Evaluation of Tourism Climate Resources in Taishan Scenic Spot

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Abstract. Climate resources is a very important resource affecting tourism, is the main reference factor for people to go to tourist attractions. The routine evaluation of climate comfort index, including temperature and humidity index, cold index, clothing index, comprehensive comfort index, and climate tourism climate index, establish the linear regression equation and the tourism climate index and linear regression equation, evaluate the tourism climate resources of mount tai scenic spot in Shandong province. The analysis results show that the suitable period of Taishan is March to November, among which April to October is the best suitable travel period, Taishan scenic area in April and October, May to September tourism comfort is better, and January, February and December are not suitable for travel.

1 Introduction

Climate is a very important objective factor affecting people's tourism and travel activities.Research evaluation of climate comfort has a research history for nearly hundreds of years. In the early stage, the direct results measured by instruments were usually used as the basis for evaluation. In the early 1920s, Houghtonet al. conducted experiments with two variables of temperature and humidity, setting a precedent for evaluating climate resource comfort with models. Qian Miaofen and other established a "degree of pleasant weather" model through the analysis of various meteorological factors, and Li Wanzhen and others drew the human comfort curve.This paper adopts the combination of tourism climate index method of Canadian scholar Miksky (hereinafter referred to as Mishi) and climate comfort comprehensive index, which can comprehensively evaluate the comfort of tourism climate resources in Taishan scenic spot. The analysis of mount tai scenic spot obtain better social benefits and economic benefits has very important practical significance. At the same time, it is also expected to develop new research directions and angles of for tourism climate comfort evaluation research.

Research evaluation of climate comfort has a research history for nearly hundreds of years. In the early stage, the direct results measured by instruments were usually used as the basis for evaluation. In the early 1920s, Houghton[35] et al. conducted experiments with two variables of temperature and humidity, setting a precedent for evaluating climate resource comfort with models. Thorn proposed discomfort index, and Masterson et al. proposed Humiture using temperature and pressure to evaluate comfort with vapor pressure. The of Wang Yuanfei and others, Yang Chengfang , Ma Lijun and others [38-42] and Wang Huafanghave successively adopted the temperature and humidity index, wind efficiency index, effective temperature index and other methods to explore China's climate comfort. Qian Miaofen and other [46]established a "degree of pleasant weather" model through the analysis of various meteorological factors, and Li Wanzhen and others drew the human comfort curve, you did not do it according to the labeling method. This paper adopts the combination of tourism climate index method of Canadian scholar Miksky (hereinafter referred to as Mishi) and climate comfort comprehensive index, which can comprehensively evaluate the comfort of tourism climate resources in Taishan scenic spot[20]. This study reviewed a large number of research literature and found no studies in this regard. Therefore, the analysis of mount tai scenic spot tourism climate resource characteristics, evaluate the climate comfort and suitable tourism time, to provide visitors with appropriate travel travel time specific elements provide reference, the sustainable development of taishan scenic spot tourism to provide certain theoretical scientific support, obtain better social benefits and economic benefits has very important practical significance. At the same time, it is also expected to develop new research directions and angles of for domestic tourism climate comfort evaluation research

2 Data sources and study methods

2.1. Sources of date

In order to obtain the suitable climate and meteorological conditions of Taishan scenic area, In this study, the relevant data of Taishan Meteorological Station from 1955 to 2021 and the ground climate data set of China Meteorological Science Data Network (http://data.cma.cn/) were selected, With the compiled climate data provided by Tai'an City Meteorological Bureau from 1071 to 2021, It can be calculated as the monthly average highest temperature, average lowest temperature and average temperature from 1955 to 2021

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to reflect the overall representative data of meteorological factors such as temperature and precipitation from 1955 to 2021 to facilitate the further one-step sorting and analysis [1].

2.2. Research technique

2.2.1 Four exponential models

This paper adopts the monthly average algorithm drawing reflects the taishan scenic spot temperature, precipitation changes, using temperature and humidity index, wind chill index, clothing index and climate comfort index the fourclimate comfort evaluation index, combined with the meter's tourism climate index of temperature, precipitation, humidity, wind speed, sunshineand other meteorological factors comprehensive analysis of mount tai scenic area climate comfort [2].

