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Study on the Influence of Different Surface Vegetation Cover on Watershed Scale Microclimate Change

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Abstract: By comparing and observing the changes of microclimate indicators of different types of vegetation cover in the Hulu River Basin, this paper analyzed the changes of microclimate under different underlying surface conditions caused by vegetation cover and discussed the role and influence of fruit tree economic forest cover on watershed scale microclimate change. The results showed that the cover of fruit tree economic forest had the effects of cooling, temperature accumulation, moistening and reducing wind speed on the underlying surface of the basin to a certain extent, which was conducive to improving the microclimate of small watershed. The average daily temperature in the forest decreased by 0.1 ~ 3.0°C compared with the average air temperature in the open land outside the forest, and the regulating effect of fruit tree economic forest was higher than that of water conservation forest. The cumulative temperature effect made the daily maximum temperature in the forest higher than that in the open area outside the forest by 0.4 ~ 1.1°C. The humidification and moisturizing effect made the relative humidity of air in the forest increase by 3.2% ~ 11.1% compared with that outside the forest, and the average daily wind speed of air in the forest was 0.4m/s ~ 4.0m/s lower than that outside the forest.

Keywords: Vegetation Cover, Watershed Scale, Microclimate Change, Impact

1. Introduction

Microclimate refers to a local climate with different characteristics from the larger climate, which is formed in a small range due to differences in the structure and characteristics of the underlying surface such as terrain, soil and vegetation, resulting in differences in the distribution of heat and water budget [5-8]. As the main environmental factor affecting vegetation community, microclimate directly affects the growth of surface vegetation and the succession of community [1-4, 10]. In turn, surface vegetation cover has a certain degree of regulation and influence on various factors of microclimate. Therefore, microclimate is the result of the interaction and influence between plant community and environmental factors on the underlying surface [8, 9, 13-16]. By comparing and observing the changes of microclimate indicators of different types of vegetation cover in the Hulu River Basin, this paper analyzes the changes of microclimate under different underlying surface conditions caused by vegetation cover, and discusses the role and influence of fruit tree economic forest cover on watershed scale microclimate change [11, 12].

2. Overview of the Research Area

The Hulu River Basin is Located in the west of Liupan Mountain and Guanshan Mountain in Pingliang City, covers a total area of 3715.52 km^2. The main stream of the Hulu River runs through the whole basin from north to south, and it is a first-level tributary of the Weihe River system in the Yellow River Basin. It belongs to the loess hilly and gully region in the middle of Gansu pronvince, with a gully density of 1.5 ~ 2.0km/km^2. The climate type belongs to the semi-arid continental monsoon climate in the middle and temperate zone. The annual average temperature is 7.9°C, the spring is dry and less rain, the summer and autumn precipitation is more and more concentrated, and the winter is dry and less rain and snow. The annual average rainfall is 484.7 mm, the annual average evaporation is 880.7mm, and the drought index is 1.83. The climate is more humid in the southern part of the basin than in the northern part. The vegetation type is the transitional zone of temperate forest grassland, which shows that the forest and grass vegetation gradually decline from the northeast to the southwest of the Hulu River Basin, and the distribution characteristics of temperate grassland vegetation are excessive. The coverage rate of forest and grass is low, only 28.63%, and the natural vegetation is scarce, most of which is artificial forest. The main tree species are *Robinia pseudoacacia L., Populus simonii Carriere, Prunus sibirica L. and Prunus davidiana (carr) franch), Salix matsudana Koidz., Ulmus pumila L., Ailanthus altissima (Mill.)* Swingle and other sparsely distributed native tree species; The main herb populations are *Stipa capillata L. population, Artemisia gmelinii population, Agropyron cristatum (L.) Gaertn.) population, Potentilla potentilla chinensis Ser.) population, Vicia villosa Roth.*

After years of fruit industry development, fruit economic forest has become the main artificial forest vegetation coverage in the Hulu River basin. By the end of 2020, the planting area of fruit economic forest in the Hulu River basin has reached 107768.26hm^2, accounting for 29.11% of the total land area. From the perspective of landscape ecology, the fruit tree economic forest has become the most obvious plantation patch Mosaic in the loess hilly gully landform in the basin, which has improved the ecological landscape pattern of the basin and greatly improved the ecological attitude of the basin. *Malus pumila Mill* (Red Fuji Apple) is the main planting species in the fruit economic forest. Due to the coverage of a large amount of fruit economic forest in the Hulu River basin, the original vegetation cover form and structure in the basin have been changed. The fruit economic forest has a stable stand structure, just like the water and soil conservation forest and other ecological public welfare forests in the basin. The fruit economic forest planted in the Hulu River basin is mainly apple. It has the characteristics of a certain density, a certain crown width, developed roots, dense branches and leaves, high biomass, and large amount of litter. It is widely distributed in geomorphic units such as ridge belt, slope conversion field and river valley in hilly region, forming a typical Mosaic plate in loess hilly and gully region, which has greatly changed the ecological landscape pattern in this region.

3. Research Methods

The method of combining field observation and indoor analysis was adopted to conduct microclimate observation and data collection by establishing field observation points. We used PH-II meteorological instrument as the microclimate observation equipment and observed at Zhaojiagou Village, Leida Town, Jingning County, from March to October in 2022. The meteorological instrument of the same model was installed respectively in the fruit-economic forest, the water conservation forest and the open land (control) for synchronous observation. The observation frequency was once a month, and the observation time was about 9h each time. The all-weather observation from sunrise to sunset was completed within 8:30am to 17:30pm as far as possible so as to ensure the continuity and integrity of data collection. The collected meteorological index data were statistically analyzed, and the difference of microclimate index in and out of the two stand structures was compared.

3.1. Observation Point Layout and Data Collection

3.1.1. Installation of Equipment at Observation Points

In this study, Zhaojiagou Village, Leida Town, Jingning County, were selected as microclimate observation points, and the geographical coordinates were E105°45 '25 ", N35°15' 32 "(Zhaojiagou Village). Microclimate data collection points inside and outside the forest were arranged respectively. The collection points inside the forest included the fruit tree economic forest and the water conservation forest. The basic information of the observation points was shown in Table 1. Equipment installation: Before observation, the PH-II handheld weather station should be set up at a height of 1.5m from the ground. According to the requirements of wind direction observation, the meteorological observation instrument should be kept facing south. For observation in the forest, the installation position (tree fork or branch) should be fixed by a line, etc., while for observation outside the forest, the instrument should be fixed by a tripod to ensure the stability of the instrument.

Table 1. *Description of the basic conditions of microclimate observation point.*

Observation point	information
Jingning Leida location	location: Zhaojia Shanggou village, Lei da town, Jingning County Geomorphic type: loess hilly and gully region Geographical coordinates: E105°45 '25 ", N35°15' 32" Altitude: 1852.80m, observation in the forest and outside the forest is the same altitude. Main soil type: yellow soil Average annual rainfall: 451.0mm Annual average evaporation: 903.2mm Annual average temperature: 6.5°C Forest and grass coverage rate: 29.2% Conditions in the forest: Economic forest orchard: planting variety is red Fuji apple, 13a full fruit stage, planting density 4×4m, tree height 3.5m, diameter 15cm, crown width 4×4.5m Water conservation forest: The forest species is pure apricot forest, 18a, the average tree height is 3.2m, the diameter is 3.6cm, the average crown width is 2×3m Outside the forest: Empty and bare land

3.1.2. Microclimate Data Collection

Data collection: Data of microclimate indicators of fruit tree economic forest (inside the forest), soil and water conservation forest (inside the forest) and control forest (outside the forest) were simultaneously collected, including 7 data indicators: atmospheric temperature (°C), atmospheric humidity (%), digital pressure (hpa), wind speed (m/s), maximum wind speed (m/s), average wind speed (m/s) and wind direction (°). The collection time is from March to October 2022, and the collection time is once a month. The daily observation time is about 8:30am to 17:30pm, and the data recording frequency is 5min/ time. The handheld weather station will automatically record and save the collected data, and finally import the collected data into the computer for analysis.

3.2. Data Processing

Excel software was used for statistics and averaging of the observed recorded data, spss21.0 software was used for correlation analysis, and OriginPro 9.1 software was used to produce the change curve of microclimate indicators.

4. Result Analysis

4.1. Variation of Air Temperature Inside and Outside the Forest

According to the basic principle of modern climatology on the division of meteorological seasons, combined with the annual meteorological data and the vegetation growth period in the Hulu River Basin, the meteorological seasons in the region were divided into three seasons which were spring, summer and autumn according to the annual average daily temperature (see Table 2).

Table 2. *Division of microclimate and meteorological seasons in the Hulu River Basin.*

Division of meteorological seasons	Annual Mean daily Temperature (°C)	Time (Month)
Spring	≥10.0	3～4
Summer	≥20.0	5～8
Autumn	≤9.0	9～10

4.1.1. Diurnal Variation of Air Temperature in Spring

(1) Diurnal variation characteristics of air temperature in spring: the air temperature inside and outside the forest showed an increasing temperature increase during the period from 8:30 am to 15:40 pm, and reached the maximum daily average temperature in turn, as shown in Figure 1. The average time for the daily maximum temperature in orchard forest, water conservation forest and open bare land was 15:05 pm, 15:10 pm and 15:40 pm respectively, the daily maximum temperature is 20.0°C, 19.3°C and 18.9°C, respectively, which indicates that the total solar radiation increases with time in spring, causing the ground temperature (1.5m above the ground) to rise gradually. However, the speed and degree of temperature rise are different due to the different surface cover characteristics of the underlying surface. Compared with the open and bare land, the orchards and water-preserved forests covered by vegetation have a certain accumulated temperature effect, resulting in a higher average daily maximum temperature of 1.1°C and 0.4°C respectively, which is very conducive to the spring sprout growth of vegetation in the temperate zone of the northern Hemisphere. Since then, with the decrease of solar radiation, the average daily temperature has decreased and decreased. It can be seen that the covering has an effect and influence on the air flow induced by the change of wind speed near the surface.

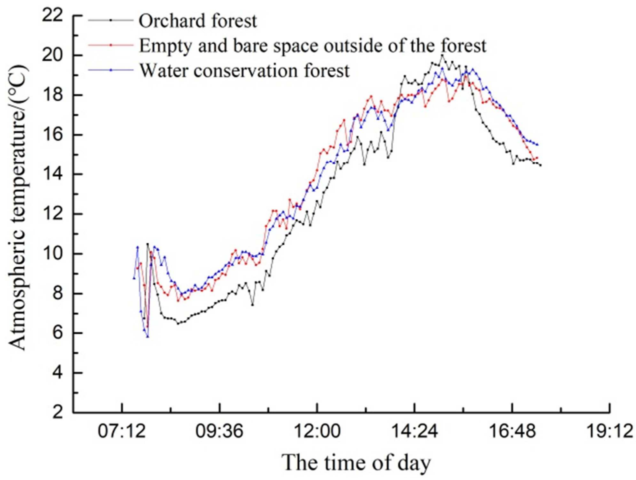


Figure 1. *Daily variation curve of air temperature in spring.*

(2) Analysis of diurnal variation of air temperature in spring: The average daily temperature was 13.8°C, 13.8°C and 13.2°C (see Table 3). Compared with that of the open land outside the forest, the average daily temperature decreased by 0.6°C, indicating that due to vegetation coverage, a large number of branches and leaves in the fruit tree economic forest and the water conservation forest played an obvious shielding role. Preventing a large amount of solar radiation from directly entering the forest space greatly reduces the heat reaching the ground, and weakens the advection and eddy flow of the air in the forest, making the low temperature air in the forest not easy to disperse, and playing a role in reducing the air temperature. Data analysis shows that the cooling effect of the orchard is more obvious.

