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A review of current knowledge concerning $PM_{2.5}$ chemical composition, aerosol optical properties and their relationships across China

Jun Tao et al.

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Contents

Table S1a: Summary of mass concentrations (μg m^{-3}) of $PM_{2.5}$ and its dominant chemical components in Beijing-Tianjin-Hebei of China

Location	Period	Annual/seasonal	$PM_{2.5}$ (μg m^{-3})						References
			Mass	OC	EC	SO_4^{2-}	NO_3^-	NH_4^+	
Urban studies									
Beijing	1999-2000	annual	121	25.3	9.4	14.3	10.1	6.4	He et al., 2001
	2000	annual	96	21.8	3.1	18.5	11.6	7	Song et al., 2006a
	2001-2002	annual	102	25.8	9.9	10.2	7.4	5.7	Duan et al., 2006
	2001-2003	annual	154			17.1	11.5	8.7	Wang et al., 2005
	2005-2006	annual	94			14.4	8.3	6.8	He et al., 2012
	2005-2006	annual	119	24.5	8.2	15.8	10.1	7.3	Yang et al., 2011b
	2008	annual	89						Chen et al., 2014c
	2008	annual	110	19.1	8.5				Yang et al., 2011a
	2009	annual	81						Chen et al., 2014c
	2009-2010	annual	123	18.2	6.3	19.1	20.5	6.4	Zhao et al., 2013
	2009-2010	annual	135	16.9	5.0	13.6	11.3	6.9	Zhang et al., 2013
	2010	annual	81						Chen et al., 2014c
	2012-2013	annual	102						Zhou et al., 2015
	2012-2013	annual	107						Zíková et al., 2016
Chengde	2009-2010	annual	92	19.0	7.3	13.0	5.8	4.1	Zhao et al., 2013
Shijianzhuang	2009-2010	annual	191	26.4	9.7	35.6	30.4	9.3	Zhao et al., 2013
Tianjin	2009-2010	annual	142	18.8	6.9	25.0	18.8	7.6	Zhao et al., 2013
	2013-2014	annual	138						Tian et al., 2016
BTH	**Average**	**annual**	**115±30**						
Beijing	1999-2000	spring	89	18.2	6.7	10.2	7.3	4.3	He et al., 2001
	2000	spring	134	23.2	3.7	24.4	22.4	12.2	Song et al., 2006a
	2001	spring	119	21.5	6.5				Yang et al., 2005a
	2002	spring	76	19.6	10.1	6.7	4.7	4.1	Duan et al., 2006
	2003	spring	78	14.1	7.6				Dan et al., 2004
	2001-2003	spring	162			13.5	11.9	6.5	Wang et al., 2005
	2009-2010	spring	128	15.8	5.2	16.4	20.4	6.8	Zhao et al., 2013

	2009-2010	spring	126	13.7	2.8	14.7	15.5	7.5	Zhang et al., 2013
	2012	spring	210						Chen et al., 2014a
	Average	**spring**	**125±43**						
	2000	summer	99	16.4	3.1	28.5	5.5	7.4	Song et al., 2006a
	2001	summer	94	17.1	8.0				Yang et al., 2005a
	2001	summer	113	13.7	4.7				Dan et al., 2004
	2001-2003	summer	93			18.4	11.2	10.1	Wang et al., 2005
	2002	summer	89	14.9	8.4	13.4	5.4	5.9	Duan et al., 2006
	2002	summer	91	10.7	5.7				Dan et al., 2004
	2003	summer	132	19.7	5.7	22.6	13.7	9.8	Cao et al., 2012b
	2003	summer	94	19.2	7.0				Chan et al., 2005
	2002-2003	summer	78	10.7	5.9	18.3	12.9	10.4	Sun et al., 2004
	2004	summer	52	10.9	4.0	8.7	3.7	3.3	Song et al., 2007
	2005	summer	68	8.2	4.9	22.5	9.7	5.4	Pathak et al., 2011
	2006	summer	102			34.8	24.5	20.7	Han et al., 2014
	2008	summer	59			13.1	3.9	8.4	Okuda et al., 2011
	2009-2010	summer	116	10.1	5.9	33.8	22.8	8.4	Zhao et al., 2013
	2009-2010	summer	138	11.1	4.2	23.5	11.8	11.0	Zhang et al., 2013
	2012	summer	103	16.8	3.6	20.6	15.8	8.3	Tian et al., 2015
	Average	**summer**	**95±24**						
	1999-2000	autumn	112	28.8	10.2	12.6	11.2	4.9	He et al., 2001
	2000	autumn	106	24.9	4.0	15.1	17.9	7.2	Song et al., 2006a
	2001	autumn	80	23.1	10.4	9.6	8.2	5.9	Duan et al., 2006
	2001.9-11	autumn	92	21.0	10.7				Yang et al., 2005a
	2001-2003	autumn	105			12.7	9.1	6.3	Wang et al., 2005
	2009-2010	autumn	124	20.2	7.1	11.5	21.5	5	Zhao et al., 2013
	2009-2010	autumn	135	17.8	5.3	7.9	10.7	4.7	Zhang et al., 2013
	2013	autumn	117			7.3	14.4	8.3	Yang et al., 2016
	2014	autumn	90			4.9	9.9	4.2	Yang et al., 2016
	Average	**autumn**	**107±17**						

	1999-2000	winter	176	31.5	11.1	24.9	15.4	7.8	He et al., 2001
	2000	winter	61	23.4	2.0	8.5	5.0	3.4	Song et al., 2006a
	2001	winter	122	32.2	11.3	9.9	10.7	7.1	Duan et al., 2006
	2001	winter	471	56.9	34.3				Dan et al., 2004
	2001	winter	184	40.1	9.9				Yang et al., 2005a
	2002	winter	169	36.7	15.2				Dan et al., 2004
	2001-2003	winter	214			21.0	12.3	10.6	Wang et al., 2005
	2002-2003	winter	153	35.7	14.2	27.8	16.6	15.5	Sun et al., 2004
	2003	winter	116	23.9	6.2	20.0	13.1	9.4	Cao et al., 2012b
	2004	winter	107	33.6	8.3	12.7	8.3	6.0	Song et al., 2007
	2006	winter	142			20.9	17.3	12.8	Tan et al., 2016a
	2009-2010	winter	127	26.8	7.1	14.2	17.1	5.2	Zhao et al., 2013
	2009-2010	winter	139	24.9	7.5	8.5	7.3	4.5	Zhang et al., 2013
	2013	winter	159	35.8*	5.5	25.4	19.0	15.6	Tao et al., 2015a
	2013	winter	143	25.7	6.9	23.9	20.2	16.5	Huang et al., 2014b
	2014	winter	138	29.0	5.2	21.0	26.0	14.1	Lin et al., 2016
	Average	**winter**	**164±89**						
Tianjin	2008	spring	108	14.4	5.0				Gu et al., 2010
	2009-2010	spring	136	13.6	5.5	20.6	18.8	7.1	Zhao et al., 2013
	2013-2014	spring	102						Tian et al., 2016
	Average	**spring**	**115±18**						
	2003.7	summer	102	16.4	3.9	22.1	8.7	7.7	Cao et al., 2012b
	2008	summer	87	10.2	5.5				Gu et al., 2010
	2009-2010	summer	161	12.7	5.9	42.7	21.1	10.6	Zhao et al., 2013
	2013-2014	summer	135						Tian et al., 2016
	Average	**summer**	**121±33**						
	2008	autumn	111	20.2	6.5				Gu et al., 2010
	2009-2010	autumn	152	23.1	8.8	15.8	20.1	6.4	Zhao et al., 2013
	2013-2014	autumn	158						Tian et al., 2016
	Average	**autumn**	**140±26**						

