Chapter XI

Dutch Historical Resources on Climate Reconstruction

TSUKAHARA Tōgo

Global warming is acknowledged as one of the most serious problems of contemporary times.[1] The IPCC (Intergovernmental Panel of Climate Change) reported that a panel of their scientists arrived at the consensus that there has been a global temperature rise of approximately 0.6 °C over the last century and that the current scenario shows signs of the temperature rising to dangerous levels during this century. Given this fact, alongside efforts to reduce current and future CO2 levels, historians and scientists are also trying to analyze the various aspects of the global climate mechanism. One of the most common approaches is reconstructing the climate in the past. Information about past climatic conditions is one of the keys to interpreting current climate change and to forecasting the climate of the future.

A critical requirement to analyze climate in the past is reliable data on climatic variability in the pre-twentieth century period. However, where is this data available? So far, several attempts have been made to reconstruct the past's climate with the aid of early instrumental data, documentary data, and natural proxy indicators, in various parts of the world.[2] However, a standard work in this field of study by Lamb argued that one problem is the lack of information regarding climatic conditions outside Europe before the mid-nineteenth century.[3]

Dutch materials and historical documents in Japan have been gaining considerable attention as they have been found to be helpful in filling the gaps in historical data from outside Europe. Through interdisciplinary cooperation between meteorologists and historians, Dutch historical material and documentation have begun to be systematically studied. A scientific analysis of the material has proved

[1] P. D. Jones, M. New, D. E. Parker, S. Martin, and I. G. Rigor, "Surface Air Temperature and Its Change over the Past 150 Years," *Reviews of Geophysics* 37, no. 2 (1999): 173–199.

[2] For example, P. D. Jones and M. E. Mann, "Climate over Past Millennia," *Reviews of Geophysics* 42, no. 2 (2004): 1–42.

[3] H. H. Lamb, *Climate, History and the Modern World*, 2nd. ed. (New York: Routledge, 1995).

that it consists of reliable data sets, and Dutch historical records are now considered as a rich resource for climate reconstruction.

In this article, I will review how these Dutch resources were found, analyzed and interpreted from the viewpoint of climate reconstruction. In doing so, this chapter attempts to highlight the potential wealth of early meteorological records from the colonial era and, in particular, Dutch materials of the early modern period from maritime Asia. The present level of research and prospects for the near future will also be considered with regard to using these materials in better understanding global warming.

Reconstruction of von Siebold's Data and Other Meteorological Observations from Nagasaki

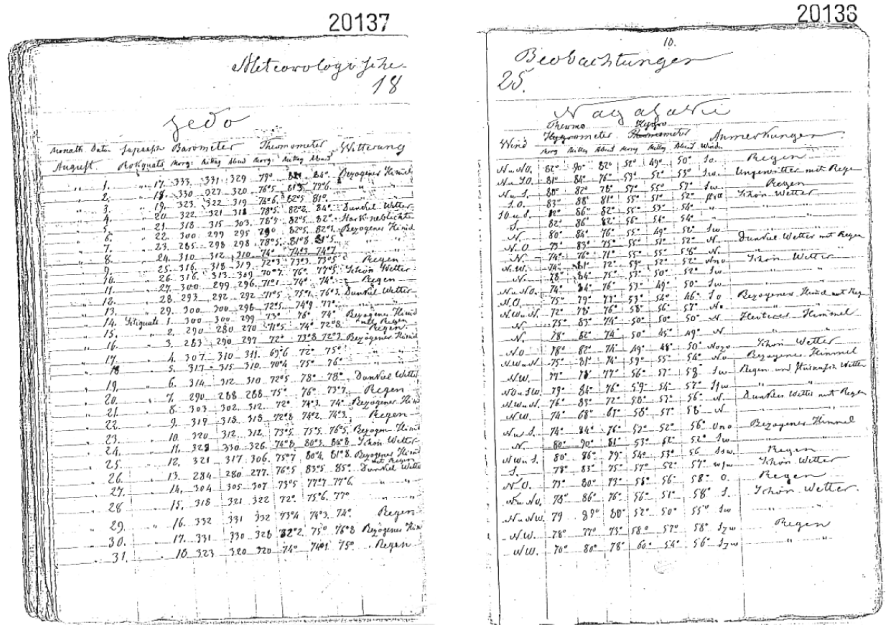
In 1989, it was reported that a manuscript had been found containing meteorological data instrumentally observed between 1819 and 1828 in Deshima in Nagasaki and Edo (Tokyo).[4] This series of data was found in the archives of Philipp Franz von Siebold in the University Library of Bochum (Fig. 1). Along with other scientific documents on mineralogy and geology, these meteorological documents are listed in a catalog compiled by Vera Schmidt (1989),[5] but they had not yet been submitted for systematic and scientific analysis. It was suggested that this material was potentially significant for further historical and scientific research. In 1996, Tsukahara (1998) closely examined the documents and determined that the series of observations were one of the earliest scientific meteorological observations conducted in Japan by von Siebold and his predecessors.[6] Tsukahara also claimed that von Siebold's observations were an important part of his scientific research on Japan's natural world, along with his voluminous works, *Flora Japonica* and *Fauna Japonica,* and the yet unpublished *Mineralogica Japonica*.

