On Trends of Monthly Average Temperature for 47 Prefectures in Japan

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Abstract

The purpose of this paper is to examine the trend of temperature rise in Japan from the data of the monthly average temperature of *43* years from January *1975* to January *2018* in each prefecture. Although average temperature of Japan has an upward tendency, the increasing rate was various by all prefectures. It is seen that the average temperature is descending in more than one prefectures. The average value of the *increasing rate (B)* for which we asked from the lowest temperature increasing rate of each prefecture is *+0.01*. This means that most rises of average temperature are not changing in recent *43* years.

Keywords: *monthly average temperature, 47 prefectures, increasing rate, Mathematica, regression line*

0. Introduction

It is the coldest of the past several years this winter. News has reported that first snow of the season also came down early for the first time in ten years. Is this also influence of "*global warming*"? In recent years, global warming is becoming a fixed fact. However, although *the climate gate incident* revealed in 2009 was in the state which was seldom reported but was buried in darkness in Japan, it had become the center of attention considerably overseas. Since the students of the "project" for a third grader had hung up on the theme of global environment problems exactly in 2011, we remember having read Mr. Takashi Hirose's pocketbook [1] "C*ollapse of a carbon dioxide warm hypothesis*" for the study meeting. The following thing was written into the preface of the book. "Global warming happened owing to artificial carbon dioxide emission. *IPCC* (Intergovernmental Panel on Climate Change) which won the *Nobel Peace Prize* claimed mainly carrying out effluent control of *CO2* all over the world. However, it was discovered in 2009 that the basic data used as the basis was fabricated. -- The fact is hardly reported in Japan. --." Moreover, at a certain lecture meeting, the author presented the graph of change of the average temperature of the whole earth of one sheet, and asked a question as follows. "Those who are investigating the temperature data of this graph need to raise a hand." "Nobody raised the hand. There were no those who are investigating the graph of the average temperature in the world at every hall. "

Carrying out the group division of the students, a certain group chose the theme which investigates a climate change of Japan, and investigated the data of 47 all prefectures of the annual (and also monthly) average temperature for the past several ten years (from the homepage of the Japan Meteorological Agency). Other groups investigated the generating situation of the big earthquake in the world. Although it has been grasped that average temperature of Japan has an upward tendency, the increasing rate was various by all prefectures. Of course, average temperature was descending in two or more prefectures. Although average temperature is generally said to go up by about *+0.85* to *+1.00* degree in *100* years of recent years on the whole earth, the value changes with measurement periods. When the monthly *maximum* temperature and the monthly *minimum* temperature were investigated, we understood the increasing rate of the maximum temperature and the increasing rate of the minimum temperature are not necessarily the same, and the increasing rate of the minimum temperature is clearly higher than that of the maximum

temperature. What is called *the heat island effect* is shown. That average temperature is rising was able to hear about what will be been because the temperature of night has not fallen compared with ancient times. May we conclude that Japanese average temperature is rising compared with 50 to 60-year before? A question is just going to remain. Furthermore, although above-mentioned Mr. Hirose [1] also claims, the position of the temperature observatory of each all prefectures and its surrounding environment will also affect the measured value of temperature considerably. This is applied also about global countries. Although there is naturally a limit in guessing only from official announcement data, we would like to have come to investigate the tendency of the temperature of the latest Japan.

We decided for the meteorological data used this time to use not only the official announcement data of the *Japan Meteorological Agency* [2] but also the data of *Mathematica* of computer software. This is for shortening of analysis time. As for this Mathematica data, there may merely be a problem in reliability a little. The merit using Mathematica is that the meteorological data of the main cities in Japan or the main cities of every country in the world can input easily, and is being able to carry out the statistics analysis of them still more nearly immediately. This paper is supported by the computer software *Mathematica ver.11.2.*

1. Long-term change tendency of temperature of Japan

From the homepage of the *Japan Meteorological Agency* [2], the rise of the annual mean air temperature of the past of Japan is about *+1.42* degrees in *120* years (from *1898* to *2017*), which means *+1.20* degrees per *100* years rise. First, we verify this result. Fig.1a shows the graph of the deviation from a standard value (refer to the homepage of the Japan Meteorological Agency [2]) for *120* years from *1898* to *2017* with a regression line such that

$$y = -23.808+0.012\,x \qquad (1898 \le x \le 2017)\,.$$

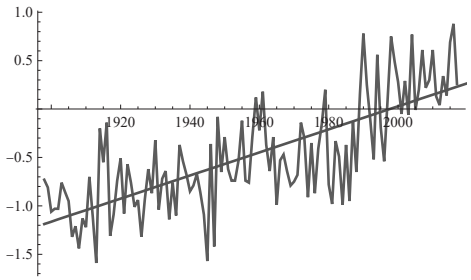

Fig.1a. The annual mean temperature of Japan for 120 years from 1898 to 2017 with the regression line.

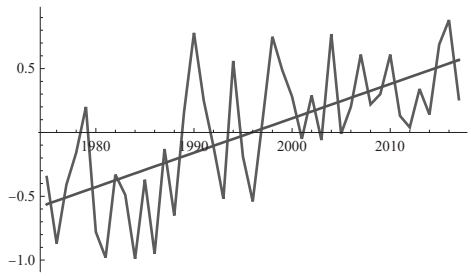

Fig.1b. The temperature of Japan for 43 latest years from 1975 to 2017 with the regression line.

Furthermore, when the difference of *y* coordinates of the starting point of this straight line and a terminal point was searched for, it is set to *+1.42* and is the increasing rate for the *120* above-mentioned years given in Fig.1a. Moreover, the increasing rate for *43* latest years from *1975* to *2017* is *+1.13* degrees in Fig.1b. This increasing rate means that the increasing rate per *100* years is *+2.96* degree, and it turns out that it is a quite high rate. By the way, how are you asking for average temperature of Japan? According to the homepage of the Meteorological Agency, the data of the following *15* cities is used to calculate an average temperature of Japan.

Abashiri, Iwanami, Nemuro, Yamagata, Ishinomaki, Takaoka, Iida, Choshi, Sakai, Hamada, Hikone, Miyazaki, Tadotsu, Nago, Ishigaki Island.

These cities are selected for the reason, "there was comparatively little influence by urbanization, and it might not incline toward a specific area." Then, we verified individually the increasing rates from the monthly average temperature data in January *1975* to January *2018* of these *15* cities. The results of having asked for the regression line of each city and having asked for the increasing rate for *43* years are Fig.1e (see also Fig.1.1 - Fig.1.15 in *Appendix A1*). In these *15* cities, the increasing rate of *Iida* is *+2.77* which is the highest degree, but the increasing rate of *Nago* and of *Tadotsu* is lower than zero. The average of the increasing rate of *15* cities is *+1.20* degrees. Sure enough, are these *15* cities reflecting the situation of whole Japan correctly? In the following chapter, We shall ask for the other average increasing rates from the cities of *47* all prefectures.

