Connecticut Department of Energy and Environmental Protection
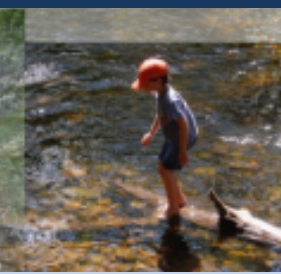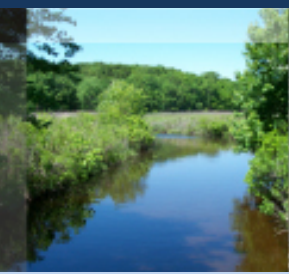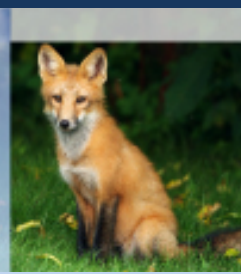
Connecticut Department of

ENERGY &
ENVIRONMENTAL
PROTECTION

2016 NOAA Model Performance 2016 for Connecticut

September 15, 2016
Michael Geigert

Connecticut Department of Energy and Environmental Protection

Ozone in Connecticut 2016

- Currently have 31 exceedance days in 2016.

20 Forecasted Unhealthy Ozone Days for 2016

Shaded dates did not verify

Month	Day	Day of the Week
May	25	Wednesday
May	26	Thursday
May	27	Friday
May	28	Saturday
June	19	Sunday
June	20	Monday
June	29	Wednesday
July	6	Wednesday
July	7	Thursday
July	8	Friday
July	15	Friday
July	16	Saturday
July	18	Monday
July	22	Friday
July	25	Monday
July	28	Thursday
August	12	Friday
August	13	Saturday
August	19	Friday
August	31	Wednesday

tion

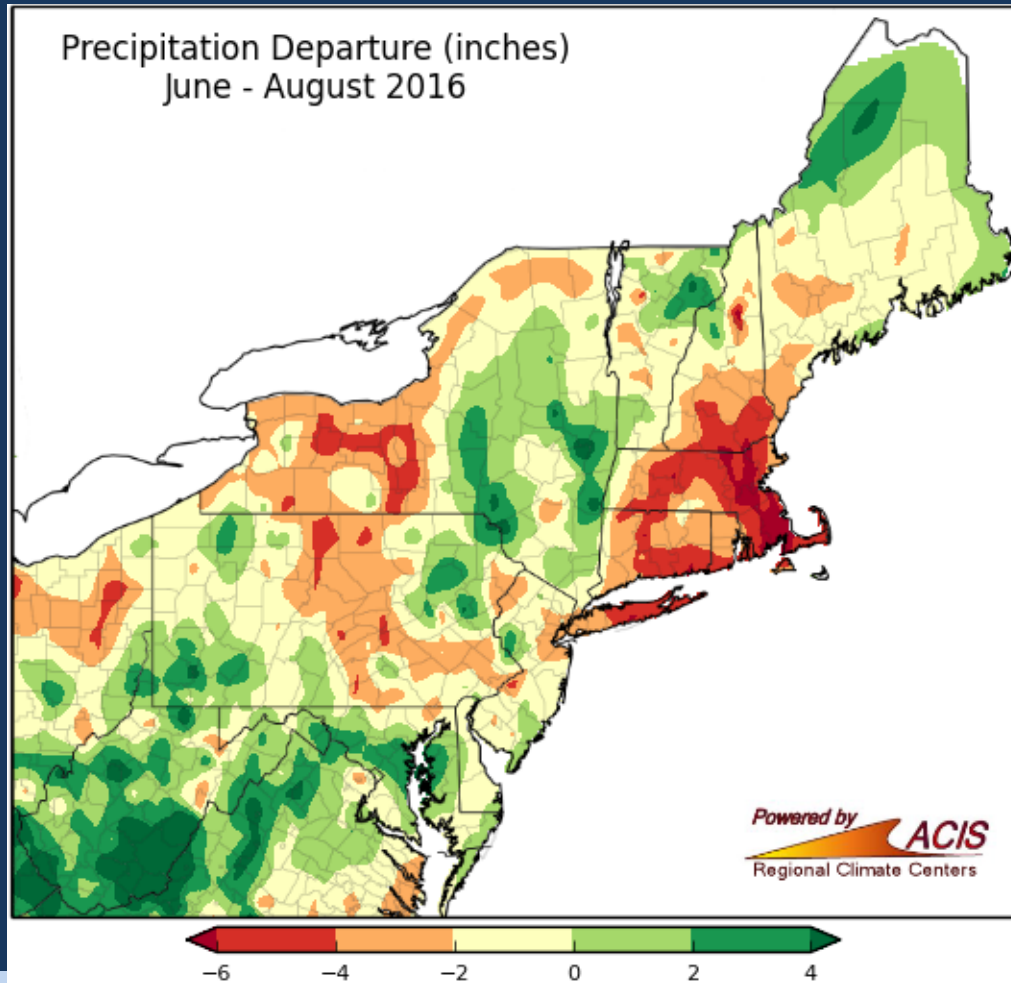# Trend Graph

Number of Days Exceeding the Ozone NAAQS in Connecticut
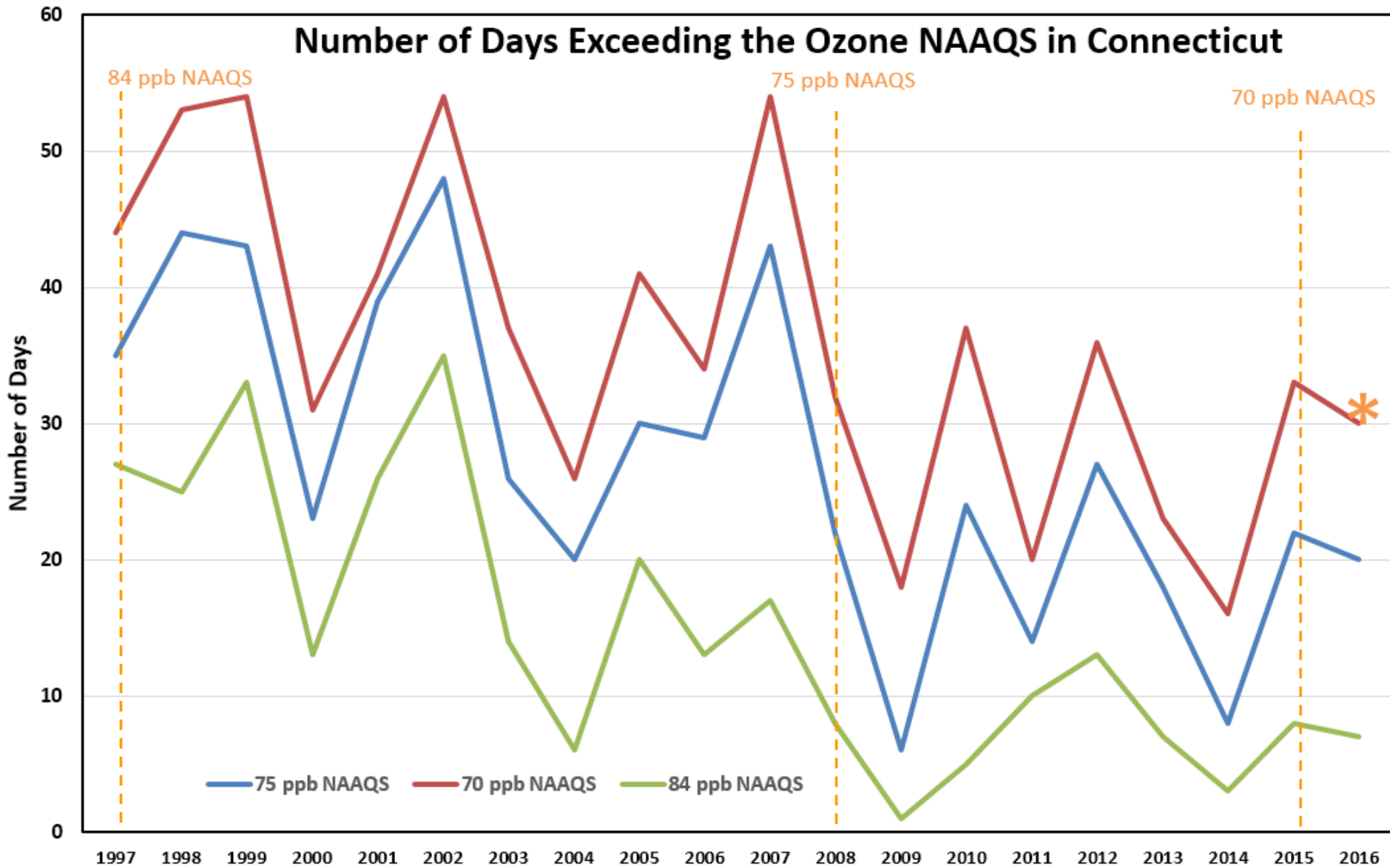
Summer Precipitation Summary

- Overall a drier summer for southern New England.

Precipitation Departure (inches)
June - August 2016

Powered by ACIS
Regional Climate Centers

-6   -4   -2   0   2   4

Summer Temperature summary

- Overall, warmer over the entire Northeast;
- August was much warmer in the Northeast.

Avg Temperature Departure (°F)
June - August 2016
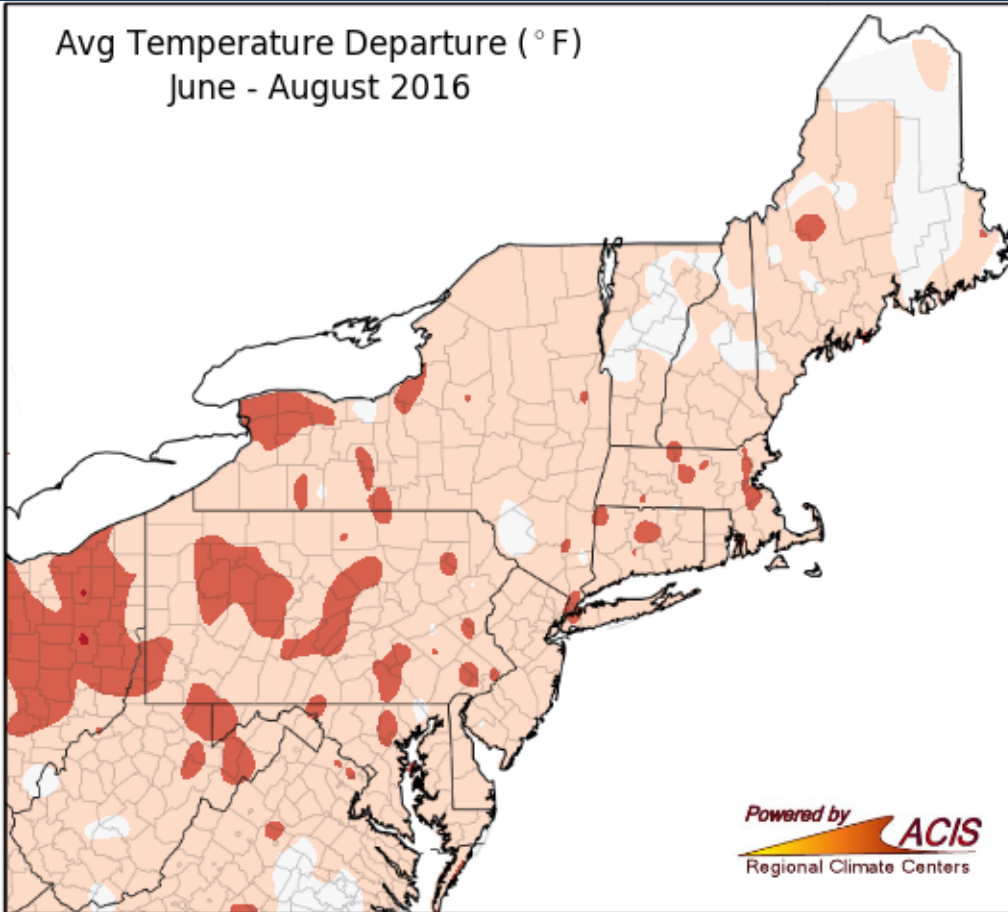
Avg Temperature Departure (°F)
August 2016
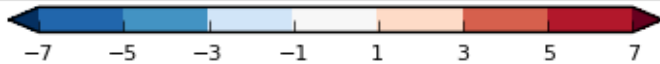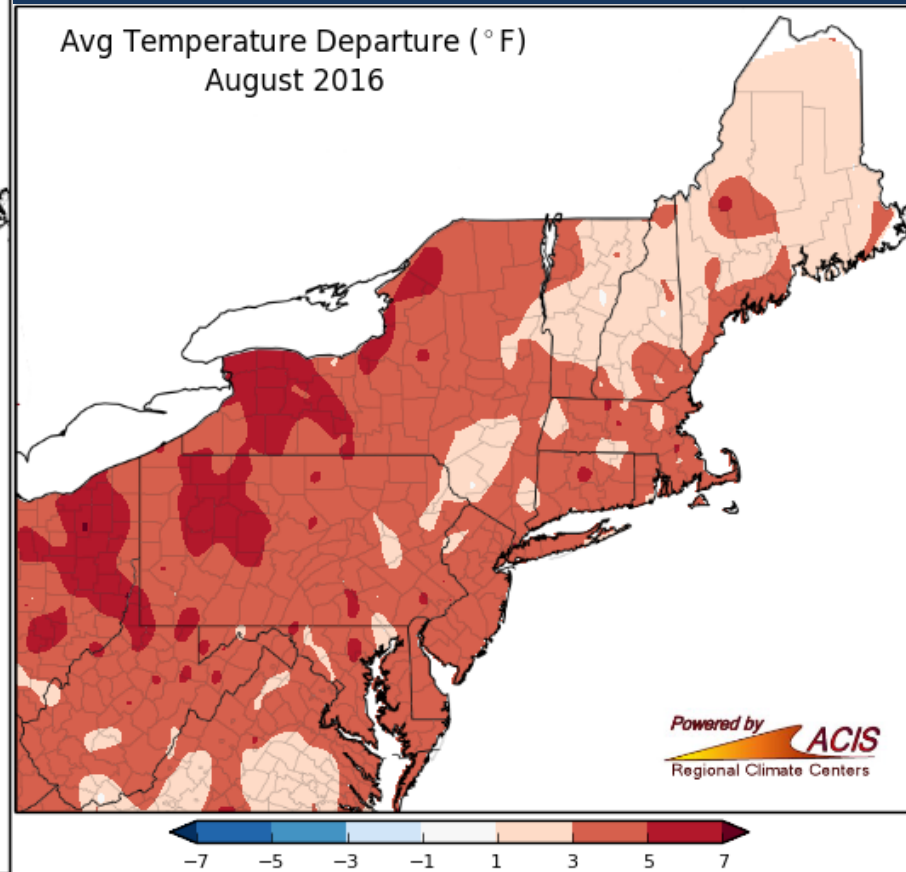
CT ozone Monitors
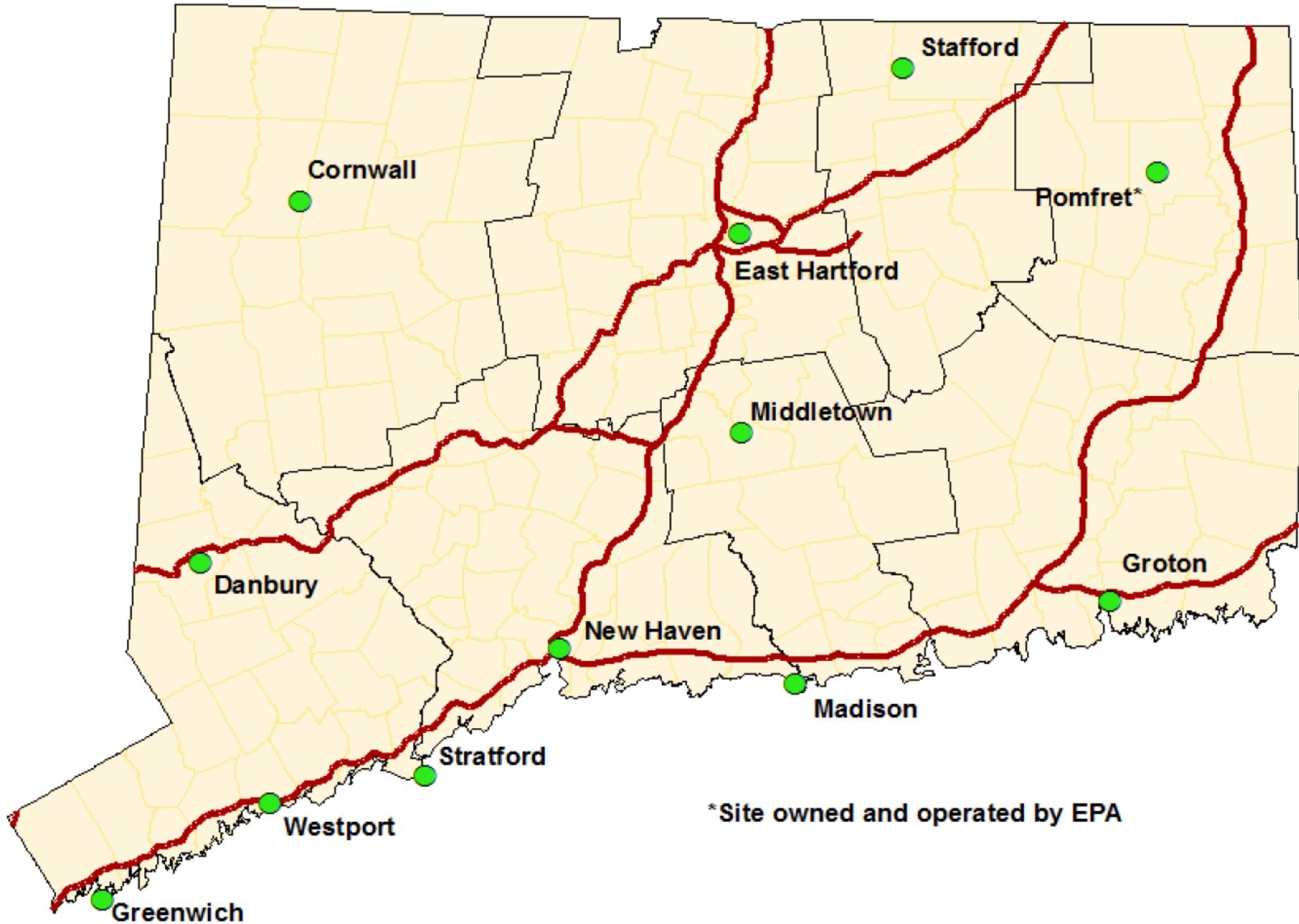
24 Days over 90 degrees at BDL Hartford

Daily Temperature Data – HARTFORD BRADLEY INTL AP, CT

Period of Record – 1949-01-01 to 2016-09-05. Normals period: 1981-2010. Click and drag to zoom chart.

Legend: Observed temperature range (2016) · Normal temperature range · Record Max · Record Min

Powered by ACIS

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
April 2016

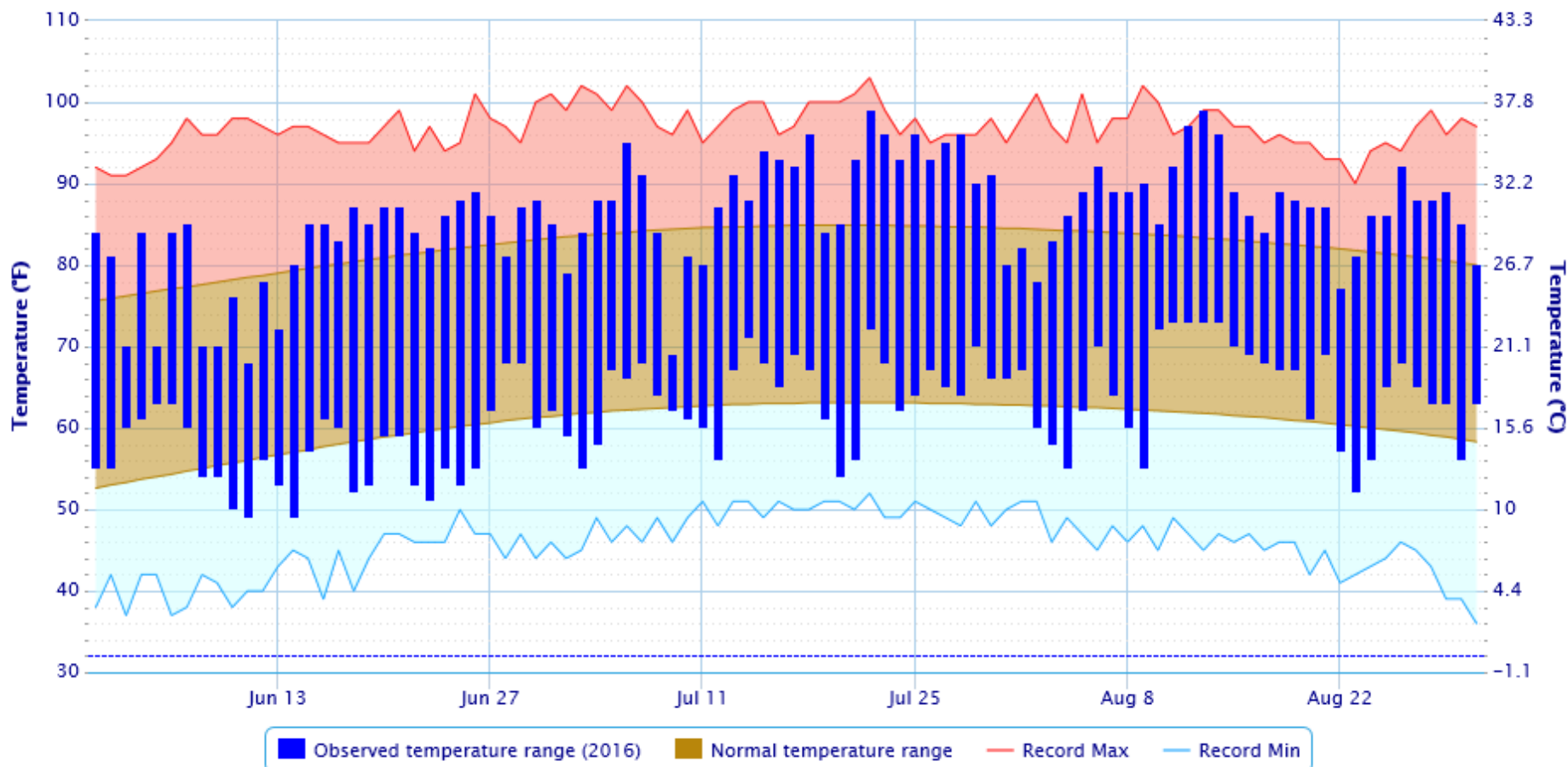| Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Abington	38	38	42	37	44	48	48	40	M	43	51	40	43	43	48	M	51	60	47	50	60	64	45	51	51	37	48	49	M	50
Cornwall	45	43	45	39	48	52	M	43	47	45	49	42	46	49	51	54	58	61	52	55	66	72	44	M	52	37	49	52	53	54
Danbury	39	41	44	36	45	51	49	42	44	45	49	40	44	48	50	53	60	65	53	49	60	67	42	49	52	32	50	48	54	58
East Hartford	37	35	43	39	47	51	47	40	47	44	51	40	45	47	51	52	56	65	54	M	58	68	46	55	49	37	47	50	50	56
Greenwich	36	44	48	40	51	53	53	46	46	47	54	46	44	49	52	58	55	68	61	59	60	59	46	57	M	44	42	52	50	57
Groton	38	M	43	38	47	49	51	41	48	47	55	46	40	44	50	53	49	60	54	52	57	52	48	54	50	38	47	M	43	44
Madison	31	40	43	35	45	53	51	41	M	46	54	42	39	42	48	52	48	58	54	51	51	51	45	51	51	37	48	49	43	45
Middletown	37	40	43	37	46	54	52	42	48	46	56	42	46	47	53	55	58	68	58	57	63	73	50	57	57	36	49	48	49	57
New Haven	31	39	43	36	46	49	47	38	44	40	45	39	35	44	49	51	49	59	54	50	46	56	44	51	50	33	45	46	44	48
Stafford	39	37	43	38	45	51	49	40	46	44	52	39	43	44	48	50	51	61	49	51	61	67	45	52	49	38	48	51	51	53
Stratford	34	42	44	39	47	55	52	41	46	46	55	41	41	45	50	54	52	59	53	56	56	51	43	52	53	41	48	50	48	51
Westport	33	40	43	35	46	52	49	41	44	45	52	42	43	46	49	54	55	64	55	54	57	59	44	53	53	34	46	49	46	51
# days > Federal Standard																						1								

