Carbon cycling in thermokarst lakes of Central Yakutia: seasonal trends and a paleoenvironmental perspective.

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Résumé

Thermokarst (thaw) lakes, which are ubiquitous across circum-Arctic permafrost regions, have been identified as potential hotspots of greenhouse gas (GHG) emissions at the global scale. Many lakes of different ages and morphologies are currently visible across the landscape. Based on previous characterization of these lakes by geochemical techniques, we investigated three types of lakes for their limnological properties and their dissolved GHG concentrations (CO2, CH4, N2O): 1) recent thermokarst lakes, formed over the last decades; 2) old alas lakes, formed at the beginning of the Holocene; and 3) young alas lakes, formed during the mid-Holocene. Measurements were conducted during autumn, winter, spring, summer, providing a full annual cycle of seasonal dynamics. Preliminary results show striking differences between lake types at a given season and between seasons for a given lake type. Additionally, lakes that are deeper than the maximum thickness of ice cover can be strongly stratified during winter time, potentially fueling high GHG production within oxygen-depleted bottom waters. Wintertime concentrations of dissolved CO2 and CH4 can be up to 100 times higher than other seasons. Such heterogeneities must be considered when attempting to quantify the contribution of Siberian thermokarst lakes to GHG emissions from high-latitude regions and the related permafrost-carbon feedbacks to the global climate. Predictions about the trajectory of permafrost landscapes can be refined by analyzing past permafrost and landscape dynamics. A high-resolution analysis (total carbon (TC) and total organic carbon (TOC), total nitrogen (TN), 13C, 15N, and elemental composition) of a sediment core from a thermokarst lake near the study site was also completed to understand the processes of lake inception and development through time. The paleoenvironmental conditions during sediment deposition and soil formation affect the quantity and potential decomposability of sequestered OM within permafrost and therefore the potential GHG production of these landscape units after thawing.

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