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Life under ice: Investigating microbial-related biogeochemical cycles in the seasonally-covered Great Lake Onego, Russia

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The Great European lakes Ladoga and Onego are important resources for Russia in terms of drinking water, energy, fishing and leisure. Because their northern location (North of Saint Petersburgh), these lakes are usually ice-covered during winter. Due to logistical reasons, their study has thus been limited to the ice-free periods, and very few data are available for the winter season. As a matter of fact, comprehension of large lakes behaviour in winter is very limited as compared to the knowledge available from small subpolar lakes or perennially ice-covered polar lakes. To tackle this issue, an international consortium of scientists has gathered around the « life under ice » project to investigate physical, chemical and biogeochemical changes during winter in Lake Onego. Our team has mainly focused on the characterization and quantification of biological processes, from the water column to the sediment, with a special focus on methane cycling and trophic interactions. A first « on-ice » campaign in March 2015 allowed the sampling of a 120 cm sedimentary core and the collection of water samples at multiple depths. The data resulting from this expedition will be correlated to physical and chemical parameters collected simultaneously.

A rapid biological activity test was applied immediately after coring in order to test for microbial activity in the sediments. In situ adenosine-5'-triphosphate (ATP) measurements were carried out in the core and taken as an indication of living organisms within the sediments. The presence of ATP is a marker molecule for metabolically active cells, since it is not known to form abiotically. Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) were extracted from these samples, and quantified. Quantitative polymerase chain reactions (PCR) were performed on archaeal and bacterial 16S rRNA genes used to reconstruct phylogenies, as well as on their transcripts. Moreover, functional genes involved in the methane and nitrogen cycles were also quantified in both sediment and water column. Preliminary results show that in the sediment, methanogenesis occurs below 7 cm. Above this redox boundary, methanotrophs are abundant but there activity remains enigmatic (10000 times less transcript than gene copies). Based on 16S rRNA transcripts, Bacteria and Archaea seem to have their maximum activity within the first 7 cm. These data are validated by ATP measurements. The principal peaks of activity actually lie at the water sediment interface, and at the redox boundary (7cm). High-throughput sequencing of 16S rRNA genes (both from DNA and RNA) are currently being performed to gain further understanding on the main actors of these microbial processes in the sediment. Diversity analysis are also being prepared and will allow to characterize the relationship between planktonic and benthic communities in the ice-covered lake.