Early China Coast Meteorology

The Role of Hong Kong

P. Kevin MacKeown

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Preface

By the middle of the nineteenth century meteorology had become a frontier science, but, unlike most frontier sciences, a most valuable one in practical terms. It was a science that should easily have translated to East Asia, where its benefits were transparently obvious. The Japanese, when they set about it, rapidly adapted to the paradigm; the Chinese, fearful of colonial encroachment, were decidedly cool on the subject. What is surprising is how sluggish the development of the subject in the colonial environments was. What were the reasons for this? The present work grew out of an effort to document the history of the physical sciences in Hong Kong. This turned out to be too daunting a task, but from it grew an acquaintance with the unheralded founding director of the Hong Kong Observatory, Dr. William Doberck, a subject who provides a central focus for an account which can make a small contribution to answering this question. I also try to give a more general description of meteorology in the region during the late nineteenth and early twentieth centuries, something that has not received much attention from historians to date. Incidental to the whole story is an account of colonial government and society in Hong Kong from a point of view which is complimentary to the more usual politically oriented studies. But the work is more a portrait of events than a researched thesis. No effort has been made to consult Japanese sources, or to track down records from the Manila (largely lost) or Zikawei observatories, and even the records from the Hong Kong Observatory, if we exclude the *Government Gazette*, are by no means complete. So reliance has often had to be placed on secondary sources, mostly Colonial Office files and contemporary newspaper reports. Not all of the material here is of wide provenance, and I thought it wise to add information to augment some of these sources. My preference for doing so would be signalled footnotes on the page — footnotes being often of greater interest than the text. I'm conscious, however, that many readers find such footnotes distracting so have relegated all such material to the end of the book.

Minutes from the Colonial Office are from files CO129/297 (1882) through CO129/442 (1917). Materials from the Hong Kong Public Records Office are in files HKRS356 and HKRS842. Different spellings in early documents, Hongkong, Hong-Kong, Kaulung etc. are all standardized throughout to 'Hong Kong', etc.

A bibliography lists all books cited, as well as journal articles that are referred to in the text more than once, and details of other publications are found in the notes where they are mentioned. In the last days of manuscript preparation I became aware of an unfinished draft of a book, *An Introduction to Typhoons*, that a late director of the Hong Kong Observatory, Gordon J. Bell, planned to produce, and which is housed in the Observatory library. Some relevant historical material, as well as some material, earlier familiarity with which would have saved me considerable effort, is to be found there.

There is a perennial problem of how names of places are to be treated, the variability over time being especially acute in that part of the world. Some accommodation must be found for the form as written at the time and for contemporary versions. Common geographical names, such as Peking, Canton, Hong Kong and Macao which have been anglicized in the same way as have Lisbon, Rome, Dublin and Copenhagen are retained in their familiar English form. More difficult to deal with are the names of other places, especially in China, where forms of a more transitory or corrupted nature were in common use. To make a blanket replacement of Chinese place names by their current Hanyu Pinyin forms, e.g. Yantai for Chefoo, or Nanpengdao for Lamocks, would make for a very perplexed reading of the historical material. For the sake of cross referencing and readability, names are given as in the context where they arise, and the accepted contemporary versions are given in a Gazetteer in an Appendix — in Pinyin transliteration in the case of places in China. In the same interest of readability, text in other than roman script is relegated to the endnotes. The Jesuit observatory at Xujiahui is referred to throughout, except in quotations, as Zikawei, in keeping with the priests' usage.

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Nineteenth-Century Observatories

> Meteorology will not be in working order for two years more: but *'Hart' is long, if time is fleeting.*
>
> Robert Hart, December 1873[1]

Introduction

The scientific approach to the physical world which blossomed in Europe from the time of Newton and his contemporaries onwards only slowly diffused to more distant regions, and that encroachment was largely under the cloak of European colonial expansion. The extension of the community of science can hardly be described as a missionary undertaking. The propagation of the ways of thinking of scientists did not preoccupy them in the way that the saving of souls moved religiously minded individuals. Of course, we are not talking of mutually exclusive classes. The role of science was pressed into service in the cause of evangelization on many fronts. Ironically, the successes of these endeavours, as we will see, were particularly favourable to the propagation of scientific thinking, more so than to the conversion of the heathen. The ground for foreign encroachment on traditional patterns of thought was fertile in some places more than others. The bulk of Asia — India, China, Japan — was heir to rich educational traditions that could easily sympathize with the new ways of thinking. We are concerned in this volume with a part of the world, the South China Sea and its littoral, and the subject of meteorology, a subject paradigmatic of the scientific approach to nature, emphasizing systematic observation and rigorous analysis in the solution of problems.

Meteorology as a subject was of as much interest 150 years ago as it is today, in the early twenty-first century. The scenario to which it relates, of course, has changed immeasurably over the intervening years, but the urgency of its practice was no less attended to then than it is these days. However, the perceived pedestrian nature of its study seems to have eclipsed its role in most chronicles of the times. The story of the military and political endeavours in the advancement of imperial designs by Europeans in other parts of the world in the seventeenth to nineteenth centuries has had many tellings. So also have there been many reports on the lives and adventures of the individuals who took part. Botanical and zoological enquiries among colonial servants, as well as casual travellers, have had wide reporting, but it is only recently that medicine, and to a much lesser extent the physical sciences and engineering, have drawn some attention.[2] We are concerned with a factual account of the small, specialized subject of meteorology and especially how it was practised on the 'China Coast'. Astronomy, and geomagnetism, bedmates of the subject in the early scientific age, will naturally also attract some attention. Although it is not our primary purpose, the story related also throws light on the strengths, foibles and prejudices of colonial society, as well as its attitudes to and interactions, in many cases minimal, with the native populations. There is much more to the story of meteorology in the Orient than an account of the role of the Hong Kong Observatory and we will make some attempt to cover these other aspects, but our focus will be on the evolution of the Observatory in Hong Kong and its relations with other Asian observatories. For good or bad, the history of the first thirty years of that observatory is in great part a chronicle of the career of Dr. William Doberck, the Observatory's founding director and the institution's feisty leader for twenty-four of those thirty years. His near quarter-century stay there and the shadow he cast for a further six years in the person of his close colleague and successor, Frederic George Figg, who retired in 1912, form a definitive timeframe for the study in hand. Doberck's fame as an astronomer is also an excuse to treat, briefly, the early history of astronomy in Hong Kong. Its later developments are described elsewhere.[3]

To some, the very identification of meteorology in the East with its manifestations in Hong Kong will appear offensive. Compared to the contributions made by the observatories in China, Japan and the Philippines, Hong Kong will often appear, at least in the sense of resources, to have been a minor, but also a fractious player in the meteorology of the region in those times. We choose 1912 as the year at which to take stock of the development of observatories in East Asia, largely because it marks a watershed in the history of the Observatory in Hong Kong. The thirtieth year of its existence was the year in which the last of the cohort of early officers retired, the time when any pretence at playing a role in astronomy was discarded and a management more

attuned to the modern demands of meteorology took charge. It was also the year in which, in a formal sense, it turned over a new leaf when 'Royal' was added to its title.[4] The same year saw the new Republican government in China introducing not one but two meteorological institutes, one associated with the ministry of agriculture and the other with the ministry of education. But before getting to the core of the story it is informative to look briefly at the geopolitical context in which the Hong Kong Observatory originated and the history of other colonial observatories predating its founding.

Early Systematic Observations

The weather in all cultures has always been a matter of comment and concern and accounts of it have survived in many places, not least in the exhaustive records of natural phenomena to be found in Chinese documents, official and private. The earliest quantitative measurements made were of rainfall in China and Korea.[5] Descriptions relevant to our story were also given by early Portuguese explorers at Macao and Canton, and by Dutch traders in Japan. Such records are valuable for studies of climatology and how the climate may have varied over time but, being largely non-quantitative, they have little to contribute to a history of meteorology as such. Before a review of systematic studies of the subject and a description of the main sources of early meteorological work in East Asia — the various observatories established there from the mid-nineteenth century onwards — we will record a few isolated instances of systematic recordings made by individuals, some dating as far back as the seventeenth century.

There is the example of an Irish sojourner at Xiamen, by the name of James Cunningham, who in 1699 published an account of measurements he made there on the pressure, the wind direction and the state of the weather from October 1698 to the following January.[6] Mr. Cunningham, later a fellow of the Royal Society, was for a time a physician to the English traders on Zhoushan (Chusan) Island, nine kilometres off the coast in Hangzhou Bay. Another notable example of early meteorological monitoring comes from Sweden. From the 1730s the Swedish Academy of Sciences had an arrangement with the Swedish East India Company (a rather enlightened body of men) to carry scientists on board their China-bound ships.[7] At least one meteorological record from this enterprise survives: a near complete tabulation by an anonymous visitor of the rainfall at Macao from early March to 12 September 1780.[8] Another interesting case is that of a private observatory that was established at Batavia, in the Dutch East Indies, as early as 1765. Its owner was the self-taught German-Dutch Reverend Johan Maurits Mohr, whose wife fell into a large inheritance. This enabled him to build and equip his own private observatory from where he made

various meteorological and astronomical observations, including two Transits of Venus. A nucleus of amateur scientists built up around his observatory, but by 1790 activity had declined, not to recover again for almost a century.[9]

China: The Early Days

Records of the weather, as is the case with all observations of nature, have a long history in China. However, in her history of the Hong Kong Observatory, Ho Pui-yin remarks on the failure to keep continuous records of meteorological phenomena, the observers in general only recording exceptional events, and she describes records of many such events, especially typhoons, in the weather in Southern China from pre-Observatory days.[10] So, unlike astronomy, meteorology in China in the pre-scientific age never reached any level of sophistication. In the words of China's most distinguished meteorological son, Zhu Kezhen,[11] it never advanced beyond the stage of prognostication by proverbs, of which many exist. Typical is:

> If on the first come wind and rain,
> 'Twill bring us pestilence and pain;
> If at *Ch'ing Ming* a south wind come,
> It means a plenteous harvest-home.[12]

Nevertheless, although extensive records exist which would be valuable to students of climate for inferring climate and climate change in China, it would be stretching a point to suggest they played any determining role in the development of modern meteorology.

From the earliest days of their participation in the working of the Peking Observatory, and the time of Ferdinand Verbiest in the mid-seventeenth century, the Jesuit priests attached to that Observatory included meteorological monitoring among the curriculum of new knowledge they introduced into the Celestial Kingdom. We have some records of the first half of the eighteenth century from the French Jesuits there in the form of data they forwarded to the French Academy in Paris. Extensive data on temperature and wind direction, measured at 06:30 and 15:30 daily from July 1743 until March 1746 at the Observatory, communicated by a Fr. Antoine Gaubil, have been reported.[13] The French had a reputation for rigour in their instrumentation — a resolution in their temperature measurements of 0.31°C at that time has been deduced[14] — and the systematic manner in which the data were accumulated must lend much confidence in their reliability. These data are particularly interesting for establishing, in the summer of 1743, a recorded all time high of 44.4°C in the

capital, and a heat wave in North China in which Fr. Gaubil reports 11 400 deaths around the capital; this heat wave is amply confirmed by many qualitative reports of the time in official documents and provincial chronicles. It has been concluded that it was the highest temperature encountered at Peking in the last seven hundred years. But there is more to meteorology than temperature records. Other observations on the pressure, the wind direction and the state of the weather, made twice daily at Peking from 1757 to 1762 were reported by another Jesuit father, Jean-Joseph Amiot.[15]

An Early Publication in Chinese

There are different readings of the confrontation in the eighteenth and nineteenth centuries between Western science as prosecuted by the colonial powers and indigenous populations in the territories they bestrode, either as colonial mandarins, philanthropists or missionaries. The case of meteorology might seem to be fairly simple compared, say, with the complexity of the encounter of Western medicine with native populations. Meteorology would largely be in the service of the foreigners, the benefit to the locals only incidental to this role. Yet the earliest systematic introduction of the subject to the China Coast, the publication of a book in Chinese on the subject in the 1850s by a foreign missionary, was exclusively directed at native readership. The subsequent establishment by the Jesuits of major meteorological observatories in China and the Philippines also cannot be easily read as the deliberate prosecution of colonial-oriented goals, even if they would eventually be co-opted into that exercise.

The book in question was published in 1853 by the American missionary doctor Daniel Jerome MacGowan at Ningbo.[16] MacGowan himself did not claim to make any meteorological measurements, but he was an active participant in a programme of bringing Western scientific thought to the attention of educated Chinese, with the twin aims of rejuvenating their society and spreading the Christian message.[17] Two years earlier at Ningbo he had published *Bo Wu Tong Shu* or the *Philosophical Almanac*, a text introducing electricity to local readers in the context of explaining the electric telegraph. It contained illustrations featuring such items as Leyden jars and Toepler-Holtz machines, and proposed a never-to-be-adopted code of eighteen Chinese symbols to be used on the telegraph keyboard. That book was eventually translated into Japanese and its terminology played a role in decisions made there between Dutch-based and Chinese-based nomenclature in physics. The book by MacGowan of interest to us is titled *Hang hai jin zhen* (the Navigator's Golden Needle, see Fig. 1) and separately in English, *The Law of Storms in Chinese*. It consists of thirty-seven

pages and is a singular publication on meteorology at the time. It contains a brief introduction in English, in which the author tells us that the chapter on typhoons in the South China Sea in Col. Reid's work forms the basis for his publication, but that works by Redfield and Piddington were also consulted.[18] He acknowledges financial assistance from J. C. Bowring at Hong Kong in publishing his pamphlet. He continues: 'So much of the science of meteorology as applies to the subject has been introduced, with some general principles of navigation as practiced in the West; the whole being interspersed with remarks on natural and revealed religion'. He castigated the Chinese for their slowness to appreciate new discoveries, but hoped that his pamphlet would help Chinese navigators to escape the fury of the storms and lead them to 'make observations calculated to perfect our acquaintance with the tracks of revolving storms, in regions rarely visited by foreign ships'. He wrote further:

> they need instruction in those sciences which are the source of so much of the wealth and power of our native lands, and without which the resources of the empire can never be fully developed. In supplying them with works of a scientific character, we shall not only promote their material interests, but by employing these as media for conveying religious truth, we shall contribute largely to their intellectual and moral regeneration.

Apart from the text it contains five leaves of diagrams and a large folding sheet showing the course of typhoons in the China Sea.

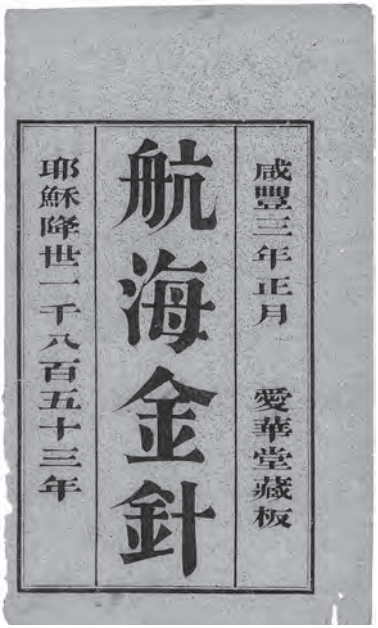

Fig. 1. MacGowan's 1853 booklet at Ningbo. Courtesy of the National Library of Australia.

