



## Air

Population density, scarcity of land, narrow streets and busy traffic all affect Macao's air quality. However, this is offset to some extent by the low discharge of industrial pollutants. The air quality is therefore generally quite good.

Every winter, a comparatively high level of pollutants in the air increases the air pollution index; while in summer the air quality improves, with lower pollution index readings, as the convective precipitation of the tropical climate dispels pollutants.

In 2004, roadside monitors recorded that the air quality was "good" on 61 percent of the days, "acceptable" on 33 percent, and "poor" on only six percent (22 days). In the high-density residential areas of the Macao peninsula, the air quality was "good" on 57 percent of the days, "acceptable" on 34 percent, and "poor" on nine percent (33 days). The air quality in the high-density residential areas of Taipa was "good" on 48 percent of the days, "acceptable" on 40 percent, and "poor" on 12 percent (44 days). General monitoring stations recorded that the air quality was "good" on 57 percent of the days, "acceptable" on 32 percent, and "poor" on 11 percent (42 days).

Apart from slightly lower concentration levels of carbon monoxide in high-density residential areas of Taipa and of nitrogen dioxide recorded at general monitoring stations, the concentration levels of other pollutants were all higher in 2004 than in 2003. The main sources of pollution throughout the year continued to be respirable suspended particulates and ozone. The number of days on which "poor" air quality readings were recorded increased in 2004. However, Macao's air quality remained mainly good. The annual average content level of every pollutant was normal, and met all relevant standards.



Average Pollutant Concentrations in 2004					
	Respirable suspended particulates ( $\mu\text{g}/\text{m}^3$ )	Sulphur dioxide ( $\mu\text{g}/\text{m}^3$ )	Nitrogen dioxide ( $\mu\text{g}/\text{m}^3$ )	Ozone ( $\mu\text{g}/\text{m}^3$ )	Carbon monoxide ( $\text{mg}/\text{m}^3$ )
Roadside stations	80.1	---	73.3	---	2.3
High-density residential areas of Macao peninsula	80.6	37.7	61.8	31.0	0.9
High-density residential areas of Taipa island	64.0	---	62.6	53.7	0.6
Overall average	67.0	31.4	36.4	48.0	---

Comparisons between Pollutant Concentrations and the Daily Air Pollution Index					
Air quality Index	Respirable suspended particulates 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Sulphur dioxide 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Nitrogen dioxide 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Ozone dioxide 8-hour average ( $\mu\text{g}/\text{m}^3$ )	Carbon monoxide 8-hour average ( $\text{mg}/\text{m}^3$ )
0	0	0	0	0	0
50	100	60	80	80	5
100	150	150	150	160	10
200	350	800	280	350	17
300	420	1,600	565	600	34
400	500	2,100	750	800	46
500	600	2,620	940	1,000	57

Air Pollution Index						
Air quality Index	0 ~ 50	51 ~ 100	101 ~ 200	201 ~ 300	301 ~ 400	401 ~ 500
Air quality level (Macao standards)	Good	Acceptable	Poor	Bad	Severe	Harmful
Symbol						



## Climate

Macao is situated in a subtropical zone, with the Asian continent to the north and a wide tropical sea to the south. In winter, Macao experiences a north wind, cold and dry weather and low rainfall, due to a cold continental high-pressure system at medium and high latitudes. In summer, the MSAR is mainly subject to southwesterly winds, hot and wet weather and heavy rainfall, due to the influence of oceanic tropical weather systems. The reversal of wind directions in winter and summer, together with minimal temperature variations during the day, give Macao a marine monsoon climate.

According to the World Meteorological Organization (WMO) 30-year-average standard calculation, the average annual precipitation in the Macao SAR between 1971 and 2000 was more than 2,000 mm, with most rainfall occurring between April and October. May had the most precipitation – an average of 361.9 mm – while January had the least – an average of 32.4 mm.

Macao has an average annual temperature of 22.4°C. The coolest month is January, when it averages 14.8°C. Most years, Macao has a short, cold weather period when temperatures fall below 5°C. The average monthly temperature exceeds 22°C during seven months of the year, indicating that Macao has a short winter but a long summer.

The MSAR is frequently hit by typhoons. The typhoon season starts in May and ends in October, with July and August as its peak period.

