



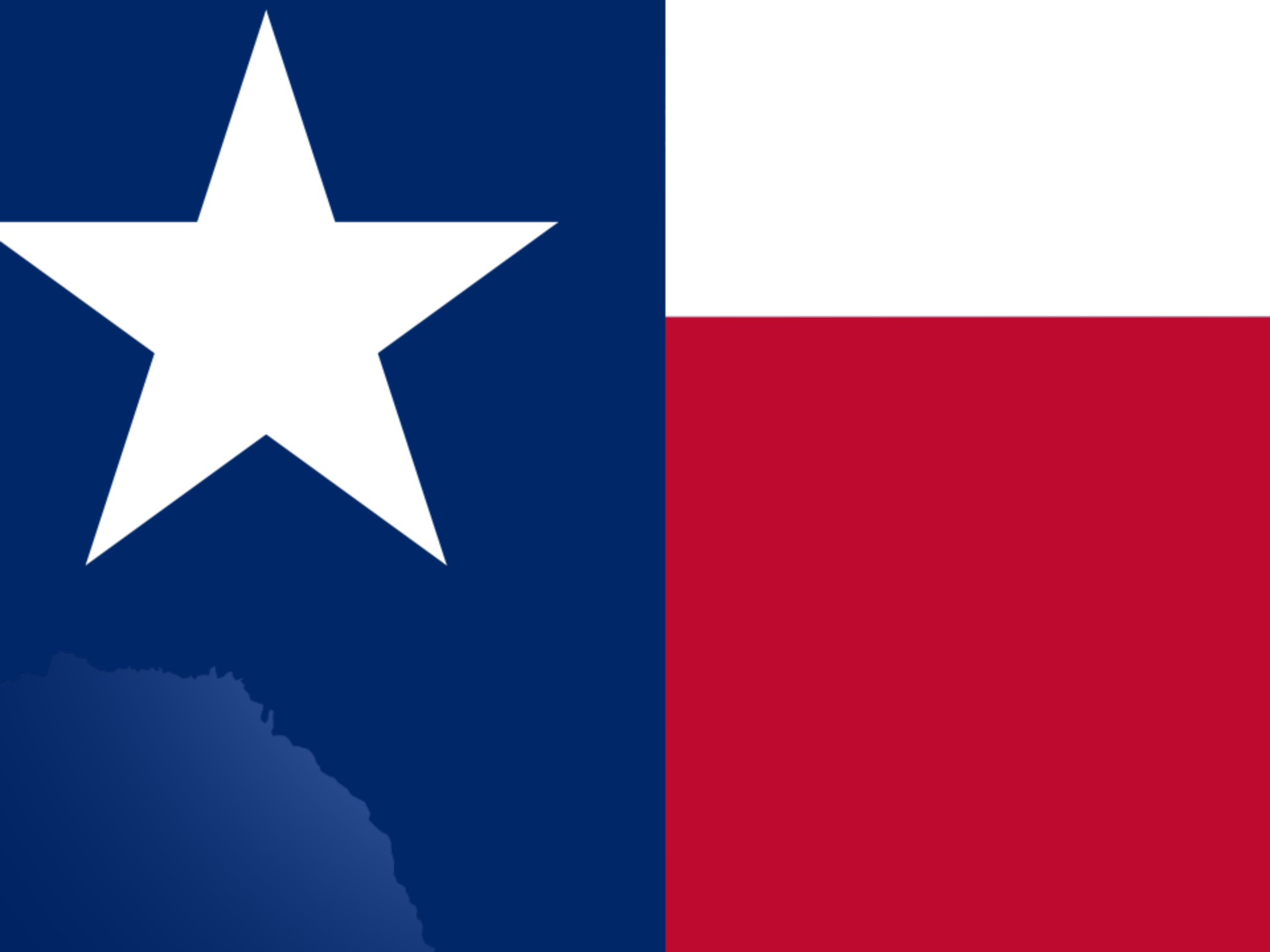
Air Quality Forecasting in Texas

Rod Truesdell

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Texas Commission on Environmental Quality





Texas... it's a big ole place.



- 16 regions
- Region-specific air quality forecasts for 13 of them (plus burn forecasts for all 16)

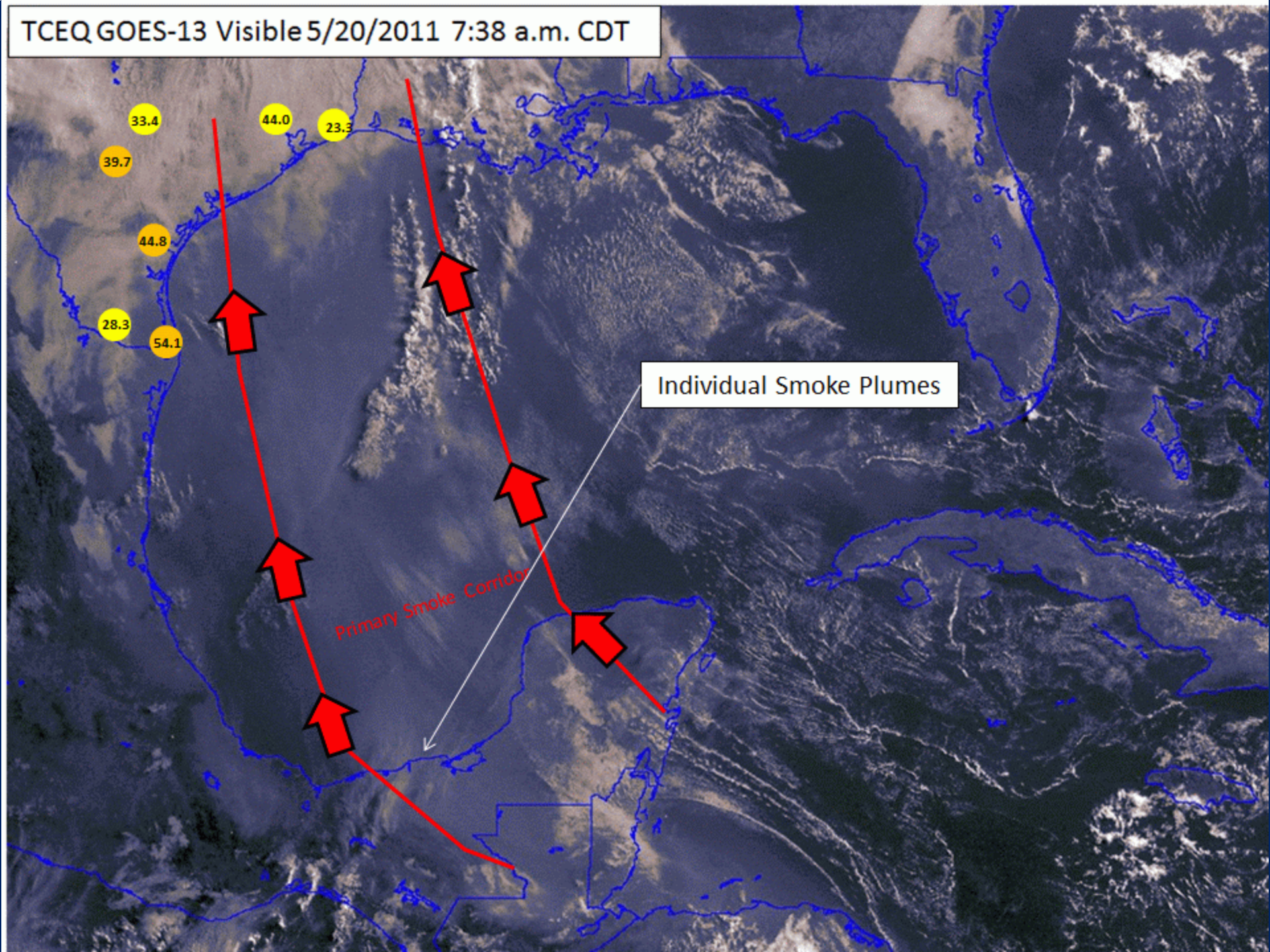


Quick “Soap Box” Topic



Smoke from Mexico/Central America

TCEQ GOES-13 Visible 5/20/2011 7:38 a.m. CDT



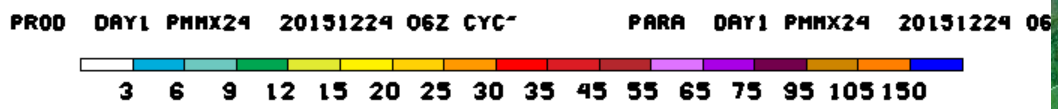
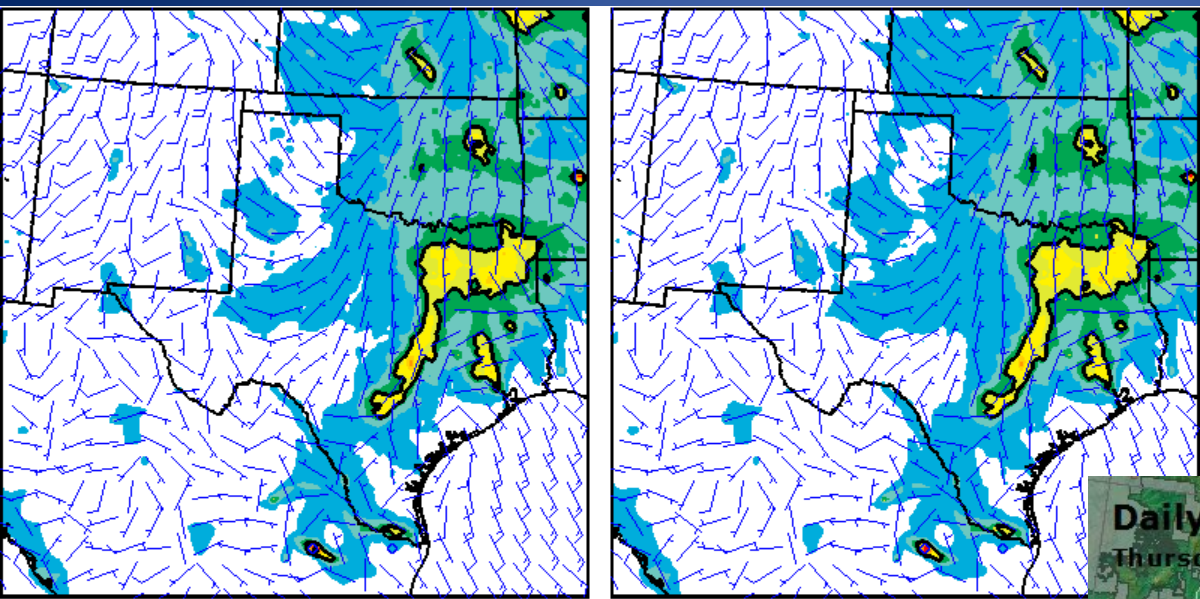
Individual Smoke Plumes

