

Analysis of the Dataset Conducted from Three *in Situ* Soil-Atmosphere Sites in the Qinghai Section of Qilian Mountains National Park (2022.7–2024.6)

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Abstract: The Qilian Mountains National Park is a crucial ecological functional area in Northwest China. Real-time monitoring of key environmental elements within its ecosystem is of great significance for exploring the responsiveness and adaptive changes of the ecological environment in the Qinghai section of Qilian Mountains National Park under climate change. This study selected coniferous forests (foot of the mountain), alpine shrubs (mid-slope), and alpine meadows (base of the mountain top) in Qinghai section of Qilian Mountains National Park as monitoring sites for key environmental elements (soil-atmosphere). Meteorological equipment (i.e., EE181 temperature and humidity sensors, CSD sunshine duration sensors, and CS650 soil moisture/temperature/ conductivity sensors) was installed in each vegetation type to collect real-time data such as solar radiation, wind speed, atmospheric temperature and humidity, as well as soil temperature and humidity. This constitutes the dataset of key environmental elements (soil-atmosphere) for the Qinghai section of the Qilian Mountains National Park (2022.7–2024.6). The dataset includes: (1) Position data of the monitoring sites; (2) Key environmental element data from the three monitoring sites, including atmospheric elements (air temperature and humidity, atmospheric pressure, wind speed and direction, total sunshine duration, etc.) and soil parameters (soil temperature, soil moisture, and soil electrical conductivity). The data cover the period from July 2022 to June 2024, on a daily time scale. The dataset is archived in .shp and .xlsx formats, comprising 8 data files, with a total data volume of 809 KB (compressed into one file, 686 KB).

Keywords: Qilian Mountains National Park; Qinghai section; key environmental factors (soil-atmosphere);

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DOI: <https://doi.org/10.3974/geodp.2026.02.10>

Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: <https://doi.org/10.3974/geodb.2025.10.09.V1>.

1 Introduction

Land surface properties are a critical factor influencing regional climate. As a distinct landform type, mountainous areas exhibit pronounced regional characteristics in climate variation^[1]. Within mountain ecosystems, the distribution of meteorological factors is highly complex due to rugged terrain, significant elevation variations, and the influence of slope aspect and gradient. As a result, climatic elements such as temperature and wind speed exhibit distinct patterns of variation with altitude across different regions^[2]. For instance, atmospheric pressure and temperature decrease with increasing elevation, whereas solar and ultraviolet radiation intensify at higher altitudes. Additionally, other environmental factors such as precipitation, wind speed, and evapotranspiration are also influenced by elevational gradients, collectively shaping the complex climatic patterns of mountainous regions^[3].

The Qilian Mountains, located in an important climate transition zone of our country, have a wide altitude range and complex terrain. The meteorological elements within its territory are highly diverse. Under the background of global climate change, the Qilian Mountains, as a typical fragile ecological area and an important climate-sensitive area in our country, are extremely sensitive to environmental changes^[4]. So far, there have been relatively few studies on the climatic aspects of the Qilian Mountains. This study focused on the mountain foot (coniferous forests), mountain mid-slope (alpine shrubs), and mountain top base (alpine meadows) areas of the Qinghai section of the Qilian Mountains National Park. Small-scale meteorological equipment was set up in each type of sample area to conduct long-term, continuous climate observation research on the vertical distribution characteristics of the mountain ecosystem environment. The main objective was to explore the temporal and spatial variation characteristics of key environmental elements between the land and the atmosphere in the Qilian Mountains ecosystem region (Figure 1), and to reveal the regional environment of the Qilian Mountains and its response to climate warming, providing important real-time data for the protection of the Qilian Mountains ecosystem environment.