It can be seen that in small mountain basins near the ground, air temperature is easily affected by factors such as land cover status and its difference, weather conditions during observation, especially in spring when the atmosphere is unstable. The results show that vegetation cover has a certain cumulative temperature effect on the daily maximum temperature near the surface of the small watershed, resulting in the daily maximum temperature in the forest is 0.4 ~ 1.1°C higher than that in the open land. In non-rainfall weather, the average daily temperature in the forest is lower than that outside the forest, and the temperature adjustment range is 0.6°C; in rainfall weather, it is the opposite, and the warming effect is generated, and the temperature adjustment range is 0.1 ~ 0.7°C.

4.1.2. Diurnal Variation of Air Temperature in Summer

(1) Diurnal variation of air temperature in summer: the air temperature inside and outside the forest showed an increasing warming change from 8:30 am to 16:35 pm, and reached the maximum daily average temperature in turn, as shown in Figure 2. The average time for the daily maximum temperature in orchard forest, water conservation forest and open bare land was 16:35 pm, 15:50 pm and 15:55 pm, respectively, the daily maximum temperature was 24.6°C, 25.0°C and 24.7°C, respectively. The daily maximum temperature in the orchard forest was 0.1°C lower than that in the open and bare areas outside the forest, while that in the water-preserved forest was 0.3°C higher than that in the open and bare areas outside the forest. The daily maximum temperature difference in the forest outside the forest in summer was lower than that in the spring. The significant increase of leaf area not only weakens the air flow in the forest, but also greatly blocks certain solar radiation and reduces the amount of solar radiation reaching the ground, thus reducing the air temperature in the forest. The data show that the average daily temperature shows a small gradient decline after 16:35 pm as the amount of solar radiation gradually decreases.

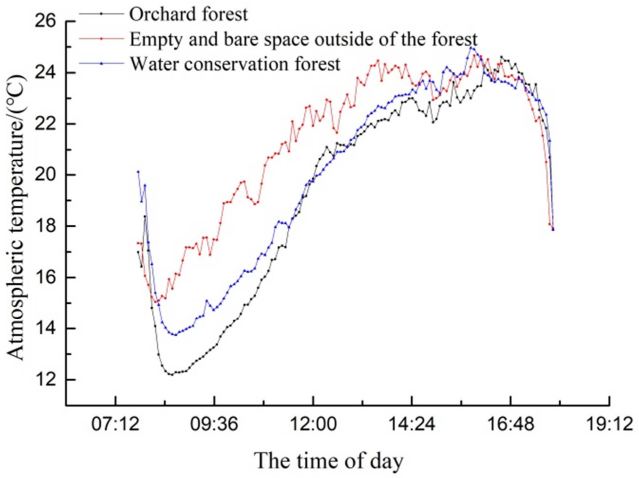


Figure 2. *Daily variation curve of air temperature in summer.*

(2)Analysis of diurnal variation of summer air temperature: The average daily temperature was 21.2°C, 20.1°C and 19.2°C, respectively, in the open forest > in the water-protected forest > in the orchard forest (see Table 3). Since fruit trees and water-protected forests in the orchard entered the peak growth period in summer, the effect of reducing the temperature in the forest was more obvious, and the average daily temperature in the water-protected forest and the orchard forest was 1.1°C and 3.0°C lower than that in the open forest, respectively.

4.1.3. Diurnal Variation Characteristics of Air Temperature in Autumn

(1) Diurnal variation of air temperature in autumn: the air temperature inside and outside the forest showed an increasing warming change during the period from 8:30am to 15:10pm, and reached the maximum daily average temperature in turn, as shown in Figure 3. The average time to reach the maximum daily average temperature in orchard forest, water conservation forest and open bare land was 15:10pm, 14:40pm and 14:05pm respectively, the maximum temperature was 10.2°C, 11.2°C and 12.0°C, respectively. In autumn, the average daily maximum temperature in the orchard forest and the water-protected forest was lower than that in the open land outside the forest, and the maximum temperature was 1.8°C and 0.8°C lower, respectively, indicating that the canopy branches and leaves of orchard trees and apricot water-protected forest could block solar radiation and reduce the amount of solar radiation reaching the near ground. Therefore, the maximum daily temperature in the forest can be reduced. The larger canopy width of the orchard apple tree has a stronger shielding effect on solar radiation, and the cooling effect is more obvious. The data showed that after 15:10pm, as the amount of solar radiation gradually decreased, the air temperature also dropped.

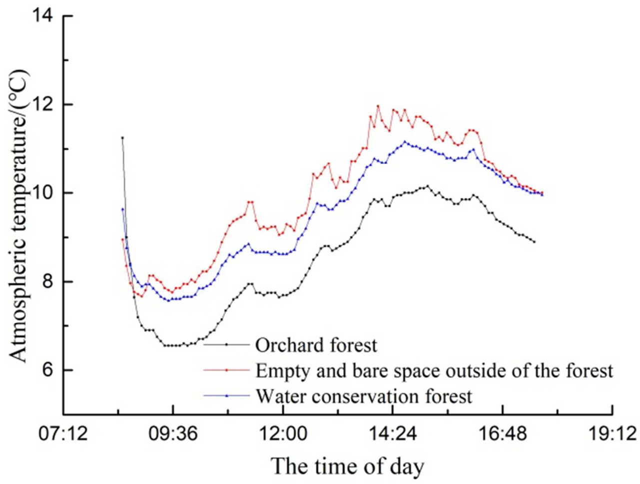


Figure 3. *Daily variation curve of air temperature in autumn.*

(2) Analysis of diurnal variation of autumn air temperature: The results show that: The average daily temperature was 10.1°C, 9.8°C and 8.8°C (see Table 3), respectively, and the average daily temperature was 1.3°C and 0.2°C lower in the orchard forest and in the water conservation forest than in the open forest. The main reason was that the total solar radiation in the region dropped significantly in autumn. At the same time, the surface space covered by fruit trees or water conservation forests is cooler. However, under the same conditions, because different vegetation cover has different shielding effect on solar radiation, the temperature in the forest is also different. From the actual analysis, the leaves of the mountain apricots in the water-preserved forest began to fall first with the fruit trees. However, due to the application of a certain amount of quick-available fertilizer and organic fertilizer in the orchard management process, the fruit trees always maintained a high level of soil fertility during the growth of the fruit trees. Therefore, when the

water-preserved forest began to appear or the phenomenon of defoliation occurred, the fruit trees still maintained almost complete canopy branches and leaves. Obviously, the canopy leaf area index of fruit trees is much greater than that of water-protected forest, and the shielding effect of canopy branches and leaves on solar radiation entering the forest is also greater than that of water-protected forest, resulting in the average daily temperature in the orchard forest in autumn is much lower than that in the water-protected forest.

4.1.4. Difference and Effect Analysis of Air Temperature Variation Between Different Seasons

(1) Analysis of seasonal variation of air temperature

By averaging the daily observed temperature in different seasons (see Table 3), the analysis results show that the variation of air temperature in different seasons is as follows: summer > spring > autumn; The variation law of near-surface air temperature at basin scale is basically consistent with the seasonal variation law of local air temperature.

(2) Effect analysis

Through the analysis of the diurnal variation of air temperature in spring, summer and autumn, the results show that vegetation cover has a certain regulatory effect on near-surface air temperature at watershed scale, which is mainly manifested as the accumulated temperature effect on the daily maximum air temperature in the forest and the cooling effect on the daily average air temperature.

Cumulative temperature effect on the daily maximum air temperature in the forest: The analysis of the daily change characteristics of the air temperature in the forest in spring shows that the cumulative temperature effect of vegetation cover on the daily maximum temperature near the ground in the small watershed makes the daily maximum temperature in the forest 0.4 ~ 1.1°C higher than that in the open land.

The cooling adjustment effect is as follows:

(1) Compared with the open land outside the forest, both orchard economic forest and water-preserved forest have the effect of reducing air temperature in summer and autumn, but the cooling effect is different in different seasons, and the average daily temperature drop in summer is higher than that in autumn. Compared with the open areas outside the forest, the average daily air temperature in the fruit tree economic forest and water conservation forest decreased by 0.1 ~ 3.0°C compared with the open areas outside the forest.

(2) Different vegetation cover has different cooling regulation effects. The above analysis shows that because different canopy structures of vegetation have different shielding effects on solar radiation, there are obvious differences in the cooling effects of the two types of vegetation cover. Relatively, fruit trees have larger canopy width and leaf area index than mountain apricot or robinia acacia water-preserved forests, which have greater shielding effect on solar radiation and plant transpiration effect. The cooling effect of fruit tree economic forest is more obvious than that of water conservation forest, especially during the most vigorous growth period in summer.

(3) The temperature regulation of vegetation cover is affected by the observed weather. For example, in spring when the atmosphere is unstable, vegetation cover has a regulating effect on the average daily temperature. In non-rainfall weather, the average daily temperature in the forest is lower than that outside the forest, and the regulating temperature range is 0.6°C; in rainfall weather, it has a warming effect, and the regulating temperature range is 0.1 ~ 0.7°C.

Table 3. *Air temperature in different seasons (°C).*

Compare	**Spring daily mean (°C)**			**Summer daily mean (°C)**		
	Measured	**Contrast**	**Difference**	**Measured**	**Contrast**	**Difference**
Orchard forest	13.2	13.8	-0.6	19.2	21.2	-3.0
Water conservation forest	13.8	13.8	0.0	20.1	21.2	-1.1

Compare	**Autumn daily mean (°C)**			**Overall daily mean (°C)**		
	Measured	**Contrast**	**Difference**	**Measured**	**Contrast**	**Difference**
Orchard forest	8.8	10.1	-1.3	13.7	15.0	-1.3
Water conservation forest	9.8	10.1	-0.3	14.6	15.0	-0.5

Explanation: The control value is the daily average temperature observed in the open land outside the forest.

In conclusion: (1) Due to the absorption and shielding effect of the canopy on solar radiation, the air temperature in the forest in the three seasons was basically lower than that in the open land outside the forest, and both the fruit tree economic forest and the water conservation forest had cooling regulating effect on the near-surface air temperature; (2) The canopy width of fruit tree economic forest is large, the branches and leaves are thick, and the temperature reduction effect in orchard forest in 3 seasons is higher than that in water conservation forest, and the cooling regulation effect is more obvious.

