《2025　International Virtual Science Symposium Report》

Investigating the Disappearance of Winter in Kaohsiung Using GLOBE Observational Data

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Abstract

As climate change intensifies, global warming is increasingly impacting daily life. Phenomena such as La Niña and El Niño have contributed to extreme weather events, including powerful typhoons and prolonged droughts. In addition, rising greenhouse gas emissions have amplified the greenhouse effect. In Kaohsiung, a noticeable change has occurred—winter appears to be disappearing. For years, heavy coats have remained unused in our closets.

To explore this phenomenon, we used GLOBE observational data to investigate whether winters in Kaohsiung are indeed becoming warmer or shorter. By analyzing daily noontime air temperature records, we examined the trends in average minimum and maximum temperatures during the winter months (December to February) over several years. This analysis helps us determine whether there is a significant warming trend that supports the idea of a disappearing winter.

Introduction of Literature

As global warming intensifies, the impacts of extreme weather on Taiwan have become increasingly evident. Climate projections indicate that drought-related indicators—such as Consecutive Dry Days (CDD), which measure the longest period without rainfall—will continue to increase, especially under high-temperature scenarios projected for the end of this century. Southern Taiwan, in particular, is expected to experience more severe drought conditions than the north, posing a growing challenge to water resource management.

In addition, short-term droughts—measured using the 3-month Standardized Precipitation Index (SPI3)—are projected to occur more frequently and with greater intensity. This raises concerns about more frequent water shortages and the increased risk of agricultural losses. Globally, 2023 marked the highest average temperature on record since 1850. From January to September 2024, the global average temperature was 0.19°C higher than during the same period in 2022, reflecting a persistent warming trend.

Climate change is not only pushing global temperatures upward but also altering the duration and distribution of the seasons. Summers are becoming increasingly prolonged, encroaching on spring, autumn, and winter. Experts warn that if this trend continues, by 2060, Taiwan could experience summers lasting up to seven months, with winter potentially disappearing altogether. This scenario would pose serious risks to ecosystems, agriculture, and daily life.

La Niña events also influence Taiwan’s climate. Historical data show that during La Niña years, rainfall tends to decrease during the summer and following spring, while it increases in the eastern and northeastern regions during autumn. Temperatures are generally lower from winter through the subsequent spring. The probability of a La Niña event occurring is approximately 60%, contributing to increased climate variability.

Traditionally, the Northern Hemisphere defines seasons based on astronomical periods:

spring (March to May), summer (June to August), autumn (September to November), and winter (December to February). However, as extreme climate patterns become more common, these conventional seasonal boundaries may no longer reflect actual weather conditions in the future.

Research Questions

To better understand the potential disappearance of winter in Kaohsiung, this study aims to explore the following questions:

1. How have the **minimum winter temperatures** in Kaohsiung changed from 2020 to 2025?
2. How have the **maximum winter temperatures** in Kaohsiung changed from 2020 to 2025?
3. How have the **maximum summer temperatures** in Kaohsiung changed from 2020 to 2025?
4. What has been the **trend in global average temperatures** in recent years?

Research Methods

1. This study utilized temperature data collected from daily noontime observations at the Cianjin1 GLOBE observation station in Kaohsiung, spanning the years 2020 to 2025. Data collection was carried out by student observers using standardized instruments provided by The GLOBE Program, ensuring consistency and accuracy in the recorded measurements.
   The collected data were uploaded to the official GLOBE website and included daily maximum and minimum air temperature values during the winter months (December to February) and summer months (June to August). These student-collected records were then compared with corresponding official temperature data from Taiwan's Central Weather Administration (CWA) for the same dates and times, to verify accuracy and identify any patterns or discrepancies.
2. The location of Cianjin1 GLOBE observation station
   Cianjin1 station locates in Kaohsiung City, Taiwan. The terrain is plain and the climate type is tropical monsoon.

