

# Comparison of the Meteorological Factors on the Forestland and Weather Station in the Middle Area of Korea

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## Abstract

Climate is one of most important environmental factors on the forest ecosystem. This study was conducted to analyze the characteristics of meteorological factors in the forest area and weather stations from July 2015 to June 2016 in Cheuncheon and Hongcheon of Kangwon Province in Korea. The HOBO data logger was installed for meteorological analysis in forests area (site 1 and site 2). The meteorological data from the HOBO data logger compared with meteorological data of the weather station. The meteorological data used for the analysis was monthly mean temperature (°C), monthly mean minimum temperature (°C), monthly mean maximum average temperature (°C), and monthly mean relative humidity (%). As a result of this study, the mean temperature (°C) of forest area was relatively lower than weather station which is the outside the forest area, and the mean maximum temperature (°C) of weather station was relatively higher than that of forest area. The mean relative humidity (%) was higher in forest area than weather station.

**Key Words:** meteorological factor, forest eco-system, weather station, HOBO data logger

## Introduction

The climate in the forest affects the structure and function of forest ecology, and all components in the forest ecosystem are directly or indirectly influenced by climate. The effects of climate change on forest ecology directly affect the physiological effects and indirectly the interaction of various organisms constituting the forest ecosystem. Climate is one of most important environmental factors on the forest ecosystem and climatic changes in the forest are play an important role in ecological phenomena, species distribution, species composition and diversity, vegetation

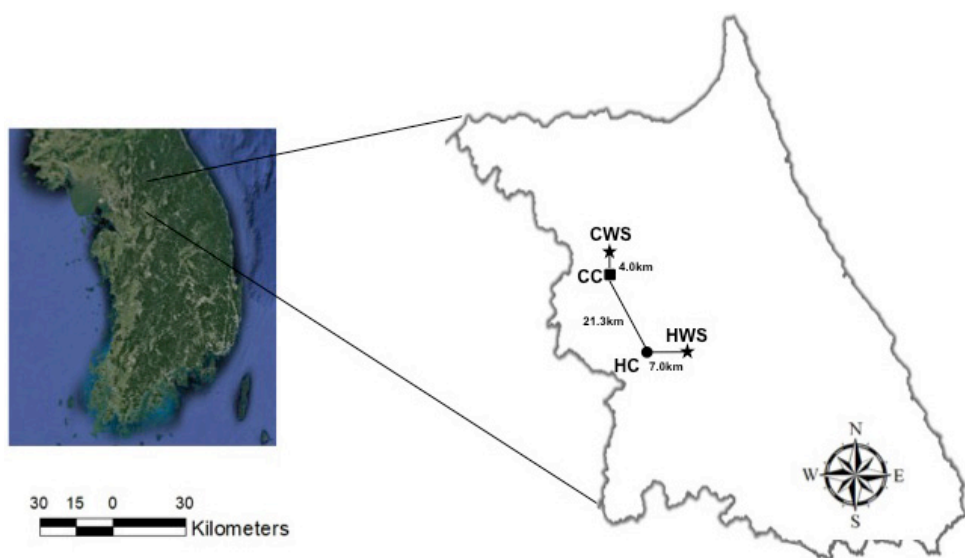
re-production and productivity (Zobel et al. 1976; Johansson et al. 1995). The microclimatic changes in the small scales play a more important role in the ecological and physiological effects of vegetation in the forest ecosystem (Waring and Schlessinger 1985; Chen and Franklin 1997), therefore collecting of microclimatic data in the forest field is need for managing forest ecosystems (Ming et al. 1997). To understand the climatic impacts within a forest ecosystem requires more interpretation of the interrelationships between climate varieties and vegetation in the forest ecosystem. Trees in forest ecosystems produce a unique micro-climate phenomenon in the lower layers, such as

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**Fig. 1.** The location of study site (1 and 2) and weather station (Chuncheon and Hongcheon) of Korea Meteorological Administration.

\* CC : Chuncheon (site 1), CWS : Chuncheon Weather Station  
 HC : Hongcheon (site 2), HWS : Hongcheon Weather Station

reduced daytime air temperature in the sunny days, increased humidity, and lower wind speeds (Grimmond et al. 2000). The change of meteorological factors such as temperature in forest was effected photosynthetic, respiration, tree growth rate and changes (Friedrich et al. 2017).

This study was conducted to analyze the characteristics of meteorological factors in the forest and to analyze the compared with characteristics of meteorological factors between forest land and weather station of Korea Meteorological Administration.