4.2. Changes in Relative Humidity of Air Inside and Outside the Forest

4.2.1. Diurnal Variation Characteristics of Air Relative Humidity in Spring Season

(1) Diurnal variation characteristics of the relative humidity of air inside and outside the forest: The relative humidity of air inside and outside the forest gradually increased during the measured time range of 9h during the day, from 8:30am to 8:55am, as shown in Figure 4. The relative humidity of air inside the orchard forest, inside the

water conservation forest and outside the forest were at 8:45am, 8:55am and 8:45 am, respectively, the air relative humidity reached the maximum daily value, and the maximum daily relative humidity was 75.0%, 68.4% and 67.0%, respectively. Due to the absorption and shielding of the solar radiation by the tree canopy in the forest, the average daily maximum relative humidity of the air in the orchard and the water conservation forest was higher than that in the open land outside the forest. The canopy structure of fruit tree economic forest is more compact than that of water conservation forest, and the maximum daily air relative humidity is the highest, which is 6.6% higher than that of water conservation forest and 8.0% higher than that of open land outside the forest. After 8:55am, due to the gradual enhancement of solar radiation, transpiration near the ground is continuously enhanced, resulting in a decreasing process of air relative humidity.

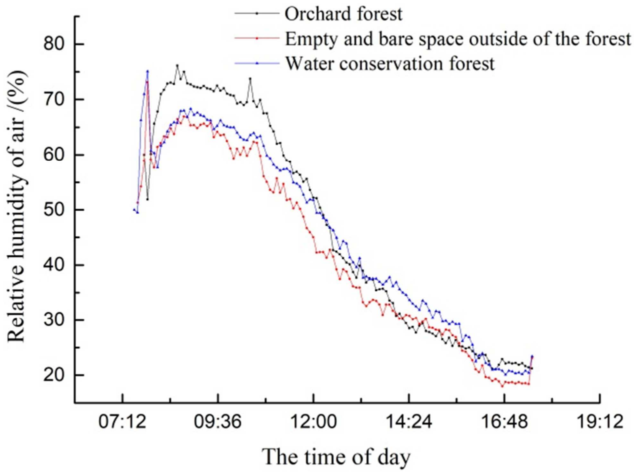


Figure 4. *Daily variation curve of air relative humidity in spring.*

(2) Difference analysis of daily variation of air relative humidity in spring: In the orchard forest > in the water conservation forest > in the open bare land outside the forest, the relative humidity was 46.7%, 45.8% and 42.6%, respectively (see Table 4). Obviously, the absorption and shielding of solar radiation by the vegetation canopy reduced the evaporation of water vapor in the forest, making the relative humidity of air in the forest higher than that outside the forest for a period of time. The daily average relative humidity in orchard forest and water conservation forest was 4.1% and 3.2% higher than that in open and bare forest, respectively. At the same time, because the fruit trees have a tighter canopy structure than the water-preserved forest, the effect of absorbing and shielding solar radiation to reduce water vapor evaporation is greater than that of the water-preserved forest, which is conducive to improving the relative humidity of the air in the orchard forest, and the average daily value is 0.9% higher than that of the water-preserved forest.

The results show that the relative humidity of air near the ground in spring is affected by both vegetation cover factors and specific cover conditions, and is related to the canopy structure and planting density of vegetation under different covers. It can be seen that the temperature change caused by solar radiation is the main factor affecting the relative humidity of air, and the low surface temperature before sunrise is the main reason why the relative humidity of air is higher in the morning than in other time periods.

4.2.2. Diurnal Variation Characteristics of Air Relative Humidity in Summer

(1) Diurnal variation characteristics of the relative humidity of air inside and outside the forest in summer: the relative humidity of air inside and outside the forest gradually increases from 8:30 am to 9:10 am, as shown in Figure 5. The relative humidity of air inside the orchard forest, inside the water conservation forest and outside the open bare land is 9:10 am, 9:05 am and 9:05 am, respectively, the daily maximum values were 74.5%, 73.1% and 65.4%, respectively. As the tree canopy and branches and leaves absorbed and shielded part of the solar radiation and reduced the evaporation of water in the forest, the daily maximum values of air relative humidity in the orchard forest and the water conservation forest were higher than those in the open and bare areas outside the forest. The canopy of fruit tree economic forest has a stronger shielding effect on solar radiation, and the maximum daily value of relative humidity of air is 1.2% higher than that of water-preserved forest. After 9:10 am, due to the gradual enhancement of solar radiation, the increase of evaporation near the ground leads to a gradual decrease in air relative humidity.

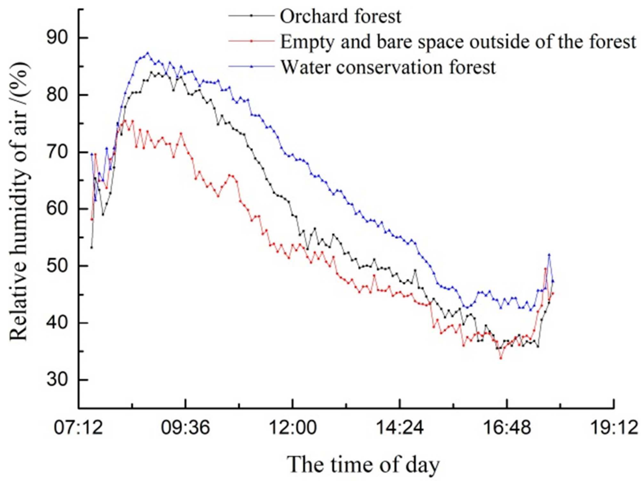


Figure 5. *Daily variation curve of air relative humidity in summer.*

(2) Difference analysis of daily variation of air relative humidity in summer: The relative humidity was 64.1%, 57.9% and 53.0% (see Table 4), respectively, in the water-protected forest > in the orchard forest > in the open bare land outside the forest. The average daily relative air humidity in the fruit tree economic forest and the water-protected forest was 11.1% and 4.9% higher than that in the bare land outside the forest, and in the water-protected forest was 6.2% higher than that in the orchard forest. As the solar radiation becomes more intense in summer, the change of relative air humidity caused

by the change of solar radiation will be more intense, resulting in an increase in the difference of average daily relative air humidity between different vegetation cover and open and bare land.

4.2.3. Characteristics of Diurnal Variation of Air Relative Humidity in Autumn

(1) Analysis of diurnal variation characteristics of the air relative humidity inside and outside the forest in autumn: the relative humidity of the air inside and outside the forest presents a small and slowly increasing change during the period of 8:30am ~ 10:05am, as shown in Figure 6. The average daily relative humidity of the air inside the orchard forest, the water conservation forest and the open bare land outside the forest is 9:50am, 9:45am and 10:05am, respectively, the maximum values were 86.8%, 85.1% and 84.1%, respectively. The average daily maximum relative humidity of air in the forest was higher than that in the open land outside the forest, indicating that the shielding and absorption of solar radiation by the tree canopy in the forest reduced the evaporation of water vapor in the forest, which was conducive to improving the relative humidity of air in the forest. After 10:05am, due to the gradual increase of solar radiation, the near-surface evaporation is enhanced, and the relative humidity of air shows a gradual decline. Among them, the relative humidity of air in orchard forest, water conservation forest and open space outside forest is at 15:15pm, 14:40pm and 14:35pm, respectively, the daily minimum values were 76.1%, 76.3% and 79.5%, respectively. Compared with the daily maximum air relative humidity, the decrease was 12.7%, 8.8% and 8.2%, respectively, and the decrease in forest was higher than that in open land. Obviously, due to the extensive use of reflective film in the management process of fruit ripening in autumn in order to promote coloring, the reverse radiation in the forest is enhanced, resulting in greatly enhanced water vapor evaporation in the orchard forest. Therefore, the decline of the relative humidity in the orchard forest in autumn is the largest; But the relative humidity of air increases slightly at 15:15pm, which indicates that in autumn, when the average daily temperature is relatively low and precipitation is relatively sufficient, during the process of decreasing solar radiation and temperature, the sufficient water vapor in the near layer of the atmosphere will be timely supplemented to the near surface under the action of gravity, resulting in the change process of rising relative humidity of air. It can be inferred that, in autumn, the relative humidity of the air near the ground in the evening or at night may reach close to saturation.

(2) Analysis of diurnal variation of relative air humidity in autumn: the difference of daily relative air humidity between the open areas outside the forest and the open areas outside the forest was: open areas outside the forest > water conservation forest > orchard forest, with values of 81.7%, 80.1% and 79.1%, respectively (see Table 4). The daily average values of fruit tree economic forest and water conservation forest were 2.6% and 1.6% lower than those of open areas outside the forest.

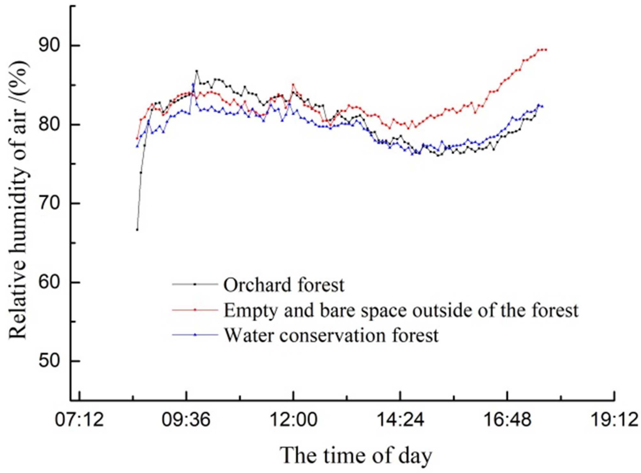


Figure 6. *Daily variation curve of air relative humidity in autumn.*

4.2.4. Difference and Effect Analysis of Air Relative Humidity Change Between Different Seasons

(1) Analysis of the difference in the variation of air relative humidity between seasons: The difference in the daily variation of air relative humidity between different seasons is as follows: Autumn > summer > spring (see Table 4). Obviously, due to the seasonal distribution of precipitation in this region, the relative humidity of the air in summer and autumn is higher than that in spring. Therefore, the seasonal distribution of the relative humidity of the air is coupled with the seasonal distribution of precipitation in the Hulu River Basin.

(2) Analysis of humidifying and moisturizing effects inside and outside the forest and differences: According to the diurnal variation characteristics of air relative humidity and the difference of diurnal variation of air relative humidity in and out of the forest, the results showed that different vegetation coverage conditions had a certain degree of regulation on the air relative humidity in the forest, which was mainly manifested as the humidification and moisturizing effect in the forest in spring and summer, and the moisturizing effect in the forest in summer was conducive to the regulation of the high temperature in the forest in summer. Compared with the control in the open and bare areas outside the forest, due to the absorption and shielding of solar radiation by the canopy in the forest, the relative humidity of air in the forest is higher than that outside the forest, resulting in humidification and moisturizing effect. The average daily relative humidity of air in the forest is higher than that outside the forest in spring and summer, with a difference of 3.2% to 11.1% (see Table 4). The difference of air relative humidity is beneficial to improve soil moisture in forest, increase water absorption on the surface of vegetation branches and leaves, regulate vegetation growth temperature and promote growth. In autumn, the temperature and ground temperature outside the forest may be lower than that inside the forest, making it easier for water vapor condensation to occur outside the

forest. For example, rain and dew are easy to occur on the open grassland after low temperature at night, thereby increasing the relative humidity of air outside the forest in autumn.

