Supplementary Materials

S1. Model Evaluation with Satellite and Ground-based Observations

Comparison with field- and satellite-derived PM2.5 (SM-Table S2), and field-based SO_2 (Table S3) and NO_2 (Table S4) observations are shown in Fig. S4(a) and Fig. S4(b). Modeled and satellite-derived PM2.5 for Indian region had a coefficient of correlation r = 0.895 and NMB = 27%]. The magnitude of NMB increased when using ground-based SO_2 concentration and the NO_2 concentrations were highly underestimated within the UAs (Fig. S4(b); SO_2: r = 0.53, NMB = 26%; NO_2: r = 0.40, NMB = -63%). The modeled NO_2 concentration was found to be in a good agreement with the NAMP concentration values of > 15 $\mu g\ m^{-3}$ (NMB = 18.5%) while a slight underestimation was observed for the SO_2 concentration values of < 15 $\mu g\ m^{-3}$ (NMB = -8%). This is reasonable because the model captures concentrations at $0.5^{o} \times 0.625^{o}$ resolution, whereas urban measurements are dependent on sampling locations and the abilities to capture urban plumes. Satellite-based measurements can also underestimate NO_2 concentrations in urban cores and overestimate them outside urban cores [1, 2] and introduce a 20-30% bias. Our model grid size means the model captures both the urban cores and the outside regions. Therefore, a one-to-one comparison of model and ground-observations is not accurate. As such, our results are applicable to the PM2.5 concentrations and population exposure over the model grid, as done in other studies (e.g., David et al. [1]), which encompasses the city (with the population being more concentrated within the city).

S2. Premature Mortality in India during 2010

The premature mortality was estimated as 0.54 (0.45 – 0.63) million in India using integrated exposure response (IER) function (to all age groups above 25 years) for 4 diseases (ischemic heart disease (IHD), chronic obstructive pulmonary disorder (COPD), stroke and lung cancer (LC)). The 2010 premature mortality in India and the percent contribution of the 4 diseases considered in the study is shown in Fig. S5 and Fig. S6, respectively. Stroke is the major reason for the premature deaths in India followed by IHD, COPD and LC (Table S6). Due to high population density and PM2.5 concentration in the IGP region the premature mortality is high in this region as compared to other parts of India.

S3. Premature Mortality in 53 Rural Regions of India

Tables S9, S10 and Fig. S7 present the premature mortality and the percentage of BOD with respect to the population in 53 rural regions in India. Fig. S7 also presents the concentration of PM2.5 and its chemical components in these rural regions. The premature mortality with respect to population in the rural regions ranged from 0.02% to 0.069% with the average of 0.052%. The annual average PM2.5 concentration in these rural sites was estimated to be 50.1 µg m^{-3} (12.5 µg m^{-3} at Pangi region of Chamba district of Himachal Pradesh to 105.33 µg m^{-3} at Jakhal region of Fatehabad of Haryana state). The annual average PM2.5 concentration in the rural sites (50.1 µg m^{-3}) are lower than the annual average concentration of PM2.5 at UAs (63.33 µg m^{-3}) of India. This value is less than the UA of India. From Fig. S7, it can be seen that the premature mortality is directly proportional to the PM2.5 concentration.

Fig. S9 presents the comparison of PM2.5 concentration for the administrative zones (namely, northern, southern, eastern, western and central zones as in Fig. S8) of India. It is

observed that the annual average PM2.5 concentrations in the UAs in the respective zone is found to be higher than the rural sites. The t-test was performed to confirm this hypothesis and the p-value was estimated for the 5 zones considered (as presented in Table S11).

The premature mortality in the rural areas were 1.2% to 50.6% higher than the country averaged BOD. Whereas there were few sites whose premature mortality was observed to be less than the average BOD of India. This is because of the low PM2.5 concentration (12.5 µg m-3 – 35.4 µg m-3) as well as the low population within the region.

Reference

[1] David LM, Ravishankara AR, Kodros JK, Pierce JR, Venkataraman C, Sadavarte P. Premature Mortality Due to PM 2.5 Over India: Effect of Atmospheric Transport and Anthropogenic Emissions. *GeoHealth.* 2019;3:2–10.

[2] Kim SW, McDonald BC, Baidar S, et al. Modeling the weekly cycle of NOx and CO emissions and their impacts on O3 in the Los Angeles-South Coast Air Basin during the CalNex 2010 field campaign. *J. Geophys. Res. Atmos.* 2016;121:1340–1360.

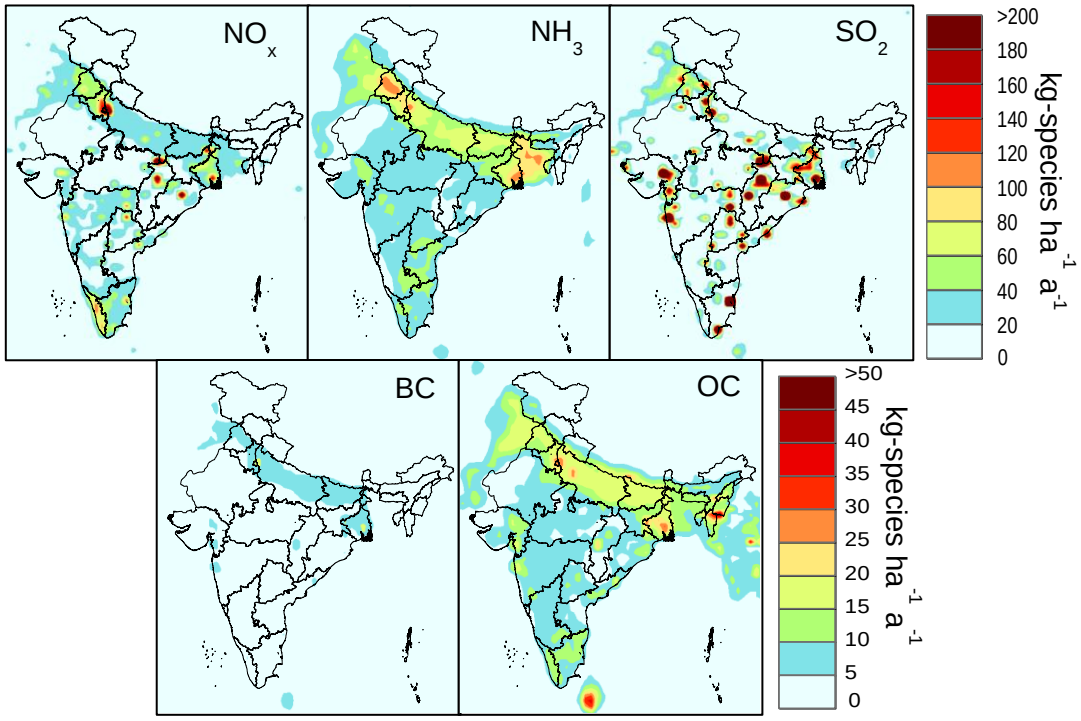


Fig. S1. The spatial distribution of anthropogenic emissions of different species in India for the year 2010.

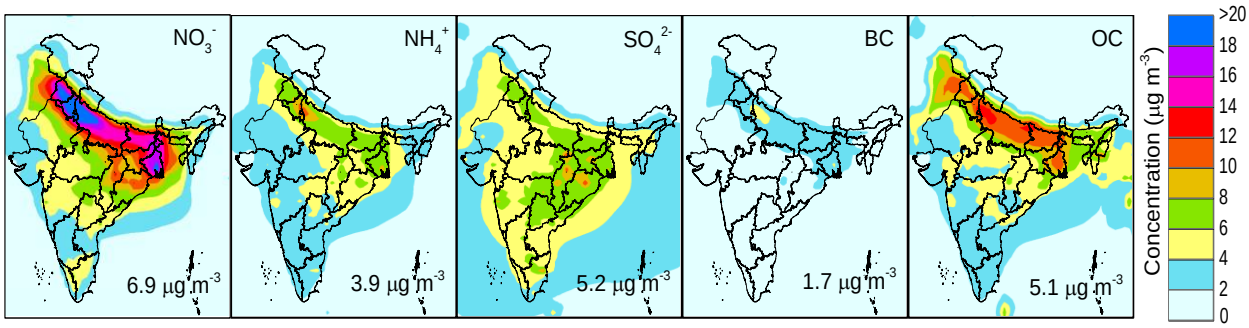


Fig. S2. 2010 spatial annual mean concentration (µg m-3) of NO_3^-, NH_4^+, SO_4^{2-}, BC and OC where the inset values are the annual mean concentrations of the respective species.