City	Increasing rate
Abashiri	1.52
Iwanai	0.96
Nemuro	1.44
Yamagata	1.47
Ishinomaki	1.72
Hushiki	0.05
Iida	2.77
Choshi	1.44
Sakai	1.69
Hamada	1.38
Hikone	1.94
Miyazaki	1.25
Tadotu	-0.44
Nago	-0.07
Ishigaki	0.93
Mean	1.20

Table 1. The increasing rate for 15 cities.

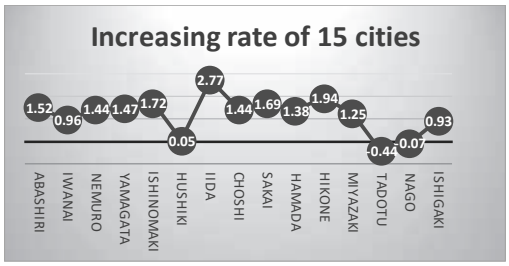

Fig.1c. A graph of the increasing rate for 15 cities.

2. Analysis of monthly average temperatures of 47 prefectures

The graph of following Fig.2a is the *monthly* average temperature of *Tokyo* for the period *January 1975* through *January 2018 from Weatherdata of Mathematica.* This figure's showing will be that the lowest temperature is rising compared with the maximum temperature. The graph which applied the regression line to this data is shown in Fig.2b.

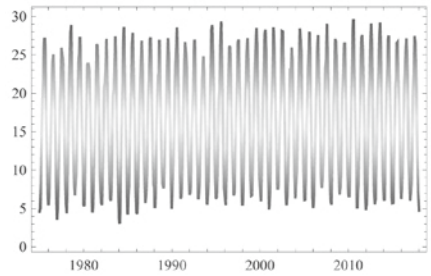

Fig.2a. The monthly average temperature of Tokyo.

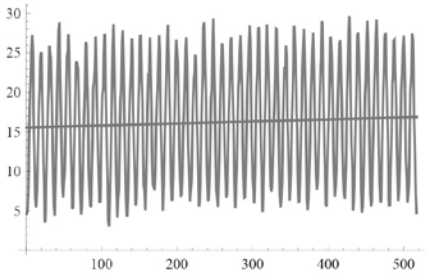

Fig.2b. The regression line to the data.

The equation of this regression line is given as

$$y = x\,(0.0026\ ^{\circ}C) + 15.5549\ ^{\circ}C,$$

and the variable x of the equation is a number of month, $1 \le x \le 517$.

The *increasing rate* of the average temperature for *43* years is defined by the increase of y coordinates of a terminal straight line from the starting point using this straight line. The increasing rate of the average temperature for *43* years of Tokyo is *+1.32* degrees. Incidentally, the following Fig.2e is a graph of the temperature of *Hachioji* and Fig.2d also shows that the temperature has not risen for several latest years. The increasing rate of Hachioji is obviously lower than that of *Tokyo*.

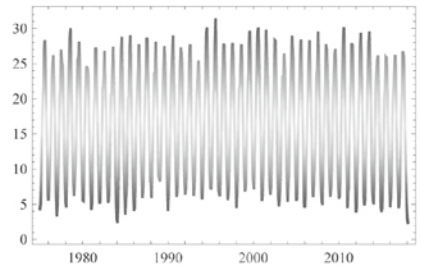

Fig.2c. The monthly average temperature of Hachioji.

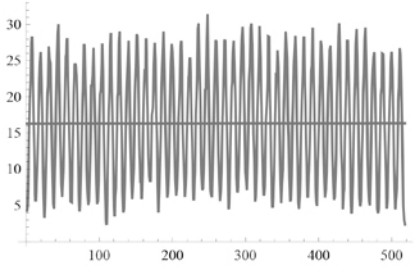

Fig.2d. The regression line to the data.

The regression line in Fig.2d is given as

$$y = x\,(0.0004\ ^{\circ}C) + 16.2325\ ^{\circ}C.$$

The degree of temperature rise for *43* years of *Hachioji* is *+0.21* degrees.

Next, we shall show the degrees of rise of *47* all prefectures similarly computed from the monthly average temperature for the period *January 1975* through *January 2018, in* Table 2 and in Appendix A2 for graphs of the data and the regression lines. In Table 2, a *temperature increasing rate (A)* is the increasing rate of the city of the prefectural capital (or the neighborhood). On the other hand, a *temperature increasing rate (B)* is the rate of the *minimum* degree in the cities in each prefectures (but we did not verify all cities in the prefectures).

Prefecture	Increasing rate (A)	Increasing rate (B)
Hokkaido	1.81	-0.32
Aomori	1.69	-1.04
Iwate	1.68	0.6
Akita	1.68	-1.02
Miyagi	1.72	0.26
Yamagata	1.48	0.22
Fukushima	1.45	-0.27
Niigata	1.39	0.57
Tochigi	1.9	-1.49
Gunma	1.85	1.72
Ibaraki	2.27	0.13
Saitama	1.47	0.21
Yamanashi	2.78	1.79
Kanagawa	1.59	0.21
Tokyo	1.47	0.21
Chiba	1.63	0.84
Shizuoka	1.27	0.21
Nagano	1.77	1.16
Gifu	1.86	0.06
Aichi	2.06	1.72
Osaka	1.31	-1.02
Kyoto	2.76	-1.3
Shiga	2.76	-1.7
Okayama	2.25	-1.73
Hyogo	2.76	-1.73
Nara	1.69	1.54
Wakayama	3.1	-1.6
Mie	1.94	-1.7
Fukui	1.44	-1.3
Ishikawa	1.67	1.41
Toyama	1.3	-0.09
Tottori	1.54	-0.31
Shimane	1.62	0.11
Hiroshima	2.26	-1.58
Yamaguchi	2.27	-0.01
Kochi	1.25	0.6
Kagawa	2.25	-0.58
Tokushima	2.25	-0.58
Ehime	1.73	0.58
Fukuoka	1.76	-0.02
Oita	1.81	-0.02
Saga	1.17	0.62
Miyazaki	1.25	0.85
Kagoshima	1.82	0.47
Kumamoto	1.18	0.4
Nagasaki	1.27	-0.27
Okinawa	1.58	0.14
Mean	1.80	0.01
Max	3.1	1.79
Min	1.17	-1.73

Table 2. Increasing rates (A) and (B) for 47 prefectures.

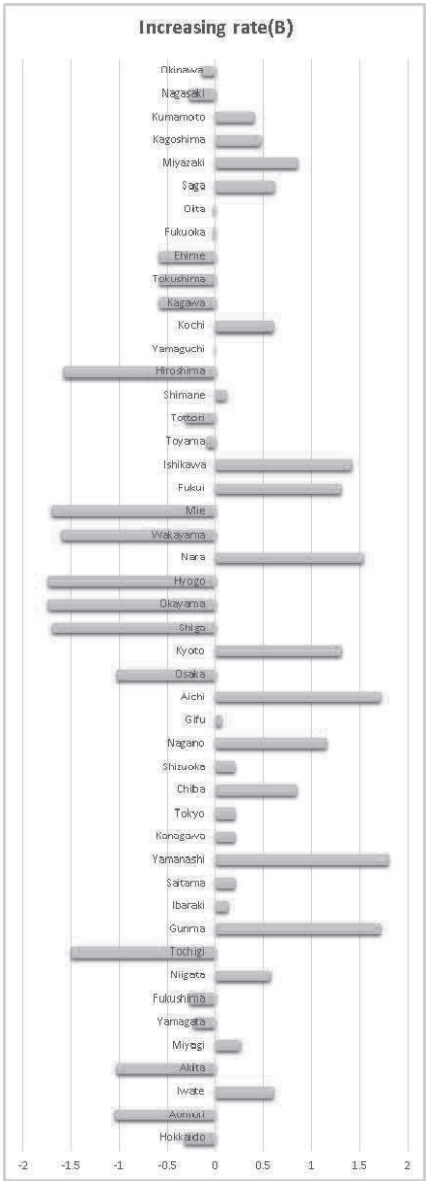

Fig.2e. A graph of the increasing rate (B).