## Materials and Methods

To compare and analyze the changes of meteorological factors on the forests and weather stations, the weather measurement equipment for micro-climate was installed on the site 1 and site 2 from July 2015 to June 2016 (Fig. 1). The site 1 was located on the university forest at Chuncheon city in Kangwon National University of Gangwon Province and site 2 was located on the research forest of Kangwon National University at Hongcheon gun of Gangwon Province.

Site 1 was dominated by *Pinus densiflora* Siebold & Zucc of the 4 age-class and aspect was 170, slope was 20 and altitude was 200m. The Chuncheon weather station of Korea Meteorological Administration was located at the 4km distance from the site 1. Site 2 was dominated by *Pinus koraiensis* Siebold & Zucc of the 4 age-class and aspect was

216, slope was 18 and altitude was 300m. The Hongcheon weather station of Korea Meteorological Administration was located at the 7km distance from the site 2. The distance of site 1 and site 2 was 21.3km.

The HOBO data logger (U-20) was installed at the midpoint on the each sites for analysis of the weather factors on the forest stand and temperature (°C) and the relative humidity (%) were measured with 1 hour interval at every day. The recorded weather factors on HOBO data logger was downloaded monthly and compared with weather factors at Chuncheon and Hongcheon weather station of Korea Meteorological Administration (2017). The meteorological data analyzed by using statistical program (SPSS 2014) as monthly mean temperature (°C), monthly mean minimum temperature (°C), monthly mean maximum temperature (°C), and monthly mean relative humidity (%). We used to Wilcoxon rank-sum test by SPSS program (2017) for the comparisons of each meteorological factors on forest land (site 2) and Hongcheon weather station.

## Results and Discussion

The annual mean temperature was 12.3°C, an annual mean maximum temperature was 19.1°C, and annual mean minimum temperature was 7.1°C in the site 1. The annual mean temperature was 12.4°C, an annual mean maximum temperature was 18.3°C, and an annual mean minimum temperature was 7.2°C of the Chuncheon weather station

**Table 1.** The compare with weather factors on the forest land (site 1 and site 2) and weather stations (Chuncheon and Hongcheon) from July 2015 to June 2016

Year	Month	Site 1				Weather station (Chuncheon)				Site 2				Weather station (Hongcheon)			
		A.T (°C)	MA.T (°C)	MI.T (°C)	RH (%)	A.T (°C)	MA.T (°C)	MI.T (°C)	RH (%)	A.T (°C)	MA.T (°C)	MI.T (°C)	RH (%)	A.T (°C)	MA.T (°C)	MI.T (°C)	RH (%)
2015	July	24.1	29.0	20.4	83.4	25.0	29.5	21.3	78.0	21.1	24.0	18.6	83.9	24.8	30.5	20.5	73.0
	August	24.7	30.3	20.9	84.8	25.6	30.9	21.6	80.0	21.8	24.8	19.5	55.5	25.4	31.8	21.0	75.0
	September	19.9	27.1	14.5	73.8	20.4	27.1	14.9	73.0	17.3	21.0	14.3	76.0	19.6	27.5	13.9	70.0
	October	13.3	20.5	7.7	73.3	13.7	20.6	7.8	75.0	11.9	15.6	8.5	71.8	13.1	21.1	7.0	69.0
	November	7.4	12.0	4.1	87.8	7.9	12.0	4.7	83.0	5.6	8.5	3.4	86.0	7.7	12.6	4.0	81.0
	December	0.0	5.3	-4.2	76.7	0.0	4.7	-4.1	75.0	-1.1	2.0	-4.0	74.7	-0.1	5.3	-4.3	71.0
2016	January	-4.2	2.0	-9.5	61.0	-4.7	1.1	-10.1	64.0	-6.1	-2.4	-9.6	65.6	-4.7	1.6	-10.1	56.0
	February	-0.7	6.5	-6.3	61.1	-1.2	4.8	-6.9	60.0	-2.7	1.1	-6.3	76.5	-1.1	5.6	-6.9	56.0
	March	7.4	18.4	0.0	57.6	5.9	12.7	-0.5	60.0	3.9	8.5	-0.1	70.3	5.8	13.3	-0.9	52.0
	April	14.4	23.5	7.7	60.2	14.0	21.2	7.3	58.0	11.3	16.6	6.6	66.0	13.8	21.8	6.6	53.0
	May	18.5	26.1	12.2	69.3	18.9	25.9	12.3	65.0	16.0	21.0	11.6	72.1	18.7	26.8	11.2	58.0
	June	22.5	28.3	17.9	79.2	23.4	29.0	18.4	71.0	19.5	23.2	16.3	80.2	23.1	29.7	17.5	65.0
Mean		12.3	19.1	7.1	72.4	12.4	18.3	7.2	70.2	9.9	13.7	6.6	73.2	12.2	19.0	6.6	64.9

