A Brief History of the Hong Kong Observatory

(2023 Edition)

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HONG KONG OBSERVATORY

Content

Abstract

Hong Kong is a coastal city in southern China. In the 19th century, Hong Kong's shipping industry had been well developed, serving as an important entrepot in the region. The Hong Kong Observatory (HKO) was established in 1883. Early operations of the Observatory were all related to the shipping industry at the time, including meteorological observations, time service, geomagnetic observations and tropical cyclone warning service. The Observatory has been conducting meteorological measurements at its Headquarters in Tsimshatsui since 1884. The long-term weather observations document the variations of climate in Hong Kong caused by global climate change and local urbanization. In 2017, the HKO Headquarters received the World Meteorological Organization's recognition as one of the first batches of centennial observing stations in the world. In more than a century, the Observatory's services have evolved in pace with the increasing expectations and requirements of the modern society. During the period, the Observatory made use of advanced technologies from time to time in tandem with its operational developments.

Chapter 1 Brief History and Background on The Establishment of The Hong Kong Observatory

Since the opening of Hong Kong as a port with an increasing population, the casualties and damages caused by typhoons have gradually attracted society's attention. The disastrous typhoon event in 1874, resulted in significant casualties in Hong Kong and Macao. There was an urgent need for an organisation that could predict the arrival of storms and issue warnings. Meanwhile, Hong Kong being an important trading port, it was necessary to provide accurate time services and geomagnetic observations for the public and the mariners. Technologically, relevant technologies for meteorological and time services, geomagnetic observations and system of storm signals have generally been established in western Europe in the 1860s or before. Moreover, commencing in 1869, meteorological stations equipped with Western meteorological instruments were set up at various locations over China, especially at ports and lighthouses.

In light of the above developments, in 1877 the Surveyor General, Mr John M Price, submitted a plan for a new observatory to the Hong Kong Government. In 1879, the Royal Society in the United Kingdom proposed to set up a dedicated meteorological observatory in Hong Kong. The proposal was later revised and improved by Major General, Mr Henry S Palmer, in 1881. After considerable studies and deliberation, the Hong Kong Government eventually approved in 1882 the proposal of establishing the HKO in the Kowloon Peninsula and building it on Mount Elgin in Tsimshatsui.

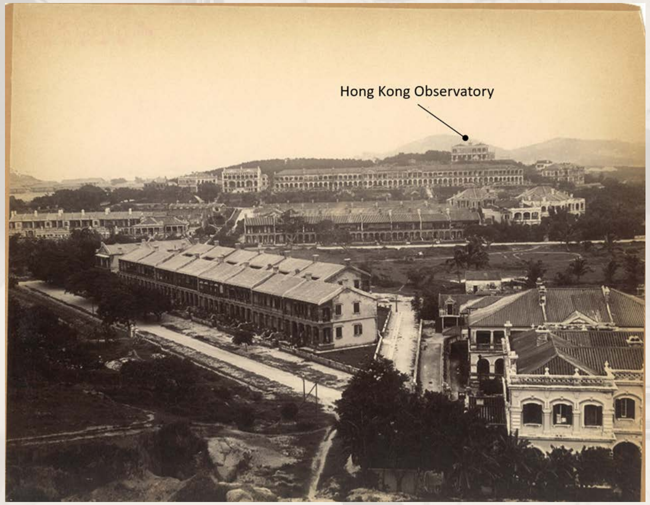


Figure 1: The Hong Kong Observatory on Mount Elgin. Photo taken in 1902-1905. (Photo courtesy of Mr Shun Chi-ming, former Director of the Hong Kong Observatory)

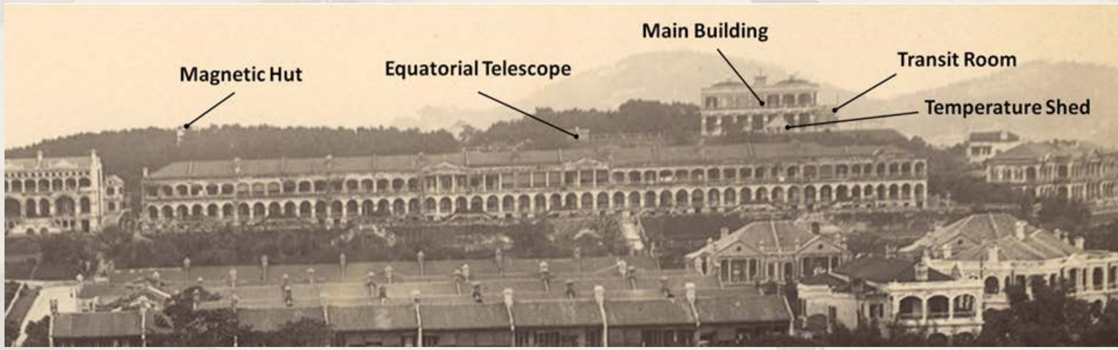


Figure 2: Zoom-in view of Figure 1 depicting the Main Building, temperature shed, transit room, equatorial telescope, and magnetic hut.

Figure 3: Main building of the Hong Kong Observatory. Photo taken in 1893 or earlier, showing the rooftop anemometer and the dome of the equatorial telescope. (Photo courtesy of Mr Shun Chi-ming, former Director of the Hong Kong Observatory)

Figure 4: The Main Building of the Observatory after the first extension. Photo taken in 1913.

Dr. W. Doberck was appointed as the first Government Astronomer (the first Director of the HKO) on 2 March 1883. Following the arrival of Dr Doberck and his First Assistant, Mr Frederick G Figg, in Hong Kong on 28 July 1883, the HKO was established in the same year as a department of the Hong Kong Government. Early operations of the HKO included meteorological observations, time service, magnetic observations and tropical cyclone warning service. In 1912, King George V granted the department the title “Royal Observatory, Hong Kong” in recognition of its services. This title was used until the return of Hong Kong’s sovereignty to China on 1 July 1997, when the original name “Hong Kong Observatory” was restored.

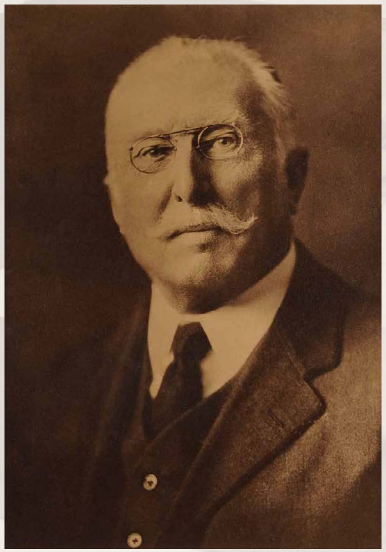


Figure 5: Dr. W. Doberck, the first Director of the Hong Kong Observatory.

The HKO Headquarters occupies a land of about 1.62 hectares (4 acres) on the top of a small hill at an elevation of about 32 metres. In 1984, it was listed as a declared monument in Hong Kong. Built on the eastern part of the hillock in 1883, the Main Building is a two-storey building in the Victorian Colonial style. The Main Building was extended in the 1910s and 1950s. Construction of a new building next to the Main Building was completed in 1982. and the new building was opened in the next year in commemoration of the 100th anniversary of the Observatory. Technical and operational divisions of the Observatory subsequently moved into the new building (now named Centenary Building), while the Main Building still housed the directorates’ offices and the administration division.

Figure 6: Photo of Kowloon Peninsula in 1886 showing the Main Building (yellow arrow) and the magnetic hut (blue arrow) of the Observatory on Mount Elgin. (Photo courtesy of Mr Shun Chi-ming, former Director of the Hong Kong Observatory)

Figure 7: Aerial photo of the Observatory in 1964, depicting the extension to the west of the Main Building in the 1950s. (Photo courtesy of Mr Gordon Bell, former Director of the Hong Kong Observatory)

Figure 8: The Main Building of the Observatory (left) and the Centenary Building (right) that was opened in 1983. Photo taken in 2019.

The Observatory has been conducting meteorological observations at its Headquarters since 1884. The Observatory Headquarters has served as the World Meteorological Organization's reference synoptic station for Hong Kong. Owing to the rapid urbanization and construction of tall buildings nearby, the synoptic station was replaced by King's Park Meteorological Station on 1 July 1992. Subsequently, the synoptic station of Hong Kong was changed to the Hong Kong International Airport at Chek Lap Kok on 1 April 2000. Basic meteorological observations still continue at the Observatory Headquarters, providing the public with meteorological information and records on temperature, rainfall, and relative humidity of the urban area. In 2017, the HKO Headquarters was recognized by the World Meteorological Organization as one of the first batches of centennial observing stations in the world.

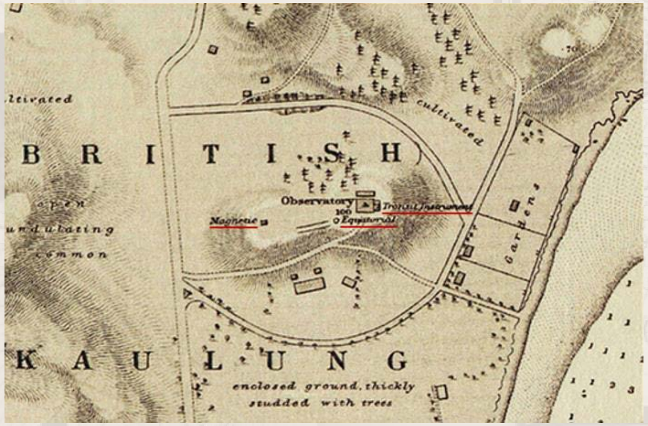
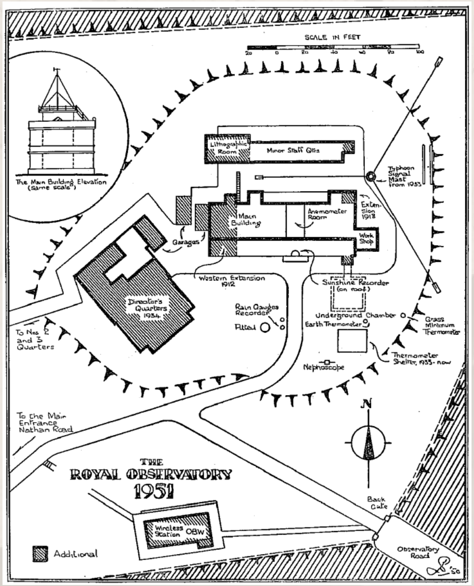


Figure 9: Map of 1886-1887 showing the location of the Observatory and the locations of the magnetic hut ('Magnetic') for measuring geomagnetic variations, the equatorial telescope ('Equatorial') for sky observations, and the transit telescope ('Transit Instrument') for determining the local time. (Photo courtesy of Mr Shun Chi-ming, former Director of the Hong Kong Observatory)



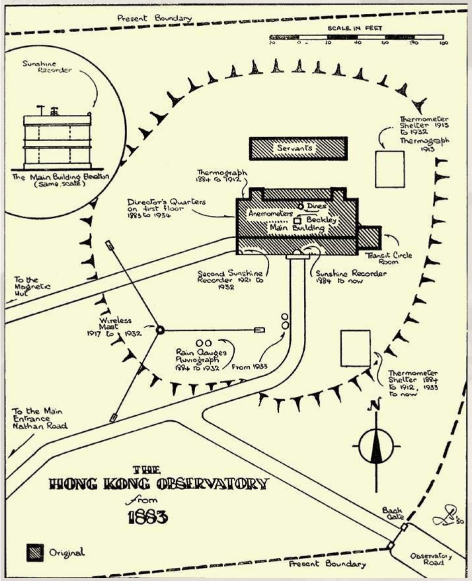


Figure 10: Sketch map of buildings and facilities of the Observatory in the 1950s, new key additions include the Western Extension, Director's Quarters, Typhoon Signal Mast, Underground Chamber, Wireless Station, Lithographic Room, and Nephoscope.

Figure 11: Sketch map prepared in the 1950s showing the locations of equipment and facilities at the Observatory from 1883 to 1950, including the transit circle room, thermometer shelter, thermograph, Beckley & Dines anemometers, sunshine recorder, rain gauges, pluviograph and wireless mast.

Meteorological data collected at the Observatory Headquarters over the century is a vital part of the history of the Observatory. These long-term meteorological observations constitute a record of the climate variations in Hong Kong due to global climate change and local urbanization over the years, and are invaluable sources of reference on climate information not only for Hong Kong but also for the world. In addition, these climate data are useful for numerous applications, including climate information services, disaster risk reduction, infrastructure and urban designs, public education, analysis of historical atmospheric reconstruction, big data analytics, smart city development, and climate and extreme weather research, etc.

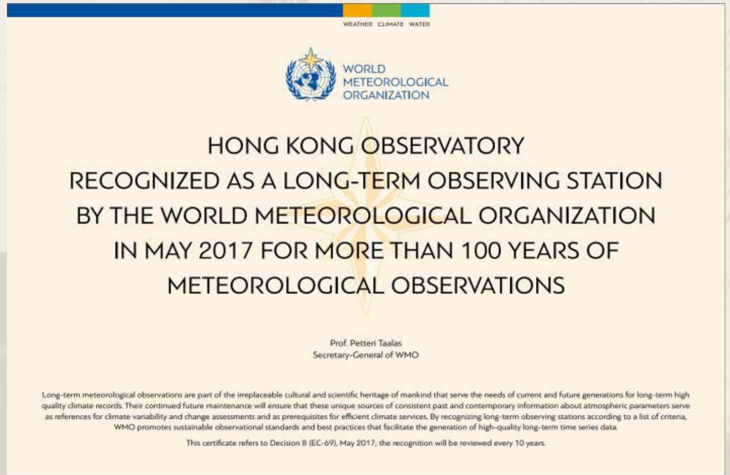


Figure 12: The long-term observing station accreditation certificate awarded by the World Meteorological Organization (WMO) to the Hong Kong Observatory.

Figure 13: Mr Shun Chi-ming (centre), the then Director of the Hong Kong Observatory, received the long-term observing station accreditation certificate from the Secretary-General of the WMO, Professor Petteri Taalas (second right), and the Deputy Secretary-General of the WMO, Dr Elena Manaenkova (first right), at the certificate presentation ceremony while attending a meeting at the WMO headquarters in Geneva, Switzerland on 18 October 2017.

The Observatory has been established for more than a century. In tandem with the development of the society, the mode of operation and scope of services of the department have evolved with times to meet the expectations and needs of the modern community. From time to time advanced technologies were adopted for various operational developments.

(1) Meteorological Observations

With Dr. W. Doberck, the first director of the HKO, setting out guidelines on meteorological observations in Hong Kong and China treaty ports in 1883, the Observatory has been regularly conducting meteorological observations at its Headquarters since 1884. The weather elements observed at the time included atmospheric pressure, temperatures, wind speed and direction, cloud type, cloud amount, cloud movement direction, rainfall and sunshine duration, etc. Relative humidity was computed using dry and wet bulb temperatures. In 1889 or earlier, an "Indian Pattern" thermometer shed made of palm leaves was used to improve the ventilation for the thermometer and to alleviate the issue of overheating in the Stevenson screen in summer. This thermometer shed has been in use since then. For rainfall measurement, the first rainfall outstation was set up in 1906 at the police station in Tai Po. Data of the surface meteorological observations at the Observatory Headquarters and other weather stations were published annually in “Meteorological Results Part I - Surface Observations” since 1884.

Figure 14: Photos of the lawn area to the southeast of the Observatory’s Main Building in the 1930s. Blue arrow shows the location of the thermometer shed. (Photo courtesy of the family of Mr G S P Heywood, former Director of the Hong Kong Observatory)

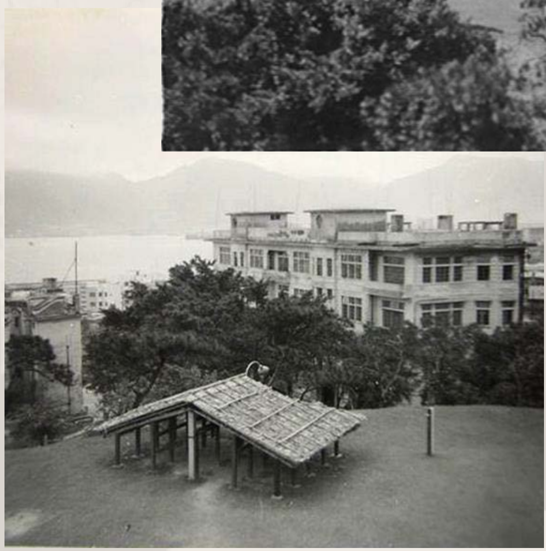


Figure 15: The thermometer shed of the Observatory in the 1950s.

Figure 16: The weather chart of 6 a.m. on 30 June 1909 is the earliest weather chart kept by the Observatory.

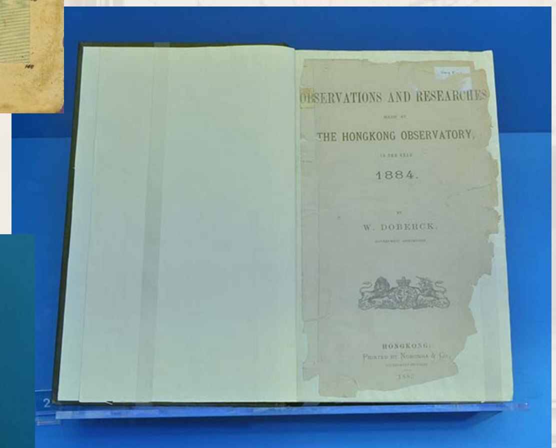


Figure 17: The “Observations and Researches made at the Hong Kong Observatory in the year 1884” published in 1885.

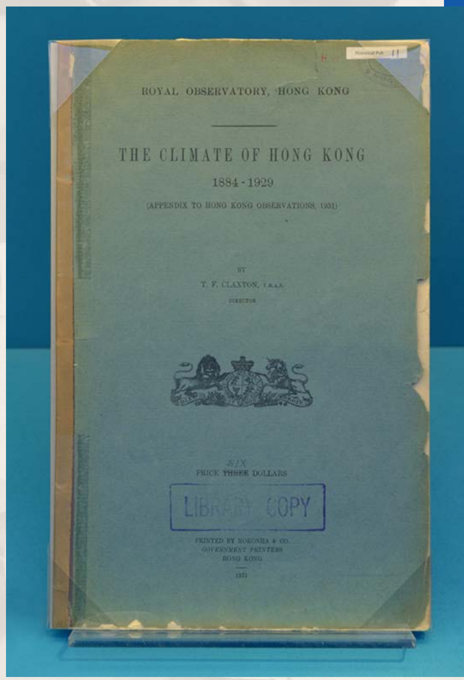


Figure 18: Published in 1931, “The Climate of Hong Kong 1884 – 1929” was a major publication on the climate of Hong Kong in the early years.

The Observatory's upper-air meteorological observations began in 1921, laying the foundation for the future provision of aviation meteorological services. At that time, pilot balloons were launched at the Observatory Headquarters in Tsimshatsui, and a theodolite was used to track the balloons for calculating the upper-air wind speed and wind direction. In 1924, the Observatory cooperated with the Royal Air Force for the first time to measure upper-air temperatures by aircraft. The Observatory's aviation weather service commenced on 18 May 1937, providing weather services to Kai Tak Airport every day. In 1938, the Far East Flying Training School began to provide the Observatory with upper-air temperature and humidity measurement data. In 1939, an Airport Meteorological Office (AMO) was set up in the new Temporary Terminal Building and put into operation.

Figure 19: Staff of the Observatory launching a pilot balloon at the Tsimshatsui Headquarters in the 1930s. In the photo, the staff on the left was holding a pilot balloon, while the staff on the right was responsible for operating the theodolite to record the balloon's azimuth and elevation angle, for calculating the upper-air wind speed and wind direction. (Photo courtesy of the family of Mr G S P Heywood, former Director of the Hong Kong Observatory)

(2) Time services

The HKO is the official timekeeper in Hong Kong. The provision of an accurate time service for the public, particularly the mariners, was one of the main tasks of the Observatory when it was established in 1883. Prior to the 20th century, Hong Kong was already a busy port of the south China coast, with a lot of ships arriving from across the vast ocean. At that time, ship navigation relied very much on the onboard chronometers in tandem with astronomical observations. As such, the ships needed an accurate time service at the port for calibrating their chronometers.

In the early days, the Observatory used a 3-inch Transit Circle and a 6-inch Lee Equatorial for astronomical observations. Observations taken with the Transit Circle were mainly for the determination of the local time. In 1884, a time ball tower was built next to the Marine Police Headquarters on a small hill along the waterfront of Tsimshatsui. The time signals were indicated by dropping a 6-feet diameter time ball from the mast of the tower, providing accurate time service to vessels commuting to and from Hong Kong.

