Model Performance Evaluation Using TOPAZ Data

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Southeast Texas Photochemical Modeling Technical Committee Meeting

November 20, 2008

CAMx Ozone Modeling in SIP Development

The Big Picture

Base Case	Day-specific meteorology and emissions; replicate what actually happened
Baseline Case	Day-specific meteorology and Typical emissions; used in RRF to predict future design values
Future Base Case	Apply future growth + on-the-books controls to estimate future ozone
Control Strategy Testing	Determine control strategies that will effectively reduce ozone
SIP	Document modeling procedures

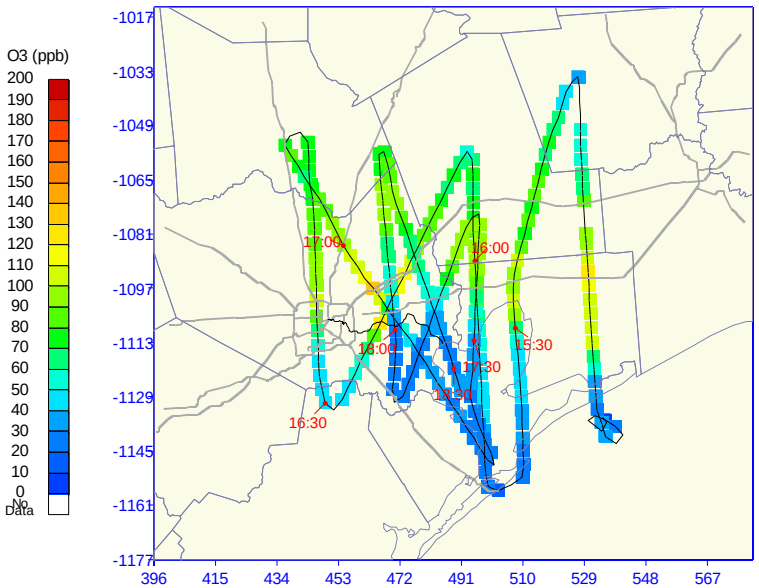
TOPAZ: Tunable Optical Profiler for Aerosol and oZone lidar

Downward-looking LiDAR flown on NOAA's Twin Otter During TexAQS-II

August 15, 2006

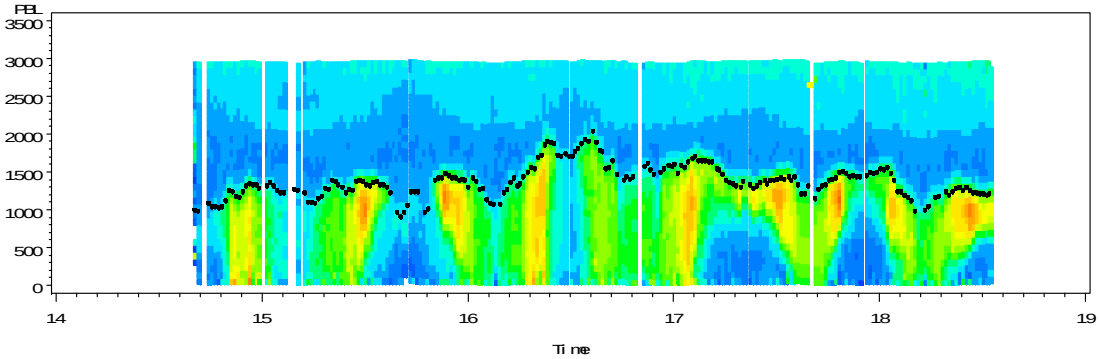
TOPAZ Measured Ozone Mixing Ratio (ppb)

Model Layer 5 (255-377 M AGL) 08/15/2006



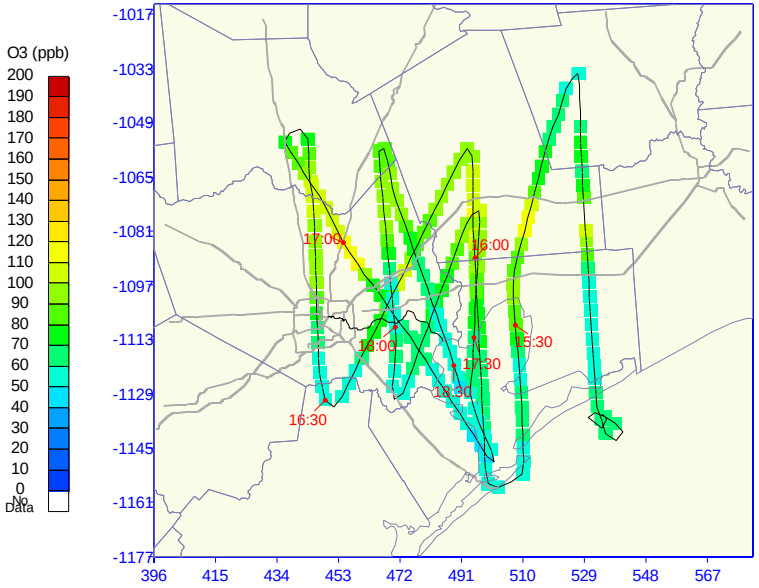
TOPAZ Measured Ozone Mixing Ratio (ppb) and PBL (m)

08/ 15/ 2006



CAMx Reg8_PSCFV2 Modeled Ozone Mixing Ratio (ppb)

Model Layer 5 (255-377 M AGL) 08/15/2006



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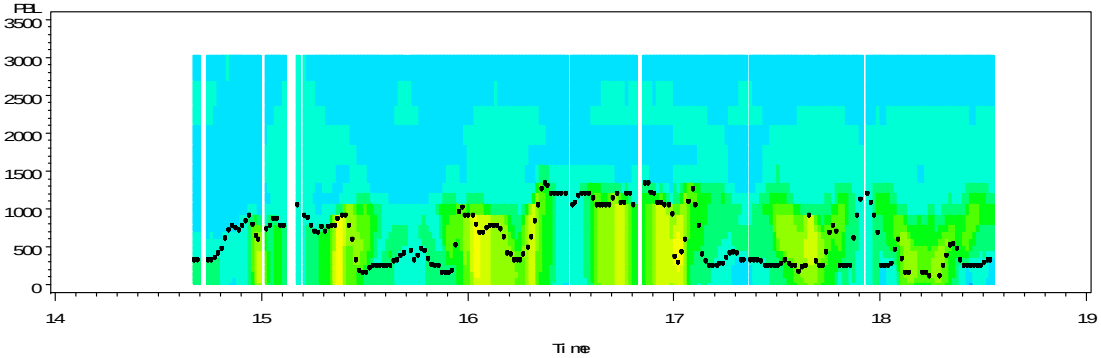
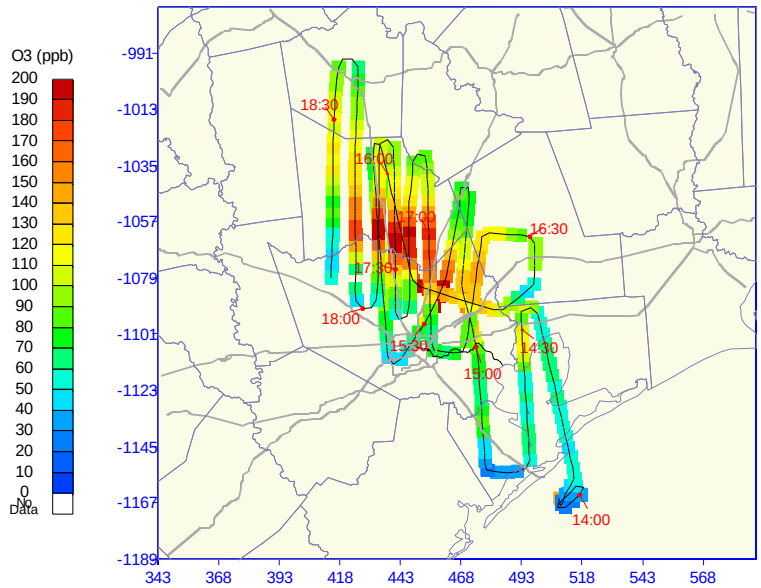


August 16, 2006

TOPAZ Measured Ozone Mixing Ratio (ppb)

Model Layer 5 (255-377 M AGL) 08/16/2006



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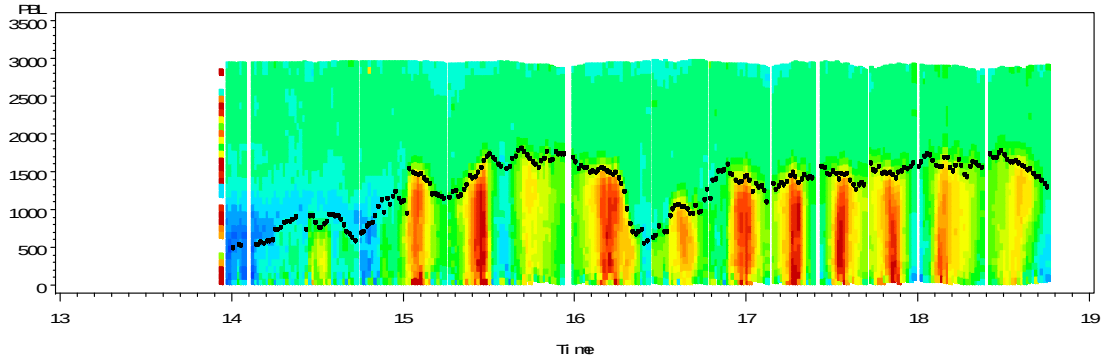

