# FOREST CLIMATES

**N.V. Kobysheva**
*Main Geophysical Observatory, St.Petersburg, Russia*

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**Contents**



**Summary**

The main forest climate characteristics in comparison with an open area are reduction of direct radiation penetrating under the forest canopy and coming to the forest soil; increase of diffuse radiation; colder summer and warmer winter; increase of atmospheric precipitation over the forest canopy; greater height, duration and uniformity of snow cover; the reduction of flood height. Besides that the forest soil freezes through smaller depth.

## 1. Introduction

The vegetation complicates the conditions of heat and moisture exchange in surface air layer. First of all vegetation changes an active surface, transforming it into an active layer. For broad-leaved plants two active surfaces are distinguished more or less clearly: the top surface of leaves and the ground surface which catch the radiation not absorbed by leaves. For forests, like for grass, there are also at least two active layers. The first one is active surface of trees crown, the second one is active surface of the ground, grass or moss covering ground or active surface of the underwood.

## 2. Solar Radiation

The radiation flows in a forest are formed as a result of interaction between radiation regimes of leaves and separate trees. The radiation balance equation for ground surface can be written down in the following form:

$$R' = Q'\left(1-\alpha'\right) - B_{\mathrm{g}} + \gamma' \cdot B_{\mathrm{a}} + \gamma'' \cdot B_{\mathrm{c}} \tag{1}$$

where $R'$ - radiation balance of ground surface under trees crowns; $Q'$ - global radiation coming on the ground through trees crowns; $\alpha'$ - albedo of ground surface; $\gamma'$ and $\gamma''$ -

factors describing a part of global radiation of the atmosphere and the trees crowns, which comes on the ground; $B_g, B_a, B_c$ - long-wave radiation of ground, atmosphere and crown.

If we assume, that the trees crowns are closed and they form continuous surface without gaps, radiation balance for the top surface of trees crowns ($R$) and for ground surface ($R'$) in a forest can be expressed by the formulas:

$$R = Q(1-\alpha) + B_a - B_c \tag{2}$$

$$R' = Q'(1-\alpha') + B_c' + B_g' \tag{3}$$

The difference between $R$ and $R'$ ($\Delta R$) allows to estimate total absorption of radiation flows by the forest active layer.

The total radiation reaching the ground surface depends on height, density and kind of vegetative cover, as well as angle of radiation incidence. Usually less than 20% of radiation reaches the ground surface in mature stand. This value can decrease down to 5%. Thus, for example, in midday from 5 to 8% of radiation coming to crowns penetrates under canopy of a young birch forest at the stage of complete foliage. As defoliation begins the transparency of forest canopy increases. After defoliation ending radiation is 20% of radiation over forest. The studies of vertical distribution of global radiation in young birch forest have shown that the greatest radiation decrease occurs in the bottom part of crowns where about 40% of radiation is retained.

Not only the short-wave radiation sum reaching ground surface decreases, but the ratio between direct and diffuse radiation also changes. The great part of direct solar radiation is transformed into diffuse one. Forest weakens the radiation intensity in the blue part of spectrum (from 0.40 to 0.45 microns) and strengthens it in red and infra-red parts (from 0.65 to 0.75 microns).

## 3. Temperature and Humidity.

The whole incoming radiation is distributed between the heat balance components: turbulent heat exchange, evaporation and heat exchange in organic layer. This distribution depends on the weather conditions and vegetative cover. However in any case the microclimate created under forests canopy differs essentially from the climate conditions in an open area.

In summer the forest soil surface is cooler than in an open area. This temperature difference can reach several degrees. In winter there is an opposite process. The forest reduces the soil cooling. However on the average the ground surface temperature in forest is lower than on glade or field. Its annual amplitude is reduced.

