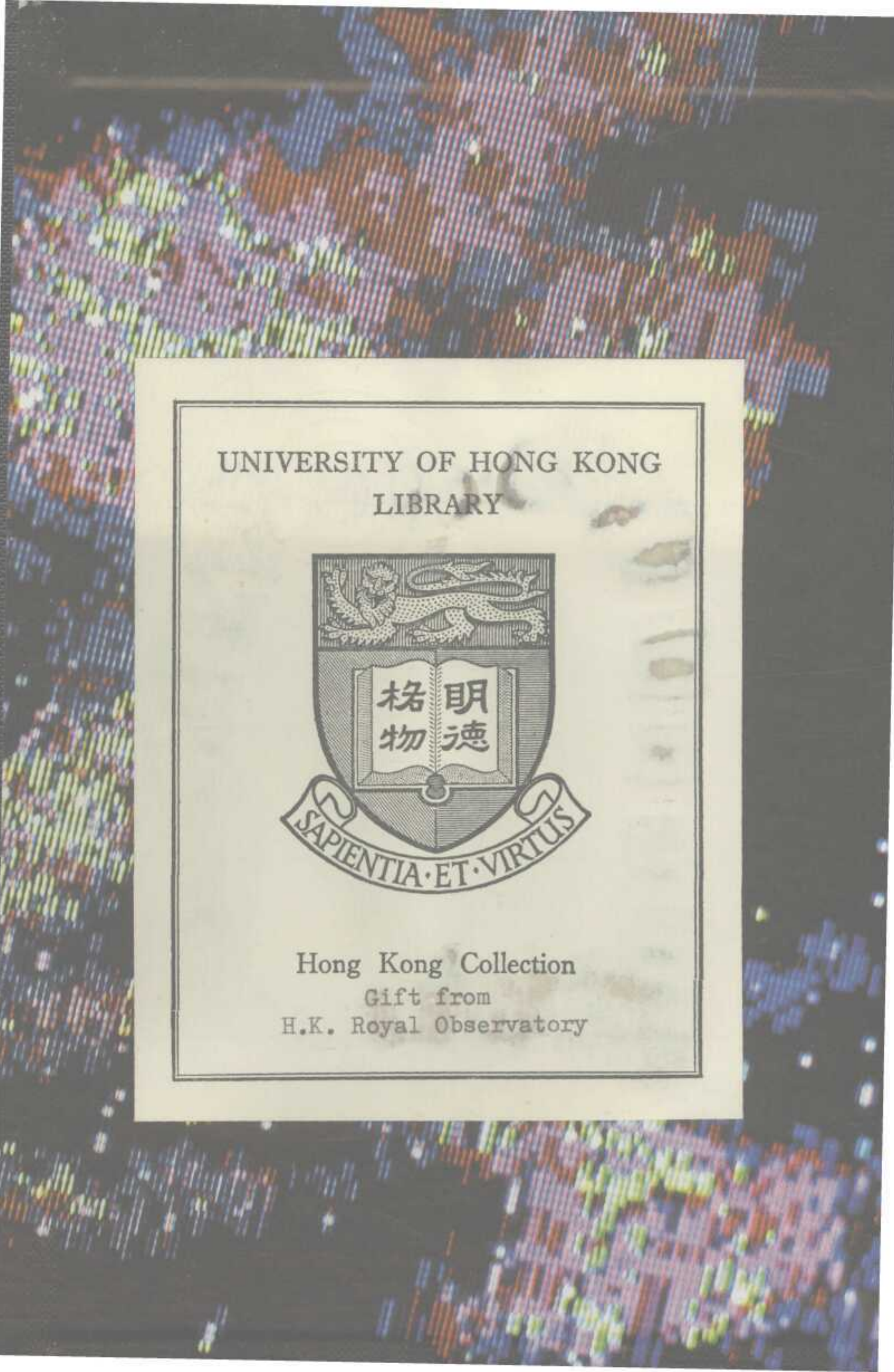
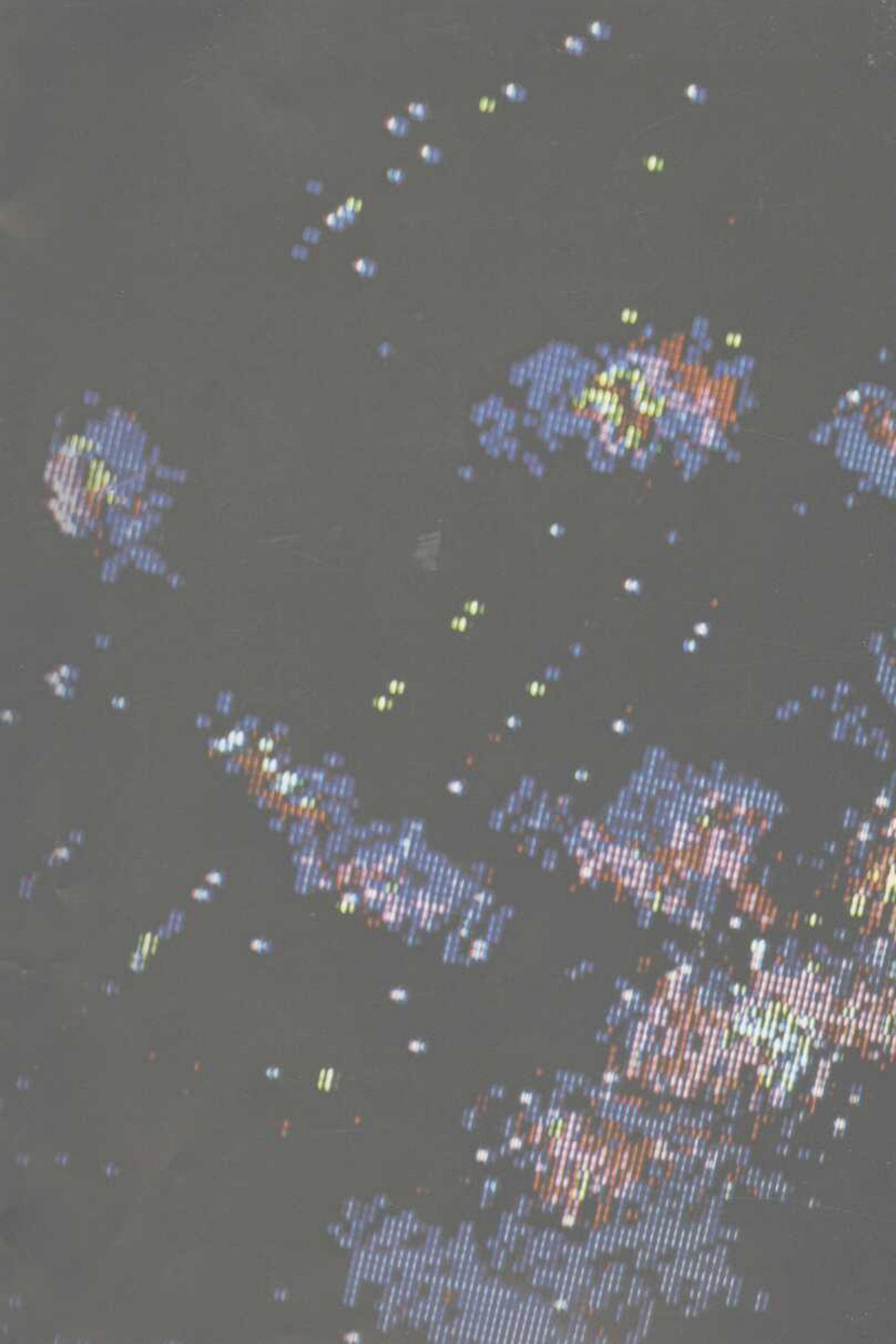
From Time Ball to Atomic Clock

Anthony Dyson





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FROM TIME BALL TO ATOMIC CLOCK

by **Anthony Dyson**

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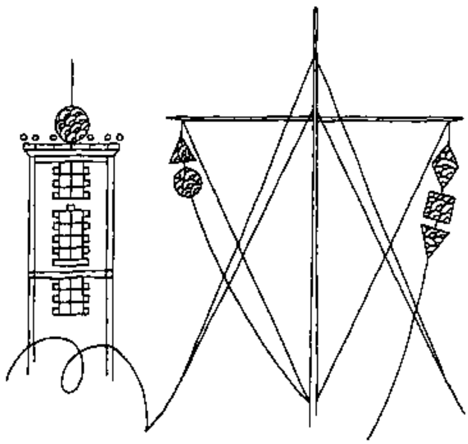
Contents

The effect of climate on human conduct has not yet been reduced to an exact science. But it cannot be entirely disregarded in considering the history of Hong Kong . . . I am not thinking of typhoons or similar extravagant outbursts of the weather, but of the ordinary routine of the year; the regular range of temperature and rainfall; the change of the monsoon; the invariable sequence of the seasons.

G. R. Sayer, *Hong Kong 1841–1862, Birth, Adolescence and Coming of Age*, Hong Kong University Press 1937.



Foreword

The early section of this book owes much to *Royal Observatory, Hong Kong: A Brief General History,* by the late Mr. L. Starbuck, Assistant Director, published in 1951.

Other extracts have been taken from relevant annual reports of successive Directors of the Royal Observatory. Further references, including those written by Observatory staff, appear in the bibliography.

Thanks are due to Mr. Ian Diamond, Archivist, Public Records Office of Hong Kong, and his staff, for assistance with old newspapers and official documents and letters.

When quoting from written sources, only minor changes have been made in spelling and syntax to make them accord with modern style. (For example, Hong Kong, instead of Hong-kong or Hongkong. The use of Hong Kong and Kowloon as the official spelling of the place names was officially adopted in 1926.)

If it was believed that a change would affect the sense of the original, detract from it, or possibly cause confusion, the original was left intact.

This policy has – broadly – been followed with punctuation, bearing in mind the comment by Geoffrey R. Sayer in a note to his *An Eastern Entrepot* (HMSO, 1964):

'Generally the documents have been given as found, but occasionally some minor editing has been done regarding punctuation, since many 19th Century officials seem to have had only a cursory acquaintance with the principles of that art.'

However, to avoid confusion, temperatures are given in degrees Celsius, even for periods long before the official adoption of the scale in Hong Kong. (For details of the change, see p. 104).

Similarly, wind speeds are expressed in knots. A knot – one nautical mile an hour – is not a metric unit, but is widely used in meteorology, aviation and seafaring. One nautical mile is 1.852 kilometres.

Dollars mentioned in the text are Hong Kong currency unless stated otherwise.

Colleagues in the Information Services Department, Mr. Geoffrey V. Somers and Mr. Phillip Bruce, added substantially to the flavour of the book by providing historical details, particularly in relation to early weather phenomena.

Finally, thanks are due to Mr. John Peacock, Director of the Royal Observatory, and his staff, for their invaluable assistance.

– A.D.

Life on earth is possible because Man has water, a blanket of life-supporting gases, and a climate that is neither too hot nor too cold.

While the scientific study of atmospheric conditions, especially to forecast weather – meteorology – is a relatively modern development, man's interest in the weather is as old as the human race.

The Chinese are known to have developed some of the earliest theories about weather, particularly in relation to agriculture.

The Record of the Rites of Chou, dating from about 200BC, mentions an imperial astronomer who, among other duties, observed the sun and moon in order to determine the succession of the four seasons. There was also an imperial astrologer who determined the coming of floods or drought from the colours of types of clouds.*

A third official, the Shih Chin, made observations of a more meteorological nature.

Such officials were organised in a special government department, the Astronomical Bureau (or Directorate – the name was often changed, but its functions remained broadly the same).

Needham notes that the Chinese kept meteorological records as far back as the 13th Century BC, with inscriptions in 1216BC recording rain, snow, sleet and wind and the direction of rain and wind.

It is clear that, with time, the use of such data became better understood, so that by the 12th Century AD there are references to more than 20 books on meteorological forecasting.

An understanding of the importance of the connection between weather and agriculture also emerges from early Chinese sources. By the late 4th Century BC, the meteoro-

*Needham, Joseph, *Science and Civilisation in China*, Vol. 3, Cambridge, 1959.

logical water cycle had been described: 'Wind blows according to the seasons and rain falls in response to wind.'

Later writers demonstrated a much clearer understanding of the formation of rain: 'Clouds and rain are really the same thing. Water evaporating upwards becomes clouds, which condense into rain, or still further into dew. When the garments [of those travelling on high mountain passes] are moistened, it is not the effect of clouds and mist, but of the suspended rain water.'

There was also an early comprehension of the hygroscopic qualities of substances such as charcoal, from which the presence of moisture in the atmosphere could be determined.

While the use of a container to measure rainfall began in Europe in 1639, it had been known in Korea some 200 years earlier, and much earlier than that in China. A Chinese text dating to 1247 contains mathematical problems on the shape of rain gauges, and mentions other devices used to measure snowfall.

Chinese observations of the winds go back as far as 120BC, and by the Ming dynasty (1368–1644) there are references to experiments with kites to test the behaviour of winds. Much earlier, there are indications during the Han dynasty (202BC–AD220) of attempts to make a rudimentary anemometer.

The intellectual traditions of the Middle Kingdom, however, were essentially literary and artistic rather than scientific, and there is evidence that this emphasis on aesthetics tended to work to the detriment of scientific inquiry.

Despite such attitudes – reinforced by occasional official prohibitions on the study of scientific subjects by rulers who feared threats to their positions – development proceeded.

Early instruments survived, such as the armillary sphere, a skelton celestial globe of metal rings, but the knowledge of how to use them slowly faded.

Theories had been developed: as early as the first Century AD the Chinese had decided, correctly, that eclipses were caused when one heavenly body was obscured by another which came between it and the earth.

Such knowledge was apparently appreciated for its intrinsic interest, but corollary inquiries were, it seems, not pursued with any vigour.

The catalyst for the detailed development of latent Chinese scientific ability was an event which, on the surface, had little to do with science – the arrival of Jesuit missionaries.

The Jesuits, as representatives of the contemporary European learned elite, soon realised that Christianity would have little appeal to the Chinese, especially the upper classes, among whom even the traditional beliefs of Buddhism and Taoism were in decline. The introduction of an alien doctrine would require the use of a wedge to create a space through, which elements of Christianity could slowly be introduced. Science and technology were to provide that wedge.

Not all the scientific assistance that the Jesuits were to give the Chinese was benign, as shown by their central role in the casting of cannon. Nor was it always entirely accurate or up-to-date: in 1616 Rome condemned as heretical Galileo's assertion that the earth revolved around the sun, leaving the Jesuits to adapt their teaching to an uneasy limbo between dogma and scientific fact.

Later, scholarly Chinese, converted to Christianity, were encouraged to burn large quantities of rare written material relating to subjects prohibited by church law. Such destruction, in what Nigel Cameron calls 'this merry little Christian fire',* eliminated vital accounts of early Chinese contributions to science.

One of the most important of these early proselytizers was the Italian Jesuit Matteo Ricci, who arrived at Macao in 1582 and later, at substantial risk, travelled slowly through

*Nigel Cameron, *Barbarians and Mandarins, Thirteen Centuries of Western Travelers in China*, Weatherhill, 1970.

China to Peking. Cameron records that at Nanking, Ricci was shown an observatory

whose instruments filled him with the utmost astonishment, for they were finer than any in the Europe he had recently left. The instruments had been made in China in the Yuan dynasty [1280–1367]. The Chinese had forgotten how to use them – so completely forgotten, in fact, that they had moved some of the instruments from another town and failed to regulate the calibrations for the latitude of the new site.

Ricci first travelled to Peking in 1598, but even with his knowledge of the Chinese language and the complexities of Ming court courtesies, he was unable to obtain an audience with the Emperor Wan-li, and was forced to retreat to Nanking.

Having assembled a collection of presents – including some clocks which were to fascinate the Emperor – Ricci returned to the capital in January 1601, this time to stay.

His association with the court confirmed his belief that the Jesuits' scientific prowess would help consolidate relations with the Chinese, and he asked Rome to send a priest who was also a good astronomer.

Ricci died in Peking in 1610, and it was not until 1622 that his request for astronomically-minded clergy was answered with the arrival in China of Adam Schall.

Before then, however, Ricci had been able to use celestial events to his advantage. The eclipses of the moon in June and December 1601, and of the sun in July 1602, May 1603 and February 1607 allowed him to demonstrate that his calculations were more accurate than those of local officials.*

Adam Schall also took advantage of an eclipse, and found his work rewarded with an unprecedented honour for a Westerner. Schall's predictions concerning an eclipse of the sun in September 1644 proved to be exactly right, and he was offered the Directorship of the Bureau of Astronomy. After consulting his superiors, he accepted. Collis remarks: 'The man of God became a Chinese bureaucrat.'

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*Collis, Maurice, *The Great Within, London,* 1941.

Then came another important scientific clergyman, the Belgian Jesuit Ferdinand Verbiest, who arrived in Peking in 1660, shortly before the accession of the second Emperor of the Ch'ing dynasty, K'ang-hsi (1662–1722).

Verbiest became a companion and confidant to the young Emperor. He refitted the observatory on Peking's eastern wall, superintending the reconstruction of instruments originally placed there during the Yuan period, including a sextant, quadrant and celestial globe. He also introduced the thermometer.

Verbiest's arrival coincided with the period of great scientific advancement in Europe, where some of the first known observations about the weather had appeared in the 4th century BC, when Aristotle wrote his *Meteorologica*.

By the early 14th century, the earliest known systematic recording of local weather was performed in England, when William Merle, Rector of Driby, kept daily records for seven years 1337–1344.

The opening of the world's great sea routes, leading to the exploration of countries such as China, created a demand for more and better meteorological information.

The first primitive network of observation stations is believed to have been established by Ferdinand II of Tuscany in 1653. His Academy of Experimentation established seven meteorological stations in northern Italy and four outside the country.

The development in Europe at this time of instruments to measure physical phenomena greatly assisted the foundation of meteorology as a science. The thermometer had been developed around 1600 and the raingauge in 1639 (although methods of measuring rainfall had been used much earlier in China, India and Korea). The barometer followed in the 1640s, along with the hygrometer to measure humidity and the anemometer to measure wind speed.

In 1780 the Meteorological Society of Mannheim was formed and established 39 weather observation stations, 14 of them in Germany and the rest in other countries.

The first steps towards scientific weather forecasting began with Heinrich Wilhelm Brandes, who drew a weather map in 1820 based on information gathered by the Mannheim society.

About the same Time, W. C. Redfield in New York drew charts of hurricanes, showing their rotary and progressive motion. In the following two decades, scientists in the United States and Britain established, as the meteorologist P. A. Sheppard said, 'the existence of characteristic patterns of pressure, wind and weather (depression, anti-cyclone, etc.) and empirical rules for their development, movement, and the accompanying sequence of weather changes.'

Despite scientific advances, the prediction of severe weather, particularly in the Far East, still depended heavily on local lore and custom. One colourful description of early Hong Kong 'forecasting' occurs in an account of the voyages of the *Nemesis*, the first ironclad steamship in the region, published in 1845:

Our squadron, after its return from Canton, was exposed to the full fury of one of these hurricanes, while it lay in the harbour [Hong Kong] previously to our advance upon Amoy. The Chinese, although ignorant of the use of the barometer, acquire from experience a tolerably accurate knowledge of the indications which determine the approach of these dreaded typhoons ... It is a curious and novel sight to watch the preparations which the Chinese make for the approaching storm; the mixture of superstitious observance and prudent precaution which they adopt, either in the hope of averting the threatening tempest, or of securing themselves against its immediate effects. The sultry, oppressive feeling of the atmosphere, the deep black clouds, and other indications, warn them to be prepared; and, from the noise and excitement which soon take place among the Chinese, one would rather imagine they were celebrating some festival of rejoicing than deprecating the fury of the gods. Many of their houses, on these occasions, are decorated with lanterns stuck upon long poles twenty or *thirty feet high, huge grotesque looking figures and various devices. The beating of gongs, the firing of crackers, and explosion of little bamboo petards, from one end of the town to the other, and in all the boats along the shore, create such a din and confusion, that a stranger cannot help feeling that there must be danger at hand, of some kind or other, besides that of a storm. . . . Frequently all the threatening appearances which call forth these preparations pass off without producing a typhoon. The flashes of lightning are fearfully quick and brilliant; the peals of thunder are almost deafening; the huge black clouds hang gloomily over the mountains, or are banded across from one side to the other, pouring their waters in torrents upon the basin between them. In this way the storm at length subsides, and the horrors of a typhoon are averted.*

The demonstration of the electric telegraph in 1843 was to lead to a revolution in weather forecasting, particularly for such things as storm warnings.

Public interest in more accurate forecasting, aided by the telegraph, had one adverse effect on the development of scientific meteorology. The concentration on *what* was expected to occur delayed the investigation of *why* it would happen.

The First International Meteorological Conference was held in Brussels in August 1853. Appropriately, it was preoccupied with maritime meteorological problems, reflecting contemporary interest in the world's expanding maritime trade routes.

In August 1872, another conference was held in Leipzig. It laid the groundwork for the First International Meteorological Congress, held in Vienna the following year, and agreed on standard methods of observation and analysis, including the use of a single set of symbols.

The Vienna congress, among other things, helped to promote the idea of meteorology as an international concern. The English essayist and critic John Ruskin, commenting on the formation of a meteorological society in London during the same period, noted:

The meteorologist is impotent if alone; his observations are useless; for they are made upon a point, while the speculations to be derived from them must be on space . . . the Meteorological Society, therefore, has been formed not for a city, nor for a kingdom, but for the world. It wishes to be the central point, the moving power, of a vast machine, and it feels that unless it can be this, it must be powerless; if it cannot do all it can do nothing. It desires to have at its command, at stated periods, perfect systems of methodical and simultaneous observations; it wishes its influence and its power to be omnipresent over the globe so that it may be able to know, at any given instant, the state of the atmosphere on every point on its surface.

The Second International Congress was held in Rome in 1879. It created a broad structure for the organisation, a programme of work, and methods based largely on international co-operation and voluntary effort.

About the same time, after a meeting in London, the Kew Committee of the Royal Society wrote to Sir Michael Hicks Beach, Secretary of State for the Colonies. The committee reminded Sir Michael that meteorological observations were being made at several centres in the Far East, including Manila and Shanghai.

It would be useful, the committee said, for measurements to be made at a point midway between those two cities. The site suggested was Hong Kong . . .

Left: *The ancient rite of making noise to ward off the evil portents of an eclipse.* Below: *The* ***Nemesis****, whose crew noted the superstitious rituals of seafarers against a tempest.*

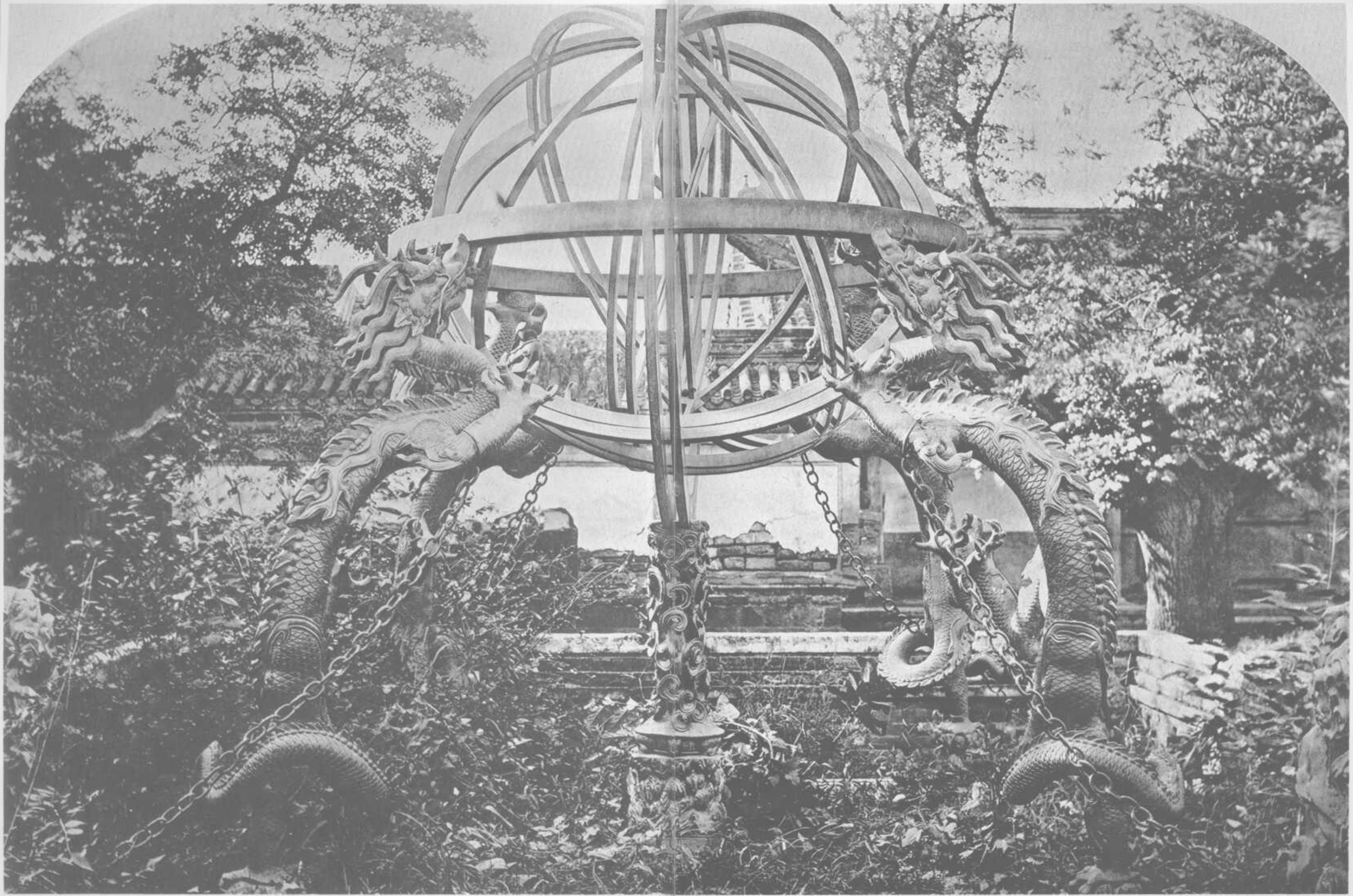
A MAN STRIKING A SMALL GONG DURING AN ECLIPSE.

THE gong, or loo, is a loud-sounding instrument peculiar to the Chinese. It is a plate of composite metal made of tin, zinc, and copper, with a narrow rim. The larger gongs, in which there is said to be a small quantity of silver, are used in concerts, in military bands, and not unfrequently as bells; they are struck with a great wooden mallet, and may be heard at the distance of several miles. The sound is very solemn, resembling a bell, but shriller or deeper according to the force with which they are beaten.

This figure represents the performance of a solemn rite, of most antique origin, but punctually observed by the Chinese at this present hour.*

The government of China, which endeavours to render itself the fountain of science and wisdom as it is of power, retains all the skilful astronomers in the capital of Pekin. These, from their knowledge of the celestial bodies, predict eclipses with much accuracy, and communicate their observations to the Emperor. Some months before an eclipse is to appear, the Grand Coláo, or prime minister, announces it by proclamation, and myriads of people in the most distant provinces are prepared to perform the ceremonies enjoined on the occasion: these chiefly consist in kneeling down, and striking the ground with their foreheads, accompanied by a hideous noise of drums, trumpets, and gongs, which are unremittingly persevered in until the eclipse is over. The Chinese consider a frightful din to be a grand specific against malignant spirits; and the notions of an eclipse among the lower ranks of people are, either that God (for they have some idea of a Supreme Being) is very much displeased, or that the luminary is in danger of being destroyed by an aerial monster.†

Ancient Chinese astronomical instruments at the Peking Observatory. The Italian Jesuit Matteo Ricci found them to be 'finer than any in the Europe he had recently left.'



The Emperor K'ang-hsi visiting the Peking church of the Jesuits, who took advantage of his interest in science and technology to try to further the Christian cause.

Chapter 1

BY FAR THE BEST SPOT

I do think that, of all the silly, irritating tomfoolishness by which we are plagued, this 'weather forecast' fraud is about the most aggravating. It 'forecasts' precisely what happened yesterday or the day before and precisely the opposite of what is going to happen today.

Jerome K. Jerome, *Three Men In A Boat*

Sir John Pope Hennessy

Before dawn, a fine drizzle drifted down from the clouds which had banked together, covering Hong Kong with a solid, grey overcast. The rainfall was not enough to record – indeed, no measurable rain was to fall for the rest of the month – but in retrospect Tuesday, 1 January 1884 does not seem to have been a particularly pleasant day. At 10 am, it was 14°C, with 75 per cent relative humidity and a stiff north easterly wind. Later, the temperature was to rise to a maximum of 15.3°C. These figures, apparently insignificant in themselves, were important to two men in a partially-completed new building on Mount Elgin on the Kowloon Peninsula: Dr. William Doberck, the Government Astronomer, and his First Assistant, Frederick Figg. By recording their observations of the weather on that chill, blustery New Year's Day, Doberck and Figg formally began the work of the Hong Kong Observatory.

