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Research Report 195

Impacts of Regulations on Air Quality and Emergency Department Visits in the Atlanta Metropolitan Area, 1999–2013

Russell et al.

Appendix A. Supplementary Figures and Tables

This Appendix was reviewed solely for spelling, grammar, and cross-references to the main text. It has not been formatted or fully edited by HEI. This document was reviewed by the HEI Review Committee.

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APPENDIX A. SUPPLEMENTARY FIGURES AND TABLES

Introduction

This appendix contains figures and tables that supplement the information in the main body of the report. The meteorological method is described in detail in Henneman and colleagues (2015). Here, we present regression results for the step that relates daily deviations (denoted Δ) to meteorological and day-specific indicators.

Abbreviations and Other Terms

ANAA	Atlanta nonattainment area
CMAQ	Community Multiscale Air Quality
CO	carbon monoxide
EC	elemental carbon
EGU	electricity generating unit
MDA8h	maximum daily 8-hour
MOB	on-road mobile
MOVES	U.S. EPA MOtor Vehicle Emissions Simulator
NBP	NO_x Budget Trading Program
NH_4^+	ammonium
NMB	normalized mean bias
NME	normalized mean error
NO_2	nitrogen dioxide
NO_3^-	nitrate
NO_x	oxides of nitrogen
O_3	ozone
OC	organic carbon
$PM_{2.5}$	particulate matter ≤2.5 μm in aerodynamic diameter
REG	regional, referring to EGU emissions in Alabama, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee minus those in the ANAA
RH	relative humidity
SEARCH	SouthEastern Aerosol Research and Characterization
SD	standard deviation
SO_2	sulfur dioxide
SO_4^{2-}	sulfate
SOA	secondary organic aerosol
STM	short-term meteorology
U.S. EPA	U.S. Environmental Protection Agency

SEARCH Sites

BHM	N. Birmingham, Alabama
CTR	Centreville, Alabama
GFP	Gulfport, Mississippi
JST	Jefferson Street, Atlanta, Georgia
OAK	Oak Grove, Mississippi
OLF	Outlying Landing Field #8, Florida
PNS	Pensacola, Florida
YRK	Yorkville, Georgia

Tables

Table A.1. Model parameters for scaled and normalized linear detrending model at the JST site for gaseous species[a]

	ΔO_3	ΔNO_X	ΔNO_2	ΔCO	ΔSO_2
R^2(adj.)	0.34	0.45	0.43	0.3	0.2
(Intercept)	0.081**	−0.26**	−0.095*	0.32***	0.016
ΔT^m	0.39***	0.082**	—	—	−0.12**
$(\Delta T^m)^2$	—	0.046***	—	—	−0.042***
$(\Delta T^m)^3$	−0.029***	—	—	—	−0.018**
$T^M * \Delta T^m$	-0.088***	−0.26***	−0.083***	−0.08***	0.16***
$T^M * \Delta RH$	−0.16***	—	—	−0.35***	0.11**
ΔWS	0.14***	−0.44***	−0.22***	−0.4***	−0.23***
ΔRH	−0.21***	0.14***	0.075***	0.53***	−0.42***
RF	−0.089***	0.11***	0.064***	0.046**	−0.042**
ΔT^m_{-1}	—	—	—	−0.076***	0.056*
ΔWS_{-1}	—	−0.039**	−0.029***	−0.074***	−0.062***
ΔRH_{-1}	−0.096***	−0.13***	−0.073***	−0.15***	—
RF_{-1}	—	—	−0.018*	−0.057***	0.064***
ΔT^m_{-2}	—	—	—	—	−0.0095*
ΔWS_{-2}	−0.075***	0.044**	—	—	—
ΔRH_{-2}	—	—	−0.00077*	—	—
RF_{-2}	−0.056*	—	—	—	—
Sun	0.47***	−0.63***	−0.21**	−0.59***	—
Mon	—	0.42***	0.17***	—	—
Tues	—	0.47***	0.2***	—	—
Wed	−0.46***	0.45***	0.19***	—	0.088*
Thu	−0.36***	0.51***	0.22***	—	0.085*
Fri	−0.16***	0.45***	0.18***	—	—
Sat	—	—	—	—	—
T^M * Sun	−0.16***	—	−0.061***	0.12***	−0.04**
T^M * Mon	−0.037**	—	—	0.087***	—
T^M * Tues	−0.049***	—	—	0.12***	—
T^M * Wed	0.11***	—	—	0.1***	—
T^M * Thu	0.068*	—	—	0.12***	—
T^M * Fri	—	—	—	0.12***	—
T^M * Sat	—	−0.1***	−0.074***	—	—
Jan	—	—	—	—	—
Feb	—	—	—	−0.12*	—
Mar	—	—	—	−0.17**	—
Apr	—	—	—	−0.3***	—
May	—	—	—	−0.3***	—
Jun	—	—	—	−0.34***	—
Jul	—	—	—	−0.35***	—
Aug	—	—	—	−0.34***	—
Sep	—	—	—	−0.36***	—
Oct	—	—	—	−0.22***	—
Nov	—	—	—	−0.13*	—
Dec	—	—	—	—	0.1*
Holidays (I)	0.17*	−0.78***	−0.38***	−0.53***	−0.27**
Holidays (2)	0.19**	−0.48***	−0.23***	−0.28***	−0.26**

[a] Δ denotes daily deviations for each pollutant and meteorological variable. RF is a daily factor representing whether or not it rained on a given day; $T^M * \Delta T^m$ and $T^M * \Delta RH$ are interaction terms between maximum daily temperature and daily deviations of mean temperature and relative humidity; WS is wind speed; –1 and –2 subscripts represent one and two days lags, respectively. Holidays (I) represent stationary holidays, and Holidays (II) represent holidays that are on different days each year. These values were estimated using centered (by the mean) and scaled (by the standard deviations) covariates; therefore, values should be interpreted relative to each other. Significance codes: $P < 0.001$***, $P < 0.01$**, $P < 0.05$*

Table A.2. Model parameters for scaled and normalized linear detrending model at JST for particulate species[a]

	$\Delta PM_{2.5}$	ΔSO_4	ΔNO_3	ΔNH_4	ΔOC	ΔEC
R^2(adj.)	0.4	0.18	0.25	0.2	0.47	0.45
(Intercept)	0.35***	0.044***	0.036*	0.093***	0.028**	0.087***
ΔT^m	−0.08**	−0.1***	−0.25***	−0.14***	0.1***	0.047*
$(\Delta T^m)^2$	−0.067***	−0.034***	−0.047***	−0.053***	−0.019***	—
$(\Delta T^m)^3$	—	—	—	—	—	0.0092**
$T^M * \Delta T^m$	0.36***	0.18***	0.13***	0.26***	0.082***	0.089***
$T^M * \Delta RH$	−0.17***	−0.14***	−0.16***	−0.082***	−0.06***	−0.043***
ΔWS	−0.2***	−0.044***	−0.17***	−0.067***	−0.099***	−0.2***
ΔRH	0.26***	0.23***	0.18***	0.24***	0.047**	—
RF	−0.17***	−0.12***	−0.061***	−0.11***	−0.029***	—
ΔT^m_{-1}	−0.063**	—	−0.13***	−0.03*	−0.045***	−0.071***
ΔWS_{-1}	−0.19***	−0.073***	−0.12***	−0.072***	−0.069***	−0.097***
ΔRH_{-1}	−0.18***	0.024*	−0.068***	—	−0.12***	−0.11***
RF_{-1}	−0.14***	−0.065***	−0.031**	−0.064***	−0.048***	−0.032***
ΔT^m_{-2}	−0.018***	—	—	−0.0071**	−0.006**	−0.006*
ΔWS_{-2}	−0.052***	−0.06***	−0.051***	−0.051***	—	—
ΔRH_{-2}	−0.0046***	—	−0.0021***	−0.0021***	−0.0022***	—
RF_{-2}	—	—	—	—	—	—
Sun	−0.35***	—	−0.16***	−0.22***	−0.071***	−0.18***
Mon	−0.37***	—	−0.081**	−0.083***	−0.046**	—
Tues	—	—	—	—	—	—
Wed	—	—	—	—	—	—
Thu	—	—	0.084**	—	—	0.21***
Fri	—	—	0.1***	—	—	—
Sat	—	—	—	—	—	—
T^M * Sun	0.072*	—	—	0.048*	—	—
T^M * Mon	0.077*	—	—	—	—	0.048***
T^M * Tues	—	—	—	—	—	0.066***
T^M * Wed	—	—	0.021*	—	—	0.078***
T^M * Thu	—	—	—	—	—	—
T^M * Fri	—	—	—	—	—	0.071***
T^M * Sat	—	—	—	—	—	—
Jan	−0.13*	—	0.099**	0.082**	—	−0.076*
Feb	−0.13*	—	—	—	—	—
Mar	−0.15**	—	—	—	0.047*	—
Apr	−0.27***	−0.067**	—	−0.061*	—	−0.11***
May	−0.21***	—	—	—	—	−0.097**
Jun	−0.2***	—	—	—	—	−0.093**
Jul	−0.13*	—	—	—	—	−0.12***
Aug	−0.21***	—	—	—	—	−0.13***
Sep	−0.3***	—	—	—	—	−0.1***
Oct	−0.27***	—	—	—	—	−0.074*
Nov	−0.21***	—	—	—	—	−0.072*
Dec	—	—	0.077*	—	0.086***	—
Holidays (I)	—	−0.13**	−0.15*	—	−0.091*	−0.29***
Holidays (2)	—	—	—	—	—	−0.18***

Δ denotes daily deviations for each pollutant and meteorological variable. RF is a daily factor representing whether or not it rained on a given day; $T^M * \Delta T^m$ and $T^M * \Delta RH$ are interaction terms between maximum daily temperature and daily deviations of mean temperature and relative humidity; WS is wind speed; −1 and −2 subscripts represent one and two days lags, respectively. Holidays (I) represent stationary holidays, and Holidays (II) represent holidays that are on different days each year. These values were estimated using centered (by the mean) and scaled (by the standard deviations) covariates; therefore, values should be interpreted relative to each other. Significance codes: $P < 0.001$***, $P < 0.01$**, $P < 0.05$*

Table A.3. Availability of daily pollutant species and meteorological metrics (2000–2013) from BHM, converted from hourly measurements[a]

Species	Metric	Period	Exclusion criteria (hours)	# Days	% Missing Days
Gaseous (ppb)					
O_3	Max of 8-h mean	12 AM–11 PM	—	4670	8.7
NO_x	Daily mean	11 AM–7 PM	≥ 5/9	3610	29.4
CO	Daily mean	11 AM –7 PM	≥ 5/9	4335	15.2
SO_2	Daily max	12 AM –11 PM	≥ 12/24	4475	12.5
Particulate ($\mu g/m^3$)					
$PM_{2.5}$	Daily mean	12 AM –11 PM	—	4627	9.5
Meteorology[b]					
SR (W/m^2)	Daily total	12 AM –11 PM	Any, 7 AM -6 PM	3684	28.0
SR^M (W/m^2)	Daily max	12 AM –11 PM	—	4583	10.4
T^m (°C)	Daily mean	11 AM –3 PM	≥ 3/5	4522	11.6
T^M (°C)	Daily max	12 AM –11 PM	—	4638	9.3
WS (m/sec)	Daily mean	11 AM –3 PM	≥ 3/5	4512	11.8
WS^{morn} (m/sec)	Morning mean	7 AM –10 AM	≥ 3/5	4512	11.8
RH (%)	Morning mean	8 AM –11 AM	≥ 3/4	4599	10.1
RF (1 or 0)	Daily factor	12 AM –11 PM	—	5046	1.33

[a] There were 5114 total days. If the exclusion criteria is violated on a certain day, the species is recorded as not available for that day.

[b] SR = shortwave radiation; SRM = maximum shortwave radiation; Tm = mean temperature; TM = maximum temperature; WS = wind speed; RH = relative humidity; RF = rainfall (1 if rain, 0 if no rain).

Table A.4. Model parameters for scaled and normalized linear detrending model at BHM[a]

	ΔO_3	ΔNO_X	ΔCO	ΔSO_2	$\Delta PM_{2.5}$
R^2(adj.)	0.3	0.38	0.23	0.27	0.38
(Intercept)	0.45***	0.28***	–0.023	0.032	0.028
ΔT^m (°C)	—	0.12***	0.13***	0.21***	—
$(\Delta T^m)^2$ (°C)	0.024*	–0.054***	–0.032**	–0.055***	—
$(\Delta T^m)^3$ (°C)	–0.0092*	—	—	—	—
$T^M * \Delta T^m$ (°C)	–0.064*	—	0.091**	—	—
$T^M * \Delta RH$ (%Δ°C)	–0.15***	0.27***	—	–0.19***	–0.13***
ΔWS (m/sec)	—	–0.33***	–0.31***	–0.3***	—
ΔRH (%)	–0.29***	—	0.17***	—	0.15***
RF (1 or 0)	—	—	—	—	–0.14***
ΔT^m_{-1} (°C)	0.097***	–0.11***	–0.11***	–0.13***	0.1***
ΔWS_{-1} (m/sec)	—	–0.092***	–0.096***	–0.085***	–0.07***
ΔRH_{-1} (%)	–0.074***	–0.16***	–0.14***	–0.15***	0.065***
RF_{-1} (1 or 0)	—	—	—	–0.033*	–0.22***
ΔT^m_{-2} (°C)	–0.0088*	–0.013**	–0.01*	—	0.03***
ΔWS_{-2} (m/sec)	–0.061***	0.041*	—	—	–0.38***
ΔRH_{-2} (%)	–0.0042***	—	—	0.0021*	–0.0075***
RF_{-2} (1 or 0)	–0.07*	—	—	—	–0.15***
Sun	—	—	—	—	–0.21***
Mon	–0.27*	—	0.31***	—	—
Tues	–0.32**	—	0.26***	—	—
Wed	–0.29*	—	—	—	—
Thu	—	–0.45***	—	—	0.33**
Fri	0.3*	–0.9***	–0.3***	—	—
Sat	—	—	—	—	—
T^M * Sun (°C)	0.3***	0.072***	0.058***	—	—
T^M * Mon (°C)	0.41***	0.094***	—	—	—
T^M * Tues (°C)	0.41***	0.085***	—	—	—
T^M * Wed (°C)	0.4***	0.071***	0.068***	—	0.029*
T^M * Thu (°C)	0.34***	—	—	—	–0.077*
T^M * Fri (°C)	0.26***	—	—	—	—
T^M * Sat (°C)	0.32***	—	—	—	—
Jan	—	0.19***	0.14**	—	—
Feb	—	—	0.11*	0.12*	—
Mar	–0.18**	—	—	—	—
Apr	–0.32***	—	—	—	–0.094*
May	–0.53***	–0.12*	—	—	—
Jun	–0.68***	—	—	—	—
Jul	–0.81***	–0.12*	—	—	—
Aug	–0.81***	–0.14*	—	—	—
Sep	–0.63***	–0.15**	—	—	—
Oct	–0.36***	—	—	—	—
Nov	–0.14**	—	–0.12*	—	—
Dec	—	—	—	—	—
Holidays (I)	—	—	—	—	–0.24**
Holidays (2)	—	–0.22*	–0.19*	—	—

