



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 airborne pollutants 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.

During 2006, roadside monitoring stations recorded "good" air quality on 67 percent of days, "acceptable" air quality on 28 percent, and "poor" air quality on only five percent (18 days). In the high-density residential area of the Macao peninsula, the air quality was "good" on 65 percent of the days, "acceptable" on 26 percent, and "poor" on nine percent (33 days). The air quality in the high-density residential area of Taipa was "good" on 69 percent of days, "acceptable" on 26 percent, and "poor" on four percent (15 days). Ambient monitoring stations recorded "good" air quality on 59 percent of days, "acceptable" air quality on 34 percent, and "poor" air quality on seven percent (24 days).

Compared with last year's figures, at monitoring stations other than the station in the high-density residential area of the Macao peninsula, there were upward trends in concentrations of respirable suspended particulates and ozone, while levels of nitrogen dioxide and carbon monoxide were decreasing. Sulphur dioxide levels dropped at the station in the high-density residential area of the Macao peninsula, but rose at the ambient monitoring station. In 2006, the number of days on which "poor" air quality readings were recorded at stations in the high-density residential areas (Macao peninsula and Taipa) was similar to the number in 2005. The number of days on which poor air quality was recorded at the roadside station was a third lower than in the previous year, while there was a slight increase in numbers of days with poor air quality at the ambient monitoring station. Overall, Macao's air quality remained good. The annual average level of each pollutant monitored was normal, and met all the air quality standards.



Average Pollutant Concentrations in 2006

Monitoring Station	Respirable suspended particulates ($\mu\text{g}/\text{m}^3$)	Sulphur monoxide ($\mu\text{g}/\text{m}^3$)	Nitrogen dioxide ($\mu\text{g}/\text{m}^3$)	Ozone ($\mu\text{g}/\text{m}^3$)	Carbon monoxide (mg/m^3)
Roadside	75.9	---	60.4	---	2.13
High-density residential area of Macao peninsula	82.0	24.0	51.9	26.1	0.61
High-density residential area of Taipa island	57.1	---	28.2	40.1	0.57
Ambient	64.3	22.6	38.5	41.9	---

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 8-hour average ($\mu\text{g}/\text{m}^3$)	Carbon monoxide 8-hour average (mg/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 reverse 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 slightly warmer than usual during 2006, with the average annual temperature of 23.1°C – 0.7°C higher than normal. Average temperatures exceeded the climate norms in seven months of the year. The average temperatures of October and November were the highest since 1952. The average relative humidity was normal, while the total rainfall and evaporation levels were lower. The total amount of bright sunshine was also lower, with the hours of bright sunshine below normal for every month except February and December.

Seven tropical cyclones affected Macao during 2006. They were Typhoon Chanchu on 15 to 17 May, Tropical Storm Jelawat on 27 to 28 June, Typhoon Prapiroon on 1 to 4 August, Tropical Storm Bopha on 9 to 11 August, tropical depressions on 24 to 25 August and 12 to 13 September, and Typhoon Cimaron between 31 October and 3 November. Of these, only Prapiroon necessitated the hoisting of the No. 8 southeast tropical cyclone warning signal; whereas the No. 1 or No. 3 alert signal was required for all the other six tropical cyclones. Overall, tropical cyclones did not inflict severe damage on Macao in 2006.

Seven rainstorm warnings were issued during 2006.

Fifty-nine thunderstorm warnings were issued during the course of the year, three more than in 2005. The first thunderstorm warning was issued on 23 March, and the last on 25 November.

Eleven strong monsoon signals (black ball) were hoisted during 2006.



Summary of Severe Weather Warning Issued in 2006			
Warning / Signal Type		Hoisted / Issued Frequency	No. of Warning Reports Issued
Tropical Cyclone Warning	No. 1 Alert Signal	7	44
	No. 3 Strong Wind Signal	4	22
	No. 8 Southeast Gale Signal	1	19
	All Signals Lowered	7	7
Strong Monsoon Warning (Black Ball)		11	39
Rainstorm Warning		7	18
Thunderstorm Warning		59	160

Temperatures

Macao had an average annual temperature of 23.1 °C during 2006, 0.7°C higher than normal. The maximum monthly average temperature during the year was 28.9°C in July, and the minimum average monthly temperature was 15.6°C in January. The hottest day was 13 July, when the temperature rose to 36°C; whereas the coldest day was 7 January, when the temperature fell to just 6.5°C.

Relative Humidity

The average relative humidity during 2006 was 79 percent, which was equal to the climate normal. April and June saw the highest average humidity, at 86 percent; whereas the lowest was 66 percent in December.

Rainfall

Total rainfall during 2006 was 1,997.8 mm, 135.6 mm below normal. June was the wettest month, with 443.4 mm of precipitation, which was 103.7 mm more the month's normal rainfall. A mere 1 mm of rainfall fell in October, considerably lower than the month's normal rainfall of 116.9 mm.

Evaporation

The total evaporation level in 2006 was 847 mm, 224.3 mm less than normal. In December, the evaporation level was 108.2 mm, the highest figure during the year, whereas the figure of 39.0 mm for April was the lowest during the year.



Sunshine

Macao had 1,542.8 hours of sunshine during 2006, 285.2 hours less than normal, also the lowest since 1952. Except in February and December, the total hours of sunshine for each month were below normal.

Wind

During 2006, Macao was subject mainly to northerly winds from January to March, September, and from November to December. Southerly winds prevailed from April to July, while southeasterly winds prevailed in August and October. Wind speeds averaged 14.8 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 realtime 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. The SMG provided 1,825 weather reports and 730 marine and weather forecasts for the South China coastal area during 2006.

