Guangdong-Hong Kong-Macao
Pearl River Delta
Regional Air Quality Monitoring Network

A Report of Monitoring Results in 2015

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Approved by	**:**	**Quality Management Committee of Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network**
Security Classification	**:**	**Unrestricted**

Purpose of the Report

This report provides the 2015 monitoring results from the Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network and their statistical analysis.

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1. Foreword

Since the Pearl River Delta (PRD) Regional Air Quality Monitoring Network came into operation on 30 November 2005, a half-yearly and an annual air quality monitoring reports were published every year since 2006.

In view of the needs of air pollution control and economic development of the region, the environmental protection departments of Guangdong and Hong Kong have worked in collaboration with the environmental protection cum meteorological authority of Macao to enhance the network by extending the coverage of monitoring area to the 3 places, i.e. Guangdong, Hong Kong and Macao, in September 2014. The enhancement include the increase of number of monitoring station from 16 to 23 to further improve the spatial distribution; and the addition of two more monitoring parameters, i.e. carbon monoxide (CO) and fine suspended particulates ($PM_{2.5}$), to enrich the air quality monitoring information. The network was accordingly renamed "Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network" (the "Network").

In conjunction with the enhancement of the Network, the update of national ambient air quality standards and the increase of reporting frequency of monitoring results, starting from 2014, we report real time monitoring data of the Network on an hourly basis through a new internet platform and publish a quarterly air quality monitoring report to replace the previous half-yearly report and continue publishing the annual air quality monitoring report. The quarterly report is mainly a brief statistical summary of the monitoring results of the regional air quality in a quarter while the annual report, in addition to the reporting of the relevant data, will provide a more detailed analysis and comparison of the condition of air quality in the year.

2. Introduction to Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network

The PRD Regional Air Quality Monitoring Network was jointly established by the Guangdong Provincial Environmental Monitoring Centre (GDEMC) and the Environmental Protection Department of the Hong Kong Special Administrative Region (HKEPD) from 2003 to 2005. The network came into operation on 30 November 2005 and its data have been used for reporting Regional Air Quality Index (RAQI) to the public. At that time, the network comprises 16 automatic air quality monitoring stations (see Figure 1) across the PRD region. Ten of these stations were operated by the Environmental Monitoring Centres of the individual cities in Guangdong while the three stations located in Hong Kong were managed by the HKEPD. The remaining three regional stations were operated by the GDEMC. All stations were installed with equipment to measure the ambient concentrations of respirable suspended particulates (PM_{10} or RSP), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3).

The network was enhanced in September 2014 and renamed "Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network". The number of monitoring station was increased from 16 to 23 that Guangdong, on its original 13 stations, added 5 stations, including Modiesha and Zhudong in Guangzhou, Duanfen and Huaguoshan in Jiangmen, and Xijiao in Huizhou. Hong Kong added Yuen Long monitoring station on the basis of its original 3 stations and Macao joined in with the monitoring station at Taipa Grande. As regards the monitoring parameters, the Network continues to monitoring the original 4 air pollutants with the addition of two new

monitoring parameters, i.e. carbon monoxide (CO) and fine suspended particulates ($PM_{2.5}$). Figure 2 shows the spatial distribution of the monitoring stations including the newly added stations.

The Network employs the existing "Standard Operating Procedures on Quality Assurance and Quality Control of the PRD Air Quality Monitoring System for Hong Kong and Guangdong" (QA/QC Operating Procedures) jointly developed by Guangdong and Hong Kong to ensure that the air quality monitoring results attain a high degree of accuracy and reliability. The design and operation of the Network comply with the requirements set out in the QA/QC Operating Procedures. In light of the development of the Network, the QA/QC Operating Procedures will be appropriately revised.

Figure 1：Spatial distribution of monitoring stations (Nov 2005 to Sep 2014)

Figure 2：Spatial distribution of monitoring stations in the Network

To cope with the enhancement of the Network and the update of national ambient air quality standards, the internet platform has increased the data reporting frequency from the previous daily RAQI to hourly dissemination of real time air quality monitoring information of each monitoring station.

The objectives of the Network are to:

- provide accurate air quality data that can help the Guangdong Provincial, Hong Kong and Macao SAR governments to appraise the air quality situation and pollution problems in the PRD region for formulating appropriate control measures;
- evaluate the effectiveness of the air pollution control measures through long-term monitoring;
- provide the public with information on the air quality of various places in the region.

This is an annual report of monitoring results in 2015, which covers fully the monitoring results of 6 monitoring parameters recorded at 23 monitoring stations of the Network.

Annexes A and B set out, respectively, the site information of the monitoring stations and the methods used for measuring air pollutant concentrations.

3. Operation of the Network

Owing to the extensive renovation work at the Tap Mun monitoring station in Hong Kong, the station was temporarily suspended from 30 November 2015.

The operation of the Network was generally smooth in 2015, the average hourly data capture rates of all monitoring stations in the Network was 96.2%, excluding the data of Tap Mun station in December 2015.

3.1 Quality Control (QC) and Quality Assurance (QA) Activities

The governments of Guangdong, Hong Kong, and Macao have fully implemented the agreed QA/QC programme, which include zero/span checks, precision checks, dynamic calibration, etc., in accordance with the QA/QC Operating Procedures so as to ensure that the air quality data from the monitoring stations are highly accurate and reliable. To ensure the operation of the Network in compliance with the QA/QC requirements, the GDEMC, HKEPD, Environmental Protection Bureau of Macau SARG and Meteorological and Geophysical Bureau of Macao SARG jointly established the "Quality Management Committee of Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network" (Quality Management Committee, the "QMC") to review, on a quarterly basis, the set-up of the Network, its performance in QA/QC and the operation of its data transmission system. The QMC also conducts system audit once a year to evaluate the effectiveness of the quality management system. The QMC prepares a report summarizing the findings of the system audit including the deficiencies found, and take appropriate corrective measures.

3.2 Accuracy and Precision

The accuracy of the Network is assessed by means of performance audits. The performance goals set for the gaseous pollutants and suspended particulates (PM_{10} and $PM_{2.5}$) are ±20% and ±15% respectively, these limits are similar to those of the United States Environmental Protection Agency and other international standards. In 2015, we have carried out 451 audit checks on the analyzers and samplers at the monitoring stations of the Network. The results showed that, based on the 95% probability limits, the accuracy of the Network varied between -9.2% and 10.2% and was within the specified performance goals (see Figure 3).

Precision is a measure of repeatability and is calculated in accordance with the QA/QC Operating Procedures. The performance goals adopted for the gaseous pollutants and suspended particulates (PM_{10} and $PM_{2.5}$) are ±15%. In 2015, we have carried out 3482 precision checks on the analyzers and samplers at the monitoring stations of the Network. The results showed that, based on the 95% probability limits, the precision of the Network varied between -7.8% and 10.9% and was within the specified performance goals (see Figure 4). Overall, the QA/QC performance of the monitoring network was good in 2015, and met all the requirements specified in the QA/QC Operating Procedures.

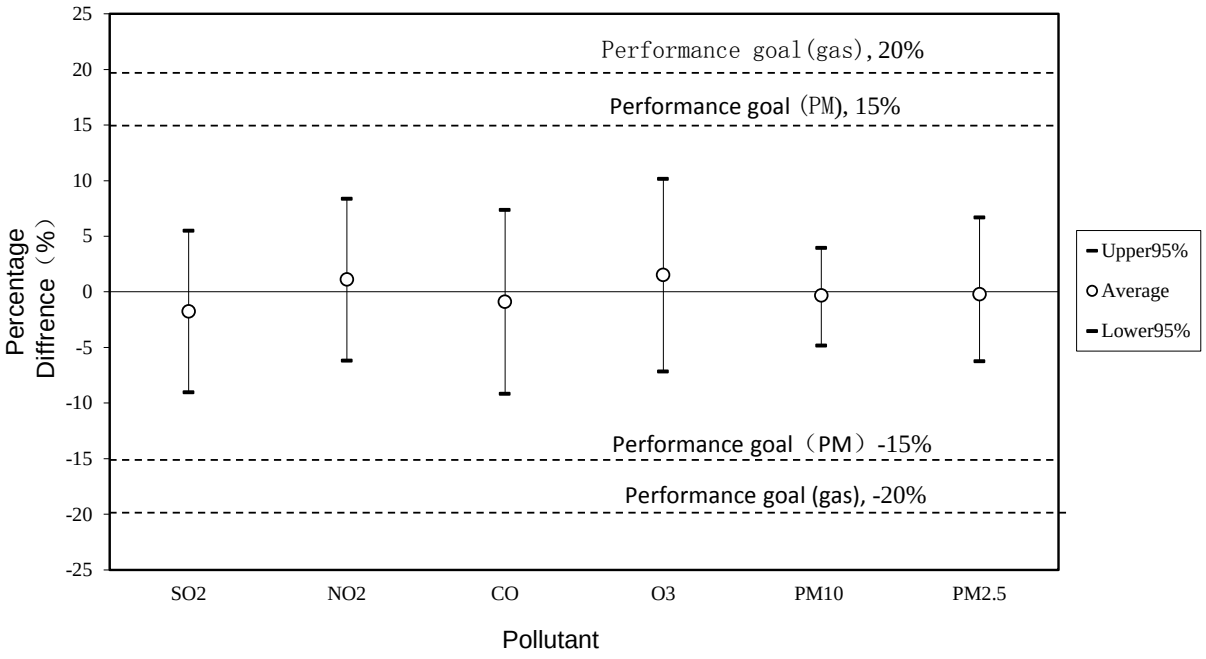

Figure 3：Accuracy of the monitoring network in 2015

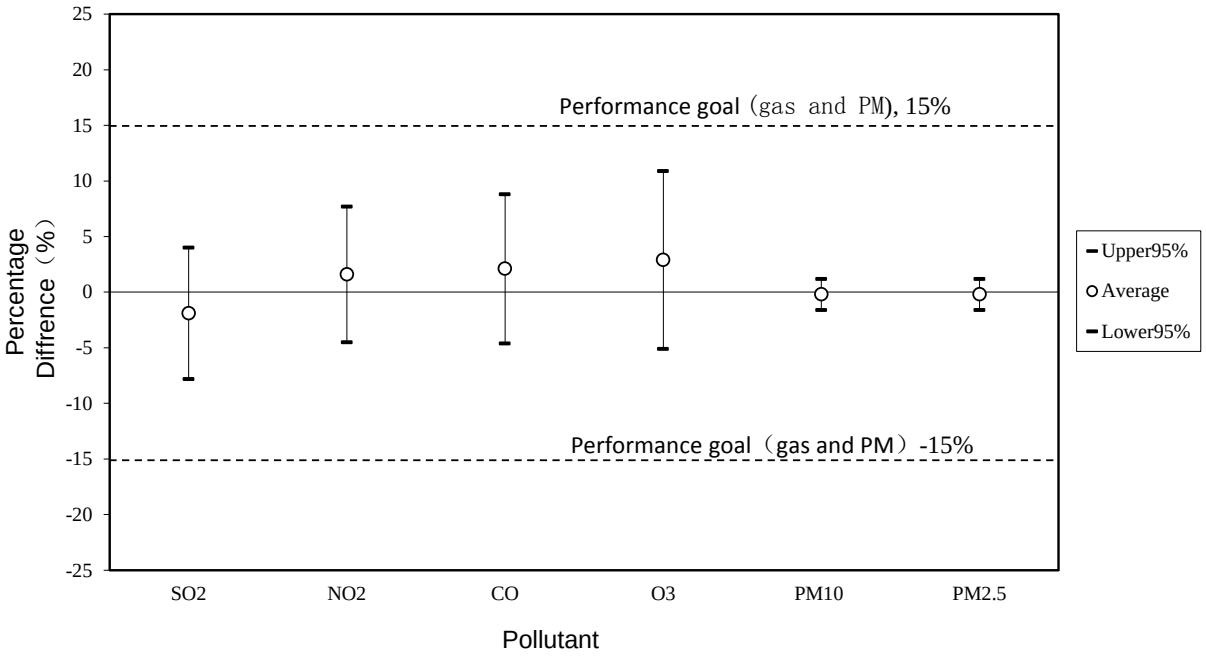

Figure 4：Precision of the monitoring network in 2015

4. Statistical Analysis of Pollutant Concentrations

Starting from 2014 annual report, the air quality assessment is conducted in reference to the class II limits of the national "Ambient Air Quality Standards" (NAAQS) (GB3095-2012).