[a] Δ denotes daily deviations for each pollutant and meteorological variable. RF is a daily factor representing whether or not it rained on a given day; $T^M * \Delta T^m$ and $T^M * \Delta RH$ are interaction terms between maximum daily temperature and daily deviations of mean temperature and relative humidity; WS is wind speed; –1 and –2 subscripts represent one and two days lags, respectively. Holidays (I) represent stationary holidays, and Holidays (II) represent holidays that are on different days each year. These values were estimated using centered (by the mean) and scaled (by the standard deviations) covariates; therefore, values should be interpreted relative to each other. Significance codes: $P < 0.001$***, $P < 0.01$**, $P < 0.05$*

Table A.5. Daily absolute mean contribution and percent of observed standard deviation (SD) explained by STM in meteorological detrending at JST

	Daily		Summer		Winter	
	Mean	SD	Mean	SD	Mean	SD
Gaseous (ppb)						
O_3	7.96 (21%)	6.76 (18%)	9.68 (19%)	7.71 (16%)	6.35 (21%)	5.48 (19%)
NO_2	2.24 (21%)	2.7 (19%)	1.39 (17%)	1.62 (15%)	3.24 (26%)	3.55 (25%)
CO	0.03 (11%)	0.04 (11%)	0.02 (8%)	0.02 (7%)	0.05 (15%)	0.07 (14%)
SO_2	4.44 (40%)	6.88 (46%)	2.82 (32%)	3.87 (37%)	6.39 (49%)	9.29 (53%)
Particulate ($\mu g/m^3$)						
$PM_{2.5}$	3.1 (24%)	2.86 (21%)	3.56 (22%)	3.32 (21%)	2.82 (25%)	2.68 (24%)
SO_4^{2-}	0.70 (19%)	0.82 (16%)	1.01 (19%)	1.09 (17%)	0.51 (20%)	0.52 (17%)
NH_4^+	0.30 (21%)	0.34 (19%)	0.36 (19%)	0.4 (17%)	0.28 (24%)	0.27 (22%)
NO_3^-	0.20 (25%)	0.31 (27%)	0.06 (18%)	0.08 (18%)	0.41 (35%)	0.44 (34%)
EC	0.38 (31%)	0.44 (33%)	0.31 (26%)	0.34 (29%)	0.43 (37%)	0.53 (41%)
OC	1.01 (28%)	0.98 (26%)	0.84 (24%)	0.75 (23%)	1.09 (31%)	1.07 (30%)

Table A.6. Cross-species Pearson correlations of observations (upper right) and counterfactual (lower left)[a]

Counterfactual / Observed	*Gaseous*				*Particulate*					
	O_3	NO_2	CO	SO_2	$PM_{2.5}$	SO_4^{2-}	NH_4^+	NO_3^-	EC	OC
Gaseous (ppb)										
O_3		–0.45	–0.26	–0.05	0.43	0.52	0.39	–0.38	0.09	0.19
NO_2	–0.58		0.68	0.27	0.19	–0.03	0.12	0.50	0.45	0.34
CO	–0.48	0.64		0.21	0.37	0.13	0.27	0.46	0.55	0.46
SO_2	–0.14	0.21	0.13		0.24	0.15	0.18	0.21	0.30	0.23
Particulate ($\mu g/m^3$)										
$PM_{2.5}$	0.47	–0.02	0.12	0.09		0.76	0.75	0.19	0.62	0.67
SO_4^{2-}	0.63	–0.32	–0.17	–0.01	0.73		0.83	–0.02	0.31	0.31
NH_4^+	0.60	–0.22	–0.15	–0.05	0.71	0.86		0.21	0.40	0.38
NO_3^-	–0.43	0.48	0.47	0.18	0.09	–0.17	–0.06		0.25	0.24
EC	0.02	0.39	0.38	0.17	0.47	0.10	0.18	0.20		0.83
OC	0.10	0.26	0.31	0.10	0.54	0.12	0.18	0.22	0.77	

[a] Red shading indicates a change in correlation between observations and counterfactual of more than 0.20. The shading is symmetric across the diagonal grey boxes.

Table A.7. CMAQ model evaluation for four years (2001, 2002, 2011, and 2012) at JST[a]

	Concentration			EGU			MOB		
	NMB (%)	NME (%)	*r*	NMB (%)	NME (%)	*r*	NMB (%)	NME (%)	*r*
Gaseous (ppb)									
O_3	4.0	19.4	0.82	−26.3	82.4	0.59	−30.9	73.4	0.59
NO_2	324.2	324.2	0.40	−40.2	110.2	−0.05	89.5	107.5	0.04
CO	154.7	155.2	0.62	−89.3	98.1	0.05	62.6	73.6	0.54
SO_2	−60	66.2	0.56	−81.4	81.9	0.24	−69.1	71.6	0.37
Particulate ($\mu g/m^3$)									
$PM_{2.5}$	−4.7	35.2	0.52	−46.2	57.5	0.57	−5.3	53.1	0.21
SO_4^{2-}	−18.1	46.5	0.49	−16.2	58.4	0.27	—	—	—
NH_4^+	−15.1	52.1	0.40	−38.7	70.5	0.48	−48.1	68	0.13
NO_3^-	40.3	80.6	0.68	−123.4	133.6	−0.19	529.6	822.1	−0.05
EC	51.1	65.5	0.60	—	—	—	−35.4	39	0.63
OC	−34.2	43.8	0.49	228.8	308.3	−0.01	−53.3	98.7	0.02

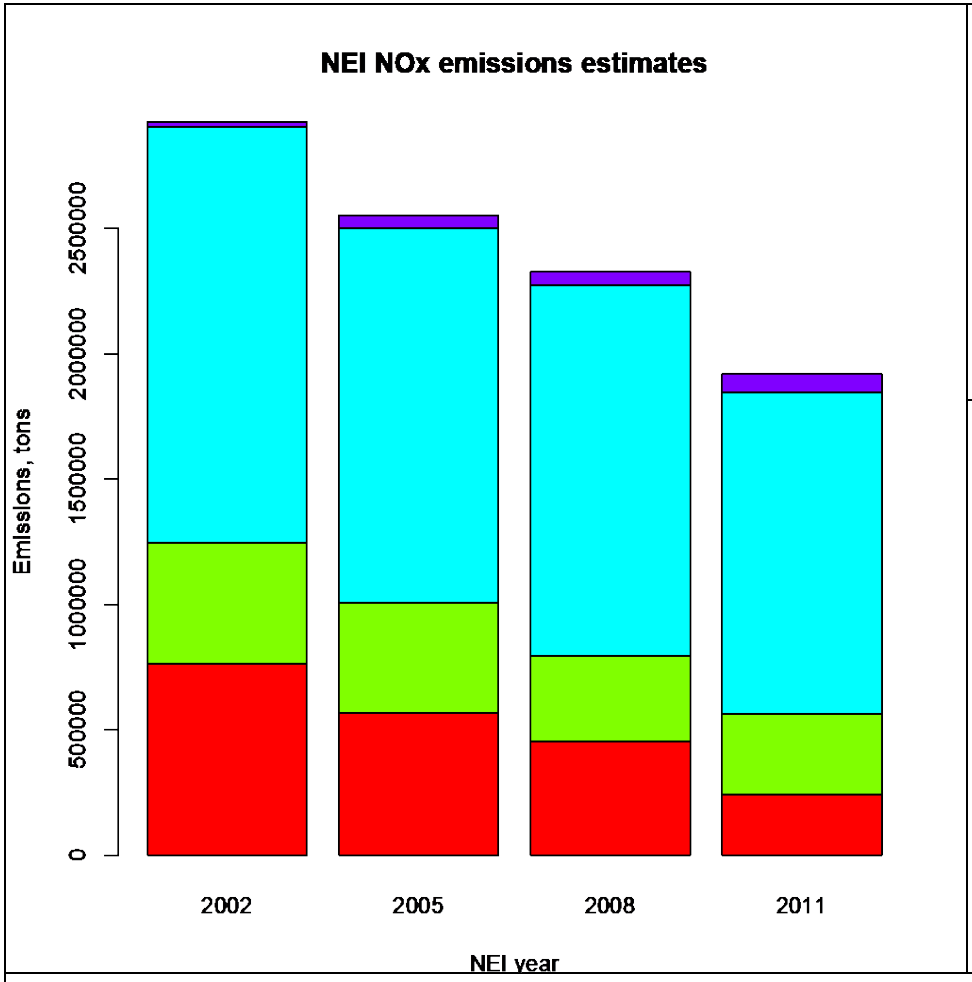
[a] EGU and MOB columns compare empirical sensitivities to CMAQ-modeled sensitivities. The SO_4^{2-} and EC empirical models do not estimate MOB and EGU sensitivities, respectively. *r* is the Pearson correlation coefficient.

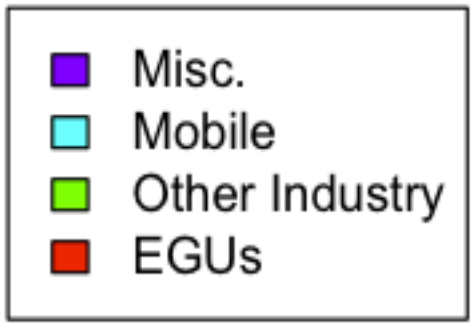
Table A.8. CMAQ values as a function of empirical values in 2011–2012[a]

	Concentration			EGU*			MOB		
	Slope	Intercept	R^2	Slope	Intercept	R^2	Slope	Intercept	R^2
Gaseous (ppb)									
O_3	0.71 (0.02)	15 (0.8)	0.69	1.1 (0.04)	0.26 (0.05)	0.54	0.67 (0.02)	–0.11 (0.2)	0.60
NO_2	0.75 (0.06)	26 (0.5)	0.18	–0.22 (0.06)	0.36 (0.03)	0.02	–0.91 (0.1)	18 (0.7)	0.06
CO	1.2 (0.09)	0.21 (0.02)	0.20	1.6E-3 (2E-3)	4.6E-4 (4E-5)	0.00	0.41 (0.2)	0.16 (0.03)	0.00
SO_2	0.038 (0.004)	1 (0.04)	0.12	0.12 (0.02)	0.31 (0.08)	0.06	–0.081 (0.1)	0.085 (0.03)	0.00
Particulate(μg/m³)									
$PM_{2.5}$	0.4 (0.04)	6.6 (0.4)	0.13	0.21 (0.02)	1.0 (0.05)	0.10	0.4 (0.03)	1.1 (0.01)	0.17
SO_4^{2-}	0.15 (0.02)	1.4 (0.06)	0.06	0.35 (0.04)	0.59 (0.04)	0.11			
NH_4^+	0.35 (0.04)	0.43 (0.04)	0.09	0.18 (0.02)	0.24 (0.009)	0.07	0.28 (0.03)	0.32 (0.02)	0.11
NO_3^-	1.5 (0.05)	0.005 (0.04)	0.57	–0.3 (0.1)	0.074 (0.02)	0.01	–4 (0.4)	0.6 (0.03)	0.15
EC	0.61 (0.05)	1.0 (0.04)	0.20				0.55 (0.04)	0.11 (0.04)	0.23
OC	0.38 (0.03)	1.5 (0.1)	0.14	0.046 (0.01)	0.015 (4E-4)	0.03	0.14 (0.009)	0.18 (0.02)	0.25

[a] EGU* here encompasses both local EGU and REG in the empirical model. Values presented here are identical to those on Figures A1.10 through A1.19.

Figures





EGU	Other Industry	Misc	Mobile
FUEL COMB. ELEC. UTIL.	FUEL COMB. INDUSTRIAL	MISCELLANEOUS	HIGHWAY VEHICLES
	CHEMICAL & ALLIED PRODUCT MFG		OFF-HIGHWAY
	METALS PROCESSING		
	PETROLEUM & RELATED INDUSTRIES		
	OTHER INDUSTRIAL PROCESSES		
	SOLVENT UTILIZATION		
	STORAGE & TRANSPORT		
	WASTE DISPOSAL & RECYCLING		

Figure A.1a. Atlanta annual emissions from various pollutants in four source categories. From the National Emissions Inventory 12-source category summaries for 2002, 2005, 2008, and 2011 (U.S. EPA 2016).

