Connecticut Department of Energy and Environmental Protection

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

2012 Ozone Season Forecasting Summary

Oct. 25, 2012
Sam Sampieri
SIPRAC Meeting

2012 Ozone Season Forecast Procedures

- Ozone Season May 1st through September 30, 2012

- AQI levels 0-50 GOOD (0-59ppb), 51-100 MODERATE (60-75ppb), 101-150 USG (96-115ppb) & 151-200 Unhealthy (116-374ppb). 2008 Ozone standard based on an 8-hour averaging period

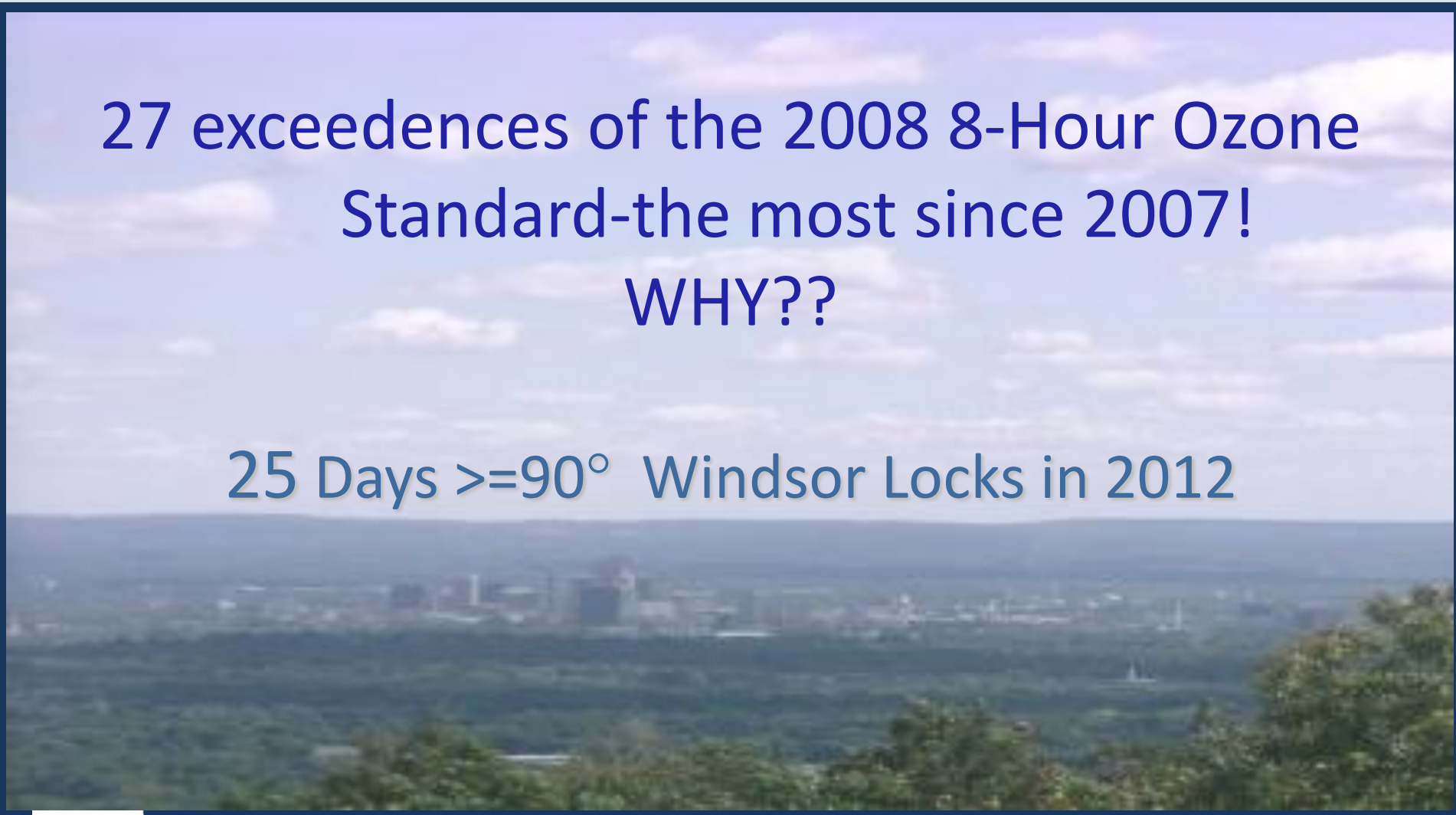
- Standard is 75ppb. Forecasted 8-Hour O3 concentrations of >= 76ppb - **U**nhealthy Sensitive Groups (USG); Regulated Community restricted to operate back-up/test generators.

- Current AQI forecast models [NOAA and BARONS Models (MAQSIP & CMAQ)] used to predict the next days' ozone levels.

- NAM/GFS/EURO forecast models used for the meteorology

- Forecasters: Sam Sampieri, Michael Geigert and Jude Catalano..(Kurt Kobschull - numerous exceedance studies)

2012 Ozone Season Re-Cap

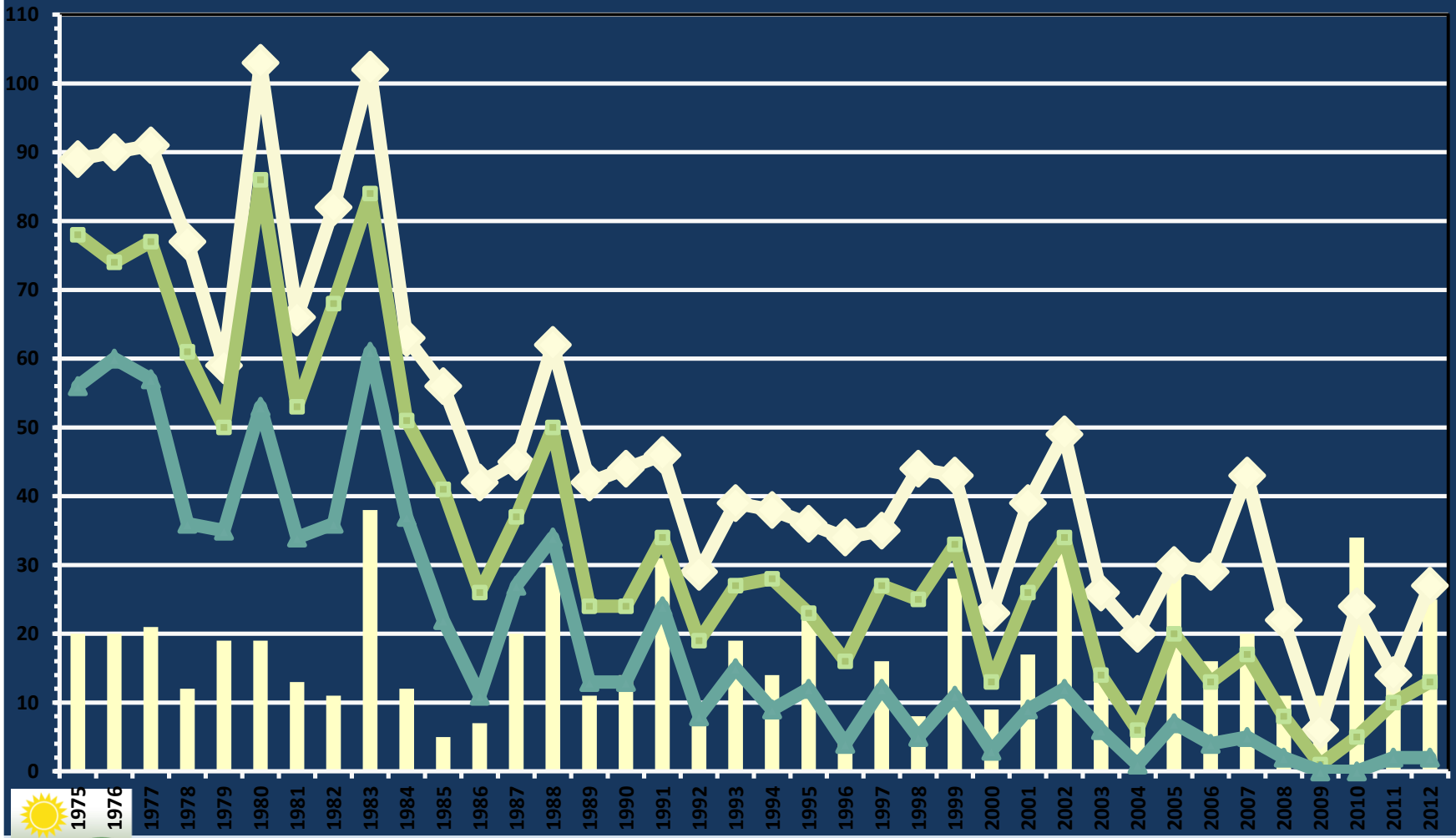


27 exceedences of the 2008 8-Hour Ozone Standard-the most since 2007!

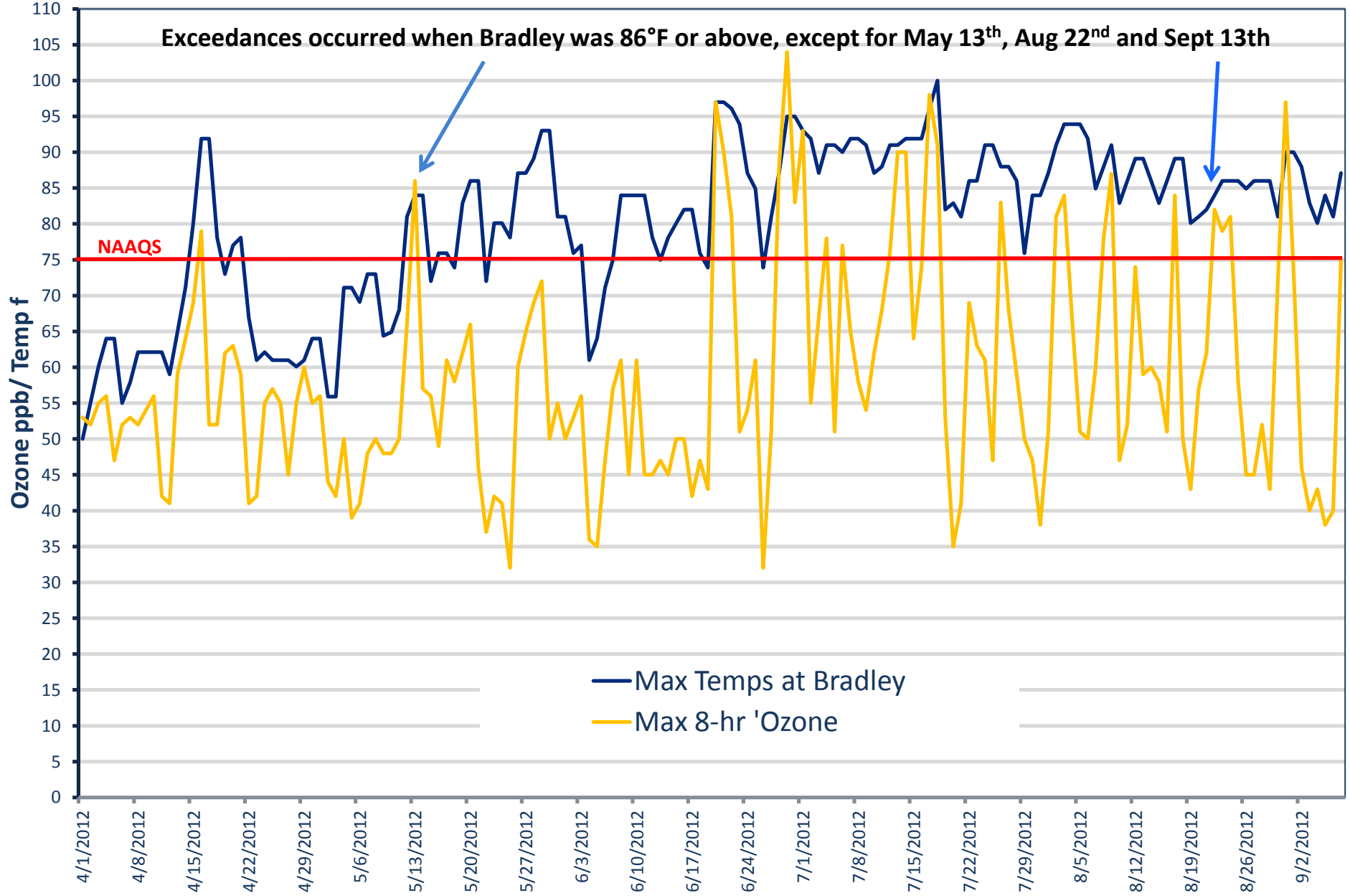
WHY??

25 Days >=90° Windsor Locks in 2012

Number of Ozone Exceedance Days in Connecticut
Compared to the Number of "Hot" Days
(2012 data are preliminary through 9/30/2012)



Bradley High temps vs. Max 8-hr Ozone



How did we do this past year?