The average value of an *increasing rate (A)* is *+1.80* which is larger than the increasing rate of average temperature of Japan given in the previous Section 1. On the other hand, the average value of the *increasing rate (B)* for which we asked from the lowest temperature increasing rate of each prefecture is *+0.01*. This means that most rises of average temperature are not changing in these *43* years. The city where an increasing rate is the lowest is *-1.73* in *Bizen* in *Okayama* in Table 2 and Fig.2e (also refer to Fig.2.23). The highest increasing rate is *+3.10* of Wakayama. It turns out that the number of the prefectures whose temperature increasing rate (B) is minus is *23* and it is *49%* of the whole. The selected cities of these *23* prefectures will be fulfill the conditions ; “there was comparatively little influence by urbanization, and it might not incline toward a specific area.”, which is showed by the Meteorological Agency. Therefore just these cities are considered to be suitable for the member of the *15* cities introduced in

Section 1. By the way, the city whose increasing rate is low was not found in prefectures, such as *Gumma*, *Yamanashi*, *Nagano*, *Aichi*, *Kyoto*, *Fukui* and *Ishikawa*. As a tendency to see the whole area, the city where an increasing rate is lower than zero exists in the *Tohoku* district, the *Kansai* region, *San-in*, *Shikoku*, *Kyushu*, and even in *Nagasaki* and *Okinawa*. However, it may be mysterious for us that there was no city where an increasing rate is lower than zero in *Fukui* and *Ishikawa*. This result may be corrected if the data of temperature is examined in detail to a slight degree.

3. Analysis of increasing temperature rates for each month of Japan

The increasing rate in January is *+0.97* per *100* years which has been announced at the homepage of the *Japan Meteorological Agency* [2]. How about other months ? We shall verify this question. Here, we use the monthly average temperature data of Japan in *1898* to *2017* which can be downloaded from the Homepage of the *Japan Meteorological Agency*. In Appendix A2, 12 graphs of the deviation data of every month are given in Fig. 3.1 - Fig. 3.12 with the approximated regression lines. Table 3 shows the results of increasing rates of 12 months and their trends of the regression line. The increasing rate 1 is the rate for 120 years and the increasing rate 2 is for 100 years. Those values are calculated from a regression line. Figure 3 is a graph of the increasing rate 2 of 12 months.

Month	Trend of line	Increasing rate1	Increasing rate2
January	0.0097	1.1543	0.97
February	0.0139	1.6541	1.39
March	0.0143	1.7017	1.43
April	0.0118	1.4042	1.18
May	0.0158	1.8802	1.58
June	0.0115	1.3685	1.15
July	0.0107	1.2733	1.07
August	0.0105	1.2495	1.05
September	0.0111	1.3209	1.11
October	0.0129	1.5351	1.29
November	0.0115	1.3685	1.15
December	0.0093	1.1067	0.93
Mean	0.012	1.42	1.19

Table 3. The increasing rates 1 and 2 for 12 Months.

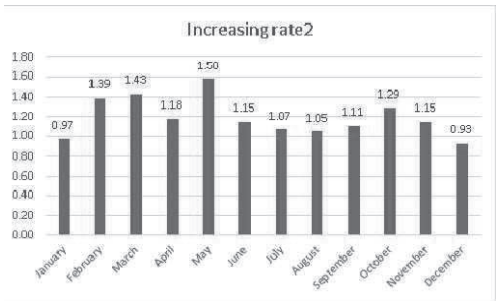

Fig.3. A graph of the increasing rate 2 for 12 months.

It is seen that the highest degree in the increasing rates is *+1.58* of May, and the lowest is +0.93 of December. But we do not know why the increasing rate of the spring season is mainly higher than that of the winter (or summer) season. That will be a future work for us.

4. Conclusions

In Section 1, we have investigated the result that the rise of the annual average temperature of the past of Japan is about *+1.42* degrees in *120* years (from *1898* to *2017*) that means *+1.20* degrees per *100* years rise, which is in the homepage of the Japan Meteorological Agency [2]. We also showed that the increasing rate for *43* latest years from *1975* to *2017* is *+1.13* degrees, and that the increasing rate per *100* years is *+2.96* degree, which is unusually high. Then, we investigated the increasing rate of the temperature of *47* all prefectures in Chapter 2. As a result, it turned out that the average value of the lowest temperature increasing rate of each prefecture is *+0.01*. This result means in Japan that a temperature rise has hardly taken place in *43* latest years. The main causes by which our result differed from the result of the Japan Meteorological Agency are how to take data. The Meteorological Agency is using the selected data of *15* cities. On the other hand, we are using the data of the city of the lowest temperature increasing rate of each prefecture. When a temperature increasing rate of Japan was investigated, it turned out that the data of the city to be used acts on a result greatly. Therefore, we need to be cautious of city selection enough.

References

[1] Takashi Hirose, 2010, "C*ollapse of carbon dioxide warm hypothesis*", Paperback of Shueisha.

[2] Japan Meteorological Agency: http://www.data.jma.go.jp/cpdinfo/chishiki_ondanka/p08.html.

Appendix

A1. Graphs 1 (Temperatures of 15 cities) Fig.1.1 - 1.15

Note that a real number *a* in the following figures is the increasing rate of the monthly average temperature data in January *1975* to January *2018* of a city.

