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

A Report of Monitoring Results in 2018

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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 2018 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.

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 and when necessary.

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

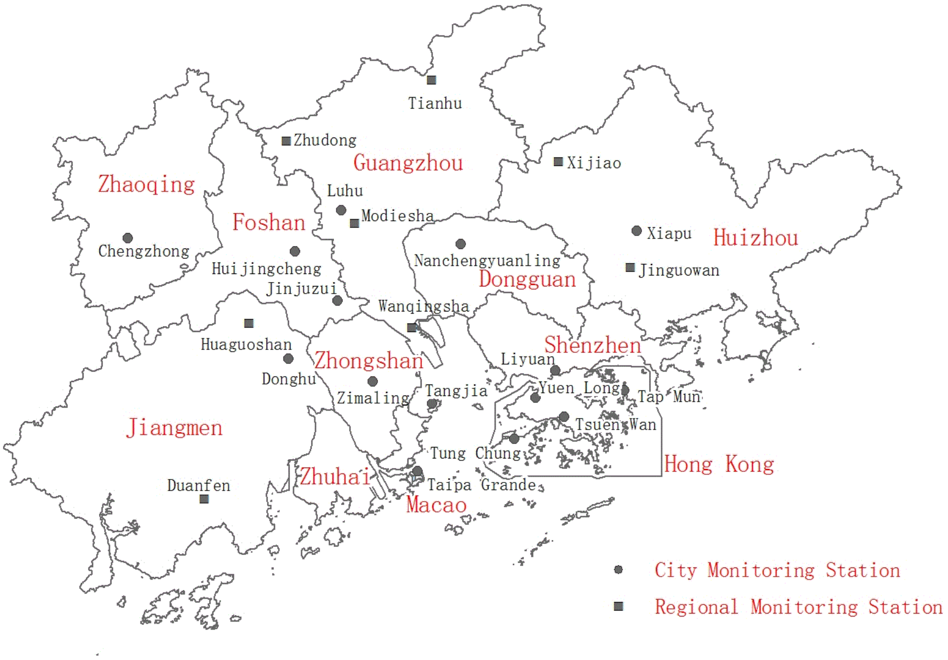

Figure 2：Spatial distribution of monitoring stations in the Network (from Sept 2014)

Remark: For the boundary of the administrative division of the Macao Special Administrative Region, according the Decree n.º665 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 2018. 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 2018, except Tap Mun and Jinguowan stations had a lower data capture rate in September owing to the influence of Typhoon Mangkhut. The average hourly data capture rate for the six air pollutants measured at all monitoring stations was 96.6%.

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 2018, we had carried out 422 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 -10.4% to 9.2%, 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 2018, we had carried out 3451 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 -9.4% and 8.4%, which were within the required performance goals (see Figure 4). In 2018, the overall QA/QC performance of the Network was satisfactory and met all the requirements specified in the QA/QC Operating Procedures.

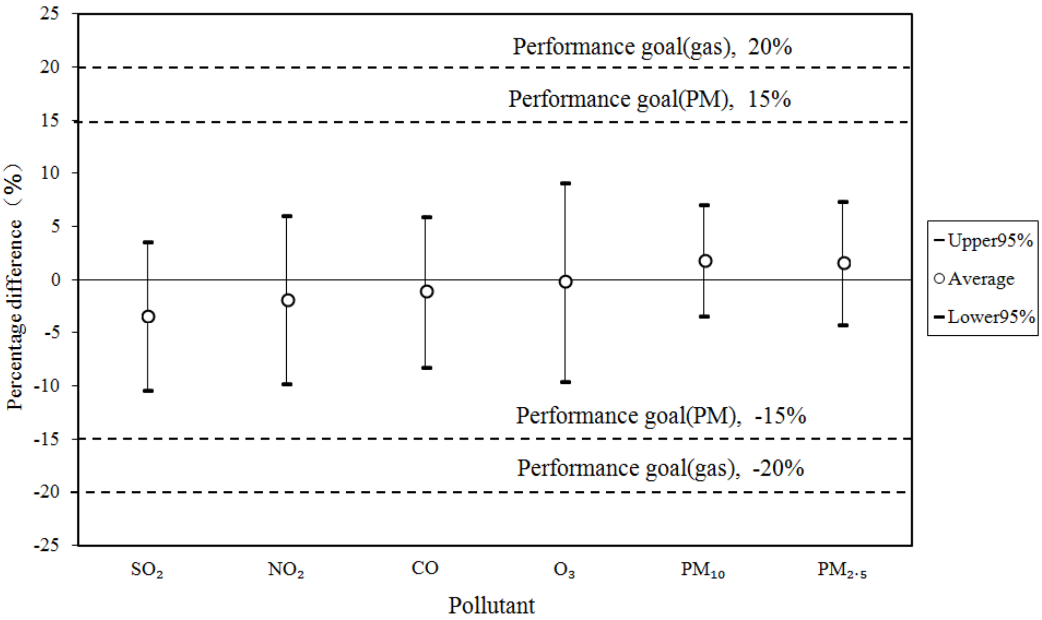

Figure 3：Accuracy of the monitoring network in 2018

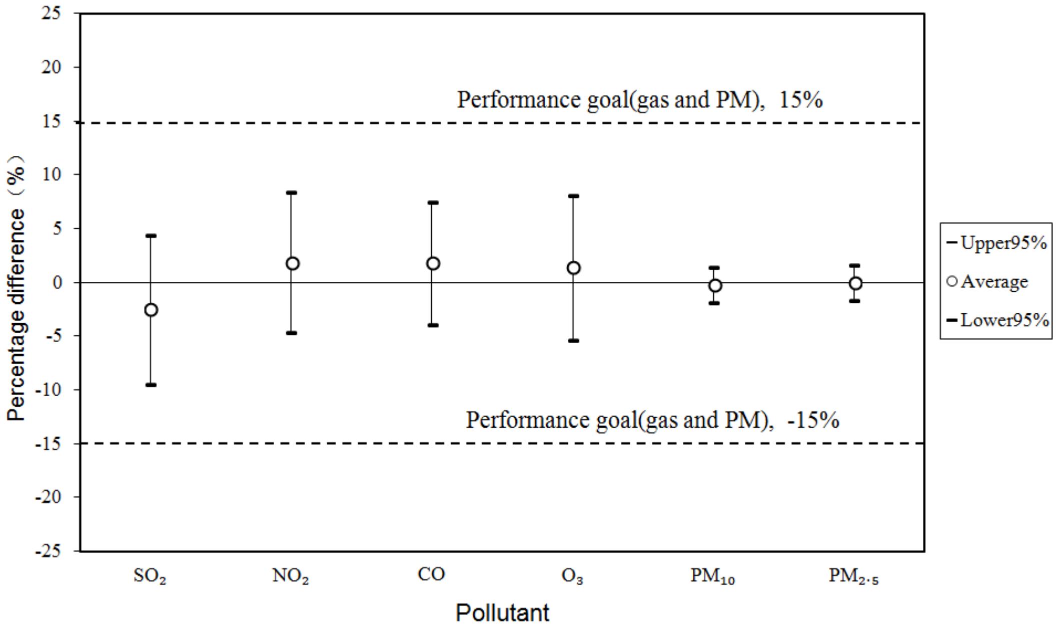

Figure 4：Precision of the monitoring network in 2018

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 rates in 2018 for all pollutants at Tap Mun station in Hong Kong and O_3 at Jinguowan station in Huizhou, these data were excluded from the following statistical analysis and 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 2018, the annual average of SO_2 recorded at each monitoring station in the Network ranged from 4 to 16 $\mu g/m^3$, and all were in compliance with the national annual average concentration limit (60 $\mu g/m^3$). 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 $\mu g/m^3$) and 1-hour average concentration limit (500 $\mu g/m^3$) of SO_2.

Tables 4.1a to 4.1c 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.

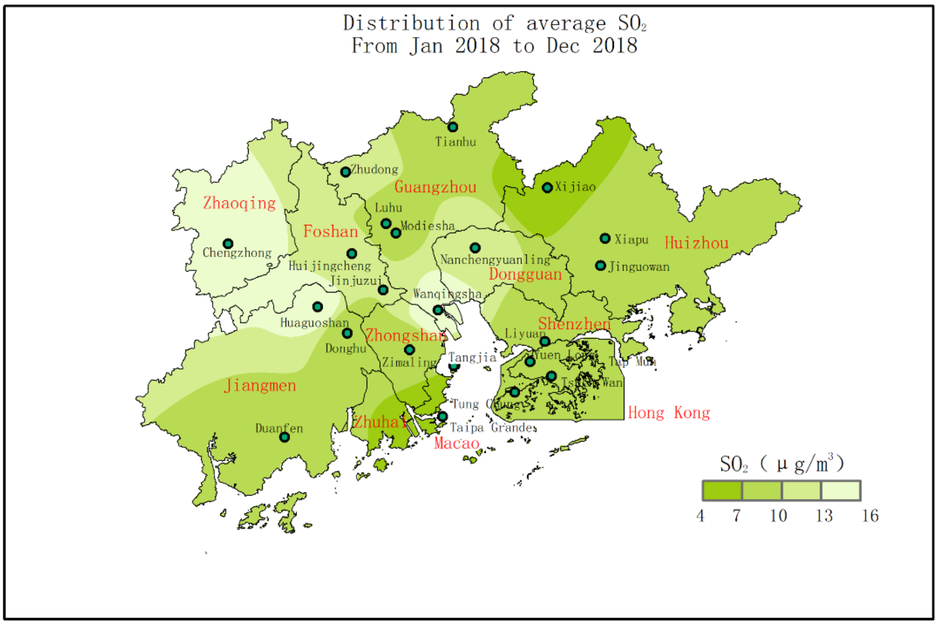

Figure 5：Spatial distribution of annual average concentrations of Sulphur Dioxide (SO_2)

Remark: Tap Mun's data are excluded owing to its low daily data capture rate in 2018.

