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跡見学園女子大学文京キャンパスと新座キャンパスの 2023 年後半から 2024 年前半の 6 ヶ月間における気温特性

Temperature characteristics of Bunkyo and Niiza campuses in Atomi University during six months from late 2023 to the beginning of 2024

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Abstract

Consecutive temperature observations with ten-minute intervals have been done over six months at suburb Niiza campus in Saitama prefecture, Bunkyo campus of Atomi university and Koishikawa botanical garden in the center of Tokyo. As shown in similar trends between measured data and regional weather observatory with Automated Meteorological Data Acquisition System（AMeDAS）data, measured temperature data in this study were decided as dependable. From the daily temperature characteristics of the three observed locations, a noticeable temperature rise was observed during the morning（from 6 to 10 AM）, and the afternoon temperature of those was hard to go down significantly in the summer season. Based on half year temperature measurements, temperatures at the Niiza campus are consistently lower than those at the Bunkyo campus, and Bunkyo's lowest winter temperatures are warmer than those in the suburban Niiza campus. In other words, it could be said that winters in the center of Tokyo are warmer than in the suburbs. The method of acquiring and analyzing daily temperature data with basic statistics and skills of EXCEL is recommended for learning data and environment sciences.

Keywords：temperature, data science, regional environment

1. Introduction

Atomi University has two campuses, the intown Bunkyo campus in Tokyo and the suburb Niiza campus in Saitama prefecture. Many faculty staff have a sense of temperature difference between them. For example, the temperature of the Bunkyo campus is much hotter and warmer than the Niiza campus in summer and winter. This study evaluated the appropriateness of the temperature difference sense using their daily temperature data. Understanding the temperature characteristics of two campuses would help make a comfortable learning environment for students and save energy for air conditioning on campuses. This study would also be an excellent example of a university's efforts towards environmental conservation.

Recently, data science has become an essential subject for university students[1)] . As the amount of digital data circulating in society is increasing explosively, the company need for "data scientists" is growing, and some universities have set up the data science department and begun training for their students[2)]. Our university is also planning to set up a data science department. Data science consists of statistics and informatics; learning them using familiar data can keep students interested and motivated. For example, weather data that is familiar to us can be collected quickly. Daily temperature data from familiar places, such as homes and campuses, would benefit student education to keep their interests and concerns of in data science.

This study used my original data from simple thermal devices and reported temperature characteristics and statistical trends of the Niiza, Bunkyo, and Koishikawa botanical gardens. Interpreting these data trends would help understand regional and global environments as well. This simple data science research method, which uses own temperature data, will be able to introduce as a typical educational tool for data science and the environmental science.

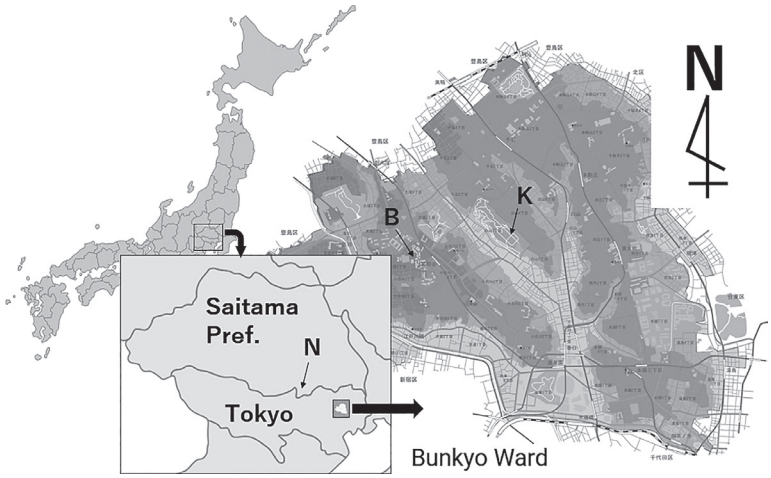
2. Method

2．1　Observing sites

Three observation sites, the Niiza campus (point N), Bunkyo campus (point B), and

Koishikawa botanical garden (point K), were shown in Fig.1. Points N and B belonged to Atomi University, and point K belonged to University of Tokyo.