4.1 Sulphur Dioxide (SO_2)

Sulphur dioxide (SO_2) comes mainly from the combustion of sulphur-containing fossil fuel. Its major sources of emissions include power plants, fuel combustion plants, vehicles and vessels. Apart from its impact on the human respiratory system, SO_2 can also be oxidized in the air to form sulphate, which has significant impact on the levels of particulate matters, acid rain and visibility in the region.

The annual averages of SO_2 at various monitoring stations in the Network ranged from 7μg/m^3 to 24μg/m^3 in 2015; all were in compliance with the national annual air quality concentration limit (60 μg/m^3). As shown in Figure 5, the annual average concentrations of SO_2 in PRD were in general quite low.

During the year, all monitoring stations in the Network were in compliance with the national 24-hour average air quality concentration limit (150 μg/m^3) of SO_2. Except Chengzhong station of Zhaoqing city, other 22 stations recorded no exceedance of national 1-hour SO_2 concentration limit（500 μg/m^3）. Summary of the monthly maximum hourly and daily averages of SO_2 with the 98th percentile at various stations are in Table 4.1a and Table 4.1b, respectively. Summary of the monthly and annual averages of SO_2 at various stations are in Table 4.1c.

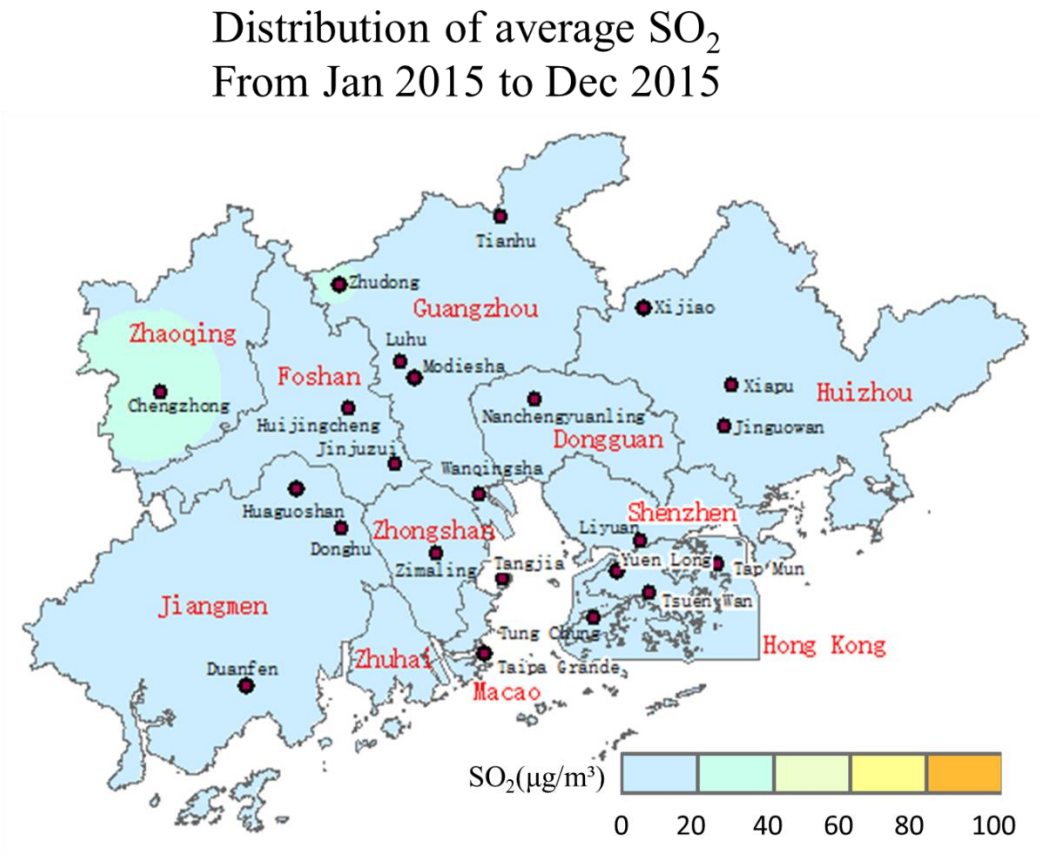

Figure 5：Spatial distribution of annual average concentrations of Sulphur Dioxide (SO_2)

Table 4.1a: Hourly averages of Sulphur Dioxide (the monthly maxima)

[Class II limit: 500 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	59	49	24	43	27	27	23	58	31	32	38	30
Modiesha (Guangzhou)	83	73	62	71	69	55	68	48	43	65	55	49
Wanqingsha (Guangzhou)	110	77	71	98	33	35	42	56	57	98	91	68
Tianhu (Guangzhou)	66	50	32	49	19	29	36	27	33	34	29	35
Zhudong (Guangzhou)	97	49	69	84	72	61	77	84	81	83	106	70
Liyuan (Shenzhen)	46	41	22	34	32	40	28	33	28	23	22	23
Jinjuzui (Foshan)	112	60	63	69	38	70	58	104	41	72	101	148
Huijingcheng (Foshan)	131	53	71	101	62	67	58	73	79	90	106	102
Tangjia (Zhuhai)	58	47	25	34	24	21	19	23	30	36	41	45
Donghu (Jiangmen)	116	145	74	78	47	40	66	59	53	111	68	64
Duanfen (Jiangmen)	75	49	38	41	21	9	27	25	20	37	45	42
Huaguoshan (Jiangmen)	126	51	70	155	65	50	78	93	308	95	125	70
Chengzhong (Zhaoqing)	186	130	52	304	568	216	245	203	124	249	168	159
Xiapu (Huizhou)	43	42	18	46	24	78	34	88	84	74	36	31
Xijiao (Huizhou)	89	59	75	181	64	76	42	430	48	72	94	54
Jinguowan (Huizhou)	39	45	23	29	26	21	51	47	41	66	27	32
Zimaling (Zhongshan)	98	54	67	45	26	39	37	37	99	68	46	93
Nanchengyuanling (Dongguan)	88	101	67	78	48	43	45	59	51	61	74	60
Tap Mun (Hong Kong)	51	32	20	27	25	26	26	29	23	24	25	-
Tsuen Wan (Hong Kong)	116	95	74	87	94	63	41	63	42	53	52	50
Yuen Long (Hong Kong)	66	39	35	33	26	48	39	38	28	40	35	31
Tung Chung (Hong Kong)	97	50	32	31	40	15	19	21	16	34	21	31
Taipa Grande (Macao)	93	43	115	93	63	33	106	70	51	31	73	54

Table 4.1b: Daily averages of Sulphur Dioxide (the monthly maxima and the 98th percentile)

[Class II limit: 150 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	98th percentile
Luhu (Guangzhou)	27	23	13	19	13	10	8	13	13	16	25	17	100%	22
Modiesha (Guangzhou)	43	32	31	34	24	21	15	21	18	27	26	22	100%	32
Wanqingsha (Guangzhou)	60	35	37	26	16	20	23	24	21	44	38	43	100%	42
Tianhu (Guangzhou)	37	33	16	33	13	16	20	14	18	18	18	20	100%	28
Zhudong (Guangzhou)	45	31	34	40	31	27	32	25	29	36	61	45	100%	39
Liyuan (Shenzhen)	21	25	12	17	10	15	14	16	16	12	9	15	100%	17
Jinjuzui (Foshan)	48	34	26	35	21	24	31	31	21	29	74	82	100%	44
Huijingcheng (Foshan)	63	34	46	45	27	36	27	29	27	40	62	45	100%	41
Tangjia (Zhuhai)	20	31	9	11	9	6	9	9	13	15	23	19	100%	18
Donghu (Jiangmen)	44	37	33	33	17	16	23	31	25	36	40	37	100%	36
Duanfen (Jiangmen)	39	31	17	18	11	3	12	8	3	17	26	25	100%	26
Huaguoshan (Jiangmen)	51	33	43	42	26	18	26	22	29	41	50	54	100%	43
Chengzhong (Zhaoqing)	46	29	31	65	71	61	50	53	44	63	55	46	100%	53
Xiapu (Huizhou)	26	23	9	16	10	22	15	18	26	21	23	19	100%	23
Xijiao (Huizhou)	29	21	24	22	22	24	18	80	19	23	27	25	100%	24
Jinguowan (Huizhou)	23	21	11	13	9	10	15	25	12	17	14	19	100%	18
Zimaling (Zhongshan)	33	26	21	18	9	11	13	17	20	25	25	32	100%	26
Nanchengyuanling (Dongguan)	49	36	39	31	26	19	20	23	25	28	28	33	100%	34
Tap Mun (Hong Kong)	15	16	10	12	8	10	10	12	13	16	12	-	100%	14
Tsuen Wan (Hong Kong)	39	37	41	34	35	31	22	21	19	19	18	19	100%	33
Yuen Long (Hong Kong)	22	21	15	17	15	18	16	18	16	17	17	19	100%	17
Tung Chung (Hong Kong)	41	28	18	18	19	6	8	11	11	11	12	14	100%	22
Taipa Grande (Macao)	39	21	35	24	19	9	18	14	13	16	17	15	100%	22

Table 4.1c：The monthly and annual averages of Sulphur Dioxide

[Class II limit for annual average: 60 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	15	10	13	10	7	6	5	8	8	8	11	8	9
Modiesha (Guangzhou)	23	16	15	18	13	13	7	7	10	15	16	12	14
Wanqingsha (Guangzhou)	32	17	14	15	9	8	9	12	14	23	22	25	17
Tianhu (Guangzhou)	15	15	10	13	7*	11	8	6	10	10	7	9	10
Zhudong (Guangzhou)	26	16	22	25	20	18	19	15	19	24	29	21	21
Liyuan (Shenzhen)	14	11	8	10	8	9	9	11	10	7	5	5	9
Jinjuzui (Foshan)	23	14	13	18	9	13	15	17	15	18	24	24	17
Huijingcheng (Foshan)	27	14	18	22	19	19	15	16	16	20*	27	21	19
Tangjia (Zhuhai)	11	12	4	4	5	3	4	4	6	7	8	11	7
Donghu (Jiangmen)	18	15	16	15	11	11	14	18	17	17	23	19	16
Duanfen (Jiangmen)	18	11	9	6	1	1	4	3	2	6	13	13	7
Huaguoshan (Jiangmen)	32	16	18	25	14*	9	16	10	20	25	29	25	20
Chengzhong (Zhaoqing)	27	19	19	31	33	27	22	24	20	24	25	16	24
Xiapu (Huizhou)	13	10	7	9	8	11	10	10	12	14	15	10	11
Xijiao (Huizhou)	16	8	10	13	12	15	10	12	11	17	18	16	13
Jinguowan (Huizhou)	12	9	6	8	7	7	8	10	8	9	9	9	9
Zimaling (Zhongshan)	18	10	9	9	7	7	5	7	9	14	14*	16	10
Nanchengyuanling (Dongguan)	27	17	15	16	12	11	12	13	13	17	17	15	15
Tap Mun (Hong Kong)	10	8	6	7	6	6	7	8	8	9	9	-	8**
Tsuen Wan (Hong Kong)	18	18	15	19	20	19	13	14	11	12	10	11	15
Yuen Long (Hong Kong)	11	9	7	10	8	8	8	10	9	10	9	11	9
Tung Chung (Hong Kong)	18	15	11	11	7	3	4	5	5	7	6	9	8
Taipa Grande (Macao)	16	11	10	11	4	4	7	7	6	7	7	7	8

Remark : All concentration units are in micrograms per cubic metre (μg/m^3).