Actual Exceedences Days = 27
Forecast Exceedences Days = 14

Month	Actual Dates	Forecast Dates
April	16	N/A
May	13	
June	20,21,22,28,29,30	20,21,22,29,30
July	1,4,6,12,13,14,17, 18,26	7,13,14,17,18
August	2,3,8,9,17,22,23,24,31	2,3,23,31
September	13	7
Total	27	15

2012 Ozone Case Studies

April 16
May 12
June 28-30
July 1, 4, 6, 17 & 26
August 17 & 22
September 7 & 13

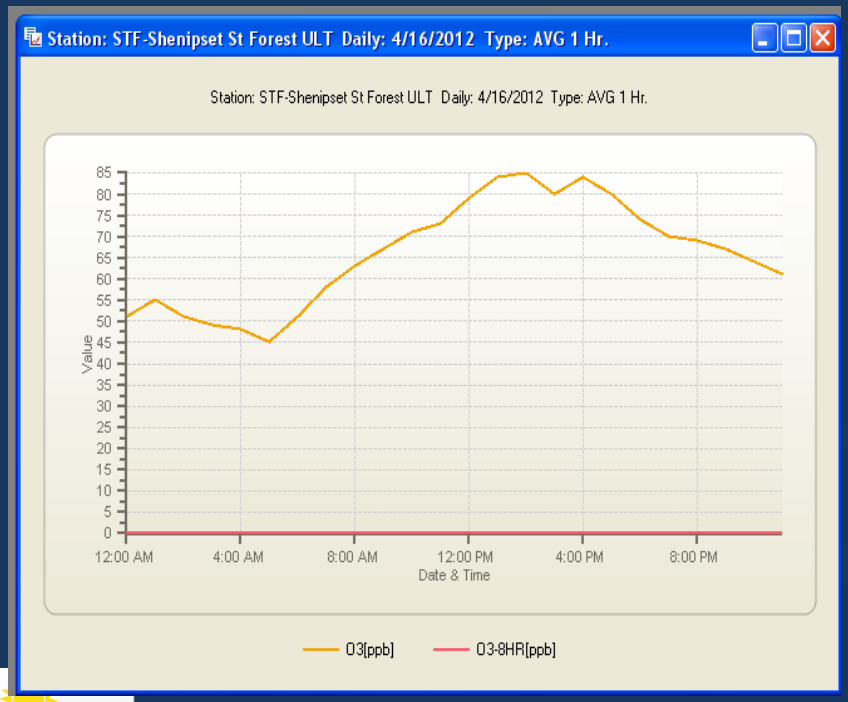
April 2012 8-Hour O3 Concentrations

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	43	48	52	50	43	47	48	51	48	53	37	40	49	59	55	73	46	41	62	63	59	28	29	51	55	52	41	55	57	55
Danbury	35	44	51	49	40	46	48	49	50	52	32	36	47	57	55	68	44	38	53	58	54	29	24	48	50	45	37	50	55	49
East Hartford	34	47	51	49	39	47	48	45	48	51	30	4	7	9	9	12	47	40	52	57	53	32	29	45	50	49	37	53	56	48
Greenwich	38	48	55	55	42	49	51	52	51	54	36	40	50	55	58	56	51	42	47	48	47	30	31	51	50	49	41	51	59	52
Groton	53	34	16	19	22	14	M	M	52	56	M	M	48	58	69	50	49	52	47	51	48	41	42	55	57	55	45	54	60	55
Madison	49	48	49	50	44	48	50	50	54	55	39	35	23	M	M	67	50	49	46	49	43	38	39	52	54	31	M	M	M	M
Middletown	44	50	53	52	42	48	50	48	50	55	42	39	48	59	66	70	48	41	53	58	55	31	31	50	51	53	41	55	58	52
New Haven	38	45	50	50	39	46	48	47	45	45	37	36	40	44	57	55	45	35	33	50	46	24	28	41	42	50	37	44	56	46
Stafford	47	52	54	56	47	52	53	52	53	50	M	M	65	64	68	79	49	45	51	56	49	35	37	53	54	51	43	52	54	55
Stratford	46	49	55	50	44	49	50	52	52	M	M	41	51	55	65	61	52	46	43	51	46	28	34	53	48	55	40	53	59	55
Westport	37	47	55	54	41	48	50	52	52	53	36	35	52	56	64	62	45	44	45	49	48	29	31	52	50	48	39	53	60	53
# days > Federal Standard																														

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

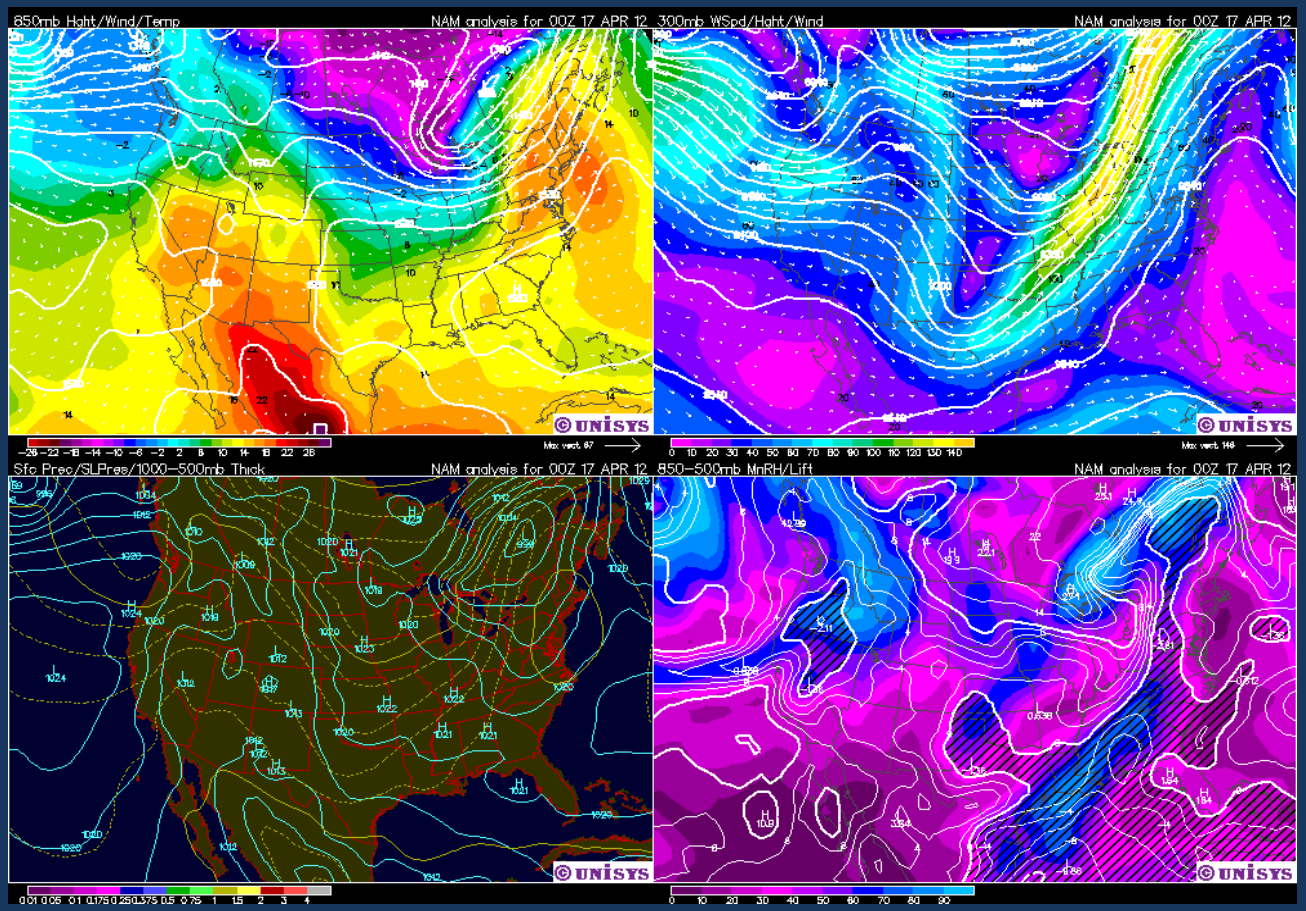
Units - parts per billion (ppb)
Federal Standard = 75 ppb
M = missing data
* Data is preliminary and has not been quality assured

2012: Starts off with an exceedance before May 1. (April 16, 2012) Oh-No is this a sign of a hot summer?



Column1	Column2	Column3
O3[ppb] Stafford Monitor: 4/16/2012 12:00 AM-4/17/2012 11:00 PM Type: AVG 1 Hr.		
Date & Time	O3	o38hr
	ppb	ppb
4/16/2012 12:00 AM	51	51
4/16/2012 1:00 AM	55	52.5
4/16/2012 2:00 AM	51	54
4/16/2012 3:00 AM	49	56.5
4/16/2012 4:00 AM	48	59.5
4/16/2012 5:00 AM	45	63.375
4/16/2012 6:00 AM	51	68.25
4/16/2012 7:00 AM	58	72.5
4/16/2012 8:00 AM	63	75.25
4/16/2012 9:00 AM	67	77.875
4/16/2012 10:00 AM	71	79.5
4/16/2012 11:00 AM	73	79.875
4/16/2012 12:00 PM	79	79.5
4/16/2012 1:00 PM	84	78.25
4/16/2012 2:00 PM	85	76.125
4/16/2012 3:00 PM	80	73.5
4/16/2012 4:00 PM	84	71.125
4/16/2012 5:00 PM	80	67.625
4/16/2012 6:00 PM	74	64
4/16/2012 7:00 PM	70	60.75
4/16/2012 8:00 PM	69	57.25
4/16/2012 9:00 PM	67	54.375
4/16/2012 10:00 PM	64	52.125

- April 16, 2012 Weather Map Analysis



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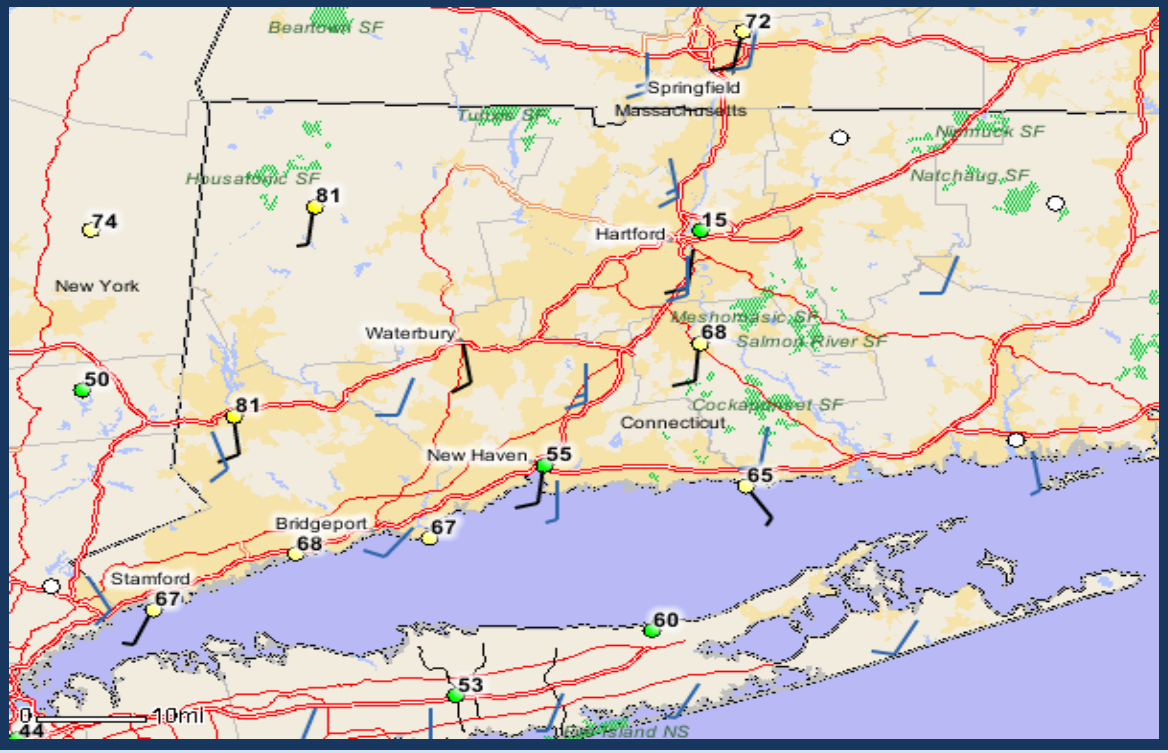
AQ Summary for 4/16/12

This was an unusually early exceedance day for CT. The conditions were: Hot air - 92° F @ BDL, SSW surface winds, cold front in central New York. Transported O3 came in from aloft (50ppb at 00Z EST 4/16 Stafford) from WV, PA (1500m) and strong low level jet (500m) from i-95 corridor. Surface winds were from S CT, coastal monitors were cleared out by the maritime air. Inland monitors were high, but only an exceedance at Stafford 79ppb. AIRNOWTECH plot for 16 EST 4/16/12



Connecticut Department of Energy and Environmental Protection

May 2012 8-Hour O3 Concentrations

Connecticut Department of Environmental Protection
8-Hour Ozone Daily Maximums*
May 2012

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	50	38	36	50	25	41	48	45	48	48	50	64	70	48	41	48	44	58	62	63	46	31	40	37	M	M	M	M	65	50	47
Danbury	47	M	M	M	M	M	M	M	M	M	M	51	77	43	41	M	M	M	M	55	31	24	42	35	27	53	63	69	M	48	45
East Hartford	47	32	29	23	23	38	41	32	22	23	39	37	62	30	32	33	61	47	56	54	27	25	38	29	22	55	56	58	72	38	48
Greenwich	51	41	36	32	34	37	40	49	38	45	50	58	71	46	45	43	40	49	60	54	42	35	40	33	28	55	54	62	50	43	55
Groton	50	43	38	35	36	35	43	45	45	43	45	66	71	51	50	37	48	45	51	54	34	26	39	30	27	40	51	43	52	43	55
Madison	31	41	36	29	36	34	40	42	41	43	45	64	66	49	45	36	45	40	48	46	35	30	35	32	26	49	48	40	50	31	53
Middletown	51	38	34	26	28	38	47	47	39	39	46	56	M	52	48	49	41	47	59	53	40	27	42	33	26	59	53	60	69	46	54
New Haven	47	39	35	27	36	36	36	39	28	39	43	59	32	42	45	40	48	49	60	58	39	29	29	37	26	48	51	60	53	33	55
Stafford	53	35	34	30	30	33	39	40	48	43	45	57	86	57	56	M	M	M	45	66	43	29	39	41	32	60	65	60	72	46	52
Stratford	56	44	42	31	39	39	41	50	41	45	49	66	69	50	50	40	45	49	57	53	42	37	38	38	30	52	62	M	M	41	52
Westport	50	42	37	27	36	40	42	50	36	45	50	65	75	43	44	37	46	49	60	54	31	34	38	33	20	60	56	62	56	40	54
# days > Federal Standard													2																		