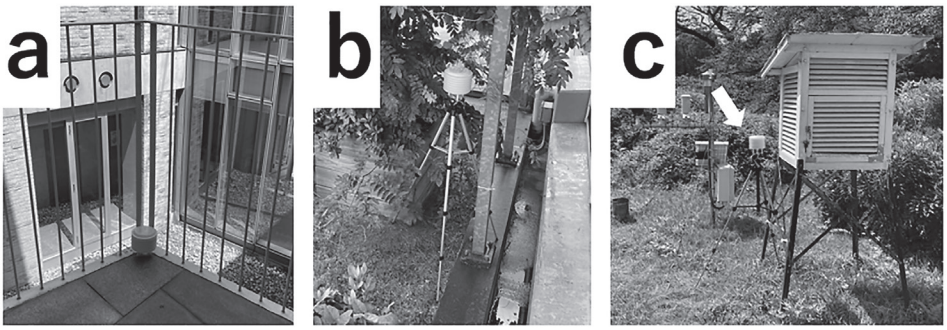
Fig. 1 Location map of temperature measuring points



Observing point N (decimal latitude and longitude were 35.817591, 139.544284)[3] was set on the outside connecting corridor between No.4 and No.3 buildings on the second floor of Niiza campus, Atomi University (Fig.2a). The altitude of this location is about 30m, so the observing point N on the second floor was set at about 40m.

Fig. 2 Appearance of observing points

a : Niiza campus　　b : Bunkyo campus　　c : Koishikawa botanical garden



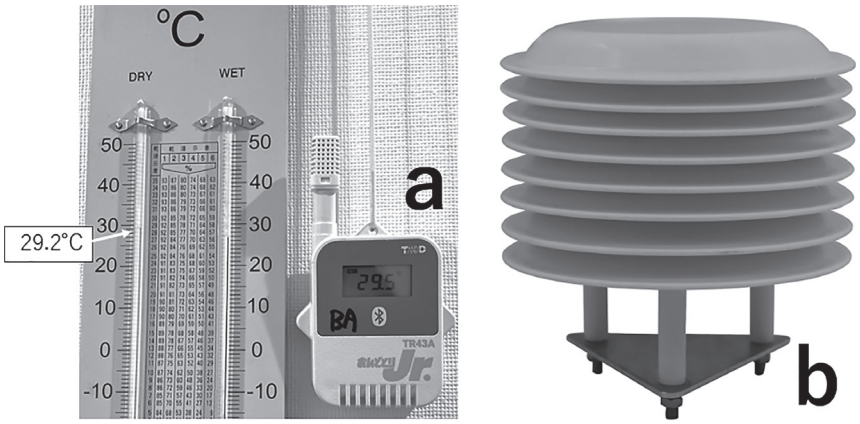
Observing point B (35.817591, 139.544284) was set on a tripod stand on the rooftop of the No.2 building of the Bunkyo campus of Atomi University (Fig.2b). The altitude of this location is about 28m, so the observing point on the rooftop of No.2 building was set at about 50m.

Observing point K（35.719079, 139.746308）was set on a tripod stand near the thermometer shelter of Koishikawa botanical garden（Fig.2c）. The altitude of the location is about 25m, so the observing point on the tripod stand was set at about 27m.

2．2　Temperature measuring devices

The data logger for temperature was TR43A by T&D Corporation（Fig.3a）[4]. This device can detect humidity, which was not used in this paper. Data recorded by the logger is sent to the mobile device via Bluetooth. The sensor of TR43A has a temperature measurement range of 0-55℃. The Radiation Shield FP1810 by Fieldpro, Inc.[5] protects temperature sensors from direct solar radiation and precipitation but permits easy air passage（Fig.3b）.

Fig. 3　Appearance of temperature measuring device (a) and radiation shield (b).



2．3　Data treatment

The obtained data from TR43A were data titles, such as Model, Serial No., Group Name, Device Name, and continuous data of Local Data Time, Temp［℃］, and Humidity［%］every 10 minutes（Table 1）. Output triserial data, except humidity, was processed using Excel functions. "HIGHEST"[6] was used to find the highest temperature in one day of 144 data sets, and the function of "LOWEST" was used to find the lowest temperature in a day. Each month's average highest and lowest temperature data were calculated using the function "AVERAGE" and graphs made. This data was processed on each observing point during September 2023 and February 2024. A paired t-test was conducted each month using the

function “T.TEST” between observing points N and B and points B and K.