[4] Tsukahara Tōgo and Ōsawa Masumi, "On the Von Siebold Collection of Crude Drugs and Related Materials from Japan," *Tokyo gakugei daigaku kiyō* 41 (1989): 41–97. Also see Tsukahara Tōgo, "Nishidoitsu Rūru-daigaku (Bohhumu) ni genzon suru Shīboruto kankei monjo chū no Nihon no chishitsugakuteki chōsa kenkyū nitsuite [On mineralogical research of von Siebold: Documents kept in Ruhr University, Bochum, West Germany]," *Nichiran gakkai kaishi* 15 (1990): 57–77.

[5] Vera Schmidt, *Die Sieboldiana-Sammlung der Ruhr-Universität Bochum*, Acta Sieboldiana 3 (Wiesbaden: Harrassowitz, 1989).

[6] Tsukahara Tōgo, "Shīboruto ni yotte kiroku sareta 1827–1828 nen no Nihon no kishōgaku dēta no shizenkagakutekina kaiseki to kenkyū [Natural scientific analysis and research on Japanese meteorological data, recorded by von Siebold, Sampled 1827–1828]," *Zaidan hōjin Fukutake gakujutsu bunka shinkō zaidan heisei 9 nendo nenpō* (1998): 63–73.

Fig. 1 von Siebold's Manuscript, "Meteorologischer Beobachtungen, 1825, Jedo (Meteorological observation, 1825, Edo)"



Source: Kept in University Library, Bochum, Germany.

H. Beukers (2002) suggested that at the time of publishing these works, climate parameters and epidemics were directly linked and, therefore, Deshima's doctors-in-charge were responsible for conducting these meteorological observations.[7] Although their motivation to conduct these observations was primarily medical, it is suspected that there might have been more to it. Tsukahara et al. (1996) discussed von Siebold's commitment to meteorology from the viewpoint of geological studies he conducted in and around Batavia. In his work, Tsukahara suspects that von Siebold's interest in meteorology might be evidence of his strategic intention to conduct scientific research in Japan. In addition to the medical aspect, according to Tsukahara et al. (1996), from the historical viewpoint of science, it can also be suggested that the instrumental observation in Japan initiated by von Siebold was dependent on the typical methodology of "Humboldtian sciences" and that von Siebold certainly modeled his scientific activities after those of Alexander von

[7] H. Beukers, "Mohnike and Vaccination: Deshima-Doctor in the Wake of von Siebold," *Nihon igakushi zasshi* 48, no. 1 (2002): 131–152.

Humboldt.[8]

Apart from a historical examination of the meaning of the Dutch doctors' meteorological practices in Deshima, the data itself also attracted attention. A part of this data was sampled and digitized in the following year with assistance from the Fukutake Foundation in 1998.[9] As a result, this documented meteorological series has been referred to by meteorologists and has also led to formal research collaborations between meteorologists and historians. Tsukahara and Mikami (Tokyo Metropolitan University) have organized research collaboration projects with researchers from KNMI (Koninklijk Nederlands Meteorologisch Instituut: Royal Dutch Meteorological Institute) and with scientists from the UK. Zaiki Masumi was an important member of this research cooperation. Zaiki completed her Ph.D. under Mikami and worked as a JSPS (Japanese Society for Promotion of Science) post-Doctoral Super-Fellow[10] with Tsukahara. She has published several papers along with G. P. Können (KNMI) and P. D. Jones (Climatic Research Unit, University of East Anglia, UK). The present authors have also extended their scope of research to include other archives (Fig. 2), resulting in the publication of some articles.[11]

In this article, I would like to pay special attention to the importance of Dutch maritime historical material and I therefore discuss a series of climatic record reconstructions from Nagasaki.

So far, there have been six series of meteorological observations recovered in Nagasaki; these are as follows: (1) 1919–1928, Blomhoff-von Siebold series at Deshima, (2) 1845–58–62, Deshima series, (3) 1852–1853, Deshima Documents,

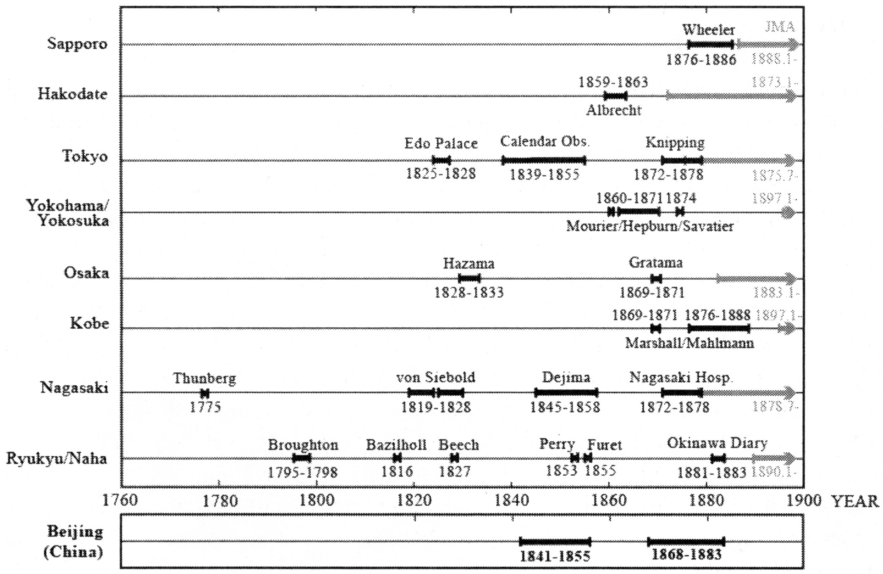
[8] Tsukahara Tōgo, Shinoda Mariko, Itō Kenji, Matsumura Noriaki, Ayabe Hironori, Kakihara Yasushi, Honma Eio, and Sugiyama Shigeo, "Kagakushi no sokumen kara saikentō shita Firippu Furantsu Fon Shīboruto no kagakuteki katsudō: Shokuminchi kagaku, Bēkonian kagaku, Funborutian kagaku to Shīboruto no kagakuteki katsudō tono kankei nitsuite no shiron [Re-examination of scientific activities of von Siebold: With special references to colonial, Baconian, and Humboldtian sciences]," *Narutaki kiyō* 6 (1996): 201–244.

