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Supplement of

Modeling intercontinental transport of ozone in North America with CAMx for the Air Quality Model Evaluation International Initiative (AQMEII) Phase 3

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Table S1. Definition of WRF 35 vertical levels and mapping to the 26 vertical layers used in CAMx. Heights (m) are geopotential heights above ground level. RTCMC aggregates O_3 boundary contributions from layers 1 to 16 (O3A; O3D), 17-23 (O3B; O3E), and 24-26 (O3C; O3F)

WRF				CAMx				
Layer	Pressure mb)	Height (m)	Depth (m)	Layer	Pressure (mb)	Height (m)	Depth (m)	
35	50	19260.0	3397					
34	**97.5**	**15863.2**	**2233**	**26**	**97.5**	**15863**	**2233**	**O3C, O3F**
33	**145**	**13630.3**	**1701**	**25**	**145**	**13630**	**1701**	
32	**192.5**	**11929.7**	**1389**	**24**	**192.5**	**11930**	**1389**	
31	**240**	**10541.2**	**1181**	**23**	**240**	**10541**	**1181**	**O3B, O3E**
30	**287.5**	**9360.1**	**1032**	**22**	**287.5**	**9360**	**1032**	
29	**335**	**8327.8**	**920**	**21**	**335**	**8328**	**920**	
28	**382.5**	**7407.9**	**832**	**20**	**382.5**	**7408**	**1592**	
27	430	6576.3	760					
26	**477.5**	**5816.1**	**701**	**19**	**477.5**	**5816**	**1353**	
25	525	5114.9	652					
24	**572.5**	**4463.3**	**609**	**18**	**572.5**	**4463**	**1182**	
23	620	3854.1	573					
22	**667.5**	**3281.6**	**540**	**17**	**667.5**	**3282**	**952**	
21	715	2741.1	412					
20	**753**	**2329.4**	**298**	**16**	**753**	**2329**	**587**	**O3A, O3D**
19	781.5	2031.4	289					
18	**810**	**1742.2**	**188**	**15**	**810**	**1742**	**373**	
17	829	1553.9	185					
16	**848**	**1369.1**	**182**	**14**	**848**	**1369**	**360**	
15	867	1187.5	178					
14	**886**	**1009.2**	**175**	**13**	**886**	**1009**	**175**	
13	**905**	**834.0**	**87**	**12**	**905**	**834**	**87**	
12	**914.5**	**747.5**	**86**	**11**	**914.5**	**747**	**171**	
11	924	661.7	85					
10	**933.5**	**576.6**	**84**	**10**	**933.5**	**577**	**84**	
9	**943**	**492.3**	**84**	**9**	**943**	**492**	**84**	
8	**952.5**	**408.6**	**83**	**8**	**952.5**	**409**	**83**	
7	**962**	**325.6**	**82**	**7**	**962**	**326**	**82**	
6	**971.5**	**243.2**	**82**	**6**	**971.5**	**243**	**82**	
5	**981**	**161.5**	**41**	**5**	**981**	**162**	**41**	
4	**985.75**	**120.9**	**40**	**4**	**985.75**	**121**	**40**	
3	**990.5**	**80.4**	**40**	**3**	**990.5**	**80**	**40**	
2	**995.25**	**40.1**	**20**	**2**	**995.25**	**40**	**20**	
1	**997.625**	**20.1**	**20**	**1**	**997.625**	**20**	**20**	
0	**1000**	**0.0**		**0**	**1000**	**0**	**0**	

Table S2. RTCMC input file for an active (A) and inert (D) tracer groups. Here tracer group A tracks boundary contributions from the lowest 16 layers. HOXA and O1DA are additional species added to track chemical destruction of O3A. An inert tracer O3D needs to be listed in the input file even though it does not undergo any chemical reaction. Other active (B,C) and inert (E,F) tracer groups have similar expressions.

```
#Equation ; Rate constants from CB05
001 [O3A]   ->  [O1DA]                      ;  0  0.000E+00  0.0000E+00
002 [O1DA]  ->  [O3A]                       ;  5  1.260E-09  1.0200E+02
003 [O1DA]  ->                              ; 15  1.320E-08  0.0000E+00
004 [O3A]  + [OH]     ->  [HOXA]            ;  2  1.020E-10 -9.4000E+02
005 [O3A]  + [HO2]    ->  [HOXA]            ;  2  6.000E-13 -4.9000E+02
006 [HOXA] + [NO]     ->  [O3A]             ;  2  2.100E-10  2.5000E+02
007 [HOXA] + [HO2]    ->                    ; 19  1.380E-11  6.00E+02  1.020E-31  1.00E+03
008 [HOXA] + [HO2]    ->                    ; 20  1.932E-32  2.80E+03  1.428E-52  3.20E+03
009 [HOXA] + [MEO2]   ->                    ;  2  2.460E-11  7.50E+02
010 [HOXA] + [XO2]    ->                    ;  2  4.500E-11  7.0000E+02
011 [HOXA] + [XO2N]   ->                    ;  2  4.500E-11  7.0000E+02
012 [HOXA] + [C2O3]   ->  (0.2) [O3A]       ;  2  2.58E-11 1.0400E+03
013 [HOXA] + [CXO3]   ->  (0.2) [O3A]       ;  2  2.58E-11 1.0400E+03
014 [O3A]  + [ISOP]   ->                    ;  2  4.716E-13 -1.9120E+03
015 [O3A]  + [TERP]   ->                    ;  2  7.2E-14 -8.2100E+02
046 [O3D]   ->                              ;  1  0.0
```

Table S3. Model performance statistics for MDA8 O_3 for CAMx basecase (no cutoff).

Major City	AQS ID	#Obs	Model Mean (ppb)	NMB (%)	NME (%)	FB (%)	FE (%)	r	RMSE
Atlanta, GA	131210055	242	52.7	4.2	17.6	4.7	18.3	0.71	11.15
Birmingham, AL	10732006	232	51.7	5.2	18.1	6.4	18.9	0.63	11.27
Boise, ID	160010017	166	48.1	-6.0	11.6	-5.7	11.9	0.60	7.50
Boston, MA	440090007	208	50.3	7.8	15.1	8.3	15.3	0.76	8.86
Chicago, IL	550590019	220	47.3	-2.8	13.1	-2.5	13.5	0.78	8.41
Cincinnati, OH	390610006	212	52.9	1.0	13.1	1.2	14.1	0.77	9.34
Columbus, OH	390490029	211	51.3	-1.7	12.5	-1.5	13.7	0.76	8.47
Dallas, TX	484392003	354	42.8	-3.0	17.0	-3.9	18.7	0.80	9.24
Denver, CO	80350004	344	48.7	-0.4	14.3	0.7	15.1	0.68	9.47
Detroit, MI	261630019	167	47.1	-5.4	14.3	-4.5	15.2	0.76	8.93
Houston, TX	480391004	353	45.2	7.9	21.1	10.4	21.4	0.68	12.17
Kansas City, KS	290490001	214	51.3	4.3	13.7	5.0	13.7	0.74	8.51
Los Angeles, CA	60710005	358	56.6	-3.3	12.5	-3.5	12.9	0.88	9.65
Minneapolis, MN	270031002	339	35.2	-8.3	20.6	-11	23.7	0.67	9.75
New York, NY	340290006	257	51.6	6.5	15.2	7.9	16.3	0.82	9.65
Philadelphia, PA	421010024	362	43.4	-2.5	14.4	-2.7	16	0.88	8.16
Phoenix, AZ	40131004	363	43.9	-11.9	15.2	-12.6	16.7	0.84	9.97
Pittsburgh, PA	420031005	356	46.3	8.8	16.2	9.0	16.8	0.85	9.15
Sacramento, CA	60670012	338	46.0	-0.6	13.1	2.8	15.2	0.88	8.16
Salt Lake, UT	490110004	152	52.3	3.0	12.7	3.5	12.6	0.56	8.46

St. Louis, MO	291831002	214	53.4	2.7	12.9	3.5	12.8	0.80	8.40
Baltimore, MD	240251001	189	57.9	1.8	12.9	3.5	14.3	0.86	9.37

Table S4. Model performance statistics for MDA8 O_3 with 40 ppb cutoff for CAMx basecase

Major City	**AQS ID**	**#Obs**	**Model Mean (ppb)**	**NMB (%)**	**NME (%)**	**FB (%)**	**FE (%)**	r	**RMSE**
Atlanta, GA	131210055	184	56.8	0.44	15.4	-0.8	15.8	0.60	11.08
Birmingham, AL	10732006	172	55.0	0.05	14.77	-0.4	15.1	0.48	10.67
Boise, ID	160010017	147	49.02	-7.53	11.54	-7.7	11.9	0.48	7.69
Boston, MA	440090007	148	53.7	3.48	12.57	2.8	12.5	0.70	8.39
Chicago, IL	550590019	159	51.0	-5.68	13.16	-6.6	13.9	0.71	9.21
Cincinnati, OH	390610006	174	56.1	-1.31	11.38	-2.2	11.9	0.74	8.50
Columbus, OH	390490029	179	53.6	-3.75	11.03	-4.6	11.8	0.75	7.94
Dallas, TX	484392003	197	50.6	-5.85	14.95	-7.7	16.3	0.73	9.93
Denver, CO	80350004	264	51.7	-4.35	11.76	-4.7	11.9	0.62	8.47
Detroit, MI	261630019	131	50.2	-7.85	13.07	-8.2	13.6	0.69	8.88
Houston, TX	480391004	183	51.3	-4.03	13.51	-3.9	13.3	0.66	10.09
Kansas City, KS	290490001	164	54.3	1.56	12.26	1.7	12.1	0.65	8.38
Los Angeles, CA	60710005	300	60.5	-3.92	12.37	-4.7	12.8	0.86	10.22
Minneapolis, MN	270031002	143	43.0	-11.48	17.8	-13.9	20.1	0.36	11.01
New York, NY	340290006	176	57.0	1.11	11.16	0.5	11.3	0.77	8.48
Philadelphia, PA	421010024	202	53.5	-4.83	12.17	-6.2	13.3	0.81	8.75
Phoenix, AZ	40131004	263	49.5	-13.06	15.29	-14.9	17	0.68	11.17
Pittsburgh, PA	420031005	189	56.3	4.6	11.93	3.8	11.9	0.78	8.39
Sacramento, CA	60670012	208	53.6	-4.24	11.33	-3.9	11.6	0.81	8.38
Salt Lake, UT	490110004	134	53.0	0.69	11.2	1	11.1	0.55	7.57
St. Louis, MO	291831002	176	56.0	0.64	11.98	0.8	11.9	0.74	8.43
Baltimore, MD	240251001	156	61.7	-1.25	10.68	-1.6	11	0.83	8.53

