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

A Report of Monitoring Results in 2017

Report Number	**:**	**PRDAIR-2017-5**
Report Prepared by	**:**	**Guangdong Provincial Environmental Monitoring Centre** **Environmental Protection Department, Hong Kong SARG** **Environmental Protection Bureau, Macao SARG** **Meteorological and Geophysical Bureau, Macao SARG**
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 2017 monitoring results from the Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network and their statistical analysis.

Contents

List of Tables

List of Figures

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.

With the growing concerns of air pollution control and economic development of the region, the environmental protection departments of Guangdong and Hong Kong had worked in collaboration with the environmental protection cum meteorological authorities of Macao to enhance the network by extending the coverage of monitoring area to Guangdong, Hong Kong and Macao in September 2014. The enhancements included the addition of monitoring stations from 16 to 23 to further improve the spatial distribution and the inclusion of two new monitoring parameters, i.e. carbon monoxide (CO) and fine suspended particulates ($PM_{2.5}$), to enrich the air quality monitoring information. At the same time, the network was renamed to "Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network" (the "Network").

With the enhancement of the network, the update of the national ambient air quality standards as well as the need for improving the reporting frequency of monitoring results, starting from 2014, the real-time hourly monitoring data was reported on a new internet platform to replace the daily Regional Air Quality Index (RAQI), the half-yearly report was also replaced by a quarterly report while the annual air quality monitoring report was maintained. The quarterly report is a brief statistical summary of the regional air quality monitoring results in a quarter. The annual report, in addition to the reporting of the monitoring data, provides a more detailed analysis and comparison of the 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 had been used for reporting Regional Air Quality Index (RAQI) to the public. At that time, the network comprised 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 stations was increased from 16 to 23. 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 continued to monitor the original 4 air pollutants with the addition of two new monitoring parameters, i.e. carbon monoxide (CO) and fine suspended particulates ($PM_{2.5}$ or FSP).

Figure 2 shows the spatial distribution of the monitoring stations after the enhancement of the network. Eight city monitoring stations of Guangdong have been operated by the operation-cum-maintenance agencies commissioned by the State since November 2016.

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 revised as necessary.

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

Figure 2：Spatial distribution of monitoring stations in the Network

Remark: For the boundary of the administrative division of the Macao Special Administrative Region, according the Decree n.°665 of the State Council of the People's Republic of China, "the map of the administrative division of the Macao Special Administrative Region" was approved at the 116th Executive Meeting of the State Council on 16 December 2015.

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 by replacing the previous RAQI that was published once a day 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 to assist the governments of Guangdong, Hong Kong and Macao in understanding 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 different areas in the region.

This is an annual report on the monitoring results for 2017. From 2015 onwards, the annual report covers the monitoring results of 6 monitoring parameters recorded at 23 monitoring stations of the Network.

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

3. Operation of the Network

The overall operation of the Network was smooth in 2017, but owing to the influence of Typhoon Hato, the operation of the PM_{10} and $PM_{2.5}$ monitoring equipment were temporarily suspended at the Taipa Grande monitoring station in Macao from 23 August to 23 October 2017. The average hourly data capture rate for the six air pollutants measured at all monitoring stations was 96.6% (Data was excluded during the period of suspension from 23 August to 23 October 2017 for PM_{10} and $PM_{2.5}$ monitoring at the Taipa Grande station in Macao).

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

The governments of Guangdong, Hong Kong, and Macao have fully implemented the agreed QC works, which include zero/span checks, precision checks, dynamic calibration, etc. The QA/QC works are carried out 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 is 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, "QMC") to review and evaluate, on a quarterly basis, the performance of equipment, QA/QC works, data transmission system and operation of the Network. The QMC also conducts a system audit every year to evaluate the effectiveness of the quality management system. Based on the audit results, a report will be prepared to summarize any corrective measures and recommendations and the QMC will take appropriate follow-up actions.

3.2 Accuracy and Precision

The accuracy of the Network is evaluated by means of performance audits. The performance goals set for the gaseous pollutants and particulates (PM_{10} and $PM_{2.5}$) are ±20% and ±15% respectively. In 2017, we had carried out 500 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 ranged from -8.6% to 11.9%, which were within the required 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 particulates (PM_{10} and $PM_{2.5}$) are ±15%. In 2017, we had carried out 3528 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 ranged from -13.9% and 12.8%, which were within the required performance goals (see Figure 4). In 2017, the overall QA/QC performance of the Network was satisfactory and met all the requirements specified in the QA/QC Operating Procedures.

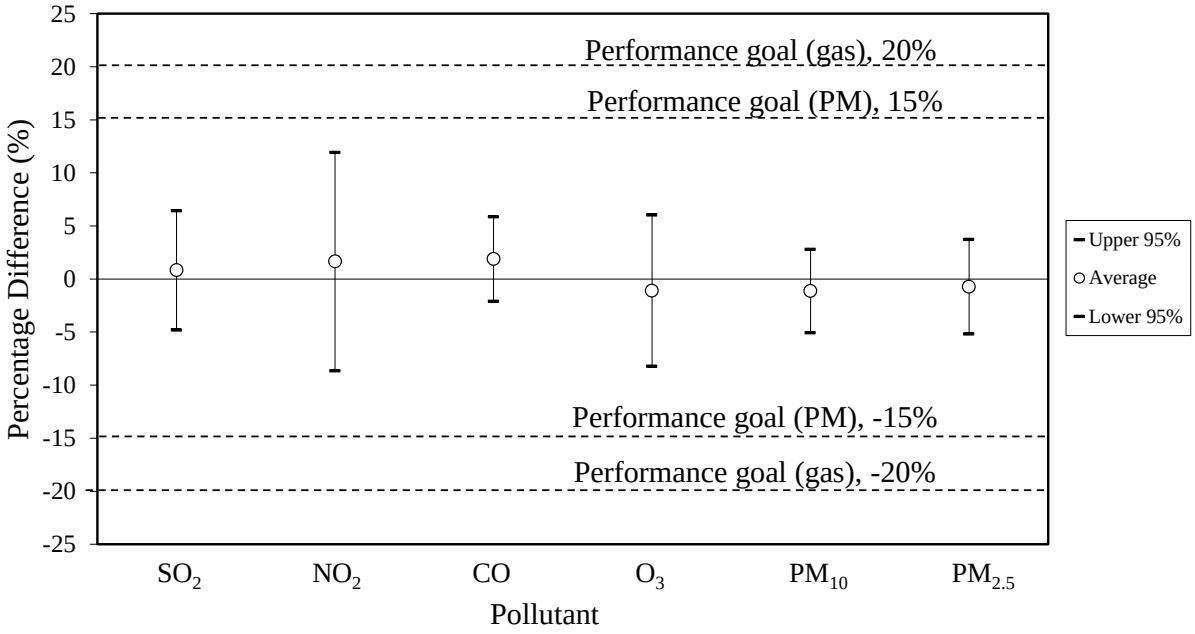

Figure 3：Accuracy of the monitoring network in 2017

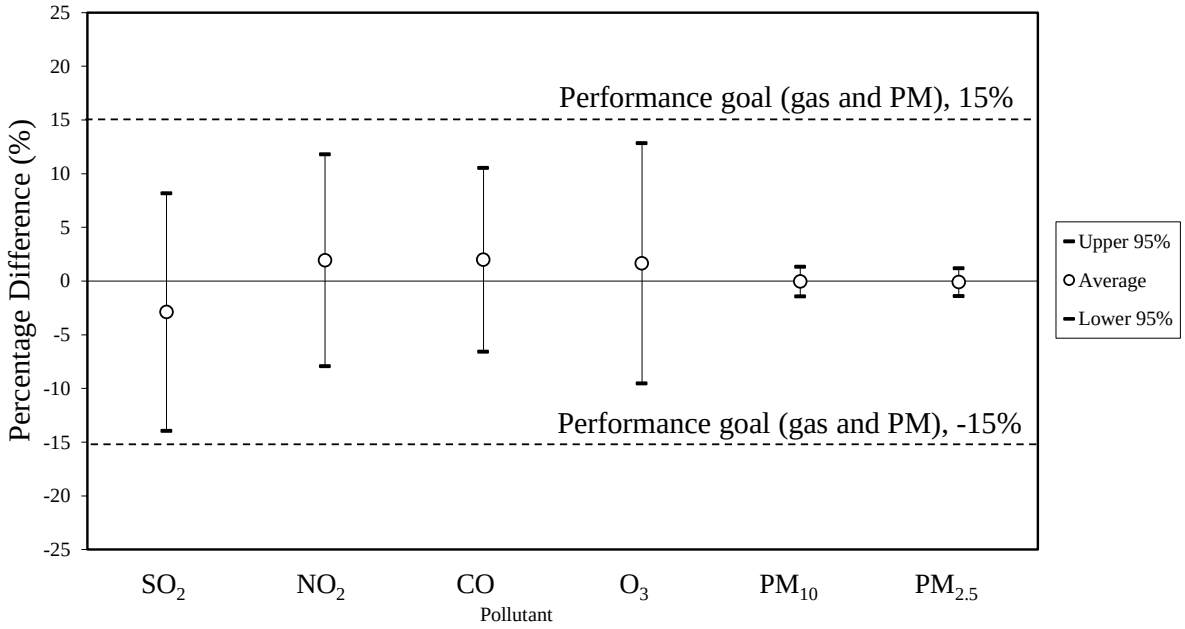

Figure 4：Precision of the monitoring network in 2017

4. Statistical Analysis of Pollutant Concentrations

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

Owing to the low daily data capture rate in 2017 for PM_{10} and $PM_{2.5}$ at Taipa Granda station in Macao, PM_{10} at Tap Mun station in Hong Kong and $PM_{2.5}$ at Xijiao station in Huizhou, these data were not used for statistical analysis but for reference only.

