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FOR 'CENTRES OF CALCULATIONS?': 'COLONIAL METEOROLOGY' IN NINETEENTH CENTURY JAPAN

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Abstract: Behind the 'success story' of Japan's rapid modernization and industrialization in the latter half of the nineteenth century, Japan was a field of colonial science for European and American visitors; some of whom were employed by the Meiji Government as science teachers, while others were sent on missions to gather information about Japan from a geopolitical perspective. This paper examines the 'colonial meteorology' in Japan that was conducted by various actors from Europe and the U.S. between the 1850s and the 1890s (inclusive). As is widely known, Japan is one of the few Asian nations that did not experience colonial rule by Western powers. Yet, in field sciences, the Japan archipelago was targeted as a newly discovered 'frontier' and thus Western navigators, naturalists, and science teachers sought and collected information on geography, climate, flora and fauna, and so forth. While the Japanese Government constructed a meteorological network throughout the country and started a weather service in the 1880s, various foreign scholars observed the weather daily and compiled climatological data during their stay, researched weather phenomena assumed to be unique to Japan (such as typhoons), and then reported the results to their home countries, to scientific journals in Europe, or to foreigners' communities in Japan without sharing the information with the locals. This paper investigates their activities and purposes, and their influences on Japanese meteorology, especially the form of knowledge production that would be duplicated in the expansive Japanese imperial territory.

Keyword: Japanese colonial meteorology; Western 'meteorologists'; climatological data; weather data; typhoons

1 INTRODUCTION

It is generally said that Japan successfully modernized in the latter half of nineteenth century, especially after the Meiji Restoration in 1868.[1] The Meiji Government promoted rapid scientific, technological and industrial renovation through an aggressive importation policy from the Western powers, and this targeted all fields of science and technology. Meteorology, of course, was one of these. Tokyo Meteorological Observatory, established in 1875 (Editorial Committee …, 1978), started storm warnings and weather forecasting in 1882 led by the German, Erwin Knipping (1844–1922), who was a navigator before coming to Japan. Tokyo consolidated the domestic meteorological network through the 1880s and 1890s, and the network was maintained by Japanese meteorologists from 1890 (Anonymous, 1975). From the last decade of the century, the Japanese observational network was expanded further to cover the whole of East Asia following the Imperial expansion, including Taiwan, Korea and Sakhalin, and Japanese meteorologists produced various modern meteorological works as they raced to catch up with Western academia (e.g. see Miyagawa, 2008; Zaiki and Tsukahara, 2007). For Japanese and other East Asian localities mentioned in the text refer to Figure 1.

Behind this 'success story', however, Japanese historians have not mentioned that nineteenth century Japan was also a field of colonial science conducted by European and American visitors. Some of these were employed by the Meiji Government as science teachers, others were sent out with missions to acquire information about Japan from geopolitical perspectives, or both of them. Many old publications about the foreign employees, called *oyatoi*, described the Westerners as teachers or 'fathers of modernization' in various fields. Also, recent literature has documented the introduction of Western science and technology into Japan and shown the tension between foreign and local knowledge and technologies in various aspects (e.g. see Low, 2005; Nakaoka, 2006). Yet, as Togo Tsukahara (2001) pointed out, the historiography of science in nineteenth century Japan tended to lack the point of view of colonial science practiced in Japan. Referring to the history of Rangaku (Dutch studies during the Edo Period), he emphasized the necessity of focusing on the foreign visitors' motivations and the global contexts for carrying out scientific activities in Japan (*ibid*.).

The use of the term 'colonial science' in this paper needs to be commented on. As many works on this theme have discussed, the strict definition of Imperial/colonial science is becoming more and more difficult and ambiguous. Scientists (or producers of knowledge in a broader sense) did not always work for their home country, and the colonial fields in which they worked were not always ruled by the Imperial powers. In many cases, the scientific information and knowledge they produced was accumulated at the Imperial centre, added to

