



Air

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

In 2002, roadside monitors recorded that the air quality was “good” on 68 percent of the days, “acceptable” on 31 percent, and “poor” on only one percent (five days). In the high-density residential areas of the Macao peninsula, the air quality was “good” on 74 percent of the days, “acceptable” on 24 percent, and “poor” on two percent (six days). The air quality of the high-density residential areas of Taipa was “good” on 82 percent of the days, “acceptable” on 18 percent, and “poor” on one percent (three days).

The ambient stations recorded that the air quality was “good” on 79 percent of the days, “acceptable” on 20 percent and “poor” on one percent (three days). Over the entire year, the air quality of Macao was generally good. The pollutant concentration level was comparable to that in 2001. Respirable suspended particulates and ozone remained the main sources of pollution.

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

Monitoring station records indicate that air quality in 2002 was similar to that in the previous year, with no obvious increase or decrease. The annual average pollutant level was normal, and met all relevant standards.



Average Pollutant Concentration in 2002

	Respirable suspended particulates ($\mu\text{g}/\text{m}^3$)	Sulphur dioxide ($\mu\text{g}/\text{m}^3$)	Nitrogen dioxide ($\mu\text{g}/\text{m}^3$)	Ozono ($\mu\text{g}/\text{m}^3$)	Carbon monoxide (mg/m^3)
Roadside stations	70.8	---	61.9	---	2.5
High density residential areas on Macao peninsula	58.4	27.3	50.3	26.0	0.7
High density residential areas on Taipa island	49.6	---	48.8	24.5	0.7
Overall average	50.3	20.7	33.0	29.3	---

Comparison between Pollutant Concentration and 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 8-hour average ($\mu\text{g}/\text{m}^3$)	Carbon monoxide 8-hour average ($\mu\text{g}/\text{m}^3$)
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 pollution index	0~50	51~100	101~200	201~300	301~400	401~500
Air quality level (by 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 reverse of wind directions in winter and summer, together with minimal temperature variation during the day, give Macao a marine monsoon climate.

Average annual precipitation in the MSAR is more than 2,000 mm, with most rainfall occurring between April and October. According to the World Meteorological Organization's 30-year average standards, between 1971 and 2000, May had the most precipitation - an average of 361.9 mm; while January the least - an average of 32.4 mm.

Macao has an average temperature of 22.4°C over the year. 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 and 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.

The Weather in 2002

General Situation

The average temperature, relative humidity and total rainfall for 2002 were higher than the norm; while total sunshine and evaporation levels were lower. A similar phenomenon occurred in 2001. Average temperatures for seven months exceeded 30-year averages. From February to April 2002, average temperatures each month were higher than the corresponding 30-year average by over 2°C. It is notable that the total amount of sunshine in October 2002 was only 130.6 hours, 64.4 hours less than the norm for this month and the lowest figure recorded in any October since 1952. The evaporation level in December was only 54.5 mm, 51.5 percent less than the norm and the lowest December figure since 1952.



Tropical cyclone signals were hoisted to mark the approach of three tropical cyclones during 2002. Typhoon Hagupit had the greatest impact on Macao, requiring the hoisting of signal No. 8. The other two typhoons, Kammuri and Vong Fong (Wasp), required the hoisting of signals No. 1 and No. 3, respectively. The three tropical cyclones did not cause any serious damage in Macao

Only two red rainstorm warnings and one black rainstorm warning were issued in 2002. The relatively small number of rainstorms reflected the fewer incidences of typhoons and unsteady low-pressure troughs.

A total of 32 thunderstorm warnings were issued in the course of the year. The first was on 29 March. Most thunderstorms occurred during May, June, July, and August; and these four months accounted for 84 percent of the year's total.

Statistics concerning extreme weather warnings issued in 2002

Categories of warnings/signals		Number of signals hoisted and warnings issued	Number of warning reports
Tropical cyclone warnings	Signal No. 1	3	18
	Signal No. 3	2	13
	Signal No. 8 (Southeast)	1	13
	Removal of signal	3	3
Strong monsoon warnings (Black ball)		14	61
Rainstorm warnings	Red	3	14
	Black	1	2
Thunderstorm warnings		32	91

Temperature

Macao had an average temperature of 23.2°C over 2002. This was 0.8°C higher than the 30-year average. The maximum monthly average temperature during the year was 28.4°C, in July, and the minimum average was 16.1°C, in January. The hottest day was 5 July, when a temperature of 35.2°C was recorded; while the coldest day was 27 December, when the temperature fell to just 5.5°C.



Relative Humidity

Average relative humidity during 2002 was 81 percent, which was two percent higher than the 30-year average. April saw the highest humidity, when the level averaged 88 percent, while November was the lowest, with humidity averaging 70 percent.

Rainfall

Total rainfall during 2002 was 2,183.6 mm, 60.7 mm above the 30-year average. September was the rainiest month, with 588.6 mm; 394.5 mm more than the 30-year September average. February was the driest, with just 6 mm of rain, 52.8 mm lower than the 30-year average for that month.

Evaporation

Total evaporation levels reached 829.9 mm in 2002, 243.9 mm less than the 30-year average. In November, the evaporation level was 103 mm, the highest figure during the year, while March was the lowest, with 53.1 mm.