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

[Class II limit: 500 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	38	20	34	28	24	20	17	20	20	25	14	17
Modiesha (Guangzhou)	38	22	34	33	22	31	22	31	29	35	28	29
Wanqingsha (Guangzhou)	120	105	89	84	50	49	57	31	41	120	45	40
Tianhu (Guangzhou)	40	35	33	34	28	24	18	31	19	39	17	17
Zhudong (Guangzhou)	56	49	39	38	36	35	40	36	71	70	52	33
Liyuan (Shenzhen)	18	11	15	16	18	11	11	14	12	15	14	11
Jinjuzui (Foshan)	64	31	33	37	24	29	46	20	75	32	23	29
Huijingcheng (Foshan)	91	34	32	26	47	48	46	58	44	52	50	37
Tangjia (Zhuhai)	56	61	54	49	26	49	38	35	18	47	44	27
Donghu (Jiangmen)	62	39	40	37	30	25	29	27	28	44	38	32
Duanfen (Jiangmen)	45	20	34	30	25	42	22	22	23	33	34	28
Huaguoshan (Jiangmen)	132	103	41	48	64	68	61	51	51	58	64	69
Chengzhong (Zhaoqing)	123	78	147	263	146	88	115	102	64	110	123	163
Xiapu (Huizhou)	31	46	22	27	29	22	27	28	26	37	33	26
Xijiao (Huizhou)	80	92	34	20	11	35	17	11	10	25	29	24
Jinguowan (Huizhou)	20	24	34	21	21	20	48	12	16	58	14	24
Zimaling (Zhongshan)	43	46	43	40	29	29	19	22	20	28	33	31
Nanchengyuanling (Dongguan)	68	37	40	49	29	40	35	51	34	45	38	32
Tap Mun (Hong Kong) ^	28	23	21	21	21	15	12	15	22	21	17	17
Tsuen Wan (Hong Kong)	99	105	57	60	46	26	26	32	41	35	43	36
Yuen Long (Hong Kong)	55	26	45	40	39	23	29	32	40	23	24	35
Tung Chung (Hong Kong)	76	34	48	46	47	41	27	30	26	43	34	49
Taipa Grande (Macao)	42	21	40	40	17	21	11	9	16	15	15	28

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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)	19	16	19	18	15	9	10	11	11	14	11	9	100.0%	16
Modiesha (Guangzhou)	18	11	16	14	12	12	13	15	19	19	18	18	100.0%	18
Wanqingsha (Guangzhou)	42	28	40	25	21	14	19	20	23	29	24	24	100.0%	29
Tianhu (Guangzhou)	22	16	15	21	14	12	12	11	10	14	12	9	100.0%	18
Zhudong (Guangzhou)	24	15	22	18	14	15	17	16	24	32	21	18	100.0%	25
Liyuan (Shenzhen)	9	10	9	10	10	9	9	8	9	12	11	9	100.0%	10
Jinjuzui (Foshan)	28	19	17	21	12	13	13	11	19	14	15	14	100.0%	21
Huijingcheng (Foshan)	46	17	15	16	22	19	16	22	21	26	25	22	100.0%	26
Tangjia (Zhuhai)	26	17	22	11	9	15	12	7	6	12	10	17	100.0%	21
Donghu (Jiangmen)	25	12	15	14	13	15	11	12	12	21	18	16	100.0%	18
Duanfen (Jiangmen)	18	13	16	14	13	12	10	13	14	18	17	17	100.0%	16
Huaguoshan (Jiangmen)	43	22	23	24	24	26	23	17	16	24	20	20	100.0%	30
Chengzhong (Zhaoqing)	36	23	39	47	30	20	36	21	20	33	41	31	100.0%	36
Xiapu (Huizhou)	16	17	12	15	17	11	13	11	12	18	16	15	100.0%	16
Xijiao (Huizhou)	15	13	12	8	6	31	14	4	5	9	10	8	100.0%	13
Jinguowan (Huizhou)	13	13	13	13	14	10	9	8	9	12	11	9	100.0%	13
Zimaling (Zhongshan)	19	15	18	15	10	11	8	9	10	17	18	10	100.0%	16
Nanchengyuanling (Dongguan)	32	17	19	18	16	15	15	20	16	21	22	17	100.0%	21
Tap Mun (Hong Kong) ^	14	13	11	11	11	8	8	11	11	15	12	11	--	--
Tsuen Wan (Hong Kong)	35	22	18	14	14	12	11	16	16	13	14	15	100.0%	18
Yuen Long (Hong Kong)	21	14	15	18	16	11	11	15	15	12	11	10	100.0%	15
Tung Chung (Hong Kong)	23	19	20	12	16	22	11	13	14	20	19	19	100.0%	19
Taipa Grande (Macao)	20	13	13	9	7	8	2	5	7	9	9	11	100.0%	12

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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

[Class II limit for annual average: 60 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	12	10	12	12	11	7	8	8	8	10	7	7	9
Modiesha (Guangzhou)	9	6	9	8	7	9	11	12	14	16	12	12	10
Wanqingsha (Guangzhou)	23	17	19	18	13	10	13	13	15	18	18	17	16
Tianhu (Guangzhou)	12	9	9	14	11	9	9	6	6	7	5	5	8
Zhudong (Guangzhou)	15	9	11	10	9	11	8	9	14	21	15	12	12
Liyuan (Shenzhen)	7	7	7	7	7*	8	7	7	7	8	8	8	7
Jinjuzui (Foshan)	17	12	14	14	8	7	9	7	7	9	9	7	10
Huijingcheng (Foshan)	21	9	7	10	11	8	8	10	13*	13	13	11	11
Tangjia (Zhuhai)	16	12	9	5	3	4	4	4	4	7	7	12	7
Donghu (Jiangmen)	12	8	9	7	7	7	6	7	6	11	10	9	8
Duanfen (Jiangmen)	10	8	9	9	8	8	7	8	10	13	12	11	9
Huaguoshan (Jiangmen)	23	15	17	16	17	15	13	7	9	14	14	11	14
Chengzhong (Zhaoqing)	18	9	22	23	15	10	15	12	11	17	18	11	15
Xiapu (Huizhou)	10	8	8	9	10	8	8	8	9	12	12	12	9
Xijiao (Huizhou)	8	7	5	4	4	7	8	3	3	5	6	5	5
Jinguowan (Huizhou)	10	10	10	11	10	7*	6	7	7*	8	7	6*	8
Zimaling (Zhongshan)	12	9	10	10	6	6	6	5	5	10	11	6	8
Nanchengyuanling (Dongguan)	17	11	13	12	10	9	10	11	11	13	13	8	11
Tap Mun (Hong Kong) ^	8	8	8	8	8	7	7	7	8*	9	8	7	8*
Tsuen Wan (Hong Kong)	15	11	8	8	9	6	7	8	9	8	8	8	9
Yuen Long (Hong Kong)	10	10	10	11	10	8	8	8	9	8	7	8	9
Tung Chung (Hong Kong)	10	11	10	7	6	7	7	8	10	11	11	12	9
Taipa Grande (Macao)	7	8	6	5	2	2	0	1	3	6	5	7	4

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

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

^ Data are for reference only owing to its low daily data capture rate in 2018.

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 2018, the annual average of NO_2 recorded at each monitoring station in the Network ranged from 13 to 51 $\mu g/m^3$ and 16 monitoring stations met the national annual average concentration limit (40 $\mu g/m^3$). During the year, 5 monitoring stations in the Network recorded no exceedance of the national 24-hour average concentration limit (80 $\mu g/m^3$) while the corresponding compliance rates in the Network ranged from 91.5% to 100.0%; 10 monitoring stations recorded no exceedance of national 1-hour average concentration limit of NO_2 (200 $\mu g/m^3$).

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.

