# Decoding of Surface Meteorological Observation Data Files and Application Research on Climatic Data

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**Abstract** In this paper, Wuzhou City of Guangxi was taken as the research object. Through the design of a climatic data warehousing system, the decoding methods of surface meteorological data and their application in the management of climatic data were explored. Based on the parsing technology of the monthly report of surface meteorological records (A-file), the design of Wuzhou climatic data warehousing system was realized, completing the precise extraction and database construction of observational elements such as regional temperature, wind direction, and weather phenomena. Based on this system, the meteorological data in 2024 were analyzed, and the probabilistic characteristics of dominant wind direction in Wuzhou (northeast wind accounting for the largest proportion), the spatiotemporal distribution patterns of extreme temperatures (annual extreme high temperature of 37.1 ℃ in August and extreme low temperature of 1.9 ℃ in January), and the general climatic overview of Wuzhou City (annual precipitation 3.2% higher than the standard value) were revealed. The research shows that climate change has a significant impact on agricultural production and economic development in Wuzhou City, and the construction of a reasonable climatic data database is of great significance for enhancing professional meteorological service capabilities in the context of climate change. This study not only provides a scientific basis for the economic development of Wuzhou region, but also offers reference ideas for other regions to cope with regional climate adaptation planning.
**Key words** Surface meteorological observation; A-file decoding; Climatic database; Climate change
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As an important foundation of weather forecast, disaster warning, meteorological service and scientific research, surface meteorological observation data has been widely valued. China uses the standardized monthly report file of surface meteorological records (A file) to record and store it[1], which is one of the most valuable data collected by China's weather and climate monitoring network.

In the field of scientific research and meteorological services, significant progress has been made in the analysis of A file[2-7], and a variety of standardized products have been successfully produced. However, with the continuous development of the demand for professional meteorological services, these standardized products are not enough to meet the needs of the market. Different customers may have specific requirements for different aspects of data, such as time resolution, spatial resolution, observation element types, *etc.* For example, aviation meteorological services pay special attention to key parameters such as wind direction, wind speed, visibility, *etc.*, and agricultural meteorological services have high sensitivity to hourly temperature changes.

As a hub city in the Pearl River - Xijiang economic belt, Wuzhou has diversified agriculture, industry and other characteristic pillar industries. However, extreme weather events have occurred frequently in recent years, which has greatly restricted the economic development, and it is in urgent need of refined climate data to support decision-making. In this paper, Wuzhou was taken as the research object. A decoding architecture based on A file was proposed, and Wuzhou climate database system was constructed. The measured data in 2024 were taken as an analysis case to quantitatively analyze the evolution law of climate elements and its impact on economic development, so as to provide a scientific basis for the formulation of regional climate adaptation strategies.

## 1 Design of climate data warehousing system based on the A file

This program has the function of extracting the data of different observation elements such as pressure, temperature and precipitation from the A file, and inserting the extracted data into the Access database. In this paper, the message decoding of temperature, weather phenomenon and wind direction is taken as a practical operation case to provide a clear decoding example for readers. For the decoding methods of other meteorological elements, it can refer to the decoding logic described in this paper for analogical processing.

When designing the decoded message, this program mainly has the following steps. First, identify the message data block according to the demand elements and the corresponding indicator code; second, carrying out data decoding and conversion and unit conversion; third, inserting data into the Access database.

**1.1 Temperature decoding** In the A file, the temperature data

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takes "T" as the indicator code, and different characteristic values can be read according to the actual needs. In daily use, the average temperature, minimum temperature, maximum temperature and the temperature at a specific time (such as 02:00, 08:00, 14:00 and 20:00) are commonly used. In order to further study the variation characteristics of temperature in a day, it is also necessary to decode and analyze the occurrence time of minimum temperature and maximum temperature.