	2003	winter	203	43.0	8.9	32.5	25.5	22.2	Cao et al., 2012b
	2006-2007	winter	223	46.0	8.0	39.7	15.9	11.2	Li et al., 2009
	2008	winter	134	22.9	5.6				Gu et al., 2010
	2008	winter	145	33.8	9.1	24.1	16.6	8.7	Gu et al., 2011
	2009-2010	winter	117	24.8	7.0	21.3	15.5	6.6	Zhao et al., 2013
	2013-2014	winter	180						Tian et al., 2016
	Average	**winter**	**167±42**						
Shijiazhuang	2009-2010	spring	175	19.6	7.8	28.9	26.5	8.7	Zhao et al., 2013
	2009-2010	summer	146	9.1	7.6	42.5	24.9	9.3	
	2009-2010	autumn	219	31.5	11.4	38	46.0	8.9	
	2009-2010	winter	227	46.5	12.1	33	25.3	10.5	
Chengde	2009-2010	spring	105	14.0	4.7	13.3	11.0	4.5	
	2009-2010	summer	68	10.5	4.5	19.6	4.6	4.7	
	2009-2010	autumn	74	19.0	7.2	9.2	2.6	3.4	
	2009-2010	winter	123	33.6	13.1	9.4	5.2	3.6	
Rural studies									
Shangdianzi	2009-2010	annual	72.0	10.8	3.9	13.8	12.2	4.5	Zhao et al., 2013
	2009-2010	spring	87	9.7	3.8	15.7	16.5	5.7	
	2009-2010	summer	71	5.7	3.3	24.2	12.4	6.3	
	2009-2010	autumn	73	10.7	3.9	8.7	11.2	3.2	
	2009-2010	winter	56	16.8	4.4	6.6	8.8	2.8	

*estimated from OM with a factor of 1.8

Table S1b: Summary of mass concentrations (μg m^{-3}) of $PM_{2.5}$ and its dominant chemical components in Yangtze River Delta of China

Location	Period	Annual/seasonal	$PM_{2.5}$ (μg m^{-3})						References
			Mass	OC	EC	SO_4^{2-}	NO_3^-	NH_4^+	
Urban studies									
Nanjing	2011-2014	annual	118	13.8	5.3				Li et al., 2015
	2013	annual	142	22.9	8	27.9	15.6	6.2	Li et al., 2016
	2013-2014	annual	98						Ming et al., 2017
Shanghai	1999-2000	annual	65	14.9	6.5	14.0	6.0	5.9	Ye et al., 2003
	2003-2005	annual	95			10.4	6.2	3.8	Wang et al., 2006
	2005-2006	annual	93	16.1	2.9				Feng et al., 2009
	2009	annual	94	14.0	4.1	11.7	7.7	4.1	Zhao et al., 2015b
	2012	annual	68	10.7	2.0	12.9	12.6	5.6	Zhao et al., 2015b
	2011-2013	annual	47	9.5	2.1	10.2	9.2	6.0	Wang et al., 2016a
	2013-2014	annual	95	9.9	1.6	14.5	18.0	8.1	Ming et al., 2017
Hangzhou	2004-2005	annual	108			17.0	8.3	9.3	Liu et al., 2015
	2013-2014	annual	134						Ming et al., 2017
YRD	**Average**	**annual**	**96±28**						
Nanjing	2011	spring	91	7.1	3.1	13.6	6.6	5.7	Shen et al., 2014
	2011-2014	spring	85	8.5	3.8				Li et al., 2015
	2013	spring	117	21.4	7.5	24.5	9.5	6.3	Li et al., 2016
	Average	**spring**	**97±17**						
	2011-2014	summer	77	7.6	3.1				Li et al., 2015
	2011	summer	70	6.7	2.6	14.6	6.3	7.9	Shen et al., 2014
	2013	summer	83	17.4	6.2	18.1	5.7	4.9	Li et al., 2016
	Average	**summer**	**77±7**						
	2001	autumn	47	10.8	4.0	11.5	3.2	3.6	Yang et al., 2005b
	2011-2014	autumn	96	15.7	5.9				Li et al., 2015
	2013	autumn	83	32.6	11.4	15.0	6.5	3.7	Li et al., 2016
	Average	**autumn**	**75±25**						
	2001	winter	74	14.9	3.1	19.2	10.5	10.4	Yang et al., 2005b

	2011-2014	winter	201	22.5	8.2				Li et al., 2015
	2013	winter	247	35.3	11.4	46.9	33.8	8.8	Li et al., 2016
	Average	**winter**	**174±89**						
Shanghai	1999-2000	spring	62	16.1	5.3	12.6	5.4	5.5	Ye et al., 2003
	2003-2005	spring	135			11.7	9.1	4.1	Wang et al., 2006
	2005-2006	spring	113	15.3	3.2				Feng et al., 2009
	2006-2007	spring	47	8.4	3.7				Hou et al., 2011
	2011-2012	spring	70	9.5	1.7	15.3	8.6	6.4	Zhao et al., 2015a
	2011-2013	spring	49	9.9	2.3	11.0	11.0	6.9	Wang et al., 2016a
	2012	spring	64	8.1	2.7	12	10.8	4.3	Huang et al., 2014a
	2013-2014	spring	96	7.5	1.3	12.3	10.4	5.5	Ming et al., 2017
	Average	**spring**	**80±32**						
	1999-2000	summer	36	11.3	5.2	9.7	3.8	3.4	Ye et al., 2003
	2003	summer	54	13.4	5.4	12	2.6	3.5	Cao et al., 2012b
	2003-2005	summer	72			5.4	2.6	2.4	Wang et al., 2006
	2005	summer/spring	67	16.9	10.0	15.6	7.2	4.2	Pathak et al., 2011
	2005-2006	summer	59	9.3	2.3				Feng et al., 2009
	2006-2007	summer	15	3.8	1.1				Hou et al., 2011
	2009	summer	40	6.8	1.8				Cao et al., 2013
	2011-2012	summer	51	6.2	1.4	9.7	5.6	3.6	Zhao et al., 2015a
	2011-2013	summer	31	7.9	2.0	8.1	5.2	4.2	Wang et al., 2016a
	2013-2014	summer	56	4.9	0.8	6.7	2.8	2.1	Ming et al., 2017
	Average	**summer**	**48±17**						
	1999-2000	autumn	66	16.3	6.9	13.9	5.1	6.5	Ye et al., 2003
	2003-2005	autumn	96			8.7	3.7	3.6	Wang et al., 2006
	2005-2006	autumn	110	23.8	3.9				Feng et al., 2009
	2006-2007	autumn	36	6.5	2.1				Hou et al., 2011
	2011-2012	autumn	82	12.8	2.4	17.9	20.2	7.8	Zhao et al., 2015a
	2011-2013	autumn	41	8.7	1.9	8.8	7.4	4.8	Wang et al., 2016a
	2013-2014	autumn	75	7.0	1.0	12.9	15.0	6.6	Ming et al., 2017
	Average	**autumn**	**72±27**						

	1999-2000	winter	91	17.0	8.1	18.5	9.9	7.8	Ye et al., 2003
	2003	winter	139	26.7	8.6	21.6	17.5	14.5	Cao et al., 2012b
	2003-2005	winter	83			10.4	6.2	4.4	Wang et al., 2006
	2005-2006	winter	91	16.4	2.3				Feng et al., 2009
	2006-2007	winter	65	10.9	4.4				Hou et al., 2011
	2009	winter	91						Feng et al., 2012
	2011-2012	winter	70	14.1	2.4	11.6	13.2	5.6	Zhao et al., 2015a
	2011-2013	winter	65	11.2	2.3	13.0	13.2	8.3	Wang et al., 2016a
	2013	winter	91	27.3*	2.2	10.8	12.4	7.5	Huang et al., 2014b
	2013-2014	winter	138	17.2	2.9	19.5	29.1	12.6	Ming et al., 2017
	Average	**winter**	**92±27**						
Hangzhou	2004-2005	spring	116			18.2	8.5	10.1	Liu et al., 2015
	2004-2005	summer	73			14.6	4.6	6.3	Liu et al., 2015
	2003	summer	80	15.2	3.5	16.5	5.5	5.3	Cao et al., 2012b
	2004-2005	autumn	114			19.1	9.3	9.9	Liu et al., 2015
	2003	winter	177	30.5	9.1	33.4	25.7	19.1	Cao et al., 2012b
	2004-2005	winter	136			15.8	10.8	11.2	Liu et al., 2015
Rural studies									
Lin’an	2008-2009	annual	60	10.3	1.5				Feng et al., 2015
	2008-2009	spring	87	13.4	2.2				
	2008-2009	summer	36	5.7	0.8				
	2008-2009	autumn	53	9.7	1.3				
	2008-2009	winter	63	12.2	1.8				
Ningbo	2009-2010	annual	46	7.1	2.5				Liu et al., 2013a
	2009-2010	spring	56	8.6	3.1				
	2009-2010	summer	17	2.7	0.8				
	2009-2010	autumn	37	5.8	1.9				
	2009-2010	winter	73	11.0	4.1				
	2013-2014	annual	96						Ming et al., 2017