* The average hourly monitoring data capture rate of certain pollutant is below 85%.

** The Tap Mun monitoring station was temporarily suspended from 30 November 2015. The annual average covered the period of January to November.

4.2 Nitrogen Dioxide (NO_2)

Nitrogen Dioxide (NO_2) is mainly formed from oxidization of nitric oxide (NO) emitted in the process of combustion. Its major emission sources include power plants, fuel combustion plants, vehicles and vessels. Apart from its impact on human respiratory system, NO_2 can also be oxidized in the air to form nitrate, which has significant impact on the levels of particulate matters, acid rain and visibility in the region.

The annual averages of NO_2 at various monitoring stations in the Network ranged from 9μg/m^3 to 64μg/m^3 in 2015, and 16 monitoring stations met the national annual air quality concentration limit (40 μg/m^3).

During the year, 7 monitoring stations in the Network recorded no exceedance of the national 24-hour average air quality concentration limit (80 μg/m^3) while the corresponding compliance rates in the Network ranged from 82.3% to 100%. 14 monitoring stations recorded no exceedance of national 1-hour NO_2 concentration limit （200 μg/m^3）. Summary of the monthly maximum hourly and daily averages with the 98th percentile, the monthly and annual averages of NO_2 at various stations are in Tables 4.2a to 4.2c, respectively.

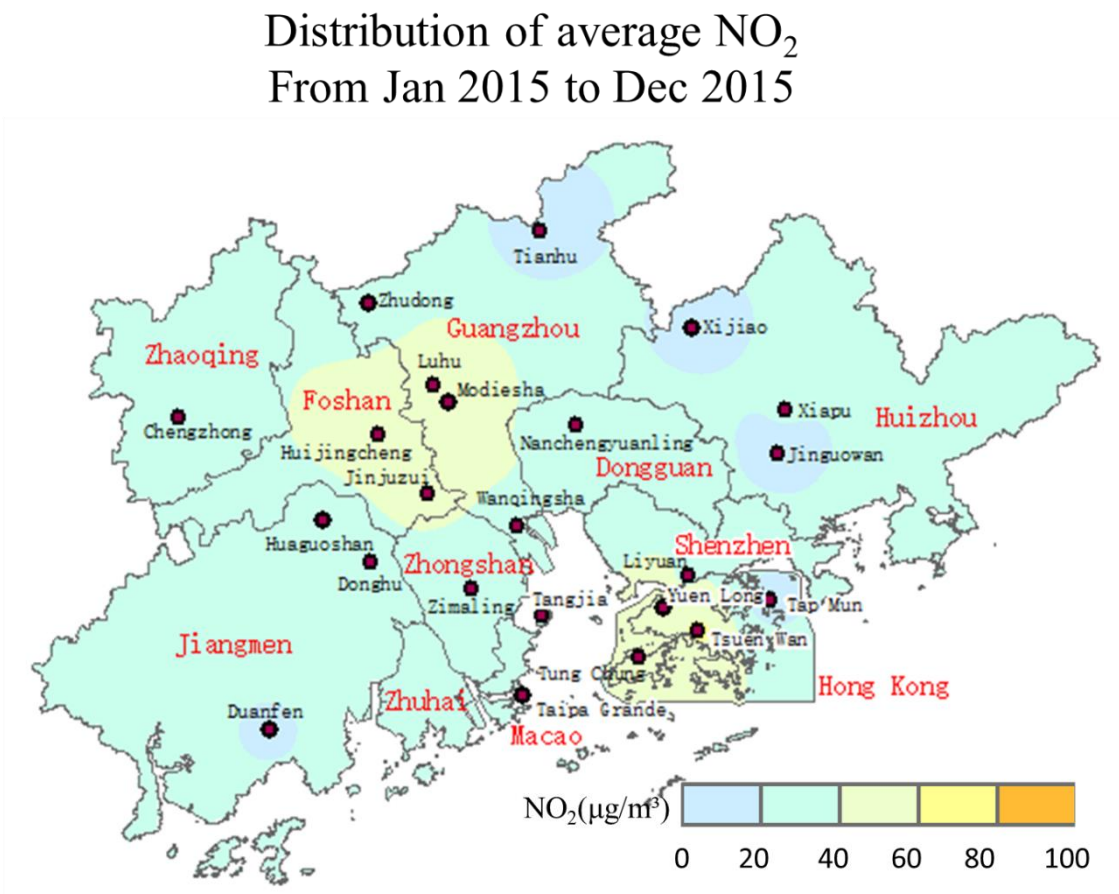

Figure 6：Spatial distribution of annual average concentrations of Nitrogen Dioxide (NO_2)

Table 4.2a：Hourly averages of Nitrogen Dioxide (the monthly maxima)

[Class II limit: 200 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	278	184	146	198	124	110	139	167	153	171	148	187
Modiesha (Guangzhou)	263	207	179	185	169	107	128	129	119	240	208	171
Wanqingsha (Guangzhou)	186	144	156	147	97	85	111	110	102	167	165	154
Tianhu (Guangzhou)	89	32	71	41	27	36	41	35	38	65	37	84
Zhudong (Guangzhou)	138	76	98	122	93	67	76	96	64	90	84	130
Liyuan (Shenzhen)	260	167	115	179	159	98	100	132	125	141	129	191
Jinjuzui (Foshan)	208	150	163	137	149	90	100	112	102	193	148	167
Huijingcheng (Foshan)	392	197	176	151	194	105	113	154	138	204	239	214
Tangjia (Zhuhai)	126	199	87	96	95	57	58	61	70	104	97	122
Donghu (Jiangmen)	166	129	104	143	99	73	76	78	94	131	155	141
Duanfen (Jiangmen)	74	88	100	64	25	16	47	39	28	49	120	127
Huaguoshan (Jiangmen)	138	173	112	100	80	54	68	59	63	115	139	189
Chengzhong (Zhaoqing)	136	91	109	91	126	59	63	82	84	126	121	138
Xiapu (Huizhou)	60	43	55	98	104	55	63	71	71	117	89	116
Xijiao (Huizhou)	56	56	50	50	39	46	46	34	37	32	40	42
Jinguowan (Huizhou)	64	78	38	60	44	46	54	69	42	42	37	51
Zimaling (Zhongshan)	148	119	136	103	103	55	67	51	57	116	121	151
Nanchengyuanling (Dongguan)	223	168	124	116	147	106	79	117	97	158	120	127
Tap Mun (Hong Kong)	93	106	37	66	60	38	46	66	47	52	41	-
Tsuen Wan (Hong Kong)	272	210	214	252	168	116	211	247	216	152	181	163
Yuen Long (Hong Kong)	364	201	161	192	147	63	119	160	120	146	178	174
Tung Chung (Hong Kong)	283	183	175	166	106	71	125	132	148	174	162	147
Taipa Grande (Macao)	179	135	108	134	134	60	68	77	84	105	82	67

Table 4.2b：Daily averages of Nitrogen Dioxide (the monthly maxima and the 98th percentile）

[Class II limit: 80 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	98th percentile
Luhu (Guangzhou)	175	105	68	81	75	74	71	57	81	92	68	105	93.0%	100
Modiesha (Guangzhou)	157	122	97	100	103	67	63	64	63	107	91	108	88.2%	107
Wanqingsha (Guangzhou)	104	92	94	57	56	47	46	53	50	88	74	92	96.6%	85
Tianhu (Guangzhou)	37	23	24	24	11	16	17	16	22	29	14	33	100%	27
Zhudong (Guangzhou)	95	51	60	63	57	30	36	44	38	43	53	72	99.7%	62
Liyuan (Shenzhen)	126	95	71	87	70	49	54	66	55	71	86	88	98.3%	72
Jinjuzui (Foshan)	131	100	94	89	89	58	54	56	54	91	86	94	92.3%	94
Huijingcheng (Foshan)	154	131	113	85	119	49	60	69	70	149	110	125	82.8%	121
Tangjia (Zhuhai)	69	59	65	40	49	25	36	32	29	38	61	77	100%	59
Donghu (Jiangmen)	96	93	68	64	59	34	47	46	47	79	96	105	96.6%	89
Duanfen (Jiangmen)	51	59	41	42	19	9	22	19	18	37	71	70	100%	51
Huaguoshan (Jiangmen)	83	82	70	68	40	30	35	29	35	56	91	95	98.4%	74
Chengzhong (Zhaoqing)	89	61	75	62	54	40	30	42	42	65	77	100	98.9%	77
Xiapu (Huizhou)	38	29	35	43	44	28	34	30	38	42	35	50	100%	38
Xijiao (Huizhou)	24	24	23	28	18	19	21	16	21	16	19	21	100%	24
Jinguowan (Huizhou)	31	37	19	30	24	29	23	29	18	16	22	21	100%	29
Zimaling (Zhongshan)	90	90	72	44	41	13	35	28	33	62	80	81	99.1%	72
Nanchengyuanling (Dongguan)	105	75	65	82	84	41	39	53	45	60	51	70	98.6%	75
Tap Mun (Hong Kong)	32	32	20	28	21	15	17	26	21	19	18	-	100%	25
Tsuen Wan (Hong Kong)	166	126	110	116	84	65	100	96	91	89	106	84	82.3%	109
Yuen Long (Hong Kong)	171	123	83	86	63	42	62	82	74	92	99	90	91.6%	92
Tung Chung (Hong Kong)	177	121	85	100	74	29	70	78	86	101	95	75	90.7%	95
Taipa Grande (Macao)	109	91	56	63	65	22	32	33	35	66	56	47	98.6%	76

Table 4.2c: The monthly and annual averages of Nitrogen Dioxide

[Class II limit for annual average: 40 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	74	55	44	46	44	41	38	43*	47	50	50	55	49
Modiesha (Guangzhou)	81	60	55	57	47	38	39	47	46	59	59	58	54
Wanqingsha (Guangzhou)	62	46	47	32	25	19	19	30	33	47	49	52	38
Tianhu (Guangzhou)	16	10	11	11	6*	10	9	8	11	5	5	10	9
Zhudong (Guangzhou)	42	29	36	37	28	20	21	25	22	28	32	28	29
Liyuan (Shenzhen)	53	40	37	43	36	30	33	44	33	37	35	44	39
Jinjuzui (Foshan)	74	49	52	46	36	20	27	39	39	53	53	48	45
Huijingcheng (Foshan)	80	49	62	46	48	27	36	46	46	72	71	66	54
Tangjia (Zhuhai)	40	35	32	25	21	15	17	19	19	18	27	37	25
Donghu (Jiangmen)	63	44	43	32	25	17	20	25	27	40	49	47	37
Duanfen (Jiangmen)	28	22	23	16	5	5	12	10	12	18	35	40	18
Huaguoshan (Jiangmen)	48	32	34	32	20*	14	17	18	20	37	52	48	31
Chengzhong (Zhaoqing)	46	27	36	30	31	19	16	25	28	38	37	40	31
Xiapu (Huizhou)	21	18	19	22	17	20	20*	22	21	21	21	24	21
Xijiao (Huizhou)	17	15	17	19	10	12	11	10	13	11	13	14	14
Jinguowan (Huizhou)	20	16	10	12	13	14	12	16	9	8	13	10	13
Zimaling (Zhongshan)	47	37	35	19	10	6	14	17	16	30	43*	45	26
Nanchengyuanling (Dongguan)	48	30	41	34	27	19	22	32	29	33	34	32	32
Tap Mun (Hong Kong)	15	15	11	14	9	8	8	13	9	8	8	-	11 **
Tsuen Wan (Hong Kong)	81	78	72	68	61	50	59	64	57	63	56	60	64
Yuen Long (Hong Kong)	77	63	50	48	37	27	35	47	42	53	50	54	48
Tung Chung (Hong Kong)	76	62	43	45	24	14	28	42	36	51	44	49	43
Taipa Grande (Macao)	62	46	41	31	17	10	16	20	22	31	33	33	30

Remark : All concentration units are in micrograms per cubic metre (μg/m^3).

