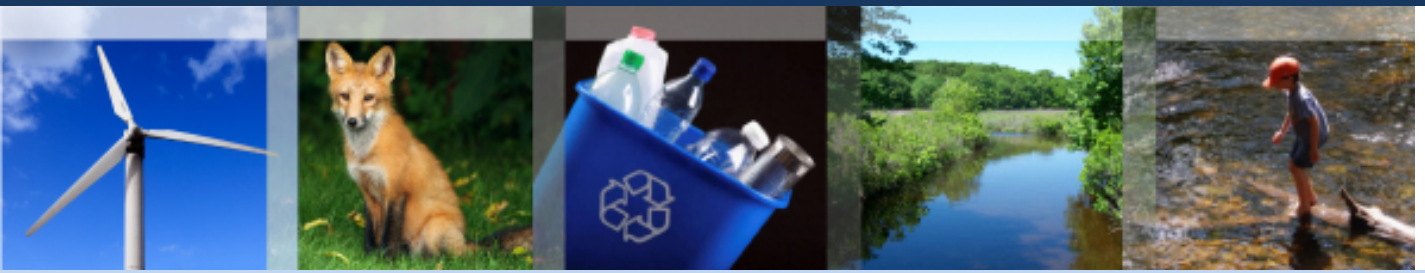
Connecticut Department of Energy and Environmental Protection



Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

2015 Ozone Season Forecasting Preliminary Summary

Michael Geigert, Sam Sampieri & Jude Catalano

August 13, 2015

SIPRAC Meeting

Connecticut Department of Energy and Environmental Protection

2015 Ozone Season So Far

12 Days (to date) over the 8-Hour Ozone NAAQS

Last Year: Only 8 Days

8 Days >=90° (BDL)So Far This Summer

How are we doing this year?

Actual Exceedences Days = 12
Forecast Exceedences Days = 7

Month	Actual Dates	Forecast Dates
May	4, 8 26	8
June	11, 12	11
July	1, 19, 20, 21, & 29	12, 19, 21,28 & 29
August	3, 4	
September		
Total	12	7

A sample of the 2015 exceedances

May 4
June 11
June 12
July 12

May Maximum 8-Hour Ozone Concentration

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
May 2015

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	M	M	52	67	M	48	61	70	40	48	40	57	46	55	63	45	52	49	33	29	49	53	42	67	61	59	41	47	46	30	20
Cornwall	42	49	55	76	M	54	66	84	42	44	50	59	45	58	67	M	M	M	43	45	52	54	49	66	71	67	53	51	46	51	34
Danbury	39	49	55	71	66	47	60	84	41	39	41	56	31	49	65	43	51	45	35	30	44	52	42	68	70	77	48	54	50	44	28
East Hartford	40	47	57	70	64	45	67	79	40	50	42	54	36	55	60	50	54	51	36	31	48	53	42	64	65	72	54	55	53	39	29
Greenwich	42	44	51	61	68	49	56	62	43	30	30	61	38	54	63	42	57	46	36	32	41	53	46	63	60	62	49	54	41	33	49
Groton	40	40	46	64	67	49	61	57	43	39	26	57	41	53	58	46	56	49	37	30	45	55	48	63	58	49	40	42	43	26	34
Madison	42	40	45	63	M	44	57	58	44	33	27	66	37	53	55	42	57	50	39	33	46	53	49	65	59	55	43	48	41	32	32
Middletown	42	46	56	69	70	47	65	78	40	47	39	60	36	55	64	48	56	49	35	32	47	51	44	70	62	67	47	55	46	33	31
New Haven	43	44	49	56	47	48	35	58	42	33	20	53	38	48	46	42	46	50	33	32	39	53	44	64	61	59	36	50	39	31	36
Stafford	39	45	54	72	61	50	67	74	41	52	47	51	43	53	61	47	52	51	36	29	45	51	42	62	61	72	49	53	43	40	32
Stratford	43	44	49	63	69	46	54	55	46	35	27	63	39	53	57	43	56	50	41	32	45	53	47	63	58	57	46	50	40	28	33
Westport	42	44	48	61	M	44	60	64	40	35	28	58	32	52	59	39	61	43	31	30	41	52	45	64	60	62	44	52	39	33	40
# days > Federal Standard				1				2																		3					

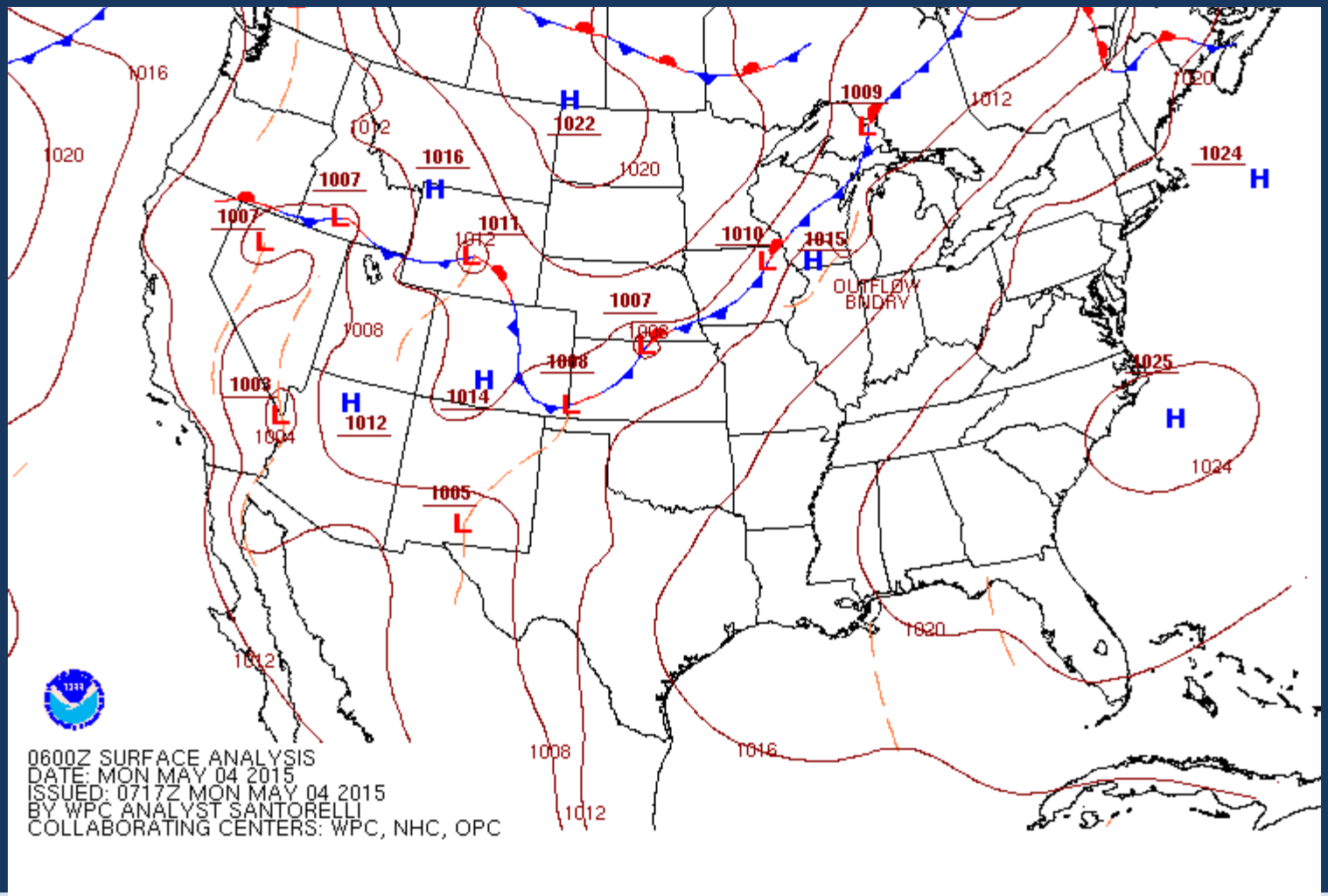
Good (0-59 ppb)
Moderate (60-75 ppb)
Unhealthy for Sensitive Groups (76-95 ppb)
Unhealthy (96-115 ppb)
Very Unhealthy (116 > ppb)