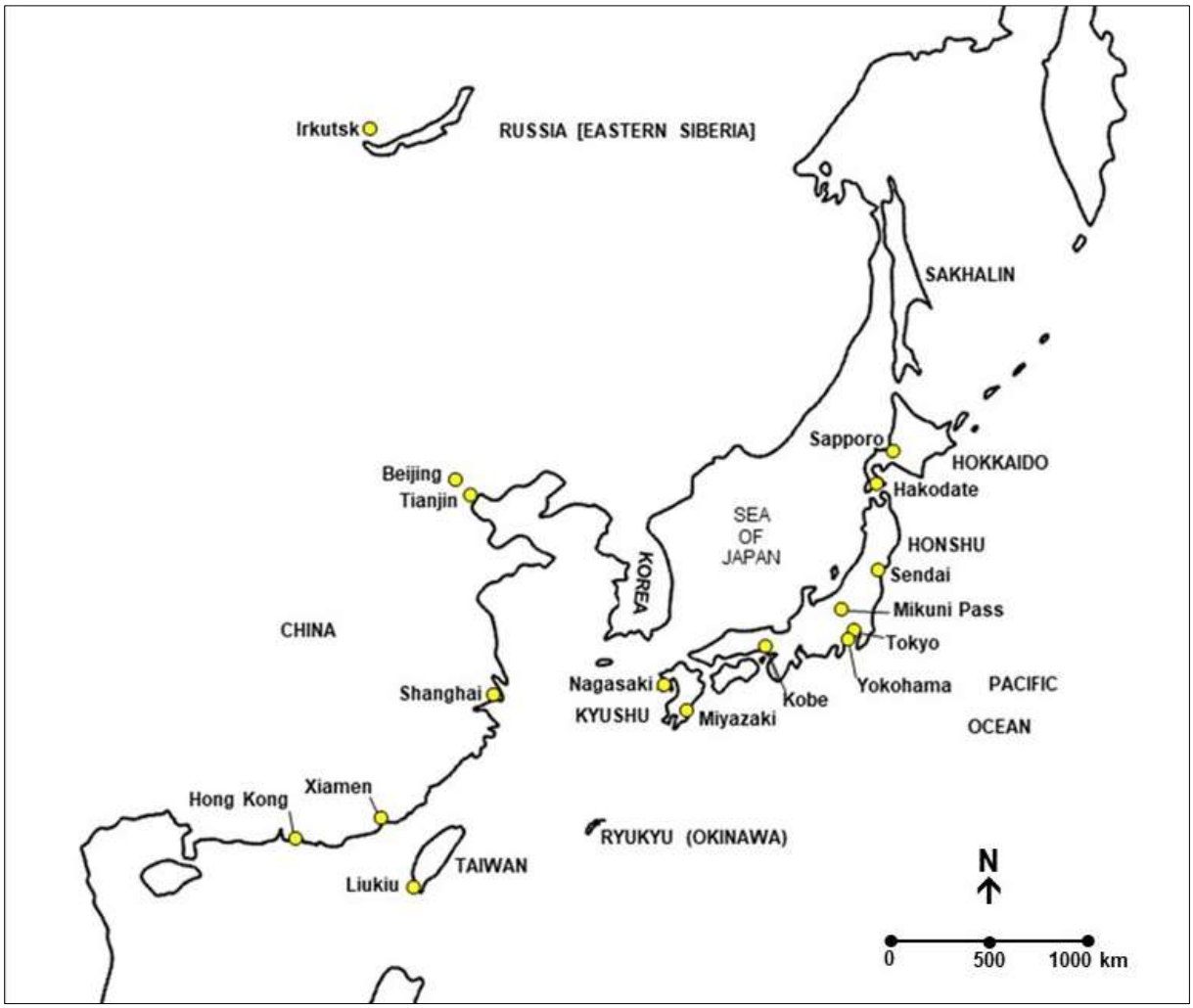

Figure 1: East Asian localities mentioned in the text (map: Takuya Miyagawa and Wayne Orchiston).

the database of scientific knowledge and made use of for colonial governance, but at the same time, it circulated over the Imperial borders in various forms (Bennett, 2011; Latour, 1987). The relationship between the colonizers and the colonized also has been pointed out as a significant factor in colonial science, which raises the issue of knowledge production in science and the involvement in the knowledge production process of the Indigenous populations, and the tensions between Western and local knowledge (e.g. see Chambers and Gillespie, 2000; Raj, 2007; Whitt, 2009).

As is widely known, Japan was one of very few Asian nations that did not experience colonial rule by Western powers. Rather, Japan became an Imperial state that from the end of the nineteenth century covered the west Pacific area. In the field sciences, however, the Japan archipelago was targeted as a newly discovered 'frontier' after it opened its ports in the late nineteenth century, and Western navigators, naturalists and science teachers sought and collected information on geography, hydrography, climate, flora and fauna, ethnicity, and so forth as had happened earlier in Qing China (Shirahata, 1994; Fan, 2004). Their activities were motivated by Imperial missions, intellectual curiosity, or perhaps personal ambitions as scientists, and in most cases, there was intellectual inequality between the foreigners and the Japanese.

This paper will illustrate how foreign visitors collected weather information and produced meteorological and climatological data and knowledge in nineteenth century Japan. How should we locate their knowledge production activities, both in Japanese intellectual history and in the broader context of the history of science? This paper also explores how they influenced Japanese meteorologists in the style of climatological knowledge production. While the Western observers practiced 'colonial meteorology and climatology' in Japan in the form of 'Humboldtian science', it functioned as a sort of model for Japanese meteorologist to achieve scientific works in the 'modern' manner by themselves.

2 OBSERVATIONAL ACTIVITIES IN LATE EDO JAPAN

As early as the late seventeenth century, thermometers were brought into Japan from the Dutch Republic, and various documents introduced thermometers from the eighteenth century on. For example, Engelbert Kämpfer (1651–1716), a German doctor, referred to a thermometer he saw during his stay in Japan in the 1690s. Gempaku Sugita (1733–1831), a Rangaku scholar, mentioned the thermometer in his retrospective essay, and Hiraga Gennai (1728–1780), a well-known inventor, made a thermometer in 1768. In the 1840s, the sericulturist Zenemon Nakamura (1806–1880) reportedly produced a thermometer for sericulture (silk-farming) by himself, after seeing a Dutch doctor using a thermometer. However, their interest in meteorology seems to have been relatively low compared to other fields of science, such as medicine and astronomy at the time (Hishikari, 2017). Rather, they were curious about this instrument itself from the outside world, rather than using it for observational activities. Although the Edo Shogunate permitted the translation of Western books in 1811, many books on science and medicine were translated into Japanese after that date, but few of them were about meteorology, and few people actually made weather observations.

The translation of books on meteorology and systematic meteorological observations was performed by the Edo Astronomical Observatory. In 1808, the Asakusa Calendar Bureau ordered Sajuro Baba, an interpreter working in Nagasaki, to translate books on the Earth Sciences such as Astronomy and Geography. One of the books he translated was *Tenki keigi yakusetsu* (*Introduction to the Weather Gauge*), which was published in 1810. According to Kanichi Koinuma (1968: 19–31), who surveyed the beginning of meteorological observations in Japan, the Asakusa Calendar Bureau began measuring pressure, temperature, humidity, etc. using observational devices imported from the Netherlands in 1818, but only for several months. The aim was to make precise astronomical observations by measuring air density and calculating the refraction of light, rather than for meteorological research itself. It was in the same context again, when the Bureau conducted observations from 1838 to 1855, which were necessary for calendar reform.

An exceptional case of observations aimed at collecting meteorological data was carried out at the Hakodate Magistrate's office. This office was established to combat the threats of Russia and other foreign powers, and intermittent weather observations began in 1854. Weather, temperature, wind direction, wind force, and earthquake were observed and recorded by Norimasa Nakamura, who was then in charge of the Hokkaido administration. According to him, observations were made not only in Hakodate but also in various places in Hokkaido (Hakodate shi shi hensanshitsu, 1974: 671–672). Yet, there are no clues as to who proposed the observations, for what purpose, and with what equipment. With the exception of the case of Hakodate, the meteorological observations by Rangaku scholars and the astronomers in the Late Edo Period were not intended to collect data and forecast and predict weather or statistically understand the climate of Japan, nor to study meteorological phenomena. They were used for other purposes, such as curiosity and astronomical observation. When astronomical observations were carried out, it was important to be able to ascertain the atmospheric conditions at the observing site at that time. But there was still no recognition of the need to conduct meteorological observations over a wide area.