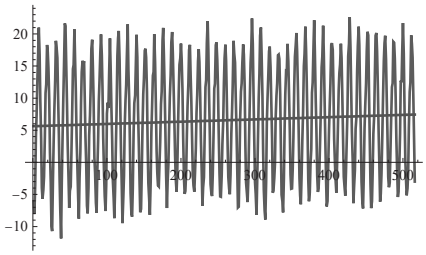

Fig. 1.1. Abashiri in Hokkaido with *a* = *+1.81*

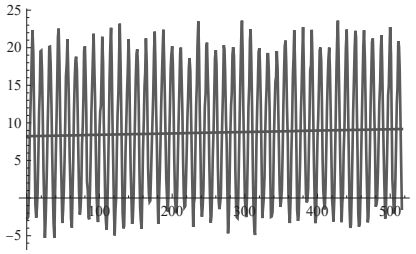

Fig. 1.2. Iwanami in Hokkaido with *a* = *+0.96*

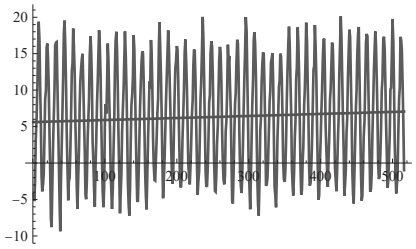

Fig. 1.3. Nemuro in Hokkaido with *a* = *+1.44*

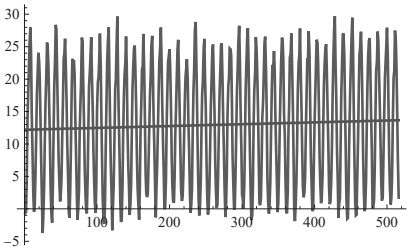

Fig. 1.4. Yamagata in Yamagata with *a* = *+1.47*

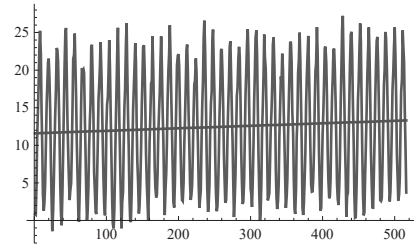

Fig. 1.5. Ishinomaki in Miyagi with *a* = *+1.72*

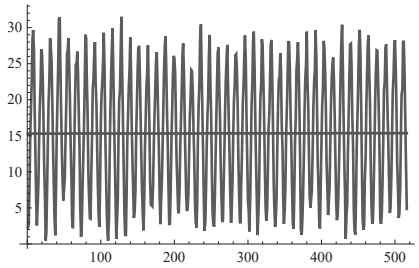

Fig. 1.6. Takaoka in Toyama with *a* = *+0.05*

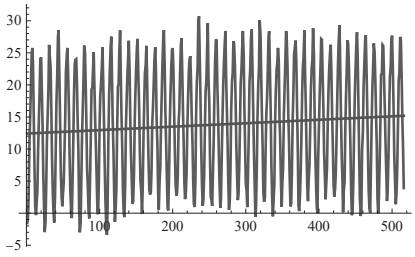

Fig. 1.7. Iida in Nagano with $a = +2.77$

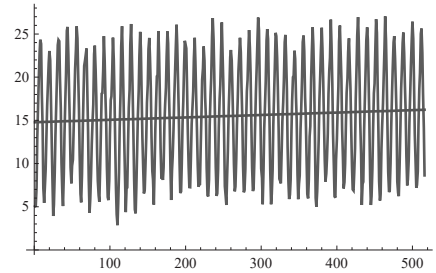

Fig. 1.8. Choshi in Chiba with $a = +1.44$

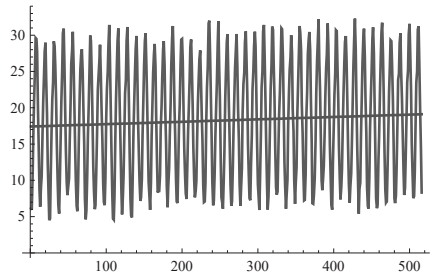

Fig. 1.9. Sakai in Osaka with $a = +1.69$

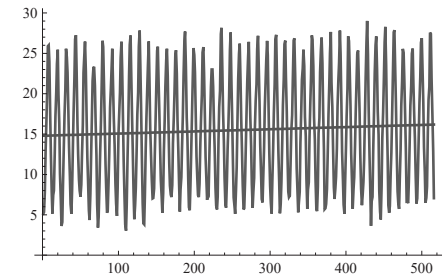

Fig. 1.10. Hamada in Shimane with $a = +1.38$

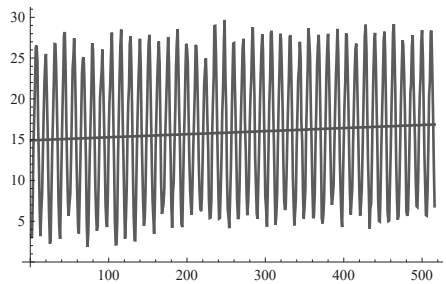

Fig. 1.11. Hikone in Shiga with $a = +1.94$

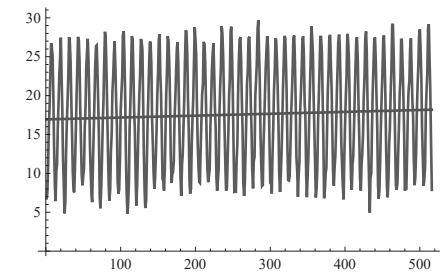

Fig. 1.12. Miyazaki in Miyazaki with $a = +1.25$

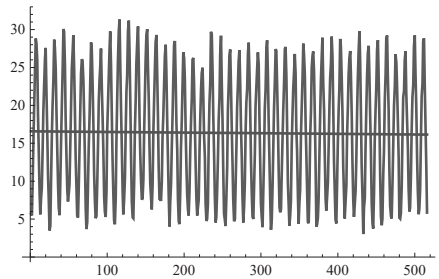

Fig. 1.13. Tadotu in Kagawa with $a = -0.44$

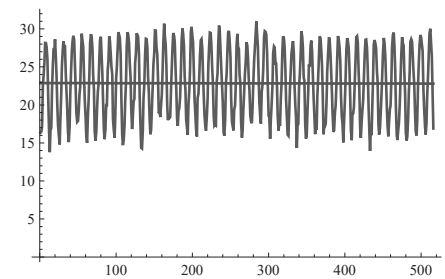

Fig. 1.14. Nago in Okinawa with $a = -0.07$

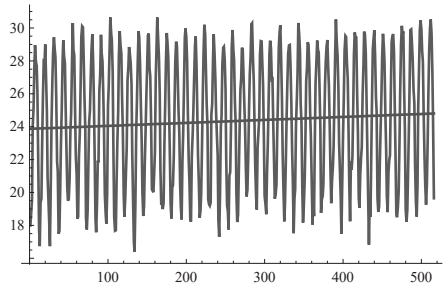