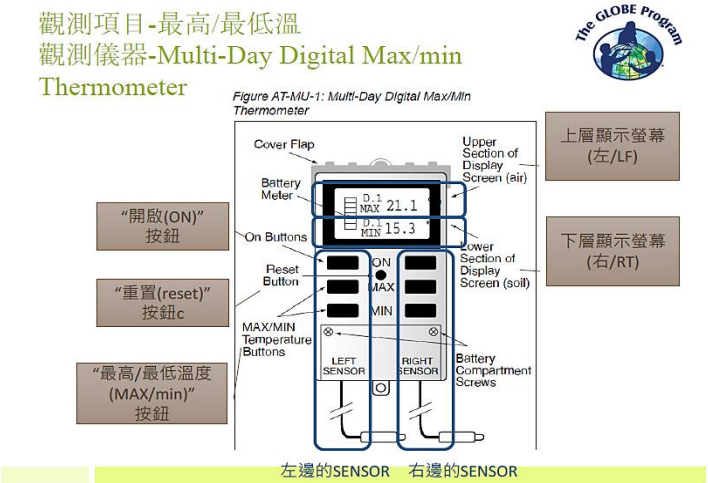
Site Information

Site ID	104218
Name	Cianjin 1
Latitude	22.630026°
Longitude	120.291204°
Elevation	6.8m
Location Source	other

【Figure 1. the Site Information of the Cianjin 1 Station】

3. The Equipment and Instruments of Observation
   We used the Multi-Day Digital Max/min Thermometer provided by the GLOBE Program to collect data on the school observation site. The surface of the observation site is grass but the underground is cement, which may cause errors in the observation data.

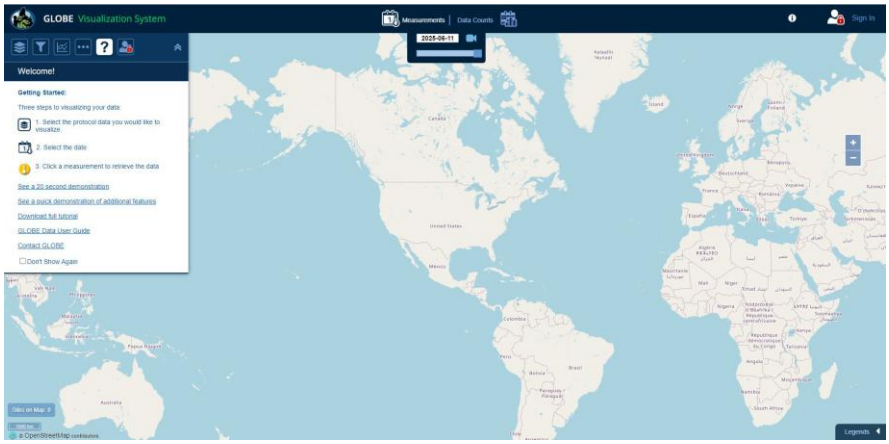
【Figure 2. Instument Placement】



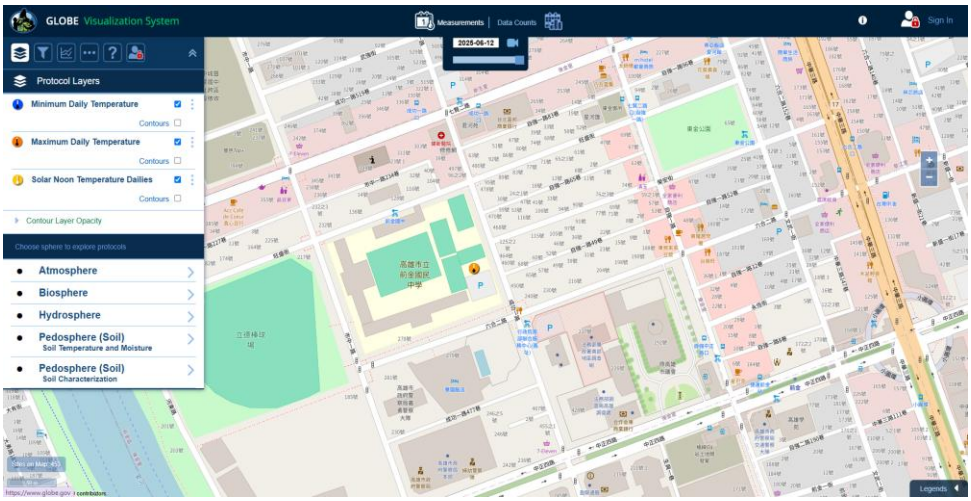
【Figure 3. Instument Button Description】