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

Units - parts per billion (ppb)
Federal Standard = 70 ppb
M = missing data
* Data is preliminary and has not been quality assured

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
May 2016

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	41	24	28	32	M	M	27	38	45	50	57	65	50	54	34	46	47	48	43	45	M	55	52	30	76	83	68	67	52	29	52
Cornwall	46	34	26	33	33	34	29	41	47	50	66	69	54	56	37	M	51	49	51	51	54	54	55	47	81	91	78	65	69	41	55
Danbury	41	22	19	29	31	27	23	40	M	50	53	69	48	57	38	46	49	51	50	48	49	57	56	38	82	99	81	81	73	46	57
East Hartford	43	18	25	33	30	35	23	39	47	50	57	66	46	55	34	46	48	49	42	49	49	54	52	27	75	93	70	81	66	36	49
Greenwich	48	31	34	38	34	36	28	46	61	40	54	70	49	59	38	51	43	47	51	58	49	55	67	48	89	91	63	82	59	49	67
Groton	41	33	29	35	30	33	41	41	54	49	54	64	44	54	36	49	50	45	44	54	48	55	58	28	87	80	54	60	51	24	48
Madison	41	32	32	34	28	32	34	38	52	43	49	62	46	53	38	49	M	45	46	55	47	49	M	30	89	86	56	63	48	22	50
Middletown	46	21	29	35	30	35	30	42	52	53	60	71	M	56	36	38	44	48	48	54	50	56	54	27	80	91	67	79	61	32	58
New Haven	42	21	27	30	26	31	23	38	49	35	43	70	47	49	37	45	38	41	46	48	49	57	48	29	63	84	65	73	54	29	51
Stafford	42	25	27	32	29	34	29	38	44	50	56	66	51	57	34	47	47	47	47	46	53	55	52	30	74	82	70	73	56	38	M
Stratford	46	30	35	37	30	35	28	41	53	42	47	62	48	55	37	47	43	46	50	54	49	54	58	42	89	76	59	70	47	32	58
Westport	40	28	26	32	30	32	24	41	56	40	53	69	48	57	36	47	41	47	51	56	45	58	62	28	87	90	61	81	58	38	64
# days > Federal Standard												2													3	4	5	6	7		

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

Units - parts per billion (ppb)
Federal Standard = 70 ppb
M = missing data
* Data is preliminary and has not been quality assured

Connecticut Department of Environmental Protection
8-Hour Ozone Daily Maximums*
June 2016

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	43	40	27	52	30	56	60	30	36	28	35	34	26	33	41	56	42	49	49	45	48	45	54	48	47	50	47	39	49	48
Cornwall	55	55	26	56	32	M	50	27	42	42	54	32	28	31	62	58	43	56	54	62	43	46	53	58	56	74	61	42	38	44
Danbury	54	49	32	64	30	54	57	27	45	43	57	42	M	34	50	74	44	63	66	66	51	53	78	59	64	87	60	47	49	51
East Hartford	49	45	30	63	31	55	55	26	40	34	39	33	26	34	37	58	43	50	54	54	46	M	65	53	57	64	55	44	44	41
Greenwich	55	42	39	62	43	69	73	33	52	49	69	51	34	M	64	47	46	60	51	52	60	M	64	58	55	64	54	42	57	65
Groton	44	33	28	50	41	60	75	36	43	33	44	43	31	39	60	71	38	57	50	39	63	55	M	50	41	33	40	37	51	51
Madison	48	32	26	M	M	62	78	34	42	36	46	42	29	37	62	68	41	52	53	41	71	58	65	52	50	40	46	43	69	54
Middletown	46	41	35	62	35	64	63	29	43	34	43	39	28	35	53	69	40	49	52	47	56	52	73	49	48	55	51	44	52	53
New Haven	M	35	36	49	35	45	55	M	41	39	51	43	27	36	58	63	M	51	52	43	48	56	75	54	51	57	51	44	52	42
Stafford	47	45	29	48	31	55	56	28	M	31	38	31	25	33	42	53	40	50	53	49	44	46	58	47	51	61	50	41	46	43
Stratford	50	37	37	52	42	67	73	28	45	43	55	44	31	37	63	55	39	57	49	51	62	57	64	58	57	61	55	52	66	58
Westport	48	37	36	58	37	66	72	30	47	44	53	44	30	36	67	51	45	61	52	50	58	55	65	55	52	65	56	43	60	60
# days > Federal Standard	7						8									9					10		11			12				

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

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* Data is preliminary and has not been quality assured

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
July 2016

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	34	43	51	42	74	54	31	25	27	23	54	51	40	64	52	59	67	35	33	66	90	39	41	57	38	47	62	51	43	30
Cornwall	53	32	37	53	48	66	53	45	23	29	34	61	65	55	54	48	47	55	32	34	62	66	41	44	57	33	41	61	50	41	30
Danbury	55	35	42	62	41	80	66	51	26	37	29	72	64	M	58	56	52	64	32	30	68	70	43	50	66	37	46	61	52	54	38
East Hartford	52	33	37	55	47	71	59	41	24	34	M	61	66	46	65	57	57	66	34	33	64	76	39	36	72	37	37	72	54	42	30
Greenwich	48	35	44	59	45	87	64	44	26	33	36	61	52	55	76	58	77	73	37	52	85	M	M	M	M	42	69	69	63	57	43
Groton	52	39	48	56	48	75	47	36	31	30	26	51	46	43	82	71	75	68	43	45	71	70	52	46	60	47	43	60	50	58	39
Madison	51	38	48	56	52	70	62	33	29	37	35	62	50	44	M	M	M	82	37	47	74	78	57	48	65	51	49	68	52	62	41
Middletown	50	34	46	56	45	80	67	36	28	34	28	62	59	48	71	61	70	84	35	34	78	100	M	44	69	38	52	66	52	47	35
New Haven	51	37	47	62	41	68	68	36	28	36	31	62	40	43	70	56	71	75	33	37	80	91	43	38	48	38	39	51	55	64	39
Stafford	M	M	M	M	46	67	58	38	23	29	30	59	66	43	55	49	50	65	34	32	M	72	40	35	63	38	46	64	44	38	31
Stratford	52	39	48	63	52	75	64	M	M	M	44	60	59	56	84	61	79	83	36	46	81	96	54	51	67	45	56	69	60	63	47
Westport	50	36	48	63	46	80	64	42	27	39	36	61	58	55	75	59	76	80	38	45	87	97	49	54	69	41	61	67	58	58	42
# days > Federal Standard	12					13						14			15	16	17	18			19	20			21			22			

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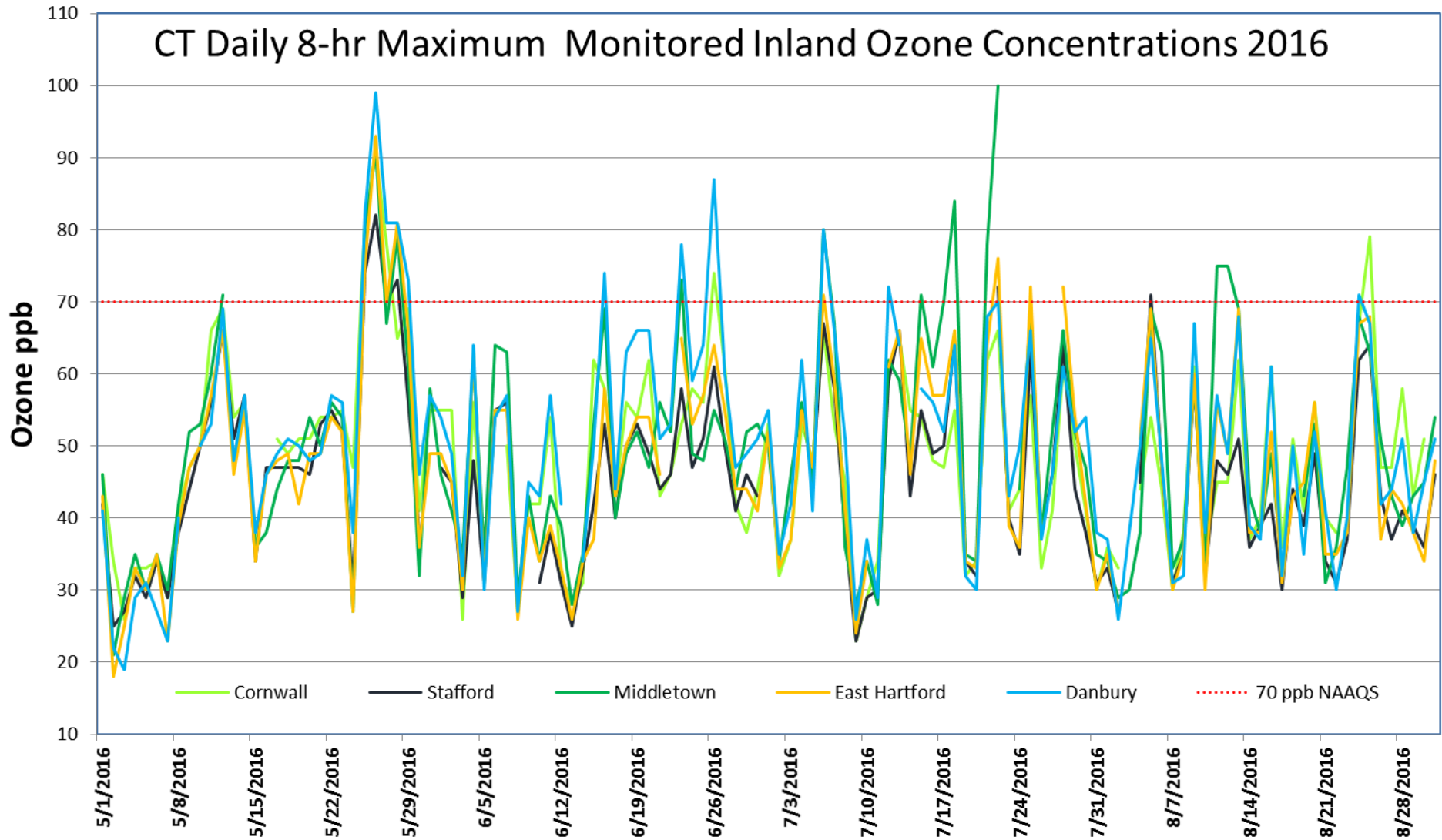* Data is preliminary and has not been quality assured

Connecticut Department of Energy & Environmental Protection
8-Hour Ozone Daily Maximums*
August 2016

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	33	31	M	36	55	47	30	34	54	28	47	55	46	39	40	42	31	51	40	40	31	33	46	55	59	45	40	35	39	44	50
Cornwall	36	33	35	44	54	44	30	38	61	35	45	45	62	37	40	61	36	51	41	56	40	38	44	67	79	47	47	58	43	51	M
Danbury	37	26	38	50	65	48	31	32	67	38	57	49	68	39	37	61	32	50	35	52	41	30	30	71	67	42	44	51	38	45	51
East Hartford	35	27	28	51	69	47	30	35	60	30	56	49	69	38	38	52	31	43	45	56	35	35	38	67	68	37	44	42	38	34	48
Greenwich	38	31	35	46	57	60	37	52	67	37	76	58	M	M	M	42	41	64	50	53	45	34	59	81	63	51	44	47	49	57	76
Groton	35	28	31	32	45	62	39	34	57	M	51	59	62	55	49	40	36	49	47	47	31	39	48	62	58	70	44	31	48	37	62
Madison	34	29	32	35	56	66	45	41	58	33	61	75	77	56	54	48	32	59	53	54	32	36	55	66	62	69	48	36	44	42	66
Middletown	34	29	30	38	69	63	33	37	59	33	75	75	69	43	38	49	33	56	43	53	31	36	47	68	63	51	43	39	43	45	54
New Haven	34	26	31	28	63	57	36	39	49	25	72	73	59	40	42	49	32	65	48	58	35	37	54	66	45	48	44	41	43	47	64
Stafford	33	27	34	45	71	47	31	35	59	32	48	46	51	36	39	42	30	44	39	49	34	31	37	62	64	43	37	41	39	36	46
Stratford	39	33	37	44	57	67	41	45	56	35	82	79	69	58	57	48	37	68	57	57	44	33	60	76	63	54	48	40	44	48	75
Westport	38	29	34	44	61	M	M	47	63	36	87	68	72	48	56	52	31	67	47	49	41	34	58	79	64	49	47	45	47	54	76
# days > Federal Standard	22				23						24	25	26											27	28						29

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

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

CT Monitoring Site Design Value Update

- Connecticut has 30 exceedance days to date, as of September 8, 2016;
- New 8-hour ozone NAAQS = 70 ppb.

	Site Name	To Date: 2016 DV	To Date 2016 Compliance Status x = Violating NAAQS			Next Possible NAAQS in Violation (key monitor in each NA is highlighted in RED)
			2015 NAAQS	2008 NAAQS	1997 NAAQS	
SWCT Portion of NYC Area	Danbury	78	x	x		Four more 102+ ppb days violates 1997 NAAQS
	Greenwich	82	x	x		Four more 93+ ppb days violates 1997 NAAQS
	Madison	76	x	x		Four more 105+ ppb days violates 1997 NAAQS
	Middletown	79	x	x		Three more 97+ ppb days violates 1997 NAAQS
	New Haven - Criscuolo Park	76	x	x		Four more 101+ ppb days violates 2008 NAAQS
	Stratford	81	x	x		Three more 95+ ppb days violates 1997 NAAQS
	Westport	85	x	x	x	**Violates all NAAQS**
Greater CT	Cornwall	73	x			Three more 86+ ppb days violates 2008 NAAQS
	East Hartford	75	x			**One more 76+ ppb day violates 2008 NAAQS**
	Groton Fort Griswold	72	x			Three more 86+ ppb days violates 2008 NAAQS
	Stafford	73	x			Three more 79+ ppb days violates 2008 NAAQS
	Abington (CASTNET)	68				One more 76+ ppb days violates 2015 NAAQS

Inland Monitors

CT Daily 8-hr Maximum Monitored Inland Ozone Concentrations 2016

Connecticut Department of Energy and Environmental Protection

Coastal Monitors

CT Daily 8-hr Maximum Monitored Coastal Ozone Concentrations 2016

Legend: Greenwich, Madison-Beach Road, Groton Fort Griswold, New Haven - Criscuolo Park, Westport, Stratford, 70 ppb NAAQS
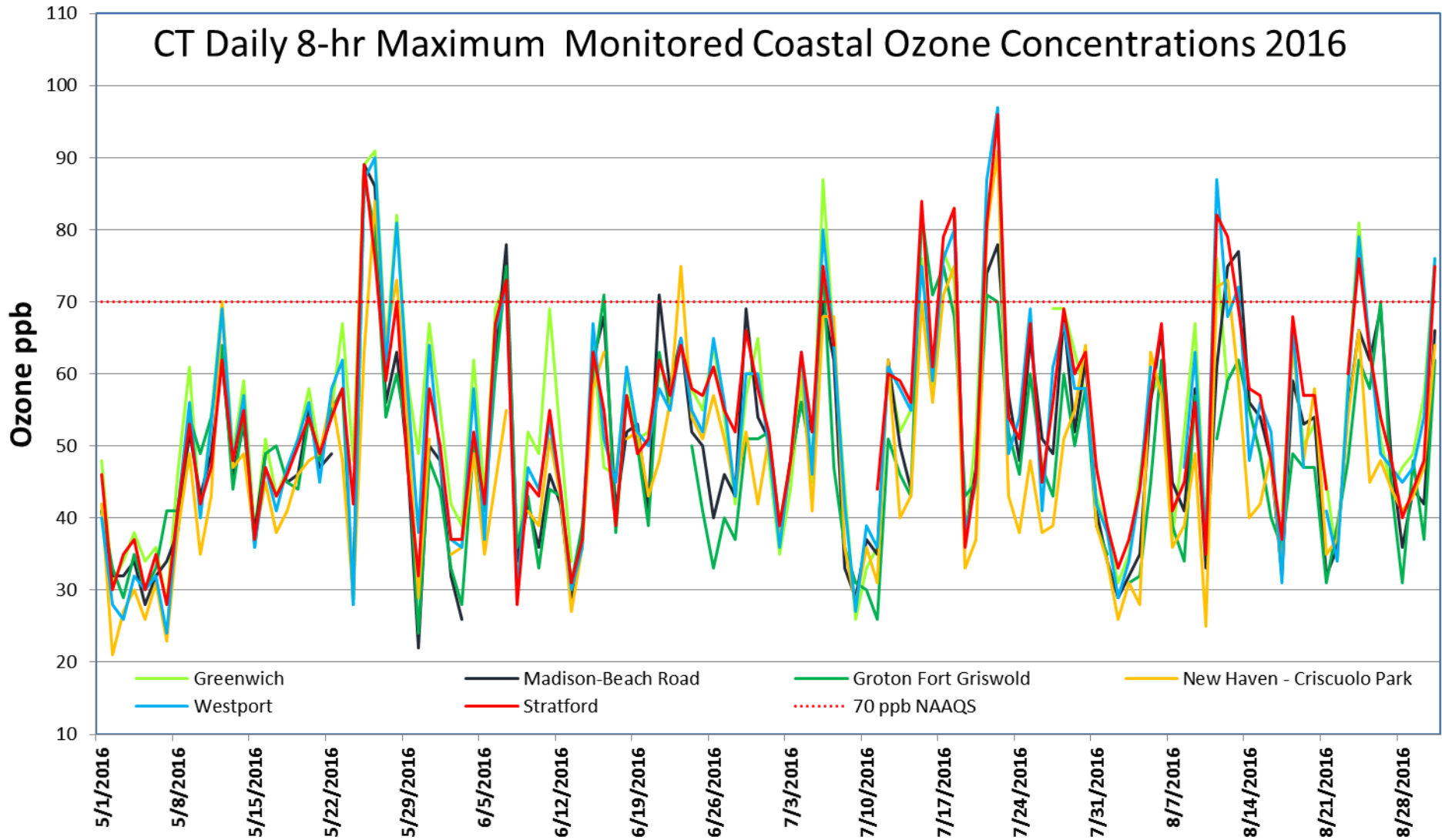
NOAA Model Performance

- The following tables show 30 USG or greater ozone exceedance days monitored in Connecticut;

- The NOAA 06z Day 2 model run correctly predicted an USG or greater 8-hour ozone concentration during 21 of those 30 days;

- Note the general USG+ under prediction until July;

- July modeled values show a sharp increase in magnitude and number of monitors over predicted;

- August predictions are more realistic, except for the major under prediction on August 11th.