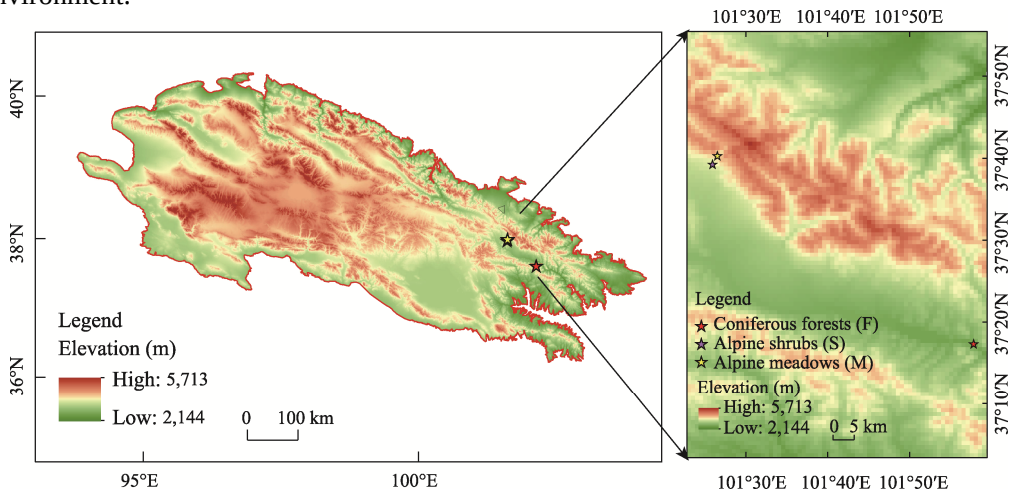


Figure 1 Location map of environmental monitoring plots for three vegetation types

2 Metadata of the Dataset

The name, authors, geographical region, year of the dataset, dataset composition, data publishing and sharing service platform, and data sharing policy of the Dataset conducted from three *in situ* soil-atmosphere sites of Qilian Mountains National Park (2022.7–2024.6)^[5] are shown in Table 1.

Table 1 Metadata summary of the Dataset conducted from three *in situ* soil-atmosphere sites of Qilian Mountains National Park (2022.7–2024.6)

Items	Description
Dataset full name	Dataset conducted from three <i>in situ</i> soil-atmosphere sites of Qilian Mountains National Park (2022.7–2024.6)
Dataset short name	ElementsSoilAtmosQinghaiQilian
Authors	Bai, L. L., Qinghai Normal University, 2534061194@qq.com Wang, W. Y., Qinghai Normal University, wangwy0106@163.com Luo, Q., Qinghai Normal University, 576303872@qq.com Niu, F. Y., Qinghai Normal University, 960287126@qq.com Yang, F. K., Qinghai Normal University, fangkun_yang@163.com Ma, Y. M., Qinghai Normal University, 1281804224@qq.com Wang, Y. X., Qinghai Normal University, 1340235967@qq.com
Geographical region	The Qinghai section of Qilian Mountain National Park
Year	2022.7–2024.6
Data format	.shp, .xlsx
Data sizes	809 MB
Data files	Geo-location data of the sample sites; key environmental element data from the 3 sites, including atmospheric elements and soil parameters
Foundations	Ministry of Science and Technology of P. R. China (2023YFF1304305); Natural Science Foundation of Qinghai Province (2025-ZJ-969T); National Natural Science Foundation of China (W2412148); Ministry of Education of P. R. China & State Administration of Foreign Experts Affairs of P. R. China (D23029)
Data publisher	Global Change scientific research data publishing System http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	(1) <i>Data</i> are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use <i>Data</i> subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute <i>Data</i> subject to written permission from the GCDataPR Editorial Office and the issuance of a <i>Data</i> redistribution license; and (4) If <i>Data</i> are used to compile new datasets, the “ten percent principal” should be followed such that <i>Data</i> records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset ^[6]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS, GEOSS, PubScholar, CKRSC

3 Data Monitoring Methodology

In mountain ecosystems, meteorological factors often exhibit different characteristics from the foothills to the summit. Based on the representativeness of the mountain range, in the vertical sampling zone of the Qinghai section of the Qilian Mountains National Park, the foot of the mountain (coniferous forests), the mid-slope (alpine shrubs), and the mountain top base (alpine meadows) were selected as long-term real-time climate monitoring sites. Small meteorological stations (equipped with EE181 temperature and humidity sensors, CSD light duration sensors, and CS650 soil moisture/temperature/conductivity sensors) were set up within each type of site to collect real-time meteorological data such as light radiation,

wind speed, soil temperature and humidity.

