

SUPPLEMENTAL MATERIAL

Median Bias: $MdnB = median(C_m - C_o)_N$

Normalized Median Bias: $NMdnB = \frac{median(C_m - C_o)_N}{median(C_o)_N} \times 100\%$

Median Error: $MdnE = median|C_m - C_o|_N$

Normalized Median Error: $NMdnE = \frac{median|C_m - C_o|_N}{median(C_o)_N} \times 100\%$

Table S1. Sectors grouped in RCPs, SCC in the GSREF file, and the speciation profile codes in GSPRO used in SMOKE v3.5. X in the table represents any number.

Sectors	IPCC Code	SCC	Speciation profile codes
Energy	1A1_1B	10100XXXX	92036
Industries	1A2_2A_B_C_D_E	10200XXXX	92084
Transportation	1A3b_c_e	220100XXXX	92050
Residential	1A4	21040080XX	92068
Solvents	2F_3	24XXXXXXXX	92052
Agriculture	4A_B_C_D_G	27301000XX	92001
Agriculture waste burning	4F	2610000XXX	92000
Waste	6A_B_C_D	101012XX	92082
Savanna burning	4E	28100010XX	92090
Forest fires	5A	28100010XX	92090

Table S2. Evaluation of the S_2000 simulation (average of three years modeled) with surface observations in 2000 for PM_{2.5} components (SO₄²⁻, NO₃⁻, NH₄⁺, OC and EC) with different networks (μg m⁻³).

	Pollutant	MdnB	NMdnB (%)	MdnE	NMdnE(%)
IMPROVE	SO ₄ ²⁻	0.16	20.75	0.45	56.96
IMPROVE	NO ₃ ⁻	-0.040	-18.14	0.23	83.91
IMPROVE	OC	-0.55	-63.55	0.60	69.13
IMPROVE	EC	-0.069	-37.00	0.11	57.04
CSN	SO ₄ ²⁻	-0.10	-4.88	0.91	44.32
CSN	NO ₃ ⁻	-0.31	-50.06	0.44	71.39
CSN	NH ₃ ⁺	0.029	4.27	0.43	64.67
CASTNET	SO ₄ ²⁻	-0.40	-15.2	0.73	27.87
CASTNET	NO ₃ ⁻	-0.051	-10.50	0.37	74.97
CASTNET	NH ₄ ⁺	-0.076	-7.63	0.31	31.30

Table S3. The regional annual means of total, domestic, and foreign co-benefits for PM_{2.5} and O₃ in the nine U.S. regions. The values (mean ± coefficient of variation (CV, %)) are calculated over three years.

	Annual PM _{2.5} (µg m ⁻³)			Ozone season (May-Oct) average of MDA8 O ₃ (ppbv)		
	Total	Domestic	Foreign	Total	Domestic	Foreign
U.S.	-0.47±7	-0.35±1	-0.12±26	-3.55±37	-0.86±1	-2.69±49
Northwest	-0.16 ±15	-0.13±2	-0.04±66	-4.15±21	-0.40±5	-3.75±28
West	-0.40 ±9	-0.30±3	-0.10±45	-3.99±46	-1.05±3	-2.94±61
West N. Central	-0.21±14	-0.13±3	-0.08±38	-4.02±41	-0.57±3	-3.45±48
Southwest	-0.30±12	-0.16±1	-0.13±24	-3.11±70	-0.79±3	-2.32±93
South	-0.62±11	-0.37±4	-0.25±22	-2.84±69	-0.79±3	-2.04±95
East N. Central	-0.45±3	-0.38±3	-0.06±29	-4.25±30	-0.81±4	-3.44±37
Central	-0.78±9	-0.65±2	-0.12±63	-3.38±55	-1.24±1	-2.14±87
Southeast	-0.75±29	-0.62±3	-0.13±84	-2.67±40	-1.14±3	-1.53±71
Northeast	-0.62±3	-0.53±1	-0.09±22	-4.61±17	-1.16±5	-3.45±21

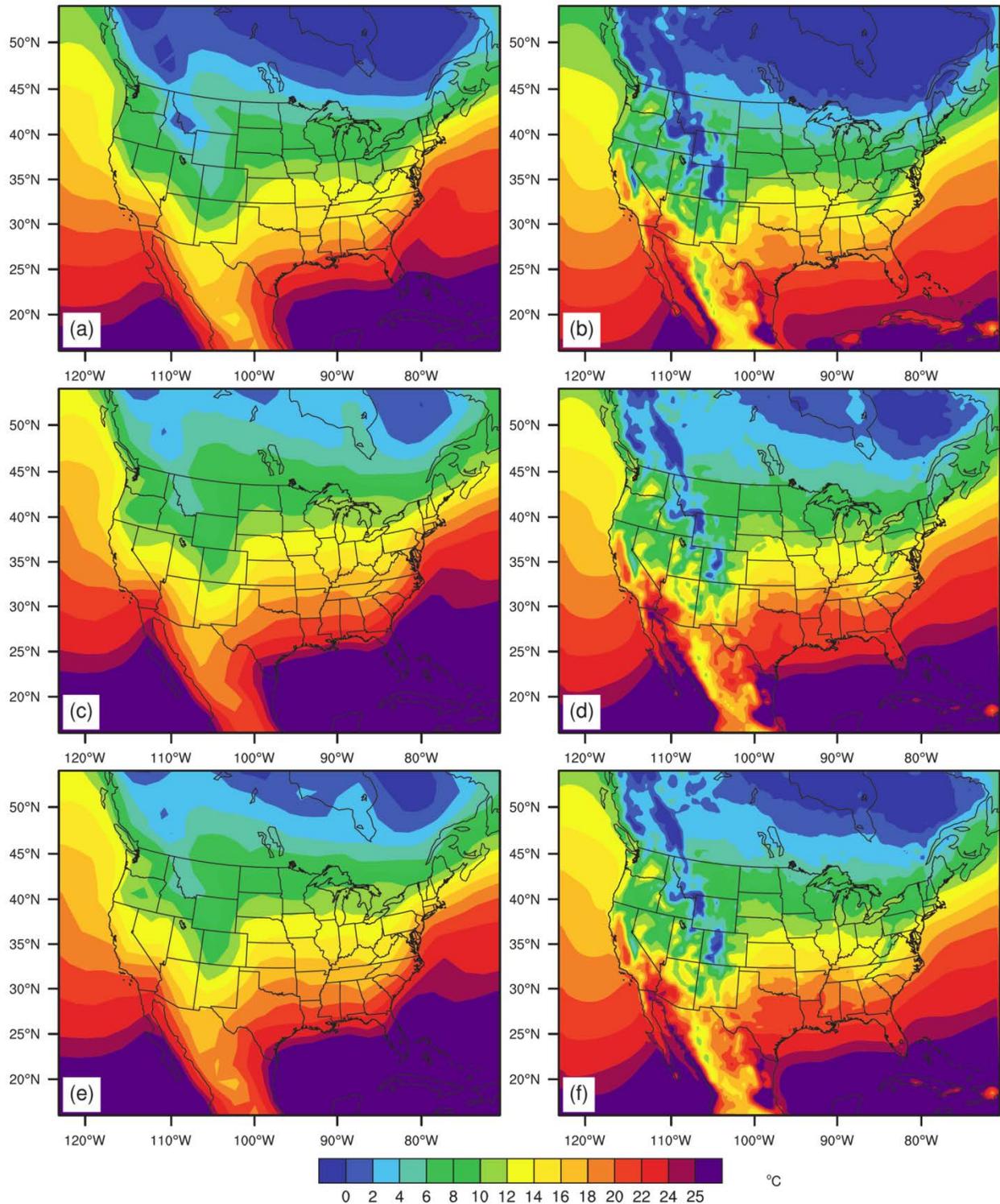


Figure S1. Comparisons of the 2-m temperature in 2000 (a, b), 2050 from RCP8.5 (c, d) and from RCP4.5 (e, f) for three-year averages of GFDL AM3 simulations on the left (a, c, e) and the WRF downscaling results on the right (b, d, f).