*estimated from OM with a factor of 1.6

Table S1c: Summary of mass concentrations (μg m^{-3}) of $PM_{2.5}$ and its dominant chemical components in Pearl River Delta of China

Location	Period	Annual/seasonal	$PM_{2.5}$ (μg m^{-3})						References
			Mass	OC	EC	SO_4^{2-}	NO_3^-	NH_4^+	
Urban studies									
Guangzhou	2002-2003	annual	71	17.6	4.4	14.7	4.0	4.5	Hagler et al., 2006
	2009-2010	annual	77	9.0	6.0	18.1	7.8	5.1	Tao et al., 2014c
	2014	annual	48	8.2	4.0	9.3	2.2	3.8	Tao et al., 2017
Shenzhen	2002-2003	annual	47	11.1	3.9	10.0	2.3	3.2	Hagler et al., 2006
	2009	annual	42	8.3	4.7	11.7	2.7	3.5	Huang et al., 2013
Hong kong	2000-2001	annual	34	8.7	5.4	9.1	1.3	2.9	Louie et al., 2005b
	2002-2003	annual	34	6.6	1.9	9.3	1.0	2.5	Hagler et al., 2006
Zhongshan	2002-2003	annual	47	10.5	2.5	11.9	1.8	3.3	Hagler et al., 2006
PRD	**Average**	**annual**	**50±16**						
Guangzhou	2007	spring	79	14.8	8.1	21.6	9.5	7.3	Tao et al., 2009
	2009	spring	76	8.3	6.1	17.8	9.9	6.0	Tao et al., 2014c
	2014	spring	44	7.5	4.2	8.2	2.4	3.6	Tao et al., 2017
	Average	**spring**	**66±19**						
	2002	summer	66	13.1	4.6	15.7	2.9	0.6	Cao et al., 2004;Lai et al., 2007
	2003	summer	40	9.9	1.3	6.4	1.2	1.2	Cao et al., 2012b
	2004	summer	75						Huang et al., 2007
	2004	summer	105	17.5	5.4				Duan et al., 2007
	2006	summer	61	9.9	4.9	16.3	2.7		Jung et al., 2009
	2009	summer	39	5.6	3.5	9.2	2.0	1.6	Tao et al., 2014c
	2013	summer	51	11.0	2.6	8.9	4.9	4.0	Cui et al., 2015
	2014	summer	37	6.1	3.5	7.6	0.3	2.6	Tao et al., 2017
	Average	**summer**	**59±23**						
	2004	autumn	103	22.4	7.1	27.8	4.3	12.1	Andreae et al., 2008
	2009	autumn	89	10.4	6.7	27.5	6.4	6.4	Tao et al., 2014c
	2010	autumn	87	14.0	6.8	18.5	5.2	4.7	Tao et al., 2015b

	2011	autumn/winter	72						Jahn et al., 2013
	2013	autumn/winter	68	15.7	2.8	9.8	7.3	4.5	Cui et al., 2015
	2014	autumn	48	7.9	3.6	11.4	1.0	4.4	Tao et al., 2017
	Average	**autumn**	**78±19**						
	2002	winter	91	17.8	6.0	15.0	10.2	3.9	Cao et al., 2004;Lai et al., 2007
	2003	winter	110	24.2	8.4	20.6	11.5	8.5	Cao et al., 2012b
	2004-2005	winter	124						Huang et al., 2007
	2005	winter	124	23.9	4.2				Duan et al., 2007
	2007-2008	winter	203	32.9	7.1	27.3	24.4	14.1	Tan et al., 2009
	2008-2009	winter	82	17.5	4.1	5.6	12.0	4.7	Yang et al., 2011b
	2010	winter	103	11.8	7.8	17.8	13.0	6.5	Tao et al., 2014c
	2012-2013	winter	75	10.8	2.1	10.6	5.8	5.1	Liu et al., 2014
	2013	winter	69	14.3*	3.5	12.7	8.9	6.9	Huang et al., 2014b
	2014	winter	63	11.6	5.0	9.8	5.5	4.8	Tao et al., 2017
	Average	**winter**	**104±41**						
Hong Kong	2000-2001	spring	29	6.4	5.3	9.1	1.2	2.7	Louie et al., 2005a
	2001	summer	29	5.6	4.3	4.6	0.4	0.8	Ho et al., 2006a
	2000-2001	summer	26	6.3	6.0	7.6	0.6	2.2	Louie et al., 2005a
	2002	summer	31	5.6	3.2	5.7	1.5	0.1	Cao et al., 2004;Lai et al., 2007
	2003	summer	30	6.6	1.9	4.3	1.2	0.3	Cao et al., 2012b
	2004	summer	46	9.6	3.4				Duan et al., 2007
	2000-2001	autumn	34	7.4	4.7	11.6	0.6	3.6	Louie et al., 2005a
	2000-2001	winter	60	10.2	5.1	15.4	2.5	2.7	Ho et al., 2006a
	2000-2001	winter	45	12.6	5.0	9.9	2.3	3.6	Louie et al., 2005a
	2002	winter	49	8.4	4.4	8.1	4.2	1.5	Cao et al., 2004;Lai et al., 2007
	2003	winter	88	13.3	6.9	21.4	9.5	8.0	Cao et al., 2012b
Foshan	2008-2014	summer/winter	113	12.9	5.1	23.2	18.9	17.7	Tan et al., 2016b

Rural studies									
Conghua	2002-2003	annual	37	9.1	1.4	10.4	0.3	2.4	Hagler et al., 2006
Tianhu	2012-2013	annual	44	6.1	0.8	12.2	2.0	5.2	Lai et al., 2016
Hok Tsui	2000-2001	annual	24	4.2	1.7	8.7	0.7	2.2	Louie et al., 2005b
Tianhu	2012-2013	spring	31	4.5	0.7	9.1	1.8	3.4	Lai et al., 2016
	2012-2013	summer	37	4.9	0.6	9.5	1.6	3.7	
Wanqingsha	2007	autumn	113	19.3	3.6	22.7	6.7	6.5	Fu et al., 2014
	2008	autumn/winter	104	22.7	4.2	15.7	8.8	5.4	
	2009	autumn/winter	95	17.2	5.5	17.0	11.5	7.1	
	2010	autumn/winter	89	18.3	3.3	17.2	10.9	7.5	
	2011	autumn/winter	79	15.2	3.1	14.2	9.6	6.6	
	2010	autumn/winter	71	14.9	2.6	13.5	8.5	6.0	Wang et al., 2012
Tianhu	2012-2013	autumn	67	7.6	0.9	17.8	1.4	7.6	Lai et al., 2016
	Average	**autumn**	**88±17**						
Tianhu	2012-2013	winter	41	7.5	1.0	12.6	2.9	5.8	Lai et al., 2016

*estimated by OM with a factor of 1.6

Table S1d: Summary of mass concentrations (μg m^{-3}) of $PM_{2.5}$ and its dominant chemical components in other regions of China