The records were not, of course, the first to be kept of the weather in Hong Kong. Such work had predated the establishment of the colony – and some of the earliest notations had been made before Doberck and Figg were born. Clark Abel, a surgeon, had accompanied the Amherst mission to Peking in 1816, and reported in his *Narrative of a Journey into the Interior of China*:

> *On the 14th of July [1816] when this [meteorological] table commences, the Alceste had left Hong Kong sound. The mean of our observations, whilst we remained there, from the 10th to the 13th, gave for the barometer 29.64 [inches], thermometer 81.5 [°F] prevailing wind SW. The south westerly winds were usually accompanied by hazy weather, the northerly winds by clear weather, with occasional squalls, attended by thunder and lightning.*

Doberck and Figg had arrived in Hong Kong in the summer of 1883 – 67 years after Abel's visit – with a commission to establish: meteorological observations in accordance with the United Kingdom requirements of a first-class observatory; a time service; and magnetic observations. Curiously, this original programme for the work of the observatory made no provision for a public weather forecasting service.

The establishment of an observatory in Hong Kong had first been suggested in 1879, when Dr. Warren de la Rue, on behalf of the Kew Committee of the Royal Society, wrote to the Secretary of State for the Colonies, Sir Michael Hicks Beach, noting that Hong Kong was favourably situated for the study of meteorology in general and typhoons in particular. It was further suggested that, because measurements were being taken at Manila, Batavia, Zi Ka Wei (Shanghai) and Peking, the establishment of an observatory in Hong Kong would be valuable because it was half way between Manila and Zi Ka Wei.

The Governor of Hong Kong, Sir John Pope Hennessy, enthusiastically supported the idea, both on 'local and imperial grounds.' He appointed his *aide de camp*, Major H. S. Palmer, Royal Engineers, to investigate the proposal even more thoroughly than had been originally suggested. Palmer prepared a detailed report suggesting a scheme which would involve establishment costs of $33 600 and estimated annual maintenance costs of $10 000.

Unabashed by the prospect of such outlays, in August 1881 Sir John presented the Legislative Council with the estimates for 1882, including $20 000 for an observatory and time ball. He told the council:

> *The experiences of the last few years will be enough to convince us of the importance of meteorological observations for the China Sea. I received within the last few days two telegrams from the government of Manila and the council are aware they indicated the full force of the gale we have recently experienced, and in the same way we shall be able to make observations that will not only be useful to ourselves but to all parts of the China Sea.*

Sir John's proposal had the strong support of the *Hong Kong Telegraph*, which described it as '. . . an undertaking which cannot fail to prove of incalculable service to the advancement of science as well as for the advantage of shipping and general interests of the Hong Kong community.'

However, the Governor's overlords in London did not, it seems, share this overt enthusiasm for the project at a cost of $33 600, and in November 1881, instructed him – by telegram – to '... spend no more money on proposed observatory until authorised ... am consulting scientific authorities here.'

Hong Kong's Surveyor-General, John Price, took a second look at the proposal and in May 1882 submitted a new plan for the observatory. While the facilities it would provide were less comprehensive than those proposed in Major Palmer's outline, it had the advantage, at least as seen by the home government in London, of being only about half so costly. Price's scheme envisaged establishment costs of $18 680 and annual expenses of $5 200, which London 'considered sufficient for the requirements of the colony and more within its financial abilities.'

In his submission, Price showed obvious enthusiasm for the Observatory, and pointed out that initial estimates of its cost had been no more than a wild guess:

The estimates given, both as regards initial cost and subsequent annual maintenance, though based on strict economy, will be found sufficient to secure a class of building and of instruments corresponding to an observatory of the first order, but I regret the estimate of first cost should so greatly exceed the grant of $10 000 conceded by the Secretary of State for the Colonies for this purpose, the fact being that this grant was not based upon any estimate of cost, but was merely an arbitrary sum named without any calculation at all, a circumstance which may perhaps influence the Secretary of State in sanctioning the appropriation of a further sum of $8 680 to complete the entire estimate of cost, which is $18 680.

... the observatory is beyond question a great local want for the daily issue of correct time to the ships, and of trustworthy forecasts of the weather to these, and to the boat population of the harbour who swarm in thousands; and that if ably conducted

its physical observations of the phenomena of the monsoons and cyclones of the China Seas, will possess extraordinary value as contributions to meteorological science, owing to the peculiarly favourable position of Hong Kong as an observing station.

Price also had his own opinions about the scope of the work the Observatory should – or should not – be asked to do, adding:

It has been suggested to saddle the Observatory with a great deal of extraneous work, geological, seismical, sea temperatures, etc. I think this would be undesirable. If the Superintendent has any spare time it could not be better devoted than to further meteorological studies of the phenomena of typhoons, and to the tabulation and investigation of the records of the entire chain of observing stations from Hong Kong to Japan . . .

The Observatory, of course, required instruments, and in August 1882, Price wrote to the Colonial Office ordering:

A Barograph similar in all respects to the one at Kew Observatory.

A Thermograph. Kew pattern.

A Sun-shine recorder with one year's supply of prepared cardboard.

An Anemograph with spindle six feet long. Kew pattern.

A Rain gauge (standard).

One year's supply of Barograph, Thermograph and Anemograph sheets and stationery.

Note: The Anemometer must be of extra strong make, to escape destruction from typhoons. The whole of the instruments to be verified at Kew Observatory before shipment to the Colony.

There remained only the question of a name for the project. Once again, distant London found it necessary to temper Hong Kong enthusiasm. Governor Hennessy's early proposals for the observatory had included the suggestion to name it after the Chinese Emperor Kong Hi [K'ang-hsi], prompting London to enquire why the Chinese leader should be so honoured, rather than Queen Victoria or the Prince of Wales. The final decision appears to have been made by default – with the correspondence in which Prince's scheme was recommended noting:

As to the name of the observatory, . . . perhaps the 'Hong Kong Observatory' will be enough for the present modest proposal.

It continued, rather laconically:

Pass over in silence Sir J. P. Hennessy's proposal to name it after Kong Hi, and the idea will probably drop into oblivion.

By the time Doberck and Figg arrived in Hong Kong, the observatory building was well under way. Surveyor-General Price had selected the present site at Mount Elgin, which had originally been levelled on the orders of the former governor, Sir Richard Macdonnell (March 1866–April 1872), who had planned to build a summer residence there. The idea was later dropped in favour of Mountain Lodge on The Peak.* Doberck found the Mount Elgin site an excellent one, saying that 'it proved to be by far the best spot in the colony for making scientific observations.'

But if Mount Elgin was ideal from a scientific point of view, Doberck was soon to find that, as a place to live, it had drawbacks. In 1885 he reported that the roof leaked and several attempts at repairs had been unsuccessful. He added:

My private quarters [the first floor] are very draughty in the winter during the height of the NE monsoon, which is so trying to the health. This cannot of course be helped, as the Observatory should be exposed to the full force of the wind.

'Trying to the health' was rather an understatement. Doberck complained that although the growth of rice in extensive paddy fields near the observatory had been prohibited, the ground had not been drained,

. . . and was during the heavy rains of last summer converted into an extensive swamp, to the malaria emanating from which the intermittent and remittent fevers, from which we all suffered, may be ascribed.

Health problems aside, the observatory building was – and remains – a graceful example of the architecture of the

*The site is now a garden at the summit of the Peak.

period. The main building was rectangular, 83 feet by 45 feet, with the two storeys constructed of plastered brickwork. The first floor was the director's residence. On the ground floor were his office and library and the clock room. On the left of the entrance hall were the instruments room and the computers' room. (Computers were members of the non-professional technical staff.)

Doberck's first major project was a tour of the Treaty ports* – on the orders of Governor Hennessy – to seek scientific assistance and cooperation. The tour was obviously a success, with Doberck reporting:

> *The Inspector General of the Imperial Maritime Customs of China [Sir Robert Hart] who has contributed so much to forward the cause of science in that country, subsequently ordered a copy of all meteorological observations henceforth made in the harbours and lighthouses along the coast to be forwarded to me . . . It is certain that not only the meteorology of China will benefit by Sir Robert Hart's enlightened action, but the meteorology of the northern hemisphere will be forwarded, when reliable observations are made on a uniform plan in that extensive country.*

Returning to Hong Kong in late 1883, Doberck found the observatory nearly completed. He moved into the building and, as previously described, began observations on 1 January 1884. At first, observations were made at 10 am, 4 pm and 10 pm of pressure, temperature, wind velocity and direction, cloud type, amount and direction of motion, rainfall and sunshine duration. A hut west of the observatory was used for magnetic observations of horizontal and vertical force and declination. The frequency of observations was later increased with the addition of readings at 1 pm. Observations were also made at Victoria Peak (7 am, 10 am, 1 pm, 4 pm, 7 pm and 10 pm, of which the 10 am, 4 pm and 10 pm readings were published). Readings from Cape D'Aguilar were found to be 'so wanting in accuracy' that all except the state of sea surface were stopped.

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*Canton, Amoy, Foochow, Ningpo and Shanghai.

One of the immediate problems for Doberck and Figg was the lack of reliable early records. There was no shortage of information, but Doberck had a low regard for its value, writing in 1884 that Figg

> *. . . also took monthly means of the height of the barometer registered for over 20 years in the Harbour Office, but as some difficulty was encountered in ascertaining the corrections, which the barometers required, the results have not yet been published and will not be of much importance when published.*

While no weather forecast as such was provided, Doberck soon realised the need for a storm warning system. On 25 May 1884 he announced that whenever there were indications of strong winds, notice would be given to the Harbour Office, the telegraph companies and the newspapers. By August, a drum, ball and cone system of signals, based on the four points of the compass, was introduced. Despite its obvious value, the system developed complications. A typhoon gun at the foot of the police station signal mast in Tsim Sha Tsui was fired once when a gale was expected, twice when typhoon force winds were likely to occur, and three times when the wind was believed likely to shift suddenly during gales.

The two systems were separate – the drum, ball and cone symbols referred to weather at some distance from Hong Kong, and were hoisted only to show ship's captains the weather they could expect after sailing from the harbour. The gun was used to indicate *local* conditions, but the public confused the two. To deepen the confusion, the gun was also fired to announce the arrival of mails, which often led to local craft seeking shelter from a non-existent typhoon. In an attempt to clarify the situation a colour code was introduced in 1890: red signals indicated tropical disturbances more than 300 miles from Hong Kong, while black signals related to disturbances within 300 miles.

There were even further problems with the signals themselves. The early symbols, made of perforated canvas on metal pipe frames, were too light, and were blown down by the very winds they were meant to indicate.

Such practical difficulties were not the only ones Doberck had to face; scientific advances which make modern meteorology easier and more accurate were years away. Although the German astronomer and physicist Heinrich Wilhelm Brandes had drawn the first weather map in 1820, the first demonstration of radio (Guglielmo Marconi's transmission of signals across the Atlantic from Cornwall to Newfoundland) would not take place until December 1901. The first demonstration of radar would be given by a team led by the British scientist Sir Robert Watson-Watt in 1935. However, using the technology of his time, Doberck was able to give a certain amount of advice, as indicated in an appendix to his report for 1884–85, in which he provided this rule of thumb 'on the practical use of the meteorological signals:'

> *Vessels in the China Sea are generally enabled by observing the rules given in the notices of the 11th May and the 16th July 1885, to avoid running into typhoons, that may be encountered. In the former notice, the following rule is given: The whereabouts of the centre of a typhoon may, in the China Sea, be ascertained by the rule: Stand with your back to the wind, and you will have the centre on your left side, but between two and four points in front of your left hand. There are however certain exceptions to this rule. Thus there often blows a steady Easterly gale along the southern coast of China, when a typhoon is crossing the China Sea, and the gale blows often steady from North-East about the northern entrance to the Formosa straits when there is a typhoon in a more southern latitude.*

Such advice was no doubt appropriate for the prevailing standards of maritime meteorology, and was meant to assist ships' officers who could not be expected to have much – if any – scientific training. Even so, Doberck soon discovered that mariners tended to disregard or misinterpret his guidance. In an 1884 report, tinged with exasperation, he wrote:

But after all [my endeavours] I have learned that cases still occur where a captain, who is less familiar with typhoons, delays his ship in port, although the information issued . . . implies that he is likely to encounter fine weather on a voyage to the port for which he is about to start, while another ship starting at the same time for some other port may run great risk.

The complaint was not new – in March 1882 the *Hong Kong Telegraph* had chastised local sailors for their casual attitude to weather warnings, commenting that:

Last year the weather was unusually violent but thanks to the storm warnings given by the Manila Observatory we learn . . . that a large number of vessels and lives have been saved. The news was published so promptly that vessels ready to start from the various coast ports were able to take precautions in time and on the only occasion that much damage was done by storm in the neighbourhood of Hong Kong the disasters were chiefly due to the obstinacy of local junk owners and boat men who refused to pay any attention to the warning.

Greater respect was, however, shown for other aspects of science as applied to seafaring – a ship's chronometer had to show the correct time if navigation was to be at all accurate. Masters normally sent their chronometers ashore to be rated – by a local watchmaker if no better service was available. The Hong Kong Observatory had a six-inch Lee Equatorial telescope to help determine local time accurately. Doberck, like his counterparts in other ports, found chronometer rating to be a useful source of income. In June 1884 he was granted permission for a private practice, rating ship's clocks for a charge of $5. He was warned however, that if the work interfered with his government duties he was to give it up without compensation.

In the same year, a time ball tower was built at the police station in Tsim Sha Tsui. The time ball, six feet in diameter, was mounted on a pole, the top of which was 84 feet above sea level. The ball was raised manually each day and dropped at exactly 1 pm (except on Sundays and Government holidays). The time ball was moved in 1907 to

Blackhead's Hill (Signal Hill) and was last used on 30 June 1933 (See Chapter 6, 'From Time Ball to Atomic Clock.')

A month after its introduction, Doberck's storm warning system first proved its value to Hong Kong. Previously, typhoons had swept through the territory with little – if any – warning, so the typhoon of September 1884 was probably the first for which the residents were properly prepared. There was some criticism after the event, but it was directed at the way in which the warning system was applied, rather than at the system itself.

The *Hong Kong Daily Press* of Thursday, 11 September 1884 reported:

All day yesterday the long-promised typhoon was expected to give this Colony a call, or at least the usual swish of its tail as it passed. On Sunday the existence of a typhoon was telegraphed from Manila and since Monday the barometer has continued to fall steadily though very gradually. On Tuesday, Dr. Doberck, Government Astronomer, had his storm signal hoisted. During Tuesday night and Wednesday morning the wind rose, and by daylight the harbour was good deal ruffled. The barometer was still falling and the appearance of the sky was considered to be very threatening. The boat people evidently did not like the aspect of things, for they soon cleared out to places of shelter and, with the exception of one or two cases, all loading and unloading [of] vessels in the harbour was suspended. The exceptions only kept it up for a few hours and they were then scared off by Dr. Doberck's gun, which indicated the approach of a storm.

The following day's edition carried two weather notices, signed by Doberck. The first, presumably reflecting publication problems rather than a delay in its transmission from the Observatory, was dated 10 September:

At 5.45 am directions were given to fire the typhoon gun one round, a strong northerly gale being expected here. At 10.15 am the following notice was telegraphed to the treaty ports – 'Typhoon approaching Hong Kong from the east. The typhoon is still about E.S.E. [east south east] of here.'

This was followed by another warning, dated 11 September:

Directions to fire the typhoon gun two rounds were given at 6 hours 28 mins. pm yesterday. At 1 am the following notice was telegraphed through the Central Police Station from here – 'Heavy typhoon crossed Hong Kong early this morning moving westward. Over nine inches of rain fell.'

In the same issue [12 September 1884] the *Telegraph* reported both the efficiency of the warning system and the effect it had on the residents:

The very sufficient notice which was given them [small Chinese craft in the harbour] and the very gradual approach of the storm enabled them all to get away so that the damage afloat and the loss of Chinese life has been trifling compared with what has usually been experienced here when a typhoon strikes the Colony. The two typhoon guns brought out a considerable number of enterprising sightseers who braved all the discomforts of the roaring gale and blinding rain for the purpose of witnessing Nature in one of her fiercest moods. As usual, a knot of these gathered at the end of Pedder's Street, taking advantage of the shelter of the buildings on the East side to stand and watch the progress of events, occasionally making short trips along the Praya . . .

On Saturday, 13 September 1884, having had time to inspect the settlement and make comparisons with previous storms, the *Telegraph* commented at length in an editorial, in words that must have been pleasing to Doberck:

In no previous storm of equal severity has the damage and loss of life been so small as in that of Wednesday night and Thursday morning. This fortunate result must be attributed to the long warning given and the precautions that were accordingly taken. Although the storm was by no means so severe as that which occured 10 years ago [the typhoon of September 1874 killed some 2 000 people in six hours] there can be little doubt that had the Colony been in the state of unpreparedness it was on that occasion the destruction of property would have been immense and the loss of life, instead of being counted by units, would have had to be indicated by hundreds if not thousands. In *many previous storms when the wind and sea had been nothing like so great as they were on Wednesday night we have seen the Praya strewn with wreckage, and the loss of life has been considerable. We are glad to believe that the conditions now established are such that no matter what may be the violence of typhoons which may be experienced here in the future, never again will they work the havoc they did in the past.* There are secure places of shelter which may be availed of by all the small craft in the harbour . . . and on shore effective precautions can be taken, provided that sufficient warning be given. Thanks to the position of telegraphic communication with Manila and the scientific attainments of the Government Astronomer** this can now always be done. The machinery for storm warnings is, relatively speaking, complete. Such being the case, any neglect or carelessness in its application is the more to be deprecated. In the case of Wednesday night's storm the public had several days notice that a typhoon was approaching this neighbourhood, and the gun indicating that a gale might be expected was fired early in the morning, but it appears the probable approach of the actual typhoon might have been notified several hours before the typhoon gun was fired. The typhoon gun is to be fired only when it appears tolerably certain that the storm will strike here, but it is important that as soon as the Government Astronomer finds himself in a position to pronounce an opinion as to the*

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* The typhoons of 1906 and 1937, among others, were to prove this hope lethally wrong.

** There are basic contradictions in the question of Doberck's title. The *Government Gazette* of 10 November 1883 announced the appointment of 'Dr. William Doberck to be Director of the Hong Kong Observatory, with effect from the 2nd March 1883,' and the appointment of Frederick George Figg to be 'Assistant to the Director of the Hong Kong Observatory . . .' Despite this, and frequent references in official correspondence to 'the Director', it is clear that for some years at least he styled himself Government Astronomer. His printed official report in 1890, for example, carries that title, as do newspaper announcements of the period. Such a personal quirk seems to be entirely in character with Doberck's generally irreverent attitude to the accepted formalities of the colonial service.

probability of its approach, that opinion should be made known to the public. Dr. Doberck had previously notified that the centre of the depression appeared to be moving northward and the storm signal indicating a gale, as distinct from a typhoon, having been given on Wednesday morning, some persons remained under the impression up to the time the typhoon gun was fired at 7 o'clock that the storm was not likely to be a very serious one.

To this point, the editorial can be seen as vindication of Doberck's complaint that residents and ships' officers either misread or ignored the storm signals. But the criticism – of the system, rather than of Doberck himself – was to become more pointed. The editorial continued:

It appears however that long before that hour [i.e., the first gun] Dr. Doberck had discovered that the typhoon had changed its course, and instead of travelling to the north was moving in this direction. He accordingly telegraphed to the Central Police Station at noon – 'Typhoon in E.S.E. At present it is moving towards Hong Kong.' This was evidently intended for distribution, and it is said that this is the way in which the Astronomer is instructed to issue such notices and that as soon as they are despatched from the Observatory his responsibility in the matter ceases. With whomsoever the responsibility may rest, the fact remains that the information was not published in Hong Kong, though it was telegraphed to the coast ports. The public therefore had good cause of complaint. It will be the duty of the government to make such arrangements that no omission of the kind can occur again. 'For want of a nail the shoe was lost, etc.,' and for want of a typhoon notice, kept close at the Central Station, a ship may be lost . . . Divided responsibility is always mischievous and we would suggest that Dr. Doberck should be authorised in future to issue his notices direct and not through the Central Station. The actual telegram must of course go there . . . but the orders as to what notices are to be issued to the public and what to be sent to the coast ports should be given on the sole responsibility of Dr. Doberck. The telegram referred to was apparently taken as intended for transmission only to the *coast ports and the police in fact say their instructions are only to circulate such notices as Dr. Doberck directs. It is easy enough to imagine how the mistake occurred and it is equally easy to see how the possibility of its occurrence may be avoided in the future. Fortunately on this occasion the mistake was not attended with serious consequences. The earlier notification, the single gun in the morning, the rapidly falling barometer, and the threatening appearance of the sky proved sufficient warning. A similar error at another time might, however, be attended with serious consequences.*

The government, however, did not share the *Telegraph's* willingness to excuse Doberck from some responsibility, particularly when it was revealed that the Director, with neither apparent reason nor authority, had decided that certain weather information be kept secret.

As the Acting Colonial Secretary, Mr. Frederick Stewart, pointed out in a letter of rebuke, Doberck had made things worse by writing to the newspapers.

The painstakingly beautiful copperplate handwriting in which much government correspondence of the time was conducted fails to take the sting out of Stewart's letter. He wrote:

It appears from recent correspondence that you have directed the Acting Captain Superintendent of Police not to distribute weather telegrams received from you unless they are specially marked for distribution, and the Harbour Master has also brought to the notice of the Officer Administering the Government that you have offered to communicate weather telegrams to him, the words of which are to be kept secret.

In consequence of the instructions given by you to the Acting Captain Superintendent of Police, an important telegram respecting the late typhoon was not distributed, and you have been disingenuous enough to write to the Public Press to attempt to cast the blame for its non-distribution on the Police Department.

I am directed by His Excellency the officer administering the Government to inform you that your conduct in writing to the

Public Press animadverting on another Department is highly improper, and must not be repeated; and to state also that the public, by whom the cost of the Observatory is supplied, is entitled to have full and early information about the weather, and will have reason to complain if such information is not furnished. The Acting Captain Superintendent of Police and the Harbour Master will be instructed therefore not to keep secret any telegram received from you respecting weather forecasts.

It is clear from the records that Doberck was undeterred by such comments. He held strong opinions about the role of the Observatory, and expressed them bluntly, often provoking an equally blunt reply from the government. The topic of staff for the Observatory was to pepper his reports for years. In 1886 he complained that:

Considerable inconvenience has been and will in future be experienced owing to the resignation of the native assistants. On leaving school they join the staff and get a special training for the work only to retire to some other branch of the service where they expect some prospect of rapid advancement. This makes the work harder on the assistants that remain, as a newcomer is for a considerable time nearly useless.

In 1889 Doberck took his complaints direct to Governor William Des Voeux, writing:

. . . the staff is so hard worked that I ventured last summer to call His Excellency's attention to the necessity for appointing another European as Chief Assistant . . .

This was only one of several similar requests that Doberck sent to the Governor around this time. If he did not, initially, receive the staff he wanted, he certainly evoked a reply from Government House.

On 8 October 1890, the Colonial Secretary, declining on behalf of the Governor to publish, at public expense, Doberck's dissertation on the law of storms, had this to say:

If you were to confine your remarks to the questions put to you, it would, in His Excellency's opinion, be of advantage.

A week later, official patience finally snapped, and the Colonial Secretary wrote to Doberck again, making a suggestion that could not be considered subtle:

His Excellency will certainly not approve of any such document [an explanation of the system of issuing weather reports] being published so long as it contains statements which, to say the least of it, are ill-advised on the part of a Government official. It is not for you to inform the public that in your opinion the staff of your department is insufficient. If you consider it is so you should again address the Government on the subject, and if you are not satisfied with the conclusion at which the Government arrives, you had better resign your appointment, and someone will doubtless be able to work the Observatory with such a staff as this Government can afford to render.

In 1890, Governor Des Voeux appointed a commission to investigate the workings of the observatory. Among other things, the commission considered a report from Major-General H. S. Palmer, Royal Engineers, who, as Major Palmer, had prepared the original outline of the observatory in 1881. Palmer told the commissioners:

The only important departure from my suggestions is the refusal by the Colonial Office to sanction the buildings and equipment for autographic magnetic records – a refusal apparently dictated by reasons of economy.

. . . with reference to current investigations, the Observatory is really less purely scientific than was contemplated by the Royal Society and Governor Hennessy and approved, later, by the Legislative Council.

Doberck refused to be sidetracked by such nobility of sentiment and in his annual report for 1890 said that after visiting the Observatory the commissioners

. . . strongly recommended a much larger annual expenditure and stated that 'the increased staff that has been found to be essential would involve a greater outlay, and the annual cost cannot be estimated at under $13 000 a year; or nearly twice the sum now spent.' They also stated that 'to render the working of the Observatory properly effective, there should be three

European assistants, at least one of whom should have sufficient experience and knowledge to permit of his taking charge of the Observatory, when necessary; there should also be three Portuguese or Chinese clerks.'

Doberck got his way: in 1891, more local staff were recruited, which allowed observations to be taken every hour from 7 am to 10 pm each day. In May 1891, the first expatriate to join the Observatory staff since Doberck and Figg arrived in 1883 was appointed. Mr. J. I. Plummer became Chief Assistant, presumably placing him over Figg, although their positions were later to be reversed.

But even this expansion failed to please Doberck, who reported at the end of 1891:

The staff recommended by the Observatory Commission as a minimum, *below which this institution could not be expected to do justice to the immense shipping interests in this great port, has now been appointed, but it is regretted that in the meantime the staff was so utterly inadequate. The work done during the past two years has suffered in consequence, and no amount of expense now could possibly remedy the loss. Once a certain phenomenon has passed unrecorded the opportunity for observing it can never arise again, the same conditions being never repeated in the physical world.*

The rate of expansion of Hong Kong in the 1890s strained official resources, and Doberck was not the only departmental head seeking to prise more money and manpower out of an increasingly cost-conscious Colonial Office. In this respect, his repeated requests for additional staff were no doubt justified. However, the rate of attrition among the existing staff may well have been due, at least in part, to the character of the Director himself.

Records show that Doberck worked hard and efficiently to develop and improve the functions of the Observatory. At the same time, however, it became clear that he was a prickly man to work for, and one whose attitude at times provoked Colonial Office officials to stiffly-worded correspondence.

The first indication of this emerged in April 1883, while Doberck was preparing to leave London for Hong Kong after being attached to the observatories at Kew and Greenwich. His written proposals about the work of the Observatory attracted this blunt comment:

The sooner this apparently unpleasant man goes out the better. As regards his letter . . . tell him that no further recommendations as to his future sphere of work can now be entertained and that he must be prepared as a member of the Government service of Hong Kong to be in the same subordinate position to the Governor as any other officer and to make all reports and recommendations to the local government in the usual manner.

In 1885, Doberck's application for a salary increase was refused, with despatches noting:

Dr. Doberck, as we well know, is a very cantankerous person, but at the same time very efficient and zealous in his own work . . . as time goes on he may with extended duties fairly expect an extended salary, but he has not been at Hong Kong three years as yet.

Cantankerous he may have been, but Doberck was certainly persistent. In 1888 he not only renewed his request for higher pay, but asked for larger quarters as well! While refusing to approve bigger accommodation, the Colonial Office admitted that he had earned the right to a higher salary. Once again, official comments were a mixture of praise for his work and criticism of his personal shortcomings:

As regards his request for larger quarters it must I think be refused, but as regards his application for an increase of salary . . . he has established some claim by the good work he has done in Hong Kong, and his disagreeable and difficult manner is calculated perhaps to lead to his actual services being rather undervalued.

In June 1890, London was informed that the Observatory's second assistant, Mr. J. B. da Silva, had resigned, an action for which blame was quickly apportioned:

. . . Mr. da Silva has resigned . . . but Dr. Doberck is a most ill conditioned man and I have no doubt that this poor man found it impossible to work under him.

Doberck continued his battle to get more staff for the observatory in 1892, this time on the basis that not enough use was being made of information from ships and shore stations:

The total number of ships whose log books have been made use of was 270; the total number of days' observations was 5 278 . . . The difficulty is . . . that no more than one of us at a time can be spared for visiting ships in the harbour, and he can devote only half his hours of duty to work afloat. Every vessel entering the harbour ought to be boarded and every log book found to be properly kept ought to be copied. That would be useful for storm warnings. Unfortunately there is no prospect of additional clerical help for a purpose so useful to the shipping as this undoubtedly is. The immense bulk of records from stations on shore is not utilised for anything beyond investigations of typhoons.

The same year (1892) saw one new member added to the Observatory's staff, a person who was considered unlikely to resign because of any personality clash with Doberck. She was his sister, Annie. She was not new to the work, having already helped her brother for some years with the storm warning service and liaison with shipping. Following her appointment as Meteorological Assistant, she continued her liaison duties, a task which led her to be known in the port as 'Typhoon Annie' or 'Sampan Annie.' London, which had expressed some doubts about Miss Doberck's formal qualifications for the post, finally approved the appointment, noting that nearly 10 years earlier, Doberck had been refused permission to appoint his housekeeper as one of his assistants:

There need however be no objection to his sister being appointed, and seeing that he is a difficult man for other people to get on with, and that his assistant is required to live with him, there is considerable advantage in selecting his sister, who is (I presume) already a member of his household.

Having settled the staffing question to his apparent satisfaction, the Director petitioned for the staff to be better paid, pointing out that Observatory staff were paid less than had been suggested by Major-General Palmer.

... moreover, the salaries were not increased in 1890 at the time general increases of about 35 per cent were awarded to officials in other Government departments. In the event of a vacancy arising, from any cause, amongst the foreign staff, it will be quite impossible to efficiently fill it on the present salary scale.