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.

In 2017, the annual average of SO_2 recorded at each monitoring station in the Network ranged from 5 to 20 μg/m^3, and all were in compliance with the national annual average concentration limit (60 μg/m^3). As shown in Figure 5, the annual average concentrations of SO_2 recorded at all the monitoring stations were generally at a low level. During the year, all monitoring stations in the Network could comply with the national 24-hour average concentration limit (150 μg/m^3) and 1-hour average concentration limit (500 μg/m3) of SO_2.

Tables 4.1a to 4.6c list the monthly maxima of hourly averages, the monthly maxima of daily averages with the 98th percentile of the year, and the monthly and annual averages of SO_2 at each station respectively.

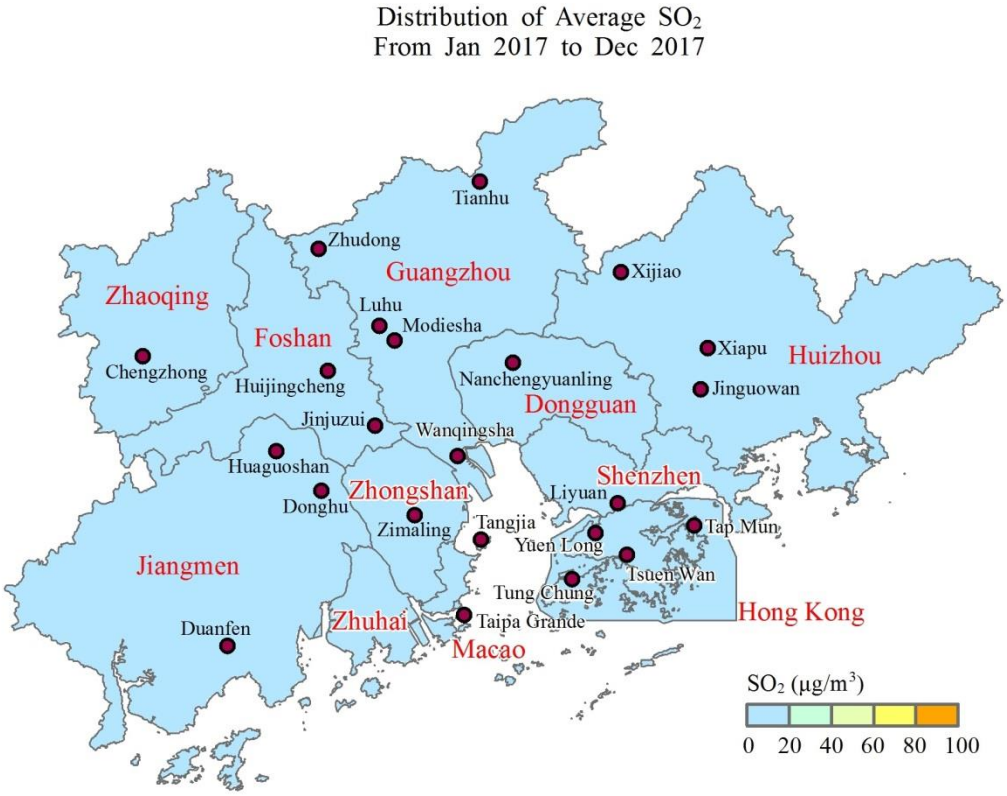

Figure 5：Spatial distribution of annual average concentrations of Sulphur Dioxide (SO_2)

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)	26	30	43	32	61	27	27	31	31	20	24	34
Modiesha (Guangzhou)	39	43	64	54	46	27	29	30	38	29	25	60
Wanqingsha (Guangzhou)	141	74	66	88	117	54	44	43	22	18	69	79
Tianhu (Guangzhou)	29	37	29	33	27	21	29	27	28	27	32	70
Zhudong (Guangzhou)	93	50	43	88	58	37	50	59	70	54	57	228
Liyuan (Shenzhen)	11	12	18	17	27	14	20	23	12	21	17	20
Jinjuzui (Foshan)	44	44	50	46	46	53	43	54	42	53	46	46
Huijingcheng (Foshan)	73	62	41	99	131	54	61	66	75	79	65	71
Tangjia (Zhuhai)	38	36	53	104	55	39	69	35	59	56	54	42
Donghu (Jiangmen)	52	47	32	40	51	24	32	33	62	60	69	76
Duanfen (Jiangmen)	40	34	54	30	30	17	39	17	27	30	39	56
Huaguoshan (Jiangmen)	94	63	243	152	60	90	53	58	92	91	78	162
Chengzhong (Zhaoqing)	61	56	112	84	77	46	65	248	115	86	103	92
Xiapu (Huizhou)	27	23	28	29	39	23	38	51	91	38	32	44
Xijiao (Huizhou)	49	57	60	49	38	36	38	46	38	42	48	59
Jinguowan (Huizhou)	40	33	15	23	42	29	21	18	32	35	36	26
Zimaling (Zhongshan)	51	38	34	29	76	15	31	49	40	36	46	46
Nanchengyuanling (Dongguan)	42	58	44	63	71	38	66	47	56	63	36	85
Tap Mun (Hong Kong)	19	23	25	29	23	14	12	18	25	19	19	27
Tsuen Wan (Hong Kong)	81	45	79	43	54	48	47	53	52	30	60	100
Yuen Long (Hong Kong)	29	26	25	41	73	27	46	35	38	27	33	70
Tung Chung (Hong Kong)	35	24	60	51	77	11	37	73	62	31	66	74
Taipa Grande (Macao)	80	48	70	71	59	20	34	59	48	24	30	42

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

Table 4.1b：Daily averages of Sulphur Dioxide (the monthly maxima and the 98th percentile of the year) **[Class II limit: 150 μg/m³]**

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	98th percentile
Luhu (Guangzhou)	14	18	21	15	21	15	16	11	14	14	15	23	100.0%	19
Modiesha (Guangzhou)	24	20	33	19	18	11	14	13	18	17	15	24	100.0%	20
Wanqingsha (Guangzhou)	47	33	31	37	38	16	17	20	12	9	36	45	100.0%	37
Tianhu (Guangzhou)	16	24	16	20	14	12	11	13	11	15	16	26	100.0%	19
Zhudong (Guangzhou)	22	32	29	43	40	26	17	24	26	26	31	106	100.0%	37
Liyuan (Shenzhen)	7	9	9	13	14	11	13	13	7	12	13	15	100.0%	13
Jinjuzui (Foshan)	20	18	23	24	22	16	13	24	20	26	22	34	100.0%	26
Huijingcheng (Foshan)	32	29	24	34	40	19	27	24	27	19	33	34	100.0%	33
Tangjia (Zhuhai)	10	9	17	19	13	5	25	18	17	17	21	24	100.0%	21
Donghu (Jiangmen)	22	21	22	20	20	10	15	12	22	22	27	30	100.0%	24
Duanfen (Jiangmen)	16	16	18	14	16	7	10	7	9	16	21	28	100.0%	21
Huaguoshan (Jiangmen)	38	33	55	41	28	18	18	24	36	37	39	52	100.0%	41
Chengzhong (Zhaoqing)	22	22	33	29	29	19	21	29	33	24	40	39	100.0%	32
Xiapu (Huizhou)	14	12	13	19	20	8	13	20	23	17	18	21	100.0%	19
Xijiao (Huizhou)	17	14	13	12	13	28	21	25	17	16	20	20	100.0%	21
Jinguowan (Huizhou)	9	11	10	12	13	7	10	11	12	16	19	18	100.0%	16
Zimaling (Zhongshan)	17	20	17	16	20	9	11	16	17	22	23	25	100.0%	22
Nanchengyuanling (Dongguan)	21	23	23	25	32	12	23	23	25	26	19	37	100.0%	27
Tap Mun (Hong Kong)	13	15	15	15	14	6	8	7	10	15	13	18	100.0%	15
Tsuen Wan (Hong Kong)	27	17	24	20	22	15	21	21	29	15	18	32	100.0%	22
Yuen Long (Hong Kong)	14	15	15	16	26	13	20	19	22	14	15	23	100.0%	19
Tung Chung (Hong Kong)	18	13	20	20	29	6	20	21	21	12	21	40	100.0%	21
Taipa Grande (Macao)	19	17	16	11	23	5	7	20	11	12	12	19	100.0%	16

Remark : All concentration units are in micrograms per cubic metre (μg/m³).

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)	9	9	9	11	12	10	10	6	8	8	10	14	10
Modiesha (Guangzhou)	10	11	12	10	9	6	10	8	8	9	9	13	10
Wanqingsha (Guangzhou)	21	18	19	20	20	11	11	10	9	7	12	26	15
Tianhu (Guangzhou)	9	11	8	8*	8	7	6	8	7	8	9	15	9
Zhudong (Guangzhou)	15	17	19	24	23	15	12	16*	19	17	17	30	19
Liyuan (Shenzhen)	6	6	6	8	9	9	7	9	6	8	8	10	8
Jinjuzui (Foshan)	8	9	12	13	12	10	10	9	12	13	14	20	12
Huijingcheng (Foshan)	12	12	13	16	16	11	11	7	11	8	13	19	12
Tangjia (Zhuhai)	5	5	7	8	6	3	7	4*	7	10	13	16	8
Donghu (Jiangmen)	10	11	11	10	12	7	8	7	10	12	14	18	11
Duanfen (Jiangmen)	9	8	9	7	7	4	5	4	5	10	13	18	8
Huaguoshan (Jiangmen)	18	18	23	22	17	14	14	13	20	20	24	33	20
Chengzhong (Zhaoqing)	10	13	17	15	18	12	14	16	18	14	16	22	15
Xiapu (Huizhou)	6	7	7	8	9	5	7	9	9	10	11	13	9
Xijiao (Huizhou)	9	5	8	7	8	12	15	16*	11	10	13	12	10
Jinguowan (Huizhou)	6	6	7	7	7	6	6	7	8	9	11	12	8
Zimaling (Zhongshan)	12	11	9	8	10	7	7	6	9	11	12	15	10
Nanchengyuanling (Dongguan)	12	12	12	12	14	10	13	13	15	12	13	20	13
Tap Mun (Hong Kong)	11	11	11	12	7	4*	5	6	7	9	8	11	8
Tsuen Wan (Hong Kong)	14	13	14	11	9	9	8	11	12	10	11	16	11
Yuen Long (Hong Kong)	10	10	10	11	11	8	8	10	11	9	9	13	10
Tung Chung (Hong Kong)	11	10	11	12	11	4	7	8	11*	7	8	13	9
Taipa Grande (Macao)	8	8	7	4	6	1	2	4	4	6	6	11	5

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

* The capture rate of validated daily data per month is below 85%.