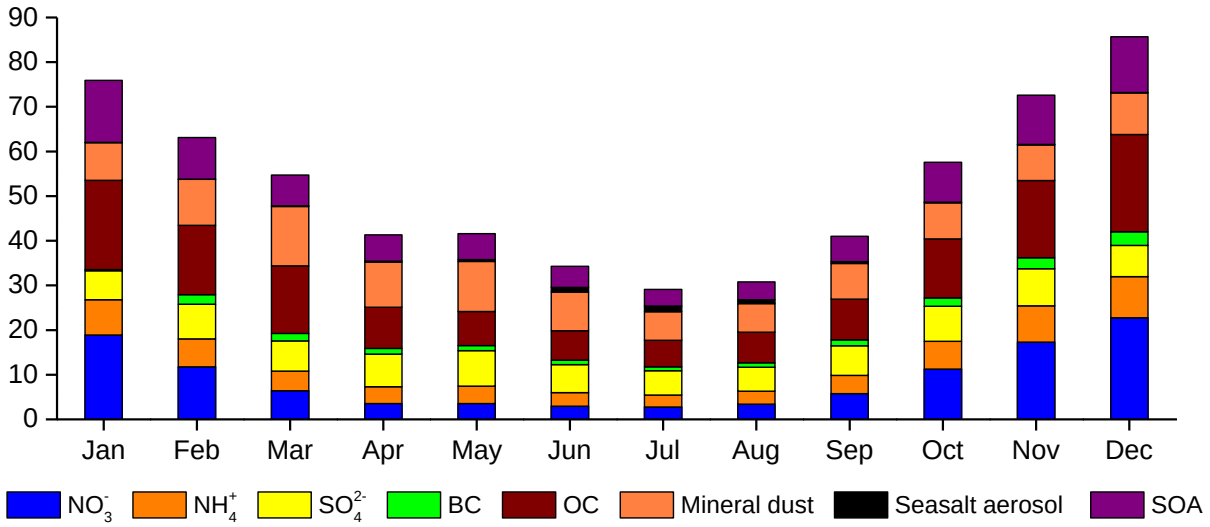
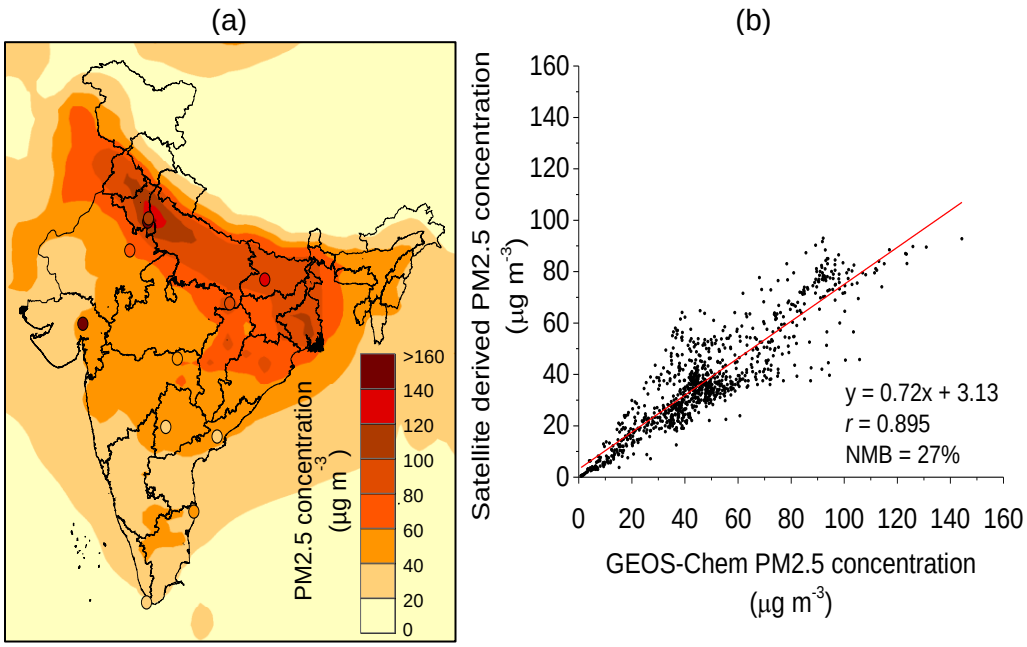


Fig. S3. Monthly mean concentration (μg m^{-3}) of components of PM2.5 obtained for the year 2010 over Indian region.



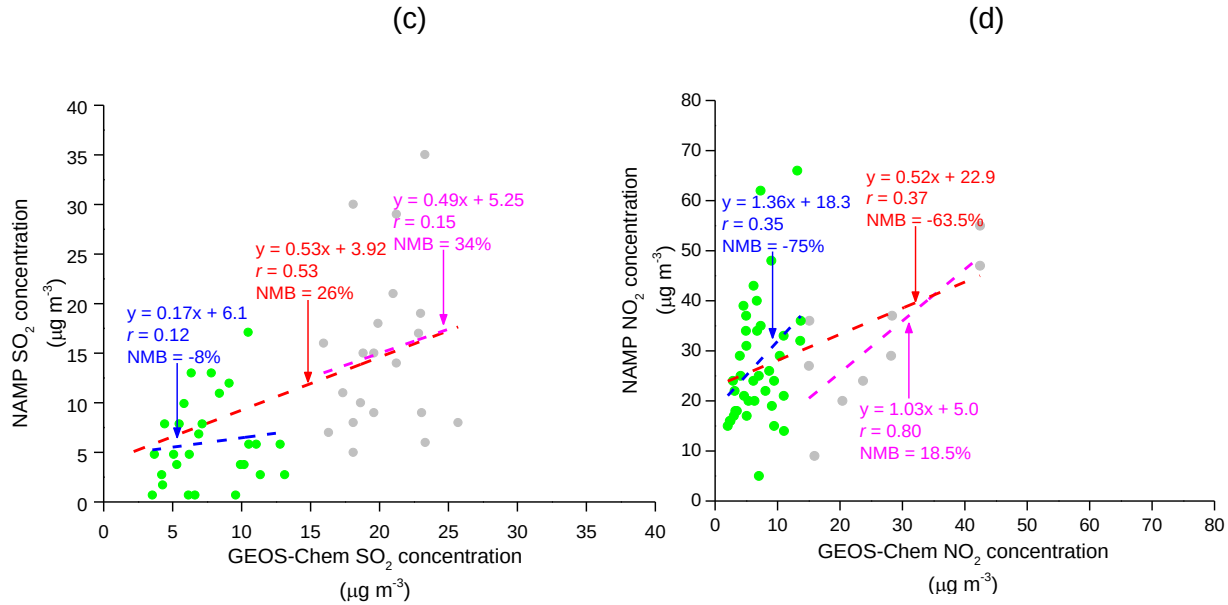


Fig. S4. (a-b) Comparison of GEOS-Chem simulated PM2.5 concentration with the satellite derived observations of India for the year 2010. (c-d) Comparison of SO_2 and NO_2 concentrations obtained from GEOS-Chem simulation with the ground-based (NAMP) observations for the year 2010 (the blue trend line is for the concentrations < 15 µg m^{-3}; pink trend line is for >15 µg $m^{-3}$and the red trend line is for all the concentrations).