4 Data Results

4.1 Dataset Composition

The dataset includes: (1) Position data of the monitoring sites; (2) Key environmental element data from the three monitoring sites, including atmospheric elements (temperature and humidity, atmospheric pressure, atmospheric CO₂ concentration, atmospheric O₂ concentration, wind speed and direction, total sunshine duration) and soil parameters (soil temperature, soil moisture and soil electrical conductivity at depths of 10 cm, 30 cm and 50 cm). The data cover the period from July 2022 to June 2024, on a daily time scale.

4.2 Data Results Analysis

4.2.1 Atmospheric Elements

The atmospheric temperature gradually decreases with increasing altitude, following the pattern of coniferous forests>alpine shrubs>alpine meadows. During the periods of 2022.7–2023.6 and 2023.7–2024.6, all of the coniferous forest, alpine shrubbery, and alpine meadow showed that the lowest temperature occurred in January and February, and the highest temperature occurred in August. All of the coniferous forests, alpine shrubs, and alpine meadows demonstrated that the average temperature during 2023.7–2024.6 was higher than that during 2022.7–2023.6 (Figure 2).

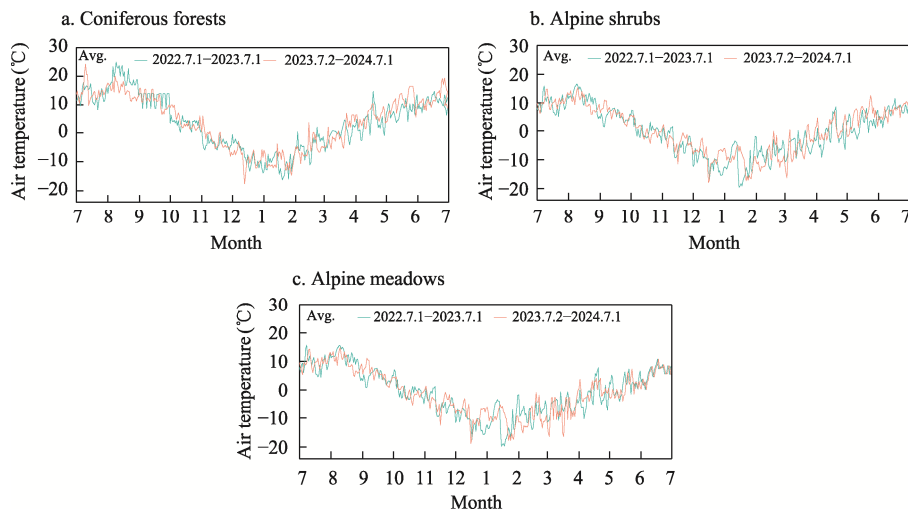


Figure 2 Inter-annual variation characteristics of temperature

The relative humidity of the atmosphere gradually decreases with increasing altitude, following the pattern of coniferous forests > alpine shrubs > alpine meadows. During the periods of 2022.7–2023.6 and 2023.7–2024.6, all the coniferous forests, alpine shrubs and alpine meadows showed that the relative humidity of the atmosphere was lower in spring (January–March) and higher in autumn (August–October). During the period of 2022.7–2023.6, the lowest relative humidity of the coniferous forests occurred in January and the highest in October; during the period of 2023.7–2024.6, the lowest relative humidity of the coniferous forests occurred in January and the highest in September. During the periods of

2022.7–2023.6 and 2023.7–2024.6, the lowest relative humidity of the alpine shrubs and alpine meadows occurred in January and the highest in August. All the coniferous forests, alpine shrubs and alpine meadows showed that the relative humidity in 2023.7–2024.6 was lower than that in 2022.7–2023.6 (Figure 3).