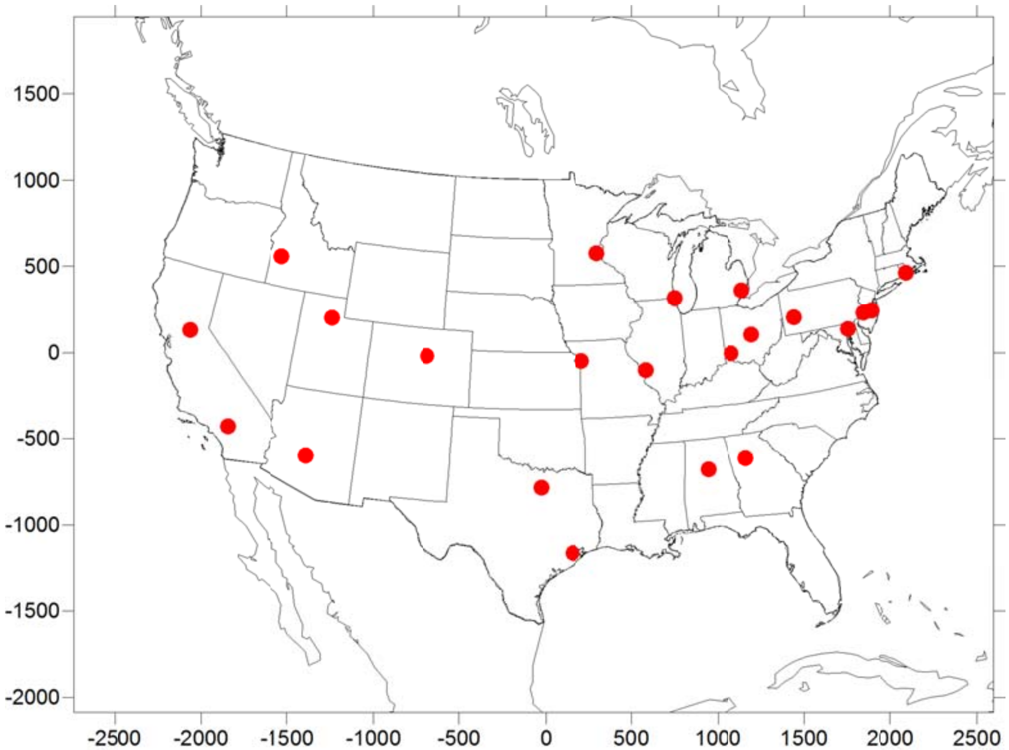


Figure S1. Circles represent 22 cities analysed in this study covering a wide variety of climatic and geographic environments. We chose their representative AQS monitoring site based on the monitoring site with highest H4MDA8 in the metropolitan statistical area.

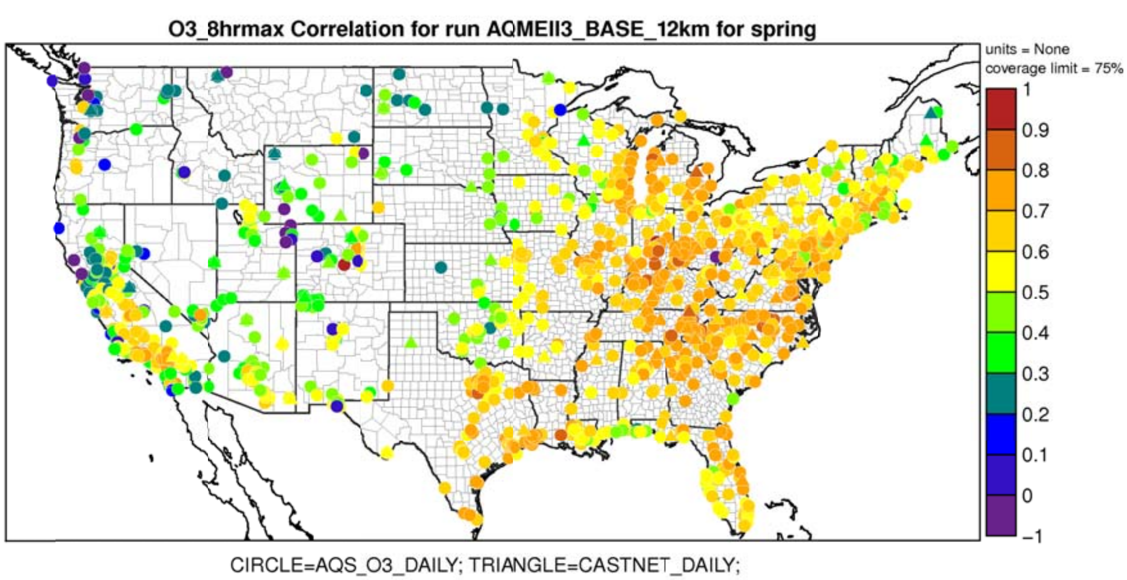


Figure S2a. Spatial map of CAMx correlation coefficient for MDA8 O_3 with 40 ppb cutoff in spring

