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Observing and modeling links between soil moisture, microbes and CH4 fluxes from forest soils

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Soil moisture is a key driver of methane (CH4) fluxes in forest soils, both of the net uptake of atmospheric CH4 and emission from the soil. Climate and land use change will alter spatial patterns of soil moisture as well as temporal variability impacting the net CH4 exchange.
The impact on the resultant net CH4 exchange however is linked to the underlying spatial and temporal distribution of the soil microbial communities involved in CH4 cycling as well as the response of the soil microbial community to environmental changes. Significant progress has been made to target specific CH4 consuming and producing soil organisms, which is invaluable in order to understand the microbial regulation of the CH4 cycle in forest soils. However, it is not clear as to which extent soil moisture shapes the structure, function and abundance of CH4 specific microorganisms and how this is linked to observed net CH4 exchange under contrasting soil moisture regimes.
Here we report on the results from a research project aiming to understand how the CH4 net exchange is shaped by the interactive effects soil moisture and the spatial distribution CH4 consuming (methanotrophs) and producing (methanogens). We studied the growing season variations of in situ CH4 fluxes, microbial gene abundances of methanotrophs and methanogens, soil hydrology, and nutrient availability in three typical forest types across a soil moisture gradient in a temperate rainforest on the Canadian Pacific coast. Furthermore, we conducted laboratory experiments to determine whether the net CH4 exchange from hydrologically contrasting forest soils responded differently to changes in soil moisture. Lastly, we modelled the microbial mediation of net CH4 exchange along the soil moisture gradient using structural equation modeling.
Our study shows that it is possible to link spatial patterns of in situ net exchange of CH4 to microbial abundance of CH4 consuming and producing organisms. We also show that the microbial community responds different to environmental change dependent on the soil moisture regime. These results are important to include in future modeling efforts to predict changes in soil-atmosphere exchange of CH4 under global change.