Journal of Global Change Data & Discovery. 2020, 4(2): 131-136
DOI:10.3974/geodp.2020.02.05
www.geodoi.ac.cn

Climate Comfortable Period and Uncomfortable Period Dataset Using Modified Model in Mainland of China (1981–2010)

Yu, D. D.[1,2] Li, S.[1,2,3 *]

1. School of Geographic Sciences, East China Normal University, Shanghai 200241, China;
2. Key Laboratory of Geographic Information Science, Ministry of Education, Shanghai 200241, China;
3. Institute of Eco-Chongming, Shanghai 200241, China

Abstract: Climate-comfortable period (CCP), as a temporal index, has a far-reaching, long-term impact on human settlements and human activities. Based on the long term daily meteorological data (from 1981 to 2010) from 814 national basic meteorological observing stations throughout China, climate comfortable and uncomfortable period dataset is carried out. Meanwhile, the "seasonal anchor method", which can be adopted as a national standard, are generated and modified the threshold values of each level of thermal sensation for THI (Temperature and Humidity Indexes) and WEI (Wind Effect Index). The dataset included: (1) Annual average climate comfortable and uncomfortable period in provinces during 1981–2010; (2) Annual average climate comfortable period and uncomfortable period of prefecture-level cities in China during 1981–2010; (3) Annual average comfortable period and uncomfortable period in China during 1981–2010; (4) Evolution of the annual average comfortable period and uncomfortable period of 814 basic meteorological stations in China during 1981–2010. The dataset was archived in .xlsx format with a data size of 152 KB after compression.

Keywords: thermal index; climatic comfort; climate comfortable period; THI; WEI

Dataset Available Statement:
The dataset supporting this paper was published at: Yu, D. D., Li, S. Climate comfortable period and uncomfortable period dataset using modified model in mainland of China (1981–2010) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2020. DOI: 10.3974/geodb.2020.01.02.V1.

1 Introduction

Climatic comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation (ANSI/ASHRAE Standard 55)[1], which has a far-reaching impact on human settlements and human activities[2–3]. Studies on climate

Received: 06-01-2020; **Accepted:** 01-06-2020; **Published:** 25-06-2020
Foundation: Ministry of Science and Technology of P. R. China (2012CB955803)
***Corresponding Author:** Li, S. M-6399-2017, School of Geographic Sciences, East China Normal University, sli@geo.ecnu.edu.cn
Data Citation: [1] Yu, D. D., Li, S. Climate comfortable period and uncomfortable period dataset using modified model in mainland of China (1981–2010) [J]. *Journal of Global Change Data & Discovery*, 2020, 4(2): 131–136. DOI: 10.3974/geodp.2020.02.05.
[2] Yu, D. D., Li, S. Climate comfortable period and uncomfortable period dataset using modified model in mainland of China (1981–2010) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2020. DOI: 10.3974/geodb.2020.01.02.V1.

comfortableness degree analysis are of substantial significance to building development[4–5], urban planning[6–7], public health[8–9], travel behavior[10–12] etc., especially important for the development of vacation destinations. Based on daily meteorological data from 814 basic weather stations in China during 1981–2010 provided by the China Meteorological Data Science Center (CMDC), a 7-level scale of thermal sensation, which includes "torrid, hot, warm, neutral, cool, cold, and frozen", is proposed. This study used the modified Temperature Humidity Index (THI) and Wind Effect Index (WEI) to fit the representative climatic comfort in China since the 1980s. And climate comfort and discomfort period in China are evaluated, which brings us some meaningful discoveries[13].

2 Metadata of the Dataset

"Climate comfortable period and uncomfortable period dataset using modified model in mainland of China (1981–2010)"[14] is summarized in Table 1. It includes the dataset full name, short name, authors, year of the dataset, temporal resolution, spatial resolution, data format, data size, data files, data publisher, and data sharing policy, etc.

Table 1 Metadata summary of the dataset

Items	Description
Dataset full name	Climate comfortable period and uncomfortable period dataset using modified model in mainland of China (1981–2010)
Dataset short name	CCP and CUCP_ China's urban scale _1981-2010
Authors	Yu, D. D. AAA-3856-2020, School of Geographic Sciences, East China Normal University, Yudd0713@outlook.com Li, S. M-6399-2017, School of Geographic Sciences, East China Normal University, sli@geo.ecnu.edu.cn
Geographical region	Mainland of China
Year	1981–2010
Spatial resolution	1 km×1 km
Data format	.xlsx
Data size	152 KB
Data files	1 file including 4 sheets
Foundation	Ministry of Science and Technology of P. R. China (2012CB955803)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[15]
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS, Crossref