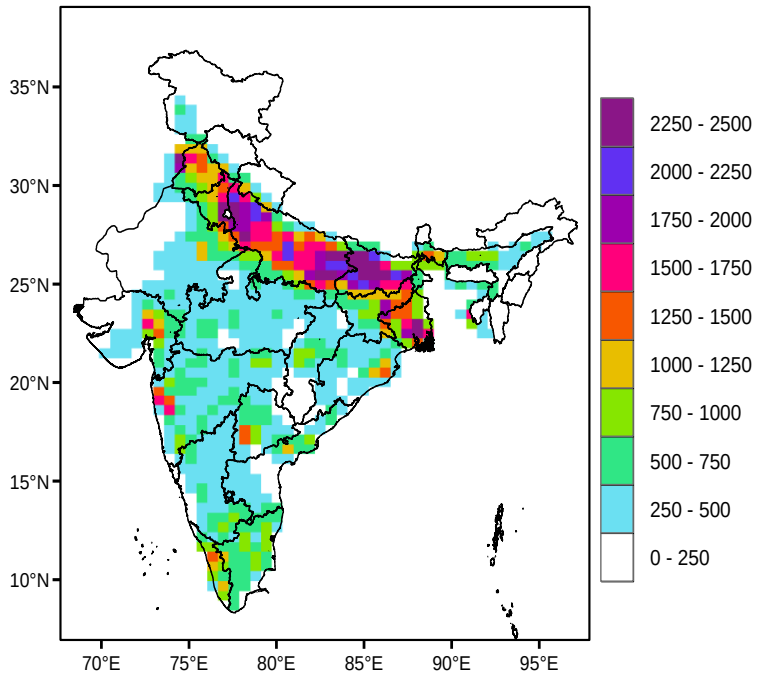


Fig. S5. Premature mortality in India due to PM2.5 obtained from GEOS-Chem simulation for the year 2010.

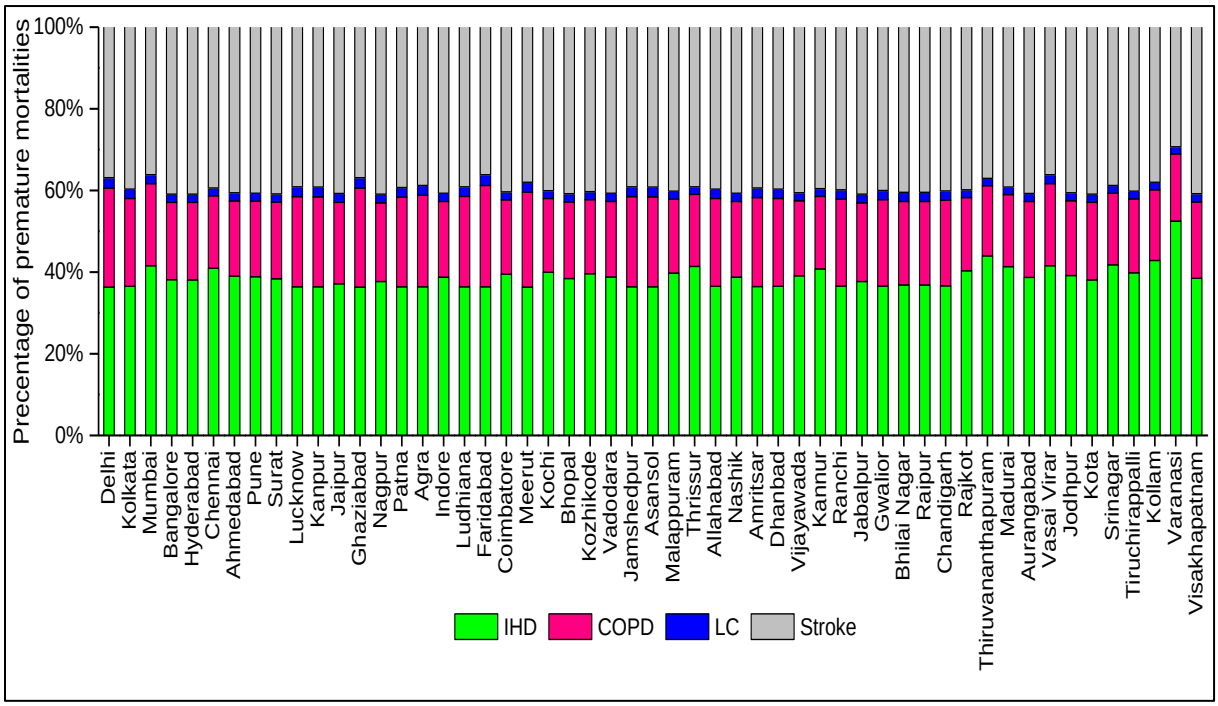


Fig. S6. Percent premature mortality due to PM2.5 for 4 diseases (COPD, IHD, Stroke and LC) in 53 UAs of India for the year 2010.

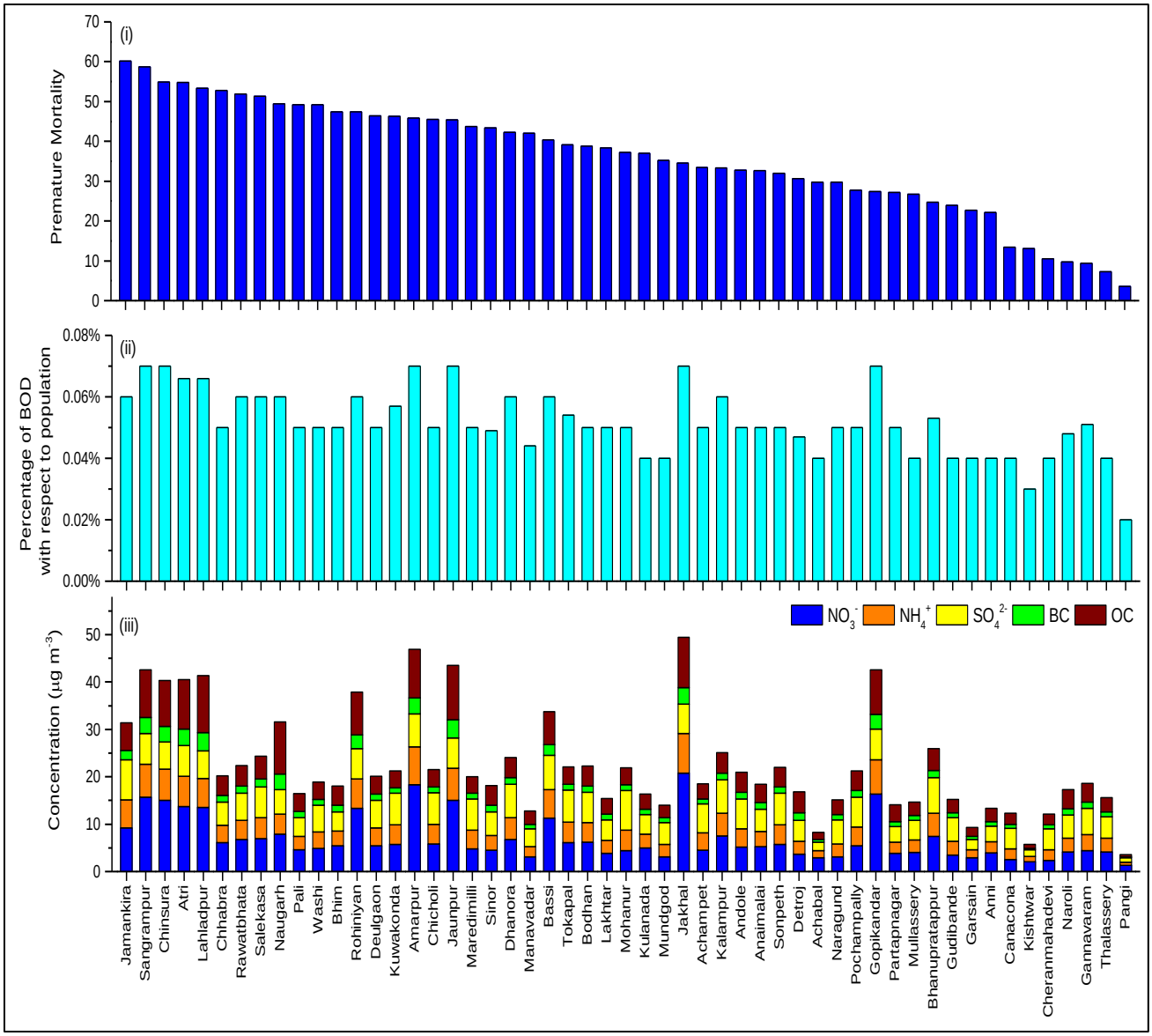


Fig. S7. Total premature mortality, percentage of BOD with respect to the population and (iii) concentration of chemical composition at 53 different rural regions of India.

