Does sea ice reduction enhance preservation of organic carbon in Arctic marine sediments?

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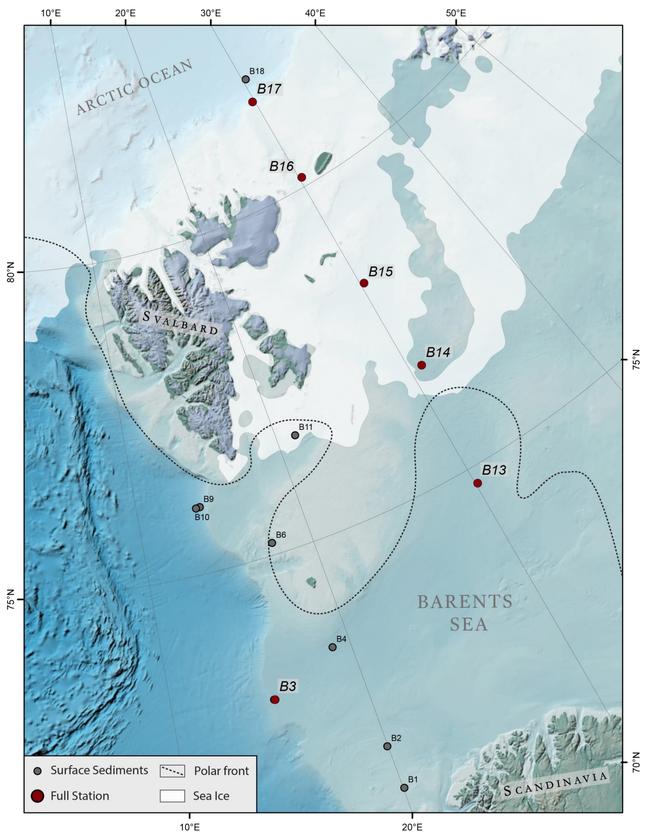
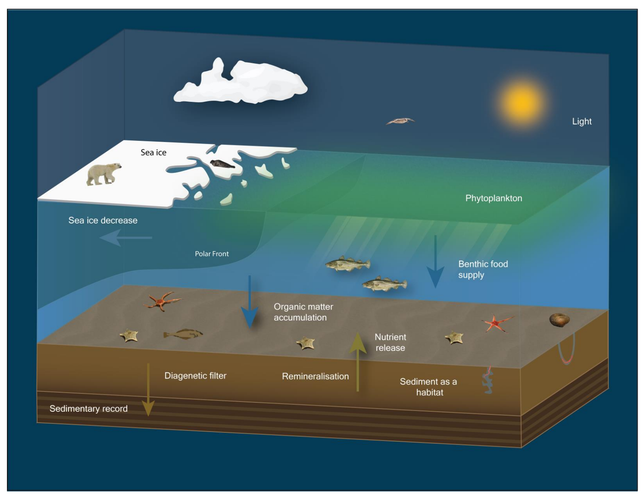
Outline & Study Area

Ongoing climate change leads to sea ice reduction and higher freshwater runoff into the Arctic Ocean. These factors could, in the future, sustain higher primary productivity due to enhanced nutrient input and more extensive open water conditions. An increase in primary productivity is likely to change the amount of organic carbon reaching the seafloor and might cause higher carbon burial rates. However, the mechanisms that control organic carbon preservation in sediments are complex and poorly characterized. Recent findings show that organic carbon burial in marine sediments can be substantially enhanced due to the association of organic carbon with reactive iron minerals.





