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Vertical profile of branch CO_2 efflux in a Norway spruce tree: a case study

M. Acosta and M. Pavelka
Global Change Research Center AS CR, Brno, Czech Republic (acosta.m@czechglobe.cz)

Despite woody-tissue CO_2 effluxes having been recognized as an important component of forest carbon budget due to the fraction of assimilates used and the dramatic increase in woody with stand development, there is limited research to determine the CO_2 efflux vertical variability of woody-tissue components. For a better understanding and quantification of branch woody-tissue CO_2 efflux in forest ecosystems, it is necessary to identify the environmental factors influencing it and the role of the branch distribution within the canopy. The proper assessment of this forest component will improve the knowledge of the ratio between ecosystem respiration and gross primary production at forest ecosystem. In order to achieve this goal, branch CO_2 efflux of Norway spruce tree was measured in ten branches at five different whorls during the growing season 2004 (from June till October) in campaigns of 3-4 times per month at the Beskydy Mts., the Czech Republic, using a portable infrared gas analyzer operating as a closed system.

Branch woody tissue temperature was measured continuously in ten minutes intervals for each sample position during the whole experiment period. On the basis of relation between CO_2 efflux rate and woody tissue temperature a value of Q_{10} and normalized CO_2 efflux rate (E_{10} – CO_2 efflux rate at 10˚C) were calculated for each sampled position. Estimated Q_{10} values ranged from 2.12 to 2.89 and E_{10} ranged from 0.41 to 1.19 ?molCO_2m^{-}2 s^{-1}. Differences in branch CO_2 efflux were found between orientations; East side branches presented higher efflux rate than west side branches. The highest branch CO_2 efflux rate values were measured in August and the lowest in October, which were connected with woody tissue temperature and ontogenetic processes during these periods. Branch CO_2 efflux was significantly and positively correlated with branch position within canopy and woody tissue temperature. Branches from the upper whorls showed higher respiration activity and seasonal dynamics than branches from the lower whorls.

The results presented in this study serve primarily to demonstrate the importance of branch location within canopy from the point of view of the CO_2 efflux. CO_2 efflux from branch woody-tissue exhibited vertical differentiation among whorls that must be taken into account when collecting, analysis and interpreting data. The determination of CO_2 efflux from individual components at ecosystem level is still needed to gain a better understanding of the carbon budget issues. Such data are important for evaluating effect of global climate or other possible influences on carbon cycling and sequestration in forest ecosystems.

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