Sunshine

Macao had 1,795.8 hours of sunshine during 2002, 32 hours less than the 30-year average.

Wind

Macao was subject to mainly northerly winds in January, and from October to December 2002. Southeasterly winds prevailed from February to May and during September, while southerly winds prevailed between June and August. Wind speeds averaged 16 kilometres per hour.

Weather Services

Meteorological and Geophysical Bureau

Meteorological observations were originally conducted by the Portuguese Navy garrison in Macao, and records date back to 1861. The Meteorological and Geophysical Observatory was officially established in 1952 to take over this role, and it was renamed the Meteorological and Geophysical Bureau (SMG) on 20 December 1999. The SMG 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, it issues various types of daily weather forecasts for the public, Government departments and private institutions. These include five weather reports, broadcast at 7am, 9.30am, 2pm, 5.30pm and 9pm every day; plus ocean wave and weather forecasts for the Southern China coastal area at 9.30am and 5.30pm, respectively. In 2002, it provided 1,825 weather forecasts, plus 730 marine and weather forecasts for the Southern China coastal area.

From 23 March 2002, the two-day forecasts previously provided at 5.30pm every day were changed to four-day forecasts. This step was taken to satisfy public demand for longer-range weather forecasts, while ensuring the highest accuracy. Since 1 July 2002, SMG officers have been interviewed by telephone every day at 7.45am and 8.15am on the TDM (Macao Broadcasting Company) TV programme "Good Morning Macao". In these interviews, they explain the day's weather conditions and the forecast for the following day. The interviews tell viewers about upcoming weather conditions and teach them about meteorology.

The SMG also provides various extreme weather warnings, which include tropical cyclone, rainstorm, thunderstorm and strong monsoon (black ball) warnings.

A round-the-clock, automated air-quality monitoring network and ultraviolet (UV) monitoring system enable the SMG to summarise air quality and UV indexes for the day 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 <http://www.smg.gov.mo/>.

With the cooperation of Companhia de Telecomunicacoes de Macau (CTM), real-time weather conditions, weather forecasts, and severe weather warning information have been available for mobile phone users since March 2000. A new service, cell-broadcasting, which delivers relevant information to registered mobile phone subscribers three times a day was inaugurated in 2002,. At the SMG's request, Hutchison Telephone (Macao) Company Ltd began to deliver SMG weather warnings to selected clients in the form of short messages in July 2002. SmarTone Mobile Communications (Macao) is also currently negotiating with the SMG to deliver



weather and related information via mobile phones. Arrangements for this are expected to be finalised in 2003.

The SMG reports to the Secretary for Transport and Public Works. Its headquarters at Taipa Grande consist of three divisions – the Meteorology Division, Computer Division and Instruments and Maintenance Division; four centres – the Meteorological Monitoring Centre, Climate and Atmospheric Environment Centre, Telecommunications and Processing Centre, and Seismological Monitoring Centre; together with an Administration Department.

The SMG Aeronautic Meteorological Centre at Macau International Airport provides hourly weather observations and special reports to aviation organisations and flight crews. Every six hours, the Centre issues a 24-hour weather forecast for them. It is also responsible for issuing thunderstorm and typhoon warnings for the airport, and providing 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 more than 15,000 such documents in 2002.

The SMG plans to expand its internal information network to provide meteorological information for airlines and air traffic control centres, with effect from mid-2003.

Air pollution caused by volatile organic compounds (VOCs) has attracted more and more attention internationally. In 2002, the SMG cooperated on this subject with the Guangdong Geochemical Research Institute, an affiliate of the Chinese Academy of Sciences, and inaugurated research into the timing and geographical distribution of VOCs, and analysis of their composition. The SMG conducted a yearlong sampling of VOCs in Macao, and undertook chemical analysis in compliance with accepted international standards. The two parties will share all the final data.

In 2002, the SMG reorganised Macao's meteorological archives dating from 1901 to 2000, and computerised all the data. The records contain information on air pressure, humidity, lowest and highest daily temperatures, evaporation, rainfall, prevailing wind directions, average wind speeds, clouds and cloud volume, and records of weather conditions, meteorological phenomena and remarks, such as typhoon warning signals.



Monitoring Network

The SMG's 10 weather observation stations located at key points in Macao make up an "Automatic Weather Observation Network". Three stations automatically send information every 15 minutes to Guangzhou and Hong Kong, using the international SYNOP code and a Global Telecommunications System (GTS). This forms part of the "Pearl River Delta Real-time Automatic Weather Observation Network" jointly operated by the Guangdong Provincial Meteorological Bureau, the Hong Kong Observatory, and the Macao SMG.

Air Quality Monitoring

The SMG established the Air Quality Monitoring Project jointly with other government departments in 1987. It now employs a fully automated mobile monitoring network to measure major pollutants in Macao, and operates four automated air-quality monitoring and measuring stations on Taipa island and the Macao peninsula.

Seismological Monitoring

The Seismological Monitoring Station on Coloane island sends earthquake information to the SMG's headquarters by wireless transmission. There, the signals are amplified and recorded. Its new digital seismological monitoring and measuring equipment enables more efficient and accurate monitoring and measurements of such data.

Environmental Radiation Monitoring

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