In 1894 Doberck went on long leave and his absence allowed his First Assistant, Figg, to show why he – and not Mr. J. I. Plummer – should have been appointed the Director's Chief Assistant. Doberck reported:

During my absence on leave from 28th May to 26th December, inclusive, after eleven years continuous service in the Colony, Mr. J. I. Plummer, Chief Assistant, took charge of the astronomical and magnetic observations, including the time ball, and Mr. F. G. Figg, First Assistant, attended to weather forecasts and storm warnings and superintended the meteorological work. The way Mr. Figg discharged these duties, which are of considerable importance to shipping, during my absence, is deserving of the highest praise, and calls, I respectfully submit, for some reward from the Government ...

Figg was not to receive his reward until 1907, when Doberck retired and Figg was appointed Director over the head of Plummer. In the meantime, Doberck continued to report favourably on the work of the man who had accompanied him to Hong Kong, writing in his report for 1897:

Too much credit cannot be given to Mr. Figg, our eminent weather forecaster, for the service he has rendered ... His warnings have saved enormous sums of money for the wealthy communities of the Far East, and have indeed been a benefit to nearly all who trade in these seas, quite apart from the lives that have thereby been preserved.

Tragically, the Observatory's warnings were not always so timely. Within 10 years, Hong Kong was to receive only a few minutes' warning of one of the most deadly and destructive typhoons in its history. On Tuesday, 18 September 1906, The *Hong Kong Telegraph* reported, in the flowery newspaper style of the period:

In the short space of barely two hours this morning, a typhoon of phenomenal velocity swept over Hong Kong, laid great part of the city in ruins, annihilated the fleet of shipping which has been the colony's pride and worked unexampled destruction to hundreds . . .

Dawn broke this morning dull, wet and threatening. For several days it has been feared that a typhoon was in the vicinity, but no inkling of its proximity could be obtained. Yesterday the weather forecast for Hong Kong was 'Variable winds, moderate, probably some thunder showers.' Shipmasters in the harbour kept an anxious eye on the typhoon signal station, prepared for any emergency that might arise. No danger signal was hoisted, however, and no danger was apprehended.

At five minutes past eight [am] the typhoon gun was fired and five minutes later the Black Ball was hanging from the yard of HMS Tamar.

The report, headed 'Holocaust in Hong Kong', continued:

At nine o'clock or thereby the wind roared through the colony. The rain had become dagger darts biting with the sting of a 60-mile gale. Rapidly the sea swelled and joined in the gale's wild shouting. Foam rose to the height of the princely houses along the Praya front.

At the end of six full columns of description, the newspaper printed, without comment:

The following report is from Mr. F. G. Figg, First Assistant of the Hong Kong Observatory:

On the 18th at 8 am – orders issued to hoist the Black Drum, and at 8.40 am to fire the typhoon gun.

The centre of a small typhoon, probably formed last night to the East of Hong Kong, passed quickly over the colony between 8.30 am and 11 am. It gave no indication of its existence until close to the colony. Telegraphic communication between the Observatory and Hong Kong is interrupted.

On 19 September, the *Telegraph* reported that the Bishop of Victoria, John Charles Hoare, had drowned when a small boat he used on pastoral visits capsized and was driven on to rocks at Castle Peak Bay. Later estimates of the total death toll ranged as high as 10 000, with thousands of boats – from small Chinese craft up to ocean-going ships – wrecked. The *Telegraph* commented:

> *The roll of death will never be known. In most cases whole families have disappeared together and there is none to ask for them.*

The Legislative Council met on 20 September, to hear the Governor, Sir Matthew Nathan, announce:

> *Hong Kong has just suffered from a catastrophe that has equalled, if not more so, any that has previously befallen the Colony.*
>
> *The loss of life and property between the hours of 9 and 11 on Tuesday morning has been . . . greater than that incurred in the great typhoon of 1874.*
>
> *It has been suggested in the Press that much of the loss of life and property would have been avoided if the Observatory had given earlier notice of the approach of the typhoon, and that such earlier notice should have been possible. I see no grounds for believing this possibility. But it is due to the public and also to the Director of the Observatory than an inquiry should be held into it.*

Sir Matthew then ordered that a senior officer of the Royal Navy be appointed to preside over a small committee which would investigate the allegations.

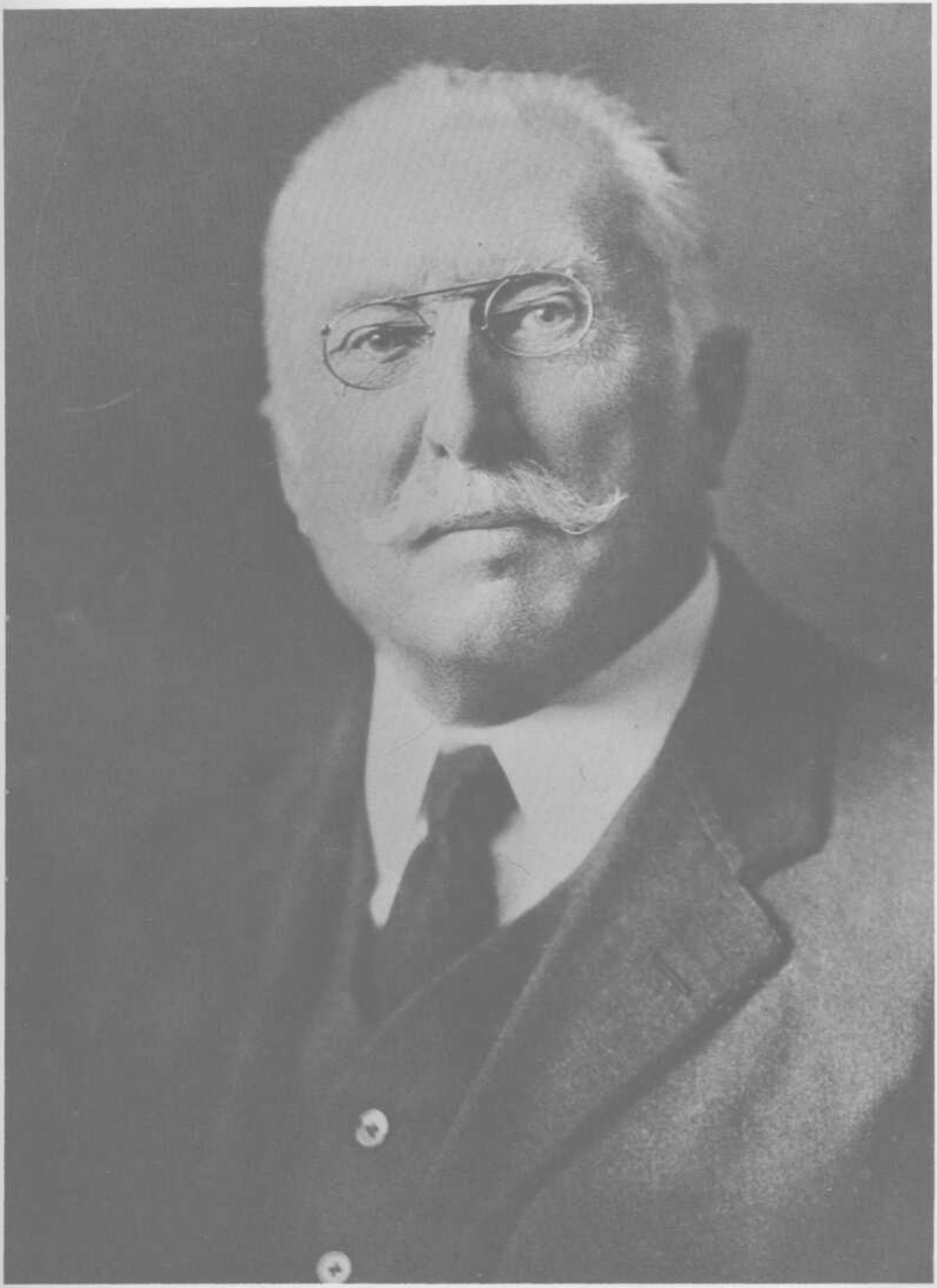
Doberck was later to comment on the disaster:

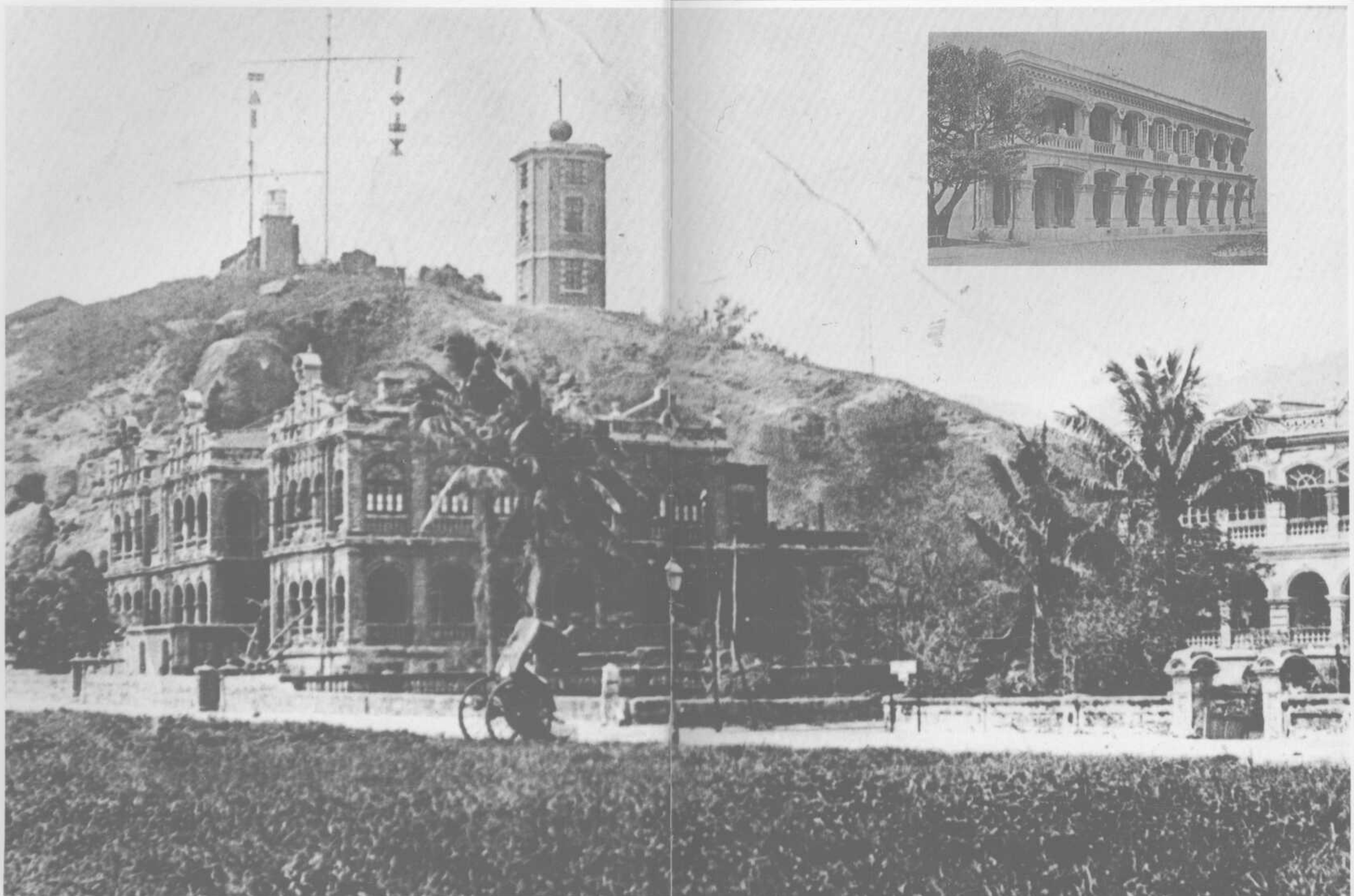
> *Could earlier warning have been given it would doubtless have contributed to the saving of life and property as far as the boat population in the harbour is concerned.*

Doberck also pointed out that the typhoon had struck at flood tide, piling up water to an exceptional height in the harbour, causing damage 'quite out of proportion both to the duration and the severity of the storm.' (This increase in water levels during a typhoon – storm surge – can raise water height by up to several metres Along with strong winds and torrential rain causing flooding, it is one of the three main causes of property damage and loss of life during typhoons)

In 1907, after 24 years service, Doberck retired As earlier noted, Mr Figg – and not Mr Plummer – was appointed to succeed him In the same year, the typhoon gun was used for the last time, being replaced with maroons which were fired only when the wind was expected to reach gale force The maroons, too, had their problems The last time they were used, in the typhoon of 1937, Barrack Sergeant Dan Brown, assigned to fire the signal, managed to explode all of them at once – an appropriately loud signal, as the 1937 typhoon proved the most destructive in Hong Kong's history, killing some 11 000 people

Dr. William Doberck, a dedicated scientist, was the sometimes prickly first Government Astronomer-cum-Director of the Observatory, serving from 1884 to 1907.

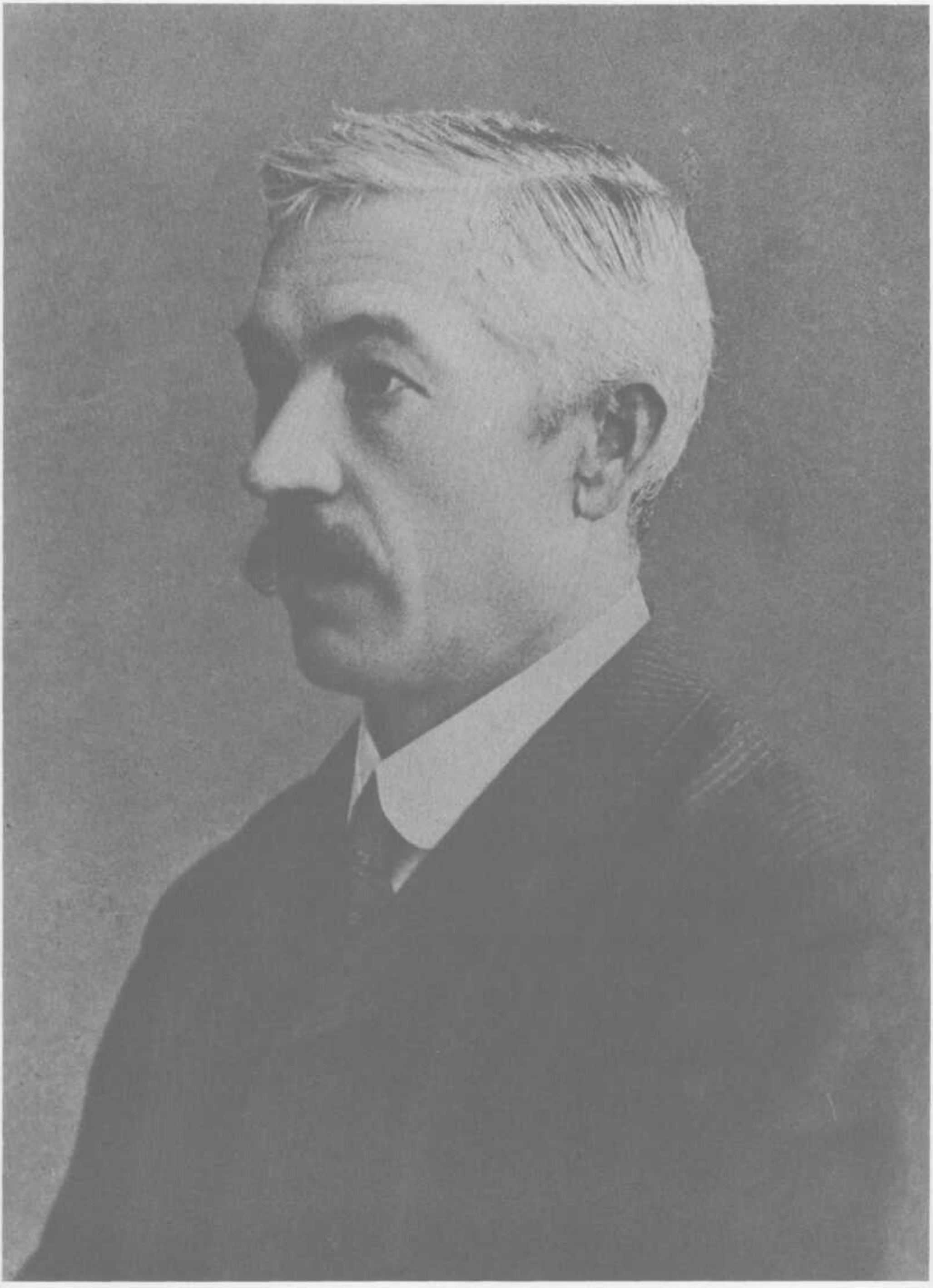




The time ball on Blackhead's Hill was raised manually and dropped precisely at 1 pm. To its left in this scene can be noted a plethora of wind and other signals.

Inset: *A 1913 photograph of the Royal Observatory building that still stands, surrounded by trees, in Tsim Sha Tsui.*

Frederick Figg's five-year Directorship included the passage of Halley's Comet in May, 1910, although to Figg's disappointment, overcast weather made observation difficult.

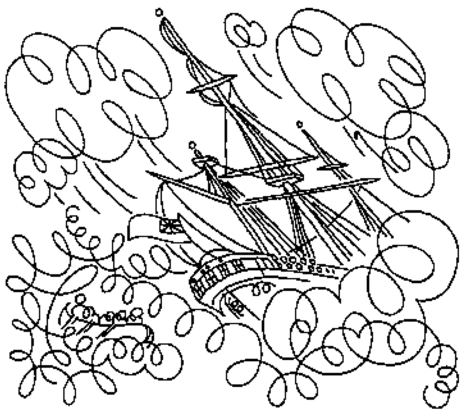


Chapter 2

AWAY FLY THE HOUSES

... the water-fowl fly about affrighted ... the force of the tempest is let loose, and away fly the houses up to the hills, and the ships and boats are removed to the dry land ...

S. Wells Williams, *The Middle Kingdom* (1893).



The early European traders, merchants and fortune-seekers found the China Coast to be an unpleasant and often unhealthy place to live. Many of their documented complaints relate to the climate, particularly the oppressive summer. Rudimentary sanitation, too, played a large role in a European death toll which at times reached alarmingly high proportions.

The Europeans were, however, partly to blame for their own failure to acclimatise. They wore thick, unsuitable clothing, ate large, heavy meals, and drank inappropriate amounts of whisky and port.

There was little to do except work, drink, eat and brood:

> *Often for days together we remained sweltering on board, from lack of energy and sufficient inducement to leave the ship. The charms of the Club or the excitement of a game of billiards failed to tempt us. Hong Kong boasts of only two walks for the valetudinarian – one along the sea-shore to the right, and the other to the left of the settlement.*
>
> *Then there is a scramble to the top of Victoria Peak at the back of it, but this achievement involves an early start, and a probable attack of fever. The monotony of life is varied by this malady alternating with boils or dysentery . . . It was not difficult to account for a certain depression of spirits and tone of general irritability, which seemed to pervade the community. A large bachelor's dinner was the extreme limit of gaiety.**

It is easy to imagine that they thought often of Home, but such pleasant thoughts must frequently have been interrupted by the nagging danger that they could easily die in the East, and never return to enjoy

> *. . . retirement to England, with its cool climate and ordered society, fox-hunting and shooting parties in the winter, London in 'the season', country house weekends, Ascot, Henley, Lord's, the rustle of newspapers in the club reading room, walks down leafy lanes on crisp autumn mornings . . .*

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*Laurence Oliphant, *Narrative of the Earl of Elgin's Mission to China and Japan in the Years 1857–59.*

*Meanwhile there was the boredom and humidity of the East, with its alien ways and temming masses, the nagging sense of failure, and of futile years wasted to no good purpose.**

Not all the sojourners, however, felt so badly about the East. Sir John Francis Davis, second Governor of Hong Kong (May 1844–March 1848), took a much more positive view, particularly of the climate, in *The Chinese: A General Description of the Empire of China and Its Inhabitants:*

Taking it all the year round, and with the exception of some oppressive heats from June to September, it may be questioned whether a much better climate exists anywhere than that of Canton and Macao; the former place being as low as latitude 23° 8′ north and the latter about a degree to the south of it. The mean annual temperature of those places is what commonly prevails in the 30th parallel . . .

The total fall of rain varies greatly from one year to another, and has sometimes been known to reach ninety inches and upwards. Vegetation is checked in the interval from November to February, not less by the dryness than by the coldness of the atmosphere; the three winter months being known sometimes to elapse with scarcely a drop of rain. The north-east monsoon, which commences about September, blows strongest during the above period, and begins to yield to the opposite monsoon in March. About that time, the southerly winds come charged with the mositure which they have acquired in their passage over the sea through warm latitudes; and this moisture is suddenly condensed into thick fogs as it comes in contact with the land of China, which has been cooled down to a low temperature by the long continued northerly winds. The latent heat given out, by the rapid distillation of this steam into fluid, produces the sudden advance of temperature which takes places about March; and its effect is immediately perceptible in the stimulus given to vegetation of all kinds, by this union of warmth with moisture.

With the progressive increase of heat and evaporation those rains commence which tend so greatly to mitigate the effects of

*Colin Crisswell, *The Taipans.*

the sun's rays in tropical climates. In the month of May the fall of rain has been known to exceed twenty inches, being more than a fourth of all the year, and this keeps down the temperature to the moderate average marked for that month; while, in Calcutta, there is no portion of the year more dreaded than May. At length the increasing altitude of the sun, which becomes just vertical at Canton about the solstice, and the accumulated heat of the earth, bring on the burning months of July, August, and September, which are the most oppressive and exhausting of the whole year. The extreme rarefaction of the atmosphere now begins to operate as one of the causes tending to the production of those terrible hurricanes, or rushes of wind, called typhoons (Tae-foong – 'great wind'), which are justly dreaded by the inhabitants of southern China; but which chiefly devastate the coasts of Haenan [Hainan] and do not extend much to the north of Canton.*

The name typhoon, in itself a corruption of the Chinese term, bears a singular (though we must suppose an accidental) resemblance to the Greek TUΦWV. The Chinese sailors and boatmen have from habit become very clever prognosticators of these hurricanes, and indeed of all kinds of weather, without the aid of the barometer. They have a common saying, that 'lightning in the east denotes fine weather – in the west, successive showers, – in the south, continuous rain – in the north, violent wind.' It is quite certain that typhoons always commence in the north quarter. The principal circumstances to be observed concerning these hurricanes are, the state of the barometer previous to and during the storm, the influence of the moon, and the localities in which they prevail. The barometer falls slowly for many hours, often a whole day before the commencement, the mercury sometimes descending nearly to twenty-seven inches during the progress of the gale; and its rising is a sure sign of subsidence. Another sign of the approaching storm is the long the heavy swell which rolls in

*In the northern hemisphere, the summer solstice occurs about 21 June each year.

upon the sea-beach without any apparent cause, for some time before the hurricane begins; but which may perhaps be explained by so much of the usual pressure of the atmosphere (equal to two inches, or a fifteenth part of the mercuial column) being removed from the surface of the water; and this circumstance may likewise partly account for the overwhelming seas that are so much dreaded by ships encountering the typhoons. The most likely periods for their occurrence are August and September, just at the change of the moon. The gale commences at north, goes about to east and south, and finishes at west. Typhoons seldom prevail below 10° north latitude, or above the parallel in which Canton lies; and their range west and east is from the shores of Cochin-China to 130° longitude. About Haenan, and the strait which divides that large island from the mainland, the typhoons are so dreadful, that temples are built expressly to deprecate them, and on the 5th day of the 5th moon the magistrates offer sacrifices. In addition to the prognostics already, noticed, they are preceded by a thick, muddy appearance of the atmosphere, and a show of unusual disquiet among the sea-fowl. Thunder is considered as a symptom of mitigation. They seldom reach forty-eight hours, and their duration is commonly confined to twenty-four. In the year 1831, on or about the 21st September, a typhoon blew with unusual fury at Macao. It commenced at night; and by three or four o'clock in the afternoon of the following day the whole place was one scene of devastation, probably not unlike the ruin occasioned by the tornadoes in the West Indies. Houses were unroofed, ships stranded, and the solid granite quay in front of the town completely levelled. Great blocks of stone, some tons in weight, were carried a considerable way up acclivities, which might appear impossible, but for the fact, that the heaviest bodies are less ponderous in water than out of it, by the weight of the fluid they displace.

No small portion of the destruction occasioned by typhoons extends to the productions of agriculture and husbandry. The wind which blows from the south and east, being charged with salt water, has a withering effect on all the vegetation near the *coast; trees are broken or rooted up; and rivers, already swelled by the summer rains, are driven in floods over the low lands which rice-cultivation chiefly occupies.*

Hong Kong had a stormy beginning in more ways then one. Disease caused many deaths, and a cemetery soon became necessary. Then the weather hammered the infant settlement:

On 21 July 1841 a violent typhoon flattened all the insubstantial housing and damaged shipping; a second less severe visitation struck the colony four days later. In this typhoon [Captain Charles] Elliot and [Commodore Sir J. J.] Bremer were caught on their way to Hong Kong from Macau in the cutter* Louisa. *Elliot assumed control of the ship and showed great seamanship in beaching it on an island, where it was completely wrecked.***

. . . Then on 12 August a fire consumed the makeshift huts of Chinese artisans and labourers who had been attracted to the island in increasing numbers.

As G. R. Sayer records in *Hong Kong 1862–1919*, the early years were punctuated by constant reports of fire and piracy, while typhoons began to weave themselves into the texture of Hong Kong's life:

The year 1867 was a notably black one for the Colony, for besides the closing of the Mint owing to the steady fall in the value of silver and the ill-fated opening of the gaming-houses, it witnessed a disastrous fire involving five hundred houses and a shattering typhoon which, in addition to a heavy toll of Chinese life, demolished the sea-wall protecting the city's newly-reclaimed waterfront. It will be clear from the above recital that few of Sir Richard's [Macdonnell, the Governor 1866–72] argosies had an easy passage and some met shipwreck.

Typhoons still brewed up in the China Sea and came crashing down on Hong Kong. In late September 1874

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* G. B. Endacott, *A History of Hong Kong*.

** Elliot was doubly lucky. There was a price of $100 000 on his head, but he persuaded a Chinese to take him back to Macau for $3 000.

came a storm which Endacott describes as 'the most destructive typhoon in the history of the colony' [up to that time]. It whipped through the settlement, so badly damaging the Civil Hospital that it had to be abandoned; two hundred houses were destroyed, and three miles of the Praya – the workmanship on which had been faulty – were badly affected.

The renovated Mountain Lodge, originally built by Governor Sir Richard Macdonnell as a summer retreat for himself and senior officials, was one of the casualties.

Sayer describes the 1874 typhoon as:

> *. . . even fiercer and more destructive than that of seven years before [the typhoon of October 1867]. Among other calamities the praya wall, laboriously rebuilt after its destruction in 1867, was once more demolished.*

And that, according to contemporary newspaper reports, was an understatement. The *Hong Kong Times* put it this way:

> *The rain descended in torrents; the wind blew with the violence of a tempest, the rage of a whirlwind. Vessels staunch and strong were driven hither and thither about the Harbour or on to the shore, like children's toy craft; roofs were torn off as by the hand of a mighty giant; trees were uprooted by the hundred; rows of buildings were blown down in a moment, many of the inhabitants being buried beneath the ruins; the Harbour water overflowed on to the Praya, dashing aside and carrying away coping stones of tons of weight. The work of destruction went on without intermission for hours; and it may be said that there is not a single house in the colony but what has suffered.*

From Macau, the newspaper's correspondent reported:

> *Tuesday was a night of terror and horror that can never be forgotten by those who survived it; for many, alas, perished amid the crash and strife of the elements . . . Chinese officials estimate that the typhoon claimed more than 100 000 lives as it swept through Kwangtung province. In Hong Kong the bodies were buried. But in Macau the loss of life was so great that the bodies were simply heaped together and burned. More than 1 000 bodies were burned on a single day.*

Professor S. Wells Williams, another early chronicler of the region, found – like Governor Davis – that the climate was not too extreme. In his book. *The Middle Kingdom* (1883), he displays evidence of having studied the development of typhoons, and provides one of the most poetic descriptions of a typhoon ever written:

Meteorology at Canton and its vicinity has been carefully studied; on the whole, its climate, and especially that of Macau, may be considered more salubrious than in most other places situated between the tropics . . . A fall of snow occurred there [Canton] in February 1835, which remained on the ground for three hours. Having never seen any before, the citizens hardly knew what was its proper name, some calling it falling cotton, and everyone endeavouring to preserve a little for a febrifuge . . .

The climate of Macau and Hong Kong has not so great a range as Canton, from their proximity to the sea. Few cities in Asia are more salutiferous than Macau, though it has been remarked that few of the natives there achieve a great age . . .

The increased temperature on the southern coast during the months of June and July operates, with other causes, to produce violent storms along the seaboard, called tyfoons, a word derived from the Chinese ta-fung, or 'great wind.' These destructive tornadoes occur from Hainan to Chusan, between July and October [and] annually occasion great losses to the native and foreign shipping in Chinese waters, more than half the sailing ships lost on that coast having suffered in them. Happily their fury is oftenest spent at sea, but when they occur inland, the loss of life is fearful. In August 1862, and on 21 September 1874, the deaths reported in two such storms near Canton, Hong Kong and their vicinity, were upward of 30 000 each. In the latter instance the American steamer Alaska, *of 3 500 tons, was lifted from her anchorage and quietly put down in five feet of water near the shore, from whence she was safely floated some months afterward.*

The reputed insalubrity of Hong Kong, in early days, was owing to other cause than climate, and when it became a well-

built and well-drained town, its unwholesomeness disappeared. The rainfall is greater than in Macau, owing to the attraction of the high peaks. During the rainy weather the walls of houses become damp, and if newly plastered, drip with moisture . . . The Chinese consider the provinces of Kwang Tung, Kwang Si and Yunnan to be the most unhealthy of the eighteen [Provinces], and for this reason employ them as places of banishment for criminals from the north-eastern districts . . .