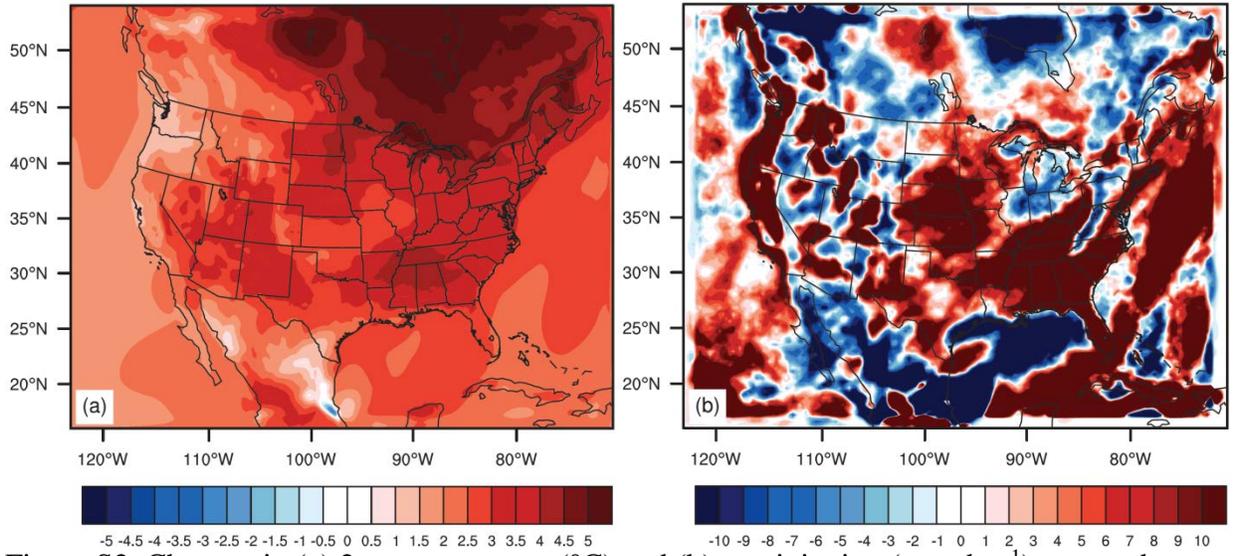


Figure S2. Changes in (a) 2-m temperature ($^{\circ}\text{C}$) and (b) precipitation (mm day^{-1}) centered on 2050 from RCP8.5 and 2000 (2050—2000).

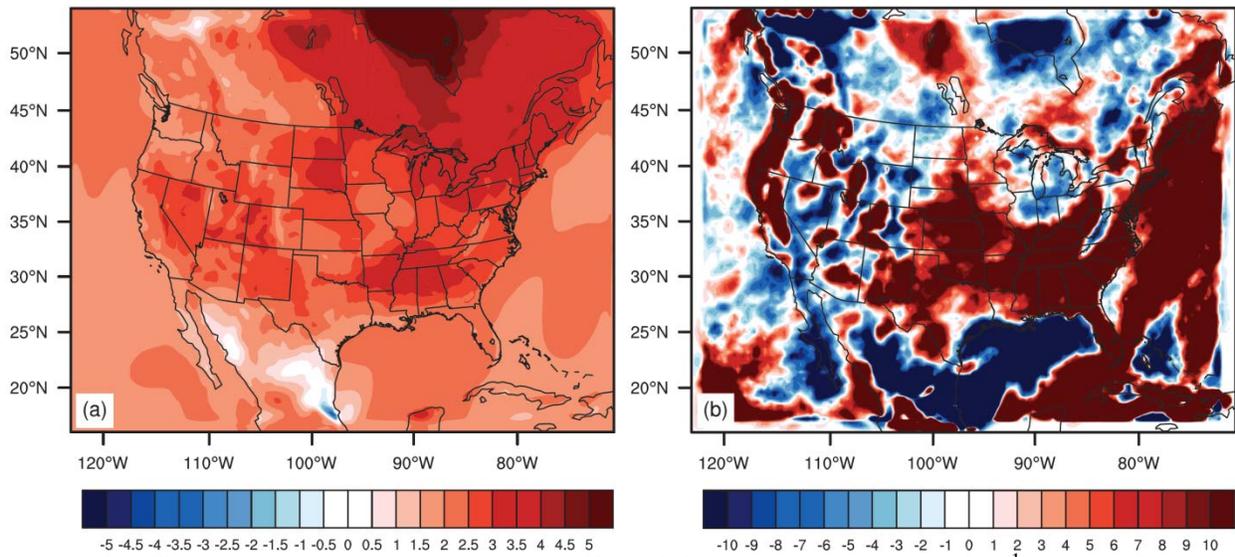


Figure S3. Changes in (a) 2-m temperature ($^{\circ}\text{C}$) and (b) precipitation (mm day^{-1}) centered on 2050 from RCP4.5 and 2000 (2050—2000).

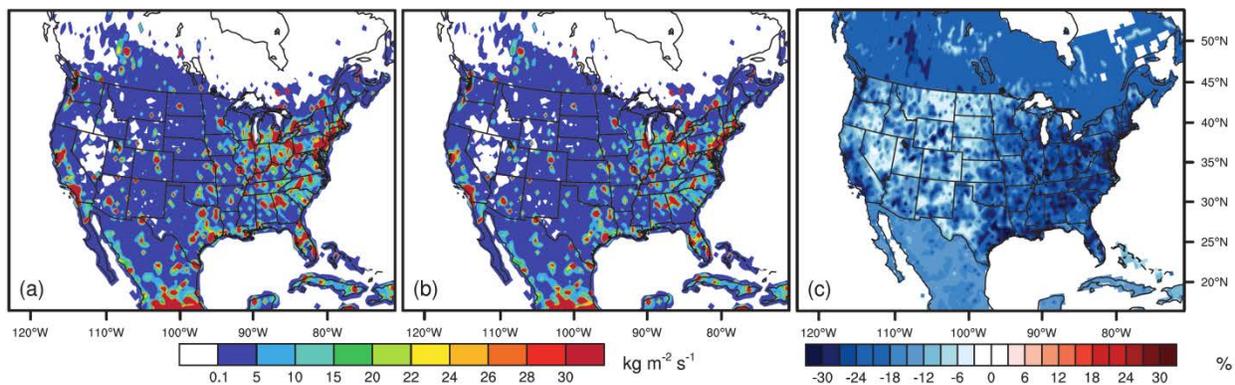


Figure S4. The spatial distribution of anthropogenic emissions of SO₂ (10^{-12} kg m⁻² s⁻¹) from (a) REF scenario, (b) RCP45 scenario in 2050, and (c) relative differences between these two scenarios (RCP45-REF)/REF×100%.