4. Data collection

We downloaded data from the official website (as shown in Figure 4 and 5)



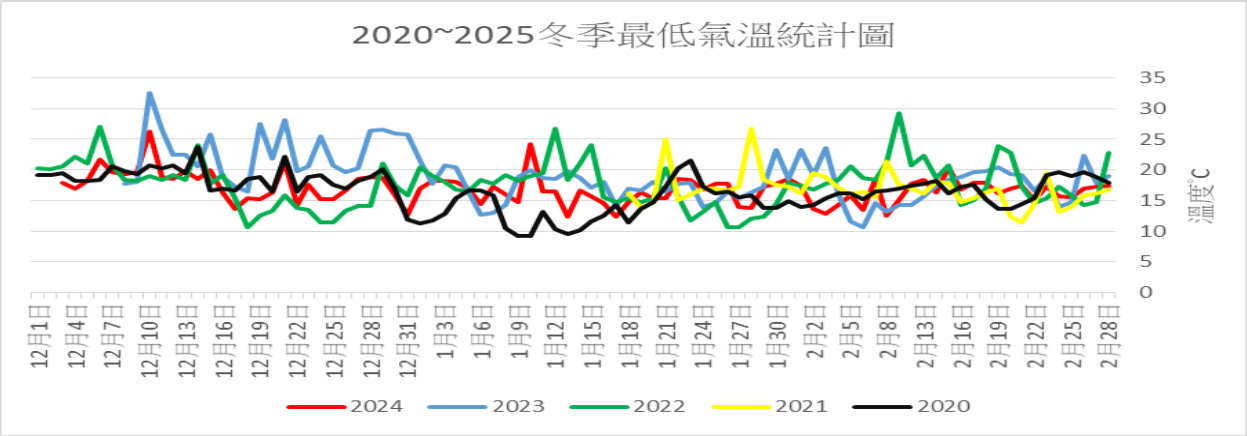
【Figure 4. Data Inquiry Page on the Official Website】



【Figure 5. Official Website Temperature Data Inquiry Screen】

Research Results

1. Changes in Kaohsiung's Minimum Winter Temperatures (2020–2025)



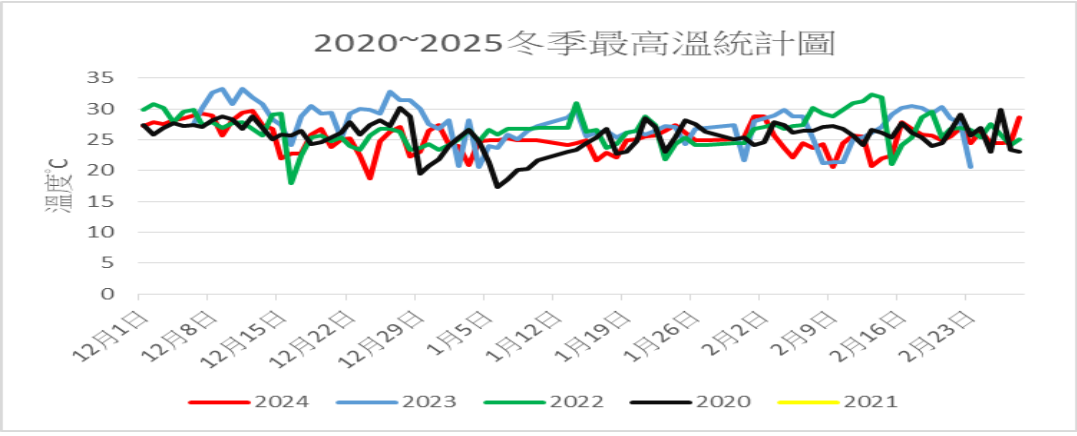
【Figure 6. Kaohsiung's Minimum Winter Temperatures2020-2025】