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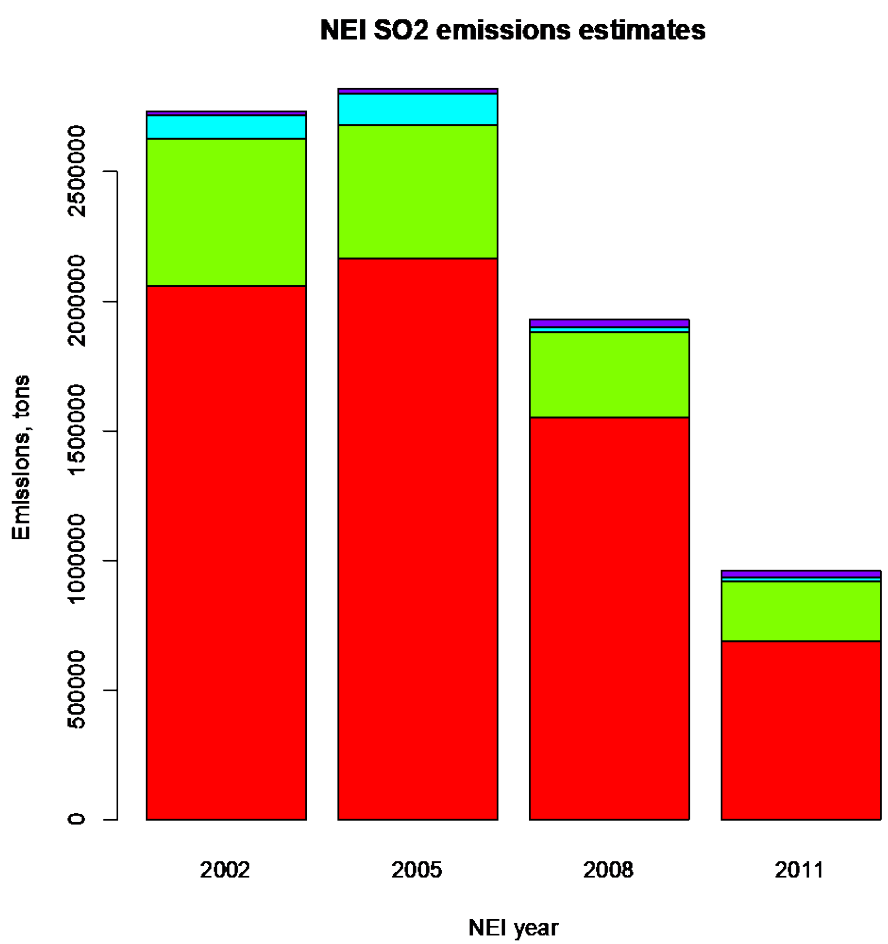

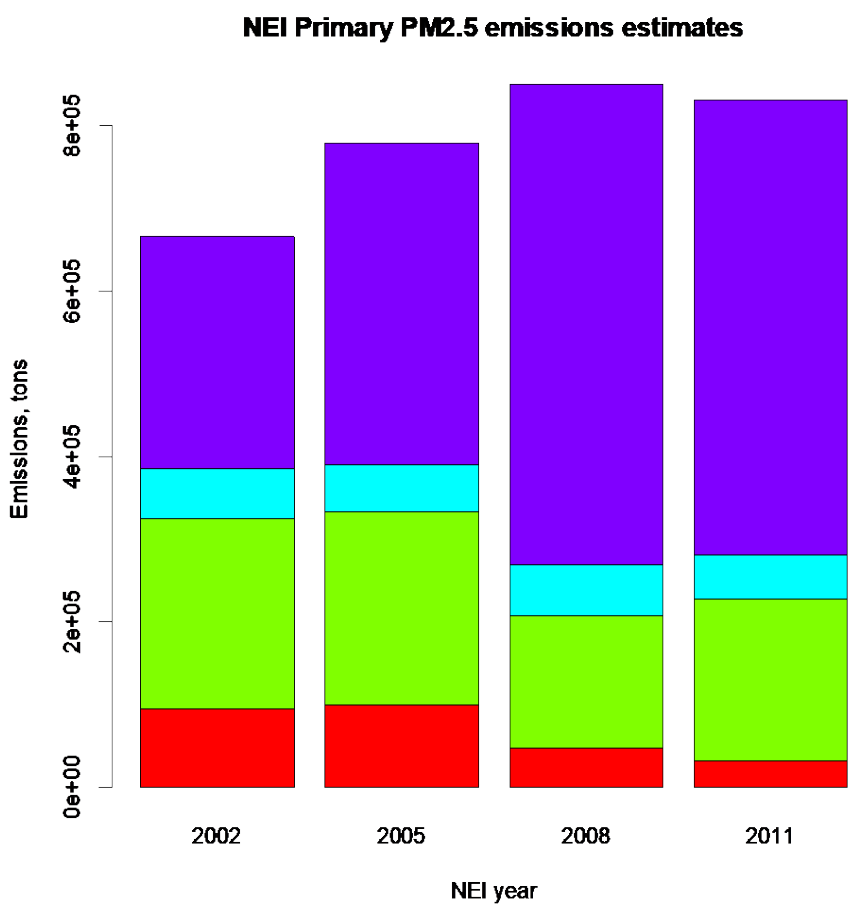

Figure A.1a *continued*. Atlanta annual emissions from various pollutants in four source categories. From the National Emissions Inventory 12-source category summaries for 2002, 2005, 2008, and 2011 (U.S. EPA 2016).

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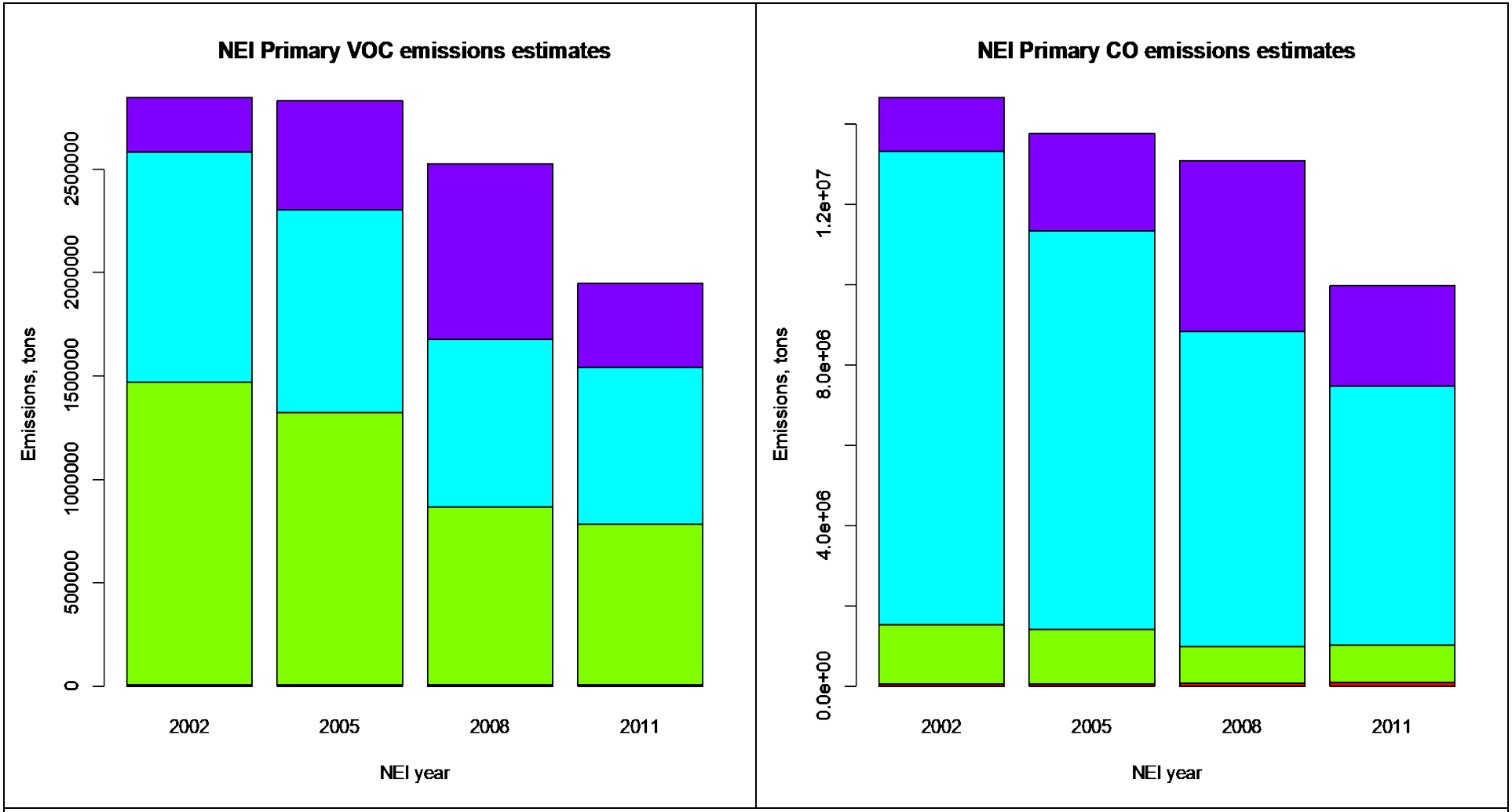
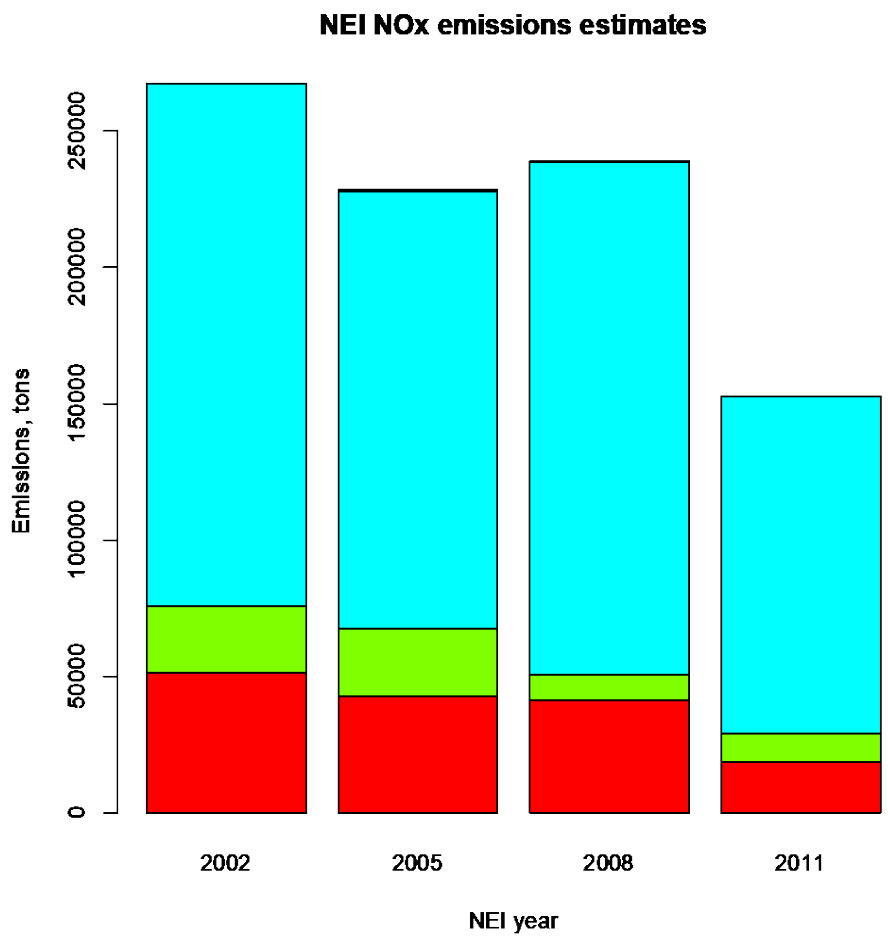
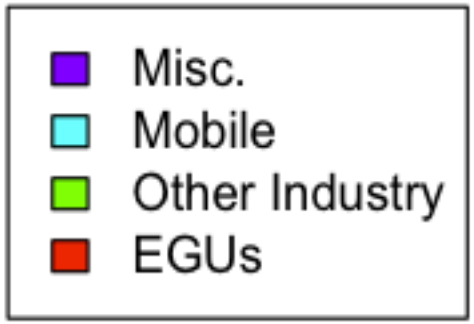


Figure A.1a *continued*. Atlanta annual emissions from various pollutants in four source categories. From the National Emissions Inventory 12-source category summaries for 2002, 2005, 2008, and 2011 (U.S. EPA 2016).





EGU	Other Industry	Misc	Mobile
FUEL COMB. ELEC. UTIL.	FUEL COMB. INDUSTRIAL	MISCELLANEOUS	HIGHWAY VEHICLES
	CHEMICAL & ALLIED PRODUCT MFG		OFF-HIGHWAY
	METALS PROCESSING		
	PETROLEUM & RELATED INDUSTRIES		
	OTHER INDUSTRIAL PROCESSES		
	SOLVENT UTILIZATION		
	STORAGE & TRANSPORT		
	WASTE DISPOSAL & RECYCLING		

Figure A.1b. Regional annual emissions from various pollutants in four source categories. From the National Emissions Inventory 12-source category summaries for 2002, 2005, 2008, and 2011 (U.S. EPA 2016).