On the contrary, meteorological observations by foreigners who stayed in Japan or sailed near the coast aimed at understanding Japan's climate in a numerical manner. The first observers were Dutch merchants and doctors at Dejima, Nagasaki, on the island of Kyushu (Figure 2). Throughout the Edo Era, Dejima was home to Dutch and Qing traders who were allowed to carry out mercantile activities, and also a place where Dutch doctors and scientists could carry out various research activities of personal interest. For example, at the end of the eighteenth century, Carl Peter Thunberg (1743–1828), a physician assigned to Nagasaki by the Dutch East India Company (VOC), and Arend Willem Feith (1745–1782), a director of Dejima trading, conducted daily observations during their stay in Nagasaki and reported the results in a magazine published in Batavia. Philipp Franz Balthasar von Siebold (1796–1866) had a major influence on the development of Rangaku, not only educating Japanese intellectuals on science and medicine during his six-year stay, but also surveying a wide range of fields, including Japanese geography, history, social systems, customs, languages and natural history. He also surveyed Japanese climate, using barometers, thermometers, and hygrometers that he installed in his office, and he sent detailed reports to his home country. He had a special interest in typhoons, which he personally experienced (Tsukahara, 2006).

From the early nineteenth century, European vessels sailing near Japan also conducted meteorological observations. In particular,

Figure 2: Nagasaki Harbour by Philipp Franz von Siebold circa 1820, showing Dejima, the artificial island where Dutch residents and visitors first reported on the local climate during the second half of the eighteenth century (https://en.wikipedia.org/wiki/Dejima#/media/File:DejimaInNagasakiBay.jpg).

observations by British warships and exploration vessels were the most frequent. In 1816, a British warship called at Ryukyu for about a month, and temperature, pressure, seawater temperature, wind direction and wind force were recorded at a fixed time every day. This record, one of the oldest continuous observational records in Japan, was included in the exploration record published two years later by the Captain, Basil Hall, in London (Hall, 1818).

Observations by foreign vessels became more active after the opening of Japanese ports in the 1850s. In 1853, when the United States Fleet led by Admiral Matthew C. Perry (1794–1858; Figure 3) approached the Edo Shogunate to open its ports, they conducted meteorological observations during a long voyage across the Pacific Ocean, and they continued to observe near Japan. Indeed, one of the main missions of Perry's fleet was to probe a safe Pacific Ocean route to East Asia. Securing a fuel base for trade with the Qing Dynasty, and whaling in the Pacific Ocean, were also important goals for Perry's fleet, but various surveys to secure the Pacific Ocean route were set as the primary goal. It was natural that weather data was included in the surveys. After asking the Edo Shogunate to open its ports, Perry took his fleet south to Ryukyu and *en route* they faced a great typhoon which was documented in detail and was later called the 'Perry Typhoon'. Weather data collected during Perry's voyage were reported to the U.S. meteorologist William Redfield, who later made use of Perry's data along with data from other regions in reporting new research on hurricanes and cyclones (Fleming, 1990: 103; Tsukahara, 2006: 106–108).

Figure 3: Commodore Perry circa 1856–1858 (upload.wikipedia.org/wikipedia/commons/c/ca/Commodore_Matthew_Calbraith_Perry.png).

In the 1860s and 1870s, the British Empire was actively engaged in meteorological and oceanographic surveys in East Asian waters. In the 1870s, the British Empire, which began a full-scale invasion of East Asia, conducted surveys in East Asia, including in Japan, as part of a global exploration project, which included the *Challenger* Expedition. By conducting comprehensive exploration and surveying prior to other colonial powers Britain sought to gain military and economic advantage, and at the same time, show off its power. Concerning a descrip-

tion of the weather near Japan for example, in 1866 Charles I. Bullock (1826–1904) of the Royal Navy conducted a survey in East Asia, while based in Shanghai. The purpose was to select an appropriate Japanese port that could later become an open port, and to investigate the climate, water depth, tides, etc. at the candidate site. The collected information was recorded in a logbook and reported to the home country (see Buchan, 1891: 137–158). Furthermore, in 1868, the British Empire requested permission from the Meiji Government to conduct meteorological observations from the survey ship *Syrvia* in the seas near Hokkaido. This was approved the following year (Anonymous, 1938). These cases indicate that the Japanese archipelago became one of the areas of interest to the USA and Britain, which were gathering and analyzing global climatic data from a geopolitical perspective.

3 OBSERVATIONS CONDUCTED AT THE OPEN PORTS

While sporadic meteorological observations were carried out in Japan by the Americans, the British and the Dutch for short periods of time, the observations were reported to their home countries and used as data for knowledge production activities in each country, but no Japanese joined in this process. Such a situation, where Japanese people were alienated from these surveys, was also seen in the open ports in the Late Edo and the Early Meiji Periods. From the late 1850s, visitors from Europe and the USA independently conducted meteorological observations at ports like Hakodate (in Hokkaido) and Yokohama (in Honshu), the first open ports.

Hakodate was where people with various jobs, such as consular officers, military personnel, doctors, merchants, and missionaries from the Western nations coexisted and vied for supremacy, as they also did in Shanghai and Tianjin during the Late Qing period (Yue, 2005). Since Hakodate was further away from metropolitan areas than other ports, such as Yokohama and Kobe (both on Honshu), which opened at the same time, the epidemic prevention activities among foreigners in Hakodate were relatively inactive, the population was not large, and people dispatched from each country made meteorological observations for their own purposes. For instance, Russia, was strategically interested in Hakodate as an antifreeze port, and it sent officials, diplomats, naval officers, doctors, missionaries and merchants, some of whom conducted meteorological observations. During his two-year stay in Hakodate from 1859, the physician Mikhail P. Albrecht (b. 1821) installed meteorological instruments, made observations, and sent the results to Russia as well as sharing them with colleagues resident in the city (Hakodate Meteorological Observatory, 1971).

Figure 4: Thomas Wright Blakiston (https://en.wikipedia.org/wiki/Thomas_Blakiston#/media/File:ThomasBlakiston.jpg).

From 1861 when Albrecht left Hakodate, meteorological observations were continued by the British. Thomas Wright Blakiston (1832–1891; Figure 4), who came to Hakodate in 1863, began recording rainy days during the following year, and he monitored temperature and pressure from 1868 to 1872.[2] After his departure, Shigetoyo Fukushi (1838–1922; Figure 5), a Japanese surveyor, took over the observations upon the suggestion of Horace

Figure 5: Shigetoyo Fukushi (http://www.zaidan-hakodate.com/jimbutsu/06_ha/06-fukushina.html).

Figure 6: James Curtis Hepburn (https://en.wikipedia.org/wiki/James_Curtis_Hepburn#/media/File:James_Curtis_Hepburn.jpg).

Capron (1804–1885), the Secretary of the US Department of Agriculture serving as an advisor to the Hokkaido pioneering bureau in the Early Meiji Period. Capron insisted on the importance of meteorological observations for promoting agriculture and mining development in Hokkaido, and he instructed Fukushi to learn meteorology and make observations (Fujita, 1994: 15–41; Koinuma, 1968a).