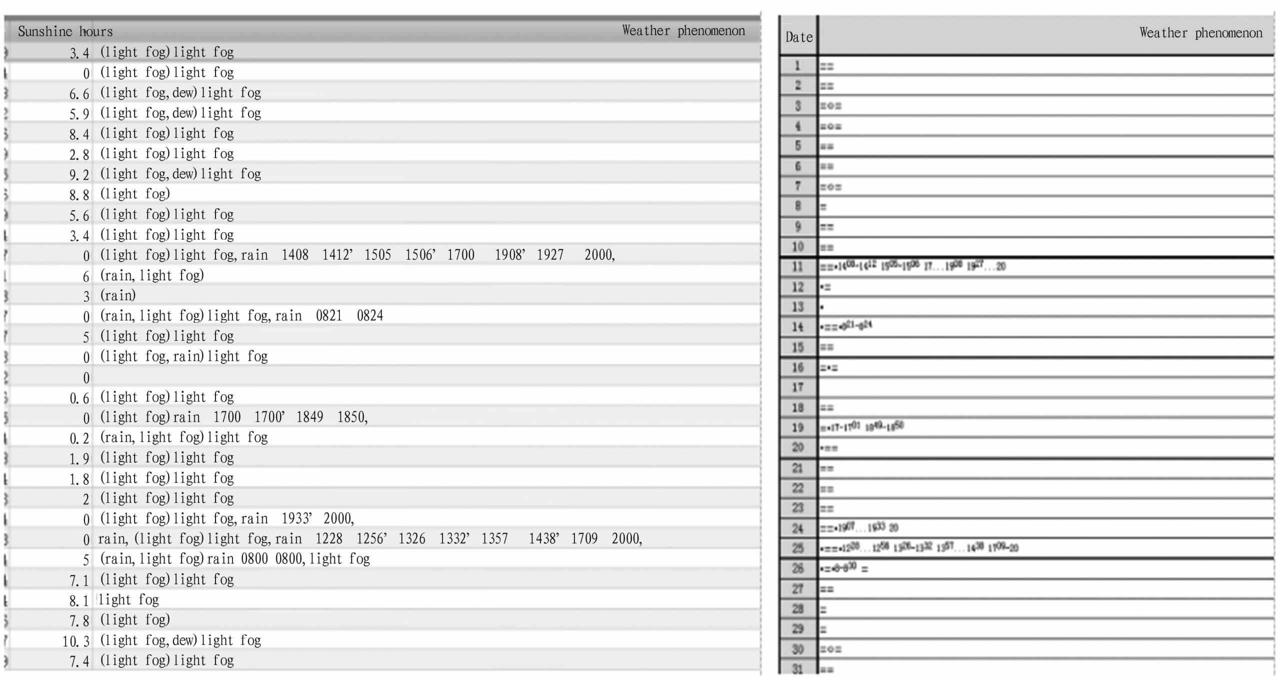
After recognizing the temperature indicator code, the program will enter the conditional statement "B", which is used to read the character string representing the temperature and complete the conversion of the character string to the actual temperature value. Then, the average temperature at four specific times is calculated to obtain the required average temperature.

In the A file, the maximum temperature and its occurrence time are clearly recorded, and the minimum temperature and its occurrence time are also clearly marked. In order to intuitively display these information, the core code in actual operation should focus on the following four key elements: maximum temperature, specific occurrence time of maximum temperature, minimum temperature, and specific occurrence time of minimum temperature.

**1.2 Weather phenomenon decoding** In the A file, weather phenomenon is identified by "W" as indicator code. In order to process these data, first, it should read the entire row of data containing weather phenomena. Then, the system function strtok is used to segment the strings representing the day and night in this row of data. Next, the segmented strings are parsed to judge and identify the weather phenomenon symbols at night and during the day. After completing this step, the weather phenomenon is decoded, and the decoded results are integrated for subsequent analysis and processing.

When judging the weather phenomenon at night and obtaining the weather phenomenon code, the custom function judge_weather is called, and the weather phenomenon code is taken as the function parameter. The function judge_weather converts the weather phenomenon code into the weather phenomenon type, and assigns a value to the weather phenomenon according to what code is passed in the process.

The observation data of weather phenomena at Wuzhou National Benchmark Climate Station in January 2020 was taken as the research object, and the monthly report of surface meteorological records showed the weather phenomenon data of that month in detail. After decoding these data from the A file, they can be written to the Access database for further analysis and processing (Fig. 1).



| Sunshine hours | Weather phenomenon |
|---|---|
| 3.4 | (light fog) light fog |
| 0 | (light fog) light fog |
| 6.6 | (light fog, dew) light fog |
| 5.9 | (light fog, dew) light fog |
| 8.4 | (light fog) light fog |
| 2.8 | (light fog) light fog |
| 9.2 | (light fog, dew) light fog |
| 8.8 | (light fog) |
| 5.6 | (light fog) light fog |
| 3.4 | (light fog) light fog |
| 0 | (light fog) light fog, rain 1408 1412' 1505 1506' 1700 1908' 1927 2000, |
| 6 | (rain, light fog) |
| 3 | (rain) |
| 0 | (rain, light fog) light fog, rain 0821 0824 |
| 5 | (light fog) light fog |
| 0 | (light fog, rain) light fog |
| 0 | |
| 0.6 | (light fog) light fog |
| 0 | (light fog) rain 1700 1700' 1849 1850, |
| 0.2 | (rain, light fog) light fog |
| 1.9 | (light fog) light fog |
| 1.8 | (light fog) light fog |
| 2 | (light fog) light fog |
| 0 | (light fog) light fog, rain 1933' 2000, |
| 0 | rain, (light fog) light fog, rain 1228 1256' 1326 1332' 1357 1438' 1709 2000, |
| 5 | (rain, light fog) rain 0800 0800, light fog |
| 7.1 | (light fog) light fog |
| 8.1 | light fog |
| 7.8 | (light fog) |
| 10.3 | (light fog, dew) light fog |
| 7.4 | (light fog) light fog |