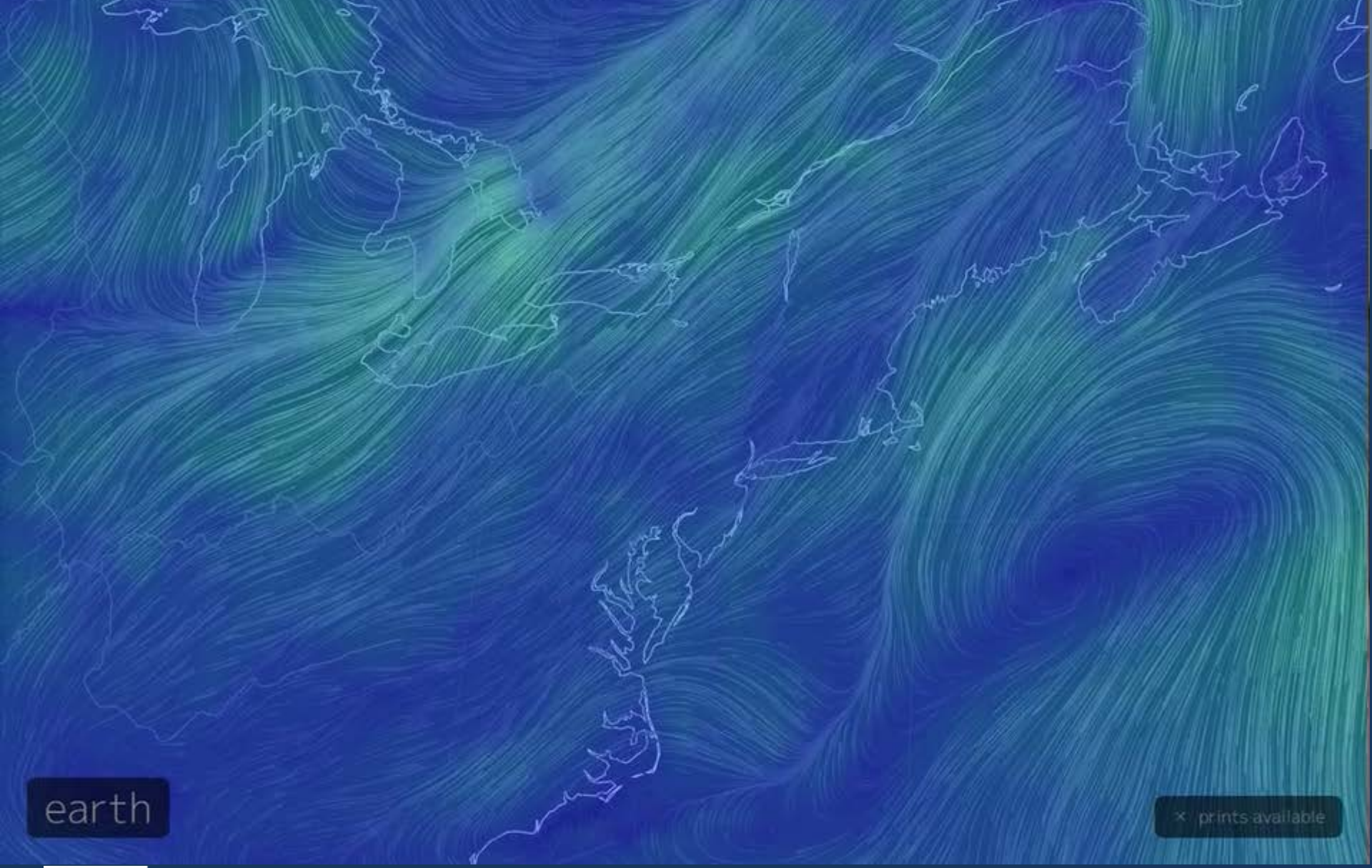
Units - parts per billion (ppb)
Federal Standard = 75 ppb
M = missing data
* Data is preliminary and has not been quality assured

CT May 4, 2015 8-Hr Maximum Ozone Averages

Site	Site AQS	Param	Param AQS	POC	Method	Duration	Date	Unit	0
Cornwall	090050005	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	76
Danbury	090011123	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	71
East Hartford	090031003	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	70
Greenwich	090010017	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	61
Groton Fort Griswold	090110124	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	64
Madison-Beach Road	090099002	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	63
Middletown	090070007	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	69
New Haven - Criscuolo Park	090090027	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	56
Stafford	090131001	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	72
Stratford	090013007	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	63
Westport	090019003	O3	44201	1		8 Hr begin time Avg-Daily Max	05/04/2015	PPB	61

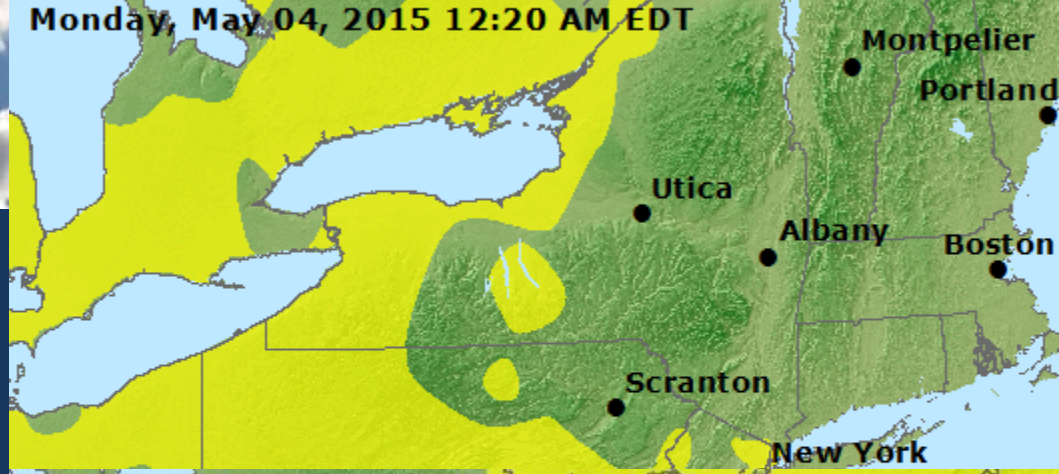
Weak high pressure off the coast with southwest winds developing during the day





Note sea breeze convergence zone developing in afternoon

- Most areas in the northeast averaged moderate air quality on May 4th.
- Cornwall monitor was the only ozone exceedance.



- The Cornwall Monitor in Connecticut recorded the only 8-hour ozone exceedance in New England

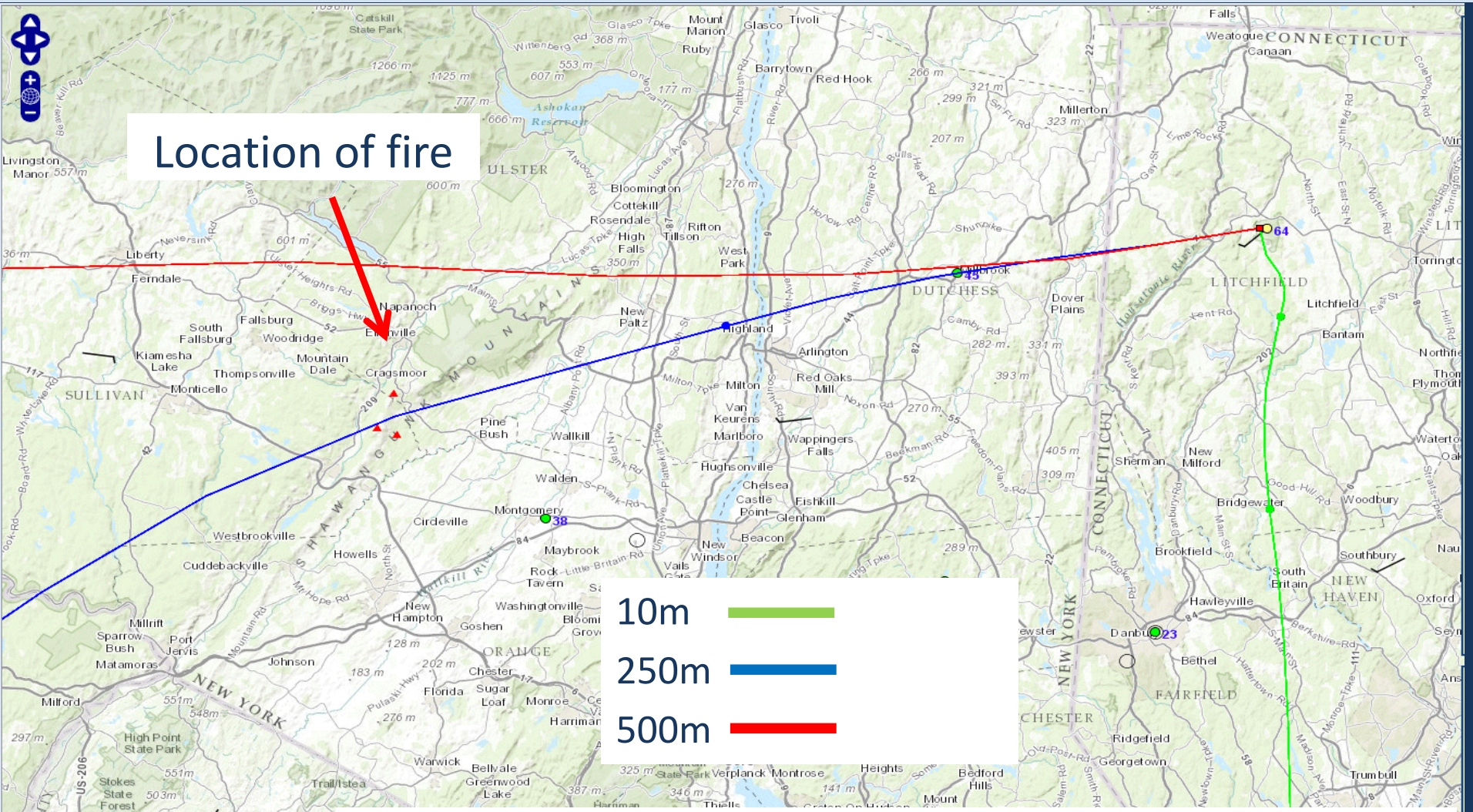
  on May 4, 2015
- 8-hour average = 76 ppb
- Current NAAQS = 75 ppb

- Modeled ozone values are typically under-predicted by 5-10 ppb in the April- May timeframe (vegetation releasing Ozone Precursors such as VOC’s & Isoprene's?)
- This produces a challenge for forecasters early in the season, since exceedances can occur with temperatures well below 90° F. What is the new norm?? 85° F

- Did the NY wild fire contributed a few ppbs to the ozone levels at Cornwall on May 4th?
- Back trajectories suggest it may be possible for a few hours in the morning
- Forward trajectories suggest plume impacted northern England