Observed 8-hour Daily Max Ozone vs. NOAA Model 06z Day 2 Forecast for the 30 Exceedance Days to September 8, 2016

Observed 8-hour Ozone ppb

Site	4/22	5/12	5/25	5/26	5/27	5/28	5/29	6/7	6/16	6/21	6/23	6/26	7/6	7/12	7/15	7/16	7/17	7/18	7/21	7/22	7/25	7/28	8/5	8/11	8/12	8/13	8/24	8/25	8/31	9/8
Cornwall	72		81	91	78							74																79		75
Danbury			82	99	81	81	73		74		78	87	80	72														71		80
East Hartford			75	93		81							71							76	72	72								61
Greenwich			89	91		82		73				87			76		77	73	85						76		81		76	69
Groton			87	80			75	71					75		82	71	75		71											49
Madison			89	86				78		71									82	74	78					75	77			56
Middletown	73	71	80	91		79					73		80		71			84	78	100					75	75				64
New Haven				84		73					75						71	75	80	91					72	73				60
Stafford			74	82		73														72			71							57
Stratford			89	76				73					75		84		79	83	81	96					82	79		76	75	65
Westport			87	90		81		72					80		75		76	80	87	97				87			72	79	76	71
Max 8-hr ppb	**73**	**71**	**89**	**99**	**81**	**82**	**73**	**78**	**74**	**71**	**78**	**87**	**87**	**72**	**84**	**71**	**79**	**84**	**87**	**100**	**72**	**72**	**71**	**87**	**79**	**77**	**81**	**79**	**76**	**80**

Modeled 8-hour 06z Day 2 Ozone ppb: 21/30 days (70%) modeled USG or greater

Site	4/22	5/12	5/25	5/26	5/27	5/28	5/29	6/7	6/16	6/21	6/23	6/26	7/6	7/12	7/15	7/16	7/17	7/18	7/21	7/22	7/25	7/28	8/5	8/11	8/12	8/13	8/24	8/25	8/31	9/8
Cornwall	60	52	54	66	65	54	73	46	58	45	45	49	68	62	76	61	55	54	46	62	66	77	72	63	52	52	53	68	67	67
Danbury	60	53	57	78	50	77	70	49	54	47	50	59	77	75	67	67	59	68	51	68	82	88	73	62	62	64	62	64	79	68
East Hartford	57	50	53	78	64	77	68	50	58	48	51	60	73	68	78	70	69	77	48	72	83	74	70	67	69	70	60	66	79	61
Greenwich	50	49	65	74	64	62	50	54	45	56	59	72	98	66	80	76	79	81	66	76	87	88	55	50	69	77	67	59	72	64
Groton	53	53	65	81	47	50	43	63	58	65	45	56	95	65	89	72	78	70	75	77	61	68	39	69	65	71	73	66	65	56
Madison	57	58	68	90	56	56	47	77	61	79	58	68	108	71	99	93	76	74	77	86	69	74	49	70	76	82	79	56	69	61
Middletown	54	51	54	79	53	72	58	55	54	51	49	57	89	71	92	72	68	84	58	87	76	72	61	65	81	76	64	60	79	60
New Haven	53	57	61	88	61	67	54	58	55	55	54	62	109	73	99	80	81	86	68	89	78	76	62	65	83	86	72	58	77	64
Stafford	62	48	51	73	63	70	66	51	48	48	49	53	70	61	76	68	63	69	45	71	80	71	67	68	66	68	60	69	75	61
Stratford	50	54	63	85	61	61	49	57	46	55	54	67	112	71	98	84	87	82	71	87	79	79	58	60	78	84	72	57	73	64
Westport	51	50	64	80	61	62	50	54	47	54	57	65	104	68	87	80	87	84	65	80	87	86	59	58	76	81	70	58	73	64
Max 8-hr ppb	**62**	**58**	**68**	**90**	**65**	**77**	**73**	**77**	**61**	**79**	**59**	**72**	**112**	**75**	**99**	**93**	**87**	**86**	**77**	**89**	**87**	**88**	**73**	**70**	**83**	**86**	**79**	**69**	**79**	**68**

April-June vs. July-September Model Performance

Site	4/22	5/12	5/25	5/26	5/27	5/28	5/29	6/7	6/16	6/21	6/23	6/26	Average	Site Max
Max 8-hr ppb observed	73	71	89	99	81	82	73	78	74	71	78	87	79.7	99
12z NOAA- Observed	-4	-10	-21	-12	-6	3	-5	-6	-8	-1	-10	-12	-7.7	
Max 8-hr ppb 12z Day 1	69	61	68	87	75	85	68	72	66	70	68	75	72.0	87
06z NOAA- Observed	-11	-13	-21	-9	-16	-5	0	-1	-13	8	-19	-15	-9.6	
Max 8-hr ppb 06z Day 2	62	58	68	90	65	77	73	77	61	79	59	72	70.1	90

Site	7/6	7/12	7/15	7/16	7/17	7/18	7/21	7/22	7/25	7/28	8/5	8/11	8/12	8/13	8/24	8/25	8/31	9/8	Average	Site Max
Max 8-hr ppb observed	87	72	84	71	79	84	87	100	72	72	71	87	79	77	81	79	76	80	79.9	100
12z NOAA- Observed	16	4	20	39	32	4	-3	-1	38	22	4	-27	-1	6	-6	-9	6	-5	7.7	
Max 8-hr ppb 12z Day 1	103	76	104	110	111	88	84	99	110	94	75	60	78	83	75	70	82	75	87.6	111
06z NOAA- Observed	25	3	15	22	8	2	-10	-11	15	16	2	-17	4	9	-2	-10	3	-12	3.4	
Max 8-hr ppb 06z Day 2	112	75	99	93	87	86	77	89	87	88	73	70	83	86	79	69	79	68	83.3	112

- Early Season average peak monitor 06z Day2= **-9.6** ppb vs. 12z Day1 = **-7.7** ppb under prediction;
- Late Season average peak monitor 06z Day2= **+3.4** ppb vs. 12z Day1 = **+7.7** ppb over prediction;
- General trend is that 12z **improved** under prediction in early season but, i**ncreased** over prediction after June!
- If 12z has best available meteorology, then what is going on?

Connecticut Department of Energy and Environmental Protection

Exceedance Day Scenarios

- **Inland-only Exceedances:** Ozone is transported aloft from the west and mixed down to the surface as daytime heating occurs. Strong southerly surface winds during the day bring in clean maritime air from the Atlantic Ocean, resulting in relatively low ozone levels along the coast. The maritime front may not penetrate very far inland, and therefore does not mitigate transported and local pollutants' contribution to inland exceedances.
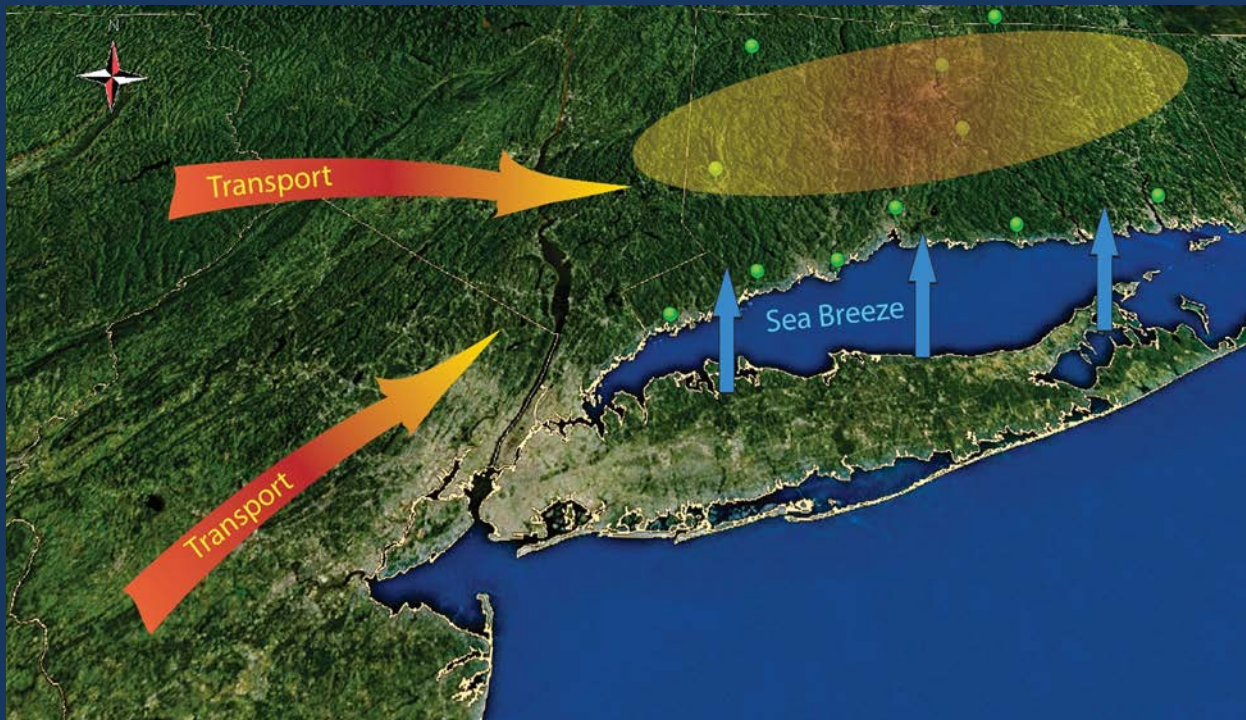
Inland-only Exceedance: July 25, 2016

- Strong southerly winds off the ocean pushed the LIS plume, sparing the immediate coast.
- NOAA model did not model convection, which lowered ozone concentrations from full potential

10-M WND, SFC HGT NAM 06H FCST VALID 18Z 25 JUL
Wind barbs displayed at every other grid point
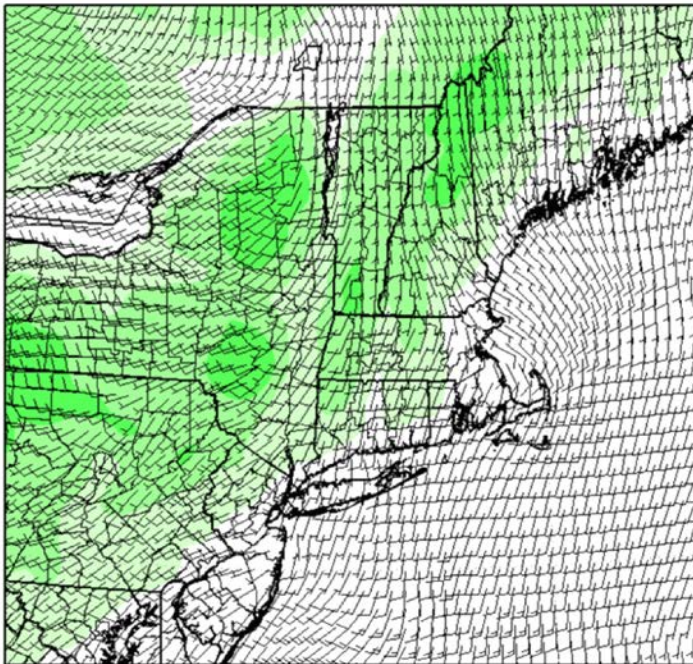
Daily Ozone AQI
Monday, July 25, 2016

Montpelier
Portland
Utica
Albany
Boston
Scranton
New York
Pittsburgh
Philadelphia

0 15 30   60 Miles
Generated: 2016-07-27 18:26:40Z
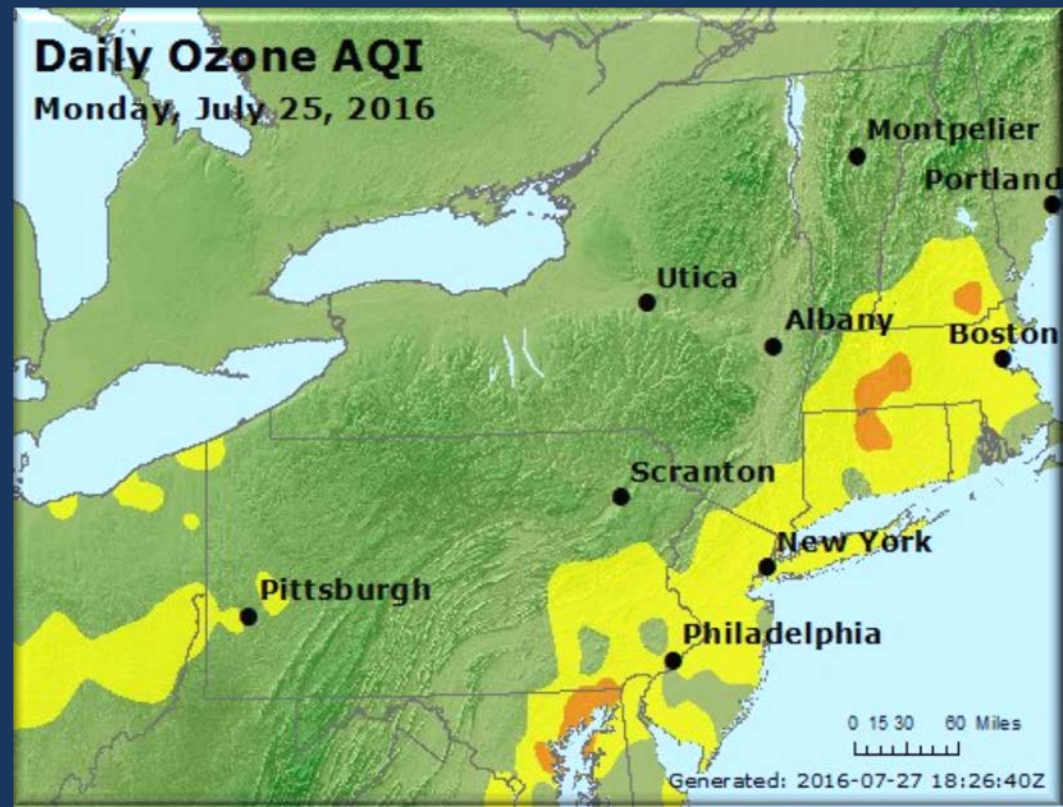
July 25 , 2016 Surface Analysis Animation

- Warm front passed through and pre-frontal trough developed near I-95 corridor, allowing southwest winds to funnel pollutants up the I-95 corridor.
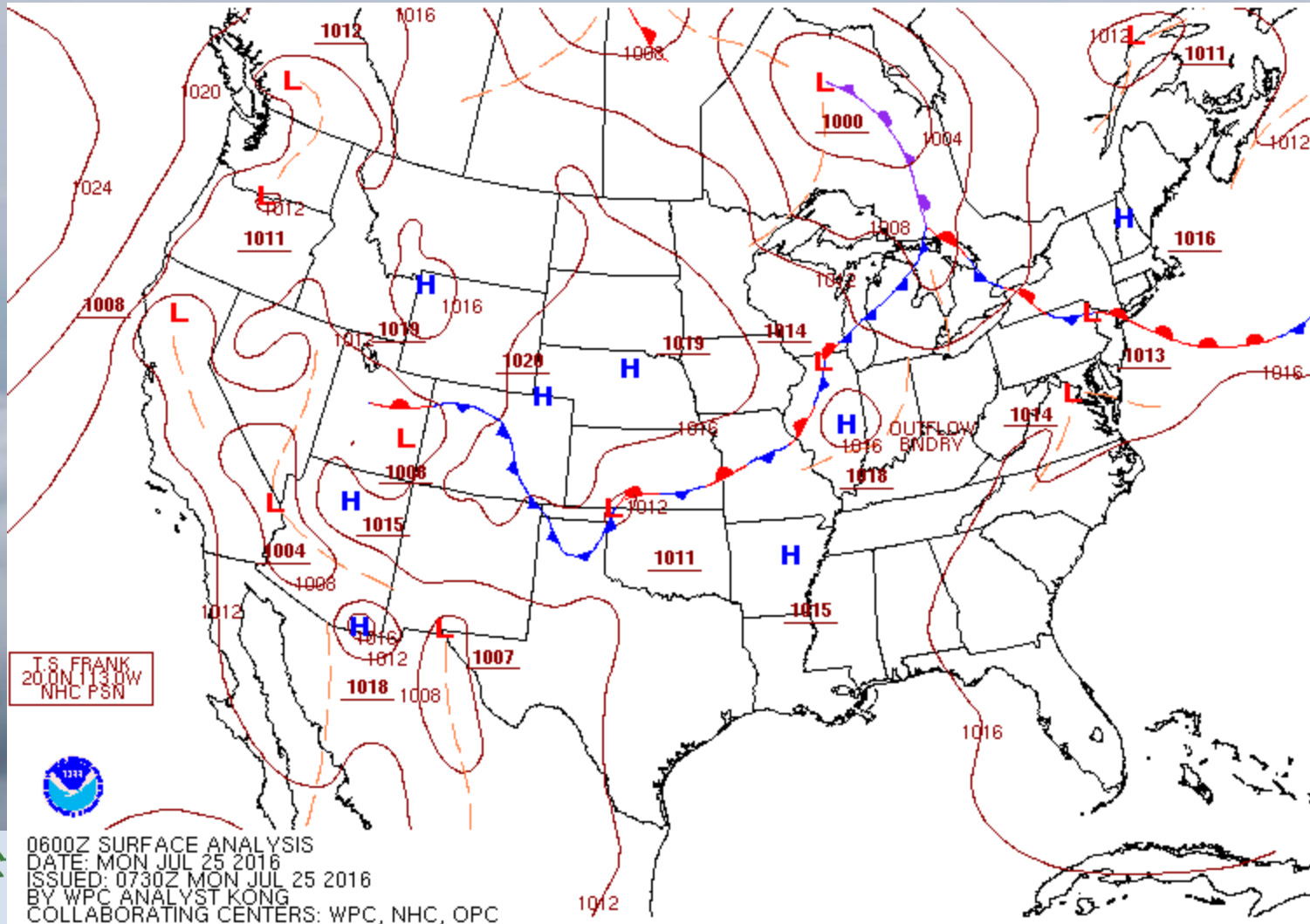
July 25 , 2016 Satellite Animation

- NAM modeled clouds/precip vs. actual satellite shows that the model missed the first wave of convection, which lead to the modeled ozone over-prediction.
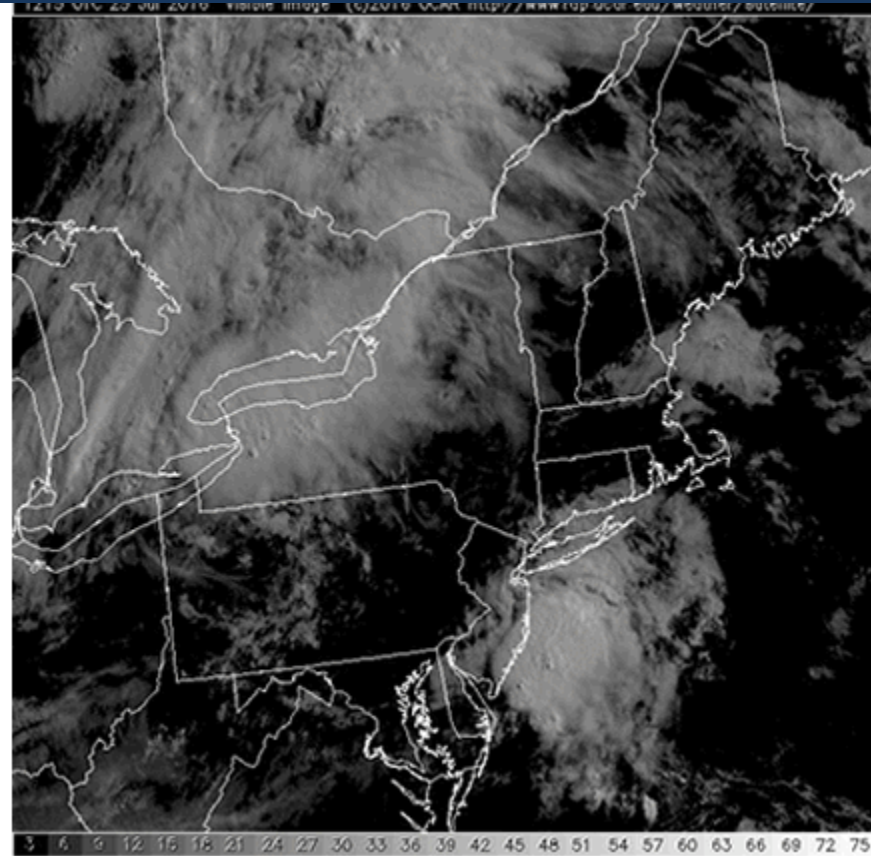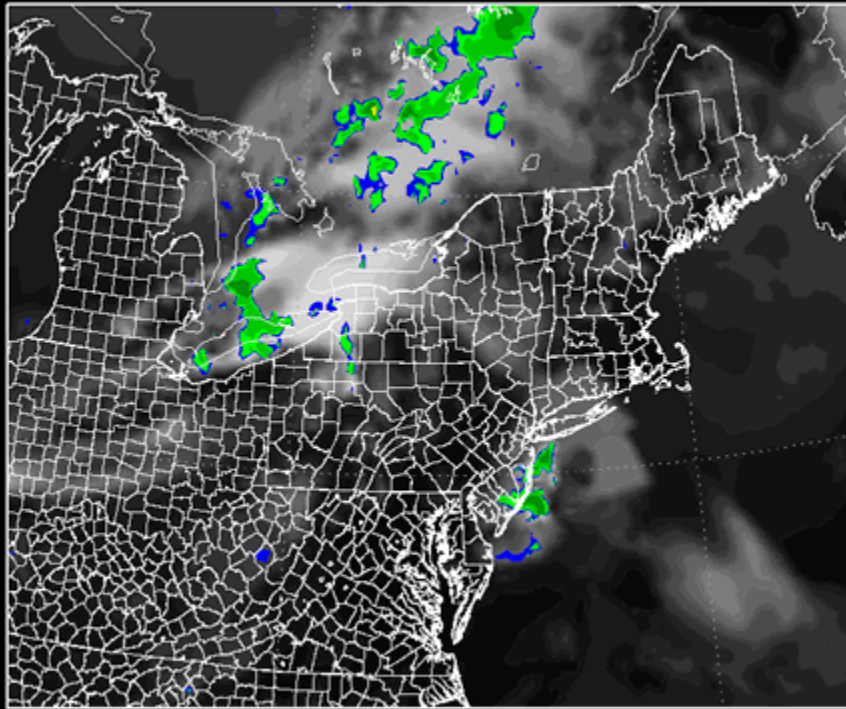
Connecticut Department of Energy and Environmental Protection

- Both Day 1 and Day 2 NOAA models greatly over-predicted the peak ozone plume (+38,+15);
- The new 'experimental' CMAQ model was much more realistic- but probably still missed the convection?