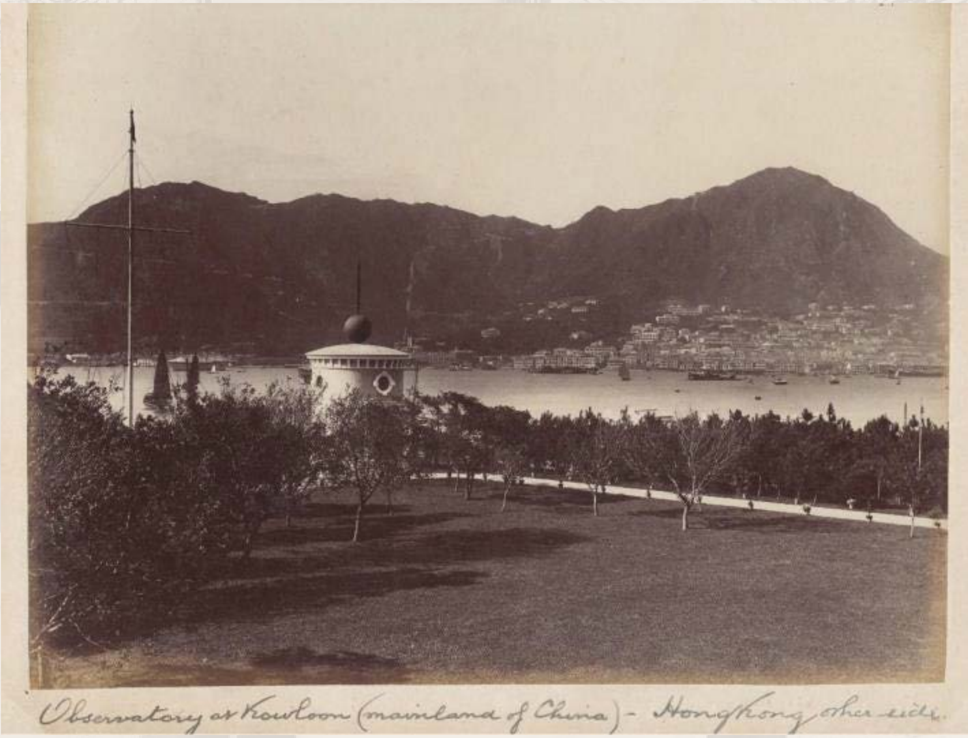


Figure 20: Photo taken in around 1886 showing the first generation time ball tower located in the Marine Police Headquarters, Tsimshatsui. (Photo courtesy of Mr. Shun Chi-ming, former Director of the Hong Kong Observatory)

The time ball tower was put into operation on 1 January 1885. At 12:55 p.m. each day, with the assistance of the officers of the Marine Police, the time ball was raised to the top of the mast and was dropped at exactly 1 p.m. The time ball was later relocated to Blackhead Point (also known as Signal Hill) in the same district in January 1908. With the establishment of a radio station that broadcasted time signals widely, the time ball was dismantled on 30 June 1933.

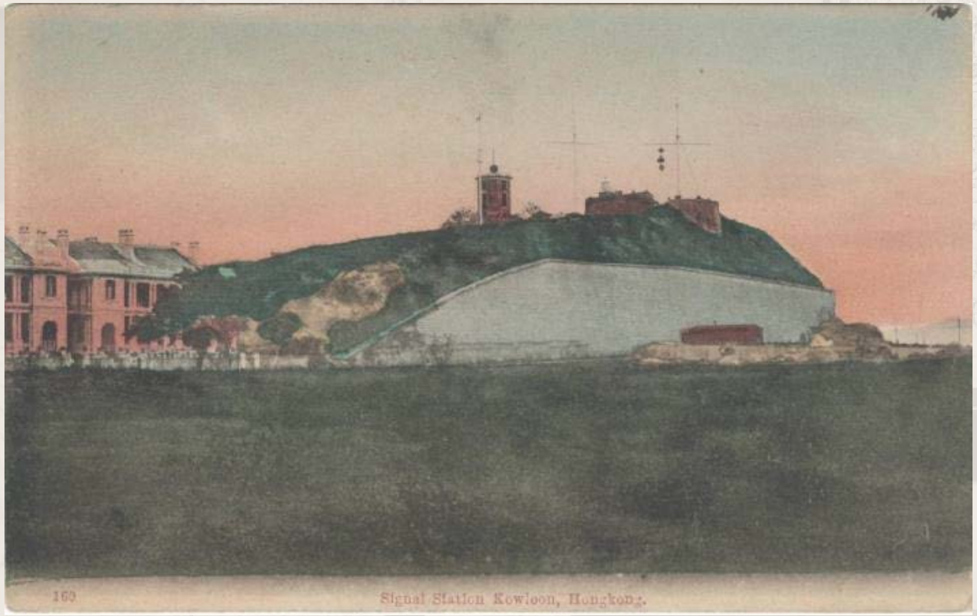


Figure 21: Postcard taken in 1910's showing the second generation time ball tower located at Blackhead Point, Tsimshatsui. (Photo courtesy of Mr. Shun Chi-ming, former Director of the Hong Kong Observatory)

In 1904, Greenwich Mean Time (GMT) was adopted as the basis for Hong Kong Time and the clocks had to be set forward by about 23 minutes 18 seconds. GMT refers to the mean solar time at the Royal Observatory Greenwich located in the countryside of London, UK. Hong Kong Time was 8 hours ahead of GMT (GMT+8).

(3) Magnetic observations

The Earth's geomagnetic field is a superimposition of several magnetic fields generated by various sources. More than 90% of the field is generated by the movement of conducting material inside the Earth's core, which is known as the Main Field. Other more important sources of the geomagnetic field include electric current flowing in the ionized upper atmosphere and currents flowing within the earth's crust. There are also local anomalies produced by mountain ranges, ore deposits, geological faults, trains, aircraft, power lines, etc.

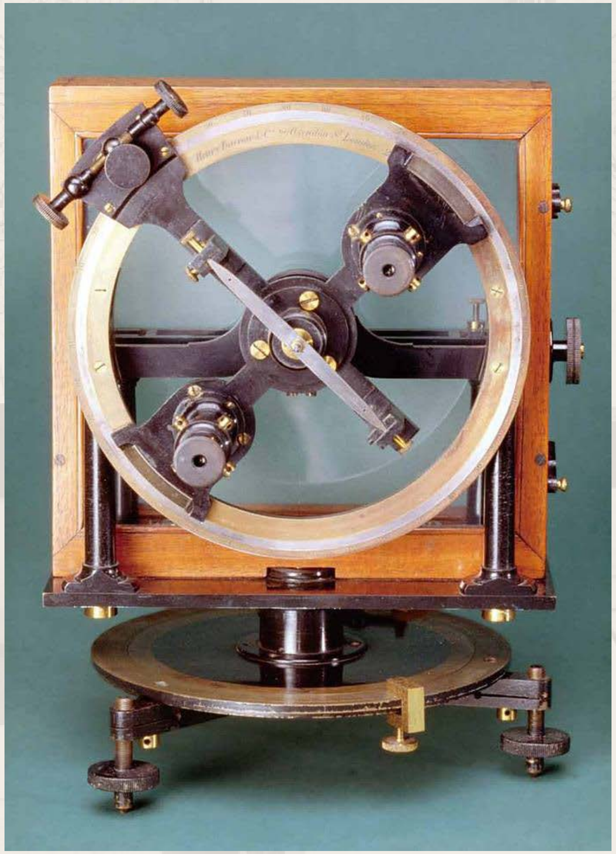


Figure 22: The Kew Pattern Dip Circle is an instrument for measuring magnetic dips. It had been used by the Observatory for regular geomagnetic measurements since 1884 till 1941 when the instrument was destroyed in World War II. (Photo by Science Museum/ Science and Society Picture Library)

Regular geomagnetic measurements on the horizontal and vertical magnetic forces, geomagnetic declination and inclination began in 1884 using Magnetometer and Dip Circle. The records continued uninterrupted until 1939. During 1884-1927, measurements were taken at two sites inside the Observatory Headquarters. The measurements then continued at Au Tau in the northwestern part of the territory from 1928 to 1939. The data collected not only aided ship navigation using compass, but also helped to understand the physics of the earth's interior and the effects of solar activities on the earth. Unfortunately, on 8 December 1941, the operation of the Au Tau Geomagnetic Station had stopped on the day when the Japanese troops invaded Hong Kong. Two Observatory's staff, namely, Mr G S P Heywood and Mr L Starbuck were captured when they tried to recover the instruments there. The geomagnetic station and the instruments were destroyed.

(4) Tropical cyclone warning system

One of the primary missions of the establishment of the Observatory was to implement a tropical cyclone warning system. In 1884, Hong Kong adopted a visual storm warning system with four red signals to alert ships in the harbour of tropical cyclones nearby and their direction relative to Hong Kong. The directions were given via a drum (east), downward cone (south), ball (west) or upwards cone (north). This signal system was known as the "Non-Local Storm Signal Code" at that time. In 1890, a set of black signals was added, which indicated that the centre of the tropical cyclone was less than 300 miles away from Hong Kong. The red signals indicated that the storm was more than 300 miles away. In 1904, the signals were further enhanced, with the direction of the tropical cyclone given in eight-point compass directions. After 1906, the evolution of this signal system followed closely with the changes in the storm signal system used by coastal ports of China at the time, including the "China Coast Code" adopted during 1906-1917.

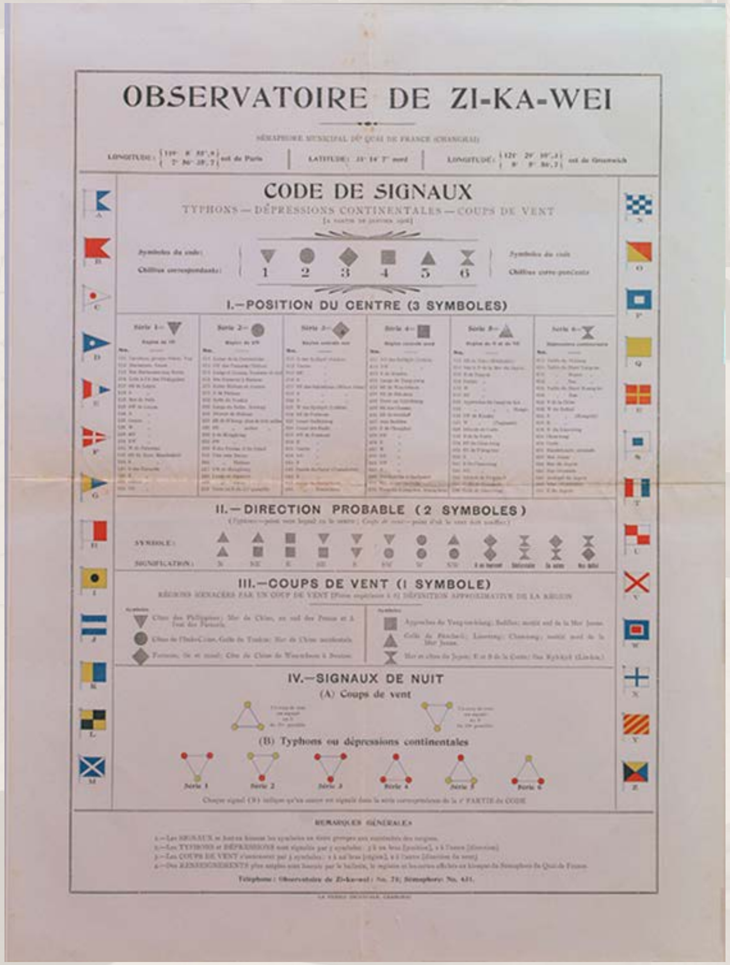


Figure 23: French edition of the China Coast Code. (Courtesy of Xujiahui Observatory, Shanghai)

For local warning signals, a typhoon gun was fired to warn the local public of imminent gale force winds when a tropical cyclone was approaching Hong Kong. In 1907, the typhoon gun was replaced by explosive bombs with louder sounds. The last typhoon bomb was set off in 1937 during the passage of the 1937 Great Hong Kong Typhoon.

The Observatory introduced night signals consisting of two lanterns in 1890. The night signals were revised in 1907.

A major revision to the storm signal system took place in 1917 when new local and non-local storm signal codes were introduced. The two signal codes were used in parallel until 1961.

1. Non-local tropical cyclone warning signals

A set of new non-local storm signal code was adopted in Hong Kong on 1 July 1917. Thereafter on 1 June 1920, Hong Kong adopted the "China Seas Storm Signal Code" at the request of the Chamber of Commerce. This set of codes was subsequently revised in 1931 and 1950 based on the recommendations from relevant meetings in the region, including the Conference of Directors of Far Eastern Weather Services held in Hong Kong in 1930.

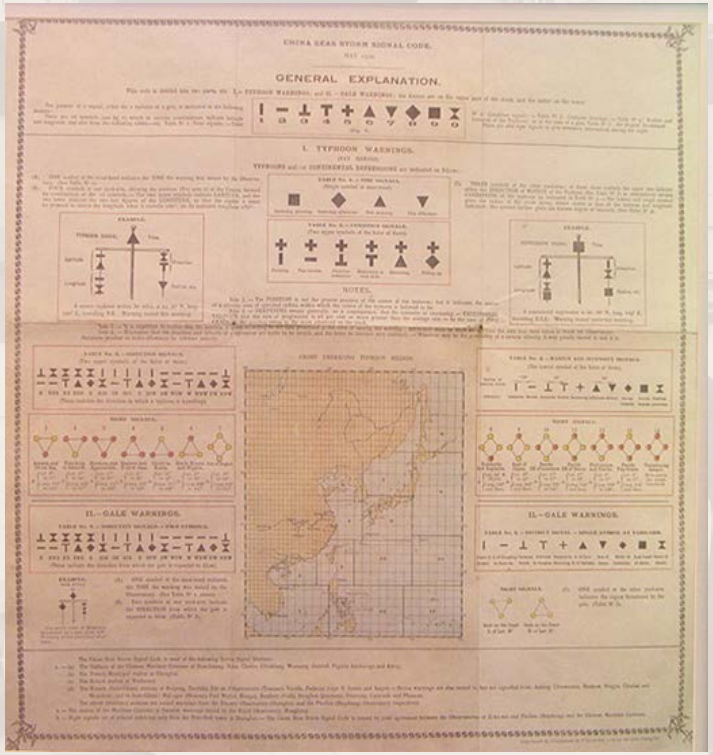
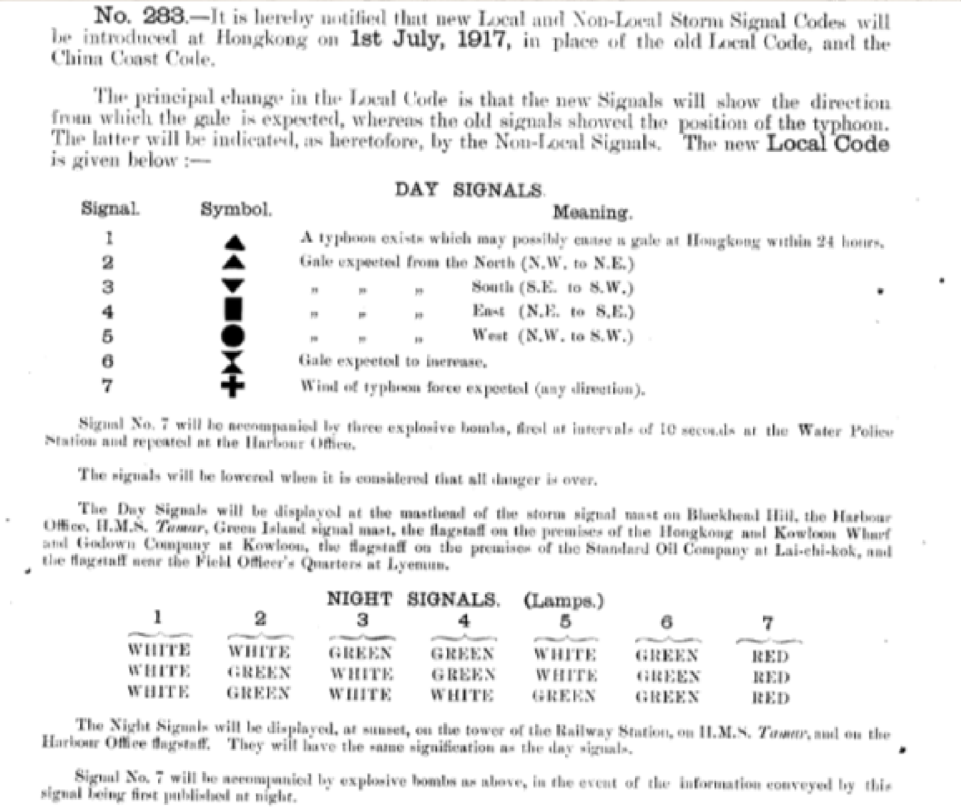


Figure 24: Poster of the China Seas Storm Signal Code (Courtesy of Xujiahui Observatory, Shanghai)

2. Local tropical cyclone warning signals

Hong Kong commenced to use a numbered local storm signals on 1 July 1917. The main purpose of this storm signal system was to warn the public of the threat of winds associated with tropical cyclones. The numbers were from 1 to 7 with numbers 2 to 5 signifying gale force winds expected from the four quadrants, namely north, south, east and west. This signal system formed the basis of the current local tropical cyclone warning system in Hong Kong. The Observatory also implemented a new set of night signals in the same year. The night signals were in use till the end of 2001 when all signal stations in Hong Kong were decommissioned.

Over the years, the local storm signal system has evolved in phases to meet the needs of the development of the society. In 1931, the signals were changed to numbers 1 to 10 with signal numbers 2 and 3 signifying strong winds from the southwest and southeast respectively, signal number 4 being a non-local signal not used in Hong Kong, signal numbers 5 to 8 signifying gales from four quadrants, namely the northwest, southwest, northeast and southeast, signal number 9 signifying increasing gales and signal number 10 indicating the threat of hurricane force winds. Signal numbers 2, 3 and 4 were used intermittently afterwards and were discontinued in the late 1930s.



No. 283.—It is hereby notified that new Local and Non-Local Storm Signal Codes will be introduced at Hongkong on **1st July, 1917,** in place of the old Local Code, and the China Coast Code.

The principal change in the Local Code is that the new Signals will show the direction from which the gale is expected, whereas the old signals showed the position of the typhoon. The latter will be indicated, as heretofore, by the Non-Local Signals. The new **Local Code** is given below :—

DAY SIGNALS.

Signal.	Symbol.	Meaning.
1	▲	A typhoon exists which may possibly cause a gale at Hongkong within 24 hours.
2	▲	Gale expected from the North (N.W. to N.E.)
3	▼	" " " South (S.E. to S.W.)
4	■	" " " East (N.E. to S.E.)
5	●	" " " West (N.W. to S.W.)
6	⧗	Gale expected to increase.
7	✚	Wind of typhoon force expected (any direction).

Signal No. 7 will be accompanied by three explosive bombs, fired at intervals of 10 seconds at the Water Police Station and repeated at the Harbour Office.

The signals will be lowered when it is considered that all danger is over.

The Day Signals will be displayed at the masthead of the storm signal mast on Blackhead Hill, the Harbour Office, H.M.S. *Tamar*, Green Island signal mast, the flagstaff on the premises of the Hongkong and Kowloon Wharf and Godown Company at Kowloon, the flagstaff on the premises of the Standard Oil Company at Lai-chi-kok, and the flagstaff near the Field Officer's Quarters at Lyemun.

NIGHT SIGNALS. (Lamps.)

1	2	3	4	5	6	7
WHITE	WHITE	GREEN	GREEN	WHITE	GREEN	RED
WHITE	GREEN	WHITE	GREEN	WHITE	GREEN	RED
WHITE	GREEN	WHITE	WHITE	GREEN	GREEN	RED

The Night Signals will be displayed, at sunset, on the tower of the Railway Station, on H.M.S. *Tamar*, and on the Harbour Office flagstaff. They will have the same signification as the day signals.

Signal No. 7 will be accompanied by explosive bombs as above, in the event of the information conveyed by this signal being first published at night.

Figure 25: The Hong Kong Government Gazette of 15 June 1917 announcing the introduction of the new Local Storm Signal Code on 1 July

3. The hoisting of storm signals

Since 1917, both the local and non-local storm signals were used in parallel in Hong Kong. The non-local storm signals were hoisted when a tropical cyclone was outside the warning area of Hong Kong. Both local and non-local storm signals were hoisted when a tropical cyclone entered the warning area. Local and non-local storm signals were hoisted at different locations in the territory.