* The average hourly monitoring data capture rate of certain pollutant is below 85%.

** The Tap Mun monitoring station was temporarily suspended from 30 November 2015. The annual average covered the period of January to November.

4.3 Ozone (O_3)

Ozone (O_3) is not directly emitted from emission sources. It is formed by the photochemical reaction of oxygen, nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the air under sunlight, and is one of the main components of photochemical smog. Ozone can cause irritation to the eyes, nose and throat. At elevated levels, it can increase a person's susceptibility to respiratory diseases and aggravate pre-existing respiratory diseases such as asthma.

The precursors of O_3 (NOx and VOCs) mainly originate from pollution sources in urban areas. However, as it usually takes several hours for O_3 to be formed and rise to its peak level, O_3 and its precursors can be transported to other areas downwind of their sources during this period. The concentrations of O_3 in downwind rural areas are therefore often higher than those in the urban areas.

In 2015, the annual averages of O_3 recorded by the Network ranged from 37μg/m^3 to 85μg/m^3 with higher average values being recorded in rural areas such as Tianhu of Guangzhou, Tap Mun of Hong Kong and Jinguowan of Huizhou, similar to the situation in previous years. During the year, one monitoring station in the Network was in compliance with the national daily maximum 8-hour average concentration limit (160 μg/m^3) while the corresponding compliance rates in the Network ranged from 83.1% to 100%. For the 90th percentile of the daily maximum 8-hour averages, 8 monitoring stations exceeded the limit. Except Tangjia station of Zhuhai city, other 22 stations recorded exceedance of 1-hour average O_3 concentration limit（200 μg/m^3）. Summary of the monthly maximum 1-hour, daily maximum 8-hour with the 90th percentile, the monthly and annual averages of O_3 at various stations are in Tables 4.3a to 4.3c, respectively.

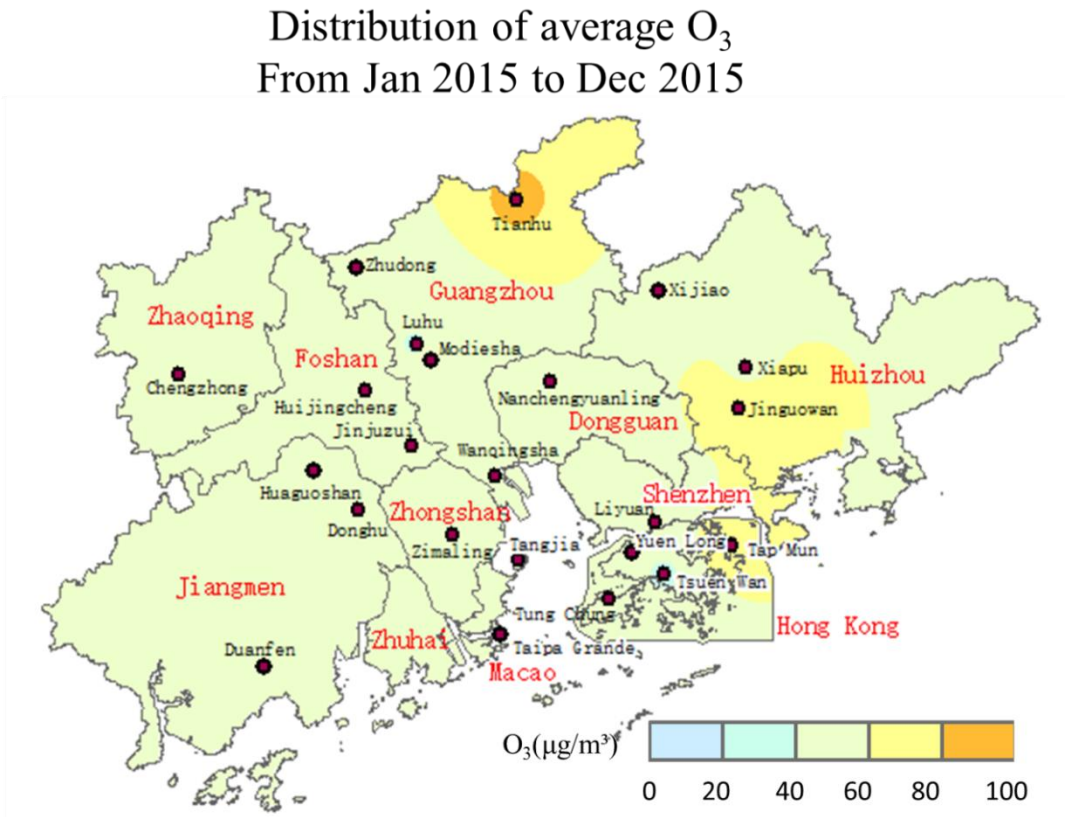

Figure 7：Spatial distribution of annual average concentrations of Ozone (O_3)

Table 4.3a: Hourly averages of Ozone (the monthly maxima) [Class II limit: 200 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	417	430	170	337	266	206	270	301	260	296	149	118
Modiesha (Guangzhou)	172	190	192	314	311	250	322	342	326	321	214	180
Wanqingsha (Guangzhou)	260	254	168	362	269	121	257	355	307	364	273	187
Tianhu (Guangzhou)	327	210	211	332	204	300	249	282	279	194	161	132
Zhudong (Guangzhou)	222	163	198	274	180	283	299	273	258	224	174	101
Liyuan (Shenzhen)	223	151	134	216	234	106	192	226	206	255	210	122
Jinjuzui (Foshan)	205	213	174	259	224	188	270	332	315	339	288	122
Huijingcheng (Foshan)	207	178	200	306	230	182	264	273	314	373	208	112
Tangjia (Zhuhai)	127	145	129	150	134	78	86	92	88	170	169	140
Donghu (Jiangmen)	226	176	164	256	119	86	218	279	266	314	205	133
Duanfen (Jiangmen)	225	217	160	215	215	83	232	322	146	316	208	131
Huaguoshan (Jiangmen)	224	162	204	285	271	99	301	194	173	353	238	97
Chengzhong (Zhaoqing)	179	150	144	187	488	191	255	272	285	266	297	143
Xiapu (Huizhou)	182	158	142	327	155	191	170	231	245	177	158	148
Xijiao (Huizhou)	221	191	253	336	222	237	209	233	293	158	133	140
Jinguowan (Huizhou)	242	218	186	396	159	174	198	244	240	187	194	142
Zimaling (Zhongshan)	184	155	104	227	215	130	225	273	288	325	234	145
Nanchengyuanling (Dongguan)	255	198	213	343	308	282	350	331	311	264	217	191
Tap Mun (Hong Kong)	237	172	166	216	160	93	252	333	307	233	233	-
Tsuen Wan (Hong Kong)	129	124	139	178	104	58	220	318	235	246	169	97
Yuen Long (Hong Kong)	149	131	132	264	199	69	231	390	231	260	220	93
Tung Chung (Hong Kong)	183	137	138	244	190	71	255	332	237	336	202	104
Taipa Grande (Macao)	239	214	153	250	220	76	235	287	249	325	219	119

Table4.3b：Daily maximum 8-hour averages of Ozone (the monthly maxima and the 90th percentile) [Class II limit: 160 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	90th percentile
Luhu (Guangzhou)	125	124	136	229	150	147	239	252	184	220	118	83	94.1%	147
Modiesha (Guangzhou)	144	155	152	244	169	152	260	278	270	257	179	120	89.6%	161
Wanqingsha (Guangzhou)	184	215	137	273	217	102	226	237	249	337	215	129	83.1%	193
Tianhu (Guangzhou)	265	205	206	301	161	284	222	246	256	180	141	111	83.2%	184
Zhudong (Guangzhou)	163	145	162	232	155	176	256	226	211	183	133	85	90.7%	157
Liyuan (Shenzhen)	166	120	123	162	161	73	167	180	163	206	167	104	96.0%	125
Jinjuzui (Foshan)	148	152	142	213	188	120	222	264	268	274	219	93	85.1%	178
Huijingcheng (Foshan)	131	142	159	273	148	128	227	234	274	239	152	79	88.7%	167
Tangjia (Zhuhai)	108	124	102	136	127	60	66	73	72	143	142	110	100%	100
Donghu (Jiangmen)	171	152	129	197	84	62	181	249	223	236	148	85	91.4%	152
Duanfen (Jiangmen)	196	181	148	197	189	80	199	277	134	263	162	110	91.4%	154
Huaguoshan (Jiangmen)	190	148	158	234	247	81	262	170	141	289	210	77	93.1%	144
Chengzhong (Zhaoqing)	123	138	126	167	169	132	236	234	248	222	239	87	91.2%	151
Xiapu (Huizhou)	151	141	118	255	113	164	159	200	206	163	119	120	95.6%	140
Xijiao (Huizhou)	168	163	187	271	158	184	177	207	235	148	103	96	92.3%	151
Jinguowan (Huizhou)	198	184	139	313	140	144	180	222	195	167	150	121	90.1%	160
Zimaling (Zhongshan)	134	128	92	192	168	80	206	239	231	272	177	96	89.0%	164
Nanchengyuanling (Dongguan)	181	172	162	255	199	172	259	272	260	218	162	148	83.2%	176
Tap Mun (Hong Kong)	187	165	157	198	144	85	186	274	273	221	176	-	88.7%	164
Tsuen Wan (Hong Kong)	105	107	124	126	88	40	161	216	161	165	120	80	98.0%	106
Yuen Long (Hong Kong)	109	113	115	173	153	60	194	281	176	206	139	78	96.0%	123
Tung Chung (Hong Kong)	113	125	130	175	122	66	225	260	185	231	126	95	92.8%	130
Taipa Grande (Macao)	163	168	137	213	186	67	214	252	232	271	161	94	90.1%	160

Table4.3c：The monthly and annual averages of Ozone

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	33	36	20	47	29	36	46	52	57	51	24	19	38
Modiesha (Guangzhou)	46	52	26	56	34	44	55	68	72	65	36	29	48
Wanqingsha (Guangzhou)	58	61	38	73	46	44	74	73	84	88	53	33	60
Tianhu (Guangzhou)	102	93	67	98	71*	91	83	98	106	107	53	50	85
Zhudong (Guangzhou)	51	52	31	59	47	56	66	53	65	60	33	27	50
Liyuan (Shenzhen)	50	52	46	49	43	32	50	46	69	79	65	41	52
Jinjuzui (Foshan)	41	47	25	60	40	42	66	67	78	69	39	23	50
Huijingcheng (Foshan)	35	46	20	66	28	43	59	66	69*	69	32	19	46
Tangjia (Zhuhai)	65	71	42	57	40	36	36	31	32	43	40	34	43
Donghu (Jiangmen)	46	47	26	51	27	26	33	57	68	55	28	20	40
Duanfen (Jiangmen)	72	72	51	68	56	43	65	66	26	56	55	35	55
Huaguoshan (Jiangmen)	51	48	25	69*	46*	36	58	50	46	56	33	20	44
Chengzhong (Zhaoqing)	48	51	30	59	56	59	64	70	70	69	43	26	54
Xiapu (Huizhou)	62	67	43	69	47	49	55	61	75	74	51	41	58
Xijiao (Huizhou)	63	62	45	61	55	60	61	59	63	55	39	38	55
Jinguowan (Huizhou)	94	89	64	88	63	51	58	62	78	77	55	45	69
Zimaling (Zhongshan)	33	40	27	56	37	37	58	56	74	77	43*	25	47
Nanchengyuanling (Dongguan)	49	65	40	71	51	52	68	75	86	74	50	34	59
Tap Mun (Hong Kong)	98	90	77	75	63	45	65	62	94	108	93	-	79**
Tsuen Wan (Hong Kong)	47	46	35	35	19	16	33	33	51	58	47	31	37
Yuen Long (Hong Kong)	40	43	36	43	29	24	44	38	57	58	42	23	40
Tung Chung (Hong Kong)	49	53	46	46	40	34	51	42	65	67	55	29	48
Taipa Grande (Macao)	54	68	51	57	49	41	59	59	75	87	54	26	56

Remark : All concentration units are in micrograms per cubic metre ($\mu g/m^3$).

