EGU24-8316, updated on 12 Sep 2024
https://doi.org/10.5194/egusphere-egu24-8316
EGU General Assembly 2024

Dissolved Oxygen Dynamics in Arctic and Boreal Lakes in Late Winter

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Arctic and boreal lakes in the Northern Hemisphere experience annual ice cover lasting 4 to 7 months. Freshwater lakes in cold regions are sensitive to subtle environmental changes and influenced by various physical and biogeochemical factors. Our study focuses on comparative analysis of under-ice metabolism shaped by the thermal and oxygen dynamics of Arctic Lake Kilpisjarvi and Boreal Lake Paajarvi during the late winter. We aim to understand the effect of different trophic levels and light regimes on lake metabolism within cold regions by using high-frequency data on temperature, dissolved oxygen, and solar radiation for Lake Kilpisjarvi in 2019 and 2020, and Lake Paajarvi in 2022. Besides the long-term data, we compared the phytoplankton biomass and chemical parameters obtained from water samples collected from different depths. We studied the changes in the vertical distribution of lake metabolism by diel cycles by considering the strength and influence of internal motions on temperature and oxygen data.

Our results demonstrate that following prolonged darkness, a significant increase in dissolved oxygen occurs in the upper water column of Lake Kilpisjarvi. The depth of the mixed layer increases with depth, ranging from 1.1 m/day to 2.3 m/day for 2019 and 2020 in Kilpisjarvi. In contrast, Lake Paajarvi has a slower and steady rate of deepening at 0.55 m/day, resulting in a comparatively shallow mixed layer.