CAMx Reg8_PSCFV2 Modeled Ozone Mixing Ratio (ppb)

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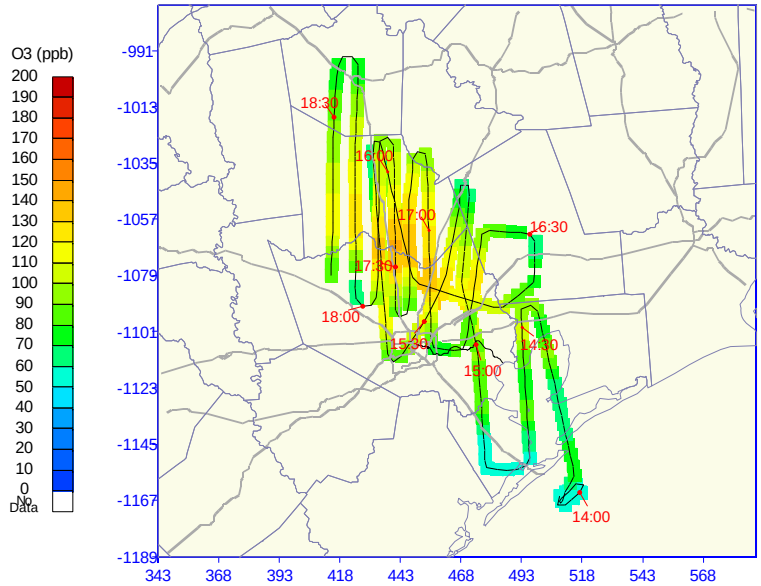

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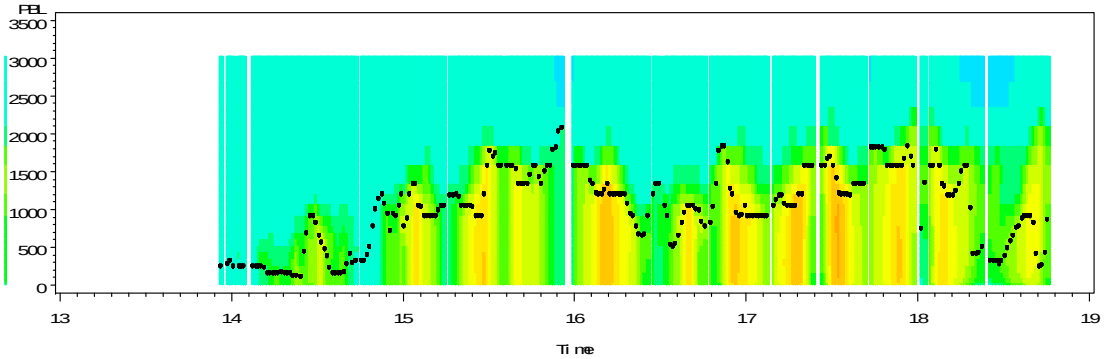
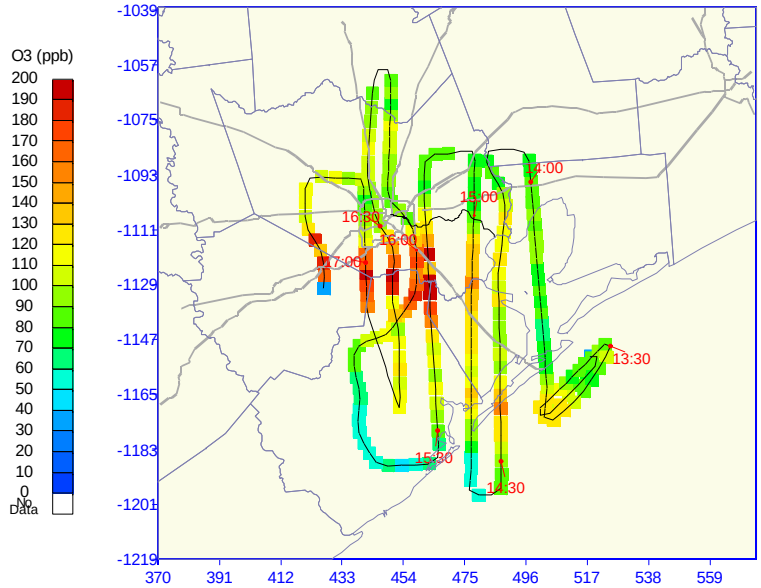


August 17, 2006

TOPAZ Measured Ozone Mixing Ratio (ppb)

Model Layer 5 (255-377 M AGL) 08/17/2006



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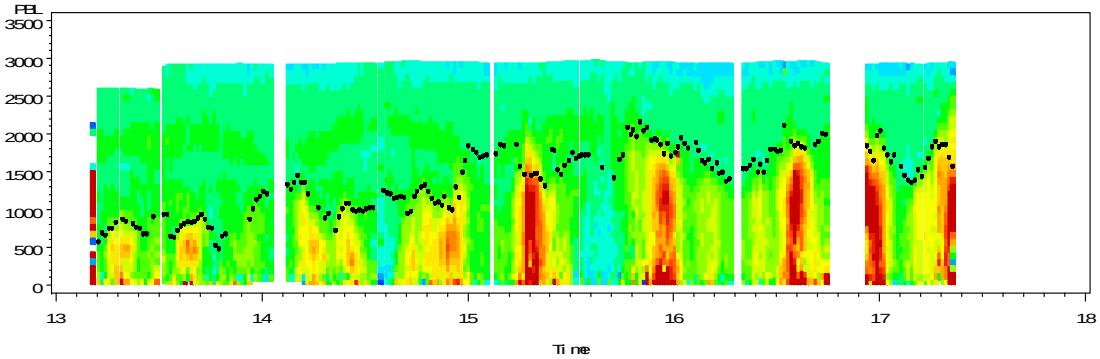

CAMx Reg8_PSCFV2 Modeled Ozone Mixing Ratio (ppb)

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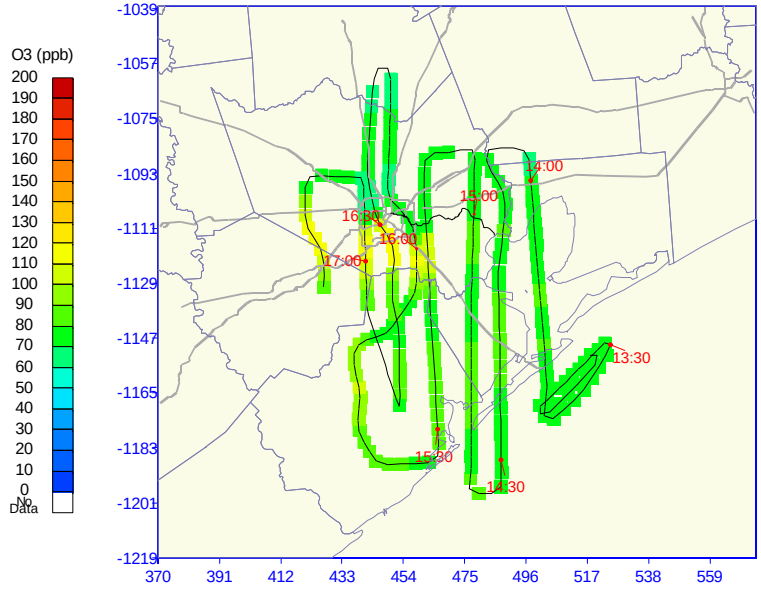

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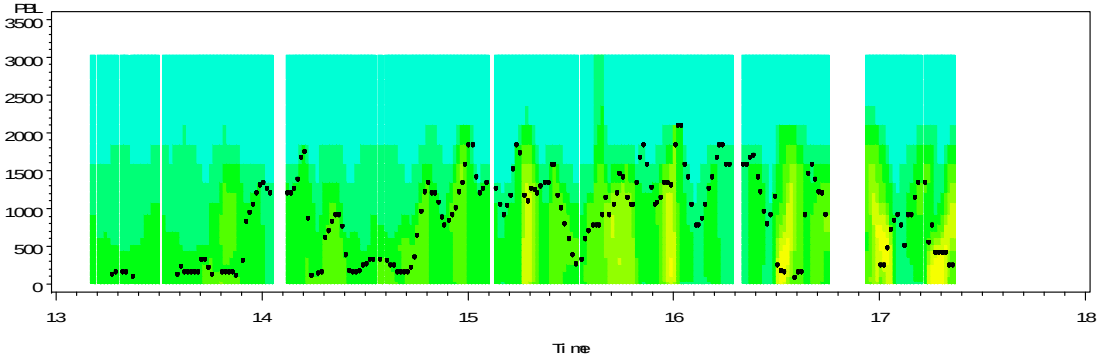
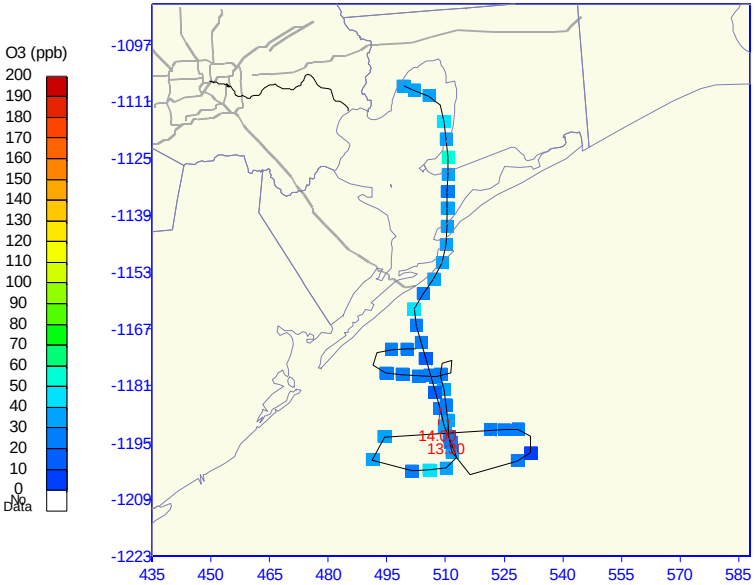