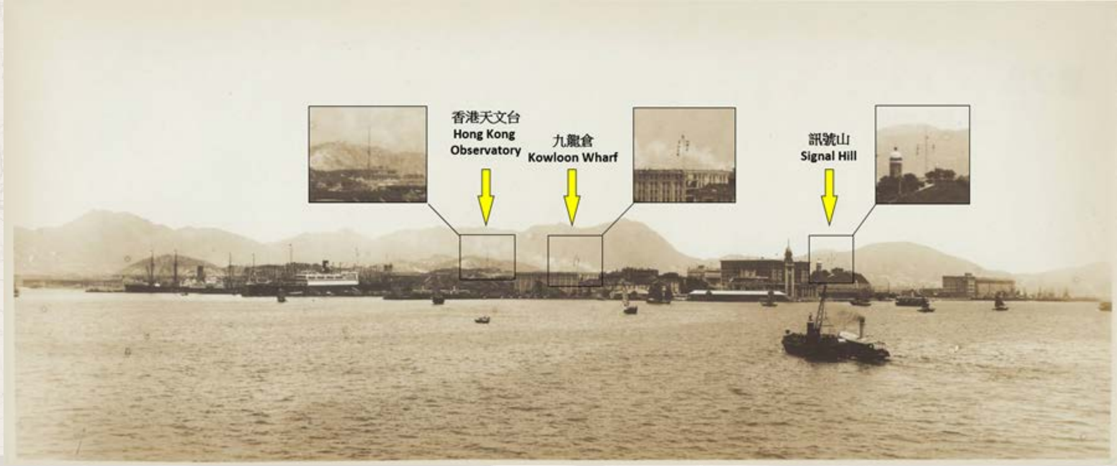
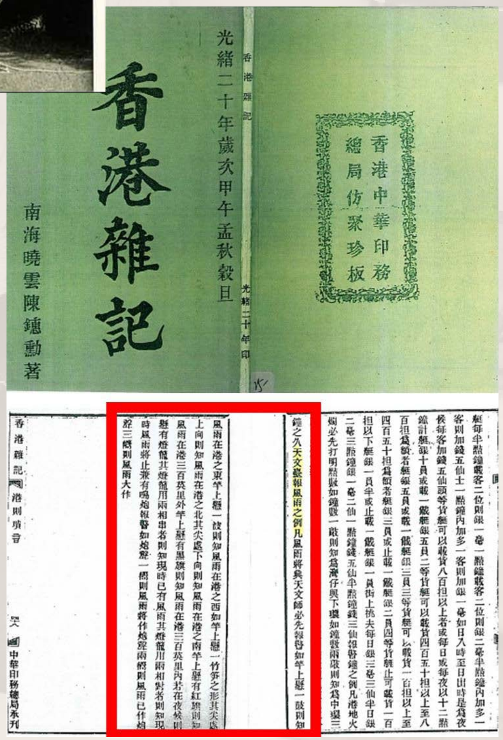


Figure 26: A panoramic view of Tsimshatsui waterfront in the late-1920s to early-1930s showing three different locations where tropical cyclone warning signals were hoisted: Hong Kong Observatory (Local Signal), Kowloon Wharf (Non-Local Signal) and Signal Hill (Non-Local Signal and Time Ball). (Photo courtesy of Mr. Shun Chi-ming, former Director of the Hong Kong Observatory)

Figure 27: In the 1920s, the Observatory hoisted the China Seas Storm Signal Code (Non-Local Signals) at Signal Hill to deliver tropical cyclone information to ships in the harbour. (Photo courtesy of Mr. Shun Chi-ming, former Director of the Hong Kong Observatory)

With the implementation of the "China Seas Storm Signal Code" as the non-local storm signals in Hong Kong in 1920, the "China Seas Storm Signal Code" started to include a time signal code at the mast head at Signal Hill of Tsimshatsui which was formerly reserved for local signals. It became necessary to select a new site for hoisting the local signals. At the suggestion of the then Director of the Observatory, the hoisting of local signals was relocated to a wireless mast at the Observatory Headquarters. The night and day signals of the local storm signals started to be displayed on the Observatory wireless mast on 3 October 1919 and 1 June 1920 respectively. In 1933, to make way for building the Director's Quarters, the wireless mast was relocated from its original position at the southwest of the Main Building to the northeast of the building.

Figure 28: Hoisting of the Standby Signal No. 1 at the Observatory Headquarters in the 1930s, under the supervision of Mr G S P Heywood (second right) who became the first Director after the Second World War. (Photo courtesy of family of Mr G S P Heywood)



香港雜記

光緒二十年歲次甲午孟秋穀旦

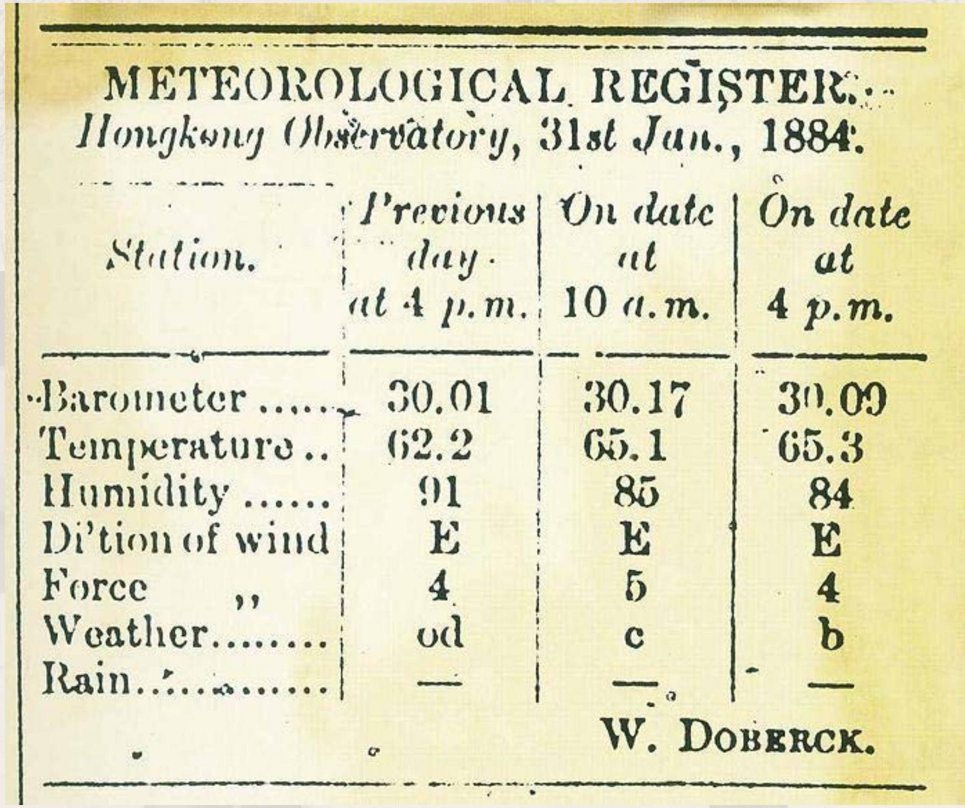
南海曉雲陳鏸勳著

香港中華印務總局仿聚珍板

Figure 29: An extract from a historical Chinese publication "Hong Kong Collections (香港雜記)" showing details of the tropical cyclone warning signal system in Hong Kong around the 1890s. (Photo courtesy of Mr Cheng Po Hung)

(5) Weather forecasting services and information delivery

From 1 January 1884, the HKO took over responsibility from the Harbour Office for the preparation and publication of the China Coast Meteorological Register, which was published in Hong Kong's major newspapers. A number of revisions were also made to the content. In addition, meteorological observations made at the Observatory Headquarters were published in the Meteorological Register, which also appeared in the major newspapers. In 1890, the Observatory utilized the telegraph network for information exchange. This allowed the Observatory to telegraph the China Coast Meteorological Register and Meteorological Register directly to telegraph companies and the Harbour Office, who could then display the latest weather reports on their information board. In addition, the Observatory was able to receive weather reports via telegraph from its station at Victoria Peak and the subsequent stations at the lighthouses on Gap Rock and Waglan Island.



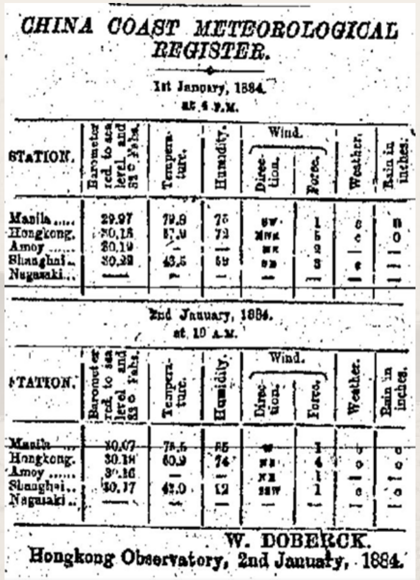
METEOROLOGICAL REGISTER.

Hongkong Observatory, 31st Jan., 1884.

Station.	Previous day at 4 p.m.	On date at 10 a.m.	On date at 4 p.m.
Barometer	30.01	30.17	30.09
Temperature ..	62.2	65.1	65.3
Humidity	91	85	84
D'tion of wind	E	E	E
Force "	4	5	4
Weather........	od	c	b
Rain............	—	—	—

W. DOBERCK.

Figure 30: The first meteorological report published by the Hong Kong Observatory on 31 January 1884 in The China Mail.



CHINA COAST METEOROLOGICAL REGISTER.

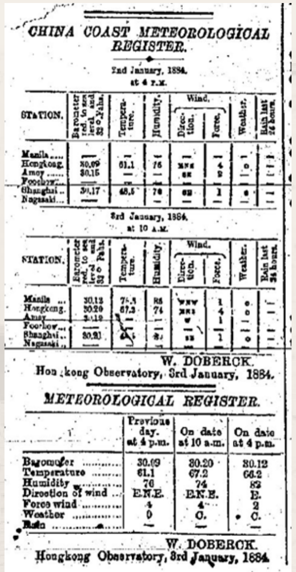
1st January, 1884.
at 4 P.M.

STATION.	Barometer red. to sea level and 32° Fahr.	Temperature.	Humidity.	Wind. Direction.	Wind. Force.	Weather.	Rain in inches.
Manila	29.97	79.8	75	SW.	1	c	0
Hongkong	30.18	67.9	73	NNE	5	c	0
Amoy	30.19	—	—	NE	2	—	—
Shanghai	30.22	43.5	69	SE	3	•	—
Nagasaki	—	—	—	—	—	—	—

2nd January, 1884.
at 10 A.M.

STATION.	Barometer red. to sea level and 32° Fahr.	Temperature.	Humidity.	Wind. Direction.	Wind. Force.	Weather.	Rain in inches.
Manila	30.07	78.5	85	W	1	b	0
Hongkong	30.18	60.9	74	NE	4	o	0
Amoy	30.16	—	—	NE	1	—	—
Shanghai	30.17	42.0	12	SSW	1	o	0
Nagasaki	—	—	—	—	—	—	—

W. DOBERCK.
Hongkong Observatory, 2nd January, 1884.



CHINA COAST METEOROLOGICAL REGISTER.

2nd January, 1884.
at 4 P.M.

STATION.	Barometer red. to sea level and 32° Fahr.	Temperature.	Humidity.	Wind. Direction.	Wind. Force.	Weather.	Rain last 24 hours.
Manila	—	—	—	—	—	—	—
Hongkong	30.09	61.1	76	ENE	4	o	—
Amoy	30.15	—	—	SE	2	—	—
Foochow	—	—	—	—	—	—	—
Shanghai	30.17	48.5	70	SE	1	•	—
Nagasaki	—	—	—	—	—	—	—

3rd January, 1884.
at 10 A.M.

STATION.	Barometer red. to sea level and 32° Fahr.	Temperature.	Humidity.	Wind. Direction.	Wind. Force.	Weather.	Rain last 24 hours.
Manila	30.12	74.5	85	WNW	1	o	—
Hongkong	30.20	67.2	74	ENE	4	o	—
Amoy	30.19	—	—	W	1	—	—
Foochow	—	—	—	—	—	—	—
Shanghai	30.21	[illegible]	[illegible]	SE	1	o	—
Nagasaki	—	—	—	—	—	—	—

W. DOBERCK.
Hongkong Observatory, 3rd January, 1884.

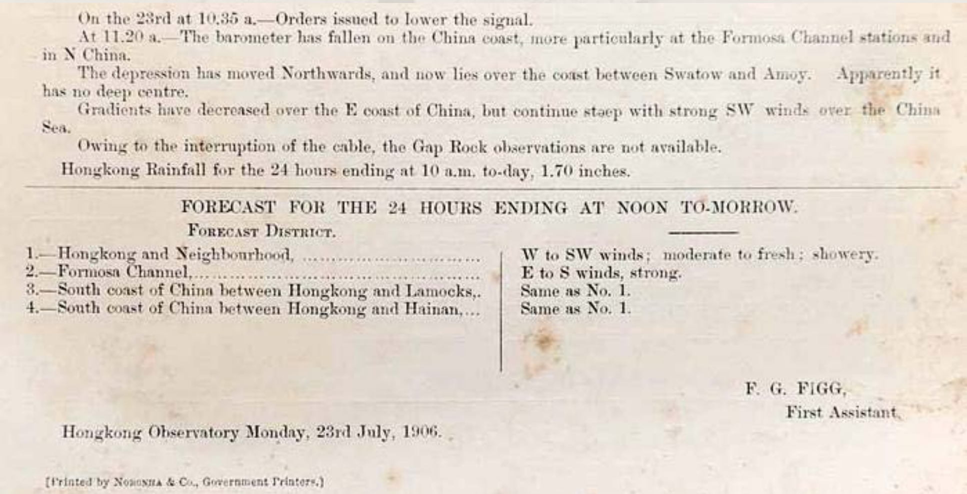
METEOROLOGICAL REGISTER.

	Previous day. at 4 p.m.	On date at 10 a.m.	On date at 4 p.m.
Barometer	30.09	30.20	30.12
Temperature	61.1	67.2	66.2
Humidity	76	74	83
Direction of wind	E.N.E.	E.N.E.	E.
Force wind	4	4	2
Weather	O	O.	C.
Rain	—	—	—

W. DOBERCK.
Hongkong Observatory, 3rd January, 1884.

Figure 31: The Observatory's first edition of the China Coast Meteorological Register (left) and Meteorological Register (right) published in the Daily Press. (Courtesy of Hong Kong Central Library)

As mentioned in the Director's Report, the Observatory has been disseminating a 24-hour weather forecast to local newspapers every day since 1892 for publication on extra edition of their newspaper around noon. Daily weather charts were even posted at the piers for public reference beginning in 1909. The Observatory started broadcasting marine weather forecasts to ships for the first time in 1915. At that time, weather forecast and typhoon information were transmitted by means of radio telegraphy using Morse code to the radio station at Cape D'Aguilar in the southern part of Hong Kong Island and was then broadcasted to ships at 1 pm.



On the 23rd at 10.35 a.—Orders issued to lower the signal.

At 11.20 a.—The barometer has fallen on the China coast, more particularly at the Formosa Channel stations and in N China.

The depression has moved Northwards, and now lies over the coast between Swatow and Amoy. Apparently it has no deep centre.

Gradients have decreased over the E coast of China, but continue steep with strong SW winds over the China Sea.

Owing to the interruption of the cable, the Gap Rock observations are not available.

Hongkong Rainfall for the 24 hours ending at 10 a.m. to-day, 1.70 inches.

FORECAST FOR THE 24 HOURS ENDING AT NOON TO-MORROW.

Forecast District.	
1.—Hongkong and Neighbourhood,	W to SW winds; moderate to fresh; showery.
2.—Formosa Channel,	E to S winds, strong.
3.—South coast of China between Hongkong and Lamocks,	Same as No. 1.
4.—South coast of China between Hongkong and Hainan,	Same as No. 1.

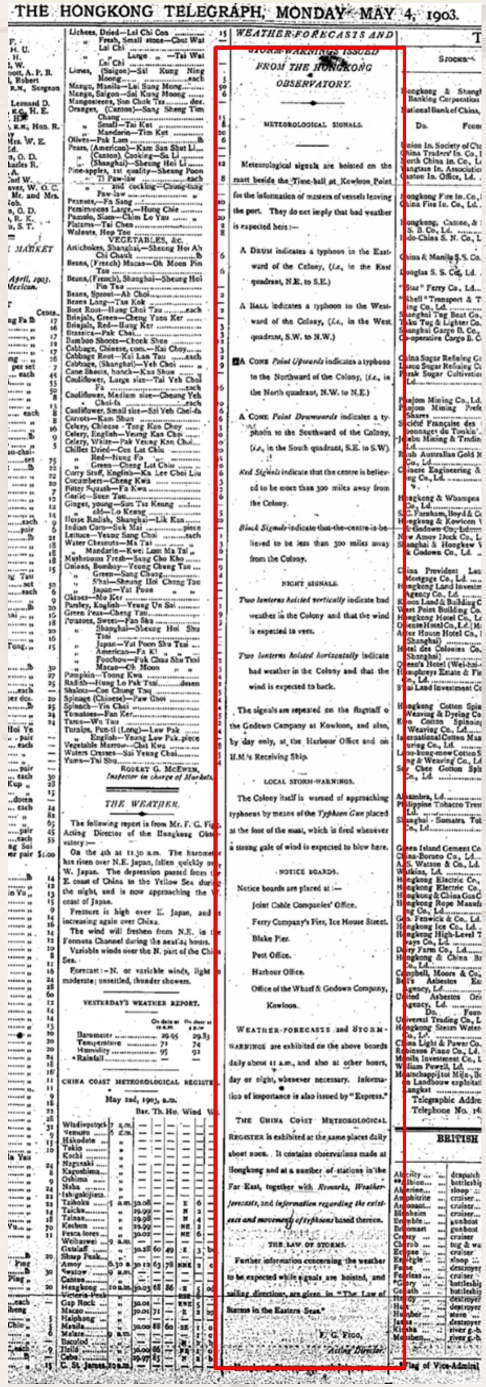
F. G. FIGG,
First Assistant.

Hongkong Observatory Monday, 23rd July, 1906.

[Printed by Noronha & Co., Government Printers.]

Figure 32: The weather forecast for the next 24 hours provided to the public by the Observatory on 23 July 1906.

From 1919 to early 1920, the broadcast frequency was increased to twice a day. The Observatory also issued the time signal twice a day via the Cape D'Aguilar radio station starting from September 1918. On 1 July 1926, Cape D'Aguilar radio station began audio broadcasts of weather reports, forecasts and typhoon information. On 30 November of the same year, a new radio station at the Observatory Headquarters was set up. The Observatory Headquarters took over Cape D'Aguilar radio station to directly broadcast in audio of weather reports, forecasts and typhoon information. Starting from 1928, Radio Hong Kong, the official radio station in Hong Kong, began to broadcast weather reports, forecasts, and typhoon information from the Observatory to the public through radio.



THE HONGKONG TELEGRAPH, MONDAY MAY 4, 1903.

WEATHER-FORECASTS AND STORM-WARNINGS ISSUED FROM THE HONGKONG OBSERVATORY.

METEOROLOGICAL SIGNALS.

Meteorological signals are hoisted on the mast beside the Time-ball at Kowloon Point for the information of masters of vessels leaving the port. They do not imply that bad weather is expected here:—

A Drum indicates a typhoon to the Eastward of the Colony, (i.e., in the East quadrant, N.E. to S.E.)

A Ball indicates a typhoon to the Westward of the Colony, (i.e., in the West quadrant, S.W. to N.W.)

A Cone Point Upwards indicates a typhoon to the Northward of the Colony, (i.e., in the North quadrant, N.W. to N.E.)

A Cone Point Downwards indicates a typhoon to the Southward of the Colony, (i.e., in the South quadrant, S.E. to S.W.)

Red Signals indicate that the centre is believed to be more than 300 miles away from the Colony.

Black Signals indicate that the centre is believed to be less than 300 miles away from the Colony.

NIGHT SIGNALS.

Two lanterns hoisted vertically indicate bad weather in the Colony and that the wind is expected to veer.

Two lanterns hoisted horizontally indicate bad weather in the Colony and that the wind is expected to back.

The signals are repeated on the flagstaff of the Godown Company at Kowloon, and also, by day only, at the Harbour Office and on H.M.'s Receiving Ship.

LOCAL STORM-WARNINGS.

The Colony itself is warned of approaching typhoons by means of the Typhoon Gun placed at the foot of the mast, which is fired whenever a strong gale of wind is expected to blow here.

NOTICE BOARDS.

Notice boards are placed at:—

Joint Cable Companies' Office.

Ferry Company's Pier, Ice House Street.

Blake Pier.

Post Office.

Harbour Office.

Office of the Wharf & Godown Company, Kowloon.

Weather-forecasts and Storm-warnings are exhibited on the above boards daily about 11 a.m., and also at other hours, day or night, whenever necessary. Information of importance is also issued by "Express."

The China Coast Meteorological Register is exhibited at the same places daily about noon. It contains observations made at Hongkong and at a number of stations in the Far East, together with Remarks, Weather-forecasts, and information regarding the existence and movements of typhoons based thereon.

THE LAW OF STORMS.

Further information concerning the weather to be expected while signals are hoisted, and sailing directions, are given in "The Law of Storms in the Eastern Seas."

F. G. Figg,
Acting Director.

Figure 33: In 1903, English newspapers in Hong Kong published weather information provided by the Hong Kong Observatory.

(6) Earthquake monitoring in Hong Kong

In the late 1910s, the Observatory already realized the importance of having equipment in order to monitor the occurrence of earthquakes. With its perseverance, the Observatory succeeded in installing the first long-period seismograph in Hong Kong in 1921 to start instrumental monitoring of distant earthquakes. The pendulum type Milne-Shaw seismograph using smoke papers for recording was set up on a temporary mounting at the Observatory Headquarters in September 1921 for recording movements in an east-west direction. The second Milne-Shaw seismograph for recording the north-south movements was received in December 1922.