Table 1 The output data form of temperature measuring (TR43A)

Model	Serial	Group Name	Device Name
TR43A	584406B6		TR43A_584406B6
Local Date Time	Temp[C]	Humidity[%]	
2023/8/7 23:13	29.1	77	
2023/8/7 23:23	29	78	
2023/8/7 23:33	29	78	
2023/8/7 23:43	28.9	78	
2023/8/7 23:53	29.1	78	

3. Results and Discussion

3．1 Comparison with Japan Meteorological Agency data

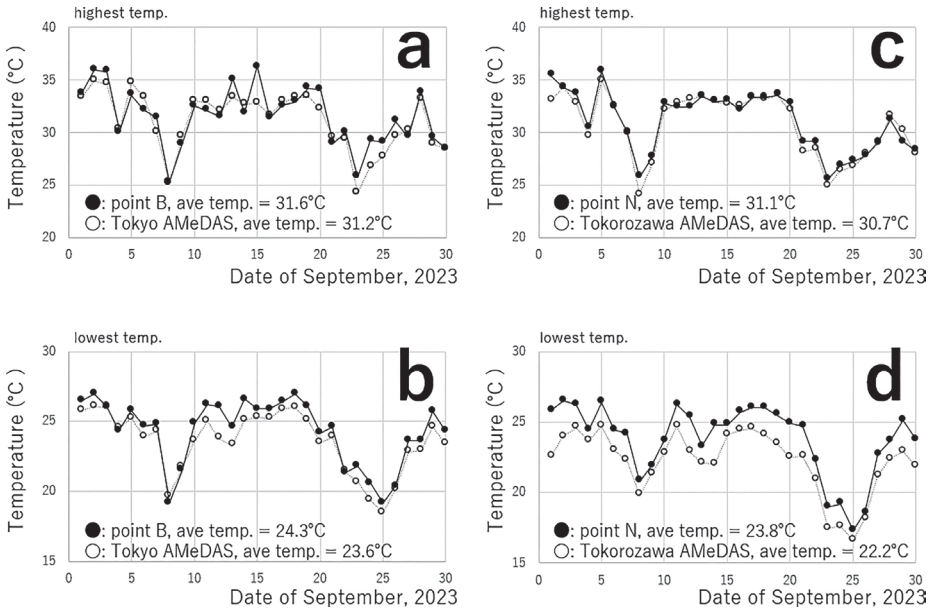
In this study, temperature data form Automated Meteorological Data Acquisition System (AMeDAS) were used for evaluation of own data.

Temperatures comparison between point B and Tokyo AMeDAS observatory

Tokyo Regional Weather Observatory with Automated Meteorological Data Acquisition System (Tokyo AMeDAS) is located at Kitanomaru Park, Chiyoda Ward, where decimal latitude and longitude were 35.691256 and 139.749876. The altitude of the observation location is about 28m, almost the same as the grand level of the Bunkyo campus at Atomi University. Both are about 3km apart in a straight line in the northwest-southeast direction.

The highest and lowest temperature data changes in both observing points during September 2023 are shown in Fig.4 (a, b). The metrological data of Tokyo AMeDAS were obtained through the Meteorological Office's HP[7] .

Fig. 4　Highest and Lowest temperatures comparison between observation points in each campus and close regional weather observatory（AMeDAS）during September 2023.



Though the highest temperature data of the date 13 and 15 in September were standing out, the analytical results of both temperatures showed no significant differences by pared two-sided t-test value with significance level of 5% was 0.056 (>0.05). These outstanding data might be an effect of temporary direct sunshine. The changes in the lowest temperature data of point B were slightly lower than those of Tokyo AMeDAS.

As shown in an identical-changing pattern of both data, the temperature data of point B was decided to be dependable in this study.

Temperatures comparison between point N and Tokorozawa AMeDAS observatory

Tokorozawa AMeDAS is at the shore of Lake Sayama in Saitama prefecture, where decimal latitude and longitude were 35.773902 and 139.413473. The altitude of the observing location is about 119m, much higher than the grand level of the Niiza campus at Atomi University. Both are about 12km apart in a straight line in the northeast-southwest direction.

The highest and lowest temperature data changes in both observing points during September 2023 are shown in Fig.4(c, d). The metrological data of Tokorozawa AMeDAS were obtained through the Meteorological Office's HP[7] .