August 28, 2006

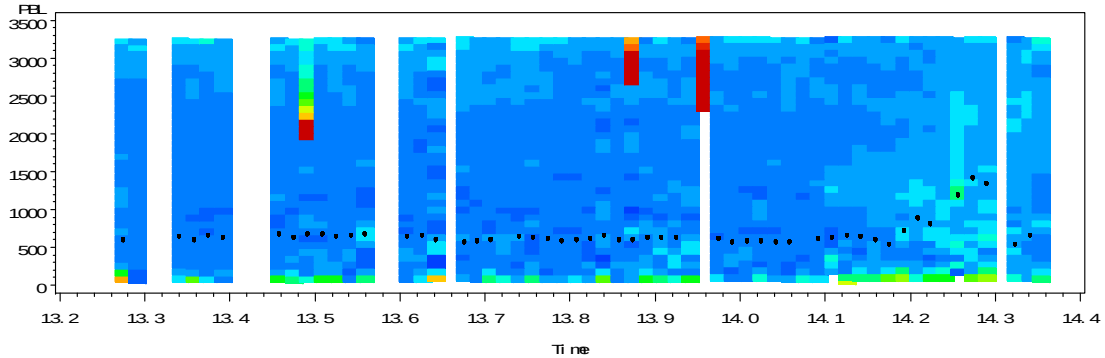
TOPAZ Measured Ozone Mixing Ratio (ppb)

Model Layer 5 (255-377 M AGL) 08/28/2006



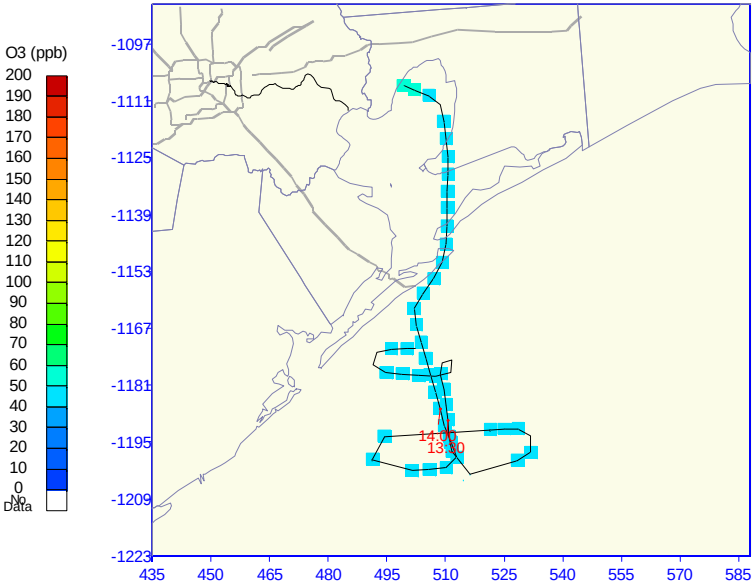
TOPAZ Measured Ozone Mixing Ratio (ppb) and PBL (m)

08/28/2006



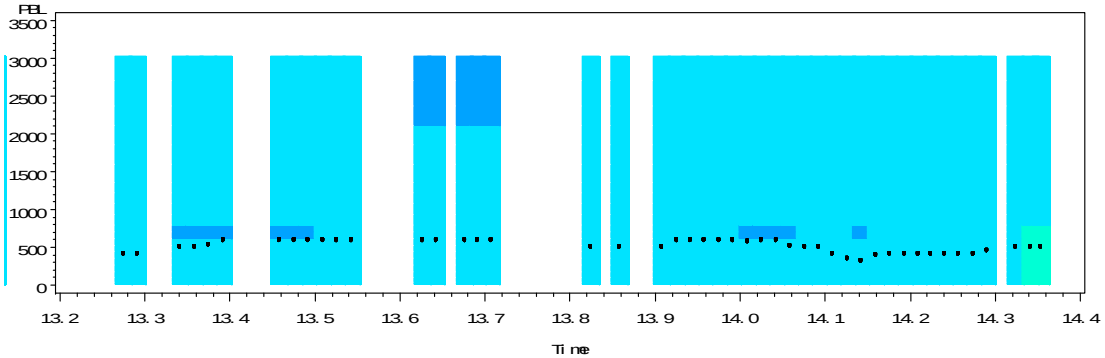
CAMx Reg8_PSCFV2 Modeled Ozone Mixing Ratio (ppb)

Model Layer 5 (255-377 M AGL) 08/28/2006



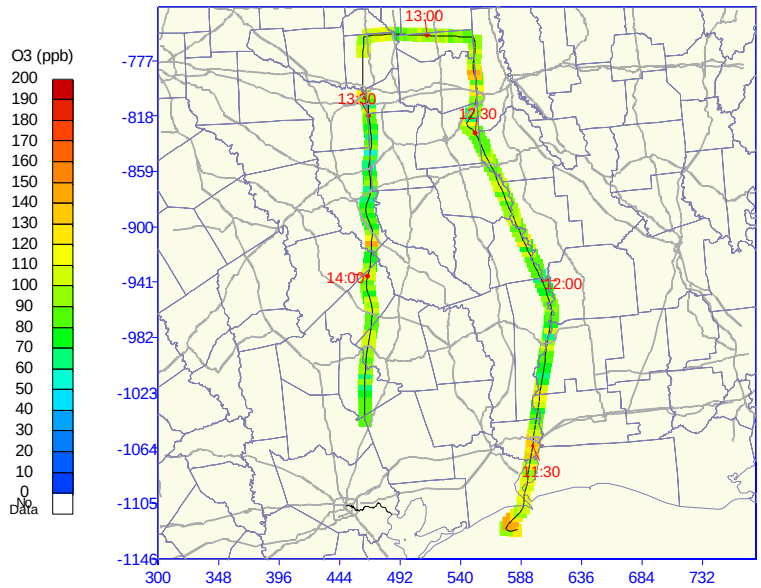
CAMx Modeled Ozone Mixing Ratio (ppb) and PBL (m)

08/28/2006

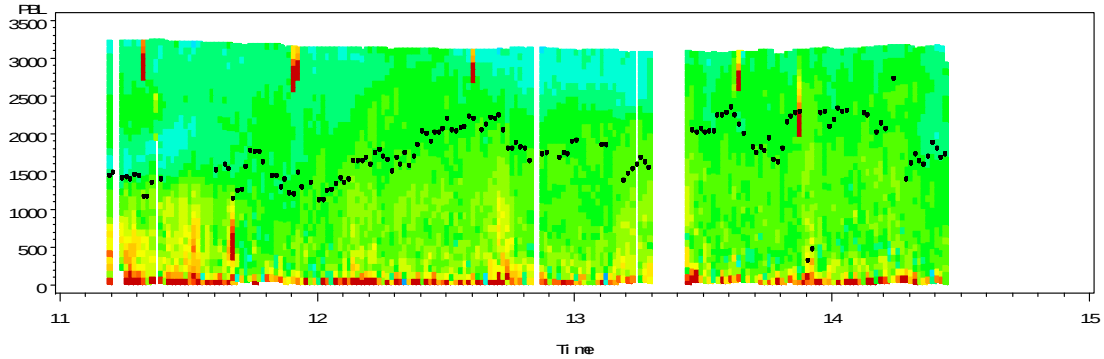


September 8, 2006

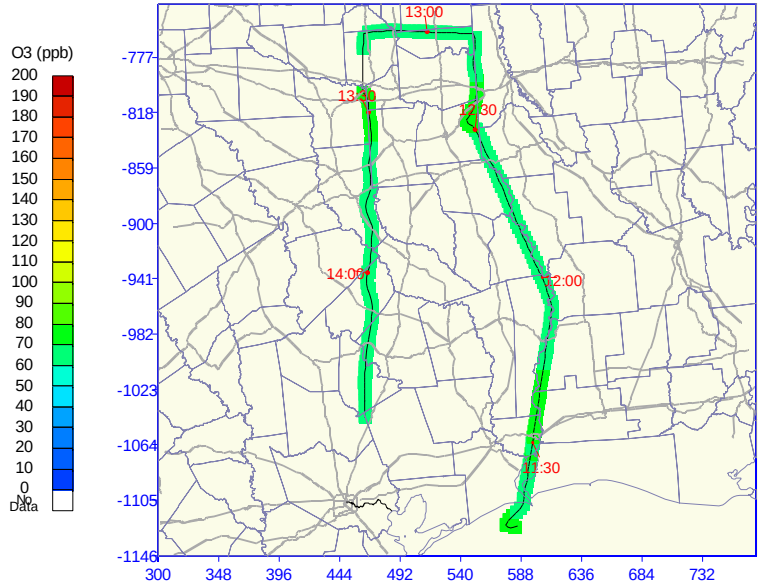
TOPAZ Measured Ozone Mixing Ratio (ppb)
Model Layer 5 (255-377 M AGL) 09/08/2006



TOPAZ Measured Ozone Mixing Ratio (ppb) and PBL (m)
09/08/2006



CAMx Reg8_PSCFV2 Modeled Ozone Mixing Ratio (ppb)
Model Layer 5 (255-377 M AGL) 09/08/2006



