**Analyzing the twenty-four solar terms using Globe observational data**

**Abstract**

The theme of this report is to discuss the changes and trends in precipitation and temperature on the specific solar terms' days, as well as in the preceding and following half-month periods, and throughout the whole year in 2022 and 2023. It also analyzes the causes of these changes and investigates whether they align with or differ from the traditional characteristics of solar terms in Taiwan. The study utilizes personnel from schools to conduct Globe atmospheric observations and automatic weather stations to record two years of data. The data results are imported into Excel for organization and to create data charts. Through multiple observations, discussions, and comparisons of the changes and characteristics of solar terms over the two years, the final conclusion is reached after discussions with the teacher, and the report is written.

**Ⅰ. Introduction**

**(Ⅰ)Motivation**

Solar terms serve various purposes in daily life, including traditional agriculture and meteorology. In agriculture, solar terms guide farmers in selecting suitable planting times and agricultural activities to make the most of natural seasonal changes. In meteorology, the changes in solar terms are often associated with weather patterns, providing some assistance in predicting weather changes.

However, we have noticed that from 2022 to 2023, many solar term characteristics seem to not align with the actual weather conditions on the day and in the following days. For instance, after the Qingming Festival, there should have been signs of rain, but there was almost no precipitation for nearly a month, leading to subsequent water shortages in reservoirs due to insufficient spring rain. Additionally, during the typically typhoon-prone months of July and August, Taiwan experienced almost no typhoons in these two years. Therefore, we want to delve into the correlation between solar term types and actual climate, as well as explore the underlying reasons for further research.

**(Ⅱ)Purpose**

1. Understand the characteristics of the four seasons' solar terms and explore their correlation with the observed data in 2022 and 2023.

2. Investigate the factors influencing the temperature and precipitation changes in 2022 and 2023.

**Ⅱ. Research materials and methods**

**(Ⅰ)Research materials:**

1.Luodong High School Atmospheric Observation Station

**(Ⅱ)Research methods:**

This study utilizes the climate data of daily weather between 2022 and 2023 collected by the atmospheric observatory equipment owned by our school campus. It compares the data with eight distinct climate characteristics from the traditional Chinese 24 solar terms (Yushui、Qingming、Xiazhi、Dashu、Chushu、Hanlu、Daxue、Dahan), using Excel-generated temperature and precipitation line charts for comparison.

**(Ⅲ)Research architecture and background:**

This experiment primarily involves the use of data collected by our school's atmospheric observation team through Globe atmospheric observations and records from automatic weather stations for the years 2022 and 2023. The data is organized and plotted using Excel, creating charts for precipitation and daily average temperature for each of the 24 solar terms, with a 15-day period before and after each term. By comparing the different line graphs, we attempt to identify patterns of change and explore which weather factors may be influencing them.

**Ⅲ.Research results**

**(Ⅰ)Spring solar terms**Chart(1)

 Chart(2) Chart(3) Chart(4)

 Chart(5)

Next, we discuss the traditional characteristics of the Spring solar terms:

1. Rains on the day of Yushui, heralding a bountiful harvest:

Does not match: According to Charts (1) and (2), there was rain on the days of Yushui in both 2022 and 2023, and there were signs of spring rain in the following days (more evident in 2022). However, according to the precipitation statistics in Figure (5), the monthly rainfall from March to May is consistently below 100 millimeters, and there is no abundant rainfall brought by typhoons in July and August. The average precipitation is far below the local long-term average, which may affect the harvest due to slight water shortage. Therefore, it does not match the traditional characteristics of the solar term.

(2) If it's sunny on Qingming day, there will be more rain in the days to come, and rain on that day will lead to drought disasters:

Does not match: According to Charts (3) and (4), the weather was clear on Qingming in both 2022 and 2023. However, there was no significant rainfall after this solar term, and it did not match the traditional saying "Rain falls plentifully around Qingming." It might be because there were no frontal systems passing through before or after this solar term, thus not matching the traditional characteristics of the solar term.

**(II)Summer solar terms**

 Chart(6)

 Chart(7)

 Chart(8)

 Chart(9)

Next, we will proceed with the discussion based on the traditional characteristics of summer solar terms:

1. XIA-ZHI：High temperatures, high humidity, and occasional thunderstorms are common during this period:

Matches:According to Charts (6) and (7), the average temperature remains around 30 degrees Celsius in both 2022 and 2023. In 2022, there were significantly fewer afternoon thunderstorms compared to 2023. Overall, the total precipitation in 2022 was even more than double that of 2023 throughout the year.