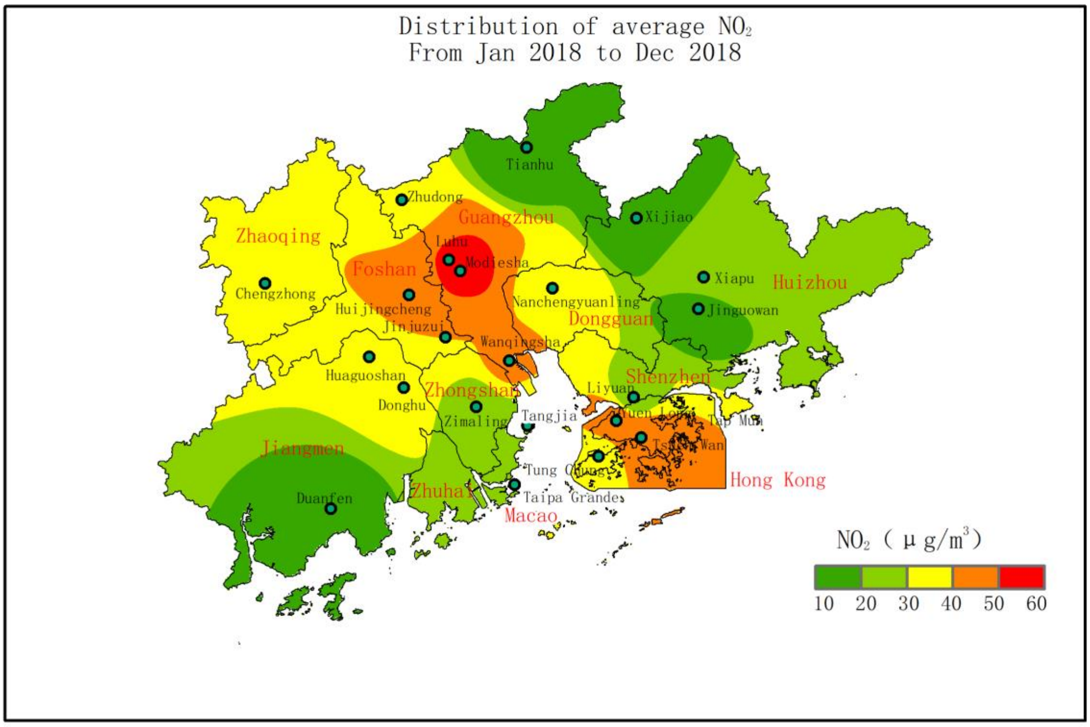

Figure 6：Spatial distribution of annual average concentrations of Nitrogen Dioxide (NO_2)

Remark: Tap Mun's data are excluded owing to its low daily data capture rate in 2018.

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

[Class II limit: 200 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	335	169	200	208	121	125	95	118	155	170	140	175
Modiesha (Guangzhou)	344	158	198	187	128	129	103	138	130	136	188	168
Wanqingsha (Guangzhou)	271	161	301	128	107	106	87	99	142	212	176	139
Tianhu (Guangzhou)	87	60	90	66	50	36	47	38	40	51	57	64
Zhudong (Guangzhou)	161	79	131	118	71	75	85	93	83	117	84	171
Liyuan (Shenzhen)	194	109	115	92	79	81	74	72	105	122	98	123
Jinjuzui (Foshan)	213	128	171	188	90	82	86	100	114	131	145	126
Huijingcheng (Foshan)	318	137	194	165	114	149	99	85	104	118	135	140
Tangjia (Zhuhai)	191	115	120	94	68	109	71	76	76	126	142	127
Donghu (Jiangmen)	197	112	140	113	70	85	70	86	77	129	148	139
Duanfen (Jiangmen)	121	87	47	56	36	29	29	28	37	58	103	92
Huaguoshan (Jiangmen)	165	119	119	115	73	84	60	71	87	110	124	204
Chengzhong (Zhaoqing)	164	106	137	158	110	136	121	88	121	141	148	202
Xiapu (Huizhou)	164	135	140	107	74	114	51	75	80	129	106	119
Xijiao (Huizhou)	46	38	109	51	38	41	43	32	33	37	49	58
Jinguowan (Huizhou)	83	47	67	47	57	55	47	57	69	78	45	72
Zimaling (Zhongshan)	181	108	95	102	59	67	49	84	82	127	186	110
Nanchengyuanling (Dongguan)	226	146	145	125	83	90	111	103	110	143	140	180
Tap Mun (Hong Kong) ^	99	60	48	60	72	41	32	43	50	45	49	77
Tsuen Wan (Hong Kong)	378	182	157	160	100	118	72	209	132	132	185	196
Yuen Long (Hong Kong)	248	139	126	130	105	112	81	128	131	161	163	199
Tung Chung (Hong Kong)	318	151	125	167	113	162	66	101	124	175	165	153
Taipa Grande (Macao)	205	114	113	95	80	89	51	100	80	98	130	131

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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)	205	99	106	93	70	61	59	58	78	83	87	117	92.5%	105
Modiesha (Guangzhou)	190	92	101	91	60	56	49	84	74	87	90	117	91.5%	105
Wanqingsha (Guangzhou)	162	88	174	73	51	44	41	49	45	94	76	88	94.6%	101
Tianhu (Guangzhou)	42	23	41	34	27	18	23	18	19	23	22	28	100.0%	30
Zhudong (Guangzhou)	82	55	82	57	38	45	37	40	37	56	55	110	98.9%	63
Liyuan (Shenzhen)	84	51	65	37	44	39	29	46	54	68	50	73	99.4%	57
Jinjuzui (Foshan)	148	91	86	93	41	40	37	62	51	69	87	78	95.5%	91
Huijingcheng (Foshan)	218	93	97	96	67	54	63	50	45	60	72	90	94.0%	98
Tangjia (Zhuhai)	84	60	76	54	37	46	32	33	29	60	58	69	99.7%	69
Donghu (Jiangmen)	113	71	53	77	46	37	33	40	44	74	97	76	97.5%	88
Duanfen (Jiangmen)	46	40	25	38	18	18	14	16	23	36	58	57	100.0%	44
Huaguoshan (Jiangmen)	121	87	67	73	41	40	28	33	40	70	70	85	97.5%	84
Chengzhong (Zhaoqing)	95	85	77	73	64	56	53	43	47	72	105	133	95.9%	92
Xiapu (Huizhou)	79	50	51	43	38	31	36	34	35	51	48	51	100.0%	52
Xijiao (Huizhou)	21	17	50	34	26	25	21	19	20	18	20	23	100.0%	23
Jinguowan (Huizhou)	36	29	48	25	27	24	27	28	28	27	26	27	100.0%	28
Zimaling (Zhongshan)	97	73	51	52	31	31	22	31	36	69	74	71	98.9%	71
Nanchengyuanling (Dongguan)	130	64	80	69	46	43	48	62	48	59	74	83	97.5%	88
Tap Mun (Hong Kong) ^	35	27	20	23	39	18	17	22	20	19	22	27	--	--
Tsuen Wan (Hong Kong)	206	118	89	83	62	58	44	92	71	73	96	90	93.5%	96
Yuen Long (Hong Kong)	144	87	72	68	71	59	43	74	77	86	90	90	97.2%	85
Tung Chung (Hong Kong)	145	82	85	85	59	79	49	57	77	78	81	85	97.1%	82
Taipa Grande (Macao)	99	80	69	58	51	44	24	42	52	62	77	76	99.4%	70

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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

[Class II limit for annual average: 40 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	74	49	64	57	37	41	36	44	44	51	55	49	50
Modiesha (Guangzhou)	78	42	63	53	39	38	35	49	45	54	59	49	51
Wanqingsha (Guangzhou)	71	43	60	44	27	27	23	27	29	36	51	46	41
Tianhu (Guangzhou)	15	12	19	20	15	10	10	10	9	10	11	12	13
Zhudong (Guangzhou)	44	26	48	40	23	25	26	27	25	37	36	37	33
Liyuan (Shenzhen)	35	27	24	23	19*	20	18	25	27	27	26	34	26
Jinjuzui (Foshan)	69	44	51	46	22	23	19	30	32	44	53	43	40
Huijingcheng (Foshan)	82	40	51	47	36	38	34	29	31	38	46	37	43
Tangjia (Zhuhai)	51	26	39	24	11	15	12	15	16	27	36	42	26
Donghu (Jiangmen)	58	29	30	30	17	19	19	25	22	44	56	46	33
Duanfen (Jiangmen)	32	20	14	17	9	7	6	7	11	21	27	28	17
Huaguoshan (Jiangmen)	66	34	30	28	16	16	15	19	20	38	46	40	31
Chengzhong (Zhaoqing)	57	29	40	38	28	30	31	32	29	45	54	48	39
Xiapu (Huizhou)	38	26	31	30	28	23	22	21	21	29	31	29	27
Xijiao (Huizhou)	15	12	16	17	17	14	12	12	12	14	15	15	14
Jinguowan (Huizhou)	23	16	19	18	17	15*	14	17	16*	17	18	20*	17
Zimaling (Zhongshan)	55	32	27	24	11	13	11	14	15	34	43	40	27
Nanchengyuanling (Dongguan)	60	32	46	40	25	28	28	37	30	37	45	42	38
Tap Mun (Hong Kong) ^	13	12	11	12	12	9	7	10	12*	11	12	17	11*
Tsuen Wan (Hong Kong)	67	68	58	48	37	35	29	46	43	49	49	55	49
Yuen Long (Hong Kong)	56	54	51	47	35	39	29	44	48	53	51	55	47
Tung Chung (Hong Kong)	46	51	38	30	21	25	19	31	40	43	39	48	36
Taipa Grande (Macao)	52	45	39	26	15	18	9	20	20	37	45	40	30

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
* The capture rate of validated daily data per month is below 85%.
^ Data are for reference only owing to its low daily data capture rate in 2018.

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 2018, the annual average of O_3 recorded at each monitoring station in the Network ranged from 46 to 73 $\mu g/m^3$ with higher average values being recorded in rural areas such as Tianhu of Guangzhou, 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 78.2% to 97.2%. 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.

