

Winter temperature reconstruction at Dejima, Nagasaki based on historical meteorological documents during the last 300 years

T.Mikami¹, M.Zaiki¹, G.P.Konnen² and P.D.Jones³

1. Tokyo Metropolitan University
2. Royal Netherlands Meteorological Institute
3. University of East Anglia, U.K.

Introduction

The oldest official meteorological observation began in the 1870's at a few meteorological observatories in Japan. Before that period, we have no official instrumental meteorological records, although there might have been some private instrumental observations during the 1860's. Recently, we have found some older meteorological records (1840s-1850s) observed by Dutch medical doctors at Dejima, Nagasaki. Some other older meteorological archives have been available during the 1810's -1820's and the 1870's at Nagasaki.

Since Nagasaki meteorological observatory was established in 1878, it would be possible to extend the meteorological records back to the 1810's for more than 60 years prior to the official data. On the other hand, we have collected daily visual weather records described in local official diaries at Isahaya feudal clans near to Nagasaki. These daily weather records have been all digitized and stored in the data base (Historical Weather Data base), for more than 160 years from 1700 to the 1860's. Since daily weather records are qualitative data, it should be converted to quantitative data by checking and calibrating both weather records and meteorological records in the overlapped period.

The purpose of this paper is to reconstruct winter temperature series from 1700 to the 1860's based on the daily weather records in old official diaries, and to combine them with the Dutch meteorological records since 1850's and the Japanese official meteorological records since 1878.

Data and methods

As reported in this volume (Konnen and Mikami, 2000), we could recover the instrumental meteorological observations which get back to the 1810's by Dutch medical doctors in Dejima (Nagasaki) prior to the Japanese official meteorological observations (1878-present), leaving major gaps for 1831-1844 and 1859-1870.

On the other hand, in many places of Japan, there remained a number of old local diaries which contain daily weather records since 17th -18th century to the late 19th century (e.g., Mikami, 1987; 1988; 1992; 1994; 1999). Most of these diaries are official diaries kept at feudal clans in

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Edo-period (17th – 19th centuries) under the control of local “shoguns”. Weather records were usually described just after the dates, such as “June 1, little rainfall in the morning, becoming fine in the afternoon”. We could find a long series of official diaries called “Isahaya Diary” in Nagasaki prefecture, which contains continuous daily weather records from 1700 to 1868. As weather records were qualitative data, we made an attempt to quantify them using statistical methods, and estimated winter temperature series from 1700 to 1868, during which both instrumental data and weather records overlapped in the 1810’s-1820’s, 1850’s and 1870’s.

From climatological point of view, the percentage of snowy days against that of rainy days may increase in colder winters. Therefore we attempted to estimate winter temperatures at Nagasaki for the period 1700-1868 using a simple linear regression analysis on the basis of relationship between the monthly mean temperature and the snowfall ratio which is defined as the percentage ratio of snowfall days to the whole precipitation days during 1951-1980 (Fig.1).

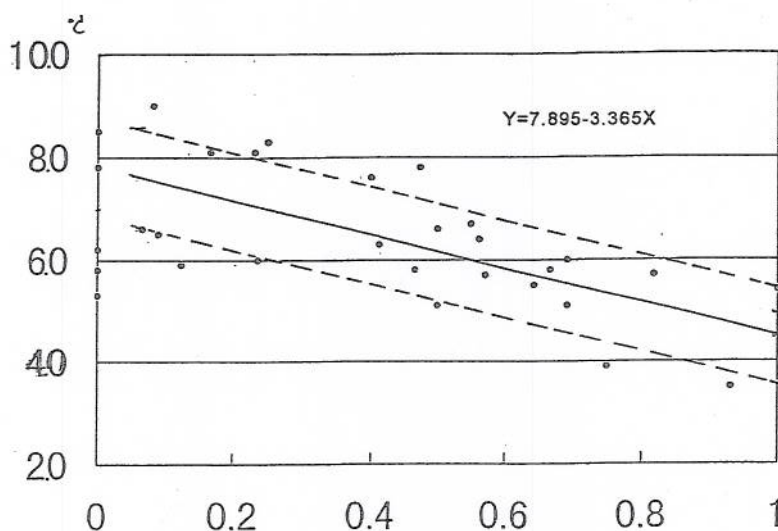


Figure 1. Relationship between the monthly mean temperature and the snowfall ratio in January (1951-1980) at Nagasaki.

$$\text{Snowfall ratio} = \text{Number of snowfall days} / \text{Number of precipitation days}$$

At the first step, we calculated the mean temperatures in January during 1700-1868 based on the daily weather records with the standard error of 1 degrees Celsius. Then we compared both estimated and instrumental temperatures during the overlapped period in the 1850’s. As indicated in Fig.2, both estimated and instrumental temperatures are relatively well correlated in the overlapped period, and we completed long term winter temperature series in Nagasaki by combining both weather-based estimated temperatures and instrumental temperatures.