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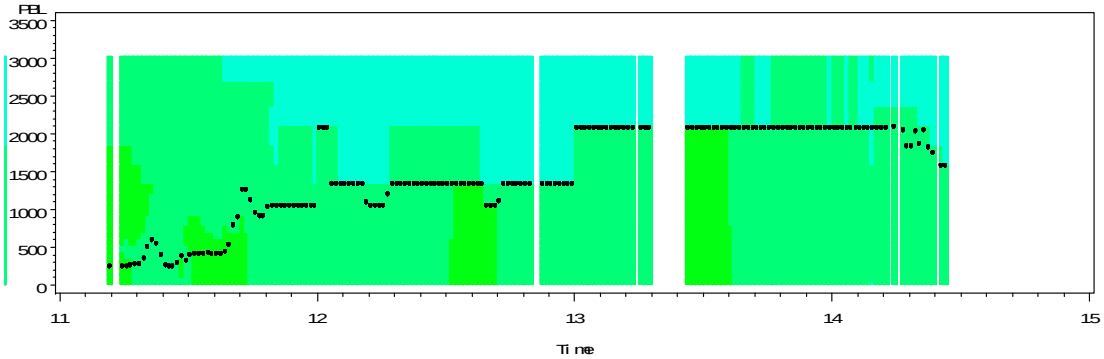

Case Study: August 31, 2006

Episode Date	ONE HOUR					EIGHT HOUR					Auxilliary Measurements	
	Data Pair of Observation > 60.0 ppb		Area-wide Maximum Ozone			Site Daily Maximum		Area-wide Maximum Ozone				
	Normalized Bias	Normalized Gross Error	Accuracy	Modeled	Observed	Normalized Bias	Normalized Gross Error	Accuracy	Modeled	Observed	P3?	TOPAZ?
	±(5-15)%	(30-35)%	±(15-20)%	ppb	ppb	-	-	±(15-20)%	ppb	ppb		
8/15/2006	9.9	20.3	9.8	120.8	110	56.1	56.8	31.2	94.9	72.4		X
8/16/2006	4.7	17.5	-1.9	139.2	141.9	39	40.3	5.5	100.7	95.5		X
8/17/2006	-4.2	16.1	-16	133.5	158.9	4.4	11.7	-1.4	112.1	113.6		X
8/18/2006	7.4	18.6	21.2	129.4	106.8	29.1	29.2	10.1	98.7	89.7		
8/19/2006	-6.8	16.2	15.2	80.7	70	19.3	19.7	30.5	67.4	51.6		
8/20/2006	-6.6	20.1	8	116.1	107.5	14.8	18.3	8.2	81.7	75.5		
8/21/2006	15.5	21	23.5	126.6	102.5	57.8	57.8	20.9	89.1	73.7		
8/22/2006	20.7	23.4	45.8	137.1	94	40	40	42	101.1	71.2		X
8/29/2006	-2.8	11.5	3.4	107.3	103.8	21.7	24	12.3	88.9	79.2		
8/30/2006	-7.4	8.7	-2.4	93.2	95.4	-1.2	6.7	1.6	82.1	80.8		X
8/31/2006	-18.9	19.4	-26.8	108.2	147.7	-13.6	17	-25.6	94.6	127.1	X	X
9/1/2006	-9.3	14.6	-20	128.8	161	-10.2	13.2	-18.2	105.6	129		X
9/2/2006	2.6	8.9	16.4	105.5	90.6	7.7	10.4	7.9	90.4	83.7		
9/3/2006	13.8	15.1	-5.7	101.6	107.8	27.4	27.6	0.3	88.9	88.6		
9/4/2006	-0.8	8.1	-3	98.4	101.4	30.4	31.9	7.4	85.7	79.8		X
9/5/2006	4.2	12.3	6.5	87.6	82.3	50.6	50.6	18.2	75.5	63.9		
9/6/2006	-13.5	14.5	-8	93.1	101.2	-9.5	11.4	-2.9	85.4	87.9		
9/7/2006	-13.7	15.9	-26.4	113	153.4	-12.5	13.8	-12	97.2	110.5		X
9/8/2006	6.2	11.5	6.9	109	102	10.3	12	10.6	89.6	81.1		X
9/12/2006	30.2	34.8	66.2	138.4	83.3	78	78	65.9	116.1	70		
9/13/2006	1.4	10.3	-2.4	107.1	109.7	13.8	14.4	9.1	97.1	89	X	
9/14/2006	1.6	10.3	-19.7	132.6	165.1	5.5	11.3	-12	104.6	118.9		

August 31, 2006

TOPAZ Measured Ozone Mixing Ratio (ppb)
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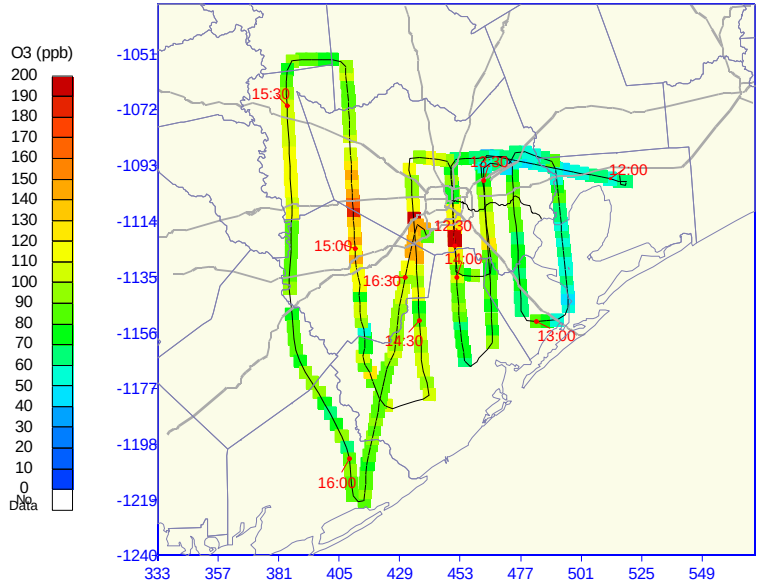
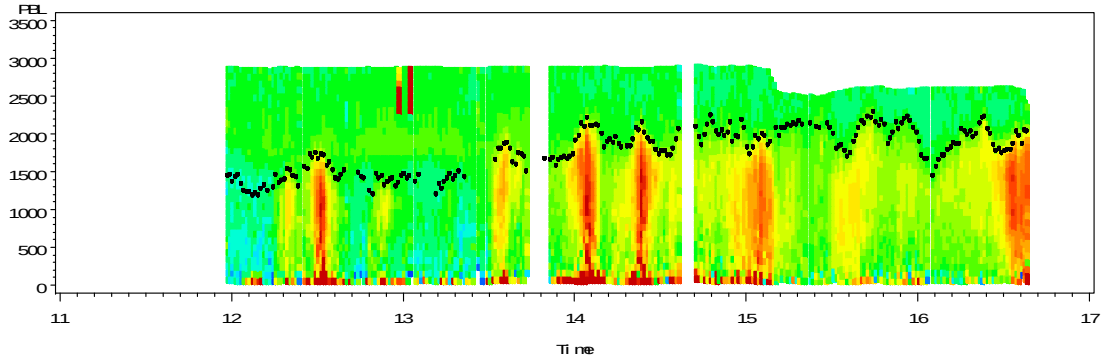
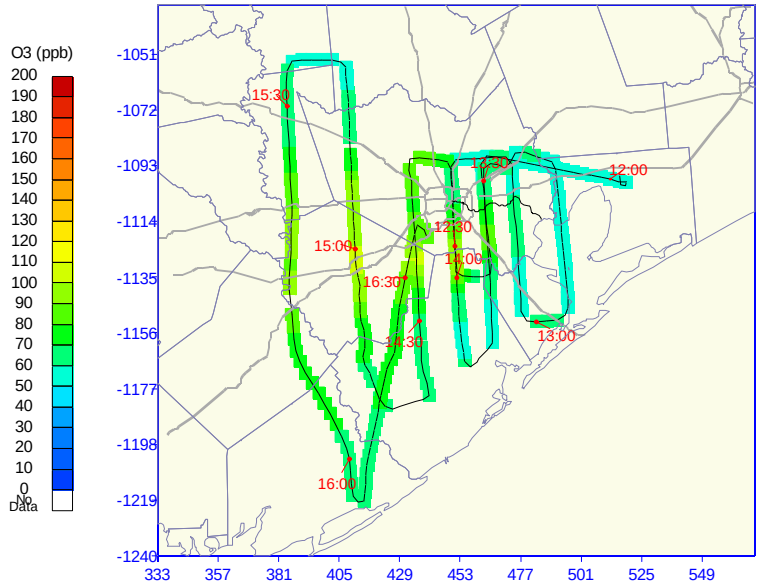


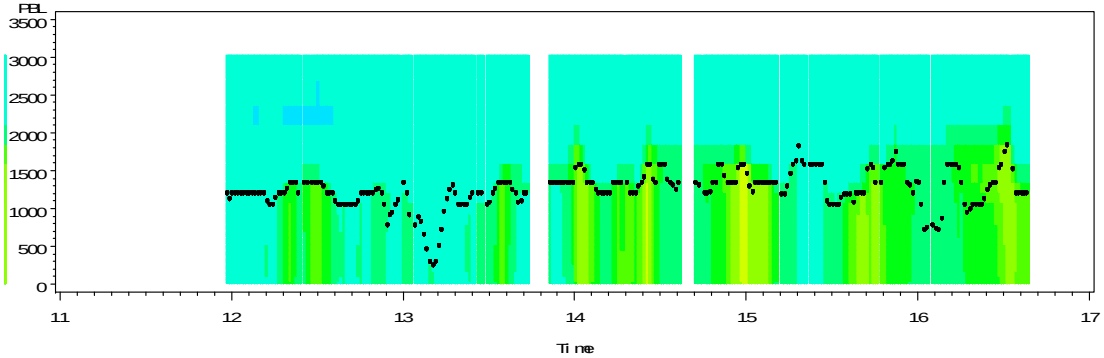
TOPAZ Measured Ozone Mixing Ratio (ppb) and PBL (m)
08/31/2006