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.

In 2017, the annual average of NO_2 recorded at each monitoring station in the Network ranged from 10 to 56 μg/m^3 and 15 monitoring stations met the national annual average concentration limit (40 μg/m^3). During the year, 6 monitoring stations in the Network recorded no exceedance of the national 24-hour average concentration limit (80 μg/m^3) while the corresponding compliance rates in the Network ranged from 86.9% to 100.0%; 11 monitoring stations recorded no exceedance of national 1-hour average concentration limit of NO_2 (200 μg/m^3).

Tables 4.2a to 4.2c list the monthly maxima of hourly averages, the monthly maxima of daily averages with the 98th percentile of the year, and the monthly and annual averages of NO_2 at each station respectively.

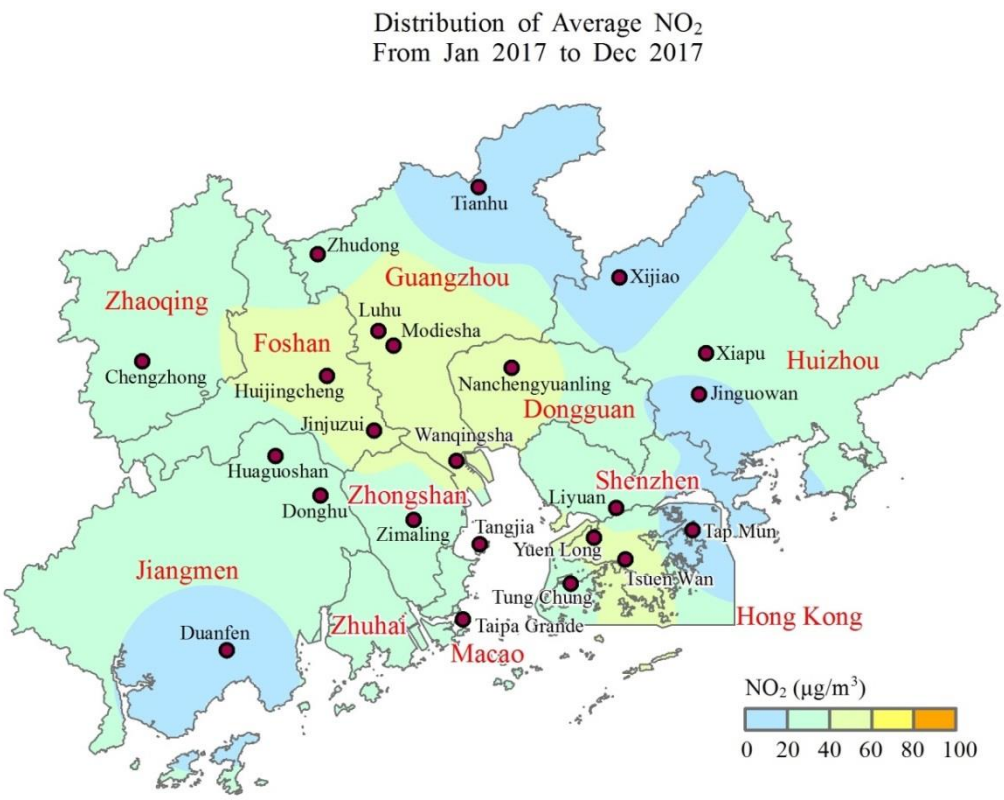

Figure 6：Spatial distribution of annual average concentrations of Nitrogen Dioxide (NO_2)

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)	274	201	135	175	165	121	119	165	180	125	151	186
Modiesha (Guangzhou)	315	220	153	158	170	130	152	135	191	171	219	203
Wanqingsha (Guangzhou)	251	154	154	126	209	70	112	170	114	179	167	337
Tianhu (Guangzhou)	67	85	77	46	67	40	47	47	31	22	48	44
Zhudong (Guangzhou)	132	104	108	116	90	78	77	252	87	96	96	101
Liyuan (Shenzhen)	131	103	97	76	120	59	115	91	81	116	105	183
Jinjuzui (Foshan)	191	155	131	148	114	91	89	77	104	153	173	218
Huijingcheng (Foshan)	249	199	168	182	192	102	154	149	194	228	240	205
Tangjia (Zhuhai)	150	110	124	118	118	59	86	74	151	107	125	154
Donghu (Jiangmen)	231	148	128	116	99	67	107	92	99	169	184	231
Duanfen (Jiangmen)	90	50	126	61	41	29	38	37	34	66	82	131
Huaguoshan (Jiangmen)	141	114	121	91	84	77	100	57	84	135	124	211
Chengzhong (Zhaoqing)	151	152	131	139	142	88	120	89	114	133	150	149
Xiapu (Huizhou)	136	136	117	139	108	55	52	96	104	165	148	167
Xijiao (Huizhou)	40	40	44	77	66	39	134	41	40	29	36	43
Jinguowan (Huizhou)	53	46	95	75	73	38	56	132	127	115	85	99
Zimaling (Zhongshan)	238	117	132	104	101	45	79	67	76	111	142	181
Nanchengyuanling (Dongguan)	171	167	152	145	130	118	138	129	112	136	172	188
Tap Mun (Hong Kong)	37	49	64	44	70	45	60	45	62	43	49	91
Tsuen Wan (Hong Kong)	224	175	160	182	254	93	177	207	246	145	217	231
Yuen Long (Hong Kong)	211	146	136	127	170	69	120	130	145	161	169	230
Tung Chung (Hong Kong)	152	113	139	121	158	72	90	162	124	138	243	203
Taipa Grande (Macao)	163	122	130	110	142	53	51	88	109	144	166	158

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

Table 4.2b：Daily averages of Nitrogen Dioxide (the monthly maxima and the 98th percentile of the year) **[Class II limit: 80 μg/m³]**

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	98th percentile
Luhu (Guangzhou)	173	119	105	90	80	54	62	59	74	72	84	128	90.4%	109
Modiesha (Guangzhou)	188	119	102	88	86	60	66	68	84	96	99	146	89.4%	111
Wanqingsha (Guangzhou)	142	82	77	69	95	37	55	60	54	78	86	164	94.7%	108
Tianhu (Guangzhou)	30	33	26	34	32	19	19	23	12	11	22	25	100.0%	28
Zhudong (Guangzhou)	66	68	83	55	56	36	38	115	44	47	61	69	99.4%	65
Liyuan (Shenzhen)	68	60	54	47	56	35	58	54	50	49	53	97	99.4%	58
Jinjuzui (Foshan)	112	67	75	74	62	47	37	46	62	85	104	159	94.2%	104
Huijingcheng (Foshan)	180	108	92	100	90	67	72	67	80	119	135	150	86.9%	131
Tangjia (Zhuhai)	87	66	76	65	55	34	44	33	49	40	69	86	99.1%	75
Donghu (Jiangmen)	112	81	92	83	53	41	48	43	58	93	108	163	94.2%	103
Duanfen (Jiangmen)	46	34	60	42	28	9	17	17	15	36	55	79	100.0%	56
Huaguoshan (Jiangmen)	78	58	62	62	55	53	36	33	38	62	73	139	97.4%	90
Chengzhong (Zhaoqing)	81	74	73	86	66	42	55	46	68	70	77	100	97.8%	81
Xiapu (Huizhou)	67	51	40	62	60	34	26	45	45	48	60	78	100.0%	60
Xijiao (Huizhou)	20	20	24	28	19	21	37	24	15	15	18	25	100.0%	24
Jinguowan (Huizhou)	29	20	28	40	37	22	36	50	45	38	33	40	100.0%	39
Zimaling (Zhongshan)	78	53	77	59	46	27	35	32	31	54	89	97	98.6%	78
Nanchengyuanling (Dongguan)	115	111	82	75	74	60	56	53	59	56	80	108	96.7%	88
Tap Mun (Hong Kong)	24	16	40	29	42	15	23	21	22	16	20	30	100.0%	24
Tsuen Wan (Hong Kong)	115	103	95	91	115	61	86	110	105	77	90	116	90.3%	103
Yuen Long (Hong Kong)	101	77	83	66	103	48	68	84	70	81	83	110	97.2%	83
Tung Chung (Hong Kong)	79	76	85	69	98	54	57	73	73	68	110	118	97.5%	85
Taipa Grande (Macao)	97	64	89	67	57	31	26	41	47	71	96	113	97.5%	81

Remark： All concentration units are in micrograms per cubic metre (μg/m³).