3 Methods

3.1 Data Sources

The meteorological observation data required in the analysis is the standard value of the surface climate dataset in China collected from 1951 to 2010 was provided by the China Meteorological Data Science Center (CMDC)[16]. With 814 National Reference Climatological Station (NRCS) and National Basic Meteorological Observing Station (NBMOS) in China, this dataset includes station attribute information (e.g., station ID, longitude, latitude) and mean daily climatology data (e.g., temperature, humidity, precipitation, sunshine, wind speed), which have been used extensively in climate-related research across China. Based on the availability and stability of the data, we selected 814 meteorological stations nationwide from 1981 to 2010.

3.2 Algorithm

The comfort levels were evaluated using the Temperature Humidity Index (THI)[17] and the Wind Effect Index (WEI)[18], while the evaluation standards were modified by a new approach named "seasonal anchor method" in this paper[13], which includes 4 steps "grading, naming, anchoring, and projecting".

$$THI = t - 0.55\,(1 - 0.01RH)\,(t - 14.5) \tag{1}$$

$$WEI = -10\sqrt{v} + 10.45 - v33 - t + \frac{200 \cdot S}{D} \tag{2}$$

where t is the daily air temperature (℃), RH is the daily relative humidity (%), v is the average wind speed ($m \cdot s^{-1}$), S is the total hours of sunshine (h), and D is the daytime length.

4 Data Results and Validation

4.1 Data Products

(1) Annual average climate comfortable and uncomfortable period in provinces during 1981–2010; (2) Annual average climate comfortable period and uncomfortable period of prefecture level cities in China during 1981–2010; (3) Annual average comfortable period and uncomfortable period in China during 1981–2010; (4) Evolution of the annual average comfortable period and uncomfortable period of 814 basic meteorological stations in China during 1981–2010, and the variations between them from 1981–1995 to 1996–2010.

4.2 Data Analysis

The method using the Thiessen polygon to weight each station's climate comfortable and uncomfortable period was applied in his study. Based on the THI (Equation 1) and WEI (Equation 2) and the corresponding comfort threshold criteria, which were modified by "seasonal anchor method", we calculated the average climate comfortable and uncomfortable period in China using two different models respectively (Table 2).

The comparison of THI value with WEI shows their better consistency. Based on the analysis of Figure 1, as far as comfortable periods are concerned, the southern is long and

the northern is short. Among them, Yunnan province ranked the first, which provides a solid foundation for "Kunming every day is spring", which means it is a good place to escape the hot summer and the frozen winter. The adjacent province Tibet autonomous region has the