Fig. 1.15. Ishigaki in Okinawa with $a = +0.93$

A2. Graphs 2 (Temperatures of 47 prefectures) Fig.2.1 - 2.47

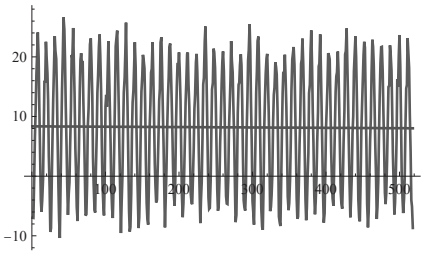

Fig. 2.1. Kitami in Hokkaido with $a = -0.32$

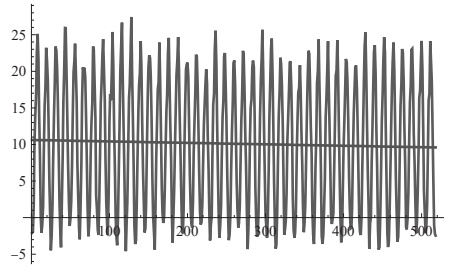

Fig. 2.2. Hirosaki in Aomori with $a = -1.04$

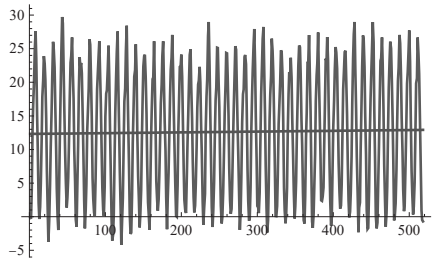

Fig. 2.3. Ichinoseki in Iwate with $a = +0.60$

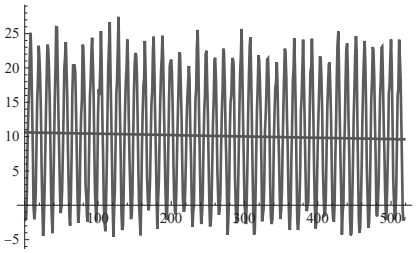

Fig. 2.4. Odate in Akita with $a = -1.02$

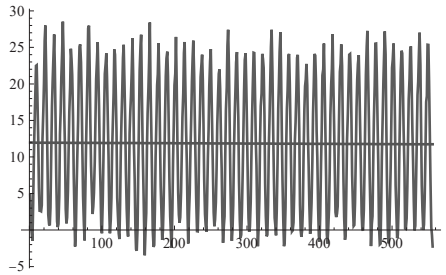

Fig. 2.5. Yuza in Yamagata with $a = -0.22$

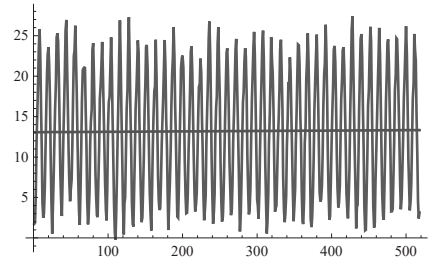

Fig. 2.6. Natori in Miyagi with $a = +0.26$

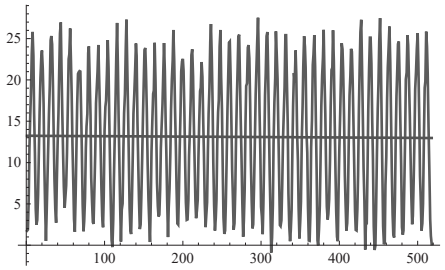

Fig. 2.7. Kawamata in Fukushima with *a = -0.27*

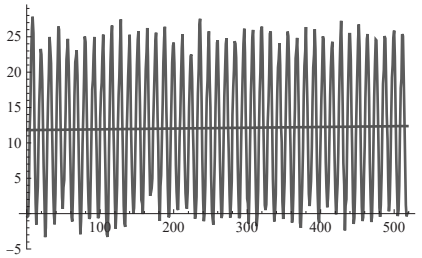

Fig. 2.8. Itoigawa in Niigata with *a = +0.57*

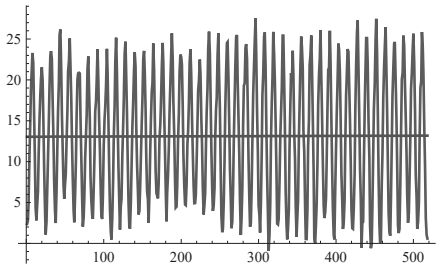

Fig. 2.9. Daigo in Ibaraki with *a = +0.13*

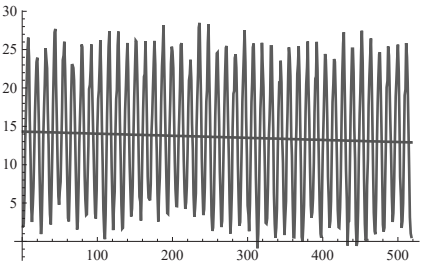

Fig. 2.10. Takanezawa in Tochigi with *a = -1.49*

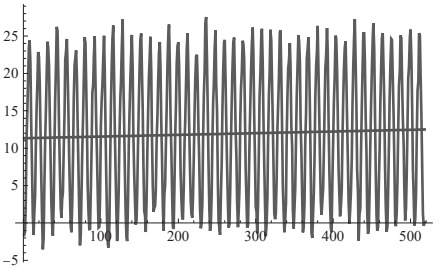

Fig. 2.11. Hakuba in Nagano with *a = +1.16*

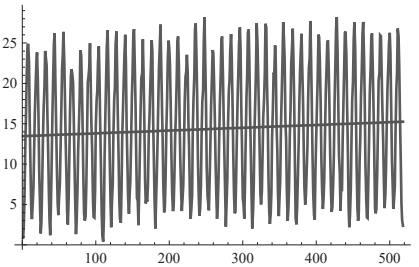

Fig. 2.12. Ryuo in Yamanashi with *a = +1.79*

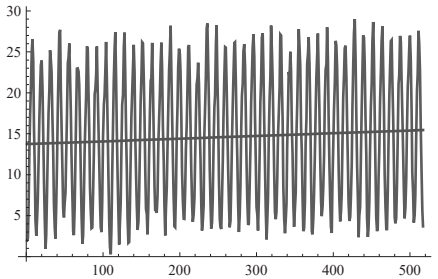

Fig. 2.13. Maebashi in Gumma with *a = +1.72*

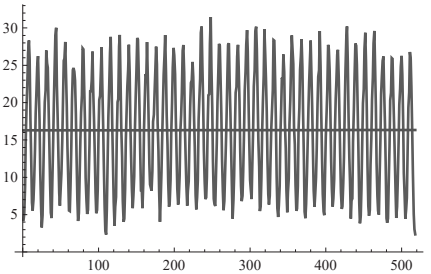