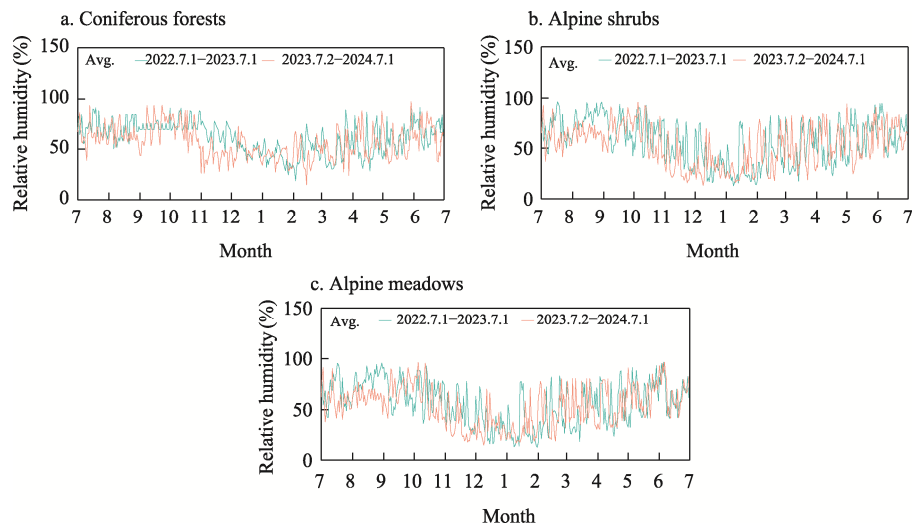


Figure 3 Inter-annual variation characteristics of atmospheric relative humidity

The saturated water vapor pressure in the atmosphere gradually decreases with increasing altitude, following the pattern of coniferous forests > alpine shrubs > alpine meadows. In the periods of 2022.7–2023.6 and 2023.7–2024.6, all of the coniferous forests, alpine shrubs, and alpine meadows showed that the atmospheric saturated water vapor pressure was lower during the Spring Festival (January–March) and higher during the autumn (July–September). The coniferous forests, alpine shrubs, and alpine meadows all showed that the atmospheric saturated water vapor pressure was the lowest in January and the highest in August (Figure 4).

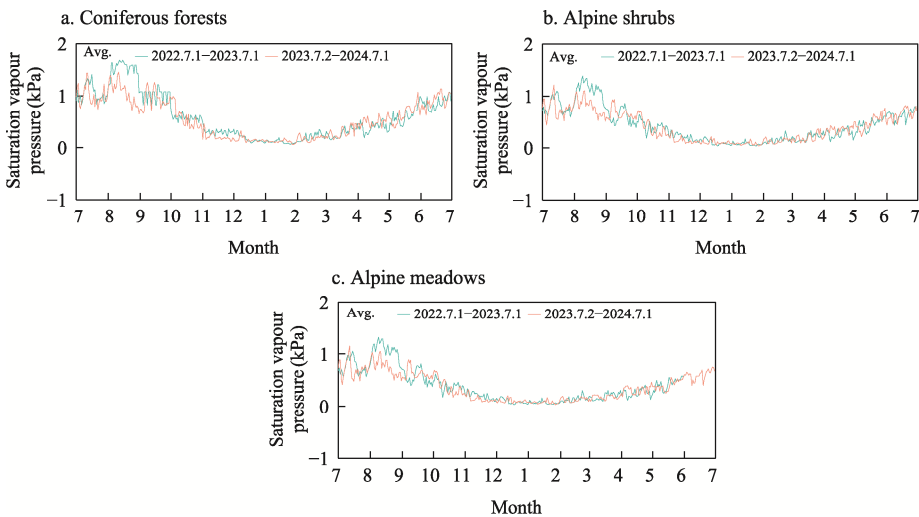


Figure 4 Interannual variation characteristics of atmospheric saturation water vapor pressure
The atmospheric CO₂ concentration gradually decreases with increasing altitude,

following the pattern of coniferous forests>alpine shrubs>alpine meadows. There is no significant seasonal difference in the atmospheric CO₂ concentration between coniferous forests and alpine shrubs. The atmospheric CO₂ concentration in alpine meadows is significantly higher in spring and summer (March–August) than in autumn and winter (September–February of the following year) (Figure 5). The atmospheric O₂ concentration gradually decreases with increasing altitude, following the pattern of coniferous forests > alpine shrubs > alpine meadows. The seasonal dynamics of atmospheric O₂ concentration in each vegetation type are all such that it is significantly higher from April to November and then gradually decreases from December to March of the following year. The alpine meadows and alpine shrubs both show a single peak curve, with the maximum atmospheric O₂ concentration occurring in August and September (Figure 6).