Primary Smoke Corridor



International Transport Example

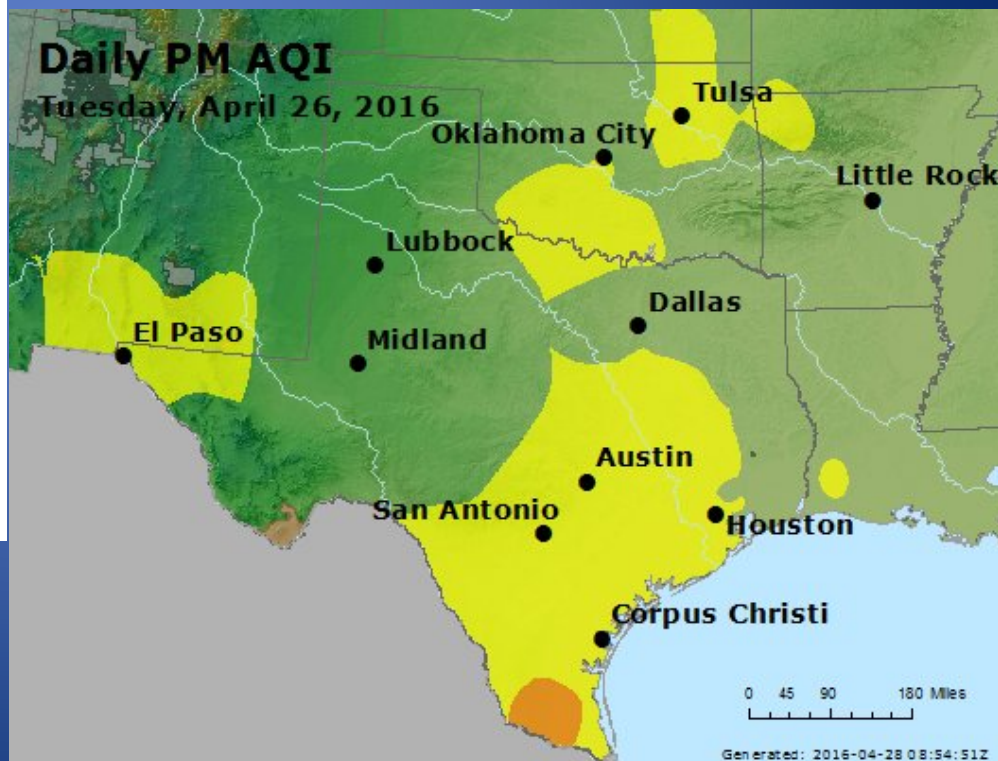
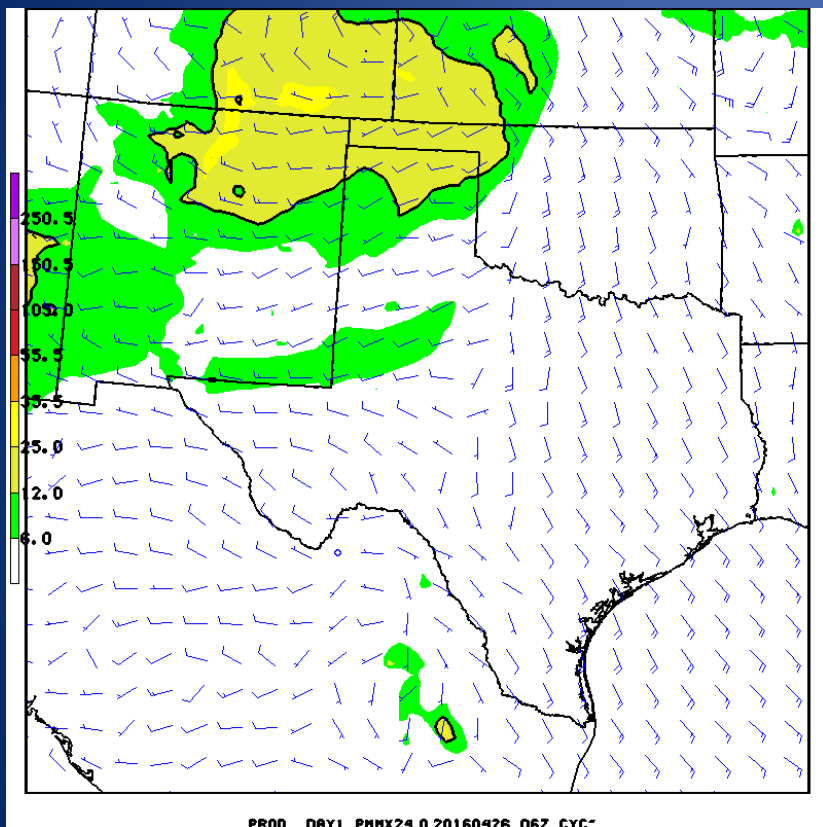
December 24, 2015





International Transport Example

April 26, 2016





DFW ozone, August 2015

Area	Monitoring Site	POC	August 2015																														
			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
Dallas-Fort Worth																																	
	Ft. Worth Northwest C13/AH302	2	70	63	83	64	41	41	43	37	38	60	64	59	85	78	73	71	70	49	51	13	50	45	43	63	65	79	80	78	62	64	64
	Keller C17	2	68	60	81	NV	42	43	45	39	38	NV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NV	80	86	70	60	66	
	Frisco C31/C680	1	58	61	82	74	54	58	60	46	54	62	52	47	58	59	57	62	75	58	46	20	54	51	45	74	59	58	78	83	71	63	61
	Midlothian OFW C52/A137	1	54	52	59	54	40	41	35	32	34	49	81	74	71	60	58	56	53	46	53	17	43	42	38	58	53	57	65	68	63	56	49
	Denton Airport South C56/A163/X157	1	77	72	88	75	51	51	56	48	47	56	52	49	71	63	63	72	89	60	46	29	59	53	48	69	76	NV	85	94	75	63	77
	Arlington Municipal Airport C61	1	56	53	64	54	35	36	34	29	33	57	71	61	75	62	62	54	55	41	45	15	41	37	33	64	47	57	NV	69	57	56	51
	Dallas North No.2 C63/C679	1	66	60	83	69	50	50	49	41	48	78	58	NV	NV	65	60	66	70	53	49	14	51	47	44	79	59	66	75	82	67	69	59
	Rockwall Heath C69	1	59	56	71	67	43	46	41	38	46	77	51	48	56	58	59	64	58	47	48	15	46	43	43	60	49	57	70	71	69	71	58
	Grapevine Fairway C70/A301/X182	1	69	67	94	58	47	48	51	40	46	56	53	50	69	69	63	71	81	51	47	17	48	44	44	79	65	75	79	87	70	60	67
	Kaufman C71/A304/X071	1	60	54	57	66	34	36	37	39	43	48	41	52	54	54	59	56	54	42	43	12	38	36	36	47	46	49	63	64	68	58	51
	Granbury C73/C681	1	64	58	68	53	40	41	35	33	35	42	57	58	86	65	69	66	58	49	52	22	48	41	39	45	59	65	67	69	59	61	57
	Eagle Mountain Lake C75	1	75	61	78	60	40	NV	41	34	35	45	52	50	73	71	63	68	71	49	45	20	51	42	43	57	NV	81	81	79	59	57	66
	Parker County C76	1	72	61	73	55	43	44	39	35	38	44	60	56	77	76	76	72	64	55	50	36	53	46	44	52	NV	76	76	74	60	61	63
	Cleburne Airport C77/C682	1	61	56	65	55	41	42	37	36	37	45	69	73	88	65	68	65	60	51	56	22	49	47	43	54	56	66	68	75	NV	53	57
	Dallas Hinton St. C401/C60/AH161	3	72	61	81	64	44	45	43	38	42	82	59	58	70	62	63	66	69	49	50	14	47	45	42	79	56	63	73	80	65	66	58
	Dallas Executive Airport C402	1	58	53	66	58	40	42	36	31	36	68	68	63	66	62	61	58	58	45	51	14	45	41	39	65	54	57	67	74	63	57	52
	Greenville C1006/A198	1	55	52	57	62	37	44	39	31	38	46	48	45	53	54	55	56	53	47	39	16	44	42	39	51	49	47	61	60	63	64	53
	Pilot Point C1032	1	59	64	71	78	57	57	62	52	51	44	52	46	55	56	56	61	79	62	42	28	59	54	42	56	59	59	78	83	82	63	65
	Italy C1044/A323	1	57	53	61	48	37	41	31	31	33	36	73	68	57	55	55	55	49	43	48	19	41	36	35	45	48	52	61	66	66	51	48
	Corsicana Airport C1051	1	61	55	62	53	32	34	34	32	41	47	58	58	58	56	57	58	63	41	42	20	38	35	39	44	47	52	67	70	72	60	51