Location	Period	Annual/seasonal	$PM_{2.5}$ (μg m^{-3})						References
			Mass	OC	EC	SO_4^{2-}	NO_3^-	NH_4^+	
Urban studies									
Chongqing	2005-2006	annual	129	30.1	6.4	25.6	5.5	7.9	Yang et al., 2011b
	2012-2013	annual	76	15.2	4				Chen et al., 2014d
	2014-2015	annual	71						Wang et al., 2017a
Chengdu	2009-2010	annual	165	22.6	9	32.8	19.7	10.4	Tao et al., 2013
	2011	annual	119	17	7	25	10.7	11.6	Tao et al., 2014a
	2012-2013	annual	94	19	4.6				Chen et al., 2014d
	2014-2015	annual	67						Wang et al., 2017a
Neijiang	2012-2013	annual	80	18.3	4.1				Chen et al., 2014d
Sichuan basin	**Average**	**annual**	**100±35**						
Zhengzhou	2011	annual	194						Wang et al., 2015a
	2012	annual	183						
	2013	annual	215						
	2010	annual	175	20.1	3.9	25.7	16.7	15.6	Geng et al., 2013
	2014-2015	annual	146	27.0	11.0				Wang et al., 2017b
Zhengzhou	**Average**	**annual**	**192±17**						
Xi'an	2006-2007	annual	169			35.8	19.3	10.6	Shen et al., 2009
	2006-2007	annual	194			34.3	15.6	10.7	Zhang et al., 2011b
	2010	annual	167	21.8	8	25.8	19.8	9.1	Wang et al., 2015b
Xi'an	**Average**	**annual**	**177±15**						
Lanzhou	2014	annual	89	17.7	9.0	5.6	5.2	2.9	Wang et al., 2016b
Jinan	2006-2007	annual	149	22.2	4.1	30.9	10.6	14.0	Yang et al., 2012
Wuhan	2012-2013	annual	107						Zhang et al., 2015a
	2011-2012	annual	113						Xiong et al., 2017
Changsha	2013-2014	annual	106	17.3	4.1	17.1	4.1	9.4	Tang et al., 2017
Fuzhou	2007-2008	annual	44	8.5	2.2	10.8	4.4	3.9	Xu et al., 2012b
Xiamen	2009-2010	annual	70	18.3	3.2				Zhang et al., 2011a

		annual	86			11.2	6.0	4.5	Zhang et al., 2012
	2013	annual	42	6.3	2.1	9.7	5.9	3.8	Zhang et al., 2016
Haikou	2015	annual	21	3.6	1.7	4.1	1.0	1.3	Liu et al., 2017a
Zhengzhou	2010	spring	181	15.4	3.0	20.5	16.8	11.6	Geng et al., 2013
	2010	summer	122	10	1.8	32	11.1	15.7	
	2010	autumn	186	18.7	5.4	35.2	23.3	15.4	
	2010	winter	211	27.1	4.7	22.3	17.3	17.4	
	2011	spring	209						Wang et al., 2015a
	2012	spring	205						
	2013	spring	205						
	2011	summer	118						
	2012	summer	84						
	2013	summer	149						
	2011	autumn	266						
	2012	autumn	186						
	2013	autumn	168						
	2011	winter	283						
	2012	winter	257						
	2013	winter	338						
Jinan	2006-2007	spring	143	15.8	3.3	21.9	9.1	9.7	Yang et al., 2012
	2006-2007	summer	129	15.0	3.1	37.4	6.7	14.7	
	2006-2007	autumn	135	24.0	4.5	27.8	9.2	12.6	
	2006-2007	winter	205	35.8	5.7	37.7	20.1	20.5	
Lanzhou	2014	spring	83	13.4	6.7	4.0	1.7	0.8	Wang et al., 2016b
		summer	38	5.9	4.4	4.8	5.8	7.6	
		autumn	93	21.1	11.5	2.0	7.1	10.1	
		winter	141	30.3	13.4	1.3	3.6	6.0	
	2012	winter	120	35.4	13.8	11.8	7.2	6.7	Tan et al., 2016c
	2013	summer	34	9.7	4.4	4.3	1.9	1.9	
Chengdu	2009-2010	spring	133	20.7	5.7	15.5	9.7	4.7	Tao et al., 2013

	2009-2010	summer	114	14.9	7.1	27.8	12.1	4.7	
	2009-2010	autumn	188	23.3	11.6	36.5	25.5	13.8	
	2009-2010	winter	226	31.5	11.6	50.6	31.2	18.2	
	2011	spring	126	15.0	7.0	26.4	10.2	11.9	Tao et al., 2014a
	2011	summer	89	11.0	6.0	23.7	5.3	9.0	
	2011	autumn	111	20.0	7.0	19.2	12.9	11.1	
	2011	winter	158	22.0	8.0	31.8	15.5	15.3	
Wuhan	2012-2013	spring	133						Zhang et al., 2015a
	2012-2013	summer	49						
	2012-2013	autumn	102						
	2012-2013	winter	143						
Changsha	2013-2014	spring	97	17.5*	4.2	17.0	1.4	7.5	Tang et al., 2017
	2013-2014	summer	78	11.8*	2.7	13.9	2.9	7.4	
	2013-2014	autumn	102	15.6*	3.9	19.4	2.6	8.7	
	2013-2014	winter	145	25.6*	6.0	19.3	9.7	14.3	
Fuzhou	2007-2008	spring	50	10.5	2.1	10.1	4.6	2.5	Xu et al., 2012b
	2007-2008	summer	24	5.3	2.0	6.6	1.1	1.3	
	2007-2008	autumn	44	7.7	2.2	11.6	3.1	3.9	
	2007-2008	winter	60	10.5	2.5	14.8	8.8	7.9	
Xiamen	2009-2010	spring	64	12.5	2.0				Zhang et al., 2011a
	2009-2010	summer	37	10.3	2.3				
	2009-2010	autumn	76	20.8	3.4				
	2009-2010	winter	106	29.5	4.9				
	2009-2010	spring	90	13.6	2.3	11.2	6.4	3.9	Zhang et al., 2012
	2009-2010	summer	62	9.7	2.2	7.1	3.1	2.7	
	2009-2010	autumn	84	14.0	3.0	10.3	4.8	3.9	
	2009-2010	winter	109	23.6	4.2	17.8	10.8	7.7	
Haikou	2015	spring	17	3.8	1.6	3.1	0.5	1.0	Liu et al., 2017a
	2015	summer	9	2.0	0.8	1.6	0.2	0.5	
	2015	autumn	23	4.0	1.8	3.8	0.3	0.8	

	2015	winter	47	4.7	2.4	7.9	3.1	3.0	
Rural studies									
Jinsha	2012-2013	annual	49	7.3	0.7	13.2	5.0	5.6	Zhang et al., 2014
	2012-2013	spring	45	6.5	0.7	12.4	3.0	4.9	
	2012-2013	summer	34	3.8	0.4	9.9	1.5	4.1	
	2012-2013	autumn	42	7.1	0.6	11.7	4.7	5.0	
	2012-2013	winter	66	10.8	0.9	16.7	9.6	7.5	

*: average values of urban (384 samples) and suburban (96 samples) in Changsha

Table S2: Summary of $PM_{2.5}$ source-apportionment analysis results across China

