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Deposition, return flux, and burial rates of carbon, nitrogen and phosphorus in the sediments of two high-Arctic fjords (Spitsbergen)

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Sediments play an important role in the biogeochemical cycles of carbon, nitrogen and phosphorus, as they constitute an important, long-term natural sink for these elements.
A significant fraction of the material deposited on the sea bottom is buried in the subsurface sediments and thus excluded from contemporary cycles. The remaining fraction after mineralization and/or hydrolysis, returns to the water column and supports the biogeochemical processes occurring there. This mechanism is particularly important in the polar regions, especially in Arctic fjords, which are characterized by large amounts of organic matter (OM) deposited to sediments. This, combined with the consequences of climate change, make fjords crucial testing ground in this respect.
The aim of this study was to determine the burial rates of C, N and P in the subsurface sediments of Hornsund and Kongsfjorden (Spitsbergen). This was estimated as the difference between deposition of these elements to sediments and their return flux from sediments to the water column. The concentrations of C, N and P organic and inorganic species were measured in surface sediments, in pore water extracted from the sediments, and in the above-bottom water at sampling stations situated along the axes of the fjords.
The results proved substantial differences in both quality and quantity of C, N and P deposited in the sediments of the both investigated fjords. More specifically, a larger amounts of organic carbon (OC), total nitrogen and phosphorus are buried in the Hornsund sediments (annually to 120 g OC m-2, 7.9 g N m-2 and 2.8 g P m-2), than in the Kongsfjorden (annually to 10 g OC m-2, 1.3 g N m-2 and 1.2 g P m-2). These differences are accompanied with higher efficiencies of the burial rates in the former fjord (up to 97% for OC, 95% for N and 99% for P), which lead to conclusion that OM load there is strongly dominated by stable, terrestrial OM, which is subsequently buried in subsurface sediments. In the case of Kongsfjorden, the amount of sedimentary OM is lower. Moreover the load mostly originates from the in situ production and is thus more labile. Therefore, the efficiencies of the burial rates are lower there (up to 48% for OC, 47% for N and 92% for P). Simply a larger fraction, than in Hornsund, of sedimentary OM undergoes mineralization and/or hydrolysis and diffuses back to the water column as return fluxes (as intensive as 14.6 g C m-2, 1.5 g N m-2 and 0.1 g P m-2 per year).
To sum up, we quantified material fluxes to- and from- bottom sediments and thus managed to evaluate the sediments role in the C, N and P cycles. Quantification of surface sediments as a ‘source’ of C, N and P species for processes in the water column is also assessed.