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First Pan-Arctic Assessment of Dissolved Organic Carbon Concentration in Permafrost-Region Lakes

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Permafrost-region lakes are dynamic landscape systems and play an important role for climate change feedbacks. Lake processes such as mineralization and flocculation of DOC, one of the main carbon fraction in lakes, contribute to the global carbon cycle. These processes are in focus of climate research but studies have been limited in geographic extent. We synthesized published datasets and unpublished datasets from the author team totaling 1,691 water samples from 1,387 lakes across the Subarctic and Arctic in permafrost regions of Alaska, Canada, Siberia, and Greenland to provide first insights for linkages between DOC concentration to the basin. In our synthesis, we find regional differences in DOC concentration of permafrost-region lakes. We focussed on relations between lake DOC concentration and latitude, permafrost zones, ecoregions, lake surrounding deposit type, and ground ice classification of each lake basin. Additionally, we analysed the lake surrounding soil organic carbon content from 0-100 cm depth and 0-300 cm depth. Individual lake DOC concentrations of our dataset range from below detection limit assigned to 0 mg L^{-1} (North Slope, Alaska) to 1,130 mg L^{-1} (Yukon Flats, Alaska). We found regional median lake DOC concentrations of 18.8 mg L^{-1} (Greenland, n=25), 12.2 mg L^{-1} (Alaska, n= 1,135), 9.6 mg L^{-1} (Siberia, n=252), and 7.2 mg L^{-1} (Canada, n=279). Lakes in the isolated permafrost zone had the highest median DOC concentration compared to lakes in the sporadic, discontinuous, and continuous permafrost zones. Our synthesis shows increasing lake DOC concentration with decreasing latitude and, due to a larger availability of biomass and organic carbon, a significant relationship of lake DOC concentration and ecoregion of the lake. We found higher lake DOC concentrations in boreal permafrost sites compared to tundra sites. About 22 %

of lakes in our dataset are located in regions with ice-rich syngenetic permafrost deposits (yedoma). Because yedoma contains large amounts of organic carbon, we assumed to find higher DOC concentrations in yedoma lakes compared to non-yedoma lakes. Our analysis shows a significant relationship of lake DOC concentration and surrounding deposit type but not a higher DOC concentration in yedoma lakes compared to non-yedoma lakes. Finally, we found a relationship of soil organic carbon content from 0-100 cm depth and lake DOC concentration. In contrast, a comparison of soil organic carbon content from 0-300 cm depth and lake DOC concentration shows no significant correlation. This was also found for ground-ice content and lake DOC concentration. Our dataset of lakes across the Arctic shows that the DOC concentration of a lake strongly depends on its environmental properties. This dataset will be fundamental to establish a pan-Arctic lake DOC pool for estimations of the impact of lake DOC on the global carbon cycle and further on climate change.