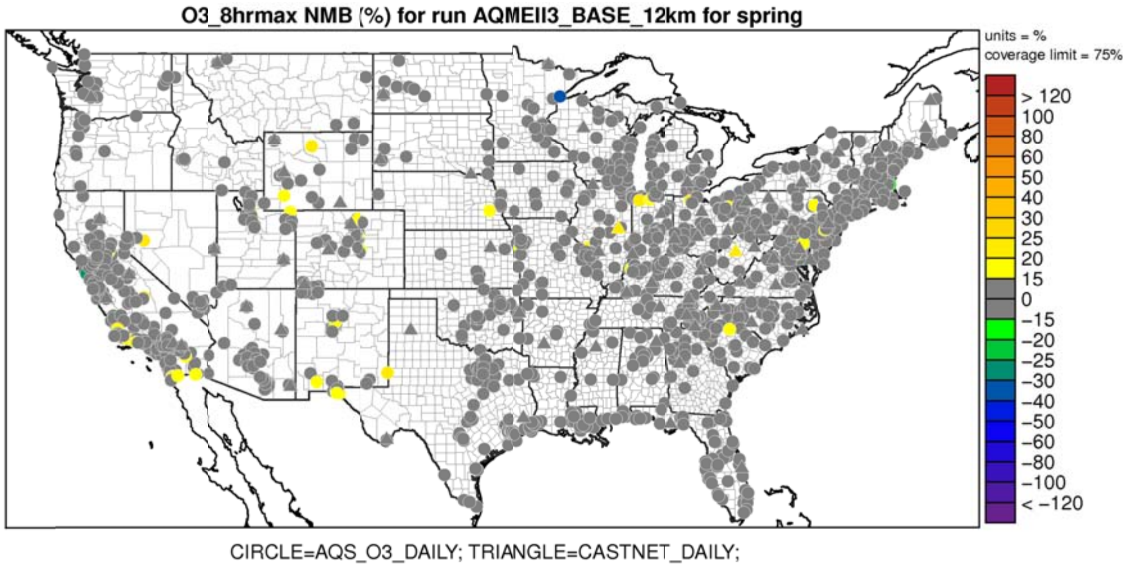


Figure S2b. Spatial map of CAMx NMB for MDA8 O_3 with 40 ppb cutoff in spring

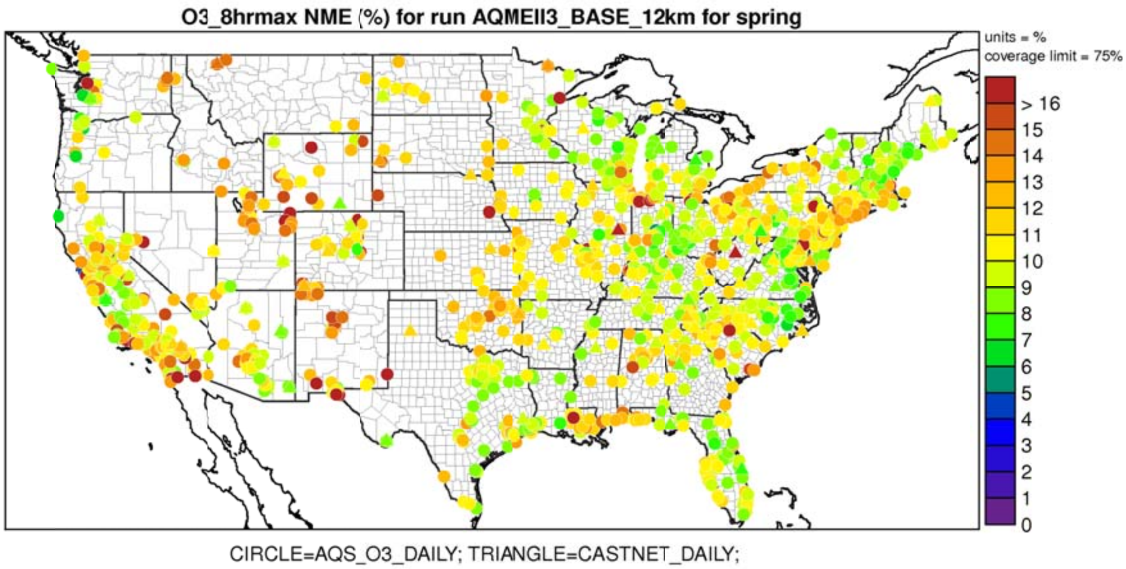


Figure S2c. Spatial map of CAMx NME for MDA8 O_3 with 40 ppb cutoff in spring

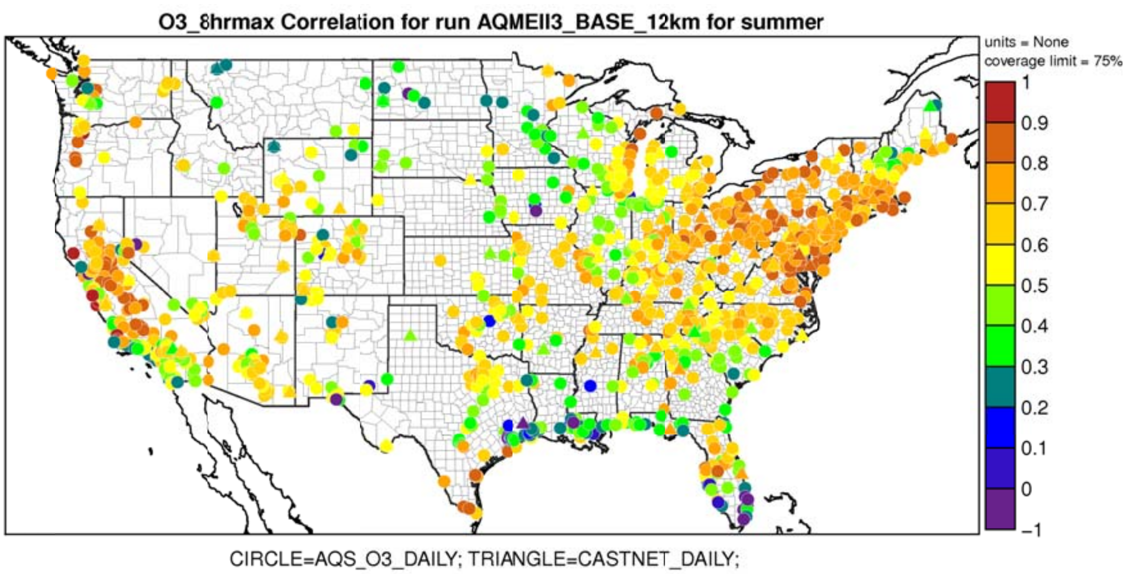


Figure S3a. Spatial map of CAMx correlation coefficnet for MDA8 O_3 with 40 ppb cutoff in summer

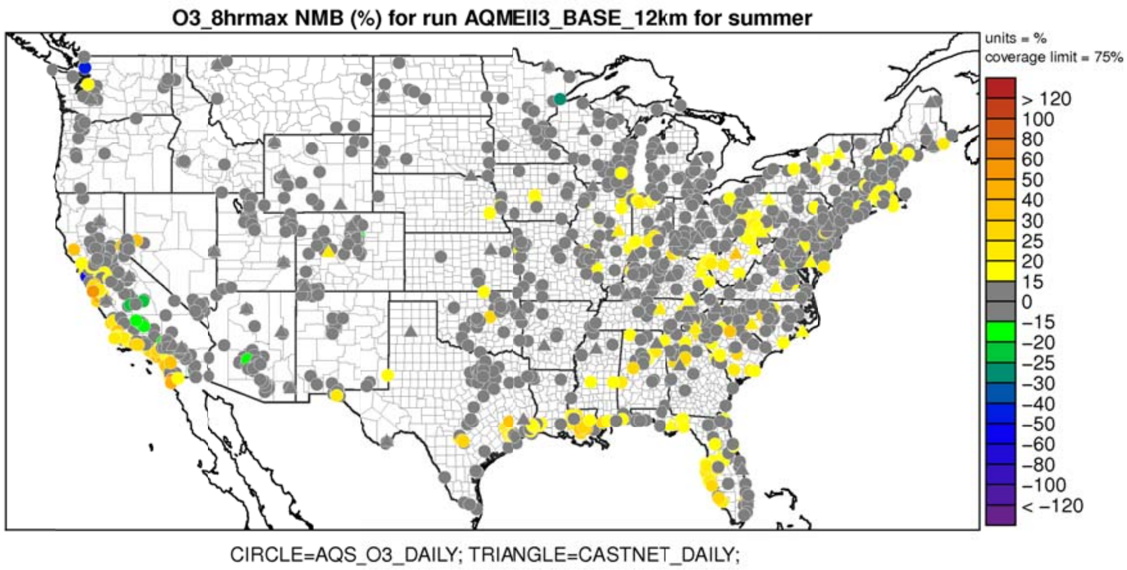


Figure S3b. Spatial map of CAMx NMB for MDA8 O_3 with 40 ppb cutoff in summer

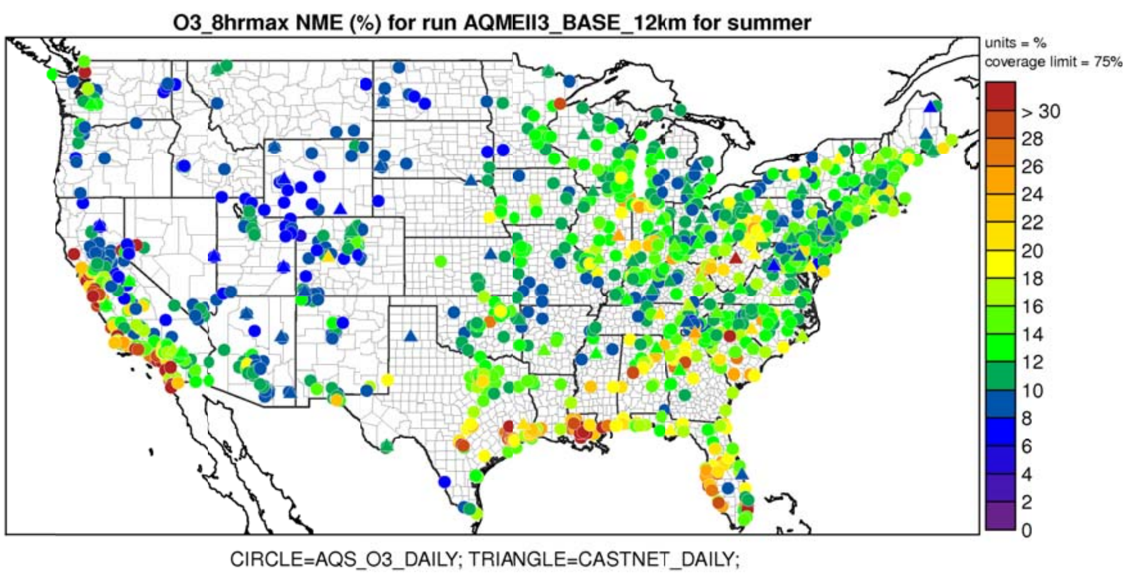


Figure S3c. Spatial map of CAMx NME for MDA8 O_3 with 40 ppb cutoff in summer

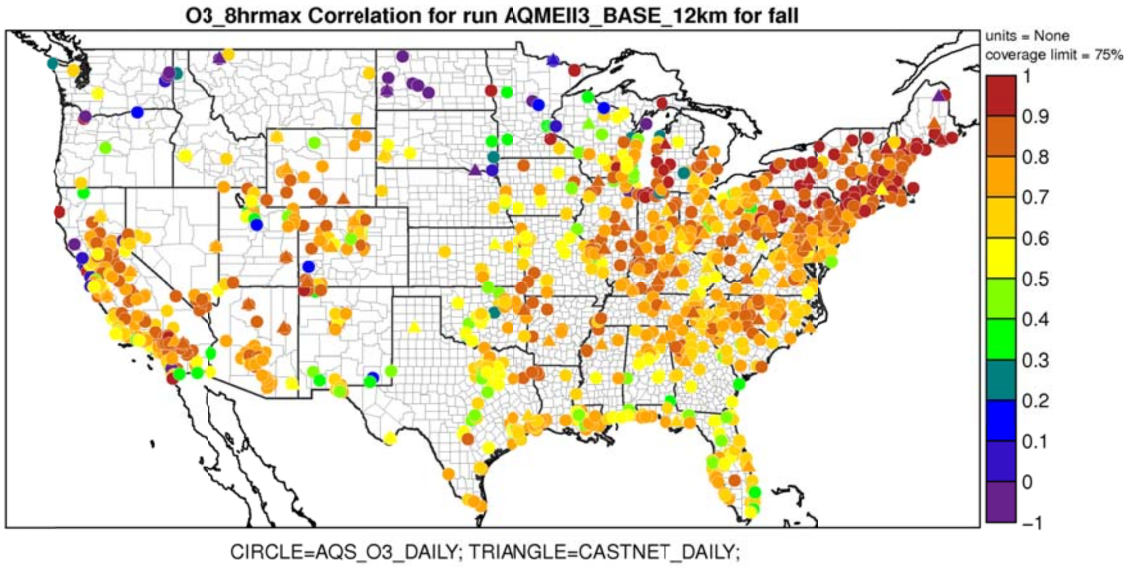


Figure S4a. Spatial map of CAMx correlation coefficient for MDA8 O_3 with 40 ppb cutoff in fall