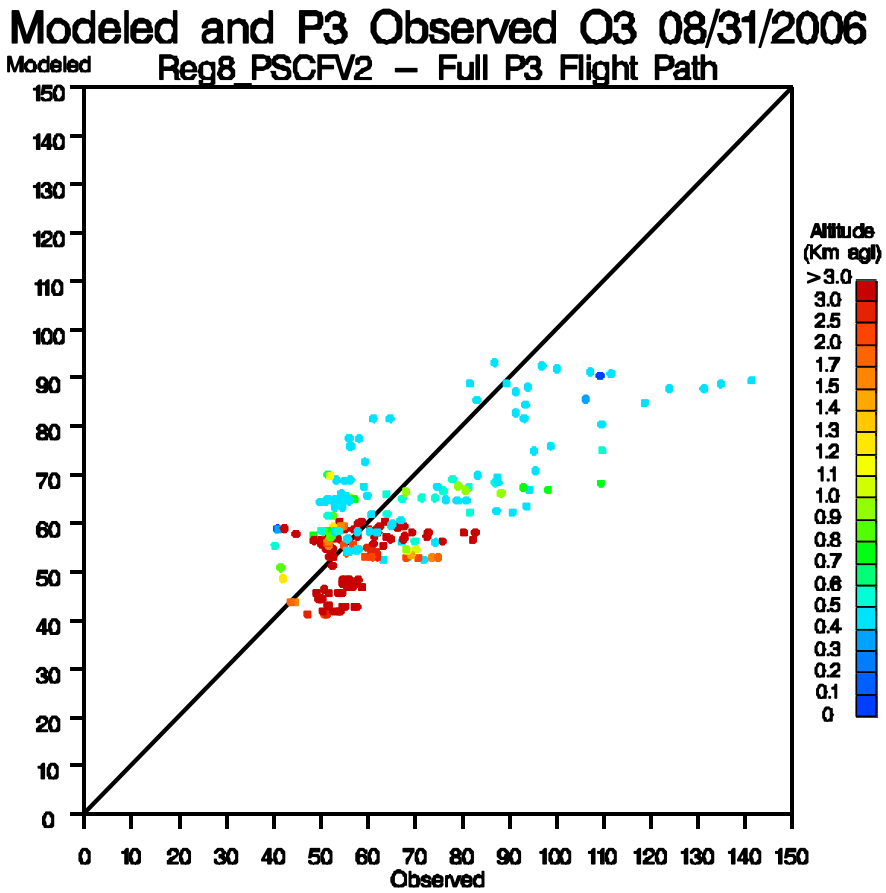
CAMx Reg8_PSCFV2 Modeled Ozone Mixing Ratio (ppb)
Model Layer 5 (255-377 M AGL) 08/31/2006



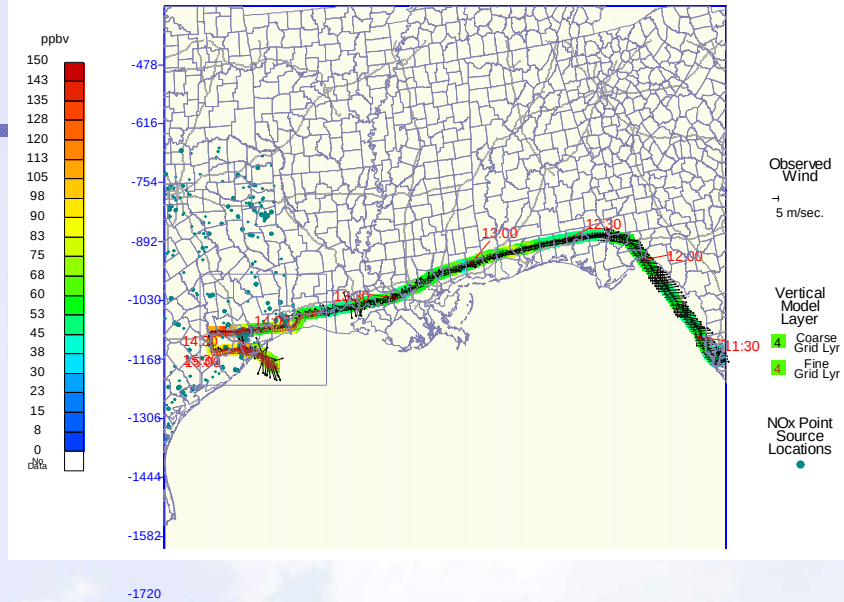
CAMx Modeled Ozone Mixing Ratio (ppb) and PBL (m)
08/31/2006



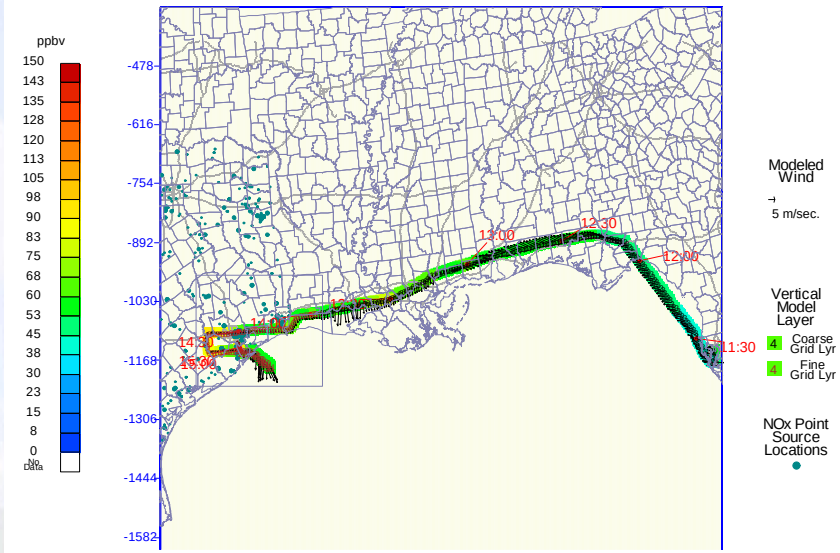
8/31/06 P3 Measured & CAMx Modeled O_3 Mixing Ratios, full flight path



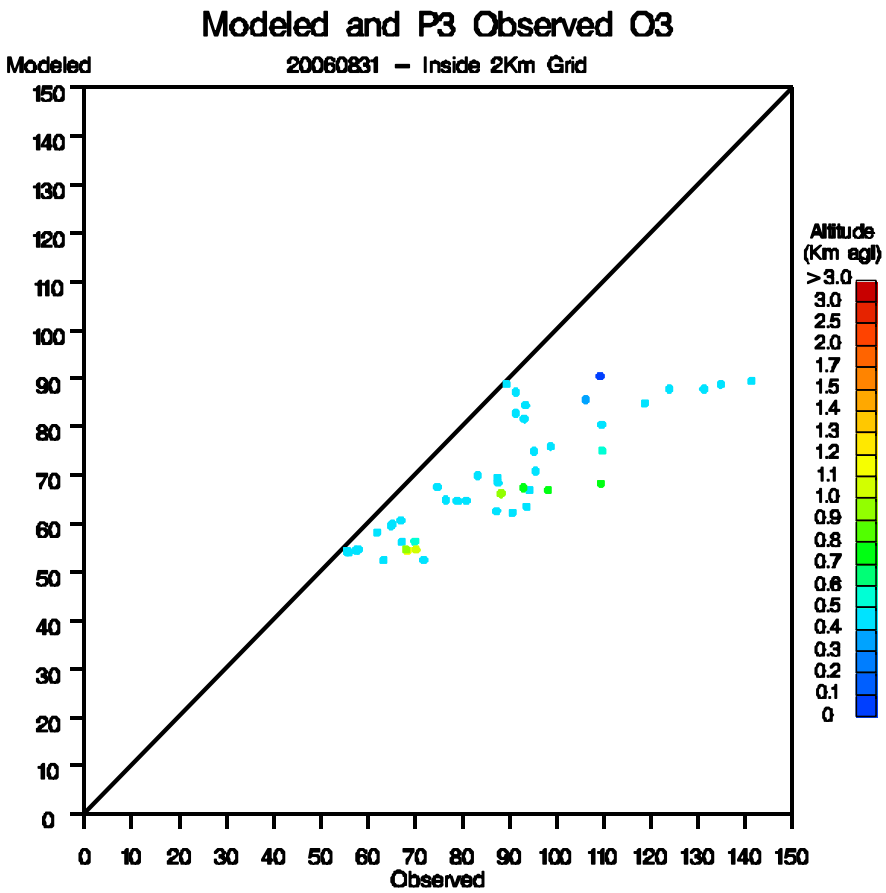
NOAA P3 Measured O3 Mixing Ratio
08/31/2006