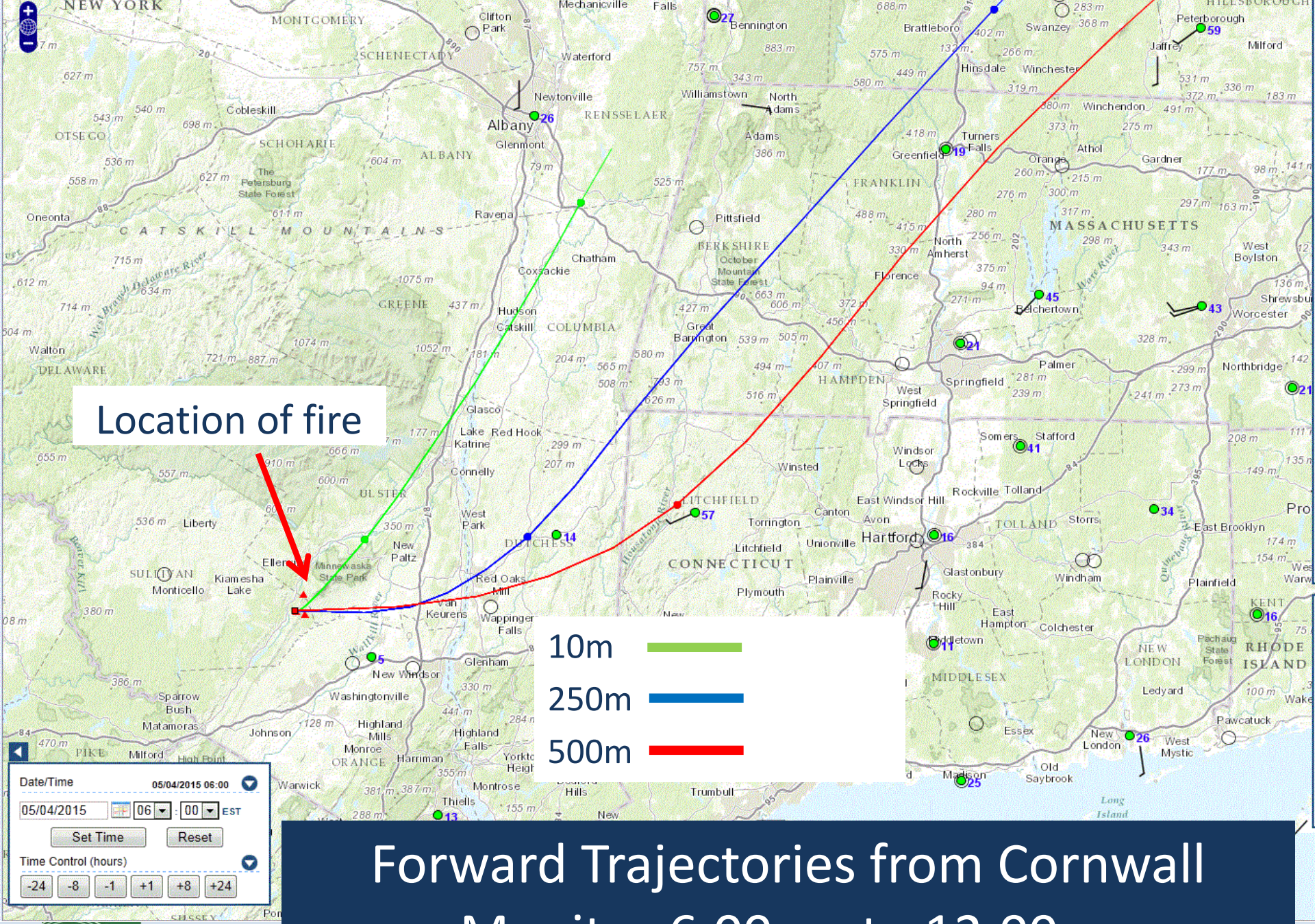
The brush fire on the Shawangunk Ridge is seen Tuesday morning northeast of Ellenville, N.Y.

May 4th Event



Back Trajectories from Cornwall Monitor

8:00am to 6:00ppm



Forward Trajectories from Cornwall Monitor 6:00am to 12:00ppm

Conclusion

- Wide spread MODERATE ozone event on May 4th, 2015 for New England
- Warmest day of the year (high temp reached 87° at BDL), combined with southwest winds and sea breeze convergence aided in low level exceedance at Cornwall.
- Trajectories suggest that wild fire probably not the issue

June Maximum 8-Hour Ozone Concentrations

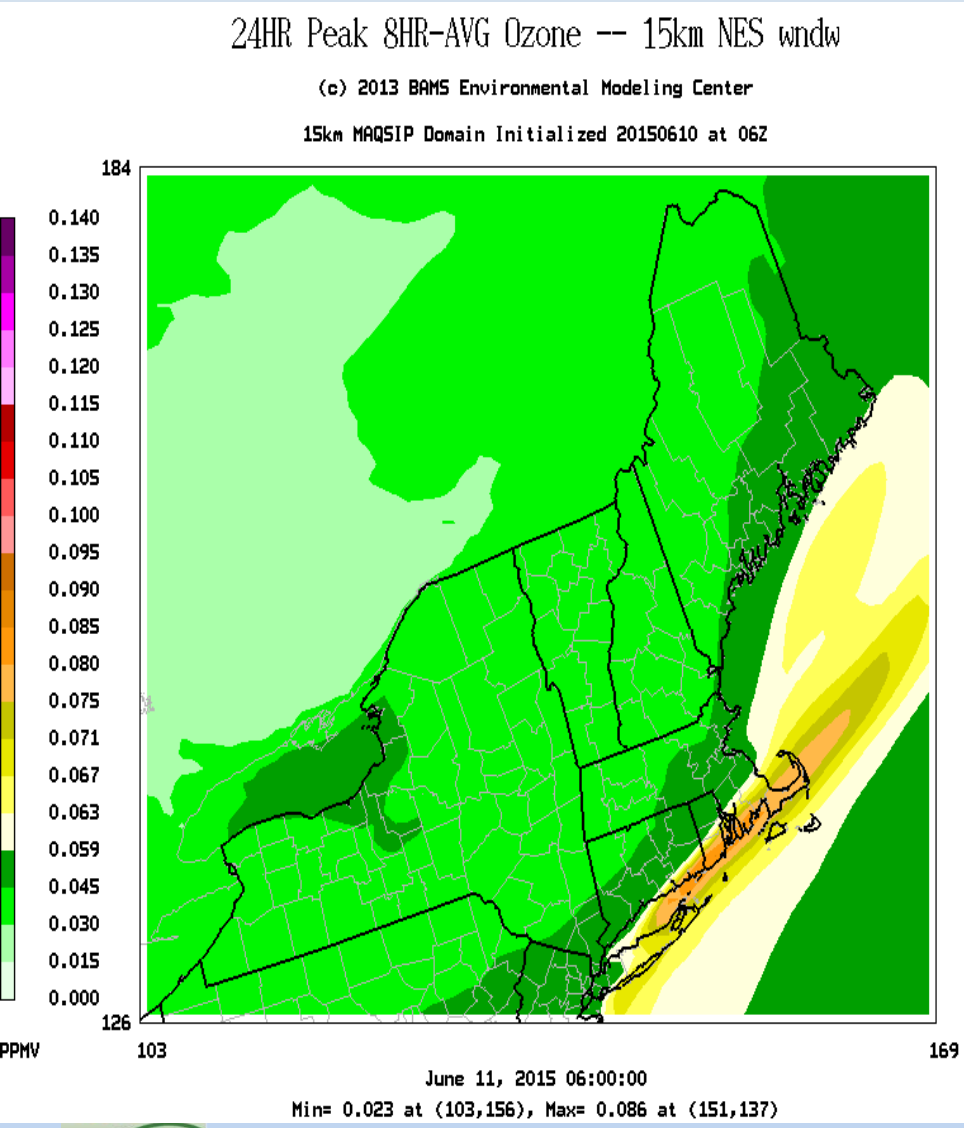
Connecticut Department of Environmental Protection
8-Hour Ozone Daily Maximums*
June 2015

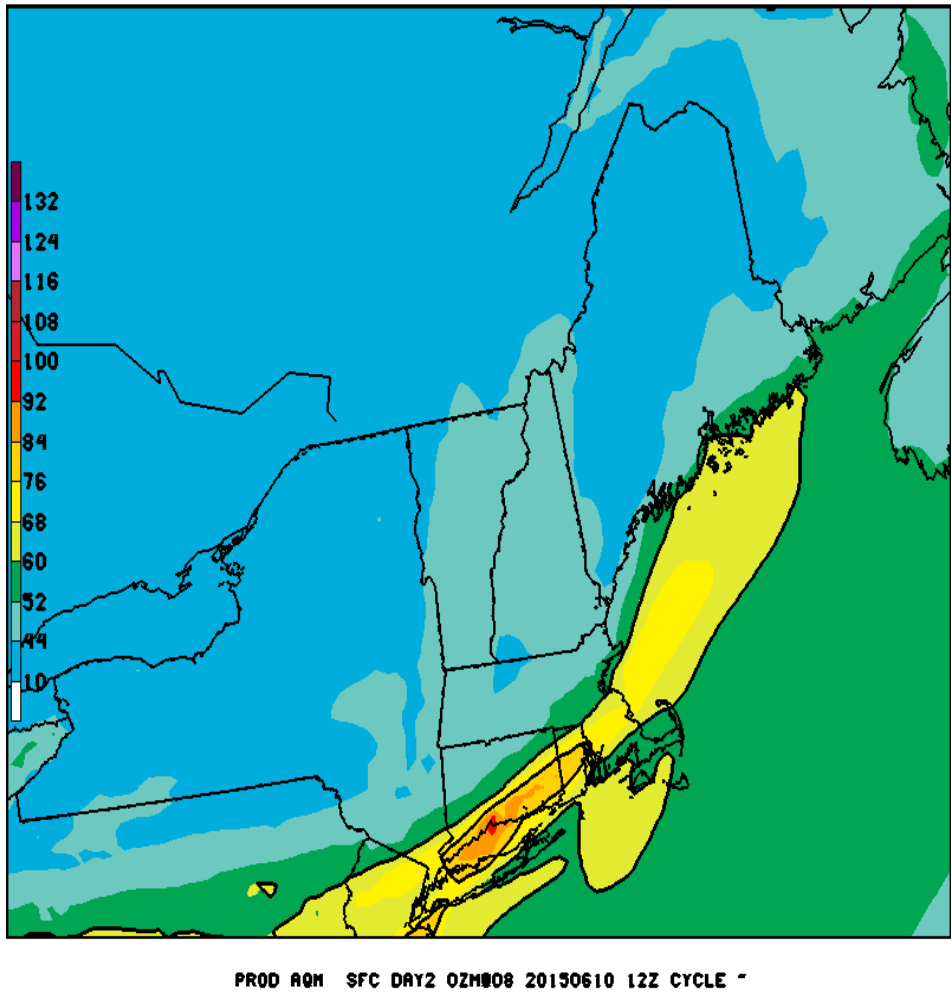
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Abington	28	28	37	40	44	40	43	45	45	60	65	M	M	M	28	41	39	48	43	31	34	44	56	40	44	42	29	28	31	50
Cornwall	31	28	33	43	42	48	52	48	54	62	56	72	43	44	40	40	36	47	48	37	37	44	53	38	44	43	39	35	35	52
Danbury	24	20	39	40	47	41	53	50	53	60	68	79	41	50	37	42	46	51	43	37	35	47	55	38	46	41	32	29	29	55
East Hartford	24	22	41	42	48	44	48	48	54	61	59	66	45	48	35	46	50	52	48	33	31	43	61	38	44	41	31	29	28	55
Greenwich	33	19	38	39	45	45	44	48	60	61	86	67	46	50	41	41	48	50	47	42	39	53	68	47	49	52	36	31	37	51
Groton	30	26	32	36	41	39	41	46	44	52	86	59	41	42	37	37	39	41	48	39	40	47	54	43	50	43	33	29	44	53
Madison	29	24	34	37	43	40	43	M	50	55	91	62	49	51	44	44	36	45	58	39	41	56	58	44	48	51	37	33	46	53
Middletown	28	20	37	36	40	44	45	48	50	66	74	64	46	49	40	45	51	46	48	33	35	43	63	38	50	41	32	28	32	54
New Haven	25	18	36	40	49	45	47	47	48	54	93	69	50	57	42	43	46	49	46	39	37	46	47	39	42	45	36	29	30	55
Stafford	26	25	37	36	45	38	45	47	50	62	57	58	37	41	34	42	35	50	40	33	30	42	62	38	41	33	31	30	23	50
Stratford	30	21	36	39	46	37	45	51	56	62	95	64	52	55	43	43	38	49	52	42	40	57	67	M	49	50	38	30	41	54
Westport	21	15	35	36	43	38	44	48	56	61	92	63	47	49	37	58	50	49	45	37	37	51	69	42	51	47	33	28	37	51
# days > Federal Standard											4	5																		