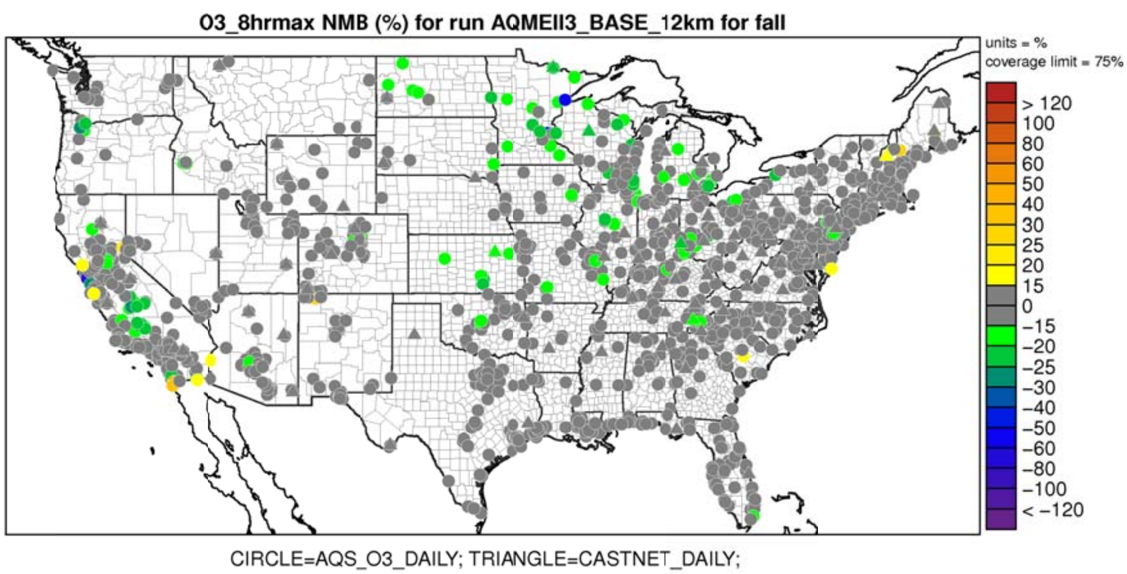


Figure S4b. Spatial map of CAMx NMB for MDA8 O_3 with 40 ppb cutoff in fall

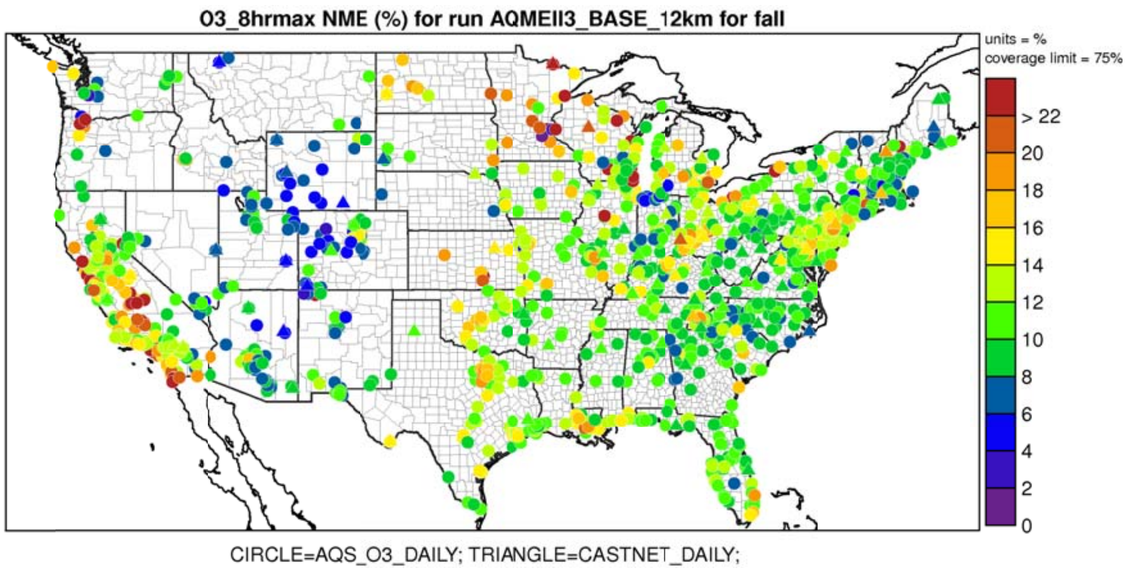


Figure S4c. Spatial map of CAMx NME for MDA8 O_3 with 40 ppb cutoff in fall

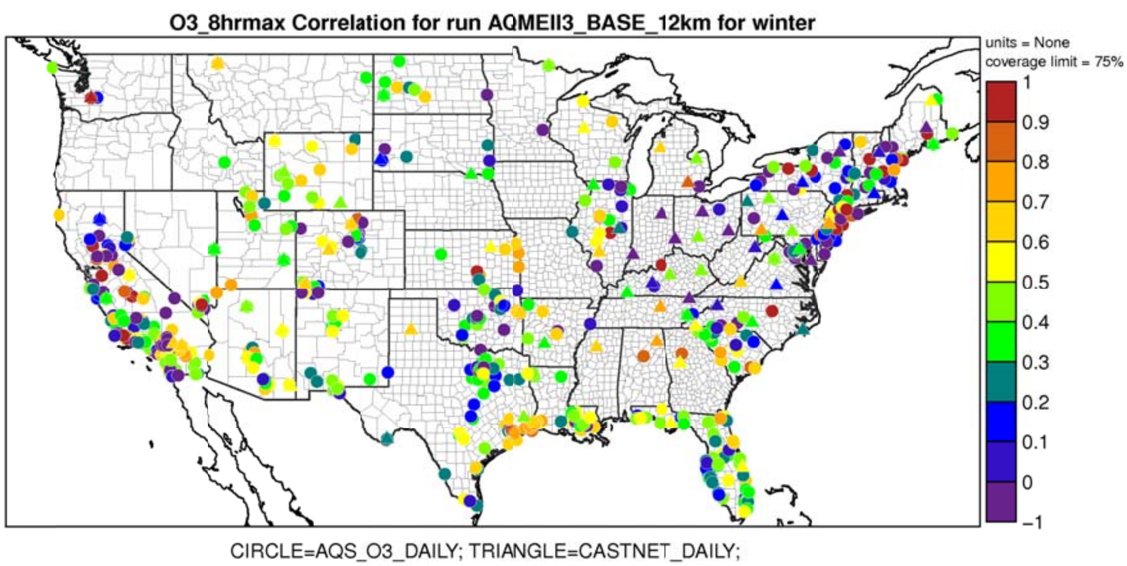


Figure S5a. Spatial map of CAMx correlation coefficient for MDA8 O_3 with 40 ppb cutoff in winter