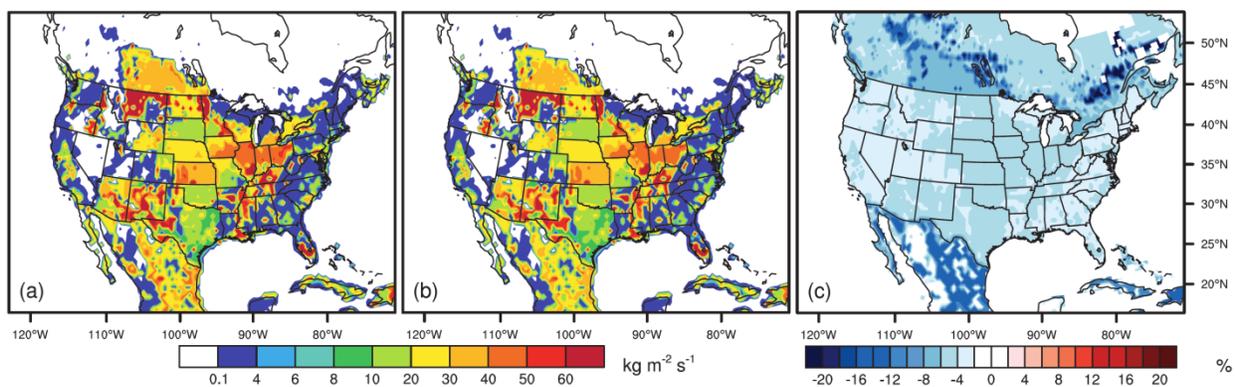


Figure S5. Same as Fig. S4 but for NH₃.

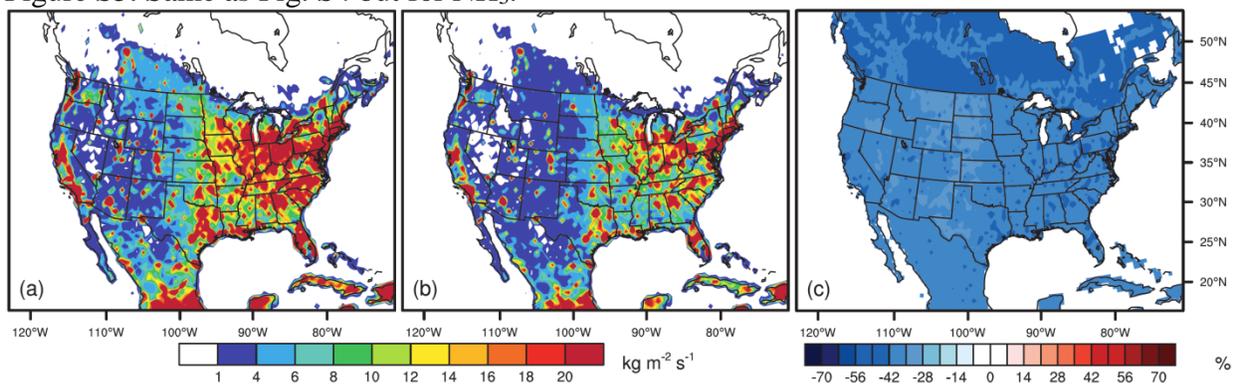


Figure S6. Same as Fig. S4 but for NO.

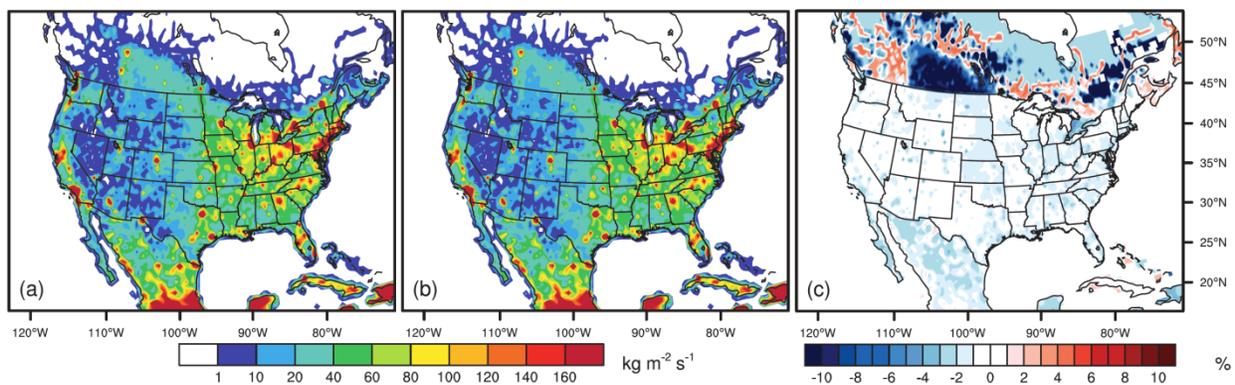


Figure S7. Same as Fig. S4 but for CO.

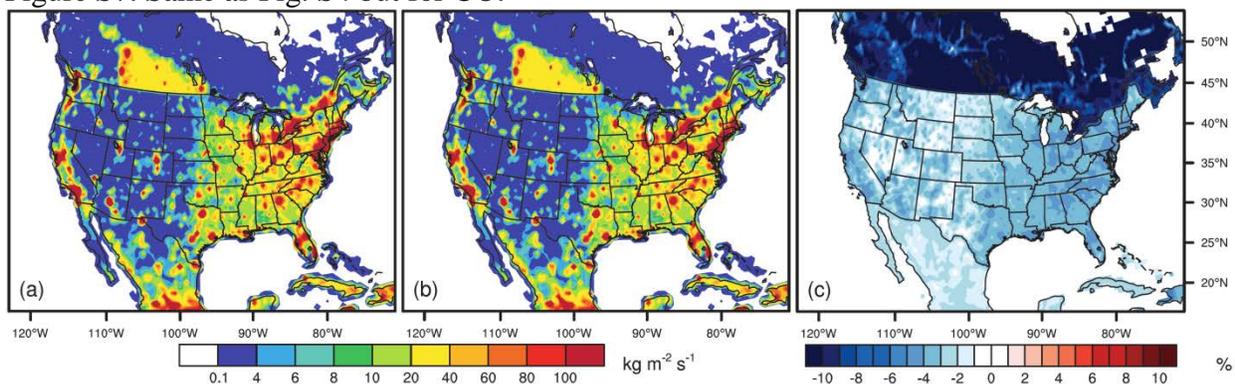


Figure S8. Same as Fig. S4 but for NMVOCs.

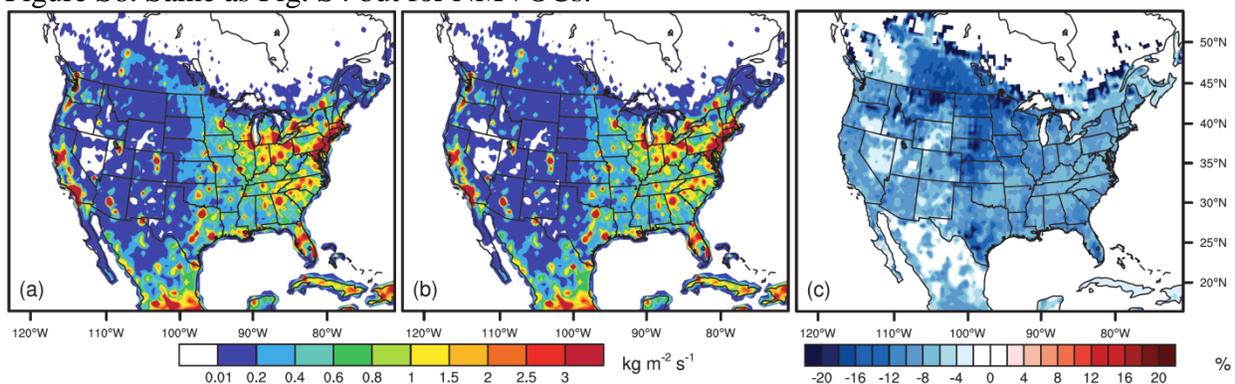


Figure S9. Same as Fig. S4 but for EC.

