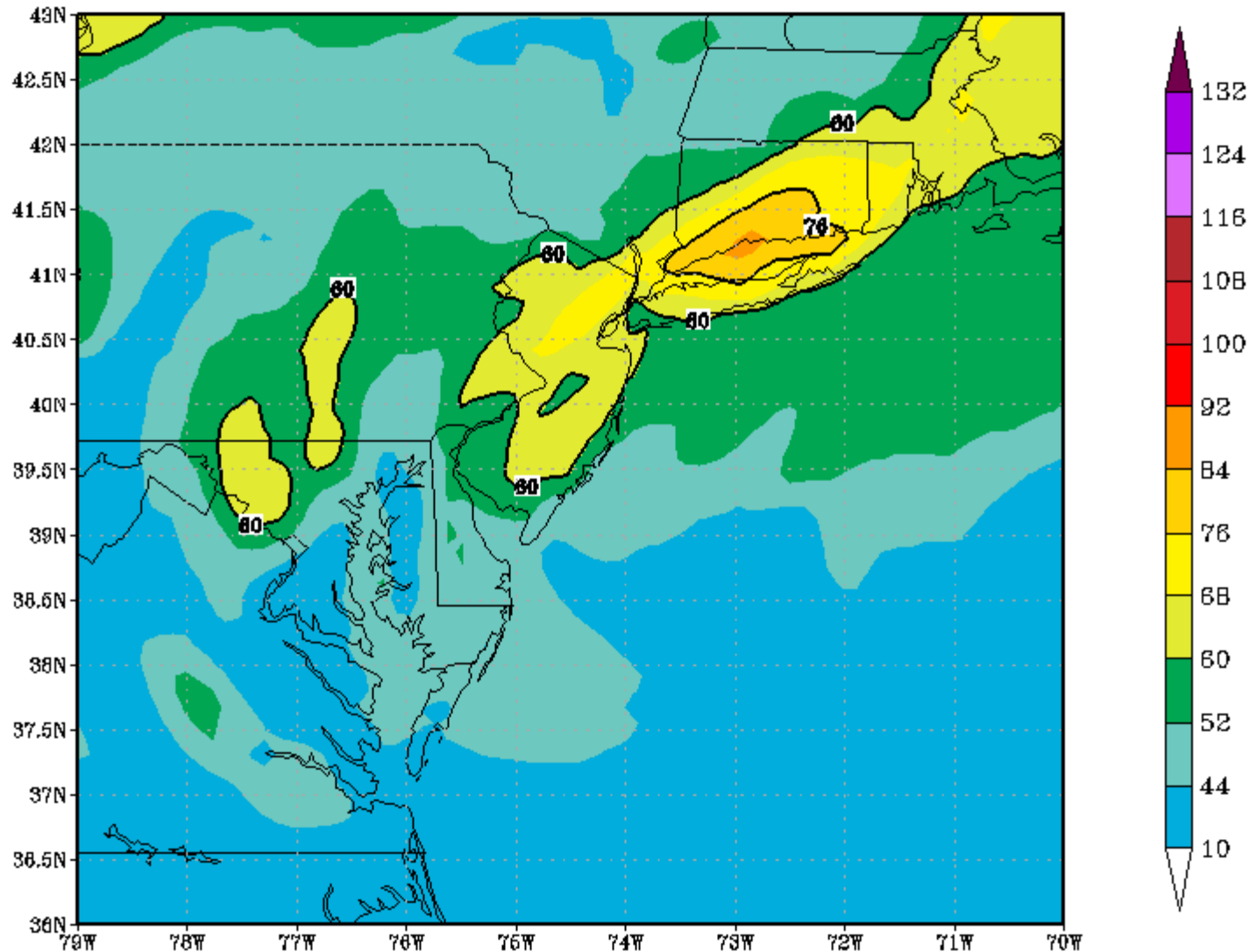
July 7th 12z Model Run

(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 08 JUL 2014



July 21st 12z Model Run

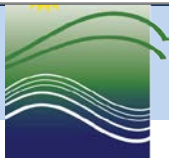
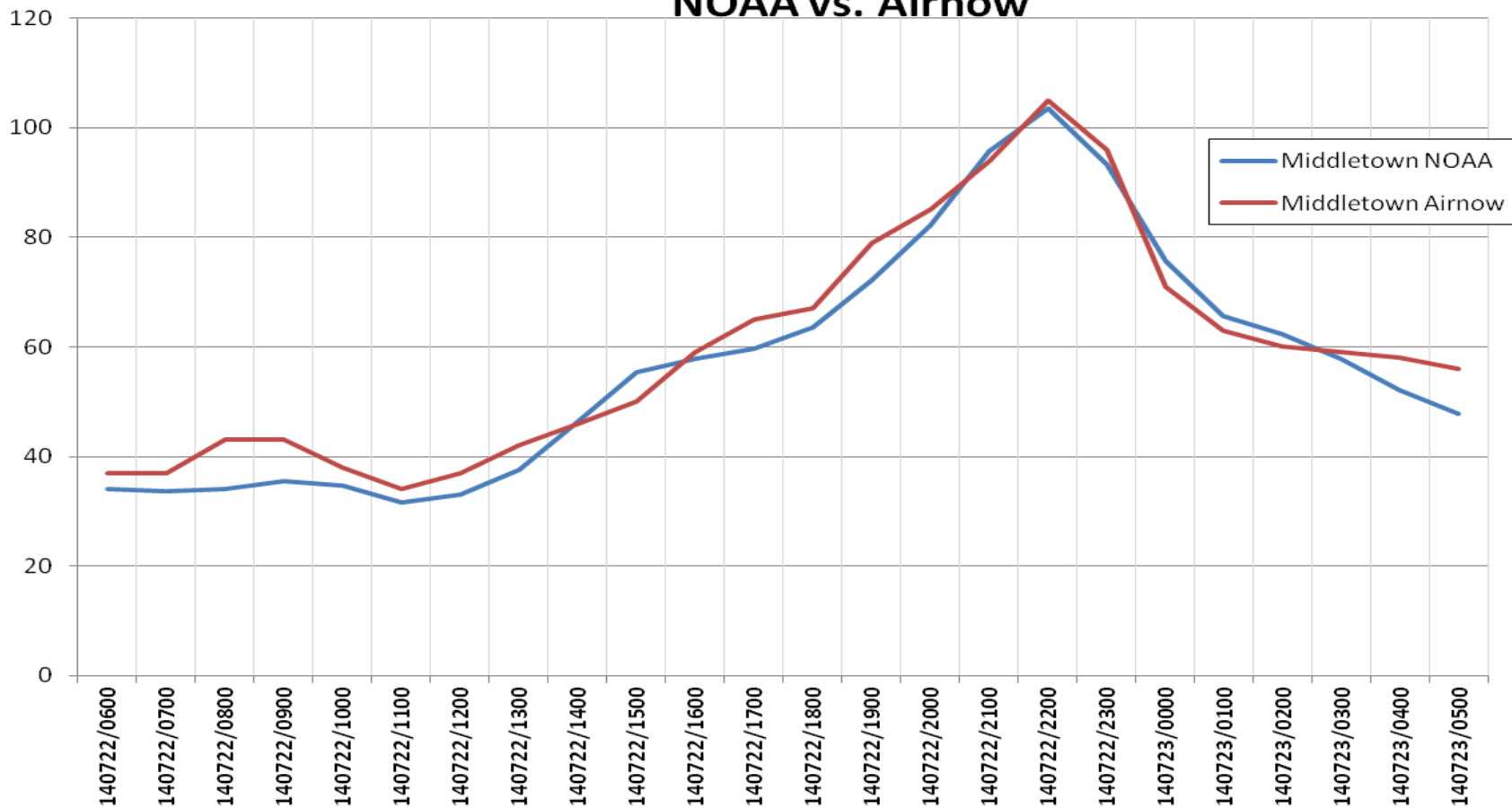
(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 22 JUL 2014



July 21st 12z EXP for Middletown

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

Middletown CT hourly Ozone For July 22 NOAA vs. Airnow



August Maximum 8-Hour Ozone Concentrations

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	27	31	34	40
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	28	33	46	38
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	30	37	52	46
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	31	35	40	43
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	38	40	46	54
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	36	33	34	40
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	36	36	39	45
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	33	34	39	51
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	33	31	39	51
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	28	31	37	42
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	33	39	42	51
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	36	39	44	55
# days > Federal Standard																											7				

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)