Table 4. *Relative humidity of air in different seasons (%).*

Compare	Spring daily mean (%)		
	Measured	Contrast	Difference
Orchard forest	46.7	42.6	4.1
Water conservation forest	45.8	42.6	3.2

Compare	Summer daily mean (%)		
	Measured	Contrast	Difference
Orchard forest	57.9	53.0	4.9
Water conservation forest	64.1	53.0	11.1

Compare	Autumn daily mean (%)		
	Measured	Contrast	Difference
Orchard forest	80.1	81.7	-1.6
Water conservation forest	79.1	81.7	-2.6

4.2.5. Correlation Analysis Between Air Temperature and Air Relative Humidity

Since changes in the amount of solar radiation will lead to corresponding changes in the air temperature near the ground, in order to further analyze the influence and effect of air temperature on the relative humidity of the air and the degree of influence, so as to explain the absorption and shielding effect of vegetation canopy structure on solar radiation, Pearson correlation analysis method was used to analyze the correlation between air temperature (°C) and air relative humidity (%) inside and outside the forest. The results showed that:

(1) In spring, the air temperature of open open land outside forest had a very significant negative correlation with the air relative humidity at the level of 0.01 ($p<0.01$), and the correlation coefficient $r=-0.916$, indicating that the air relative humidity was extremely sensitive to the change of air temperature and rapidly decreased with the increase of air temperature in the mountain climate of small watershed. Comparing the correlation between air temperature and air relative humidity in orchard forest and water conservation forest, there was a very significant negative correlation in orchard at 0.01 level ($p<0.01$), correlation coefficient $r=-0.928$, and there was a significant negative correlation between air temperature and air relative humidity in water-conservation forest at 0.05 level ($p<0.05$). The correlation coefficient $r=-0.909$ (see Table 5), and the significant difference indicates that the temperature in the forest caused the negative correlation change of the air humidity in the forest was relatively weak.

(2) The same as in spring, the air temperature and air relative humidity of the bare land outside the forest in summer had extremely significant negative correlation at 0.01 level ($p<0.01$), and the correlation coefficient $r=-0.901$, indicating that the air relative humidity decreased with the increase of air temperature. There were differences in the correlation between air temperature and air relative humidity in orchards and water-preserved forests. The orchards had extremely significant negative correlation at 0.01 level ($p<0.01$), and the correlation coefficient $r=-0.959$; the water-preserved forests had significant negative correlation at 0.05 level ($p<0.05$), and the correlation coefficient $r=-0.972$ (see Table 5). Obviously, the daily average temperature difference between the forest and the open space caused this phenomenon. The observed daily average temperature difference between the forest and the open space of the fruit tree economic forest in summer was -3.0°C, while that between the forest and the open space outside the water conservation forest was -1.1°C. It can be seen that the average daily temperature difference determines the strength of the negative correlation between air temperature and air relative humidity. The greater the absolute value of the temperature difference, the more significant the negative correlation, and the rise of air temperature is more likely to cause the change of air relative humidity decline.

(3) There was a significant negative correlation between air temperature and air relative humidity at 0.01 level ($p<0.01$), and the correlation coefficient $r=-0.609$. Similarly, air temperature and air relative humidity in orchards and water-protected forests had extremely significant negative correlation at 0.01 level ($p<0.01$), and the correlation coefficients r were -0.868 and -0.907, respectively (see Table 5). The absolute values of the correlation coefficients were as follows: in orchard forests < in water-protected forests. It can be seen that the decrease of air relative humidity caused by the increase of air temperature in water conservation forest in autumn is more sensitive than that in fruit tree economic forest.

The above analysis of different seasons shows that the change of air relative humidity decrease caused by air temperature increase in orchard forest and water conservation forest at the same observation site is different in time and space, reflecting that different vegetation structures in the underlying surface of small watershed have different effects on air temperature and relative humidity in mountain microclimate.

The correlation analysis between air temperature and air relative humidity shows that there is a negative correlation between air temperature and air relative humidity in watershed scale microclimate, that is, air relative humidity decreases with the increase of air temperature, and the correlation is also different at different observation points due to the differences in underlying surface characteristics.

Table 5. *Correlation analysis between air temperature and air relative humidity.*

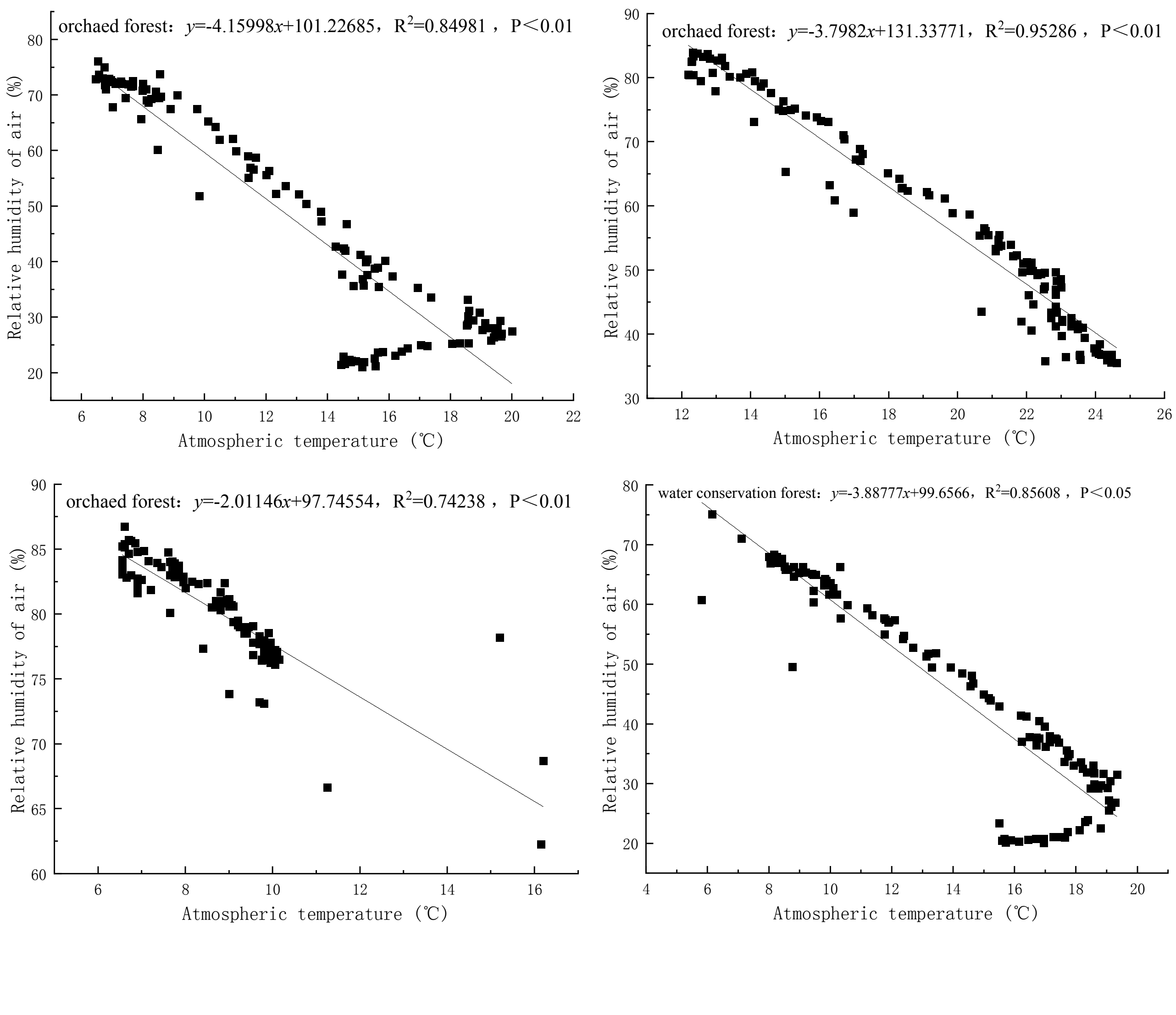
Compare	Spring correlation coefficient	summer correlation coefficient	autumn correlation coefficient
Orchard forest	-0.928**	-0.959**	-0.868**
Water conservation forest	-0.909*	-0.972*	-0.907**
Compare	-0.916**	-0.901**	-0.609**

**. At 0.01 level (two-tailed), the correlation was significant; *. At level 0.05 (two-tailed), the correlation was significant.

On the basis of the above correlation analysis, through linear and polynomial fitting, the model was optimized according to the adjusted correlation coefficient R^2, and the fitting equation (see Table 6) and fitting curve (see Figure 7) between air temperature and air relative humidity were obtained. The fitting equation quantitatively describes the functional relationship between air temperature and air relative humidity under different underlying surface conditions in the Hulu River Basin, and provides reference for subsequent microclimate observation and other fields.

Table 6. *Fitting equation of air temperature (°C) and air relative humidity (%).*

Compare	Fitting equation		
	Spring	summer	Autumn
Orchard forest	$y=-4.15998x+101.22685$ $R^2=0.84981$	$y=-3.7982x+131.33771$ $R^2=0.95286$	$y=-2.01146x+97.74554$ $R^2=0.74238$
Water conservation forest	$y=-3.88777x+99.6566$ $R^2=0.85608$	$y=-4.04027x+145.19581$ $R^2=0.92327$	$y=-1.77606x+96.50144$ $R^2=0.81823$
empty and bare space outside of The forest	$y=-3.92066x+97.1028$ $R^2=0.85042$	$y=-3.91206x+136.04035$ $R^2=0.83669$	$y=-0.61655x^2+10.77664x+36.93558$ $R^2=0.94843$