Using temperature data from the GLOBE website, we created a graph showing the minimum winter temperatures in Kaohsiung from 2020 to 2025. Overall, we observed a gradual increase in winter minimum temperatures, suggesting a long-term warming trend. For example, 2023 (light blue line) displays generally higher minimum temperatures compared to earlier years like 2020 (black line) and 2021 (yellow line).

However, in the winter of 2024 (red line), there was a noticeable drop in minimum temperatures, interrupting the warming pattern. We suspect this drop was influenced by the La Niña phenomenon.

Despite the presence of six cold air mass events in the second half of 2023, the overall winter remained relatively warm with limited rainfall. This anomaly may be attributed to an anticyclonic circulation over the Indochina Peninsula and the South China Sea, which likely blocked cold air from moving southward and suppressed atmospheric convection, reducing cloud cover and rainfall.

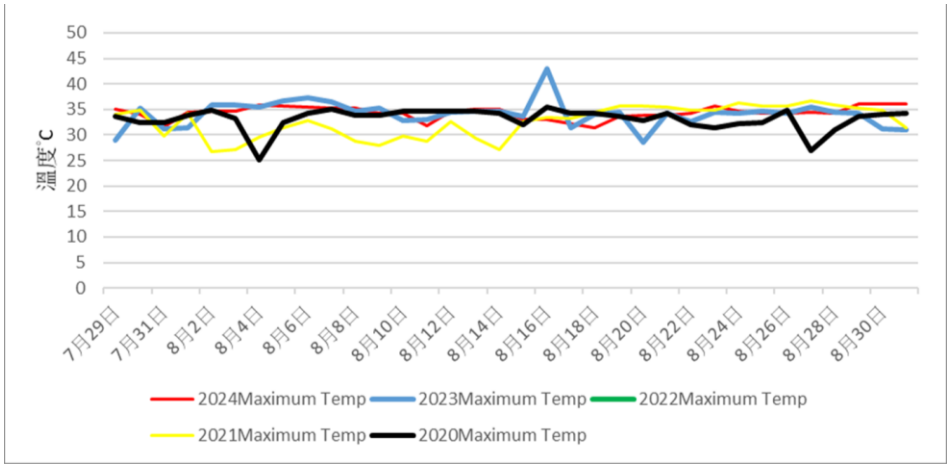
2. Changes in Kaohsiung's Maximum Winter Temperatures (2020–2025)



【Figure 7. Kaohsiung's Maximum Winter Temperatures2020-2025】

The data show a gradual increase in Kaohsiung's maximum winter temperatures over the five-year period. A noticeable drop in February 2021 can be observed, likely due to the passage of a strong cold front. However, some data for that period is missing as classes and observational work were suspended during the COVID-19 outbreak. In 2023, Taiwan recorded an annual average temperature of 24.3°C—approximately 0.4°C above the long-term average—making it the sixth-warmest year on record. Another decline in winter temperatures occurred in 2024, which may be attributed to the effects of the La Niña phenomenon.

