Geophysical Research Abstracts
Vol. 20, EGU2018-7429, 2018
EGU General Assembly 2018

Nitrous oxide (N2O) exchange of upland trees as a missing component in greenhouse gas balance of forest ecosystems

Katerina Machacova (1), Martin Maier (2), Elisa Halmeenmäki (3,4), Katerina Svobodova (1), Friederike Lang (5), Mari Pihlatie (3,4), and Otmar Urban (1)

(1) Global Change Research Institute CAS, Brno, Czech Republic (machacova.k@czechglobe.cz), (2) Forest Research Institute Baden Wuerttemberg, Freiburg, Germany, (3) Environmental Soil Science, Department of Agricultural Sciences, University of Helsinki, Finland, (4) Institute for Atmospheric and Earth System Research/Forest Sciences, University of Helsinki, Finland, (5) Chair of Soil Ecology, Albert-Ludwigs-University, Freiburg, Germany

The increase in atmospheric nitrous oxide (N_2O) concentration contributes to the acceleration of the greenhouse effect. Plants are known to emit N_2O; however, the role of trees in the N_2O exchange of forest ecosystems is still an open question. While the soils of temperate and boreal forests were shown to be natural sources of N_2O, trees have been so far overlooked in the forest N_2O inventories.

We determined N_2O fluxes in common tree species of boreal and temperate forests: Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), downy and silver birch (*Betula pubescens*, *B. pendula*), and European beech (*Fagus sylvatica*). We investigated (1) whether these tree species exchange N_2O with the atmosphere under natural field conditions, (2) how the tree N_2O fluxes contribute to the forest N_2O balance, and (3) whether these fluxes show seasonal dynamics.

The studies were performed in a boreal forest (Pirkanmaa region/SMEAR II, FI; June 2014 - May 2015) and in two temperate mountain forests (White Carpathians, CZ; Black Forest, DE; June - July 2015). Fluxes of N_2O in mature tree stems and forest floor were measured using non-steady-state chamber systems followed by chromatographic and photo-acoustic analyses of N_2O concentration changes.

Pine, spruce and birch stems were identified as net annual N_2O sources. Spruce was found the strongest emitter (0.27 mg ha^{-1} h^{-1}) amounting up to 2.5% of forest floor N_2O emissions. All these tree species showed a substantial seasonality in stem N_2O fluxes, and the seasonality was related to the physiological activity of the trees and climatic variables. In contrast, stems of beech trees growing at soils consuming N_2O may act as a substantial sink of N_2O from the atmosphere. Consistent N_2O consumption by tree stems ranging between -12.1 and -35.2 mg ha^{-1} h^{-1} and contributing up to 3.4% to the forest floor N_2O uptake is a novel finding in contrast to current studies presenting plants as N_2O emitters. To understand these fluxes, N_2O exchange of photoautotrophic organisms associated with beech bark (lichens, mosses, algae) was quantified. All the organisms were net N_2O sinks at full rehydration with consumption rates comparable to stem consumption rates.

We demonstrate for the first time that trees can act not only as N_2O emitters but also as N_2O sinks. Mechanisms and the global extent of such consumption capability of trees are, however, unknown and need further research. In summary, all the studied boreal and temperate tree species contribute to ecosystem N_2O exchange, and these fluxes should be included in the forest N_2O emission inventories.

Acknowledgement

This research was supported by Czech Science Foundation (17-18112Y), Czech Academy of Sciences and German Academic Exchange Service (DAAD-15-03), National Programme for Sustainability I (LO1415), CzeCOS (LM2015061), DFG (MA 5826/2-1), EU FP7 project ExpeER (262060), Academy of Finland - Research Fellow and Centre of Excellence (263858, 288494, 294088, 1118615, 272041), and ICOS-Finland (281255). We thank M. Jakubík, M. Pavelka, J. Dušek, S. Stellner, J. Mikula, S. Paulus, E. Halaburt, S. Haddad and U. Großmann for their support.