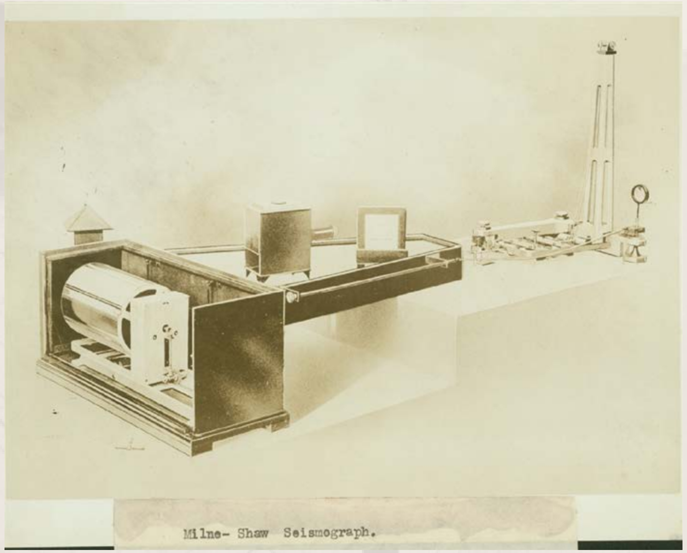


Figure 34: Same type of Milne-Shaw seismograph used by the HKO in 1921. (Source: NOAA Central Library Historical Imagery)

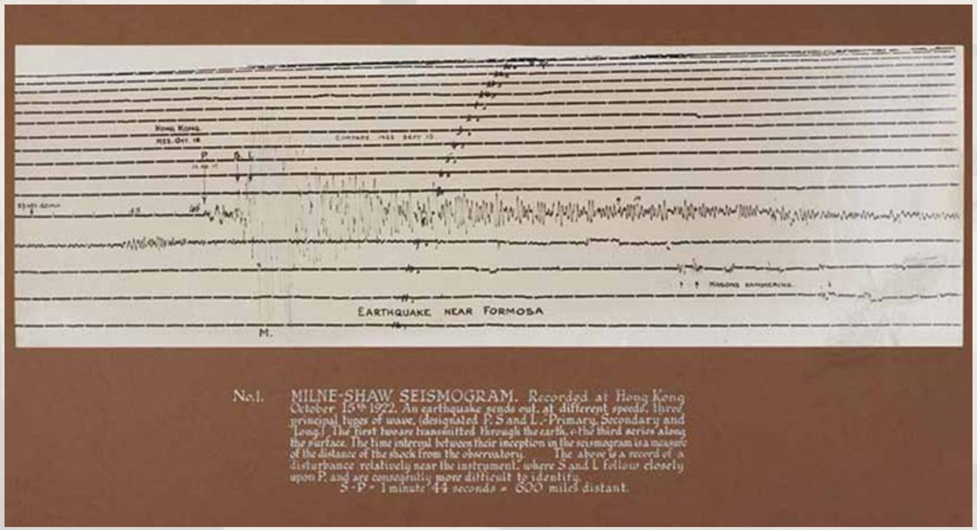


Figure 35: The earliest available seismogram of HKO, showing the earthquake of 15 October 1922 in Taiwan recorded on the Milne-Shaw seismograph. (Photo by Science Museum/Science and Society Picture Library)

To minimize the environmental noise and enhance detection capability, the building of a double-walled cellar about 6 m below the Observatory grounds for housing the seismographs commenced in September 1922 and was completed in May 1923. The seismograph received in 1922 was relocated to the cellar and set up for recording east-west movements in May 1923 for comparison with the one received in 1921 until August in the same year. The seismograph received in 1921 was then relocated to the cellar and initially set up parallel to the one received in 1922. The seismograph received in 1921 was finally mounted for recording north-south movements in September 1923. The Milne-Shaw seismographs were removed by the Japanese during the war.

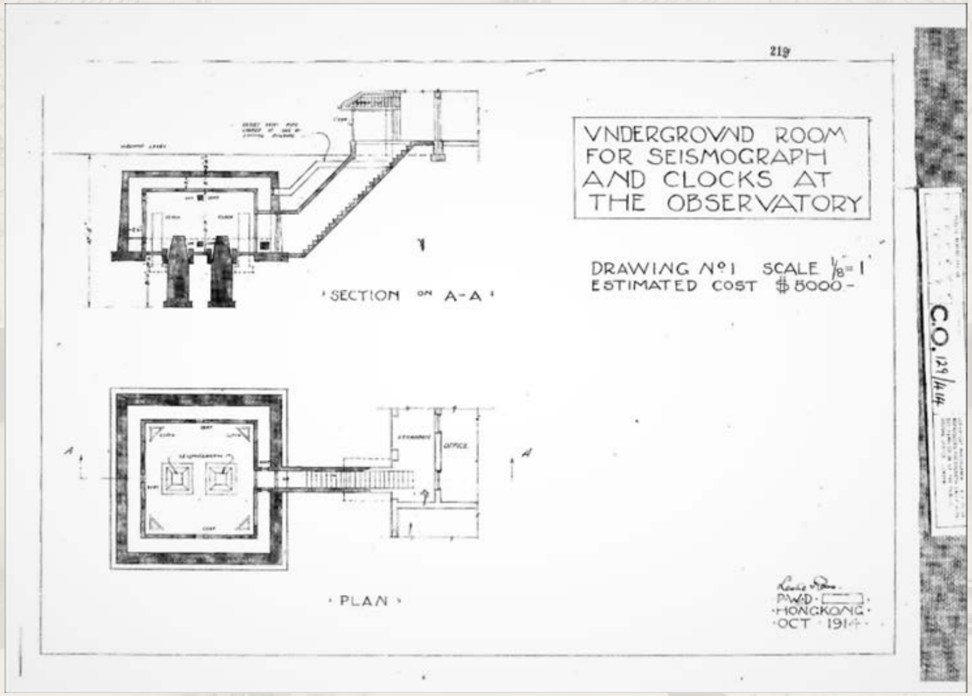


Figure 36: Construction drawing of the double-walled cellar below the HKO grounds for accommodating the seismographs.

(7) Tidal measurements

Hong Kong's early tide data came mainly from manual observation using tide poles. The first instrumental tidal measurement in Hong Kong was conducted by Dr William Doberck, the first Director of the Hong Kong Observatory. A Sir William Thomson's automatic tide gauge was mounted in a hut in the boat basin belonging to the Police Station at Kowloon Point to conduct tidal measurements in Victoria Harbour in 1887-1889. Instrumental observation of tides ceased in 1890.

(8) Participation in international meteorological affairs in early years

The Observatory actively participated in international meteorological affairs in the early days. In 1930, the Observatory convened the "First Conference of Directors of Far Eastern Weather Services" in Hong Kong. In 1937, the Observatory hosted the "First Conference of the Regional Commission II of the International Meteorological Organization (IMO)". Mr C W Jeffries, former Director of the Observatory, was elected as the Chair of the Regional Commission II in the following year.

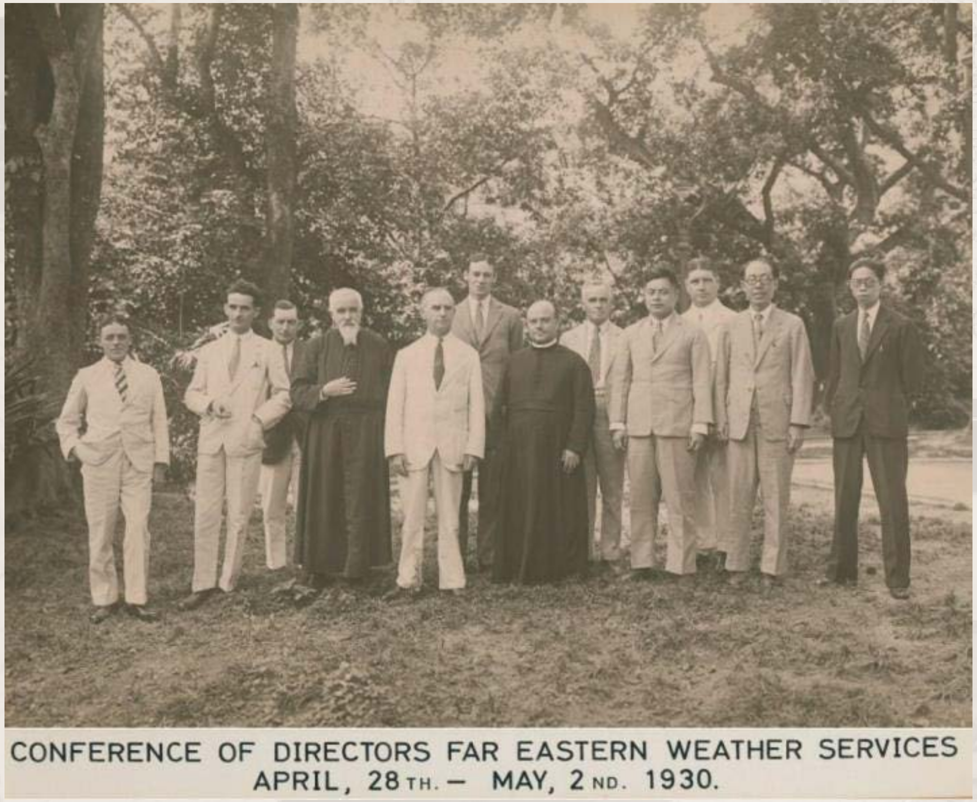


Figure 37: A group photo of participants at the "First Conference of Directors of Far Eastern Weather Services" organised by the HKO in 1930. Mr T F Claxton, the then Director of the Observatory (5th from the left); The Rev. Father Louis Froc, SJ, the then Director of the Zikawei Observatory (4th from the left); The Rev. Father Miguel Selga, SJ, the then Director of the Manila Observatory (7th from the left); Mr Shen Xiaohuang representing Mr Zhu Kezhen (4th from the right); Mr Jiang Bingran, the then Director of the Qingdao Observatory (2nd from the right); Mr Shen Youji, the then Director of the Dongsha Observatory (1st from the right). Photographed on 28 April 1930.

Chapter 3 Test of The War

Hong Kong came under the attack of the Japanese on the morning of 8 December 1941 and was eventually occupied by the Japanese on 25 December 1941. The Observatory was forced to suspend its service. During the occupation of Hong Kong from 1941 to 1945, the Observatory Headquarters was mainly used for operating two anti-aircraft guns. According to recovered data, weather observations were conducted by the Japanese soldiers at the Observatory Headquarters during the period. Although the Observatory buildings suffered only superficial damages, almost all the equipment was removed.

During the Japanese occupation period, the then Director, Mr B D Evans, was detained at the Stanley Internment Camp. The then Assistant Director, Mr G S P Heywood and his colleague, Mr L Starbuck, were kept at the Sham Shui Po Prisoner-of-War Camp. Despite the harsh environment, Mr Evans continued to maintain partial weather observations with his bare hands and simple equipment. These wartime meteorological data, including data on rainfall, air temperature, atmospheric pressure, wind directions, and relative humidity, were recorded on ledger sheet, letter paper, wrapper of cigarettes pack, and back of animal cards that came with canned biscuits.

Figure 38: Mr B D Evans, the former Director of the Observatory who persisted in taking and recording meteorological observations while imprisoned at the Stanley Internment Camp during the Japanese occupation.

Figure 39: Mr G S P Heywood, survived the nearly four years of daunting life in the Sham Shui Po Prisoner-of-War Camp during the Japanese occupation. He wrote a diary entitled "It Won't Be Long Now" (Heywood, 2015) and also conducted tidal observations. He then became the first post-war Director of the Observatory.

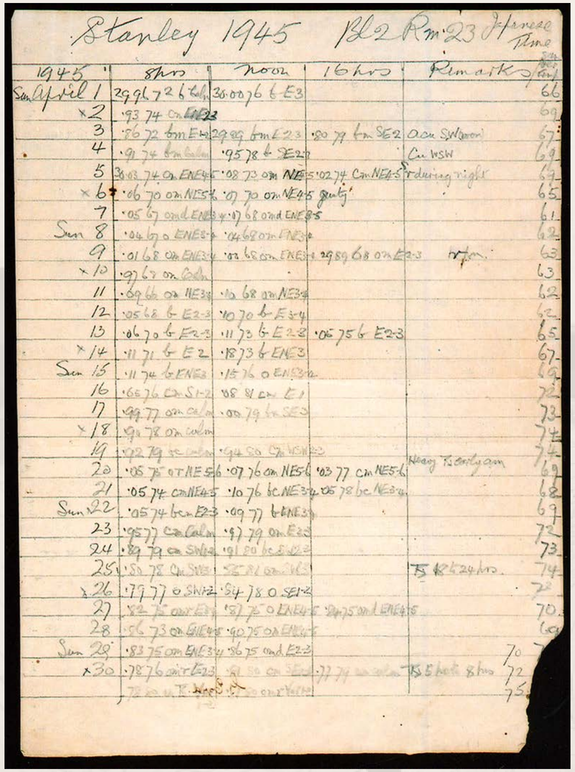
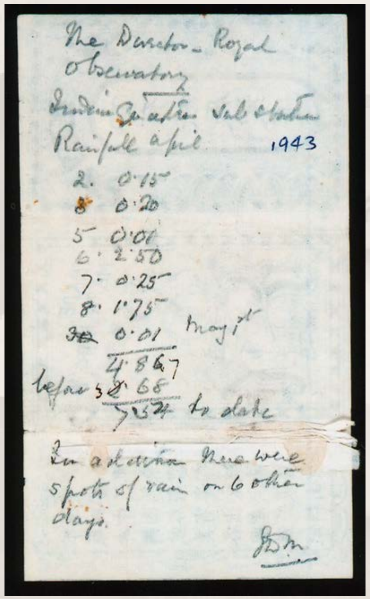


Figure 40: Weather report of 1945 at Stanley during the Japanese occupation of Hong Kong. (Photo courtesy of the Public Records Office, Hong Kong)

Figure 41: Rainfall record of April 1943 on the wrapper of cigarettes pack with the signature of Mr Evans in the Internment Camp. (Photo courtesy of the Public Records Office, Hong Kong)



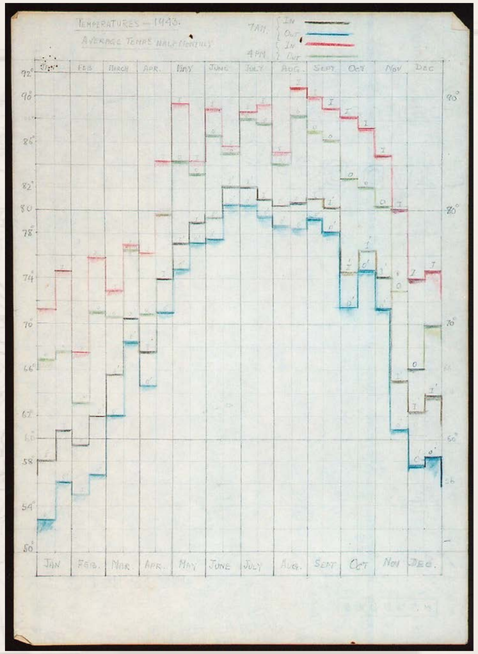


Figure 42: Temperature records of 1943 written on Internment Camp letter paper during the Japanese occupation of Hong Kong. (Photo courtesy of the Public Records Office, Hong Kong)

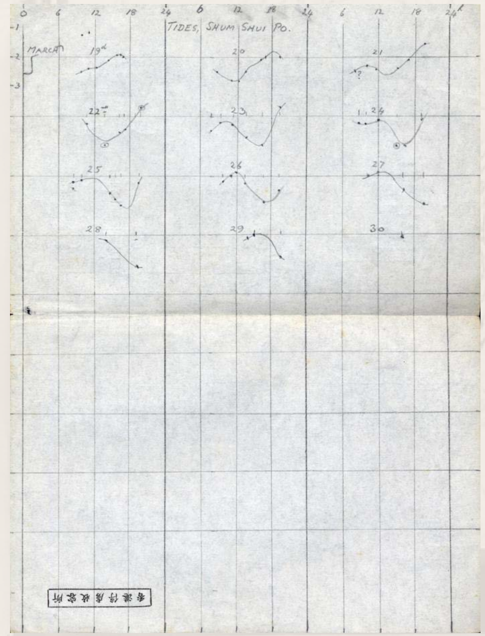


Figure 43: Records of tidal observations conducted by Mr G S P Heywood at the Sham Shui Po Prisoner-of-War Camp during the Japanese occupation. (The tidal records were provided by the family of Mr G S P Heywood and were kept in the History Room of the HKO)

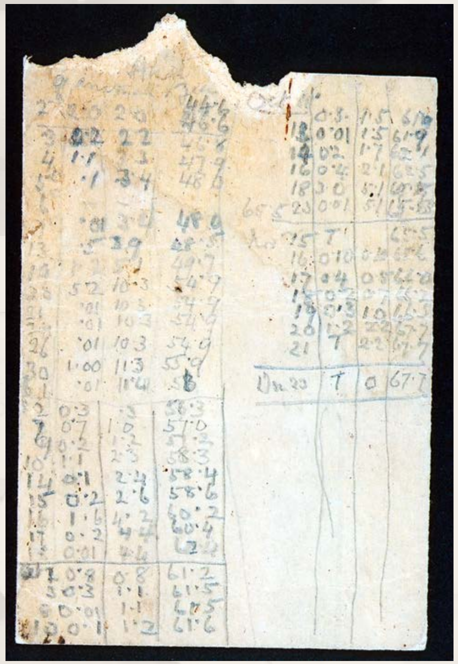
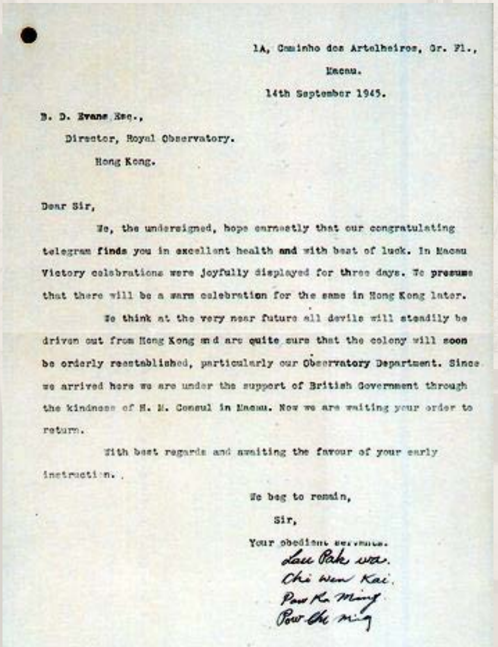


Figure 44: Meteorological data recorded by the Observatory's staff during the Japanese occupation on the back of animal cards that came with canned biscuits. (Photo courtesy of the Public Records Office, Hong Kong)

After the end of the World War II, the Observatory Headquarters was taken over by the Royal Navy and Royal Air Force. In 1945, the Chinese staff of the Observatory jointly requested for reinstating their work. When the Hong Kong Government regained control of the Observatory on 1 May 1946, all staff of the Observatory were reinstated and Mr G S P Heywood who was imprisoned in the Sham Shui Po Prisoner-of-War camp became the first post-war Director of the Observatory. The meteorological observations at the Observatory Headquarters resumed in phases since 9 May 1946. Aviation weather services also resumed in a Nissen hut at the Kai Tak Airport in August 1947. In May 1948, AMO moved to the operations building of the airport, resulted in a closer liaison with Area and Flying Controls with a great improvement in efficiency.



1A, Caminho dos Artelheiros, Gr. Fl.,
Macau.
14th September 1945.

B. D. Evans Esq.,
Director, Royal Observatory.
Hong Kong.

Dear Sir,

We, the undersigned, hope earnestly that our congratulating telegram finds you in excellent health and with best of luck. In Macau Victory celebrations were joyfully displayed for three days. We presume that there will be a warm celebration for the same in Hong Kong later.

We think at the very near future all devils will steadily be driven out from Hong Kong and are quite sure that the colony will soon be orderly reestablished, particularly our Observatory Department. Since we arrived here we are under the support of British Government through the kindness of H. M. Consul in Macau. Now we are waiting your order to return.

With best regards and awaiting the favour of your early instruction.

We beg to remain,
Sir,
Your obedient servants.
Lau Pak wa.
Chi Wen Kai.
Pow Ka Ming
Pow Che ming

Figure 45: Letter by Observatory staff in 1945 requesting for reinstatement after the end of the Japanese occupation of Hong Kong. (Photo courtesy of the Public Records Office, Hong Kong)

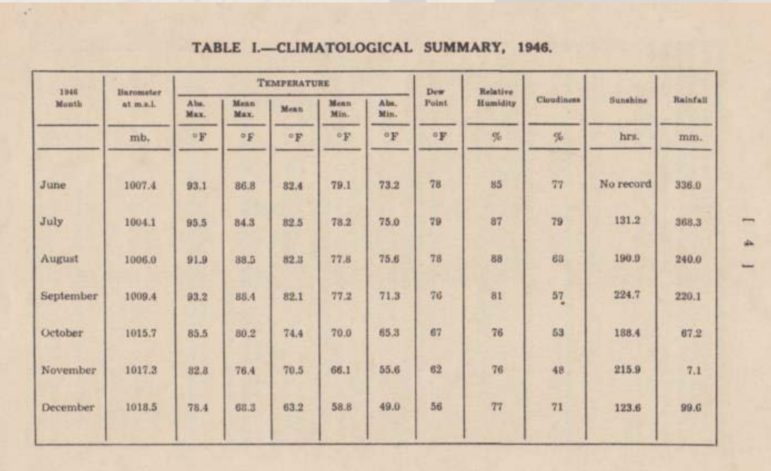


TABLE I.—CLIMATOLOGICAL SUMMARY, 1946.

1946 Month	Barometer at m.s.l.	Temperature Abs. Max.	Mean Max.	Mean	Mean Min.	Abs. Min.	Dew Point	Relative Humidity	Cloudiness	Sunshine	Rainfall
	mb.	°F	°F	°F	°F	°F	°F	%	%	hrs.	mm.
June	1007.4	93.1	86.8	82.4	79.1	73.2	78	85	77	No record	336.0
July	1004.1	95.5	84.3	82.5	78.2	75.0	79	87	79	131.2	368.3
August	1006.0	91.9	88.5	82.3	77.8	75.6	78	88	63	190.9	240.0
September	1009.4	93.2	88.4	82.1	77.2	71.3	76	81	57	224.7	220.1
October	1015.7	85.5	80.2	74.4	70.0	65.3	67	76	53	188.4	67.2
November	1017.3	82.8	76.4	70.5	66.1	55.6	62	76	48	215.9	7.1
December	1018.5	78.4	68.3	63.2	58.8	49.0	56	77	71	123.6	99.6

— 4 —

Figure 46: The Climatological Summary of Hong Kong from June to December 1946 documented in the Director's Report published in June 1947.