Location	Period	Annual/Seasonal	Method	$PM_{2.5}$ ($\mu g\ m^{-3}$)	Source factors and percentage contribution (%)	References
Beijing-Tianjin-Hebei						
Beijing	2000	annual	CMB	96	Secondary inorganic aerosols (33), Coal combustion (7), Biomass aerosols (6), Motor vehicles (7), Road dust (20), Others (27)	(Song et al., 2006b)
Beijing	2000	annual	PMF	96	Secondary inorganic aerosols (31), Coal combustion (19), Biomass aerosols (11), Motor vehicles (6), Road dust (9), Industry (6), Others (18)	(Song et al., 2006b)
Beijing	2000	annual	PCA/APCS	96	Secondary inorganic aerosols (24), Coal combustion (28), Motor vehicles (6), Road dust (8), Industry (7), Others (28)	(Song et al., 2006a)
Beijing	2000	annual	UNMIX	96	Secondary inorganic aerosols (29), Coal combustion (24), Motor vehicles (11), Road dust (9), Industry (11), Others (15)	(Song et al., 2006a)
Beijing	2001-2004	annual	PMF	142	Soil dust (20), Biomass burning (12), Secondary inorganic aerosols (19), Automobile (28), Coal combustion (14), Industrial (5), Unknown (2)	(Zhang et al., 2007)
Beijing	2009-2010	annual	PMF	135	Secondary inorganic aerosols (26), Industrial pollution (25), Biomass burning (12), Coal combustion (18), Soil dust (15), Traffic and waste incineration emission (4)	(Zhang et al., 2013)
Beijing	2012-2013	annual	PMF	107	Soil dust (4), Biomass combustion (12), Coal combustion (11), Traffic emissions (25), Secondary inorganic aerosols (48)	(Zíková et al., 2016)
Tianjin	2013-2014	annual	ME-2	138	Traffic emissions (14), Crustal /cement dust (20), Coal combustion (25), Secondary aerosols (41)	(Tian et al., 2016)
Beijing	2000	winter	CMB	61	Secondary inorganic aerosols (27), Coal combustion (15), Biomass burning (9), Soil dust (14), Automobile(6), Others(28)	(Zheng et al., 2005)

Beijing	2000	spring	CMB	139	Secondary inorganic aerosols (28), Coal combustion (3), Biomass burning (2), Soil dust (36), Automobile (5), Others (25)	(Zheng et al., 2005)
Beijing	2000	summer	CMB	99	Secondary inorganic aerosols (41), Coal combustion (2), Soil dust (17), Automobile (8), Others (31)	(Zheng et al., 2005)
Beijing	2000	autumn	CMB	106	Secondary inorganic aerosols (38), Coal combustion (9), Biomass burning (13), Soil dust (11), Automobile (8), Others (22)	(Zheng et al., 2005)
Beijing	2004	winter	PMF	107	Coal combustion (38), Secondary inorganic aerosols (18), Biomass burning (15), Motor vehicle (8), Road dust (7), Unknown(13)	(Song et al., 2007)
Beijing	2004	summer	PMF	52	Coal combustion (11), Secondary inorganic aerosols (32), Biomass burning (13), Motor vehicle (15), Road dust (8), Unknown (20)	(Song et al., 2007)
Beijing	2009-2010	spring	PMF	126	Secondary inorganic aerosols (34), Industrial pollution (14), Biomass burning (19), Coal combustion (5), Soil dust (23), Traffic and waste incineration emission (5)	(Zhang et al., 2013)
Beijing	2009-2010	summer	PMF	138	Secondary inorganic aerosols (54), Industrial pollution (32), Biomass burning (6), Coal combustion (1), Soil dust (3), Traffic and waste incineration emission (4)	(Zhang et al., 2013)
Beijing	2009-2010	autumn	PMF	135	Secondary inorganic aerosols (13), Industrial pollution (42), Biomass burning (17), Coal combustion (7), Soil dust (18), Traffic and waste incineration emission (4)	(Zhang et al., 2013)
Beijing	2009-2010	winter	PMF	139	Secondary inorganic aerosols (6), Industrial pollution (12), Biomass burning (7), Coal combustion (57), Soil dust (16), Traffic and waste incineration emission (2)	(Zhang et al., 2013)
Beijing	2010	spring/summer	PMF	60	Traffic emissions (13), Coal combustion(21), Secondary inorganic aerosols (26), Soil dust (16), Industry(8), Secondary organic aerosol (12), Unknown (4)	(Wu et al., 2014)
Beijing	2010	autumn	PMF	78	Traffic emissions (16), Coal combustion (31), Secondary inorganic aerosols (23), Soil dust (7), Industry (7), Secondary organic aerosol (10), Unknown (6)	(Wu et al., 2014)

Beijing	2012-2013	spring	PMF	119	Soil dust (7), Biomass combustion (8), Coal combustion (17), Traffic emissions (13), Secondary inorganic aerosols (55)	(Zíková et al., 2016)
Beijing	2012-2013	summer	PMF	100	Soil dust (3), Biomass combustion (20), Coal combustion (4), Traffic emissions (13), Secondary inorganic aerosols (61)	(Zíková et al., 2016)
Beijing	2012-2013	autumn	PMF	58	Soil dust (9), Biomass combustion (18), Coal combustion (4), Traffic emissions (31), Secondary inorganic aerosols (38)	(Zíková et al., 2016)
Beijing	2012-2013	winter	PMF	156	Soil dust (2), Biomass combustion (7), Coal combustion (13), Traffic emissions (38), Secondary inorganic aerosols (40)	(Zíková et al., 2016)
Beijing	2013	winter	ME-2	159	Traffic (6), Coal burning (26), Biomass burning (6), Cooking (2), Dust related (10), Secondary organic-rich (26), Secondary inorganic-rich (25)	(Huang et al., 2014b)
Yangtze River Delta						
Nanjing	2013	annual	PMF	139	Secondary nitrate (35), Road dust (8), Sea salt and ship emissions (7), Coal combustion (10), Secondary sulfate (33), Iron and steel industry (7)	(Li et al., 2016)
Hangzhou	2004-2005	annual	PMF	108	Power plant (13), Iron/steel and other metal manufacturing (32), a mixture sources (10), motor vehicles and brake/tire wear (17), secondary particles (28)	(Liu et al., 2015)
Nanjing	2013	spring	PMF	110	Secondary nitrate (30), Road dust (8), Sea salt and ship emissions (6), Coal combustion (7), Secondary sulfate (41), Iron and steel industry (8)	(Li et al., 2016)
Nanjing	2013	summer	PMF	86	Secondary nitrate (31), Road dust (3), Sea salt and ship emissions (13), Coal combustion (3), Secondary sulfate (47), Iron and steel industry (3)	(Li et al., 2016)
Nanjing	2013	autumn	PMF	77	Secondary nitrate (29), Road dust (9), Sea salt and ship emissions (7), Coal combustion (12), Secondary sulfate (29), Iron and steel industry (14)	(Li et al., 2016)

Nanjing	2013	winter	PMF	243	Secondary nitrate (43), Road dust (10), Sea salt and ship emissions (5), Coal combustion (18), Secondary sulfate (20), Iron and steel industry (4)	(Li et al., 2016)
Shanghai	2013	winter	ME-2	91	Traffic (7), Coal burning (5), Biomass burning (5), Dust related (9), Secondary organic-rich (12), Secondary inorganic-rich (62)	(Huang et al., 2014b)
Pearl River Delta						
Guangzhou	2014	annual	PMF	48	Ship emissions (17), Soil dust (7), Coal combustion (15), Traffic emissions (10), Secondary nitrate and chloride (12), Secondary sulfate and biomass burning (38)	(Tao et al., 2017)
Shenzhen	2009	annual	PMF	42	Secondary sulfate (30), Vehicular emission (27), Biomass burning (10), Secondary nitrate (9), Others (24)	(Huang et al., 2013)
Hong Kong	2000-2001 2004-2005	annual	PCA/APCA	/	Vehicle emission/road erosion (23), Soil suspension (10), Secondary sulfate (28), Oil residue (19), Sea salt (7), Unknown (13)	(Guo et al., 2009)
Hong Kong Suburban	2011-2012	annual	PMF	28	Secondary sulfate (28), Fresh sea salt (9), Crustal dust (7), Secondary nitrate (11), Residual oil combustion (12), Biomass burning (20), Aged sea salt (8), Vehicular exhaust (5)	(Huang et al., 2014c)
Zhuhai Suburban	2014-2015	annual	PMF	45	Mixed source (36), Secondary nitrate and chloride (20), Ship emissions (18), Coal combustion (13), Electronic industry (13)	(Tao et al., 2017)
Guangzhou	2013	winter	ME-2	69	Traffic (9), Coal burning (3), Biomass burning (7), Dust related (4), Secondary organic-rich (18), Secondary inorganic-rich (59)	(Huang et al., 2014b)
Foshan	2008	winter	PMF	132	Industry (39), Dust (18), Secondary aerosol (13), Vehicle (20), Biomass burning (10)	(Tan et al., 2016b)
Foshan	2014	summer/winter	PMF	73	Industry (20), Dust (14), Secondary aerosol (30), Vehicle (24), Biomass burning (12)	(Tan et al., 2016b)

