# Response of methanogenic communities to glacial-interglacial climate changes in the Siberian Arctic

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## Introduction

The Arctic has gained specific attention within the current debate on climate change. With the thawing of permafrost large amounts of stored carbon become accessible again for microbial degradation and will form a potential source for the release of $CO_2$ and methane to the atmosphere having a positive feedback on the global warming. Therefore, it is of specific interest to understand the microbial driven greenhouse gas dynamics of the Siberian Arctic and their response to glacial-interglacial changes in the past.

Sample material was drilled on Kurungnahk Island (Russian-German expedition LENA 2002) located in the southern part of the Lena Delta and in lake El'gyggytgyn (ICDP-project) in Northeast Siberia. The Kurungnahk samples comprise Late Pleistocene to Holocene deposits, whereas the lake El'gyggytgyn samples cover Middle to Late Pleistocene sediments. Samples were investigated applying a combine biogeochemical and microbiological approach.

## Results and Conclusion

The methane profile of the Kurungnahk core reveals highest methane contents in the warm and wet Holocene and Late Pleistocene (LP) deposits and correlates largly to the organic carbon (TOC) contents. Archaeol concentrations, being a biomarker for past methanogenic archaea, are also high during the warm and wet Holocene and LP intervals and low during the cold and dry LP periods. This indicates that part of the methane might be produced and trapped in the past. However, biomarkers for living microorganisms (bacteria and archaea) and microbial activity measurements of methanogens point, especially, for the Holocene to a viable archaeal community, indicating a possible *in-situ* methane production. Furthermore, warm/wet-cold/dry climate cycles are recorded in the archaeal diversity as revealed by genetic fingerprint analysis.

In contrast to the results from the Kurungnakh core, in general the bacterial and archaeal biomarker profiles from the lake El'gygytgyn deposits reveal no distinct glacial-interglacial variability. This might be due to the fact that the overlying lake water buffers the temperature effect on the lake sediments which never became permafrost. The microbial abundance rather correlates to the TOC contents in the sediments forming the accessible carbon and energy source for the indigenous microbial communities. Also the diversity of methanogenic archaea, being still active in 400 ka old sediments, appears to vary with the organic carbon content. TOC-rich lake intervals seem to sustain a divers microbial ecosystem independent from glacial-interglacial climate cycles.

# Oxygen and di-nitrogen ($N_2$) dynamics in the hypoxic zone of the St-Lawrence Estuary

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Di-nitrogen ($N_2$) is the terminal end product of denitrification and annamox, microbial processes that eliminates fixed-Nitrogen (N) from ecosystems. N loss is critical given the key role of N in coastal eutrophication. The Lower St-Lawrence Estuary (LSLE) is a heavily stratified ecosystem, where persistent hypoxic conditions have established and steadily increased over the last 80 years. In order to estimate fixed-N loss, we tracked the change in $N_2$ concentrations along an isopycnal that progressively loses oxygen as it moves landward from the Laurentian Channel into the LSLE. We found a very strong relationship between $N_2$ excess and the $O_2$ deficit in the LSLE, where excess $N_2$ could be predicted linearly from AOU with an $r^2=0.84$. We estimate fixed-N losses from the change in $N_2$ excess along the isopycnal of around 685-1370 μmol N $m^{-2}$ $d^{-1}$. Compared with other methods estimating fixed-N loss, we found that our lower estimate corresponds with the higher estimates determined in core incubations, whereas our higher estimate, corresponds to the lower estimate as predicted using N*. Using excess $N_2$ represents however the most integrative approach at the basin scale.