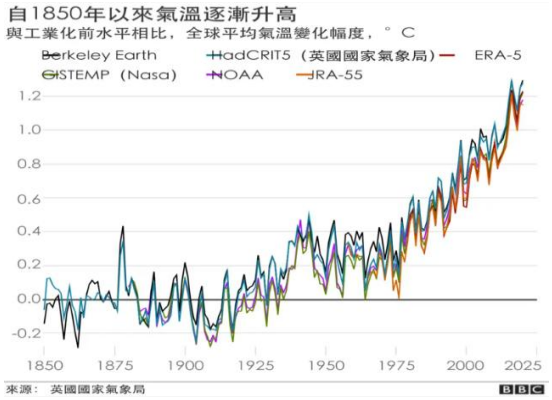
3. Changes in Kaohsiung's Maximum Summer Temperatures (2020–2024)



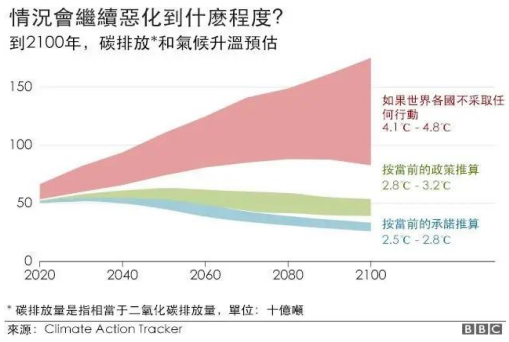
【Figure 8. Kaohsiung's Maximum Summer Temperatures2020-2025】

The statistical chart of maximum summer temperatures reveals a steady increase in summer heat over recent years. In particular, daily maximum temperatures in 2023 (light blue line) and 2024 (red line) are generally higher than those recorded in 2020 (black line) and 2021 (yellow line) on many days throughout the observation period. This pattern suggests a warming trend during the summer months, with more frequent and intense heat days. The overall elevation in peak temperatures reflects the broader impacts of climate change on seasonal weather patterns in Kaohsiung.

4. Global Average Temperature Trends



【Figure 9. Global temperature change】



【Figure 10. Future warming projections】

Data show that the global average temperature has already increased by nearly 1°C compared to the pre-industrial era. If current patterns of energy use and lifestyle habits continue without significant change, global temperatures could rise by 3 to 5°C by the year 2100.

As global warming accelerates, its impacts are becoming increasingly severe and difficult to ignore. For instance, the United Kingdom recorded its highest temperature ever—reaching 40°C. Across Europe, wildfires have become more frequent and intense, and thousands of people in Portugal and Spain have died due to extreme heat events.

Researchers and the United Nations continue to warn that the Earth is heating at an alarming rate, largely driven by human activities. The burning of fossil fuels releases large amounts of greenhouse gases—particularly carbon dioxide (CO_2)—which trap heat in the atmosphere and intensify the greenhouse effect.

Discussion

1. This research used temperature data from the GLOBE website to investigate seasonal temperature changes in Kaohsiung from 2020 to 2025, with a focus on understanding how local winter conditions have been affected by global climate change. Data for the summer of 2022 are missing. This may be because during the COVID-19 outbreak, classes were taught online and it was impossible to observe on campus.
2. We found that winters are getting warmer and summers are getting hotter.
   (1) First, the minimum winter temperatures (the lowest temperatures in winter) have gone up in most years. For example, in 2023, the temperatures were higher than in 2020 and 2021. This shows that winter is becoming less cold. But in 2024, there was a sudden drop in temperature. We think this was caused by La Niña, a climate pattern that can bring cooler weather to some places. Still, even with several cold air events in late 2023, the winter stayed quite warm. This may be because of a high-pressure system over Southeast Asia that blocked cold air and kept the weather dry.
   (2) Next, the maximum winter temperatures (the highest temperatures in winter) also increased over time. There was a short drop in February 2021, probably because of a cold front. However, some data was missing that year due to COVID-19. In 2023, Taiwan had one of its warmest years on record. Another drop in 2024 may also be linked to La Niña.
   (3) We also looked at the maximum summer temperatures, which clearly show a rising trend. Summers in 2023 and 2024 were hotter than in 2020 and 2021. This means Kaohsiung is having more hot days during summer.
   (4) When we compared our results to global temperature trends, we saw the same pattern. Around the world, temperatures have already gone up by almost 1°C since before the industrial age. If people don’t change how they use energy, global temperatures could rise by 3–5°C by the year 2100. This warming is mostly caused by burning fossil fuels, which releases greenhouse gases like carbon dioxide that trap heat. This is causing more heatwaves, wildfires, and other extreme weather in many places.
3. Our study shows that Kaohsiung is also feeling the effects of global warming, especially in the way winters are changing.