Fig. 2.14. Hachioji in Tokyo with *a = +0.21*

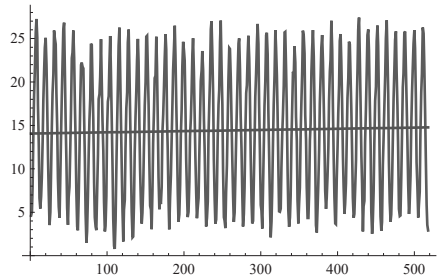

Fig. 2.15. Sakura in Chiba with $a = +0.84$

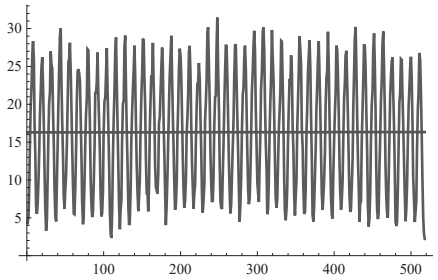

Fig. 2.16. Atugi in Kanagawa with $a = +0.21$

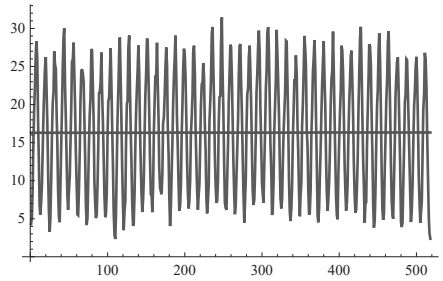

Fig. 2.17. Asaka in Saitama with $a = +0.21$

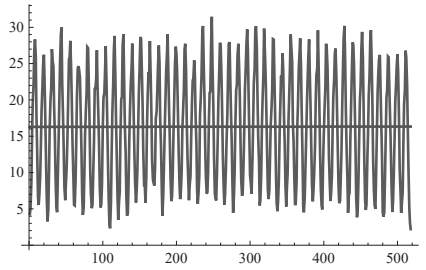

Fig. 2.18. Gotemba in Shizuoka with $a = +0.21$

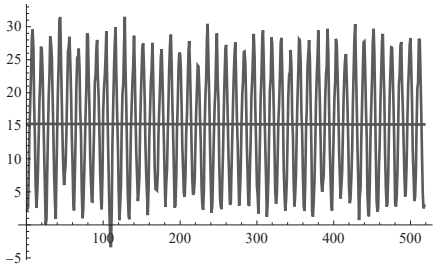

Fig. 2.19. Takayama in Gifu with $a = +0.06$

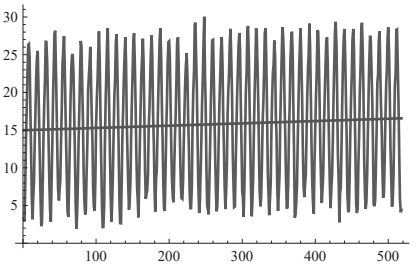

Fig. 2.20. Nagoya in Aichi in with $a = +1.72$

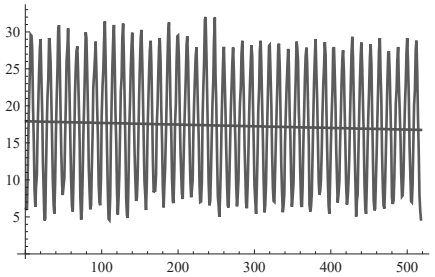

Fig. 2.21. Hannan in Osaka with $a = -1.02$

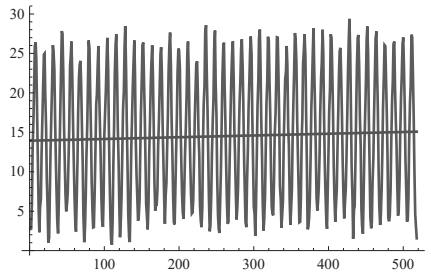

Fig. 2.22. Ayabe in Kyoto with $a = +1.30$

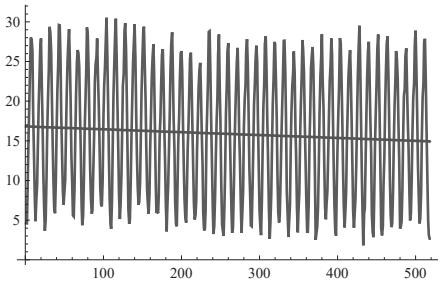

Fig. 2.23. Bizen in Okayama with *a = -1.73*

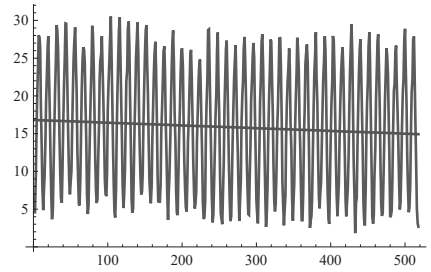

Fig. 2.24. Aioi in Hyogo with *a = -1.73*

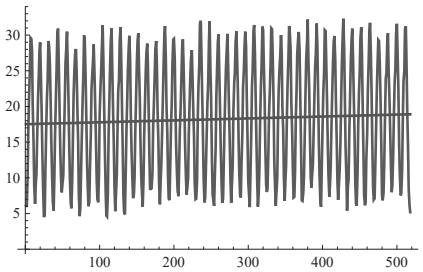

Fig. 2.25. Sango in Nara with *a = +1.54*

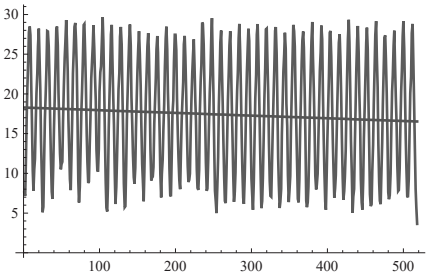

Fig. 2.26. Kainan in Wakayama with *a = -1.60*

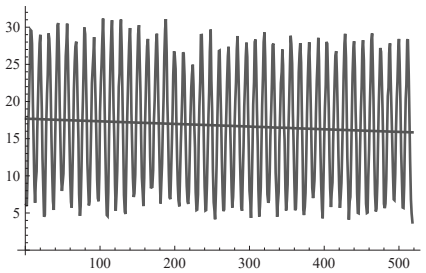

Fig. 2.27. Nabari in Mie with *a = -1.70*

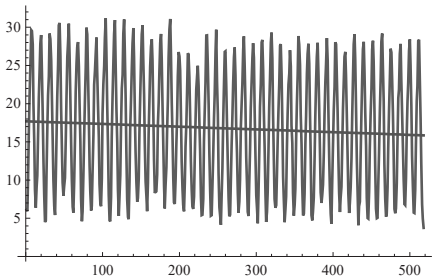

Fig. 2.28. Minakuchi in Shiga with *a = -1.70*

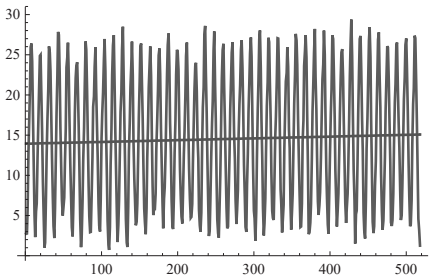

