Geophysical Research Abstracts
Vol. 21, EGU2019-7190, 2019
EGU General Assembly 2019

Methane and nitrous oxide cycles in forests

Ülo Mander (1), Thomas Schindler (1), Kateřina Macháčová (2), Alisa Krasnova (1), and Kaido Soosaar (1)
(1) Uni Tartu, Department of Geography, Tartu, Estonia (ulo.mander@ut.ee), (2) Department of Ecosystem Trace Gas Exchange, Global Change Research Institute CAS, Brno, Czech Republic (machacova.k@czechglobe.cz)

Forests cover globally about 3.7 billion ha. They are important regulators of carbon dioxide (CO_2) fluxes whereas their overall greenhouse gas (GHG) budgets, especially for methane (CH4) and nitrous oxide (N2O), are still largely unknown. Wetland forests are normally known as sources of CH4 whereas in upland forest soils CH4 is consumed. However, recent studies demonstrate that trees themselves can emit a large amount of CH4 through poorly studied and partly unidentified aerobic processes. Some studies connect it with exposure to ultraviolet radiation, which may trigger chemical reactions that produce CH4 from antioxidants commonly found in the mitochondria of living cells. Moreover, tree stems can have substantial concentration of CH4 inside, which can originate from soil or be produced by methanogens within the wood. Thus forest vegetation can be a significant CH4 source.
N2O fluxes in forest soils are influenced by various microbiological, chemical and physical properties of soil. However, some general trends for particular forest types are as follows. Emissions of N2O from rainforest soils are significantly higher than those from tropical upland forests and temperate forests. High nitrogen (N) availability, coupled with high moisture content, makes tropical soils especially likely to emit N2O. Similarly, forests on drained N-rich peatland soils in temperate and boreal areas can be significant N2O sources. A significant part of such emissions appears in winter. No studies on ecosystem-level N2O budgets (fluxes from soil, tree stems and shoots + eddy covariance (EC) measurements above canopy) could be found. Only few examples are available on N2O emissions from tree stems. Nevertheless, estimation of the GHG balance in different forest ecosystems under various environmental conditions is essential to understand their impact on earth climate.
During the period of August 2017 to September 2018 we measured the CH4 and N2O budget of a 40-yrs old hemiboreal grey alder (Alnus incana) forest stand on former agricultural land in Estonia considering fluxes from the soil, tree stems and whole ecosystem (above canopy; EC).
In the wet periods, stem flux of CH4 was the main source for ecosystem exchange, whereas in the dry periods, unpredictably, ecosystem flux was significantly higher than fluxes from soil and tree stems. Most likely, canopy was the main CH4 emitter. N2O fluxes from the soil and stems were low during the dry periods and peaked during the wet periods and the freezing-thawing. The forest was a net annual source of both CH4 and N2O (6.33 ± 0.29 kg CH4 ha-1 and 3.42 ± 0.12 kg N2O ha-1, mean±SE).
In conclusion, we need long-term, high-frequency measurements of soil and tree CH4 and N2O emissions in combination with ecosystem-level EC measurements to understand the fine-scale processes across individuals, species and ecosystems. The identification of microorganisms and biogeochemical pathways associated with CH4 and N2O production and consumption, and development of mechanistic models including passive and active transport of CH4 and N2O in the soil–tree–atmosphere continuum is also a challenge.