| Date | Weather phenomenon |
|---|---|
| 1 | == |
| 2 | == |
| 3 | =○= |
| 4 | =○= |
| 5 | == |
| 6 | == |
| 7 | =○= |
| 8 | = |
| 9 | == |
| 10 | == |
| 11 | ==•1408-1412 1505-1506 17...1908 1927...20 |
| 12 | •= |
| 13 | • |
| 14 | •==•821-824 |
| 15 | == |
| 16 | =•= |
| 17 | |
| 18 | == |
| 19 | =•17-1701 1849-1850 |
| 20 | •== |
| 21 | == |
| 22 | == |
| 23 | == |
| 24 | ==•1907...1933 20 |
| 25 | •==•1220...1256 1326-1332 1357...1438 1709-20 |
| 26 | •=•8-830 = |
| 27 | == |
| 28 | = |
| 29 | = |
| 30 | =○= |
| 31 | == |

**Fig. 1 Comparison between Wuzhou (59265) database (Access) weather phenomenon (left) and monthly report of surface meteorological records (right)**

**1.3 Wind direction decoding** In the A file, the wind is identified by "F" as an indicator code. After reading the wind indicator code, the program will enter the conditional statement "N", to read the corresponding field representing the wind direction, which is string type. The string is converted to floating-point type, and the wind direction is judged through the converted value.

Through the test, the meteorological element of 2-minute average wind direction in the monthly report of ground meteorological records (A file) at Wuzhou National Benchmark Climate Station in January 2020 was consistent with the data in the decoded Access database. The decoding process involved extracting meteorological elements such as the 2-minute average wind direction and speed (unit: 0.1 m/s) from the A file and writing them into the Access database. In addition, the database also accurately recorded the wind direction and wind speed, monthly average or extreme wind speed, average wind speed, maximum wind speed, extreme wind speed and other key data values from 21:00 to next 20:00 in the month (Fig. 2).

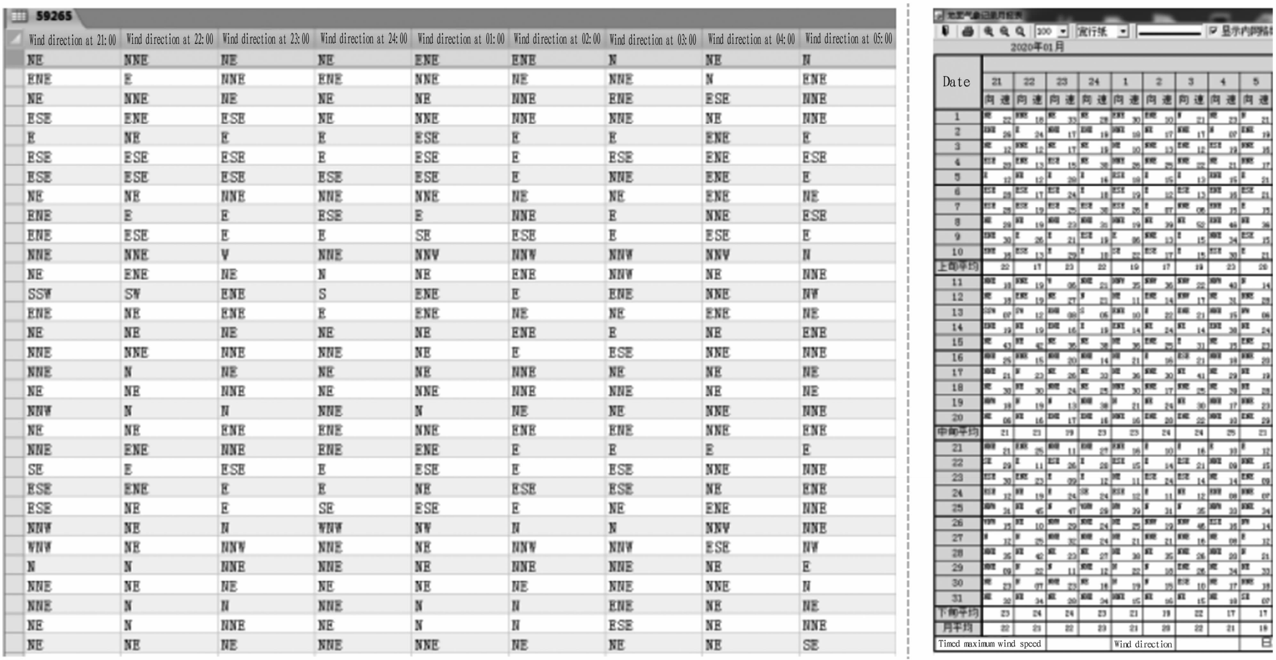



**Fig. 2 Comparison between Wuzhou (59265) database (Access) 2-minute average wind direction (left) and the monthly report of surface meteorological records (right)**

**1.4 Construction of database** The Microsoft Access database is used. A new database file is created in Microsoft Access. The required data table is created in the database, and the fields of table are designed according to the actual needs. Each field should include the field name and data type. The data table structure is designed according to the specific content contained in the A file. Table 1 shows some meteorological elements, which can be added or adjusted according to actual needs. The decoded meteorological element values are accurately filled into the corresponding field positions in the Access database (Table 1).