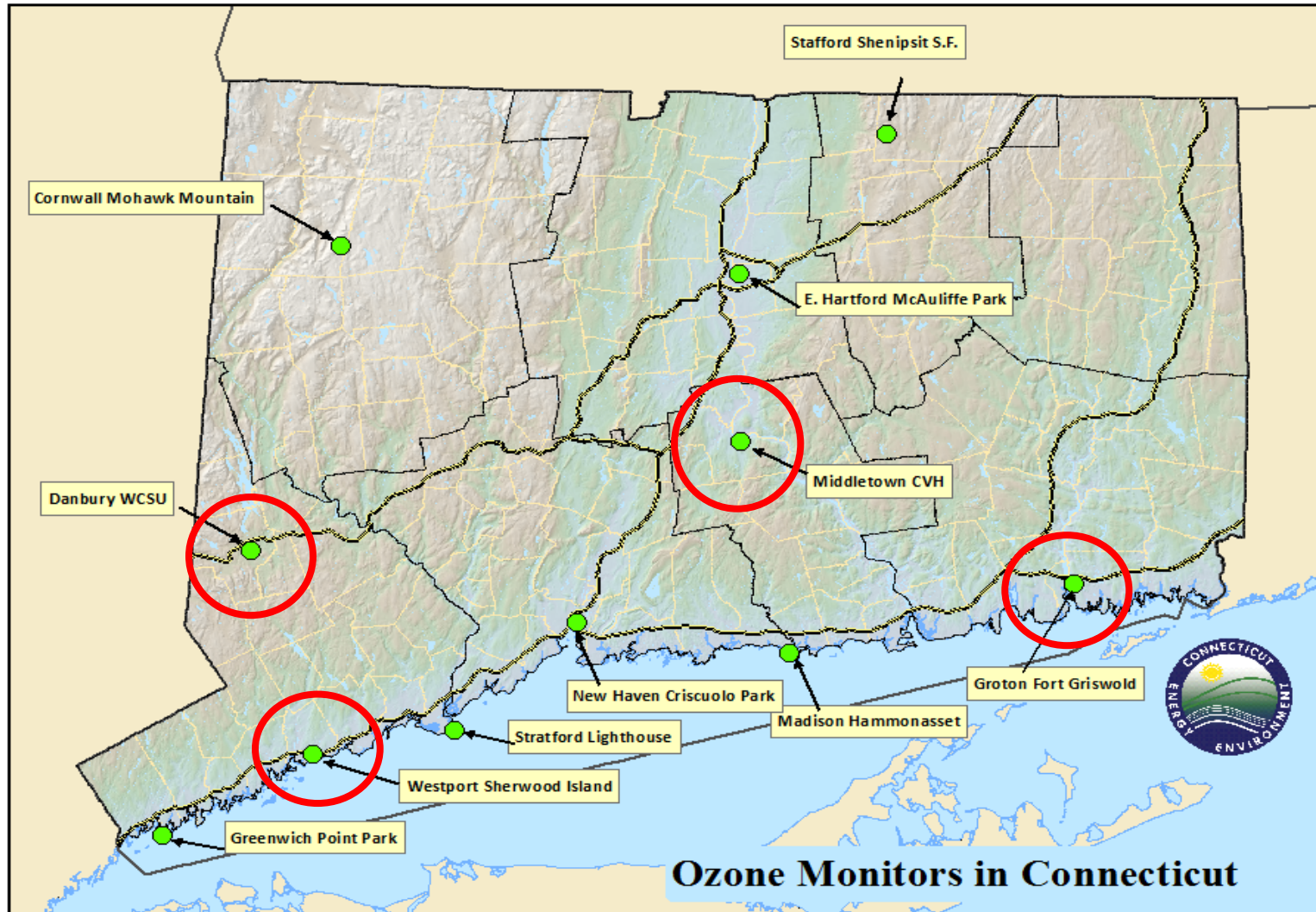
Federal Standard = 75 ppb

M = missing data

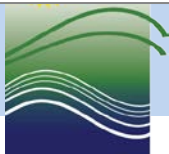
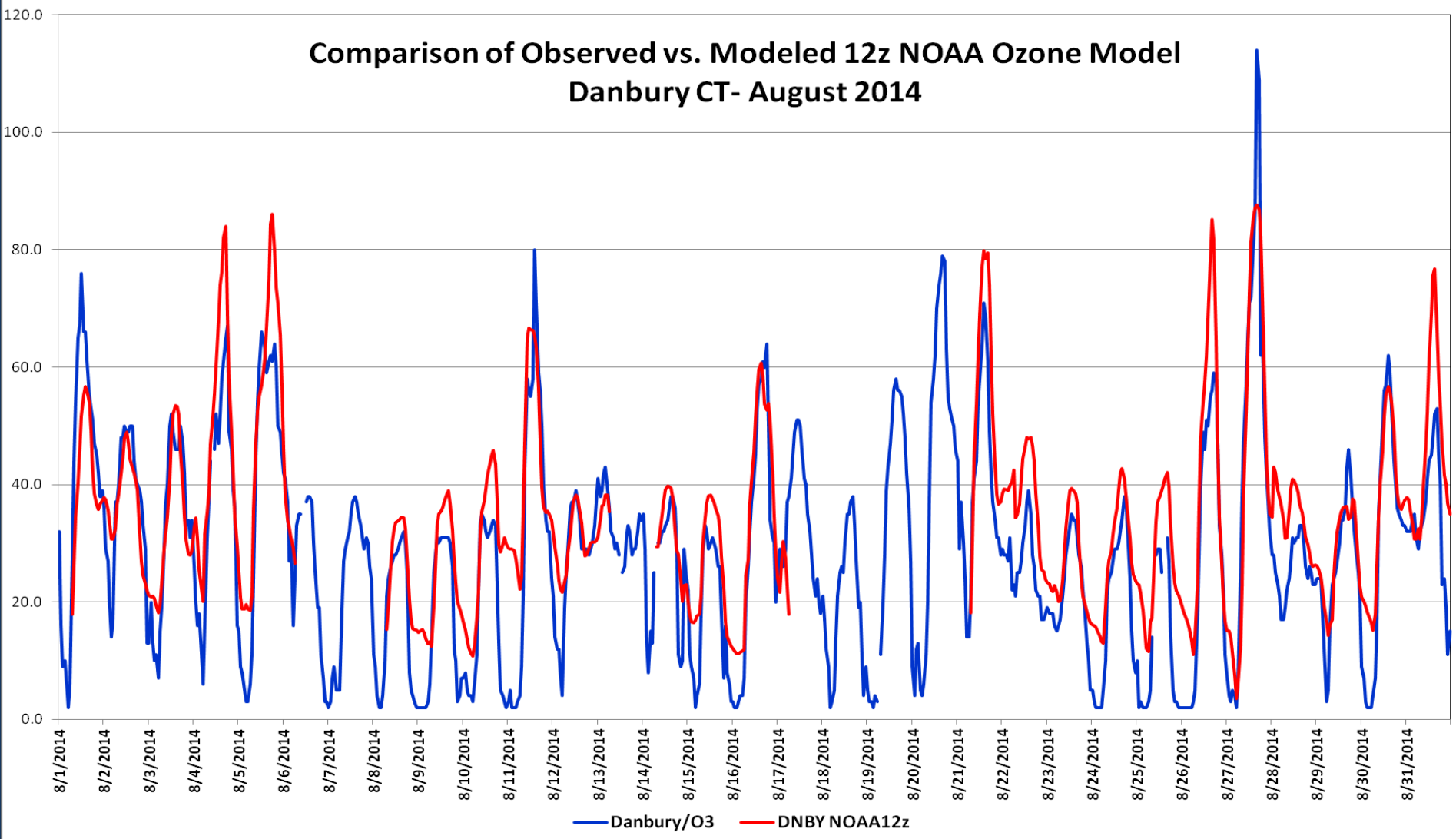
* Data is preliminary and has not been quality assured