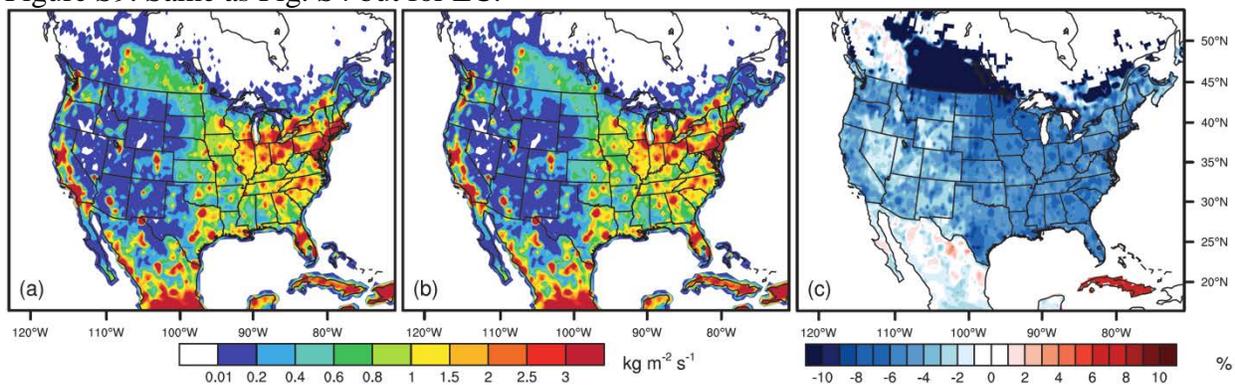


Figure S10. Same as Fig. S4 but for OC.

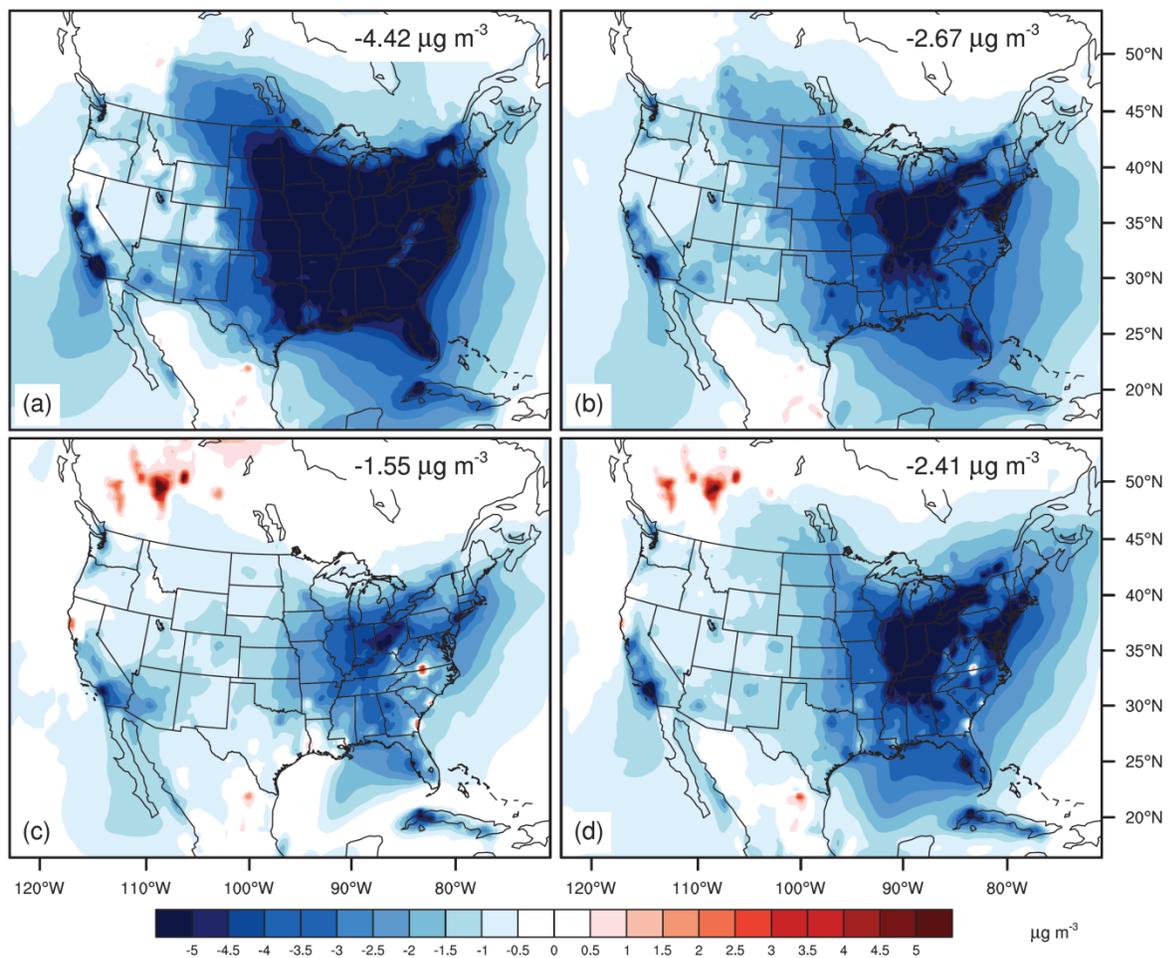


Figure S11. Seasonal distributions of PM_{2.5} changes ($\mu\text{g m}^{-3}$) between S_REF in 2050 and S_2000 for (a) winter, (b) spring, (c) summer and (d) fall. The three-year annual average over the U.S. is $-2.76 \mu\text{g m}^{-3}$.