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)
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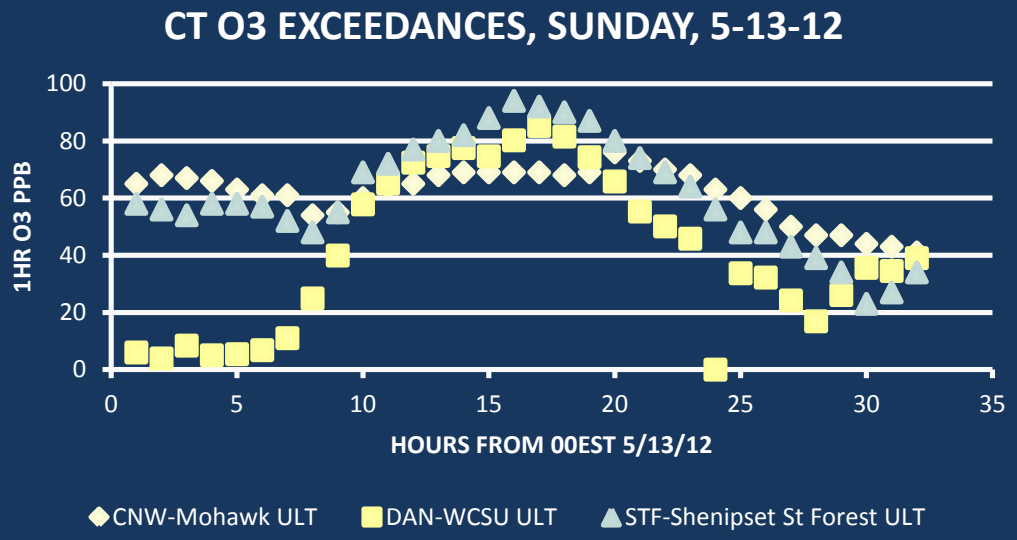
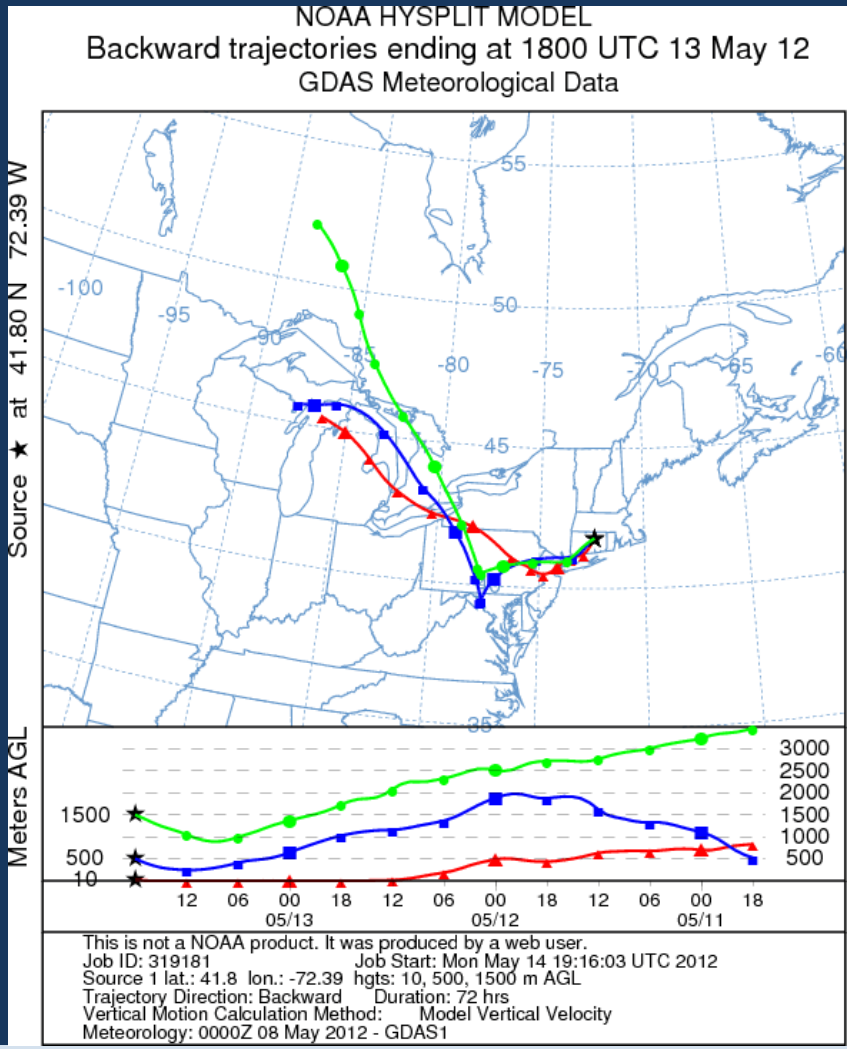
May 13, 2012 Exceedance





June 2012 8-Hour O3 Concentrations

Connecticut Department of Environmental Protection
8-Hour Ozone Daily Maximums*
June 2012

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	44	34	42	34	23	36	44	43	41	54	45	35	36	45	46	45	37	46	43	66	68	60	42	37	42	30	45	66	62	53
Danbury	40	39	46	31	25	37	44	45	42	61	44	37	M	41	47	46	41	47	41	75	75	65	42	M	45	25	45	68	69	56
East Hartford	42	31	41	34	28	29	41	41	39	49	37	35	29	36	48	44	38	42	30	65	71	69	M	M	42	25	37	33	44	36
Greenwich	45	53	52	34	27	45	53	53	42	61	45	43	43	M	M	M	42	43	37	90	82	81	47	52	55	32	45	88	74	61
Groton	38	48	47	30	30	37	49	61	41	55	38	38	38	29	42	34	37	32	31	87	82	74	50	51	55	31	43	71	104	83
Madison	38	44	49	31	32	38	52	M	M	M	35	36	37	29	39	36	35	35	32	93	90	79	51	50	52	26	47	76	99	80
Middletown	42	38	48	36	31	38	51	54	44	53	40	42	41	40	48	45	41	43	42	73	78	81	49	52	55	27	44	68	76	68
New Haven	43	42	50	33	29	34	54	42	43	55	44	40	42	37	50	48	42	41	28	66	76	76	46	54	53	29	51	74	79	72
Stafford	50	35	42	36	30	39	48	51	45	55	44	37	37	37	50	45	39	42	36	66	75	71	44	43	50	24	37	60	71	52
Stratford	46	47	56	34	35	47	54	54	42	54	45	45	47	37	50	47	41	41	38	97	89	77	47	54	61	29	47	84	90	82
Westport	43	48	52	32	28	44	57	51	44	58	39	38	39	36	50	50	39	41	38	89	82	74	46	54	50	28	46	84	78	68
# days > Federal Standard																				3	4	5						6	7	8

Good (0-59 ppb)
Moderate (60-75 ppb)
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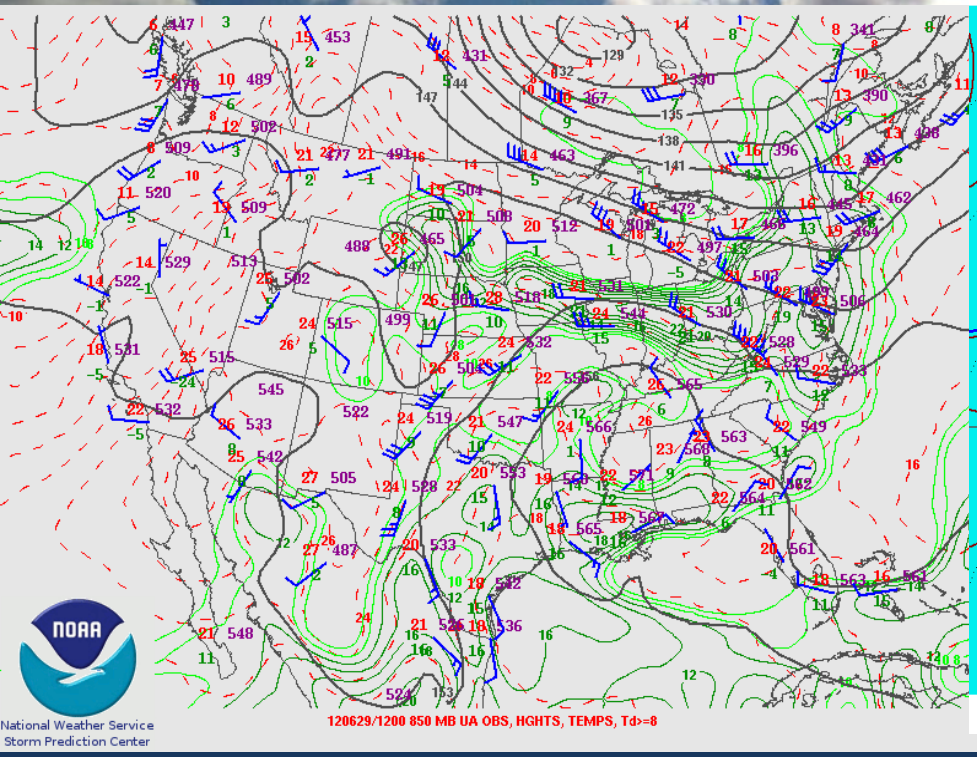
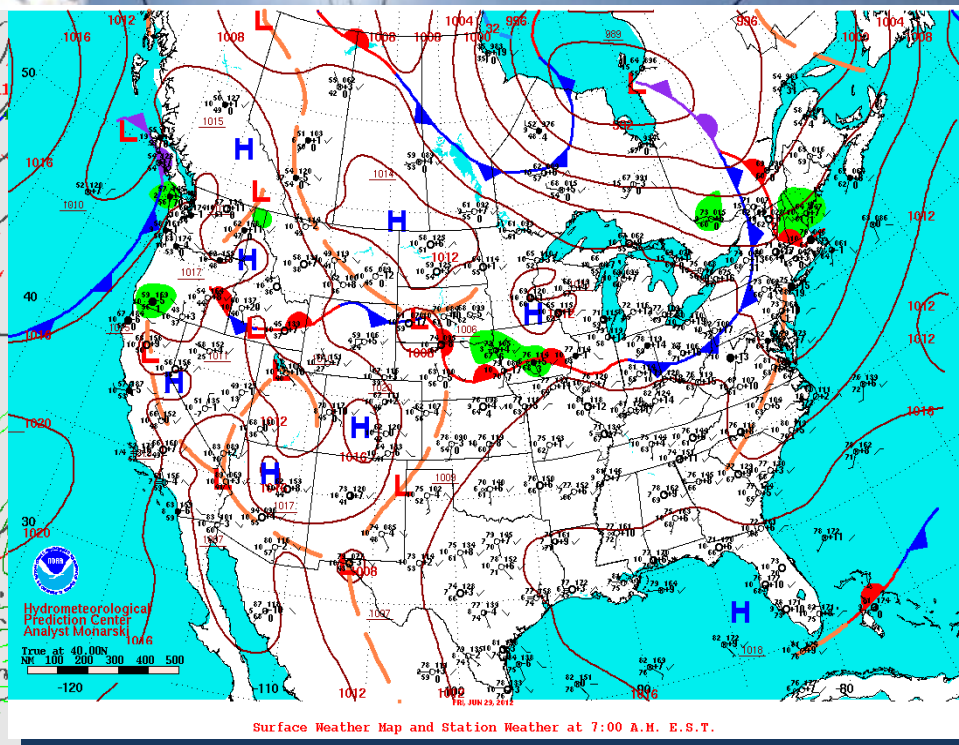
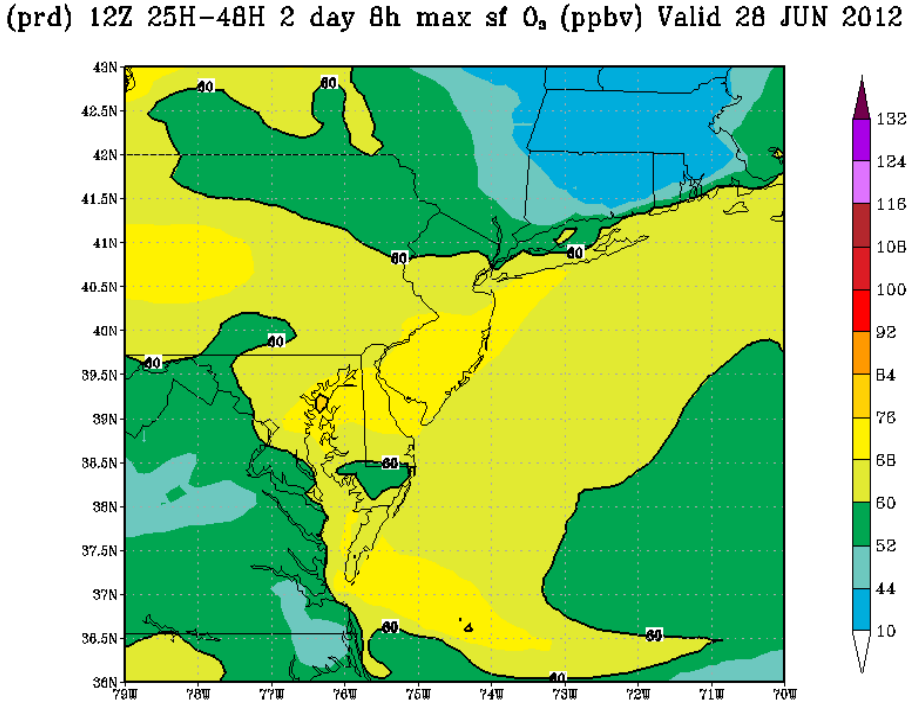
June 28-30-3-Day Event

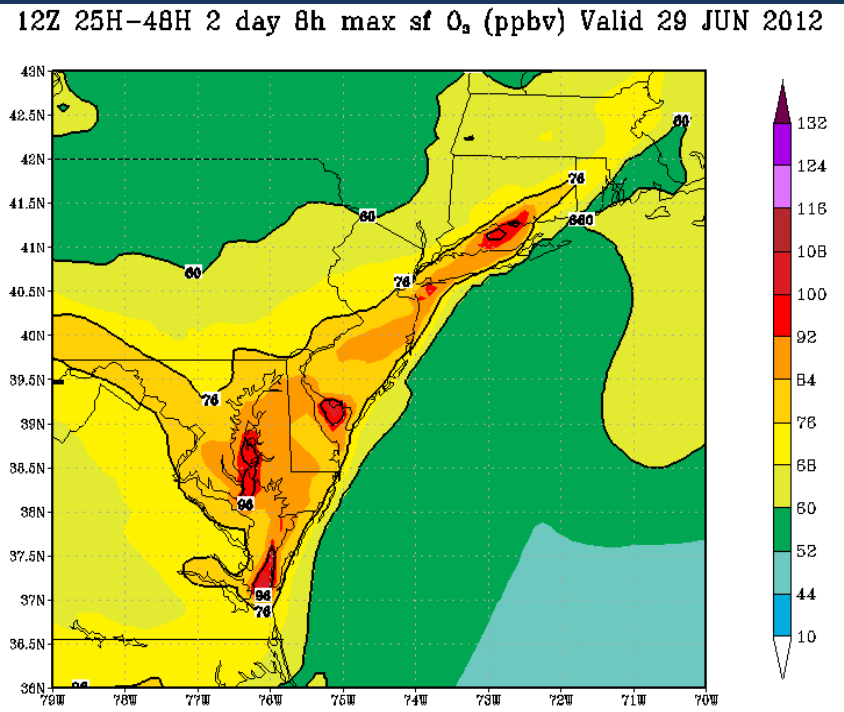




Upper level wind pattern shows ridge of high pressure across south central US with a major heat wave in mid-west. With the upper level wind pattern from the WNW and surface winds from the SSW, it has become apparent that a wind direction change with height is the main reason for acut high levels of ozone reaching over 100 ppb for the 8-hour average and exceedence of the old 1-hour standard. Basically it's long range transport (mid-west) and local sources (mid-Atlantic).

June 28-30-3-Day Event





NOAA model under-predicted 8-Hour Maximum Ozone Concentrations on the 28th, did well on the 29th and 30th and July 1st . Why?