The principal phenomena indicating their [typhoons'] approach are the direction of the wind . . . and the falling barometer . . . The rains fall heaviest toward the close of the gale, when the glass begins to rise. The barometer not unfrequently falls below 28 in. Capt Krusenstern in 1804 records his surprise at seeing the mercury sink out of sight.

The Chinese have erected temples in Hainan to the Tyfoon Mother, a goddess whom they supplicate for protection against these hurricanes. They say that a few days before a tyfoon comes on, a slight noise is heard at intervals, whirling round and then stopping, sometimes impetuous and sometimes slow. This is a 'tyfoon brewing.' Then fiery clouds collect in thick masses; the thunder sounds deep and heavy. Rainbows appear, now forming an unbroken curve and again separating, and the ends of the bow dip into the sea. The sea sends back a bellowing sound, and boils with angry surges; the loose rocks dash against each other, and detached sea-weed covers the water; there is a thick, murky atmosphere; the water-fowl fly about affrighted; the trees and leaves bend to the south – the tyfoon has commenced. When to it is superadded a violent rain and a frightful surf, the force of the tempest is let loose, and away fly the houses up to the hills, and the ships and boats are removed to the dry land; horses and cattle are turned heels over head, trees are torn up by the roots, and the sea boils up twenty or thirty feet, inundating the fields and destroying vegetation. This is called tieh ku, or an iron whirlwind.

In some years the typhoons gave respite but the rains came. The Rev John A. Turner, missionary, in *Kwang Tung, or Five Years in South China* (1894):

We had a striking example in Hong Kong of the destructive power of tropical rain on the 28th and 29th of May 1888, when there burst upon the island the most terrific storm that has occurred in the history of the Colony. Twenty-four inches of rain fell in twenty-four hours, which was equivalent 230 000 tons per hour, within the three and a half square miles covered by the city of Victoria, and equal to twice the average rainfall of the whole month. Such a terrific deluge naturally dislodged enormous quantities of earth and stones, and if we reckon one-tenth the weight of the water, this gives over half a million tons of solid matter carried away and driven down the steep mountain side. What wonder than that fearful havoc was wrought!

The new service-reservoir was quickly choked with earth and large rocks, and the water poured over the retaining wall like a cataract, causing great alarm lest it should burst. But the quantity of solid matter deposited half filled it, thus preventing that calamity. The tramway line above was, however, cut asunder, and much of the material carried into the reservoir, while the aqueduct was severed in many places, and added its deluge of water to the torrent already rushing down into Happy Valley, where the rececourse was turned into a lake.

The main drains of the city burst, and the roads were torn up and coverted into deep ravines; a few houses also fell, and five hundred Chinese were rendered homeless. All the streets became rivers, along which water, bearing earth and stones, rushed with terrific force. Eight men were killed by lightning, and two or three burried in the debris.

At one time great fear was entertained for the safety of the barracks and other important buildings, but fortunately they were very solidly constructed, and withstood the strain. The storm lasted for thirty-three hours, and the rainfall during that time of thirty inches was equal to the rainfall of the whole of the British Isles in a year. Never will those who witnessed the havoc made forget it, or cease to reflect on the awful forces of nature kept in control by Him 'who holds the winds in His fists;' and who, if He would, could in a few hours utterly destroy everything from the face of the earth.

The colony, but a few hours before a perfect paradise of beauty and order, was now to a great extent wrecked. The streets were buried three feet deep in earth and rocks, and large gangs of coolies, supervised by soldiers, were kept working for weeks to remove them. All the damage done was not repaired in less than two years, and the estimated cost was a million dollars (£Stg160 000).

Turner, who was a scholar and a keen observer as well as a dedicated Wesleyan, had many opportunities to witness the fury of the weather during his mission . . .

In June 1891 sickness compelled us to leave the malarial swamps of Fat Shan and move to Hong Kong. Soon after we arrived there a typhoon burst upon us. To guard against such storms the windows of our houses are fitted with jalousies or wooden shutters, something like Venetian blinds, only with much thicker slips, and capable of being made fast with vertical bars. It was night when the storm began to howl around us. The rain came down in torrents and the wind pressure was enormous; the house in which we were staying was the new Union Church Manse, kindly lent us by the devoted and successful pastor, Rev G. H. Bondfield; though new and solidly built of brick with granite foundations it perceptibly rocked.

Ever and anon these typhoons or great winds visit the China Seas, and many are the narrow escapes that steamers have had when caught in the path of the storm. Small craft are quickly swamped or dashed upon the shore. For their warning a red ball is hoisted at Kowloon when a typhoon is known to be approaching; they then make their way as quickly as possible to the shelter of a breakwater, specially provided for them in Causeway Bay. Not always, however, does the warning come in time. Such was the case in December 1892, when hundreds of Chinese craft were wrecked and about a hundred lives lost. The deaths are numerous on such occasions, because every boat being a home, contains a family. Yet, even on this occasion, the survivors showed their usual stolidity, though it was noticeable that one old woman was inconsolable because she had lost — her clock!

Hong Kong lies just within the tropics. There have, however, been times when the weather became positively Arctic.

January 1893 brought Hong Kong's coldest weather on record. The temperature at the Observatory fell to zero, and at the top of The Peak, it was estimated to have gone as low as minus 4°C.

Newspaper reports said that Hong Kong had turned to ice, and that description was no exaggeration. Icicles formed on the rigging of sailing ships in the harbour, walking on icy pavements became hazardous and residents gathered to observe this rare event.

Mr. Charles Ford, superintendent of the Botanical and Afforestation Department, wrote a report for the government, noting that the low temperatures combined with rain caused ice to form 'varying in quantity from a thin coating on the upper leaves of pine trees growing at 300 feet above sea level to an encasement of perfectly transparent solid ice of 5½ inches in circumference on the blades and bents of grass at the summit of Victoria Peak.'

Mr. Ford continued:

These large accumulations of ice were on the windward side of the hill where rain drifted, but even on the lee side the average coating of ice was about three inches in circumference.

All vegetation through the hill regions of the colony was thus covered with ice, as were also most other objects. Telephone and telegraph wires from Victoria Gap upwards were covered in ice ⅝ of an inch in thickness and in addition carried icicles as close as they could be packed side by side. This caused many of the telephone wires to break, and the iron post at Victoria Gap which supported them was snapped off a few inches above the ground.

Ford noted that all the hills on the mainland and Lantau Island were white with ice, and one of the Lantau hills had what appeared to be snow for some hundreds of feet from its summit.

The cold snap had a disastrous effect on vegetation in general, and particularly the exotic plants in the Botanical

Gardens. Ferns and orchids suffered severely, many of them dying.

The *China Mail* of 18 January 1893 reported:

At the path leading from Stewart Terrace past the Peak Church, the house servants had turned out with hatchets to cut the ice so as to form a flight of steps and the boys bringing supplies of provisions from the town had to send their baskets sliding down declivities and clamber after them as best they can. . . . the trees and grass on the Peak scintillate as if they were studden with diamonds while at other times the hillside is gleaming with tiny fairy lights or flashing with rubies and many coloured gems.

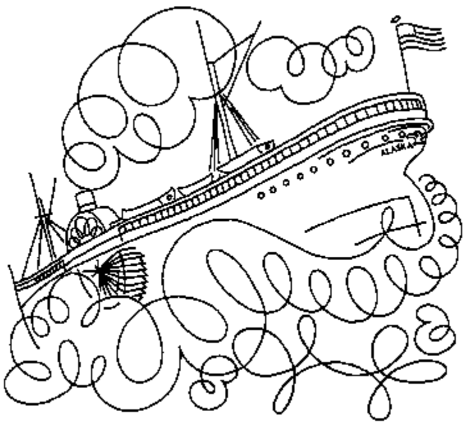
Conditions became so bad, the *Mail* noted, that not even pigeons were able to keep their foothold and had to use both wings and feet to try to walk.

Chapter 3

OF COMETS AND KINGS

Everybody talks about the weather, but nobody does anything about it.

Editorial, *Hartford Courant*, 24 August 1897.



Frederick George Figg's tenure as Director of the Observatory began in 1907, and was to last only five years, but he had an opportunity to try to observe a rare and famous astronomical event – the passage of Halley's Comet in 1910.

The comet is named for the English astronomer Edmond Halley, who observed it in 1682 and found that it corresponded with sightings in 1531 and 1607. Halley predicted that it would return in 1758. It did, and has since been sighted at intervals of about 76 years, being due to make another pass visible from the earth in 1986.

If the regularity of this comet was a revelation in Europe, it was extremely old news in China. There are strong indications that the Chinese had observed the comet as far back as 467BC and there is conclusive evidence of later sightings.

Joseph Needham notes in his *Science and Civilisation in China*, Vol. 3 (Cambridge, 1959) that Chinese records of further appearances of the comet in 87BC and 11BC are quite definite, and records of all subsequent reappearances are found in Chinese texts.

During its swing past the earth in 1910, however, Halley's Comet proved elusive for the watchers in Hong Kong, with Figg reporting:

In view of the possibility of Halley's Comet being visible during its transit of the sun on May 19th, a camera from which the lens had been removed was fitted to the Lee Equatorial [telescope] and adjusted so that a photographic plate was situated in the principal focus of the six-inch object glass. The computed time of ingress and egress, 11 hours 6 minutes and 12 hours 6 minutes, Hong Kong Mean time, kindly communicated by Kiel, was received by telegram early in the morning. The sky was partially cloudy but during breaks four exposures were made between 10h. 9m. and 10h. 25m., and during transit nine exposures between 11h. 21m. and 12h. 5m., after which the sky became entirely overcast. The plates were successfully developed by Mr. [C.W.] Jeffries [First Assistant, and later Director].

The sun's disc had a diameter on the plates of one inch only, but under magnification a fair amount of detail could be detected in a group of sunspots situated near its centre. A critical examination of the negatives, however, revealed no trace of the comet.

With both Figg, and his Chief Assistant, Plummer, due to retire, Mr. T. F. Claxton, formerly Director of the Royal Albert Observatory in Mauritius, was appointed Director Designate. He became Director in 1912, with Jeffries as his Chief Assistant.

It was a significant year for the Observatory. In May the Hong Kong Government asked whether:

In view of the interest shown by His Majesty the King [George V] in Meteorology and Navigation and of the utility of the Observatory in this Colony to His Majesty's ship of the China Squadron . . . His Majesty would be graciously pleased to permit the addition of the prefix 'Royal' to the designation of the Observatory . . .

The royal assent was obtained, and the new title was gazetted in July 1912.

Claxton, following the lead of Doberck, chided the government about the service being provided, noting that:

The present weather forecast service, which has become possible through the courteous cooperation of other Observatories in the Far East, and the Chinese Maritime Customs, who forward weather telegrams twice daily, was not included in the scheme [the original scheme for the observatory in 1882].

(There was at the time a distinction between the meteorological service – storm warning – and the weather forecast service. The present typhoon or storm warning signals were known in 1913 as meteorological signals.)

But if the government was indeed getting more than it paid for, Claxton evidently believed that the public had a right to know the basis for weather forecasting in Hong Kong. The forecasts were, he proclaimed in 1915, based on these principal rules:

1. With a typhoon crossing Luzon in a W or WNW direction the weather will be fine in Hong Kong until the centre *reaches within about 200 miles of Hong Kong, after which it becomes rainy and squally.*

2. Very shallow gradients over Hong Kong are usually accompanied by fine weather.

3. Typhoons whose centres pass from 200 to 600 miles to the eastward produce very sultry though fine weather at Hong Kong.

4. When typhoons pass within 300 miles to northward on a westerly track, heavy rain occurs at Hong Kong.

5. A trough of low pressure running east and west, either to the north or to the south of Hong Kong, indicates rain, and also thunderstorms in the summer and spring.

6. A rapid increase of pressure over China, with a moderate to steep gradient over Hong Kong, produces drizzling rain and a fall of temperature; principally from autumn to spring.

7. After the disturbance produced by No. 6, which may last from 6 hours to two days, the weather may become quite fine, though the weather map drawn from the meagre data available remains apparently unchanged.

8. A rapid decrease of pressure over China is followed by a rise of temperature at Hong Kong with fine or rainy weather according to conditions not usually visible on the map.

9. While forming to the southwest of Hong Kong depressions produce showery weather, with squalls from the SE quadrant.

10. Pronounced kinks in the isobars near Hong Kong indicate rain and squalls; the latter more particularly if the gradient wind is in the SW quadrant.

11. Winds blowing towards Hong Kong from different directions indicate rain.

12. Winds blowing away from Hong Kong in different directions indicate fine weather.

13. V-shaped depressions (rare at Hong Kong) are accompanied by rain.

14. In the winter and spring, when the NE monsoon is blowing, a decided fall of the barometer indicates fog along the coast.

15. Weather systems travel from west to east over China and Japan, into the Pacific.

Such detailed rules failed to impress everybody in Hong Kong and the Royal Observatory was later to be strongly criticised over the typhoon which surprised Hong Kong on 17 August 1923. Writing in the *South China Morning Post*

> a correspondent said that . . . *the public outcry and the overtures made to official circles mark down this typhoon as different. In short, Hong Kong was not prepared to suffer any longer a sort of 'make-learn' Royal Observatory system where weather warnings depended upon a bit of seaweed hung outside the door or a painful corn on the meteorologist's toe. In fact, Hong Kong wanted to know just why warnings were so short, and what liaison existed between Hong Kong Observatory and other observatories up and down the China coast.*

The correspondent noted, however, that Claxton had said at the time that he had done all that was possible and had acted on his own initiative. The article continued:

> *For what was typhoon information at that time, as far as Hong Kong was concerned? A weather station at Waglan Island, which picked up by wireless storm information from ships generous enough to broadcast rough details of the position and intensity of a storm. So on Friday, August 17, 1923, Mr. Claxton received a warning from Waglan Island. A typhoon, travelling quickly, small in area but pretty vicious otherwise, was heading Hong Kong's way.*
>
> *Now of course, as we know from experience, typhoons without number start heading for Hong Kong, and right up to the last moment threaten to blow the daylights out of us, then with a feint they swerve . . . So before knocking off on the Friday in question, Mr. Claxton . . . ordered the No. 2 typhoon signal to be hoisted. And Hong Kong said, 'Oh, the No. 2 up is it? Oh well,' and went its way. Perhaps Mr. Claxton felt a little uneasy and kept his eye on the barometer, but at any rate he was out and about early on the morning of Saturday, August 18. To get any extra information, he had to telephone Waglan, and if anything was happening, Waglan should have telephoned the Observatory. Waglan did telephone, and Mr. Claxton acted quickly. At 8.23 am Saturday, the No. 6 signal*

went up. From then on, no information was, or could be exchanged between the weather station and the observatory. Mr. Claxton acted on his initiative and at exactly 9 am ran up the black cross, or the No. 9 typhoon signal, which was, from an exchange of later information, the precise moment when the wind hit the colony at a force of 130 miles an hour.

In the light of this criticism it is interesting to note Claxton's comment in his report for 1923 about the sudden drop in co-operation from British ships:

. . . while the number of foreign ships sending weather reports by radio telegraphy has increased by 17 per cent, the number of British ships has decreased by 30 per cent (compared with the previous year). This is a serious matter which is engaging the attention of the government.

Indeed, two years earlier, Claxton had commented on the danger of the formation of 'secondary' typhoons in the China Sea, a dangerous occurrence because of its unpredictability. He noted:

The attention of meteorologists is drawn to these three typhoons [during the year]. No indication of the first was shown on the weather map. This Observatory had no knowledge of its existence until nearly eight months later, when the log of the Anamba *was received . . . Both of the others absorbed the primary cyclone and one formed in the southern portion of it while the other formed in the north-east portion. They were evidently analogous to the typhoon which caused so much damage to Hong Kong on 18 September 1906. The formation of these secondaries in the China Sea where there are no observing stations adds to the difficulty of the weather forecaster and emphasises the importance of wireless weather telegrams from ships.*

But these typhoon problems were some years ahead. In 1916 Claxton was preoccupied with other problems, including Hong Kong's periodical droughts. Studies were made in an effort to see whether long-term forecasting could help.

However, after studying records of weather patterns in China, Siberia, India, South Africa and South America in the periods before winter droughts affected Hong Kong, Claxton was forced to report that he could find no correlation which would help to forecast dry periods in Hong Kong.

Other changes were being made to the Observatory's routine work. In January 1916, full 24-hourly observations of the main meteorological elements began. Supplementary storm warnings were introduced the same year, with a cone exhibited at several outlying stations when the day signals were being displayed in the harbour, indicating a depression in the China Sea.

Radio time signals were introduced in September 1918, and visual time signals – flashing lights – the following year.

The growing needs of aviation led to some changes at the Observatory, though not on the scale that Claxton requested. While on home leave in 1920, Claxton had discussed proposals with the Air Ministry, and, on his return, asked the Hong Kong authorities for extra equipment and staff for upper air research.

He received sympathy, but little material help. The leading British meteorologist, Sir Napier Shaw, wrote:

I cannot find that there is any immediate prospect of developing air routes on the line of which Hong Kong will lie. It is quite clear that if air routes were to be developed between Japan and Australia or between India and Japan, Hong Kong would be a centre of information of the most vital importance, but I am not aware that projects of that kind are being actively prosecuted. We have therefore to deal with the general meteorological importance of the position of Hong Kong and of that there can be no question, and what will be useful for aviation when it materialises will be in the meantime useful for the study of cyclones and other atmospheric visitations of Hong Kong.

While therefore I cannot say that aviators will forthwith claim your assistance, meteorologists will look to you as the natural centre of information for the region between Calcutta and the Philippines and between the equator and latitude 50 degrees. It is very desirable that you should be equipped with *means of exploration of the upper atmosphere and provided with facilities for acquiring information from a network of stations in the region specified.*

This much, at least, was done – in 1921 pilot balloons were first used to record wind speeds and directions in the upper air.

By 1924, Claxton was able to report a dramatic improvement in the provision of weather reports from ships. While in 1923, he had complained of the decrease in the number of such reports, in 1924 he noted that after the question had been 'taken up vigorously by the Chamber of Commerce,' 665 British ships had provided reports, compared with only 196 in the previous year.

In 1925 Hong Kong experienced a strike and economic boycott. The troubles did not greatly affect the work of the Observatory, though there were some painful personal consequences for two staff members.

The Director reported:

On leaving the Observatory on June 25th the printer and his assistant [who prepared such documents as the daily weather map] were assaulted by intimidators, so failed to attend on June 27th and 28th. In consequence the weather reports for those days were not issued until June 29th when the printers returned to duty. This was the only interruption caused by the strike so far as the routine work of the Observatory was concerned.

Claxton retired as director in 1932 and was succeeded by Mr. C. W. Jeffries. By this time, the expansion of world air routes was imposing more demands on the Observatory, and the staff was gradually expanded to cope with the work. By 1937, a limited aviation forecasting service was begun, with staff based at Kai Tak.

Developments at the Royal Observatory from 1937, however, began to be overshadowed by international events as Japanese forces moved through China, coming closer to Hong Kong.

By 1937, the Japanese advance was already affecting the colony. That year an estimated 100 000 refugees from China crossed into Hong Kong, followed by some 500 000 the following year, when the Japanese captured Canton.

Along with the first wave of refugees came the most destructive natural disaster in Hong Kong's recorded history – the typhoon of 2 September 1937.

Estimates of the final toll from the typhoon range up to 11 000 dead* – and that in a territory which had been warned well in advance that the typhoon was approaching, the Standby signal, No. 1, having been hoisted 26 hours before the first gales arrived.

Newspapers of the time were naturally preoccupied with the fighting in China and the Civil War in Spain, but the *South China Morning Post* of 3 September 1937 carried four pages of typhoon reports and photographs, including the bizarre picture of a sampan which had been whisked into Des Voeux Road West.

Under the headline, 'Hong Kong's Worst Typhoon', the *Post* reported:

Hong Kong is recovering again from another typhoon. The swift moving cyclone which formed east of Manila a few days ago lashed the colony from midnight Wednesday until after dawn yesterday. Irresistible gusts continuously swept the streets, smashed plate glass windows, tore heavy signboards adrift, ripped and overturned parked motor cars and shifted everything moveable.

The Observatory states it was the fiercest typhoon yet experienced in Hong Kong. At 125 miles per hour the wind instruments at the Observatory ceased attempting serious register. The barometer dropped to the low record of 28.298. Huge waves surged over the Praya, reaching almost to Queen's Road . . . Among the many ships in harbour were some laid up because of the war, or under repair at docks and without steam. A score of these broke loose from their doubled moorings and careered drunkenly about the harbour in macabre dance.

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*By comparison, the battle for Hong Kong, 8–25 December 1941, saw some 2 250 Allied servicemen killed, and an estimated 4 500 or more Japanese deaths, plus unknown – but significant – civilian casualties.

The *Post* reported that a privately-owned wind gauge registered a gust of more than 145 knots, but the anemograph at the Observatory did not read that high:

Mr. C. W. Jeffries, Director of the Royal Observatory, when issuing his official report on the gale yesterday morning, declared that it was the most intense he had ever known. The wind force was of such an intensity that the register of the Observatory's anemograph was incapable of recording the gusts. The register will only accurately record up to 125 mph, but for a long time the needle was bumping the maximum point.

On Saturday, 4 September 1937, the *Post* indicated one of the major causes of death, headed 'Taipo Tidal Wave Toll':

Yesterday's assessment of the toll of death and damage caused by Thursday morning's typhoon revealed that the New Territories was one of the biggest sufferers with at least 200 dead as a result mainly of a tidal wave which carried all before it for a quarter of a mile inland . . . A tidal wave more than six feet high rose in Tolo Bay Harbour shortly after 3 am on Thursday, swept down the entire length of the narrowing inlet, wiped out the fishing fleet of Shataukok and devastated Taipo Old Market . . .

A Taipo resident told the *Post* that the wave was more than 20 feet high, and other estimates were even higher. A former Director of the Royal Observatory, Mr. G. S. P. Heywood, later noted the immense force of such waves in areas which – unlike Hong Kong Harbour – do not have natural geographical protection*:

One such tidal wave caused the deaths of some 60 000 people by drowning in Swatow in 1922. No such disaster has occurred in the land-locked waters of Hong Kong harbour, for the water cannot be driven through the narrows of Lyemoon Pass in sufficient volume to cause a tidal wave. Even in the great typhoon of 2 September 1937, the level of high water [in the harbour] was only some 6 feet above the predicted level. In the same typhoon, however, the NE wind blowing through the long

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*G. S. P. Heywood, *Hong Kong Typhoons*, 1950.

inlet of Tolo Harbour in the New Territories raised a disastrous tidal wave, estimated to be 30 feet in height, which flooded the low-lying ground around Taipo and Shatin, and caused great damage and loss of life.

One positive result of the typhoon was the eventual installation of better instrumentation. The *Post* of 4 September 1937 reminded readers that while the 125 mph limit of the Observatory's anemograph

. . . is more than sufficient for all normal purposes it has long been realised that a better instrument is desirable. Government has now, however, undertaken to supply the Observatory with an instrument capable of registering gusts up to 200 mph. This, it is understood, will be available next year.

(This anemograph was installed in 1939 and was capable of reading gusts up to 190 knots. Heywood notes that the gust of 145 knots on 2 September 1937 was recorded by an instrument on the roof of the Hong Kong Electric Co. power station and can be considered reliable as the anemograph was checked and calibrated by Observatory staff a few days after the typhoon.)

Heywood also reports that the September 1937 typhoon was Hong Kong's worst, with the maximum gust of 145 knots at North Point, 130 knots at the Observatory and the minimum pressure of 958.3 mb at mean sea level being the most extreme on record.

His description of the typhoon is a model of detached scientific reporting:

The storm developed about half way between the Marianas and the Philippines on 28 August, and moving generally in a west-northwesterly direction passed through the Balintang Channel on the 31st, crossing the 'danger belt' between Basco and Manila. Thereafter it approached Hong Kong directly at a speed of about 15 knots. Its track was typical of many typhoons which have affected Hong Kong, approaching from ESE and passing to the south of the Colony; in severity it has probably been equalled by a number of other typhoons which have occurred in the Far East . . . As usual the weather was fine and *sultry at the time when the typhoon was entering the China Sea; the fine spell lasted until daybreak on the 1st, when the sky clouded over. There were no very obvious premonitory signs that day – no bands of cirrus radiating from the east, no halos, no lurid sunset; it was just a cloudy humid day. The wind began to rise in the late evening, and rain set in at 23h.; at the same time the barometer, which had been falling steadily, began to drop steeply. The rising wind held steadily in the NNW, and it was obvious that Hong Kong was in for a severe blow.*

The wind reached gale force at about 2h. and hurricane force 1½ hours later. The barometer reached its minimum of 956.4 mb at 03.40h.; at this time there was a perceptible lessening of the violence of the wind, and rainfall almost ceased, indicating that the eye of the storm was extremely close. The centre in fact passed some 5 miles to the south of Hong Kong Island. The wind veered quickly from N to ESE as the centre was passing and soon began to lessen, although the rainfall was heaviest during the following hour. Daybreak showed a desolate scene; ships were aground all around the harbour, streets were littered with branches and debris, and the trees were combed bare of leaves. In all 28 steamships were stranded . . . providentially none broke up, and the loss of life due to these strandings was extremely small. But a large number of junks and small craft sank with heavy loss of life. The worst disaster occurred in Tolo Harbour and Tide Cove, where a tidal wave estimated to be 30 feet in height swept across the low-lying ground at Taipo and Shatin, destroying several villages and four miles of railway embankment, and taking many lives. Ample warning of the approach of this typhoon was given by means of the local storm warnings issued by the Observatory.

Wearily, Hong Kong cleaned up, buried its dead, and began rebuilding. There were to be four further typhoons – November 1939, August 1940, June 1941 and September 1941 – before the Japanese came to Hong Kong. Mercifully for a Hong Kong increasingly conscious that an attack was inevitable, they were not so severe as the tragedy of September 1937.

The war in Europe had spurred the development of new technology – such as better ways to study the upper atmosphere – which would have assisted the work of the Observatory. The same war, however, meant that the technology was needed for other purposes.

In England in 1939, the Director, Mr. Jeffries, studied the use of new radiosondes, and was forced to report that the instruments were:

> *... practical and reasonable in price, but a shortage of supplies for manufacture, etc., will prevent their extensive use, until the termination of hostilities.*

Additional staff had been approved for the expanding aviation meteorological service, based in the new Kai Tak terminal building, but they had to be withdrawn as the international situation worsened.

At the Observatory itself, the staff could do little except continue their work.

By early 1941 it had become clear that the Japanese advance through China was not going to stop at Canton. By late June, that fear had been confirmed when Japanese troops occupied Shum Chun.

At 4.45 am on Monday, 8 December 1941, Major Charles Boxer, monitoring Radio Tokyo on behalf of the Hong Kong defence forces, heard normal programming interrupted by the message: *Higashi no kaze ame* – East wind, rain.

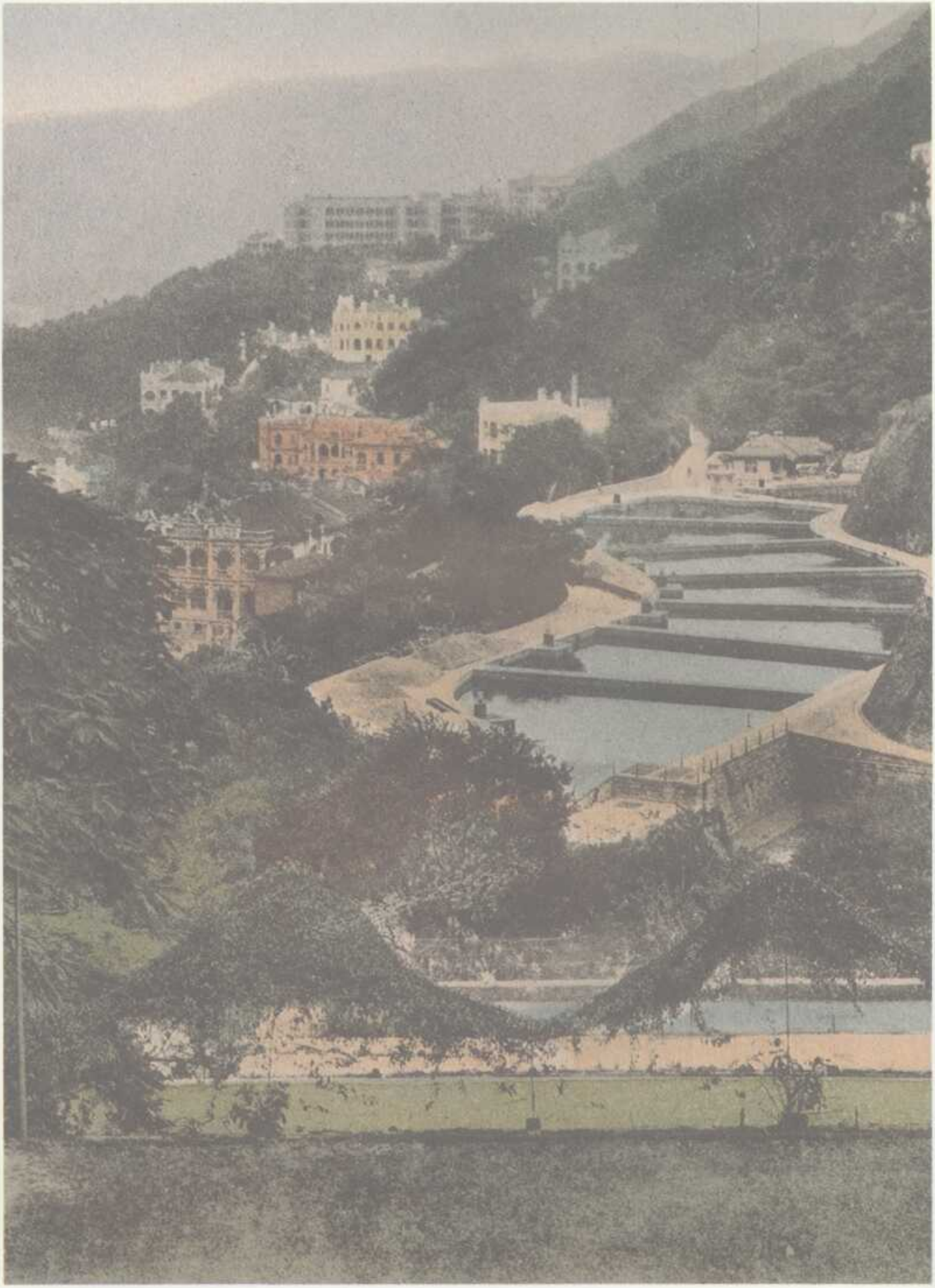
It was not meteorological information. The Pacific war had begun.