* The average hourly monitoring data capture rate of certain pollutant is below 85%.

** The Tap Mun monitoring station was temporarily suspended from 30 November 2015. The annual average covered the period of January to November.

4.4 Respirable Suspended Particulates (PM_{10})

Respirable suspended particulates (PM_{10} or RSP) in the atmosphere come from a great variety of emission sources, such as power plants, vehicles, vessels, cement and pottery manufacturing, fugitive dust, etc. while some are products of oxidization of gaseous pollutants in the air (e.g. sulphate formed from oxidation of SO_2) or formed from photochemical reactions. PM_{10} can penetrate deeply into human lungs and cause impact on human respiratory system. Furthermore, finer particles in PM_{10} have significant effect on visibility.

In 2015, the annual averages of PM_{10} at various monitoring stations in the Network ranged from 38μg/m^3 to 64μg/m^3, and all monitoring stations met the national annual air quality concentration limit (70 μg/m^3).

During the year, 10 monitoring stations in the Network recorded no exceedance of the national 24-hour average air quality concentration limit (150 μg/m^3) while the corresponding compliance rates in the Network ranged from 97.4% to 100%. Summary of the monthly maximum daily averages of PM_{10} with the 95th percentile, the monthly and annual averages of PM_{10} at various stations are in Table 4.4a and Table 4.4b, respectively.

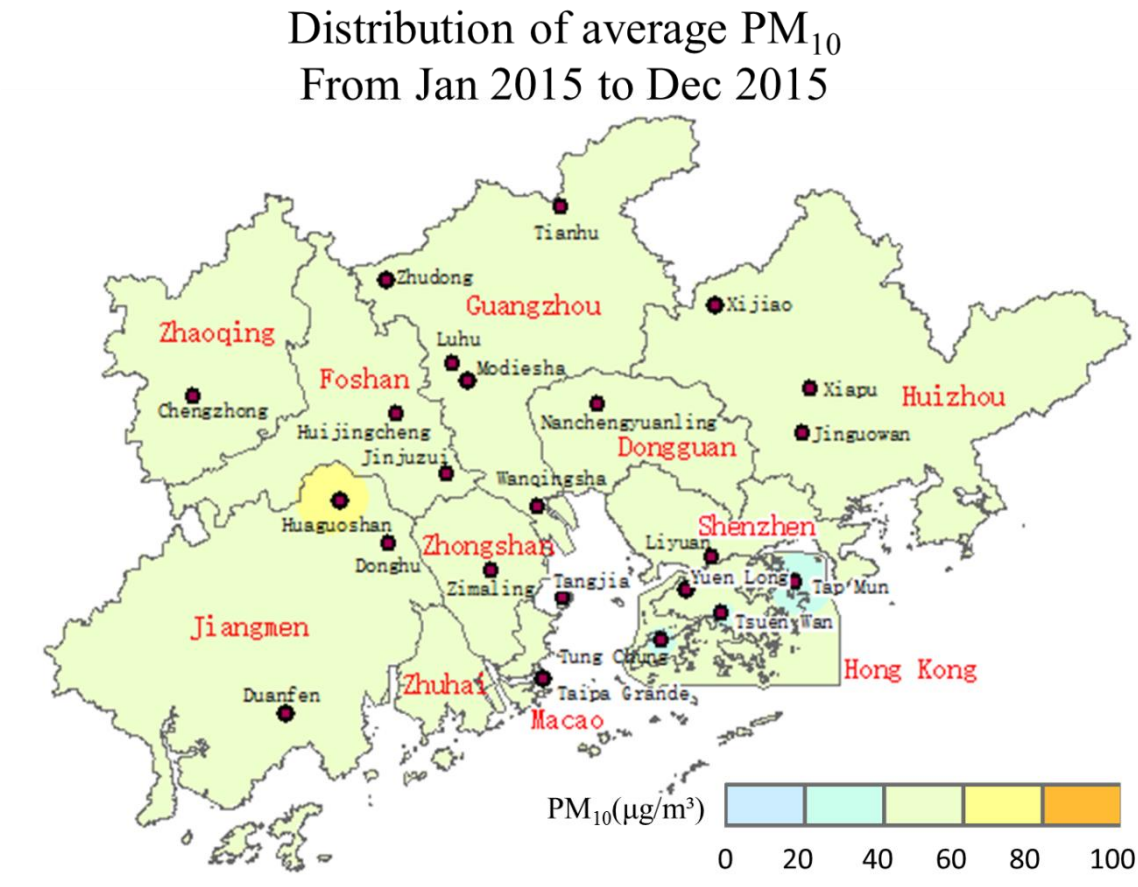

Figure 8: Spatial distribution of annual average concentrations of Respirable Suspended Particulates (PM_{10})

Table 4.4a：Daily averages of PM_{10} (the monthly maxima and the 95th percentile)

[Class II limit: 150 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	95th percentile
Luhu (Guangzhou)	169	136	118	106	73	51	119	95	87	126	99	171	99.2%	97
Modiesha (Guangzhou)	231	154	137	123	76	56	104	97	93	137	111	143	98.9%	119
Wanqingsha (Guangzhou)	142	143	113	87	49	41	82	91	74	113	101	96	100%	101
Tianhu (Guangzhou)	113	129	75	97	51	48	66	75	92	74	64	73	100%	89
Zhudong (Guangzhou)	164	145	93	122	65	47	93	92	94	103	85	147	98.9%	108
Liyuan (Shenzhen)	143	113	79	121	52	48	60	80	78	97	116	104	100%	84
Jinjuzui (Foshan)	157	144	142	113	58	42	72	70	81	125	123	152	99.2%	111
Huijingcheng (Foshan)	232	161	138	111	58	42	81	71	95	149	125	184	97.4%	125
Tangjia (Zhuhai)	140	126	72	99	41	28	45	86	90	104	114	111	100%	99
Donghu (Jiangmen)	167	160	158	108	69	44	74	115	83	143	132	135	98.8%	120
Duanfen (Jiangmen)	122	142	80	81	42	31	63	93	88	118	128	120	100%	103
Huaguoshan (Jiangmen)	193	168	141	140	70	49	94	103	106	165	131	154	97.4%	138
Chengzhong (Zhaoqing)	156	149	109	132	76	61	95	112	96	118	125	181	99.1%	116
Xiapu (Huizhou)	136	115	74	90	55	43	69	73	77	98	96	102	100%	90
Xijiao (Huizhou)	100	113	75	78	48	41	50	65	94	66	58	63	100%	73
Jinguowan (Huizhou)	107	122	74	72	52	37	71	70	78	89	73	74	100%	82
Zimaling (Zhongshan)	156	152	93	96	49	26	70	82	86	107	114	154	99.1%	96
Nanchengyuanling (Dongguan)	172	130	82	105	67	41	80	68	100	119	95	120	99.4%	100
Tap Mun (Hong Kong)	121	121	84	69	44	27	50	67	69	86	67	-	100%	86
Tsuen Wan (Hong Kong)	95	142	72	76	36	29	62	78	71	87	106	75	100%	77
Yuen Long (Hong Kong)	192	162	84	97	40	27	66	86	77	106	86	101	99.4%	103
Tung Chung (Hong Kong)	160	172	73	82	38	24	64	76	60	93	109	87	99.4%	87
Taipa Grande (Macao)	178	153	95	110	48	39	69	100	90	134	127	108	99.4%	111

Table 4.4b：The monthly and annual averages of PM_{10}

[Class II limit for annual average: 70 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	74	66	44	52	35	35	44	56	54	60	53	56	52
Modiesha (Guangzhou)	98	79	57	64	44	42	46	54	59	67	64	61	61
Wanqingsha (Guangzhou)	81	70	47	44	27	24	36	45	45	64	56	49	49
Tianhu (Guangzhou)	60	62	33	50	25*	31	34	41	49	45	34	36	42
Zhudong (Guangzhou)	89	75	50	64	39	38	41	55	55	57	48	48	55
Liyuan (Shenzhen)	64	60	44	45	32	37	31	40	42	54	44	48	46
Jinjuzui (Foshan)	84	71	52	52	32	26	37	43	49	62	59	58	53
Huijingcheng (Foshan)	104	80	52	53	33	29	38	44	49	78	67	70	58
Tangjia (Zhuhai)	72	69	34	40	21	18	24	38	43	63	49	48	43
Donghu (Jiangmen)	90	82	59	51	35	24	36	53	52	68	62	62	57
Duanfen (Jiangmen)	71	72	44	38	18	15	30	31	39	65	70	55	45
Huaguoshan (Jiangmen)	105	95	64	63*	36*	27	43	53	57	78	76	66	64
Chengzhong (Zhaoqing)	87	82	54	61	44	37	43	54	60	59	62	48	58
Xiapu (Huizhou)	70	61	38	49	34	31	38	46	50	58	53	46	48
Xijiao (Huizhou)	57	59	36	46	27	26	30	39	49	43	39	36	41
Jinguowan (Huizhou)	65	67	37	41	31	28	34	39	44	54	42	35	43
Zimaling (Zhongshan)	72	72	48	44	23	19	33	37	43	60	58*	55	47
Nanchengyuanling (Dongguan)	85	68	45	47	32	25	38*	49*	56	67	60	52	52
Tap Mun (Hong Kong)	74	65	36	33	26	18	26	31	35	47	37	-	38**
Tsuen Wan (Hong Kong)	58	72	45	36	24	18	26	34	35	46	41	42	39
Yuen Long (Hong Kong)	83	81	52	48	24	19	31	38	39	59	49	53	48
Tung Chung (Hong Kong)	68	75	41	37	21	15	27	30	29	43	39	49	39
Taipa Grande (Macao)	87	85	55	47	26	22	35	39	42	67	60	64	52

Remark : All concentration units are in micrograms per cubic metre (μg/m^3).

* The average hourly monitoring data capture rate of certain pollutant is below 85%.

** The Tap Mun monitoring station was temporarily suspended from 30 November, 2015. The annual average covered the period of January to November.

4.5 Fine Suspended Particulates ($PM_{2.5}$)

Fine suspended particulates ($PM_{2.5}$) in the atmosphere come from a great variety of combustion sources, such as the emissions from power plants and diesel vehicles exhaust while some are products of oxidization of gaseous pollutants in the air (e.g. sulphate formed from oxidation of SO_2) or formed from photochemical reactions. $PM_{2.5}$ have significant effect on visibility.

In 2015, the annual averages of $PM_{2.5}$ at various monitoring stations in the Network ranged from 24μg/m^3 to 40μg/m^3, and 18 monitoring stations met the national annual air quality concentration limit (35 μg/m^3).

During the year, 2 monitoring stations in the Network recorded no exceedance of the national 24-hour average air quality concentration limit (75μg/m^3) while the corresponding compliance rates in the Network ranged from 90.7% to 100%. Summary of the monthly maximum daily averages of $PM_{2.5}$ with the 95th percentile, the monthly and annual averages of $PM_{2.5}$ at various stations are in Table 4.5a and Table 4.5b, respectively.