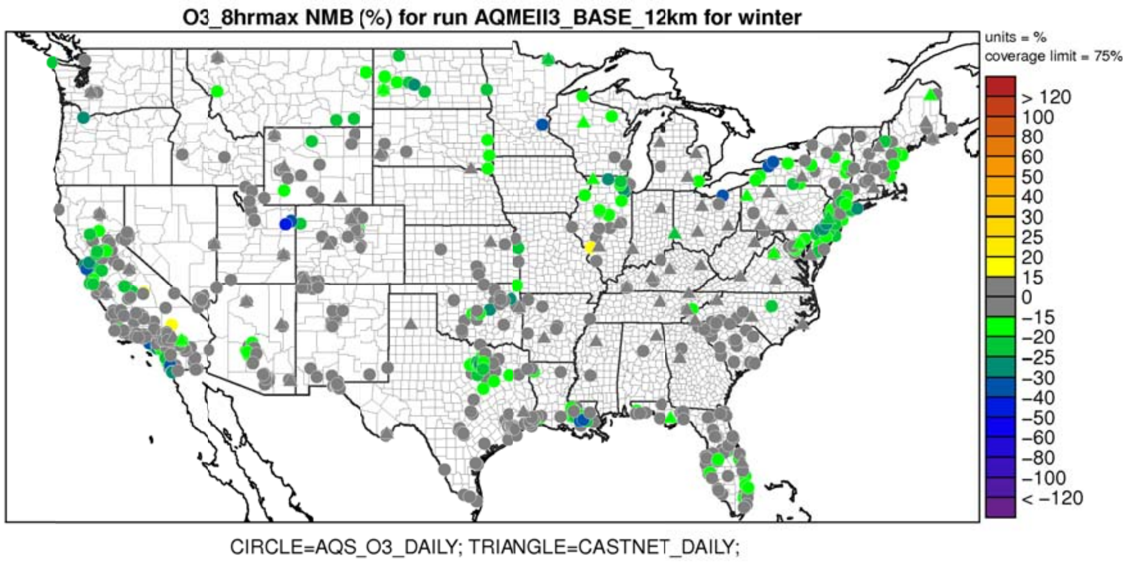


Figure S5b. Spatial map of CAMx NMB for MDA8 O_3 with 40 ppb cutoff in winter

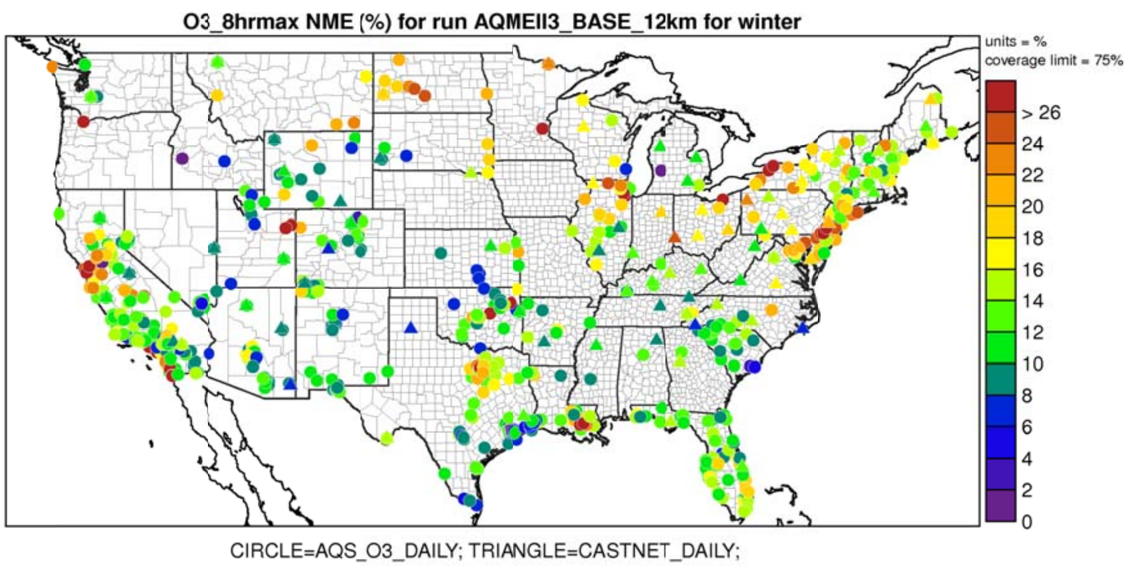


Figure S5c. Spatial map of CAMx NME for MDA8 O_3 with 40 ppb cutoff in winter

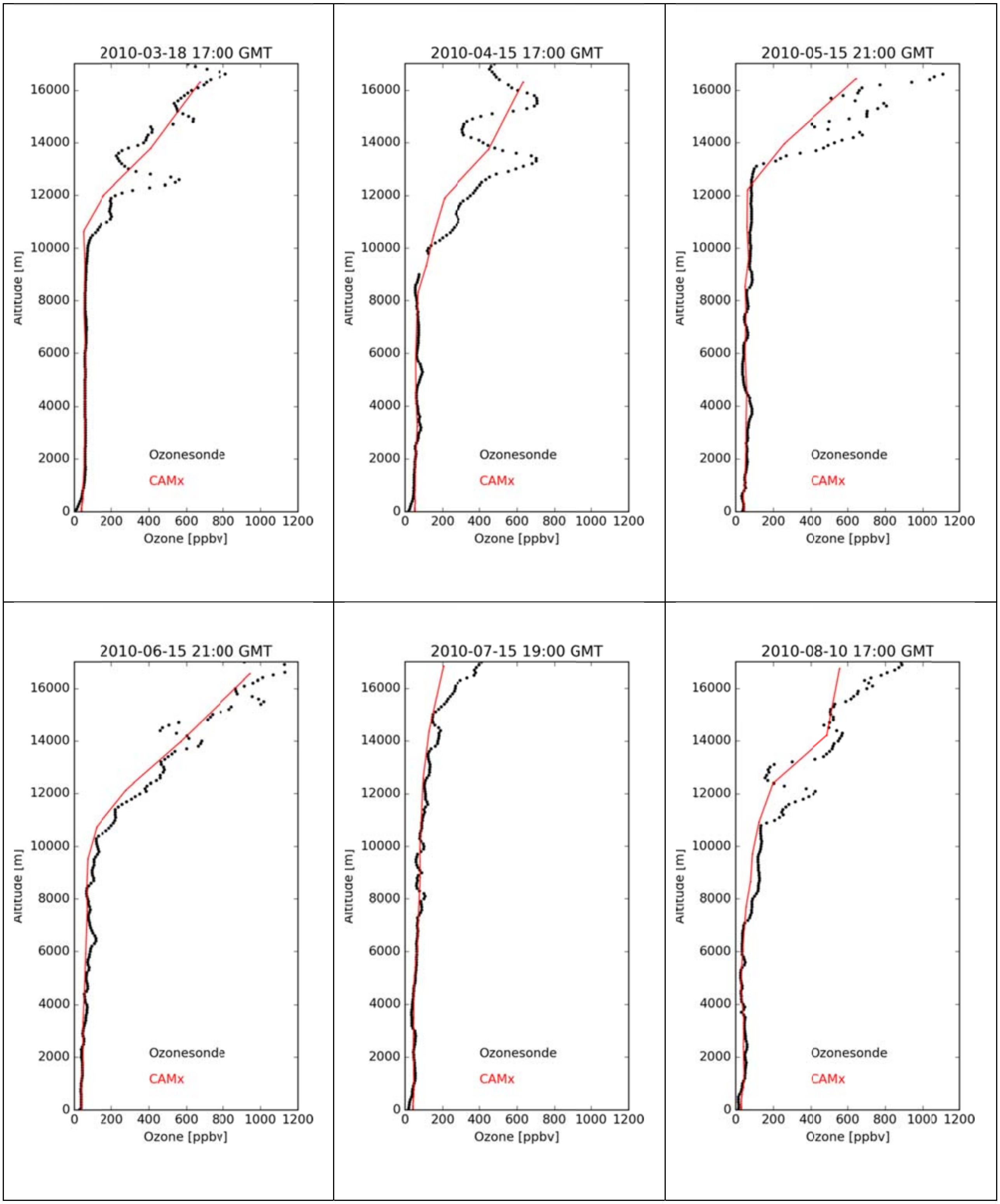


Figure S6. Vertical distribution of O_3 at Trinidad Head (March-August 2010) up to 16 km