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 (TDM) morning TV programme. These presentations explain forthcoming weather conditions and teach viewers about meteorology. The SMG also cooperates with the Sai Van Bridge Management Company to offer real-time weather information and severe weather warnings. To help drivers understand the prevailing weather condition and forecast changes, weather-related messages are displayed on electronic message boards at both ends of the bridge.



The SMG also issues timely warnings of adverse weather conditions, including tropical cyclones, strong monsoons (black ball), rainstorms, and thunderstorms.

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.

The SMG launched the Mobile WebWeather Service for mobile phone and personal data assistant (PDA) users on 23 March 2005. It makes weather data about Macao and other places worldwide more accessible to the public via the Internet through its website at mobile.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 Center 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 27,000 such documents during 2006.

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.



Monitoring Network

The SMG collects weather data 24 hours a day via its Automatic Weather Station Network of 12 weather-observation stations in key locations around Macao. Three of these automatically send information every 15 minutes to destinations worldwide, using the international SYNOP code and the Global Telecommunications System (GTS). This forms part of the Pearl River Delta Real-time Automatic Weather Monitoring Network, which was jointly established to exchange meteorological data by the Guangdong Provincial Meteorological Bureau, the Hong Kong Observatory and the Macao SMG. In addition, the SMG has equipped the Macau Tower with Automatic Weather Station Network installations at different altitudes of 100, 150, 241, 294 and 324 metres, to facilitate round-the-clock collection of weather information.

The SMG also teamed up with the Hong Kong Observatory to establish a substation of the Pearl River Delta Lightning Location Network in Macao. The system operates around the clock, and provides real-time lightning information for the Pearl River Delta.

Regarding meteorological telemetry: the SMG boasts a sophisticated Doppler Meteorological Radar, a ground reception and processing system for the Fengyun-2C geostationary meteorological satellite, a low-level wind profiler, and a transmissometer.

The SMG established the Air Quality Monitoring Project in partnership with other Government departments in 1987.

The SMG 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. The SMG introduced another new type of technology during 2005, when it cooperated with the City University of Hong Kong in developing and installing a laser radar system that detects respirable suspended particulates in the atmosphere. In 2006, it continued to study and develop the system, and planned to use it for wider applications.

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.

During 2006, the SMG recorded six felt earthquakes in the vicinity of Macao.

The SMG's headquarters is equipped with an environmental radiation monitoring station, 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, seminars, workshops and training programmes arranged by the WMO, mainland and overseas meteorological agencies and academic organisations. In 2006, 45 of its delegates attended 26 sessions and training activities.

On 1 and 2 March 2006, the SMG hosted the Second Guangdong-Hong Kong-Macao Seminar on Earthquake Science and Technology, during which 40 experts in seismology, geophysics and meteorology from the three regions exchanged experiences and delivered 17 papers.

From 4 to 9 September 2006, the SMG hosted the Workshop on Integrating Activities of Hydrology, Meteorology and DPP Components of the Typhoon Committee into the related International Frameworks on Disaster Risk Management for better Impacts and Visibility. Sixtyfive experts in meteorology, hydrology and disaster prevention and preparedness (DPP) from 13 member countries and regions participated, and discussed and drew up strategic plans for disaster prevention.

Delegates from the SMG attended the 39th Session of the Typhoon Committee of the Economic and Social Commission for Asia and the Pacific and the WMO (ESCAP/WMO), which was held in Manila, the Philippines, from 4 to 9 December 2006. During the meeting, Chinese Ambassador to the Philippines Li Jinjun, on behalf of the Chinese government, signed the Host Country Agreement Between the Government of People's Republic of China and the Typhoon Committee Regarding the Typhoon Committee Secretariat, with the Chairman of the Typhoon Committee, Prisco D. Nilo. The agreement stipulates the relocation of the Typhoon Committee



Secretariat from the Philippines to Macao, China.

The SMG also keenly takes part in meteorological science meetings and exchange activities conducted by its mainland and Hong Kong counterparts. Its staff visit their weather and environmental departments, and receive their personnel when they visit Macao. The annual Guangdong-Hong Kong-Macao Seminar on Meteorological Science and Technology, the Guangdong-Hong Kong-Macao Meeting on Cooperation in Meteorological Operations, and the Pearl River Delta 5 Cities Air Quality Technical Workshop are all held alternately in the three regions. All these events are forums for exchanging opinions and exploring issues about research, technical developments and the application of meteorological science and air quality monitoring. In 2006, the SMG presented seven papers at the Guangdong-Hong Kong-Macao Seminar on Meteorological Science and Technology and the Guangdong-Hong Kong-Macao Meeting on Cooperation in Meteorological Operations, which were held in Macao in 2006. Shenzhen hosted the Pearl River Delta 5 Cities Air Quality Technical Workshop, during which the SMG delivered two papers.

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 have gradually extended to include researches and exchanges on various aspects of meteorology and the environment. This agreement has since been renewed, and the university has hailed it as a paragon of cooperation. The two organisations published 10 papers in renowned mainland and overseas scientific journals and collections of essays during 2006.

During 2006, the SMG again collaborated with the China Meteorological Administration's Meteorological Press on the publication of the *MMGB (Macao Meteorological and Geophysical Bureau) Collected Papers Vol. 2 – Asia Summer Monsoon and Mesoscale Numerical Simulation*.

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 for member states of the European Union. It sent two delegates to two COST meetings during 2006.