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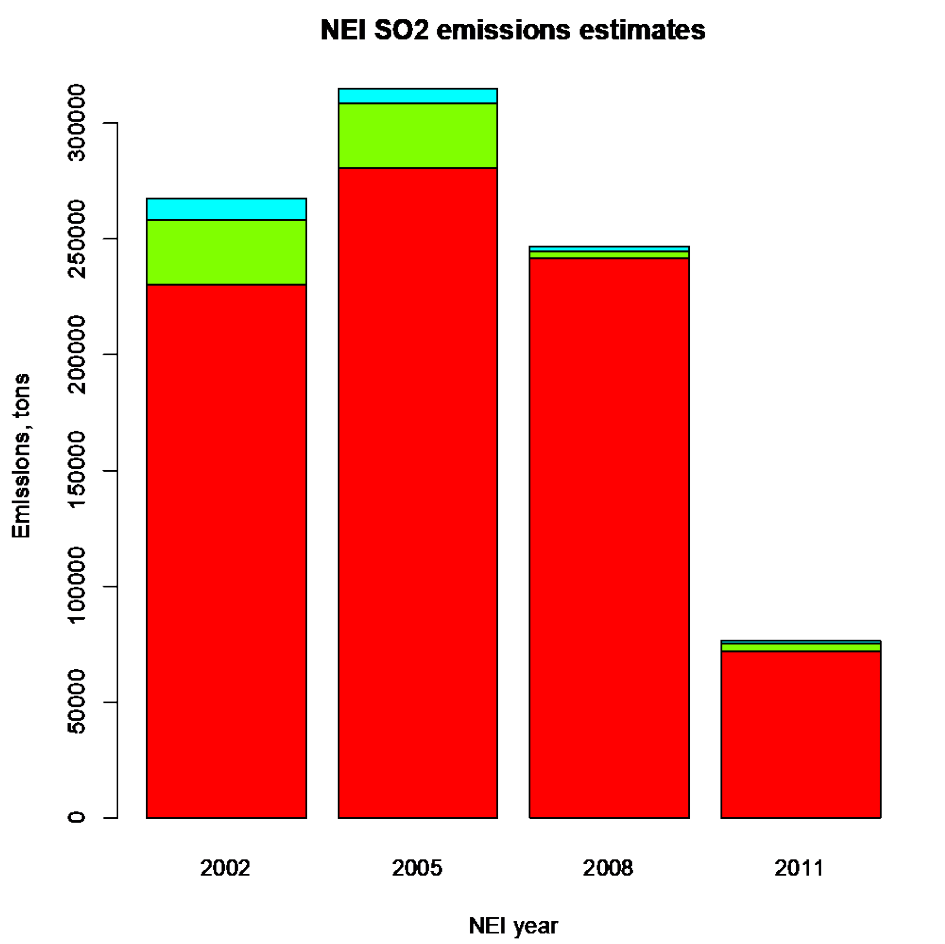

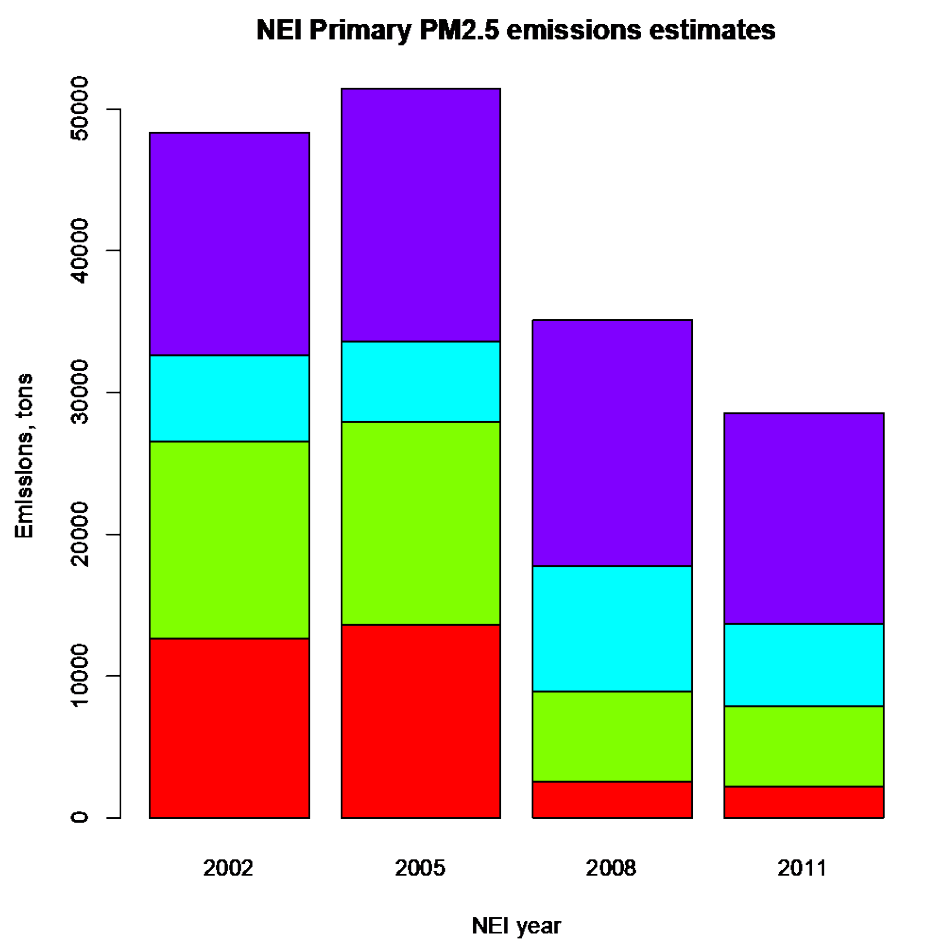

Figure A.1b *continued*. Regional annual emissions from various pollutants in four source categories. From the National Emissions Inventory 12-source category summaries for 2002, 2005, 2008, and 2011 (U.S. EPA 2016).

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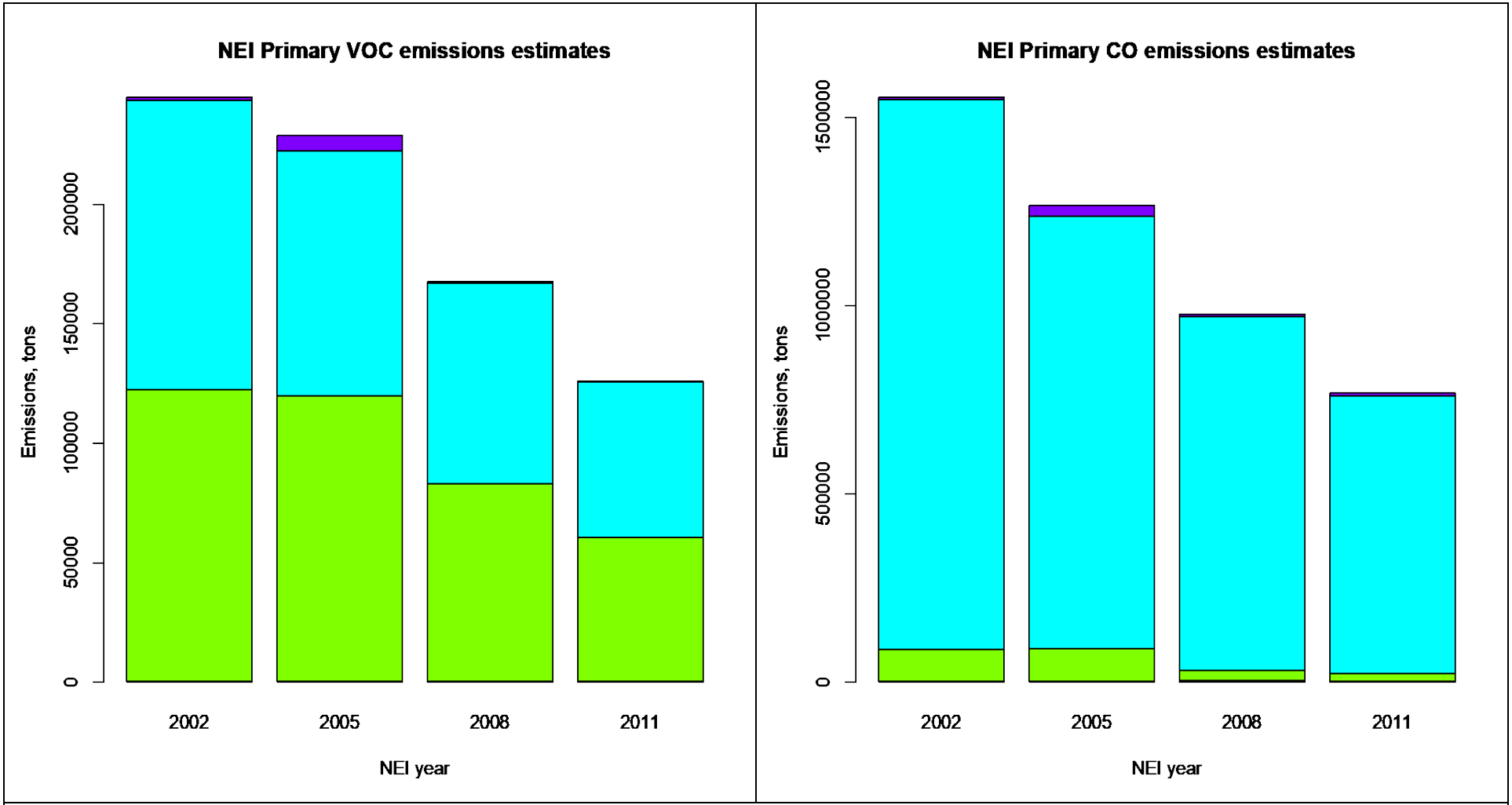


Figure A.1b *continued*. Regional annual emissions from various pollutants in four source categories. From the National Emissions Inventory 12-source category summaries for 2002, 2005, 2008, and 2011 (U.S. EPA 2016).

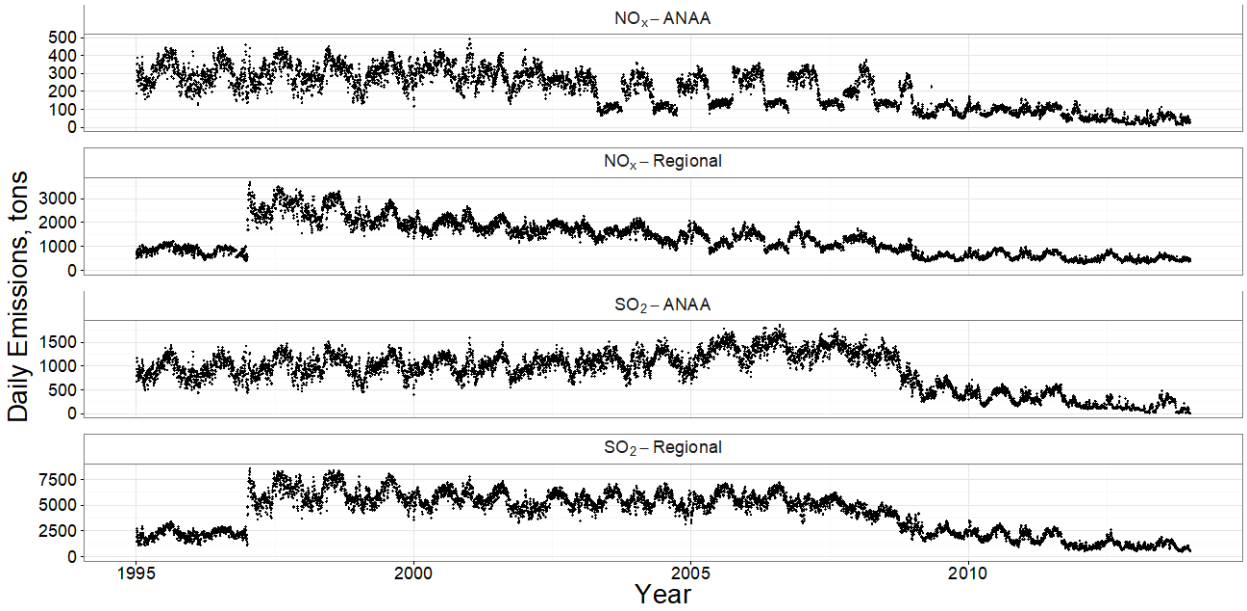


Figure A.2. Daily EGU and REG emissions in the ANAA and in the southeast region.

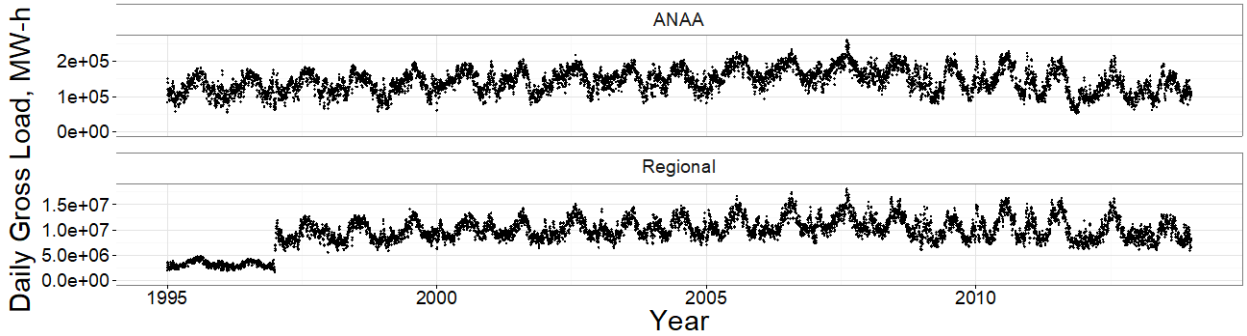


Figure A.3. Daily gross load for EGUs in the ANAA and the southeastern region. Regional load is plotted with the ANAA load subtracted.

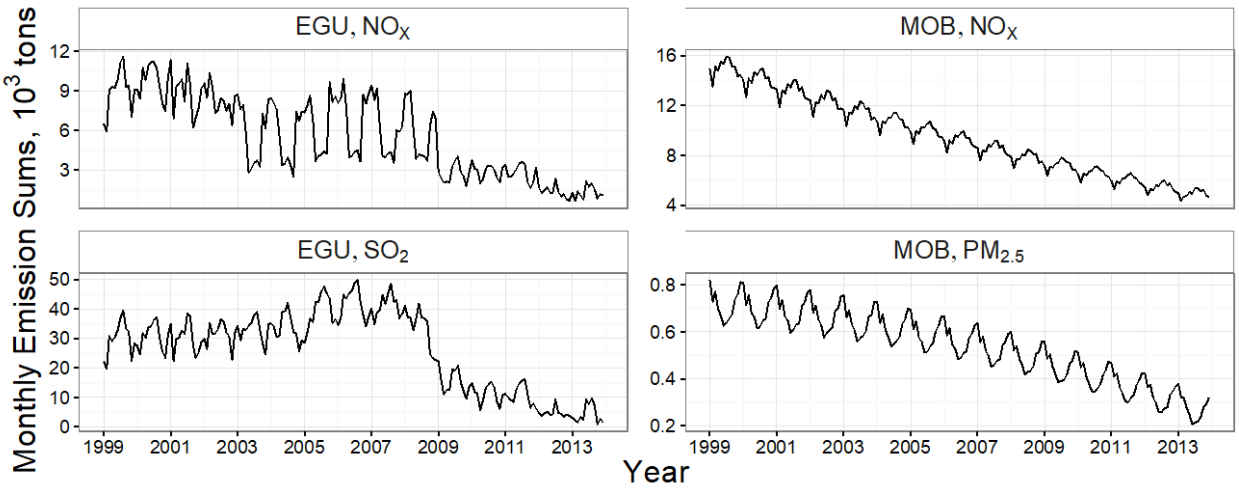


Figure A.4. Monthly-averaged ANAA emissions of key pollutants for EGU and MOB sources.