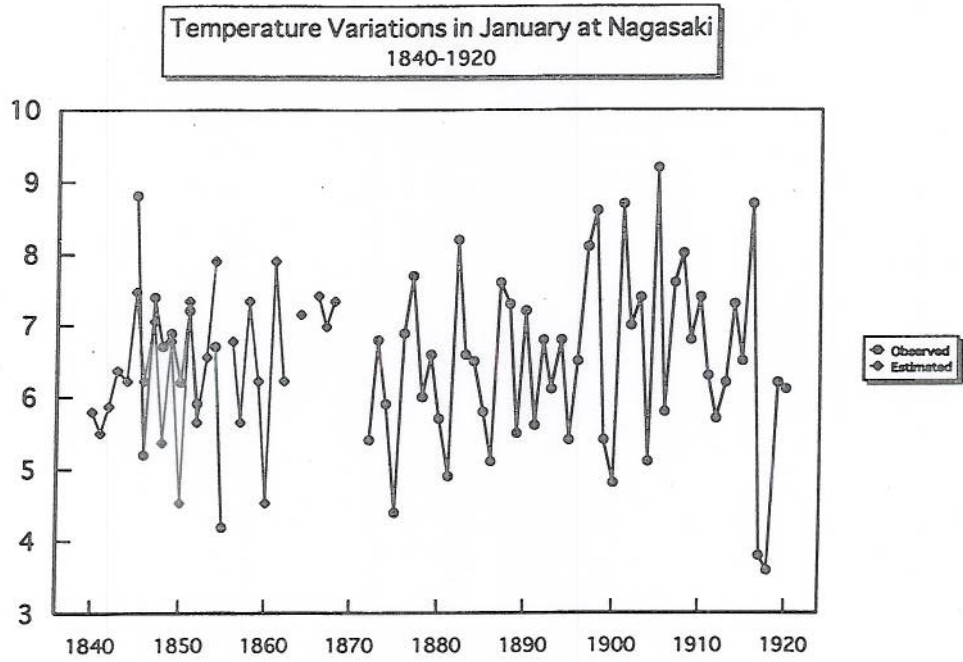


Figure 2. Estimated and observed temperature variations in January at Nagasaki

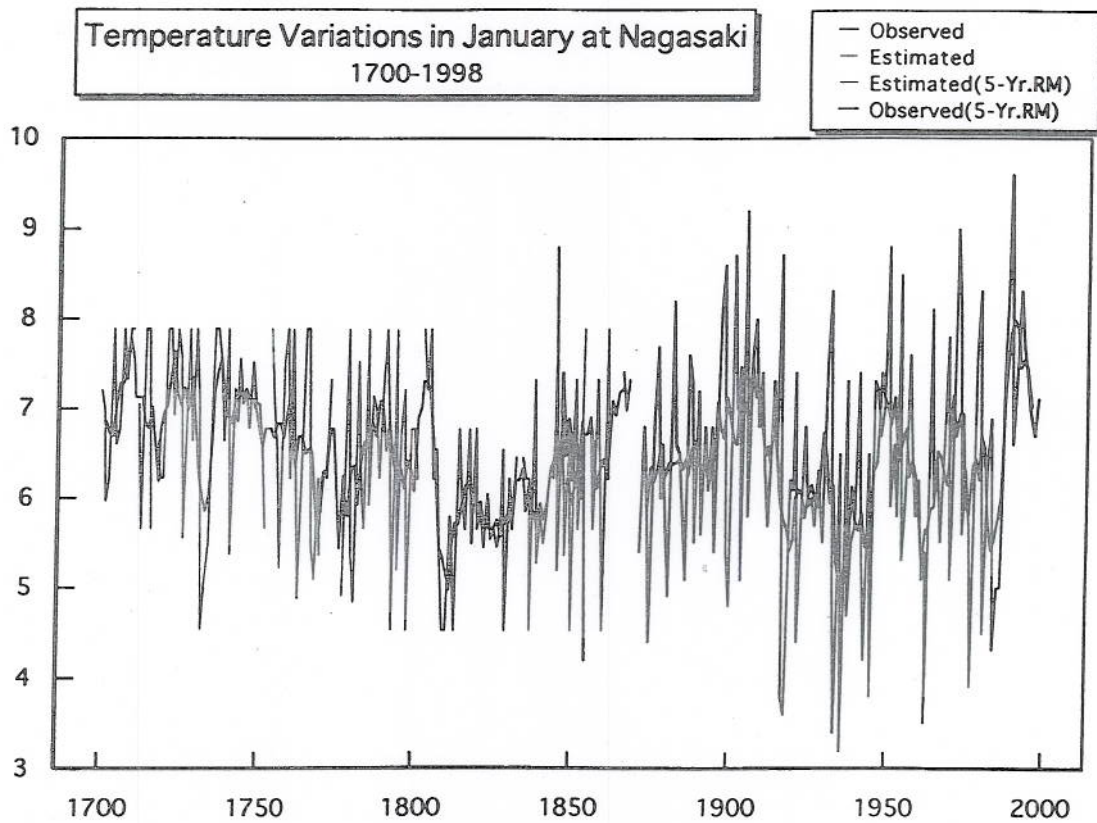


Figure 3. Recovered temperature variations in January at Nagasaki. Temperature series from 1700 to 1868 are estimated from daily weather records in old official diaries.

Results

Figure 3 shows the recovered temperature variations in January at Nagasaki for the period 1700-1998. The results indicate that the mean winter temperatures from the 1810's to 1820's are estimated to have been colder than those in the early 18th century and 1850's to the 1860's. This cooling period in the early 19th century may have some connection with the weakening of solar activities and the frequent volcanic activities in this period. The rapid temperature increase from the 1830's to the 1850's might have corresponded to the termination of the Little Ice Age in the mid-19th century. The warm winters in the 1850's and 1860's seem to have been connected with the higher winter temperatures reconstructed from the long-term freezing dates record at Lake Suwa in central Japan (Mikami, 1999). It should be noted that the estimated winter temperature were relatively high during the first half of the 18th century, just after the Maunder Minimum period in the latter half of the 17th century.

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Edited by

Takehiko Mikami

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Koninklijk Nederlands
Meteorologisch Instituut
Bibliotheek,
Postbus 201,
3730 AE DE BILT
Nederland.

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