Hong Kong	2001-2002	summer/winter	PCA/APCA	44	Automobile emission and secondary aerosols (44), Crustal matter and secondary aerosols (30), Diesel emission (14), Oil combustion (4), Unexplained (8)	(Ho et al., 2006b)
Hong Kong Suburban	2011-2012	spring	PMF	34	Secondary sulfate (35), Fresh sea salt(5), Crustal dust (17), Secondary nitrate (10), Residual oil combustion (11), Biomass burning (9), Aged sea salt (8), Vehicular exhaust (5)	(Huang et al., 2014c)
Hong Kong Suburban	2011-2012	summer	PMF	18	Secondary sulfate (28), Fresh sea salt(14), Crustal dust (6), Secondary nitrate (2), Residual oil combustion (25), Biomass burning (6), Aged sea salt (11), Vehicular exhaust (8)	(Huang et al., 2014c)
Hong Kong Suburban	2011-2012	autumn	PMF	29	Secondary sulfate (35), Fresh sea salt(4), Crustal dust (5), Secondary nitrate (7), Residual oil combustion (6), Biomass burning (32), Aged sea salt (7), Vehicular exhaust (4)	(Huang et al., 2014c)
Hong Kong Suburban	2011-2012	winter	PMF	34	Secondary sulfate (21), Fresh sea salt(7), Crustal dust (5), Secondary nitrate (22), Residual oil combustion (4), Biomass burning (32), Aged sea salt (6), Vehicular exhaust (3)	(Huang et al., 2014c)
Other cities						
Northwest China (Lanzhou and Xi'an)						
Xi'an	2010	annual	PMF	167	Coal combustion (19), Vehicle emissions (15), Secondary inorganic sulfate (17), Secondary inorganic nitrate (12), Geological material (10), Construction dust (7), Biomass burning (9), Industrial emissions (11)	(Wang et al., 2015b)
Xi'an Rural	2010	annual	PMF	90	Coal combustion (16), Vehicle emissions (13), Secondary inorganic sulfate (16), Secondary inorganic nitrate (15), Geological material (12), Construction dust (8), Biomass burning (13), Industrial emissions (7)	(Wang et al., 2015b)
Lanzhou	2014	annual	PMF	91	Traffic emissions (22), Secondary inorganic aerosols (17), Coal combustion (22), Biomass burning and waste incineration (8), Refined copper industry (9), Soil dust (22)	(Wang et al., 2016b)
Xi'an	2006	winter	PMF	230	Motor vehicle emissions (19), Coal combustion (31), Secondary inorganic aerosol (21), Fugitive dust (13), Industrial emissions (10), Biomass burning (6)	(Xu et al., 2016)

Xi’an	2008	winter	PMF	233	Motor vehicle emissions (21), Coal combustion (28), Secondary inorganic aerosol (23), Fugitive dust (12), Industrial emissions (11), Biomass burning (5)	(Xu et al., 2016)
Xi’an	2010	winter	PMF	199	Motor vehicle emissions (21), Coal combustion (24), Secondary inorganic aerosol (18), Fugitive dust (19), Industrial emissions (13), Biomass burning (5)	(Xu et al., 2016)
Lanzhou	2013	summer	PMF	34	Steel industry (7), Secondary aerosols (15), Coal combustion (3), Power plants (3), Vehicle emissions (25), Crustal dust (12), Smelting industry (35)	(Tan et al., 2017)
Lanzhou	2012	winter	PMF	121	Steel industry (7), Secondary aerosols (33), Coal combustion (29), Power plants (3), Vehicle emissions (9), Crustal dust (13), Smelting industry (6)	(Tan et al., 2017)
Southwest China (Chengdu and Chongqing)						
Chengdu	2011	annual	PMF	119	Secondary inorganic aerosols (37), Coal combustion (20), Biomass burning (11), Iron and steel industry (11), Mo-related industries (11), Soil dust (10)	(Tao et al., 2014a)
Chongqing	2012-2013	annual	PMF	104	Secondary inorganic aerosols (38), Coal combustion (22), Other industrial pollution (17), Soil dust (11), Vehicular emission (10), Metallurgical industry (2)	(Chen et al., 2017)
Chengdu	2011	spring	PMF	126	Secondary inorganic aerosols (37), Coal combustion (22), Biomass burning (7), Iron and steel industry (8), Mo-related industries (8), Soil dust (18)	(Tao et al., 2014a)
Chengdu	2011	summer	PMF	89	Secondary inorganic aerosols (37), Coal combustion (23), Biomass burning (1), Iron and steel industry (19), Mo-related industries (11), Soil dust (9)	(Tao et al., 2014a)
Chengdu	2011	autumn	PMF	111	Secondary inorganic aerosols (33), Coal combustion (14), Biomass burning (19), Iron and steel industry (11), Mo-related industries (14), Soil dust (8)	(Tao et al., 2014a)
Chengdu	2011	winter	PMF	158	Secondary inorganic aerosols (44), Coal combustion (18), Biomass burning (16), Iron and steel industry (5), Mo-related industries (13), Soil dust (4)	(Tao et al., 2014a)

Chongqing	2012-2013	spring	PMF	104	Secondary inorganic aerosols (24), Coal combustion (27), Other industrial pollution (25), Soil dust (15), Vehicular emission (8), Metallurgical industry (1)	(Chen et al., 2017)
Chongqing	2012-2013	summer	PMF	104	Secondary inorganic aerosols (52), Coal combustion (19), Other industrial pollution (15), Soil dust (5), Vehicular emission (6), Metallurgical industry (3)	(Chen et al., 2017)
Chongqing	2012-2013	autumn	PMF	104	Secondary inorganic aerosols (32), Coal combustion (23), Other industrial pollution (21), Soil dust (12), Vehicular emission (11), Metallurgical industry (1)	(Chen et al., 2017)
Chongqing	2012-2013	winter	PMF	104	Secondary inorganic aerosols (42), Coal combustion (22), Other industrial pollution (13), Soil dust (11), Vehicular emission (11), Metallurgical industry (1)	(Chen et al., 2017)
Eastern and central China (Jinan, Zhengzhou, Heze, Dongying, Tai'an, Longkou, Wuhan and Changsha)						
Jinan	2007-2008	annual	PMF	/	Coal combustion (21), Biomass burning (5), Industry (3), Secondary (55), Soil dust (9), Motor vehicles (6), Unknown (1)	(Yang et al., 2013)
Zhengzhou Industrial Zone	2010	annual	PMF	175	Industrial (4), Soil dust (26), Secondary aerosol (24), Biomass burning/oil combustion/incineration (13), Vehicle (10), Coal combustion (23)	(Geng et al., 2013)
Heze, Shandong Province	2015-2016	annual	PMF	101	Secondary source (27), Coal combustion (17), Vehicle exhaust (17), Soil dust (11), Construction dust (8), Biomass burning (7), Metal manufacturing (4), Others (9)	(Liu et al., 2017b)
Dongying, Regional site	2011	annual	PMF	79	Biomass (16), Vehicular (5), Cu smelt (5), Secondary inorganic aerosols (54), Industry (11), Crustal (8), Other (1)	(Yao et al., 2016)
Changsha	2013-2014	annual	PMF	106	Metal smelting and mining (9), Urban raised dust (13), Industrial and biomass burning (18), Secondary inorganic aerosols (60)	(Tang et al., 2017)
Jinan	2007-2008	spring	PMF	/	Coal combustion (27), Biomass burning (4), Industry (3), Secondary (40), Soil dust (18), Motor vehicles (4), Unknown (4)	(Yang et al., 2013)