Compared Hourly 12z EXP NOAA Model Runs at 4 Sites During August 2014

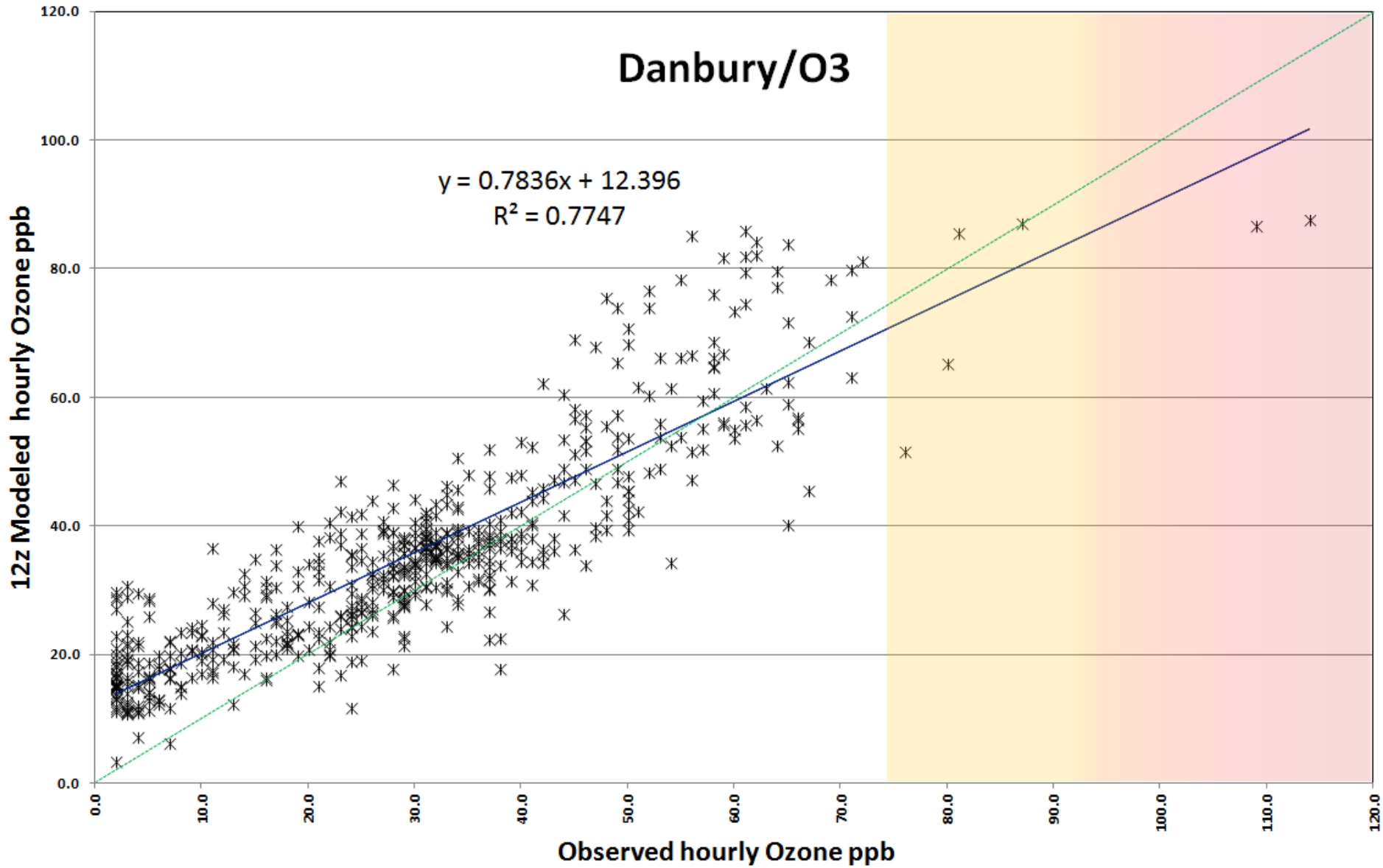


Peaks are Characterized Well NO_x Scrubbing Not Captured on Most Days



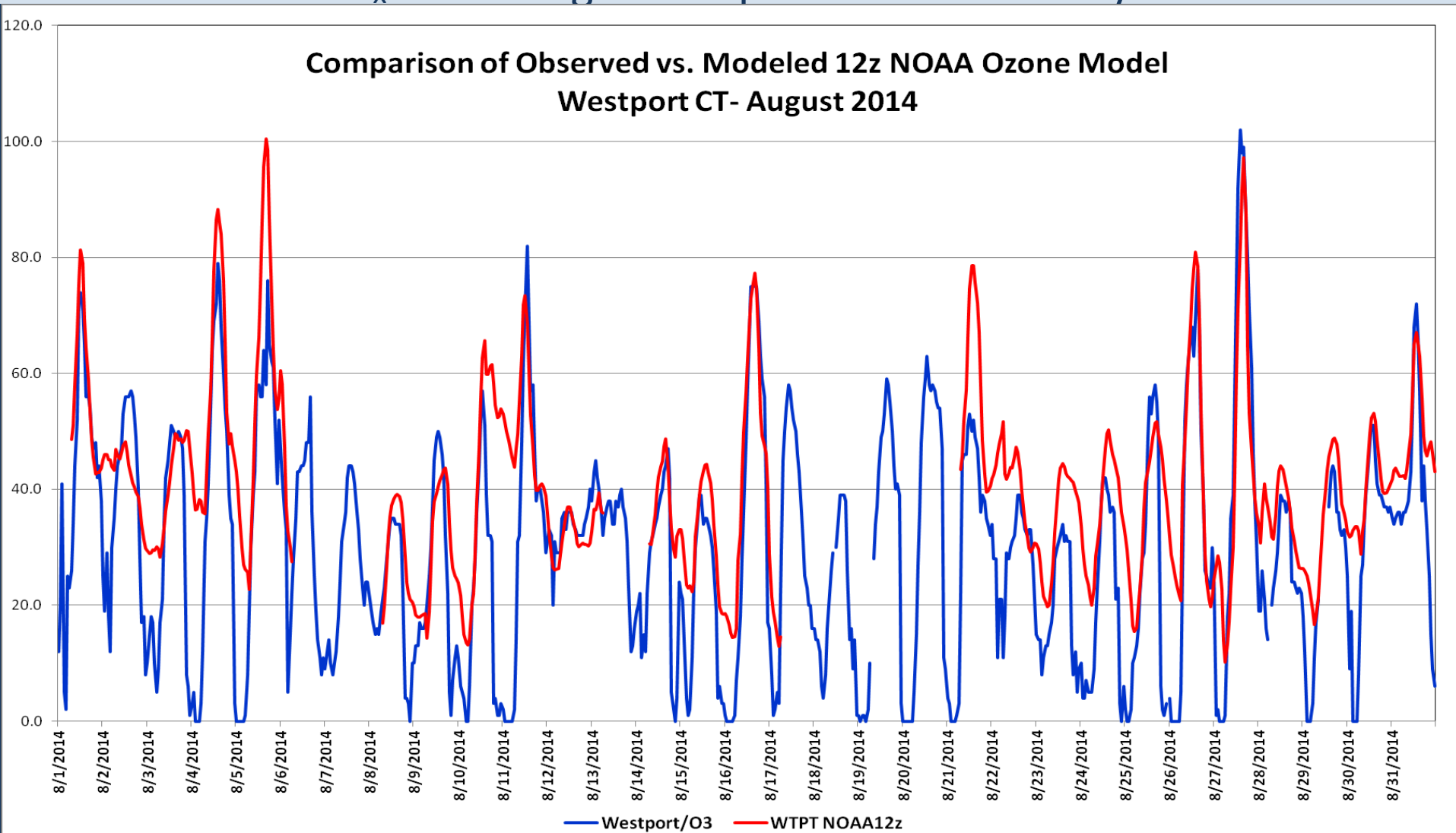
Danbury/O3

$$y = 0.7836x + 12.396$$
$$R^2 = 0.7747$$



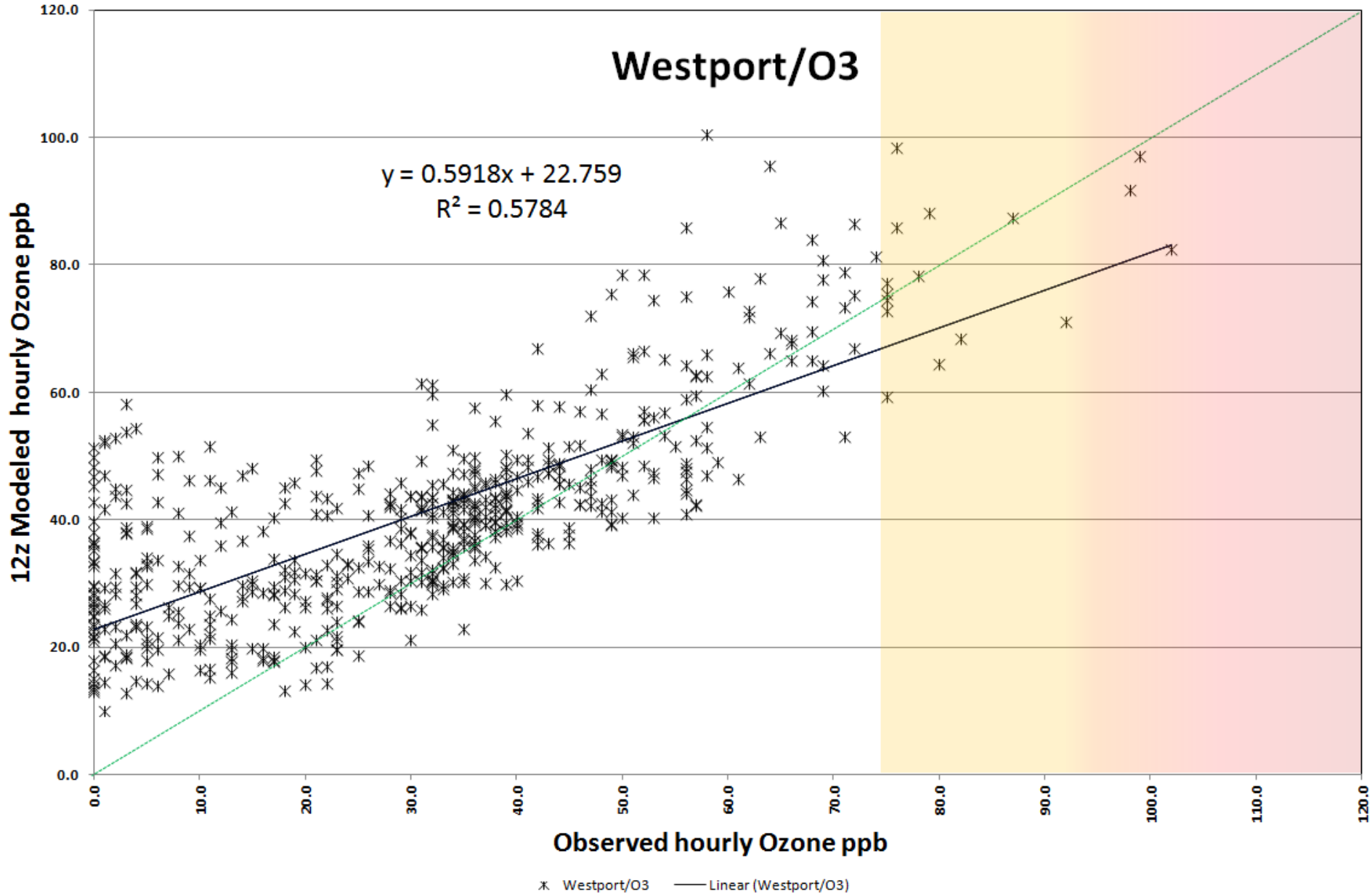
* Danbury/O3 — Linear (Danbury/O3)