Humidity-temperature index（K_{TH}）See formula (1):

$$K_{TH}=(1.8t+32)-0.55(1-H)\times(1.8t-26) \quad (1)$$

The t is temperature in unit (℃); H is relative humidity in unit (%) [3]. the swimming duration temperature and humidity index is calculated and the evaluation standard is shown in Figure 1.

Wind chill index (K_{WC}) is calculated as as described in formula (2):

$$K_{WC}=-(10\sqrt{V}+10.45-V)\times(33-t)+8.55\times S \quad (2)$$

The "t" is temperature, unit: (℃); "V" is average wind speed, unit: (m/s) [4]. "S" is sunshine hours, unit: (h / d) calculates suitable travel wind chill index and the evaluation standard is shown in Figure 1.

Clothing index (K_{CL}) is calculated as described in formula (3):

$$K_{WC}=-(10\sqrt{V}+10.45-V)\times(33-t)+8.55\times S \quad (3)$$

The "t" is temperature, in unit: (℃);"H" is 75% of human metabolic rate, in unit: (W / m²); "a" is the human absorption of solar radiation, "R" is solar radiation received by vertical sunlight per unit time on land, in unit (W/m²);"α" is solar height Angle, in unit (°); "v" is average wind speed, in unit: (m/s) [5]. The fitness clothing index was calculated and the evaluation criteria were shown in Figure 1.

Humidity-temperature index			Wind-chill index			Clothing index		
Range	Human feeling	Out line	Range	Human feeling	Outline	Range	Human feeling	Outli ne
<40	Extremely uncomfortable	e	<-1 000	Cold wind	e	>25	Down or fur coat	e
40～45	Uncomfortable	d	-800～-1 000	Cold air blast	d	1.8-2.5	Easy clothes and a solid coat	d
45～55	Less comfortable	c	-600～-800	A little cold wind	c	1.5-1.8	Commonly used clothing in winter	c
55～60	Comfortable	b	-300～-600	Cool breeze	b	1.3-1.5	Casual clothes	b
60～65	Very comfortable	A	-200～-300	Comfortable wind	A	0.7-1.3	Shirts	A
65～70	comfortable	B	-50～-200	Warm braw	B	0.5-0.7	Light summer clothes	B
70～75	Hot and comfortable	C	80～-50	Not obvious wind	C	0.3-0.5	Short-sleeved cardigan	C
75～80	Uncomfortable	D	160～80	Feels hot	D	0.1-0.3	Tropical single clothes	D
>80	Very hot and extremely uncomfortable	E	>160	Feels uncomfortable	E	<0.1	Mini skirt	E

Fig.1. Classification criteria of temperature and humidity index, wind chill index and dressing index [Self-drawn]

According to the scores of temperature and humidity index, wind efficiency index and garment index, FAHP (Fuzzy analytic hierarchy process) is used to process the empowerment data of each index model. KCC see formula (4) for calculation [6].

$$KCC=0.6\times KTH+0.3\times KWC+0.1\times KCL \quad (4)$$

The climate comfort comprehensive index was analyzed and compared, and the evaluation criteria are shown in Table 1.

Table 1. Climate Comfort Composite Index Evaluation Standards

Evaluation criterion	Money worth of the piontes
$7 < K_{CC} \leq 9$ (The human body feels extremely comfortable)	15
$6 < K_{CC} \leq 7$ (The human body feels comfortable)	12
$5 < K_{CC} \leq 6$ (The human body feels more comfortable)	9
$3 < K_{CC} \leq 5$ (The human body feels less comfortable)	6
$1 \leq K_{CC} \leq 3$ (The human body feels uncomfortable)	3

2.2.2 Tourism Climate Index, TCI

Combined with 7 meteorological factors, regional average maximum temperature (℃), monthly average temperature (℃) monthly minimum relative humidity (%), monthly average relative humidity (%), precipitation (mm), sunshine hours (h), and average wind speed (m/s). The calculation formula is shown in formula (5):

$$TCI=2\times(4CID+CIA+2R+2S+W) \quad (5)$$

In the formula, CID is daytime comfort, composed of average maximum air temperature (℃) and monthly minimum relative humidity (%); CIA is average daily comfort, composed of monthly average air temperature (℃) and monthly average relative humidity (%); R is precipitation (mm); S is sunshine hours (h); W is average wind speed (m/s) [7]. Compared with the widely applied climate comfort analysis indicators in China, the climate index method can not only give a relatively stable and comprehensive evaluation results, but also consider more relevant comfort indicators to make the evaluation results more comprehensive and perfect. More importantly, the study of the index on the influence of meteorological factors on human comfort level gives different weights to different factors to achieve the quantitative comparison of different tourism climate indexes, and provides a basis for the study of the superiority of tourism climate resources[8]. Mishi divides tourism climate comfort into four levels, as shown in Table 2.

