

Figure S1. 2010 aggregated population density in South America estimated by Gridded Population of the World, version 4, revision 11 (GPWv4.11) (Center for International Earth Science Information Network, 2018).

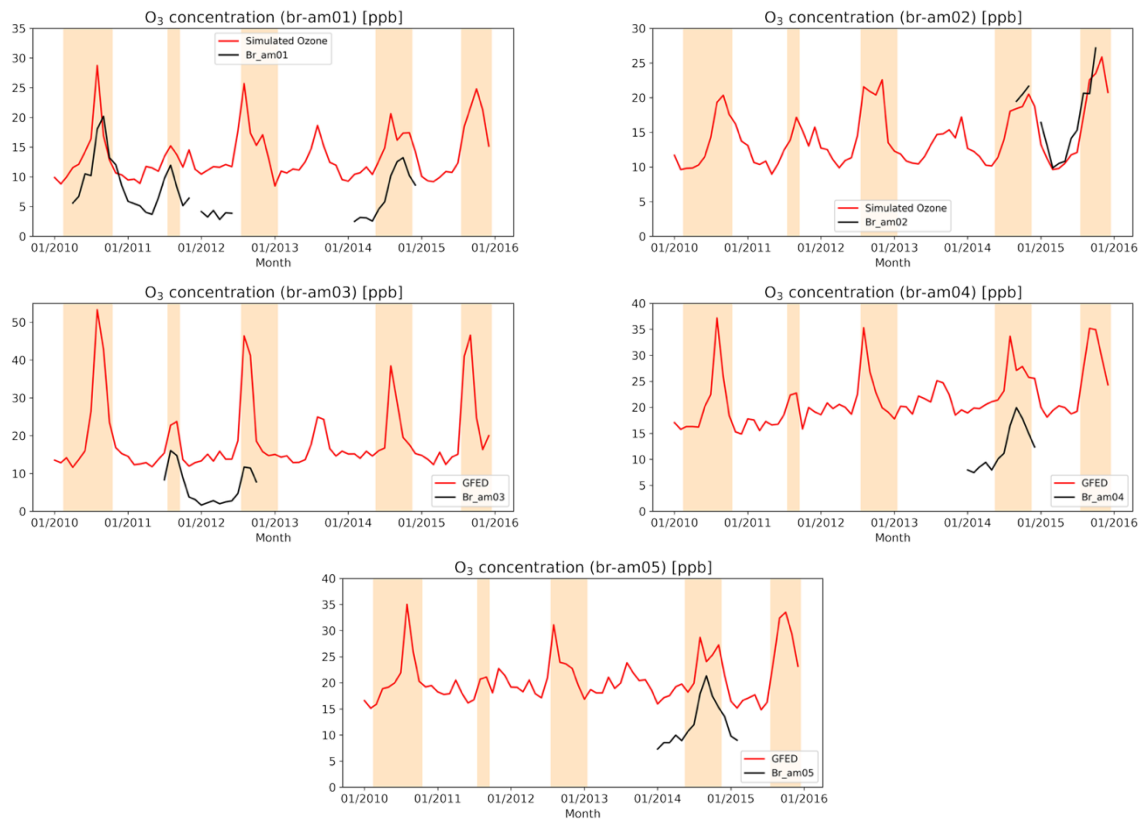


Figure S2. Time series comparison of surface ozone concentrations between five ground stations of Tropospheric Ozone Assessment Report (TOAR) and the nearest grid cell in GCHP simulations.