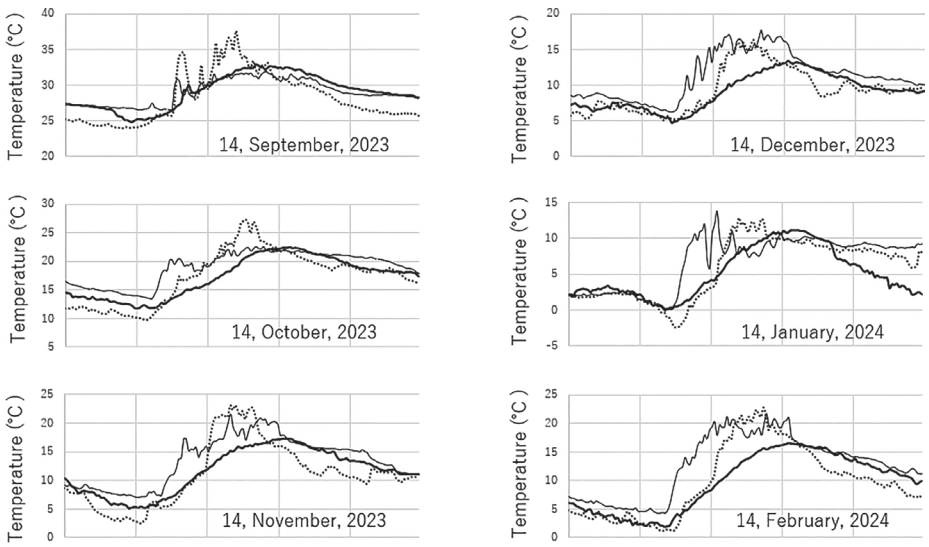
The trends of the highest temperature data of both observing points roughly resemble patterns. The trends of the lowest temperature data of Tokorozawa AMeDAS showed slightly lower than point N. The Tokorozawa Observing site is at a higher altitude than point N and is located on the shore of Lake Sayama, so the lowest temperature there might be observed lower. On the other hand, point N was set on an outside corridor surrounded by campus buildings, so poor ventilation might be one reason for slightly higher temperature observed.

As shown in an identical-changing pattern of both data, the temperature data of point N was decided to be dependable in this study.

3．2　Daily temperature trends on the date of the 14th during the measured month

Daily temperature trends on the date of 14^{th} during the measured month are shown in Fig.5. The 14th day in the middle of the month was chosen as the average date during the month.　The temperature trend of point K showed the same pattern as point B, and the data of point K was decided to be dependable in this study. Though up and down trends were observed on points B and K in the morning, these unstable data might be an effect of temporary direct sunshine. If there is a mechanical problem with the measuring device, it will need to be investigated in detail.

Fig. 5　Highest and Lowest temperatures comparison between observation points on the date of 14th during measured month.（bold line: Niiza campus, thin line: Bunkyo campus, dotted line: Koishikawa botanical garden）



The temperature characteristics that were ignored in the irregular data were summarized below. A noticeable rise was observed in the morning from the temperature characteristics of points B and K. At point B, the temperature quickly rose from 6 AM to 10 AM, and the slow temperature decreased in the afternoon. Though point K showed a similar trend to point B, the trend changed quickly than point B. Point N, surrounded by campus buildings, showed smoother temperature trends than points B and K.

The response to the quick temperature rising at the Bunkyo campus was thought to be essential for both making a comfortable study environment for students and saving energy on campus. As it was revealed that afternoon temperature declined slowly, the University should use air conditioners appropriately and take measures to prevent heatstroke indoors. On the other hand, the winter temperature trend quickly rose in the morning, and appropriate use of air conditioners would be critical for student life and saving energy.

3．3　Monthly trends of highest and lowest temperatures

Monthly trends and the average of the highest and lowest temperatures of each observing point are shown in Fig. 6 and Fig.7. The lower temperature days compared to surrounding data, such as Sep. 8 and 23（black arrows in Fig.7）, were caused by bad weather, such as heavy rain, etc. Recognized characteristics of each month's trends are shown below, especially in Fig.7.

Highest and Lowest temperature trends of September 2023

The average highest temperature of September decreases in the order of point K → B → N. The average lowest temperature of September decreases in the order of point B → N → K. There was a big difference in the highest and lowest temperature at point K. The temperature trends of points N and B showed a similar pattern, especially regarding their highest temperature data, which showed no differences by pared two-sided t-test value with significance level of 5% was 0.057（>0.05）. To summarize the temperature trends in September, the summer temperature trend of point N（Niiza campus）showed a similar pattern to point B（Bunkyo campus）.