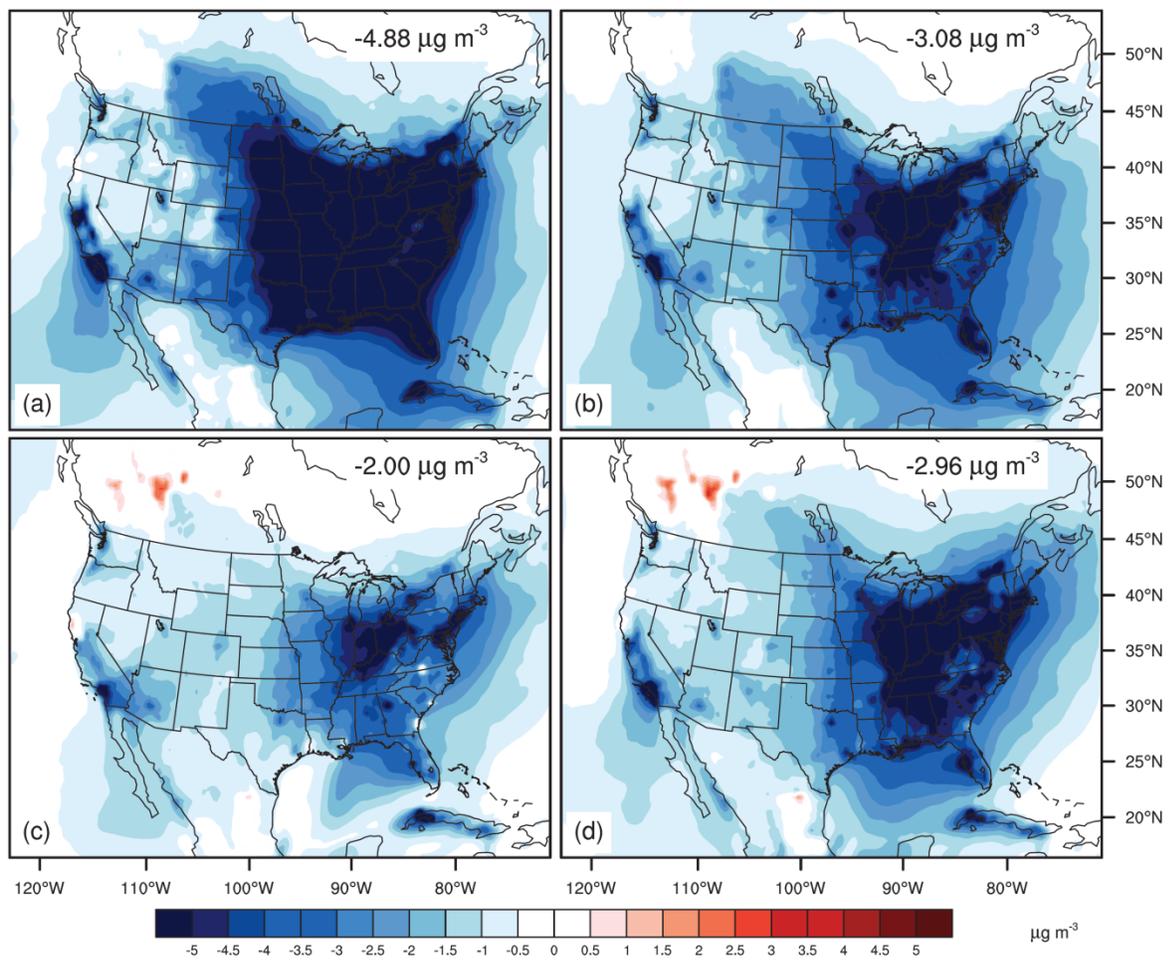


Figure S12. As Fig. S11 but for the changes between S_RCP45 in 2050 and S_2000. The U.S. three-year average is $-3.23 \mu\text{g m}^{-3}$.

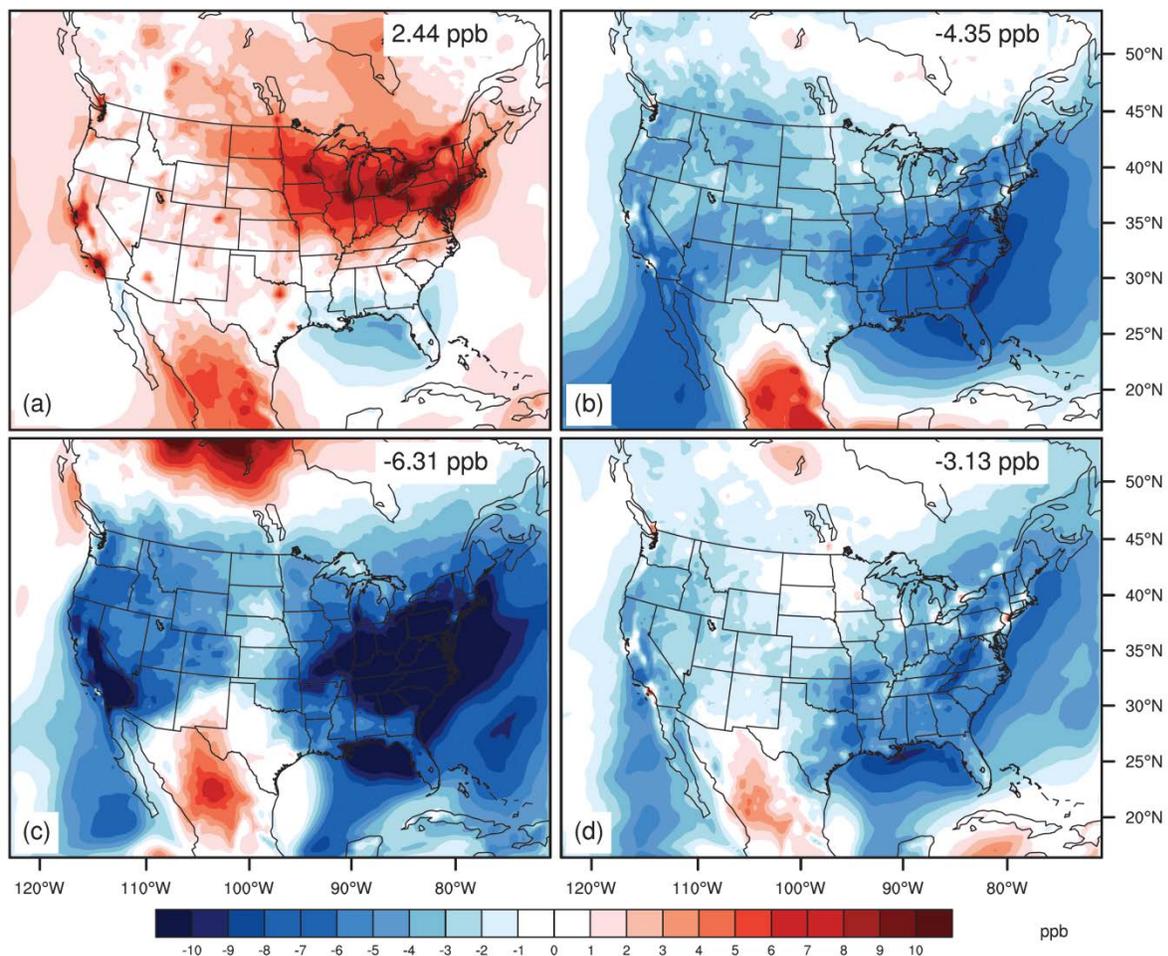


Figure S13. Seasonal distributions of O₃ changes (ppb) between S_REF in 2050 and S_2000 for (a) winter, (b) spring, (c) summer and (d) fall. The three-year annual average over the U.S. is -2.84 ppb.