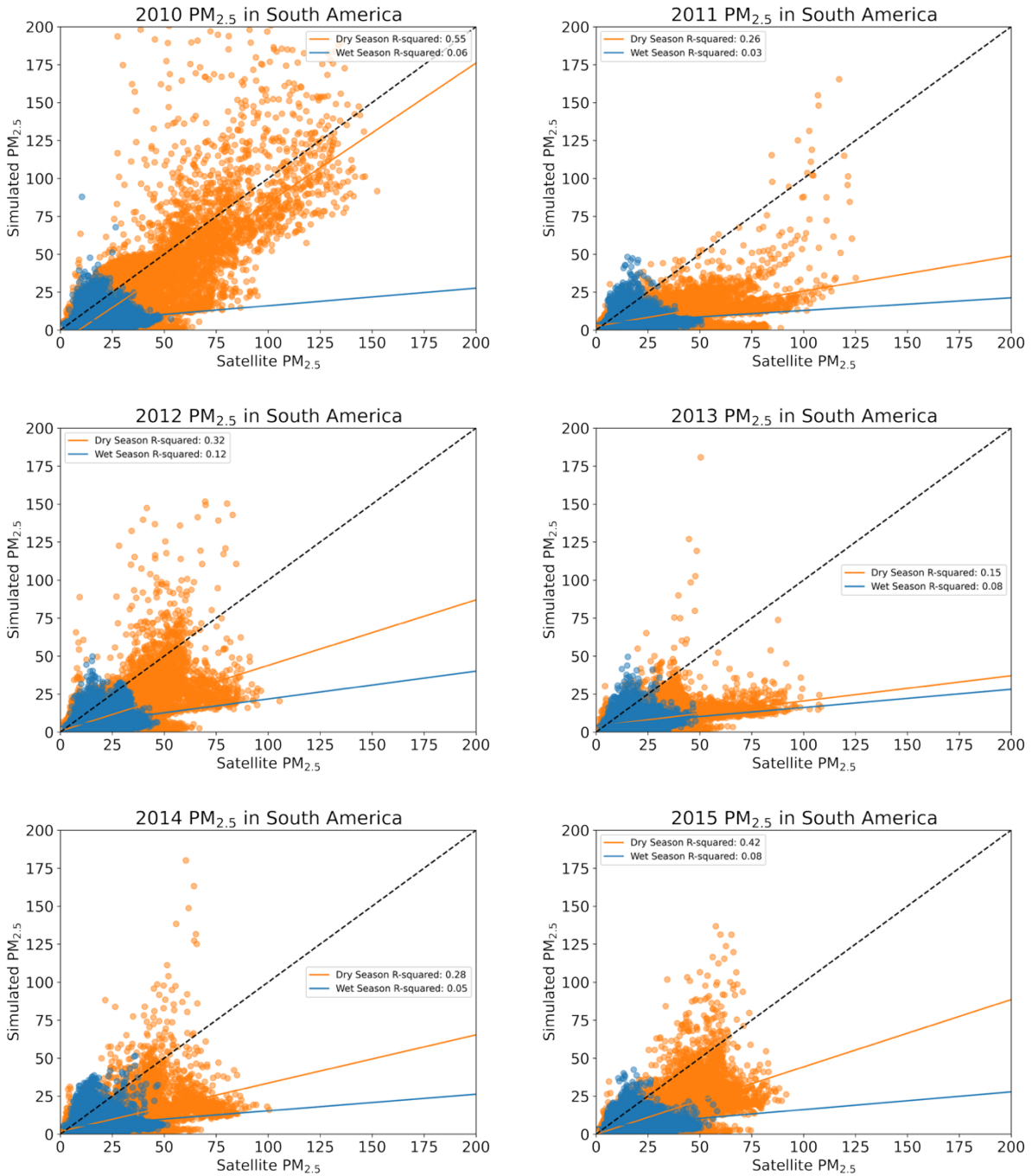


Figure S3. Comparison of GCHP versus satellite-derived monthly $PM_{2.5}$ for 2010-2015 over South America (land-only). Orange circles represent the Amazonian wet season (January to May); blue circles, the dry season (July to November).