Peaks are Characterized Well NO_x Scrubbing Not Captured on Most Days



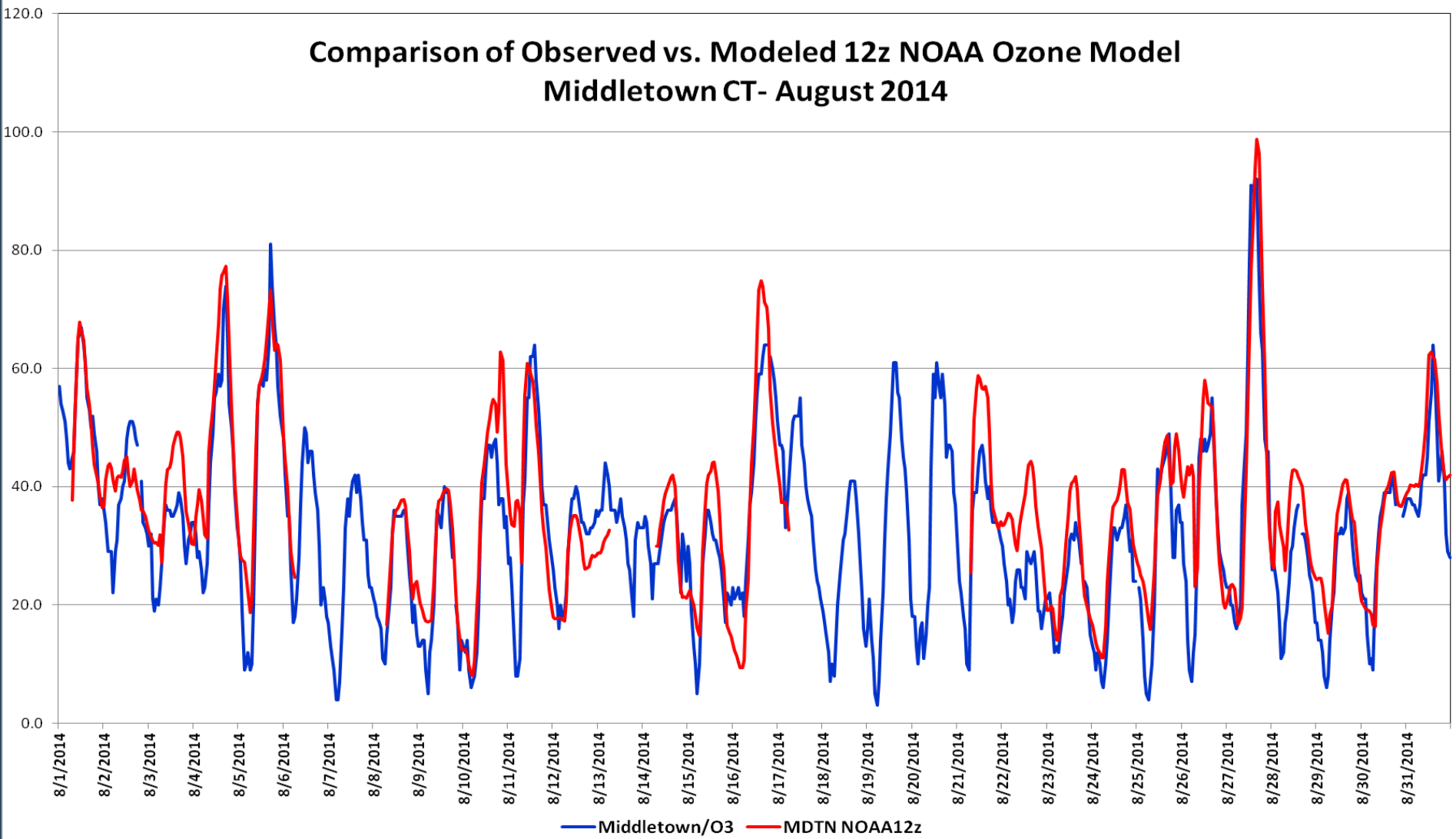
Westport/O3

$$y = 0.5918x + 22.759$$
$$R^2 = 0.5784$$



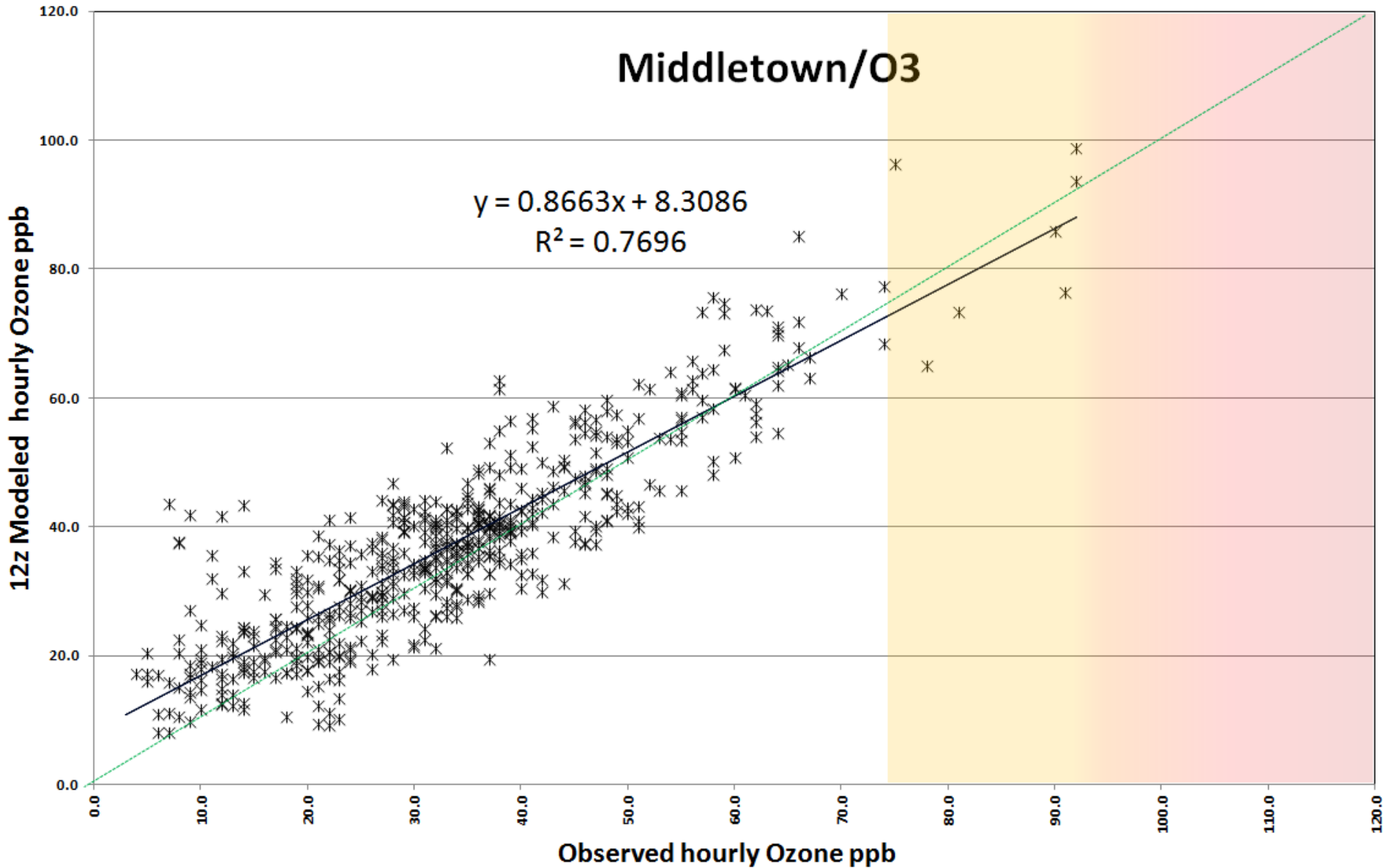
Peaks are Characterized Well

NO_x Scrubbing not as Evident Further Inland - Better Agreement



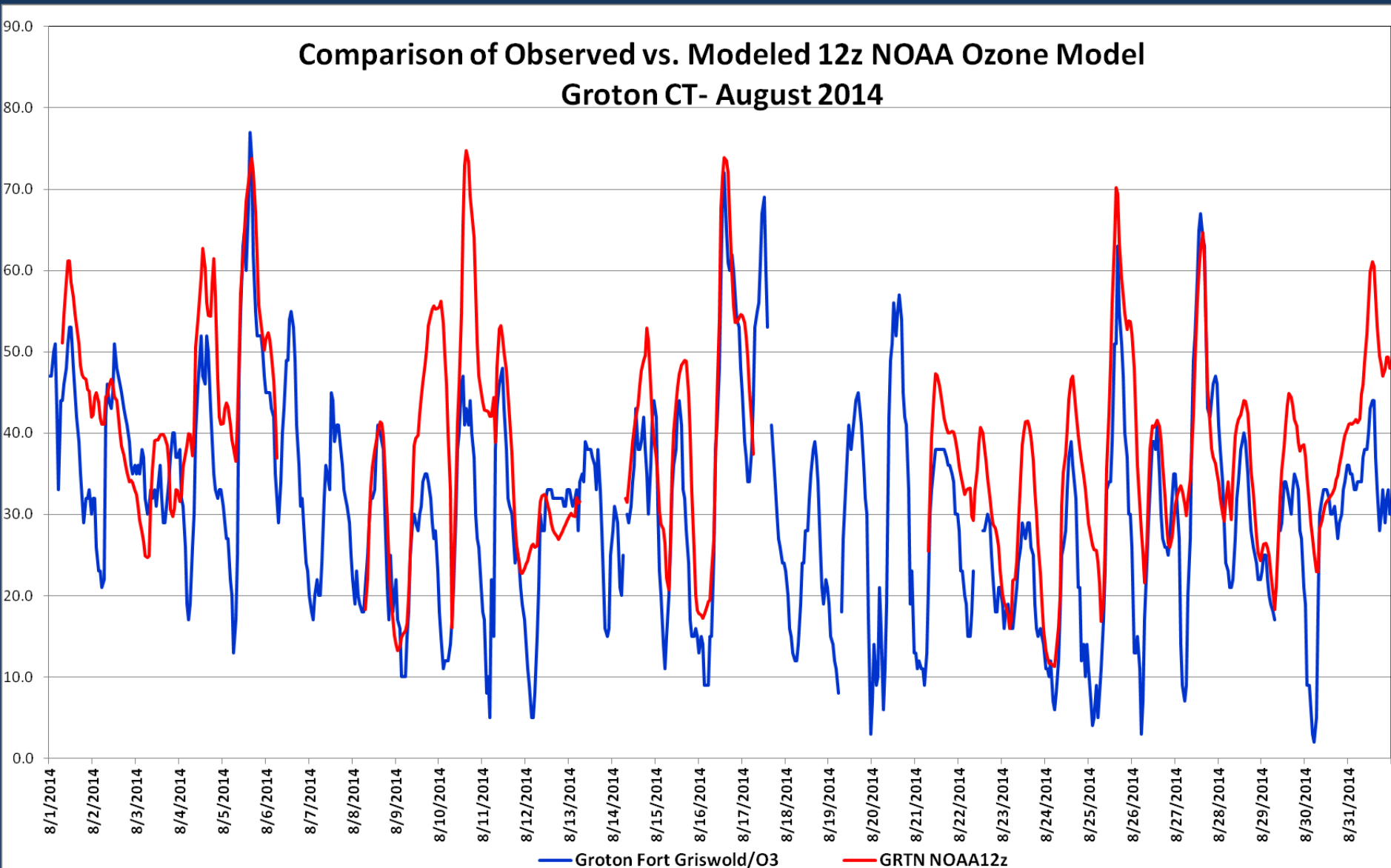
Middletown/O3

$$y = 0.8663x + 8.3086$$
$$R^2 = 0.7696$$



* Middletown/O3 — Linear (Middletown/O3)