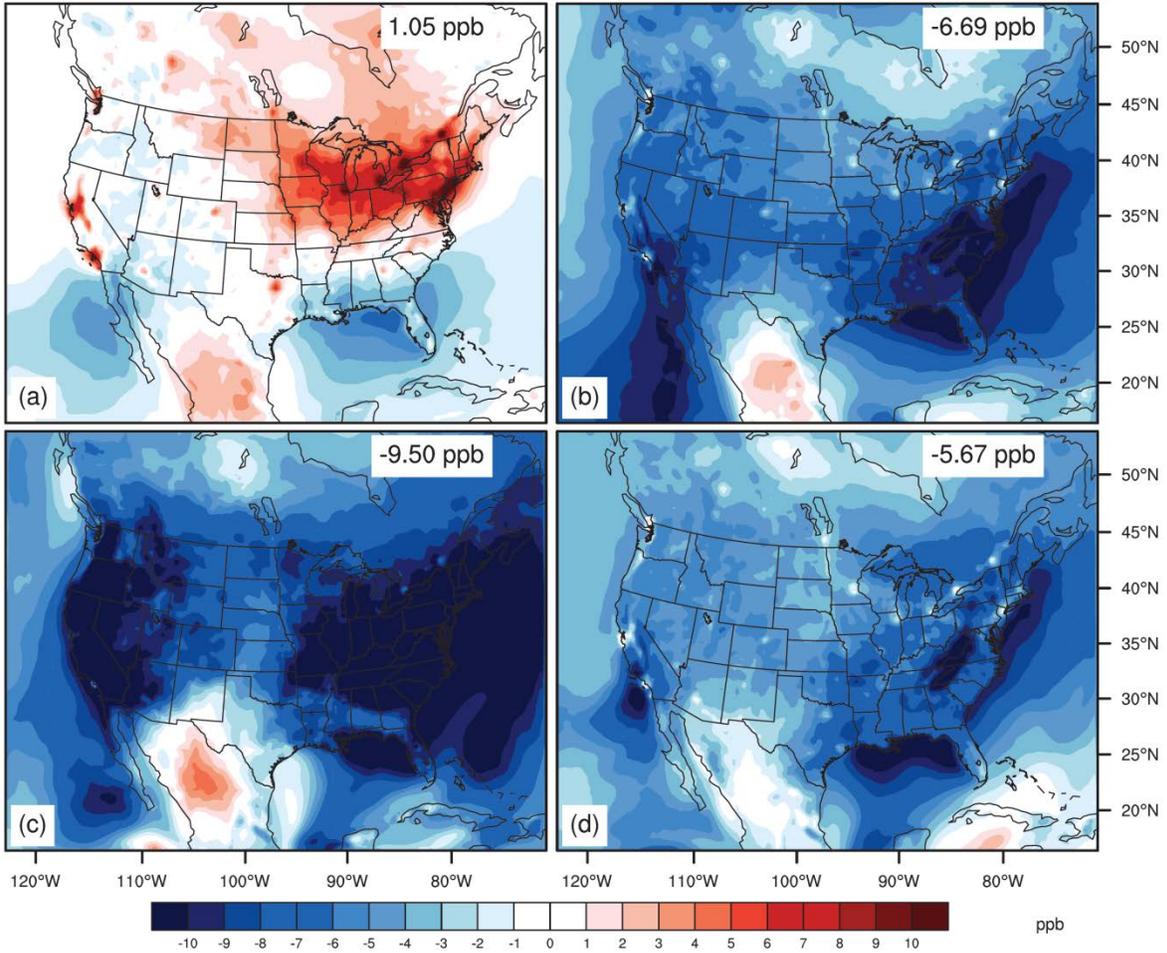


Figure S14. As for Fig. S13, but for the changes between S_RCP45 in 2050 and S_2000. The three-year U.S. average is -5.20 ppb.

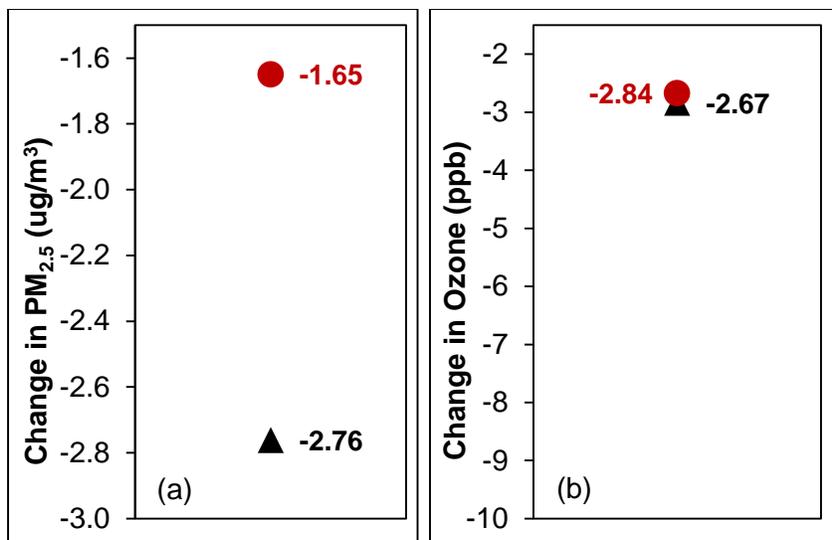


Figure S15. Comparison of air quality changes over the U.S. for REF in 2050 relative to 2000, for this study (black triangle), and MZ4 from WEST2013 (red circle), for (a) the annual average PM_{2.5}, and (b) annual average O₃ surface concentration. Values shown are the average of three years for both CMAQ and MZ4.

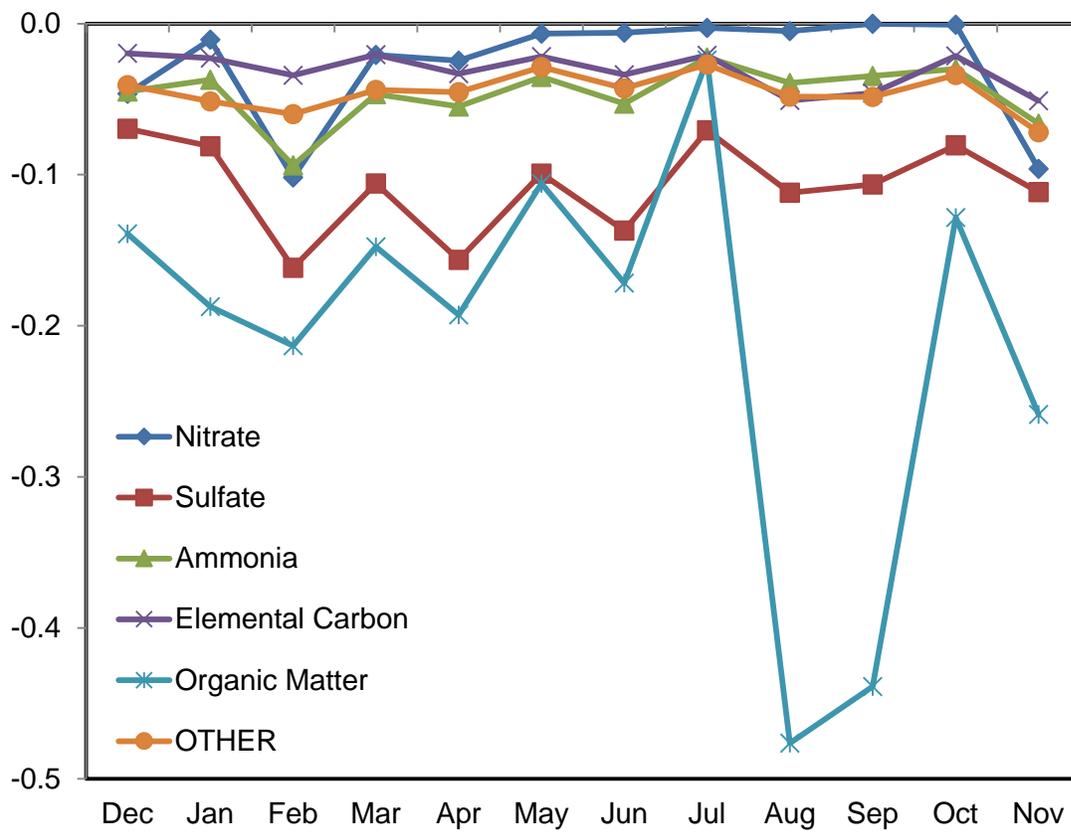


Figure S16. Seasonal distributions of total co-benefits for major PM_{2.5} components ($\mu\text{g m}^{-3}$).