MacGowan translated the booklet into Chinese, he said, with supplements of his own ideas, so that mariners would know how to avoid hurricanes and master the principles of navigation. In this he is being modest. The work is not at all a literal translation of Reid's chapter. Not only does he add a discussion of basic meteorological principles like atmospheric pressure and the role of the earth's rotation in wind patterns, and adapt the material to the region of the South China Sea, but his discussions of phenomena are much more user-friendly than the sometimes rambling account in Reid. Although his main intention was to advise sailors on the avoidance of harm when encountering a typhoon, in a final chapter he introduces the principles and methods of navigation, especially the determination of position. Explaining the arbitrariness in assigning a zero of longitude, he chose the capital, Peking, as his zero reference in the one labelled chart he presented.[19] He also explains the origins of the tides, contrasting the moon/sun role in the phenomenon with the role of a large fish in a hole in the sea believed by some, he said, to be the explanation. He admitted to ignorance of the names of some islands along the coast and of conditions in the seas north of Taiwan, and invited his Chinese sailor readers to help him. They should fill in the names of the unknown islands and if they encountered typhoons they should record the time, location and the change of the direction of the wind in a timely and continuous fashion, and send their records to the consuls of Western countries. When he had the results he promised he would write another book. He included a chart of typical typhoon tracks in the region, but in the absence of any land-based observatories in that part of the world at the time all such compilations were based on the reports in ships' logs, and it is not too surprising that the chart shows some deficiencies when compared with later summaries. We will return to this issue in chapter 6.

The theological interventions threatened in the introduction are tolerably few. In defence of the scientific method he wrote how as a king administers his kingdom according to laws, so God administers the universe according to laws, too, and that the wind was to be understood as one of God's laws — a contrast he wished to make against prevailing *yin-yang* theories. More evangelical was his advice on personal behaviour on encountering a storm, and being in a position where the ship is nearly destroyed. The mariner should keep a cool head, not panic nor lose his wits and abandon steering. He should not prostrate himself before idols on board and so lose his own judgment. Instead, he should worship with his heart the only true God in heaven, and his son Jesus Christ. Only this God was effective. How could idols made from wood and earth save him? He closed his pamphlet on a moralizing tone, explaining how he had come from afar, not in search of profit or rank but to awaken common people to the truth, and how proper conduct in society, not focussing on profit and greed, was ultimately of greater importance than the avoidance of typhoons. Although

of considerable interest to us here, it is questionable whether MacGowan's book had any significant influence in the country at the time. Did any sailors take up his advice to abandon idols, or his request to forward information to the foreign consuls? It seems unlikely; no second book emerged and no later writers on meteorology in China makes any mention of the one he did write. As we have seen, the book was an early indicator of efforts of foreigners and Chinese together to bring modern developments in mathematics and the sciences to the attention of the citizens of the Empire, but it was to be the only one centred on meteorology.[20] We will encounter no later instances where colonial officials or missionary priests attempted to assimilate native potential in the advancement of the subject, but more usually an opinion on their part dismissive of the ability of local employees for such work.

China: Systematic Recording Pre-1860

The earlier meteorological activity of the Jesuits in the capital had largely been forgotten by the time, more than a hundred years later in 1863, when an attempt was made to revive scientific meteorology there by Robert Hart, inspector-general of the Imperial Chinese Maritime Customs. But before we embark on that episode we must note some organized efforts to publish meteorological data for the country. The *Canton Register* was inaugurated as an English-language publication in November 1827 and from issue No. 36 in October 1838 it began to carry regularly daily temperature, pressure and wind measurements for that city, although it does not state where or by whom they were made. The temperature was quoted to the nearest Fahrenheit degree and the pressure to 1/20th of an inch of mercury. A new journal in the city, the *Chinese Repository*, in its first volume in 1833 carried an article on the climate, reproduced some of the data for 1831 from the *Canton Register*, but also carried records of temperature and pressure at Macao from the 'private diary of Mr. Blettermann' and rainfall data at Macao for sixteen years courtesy of a Mr. Beale.[21]

In 1835 *Bemerkungen über die klimatischen Verhältnisse des südlichen China* by the pioneering German plant physiologist Franz Julius Ferdinand Meyen was published in Europe.[22] On a round-the-world expedition, 1830–32, he monitored meteorological conditions four times daily. On the basis of a four-month sojourn at Macao and Canton in the autumn of 1831, he presumed to write an account of the climate of South China. He made observations of the temperature for a couple of days in August at Northwest Lantau[23] — where he also collected some botanical specimens — before moving on to Macao. There, for a couple of days he recorded temperature and pressure, followed by two weeks at Canton where he recorded thermometer and psychrometer (relative

humidity) data. Although his report may contain the first meteorological data from what would become the territory of Hong Kong, his work is less useful for his own observations than for the compilation of earlier data from Canton and Macao that he presented. Some of it dates back to 1785, the temperature and the winds throughout that year at Canton recorded by C.-L.-J. de Guignes, the French consul in the city at the time.[24] Meyen, in furtherance of his primary interest, botany, took the opportunity of visiting two men in Macao who cultivated large and mature gardens and found some interesting plant specimens. But the two men, the same two responsible for the data published at Canton noted above, were the Dutch general-consul there, Mr. Blettermann and an English merchant, Thomas Beale, who both dabbled in meteorology and had accumulated some records on rainfall and temperature.[25] From Blettermann he collected the extensive data on rainfall he had recorded at Macao from 1812 to 1831 (excluding two years). Meyen also presents four years (1827–30) of temperature data (and one year of pressure data) at Macao recorded by Beale, and temperature data at Canton for 1829–31 as reported in the *Canton Register* of the time. The climate of Canton and Macao was also considered by another traveller at this time.[26] He gave the mean monthly temperature and pressure during 1831 at Canton, from the *Canton Register*, and at Macao from a 'private diary' of Mr. Blettermann. Average monthly rainfall over a period of sixteen years attributed to Mr. Beale was also presented.

The Role of Observatories

As we have noted, established observatories would be the main source of information on meteorology. Apart from evolving observatories in Japan, which in the years of interest to us, in their infancy, made but a small contribution to China Coast meteorology, all such institutions were products of the Western colonial expansion in that part of the world. As such they must be viewed in the context of the establishment of observatories overseas by the colonial powers generally, with the British dictating the paradigm for this study. There were, however, contributions by the French, the Spanish, the Russians and the Dutch, and also a tentative role by the quasi-autonomous Imperial Chinese Maritime Custom Service authorities. The role of observatories in the colonial expansion of Western powers into Asia is not a simple linear story. All the major colonial powers devoted effort to some aspects of the physical sciences usually associated with an observatory and established suitable institutions in that part of the world. In the case of Hong Kong a direct role in colonial expansion is clear. In several other cases it was more the fact that observatories, and observers, were co-opted into the imperial enterprise. However, the aspects emphasized could

vary greatly, and the forces directing them were equally diverse. Astronomy, meteorology, seismology and geomagnetic phenomena all featured, with greater or lesser emphasis, in the developments.

Astronomy was, of course, the doyen among these subjects, but its occurrence was more often the default condition of the practical requirements of providing a time service rather than the academic pastime its practitioners pursued in other parts and, indeed, would have liked to pursue in the Orient. Nowhere is this better illustrated than in Hong Kong, where, as we will see, the frustrated 'Government Astronomer' fought a gallant, but unavailing, fight in defence of his passion for the subject. Nor can anywhere else in the region be said to have fared any better in this respect. The provision of a time service was a very important duty in the early days of these observatories, especially at ports with major shipping traffic such as Shanghai and Hong Kong. Indeed it was the very *raison d'être* for the founding of the latter observatory. The demands for such a service can be seen from the total numbers of vessels entering and leaving Hong Kong: in 1885, 27 100 (344 sailing), in 1900, 82 500 (78 sailing) and in 1912, 489 000 (1 sailing), with respective tonnages of 5.66 million, 18.45 million and 36.74 million. But from the intellectual point of view there was nothing new to be learned from this pursuit and, as it happened, the growth of telegraphy meant that the importance of locally establishing the time steadily declined.

Seismology, in general, had a more particular local interest but, more relevantly, the subject was far from being easily understood and, at the same time, was of little practical application. Only true devotees were involved. The most intriguing subject in our purview of subjects studied in the observatories is terrestrial magnetism. The magnetic compass was an essential of navigation, both by sea and surface, and an accurate map of the geomagnetic field was a prime necessity, but the study of magnetism went far beyond such a pedestrian requirement. The analogue, in the nineteenth century, of a modern high-technology laboratory was a geomagnetic observatory. No expense was spared in furnishing such laboratories world-wide with the most sensitive of instruments, monitoring the time variability of the components of the earth's magnetic field. Once set up, such a laboratory was relatively easy to maintain, but did require a dedicated observer to supervise the observations. It must often have seemed a thankless task, but they contributed to the very foundations of the subject of geophysics, one might almost say, when correlations with solar conditions are acknowledged, cosmic physics.

Meteorology, however, was the paramount subject justifying the existence of these observatories. Not only did the expansion in sea and, later, air travel mean that it came to play an increasingly important role, but there was much that was new to be learned. This was especially the case with regard to storms

in the Pacific and the China Sea, which were such a source of destruction to life and property both on land and on sea. It is recorded that on 17 July 1281 a fleet of 3500 ships assembled by the Mongol emperor Kublai Khan for an invasion of Japan was totally destroyed by a typhoon off the coast of Kyushu, and it was reported that only three of the 100,000 men aboard made it back to China. Storms in Europe, the Indian Ocean and the Antilles had been extensively studied by the middle of the nineteenth century and it remained to establish their nature and properties in the Far East. The historical importance of all the observatories in that part of the world lies almost entirely in the advances achieved by their pioneering staff in understanding such meteorological phenomena, and in weather forecasting.

The Earliest European Institutions

The Russian Observatory at Peking

The earliest of the European-run meteorological services in Asia was a small unit attached to the Russian Orthodox Mission in Peking from 1841. In 1849 this was expanded to a magnetic cum meteorological observatory which was constructed on the grounds of the Embassy, and it recorded data sporadically until 1863.[27] In 1867 the Academy of Science in St. Petersburg took over the operation and dispatched Dr. Hermann Fritsche as director of the Peking Observatory. For the next sixteen years Fritsche coordinated a systematic programme of magnetic and meteorological observations, some of them at stations away from Peking. In 1877, at Shanghai, he published *The Climate of Eastern Asia*, the first substantial work (230 pages) on meteorology in that part of the world. It is perhaps a surprise to find Fritsche decrying the adoption of the metric system by European meteorologists (which, perforce, he had to use himself) since he was of the opinion that the French system differed more from the so-called natural measure than the English, and only 'France with its small territory' would be at a disadvantage if English standards were used.[28] Much of his book is devoted to tables of temperature, pressure and cloud cover (minima, maxima and means), mostly at North Asian locations but including Shanghai, Fuzhou, Keelung, Canton, Hong Kong and Bangkok. We shall have cause to refer to it from time to time later.

The Imperial Chinese Customs: Robert Hart

An important figure in early meteorology in China is Robert Hart, the inspector-general of the Imperial Chinese Maritime Customs. The Chinese Maritime Customs, later when amalgamated with the Qing office of foreign affairs (the *Tsungli Yamen*), the Imperial Chinese Maritime Customs, was originally set up in 1854 as a foreign-operated institution by the Shanghai municipal authorities and the foreign consuls in the city. Although later formally part of the Qing administration, the British always retained a dominant position in the unit.

Hart, an Irishman, was its long-serving second head (1863–1910). In the event, his efforts in meteorology, always but a very small part of his portfolio, were of much value, although much less successful than he had hoped for. Hart had already coordinated the customs medical officers at stations in the treaty ports into a data-gathering body for providing half-yearly reports, which went on to become a very successful operation.[29] Encouraged by this, and mindful that climatic factors was one of the categories encompassed in that work, in November 1869 he devised a similar plan to encompass meteorology in the Empire.[30] He wrote to the commissioners at fourteen Customs stations informing them that he intended a meteorological station to be associated with each Customs office. They would be equipped with the necessary apparatus, and 'two or three simple books on Meteorology etc'. He originally saw the collection of data would also be done by lighthouse keepers at the many new lighthouses established along the coast. They would report, at least initially, to a meteorological department under the statistical secretary and the marine secretary, resident at Shanghai, although he hoped that 'in a few years these meteorological stations will … have at their head an observatory to be established in connection with the Peking college [*Tongwen Guan*]'. The *Tongwen Guan*, originally founded in 1862 as a college for interpreters, was later expanded and became the premier venue for the expansion in the teaching of mathematics and the physical sciences in the country. It was under the administration of the Customs Service.

It was not until four years later that Hart became really enthusiastic about encompassing meteorology in the Custom Service's activities, observing that: 'the Medical Reports are a success … the meteorological observations and exchange of weather-news will, in time, fill up the gap and help to give the West sets of facts concerning the East that must prove most useful to scientific men',[31] and 'if comparative meteorology is to accomplish *anything anywhere anyday*, I fancy our Stations will be as near the front as any others. I seem to have kept it back until just the right moment'.[32] He would be sorely disappointed. He took steps to equip these stations. In March 1873 he asked J. D. Campbell, his agent in London, to consult with the astronomer royal on the required instrumentation, of which twenty sets would be purchased. Twelve sets were to

be sent, he hoped by August of that year, to Shanghai, and eight to the Customs agent in Hong Kong,[33] but later, on 29 May, he speaks only of twelve sets to be sent to the 'cosmopolitan stations'.[34] It is almost certain that his original idea to have sets of instruments sent to Hong Kong was not followed up, for reasons we cannot discern.

The unknown context, however, may explain a certain coolness detectable in his attitude later to the observatory established there; he appears to have had no input in the setting up of the observatory. He also wished his proposal to be made widely known among scientific circles at home, although he was not convincingly clear as to what would be achieved, at one time writing: 'find out if there is any special line in which such stations can be made useful — either to established receptacles of knowledge, or to isolated experimentalists, specialists, etc.' and at another: 'here … there is a movement under way to assist science and give shipping the benefit of the information supplied by daily observations'.[35] For a man educated in the liberal arts (Greek, Latin, English literature, modern languages, etc.) at Queen's University, Belfast, Hart always showed a shrewd scientific sense, here wanting to know: 'which will be the *best hours* to take [the observations] and what will be the *very smallest number* to be taken daily to be compatible with utility'. By May of that year he had drawn up an ambitious list of sites along the Asian coast accessible by telegraph where he hoped to have meteorological stations established — Posiet (Vladivostock), Yokohama, Nagasaki, Newchwang, Hankow, Lamock Islands (near Shantou), Hong Kong, Manila, Saigon, Bangkok, Singapore and Batavia, and had written to the relevant authorities in this context. Already, he reported, the 'Chinese Customs are going to send weather news by telegraph every morning from Shanghai to Hong Kong, Amoy and Nagasaki'.[36] Some of the instruments arrived at Shanghai by early December, 'two whole and four smashed barometers', but these broken instruments were not his only difficulty.