**Table 1 Field name and data type of meteorological elements**

| Field name | Data type | Field name | Data type | Field name | Data type |
|---|---|---|---|---|---|
| Year | Digit (integer) | Month | Digit (integer) | Day | Digit (integer) |
| Daytime rainfall | Text | Nighttime rainfall | Text | Daily rainfall | Text |
| Average temperature | Digit (single precision) | Minimum temperature | Digit (single precision) | Occurrence time of minimum temperature | Digit (double precision) |
| Maximum temperature | Digit (single precision) | Occurrence time of maximum temperature | Digit (double precision) | Temperature at 02:00 | Digit (single precision) |
| | | | …… | | |
| Wind speed at 14:00 | Digit (single precision) | Wind speed at 20:00 | Digit (single precision) | Maximum wind speed | Digit |
| Ground temperature at 02:00 | Digit | Ground temperature at 08:00 | Digit | Ground temperature at 14:00 | Digit |
| Ground temperature at 20:00 | Digit | Maximum ground temperature | Digit | Minimum ground temperature | Digit |
| Sunshine hours | Digit | Weather phenomenon | Text | | |

**1.5 Operation interface of Wuzhou climate data warehousing system based on the A file** According to the above ideas, the design of "Wuzhou climate data warehousing system based on the A file" was completed, which can import the meteorological observation data of Mengshan (59058), Tengxian (59256), Wuzhou (59265), Cangwu (59266) and Cenxi (59454), five national manned meteorological stations under the jurisdiction of Wuzhou, into the Access database, and realize the construction of regional climate database. The system interface of the program was shown in Fig. 3. Through the GUI interactive interface, the functions of site selection, file selection and data warehousing can be realized.

## 2 Application analysis of climate data

The establishment of "Wuzhou climate data warehousing system based on A-file decoding" has realized the efficient integration and standardized management of multi-element meteorological data, and laid a data foundation for in-depth analysis of regional climate characteristics. In this part, quantitative analysis was conducted based on the above integration results to explore the distribution of dominant wind direction and the time distribution of extreme temperature in Wuzhou in 2024, so as to reveal the characteristics of climate anomalies in Wuzhou.

**2.1 Temporal and spatial characteristics of dominant wind direction** Taking the wind direction and its frequency in Wuzhou in 2024 as an example, the daily wind direction and its frequency data recorded by Wuzhou National Benchmark Climate Station in that year were displayed. The statistics were based on the 2-minute average wind direction, and the specific data were shown in Fig. 4.

