

Supplemental of

Modeling Trans-Pacific Transport using Hemispheric CMAQ on April 2010: Part 1. Model Evaluation and Characterization of Stratosphere Intrusion to Tropospheric Ozone

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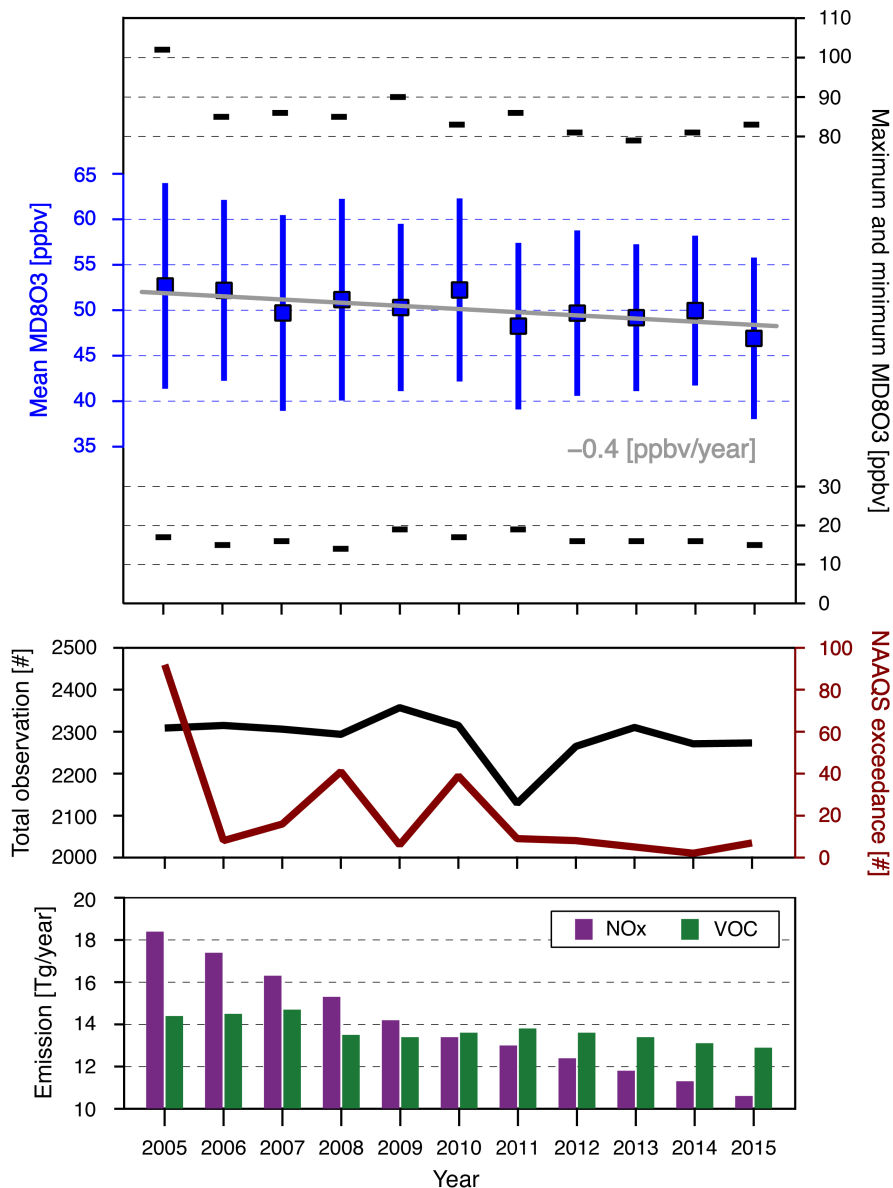


Figure S1. Long-term trends from 2005 to 2015 as before and after 5 years comparison to 2010. (Top) Mean (blue color, left-axis) and maximum and minimum (black color, right-axis) MD8O3 on April. (Center) Number of total observations (black color, left-axis) and exceedance of NAAQS (dark red color, right-axis; 75 ppbv is used as a criterion as 2010) on April. (Bottom) Annual NO_x (purple) and VOCs (green) emissions in the U.S.A. except wildfire (<https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data>).