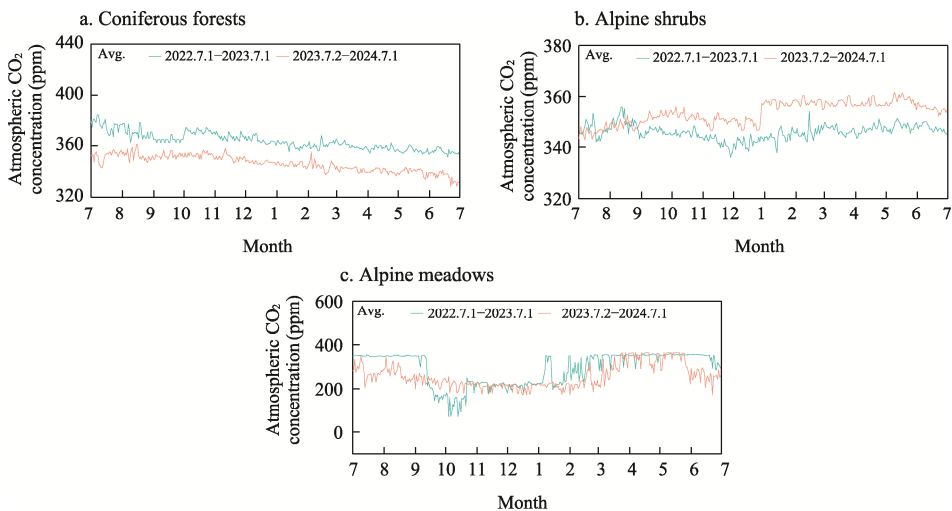


Figure 5 Inter-annual variation characteristics of atmospheric CO₂ concentration

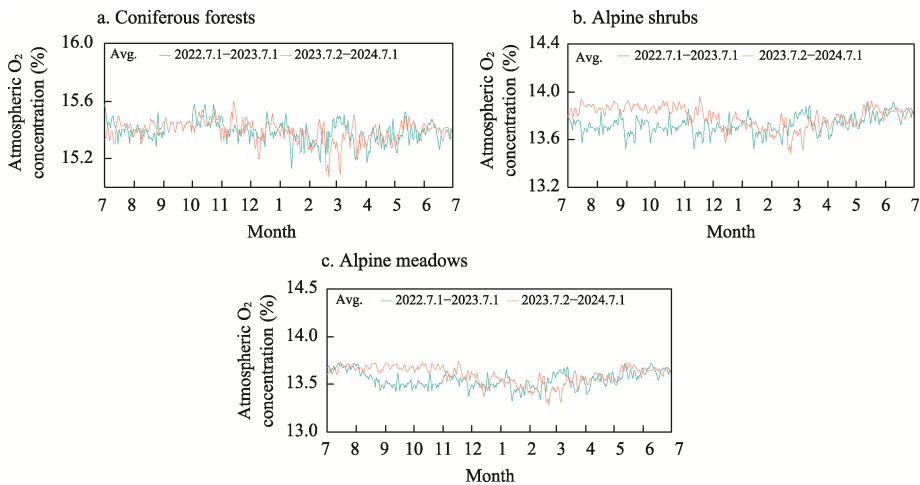


Figure 6 Inter-annual variation characteristics of atmospheric O₂ concentration

The month with the longest sunshine duration is June and July, with the sunshine duration reaching over 11 h. The shortest sunshine duration occurs in December, January, and February, with a duration of approximately 7–9 h. The sunshine duration in other months is all above 10 h. During the period from 2022.7 to 2023.6, the annual cumulative sunshine

duration was 2,177.49 h, and during the period from 2023.7 to 2024.6, the annual cumulative sunshine duration was 2,349.81 h. The annual cumulative sunshine duration from 2023.7 to 2024.6 was 172.32 h more than that from 2022.7 to 2023.6 (Figure 7). The wind direction is mostly southeast wind and east wind, with relatively low wind speed, and there is no strong wind, with the maximum wind speed not exceeding 5 m/s (Figure 8).