Table 2. Climate comfort of meter tourism

Evaluation criterion	Climate comfort
TCL<40	Uncouth
40≤TCL<60	Acceptable
60≤TCL<80	Comfort and very comfortable
TCL≥80	Very comfortable

3 Results and analysis

3.1 Climate analysis of the Taishan area

3.1.1 Atmospheric temperature

In 1955-2021, taishan weather station monthly average highest temperature, monthly average minimum temperature and monthly average temperature change law consistent, are inverted U fold line distribution (Figure 2), are single peak curve [9].The average July maximum temperature is 22.3℃, and the average minimum temperature is 16.5℃. The average maximum temperature in January is -5.4℃, the average lowest temperature is -10.6℃, the average temperature in May to September is above 10℃, the lowest temperature is above zero in April to October, and the average temperature in January-March and November to December is below 0℃ and 0℃.Therefore, from the perspective of temperature, May to September is the most suitable time for tourist climbing in the year, from April to October is more suitable for tourists to visit Taishan scenic area, from January to March and between November and December, the temperature is low and cold, there may be snow and ice weather when climbing, the mountain road is easy to ice, it is not suitable for travel [10].

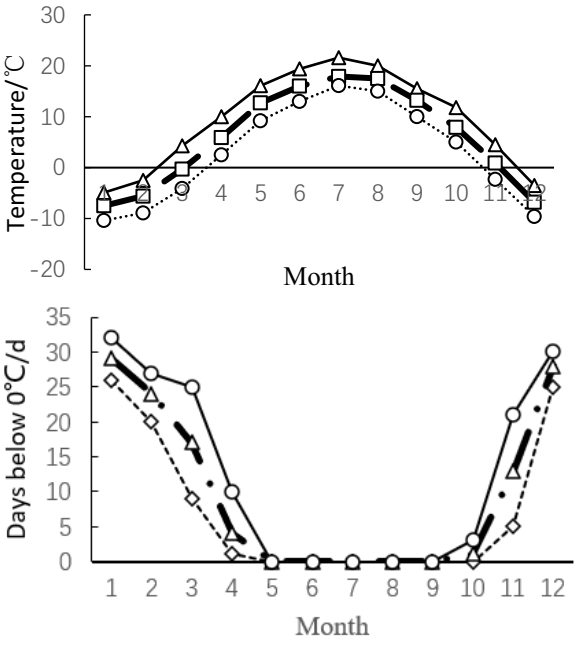

Fig. 2. The average maximum temperature, average temperature and average minimum temperature and The monthly variations of days for daily maximum temperature , daily average temperature and daily minimum temperature in Taishan from 1955 to 2021

3.1.2 Precipitation

The average annual precipitation from 1955 to 2021 was 1042.7 mm. May-June precipitation decreased, June to July precipitation increased significantly, July to October precipitation decreased monthly, July to September precipitation was more than 50mm, more precipitation.

The precipitation law of the whole year is relatively stable, with obvious monsoon climate characteristics. The precipitation rises sharply before and after the rainy season, and the precipitation in the rest of the months is less and less radiation. In July, it is prone to heavy rain, which is not conducive to travel safety. The number of precipitation days from 3 to November is greater than or equal to 5 days (Figure 5), only the precipitation days from July to September exceed 10 days, the number of precipitation days (heavy rain days) greater than or equal to 25mm is less than 5 days, and the number of precipitation days of 25mm (heavy rain days) greater than 0 is more than 0 or less than 5 days. And July-September precipitation days more than or equal to 10mm (moderate rain days). In terms of precipitation, the precipitation from January to April and October to December is less, the total precipitation is less than 50mm, the number of precipitation days is around 5 days, and the precipitation is relatively small, which is more suitable for mountain climbing tourism in Taishan scenic spot [11].

