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The Prediction and Comparison of the Mean Temperature in Beijing, Shanghai, and Guangzhou by Using the Methods of Numerical Modelling

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Abstract. The destination of this paper is to predict future high and cold temperatures and compare them in Beijing, Shanghai, and Guangzhou. Using the numerical modeling, it finds that both average high and low temperatures' changing rate has no significant differences and predicts the future temperature using the regression equation. Then, by comparing and contrasting the three cities' mean temperatures, the overall change is similar, and the mean temperature of Guangzhou is the highest, which Shanghai follows. In this essay, people can use numerical modeling methods to predict the weather by using the historical data given by the government.

Keywords: Differences in temperature, Numerical Modeling, Graphing, and regression function.

1. Introduction

Nowadays, with the development of science and technology, the computer has become more widespread in daily life. Programming and modeling allow the computer to calculate complex puzzles faster than the average category. Numerical modeling is a very convenient category for solving numerical questions. It is a model using numerical computation to describe the character and law of the object. They can use numerical models, from mathematical structure expressions to interactive game projects with pictures, videos, and sound effects. Generally, numerical modeling is not only used in traditional subjects such as physics and biology. Still, it is an essential tool in most social majors like the economy, humanity, and even PE. [1]

Recently, the government has mastered the techniques of weather prediction, which use satellite, radar, and other technologies to observe the weather in different dimensions. These techniques are usually very accurate. However, in small-scale climate or the change of elements, they cannot predict it precisely because the weather is variable and a non-linear process. Recently, high-precision observation machines have been developed continuously.[2]

In this work, we aim to use numerical modeling to find the changing rule and predict the future mean high and low temperatures by using the historical data given so that people can have a more convenient way to predict the weather by themselves. Also, compare and contrast the changing law of average temperature in three cities.

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2. Analyze and Prediction

2.1. I graph three cities' changing laws of mean high and low temperatures.

I got the data from the website of the National Meteorological Administration [3-5]. I imported all monthly data for three years in three cities into excel to make a table and use it to make line graphs of them.

2.2. Analyze and predict the graph and table

After graphing three cities' changing law mean temperatures, it is found that the changing law has no apparent differences in each year that they usually began to increase or decrease in a stationary date, such as reducing in July or August and increasing in January or February.

2.2.1. Beijing.

Table 1. The monthly mean highest and lowest temperature in Beijing from 2020 to 2022[3].

Beijing								
	low T/℃	high T/℃	2021.1	-8	2	2022.1	-4	3
2020.2	-2	9	2021.2	-3	10	2022.2	-6	6
2020.3	1	15	2021.3	4	14	2022.3	-5	14
2020.4	7	22	2021.4	9	21	2022.4	2	23
2020.5	15	27	2021.5	14	26	2022.5	9	28
2020.6	21	33	2021.6	19	31	2022.6	14	31
2020.7	22	31	2021.7	23	31	2022.7	20	33
2020.8	21	31	2021.8	21	30	2022.8	22	31
2020.9	16	27	2021.9	17	26	2022.9	21	29
2020.10	7	20	2021.10	7	18	2022.10	17	19
2020.11	1	11	2021.11	1	11	2022.11	2	15
2020.12	-6	3	2021.12	-4	6			

2.2.2. Analyze. According to table 1, in 2020, the mean low temperature began at -2℃ in February and then increased in the next five months, peaking at 22℃ in July. In the following year, in January, it decreased from 22℃ to -8℃. In the next two years, it has a similar trend in the next three years. By contrast, in February 2020, the mean high temperature reached 9℃ followed by five months, increasing to 33℃ at its peak in February.

In the following year, 2021, the mean low temperature increased from January to July, peaking at 23℃, then decreasing to -4℃ during the next half year. In 2022, the overall trend had no significant change, with the mean high and low temperatures reaching the highest number in August (22℃) and July (33℃) and at the lowest number in November, which was 2℃ and 15℃.

