

# Co-benefits of global, domestic, and sectoral greenhouse gas mitigation for US air quality and human health in 2050

## Supporting Info

Table S1. Total anthropogenic emission reductions (Tg yr<sup>-1</sup>) in the US in 2050 in RCP4.5 and REF, and the reductions (Abs Diff, Tg yr<sup>-1</sup>) in different sectors in RCP4.5 compared with REF in the US. Relative difference (Ref Diff, %), the fraction of the total emission reduction under RCP4.5, is calculated as  $(Emissions_{sector} - Emissions_{REF}) / (Emissions_{RCP4.5} - Emissions_{REF}) * 100$ .

RCP4.5-REF		Industry		Residential		Energy	
		Abs Diff	Rel Diff	Abs Diff	Rel Diff	Abs Diff	Rel Diff
SO <sub>2</sub>	-0.71	-0.38	53.52	-0.057	8.03	-0.26	36.62
NH <sub>3</sub>	-0.26	-0.0013	0.50	0.00005	-0.02	-0.0004	0.15
NO <sub>x</sub>	-0.48	-0.20	41.67	-0.022	4.58	-0.25	52.08
CO	-0.17	-0.071	41.76	0.014	-8.24	-0.078	45.88
NMVOCS	-0.91	-0.077	8.42	0.007	-0.72	-0.03	3.52
EC	-0.017	-0.0012	12.00	-0.0016	16.00	-0.0036	36.00
OC	-0.022	-0.0067	33.50	-0.0040	20.00	-0.0009	4.50

Table S2. The US average baseline mortality rates ( $y_0$ , deaths per 1000 adult population) used by WEST2013 (in 2050 projected in IFs, version 6.54 under the UNEP GEO Base Case scenario) and BenMAP-CE (in 2005), and the adjustment ratio used in this study.

	WEST2013	BenMAP-CE v1.0.8	<sup>a</sup> Adjustment ratio
Respiratory	1.56	1.25	1.25
Cardiopulmonary	5.90	5.61	1.05
Lung Cancer	0.93	0.91	1.02
All-Cause	8.91	12.74	0.70

<sup>a</sup>Adjustment ratios are calculated by dividing the number in WEST2013 by BenMAP-CE.

Table S3. Total anthropogenic emission in the US in the reference case for the year 2050 from the latest Shared Socio-economic Pathways 4 (SSP4-REF), and emission reductions from two climate policy scenarios, SSP4-34, and SSP4-60. The absolute difference (Abs Diff) was calculated as climate policy scenario (SSP4-34 or SSP4-60) minus REF, and the relative difference (Rel Diff) was calculated as  $(Emission_{policy} - Emission_{REF})/Emission_{REF} * 100$  .

SSP4-REF		SSP4-34		SSP4-60	
		Abs Diff	Rel Diff	Abs Diff	Rel Diff
SO <sub>2</sub>	3.67	-2.20	-59.92	-0.32	-8.78
NH <sub>3</sub>	4.94	-0.31	-6.37	-0.0038	-0.08
NO <sub>x</sub>	5.98	-1.84	-30.78	-0.26	-4.35
CO	26.84	-4.15	-15.48	0.049	0.18
NMVOCS	7.73	-0.93	-11.97	0.0325	0.42
EC	0.10	-0.032	-32.12	-0.0016	-1.65
OC	0.60	-0.10	-17.05	0.0038	0.63

Table S4. Total co-benefits for avoided premature mortality in the US in 2050 and the mortality per capita (the avoided deaths per million people, for the future exposed population aged 30 and over), for both PM<sub>2.5</sub>- and O<sub>3</sub>-related mortality.