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)	66	62	67	58	54	39	41	38	54	38	50	67	53
Modiesha (Guangzhou)	68	55	67	57	48	35	41	42	59	40	56	67	53
Wanqingsha (Guangzhou)	55	44	56	38	46	20	31	26	31	32	55	70	42
Tianhu (Guangzhou)	12	15	15	15*	10	12	5	10	6	5	9	13	10
Zhudong (Guangzhou)	30	32	45	35	31	25*	26	31*	32	26	35	42	33
Liyuan (Shenzhen)	37	28	30	28	22	22	20	26	25	24	34	39	28
Jinjuzui (Foshan)	56	45	52	43	37	19	21*	24	34	37	53	69	42
Huijingcheng (Foshan)	70	54	65	58*	54	38	42	37	53	48	57	78	54
Tangjia (Zhuhai)	37	32	54*	32	26	13	27	16*	18	20	38	47	30
Donghu (Jiangmen)	53	40	52	37	32	19	26	22	30	42	53	65	39
Duanfen (Jiangmen)	29	19	29	16	10	4	9	5	7	22	34	45	19
Huaguoshan (Jiangmen)	38	24	40	33	29	18*	24	17	28	38	51	68	34
Chengzhong (Zhaoqing)	41	39	46	36	35	27	39	29	42	37	35	50	38
Xiapu (Huizhou)	32	26	29	30	23	22	18	30	30	21	30	37	27
Xijiao (Huizhou)	14	12	16	16	13	13	16*	13*	9	9	12	15	13
Jinguowan (Huizhou)	17	13	18	17	13	15	14	22	25	18	22	26	18
Zimaling (Zhongshan)	40	32	39	24	20	8	17	11	13	31	50	59	29
Nanchengyuanling (Dongguan)	48	45	53	48	35	33	34	34	43	29	42	54	41
Tap Mun (Hong Kong)	14	11	15	15	10	6*	5	9	9	7	11	14	11
Tsuen Wan (Hong Kong)	68	62	66	61	63	46	42	46	56	44	54	63	56
Yuen Long (Hong Kong)	55	49	52	47	48	27	28	32	40	40	47	57	43
Tung Chung (Hong Kong)	48	44	39	35	41	19	22	25	36	37	51	62	38
Taipa Grande (Macao)	50	42	50	35	33	10	13	15	19	31	55	61	35

Remark : All concentration units are in micrograms per cubic metre (μg/m^3).
* The capture rate of validated daily data per month is below 85%.

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 2017, the annual average of O_3 recorded at each monitoring station in the Network ranged from 44 to 79 $\mu g/m^3$ with higher average values being recorded in rural areas such as Tap Mun of Hong Kong, Tianhu of Guangzhou and Duanfen of Jiangmen, the situation was similar to the one in previous years. During the year, the compliance rates of the daily maximum 8-hour averages of O_3 in the Network ranged from 77.4% to 97.7%. All monitoring stations recorded exceedance of the national 1-hour average concentration limit (200 $\mu g/m^3$) and the daily maximum 8-hour average concentration limit (160 $\mu g/m^3$) of O_3.

Tables 4.3a to 4.3c list the monthly maxima of hourly averages, the monthly maxima of daily maximum 8-hour averages with the 90th percentile of the year, and the monthly and annual averages of O_3 at each station respectively.

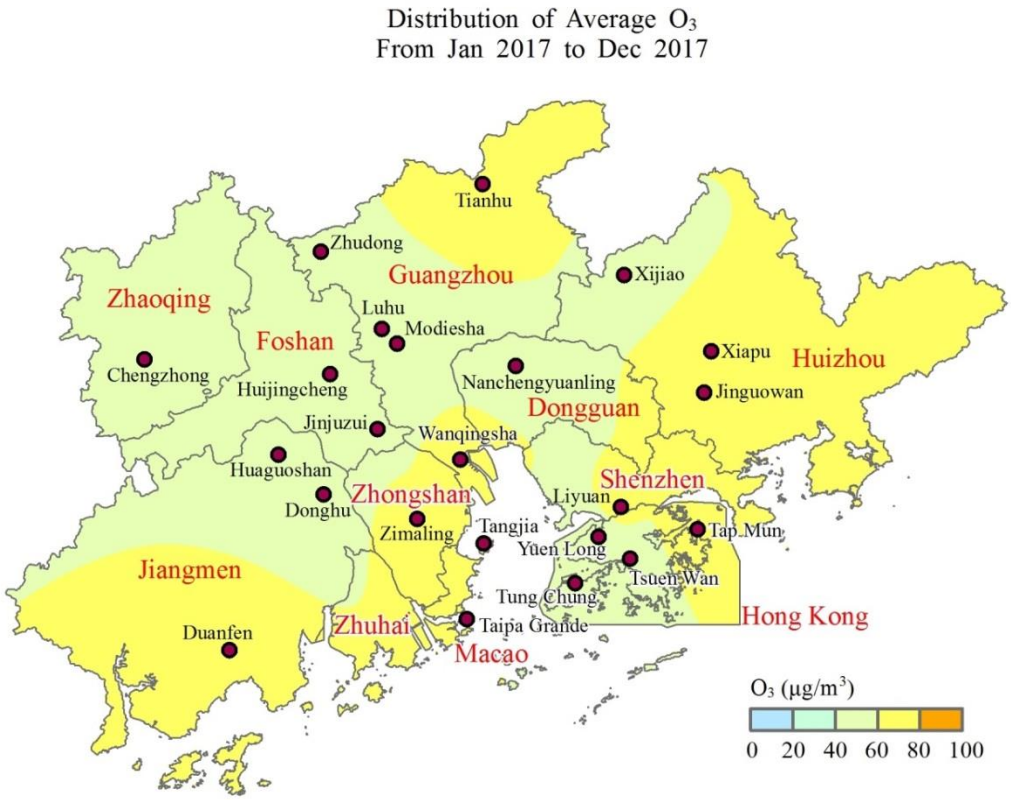

Figure 7：Spatial distribution of annual average concentrations of Ozone (O_3)

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)	178	221	214	303	287	217	263	248	338	224	216	164
Modiesha (Guangzhou)	201	204	344	256	261	188	276	213	329	162	164	166
Wanqingsha (Guangzhou)	310	343	216	291	436	115	413	357	411	316	291	275
Tianhu (Guangzhou)	170	209	320	243	216	232	168	219	204	152	147	150
Zhudong (Guangzhou)	216	278	235	290	326	209	264	288	316	224	224	234
Liyuan (Shenzhen)	175	179	182	238	355	104	291	420	386	237	240	221
Jinjuzui (Foshan)	301	336	215	324	326	215	325	282	356	276	231	252
Huijingcheng (Foshan)	194	221	187	354	341	218	287	264	336	282	226	159
Tangjia (Zhuhai)	163	136	138	177	220	82	279	296	318	314	305	266
Donghu (Jiangmen)	266	308	194	294	343	127	318	278	319	274	259	268
Duanfen (Jiangmen)	270	212	158	207	301	101	252	192	214	373	294	241
Huaguoshan (Jiangmen)	316	312	176	249	352	184	321	258	293	315	265	221
Chengzhong (Zhaoqing)	201	187	148	197	238	178	231	202	389	279	219	174
Xiapu (Huizhou)	155	203	178	251	217	171	221	295	264	185	170	160
Xijiao (Huizhou)	162	224	246	293	250	235	150	308	267	201	199	175
Jinguowan (Huizhou)	170	194	181	292	197	143	296	267	249	411	172	180
Zimaling (Zhongshan)	222	330	187	268	359	129	343	373	372	317	317	280
Nanchengyuanling (Dongguan)	236	260	188	327	270	256	324	303	393	219	201	178
Tap Mun (Hong Kong)	203	190	177	213	332	99	324	264	381	224	216	241
Tsuen Wan (Hong Kong)	114	133	167	147	239	50	287	254	394	229	185	163
Yuen Long (Hong Kong)	210	158	169	193	263	82	379	437	425	232	211	204
Tung Chung (Hong Kong)	202	143	144	195	364	81	334	407	409	227	220	167
Taipa Grande (Macao)	234	168	156	217	380	76	223	323	454	280	278	213

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

Table 4.3b：Daily maximum 8-hour averages of Ozone (the monthly maxima and the 90th percentile of the year) **[Class II limit: 160 μg/m³]**

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	90th percentile
Luhu (Guangzhou)	135	182	152	222	254	163	189	201	244	180	163	129	89.2%	159
Modiesha (Guangzhou)	148	158	170	191	222	156	205	176	265	147	142	135	92.2%	150
Wanqingsha (Guangzhou)	223	175	135	242	326	91	262	289	325	269	211	213	79.4%	205
Tianhu (Guangzhou)	130	189	220	199	200	192	125	198	183	143	142	124	93.4%	143
Zhudong (Guangzhou)	164	239	180	251	270	165	187	241	267	198	179	133	83.0%	173
Liyuan (Shenzhen)	142	148	149	182	220	75	227	293	268	207	194	186	90.1%	156
Jinjuzui (Foshan)	250	242	155	258	276	158	257	233	292	230	189	204	81.0%	184
Huijingcheng (Foshan)	126	180	151	261	292	153	241	204	289	207	168	131	85.6%	167
Tangjia (Zhuhai)	120	109	89	153	192	73	196	239	247	275	260	217	84.6%	191
Donghu (Jiangmen)	214	222	163	233	297	100	259	241	263	242	215	208	81.2%	186
Duanfen (Jiangmen)	227	176	148	196	265	73	212	159	190	284	260	193	85.6%	176
Huaguoshan (Jiangmen)	268	216	153	204	315	113	276	218	241	277	211	179	81.8%	187
Chengzhong (Zhaoqing)	137	151	121	162	188	124	208	161	343	247	176	143	90.1%	156
Xiapu (Huizhou)	115	157	158	228	175	133	169	273	224	169	157	133	94.4%	148
Xijiao (Huizhou)	132	206	185	246	199	179	98	229	207	177	164	154	89.7%	157
Jinguowan (Huizhou)	139	161	160	239	174	126	238	230	187	170	154	152	95.6%	143
Zimaling (Zhongshan)	174	208	165	227	286	106	278	282	308	270	209	213	77.4%	193
Nanchengyuanling (Dongguan)	183	190	137	263	227	194	231	259	329	191	160	155	86.0%	173
Tap Mun (Hong Kong)	152	177	158	190	252	85	239	231	260	216	188	199	84.6%	174
Tsuen Wan (Hong Kong)	100	111	125	141	188	39	216	155	275	181	147	135	97.7%	114
Yuen Long (Hong Kong)	138	116	125	151	198	65	272	274	293	183	170	156	93.3%	142
Tung Chung (Hong Kong)	118	107	141	160	287	72	235	252	258	162	150	111	95.0%	133
Taipa Grande (Macao)	180	139	149	186	273	69	182	305	378	254	222	160	90.1%	154

Remark： All concentration units are in micrograms per cubic metre (μg/m³).

