

Supporting information

PM_{2.5} Characteristics in Qingdao and across Coastal Cities in China

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Table S1. Brief introduction of PM_{2.5} sampling and analyses in coastal cities from Northern to Southern China.

Location	Sampling Dates	Sampling Description	Chemical Species	OC & EC method	References
Tianjin 1	Aug, Sept, Oct, Nov and Dec 2006	urban (Atmospheric Boundary Layer Observation Station)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		[1]
Tianjin 2	3–20 Jan and 3 Jun–30 Jul 2003	urban (Nankai University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[2,3]
Tianjin 3	1–25 Jan, 1–25 Apr, 1–25 Jul and 1–25 Oct 2008	urban (Atmospheric Boundary Layer Gradient Observation Station)	OC and EC	TOR	[4]
Qingdao 1	Spring, summer, autumn and winter 1997–2000	suburban (Gaokeyuan Monitoring Station)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		[5]

Qingdao 2	3–20 Jan and 3 Jun–30 Jul 2003	urban (Chinese Ocean University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[2,3]
Qingdao 3	Spring, summer, autumn and winter 2006–2007	urban (Debao Garden Hotel)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TTP ¹	Present study
Shanghai 1	5 May 1999–20 Mar 2000	urban (Hainan Road)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[6]
	20 Mar 1999–27 Mar 2000	urban (Tongji University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	
Shanghai 2	4 Sept–10 Oct 2003, 9 Mar–20 Apr, 15 Jul–16 Aug 2004 and 24 Nov 2004–4 Jan 2005	urban (Fudan University and Taopu)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		[7]
Shanghai 3	3–20 Jan and 3 Jun–30 Jul 2003	urban (Donghua University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC		[2,3]
Shanghai 4	Autumn and winter 2005, spring and summer 2006	urban (Yan-chang campus of Shanghai University in Zha-bei district)	OC and EC	TOR	[8]
	Autumn and winter 2005, spring and summer 2006	suburban area (the Environmental Monitoring Station (EMS) of Jia-ding district)	OC and EC	TOR	
Shanghai 5	12–27 Apr, 1–21 Aug, 13–29 Oct 2006, 5–21 Jan 2007	urban (Fudan University)	OC and EC	TOR	[9]
Shanghai 6	Jan, Apr, Jul, Oct 2008	urban (Xujiahui)	OC and EC	TOR	[10]
	Jan, Apr, Jul, Oct 2008	urban (Baoshan)	OC and EC	TOR	

Hangzhou 1	Apr 2004–Mar 2005	urban (HJ)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		[11]
	Apr 2004–Mar 2005	urban (MZ)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		
	Apr 2004–Mar 2005	urban (JK)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		
Hangzhou 2	3–20 Jan and 3 Jun–30 Jul 2003	urban (Hangzhou Environmental Monitoring Station)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺		[2,3]
Taizhou	4–13 Jul 2006 and 7–15 Jan 2007	urban (LQ)	OC and EC	TOT	[12]
Fuzhou	Spring, summer, autumn, winter Apr 2007–Jan 2008	urban	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[13]
Xiamen 1	Jun 2009–May 2010	peri-urban (Jimei University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOT	[14]
Xiamen 2	3–20 Jan and 3 Jun–30 Jul 2003	urban (Xiamen University)	OC and EC	TOR	[3]
Guangzhou 1	8 Jan–8 Feb and Jun–Jul 2002	urban (Zhongshan University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[15-17]
		urban (Huangpu)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	
Guangzhou 2	3–20 Jan and 3 Jun–30 Jul 2003	urban (Zhongshan University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[2,3]
Shenzhen 1	8 Jan–8 Feb. and Jun–Jul 2002	urban (Luohu)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[15-17]
Shenzhen 2	Summer and winter 2004	urban	OC and EC	TOR	[18]
Zhuhai	8 Jan–8 Feb 2002	urban (Xiangzhou)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC	TOR	[15-17]

			and EC		
Hong Kong 1	Nov 2000–Feb and Jun–Aug 2001	urban (Polytechnic University)	OC and EC	TMO ²	[19]
	Nov 2000–Feb and Jun–Aug 2001	urban (Kwun Tong)	OC and EC	TMO	
Hong Kong 2	6 Jan–8 Feb and Jun–Jul 2002	urban (Polytechnic University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[15-17]
	6 Jan–8 Feb and Jun–Jul 2002	urban (Baptist University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	
Hong Kong 3	3–20 Jan and 3 Jun–30 Jul 2003	urban (Hong Kong Polytechnic University)	SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , OC and EC	TOR	[2,3]
Hong Kong 4	21 Jan–29 Feb and 1 Mar–31 May 2004	urban (Polytechnic University)	OC and EC	TOR	[20]