[9] Tsukahara, "Shīboruto niyotte kiroku sareta 1827–1828 nen no Nihon no kishō," 63–73.

[10] "Super-Fellow" is prestigious position politically set by JSPS and Japan's leading science policy makers. In their plan, this position is supposed to be awarded to the highest standard scientific research, in order to attain political goal to win more Nobel prizes for the young Japanese scientists.

[11] G. P. Können, Zaiki Masumi, A. P. M. Baede, Mikami Takehiko, P. D. Jones, and Tsukahara Tōgo, "Pre-1872 Extension of the Japanese Instrumental Meteorological Observation Series Back to 1819," *Journal of Climate* 16, no.1 (2003): 118–131; Zaiki Masumi, G. P. Können, Tsukahara Tōgo, P. D. Jones, Mikami Takehiko, and Matsumoto Keiko, "Recovery of Nineteenth-Century Tokyo/Osaka Meteorological Data in Japan," *International Journal of Climatology* 26, no. 3 (2006): 399–423; Zaiki Masumi, Phil Jones, and Tsukahara Tōgo, "The Nineteenth Century 1841–1883 Temperature Records in Beijing, China," *Geographical Reports of Tokyo Metropolitan University* 43 (2008): 69–76.

Fig. 2 The Availability of Pre-1900 Instrumental Meteorological Data in Japan and China.



Note: Black; Recovered Data by the Present Authors.
Gray; Official Meteorological Station Data.

(4) 1871–1878, Nagasaki Hospital, (5) 1871–1874, Nagasaki Lighthouse, (6) 1878–present, Nagasaki Observatory.

Of these, I will mainly discuss the first series, since this is one of the oldest and most historical. Although this series is usually referred to as "the von Siebold series," the observations made in the early period, that is 1819–1823, are now known to have been taken by *Opperhoofd* (the chief of the Deshima Trade Factory), Jan Cock Blomhoff. The observations made in the later part, between 1825 and 1828, have been taken by Ph. F. von Siebold. There is a fourteen-month gap between the two series, that is, November 1, 1823–December 31, 1824, and a one-year period missing in the von Siebold observation series, that is, November 1, 1825–October 31, 1826.

The first part only contains records of temperatures, but 1826 onward, it includes data on atmospheric pressure and humidity as well. Although data on pressure has only been recorded in the series taken by von Siebold, it should be noted that occasional references to atmospheric pressure have also been made in Blomhoff's Official Deshima diary, from the years 1820 to 1823 for instance. Können therefore concluded that Blomhoff's list of systematic pressure readings has been misplaced, but it is not yet clear whether it went missing or was deliberately

ignored by von Siebold, his assistant, or some unknown copyist.

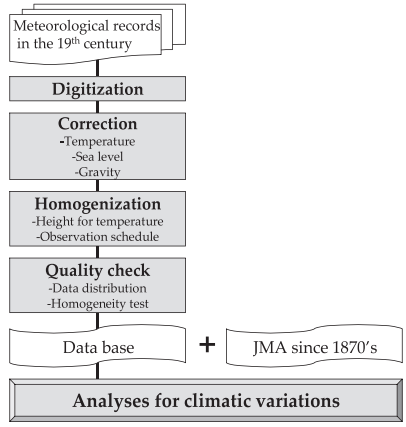
In dealing with this set of historical documents, we have to be careful to examine who the observers were and how the observations were most likely carried out. This is because von Siebold often claimed other people's work as his own. In this case, the fact is that this series of manuscripts were part of the von Siebold collection and thus were in von Siebold's possession. In this sense, it is thus right to refer to them as "the von Siebold series," but a critical point is that many of the observations they contain were not necessarily made by von Siebold himself. In reality, the data set owned by Cock Blomhoff contains climatic data that was evidently recorded before the arrival of von Siebold at Deshima, Nagasaki, in 1823, and has apparently been hand-written by von Siebold copying from an older document.

The observation series prepared by von Siebold himself during his stay in Japan from 1823 to 1930 also consists of two parts: documents 20211–20239 (V. Schmidt's catalog number) are clearly the originals as they are in von Siebold's handwriting; documents 04928–04956, however, are a copy of these originals made by an anonymous copyist. For the period January–December 1825, there are also parallel observations recorded in Tokyo (documents 20123–20145). During his journey to the Palace of the *shōgun* in Edo from March to July 1826, von Siebold recorded his observations, which are now numbered as documents 20149–20162. It can be assumed that he was assisted by Japanese scholars, since he had a circle of Japanese *Rangakusha* (Dutch scholars) who were willing to collaborate in his scientific research, both in Nagasaki and Edo as well as at various stops during his journey between the two cities. We also need to pay attention to Heinrich Bürger's contribution to von Siebold's scientific research project, because Bürger was a capable assistant and pharmacist who was often overshadowed and underestimated by von Siebold.[12]