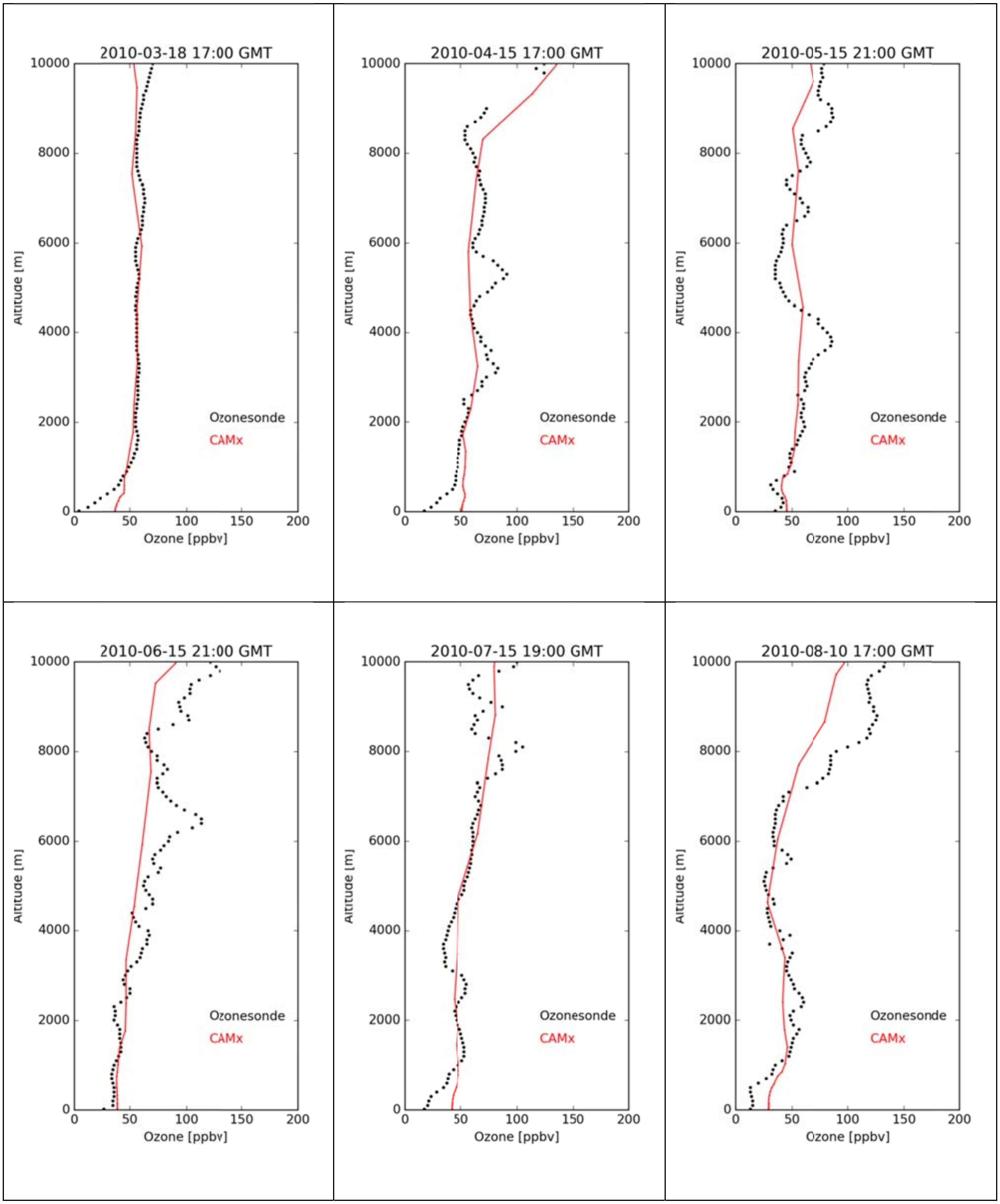
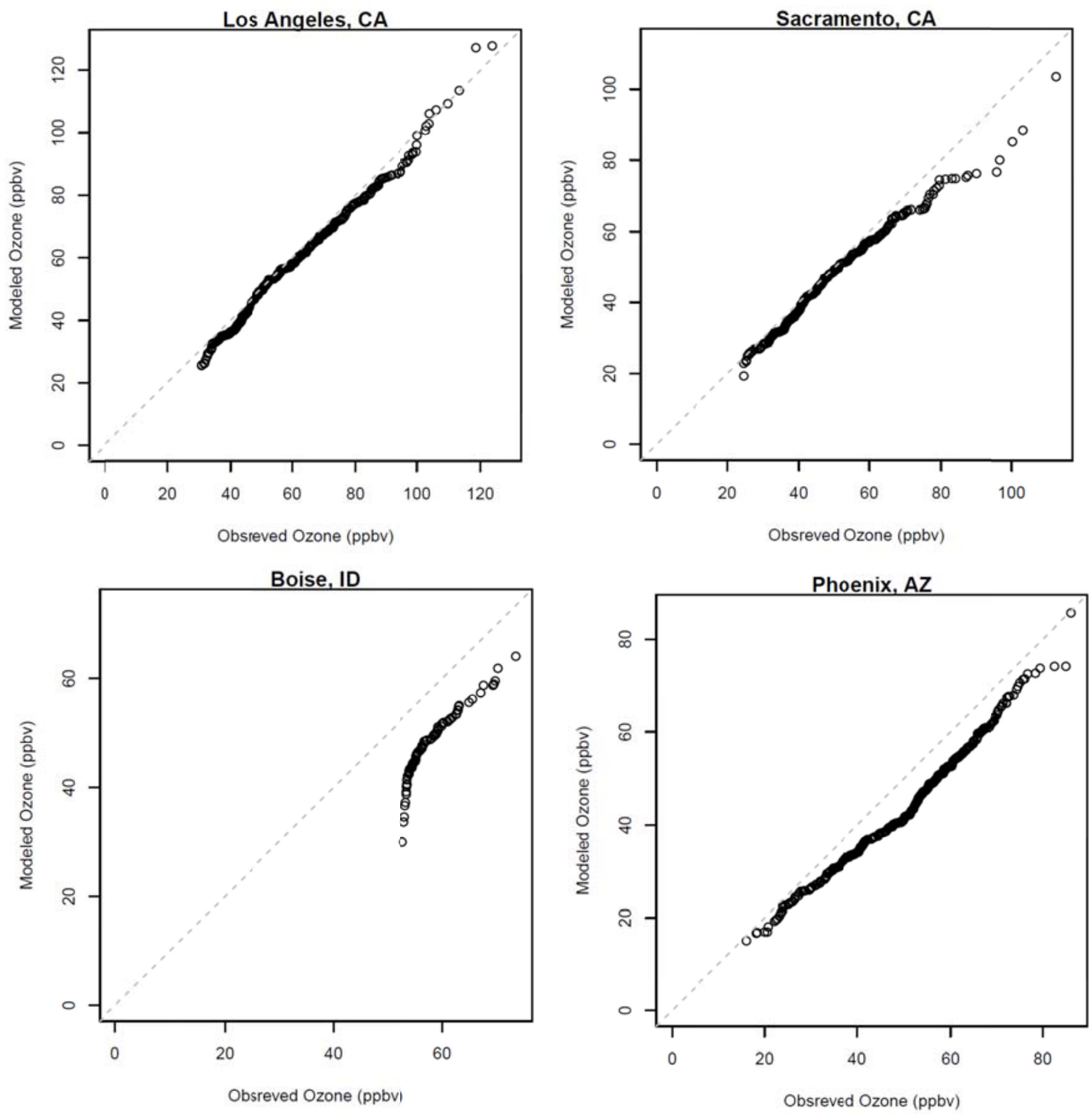
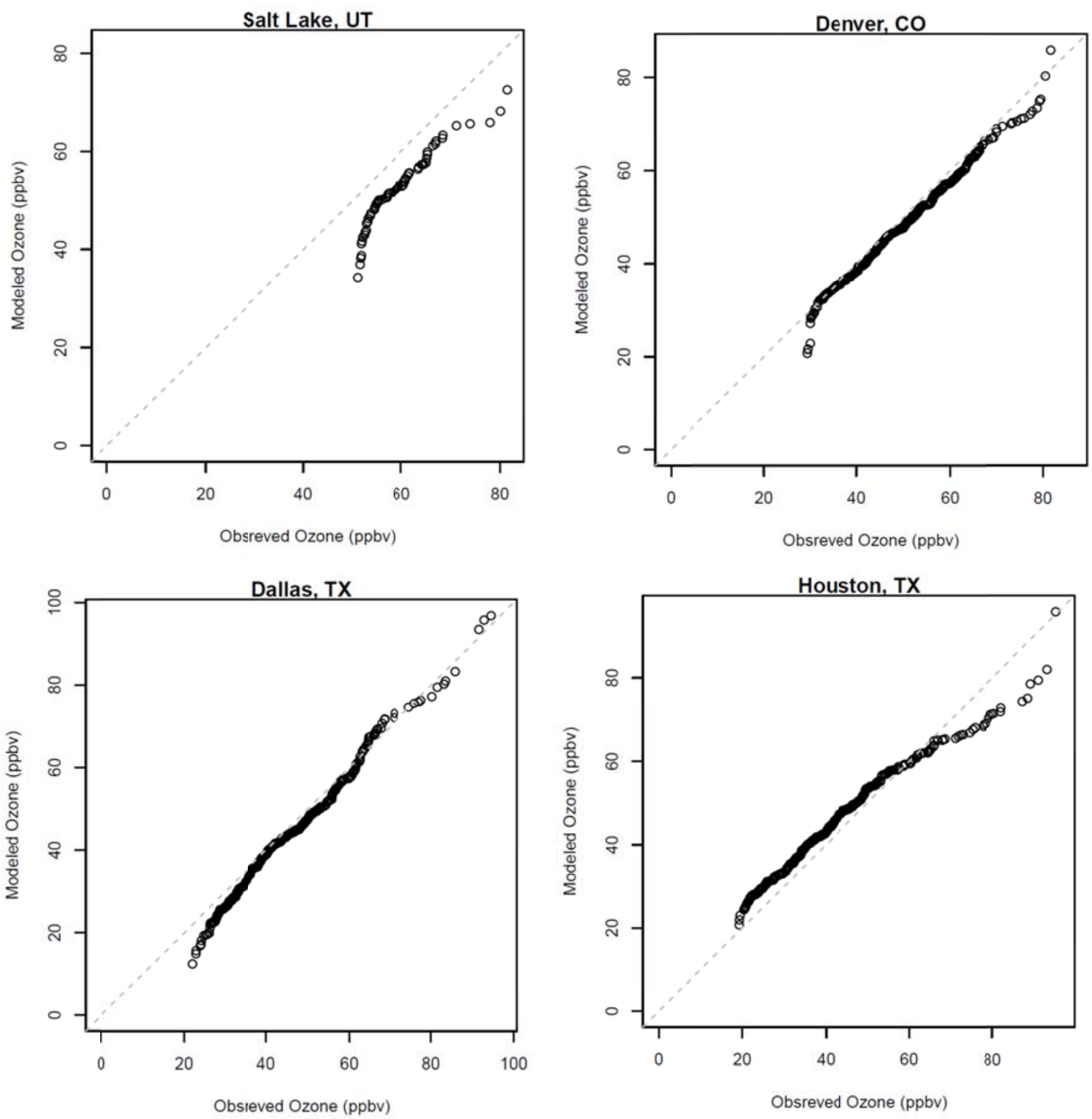
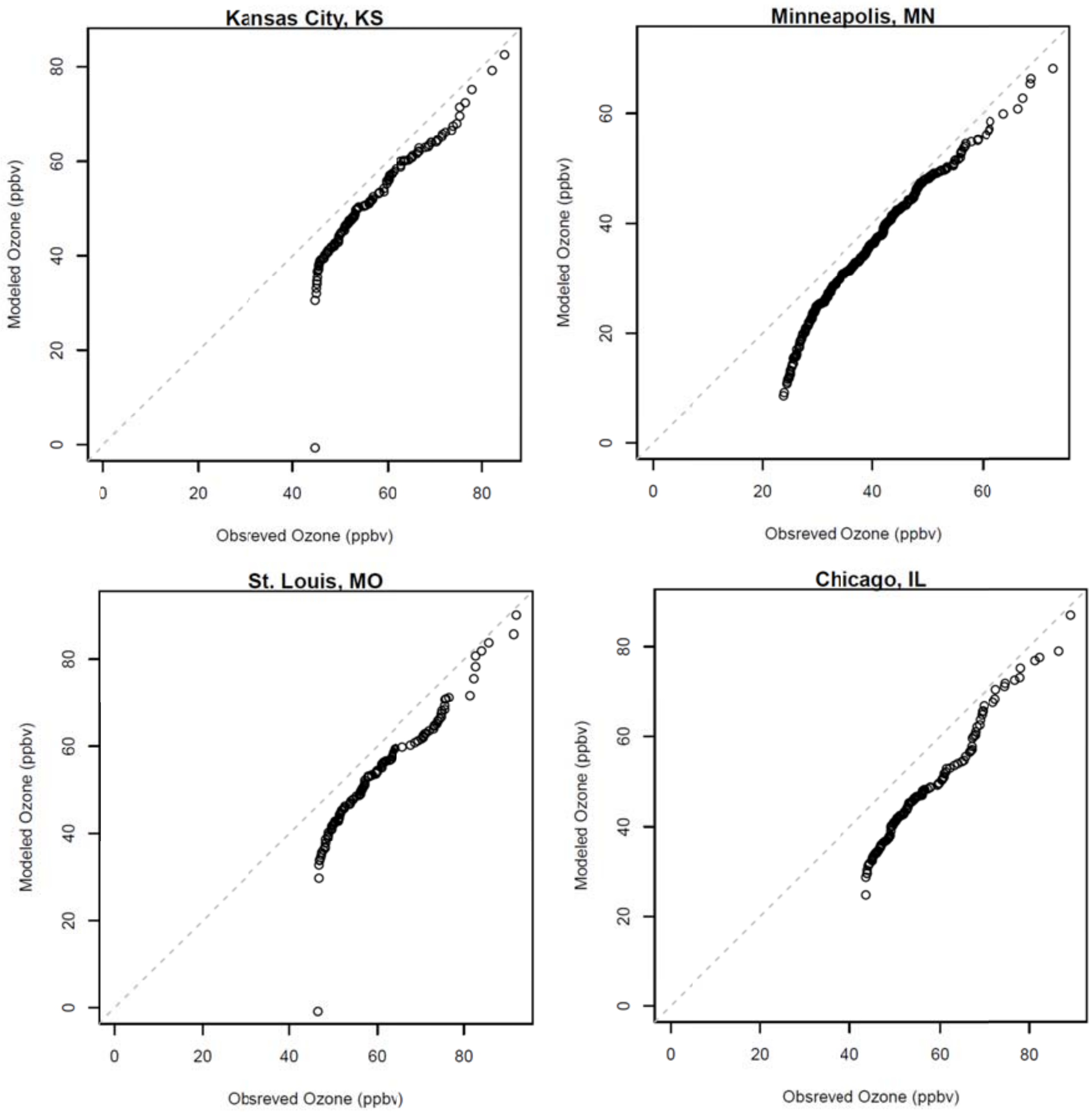