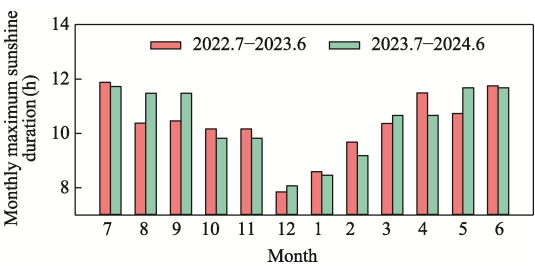


Figure 7 Inter-annual variation characteristics of monthly sunshine duration

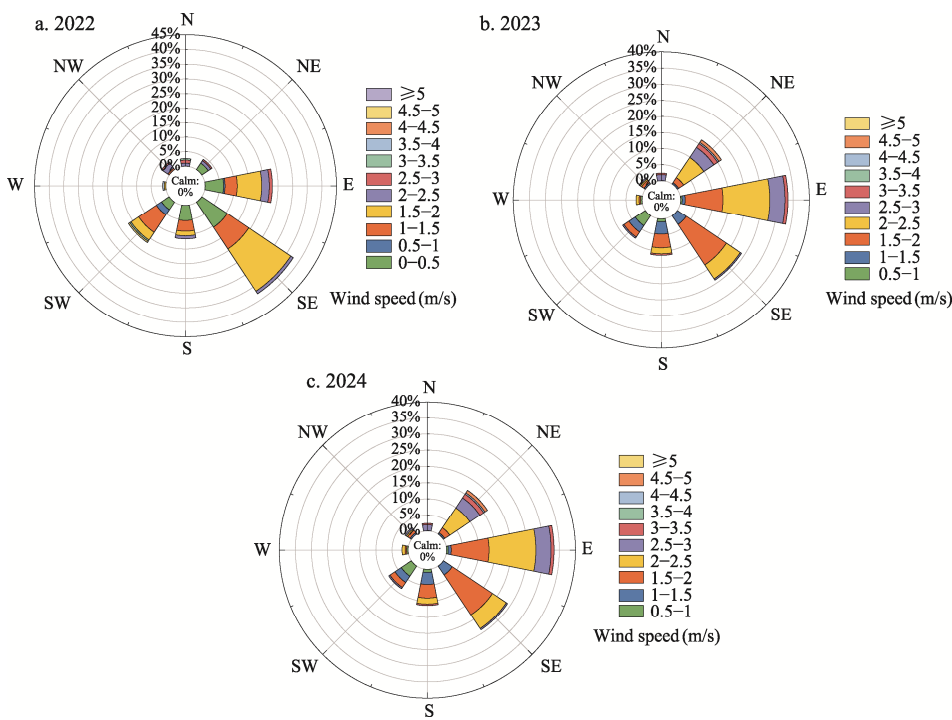


Figure 8 Inter-annual variation characteristics of wind speed and wind direction

4.2.2 Three Soil Parameters

The soil temperature in coniferous forests, alpine shrubs and alpine meadows all showed an increase with the rise of atmospheric temperature, reaching its maximum in August and then decreasing. In coniferous forests, the soil temperature from 2023.7 to 2024.6 was lower than that from 2022.7 to 2023.6. In alpine shrublands, the surface (10 cm) soil temperature showed an increase from 2023.7 to 2024.6 compared to 2022.7 to 2023.6. The deep soil (30 cm and 50 cm) showed a decrease from 2023.7 to 2024.6 compared to 2022.7 to 2023.6. In alpine meadows, the soil temperatures at 10 cm, 30 cm and 50 cm all showed that 2023.7 to 2024.6 was significantly higher than 2022.7 to 2023.6 (Figure 9).