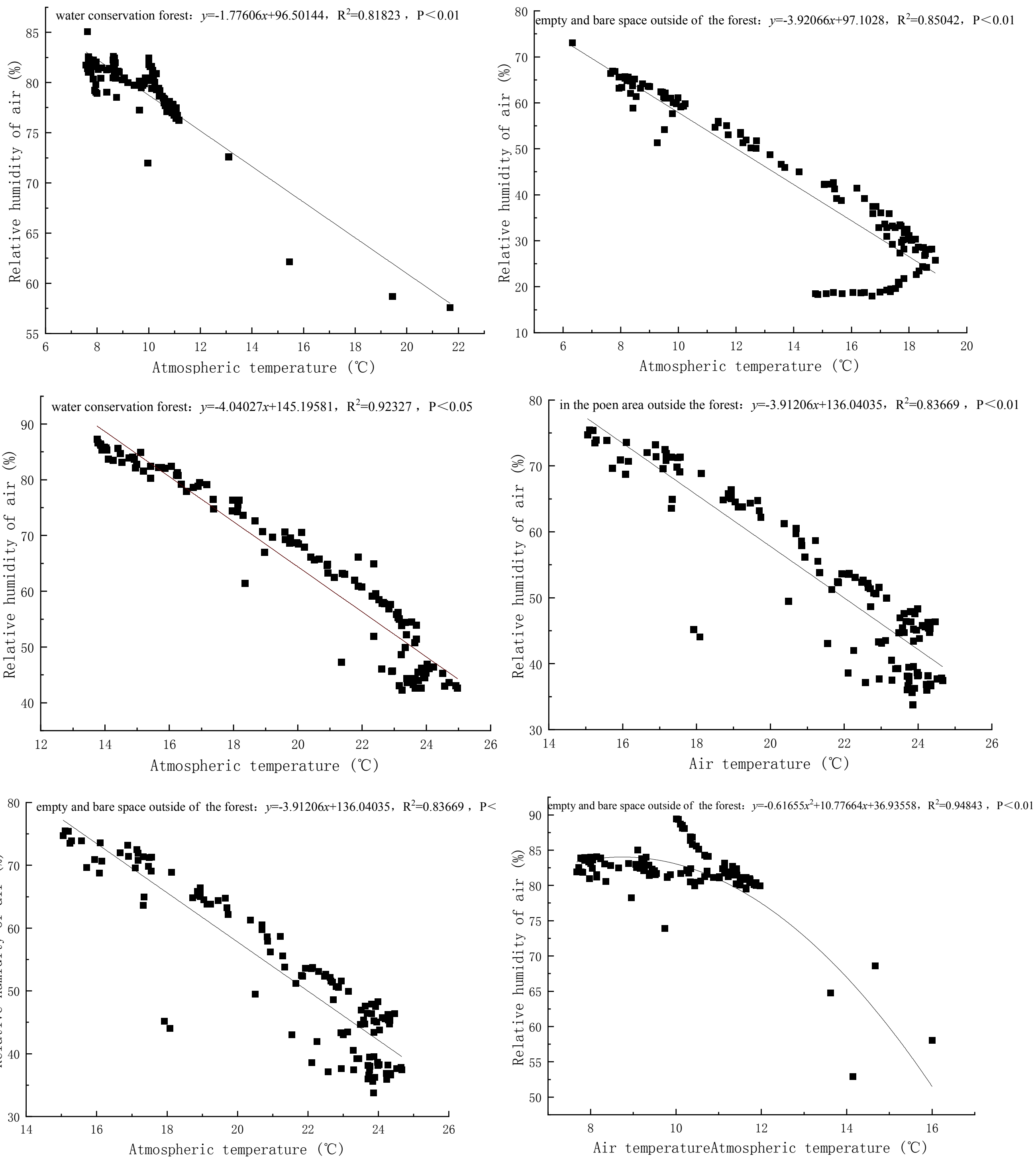


Figure 7. *Fitting curve of air temperature and relative humidity.*

4.2.6. Correlation Analysis Between Average Wind Speed and Air Relative Humidity

In order to further explain the influence of the change of average air speed on the relative humidity of air, the correlation between the average air speed and the relative humidity of air in and outside the forest under different vegetation coverage conditions in different seasons was analyzed. The results showed that:

(1) In spring, the average wind speed in the forest and the open area outside the forest had a significant negative correlation with air relative humidity at 0.01 level ($p<0.01$), and the correlation coefficients r were -0.236 and -0.425, respectively. The average wind speed in the water conservation forest had a significant negative correlation with air relative humidity at 0.05 level ($p<0.05$). The correlation coefficient $r=-0.546$ (see Table 7) indicates that the relative humidity of air in and outside the forest is affected by the average wind speed, and the relative humidity of air decreases with the increase of wind speed.

(2) In summer, the average wind speed in orchard forest, water conservation forest and open areas outside the forest had extremely significant negative correlation with air relative humidity at 0.01 level (p<0.01), and the correlation coefficients r were -0.231, -0.208 and -0.450, respectively (see Table 7).

(3) There was a positive correlation between the average wind speed and the relative humidity of the air in the orchard forest and the open area outside the orchard forest in autumn, among which the open area outside the forest had a very significant positive correlation (p<0.01), the correlation coefficient r=0.256, and the orchard forest inside the orchard forest had a significant positive correlation (p<0.05). Correlation coefficient r=0.214, the average wind speed in the water conservation forest and air relative humidity at 0.05 level had a significant negative correlation (p<0.05), correlation coefficient r=-0.239 (see Table 7). Perhaps due to the greatly increased precipitation in autumn, the relative humidity of the air is originally in a high state. The change of local wind speed in a small range is conducive to improving the relative humidity of the air near the ground, and may also lead to the decline of the relative humidity of the air, such as the water conservation forest.

Table 7. *Correlation analysis between average wind speed (m/s) and air relative humidity (%).*

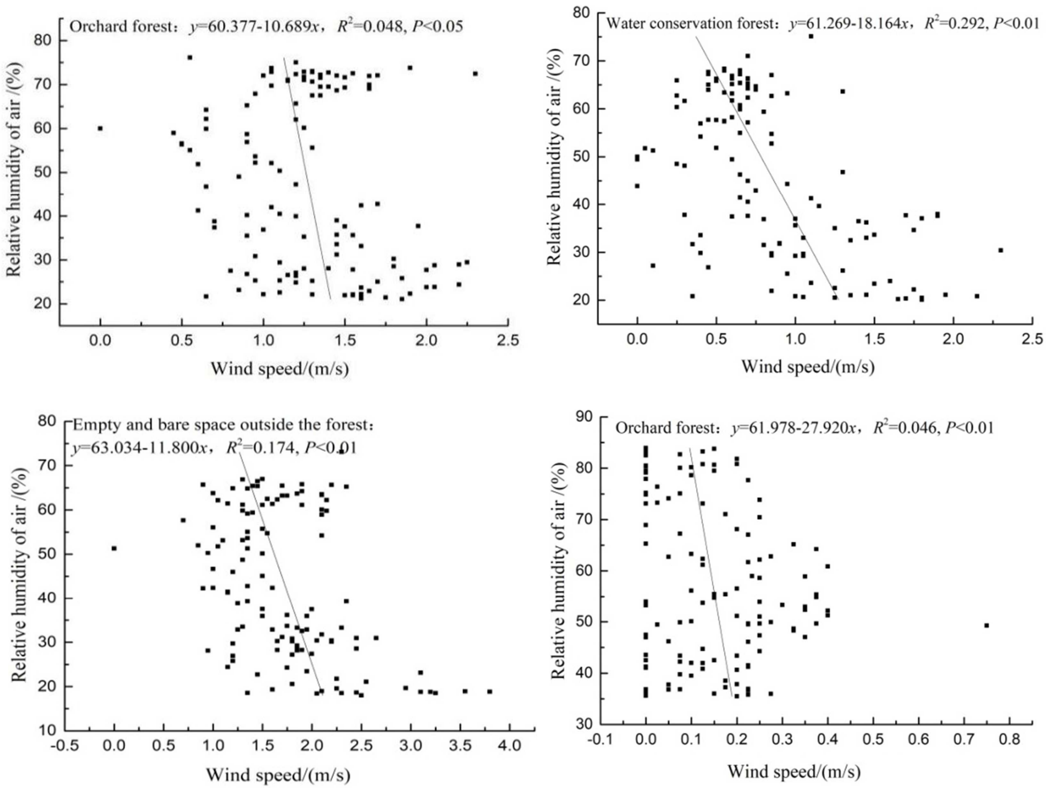
Compare	Spring correlation coefficient	summer correlation coefficient	autumn correlation coefficient
Orchard forest	-0.236**	-0.231**	0.214*
Water conservation forest	-0.546*	-0.208*	-0.239*
empty and bare space outside of The forest	-0.425**	-0.450**	0.256**

**. At 0.01 level (two-tailed), the correlation was significant; *. At level 0.05 (two-tailed), the correlation was significant.

On the basis of the above correlation analysis, the model was optimized by linear and polynomial fitting according to the adjuted correlation coefficient R2, and the fitting equation (see Table 8) and fitting curve (see Figure 8) of the average wind speed and air relative humidity were obtained. The fitting equation quantitatively describes the functional relationship between mean wind speed and air relative humidity under different underlying surface conditions in the Hulu River Basin, and provides reference for subsequent microclimate observation and other fields.

Table 8. *Fitting equation between average wind speed (m/s) and air relative humidity (%).*

Compare	Fitting equation		
	Spring	summer	Autumn
Orchard forest	y=-10.689x+60.377, R^2=0.048	y=-27.920x+61.978, R^2=0.046	
Water conservation forest	y=-18.16x+61.269, R^2=0.292	y=-12.77x+68.039, R^2=0.035	y=-1.420x+80.389, R^2=0.093
empty and bare space outside of The forest	y=-11.800x+63.034, R^2=0.174	y=-13.251x+71.657, R^2=0.196	y=-1.090x+75.095, R^2=0.048



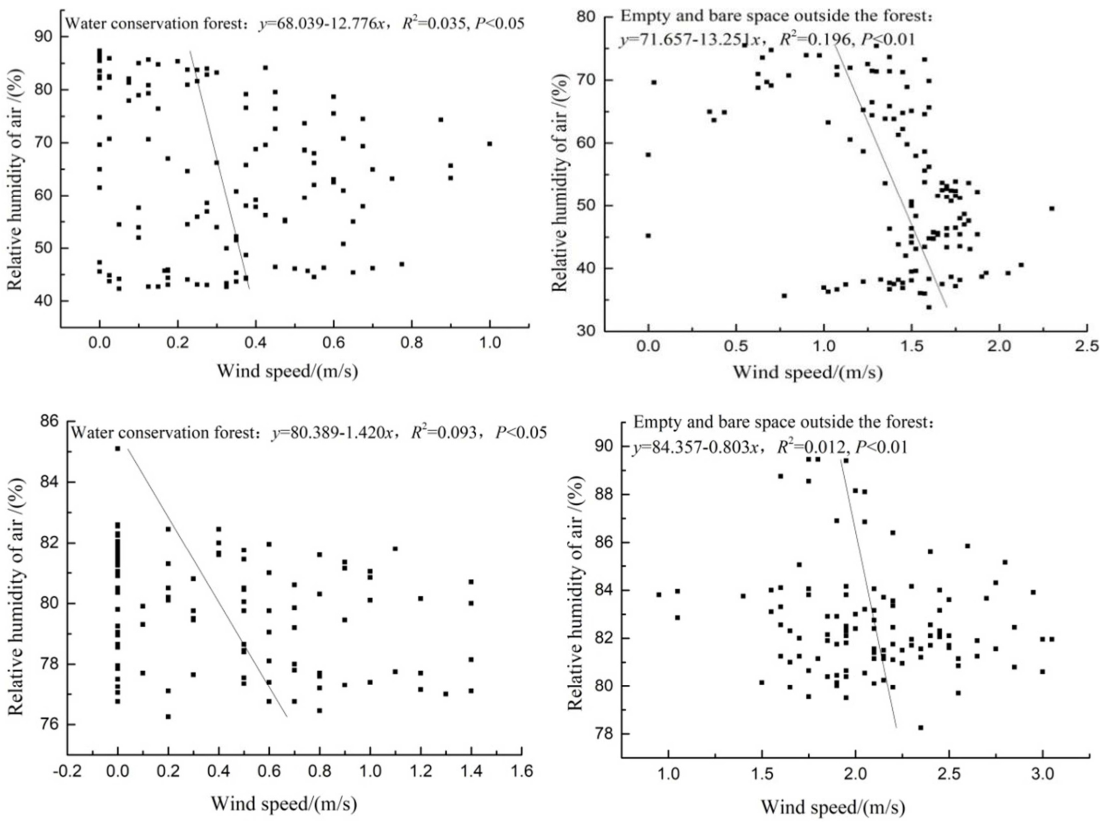


Figure 8. *Fitting curve of average wind speed and air wind speed.*

The analysis of correlation between average wind speed and air relative humidity shows that: in the watershed scale microclimate, the influence of average wind speed on air relative humidity is more complex and variable due to the transient change of near-surface air flow. On the one hand, it is related to the characteristics of underlying surface such as different landforms, and on the other hand, it is closely related to the weather conditions in the observation process.