(1) Surface meteorological observations

The Observatory resumed meteorological observations after the World War II. There was an increase in the types of weather elements observed compared with those before the war. The Observatory began visibility observations in 1947. The measurement of soil temperature and grass minimum temperature were also commenced in 1949-1950. From 1952 to 1953, weather stations were established at Waglan Island and Cheung Chau to support aviation weather service. A bimetallic actinograph was used by the Observatory for measuring solar radiation since 1958 and was relocated in 1959 to the King's Park Meteorological Station, which is about 1 kilometre to the north of the Headquarters. The Observatory also commenced the daily measurement of evapotranspiration and evaporation at King's Park in 1951 and 1957 respectively. In the mid-1950s, the Observatory utilised a modified windfinding radar, and a marine radar on loan from the Police, to detect successfully distant rain. The Observatory's first storm-detecting weather radar was installed at Tate's Cairn in 1959 which monitored tropical cyclones and rainstorms by measuring raindrops in the atmosphere.

Figure 47: The Observatory's first storm-detecting weather radar installed at Tate's Cairn in 1959.

After the replacement of the radar twice, the Observatory implemented Hong Kong's first Doppler weather radar in 1994. This radar made use of "Doppler effect" to detect the speed of movement of raindrops to aid estimation of storm's structure and intensity. In 1999, the Observatory installed another Doppler weather radar at Tai Mo Shan, the highest peak in Hong Kong, to strengthen the reliability of storm detection. In end-2021, the Observatory installed its first phased array weather radar for trial use of this new technology to enhance the capability in monitoring storms and intense convection. Phased array weather radar adopts electronic scanning method to enable it to scan the atmosphere quickly.

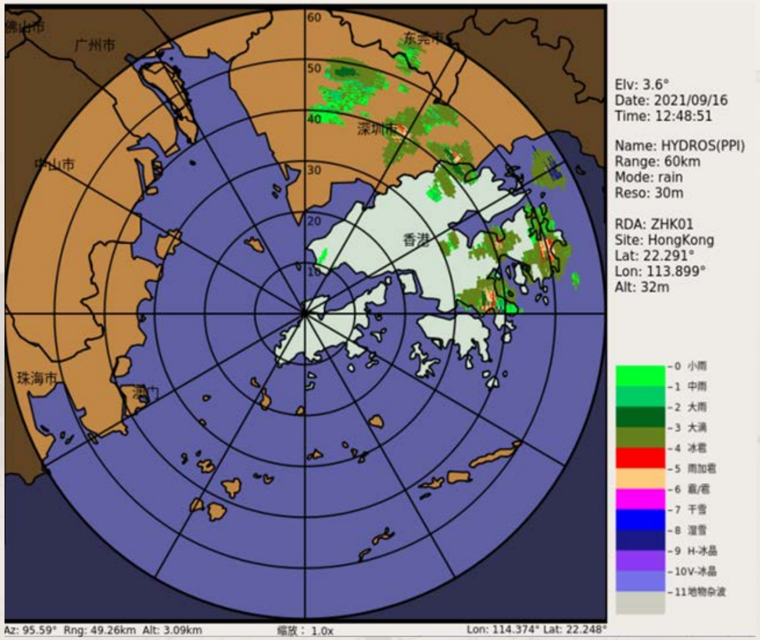


Figure 48: The Observatory's first phased array weather radar detected the occurrence of hails (in red colour) over the eastern part of Hong Kong in the early afternoon on 16 September 2021.

In the end-1970s, the Observatory employed integrated circuit and microprocessor technologies to develop automatic rain gauges and automatic weather stations. This helped to extend weather observations to different places in Hong Kong and even to neighbouring areas, and improve the frequency and types of observations. For instance, in 2005 the HKO collaborated with Guangdong Province and Macao to implement a lightning location system, providing real-time lightning information. The Observatory also installed webcams in different districts of Hong Kong to provide real-time weather photos starting the same year.

Figure 49: Panoramic view of the lawn area of the Observatory (towards the south). This photo was likely taken in the early 1970s.

Figure 50: The anemometer mast on the roof of the Main Building in August 1977.

In 2009, the Observatory successfully registered a patent in Hong Kong for its in-house developed "Heat Stress Monitoring System" and the system was installed at the Headquarters in 2010. The dry bulb temperature, natural wet bulb temperature, and globe temperature measured by the system are combined to calculate the Hong Kong Heat Index, which is tailored for the climate and environment of Hong Kong for enhancing the heat stress information service of the Observatory. Further information about the changes in site environment, instrument and measurement methods of the Observatory Headquarters from 1884 to 2015 are available from a relevant Observatory Technical Note (Lee, 2016). In 2020, the Observatory developed in-house a design of bollard type automatic weather station, which was also successfully registered for a patent in Hong Kong. The new design enables various meteorological sensors to be accommodated in a tiny enclosure. This resolves the issues of installing automatic weather stations in a city of limited space and facilitates the future development in microclimate monitoring.

Figure 51: "Heat Stress Monitoring System" developed in-house by the Observatory.

Figure 52: "Bollard type automatic weather station" developed in-house by the Observatory.

Since 1969, surface meteorological data of the Observatory Headquarters and other weather stations were compiled by computer. The "Meteorological Results Part I - Surface Observations", which was published since 1884, was re-named as "Surface Observations in Hong Kong" In 1987. With a view to simplifying the publication and aiding readers to get hold of the weather condition in the year, the publication was condensed to contain only summarized information and charts since 1993. Both surface and upper-air data were then included in the publication, which was re-entitled as "Summary of Meteorological Observations in Hong Kong". Starting in 2007, summaries of observed sea levels at tide gauge stations operated by the Observatory and the number of lightning strokes detected over the Hong Kong territory by the Lightning Location Network were included in the publication, which was subsequently renamed as "Summary of Meteorological and Tidal Observations in Hong Kong".

As part of the feasibility study for a replacement airport, Observatory started to operate a manned temporary meteorological station at Chek Lap Kok in 1979. An experimental wind shear warning system for Kai Tak Airport was commissioned in September in the same year. The meteorological station at Chek Lap Kok was blown down by Typhoon Ellen in September 1983 and was then replaced by an automatic weather station which operated until levelling of the site for construction of the new airport in 1991. In October 1995, a new automatic weather station was set up at the levelled Chek Lap Kok airport construction site to continue weather observation. From April 1996, weather observation at Chek Lap Kok was conducted by a weather observer.

Figure 53: Mr. Shun Chi-ming, the Senior Scientific Officer at the time, led a group to develop the LIDAR-based windshear alerting system. The system commenced its dual-LIDAR operation in 2007.

The Hong Kong International Airport at Chek Lap Kok was opened in July 1998. A series of meteorological systems for the new airport was also put into operation. These include the aerodrome meteorological observing system and the Terminal Doppler Weather Radar for windshear detection. To enhance windshear monitoring under rain free situations, the Observatory introduced in 2002 the world's first Doppler LIDAR for airport weather monitoring. LIDAR can detect the movement of particulates in the air for monitoring of windshear on flight paths. In 2005, the Observatory operated a LIDAR-based windshear alerting system. This system was developed in-house and was the first operational LIDAR windshear alerting system in the world. The development of the system filled the technical gap in clear air windshear detection and was highly recognized by the international aviation and meteorological community. The LIDAR windshear alerting system won the Award of the Year, the top award in the Hong Kong ICT Awards 2009. It also won the Best Innovation and Research Grand Award as well as the Gold Award for the Open Stream.

In 2001, the Observatory installed the first weather buoy of monitoring weather over the seas near the airport, especially for early warning of wind shear brought by sea breeze. By using LIDAR at the airport, the Observatory started some trials to detect building-induced turbulences in 2009 and aircraft wake vortices in 2014. In 2012, the first X-band Doppler weather radar was commissioned. A second Terminal Doppler Weather Radar station installed near Brothers Point began operation in 2014 to enhance the safety of aircraft operations. In 2014, a study on wake vortex detection was made using a short-range LIDAR (SRL) at the airport. Since the middle of 2019, the Observatory developed SRL based alerting technology as an enhancement of the Windshear and Turbulence Warning System and commenced its operational use for the detection of turbulence arising from buildings near the runway. In 2022, in order to support the operation of the third runway of the Three-Runway System project, a number of meteorological equipment was installed to expand the surface observation network with system enhancement.

(2) Upper air meteorological observations

After the war, the Observatory resumed launching pilot balloons and using a theodolite to measure the upper-air winds twice daily during daytime at the Observatory Headquarters. The launching of pilot balloons at night time started in February 1949. From February 1950, upper-air observations increased to four times daily (03, 09, 15, and 21 GMT).

On 1 November 1949, the first upper-air sounding system using radiosonde was installed at the Observatory Headquarters and routine upper-air observations were carried out at 8 a.m. daily. The staff of the Observatory manually inflated and released a balloon that was tied with a radiosonde. When the balloon rose, the radiosonde sent the upper-air pressure, temperature and humidity data measured by the sensor back to the ground station at the Observatory Headquarters using radio signals. Routine upper-air meteorological observations were carried out at the Observatory Headquarters every morning until the end of May 1951, when a small hilltop at King’s Park, north of the Headquarters, was identified as a more suitable location for launching meteorological balloons and an upper-air meteorological station was established there. Starting from 1 June 1951, routine radiosonde was then made at the King’s Park Meteorological Station every morning. On 1 July 1954, the observations made by pilot balloons at 09, 15, and 21 GMT were changed to be made at the King’s Park Meteorological Station, and those at 03 GMT were also carried out at the King’s Park Meteorological Station instead from 16 October 1954. The 30 odd years of glorious mission in upper-air meteorological observations since 1921 at the HKO Headquarters also ended.

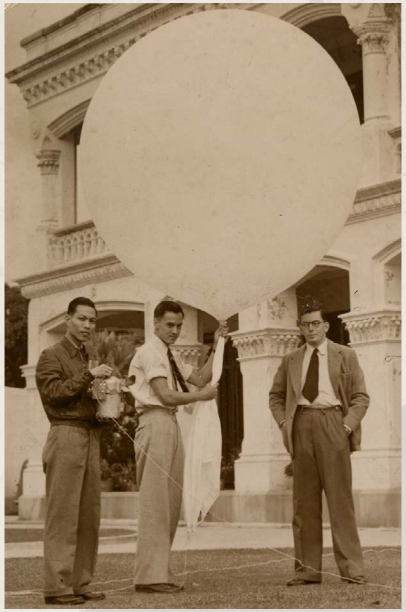


Figure 54: Colleagues of the Observatory were preparing to launch an upper-air sounding balloon in front of the 1883 Building at the Observatory Headquarters on the morning of 16 December 1949. The staff on the far left and the centre of the photo were holding the radiosonde and the balloon respectively. Due to the relatively large size and heavy weight of the instrument at that time, a dedicated staff was required to operate the radiosonde. (Courtesy of Mr Shun Chi-ming, former Director of the Hong Kong Observatory)

Figure 55: The inauguration ceremony of the King's Park Meteorological Station on 9 November 1951. (Courtesy of the family of Mr L Starbuck, former Deputy Director of the Hong Kong Observatory)

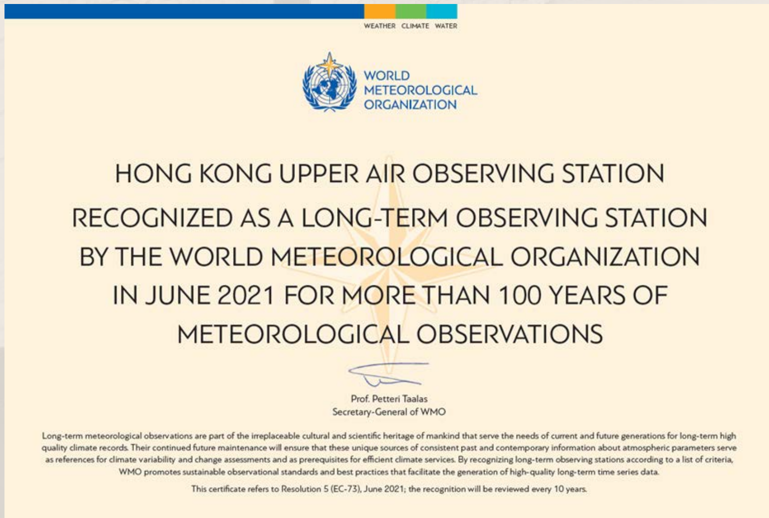
In conducting upper air sounding at King’s Park Meteorological Station, a radar reflector would be attached to the upper air sounding balloon in addition to a radiosonde. The Observatory staff employed a ground-based army radar to track the movement of the radar reflector and determined its range, direction and elevation, from which the upper level wind direction and speed could be computed. A newly installed windfinding radar was used instead of the army radar on 1 January 1955.

Figure 56: The windfinding radar at King’s Park Meteorological Station in 1962. (Courtesy of Mr Peterson, former Senior Scientific Officer)

In 1993, the Observatory adopted a digital sounding system that, in addition to performing routine upper-air weather measurements, supported also specially designed detectors to measure upper-air ozone content as well as gamma and beta radiation levels. Since then, the Observatory has been monitoring upper-air ozone content at the King’s Park Meteorological Station once a week, and regularly conducting upper-air radiation measurements under different weather conditions every year. In 2004, the Observatory installed a fully automatic upper-air sounding system, the first of its kind in Southeast Asia, at the King’s Park Meteorological Station to automatically inflate and release balloons. This not only reduced operating costs and increased work efficiency, but also enhanced the safety of personnel in work. In November 2019, the King's Park Meteorological Station was awarded a certificate by the World Meteorological Organization (WMO) in recognition of its long-term contribution to supporting the Global Climate Observing System (GCOS) Upper Air Network (GUAN). In 2020, the King’s Park Meteorological Station became a candidate site of the GCOS Reference Upper Air Network (GRUAN) of the WMO, and commencing October, a cryogenic frost-point hygrometer was launched monthly as required to provide long-term and high-quality upper-air atmospheric water vapor content data to the meteorological community. In 2021, the upper air observing station in Hong Kong became the world's first centennial upper air observing station recognised by the WMO.

Figure 57: The fully automatic upper-air sounding system was commissioned at King's Park Meteorological Station in 2004, the first of its kind in Southeast Asia at that time.

Figure 58: The then Director of the Hong Kong Observatory, Mr Shun Chi-ming (right) received a certificate from Mr Tim Oakley (left), Network Manager of the Global Climate Observing System (GCOS) in November 2019, in recognition of the long-term contributions of the Observatory's upper-air meteorological station to the GCOS Upper-Air Network (GUAN).



WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

HONG KONG UPPER AIR OBSERVING STATION RECOGNIZED AS A LONG-TERM OBSERVING STATION BY THE WORLD METEOROLOGICAL ORGANIZATION IN JUNE 2021 FOR MORE THAN 100 YEARS OF METEOROLOGICAL OBSERVATIONS

Prof. Petteri Taalas
Secretary-General of WMO

Long-term meteorological observations are part of the irreplaceable cultural and scientific heritage of mankind that serve the needs of current and future generations for long-term high quality climate records. Their continued future maintenance will ensure that these unique sources of consistent past and contemporary information about atmospheric parameters serve as references for climate variability and change assessments and as prerequisites for efficient climate services. By recognizing long-term observing stations according to a list of criteria, WMO promotes sustainable observational standards and best practices that facilitate the generation of high-quality long-term time series data.

This certificate refers to Resolution 5 (EC-73), June 2021; the recognition will be reviewed every 10 years.

Figure 59: The long-term observing station accreditation certificate awarded by the WMO to the Hong Kong Upper Air Observing Station.

In the mid-1960s, the Observatory started using in-house developed radio antenna and equipment installed at King's Park to receive satellite images from the meteorological satellites launched by the U.S.A. In the following decades, the Observatory installed more ground reception systems to receive satellite images and data from the satellites of the Mainland, Japan and the Republic of Korea, and to receive global satellite images via the Internet.

Figure 60: The Observatory staff used in-house developed equipment to receive images from the meteorological satellites of the USA at the King's Park Meteorological Station in the mid-1960s.

In 2003, automatic weather reports were successfully received for the first time from computers on board commercial aircraft. The next year, the Observatory started operational reception and global dissemination of automatic (Aircraft Meteorological Data Relay) AMDAR weather reports made by computers onboard of a commercial aircraft. The number of participating aircraft increased gradually from one at the start of this system to a peak of 50 in 2020.

In collaboration with the Government Flying Service, fixed-wing aircraft was deployed to collect meteorological data on tropical cyclones over the South China Sea for the first time in 2011 and to release dropsonde from a high altitude to collect the meteorological data at various heights in the vicinity of a tropical cyclone since 2016. The data is valuable to the Observatory in determining the location and intensity of a storm.

Figure 61: The old and new fixed wing aircraft operated by the Government Flying Service. Since 2011, the Observatory has been making use of them in many occasions to collect meteorological data on tropical cyclones over the South China Sea by flying into the tropical cyclones. A dropsonde launching system was installed on the new fixed wing aircraft for collecting weather data along the vertical direction.

(3) Tidal measurements

In the early 1950s, the Observatory obtained data from an automatic tide gauge installed at the base of the Arsenal base in Wan Chai. The tide gauge was relocated to North Point in October 1952 and further to Quarry Bay in 1985. The concurrent observations at North Point and Quarry Bay compared well with each other. As such, the tide records of the two tide stations can be regarded as coming from the same tide station. The combined tide records from North Point and Quarry Bay are the longest tide records in Hong Kong. Other automatic tide stations were installed in various locations in the 1960s. The Observatory currently operates six tide stations at Tsim Bei Tsui, Tai Po Kau, Quarry Bay, Tai Miu Wan, Shek Pik and Waglan Island.

In 1983, the Observatory acquired a computer program for tidal analysis and prediction from the Institute of Ocean Sciences, Canada, and successfully modified the program for application in Hong Kong in 1986. As a result, the Observatory started to produce tidal forecasts and publish Hong Kong tide tables annually since 1987.

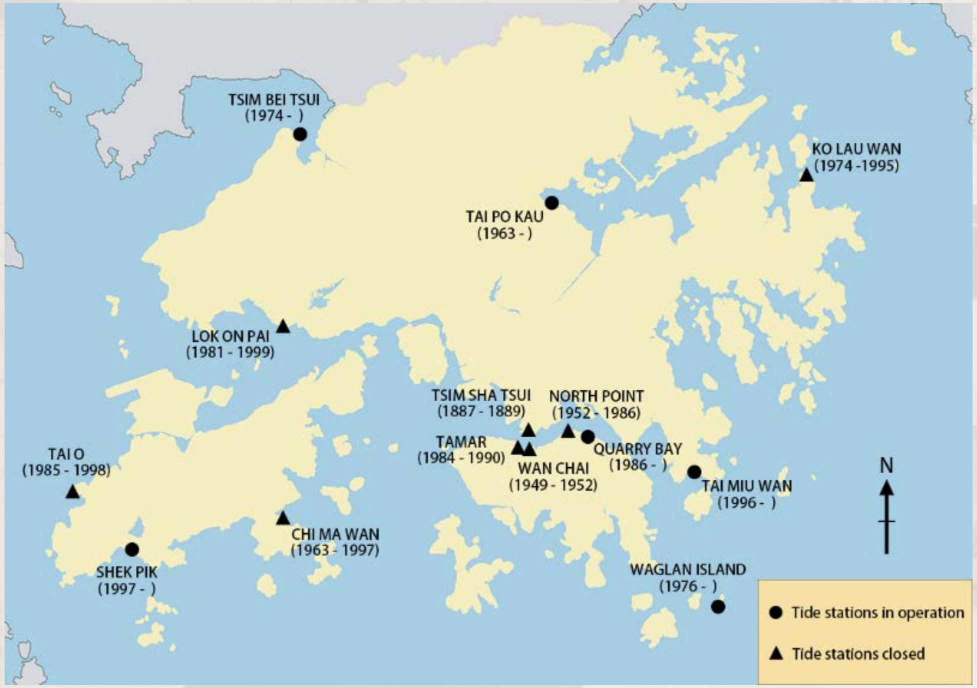


Figure 62: Locations of tide stations that were being operated and closed down by the Observatory since 1883.

(4) Time services

The three pendulum clocks of the Observatory that were used before the war all luckily survived the war. After the Observatory resumed its operations in 1946, one of these pendulum clocks was adopted as the time standard. It was regulated by radio time signals from other time centres in the world. In 1950, an electro-mechanical synchronous standard pendulum clock that could provide time signals was installed. Timing accuracy gradually improved from seconds to within one-fifth of a second per day. The flashing light time service and the radio time service resumed in 1950-51. On 11 April 1953, Radio Hong Kong began broadcasting hourly six-pip time signals of Hong Kong Standard Time provided by the Observatory.

In 1966, a quartz-controlled timing system was implemented to replace the pendulum clocks. By comparing daily the time signals received from other centres in the world, the time accuracy was kept within 80 milliseconds per day. Direct broadcasting of the 6-pip time signal from the Observatory on 95 MHz commenced in the same year, which lasted until 16 September 1989.

On 1 January 1972, Hong Kong adopted the Coordinated Universal Time (UTC) as the official time standard, with a time zone of UTC+8 hours. In 1980, a timing system based on a Caesium Beam Atomic Clock was acquired, with accuracy of within fractions of a microsecond a day, and was traceable to the primary standard at the Communications Research Laboratory in Japan.

Figure 63: Synchronous standard pendulum clock providing time service in Hong Kong from 1950 to 1966.