July 2012 8-Hour O3 Concentrations

Connecticut Department of Environmental Protection
8-Hour Ozone Daily Maximums*
July 2012

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	36	33	36	34	46	44	36	40	62	68	68	79	64	53	51	79	61	40	27	36	57	59	44	39	58	41	45	34	37	35
Danbury	70	33	53	51	43	52	49	41	37	56	66	75	90	72	54	56	85	68	39	18	41	69	59	50	32	71	46	48	36	44	37
East Hartford	42	27	36	37	22	29	29	27	27	48	64	69	77	73	53	54	91	60	48	19	37	59	55	47	35	76	47	44	35	42	35
Greenwich	80	46	61	73	44	76	59	58	54	55	52	60	74	79	59	64	95	77	44	35	33	54	44	57	43	80	53	54	44	46	37
Groton	76	40	54	71	M	57	56	41	46	51	45	45	52	M	M	67	70	91	44	24	35	28	41	57	48	68	59	48	35	38	32
Madison	75	55	58	78	47	60	63	47	46	50	45	47	61	86	64	74	74	87	40	20	37	37	46	61	47	45	68	47	36	40	33
Middletown	68	39	61	69	45	56	48	42	46	54	57	65	74	85	62	56	98	71	40	31	36	55	60	53	39	79	57	47	37	40	32
New Haven	89	41	61	78	45	64	58	52	51	52	48	54	68	90	64	60	81	84	39	24	32	56	45	58	40	81	46	51	44	42	34
Stafford	51	34	50	55	33	49	42	41	41	52	57	76	73	76	62	60	96	65	53	24	39	60	63	48	36	83	46	44	33	41	36
Stratford	93	52	67	78	46	71	65	51	51	62	46	62	80	88	61	72	87	80	48	30	34	58	48	56	46	70	67	59	50	47	38
Westport	91	43	64	74	51	77	60	54	52	54	55	65	74	86	58	61	93	83	42	19	32	62	50	53	39	80	51	48	42	47	34
# days > Federal Standard	9			10		11						12	13	14			15	16								17					

Good (0-59 ppb)
Moderate (60-75 ppb)
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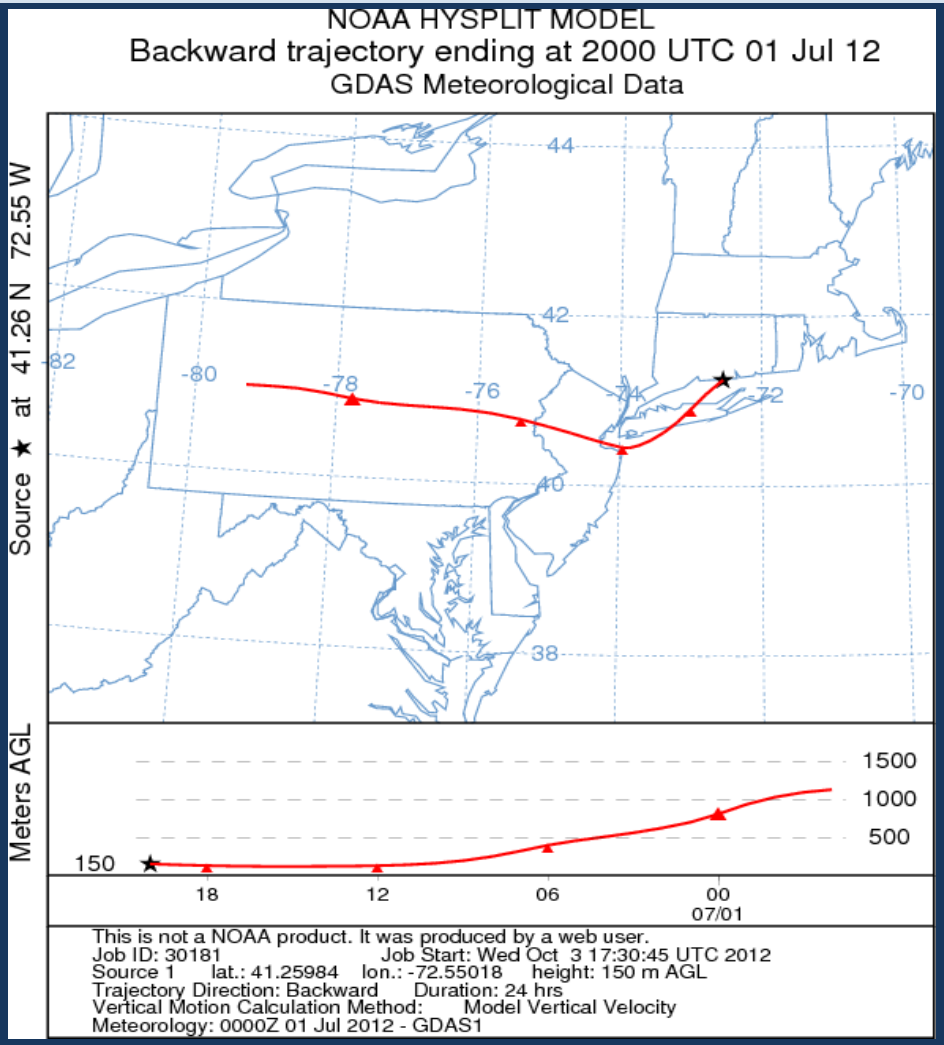
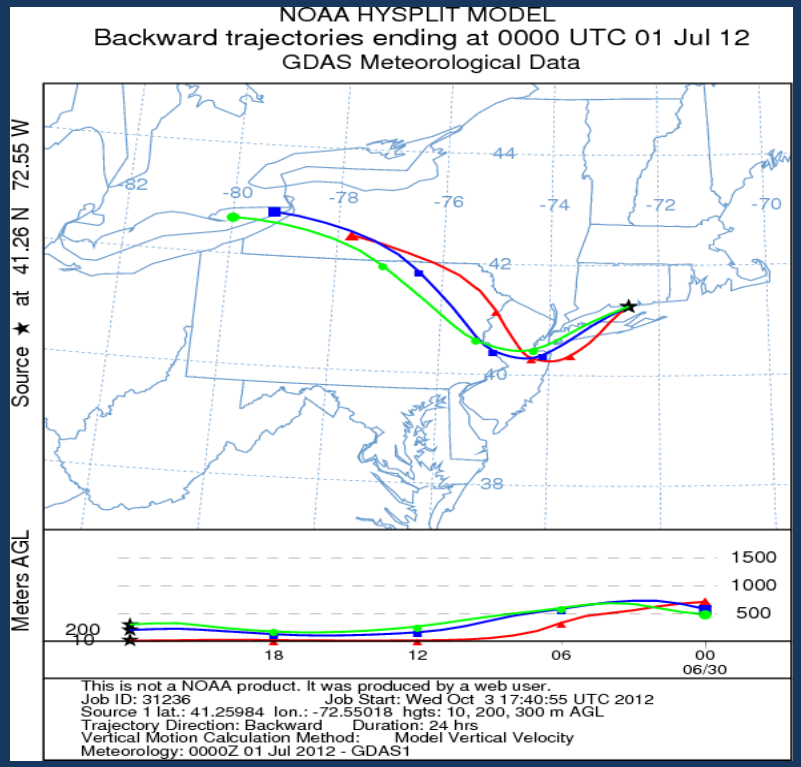
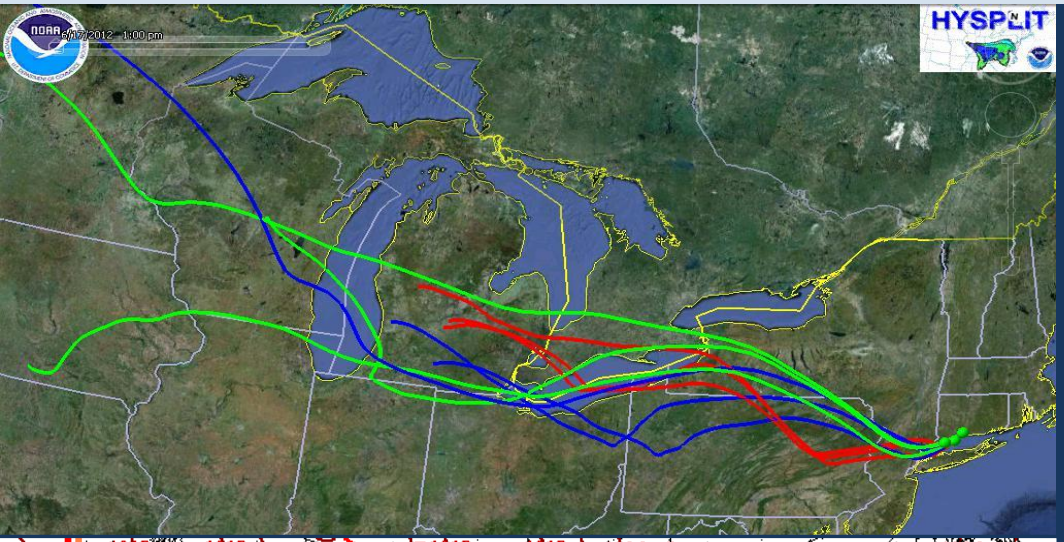
July 1



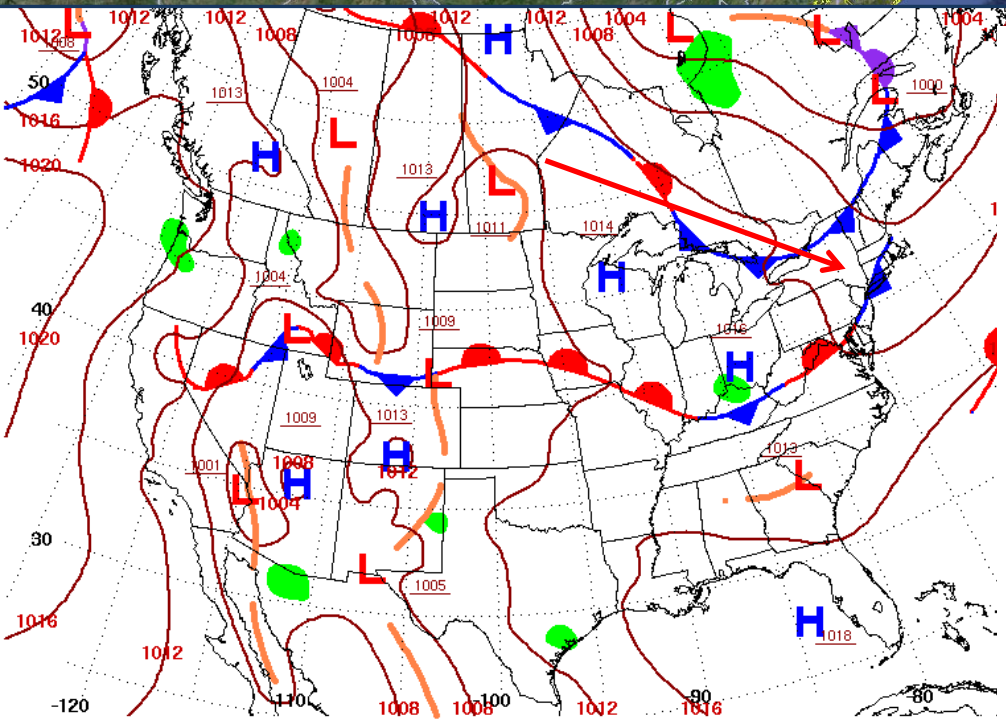
- Trajectory analyses show that wind was WNW aloft, SSW at surface converged off coast and into coastal CT



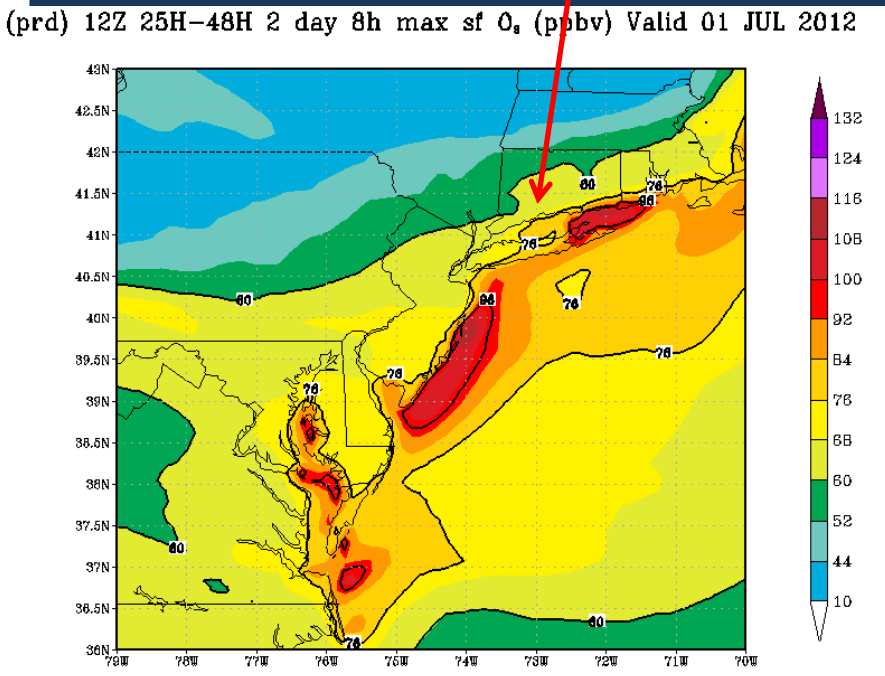
July 1



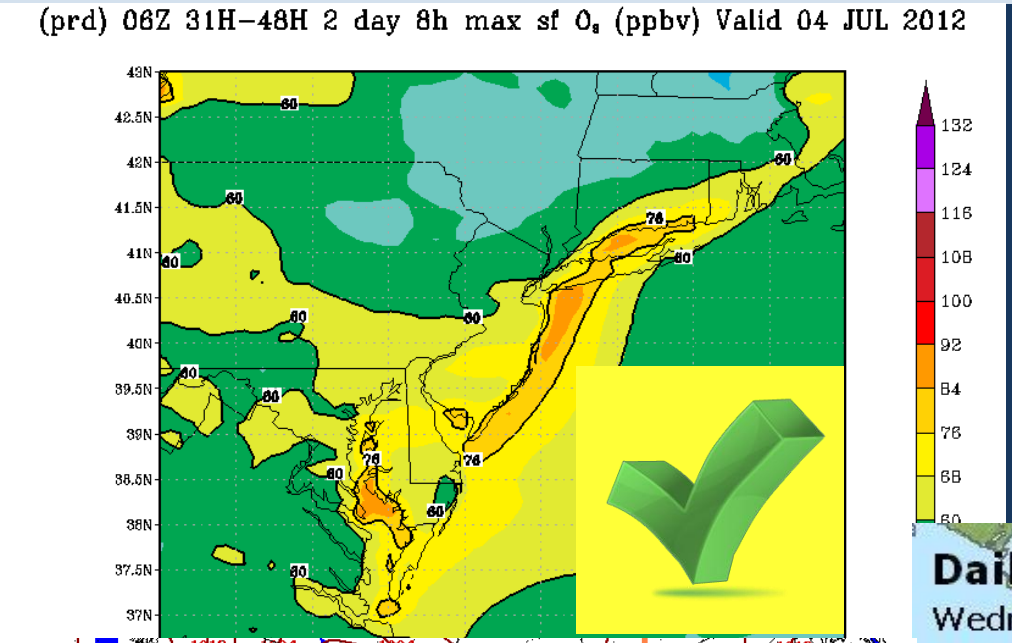
- Winds at all levels converge across northern New Jersey and NYC then turn northeast into Connecticut thus high levels of ozone was realized
- However, models under-predicted thus we forecasted 72ppb at Stratford, verified at 93 ppb, 1hr exceedence at Middletown Why? Clouds gave way to sun, much hotter than expected!