Others were to arise on two fronts, with the Chinese authorities — perhaps not unanticipated — but also apparently, elsewhere. In his letter to Campbell, on 18 October 1873, he writes: 'The [meteorological] work can be put off for another year: it will be better to begin well than to begin badly. You may be on the lookout for a meteorologist: but do not engage one until you have my positive orders to do so. I do not quite like the intensity of "Brother J's" interest: to me it looks like a desire to take the lead out of our hands, and I shall not authorize you to visit W. for the present'.[37] A month later he is writing: 'we'll have to go at Meteorology very gradually'[38] and in December: 'Meteorology will not be in working order for two years more: but *"Hart" is long, if time is fleeting*'. If we take the identification by the editors of the letters, of 'Brother J' with John Bull, i.e. England, and 'W' with Whitehall, it seems that the Colonial Office, with which Hart had no official relations, was taking an interest in the

matter — here, perhaps, lies another possible explanation for the total absence of any reference to Hart in the setting up of the Hong Kong Observatory. An antagonism in this direction is also suggested by Hart's unfavourable opinion of a Mr. Wodehouse who applied for a meteorological position, ostensibly because he was an amateur, but, as the editors of his letter suggest, the fact that Wodehouse was 'a man of very high standing in the Colonial Service' did not endear him to the inspector general.[39]

Campbell informed Hart of the high opinion of Mr. Blanford, the meteorological reporter for Bengal, of his scheme: 'but thinks it too "ambitious" and fears it will fail unless you can get a man, who thoroughly understands such work, to carry it out'.[40] He finally decided that the data from the chain of coastal stations would be channelled to the head station in Peking and the programme directed by an astronomer stationed at the *Tongwen Guan*. A very suitable candidate for the astronomer's post was found, one Ralph Copeland, and in a letter to Campbell of 30 September 1874, he writes: 'Herewith authority to appoint Copeland … the "Chair" means *schoolmaster's work*, … life in China has many drawbacks: on the other hand it is possible that if he "takes well", he may make a career, for the Chinese have an immense reverence for Astronomy'.[41] Mr. Copeland had some short-term plans, including a visit to Mauritius for observing the transit of Venus in late 1874, but such a delay was deemed acceptable and, for Copeland, turned out to be fortunate, for when the time came around that he was free to go to China the whole scheme had fallen through. The Chinese authorities appear to have had a change of heart, probably a reluctance to see further encroachment by foreigners in its territory in a sensitive field, though not so explained by Hart when he wrote to Campbell in January 1876 that: 'the Yamen has backed out of its desire to have a Professor of Astronomy and says we must wait. I tell them they have lost such a chance as they'll never have again. They reply. "There's corn in Egypt".'[42] No more is heard of his proposal. Copeland went on to a distinguished career: professor of astronomy at Edinburgh and eventually astronomer royal for Scotland. As will be seen later, after 1882 the Jesuit observatory at Zikawei took over the coordination of data monitored by Customs officers along the coast, while the founding director of the Hong Kong Observatory was to come across the meteorological instruments, still stored unboxed, in the Custom Houses at Shanghai and Xiamen in the autumn of 1883 to begin a new phase in the story.[43]

The attitude of reluctance of the Chinese Imperial government in respect of making use of foreign expertise contrasts with that of contemporary Meiji Japan, where foreigners were conscripted, at very attractive rates of pay, but for just such duration as enabled their expertise to be transferred to local students. A notable example was the unemployed ex-master of the Hong Kong Mint, Thomas William Kinder, whose salary as director of the Osaka Mint in 1870

was 50% more than that of the Japanese prime minister. There was also in China a failure to abjure traditional thinking. What one writer has described as 'moral meteorology' still held a place in Imperial decrees, where the visitations of unwelcome climatic conditions was attributed to objectionable behaviour by the local population or their officials.[44] As late as 1870 the emperor in a decree blamed floods, droughts and deficient harvests on unhappiness in heaven with officials, great and small, in this echoing the earlier 'moral meteorological analysis' of the Yongzheng Emperor:

> We are of the opinion that although icy hail commonly occurs in the northern regions, yet the disasters suffered by the villages of Xuanhua seem uniquely severe, and rarely seen in recent times. It is evident that Heaven Above has been sending signs again and again to warn Xuanhua. If by any chance the local officials or common peoples regard these as accidents due to natural causation then they are inferior people who do not know how to tremble in fear and reflect on their transgressions.[45]

In summary, it may be said that Hart overreached himself in his enthusiasm for meteorology, but his efforts were not totally in vain. Although lacking any formal integrating structure, meteorological recordings at the Customs stations were begun. Fritsche presents sporadic data on temperature and pressure, starting in 1871 from Imperial Maritime Customs stations at Chefoo, Newchang, Taku and Kelung. However, he considered the observations not of very great use, 'being very incomplete, and obtained with instruments whose corrections are not known'.[46] Some further information on observations made at the treaty ports is available in a recent publication.[47] When Doberck arrived on the scene at Hong Kong some use could be made of the archived instruments, and data from the Customs stations were later to play an important role in the development of synoptic meteorology in the region. However, the prosecution of meteorology in a professional manner in China would have to wait a few years more until the establishment of the Zikawei Observatory at Shanghai by the Jesuits in 1873.

The Established Observatories

In the Europe of the eighteenth and nineteenth centuries the attraction of distant parts for students of the botanical and zoological sciences was obvious, as much from the point of view of gainful pursuit as the pursuit of pure science itself. And, indeed, such studies were enthusiastically pursued in the newly acquired colonies in both contexts. The case of the physical sciences was not so clear cut. By and large, exotic locations did not offer an advantage in studying them and their pursuit 'overseas' hinged very much on their utilitarian value. This aspect

of the history of science has been vigorously promoted by commentators on 'colonial science' in recent times, and, indeed, the argument may be valid, but it certainly needs more investigation than it has received heretofore.[48] Before looking into the observatories that had an important impact on the one that was to develop in Hong Kong, it is interesting to look briefly at some other related institutions.

The nineteenth century brought a flourishing of scientific-related activity generally and advances in meteorology became important from a practical point of view. However, it is with a brief consideration of geomagnetic monitoring that we introduce the 'overseas' observatories. Following C. F. Gauss's suggestion of a systematic study of the earth's magnetic field, an international array of monitoring stations was supported by the British government — the earliest example of what would later be termed a 'campaign'. Under the supervision of Edward Sabine at the Royal Society, stations at Toronto, South Africa, St. Helena and Van Diemen's Land (Tasmania) — the 'Colonial Observatories' — were equipped with instruments designed by Humphrey Lloyd in Dublin. They monitored the field hourly (and for short periods, every few minutes), for a period of at least three years between 1840 and 1850. Meteorological observations did tag along — the temperature, in particular, was required for reducing the magnetic data — but otherwise it was a low priority concern. These colonial observatories were the prototype for later meteorological observatories, notably those at Mauritius and Hong Kong.

There were observatories at Madras and at Bombay but the most influential of the early observatories in the Indian Ocean, and one which could play a role model for a similar establishment at Hong Kong, was that operating at Mauritius. Time-keeping, meteorology and geomagnetic recording were practised at a public observatory on the island of Mauritius from as early as 1831, but it was 1874 when The Royal Alfred Observatory attained the status of a government department and became operational. Its first director was Dr. Charles Meldrum, a pioneer in the study of tropical storms. There was a lot of maritime traffic in the Indian Ocean, and good seamen's practice was that the meteorological situation should be regularly recorded in the ship's log. Among the important parameters were the barometric pressure, the wind strength and direction, and the temperature. When later reduced and collated, such data, when combined with observations from the islands of Rodrigues, St. Brandon, Agalega, Diego Garcia and the Seychelles, enabled charts, so-called synoptic charts, of the situation at some earlier times to be drawn, which, if without direct forecasting potential, could reveal some useful information. On such a basis Meldrum first established the spiral motion of the wind inwards towards the centre of a tropical storm.[49] This study gave rise to the well-regarded 'Meldrum's rules' for sailors when encountering such a storm.[50]

East Asia provided a notable void in the availability of global climatic data from before about 1875 — data which would be of considerable contemporary interest in the context of assessing the status of global climate change. Quantitative meteorology only became a subject of organized study from about that time.

The Philippines

Of all the external institutions that were to have an impact on the study of meteorology in Hong Kong, none rivalled in importance the observatory at Manila, even if the first director of the Hong Kong Observatory did not quite see the relationship in this way. By the mid-nineteenth century the extent of the great Spanish empire had dwindled to a few remote colonies. Although the Philippines was the largest of these, it was very much neglected, and education was poorly provided for. There were universities, but science was totally lacking from their curricula. The setting up of observatories under Spanish and French control fell to the private sector, in the guise of Jesuit missionaries. Suppressed for forty-one years from 1773 — at a time when they controlled thirty astronomical observatories — the Society of Jesus was re-established in 1814 and steadily reclaimed the ground it had occupied in the intellectual world in the seventeenth and eighteenth centuries. Harnessing advances in scientific knowledge in the cause of evangelization, as they had done with astronomical knowledge at Peking in earlier years, they set about establishing institutions of learning in various parts of the world. The first half of the nineteenth century had seen major advances in the field of meteorology which elevated it to a subject of great practical utility and thus recommended itself as a vehicle for their aims, much as a later generation of missionaries would see medical skills as an opportunity in the same cause.

Meteorological recordings in the Philippines were started, as a hobby, at the Ateneo, the Jesuit school in Manila, by Fr. Francisco Colina in 1860. Colina began publishing his observations in a local newspaper and these, together with the passage of a major typhoon over the city in 1865, stimulated local interests to contribute for the provision of meteorological instruments. These enabled regular monitoring and forecasting to be carried out from that year onwards, and the operation informally became known as the 'observatory' and Fr. Colina as its 'director'. The importance of the school as a meteorological observatory dates from 1866, with the arrival there of Federico Faura, who put the Observatory on a firm footing.[51] Faura's first interest was astronomy, and with two assistants he joined a Dutch team to observe a total solar eclipse in 1868 on the small

island of Mantawalok in the Celebes.[52] They were brought there on a British ship under a Captain Charles Bullock, who also reported to London on his observations of the phenomenon. The attention of Europe to an observatory operating in Manila was drawn by the results of the photographs taken by the Manila priests being published in Rome by the leading astronomer Pietro Angelo Secchi.[53] Faura then returned to Europe for seven years, spending time with Secchi in Rome, and at the Stonyhurst Observatory in England. Stonyhurst at the time was one of the seven first-class meteorological stations of the British Meteorological Office and had a well-known observatory for geomagnetism. He returned to Manila in 1878 to become director of the Observatory, a position he held for ten years. He immediately began his investigations into typhoons. His timely warning of the approach of major typhoons on two occasions in 1879 greatly raised the prestige of the Observatory.

The study of meteorology, and especially the role of weather forecasting, had been revolutionized in Europe and North America from mid-century by the introduction of cable telegraphy. The possibilities of this new technology in East Asia were not as readily realized, but from 1 May 1880 Manila was in telegraphic contact with Hong Kong. Knowing of the Observatory's expertise in storm warning, the government of Hong Kong requested their forwarding to the port, and this led the Spanish governor of the Philippines to set up a committee to look into the matter generally. The result was a proposal, drafted by Faura, to establish a government-supported meteorological service, to be managed by the Jesuits. It took the home authorities in Madrid three years to take action and grant the Observatory official status as headquarters of the Meteorological Service of the Philippines. In 1886 it moved out of the old city to occupy several buildings which were part of a newly constructed school in Ermita. At that time it embraced ten other monitoring stations in the islands.[54] The Observatory was divided into four sections, for meteorology, astronomy, geomagnetism and seismology, respectively. Equipped with a meridian telescope by Dollond, the Observatory assumed responsibility for official time-keeping in the Colony in 1885, dropping a time-ball at noon daily, which was followed by a cannon shot in the Manila harbour. From 1880 Faura had regularly sent messages to Hong Kong, so that his observatory was seen as an important complementary component when plans for an observatory were being drawn up there in 1881. In the context of these messages, we will later have more to say on Fr. Faura, his successor José Algué and the Manila Observatory. Faura was succeeded by José Algué in 1897; Algué had studied at Georgetown University with Hagen and had worked with the distinguished meteorologist Vines in Havana. In 1901 the American administration entrusted the direction of the new Philippines Weather Bureau to the Observatory, with Algué as director.[55]

China: Zikawei

French contributions to systematic meteorology in the East centre on Shanghai, and to a lesser extent on their colonies in Indo-China, the former, courtesy of the Jesuits. Notwithstanding the fact that for 150 years they had served as directors of the Imperial Observatory in Peking, the beginnings of a revived scientific presence by the Jesuits in China, almost contemporaneous with those in Manila, were similarly modest. The role of some early French Jesuits in meteorological observations at Peking has been described above. When they returned to China in 1842 they started with a college and seminary at Zikawei, a suburb of Shanghai (now in Shanghai city proper). Starting in 1868, under the direction of Fr. P. M. Heude, they developed a museum of natural history, the first of its kind in China, which attained international recognition. Following that, in 1873, they again started reporting meteorological observations. Some observations from Shanghai in the period 1848–53 and in the late 1860s also exist.[56] In August 1872 they decided to establish a Jiangnan Association for Science — Jiangsu and Anhui constitute the diocese of Jiangnan — which would incorporate a meteorological observatory at Zikawei under the direction of Fr. A. Colombel.[57] The Observatory was equipped with a barometer (Fortin), maximum and minimum thermometers and a psychrometer of French manufacture, all calibrated at the Observatory of the Meteorological Society of Paris, and started publishing data from January 1873 in a *Bulletin Météorologique*. The bulletin's ornate banner reading '*A. M. D. G.*' [*Ad Majorem Dei Gloriam*], the motto of the Jesuits, was the only indicator of any evangelical content.

The professionalism of a modern observatory, however, only dates from the following year when Marc Dechevrens arrived to take up the directorship, and lead it to recognition as a first class observatory. Dechevrens, a sometime teacher of physics in the Jesuit College Vaugirard in Paris, spent three months before embarking for the East at Stonyhurst Observatory, familiarizing himself with meteorological and geomagnetic observing practices. In June 1874 he reported his first measurements of the magnetic field at Zikawei.[58] Like his contemporary Faura in Manila, Dechevrens took a keen interest in typhoons, and on the basis of a major one that struck Shanghai in 1879 wrote a detailed study of the storm and its effects, including an early trajectory for such a storm, which won favourable comment. These developments led the International Chamber of Commerce in Shanghai to suggest the possibility of Dechevrens heading up a typhoon signal service for the city and the coast. They would provide some support for his work, and it was expected that Sir Robert Hart and the Chinese Maritime Customs Service would supply the Zikawei Observatory with regular meteorological observations from the coastal stations. Together with data collected from ships and lighthouses, and reports from Manila and

Tokyo, Dechevrens was able to publish a pamphlet giving an account of the typhoons of 1882. For the first time in that part of the world, in the words of a reviewer in *Nature*, he 'has been able to … trace the history of several typhoons from their cradle in the equatorial maritime regions to their grave in the North Pacific Ocean'.[59] We shall return to this project later.

From 1884 a time service was provided for ships in the Shanghai harbour, using a Billant equatorial telescope for calibration, by dropping a time-ball at the Observatory at noon, and firing a cannon from the harbour. In 1884 Dechevrens devised a storm warning system, which was to be widely used in the region, and which could be transmitted to the harbour at Shanghai via a newly installed telegraphic link with his observatory.[60] Despite the frosty attitude of Doberck in Hong Kong, the Zikawei Observatory, with some financial assistance from Chinese and English insurance companies, would establish itself as the premier meteorological observatory in the East. Under the leadership of Stanislas Chevalier and, especially from 1897, Louis Marie Froc, its operations embraced most of East Asia. By 1904, Zikawei was receiving 150 telegraphic bulletins daily from 60 stations, ranging in latitude from Yap (9° 25′N) to Tomsk (56° 30′N), 14 from Japan and Formosa, 11 from Siberia, 6 from Indochina, 6 from the Yangtze valley, and 11 from the China coast, among others. It took one Jesuit the better part of a day to make sense of them and prepare the forecast.[61] The Observatory's activities in magnetic monitoring and in astronomy would go on to become major autonomous operations.

South-East Asia

Above and beyond the Jesuit contribution, there were some more official French contributions to meteorology in the region. Dr. Alfred-Emile Borius, the surgeon general in Tonkin, was also an enthusiastic amateur meteorologist who had worked in Africa. He was charged with setting up a meteorological service in 1884 for Indochina based on Haiphong. Although he was dead within a year, he had already established regular telegraphic contact with the Hong Kong Observatory, and was exchanging observations twice a day with them. According to the *Hong Kong Daily Press* in 1884, he acknowledged 'information about typhoons from here, the necessity for which was made apparent by the disastrous typhoon of 8 July [1884] that ravaged Haiphong, the course of which was forecast here by the Government Astronomer, whose subsequent telegrams Dr. Borius states to have produced great effect and to have convinced the most skeptical'.[62] From a meteorological point of view, Hong Kong stood in relation to Indochina very much as Manila stood in relation to Hong Kong; important

traffic was to a large extent one way. Apart from dispatching routine readings by telegraph, no great activity there followed Borius's death until the end of the century. The French administration then decided on a more comprehensive meteorological service and, in 1898, employed the services of the experienced Fr. Froc from the Zikawei Observatory to identify a suitable location for an observatory, and engaged his help in designing the observatory buildings. His choice of Phu Lien, nine kilometres south of Haiphong, became the site of the Phu Lien Observatory (also known as Tonkin Observatory, Haiphong Observatory). Apart from the major observatories in the East, it also received reports from French observers in Yunnan, Guangdong and Guangxi, but it was 1905 before it was fully operational, too late to make much impression on our story.[63]

A Magnetical and Meteorological Observatory at Batavia was started in 1875 under Dr. Pieter Adriaan Bergsma as director, but he died en route to the Netherlands in 1882. For most of the time 1883–99, although well funded, it lacked consistent leadership (part of the time under J. P. van der Stok), and it only gained fame from the early years of the twentieth century onwards.[64] It never had telegraphic connection with Hong Kong.