## Weather Overview

### General Situation

Macao was warmer than usual in 2004, with the average annual temperature of 22.8°C, 0.4°C higher than the norm. Average temperatures exceeded the 30-year average (calculated in accordance with WMO criteria) during eight months of the year. The total amount of sunshine was also higher than the standard average; while the relative humidity, total rainfall and evaporation level were lower. In addition, the total rainfall in June was 74.2 mm, 265.5 mm less than the norm. This was the lowest figure recorded in June since 1952. The total amount of rainfall between October and December was a mere 1.6 mm, the lowest figure ever recorded during this period.



Only one tropical cyclone approached Macao in 2004, the lowest figure ever recorded. Tropical storm Kompasu moved close to Macao on 15 and 16 July, causing the hoisting of the No. 3 strong wind signal.

Four rainstorm warnings were issued in 2004.

Forty thunderstorm warnings were issued in the course of the year, 11 more than in the previous year. The first was on 30 March, and the last was on 1 October.

Thirteen strong monsoon signals (black ball) were hoisted in 2004.

Summary of Severe Weather Warnings Issued in 2004			
Warning/Signal Type		Hoisted/Issued Frequency	No. of Warning Reports Issued
Tropical Cyclone Warning	No. 1 Alert Signal	1	7
	No. 3 Strong Wind Signal	1	4
	No. 8 Gale Signal	0	0
	All Signals Lowered	1	1
Strong Monsoon Warning (Black Ball)		13	49
Rainstorm Warning		4	14
Thunderstorm Warning		40	102

### Temperatures

Macao had an average annual temperature of 22.8°C during 2004. This was 0.4°C higher than the 30-year average. The maximum monthly average temperature during the year was 28.4°C recorded in June, and the minimum average was 14.6°C recorded in January. The hottest days were 29 and 30 June, when the temperature shot up to 36.2°C; while the coldest day was 21 January, when the temperature fell to just 5.2°C.

### Relative Humidity

The average relative humidity during 2004 was 76 percent, three percent lower than the 30-year average. April saw the highest average humidity, 84 percent, while October was the lowest, with humidity averaging 60 percent, the lowest October



figure since 1952.

### **Rainfall**

Total rainfall during 2004 was 1,516 mm, 617.4 mm below the 30-year average. August was the rainiest month, with 519.4 mm, which was 167.7 mm more than the 30-year August average. Only tiny amounts of rainfall were recorded in November and December.

### **Evaporation**

Total evaporation levels reached 968.5 mm in 2004, 102.8 mm less than the 30-year average. In October, the evaporation level was 152.4 mm, the highest figure during the year, while April was the lowest, with 47.8 mm.

### **Sunshine**

Macao had 1,907.8 hours of sunshine during 2004, 79.8 hours more than the 30-year average.

### **Wind**

In 2004, Macao was subject to mainly northerly winds from January to March and from September to December. Southeasterly winds prevailed from April to May, while southerly winds prevailed between June and August. Wind speeds averaged 15.1 kilometres per hour.

## **Weather Services**

### **Meteorological and Geophysical Bureau**

The Meteorological and Geophysical Bureau (SMG) is supervised by the Secretary for Transport and Public Works. It provides weather reports, monitors air quality, and conducts research into climate, climate change and earthquakes.

The SMG's work has a direct influence on Macao's everyday life. Apart from hourly real-time weather information, the SMG issues various types of daily weather forecasts for the public, Government departments and private institutions. These include five weather reports and forecasts and two marine and weather forecasts for the South China coastal area, all of which are broadcast daily. In 2004, it provided 1,830 weather reports and 732 marine and weather forecasts for the South China



coastal area.

The SMG releases four-day forecasts on a daily basis. Every day, its officers explain the day's weather conditions and the forecast for the following day in telephone reports broadcast on the Macau Broadcasting Company's morning TV programme. These presentations explain forthcoming weather conditions and teach viewers about meteorology.

The SMG also provides various types of severe weather warnings, including tropical cyclone, rainstorm, thunderstorm and strong monsoon (black ball) warnings. In response to the community's demands and prevailing circumstances, the SMG discontinued its red and black rainstorm warnings from 1 July 2004 onwards, and switched to announcing a new rainstorm signal. This indicates that heavy rain exceeding 50 mm is expected to fall over the MSAR within the next two hours.

A round-the-clock, automatic air-quality monitoring network and ultraviolet (UV) monitoring system enable the SMG to summarise daily air quality and UV indices, and report them to the public together with an air quality forecast for the following day. Residents can access this information by dialling 1311 - the "Hotline Weather Report" and 1313 - the "Weather Report Fax", or by visiting the SMG's website at [www.smg.gov.mo/](http://www.smg.gov.mo/).