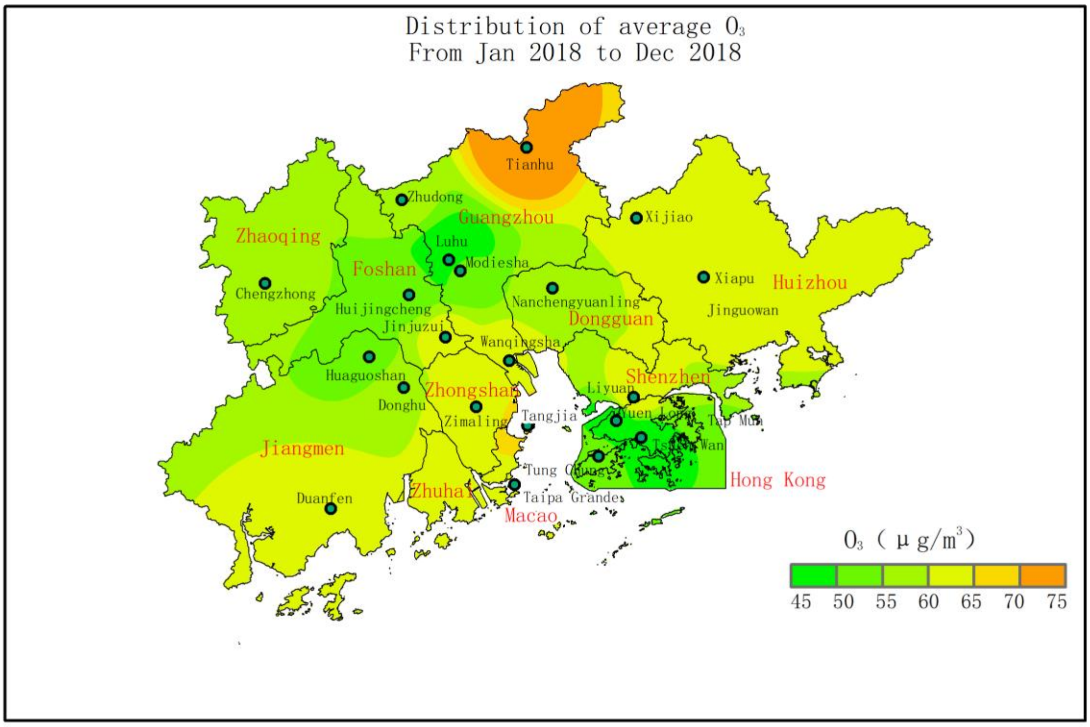

Figure 7 : Spatial distribution of annual average concentrations of Ozone (O_3)

Remark: Jinguowan's and Tap Mun's data are excluded owing to its low daily data capture rate in 2018.

Table 4.3a：Hourly averages of Ozone (the monthly maxima)

[Class II limit: 200 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	217	159	282	259	229	250	236	266	254	250	221	182
Modiesha (Guangzhou)	236	163	286	247	286	293	263	299	302	293	229	177
Wanqingsha (Guangzhou)	414	178	310	308	282	307	264	343	433	306	306	216
Tianhu (Guangzhou)	283	208	211	281	236	193	238	194	242	175	207	179
Zhudong (Guangzhou)	232	163	279	324	264	265	286	274	229	271	207	172
Liyuan (Shenzhen)	218	149	217	166	272	265	267	371	275	255	222	195
Jinjuzui (Foshan)	279	175	229	257	301	345	316	326	309	289	299	204
Huijingcheng (Foshan)	218	164	274	279	269	354	265	277	285	286	252	177
Tangjia (Zhuhai)	337	173	221	310	286	312	260	345	282	282	312	263
Donghu (Jiangmen)	338	178	280	260	239	340	295	345	289	312	323	251
Duanfen (Jiangmen)	196	171	186	197	185	307	227	197	228	275	213	126
Huaguoshan (Jiangmen)	327	172	262	240	214	327	267	254	214	272	206	180
Chengzhong (Zhaoqing)	265	152	277	224	200	289	242	273	256	250	229	200
Xiapu (Huizhou)	143	134	179	227	312	254	285	233	236	207	205	163
Xijiao (Huizhou)	173	159	264	327	252	238	273	237	290	193	177	179
Jinguowan (Huizhou) ^	184	172	222	235	309	208	293	294	255	222	230	221
Zimaling (Zhongshan)	320	166	214	201	317	344	262	353	244	289	246	205
Nanchengyuanling (Dongguan)	220	166	278	254	290	245	308	269	251	243	203	175
Tap Mun (Hong Kong) ^	220	168	181	188	329	218	143	365	200	269	224	164
Tsuen Wan (Hong Kong)	139	112	148	146	229	216	84	331	262	251	137	128
Yuen Long (Hong Kong)	212	130	149	133	238	285	230	379	243	238	235	190
Tung Chung (Hong Kong)	245	114	143	156	229	245	194	337	283	287	289	188
Taipa Grande (Macao)	372	158	176	201	308	293	201	295	273	295	275	176

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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)	151	127	209	215	185	204	175	174	184	200	162	120	89.0%	159
Modiesha (Guangzhou)	145	133	208	206	250	249	225	219	205	246	172	116	84.2%	173
Wanqingsha (Guangzhou)	255	161	222	234	225	282	190	275	264	262	211	146	79.8%	201
Tianhu (Guangzhou)	185	122	173	191	193	166	180	160	220	164	128	156	93.5%	152
Zhudong (Guangzhou)	182	137	243	261	212	232	183	233	204	235	163	123	82.9%	172
Liyuan (Shenzhen)	167	128	162	147	223	238	182	277	189	205	169	144	92.1%	148
Jinjuzui (Foshan)	203	148	198	225	272	305	240	252	227	244	227	136	79.2%	192
Huijingcheng (Foshan)	125	142	238	242	234	297	195	230	201	245	188	123	84.0%	177
Tangjia (Zhuhai)	290	144	186	248	237	282	212	291	235	261	231	209	85.1%	181
Donghu (Jiangmen)	246	152	226	219	189	308	230	316	226	280	274	176	78.2%	203
Duanfen (Jiangmen)	173	148	156	163	152	257	197	179	198	236	158	97	91.7%	152
Huaguoshan (Jiangmen)	244	148	211	212	180	283	214	206	184	246	170	127	86.5%	169
Chengzhong (Zhaoqing)	162	135	230	198	173	240	200	235	189	222	194	142	87.2%	165
Xiapu (Huizhou)	111	116	156	187	267	222	254	178	212	182	146	125	91.6%	153
Xijiao (Huizhou)	145	135	197	267	207	193	191	177	242	185	138	139	86.0%	166
Jinguowan (Huizhou) ^	150	143	166	198	248	186	251	217	210	192	170	188	--	--
Zimaling (Zhongshan)	221	145	167	167	225	318	228	300	216	254	197	147	84.6%	168
Nanchengyuanling (Dongguan)	176	141	215	215	232	206	269	216	205	208	158	141	87.1%	165
Tap Mun (Hong Kong) ^	195	146	169	177	249	195	120	277	181	208	181	156	--	--
Tsuen Wan (Hong Kong)	95	96	131	132	177	175	62	244	181	198	113	108	97.2%	112
Yuen Long (Hong Kong)	147	107	123	124	162	232	134	267	175	207	167	115	94.7%	124
Tung Chung (Hong Kong)	135	90	131	139	179	201	124	238	218	202	140	121	94.1%	128
Taipa Grande (Macao)	291	124	149	148	207	231	73	236	241	271	182	118	89.5%	155

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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)	29	49	51	45	54	50	41	47	56	65	39	26	46
Modiesha (Guangzhou)	31	51	50	42	48	58	46	60	71	79	44	26	51
Wanqingsha (Guangzhou)	51	64	69	61	55	66	46	72	68	95	63	35	62
Tianhu (Guangzhou)	69	74	84	83	79	68	61	72	84	78	67	55	73
Zhudong (Guangzhou)	42	61	61	58	63	66	58	67	73	67	42	24	56
Liyuan (Shenzhen)	61	67	77	68	56*	63	42	62	65	97	71	43	64
Jinjuzui (Foshan)	42	62	67	60	67	72	55	72	73	83	54	31	61
Huijingcheng (Foshan)	30	57	66	61	60	69	50	59	72	71	38	22	54
Tangjia (Zhuhai)	58	69	67	68	60	72	46	74	71	104	62	64	68
Donghu (Jiangmen)	39	59	77	63	55	71	46	69	70	89	56	32	60
Duanfen (Jiangmen)	60	69	79	64	48	66	42	59	67	90	56	39	61
Huaguoshan (Jiangmen)	44	61	71	55	45	62	41	56	58	71	43	25	53
Chengzhong (Zhaoqing)	38	60	65	56	53	66	54	61	66	78	50	31	56
Xiapu (Huizhou)	48	59	72	68	72	73*	52	64	72	99	65	38	65
Xijiao (Huizhou)	52	65	71	70	75	60	48	57	72	71	52	39	61
Jinguowan (Huizhou) ^	60	73	87	71	69	58*	40	47	67*	93	64	67*	67*
Zimaling (Zhongshan)	45	56	70	61	67	74	49	73	67	85	56	31	61
Nanchengyuanling (Dongguan)	45	61	65	56	68	65	48	65	61	76	48	31	57
Tap Mun (Hong Kong) ^	85	88	88	84	63	70	45	70	76*	120	88	57	78*
Tsuen Wan (Hong Kong)	46	43	57	53	39	48	25	42	46	88	57	34	48
Yuen Long (Hong Kong)	45	42	53	45	45	50	29	49	50	73	49	31	47
Tung Chung (Hong Kong)	45	33	52	49	53	62	41	57	53	79	56	29	51
Taipa Grande (Macao)	66	64	74	69	53	63	37	64	66	110	67	34	64

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%.
^ Data are for reference only owing to its low daily data capture rate in 2018.