Japan

Although not strictly a component of the 'colonial observatories', early instrumental meteorology in Japan was largely in the hands of expatriates. The country in these early days played but a small role in regional meteorology. Only after the Meiji Restoration in 1867 did instrumental meteorology gain a foothold there. Hakodate Meteorological Station started in 1872. Europeans and Americans, no less than in the Philippines or China, played the lead role in this development, in the guise of *yatoi*, specialists recruited by the Japanese government to facilitate the entry of modern scientific methods into the administration of the Empire. Previous recordings of meteorological data, by visitors, were much less common than in the case of China because of the severely limited mobility of foreigners in the country. However, in recent years some early records have been located. Some data for Nagasaki and Tokyo (Edo) collected by a German doctor serving with the Dutch colony at Nagasaki from 1819 to 1828 survive, and there is a series of data from 1839 to 1855 recorded in the native observatory at Tokyo devoted to maintaining the calendar. The Dutch themselves started recording basic climatic data on Dejima Island (Nagasaki) from 1845.[65] The earliest comprehensive recordings of meteorological parameters are by Erwin Knipping, and date from 1872. Dr. Knipping was a German mathematician

at the University of Tokyo and he took a professional approach to the subject. Starting with data from October 1872, he regularly published monthly summaries of meteorological parameters (and sometimes daily observations) and his data were widely distributed.[66] He also published some material on typhoons related to those islands. Later, Thomas Corwin Mendenhall, a professor of physics in the same university also started publishing meteorological recordings. The Tokyo Meteorological Observatory was set up in 1875, followed by observatories at Osaka (1883) and Kobe (1897). Storm warnings were hoisted, starting from 1883.

Early Meteorology in Hong Kong

Anecdotal records of some of the great storms in the counties adjacent to Hong Kong from the Song to the Qing dynasties (thirteenth to nineteenth century) have been preserved.[67] In July 1841, in the earliest stages of the settlement by the British, a major typhoon struck, for which we have vivid reminiscences[68] and, according to Eitel its near-annihilation of Hong Kong brought rejoicing in Imperial circles.[69] If we ignore the very cursory observations by Meyen on Lantau in 1831, the earliest recorded readings were made by the British authorities. From day one of their occupation they monitored the basic meteorological parameters and as early as 1845 published in *The Friend of China* and the *Hong Kong Government Gazette* a 'Meteorological Register'. A summary of the earliest data has been given by Ho.[70] Both the locations and the times where the observations were made changed over time. More devoted attention to meteorology resulted in a network of seventeen stations across the globe, including Hong Kong, under British Royal Engineer officers being established in 1851, later (1 April 1862) transferred to the Army Medical Department. Climate at the time was seen as a major factor in medical conditions. Some of them, including Hong Kong, reported until December 1884, when the operation was disbanded.[71] These observations were, it seems, sometimes made in parallel with other observations. The *Hong Kong Government Gazette* was set up in September 1853, and from 29 April 1854 carried systematic reporting of these observations in the form of monthly averages (at five recording times daily) of pressure, wet and dry bulb thermometer, and associated dew point and humidity for the previous year taken at the Seamen's Hospital in Wanchai. A Dr. James B. Thompson addressed some remarks on the climate of Hong Kong at a meeting of the Royal Geographical Society in London in 1845, but he focused mainly on the precautions Europeans should take to avoid illness.[72] The first published summary of the climate in Hong Kong seems to be that of a Dr. Smart at the Royal Naval Hospital in 1863, but he gives no information on typhoons.[73]

He analyzed the local data, pressure and temperature from 1853 to 1858. He also compared the average of this six years' temperature data with those reported from Macao by Beale twenty years before, noted earlier, and commented on a 'great want of accordance'. Seeing that he could find good agreement between current data from Hong Kong and Canton, he concluded that 'in the Macao series the instruments used may have been less exact than those with more modern improvements'. This illustrates just one of the many pitfalls modern day climatologists have to circumvent in their study of past records.

Quite detailed reporting of meteorological parameters in the *Gazette* began in February 1861 when bi-daily (9 A.M., 3 P.M.) readings at the Government Civil Hospital (later Government Lock Hospital) for every day in the previous month were presented as 'Meteorological Tables' and continued, with only slight interruption, until the opening of the new observatory in 1884. Considering that they could hardly have served any practical use in the colony and were presumably offered as a contribution to the cause of pure science, the regularity, usually weekly, with which the data were published is impressive. They were sometimes summarized in global compilations, e.g. in 1863 the average monthly temperatures, as by then established, were published in the *Philosophical Transactions of the Royal Society*.[74] But as with the data from other stations, it is not clear to what other purpose they obtained. To quote one writer: 'it is possible that the Army Medical Department put them to practical use, but it seems more likely that they were stored on a shelf and forgotten'.[75] In parallel with these data, from 24 November 1860 the *Gazette* every week printed 'Weather Tables' (from July 1876 titled 'Meteorological Observations') which contained data taken three times a day, at 6 A.M., 12 and 6 P.M. Initially the measurements were of the temperature and pressure as recorded at the Harbour Master's Office on Queen's Road and on the Peak, but they were eventually extended to include dry and wet bulb thermometers, maxima and minima, the wind and the weather, and to include reports also from Police Gap Station, Stonecutter's Island and Cape d'Aguilar. From May 1876 the *Daily Press* also carried a 'China Coast Meteorological Register' which gave data for the previous day at Hong Kong, Shanghai, Xiamen and Nagasaki. There was thus no scarcity of recorded data, but the practical utility of the efforts must be questioned: published figures were never less than a week old, and usually much longer after the event. The quality of the data was also questionable in some cases; certainly the future director of the Observatory did not have a very high opinion of its reliability.[76] A summary of some of the results is given by Ho.[77] In terms of the acquisition of basic meteorological data the existing arrangements by the end of the 1870s were probably adequate or, at most, required some closer supervision of the instruments used.

What was not adequately provided for was any kind of forecasting, and especially warning of, approaching typhoons. This was illustrated by the case of a big typhoon that struck Hong Kong in September 1874 and claimed more than 2500 victims. In his history of the times, Eitel, a witness to the event, gives a colourful account of it.[78] An account of the storm was also carried in *Nature*, which claimed, *inter alia*, that an earthquake occurred while the typhoon was raging.[79] This was based on the fact that several public clocks stopped at the same time, just the time when the storm was registered at being at its peak. This was not the first suggestion of the possible association of an earth tremour with a typhoon, but none of the evidence was unambiguous.[80] The prominent meteorologist and author, Piddington, had drawn attention to the need for study of the matter, but his work seems to have been overlooked by the *Nature* columnist. Some years later, in 1894, Fr. Algué in Manila hit upon microseismic movements as possible precursory signals for a typhoon and devoted a chapter to them in his book.[81] The Manila observatory was doing seismic monitoring at the time, taking readings of a tromometer (a primitive seismograph) every hour. From his own observations on several storms Algué argued that the main disturbances occurred when the storm was over land, and in particular when it was incident on a mountain range. It would be many more years before it became established that microseisms can be produced, mainly by the oceanic convulsions which result from cyclonic storms. Indeed these disturbances can now be used to estimate the locations of typhoons over the sea. It is likely that such travelling microseismic disturbances will act as a trigger for a more significant tremour in a region where critical crustal stresses already occur.

An alternative proposal for the association of seismic movement with typhoons is the proposal that a sudden release of pressure, as would occur when the eye of a typhoon passes over land, may play a similar role in releasing pent-up stresses. The latter hypothesis, now seldom embraced, was especially propounded by Fr. Ernesto Gherzi, a later director of Zikawei, and post-1949 a member of staff of the Hong Kong Observatory.[82] This has been an opportunity to mention, however briefly, the aspect of seismology in an observatory and to note that we will not be returning to it. Although obviously of great importance in places like Japan and the Philippines, in the days before nuclear power stations were contemplated it was realized that little practical benefit to the Hong Kong community could accrue from a pursuit of this discipline. There were occasional, fleeting references to the introduction of seismology into the future Hong Kong Observatory, notably efforts in 1898 from London to establish seismic monitoring. This was aborted, ostensibly on the grounds of the, not very large, cost, but with the hand of the governor strengthened by the director's reluctance to get involved, citing lack of space and shortage of manpower at the Observatory.[83] It would be 1921 before instrumentation appropriate to the

study of the subject would be installed in the Colony. The memory of the great storm of 1874 was still very much alive when proposals came to be floated for an observatory in Hong Kong.

Compared to the Indian Ocean and the Caribbean, knowledge of cyclonic storms in the China Sea by the mid-1870s was very incomplete. It is clear that at the time a very promising field of study was waiting to be undertaken. The coordination of meteorological monitoring in Hong Kong was in the hands of the harbour master, and it is from his office that the first mention of a practical aspect of meteorological monitoring appeared, in the form of a notice of proposed storm warnings published in the 4 August 1877 issue of the *Gazette*:

> In the event of bad weather being apprehended by this Department, a black drum will be hoisted at the *Office Flagstaff*. A similar signal will be hoisted and a *gun* will be fired from the *Police Hulk*.
>
> The usual signs of approaching bad weather are a falling Barometer with high Thermometer, sultriness of the atmosphere, wildness and discoloration of the clouds, and birds flying about in unusual numbers. Should these symptoms exist and the wind be anywhere between North-Westerly and North-Easterly, a typhoon of a severe type may be looked for.
>
> The same indications of bad weather with the wind between South-Easterly and South-Westerly, a typhoon may be known to be in the neighbourhood, but not likely to be severely felt at Hong Kong.

This was repeated, essentially unchanged in 1878, 1879, 1880 (also now in Chinese — there was some *Gazette* notification in Chinese in earlier years, e.g. 28 April 1858 related to rates payment, but only in the administration of Pope Hennessy, from 1 January 1879, was regular notification of items considered of interest to the local population given in Chinese in the *Gazette*), 1881, 1882, 1883. These warnings were basically for the information of mariners so they could decide whether or not to set sail. More local warning signs familiar to the commercial and boat populations were not countenanced.

The weather was not the only factor which motivated the maritime community to seek an observatory. The availability of a reliable time signal at the port of Hong Kong was also a high priority and it was this requirement, as we will see in the next chapter, that acted as a trigger in moving officialdom to consider the setting up of such an institution.

Notes

Chapter 1

1. Fairbank et al. (1975), Letter 69.
2. In the case of Hong Kong, for medicine see Evans (1987); for marine studies from about 1860, Morton (1990). There was some chemistry (physical chemistry at the Mint, 1866–68, and from 1879 a 'Government Apothecary and Analyst' in the Colonial Surgeon's Department). Civil engineering is described by C. Michael Guilford, A Look Back: Civil Engineering in Hong Kong 1841–1941, *J. Hong Kong Branch Roy. Asiatic Soc.*, **37**, 81–135, 1998.
3. A. Chu, *Amateur Astronomy in Hong Kong — A Brief History*, 2003; available at www.alanchuhk@HK_Astro.doc.
4. According to the official notification in the *Hong Kong Government Gazette* in July 1912, it was to be known as 'The Royal Observatory, Hongkong'.
5. Needham (1959), §21; Ho (2003).
6. James Cunningham, Some Observations of the Mercury's Altitude, with the Changes of the Weather at Emuy in China. Lat. 24 degrees 20′. No., *Phil. Trans.*, **21**(256), 323–30, 1699.
7. Gaston Demaree and Øyvind Nordli, On the Amount of Rain Fallen in Macau, China, in the Year 1780, *Meded. Zitt. K. Acad. Overzeese Wet.*, **49**, 497–506, 2003.
8. Ibid.
9. Huib J. Zuidervaart and Rob H. Van Gent, 'A Bare Outpost of Learned European Culture on the Edge of the Jungles of Java' — Johan Maurits Mohr (1716–1775) and the Emergence of Instrumental and Institutional Science in Dutch Indonesia, *Isis*, **95**, 1–33, 2004.
10. Ho (2003), §1.
11. Coching Chu, Some Chinese Contributions to Meteorology, *Geographical Review*, **5**, 136–9, 1918.
12. Under 'Meteorology', in *Encyclopaedia Sinica*, ed. Samuel Couling, Shanghai: Kelly & Walsh, 1917, pp. 349–61.
13. De'er Zhang and Gaston Demaree, Northern China Maximum Temperature in the Summer of 1743: A Historical Event of Burning Summer in Relatively Warm Climate Background, *Chinese Science Bulletin*, **49**, 2508–14, 2004.
14. Ibid.
15. Khrgian (1970), p. 13.
16. MacGowan (1853).
17. An American medical doctor and Protestant missionary, MacGowan arrived in Hong Kong in 1843 and died fifty years later in Shanghai. His early missionary work at Ningbo and Shanghai was followed by a stint, 1862–1865, in the Federal Army. He then returned to China as an agent of a syndicate planning to build a telegraph line

to China via the Bering Straits and participated in the translation programme run from the Jiangnan Arsenal. In 1879 he took up a position with the Imperial Chinese Maritime Customs, where he wrote medical reports of lasting value from Wenzhou. See MacPherson (1987), Elman (2005) and *Memorials of Protestant Missions to the Chinese: Giving a List of Their Publications and Obituary Notices of the Deceased, Shanghai*: American Presbyterian Mission Press, 1867, p. 133.

18. Reid (1849). Reid (1850) also has a chapter on typhoons in the China Sea, but it lacks many of the diagrams of the earlier book.
19. It should be noted that as late as 1900, the Jesuits, in the masthead of their publications, gave the longitude of their observatory at Zikawei relative to Paris, although they seem to have invariably used Greenwich as reference in the body of the text.
20. Widely described in recent years, see for instance Elman (2005). The only other material in Chinese related to meteorology are two articles in the August and September 1876 issues of *Gezhi huibian* (格致彙編, *The Chinese Scientific and Industrial Magazine*, Shanghai). These are translations by John Fryer from an elementary British publication, *Chamber's Introduction to Science*; they describe the mercury and aneroid barometers ('wind-rain meter') but do not have anything to say about typhoons.
21. Climate of Canton and Macao, *Chinese Repository*, **1**, 488–91, 1833.
22. Meyen (1835).
23. He locates it at Cap Syng-moon, by which he seems to mean the straits between North Lantau and Tuen Mun.
24. Chretien-Louis-Joseph de Guignes, son of the famous orientalist Joseph de Guignes, arrived at Canton as consul in 1784 and remained in the country for seventeen years, as a trader and interpreter. He appears to have only made records for a year. In later life he is known as the author of a plagiarized Chinese-Latin dictionary.
25. Thomas Beale, English merchant and opium importer, spent forty-nine years in Macao from his arrival in 1792 until his death there in 1841. A colourful character, whose fortunes took a serious turn for the worse in later life, at the time of the botanist Meyen's visit he had a garden described as the most lavish in the territory, a magnet for his wandering visitor.
26. Roberts (1837), §12.
27. Khrgian (1970), p. 131.
28. Fritsche (1877), p. 142.
29. See for example, MacPherson (1987).
30. Circular No. 28 of the Inspectorate-General of Customs, 12 November 1869.
31. Fairbank et al. (1975), Letter 56, 29 May 1873. See also Wright (1950), p. 304.
32. Ibid., Letter 66.
33. Ibid., Letter 49, 14 March 1873.
34. Ibid., Letter 56.
35. Ibid.
36. Ibid., Letter 55, 23 May 1873.
37. Ibid., Letter 67.
38. Ibid., Letter 69.
39. Ibid., Letter 82, n3.
40. Henry Francis Blanford (1834–93); Letter No. 41 in Vol. 1 of Chen and Han (1990).
41. Fairbank et al. (1975), Letter 113.
42. Ibid., Letter 142.