	PM <sub>2.5</sub> -related all-cause mortality			O <sub>3</sub> -related Resp mortality		
	Mortality	90% CI	Mortality per million	Mortality	90% CI	Mortality per million
AL	272	(198, 345)	76	105	(47, 163)	29
AR	149	(108, 189)	65	55	(24, 85)	24
AZ	241	(175, 306)	40	206	(91, 319)	34
CA	2505	(1825, 3180)	87	1414	(629, 2185)	49
CO	113	(82, 144)	27	131	(58, 202)	31
CT	234	(171, 298)	88	117	(52, 182)	44
DC	11	(8, 14)	69	4	(2, 7)	28
DE	42	(31, 53)	78	23	(10, 35)	42
FL	1001	(728, 1271)	58	395	(175, 613)	23
GA	544	(396, 691)	68	222	(99, 344)	28
IA	90	(66, 115)	45	72	(32, 111)	36
ID	17	(12, 21)	14	39	(17, 61)	33
IL	762	(555, 968)	87	297	(132, 460)	34
IN	300	(218, 381)	67	134	(59, 207)	30
KS	99	(72, 126)	52	56	(25, 87)	29
KY	224	(163, 284)	72	91	(40, 141)	29
LA	258	(188, 328)	81	81	(36, 126)	26
MA	310	(225, 393)	68	188	(84, 291)	41
MD	412	(300, 523)	80	185	(82, 286)	36
ME	41	(30, 52)	38	49	(22, 76)	46
MI	468	(340, 594)	71	252	(112, 390)	38
MN	169	(123, 214)	42	110	(49, 171)	28
MO	237	(173, 301)	60	109	(48, 169)	27
MS	167	(122, 212)	77	58	(26, 90)	27
MT	10	(8, 13)	13	32	(14, 49)	40
NC	540	(393, 685)	67	254	(113, 393)	32
ND	8	(6, 10)	18	14	(6, 22)	33
NE	39	(28, 49)	36	35	(16, 55)	33
NH	68	(50, 87)	55	48	(21, 75)	39
NJ	758	(552, 962)	107	296	(132, 458)	42

NM	52	(38, 67)		28	61	(27, 94)		33
NV	82	(60, 105)		34	105	(46, 162)		44
NY	1347	(981, 1709)		108	514	(229, 794)		41
OH	651	(474, 827)		85	283	(126, 438)		37
OK	151	(110, 192)		57	66	(29, 103)		25
OR	67	(49, 85)		22	91	(40, 141)		30
PA	728	(530, 924)		89	368	(164, 569)		45
RI	45	(33, 57)		71	27	(12, 42)		43
SC	296	(216, 376)		77	122	(54, 189)		32
SD	11	(8, 14)		21	18	(8, 28)		35
TN	340	(248, 432)		69	152	(68, 236)		31
TX	1162	(846, 1476)		54	470	(209, 728)		22
UT	48	(35, 61)		24	54	(24, 84)		27
VA	465	(338, 590)		71	210	(93, 324)		32
VT	22	(16, 28)		43	19	(9, 30)		37
WA	119	(87, 152)		21	175	(78, 271)		31
WI	241	(176, 306)		57	135	(60, 209)		32
WV	88	(64, 112)		70	48	(21, 74)		38
WY	7	(5, 9)		16	19	(8, 29)		41

Table S5. Domestic co-benefits for avoided premature mortality in the US in 2050 and the mortality per capita (the avoided deaths per million people, for the future exposed population aged 30 and over), for both PM<sub>2.5</sub>- and O<sub>3</sub>-related mortality.