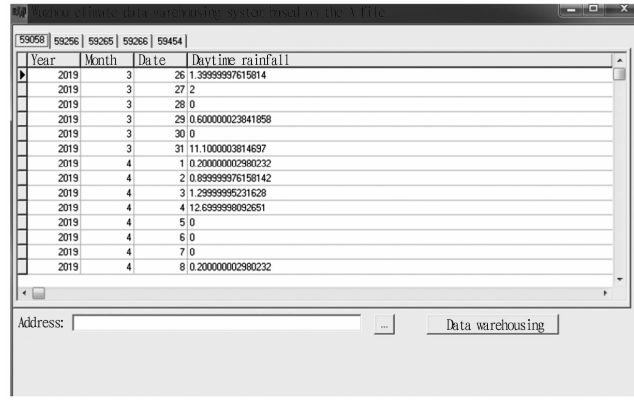
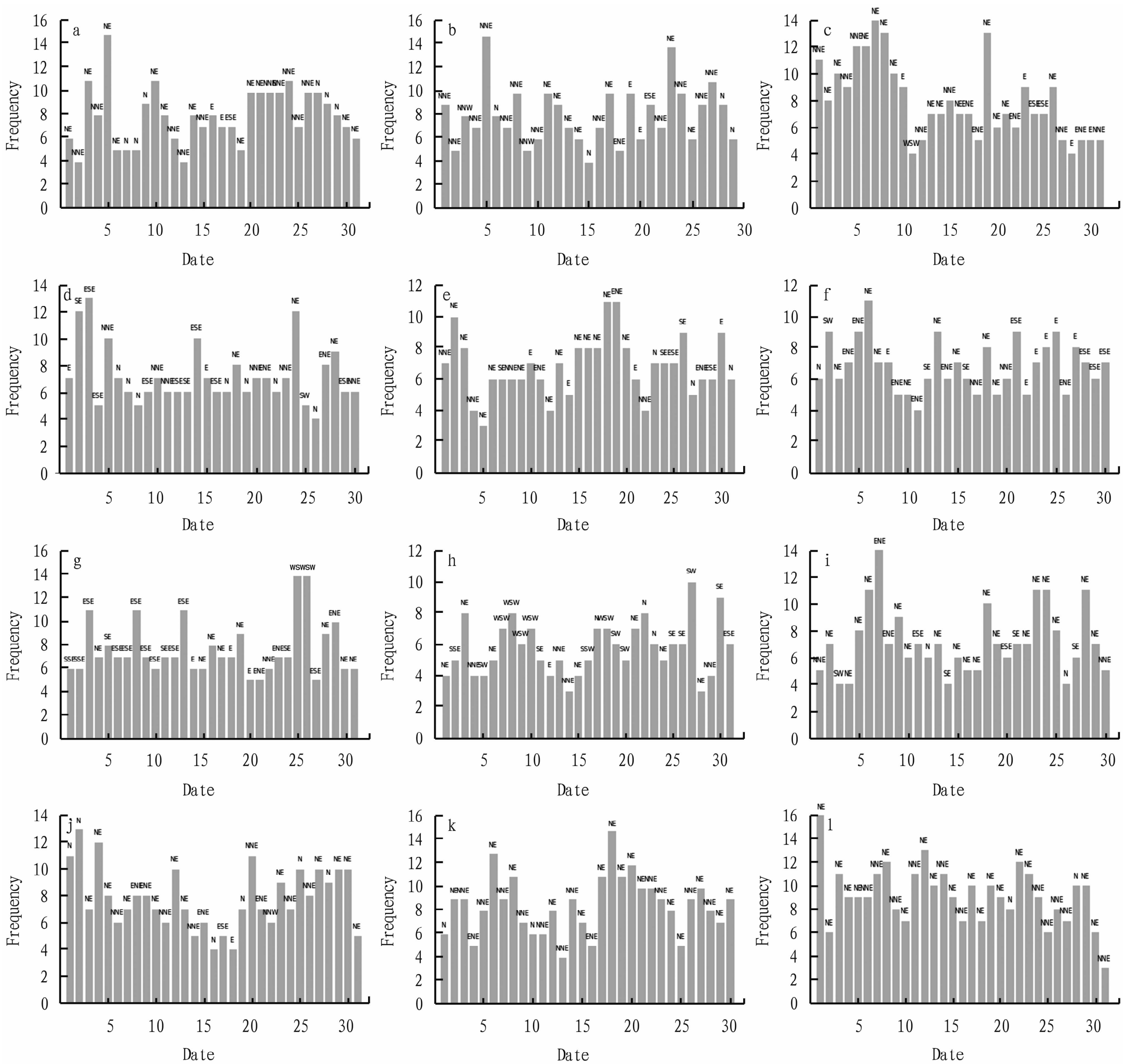



**Fig. 3 Wuzhou climate data warehousing system based on the A file**




Note: a. January; b. February; c. March; d. April; e. May; f. June; g. July; h. August; i. September; j. October; k. November; l. December.

**Fig. 4 Daily dominant wind direction from January to December 2024**

The maximum wind speed, extreme wind speed and their occurrence time in 2024 were shown as Table 2.

**Table 2 Maximum wind speed, extreme wind speed and their occurrence time in 2024**

| Month | Maximum wind speed (0.1 m/s) | | | Extreme wind speed (0.1 m/s) | | |
|---|---|---|---|---|---|---|
| | Wind speed | Wind direction | Date | Wind speed | Wind direction | Date |
| 1 | 78 | NE | 22 | 137 | NE | 22 |
| 2 | 60 | NE | 22 | 105 | NNE | 22 |
| 3 | 65 | NE | 6 | 113 | NNE | 6 |
| 4 | 149 | W | 28 | 266 | W | 28 |
| 5 | 99 | WNW | 6 | 174 | W | 6 |
| 6 | 115 | SW | 16 | 203 | SSW | 16 |
| 7 | 112 | NE | 14 | 202 | ENE | 21 |
| 8 | 106 | SSW | 12 | 227 | S | 12 |
| 9 | 156 | E | 3 | 314 | E | 3 |
| 10 | 80 | N | 22 | 128 | N | 22 |
| 11 | 54 | NE | 18 | 111 | ENE | 18 |
| 12 | 51 | N | 14 | 101 | NE | 14 |

From Fig. 4, it can intuitively understand the occurrence frequency and change trend of different wind directions in Wuzhou in 2024. The dominant wind direction was NE in January, NNE in February, NE in March, NE in April, NE in May, NE in June, ESE in July, NE in August, NE in September, NE in October, NE in November and NE in December. The annual dominant wind direction was northeast wind (NE). It can be seen from Table 2 that the maximum wind speed in 2024 was 15.6 m/s, which occurred on September 3, and the extreme wind speed was 31.4 m/s, which occurred on September 3. This had important reference value for the fields of climate analysis, urban planning, low-altitude economy and environmental protection.