DFW ozone, August 2016

Area	Monitoring Site	POC	August 2016																														
			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
Dallas-Fort Worth																																	
	Ft. Worth Northwest C13/AH302	2	32	36	41	46	56	47	37	40	44	46	43	44	48	38	31	32	20	22	18	40	44	21	30	33	35	32	56	48	35	43	58
	Keller C17	2	36	39	44	47	57	49	37	43	44	47	43	43	43	35	30	36	20	21	18	37	38	23	29	33	37	38	57	45	32	39	NV
	Frisco C31/C680	1	45	52	56	60	73	61	46	54	NV	56	58	58	46	34	33	32	23	29	21	38	38	31	31	37	44	46	49	41	33	44	50
	Midlothian OFW C52/A137	1	30	29	40	43	40	39	30	35	NV	36	32	39	48	41	25	23	21	21	25	38	38	20	27	28	27	35	42	34	29	44	54
	Denton Airport South C56/A163/X157	1	44	52	54	58	68	60	44	54	56	64	57	51	46	40	38	46	25	24	23	43	41	32	33	41	51	42	59	42	30	39	48
	Arlington Municipal Airport C61	1	29	30	NV	43	44	40	29	36	42	38	34	40	46	36	28	23	19	21	21	37	42	18	25	26	26	38	43	38	34	50	59
	Dallas North No.2 C63/C679	1	41	42	52	53	65	55	41	47	58	51	52	58	47	35	27	28	16	25	21	36	38	22	28	31	36	44	51	41	30	43	51
	Rockwall Heath C69	1	35	35	49	53	52	51	38	43	49	42	38	59	45	31	25	NV	NA	NV	21	32	36	24	25	26	28	41	40	40	32	43	49
	Grapevine Fairway C70/A301/X182	1	35	46	50	54	67	57	41	50	54	55	53	47	45	35	31	36	20	25	18	36	38	23	29	35	42	NV	57	44	35	45	50
	Kaufman C71/A304/X071	1	31	33	50	51	47	42	38	43	41	42	33	41	50	32	27	23	20	22	21	31	31	24	24	26	25	37	36	39	33	NA	NA
	Granbury C73/C681	1	33	32	38	43	48	38	32	33	34	37	36	34	50	44	37	34	26	24	22	39	54	19	32	34	28	31	45	43	45	46	52
	Eagle Mountain Lake C75	1	37	41	46	49	60	51	40	44	49	52	46	49	50	39	35	35	19	16	12	30	41	25	30	34	39	45	59	49	31	NV	46
	Parker County C76	1	32	33	38	41	46	40	35	34	39	38	38	38	46	41	42	41	25	20	22	37	40	21	29	32	33	32	39	50	38	NV	47
	Cleburne Airport C77/C682	1	38	38	46	48	52	45	39	42	46	47	43	43	61	52	41	33	32	29	NA	NA	NA	NA	NV	39	35	42	51	44	47	54	78
	Dallas Hinton St. C401/C60/AH161	3	38	37	46	50	59	50	38	44	54	46	41	50	49	37	30	31	16	24	21	37	43	20	27	30	31	43	53	44	30	51	60
	Dallas Executive Airport C402	1	32	32	47	45	47	43	33	38	41	41	31	44	46	37	26	24	17	18	21	34	39	18	25	25	25	39	44	38	31	48	55
	Greenville C1006/A198	1	32	32	45	56	52	47	36	45	50	41	40	43	46	28	21	24	19	24	20	28	34	21	24	28	28	41	37	38	32	39	50
	Pilot Point C1032	1	50	59	58	63	71	57	48	57	57	68	58	55	43	35	35	36	25	24	22	40	39	33	34	43	51	42	45	39	32	40	47
	Italy C1044/A323	1	33	32	48	40	42	42	31	37	36	37	33	42	49	43	30	22	23	23	27	34	33	25	24	23	23	35	44	36	33	40	48
	Corsicana Airport C1051	1	32	32	NV	NA	NA	NA	NA	NA	NV	39	33	39	51	37	29	20	20	23	23	36	27	27	26	25	29	38	40	37	34	35	52



Houston ozone, August 2016

Area	Monitoring Site	POC	August 2016																															
			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	
Houston-Galveston-Brazoria																																		
	Houston East C1/G316	2	33	44	61	53	36	32	36	49	49	NV	NV	27	34	25	21	18	20	5	16	20	21	14	18	19	20	38	32	26	18	36	29	
	Houston Aldine C8/AF108/X150	2	44	58	89	65	49	41	40	61	64	45	32	37	39	32	25	23	23	16	21	25	27	19	25	28	33	41	38	31	29	30	33	
	Channelview C15/AH115	3	32	49	56	47	38	36	39	48	47	36	33	29	38	27	24	19	19	15	18	19	22	15	18	22	34	39	37	29	27	33	32	
	Northwest Harris Co. C26/A110/X154	2	33	42	49	54	38	25	25	43	50	30	26	28	43	22	25	21	20	21	20	24	24	21	24	27	36	38	37	27	29	29	33	
	Hou.DeerPrk2 C35/235/1001/AFH139FP239	1	23	30	41	42	25	24	22	31	29	24	22	21	29	24	26	22	23	13	19	18	22	14	17	20	29	36	37	34	26	38	40	
	Seabrook Friendship Park C45	1	26	31	40	44	27	24	26	34	30	25	23	21	28	27	26	24	27	17	19	17	23	20	20	22	34	44	41	36	33	44	38	
	Houston Bayland Park C53/A146	1	29	33	38	44	34	30	30	36	40	34	31	27	37	25	27	29	26	18	21	20	33	21	19	22	NV	51	45	35	31	39	42	
	Conroe Relocated C78/A321	1	55	55	60	71	60	30	36	61	59	47	32	40	49	26	23	28	26	26	32	29	22	25	41	43	36	39	37	30	28	28	33	
	Manvel Croix Park C84	1	25	26	27	39	26	25	24	28	31	25	23	23	28	25	31	27	25	18	17	19	25	22	20	22	31	60	53	44	33	42	50	
	Clinton C403/C304/AH113	3	24	33	44	32	26	26	27	32	37	29	26	21	31	25	25	21	18	8	14	20	23	14	16	17	18	42	36	30	25	38	37	
	Houston North Wayside C405	1	28	40	56	47	31	30	33	41	49	36	27	26	32	22	21	19	14	8	13	17	22	12	17	18	16	33	31	26	20	23	27	
	Houston Monroe C406	1	21	22	30	33	21	22	21	25	27	24	23	19	NA	NA	NV	22	19	9	14	16	22	14	16	17	24	38	37	33	22	36	40	
	Lang C408	2	36	42	52	50	40	32	32	49	48	37	30	30	37	28	25	21	21	14	20	23	30	16	20	24	28	45	44	33	27	31	37	
	Houston Croquet C409	2	25	29	NA	NV	27	26	25	28	32	26	26	22	30	23	24	26	23	15	17	16	25	18	16	20	26	55	41	36	29	37	42	
	Houston Westhollow C410	1	31	33	38	44	33	29	27	37	39	29	28	27	39	25	32	24	25	22	19	20	32	21	21	23	34	51	51	38	34	NA	NA	
	Houston Texas Avenue C411	1	28	33	44	45	NV	32	29	37	39	35	31	27	34	27	24	22	20	9	18	21	29	16	21	22	30	47	39	32	27	41	39	
	Park Place C416	1	26	29	39	NV	28	26	27	33	36	31	28	23	31	27	23	27	22	9	17	20	26	16	20	NV	NV	46	40	33	26	41	40	
	Lynchburg Ferry C1015/A165	1	29	47	51	45	34	31	35	51	44	35	28	25	34	28	21	17	20	10	18	18	22	16	17	21	33	35	34	27	27	35	30	
	Lake Jackson C1016	1	18	19	24	37	19	20	17	18	21	16	17	17	20	23	22	24	22	18	17	17	19	13	15	16	24	48	56	35	34	38	37	
	Baytown Garth C1017	1	37	40	42	43	40	42	45	55	46	44	40	31	42	26	25	19	23	20	17	20	23	19	22	23	31	42	37	30	30	35	33	
	Galveston 99th St. C1034/A320/X183	1	NA	NV	29	45	23	23	22	23	22	17	19	18	29	31	34	30	30	24	20	20	28	22	22	22	47	58	47	40	41	52	52	



Regression model

- TCEQ forecasters* have developed a multi-variable regression air quality forecast model

(* aka Weslee Copeland)

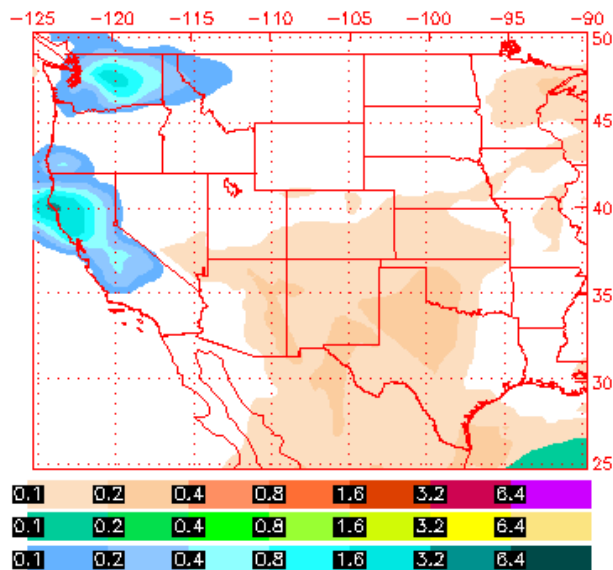


Regression model

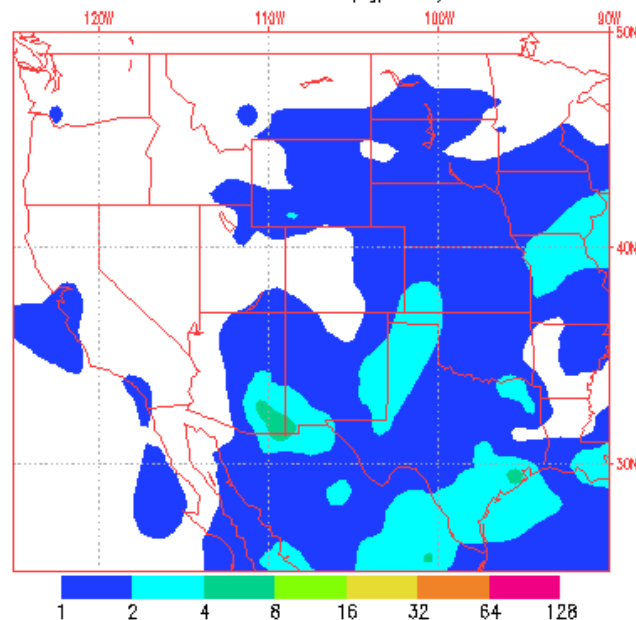
- TCEQ forecasters have developed a multi-variable regression air quality forecast model
- Two main inputs
 - GFSX MOS forecasts (00Z temp/dp, ws, PoPs)
 - Naval Research Laboratory NAAPS aerosol model
 - 12Z AOD forecast, plus surface concentration forecasts for sulfates, dust, and smoke