	PM <sub>2.5</sub> -related all-cause mortality			O <sub>3</sub> -related Resp mortality		
	Mortality	90% CI	Mortality per million	Mortality	90% CI	Mortality per million
AL	192	(139, 243)	53	39	(17, 61)	11
AR	97	(71, 124)	42	25	(11, 38)	11
AZ	149	(109, 190)	25	58	(26, 90)	10
CA	2081	(1515, 2642)	73	579	(257, 897)	20
CO	72	(52, 92)	17	36	(16, 57)	9
CT	211	(154, 268)	79	52	(23, 80)	19
DC	11	(8, 14)	71	2	(1, 3)	12
DE	42	(31, 54)	79	10	(4, 15)	18
FL	845	(615, 1073)	49	168	(75, 261)	10
GA	456	(332, 580)	57	97	(43, 151)	12
IA	75	(55, 96)	38	21	(9, 32)	10
ID	13	(9, 16)	11	6	(2, 9)	5
IL	674	(491, 856)	77	118	(53, 184)	14
IN	290	(211, 368)	65	63	(28, 97)	14
KS	65	(47, 83)	34	20	(9, 30)	10
KY	185	(134, 234)	59	46	(20, 71)	15
LA	191	(139, 242)	60	29	(13, 45)	9
MA	277	(202, 352)	61	72	(32, 111)	16
MD	419	(305, 532)	82	80	(36, 124)	16
ME	30	(22, 38)	28	13	(6, 20)	12
MI	465	(339, 591)	71	87	(39, 136)	13
MN	145	(106, 185)	36	26	(12, 41)	7
MO	173	(126, 219)	43	45	(20, 69)	11
MS	116	(84, 147)	53	22	(10, 33)	10
MT	6	(4, 7)	8	3	(2, 5)	4
NC	508	(370, 645)	63	107	(48, 166)	13
ND	6	(4, 8)	14	2	(1, 3)	4
NE	28	(20, 35)	25	9	(4, 15)	9
NH	59	(43, 74)	47	16	(7, 24)	13
NJ	707	(515, 898)	100	121	(54, 187)	17

NM	31	(23, 39)		17	15	(7, 23)		8
NV	53	(39, 68)		22	27	(12, 42)		11
NY	1223	(891, 1552)		98	203	(90, 315)		16
OH	624	(454, 793)		82	120	(53, 186)		16
OK	91	(66, 115)		34	28	(12, 44)		11
OR	57	(41, 72)		18	12	(5, 18)		4
PA	692	(504, 878)		84	145	(64, 225)		18
RI	40	(29, 51)		63	11	(5, 18)		18
SC	266	(193, 337)		69	51	(23, 79)		13
SD	9	(7, 12)		18	4	(2, 6)		7
TN	264	(192, 335)		53	65	(29, 101)		13
TX	788	(574, 1001)		36	166	(73, 257)		8
UT	35	(26, 45)		17	13	(6, 21)		6
VA	435	(317, 552)		66	92	(41, 143)		14
VT	16	(12, 21)		31	5	(2, 8)		10
WA	111	(81, 141)		19	21	(9, 33)		4
WI	209	(152, 266)		49	44	(19, 68)		10
WV	81	(59, 102)		64	21	(9, 32)		16
WY	4	(3, 5)		9	4	(2, 6)		8

Table S6. Foreign co-benefits for avoided premature mortality in the US in 2050 and the mortality per capita (the avoided deaths per million people, for the future exposed population aged 30 and over), for both PM<sub>2.5</sub>- and O<sub>3</sub>-related mortality.

	PM <sub>2.5</sub> -related all-cause mortality			O <sub>3</sub> -related Resp mortality		
	Mortality	90% CI	Mortality per million	Mortality	90% CI	Mortality per million
AL	80	(59, 102)	22	66	(29, 102)	18
AR	52	(38, 66)	23	30	(13, 47)	13
AZ	92	(67, 117)	15	148	(66, 230)	25
CA	427	(311, 543)	15	841	(374, 1303)	29
CO	41	(30, 52)	10	94	(42, 146)	23
CT	24	(17, 30)	9	66	(29, 102)	25
DC	0	(0, 0)	-2	3	(1, 4)	16
DE	0	(0, 0)	-1	13	(6, 20)	24
FL	156	(114, 198)	9	228	(101, 353)	13
GA	88	(64, 112)	11	126	(56, 195)	16
IA	15	(11, 19)	8	51	(23, 79)	25
ID	4	(3, 5)	3	34	(15, 52)	29
IL	89	(65, 113)	10	180	(80, 278)	21
IN	10	(7, 12)	2	71	(32, 111)	16
KS	34	(25, 44)	18	36	(16, 57)	19
KY	40	(29, 50)	13	45	(20, 70)	15
LA	68	(49, 86)	21	53	(23, 81)	17
MA	32	(24, 41)	7	117	(52, 181)	26
MD	-7	(-5, -8)	-1	105	(47, 164)	21
ME	11	(8, 14)	10	37	(16, 57)	34
MI	2	(2, 3)	0	165	(73, 256)	25
MN	23	(17, 30)	6	84	(37, 131)	21
MO	65	(47, 82)	16	65	(29, 101)	16
MS	52	(38, 66)	24	37	(16, 57)	17
MT	5	(3, 6)	6	28	(13, 44)	36
NC	32	(23, 41)	4	147	(65, 228)	18
ND	2	(1, 3)	5	13	(6, 19)	29
NE	11	(8, 14)	10	26	(12, 40)	24
NH	10	(7, 12)	8	33	(15, 51)	26
NJ	51	(37, 65)	7	177	(79, 274)	25