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 2018, the annual average of CO recorded at each monitoring station in the Network ranged from 0.5 to 0.9 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 4.4a to 4.4c 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.

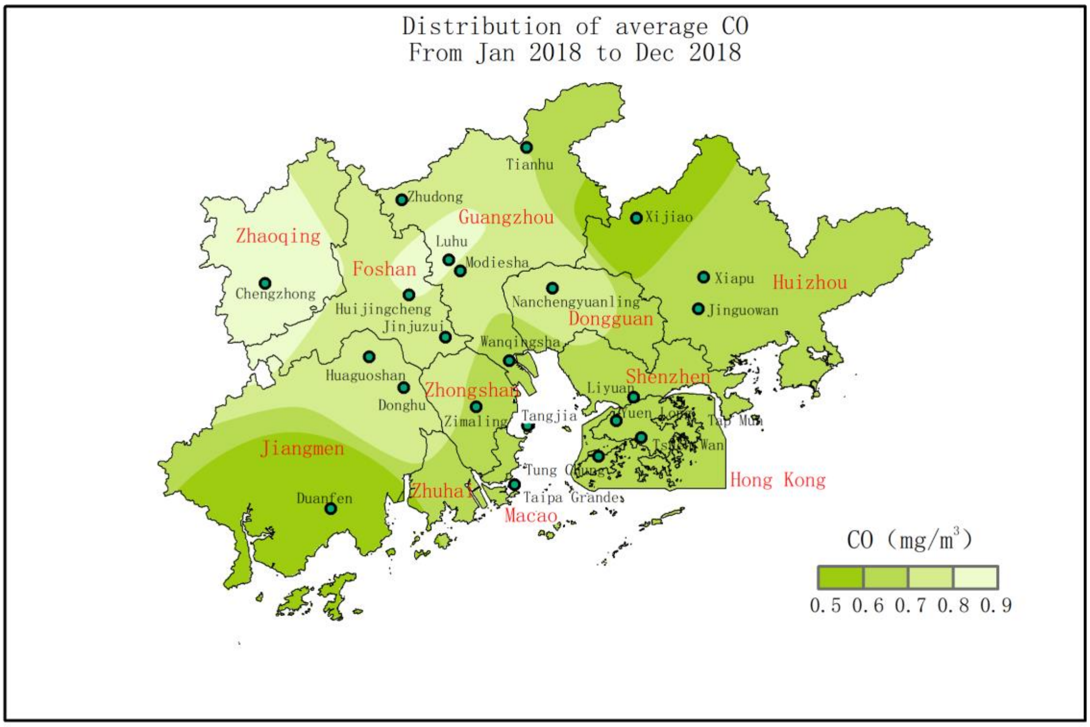

Figure 8：Spatial distribution of annual average concentrations of Carbon Monoxide (CO)

Remark: Tap Mun's data are excluded owing to its low daily data capture rate in 2018.

Table 4.4a：Hourly averages of Carbon Monoxide (the monthly maxima)

[Class II limit: 10 mg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Luhu (Guangzhou)	2.7	1.8	2.0	1.9	1.3	1.5	1.4	2.6	1.7	1.8	1.4	1.8
Modiesha (Guangzhou)	3.6	1.6	1.9	1.5	1.4	1.0	0.9	1.3	1.5	1.5	1.7	1.7
Wanqingsha (Guangzhou)	1.9	1.1	1.0	1.2	1.1	1.4	1.4	1.3	1.2	2.3	1.4	1.5
Tianhu (Guangzhou)	1.5	1.6	1.4	1.2	1.7	1.9	0.9	1.3	0.9	1.2	1.2	1.5
Zhudong (Guangzhou)	1.8	1.3	1.7	1.2	1.3	2.1	0.9	1.2	0.9	1.2	1.2	1.4
Liyuan (Shenzhen)	1.9	1.3	1.3	1.2	1.0	1.3	0.9	1.2	1.1	1.3	1.6	1.7
Jinjuzui (Foshan)	3.1	1.8	1.7	2.0	1.4	1.3	1.5	1.2	1.6	1.7	2.3	1.9
Huijingcheng (Foshan)	4.7	1.7	1.7	1.7	1.2	1.2	1.0	1.3	1.3	1.5	2.2	3.1
Tangjia (Zhuhai)	1.6	1.8	1.1	1.2	1.1	1.0	0.8	1.2	1.0	1.2	1.4	1.8
Donghu (Jiangmen)	4.9	2.1	1.9	1.9	1.4	1.9	1.5	1.8	1.6	2.0	3.1	3.1
Duanfen (Jiangmen)	2.0	1.2	1.3	1.2	0.6	1.0	1.0	0.8	0.8	1.0	1.3	1.4
Huaguoshan (Jiangmen)	2.0	1.2	1.4	1.4	1.0	2.4	1.0	1.2	1.4	1.4	1.6	1.4
Chengzhong (Zhaoqing)	2.4	2.1	1.7	1.8	2.2	1.5	1.6	1.6	1.4	2.0	2.1	2.3
Xiapu (Huizhou)	2.2	2.1	1.6	1.0	1.3	1.4	1.0	1.1	0.9	1.1	1.5	1.8
Xijiao (Huizhou)	1.8	1.2	2.4	1.7	1.0	1.2	1.0	0.9	0.9	1.6	1.2	1.7
Jinguowan (Huizhou)	1.3	1.1	1.4	1.0	0.9	2.0	0.9	1.0	0.8	1.0	1.1	1.4
Zimaling (Zhongshan)	1.8	1.3	1.1	1.4	1.2	1.4	0.9	1.6	1.4	1.2	1.7	2.1
Nanchengyuanling (Dongguan)	3.1	1.6	1.7	1.4	1.1	1.2	1.5	1.3	1.0	1.4	1.8	1.6
Tap Mun (Hong Kong) ^	1.2	0.9	1.0	1.0	0.9	0.8	0.6	1.0	0.8	0.8	0.8	1.0
Tsuen Wan (Hong Kong)	1.8	1.6	1.7	1.1	0.9	0.9	0.9	1.1	1.4	1.2	1.2	1.3
Yuen Long (Hong Kong)	1.5	1.3	1.2	1.0	0.7	1.1	1.0	1.2	1.3	1.4	1.4	1.8
Tung Chung (Hong Kong)	1.9	1.6	1.2	1.7	0.9	1.1	0.5	1.1	1.1	1.2	1.3	1.4
Taipa Grande (Macao)	1.4	1.1	1.4	1.0	0.7	0.8	0.8	1.6	1.5	1.4	1.4	5.3

Remark : All concentration units are in milligrams per cubic metre (mg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

Table 4.4b：Daily averages of Carbon Monoxide (the monthly maxima and the 95th percentile of the year) **[Class II limit: 4 mg/m³]**

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	95th percentile
Luhu (Guangzhou)	2.1	0.9	1.2	1.6	0.9	1.2	0.9	1.1	1.2	1.4	1.1	1.3	100.0%	1.3
Modiesha (Guangzhou)	1.9	1.4	1.2	1.2	0.9	0.7	0.6	1.1	1.1	1.1	1.3	1.1	100.0%	1.1
Wanqingsha (Guangzhou)	1.3	0.9	0.7	1.1	0.9	0.8	1.0	0.9	0.8	1.1	1.1	1.1	100.0%	1.0
Tianhu (Guangzhou)	1.3	1.4	1.3	0.7	0.6	1.0	0.8	1.2	0.9	0.9	1.0	1.0	100.0%	1.0
Zhudong (Guangzhou)	1.6	1.1	1.1	1.0	0.8	1.2	0.6	0.8	0.7	0.9	0.9	1.2	100.0%	1.0
Liyuan (Shenzhen)	1.1	1.0	0.9	1.0	0.8	0.9	0.7	0.9	0.8	0.9	1.0	1.2	100.0%	1.0
Jinjuzui (Foshan)	1.8	1.1	1.0	1.4	1.0	0.9	0.8	0.9	1.0	1.2	1.5	1.4	100.0%	1.4
Huijingcheng (Foshan)	2.4	1.0	0.9	1.3	0.9	0.8	0.7	1.0	0.9	1.1	1.4	1.6	100.0%	1.3
Tangjia (Zhuhai)	1.1	1.0	0.8	1.0	0.8	0.8	0.6	0.9	0.8	1.1	1.1	1.3	100.0%	1.0
Donghu (Jiangmen)	1.9	1.2	1.1	1.4	1.1	1.0	0.9	1.1	1.0	1.3	1.7	1.3	100.0%	1.2
Duanfen (Jiangmen)	1.2	0.9	0.7	0.8	0.4	0.6	0.4	0.7	0.7	0.8	1.0	1.2	100.0%	0.9
Huaguoshan (Jiangmen)	1.8	1.0	1.0	1.2	0.8	0.9	0.7	0.9	0.8	1.1	1.2	1.2	100.0%	1.1
Chengzhong (Zhaoqing)	1.7	1.3	1.4	1.4	1.0	1.2	1.1	1.1	0.9	1.4	1.4	1.6	100.0%	1.4
Xiapu (Huizhou)	1.5	1.2	0.8	0.9	0.8	1.0	0.9	0.9	0.7	0.8	1.2	1.0	100.0%	1.0
Xijiao (Huizhou)	1.2	0.9	1.8	1.1	0.5	0.7	0.8	0.8	0.7	0.9	0.7	0.9	100.0%	0.8
Jinguowan (Huizhou)	1.2	1.0	1.0	0.8	0.7	0.9	0.6	0.8	0.7	0.9	1.0	0.9	100.0%	0.9
Zimaling (Zhongshan)	1.3	0.9	0.9	1.0	1.1	1.1	0.7	1.3	1.1	0.9	1.0	1.5	100.0%	1.1
Nanchengyuanling (Dongguan)	1.7	1.1	1.1	1.2	0.9	0.9	1.1	1.2	0.7	1.1	1.4	1.4	100.0%	1.2
Tap Mun (Hong Kong) ^	1.2	0.8	0.9	0.8	0.8	0.8	0.6	0.8	0.7	0.7	0.6	0.8	--	--
Tsuen Wan (Hong Kong)	1.3	1.4	1.2	0.9	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.1	100.0%	1.1
Yuen Long (Hong Kong)	1.0	0.8	0.8	0.8	0.5	0.7	0.8	1.0	1.0	1.0	1.1	1.4	100.0%	1.0
Tung Chung (Hong Kong)	1.2	1.0	0.7	0.9	0.7	0.8	0.4	0.9	0.8	0.9	1.0	1.2	100.0%	1.0
Taipa Grande (Macao)	1.0	0.8	0.8	0.8	0.6	0.6	0.7	1.1	1.1	1.2	1.1	1.1	100.0%	1.0