1. Dashu:"Great Heat brings great decline and great death, but without decline, there is no death." It's the hottest and most intense solar term of the year, characterized by scorching heat, thunderstorms, and frequent typhoons.

Matches:According to Charts (8) and (9), in both 2022 and 2023, the highest temperatures of the year occurred in the days before and after the Dashu, also known as "San Fu Tian" in Chinese folklore (between Xiaoshu and Chushu). That year also broke the record for the highest temperature ever recorded in Taiwan, which typically happens during the "San Fu Tian" period. In terms of precipitation in 2022, there was very little rainfall in the 15 days before and after the Dashu, with no typhoons passing through, indirectly resulting in an unsatisfactory rice harvest and water shortages for daily use. In contrast, in 2023, rainfall was mainly concentrated in the days following the Dashu.

**(Ⅲ)Autumnal solar terms**

 Chart(10) Chart(11) Chart(12) Chart(13)

Next, we discuss the traditional characteristics of the Autumnal Equinox:

(1) The weather is hot during Chushu, unlike the autumn season, and people call this hot weather "autumn tiger":

Matches: According to Charts (10) and (11), the temperature during Chushu in these two years ranged from 28 to 32 degrees Celsius, similar to the summer temperatures in Taiwan. There was only light rain of less than 10 millimeters on the day of Chushu in 2022, and no rainfall at all during the solar term in 2023. It indicates that it was very hot during Chushu, consistent with the typical weather of Chushu.

(2) As the time of Hanlu approaches, the autumnal atmosphere gradually thickens, and the air becomes cool and crisp with less rain:

Not quite matches: Observing Charts (12) and (13), we find that after the Hanlu solar term in both 2022 and 2023, there is a trend of temperature decrease. However, there were heavy rains of 40 and 60 millimeters respectively on those days, which does not quite match the traditional characteristics of this solar term. It is speculated that this discrepancy might be due to the northeast monsoon bringing a large amount of moisture from the sea.

**(Ⅳ)Winter solar terms**

 Chart(14)

 Chart(15)

Chart(16)

 Chart(17)

Next, we discuss the traditional characteristics of the Winter Equinox:

1. During the period of Major Snow, influenced by cold air masses, snowfall may occur:

Does not match: According to Charts (14) and (15), although the temperature is low, it has not dropped below zero degrees.

1. During Dahan, influenced by cold air masses from Siberia, it is often the coldest period of the year:

Matches: According to Charts (16) and (17), as well as observational station data, in both 2022 and 2023, temperatures dropped to around 10 degrees Celsius during Major Cold, and the coldest days occurred within approximately 4 days before or after Dahan.

**Ⅳ.Conclusion**

1. The seasonal changes in Yushui and Qingming do not align with observations over the past two years. Since Taiwan's main precipitation occurs during typhoons in July and August, the description of precipitation in the seasonal changes doesn't necessarily imply a bountiful harvest.

1. The seasonal changes in Xiazhi and Dashu align with observations over the past two years. Southeastern China and Taiwan both belong to the Northern Hemisphere. Although China exhibits characteristics of a continental climate due to its geography, the latitudes are similar, and the summer climates are generally alike.
2. The seasonal changes in Chushu and Hanlu roughly correspond to observations over the past two years. One explanation for the formation of the "autumn tiger" phenomenon is the weakening of the northeasterly monsoon, which affects both China and Taiwan. This is naturally related. Furthermore, due to Taiwan's surrounded-by-sea geography, the northeasterly monsoon brings maritime moisture, which contrasts with the dryness of the Chinese mainland.
3. The seasonal changes in Daxue and Dahan may or may not correspond to observations over the past two years. Due to China's continental climate, temperatures can drop below freezing in winter, while Taiwan is surrounded by oceans with ocean currents passing through, resulting in smaller annual temperature differences, making snow rare. However, the times of lowest temperatures are generally similar.

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**Ⅴ.Quote**

1. <https://www.moa.gov.tw/ws.php?id=2506893> -二十四節氣