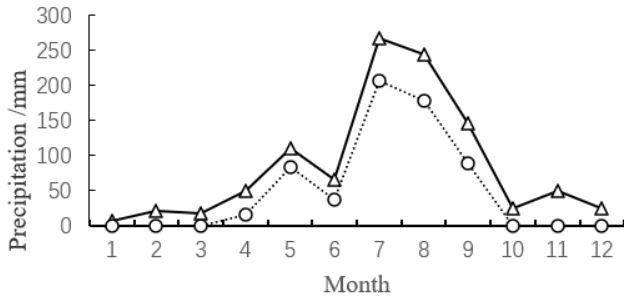

Fig.3. The monthly variations for mean total precipitation amount, precipitation amount (≥10 mm) and precipitation amount (≥25 mm) in Taishan mountain from 1955 to 2021

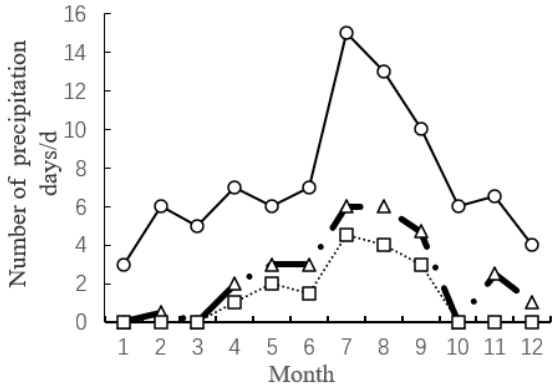

Fig. 4. The monthly variations for mean total precipitation days, precipitation (≥10 mm) days and precipitation (≥25 mm) days in Taishan mountain from 1955 to 2021

3.2 Taishan climate Comfort analysis

The monthly average value of the three evaluation model indexes is shown in Figure 4. The local temperature and humidity index, wind efficiency index and clothing index are analyzed by using the local temperature and humidity index and the daily and monthly data of Taishan scenic spot over the years to obtain the comprehensive climate comfort index (Figure 5).

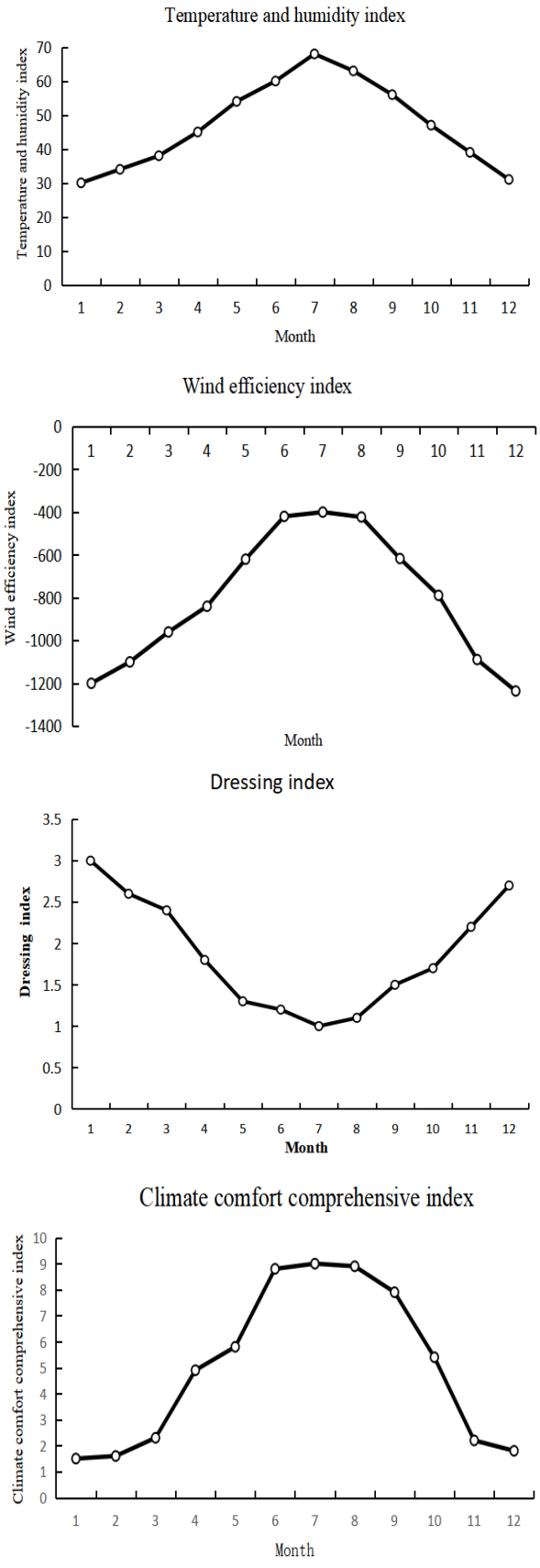

Fig.5 Taishan monthly temperature and humidity index, wind efficiency index, clothing index and climate comfort comprehensive index