Figure S7. Same as Figure S5 but up to 10 km.

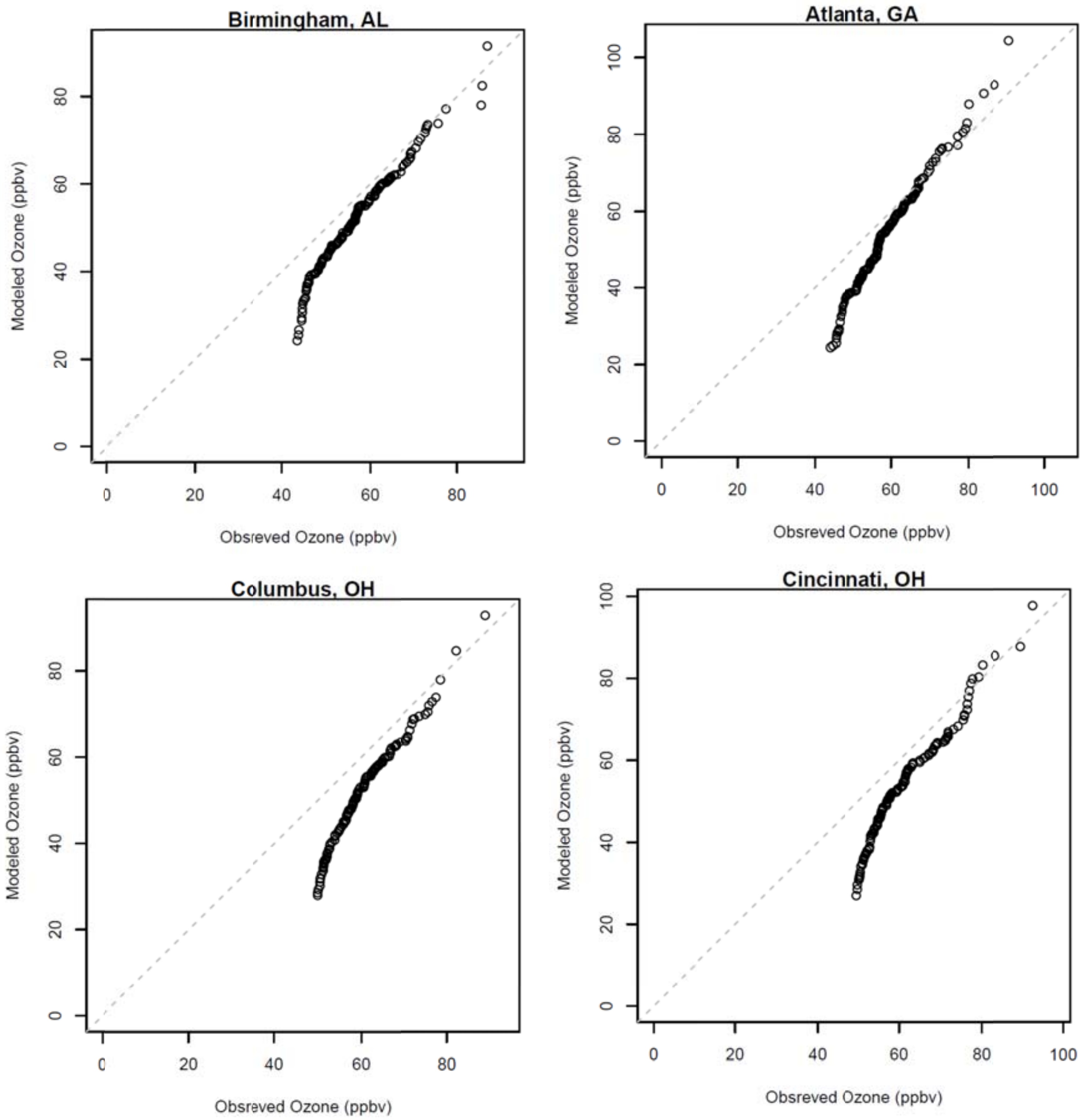


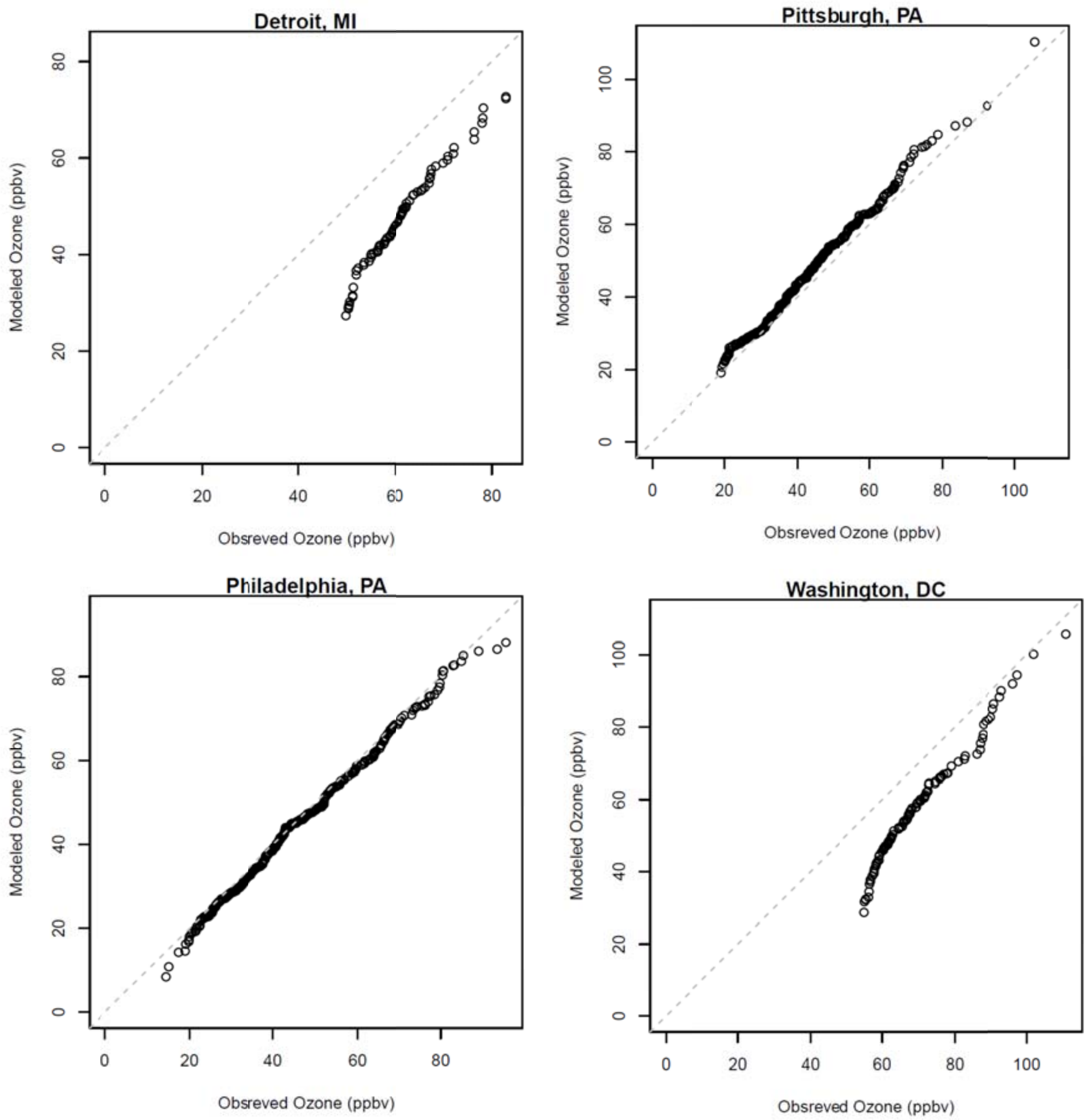
Los Angeles, CA
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
Sacramento, CA
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
Boise, ID
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
Phoenix, AZ
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)


