TRANSMITANCE KORUNOVÉ VRSTVY MLADÉHO SMRKOVÉHO POROSTU

TRANSMITTANCE OF THE YOUNG SPRUCE STAND CANOPY

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Abstract

Radiation field within a forest stand is characterized by a considerable temporal and spatial variability and its changes depend among others on the development of the stand canopy. Changes in the canopy transmittance of a young spruce stand were studied at the beginning of the growing season in 2000. The spruce stand studied is a part of the experimental ecological study site of the Bílý Kříž (Moravian-Silesian Beskydy Mts., Czech Republic) and may be characterized as a closed, relatively homogeneous stand. In the present paper, we tried to demonstrate that the use of a continuous measurement of PAR penetration into the young spruce stand canopy for the purpose of describing the stand canopy development is realistic. The development of new shoots affected the changes in radiation regime within the stand canopy. The measurement of transmittance can be used for a long-term analysis of the changes in stand canopy density, however, not in a stand with a high density. In the present paper we proved that single measurements of PAR, penetrating into the stand canopy, do not suffice to describe the radiation regime within the stand canopy, hence continuous or repeated measurements of the penetrating PAR are necessary.

Introduction

Information about the radiation regime within a forest stand are an important data input for growth models (Grace et al., 1987, Wang and Jarvis, 1990, Hassika and Berbigier, 1998, Palva et al., 1998, Hansen, 1999, Palmroth et al., 1999, Vesala et al., 2000), are also important for studying energy fluxes between the stand and the atmosphere boundary layer (Kuusk, 1992,

Baldocchi and Meyers, 1998, Lee, 1998, Janouš et al., 1998) and are used for determining the stand energy balance as well (Tajchman, 1972, Lindroth, 1985). Moreover, solar radiation is recognised to influence some other characteristics of the stand climate (temperature, humidity, etc.).

Radiation regime within a stand canopy is characterized by a considerable temporal and spatial variability. Changes in radiation regime within forest stands are, among others, coupled to the changes in stand canopy density due to a development of new shoots at the beginning of the growing season and to the natural needles falling at the end of the growing season.

In the presented paper, we described transmittance changes occurring in a young spruce stand canopy in May (i.e. the period of the new shoots development).

Method

Transmittance was studied within a young spruce stand, belonging to the experimental ecological study site of the Bílý Kříž (Moravian-Silesian Beskydy Mts., Czech Republic). The studied spruce stand has grown up on a slope (SSE exposure, $13{,}5^0$) and was planted with 4-year-old Norway spruce (*Picea abies* (L.) Karst.) seedlings in 1981.

Transmittance of the stand canopy was determined in May 2000. Then, it was calculated as the proportion between the photosynthetic photon flux density (PPFD) penetrating into a determined level of the canopy and the incident PPFD in this canopy.

The incident PPFD was recorded with a quantum sensor. This one was placed at a height of 12 m above the ground level. PPFD penetrating into and below the stand canopy was recorded with a set of 25 quantum sensors. They were placed in a line, and the distance between each of them was of 40 cm. The first set of 25 sensors was placed under the stand canopy (0.5 m above the ground level), the second one was between the upper and the lower part of the canopy (3.5 m above the ground level). The upper part of the canopy was characterized by a sunny foliage type. Quantum sensors were made from photodiodes BPW21 (Siemens, Germany) and were calibrated according to a Quantum Sensor LI-190S (LI-COR, USA).

PPFD was recorded during the daytime. Instantaneous values of PPFD were recorded and stored every 30 minutes.

Results and discussion

Some clear days at the beginning (02.05. and 03.05.), in the middle (13.05. and 14.05.) and at the end (27.05.) of May 2000 were chosen for describing the changes in radiation regime within a young spruce stand canopy (Fig. 1). The studied spruce stand is characterized as being a