The linear regression equation was obtained by analyzing the monthly mean of 1955-2021 and 1955-2021 by SPSS software (Table 3). As can be seen from Table 3, the significance level below 0.05, through the significance test, there is a significant correlation between the climate comprehensive comfort index and monthly average temperature, goodness of fit R^2=0.953 close to 1, almost perfect, according to the regression analysis, the climate comprehensive comfort index and monthly average temperature between the following linear equation (6):

$$Y=0.298X+3.164 \quad (6)$$

In the formula, X represents the average temperature and Y represents the comprehensive climate comfort index.

Using the calculation method of the tourism climate index, the monthly mean of the tourism climate index of 1955-2021 in Taishan Scenic area can be obtained. The regression equation between the average monthly tourism climate index and the average monthly temperature of 1955-2021 can also be obtained through SPSS software (Table 4). As can be seen from Table 4, the significance level is below 0.05, and there is a significant correlation between the tourism climate index and monthly average temperature after passing the significance test. According to the regression analysis results, the following linear equation shows between the tourism climate index and monthly average temperature. (7):

$$Y=0.525X+60.196 \quad (7)$$

In the formula, X represents the monthly average temperature, and Y represents the tourism climate index.According to the evaluation standard of rice tourism climate index, the average monthly climate temperature is greater than or equal to-0.37℃, and the climate comfort level is better. Therefore, Figure 1 shows that the average monthly climate temperature is in this range from March to November. According to the evaluation standard of the comprehensive climate comfort index, the monthly average temperature is between 3.49-11.12℃, and the climate comfort level is good. According to Figure 1, the monthly average temperature is in this range from April to October. The reference of the linear regression equation of the two models concludes that April-October is the best travel period of Mount Tai.

Table 3. Climate Comprehensive Comfort Index and monthly average temperature regression equation

	Regression coefficient	T value	Conspicuousness
Constant	3.164	13.102	0.000***
X	0.298	14.262	0.000***

Table 4. Tourism climate index and monthly average temperature regression equation

	Regression coefficient	T value	Conspicuousness
Constant	60.196	59.975	0.000***
X	0.525	4.513	0.000***

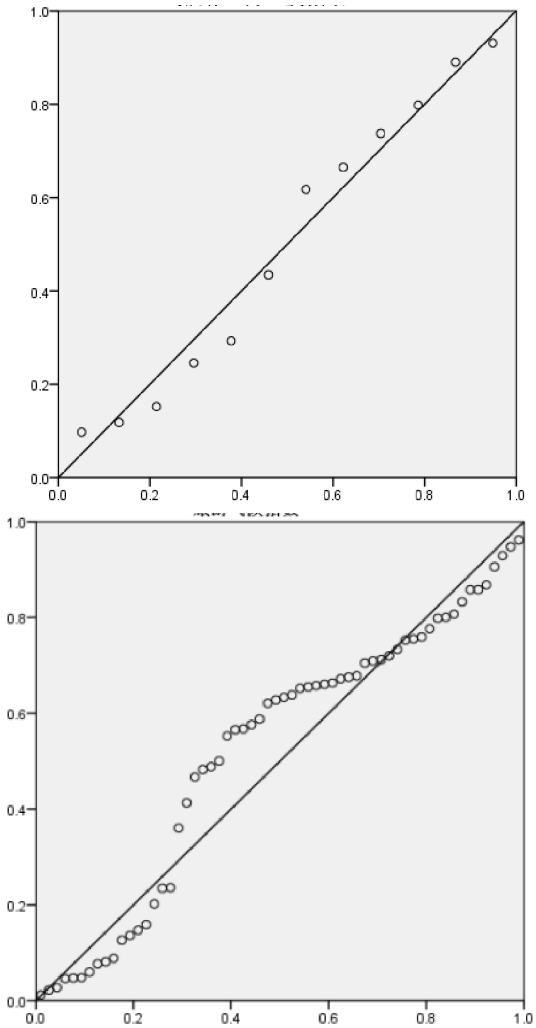

Fig.6. Regression curve of comprehensive climate comfort index and tourism climate index