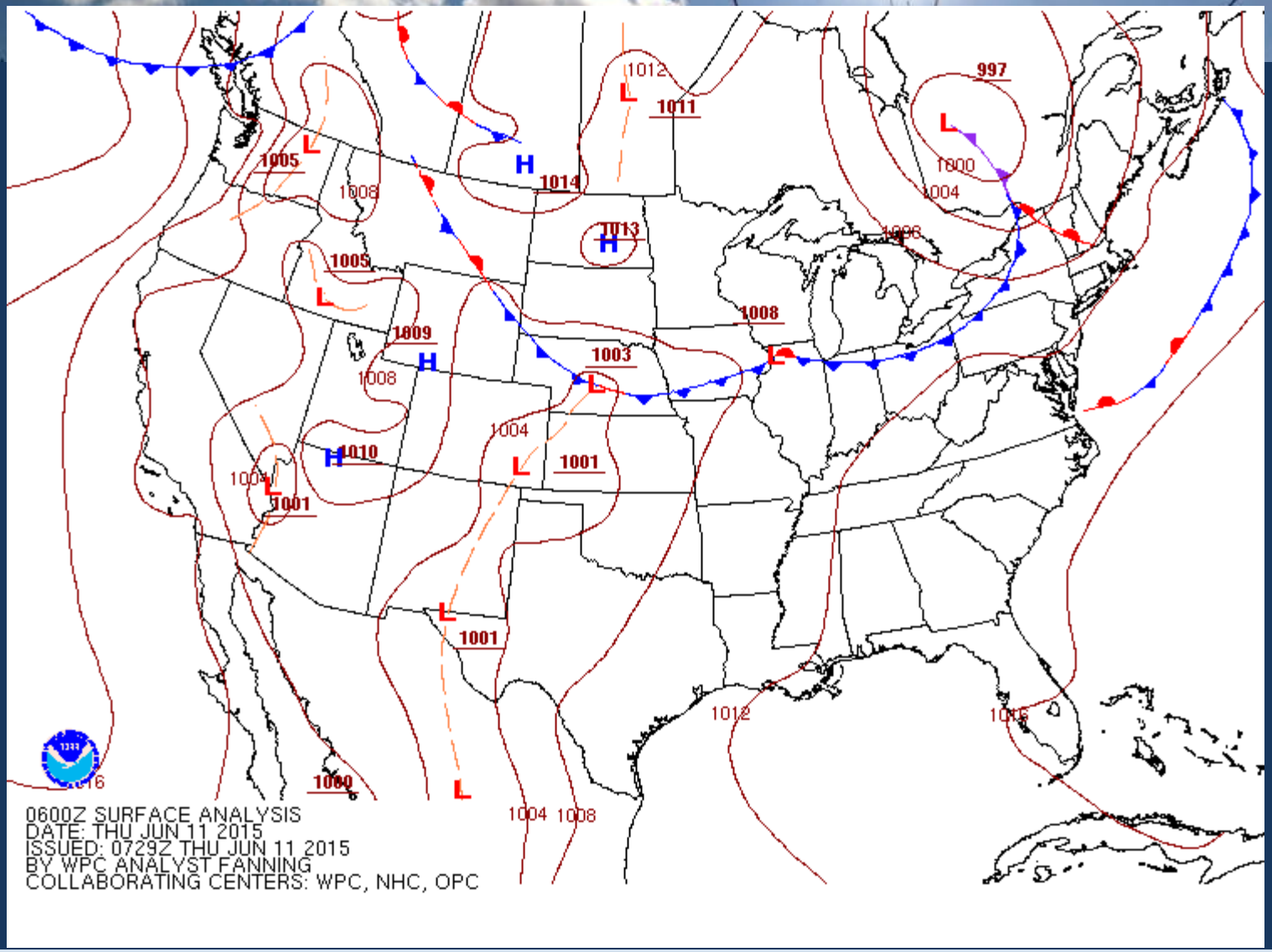
Good (0-59 ppb)
Moderate (60-75 ppb)
Unhealthy for Sensitive Groups (76-95 ppb)
Unhealthy (96-115 ppb)
Very Unhealthy (116 > ppb)

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

June 11 Modeled Analyses







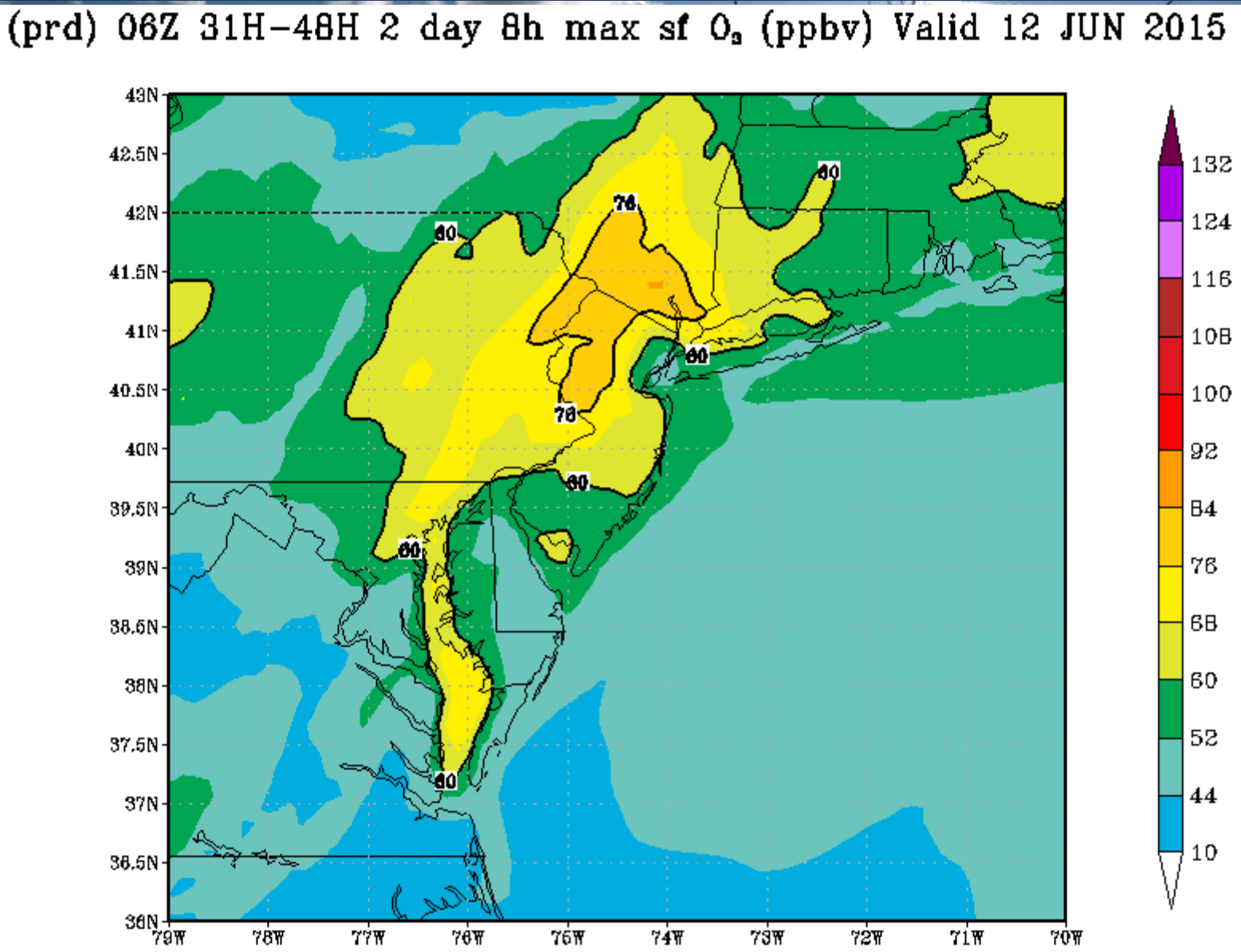
Connecticut Department of Energy and Environmental Protection