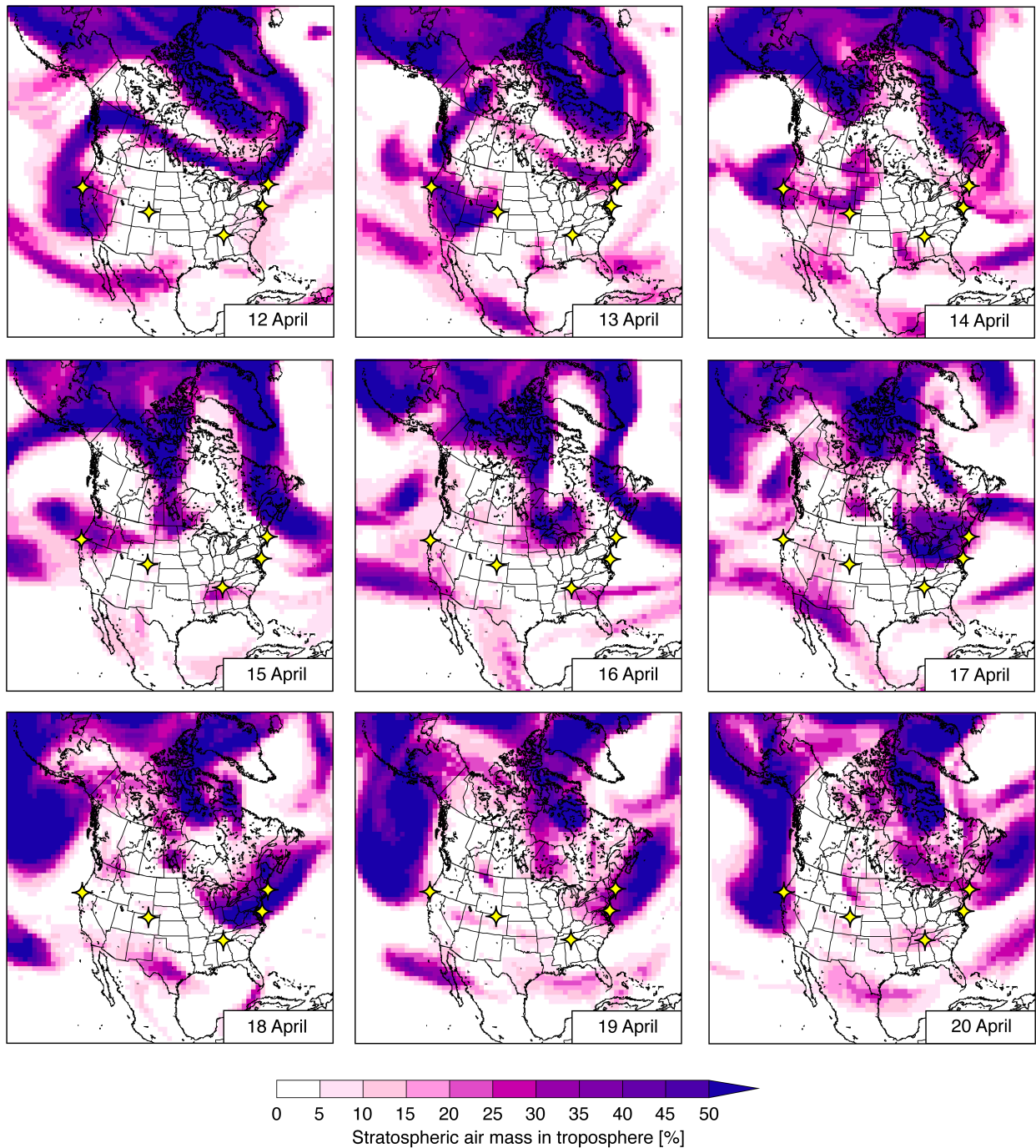


Figure S2. Spatial distributions of day-to-day variations of stratospheric air mass in troposphere over U.S. during middle April 2010. Yellow stars indicate the ozonesonde observation sites.

Table S1. Statistical analysis of modeled O₃ mixing ratios to ozonesonde as latitude dependence.

	N	Mean		R	NMB	NME
		Observation	Model			
Ozonesonde						
< 40°N sites						
–boundary layer	517	47.12	49.13	0.55 ^{***}	4.3%	21.6%
–free troposphere	483	81.07	59.55	0.75 ^{***}	–26.5%	29.6%
–upper model layer	283	538.86	461.51	0.90 ^{***}	–14.4%	33.8%
40°–50°N sites						
–boundary layer	907	49.20	48.95	0.37 ^{***}	–0.5%	16.6%
–free troposphere	831	77.97	58.12	0.76 ^{***}	–25.5%	29.0%
–upper model layer	488	932.12	845.30	0.92 ^{***}	–9.3%	26.9%
50°–60°N sites						
–boundary layer	966	46.64	43.37	0.55 ^{***}	–7.0%	16.9%
–free troposphere	776	78.39	56.28	0.78 ^{***}	–28.2%	29.3%
–upper model layer	461	1026.12	861.52	0.94 ^{***}	–16.0%	25.1%
> 60°N sites						
–boundary layer	387	40.30	37.06	0.56 ^{***}	–8.0%	20.3%
–free troposphere	378	92.86	60.65	0.78 ^{***}	–34.7%	35.8%
–upper model layer	221	1260.21	1061.29	0.94 ^{***}	–15.8%	25.3%