The two data models of climate comfort comprehensive index and mi's tourism climate index, and it can also show that the impact of Taishan temperature on tourism is beyond doubt. It can provide data reference for passengers to visit Mount Taishan scenic spot more intuitively, comprehensively and accurately, and also create a new idea for the evaluation and analysis of climate comfort.

4 Suggestion

4.1 Adjust measures to local conditions, develop characteristic tourism industry

Taishan scenic spot can develop the seasonal and seasonal characteristic tourism industry according to local conditions, or can carry out a further excavation and transformation of the existing tourism project resources. Due to the high summer precipitation in Taishan scenic area, the high altitude temperature is relatively low in other areas, we can focus on creating summer summer tourism, but also can vigorously develop Taishan natural hot spring health tourism projects, forming a health brand to make up for the lack of excessive summer precipitation and poor climate. How to make full use of local climate

resources and learn from each other to develop local tourism is the content and direction that can be studied next.

4.2 Make good weather monitoring and forecast to ensure passenger travel

Meteorological elements on the influence of tourism resources are changing, suggest mount tai related local government departments for meteorological monitoring and forecast, closely monitoring weather changes, ensure the safety of passenger travel.

4.3 Develop ecotourism and protect ecotourism resources

While vigorously developing tourism, we should also pay attention to the protection of ecological resources and vigorously develop ecological tourism. Combined with the climate and tourism resources of Mount Taishan scenic spot, the ecological tourism route is reasonably planned to maximize the benefits of the "golden signboard" of mount Taishan world cultural and natural heritage.

5 Conclusion

When multiple meteorological factors are overall considered, $5 < K_{CC} < 9$ human body feels comfortable. Figure 6 shows that the comfort index of Taishan Scenic area in April is good from April to October, which is suitable for tourism. In addition,establish two models combined with the actual situation, more innovative and comprehensively consider more meteorological factors, but also reduce the possibility of error in the process of data processing. The establishment of two linear regression equations can be more suitable for visiting Taishan scenic area in April and October. To sum up, Taishan scenic spot in April and October tourism comfort is the best, May to September tourism comfort is better.

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References

1. Zhang Fuxian now. Study on the Numerical Evaluation Index System of Tourism Climate Comfort [J]. Geography teaching, 2015 (18): 4-11.
2. Pan Shimei, et al. Tourism Climate Resource Evaluation in Haiyang City, Shandong Province [J]. Journal of Southwest University (Natural Science edition), 2018.40 (04): 125-131.
3. Luo Peiyu, et al. Climate Comfort Evaluation based on FAHP [J]. Guangdong Meteorological, 2021.43 (05): 44-48.
4. Long Yaping, Li Lihua. Evaluation of Mountain Tourism and Climate Resources in Sichuan Province [J]. Mountain Journal, 2018 (01): 116-124.
5. Jia Hankui, et al. Climate change characteristics of Mount Taishan in the last 50 years [J]. Shandong Meteorological Department, 2006 (02): 33-35.
6. Ma Lijun, Sun Gennian, Li Fuli, and other Shaanxi Province tourism climate comfort evaluation [J]. Resource Science, 2007,29 (6): 40-44.
7. Wang Huafang. Analysis and Evaluation of Tourism Climate Comfort in Western Province [D]. Taiyuan: Shanxi University, 2007.
8. Thorn E C.The discomfort index[J].Weathenvise, 1959, (12) :57-60.
9. Masterson J M,Richardson F A.Humidex:A Method of Quantifying Human Discomfort Due to Excessive Heat and Humidity[M].Downsview, Ontario:E nvironment Canada, 1979.
10. Qian Miaofen, Ye Mei. Study on Evaluation Method of Tourism Climate [J]. Journal of Chengdu Meteorological College, 1996,11 (3): 128-134.
11. Li Wanzhen, Tan Chuanfeng. Study on climate suitability of human body [J] Journal of Central China Normal University: Natural Science edition, 1994, (6): 255-259.