**2.2 Analysis of extreme temperature period** Temperature change has a significant impact on agricultural economy. The daily minimum temperature and its occurrence time in 2024 were shown as Fig. 5.

The monthly minimum temperature, their occurrence date and time in 2024 were shown as Table 3.

**Table 3 Monthly minimum temperature, their occurrence date and time in 2024**

| Date | Minimum temperature//℃ | Occurrence time | Date | Minimum temperature//℃ | Occurrence time |
|---|---|---|---|---|---|
| 01 – 23 | 1.9 | 06:42 | 07 – 14 | 24.3 | 18:24 |
| 02 – 25 | 3.5 | 05:43 | 08 – 22 | 23.7 | 04:16 |
| 03 – 01 | 6.4 | 06:30 | 09 – 24 | 19.9 | 06:46 |
| 04 – 07 | 16.5 | 10:53 | 10 – 24 | 16.1 | 06:57 |
| 05 – 02 | 18.6 | 10:35 | 11 – 29 | 10.5 | 05:57 |
| 06 – 06 | 21.5 | 06:06 | 12 – 20 | 5.7 | 06:17 |

According to the analysis of the above statistical results, the monthly minimum temperature in Wuzhou mainly occurred from the 20$^{th}$ to the 25$^{th}$, mostly in the period from 04:00 to 06:00, of which the extreme low temperature (1.9 ℃) occurred on January 23, 2024.

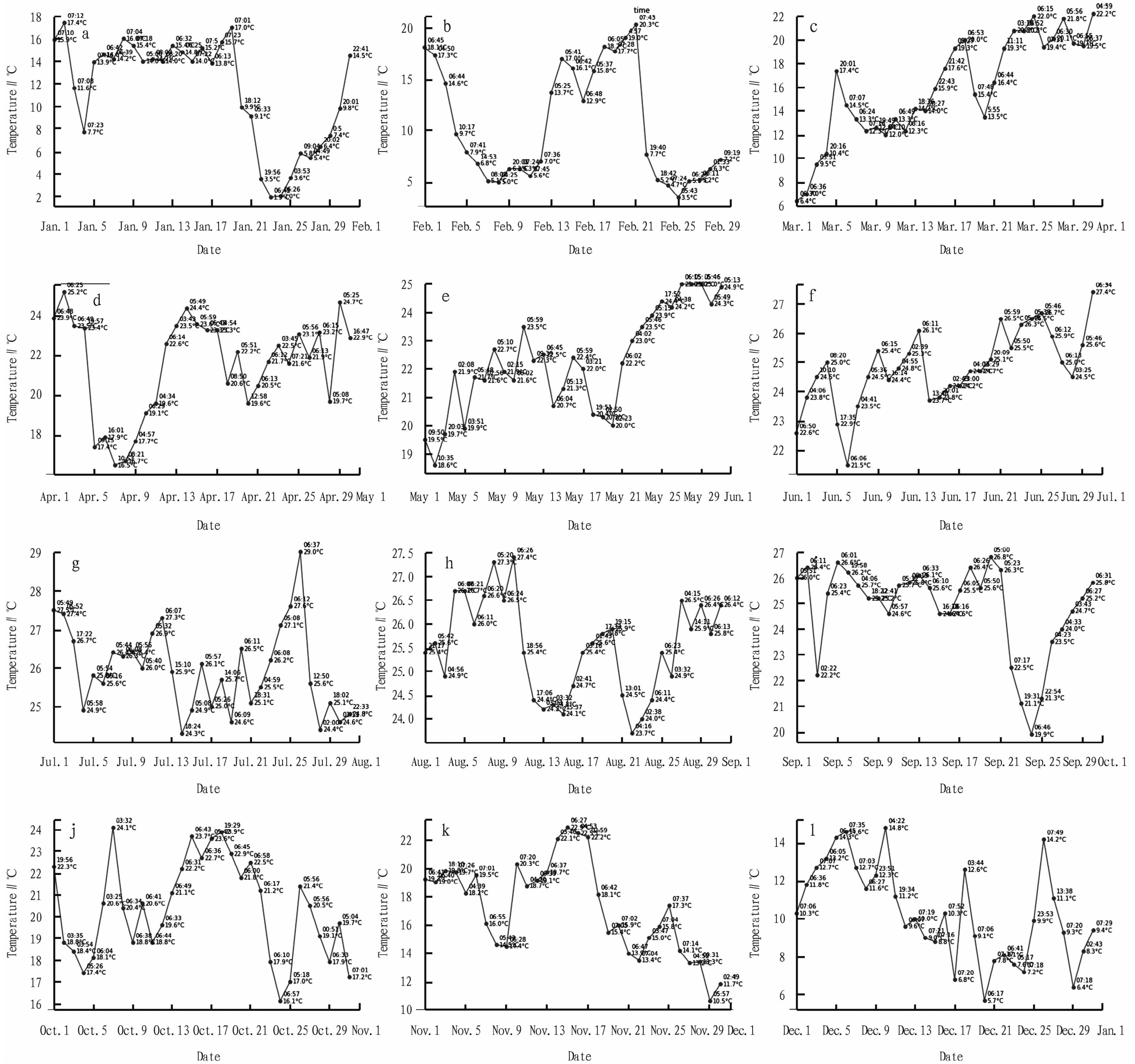
The monthly maximum temperature, their occurrence date and time in 2024 were shown as Table 4.