Fig. 6 Monthly changes of Highest（●）and Lowest（○）temperatures of each observing points during measured month.（K：Koishikawa botanical garden, B：Bunkyo campus, N：Niiza campus）

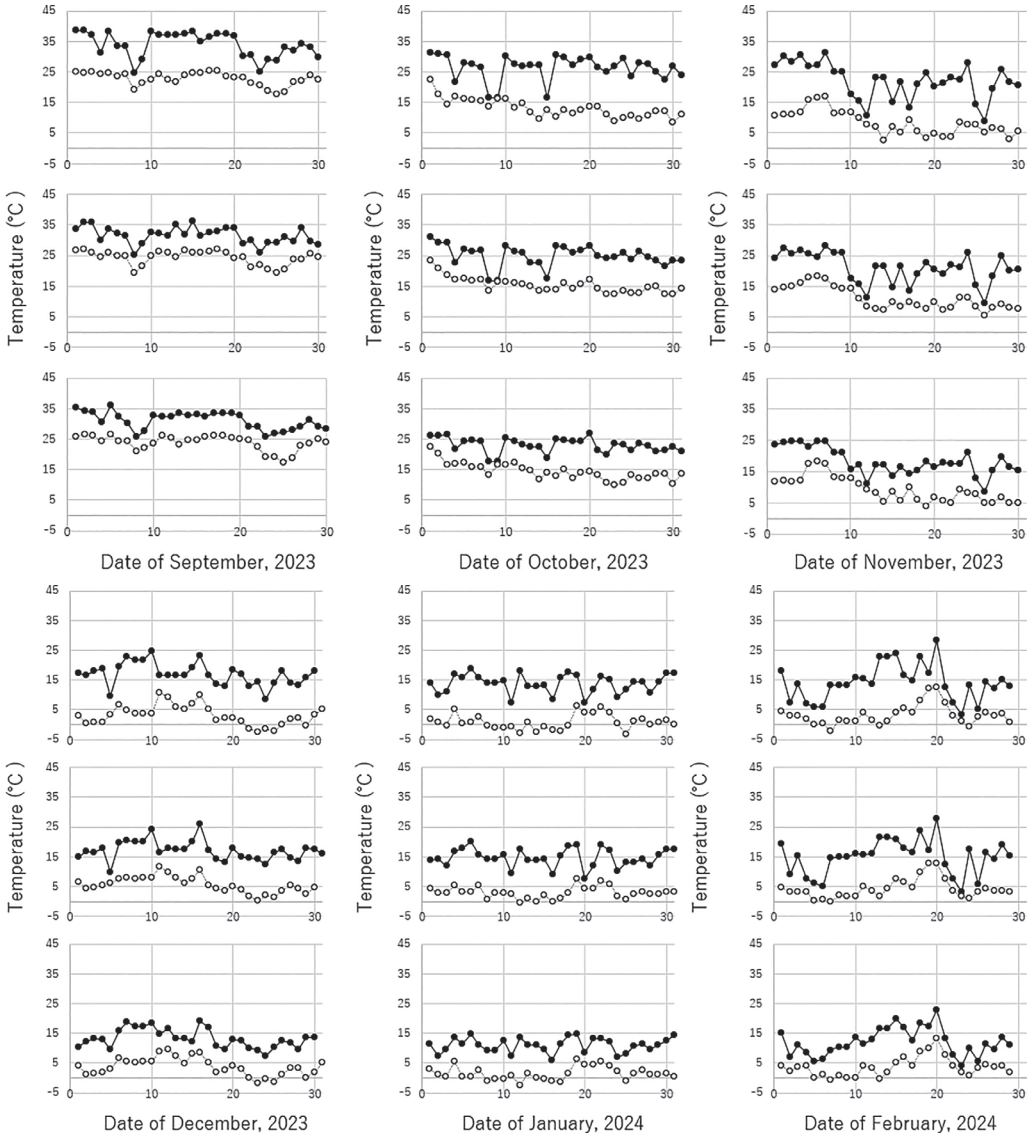
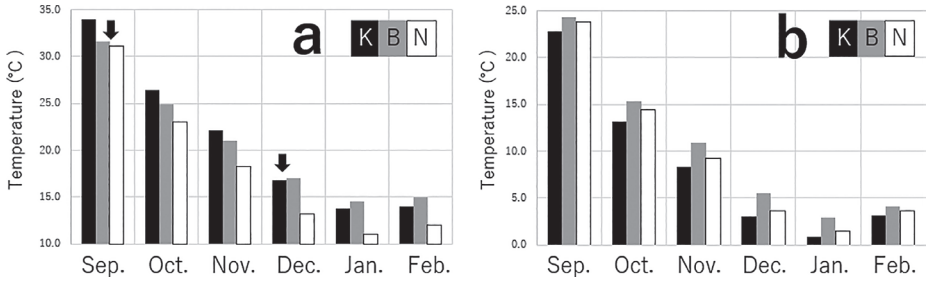