Figure 7: Tsurugisaki Lighthouse near Yokohama (https://en.wikipedia.org/wiki/Tsurugisaki_Lighthouse#/media/File:Turugi19.jpg).

In planning their activities the Westerners, including Capron, obviously prioritized their national interests over Japan's. Although the Americans in Hokkaido were hired to educate Fukushi and other Japanese engineers and to make other investigations necessary for the development of Hokkaido, they were aggressive in developing mining projects that would bring great benefit to the USA. From 1866, William P. Blake (1826–1910) and Raphael Pumpelly (1837–1923) conducted geological surveys around Hakodate, and they wrote a number of geological articles and reports on the mineral resources of the area relating to the USA's acquisition of mining concessions and resource trading (Minato, 1982: 893–907). As well as in other Asian countries where the Westerners conducted exploration activities for their own interests, early weather observing in Hokkaido was performed as a part of the Imperial project of the Americans.

Foreigners in Yokohama also performed weather observations. James Hepburn (1815–1911; Figure 6), a missionary physician who began medical activities in Yokohama in 1859, made daily observations for ten years after receiving a request from the American Meteorological Society (AMS).[3] He reported his results in the *Japan Herald* (a newspaper published in Yokohama), and to the AMS and the Asiatic Society of Japan (ASJ) (see Hepburn, 1882). The ASJ, established in the Yokohama Settlement in 1872, was a place for the foreigners staying in Japan to exchange information about Japan. The ASJ members published research on Japanese history, geography, anthropology, natural history and so forth in the *Transactions of the Asiatic Society of Japan*. Along with these, some articles about Japan's climate were reported. Hepburn's ten-year record of continuous observations was used as a valuable record by many Western meteorologists.

In Yokohama, observations were made at the lighthouses built by Richard Henry Brunton (1841–1901), a British engineer who was hired by the Meiji Government to build and manage lighthouses. Under Brunton's guidance, the Government constructed lighthouses at the economically significant ports. Yokohama, where the largest number of foreign ships visited, had nine lighthouses and two light boats. Two of them, Tsurugasaki Lighthouse (Figure 7) and Honmoku Lightship, conducted meteorological observations, measuring air pressure, temperature, rainfall, and wind direction twice a day. Brunton handed over the meteorological results to the *Challenger* when it called at Yokohama in 1875, and later he reported to the British Meteorological Office (Tizard, 1876).

In the cities that opened slightly later than Hakodate and Yokohama, foreign visitors also conducted observations. In Kobe, which opened in 1868, John Marshall (1833–1877), British navigator and engineer hired to improve the harbor facilities, made observations daily. He imported instruments from Britain, recorded observations from 1876 to 1887, and posted the results in Kobe's English-language newspaper, *Hiogo News* (Nakatsu et al., 2003; see Figure 8). In Nagasaki (on Kyushu), Anton J.C. Geerts (1843–1883; Figure 9), a Dutch chemist, made observations at the Nagasaki Medical School. In 1873, Geerts exchanged weather telegrams

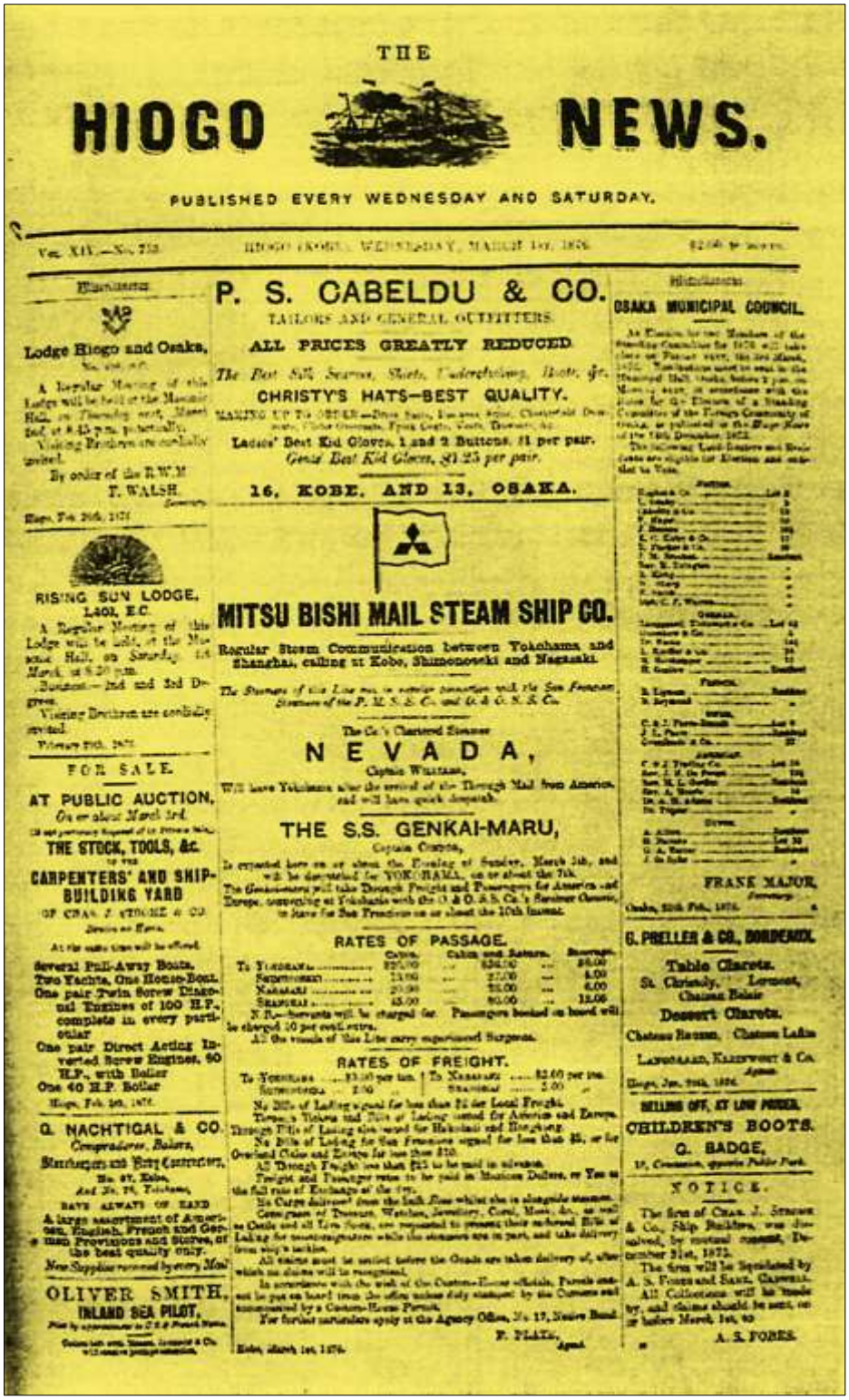

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Figure 8: A color-enhanced copy of the front page of the 1 March 1874 issue of *The Hiogo News* (after Nakatsu et al. 2003: 16).