- Both models show good agreement
- NOAA model shows exceedances along entire CT coast
- Observed 8-hour averages ranged from 86ppb Groton to 95 ppb Stratford
- One day event expected at the time

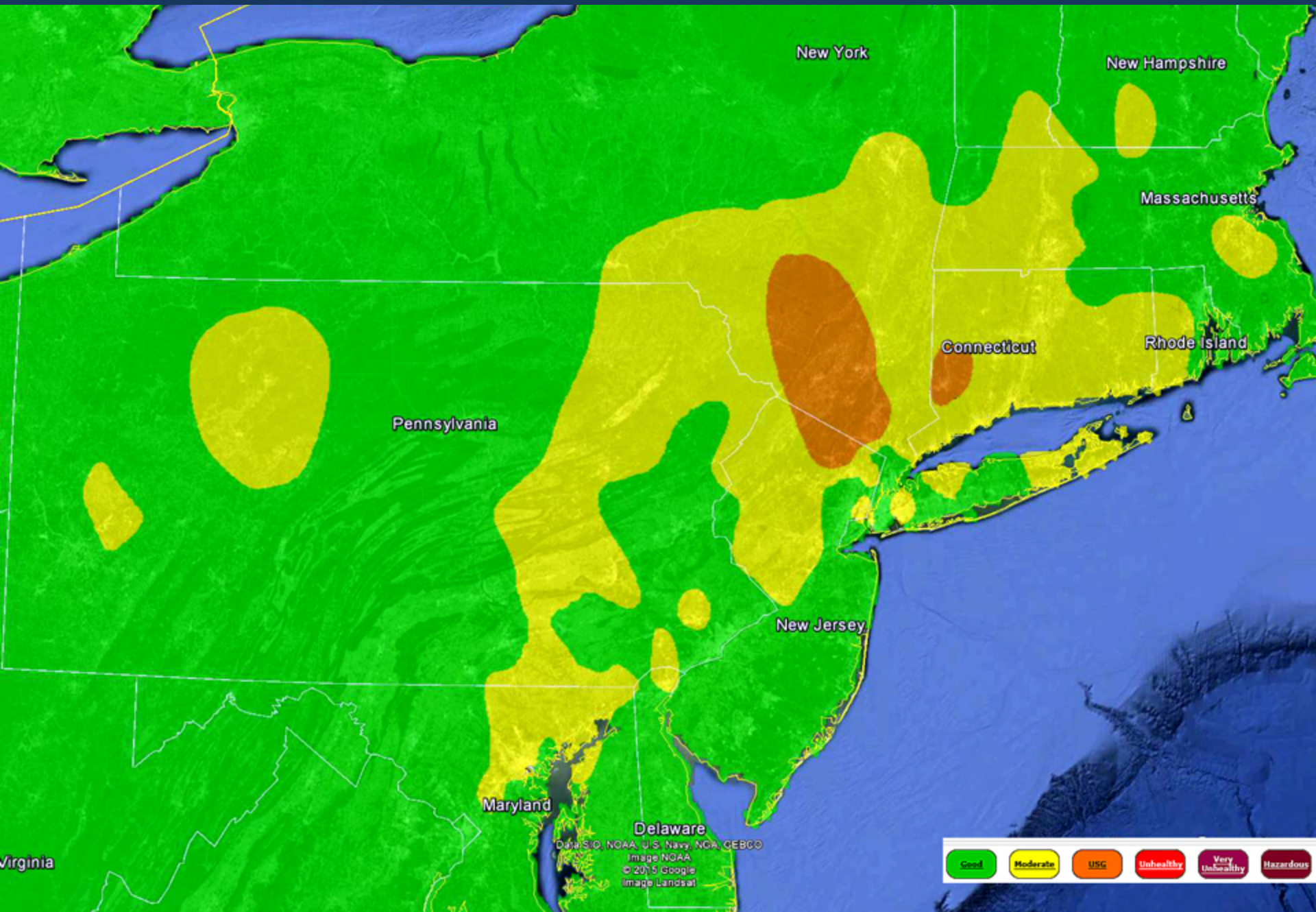
Danbury Monitor Exceeded the 8-hour Ozone NAAQS of 75 ppb

Monitor	8-hr Ozone PPB
Cornwall-Mohawk Mountain	72
Danbury-Western CT. State Univ	79
East Hartford-McAuliffe Park	66
Greenwich Point Park	67
Groton-Fort Griswold	59
Madison-Hammonasset St. Park	62
Middletown-C.V.H.-Shew Hall	64
New Haven-Criscuolo Park	69
Stafford-Shenipsit St Forest	58
Stratford-U.S.C.G. Lighthouse	64
Westport-Sherwood Island	63

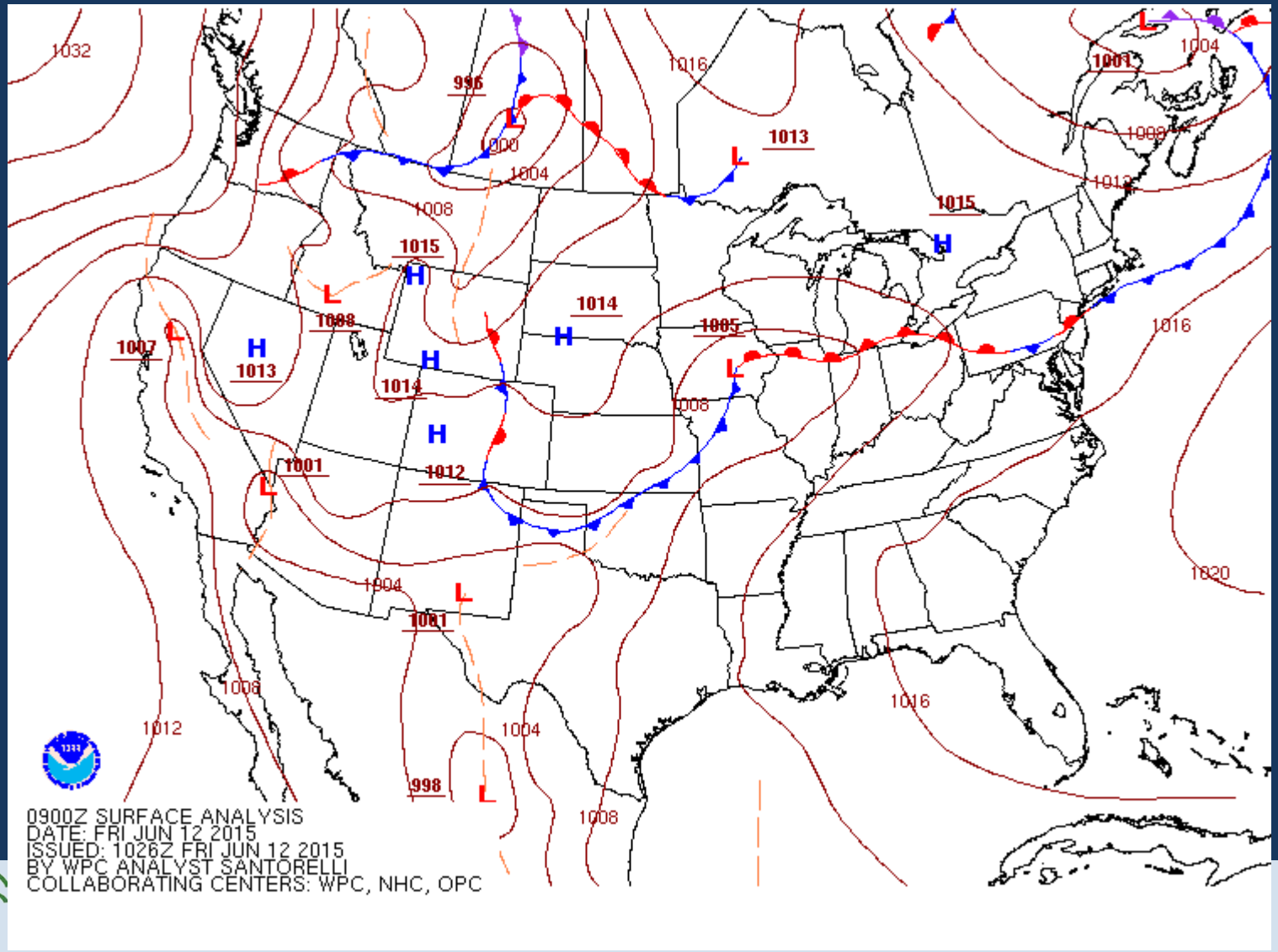
NOAA Model Animation for June 12, 2015
Shows High Moderate for Western CT