The time ball near the Marine Police Station, Tsim Sha Tsui, first used in January 1885. The time ball was moved to Blackhead's Point in January 1908.

Inset: *The backs of these cigarette packets were used to record weather observations when senior staff were interned at Stanley.*

Following Hong Kong's surrender on Christmas Day, 1941, victorious Colonel Tanaka of the Japanese 229 Regiment looks over Lyemun Gap, across which his troops attacked.

Elegant mansions look down on the old reservoirs along Bowen Road.

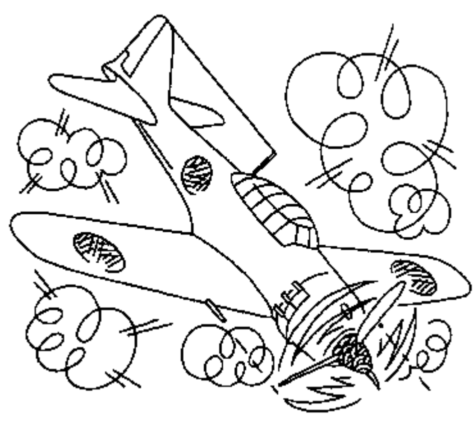


Chapter 4

UNHAPPY CHRISTMAS

I heard 'crumping' sounds from Kai Tak and looked out the window You could see the planes diving in with their bombs

Joyce Bassett, secretary to the Governor, Sir Mark Young, in *Captive Christmas The Battle of Hong Kong – December 1941.*



At 8 am on 8 December 1941, 12 Japanese bombers, supported by 36 fighters, attacked Kai Tak airport. At the same time (though it was 7 December because of the International Date Line) the Japanese attacked Pearl Harbour.

The bombing of Kai Tak, which must have been audible from the Observatory, destroyed Hong Kong's handful of Royal Air Force aircraft on the ground, along with eight civilian planes.

The ground forces resisted valiantly, but were eventually driven back to Hong Kong Island, and on Christmas Day the colony fell.

The occupying Japanese forces used the Observatory – rather casually – as a meteorological station from then until they surrendered in August 1945. The Observatory compound was the site of two anti-aircraft guns.

The Observatory buildings suffered only superficial damage, but the Japanese removed most of the equipment, including the transit circle and the chronograph.

During the battle of Hong Kong in December 1941, the Japanese shelled the Island with guns based on the lawn in front of the Water Police Station, Tsim Sha Tsui. The time ball tower was temporarily used as an ammunition store.

The Director of the Observatory, Mr. Jeffries, had died suddenly in June 1941. His successor, Mr. B. D. Evans, was interned, along with other senior officers.

No records survive of any observations made at the Observatory during the Japanese occupation.

What records do exist are interesting not only for the weather information they contain, but as historic documents. They were compiled in the internment camp at Stanley, and fall into four broad sections:

Rainfall records for 1942 and 1943, kept by Evans. These are scribbled in pencil on the backs of carefully flattened cigarette packets. Mr. Thompson recorded rainfall for 1944, also on cigarette packets, along with a table of annual rainfall – minimum, maximum, average and total – for the 50 years 1884–1933.

A summary of the weather in 1942, 1943 and 1944 is written in pencil on a small sheet of thin cardboard. It is headed 'Stanley, Hong Kong. Weather Notes', and continues:

1942. The first half of the year was unusually fine and dry. The estimated rainfall of seven inches was over forty three inches below normal. July was a very wet month; rain fell on every day, and the total for the month, 37.6 inches, was 22.6 inches over normal. No winds of typhoon force were experienced during the year.

1943. The weather was fine and dry up to the middle of May except for a damp spell covering the last week in March and the first week in April. There was a wet period from the middle of May to the end of June with rainfall somewhat above normal. The rainfall during July and August was below normal. September was normal and the last three months of the year again fine and dry. The annual rainfall was 69 inches, 16 inches less than normal.

1944. A fine dry spell persisted until the last week in April; from then until the last week in August was very wet, the rainfall at the end of this period being no less than 24 inches above normal. The remainder of the year was fine and dry. The third week of December was unusually cold. The rainfall for the year amounted to 102.975 inches, 17.72 inches in excess of average.

Another sheet of paper gives daily weather details for April 1945. This is believed to have been compiled by Evans, as it is pencilled on the back of a typewritten letter to Evans in which one internee complains, in some detail, about the behaviour of another.

The most important record fills some 40 sheets of paper (apparently provided by the Japanese, as each sheet has the printed heading, in Chinese characters, saying that it is from the internment camp in Hong Kong). The sheets are neatly ruled with columns for temperatures at 7 am, 4 pm and 10 pm, rainfall and remarks. This details the weather from 1 January 1943 to 31 March 1944.

The records are all in pencil, neatly displayed, with various interesting remarks in small hand-printed capital letters.

Samples:

Monday 24 May 1943: Angry dawn. Heavy clouds and very humid. No rain.

Saturday 31 July 1943: PM leaden. Damp. Ominous.

Monday 23 August 1943: Lovely dawn. Orion Sirius etc. in E sky very soft and luminous. Sunny with large white clouds around. Fresh SW breeze. Fairly warm. Dry.

Thursday 23 September 1943: Heavy showers AM. [Rain] gauge uprooted and destroyed by G.C. Great pity. Heavy rain squalls from SE all day.

Sunday 3 October 1943: Fresh N or NNE all night and this AM cold. Blanket and cardigan. Very dry.

Tuesday 25 January 1944: [Lunar new year] Lovely morning. Nippy but no wind. 'Kung ee fat choi.' Warmest day for some time.

The final entry, for Friday 31 March 1944, may well have reflected internees' feelings: Dark misty morning. Dull and depressing weather.

There are also several charts and graphs of weather data, including:

A graph of rainfall from 1 July 1942 to 1 July 1943;

A bar graph in four colours of average half-monthly temperatures in 1943;

A rainfall graph for 1943;

A monthly rainfall graph for 1943 and 1944;

A graph of outdoor shade temperatures for 1943 and

A detailed chart of temperatures for 1943 in No. 3 Hut, both inside and outdoors.

The Japanese surrendered in August 1945. Staff returned to the Observatory and work was resumed. On 14 September 1945, four Chinese staff wrote to Evans from Macau:

> *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 Chi Ming

Evans did not return to Hong Kong after recuperation leave and Mr. G. S. P. Heywood was appointed Director of the Observatory from the resumption of civilian government. The loss of Observatory equipment was a setback but it could be replaced. Observatory officers worried more about the irreplaceable records.

The reality was much better than they had feared. In his report for 1946–47, Heywood was obviously pleased to note that:

Almost the entire library of some 3 500 bound volumes was left intact, though some unbound papers were lost. Stocks of all the printed records and other publications survived.

There was, however, one tragic loss, an item of great historical value:

The treasured manuscript record book, in which the meteorological results had been entered month by month since the foundation of the Observatory in 1884, has gone.

Following the Japanese surrender, Hong Kong had a military administration, during which the Observatory was operated by a joint Royal Navy and Royal Air Force staff. When the civil administration took over on 1 May 1946, two European officers were available, along with 10 former Chinese staff.

The hand-over of duties from services personnel to civilian staff was completed by mid-July 1946 – just in time, as Heywood noted:

The civil staff was soon put to the test, for the worst typhoon for some years occurred a few days after the departure of the naval party. [The typhoon, on 18 July, had maximum gusts of 95 knots.]

With hundreds of projects jostling for priority, the resumption of work at the Observatory was naturally subject to severe handicaps. Heywood recorded that:

The work of reconstruction often seemed dishearteningly slow, owing to administrative difficulties, shortage of staff and lack of equipment. Gradual progress was made, however, during the year [1946], although much remains to be done before the Observatory can be considered as a first-class weather centre and scientific institution.

. . . The demand for the restoration of weather services after the war had to receive first consideration, and at the moment the Observatory is a weather centre and nothing more. The typhoon warning services will always be of primary importance, followed by forecasting and climatology, but in due course we hope to widen the scope of our work . . .

Unfortunately for Heywood, whose reports contain many almost apologetic references to the lack of research, that wider scope of work was not to be achieved for some time. In fact, in 1947–48, when the Observatory took over all meteorological services from the military, the acting Director, Mr. L. Starbuck, reported:

The expansion of staff during the year only just managed to cope with the ever-increasing demands of civil aviation for an up-to-date meteorological service, and so far there has been neither staff nor time to devote to the other scientific activities of the Royal Observatory, including research.

The resumption of full civilian control of the Observatory, however, did mark some progress for the post-war reconstruction programme. Heywood, reporting on work done in 1948–49, noted this fact, but again expressed concern at the lack of progress in other directions. At least, he wrote, 1949 was:

. . . the first complete year since the war in which the Royal Observatory provided all the meteorological services required in

the Colony without assistance from the Royal Navy or Royal Air Force . . . During the post-war reconstruction period, the department has endeavoured to meet first the urgent demands for storm warning and weather services, while other scientific work has had to be deferred. The Observatory is still primarily a weather centre, and only secondarily a scientific institution. Beyond the immediate needs for weather services, it is particularly important that research should be undertaken. An observatory which does not contribute to the general fund of scientific knowledge is hardly worthy of the name.

But progress, while admittedly slow, was being made. In December 1952, the weather station at Waglan Island was opened, followed a month later by a similar installation on Cheung Chau island. Both centres were primarily for aviation forecasting, and were manned by trained observers who had direct radiotelephone contact with the meteorological office at Kai Tak.

At last it was time for some subdued self-congratulation, with the acting Director, Starbuck, being able to say of 1951–52:

Research was on a wider scale than before; in fact it is felt that Hong Kong now yields pride of place to only India and the Caribbean area as a centre of tropical meteorological investigation.

But later in the same report, Starbuck returned, wistfully, to a discussion of the conflict between the attractions of scientific investigations and the duty of the Observatory's day-to-day work:

To attend merely to the directly revenue-making aspects of the department's work to the exclusion of scientific advancement comes dangerously near to living on the capital of past endeavours. Nevertheless it is frequently difficult to justify allegedly academical activities in the face of the immediately practical demands of, say, airline operation.

Heywood continued this theme in his comments on work in 1952–53, in a note promoting a wider community role for the Observatory:

The department is in fact primarily a weather centre, as is inevitable in a great commercial port such as Hong Kong. All the effort expended in providing weather services to shipping and aircraft is fully justified, for the safety of lives and property is involved. But one is inclined to wonder whether other sections of the community are making full use of the improved meteorological facilities now available, largely as a result of the demands of aviation. Agriculture, for instance, depends no less than aviation on the weather, and its importance cannot be denied: after all, one must eat, though one need not fly.

There was another setback for the Observatory the next year – the Assistant Director, Starbuck, died in September.

The 70th anniversary of the Royal Observatory fell on 1 January 1954. Heywood took the opportunity to examine the achievements and changes in that time:

To outward appearance the Observatory has not changed greatly since it was first built; minor additions have been made from time to time but the main building is very little altered – which speaks well for the soundness of the original design and construction. But the department as a whole has expanded immensely since 1884. The first director, Dr. Doberck, was assisted by one professional officer, two clerks and perhaps a coolie or so; now the staff numbers about 80.

. . . In early years the work of the Observatory was limited to the provision of a storm warning service and a time service, and the recording of meteorological, astronomical and magnetic observations; no regular weather forecasts were issued. The storm warning service is still one of its most important functions, but astronomy and magnetism have been discontinued; pure science is represented only by the seismological section and the Observatory is occupied more and more with the very practical task of providing forecasts and weather information to a great variety of users.

In the years after the war, the Observatory's responsibilities increased rapidly, and there was little opportunity – despite the obvious enthusiasm – to consider ways to improve the quality of the work performed. The mid-1950s also brought problems with communications, with a consequent effect on the amount of data available, especially for forecasting.

The post-war aviation boom was another continuing drain on the Observatory. In 1955, Mr. C. S. Ramage, Acting Director, outlined the problem:

Since the war the insistent but vital demands of aviation have largely dictated the Observatory's operations. The needs of aviation have been satisfied but only by reducing or postponing other legitimate activities . . . Our forecast service [for aviation], separated from the Observatory itself, is designed and located to meet aviation needs; inevitably forecasts for the general public (including local typhoon warnings) and for shipping have suffered.

Not only did the continuing growth of aviation put such large-scale pressure on the Observatory, there were other, local, problems. Ramage describes them:

Even under the best conditions, forecasting is trying and exacting work. At Kai Tak, where the forecaster is continually interrupted, conditions are not suitable for accurate forecasting . . . In the coming year it is hoped to locate senior forecasters where careful uninterrupted thinking and helpful consultations are possible. This move should raise standards generally and in particular greatly improve services for the general public.

Heywood, Director since 1946, retired in October 1955, and was succeeded by Dr. I. E. M. Watts, who was able to report that more research papers had been published in 1955–56 than in any previous year because more Observatory officers were interested in – and engaged in – research.

The year 1955 was notable for another reason: it was the sunniest year in Hong Kong up to that time with 2 279 hours of sunshine – 267 hours more than average.

The sunshine, while enjoyable in itself, had a more sinister effect –drought. Watts reported:

Until the end of March [1955] the Colony suffered the most prolonged and severe drought since records were started . . . Between 5 and 12 January an intense cold spell brought the *temperature down to 3.1°C at the Observatory, the lowest for 55 years, and to minus 3.1°C at Sek Kong in the New Territories, the lowest temperature ever recorded in the Colony.*

There was indeed a drought, but it broke in April, and the total rainfall in 1955 was 2 350 mm, 126 mm above average.

For a description of rainmaking experiments in Hong Kong, see p. 107.

The following year saw completion of a major reorganisation of the Observatory, including the establishment of a Central Forecasting Office to provide meteorological information for the public, the armed services and shipping, and an aviation forecasting office at Kai Tak (obtaining weather analyses from the central office) to concentrate entirely on aviation needs.

May is normally a wet month in Hong Kong – the wettest month on record was May 1889, with 1 240.5 mm of rain. May 1957 brought nearly 900 mm – more than three times normal, and clearly illustrated the irregularities of rainfall distribution. On 21 May 1957, Beacon Hill, only some 6.5 km northwest of the Observatory, had 716.5 mm – five times that at the Observatory on the same day.

(May 1963 was to be a bizarre month for rainfall, with a total of only 6 mm, or 2 per cent of normal.)

In 1958–59, the Observatory's emphasis was on the recording and tabulation of data for the International Geophysical Year. Aviation needs again emerged as a problem area. Extra staff needed for a 24-hour service at the airport were recruited and trained, while the increasing number of high altitude flights by commercial jets meant that additional upper-air information was required.

More weather records were set in 1959, which was one of the hottest and wettest years on record. The mean annual temperature of 23.1°C had been equalled on only three previous occasions, and annual rainfall was more than a third above average.

It was also the year of one of the Observatory's most unusual tasks, as Watts recorded:

An investigation of the meteorological factors relevant to the location of nuclear reactors within the Colony was undertaken at the request of the Director, Public Works. The investigation was to be composed of two main parts, a preliminary climatological survey and an experimental survey of the most promising site. Following the decision to discontinue the nuclear distillation/generating project, the experimental survey was not made. The report on the climatological aspect is in preparation.

The records of 1959 did not last long – 1960 was another hot year for Hong Kong. The mean annual temperature edged up to 23.1°C and the annual mean maximum touched 26.1°C – both readings being the highest up to that time.

After a year of relatively normal weather in 1961, Hong Kong sweltered again in 1962. July and August broke records for highest mean temperatures, and July had record sunshine, averaging more than nine hours a day.

The mean daily maximum in July was 32.4°C and in August it reached a sapping 32.7°C. The mean daily temperature of 29.2°C and the mean daily minimum of 26.8°C in August were the highest recorded at the Observatory. The absolute maximum of 35.5°C on 31 August was the highest since 1900.

There was some relief, however, as the mean relative humidity of 78 per cent was a record low.

The heat was not confined to Hong Kong. Down near the Philippines, it warmed the sea and stirred the air, creating a tropical depression by 27 August. This depression moved towards the Luzon Strait and by the following day had become a severe tropical storm.

On 29 August a United States Air Force reconnaisance aircraft penetrated the eye and reported hurricane force winds. Typhoon Wanda with a circulation area more than 1 500 kilometres across, headed straight for Hong Kong.

By early morning on 1 September, Wanda was centred about 160 kilometres from Hong Kong. The No. 9 signal was hoisted, indicating that gales were expected to increase. Two hours later, with Wanda only 80 kilometres away and moving directly towards Hong Kong, the No. 10 signal was raised.

As had occurred on 2 September 1937, the typhoon arrived with high tide, and a warning was issued of flooding in low-lying areas, particularly Tolo Harbour.

At 9 am, hurricane-force winds were blowing over most of Hong Kong, including a gust of 154 knots at Tate's Cairn. As the typhoon centre passed south of Waglan Island, a gust of 140 knots was recorded at the Royal Observatory – the highest gust reading noted there.

Tides in Tolo Harbour rose some three metres above normal high tide, and wind driven waves were estimated to have contributed an additional two metres on the downwind shore near Sha Tin.

The main difference between Wanda and the killer typhoon of 1937 was that then the flooding had been unexpected and occurred in darkness. Wanda's high water came in daylight, and residents had been warned several hours earlier.

Therefore, although Wanda was one of Hong Kong's most severe typhoons, the death toll of 130 was far lower than the estimated 11 000 in 1937. More than 260 mm of rain fell over three days, the lowest pressure of 953.2 mb was a record low and the maximum gust was the highest at the Observatory since gust recording began in 1911.

Apart from death and damage throughout Hong Kong, Wanda had a direct effect on the Observatory – it wrecked the weather radar at Tate's Cairn.

As if to compensate for the violence of Wanda, rainfall diminished in its wake so markedly that one of Hong Kong's worst droughts began in October 1962. As Director Watts was to report later, 1963 was, on average, the hottest, sunniest and least humid year since records began. The drought and the accompanying water crisis were front-page news throughout most of the year.

As previously noted, May is normally a wet month, but rainfall in May 1963 was 6 mm, about one fiftieth of average. June brought nearly 205 mm – half average rainfall – which appeared plentiful in comparison with the previous seven-month total of only 74 mm.

Typhoon Wanda and the 1963 drought were only the forerunners of more uncharacteristic weather, and 1964 was to become known as the year of the gales.

In the 80 years between 1884 and 1963, some 100 typhoons had caused gales in Hong Kong, an average of little more than one a year. There had been typhoon gales four times in each of the years 1893, 1894 and 1923, but 1964 was the first year with five typhoons causing gales in Hong Kong. Another five storms passed close enough to cause strong winds and disrupt shipping, and the Observatory tracked a total of 41 storms in the year.

Local storm signals were displayed for a record 14 days in September to warn of Typhoons Ruby, Sally, Tilda and Billie. Ruby was probably the second most severe typhoon since the war, with winds exceeding hurricane force for nearly 3½ hours at Cape Collinson.

As an estimated 10 000 tons of Ruby's debris were being cleared from the streets, Typhoon Sally approached. Sally passed some 50 kilometres northeast of Hong Kong on 10 September and caused serious damage in Guangdong.

There were three fine days before Typhoon Tilda bore down. It caused no damage in Hong Kong, but local storm signals were up for a record 161 hours.

Then came Typhoon Anita (27 September), Typhoon Billie (30 September) and Typhoon Clara (7 October). Typhoon Dot on 13 October brought 17 hours of gales and killed nearly 30 people.

In 1965, Hong Kong was spared. The Observatory's Director, Mr. Gordon Bell, described the weather as comparatively normal, with abundant rainfall and no destructive storms. Bell also noted that two new tools at the Observatory – a 10 cm weather radar and data from meteorological satellites – were providing valuable information.

If the weather in 1965 was comparatively normal, the following year's was totally abnormal. It began innocently enough until April 1966, which saw twice the average rainfall. May was dry, but 12 June brought some of Hong Kong's heaviest rain: between 6.30 am and 7.30 am, Aberdeen had 157 mm, and in the 24 hours to noon on 12 June, the Observatory recorded 401 mm. Floods and landslides killed more than 60 people.

The help warn against the possibility of such disasters, the thunderstorm and heavy rain service was started in 1967, following the installation of a new weather radar at Tate's Cairn.

However, the intensity of weather can sometimes transcend even the most efficient warning system, as was tragically demonstrated in June 1972.

The weather deteriorated rapidly in the middle of the month, and became particularly bad on 15 June, the day of the Dragon Boat Festival.

In the next three days, heavy rain and frequent thunderstorms, reminiscent of the heavy rainstorms in 1966, lashed Hong Kong. The maximum hourly rainfall of nearly 99 mm on 18 June was close to the record of 108 mm set in 1966.

For the first time in the recorded history of the Royal Observatory, more than 200 mm of rain fell on each of three consecutive days. Thunderstorm and heavy rain warnings were issued and renewed almost continuously from 15–18 June.

The territory's notoriously unstable hillsides could not cope with the deluge, and on Sunday 18 June 1972, two of them gave way.

About 1.10 pm, part of the embankment opposite the Sau Mau Ping public housing estate in Kowloon suddenly collapsed and 'slid down like a carpet' on to the huts below, engulfing the area in earth, mud and rock. Most of the huts were buried or crushed.

The final death toll was 71.

Earlier the same day, small landslips had occurred at Po Shan Road on Hong Kong Island. Some residents of flats in the area had been evacuated, while others left voluntarily.

There was another slip about 5.10 pm when a huge mass of earth, rocks and vegetation broke loose and slid down across Conduit Road.

Witnesses said later that the major landslip, just after 8.50 pm, probably took less than 10 seconds.

The slip began on the south side of Po Shan Road, and crossed the road, It gathered momentum, swept past Skyline Mansion, crossed Conduit Road and swallowed a house in Kotewall Road.

It then roared across Kotewall Road and struck the block of flats named Kotewall Court. The report of the official inquiry noted:

Kotewall Court – then the only well-lit building in the area – appeared to shudder and come away from its foundation on being struck by the slip, and it moved forward in the direction of the harbour. It then toppled and broke up transversely near the middle, like a man kneeling, then falling forward. It struck and damaged a portion of the upper storeys of a new block of unoccupied flats in the vicinity [Greenview Gardens, in Robinson Road] and then crumbled and disintegrated into rubble. Part of the demolished building fell [into a construction site] at Babington Path. The lights went out as the building collapsed in a cloud of dust. The whole incident took seconds only.

Another witness told the inquiry that when Kotewall Court began to crumble, all the lights went out:

I saw furniture falling from the building and particularly noticed a bed which people were in and they were thrown out.

The landslip measured some 900 feet by 200 feet and it was estimated that the weight of earth and rock in the slip was some 50 000 tons.

The final death toll was 67.

Less than a year previously, Typhoon Rose had caused the Hurricane signal, No. 10, to be raised for the first time since Typhoon Shirley in 1968. It had, as Director Bell remarked, destroyed the complacency of many regarding the seriousness of tropical cyclones.

In 1973, the unusual weather continued, with total annual rainfall of 3 100 mm – more than 39 per cent above average, making it the wettest year since 1884. At the same time it was the first year since 1917 that tropical cyclones were completely absent from the western North Pacific in the first half of the year.

The second half of 1973, however, was not so calm. During Typhoon Dot in July the new Gale signals – Nos. 8NW, 8SW, 8NE and 8SE – were used for the first time to indicate the approach of gales from the appropriate quadrant.

Typhoon Dot was also the first time that a special reconnaissance flight by a Hong Kong-based aircraft located the centre of a tropical cyclone.

The Director of the Observatory, Mr. Bell, literally took an inside view of the storm. In a twin-engined Islander of the Royal Hong Kong Auxiliary Air Force, he flew into the eye of Dot – then of tropical storm intensity – on 15 July, when Dot was about 230 miles south of Hong Kong.

The aircraft flew into the centre of Dot at 5 000 ft., and made radio contract with a U.S. Air Force Hercules making observations at 10 000 ft.

Further heavy rain in 1975 and 1976 continued the reversal of drought conditions which had afflicted Hong Kong during the early 1960s.

Active troughs of low pressure in April, May and June 1975, followed by three tropical cyclones in October, brought the year's rainfall to nearly 3 030 mm, 36 per cent above average.

The fifth consecutive year with above average rain came in 1976, with Typhoon Ellen in August causing flooding and landslips.

Finally, Hong Kong dried out a little, with rainfall in 1977 of 1 680 mm being only three quarters of normal. In the five months to 31 March, only 29.2 mm of rain fell, the lowest recorded for the period.

Typhoon Dinah stayed over the northern part of the South China Sea for a week in September, and the Standby signal, No. 1, was hoisted for a record of more than 124 hours.

In the wake of the dry weather, water restrictions were imposed on 1 June 1977. Full supply was resumed on 18 April 1978.

It was also a year of tropical cyclones, with eight approaching Hong Kong.

Few tropical cyclones have approached Hong Kong twice, and Severe Tropical Storm Agnes (24–30 July 1978) was the only one for which gale signals were hoisted on two separate occasions. Fortunately for Hong Kong, Agnes was not particularly powerful, with maximum sustained winds in the harbour of only 41 knots.

Agnes was, however, a wet storm, bringing Hong Kong 519 mm of rain. Agnes was slow moving, and the rain, while not particularly intense, persisted for a long period.

Because of its unique behaviour, Agnes is worth describing in some detail.

On 22 July an area of low pressure formed over the northern part of the South China Sea. By the early afternoon of 24 July, satellite photographs showed that the low pressure area had become a tropical depression.

At 2 pm it was centred just over 300 miles south of Hong Kong, moving towards the China Coast at 9 knots.

At 7.30 am on 25 July, the storm was 180 miles south-southeast and the Standby signal, No. 1, was hoisted.

Later on 25 July, the depression intensified into a tropical storm, and satellite photographs showed that the spiral rain bands had become more organised, though the eye was diffuse.

As it moved towards Hong Kong, the No. 1 signal was replaced with the No. 3 Strong Wind Signal at 10.50 pm on 25 July.

Radar observations early on 26 July showed that the circulation of Agnes had become well organised, though the eye was still ill-defined. At 7 am on 26 July, when it was centred about 65 miles southeast of Hong Kong, Agnes was upgraded to a severe tropical storm.

The track of Agnes then began to indicate that stronger winds could be expected in Hong Kong, and at 9.15 am on 26 July, the No. 8 Northeast Gale or Storm signal was hoisted.

As expected, winds in Hong Kong gradually turned easterly and the No. 8 Southeast Gale or Storm signal was hoisted at 3.43 pm when Agnes was centered about 50 miles south of the Royal Observatory.

Later, Agnes remained almost stationary for five hours, then began to drift slowly westwards away from Hong Kong. The Southeast Gale signal was replaced by the Strong Wind signal at 1.30 pm on 27 July.

During the night of 27 July, Agnes slowed down – probably because of the extensive circulation of Typhoon Wendy, then centered near the Ryukyu Islands – and eventually reversed course, once again coming closer to Hong Kong.

The Strong Wind signal remained hoisted, and warnings were issued that the Gale or Storm signal might have to be raised again.

As winds gradually increased, the No. 8 Northeast Gale or Storm signal was indeed hoisted at 5.25 pm on 29 July when Agnes was 65 miles south of the Royal Observatory.

Agnes came closest to Hong Kong about 3 am on 30 July, when it was some 35 miles east of the Royal Observatory. Gales in Hong Kong backed steadily from northeast to west overnight and the No. 8 Northeast signal was replaced in turn by the No. 8 Northwest Gale or Storm signal at 2.30 am and the No. 8 Southwest at 4.40 am on 30 July.

Radar observations during the night showed that Agnes was becoming less intense and its centre was difficult to locate.

Agnes crossed the South China coast about 5 am and the No. 8 was replaced by the Strong Wind signal at 7.10 am on 30 July when Agnes was about 40 miles east-northeast. Over land, Agnes weakened rapidly and all signals in Hong Kong were lowered at 3.10 pm on 30 July when Agnes had degenerated into an area of low pressure.