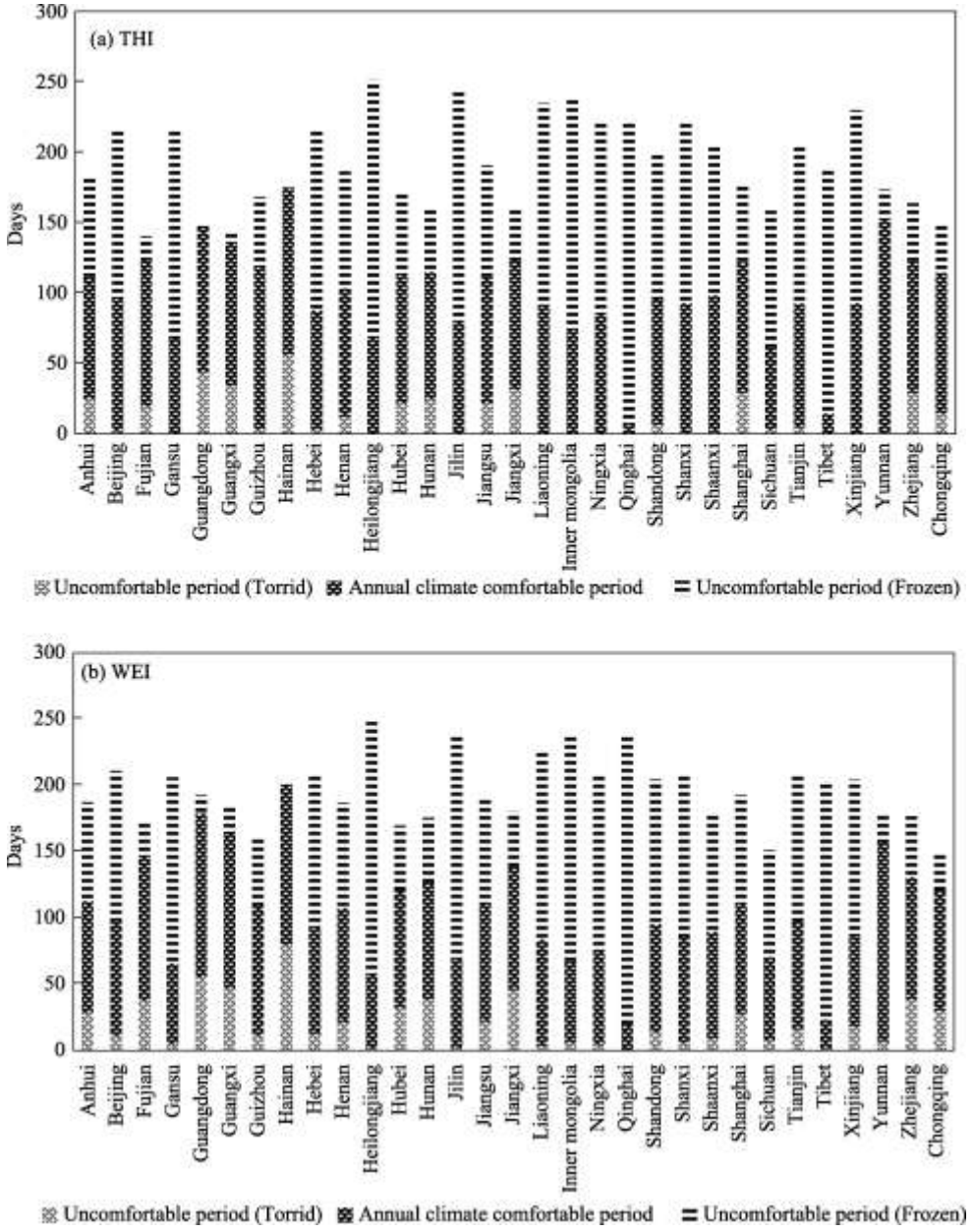

Figure 1 Annual average comfortable and uncomfortable periods of the provinces from 1981 to 2010

shortest period of comfortable. Hainan, Guangdong and Guangxi province became high value centers for torrid period. High altitude areas such as Qinghai province and Tibet autonomous region become extreme centers of frozen discomfort. Also, we evaluated the historical changes during the annual average climate comfortable period and uncomfortable

period in China. In general, the uncomfortable period is much longer than the comfortable period, and the frozen period is much longer than the torrid period. As in other parts of the world, China has experienced noticeable changes in climate over the past years. The trend of climate warming in China is projected to intensify in the future. Methods provided similar results and formed an interactive verification indicating that the CCP in most regions showed an increasing trend from 1981 to 2010.

Table 2 Average annual comfortable period and uncomfortable period on climate in China (1981–2010) (Unit: day)

Climate comfort state		Year		Spring		Summer		Autumn		Winter	
		THI	WEI	THI	WEI	THI	WEI	THI	WEI	THI	WEI
Comfortable period		73.2	67.8	16.0	16.3	41.2	31.3	14.8	17.9	1.2	2.4
Uncomfortable period	Torrid	5.6	13.4	0.2	0.8	5.1	11.4	0.3	1.2	0	0
	Frozen	125.6	122.7	24.4	30.0	1.2	3.1	28.2	24.2	71.9	65.4

4.3 Data Validation

According to the daily meteorological data of 69 provincial capitals meteorological stations in China from 1981 to 2010, an interactive verification between models and air temperature in the levels of thermal sensation were adopted. In this paper, we used the ordinary kriging interpolation in the ArcGIS software and rasterized into pixels of dimension 1 km × 1 km. Then the annual average comfortable and uncomfortable periods were obtained under the THI and WEI and their corresponding comfort threshold criteria, which had a high consistency. Also, in the part of the annual average comfortable and uncomfortable periods in China during 1981–2010, the results show that the fluctuation of THI and WEI scales are also consistent.

5 Discussion and Summary

Using the modified model and daily data from 814 weather stations in Mainland of China to examine inter-regional differences in the tourist climate comfortable and uncomfortable period across China and summarizes the spatial-temporal evolution from 1981–2010 in a changing climate, which brings us some meaningful discoveries. Based on the analysis, as far as comfortable periods are concerned, the southern is long and the northern is short. Among them, the annual average CCP of 25 provinces (cities) exceeded the national average (73.2 days). Yunnan province ranked first (151.9 days) throughout the year, which was approximately 32 days longer than values obtained for Hainan province. The climate ranked as less comfortable in Qinghai and Tibet with 14.7 days and 7.3 days, respectively. Both methods (THI or WEI) provided similar results and formed an interactive verification indicating that the CCP in most regions showed an increasing trend from 1981 to 2010, While the uncomfortable (torrid) remained basically stale and the uncomfortable (frozen) showed a wavelike decrease change.

