Supporting Information

Projecting Fine Particulate Matter-related Mortality in East China

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Contents

1. The $PM_{2.5}$-mortality associations (CRF):

Several studies have been conducted in China to investigate the relationships between $PM_{2.5}$ and total, cardiovascular and respiratory mortality. Most of them were conducted in East China. Thus, we used a meta-analysis to pool averaged associations of $PM_{2.5}$ with total, cardiovascular and respiratory mortality from those studies conducted in East China.

First, a literature search was conducted using the electronic databases PubMed, MEDLINE (Web of Knowledge), Embase, CNKI (Chinese National Knowledge Infrastructure), and Wanfang Database. CNKI and Wanfang Database are the two largest databases in China. The search was limited to journal articles published in English and Chinese from January 1990 through October 2013. The following key words were used: a). fine particles, $PM_{2.5}$; b). mortality, death; c). China, Chinese, and the names of municipalities, provinces and corresponding capitals in East China. References and citations of the articles identified were manually inspected to ensure that all relevant articles were included. The following eligibility criteria were used: a). all epidemiological studies, involving the impact of $PM_{2.5}$ on mortality in Chinese population; b). the full texts were available; c). the study period was from 1990 to 2013; d). the study locations were in East China (including 3 municipalities (Beijing, Tianjin and Shanghai) and 8 provinces (Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong and Hainan)); e). study population was not specific high-risks groups (e.g., elderly or children); f). the outcome must include at least one type of mortality (total, cardiovascular or respiratory); g). the results must include at least one of these measures: relative risk, regression coefficient or percent change of mortality;

Because some studies reported multiple estimates by exploring different lag days, age groups, seasons, and co-pollutants, only one estimate from each study -estimates for all ages, whole season and without adjustment for other pollutants- was included. [1] If one lag estimate was

reported, this estimate was used for our meta-analysis. For multiple lag days, we selected the lags following the rules: [2, 3] the lag with the most statistical significance or the largest effect estimate; the lag that the author focused on. The Cochran's Q-test indicates homogeneity among estimates ($p>0.05$), thus fixed-effect model was chosen to combine estimates.

Table S1. The percent increase of total mortality (95CI %) associated with a 10-μg/m^3 increase of $PM_{2.5}$ concentrations and detailed information for each study included in the meta-analysis.

	Author	Study Field	Study Time	Study design and method	Lag	$PM_{2.5}$ concentrations during the study period (μg/m^3)	Results		
						Mean ± SD	Total Mortality	Cardiovascular Mortality	Respiratory Mortality
1	Chen, et al. [4]	Shanghai	2001-2008	Time series analysis (GAM)	Lag0	56±33	0.17(0.02, 0.35)	N.A.	N.A.
2	Geng, et al. [5]	Shanghai	2007-2008	Time series analysis (DLM)	Lag0-Lag2 (cumulative effects)	53.9±31.4	0.57 (0.12, 0.26)	0.79 (0.10, 1.48)	0.07 (-1.26, 1.40)
3	Yang, et al. [6]	Guangzhou	2007-2008	Time-stratified case-crossover	lag0–1	70.1 ± 34.6	0.90 (0.55, 1.26)	1.22 (0.63, 1.81)	0.97 (0.17, 1.77)
4	Chen, et al. [7]	Beijing	2007-2008	Time series analysis (GLM)	Lag0-lag2	82 ±52	0.53(0.37,0.69)	0.58 (0.34, 0.82)	0.66 (0.21, 1.11)
		Shanghai	2004-2008			55±30	0.47(0.22,0.72)	0.41 (0.00, 0.82)	0.61 (-0.15, 1.37)
		Shenyang	2006-2008			94 ±52	0.35(0.17,0.53)	0.46 (0.19, 0.73)	0.29 (-0.30, 0.88)
5	Ma, et al. [8]	Shenyang	2006-2008	Time-stratified case-crossover	lag0–1	75±43	0.49(0.19, 0.79)	0.53 (0.10, 0.96)	0.97 (0.01, 1.93)
6	Huang, et al. [9]	Shanghai	2004-2005	Time series analysis (GAM)	Lag0	56.4±1.34	0.30(0.06, 0.54)	0.39 (0.12, 0.66)	0.71 (0.04, 1.38)
7	Kan, et al. [10]	Shanghai	2004-2005	Time series analysis (GAM)	lag0–1	56.4±1.34	0.36(0.11, 0.61)	0.41 (0.02, 0.80)	0.95 (0.17, 1.73)
8	Dai, et al. [11]	Shanghai	2004	Time series analysis (GAM)		68.8±47.9	0.85(0.32,1.39)		

Abbreviations: DLM, Dynamic Linear Models; GAM, Generalized Additive Models; GLM, Generalized Linear Models.