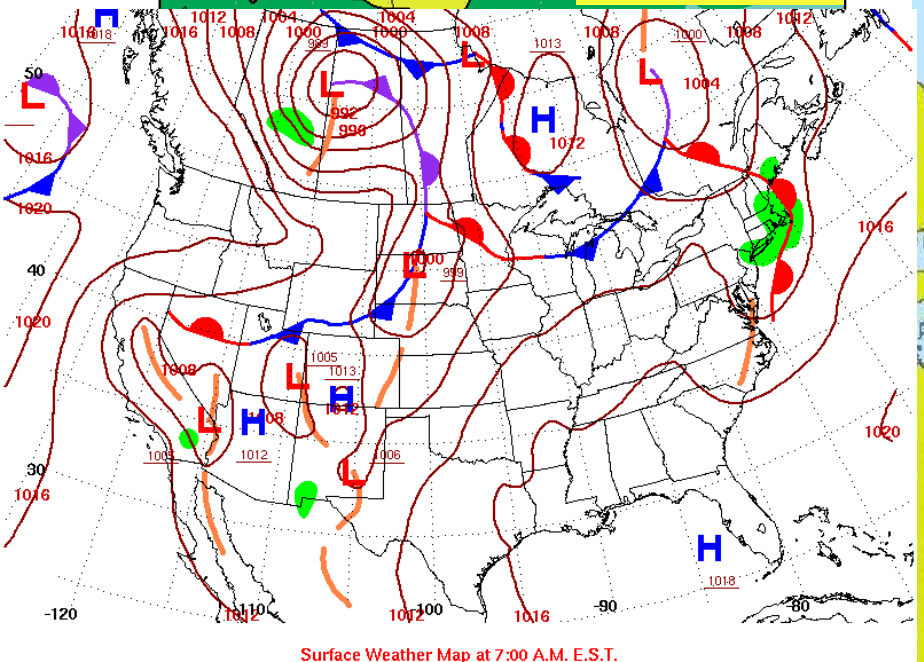
Surface Weather Map at 7:00 A.M. E.S.T.

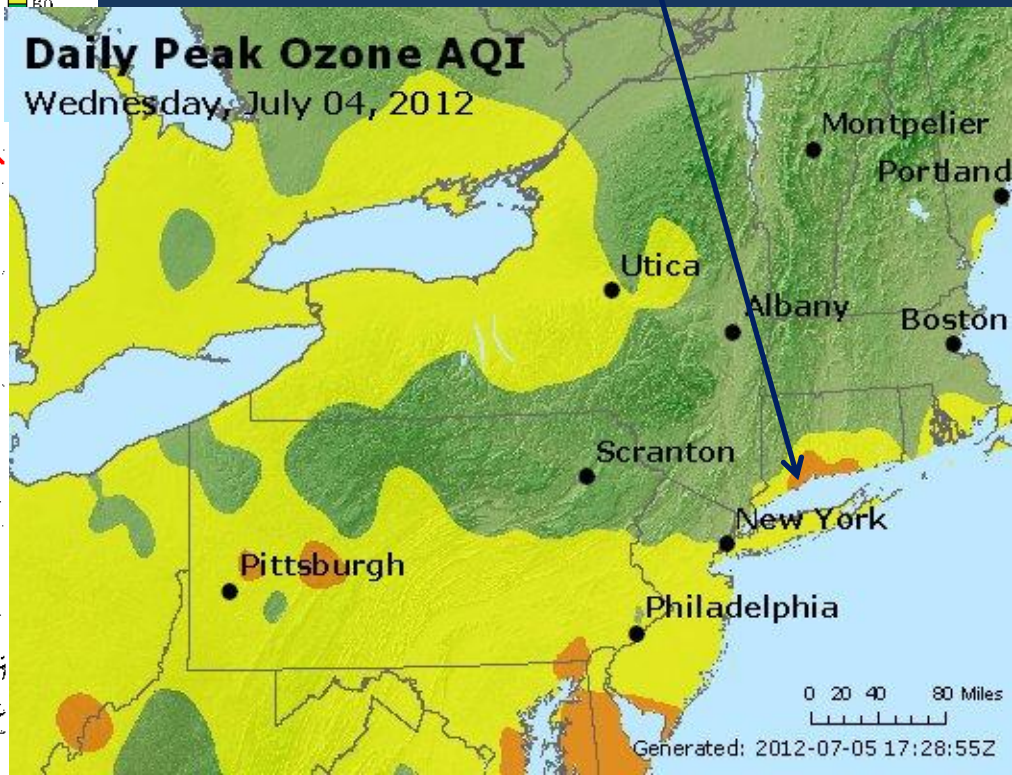


July 4, 2012

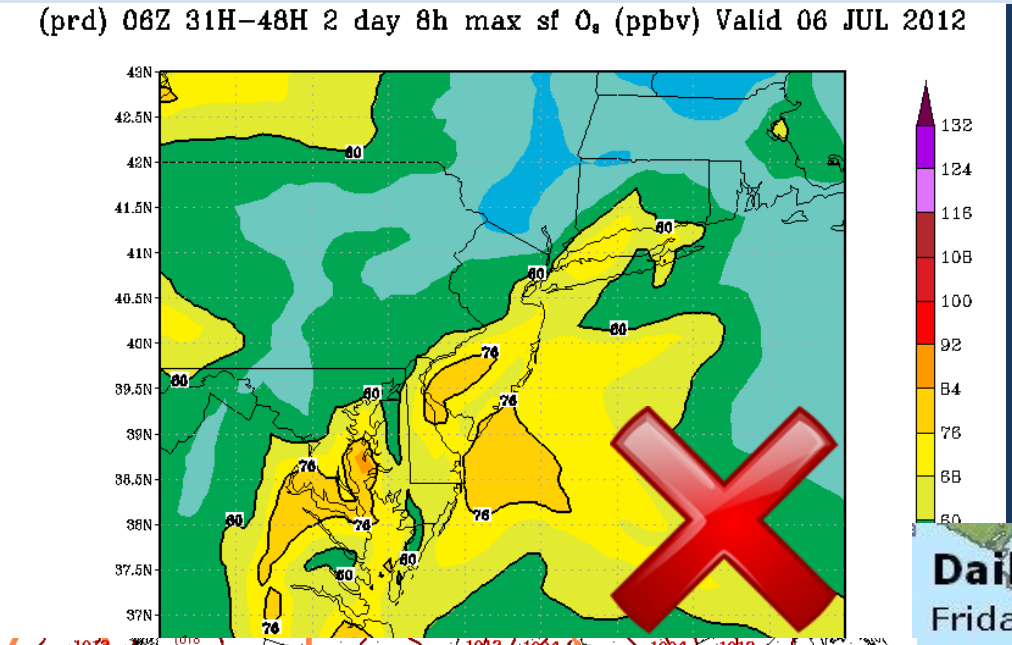


- Weak warm front with northwest winds inland and southwest along coast
- We forecasted 75ppb at Stratford, verified at 78 ppb
- Wind direction change with height main cause of ozone levels to exceed 75ppb.