- Some Peaks are Characterized, Some Over-Prediction
- Several Days with NO_x Scrubbing Not Captured



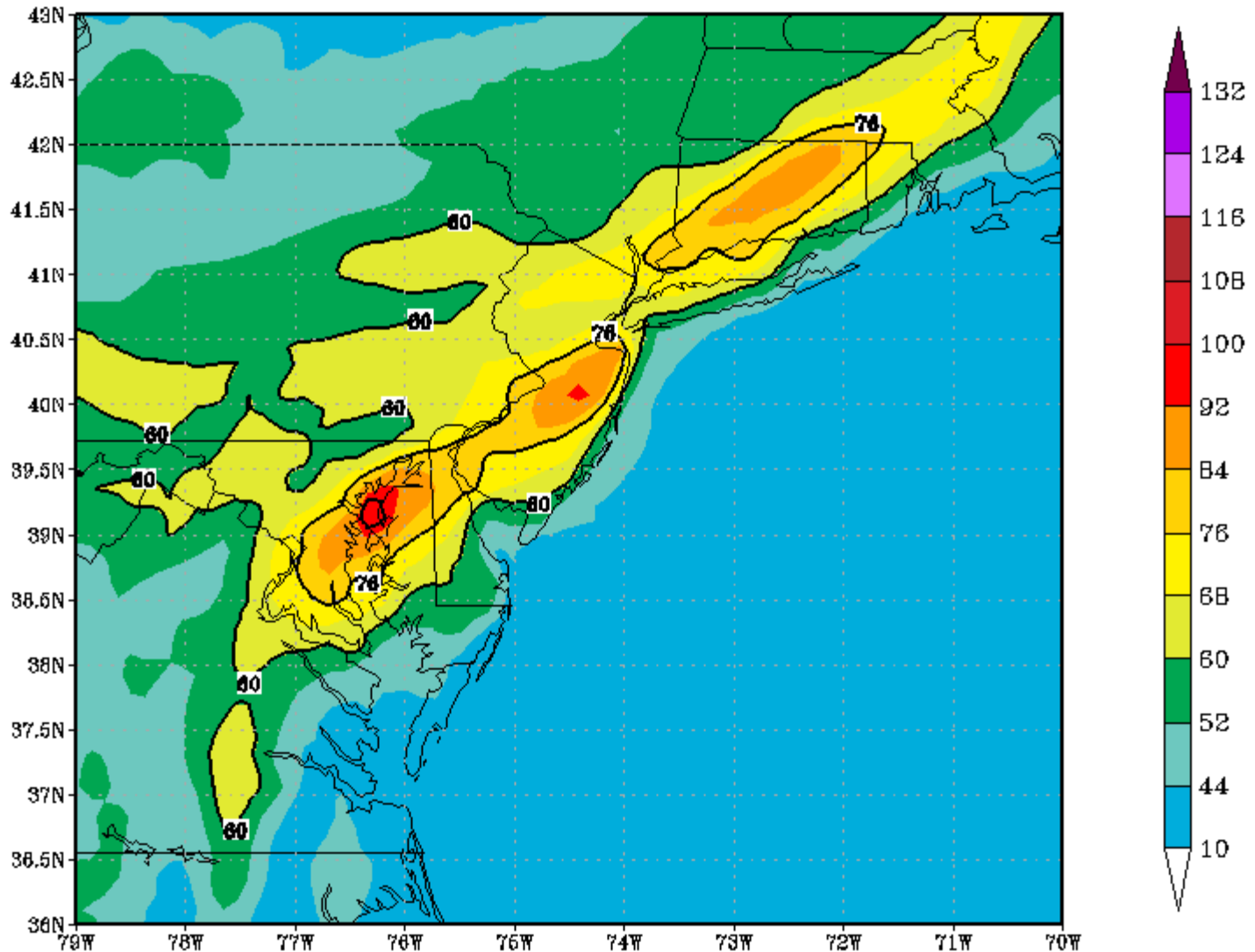
NOAA Experimental Model Conclusions

- Peaks are characterized well on most days
- NO_x scrubbing in urban areas not captured
- Scatter plots show most over-prediction occurs when concentrations < 60 ppb
- Model very useful for when it matters most: > 75ppb
- Model often showed over-prediction (esp. Westport, Danbury) when NO_x scrubbing not modeled during the morning

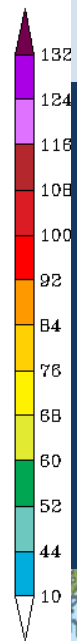
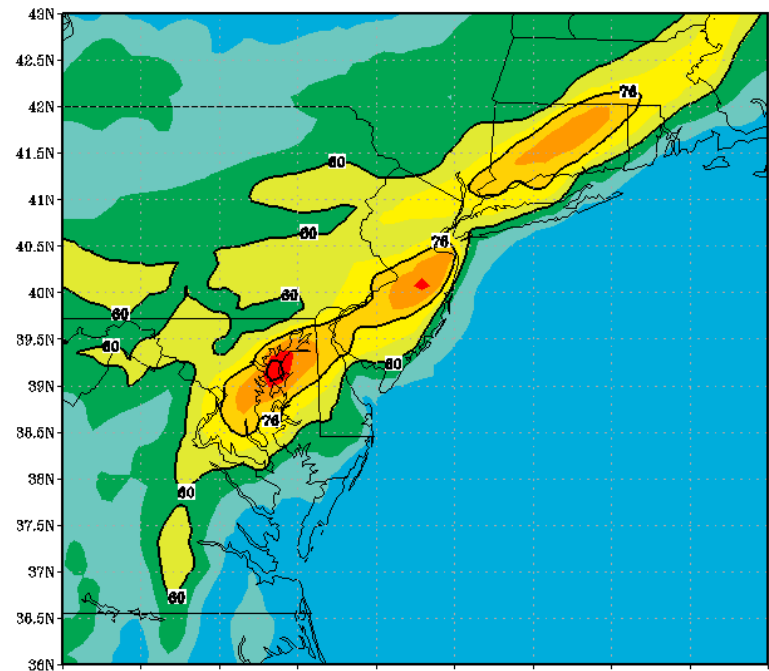


August 26th 12z Model Run

(prd) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 27 AUG 2014



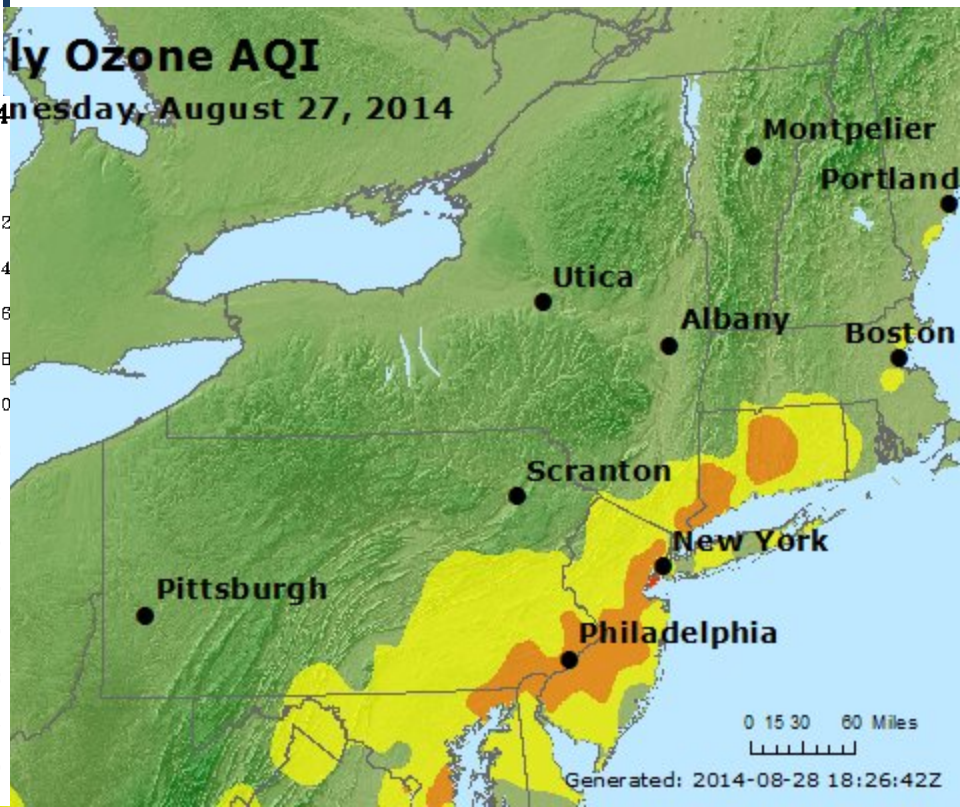
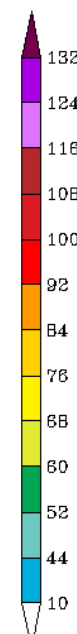
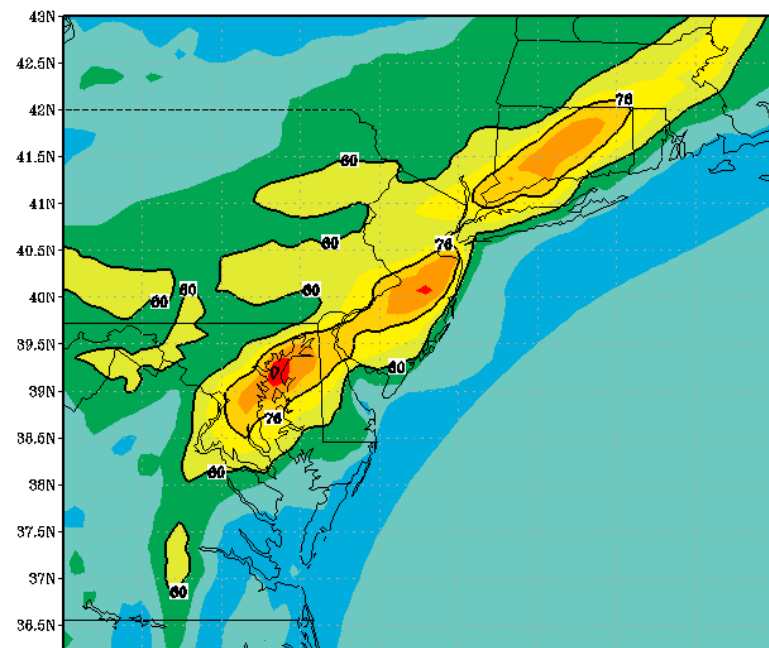
(prd) 12Z 25H-48H 2 day 8h maxsf O₃ (ppbv) Valid 27 AUG 2014