**Table 4 Monthly maximum temperature, their occurrence date and time in 2024**

| Date | Maximum temperature//℃ | Occurrence time | Date | Maximum temperature//℃ | Occurrence time |
|---|---|---|---|---|---|
| 01 – 19 | 26.0 | 15:05 | 07 – 26 | 36.8 | 15:38 |
| 02 – 20 | 28.8 | 12:53 | 08 – 09 | 37.1 | 16:30 |
| 03 – 25 | 31.1 | 15:25 | 09 – 02 | 36.5 | 16:25 |
| 04 – 02 | 33.0 | 13:33 | 10 – 14 | 32.3 | 16:08 |
| 05 – 24 | 33.2 | 15:25 | 11 – 29 | 31.3 | 14:32 |
| 06 – 23 | 34.7 | 15:12 | 12 – 04 | 25.9 | 15:41 |

According to the analysis of the above statistical results, the monthly maximum temperature in Wuzhou mainly occurred from the 23$^{rd}$ to the 26$^{th}$, mostly in the period from 15:00 to 16:30, of which the extreme low temperature (37.1 ℃) occurred on August 9, 2024.

According to the analysis results, it is necessary to pay attention to the possible impact of extreme temperature during this period on winter crops in actual agricultural production.




Note: a. January; b. February; c. March; d. April; e. May; f. June; g. July; h. August; i. September; j. October; k. November; l. December.

**Fig. 5 Daily minimum temperature and its occurrence time in each month of 2024**

**2.3 Overview of climate in Wuzhou in 2024** The annual average temperature in Wuzhou in 2024 was 22.3 ℃, which was 0.8 ℃ higher than the standard climate value (21.5 ℃). The annual extreme maximum temperature was 37.1 ℃, which occurred on August 9. The annual extreme minimum temperature was 1.9 ℃, which occurred on January 23. The annual precipitation was 1 530.6 mm, 48.1 mm more than the standard climate value (1 482.5 mm). The annual sunshine duration was 1 810.6 h, 94.4 h more than the standard climate value (1 716.2 h). The monthly average temperature in April was 24.2 ℃, which was 2.3 ℃ higher than the average value of the same period over the years (21.9 ℃), and was the largest value in the same period in history. The total monthly precipitation in April was 347.5 mm, 190.4 mm more than the average value (157.1 mm) over the same period over the years, which was the largest value in the same period in history. The total monthly precipitation in December was 0.6 mm, 38.4 mm less than the average value (39.0 mm) of the same period over the years, which was the second lowest value in the same period in history. During the year, there were 10 gales in Wuzhou City, and the number of gales increased compared with previous years. The daily average temperature in winter and spring was lower than 12.0 ℃ for many times, which had adverse effects on the safe overwintering of winter crops, aquaculture, poultry and livestock and spring sowing. Due to the joint influence of high-altitude trough, shear line and cold air or the influence of typhoon, there were two rainstorm weather processes in the year. Affected by the subtropical high, the high temperature weather with the maximum

(To page 25)

temperature and annual average maximum temperature were the main positive factors, while annual precipitation, annual average relative humidity and annual average wind speed were negative contributing factors. Principal component 2 mainly reflects the positive contribution of annual precipitation to UHII. In principal component 3, annual average wind speed dominated. In conclusion, temperature was the main influencing factor of UHII in Jining City.

**Table 4 Load matrix of principal components**

| Factor | Principal component 1 | Principal component 2 | Principal component 3 |
|---|---|---|---|
| Annual average temperature | 0.609 | 0.286 | 0.049 |
| Annual average maximum temperature | 0.621 | 0.160 | 0.081 |
| Annual precipitation | -0.069 | 0.834 | -0.066 |
| Annual average relative humidity | -0.450 | 0.426 | -0.220 |
| Annual average wind speed | -0.190 | 0.126 | 0.969 |

## 4 Conclusions

Based on meteorological observation data, methods such as MK mutation test, correlation test and PCA were adopted to study the variation law of UHII and analyze the influences of five meteorological elements on UHII in Jining City. It is concluded that from 1970 to 2024, the UHII in Jining City generally increased at a rate of 0.1 ℃/10 a. On the interannual scale, the correlation between temperature and UHII was most significantly positive. On the seasonal scale, wind speed showed a strong negative correlation with the variation of UHII. From PCA, it is found that temperature had a significant positive impact on the increase of UHII in Jining City.

