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Rapid Permafrost Thaw Removes Nitrogen Limitation Rising the Potential of N_2O Emissions

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Previous research was addressed to carbon emissions after permafrost thaw, but less attention was paid to changes in nitrogen availability and N_2O emissions and in particular data from the Russian Arctic are scarce. Rise in water temperature and sea-level contribute to coastal erosion accelerating thaw rates and the release of dissolved nitrogen. Already 78% of the coastal regions of the Laptev Sea are affected by rapid permafrost thaw. This study estimates whether eroded Arctic coasts are hotspots for N availability and N_2O emissions and to further understand the impact of NO_3^- leaching. Therefore, we estimated N-transformation rates and greenhouse gas (GHG) production (CO_2, CH_4, N_2O) by incubating non-vegetated and revegetated soil samples from a retrogressive thaw slump in the Lena River Delta, Siberia. Within the thaw slump we found at exposed thaw mounds a domination of DIN over DON and an accumulation of NO_3^- with up 110 µg N $(g\ DW)^{-1}$ within the growing season and in the presence of vegetation. Those results are contracting to what is normally reported in Arctic regions. Our incubations indicate that thaw mounds are hotspots for N-mineralization and N_2O release (up to 390 ng N_2O-N $(g\ DW)^{-1}$) via denitrification while at the slump floor denitrification was substrate limited. Substrate limitation is rather caused by soil moisture and pH value than by functional limitation, since in our incubation N-mineralization could proceed in all samples. Simulated NO_3^- leaching removed the substrate limitation of the denitrification and converted the slump floor to a significant N_2O hotspot (410 ng N_2O-N $(g\ DW)^{-1}$).

Our results emphasise that it is necessary to consider geomorphology and landscape processes to identify hotspots of gaseous and dissolved N loss. A higher availability of inorganic nitrogen in coastal zones will have effects on marine ecosystems and more in depth-studies are needed to characterise seasonality of nitrogen leaching by melt water and eroded sediments.