August 27th Ozone Event

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

(exp) 12Z 25H-48H 2 day 8h max sf O₃ (ppbv) Valid 27 AUG 2014

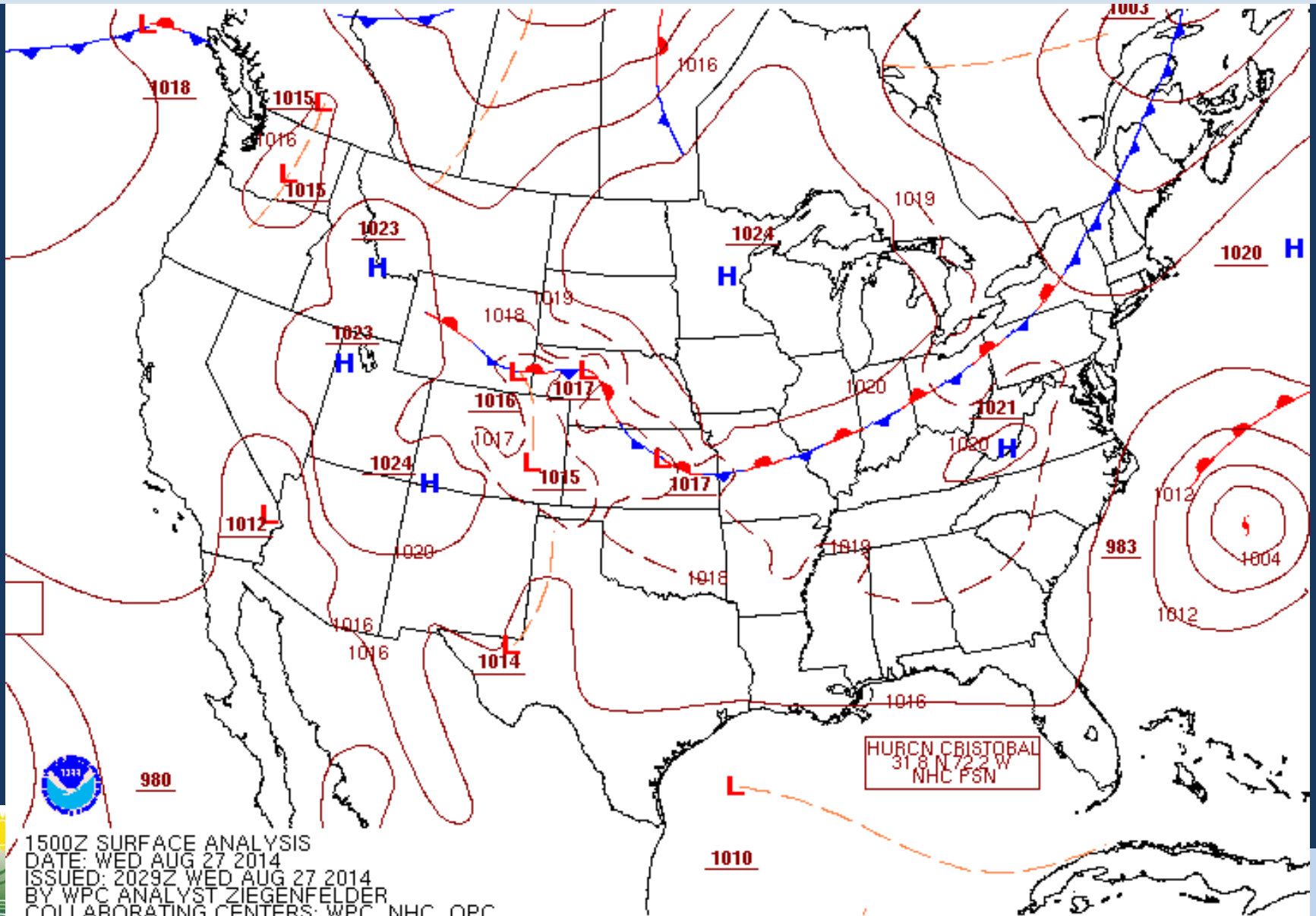


August 27th, 2014 Ozone Event

Site	Max 8-hour Ozone ppb	8/26/2014 EXP 12z ppb	8/26/2014 PROD 12z ppb
Cornwall	51	59	60
Danbury	82	75	78
East Hartford	82	87	85
Greenwich	81	--	--
Groton	59	58	58
Madison-Beach	68	69	68
Middletown	80	86	86
New Haven	75	85	82
Stafford	74	81	81
Stratford	73	79	78
Westport	88	80	76

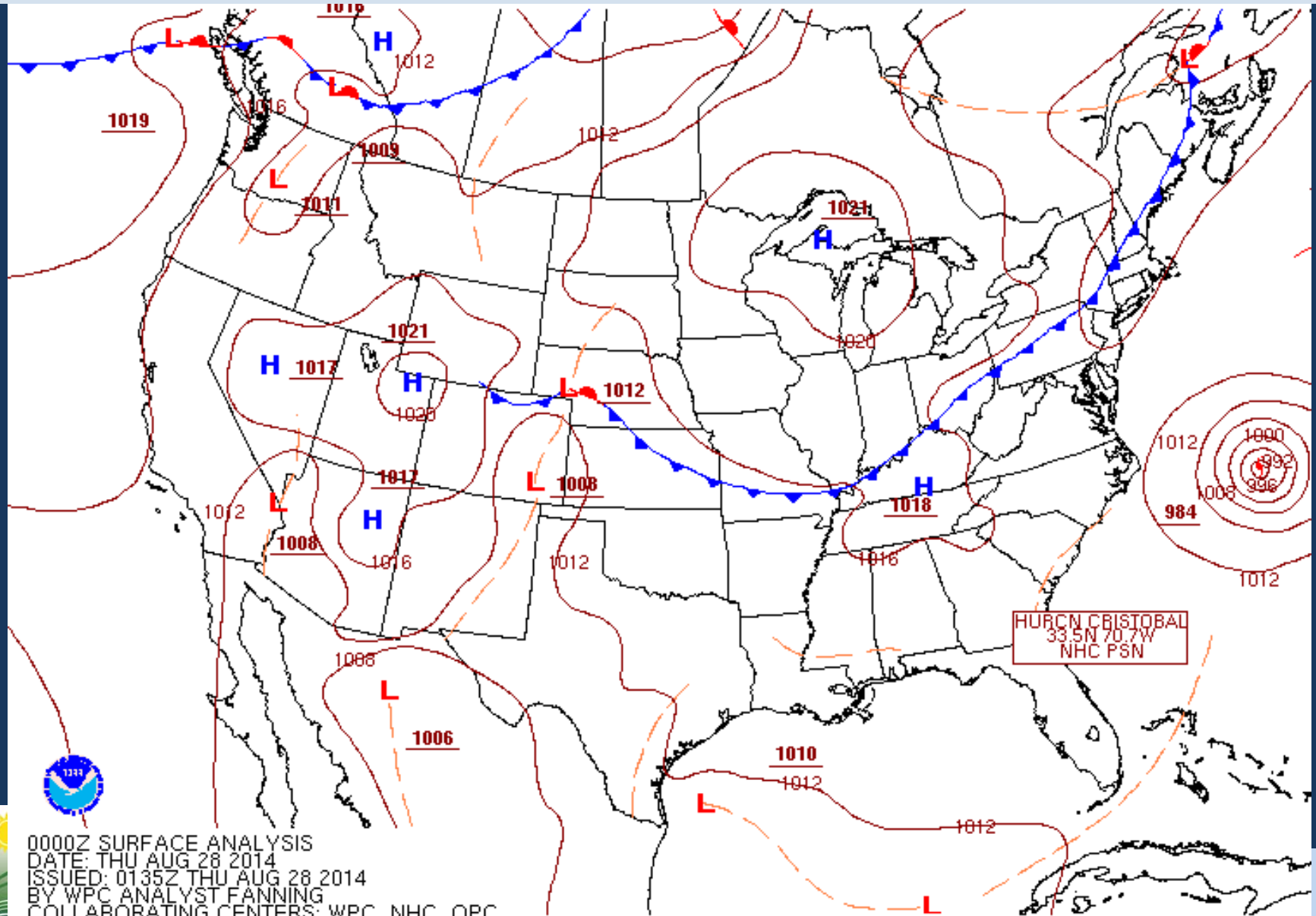


August 27th, 2014 (15z)