43. Report from the Government Astronomer, *Hong Kong Government Gazette*, 17 November 1883, pp. 876–80.
44. Mark Elvin, Who Was Responsible for the Weather, *Osiris*, **13**, 213–37, 1998. The attitude, of course, still occurs in parts of the world to this day.
45. Ibid., p. 227, in a translation of *Da Qing Shizong Yongzheng huangdi shengxun*, juan 8, pp. 4–7.
46. Fritsche (1877), p. 127.
47. Hong, Liu et al. (2006), §11.
48. For example, Hebe Vessuri in Salomon et al. (1994), pp. 168–200.
49. *Nature*, **6**, 357–8, 1882.
50. Ralph Abercromby, On Meldrum's Rules for Handling Ships in the Southern Indian Ocean, *Proceedings of the Royal Society of London*, **44**, 314–7, 1888.
51. For a brief biography of Faura see Bernad (2006), pp. 3–10.
52. Also listed as Mantawalok-Kekee, and Mantawalok-Kelee. Where was it? No such name is to be found nowadays attached to an island in the Celebes, and the coordinates, 0°32´ S, 122°20´ E quoted by Saderra Masó and elsewhere, do not define any island. Other reports are no more helpful, saying that it was only half a mile across, and 'two miles from the Celebes coast'. It is almost certainly the very small island labelled on modern maps as Mantawatukiki at 0° 30´ 56" S, 123° 05´ 46" E, about ninety kilometres away from the location specified. The original destination of the expedition was Taliabu Island further south, but problems with the ship meant they could only make as far as Mantawalok, already in the swath of totality, in time.
53. Their sketch of the solar corona is reproduced in Procter (1871), p. 334. Lockyer mentioned the observations, attributing them only to Captain Bullock, in a lecture published in *Nature*, **4**, 232, 1871. As recently as 2005 their sketch of the solar corona has been cited and reproduced, in Richard Woo, Relating White-Light Coronal Images to Magnetic Fields and Plasma Flow, *Solar Physics*, **231**, 71–85, 2005.
54. Saderra Masó (1915), §8. Briefer accounts of the Manila Observatory are given in James J. Hennessy, The Manila Observatory, *Philippine Studies*, **8**, 99–120, 1960, and John N. Schumacher, One Hundred Years of Jesuit Scientists: The Manila Observatory 1865–1965, *Philippine Studies*, **13**, 258–86, 1965. The early archives of the Observatory were destroyed in 1945.
55. Saderra Masó (1915), §16.
56. Fritsche (1877), pp. 199, 262.
57. It is surprising that no formal history of the Zikawei Observatory has been written but fragmentary accounts occur in various places, notably, Gherzi (1951), and *Boletim Instituto Português de Hongkong*, 45–57, 1950; J. Dehergne, Zi-Ka-Wei — l'Observatoire des Cyclones, *La Meteorologie*, **4**, 179–88, 1976; Shu and Jiang (1997), §16; Pyenson (1993), §6; Udias (2003), §7 and Zhou (2005), pp. 160–73.
58. M. Dechevrens, Magnetic Observations at Zi-Ka-Wei, *Proc. Roy. Soc.* (London), **22**, 440, 1874.
59. *Nature*, **30**, 388, 1884.
60. Udias (2003).
61. Pyenson (1993), p. 162.
62. Noted in The *Observatory*, **8**, 27–8, 1885.
63. Auguste Chevalier, *L'exploration Scientifique*, in Maspero (1930), pp. 123–4.
64. Pyenson (1989), §3.

65. Zaiki et al. (2006); and T. Tsukahara, Reconstructing the Climate of Nineteenth-East Asia from the Perspective of the History of Science, *Proceedings of International Commission on History of Meteorology (ICHM) from Beaufort to Bjerknes and Beyond. Critical Perspectives on Observing, Analyzing and Predicting Weather and Climate*, Weilheim, Germany, 5–9 July 2004.
66. In *Mittheilungen der Deutschen Gesellschaft für Natür-Und Völkerkunde Ostasiens in Tokio*, starting with Vol. 1, Part 1, May, 1873. There are records of earlier measurements by local, and expatriate, observers, these now of some importance in discussions of climate change. See for example, J. C. Hepburn in Trans. *Asiatic Soc. Japan*, **2**, 215–6, 1874, and Zaiki et al. (2006).
67. Ho (2003), pp. 24–5.
68. Bernard (1847), pp. 210–5.
69. Eitel (1895), p. 176.
70. Ho (2003), pp. 34–43.
71. Burton (1997), pp. 59–65.
72. James B. Thompson, Some Remarks on the Climate of Hong Kong, *Simmond's Colonial Magazine*, **6**, 87–8, 1845.
73. William R. E. Smart, Observations on the Climatology, Topography, and Diseases of Hong-Kong, and the Canton-River Station, *Transactions of the Epidemiological Society of London*, **1**, 191–205, 1863.
74. Hermann de Schlagintweit, Numerical Elements of Indian Meteorology, *Phil. Trans. Roy. Soc.*, **153**, 525–42, 1863.
75. Burton (1997), pp. 59–65.
76. Doberck in *Observations and Researches Made at the Hong Kong Observatory in the Year 1885*, Appendix D.
77. Ho (2003), pp. 44–53.
78. Eitel (1895), pp. 514–5.
79. *Nature*, **11**, 168–9, 1874.
80. Piddington, in the 1860 edition of his book, pp. 225–8, relates several reports of apparent earthquakes occurring just before or during storms. See also James F. Lander, Lowell F. Whiteside and Paul Hattori, The Tsunami History of Guam 1849–1993, *Science of Tsunami Hazards*, **20**(3), 158–74, 2002.
81. Algué (1904), §10.
82. For Gherzi, see G. J. Bell, Father Ernesto Gherzi, S.J., 1886–1973 — An Appreciation, *Weather*, **29**(5), 1974, reprinted in *J. Hong Kong Branch Roy. Asiatic Soc.*, **14**, 85–91, 1974. The interaction between typhoons and earthquakes has been long debated but it is only in 2009 that convincing evidence has appeared with the discovery of the correlation of seismic disturbances and typhoons in Taiwan, this adding plausibility to Gherzi's ideas; see Chi Ching Liu, Alan T. Linde and I. Selwyn Saks, Slow Earthquakes Triggered by Typhoons, *Nature*, 459, 833–6, 2009.
83. See CO129/286, pp. 154–6.

Chapter 2

1. *Nature*, **25**, 39–40, 1881.
2. *Hong Kong Government Gazette*, 24 February 1877.
3. Letter of 5 October 1877 to Acting Colonial Secretary, *Hong Kong Government Gazette*, 17 November 1877.
4. Ryder to Governor, 30 October 1877, *Hong Kong Government Gazette*, 17 November 1877.

5. Legislative Council meeting 12 November 1877, *Hong Kong Government Gazette*, 24 November 1877.
6. CO129/186, p. 265.
7. *Proceedings of the Royal Society*, **17**, 81–90, 1868. He had aspirations for a scientific career from an early age, having within a month of his sixteenth birthday submitted a note on a problem in Euclid to the *Philosophical Magazine*; John Hennessy Jun., Direct Demonstration of the Fortieth Proposition of Euclid, *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Series 3, p. 312, October 1850.
8. James Joyce, *Ulysses*, New York: The Modern Library, 1961, p. 592. Pope Hennessy is also believed to be the main inspiration for the character Phineas Finn in two novels by Trollope, and makes a brief appearance as Hope Ennythink in the novel *Broken to Harness* by Edmund Yates.
9. Pope-Hennessy (1984), Bresnihan (1990), Lowe and McLaughlin (1992).
10. Roger T. Stearn, *Oxford Dictionary of National Biography*, vol. 26, pp. 379–82.
11. As a colonial governor Pope Hennessy regularly reported to the Colonial Office, but as he simultaneously was holding the position of consul general to Brunei he also reported to the Foreign Office.
12. For example, by J. Norman Lockyer in *Nature*, **4**, 232, 1871. It was the same eclipse that was observed by the Manila fathers at Mantawalok in the Celebes, noted in the previous chapter.
13. F. E. Dixon, Irish Meteorologists, *Ir. Astron. J.*, **9**, 240–5, 1970.
14. CO489/1, 3 January 1873. Price was also known to Governor Kennedy, under whom he had also served at Freetown.
15. CO129/186, p. 267.
16. Legislative Council 10 September 1880, *Hong Kong Government Gazette*, 11 September 1880.
17. *China Mail* and *Hong Kong Daily Press*, 8 September 1880.
18. Saderra Masó (1915), §6.
19. *One Hundred Years of the Tung Wah Group of Hospitals, 1870–1970*, Hong Kong: Tung Wah Hospital, 1971; 2 volumes, edited by the Board of Directors, vol. 1, pp. 178 and 220.
20. *Hong Kong Daily Press*, in the autumn of 1881 (unseen), reproduced in the *North China Daily News*, 29 October 1881. The cemetery, located where Wah Fu Estate now stands, was resumed by government in 1959, and although the graves were moved elsewhere it seems that the monument was demolished.
21. J. Pope Hennessy to the Legislative Council, 7 February 1882, *Hong Kong Administrative Reports* for 1881; for Price's reply see *China Mail*, 11 August 1882.
22. J. M. Price to Secretary of State for the Colonies, 7 August 1880, in CO129/191, p. 531.
23. CO489/3, 26 July 1880.
24. For pen-portraits of these men see Henry James Lethbridge, Adventurers in Hong Kong: The Marques de Mores and David de Mayrena, *J. Hong Kong Branch Roy. Asiatic Soc.*, **14**, 28–57, 1974.
25. *China Mail*, 22 February 1882.
26. For all details see *Hong Kong Government Gazette*, 3 September 1881.
27. *Nature*, **25**, 39–40, 1881.
28. *China Mail*, 6 September 1881.

29. Higuchi (2002), pp. 198–202. Elizabeth Baigent, in *Oxford Dictionary of National Biography*, vol. 42, pp. 498–9. Obituary in *Monthly Notices of the Royal Astronomical Society*, **54**, 196–8, 1894.
30. *Hong Kong Government Gazette*, 3 September 1881.
31. *China Mail*, 9–14 March 1882.
32. Saderra Masó (1915), p. 67.
33. *Peking Gazette*, 21 December 1878, reported in the *China Mail*, 27 February 1879.
34. H. Fritsche, The Amount of Precipitation (Rain and Snow) of Peking, *The China Review*, **10**, 120–3, 1881.
35. Legislative Council, 23 August 1881, *Hong Kong Government Gazette*, 3 September 1881.
36. CO129/195, pp. 20–4.
37. C. P. Lucas in CO129/195, pp. 15–17.
38. Ibid.
39. Mr. Herbert in CO129/195, p. 19 [Robert G. W. Herbert, permanent undersecretary at the Colonial Office, 1871–92].
40. CO129/195, p. 17.
41. CO129/196, pp. 536–7.
42. CO129/197, pp. 262–3.
43. CO129/195, p. 17.
44. Ibid.
45. CO129/195, pp. 98–100.
46. The contents of this dispatch we know from the local press, see *China Mail*, 13 March and 11 August 1882, *Hong Kong Telegraph*, 15 March 1882.
47. CO129/197, pp. 259–60.
48. The scandal is extensively described in Pope-Hennessy (1984), pp. 214–24; and Bresnihan (1990), pp. 109–18.
49. 'Veritas' in *China Mail*, 5 September 1881.
50. *Hong Kong Telegraph*, 26 September 1881.
51. *North China Daily News*, 31 August 1881.
52. Younger brother of Robert Hart, a Customs commissioner from 1872.
53. *North China Daily News*, 1 October 1881.
54. *North China Herald*, 31 January 1882.
55. Full details in *North China Herald*, 31 January 1882.
56. CO129/206, pp. 456–8.
57. Saderra Masó (1915), p. 69.
58. 29 April 1882 in CO129/206, pp. 454–8.
59. *China Mail*, 14 April 1882.
60. *China Mail*, 18 April 1882.
61. *China Mail*, 14 April 1882. Dechevrens's praises were widely sung at Shanghai, e.g. the editor of the *North China Daily News*, 16 July 1883: 'the thanks of the general public are due for the disinterested services of the distinguished meteorologist … who has undertaken to organize, without any prospect of remuneration, a General China Coast Service, with the indispensable co-operation of the I. M. Customs Service'.
62. *North China Daily News*, 4 April 1883.
63. *Hong Kong Telegraph*, 5 October 1883.
64. *China Mail*, 27 June 1882.
65. CO129/197, pp. 266–8.

66. E.g. in the *China Mail*, 15 November 1887.
67. CO129/199, p. 81.
68. CO129/197, pp. 259–60.
69. Described, for example, in Lowe and McLaughlin (1992), pp. 232–7.
70. *Hong Kong Government Gazette*, 4 March 1882; with correction in the *Gazette* for 16 December 1882.
71. W. Doberck, in *Observations and Researches Made at the Hong Kong Observatory in the Year 1897*, pp. 109–54.
72. *China Mail*, 17 February 1882.
73. CO129/198, pp. 52–4.
74. CO129/198, p. 56.
75. April 3 1882, F. Bulkeley Johnson to Secretary of State for the Colonies, in CO129/199, p. 81.
76. 28 April 1882, in CO129/198, p. 66.
77. Available in CO129/206, pp. 503–11.
78. 22 May 1882, Price to Under Secretary of State for the Colonies, in CO129/206, p. 501.
79. CO129/206, p. 499.
80. 3 July 1882, in CO129/206, p. 126.
81. 24 July 1882, from R. Lee, in CO129/206, p. 152.
82. Harbour Master's Report for 1881, *Hong Kong Government Gazette*, 15 April 1882.
83. *Hong Kong Government Gazette*, 29 July 1882.
84. CO129/206, p. 154.
85. 天文台.
86. *Hong Kong Telegraph*, 25 December 1883.
87. Report of 16 December 1884 on the Finances of the Colony by the Colonial Secretary and Auditor General, in *Hong Kong Sessional Papers*, December 1884 to June 1885, No. 13, item 4.
88. Eitel (1895), pp. 538–9.
89. Ho (2003), p. 152.
90. For Palmer post–Hong Kong see Higuchi (2002). In another biography (*The Biography of Major-General Henry Spencer Palmer R.E. F.R.A.S. (1838–1893)*, Yokohama, 2002), Higuchi is mistaken in his assertion that Palmer's 'plan and the report accompanying it, were referred to the Kew Committee, of the Royal Society, who recommended the adoption without the alteration of a single item'.

Chapter 3

1. CO129/214, p. 706.
2. CO129/205, p. 582.
3. CO129/126, p. 545.
4. For the remaining thirty years of his life Clarke published no further scientific work, *Photogrammetric Engineering and Remote Sensing*, March 1999, p. 23.
5. Robert Herbert to Doberck, 29 January 1883.
6. *Nature*, **27**, 565, 1883. His appointment was also noted in *The English Mechanic and World of Science*, 20 April 1883, p. 148, as 'astronomer and director of the new Hong Kong observatory'.
7. For allegations of jobbery in selecting the master of the Mint, and in the appointment of the postmaster general see an editorial in the *Hong Kong Daily Press*, 29 September 1864.

