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Warming-controlled glaciers retreat and enhanced carbon burial – is there a negative feedback effect? – summary of multidisciplinary study in fjords of Svalbard

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Carbon burial and sequestration in the oceans are very important issues in understanding global climate controls and are necessary to provide more accurate future climate models. Recently fjords were highlighted as globally important carbon sinks, mainly on the basis of studies conducted in temperate fjords. However, an important rising question is if these estimates are also valid for fjords with catchments covered mainly by glaciers, and thus with limited supply of modern terrigenous organic carbon. Many of them witness a rapid glacier retreat, increase in sediment input and in fjord area. Thus, the following question arise on likely changes in carbon burial efficiency. We considered a following hypothesis: may climate warming-accelerated glaciers retreat provide conditions (higher sediment accumulation rates) for more efficient carbon burial, and thus a negative feedback effect between increase in atmospheric carbon dioxide and enhanced carbon sequestration and burial in marine sediments? In order to test this hypothesis and address the above stated question a multidisciplinary study was conducted in fjords of Svalbard, with Hornsund fjord being a key example. Svalbard is particularly sensitive to global climate changes as proved by modern monitoring data and the past records. One of the most spectacular changes is the rapid retreat of tidewater glaciers during the post-Little Ice Age period (after $\sim$1900). Due to the retreat, new bays characterised by high sediment accumulation rates have been formed in the inner parts of the fjords. The present study is based on high resolution data including: multibeam echosounder bathymetry, shallow seismics, high resolution analyses of over 30 sediment cores and end member sediment samples. The sediment analyses included sedimentological description, grain size, 210Pb and 137Cs dating, bulk geochemical analyses and XRF scanning, organic carbon age analyses (14C) and stable isotopes analysis of organic matter. Along with the relatively good historical documentation of glacier front positions and climate during the post-Little Ice Age period it allowed to quantify the sediment and carbon fluxes to the new bays in decadal scale. The sediment dispersal pattern seem to be largely affected by glacier retreat rates, changing bay geometry and increase in influence of oceanographic conditions. The extremely high carbon burial rates (in order of several hundreds of gOC/m2/yr) are higher than in temperate fjords and makes the studied bays an important sinks in context of the total carbon burial in polar marine sediments. However, most of the carbon comes from subglacial erosion of older sedimentary rocks, not from modern sequestration of atmospheric carbon. Thus the hypothesized negative feedback effect between increase in atmospheric carbon and its enhanced burial is not confirmed.

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