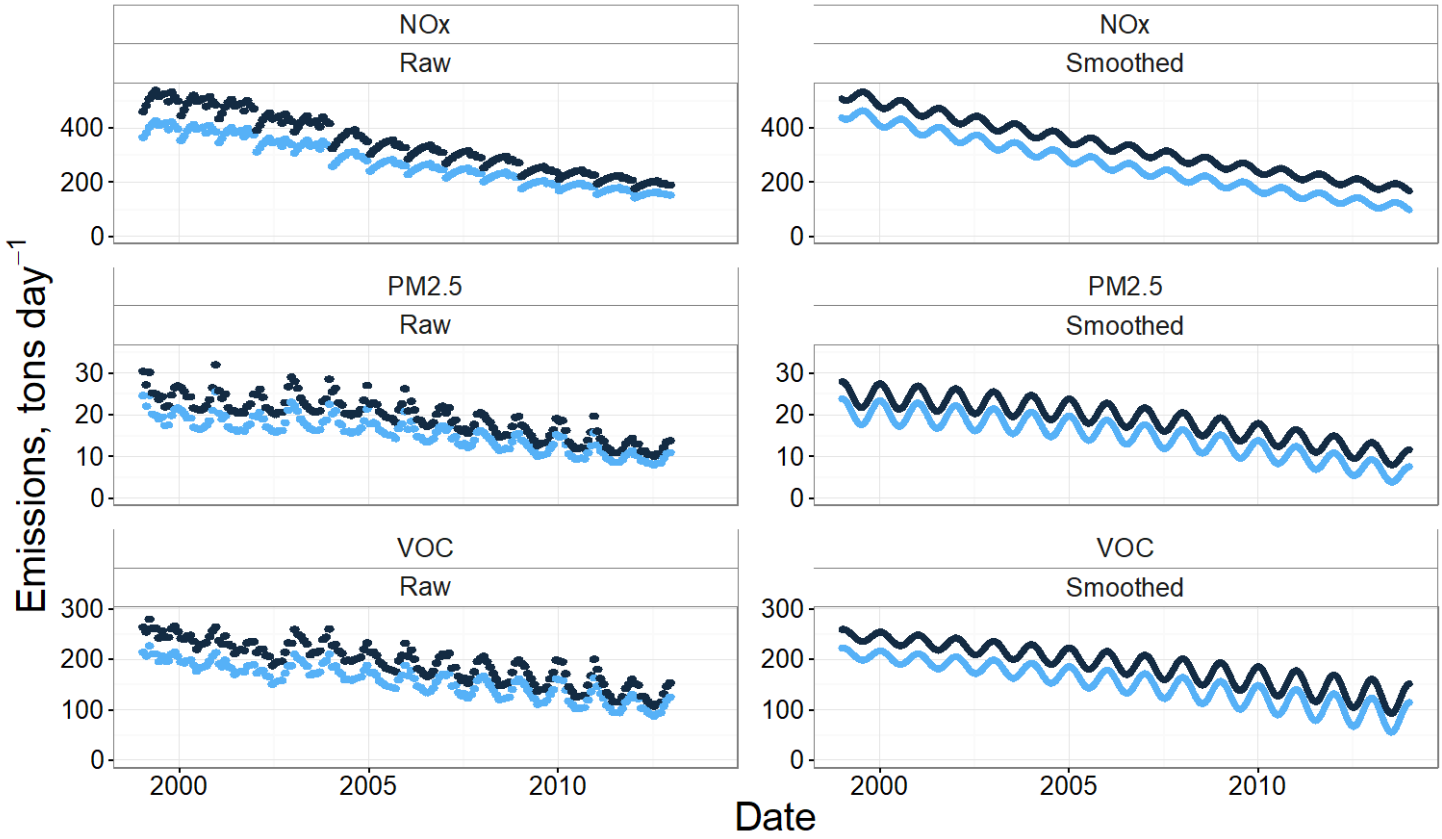


Figure A.5. Daily mobile emissions of three species as modeled by MOVES (left) and smoothed using the linear model. Blue values are weekend emissions, and black are weekend.

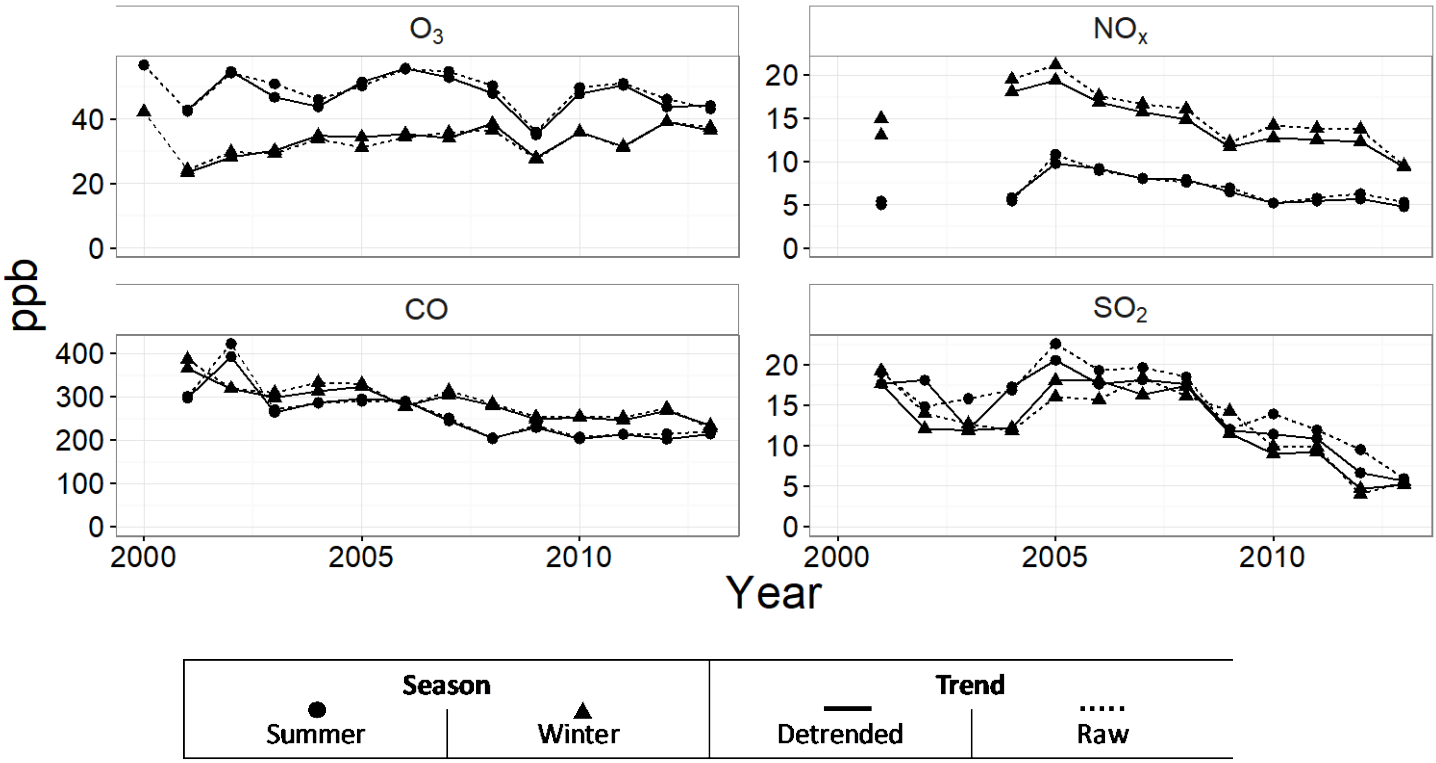


Figure A.6. Detrending differences for BHM (gases).

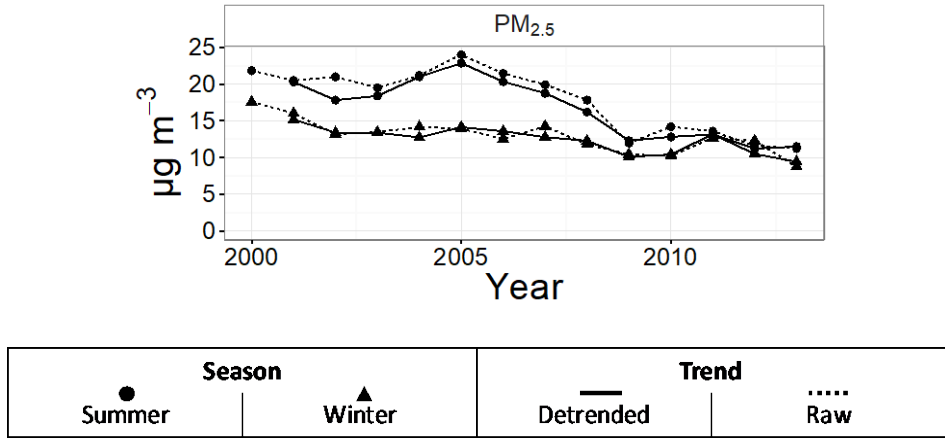


Figure A.7. Detrending time series for BHM.

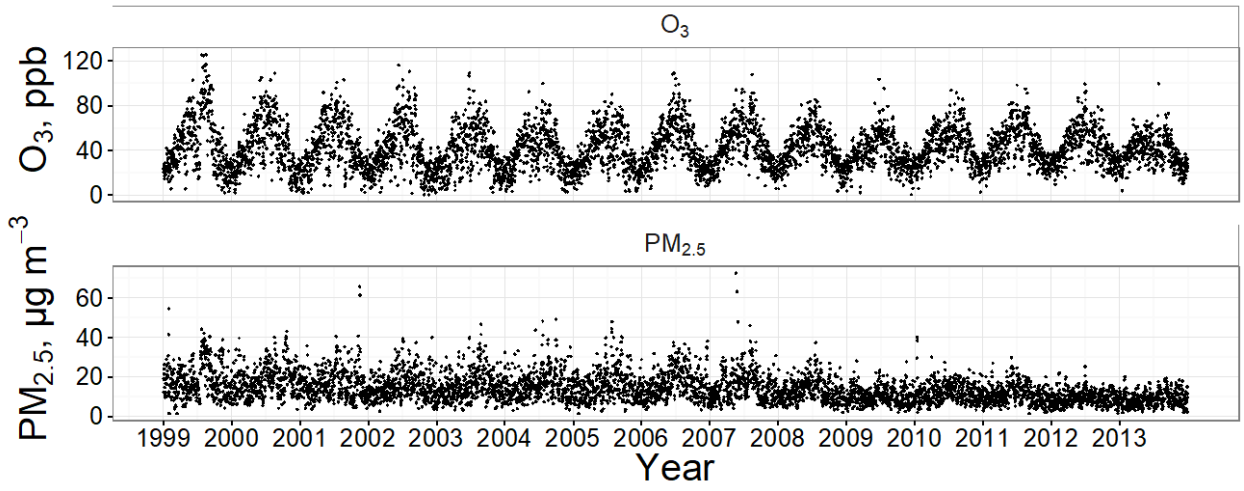


Figure A.8. Daily time series of O_3 and $PM_{2.5}$ at JST. O_3 and $PM_{2.5}$ concentrations show variability on a variety of time scales over the study period, including long-term, annual, and daily. Annual O_3 concentration ranges have decreased with little change in the median, and annual $PM_{2.5}$ mean concentrations have decreased.

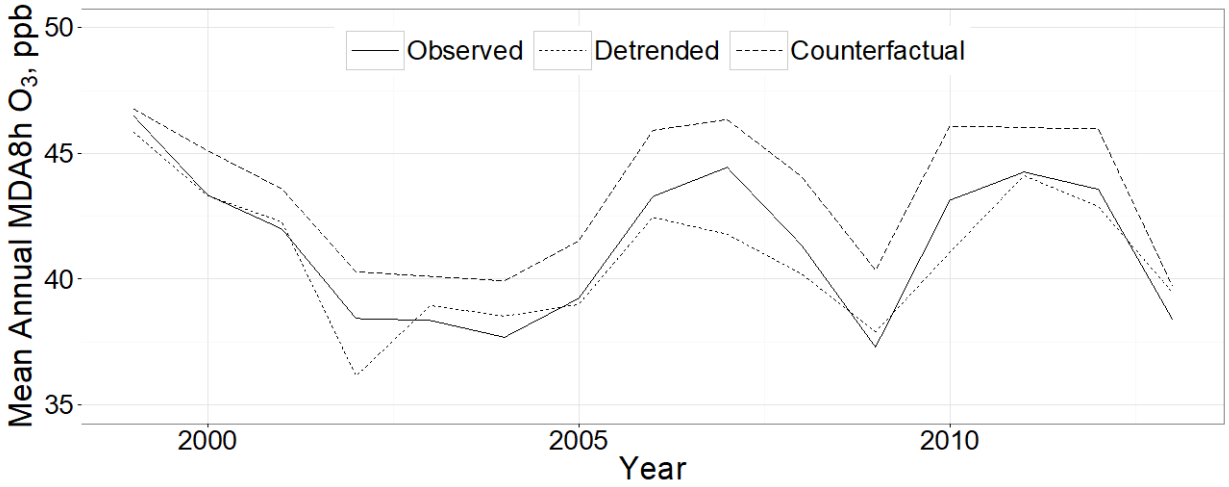


Figure A.9. Annual average observed, detrended, and counterfactual O_3.