Generally, although the mean trend has not significantly changed during these three years, there are also some unique points. The temperature reached its highest point in June 2020 and July 2022, which means high temperatures reached 33℃, and the lowest point in January 2021, which represent low temperature reached -8. Also, in October 2022, the differences between the mean high and low temperatures were minor, with only a disparity of 2℃.

2.2.3. Prediction. According to Figure 1, although some data is different with different years, it also has a clear changing rule which is a form of a wave that, in each period, it has a stable maximum and minimum, such as a peak at 22℃ in mean low temperature or 33℃ in mean high temperature, so that we can use the categories of a trigonometric function.

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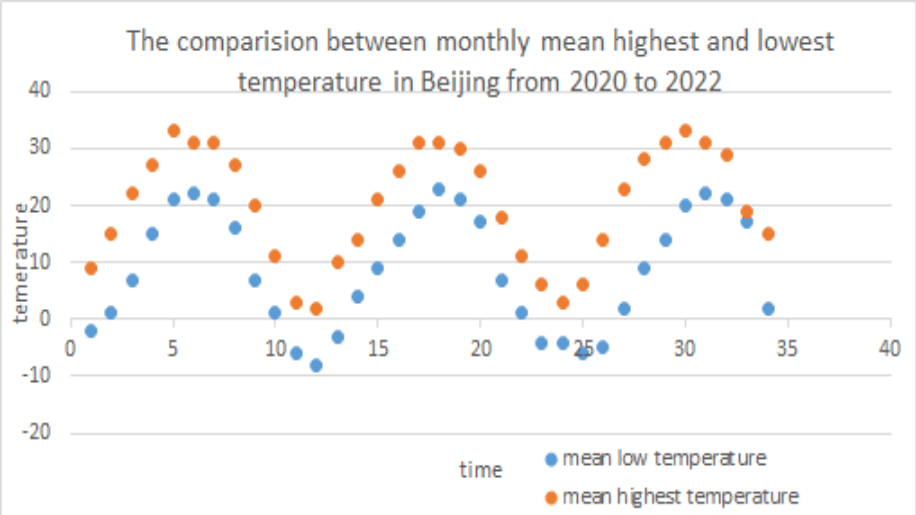

Figure 1. The comparison between the monthly mean highest and lowest temperature in Beijing from 2020 to 2022.

First, make the trendlines for each scatter diagram by using Excel's trendline. Then, change the years into a serial number from 0 to 34.

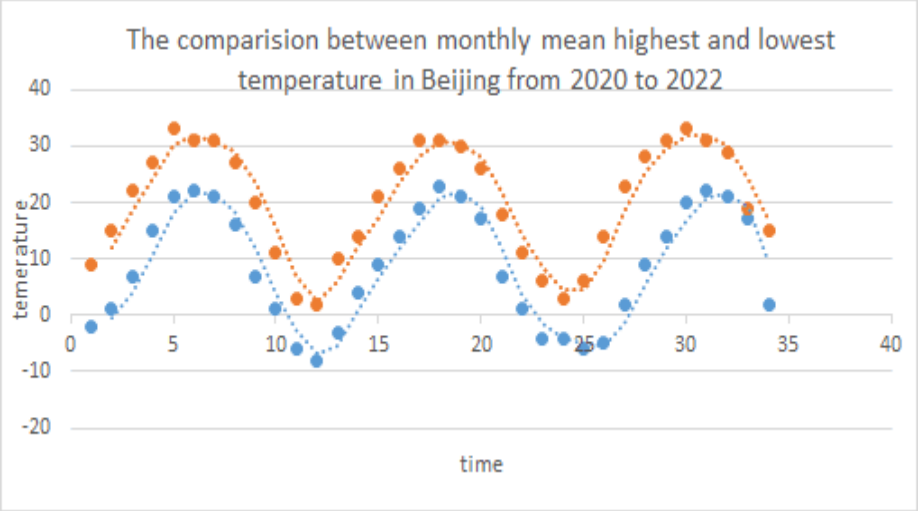

Figure 2. The trendline of comparison between the monthly mean highest and lowest temperature in Beijing from 2020 to 2022.