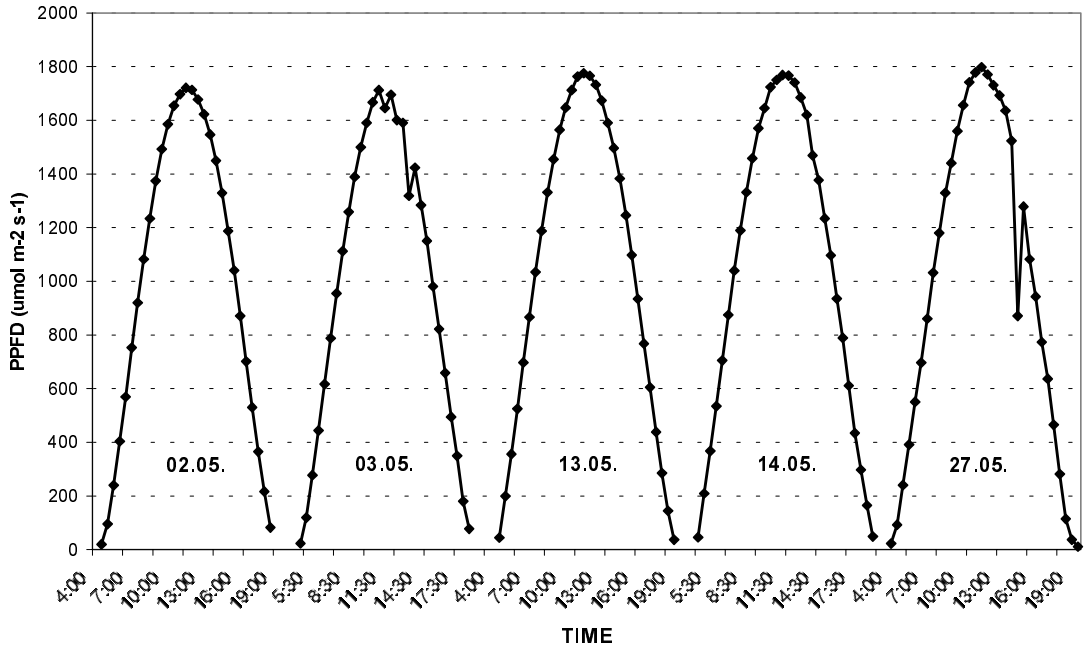

Fig. 1: The incident photosynthetic photon flux density in the study site of the Bílý Kříž during the chosen days.

closed, relatively homogeneous stand. Projected leaf area index (LAI) of this stand canopy was of 7.7. (LAI was measured during May 10th using a Plant Canopy Analyzer 2000, LI-COR, U.S.A.). Canopy transmittance amounted to 0.45 $\pm$ 0.24% during the morning and in the afternoon hours (Fig. 2). This transmittance values are very low to be sensitive for a stand canopy development description during the growing season (period of the new shoots development, period of the old needles falling, etc.). During noon hours (i.e. the highest sun elevation angle) when photosynthetically active radiation (PAR) penetrated through the stand canopy gaps, canopy transmittance values reached up to 17.1%. Transmittance of the upper part of the canopy was of 6.3 $\pm$ 1.9% (Fig. 3) and encreases to 39.6% at noon hours. The figure showed a decline from the

beginning of the studied month. It answered to a successive development of new shoots because changes in stand density provided a different transmittance.

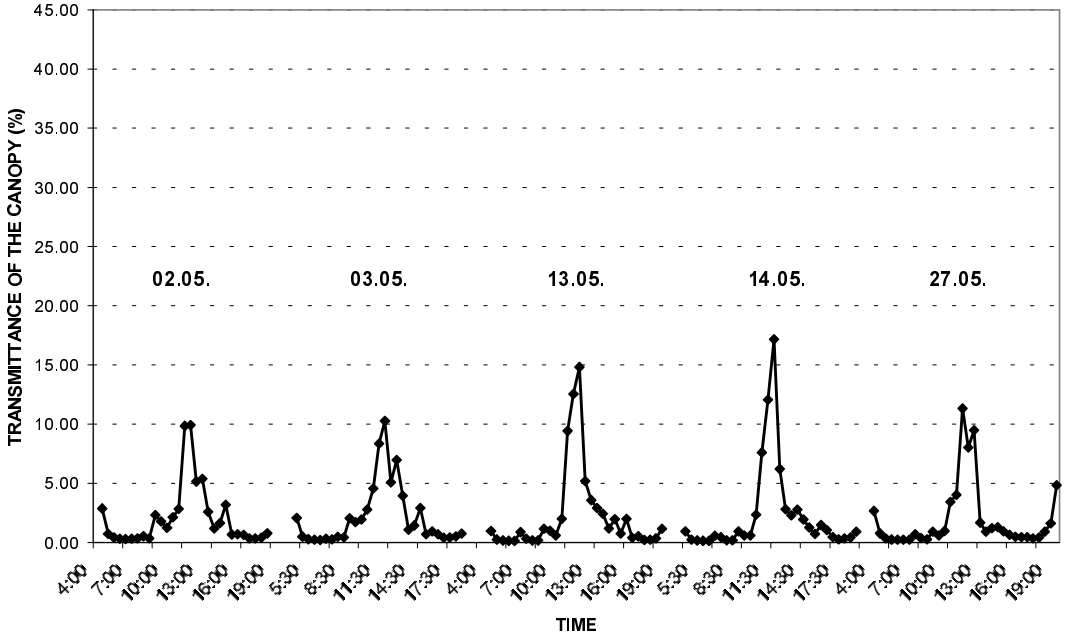

Fig. 2: PAR transmittance of the spruce canopy in the Bílý Kříž during the chosen days.