Note: Corresponded hourly modeled O₃ mixing ratio is used for the comparison with ozonesonde data. Significance levels by Students' t-test for correlation coefficients between observations and simulations are remarked as *p < 0.05, **p < 0.01, and ***p < 0.001, and lack of a mark indicates no significance. Ozonesonde observational sites located on < 40°N, 40°–50°N, 50°–60°N, > 60°N, respectively, contain 9, 9, 9, and 6 sites.

Table S2. Statistical analysis of modeled relative humidity to ozonesonde as latitude dependence.

	N	Mean		R	NMB	NME
		Observation	Model			
Ozonesonde						
< 40°N sites						
-boundary layer	517	61.70	70.69	0.63***	14.6%	26.0%
-free troposphere	469	36.38	42.22	0.72***	16.1%	42.3%
-upper model layer	148	13.81	16.64	0.56***	20.5%	77.2%
40°–50°N sites						
-boundary layer	907	59.74	70.99	0.51***	18.8%	27.5%
-free troposphere	810	38.73	43.47	0.77***	12.5%	34.1%
-upper model layer	339	9.45	10.77	0.91***	13.9%	44.2%
50°–60°N sites						
-boundary layer	973	60.79	65.28	0.85***	7.4%	14.5%
-free troposphere	776	36.04	41.90	0.85***	16.2%	27.6%
-upper model layer	461	6.64	9.27	0.93***	39.7%	56.8%
> 60°N sites						
-boundary layer	387	69.36	73.82	0.81***	6.4%	15.4%
-free troposphere	378	42.46	49.42	0.80***	16.4%	29.8%
-upper model layer	172	2.65	4.12	0.74***	55.5%	102.5%

Note: Corresponded hourly modeled O₃ mixing ratio is used for the comparison with ozonesonde data. Significance levels by Students' t-test for correlation coefficients between observations and simulations are remarked as *p < 0.05, **p < 0.01, and ***p < 0.001, and lack of a mark indicates no significance. Ozonesonde observational sites located on < 40°N, 40°–50°N, 50°–60°N, > 60°N, respectively, contain 9, 9, 9, and 6 sites.

Table S3. Elevated CASTNET sites in an alphabetical order.

ID	Site name	State	Longitude (°)	Latitude (°)	Elevation (m a.s.l.)
BBE401	Big Band NP	TX	-103.178	29.303	1052
CAN407	Canyonlands NP	UT	-109.821	38.458	1809
CHA467	Chiricahua NM	AZ	-109.389	32.009	1570
CNT169	Centennial	WY	-106.240	41.365	3175
CON186	Converse Station	CA	-116.913	34.194	1718
GRB411	Great Basin NP	NV	-114.216	39.005	2060
GRC474	Grand Canyon NP	AZ	-112.184	36.059	2073
GTH161	Gothic	CO	-106.986	38.956	2915
JOT403	Joshua Tree NP	CA	-116.389	34.070	1244
LAV410	Lassen Volcanic NP	CA	-121.576	40.540	1756
MEV405	Mesa Verde NP	CO	-108.490	37.198	2165
PAL190	Palo Duro	TX	-101.665	34.881	1053
PET427	Petrified Forest	AZ	-109.892	34.823	1723
PND165	Pinedake	WY	-109.788	42.929	2386
PNF126	Cranberry	NC	-82.045	36.105	1216
ROM206	Rocky Mountain NP Collocated	CO	-105.546	40.278	2742
ROM406	Rocky Mountain NP	CO	-105.546	40.278	2743
SHN418	Shenandoah NP	VA	-78.435	38.523	1073
WNC429	Wind Cave NP	SD	-103.484	43.558	1292
YEL408	Yellowstone NP	WY	-110.400	44.565	2430
YOS404	Yosemite NP	CA	-119.706	37.713	1605

Note: Elevated sites defined as sites with an elevation higher than 1000 m a.s.l. (above sea level). The available sites during April 2010 are listed.