Remark : All concentration units are in milligrams per cubic metre (mg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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)	1.3	0.6	0.8	0.9	0.7	0.8	0.7	0.9	0.9	0.9	0.8	0.9	0.9
Modiesha (Guangzhou)	1.1	0.9	0.8	0.8	0.6	0.5	0.3	0.7	0.7	0.8	0.9	0.9	0.7
Wanqingsha (Guangzhou)	0.9	0.6	0.5	0.6	0.5	0.5	0.5	0.6	0.6	0.7	0.9	0.8	0.6
Tianhu (Guangzhou)	0.9	0.8	0.8	0.5	0.5	0.5	0.6	0.8	0.7	0.7	0.7	0.7	0.7
Zhudong (Guangzhou)	1.0	0.8	0.8	0.7	0.5	0.4	0.5	0.5	0.6	0.7	0.6	0.8	0.7
Liyuan (Shenzhen)	0.8	0.8	0.7	0.6	0.5*	0.6	0.5	0.7	0.6	0.7	0.7	0.9	0.7
Jinjuzui (Foshan)	1.3	0.7	0.8	0.9	0.7	0.7	0.6	0.6	0.8	0.9	1.0	1.0	0.8
Huijingcheng (Foshan)	1.1	0.7	0.6	0.7	0.5	0.7	0.5	0.7	0.7	0.8	1.0	1.0	0.8
Tangjia (Zhuhai)	0.8	0.7	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.7	0.7	0.9	0.6
Donghu (Jiangmen)	1.1	0.8	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.9	1.1	1.0	0.8
Duanfen (Jiangmen)	0.8	0.7	0.5	0.4	0.3	0.3	0.3	0.4	0.4	0.6	0.7	0.8	0.5
Huaguoshan (Jiangmen)	1.1	0.7	0.7	0.7	0.5	0.6	0.5	0.7	0.6	0.8	0.9	0.9	0.7
Chengzhong (Zhaoqing)	1.3	0.9	0.9	0.9	0.7	0.8	0.9	0.9	0.8	0.9	1.1	1.0	0.9
Xiapu (Huizhou)	1.0	0.8	0.5	0.5	0.5	0.6	0.7	0.6	0.6	0.6	0.8	0.8	0.7
Xijiao (Huizhou)	0.7	0.6	0.6	0.5	0.3	0.5	0.5	0.4	0.5	0.6	0.6	0.7	0.5
Jinguowan (Huizhou)	0.6	0.7	0.6	0.4	0.5	0.5*	0.4	0.5	0.5*	0.7	0.7	0.7*	0.6
Zimaling (Zhongshan)	0.8	0.6	0.6	0.7	0.6	0.6	0.5	0.8	0.7	0.6	0.6	1.0	0.7
Nanchengyuanling (Dongguan)	1.2	1.0	0.9	0.8	0.6	0.7	0.7	0.8	0.5	0.9	1.0	0.9	0.8
Tap Mun (Hong Kong) ^	0.6	0.5	0.6	0.6	0.4	0.5	0.4	0.5	0.5*	0.4	0.4	0.6	0.5*
Tsuen Wan (Hong Kong)	0.9	1.1	1.0	0.6	0.5	0.5	0.5	0.6	0.4	0.7	0.6	0.8	0.7
Yuen Long (Hong Kong)	0.6	0.6	0.6	0.6	0.3	0.4	0.6	0.7	0.6	0.7	0.9	0.9	0.6
Tung Chung (Hong Kong)	0.8	0.8	0.5	0.5	0.5	0.5	0.3	0.5	0.5	0.6	0.6	0.9	0.6
Taipa Grande (Macao)	0.7	0.6	0.6	0.6	0.3	0.4	0.4	0.8	0.7	0.7	0.8	0.8	0.6

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%.

^ Data are for reference only owing to its low daily data capture rate in 2018.

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 2018, the annual average of PM_{10} recorded at each monitoring station in the Network ranged from 31 to 60 $\mu g/m^3$, and all monitoring stations met the national annual average concentration limit (70 $\mu g/m^3$). During the year, 8 monitoring stations in the Network recorded no exceedance of the national 24-hour average concentration limit (150 $\mu g/m^3$) while the corresponding compliance rates in the Network ranged from 97.8% to 100.0%.

Table 4.5a and Table 4.5b 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.

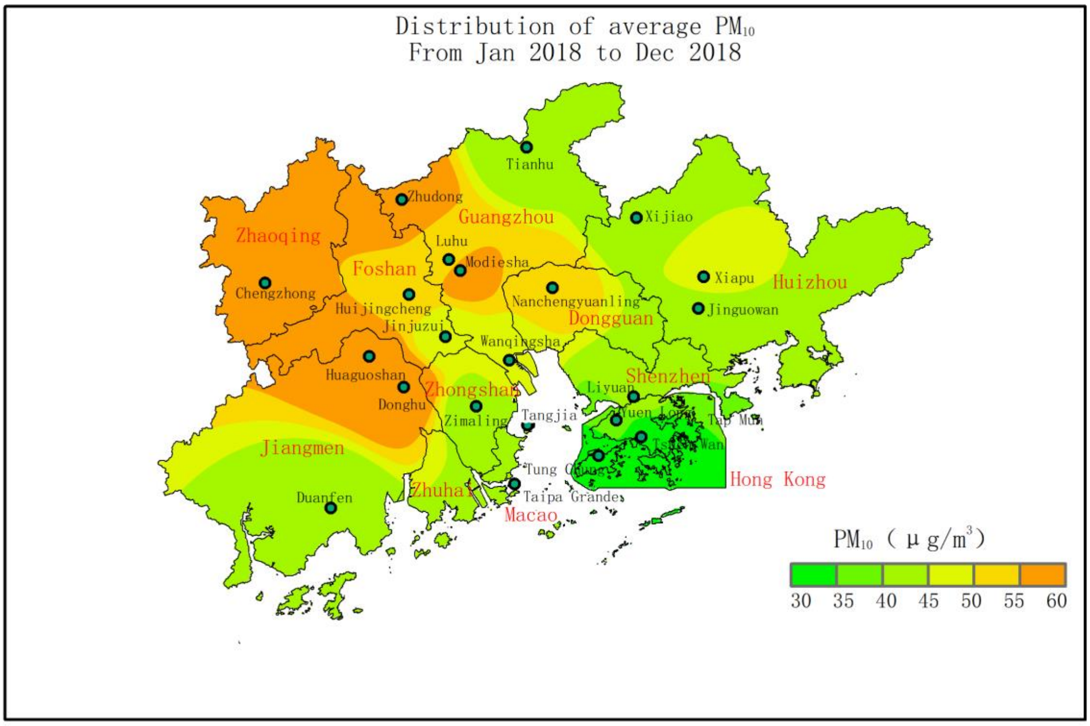

Figure 9：Spatial distribution of annual average concentrations of Respirable Suspended Particulates (PM_{10})

Remark: Tap Mun's data are excluded owing to its low daily data capture rate in 2018.