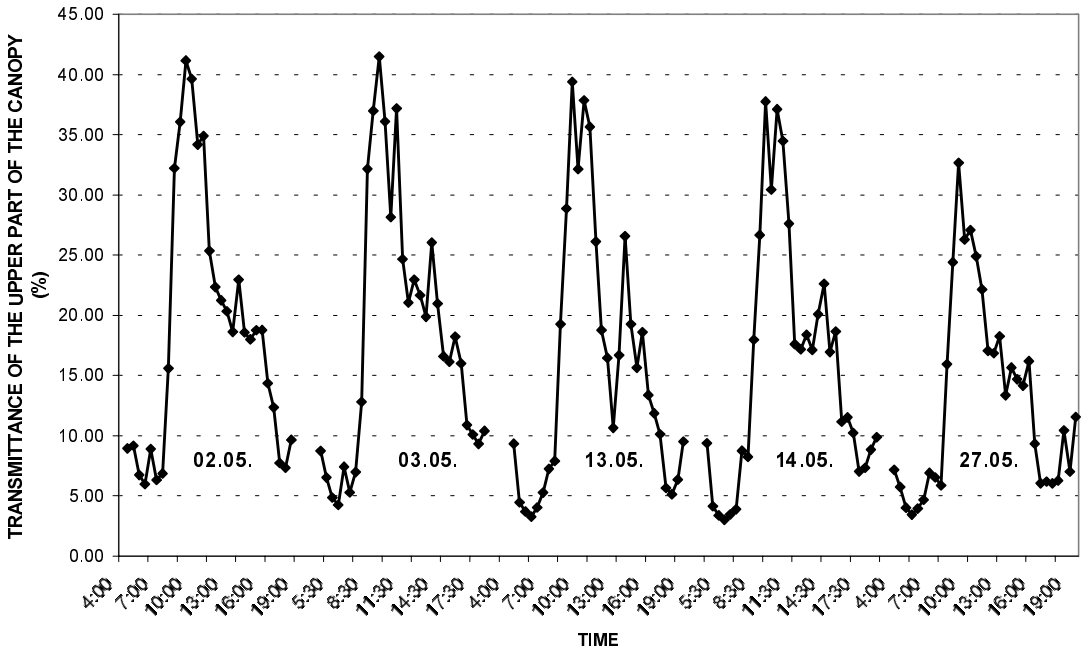

Fig. 3: Transmittance of the upper part of the spruce canopy in the Bílý Kříž during the chosen days.

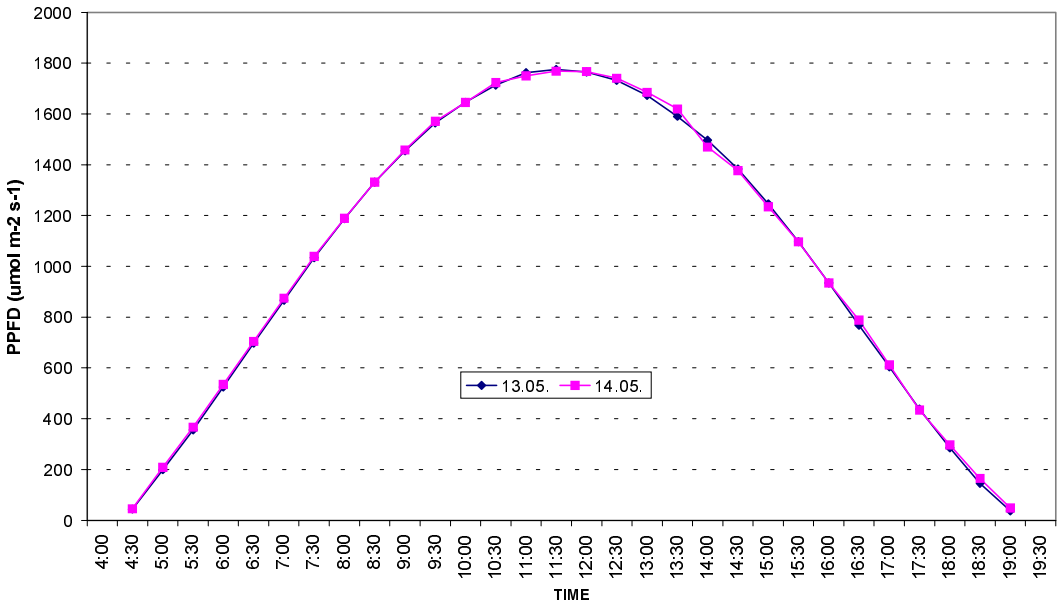

Fig. 4: Comparison of the incident photosynthetic photon flux densities in the chosen two days.