Jinan	2007-2008	summer	PMF	/	Coal combustion (10), Biomass burning (5), Industry (1), Secondary (69), Soil dust (6), Motor vehicles (8), Unknown (1)	(Yang et al., 2013)
Jinan	2007-2008	autumn	PMF	/	Coal combustion (13), Biomass burning (3), Industry (3), Secondary (65), Soil dust (8), Motor vehicles (7), Unknown (1)	(Yang et al., 2013)
Jinan	2007-2008	winter	PMF	/	Coal combustion (28), Biomass burning (6), Industry (3), Secondary (51), Soil dust (6), Motor vehicles (6), Unknown (0)	(Yang et al., 2013)
Dongying Regional site	2011	spring	PMF	71	Biomass (14), Vehicular (8), Cu smelt (6), Secondary inorganic aerosols (45), Industry (11), Crustal (16), Other (0)	(Yao et al., 2016)
Dongying Regional site	2011	summer	PMF	93	Biomass (6), Vehicular (3), Cu smelt (2), Secondary inorganic aerosols (72), Industry (12), Crustal (5), Other (0)	(Yao et al., 2016)
Dongying Regional site	2011	autumn	PMF	97	Biomass (13), Vehicular (4), Cu smelt (7), Secondary inorganic aerosols (66), Industry (7), Crustal (4), Other (0)	(Yao et al., 2016)
Dongying Regional site	2011	winter	PMF	63	Biomass (30), Vehicular (7), Cu smelt (5), Secondary inorganic aerosols (35), Industry (12), Crustal (8), Other (2)	(Yao et al., 2016)
Tai’an	2014	summer/autumn	PMF	71	Secondary aerosol (27), Coal combustion(18), Metal manufacturing (19), Soil/resuspended/construction dust (9), vehicle exhaust/biomass burning (17)	(Liu et al., 2016)
Longkou	2014	winter	PMF	78	Vehicle emission (16), Traffic dust(4), Ship emission (9), Industrial process (3), Biomass burning (19), Mineral dust (13), Coal combustion (30), Sea salt (7)	(Zong et al., 2016)
Wuhan Industrial Zone	2011-2012	spring	CMB	154	Vehicle emissions (20), Mineral dust (23), Coal combustion (4), Industrial sources (8), Other organic matter (17), Secondary inorganic aerosols (27), Others (1)	(Xiong et al., 2017)
Wuhan Industrial Zone	2011-2012	summer	CMB	135	Vehicle emissions (28), Mineral dust (22), Coal combustion (2), Industrial sources (8), Other organic matter (14), Secondary inorganic aerosols (23), Others (3)	(Xiong et al., 2017)

Wuhan Industrial Zone	2011-2012	autumn	CMB	196	Vehicle emissions (31), Mineral dust (18), Coal combustion (4), Industrial sources (14), Other organic matter (13), Secondary inorganic aerosols (17), Others (2)	(Xiong et al., 2017)
Wuhan Industrial Zone	2011-2012	winter	CMB	233	Vehicle emissions (23), Mineral dust (8), Coal combustion (16), Industrial sources (9), Other organic matter (10), Secondary inorganic aerosols (33), Others (0)	(Xiong et al., 2017)
Wuhan suburban	2011-2012	spring	CMB	72	Vehicle emissions (15), Mineral dust (34), Coal combustion (1), Industrial sources (6), Other organic matter (18), Secondary inorganic aerosols (21), Others (4)	(Xiong et al., 2017)
Wuhan suburban	2011-2012	summer	CMB	49	Vehicle emissions (27), Mineral dust (21), Coal combustion (0), Industrial sources (4), Other organic matter (14), Secondary inorganic aerosols (32), Others (2)	(Xiong et al., 2017)
Wuhan suburban	2011-2012	autumn	CMB	87	Vehicle emissions (16), Mineral dust (11), Coal combustion (0), Industrial sources (3), Other organic matter (40), Secondary inorganic aerosols (26), Others (3)	(Xiong et al., 2017)
Wuhan suburban	2011-2012	winter	CMB	162	Vehicle emissions (23), Mineral dust (7), Coal combustion (0), Industrial sources (4), Other organic matter (21), Secondary inorganic aerosols (42), Others (3)	(Xiong et al., 2017)
Wuhan	2011-2012	spring	CMB	113	Vehicle emissions (26), Mineral dust (27), Coal combustion (4), Industrial sources (2), Other organic matter (18), Secondary inorganic aerosols (23), Others (1)	(Xiong et al., 2017)
Wuhan	2011-2012	summer	CMB	80	Vehicle emissions (31), Mineral dust (15), Coal combustion (0), Industrial sources (4), Other organic matter (13), Secondary inorganic aerosols (36), Others (1)	(Xiong et al., 2017)
Wuhan	2011-2012	autumn	CMB	132	Vehicle emissions (35), Mineral dust (7), Coal combustion (5), Industrial sources (3), Other organic matter (19), Secondary inorganic aerosols (25), Others (6)	(Xiong et al., 2017)
Wuhan	2011-2012	winter	CMB	118	Vehicle emissions (16), Mineral dust (8), Coal combustion (11), Industrial sources (3), Other organic matter (15), Secondary inorganic aerosols (41), Others (6)	(Xiong et al., 2017)
South coastal cities (Xiamen and Haikou)						

Xiamen	2013	annual	CMB	42	Secondary inorganic components (27), Motor vehicle emissions (21), Fugitive dust (12), Sea salt (10%), Coal burning (9), Biomass burning (5), Industry (3), Others (13)	(Zhang et al., 2016)
Haikou	2015	spring	CMB	17	Resuspended dust (13), Coal dust (8), Construction dust (7), Vehicle exhaust (14), Secondary inorganic aerosols (24), Sea salt (8), Secondary organic carbon (4), Unresolved (22)	(Liu et al., 2017a)
Haikou	2015	summer	CMB	9	Resuspended dust (16), Coal dust (4),Construction dust (9), Vehicle exhaust (20), Secondary inorganic aerosols (11), Sea salt (4), Secondary organic carbon (11), Unresolved (25)	(Liu et al., 2017a)
Haikou	2015	autumn	CMB	23	Resuspended dust (19), Coal dust (6), Construction dust (7), Vehicle exhaust (18), Secondary inorganic aerosols (19), Sea salt (6), Secondary organic carbon (6), Unresolved (19)	(Liu et al., 2017a)
Haikou	2015	winter	CMB	47	Resuspended dust (10), Coal dust (14), Construction dust (5), Vehicle exhaust (11), Secondary inorganic aerosols (26), Sea salt (5), Secondary organic carbon (3), Unresolved (26)	(Liu et al., 2017a)

Principal Component Analysis/Absolute Principal Component Scores (PCA/APCS); Chemical Mass Balance receptor (CMB); Positive Matrix Factorization (PMF); Multilinear Engine-2 (ME-2).

Table S3-a: Summary of aerosol scattering and absorption coefficient in Beijing-Tianjin-Hebei of China

Location	Period	Annual/seasonal	b_{sp} (Mm^{-1})	b_{ap} (Mm^{-1})	BC ($\mu g\ m^{-3}$)	References
Urban studies						
Beijing	2005	annual	264	58		He et al., 2009
	2006	annual	310	53		
	2008-2009	annual	301			Zhao et al., 2011
	2009-2010	annual	360	64		Jing et al., 2015
	Average	**annual**	**309±40**	**58±6**		
	2005-2006	spring	243	45		He et al., 2009
	2008-2009	spring	292			Zhao et al., 2011
	2009-2010	spring	289	35		Jing et al., 2015
	Average	**spring**	**275±27**	**40±7**		
	1999	summer	488	83		Bergin et al., 2001
	2005-2006	summer	351	54		He et al., 2009
	2006	summer	361	52		Garland et al., 2009
	2006	summer	364	58		Han et al., 2014
	2006	summer	300	55		Liu et al., 2009
	2008	summer	424	46		Li et al., 2013b
	2009-2010	summer	344	58		Jing et al., 2015
	2012	summer	313	29		Tian et al., 2015
	Average	**summer**	**368±61**	**54±15**		
	2005-2006	autumn	311	67		He et al., 2009
	2008-2009	autumn	286			Zhao et al., 2011
	2009-2010	autumn	452	92		Jing et al., 2015
	Average	**autumn**	**350±90**	**80±18**		
	2005-2006	winter	259	58		He et al., 2009
	2008-2009	winter	325			Zhao et al., 2011
	2009-2010	winter	356	70		Jing et al., 2015
	2013	winter	723			Tao et al., 2015a
	2013	winter		46	5.5	Wu et al., 2016