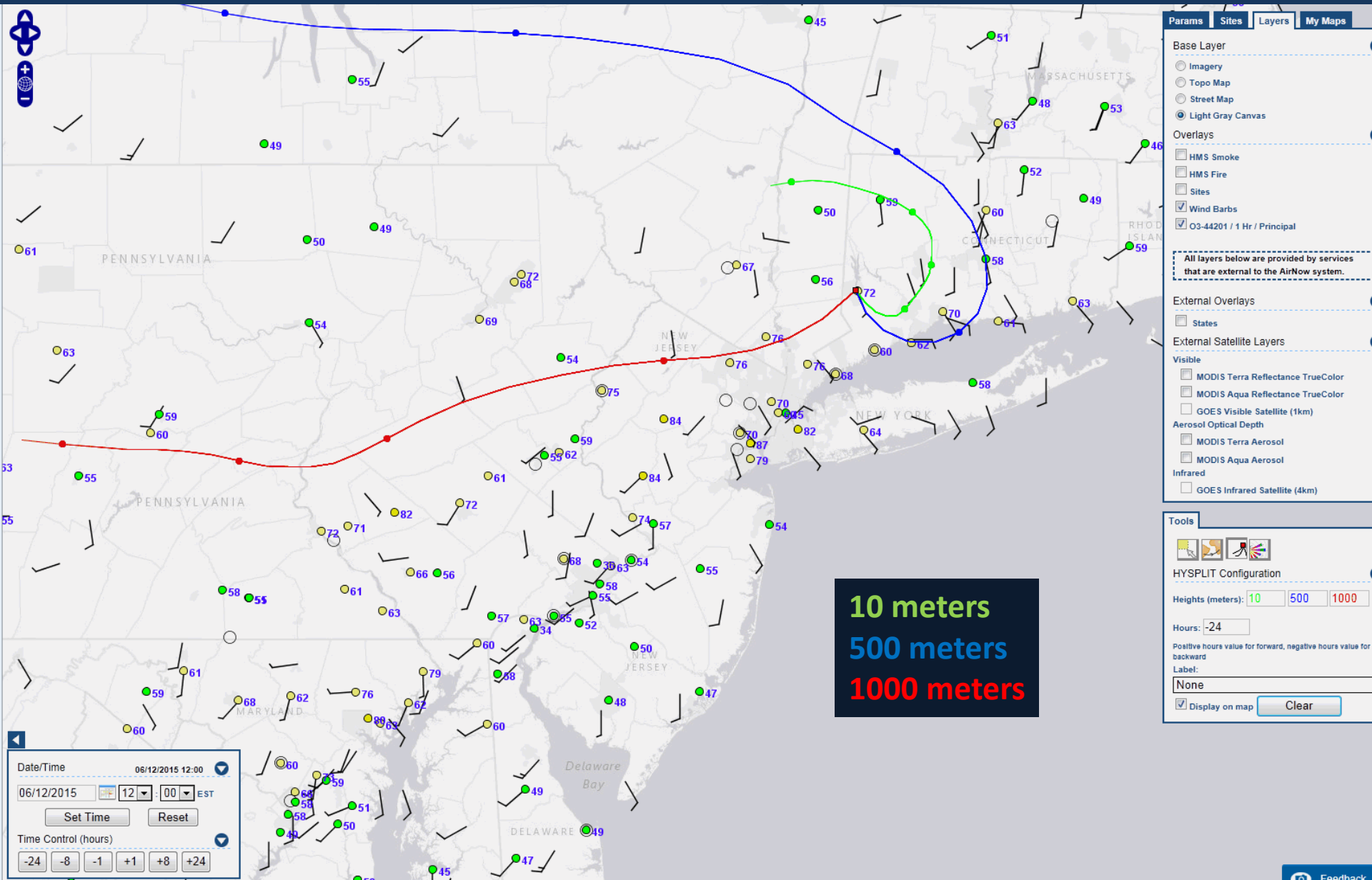
AirNow 8-hr Ozone Observed AQI Map for June 12, 2015



Surface Map Animation for June 12, 2015 Shows Warm Front Passage late in Day



Back Trajectory Animation for June 12, 2015
Shows Southwest Transport at 1000m above Ground level



- NOAA model under-predicted ozone (GOOD to MODERATE) in CT, but predicted USG for southeast New York and northern New Jersey
- Low levels trajectories were local - off LIS, but at 1000 meters, transport was from southwest
- Warm front passage was sooner than modeled, resulting in MODERATE ozone forecasted, instead of MODERATE to USG.

July Maximum 8-Hour Ozone Concentrations

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
July 2015

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	69	42	39	32	45	55	38	38	31	36	37	48	54	M	42	35	52	37	50	47	49	37	36	34	32	49	47	42	60	40	38
Cornwall	55	40	51	51	45	64	46	41	36	37	42	48	64	42	37	42	67	49	63	44	48	38	38	38	43	57	60	48	67	47	38
Danbury	60	45	41	43	52	68	50	35	39	39	40	53	74	46	40	37	67	55	72	50	58	32	39	34	45	63	66	41	70	46	39
East Hartford	60	40	48	38	46	70	38	36	40	41	43	47	62	43	45	46	65	51	69	46	53	36	37	38	42	57	61	43	53	51	37
Greenwich	69	48	56	49	62	59	52	51	45	43	48	70	62	42	43	49	56	52	79	65	M	43	46	47	56	60	55	75	84	46	46
Groton	71	44	44	43	60	51	39	65	39	41	50	56	48	43	44	37	56	39	63	71	70	41	49	45	41	48	44	56	79	34	59
Madison	78	46	47	48	59	51	45	69	45	43	57	65	51	43	41	49	58	43	60	77	73	43	M	52	45	57	55	68	87	42	61
Middletown	72	47	48	39	55	63	41	44	38	42	49	50	57	41	44	47	61	49	67	58	61	38	38	39	40	51	55	47	69	46	40
New Haven	58	49	52	44	60	60	40	45	40	40	42	44	55	43	47	48	M	46	62	49	60	38	39	38	46	57	54	53	67	28	42
Stafford	56	37	42	32	44	64	41	37	36	34	38	44	50	M	35	34	58	45	59	42	48	37	34	35	34	54	57	41	54	53	34
Stratford	75	47	53	52	60	59	49	57	44	40	53	62	57	49	43	50	60	48	80	73	76	42	50	49	53	56	59	70	79	45	55
Westport	68	48	49	46	62	59	48	53	41	41	51	63	62	42	39	42	58	52	86	64	73	42	46	45	44	57	52	74	79	44	46
# days > Federal Standard	6																		7	8	9								10		

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

Units - parts per billion (ppb)
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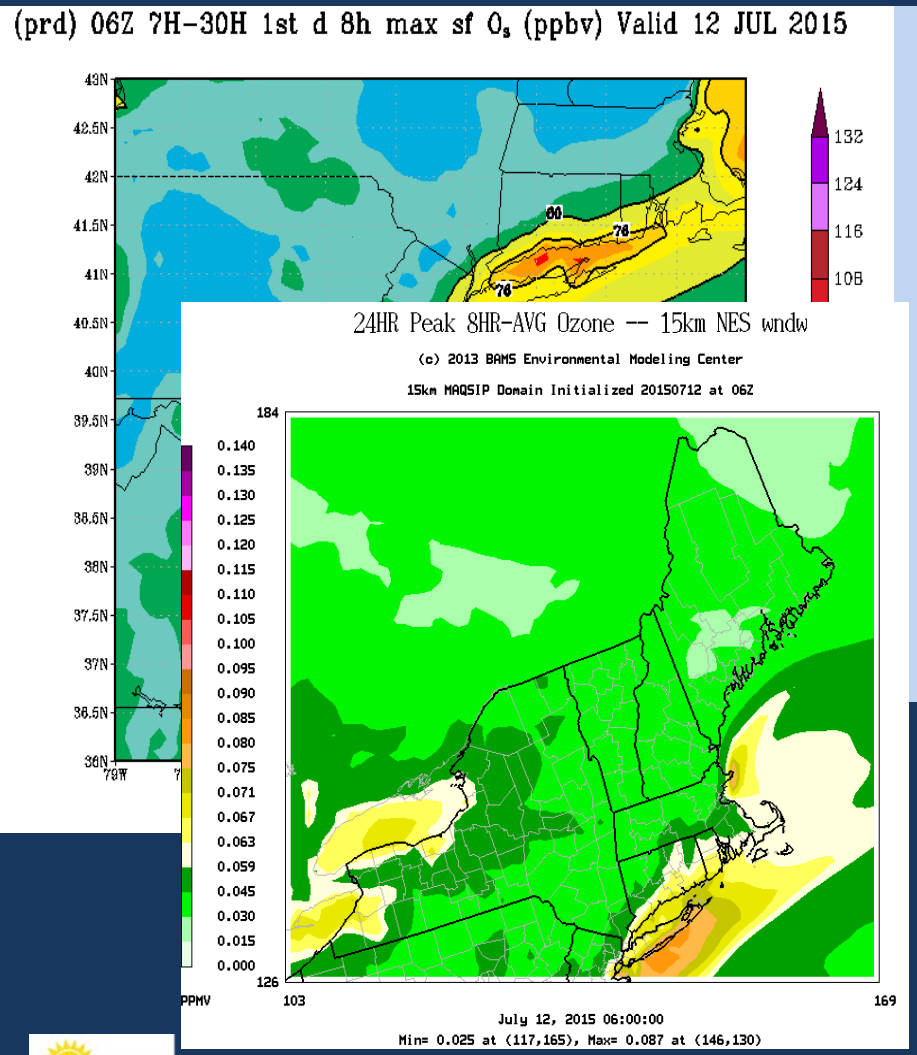
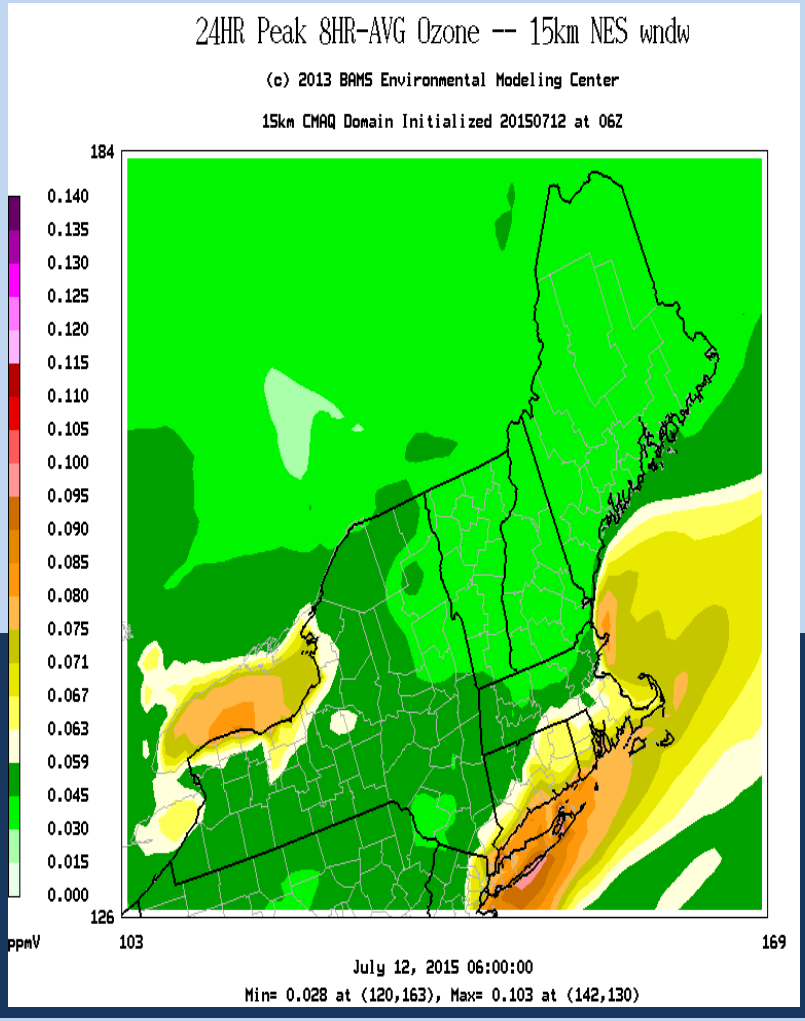
M = missing data