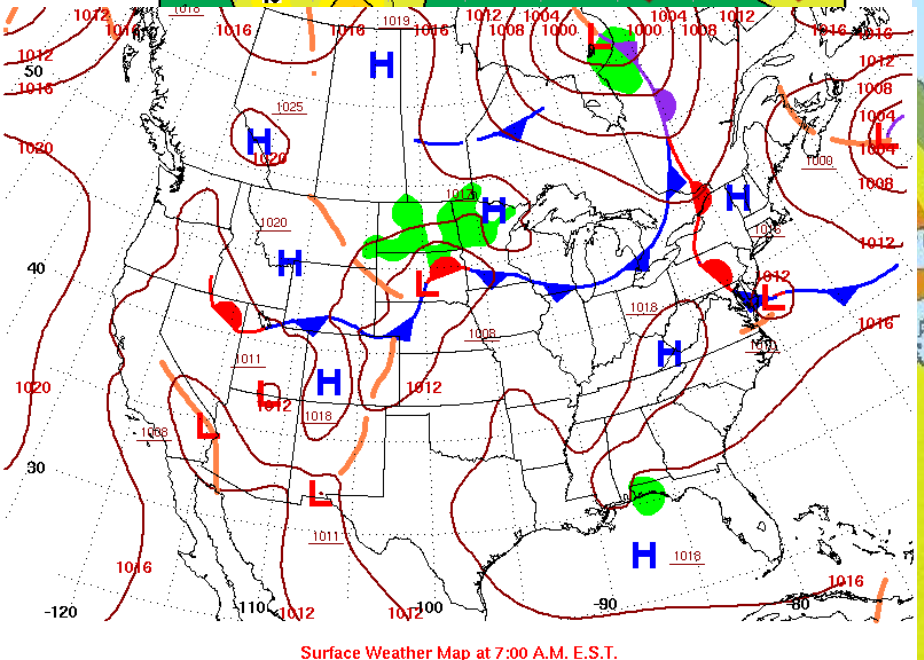


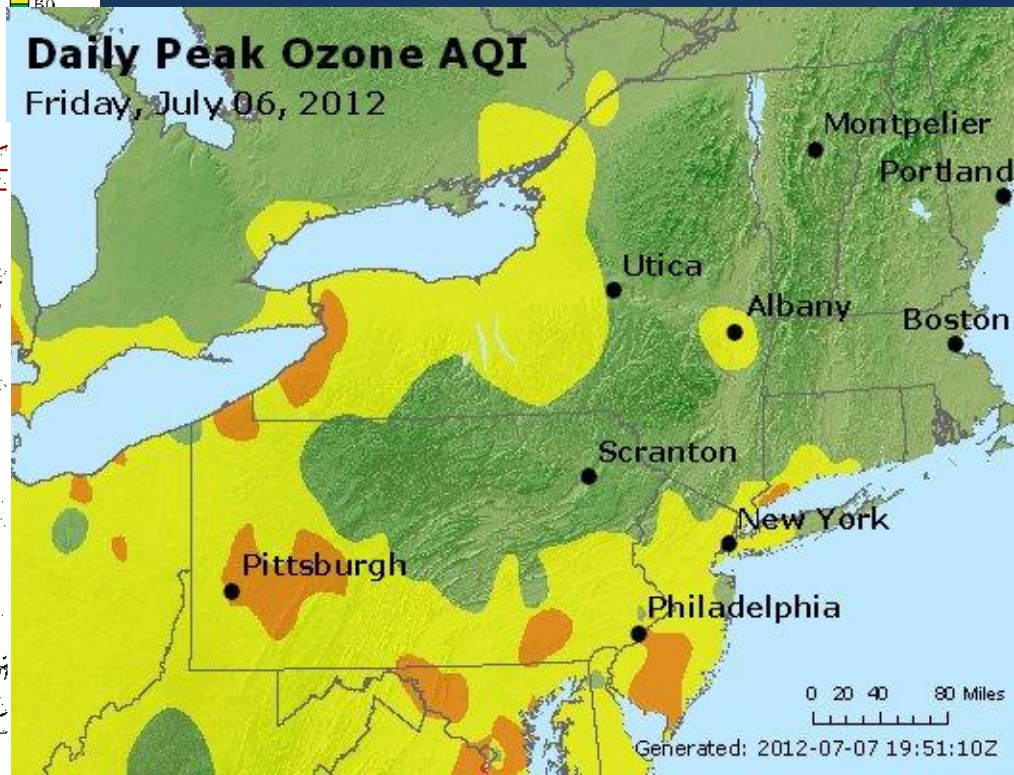


July 6, 2012

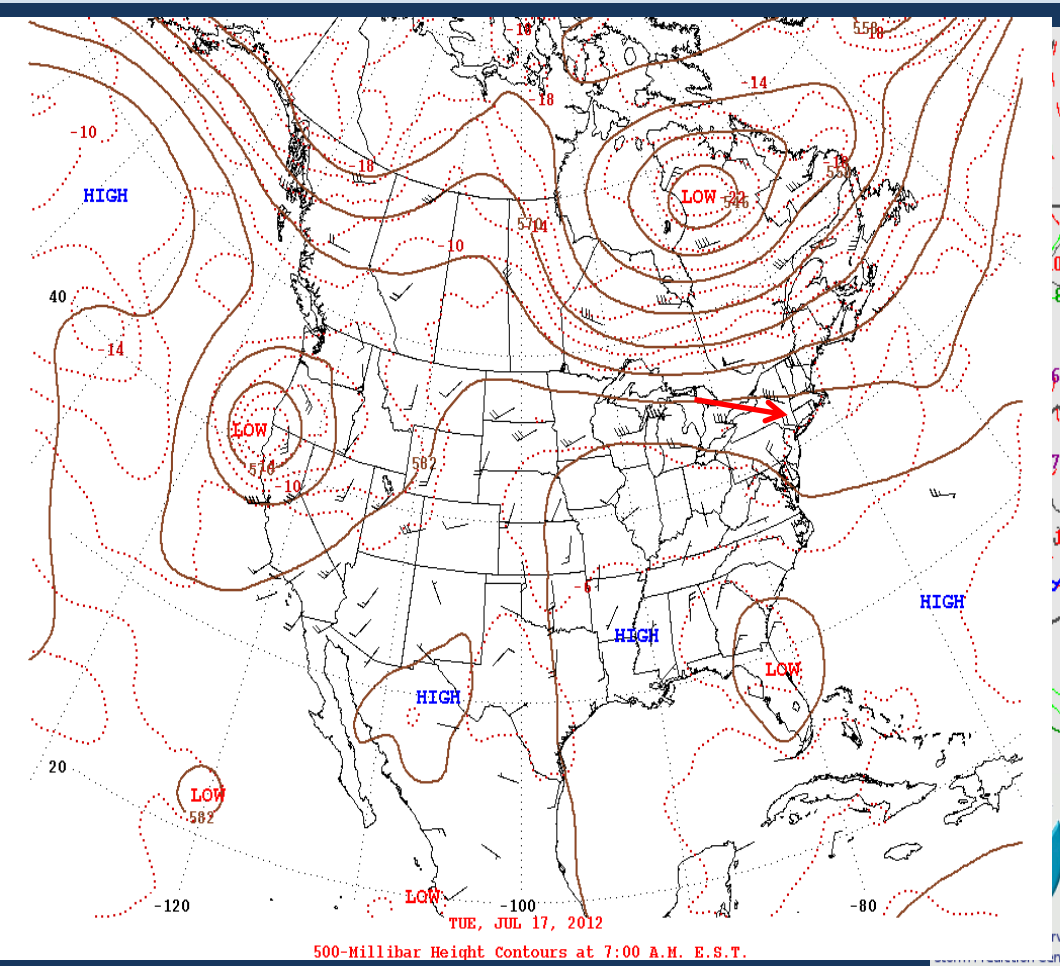


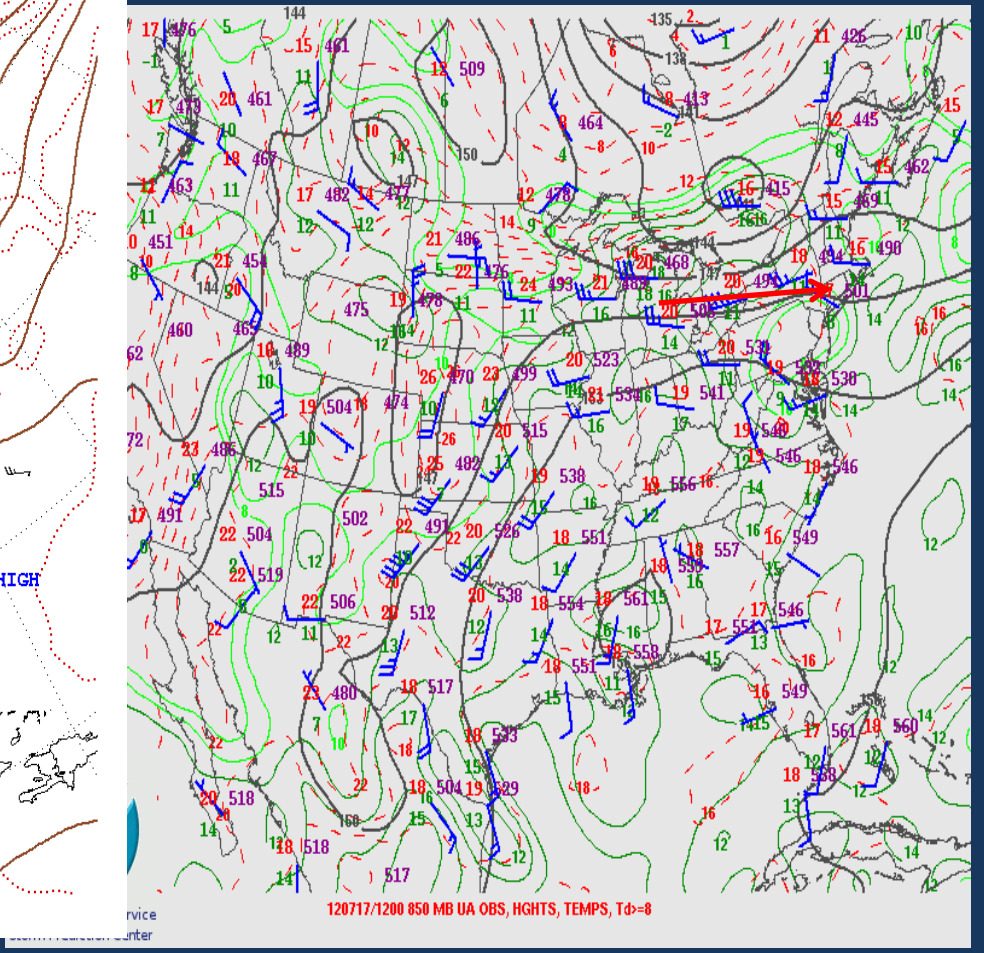
- Warm front passage late in the day
- Model had right idea, just a slight under-prediction
- We forecasted 72 ppb at Westport, verified at 77 ppb
- Enough sunshine in the afternoon caused temperature to rise as well O3 levels.





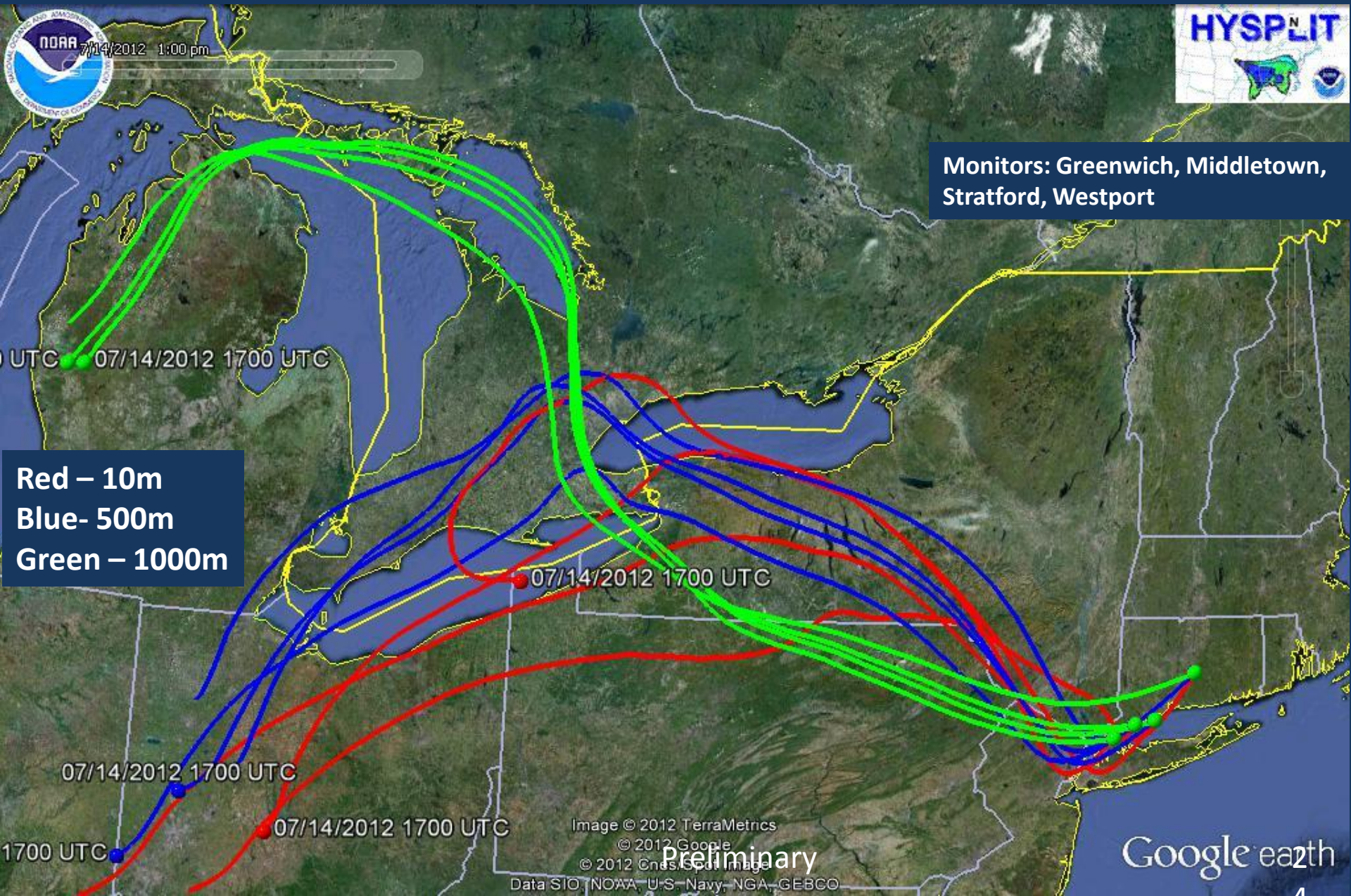
July 17 – 500mb, 850mb Upper Air





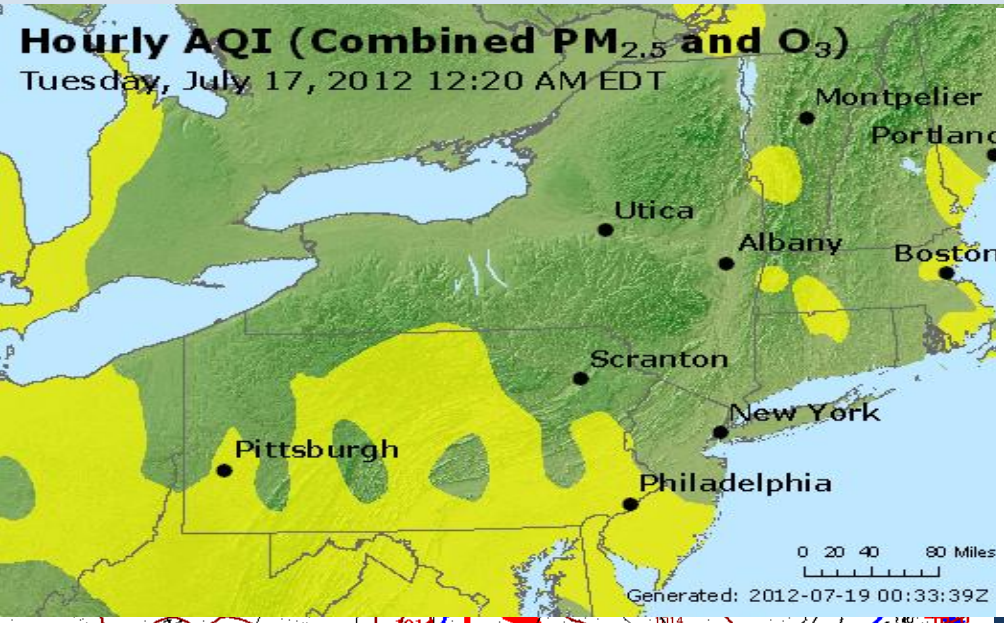
Connecticut Department of Energy and Environmental Protection

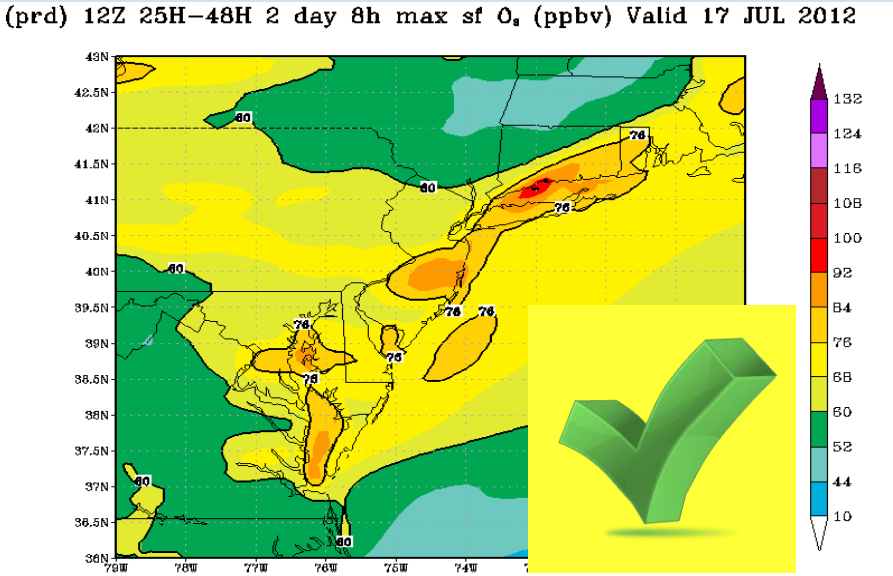
72Hour Back Trajectories for 1-Hour Ozone Values >100ppb in the Northern NAA, 7/17/12

