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The sedimentary profiles of mercury and pyrolysable organic carbon as a long-term recorder of aquatic primary productivity and springtime temperatures for Arctic lakes

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An effect of recent Arctic climate warming is increased primary productivity in lakes, which is attributed to longer ice-free growing seasons. Here, we report sediment geochemistry data for the last millennium for two lakes in the Canadian High Arctic (at ca. 75^{O}N), which suggest the utility of a combined approach to paleo-temperature reconstruction using the down-core concentration and flux patterns of Hg and a specific type of organic carbon (OC) characterized by RockEval ® analysis. The pyrolyzable S2 carbon fraction, which includes cell wall aliphatic hydrocarbons, is indicative of phytoplankton biomass and is relatively resistant to bacterial metabolism. RockEval analysis confirmed that virtually all sediment OC came from within-lake algal productivity, and that it was well preserved. Down-core [S2] was highly correlated ($r^2 \sim 0.9$) with [Hg] in both lakes, and showed similarities to previous reconstructions of past Arctic temperatures, including an increase during the Medieval Warm Period. S2 data showed too that the latter half of the 20^{th} Century was the most productive of the past 1,200 years in these lakes. Recent OC fluxes were strongly correlated between study lakes, indicating a common driver of phytoplankton productivity, with the patterns corresponding to the limited instrumented Arctic spring air temperature record. We suggest that in High Arctic lakes, which mostly lack terrestrial carbon

inputs that might confound aquatic productivity patterns, S2 carbon can be used to infer a near-sea level temperature record for the Holocene and perhaps longer. Mercury also appears to be a good paleo-thermometer because its sediment accumulation rate is tightly controlled by primary productivity and, by extension, the seasonal duration of ice-cover.