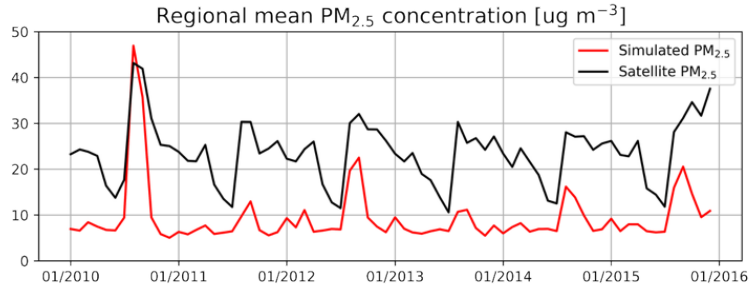


Figure S4. Time series comparison between GCHP simulated surface PM_{2.5} (red) and satellite derived surface PM_{2.5} (black) obtained from global monthly mean dataset between Jan 2010 to Dec 2015.

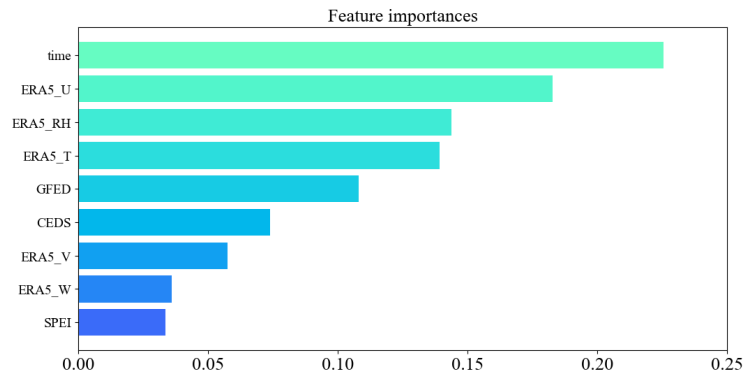


Figure S5. Feature importances of different variables to the biases between GCHP-simulated surface PM_{2.5} concentration and satellite-derived surface PM_{2.5} concentration.