Figure 9: Anton J.C. Geerts (https://ja.wikipedia.org/wiki/アントン・ヨハネス・ゲールツ#/media/ファイル:Anton_Johannes_Cornelis_Geerts.jpg).

with observing stations in Hong Kong, Amoy (now Xiamen), and Shanghai, with the support of the Great Northern Telegraph Company

Figure 10: The cover of an issue of the *Zeitschrift der Österreichischen Gesellschaft für Meteorologie* (https://www.digitale-sammlungen.de/de/view/bsb11392895?q=%28Österreichische+Gesellschaft+für+Meteorologie%29&page=,1).

which at that time operated the East Asian submarine telegraph (Geerts, 1875).

Thus, from the Late Edo Period to the Early Meiji Era, weather observations by foreigners were made sporadically at the open ports. Except for Fukushi's case, none of these activities was carried out with the Japanese, and the observational results were either disclosed only to the Westerners residing in Japan or re-ported to the observers' home countries. In particular, it is noteworthy that many of the reports on Japan's climate produced during this period were published in the journal of the German Meteorological Society (Okada, 1904). The journal, *Zeitschrift der Österreichischen Gesellschaft für Meteorologie* (ZOG—see Figure 10), was led by Julius von Hann (1839–1921), an Austrian climatologist, who collected reports on the climate of Japan and around the world. In other words, intellectual practices such as collecting information on Japanese weather were monopolized by the Imperial scientists before many Japanese became involved in observational activities. Bruno Latour (1987: 215–257) pointed out that the collection and accumulation of diverse information was an important foundational stage of knowledge production, and the results of exploration activities by European explorers were accumulated at the 'centres of calculation' in the empires, which led to the production of universal knowledge. From the mid-nineteenth century on, weather information on Japan was transmitted to these 'centres' by these Western visitors, who played a vital role as providers of the basic information for the global knowledge production program of the European climatologists.

4 CLIMATOLOGICAL RESEARCH IN JAPAN CARRIED OUT BY FOREIGN VISITORS

The Japanese meteorological observation system was gradually developing under the initiative of the hired foreign teachers from the late 1870s on, and they wrote many articles on the characteristics of climate in Japan based upon their own observations. They studied the Japanese climate, providing introductory descriptions of the four seasons, temperature, rainfall, typhoons, and so on. In the 1880s, although the Tokyo Meteorological Observatory set up an academic organization to conduct research activities by the Japanese themselves, there were few research papers since meteorology was not yet established nor identified as a scientific activity among the Japanese. By the mid-1890s, therefore, research on climate in Japan was dominated by foreign scholars, as colonial knowledge production.

The early works written to introduce European and American readers to Japan's climate were produced by advisors of the Hokkaido Development Bureau. Those works were to comprehend the climate of Hokkaido, which was essential for their mission, the promotion of agriculture. For example, in the early 1870s, the American chemist and geologist Thomas Antisel (1817–1893; Figure 11) conducted a comparative analysis of his own data and Hepburn's meteorological observations made in Yokohama. In the report Antisel (1872) stated that Japan was a country with a mild climate with no sharp changes in temperature and pressure throughout the year. He said that the Japanese archipelago was a land suitable for plant breeding and crop cultivation, thanks to a slow climate cycle in which the temperature gradually rose in the first half of the year and gradually decreased in the second half. According to him, such a temperate climate was attributed to the characteristics of island nations that were strongly affected by the sea. He showed that the great current circulating in the Pacific Ocean created a mild climate, and the impact of the Asian continent was relatively small on the archipelago. The atmospheric pressure remained stable throughout the year without abrupt changes, and the fact that ocean currents accompanied the wind and caused more rain on the coast was shown as evidence that the influence of the ocean was greater than that of a continent. His report was translated into Japanese, and submitted to Kaitakushi, the Hokkaido governmental organization relating to governance and cultivation.

Two of Antisel's American colleagues, Horace Capron (Figure 12) and Benjamin S. Lyman (1835–1920), also studied Hokkaido's climate for five years, and they wrote briefly about it in their reports on the promotion and development of agriculture and mining. Capron (1874; 1875), who did not make the meteorological observations himself, analyzed the climate in Hokkaido making use of data provided by Albrecht and Blakiston in his report on agricultural development that he submitted to the Japanese Government as a consultant. He said that Hokkaido's climate was similar to that found in New York, Pennsylvania, and Wisconsin, at the same latitude in the USA, and that it would not hinder farming around Hakodate considering its mean temperature and amount of precipitation. He also thought that the heavy winter snow in Hokkaido would play a role in protecting the quality of soil, which would be greatly beneficial to the sustainable development of agriculture. According to Capron, while Hokkaido was not suited to rice cultivation, wheat and corn were possible with productivity

Figure 11: Geologist Thomas Antisel (https://en.wikipedia.org/wiki/Thomas_Antisell#/media/File:Thomas_Antisell_(1817-1893).jpg).

likely as high as that of the Northeastern United States. He emphasized that further accumulation of observational data would be necessary for agricultural production.

Benjamin Lyman (Figure 13), a geologist who mainly focused on mining development research in Hokkaido, also mentioned the climate of Hokkaido. Although Lyman's description was limited to the area around Hakodate where reliable observations were available at the time, he pointed out that winter was shorter and less cold and summer was more comfortable than in Boston, which was at almost the same latitude. On the other hand, he noted that in Tokyo it was not too hot and the summer was not too long, but there was little snow, and there was warm sunlight during the day, even in winter. For Lyman, the weather in Hakodate and Tokyo seemed to be comfortable and pleasant for the

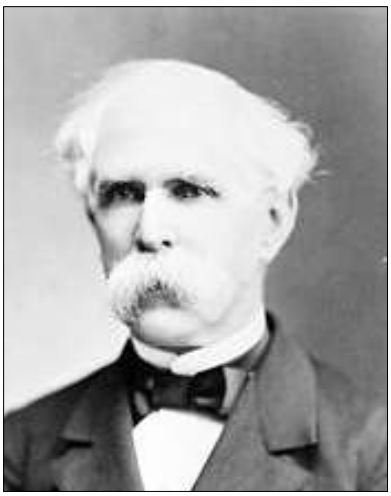

Figure 12: Horace Capron (https://en.wikipedia.org/wiki/Horace_Capron#/media/File:Horace_Capron.jpg).