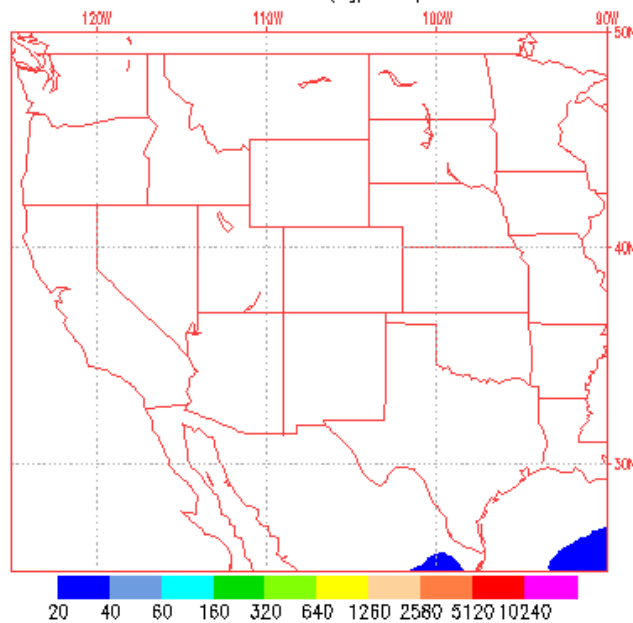
NAAPS Total Optical Depth for 12:00Z 02 Aug 2015
 Sulfate: Orange/Red, Dust: Green/Yellow, Smoke: Blue



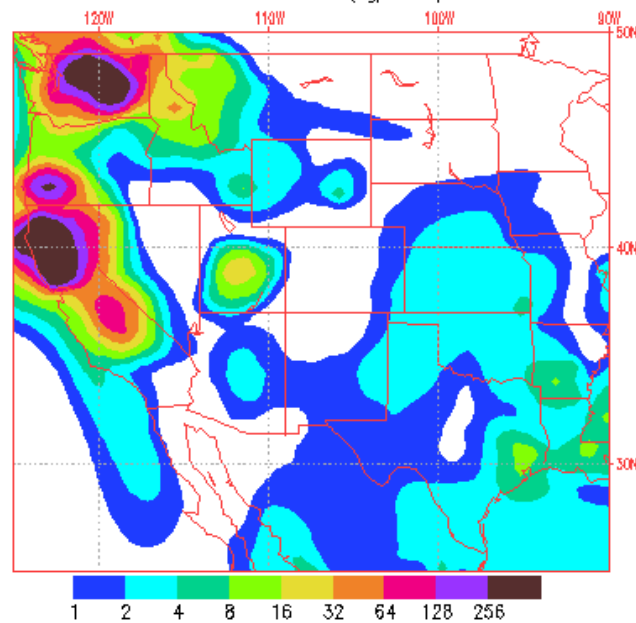
Sulfate Surface Concentration ($\mu\text{g}/\text{m}^3$) for 2015080212



Dust Surface Concentration ($\mu\text{g}/\text{m}^3$) for 2015080212



Smoke Surface Concentration ($\mu\text{g}/\text{m}^3$) for 2015080212





Regression model

- TCEQ forecasters have developed a multi-variable regression air quality forecast model
- Two main inputs
 - GFSX MOS forecasts (00Z temp/dp, ws, PoPs)
 - Naval Research Laboratory NAAPS aerosol model
 - 12Z AOD forecast, plus surface concentration forecasts for sulfates, dust, and smoke
- Forecasts for ozone, PM_{2.5}, and (for El Paso/West Texas only) PM₁₀



Regression model

8/30/2016 Dallas-Fort Worth region model forecast

30					GFSX								NRL Aerosol Model				Adj								
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl	TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx						
Tue 8/30	93	68	65		88	67	7	7	0.10	3.0	0.0	4.5	79	50	13.0	#VALUE!	79	50	14.4						
Wed 8/31	140	82	73		88	68	7	7	0.10	3.0	0.0	5.0	79	50	13.1	#VALUE!	79	50	14.5						
Thu 9/1		54	53		86	68	7	12	0.10	1.5	0.0	3.0	57	36	10.6	#VALUE!	57	36	12.0						
Fri 9/2		45	43	0	83	66	9	39					47	31	9.3	#VALUE!	47	31	10.7						
Sat 9/3		52	51	0	88	64	9	14					55	36	10.1	#VALUE!	55	36	11.5						
Sun 9/4		49	47		91	64	12	16					52	35	9.5	#VALUE!	52	35	10.9						
Mon 9/5		47	45		88	66	13	19					49	33	8.5	#VALUE!	49	33	9.9						
Tue 9/6		49	47		87	64	11	17					52	35	9.1	#VALUE!	52	35	10.5						
12Z Forecast																									
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl	GFSX								NRL Aerosol Model				Adj								
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl	TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx						
Wed 8/31	143	83	74	72	89	68	7	13	0.10	3.0	0.0	5.0	78	50	13.7	#VALUE!	78	50	15.1						
Thu 9/1		51	47		85	68	7	15	0.10	1.5	0.0	0.5	52	32	9.6	#VALUE!	52	32	11.0						
Fri 9/2		50	46		82	65	8	28					51	33	9.3	#VALUE!	51	33	10.7						
Sat 9/3		60	55		86	60	7	9					61	40	10.5	#VALUE!	61	40	11.9						
Sun 9/4		52	48		89	62	12	12					53	37	9.1	#VALUE!	53	37	10.5						
Mon 9/5		53	49		90	67	11	9					54	35	9.7	#VALUE!	54	35	11.1						
Tue 9/6		50	46		88	64	12	18					51	35	8.9	#VALUE!	51	35	10.3						
GFSX																									
Date	NOAA O3 AQI	NOAA O3	O3	O3bg	PM2.5	PM10	ln(O3)	ln(O3bg)	ln(PM2.5)	ln(PM10)	TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx
8/29/2016	84	65	47	30	11.2		3.8501476	3.4011974	2.4159138	#NUM!	88	67	10	17	0.05	2.0	0.0	1.5	57	36	9.9	#VALUE!	57	36	11.3
8/28/2016	87	66	50	37	9.8		3.912023	3.6109179	2.2823824	#NUM!	86	67	9	19	0.15	1.5	0.0	1.0	52	34	9.4	#VALUE!	52	34	10.8
8/27/2016	74	62	59	39	10.8		4.0775374	3.6635616	2.3795461	#NUM!	86	69	7	26	0.05	1.5	0.0	0.0	49	29	9.9	#VALUE!	49	29	11.3
8/26/2016	80	64	46	32	11.0		3.8286414	3.4657359	2.3978953	#NUM!	86	68	8	52	0.05	1.5	0.0	1.0	44	28	10.5	#VALUE!	44	28	11.9
8/25/2016	49	53	51	25	10.5		3.9318256	3.2188758	2.3513753	#NUM!	90	67	8	7	0.00	0.5	0.0	2.0	50	31	10.1	#VALUE!	50	31	11.5
8/24/2016	49	53	43	25	12.2		3.7612001	3.2188758	2.501436	#NUM!	91	67	13	3	0.00	0.5	0.0	0.0	45	30	7.9	#VALUE!	45	30	9.3
8/23/2016	49	53	34	24	12.6		3.5263605	3.1780538	2.5386968	#NUM!	91	69	16	7	0.05	1.0	0.0	0.0	45	31	7.4	#VALUE!	45	31	8.8
8/22/2016	49	53	33	19	10.1		3.4965076	2.944439	2.3125354	#NUM!	83	71	9	70	0.05	2.5	0.0	0.0	42	26	10.0	#VALUE!	42	26	11.4
8/21/2016	74	62	54	33	9.6		3.988984	3.4965076	2.2617631	#NUM!	85	58	9	8	0.05	1.0	0.0	0.0	53	35	8.4	#VALUE!	53	35	9.8
8/20/2016	43	46	43	31	9.6		3.7612001	3.4339872	2.2617631	#NUM!	79	72	8	79	0.10	2.0	0.0	0.0	36	23	9.2	#VALUE!	36	23	10.6
8/19/2016	40	43	27	18	7.8		3.2958369	2.8903718	2.0541237	#NUM!	79	72	9	76	0.10	1.5	0.0	0.0	33	21	8.5	#VALUE!	33	21	9.9
8/18/2016	41	44	29	20	8.0		3.3672958	2.9957323	2.0794415	#NUM!	81	72	10	71	0.05	1.5	0.0	0.0	34	21	8.4	#VALUE!	34	21	9.8
8/17/2016	40	43	32	17	7.7		3.4657359	2.8332133	2.0412203	#NUM!	77	71	10	87	0.05	1.5	0.0	0.0	31	19	7.9	#VALUE!	31	19	9.3
8/16/2016	71	61	46	23	8.0		3.8286414	3.1354942	2.0794415	#NUM!	81	68	8	31	0.10	2.5	0.0	0.0	52	32	9.0	#VALUE!	52	32	10.4
8/15/2016	47	51	42	25	6.6		3.7376696	3.2188758	1.8870696	#NUM!	77	62	7	32	0.10	2.0	0.0	0.0	50	31	8.2	#VALUE!	50	31	9.6
8/14/2016	71	61	52	34	7.2		3.9512437	3.5263605	1.974081	#NUM!	84	66	11	18	0.15	1.5	0.0	0.5	49	33	8.1	#VALUE!	49	33	9.5
8/13/2016	71	61	61	45	8.8		4.1108739	3.8066625	2.1747517	#NUM!	90	68	14	30	0.15	2.5	0.0	2.0	57	41	9.8	#VALUE!	57	41	11.2
8/12/2016	100	70	59	39	14.9		4.0775374	3.6635616	2.7013612	#NUM!	98	68	8	12	0.00	1.0	0.0	2.0	58	36	13.2	#VALUE!	58	36	14.6
8/11/2016	80	64	58	33	11.7		4.060443	3.4965076	2.4595888	#NUM!	99	64	9	1	0.05	1.0	0.0	1.0	63	41	12.5	#VALUE!	63	41	13.9
8/10/2016	87	66	68	37	9.9		4.2195077	3.6109179	2.2925348	#NUM!	99	65	9	5	0.00	1.0	0.0	2.0	62	40	12.9	#VALUE!	62	40	14.3
8/9/2016	90	67	58	38	10.3		4.060443	3.6375862	2.3321439	#NUM!	96	65	8	8	0.00	1.0	0.0	2.0	60	38	12.4	#VALUE!	60	38	13.8
8/8/2015	50	54	52	31	12.6		3.9512437	3.4339872	2.5386968	#NUM!	102	60	12	1	0.00	0.5	0.0	0.0	59	40	11.3	#VALUE!	59	40	12.7
8/7/2015	71	61	62	34	12.5		4.1271344	3.5263605	2.5257286	#NUM!	101	60	13	3	0.00	0.5	0.0	0.0	57	39	10.6	#VALUE!	57	39	12.0
8/6/2015	67	60	58	36	14.2		4.060443	3.5835189	2.653242	#NUM!	101	63	14	2	0.00	0.5	0.0	0.5	54	38	10.3	#VALUE!	54	38	11.7
8/5/2015	58	57	57	35	11.7		4.0430513	3.5553481	2.4595888	#NUM!	99	66	12	4	0.05	0.5	0.0	0.5	53	36	10.6	#VALUE!	53	36	12.0
8/4/2015	106	72	78	53	15.8		4.3567088	3.9702919	2.7600099	#NUM!	95	60	10	7	0.15	1.5	0.0	1.0	66	47	11.5	#VALUE!	66	47	12.9