Table 4.3c：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)	38	43	25	42	64	38	37	47	57	61	37	42	44
Modiesha (Guangzhou)	41	59	35	46	62	34	36	41	58	59	38	51	47
Wanqingsha (Guangzhou)	62	67	44	59	84	40	44	59	83	87	54	66	63
Tianhu (Guangzhou)	76	84	73	74*	84	63	52	76	88	85	66	78	75
Zhudong (Guangzhou)	54	63	37	53*	78	53*	51	58*	80	72	45	53	58
Liyuan (Shenzhen)	63	73	78	64	79	29	35	44	62	80	63	79	62
Jinjuzui (Foshan)	50	63	37	55	77	43	48	52	77	81	42	51	56
Huijingcheng (Foshan)	36	48	28	49	73	39	45	52	72	67	37	40	49
Tangjia (Zhuhai)	50	53	36	65	67	43	42	52*	67	104	87	90	63
Donghu (Jiangmen)	49	62	37	55	81	36	45	49	69	71	42	50	54
Duanfen (Jiangmen)	64	74	66	67	84	46	49	51	67	90	65	68	66
Huaguoshan (Jiangmen)	57	59	35	54	75	37	47	47	67	74	45	45	54
Chengzhong (Zhaoqing)	41	45	26	39	59	44	53	52	73	79	46	53	51
Xiapu (Huizhou)	57	72	62	67	76	39	37	58	64	79	53	63	61
Xijiao (Huizhou)	54	67	63	65	70	49	26	58*	54	67	60	68	59
Jinguowan (Huizhou)	64	81	68	69	76	36	36	47	52	71	57	74	61
Zimaling (Zhongshan)	54	67	48	63	88	45	47	57	77	85	49	62	62
Nanchengyuanling (Dongguan)	43	53	37	54	71	43	50	68	79	80	45	57	57
Tap Mun (Hong Kong)	83	90	93	76	93	39*	47	48	75	110	87	102	79
Tsuen Wan (Hong Kong)	44	50	58	41	54	16	23	27	42	68	51	61	44
Yuen Long (Hong Kong)	45	54	53	43	58	23	28	34	52	69	53	67	48
Tung Chung (Hong Kong)	37	43	65	60	80	38	34	39	57	66	47	51	52
Taipa Grande (Macao)	56	65	65	65	85	43	38	44	67	86	54	66	61

Remark : All concentration units are in micrograms per cubic metre ($\mu g/m^3$).
* The capture rate of validated daily data per month is below 85%.

4.4 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 of CO is automobiles.

In 2017, the annual average of CO recorded at each monitoring station in the Network ranged from 0.6 to 1.0 mg/m^3. During the year, all monitoring stations in the Network were in compliance with the national 1-hour and 24-hour average concentration limits (10 mg/m^3 and 4 mg/m^3).

Tables 4.6a to 4.6c list the monthly maxima of hourly and daily averages, the maxima of daily averages with the 95th percentile of the year, and the monthly and annual averages of CO at each station respectively.

Figure 8：Spatial distribution of annual average concentrations of Carbon Monoxide (CO)

Table 4.4a：Hourly averages of Carbon Monoxide (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)	2.4	1.8	2.3	1.6	1.9	1.4	1.4	1.7	2.6	1.8	2.2	2.0
Modiesha (Guangzhou)	3.2	2.0	3.8	1.3	2.0	1.5	1.1	1.2	1.5	1.6	1.6	2.0
Wanqingsha (Guangzhou)	1.9	1.4	1.6	1.3	1.5	1.1	1.3	1.1	1.4	1.1	1.8	1.6
Tianhu (Guangzhou)	1.3	1.1	1.9	1.4	1.0	1.1	1.4	1.2	1.6	1.0	1.2	1.8
Zhudong (Guangzhou)	1.7	1.3	1.4	1.4	1.5	1.4	0.9	1.3	1.0	1.4	1.4	1.4
Liyuan (Shenzhen)	1.5	1.4	1.3	1.2	1.5	1.5	1.4	1.3	1.3	1.6	1.2	1.7
Jinjuzui (Foshan)	3.3	1.4	2.0	1.6	2.0	1.6	1.6	1.5	1.8	2.0	2.3	2.0
Huijingcheng (Foshan)	3.7	2.0	3.0	1.4	1.5	1.3	1.5	1.3	1.3	2.2	2.1	3.9
Tangjia (Zhuhai)	1.8	1.4	1.6	1.4	1.3	0.7	1.1	1.0	1.1	0.9	1.3	1.3
Donghu (Jiangmen)	3.7	2.1	2.6	1.8	2.0	1.4	1.7	1.5	2.3	2.6	3.2	4.3
Duanfen (Jiangmen)	2.1	1.6	1.8	1.2	1.6	0.8	0.9	0.8	1.2	1.6	1.2	1.5
Huaguoshan (Jiangmen)	2.2	2.2	2.6	2.0	1.7	1.4	1.4	1.3	1.4	1.6	1.6	2.0
Chengzhong (Zhaoqing)	2.7	1.8	2.6	2.1	2.0	1.5	1.8	1.6	2.2	2.3	2.6	2.1
Xiapu (Huizhou)	2.9	1.9	1.8	1.5	1.8	1.2	1.2	1.6	1.2	1.5	3.0	2.3
Xijiao (Huizhou)	1.6	1.7	2.1	1.2	1.2	1.0	1.0	0.9	1.2	1.1	1.2	1.4
Jinguowan (Huizhou)	1.1	0.8	1.4	1.1	1.2	1.3	1.2	1.0	1.6	0.9	1.2	1.3
Zimaling (Zhongshan)	2.5	1.3	2.0	1.5	1.6	1.1	1.1	1.3	1.7	1.6	2.3	1.7
Nanchengyuanling (Dongguan)	2.6	1.7	1.9	1.5	1.6	1.6	1.5	1.6	1.7	1.7	1.7	2.1
Tap Mun (Hong Kong)	1.9	1.3	1.2	1.1	1.1	0.6	1.0	1.0	1.1	1.0	1.2	1.3
Tsuen Wan (Hong Kong)	1.6	1.3	1.7	1.6	1.7	1.1	1.2	1.1	1.2	1.0	1.0	1.4
Yuen Long (Hong Kong)	1.5	1.5	1.4	1.5	1.5	0.8	1.0	0.9	1.0	1.4	1.0	1.5
Tung Chung (Hong Kong)	1.7	1.6	1.9	1.5	1.7	0.9	1.0	1.2	1.3	1.2	1.7	1.4
Taipa Grande (Macao)	1.7	1.1	1.5	1.6	1.4	0.9	1.8	1.6	1.1	1.2	1.5	1.3