	Average	**winter**	**468±221**	**70±17**		
Rural studies						
Shangdianzi	2003-2005	annual	175	18		Yan et al., 2008
	2008-2009	annual	182			Zhao et al., 2011
	2003-2005	spring	154	18		Yan et al., 2008
	2003-2005	summer	190	21		
	2003-2005	autumn	215	17		
	2003-2005	winter	116	9		
	2008-2009	spring	201			Zhao et al., 2011
	2008-2009	summer	206			
	2008-2009	autumn	112			
	2008-2009	winter	176			
Wuqing	2009	spring	280	47		Ma et al., 2011
	2009	summer	379	43		
	2010	winter	485			Chen et al., 2014b

Table S3-b: Summary of aerosol scattering and absorption coefficient in Yangtze River Delta of China

Location	Period	Annual/seasonal	b_{sp} (Mm^{-1})	b_{ap} (Mm^{-1})	BC ($\mu g\ m^{-3}$)	References
Urban studies						
Shanghai	2011-2012	annual		19	2.3	Zha et al., 2014
	2010	annual		31	3.8	Feng et al., 2014
	2011	annual		27	3.3	
	2010-2012	annual	217	38		Cheng et al., 2015
	2010	spring	102	44		Li et al., 2013a
	2010	spring		25	3.0	Feng et al., 2014
	2011	spring		30	3.6	
	2011-2012	spring		19	2.3	Zha et al., 2014
	2012	spring	91	35		Huang et al., 2014a
	2010	summer		33	4.0	Feng et al., 2014
	2011	summer		25	3.0	
	2011-2012	summer		20	2.4	Zha et al., 2014
	2010	autumn		35	4.2	Feng et al., 2014
	2011	autumn		25	3.0	
	2011-2012	autumn		14	1.7	Zha et al., 2014
	2010	winter		35	4.2	Feng et al., 2014
	2010-2011	winter	293	66		Xu et al., 2012a
	2011	winter		31	3.7	Feng et al., 2014
	2011-2012	winter		22	2.7	Zha et al., 2014
	2012	winter	289	28		Han et al., 2015
Nanjing	2009	autumn	697			Kang et al., 2013
Rural studies						
Lin'an	2013	spring	223			Zhang et al., 2015b
	1999	autumn	353	23		Xu et al., 2002

Table S3-c: Summary of aerosol scattering and absorption coefficient in Perl River Delta of China

Location	Period	Annual/seasonal	b_{sp} (Mm^{-1})	b_{ap} (Mm^{-1})	BC ($\mu g\ m^{-3}$)	References
Urban studies						
Guangzhou	2009-2010	annual	326			Tao et al., 2014c
	2004	annual		90	10.9	Wu et al., 2009
	2005	annual		74	8.9	
	2006	annual		64	7.7	
	2007	annual		51	6.2	
	2009	spring	243			Tao et al., 2014c
	2009	summer	95			
	2006	summer	212	47		Jung et al., 2009
	2006	summer		39	4.7	Verma et al., 2010
	2008	summer		84		Wu et al., 2013
	2008	summer		53		
	2009	autumn	473			Tao et al., 2014c
	2004	autumn	418	91		Andreae et al., 2008
	2010	winter	469			Tao et al., 2014c
	2008-2009	winter		189		Wu et al., 2013
	2008-2009	winter		73		
Hong Kong	1998	spring	39	16		Man and Shih, 2001
	1998	summer	8	5		
	1998	autumn	71	19		
	2010	autumn/winter	202	40		Gao et al., 2015
	1997-1998	winter	65	26		Man and Shih, 2001
	1998-1999	winter	97	31		
Dongguan	2008	summer		47		Wu et al., 2013
	2008-2009	winter		96		
Shenzhen	2011	summer		25	4.0	Lan et al., 2013
Rural studies						
Maofeng moutain	2008	summer		26		Wu et al., 2013

	2008-2009	winter		29		
Xinken	2004	autumn	333	70		Cheng et al., 2008a
	2004	autumn	301	61		Cheng et al., 2006b
	2008-2009	winter		119		Wu et al., 2013
Backgarden	2006.7	summer	200	43		Garland et al., 2008
Hok Tsui	2000.6-2005.5	annual		20	2.4	Cheng et al., 2006a

Table S3-d: Summary of aerosol scattering and absorption coefficient in other regions of China

Location	Period	Annual/seasonal	b_{sp} (Mm^{-1})	b_{ap} (Mm^{-1})	BC ($\mu g\ m^{-3}$)	References
Urban studies						
Shouxian	2008	annual	401	29		Fan et al., 2010
Chengdu	2011	annual	456	96		Tao et al., 2014b
		spring	431	120		
		summer	318	79		
		autumn	488	98		
		winter	619	89		
Chengdu	2014-2015	annual	421	37		Wang et al., 2017a
		spring	254	28		
		summer	236	18		
		autumn	447	41		
		winter	725	60		
Chongqing	2014-2015	annual		45		
		spring		28		
		summer				
		autumn		48		
		winter		67		
Xi'an	2012	summer/autumn	272	31		Zhu et al., 2015
	2009	annual	525	83		Cao et al., 2012a
		spring	434	73		
		summer	455	58		
		autumn	606	107		
		winter	657	104		
Remote studies						
Dunhuang,Gansu	2004	spring	126			Yan, 2007
	2004	winter	303			
Dongsheng, Inner Mongolia	2004	spring	183			
	2004	winter	304			

Yulin,Shanxi	2001	spring	158	6		Xu et al., 2004
Zhangye,Gansu	2008	spring	159	10		Li et al., 2010

Table S4: Summary of aerosol hygroscopic parameters in China

Location	Period	Methods	Empirical formula	a	b		References
Urban studies							
Beijing	autumn, 2007	Method1	$1+a\times(RH/100)^{b}$	8.80	9.70		Liu et al., 2013b
	autumn, 2011			4.34	6.72		Liu et al., 2013c
	autumn, 2014			3.79	6.10		Yang et al., 2015
Guangzhou	summer, 2006	Method1		2.06	3.60	Urban aerosol	Liu et al., 2008
				3.26	3.85	Mixed aerosol	
				2.68	4.92	Marine aerosol	
	summer/autumn, 2010	Method3	$((1-RH/100)/0.9)^{-a(RH/100)}$	0.54		Internal mixed	Lin et al., 2014
				0.51		External mixed	
Rural studies							
Baodi, Tianjin	spring, 2006	Method2	$1+a\times(RH/100)^{b}$	0.64	5.17	Dust	Pan et al., 2009
				1.20	6.07	Clean	
				2.30	6.27	Polluted	
Wuqing, Tianjin	winter, 2010	Method2	$a\times(1-RH/100)^{-b(RH/100)}$	1.02	0.21		Chen et al., 2014b
Lin'an, Zhejiang	spring, 2013	Method2	$1+a\times(RH/100)^{b}$	1.24	5.46	Locally polluted	Zhang et al., 2015b
				1.20	3.90	Northly polluted	
				1.02	4.51	Dust influenced	
Wanqingsha, Guangzhou	autumn, 2004	Method3	$((1-RH/100)/0.9)^{-a(RH/100-0.1)}$	0.72			Cheng et al., 2008b

Method1: measures simultaneously dry and wet b_{sp} using nephelometer and visibility meter, respectively;

Method2: measures wet b_{sp} by integrating nephelometer equipped with a humidifier;

Method3: estimates dry and wet b_{sp} based on Mie theory with size-resolvedchemical components.

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