Regression model

8/30/2016 Dallas-Fort Worth model forecast w/o aerosol component

30										GFSX								Adj					
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl						TMP	DPT	WND	P12			O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx	
Tue 8/30	93	68	65							88	67	7	7			59	37	11.0	#VALUE!	60	38	11.4	
Wed 8/31	140	82	73							88	68	7	7			58	36	10.9	#VALUE!	59	37	11.3	
Thu 9/1		72	68							86	68	7	12			56	35	10.5	#VALUE!	57	36	10.9	
Fri 9/2		60	58	0						83	66	9	39			47	31	9.3	#VALUE!	48	32	9.7	
Sat 9/3		71	67	0						88	64	9	14			55	36	10.1	#VALUE!	56	37	10.5	
Sun 9/4		67	64							91	64	12	16			52	35	9.5	#VALUE!	53	36	9.9	
Mon 9/5		63	61							88	66	13	19			49	33	8.5	#VALUE!	50	34	8.9	
Tue 9/6		67	64							87	64	11	17			52	35	9.1	#VALUE!	53	36	9.5	
12Z Forecast										GFSX								Adj					
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl						TMP	DPT	WND	P12			O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx	
Wed 8/31	143	83	74	72						89	68	7	13			57	35	11.3	#VALUE!	58	36	11.7	
Thu 9/1		74	67							85	68	7	15			55	35	10.3	#VALUE!	56	36	10.7	
Fri 9/2		68	62							82	65	8	28			51	33	9.3	#VALUE!	52	34	9.7	
Sat 9/3		82	74							86	60	7	9			61	40	10.5	#VALUE!	62	41	10.9	
Sun 9/4		71	65							89	62	12	12			53	37	9.1	#VALUE!	54	38	9.5	
Mon 9/5		72	66							90	67	11	9			54	35	9.7	#VALUE!	55	36	10.1	
Tue 9/6		68	62							88	64	12	18			51	35	8.9	#VALUE!	52	36	9.3	
										GFSX								Adj					
Date	NOAA O3 AQI	NOAA O3	O3	O3bg	PM2.5	PM10	ln(O3)	ln(O3bg)	ln(PM2.5)	ln(PM10)	TMP	DPT	WND	P12			O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx
8/29/2016	84	65	47	30	11.2		3.8501476	3.4011974	2.4159138	#NUM!	88	67	10	17			52	34	9.7	#VALUE!	53	35	10.1
8/28/2016	87	66	50	37	9.8		3.912023	3.6109179	2.2823824	#NUM!	86	67	9	19			52	34	9.7	#VALUE!	53	35	10.1
8/27/2016	74	62	59	39	10.8		4.0775374	3.6635616	2.3795461	#NUM!	86	69	7	26			52	32	10.7	#VALUE!	53	33	11.1
8/26/2016	80	64	46	32	11.0		3.8286414	3.4657359	2.3978953	#NUM!	86	68	8	52			45	29	10.5	#VALUE!	46	30	10.9
8/25/2016	49	53	51	25	10.5		3.9318256	3.2188758	2.3513753	#NUM!	90	67	8	7			58	37	11.0	#VALUE!	59	38	11.4
8/24/2016	49	53	43	25	12.2		3.7612001	3.2188758	2.501436	#NUM!	91	67	13	3			53	36	9.0	#VALUE!	54	37	9.4
8/23/2016	49	53	34	24	12.6		3.5263605	3.1780538	2.5336968	#NUM!	91	69	16	7			48	33	7.9	#VALUE!	49	34	8.3
8/22/2016	49	53	33	19	10.1		3.4965076	2.944439	2.3125354	#NUM!	83	71	9	70			39	25	9.6	#VALUE!	40	26	10.0
8/21/2016	74	62	54	33	9.6		3.988984	3.4965076	2.2617631	#NUM!	85	58	9	8			59	40	9.4	#VALUE!	60	41	9.8
8/20/2016	43	46	43	31	9.6		3.7612001	3.4339872	2.2617631	#NUM!	79	72	8	79			37	23	9.2	#VALUE!	38	24	9.6
8/19/2016	40	43	27	18	7.8		3.2958369	2.8903718	2.0541237	#NUM!	79	72	9	76			37	23	8.8	#VALUE!	38	24	9.2
8/18/2016	41	44	29	20	8.0		3.3672958	2.9957323	2.0794415	#NUM!	81	72	10	71			37	24	8.8	#VALUE!	38	25	9.2
8/17/2016	40	43	32	17	7.7		3.4657359	2.8332133	2.0412203	#NUM!	77	71	10	87			34	22	8.1	#VALUE!	35	23	8.5
8/16/2016	71	61	46	23	8.0		3.8286414	3.1354942	2.0794415	#NUM!	81	68	8	31			49	31	9.2	#VALUE!	50	32	9.6
8/15/2016	47	51	42	25	6.6		3.7376696	3.2188758	1.8870696	#NUM!	77	62	7	32			51	34	8.7	#VALUE!	52	35	9.1
8/14/2016	71	61	52	34	7.2		3.9512437	3.5263605	1.974081	#NUM!	84	66	11	18			50	34	8.5	#VALUE!	51	35	8.9
8/13/2016	71	61	61	45	8.8		4.1108739	3.8066625	2.1747517	#NUM!	90	68	14	30			45	31	8.7	#VALUE!	46	32	9.1
8/12/2016	100	70	59	39	14.9		4.0775374	3.6635616	2.7013612	#NUM!	98	68	8	12			58	36	13.3	#VALUE!	59	37	13.7
8/11/2016	80	64	58	33	11.7		4.060443	3.4965076	2.4595888	#NUM!	99	64	9	1			62	40	12.8	#VALUE!	63	41	13.2
8/10/2016	87	66	68	37	9.9		4.2195077	3.6109179	2.2925348	#NUM!	99	65	9	5			61	39	12.9	#VALUE!	62	40	13.3
8/9/2016	90	67	58	38	10.3		4.060443	3.6375862	2.3321439	#NUM!	96	65	8	8			60	38	12.6	#VALUE!	61	39	13.0
8/8/2015	50	54	52	31	12.6		3.9512437	3.4339872	2.5336968	#NUM!	102	60	12	1			61	41	12.1	#VALUE!	62	42	12.5
8/7/2015	71	61	62	34	12.5		4.1271344	3.5263605	2.5257286	#NUM!	101	60	13	3			59	41	11.3	#VALUE!	60	42	11.7
8/6/2015	67	60	58	36	14.2		4.060443	3.5835189	2.653242	#NUM!	101	63	14	2			56	39	10.8	#VALUE!	57	40	11.2
8/5/2015	58	57	57	35	11.7		4.0430513	3.5553481	2.4595888	#NUM!	99	66	12	4			57	37	11.3	#VALUE!	58	38	11.7
8/4/2015	106	72	78	53	15.8		4.3567088	3.9707919	2.7600098	#NUM!	95	60	10	7			60	40	11.3	#VALUE!	61	41	11.7