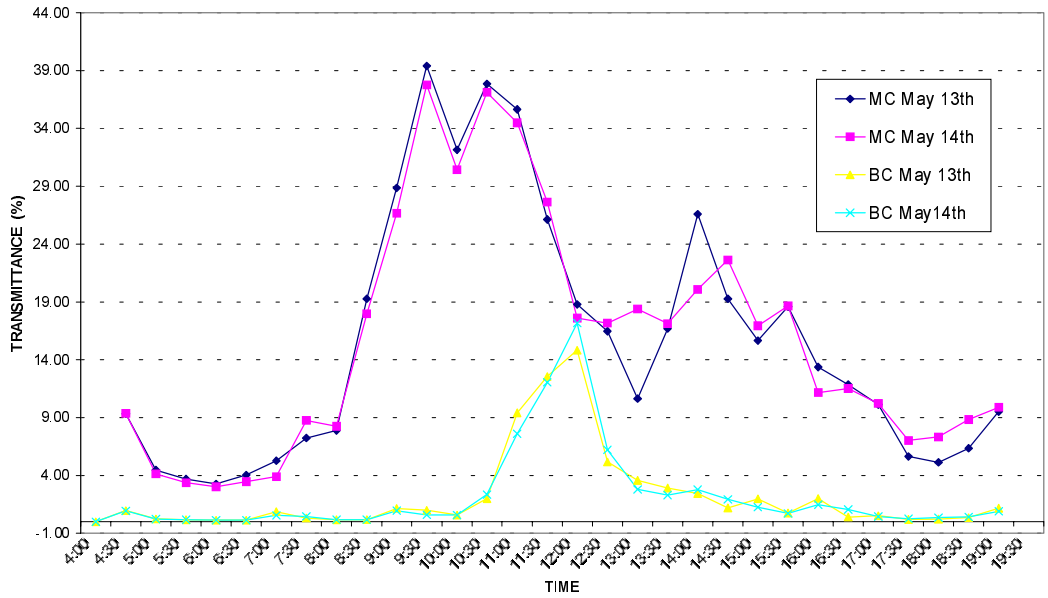

Fig. 5: Comparison of the transmittances of the spruce canopy (BC) and its upper part (MC) in the Bílý Kříž during the chosen two days.

May 13th and 14th were almost characterized by coincident values of incident PPFD (Fig. 4). In comparison with these two days, when it was not possible to assume a change in the stand canopy density, we could find that transmittance values are not identical in these two days (Fig. 5). For example, differences in incident PPFD were maximally about 1.8% at 13:30 p.m. and at 14:00 p.m. This divergence in PAR input displayed a change in transmittance values but differences remained 27.1% at 13:30 p.m. and about 14.0% at 14:00 p.m. On the upper part of the stand canopy, it was of 2.6% at 13:30 p.m. and of 32.4% at 14:00 p.m. Hence, results from this situation, that the one-off measurement of PAR penetration into the stand canopy is insufficient for describing radiation regime. As an evidence, it clearly showed that some continuous measurements during longer time period or at least repeated measurements at the different moments of the daytime are of a great need to provide some reliable estimates.

Souhrn

Marková[1)], D. Janouš[2)]: Transmitance korunové vrstvy mladého smrkového porostu.

Radiační pole uvnitř porostů lesních dřevin je charakterizováno značnou časovou a prostorovou variabilitou a jeho změny závisí mj. na rozvoji korunové vrstvy porostu. Na začátku vegetační sezóny roku 2000 byla v mladém smrkovém porostu sledována změna transmitance korunové vrstvy. Studovaný smrkový porost je součástí experimentálního ekologického pracoviště Bílý Kříž (Moravskoslezské Beskydy, Česká republika) a lze jej charakterizovat jako zapojený, relativně homogenní porost. V předloženém příspěvku jsme se pokusili ukázat možnost využití kontinuálního měření FAR pronikající do korunové vrstvy mladého smrkového porostu k posouzení rozvoje korunové vrstvy porostu. Bylo potvrzeno, že nárůst nových letorostů ovlivňuje změny radiačního režimu v korunové vrstvě a že je tedy možné tuto metodu využít pro dlouhodobou analýzu změn hustoty korunové vrstvy (ne však v příliš hustém porostu). Dále je ukázáno, že pro dostatečný popis radiačního režimu v korunové vrstvě porostu lesních dřevin nestačí jednorázové měření FAR pronikající do korunové vrstvy porostu, ale že je nutné provádět kontinuální nebo alespoň opakované měření.

Keywords: photosynthetic photon flux density, development of the stand canopy, stand density

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