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2. The risk assessment models and their choices on mortality rate, population and CRF

Table S2. The risk assessment models and their choices on mortality rate, population and CRF

Model No.	Mortality [Δ]		Population						CRF	
	Mortality 2005	Total Mortality projection 2030	Population 2005	Population Projection Scenario 2030					CRF from Meta-analysis	local CRF*
				C	L1	L2	H1	H2		
M1	√		√						√	
M2	√			√					√	
M3	√				√				√	
M4	√					√			√	
M5	√						√		√	
M6	√							√	√	
M7		√	√						√	
M8	√		√							√
M9		√		√					√	
M10		√			√				√	
M11		√				√			√	
M12		√					√		√	
M13		√						√	√	
M14				√						√
M15					√					√
M16						√				√
M17							√			√
M18								√		√
M19		√								√
M20		√		√						√
M21		√			√					√
M22		√				√				√
M23		√					√			√
M24		√						√		√

*There is one option on local CRF for Beijing, Shanghai and Guangdong. Thus, there are 24 risk assessment models in total for these three regions. There are two options on local CRF for Liaoning. Thus, except from the listed 24 risk assessment models, there are 12 more risk assessment models for Liaoning, which includes the second option on local CRF.

For other regions, there is no option on local CRF. Thus, there are 12 risk assessment models for such regions.

[Δ] There is only one projection on total mortality in 2030, without any projection on cardiovascular and respiratory mortality in 2030. Thus, for cardiovascular and respiratory mortality, there are 12 risk assessment models for Beijing, Shanghai and Guangzhou, 18 risk assessment models for Liaoning, and 6 risk assessment models for other regions.

3. The ranges for estimated $PM_{2.5}$-related total, cardiovascular and respiratory mortality (cases) between 2005 and 2030

Table S3. The ranges for estimated $PM_{2.5}$-related total, cardiovascular and respiratory mortality (cases) between 2005 and 2030

Region	Total Mortality		Cardiovascular Mortality		Respiratory Mortality	
	CLE	MFR	CLE	MFR	CLE	MFR
Beijing	1074, 6501	-4396, -2406	557, 3538	-2252, -1364	136, 929	-540, -337
Tianjin	2275, 7593	-6816, -5514	1692, 3526	-4131, -3682	495, 971	-1016, -899
Liaoning	1494, 9522	-17096, -11603	859, 2898	-8264, -6981	102, 711	-2461, -871
Hebei	1156, 14013	-39900, -36841	2478, 4588	-10991, -10489	792, 1371	-2902, -2764
Shanghai	126, 29256	-11497, -4380	65, 7096	-5800, -3930	33, 3210	-2401, -1798
Shandong	3578, 16114	-64727, -61809	5733, 9798	-31055, -30109	2828, 4430	-11675, -11302
Jiangsu	4179, 9368	-61986, -60606	2589, 4165	-19211, -18792	1481, 2130	-7489, -7317
Zhejiang	1227, 7529	-23001, -21043	889, 2870	-7449, -6833	860, 2297	-5187, -4740
Fujian	-1337, 3395	-9879, -8285	-453, 1053	-4010, -3503	-111, 363	-1233, -1073
Guangdong	-2865, 66558	-51443, -9959	-334, 17088	-11359, -3000	-938, 71671	-16827, -4945
Hainan	-174, 611	-1485, -1243	-26, 415	-936, -800	-2, 83	-179, -153
East China	-20679, 71719	-368319, -229928	-7653, 29993	-162511, -152250	-3942, 16907	-72692, -66948

+excess deaths; - avoided deaths.

4. The characteristics of similar projection studies conducted in China

Table S4. The characteristics of similar projection studies conducted in China

	Study Area	Time line	Air pollutants	Scenarios
Kan et al. 2004	Shanghai	2000, 2010, 2020	PM_{10}	Base case scenario (BC), energy option scenarios, environmental target scenarios; carbon emission control scenario.
Li et al. 2004	Shanghai	1995-2020	PM_{10}	Two pollution control scenarios for power generation and industry coal use, respectively
Wang et al. 2006	Zaozhuang	2000-2020	PM (including $PM_{2.5}$)	Business-as-usual scenario, the best available emission control technology, and advanced coal gasification technologies.
Chen et al. 2007	Shanghai	2000, 2010, 2020	PM_{10} and SO_2	BC, low carbon scenarios
Pan et al. 2007	Beijing	1999, 2010, 2020, 2030	PM_{10} and SO_2	BAU, three energy use scenarios based on different assumptions on clean energy consumption, energy efficiency program and green transportation.
This study	East China, including 11 provinces and municipalities	2005, 2030	$PM_{2.5}$	CLE and MFR scenarios