The daily and annual courses of air temperature have the same regularities as the ground surface temperature when comparing with ones on an open place. True, the air temperature difference between a forest and an open place are a little less. We can study microclimatic features of hornbeam forest as example of daily and annual course of air temperature differences. The maximal air temperature difference between a forest and an open area is observed in the afternoon and is about 3.2°C. Sometimes it can reach 6.5°C. Usually, such a great difference takes place after the long rainless period. Thus the soil dries up in an open area and turbulent heat exchange develops. Under the trees crowns the soil heating is much less. The differences of soil surface temperatures can be larger than 20°C.

The differences of monthly mean air temperature are the greatest in the warm period. They are from 0.7 to 1.6°C.

It is necessary to note, that both radiation, and the heat regime in forest depends on the age, closeness and species of trees. In winter the deciduous forest has smaller influence on the daily temperature amplitude than coniferous forest. Thus the temperature amplitude in deciduous forest is larger, than in an open area. In summer the amplitude differences deciduous forest/open area increase and become larger, than in coniferous forest.

In forest favorable conditions for the increased air humidity are created owing to the weakened exchange between soil, crowns and air layers located over crowns. The air humidity changes essentially in a vertical direction depending on the stand structure. The maximal temperature is coordinated usually with the crowns surface. In crowns the maximums of absolute humidity and relative humidity are observed as well. Figure 1 illustrates the hourly mean profiles of meteorological elements in fur-tree forest in Central Europe, which are rather characteristic for forests in middle latitudes.



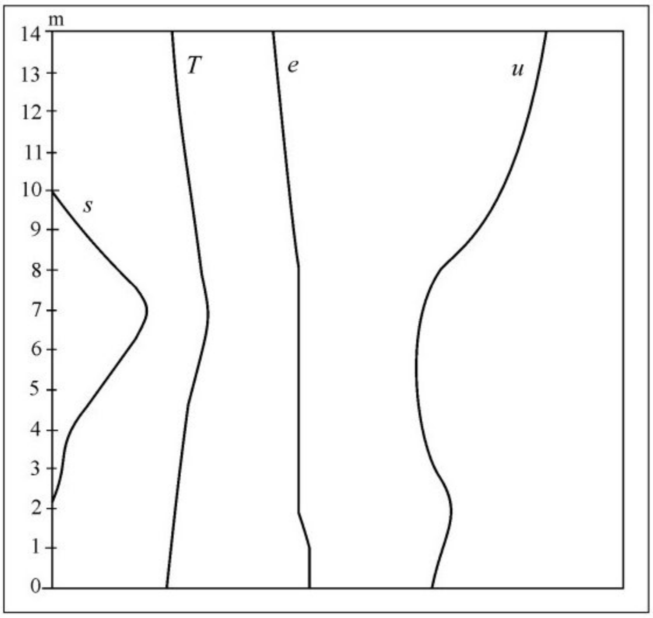


Figure 1: The hourly mean profiles of temperature (T), water vapor pressure (e), and wind speed (u) in fur-tree forest in the noon of sunny day in July;
s- the distribution of crown density according to altitude

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## Biographical Sketch

**Kobysheva Nina Vladimirovna**, Dr. of geogr. Sci., Professor, Honored Scientist, Head of the technical climatology laboratory of MGO, Professor of St-Petersburg University. Fields of scientific interests are statistical methods in climatology, applied climatology. Author of 7 monographs, 3 text-books, Building Standards and Rules "Building Climatology", more then 200 papers. Supervisor and editor of Scientific-Applied reference book. About 25 Candidate's dissertation were defended under her guidance. A member of working group of WMO, working group № 13 CIB, working group № 75 of International Electrotechnical Commission. Was conferred a medal of National Exhibition of economy achievements, medal "Honored expert of gidro-meteo service", Voeikov's prize, International WMO and CCL certificate.

Was born in 1925 in Omsk city. Was graduated from the Odessa Hydrometeorological Institute in 1948. In 1955 has defended the candidate dissertation after finishing the post-graduate course of Main Geophysical Observatory.