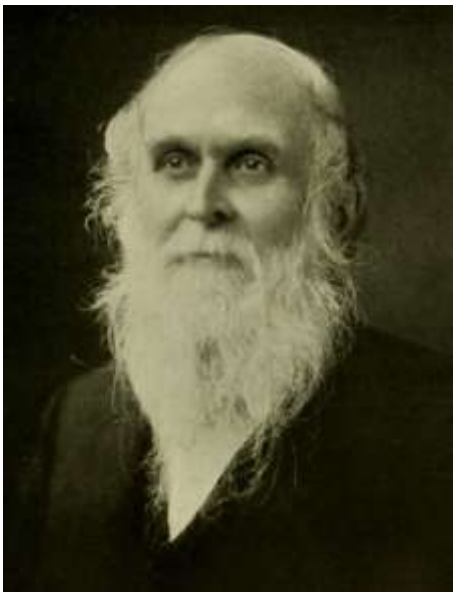

Figure 13: Benjamin Smith Lyman at 81 (https://en.wikipedia.org/wiki/Benjamin_Smith_Lyman#/media/File:Benjamin_Smith_Lyman_1917.png).

promotion of industries. Lyman found that Japan's temperature and humidity remained moderate throughout the year due to the geographical location of the islands, hundreds of miles from the Asian continent. He added that Hokkaido had a suitable climate for the promotion of industries as long as many people were willing to move to the island (Lyman, 1873: 5–10; c.f. Lyman, 1874). Since the American observers in Hokkaido were employed by the Japanese Government, they were obliged to submit reports, and most of these included

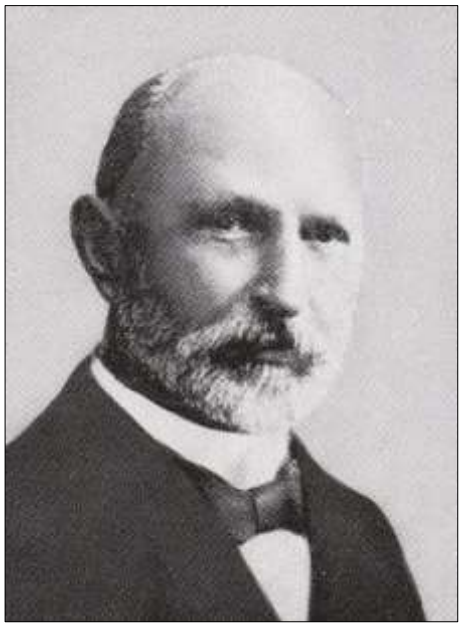

Figure 14: Erwin Rudolf Theobold Knipping (https://www.wikidata.org/wiki/Q11291134#/media/File:Erwin_Knipping.jpg).

weather information. For the Japanese leaders, this probably was the first time they had read about the climate of Japan based on observational data, with comparisons to other countries, and the climatic demands of various industries. It is not clear, though, whether they fully comprehended and used the climatic data provided for Hokkaido, since the reports used a standard format required by the Japanese bureaucracy. Furthermore, the foreign visitors did not always share all of their knowledge with the Japanese.

Hepburn embraced a common view with Antisel that the climate in Japan was determined by geographical conditions. Based on his ten-year observations made in Yokohama, Hepburn (1882) explained that the Japan archipelago was the destination of the warm current (Kuroshio) flowing northward from the Equator. Also, unlike along the Chinese coast, winds in Japan were irregular and sometimes violent. According to his own experience, 'cyclones', called 'violent winds', came regularly once or twice a year. He pointed out that Japan's climate was characterized by much more annual rainfall than other countries. Looking at the distribution of monthly precipitation in Japan, more than two-thirds of the annual rainfall fell between April and October, while there was no more than 20 cm of snow in winter. His descriptions were based on his observations only in Yokohama where relatively little snow fell in winter, and this differed from the northern part of Japan which has heavy snow annually (Hepburn, 1882). Although his depiction of Japanese climate was regionally limited, he presented a reliable record of ten years of continuous observations in the journal of the ASJ (which had a close link with the Royal Asiatic Society of England and Ireland). Thus, he was successful in widely publicizing Japan's climate throughout Europe.

The German, Erwin Knipping (Figure 14), who led the establishment of the meteorological observation system through the 1880s, also discussed the Japanese climate and provided a lot of information for foreign residents. His important contribution was that he demonstrated how to describe the climate and observational data for Japanese meteorologists, most of whom were receiving meteorological education. He published "The climate of Japan" in 1885, which was translated into Japanese (*Nihon Kisho ron*) two years later (Knipping, 1887) and was the first report Knipping wrote about Japan's general climate, based on a whole year of data gathered from 23 weather stations. Up to that time, he had published research papers about typhoons, some meteorological aspects (such as wind and pressure), and earthquakes,

but *Nihon Kisho ron* was the first work to summarize the characteristics of the Japanese climate. Knipping focused on the relationship between temperature and barometric pressure by comparing changes in temperature, barometric pressure and precipitation month-by-month regionally, and with foreign countries. For example, the differences in temperature in February and August, the months with the lowest and the highest mean temperature each year, respectively, were 19° C in Miyazaki, almost 20° C on the Pacific coast, and 28° C in Sapporo. These differences were smaller than in Beijing (30° C) and Irkutsk (39° C), and twice as large as those in southern Ireland (8° C), Glasgow (11° C), and London (14° C) (Knipping, 1885). Although Knipping did not explain the significance of these comparisons but just provided a descriptive introduction, the translated version of his book was the first climatographical work on the climate of Japan with numerical evidence, and thereafter, Japanese meteorologists would follow his style of writing, such as is typically seen in Kiyoo Nakamura's work.