Regression model

8/30/2016 Houston region model forecast

00Z Forecast										GFSX										NRL Aerosol Model										Adj									
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl						TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx															
Tue 8/30	90	67	64							86	74	10	35	0.05	1.5	0.0	0.5	45	24	9.3	#VALUE!	46	25	9.7															
Wed 8/31	126	78	77							88	74	7	12	0.05	2.0	0.0	3.0	54	28	11.5	#VALUE!	55	29	11.9															
Thu 9/1		89	89							89	72	6	12	0.10	2.5	0.0	2.0	61	33	12.3	#VALUE!	62	34	12.7															
Fri 9/2		73	72	0						86	72	6	25					50	26	10.9	#VALUE!	51	27	11.3															
Sat 9/3		75	74	0						86	70	6	31					51	27	10.7	#VALUE!	52	28	11.1															
Sun 9/4		64	60							84	75	12	22					44	23	9.6	#VALUE!	45	24	10.0															
Mon 9/5		63	59							84	73	12	38					43	24	8.9	#VALUE!	44	25	9.3															
Tue 9/6		67	64							86	73	10	33					46	24	9.6	#VALUE!	47	25	10.0															
12Z Forecast										GFSX										NRL Aerosol Model										Adj									
Date	NOAA O3 AQI	NOAA O3	Adj O3	MxMdl						TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx															
Wed 8/31	133	80	79	60						87	74	7	25	0.05	3.0	0.0	3.0	57	31	10.3	#VALUE!	58	32	10.7															
Thu 9/1		87	85							89	72	6	6	0.05	2.5	0.0	1.0	60	31	11.6	#VALUE!	61	32	12.0															
Fri 9/2		74	72							87	71	7	24					51	27	11.0	#VALUE!	52	28	11.4															
Sat 9/3		75	73							85	70	7	21					52	28	11.2	#VALUE!	53	29	11.6															
Sun 9/4		68	66							85	73	14	14					47	25	10.1	#VALUE!	48	26	10.5															
Mon 9/5		59	58							83	75	11	42					41	22	8.6	#VALUE!	42	23	9.0															
Tue 9/6		61	59							86	73	13	45					42	23	8.5	#VALUE!	43	24	8.9															
										GFSX										NRL Aerosol Model										Adj									
Date	NOAA O3 AQI	NOAA O3	O3	O3bg	PM2.5	PM10	ln(O3)	ln(O3bg)	ln(PM2.5)	ln(PM10)	TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx														
8/29/2016	40	43	41	22	5.8		3.7135721	3.0910425	1.7578579	#NUM!	80	75	14	67	0.05	1.5	0.0	0.0	36	21	7.1	#VALUE!	37	22	7.5														
8/28/2016	54	56	44	27	5.6		3.7841896	3.2958369	1.7227666	#NUM!	80	76	12	68	0.10	2.5	0.0	1.5	41	26	7.8	#VALUE!	42	27	8.2														
8/27/2016	74	62	56	36	7.1		4.0253517	3.5835189	1.9600948	#NUM!	77	74	10	51	0.15	3.0	0.0	0.5	46	30	9.3	#VALUE!	47	31	9.7														
8/26/2016	77	63	60	38	6.6		4.0943446	3.6375862	1.8870696	#NUM!	80	74	6	58	0.10	3.0	0.0	2.0	45	26	8.5	#VALUE!	46	27	8.9														
8/25/2016	77	63	46	20	9.1		3.8286414	2.9957323	2.2082744	#NUM!	84	76	7	37	0.00	1.0	0.0	2.0	38	18	8.7	#VALUE!	39	19	9.1														
8/24/2016	54	56	43	17	9.5		3.7612001	2.8332133	2.2512918	#NUM!	84	76	9	24	0.00	1.0	0.0	0.0	39	19	9.1	#VALUE!	40	20	9.5														
8/23/2016	64	59	41	16	9.6		3.7135721	2.7725887	2.2617631	#NUM!	83	78	10	23	0.00	1.0	0.0	0.0	38	18	9.1	#VALUE!	39	19	9.5														
8/22/2016	49	53	25	14	7.3		3.2188758	2.6390573	1.9878743	#NUM!	83	76	8	54	0.00	1.0	0.0	0.0	34	17	7.4	#VALUE!	35	18	7.8														
8/21/2016	45	49	33	22	7.0		3.4965076	3.0910425	1.9459101	#NUM!	79	72	5	54	0.10	1.0	0.0	0.0	35	19	8.8	#VALUE!	36	20	9.2														
8/20/2016	54	56	29	17	12.1		3.3672958	2.8332133	2.4932055	#NUM!	83	76	8	20	0.05	1.0	0.0	0.0	40	20	10.2	#VALUE!	41	21	10.6														
8/19/2016	47	51	32	14	10.6		3.4657359	2.6390573	2.360854	#NUM!	84	77	8	41	0.00	1.0	0.0	0.0	36	17	8.2	#VALUE!	37	18	8.6														
8/18/2016	44	48	26	8	8.1		3.2580965	2.0794415	2.0918641	#NUM!	82	77	7	42	0.00	1.0	0.0	0.0	34	16	8.0	#VALUE!	35	17	8.4														
8/17/2016	51	55	30	19	5.0		3.4011974	2.944439	1.6094379	#NUM!	79	76	6	83	0.05	1.5	0.0	0.0	30	16	6.5	#VALUE!	31	17	6.9														
8/16/2016	51	55	30	19	6.3		3.4011974	2.944439	1.8405496	#NUM!	75	75	5	77	0.05	4.5	0.0	0.0	42	26	6.3	#VALUE!	43	27	6.7														
8/15/2016	42	45	34	21	5.1		3.5263605	3.0445224	1.6292405	#NUM!	78	76	10	99	0.05	1.0	0.0	0.0	27	15	5.8	#VALUE!	28	16	6.2														
8/14/2016	44	48	32	23	6.3		3.4657359	3.1354942	1.8405496	#NUM!	75	75	6	92	0.15	4.0	0.0	0.5	40	27	6.9	#VALUE!	41	28	7.3														
8/13/2016	51	55	49	28	14.1		3.8918203	3.3322045	2.6461748	#NUM!	85	76	10	82	0.10	1.0	0.0	0.5	34	19	7.4	#VALUE!	35	20	7.8														
8/12/2016	74	62	40	19	13.2		3.6888795	2.944439	2.5802168	#NUM!	92	74	10	4	0.05	1.0	0.0	2.0	54	27	12.3	#VALUE!	55	28	12.7														
8/11/2016	61	58	40	22	10.8		3.6888795	3.0910425	2.3795461	#NUM!	91	76	8	26	0.05	1.0	0.0	1.0	46	22	10.4	#VALUE!	47	23	10.8														
8/10/2016	74	62	47	23	10.8		3.8501476	3.1354942	2.3795461	#NUM!	92	75	7	24	0.05	1.0	0.0	4.0	49	23	11.2	#VALUE!	50	24	11.6														
8/9/2016	108	73	64	27	10.3		4.1588831	3.2958369	2.3321439	#NUM!	92	73	8	12	0.00	1.0	0.0	2.0	51	24	10.7	#VALUE!	52	25	11.1														
8/8/2015	51	55	45	22	20.4		3.8066625	3.0910425	3.0155349	#NUM!	96	70	12	2	0.00	1.0	10.0	0.5	57	31	17.2	#VALUE!	58	32	17.6														
8/7/2015	58	57	53	23	13.2		3.9702919	3.1354942	2.5802168	#NUM!	94	72	13	1	0.00	0.5	0.0	2.0	55	27	11.7	#VALUE!	56	28	12.1														
8/6/2015	49	53	42	21	15.6		3.7376696	3.0445224	2.7472709	#NUM!	94	72	13	2	0.00	1.0	0.0	0.5	57	28	11.2	#VALUE!	58	29	11.6														
8/5/2015	45	49	42	19	12.9		3.7376696	2.944439	2.5572273	#NUM!	92	73	13	3	0.00	1.0	0.0	1.0	55	27	11.1	#VALUE!	56	28	11.5														
8/4/2015	50	54	42	21	19.3		3.7376696	3.0445224	2.9601051	#NUM!	90	71	8	29	0.10	1.5	0.0	1.0	53	29	11.0	#VALUE!	54	30	11.4														



Another tool – TCEQ ozone “max model”

O3 Max Model Day 2		08/31/16 Wed											
Forecast Summary	8-Hr O3 (ppb)					Fcst	Fcst	Fcst	WSA		Wind Vector		
	Upw Est	Forecast				Tmp Max	SRd Sum	Prec Prob	5-8 Avg	9-14 Avg	Sum 9-14		
		Add	Max	Na	Nmx						Dir	Dist	
Houston IAH GFS	32	26	58	26	58	93	7.43	25	3.5	7.3	34	43.6	
Houston IAH NAM	32	34	66	34	66	96	8.03	17	2.9	6.1	34	35.3	
Houston HOU GFS	32	23	55	23	55	92	6.79	26	4.0	7.3	33	43.6	
Houston HOU NAM	32	30	62	30	62	94	8.03	17	4.0	6.5	36	35.1	
Dallas-FW DFW GFS	50	13	63	13	63	93	5.26	13	3.5	6.5	33	38.6	
Dallas-FW DFW NAM	50	30	80	30	80	97	8.58	4	3.5	4.6	46	24.0	
San Antonio SAT GFS	33	11	44	8	41	94	6.07	22	4.0	6.9	51	39.9	
San Antonio SAT NAM	33	9	42	6	39	96	5.26	15	3.5	8.1	53	45.2	
Austin AUS GFS	39	9	48	8	47	92	6.07	14	1.7	6.5	35	38.7	
Austin AUS NAM	39	9	48	8	47	95	6.07	7	1.7	6.9	32	40.3	
Waco-Killeen ACT GFS	49	5	54	4	53	92	6.79	12	3.5	6.5	26	39.0	
Waco-Killeen ACT NAM	49	8	57	7	56	96	9.10	4	4.6	5.8	41	34.3	
Tyler-Longview GGG GFS	46	12	58	11	57	93	8.03	8	1.7	6.5	31	38.8	
Tyler-Longview GGG NAM	46	15	61	15	61	94	9.10	4	2.3	5.8	25	34.1	
Beaumont-PA BPT GFS	37	17	54	8	45	94	9.60	18	4.6	7.3	20	43.3	
Beaumont-PA BPT NAM	37	16	53	9	46	95	9.10	18	5.2	6.9	27	37.2	
Corpus Christi CRP GFS	42	5	47	2	44	92	5.26	32	6.3	10.4	45	59.7	
Corpus Christi CRP NAM	42	3	45	1	43	93	3.03	27	5.8	10.7	48	61.7	
Brownsville-MA BRO GFS	34	6	40	6	40	92	6.79	36	1.7	8.4	18	47.6	
Brownsville-MA BRO NAM	34	3	37	3	37	92	3.03	67	2.3	8.1	36	47.2	
Laredo LRD GFS	31	4	35	1	32	92	6.07	24	2.9	6.5	14	39.0	
Laredo LRD NAM	31	4	35	1	32	98	5.26	9	4.6	8.1	40	48.4	
El Paso ELP GFS	38	3	41	1	39	80	3.03	53	8.1	8.4	46	49.4	
El Paso ELP NAM	38	5	43	4	42	82	3.03	69	6.3	5.0	61	28.0	

O3 Max=Upwind+EmFactor*(Tmp-Tb)*SRd/(WSa*0.1+WSp*0.5+1)