8. Bickley (1997), p. 202.
9. Lethbridge in Introduction to Eitel (1983).
10. As the first Ph.D. holder in government Doberck is probably beaten out by a few years by the German Ernest Eitel, who became inspector of schools in 1879, and who held a doctorate in philosophy degree awarded by the University of Tübingen in 1870, for his *Handbook for the Study of Chinese Buddhism*.
11. Communication from Michael Doberck.
12. What little we do know about his early life is almost entirely due to an entry in *Dansk biografisk Lexikon*, volume 4, p. 285, which only takes us up to about 1890, and two short obituary notices, one in *Nature*, **147**, 409, 1941 and one in *Publications of the Astronomical Society of the Pacific*, **53**, 263–4, 1941.
13. Recorded in an obituary for John Louis Emil Dreyer. *Monthly Notices of the Royal Astronomical Society*, **87**, 251–7, 1927.
14. W. Doberck, *Bahnbestimmung der Cometen I 1801, III 1840 und II 1869. Inaugural-Dissertation … zu Jena*, Copenhagen: Cohens Buchdrukerei, 1873.
15. T. R. Robinson, 1852, cited in Glass (1997), p. 42.
16. John F. Fitzsimons, *Markree Castle Observatory — a Bygone Era in Irish Astronomy*, 2nd edition, [Sligo] 1982.
17. W. Doberck, Markree Observatory, *The Observatory*, **7**, 283–8, 1884; M. Hoskin, Archives of Dunsink and Markree Observatories, *Journal for the History of Astronomy*, **13**, 146–52, 1982.
18. *Monthly Notices of the Royal Astronomical Society*, **11**, 104–5, 1851.
19. *The Astronomical Register*, **1**, 157, 1863.
20. Obituary: Colonel Edward H. Cooper. *Monthly Notices of the Royal Astronomical Society*, **63**, 197–8, 1903.
21. *Monthly Notices of the Royal Astronomical Society*, **36**, 171, 1876; **37**, 173, 1877; **38**, 183, 1878; **39**, 251–2, 1879; **40**, 226, 1880; **41**, 206, 1881; **42**, 164–5, 1882; **43**, 197–9, 1883.
22. *The Observatory*, **7**, 283–8 and 329–32, 1884.
23. Aitken (1918).
24. *Publications of the Astronomical Society of the Pacific*, **53**, 263–4, 1941.
25. *The English Mechanic and World of Science*, 5 January 1877, p. 402.
26. *Report of the Meteorological Committee of the Royal Society for the Year Ending 31st December 1875*, London: H M Stationary Office, 1876, p. 21.
27. O'Rorke (1878), p. 544.
28. *The Observatory*, **2**, 140–4, 1878.
29. In a letter to the Acting Colonial Secretary, 5 October 1885, in CO129/222.
30. J. L. E. Dreyer, Obituary for Albert Marth, 1828–97, *Astronomische Nachrichten*, **144**, 223, 1897.
31. On this see, for example, Anderson (2005).
32. Griffiths and Lau (1986).
33. Fa-Ti Fan, Victorian Naturalists in China: Science and Informal Empire, *British Journal for the History of Science*, **36**, 1–26, 2003.
34. CO129/214, p. 684.
35. HKRS356 1–1(1), #17.
36. 7 May 1883, Figg to Colonial Office, #47 in HKRS356 1–1(1). Invariably cited as Frederick, his correct name was Frederic, as he informed Doberck in a note of 11 May 1883, in HKRS356 1–1(1).
37. CO129/212, p. 261.

38. Dyson (1983), p. 29.
39. CO129/214, p. 691.
40. 22 February 1883, in CO129/214.
41. CO129/214, p. 707.
42. Ibid.
43. CO129/214, p. 706.
44. 27 April 1883, R. H. Meade to Doberck, HKRS356 1–1(1), [Robert H. Meade, assistant undersecretary at the Colonial Office 1871–92].
45. CO129/214, pp. 712–3.
46. CO129/214, p. 710.
47. Ibid.
48. MacKeown (2007), p. 46.
49. *China Mail*, 28 July 1883.
50. *China Mail*, 30 July 1883.
51. *China Mail*, 12 November 1883.
52. *China Mail*, 8 October 1883.
53. *China Mail*, 6 March 1884.
54. CO129/206, p. 504.
55. CO129/211, p. 135.

Chapter 4

1. Quoted in *China Mail*, 11 March 1886.
2. 22 November 1883, Bowen to the Colonial Office, CO129/212, p. 263.
3. MacKeown (2007).
4. 12 May 1866, MacDonnell to Cardwell, Principal Secretary of State at the Colonial Office, in PRO MINT13/201.
5. CO129/212, p. 256.
6. CO129/210, p. 483.
7. HKRS356 1–1(1), #70.
8. HKRS356 1–1(1), #78.
9. Indexed as 'Astronomer's Report' in the *Hong Kong Government Gazette* (Administrative Report No. 380), 17 November 1883. His failure to visit Manila seems to be confirmed by an item in the *Hong Kong Government Gazette*, 15 May 1886 which lists all the meteorological stations in communication with the Observatory with those which he had visited so indicated. Manila is listed but not so indicated. In the Observatory files copies of each of the governor's introductions to the consuls at Ningbo and Fuzhou, saying, among other things, that: 'Dr Doberck will show you the instructions which he has received' occur, with the annotation: 'found in a sealed envelope evidently not presented by Dr Doberck'.
10. At Zikawei, *Hong Kong Government Gazette*, 24 November 1883.
11. 1 October 1883, Doberck to Manila Observatory, Saderra Masó (1915), p. 71.
12. *Hong Kong Telegraph*, 20 March 1899.
13. *North China Daily News*, 1 October 1883, reproduced in the *Hong Kong Telegraph*, 5 October 1883.
14. HKRS356 1–1(1), #81.
15. HKRS356 1–1(1), #108.
16. *Hong Kong Telegraph*, 20 March 1899.
17. Tyler (1929), pp. 136, 221.

18. Saderra Masó (1915), p. 72.
19. *Hong Kong Government Gazette*, 22 April 1884.
20. Eitel (1895), p. 529.
21. CO129/212, p. 261.
22. 1 May 1883, Robert Scott to Doberck, in HKRS356 1–1(1).
23. CO129/212, p. 256.
24. CO129/212, p. 263.
25. *Hong Kong Telegraph*, 1 February 1890.
26. Welsh (1993), p. 293.
27. 13 December 1883, in CO129/213, p. 150.
28. Endacott (1958).
29. *China Mail*, 2 February 1886.
30. *China Mail*, 15 September 1884.
31. *China Mail*, 19 October 1887.
32. *Hong Kong Telegraph*, 4 December 1883.
33. MacKeown (2007), p. 55.
34. In a notice in the *Government Gazette*, 10 January 1885, he mistakenly reported this as 17h instead of 05h, the same mistake made again twenty-three years later in a notice by Figg, *Hong Kong Government Gazette*, 16 April 1908.
35. *Hong Kong Government Gazette*, 29 November 1884.
36. With the widespread adoption of radio signalling, the time-ball eventually became redundant and was hoisted for the last time in 1933. Local astronomical calibration of clocks was no longer continued after the Second World War, signals arriving by radio being relied on.
37. Letter to the editor, *North China Daily News*, 9 September 1884.
38. Sir Thomas Stevenson, a British civil engineer and meteorologist, and father of the writer Robert Louis Stevenson.
39. Thomas Romney Robinson, sometime director of Armagh Observatory.
40. John Ball, MP for Carlow 1852–57, *Hansard*, vol. 134, p. 1006, 1854.
41. A distinguished sea captain, on one of whose journeys on HMS *Beagle* the naturalist Charles Darwin was a passenger. He was also a sometime governor of New Zealand.
42. At the Cardiff Naturalists' Society, reported in the *Western Mail*, 28 January 1882.
43. Sun-spots and Markree Rainfall, *Nature*, **26**, 366–7, 1882. With rainfall in inches, a Least Squares analysis of the data yields a coefficient of 0.049±.021, a value almost significant at the three standard deviation level. He found the correct value for the estimate of the coefficient, but probably was not familiar with the method for evaluating its uncertainty. There would be very many such studies over the years, but it was not until the twenty-first century that a convincing, small, correlation was established. Gerald A. Meehl, Julie M. Arblaster, Katja Matthes, Fabrizio Sassi and Harry van Loon, Amplifying the Pacific Climate System Response to a Small 11-Year Solar Cycle Forcing, *Science*, **325**, 1114–8, 2009.
44. The most used work was William Marriot's *Hints to Meteorological Observers with Instructions for Taking Observations and Tables for Their Reduction*, London: Edward Stanford, 1881, which went into many editions. Robert H. Scott's *Instructions in the Use of Meteorological Instruments*, London: Her Majesty's Stationary Office, 1875, went into greater detail on apparatus and methods.
45. The height of the mercury column which defines the pressure must be corrected for the thermal expansion of the mercury — it is usual to standardize it to 0°C.

46. Ahvenainen (1981), §1, §2.
47. Eitel (1895), p. 284.
48. *Hong Kong Government Gazette*, 16 August 1884; a detailed description of the storm warning system is given in Wai (2004, 2005).
49. *China Mail*, 28 August 1884.
50. *China Mail*, 11 September 1884; he gives details of the typhoon in the *Hong Kong Government Gazette*, 27 September 1884.
51. *China Mail*, 12 September 1884.
52. *China Mail*, 13 September 1884.
53. *China Mail*, 20 September 1884.
54. 7 July 1884, Harbour Master to Doberck, in HKRS356 1–1(1).
55. 9 August 1884, Doberck to Colonial Secretary (unsigned draft), HKRS356 1–1(1), #111.
56. 23 August 1884, Ag. Colonial Secretary (Frederick Stewart) to Doberck, HKRS356 1–1(1), #114.
57. 7 August 1884, Ag. Colonial Secretary to Doberck, HKRS356 1–1(1), #110.
58. CO129/216, p. 50.
59. *Hong Kong Government Gazette*, 29 November 1884.
60. CO129/222, p. 399.
61. CO129/222, p. 396.
62. CO129/222, p. 390.
63. CO129/222, p. 387.
64. CO129/239, p. 189.
65. Price in CO129/206, p. 505.
66. CO129/239, p. 188.
67. CO129/239, p. 194.
68. *China Mail*, 27 August 1885.
69. *China Mail*, 14 April 1886.
70. HKRS356 1–1(2), #9.
71. CO129/226, p. 230.
72. HKRS356 1–1(2), #18.
73. 8 October 1890, Ag. Colonial Secretary (Deane) to Doberck, HKRS356 1–1(2).
74. *Nature*, **35**, 229, 1886.
75. The *Register* (from 1894 only) and *Observations* (from 1884) are available at http://docs.lib.noaa.gov/rescue/data_rescue_china.html. The latter was titled *Observations and Researches Made at the Hong Kong Observatory* from 1884 to 1886 and 1892–1898; in the periods 1887–1891 and 1899–1903 it was known as *Observations Made …*, and from 1904 as *Meteorological Observations Made …* From 1884 to 1886 it was authored by W. Doberck, government astronomer, from 1887 to 1903 by W. Doberck, director, and thereafter anonymously.
76. *Hong Kong Telegraph*, 3 April 1890.
77. *China Mail*, 8 September 1886.
78. As reported in *China Mail*, 18 October 1886.
79. *China Mail*, 15 April 1886.
80. *China Mail*, 16 April 1886.
81. CO129/226, p. 226.
82. CO129/237, p. 375.
83. CO129/240, pp. 334–42.

84. This telescope, on loan from the astronomer royal, had a refractor with a highly regarded 5.9-inch lens by Tully, originally made for W. H. Smyth in his Bedford Observatory. Smyth sold it to Dr. John Lee of the Hartwell House Observatory. It is now in the Science Museum in London. A picture of it may be seen in King (1979), p. 159.
85. 8 January 1887, Acting Colonial Secretary to Doberck, HKRS356 1–1(2), #35.
86. For Frederick Stewart, see Bickley (1997).
87. Pope-Hennessy (1984), p. 207.
88. *Hong Kong Government Gazette*, 29 January 1887.
89. *Hong Kong Government Gazette*, 28 May 1887.
90. CO129/232, p. 408.

Chapter 5

1. 11 March 1886, Doberck to Acting Colonial Secretary, in CO129/252, p. 332.
2. 21 October 1887, Frederick Stewart to Doberck, HKRS356 1–1(2).
3. HKRS356 1–1(2), #69.
4. HKRS356 1–1(2), #77.
5. HKRS356 1–1(2), #70.
6. O'Rorke (1889), Vol. II, p. 529.
7. Tyler (1929), p. 147.
8. 'Veritas' in *China Mail*, 16 October 1889.
9. *The English Mechanic and World of Science*, 20 April 1888, p. 165.
10. 7 February 1925, Doberck to R. G. Aitken, in the Lick Observatory archives.
11. In the canonical histories he is recorded as transferring from 'Government Astronomer' to 'Director' in 1887, e.g. in Starbuck (1951), and in G. C. Hamilton, *Government Departments in Hong Kong 1841–1969*, Hong Kong Government Printer, 1969, p. 61, but this is erroneous.
12. *Hong Kong Telegraph*, 5 October 1881.
13. CO129/238, p. 296.
14. CO129/241, p. 508.
15. Saderra Masó (1915), p. 72.
16. 12 June 1892, Chief Secretary to the Inspector General to Doberck, HKRS842 1/1.
17. 5 June 1889, Doberck to Figg, HKRS356 1–1(2).
18. 8 July 1889, Colonial Secretary to Doberck, HKRS356 1–1(2).
19. Minutes of 10 July and 13 July 1889 in HKRS356 1–1(2).
20. 16 August 1889, Colonial Secretary to Doberck, HKRS356 1–1(2).
21. 12 February 1889, HKRS356 1–1(2), #101.
22. Among the early chief clerks, appointed 2 June 1885 at $480/year (not listed in 1886) who did not see his future with the Observatory was Lau Chu Pak (1867–1922) (劉鑄伯) who had studied at the Government Central School. He later became a wealthy tea merchant, co-founder of the Chinese Chamber of Commerce and a Legislative Councillor.
23. L. Starbuck, in J. E. Peacock (ed.), *Hong Kong Meteorological Records and Climatological Notes 60 years 1884–1939, 1947–1950*, Hong Kong: The Government Printer, 1952, p. 9.
24. *China Mail*, 2 May 1890.
25. *China Mail*, 15 October 1889.

26. No record of this alleged correspondence is to be found, and Saderra Masó (1915), who would not be shy in embarrassing Doberck, makes no mention of it.
27. *China Mail*, 16 October 1889.
28. Catchick Paul Chater, a very successful Armenian businessman and Masonic leader, elected to the Legislative Council in 1887. He was later appointed the first unofficial member of the Executive Council.
29. Phineas Ryrie, member of a Scottish family active in the 'China trade'. First chairman of the Jockey Club, he was chairman of the Chamber of Commerce at this time and its representative on the Legislative Council.
30. *China Mail*, 10 December 1889.
31. *China Mail*, 10 February 1890.
32. *China Mail*, 12 February 1890.
33. *Hong Kong Government Gazette*, 18 January 1890.
34. *China Mail*, 20 January 1890.
35. *China Mail*, 1 May 1890.
36. *Japan Weekly Mail*, 15 February 1890.
37. No sign of it is to be found in the archives.
38. *Hong Kong Daily Press*, 2 May 1890.
39. *China Mail*, 29 April, 1 and 15 May 1890.
40. *China Mail*, 1 May 1890.
41. *China Mail*, 15 May 1890.
42. 10 May 1890, Doberck to Acting Colonial Secretary, HKRS356 1–1(1).
43. 20 May 1890, Acting Colonial Secretary W. M. Deane to Acting Governor F. Fleming, HKRS365 1–1(1).
44. CO129/245, p. 486.
45. 10 October 1890, HKRS356 1–1(2), #198.
46. 16 April 1891, Colonial Secretary to Doberck, HKRS842.
47. Thomas Kirkman Dealy, FRGS, was later headmaster at Queen's College 1909–18. He wrote *Notes on the Geography of the Chinese Empire,* Hong Kong: Noronha & Co., 1896, and revised Chalmer's *English and Cantonese Dictionary*, 7th ed., Hong Kong: Kelly & Walsh, 1907.
48. *China Mail*, 12 February 1890.
49. *China Mail*, 13 June 1891.
50. Anderson (2005), p. 279.
51. Pyenson (1993), p. 161.
52. CO129/245, p. 230.
53. 18 April 1890, Acting Colonial Secretary to Doberck, HKRS356 1–1(2).
54. 7 May 1890, Officer Administering the Government minute, HKRS356 1–1(2).
55. CO129/265, p. 677.
56. 5 December 1890, Doberck to Christie, in Papers of William Christie in RGO 7/161, 7/183, 7/241, cited in Appleton (2009). Lucas Christiaan Frederik Eduard Engelenburg at the time had mostly worked on geomagnetism, and had recently published, with E. Van Rijckevorsel, *Magnetic Survey of the Eastern Part of Brazil*, Amsterdam: Johannes Muller, 1890. He later rose to a high position in the Royal Netherlands Meteorological Institute, Pyenson (1989), p. 97.
57. CO129/247, p. 378.
58. CO129/247, pp. 380–3.
59. *The Observatory*, **14**, 287, 1891.
60. For more details on Plummer's early career, see Appleton (2009).