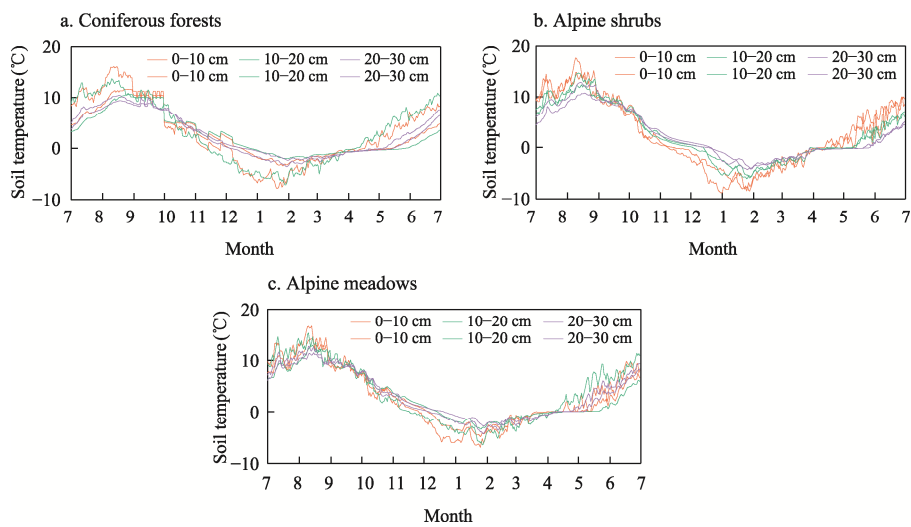


Figure 9 Annual variation characteristics of soil temperature

The soil volumetric moisture content is as follows: alpine shrubs>alpine meadows>coniferous forests. The soil begins to thaw in mid-April to mid-May, and the soil volumetric moisture content gradually increases. From mid-November to mid-December, it gradually freezes from the surface to the underground, and the soil volumetric moisture content drops rapidly. In the coniferous forests, the soil volumetric moisture content at 30 cm is higher than that at the surface (10 cm) and the deep layer (50 cm). There is little change in the soil layer between the high-altitude shrubs. The soil volumetric moisture content at the surface (10 cm) of the alpine meadows is higher than that in the middle layer (30 cm) and the deep layer (50 cm). In the period from 2022.7 to 2023.6 and from 2023.7 to 2024.6, all of the coniferous forests, alpine shrubs and alpine meadows showed that the soil volumetric moisture content in January to April was significantly lower than that in other months (Figure 10).

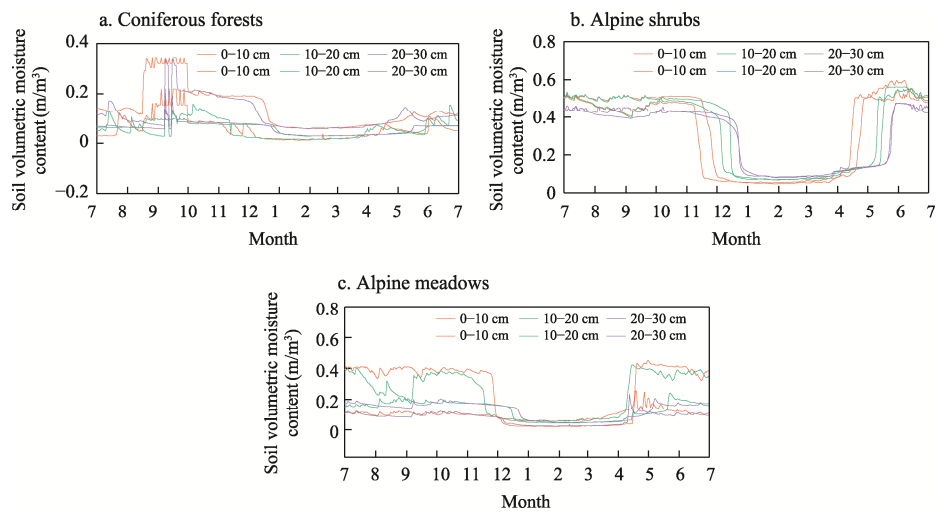


Figure 10 Inter-annual variation characteristics of soil moisture content

The soil electrical conductivity and soil volumetric moisture content show the same trend:

alpine shrubs > alpine meadows > coniferous forests. From January to April, the values of soil volumetric moisture content and soil electrical conductivity were relatively low and stable. From May to November, the soil volumetric moisture content and soil electrical conductivity were relatively high but fluctuated greatly. After November, they dropped rapidly. In the soil layer, the soil electrical conductivity of coniferous forests and alpine shrubs was higher at 30 cm than at the surface (10 cm) and deep soil (50 cm). The soil electrical conductivity at the surface (10 cm) of alpine meadows was higher than that at the middle layer (30 cm) and deep layer (50 cm) (Figure 11).

