Geophysical Research Abstracts
Vol. 21, EGU2019-5452-1, 2019
EGU General Assembly 2019

CO_2, CH_4 and N_2O fluxes from soil under different vegetation cover and soil features

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Arctic soils are fragile ecosystems nowadays subjected to fast changes under current trends of climate warming. Changes in soil moisture and temperature, influencing vegetation cover and substrates quality, may strongly affect green-house gas emission patterns, possibly providing feedback accelerating climate change. A field campaign has been conducted in the small catchment of the Kidisjoki in Finnish Lapland, close to the Kevo Subarctic Research Institute of the University of Turku (69º 48' N, 27º 06.5' E), granted by INTERACT TA program. Soil profiles were described under different vegetation covers, soil was chemically and physically characterized, and CO_2, CH_4 and N_2O fluxes measured. We aimed at detecting differences in soil characteristics and functioning, evaluating carbon and nitrogen dynamics and assessing the potential climate change feedback of GHG emissions in different vegetation cover and/or soil features: Pine Forest (> 75 % Pine), Mixed Forest (25-75 % Pine), Birch Forest, Open Birch Forest, Alpine Tundra, Alpine Palsa, Flooded Tundra, Palsa Mire, Wetland Mire. Alpine Palsa and Palsa Mire sites were respectively at the top (360 m asl) and at the bottom (160 m asl) of the hillslopes. Due to the exceptionally high temperatures of summer 2018 and the consequent permafrost melting, Upland Palsa formations were surrounded by flooded tundra, even if not properly forming a mire. Soils are typically shallow podzols poorly developed, with an upper organic layer (up to 5-10 cm) and a deeper sandy layer (5-10 up to 30 cm). Overall, forest sites emitted the largest amount of CO_2, up to 60 kg C-CO_2 ha^{-1} d^{-1} with the ranking Birch forest > Mixed > Open Birch forest > Pine forest> Alpine Tundra. This result is in line with other findings, suggesting that colonization of tundra by birch forest under warmer temperatures would substantially increase decomposition rates, and thus CO_2 emissions, acting as a potential feedback for climate change. Palsa Mires emitted three times more CO_2 than Alpine Palsa, which are smaller and at a later development stage. A weak CH_4 sink in Forest sites (around 10 g C-CH_4 ha^{-1} d^{-1}) and values close to zero for Alpine Palsa, Alpine and Flooded Tundra were observed. 60 and 350 g C-CH_4 ha^{-1} d^{-1} were emitted from Palsa Mires and Wetland Mires, respectively. These results highlighted that i) carbon accumulation, vegetation development and permanent flooding conditions favored CH_4 production; ii) a huge positive feedback of permafrost melting on CH_4 emissions is expected in the long term. Few data are available on N_2O fluxes in arctic regions; our results highlighted low values in general, with maximum emission rates (around 1 g ha^{-1} d^{-1}) from Birch and Open Birch forests, whereas Pine and Mixed forests showed on average an uptake. Palsa Mires were also a source of N_2O, differently from Alpine Palsa and Wetland Mires, which showed values close to zero. Vegetation cover and the consequent N availability seemed to be the main factors affecting N_2O fluxes, even if further measurements are needed to reach conclusive remarks.