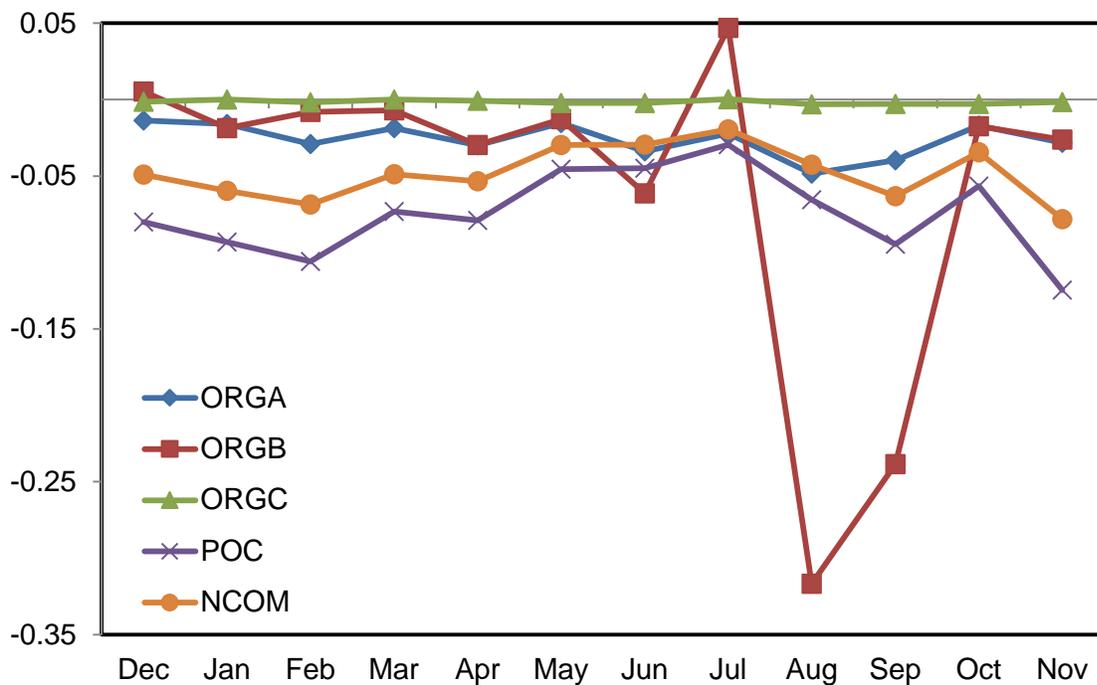


Figure S17. Seasonal distributions of total co-benefits for organic matter (OM, $\mu\text{g m}^{-3}$), including SOA from anthropogenic source (ORGA), SOA from biogenic source (ORGB), SOA from aqueous-phase oxidation (ORGC), Primary organic carbon (POC) and non-carbon organic matter (NCOM).

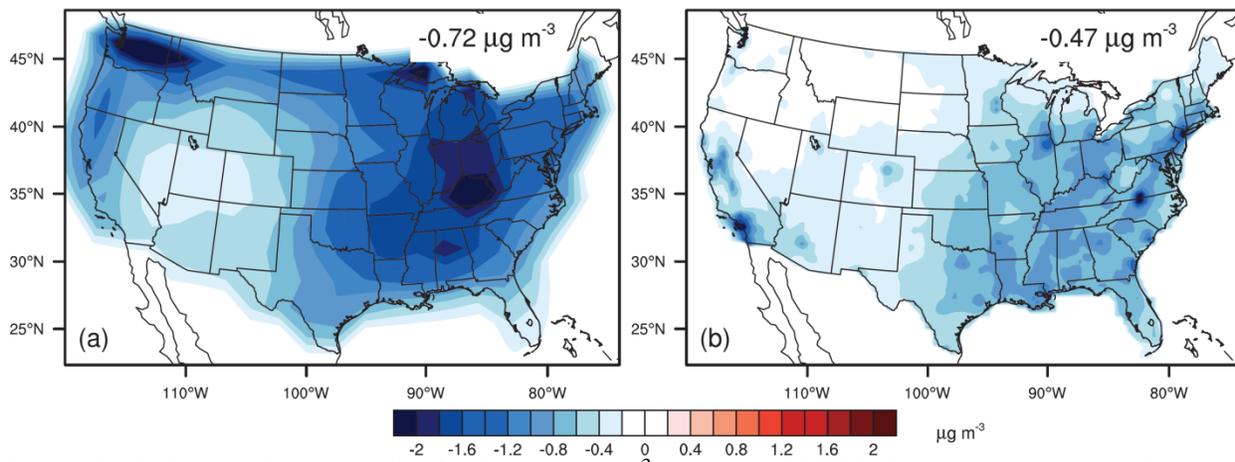


Figure S18. The total co-benefits for $\text{PM}_{2.5}$ ($\mu\text{g m}^{-3}$) in (a) WEST2013 and (b) this study. Both the results from WEST2013 and this study are using three-year averages.

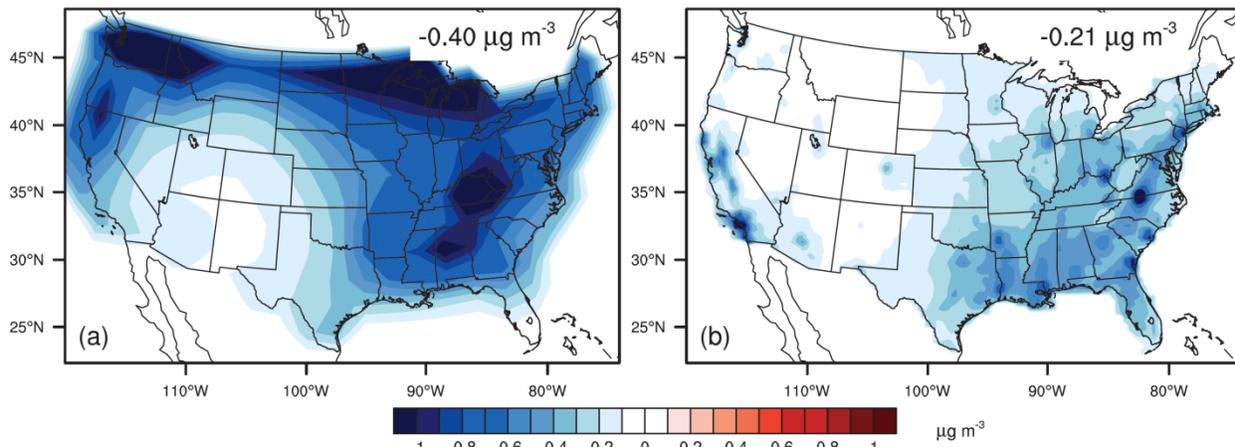


Figure S19. As for Fig. S18 but for OM ($\mu\text{g m}^{-3}$, including primary OC, SOA and NCOM).

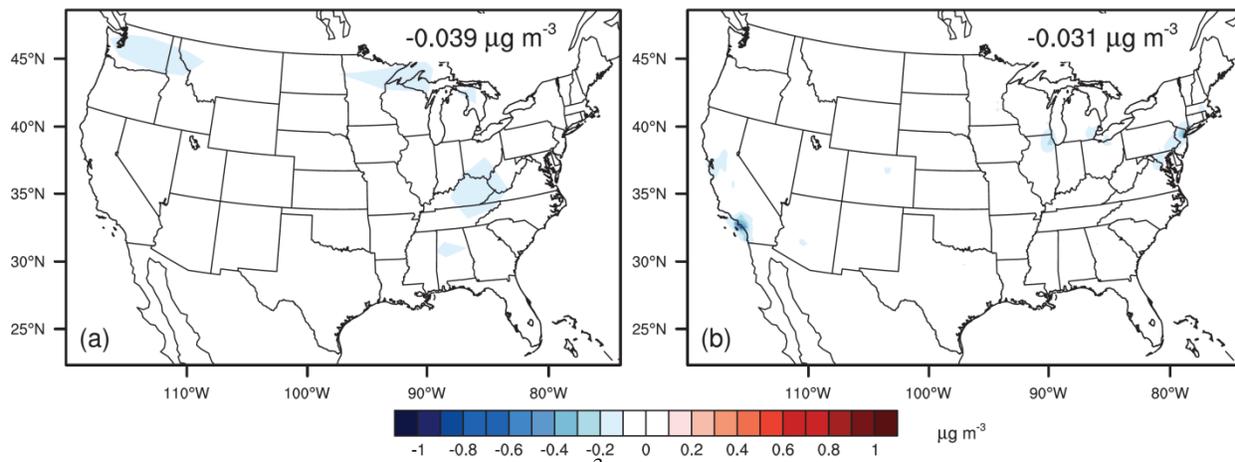


Figure S20. As for Fig. S18 but for EC ($\mu\text{g m}^{-3}$).