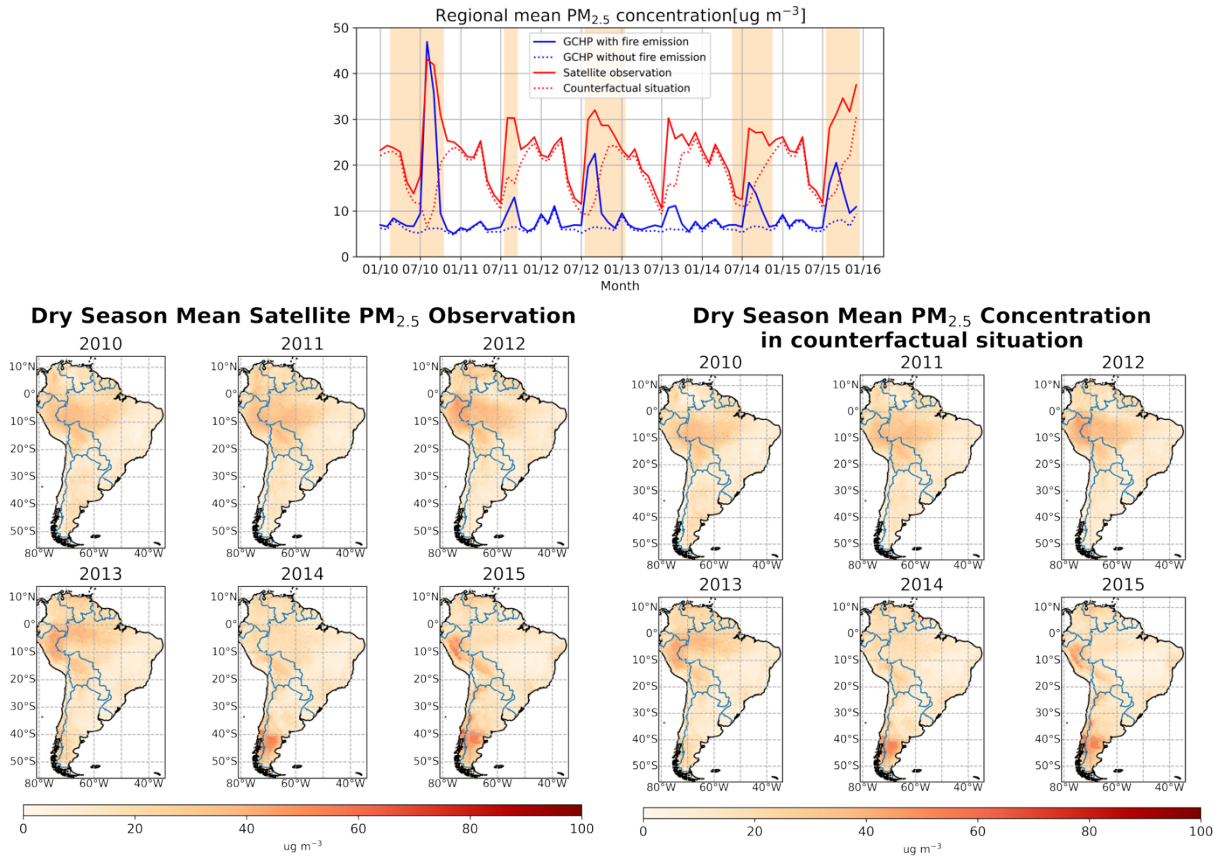


Figure S6. (a) Time series plot of GCHP simulated PM_{2.5} with fire emission (blue solid), without fire emission (blue dotted), satellite PM_{2.5} observation (red) and PM_{2.5} concentration in counterfactual situation (red dotted). Dry season mean (b) satellite PM_{2.5} observation and (c) derived concentration in counterfactual situation.

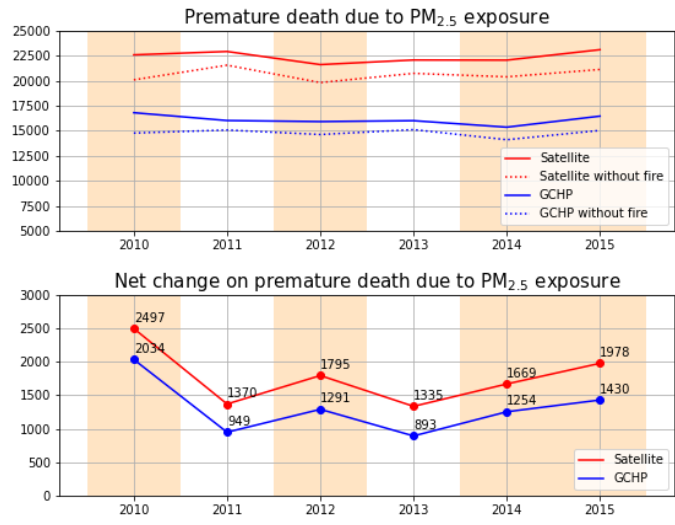


Figure S7. Timeseries of (a) annual premature mortalities due to exposure to PM_{2.5} and (b) net change on annual premature mortalities due to exposure to fire-emitted PM_{2.5} using direct GCHP output (blue) and satellite-derived with GCHP correction (red).

Table S1 Emission factors from Global Fire Emission Dataset version 4 (GFEDv4) (van der Werf et al., 2017).