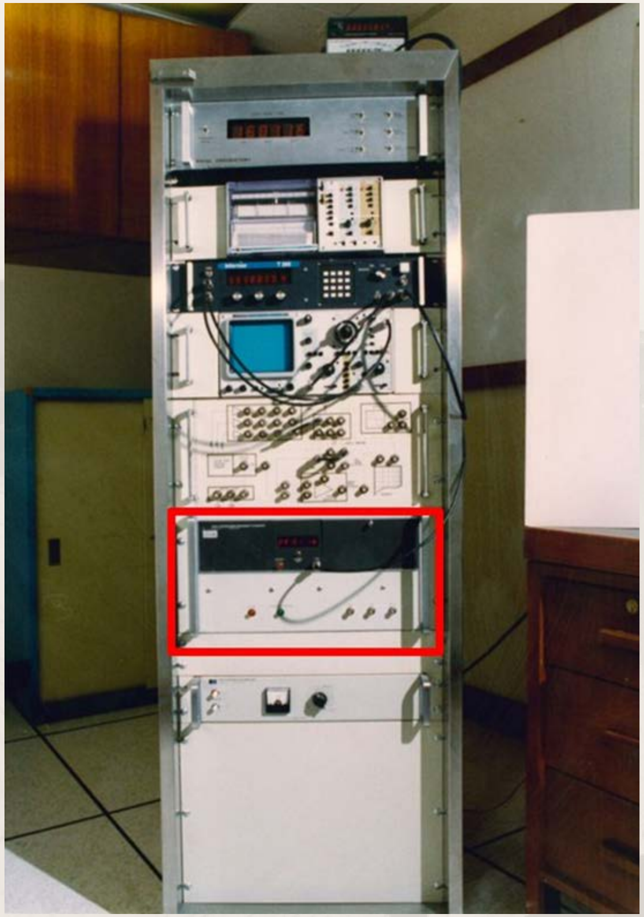


Figure 64: The first Caesium Beam Atomic Clock (red square) installed in 1980 for maintaining the Hong Kong time standard and operating local time service.1966.

In 2004, the Observatory installed a high accuracy time transfer system that employed the Global Positioning System common-view method to provide time information of the Observatory's atomic clock to the Bureau International des Poids et Mesures (BIPM) for the determination of UTC. The Observatory also adjusts its atomic clock based on time information provided by BIPM.

In 2012, the Observatory launched the IPv6 network time service to provide accurate, more direct and low-latency time signals in supporting the setting up of network facilities and servers over IPv6 networks in Hong Kong. The service can be accessed through the Observatory's Network Time Protocol (NTP) servers at the network address of time.hko.hk for calibrating the computer clocks. Besides, the Observatory also provides web clock service, enabling direct access by members of the public to the standard time from the Observatory's atomic clocks via computers or mobile phones.

In 2019, the accuracy of the Observatory's time system based on Caesium Beam Atomic Clocks has further improved to within 0.01 microseconds a day. Such a level of accuracy is particularly useful to scientists, industries and other professionals. The Observatory's network time service served more than 100 billion synchronisations in 2022.

(5) Geomagnetic observation

Operation of the geomagnetic station at Au Tau in the northwestern part of Hong Kong was terminated with the Japanese invasion of Hong Kong on 8 December 1941. It was also not possible to restore the operation after the war. In 1968, the Observatory, in collaboration with the Physics Department of the University of Hong Kong, explored the possibility of re-establishing a geomagnetic station. After a visit organized by the World Magnetic Survey Mission in the same year, a scientist from the Australian Bureau of Mineral Resources (predecessor of the present Geoscience Australia) recommended to establish a geomagnetic station at Tate's Cairn, where there was little magnetic interference from man-made sources. The station was established and put into operation in 1971. It was jointly operated by the Observatory and the Physics Department of the University of Hong Kong until it was closed in 1982 due to the shortage of funding and manpower. Thereafter, the Observatory borrowed equipment from the Royal Navy of UK to conduct geomagnetic measurement in 1988 and 1990, so as to update the information of magnetic declination on map, particularly the map of the airport. Since 2010, the Observatory instead engaged the Earthquake Administration of Guangdong Province to conduct geomagnetic measurements once every few years.

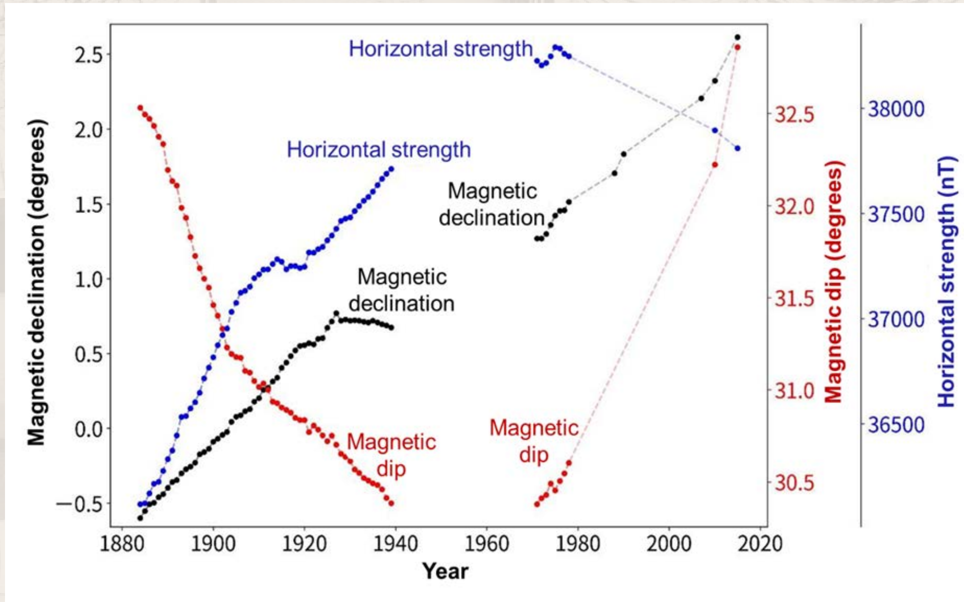


Figure 65: Result of geomagnetic measurements from the establishment of the Observatory.

(6) Tropical cyclone warning system

1. Development of the tropical cyclone warning system

After the Second World War, with non-local warnings being disseminated to ships through radio, the provision of non-local signals by visual means ceased at the end of June 1961.

To meet the needs of the development of the society, the local storm signal system has evolved in phases after the World War II. In 1956, the No. 3 Strong Wind Signal was introduced between the No. 1 Stand-by Signal and the No. 5 Gale Wind Signal.

Starting from 1973, the Observatory re-numbered the gale wind signals 5 to 8 of the warning system as No. 8 NW, 8 SW, 8 NE and 8 SE respectively so as to avoid misunderstanding by the public on the meaning of wind direction and wind strength. This led to the current 1-3-8-9-10 scheme of tropical cyclone warning system which remains in use today.

Figure 66: Major evolution of the numbered tropical cyclone warning signal system in Hong Kong since 1917.

Moreover, a "Local Strong Wind Signal" in the form of black ball, was once introduced by the Observatory on 1 January 1950. The purpose of this signal was to warn small crafts of the onset of strong winds due to monsoon or weaker tropical cyclones. With effect from 15 April 1956, the Observatory introduced the Strong Monsoon Signal (Black Ball) and the Tropical Cyclone Strong Wind Signal No. 3 (inverted T symbol) to replace the "Local Strong Wind Signal", and to separate warning signals for monsoon systems and tropical cyclones.

Figure 67: Aerial photo of the HKO Headquarters in 1950s showing the signal mast (on the right side of the photo) for hoisting the tropical cyclone warning and strong monsoon signals.

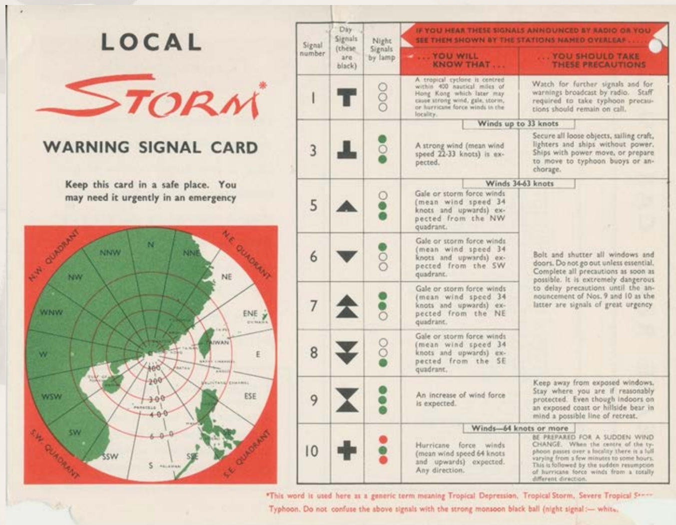


Figure 68: Local Storm Signal in the late 1950s and 1960s.

With the advancement of communication technologies, the way to convey visual information through signal stations became obsolete and inadequate, and these stations had been progressively closed down by the Observatory since the late 1970s. The mast for hoisting signals at the Observatory Headquarters was dismantled in 1978 for the construction of the Centenary Building. The last signal station in Hong Kong on Cheung Chau island, was decommissioned on 1 January 2002, marking the end of the era of hoisting tropical cyclone warning signals.

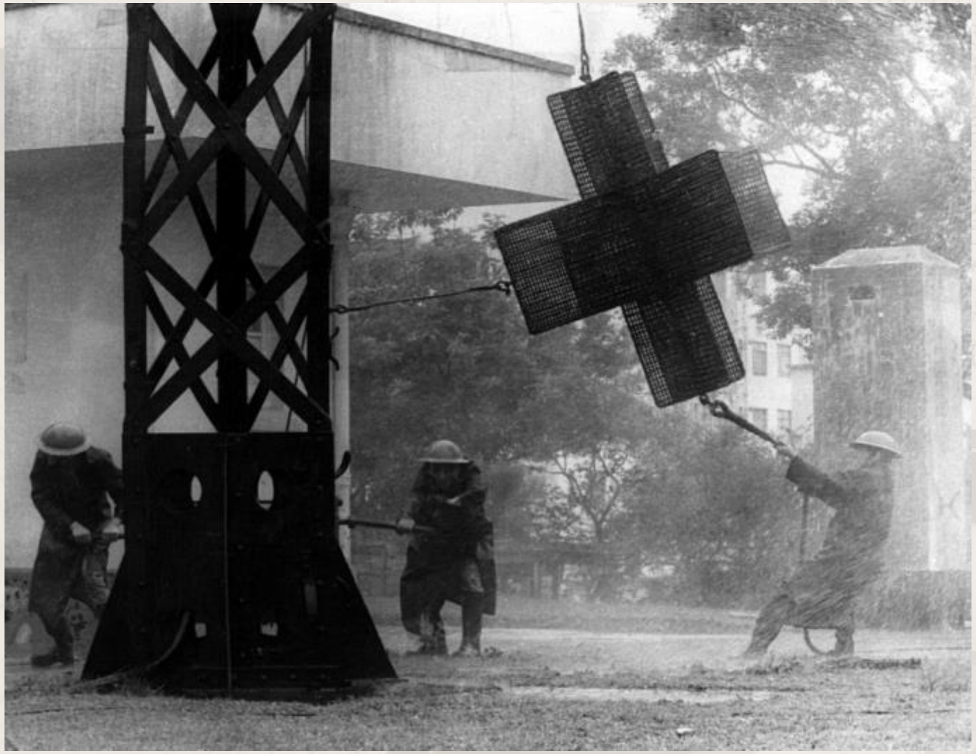


Figure 69: Hoisting Hurricane Signal No. 10 at the Headquarters of the Observatory.

Apart from the changes in the Tropical Cyclone Warning System, the Observatory progressively improves the accuracy, valid time length and geographical coverage of tropical cyclone forecast through scientific research and innovation. The valid time length of tropical cyclone track and intensity forecast was extended from 2 days in 1978 to 3 days in 2003, and further to 5 days in 2015. In 2017, the Observatory launched the "Tropical Cyclone Track Probability Forecast" as a new service providing the probability of tropical cyclone forecast track in the coming 9 days. The geographical coverage was extended in 2020 out to 180 degrees east longitude over the western North Pacific. This service enables members of the public to appraise the trend of tropical cyclone movement and be better prepared as early as possible.

More information about the evolution of the tropical cyclone warning systems in Hong Kong over the years is available from the relevant Observatory Technical Note (Lui et al., 2018).

2. Storm surge and high waves induced by tropical cyclones

In addition to heavy rain and squalls, tropical cyclones also bring storm surges and high waves that can cause serious inundation in the coastal areas. For the first time in history, in September 1962, storm surge was predicted for Tolo Harbour in the warning for Tropical Cyclone Wanda which brought the highest tide level records in both Victoria Harbour and Tolo Harbour after World War II. The storm surges brought by tropical cyclones Hope in 1979 and Ellen in 1983 also worth mentioning. In 2008, Tropical Cyclone Hagupit skirted 180 kilometres south-southwest of Hong Kong, causing flooding in many low-lying areas in Hong Kong. The inundation in Tai O in the western part of Lantau Island was particularly serious.

To tackle storm surges, the Observatory began to provide early alerts of serious inundation in Tai O in 2009 under the respective contingency plan. This storm surge alerting service was gradually expanded to a number of other areas in Hong Kong that were also prone to storm surges and high waves, enabling relevant government departments to initiate contingency plans as soon as possible to reduce the impacts of inundation to local residents.

After Tropical Cyclone Hato wreaked havoc and brought significant storm surge in 2017, the storm surge and high waves brought by Tropical Cyclone Mangkhut in 2018 caused even more serious damages to many coastal facilities in Hong Kong, including sewage treatment works, public beaches, and waterfront promenades. The sea levels recorded at Quarry Bay and Tai Po Kau were the highest since Tropical Cyclone Wanda in 1962.

(7) Development and modernization of weather service

1. Weather forecast services

With the advancement in forecasting technology, the Observatory progressively extended the forecast range, from 24 hours before the war to 3 days in 1983, 4 days in 1998, 5 days in 2000, 7 days in 2003, and further to 9 days in 2014. In addition to providing the 9-day weather forecast, the Observatory has also provided the hourly automatic regional weather forecast for various locations in Hong Kong for the next nine days through the "Hong Kong Automatic Regional Weather Forecast" webpage since 2013. In 2017, the Observatory launched the "Extended Outlook" forecast service, providing probabilistic forecasts of daily minimum and maximum temperatures for the next 14 days, and later launched probabilistic forecasts of mean sea level pressure in 2019 to facilitate the public to grasp future weather trends. In 2021, the Observatory launched the “Probability of Significant Rain” forecast, or “PSR” forecast for short, as a further enhancement to the 9-day weather forecast service. The PSR forecast provides users with additional reference on rainfall amount and forecast trend for the coming 9 days.

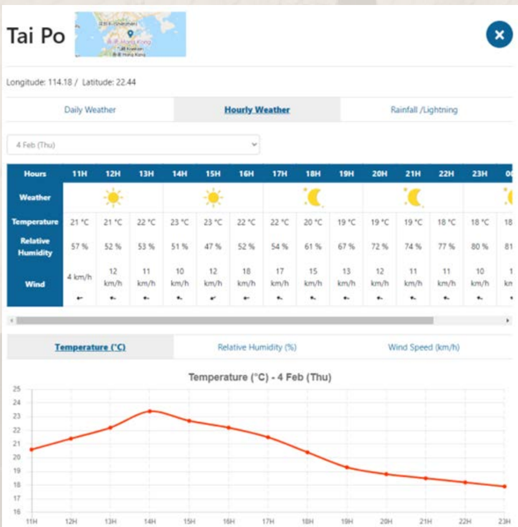


Figure 70: Webpage on “Automatic Regional Weather Forecast”.

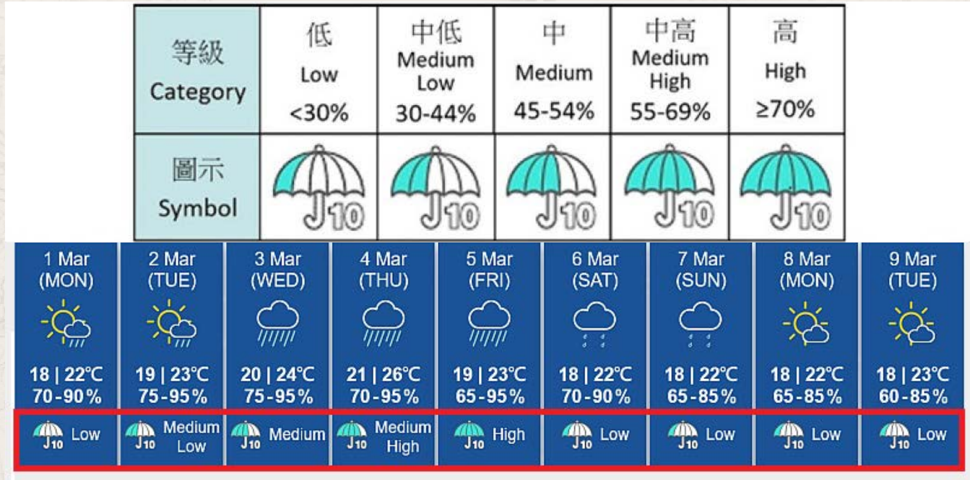


Figure 71: 9-day “Probability of Significant Rain” Forecast.

To handle forecasting of severe weather, to enhance the respective warning services, to protect the safety of the public and to safeguard the operation of various organizations in the society, the Observatory commenced the development of a nowcasting system known as SWIRLS (Short-range Warning of Intense Rainstorms in Localized Systems) in 1997 and put it into operation in 1999 (Li et al., 2000). SWIRLS utilizes observations including radar, rainfall and lightning data, as well as computer model outputs to generate forecasts of rainstorms and associated severe weather for the next few hours. Apart from supporting the operation of rainstorm and landslip warnings in Hong Kong, the HKO also cooperated closely with Mainland meteorological services, including those in Shanghai, Guangdong and Shenzhen, to further the scientific research and applications of SWIRLS. SWIRLS demonstrated its strengths at the Beijing 2008 Olympic Forecast Demonstration Project (B08FDP) under the World Weather Research Program (WWRP) of the WMO, and was further employed to support the 2010 World Expo in Shanghai, the 2010 Commonwealth Games in Delhi and the 2011 Summer Universiade in Shenzhen.

In view of lightning threat to the airport, the Observatory launched an Airport Thunderstorm and Lightning Alerting System (ATLAS) in 2008 providing lightning alerts to personnel on the apron of the airport.

In 2012, the Observatory launched the two-hour rainfall forecast on its website and the "MyObservatory" mobile application, and later launched the one-hour lightning nowcast in 2017, allowing the public to obtain high-impact weather forecasts anytime and anywhere.

The Observatory has been collaborating with the universities in Hong Kong in recent years to conduct research on applying deep learning on nowcasting. In 2018, the Observatory partnered with Shenzhen Meteorological Bureau to organise the Global Artificial Intelligence (AI) Challenge on Meteorology and promote the use of AI in meteorological research and innovative application. The Observatory also collaborated with the State Meteorological Agency of Spain (AEMET) to develop nowcasting techniques based on satellite data in order to enhance nowcasting performance.

SWIRLS won the Smart Business Grant Award and the Smart Business (Solution for Business and Public Sector Enterprise) Gold Award at Hong Kong ICT Awards 2019.

On the other hand, the Observatory made use of computer models to forecast weather within Hong Kong and neighbouring waters, providing fine-resolution weather forecasts in both space and time to members of the public. Besides the 9-day weather forecast for Hong Kong, the Observatory started to provide hourly forecasts at different locations in Hong Kong and the Pearl River Delta region for the next 9 days through the "Automatic Regional Weather Forecast" webpage in 2013.

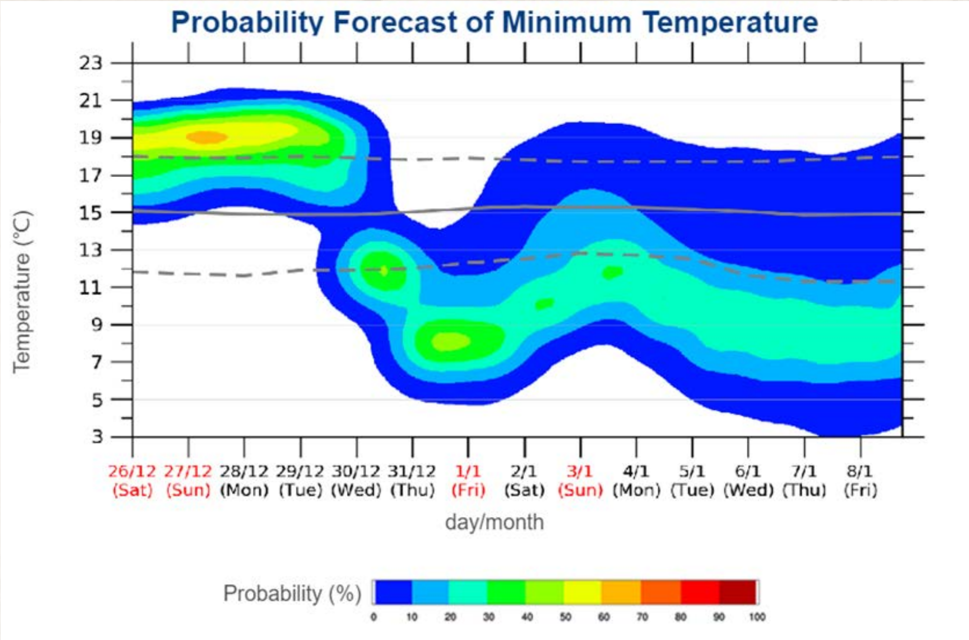


Figure 72: Probability Forecast of Daily Minimum Temperature for the next 14 days.