During Agnes' two approaches to Hong Kong, a total of 48 hours of gales was recorded at Tate's Cairn, 30 hours of which were continuous. Waglan Island recorded 39 hours, 27 of which were continuous. (In this context, mean hourly winds of 34 knots or more are recorded as gales.)

Agnes severely affected traffic – e.g., 34 incoming flights were diverted from Hong Kong and 39 scheduled arrivals and 42 departures were cancelled. Another 61 flights in and out were delayed, and public transport stopped.

From December 1978 to November 1979, the Royal Observatory took part in the Global Weather Experiment organised by the World Meteorological Organisation.

Some of the observations were dramatic. The Hurricane signal – No. 10 – was hoisted on 2 August 1979 for Typhoon Hope, the most severe typhoon to affect Hong Kong since Rose in 1971.

Then came another swing in local weather patterns, with the winter of 1979–80 being exceptionally dry – a total of 15.7 mm of rain was Hong Kong's driest four-month period. This continued into a hot June, with eight consecutive days of maximum temperatures above 33°C.

January 1980 saw a consolidation of the Royal Obsersvatory's space age technology with the opening of the new satellite ground station. The use of satellites has revolutionised tropical meteorology. Pictures from the Japanese geostationary meteorological satellite (GMS) can be enlarged and enhanced by a computer to a point where even a bush fire in Australia can be identified.

The satellite pictures make it possible to locate the centre, and estimate the maximum winds, of a tropical cyclone almost as accurately as from a reconnaissance aircraft, and without the risks inherent in such a flight.

The Observatory's time service was also modernised in 1980, with the caesium beam atomic clock replacing the old crystal instrument. The accuracy of the atomic clock has an important industrial application in that it provides calibration standards for Hong Kong's expanding watch and clock industry.

The year 1980 saw the start of work on the biggest project in the Observatory's near-century of service – a new nine-storey building to house the expanding staff and new equipment. While the directorate remains in the old building, much of the Observatory's work was transferred to the new building in mid-1982.

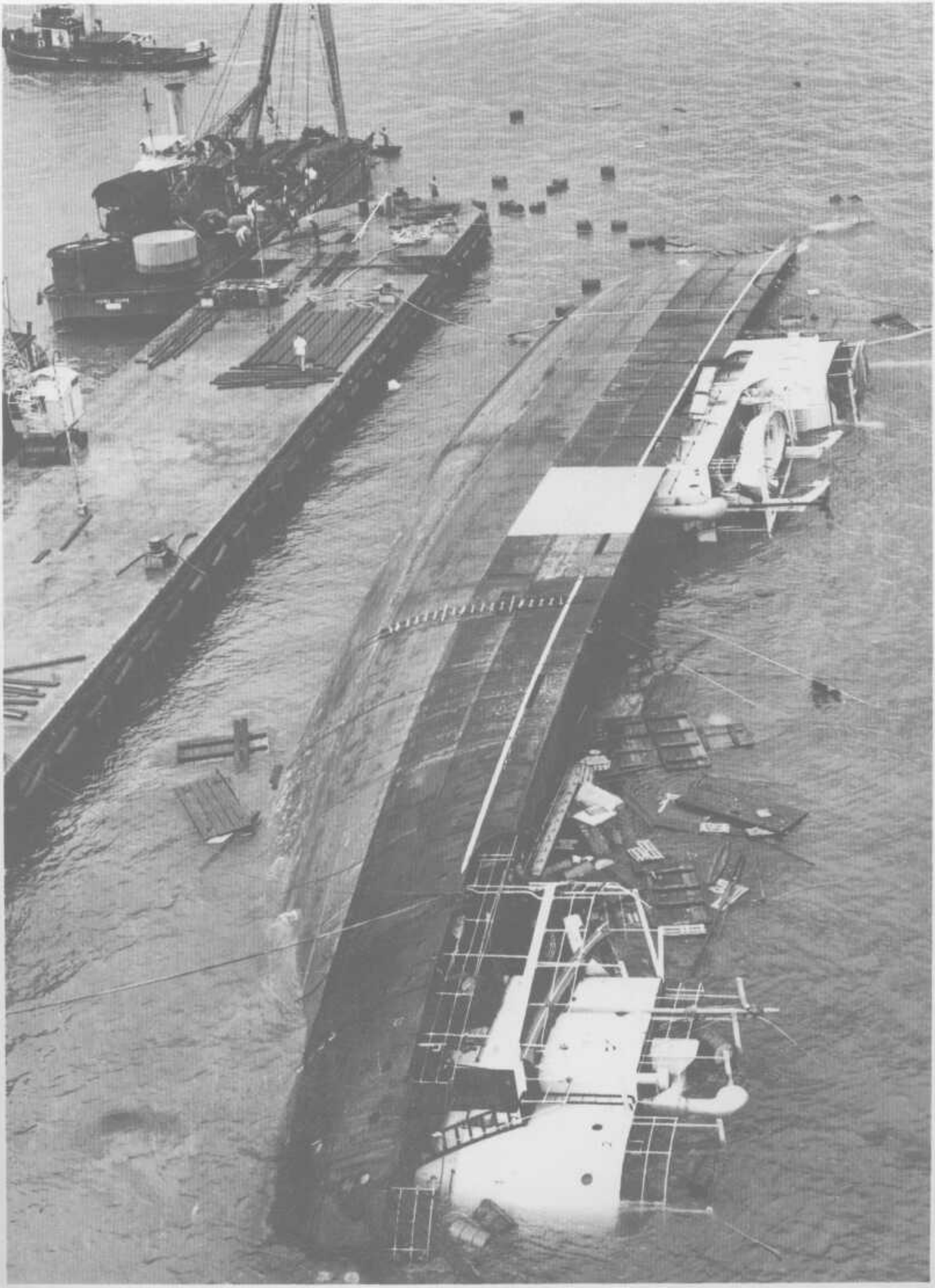
The equipment in the new building, such as computer terminals, radar screens and satellite tracking installations, would no doubt be as much of a mystery to William Doberck as his scientific knowledge must have seemed to the unlettered ship's officers with whom he dealt in 1884.

On a headland not far away, the old time ball tower – now renovated, though without the machinery – still overlooks the harbour. No longer the centre of attention for mariners, it is a curio for children who visit the public park in which it stands.

And at the Observatory the caesium beam atomic clock, accurate to within millionths of a second, marks off time, taking the Observatory into its second century.

Meanwhile, Nature rather perversely decided to mark the Observatory's fast approaching centenary with its own particular brand of ceremony—a crescendo known as Typhoon Ellen which severely battered Hong Kong between September 8–9, 1983, the No. 10 signal having to be raised as screaming winds with gusts up to 128 knots flung ships about like shuttlecocks and contemptuously tore away the territory's mantle of greenery. The toll was 15 dead, 27 ships sunk, driven ashore or damaged, and a bill of tens of millions of dollars in widespread damage.

Typhoon Wanda's 140-knot hammerblow in 1962 killed 130 people and sank or damaged more than 2 000 craft, including the freighter ***Cronulla,*** *seen capsized at North Point.*



Waves smash over the praya at Kennedy Town at the height of Typhoon Dot on July 17, 1973.

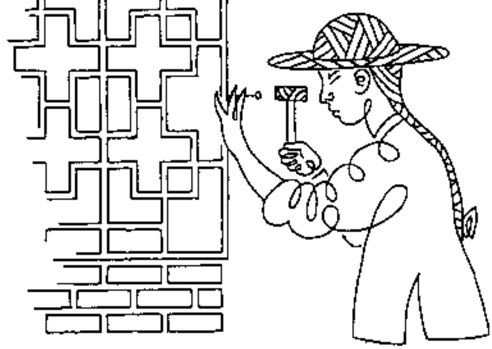
Jumble of smashed cars at the foot of Ming Yuen Street, North Point, after a June deluge in 1966 sent water roaring down the slope.

Chapter 5

THE CLACKING OF THE HAMMERS

At the present moment all business is suspended and an oppressive silence reigns over the Colony, broken only by the clacking of the hammers of those repairing the houses and other ruins

Hong Kong Daily Press, 24 September 1874.



Hong Kong's climate is sub-tropical, tending towards temperate for nearly half the year, and the recorded outer limits are not, generally speaking, extreme.

It can, however, be *Hot:* the highest temperature recorded at the Observatory was 36.1°C on 19 August 1900.

It can be *Cold:* the lowest reading was 0°C on 18 January 1893 (at the Observatory; lower temperatures have been noted in the New Territories – minus 3.1°C at Sek Kong in January 1955 – and at higher elevations).

It can be *Wet:* 1982 was the wettest year on record, with 3 247.5 mm of rain at the Observatory, 46 per cent above the average annual fall of 2 224.7 mm.

It can be *Dry:* 1963 saw only 901 mm of rain at the Observatory, by far the lowest on record. In the same year, Waglan Island had only 430 mm.

It can be *Violent:* Typhoon Wanda on 1 September 1962 brought a wind gust at Tate's Cairn of 154 knots.

It can be *Windy:* the long-term average number of typhoons causing gales in Hong Kong is a little over one a year, but 1964 brought an unprecedented five typhoons – Viola (May), Ida (August), Ruby (September), Sally (September) and Dot (October).

It can be *Sunny:* in 1963, Hong Kong enjoyed 2 470 hours of sunshine, 458 hours more than average.*

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*Meteorological statistics are interesting in themselves, but it must be remembered that they are no more than long-term averages from a scientific discipline which is – probably more than any other – subject to unpredictable variations.

For example, while this book was in production, Hong Kong experienced its most unusual January–March weather since records began. The period is usually dry and sunny, but the first three months of 1983 brought a total of 745.3 mm of rain, more than six times the average of 123.6 mm.

1983 rainfall	(mm)	Average (mm)
January	76.3	26.9
February	241	41.9
March	428	54.8

November and December are normally the best months of the year, with breezes, sunshine and comfortable temperatures. January and February bring more cloud and cold winds blow down from China.

March and April are usually pleasant months, except for spells of fog, drizzle and high humidity. Showers and thunderstorms become frequent in May.

In June, the hot, prickly blanket of summer settles on Hong Kong, bringing heavy tropical rain and heralding the start of the most dramatic part of the climatological year – the typhoon season.

Each year, normally between July and October, an average of 30 tropical cyclones form in the western North Pacific or the South China Sea. About half of these become mature typhoons, i.e., with winds of 64 knots. Tropical cyclones typically affect Hong Kong between May and November, and none has caused gales in Hong Kong between December and April.

Tropical cyclone is a generic term, and not all such disturbances progress through the four categories:

A *tropical depression* has maximum sustained winds of less than 34 knots. Its centre is often not clearly defined.

A *tropical storm* has maximum sustained winds of 34–47 knots.

A *severe tropical storm* has maximum sustained winds of 48–63 knots.

A *typhoon* has maximum sustained winds of 64 knots or more.

The name typhoon (from the Cantonese 颱風 *dai fung* – big wind – is used in Southeast Asia, China, Korea and Japan; Indians and Australians prefer 'cyclone', while the United States and Central American countries use the term 'hurricane.'

Whatever its name, a mature typhoon is probably the most savage and destructive force in nature with the possible exception of severe earthquakes – but tropical cyclones are more common than destructive earthquakes.

Official estimates put typhoon damage in Hong Kong, the Philippines, Korea and Japan in 1981 at $11,992.5 million. The loss of life is not accurately known, but is believed to be more than 2 000 a year on average in Southeast Asia alone.

A mature typhoon is malevolent, capricious and extremely dangerous. It is almost unbelievably powerful. One estimate is that an average tropical cyclone generates some 20 million megawatts of mechanical power – enough, if converted into electricity, to power more than 6 000 cities the size of Hong Kong.

The formation, development and progression of a tropical cyclone is a complex process. Modern technology, including satellite surveillance, allows man to watch and track a typhoon, thus partly reducing its potential to cause harm, but the details of cyclone formation are still not fully understood. However, it *is* known that three basic conditions must exist:

- The sea surface temperature must be higher than 26°C;
- Air at low levels must converge inwards over a large area, picking up moisture from the sea. This moisture later condenses to form rain, releasing enormous amounts of latent heat, and this heat is the main energy which powers a typhoon.
- Air flow at high levels must be divergent, to sustain three-dimensional circulation.

A tropical cyclone is a huge rotating mass of warm, humid air, with the lowest sea level pressure near the centre. A typhoon has a relatively calm centre, or eye, averaging some 50 kilometres in diameter. This is surrounded by walls of cloud up to 20 kilometres thick.

The strongest winds rotate anti-clockwise (in the northern hemisphere; in the southern hemisphere the rotation is clockwise). Outside this wall of cloud are the spiral rain bands which give the typhoon its characteristic appearance on a radar screen.

In tropical latitudes, typhoons move at relatively slow speeds, but their pace, like that of a plodding cargo ship, can move them a substantial distance in a day. For example, Typhoon Wanda in 1962 moved from north of Luzon in the Philippines to Hong Kong in less than two days.

The Royal Observatory's visual storm warning signal system is related to the distance a storm is away from Hong Kong and the expected wind conditions in the territory.

The first step is the hoisting of the Standby signal, No. 1, meaning that a tropical cyclone is centered within about 400 nautical miles of Hong Kong and may affect the territory. The No. 1 is an advisory signal, indicating potentially destructive winds. (For a full description of Hong Kong's tropical cyclone warning systems, their meaning and the precautions to be taken, see Appendix.)

Next, as the storm moves closer to Hong Kong, the Strong Wind signal, No. 3, is raised, indicating that winds with sustained speeds of 22–33 knots are expected, or are blowing. Gusts may reach 60 knots. The No. 3 signal aims to give about 12 hours warning of strong winds in Victoria Harbour.

As wind speeds increase, a Gale or Storm signal, No. 8, is hoisted. There are four signals to indicate the general direction from which the winds are expected to blow – northwest, southwest, southeast, northeast. They indicate that a gale or storm is expected, or blowing, with sustained winds of 34–63 knots and gusts which may exceed 100 knots.

A No. 8 signal is a signal for action. Schools, stores, law courts, government offices, banks and businesses close. Public transport – particularly buses and ferries – may stop running at short notice. Emergency services go on full alert.

Depending on the direction and strength of the wind, the airport may be closed to departures and incoming flights diverted. Small craft head for typhoon shelters and the crews of larger vessels strengthen their mooring lines.

Because of its effect on commerce, the hoisting of a No. 8 signal must be carefully timed, with the need for sufficient warning weighed against possibly unnecessary disruption of daily life. It is, however, necessary to err on the side of caution.

If the gale or storm is expected to strengthen significantly, the Increasing Gale or Storm signal, No. 9, is raised, indicating expected winds of up to 63 knots.

When there are definite indications that the sustained wind speed near sea level in Hong Kong may exceed 64 knots, the Hurricane signal, No. 10, is hoisted. This means that the centre of a typhoon will come close to – or even pass over – Hong Kong. If this does happen, there will be a period of extremely high winds and driving rain, followed by an eerie calm as the eye passes, followed by a sudden resumption of winds from a different direction.

As mentioned in Chapter 1, the three main causes of damage during typhoons are: destructive winds, torrential rain causing flooding, and storm surge. As a former Director of the Royal Observatory, Mr. G. S. P. Heywood, wrote in *Hong Kong Typhoons* (Government Printer, Hong Kong, 1950):

> *Typhoon winds can raise a high sea in a very short distance. Even in the sheltered waters of Hong Kong harbour seas may be high enough to swamp small craft and cause considerable damage to sea walls and installations along the waterfront. During easterly gales salt spray has been noticed on the roof of the Observatory, a quarter of a mile from the sea front and 150 feet above sea level. But the seas experienced in the harbour bear no comparison with the turmoil in open waters where mountainous seas are encountered. Ships sailing from Hong Kong during the onset of a typhoon have found no difficulty in clearing the harbour, but have become uncontrollable on rounding Tathong Head and meeting the full force of wind and sea outside.*

If, as previously discussed, such seas are generated in conjunction with a high tide, the effect can be disastrous. Heywood, writing of Hong Kong's most destructive typhoon, 2 September 1937, noted that while the level of high water was only about six feet above the predicted level,

... wind blowing through the long inlet of Tolo Harbour in the New Territories raised a disastrous tidal wave, estimated to be 30 feet in height, which flooded the low-lying ground around Tai Po and Sha Tin, and caused great damage and great loss of life.

Even after a typhoon has passed, a careful watch is maintained. Typhoons dissipate rapidly when their motive power – warm, moist air – is cut off.

This normally occurs when the typhoon moves across land, or over cooler seas. A surge of cool air, moving south across the China coast, particularly in autumn, has the same effect, making the typhoon weaker until it finally disappears.

While the great majority of typhoons keep moving away from Hong Kong and eventually dissipate, they have been known to suddenly return and lash the territory again. While this is rare, the first recorded such 'boomerang' effect is believed to have occurred less than six months after Hong Kong was proclaimed a British colony in 1841.

The British flag was hoisted at Possession Point on 26 January 1841 and Captain Charles Elliot, R.N., formally proclaimed the colony. The early settlers did not have long to wait for their first taste of bad weather. On 20 July 1841 (some records say it was the following day), the centre of a typhoon passed between Hong Kong and Macau, causing heavy damage in both places. On 26 July, the centre of a typhoon or tropical storm passed over Hong Kong. Analysis of the fragmentary records indicates that this second visitation in such a short period was not another typhoon, but a return of the first.

As previously noted, Professor S. Wells Williams wrote extensively about typhoons – or, as he called them, typhoongs – in the mid 19th Century.

In *The Chinese Commercial Guide* (Hong Kong, 1863) he included an appendix of sailing directions with this warning on the occurrence of severe weather in the China seas:

Typhoongs – these dangerous tempests derive their name from two Chinese words, ta *(great) and* fung *(wind), which are* *applied by the natives, like our words storm or gale, to any unusual wind, and do not specifically mean rotatory tempests. They occur in the northern part of the China Sea, near Formosa, the Bashi islands, and the north end of Luzon; also to the eastward of those islands, and between Formosa and the Japan archipelago; extending into the Formosa channel, and down the coast beyond Amoy, Hong Kong and even to the island of Hainan, where they are expected earlier in the season than off Fukien . . .*

. . . These tempests are liable to happen in both monsoons; but they are usually less severe in the China Sea, if they occur in May, November or December, although in the vicinity of Formosa and the Bashi islands there are sometimes furious gusts in November. From December to May they seldom or never happen. Of late years, those that have been experienced in June or July were the most violent; many vessels have been dismasted and sustained other damage by them. The months of August, September, and October are also subject to these tempests. The September equinox is a very precarious period, particularly if the change or perigee of the moon coincides with the equinox. When this was the case typhoongs happened several years at the equinox in September, on the coast of China, and many ships were dismasted on the 21st or 22nd of that month.

The coming of these tempests cannot be prognosticated with certainty, for they frequently commence without giving much indication of their approach. The clouds having a red aspect is not a certain warning of the approach of a typhoong; for, at the rising, but more particularly at the setting of the sun, the clouds, especially those opposite to it in settled weather, are sometimes tinged with a deep red colour by the reflected light. Neither is an irregular swell a good criterion to judge of their approach; for near the coast of China a cross swell frequently prevails during settled weather. A hazy atmosphere preventing land from being seen at great distances is no unfavourable sign on the coast of China; for this is generally its state in medium or settled weather.

A serene sky, with the horizon remarkably clear, should not be considered an indication of a continuance of favourable weather;

for a series of fine weather and calms, favouring an increase of heat above the mean temperature, is likely to be succeeded by a typhoong. When the horizon is very clear in some parts, and the summits of the hills or islands obscured by dense black clouds, there is some irregularity in the atmosphere, and stormy weather may be apprehended; but in reality typhoongs are seldom preceded by any sign or indication. Marine barometers seem to afford the best means of anticipating their approach; for, on the south coast of China, there is a greater fall of mercury than might be expected within the tropics.

Records of Hong Kong typhoons in the early years are not considered to be complete, but it is known that other severe storms – probably full typhoons – did affect Hong Kong in September 1848; July 1864; August 1867; October 1867; September 1870; September 1871; September 1874 (a blow which demolished the Civil Hospital and St. Joseph's church); August 1881 and October 1881.

There are, however, relatively full records of some storms in this period between the British occupation of Hong Kong and the founding of the Observatory. Those of September 1870, September 1871 and September 1874, for example, can no doubt be considered typical of a time in which no scientific forecasting was available and warnings came only from those 'experts' who claimed to be able to read portents from the skies.

The *Hong Kong Daily Press* of Tuesday, 27 September 1870 noted:

Since the memorable typhoons of September 8th and October 1st 1867 Hong Kong has been providentially free from such fearful visitations up to this time and although during the summer months of the present year threatening appearances in the weather on two or three occasions have called for prophesies from the weather wise of impending disasters, these have happily been hitherto unfounded and nothing worse than a few squalls and heavy rains have resulted and it was universally hoped that the present season might have passed over without being marked by such disastrous accidents and loss of life as have *been too frequently chronicled in the annals of Hong Kong. On Sunday last however the peculiar state of the atmosphere – a remarkable calm closeness so often the precursor of a heavy blow in this part of the world together with a low and continually falling barometer gave sufficient indications to those afloat that it was time to take all due precautions against what would in all probability turn out bad weather and possibly a typhoon ... During the forenoon a most remarkable fall continued until 2 pm when the almost unprecedentedly low range of 29.98 [inches] was noted, at which the mercury appeared for a time inclined to remain stationary ...*

It is lamentable to have to state that beside the great loss of property many lives have been sacrificed – it is of course impossible as yet to arrive at anything like an estimate of the number. The terrific gusts which passed between noon and 3 pm caused fearful destruction among the trading junks moored between the Canton Wharf and the Sailor's Home.

By Friday, 30 September, the *Daily Press*, while continuing to chronicle the adverse effects of the typhoon, did manage to find one bright spot in the wreckage, reporting:

It's an ill wind that blows nobody any good, and who knows whether the 'Great Wind' the other day was not providentially ordained on purpose to destroy the bath-house belonging to the Swimming Club. It is quite certain that it is destroyed, or very nearly so, and it is also certain that this destruction may be turned to excellent account if the committee will only accept the suggestion of the typhoon. It is clear that the bath was not in the right place and the best thing that can now be done is to find out where the right place is, and put it there. The abomination being now a desolation there is every opportunity to convert it into a really serviceable institution by placing it in a healthy position. As the now defunct house last stood, it occupied precisely the spot of all spots in the harbour which it should not have occupied.

Even when the signs of an approaching typhoon were unmistakable, it seems, they were not always heeded, with consequent tragic results. On 7 September 1871, *The China Mail* commented:

The typhoon of Saturday September 2nd will be long remembered for the widespread destruction caused on shore and in the harbour of Victoria. As we mentioned on Saturday evening, the barometer had been steadily falling during the day and the inevitable gusty signs of the storm's fury had even then begun to show themselves. Fortunately, the warnings thus given were noted and acted upon by many, and the list of casualties is therefore smaller than it might otherwise have been. Still, the record of destruction is much fuller than could be desired; and it is matter for regret that more heed is not taken by those interested of the warnings so clearly and unmistakeably given ... Since 1862 – the hurricane which swept away nearly the entire boat population of Canton – nothing like the grand exhibition of wild destruction has been seen here as that which greeted the few staggering visitants of the Bund on Saturday night. In 1848, there was no Praya to wash away, and no retaining wall to get wrecked upon; but on this occasion the dark scene of havoc will long remain engraved on the minds of many.

Three years later there is evidence that the Chinese population was better than the European settlers at forecasting the approach of a storm. On Thursday, 24 September 1874, the *Hong Kong Daily Press* reported, under the heading 'Terrific Typhoon':

On Tuesday night and yesterday morning Hong Kong was visited by the most awful typhoon which has ever been recorded in the history of the Colony. The weather during the day had been threatening, the barometer having fallen very considerably during the forenoon and still remaining low in the evening ... in the course of an hour it was evident that a typhoon of a severe character was to be apprehended and this proved too soon to be the case. The Chinese had, as usual, during the Tuesday anticipated the danger and the sampans and junks cleared out in large numbers to seek shelter. Some doubts were however felt among foreigners as to whether there would be more than a gale, though the preponderating opinion on Tuesday evening was that a typhoon was to be anticipated. In fact the indications were *strongly in that direction and the doubts probably only arose from consequence of there having already been several false warnings of typhoons this year ...*

Two days later, the *Daily Press* carried a full report of the damage and death caused by the typhoon, noting:

At times even above the fierce howling of the wind could be heard the pitiful cries of thousands vainly battling with the storm. Not a single ship in port escaped undamaged and the casualties and loss of life – the latter estimated at over 2 000 souls – has exceeded anything ... before.

Later, the same report carried this evocative description of the aftermath:

To convey an adequate idea in general words of the awful effects which this unprecedented gale has produced is impossible. At the present moment all business is suspended and an oppressive silence reigns over the Colony, broken only by the clacking of the hammers of those repairing the houses and other ruins; at Aberdeen, near the docks, lies high and dry on the land the magnificent steamer Alaska *belonging to the Pacific Mail Co., and the dead bodies of the victims are being drifted ashore in all directions.*

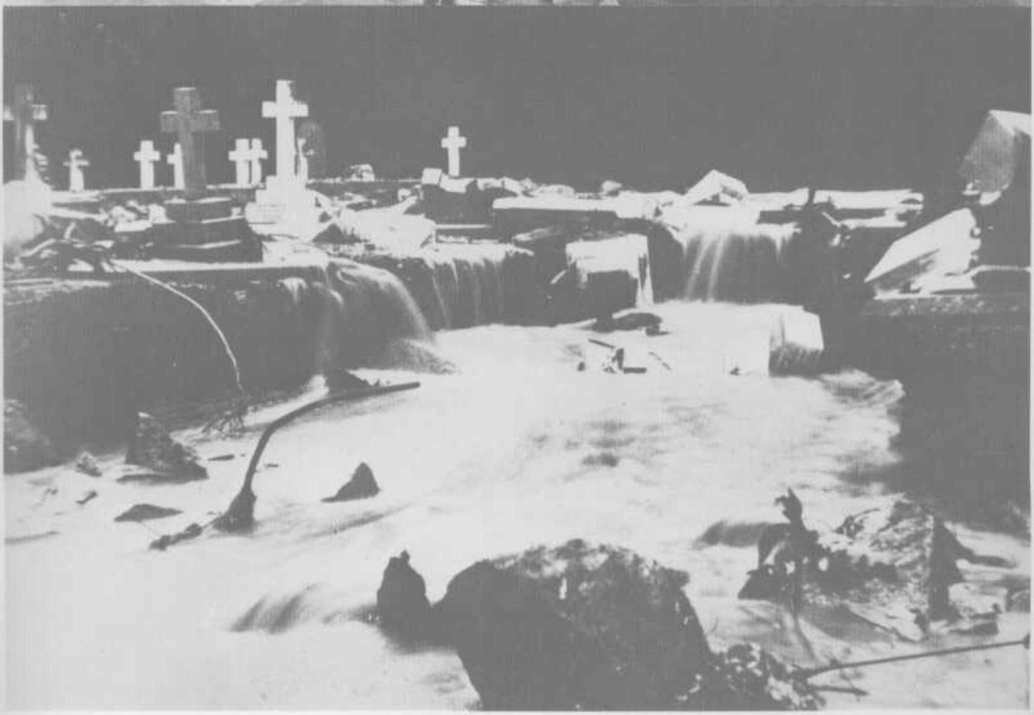
But perhaps the full horror of the 1874 typhoon was conveyed by a short public notice:

We have been requested by the Captain Superintendent of Police to warn the public that in consequence of the late disaster, dead bodies are coming in rapidly on the Praya, and that those who wish to avoid unpleasant sights will do well to abstain from going there.

In less than a decade the Observatory was to be established and Dr. Doberck was to be credited with helping to save lives and property by starting the storm warning service. By 1894, the Observatory was 10 years old and Hong Kong was subjected to a severe typhoon, the timing of which was seen as a remarkable coincidence.