The studied dataset focused more on the characteristics of the overall situation in China, such as the length of climate-comfortable period and climate-uncomfortable period and its spatial patterns in the mainland of China over the past 30 years. This database measures the climate-comfortable period and climate-uncomfortable period and combine the infor-

mation to carry out "humanistic influence" research and enrich the associated practical topics. These results can provide some scientific understandings for human settlements environmental constructions, and improve understanding of local or regional resilience responding to global climate change.

Author Contributions

Li, S. made the overall design of the dataset, including setting the models and algorithms. Yu, D. D. contributed to data processing and manuscript writing. Yu, D. D. was responsible for collecting the raw data and the data screening and preprocessing.

References

[1] ANSI/ASHRAE Standard 55-2010. Thermal environmental conditions for human occupancy [S]. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2010: 2–4.

[2] Shindell, D., Kuylenstierna, J. C. I., Vignati, E., *et al*. Simultaneously mitigating near-term climate change and improving human health and food security [J]. *Science*, 2012, 335(6065): 183–189.

[3] de Freitas, C. R., Grigorieva, E. A. A comprehensive catalogue and classification of human thermal climate indices [J]. *International Journal of Biometeorology*, 2015, 59(1): 109–120.

[4] Middel, A., Häb, K., Braze, A. J., *et al*. Impact of urban form and design on mid-afternoon microclimate in Phoenix Local Climate Zones [J]. *Landscape & Urban Planning*, 2014, 122(2): 16–28.

[5] Chandel, S. S., Sharma, V., Marwah, B. M. Review of energy efficient features in vernacular architecture for improving indoor thermal comfort conditions [J]. *Renewable and Sustainable Energy Reviews*, 2016, 65: 459–477.

[6] Rupp, R. F., Vásquez, N. G., Lamberts, R. A review of human thermal comfort in the built environment [J]. *Energy & Buildings*, 2015, 105: 178–205.

[7] Djukic, A., Vukmirovic, M., Stankovic, S. Principles of climate sensitive urban design analysis in identification of suitable urban design proposals. Case study: central zone of Leskovac competition [J]. *Energy & Buildings*, 2016, 115: 23–35.

[8] Parsons, K. Human Thermal Environments: The Effects of Hot, Moderate, and Cold Environments on Human Health, Comfort, and Performance [M]. New York: CRC Press. 2014.

[9] Song, C., Liu, Y., Zhou, X., *et al*. Temperature field of bed climate and thermal comfort assessment based on local thermal sensations [J]. *Building and Environment*, 2016, 95: 381–390.

[10] Ridderstaat, J., Oduber, M., Croes, R., *et al*. Impacts of seasonal patterns of climate on recurrent fluctuations in tourism demand: evidence from Aruba [J]. *Tourism Management*, 2014, 41(2): 245–256.

[11] Nalau, J., Becken, S., Noakes, S., *et al*. Mapping tourism stakeholders' weather and climate information seeking behavior in Fiji [J]. *Weather Climate & Society*, 2017, 9(3): 377–391.

[12] Yu, Z. K., Sun, G. N., Luo, Z. W., *et al*. An analysis of climate comfort degree and tourism potential power of cities in Northern China in summer to the north of 40°N [J]. *Journal of Natural Resources*, 2015, 30(2): 327–339.

[13] Yu, D. D., Li, S. Scale of human thermal sensation using seasonal anchor method: a Chinese case study [J]. *Journal of Natural Resources*, 2019, 34(8): 1633–1653.

[14] Yu, D. D., Li, S. Climate comfortable period and uncomfortable period dataset using modified model in mainland of China (1981–2010) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2020. DOI: 10.3974/geodb.2020.01.02.V1.

[15] GCdataPR Editorial Office. GCdataPR Data Sharing Policy [OL]. DOI: 10.3974/dp.policy.2014.05 (Updated 2017)

[16] National Meteorological Data Science Center. China surface climate data daily value dataset [DB/OL]. http: // data.cma.cn/data/detail/dataCode/A.0029.0001.html.

[17] Thom, E. C. A new concept of cooling degree days [J]. *Air Condition*: *Heat & Ventilation*. 1957, 54(6): 73–80.

[18] Terjung, W. H. Physiologic climates of the conterminous United States: a bioclimatic classification based on man [J]. *Annals of the Association of American Geographers*, 1966, 56(1): 141–179.