In terms of disseminating Japan's climate to the world, Johannes Justus Rein (1835–1918; Figure 15), the Prussian geographer, and Julius von Hann, the Austrian climatologist, were remarkable. The Prussian Government was planning to send a Prussian trading company to Japan, so Rein was dispatched there to collect relevant information. Traveling around the archipelago for two years, he surveyed the geography, geology, flora and fauna, folklore, etc., and published the results in bulletins of the ASJ and the *Deutsche Gesellschaft für Natur und Volkerkunde Ostasiens* (the German Association on East Asian Nature and Folklore) throughout the 1870s (Rein, 1878). In 1881, he published a travelogue that summarized his research in German (Figure 16), and translated it into English himself three years later (Rein, 1884). It was the most systematic and comprehensive book on Japan at the time, and accordingly widely read in Europe.

Although Rein did not undertake fixed-point observations, he provided a comprehensive description of the Japanese climate by combining the observational records sporadically gathered at the open ports. Rein stated that Japan's climate was able to be characterized by (1) more frequent changes in temperature throughout the year than other regions at the same latitude; (2) higher annual rainfall; and (3) its diversity. According to him, these characteristics were attributed to four factors: the monsoon, ocean currents, islands away from a continental land mass, and mountain ranges, among which he saw the monsoon as the defining factor. For example, the rainy season

Figure 15: Geographer Johannes Justus Rein (https://alchetron.com/Johannes-Justus-Rein).

from June was attributed to the monsoon from the Pacific Ocean. Rein also stated that a typhoon in East Asia was a phenomenon similar to a cyclone in the Indian Ocean, quoting a Brit-

Figure 16: The cover of Rein's *Japan Nach Reisen und Studien*, published in 1881 (https://archive.org/details/bub_gb_1CtLAAAAYAAJ/page/n3/mode/2up).

ish meteorologists' study of cyclones. He concluded that the typhoon and cyclone were essentially the same phenomenon with only two differences: the area in which they occurred and lightning, which was not associated with typhoons (Rein, 1884: 104–134).

Rein's description of Japan's climate would be quoted by many scholars and shared worldwide, significantly by the Austrian climatologist Julius von Hann, who helped spread Rein's work. Von Hann had been working on an ambitious project since the 1870s to collect weather data from around the world and complete a world climatography. In short, von Hann's project was to produce information about Japan's climate as part of a global knowledge production project that was already underway in Europe when the construction of

Figure 17: The German Max Fesca (https://en.wikipedia.org/wiki/Max_Fesca#/media/File:Max_Fesca.jpg).

meteorological observation network was beginning in Japan. Rein's textbook on climatology (*Handbuch der Klimatologie*), published in 1883, described the basic elements that made up climate, such as temperature, rainfall, monsoon, and climate around the world. He classified the world's climate into three categories: tropical, temperate, and cold, and he explained the climatic features in each region where observational data were available to him. Japan was included in the 'Non-tropical East Asia' section along with East Siberia and China. Von Hann noted that the three regions were heavily influenced by the continental monsoon, which made winter colder than any other region in the world at the same latitude. Among them, Japan was characterized by the large difference in climate between the Pacific Ocean side of the islands and the Sea of Japan side, as well as the large amount of annual precipitation overall (von Hann, 1883: 522–543).

Von Hann's description, based on data from the open ports in Japan and Rein's report, became a standard reference work on the climate of Japan. Indeed, the volumes about Japan's climate by Rein and von Hann were passed on to European intellectuals who came to Japan in the 1880s. Max Fesca (1846–1917; Figure 17), a German soil technologist and agronomist, was a case in point. He was employed as an advisor to the Geological Survey of Japan and a teacher at the Komaba Agricultural School (later the Faculty of Agriculture at Tokyo Imperial University) from 1882 to 1894.

In a paper discussing the relationship between agriculture, plants, and climate in Japan Fesca emphasized that correct knowledge of the climate was essential to find suitable agricultural products for each region, since the Japanese archipelago was elongated from north to south and the climate in each region was different. He believed it would be difficult to create a climatography covering the whole of Japan because there were not enough observational facilities in the inland areas, but he assumed it would be possible to gain an approximate view of the climate of each place on the basis of the publications by Rein and von Hann. For example, von Hann pointed out that terrestrial land typically had different climates on its eastern and western sides, and the same was observed in Japan. Fesca supported von Hann's observation that the mountains running north–south along the archipelago created distinct climatic differences between east and west (the Pacific Ocean and the Sea of Japan). Although Rein also pointed out that Japan was subject to drastic temperature changes throughout the year, Fesca followed von Hann's claim that as an island nation Japan had smaller and warmer temperatures than on the adjacent continental coast. Fesca classified the southern part of Japan as semi-tropical and the northern part as temperate, adding von Hann's classification on the eastern and western parts to it. He expected that a careful consideration of the climate was needed to select the plants to be cultivated that would be suitable for each of the four areas and would greatly improve agricultural production in Japan (Fesca, 1891a; 1891b; se, also *Nihon chisan* …, 1891).

5 INFLUENCE ON JAPANESE METEOROLOGISTS

These publications on Japanese climate by foreign scholars exerted a potent influence upon

Japanese meteorologists. It is obviously seen in *Dainihon fudo hen* (*Climate of Japan*, hereafter, *DFH*) by Kiyoo Nakamura (1855–1930; Figure 18), the Director of the Statistics Division of the Central Meteorological Observatory (CMO) at the time (and later the third Director of the CMO). The *DFH* was the compilation of fifteen years of observational data from all over Japan in discussing the general characteristics of Japanese climate. It was originally intended as an exhibit at the World Expo in Chicago in 1893 under the title *The Climate of Japan*, written in English and later translated into Japanese in 1897, so as to demonstrate the academic excellence of an emerging Asian nation to the rest of the world. Japanese meteorologists judged it as one of the most important works by the end of the nineteenth century. For instance, Takematsu Okada, the fourth Director of the CMO, noted that the *DFH* was "… the first scientific and comprehensive work on Japan's climate by the Japanese." (Okada, 1937: 246).

Yet the description style, methodology, and its content relied heavily on the earlier works of foreign scholars. For example, it was almost an imitation of Knipping in that most of the contents were occupied by tables summarizing various meteorological elements (temperature, pressure, wind, humidity, precipitation) in various parts of Japan, and the descriptive method for comprehensively discussing Japan's climate in conclusion. At the time the *DFH* was published, it had been only about 15 years since systematic meteorological observations had begun in Japan, and the only options for Nakamura and other Japanese meteorologists were either to receive training in meteorology from Knipping or to study by themselves using books published overseas. Therefore, creating a systematic Japanese climatography was obviously a big challenge for them, and it was only natural that Nakamura had to depend on the previously published results when completing the *DFH*.