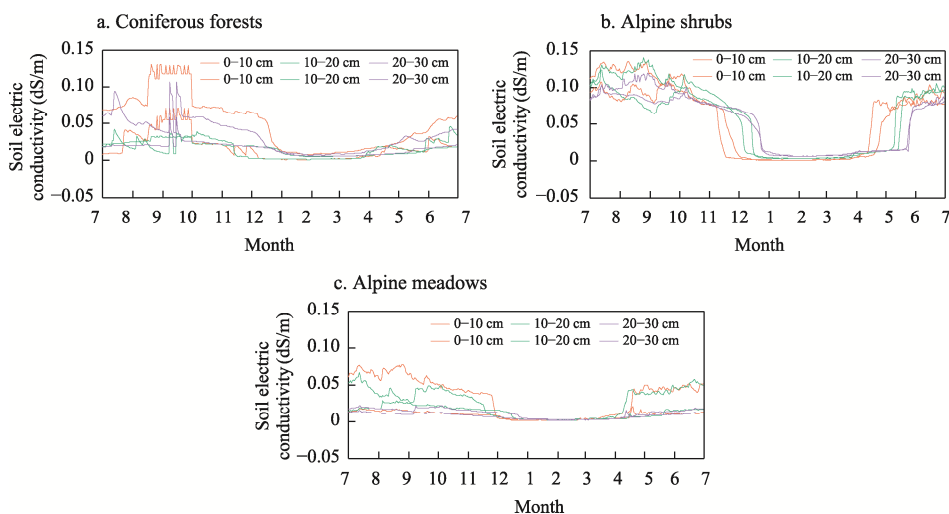


Figure 11 Inter-annual variation characteristics of soil electrical conductivity

5 Discussion and Discussion

The Qilian Mountains are situated at the center of the Eurasian continent, adjacent to the northern Xizang Plateau. Influenced by both continental desert climate and alpine topography, the region exhibits a typical alpine semi-arid climate^[7]. Due to the complex terrain and special geographical environment, the temperature in the Qinghai section of the Qilian Mountains National Park shows significant temporal and spatial differences and has a tendency towards warming and humidification^[8]. Climate warming will change the water and heat conditions within the original ecosystem, increase the transpiration of above-ground vegetation, and reduce the soil moisture content^[9]. This study found that the longest sunshine duration in the Qinghai section of the Qilian Mountains National Park occurs in June and July, while the shortest sunshine duration occurs in December, January and February of the following year. The predominant wind directions are southeast wind and east wind, with relatively low wind speeds and no strong winds, with the maximum wind speed not exceeding 5 m/s. Atmospheric temperature, humidity, and saturation pressure difference are related to the terrain and decrease spatially with the increase in altitude. The distribution follows the pattern of coniferous forests>alpine shrubs>alpine meadows. Coniferous forests, alpine shrubs, and alpine meadows all show that the average air temperature during the period of 2023.7–2024.6 is higher than that during the period of 2022.7–2023.6, which is consistent with the research results of Yang, *et al.*^[8]. The concentrations of atmospheric CO₂ and O₂ both gradually decrease with increasing altitude. The soil temperature in the Qinghai section of the Qilian Mountains National Park gradually decreases with altitude, following the pattern of coniferous forests>alpine shrubs>alpine meadows. The lowest temperature

occurs in January and February, while the highest temperature is in August. Soil electrical conductivity and soil volumetric moisture content show the same trend, with alpine shrubs>alpine meadows>coniferous forests. The soil volumetric moisture content in alpine shrubs is higher, which is related to the groundwater level in this area. The main influencing factor of soil moisture in the Qinghai section of the Qilian Mountains National Park is the groundwater level rather than atmospheric precipitation. Our research team installed automatic meteorological observation equipment at different altitude gradients in the Qinghai section of the Qilian Mountain National Park. They conducted continuous and real-time monitoring of key meteorological elements in the area, filling the gap in the research on the ecological effects of the Qilian Mountains National Park in Qinghai under the trend of climate warming. However, the feedback of mountain ecosystems to climate warming is time-lagged. The temporal stability of this study may seem insufficient. In the future, our research team will continue to conduct long-terms, continuous and multi-angle investigations into the response of the Qilian Mountain ecosystem to global climate warming, in order to understand the potential changes in high-altitude ecosystems under the background of future climate warming and their patterns.

Author Contributions

Bai, L. L. and Wang, W. Y. did the overall design for the development of the dataset; Luo, Q., Niu, F. Y., Yang, F. K., Ma, Y. M., and Wang, Y. X. collected and processed all the data; Bai, L. L. wrote the data paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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