2. Weather warning services

Apart from tropical cyclone warnings, the Observatory also developed warning systems for other types of severe weather. The rainstorm in June 1966 resulted in serious causalities in Hong Kong. The Observatory started issuing warnings on thunderstorm and heavy rain from 1967 onwards. During the rainstorm in the morning of 8 May 1992, the Observatory recorded nearly 110 millimetres of rainfall in an hour that set the highest hourly rainfall record at that time. Serious flooding and landslides occurred in many places on that day with paralyzed traffic in various districts. Some people even lost their lives in this event. This rainstorm led to the establishment of the Rainstorm Warning System, of which the warning was issued based on recorded rainfall. In 1998, the Rainstorm Warning System was revised with the use of amber, red and black colours to signal the severity of rainstorms while incorporating forecast rainfall in order to give early alert on imminent rainstorms to facilitate early preparation.

Owing to the hilly landscape of Hong Kong, heavy rain in summer often came with landslides. In the 1970s, Hong Kong experienced a number of serious landslides, resulting in numerous fatalities and property losses. With the establishment of the Geotechnical Engineering Office, the Observatory introduced the Landslip Warning for emergency response units in 1977. The Landslip Warning was simplified and commenced dissemination to the public in 1983. In the same year, the Observatory introduced the Flood Warning System to warn against the risk of flooding associated with heavy rain. This Flood Warning System was abolished upon the introduction of the Rainstorm Warning System in 1992. Commencing 1998, a Special Announcement on Flooding in the northern New Territories will be issued by the Observatory whenever flooding is expected to occur or is occurring in the low-lying plains of northern New Territories.

Besides the warnings associated with rain, the Observatory commenced to operate the "Grass Fire Warning" which was only issued during public holidays since 15 November 1968. The Observatory started to issue the Yellow and Red Fire Danger Warning signals from 1972. In 1999, the Observatory introduced the Cold Weather Warning to remind members of the public to take care of the elderly persons or persons with chronic medical conditions. The Very Hot Weather Warning was introduced in the same year to raise public awareness on preventing heatstroke.

To meet the increasing demand on weather services, the Observatory has been providing timely “Special Weather Tips” to members of the public in recent years when the weather conditions have not yet reached the criteria for issuing weather warnings. For example, under relatively high temperature, humid and light wind conditions, the Observatory would consider issuing the “Hot Weather Special Advisory” to alert the public of the risk of heatstroke even if the weather conditions remain below the warning criteria for the Very Hot Weather Warning. A similar service was also introduced for heavy rain in 2016. When heavy rain is limited to a particular district in Hong Kong, posing serious threat of flooding there but not yet extending generally over Hong Kong and reaching the criteria for a Red or Black Rainstorm Warning signal, the Observatory will issue the Announcement on Localised Heavy Rain to alert the public of the affected districts and the potential flooding due to heavy rain in the districts, so as to take precautionary measures. This Announcement on Localised Heavy Rain service was replaced in 2021 by the Localised Heavy Rain Advisory service that takes into account the nowcast rainfall in addition to recorded rainfall, with a view to advising people of localized heavy rain as early as possible.

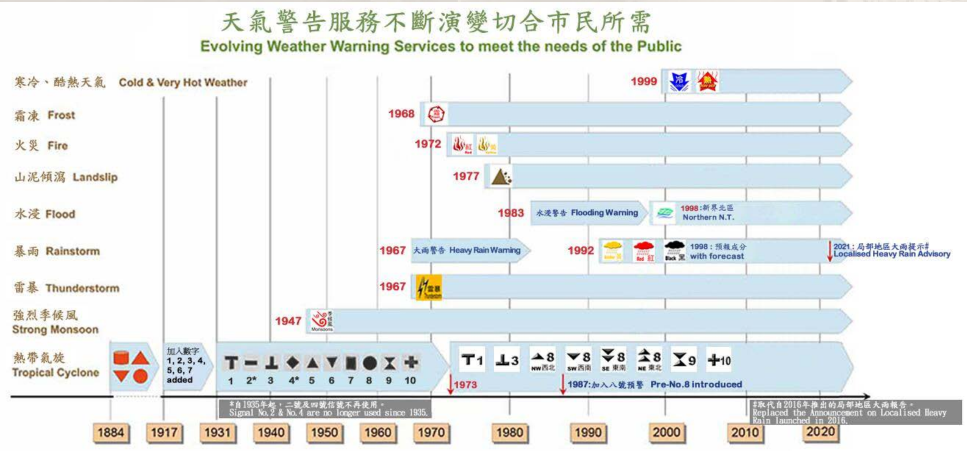


Figure 73: Evolving Weather Warning Services to meet the needs of the Public (1884 to 2022)

The weather warnings issued by the Observatory will trigger the contingency plans of government departments, public utilities and non-governmental organizations and facilitate early preparation and reduction in the loss of life.

3. Seasonal and long-term forecasts

In addition to the 9-day weather forecast, the Observatory also provides long-range forecasts to the general public. In the 1970s, the Observatory provided long-range rainfall forecast to Water Supplies Department to support water resource management. With increasing public and media demand for long-range forecast, the Observatory began to disseminate annual outlook to the general public in the early 2000’s. The forecast covers the annual Hong Kong rainfall in categorical terms and the annual number of tropical cyclones affecting Hong Kong, and then progressively added the Hong Kong annual temperature category, onset and cessation time of Hong Kong tropical cyclone season. The contents were later enhanced in phases with the addition of annual Hong Kong temperature in categorical terms, the onset and cessation of tropical cyclone season in Hong Kong. In the mid-2000s, the Observatory began to disseminate seasonal forecast on the web, predicting seasonal average temperature and total rainfall in categorical terms. In 2022, the frequency of seasonal forecast increased to once a month with the forecast period covering the next three months.

4. Release of information and public communication

The Observatory’s services went in tandem with the development of technology over the past 140 years, from the use of physical tropical cyclone signals, newspapers, and radio in early days, to the later use of television and telephones, and to the recent use of such channels as the Internet, mobile application and social media to effectively disseminate weather information to the public.

In the early days after the end of the World War II, weather reports and forecasts issued by the Observatory were broadcast twice a day in Chinese and English via Radio Hong Kong. In the late 1950s, the number of daily broadcasts increased gradually. Since 1955, 12-hour weather forecasts for local fishermen in fishing areas along the South China coast were produced by the Observatory, and were broadcast to the fishermen in Cantonese via Radio Hong Kong. The forecasts were extended to 24 hours in 1960. In 1960-61, weather information issued by the Observatory was distributed to the local media through the Information Services Department of the Hong Kong government.

As time went by, public demand for weather information was also increasing. In response, the Observatory applied the latest technology to provide weather information services to the public. In 1985, the Observatory used advanced communication equipment to set up an automatic telephone enquiry system called "Dial-a-Weather", which enabled the public to obtain the latest weather information via telephone while not requiring a lot of manpower. Since 1987, the Observatory launched television (TV) weather programme service. The TV weather programmes hosted by colleagues from the Observatory brought weather information to every household through TV and became popular. In the early days, colleagues from the Observatory went to the TV station to record the TV weather programme once a week. The service developed gradually and a studio was later established at the Observatory Headquarters to provide TV weather service. Commencing 2013, the Observatory launched its self-produced free TV weather service for many local TV stations, featuring regular TV weather programmes and educational video series called "Cool Met Stuff" to enhance public science education. Starting in December 2020, the Observatory extended the broadcast of regular TV weather programmes to daily basis.

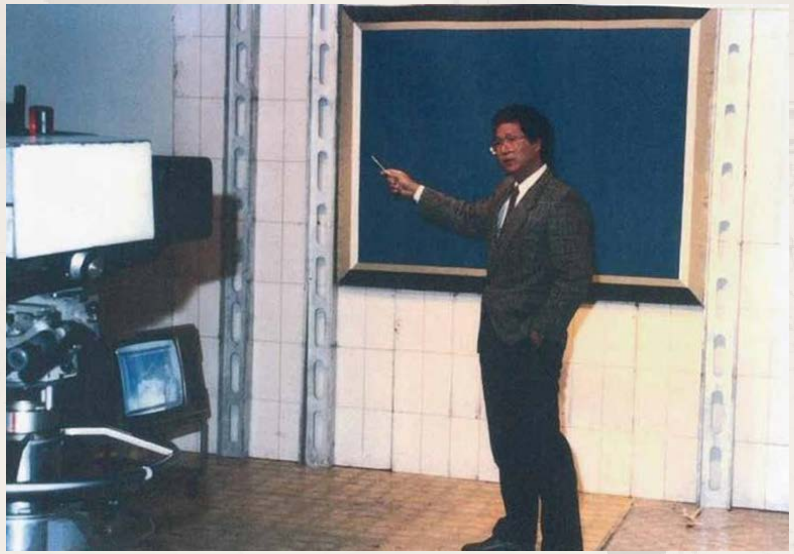


Figure 74: Since 1987, Scientific Officers of the Observatory have been making weather presentations on television, bringing weather services to every household.

Figure 75

Figure 76

In 2013, the Observatory launched free in-house produced public television weather service, including routine television weather programmes (Figure 76) and educational video series named "Cool Met Stuff" (Figure 77).

The emergence of the internet at the end of the 20th century brought unprecedented opportunities for the development of weather services. The Observatory established a website as early as 1996. In 2000, the annual total number of page views of the Observatory's website was close to 50 million. From 2000 to 2009, the Observatory continued to strengthen the content of its website. A mobile version designed specifically for mobile devices was launched in 2001. During these 10 years, the annual total page views of the Observatory's website increased by 32 times, reaching 1.59 billion page views in 2009.

With the advent of Internet 2.0, the Observatory started to set up a channel (hkweather) on the video-sharing website YouTube in 2009 to impart weather-related knowledge to the public through video every week.

Figure 77: The Observatory set up an account on YouTube in 2009 for uploading television weather videos of the Observatory.

The Observatory started providing weather information to the public on other social media websites such as Twitter, Weibo, and WeChat commencing 2010. In March 2018, the Facebook Page " 香港天文台 HKO" and the "hk. observatory" on Instagram platform were also launched. In addition to disseminating information more effectively, meteorological knowledge can be explained more creatively to enhance public engagement.

Figure 78: The Observatory launched " 香港天文台 HKO" Facebook page and "hk.observatory" Instagram platform in March 2018.

Figure 79: The Observatory started providing weather information to the general public via social media channels WeChat (left), Weibo (centre), and Twitter (right) in 2010.

Internet 2.0 promoted interaction, allowing the Observatory to better understand the needs of the public, and to raise the public's awareness of disaster prevention and mitigation. The emergence of smartphones and the development of wireless telecommunications technology promote great advancement in Internet speed, thereby enabling the further proliferation of Internet 2.0. In mid-2009, in view of the increasing popularity of smartphones with the introduction of the third-generation mobile network (3G), the Observatory developed a mobile weather application "MyObservatory", which was launched in early 2010. In addition to providing users with the convenience of surfing online weather information anytime and anywhere, the mobile weather application offers an opportunity in providing personalized weather services. In 2013, the usage of the "MyObservatory" mobile application surpassed that of the Observatory's website for the first time. By the end of 2022, the total number of downloads of "MyObservatory" exceeded 9.6 million, which was more than the total population in Hong Kong. In 2022, the total pageviews of the Observatory's online information service (including mobile applications and websites) were close to 160 billion, which was 100 times more than that in 2009. In 2020, the "MyObservatory" won an award in "Public weather forecasts and information - information content" category of the WMO International Weather Apps Awards 2020, and won an honourable mention in the "Specialized apps award - weather warnings" category.

Figure 80: The total number of downloads of the "MyObservatory" mobile application exceeded 8 million by 2020, whilst the total page views of the Observatory's online information service was close to 158 billion in the same year.

In the big data era, the Observatory launched a trial feature of "My Weather Observation" on "MyObservatory" to allow the public to report such weather and optical phenomena as hail and rainbow, etc. Members of the Community Weather Observation Scheme can also upload weather photos and video clips through "MyObservatory". The scheme aims to raise public's awareness and understanding on different weather situations through crowdsourcing of weather information.

In 2006, the Observatory enhanced its website by launching a new Climatological Information Services webpage. Through a user-friendly interface, the public can easily get access to a range of climatological information, including averages and extreme values of various weather elements, statistics of different weather data since 1884 and information related to climate change. This new webpage aims to serve the public, students, researchers, engineering professionals and the media.

In addition to developing the "MyObservatory" mobile application to serve the general public, an Android mobile application, MyAeroMET, was developed in 2013 to enhance the ease of accessing aeronautical meteorological information by users in the aviation community. Subsequently the Observatory also collaborated with Cathay Pacific Airways to jointly develop the "MyFlightWx" mobile application, which is fully compatible with the crew's workflow and provides real-time information dedicated for individual flights. The "MyFlightWx" mobile application was put to operational use at cockpits of all Cathay Pacific aircraft in 2019. "MyFlightWx" is the world's first electronic flight bag weather mobile application developed in-house by a meteorological authority.

Figure 81: Mr Shun Chi-ming (left), the then Director of the Hong Kong Observatory, and the Chief Operations and Service Delivery Officer of Cathay Pacific Airways, Mr Greg Hughes, showcasing the mobile application "MyFlightWx" in a flight simulator.

Upon the second decade of the 21st century, artificial intelligence (AI) developed rapidly in various fields, and applications became popular. The Observatory also applied AI technology to develop new services. A pilot chatbot service that employed AI in identifying user's questions was launched in 2020 on the "MyObservatory" mobile application, website, etc. After the launch of the service, an average of about 4,000 messages were handled per day. The number of messages soared to over 30,000 per day during the days of weather with significant impact. The launch of the chatbot service also reduced the workload of frontline staff. On the days with tropical cyclones, red or black rainstorm warning signals issued, the number of telephone calls handled by Observatory's staff dropped by about 37%.

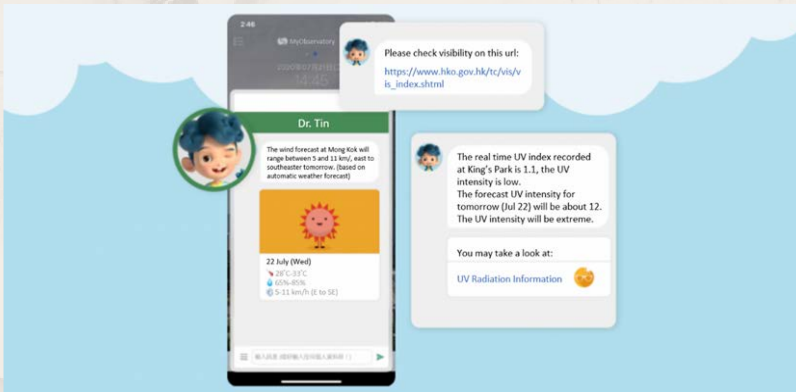


Figure 82: Chatbot "Dr Tin" developed by employing AI technology

4. Exchange of meteorological data

The Observatory exchanges meteorological data with other meteorological services over the Global Telecommunications System (GTS) of the WMO. In 1969, the Observatory and the Japan Meteorological Agency jointly established a dedicated Hong Kong-Tokyo regional communication link and commenced the exchange of real-time meteorological data. In the ensuing years, the Observatory explored data exchange arrangements with other meteorological services progressively. The dedicated Hong Kong-Bangkok and Hong Kong-Beijing regional communication links established in 1970 and 1975 respectively to support the increasingly frequent global data exchange activities, enhancing the connection between the Observatory and other meteorological services. In 1999, the HKO and the Macao Meteorological and Geophysical Bureau jointly established the Hong Kong-Macao dedicated link, thus strengthening the meteorological data exchange between Hong Kong and Macao. Subsequent to the rapid expansion of the GTS, the bandwidths of the above communication links were upgraded progressively. Owing to duplication of interconnections in parts of the GTS, the Hong Kong-Bangkok dedicated communication link was decommissioned in 2001.

Following the emergence of the Internet in the 1990s, the Observatory took advantage of the information technology to obtain meteorological data from other places in the world through the Internet. In 2012, the Observatory linked up with the Thai Meteorological Department again and resumed direct data exchange activities through the Internet. In addition to supporting data exchange activities, the Hong Kong-Beijing dedicated link also supports video conferencing between the HKO and the China Meteorological Administration (CMA). Benefiting from the development of Internet technology, the transmission of meteorological data has become more convenient and efficient. At the same time, the significant increase in data loading over the communication links enabled the transmission of huge volume of meteorological data. With the Internet, the HKO managed to inter-connect with numerous meteorological centres in the Mainland and elsewhere, including the CMA, the European Centre for Medium-Range Weather Forecasts, the Japan Meteorological Agency, etc., under the WMO Information System framework, to obtain numerical weather prediction model products and data, satellite data and weather radar data, etc. With the advent of big data technology in recent years, the availability of vast amount of meteorological data has enabled the Observatory to enter the big data era, laying a solid foundation for development in weather big data.

(8) Earthquake monitoring

A Sprengnether seismometer was set up in the Observatory cellar in May 1951 and seismological recording (east-west movement) resumed in November 1951. Two more Sprengnether seismometers arrived in October 1954 and recording of movements of all three components began on 1 January 1955. The operation of the Sprengnether seismometers was terminated on 1 November 1976.

As part of the programmes for the International Geophysical Year, a set of three-component long period seismographs for detecting earthquakes worldwide was set up at the Observatory cellar in January 1958 in a cooperative experiment with the Lamont-Doherty Geological Observatory of Columbia University. The seismograph was decommissioned in May 2011.

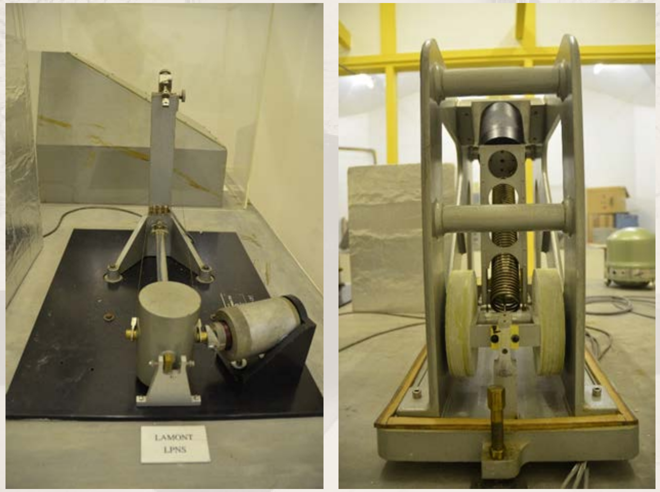


Figure 82: The Lamont seismometers in the HKO cellar (left: horizontal component; right: vertical component)

In May 1963, a set of 3-component long period seismograph and another set of 3-component short period seismograph were installed at the Observatory cellar as part of the U.S. Worldwide Standardized Seismograph Network (WWSSN), making the Observatory one of the stations of the network. The WWSSN seismographs stopped operation in the early 2000s.

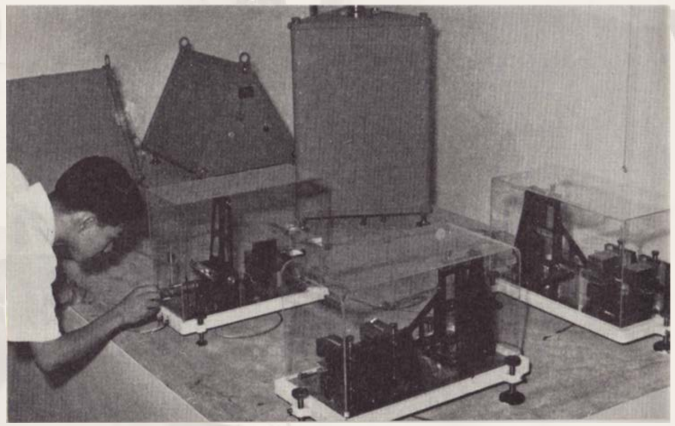


Figure 84: A HKO colleague checking seismometers at the HKO cellar. The three in the foreground are Sprengnether instruments and the other three are the short-period world-standard seismometers.

The occurrence of the Tangshan earthquake in July 1976 aroused serious concern of the general public on the occurrence of earthquakes in the vicinity of Hong Kong and their possible impacts on the local community. In order to locate the epicentres of such earthquakes and to determine quantitatively their magnitude, a telemetry network of three short-period seismographs located at Tsim Bei Tsui, Yuen Ng Fan and Cheung Chau was installed in 1979 and put into operation in March 1980.

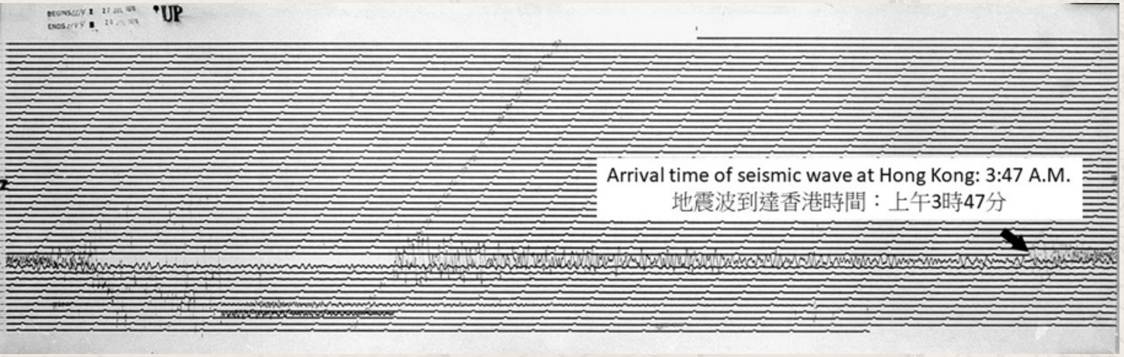


Figure 85: Seismogram for the magnitude 7.8 Tangshan earthquake recorded at the Observatory. The earthquake occurred on 28 July 1976.