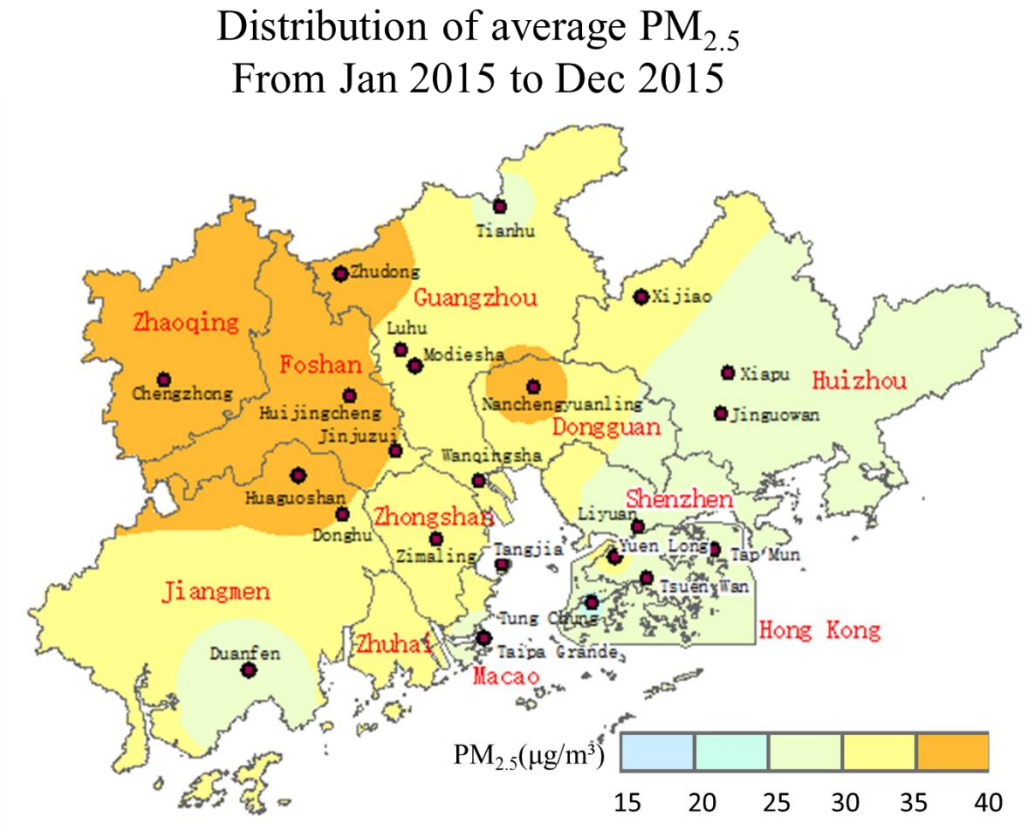

Figure 9：Spatial distribution of annual average concentrations of Fine Suspended Particulates ($PM_{2.5}$)

Table 4.5a: Daily averages of $PM_{2.5}$ (the monthly maxima and the 95th percentile)

[Class II limit: 75 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	95th percentile
Luhu (Guangzhou)	120	106	70	106	86	29	75	62	56	81	72	130	96.1%	71
Modiesha (Guangzhou)	131	97	70	82	58	33	69	57	58	73	56	87	96.9%	69
Wanqingsha (Guangzhou)	98	118	79	48	32	19	40	57	73	81	71	76	95.7%	73
Tianhu (Guangzhou)	78	104	54	61	26	28	50	53	56	53	47	60	99.1%	56
Zhudong (Guangzhou)	132	118	69	73	38	36	76	69	71	73	60	108	94.0%	77
Liyuan (Shenzhen)	104	98	42	62	36	17	42	52	52	64	81	64	98.6%	61
Jinjuzui (Foshan)	108	110	93	84	48	27	55	48	57	94	80	119	94.7%	76
Huijingcheng (Foshan)	161	134	86	88	58	26	64	60	50	101	75	124	92.1%	87
Tangjia (Zhuhai)	116	122	59	70	24	14	50	54	59	74	76	70	96.3%	72
Donghu (Jiangmen)	121	122	104	62	26	39	56	84	54	99	62	87	92.8%	84
Duanfen (Jiangmen)	77	106	49	50	22	14	44	56	69	79	73	77	97.7%	67
Huaguoshan (Jiangmen)	113	118	88	88	42	26	63	67	73	110	87	96	91.3%	86
Chengzhong (Zhaoqing)	122	126	89	100	49	37	65	74	66	81	81	82	90.7%	88
Xiapu (Huizhou)	69	67	43	52	43	30	49	52	67	59	58	68	100%	53
Xijiao (Huizhou)	85	99	63	59	35	36	46	53	75	57	49	53	98.6%	58
Jinguowan (Huizhou)	69	75	51	49	24	20	47	49	57	52	58	50	100%	52
Zimaling (Zhongshan)	118	130	77	69	31	24	57	62	71	89	88	114	93.1%	80
Nanchengyuanling (Dongguan)	130	110	74	84	54	29	51	55	71	89	70	95	96.1%	73
Tap Mun (Hong Kong)	84	107	46	46	28	15	44	51	49	55	42	-	97.6%	59
Tsuen Wan (Hong Kong)	92	120	54	52	22	13	49	55	48	66	81	54	98.1%	55
Yuen Long (Hong Kong)	138	134	59	68	25	14	51	56	53	80	65	53	95.4%	72
Tung Chung (Hong Kong)	107	137	43	54	22	12	48	49	38	71	84	56	97.8%	56
Taipa Grande (Macao)	115	125	54	67	27	12	49	62	57	84	79	70	95.6%	72

Table 4.5b：The monthly and annual averages of $PM_{2.5}$

[Class II limit for annual average: 35 μg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	49	48	29	37	26	17	26	35	35	39	34	40	34
Modiesha (Guangzhou)	56	49	30	32	22	17	22	30	33	37	30	34	33
Wanqingsha (Guangzhou)	58	54	32	25	15*	12	18	29	34	44	39	37	33
Tianhu (Guangzhou)	42	46	25	33	15	18	24	28	32	31	23	26	29
Zhudong (Guangzhou)	64	58	34	42	25	25	29	41	41	42	34	35	39
Liyuan (Shenzhen)	46	46	27	26	16	11	19	24	27	35	30	32	28
Jinjuzui (Foshan)	55	51	34	32	21	16	24	29	33	41	36	38	35
Huijingcheng (Foshan)	72	63	36	33	22	15	25	32	34	48	38	41	38
Tangjia (Zhuhai)	61	58	33	31	13	10	18	23	25	40	35	34	31
Donghu (Jiangmen)	67	61	36	28	15	14	25	32	32	39	29	36	35
Duanfen (Jiangmen)	43	48	27	22	9	6	16	18	24	41	38	32	27
Huaguoshan (Jiangmen)	59	69	37	37*	20*	14	26	33	35	47	44	39	37
Chengzhong (Zhaoqing)	64	66	42	41	28	22	26	36	40	40	40	32	40
Xiapu (Huizhou)	37	34	21	29	19	17	23	29	33	34	31	30	28
Xijiao (Huizhou)	47	48	28	33	20	19	24	30	38	34	31	29	32
Jinguowan (Huizhou)	41	42	23	26	16	15	19*	25	28	32	29	24	27
Zimaling (Zhongshan)	56	57	37	33	15	12	21	26	31	46	41*	40	34
Nanchengyuanling (Dongguan)	63	55	36	34	22	17	23	32	38	47	42	39	37
Tap Mun (Hong Kong)	53	48	25	20	14	10	17	22	24	31	20	-	26**
Tsuen Wan (Hong Kong)	41	51	30	22	12	8	15	22	22	31	26	28	26
Yuen Long (Hong Kong)	60	59	37	34	14	10	19	24	29	41	34	29	33
Tung Chung (Hong Kong)	43	48	25	21	11	7	15	19	18	28	24	32	24
Taipa Grande (Macao)	55	55	33	28	10	7	14	17	24	39	34	36	29

Remark : All concentration units are in micrograms per cubic metre (μg/m^3).

* The average hourly monitoring data capture rate of certain pollutant is below 85%.

** The Tap Mun monitoring station was temporarily suspended from 30 November 2015. The annual average covered the period of January to November.

4.6 Carbon Monoxide (CO)

Carbon Monoxide (CO) is formed when the fuel is not completely burned. Except for methane conversion, plant emissions, forest fires and other natural sources, deforestation, grassland and waste incineration, and the use of fossil fuels and civilian fuel are the main anthropogenic sources of CO. In most urban areas, the major emission source is automobiles.

The annual averages of CO at various monitoring stations in the Network ranged from 0.6 mg/m^3 to 1.1 mg/m^3 in 2015. During the year, all monitoring stations in the Network were in compliance with the national 1-hour and 24-hour daily concentration limits (10 mg/m^3 and 4mg/m^3). Summary of the monthly maximum hourly and daily averages with the 95th percentile, the monthly and annual averages of CO at various stations are in Tables 4.6a to 4.6c respectively.

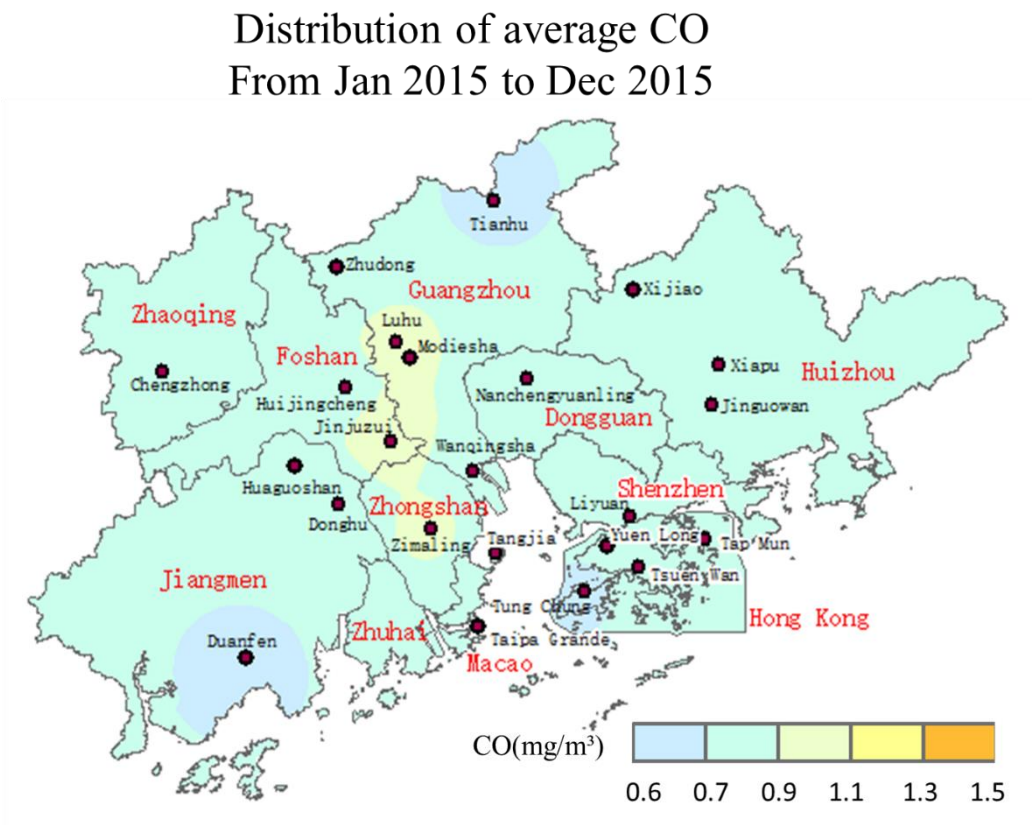

Figure 10：Spatial distribution of annual average concentrations of Carbon Monoxide (CO)