¹TTP, two-step thermal procedure;

²TMO, selective thermal manganese dioxide oxidation.

Table S2. The concentrations of SO₄²⁻, NO₃⁻ and NH₄⁺ in coastal 10 cities in China during 1997-2010.

Location	Sampling Dates	Sampling Description	PM _{2.5} , µg/m ³	SO ₄ ²⁻ , µg/m ³	NO ₃ ⁻ , µg/m ³	NH ₄ ⁺ , µg/m ³	References
Tianjin 1	Aug. 2006	urban (Atmospheric Boundary Layer Observation Station)	103.90	31.41	9.02	4.42	[1]
	Sep. 2006		125.00	14.50	7.22	3.81	
	Oct. 2006		131.10	11.02	7.60	5.81	
	Nov. 2006		129.40	15.00	10.72	7.00	
	Dec. 2006		217.40	29.85	14.61	14.31	
Tianjin 2	3-20 Jan. 2003	urban (Nankai University)	203.10	32.50	25.50	22.20	[2]
	3 Jun.-30 Jul.2003		101.70	22.10	8.70	7.70	
Qingdao 1	Spring 1997-2000	suburban (Gaokeyuan Monitoring Station)	43.56	11.94	3.40	5.79	[5]
	Summer 1997-2000		47.91	12.26	2.54	5.37	
	Autumn 1997-2000		38.15	11.60	3.05	3.93	
	Winter 1997-2000		56.88	16.10	9.04	8.13	
Qingdao 2	3-20 Jan. 2003	urban (Chinese Ocean University)	134.80	21.10	19.30	15.30	[2]
	3 Jun.-30 Jul.2003		27.30	6.70	1.80	1.60	
Qingdao 3	Spring 2006-2007	urban (Debao Garden Hotel)	70.110	14.605	9.291	8.173	This study
	Summer 2006-2007		42.774	14.024	2.903	6.157	
	Autumn 2006-2007		98.553	25.909	9.621	13.619	
	Winter 2006-2007		109.518	19.513	12.576	12.288	
Shanghai 1	5 May 1999-20 Mar. 2000	urban (Hainan Road)	67.60	14.56	6.30	6.07	[6]

	Summer				35.85	9.32	4.76	3.34	
	Autumn				67.78	14.31	5.12	6.59	
	Winter				93.91	19.22	10.10	8.09	
	5 May 1999-20 Mar. 2000	urban (Tongji University)			62.40	13.48	5.77	5.67	
	Spring				61.66	12.60	5.41	5.53	
	Summer				36.80	10.01	2.92	3.49	
	Autumn				64.77	13.55	5.12	6.26	
	Winter				88.57	17.78	9.64	7.38	
Shanghai 2	9 Mar. -20 Apr. 2004	urban (Fudan University)			134.77	11.73	9.05	4.05	[7]
	15 Jul. -16 Aug. 2004	urban (Fudan University)			71.66	5.43	2.59	2.44	
	4 Sep. -10 Oct. 2003	urban (Fudan University)			96.38	8.70	3.70	3.60	
	6:00–17:00 Nov.2004-4 Jan. 2005	24 urban (Taopu)			76.09	12.79	8.53	4.38	
	17:00–6:00 Nov.2004-4 Jan. 2005	24 urban (Taopu)			89.16	13.06	6.96	4.36	
	Annual 2003-Jan. 2005	Sep.			94.64	10.39	6.23	3.78	
Shanghai 3	3-20 Jan. 2003	urban (Donghua University)			139.40	21.60	17.50	14.50	[2]
	3 Jun.-30 Jul.2003	urban (Donghua University)			54.00	12.00	2.60	3.50	