Development and optimization of the seismograph network continues with the advancement in science and technology. Nowadays, the Observatory operates seven short period seismograph stations at Cape D'Aguilar, Cheung Chau, Keung Shan, Lead Mine Pass, Luk Keng, Tsim Bei Tsui and Yuen Ng Fan respectively. Furthermore, the Observatory has been operating broadband seismographs at Po Shan Road and the Observatory Headquarters since 2010 to monitor earthquakes worldwide, especially those earthquakes in the South China Sea that may generate tsunami. The Po Shan Seismograph Station is one of the members of the Global Seismographic Network (GSN) that possess broadband seismograph, its recorded seismic waves are provided to various tsunami centres around the world via the Incorporated Research Institutions for Seismology (IRIS) in the United States. Accelerographs have also been installed at five seismograph stations for recording peak ground acceleration during felt earthquake which helps determine the earthquake intensity in Hong Kong.

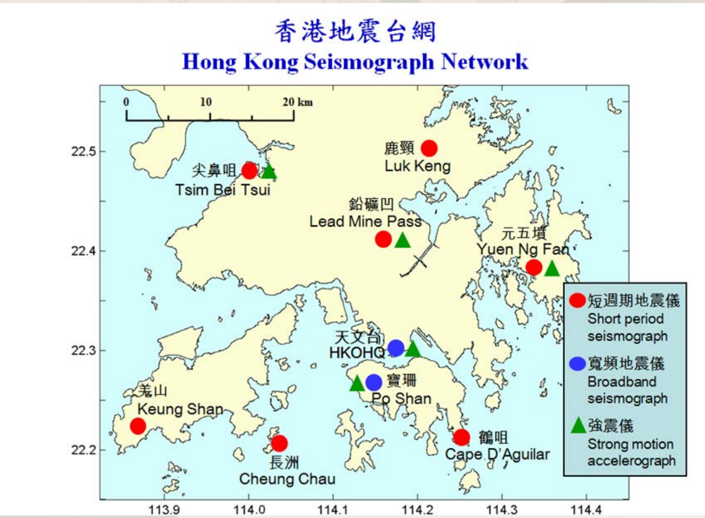


Figure 86: The Hong Kong Seismological Network

Figure 87: The broadband seismometer at Po Shan Seismograph Station located inside a deep tunnel.

The Observatory now also operates an earthquake data processing system which collects real time seismic waveform data from global and Hong Kong seismograph networks to compute earthquake parameters such as origin time, epicentre and magnitude. The Observatory also collects earthquake and tsunami information issued by the Ministry of Natural Resources (including the South China Sea Tsunami Advisory Center (SCSTAC)), China Earthquake Administration, Earthquake Administration of Guangdong Province, Pacific Tsunami Warning Center (PTWC), Northwest Pacific Tsunami Advisory Center (NWPTAC), West Coast and Alaska Tsunami Warning Center (WCATWC) and U.S. Geological Survey (USGS).

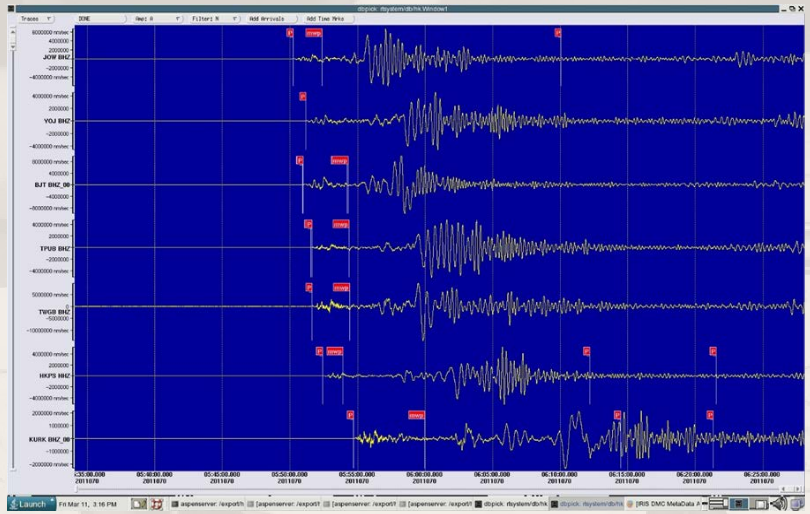


Figure 88: Seismograms recorded by the Observatory's seismic data processing system during the magnitude 9 earthquake near Japan on 11 March 2011. The second trace from bottom was recorded by the Hong Kong Po Shan Seismograph Station. Other traces were recorded by overseas seismographs.

As regards information dissemination, the Observatory began to issue quick earthquake messages automatically generated by computers on Twitter on 23 March 2011, providing members of the public with more rapid earthquake information. The Quick Earthquake Message Service was extended to the Weibo platform in August 2011, and was further provided in RSS format for subscription by the public in June 2012.

(9) Radiation monitoring

The Observatory monitors the ambient radiation levels in Hong Kong and collects environmental and food samples for regular radiological measurements. In the unlikely event of a nuclear accident, the Observatory will step up its radiation monitoring activities and work with other relevant government departments to provide decision makers with the assessment of the radiological consequences and suggestions on the protective measures for the public. Information on radiation levels and the latest developments will also be provided to the public through various channels.

Since 1961, the Observatory has been monitoring environmental radiation levels in Hong Kong. At that time, airborne particulates, total deposition and rain water were collected at King's Park for radiological measurement. The Observatory also participated in international programmes on environmental radiation monitoring organised by the International Atomic Energy Agency and the World Meteorological Organization.

Figure 89: Observatory staff conducting radiological measurement at King's Park in the 1960s.

In response to the construction of nuclear power stations at Daya Bay in Guangdong, the Observatory embarked in the 1980s on a comprehensive program to monitor the environmental radiation levels in Hong Kong. In 1986, a radiation laboratory was established at King's Park with radiation measuring instruments implemented to carry out radiological analysis of samples. In 1987, the "Environmental Radiation Monitoring Program" (ERMP) was launched to monitor three major exposure pathways, namely the atmospheric pathway, the terrestrial pathway and the aquatic pathway, aiming to detect any long-term changes in the environmental radiation levels in Hong Kong. In the same year, the Observatory established radiation monitoring stations at King's Park, Tsim Bei Tsui, Sha Tau Kok and Yuen Ng Fan. These stations were equipped with high pressure ionization chambers for real-time measurement of environmental gamma dose rates which were sent back instantly to the radiation laboratory for monitoring purposes. A radiological survey vehicle, equipped with portable radiation measuring instruments and sampling tools, was put into operation in 1988. It facilitates sampling and on-site measurement of environmental radiation levels at different places in Hong Kong. In 1989, the Observatory also measured the radiation intensity of cosmic rays at the Plover Cove Reservoir for the first time.

Figure 90: The King's Park Radiation Laboratory (building with railings on the top) in the 1980s.

In 1990, the Monitoring and Assessment Centre was established at the Observatory Headquarters for coordination of emergency radiation monitoring and accident consequence assessment. In 1993, the Observatory expanded its radiation monitoring network to ten fixed monitoring stations. In the same year, a balloon carrying a radiation sensor for measurement of radioactivity in the upper atmosphere was launched at King's Park for the first time. In 1996, the Observatory set up an automatic gamma spectroscopy system at Ping Chau in Mirs Bay, for the early detection of any artificial radionuclides in the environment. In 1998, the Observatory started using the Aerial Radiation Monitoring System (ARMS) to carry out aerial radiological surveys over the territory. The system was mounted on board a helicopter of the Government Flying Service. The ARMS could operate in the plume tracking mode to determine the existence of any radioactive plume aloft over Hong Kong, and it could also be switched to the ground contamination measurement mode to identify surface areas affected by deposited radionuclides.

IIn 2011, in response to the public's concern about the radiation levels in Hong Kong after the occurrence of the Fukushima nuclear accident in Japan, the Observatory promptly released on its website within a few days the real-time environmental gamma radiation levels from the radiation monitoring stations in Hong Kong. In addition, the Observatory also acquired additional equipment for radiation measurement and air sampling to enhance its emergency radiation monitoring capabilities. The equipment included an enhanced high volume air sampler and the online gamma spectroscopic analyzers, which could speed up the collection of radioactive substances in the air and facilitate early identification of the types of radionuclides. The Observatory also acquired one more radiological survey vehicle to enhance the flexibility and effectiveness of mobile surveys and sample collection, as well as to assist in the identification of radiation hot spots in Hong Kong during emergencies situations.

In response to the construction of the nuclear power plants in western Guangdong, the Observatory set up additional radiation monitoring stations at Chek Lap Kok over the western part of Hong Kong and Cape D'Aguilar in the south in 2012. The number of fixed stations of the radiation monitoring network increased to twelve. In 2018, the Online Gamma Spectroscopic Analyzer Network with instruments installed at eight radiation monitoring stations commenced operation, further enhancing the Observatory's capability in environmental radiation monitoring. In 2019, the Observatory installed a radiation sensor on a fishing vessel for the first time as a trial on mobile measurement of environmental gamma dose rate in real-time over the coastal waters of southern China.

(10) Numerical weather prediction and high-performance computing systems

Numerical weather prediction (NWP) computes, using high-performance computing systems, the future weather by solving the complex set of physics and mathematical equations governing the atmosphere, and is a basic means of modern weather forecasting. The Observatory introduced regional NWP models as early as 1989 to produce its own short-term weather forecasts over southern China. With the increasing processing power of computer systems, horizontal model resolution at the Observatory saw a corresponding increase from the initial 100 km (1989, ROLAM) gradually to 20 km (1999, ORSM) and recently 2 km (2010, AIR-NHM) or below. Trials on regional ensemble prediction and global NWP are also underway with a view to enhancing support for impact assessment and regional collaboration.

Figure 91: (Left) The Observatory installed its first computer system, with a computing speed of 10 FLOPS, in 1973. (Right) By 2019, the high-performance computing system of the Observatory has reached 200 TFLOPS.

(11) Quality management

The Observatory strives to protect lives and to provide people-oriented quality services, and to enhance the society's capability in natural disaster prevention and response. As early as 2002, the Observatory's aviation weather services were certified to the International Organization for Standardization (ISO) 9001:2000 Quality Management Systems (QMS), and also to ISO 9001:2015 QMS thereafter. Other services of the Observatory subsequently were certified to ISO 9001:2015 QMS successively. In particular in 2017, the Observatory's weather forecasting and warning services were certified to ISO 9001:2015 QMS. It is among the first batch of meteorological centres in this region to receive this certification. Other Observatory's services certified to ISO 9001:2015 QMS included:

(1) Automatic Regional Meteorological Measurement Services;
(2) Radiation and Meteorological Measurement Services; and
(3) Ambient Gamma Radiation Monitoring Service.

Figure 92: ISO 9001:2015 Quality Management Systems certificate for aviation weather services (left) and weather forecasting and warning services (right).

To enhance the quality management of its professional services, the Information Technology (IT) service management system supporting the critical infrastructures of the Observatory was also awarded the International Organisation for Standardization/International Electrotechnical Commission (ISO/IEC) 20000-1:2018 certification in 2022.

A Competency Assessment System for Aeronautical Meteorological Personnel was set up to satisfy the WMO Competency Standards for aeronautical meteorological personnel approved by the 16th World Meteorological Congress in 2011.

(12) International participations

1. Participation in international organizations

The WMO was established on 23 March 1950 to replace the International Meteorological Organization. Hong Kong became a member territory[1] with the Director of the Observatory being the permanent representative. In 1956, in response to the new standards by International Civil Aviation Organization, the HKO was designated as the Meteorological Authority in Hong Kong for the provision of Aviation Weather Service for international air navigation. In 1968, the Typhoon Committee was established under the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and WMO with Hong Kong as one of the founding members. Mr. Patrick P. Sham, former Director of the HKO, was elected Chairman of the Meteorology (MET) Committee of the Asia/Pacific Regional Air Navigation Meeting of the International Civil Aviation Organization (ICAO) held in Honolulu in September 1973. In 1997, Hong Kong was returned to China. With the support of the Chinese government, Hong Kong, China maintained its membership as a member territory of WMO, laying an important foundation for the HKO's continuous participation in international affairs.

At the start of the millennium, the Observatory developed the "Severe Weather Information Center (SWIC)" and the "World Weather Information Services (WWIS)" on behalf of WMO, providing a centralised and authoritative channel for meteorological services around the world to deliver official weather warning and forecast information. In 2011, on behalf of WMO, the Observatory launched "MyWorldWeather", the world's first mobile application of official weather information. The Observatory was further entrusted by WMO to develop an online version of "International Cloud Atlas (ICA)" (https://cloudatlas.wmo.int) with a platform to collect photos globally, and to launch a greatly expanded version of ICA in 2017. In 2018, the Observatory signed a Memorandum of Understanding with WMO and launched SWIC 2.0 that collects warning information from worldwide meteorological services. The Observatory also partnered with the CMA and launched the Asian version of the WMO's Global Multi-hazard Alert System (GMAS).

1 Hong Kong signed the "Convention of the World Meteorological Organization" on 11 October 1947, and officially became a member territory of the "World Meteorological Organization" on 14 December 1948.

The Observatory hosted the 13th Session of Regional Association II (Asia) in 2004, the 14th Session of the Commission for Aeronautical Meteorology (CAeM-XIV) of WMO in 2010, the 45th and 52nd Sessions of the Typhoon Committee in 2013 and 2020, and the WMO World Weather Research Programme (WWRP) International Symposium on Nowcasting and Very-short-range Forecast in 2016 (WSN16). The Observatory also organized annual workshops under the Voluntary Cooperation Programme (VCP) of WMO to train meteorological experts from around the world, actively participated in training workshops and technical seminars of WMO, and sent experts to give lectures on the latest developments in various meteorological domains. In addition, the Observatory rendered support to assist overseas meteorological services in establishing or upgrading forecast systems, and developing operational applications and related warning services.

Dr Lam Hung-kwan and Mr Lam Chiu-ying, former Directors of the Hong Kong Observatory, had once been elected as Vice-Presidents of the Regional Association II (Asia) of the WMO. Mr Shun Chi-ming, former Director of the Hong Kong Observatory, had served as President of the Commission for Aeronautical Meteorology (CAeM) for two terms during 2010-2018, which was the highest position ever held by an Observatory staff at the WMO. Besides, many staff members of the HKO have attended various meetings of international organisations such as the WMO, the International Civil Aviation Organization, the Intergovernmental Panel on Climate Change, the Intergovernmental Oceanographic Commission of UNESCO, the Typhoon Committee, etc. Some staff members served as chairs of committees, coordinators or members of working groups, rapporteurs of workshops, etc., contributing towards international meteorology and related sciences.

In 2018, the Observatory was designated by the WMO as a Regional Specialized Meteorological Centre (RSMC) on Nowcasting in Asia, providing nowcast products, the Community SWIRLS nowcast system, as well as related professional training to meteorological and hydrological services in the region. The HKO was also designated in the same year by WMO as a Testbed for Doppler LIDAR Systems for Aviation Applications (renamed to Measurement Lead Centre in 2021).

2. Cooperation with meteorological and radiation monitoring services in Mainland China and Macao

A direct communication link for the exchange of meteorological data between Hong Kong and Beijing was established as early as 1975. Following the economic reform in the Mainland, the HKO and the Guangdong Meteorological Bureau (GMB) signed a cooperation agreement in 1984 on the establishment of an automatic weather station on Huangmaozhou, an island south of Hong Kong, and started taking turn to host the "Guangdong – Hong Kong Seminar on Significant Weather" since 1985. After 1989, Macao also joined in this Seminar, which evolved into an annual "Guangdong-Hong Kong-Macao Meeting on Cooperation in Meteorological Operations cum Guangdong–Hong Kong–Macao Seminar on Meteorological Science and Technology".

Figure 93: Hong Kong Observatory collaborated with Guangdong Meteorological Bureau to jointly establish the first automatic weather station on Huangmaozhou of Zhuhai in July 1985.

The Observatory signed with the CMA the "Memorandum of Understanding on Long Term Cooperation between the China Meteorological Administration and the Hong Kong Observatory" in 1996 and then the "Arrangement on Long Term Co-operation between the China Meteorological Administration and the Hong Kong Observatory" in 2001. The Observatory further signed the "Long-term Co-operation Agreement in Numerical Weather Prediction Technology" with Shenzhen Meteorological Bureau in 2011 and the "Co-operation Agreement in Meteorological Science and Technology" with GMB in 2014. The Observatory subsequently signed cooperation plans with Shanghai Meteorological Bureau and Hainan Meteorological Bureau in 2016 and 2017 respectively.

Recent years saw more frequent interflow among Guangdong, Hong Kong and Macao via numerous seminars and training courses. Apart from sharing real-time observation data and technical knowledge on heat stress measurement, the three parties also joined hands to establish a lightning location network in 2005. In 2011 the "Greater Pearl River Delta Weather Website" was launched, providing the public with the latest weather warnings, forecasts, and real-time observations in the region. In 2019, the three parties collaborated to enhance the "Greater Pearl River Delta Weather Website" to the "Weather Website for Greater Bay Area". The weather forecasts were further extended to 7 days to provide convenient and reliable quality weather services for citizens commuting within the Greater Bay Area.

In 2014, the Observatory signed a technical cooperation agreement with the Environmental Radiation Monitoring Technical Center of the Ministry of Ecology and Environment. This was the first cooperation agreement between the Observatory and an environmental radiation monitoring service in the Mainland for promoting exchange and technical cooperation in environmental radiation monitoring. In the same year, the Observatory signed letters of intent on technical cooperation with the China Institute of Atomic Energy and the Shanghai Radiation Environmental Supervision Station. Thereafter, the Observatory also signed letters of intent or memorandum on technical cooperation with a number of professional institutions in the Mainland, including the China Institute for Radiation Protection (2017), the Airborne Survey and Remote Sensing Center of Nuclear Industry, and the Nuclear and Radiation Safety Center of the Ministry of Ecology and Environment (2019).

Figure 94: The then Assistant Director of the Hong Kong Observatory, Mr Tsui Kit-chi (fourth right), and the Deputy Director of the Environmental Radiation Monitoring Technical Center (RMTC), Mr Zhao Shunping (fifth right), were pictured with other colleagues of the RMTC and the Observatory after the signing ceremony of the co-operation agreement in January 2014.

3. Cooperation with overseas meteorological and hydrological services and civil aviation departments overseas and in the Mainland

On 21 April 1999, the Observatory and the Air Traffic Management Bureau (ATMB) of the Civil Aviation Administration of China (CAAC) signed a memorandum on long term technical cooperation in aviation meteorological services.

To promote data exchange, collaborative developments and trainings with other countries, the Observatory signed Memoranda of Understanding with the National Meteorological and Hydrological Services of the Republic of Korea (2012), France (2015), the Philippines (2015), Thailand (2017), Myanmar (2018), Vietnam (2018), and Solomon Islands (2022) as well as with the civil aviation department of Cambodia (2018).

Figure 95: HKO signed an agreement with the Guangdong Meteorological Bureau in 1984.

In order to further improve the Significant Meteorological Information (SIGMET) service, ICAO began to promote cooperation and linkage across the Flight Information Region borders in 2015 to coordinate weather-related products. For this purpose, the Observatory developed the Regional SIGMET Coordination Platform in 2017, and successfully completed the WMO preliminary study and was used by Southeast Asian countries. Since 2017, the Observatory has successively carried out weather cooperation with neighbouring Flight Information Regions (Guangzhou, Sanya, Vietnam and the Philippines), and also supported Pacific Island countries and Indian Ocean countries in coordinating to improve the quality of weather warnings in the region.

In 2018, the Asian Aviation Meteorological Centre (AAMC) jointly established by the HKO, the Civil Aviation Administration of China (CAAC) and CMA commenced operation. Through the cooperation, the AAMC provides the aviation sector with quality en-route weather information, so as to meet industry needs and improve aviation safety and efficiency.

Figure 96: Mr Shun Chi-ming, the then Director of the Hong Kong Observatory, was elected as the President of the Commission for Aeronautical Meteorology in 2010.

Figure 97: The Civil Aviation Administration of China, the China Meteorological Administration and the Hong Kong Observatory signed an agreement to jointly establish the AAMC on 28 October 2016.

Figure 98: The then Director of the Hong Kong Observatory, Mr Shun Chi-ming (right), and the Secretary-General of the WMO, Professor Petteri Taalas (left), officiating at the opening ceremony of the Regional Specialized Meteorological Centre (RSMC) for Nowcasting in October 2018.

In 2019, following the approval of the Ministry of Natural Resources, the National Marine Environmental Forecasting Centre invited the Observatory to establish a backup centre of the South China Sea Tsunami Advisory Center (SCSTAC) to provide tsunami warning or advisory messages on potentially destructive tsunamis to nine National Tsunami Warning Centers (NTWCs) of the IOC/UNESCO Member States around the South China Sea. The Observatory set up the "Backup South China Sea Tsunami Advisory Center (Hong Kong)" (BSCSTAC) at the Central Forecasting Office and commenced its trial operation in March 2022.

Figure 99: The Weather Website for Greater Bay Area, providing weather warnings, observations, and 7-day forecasts for more than 60 regions in 11 cities in the area.

Figure 100: The Director of the Hong Kong Observatory, Dr Cheng Cho-ming (left), and the Assistant Director, Ms Song Man-kuen Sandy, announced the commencement of trial operation of the "Backup South China Sea Tsunami Advisory Center (Hong Kong)" on 29 March 2022.

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