Table 4.5a：Daily averages of PM_{10} (the monthly maxima and the 95th 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	95th percentile
Luhu (Guangzhou)	171	105	117	111	60	55	53	64	78	96	87	102	99.7%	99
Modiesha (Guangzhou)	178	144	140	124	70	68	67	76	79	104	128	117	99.4%	115
Wanqingsha (Guangzhou)	177	97	96	112	50	66	44	61	71	83	92	79	99.7%	87
Tianhu (Guangzhou)	101	81	90	132	57	70	62	58	69	81	64	76	100.0%	80
Zhudong (Guangzhou)	151	163	131	138	76	80	75	76	82	122	125	168	99.2%	119
Liyuan (Shenzhen)	135	86	78	114	50	59	42	68	65	87	80	85	100.0%	77
Jinjuzui (Foshan)	153	95	85	100	48	62	46	62	58	81	94	94	99.4%	89
Huijingcheng (Foshan)	200	107	100	104	57	66	49	77	75	115	118	124	98.8%	104
Tangjia (Zhuhai)	174	101	72	116	65	72	44	77	70	82	83	100	99.7%	82
Donghu (Jiangmen)	216	102	117	199	60	81	61	79	74	106	178	110	97.8%	118
Duanfen (Jiangmen)	114	85	77	121	52	42	46	42	70	88	79	78	100.0%	77
Huaguoshan (Jiangmen)	199	127	110	150	58	87	54	67	79	111	151	145	98.6%	129
Chengzhong (Zhaoqing)	188	127	112	126	81	99	70	71	74	111	131	208	98.6%	120
Xiapu (Huizhou)	115	187	83	114	61	55	64	68	57	72	76	83	99.7%	80
Xijiao (Huizhou)	83	81	68	99	57	55	53	49	73	58	50	65	100.0%	65
Jinguowan (Huizhou)	120	92	80	107	62	52	59	69	61	79	65	66	100.0%	72
Zimaling (Zhongshan)	121	87	78	114	48	72	45	75	66	75	107	90	100.0%	77
Nanchengyuanling (Dongguan)	151	127	105	114	66	66	60	72	60	97	110	105	99.7%	100
Tap Mun (Hong Kong) ^	77	63	58	98	52	38	33	67	56	62	56	53	--	--
Tsuen Wan (Hong Kong)	135	78	57	83	38	42	23	74	52	70	65	52	100.0%	58
Yuen Long (Hong Kong)	121	89	63	116	39	46	25	71	62	72	80	56	100.0%	70
Tung Chung (Hong Kong)	157	74	56	97	38	49	24	58	60	73	80	68	99.7%	65
Taipa Grande (Macao)	156	105	77	150	59	67	36	68	85	75	93	88	99.7%	76

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

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)	73	52	58	64	41	35	33	41	47	54	55	48	50
Modiesha (Guangzhou)	85	56	70	72	48	38	40*	45	49*	64	69	53	58
Wanqingsha (Guangzhou)	75	55	50	54	30	30	25	31	39	57	62	50	47
Tianhu (Guangzhou)	49	46	46	61	40	28	30	33	37	44	39	33	41
Zhudong (Guangzhou)	80	63	72	82	50	43	45	46	54	65	63	56	60
Liyuan (Shenzhen)	57	51	44	55	29*	28	23	29	38	54	49	51	43
Jinjuzui (Foshan)	72	51	49	59	33	31	28	36	40	53	58	49	47
Huijingcheng (Foshan)	84	49	53	61	37	36	32	42	50	59	69*	55	52
Tangjia (Zhuhai)	66	61	43	50	26	29	22	32	36	58	57	55	45
Donghu (Jiangmen)	98	64	63	77	39	38	35	45	44	71	85	62	60
Duanfen (Jiangmen)	55	53	48*	46	22	21	20	22	33	58	51	46	40
Huaguoshan (Jiangmen)	96	66	67	71	33	35	30	38	52	76	91	68	60
Chengzhong (Zhaoqing)	88	62	62	70	41	43	43	43	42	61	67	55	56
Xiapu (Huizhou)	61	56	49	61	43	33	35	34	38	53	51	45	47
Xijiao (Huizhou)	46	47	45	56	40	31	32	31	40	41	38	34	40
Jinguowan (Huizhou)	47	43	42	57	38	31*	28	29	40*	50	42	39*	41
Zimaling (Zhongshan)	59	51	43	52	28	28	23	33	36	57	60	49	43
Nanchengyuanling (Dongguan)	76	53	58	65	41	38	37	43	42	61	63	50	52
Tap Mun (Hong Kong) ^	37	38	33	40	24	23	22	23	32*	41	32	31	31*
Tsuen Wan (Hong Kong)	43	44	35	37	19	18	14	24	30	39	34	30	31
Yuen Long (Hong Kong)	49	50	38	45	22	21	16	25	35	53	46	40	37
Tung Chung (Hong Kong)	45	45	32	34	15	19	14	20	28	44	39	42	31
Taipa Grande (Macao)	53	61	45	54	25	26	20	28	34	53	52	53	42

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%.
^ Data are for reference only owing to its low daily data capture rate in 2018.

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 2018, the annual average of $PM_{2.5}$ recorded at each monitoring station in the Network ranged from 18 to 41 $\mu g/m^3$, and 19 monitoring stations met the national annual average concentration limit (35 $\mu g/m^3$). During the year, 4 monitoring stations in the Network recorded no exceedance of the national 24-hour average concentration limit (75$\mu g/m^3$) while the corresponding compliance rates in the Network ranged from 90.8% to 100.0%.

Tables 4.6a and 4.6b 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.

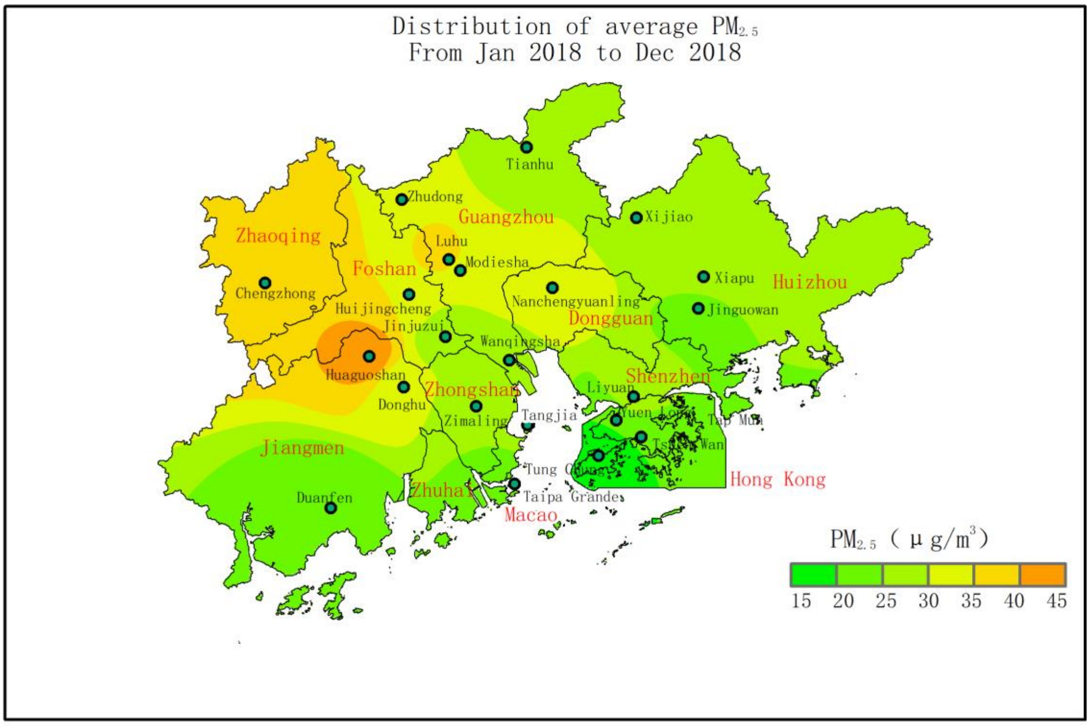

Figure 10：Spatial distribution of annual average concentrations of Fine Suspended Particulates ($PM_{2.5}$)

Remark: Tap Mun's data are excluded owing to its low daily data capture rate in 2018.

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

[Class II limit: 75 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compliance	95th percentile
Luhu (Guangzhou)	172	92	79	97	35	49	33	42	57	76	62	73	95.2%	74
Modiesha (Guangzhou)	97	112	59	54	32	39	39	53	47	62	63	56	97.4%	56
Wanqingsha (Guangzhou)	121	64	54	61	32	42	25	43	42	53	60	46	98.1%	51
Tianhu (Guangzhou)	72	64	50	54	33	48	39	38	46	54	41	39	100.0%	46
Zhudong (Guangzhou)	92	116	68	69	38	53	43	48	50	81	71	82	96.9%	68
Liyuan (Shenzhen)	99	61	47	48	29	45	27	54	53	68	62	50	99.2%	53
Jinjuzui (Foshan)	101	73	48	63	29	40	29	43	37	51	54	46	98.6%	52
Huijingcheng (Foshan)	152	104	69	73	34	46	34	55	49	80	85	76	95.4%	72
Tangjia (Zhuhai)	137	85	45	56	32	49	27	54	39	71	71	60	98.9%	56
Donghu (Jiangmen)	113	63	60	74	38	50	28	51	40	71	71	60	97.8%	63
Duanfen (Jiangmen)	73	55	51	43	23	23	24	28	42	51	50	47	100.0%	45
Huaguoshan (Jiangmen)	162	89	86	109	36	63	35	49	58	78	89	94	91.1%	86
Chengzhong (Zhaoqing)	170	113	90	84	52	70	40	44	45	76	101	154	90.8%	91
Xiapu (Huizhou)	84	151	50	48	37	36	33	42	36	52	51	50	98.1%	50
Xijiao (Huizhou)	62	58	42	59	36	38	37	31	54	47	37	52	100.0%	46
Jinguowan (Huizhou)	64	67	39	42	37	30	36	42	40	50	46	38	100.0%	40
Zimaling (Zhongshan)	86	61	49	42	28	40	29	55	40	59	59	50	98.9%	50
Nanchengyuanling (Dongguan)	136	106	79	83	35	42	35	42	39	61	75	72	95.9%	73
Tap Mun (Hong Kong) ^	46	41	31	31	29	26	15	51	29	32	25	30	--	--
Tsuen Wan (Hong Kong)	101	58	39	38	26	31	12	58	41	50	45	41	99.4%	41
Yuen Long (Hong Kong)	80	58	40	38	22	28	15	48	34	46	39	36	99.7%	41
Tung Chung (Hong Kong)	119	53	36	34	23	31	13	41	35	51	50	48	99.4%	37
Taipa Grande (Macao)	106	61	41	51	30	40	16	42	47	45	55	52	99.4%	41

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
^ Data are for reference only owing to its low daily data capture rate in 2018.