Species	Tropical Forest	Temperate Forest	Boreal Forest	Savanna	Agricultural Waste	Peat
CO ₂	1643	1647	1489	1686	1585	1549
CO	93	88	127	63	102	210
CH ₄	5.07	3.36	5.96	1.94	5.82	13.825
NMHC	1.7	8.4	8.4	3.4	9.9	x
H ₂	3.36	2.03	2.03	1.7	2.59	x
NO _x (as NO)	2.55	1.92	0.9	3.9	3.11	1
N ₂ O	0.2	0.16	0.41	0.2	0.1	x
PM _{2.5}	9.1	12.9	15.3	7.17	6.26	x
TPM	13	17.6	17.6	8.5	12.4	x
TPC (OC+BC)	5.24	10.1	10.1	3	3.05	6.06
OC	4.71	9.6	9.6	2.62	2.3	6.02
BC	0.52	0.5	0.5	0.37	0.75	0.04
SO ₂	0.4	1.1	1.1	0.48	0.4	x
C ₂ H ₆ (ethane)	0.71	0.63	1.79	0.66	0.91	x
CH ₃ OH (methanol)	2.43	1.74	2.82	1.18	3.29	6.25
C ₂ H ₅ OH (ethanol)	0.037	0.1	0.055	0.024	0.035	x
C ₃ H ₈ (propane)	0.126	0.22	0.44	0.1	0.28	x
C ₂ H ₂ (acetylene)	0.44	0.26	0.18	0.24	0.27	0.08
C ₂ H ₄ (ethylene)	1.06	1.17	1.42	0.82	1.46	1.97
C ₃ H ₆ (propylene)	0.64	0.61	1.13	0.79	0.68	2.92
C ₅ H ₈ (isoprene)	0.13	0.099	0.15	0.039	0.38	1.38
C ₁₀ H ₁₆ (terpenes)	0.15	2.003	2.003	0.081	0.005	x
C ₇ H ₈ (toluene)	0.26	0.19	0.48	0.08	0.19	1.55
C ₆ H ₆ (benzene)	0.39	0.27	1.11	0.2	0.15	3.19
C ₈ H ₁₀ (xylene)	0.11	0.13	0.18	0.014	0.114	x
Toluene lump	0.6970139	0.5404448	1.6258951	0.2703381	0.41518508	4.35983
Higher Alkenes	0.2674285	0.3694285	0.3848571	0.1332	0.33342857	x
Higher Alkanes	0.0722821	0.2245700	0.3494449	0.0549472	0.33955880	x
CH ₂ O (formaldehyde)	1.73	2.09	1.86	0.73	2.08	1.695
C ₂ H ₄ O (acetaldehyde)	1.55	0.77	0.77	0.57	1.24	3.27
C ₃ H ₆ O (acetone)	0.63	0.54	0.75	0.16	0.45	1.25
NH ₃ (ammonia)	1.33	0.84	2.72	0.52	2.17	x
C ₂ H ₆ S (dms)	0.00135	0.008	0.00465	0.0013	0.0013	x
NH ₃ (ammonia)	1.33	0.84	2.72	0.52	2.17	x
C ₂ H ₆ S (dms)	0.00135	0.008	0.00465	0.0013	0.0013	x
HCN (hydrogen cyanide)	0.42	0.72	1.52	0.41	0.29	6.6
HCOOH (formic acid)	0.79	0.28	0.57	0.21	1	0.63
CH ₃ COOH (acetic acid)	3.05	2.13	4.41	3.55	5.59	8.13
MEK (methyl Ethyl Ketone)	0.5	0.13	0.22	0.181	0.9	x
CH ₃ COCHO (methylglyoxal)	0.73	0.73	0.73	0.73	0.73	x
HOCH ₂ CHO (hydroxyacetaldehyde)	0.74	0.86	0.86	0.25	0.71	x
Combustion Completeness (CC)	0.4917505	0.4894161	0.4649894	0.4882731	0.48035201	0.52282

Table S2 Baseline mortality rates obtained from Global Burden of Disease (GBD).