Summary/Forecast verification

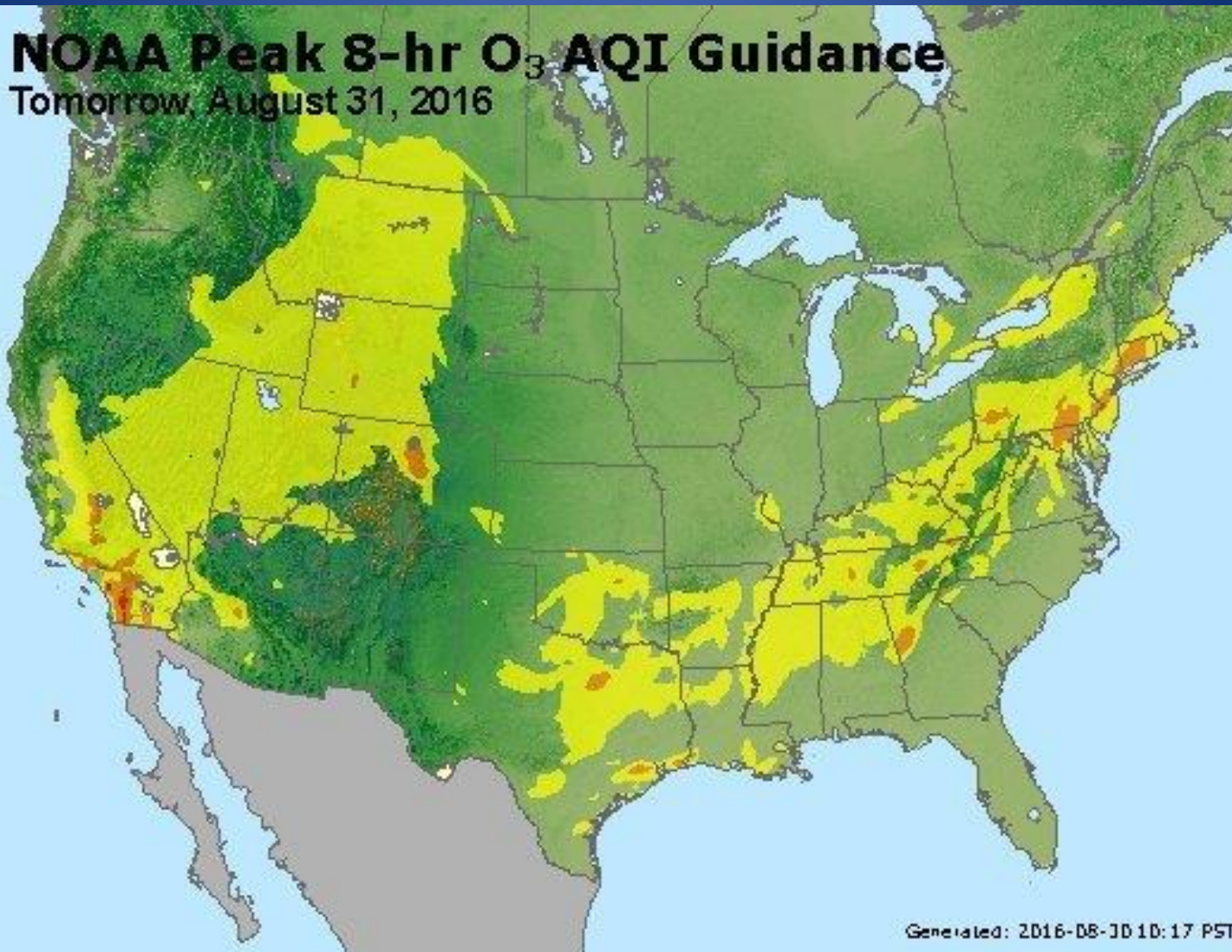
City	12Z NOAA model 8-hr ozone forecast for 8/31 (ppb)	12Z Regress. model 8-hr ozone forecast for 8/31 (ppb)	Monitored 8-hr ozone max conc. 8/31 (ppb)
Dallas-Fort Worth	83	78	
Houston	80	57	



8/30 – Op. NOAA 12Z Day 2

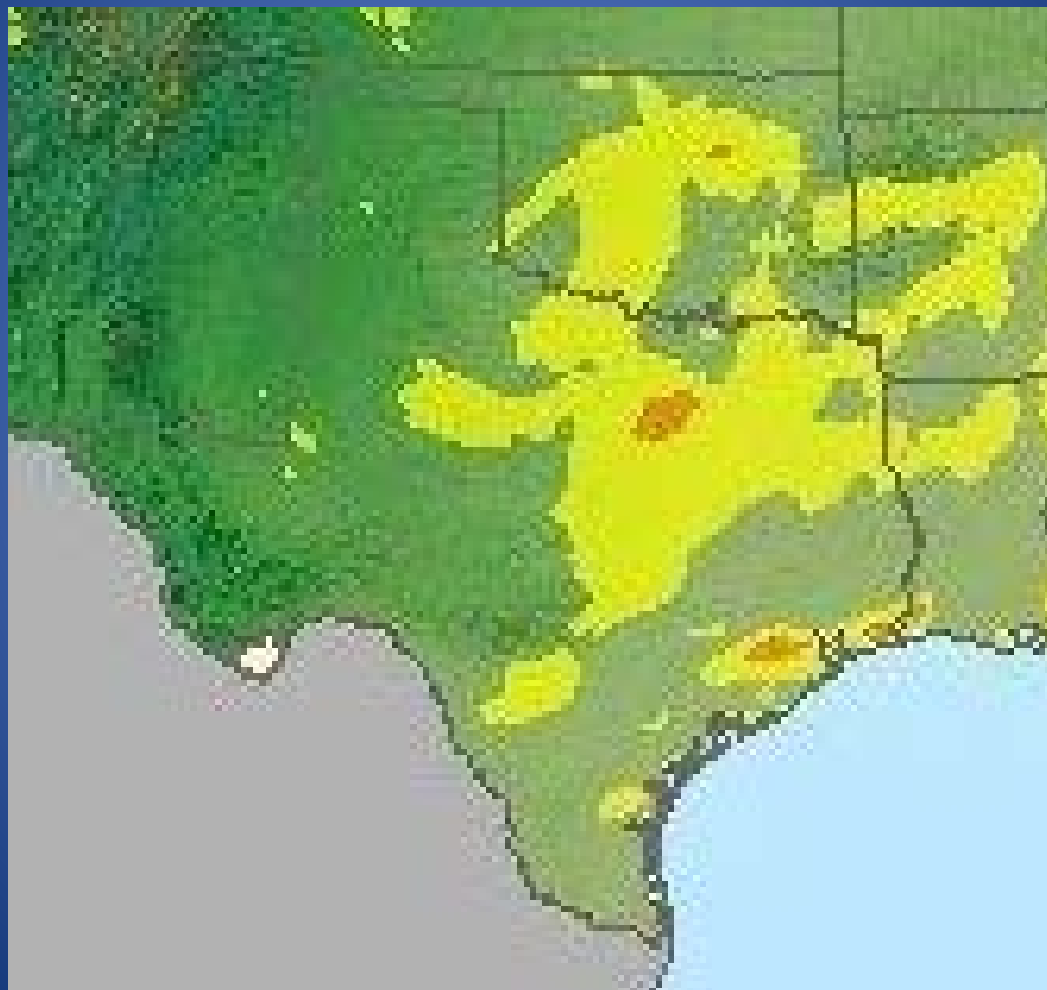
NOAA Peak 8-hr O₃ AQI Guidance

Tomorrow, August 31, 2016





8/30 – Op. NOAA 12Z Day 2





Observed 8/31



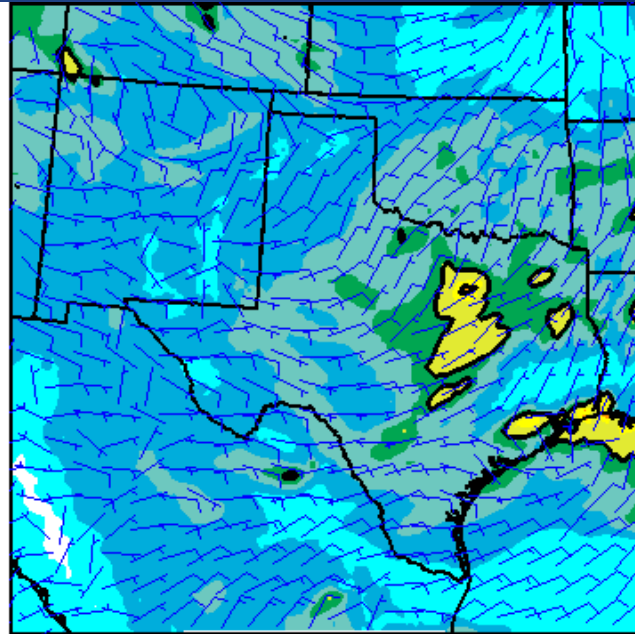
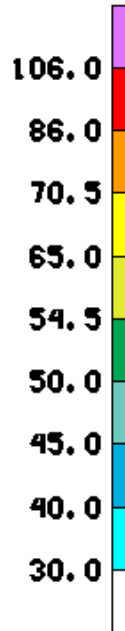


Summary/Forecast verification

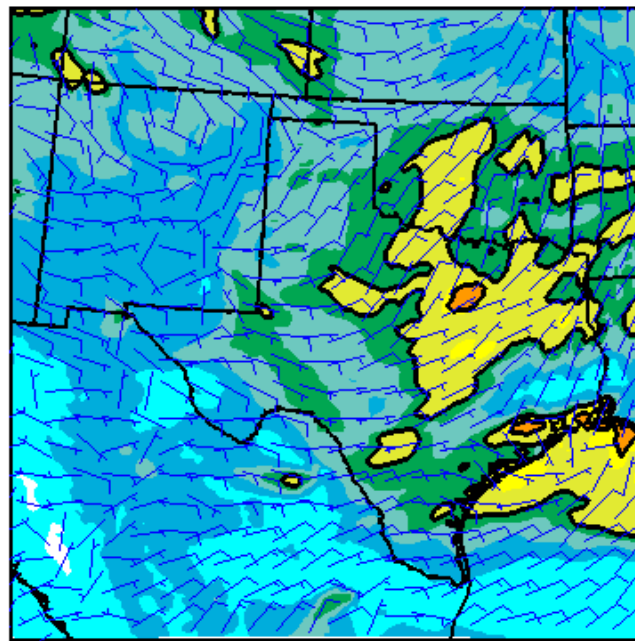
Region	12Z NOAA model 8-hr ozone forecast for 8/31 (ppb)	12Z Regress. model 8-hr ozone forecast for 8/31 (ppb)	Monitored 8-hr ozone max conc. 8/31 (ppb)
Dallas-Fort Worth	83	78	78
Houston	80	57	52



The Good News...