July 12, 2015 Ozone Forecast (ppb) and Observed Values

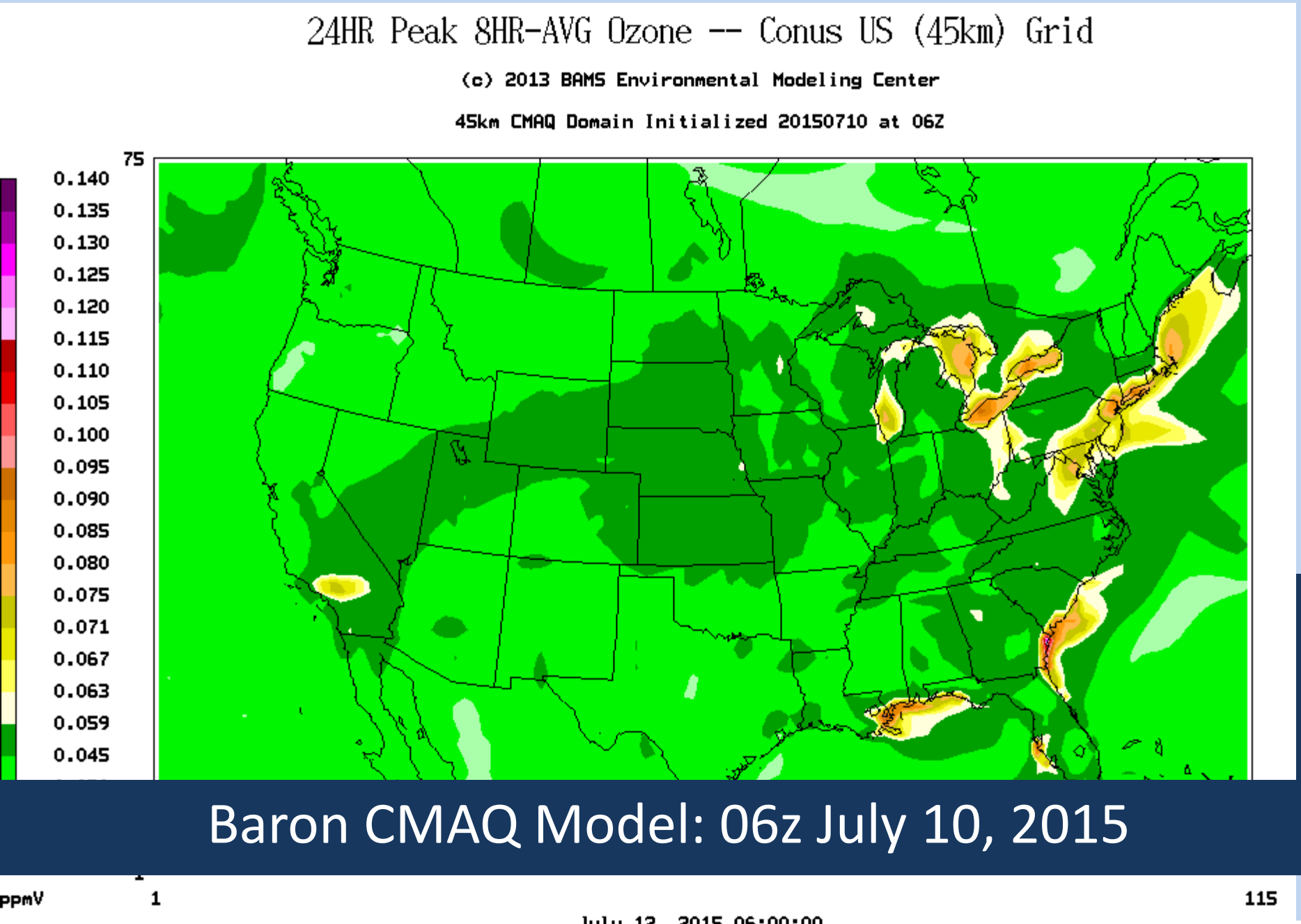
Site/Site AQS/Param/POC	Date (LST)	Max Observed	NOAA 06z	CTDEEP Forecast
Cornwall/090050005/O3/1	7/12/2015	48	46	62
Danbury/090011123/O3/1	7/12/2015	53	54	70
East Hartford/090031003/O3/1	7/12/2015	47	53	72
Greenwich/090010017/O3/1	7/12/2015	70	79	80
Groton Fort Gri/090110124/O3/1	7/12/2015	56	81	80
Madison-Beach R/090099002/O3/1	7/12/2015	65	93	80
Middletown/090070007/O3/1	7/12/2015	50	61	74
New Haven - Cri/090090027/O3/1	7/12/2015	44	81	80
Stafford/090131001/O3/1	7/12/2015	44	49	70
Stratford/090013007/O3/1	7/12/2015	62	90	80
Westport/090019003/O3/1	7/12/2015	63	80	80