61. *Monthly Notices of the Royal Astronomical Society*, **35**, 194–5, 1875; **36**, 172–3, 1876; **37**, 175–6, 1877; **38**, 186, 1878; **39**, 253, 1879; **40**, 231–2, 1880; **41**, 209–10, 1881; **42**, 168, 1882; **44**, 174, 1884; **45**, 233–4, 1885; **47**, 161, 1887; **48**, 197, 1888; **49**, 204–5, 1889; **50**, 211, 1890.
62. Kronk (2003).
63. J. J. Plummer, On Some Results of Temperature Observations at Durham, *Quart. J. Roy. Met. Soc.*, **1**, 241–6 and 264–6, 1873. The assessment of their quality is due to Appleton (2009). During his stay at the Durham Observatory, 1867–74, he would have been in charge of routine monitoring of meteorological parameters, see G. D. Rochester, The History of Astronomy in the University of Durham from 1835 to 1939, *Q. Jl. R. Astr. Soc.*, **21**, 369–78, 1980.
64. *China Mail*, 1 May 1891. Accompanied by his wife, Marion (née Forsyth), son John and daughters Marion and Euphemia Beatrice.
65. *China Mail*, 13 June 1891.
66. For example in *Catalogue of Right-Ascensions of 2120 Southern Stars for the Epoch 1900 from Observations Made at the Hong Kong Observatory during the Years 1898 to 1903*, Hong Kong: Noronha & Co., 1905, p. 75, we find '… Mr Plummer's skill is well known and the smallness of the probable errors prove [*sic*] that the work was accurately done'.
67. Fritsche (1877), p. 188; the two adventurous ladies were a Miss Dsodbojeff and a Miss Mossin.
68. Treatise unspecified, but plausibly, *Meteorological Researches*, in three volumes (Washington: Government Printer, 1877–82) by the American theoretical meteorologist William Ferrel (1817–91).
69. Very likely, *Grundzüge der Meteorologie*, Berlin: Dietrich Reimer, 1883, by the Norwegian geophysicist Henrik Mohn (1835–1916). The theories of Ferrel and Mohn are well presented by Kutzbach in Kutzbach (1979).
70. CO129/252, p. 325.
71. CO129/252, p. 325r.
72. CO129/252, p. 328.
73. CO129/252, p. 327.
74. *Monthly Notices of the Royal Astronomical Society*, **36**, 171, 1876.
75. For example, he reports her work on the rainfall in Sligo in his 1884 paper, On the Rainfall and Temperature of Markree, Sligo, *Quart. J. Roy. Met. Soc.*, **10**, 158–61, 1884.
76. O'Rorke (1878).
77. Noted in the Stockholm women's magazine *Dagny*, **8**, 271, 1892.
78. Joanne Malkus Simpson, at the University of Chicago.
79. *Nature*, **46**, 108, 1892.
80. Draft of 9 March 1890, HKRS356 1–1(2).
81. 15 December 1913, Anna Doberck to Claxton, HKRS 842/4. In the 'Ladies Directory' of the annual *Chronicle and Directory for China, Japan and the Philippines* she is listed from 1896 as Miss Doberck BA.
82. 2 March 1900, Anna Doberck to Colonial Secretary, HKRS 842/3.

Chapter 6

1. Colonial Office: Minutes of 17 July 1894, in CO129/263.
2. 21 October 1891, HKRS842.

3. 2 October 1891, HKRS842.
4. Doberck to Christie, 4 November 1891, reported by Appleton (2009).
5. *China Mail*, 29 December 1891.
6. *China Mail*, 4 June 1892.
7. Plummer (1910).
8. 23 June 1891, in CO129/250, p. 219.
9. Officer Administering the Government, May to December 1891.
10. *Hong Kong Hansard*, 23 May 1892.
11. 13 July 1892, Governor Robinson to Secretary of State, in CO129/255, pp. 572–94.
12. 24 October 1892, Ripon to Governor Robinson, ibid.
13. 羊角 — literally a sheep's horn, presumably reflecting the helicity of the two phenomena.
14. 颶風 — literally a wind from all quarters, a form recorded as early as 470 AD, and featuring in Tang poetry; see Kin-sheun Louie and Kam-biu Liu, Ancient Records of Typhoons in Chinese Historical Documents, in Murnane and Liu (2004), 223–48. The modern name for a typhoon is *taifeng* (颱風). Few words have had more etymological attention than the word 'typhoon', see, for example, H. Himly, Ursprung des Wortes Typhon und der aussprache Teifun, *Mittheilungen der Deutschen Gesellschaft für Natür-und Völkerkunde Ostasiens in Tokio*, Vol. 1, Part 8, September, 1875; or the detailed investigation into the etymology of the modern English name by Gherzi (1951), vol. 1, 199–200. It is now generally accepted that the words used by the Arabs and the Portuguese, from which current English usage derives, are of Chinese origin.
15. 'G' [=Gherzi?], 'Meteorology' in Samuel Couling (ed.) *Encyclopaedia Sinica,* Shanghai: Kelly & Walsh, 1917.
16. For example, J. C. L. Chan and J. E. Shi, Frequency of Typhoon Landfall over Guangdong Province of China during the Period 1470–1932, *International Journal of Climatology*, **20**, 183–90, 2000; and K.-B. Liu, C. Shen and K. S. Louie, A 1000-Year History of Typhoon Landfalls in Guangdong, Southern China, Reconstructed from Chinese Historical Documentary Records, *Annals of the Association of American Geographers*, **91**, 453–64, 2001.
17. 8 January 1969, Joseph Needham to G. J. Bell (director of the Royal Hong Kong Observatory), in Needham Research Institute archives, file NRI2/SCC6/13/1, where Needham dates the *Nanyue Zhi* to around 465. The text, with translation, is available in Ho (2003), pp. 58–9.
18. Notably the account by Ma Huan, *Ying-yai Sheng-lan*, translated by J. V. G. Mills, Cambridge: Cambridge University Press, 1970.
19. The chronicles of Fr. Gaspar da Cruz, of which an English translation appeared in 1625, see Boxer (1953), pp. 223–4.
20. Boxer (1951), pp. 408–9.
21. Dampier (1703), pp. 413–6.
22. A Seventeenth Memoir on the Law of Storms in India, Being Storms of the China Seas from 1842 to 1847, *J. Asiatic Soc. Bengal*, 18, 1–45, 1849.
23. Reid (1849) and Reid (1850).
24. 1*chi*=10*cun*. His precise figure of 24*cun* for the standard value, which should correspond to 760mm, either reflects an easy-going attitude to the quantitative, not suggested elsewhere in his writing, or an ambiguity at the time in the accepted value of the *cun*. It implies a value of 31.7mm for the *cun* — not in agreement with the modern prescribed value of 33.3mm, or the traditional value used in Hong

Kong of 37.1mm. A commercial guide of the time stated that there were no less than eighty-four definitions for the *chi*. The Hai Guan, or Customs, *chi* was 14.1 inches, implying a value of 35.814 mm for the *cun*, again not in agreement with the value used by MacGowan.

25. MacGowan (1853), fig. 6.
26. Fritsche (1877), p. 294.
27. *Nature*, **4**, 435, 1871.
28. In *Mittheilungen der Deutschen Gesellschaft für Natür-und Völkerkunde Ostasiens in Tokio*, Vol. 1, Part 6, pp. 11–3, December, 1874. The author is most likely M. von Brandt, a regular early contributor to the journal. Details of typhoons from 1872, but without any tracks, were given by a Lt. Commander Nelson in *Trans. Asiatic Soc. Japan*, **1**, 52–85, 1873.
29. E. Knipping, The September Taifuns 1878, *Mittheilungen der Deutschen Gesellschaft für Natür-und Völkerkunde Ostasiens in Tokio*, Vol. 2, Part 18, pp. 333–6, September, 1879; The Great Taifun of August 1880, *Mittheilungen der Deutschen Gesellschaft für Natür-und Völkerkunde Ostasiens in Tokio*, Vol. 3, Part 23, pp. 90–102 and 166–70, 1882. Both articles are written in English in deference to the English-speaking captains who had provided most of the data.
30. T. C. Mendenhall, Report on the Meteorology of Tokio for the Year 2540 (1880), *Memoirs of the Science Department Tokio Daigaku*, No. 7, Tokyo, 1881.
31. *Le Typhon du 31 Juillet 1879*, Shanghai: Zikawei Observatory, 1879.
32. *Hong Kong Government Gazette*, 31 May 1884, 27 September 1884, 16 May 1885 and 18 July 1885.
33. *The Law of Storms in the Eastern Seas*, pp. 24+map, Hong Kong: Hong Kong Telegraph, 1886; reproduced in *Nature*, **35**, 135–41, 1886.
34. *Über das Gesetz der Stürme in den ostasiatischen Gewässern*, Vienna: 1891.
35. P. Bergholz, *Die Taifune in den ostasiatischen Gewässern, nach Doberck*, E. Hölzel, 1898; also in *Meteorolog. Z.*, **15**, 332–41, 1898.
36. Results of further investigations concerning typhoons, *Hong Kong Government Gazette*, 7 January 1888.
37. He seems to have been fully familiar with the then existing, somewhat incomplete, theories of the phenomenon. Elsewhere he invoked a role also for the heat liberated at a height by condensation, and for the friction between the wind and the sea surface, in the development of the storm; see his report on the typhoons of 1884 and 1885, Appendix B of *Observations and Researches Made at the Hongkong Observatory in the Year 1886*.
38. 6 February 1897, Doberck to the Colonial Secretary, in HKRS842 1/4.
39. W. Doberck, Die Zugstrassen der Teifune, *Meteorolog. Z.*, **14**, 101–2, 1897.
40. 5 April 1899, Doberck to the Colonial Secretary, in HKRS842.
41. Gherzi (1951), p. 267.
42. *Liverpool Journal of Commerce*, 17 January 1896, reproduced in the Hong Kong Daily Press on 27 February.
43. Bergholz (1901).
44. José Algué, *Baguios ó Ciclones Filipinos — Estudio Téorico-practicó*, Manila, 1897.
45. Algué, in his second (revised) edition, *Cyclones of the Far East*, published in English in Manila in 1904, is not overly critical of Bergholz's appropriation of the first edition of the book, but notes that Scott's revision of the English translation thereof contains numerous scientific inaccuracies and 'a number of passages of sheer nonsense'.

46. Algué (1904), p. 24.
47. Newnham (1922).
48. *Monthly Weather Review*, **27**, 108–9, 1899.
49. Coching Chu, A New Classification of Typhoons of the Far East, *Monthly Weather Review*, **52**, 570–9, 1924.
50. Coching Chu, The Place of Origin and Recurvature of Typhoons, *Monthly Weather Review*, **53**, 1–5, 1925.
51. Jeffries and Heywood (1938).
52. Hong and Liu (2006), §11.
53. *Hong Kong Hansard*, 24 July 1891.
54. *China Mail*, 2 July 1892.
55. *China Mail*, 6 July 1892.
56. *China Mail*, 11 July 1892.
57. *China Mail*, 22 July 1892.
58. *China Mail*, 5 November 1892.
59. *China Mail*, 29 November 1892.
60. *Hong Kong Telegraph*, 5 September 1893.
61. *Hong Kong Hansard*, 21 November 1892.
62. For example, a letter in *China Mail*, 17 April 1894.
63. *Hong Kong Telegraph*, 30 September 1893.
64. *China Mail*, 20 December 1893.
65. *China Mail*, 9 October 1893.
66. *China Mail*, 11 October 1889.
67. *China Mail*, 15 November 1887.
68. *China Mail*, 11 September 1894.
69. A familiarity with the mechanics of the tides, and a role for the moon in the phenomenon, were among the more sophisticated developments in meteorology in Chinese thought, and tide tables had been constructed from as early as the eighth century, see Needham (1959), §21(i).
70. Ryder to Governor, 30 October 1877, *Hong Kong Government Gazette*, 17 November 1877.
71. In principle, for 369 days for an acceptable level of accuracy; for a more exact specification a period of 235 lunar months, almost nineteen years, is required.
72. Later, Sir Osbert Chadwick, a civil engineer frequently consulted by the Colonial Office on overseas projects, later professor of municipal engineering at University College London.
73. Osbert Chadwick to the Crown Agents, 7 September 1882, HKRS356 1–1(1).
74. Osbert Chadwick to the Colonial Office, 6 April 1883, HKRS356 1–1(1); the Colonial Office copy is in CO129/214, pp. 647–9.
75. The data for 1887 and 1888 are in *Supplement to the Hong Kong Government Gazette*, 25 October 1890, while the data for 1889 are in W. Doberck, *Observations and Researches Made at the Hong Kong Observatory in the Year 1892*, pp. 109–20.
76. From 1893, by virtue of his official position he was a justice of the peace, and presumably attended such occasions as would be called for by this appointment.
77. 29 July 1891, Plummer to Doberck, HKRS842.
78. Akers-Jones (2004), p. 12.
79. *China Mail*, 3 July 1882.
80. *China Mail*, 16 March 1894.

81. Des Voeux (1903); Sir Mathew Nathan, Diaries and Letters 1904–07, Oxford: Bodlean Library; for Bowen, see Lane-Poole (1899).
82. Tyler (1929), p. 147.
83. 12:00 hours standard time was synchronized with 11:36:42 local time on Sunday 30 October 1904. It is not clear whether the observations reported in the *China Coast Meteorological Register* are additional measurements made on the hour, or the usual observations made 23 minutes past the hour, most likely the latter.
84. Pyenson (1993), p. 161.
85. *Hong Kong Government Gazette*, 29 January 1898.
86. *Trans. Roy. Ir. Acad.*, **29**, 379–426, 1890. The order, *l'Ordre du Dragon de l'Annam*, was established by the emperor of Annam, which was already a French Protectorate, in March 1886. At the time of Doberck's award, and until 1896, it was considered in France a 'foreign decoration', but in that year was adopted as a French colonial decoration, awarded for services in the facilitation of colonial expansion.
87. Dated 1 November 1892, HKRS842.
88. 25 April 1894, HKRS842.
89. 27 April 1894, Colonial Secretary to Doberck, HKRS842.
90. CO129/265, p. 677.
91. CO129/260, p. 7.
92. CO129/278, p. 38.
93. *China Mail*, 19 April 1894.
94. *China Mail*, 25 September 1894.
95. *Hong Kong Government Gazette*, 13 October 1894.
96. Definitive Elements of the Orbit of Comet 1824 I, *Astronomische Nachrichten*, **138**, 321–32, 1895.
97. CO129/263, p. 395.
98. CO129/263, p. 393.
98. CO129/265, p. 674.
100. CO129/265, p. 275.
101. Entry for 3 October 1894, working journal of William Christie, Royal Greenwich Observatory archives.
102. Her father's name is given as Obenchain, so it is likely that she had been married before.
103. 28 December 1894, Colonial Secretary to Doberck, HKRS842.
104. 12 January 1895, Doberck to the Astronomer Royal, HKRS842 1/4.
105. Available in CO129/278, pp. 32–40.
106. 3 October 1894, Plummer to the Acting Colonial Secretary, HKRS842 1/1.
107. CO129/278, p. 41.
108. Plummer to the Colonial Secretary, 2 June 1897, HKRS842.
109. CO129/276, pp. 191–5 and CO129/280, p. 490.
110. CO129/278, p. 28.
111. CO129/278, p. 524.
112. CO129/260, p. 12.
113. 9 April 1897, Doberck to the Colonial Secretary, HKRS842 1/4.
114. CO129/276, p. 188.
115. CO129/278, p. 508.
116. CO129/278, p. 507.
117. *Telegraphic Code Used for Issuing Storm-Warnings from the Hongkong Observatory* prepared by F. G. Figg, first assistant, 22 pp., Hong Kong: Noronha & Co.,1898, available in CO129/281, p. 163.