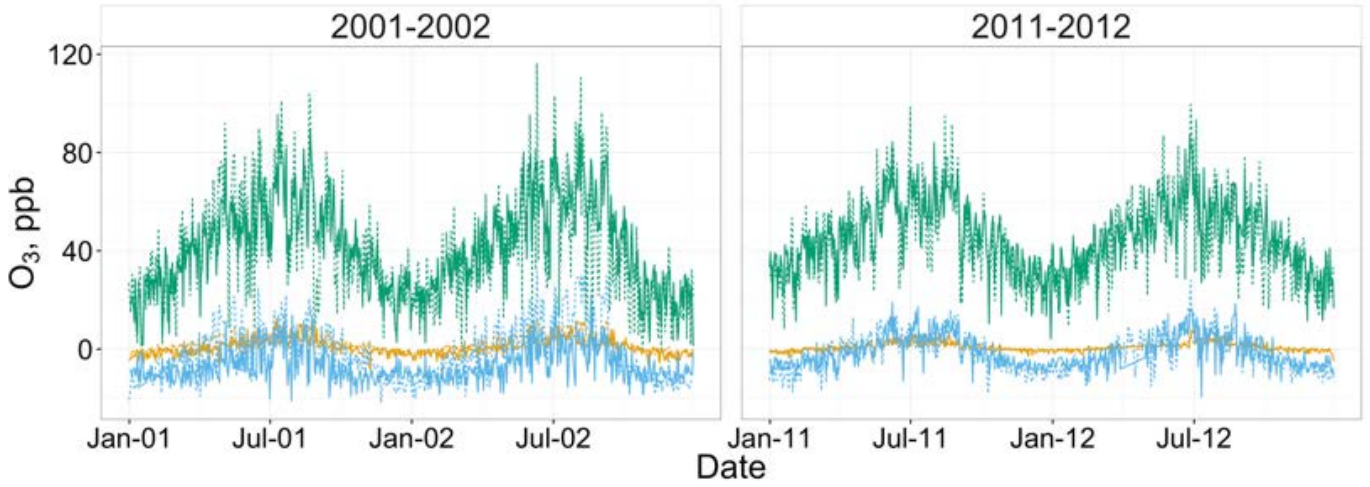
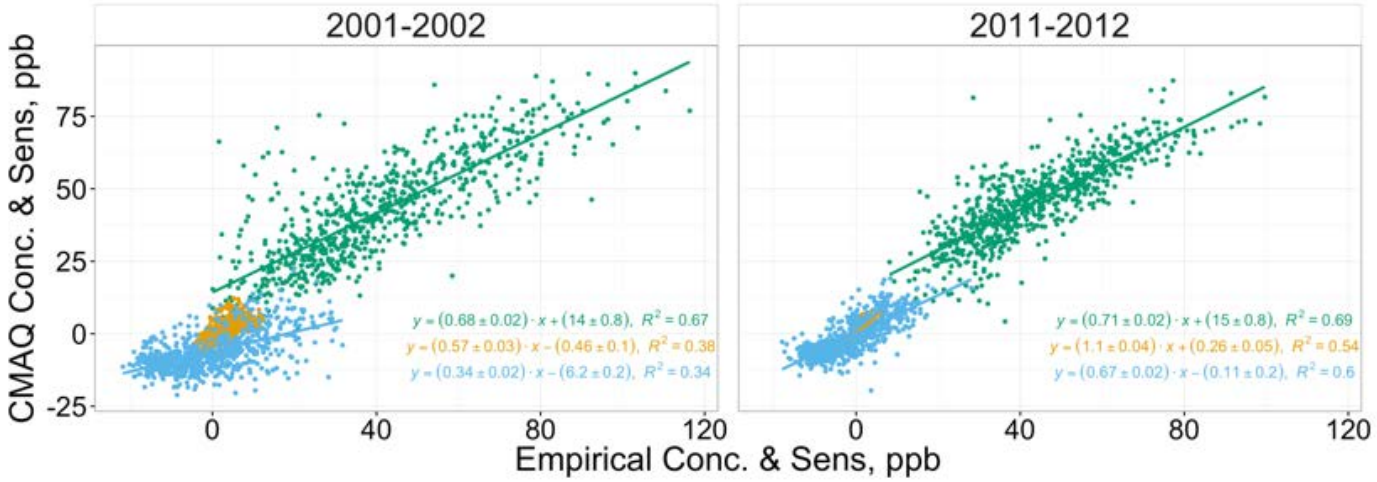


Figure A.10. O_3 daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom)



for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs.

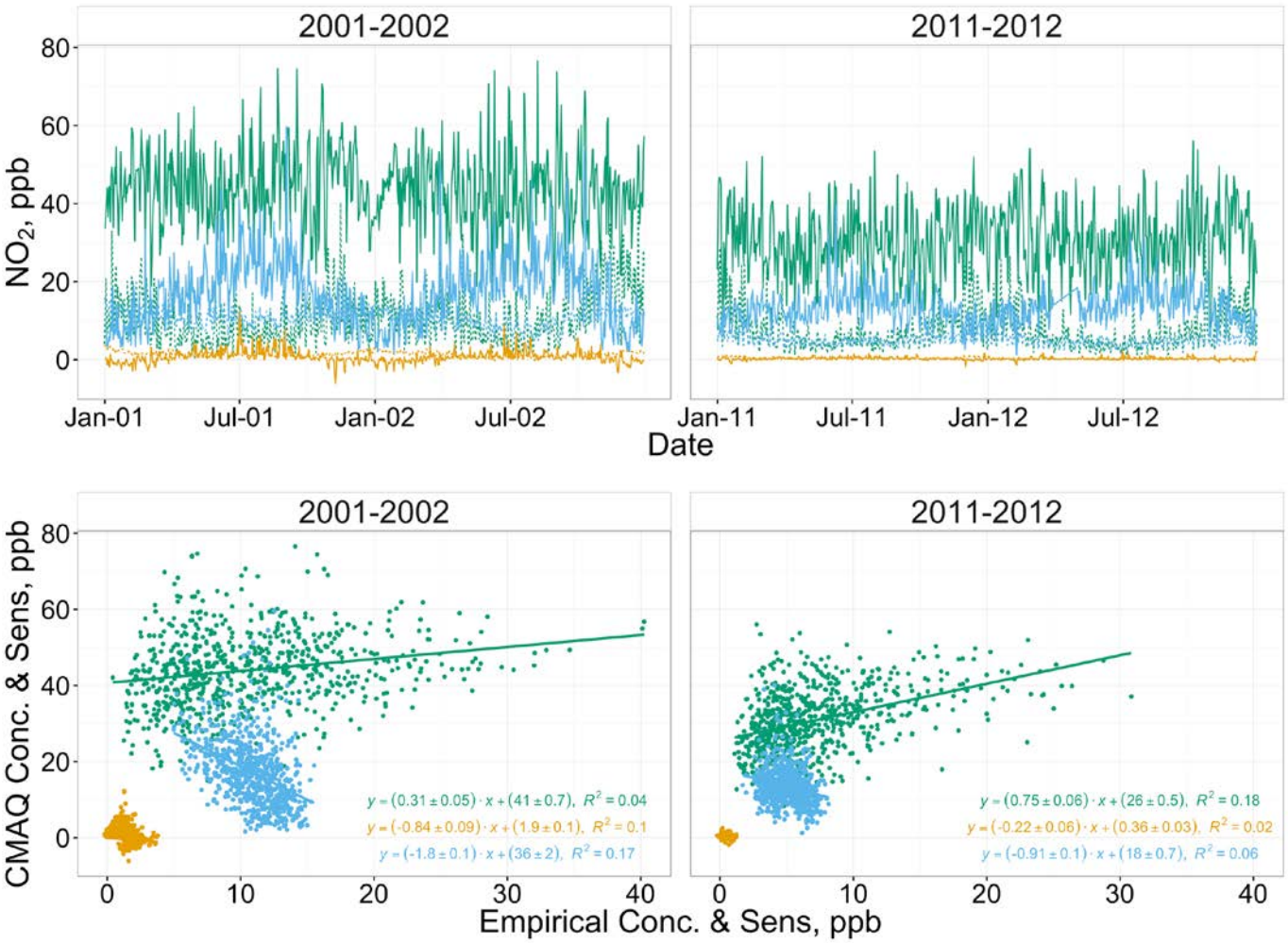


Figure A.11. NO_2 daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs.