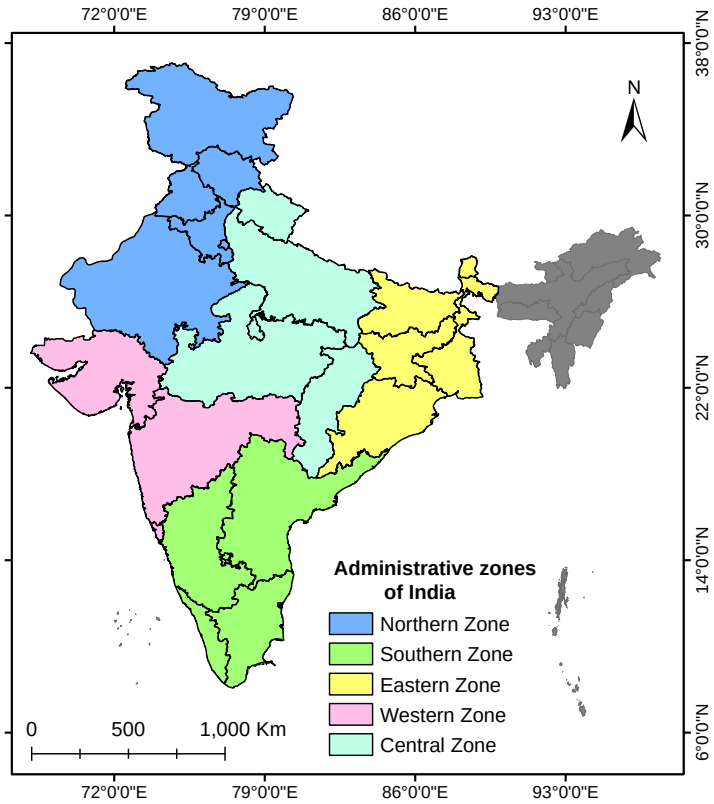


Fig. S8. Administrative zones of India considered in the study.

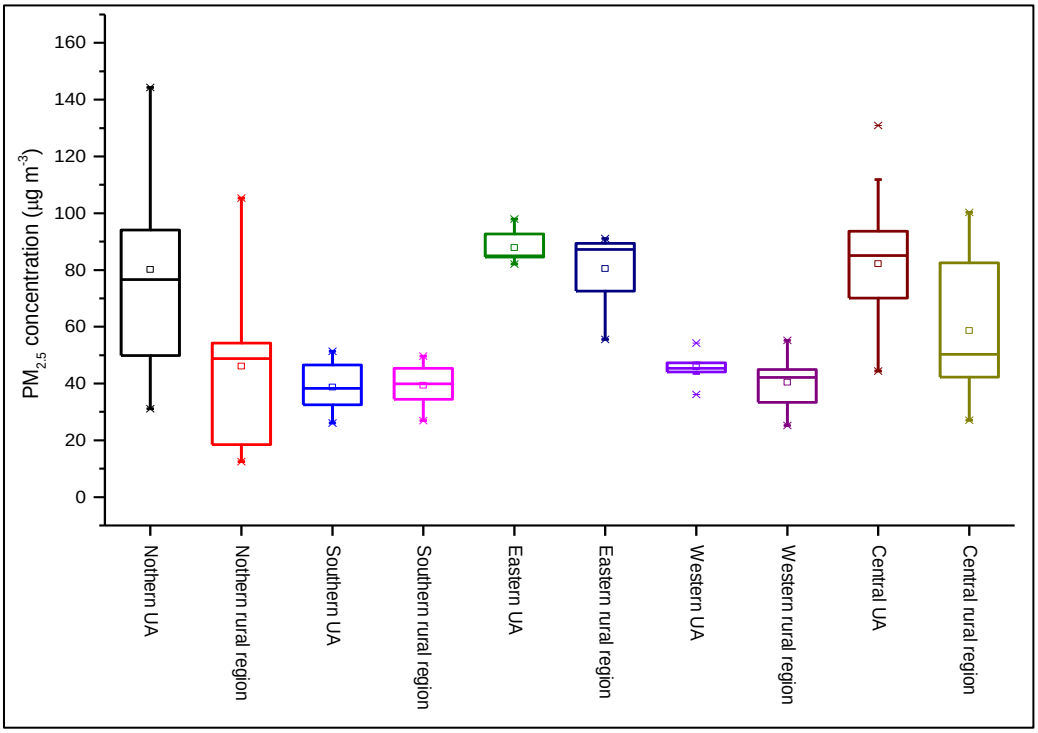


Fig. S9. Regional (Northern, Southern, Eastern, Western and Central) comparison of PM2.5 concentration between 53 Urban agglomerations of India and 53 rural regions of India.

Table S1. Total Emissions for Various Species in 2010 over Indian Region

	Source Type	Emission (Tg-species a^{-1})
NO_x *	Total	4.4
	Anthropogenic	2.69
	Open Fires	0.039
	Ships	8.53×10^{-4}
	Aircrafts	1.72×10^{-4}
	Soil	0.75
	Lightning	0.164
	Fertilizer use	0.75
NH_3	Total	10
	Anthropogenic	9.46
	Open Fires	0.033
	Natural	0.5
SO_2	Total	8.65
	Anthropogenic	8.61
	Open Fires	0.019
	Ships	0.014
	Aircrafts	6.56×10^{-5}
OC	Total	2.69
	Anthropogenic	2.53
	Open Fire	0.16
BC	Total	0.876
	Anthropogenic	0.86
	Open Fire	0.016

Units: Tg-species a^{-1} (*Unit for emission of NOx is Tg-N a^{-1})

Table S2. National Ambient Air Quality Monitoring Programme (NAMP) Observed PM2.5 Concentration and GEOS-Chem Model Results

Location	Latutude (˚N)	Longitude (˚E)	Annual Mean PM2.5 concentration	GEOS-Chem obtained PM2.5 concentration
Nagpur	21.15	79.07	44.8	54.3
Hyderabad	17.51	78.28	39.8	50
Rajamahendravaram	17	81.8	39.3	48.8
Jaipur	26.92	75.8	75.6	63
Ahmedabad	23	72.6	160.8	49.6
Patna	25.36	85.08	120.9	93.9
Singrauli	24.1	82.67	93.2	77.1
Chennai	13	80.2	54.5	27
Gurugram	28.45	77.03	153.6	144.3
Thiruvananthapuram	8.15	76.95	32.7	26.1
Janakpuri	28.62	77.09	107	130.9