In order to reconstruct the climate of the time from this data, we need to reformulate it through a scientific process. In other words, we must unify the various units under the metric system, for instance, convert Fahrenheit to Celsius, English and French inches to centimeters, and pounds and poids to kilograms. Thereafter, the process is as follows: (1) digitization of historical documents, (2) corrections, (3) homogenization, (4) quality check. (See Fig. 3). Data homogenization is the

[12] For more on Heinrich Bürger, see Tsukahara Tōgo, "Nihon saisho no kindaiteki yakuzaishi Hainrihhi Byurugā: Shīboruto purojekuto no mottomo jūyōna kyōryokusha [Heinrich Bürger, the first modern pharmacist in Japan: The most important collaborator of von Siebold's scientific research project in Japan]," in *Nagasaki yakugakushi*, ed. Faculty of Pharmacology, Nagasaki University, 7–15 (Nagasaki: Faculty of Pharmacology, Nagasaki University, 1999); Tsukahara Tōgo, "Nihon saisho no kindaiteki yakuzaishi Hainrihhi Byurugā [The first modern pharmacist in Japan, Heinrich Bürger]," in *Deshima no kusuri* [Medical drags of the Deshima], ed. Faculty of Pharmacology, Nagasaki University (Fukuoka: Kyūshū University Press, 2000), 23–34.

Fig. 3 Scientific Process of Historical Data Recovery: How the Data Set of the Historical Meteorological Data from the Nineteenth Century can be Used to Examine Contemporary Climatic Variations



adjustment and correction of raw data so as to adjust it as per a contemporary scientific scale. This is the most crucial step when interpreting historical data in a modern scientific way.

The process of homogenization further consists of the following steps: (1) corrections to differing observation schedules, (2) temperature corrections, (3) pressure corrections, (4) homogeneity test. Temperature correction is a reduction in the height of an observation site, that the difference in height was accounted for by the moist adiabatic lapse rate: $T(n) = T(h) + (h - n) \times 0.006$. Pressure correction is reduction to 0 °C with aid of the tables prepared by Kämtz (1832),[13] which were used at the time (Onnen 1844)[14] by applying the following formula: P(0C) = P(t)(1 – 1.62 × 10(powered –4)Tbar), where Tbar is the reported barometer temperature in Celsius and P the pressure. For the temperature correction of the von Siebold data, Können, Zaiki, Tsukahara et al. (2003) used the reported temperature for Tbar.[15] After this reduction, we added 7.2 mb to all von Siebold pressures after September 22, 1827 to account for the observed bias. The value of atmospheric pressure from

[13] L. F. Kämtz, *Lehrbuch der Meteorologie*, 3 vols. (Halle: Gebauerschen Buchhandlung, 1831–1836). vol. 2, 238–239.

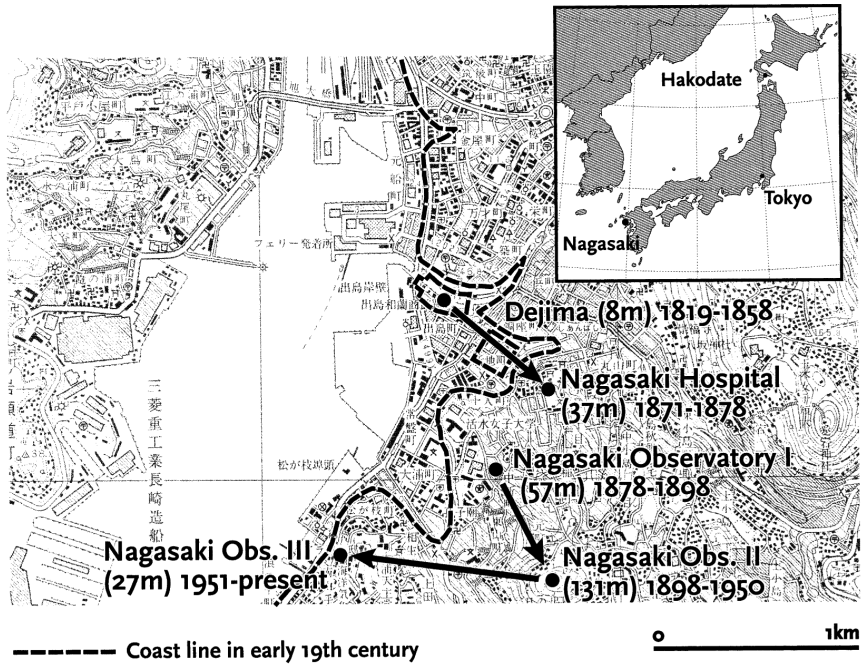
[14] P. L. Onnen, "Meteorologische waarnemingen te Buitenzorg op het eiland Java," *Nieuwe verhandelingen der Eerste Klasse van het Koninklijk Nederlandsche Instituut van Wetenschappen, Letterkunde en Schoone Kunsten te Amsterdam* 10 (1844): 1–36.

[15] G. P. Können, Zaiki Masumi, A. P. M. Baede, Mikami Takehiko, P. D. Jones, and Tsukahara Tōgo, "Pre-1872 Extension of the Japanese Instrumental Meteorological Observation Series Back to 1819," *Journal of Climate* 16, no. 1 (2003): 118–131.

various sites was corrected according to gravity, by applying the following formula: P(sea level) = P(h) + 0.1251 (1 – T/273)h. For the sea level and a map of the observation site in Nagasaki, see Fig. 4.