Hangzhou 1	Apr. 2005	2004-Mar.						
	Spring	urban (HJ)		121.80	19.55	7.78	8.48	[11]
	Summer	urban (HJ)		72.90	13.80	3.40	5.01	
	Autumn	urban (HJ)		119.00	16.87	8.02	7.86	
	Winter	urban (HJ)		144.90	17.07	11.44	10.00	
	Spring	urban (MZ)		120.70	16.99	9.03	10.80	
	Summer	urban (MZ)		70.90	15.61	4.76	6.99	
	Autumn	urban (MZ)		113.30	17.99	8.16	10.29	
	Winter	urban (MZ)		136.00	15.48	10.75	11.92	
	Spring	urban (MZ)		105.80	18.12	8.69	10.81	
	Summer	urban (JK)		75.40	14.24	5.53	6.98	
	Autumn	urban (JK)		110.40	22.31	11.77	11.62	
	Winter	urban (JK)		127.90	14.82	10.31	11.55	
Hangzhou 2	3-20 Jan. 2003	urban (Hangzhou Monitoring Station)	Environmental	177.30	33.40	25.70	19.10	[2]
	3 Jun.-30 Jul.2003	urban (Hangzhou Monitoring Station)	Environmental	80.00	16.50	5.50	5.30	
Fuzhou	Spring 2007-Jan. 2008	Apr.	urban	49.78	10.14	4.60	2.49	[21]
	Summer 2007-Jan. 2008	Apr.		23.58	6.62	1.10	1.32	
	Autumn 2007-Jan. 2008	Apr.		44.14	11.59	3.13	3.91	

	Winter 2007-Jan. 2008	Apr.	59.81	14.78	8.77	7.86	
Xiamen 1	Jun. 2009	suburban (Jimei University)	58.61	6.88	2.54	2.22	[22])
	Jul. 2009		61.05	7.22	2.69	3.16	
	Aug. 2009		67.13	7.27	4.02	2.76	
	Sep.2009		75.14	9.85	4.32	3.62	
	Oct. 2009		82.34	9.54	4.71	3.87	
	Nov. 2009		93.76	11.53	5.37	4.09	
	Dec 2009		109.17	19.83	9.95	6.79	
	Jan. 2010		108.16	17.67	13.15	9.17	
	Feb. 2010		109.39	16.03	9.41	7.03	
	Mar.2010		99.16	11.12	7.26	4.09	
	Apr. 2010		92.67	10.13	5.37	4.01	
	May. 2010		77.33	7.59	3.72	3.64	
	Average		86.16	11.22	6.04	4.54	
Guangzho u 1	8 Jan.-8 Feb. 2002	urban (Zhongshan University)	90.50	15.00	10.20	3.90	[15]
		urban (Huangpu)	104.00	12.90	4.70	1.90	
	Jun.-Jul. 2002	urban (Zhongshan University)	66.30	15.70	2.90	0.60	
		urban (Huangpu)	101.70	22.40	4.70	2.70	
Guangzho u 2	3-20 Jan. 2003	urban (Zhongshan Uiversity)	110.20	20.60	11.50	8.50	[2]
	3 Jun.-30 Jul.2003		39.70	6.40	1.20	1.20	

Shenzhen 1	8 Jan.-8 Feb. 2002	urban (Luohu)	60.80	13.00	4.40	2.00	[15]
	Jun.-Jul. 2002		47.10	8.70	2.50	0.40	
Zhuhai	8 Jan.-8 Feb. 2002	urban (Xiangzhou)	59.30	17.10	8.60	4.50	[15]
	Jun.-Jul. 2002		31.00	11.20	1.40	1.00	
Hongkong 2	6 Jan.-8 Feb. 2002	urban (Polytechnic University)	60.40	10.70	6.10	2.80	[15]
		urban (Baptist University)	48.50	8.10	4.20	1.50	
	Jun.-Jul. 2002	urban (The Hong Kong Polytechnic University)	40.10	9.10	1.70	1.80	
		urban (Baptist University)	30.80	5.70	1.50	0.10	
Hongkong 3	3-20 Jan. 2003	urban (Hong Kong Polytechnic University)	88.37	21.40	9.50	8.00	[2]
	3 Jun.-30 Jul.2003	urban (Hong Kong Polytechnic University)	30.40	4.30	1.20	0.30	

Table S3. The concentrations of OC and EC in coastal 10 cities in China during 1997-2010.