NM	21	(16, 27)		11	46	(21, 72)		25
NV	29	(21, 37)		12	78	(35, 121)		33
NY	125	(91, 158)		10	313	(139, 484)		25
OH	27	(20, 34)		4	164	(73, 254)		21
OK	61	(44, 77)		23	38	(17, 59)		14
OR	10	(8, 13)		3	79	(35, 123)		26
PA	36	(26, 46)		4	224	(99, 347)		27
RI	5	(4, 7)		8	16	(7, 25)		25
SC	31	(22, 39)		8	71	(32, 111)		18
SD	2	(1, 2)		4	15	(6, 23)		28
TN	77	(56, 97)		15	87	(39, 135)		18
TX	375	(273, 477)		17	305	(136, 474)		14
UT	13	(9, 16)		6	41	(18, 64)		20
VA	30	(22, 38)		5	118	(52, 183)		18
VT	6	(4, 8)		12	14	(6, 22)		27
WA	9	(6, 11)		2	154	(68, 239)		27
WI	32	(23, 41)		8	92	(41, 143)		22
WV	8	(6, 10)		6	27	(12, 42)		22
WY	3	(2, 4)		7	15	(7, 24)		33

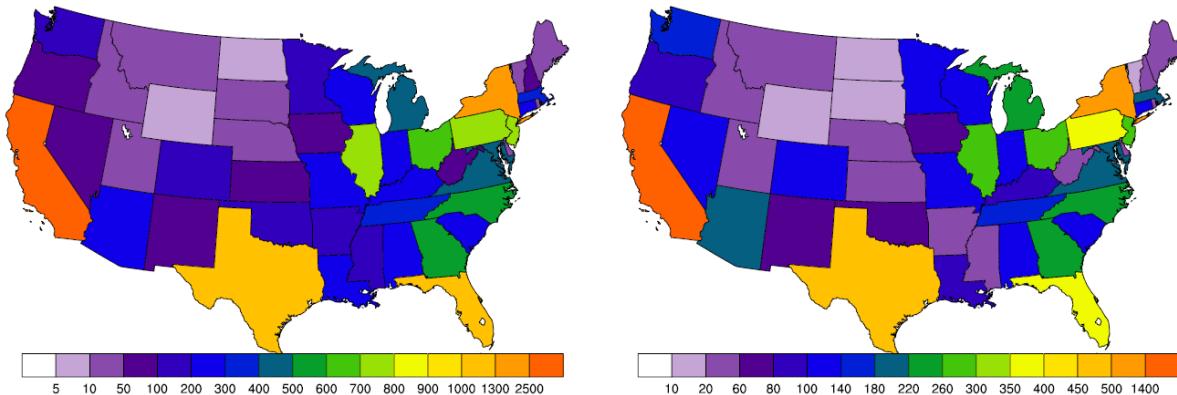


Figure S1. Avoided mortality (deaths yr<sup>-1</sup>) by state for the total co-benefits in US in 2050 for PM<sub>2.5</sub> (left) and O<sub>3</sub> (right). Note that the scales in the two panels differ.