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

Table 4.4b：Daily averages of Carbon Monoxide (the monthly maxima and the 95th percentile of the year) **[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)	1.8	1.2	1.4	1.2	1.2	1.0	1.0	1.0	1.3	1.2	1.2	1.3	100.0%	1.3
Modiesha (Guangzhou)	2.3	1.5	2.2	1.0	1.4	1.0	0.7	0.8	1.0	1.3	1.0	1.4	100.0%	1.4
Wanqingsha (Guangzhou)	1.3	1.1	1.3	1.0	1.2	0.9	0.8	0.7	1.0	0.9	1.2	1.2	100.0%	1.1
Tianhu (Guangzhou)	1.1	0.9	1.4	0.9	0.9	0.9	1.0	1.1	1.3	1.0	1.1	1.0	100.0%	1.0
Zhudong (Guangzhou)	1.5	1.0	1.1	1.0	0.9	1.0	0.7	0.6	0.7	0.9	1.2	1.2	100.0%	1.0
Liyuan (Shenzhen)	1.4	1.1	1.1	1.0	1.2	1.1	1.1	0.9	1.1	1.0	1.0	1.1	100.0%	1.0
Jinjuzui (Foshan)	1.7	1.0	1.5	1.3	1.4	1.1	1.2	1.1	1.3	1.3	1.6	1.4	100.0%	1.4
Huijingcheng (Foshan)	1.9	1.2	1.3	1.1	0.9	0.9	0.9	0.7	0.8	1.3	1.3	1.7	100.0%	1.2
Tangjia (Zhuhai)	1.3	1.0	1.0	0.9	1.0	0.6	1.0	0.8	0.8	0.7	0.9	1.0	100.0%	1.0
Donghu (Jiangmen)	1.8	1.3	1.3	1.3	1.3	0.9	1.1	0.9	1.2	1.4	1.5	1.7	100.0%	1.3
Duanfen (Jiangmen)	1.6	1.5	0.8	0.9	0.9	0.5	0.6	0.6	0.7	0.9	0.9	1.2	100.0%	1.0
Huaguoshan (Jiangmen)	1.7	1.3	1.8	1.0	1.2	0.9	0.9	0.6	0.9	1.1	1.2	1.5	100.0%	1.4
Chengzhong (Zhaoqing)	1.6	1.4	1.8	1.4	1.2	1.1	1.1	1.1	1.3	1.4	1.4	1.5	100.0%	1.4
Xiapu (Huizhou)	1.4	1.2	1.2	1.1	1.4	0.7	0.8	0.9	0.9	0.9	1.5	1.2	100.0%	1.1
Xijiao (Huizhou)	1.3	0.9	1.1	0.8	0.7	0.6	0.7	0.7	0.8	0.9	0.9	0.9	100.0%	0.9
Jinguowan (Huizhou)	0.8	0.6	0.9	1.1	0.9	0.8	1.0	0.8	1.0	0.8	1.1	1.0	100.0%	0.9
Zimaling (Zhongshan)	1.6	1.0	1.5	1.0	1.1	0.8	0.8	0.9	1.1	1.3	1.6	1.1	100.0%	1.2
Nanchengyuanling (Dongguan)	1.6	1.1	1.3	1.1	1.2	1.1	1.1	1.2	1.3	1.2	1.3	1.4	100.0%	1.3
Tap Mun (Hong Kong)	1.6	1.1	1.1	0.8	1.0	0.6	0.8	0.8	0.9	0.9	1.1	1.1	100.0%	1.1
Tsuen Wan (Hong Kong)	1.4	1.1	1.1	1.2	1.2	0.7	1.1	0.9	1.0	0.7	0.8	1.0	100.0%	1.1
Yuen Long (Hong Kong)	1.1	1.0	1.1	1.1	1.1	0.5	0.8	0.7	0.9	0.8	0.8	1.0	100.0%	1.0
Tung Chung (Hong Kong)	1.5	0.9	0.9	1.0	1.0	0.7	0.9	0.8	0.9	0.9	0.9	1.1	100.0%	1.0
Taipa Grande (Macao)	1.3	1.0	1.1	1.0	1.1	0.7	0.9	0.9	0.7	1.0	1.1	1.2	100.0%	1.0

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

Table 4.4c：The monthly and annual averages of Carbon Monoxide

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

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

* The capture rate of validated daily data per month is below 85%.

4.5 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 2017, the annual average of PM_{10} recorded at each monitoring station in the Network ranged from 33 to 66 μg/m^3, and all monitoring stations met the national annual average concentration limit (70 μg/m^3). During the year, 9 monitoring stations in the Network recorded no exceedance of the national 24-hour average concentration limit (150 μg/m^3) while the corresponding compliance rates in the Network ranged from 96.4% to 100.0%.

Table 4.4a and Table 4.4b list the monthly maxima of daily averages with the 95th percentile of the year, and the monthly and annual averages of PM_{10} at each station respectively.

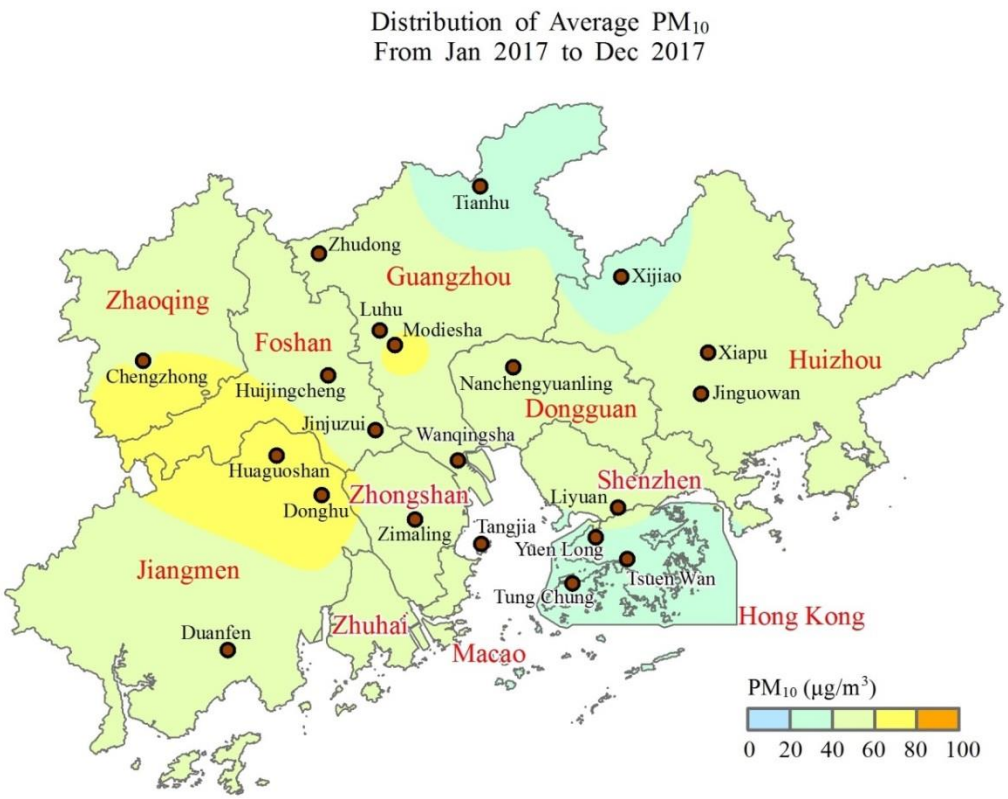

Figure 9：Spatial distribution of annual average concentrations of Respirable Suspended Particulates (PM_{10})

Remark: Taipa Grande's and Tap Mun's data are excluded in the spatial distribution map owing to its low daily data capture rate in 2017.

Table 4.5a：Daily averages of PM_{10} (the monthly maxima and the 95th percentile of the year)

[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)	176	113	105	107	127	52	75	61	94	101	109	115	99.7%	99
Modiesha (Guangzhou)	228	119	149	111	133	54	77	76	124	123	117	145	99.1%	116
Wanqingsha (Guangzhou)	130	95	114	86	137	36	83	73	112	108	128	153	99.7%	111
Tianhu (Guangzhou)	99	69	89	76	77	43	58	62	70	80	96	95	100.0%	71
Zhudong (Guangzhou)	160	110	130	85	103	58	68	69	104	106	111	131	99.7%	104
Liyuan (Shenzhen)	98	74	82	63	66	32	76	81	76	93	121	129	100.0%	82
Jinjuzui (Foshan)	159	90	112	83	114	39	78	63	87	110	112	136	99.7%	102
Huijingcheng (Foshan)	262	99	96	121	114	63	84	68	96	121	134	164	98.9%	114
Tangjia (Zhuhai)	95	85	97	58	81	34	91	60	111	107	141	157	99.7%	101
Donghu (Jiangmen)	217	103	148	123	155	58	95	67	115	145	152	205	96.4%	135
Duanfen (Jiangmen)	102	94	98	69	89	33	53	44	58	106	117	155	99.7%	100
Huaguoshan (Jiangmen)	269	123	144	136	123	72	87	72	97	144	140	220	97.1%	136
Chengzhong (Zhaoqing)	196	105	124	118	116	52	77	64	108	130	112	156	98.6%	116
Xiapu (Huizhou)	116	86	95	98	70	51	77	85	76	98	106	120	100.0%	93
Xijiao (Huizhou)	73	68	72	70	64	43	67	58	61	68	98	82	100.0%	65
Jinguowan (Huizhou)	104	64	80	88	74	58	176	240	120	94	149	127	98.8%	101
Zimaling (Zhongshan)	103	73	96	62	94	29	77	64	82	100	107	118	100.0%	92
Nanchengyuanling (Dongguan)	142	107	107	81	107	52	78	75	97	115	104	132	100.0%	102
Tap Mun (Hong Kong) ^	69	69	82	66	55	28	65	44	62	76	96	88	--	--
Tsuen Wan (Hong Kong)	63	60	85	56	105	30	77	65	107	74	90	102	100.0%	65
Yuen Long (Hong Kong)	101	78	99	57	88	29	75	64	90	90	111	91	100.0%	77
Tung Chung (Hong Kong)	116	71	90	50	115	27	75	73	79	73	87	106	100.0%	75
Taipa Grande (Macao) #	105	93	112	70	122	31	64	53	--	97	120	162	--	--

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

^ Tap Mun's data are for reference only owing to its low daily data capture rate in 2017.

The operation of the PM_{10} monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are for reference only owing to its low daily data capture rate in 2017.

Table 4.5b：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)	66	58	62	55	56	35	35	38	56	48	54	69	53
Modiesha (Guangzhou)	78	65	73	65	62	40	43	47	68	57	58	81*	61
Wanqingsha (Guangzhou)	75	57	66	50	48	21	30	31	44	55	71	87	53
Tianhu (Guangzhou)	45	45	38	41*	38	29	24	34	37	36	37	51	38
Zhudong (Guangzhou)	68	61	61	59	57	40*	37	40*	59*	56*	59	77	57
Liyuan (Shenzhen)	52	43	45	39	34	18	19	27	35	49	56	77	41
Jinjuzui (Foshan)	71	57	63	53	51	29	31	32	46	48	61	76	52
Huijingcheng (Foshan)	78	55	65	62	58	37	38	38	54	52	64	82	57
Tangjia (Zhuhai)	62	50	55	40	40	20	25	25*	39	57	70	87	48
Donghu (Jiangmen)	83	62	82	63	65	35	40	38	56	62	78	100	64
Duanfen (Jiangmen)	60	48	59	38	38	21	23	22	28	50	65	86	45
Huaguoshan (Jiangmen)	98	69	88	66	64	32	39	32*	55	64	75	107	66
Chengzhong (Zhaoqing)	77	60	72	63	60	38	45	39	59	55	60	83	60
Xiapu (Huizhou)	63	52	53	54	48	32	29	41	45	51	59	72	50
Xijiao (Huizhou)	45	42	37	40	40	30	28	34*	35	37	41	51	38
Jinguowan (Huizhou)	53	42	49	48	47	25	45	46	54	55	62	69	50
Zimaling (Zhongshan)	59	46	52	40	40	18	22	26	35	49	64	76	44
Nanchengyuanling (Dongguan)	71	57	61	53	53	31	35	38	51	51	60	77	53
Tap Mun (Hong Kong) ^	39	40	49	36	29	17	19	23*	29	43	40	54	35*
Tsuen Wan (Hong Kong)	37	38	42	34	33	16	16	21	32	37	40	55	33
Yuen Long (Hong Kong)	55	47	49	41	36	17	16	23	32	46	55	59	40
Tung Chung (Hong Kong)	54	43	41	30	29	13	16	19	26	35	45	60	34
Taipa Grande (Macao) #	64	55	58	45	43	14	17	19*	-	84*	51	79	46*

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

* The capture rate of validated daily data per month/year is below 85%.