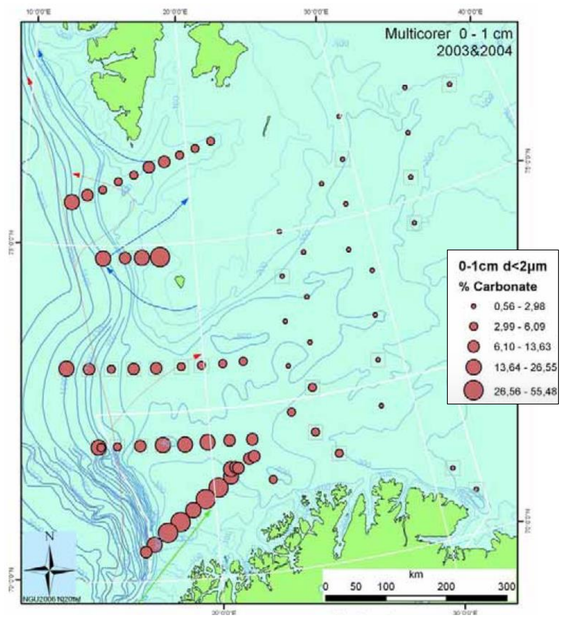
Objectives

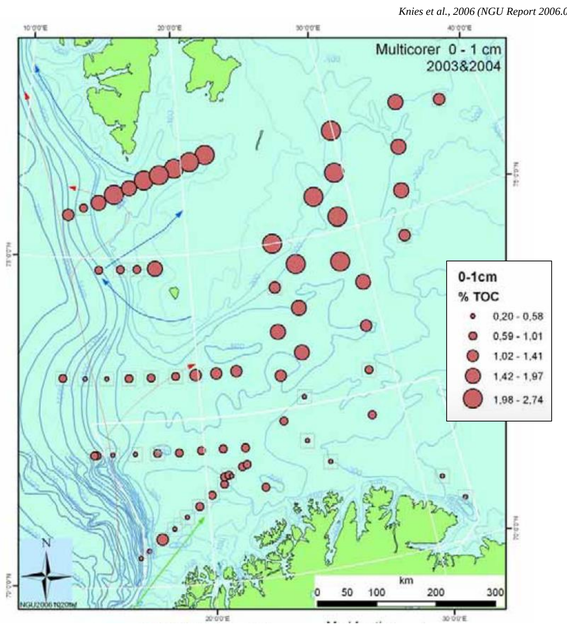
- How will changes in the surface ocean influence seafloor processes?
- What are the consequences of this for carbon sequestration in seafloor sediments?
- How will seafloor biota respond to changes in food quantity and quality?
- Will there be changes to benthic ecosystem services, for example, the recycling of nutrients to overlying waters?

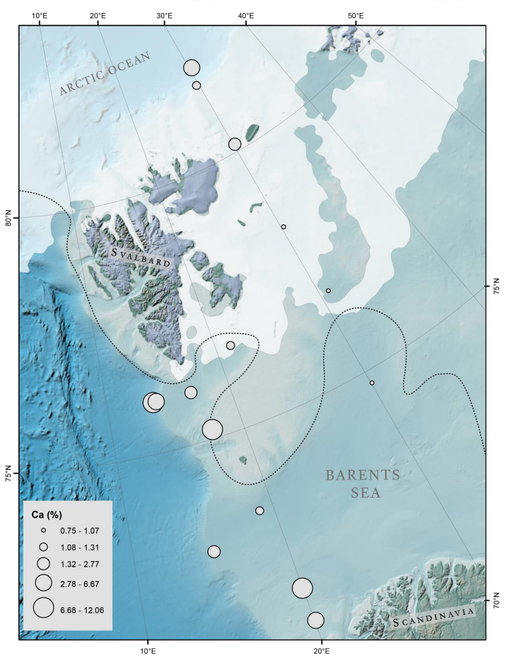
$CaCO_3$ and Organic Carbon in Barents Sea Surface Sediments

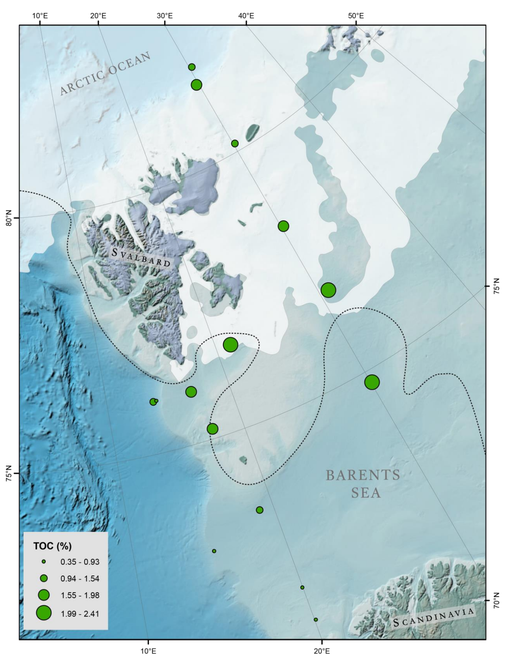
Under the assumption that the amount of terrigenous carbonate is negligible higher carbonate concentrations are an indication for higher primary productivity. Literature data and our own investigation show a strong west-east gradient of $CaCO_3$ versus TOC in the Barents Sea.