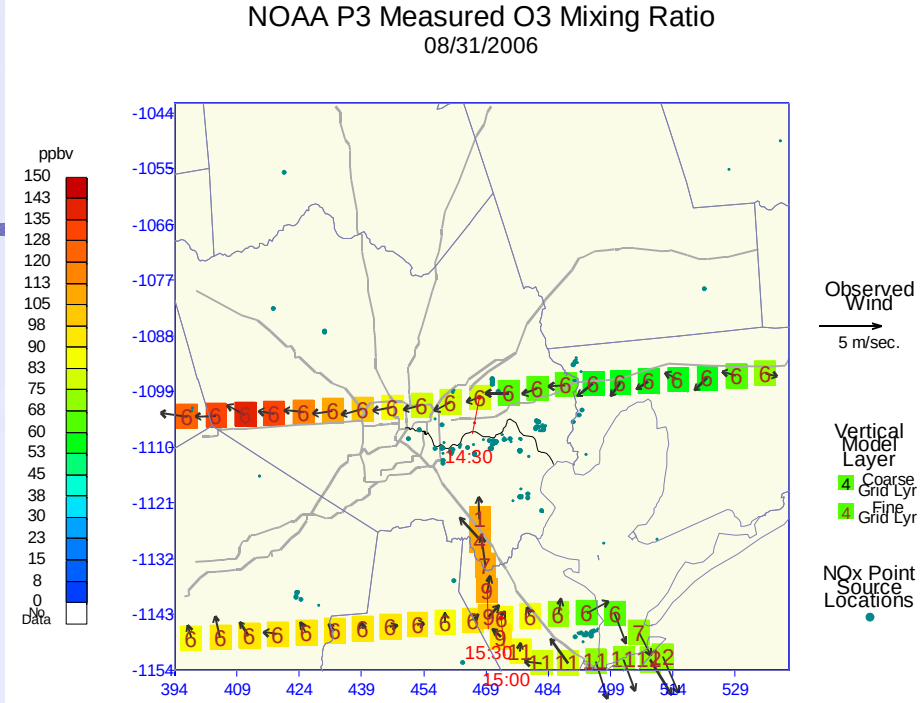


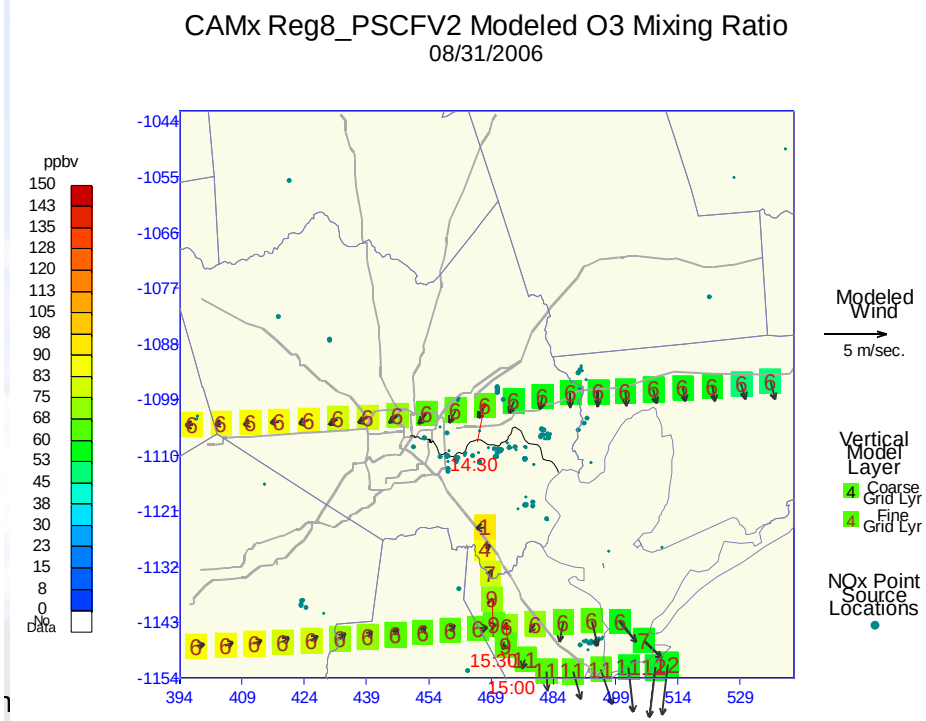
CAMx Reg8_PSCFV2 Modeled O3 Mixing Ratio
08/31/2006



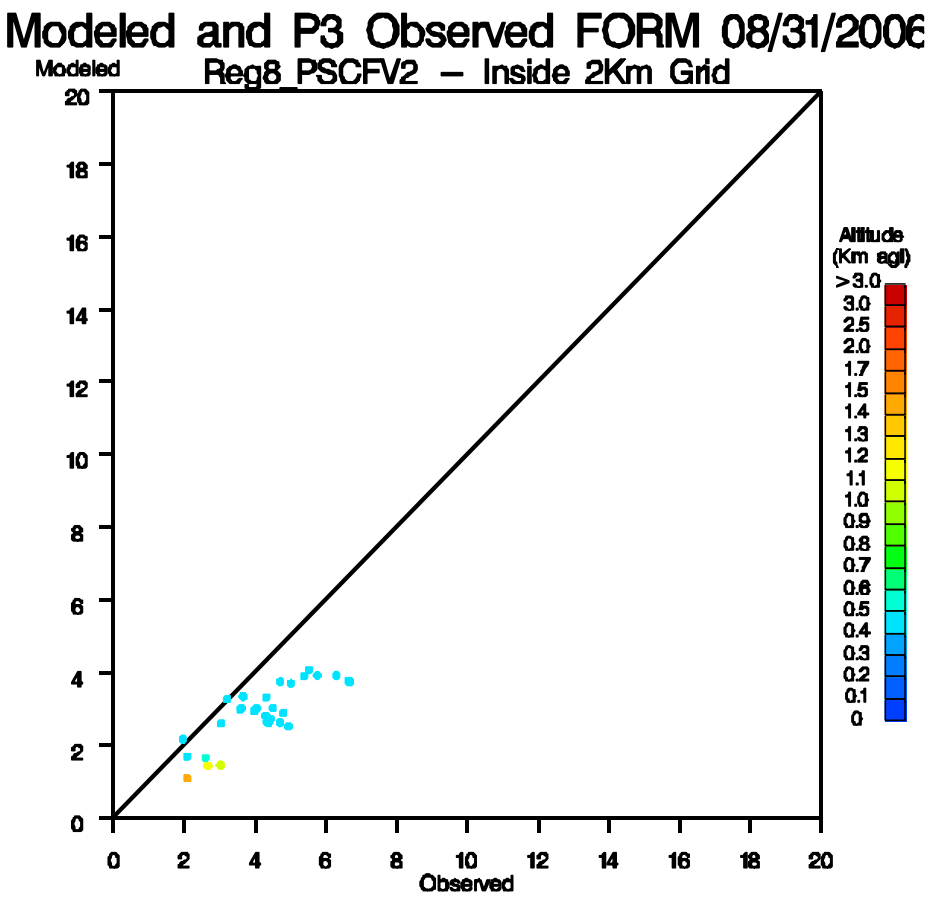
8/31/06 P3 Measured & CAMx Modeled O_3 Mixing Ratios inside the HG 2 Km Grid



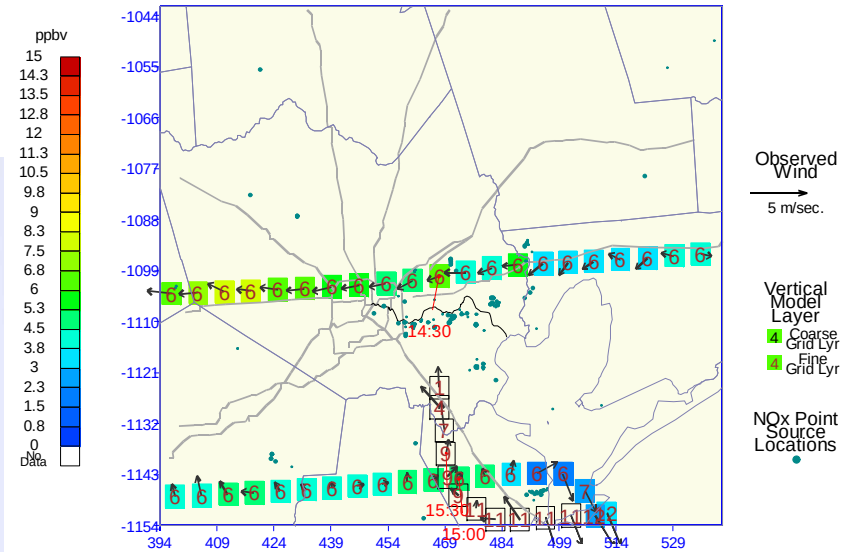




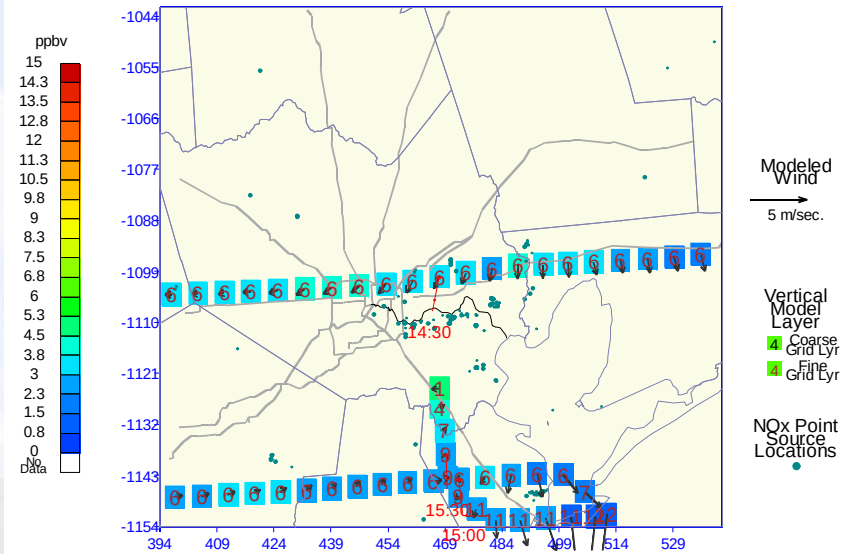
8/31/06 P3 Measured & CAMx Modeled Formaldehyde Mixing Ratios inside the HG 2 Km Grid