4.3. Changes in Wind Speed of Air Inside and Outside the Forest

4.3.1. Diurnal Variation Characteristics of Spring Air Speed

The diurnal characteristics of the average wind speed in the forest and outside the forest in spring are as follows: the average wind speed in the forest and outside the forest gradually decreases during 8:30am ~ 11:50am, and the average wind speed in the orchard forest, the water conservation forest and the open land outside the forest is 11:40am, 11:50am and 11:25 am, respectively, the average daily wind speed reached the lowest value with 0.5m/s, 0.1m/s and 0.9m/s, respectively. Due to the blocking effect of fruit trees and water conservation forest, the average daily air speed in the forest was much lower than that in the open area outside the forest, indicating that both fruit tree economic forest and water conservation forest had obvious effect on reducing wind speed. According to the difference of average daily minimum wind speed between the forest and the forest, the wind speed of the fruit tree economic forest and the water conservation forest decreased by 0.4m/s and 0.8m/s, respectively. After 11:50am, due to the gradual enhancement of solar radiation, the temperature inside and outside the forest rose, and the mobility of the air near the ground gradually increased, and the average air speed also gradually increased, as shown in Figure 9.

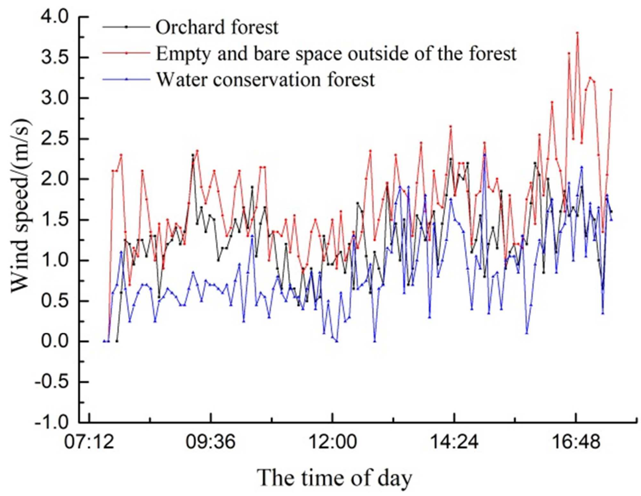


Figure 9. *Daily variation curve of average air speed in spring.*

Analysis of diurnal variation of air velocity in spring

The difference of average daily air speed between the forest and the open areas outside the forest is as follows: The average wind speed was 1.7m/s, 1.3m/s, and 0.9m/s (see Table 9), indicating that the stand structure of orchards and water-preserved forests had a significant effect on wind speed reduction. Among them, water-preserved forests had a greater effect on wind speed reduction than orchards, which may be related to the high density of water-preserved forests. As a result, the planting density is kept at a certain low density level, usually 833 plants /hm^2, while the planting density of water conservation forest is usually 1600 ~ 2100 plants /hm^2.

4.3.2. Diurnal Variation Characteristics of Summer Air Speed

(1) Diurnal variation of summer air velocity

Characteristics of the daily variation of the average wind speed in the air inside and outside the forest in summer: the daily variation of the average wind speed in the air outside the forest gradually increases from 8:30 am to 12:00 am, as shown in Figure 10. The average wind speed in the orchard forest, in the water conservation forest and in the open bare land outside the forest is at 12:00 am, 11:25 am and 11:50 am, respectively, the average air speed reached the daily maximum, with the highest average wind speed being 0.4m/s, 0.9m/s and 1.9m/s respectively. This was due to the rise of the air temperature near the ground in the afternoon, which intensified the upper and lower heat convection in the air, resulting in the rise of the wind speed in the air reaching the maximum value. With the decrease of the ground temperature, the heat convection continued to weaken, and the average air speed began to decline gradually. The results indicated that the average air speed was related to the change of air temperature near the ground caused by the change of solar radiation, and the daily maximum of the average air speed in orchard forest and water-protected forest was 1.5m/s and 1.0m/s lower than that in the open land outside the forest, respectively. Because the canopy of fruit trees and water-protected forest can block air flow, the air speed in forest can be effectively reduced. After 12:00 am, as the amount of solar radiation decreases, the average wind speed of the air inside and outside the forest gradually decreases.

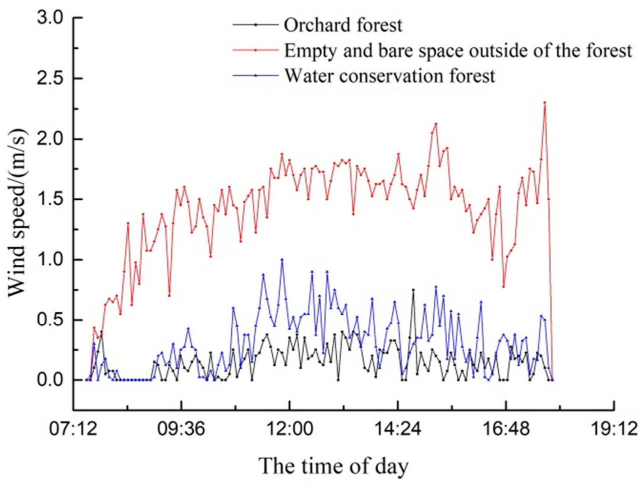


Figure 10. *Diurnal variation curve of average air speed in summer.*

(2) Analysis of diurnal variation of air velocity in summer

The average wind speed of the air in the forest was different from that in the open land outside the forest: open land outside the forest > water conservation forest > orchard forest, and the average daily wind speed was 1.4m/s, 0.3m/s and 0.2m/s, respectively (see Table 9). The average daily wind speed in the fruit tree economic forest and water conservation forest was 1.2m/s and 1.1m/s lower than that in the open land outside the forest.

4.3.3. Diurnal Variation Characteristics of Autumn Air Wind Speed

(1) Diurnal variation of air speed in autumn

Characteristics of diurnal variation of the average wind speed of air inside and outside the forest in autumn: The average wind speed of air inside and outside the forest changed steadily during the observation period from 8:30 am to 17:30 pm, as shown in Figure 11. Due to the weakening of solar radiation in autumn, the diurnal variation of air wind speed decreased.

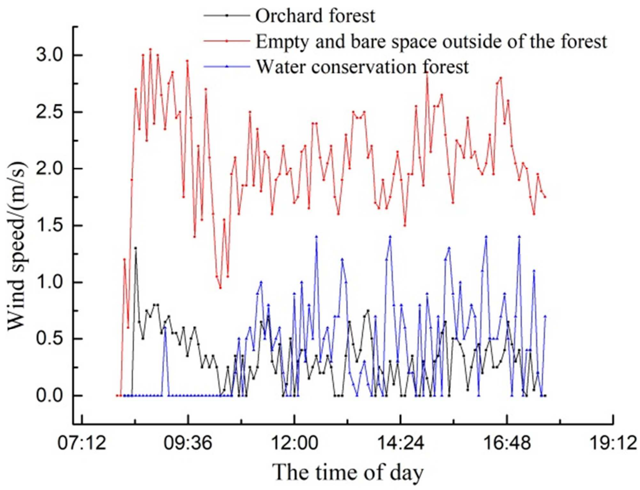


Figure 11. *Daily variation curve of average air speed in autumn.*

(2) Analysis of diurnal variation of air speed in autumn

The difference of average daily air speed between open areas outside forest and open areas outside forest was as follows: open areas outside forest > water conservation forest > orchard forest, and average daily air speed was 2.1m/s, 0.9m/s and 0.3m/s, respectively (see Table 9). The average daily air speed in fruit tree economic forest and water conservation forest was 1.8m/s and 1.2m/s lower than that in open areas outside forest.

4.3.4. Difference Analysis and Effect Analysis of Air Speed Variation Between Different Seasons

(1) Analysis of variation difference of average air speed between seasons

By averaging the average air speed under different vegetation cover conditions in different seasons (see Table 9), the analysis results show that the change characteristics of the daily average air speed in forest in different seasons are: autumn > summer > spring. This is mainly due to the dense foliage in the forest in autumn, and the higher wind speed in autumn, so the effect of wind speed reduction is obvious.

(2) Analysis of the effect of reducing the average air speed

Through the analysis of the diurnal variation characteristics and diurnal variation differences of the average air speed in spring, summer and autumn, the results showed that different vegetation cover conditions had the effect of reducing the average air speed in the forest, and the average daily air speed in the forest in spring, summer and autumn was 0.4m/s ~ 4.0m/s lower than that in the open area outside the forest. The decrease of the average wind speed in the forest can promote the gas exchange around the leaves and accelerate the transpiration rate, which is conducive to plant growth and increase the net production capacity of plants, especially conducive to the accumulation of sugar in fruit trees, so as to improve the quality of apples. However, there are differences in the regulating effects on the average air speed in the forest (see Table 9).

Table 9. *Air Speed in different seasons (m/s).*

Compare	Spring daily mean (%)		
	Measured	**Contrast**	**Difference**
Orchard forest	1.3	1.7	-0.4
Water conservation forest	0.9	1.7	-0.8

Compare	Summer daily mean (%)		
	Measured	**Contrast**	**Difference**
Orchard forest	0.2	1.4	-1.2
Water conservation forest	0.3	1.4	-1.1

Compare	Autumn daily mean (%)		
	Measured	**Contrast**	**Difference**
Orchard forest	0.3	2.1	-1.8
Water conservation forest	0.9	2.1	-1.2

4.3.5. Correlation Analysis Between Air Temperature and Air Wind Speed

In order to further show the effect and influence degree of air temperature inside and outside the forest on the average air speed, Pearson correlation analysis method was used to analyze the correlation between air temperature (°C) and average air speed (m/s). The results showed that:

(1) In spring, there was a significant positive correlation between air temperature and average wind speed in open areas outside forest at 0.05 level ($p<0.05$), and the correlation coefficient $r=0.254$. Compared with the correlation between air temperature and air speed in orchard forest and water conservation forest, there was a significant positive correlation in orchard at 0.05 level ($p<0.05$), and the correlation coefficient $r=0.189$. There was a very significant positive correlation at 0.01 level ($p<0.01$), and the correlation coefficient $r=0.440$, indicating that the average air speed gradually increased with the increase of air temperature (see Table 10).

(2) There was a significant positive correlation between the air temperature and the average air speed in the open land outside the forest in summer ($p < 0.01$), and the correlation coefficient $r=0.612$. Compared with the correlation between the air temperature and the average air speed in the orchard forest and the water conservation forest, there was a significant positive correlation between the orchard and the water conservation forest at the 0.01 level ($p < 0.01$). The correlation coefficients r were 0.323 and 0.362, respectively (see Table 10).

(3) There was a significant negative correlation between the air temperature outside the forest and the average wind speed at level 0.01 ($p<0.01$), and the correlation coefficient $r=-0.416$. Compared with the correlation between air temperature and air speed in the orchard forest, there was a very weak negative correlation in the orchard forest, and the correlation coefficient $r=-0.103$, while there was a very weak positive correlation in the water conservation forest. Correlation coefficient $r=0.111$ (see Table 10);

Through the analysis of the correlation between air temperature and air speed under different vegetation cover conditions, the results show that: There is a very significant positive correlation between air temperature and average air speed in summer, and the average air speed increases with the increase of air temperature. As the increase of air temperature aggravates the up-down convection of air and leads to the increase of wind speed, the variation range of air temperature in summer is higher than that in spring and autumn, making the correlation between air temperature and average air speed more significant than that in other two seasons.