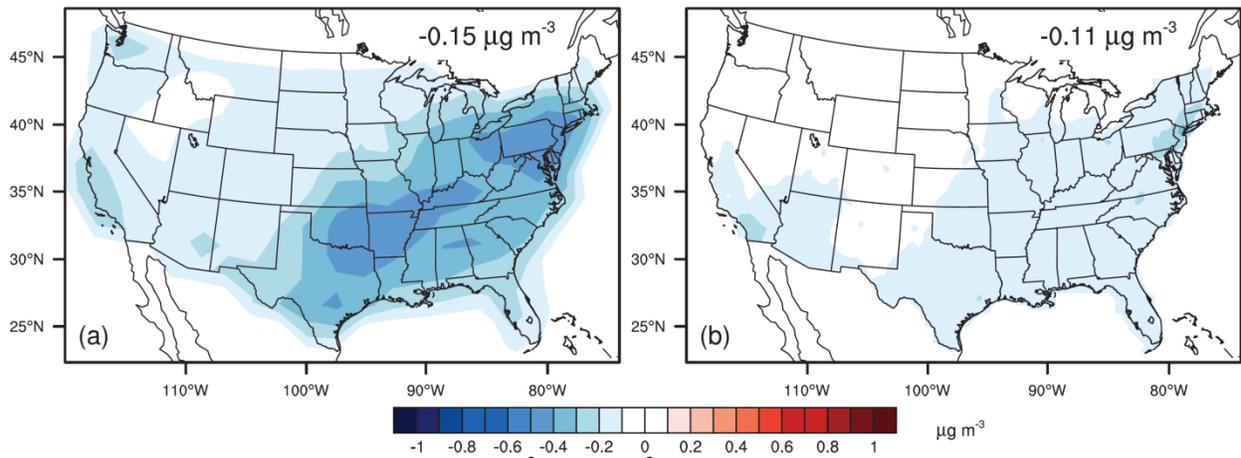


Figure 21. As for Figure S18 but for SO_4^{2-} ($\mu\text{g m}^{-3}$).

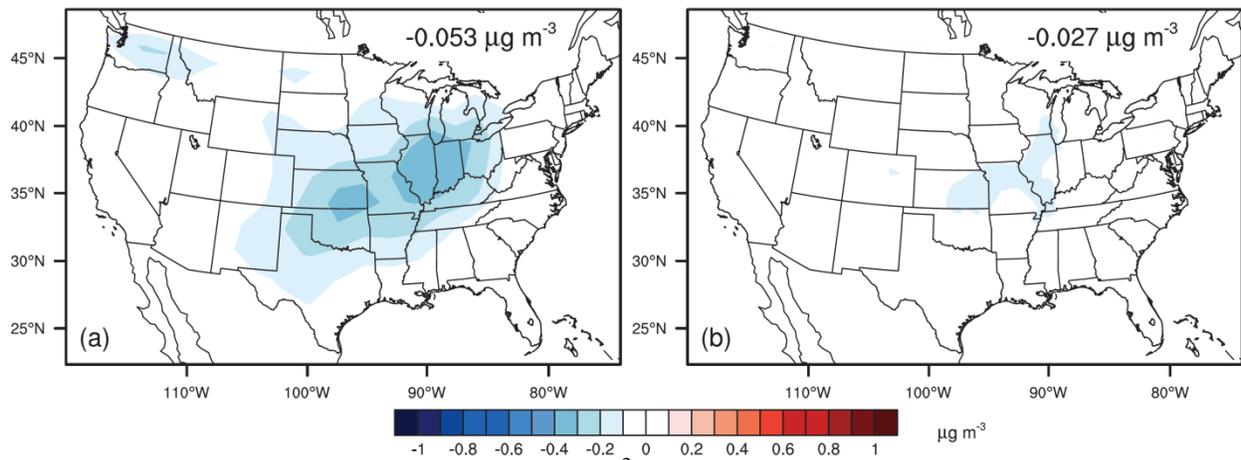


Figure S22. As for Fig. S18 but for NO_3^- ($\mu\text{g m}^{-3}$).

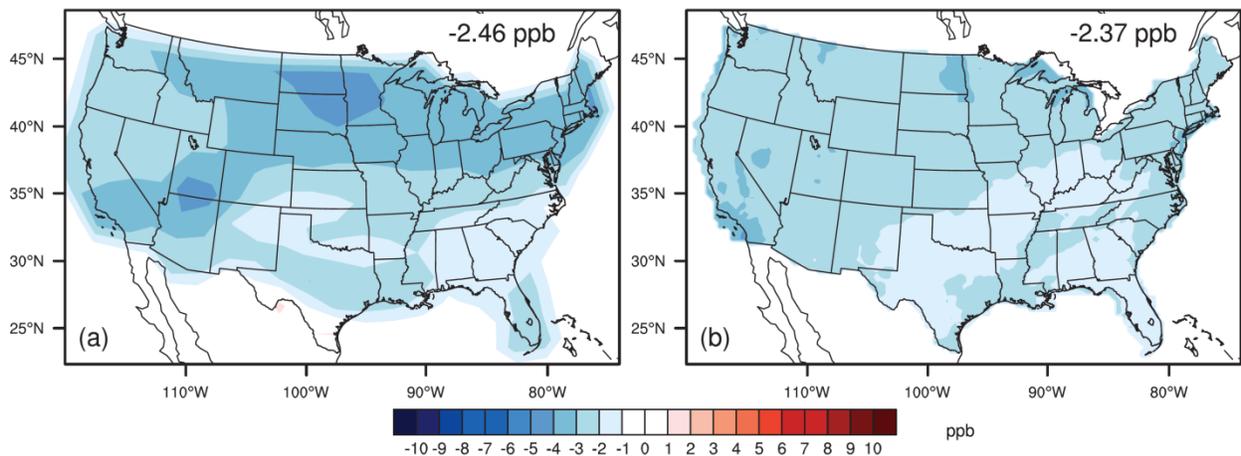


Figure S23. The total co-benefits for annual area-weighted O_3 (ppb) in (a) WEST2013 and (b) this study. Both WEST2013 and this study are using three-year averages.

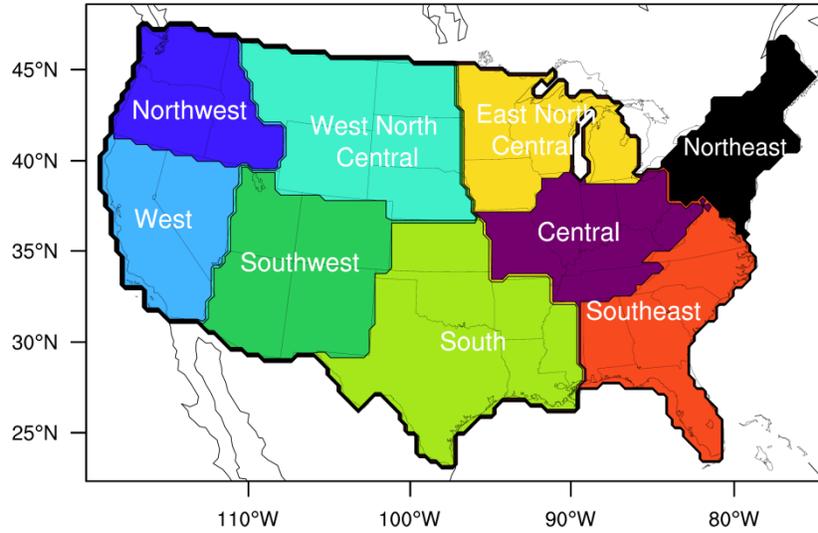


Figure S24. The nine U.S. climate regions defined by the National Oceanic and Atmospheric Administration (<http://www.ncdc.noaa.gov/monitoring-references/maps/us-climate-regions.php>, accessed 5 December 2014).