Sex	Age	Cause	Value
Female	25-29 years	Lower respiratory infections	2.78245435
Female	25-29 years	Ischemic heart disease	1.53130145

Female	25-29 years	Stroke	2.85034078
Female	30-34 years	Lower respiratory infections	3.59900647
Female	30-34 years	Ischemic heart disease	3.43416113
Female	30-34 years	Stroke	5.23204765
Female	35-39 years	Lower respiratory infections	4.76043924
Female	35-39 years	Ischemic heart disease	7.17408212
Female	35-39 years	Stroke	10.3348412
Female	40-44 years	Lower respiratory infections	6.74626082
Female	40-44 years	Ischemic heart disease	15.743864
Female	40-44 years	Stroke	20.3725127
Female	45-49 years	Lower respiratory infections	9.81062598
Female	45-49 years	Ischemic heart disease	32.7502345
Female	45-49 years	Stroke	32.5160714
Female	50-54 years	Lower respiratory infections	15.2685162
Female	50-54 years	Ischemic heart disease	55.0732145
Female	50-54 years	Stroke	49.0338998
Female	55-59 years	Lower respiratory infections	23.4317703
Female	55-59 years	Ischemic heart disease	88.0125886
Female	55-59 years	Stroke	70.4061655
Female	60-64 years	Lower respiratory infections	36.9893078
Female	60-64 years	Ischemic heart disease	146.78515
Female	60-64 years	Stroke	105.338656
Female	65-69 years	Lower respiratory infections	65.249512
Female	65-69 years	Ischemic heart disease	236.796355
Female	65-69 years	Stroke	175.77584
Female	70-74 years	Lower respiratory infections	123.893763
Female	70-74 years	Ischemic heart disease	379.296204
Female	70-74 years	Stroke	307.659775
Female	75-79 years	Lower respiratory infections	245.196109
Female	75-79 years	Ischemic heart disease	579.852709
Female	75-79 years	Stroke	534.032198
Female	80+ years	Lower respiratory infections	879.503716
Female	80+ years	Ischemic heart disease	1362.43486
Female	80+ years	Stroke	1274.77364
Male	25-29 years	Lower respiratory infections	4.63860607
Male	25-29 years	Ischemic heart disease	4.06449607
Male	25-29 years	Stroke	3.01496519
Male	30-34 years	Lower respiratory infections	6.7828033
Male	30-34 years	Ischemic heart disease	9.19195351
Male	30-34 years	Stroke	5.39738423
Male	35-39 years	Lower respiratory infections	10.2394054
Male	35-39 years	Ischemic heart disease	18.3790601
Male	35-39 years	Stroke	10.3518353
Male	40-44 years	Lower respiratory infections	14.8316832
Male	40-44 years	Ischemic heart disease	37.4501464
Male	40-44 years	Stroke	20.5104289
Male	45-49 years	Lower respiratory infections	21.9448594
Male	45-49 years	Ischemic heart disease	74.4307288
Male	45-49 years	Stroke	37.4920038

Male	50-54 years	Lower respiratory infections	32.3688776
Male	50-54 years	Ischemic heart disease	134.743167
Male	50-54 years	Stroke	67.6695385
Male	55-59 years	Lower respiratory infections	45.7913992
Male	55-59 years	Ischemic heart disease	214.575517
Male	55-59 years	Stroke	110.848993
Male	60-64 years	Lower respiratory infections	64.8854565
Male	60-64 years	Ischemic heart disease	309.399209
Male	60-64 years	Stroke	177.456956
Male	65-69 years	Lower respiratory infections	105.613723
Male	65-69 years	Ischemic heart disease	453.047517
Male	65-69 years	Stroke	292.519057
Male	70-74 years	Lower respiratory infections	188.912317
Male	70-74 years	Ischemic heart disease	646.013708
Male	70-74 years	Stroke	481.826824
Male	75-79 years	Lower respiratory infections	340.234856
Male	75-79 years	Ischemic heart disease	906.263832
Male	75-79 years	Stroke	780.140875
Male	80+ years	Lower respiratory infections	944.566408
Male	80+ years	Ischemic heart disease	1643.54237
Male	80+ years	Stroke	1460.57749

Table S3 Station location of Tropospheric Ozone Assessment Report (TOAR).

Station ID	Station longitude	Station latitude
Br-am01	-60.21	-2.59
Br-am02	-54.96	-2.85
Br-am03	-63.87	-8.69
Br-am04	-60.60	-3.21
Br-am05	-60.13	-3.14