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Dissolved organic carbon dynamics of arctic Canadian lakes

Lakes are significant parts of the global carbon cycle and emit large amounts of carbon dioxide, for example when Dissolved Organic Carbon (DOC) is degraded by bacteria in water. However, lakes in the arctic are understudied. There is a need to improve our understanding of how bacterial processes, such as biomass production and respiration, are related to the composition of DOC, as this impacts ecosystem functioning and carbon dioxide emissions. For example, some arctic lakes contain DOC which comes from the nearby land, which usually is less reactive (degradable), has a more brownish colour, and is a poorer source of bacterial production, compared to DOC which is made within lakes by algae. In this study, these relationships were tested within 53 arctic lakes located in Churchill, Canada, which is a geographical area where no similar study has been done in the past.

The composition and origin of DOC, including amounts of CDOM, were analysed by using fluorescent spectroscopy, in which three fluorescent DOC components were found: C1, which is linked to input from land; C2, which is linked to microbial sources, and; C3, which is linked to algal sources within the lakes. In addition, standard laboratory DOC degradation experiments were performed, which gave amounts of bacterial production and bacterial respiration over a 28-day dark incubation period.

Lake area proved to be a very important factor for these lakes, having a large control of not only the amount of DOC, but also the range in magnitude of bacterial processes. The results suggested that small arctic lakes play an especially important role in the carbon cycle. Expected relationships between bacterial processes and our 3 components were partially found, proving that DOC composition affects bacterial and lake processes. For example, bacterial production correlated positively with C3, while C3 had no correlation with DOC lost, suggesting this component does not act as a good indicator of the reactive DOC consumed. Bacterial respiration and DOC contributed to potential carbon dioxide emissions in indirect ways, while further emissions could be enhanced by sun-light induced processes. Overall, small arctic lakes have an increasing importance in the carbon cycle as the impacts of climate change continue, facing increased DOC input, and hydrological changes with extreme precipitation events.

Keywords: Physical Geography and Ecosystem Science, Dissolved Organic Carbon, Arctic, Lake, Fluorescence, Area, pCO_2

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