Table S3. NAMP Observed SO_2 Concentrations and GEOS-Chem Model Results

Sr. No.	State	Classifica-tion of Cities	Urban location	Latitude (˚N)	Longitude (˚E)	SO_2 concentration ($\mu g\ m^{-3}$)	
						GEOS-Chem	NAMP
1	Telanagana	Tier -1	Hyderabad	17.39	78.49	9.12	5.40
2	Andhra Pradesh	Tier - 2	Vijaywada	16.51	80.65	23.33	5.00
3		Tier - 2	Visakhapatnam	17.69	83.22	12.24	13.38
4	Bihar	Tier - 2	Patna	25.59	85.14	10.36	6.00
5	Chandigarh	Tier - 2	Chandighar	21.15	86.65	8.73	2.00
6		Tier - 3	Bhillai	21.19	81.35	19.60	8.67
7	Chhattisgarh	Tier - 2	Raipur	21.25	81.63	19.60	15.00
8	Delhi	Tier - 1	Delhi	28.70	77.10	18.11	4.10
9	Gujarat	Tier - 1	Ahmedabad	23.02	72.57	NA	NA
10		Tier - 2	Rajkot	22.30	70.80	8.22	12.00
11		Tier - 2	Surat	21.17	72.83	15.96	13.00
12		Tier - 2	Vadodara	22.31	73.18	22.85	13.33
13	Haryana	Tier - 2	Faridabad	28.41	77.32	19.90	13.00
14	Jharkhand	Tier - 2	Dhanbad	23.80	86.43	18.83	16.33
15		Tier - 2	Jamshedpur	22.81	86.21	23.30	16.33
16		Tier - 2	Ranchi	23.34	85.31	23.00	16.33
17	Karnataka	Tier - 1	Bangalore	12.97	77.60	6.82	12.50
18	Kerala	Tier - 2	Kochi	9.93	76.27	2.91	2.00
19		Tier - 2	Kollam	8.89	76.61	2.98	4.00
20		Tier - 2	Kozhikode	11.26	75.78	5.01	2.00
21		Tier - 2	Malapuram	11.05	76.07	2.17	2.00
22		Tier - 2	Thiruvananthapuram	8.52	76.94	4.28	9.50
23	Madhya Pradesh	Tier - 2	Bhopal	23.26	77.41	6.09	2.67
24		Tier - 2	Gwalior	26.22	78.18	7.45	12.50
25		Tier - 2	Indore	22.72	75.86	5.23	11.00
26		Tier - 2	Jabalpur	23.18	79.99	5.53	2.00
27	Maharashtra	Tier - 2	Aurangabad	19.88	75.34	5.08	10.00
28		Tier - 1	Mumbai	19.08	72.88	12.60	3.00
29		Tier - 2	Nagpur	21.15	79.09	16.31	8.50
30		Tier - 2	Nashik	12.00	73.79	21.00	28.00
31		Tier - 1	Pune	18.52	73.86	21.24	20.00
32	Punjab	Tier - 2	Amritsar	31.63	74.87	21.24	12.50
33		Tier - 2	Ludhiana	30.90	75.86	23.07	11.25
34	Rajasthan	Tier - 2	Jaipur	26.91	75.79	3.85	7.50
35		Tier - 2	Jodhpur	26.24	73.02	2.33	5.33
36		Tier - 3	Kota	25.22	75.86	18.64	7.00
37	Tamil Nadu	Tier - 1	Chennai	13.08	80.27	3.13	13.90
38		Tier - 2	Coimbatore	11.01	76.96	4.10	4.00
39		Tier - 2	Madhurai	9.93	78.12	4.66	14.33
40		Tier - 2	Trichy	10.79	78.71	12.85	14.00
41	Uttar Pradesh	Tier - 2	Agra	27.18	78.01	9.40	5.33
42		Tier - 3	Allahabad	25.44	81.85	10.68	5.00
43		Tier - 2	Ghaziabad	28.67	77.45	18.11	17.00

44		Tier - 2	Kanpur	26.45	80.33	9.78	6.75
45		Tier - 2	Lucknow	26.85	80.95	5.82	7.40
46		Tier - 2	Meerut	28.99	77.71	18.11	5.00
47		Tier - 2	Varanasi	25.32	82.97	9.72	19.50
48	West Bengal	Tier - 2	Asansol	23.69	86.97	25.71	10.00
49		Tier - 1	Kolkata	22.57	88.36	17.36	10.56

Table S4. NAMP Observed NO_2 Concentration and GEOS-Chem Model Results

Sr. No	State	Classification of Cities	Urban location	Latitude (°N)	Longitude (°E)	NO_2 concentration ($\mu g\ m^{-3}$)	
						GEOS-Chem	NAMP
1	Telanagana	Tier -1	Hyderabad	17.39	78.49	9.12	5
2	Andhra Pradesh	Tier - 2	Vijaywada	16.51	80.65	23.33	6
3		Tier - 2	Visakhapatnam	17.69	83.22	12.24	7
4	Bihar	Tier - 2	Patna	25.59	85.14	10.36	7
5	Chandigarh	Tier - 2	Chandighar	21.15	86.65	8.73	2
6		Tier - 3	Bhillai	21.19	81.35	19.60	9
7	Chhattisgarh	Tier - 2	Raipur	21.25	81.63	19.60	15
8	Delhi	Tier - 1	Delhi	28.70	77.10	18.11	5
9	Gujarat	Tier - 1	Ahmedabad	23.02	72.57	61.57	15
10		Tier - 2	Rajkot	22.30	70.80	8.22	13
11		Tier - 2	Surat	21.17	72.83	15.96	16
12		Tier - 2	Vadodara	22.31	73.18	22.85	17
13	Haryana	Tier - 2	Faridabad	28.41	77.32	19.90	18
14	Jharkhand	Tier - 2	Dhanbad	23.80	86.43	18.83	15
15		Tier - 2	Jamshedpur	22.81	86.21	9.01	48
16		Tier - 2	Ranchi	23.34	85.31	7.31	35
17	Karnataka	Tier - 1	Bangalore	12.97	77.60	5.01	31
18	Kerala	Tier - 2	Kochi	9.93	76.27	5.07	17
19		Tier - 2	Kollam	8.89	76.61	9.45	15
20		Tier - 2	Kozhikode	11.26	75.78	15.91	9
21		Tier - 2	Malapuram	11.05	76.07	7.01	5
22		Tier - 2	Thiruvananthapuram	8.52	76.94	9.45	24
23	Madhya Pradesh	Tier - 2	Bhopal	23.26	77.41	3.26	18
24		Tier - 2	Gwalior	26.22	78.18	5.35	20
25		Tier - 2	Indore	22.72	75.86	3.48	18
26		Tier - 2	Jabalpur	23.18	79.99	4.09	25
27	Maharashtra	Tier - 2	Aurangabad	19.88	75.34	4.64	21
28		Tier - 1	Mumbai	19.08	72.88	9.10	19
29		Tier - 2	Nagpur	21.15	79.09	10.98	33
30		Tier - 2	Nashik	12.00	73.79° E	8.66	26
31		Tier - 1	Pune	18.52	73.86	4.54	39
32	Punjab	Tier - 2	Amritsar	31.63	74.87	15.10	36
33		Tier - 2	Ludhiana	30.90	75.86	13.64	32
34	Rajasthan	Tier - 2	Jaipur	26.91	75.79	4.98	37
35		Tier - 2	Jodhpur	26.24	73.02	3.13	22
36		Tier - 3	Kota	25.22	75.86	3.97	29

37	Tamil Nadu	Tier - 1	Chennai	13.08	80.27	2.03	15
38		Tier - 2	Coimbatore	11.01	76.96	15.04	27
39		Tier - 2	Madhurai	9.93	78.12	7.00	25
40		Tier - 2	Trichy	10.79	78.71	NA	NA
41	Uttar Pradesh	Tier - 2	Agra	27.18	78.01	20.39	20
42		Tier - 3	Allahabad	25.44	81.85	6.13	24
43		Tier - 2	Ghaziabad	28.67	77.45	28.35	37
44		Tier - 2	Kanpur	26.45	80.33	6.73	34
45		Tier - 2	Lucknow	26.85	80.95	4.94	34
46		Tier - 2	Meerut	28.99	77.71	42.45	47
47		Tier - 2	Varanasi	25.32	82.97	6.30	20
48	West Bengal	Tier - 2	Asansol	23.69	86.97	13.17	66
49		Tier - 1	Kolkata	22.57	88.36	7.28	62

Table S5. Values of α, γ and δ Considered in the Premature Mortality due to the Four Disease [median (95% confidence limits)] [1].