PARA2 CMAQ.V5.0.2 DAY2 OZMX08 20160830 12Z CYC



PROD DAY2 OZMX08 20160830 12Z CYC



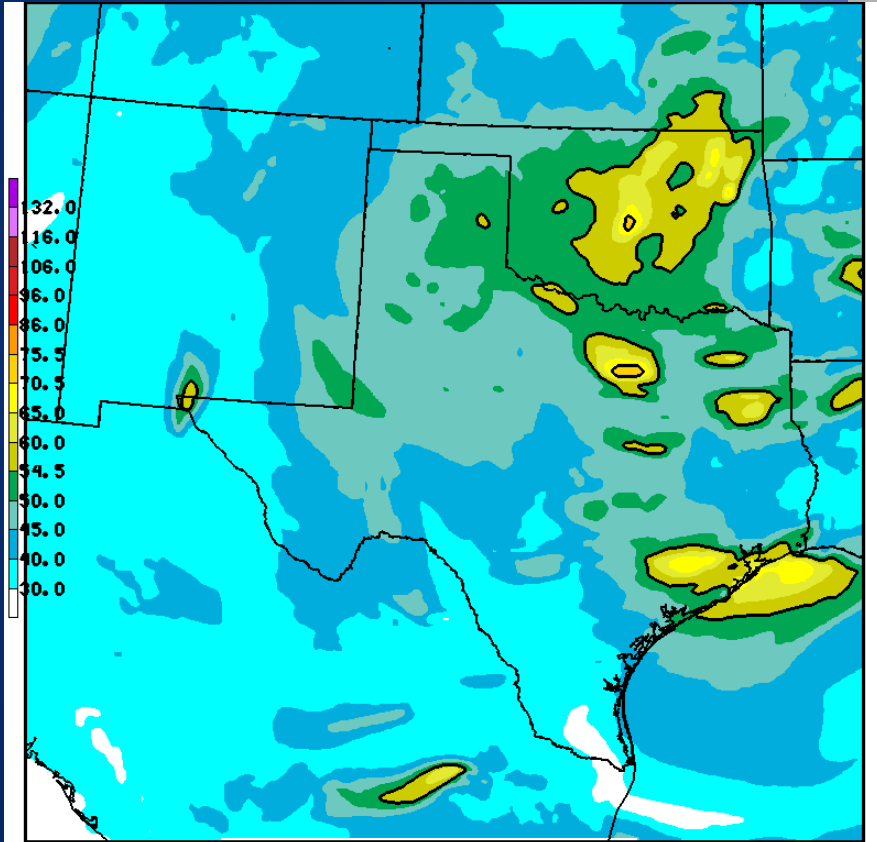
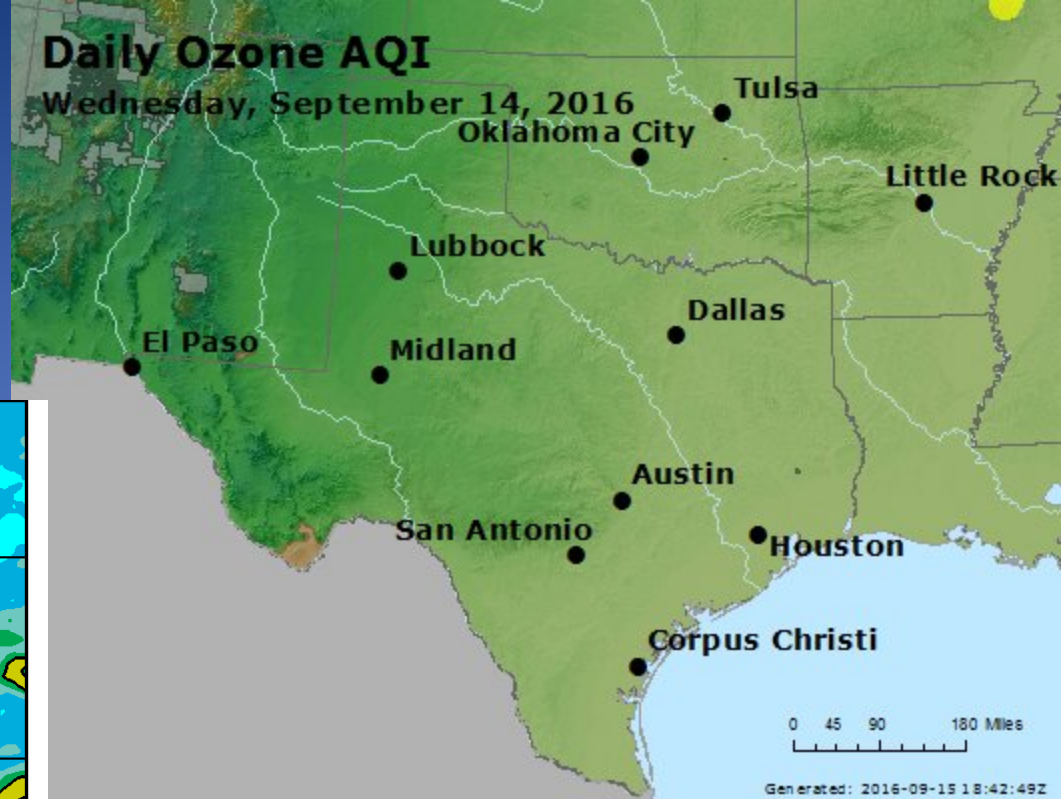
Observed 8/31





Daily Ozone AQI

Wednesday, September 14, 2016



PROD DAY2 OZMX08 0 20160913 12Z CYC*

9/14 Actual

9/13 NOAA Op. 12Z Day 2



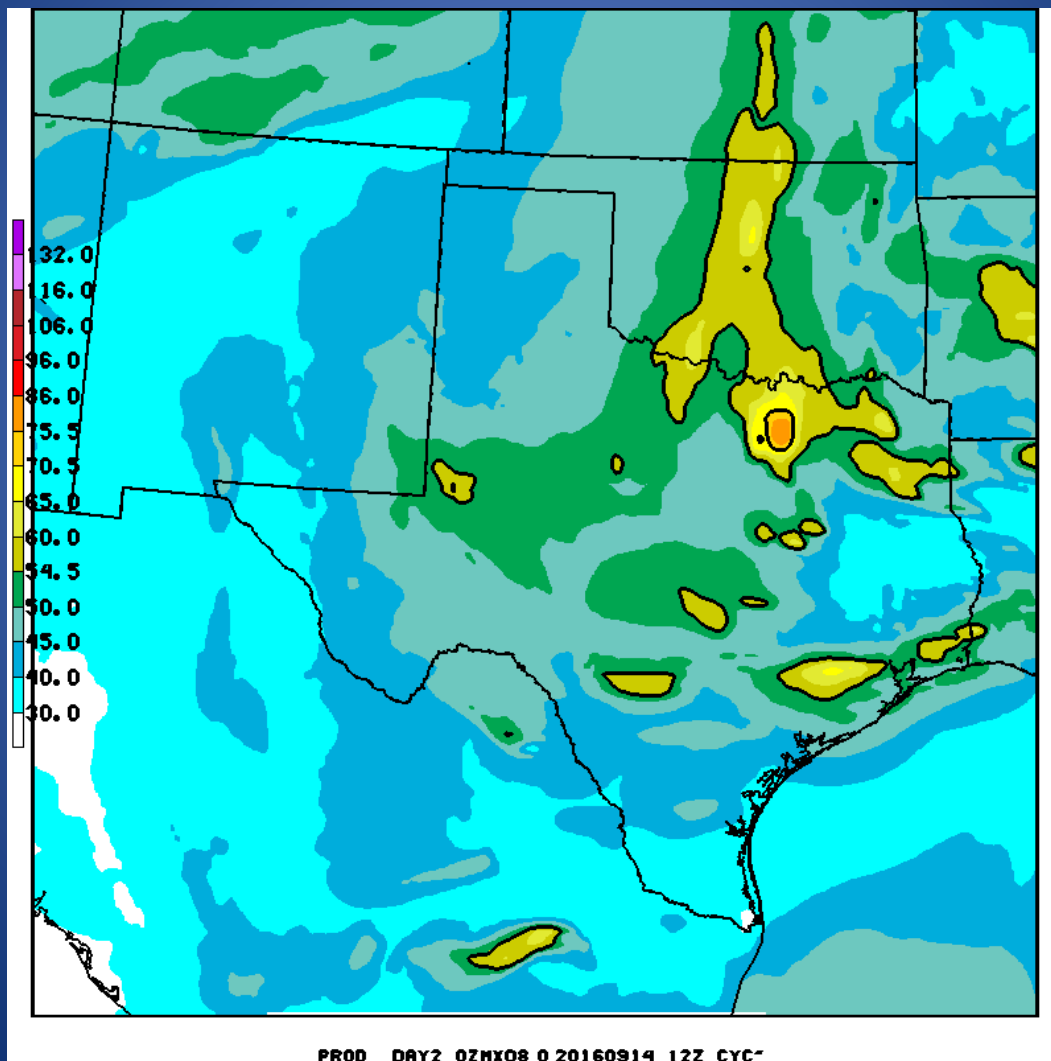
Wed, 9/14 – 12Z Day 2

NOAA O3	Adj O3	MxMdl	GFSX				NRL Aerosol Model				Adj						
			TMP	DPT	WND	P12	AOD	Sulfate	Dust	Smoke	O3fx	O3bgfx	PM2.5fx	PM10fx	O3fx	O3bgfx	PM2.5fx
80	73	52	85	68	7	26	0.05	1.5	0.0	3.0	51	32	11.0	#VA	54	34	12.5

O3 Max Model Day 2	09/15/16 Thu											
Forecast Summary	8-Hr O3 (ppb)					Fcst Tmp	Fcst SRd	Fcst Prec	WSA		Wind Vector	
	Upw Est	Forecast				Max	Sum	Prob	5-8	9-14	Sum 9-14	
		Add	Max	Na	Nmx				Avg	Avg	Dir	Dist
Houston IAH GFS	25	16	41	14	39	90	6.49	28	4.6	10.0	91	56.2
Houston IAH NAM	25	17	42	17	42	92	5.51	37	2.9	8.4	68	45.6
Houston HOU GFS	25	14	39	13	38	90	5.35	26	5.2	9.2	81	53.2
Houston HOU NAM	25	16	41	16	41	91	5.51	37	4.0	8.4	67	47.6
Dallas-FW DFW GFS	34	15	49	15	49	91	5.95	26	3.5	5.8	127	33.7
Dallas-FW DFW NAM	34	20	54	20	54	92	5.51	19	2.9	3.5	108	19.8



9/14 – NOAA 12Z Day 2





Observed 9/14





Thank you!

Contact info:

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