^ Tap Mun's data are for reference only owing to its low daily data capture rate in 2017.

The operation of the PM_{10} monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are for reference only owing to its low daily data capture rate in 2017.

4.6 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 2017, the annual average of $PM_{2.5}$ recorded at each monitoring station in the Network ranged from 20 to 49 μg/m^3, and 16 monitoring stations met the national annual average concentration limit (35 μg/m^3). During the year, 2 monitoring stations in the Network recorded no exceedance of the national 24-hour average concentration limit (75μg/m^3) while the corresponding compliance rates in the Network ranged from 83.2% to 100.0%.

Tables 4.5a and 4.5b list the monthly maxima of daily averages with the 95th percentile of the year, and the monthly and annual averages of $PM_{2.5}$ at each station respectively.

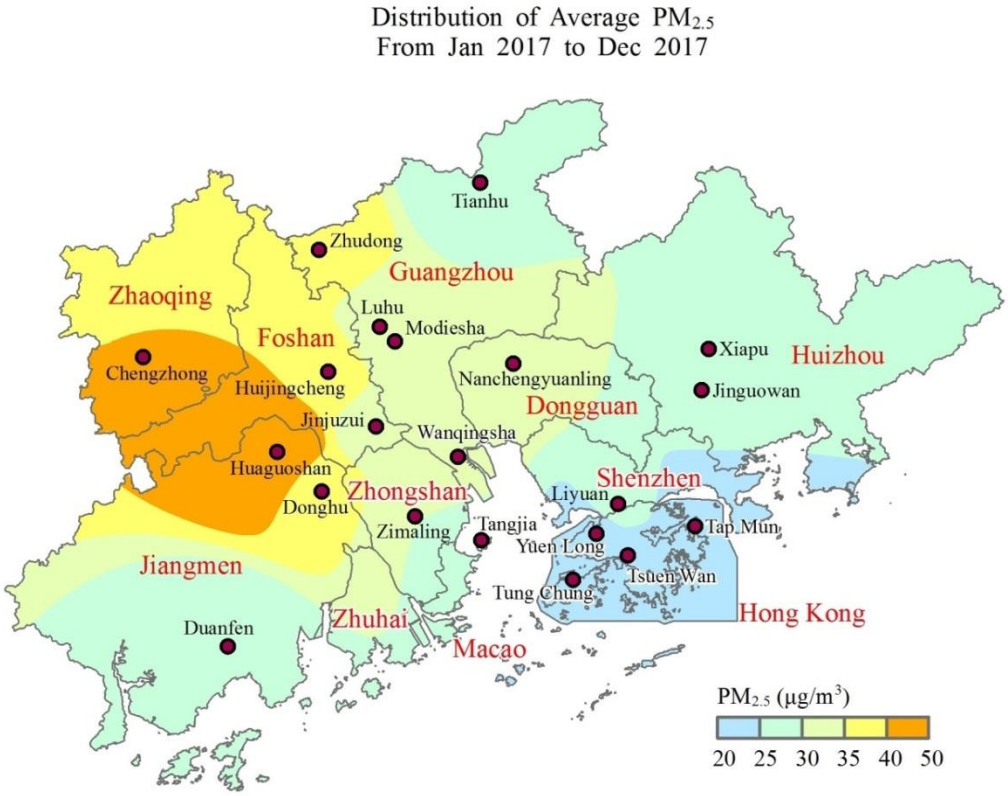

Figure 10：Spatial distribution of annual average concentrations of Fine Suspended Particulates ($PM_{2.5}$)

Remark: Taipa Grande's and Tap Mun's data are excluded in the spatial distribution map owing to its low daily data capture rate in 2017.

Table 4.6a：Daily averages of $PM_{2.5}$ (the monthly maxima and the 95th percentile of the year)

[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)	128	67	82	69	79	29	46	36	58	69	72	87	98.6%	67
Modiesha (Guangzhou)	123	58	59	59	83	27	47	37	64	71	74	78	97.3%	59
Wanqingsha (Guangzhou)	79	59	66	57	106	19	60	48	79	74	79	91	97.8%	66
Tianhu (Guangzhou)	67	53	47	47	47	30	47	43	50	61	66	58	100.0%	47
Zhudong (Guangzhou)	124	74	75	64	80	47	52	58	84	79	75	83	95.8%	74
Liyuan (Shenzhen)	67	64	53	34	49	21	58	50	56	61	82	88	98.6%	56
Jinjuzui (Foshan)	106	61	56	50	84	27	54	36	59	76	75	82	97.8%	61
Huijingcheng (Foshan)	215	81	64	82	87	39	63	42	71	83	86	104	94.9%	76
Tangjia (Zhuhai)	62	64	53	34	63	15	55	41	74	68	90	102	98.3%	64
Donghu (Jiangmen)	123	82	73	62	76	29	63	45	81	89	93	115	93.4%	82
Duanfen (Jiangmen)	68	64	58	39	67	12	36	26	37	74	77	96	99.1%	62
Huaguoshan (Jiangmen)	219	93	108	115	99	56	70	63	77	113	119	147	83.2%	104
Chengzhong (Zhaoqing)	143	90	77	75	78	39	51	35	79	94	75	132	92.5%	80
Xiapu (Huizhou)	89	58	55	61	40	22	47	52	51	65	71	83	98.9%	60
Xijiao (Huizhou) ^	59	54	47	50	46	32	53	46	47	58	67	63	--	--
Jinguowan (Huizhou)	81	50	48	52	36	20	59	50	47	51	65	58	99.7%	48
Zimaling (Zhongshan)	83	67	65	41	66	18	56	45	57	72	78	98	98.6%	64
Nanchengyuanling (Dongguan)	102	65	59	68	70	25	52	47	58	84	75	99	95.9%	70
Tap Mun (Hong Kong)	47	50	44	39	41	19	49	19	39	45	56	47	100.0%	39
Tsuen Wan (Hong Kong)	49	49	63	39	84	15	56	48	82	50	65	76	99.1%	47
Yuen Long (Hong Kong)	52	52	52	30	50	15	54	41	58	47	63	77	99.4%	47
Tung Chung (Hong Kong)	76	55	61	31	88	11	55	49	55	45	57	74	99.4%	53
Taipa Grande (Macao) #	72	67	69	39	79	8	48	34	--	54	74	96	--	--

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

^ Xijiao's data are for reference only owing to its low daily data capture rate in 2017.

The operation of the $PM_{2.5}$ monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are for reference only owing to its low daily data capture rate in 2017.

Table 4.6b：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)	42	38	43	32	33	17	18	20	33	29	37	49	33
Modiesha (Guangzhou)	46	36	35	32	33*	18*	20	20	33	28	34	48*	32
Wanqingsha (Guangzhou)	44	36	33	32	35	12	19	19	29	36	45	54	33
Tianhu (Guangzhou)	33	33	22	26*	25	17	16	21	25	25	27	31	25
Zhudong (Guangzhou)	50	44	37	39*	44	27*	26	28*	46	37	39	46	39
Liyuan (Shenzhen)	35	30	28	25	24	11	12	17	24	31	36	49	27
Jinjuzui (Foshan)	47	37	35	32	33	17	20	20	30	30	38	45	32
Huijingcheng (Foshan)	61	43	44	38	40	21	24	23	37	34	42	52	39
Tangjia (Zhuhai)	38	35	30	23	24	8	14	12*	23	33	42	55	28
Donghu (Jiangmen)	57	43	43	34	35	16	22	19	33	37	46	58	37
Duanfen (Jiangmen)	35	29	31	22	23	7	11	10	16	30	39	47	25
Huaguoshan (Jiangmen)	78	55	64	52	52	21	27	24	42	48	55	73	49
Chengzhong (Zhaoqing)	60	49	48	36	35	19	27	21	39	38	42	60	40
Xiapu (Huizhou)	43	35	30	28	27	15	13	21	25	30	39	51	30
Xijiao (Huizhou) ^	37	34	27	29	30	20*	19*	27*	26	29	31	36	29*
Jinguowan (Huizhou)	33	28	27	27	23	13	16	20	25	28	30	37	26
Zimaling (Zhongshan)	46	35	33	27	29	10	14	16	23	31	41	51	30
Nanchengyuanling (Dongguan)	53	41	36	36	36	18	21	22	31	34	42	55	35
Tap Mun (Hong Kong)	26	25	26	22	19	9	10	11*	17	22	22	28	20
Tsuen Wan (Hong Kong)	28	27	28	23	24	8	10	13	23	25	28	36	23
Yuen Long (Hong Kong)	29	26	25	21	20	10	12	14	20	24	26	38	22
Tung Chung (Hong Kong)	37	27	23	17	19	6	10	12	16	21	28	36	21
Taipa Grande (Macao) #	39	34	31	23	22	2	9	10*	-	44*	27	40	24*

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

* The capture rate of validated daily data per month/year is below 85%.