## References

[1] LI Y, ZHOU DC, YAN ZM. Spatiotemporal variations in atmospheric urban heat island effects and their driving factors in 84 major Chinese cities [J]. Environmental Science, 2021, 42(10): 5037-5045.
[2] SUN YL, WANG HF, LI G, *et al.* Study and influence factors of heat island spatio-temporal changes in Beijing from 2000 to 2019[J]. Environmental Ecology, 2020, 2(8): 43-50.
[3] XU R, DONG JH, WANG FL. Review on the influencing factors, methods and countermeasures of urban heat island effect[J]. Journal of Zhongkai University of Agriculture and Engineering, 2020, 33(4): 65-70.
[4] MENG FC, HUANG H, GUO J, *et al.* Analysis of fine-scale spatial and temporal characteristics of Tianjin urban heat island intensity[J]. Ecology and Environmental Sciences, 2020, 29(9): 1822-1829.
[5] TIAN L, LU J, LI Y, *et al.* Temporal characteristics of urban heat island and its response to heat waves and energy consumption in the mountainous Chongqing, China [J]. Sustainable Cities and Society, 2021, 75: 103260.
[6] XIONG Y, ZHANG F. Thermal environment effects of urban human settlements and influencing factors based on multi-source data: A case study of Changsha City[J]. Acta Geographica Sinica, 2020, 75(11): 2443-2458.
[7] HU NL, REN ZB, DONG YL, *et al.* Spatio-temporal evolution of heat island effect and its driving factors in urban agglomerations of China[J]. Scientia Geographica Sinica, 2022, 42(9): 1534-1545.
[8] ZHANG JZ, LIANG YN, WANG J, *et al.* Temporal and spatial characteristics of urban heat island effect and its influencing factors in Beijing from 1981 to 2020[J]. Transactions of Atmospheric Sciences, 2024(4): 581-591.
[9] FENG XG, SA LW, XU WD, *et al.* Analysis of the characteristics and causes of the evolution of the urban heat island amidist the of rapid urbanization[J]. Journal of Xi'an University of Architecture & Technology (Natural Science Edition), 2015, 47(4): 565-570.

(From page 21)

temperature ≥ 35.0 ℃ for 3 consecutive days or more occurred repeatedly in summer, which brought inconvenience to people's work and life. The average temperature was higher in 2024, with more precipitation and sunshine hours.

## 3 Conclusions

By constructing a climate data management program, this paper realized the efficient management of Wuzhou climate data, and provided a new idea and method for the collection, integration and utilization of climate data. At the same time, through a practical application, this paper systematically analyzed the climate overview of Wuzhou City in 2024 and its impact on the economy, revealed the specific performance and potential threat of climate change in the region, and promoted the application of climate data in decision support, disaster prevention, resource planning and other fields.

In the future, with the continuous progress of technology and the continuous accumulation of data, it will lay a solid foundation for achieving the goals of more green, low-carbon and sustainable development by deepening the application research of climate data. Finally, it is expected to stimulate more in-depth discussion on the interaction between climate change and local economic development, and jointly build a better future of harmonious coexistence between human and nature.

## References

[1] China Meteorological Administration. Format of surface meteorological observation data files and record books[M]. Beijing: Meteorological Publishing House, 2005.
[2] GUAN JY. Ground meteorological information data processing system [J]. Journal of Guangxi Meteorology, 2005, 26(A02): 53-56.
[3] PENG JL, LI F, LU Y, *et al.* Using VB6.0 programming to extract elements from A file and generate meteorological service summary table in Excel format[J]. Desert and Oasis Meteorology, 2009,3(S1): 80-82.
[4] HUANG Z, QIU PZ, TAN F. Research and implementation of precipitation timesharing accounting key technologies for regional automatic station [J]. Journal of Meteorological Research and Application, 2019, 40(2): 86-89.
[5] JIANG LZ, FU YX, XU YH. Development and application of the regional automatic station message-handling system of municipal level[J]. Journal of Meteorological Research and Application, 2010, 31(1): 77-79.
[6] CHEN B, CHEN K. Design and application of meteorological data database in mesoscale encryption station[J]. Computer Knowledge and Technology, 2011, 7(31): 7572-7573, 7578.
[7] QUAN WJ, ZHAO Y, LIAN LM. Data processing system of the medium-scale automatic observatory[J]. Journal of Guangxi Meteorology, 2006, 27(4): 54-56.