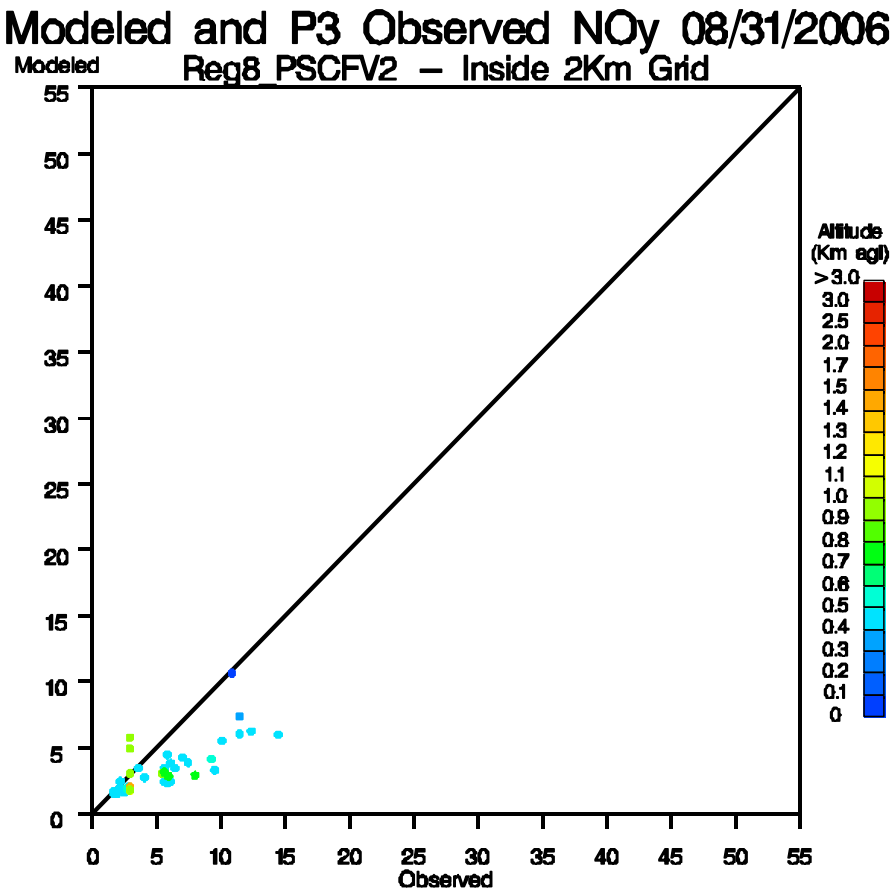
NOAA P3 Measured FORM Mixing Ratio
08/31/2006

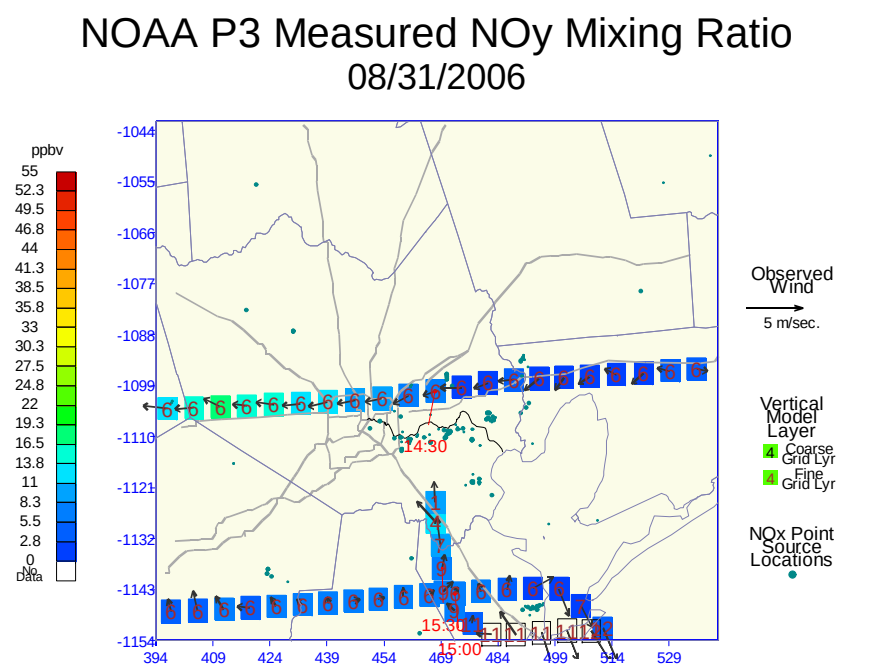


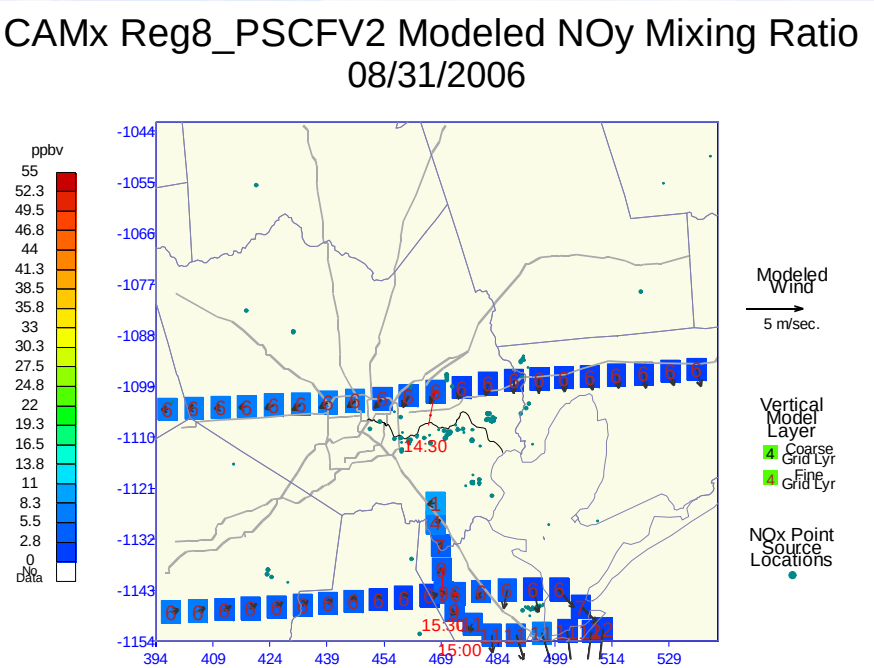
CAMx Reg8_PSCFV2 Modeled FORM Mixing Ratio
08/31/2006



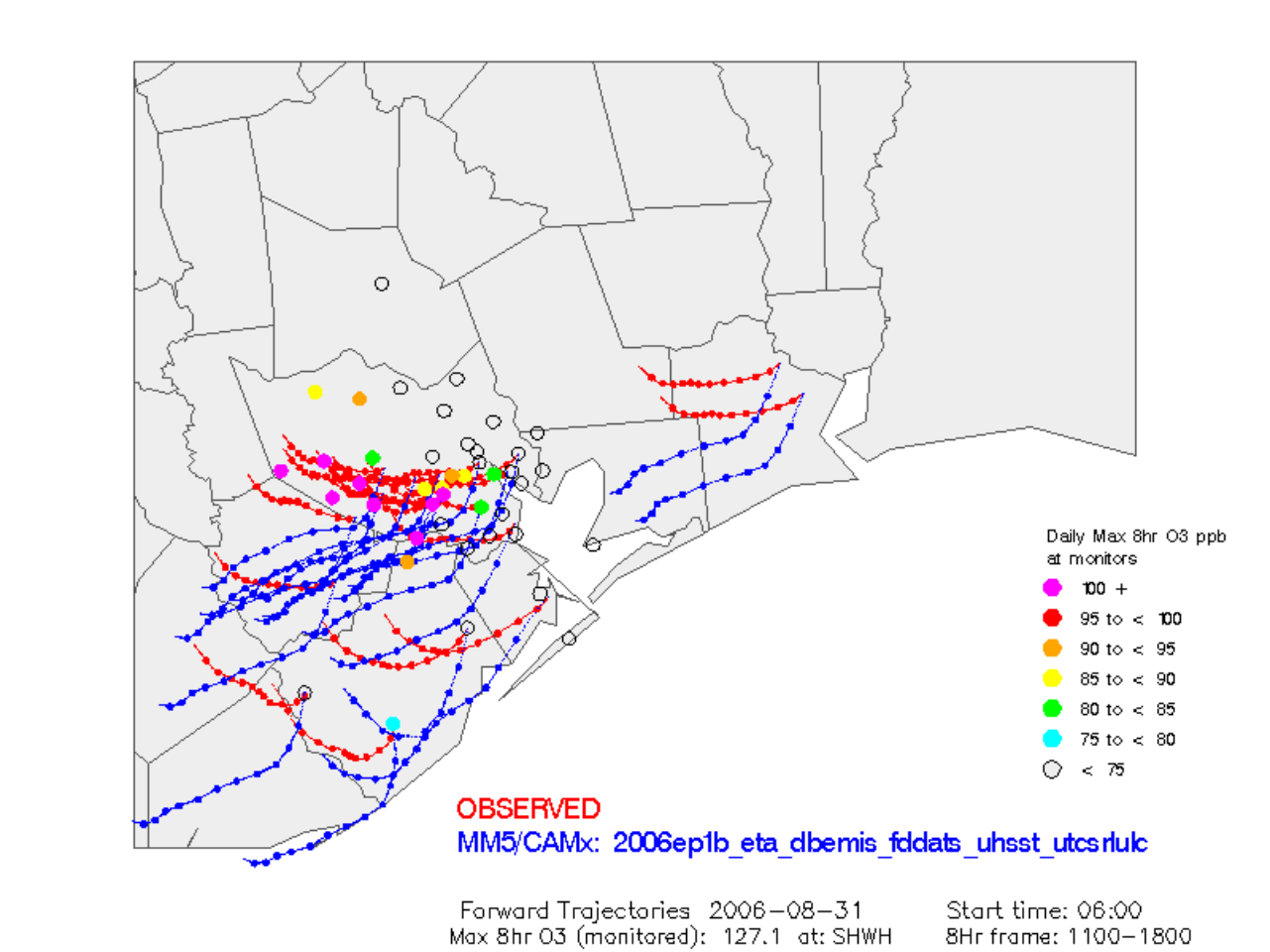
8/31/06 P3 Measured & CAMx Modeled NO_Y Mixing Ratios inside the HG 2 Km Grid