Location	Sampling Dates	Sampling Description	Analytical method	PM _{2.5} , µg/m ³	OC,µg/m ³	EC,µg/m ³	References
Tianjin 2	3-20 Jan. 2003	urban (Nankai University)	TOR	179.4	38.9	8.5	[3]
	3 Jun.-30 Jul. 2003		TOR	103.2	16.5	3.7	
Tianjin 3	1-25 Apr. 2008	urban(Atmospheric Boundary Layer Gradient Observation Station)	TOR	107.50	14.40	5.30	[4]
	1-25 Jul. 2008		TOR	87.00	10.20	5.51	
	1-25 Oct. 2008		TOR	111.00	20.20	6.52	
	1-25 Jan. 2008		TOR	133.70	22.90	5.63	
Qingdao 2	3-20 Jan. 2003	urban (Chinese Ocean University)	TOR	127.9	26.6	6.3	[3]
	3 Jun.-30 Jul. 2003		TOR	30.1	5	1.4	
Qingdao 3	Spring 2006-2007	urban (Debao Garden Hotel)	TTP	70.110	9.286	1.515	This study
	Summer 2006-2007			42.774	3.415	0.848	
	Autumn 2006-2007			98.553	15.266	3.081	
	Winter 2006-2007			109.518	22.061	2.963	
Shanghai 1	5 May 1999-20	urban (Hainan Road)	TOR	67.6	15.43	6.77	[6]

	Mar.2000						
	Summer		TOR	35.85	13.07	5.71	
	Autumn		TOR	67.78	17.28	6.97	
	Winter		TOR	93.91	17.59	8.07	
	20 Mar.1999-27Mar.2000	urban (Tongji University)	TOR	62.4	14.34	6.21	
	Spring		TOR	61.66	16.1	5.27	
	Summer		TOR	36.8	9.62	4.61	
	Autumn		TOR	64.77	15.22	6.81	
	Winter		TOR	88.57	16.4	8.16	
Shanghai 3	3-20 Jan. 2003	urban (Donghua University)	TOR	151.1	28.6	8.3	[3]
	3 Jun.-30 Jul. 2003		TOR	52.2	13.3	2.9	
Shanghai 4	Autumn 2005	urban (Yan-chang campus of Shanghai University in Zha-bei district)	TOR	106.4	21.8	3.9	[8]
	Winter 2005		TOR	93.4	16.7	2.3	

	Spring 2006		TOR	113.5	14.1	3.1	
	Summer 2006		TOR	50.2	7.2	1.9	
	Autumn 2005	suburban area (the Environmental Monitoring Station (EMS) of Jia-ding district)	TOR	113.3	25.8	3.8	
	Winter 2005		TOR	88	16.1	2.3	
	Spring 2006		TOR	113.1	16.4	3.3	
	Summer 2006		TOR	66.9	11.4	2.7	
Shanghai 5	12-27 Apr. 2006	urban (Fudan University)	TOR	47.3	8.4	3.7	[9]
	1-21 Aug. 2006		TOR	15.1	3.8	1.1	
	13-29 Oct. 2006		TOR	36.1	6.5	2.1	
	5-21 Jan. 2007		TOR	65.4	10.9	4.4	
Shanghai 6	Apr. 2008	urban (Xujiahui)	TOR	62.14	7.14	4.06	[10]
		urban (Baoshan)	TOR	105.15	11.28	4.96	
	Jul. 2008	urban (Xujiahui)	TOR	44.02	5.53	3.41	