Können et al. (2003) argued that the Nagasaki series of data, especially those of von Siebold and Blomhoff, were important not only because they were thought to be one of the earliest series of observations but also because they overlapped with the long daily series of visual weather reports from 1676–1868, as documented in a number of *Han-nikki* (Diaries of the Japanese feudal administration), by Mikami (1988) and Mikami et al. (2000).[16] One of the diaries is that of *Ōmura-han*

Fig. 4 Observation Sites in Nagasaki and Characteristics of Localities for Corrections



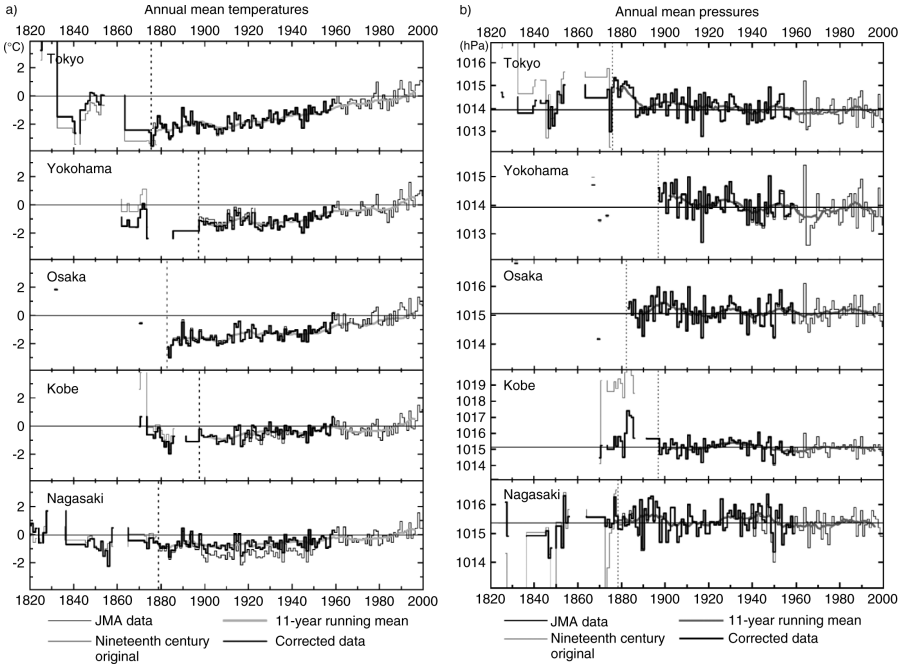
Source: Können et al., 124.

[16] Mikami Takehiko, "Climate Reconstruction in Historical Times Based on Weather Records," *Geographical Review of Japan*, ser. B, 61 (1988): 14–22; Mikami Takehiko, Zaiki Masumi, G. P. Können, and P. D. Jones, "Winter Temperature Reconstruction at Dejima, Nagasaki Based on Historical Meteorological Documents During the Last 300 Years," in *Proceedings of the International Conference on Climate Change and Variability, Tokyo, Japan, September 13–17, 1999*, by Tokyo Metropolitan University (Tokyo: International Geographical Union, 2000), 103–106.

tsutomegaki (Diary of the Ōmura feudal government), which is close to Nagasaki (approximately 20 linear kilometers). The fact that the Dutch were the only Westerners permitted to run a trade factory on the Japanese mainland, combined with the fact that in the 1840s the Dutch set up a meteorological network in their colonies, potentially corroborates this documentary series from Japan. It is also fortunate that the Dutch were allowed to continue their activities after the opening of Japan in 1854. This allowed the recovered series to overlap with the official data of the Nagasaki Observatory, which was founded in 1878, less than 1 km away from Deshima. This overlap makes the Deshima series more significant than the stand-alone series.

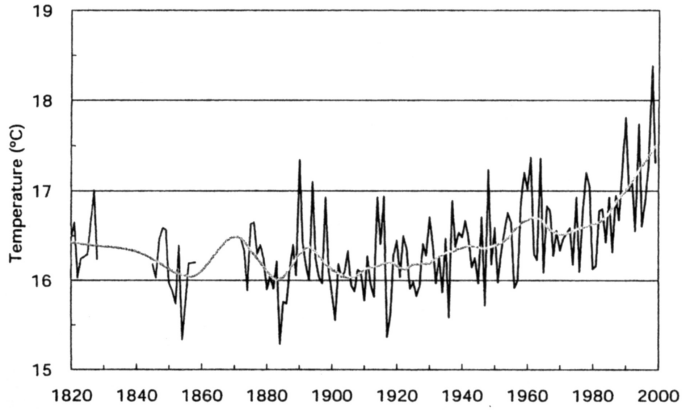
The graphic presentations of the much-published results of our analysis and reconstruction of temperature are presented below. Fig. 5 is a reconstruction of data in comparison with other observation localities. It should be noted that the Nagasaki data is the longest and most continuous and that such consistent data presentation means that the Nagasaki data is the most reliable. Nagasaki's data reconstruction has been represented in Fig. 6, and the extension of the earlier part

Fig. 5 Reconstructed Time-Order Yearly Average Temperature at Tokyo, Yokohama, Osaka, Kōbe and Nagasaki



Source: Zaiki et al., "Nihon niokeru 19 seiki ikō no kokishō kiroku," 709.

Fig. 6 Nagasaki Pre-1872 Temperature Reconstructed



Source: Können et al., 127.

of the nineteenth-century temperature fluctuation is seen in the graph.