Table 10. *Correlation analysis between air temperature (°C) and average wind speed (m/s).*

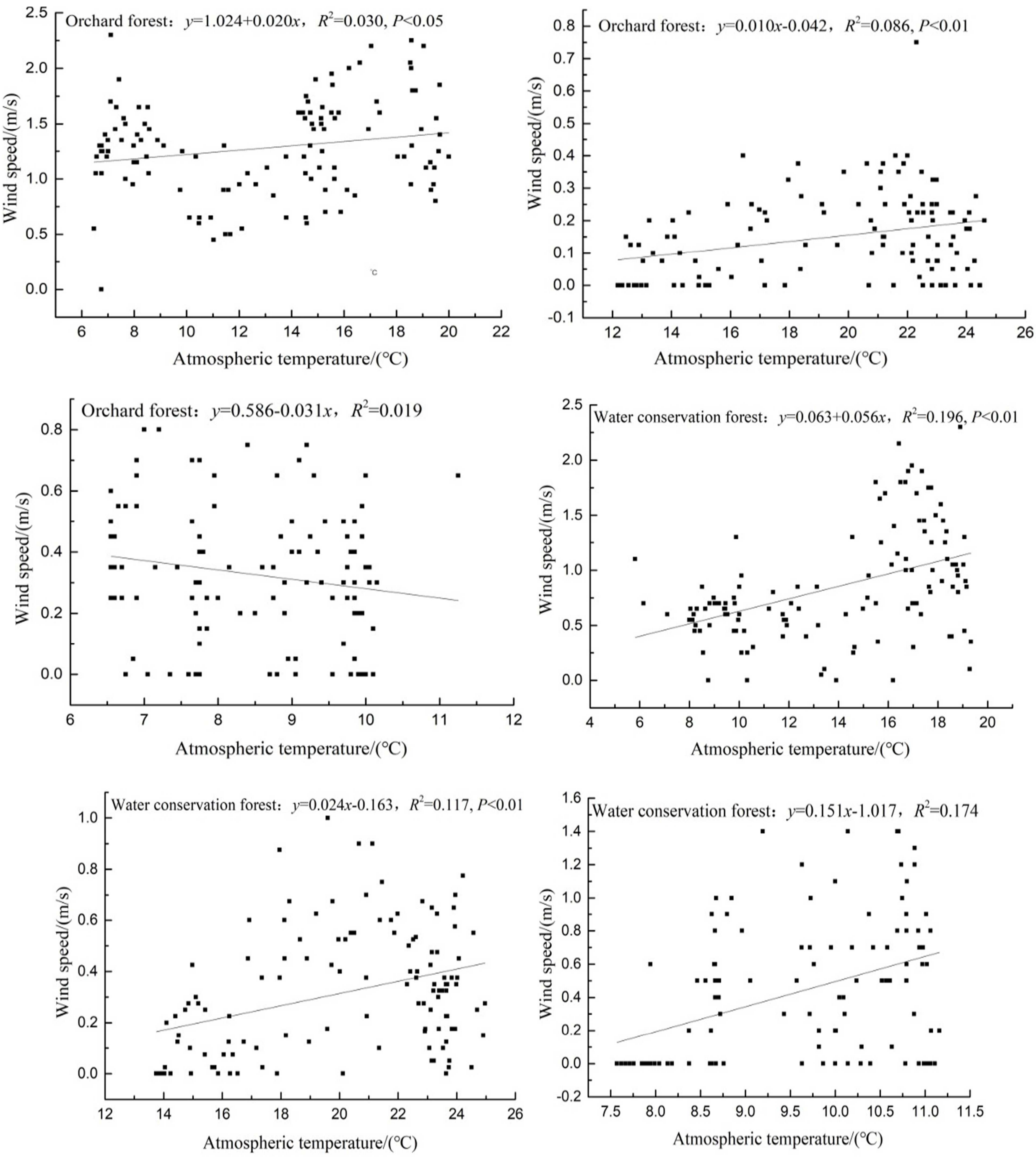
Compare	Spring correlation coefficient	summer correlation coefficient	autumn correlation coefficient
Orchard forest	0.189*	0.323**	-0.103
Water conservation forest	0.440**	0.362**	0.111
empty and bare space outside of The forest	0.254*	0.612**	-0.416**

**. At 0.01 level (two-tailed), the correlation was significant; *. At level 0.05 (two-tailed), the correlation was significant.

On the basis of the above correlation analysis, the linear and polynomial fitting between air temperature and average wind speed were carried out. The model was optimized according to the adjusted correlation coefficient R^2, and the fitting equation (see Table 11) and fitting curve (see Figure 12) between air temperature and air speed were obtained. The fitting equation can describe the functional relationship between air temperature and air wind speed under different vegetation cover conditions in the Hulu River Basin, and provide reference for subsequent microclimate observation and other fields.

Table 11. *Fitting equation of air temperature and air velocity.*

Compare	**Fitting equation**		
	Spring	**summer**	**Autumn**
Orchard forest	y=0.020x+1.024, R^2=0.030	y=0.010x-0.042, R^2=0.086	y=0.586x-0.031, R^2=0.019
Water conservation forest	y=0.056x+0.063, R^2=0.196	y=0.024x-0.163, R^2=0.117	y=0.151x-1.017, R^2=0.174
empty and bare space outside of The forest	y=0.040x+1.169, R^2=0.063	y=0.077x+0.196, R^2=0.345	y=0.036x^2-0.735x+5.747, R^2=0.004



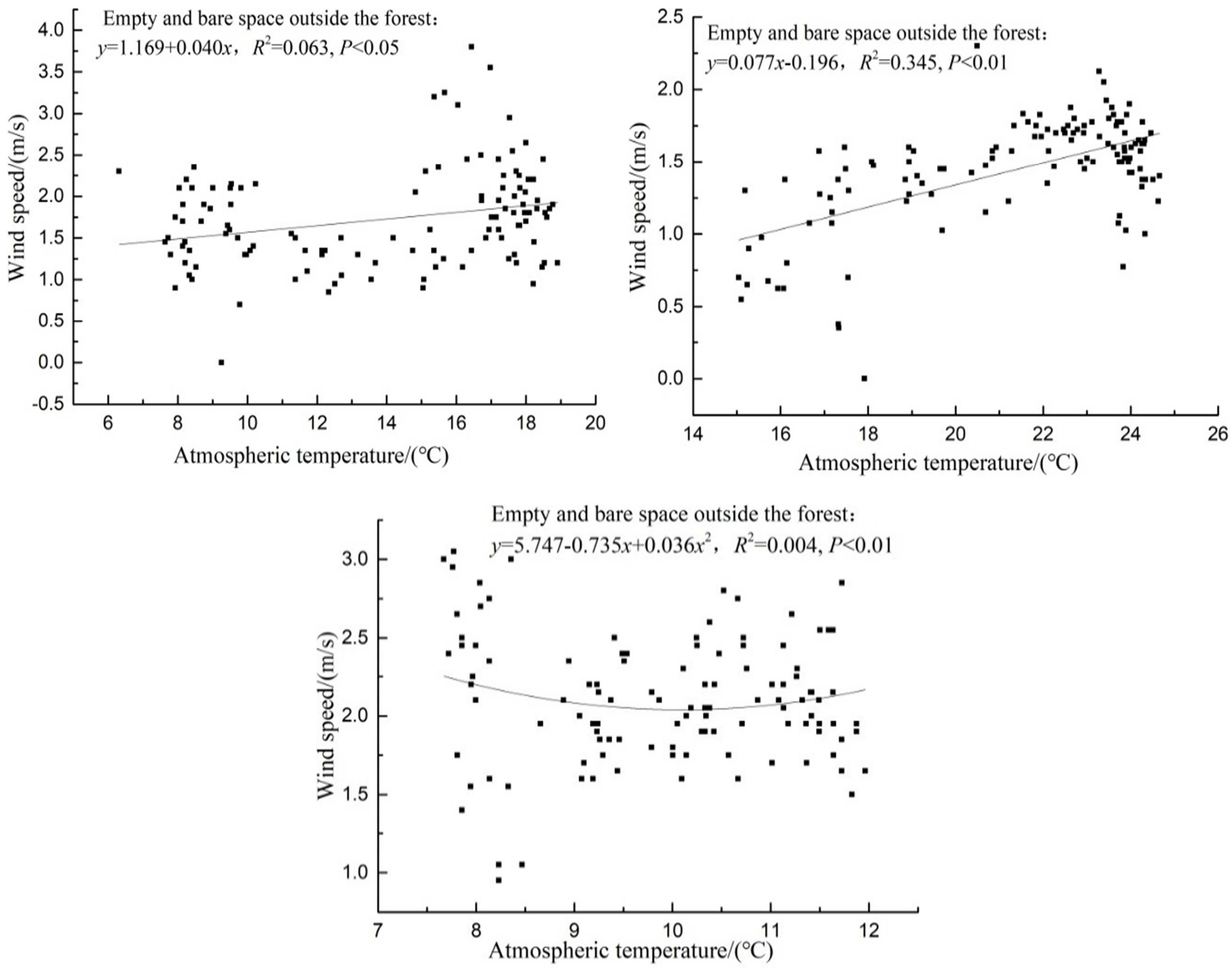


Figure 12. *Fitting curve of air temperature and air wind speed.*

4.4. Wind Direction Changes Inside and Outside the Forest

The change of wind direction at the catchment scale reflects the interaction between the regional atmospheric circulation and the underlying surface of the catchment. By observing the change of wind direction over a long period of time, we can understand the influence of wind on different landforms and land cover in the catchment, which is helpful for fruit farmers to arrange appropriate measures according to the wind direction in field management such as spraying pesticides, avoid disastrous weather caused by wind, and reduce agricultural losses.

4.4.1. Difference of Wind Direction Inside and Outside the Forest in Spring

In spring, the main wind direction was NNE in the orchard forest, the water conservation forest and the open land outside the forest. Among them, NNE, NE and ESE wind direction is dominant in orchard forest, NNE, NE and SW wind direction is dominant in water conservation forest, and NNE, NE and SW wind direction is dominant in open bare land outside forest, as shown in Figure 13.

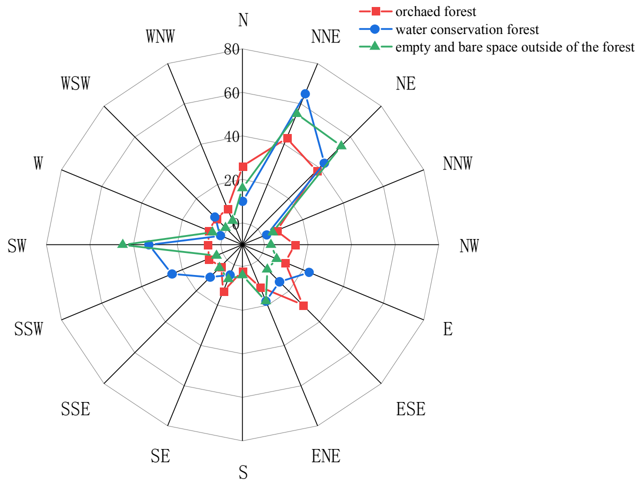


Figure 13. *Radar chart of wind direction in spring.*

4.4.2. Variation of Wind Direction Inside and Outside the Forest in Summer

In summer, the main wind direction is NNW in the orchard forest, SW in the water conservation forest, and SSW in the open land outside the forest. Among them, NNW, ENE and NE wind directions are dominant in orchard forest, SW, SSW and WSW wind directions are dominant in water conservation forest, and SSW, SE and SW wind directions are dominant in open areas outside forest, as shown in Figure 14.