	Alpha (α)	Gamma (γ)	Delta (δ)
IHD	1.43 (1.38 – 1.48)	0.048 (0.047 – 0.049)	0.38 (0.36 – 0.39)
Stroke	1.26 (1.24 – 1.29)	0.0072 (0.0064 – 0.008)	1.31 (1.28 – 1.35)
COPD	15.22 (13.85 – 16.60)	0.95×10^{-3} (0.90×10^{-3} – 1.0×10^{-3})	0.684 (0.679 – 0.689)
LC	114.74 (107.58 – 121.91)	0.14×10^{-3} (0.13×10^{-3} – 0.15×10^{-3})	0.74 (0.73 – 0.75)

* COPD = Chronic Obstructive Pulmonary Disease; IHD = Ischemic Heart Disease; LC = Lung Cancer

Table S6. Premature Mortality due to PM2.5 in India for the Year 2010

Disease due to air pollution	**Premature Mortalities (95%CL) due $PM_{2.5}$ simulated (in millions)**
COPD	0.102 (0.072 – 0.14)
IHD	0.21 (0.18 – 0.24)
LC	0.012 (0.01 – 0.013)
Stroke	0.22 (0.19 – 0.24)

Table S7. Premature Mortality Estimated for 53 UAs of India for the Year 2010

Sr. No	**Urban Cities**	**Latitude (° N)**	**Longitude (° E)**	**Premature Mortality**
1	Delhi	28.70	77.10	11,945
2	Kolkata	22.57	88.36	9,205
3	Mumbai	19.08	72.88	8,817
4	Bangalore	12.97	77.59	4,528
5	Hyderabad	17.39	78.49	4,157
6	Chennai	13.08	80.27	3,818

7	Ahmedabad	23.02	72.57	3,160
8	Pune	18.52	73.86	2,542
9	Surat	21.17	72.83	2,399
10	Lucknow	26.85	80.95	1,947
11	Kanpur	26.45	80.33	1,940
12	Jaipur	26.91	75.79	1,812
13	Ghaziabad	28.67	77.45	1,727
14	Nagpur	21.15	79.09	1,388
15	Patna	25.59	85.14	1,363
16	Agra	27.18	78.01	1,192
17	Indore	22.72	75.86	1,101
18	Ludhiana	30.90	75.86	1,084
19	Faridabad	28.41	77.32	1,053
20	Coimbatore	11.02	76.96	1,037
21	Meerut	28.98	77.71	1,003
22	Kochi	9.93	76.27	988
23	Bhopal	23.26	77.41	987
24	Kozhikode	11.26	75.78	971
25	Vadodara	22.31	73.18	920
26	Jamshedpur	22.80	86.20	897
27	Asansol	23.69	86.97	831
28	Malappuram	11.05	76.07	803
29	Thrissur	10.53	76.21	794
30	Allahabad	25.44	81.85	794
31	Nashik	20.00	73.79	792
32	Amritsar	31.63	74.87	783
33	Dhanbad	23.80	86.43	779
34	Vijayawada	16.51	80.65	740
35	Kannur	11.87	75.37	730
36	Ranchi	23.34	85.31	727
37	Jabalpur	23.18	79.99	704
38	Gwalior	26.22	78.18	703
39	Bhilai Nagar	21.19	81.35	688
40	Raipur	21.25	81.63	652
41	Chandigarh	30.73	76.78	647
42	Rajkot	22.30	70.80	635
43	Thiruvananthapuram	8.52	76.94	630
44	Madurai	9.93	78.12	628
45	Aurangabad	19.88	75.34	607
46	Vasai Virar	19.39	72.84	585
47	Jodhpur	26.24	73.02	562
48	Kota	25.21	75.86	537
49	Srinagar	34.08	74.80	533

50	Tiruchirappalli	10.79	78.70	482
51	Kollam	8.89	76.61	439
52	Varanasi	25.32	82.97	367
53	Visakhapatnam	17.69	83.22	124

Table S8. Percent Premature Mortality in 53 UAs of India

Sr. No	Urban Cities	Latitude (° N)	Longitude (° E)	% Burden wrt population	% Burden wrt total UAs BOD	% Burden wrt Total National Mortality
1	Delhi	28.70	77.10	0.073	13.38	2.13
2	Kolkata	22.57	88.36	0.065	10.31	1.64
3	Mumbai	19.08	72.88	0.048	9.88	1.57
4	Bangalore	12.97	77.59	0.053	5.07	0.81
5	Hyderabad	17.39	78.49	0.054	4.66	0.74
6	Chennai	13.08	80.27	0.044	4.28	0.68
7	Ahmedabad	23.02	72.57	0.050	3.54	0.56
8	Pune	18.52	73.86	0.050	2.85	0.45
9	Surat	21.17	72.83	0.052	2.69	0.43
10	Lucknow	26.85	80.95	0.067	2.18	0.35
11	Kanpur	26.45	80.33	0.067	2.17	0.35
12	Jaipur	26.91	75.79	0.059	2.03	0.32
13	Ghaziabad	28.67	77.45	0.073	1.93	0.31
14	Nagpur	21.15	79.09	0.056	1.55	0.25
15	Patna	25.59	85.14	0.067	1.53	0.24
16	Agra	27.18	78.01	0.068	1.34	0.21
17	Indore	22.72	75.86	0.051	1.23	0.20
18	Ludhiana	30.90	75.86	0.067	1.21	0.19
19	Faridabad	28.41	77.32	0.075	1.18	0.19
20	Coimbatore	11.02	76.96	0.048	1.16	0.19
21	Meerut	28.98	77.71	0.070	1.12	0.18
22	Kochi	9.93	76.27	0.047	1.11	0.18
23	Bhopal	23.26	77.41	0.052	1.11	0.18
24	Kozhikode	11.26	75.78	0.048	1.09	0.17
25	Vadodara	22.31	73.18	0.051	1.03	0.16
26	Jamshedpur	22.80	86.20	0.067	1.00	0.16
27	Asansol	23.69	86.97	0.067	0.93	0.15
28	Malappuram	11.05	76.07	0.047	0.90	0.14
29	Thrissur	10.53	76.21	0.043	0.89	0.14
30	Allahabad	25.44	81.85	0.065	0.89	0.14
31	Nashik	20.00	73.79	0.051	0.89	0.14
32	Amritsar	31.63	74.87	0.066	0.88	0.14
33	Dhanbad	23.80	86.43	0.065	0.87	0.14

34	Vijayawada	16.51	80.65	0.050	0.83	0.13
35	Kannur	11.87	75.37	0.044	0.82	0.13
36	Ranchi	23.34	85.31	0.064	0.81	0.13
37	Jabalpur	23.18	79.99	0.056	0.79	0.13
38	Gwalior	26.22	78.18	0.064	0.79	0.13
39	Bhilai Nagar	21.19	81.35	0.061	0.77	0.12
40	Raipur	21.25	81.63	0.061	0.73	0.12
41	Chandigarh	30.73	76.78	0.063	0.73	0.12
42	Rajkot	22.30	70.80	0.046	0.71	0.11
43	Thiruvananthapuram	8.52	76.94	0.037	0.71	0.11
44	Madurai	9.93	78.12	0.043	0.70	0.11
45	Aurangabad	19.88	75.34	0.051	0.68	0.11
46	Vasai Virar	19.39	72.84	0.048	0.66	0.10
47	Jodhpur	26.24	73.02	0.049	0.63	0.10
48	Kota	25.21	75.86	0.054	0.60	0.10
49	Srinagar	34.08	74.80	0.042	0.60	0.10
50	Tiruchirappalli	10.79	78.70	0.047	0.54	0.09
51	Kollam	8.89	76.61	0.040	0.49	0.08
52	Varanasi	25.32	82.97	0.026	0.41	0.07
53	Visakhapatnam	17.69	83.22	0.052	0.14	0.02

(wrt : with respect to)

Table S9. The Premature Mortality and Percentage of BOD with Respect to Population at 53 Different Rural Regions of India