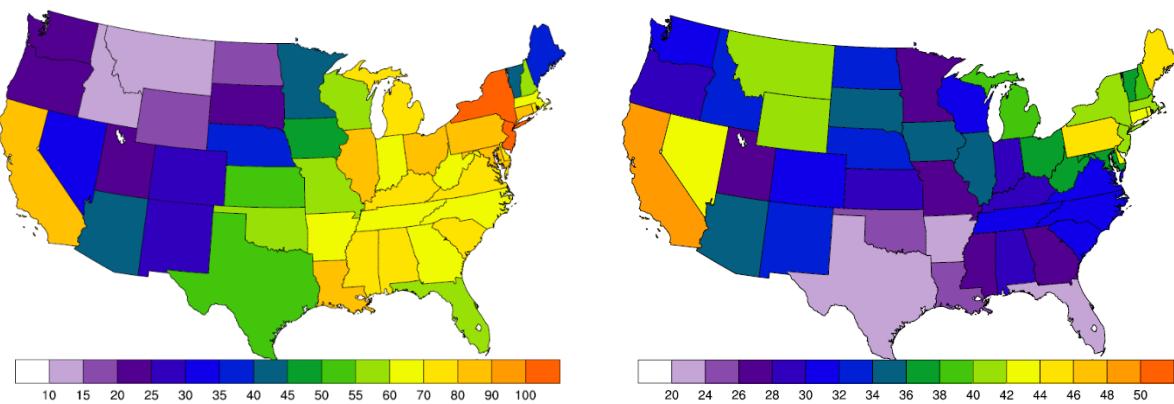


Figure S2. Avoided mortality per capita (MPC, total avoided deaths per million people) by state for the total co-benefits in US in 2050 for PM<sub>2.5</sub> (left) and O<sub>3</sub> (right). Note that the scales in the two panels differ.

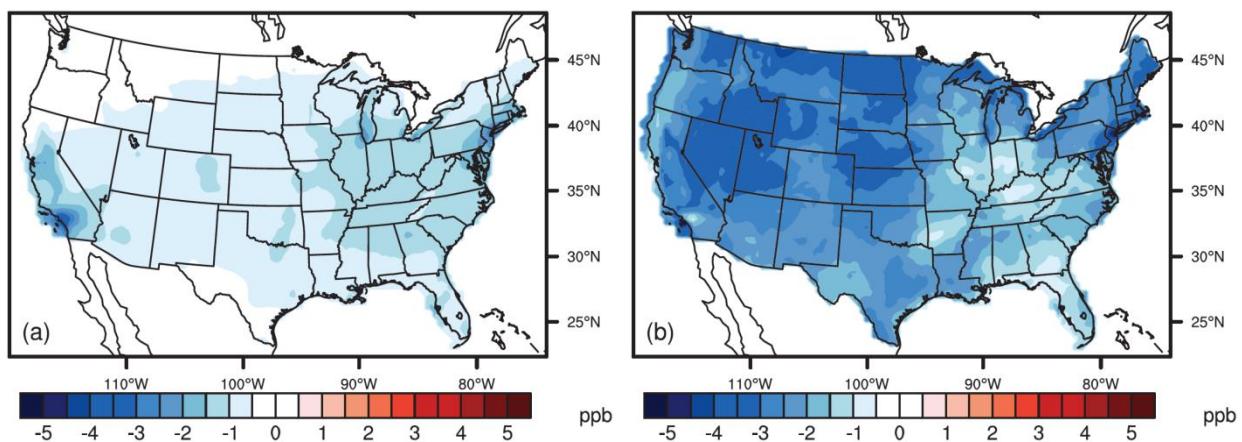


Figure S3. (a) Domestic (0.80 ppbv for three-year Simple Average in US in 2050), and (b) foreign co-benefits (2.16 ppbv for three-year Simple Average in US in 2050) for 6-month ozone-season average of 1-hr daily maximum of O<sub>3</sub>.