NOAA/BARONS Models: 06z July 12, 2015



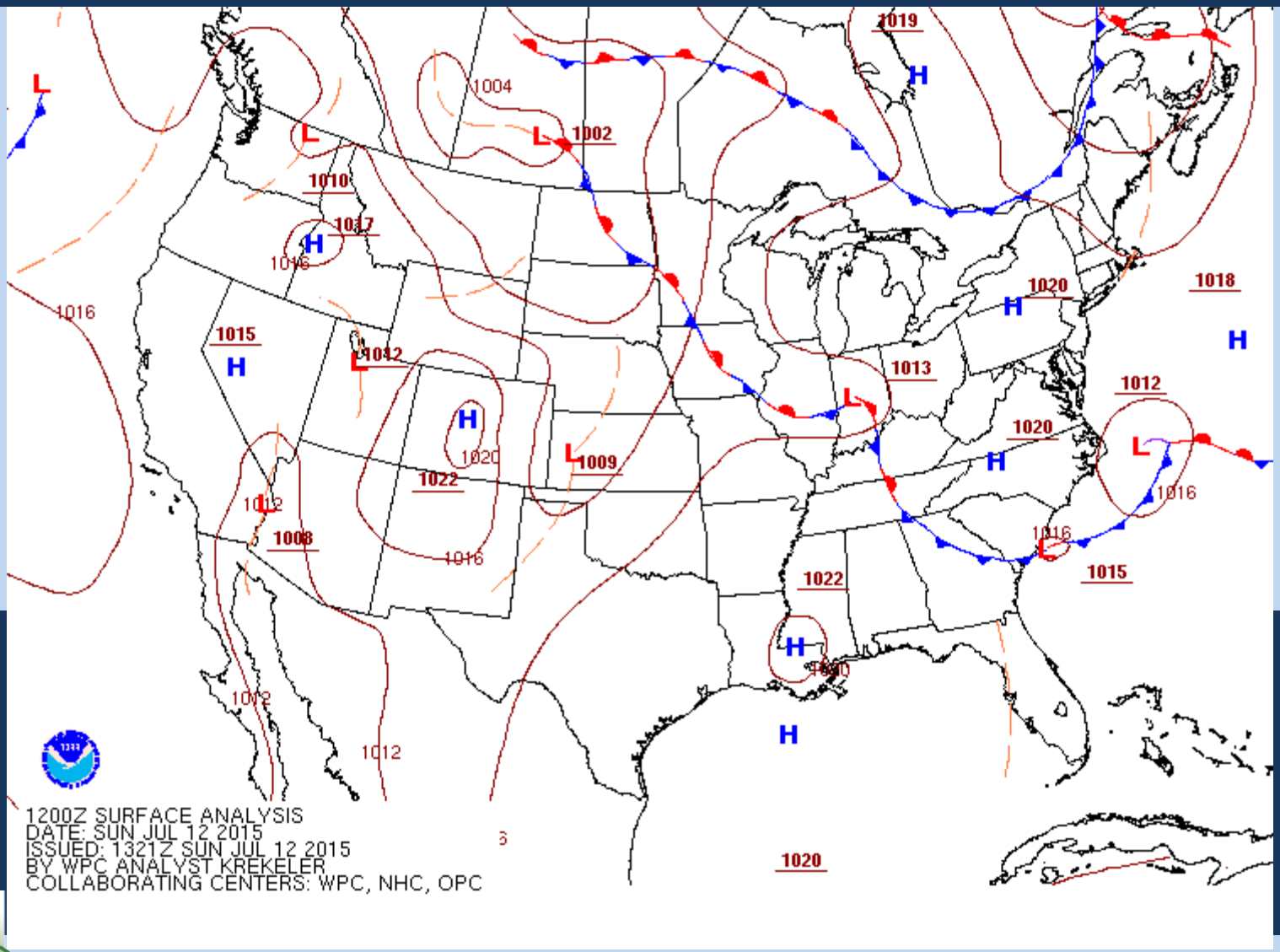


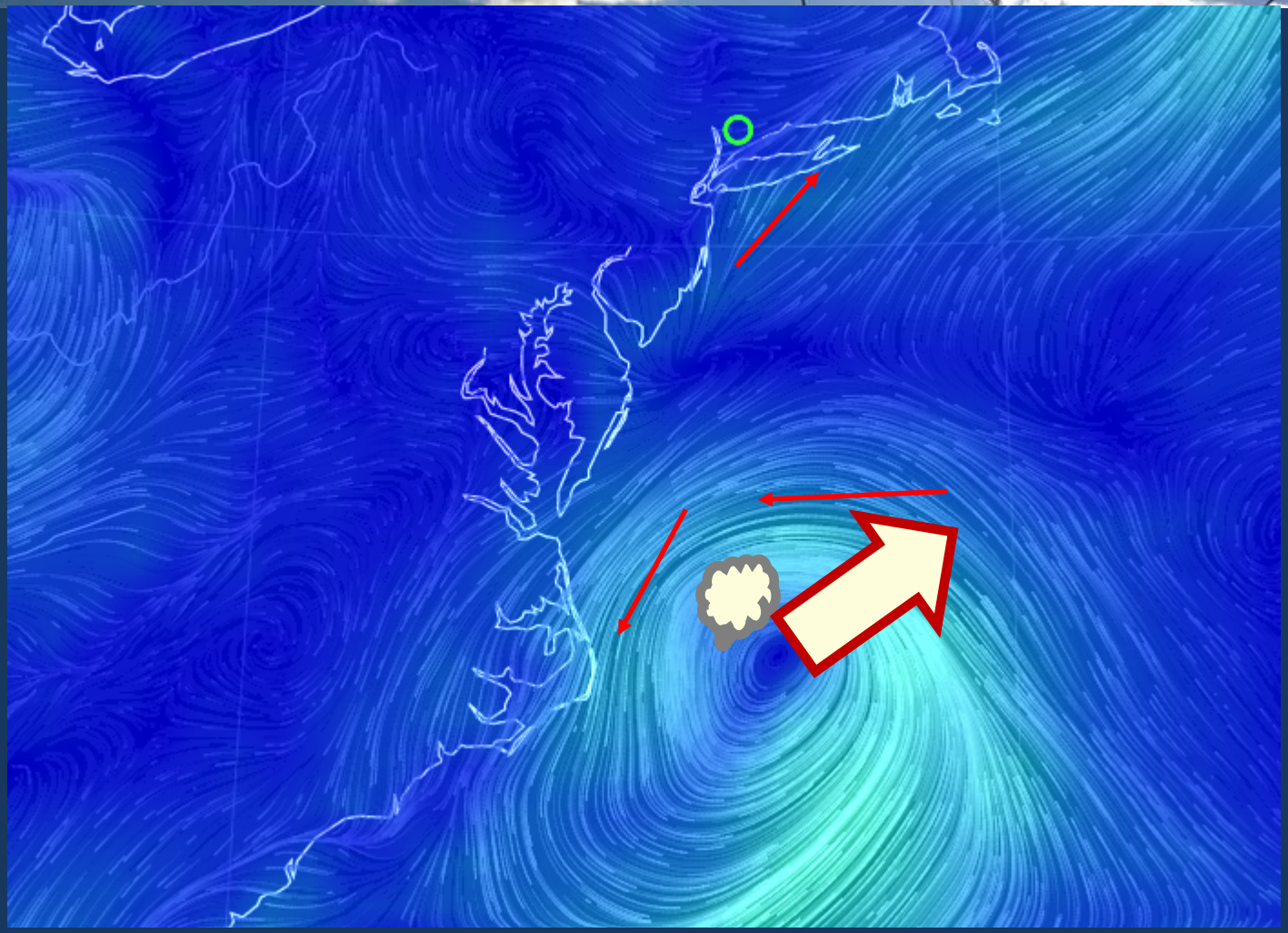
Connecticut Department of Energy and Environmental Protection



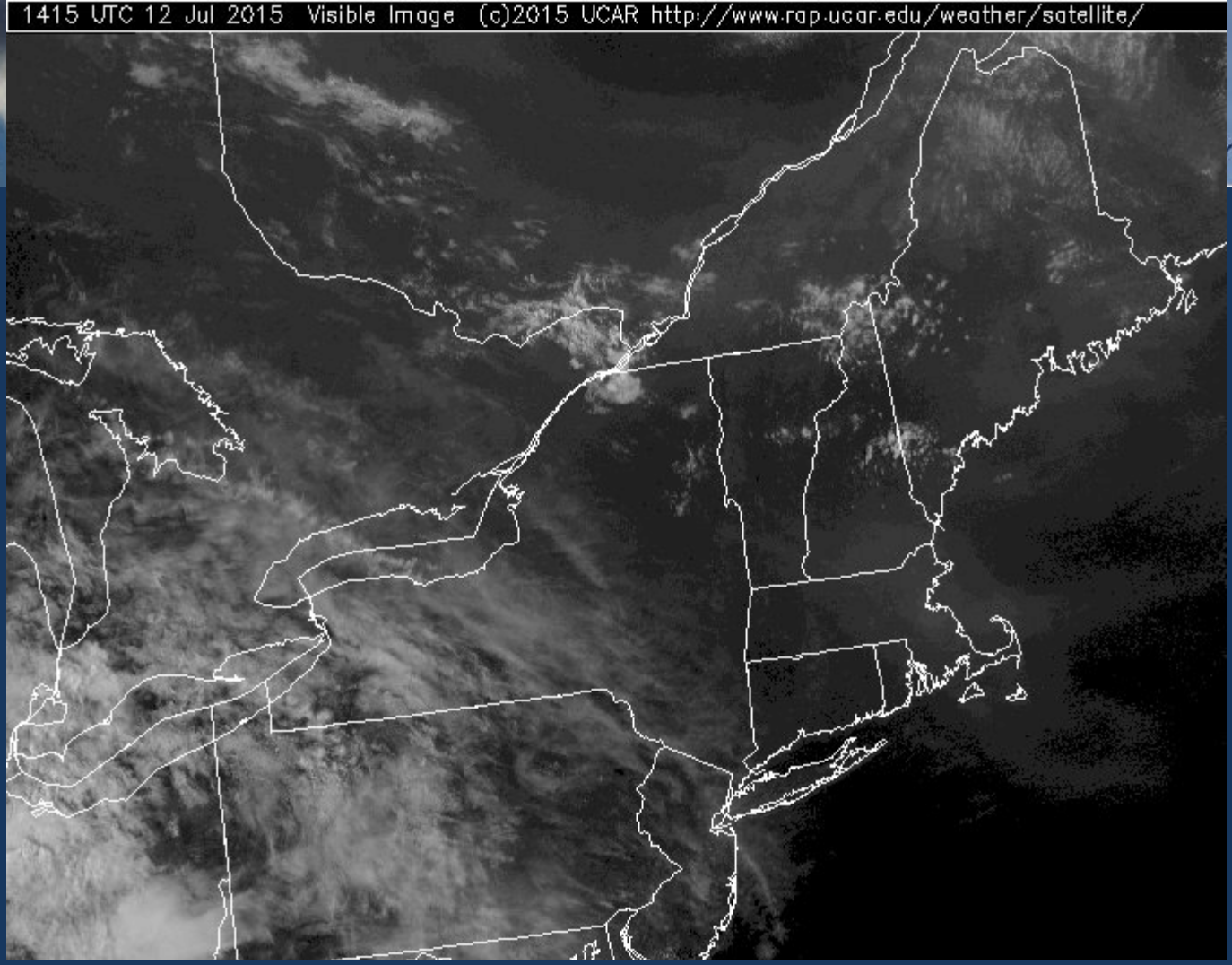
Baron CMAQ Model: 06z July 10, 2015

Surface Map Animation Showing Ocean Low





GFS 18z windstream analysis further exemplifies prevailing southwest winds over LIS while tropical system gets going to the south.



- Satellite shows high clouds streaming over the area
- Typically, this is not enough to limit ozone production

- Irregularity of observed ozone curve suggests that expected sea-breeze was disrupted.
- NAM model was predicting influence of ocean ‘low’ by Monday, mixing in the maritime air
- It’s possible that ‘low’ developed sooner and stronger than forecast by NAM
- The Greenwich wind direction trace vs. ozone shows how sensitive it is to wind direction

Conclusions

- Ozone levels were above USG over LIS, as observed by Greenwich monitor
- Normal sea breeze pattern was likely disrupted by developing ocean ‘low’, later to become tropical storm Claudette.
- A finer model grid could have improved the model output, assuming the meteorology was well characterized.
- Ozone forecasting beyond 2 days is still a formidable task, however, running the NOAA model to **72 hours** would still be helpful to forecasters.
- I would still make the same forecast with what tools were available

August Maximum 8-Hour Ozone Concentrations

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
August 2015

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	50	43	57																												
Cornwall	45	54	76																												
Danbury	50	59	79																												
East Hartford	48	53	73																												
Greenwich	59	60	70																												
Groton	68	44	57																												
Madison	73	55	61																												
Middletown	55	54	66																												
New Haven	55	55	53																												
Stafford	44	47	66																												
Stratford	64	52	65																												
Westport	61	M	68																												
# days > Federal Standard			11																												

Good (0-59 ppb)
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M = missing data

Questions?

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