Fig. 2.29. Obama in Fukui with *a = +1.30*

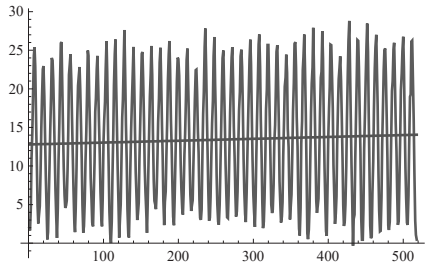

Fig. 2.30. Nanao in Ishikawa with *a = +1.41*

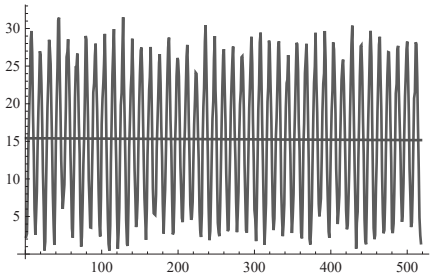

Fig. 2.31. Himi in Toyama with *a = -0.09*

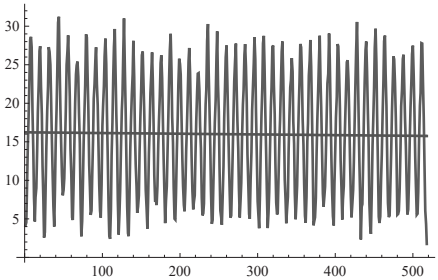

Fig. 2.32. Kurayoshi in Tottori with *a = -0.31*

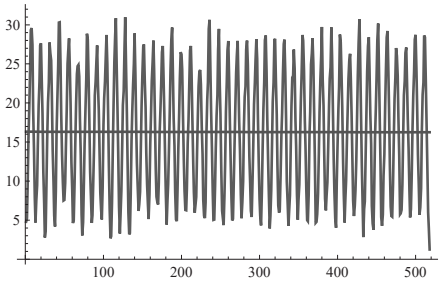

Fig. 2.33. Izumo in Shimane with *a = +0.11*

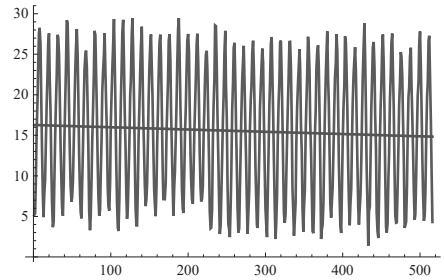

Fig. 2.34. Shobara in Hiroshima with *a = -1.58*

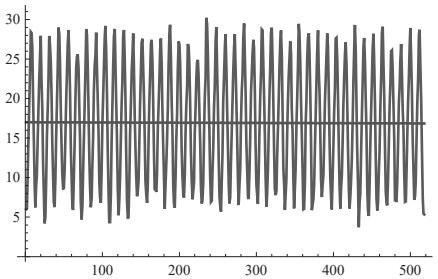

Fig. 2.35. Shimonoseki in Yamaguti with *a = -0.01*

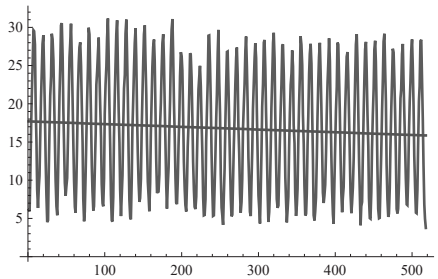

Fig. 2.36. Aki in Kochi with *a = +0.60*

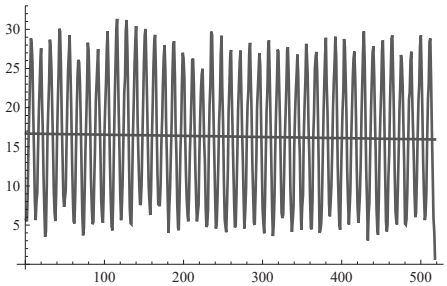

Fig. 2.37. Marugame in Kagawa with *a = -0.58*

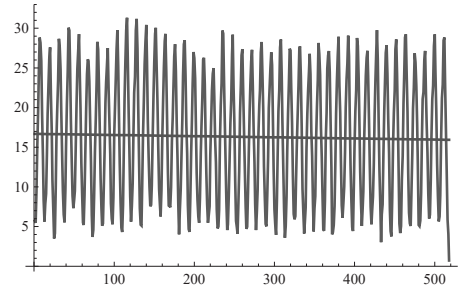

Fig. 2.38. Anan in Tokushima with *a = -0.58*

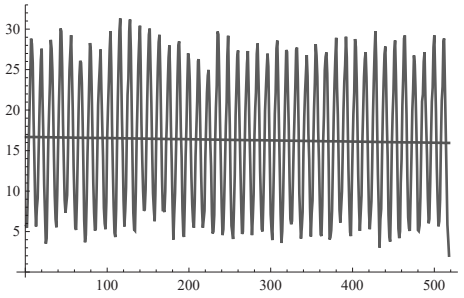

Fig. 2.39. Kawanoe in Ehime with *a = -0.58*

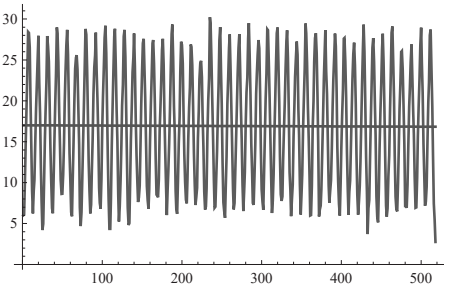

Fig. 2.40. Kitakyushu in Fukuoka with *a = -0.02*

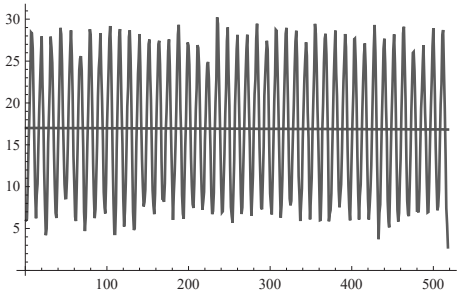

Fig. 2.41. Nakatu in Oita with *a = -0.02*

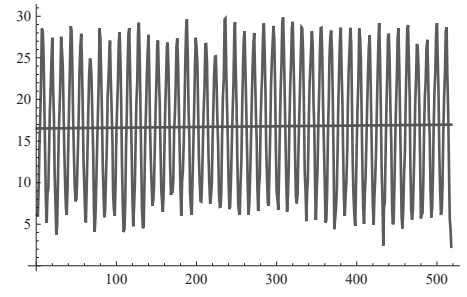

Fig. 2.42. Taku in Saga with *a = +0.62*

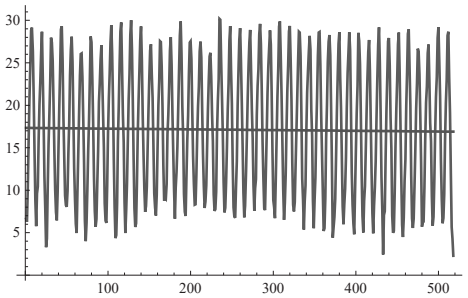

Fig. 2.43. Shimabara in Nagasaki with *a = -0.27*

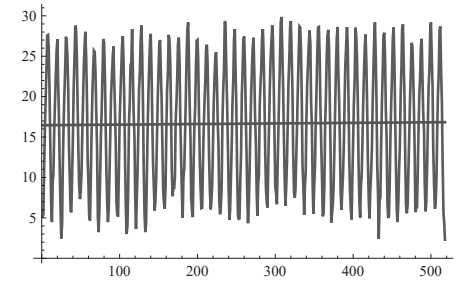

