

Jan Evangelista Purkyně University in Ústí nad Labem

Faculty of Environment

Study material

FLUXES OF METHANE AND NITROUS OXIDE IN FOREST  
ECOSYSTEMS

Dr. rer. nat. Mgr. Kateřina Macháčová



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## Objectives

to acquire and deepen knowledge and practical skills related to investigation of greenhouse gas fluxes within forest ecosystems. In this course we will focus on methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) as greenhouse gases that significantly contribute to global climate change. Both gases are naturally produced and transformed not only in the soil but also in woody plants. Within the course, students will get acquainted with the fluxes of CH<sub>4</sub> and N<sub>2</sub>O and their dynamics in the soil-tree-atmosphere system and the associated processes of transformation and transport. We will also focus on the role of trees, cryptogams (mosses, lichens, etc.) and soil as sources and sinks of these gases in the forest ecosystem exchange of CH<sub>4</sub> and N<sub>2</sub>O.

After a theoretical introduction to the methodology of studying greenhouse gas flows from soils, trees and forest ecosystems, we will focus on practical acquaintance and testing of methods for measuring gas exchange. Students will learn to install measuring systems for investigation of gas fluxes from tree stems and soils, and to operate a portable greenhouse gas analyzer and other measuring devices for additional study of environmental parameters. Furthermore, with the assistance of the lecturer, they will measure CH<sub>4</sub> and N<sub>2</sub>O fluxes from stems and soils and learn to evaluate these data (calculation of CH<sub>4</sub> and N<sub>2</sub>O fluxes and their further processing). During the final colloquium, students will present the measured results in the form of a short scientific lecture followed by a joint discussion. At the end, the students will be examined orally.

## Study topics

1. Introduction to the research topic of greenhouse gas exchange with focus on methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) in forest ecosystems (overview of the processes of production, consumption, conversion and transport of both gases within soil and woody plants, the role of soil and woody plants as sources and sinks in ecosystem exchange, the role of other components of forest ecosystems, etc.).
2. An overview of the basic methods used to study CH<sub>4</sub> and N<sub>2</sub>O fluxes in forest ecosystems.
3. Installation of chamber systems for measuring greenhouse gas fluxes from trees and soil, work with a portable greenhouse gas analyzer, measuring greenhouse gas fluxes, measuring ancillary environmental parameters.
4. Procedure of processing measured data and calculation of greenhouse gas fluxes from tree trunks and soil, their comparison, evaluation of results.

## Study literature

### Mandatory literature

BARBA J, BRADFORD MA, BREWER PE, BRUHN D, COVEY K, VAN HAREN J, MEGONIGAL JP, MIKKELSEN TN, PANGALA SR, PIHLATIE M et al. 2019. Methane emissions from tree stems: a new frontier in the global carbon cycle. *New Phytologist* 222: 18–28.

COVEY KR, MEGONIGAL JP. 2019. Methane production and emissions in trees and forests. *New Phytologist* 222: 35–51.

MACHACOVA K, BACK J, VANHATALO A, HALMEENMAKI E, KOLARI P, MAMMARELLA I, PUMPANEN J, ACOSTA M, URBAN O, PIHLATIE M. 2016. *Pinus sylvestris* as a missing source of nitrous oxide and methane in boreal forest. *Scientific Reports* 6: 23410. (metodologie)

MACHACOVA K, MAIER M, SVOBODOVA K, LANG F, URBAN O. 2017. Cryptogamic stem covers may contribute to nitrous oxide consumption by mature beech trees. *Scientific Reports* 7: 13243.

MACHACOVA K, VAINIO E, URBAN O, PIHLATIE M. 2019. Seasonal dynamics of stem N<sub>2</sub>O exchange follow the physiological activity of boreal trees. *Nature Communications* 10: 4989.

MACHACOVA K, URBAN O (2019) Role dřevin při výměně metanu a oxidu dusného/Role of trees in methane and nitrous oxide exchange. In: Skleníkové plyny z půdy a zemědělství (eds. Šimek M et al.) Academia, Praha, p. 168-172, ISBN 978-80-200-3011-5.

### **Recommended literature**

MAIER M, MACHACOVA K, LANG F, SVOBODOVA K, URBAN O. 2018. Combining soil and tree-stem flux measurements and soil gas profiles to understand CH<sub>4</sub> pathways in *Fagus sylvatica* forests. *Journal of Plant Nutrition and Soil Science* 181: 31–35.