5. The changes of annual concentration of $PM_{2.5}$ components between 2005 and 2030 under CLE and MFR scenarios in East China

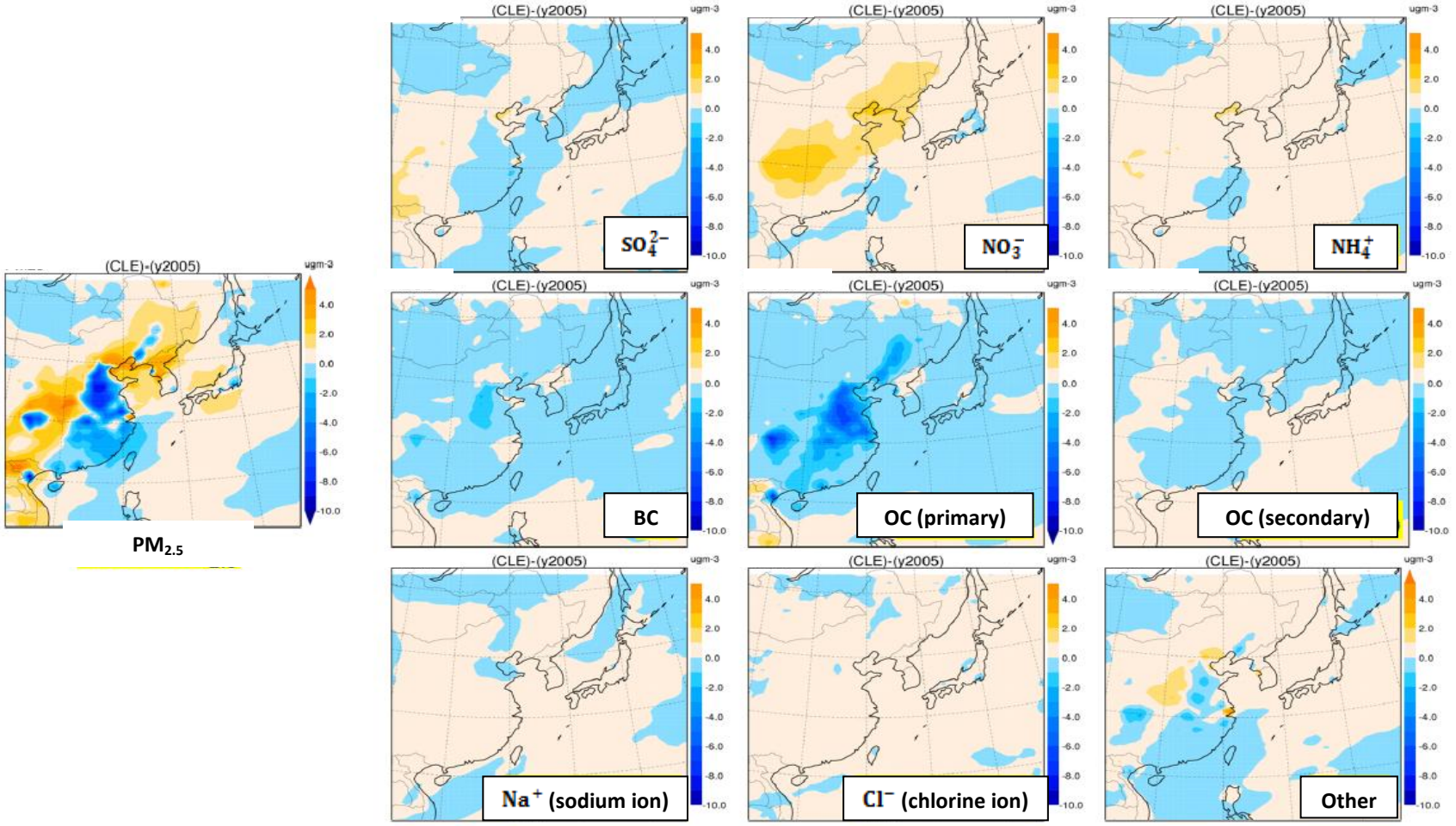

Figure S1. Changes in annual mean concentrations of $PM_{2.5}$ components between 2005 and 2030 under the CLE scenario

Note: SO_4^{2-}: sulfate ion, NO_3^-: nitrate ion; NH_4^+: ammonium ion; BC: black carbon; OC: organic aerosols; Na^+:sodium ion; Cl^-:chlorine ion; Other: other primary aerosols (including road dust and etc.).