Table 4.6b：The monthly and annual averages of $PM_{2.5}$

[Class II limit for annual average: 35 μg/m³]

Monitoring Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Luhu (Guangzhou)	65	43	41	40	25	24	19	27	31	37	40	33	36
Modiesha (Guangzhou)	45	32	34	34	22*	21	19*	27	30*	36	36	26	30
Wanqingsha (Guangzhou)	49	37	31	32	18	18	14	21	25	35	38	29	29
Tianhu (Guangzhou)	33	29	28	31	23	18	16	20	24	27	25	22	25
Zhudong (Guangzhou)	49	38	40	39	28	25	25	28	33	40	40	36	35
Liyuan (Shenzhen)	40	36	28	31	18*	18	14	21	27	34	33	30	28
Jinjuzui (Foshan)	45	34	29	33	19	18	15	22	25	32	34	27	28
Huijingcheng (Foshan)	58	38	36	38	23	24	20	28	33	39	46	37	35
Tangjia (Zhuhai)	46	42	27	28	15	15	10	18	21	38	44	33	28
Donghu (Jiangmen)	51	40	33	34	19	20	16	25	25	38	44	33	31
Duanfen (Jiangmen)	32	28	23	22	11	9	8	13	19	31	30	25	21
Huaguoshan (Jiangmen)	72	49	44	43	23	25	17	28	34	50	57	42	41
Chengzhong (Zhaoqing)	73	52	44	41	24	27	24	27	27	40	52	44	40
Xiapu (Huizhou)	44	42	31	32	22	18	17	19	23	32	33	29	28
Xijiao (Huizhou)	32	33	29	33	25	19	18	20	28	29	28	26	26
Jinguowan (Huizhou)	27	29	25	30	21	17*	16	18	27*	30	27	26*	24
Zimaling (Zhongshan)	41	37	26	27	16	15	12	22	22	34	35	28	26
Nanchengyuanling (Dongguan)	61	43	41	39	23	22	19	25	26	38	43	35	35
Tap Mun (Hong Kong) ^	21	23	20	21	14	12	10	14	18*	21	18	17	17*
Tsuen Wan (Hong Kong)	30	31	22	22	13	11	7	18	21	25	24	21	20
Yuen Long (Hong Kong)	28	33	23	23	10	12	8	17	21	26	22	22	20
Tung Chung (Hong Kong)	28	28	18	15	7	10	6	12	16	24	22	24	18
Taipa Grande (Macao) #	29	31	22	25	11	11	6	14	17	27	27	25	20

Remark : All concentration units are in micrograms per cubic metre (μg/m³).
* The capture rate of validated daily data per month/year is below 85%.
^ Data are for reference only owing to its low daily data capture rate in 2018.

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 2018. 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.

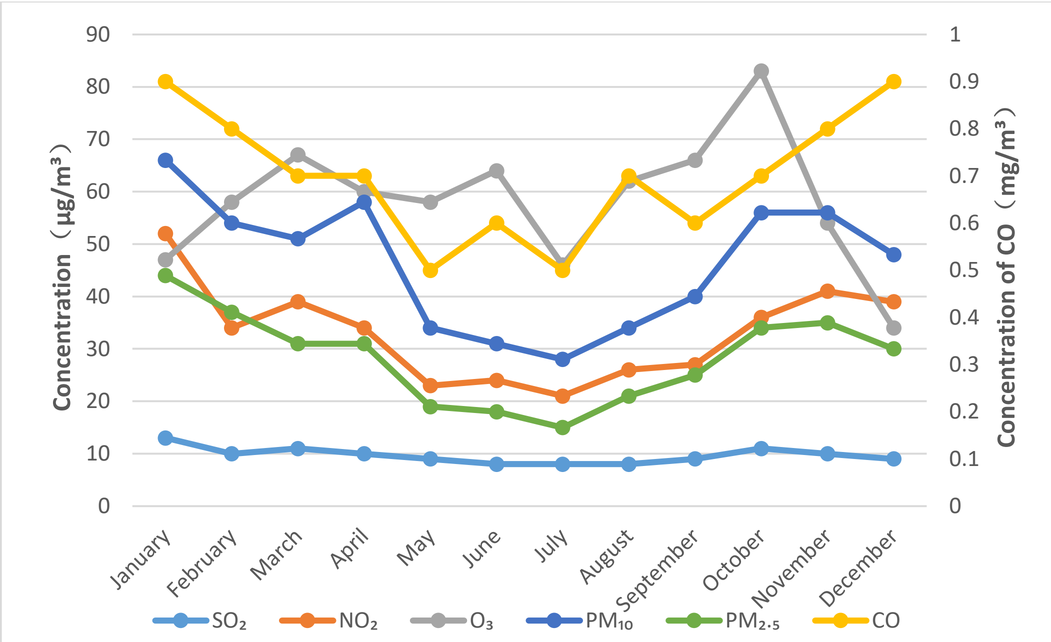

Figure 11：Monitoring network monthly variations of air pollutant concentrations

Remark: All Tap Mun's pollutants and Jinguowan's O_3 data are excluded owing to its low daily data capture rate in 2018.

4.8 Annual Variations of Pollutant Concentrations (2006-2018)

Table 4.8 shows the annual average concentrations of air pollutants recorded by the Network from 2006 to 2018, while Figure 12 shows the trend of rate of changes in the annual pollutant concentrations.

From 2006 to 2018, the annual averages recorded by the Network for SO_2, NO_2, and PM_{10} decreased by 81%, 28% and 36% respectively, which exhibited a discernible downward trend with a descending rate of about 3.2, 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 13% between 2015 and 2018. 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 2018 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
2018	9	33	58	47	28	0.691

Remark:
(1) All Tap Mun's pollutants data are excluded from the calculation of the annual averages of pollutants in 2016 owing to its low hourly data capture rate in 2016.

(2) Taipa Grande's PM_{10} and $PM_{2.5}$, Tap Mun's PM_{10} and Xijiao's $PM_{2.5}$ data are excluded from the calculation of the annual averages of pollutants in 2017 owing to its low daily data capture rate in 2017.
(3) All Tap Mun's pollutants and Jinguowan's O_3 data are excluded from the calculation of the annual averages of pollutants in 2018 owing to its low daily data capture rate in 2018.

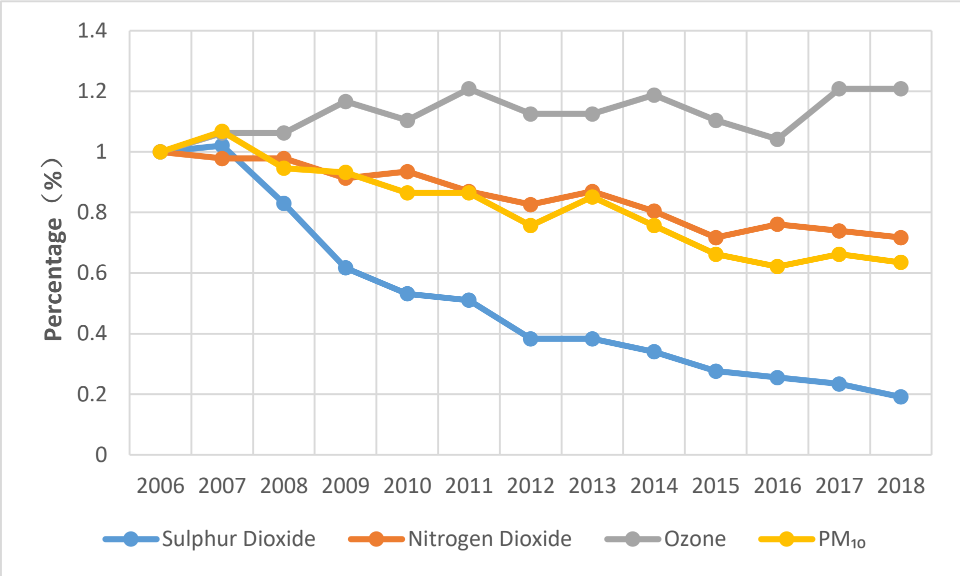

Figure 12：Trend of rates of changes in pollutant's annual averages in the monitoring network

Remark:
(1) All Tap Mun's pollutants data are excluded from the calculation of the annual averages of pollutants in 2016 owing to its low hourly data capture rate in 2016.
(2) Taipa Grande's PM_{10} and Tap Mun's PM_{10} data are excluded from the calculation of the annual averages of pollutants in 2017 owing to its low daily data capture rate in 2017.
(3) All Tap Mun's pollutants and Jinguowan's O_3 data are excluded from the calculation of the annual averages of pollutants in 2018 owing to its low daily data capture rate in 2018.

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