Knies et al., 2006 (NGU Report 2006.067)



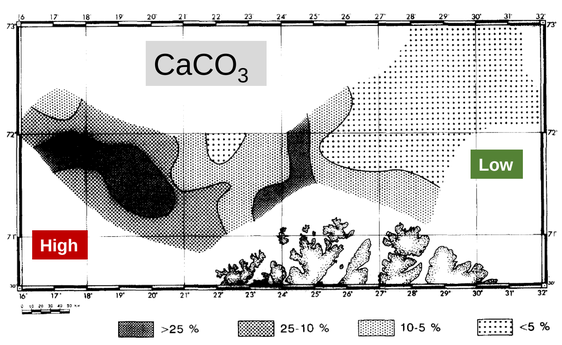


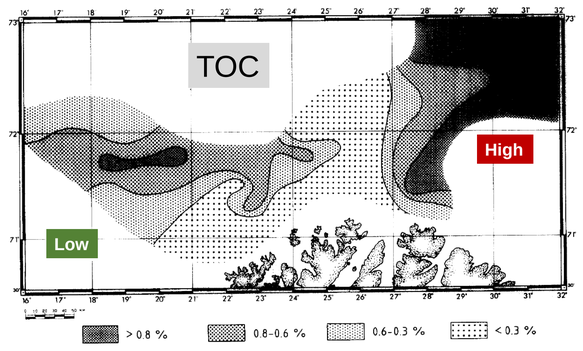




$CaCO_3$ is yet not available for all our samples. However, Ca versus $CaCO_3$ for samples from B13-B17 show a strong correlation (r = 0.9) indicating that $CaCO_3$ is the main source of Ca in our samples.

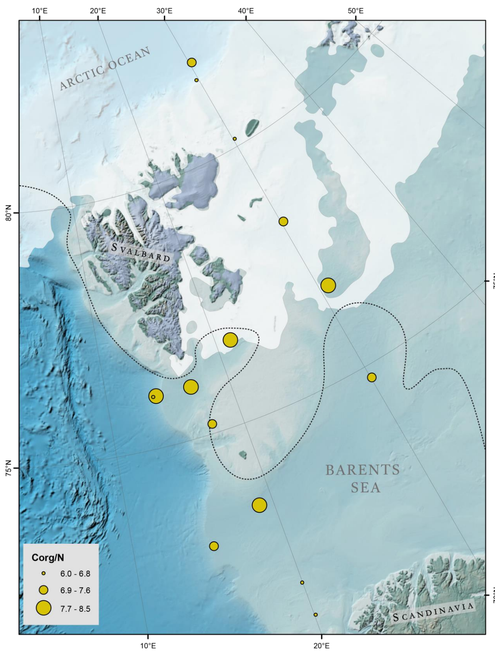
Steinsund and Hald 1994 (Marine Geology)



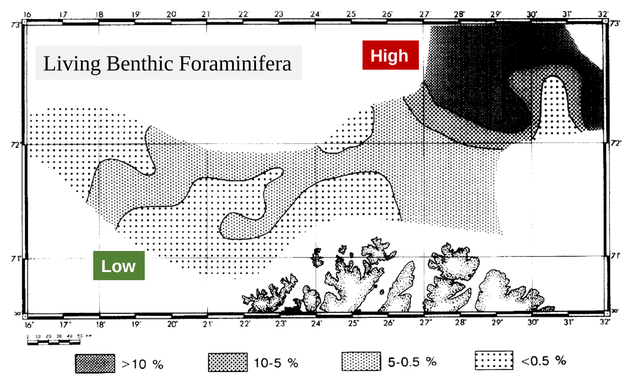


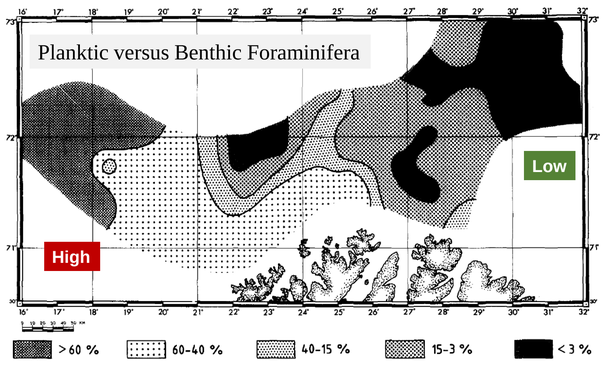
Marine Productivity and Organic Carbon Sources

The main source for the organic matter in the Barents Sea seems to be marine productivity. We found that the east-west gradient of organic carbon and carbonate may be related to differences in the planktic versus benthic marine productivity.