118. *China Mail*, 3 August 1895.
119. Supplement to *Hong Kong Government Gazette*, 19 September 1896, pp. 1–71.
120. *Monthly Notices of the Royal Astronomical Society*, **56**, 242–3, 1896.
121. W. Doberck, On the Latitude of Hong Kong, *Observations and Researches Made at the Hong Kong Observatory in 1897*, Hong Kong: Noronha & Co., 1898, pp. 109–54.
122. Apparently a consensus was arrived at later, on the basis of these observations, that the latitude was 22°18′13.2′N.
123. Astronomers at the time usually quoted the so-called probable error, defined as 0.674 times the standard deviation on the mean.
124. The concept of latitude is more complicated than initial familiarity might suggest, even for an assumed spherical earth. Astrometrically measured latitude is determined from measurements of stars at the zenith with respect to the equatorial plane, the plane normal to the earth's rotation axis. This axis, however, is not fixed in space, it wobbles a little (and on a long time scale precesses) so that the latitude of a place defined in this way will change with time.

Chapter 7

1. 5 June 1899, copied by Willis L. Moore to Doberck, HKRS842.
2. Sydney B. J. Skertchly, in *The Hong Kong Weekly Press and China Overland Trade Report*, 23 January 1893.
3. *China Mail*, 17 January 1893.
4. *China Mail*, 12 October 1896.
5. 20 November 1896, Dechevrens to Colonial Secretary, HKRS842.
6. *Hong Kong Government Gazette*, 29 August 1896, pp. 877–8.
7. 31 January 1898, Doberck to Colonial Secretary, HKRS 842/3.
8. There are conflicting reports on the break in the line to Manila. The United States declared war on Spain in April 1898, but according to Headrick (1981), p. 83, failed in an effort to cut the newly laid cable in Manila Bay. They then appealed to the British authorities in Hong Kong who ordered, despite declared neutrality in the dispute, the Eastern Extension Telegraph Co. to seal off the Hong Kong end of the cable; it was restored on 22 August. According to Ahvenainen (1981), p. 165 the U.S. navy cut the Eastern Extension cable, but came to regret it, and asked the company to reestablish it, which they refused to do, arguing that their contract with the Spanish government excluded actions unfriendly to that government.
9. 23 November 1898, Doberck to Colonial Secretary, HKRS842.
10. *China Mail*, 17 March 1899; Fr. Algué had also sent a copy of his letter to the Shanghai newspapers.
11. In its early days, before it had official status the Observatory was known as 'Observatorio del Ateneo Municipal'.
12. 5 November 1898, Doberck to Dr. Moore of the U.S. Weather Bureau, HKRS842.
13. *Hong Kong Telegraph*, 20 March 1899.
14. *China Mail*, 21 March 1899.
15. *Hong Kong Daily Press*, 28 March 1899.
16. Reference 1 above.
17. 24 March 1899, Fr. Louis Froc to Sir Henry Blake, HKRS842.
18. 17 March 1899, Doberck to the Colonial Secretary, HKRS842.
19. 28 March 1899, Doberck to the Colonial Secretary, HKRS842/3.
20. 28 April 1899, Doberck to the Colonial Secretary, HKRS842/3.

21. Suggesting they were reading the barometer accurate to 1mm, and he was asking for readings accurate to 1/4 mm. It may be, to economize on message size, that values were transmitted to this accuracy, but Zikawei, and presumably Manila, were recording pressure ostensibly accurate to 1/100 mm, but anyway accurate to 1/20 mm. Knipping at Tokyo used inches. The Hong Kong Observatory only started to use metric units from 1916.
22. 5 April 1899, Doberck to the Colonial Secretary, HKRS842.
23. 9 May 1899, Colonial Secretary to the Governor, HKRS842.
24. Undated draft by the Colonial Secretary, May 1899, HKRS842.
25. 5 April 1899, Doberck to the Colonial Secretary, HKRS842.
26. Udias (2003).
27. Sheets and Williams (2001), p. 47.
28. Reference 1 above.
29. *Monthly Weather Review*, **27**, 60–1, 1899.
30. 27 September 1899, U.S. Consul General to Colonial Secretary, HKRS 842/3.
31. 28 September 1899, Doberck to Colonial Secretary, HKRS 842/3.
32. 18 October 1901, Consul M. Kato to Doberck, HKRS 842/4.
33. 19 October 1901, Doberck to Japanese Consul HKRS 842/4.
34. Report of the Director of the Philippines Weather Bureau for 1902.
35. *Hong Kong Government Gazette*, 27 February 1897. Our account here draws, in part, on the articles by Wai (2004, 2005).
36. *China Mail*, 8 and 13 January 1898.
37. Revd. Beaurepaire S.J., in the *North China Herald*, 4 December 1899.
38. *China Mail*, 10 May 1892.
39. All the correspondence in *Hong Kong Telegraph*, 2 September and 7 October 1902.
40. *Hong Kong Telegraph*, 19 July 1902.
41. 5 September 1902, Figg to Colonial Secretary, in HKRS 842.
42. *China Mail*, 27 September 1902.
43. *Hong Kong Telegraph*, 30 January 1903.
44. Announced in the Acting Director's Annual Report for 1903.
45. *Hong Kong Hansard*, 17 September and 1 October 1903.
46. Approved by the Acting Colonial Secretary, 18 December 1893, HKRS 1–2(1).
47. Notified in the *Hong Kong Government Gazette*, 22 December 1905, with a correction in the 29 December issue.
48. *South China Morning Post*, 23 May 1906.
49. E. Osborne in the Legislative Council, 3 October, 1907. The population of the Colony, including the New Territories at the time of the 1906 census was only slightly more than 400 000.
50. *China Mail*, 18 September 1906.
51. Manager of the P&O Line, Chairman of the Chamber of Commerce 1903–15.
52. Robert E. Brown, The Hong Kong Typhoon and the Jesuit Observatories, *The Month*, **8**, 561–70, 1906.
53. *South China Morning Post*, 1 October and 3 October 1906.
54. *Hong Kong Daily Press*, 26 September 1906.
55. Supplement to the *Hong Kong Government Gazette*, 22 March 1907, pp. 42–98.
56. *China Mail*, 25 March 1907.
57. 'Anxious' in *China Mail*, 27 March 1907.
58. *South China Morning Post*, 26 September 1906.
59. *South China Morning Post*, 25 March 1907.

60. In CO129/335.
61. Jose Algué, in Department of the Interior Weather Bureau Manila Central Observatory, Bulletin for September 1906, Manila: Bureau of Printing, 1907, pp. 235–45. The essentials of this report were carried in the *South China Morning Post* on 15 October 1906.
62. Hong Kong Legislative Council Sessional Papers, No. 33/1907, 1907.
63. *Observatoire de Zikawei Bulletin des Observations, Part B (Meteorology)*, **32**, 21–2, 1909.
64. *Hong Kong Daily Press*, 8 August 1907.
65. Saderra Masó (1915), p. 164.
66. *South China Morning Post*, 3 October 1906.
67. *Meteorological Observations Made at the Hong Kong Observatory in the Year 1906*, Hong Kong: Noronha & Co, 1907, plate I.
68. L. Starbuck, *A Statistical Survey of Typhoons and Tropical Depressions in the Western Pacific and China Sea Area from Observations and Tracks Recorded at the Royal Observatory Hong Kong from 1884 to 1947*, Hong Kong: Government Printers, 1951.
69. Chin (1958).
70. Reference 58 above.
71. Udias (2003), p. 163, states: 'Doberck, … motivated by his animosity against the Jesuits, prevented the publication in the Colony of the forecast of a typhoon made by Froc [director of the Zikawei Observatory] two days in advance, with the result of the loss of many lives and ships'.
72. *North China Daily News*, 29 July 1907.
73. The undated [February 1907] report is in HKRS356 1–1(2), and the new scheme promulgated in the *Hong Kong Government Gazette*, 31 May 1907.
74. 4 March 1907, Nathan to Secretary of State for the Colonies, in CO129/339, p. 345.
75. Undated [January] minute in HKRS356 1–2(1).
76. A minute by the Acting Governor May, 15 January 1907, HKRS356 1–2(1).
77. Saderra Masó (1915), p. 164.
78. Available at Hong Kong Public Records Office, www.grs.gov.hk/PRO/srch/english/sys_carlsmith.jsp?language=english.
79. Doberck was still described as director in the storm warning signals published in the *Gazette* on 31 May, although Figg was so described in an identical notice there on 26 July.
80. Plummer (1910).
81. *Hong Kong Telegraph*, 22 March 1910.
82. Plummer obituary in *Hong Kong Daily Press*, 9 February 1925.
83. See for example Kutzbach (1979).
84. Plummer (1910), p. 25.
85. The following is based, in part, on P. Kevin MacKeown, A Note on an Early Female Meteorologist: Miss Anna Doberck, *Int. J. Meteorology UK*, **33**, 334–9, 2008.
86. Among such are, Peggy Aldrich Kidwell, Women Astronomers in Britain, 1780–1930, *Isis*, **75**, 534–46, 1984, and Ogilvie (1986). For women in astronomy in the United States, see Lankford (1997).
87. P. Sham, Centenary of the Royal Observatory Hong Kong, *WMO Bulletin*, **32**, 313–6, 1983.
88. CO129/273, p. 192.
89. CO129/273, p. 191.
90. CO129/273, p. 193.

91. CO129/275, p. 100.
92. 1 March 1893, Commander-in Chief China to Doberck, HKRS842 1/1. Some logs, however, would eventually be received from navy ships, as noted in the annual reports from the Observatory.
93. For example, Chin (1958).
94. 1 July 1902, Anna Doberck to Colonial Secretary, HKRS842 1/4.
95. 18 January 1906, Anna Doberck to Sir Matthew Nathan, in Nathan, Bodlean Archives.
96. 5 April 1907, Anna Doberck to Sir Matthew Nathan, in Nathan, Bodlean Archives.
97. *South China Morning Post*, 16 October 1904.
98. Hoe (1991), §17, and personal communication.
99. Mary Kingsley, quoted in Hoe (1991).
100. Welsh (1993), p. 343.

Chapter 8

1. *China Mail*, 25 July 1907.
2. CO129/339, p. 348.
3. CO129/339, p. 345.
4. CO129/339, p. 351.
5. *Monthly Weather Review*, **27**, 98–9, 1899.
6. *Hong Kong Hansard*, 17 September 1907 and 24 September 1908.
7. *Hong Kong Hansard*, 1 April 1909.
8. Reported in the *China Mail*, 1 April 1907.
9. *China Mail*, 8 August 1907.
10. Report from the Director of the Observatory for 1913, Hong Kong Government Administrative Reports, 1913, pp. E1–E11; Froc also visited the Observatory in 1914.
11. *China Mail*, 30 July 1907.
12. *China Mail*, 25 July 1907.
13. *Hong Kong Hansard*, 9 October 1921.
14. *Hong Kong Hansard*, 7 October 1909.
15. *Hong Kong Telegraph*, 6 May 1910.
16. CO129/370, p. 53.
17. CO129/370, p. 49.
18. 20 November 1911, F. W. Dyson to Claxton, HKRS 842/4.
19. Report from the Director of the Observatory for 1911 (F. G. Figg), Administrative Reports, 1911, pp. E1–E12.
20. CO129/381, p. 378.
21. Ibid., p. 380.
22. Kutzbach (1979), p. 8.
23. Jill Austin, A Forgotten Meteorological Instrument — The Rainband Spectroscope, *Weather*, **36**, 151–4, 1981.
24. Report of the Director of the Hong Kong Observatory for the Year 1906, *Hong Kong Government Gazette*, Supplement, 26 April 1907.
25. Pyenson (1989).
26. *Trans. China Branch Roy. Asiatic Soc.*, part III, p. 116, 1853.
27. Burton (1997), p. 61.
28. Griffiths and Lau (1986).

29. The incumbent, who transferred to the newly designated position, was one Wan Suit Ngam. He had been with the Observatory since January 1890, and, working his way up from telegraphist, served there for more than thirty-three years. He retired, as a third grade computer, at the end of January 1923. Later the position of assistant was designated as scientific officer, and in 1949 the first Chinese were appointed as assistant scientific officers. One of them, Chin Ping Chuen was promoted to scientific officer in 1954 and worked there until retirement.
30. Before he came to Hong Kong, he had a good opinion of at least one Jesuit, writing: 'the highly merited Jesuit, Christian Mayer, of the observatory at Mannheim', in *Nature*, **26**, 418–9, 1882.
31. O'Rorke (1878).
32. O'Rorke (1889), Vol. II, p. 529.
33. *Science*, **35**, 448, 1912.
34. *Hong Kong Hansard*, 19 October 1911.
35. Plummer's wife, Marion, had died at their home in Kowloon on 14 October 1900; *China Mail*, 18 October 1900.
36. Appleton (2009).
37. Plummer obituaries in *Hong Kong Telegraph*, 7 February 1925, *Hong Kong Daily Press*, 9 February 1925, *South China Morning Post*, 9 February 1925.
38. 1 July 1902, Anna Doberck to Colonial Secretary, HKRS 842/4.
39. Report from the Director of the Observatory for 1911, Hong Kong Government Administrative Reports, 1911, pp. E1–E12.
40. CO129/421, p. 65.
41. CO129/421, p. 69.
42. CO129/442, p. 54.
43. *Quart. J. Roy. Met. Soc.*, **58**, 181, 1932.
44. W. Doberck, Dr. Doberck's Observatory, Sutton, Surrey, *Monthly Notices Roy. Astron. Soc.*, **69**, 281–2, 1909.
45. *Monthly Notices Roy. Astron. Soc.*, **69**, 1, 1908.
46. For a more detailed account of Doberck's work in astronomy see the author's William Doberck — Double Star Astronomer, *J. Astron. History and Heritage*, **10**, 49–64, 2007.
47. 28 December 1922, Doberck to R. G. Aitken, in Lick Observatory Archives.
48. Aitken (1918), p. 240.
49. W. Doberck, On the Orbit of τ Ophiuchi, *Astronomische Nachrichten*, **170**, 101, 1906.
50. W. Doberck, On the Orbit of xi Bootis, *Astronomische Nachrichten*, **214**, 89–98, 1921.
51. W.D. Heintz, The Castor System, *Publications of the Astronomical Society of the Pacific*, **100**, 834–8, 1988.
52. J. Dommanget, The Mass/Eccentricity Limit in Double Star Astronomy, *Journal of Astrophysics and Astronomy*, **24**, 99–109, 2003.
53. Obituary: Dr. William Doberck, *Nature*, **147**, 409, 1941.
54. R. G. Aitken, Obituary, *Publications of the Astronomical Society of the Pacific*, **53**, 263–4, 1941.
55. W. Doberck, Markree Observatory, *The Observatory*, **7**, 329–32, 1884.

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