PROD DAY2 OZMX08 0 20160724 06Z CYC

PARA2 CMAQ.V5.0.2 DAY1 0ZMX08 20160725 12Z CYC

PROD DAY1 OZMX08 20160725 12Z CYC
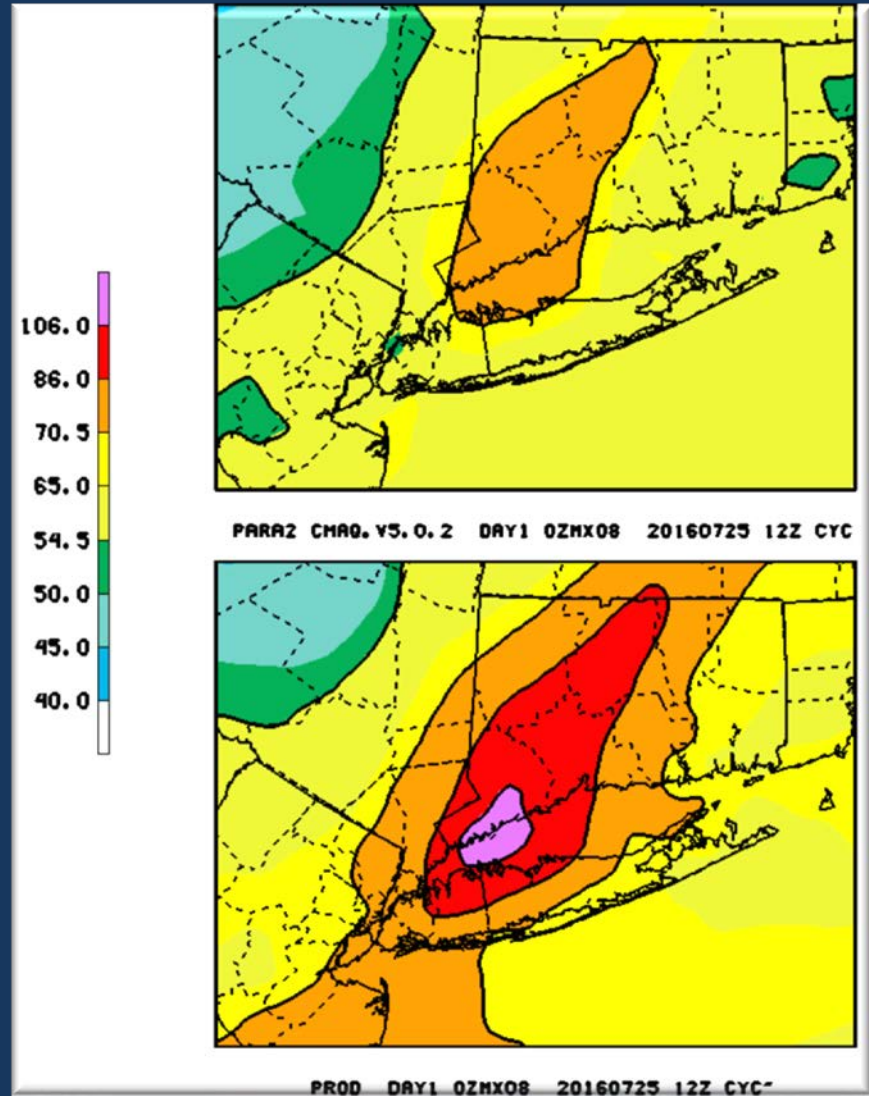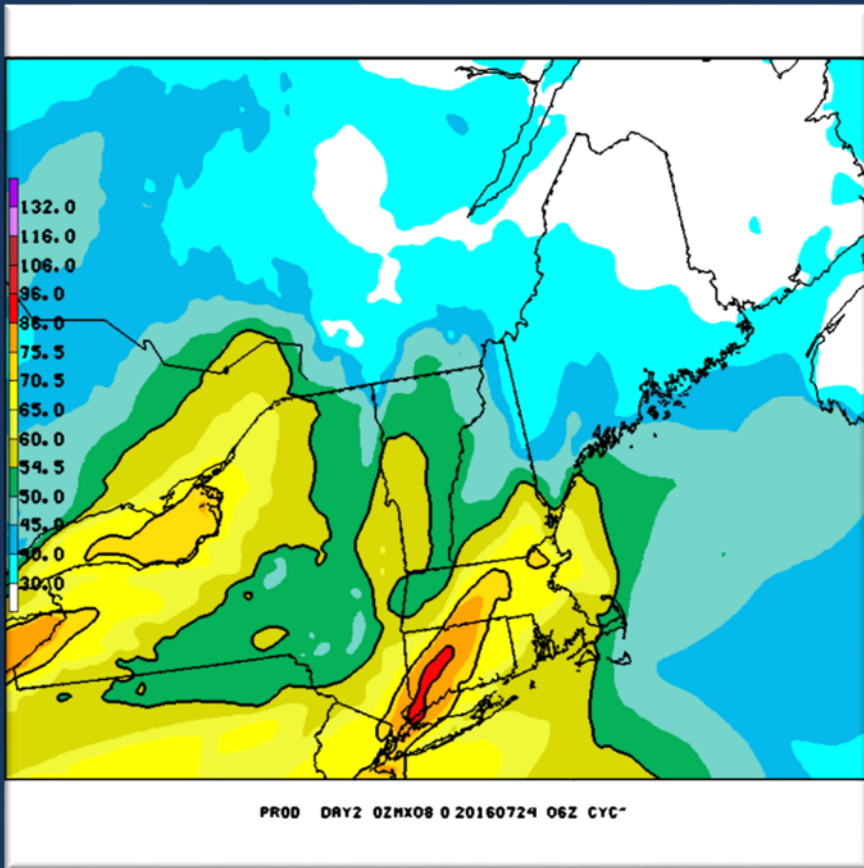
Exceedance Day Scenarios

- **Coastal-only Exceedances:** Strong westerly surface winds transport dirty air down Long Island Sound from source regions to the west (e.g., New York and New Jersey). The relatively cool waters of Long Island Sound confine the pollutants in the shallow marine boundary layer. Afternoon heating over coastal land creates a sea breeze with a southerly component, resulting in ozone exceedances along the coast

Coastal-only Exceedance: June 7, 2016

- Clean westerly surface winds following a cold front kept ozone lower away from the coast.
- Southwest winds ahead of the front funneled pollutants into LIS and into coastal monitors.
- Day 2 NOAA model predicted exceedance at the Madison monitor.
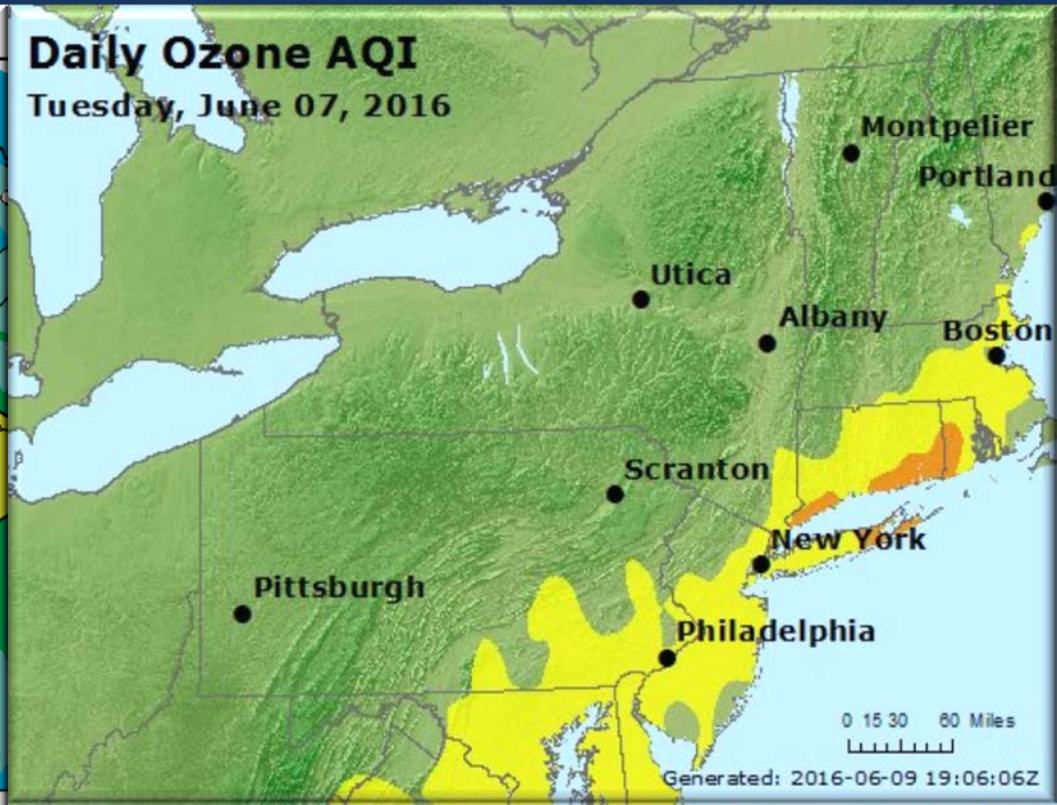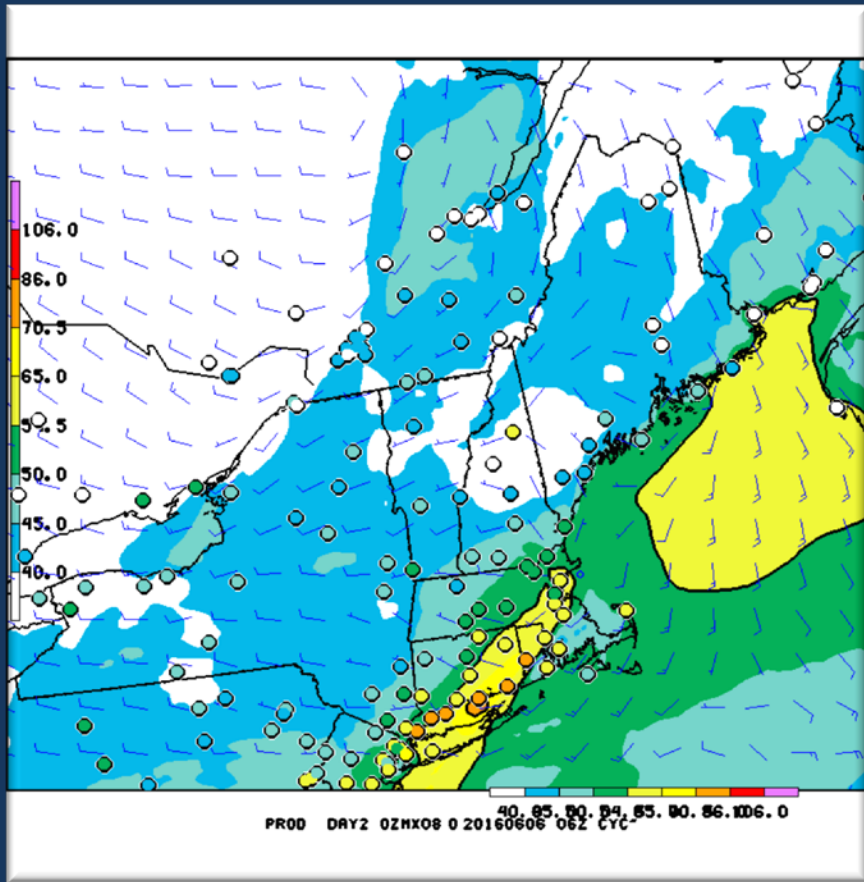
June 7, 2016 Surface Front Animation
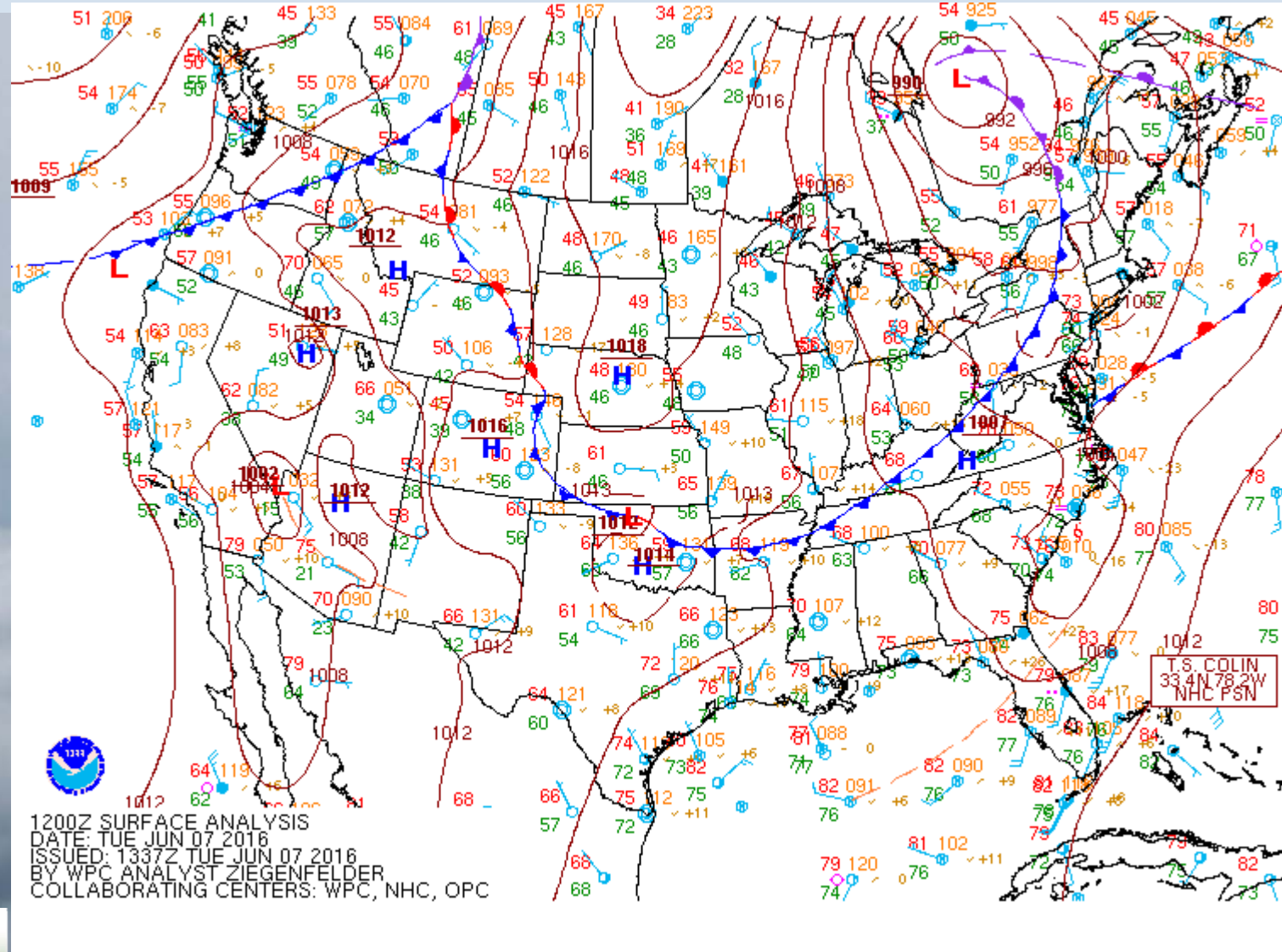
Approaching cold front produced southwest winds that transported ozone from I-95 corridor region into LIS. Frontal passage occurred around 7:00 pm local time in CT.

June 7, 12z NOAA Ozone Model
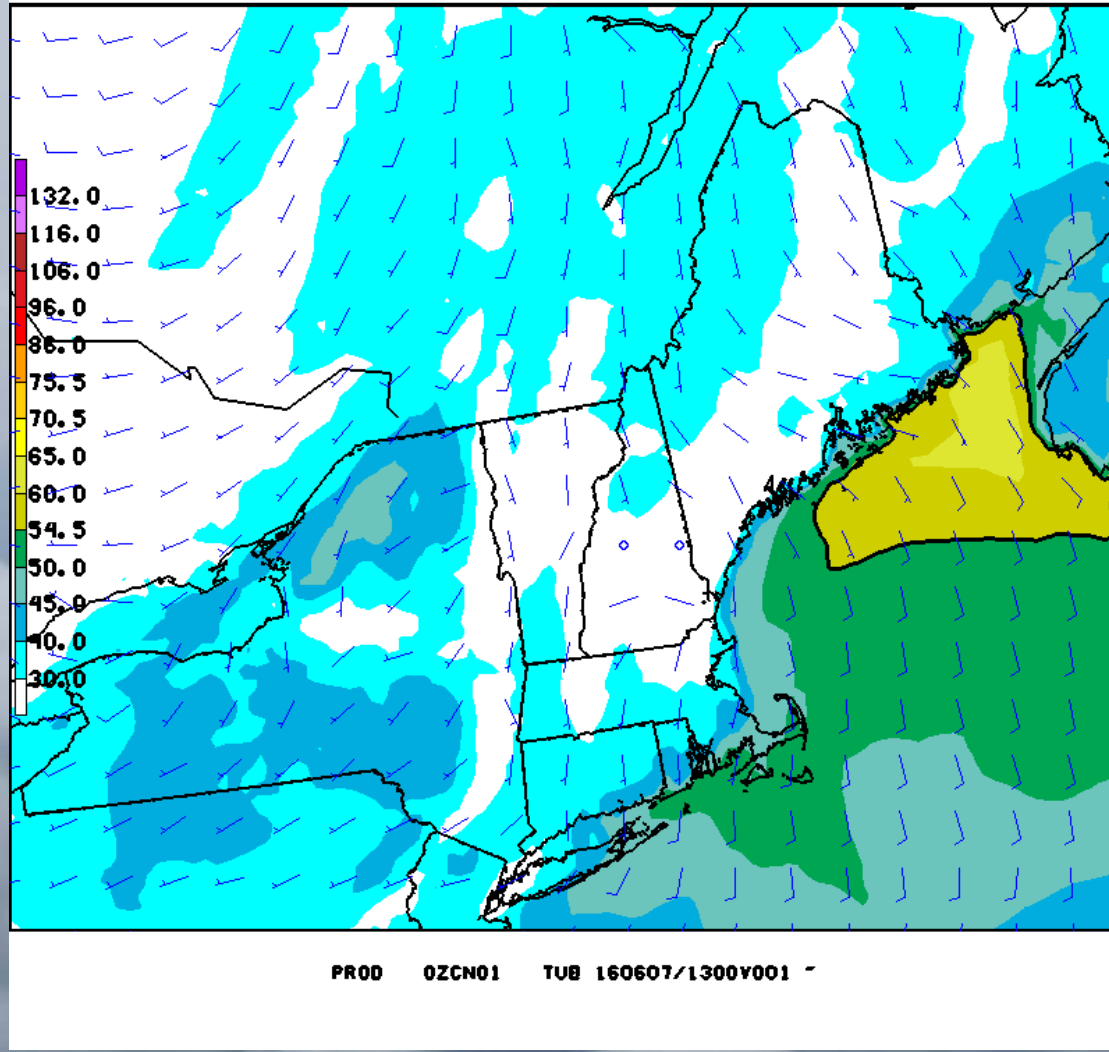
NOAA model 3-hr animation confirms elevated ozone advected from southwest surface winds.

June 7, 12z vs 06z NOAA Ozone Model
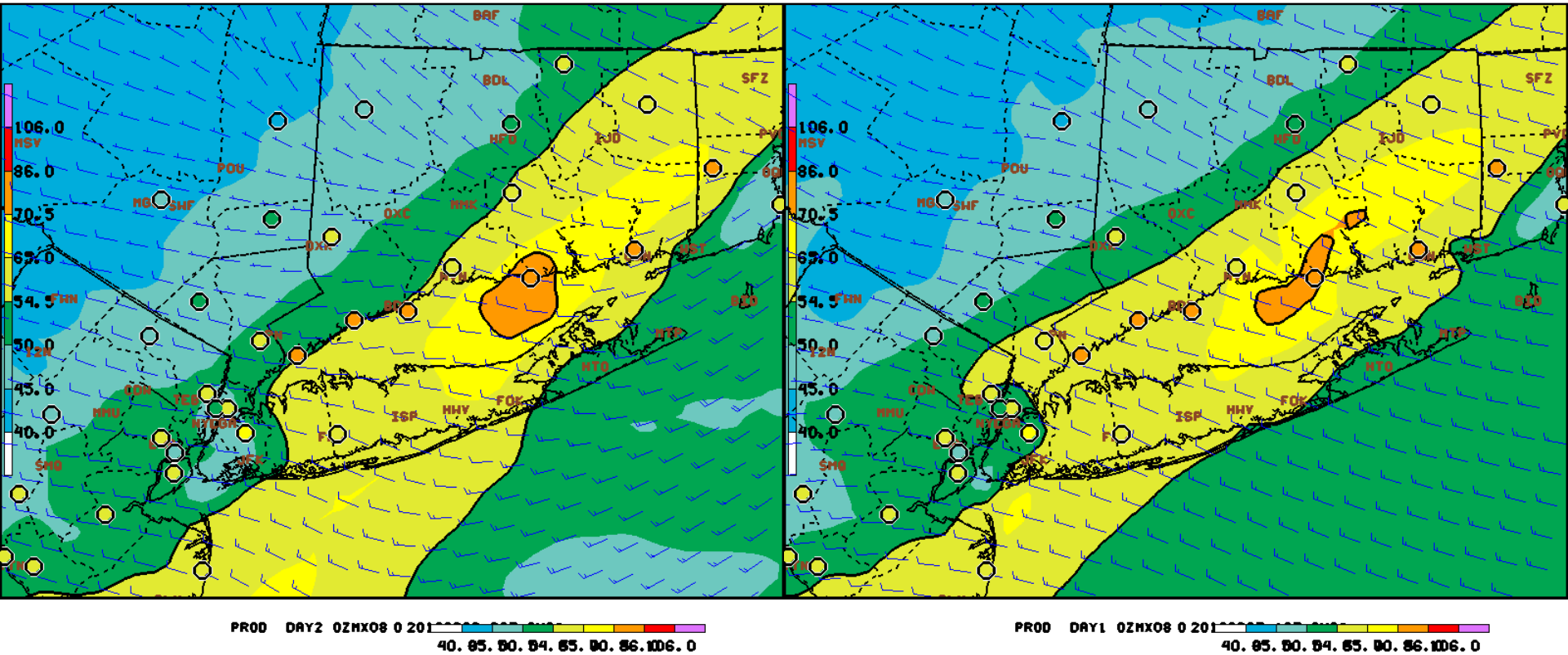
NOAA model 06z Day 2 and 12z Day 1 were almost identical.