Sr No	State	District	Rural region	Latitude (˚N)	Longitude (˚E)	Premature mortality	% BOD wrt population
1	Andhra Pradesh	East Godavari	Maredimilli	17.60	81.71	43.69	0.050
2	Andhra Pradesh	Krishna	Gannavaram	16.54	80.81	9.42	0.051
3	Bihar	Gaya	Atri	24.94	85.31	54.74	0.066
4	Bihar	Saran	Lahladpur	26.05	84.62	53.34	0.066
5	Chhattisgarh	Dantewada	Kuwakonda	18.73	81.44	46.31	0.057
6	Chhattisgarh	Bastar	Tokapal	19.01	81.89	39.19	0.054
7	Chhattisgarh	Kanker	Bhanupratappur	20.30	81.07	24.66	0.053
8	Dadar Nagar Haveli and Damana and Diu	Dadra and Nagar Haveli	Naroli	20.27	72.94	9.77	0.048
9	Goa	South Goa	Canacona	15.00	74.04	13.43	0.040
10	Gujarat	Vadodara	Sinor	21.91	73.34	43.37	0.049
11	Gujarat	Junagadh	Manavadar	21.49	70.14	42.09	0.044
12	Gujarat	Surendranagar	Lakhtar	22.86	71.79	38.40	0.050
13	Gujarat	Ahmadabad	Detroj	23.33	72.19	30.67	0.047
14	Haryana	Fatehabad	Jakhal	29.81	75.83	34.50	0.07

15	Himachal Pradesh	Kullu	Anni	31.43	77.42	22.19	0.04
16	Himachal Pradesh	Chamba	Pangi	31.59	78.28	3.54	0.02
17	Jammu and Kashmir	Anantnag	Achabal	33.68	75.22	29.75	0.04
18	Jammu and Kashmir	Kishtwar	Kishtwar	33.31	75.77	13.13	0.03
19	Jharkhand	Dumka	Gopikandar	24.43	87.48	27.35	0.07
20	Karnataka	Uttar Kannada	Mundgod	14.97	75.04	35.19	0.04
21	Karnataka	Gadag	Naragund	15.72	75.38	29.72	0.05
22	Karnataka	Chik Ballapur	Gudibande	13.67	77.70	23.98	0.04
23	Kerala	Pathanamthitta	Kulanada	9.25	76.67	37.06	0.04
24	Kerala	Thrissur	Mullassery	10.54	76.09	26.74	0.04
25	Kerala	Kannur	Thalassery	11.75	75.49	7.26	0.04
26	Madhya Pradesh	Umaria	Pali	25.78	73.33	49.15	0.05
27	Madhya Pradesh	Dindori	Amarpur	25.50	82.68	45.85	0.07
28	Madhya Pradesh	Betul	Chicholi	22.01	77.67	45.53	0.05
29	Madhya Pradesh	Seoni	Dhanora	20.27	80.31	42.27	0.06
30	Maharashtra	Gondia	Salekasa	21.30	80.49	51.31	0.06
31	Maharashtra	Osmanabad	Washi	18.54	75.77	49.15	0.05
32	Maharashtra	Buldana	Deulgaon Raja	20.02	76.03	46.37	0.05
33	Maharashtra	Parbhani	Sonpeth	19.03	76.46	31.99	0.05
34	Odisha	Sambalpur	Jamankira	21.54	84.39	60.16	0.06
35	Odisha	Kalahandi	Kalampur	19.62	82.89	33.37	0.06
36	Punjab	Fatehgarh	Bassi Pathanan	30.69	76.40	40.32	0.06
37	Rajasthan	Baran	Chhabra	24.67	76.85	52.77	0.05
38	Rajasthan	Chiitaurgarh	Rawatbhata	24.93	75.59	51.94	0.06
39	Rajasthan	Rajsamand	Bhim	25.74	74.08	47.46	0.05
40	Tamil Nadu	Namakkal	Mohanur	11.06	78.14	37.22	0.05
41	Tamil Nadu	Coimbatore	Anaimalai	10.58	76.93	32.61	0.05
42	Tamil Nadu	Tirunelveli	Cheranmahadevi	8.67	77.57	10.53	0.04
43	Telangana	Nizamabad	Bodhan	18.68	77.88	38.82	0.05
44	Telangana	Mahabubnagar	Achampet	16.40	78.64	33.44	0.05
45	Telangana	Medak	Andole	17.82	78.08	32.74	0.05
46	Telangana	Nalgonda	Pochampally	17.35	78.82	27.76	0.05
47	Uttar Pradesh	Chatrapati Shahu Ji Nagar	Sangrampur	24.95	86.59	58.72	0.07
48	Uttar Pradesh	Chandauli	Naugarh	27.30	83.09	49.47	0.06
49	Uttar Pradesh	Rae Bareli	Rohiniyan	25.21	81.25	47.42	0.06
50	Uttrakhand	Tehri	Jaunpur	25.50	82.68	45.44	0.07
51	Uttrakhand	Tehri	Partapnagar	30.45	78.48	27.16	0.05
52	Uttrakhand	Chamoli	Garsain	30.05	79.29	22.71	0.04
53	West Bengal	Hooghly	Chinsura Magra	22.90	88.39	54.91	0.07

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Table S10. Concentration of PM2.5 and its Chemical Components in the 53 Rural Regions of India

Sr No	State	District	Rural region	Concentration (µg m^{-3})					
				PM2.5	NO_3^-	NH_4^+	SO_4^{2-}	BC	OC
1	Andhra Pradesh	East Godavari	Maredimilli	45.32	4.84	3.86	6.63	1.18	3.53
2	Andhra Pradesh	Krishna	Gannavaram	42.36	4.46	3.34	5.57	1.29	3.91
3	Bihar	Gaya	Atri	89.33	13.77	6.39	6.44	3.48	10.39
4	Bihar	Saran	Lahladpur	89.28	13.55	6.09	5.80	3.93	12.03
5	Chhattisgarh	Dantewada	Kuwakonda	47.88	5.74	4.14	6.65	1.18	3.57
6	Chhattisgarh	Bastar	Tokapal	49.75	6.08	4.31	6.83	1.22	3.68
7	Chhattisgarh	Kanker	Bhanupratappur	58.93	7.40	4.93	7.50	1.55	4.52
8	Dadar Nagar Haveli and Damana and Diu	Dadra and Nagar Haveli	Naroli	25.25	4.17	2.92	4.81	1.39	3.99
9	Goa	South Goa	Canacona	29.39	2.58	2.26	4.29	0.85	2.32
10	Gujarat	Vadodara	Sinor	42.55	4.48	3.12	4.99	1.44	4.13
11	Gujarat	Junagadh	Manavadar	33.37	3.08	2.21	3.72	0.99	2.82
12	Gujarat	Surendranagar	Lakhtar	37.97	3.89	2.69	4.35	1.18	3.33
13	Gujarat	Ahmadabad	Detroj	41.77	3.71	2.69	4.45	1.56	4.41
14	Haryana	Fatehabad	Jakhal	105.33	20.75	8.36	6.26	3.50	10.57
15	Himachal Pradesh	Kullu	Anni	35.46	3.96	2.37	3.25	0.95	2.82
16	Himachal Pradesh	Chamba	Pangi	12.53	1.30	0.70	0.87	0.19	0.50
17	Jammu and Kashmir	Anantnag	Achabal	14.31	2.87	1.51	1.81	0.54	1.58
18	Jammu and Kashmir	Kishtwar	Kishtwar	18.52	2.09	1.12	1.38	0.30	0.82
19	Jharkhand	Dumka	Gopikandar	91.06	16.37	7.19	6.56	3.11	9.36
20	Karnataka	Uttar Kannada	Mundgod	32.58	3.09	2.60	4.68	0.99	2.65
21	Karnataka	Gadag	Naragund	35.35	3.10	2.76	5.07	1.14	3.08
22	Karnataka	Chik Ballapur	Gudibande	35.08	3.51	2.87	5.01	0.99	2.89
23	Kerala	Pathanamthitta	Kulanada	34.59	4.95	2.94	4.11	1.13	3.18
24	Kerala	Thrissur	Mullassery	32.29	4.04	2.65	4.13	1.02	2.83
25	Kerala	Kannur	Thalassery	34.39	4.17	2.84	4.51	1.09	3.04
26	Madhya Pradesh	Umaria	Pali	42.26	4.64	2.79	3.95	1.31	3.73
27	Madhya Pradesh	Dindori	Amarpur	100.26	18.36	7.93	6.98	3.40	10.22
28	Madhya Pradesh	Betul	Chicholi	50.32	5.84	4.17	6.67	1.20	3.62
29	Madhya Pradesh	Seoni	Dhanora	54.60	6.75	4.58	7.06	1.43	4.23
30	Maharashtra	Gondia	Salekasa	55.17	6.93	4.43	6.52	1.63	4.79
31	Maharashtra	Osmanabad	Washi	44.80	4.91	3.49	5.60	1.24	3.67
32	Maharashtra	Buldana	Deulgaon Raja	44.93	5.44	3.75	5.86	1.28	3.77
33	Maharashtra	Parbhani	Sonpeth	48.81	5.70	4.13	6.70	1.36	4.06
34	Odisha	Sambalpur	Jamankira	72.52	9.25	5.86	8.52	1.97	5.77
35	Odisha	Kalahandi	Kalampur	55.58	7.54	4.80	7.03	1.43	4.27
36	Punjab	Fatehgarh	Bassi Pathanan	76.66	11.29	5.98	7.23	2.27	6.95
37	Rajasthan	Baran	Chhabra	48.74	6.13	3.61	4.95	1.40	4.15