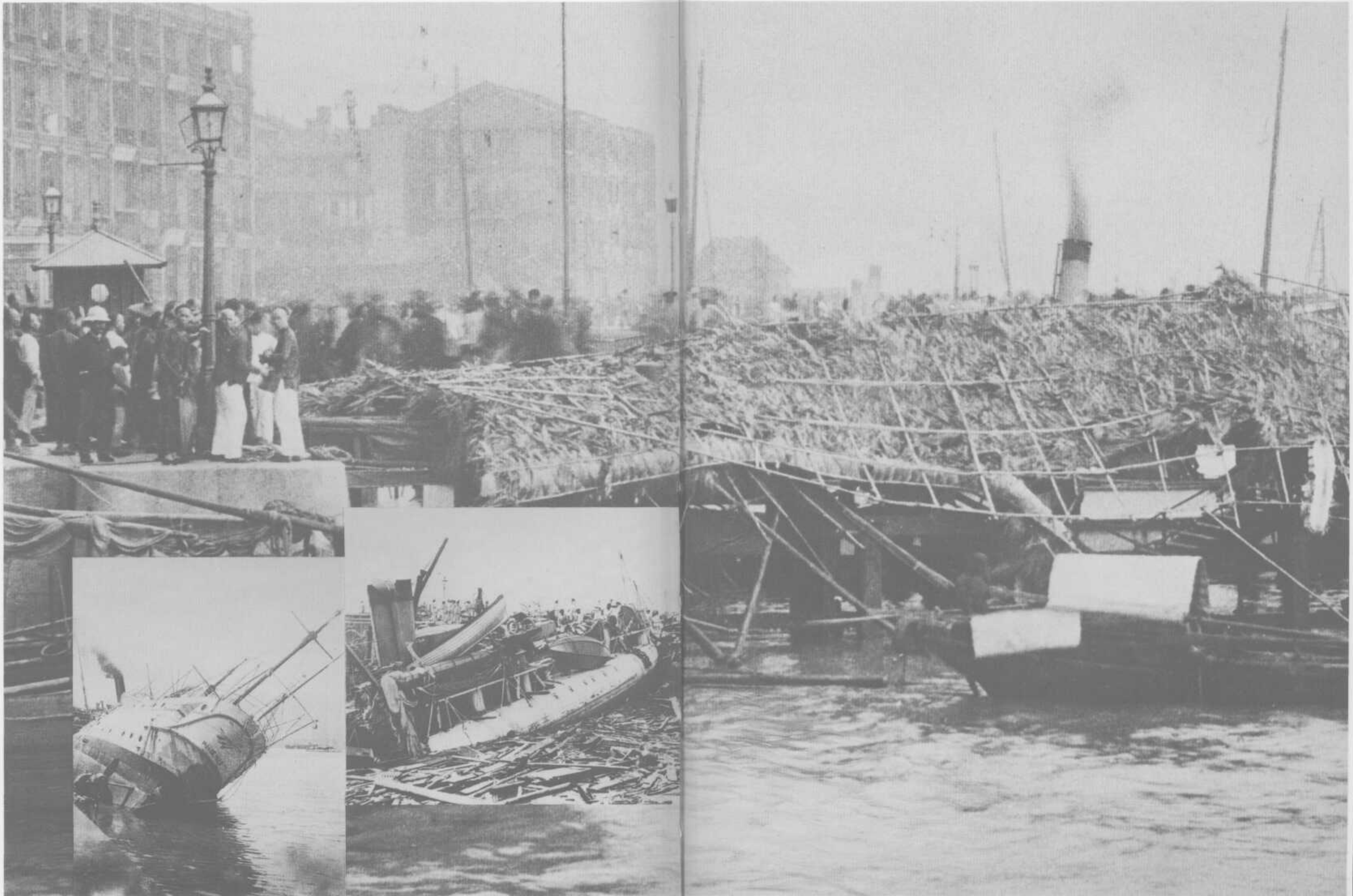
On 26 September 1894, the *Hong Kong Daily Press* commented:

The heaviest gale which has visited the Colony for many years was experienced during the early hours of yesterday morning, Above: *How the 1874 typhoon destroyed the wall of the central praya for the second time in seven years.* Below: *Devastation in the Happy Valley Cemetery, 1906.*

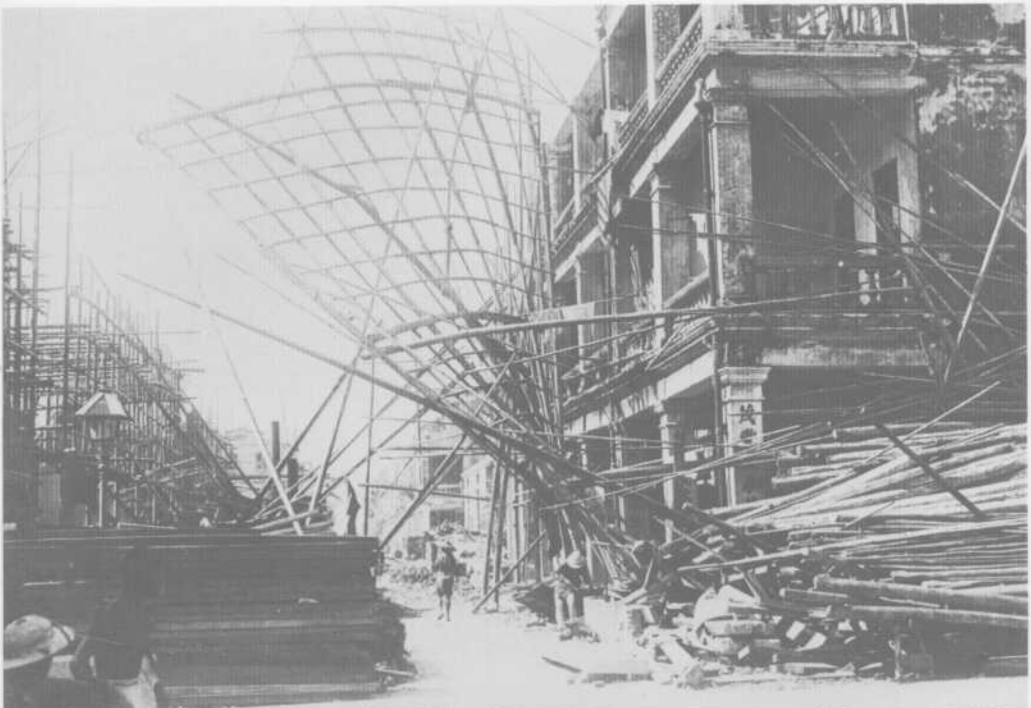


Inset below: *Among the thousands of craft sunk or wrecked by the 1906 typhoon were* (left) *the steamer* ***Phoenix*** *and* (right) *the French destroyer* ***Fronde.***

In only two hours the 'phenomenal velocity' of the 1906 typhoon killed up to 10 000 people and (below) *reduced parts of the waterfront to matchwood.*



Above: *Aftermath of the 1923 blow which caught Hong Kong badly by surprise.* Below: *In 1964 five typhoons hit Hong Kong; here scaffolding arches across Des Voeux Road.*



and although the tale of destruction which has to be told is not nearly so serious as might reasonably have been feared it is still considerable. It is a singular coincidence that on September 25th 1894 there should have been a repetition (though fortunately on a much smaller scale) of the never-to-be-forgotten typhoon of September 24th 1874, when over 2 000 lives were lost and incalculable damage was done both on land and sea. During the height of the blow yesterday when typhoon gusts carried away doors and windows and howled round the houses old residents were reminded of that occasion and the remarkable coincidence noted.

Two more typhoons occured in quick succession: one on 30 September and another on 5 October, during which gales lashed Hong Kong for 27 hours. The day after the October blow, the *Daily Press* again commented favourably on the storm warning service:

. . . In 1874 the community was uninformed of the proximity of the typhoon and was then taken unawares when the disaster burst upon them. The shipping did not seek shelter, the native craft were not notified of the approaching danger and the result was a most calamitous and unprecedented loss of life. But during the twenty years which have elapsed since that catastrophe scientific aid has been enlisted and the approach of a typhoon is heralded by notices and telegrams based upon scientific data and the whole colony knows days before its advent the character and direction of the depression . . . This is exactly what happened yesterday. A typhoon of appalling force passed within a very few miles of the Colony and though the centre did not actually pass over Hong Kong there can be no doubt that had the island been as ill informed and as ill equipped to meet the blow as it was in 1874 a repetition of the damage then occasioned would have been inevitable.

The Observatory, it must be said to its credit, gave ample warning of a storm. On Thursday at 10.30 am the gun was fired and throughout the day the wind blew with full typhoon force. At an early hour the corner of the Hong Kong Hotel on the Praya was thronged with spectators of one of the grandest *bits of storm water which could be seen. All the hongs and stores closed their doors before tiffin, business being hopeless, and most of the residents on the lower levels devoted themselves to watching the progress of events.*

Hong Kong has few natural resources for the collection of fresh water and has since the early days relied on the annual rainfall to provide the increasing amounts of water required.

The territory's mean annual rainfall is 2 225 mm, but year-by-year falls have varied dramatically from that figure.

Much of the rainfall is a product of tropical cyclones, some of which have dumped huge amounts of water on Hong Kong in a short period – in some cases, as much as one quarter of the mean annual rainfall has been recorded in a couple of days.

A tropical storm in mid-July 1926, for example, gave Hong Kong 597.4 mm of rain over two days, representing nearly 27 per cent of the annual average.

This total tropical cyclone rainfall, as recorded at the Royal Observatory, is defined as rainfall recorded during the period when the tropical cyclone was centered within 300 nautical miles of Hong Kong and during the following three days after the tropical cyclone moved outside or dissipated within 300 nautical miles of Hong Kong.

This table shows the 10 wettest tropical cyclones in Hong Kong, 1884–1939 and 1947–1978 in chronological order:

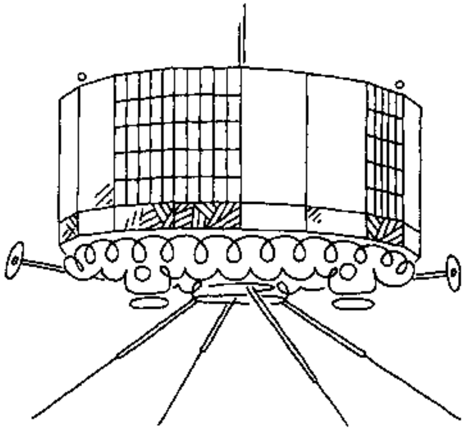
Period	Name (if any)	Rain (mm)
4–6 Oct 1894		427.4
23–28 Aug 1904		447.0
3–5 Aug 1911		437.9
1–3 Jun 1916		559.8
14–15 Jul 1925		423.2
17–18 Jul 1926		597.4
26–27 Sep 1965	T. S. Agnes	527.4
17–19 Oct 1974	T. Carmen	469.3
23–24 Aug 1976	T. S. Ellen	516.1
24–30 Jul 1978	S. T. S. Agnes	519.0

Chapter 6

FROM TIME BALL TO ATOMIC CLOCK

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.

Definition adopted by the Thirteenth General Conference of Weights and Measures, 1967.



The splitting of time into microscopically small segments has been a product of the nuclear age, and is an appropriate entry to a description of the technical work of the Observatory. Much of this work would be difficult, if not impossible, without modern technology.

The Royal Observatory's time service is based on a caesium beam frequency standard with an accuracy of better than one microsecond (one millionth of a second) a day.

Such a level of accuracy is important to scientists and other professionals whose work requires it, and to industry. The vast majority of Hong Kong residents can easily obtain a time check from radio broadcasts, which relay a six-pip time signal from the Observatory.

As previously noted, the provision of an accurate time service, particularly for mariners, was one of the original duties for the Observatory.

Relatively accurate clocks were installed at the Observatory, but the problem was to indicate the correct time to as many people as possible.

The original time ball tower was built close to the signal mast at Tsim Sha Tsui police station. From the top of the tower an 18 ft pole protruded, the top of which was about 84 ft above sea level.

On the pole was mounted a 6 ft diameter ball. Each day about 12.50 pm, the barrack sergeant of the Marine Police, in conjunction with the Observatory, raised the ball to the top of the pole, and it was dropped at exactly 1 pm. The ball was first dropped on 1 January 1885.

In 1907 the time ball was moved to Blackhead's Hill (Signal Hill), where a new tower had been built. In 1928 a new storey was added so that the time ball could be seen above the new buildings which were rising in the area.

The time ball was last dropped on 30 June 1933 – a victim of technical improvements, as the use of the time ball ceased

... with the approval of the Naval authorities and the General Chamber of Commerce, the opinion being expressed that in

comparison with radio-telegraphy and telephony the method had become obsolete.

The tower was later used as a temporary ammunition store during World War II, and slowly fell into disrepair. In 1978 the Urban Council decided to restore the tower, though without the time signal mechanism, and the area has been opened to the public as Signal Hill Garden.

Universal time (Greenwich Mean Time) was adopted as the basis for Hong Kong time in 1904. In 1966, a crystal-controlled timing system was installed to replace the pendulum clocks. The Observatory began broadcasting the six-pip time signal in the same year. Daily comparisons with radio time signals from other centres brought accuracy to within one-twentieth of a second.

On 1 January 1972, Hong Kong adopted Universal Co-ordinated Time as its official standard. For most practical purposes, this corresponds with Greenwich Mean Time.

In 1980, the timing system based on the caesium beam atomic clock was introduced. This is accurate to within fractions of a millionth of a second.

In addition to its role in the maintenance of a time standard, the Observatory was also a prime mover in the adoption of another standard of measurement – the Celsius temperature scale.

Hong Kong's change from Farenheit to Celsius was made in a series of steps from 1964 to 1966, though the international trend towards Celsius had begun much earlier.

In 1948 the Ninth Conference on Weights and Measures, on the advice of the International Committee on Weights and Measures, adopted the International Temperature Scale and recommended that Celsius replace Centigrade and Centesimal as names for the scale.

On 1 January 1949, National Standards Laboratories around the world adopted the name and new definitions for the Celsius scale, and other international bodies began to change over.

The Third Congress of the World Meteorological Organisation adopted Celsius for measuring air temperature and for general use in 1953.

The Fourth Congress, in 1959, at which Hong Kong was represented, noted that good progress had been made and resolved that Celsius be used in the international exchange of air temperatures – a usage that became world-wide by 1963.

At the same time, some nations stopped using Farenheit for any purpose, to avoid confusion.

When he returned from the Congress, the Director of the Observatory, Dr. I. E. M. Watts, noted that the case for changing to Celsius was even stronger in Hong Kong than in Britain because:

- Celsius had been used in China for many years and many adult Chinese in Hong Kong were familiar with the scale.
- Continental Europeans in Hong Kong had used Celsius for years.
- Neighbouring countries, including China, Macau and Japan, used Celsius.
- A large proportion of Hong Kong's population was below school leaving age, a good age at which to introduce a change.
- Celsius was already used at the airport, the Observatory, and in schools and laboratories.
- Given the rapid pace of technological development, a change should be made sooner rather than later.

Several points of a more general nature which supported the need for a change were found, including:

- Other countries were changing to Celsius.
- The use of two scales was inefficient and undesirable.
- Many more people in other parts of the world used Celsius than Farenheit.
- Major economic blocs, such as the European Common Market and the Communist countries, used Celsius exclusively.

It was recommended that Celsius be adopted in Hong Kong from 1 January 1966, following a transition period in which both scales would be used.

This recommendation was adopted, and the British pattern was followed—

In 1964, temperatures were given in Farenheit with Centigrade in brackets;

In 1965, temperatures were given in Centigrade with Farenheit in brackets;

On 1 January 1966, Farenheit was discontinued and Celsius was used instead of Centigrade. In each case, wide publicity had been given to the change before it was made.

The Royal Observatory provides many services. To the layman, some of these may not appear to have obvious relevance to daily life in Hong Kong, but they all help to contribute to the community.

The Observatory provides all meteorological services in Hong Kong. The most important of these is the public weather service, including weather forecasts and warnings, climatological enquiries and the preparation of weather charts and meteorological records.

Preparation of weather bulletins requires information from other parts of the world. The World Meteorological Organisation (WMO) – of which Hong Kong became a member in December 1948 – has a Global Telecommunications System (GTS), with its main centres in Moscow, Washington and Melbourne.

Through the GTS network the Observatory is connected to Peking, Tokyo and Bangkok, and obtains from these centres the regional weather information it needs.

Hong Kong weather bulletins, including a general description of weather systems, information on tropical cyclones and a local forecast are prepared at least seven times a day in the Central Forecasting Office. The Information Services Department then distributes the bulletins to the media.

Weather information for South China coastal waters is issued four times a day, mainly for fishermen and owners of small craft. It includes 24-hour area forecasts for seven coastal areas.

On Saturdays, Sundays and public holidays, weather reports from Waglan Island, the Airport runway, the Star Ferry, Green Island and Cheung Chau Island, the sea surface temperature and tidal information are appended to the bulletin.

Warnings and special weather information:

The Royal Observatory issues various types of warnings, the most important of which is the tropical cyclone warning (for details, see appendix).

The *Strong Monsoon Warning* is issued when the winter monsoon (usually from the north or east) or, more rarely, the summer monsoon (usually from the southwest) is expected to bring winds of more than 21 knots near sea level anywhere in Hong Kong. Such winds may reach 40 knots in exposed places.

During periods of heavy or prolonged rain, the Observatory issues warnings of possible flooding and/or landslips.

In autumn and winter the humidity falls, vegetation dries out and Hong Kong becomes subject to fires. The Observatory then issues yellow or red fire danger warnings.

A *yellow* warning indicates that humidity is low, the risk of fire is high, and more than twice the normal number of fires can be expected. A *red* fire danger warning is issued when the danger is considered extreme and more than five times the normal number of fires can be expected.

In winter, temperatures can be low, particularly on high ground and in the New Territories. If ice or frost is expected a warning is issued so that farmers can take precautions to protect crops.

Aviation Weather Services:

Hong Kong International Airport, Kai Tak, with some 55 000 international aircraft movements a year (an average of more than 150 a day) is one of the busiest in the world. This volume of air traffic has been a relatively recent development, although the origins of civil aviation in Hong Kong go back more than half a century.

The airfield at Kai Tak – not the present airport, which is built on reclaimed land – dates from the late 1920s. The essential connection between meteorology and flying emerges in the Royal Observatory's records for 1927:

On November 24th, Flying Officer R. Vaughan Williams, R.A.F., came to interview the Director in connection with the establishment of an air route to Shanghai.

The following year brought another visit for a similar purpose – quite probably from the same officer, though the name is slightly different:

Flying Officer R. Vaughan Fowler, R.A.F., came to interview the Director in connection with the meteorological needs of a proposed civil aviation company for Hong Kong.

The development of meteorological services for the fledgling aviation industry was slow at first, but in his report for 1937, the Director, Mr. C. W. Jeffries, noted:

Commencing on May 18, a Senior Officer and a Chinese assistant have been stationed at Kai Tak aerodrome daily during the forenoon. A synoptic chart of the Far East, on which is also all available information concerning upper winds, is prepared and exhibited in the aerodrome, and the officer is available for consultation by departing pilots. An hourly weather report is broadcast daily, usually from 0600 to 1600 Hong Kong Standard Time, and is communicated directly to the Imperial Airways plane during its weekly flight from Indo-China to Hong Kong. A route forecast is also furnished to the pilot on his return flight to Indo-China.

The growth of civil and military aviation in the region soon outstripped the meteorological facilities, and a meteorological office was included in plans for the new Kai Tak terminal.

This office began work in 1939, but operations did not last long. By Christmas Day 1941, Hong Kong was in Japanese hands.

When civilian government resumed in May 1946, Mr. G. S. P. Heywood became Director of the Observatory, and much of the Observatory's work involved the improvement of aviation meteorology.

In June 1946, the R.A.F. forecasting centre was moved to Kai Tak, and in August 1947 the Observatory took over all responsibility for all air force and civil aviation meteorology.

The sudden expansion of aviation in the immediate post-war years strained the Observatory's resources, and extra staff were recruited. As part of work in this area, weather stations were opened on Waglan Island (1 December 1952) and Cheung Chau (1 January 1953). The Director, Mr. Heywood, later reported:

> *Owing to the mountainous nature of the Colony, the weather in the approaches is often very different from that in the harbour and at the airport, and although Waglan and Cheung Chau are only 12 miles and 14 miles respectively from Kai Tak, the weather reports from these islands undoubtedly contribute to the safety of aircraft approaching or leaving Hong Kong in bad weather.*

The Royal Observatory provides all meteorological facilities and services for international air navigation in Hong Kong. Surface observations are taken every half hour at the airport and the Cheung Chau aeronautical station and distributed to local users. Hourly observations from the same two points are sent to various offices overseas.

Terminal Aerodrome Forecasts (TAF) are issued every three hours, covering a nine-hour period for local users and every six hours, covering a 24-hour period, for overseas meteorological offices. Routine route forecasts are issued twice daily for inbound flights, and local area forecasts are issued twice a day to the Royal Air Force and the Royal Hong Kong Auxiliary Air Force. Forecasts of take-off conditions are supplied to the crew of every outbound flight.

Pilots of outbound flights are briefed on weather they can expect en route, at the destination and at alternate airports; charts of significant weather and wind and temperature at cruising levels are given to all flights leaving Hong Kong.

Forecasters at the Airport Meteorological office keep a continuous watch for weather which may affect flights, and issue warnings of tropical cyclones, thunderstorms, icing or severe turbulence.

An experimental wind shear warning system using data recorded by five anemometers near the airport provides effective warning of low-level wind shear, which can affect aircraft during takeoff or landing. The Royal Observatory also has a Doppler acoustic radar installation, with three acoustic radars pointing in different directions. This measures horizontal and vertical winds at various heights and contributes to aircraft safety.

Air temperature affects aircraft, particularly during takeoff. Whenever there is a marked temperature inversion of more than 5°C from the surface to a height of 300 metres, a special warning is issued.

Weather for shipping:

One of the primary functions of the Royal Observatory is to provide weather services for ships at sea or in port. The Observatory's bulletins contain a synopsis of significant weather features over the western North Pacific west of 140 degrees east and the China Seas, warnings of winds of gale force or above, 24-hour forecasts for 17 marine areas, weather reports from land stations and ships and a coded analysis of the synoptic situation in the western North Pacific west of 150 degrees east and the China Seas. These bulletins are broadcast in Morse code three time a day.

When there is a tropical cyclone within the area bounded by the latitudes of 10 degrees north and 30 degrees north and longitudes 105 degrees east and 125 degrees east, warning bulletins are issued every three hours.

When a tropical cyclone is within about 400 nautical miles of Hong Kong and may later affect the territory, warnings are issued for ships in Hong Kong and visual warning signals are displayed.

The marine meteorology section of the Royal Observatory recruits voluntary weather observing ships and provides equipment for their reports. The Observatory maintains contact with the crews of many ships which call regularly at Hong Kong, and the information they provide is valuable in compiling forecasts.

One good example of this cooperative volunteer work occurred in 1953. In May of that year, volunteer Observatory staff began observations from the Indo-China Steam Navigation Company's *S.S. Hing Sang*, plying between Hong Kong and British North Borneo. They signed on as supernumeraries at a token payment.

After two voyages, Observatory staff could no longer be spared for such work, so Captain George Edwards and his officers volunteered to take over. They made regular observations of winds up to 25 000 feet and in December 1953 they tracked a balloon to 72 000 feet, following the flight by theodolite and taking readings each minute for nearly two hours.

In a broader area of weather services for shipping, the Observatory is closely involved in an international programme of marine climatology.

Hong Kong's role in this field follows a decision of the World Meteorological Organisation in 1963 to provide marine climatological summaries. The world was divided into areas of responsibility, with Hong Kong as the 'responsible member' in charge of collecting and processing weather reports from ships in the South China Sea.

The first marine climatological summary for the South China Sea (for 1964), published in 1970, was the first of its kind in the world. Summaries for 1961–70 are now available.

In the process of producing these summaries, the Observatory has accumulated a large number of weather reports from the South China Sea. Since 1979, special analyses of climatological conditions have been prepared to meet the needs of off-shore operations along the South China coast.

In 1980 the Observatory began to provide forecasting services in support of petroleum exploration and related activities in off-shore areas. The climatological data collected for the summaries was an important foundation for these forecasting services.

Rainmaking

Some of the earliest foreign visitors to Hong Kong called in to replenish their water supplies. Water – or a shortage of it – has always been a problem for the territory.

Much of the problem is physical. Hong Kong has no large rivers and water has to be impounded in reservoirs. The rainfall to feed those reservoirs is not evenly distributed, either geographically over the rugged terrain, or throughout the year – some 80 per cent of annual average rain falls between May and September.

This has meant periodic droughts and the need to impose water restrictions. At least two attempts have been made during droughts to stimulate rain artificially.

The results were so discouraging that during the drought of 1963, the Director of the Royal Observatory, Dr. I. E. M. Watts, advised the government not to bother making further experiments.

Broadly, there are three ways to stimulate rain from clouds:

Dry ice seeding. This requires cloud-top temperatures to be below freezing point. It is also extremely expensive on a large scale, and the method cannot usefully be used in Hong Kong.

Silver iodide seeding. This, too, requires cloud-top temperatures below freezing point, and is considered even less likely to succeed in Hong Kong than the use of dry ice.

Seeding with water droplets. This method has been tried in Hong Kong (see below).

Hong Kong's first experiment, following a drought which began in mid-1928, used another method, with Observatory documents for 1929 noting that:

The water shortage having become very serious, on June 18 R.A.F. planes from the R.A.F. base Kai Tak, dropped 6½ cwts of powdered kaolin [fine white clay] on cumulus cloud, with a view to producing rain. The experiments were suggested by a Hong Kong resident and were sanctioned by the Naval authorities at the request of the Hong Kong government, not with any hope of producing rain, but to satisfy the public. The results were as expected.

The last sentence, implying that the experiment failed, is interesting in view of the report for 1929 of the Director, Mr. T. F. Claxton, who commented:

A water famine resulted from a serious shortage of rain from the middle of July 1928 to the middle of June 1929, when only 27 inches of rain fell against an average of 71 inches. Disaster was averted by a rainfall of 3.8 inches between June 14 and 25, 1929 . . .

Another experiment, using water seeding, was made in May and June 1955. The preferred method of spraying water drops from an aircraft flying just above the cloud base was considered too expensive – and impractical – for Hong Kong.

Instead, three ground-based sprays were installed on the ridge which runs east southeast from The Peak on Hong Kong Island. The sites were chosen because on most days in May and June the sprays would be working close enough to passing convective clouds to be effective.

While the experiment provided valuable information about rainfall in general, it also showed that water seeding of cumulus clouds did not increase rainfall in Hong Kong.

Climatological information services:

Apart from providing data for the weather forecasting and tropical cyclone warning services, the Royal Observatory's climatological information service is also operated to meet the needs of shipping, aviation, engineering, industry, recreational activity and the public.

The information provided includes data collected at the surface and in the upper air. Daily, weekly, monthly and annual summaries of weather observations are published, and more technical publications are also available. The Monthly Weather Summary gives general climatological information for Hong Kong and describes actual daily weather. It also contains tables of monthly means and extreme values which are adequate for simple planning purposes based on climatology.

Each issue includes a description of the month's weather and a set of simplified daily weather maps. A monthly rainfall chart is included and, when appropriate, maps are included showing the rainfall distribution over Hong Kong during heavy rain.

The Monthly Extract of Meteorological Observations of Hong Kong is useful for those who need information on daily weather. For example, contractors use it to cross-check the number of working days lost because of poor weather, and other weather-sensitive industries can relate their activities to the data.

Detailed observations are published in the annual meteorological results, which are presented in three parts:

Part I, surface observations, contains tables of readings made at local stations, usually hourly. Apart from an interruption during 1940–46, this annual volume dates back to the establishment of the Observatory in 1884.

Part II, upper air observations, contains observations of wind, pressure, temperature and humidity in the atmosphere. Detailed annual volumes are available for 1947–80, and since 1981, only summaries have been provided.

Part III, tropical cyclone summaries, describes tropical cyclones affecting Hong Kong. The first issue covered tropical cyclones in 1968.

Meteorological satellite reception:

Soon after the launching of the United States TIROS 8 (television and infrared observation satellite) in December 1963 the Royal Observatory started to intercept satellite signals from the automatic picture transmission system on the TIROS 8, using locally designed equipment.

The signal was received by a helical aerial which was moved manually at one-minute intervals. Data from the satellite was displayed on a modified television set, and photographed. This home-made system was used to receive data from the ESSA and NOAA series of polar orbiting satellites until a photographic facsimile recorder was obtained in 1968.

In July 1977, Japan launched a geostationary meteorological satellite (GMS1) into orbit 35 800 kilometres above the earth over the equator at 140 degrees east. An aerial, preamplifier and converter were assembled at the Royal Observatory to receive low resolution images from the satellite starting from August 1978. The images were received at three-hourly intervals, and pictures reproduced on the photographic facsimile recorder.

In October 1979 a new receiving system was installed to receive high resolution satellite pictures. This also marked the end of reception of data from US polar orbiting satellites. Different degrees of enlargement (by two, four or eight times) can be used to show greater detail of a particular area.

When a tropical cyclone is in the area west of 125 degrees east, satellite data are preserved on colour slides and video tape until the tropical cyclone leaves the area or weakens into an area of low pressure.

Application of satellite data:

Satellite pictures give a unique view of global weather patterns. The distribution of cloud cover is the essential source of information for determining weather over oceans and other areas from which data is sparse.

The high-resolution pictures also reveal middle-scale weather phenomena which could easily go undetected on a conventional weather chart.

The characteristic circular cloud patterns of a tropical cyclone are easily recognisable on a satellite picture and allow its centre to be located with accuracy (depending on how far the cyclone has developed).

Maximum sustained winds can also be estimated by using enhancement techniques which reveal cloud features and the cloud-top temperatures near the centre of the cyclone.

Enhancement techniques also enable sea surface temperatures to be mapped from infrared pictures. This data is useful in helping to forecast sea fog and the development of tropical cyclones.

It also reveals ocean currents and sea surface temperature fronts where certain species of fish tend to congregate.

Earthquakes:

Each year, about 10 000 earthquakes are recorded throughout the world. The majority cause no damage, but about 1 000 are strong enough to have serious consequences if they occur near populated areas.

Hong Kong's terrain indicates that in prehistory there must have been violent earthquakes associated with the formation of hills. However, Chinese records of earthquakes, collected over many centuries, show that the whole of Guangdong Province has had only some 30 destructive earthquakes since 288AD, an average of about one every 60 years.

On average, Hong Kong residents feel about three earthquakes each year, but the tremors are not severe. The earthquake risk in Hong Kong is low and significantly less than that in areas such as parts of China, Japan, Taiwan and the Philippines.

In more recent times, the highest intensity of an earthquake felt in Hong Kong was of magnitude 6 to 7 on the Modified Mercalli scale.

This was the earthquake of 13 February 1918 which occurred near Shantou (Swatow), about 320 kilometres east northeast of Hong Kong.

The earthquake was clearly felt in Hong Kong, but fortunately did little real damage. The *China Mail* reported on Thursday, 14 February:

Further earth tremors were noticed last night, some residents of the Colony counting as many as five distinct shocks.