24-hr Back Trajectories 2:00 pm EST
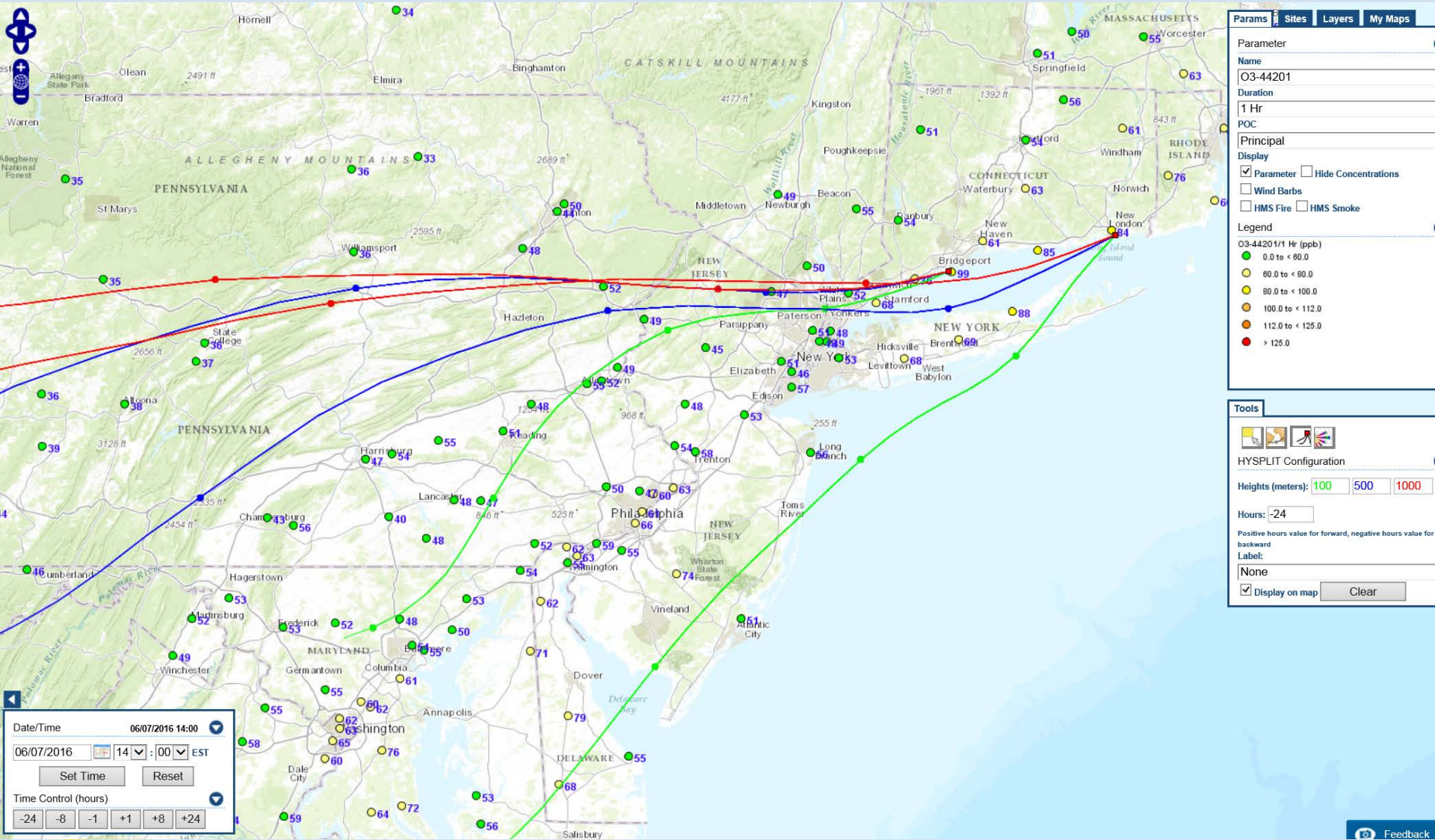
It appears that the 24 hour back trajectories at 100 meters transported the precursors to the LIS region after passing over the I-95 corridor region.

Exceedance Day Scenarios

- **Western Boundary-only Exceedances :** Southerly maritime surface flow invades the eastern two-thirds of Connecticut, keeping ozone levels in that portion of the state low. The south-southwest urban winds out of New York City result in exceedances along Connecticut's western boundary. Winds aloft are often weak for this scenario.
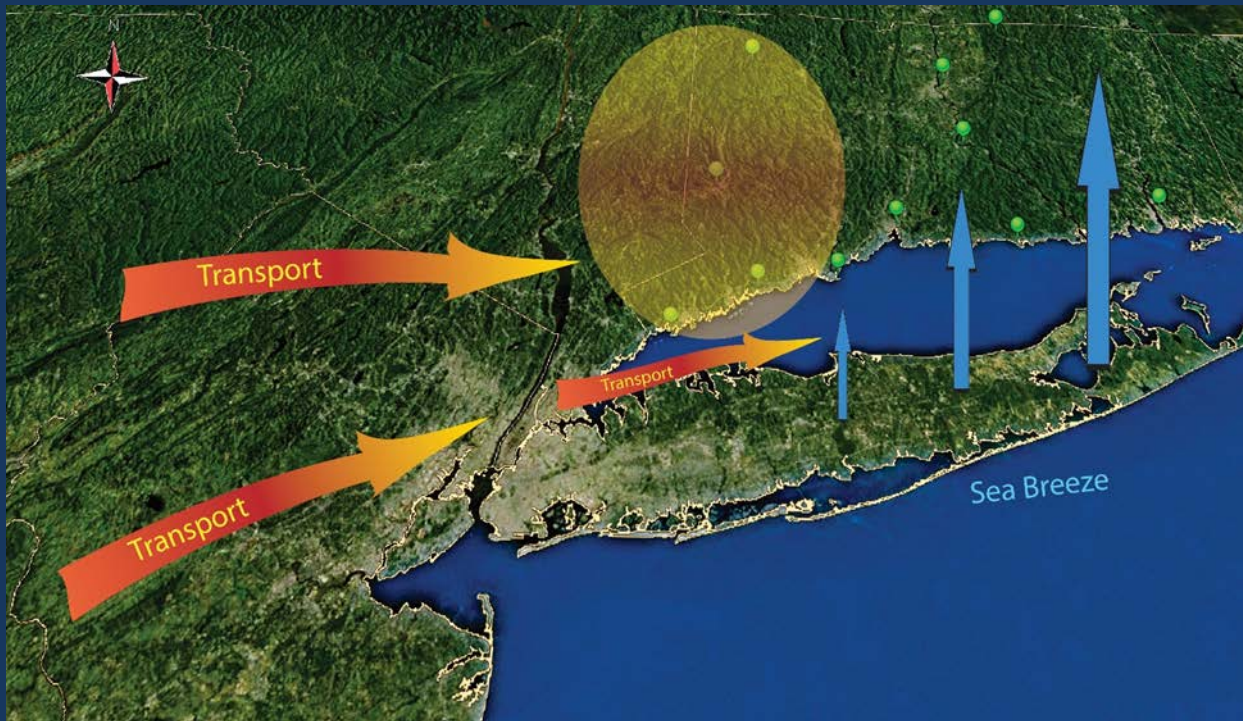
Western Boundary-only Exceedances: June 26

- Day 2 NOAA model showed correct position of ozone plume
- Southerly winds off ocean transported clean air to eastern Connecticut.

PROD DAY2 OZMXO8 0 20160625 06Z CYC

Daily Ozone AQI
Sunday, June 26, 2016

Montpelier
Portland
Utica
Albany
Boston
Scranton
New York
Pittsburgh
Philadelphia

0 15 30   60 Miles
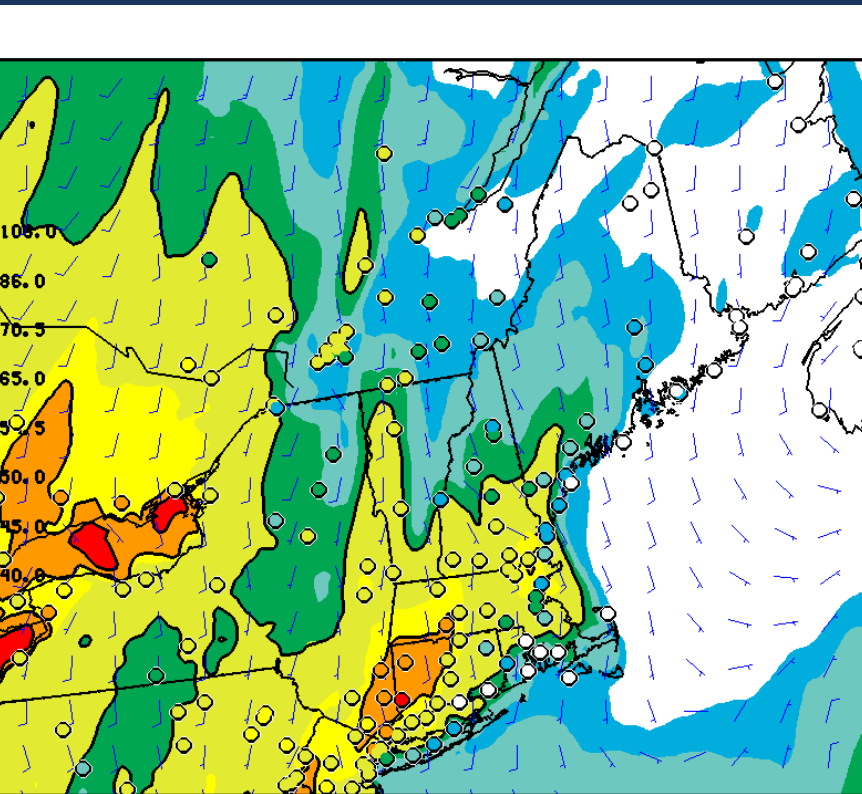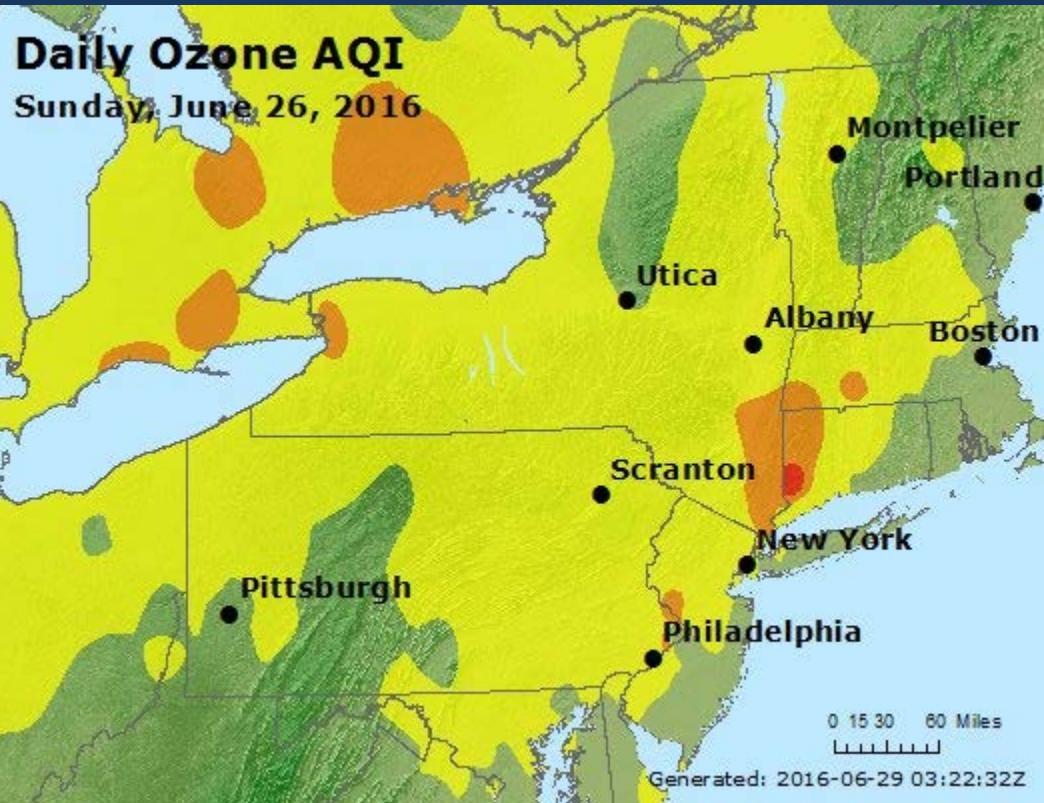
Generated: 2016-06-29 03:22:32Z

- Southerly winds off the ocean push the ozone plume to the northwest
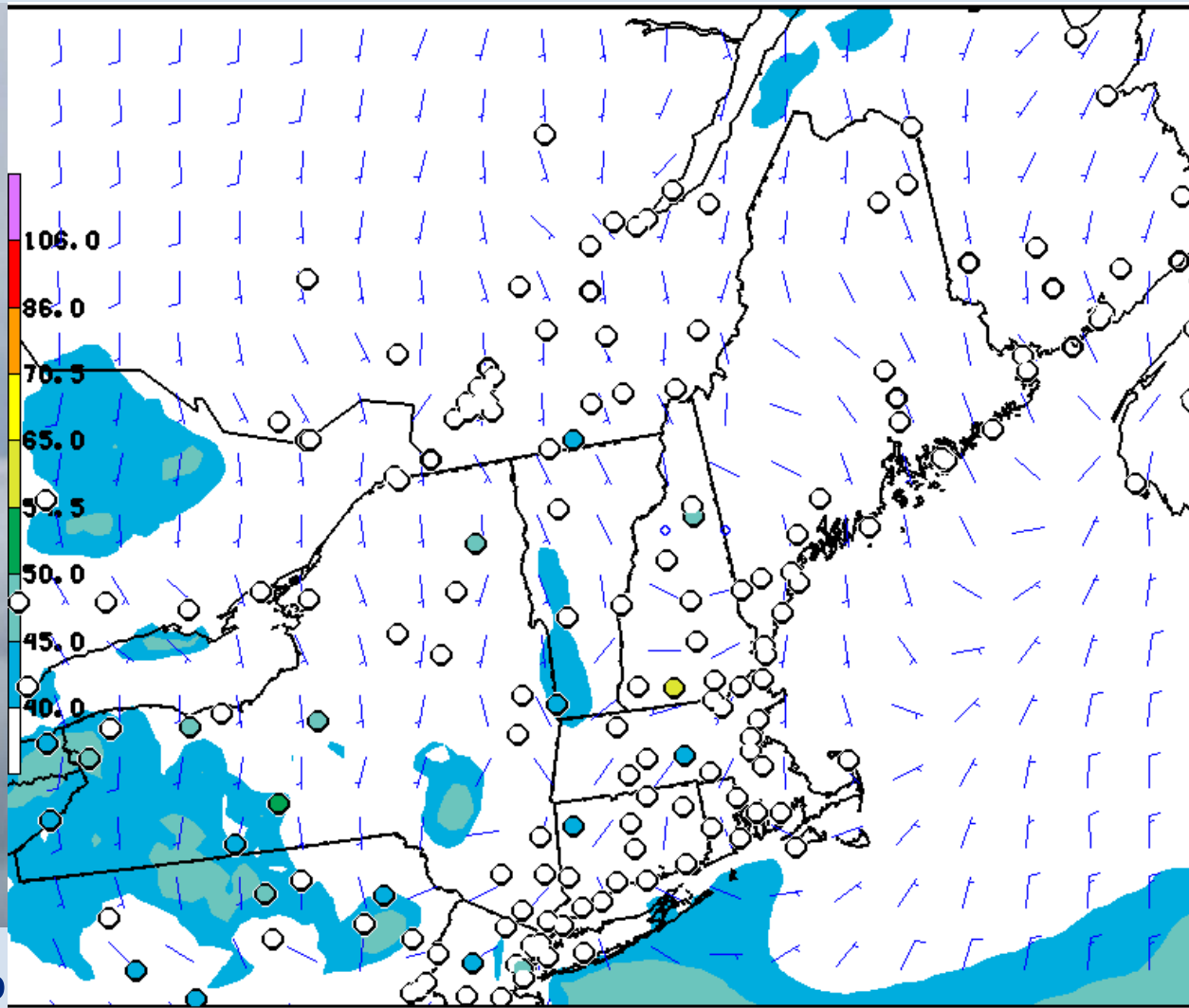
June 26, 12z vs 06z NOAA Ozone Model

- Both model runs performed quite well!
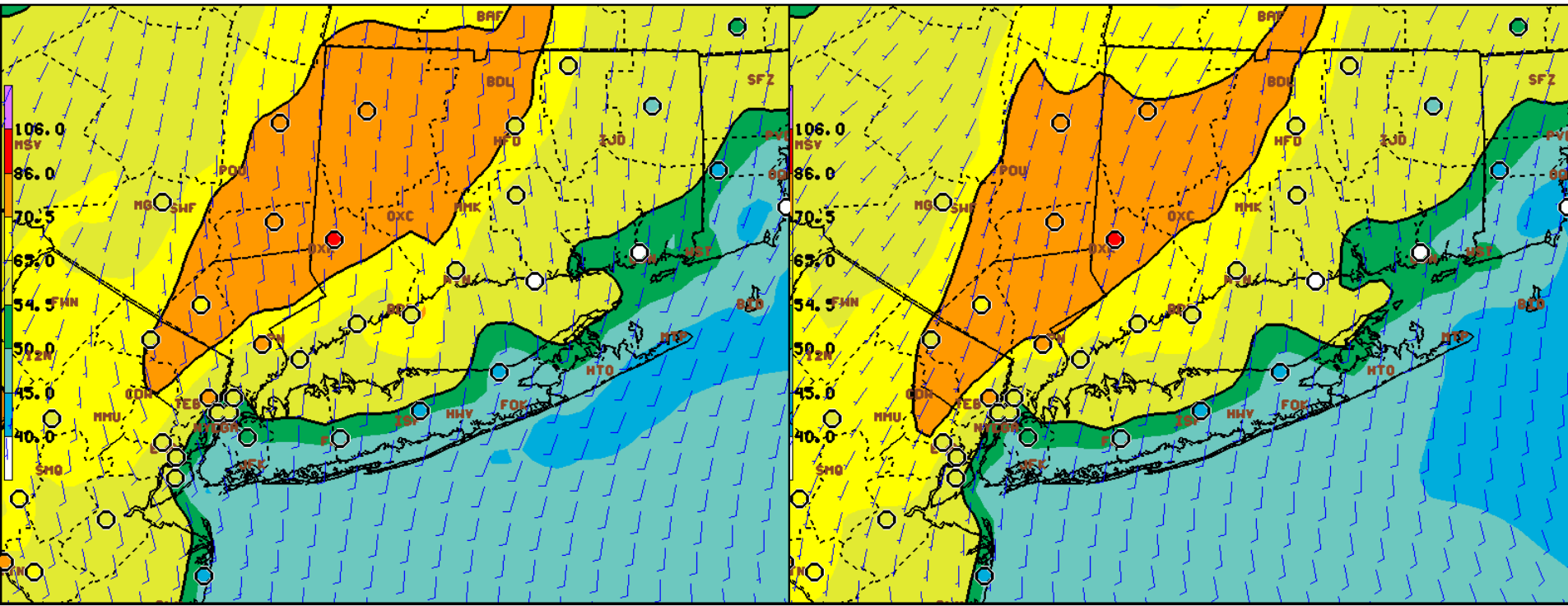
PROD DAY2 OZMXO8 0 20160625 06Z CYC~   PROD DAY1 OZMXO8 0 20160626 12Z CYC~

June 26, 2016 Surface Analysis (5:00am -11:00pm) Animation

- Weak high pressure moves off the coast, allowing some southwest wrap around surface winds to bring NYC pollutants over western Connecticut.
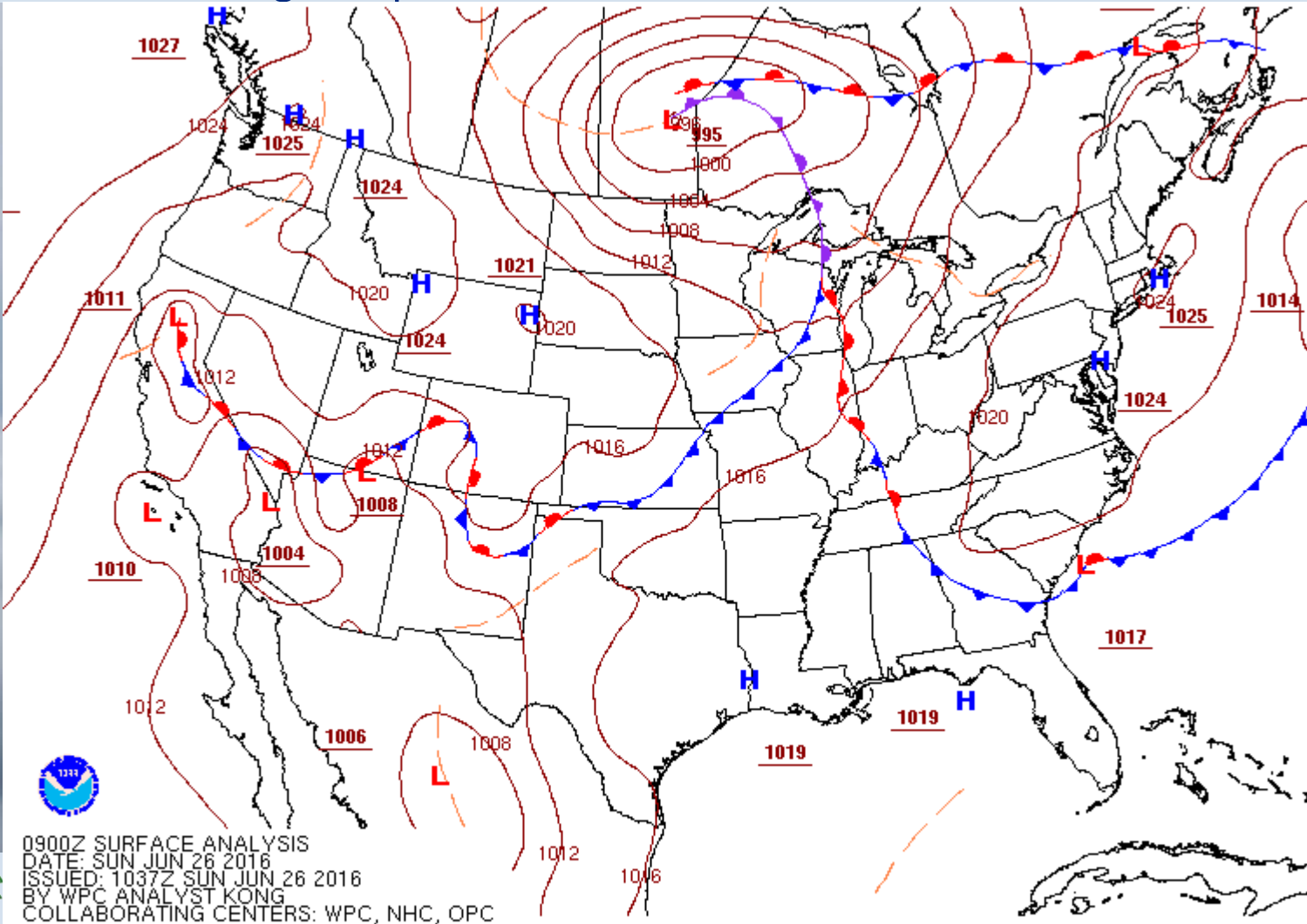
24-hr Back Trajectories 2:00 pm EST

The 10/500 meters trajectories around CT showed light east winds becoming southwest during the afternoon. Low level flow from the NYC metro area impacted Danbury at the hour of peak ozone. Higher level flow at 1000 meters from the west, originated in eastern PA, from an area with elevated ozone.