of Korea Meteorological Administration which is close to site 1. The annual mean temperature was 9.9°C, an annual mean maximum temperature was 13.7°C, and annual mean minimum temperature was 6.6°C of the site 2. The annual mean temperature was 12.2°C, an annual mean maximum temperature was 19.0°C, and annual mean minimum temperature was 6.6°C of the Hongcheon weather station of Korea Meteorological Administration which is close to site 2. In the case of annual mean relative humidity, site 1 was 72.4%, site 2 was 73.2%, and Chuncheon and Hongcheon weather station of Korea Meteorological Administration was 70.2%, 64.9%, respectively.

The annual mean temperature (°C) in the forest stand (site 1 and 2) was relatively lower than that in the weather station of Korea Meteorological Administration. The annual mean minimum temperature (°C) was similar to forest stand (site 1 and 2) and weather station of Korea Meteorological Administration. The annual mean maximum temperature of site 1 was higher than that of Chuncheon weather station, but that of site 2 was relatively lower than Hongcheon weather station. The maximum temperature difference between the two study sites seems to reflect the characteristics of forest land, such as slope and forest density, but it should be analyzed through long-term research. In the case of relative humidity, forest area (site 1 and 2) forest area is higher than the weather stations.

The mean temperature in the forest area during the summer period (June to August) was 12.3°C for site 1,

9.9°C for site 2, 12.4°C for Chuncheon weather station and 11.2°C for Hongcheon weather station. The mean maximum temperature was 19.1°C for site 1, 13.7°C for site 2, 18.3°C for Chuncheon weather station and 19°C for Hongcheon weather station. The mean temperature was relatively low in the forest area compared to the weather station. In the case of mean minimum temperature, forest area and weather station showed a similar tendency, and the relative humidity was higher in forest areas than in weather stations in all regions.

The mean temperature during the winter period (December to February) was slightly higher in site 1 (-1.7°C) than Chuncheon weather station (-2.0°C) and site 2 (-3.3°C) was lower than Hongcheon weather station (-2.0°C). In the case of mean maximum temperature, site 1 (4.6°C) was higher than Chuncheon weather station (3.5°C) and Hongcheon weather station (4.2°C) was higher than site 2 (0.3°C). These results indicate that site 1 is relatively located in urban area than site 2 but it is necessary to interpret through continuous research (that is forest type, slope and aspect of forest stands, etc.) in future. In the case of the mean minimum temperature, the forest area and the weather station showed similar tendency.

The mean temperature (Wilcoxon rank-sum test:  $z = -15.11$ ,  $P = 0.000$ ), mean maximum temperature ( $Z = -16.220$ ,  $P = 0.000$ ) and relative humidity ( $Z = -10.906$ ,  $P = 0.000$ ) in the site 2 (forest land) and weather station were significant, but mean minimum temperature ( $Z = -0.568$ ,  $P = 0.570$ ) was not

**Table 2.** Differences in meteorological factors (mean± SD) in the forest land and weather stations during study area by analyzed with Wilcoxon rank-sum test

	Site 2 (Hongcheon study site)	Hongcheon Weather station	Z	P
A.T (°C)	9.9±9.94	12.2±10.48	-15.11	0.000
MA.T (°C)	13.7±10.04	19.0±19.49	-16.220	0.000
MI.T (°C)	6.6±10.19	6.6±10.68	-0.568	0.570
RH (%)	73.2±19.94	64.9±16.12	-10.906	0.000

\* A.T : Mean Air Temperature, MA.T : Mean Maximum Temperature, MI.T : Mean Minimum Temperature RH : : Mean Relative Humidity

significant (Table 2).

As a result of this study, the annual mean temperature (°C) of forest area was relatively lower than weather station which is the outside the forest area, and the annual mean maximum temperature (°C) of weather station was relatively higher than that of forest area. The annual mean relative humidity was higher in forest area than weather station. The meteorological factors the forest area was different to the non-forest area where the forest is not constructed due to the influence of the vegetation constituting the forest. However, since this study was based on the results of short-term studies (only 1 year), this study was not analyze the meteorological differences between the study sites (sites 1 and 2) and some temperature changes between the weather stations and the study area. Therefore, there is a need to conduct long-term research to analyze the correlation with various factors such as forest density, slope, aspect, forest type affecting meteorological factors the forest area.

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