Using the calculation, we could not get the formula directly by regression. Still, the law of the trigonometric function also can be used, which is that in a constant period, the value of the process doesn't change. More precisely, in this graph, one period is about 12 units, which is also 12 months, and the temperature will not change significantly. For example, in January 2023, the mean high temperature will also be about 3°C or 2°C, and the mean low temperature will be approximately 6°C.

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2.2.4. Shanghai

Table 2. The monthly mean highest and lowest temperature in Shanghai from 2020 to 2022[4].

	Shanghai							
	low T/℃	high T/℃	2021.1	2	10	2022.1	4	9
2020.2	9	16	2021.2	6	14	2022.2	3	9
2020.3	9	16	2021.3	9	15	2022.3	9	18
2020.4	12	21	2021.4	14	21	2022.4	13	22
2020.5	19	27	2021.5	19	27	2022.5	17	25
2020.6	23	29	2021.6	22	29	2022.6	22	31
2020.7	24	30	2021.7	26	33	2022.7	28	36
2020.8	27	35	2021.8	26	32	2022.8	28	37
2020.9	21	28	2021.9	23	31	2022.9	22	28
2020.10	16	22	2021.10	18	24	2022.10	16	23
2020.11	13	19	2021.11	10	18	2022.11	13	21
2020.12	4	11	2021.12	5	12			

2.2.5. Analyze. According to Table 2, in 2020, the mean low temperature started at 9℃ in February, with an in rising in the next six months, peaking at 27℃ in August. From August 2020 to December, there was a dramatic decline from 27℃ to 4℃. By contrast, the mean high temperature began at 16℃ in February, followed by a stable temperature in the next month, and then grew from 16℃ to 35℃ in August 2020. After, it decreased at the end of 2020, bottoming at 11℃.

In 2021, the mean low temperature decreased to 2℃ in January and rose to 26℃ in the following six months, followed by a staying at 26℃ in August and reducing to 5℃ in December. By comparison, the mean high temperature sharply increased from 10℃ to 33℃ in the first seven months and dropped to 12℃ in the next half year. In 2022, the overall changing rate had no extraordinary transformation.

Although the overall changing rate had no extraordinary transformation in these three years, there were also many unique points. In February and March 2020, the mean high and low temperatures had no change for two months, and they also appeared in July and August of 2021 and 2022.

2.2.6. Prediction. According to Figure 3, although some data is different with different years, it also has a clear changing rule which is a form of a wave that, in each period, it has a stable maximum and minimum, such as a peak at 26℃ in mean low temperature or 36℃ in mean high temperature, so that we can use the categories of a trigonometric function.

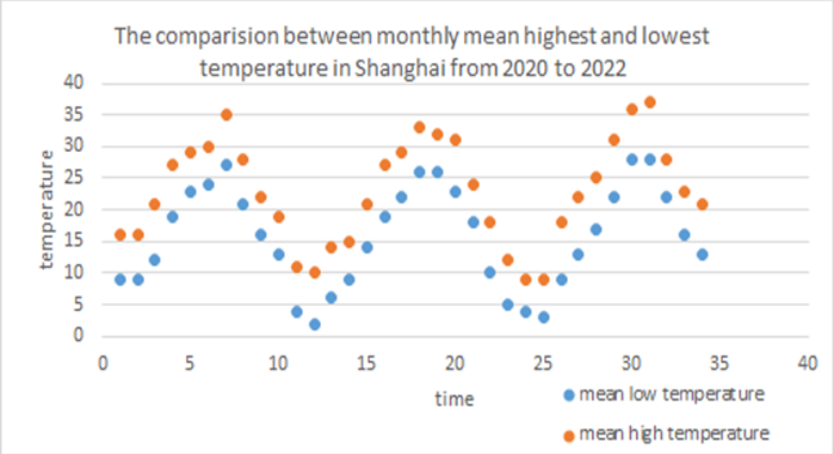

Figure 3. The comparison between the monthly mean highest and lowest temperature in Shanghai from 2020 to 2022.