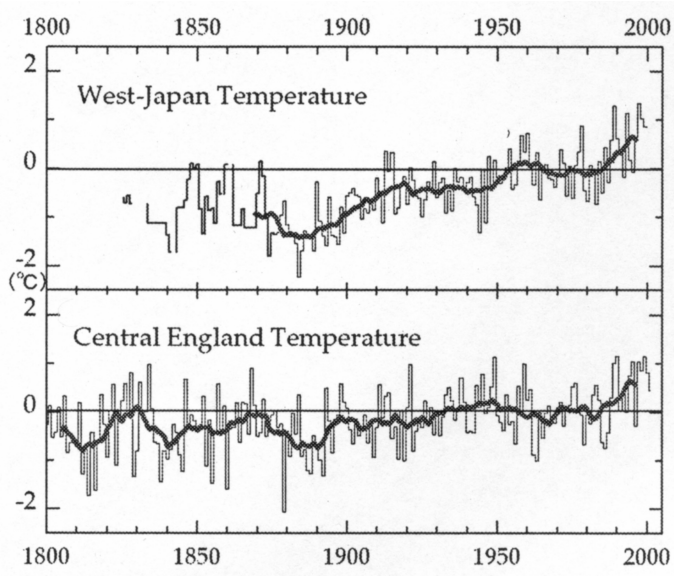
We are currently building a combined data set of the West Japan Temperature (WJT) Series, which is a result of one of our current research projects. We exploit the merit of five localities west of Tokyo, all situated a few degrees around 35 northern latitude, though far in terms of distance. Tokyo and Yokohama form one cluster, as do Osaka and Kōbe, and these three data sets are gridded and combined into one WJT. Similar attempts have now been made in other places, for instance the CBT (Central Belgium Temperature Series 1767–1998) has been reconstructed by Demarée et al.,[17] and a comparison of CET (Central English Temperature Series) with WJT is shown in Fig. 7. We can point out a relatively slow pace of warming in England as seen in the CET in comparison with the gradual and constant rise of temperatures in Japan from the mid-nineteenth century to the mid-twentieth century. The local and regional characteristics of temperature fluctuations are an important research topic these days, and this set of research results serve as the basis for further examination.

Thunberg's Earliest Set of Observations

Is the von Siebold series and its forerunner, the Blomhoff series, the first systematic and instrumental meteorological observation in Japan? Although this is yet to be

[17] G. R. Demarée, P. J. Lachaert, T. Verhoeve, and E. Thoen, "The Long-Term Daily Central Belgium Temperature (CBT) Series (1767–1998) and Early Instrumental Meteorological Observations in Belgium," *Climatic Change* 53, nos. 1–3 (2002): 269–293.

Fig. 7 Comparison of West Japan's Temperature and Central England's Temperature



Source: Zaiki, "Correction and Homogenization of the 19th Century Instrumental Meteorological Records in Japan."

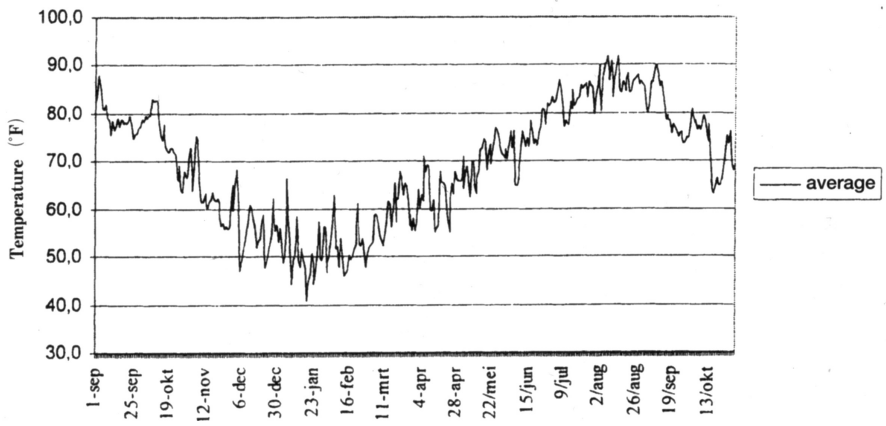
determined, some other possibilities have been suggested by Tsukahara (2006).[18] According to this study, the first record of thermometer was seen as early as 1720s, that the instrument was reportedly brought to Nagasaki, intended as a gift to the *shōgun* Tokugawa Yoshimune. Regretfully, only documents are observed and no material evidence is found concerning this first record. Then later than this period, there were sporadic descriptions of barometers brought to Japan via Nagasaki in the writings of *Rangakusha*. One of the early series of meteorological observations that was published was reportedly conducted by Carl Peter Thunberg. Thunberg was a famous botanist and a forerunner of von Siebold as a medical doctor in Deshima, Nagasaki, Japan. He was also the successor of Carl von Linné, of his Professorship of Botany at the University of Upsala. During his stay in Japan, his meteorological observations were reported to *Verhandelingen van het Bataviaasch Genootschap der Kunsten en Wetenschappen* (The bulletin of the Batavian Society of Arts and

[18] Tsukahara Tōgo, "Rangaku, chikyū ondanka, kagaku to teikoku-shugi: Rekishi to kikō, Oranda shiryō [Rangaku, global warming, science and empires: History and climate viewed from Dutch historical materials]," *Tokyo daigaku shiryō hensanjo kenkyū kiyō* 16 (2006): 79–108.