Fig. 7　Monthly changes of Highest and Lowest average temperatures of each observation points during measured month.（a：average highest temperature, b：average lowest temperature, K：Koishikawa botanical garden, B：Bunkyo campus, N：Niiza campus）



Highest and Lowest temperature trends of October 2023

The average highest and lowest temperatures of the three observing points showed almost the same trend in September 2023. The differences between the average highest value（point K）and average lowest value（point N）were expanded wider than in September. The average value of point N clearly showed lower than the others.

Highest and Lowest temperature trends of November 2023

The average highest and lowest temperatures of the three observing points showed the same trend in September and October 2023. However, the difference between point K and point B has narrowed. On the other hand, the differences between the average highest value（point K）and average lowest value（point N）were expanded much wider than in October, and the average value of point N was much lower than the others.

Highest and Lowest temperature trends of December 2023

The average highest temperatures at points K and B have reversed, but the t-test result showed no differences by pared two-sided t-test value with significance level of 5% was 0.456（>0.05）. Point N's average highest temperature was clearly lower than the other points. The average lowest temperature of point B was higher than the other points.

Highest and Lowest temperature trends of January 2024

The average highest temperature of the three observing points showed the same trend as December 2023. However, the average highest value of point N clearly showed much lower than the others（-3.6℃ compared to point B）. The average lowest temperature of point B was

higher than the other points, as was the December trend, and point K was always the lowest of the three.

Highest and Lowest temperature trends of February 2024

The average highest temperature of the three observing points showed almost the same trend in December 2023 and January 2024. The average highest value of point B clearly showed much higher than the others, and point N clearly showed lower than the others. The average lowest temperature of point B was higher than the other points as well as the previous month of itself, and point K was always the lowest of the three. As the winter temperature trend of point B was higher than the other points, winter temperature in the mid-town area might be warmer than in the suburban area.

3．4　Data-science education by meteorological data

Many companies want to get data scientists to analyze their customer data, and they have tried to get more data scientists in recent years. Shortage of data scientists is a serious problem in Japan. There is an urgent need to develop them. Data science knowledge is required in many economic fields, and huge data treatment is now essential in every aspect of society.

With this trend, Atomi University is also preparing to create a data science department. There are two critical academic fields, statistics and information science, in the basement of data science. Raw data is essential for data science education, and it is necessary to learn statistics skills using Excel. Though taking raw data by students themselves is preferable, students may also use public statistical data provided on the internet. Students' interest in data science and the earth environment can be maintained by selectively using recent temperature data. In that sense, the method of acquiring and analyzing daily temperature data shown in this study is recommended for data and environmental science education. Data science progresses daily, and the environmental crisis continues, so it is necessary to constantly update methods and targets.

4. Conclusion

1. The results of the detailed comparison between observing points and nearest AMeDAS data, as well as the measured temperature data of observing points N and B, were decided to be dependable in this study. The temperature trend of point K showed the same trend as point B and point K data was decided to be dependable as well.
2. From daily temperature characteristics of the mid-town area (points B and K), a noticeable temperature rise was observed from 6 AM to 10 AM, and those afternoon temperatures were hard to go down. The temperature trend of the suburban area (point N) showed an intermediate trend between points B and K.
3. Half of the year's observed results can be summarized as follows. 1) The temperature trends of point N (Niiza campus in the suburbs) were consistently lower than the other two points. 2) The lowest temperature trends of point B (Bunkyo campus in central Tokyo) were consistently higher than the other two points. In other words, it could be said that winter inner city is warmer than in the suburbs. 3) January's highest and lowest temperature trends were consistently the lowest during observed half year.
4. The method of acquiring and analyzing daily temperature data, which contains statistics and information science with EXCEL skills, is also recommended for data science and environmental science learning.

Acknowledgement

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