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First, make the trendlines for each scatter diagram by using Excel's trendline. Then, change the years into a serial number from 0 to 34.

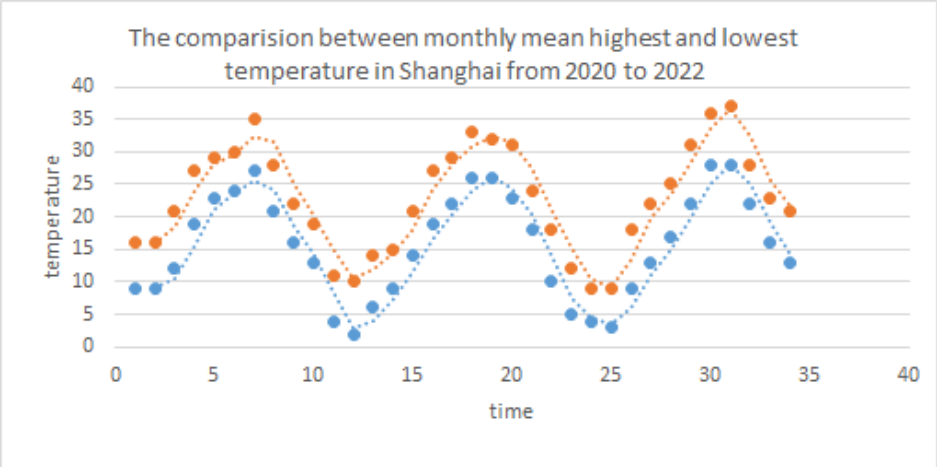

Figure 4. The trendline of comparison between the monthly mean highest and lowest temperature in Shanghai from 2020 to 2022.

As with Beijing, we cannot get the formula of the function directly by calculation; however, we can use the wave category to predict the weather in the next year. For example, it will be about 10℃ of mean high temperature and 3℃ of mean low temperature in January.

2.2.7. Guangzhou

Table 3. The monthly mean highest and lowest temperature in Guangzhou from 2020 to 2022[5].

	Guangzhou							
	low T/℃	high T/℃	2021.1	9	20	2022.1	12	19
2020.2	16	26	2021.2	14	25	2022.2	8	16
2020.3	17	24	2021.3	17	26	2022.3	17	26
2020.4	17	25	2021.4	20	28	2022.4	18	28
2020.5	24	32	2021.5	25	33	2022.5	21	29
2020.6	26	33	2021.6	25	33	2022.6	25	32
2020.7	27	35	2021.7	26	34	2022.7	26	35
2020.8	26	34	2021.8	26	34	2022.8	25	33
2020.9	25	32	2021.9	25	34	2022.9	24	34
2020.10	20	28	2021.10	20	29	2022.10	20	31
2020.11	18	27	2021.11	15	25	2022.11	18	25
2020.12	11	20	2021.12	10	21			

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2.2.8. Analyze. According to Table 3, the data's overall trend has not precisely changed compared with the other cities. However, there are also some unique points. From May to September 2021, the mean high and low temperature remain stable data, which is 33℃ to 34℃ and 25℃ to 26℃. Also, from August to September 2020, the mean high temperature increased by a small degree after rising.