38	Rajasthan	Chiitaurgarh	Rawatbhata	54.21	6.76	4.08	5.72	1.49	4.36
39	Rajasthan	Rajsamand	Bhim	49.04	5.45	3.09	4.09	1.39	4.03
40	Tamil Nadu	Namakkal	Mohanur	44.35	4.43	4.29	8.36	1.24	3.56
41	Tamil Nadu	Coimbatore	Anaimalai	39.94	5.22	3.25	4.73	1.38	3.82
42	Tamil Nadu	Tirunelveli	Cheranmahadevi	26.98	2.34	2.28	4.44	0.80	2.30
43	Telangana	Nizamabad	Bodhan	49.61	6.17	4.15	6.37	1.39	4.16
44	Telangana	Mahabubnagar	Achampet	41.87	4.55	3.59	6.13	1.08	3.14
45	Telangana	Medak	Andole	47.85	5.20	3.83	6.27	1.43	4.19
46	Telangana	Nalgonda	Pochampally	48.22	5.45	3.93	6.36	1.37	4.09
47	Uttar Pradesh	Chatrapati Shahu Ji Nagar	Sangrampur	91.49	15.66	6.98	6.53	3.38	10.07
48	Uttar Pradesh	Chandauli	Naugarh	27.07	7.89	4.23	5.20	3.26	11.00
49	Uttar Pradesh	Rae Bareli	Rohiniyan	82.55	13.36	6.23	6.32	2.96	9.02
50	Uttrakhand	Tehri	Jaunpur	92.85	15.06	6.76	6.39	3.84	11.45
51	Uttrakhand	Tehri	Partapnagar	37.42	3.87	2.34	3.25	1.10	3.51
52	Uttrakhand	Chamoli	Garsain	27.09	2.92	1.67	2.21	0.61	1.88
53	West Bengal	Hooghly	Chinsura Magra	85.10	15.08	6.50	5.75	3.28	9.69

Table S11. p-test Values for the Different Zones of India Obtained while Comparing the UA and Rural Region PM2.5

Indian regions	p-value
Northern (n = 9)	0.028
Southern (n = 15)	0.40
Eastern (n = 6)	0.11
Western (n = 10)	0.02
Central (n = 3)	0.012

Table S12. The Effect of Different Chemical Components of PM2.5 on the Total Premature Mortality in India Estimated for the Year 2010

Sr. No	Urban Cities	BOD without NO_3^-	BOD without NH_4^+	BOD without SO_4^{2-}	BOD without BC	BOD without OC
1	Hyderabad	3,868.0	3,934.5	3,757.0	4,104.9	3,810.0
2	Vijayawada	684.1	699.2	668.4	728.9	659.6
3	Visakhapatnam	115.4	117.5	111.9	122.6	112.6
4	Patna	1,264.5	1,323.2	1,325.9	1,345.9	1,236.0
5	Chandigarh	599.7	623.9	618.5	641.1	601.3
6	Bhilai Nagar	636.1	659.5	648.8	681.1	641.3
7	Raipur	603.0	625.2	615.0	645.6	607.9

8	Delhi	10,948.4	11,610.9	11,735.3	11,836.7	11,216.9
9	Ahmedabad	2,944.9	3,010.4	2,907.7	3,101.4	2,756.7
10	Rajkot	1,540.2	1,579.8	1,529.1	1,628.0	1,463.0
11	Surat	1,730.1	1,772.8	1,712.4	1,831.2	1,640.1
12	Vadodara	419.3	430.2	414.1	445.8	401.2
13	Faridabad	973.5	1,024.2	1,032.0	1,044.0	998.2
14	Srinagar	481.7	507.2	502.2	524.0	471.6
15	Dhanbad	717.5	753.2	753.0	770.8	717.4
16	Jamshedpur	837.4	869.4	866.1	886.3	826.2
17	Ranchi	676.7	700.3	691.6	719.9	678.1
18	Bangalore	4,282.8	4,287.2	4,039.5	4,473.7	4,190.5
19	Kannur	655.6	680.7	648.9	716.1	643.2
20	Kochi	874.9	924.2	897.4	972.5	885.9
21	Kollam	387.7	406.3	386.6	429.4	375.9
22	Kozhikode	856.4	908.3	884.5	955.1	867.8
23	Malappuram	707.6	750.7	729.7	789.8	715.5
24	Thiruvananthapuram	561.9	582.3	549.2	615.6	538.2
25	Thrissur	707.3	738.9	705.3	778.7	697.1
26	Bhopal	909.9	939.8	913.5	975.0	891.7
27	Gwalior	643.6	679.0	680.6	694.3	640.3
28	Indore	1,017.4	1,043.5	1,005.5	1,084.7	986.6
29	Jabalpur	646.2	671.6	657.9	695.7	641.7
30	Aurangabad	555.4	571.9	549.4	598.0	548.6
31	Mumbai	8,867.6	9,044.1	8,681.6	9,333.4	8,373.3
32	Nagpur	1,279.6	1,319.6	1,280.7	1,372.0	1,276.6
33	Nashik	729.1	746.7	713.2	781.2	716.8
34	Pune	2,349.1	2,395.0	2,277.5	2,504.9	2,294.8
35	Vasai Virar	588.1	599.8	575.8	619.0	555.3
36	Amritsar	722.8	758.5	759.9	773.5	709.0
37	Ludhiana	1,007.4	1,052.1	1,053.1	1,073.9	1,011.0
38	Jaipur	1,653.1	1,743.0	1,740.1	1,787.7	1,641.0
39	Jodhpur	515.8	536.1	525.2	553.2	501.2
40	Kota	491.2	512.6	504.6	528.9	483.9
41	Chennai	3562.1	3,591.4	3,378.0	3,746.3	3,347.8
42	Coimbatore	933.0	974.8	803.9	1,017.9	914.7
43	Madurai	568.5	587.9	562.0	615.7	545.5
44	Tiruchirappalli	441.9	451.9	428.9	473.4	426.4
45	Agra	1,095.5	1,156.7	1,164.7	1,179.1	1,100.0
46	Allahabad	734.4	768.1	767.4	784.1	722.8
47	Ghaziabad	1,582.7	1,678.5	1,696.5	1,711.2	1,621.5

48	Kanpur	1,792.2	1,881.4	1,887.1	1,917.7	1,775.7
49	Lucknow	1,798.0	1,888.8	1,896.4	1,923.8	1,773.6
50	Meerut	922.3	974.8	983.1	993.3	931.7
51	Varanasi	882.2	921.5	921.5	938.8	864.8
52	Asansol	761.9	803.8	823.0	806.0	770.0
53	Kolkata	8,417.6	8,900.2	8,938.0	9,094.5	8,403.7