Exceedance Day Scenarios

- **State-wide Exceedances :** This is the classical worst-case pattern, with flow at the surface in the Northeast up the Interstate-95 corridor, transport at mid-levels also from the southwest via the low level jet and flow at upper levels from the west. All of these flows are from emission-rich upwind areas, serving to transport ozone precursors and previously formed ozone into Connecticut.

State-wide Exceedances: May 25-26

- This was indeed a worst-case scenario, with flow aloft from the west and northwest transporting ozone and precursors from Canadian wildfires. Low level winds turned southwest, which further enhanced the ozone production after passing the NYC area.

Daily Ozone AQI
Wednesday, May 25, 2016

Daily Ozone AQI
Thursday, May 26, 2016
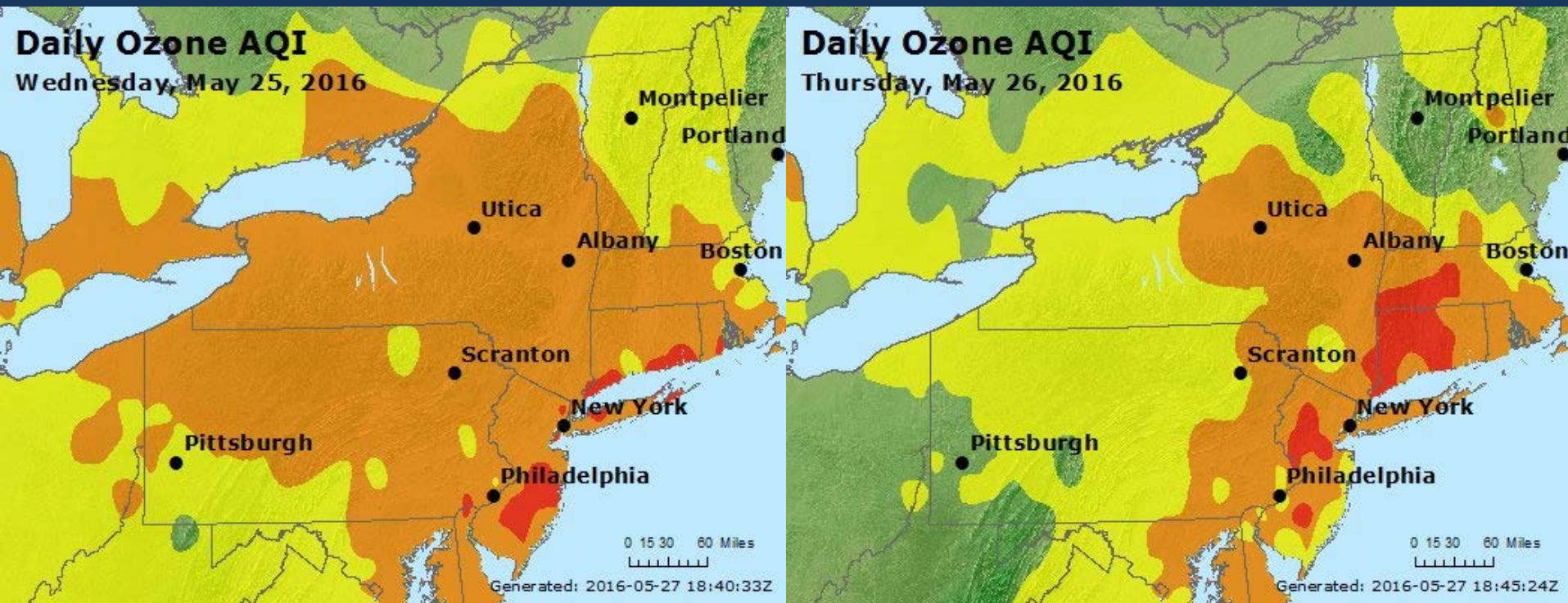
May 24th-29th, 2016 Ozone AQI Map Animation
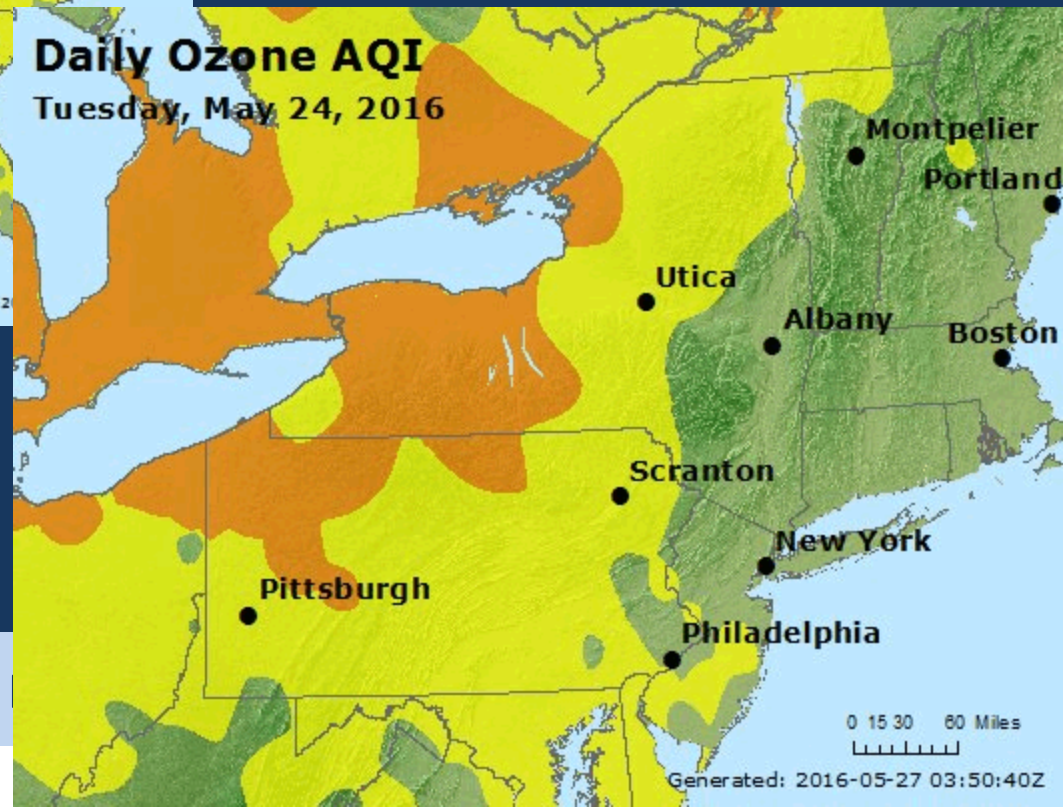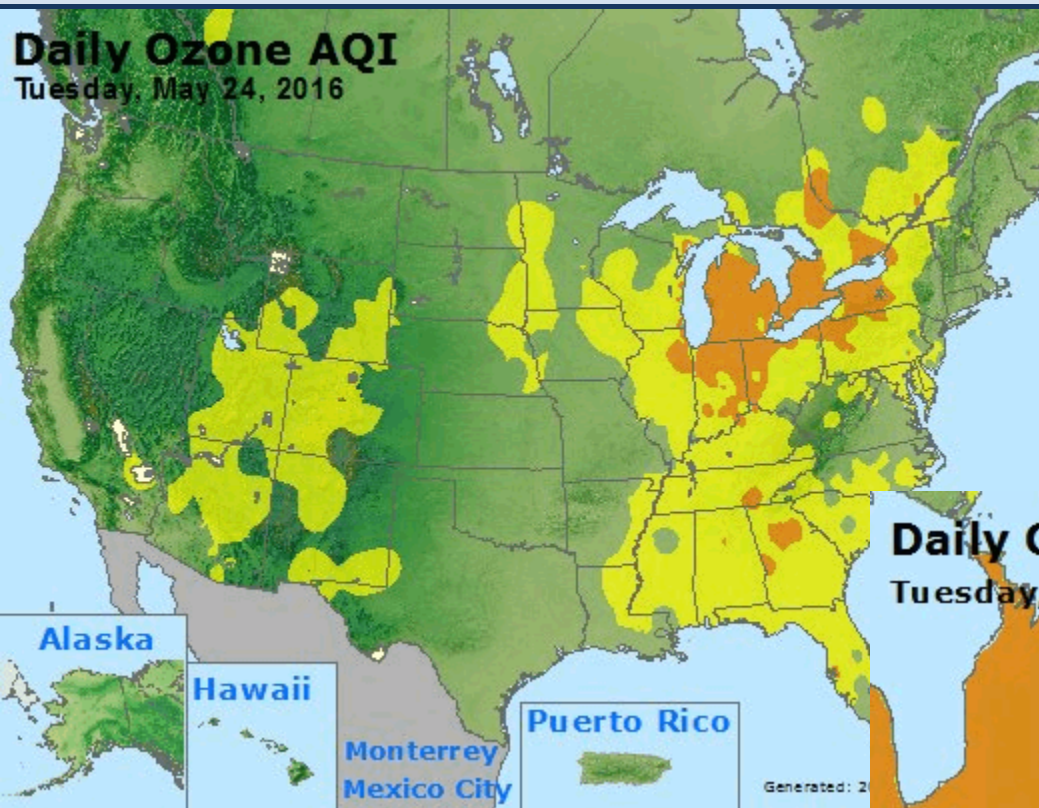
Connecticut Department of Energy

24-hr Back Trajectories May 25th, 4:00 pm
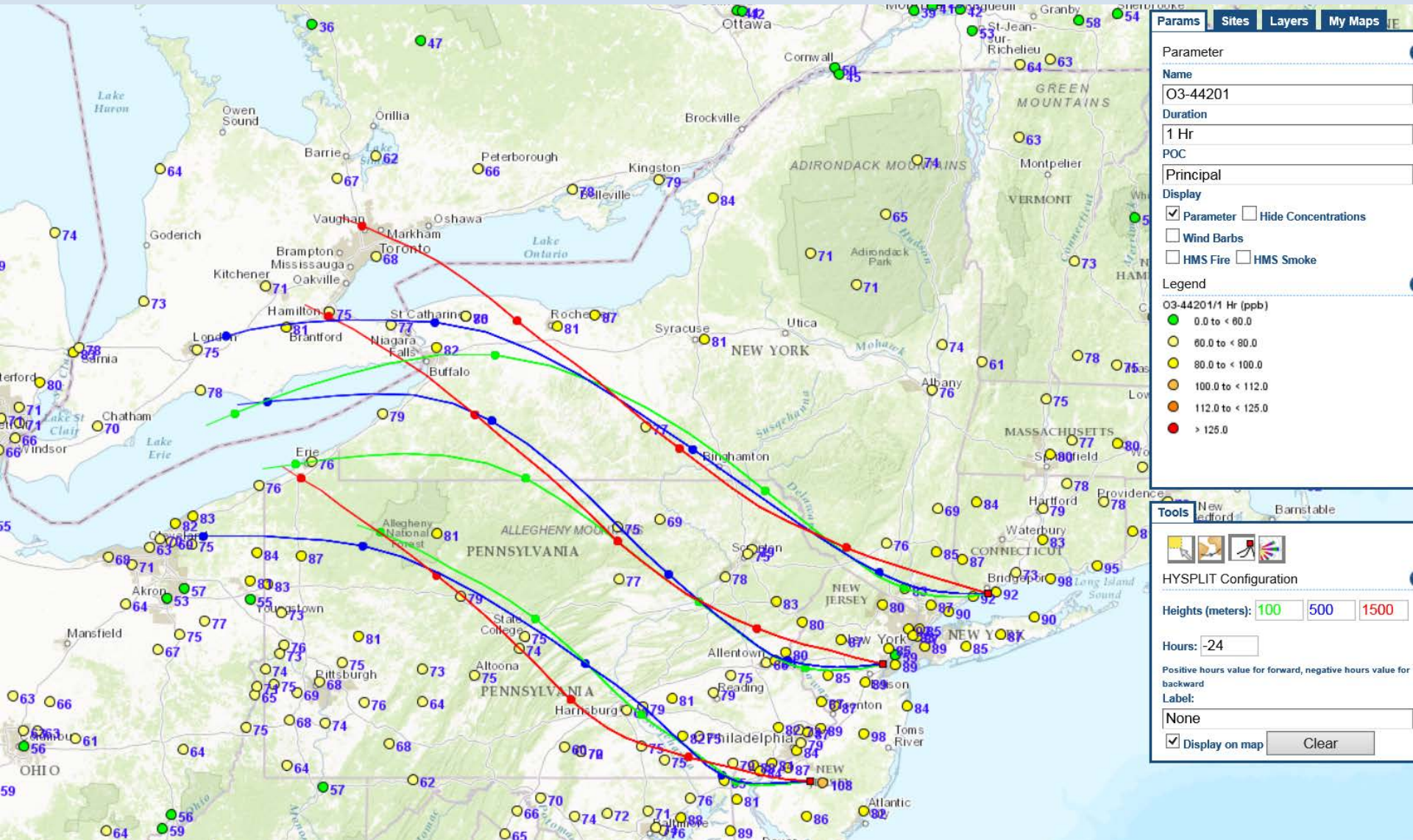
Long range transport from Michigan, with surface winds turning southwest during afternoon, mixed with I-95 corridor ozone and enhanced the ozone along the CT coast.

36-hr Back Trajectories 4:00 pm EST with Analyzed Smoke Plume
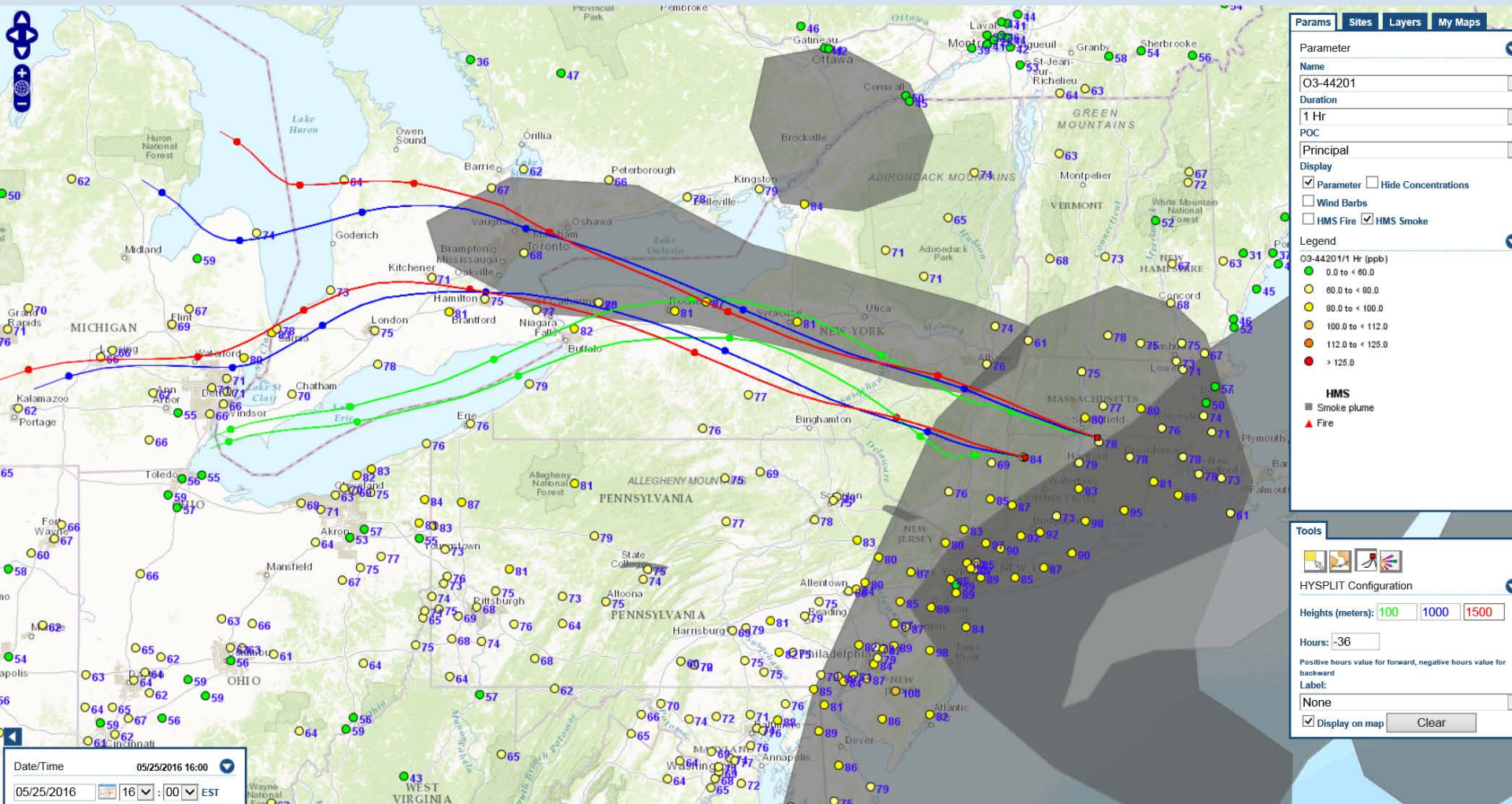
Long range transport from Michigan up to 1500 meters, appears to pass through smoke plume.

VIIRS May 20-28, 2016

May 20-28 VIIRS Satellite with AOD

AOD May 20-28, 2016
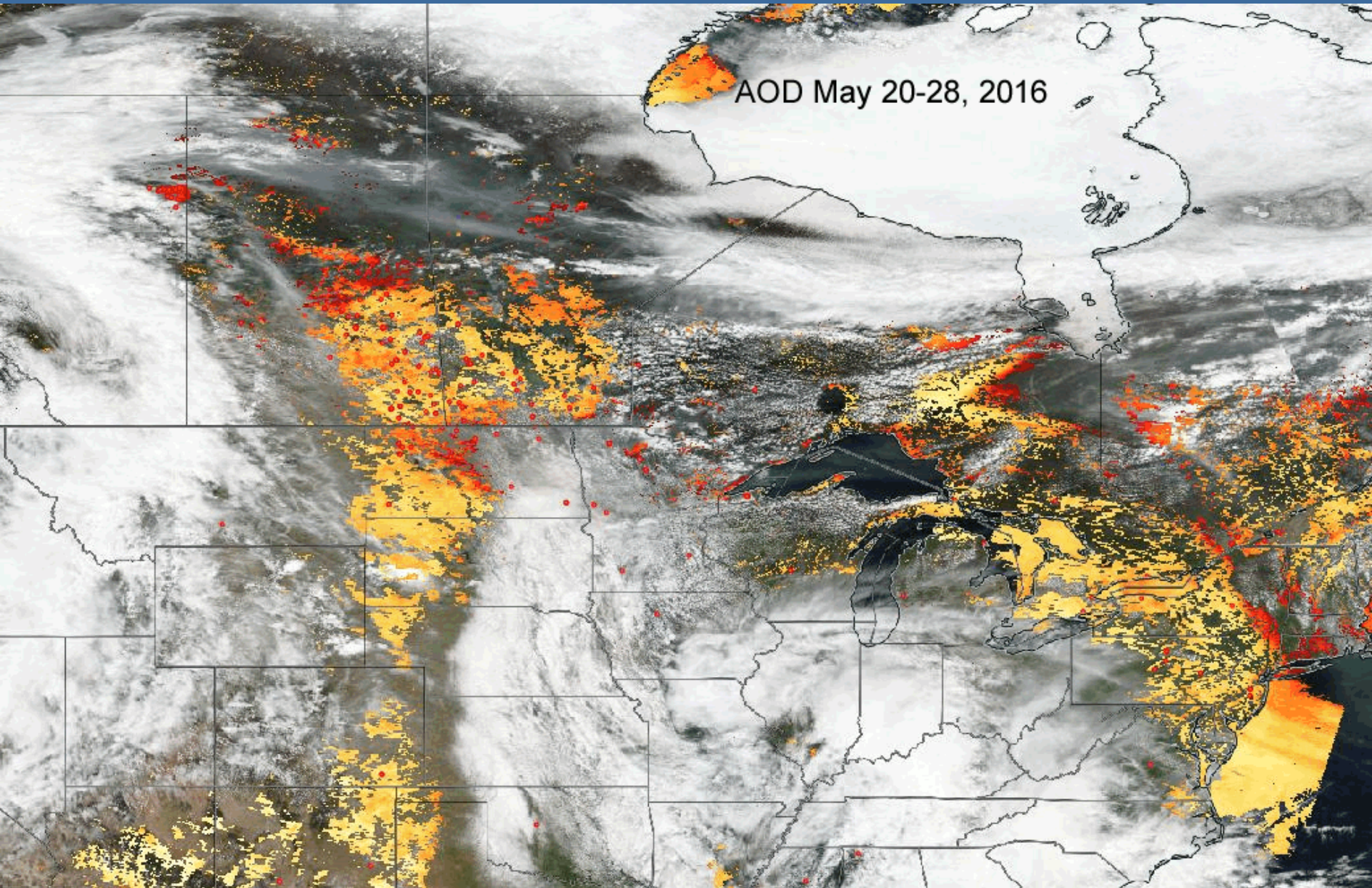
May 25, 2016 'Value Added' AOD
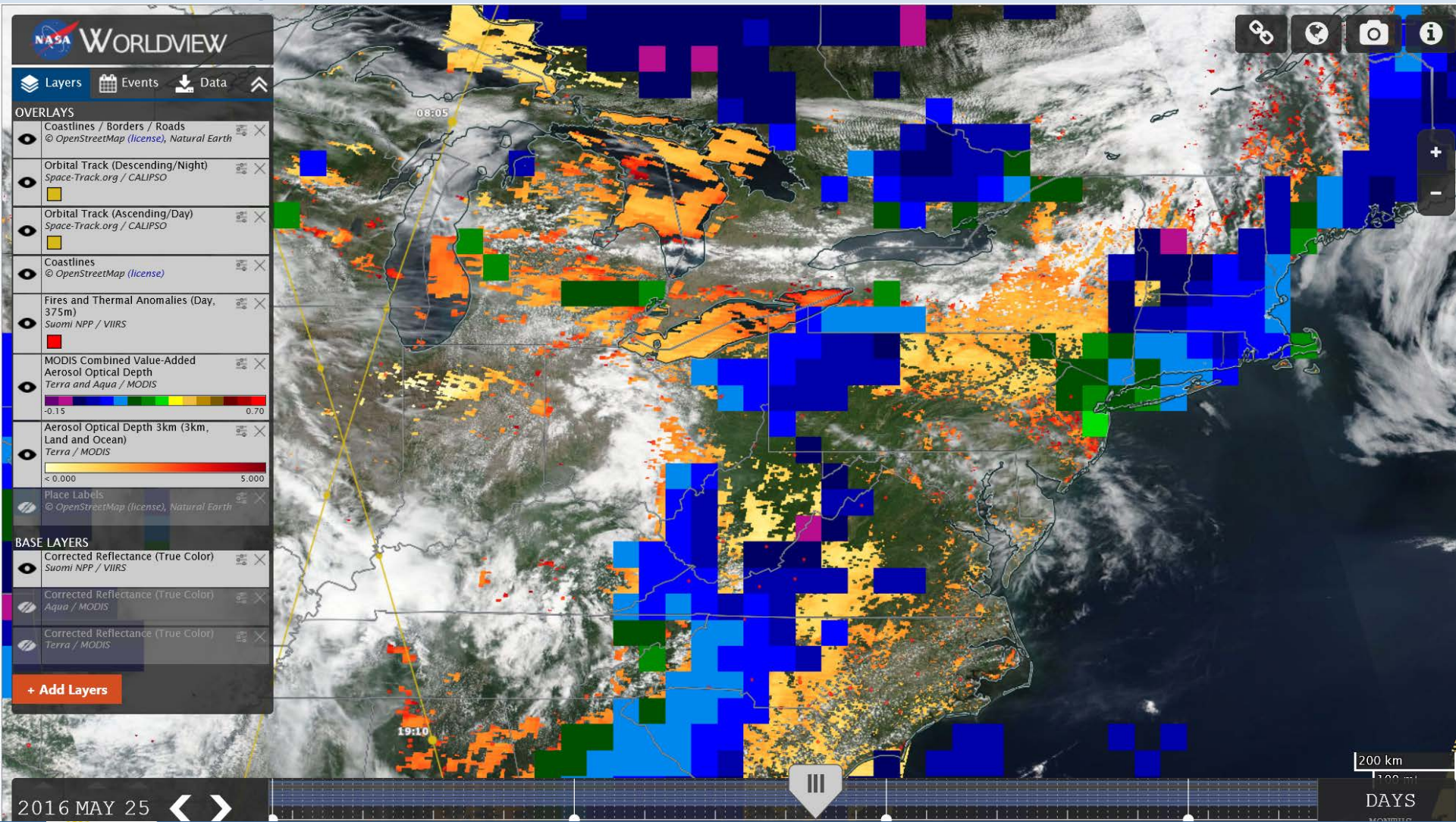
Connecticut Department of Energy and Environmental Protection

NOAA Ozone Model May 25th, 2016

NOAA model does not model pollutants from wildfire smoke, so it vastly under-predicted the ozone.