1500Z SURFACE ANALYSIS
DATE: WED AUG 27 2014
ISSUED: 2029Z WED AUG 27 2014
BY WPC ANALYST ZIEGENFELDER
COLLABORATING CENTERS: WPC, NHC, OPC

August 28th, 2014 (00z)



September Maximum 8-Hour Ozone Concentrations

Connecticut Department of Environmental Protection 8-Hour Ozone Daily Maximums* September 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	
Abington	41	38	39	54	48	45	29	32	30	36	34	29	27	25	35	36	40	42	31	40	29	30	29	27	16	40	31	51	32	17	
Cornwall	36	49	41	59	64	48	36	36	32	38	31	29	27	27	38	33	43	46	34	43	33	33	33	34	28	38	43	49	41	24	
Danbury	51	59	40	63	66	53	33	33	25	40	37	30	24	30	37	37	43	45	35	48	31	30	34	33	21	36	40	57	30	17	
East Hartford	47	73	38	57	63	60	33	38	36	38	36	31	28	30	31	27	39	41	33	44	31	30	29	33	17	35	42	50	22	18	
Greenwich	59	69	53	69	53	61	33	38	33	41	43	32	31	31	43	41	47	54	38	46	37	31	28	36	24	45	40	57	39	21	
Groton	50	53	43	59	43	41	31	30	31	36	34	33	29	28	38	38	44	49	34	41	37	35	30	35	20	39	41	67	34	17	
Madison	57	59	43	67	51	47	36	34	32	39	40	40	30	35	44	46	52	57	38	46	38	36	34	37	21	37	44	66	42	20	
Middletown	60	70	42	61	57	63	36	31	33	37	40	35	30	32	38	29	43	47	36	45	35	33	32	34	19	38	48	71	32	19	
New Haven	59	65	39	64	51	63	33	33	30	36	28	32	27	30	34	33	38	49	33	41	35	31	23	33	14	37	45	63	31	18	
Stafford	43	62	37	58	62	57	28	36	34	35	38	29	28	26	33	33	37	41	33	43	33	29	29	31	19	31	36	55	34	17	
Stratford	60	73	46	66	50	61	35	36	32	40	35	30	31	29	44	43	48	48	39	45	36	31	33	36	23	41	45	57	36	24	
Westport	69	76	47	67	57	61	32	35	29	38	43	31	24	29	37	37	48	45	33	45	38	29	29	34	20	40	44	63	25	18	
# days > Federal Standard		8																													

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)

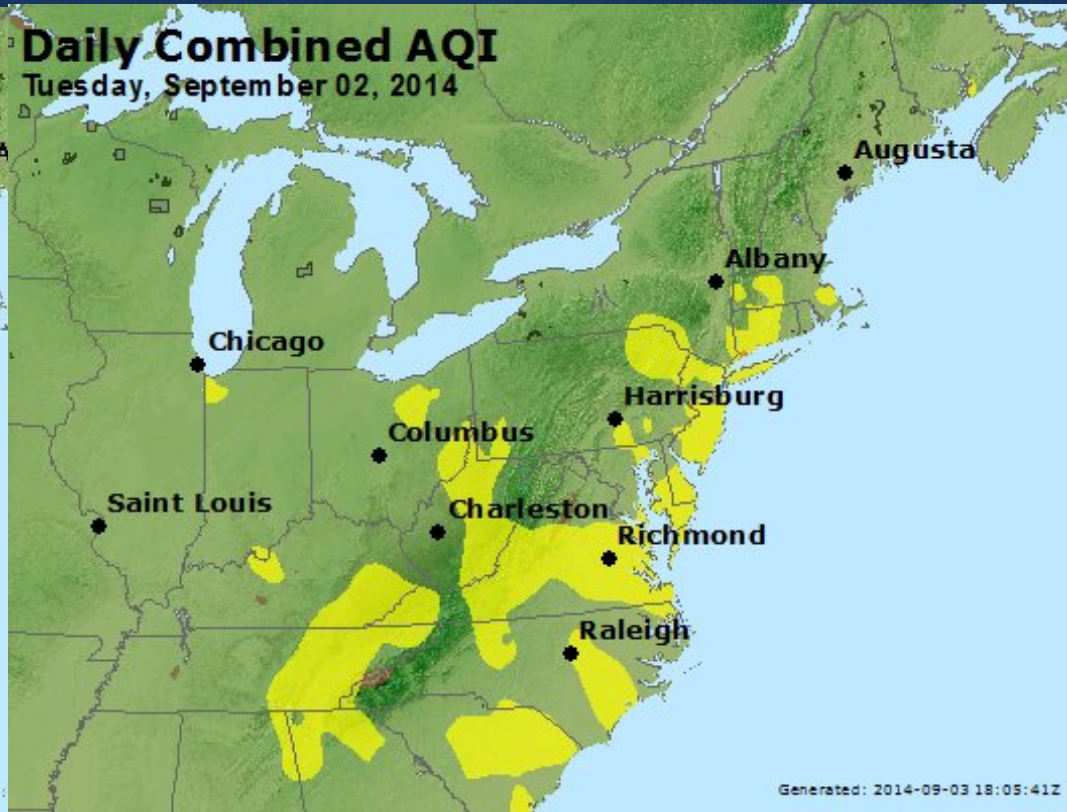
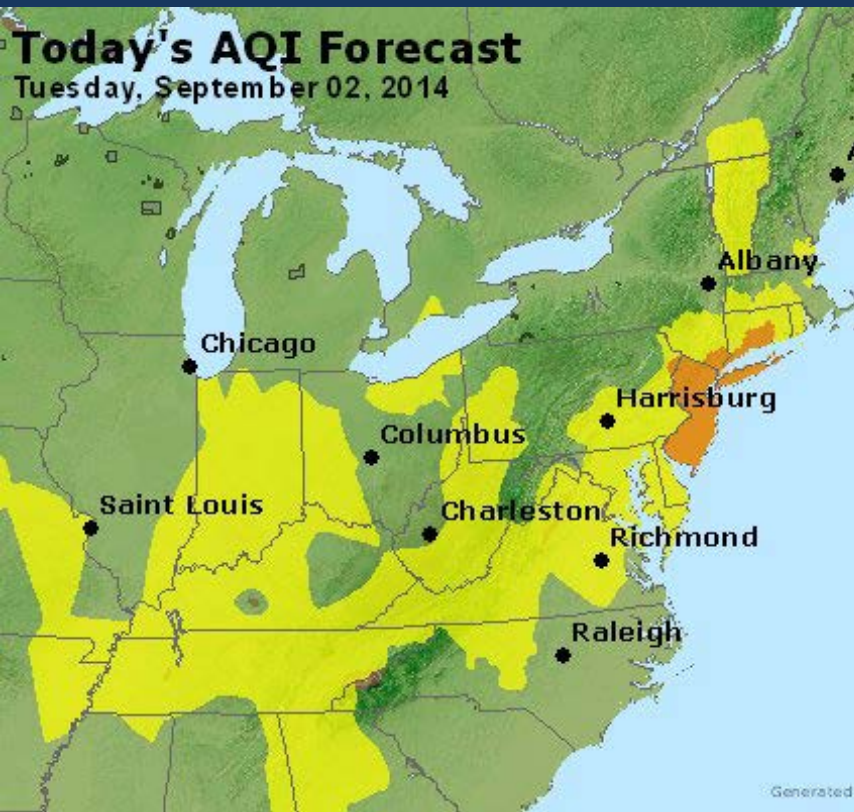
Federal Standard = 75 ppb