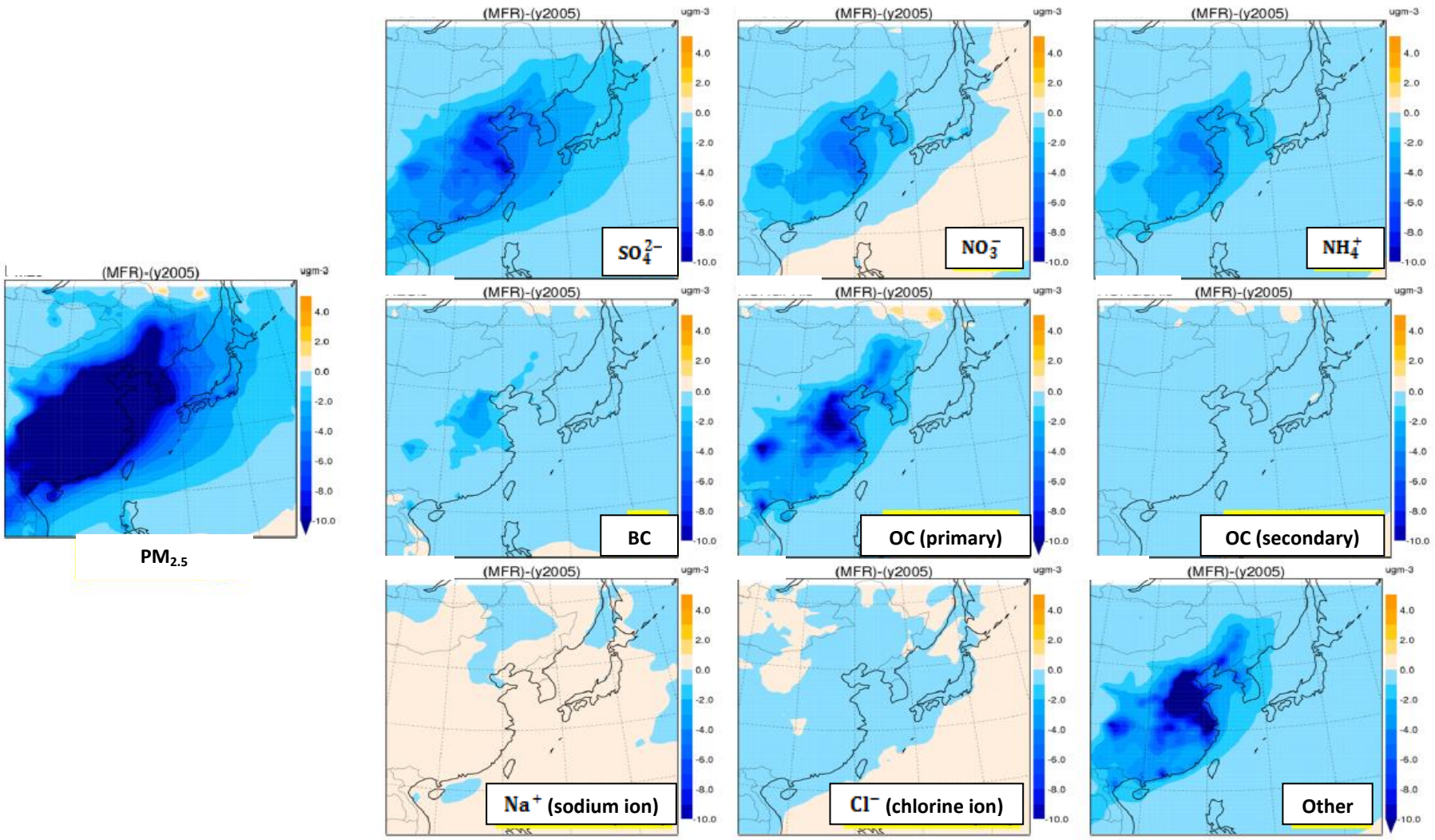

Figure S2. Changes in annual mean concentrations of $PM_{2.5}$ components between 2005 and 2030 under the MFR scenario

Note: SO_4^{2-}: sulfate ion, NO_3^-: nitrate ion; NH_4^+: ammonium ion; BC: black carbon; OC: organic aerosols; Na^+:sodium ion; Cl^-:chlorine ion; Other: other primary aerosols (including road dust and etc.).