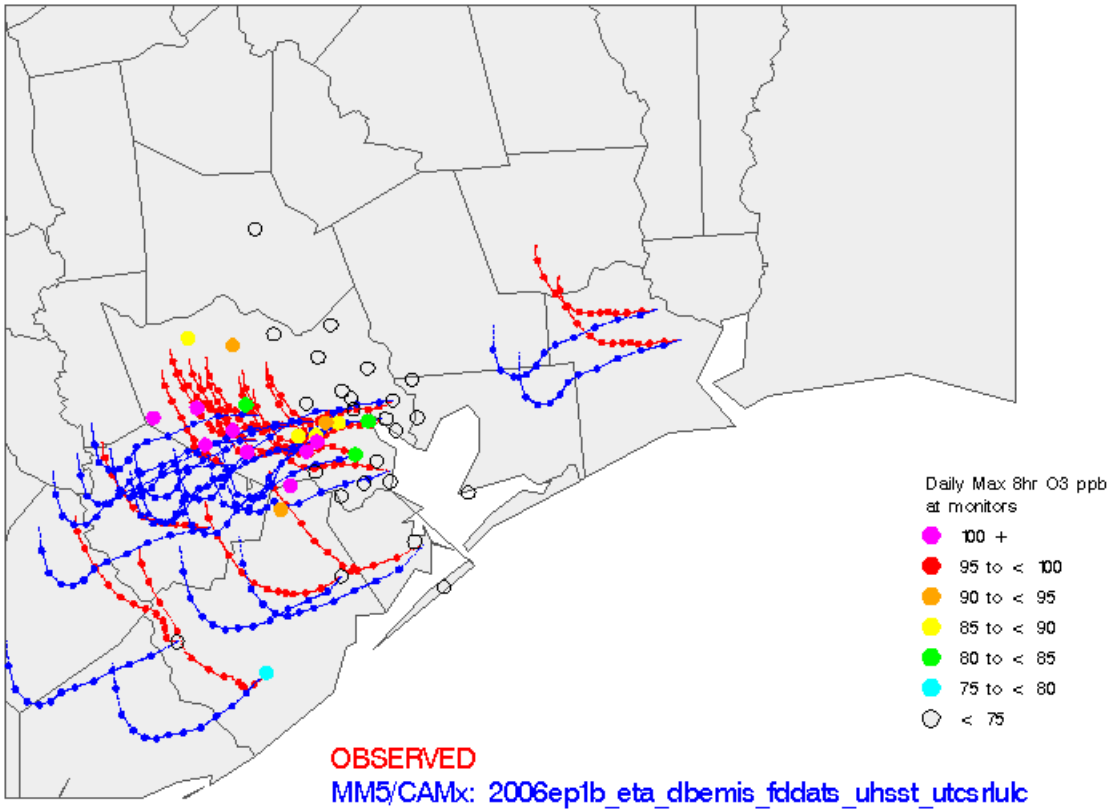




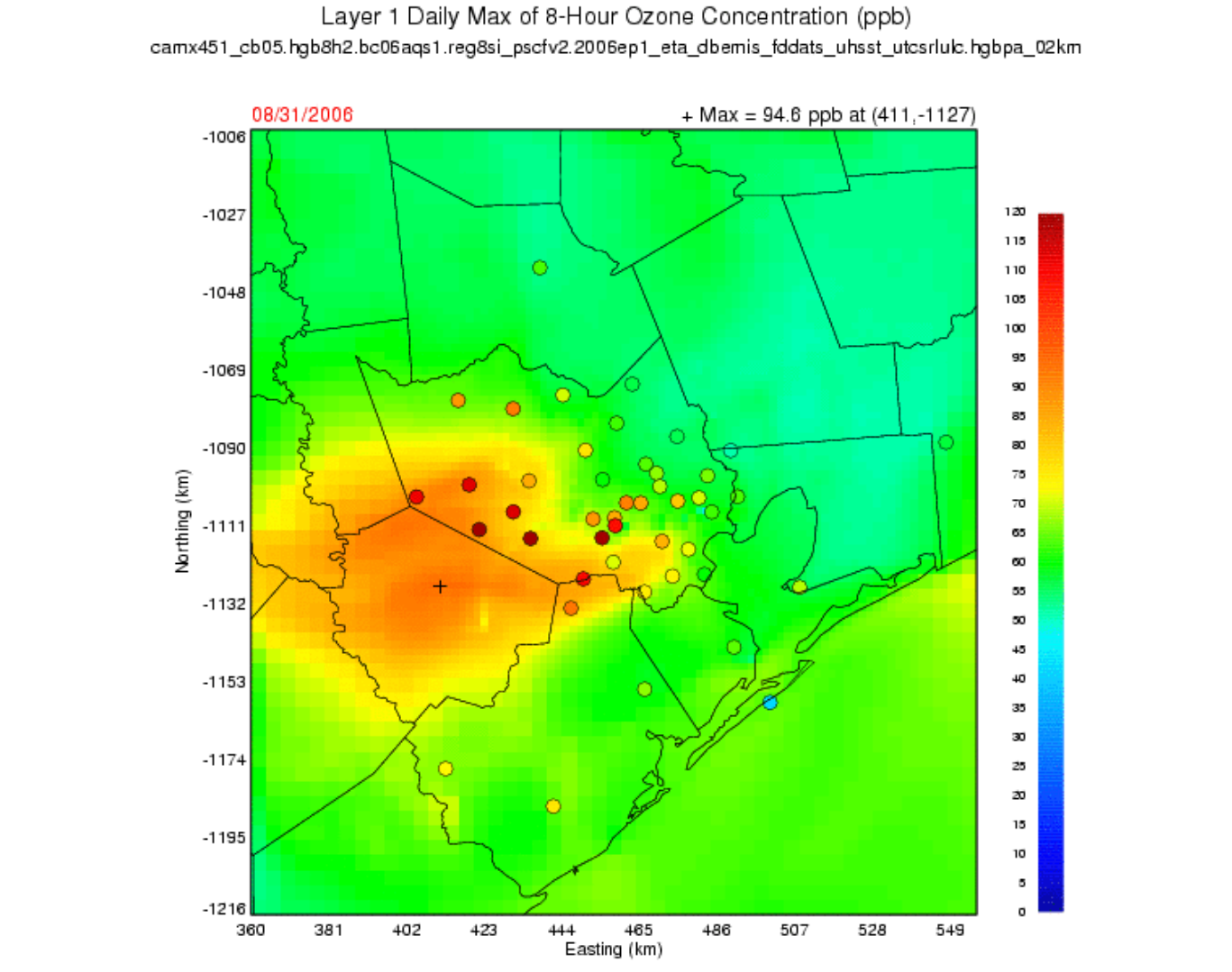
6 AM Forward Trajectory (12 Hours), August 31, 2006



9 AM Forward Trajectory (12 Hours), August 31, 2006



Measured & Modeled Surface Ozone Concentrations, August 31, 2006



Conclusions

- TOPAZ data provides an extremely useful tool for evaluating model performance:
  - Allows us to see what's happening above the ground.
  - Intuitive, visually appealing displays of modeled vs. measured ozone.
  - TOPAZ data complements routinely-collected and special study (TexAQS-II) data to help form a better understanding of ozone formation.

Conclusions

- August 31 provides a good example of using TOPAZ and other data to diagnose model performance issues:
  - Good agrrement between TOPAZ and NOAA P3 *in situ* measurements of ozone.
  - High formaldehyde and NO_Y concentrations are consistent with intense ozone production driven by highly-reactive VOCs.
  - CAMx produced relatively high ozone concentrations, but modeled wind bias dispersed plume and pushed it south and west of 8-hour observed peaks.

Future Work

- Much TexAQS-II data still needs to be incorporated into model performance evaluations, including:
  - Data from RV Ron Brown (in progress)
  - Rural Monitoring Network data (in progress)
  - Additional hydrocarbon measurements from P3
  - Moody Tower data
  - Ozone Sonde data
  - Houston Triangle data