		urban (Baoshan)	TOR	72.8	8.94	3.99	
	Oct. 2008	urban (Xujiahui)	TOR	71.47	7.8	3.49	
		urban (Baoshan)	TOR	78.46	11.59	4.66	
	Jan. 2008	urban (Xujiahui)	TOR	84.65	13.18	4.93	
		urban (Baoshan)	TOR	97.68	16.02	5.13	
Hangzhou 2	3-20 Jan. 2003	urban (Hangzhou Environmental Monitoring Station)	TOR	168.6	30.6	9.3	[3]
	3 Jun.-30 Jul. 2003		TOR	90.6	17.1	3.6	
Taizhou	4-13 Jul. 2006	urban (LQ)	TOT	37.55	7.75	2.77	[4]
	7-15 Jan. 2007	urban (LQ)	TOT	108.91	22.08	5.59	
Fuzhou	Spring 2007-Jan. 2008	Apr. urban (Wusibei Gulou Distric, Ziyang Jin'an District)	TOR	49.78	10.47	2.08	[13]
	Summer 2007-Jan. 2008	Apr.	TOR	23.58	5.28	1.95	
	Autumn 2007-Jan. 2008	Apr.	TOR	44.14	7.71	2.15	
	Winter 2007-Jan. 2008	Apr.	TOR	59.81	10.54	2.51	
Xiamen 1	Jun.-Aug.2009	peri-urban (Jimei university)	TOT	62.26	9.65	2.2	[22]

	Sep.-Nov. 2009		TOT	83.75	14.03	3.02	
	Dec.2009-Feb.2010		TOT	108.91	23.61	4.24	
	Mar.-May2010		TOT	89.72	13.63	2.25	
Xiamen 2	3-20 Jan. 2003	urban (Xiamen University)	TOR	70.2	16.5	5	[3]
	3 Jun.-30 Jul.2003		TOR	25.2	4.8	1.4	
Guangzhou 1	8 Jan.-8 Feb. 2002	industrial (Huangpu)	TOR	104	23.3	11	[16]
		urban (Zhongshan University)	TOR	90.5	17.8	6	
	Jun.-Jul. 2002	urban (Huangpu)	TOR	101.7	20	7.9	[17]
		urban (Zhongshan University)	TOR	66.3	13.1	4.6	
Guangzhou 2	3-20 Jan. 2003	urban (Zhongshan Uiversity)	TOR	156	41.1	14.5	[3]
	3 Jun.-30 Jul.2003		TOR	49.1	10.6	3.2	
Shenzhen 1	8 Jan.-8 Feb.2002	urban (Luohu)	TOR	60.8	13.20	6.1	[16]
	Jun-Jul 2002	urban (Luohu)	TOR	47.1	7.60	4.2	[17]
Shenzhen 2	Summer 2004	urban	TOR	34.9	7.2	2.1	[18]
	Winter 2004	urban	TOR	99	20.3	12.7	
Zhuhai	8 Jan.-8 Feb. 2002	urban (Xiangzhou)	TOR	59.3	12.2	5	[16]

	Jun.-Jul. 2002	urban (Xiangzhou)	TOR	31	5.4	1.9	[17]
Hongkong 1	Nov. 2000-Feb. 2001	urban (Polytechnic University)	TMO ²	50.92	9.45	5.8	[19]
		urban (Kwun Tong)	TMO	57.38	10.16	5.05	
	Jun.-Aug. 2001	urban (Polytechnic University)	TMO	32.71	7.96	6.12	
		urban (Kwun Tong)	TMO	28.73	5.61	4.33	
Hongkong 2	6 Jan.-8 Feb. 2002	urban (Polytechnic University)	TOR	60.4	10.6	6.1	[3]
		urban (Baptist University)	TOR	48.5	8.4	4.4	
	Jun.-Jul. 2002	urban (Polytechnic University)	TOR	40.1	6.3	3.9	[17]
	Jun.-Jul. 2002	urban (Baptist University)	TOR	30.8	5.6	3.2	
Hongkong 3	3-20 Jan. 2003	urban (Polytechnic University)	TOR	64	11.2	5.8	[3]
	3 Jun.-30 Jul. 2003	urban (Polytechnic University)	TOR	40.1	7.3	3.6	
Hongkong 4	21 Jan.-29 Feb. 2004	urban (Polytechnic University)	TOR	54.1	13.2	11	[23]
	1 Mar.-31 May 2004	urban (Polytechnic University)	TOR	51.5	10	12.7	

¹TTP, two-step thermal procedure;

²TMO, selective thermal manganese dioxide oxidation.

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