Con_____otection

PROD DAY1 OZMX08 0 20160525 06Z CYC

May 26, 2016 Surface Map Animation
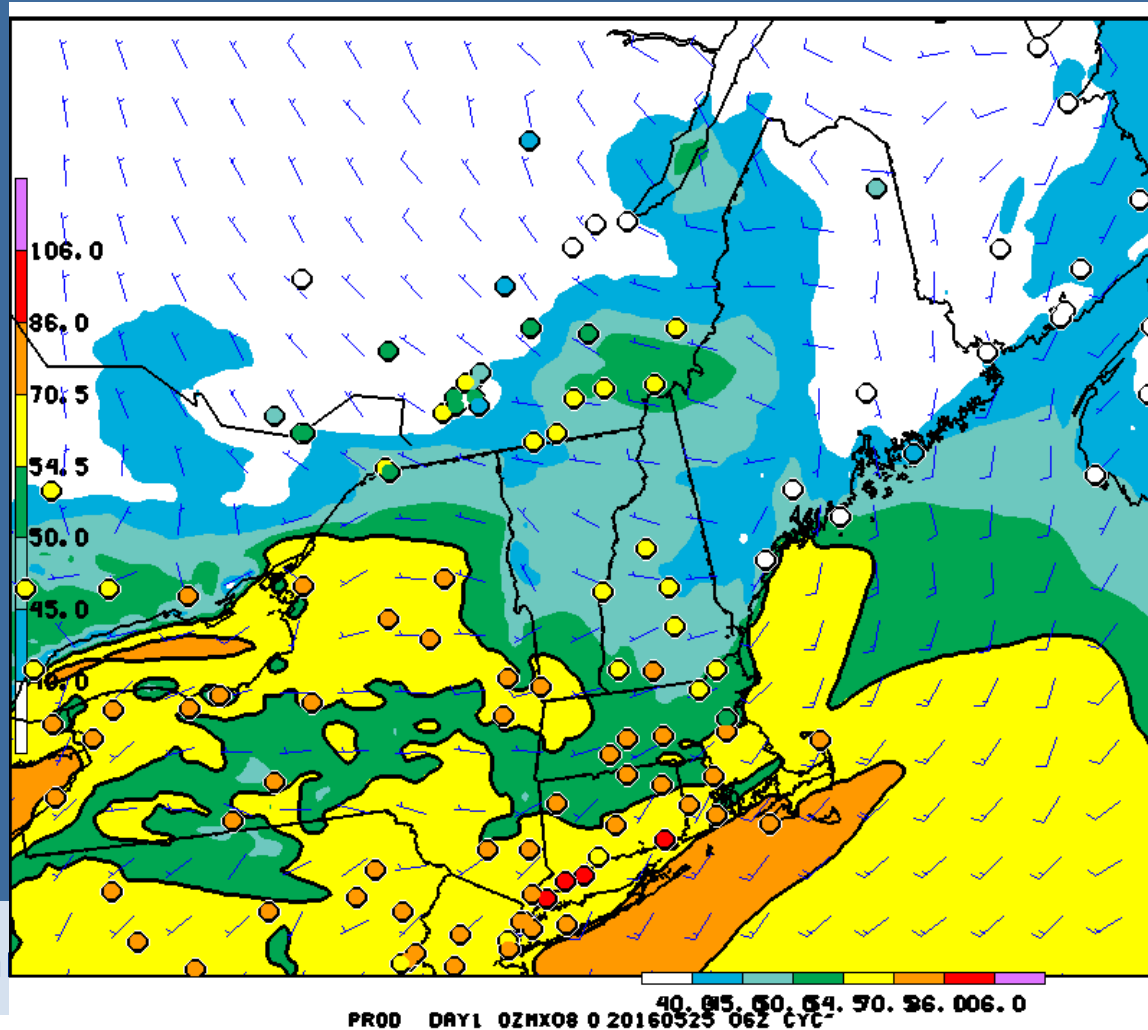
Connecticut Department of Energy and Environmental Protection
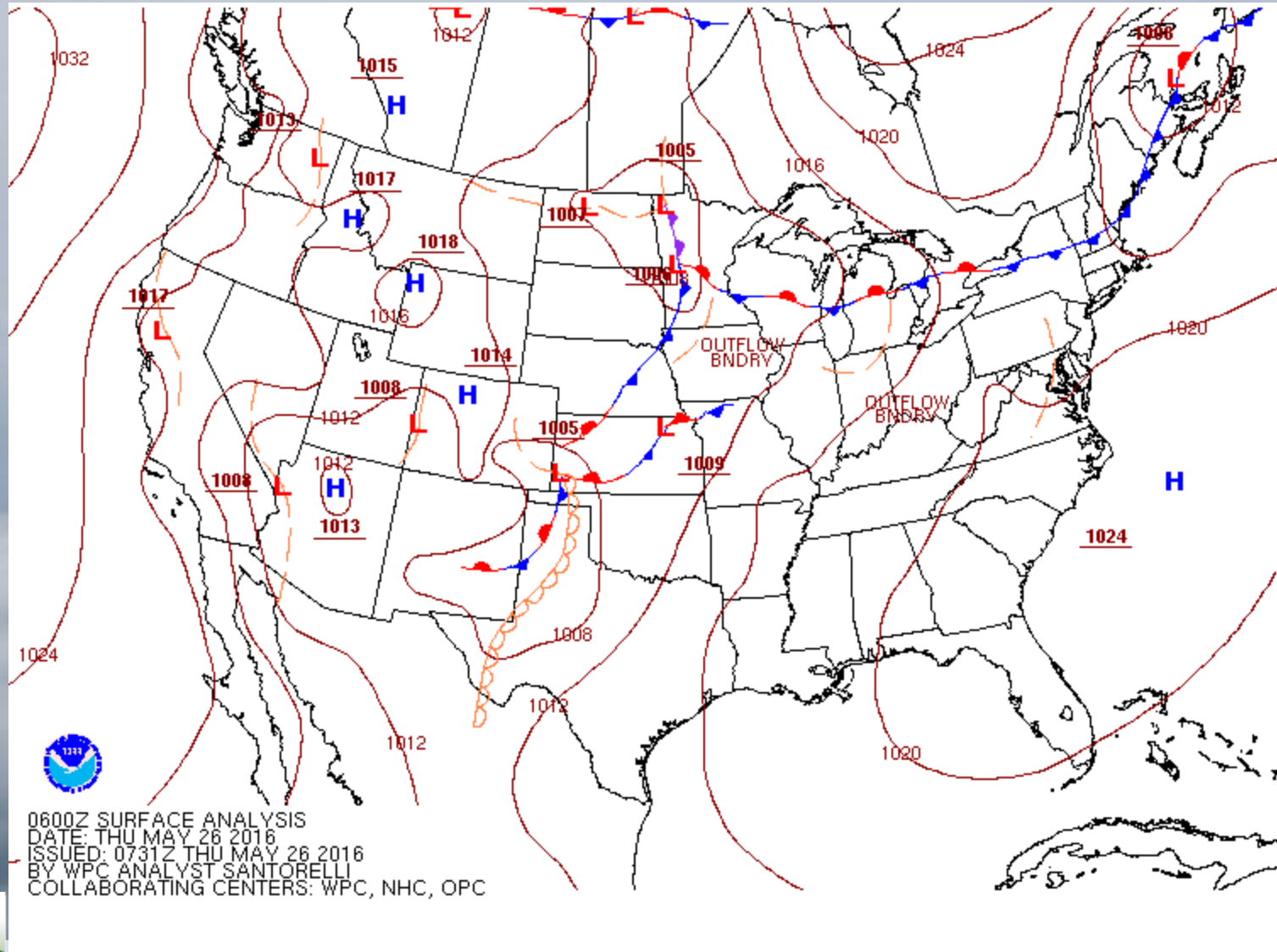
36-hour Back Trajectories, May 26ᵗʰ, 2016
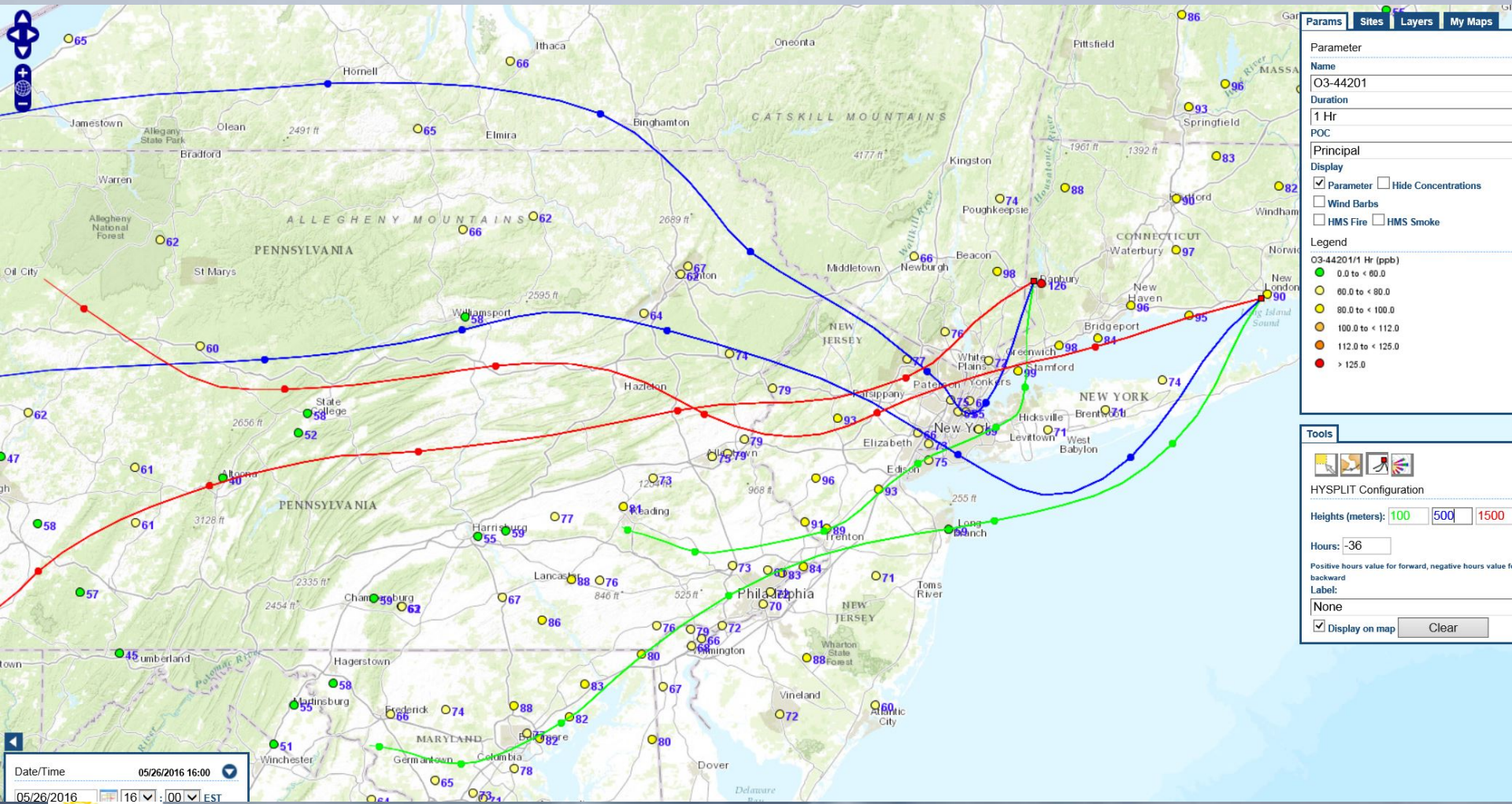
Connecticut Department of Energy and Environmental Protection
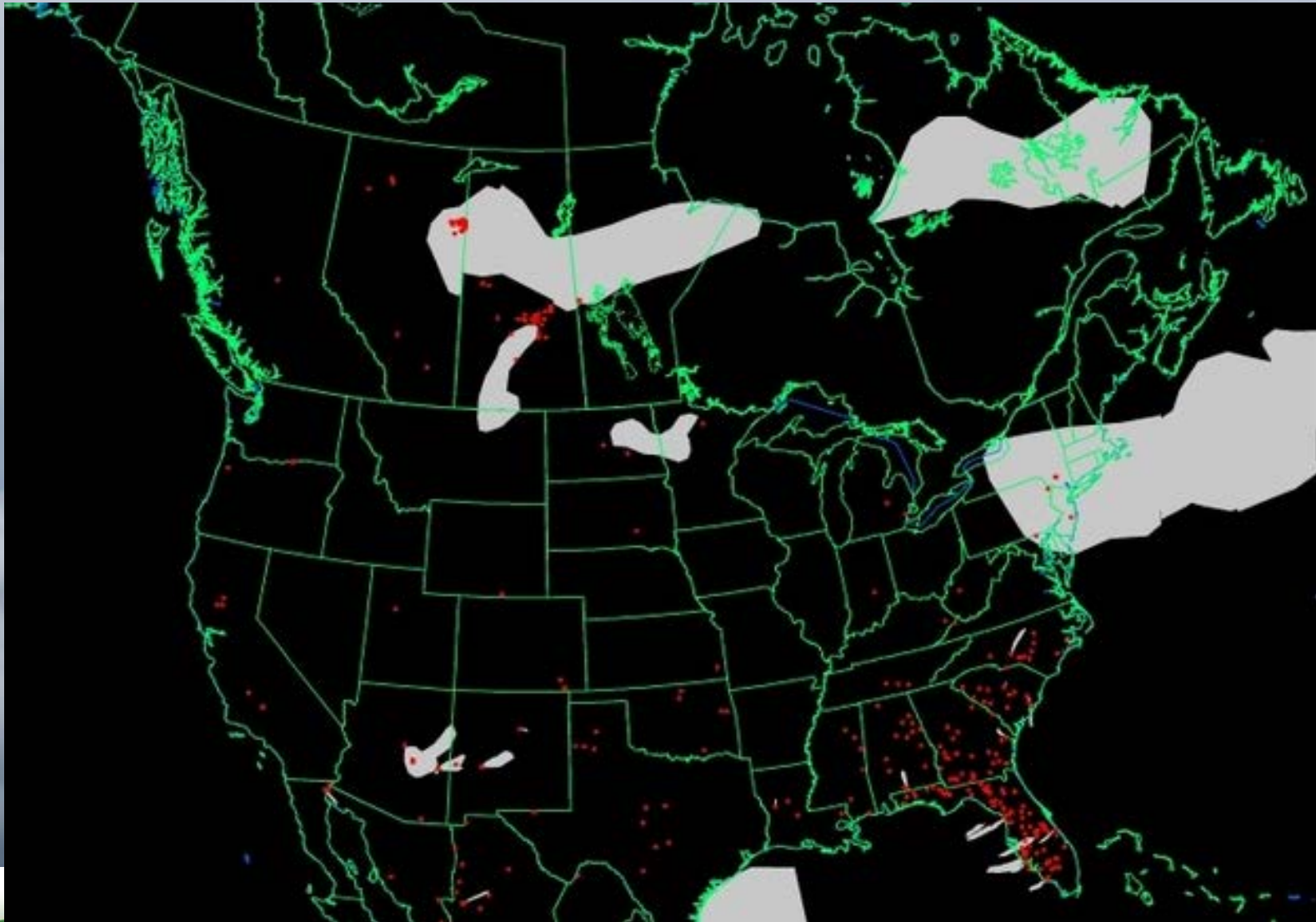
Connecticut Department of Energy and Environmental Protection

5/26/16
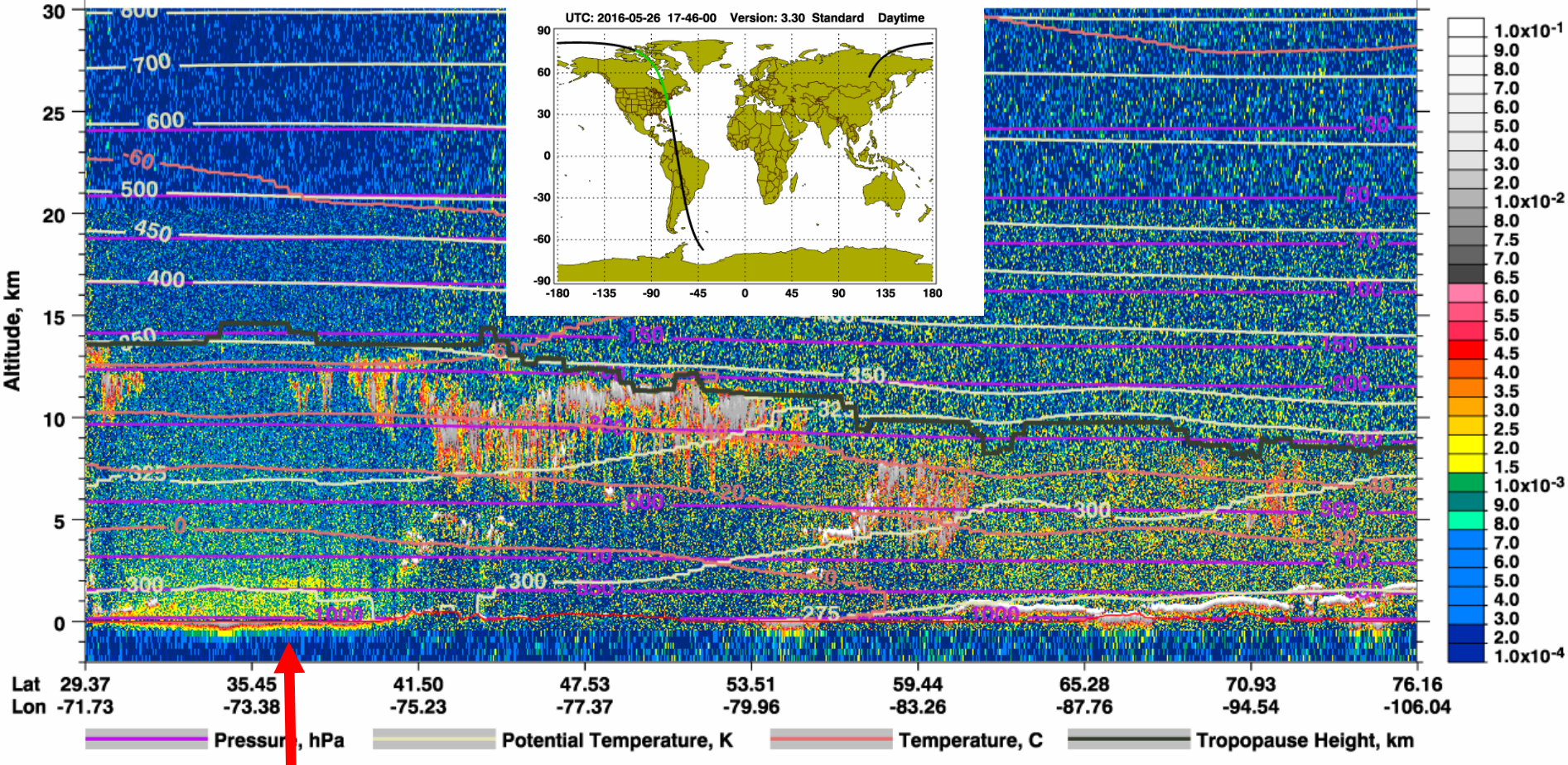
MD-NY

Connecticut Department of Energy and Environmental Protection

NOAA Ozone Model May 26th, 2016

NOAA modeled ozone plume from I-95 corridor, but underpredicted peak levels due to the smoke.

May 27, 2016 Surface Map Animation

Connecticut Department of Energy and Environmental Protection

May 27th, 2016 Smoke Plume

By May 27th, it appears that the smoke plume had dissipated, but pollutants could have a lingering effect.