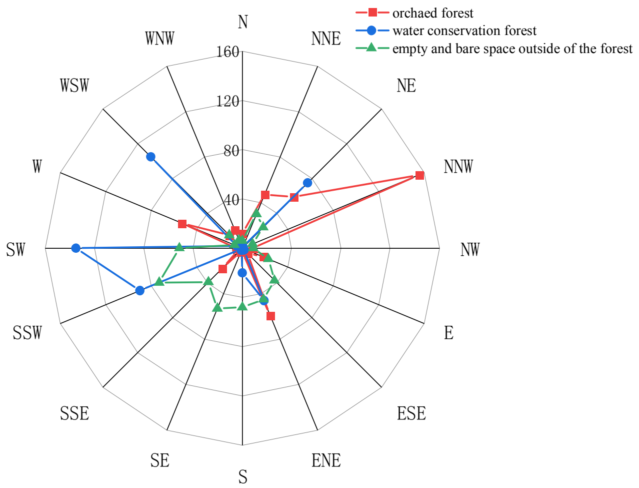


Figure 14. Radar chart of summer wind direction.

4.4.3. Wind Direction Difference Inside and Outside the Forest in Autumn

In autumn, the main wind direction in the orchard forest was SW, the main wind direction in the water conservation forest was NW, and the main wind direction in the open forest was SW. In the orchard forest, SW, WNW and NE wind directions are dominant, in the water conservation forest, NW, S and SSW wind directions are dominant, and in the open areas outside the forest, S, SSW and W wind directions are dominant, as shown in Figure 15.

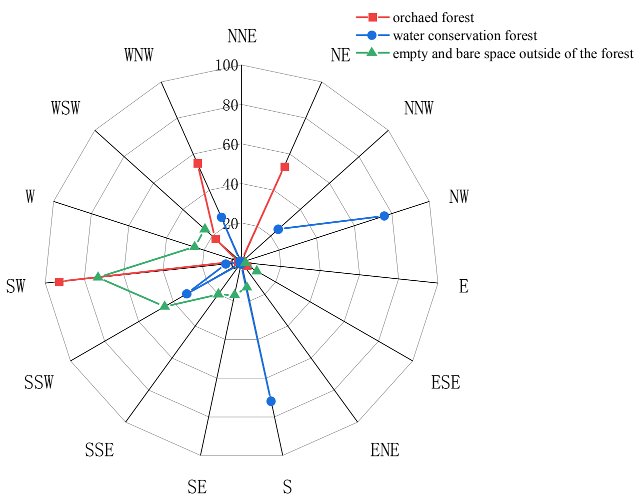


Figure 15. Radar chart of autumn wind direction.

4.5. Variation Characteristics of Digital Air Pressure Inside and Outside the Forest

4.5.1. Characteristics of Digital Pressure Changes in Spring

The digital air pressure in and outside the forest gradually increased and reached the daily maximum during 8:30am ~ 11:00am, among which the time of reaching the daily maximum digital air pressure in the orchard forest, the water conservation forest and the open area outside the forest were 11:00am, 10:35am and 10:25 am, respectively. the daily maximum digital pressure is 814.9hPa, 814.1hPa and 813.3hPa, respectively. After 11:00 am, the digital pressure inside and outside the forest gradually decreases, as shown in Figure 16.

The difference analysis of diurnal variation of digital pressure in spring: the difference of mean and maximum of digital pressure in spring is: inside orchard forest > inside water conservation forest > open bare land outside forest; The minimum value difference was: inside the water conservation forest > inside the orchard forest > outside the forest (see Table 12).

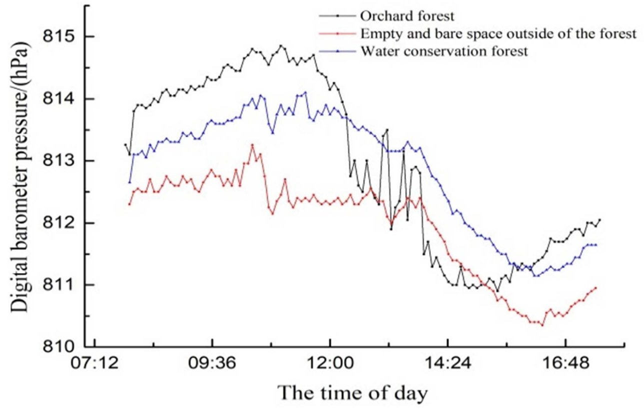


Figure 16. Diurnal variation curve of digital pressure (hPa) in spring.

4.5.2. Variation Characteristics of Digital Pressure in Summer

(1) Diurnal variation of digital pressure in summer: the digital pressure of air in and outside the forest gradually decreases during the period from 8:30 am to 17:30 pm, as shown in Figure 17.

(2) Analysis of diurnal variation of digital pressure in summer: the difference of mean digital pressure in summer is: water conservation forest > orchard forest > open bare land outside forest; The maximum difference is: orchard forest > water conservation forest > open land outside forest; The minimum value difference was: inside the water conservation forest > inside the orchard forest > outside the forest (see Table 12).

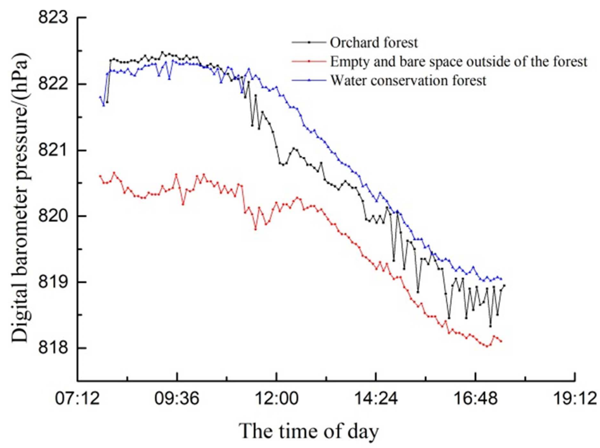


Figure 17. Diurnal variation curve of digital barometric pressure (hPa) in summer.

4.5.3. Autumn Digital Pressure Change

(1) Diurnal variation of digital air pressure in autumn: the digital air pressure in the forest and outside the forest gradually increased and reached the maximum daily value during the period of 8:30am to 11:25am, among which the time of reaching the maximum daily digital air pressure in the orchard forest, the water conservation forest and the open area outside the forest were 11:00am, 10:25am and 10:00 am, respectively. the maximum daily digital barometric pressure is 825.1hPa, 827.1hPa and 823.1hPa, respectively, and the digital barometric pressure inside and outside the forest gradually decreases at 11:25am, as shown in Figure 18.

(2) Diurnal variation difference analysis of digital pressure in autumn: water conservation forest > orchard forest > open bare land outside forest; The maximum difference was: inside the water conservation forest > inside the orchard forest > outside the forest; The minimum value difference was: inside the water conservation forest > inside the orchard forest > outside the forest (see Table 11).

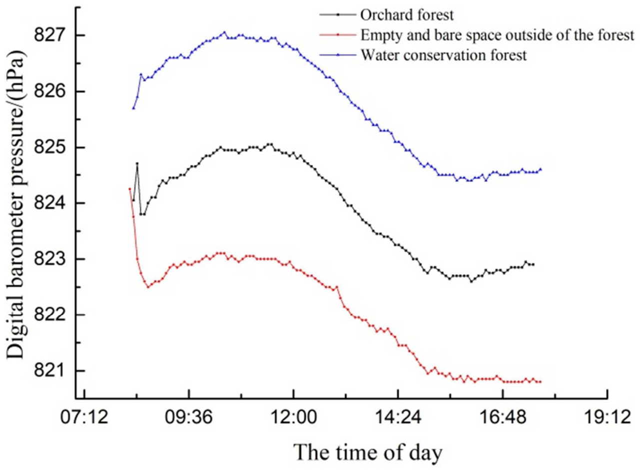


Figure 18. *Diurnal variation curve of digital pressure (hPa) in autumn.*

Table 12. *Digital Pressure (hPa) in different seasons.*

Compare	Spring			
	Mean value	**the maximum**	**The minimum**	**The difference**
Orchard forest	813.0	814.9	810.9	4.0
Water conservation forest	812.9	814.1	811.2	2.9
empty and bare space outside of The forest	811.9	813.3	810.4	2.9

Compare	Summer			
	Mean value	**the maximum**	**The minimum**	**The difference**
Orchard forest	820.8	822.5	818.3	4.2
Water conservation forest	821.1	822.4	819.0	3.3
empty and bare space outside of The forest	819.7	820.7	818.0	2.7

Compare	Autumn			
	Mean value	**the maximum**	**The minimum**	**The difference**
Orchard forest	823.9	825.1	823.9	2.5
Water conservation forest	825.8	827.1	825.8	2.7
empty and bare space outside of The forest	822.1	823.1	820.8	2.3

5. Conclusion

The research results show that a certain vegetation cover on the lower surface of the basin has the effects of cooling, humidifying and reducing wind speed to a certain extent, which is conducive to improving the microclimate of small watershed, as follows:

(1) At the catchment scale, vegetation cover has a certain regulatory effect on near-surface air temperature, and is affected by the observed weather. This regulatory effect is mainly manifested as the cumulative temperature effect on the daily maximum temperature in the forest and the cooling effect on the daily average air temperature.

(2) Due to the absorption and shielding of solar radiation by forest canopy, both fruit tree economic forest and water conservation forest have cooling regulating effect on near-ground air temperature, which reduces the average daily temperature in forest by 0.1 ~ 3.0°C compared with the air temperature in open land outside forest. However, the cooling regulation effect in summer is more significant than that of other seasons.

(3) The cumulative temperature effect of vegetation cover on the daily maximum temperature near the ground in the small watershed in spring made the daily maximum temperature in the forest 0.4 ~ 1.1°C higher than that in the open area outside the forest.

(4) Different vegetation coverage conditions have a certain degree of regulating effect on the relative humidity of air in the forest, which is mainly reflected in the humidification and moisturizing effect in the forest in spring and summer, which increases the relative humidity of air in the forest by 3.2% to 11.1% compared with that outside the forest. The seasonal distribution of the relative humidity of air is basically coupled with the seasonal distribution of precipitation in the Hulu River Basin.

(5) Different vegetation cover conditions have the effect of reducing the average air speed in the forest, and the average daily air speed in the forest is 0.4m/s ~ 4.0m/s lower than that in the open area outside the forest.
(6) In small catchment scale, the wind direction is transient and variable with the underlying surface, but the main wind direction is still controlled by atmospheric circulation; The near-surface digital pressure is relatively stable, and there are regional differences affected by altitude, but the differences are not large.

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