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Vertical structure and horizontal variations in the cycling of methane in the sediment of Lake Onego, Russia

Camille Thomas (1), Marie-Elodie Perga (2), Victor Frossard (3), Natacha Pasche (4), Hilmar Hofmann (5), Daniel Ariztegui (1), Nathalie Dubois (6), Natalya Belkina (7), and Emilie Lyautey (3)

(1) Department of Earth Sciences, University of Geneva, Geneva, Switzerland (camille.thomas@unige.ch), (2) Institute of Terrestrial Surfaces Dynamic, University of Lausanne, Lausanne, Switzerland, (3) UMR CARRTEL, Université Savoie Mont Blanc, Le Bourget-du-Lac, France, (4) APHYS, EPFL, Lausanne, Switzerland, (5) Limnological Institute, University of Konstanz, Konstanz, Germany, (6) Department Surface Waters Research & Management, EAWAG, Dübendorf, Switzerland, (7) Laboratory of Paleolimnology, Northern Water Problems Institute, Petrozavodsk, Russia

Lake Onego, the second largest lake in Europe, is a dystrophic, seasonally ice-covered lake in Karelia, Russia. Like most winter-covered lakes, its study has largely been limited to the summer period. However, it is well known that methane production is still ongoing in lake sediments during winter, potentially resulting in accumulation and major release upon thawing. Within the "Life Under The Ice" research project, our objectives were to assess winter contribution to the annual methane flux in Lake Onego, and to understand conditions and factors influencing methane cycling. During two on-ice field campaigns in March 2015 and 2016, sediment cores were retrieved at different sites of Petrozavodsk Bay, located in the north-western part of the lake. DNA and RNA were extracted from these cores to investigate the functional structure of microbial communities. Genes involved in methanogenesis, anaerobic and aerobic methane oxidations were quantified along with the concentrations and isotopic ratio of methane in the sediment pore water. Incubations, fingerprinting and sequencing of mcrA genes were also realized.
Vertically, the sediment is structured in a deep anoxic zone (below 10 cm) where mcrA gene and transcript copies increased implying methanogenesis, a transitional zone (5-8 cm) hosting methanotrophic organisms (Cand. Methanoperedens) able to oxidize the diffusing methane anaerobically by coupling nitrate reduction (Haroon et al., 2013), and a shallower oxic zone where methanotrophs were detected (pmoA gene and transcripts) and where methane concentrations drop below detection limit.
Sediment cores were also collected at three sites along a transect from the mouth of the river Shuya (the major inflow to the bay) to the open lake. Functional assemblage close to the river mouth had higher diversity and higher potential production rates and consumption of methane than further in the lake. However, the methane produced was almost completely consumed regardless of the sites, suggesting that this heterogeneity does not convey significant methane inputs to Lake Onego's water column during ice cover in winter.

Haroon, M. F., Hu, S., Shi, Y., Imelfort, M., Keller, J., Hugenholtz, P., ... Tyson, G. W. (2013). Anaerobic oxidation of methane coupled to nitrate reduction in a novel archaeal lineage. Nature, 500(7464), 567–70.