The shock occurring yesterday afternoon appears to have done some slight damage to property. St. John's Cathedral, we understand, was badly shaken, but the damage done was slight.

The following day, the *China Mail* noted that while Hong Kong had escaped serious damage, Swatow had not. Under the headline 'Great Disaster at Swatow' the newspaper reported:

The earthquake felt in the Colony on Wednesday had its centre further up the coast whence the reports yet to hand go to show that it has taken the form of a great disaster.

Unfortunately at Swatow something in the nature of a cataclysm occurred in that city on Wednesday last ... practically every house in the native quarter of the town is demolished and the European quarter has also suffered sufficiently badly as to probably render it necessary to rebuild most if not all the houses.

On Saturday 16 February, the *China Mail* devoted its leading article to a discussion of the history of earthquakes in China, concluding with this comment:

... South China, we believe, has never been visited before by such an earthquake as that just experienced at Swatow ... seismologists who have placed South China outside the earthquake zone have evidently a lot to learn on the subject yet.

The Royal Observatory operates a network of instruments to monitor earth tremors:

Short period seismographs monitoring earthquakes for the Regional Seismological Network for Southeast Asia;

Long period seismographs as part of the Worldwide Standardised Seismograph Network.

Seismographs are instruments used to measure and record earth movements. A seismograph consists of a seismometer, an amplifier, recorder and timing system. The seismometer detects the relative motion between a free mass – which tends to remain at rest – and a frame which moves with the earth. This motion is converted into an electric current which is amplified and recorded as a seismogram.

To measure complete ground movement, three components of motion (usually north-south, east-west and vertical) are sensed and recorded by three separate seismographs. Different seismometers are designed to respond to different periods of vibration and are used to detect earth movements originating from sources at different distances.

The Royal Observatory began seismological recording in 1921 with a smoked paper seismograph for direct visual observation. A cellar was constructed inside the Observatory compound for the instrument. The first earthquake so recorded was at 10.45 am on 10 January 1924.

During the Japanese occupation the seismographs were removed and no observations were made.

After the war, recording was resumed with the installation of seismographs using photographic paper. In 1958, the Lamont Observatory of New York, as part of a programme to establish overseas observing stations, asked the Royal Observatory to operate three seismographs which they provided. In 1963, two more sets of three seismographs were received from the United States and the cellar was modified to house them. All these instruments are suitable for recording distant tremors.

In 1979 the Royal Observatory established a network of three high gain, short period seismographs to record earthquakes within 500 kilometres of Hong Kong. These are at Tsim Bei Tsui, Yuen Ng Fan and Cheung Chau. Seismic signals are sent to the Observatory, where a microcomputer determines the epicentres and magnitudes of the earthquakes.

During severe tremors, conventional seismometers go off-scale and may be damaged, causing the loss of valuable information. In 1977, three strong motion accelerographs were installed. One is on granite at Tate's Cairn; one is on decomposed granite at the Royal Observatory; and the third is on reclaimed land at Wan Chai Auxiliary Police Headquarters. This enables ground acceleration to be monitored on different geological formations.

The Royal Observatory is part of two international seismological networks: the Worldwide Standardised Seismological Network, based in Washington, which monitors the larger earthquakes, and the Regional Seismological Network for Southeast Asia. This monitors in greater detail seismic activity in the region, including all smaller earthquakes. Data is sent to the two organisations and to other processing centres in Tokyo, Honolulu and the International Seismological Centre in the United Kingdom.

Tsunami monitoring:

Tsunamis are large ocean waves which may accompany coastal or undersea earthquakes. Not all are large enough to cause damage, but some have caused heavy casualties and damage.

The Royal Observatory cooperates with the Japan Meteorological Agency and the United States Geological Survey in the Pacific Tsunami Warning Service. Reports on severe earthquakes recorded in Hong Kong are sent to the data collection and processing centres in Tokyo and Honolulu. In return, the Observatory receives warnings of possible tsunamis caused by earthquakes under the Pacific Ocean.

Upper air wind meteorological measurements:

The Royal Observatory began upper air wind measurements in 1921 using pilot balloons. The frequency of ascents was gradually increased, and by 1930 observations were being made in the morning and the afternoon. The twice-daily ascents were made when the cloud base was above The Peak (about 300 metres). In 1938, 667 balloon ascents were made.

About the same period, Royal Navy and Royal Air Force aircraft made occasional meteorological flights, with 69 being made in 1928.

Newer and better systems of upper air sounding were being developed. In 1939, the Director was in England and studied the operation of radiosonde equipment, reporting that the instruments were 'practical and reasonable in price, but a shortage of supplies for manufacture . . . will prevent their extensive use until the termination of hostilities.'

In 1950, four routine ascents were made daily at 5 am, 11 am, 5 pm and 11 pm, as recommended by the World Meteorological Organisation. Balloons were not released when the base of the cloud layer was lower than 600 metres above mean sea level.

The balloon was inflated with hydrogen, and rose about 500 feet a minute. A theodolite on the Observatory roof was used to track the balloon. At night, a light was attached to make tracking easier. Winds at 1 000 feet intervals were measured over two minutes (one minute before and one minute after the balloon attained a particular height). The method was restricted by human visual range, and the balloon's rate of ascent was an estimate that could cause calculation errors.

A daily meteorological flight from Kai Tak was instituted in January 1949. The observations of dry and wet bulb temperatures made on these flights were the Observatory's first attempt to measure upper air temperature and humidity. The flights – first by the Far East Flying Training School and later by the Hong Kong Flying Club – continued until November 1949, when they were replaced with radiosonde ascents.

Radiosonde ascents:

Radiosonde ground equipment to determine upper air pressure, temperature and humidity was installed in 1949. Obstructions around the launching site caused difficulties in releasing the balloons, particularly when it was windy. In 1951, the new site was established at King's Park, about 1 kilometre north of the Observatory.

The first radiosonde ascent was launched in November 1949. Combined radiosonde and radar wind ascents were made routinely once a day from December 1949, using Army-operated radar equipment. In 1955, the Observatory acquired its own radar, which was used until 1962 when a wind-finding radar was installed.

Beginning in July 1957, the International Geophysical Year, combined radiosonde and radar wind ascents were made twice a day, and two radar wind ascents were also made. In the combined ascent, a hydrogen-filled balloon lifted a radiosonde, radar reflector and parachute at some 360 metres a minute. Instrument readings were sent to the ground station, and the reflector was tracked by radar. The parachute prevented the equipment from crashing to earth when the balloon – having risen through progressively lower air pressure, and thus expanded – eventually burst, sometimes as high as 30 kilometres.

The Cora system:

A new automatic sounding system, known as Cora, was installed in January 1981. This measures upper air pressure, temperature and humidity, and sends the data back to a minicomputer for analysis. The system applies a new concept which uses the world-wide Omega navigational network. This has eight stations with very low frequency transmitters in different parts of the world: Japan, Norway, Liberia, Hawaii, North Dakota, La Reunion (Indian Ocean), Argentina and Australia.

A minicomputer receives and stores the information, processes it and prepares coded messages for dissemination.

Surface meteorological measurements:

Surface meteorological measurements are those made near the earth's surface with the eye and instruments such as barometer, thermometer and rain gauge.

Surface observations of pressure, temperature, humidity, cloud, wind speed and direction, and sea surface temperature are used in day-to-day weather analysis and forecasting. With other readings such as sunshine duration, solar radiation, grass minimum and soil temperature, and evaporation, they are also useful in several other fields, including climatology, hydrology, agriculture and civil engineering.

Routine surface observations began at the Observatory in 1884. The frequency of observations, the number of observing stations and the number of meteorological elements observed have increased with time (apart from an interruption during the Japanese occupation of Hong Kong, when some equipment was removed or damaged).

Seven stations in Hong Kong, including four manned by Royal Observatory staff, make and report surface meteorological observations to the Observatory hourly or once every three hours.

There are some 15 supplementary stations equipped with chart recorders, and a network of nearly 100 rain gauge stations which report rainfall.

Conventional mercury barometers are used to measure atmospheric pressure, although the use of digital barometers is being introduced. Digital barometers are more convenient as they display corrected mean sea level pressure without the need for further computations.

Digital thermometers, using platinum resistance sensors, have been used since 1982 to measure temperature, dew point and relative humidity. The instruments are backed up by mercury thermometers.

Except at the Observatory, which has a special thermometer shed, the wet and dry bulb thermometers are placed in screens about 1.2 metres above the ground. A computer automatically calculates dew point and relative humidity. The digital thermometer also records maximum and minimum temperatures, and operates a chart recorder.

Cloud – Observations of cloud type, amount and height are made by observers. The airport at Kai Tak and the island of Chek Lap Kok have ceilometers to give more accurate measurements of the height of the base of low cloud.

Sunshine – The duration of sunshine is measured by a recorder at King's Park.

Grass minimum and soil temperatures – The grass minimum temperature is read from a minimum thermometer lying horizontally over ground covered with short grass. Soil temperatures are read from mercury-in-glass themometers 5 cm, 10 cm, 50 cm, 1 m, 1.5 m and 3 m below the ground surface.

Visibility – Horizontal visibility is estimated by the eye. At Chek Lap Kok island a visibility meter measures the visibility to the north east. Kai Tak airport also has three runway-visual-range meters.

Sea surface temperature – The sea surface temperature is measured at Waglan Island and North Point by thermometers housed in rubber buckets.

Rainfall – Several types of rain gauges are used in Hong Kong. The most common is the Snowden type gauge, which is read manually, but there are also autographic rain gauges which give continuous records of rainfall amounts and intensities.

Apart from the gauges at the Observatory, King's Park, Kai Tak, Cheung Chau, Tate's Cairn and Chek Lap Kok, gauges are read by voluntary observers from other Government departments, universities, schools, hospitals, farms, factories, building construction companies and consultants.

As in other areas of the Observatory's duties, the trend in surface observations is towards automation, including measurement, telemetry, data processing and recording, to help save manpower and time.

Meteorological radar observations:

A weather radar probes the atmosphere by sending out electromagnetic pulses from a rotating antenna. When a pulse encounters rain, part of the energy of the pulse is reflected back. This makes it possible to calculate the distance of the rain from the radar, and the rainfall intensity.

Information is then displayed on a cathode ray tube in various ways, such as a vertical cross-section through the atmosphere or as different rainfall intensities displayed by different degrees of brightness.

A weather radar is mainly used to monitor the location, movement and development of rain areas, and is particularly useful in locating the centres of tropical cyclones within the radar's range.

The Royal Observatory began using radar for weather observation and forecasting in 1959. The first installation was a Decca storm warning radar with a maximum range of 250 nautical miles based on top of Tate's Cairn. This equipment was used for nearly 20 years, until June 1979. However, in December 1966, a second radar, with a maximum range of 240 nautical miles, had been installed at Tate's Cairn.

In early 1983 a new computer-based radar was installed at Tate's Cairn. This equipment has three elements: the Tate's Cairn installation; a data processing station at the Royal Observatory; and a remote display station at the airport meteorological office.

Computerised equipment at each station can produce a constant altitude plane position indicator – basically a display of a horizontal cross-section of the atmosphere at a specified altitude. Other special displays can also be produced on a coloured screen. Different rainfall intensities are indicated by different colours.

The radar antenna at Tate's Cairn is a 3.6 metre diameter dish. The sensitive receiver can detect rainfall rates as low as 0.6 mm an hour at the radar's maximum range of 450 kilometres.

In normal operation the antenna scans helically upwards at six revolutions a minute. At the maximum elevation of 37 degrees, the antenna is lowered and the helical scan repeated. Microprocessors generate cross-sectional displays up to 20 kilometres in height at one kilometre intervals. A microwave link carries the data to the Observatory.

At the Observatory, a minicomputer can generate one or more of these special displays at the operator's command:

- An echo top map showing the heights of the tops of rain areas;

- Vertical section through the atmosphere across any two selected points;
- A rainfall accumulation map displaying accumulated rainfall over a specified time;
- A forecast of horizontal cross-sections for two hours ahead, based on past movement and development of rain areas;
- A forecast of rainfall rate for a specified period for 16 selected points, and
- Map overlays.

These displays can be sent to the airport meteorological office. A time lapse system allows up to 100 displays of any type to be stored and replayed at high speed to help a forecaster follow the movement and development of rain areas.

If necessary, the scan data can be stored on magnetic tape for future research.

The system thus allows forecasters to monitor the three-dimensional movement and development of rain areas within a volume 450 kilometres in radius and 20 kilometres high centred on Tate's Cairn.

It also provides the information required for short range (two hours ahead) forecasts of rainfall intensities, which are useful for heavy rain warnings. The storage ability gives researchers much valuable information about the movement and development of weather systems in the Hong Kong area.

Royal Observatory computer use:

In 1968 the Royal Observatory began to use computers at the Government Data Processing Division for annual climatological summaries. By the early 1970s, the amount of data available through the World Meteorological Organisation had increased greatly, and in 1973 the Observatory obtained its own computer system to receive and transmit meteorological messages. This initial installation was replaced in July 1978, and the new system was enlarged in 1982 to provide more facilities.

The Observatory's computer division acquires, processes and stores data from the international telecommunication network and local stations. This information is used to prepare weather forecasts, warnings of tropical cyclones and other severe weather, and flight information for aircraft.

Geomagnetic measurements:

The earth's magnetic field at any one place has three components: horizontal, vertical and declination. A magnetometer is used to measure a magnetic field. Variometers are magnetometers that record the variations in the three components of the magnetic field, producing records called magnetograms.

Short-term fluctuations recorded by variometers may be caused by:

- Distortion of the earth's magnetic field by energetic particles from the sun;
- The formation of a ring current of charged particles around the earth at a distance of several times the radius of the earth;
- Irregular electric currents in the ionosphere which may be caused by charged particles entering the earth's atmosphere in the polar regions or by electro-magnetic induction.

Studies of the variation of the earth's magnetic field can increase understanding of the processes occurring inside the earth, and the effect of the sun's activity on the earth.

The Royal Observatory began regular geomagnetic observations in Hong Kong in 1884 and continued uninterrupted until 1939.

Observations were made at two sites in the Observatory grounds (from 1884 to 1927) and one at Au Tau (from 1928 to 1939). The Au Tau site was destroyed during the war.

In 1968, the Observatory, in conjunction with the Physics Department of the University of Hong Kong, investigated the possibility of re-establishing a geomagnetic station. After a visit organised by the World Magnetic Survey Mission in 1968, a scientist from the Australian Bureau of Mineral Resources recommended a site at Tate's Cairn, where there was little magnetic interference from man-made sources.

Instruments were obtained and the geomagnetic station established at Tate's Cairn in February 1971. It was jointly operated by the Observatory and the Physics Department of the University until it was closed at the end of 1982.

Air pollution meteorological studies:

With the expansion of industry and the growth of population, air pollution has become a major concern in Hong Kong.

Air pollutants are transported and dispersed by a complex process which depends heavily on prevailing meteorological conditions. Studying these conditions is an important and specialised task.

The Observatory monitored ambient air pollution levels from 1977–80. Measurements of sulphur dioxide and particulate concentration in the air were made at the Observatory and the King's Park meteorological station.

In May 1980 an air pollution meteorology research unit was established at the Observatory. This unit does not monitor pollution, but conducts micro-meteorological surveys to assess air pollution potential in areas where new developments are planned.

Junk Bay, where a New Town for up to 300 000 people is being planned, was the first area the research unit studied. The work included studies of air flow and diffusion patterns to help with land use planning.

Radioactivity measurement:

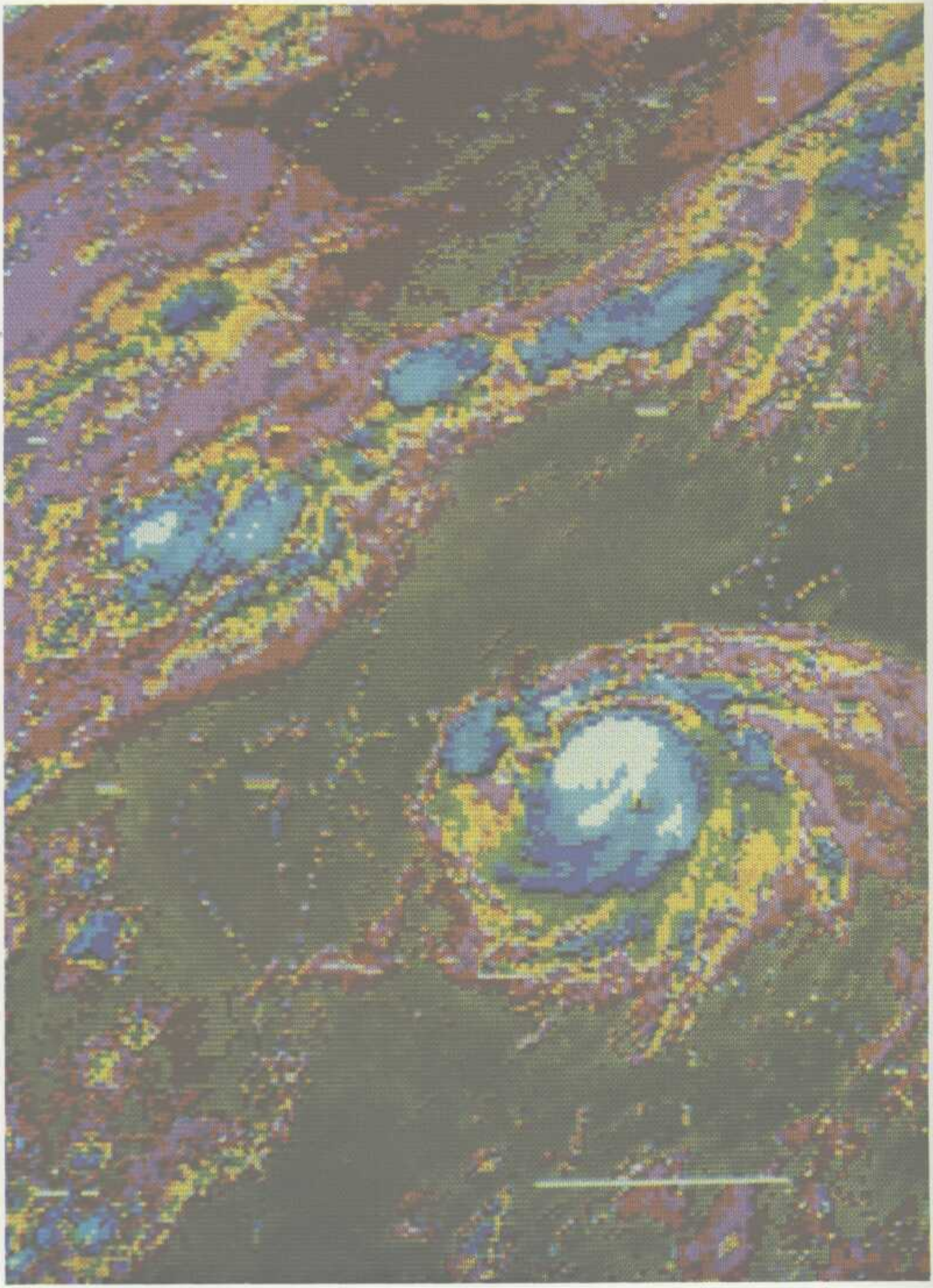
Regular daily measurements of total beta radioactivity of airborne dust and rainfall in Hong Kong began in October 1961. For some months, measurements were made in the radiological section of Queen Mary Hospital. Work was later transferred to the King's Park meteorological station.

Three types of samples are collected for measurement:

The Observatory's caesium beam atomic clock, nuclear age successor to the time ball, provides a precise timing standard for commerce and industry.

The Doppler acoustic radar measures horizontal and vertical winds at various heights.

Satellite photographs give meteorologists accurate information about the movement of tropical cyclones. This is Typhoon Ellen which battered the territory in September 1983.



• Airborne dust collected at King's Park on a glassfibre filter.

• Total wet and dry deposition from the atmosphere collected at King's Park.

• Daily rainfall (if any) collected at the Observatory.

Observatory staff assembled a radioactivity counter to test the samples.

In November 1964, the Atomic Energy Research Establishment, Harwell, UK, installed an additional air sampler at the station, and samples were sent to Harwell for further analysis.

A new atomic scaler was installed in May 1963, replacing the home-made equipment.

Research and consultation:

There has been increasing interest in the application of meteorological data to engineering design such as the development of water resources, the design of tall buildings and the design of drainage systems.

The Observatory takes part in such studies, and special investigations are made when required.

The Observatory routinely records all available data on tropical cyclones in the western North Pacific and South China Sea. Guidelines are developed on aspects of weather associated with tropical cyclones to help improve forecasting.

Hong Kong's winter weather is to a large extent controlled by surges in the winter monsoon. Weather patterns leading to the arrival of cold surges in Hong Kong are examined and common features identified to help forecasters.

Heavy rain causes much loss and damage through floods and landslips in Hong Kong every year. The Observatory investigates major rainstorms to identify precursors in weather patterns, and studies the application of information from radar and satellite observations.

The long series of meteorological observations made at the Observatory, including studies of extreme winds, is used in engineering design.

Much of Hong Kong's population lives near the coast and is subject to the threat of storm surge associated with typhoons. The Observatory has developed ways to forecast storm surge, and analyses are made of coastal locations where big engineering projects are planned.

The Observatory advises Government department on the meteorological aspects of engineering development projects and provides data to private enterprise when required.

If a specific project requires substantial data collection and analysis, the Observatory organises a special team to do the work.

Hong Kong's Tropical Cyclone Warning Signals

Signal		Lights	Display Symbol
Stand by	1		
Strong Wind	3		
NW' LY Gale or Storm	8 NW		
NE' LY Gale or Storm	8 NE		
SW' LY Gale or Storm	8 SW		
SE' LY Gale or Storm	8 SE		
Increasing Gale or Storm	9		
Hurricane	10		

<table>
<tr><th>Meaning of the Signal</th><th>What You Should Do</th></tr>
<tr><td>A tropical cyclone is centred within about 400 nautical miles of Hong Kong and may later affect Hong Kong.
Hong Kong is placed in a state of alert because the tropical cyclone is a potential threat and may cause destructive winds later.</td><td>Listen to weather broadcasts. Some preliminary precautions are desirable and you should take the existence of the tropical cyclone into account in planning your activities.</td></tr>
<tr><td>Strong wind expected or blowing, with a sustained speed of 22–33 knots and gusts which may exceed 60 knots.
The timing of the hoisting of this signal is aimed to give about 12 hours advance warning of a strong wind in Victoria Harbour.</td><td>Take all necessary precautions. Secure all loose objects, particularly on balconies and roof tops. Secure hoardings, scaffolding and temporary structures. Clear gutters and drains. Take full precautions for the safety of boats. Ships in port normally leave for typhoon anchorages or buoys.</td></tr>
<tr><td>Gale or storm expected or blowing, with a sustained wind speed of 34–63 knots from the quarter indicated and gusts which may exceed 100 knots.
The timing of the replacement of the Strong Wind Signal, No. 3, by the appropriate one of these four signals is aimed to give about 12 hours advance warning of a gale in Victoria Harbour but the sustained wind speed may reach 34 knots within a shorter period over more exposed waters. Expected changes in the direction of the wind will be indicated by corresponding changes of these signals.</td><td>Complete all precautions as soon as possible. It is extremely dangerous to delay precautions until the hoisting of No. 9 or No. 10 signal as these are signals of great urgency. Windows and doors should be bolted and shuttered.
Stay indoors when the winds increase to avoid flying debris but if you must go out keep well clear of overhead wires and hoardings. All schools and law courts close and ferries will probably stop running at short notice.
The sea level will probably be higher than normal particularly in narrow inlets. If this happens near the time of normal high tide then low lying areas may have to be evacuated very quickly. Heavy rain may cause flooding, rockfalls and mudslips.</td></tr>
<tr><td>Gale or storm expected to increase significantly in strength.
This signal will be hoisted when the sustained wind speed is expected to increase and come within the range 48–63 knots during the next few hours.</td><td rowspan="2">Stay where you are if reasonably protected and away from exposed windows and doors.
These signals imply that the centre of a severe tropical storm or a typhoon will come close to Hong Kong. If the eye passes over there will be a lull lasting from a few minutes to some hours but be prepared for a sudden resumption of destructive winds from a different direction.</td></tr>
<tr><td>Hurricane force wind expected or blowing, with sustained speed reaching upwards from 64 knots and with gusts that may exceed 120 knots.
This signal is hoisted as soon as there are definite indications that the sustained wind speed anywhere near sea level in Hong Kong is likely to exceed 63 knots.</td></tr>
</table>

t confuse the Tropical Cyclone Signals on the the Strong Monsoon Signal. The Strong Signal is a black ball and the lights are white, ite. It is used whenever the winter monsoon om the north or east) or more rarely the nonsoon (usually from the southwest) is o exceed 21 knots near sea level anywhere in ng. These winds may sometimes reach 35 /en 40 knots in very exposed places.

By Signal is an advisory signal indicating the of destructive winds occurring in Hong s important to realise that while the Tropical Warning Signals give warnings of winds r blowing near sea level over open water and xposed areas, they do not specifically warn of gers which may result from the tropical hese include flooding in low lying areas as a storm surge which may cause the sea level to lerably higher than is normal and the de- effects of very heavy rain which usually es tropical cyclones. This rain can cause andslips and ground subsidence. Small streams into raging torrents within a short period anger to anyone in their vicinity. Rocks may ed from hillsides and there may be mudslips. It important that you should listen to broadcast illetins to obtain information on all expected eather so that you may take appropriate s against violent winds, heavy rain and storm **nply knowing what signal is displayed is gh.** Tropical cyclone warning bulletins are at two minutes to and half-past every hour of the signals No. 8 to No. 10 are displayed. If ot have a radio or if you miss a broadcast formation on the signal status or the tropical ay be obtained from the Information Centre ome Affairs Department, Tel. 5-456381.

do not telephone the Royal Observatory telephone lines there must be kept free for nation of warnings and other urgent opera- irements.

know these terms used in broadcast ulletins?

clones are classified into these four categories o the maximum sustained winds within their : –

depression has maximum sustained winds 34 knots and at this stage the centre is often learly defined and cannot always be fixed

storm has maximum sustained winds in the 7 knots.

A severe tropical storm has maximum sustained winds in the range 48–63 knots.

A typhoon has maximum sustained winds of 64 knots or more.

The eye at the centre of a developed tropical cyclone is a relatively calm and lightly clouded area that may be from 5 to over 50 nautical miles in diameter. The strongest winds in a tropical cyclone blow in a tight band round the outside edge of the eye in an anti-clockwise direction.

One **nautical mile** is 1852 metres. In weather bulletins, all distances are stated in nautical miles, but the adjective 'nautical' is sometimes omitted for the sake of brevity.

One **knot** is one nautical mile per hour and is a little over half a metre per second. Wind speed and the speed of movement of a tropical cyclone are measured in knots.

The direction from which the wind is blowing, the direction towards which a tropical cyclone is moving and the bearing of its centre from Hong Kong are each given to the nearest point of a 16-point compass bearing. Thus the actual bearing will be within 11¼° of the reported value. For example, a typhoon moving on any heading between 259° and 281° is said to be 'moving west'; although due west is 270° from true north.

Bibliography

ABEL, Clarke, **Narrative of a Journey in the Interior of China**; London, 1818.

BERNARD, W. D. and HALL, W. K., **Narrative of the Voyages and Services of the Nemesis**; London, 1844.

CAMERON, Nigel, **Barbarians and Mandarins, Thirteen Centuries of Western Travelers in China**; New York, 1970.

CHIN, P. C., **The Life History of a Tropical Cyclone**; Hong Kong, 1977.

COLLIS, Maurice, **The Great Within**; London, 1941.

CRISSWELL, Colin N., **The Taipans, Hong Kong's Merchant Princes**; Hong Kong, 1981.

DAVIS, Sir John Francis, **The Chinese: A General Description of the Empire of China, and Its Inhabitants**; London, 1836.

ENDACOTT, G. B., **A History of Hong Kong**; London, 1958; Revised Edition, Hong Kong, 1973.

ENDACOTT, G. B., **A Biographical Sketchbook of Early Hong Kong**; Singapore, 1962.

HEYWOOD, G. S. P., **Hong Kong Typhoons**; Hong Kong, 1950.

NEEDHAM, Joseph, **Science and Civilisation in China**; Vol. 3, Cambridge, 1959.

OLIPHANT, Laurence, **Narrative of the Earl of Elgin's Mission to China and Japan in the Years 1857–59**; London, 1880.

PETERSON, P. and CHENG, T. T., **Supplement to Meteorological Results 1962. Typhoon Wanda**; Hong Kong, 1966.

SAYER, G. R., **Hong Kong 1841–1862. Birth, Adolescence and Coming of Age**; Hong Kong, 1937.

SAYER, G. R., **Hong Kong 1862–1919. Years of Discretion**; Hong Kong, 1975.

STARBUCK, L., **Royal Observatory, Hong Kong: A Brief General History**; Hong Kong, 1951.

TURNER, Rev. John A., **Kwang Tung, or Five Years in South China**; London, 1894. Republished, Hong Kong, 1982.

WILLIAMS, S. Wells, **The Middle Kingdom**; London, 1883; *The Chinese Commercial Guide* Hong Kong, 1863.

WOODCOCK, George, **The British in the Far East**; London, 1969.

NEWSPAPERS:

China Mail
Hong Kong Daily Press
Hong Kong Telegraph
Hong Kong Times
South China Morning Post

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