Conclusion

Our study shows that Kaohsiung's winters are becoming warmer, and summers are getting hotter. This means winter is slowly disappearing. Although cold weather can still happen—like in 2024—these are short-term changes. The long-term trend shows that temperatures are rising. What's happening in Kaohsiung is also happening around the world. Global warming is making seasons change and bringing more extreme weather. By using GLOBE data, we were able to see how this affects our local area.

We hope our research helps more people understand why it's important to care about climate change. Even students like us can make a difference by observing nature, sharing what we learn, and encouraging others to take action to protect our planet.

Refereces

1. The 2024 National Climate Change Scientific Report: Phenomena, Impacts, and Adaptation: *https://www.nera.gov.tw/upload/cmNormalFile/2024-08-28/22022365-f111-4c42-b823-1ffba3d9b50a/%E7%AC%AC3%E7%AB%A0.pdf*
2. Is the Earth Running a Fever? Could Taiwan's Winters Disappear in the Future? A 1°C Rise in Temperature Increases the Risk of Depression by 7%: *https://esg.tvbs.com.tw/exhibition/climate-inflation/2024-nov/topic_2.html*
3. La Niña Is Fading! Expert Reveals Its Impact on Taiwan: *https://tw.nextapple.com/life/20250130/123EE7BA5B6D5D6FA987EA1A85CF4E72*
4. Ministry of Transportation and Communications Central Weather Administration – 100 Climate Questions: *https://www.cwa.gov.tw/V8/C/K/Encyclopedia/climate/climate2_list.html#climate2-02*
5. Central Weather Bureau Official *https://www.cwa.gov.tw/V8/C/K/Encyclopedia/climate/climate7_all.html*
6. GLOBE Atmosphere *https://vis.globe.gov/GLOBE/*
7. Global Average Temperature Change *https://www.bbc.com/zhongwen/trad/science-57749347*
8. NOWnews Today's News *https://www.nownews.com/news/6376146?utm_source=chatgpt.com*
9. National Climate Change Adaptation Policy Framework (National Development Council) *https://ws.ndc.gov.tw/Download.ashxu=LzAwMS9hZG1pbmlzdHJhdG9yLz*
10. Climate Change: 4 Ways to Cut Your Carbon Footprint *https://www.bbc.com/zhongwen/trad/world-59067541*
11. Ministry of Education – Global Information *https://www.edu.tw/News_Content.aspx?n=9E7AC85F1954DDA8&s=8BF1696CC31F4FE9*
12. United Daily News: El Niño and La Niña Phenomena *https://ubrand.udn.com/ubrand/story/12116/7511406*

《Optional Badges》

I am a Data Scientist

We used statistical analysis tools to process and compare temperature data from different years. By visualizing the minimum and maximum temperatures during winter and summer, we identified climate trends and potential anomalies (e.g., La Niña impacts).

I Make an Impact

Our project highlights the reality of climate change and its impact on daily life. We also proposed actions individuals can take — such as eating less meat, using public transportation, and saving electricity — to help reduce greenhouse gas emissions and slow global warming.

I am a Collaborator Badge:

The report was completed through teamwork. Each team member contributed by analyzing data, interpreting graphs, and writing content. We also consulted with teachers and used data from both the GLOBE platform and Taiwan's Central Weather Administration, showcasing collaboration across sources.