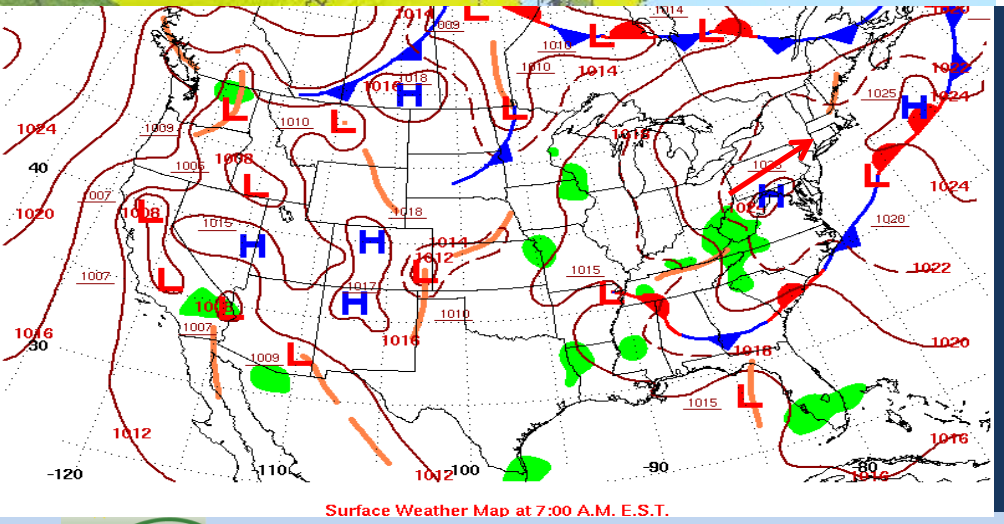


Preliminary

July 17, 2012

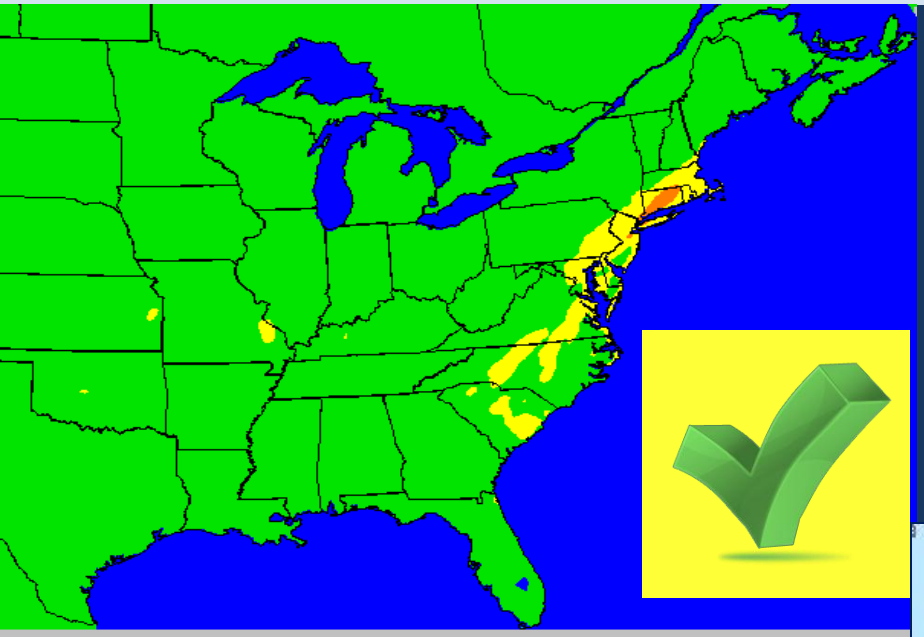


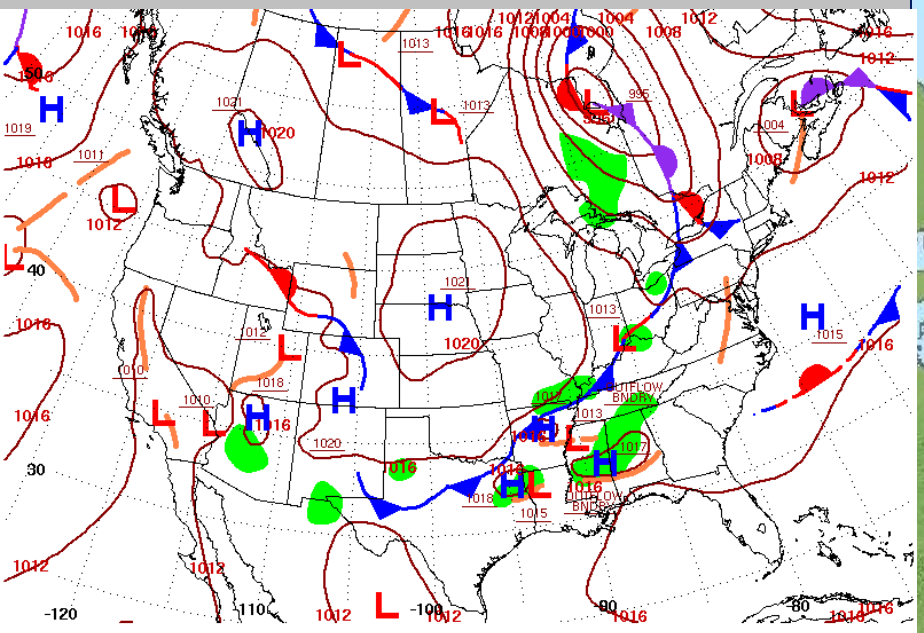




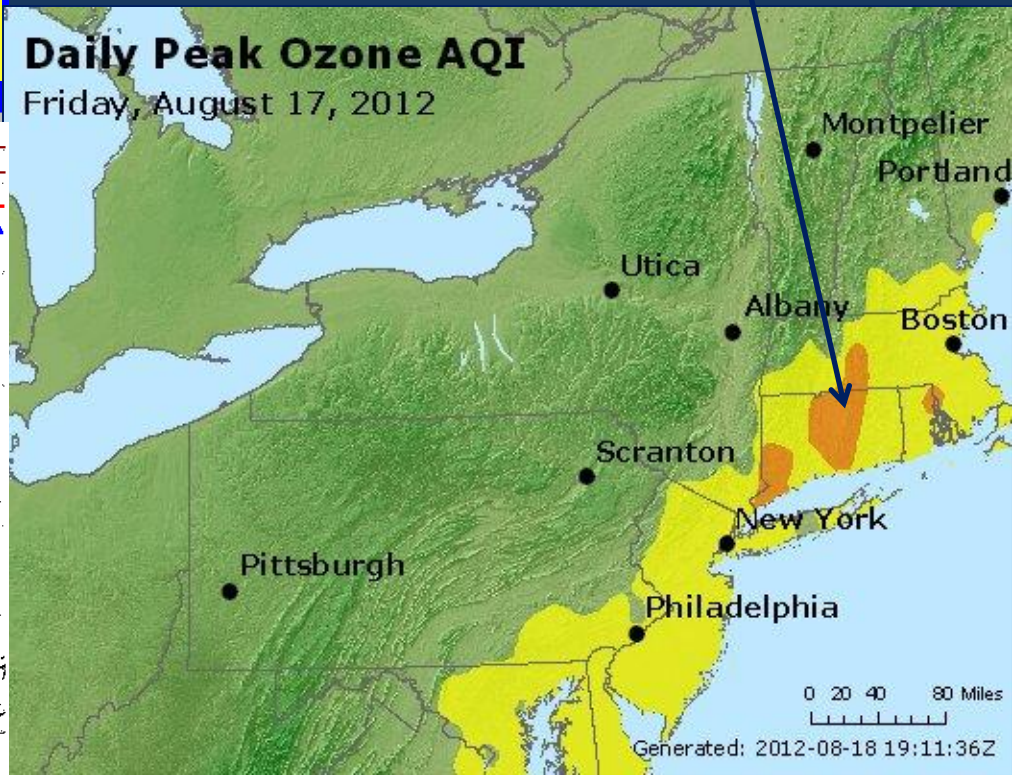
- Southerly winds , turning southwest in western CT ahead of the cold front
- Forecasted 79 ppb in Danbury, verified at 90 ppb
- WNW wind aloft very good long range transport direction
- S-SW wind at surface conducive for more transport locally
- Combination flow caused levels > 84ppb

August 17, 2012

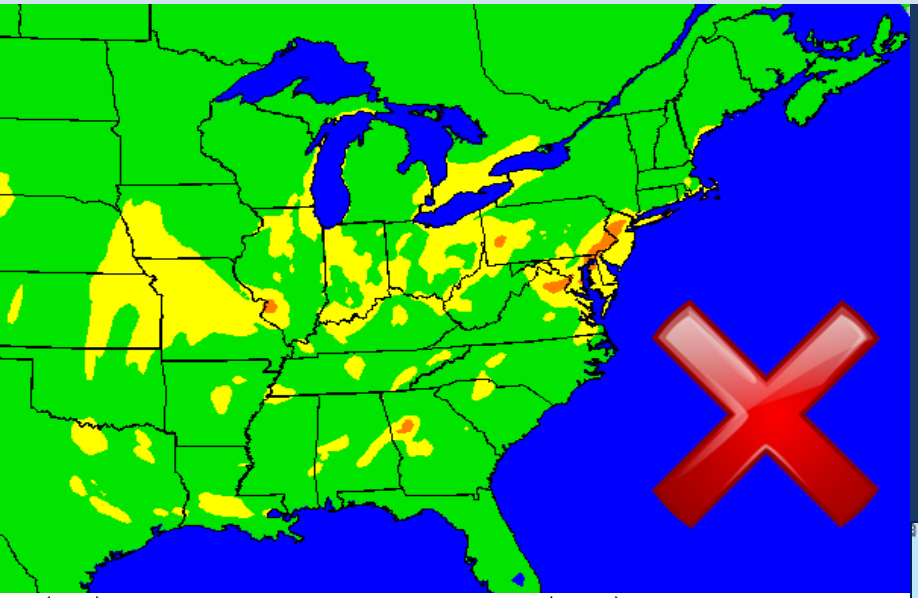




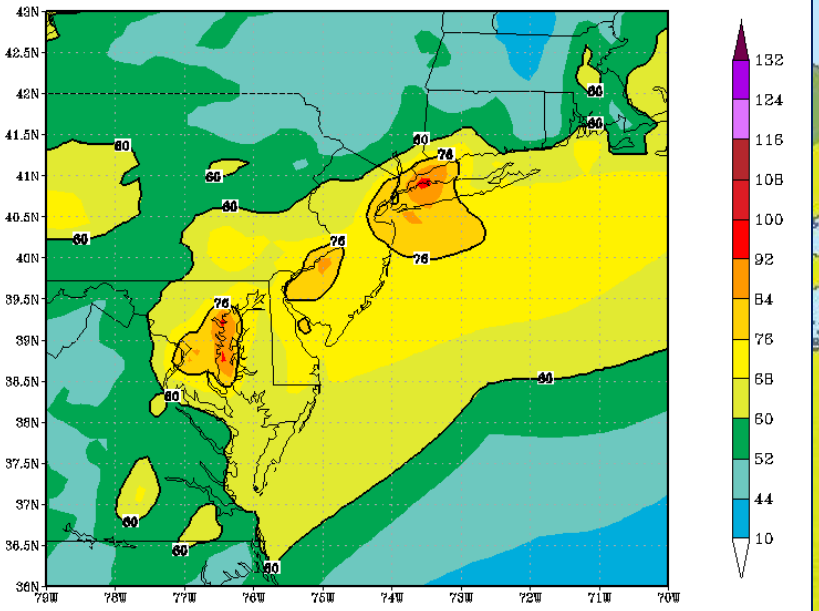
- South to southwest surface winds, advected ozone from I-95 corridor
- We forecasted 71 ppb at Stafford, verified at 83 ppb



August 22, 2012

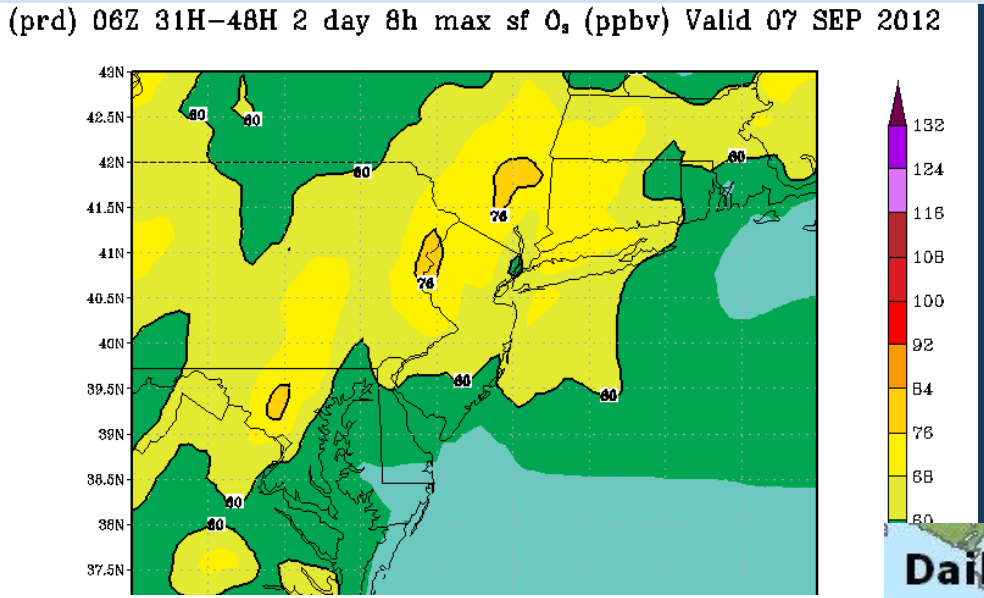


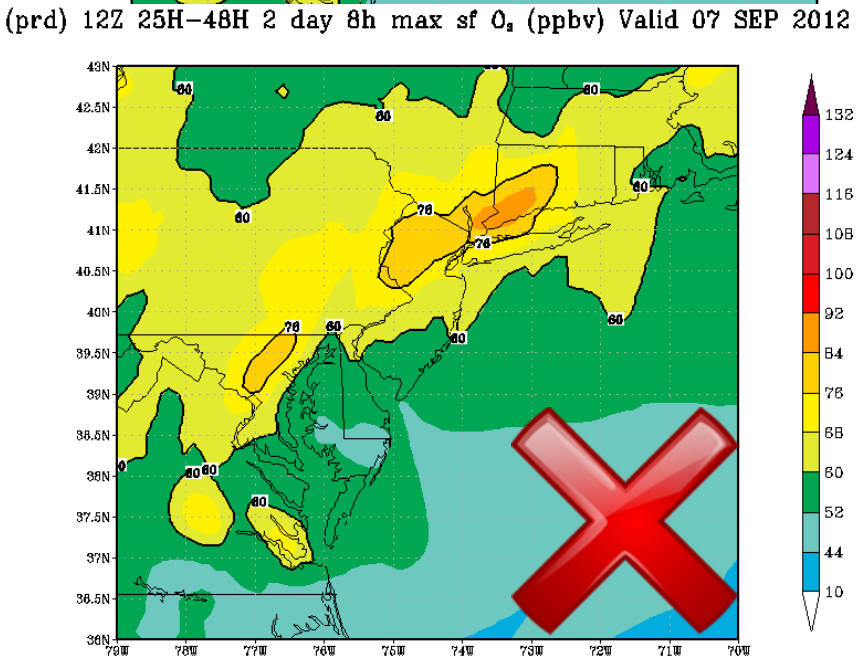
(prd) 06Z 7H-30H 1st d 8h max sf O_3 (ppbv) Valid 22 AUG 2012



- Weak trough off the coast made this hard to predict. Same day model forecast picked up the exceedance
- We forecasted 72 ppb at Stratford, verified at 82 ppb

September 7, 2012

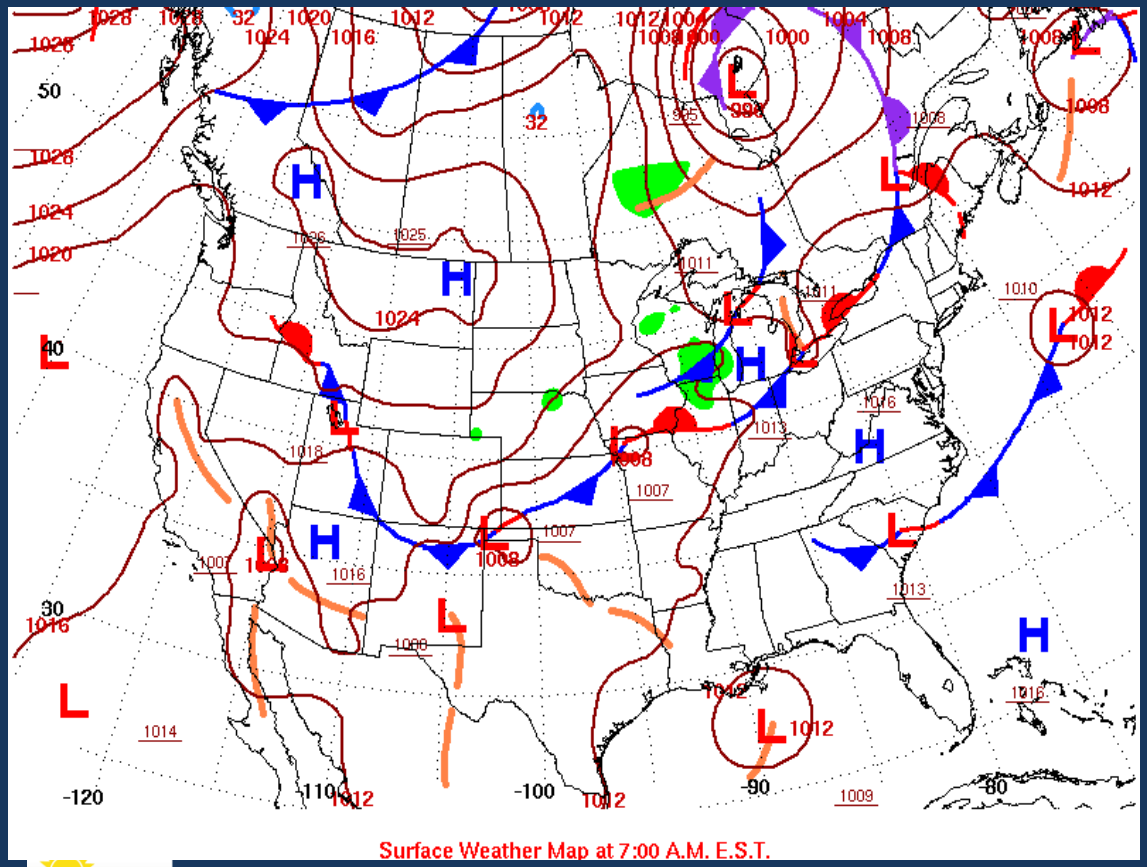




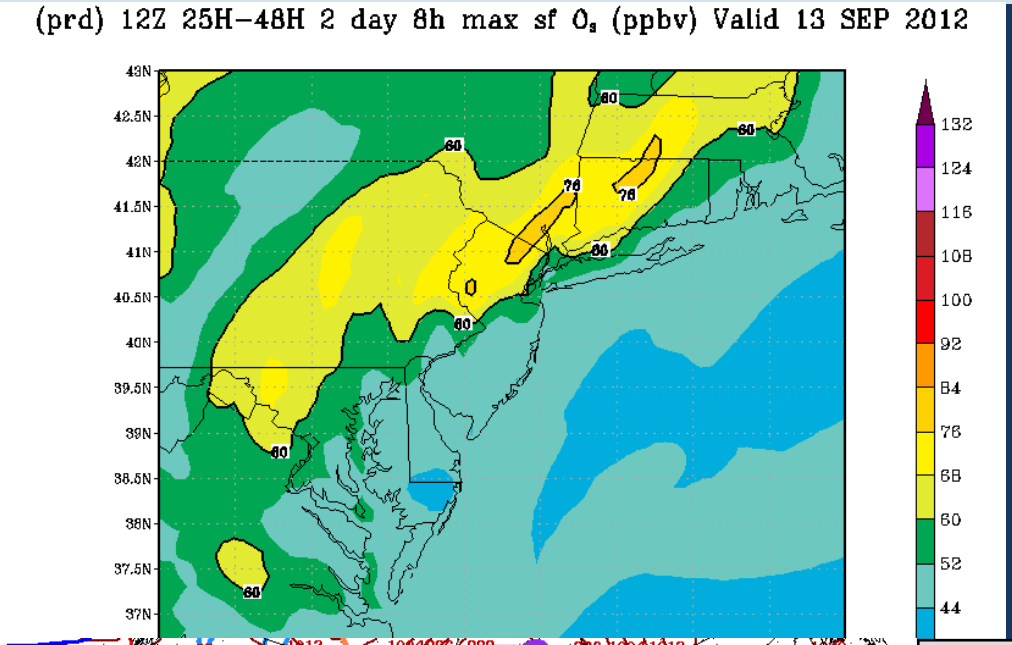
- A rare case of over-prediction
- Since model performed well with the mid-Atlantic high scenario, we went for it!
- We forecasted 79 ppb at Danbury, but it verified only at 75 ppb