Sciences) in 1780.[19] This Society is known to be the oldest European-style scientific society in Asia, established even before the Asiatic Society in Bengal by the British, which became the seat of the "Batavian Paradigm" of colonial science.[20]

The Bulletin's report contains two series of observations: One between September 1, 1775 and October 13, 1776, and the other from January 1779 to November 1779. This article containing two series was analyzed and reported by Gaston Demarée who made both series of observations in the form of a graphic presentation (Figs. 8 and 9).[21] The first series was obviously taken by Thunberg, since he arrived in Japan on August 23, 1775 and left on October 23, 1776. His observations began just a week after his arrival and ended ten days before his

Fig. 8 Meteorological Observation by Thunberg, 1775–1776



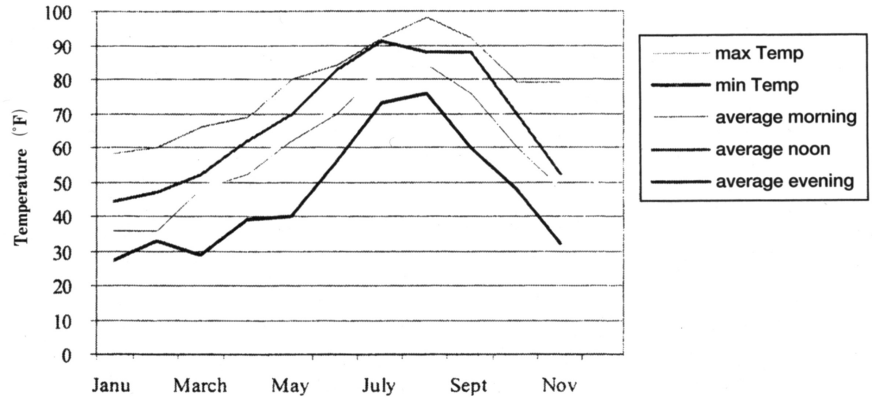
Source: Demarée and Mikami, 107–113.

[19] "Berigt wegens de hoogte der Barometer en Thermometer, de gesteldheid van Weer en Wind, en hoogte van het Water aan het Zeehoofd, en in de Rivieren in 1779, op Batavia. En van Weer en Wind tot Caap de Goede Hoop, en Nagazaki," *Verhandelingen van het Bataviaasch Genootschap der Kunsten en Wetenschappen* 2 (1780): 63–67.

[20] For more on the Batavian Society and the "Batavian Paradigm," see Tsukahara et al., "Nihon no kiki kansoku no hajimari: Dare ga donoyōna jōkyō de hajimetanoka? [The beginning of instrumental observation in Japan: By whom, in what situation?]," *Gekkan chikyū* 27, no. 9 (2005): 713–720. Also see Tsukahara et al., "Kagakushi no sokumen kara saikentō shita Firippu Furantsu Fon Shīboruto," 201–244.

[21] Gaston Demarée and T. Mikami, "Some 17th and 18th Century Dutch Meteorological Observations at Deshima, Nagasaki (Japan), Seen as a Complement to Japanese Climatological Historical Documents," in *Proceedings of the International Conference on Climate Change and Variability, Tokyo, Japan, September 13–17, 1999*, by Tokyo Metropolitan University (Tokyo: International Geographical Union, Commission on Climatology, 2000), 107–113.

Fig. 9 Meteorological Observation, Presented to Bataviaasch Genootschap der Kunsten en Wetenschappen, Anonymous, 1779



Source: Demarée and Mikami, 107–113.

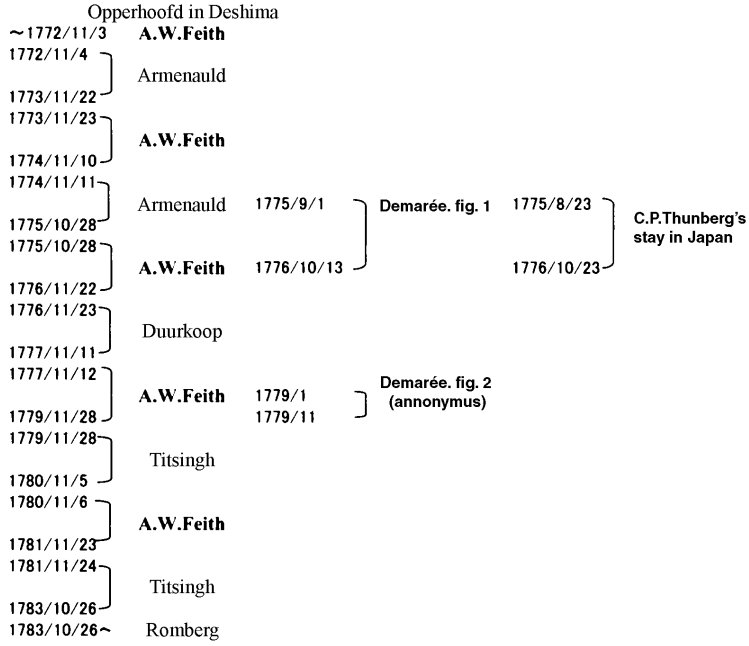
departure, precisely covering the period corresponding with Thunberg's stay in Japan.