^ Xijiao's data are for reference only owing to its low daily data capture rate in 2017.

The operation of the $PM_{2.5}$ monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are for reference only owing to its low daily data capture rate in 2017.

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 2017. In general, the monthly average concentrations of SO_2, NO_2, PM_{10}, $PM_{2.5}$, and CO were higher during the winter season (first and fourth quarters of the year) and relatively lower in the summer months. The lower pollutant levels in summer were mainly due to the cleaner 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. The ozone concentration was higher in October, mainly due to the fact that there were more days with meteorological conditions that favoured photochemical reactions (such as strong solar radiation and less amount of clouds) and resulted in more ozone formation during the period.

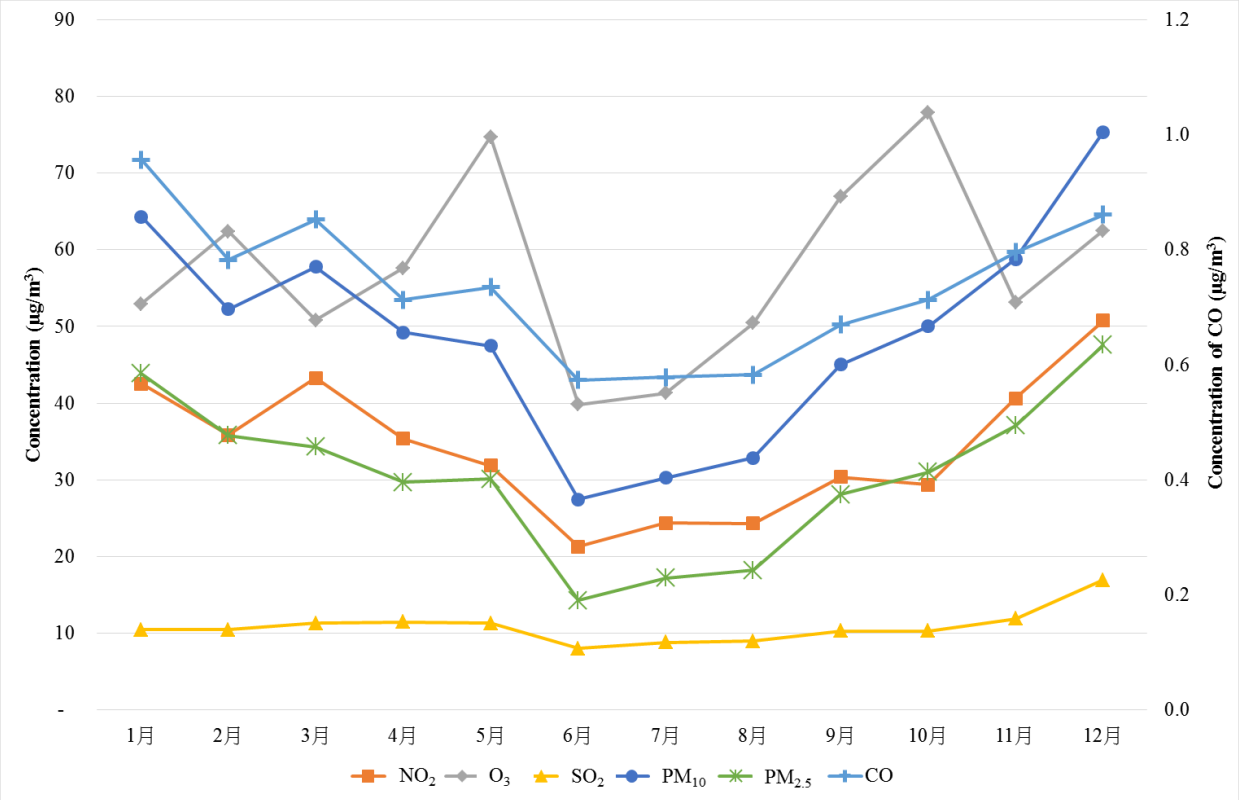

Figure 11：Monitoring network monthly variations of air pollutant concentrations

Remark: (1) Tap Mum's PM_{10} and Xijiao's $PM_{2.5}$ data are excluded in calculation of the monthly variation of pollutant concentrations owing to its low daily data capture rate in 2017.

(2) The operation of the PM_{10} and $PM_{2.5}$ monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are excluded in calculation of the monthly variation of pollutant concentrations owing to its low daily data capture rate in 2017.

4.8 Annual Variations of Pollutant Concentrations (2006-2017)

Table 4.8 shows the annual average concentrations of air pollutants recorded by the Network from 2006 to 2017, while Figure 12 shows the trend of rate of changes in the annual pollutant concentrations.

From 2006 to 2017, the annual averages recorded by the Network for SO_2, NO_2, and PM_{10} decreased by 77%, 26% and 34% respectively, which exhibited a discernible downward trend with a descending rate of about 3.3, 1.1 and 2.3 $\mu g/m^3$ per year respectively. As for CO and $PM_{2.5}$, although these two parameters had only been added to the Network in September 2014, their annual averages also decreased by 7% and 3% respectively between 2015 and 2017. These reductions indicate that the measures implemented in recent years by concerted or individual effort of Guangdong, Hong Kong and Macao, including retrofitting of power plants with flue-gas desulphurization facilities, 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. Compared with 2006, the annual average of O_3 in 2017 increased by 21%, reflecting the photochemical smog problem in the region has not yet been resolved. 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 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	O_3 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	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	0.791
2016	12	35	50	46	29	0.786
2017	11	34	58	49	31	0.739

Remark: (1) Tap Mum's PM_{10} and Xijiao's $PM_{2.5}$ data are excluded in calculation of annual averages of the pollutants in 2017 owing to its low daily data capture rate in 2017.

(2) The operation of the PM_{10} and $PM_{2.5}$ monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are excluded in calculation of annual averages of the pollutants in 2017 owing to its low daily data capture rate in 2017.

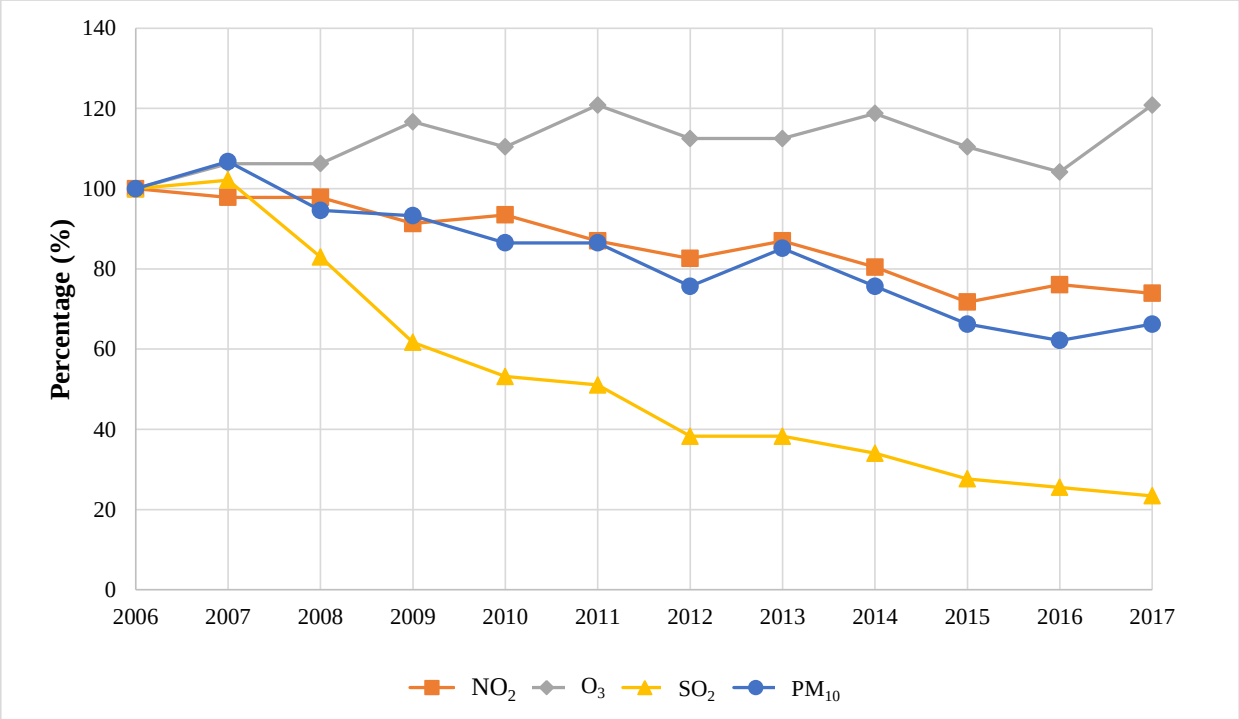

Figure 12：Trend of rates of changes in pollutant's annual averages in the monitoring network

Remark: (1) Tap Mum's PM_{10} data are excluded in calculation of annual averages of the pollutants in 2017 owing to its low daily data capture rate in 2017.

(2) The operation of the PM_{10} monitoring equipment at the Taipa Grande monitoring station was temporarily suspended from 23 August to 23 October 2017 due to the influence of Typhoon Hato, hence its data are excluded in calculation of annual averages of the pollutants in 2017 owing to its low daily data capture rate in 2017.

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. 63, Zhengdong Road, Duanzhou District	Urban: mixed residential/commercial	38m	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