Table 4.6a: Hourly averages of CO (the monthly maxima) [Class II limit: 10 mg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	6.5	2.3	3.1	2.0	2.1	4.2	1.6	1.7	1.6	4.6	3.2	3.1
Modiesha (Guangzhou)	3.3	3.1	3.0	4.5	1.8	1.4	1.3	1.3	1.7	2.0	2.1	3.3
Wanqingsha (Guangzhou)	2.1	1.7	2.3	1.7	1.1	0.9	1.3	1.4	1.3	1.7	1.6	1.8
Tianhu (Guangzhou)	1.6	1.7	1.5	1.2	0.9	0.8	1.2	1.1	1.1	1.1	1.1	1.6
Zhudong (Guangzhou)	1.9	1.4	1.9	2.0	1.7	1.1	1.1	1.5	1.4	1.3	1.4	2.1
Liyuan (Shenzhen)	2.8	2.1	1.6	2.5	2.4	2.7	1.8	1.7	1.3	1.7	1.4	1.5
Jinjuzui (Foshan)	3.6	2.5	2.8	2.6	2.3	1.4	1.7	1.9	1.6	2.4	2.5	3.5
Huijingcheng (Foshan)	3.3	2.9	2.5	2.0	2.5	1.4	1.6	1.3	1.6	2.0	2.4	2.3
Tangjia (Zhuhai)	2.4	3.0	1.9	1.8	0.9	2.5	1.4	1.4	1.0	1.1	1.3	1.9
Donghu (Jiangmen)	3.1	3.2	3.0	2.3	1.7	1.6	1.5	1.3	1.7	2.9	3.8	3.5
Duanfen (Jiangmen)	1.8	1.7	1.4	1.2	0.9	0.9	1.1	1.2	1.7	1.4	1.4	1.8
Huaguoshan (Jiangmen)	2.6	2.2	1.9	1.4	1.5	1.3	1.5	1.3	1.6	1.5	1.8	2.6
Chengzhong (Zhaoqing)	3.1	4.3	3.3	2.4	2.5	1.8	1.5	1.9	2.8	2.2	2.1	4.0
Xiapu (Huizhou)	3.9	2.2	2.1	2.5	2.3	1.4	1.5	1.9	2.4	1.9	1.9	2.3
Xijiao (Huizhou)	1.9	2.1	1.9	1.8	2.0	1.6	1.5	1.3	1.5	1.4	1.8	1.8
Jinguowan (Huizhou)	1.6	1.5	1.5	4.2	1.2	1.7	1.1	1.5	1.1	1.3	1.3	1.4
Zimaling (Zhongshan)	2.7	3.5	2.8	2.7	1.8	1.4	1.5	1.5	2.5	1.8	2.8	2.6
Nanchengyuanling (Dongguan)	2.2	1.6	2.0	2.4	2.1	1.4	1.3	1.4	1.2	1.4	1.8	2.9
Tap Mun (Hong Kong)	2.3	1.3	1.0	1.3	0.8	0.7	1.2	1.2	1.1	1.2	1.4	-
Tsuen Wan (Hong Kong)	1.7	2.2	1.5	1.5	1.5	1.1	1.2	1.5	1.4	1.5	1.5	1.7
Yuen Long (Hong Kong)	2.6	2.0	1.6	1.6	1.2	0.8	1.1	1.3	1.1	1.3	1.3	1.7
Tung Chung (Hong Kong)	1.6	1.6	1.4	1.4	1.0	0.6	1.3	1.4	1.0	1.0	1.6	1.9
Taipa Grande (Macao)	1.9	2.0	1.4	2.0	1.1	0.6	1.1	1.7	1.0	1.2	1.5	2.0

Table4.6b：Daily averages of CO（the monthly maxima and the 95th percentile）

[Class II limit: 4 mg/m^3]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	95th percentile
Luhu (Guangzhou)	2.3	1.5	1.8	1.5	1.4	1.4	1.1	1.3	1.2	1.8	2	2.1	100%	1.7
Modiesha (Guangzhou)	1.9	1.4	1.9	2	1.3	1.1	0.9	1	1.4	1.4	1.5	2.1	100%	1.4
Wanqingsha (Guangzhou)	1.8	1.4	1.5	1.3	0.7	0.6	0.9	0.8	1.1	1.2	1.3	1.3	100%	1.2
Tianhu (Guangzhou)	1.4	1.2	1.2	0.9	0.7	0.6	0.9	0.9	0.9	0.8	1	0.9	100%	0.9
Zhudong (Guangzhou)	1.7	1.2	1.5	1.2	1.1	0.7	1	1.2	0.9	0.9	1.2	1.7	100%	1.2
Liyuan (Shenzhen)	1.6	1.5	1.2	1.5	1.2	0.8	0.9	1.3	1.1	1.2	1.2	1.1	100%	1.2
Jinjuzui (Foshan)	2.2	1.7	1.6	1.7	1.7	1.1	1.2	1.2	1.3	1.7	1.7	2.3	100%	1.6
Huijingcheng (Foshan)	2	1.4	1.8	1.2	1.5	0.9	1.1	0.9	1.1	1.4	1.6	1.6	100%	1.4
Tangjia (Zhuhai)	2.1	2.7	1.7	1.2	0.8	0.6	1.2	1.2	0.8	0.9	1	1.2	100%	1.6
Donghu (Jiangmen)	1.6	1.2	1.8	0.8	1	0.9	1	0.9	1	1.5	1.6	2.1	100%	1.4
Duanfen (Jiangmen)	1.3	1.2	1	0.9	0.7	0.4	0.8	0.8	0.8	1.1	1	1.5	100%	1.0
Huaguoshan (Jiangmen)	1.8	1.7	1.4	1.2	1.2	0.8	1.2	0.9	1.2	1.3	1.4	1.8	100%	1.3
Chengzhong (Zhaoqing)	1.8	2	2.4	1.2	1.4	1	1.1	1.2	1.3	1.1	1.4	2.7	100%	1.5
Xiapu (Huizhou)	1.6	1.5	1.3	1.2	1.3	1	1	1.2	1.1	1.3	1.4	1.3	100%	1.3
Xijiao (Huizhou)	1.2	1	1.5	1.5	1.2	0.7	0.7	0.6	0.8	1	1.2	1.4	100%	1.1
Jinguowan (Huizhou)	1.4	1	1.1	1.3	0.8	1.3	0.9	0.8	1	1.1	1.1	1.2	100%	1.0
Zimaling (Zhongshan)	1.9	2.9	2.1	1.5	1.3	1	1.1	1.2	1.2	1.3	2.4	2.1	100%	1.9
Nanchengyuanling (Dongguan)	1.7	1.2	1.2	1.3	1.6	1.1	1	1	0.9	0.9	1.1	1.6	100%	1.2
Tap Mun (Hong Kong)	1.2	1.1	0.8	1.2	0.7	0.7	1	1	0.9	1	1.1	-	100%	1.0
Tsuen Wan (Hong Kong)	1.4	1.4	1.2	1.3	1	0.8	1	1.1	1.1	1.2	1.3	1.5	100%	1.2
Yuen Long (Hong Kong)	1.8	1.4	0.9	1.2	0.9	0.6	0.9	0.8	0.7	0.9	0.8	1.3	100%	1.1
Tung Chung (Hong Kong)	1.2	1.1	1	1.2	0.8	0.5	1	1.1	0.9	0.9	1	1.5	100%	1.1
Taipa Grande (Macao)	1.5	1.7	1.3	1.6	1	0.5	0.8	0.9	0.8	0.9	1	1.3	100%	1.2

Table 4.6c: The monthly and annual averages of CO

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	1.4	1.3	1.1	1.0	0.9	0.9	0.7	1.0	0.8	0.9	1.2	1.2	1.0
Modiesha (Guangzhou)	1.2	1.1	1.3	1.1	0.8	0.6	0.7	0.6	0.8	0.8	1.2	0.9	0.9
Wanqingsha (Guangzhou)	0.9	0.9	0.8	0.8	0.5	0.4	0.6	0.6	0.7	0.8	0.8	0.7	0.7
Tianhu (Guangzhou)	0.7	0.7	0.6	0.6	0.4*	0.5	0.7	0.7	0.6	0.5	0.6	0.6	0.6
Zhudong (Guangzhou)	1.0	0.9	0.8	0.8	0.5	0.6	0.6	0.6	0.7	0.6	0.9	1.1	0.7
Liyuan (Shenzhen)	1.0	1.1	1.0	0.8	0.7	0.6	0.7	1.0	0.9	0.8	0.8	0.7	0.8
Jinjuzui (Foshan)	1.3	0.8	1.0	1.2	1.0	0.7	0.9	0.9	1.0	1.2	1.3	1.3	1.1
Huijingcheng (Foshan)	1.3	0.8	0.9	0.8	0.7	0.5	0.6	0.6	0.7	0.9	0.9	0.9	0.8
Tangjia (Zhuhai)	1.3	1.4	1.2	0.7	0.5	0.5	0.7	0.9	0.6	0.6	0.7	0.8	0.8
Donghu (Jiangmen)	0.9	0.8	0.8	0.4	0.4	0.4	0.5	0.6	0.8	1.0	1.0	1.2	0.7
Duanfen (Jiangmen)	0.8	0.8	0.7	0.5	0.4	0.3	0.5	0.5	0.5	0.7	0.7	0.9	0.6
Huaguoshan (Jiangmen)	1.3	1	0.9	0.9*	0.8*	0.5	0.8	0.7	0.9	0.9	0.9*	1.1	0.9
Chengzhong (Zhaoqing)	1.1	1.2	1.2	0.8	0.8	0.6	0.7	0.8	1.0	0.9	1.0	1.2	0.9
Xiapu (Huizhou)	1.2	1.0	0.9	0.9	0.9	0.7	0.8	0.9	0.9	0.9	1.2	0.9	0.9
Xijiao (Huizhou)	0.9	0.8	0.7	0.7	0.7	0.5	0.5	0.5	0.6	0.6	0.7	0.8	0.7
Jinguowan (Huizhou)	0.9	0.8	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.8	0.7
Zimaling (Zhongshan)	1.3	1.5	1.1	0.8	0.8	0.8	0.9	0.9	0.8	0.9	1.4*	1.3	1.0
Nanchengyuanling (Dongguan)	1.1	0.9	0.9	0.8	0.9	0.8	0.7	0.7	0.6	0.7	0.9	1.0	0.8
Tap Mun (Hong Kong)	0.8	0.7	0.6	0.8	0.5	0.6	0.7	0.7	0.7	0.7	0.8	-	0.7**
Tsuen Wan (Hong Kong)	0.9	1.1	1.0	0.9	0.7	0.6	0.7	0.8	0.9	1.0	0.9	1.0	0.9
Yuen Long (Hong Kong)	1.1	0.9	0.7	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.7	0.7
Tung Chung (Hong Kong)	0.7	0.6	0.6	0.6	0.5	0.4	0.6	0.7	0.5	0.6	0.7	0.9	0.6
Taipa Grande (Macao)	1.1	1.1	0.8	1.0	0.7	0.4	0.6	0.5	0.5	0.7	0.7	0.8	0.7

Remark : All concentration units are in milligrams per cubic metre (mg/m^3).
* The average hourly monitoring data capture rate of certain pollutant is below 85%.
** The Tap Mun monitoring station was temporarily suspended from 30 November 2015. The annual average covered the period of January to November.