In many parts of Nakamura's description, he seems to have drawn on Rein's text, although it is not explicitly stated where he drew his information from. For example, when Rein observed the sky at Mikuni Pass at the border of Niigata and Gunma in winter, the western sky was dark and snowy, while the eastern sky was clear, revealing a completely different sky pattern in the east and in the west. Rein (1884: 122) pointed out that this was the symbolic scenery to show the completely different winter climate in Japan, where the east and west of the Japanese archipelago were separated by a central mountain range. And this depiction was also included in the *DFH*, without any major changes the (see Nakamura, 1893: 107–108).

Of course, Nakamura also presents his own views on the climate of Japan in the *DFH*. For instance, the description on the effects of ocean currents near Japan was based on his analysis. While Anticell and Hepburn also mentioned the impact of ocean currents on the climate, Nakamura pointed out that their descriptions were incorrect. According to him, only two currents were strongly related to temperature changes and precipitation. They were the Tsushima Current, which eased the cold air flowing from the continent in winter, and the Oyashio Current, which in summer sometimes caused cold damage to the Tohoku region (i.e. along the coast to the north and south of Sendai). On the other hand, when the Kuroshio approached the Japanese archipelago from the Equator, he argued

Figure 18: Japanese pioneer Kiyoo Nakamura (https://ja.wikipedia.org/wiki/中村精男).

that it would not have much effect because the temperature of the archipelago had already been sufficiently raised by solar heat. Nakamura believed that the climate of Japan was greatly influenced by the atmospheric conditions on the Asian continent, but at the same time, that the surroundings of the sea and the mountain range running through the archipelago were the most important factors that characterized Japan's climate. He concluded that this geographical feature provided Japan with a favorable climate:

> In short, though our country is very much influenced by the Continent of Asia in its climate, not being as gentle as on other islands, yet as it is surrounded on all sides by seas it still

> maintains the character of an island. Moreover, since its extent in the south and north direction is very great, and high mountains tower here and there, there is every possible variety in the configuration. If we wish for cold places, there are very cold places (as Hokkaido) and if we wish for hot places, there are very hot places (as Liukiu). And there are abundant precipitations all the year everywhere. Hence in our country, tropical plants can grow luxuriantly, and also plants in frigid zones can flourish equally well. Indeed, there is no plant in the whole vegetable kingdom that does not flourish in this Empire. With regard to climate, the Empire of Japan is really the Paradise on the whole globe (Nakamura, 1893: 109).

Nakamura's nationalistic description of the Japanese climate as a paradise on Earth was partly motivated by the intention that it was written for the World Expo to promote the emerging nation state. As the Japanese Government was aggressive in participating in the Expo in the name of enhancement of the national prestige and expanding trade and commerce, it formulated a special budget and organized a temporary exposition committee led by the Ministry of Agriculture and Commerce to encourage many companies to participate actively. An important issue for the Expo was to show the maturity of various industries and science and technology, and the advanced state of the emerging Japanese Empire through the numerous exhibitions. The *DFH* was exhibited to show that the meteorological project was well developed, and was being carried out just like similar projects in Europe and in the USA. Kazunori Kobayashi (1893: i–ii), the second Director of the CMO, confidently noted that the number of observing facilities was increasing rapidly and the description in the *DFH* was reliable enough since it was supported by data drawn from the history of Japanese meteorological observations.

6 CONCLUDING REMARKS

In most cases, the foreign scholars observed daily weather and compiled climatological data during their stays and researched Japanese climate and weather phenomena which they assumed to be unique to Japan, like typhoons in the late nineteenth century. The backgrounds of these foreign visitors were varied. They came from Britain, Germany, Russia and the United States, and included a diplomat, a doctor, a merchant, a missionary, a teacher and a traveler. In the late nineteenth century, Japan was a place to practice field science as an emerging frontier of Western Imperial missions and global knowledge production.

These visitors reported the results to their home countries and to scientific journals in Europe, and shared them with colleagues in foreign communities living in Japan. Their data-collecting activities led to the climatographical studies of Japan by the Western scholars such as Knipping, Rein and von Hann. Knipping described the climate of Japan in 1885, and Rein published a travel book around 1880 which was broadly circulated in Europe because of its voluminous information. His description of the Japanese climate relied on observations by merchants, missionaries, and teachers at open ports like Yokohama and Kobe, and this partly helped von Hann complete his world climatography in 1883. However, in this knowledge production and circulation process, the Japanese were almost alienated.

These climatological studies by foreigners served as a model for Nakamura's book, *The Climate of Japan*, published in 1893, which was the first achieved by a Japanese meteorologist. However, the narrative and methodology showed similarity to the earlier works by Knipping, Rein and von Hann when describing the characteristics of the Japanese climate, the only difference being his patriotic descriptions. Nakamura's work would be revised again and again by Japanese scholars based on the accumulation of further observational data following the Imperial expansion of the network, but the basic elements of his description of the Japanese climate would remain. This was partly because the establishment of a modern observationally based weather system was a novelty for Japan, and so initially there were few Japanese with the incentive or the background to systematically study the climate of their nation.

This form of knowledge production, including ignoring the Indigenous communities, was then duplicated when Japanese meteorologists surveyed East Asian weather and climate in the Imperial territory.[4] In Taiwan, Korea, and other colonies of the Japanese Empire, the Japanese established observational facilities, collected climatic data, and carried out meteorological investigations without involving the local populations. The Japanese meteorologists merely repeated the way in which they had seen colonial science operate during the early years of the Japanese meteorological enterprise.

7 NOTES

1. For the purposes of this paper the following chronological framework is used:

Edo (Tokugawa) Period:- 1603–1867 CE
Meiji Era:- 1868–1912 CE
Taisho Era:- 1912–1926 CE

2. Blakiston (1883) is better known for his Hokkaido exploration and research on natural history than for weather observations. At the end of the Edo period, he had a career as a merchant of the British Empire in various regions of East Asia, and in Japan he mainly proceeded with taxonomic surveys of animals. Blakiston, who studied natural history and zoology for twenty years in Hokkaido, wrote an article about Hokkaido's nature for the newspaper, the *Japan Gazette*, which was published in the Yokohama settlement. He introduced nature as he observed it in various parts of Hokkaido, but mainly in Sapporo and Hakodate, and he also mentioned the climate in each part.
3. For an overview of American Christian missionaries in Japan at this time, see Ion (2009).
4. For research on the East Asian rainy season, see Miyagawa (2016).

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