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The influence of Holocene climate and catchment ontogeny on organic carbon cycling in low-Arctic lakes of SW Greenland

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Arctic soils represent a major store of organic carbon which is now under threat from regional warming. While much of the carbon is mineralized and released directly to the atmosphere as CO_2, some is moved laterally as dissolved and particulate organic C into streams and lakes where it fuels microbial processes and is degassed, some however is buried in lake sediments, where it is effectively removed from the terrestrial C cycle. It is possible to consider how catchment-lake C interactions have varied under natural climate variability and soil/vegetation development by using lake sediment records. Here we present Holocene organic C concentration and isotope data (TOC, C/N, δ13C) from a series of small lakes along Kangerlussuaq (coast to ice cap margin), southwest Greenland, a transect that covers a natural climate gradient and range of limnological conditions. Most Arctic lakes, including those in coastal west Greenland are considered to be net heterotrophic (ecosystem respiration is greater than primary production), i.e. they are net CO_2 sources. However, there is evidence that some of the inland Kangerlussuaq lakes are autotrophic. The coastal lakes formed c. 11 cal. ka BP following initial retreat of the ice sheet margin while the inland lakes formed between 8-7 ka BP after its rapid retreat eastwards. The sediment C isotope data suggest a complex Holocene history of interactions between the lakes and their catchments, reflecting glacial retreat, soil and vegetation development and climate-driven hydrological change that had a strong influence on transfer of terrestrially-derived carbon from land to water. At the coast, after 8.5 cal. ka BP, soil development and associated vegetation processes began to exert a strong control on terrestrial-aquatic C-cycling. This is not seen in the inland lakes until ca. 5 ka BP with the maximum extent of dwarf shrub tundra. Some of the lakes respond to Neoglacial cooling from around 5-4 cal. ka BP, when there was a change in catchment-lake interactions which resulted in changing carbon dynamics. Overall, in the coastal lakes, changes in bulk organic geochemistry are most likely the result of increasing contribution (and burial of) terrestrial organic matter as a result of enhanced soil instability while in the inland lakes changes in aquatic productivity are more important. By the mid- to late-Holocene the effect of climate variation on the lakes' C-cycling is quite complex, some coastal lakes, for example, are buffered by the strong maritime influence while others show significant environmental variability (MWP, LIA) especially those close to the present-day ice sheet margin. Overall, there is considerable variability in the C profiles in the Greenland lakes, presumably related to the contrasting way in-lake and catchment processes filter climate forcing. We illustrate this complexity of individual lake response by reference to Holocene profiles from a number of lakes. We consider the implications of these geochemical and isotopic profiles for the long-term development and metabolic balance (i.e. net heterotrophy vs autotrophy) of these lakes.