M = missing data

* Data is preliminary and has not been quality assured

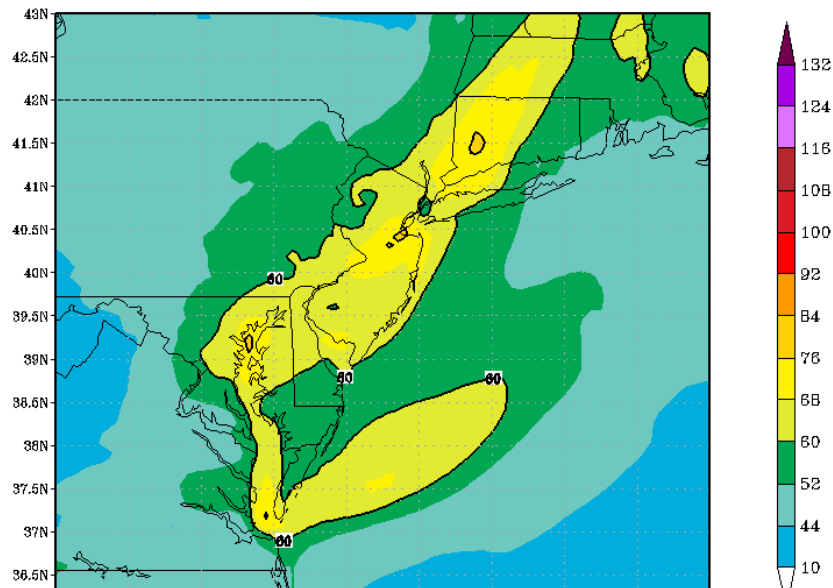


September 2nd AQI Maps

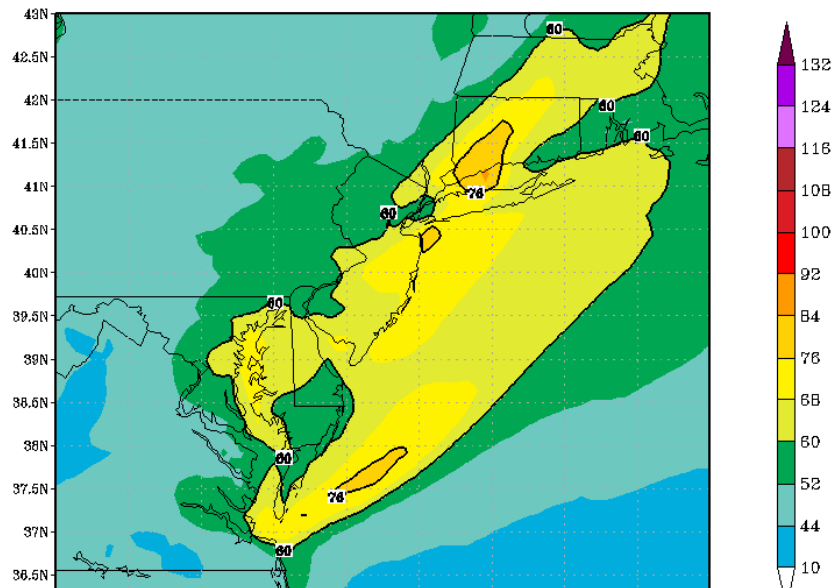


September 2, 2014 event EXP model

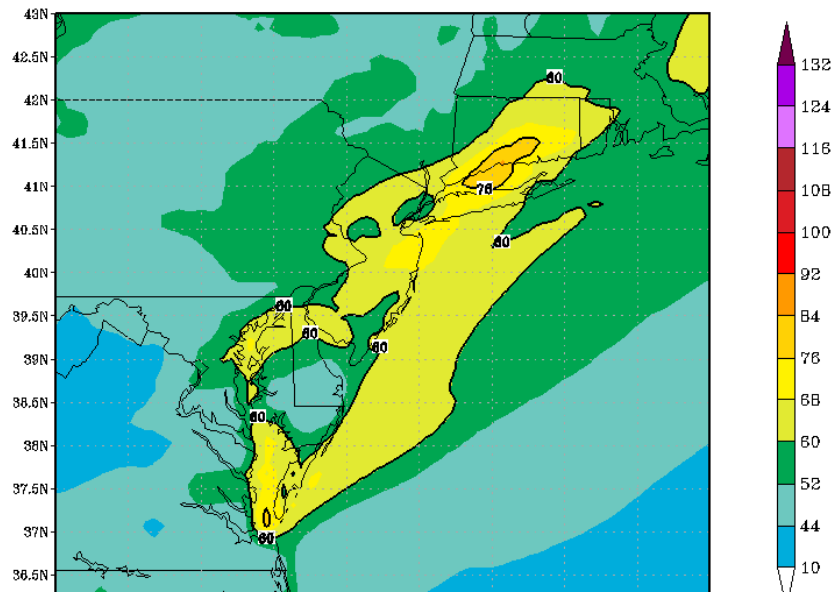
(exp) 06Z 31H-48H 2 day 8h max sf O_3 (ppbv) Valid 02 SEP 2014



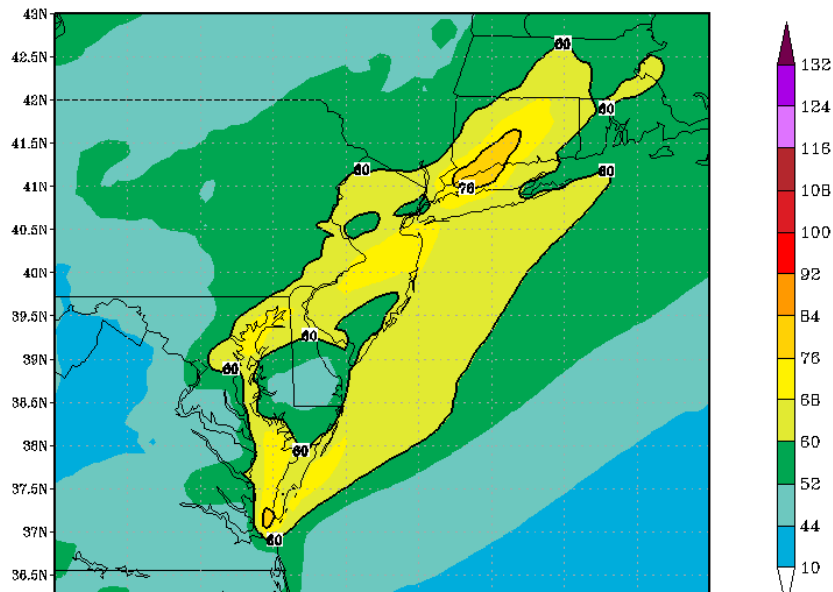
(exp) 12Z 25H-48H 2 day 8h max sf O_3 (ppbv) Valid 02 SEP 2014



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

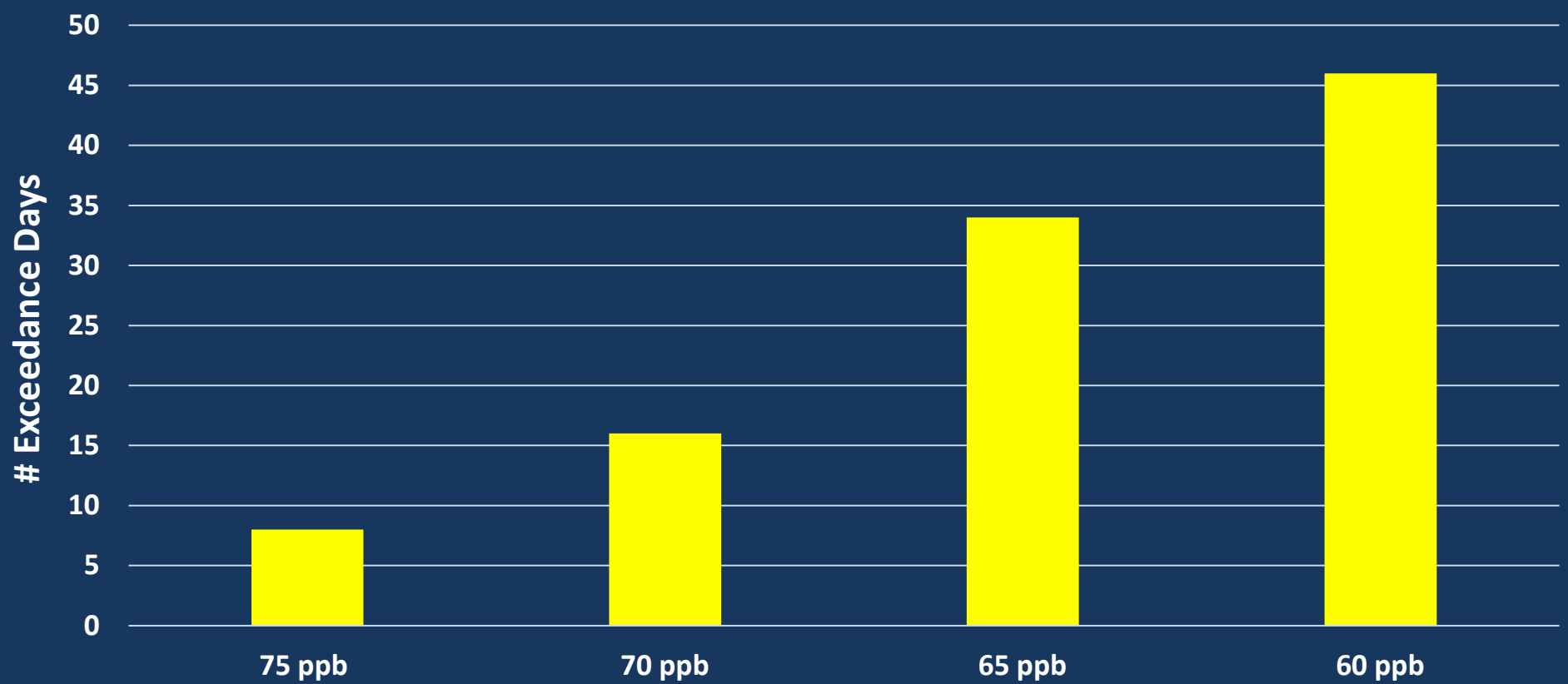


(exp) 12Z 1H-24H 1st d 8h max sf O_3 (ppbv) Valid 02 SEP 2014



8-Hour Current and Future Ozone Standards/Exceedance Days

Number of CT Exceedance Days in 2014 Compared to Potential 2015 Ozone NAAQS



Current NAAQS

Range of NAAQS Under Consideration by EPA



Why Are You Required To Restrict Testing Engines

- Protect Human Health & Provide Better Quality of Life
- Get Neighboring States to Cut Their Emissions Similar to Ct RACT Limits
- Ct Sources' Impact within Ct & Downwind States
- EPA will propose a revised 8-Hour Ozone NAAQS ranging between 60-70 PPB in 2015
- Connecticut Non-attainment Statewide with the Current 8-Hour Ozone Standard of 75ppb
- Any questions?



2014 Ozone Season Wrap-Up

- Recent Model Improvements Have Allowed Ct Forecasters to Increasingly Trust the Model Output.
- 24-Hour Modeled Forecasts Have Become Nearly as Reliable as the Same Day Model Runs.
- Still Challenging for Extended Forecasting Beyond 24 Hours, i.e. Weekend Forecasts
- Experimental NOAA Model Becomes Operational November
- EPA Will Proposed Revised 8-Hour Ozone NAAQS as Recommended by CASAC Ranging 60-70ppb



Questions?

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