2.2.9. Prediction

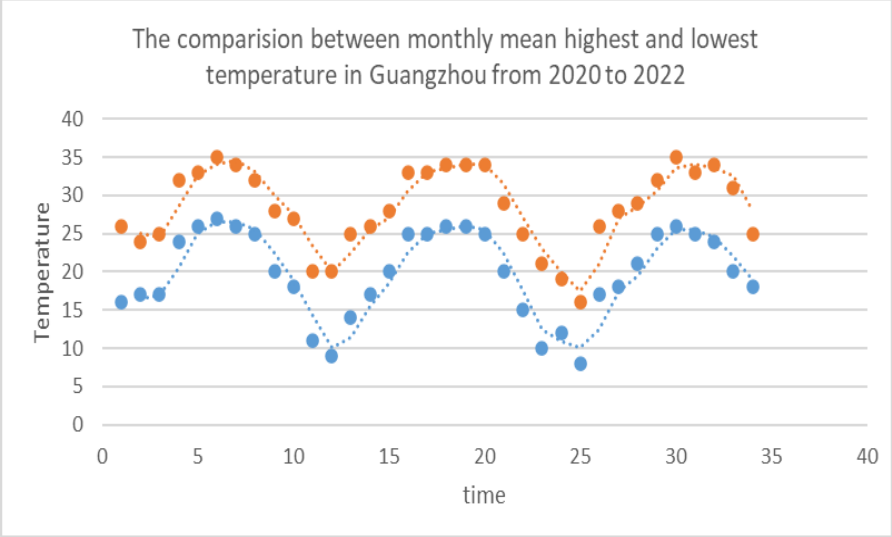

Figure 5. The comparison between the monthly mean highest and lowest temperature in Guangzhou from 2020 to 2022.

According to Figure 5, like the other two cities, in Guangzhou, the function of the graph also cannot be calculated, and the law of the wave can also be used. In 2023, the mean low and high temperature in Guangzhou will start at about 10℃ and 19℃ and peak at around 26℃ and 33℃ in July, which was followed by a decline to 10℃ and 20℃ during the following five months.

2.3. The compare and contrast of three cities' transformation of temperature

Comparing Figure 1 to Figure 4, it is clear that there were many similarities and differences between the three cities from 2020 to 2022.

2.3.1. Contrast. During these three years, the laws of change were the same, a form of a wave. For example, the highest and lowest point of mean high and low temperature in each period, which is about one year, often had a stationary temperature, like in Beijing, the highest point in mean low temperatures was 22℃ in mean low temperature and 31℃ in mean high temperature.

2.3.2. Compare. First, the temperatures of three cities in the same month were different. It was also apparent that the temperature of Guangzhou was often the highest of the three towns, which Shanghai followed, and that Beijing was the lowest except on some special dates, such as in June 2021; for example, the mean high temperature of Guangzhou in February 2020 was 26℃, but that of Shanghai was 16℃, and Beijing was 9℃.

3. Conclusion

In a nutshell, in the next year, the daily mean high and low temperature will be as similar as the temperature on the same date of the past year; also, in Beijing, Shanghai, and Guangzhou, the law of transformations of their temperature were the same. However, Guangzhou is the hottest city, and Shanghai is the coldest of these three cities.

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In the future, I hope that the trendline of these graphs can be calculated directly using the regression function. Also, the data results will be predicted precisely by using the regression function.

References

[1] Gong Jiwen, Xi Xianwu, Wang Yuejun etc., (2002) Numerical Modeling Method of Stress and Deformation -- Introduction of Numerical Simulation Software FLAC, Journal of East China University of Technology (Natural Science Edition), 25(3):220-227
[2] Li Jinxiao, 2015-10-06, Li Jinxiao: Development History of Weather Forecast, the website: http://iap.cas.cn/gb/kxcb/kpwz/202004/t20200417_5551357.html
[3] Whether 24, 2022-11-25, https://www.tianqi24.com/beijing/history.html
[4] Whether 24, 2022-11-25, https://www.tianqi24.com/shanghai/history.html
[5] Whether 24, 2022-11-25, https://www.tianqi24.com/guangzhou/history.html