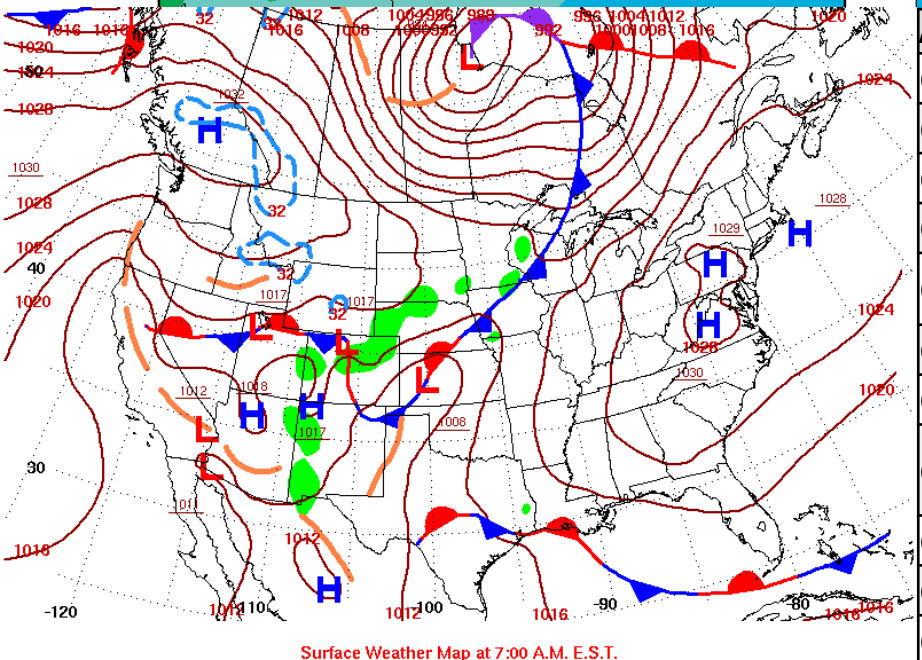
September 7, 2012

- Weak high pressure with approaching cold front usually supplies set up for transport from mid-Atlantic and New York City
- Next day model update showed even higher ppbs, but stayed below USG!



September 13, 2012

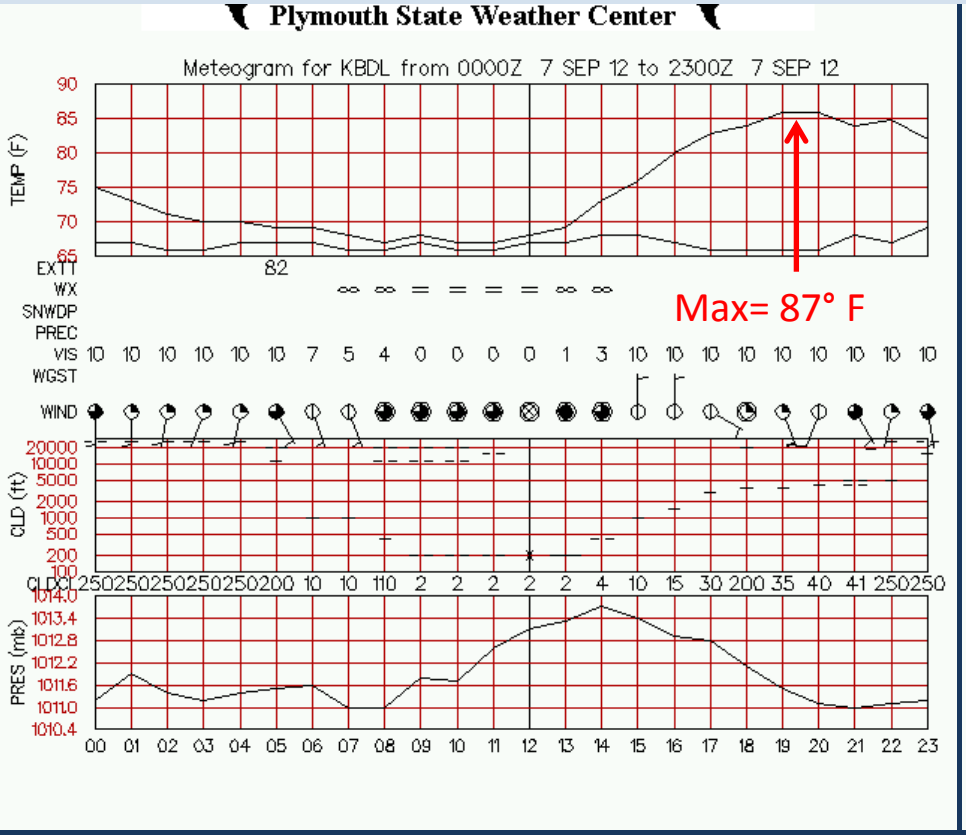


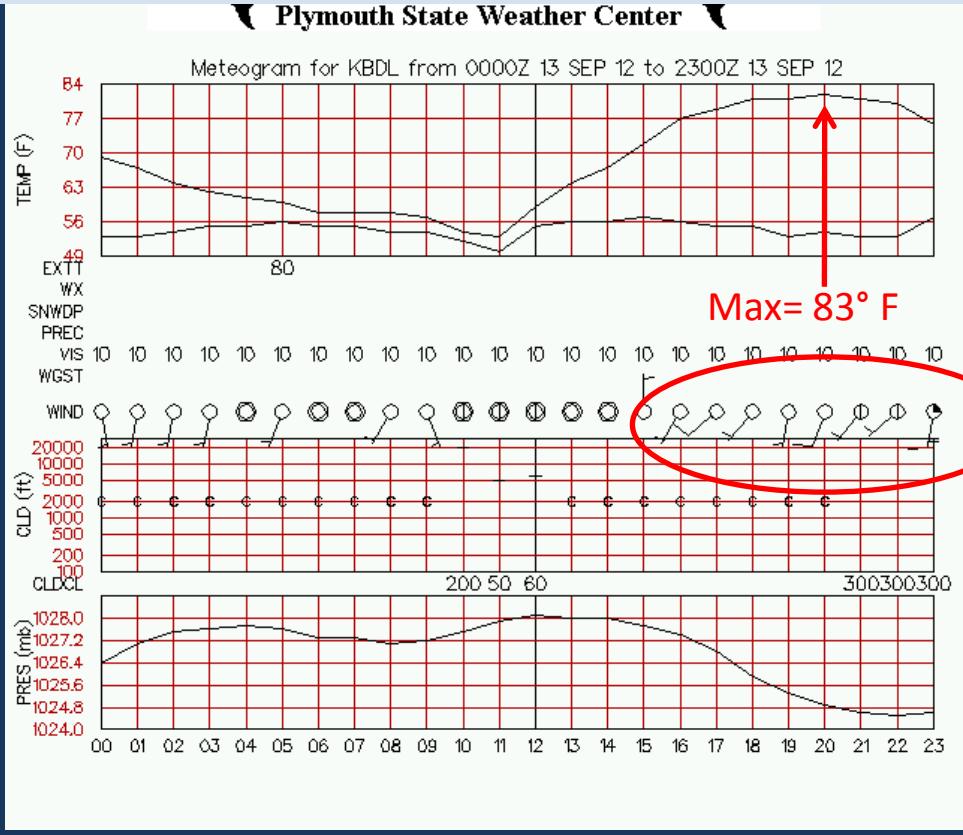


- 06z model run was high moderate, but increased to USG on 12z and next day model runs
- Because model over predicted on September 7, forecasters did not go for USG!
- Model actually under predicted somewhat, so, what was different?

Agency	Site Name	AQS Code	9/13/2012
CT1	Cornwall	090050005	70
CT1	Danbury	090011123	76
CT1	East Hartford	090031003	79
CT1	Greenwich	090010017	67
CT1	Groton Fort Griswold	090110124	61
CT1	Madison	090093002	68
CT1	Middletown	090070007	81
CT1	New Haven - Criscuolo Park	090090027	74
CT1	Stafford	090131001	85
CT1	Stratford	090013007	70
CT1	Westport	090019003	69

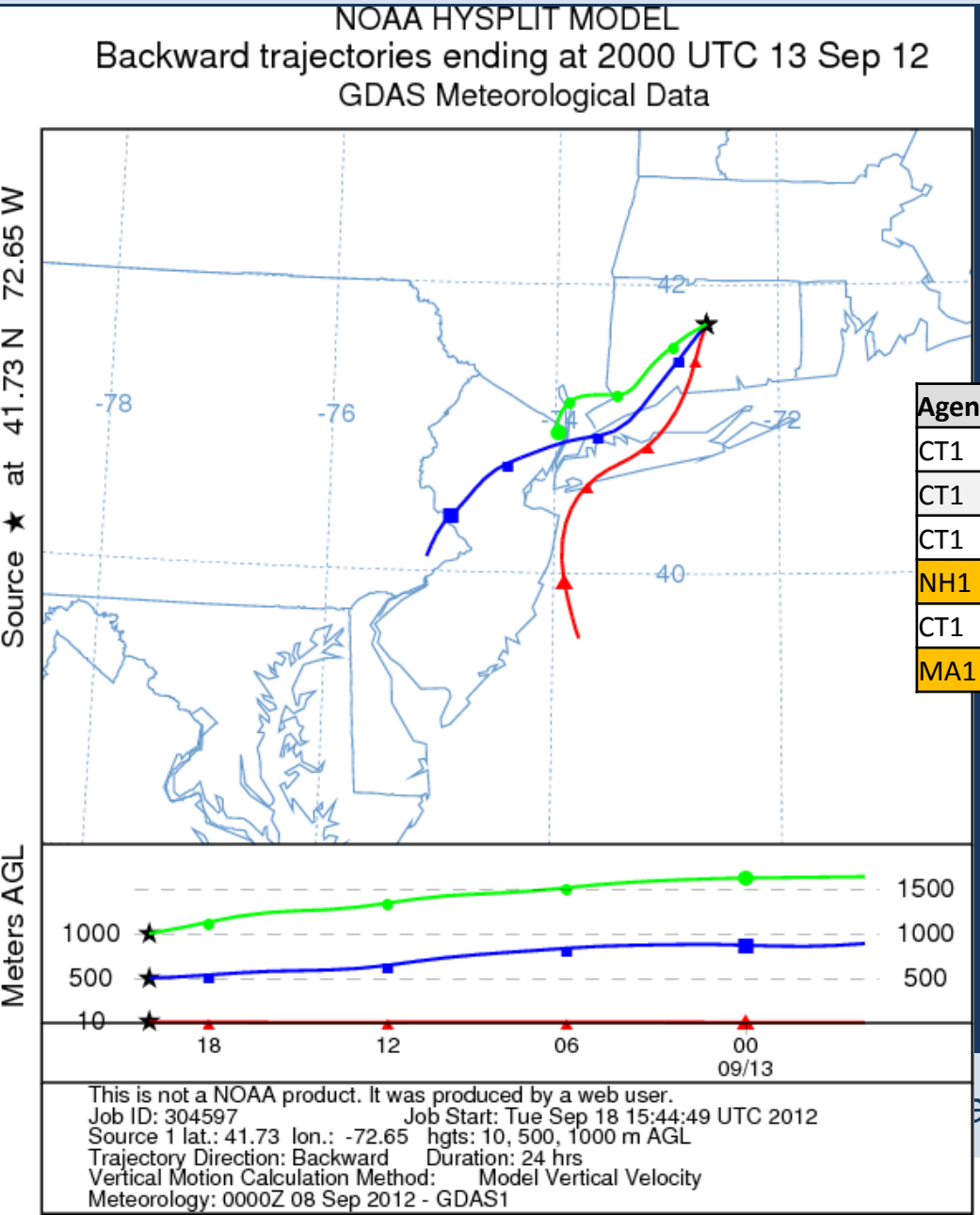
Sept 7 vs. Sept 13 (Bradley)





- Both Bradley airport and the E. Hartford monitor site were 4° F cooler on Sept 13 vs Sept 7th!
- More cloud cover reported on Sept 7, which probably limited the ozone production.
- Winds turned southwest late in the day on Sept 13th , which provided more opportunity for transport.

September 13th Transport



- Only CT, MA and NH had exceedances
- NOAA HYSPLIT MODEL reanalysis showed that transport was ideal for exceedance

Agency	Site Name	AQS Code	9/13/2012
CT1	Stafford	090131001	85
CT1	Middletown	090070007	81
CT1	East Hartford	090031003	79
NH1	Miller State Park	330115001	78
CT1	Danbury	090011123	76
MA1	WARE	250154002	76

Conclusions

- The NOAA model outperformed our forecasts- 74% vs. 52%
- The NOAA model past record of over-predicting during July-August didn't occur this year!
- Other forecasters have confirmed this for the Northeast region
- NOAA modelers believe that the new emission estimates for 2012 were biggest difference (mobile6 2005⟶2012)

Conclusions

- Many cases of prefrontal troughs with southwest winds along coast handled well by model
- We expected days with southerly winds to have more maritime ‘clean’ air, but westerly winds aloft mixed down converged across mid-Atlantic and intensified into Ct, during the afternoon hours.
- Forecasting around the 75ppb NAAQS has become more challenging, especially since exceedances occur at much lower maximum temperatures!

Questions?

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