Salt Lake, UT
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
0
20
40
60
80
Denver, CO
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
0
20
40
60
80
Dallas, TX
Modeled Ozone (ppbv)
Obsieved Ozone (ppbv)
0
20
40
60
80
100
Houston, TX
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
0
20
40
60
80



Kansas City, KS
Minneapolis, MN
St. Louis, MO
Chicago, IL
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)


Birmingham, AL
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
Atlanta, GA
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
Columbus, OH
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)
Cincinnati, OH
Modeled Ozone (ppbv)
Obsreved Ozone (ppbv)


Detroit, MI
Modeled Ozone (ppbv)
0
20
40
60
80
Obsreved Ozone (ppbv)
Pittsburgh, PA
Modeled Ozone (ppbv)
0
20
40
60
80
100
Obsreved Ozone (ppbv)
Philadelphia, PA
Modeled Ozone (ppbv)
0
20
40
60
80
Obsreved Ozone (ppbv)
Washington, DC
Modeled Ozone (ppbv)
0
20
40
60
80
100
Obsreved Ozone (ppbv)

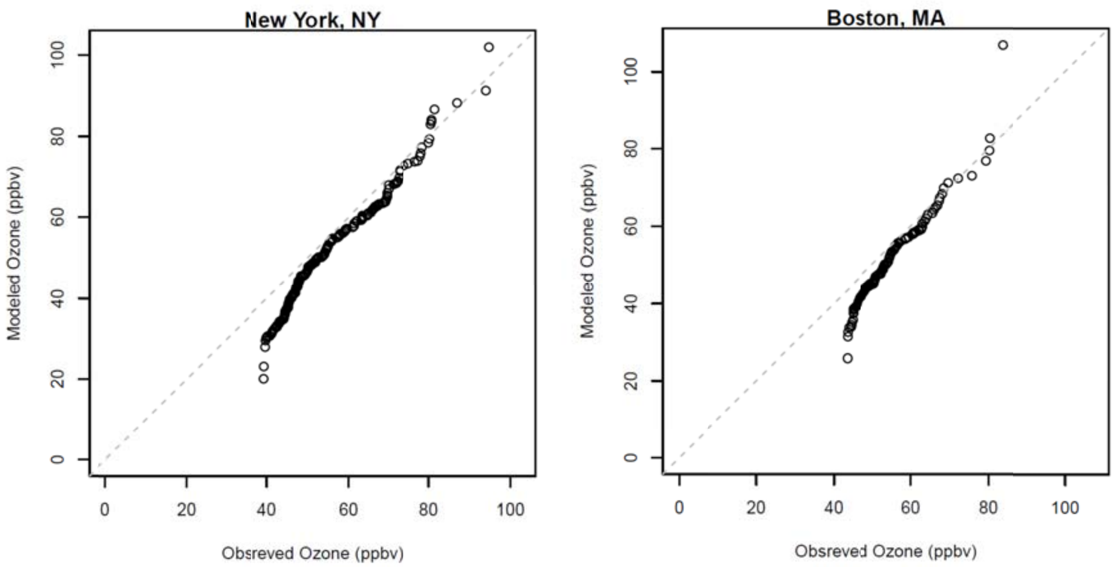


Figure S8. Quantile-quantile(Q-Q) plots of MDA8 O3 at major US cities. Q-Q plots represent the sorted values of observed and modeled concentrations and are useful for model evaluation providing extra details such as overestimation and/or underestimation of high and low concentrations. A Q-Q plot of perfect model performance would show data pairs along the 1:1 line.

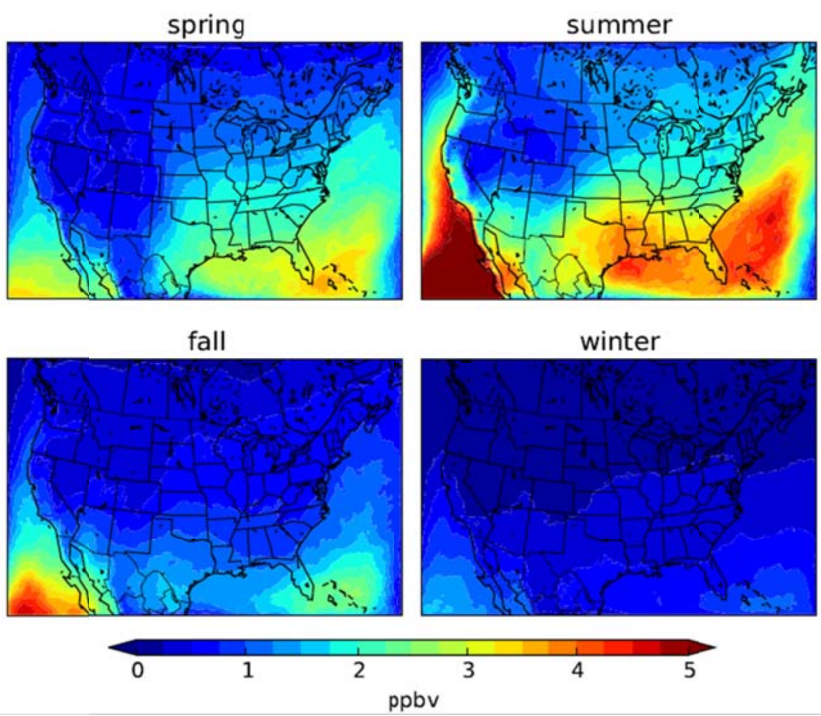


Figure S9. The difference in seasonal average daily maximum 8-hour O_3 contribution from BCs inert and active O_3 tracers, i.e., inert minus active, at layers below 750 mb.

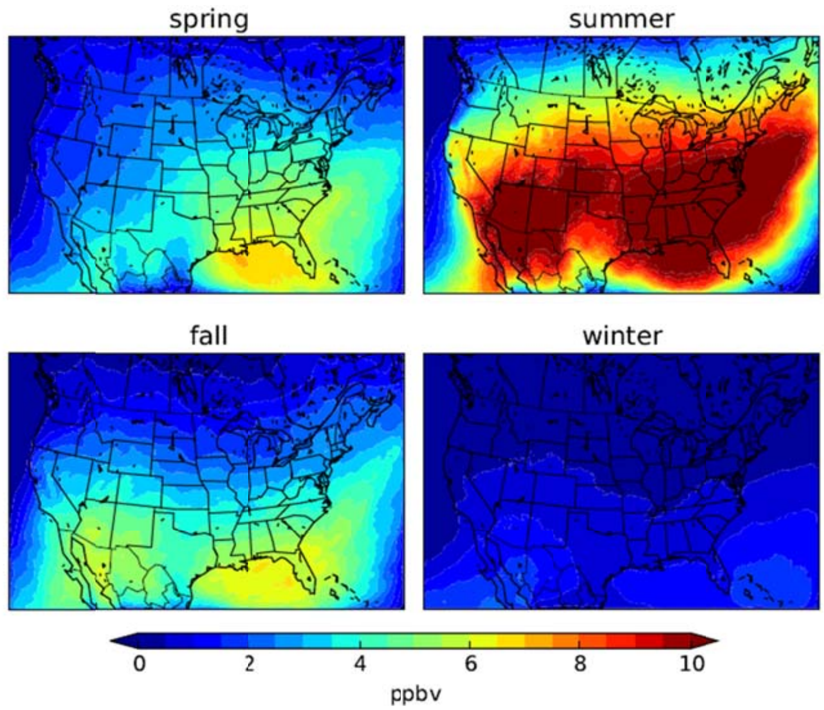


Figure S10. The difference in seasonal average daily maximum 8-hour O_3 contribution from BCs inert and active O_3 tracers, i.e., inert minus active, at layers between 240-750 mb.

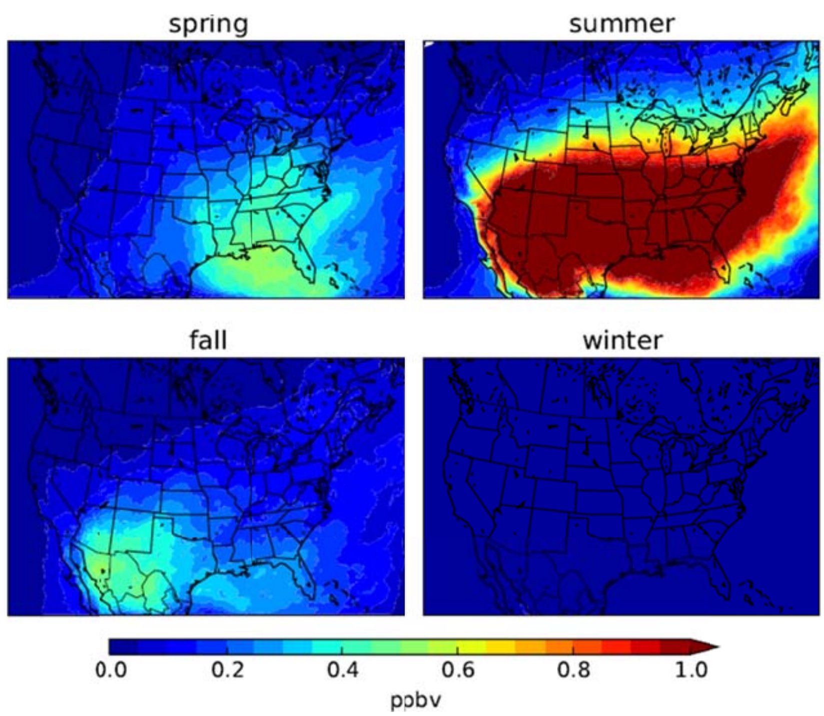


Figure S11. The difference in seasonal average daily maximum 8-hour O_3 contribution from BCs inert and active O_3 tracers, i.e., inert minus active, at layers above 240 mb.