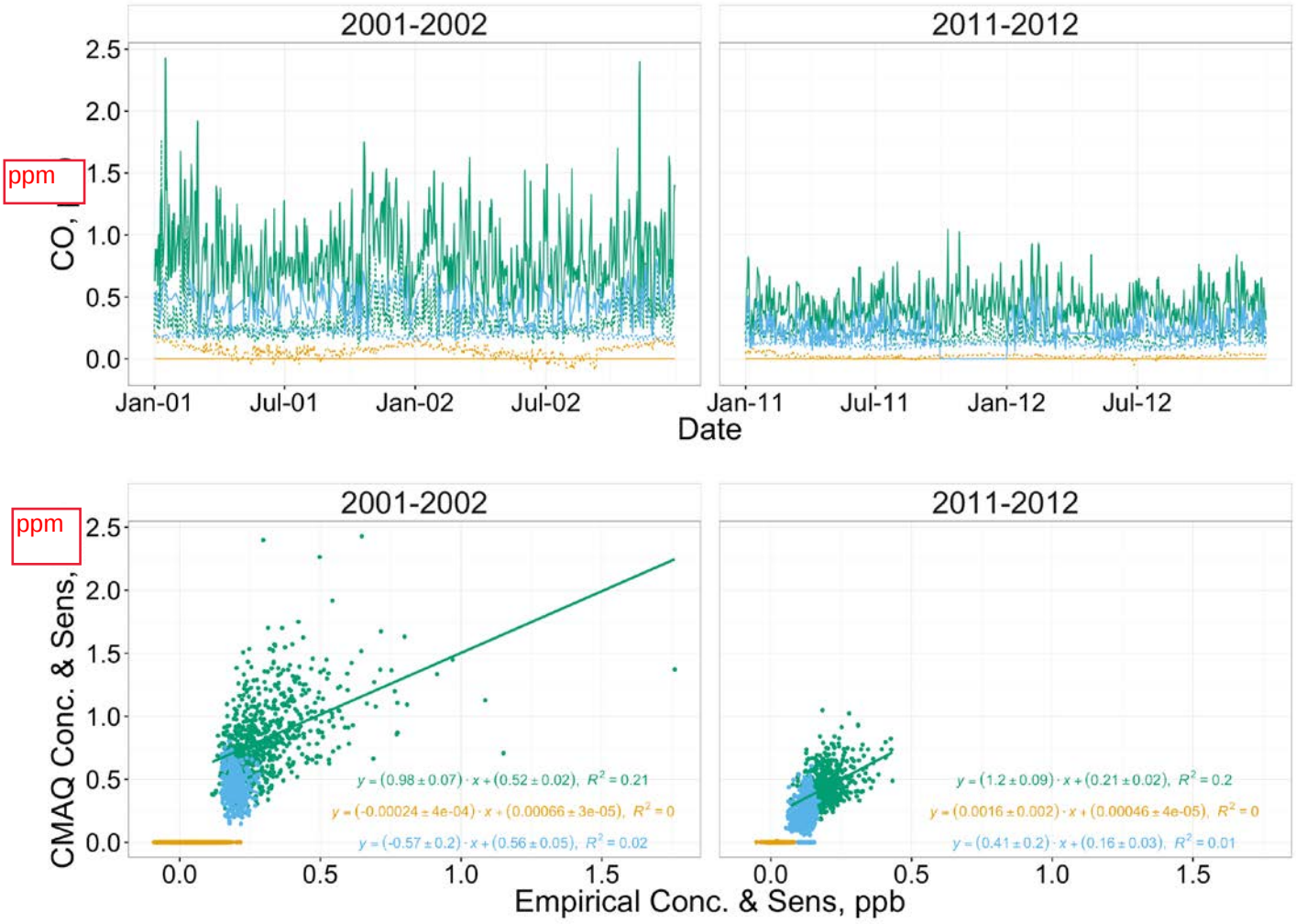


Figure A.12. CO daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

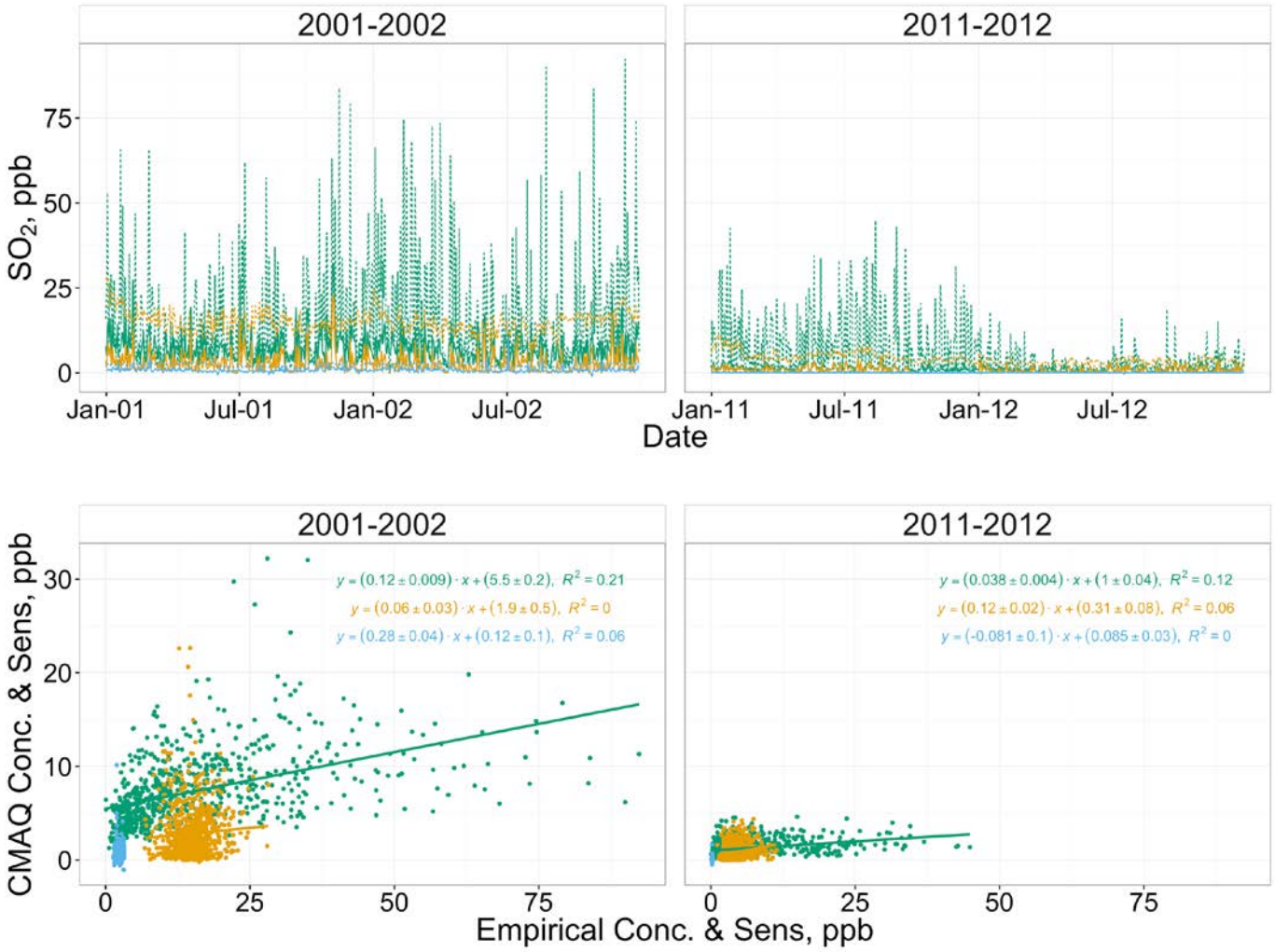


Figure A.13. SO_2 daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

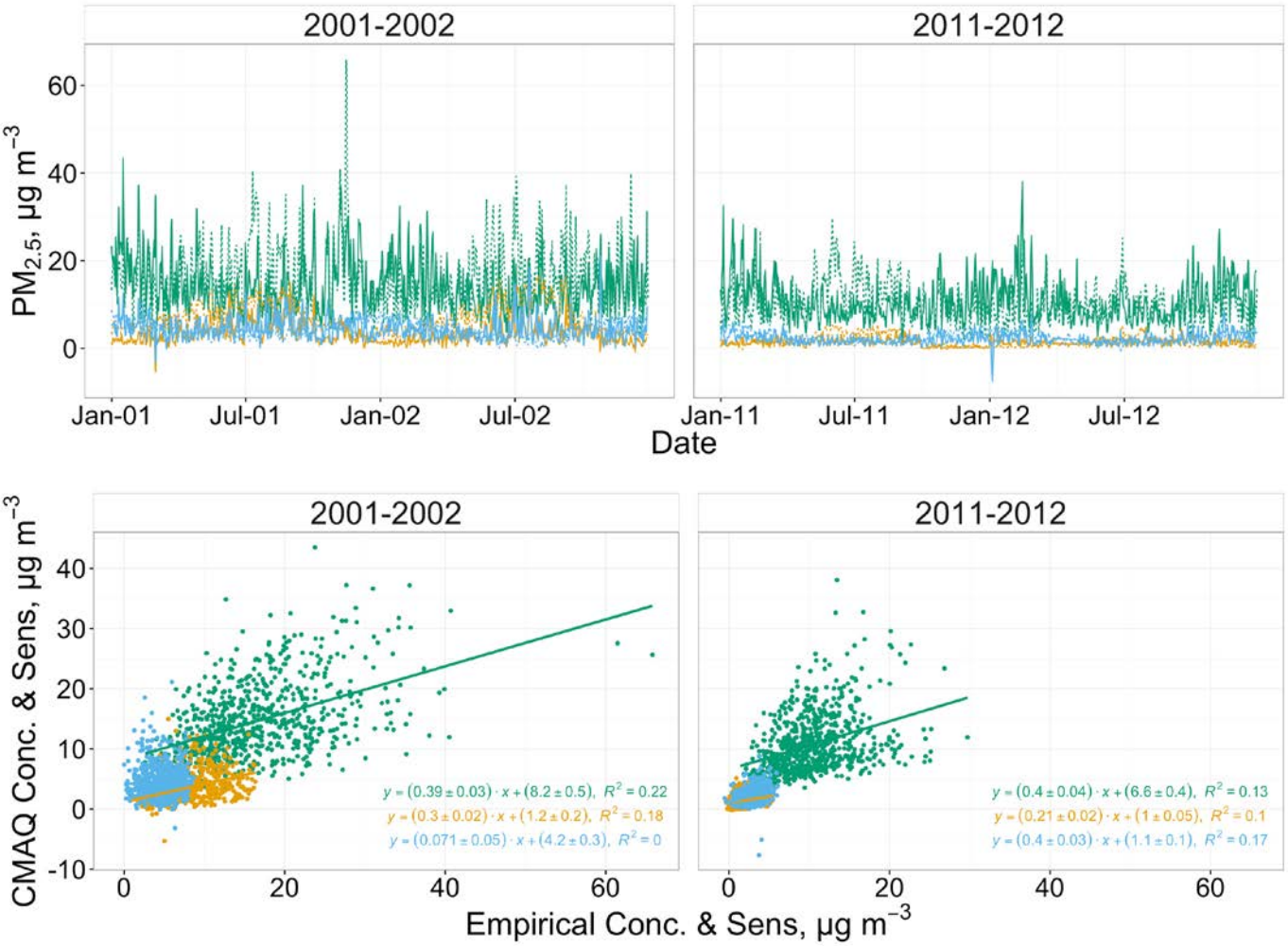


Figure A.14. $PM_{2.5}$ daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

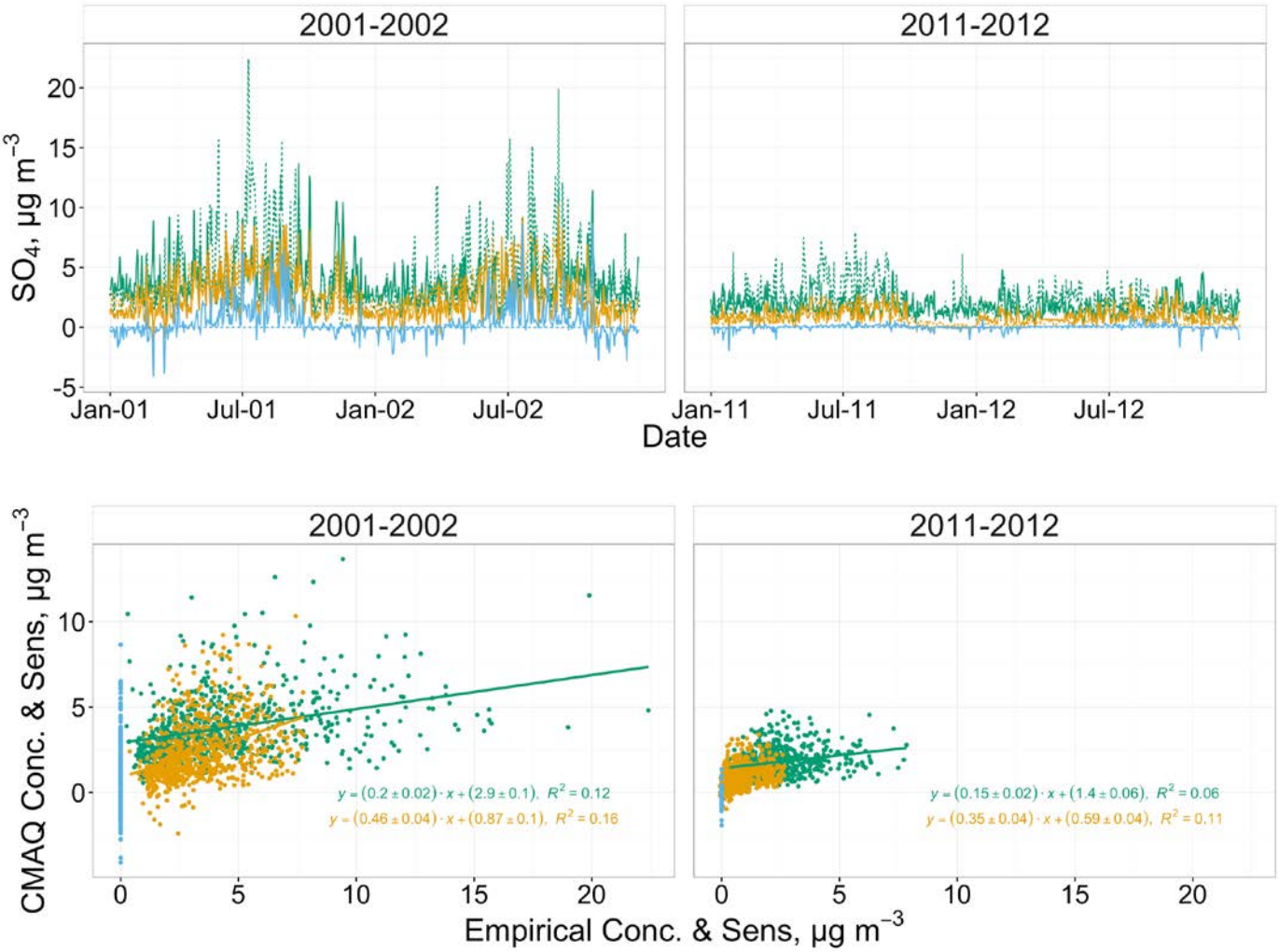


Figure A.15. SO_4^{2-} daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

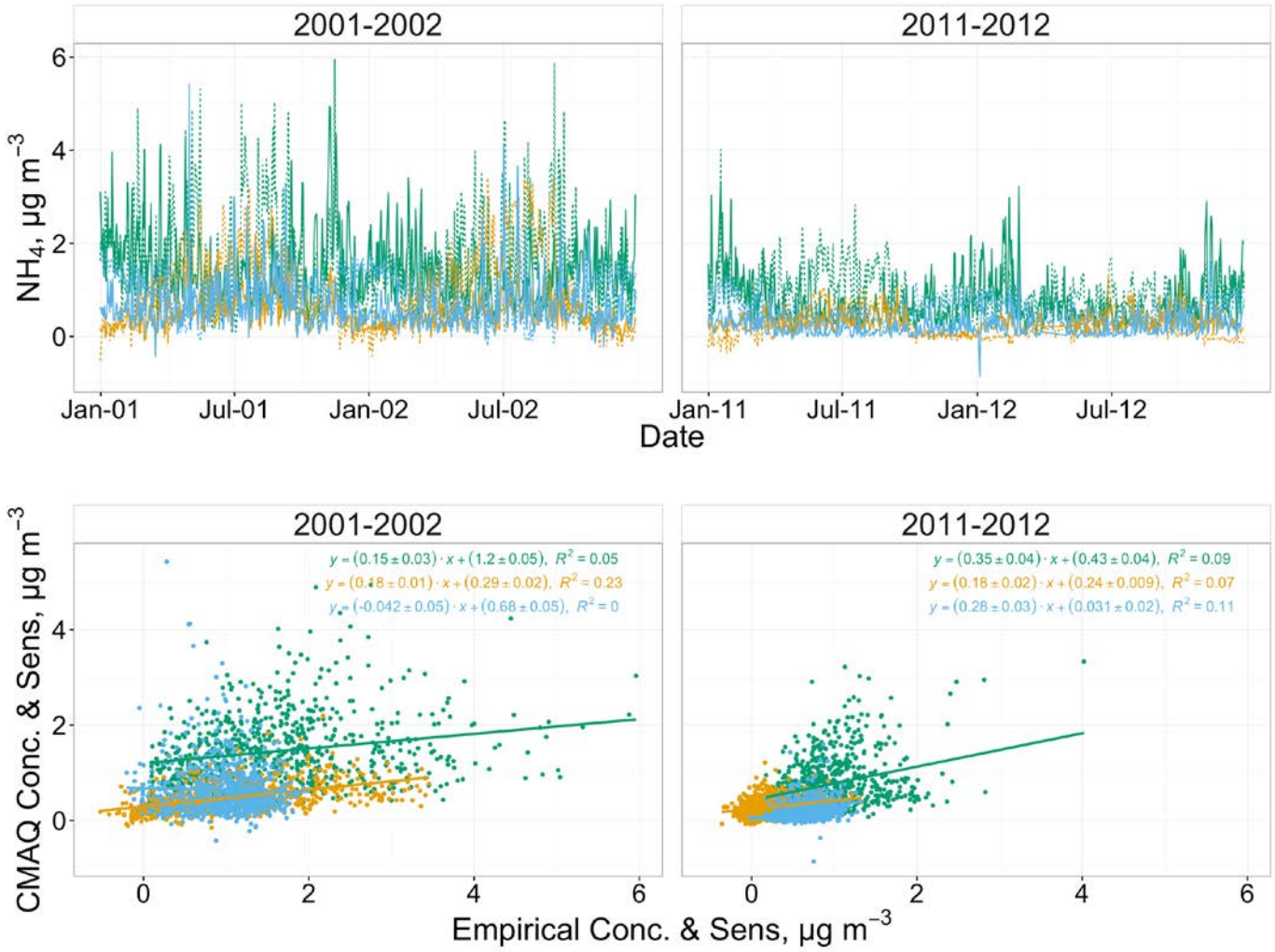


Figure A.16. NH_4^+ daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

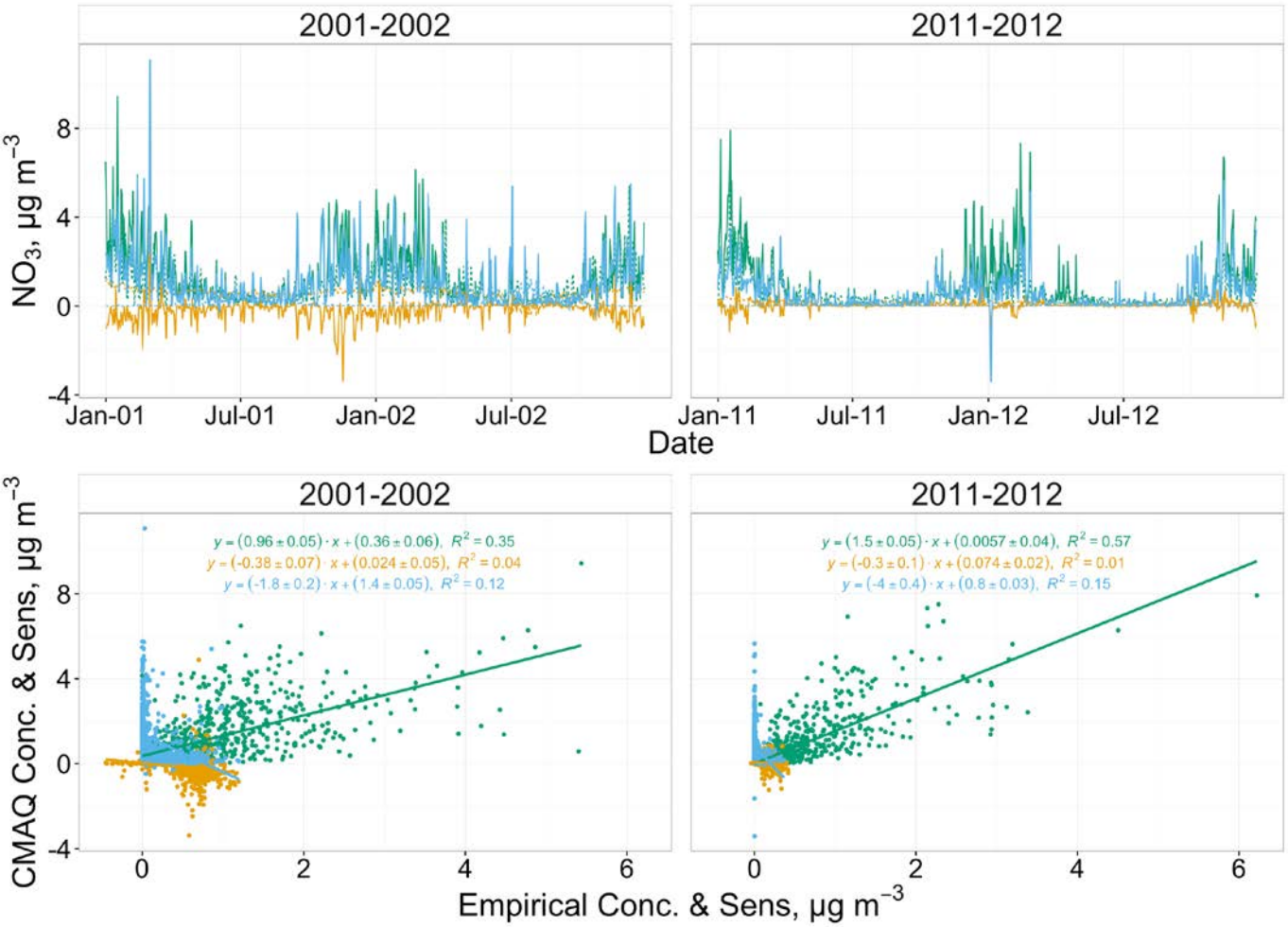


Figure A.17. NO_3 daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

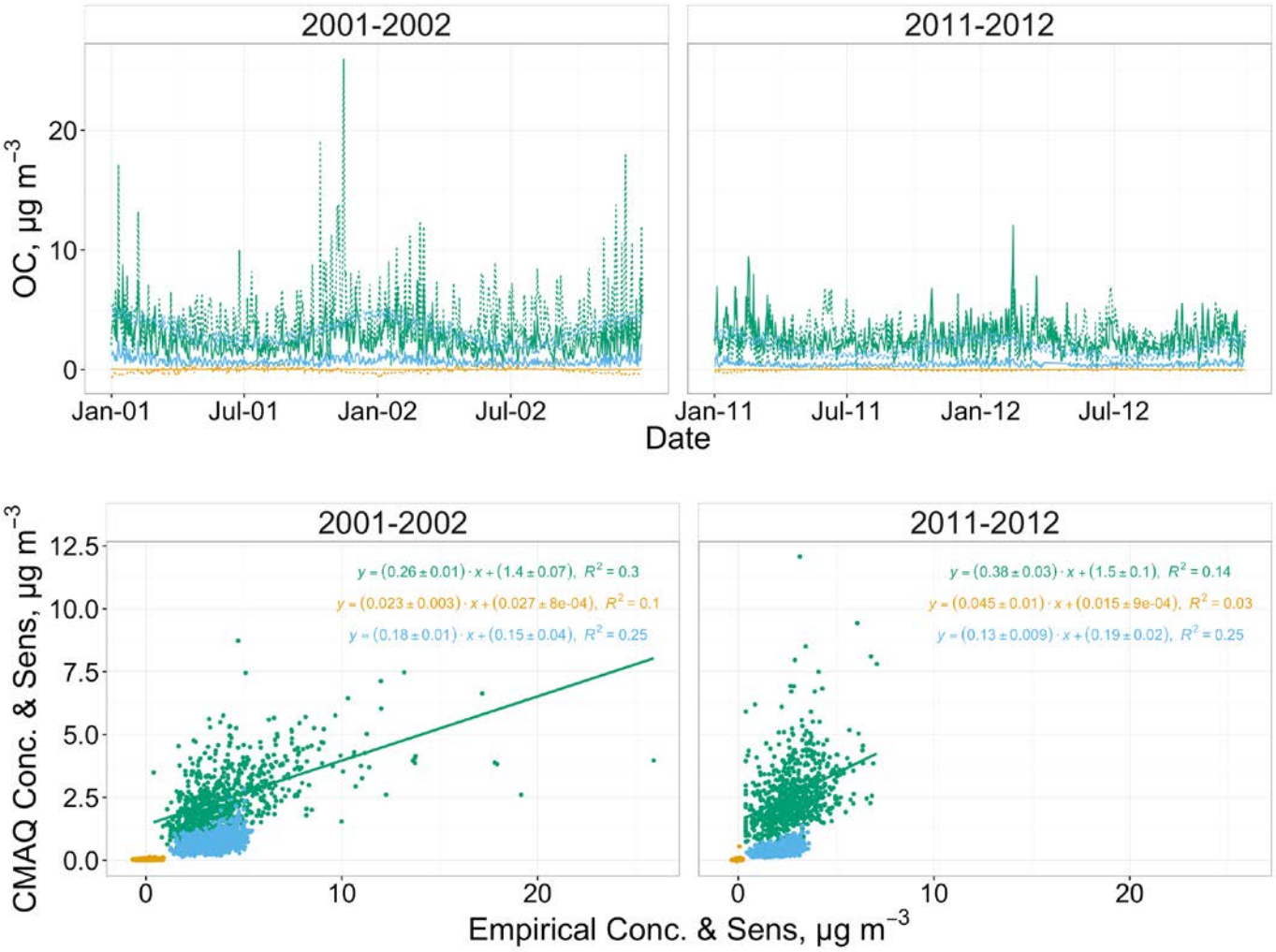