The later part however was presented anonymously to the society's Bulletin. In order to identify the observer, I have examined some of the Deshima staff, especially the *opperhoofd*, from that period. It is highly probable that *Opperhoofd* Arend Willem Feith played a role in conducting this observation. Feith was appointed as *opperhoofd* five times, and his third period of service coincided with Thunberg's stay in Japan. It again overlapped with the period of anonymous observations that ended exactly when Feith left the position and Isaac Titsingh took over from him (Fig. 10). We have not yet found specific evidence to prove Feith's involvement with the meteorological observations, but it was certainly under his command that the observations were conducted.

There is also circumstantial evidence to prove that this was the period when instrumental observations in Deshima had became common among Dutch personnel after Thunberg's stay in Japan. For instance, we should note that Feith's immediate successor, Isaac Titsingh, who in fact held office for two terms, both succeeded in turn with Feith, frequently wrote about climatic conditions in his diary,[22] in particular, often complaining about the hot weather in the locations where he was posted, expressed in terms of temperatures of the instrumentally observed scale. We can interpret his frequent complaints as a symbol of the changing method

[22] Titsingh's diary has been edited and published by Frank Lequin. Frank Lequin, ed., *The Private Correspondence of Isaac Titsingh*, vol. 1, *1785–1811* (Amsterdam: J. C. Gieben, 1990).

Fig. 10 Closer Examination of Thunberg's and Anonymous Series of Observations in the 1770s



Source: Tsukahara, "Rangaku, chikyū ondanka, kagaku to teikoku-shugi."

of expressing natural phenomena, transitioning from containing the vocabulary of senses and feelings (hot, sweaty, humid, etc.) to instrumentally observed and quantified numbers ("hot" expressed as 96 F.). How can we compare the heat of the summer in Batavia, Bengal, and Nagasaki without referring to the degree of temperature? This is possible by referring to instrumentally observed numbers of a standardized scale. Of course, one must include conditional data such as humidity and wind force, sunshine, and the height of the location, but the first historical change in expressing sense and feeling of natural circumstances is to express the degree shown on a thermometer. This change in the mode of expression has been referred to as "the quantification of nature," also referred to in some scientific writings as the newly emerging mentality of the eighteenth century.[23] Today, this

[23] Alfred W. Crosby, *The Measure of Reality: Quantification and Western Society, 1250–1600* (New York: Cambridge University Press, 1997); Daniel Headrick, *When Information Came of Age: Technologies of Knowledge in the Age of Reason and Revolution, 1700–1850* (Oxford and New York: Oxford University Press, 2000).

change of mode can be seen in writings by Dutch personages in Deshima, most likely to have appeared in and around the period of diaries in the later part of the eighteenth century, at the time as the visit of science-minded people such as Titsingh to Nagasaki.

Concluding Remarks: Climate Observation in Nagasaki and Other Places

As reviewed above, historical Nagasaki observations are undoubtedly climatologically significant to the contemporary issue of global warming, since the observations have been examined applying scientific methodology they are the most comprehensive and continuous data sets, and since they have been proven to be the most reliable data set from nineteenth century Japan. The historical port town of Nagasaki is therefore also recognized as an important climatological reference site in East Asia. This data had been recorded by Dutch scientific agents, and it was also the Dutch who brought information from outside Japan through their European agents. Thus, Japan's cooperation with the Netherlands resulted in the movement of *Rangaku* (Dutch studies) in pre-modern Japan. From the viewpoint of climate change, it was also this historical exchange that helped unearth the earliest historical climatic data.

As a result of initial research cooperation, the Nagasaki data set can now be compared with the Tokyo/Yokohama and the Osaka/Kōbe data sets with reference to 35 N.[24] Geographically, it can be investigated in comparison to other observation points in East Asia, such as Beijing,[25] because those locations are situated between 35 N and 40 N.

Apart from temperature records, a record of atmospheric pressure can also be examined and reconstructed from a historical perspective. By means of historical data, the pattern of seasonal changes of atmospheric pressure has been meteorologically reconstructed and climatologically examined.[26] Such reconstructions will contribute toward the enhanced understanding of the mechanism of recent climate change and also help make predictions for the near future.

Conversely, the common approach to early modern history has a different view of emphasizing on historical aspects of the Dutch materials, less to its

[24] Zaiki et al. (2006) discussed the reconstruction of Tokyo/Yokohama and Osaka/Kōbe, with reference to Nagasaki. Zaiki et al., "Recovery of Nineteenth-Century Tokyo/Osaka Meteorological Data in Japan," 399–423.

[25] Zaiki et al., "The Nineteenth Century 1841–1883 Temperature Records in Beijing, China," 69–76.

[26] Zaiki Masumi, Gunter. P. Können, Kimura Keiji, Mikami Takehiko, and Tsukahara Tōgo, "Reconstruction of Historical Pressure Patterns over Japan Using Two-Point Pressure-Temperature Datasets since the 19th Century," *Climatic Change* 95, nos. 1–2 (2009): 231–248.

contemporary value, as compared to meteorologists and scientific historians. Yet, even they agree that the data helps shed light on modern environmental problems as well as shedding new historical light on the material. We are therefore able to conclude that the Dutch historical materials are more important than has been previously assumed and that they signify how history is a mirror that reflects the present. This information found in Deshima is often metaphorically referred to as a small window into the then closed and dark Japan, through the European agents of enlightenment. Even so, I believe that Dutch history in maritime Asia still warrants a thorough and detailed research from various aspects, because it is still a leading light for contemporaries living in a dark age of environmental disaster, that would be darker and obscure than Edo Japan, dismayed and stranded upon the verge of a warming globe.

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