NOAA Ozone Model May 27ᵗʰ, 2016

Model was still under-predicting peak ozone levels.
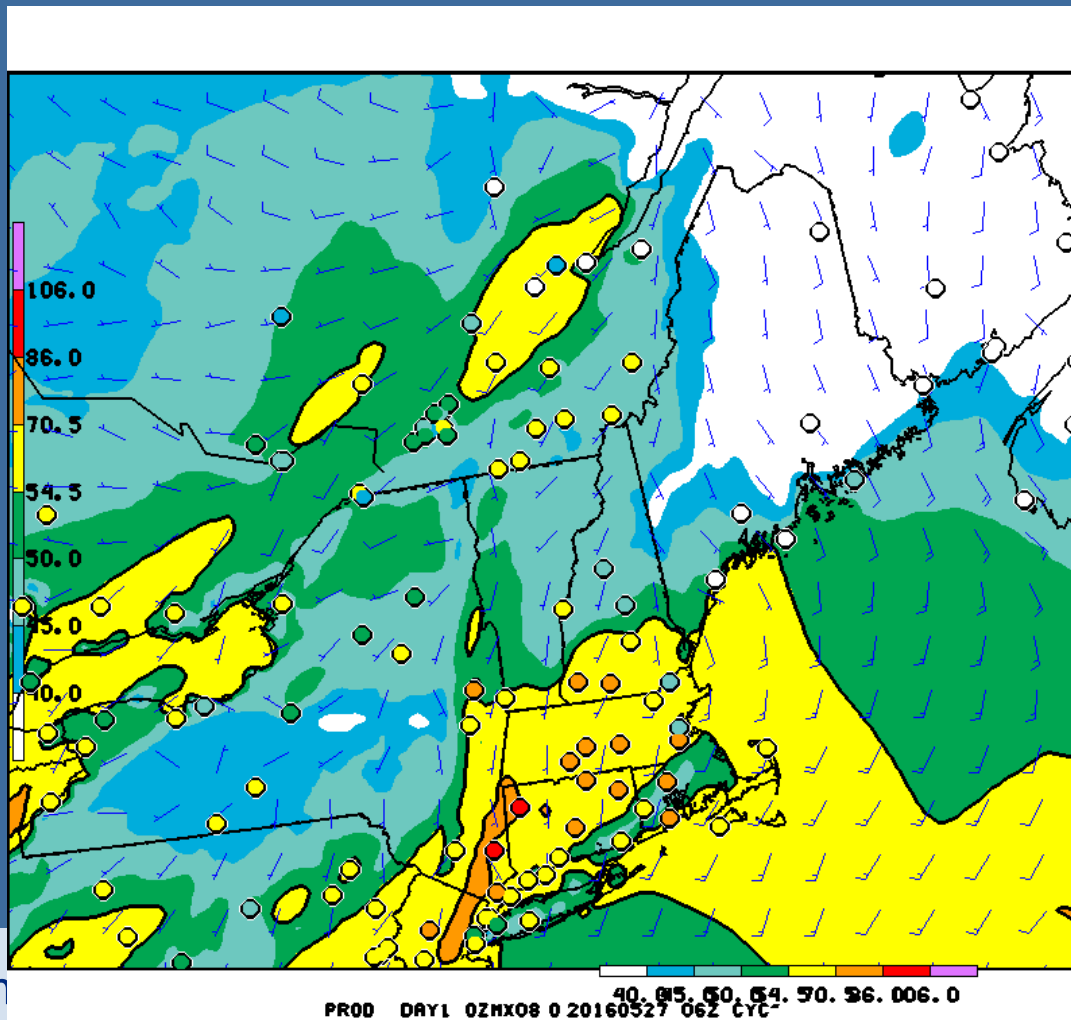
Conn...   Protection

What about false alarms?

- NOAA 06z Day 2 predicted 37 days USG+ for at least 1 monitor during 2016
- 21 of those days were hits; 16 days were misses (43%)
- July 8th was one of those days.
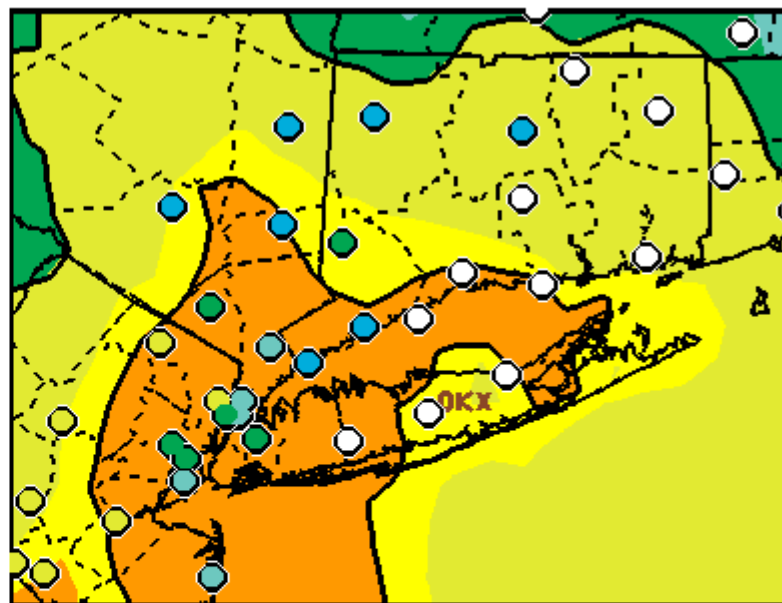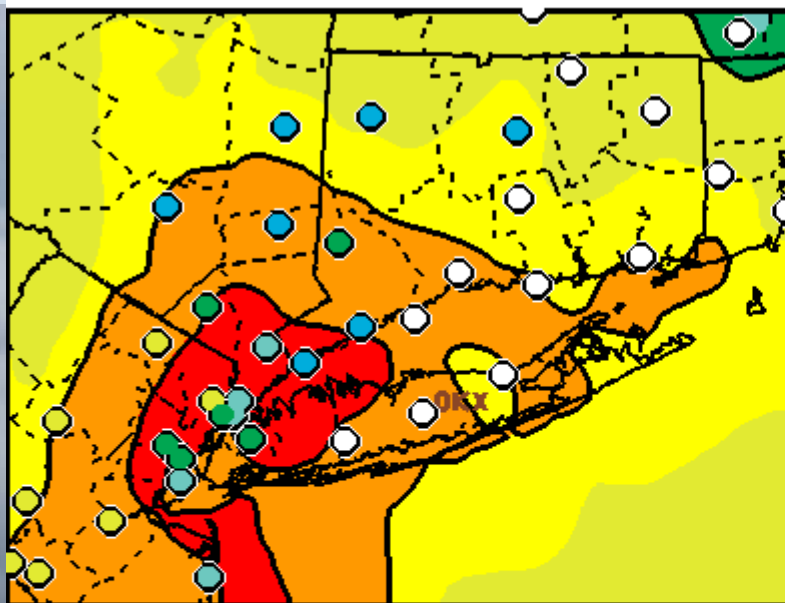
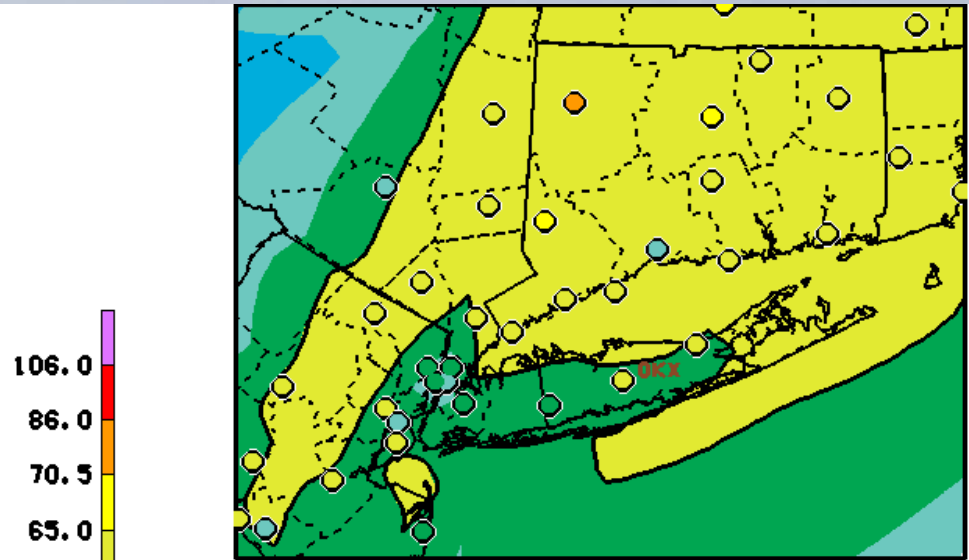PROD   DAY2 OZMX08   20160707 12Z CYC⁻   :A2 CMAQ.V5.0.2   DAY2 OZMX08   20160707 12Z

40.0   45.0   50.0   54.5   65.0   70.5   86.0   106.0

What about false alarms?

- NOAA 12km missed the stalled front on July 8th!
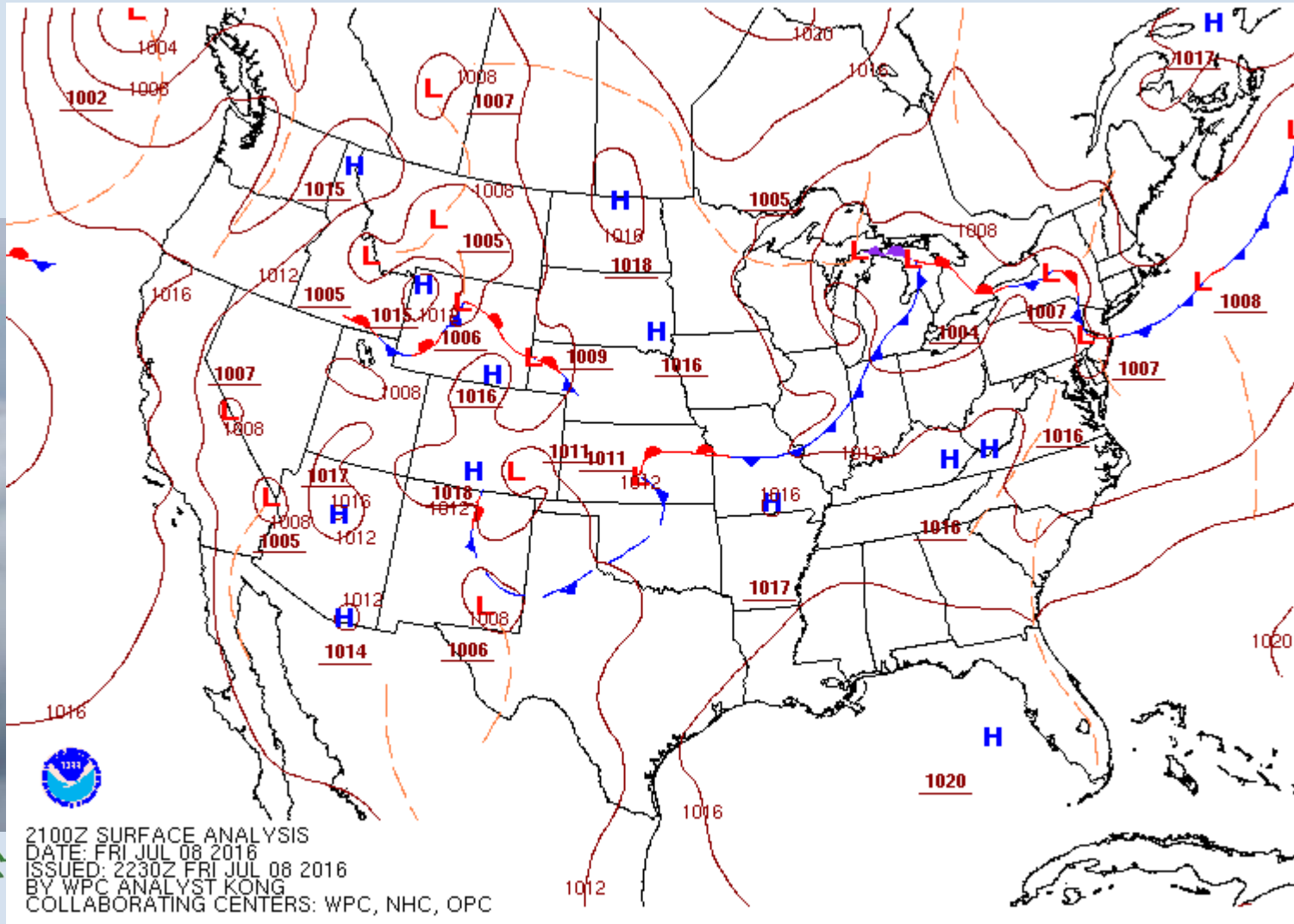
What about CMAQ v5.0.2?

- EXP CMAQ seems to subtract ~10+ppb, so may not be helpful in marginal exceedances and in early season.
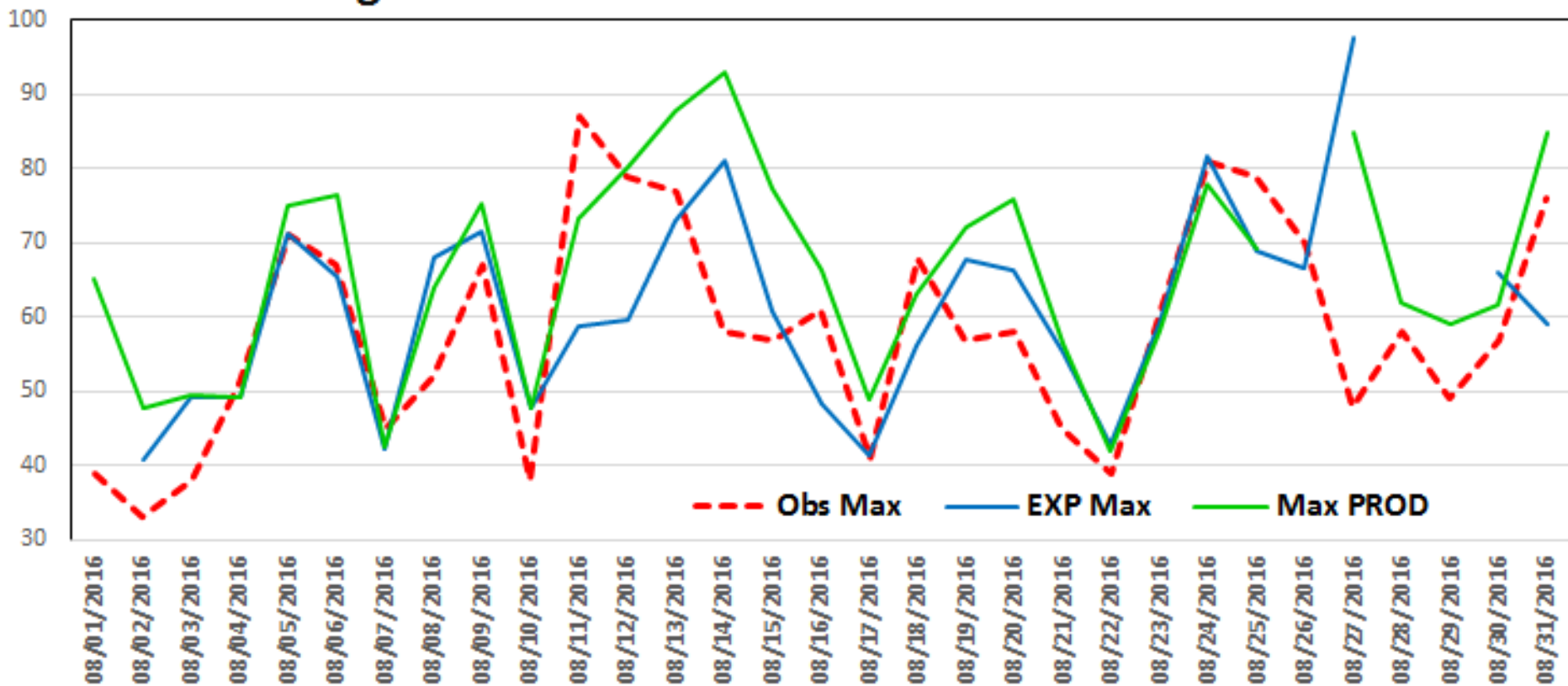

PARA2 CMAQ.V5.0.2   DAY1 OZMX08   20160825 12Z CYC

PROD   DAY1 OZMX08   20160825 12Z CYC

Connecticut Depart
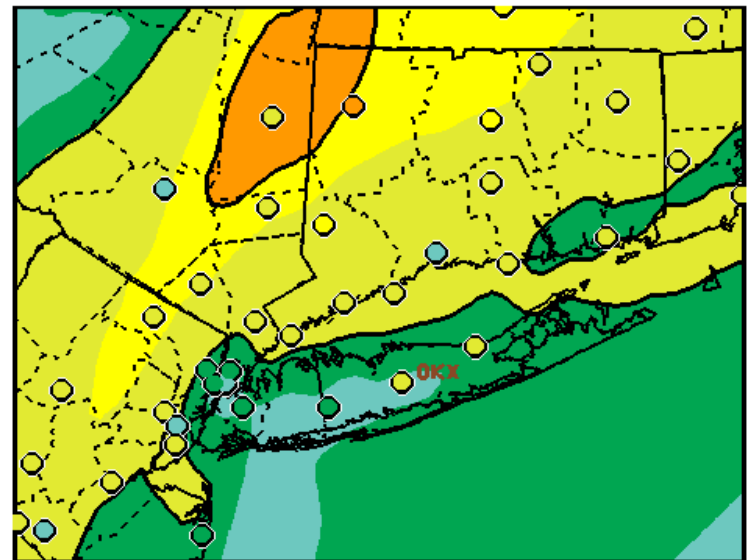
What about CMAQ v5.0.2?

- EXP CMAQ missed the August 11-12 exceedance.
- Need to look at May-June period for under prediction.

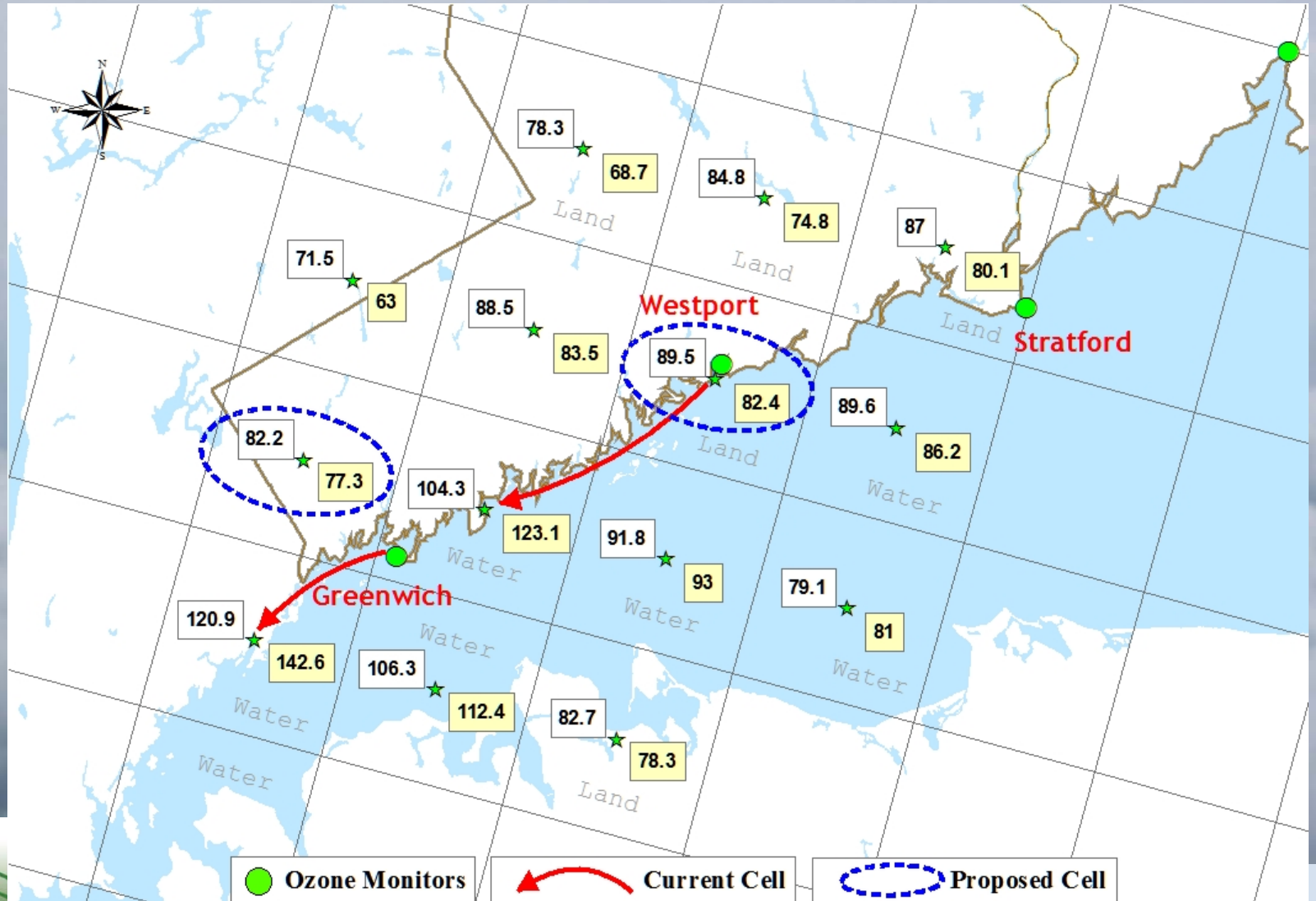August 2016 Maximum 8hr Ozone for Connecticut

Conclusions

- 31 exceedance days so far this year with new NAAQS of 70 ppb
- Last year there were 33 exceedance days with new NAAQS, but September 2015 had 5 exceedance days!
- Difficult to forecast exceedances with model tendency to under-predict up to July, then it tends to over-predict.
- The May 25-28th event was flagged as a possible exceptional event, but now we need to prove it!
- 12km NAM had issues with convection and fronts. Maybe time for 4km integration?
- CMAQ 5.0.2 needs improvement with emission reductions, seems arbitrary with just mobile?

Connecticut Department of Energy and Environmental Protection

Map of Gridded CMAQ results for July 11, 2011

Arrows point to the grid cells used by EPA method with 2011/2018 results at each point