Figure A.18. OC daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGUs. Reprinted from Henneman et al. 2017b with permission from Elsevier.

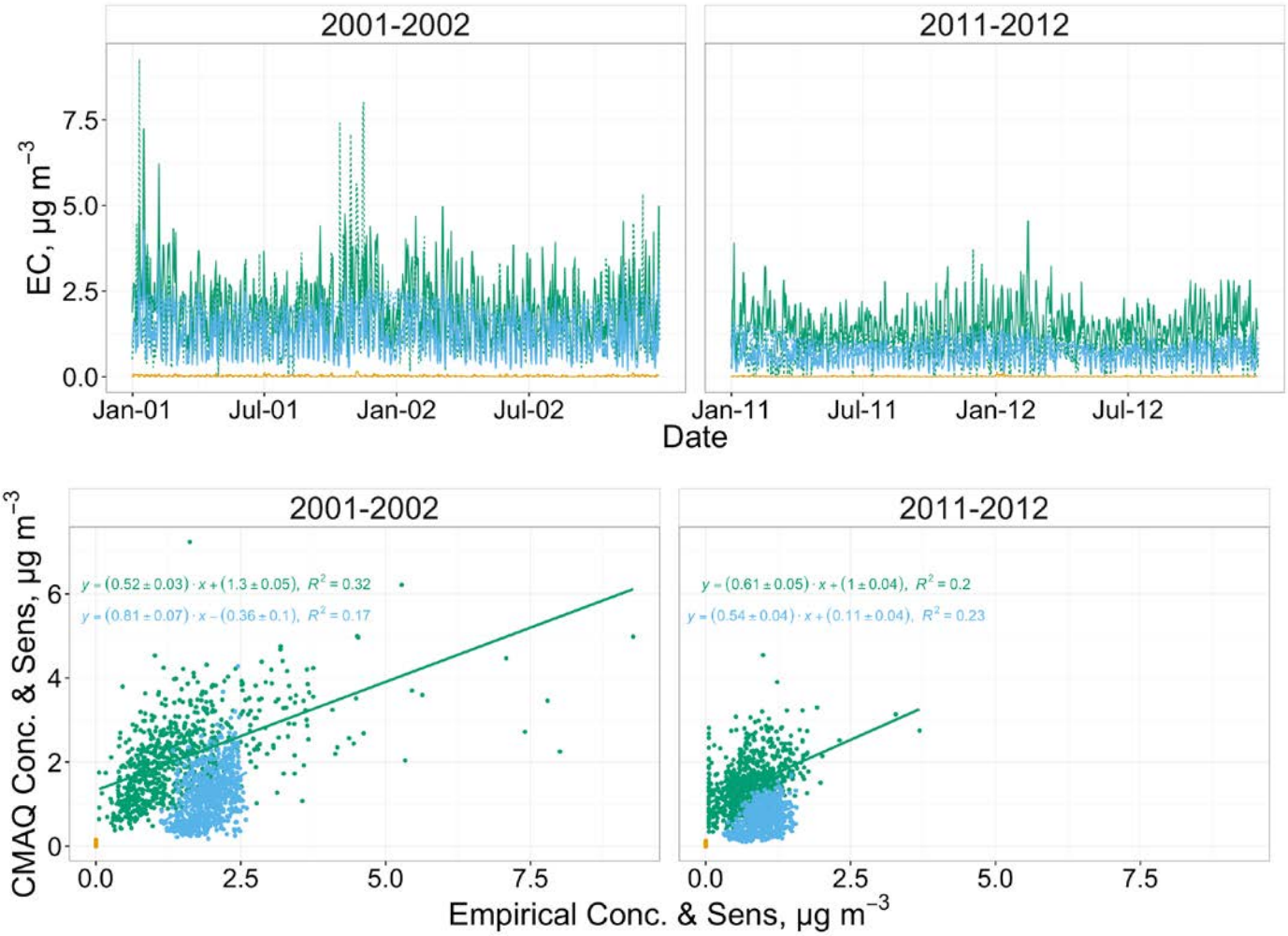


Figure A.19. EC daily CMAQ-empirical comparisons (time series on the top, scatter plot on the bottom) for ambient concentrations, mobile, and EGU sensitivities. EGU* represents the combination of local and regional EGU. Reprinted from Henneman et al. 2017b with permission from Elsevier.

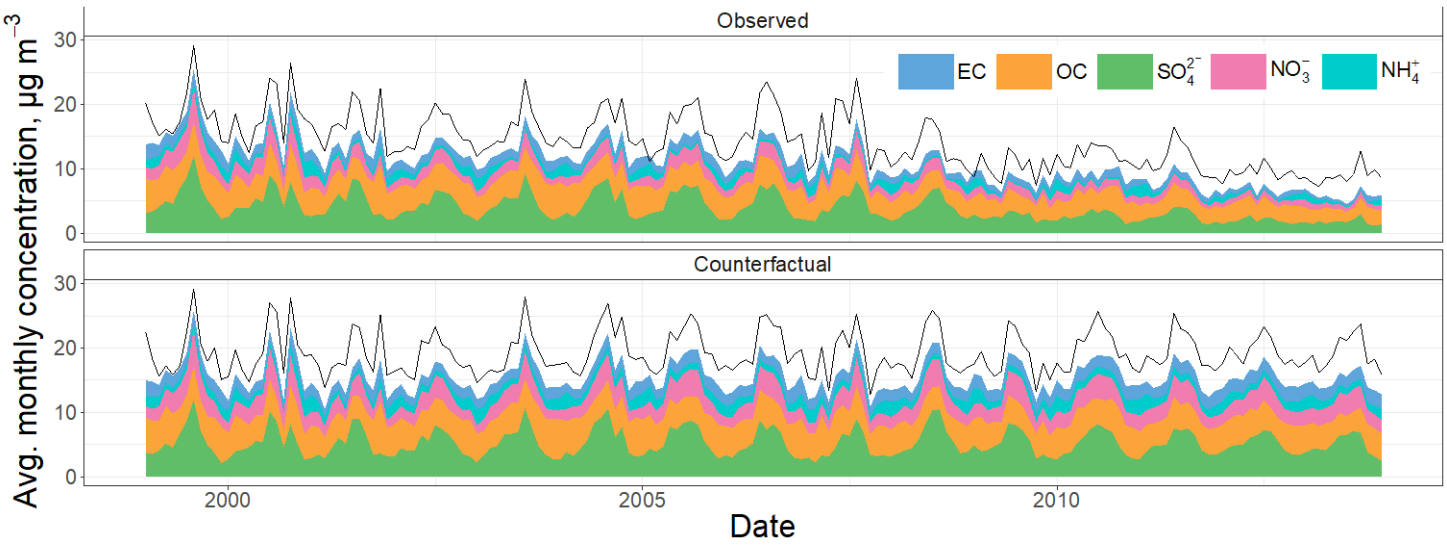


Figure A.20. Monthly-averaged $PM_{2.5}$ species composition at JST. The black line in the Observed (above) and Counterfactual (below) represents observed $PM_{2.5}$.

References

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