4.7 Monthly Variations of Pollutant Concentrations

Figure 11 shows the monthly variations of the major pollutants (Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ozone (O_3), Respirable Suspended Particulates (PM_{10}), Fine Suspended Particulates ($PM_{2.5}$), and Carbon Monoxide (CO)) recorded by the Network in 2015. The overall concentrations of SO_2, NO_2, PM_{10}, $PM_{2.5}$, and CO were generally higher during the winter season (first and fourth quarters of the year) and relatively lower in the summer months. The lower pollutants levels in summer were mainly due to the relatively clean maritime air stream prevailed in the PRD region under the influence of southern monsoon together with heavier rainfall and higher mixing layer that favoured the dispersion of pollutants. As for ozone, higher monthly averages occurred in October because of more days with meteorological conditions that favoured photochemical reactions (such as strong solar radiation, less amount of clouds, low wind speed etc.) causing more ozone formation in the period.

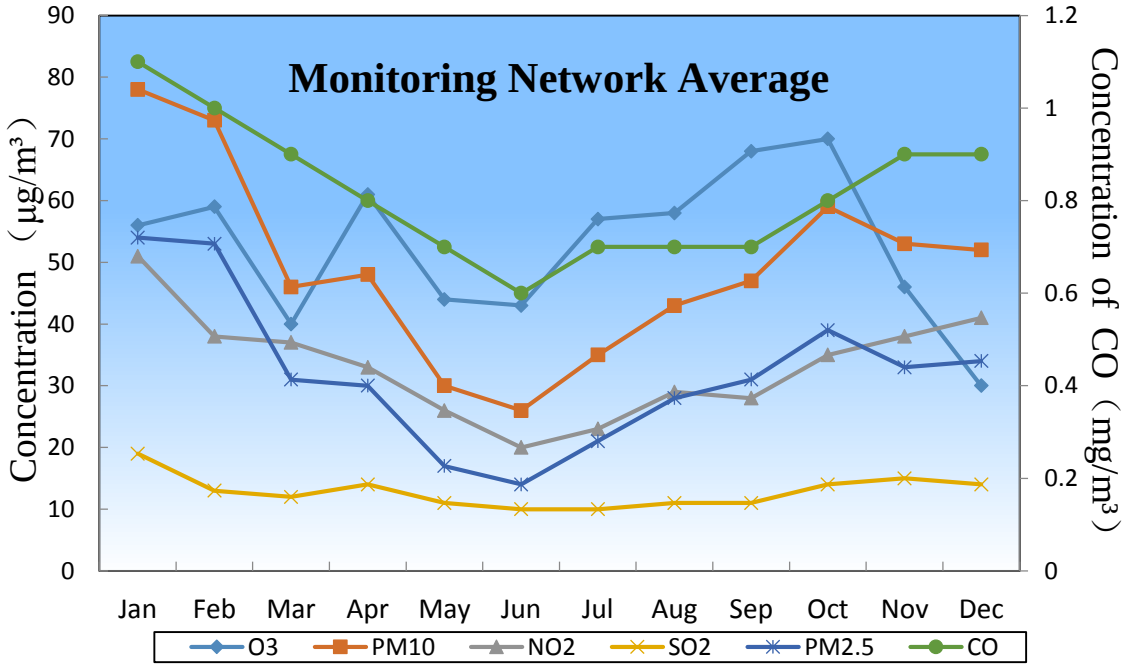

Figure 11：Monitoring network monthly variations of air pollutant concentrations

4.8 Annual Variations of Pollutant Concentrations (2006-2015)

Table 4.8 shows the annual average concentrations of air pollutants recorded by the Network from 2006 to 2015, while Figure 12 shows the trend of the annual pollutant concentrations by percentage changes. The trend of annual average concentrations of CO and $PM_{2.5}$ were not included here, as they were not regularly monitored before the enhancement of the network in September 2014.

From 2006 to 2015, the annual averages recorded by the Network for SO_2, NO_2, and PM_{10} decreased by 72%, 28% and 34% respectively, which exhibited an obvious downward trend with an annual descending rate of about 3.8, 1.4 and 2.8μg/m^3 respectively. These reductions indicate that the measures implemented in recent years by Guangdong, Hong Kong and Macao, including the retrofitting of power plants with flue-gas desulphurization facilities, formulating and tightening the vehicle emission standards, prohibiting import of heavy polluting vehicles, tightening the fuel specifications, and phasing out the more polluting industrial facilities in the PRD, etc., have brought improvements in the overall air quality in the PRD region. Moreover, the annual average of O_3 in 2015 decreased by 7% as compared with that in 2014, reflecting that the photochemical smog pollution in the region has been improved. The Guangdong, Hong Kong and Macao governments will continue to implement emission reduction measures to further improve the air quality in the region and tackle the photochemical pollution problem.

Table 4.8：Annual averages of the pollutants in the monitoring network

Year	SO_2 (μg/m^3)	NO_2 (μg/m^3)	O_3 (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	CO (mg/m^3)
2006	47	46	48	74	-	-
2007	48	45	51	79	-	-
2008	39	45	51	70	-	-
2009	29	42	56	69	-	-
2010	25	43	53	64	-	-
2011	24	40	58	64	-	-
2012	18	38	54	56	-	-
2013	18	40	54	63	-	-
2014	16	37	57	56	-	-
2015	13	33	53	49	32	0.8

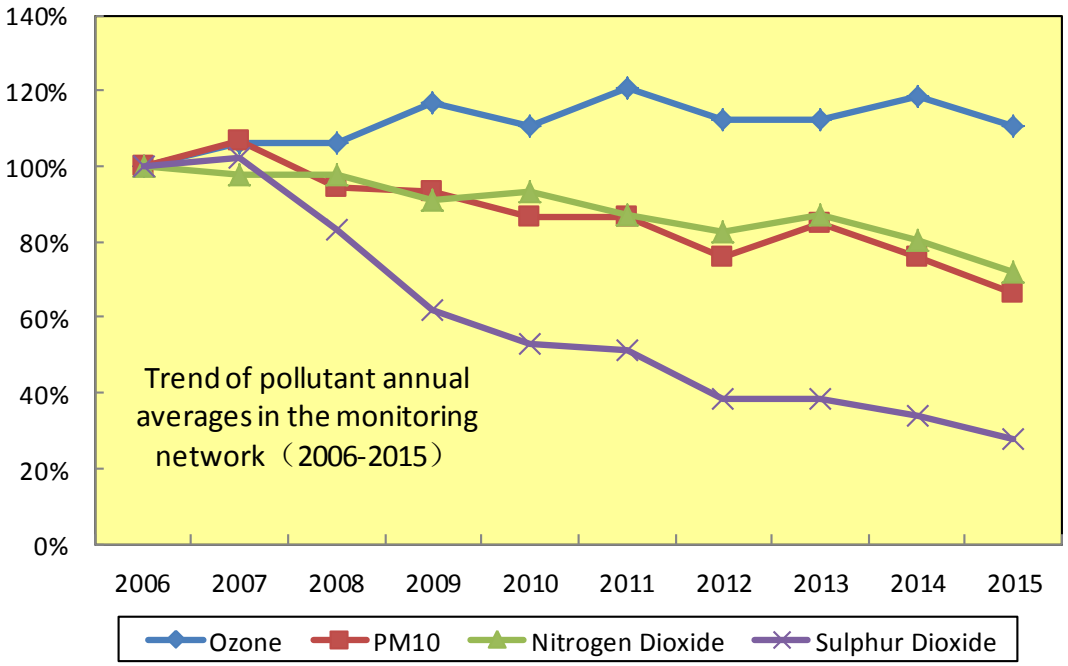

Figure 12：Trend of rates of changes of pollutant's annual averages in the monitoring network

Annex A：Site Information of Monitoring Stations

Monitoring Stations	Address	Area Type	Sampling Height (Above P.D.)	Above Ground	Date Commenced Operation
Luhu (Guangzhou)	Jufong Garden of Luhu Park (Big yard, No. 11 Luhu Park)	City	30m	9m	Jan 1993
Modiesha (Guangzhou)	Modiesha Street, Haizhu District	City	95m	45m	Dec 2011
Wanqingsha (Guangzhou)	HKUST Fok Ying Tung Research Institute, Nansha	Mixed educational/ commercial and residential/industrial	54m	28m	Oct 2004
Tianhu (Guangzhou)	Tianhu Park, Conghua	Background : rural	251m	13m	Oct 2004
Zhudong (Guangzhou)	Zhudong Village Committee, Chini Town, Huadu District	Rural	19m	10m	Dec 2011
Liyuan (Shenzhen)	Shennan Zhong Road, Futian District	City	38m	12m	Sep 1997
Jinjuzui (Foshan)	Foshan City Communist Party School, Jinjuzui, Shunde District	Tourist and cultural /educational	27m	17m	Oct 1999
Huijingcheng (Foshan)	No. 127, Fenjiang Nan Road, Chancheng District	Urban: mixed residential/commercial/ industrial	24m	14m	Feb 2000
Tangjia (Zhuhai)	Qiao Island Mangrove Monitoring Station, Tangjia Town	Mixed educational/ commercial and residential/industrial	13m	13m	Jan 2010
Donghu (Jiangmen)	Donghu Park, Jiangmen	City	17.5m	5m	Nov 2001
Duanfen (Jiangmen)	Duanfen Middle School, Taishan	Rural	15m	12m	Dec 2011
Huaguoshan (Jiangmen)	Huaguoshan, Taoyuan, Heshan	Rural	25m	15m	Feb 2012
Chengzhong (Zhaoqing)	No. 17, Qintian Road, Zhaoqing	Urban: mixed residential/commercial	21m	16m	Jun 2001
Xiapu (Huizhou)	No. 4 Xiabuhengjiang Road No. 3, Huicheng District	Urban: commercial	49m	20m	Dec 1999
Xijiao (Huizhou)	Xijiao Village Committee, Boluo County	Rural	39m	12m	Dec 2011
Jinguowan (Huizhou)	Jinguowan Ecological Farm, Huizhou	Residential	77m	8m	Oct 2004

Monitoring Stations	Address	Area Type	Sampling Height (Above P.D.)	Above Ground	Date Commenced Operation
Zimaling (Zhongshan)	Zimaling Park, Zhongshan	Mixed residential/ commercial	45 m	7m	Aug 2002
Nancheng-yuanling (Dongguan)	Nanchengyuanling Community, Dongguan	Mixed residential/ commercial/industrial	33 m	18m	Sep 2010
Tap Mun (Hong Kong)	Tap Mun Police Station	Background: rural	26m	11m	Apr 1998
Tsuen Wan (Hong Kong)	60 Tai Ho Road, Tsuen Wan	Urban: mixed residential/commercial/ industrial	21m	17m	Aug 1988
Yuen Long (Hong Kong)	Yuen Long District Office, 269 Castle Peak Road, Yuen Long	New Town: residential	31m	25m	Jul 1995
Tung Chung (Hong Kong)	6 Fu Tung Street, Tung Chung	New Town: residential	34.5m	27.5m	Apr 1999
Taipa Grande (Macao)	Rampa do Observatorio, Taipa Grande	Rural	120m	10m	Mar 1999

Annex B: Measurement Methods of Air Pollutant Concentration

Pollutants	**Measuring Principles**
Sulphur dioxide (SO_2)	UV fluorescence / Differential Optical Absorption Spectroscopy
Nitrogen dioxide (NO_2)	Chemiluminescence / Differential Optical Absorption Spectroscopy
Ozone (O_3)	UV absorption / Differential Optical Absorption Spectroscopy
Respirable suspended particulates (PM_{10})	Oscillating microbalance (TEOM) Beta particulate monitor
Fine suspended particulates ($PM_{2.5}$)	Oscillating microbalance (TEOM) Beta particulate monitor Hybrid nephelometric/radiometric particulate mass monitor
Carbon monoxide (CO)	Gas filter correlation infrared absorption method Non-dispersive infrared absorption method