Real-time weather conditions, weather forecasts, and extreme weather warning information are available via SMS for registered customers of three mobile phone service providers. The SMG has also teamed up with Companhia de Telecomunicacoes de Macau (CTM) for cellular broadcasting of relevant information to its mobile phone subscribers three times a day.

The SMG Aeronautic Meteorological Centre at Macau International Airport provides hourly weather observations and special reports to aviation organisations and flight crews. The center issues 24-hour and nine-hour weather forecasts for Macau International Airport every six hours and three hours, respectively. It also issues thunderstorm and typhoon warnings for the airport, and provides updated aeronautical meteorological documents for departing flights. The latter include meteorological maps for every route, as well as high-altitude air temperatures, wind maps, and weather forecasts. The centre issued about 20,000 such documents in 2004.



The SMG has acquired a caesium beam atomic clock and time device to offer the public an accurate and convenient time service. Residents may synchronise the clocks of their computers with the time provided by the bureau via the Internet. The SMG also makes standard time signals available to telecommunications companies in Macao. Residents can check Macao standard time through the services offered by these companies.

### **Monitoring Network**

To collect weather data 24 hours a day, the SMG maintains the Automatic Weather Observation Network of 11 weather observation stations in key locations around Macao. Three stations automatically send information every 15 minutes to Guangzhou and Hong Kong, using the international SYNOP code and Global Telecommunications System (GTS). This forms part of the Pearl River Delta Real-time Automatic Weather Observation Network, which is jointly operated by the Guangdong Provincial Meteorological Bureau, the Hong Kong Observatory, and the Macao SMG. The SMG has equipped the Macau Tower with Automatic Weather Observation Network installations at altitudes of 100, 150, 241, 294 and 324 metres, to facilitate round-the-clock collection of weather information.

### **Air Quality Monitoring**

The SMG established the Air Quality Monitoring Project in partnership with other Government departments in 1987. It now employs a fully automated air monitoring network to measure major pollutants that jeopardise Macao's air quality. Macao now has six automatic air quality monitoring stations. Two of these – located in Concordia Industrial Park and the Westin Resort Macau golf course – currently operate on a trial basis.

### **Seismological Monitoring**

The SMG has two seismological monitoring stations, one in Ka Ho Lighthouse on Coloane, and the other in its Taipa Grande headquarters on Taipa. A simulated seismograph and digital seismograph are installed inside the Ka Ho Lighthouse. The Taipa Grande headquarters is equipped with a deepshaft (30 metres from ground level) digital seismograph.



### **Environmental Radiation Monitoring**

The SMG's headquarters is equipped with an environmental radiation monitoring and measuring workstation, mainly for detecting harmful Gamma radiation in the atmosphere.

### **Regional and International Cooperation**

The SMG is a member of the WMO. It actively participates in promoting technology, research, training and applications relating to meteorology. Every year, it sends delegations to meetings and training programmes arranged by the WMO, as well as to mainland and overseas meteorological agencies. In 2004, it sent 21 delegates to attend and deliver seven papers and reports at 14 sessions and training activities.

The SMG is keen to exchange technology and experience with its mainland and Hong Kong counterparts. Every year, the Guangzhou-Hong Kong-Macao Seminar on Meteorological Science and Technology, the Guangzhou-Hong Kong-Macao Meteorological Cooperation Meeting, and the Seminar on Urban Air Quality in the Pearl River Delta Region are held alternately in the three regions. Their aim is to exchange opinions and explore issues related to scientific research outcomes, technical developments and applications, and air quality monitoring. The first two of these meetings in 2004 were hosted by Hong Kong, and the SMG presented five papers. The third meeting was held in Guangzhou, and the SMG delivered one paper.

The SMG and the Department of Atmospheric Science of the Sun Yat-sen University in Guangzhou signed their first cooperation agreement in 1997. Starting with the introduction of a mesoscale model for weather forecasts, their cooperation projects have gradually developed into research and exchanges on various aspects of meteorology and the environment. The scope of their collaboration has been continuously extended, and the university has described it as a paragon of cooperation. During 2004, the two organisations published a total of 14 papers in several renowned scientific journals and books on the mainland.

The SMG also participates in the European Cooperation in the field of Scientific and Technical Research (COST), a cooperative research project on science and technology by member states of the European Union. It sent two delegates to attend two COST meetings in 2004.