Fig. 2.44. Arao in Kumamoto with *a = +0.55*

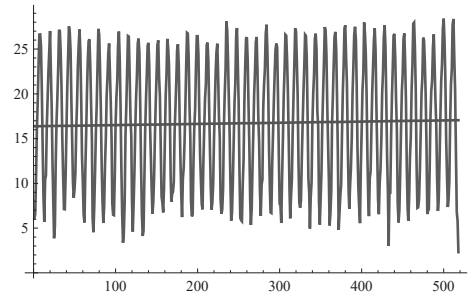

Fig. 2.45. Ebino in Miyazaki with *a = +0.85*

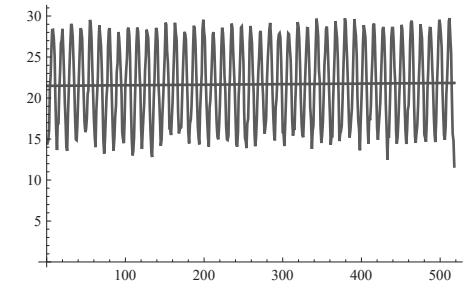

Fig. 2.46. Naze in Kagoshima with *a = +0.47*

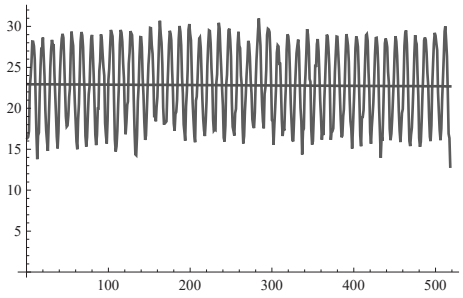

Fig. 2.47. Nago in Okinawa with $a = -0.14$.

A3. Graphs 3 (Temperatures for 12 months and regression lines) Fig.3.1-3.12

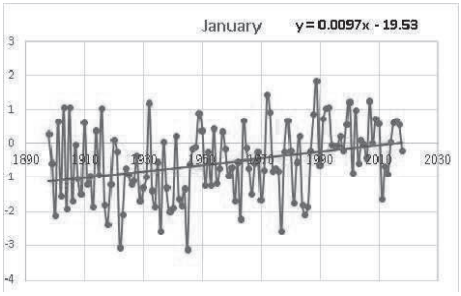

Fig.3.1 Temperature of January for 120 years.

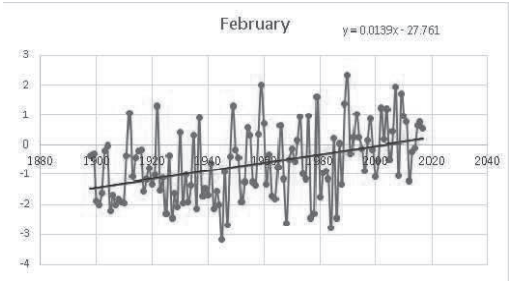

Fig.3.2 Temperature of February.

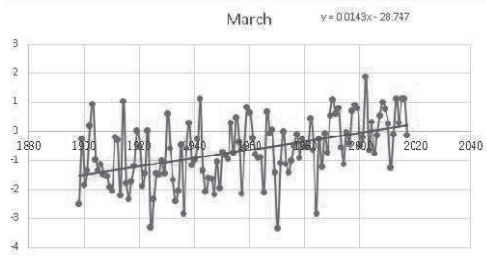

Fig.3.3 Temperature of March.

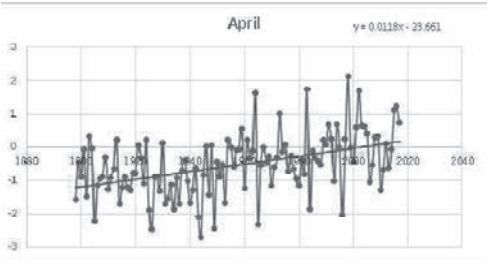

Fig.3.4 Temperature of April.

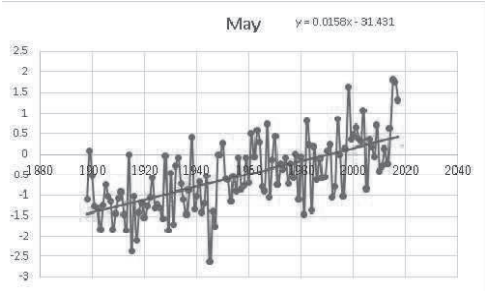

Fig.3.5 Temperature of May.

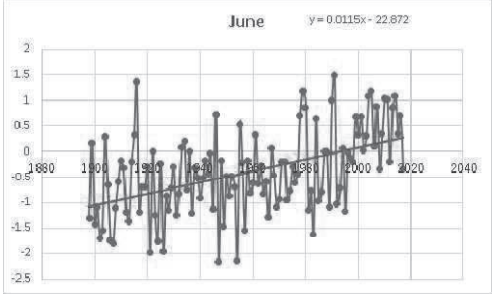

Fig.3.6 Temperature of June.

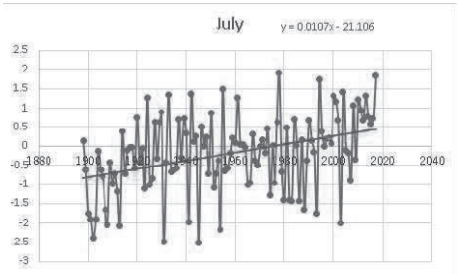

Fig.3.7 Temperature of July.

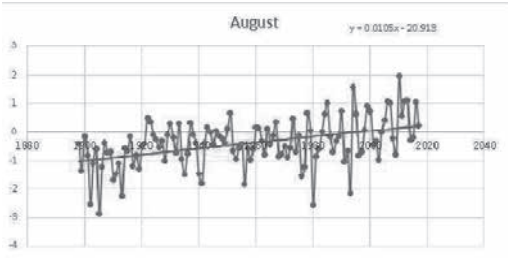

Fig.3.8 Temperature of August.

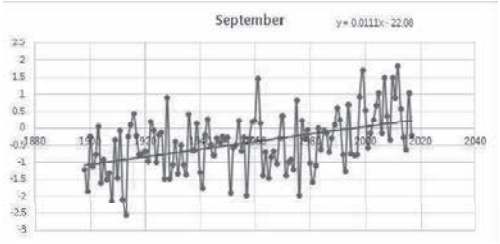

Fig. 3.9 Temperature of September.

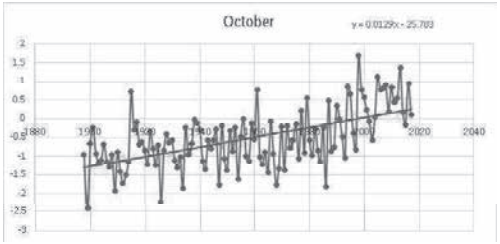

Fig.3.10 Temperature of October.

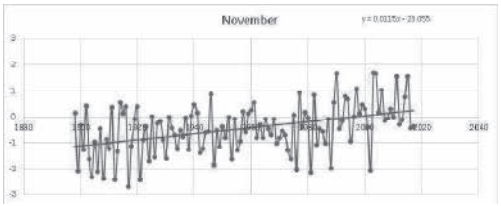

Fig. 3.11 Temperature of November.

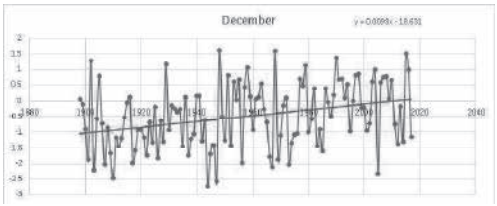

Fig. 3.12 Temperature of December.