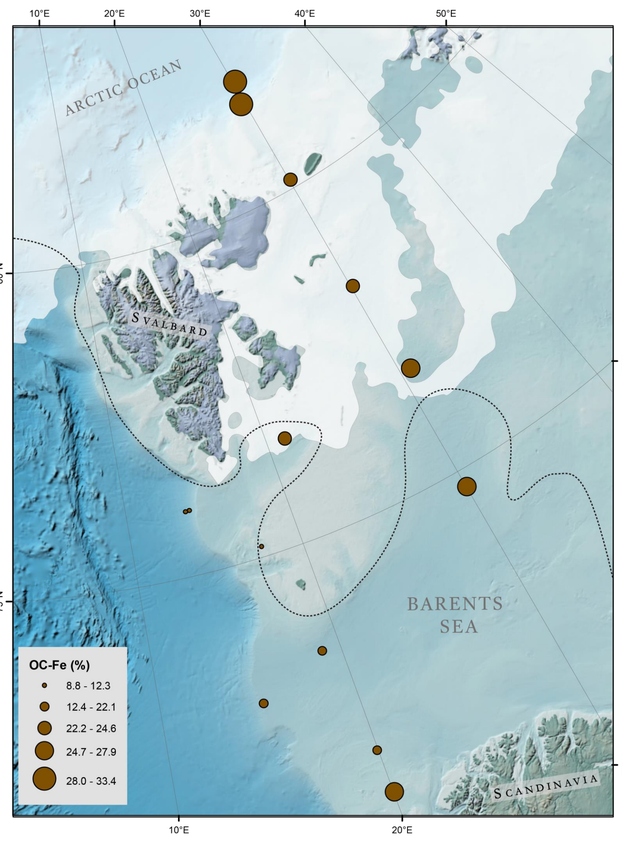
During our research cruises in 2017 and 2018 we found that the abundance of benthic organisms is much higher in the east than in west Barents sea. A similar pattern was found in the distribution of plantic versus benthic foraminifera by Steinsund and Hald 1994 (Marine Geology).

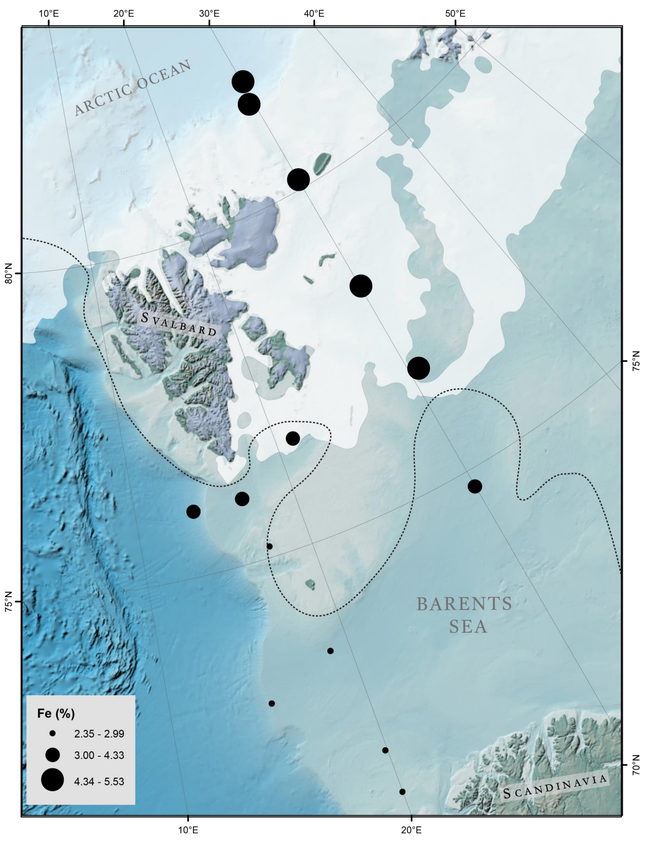




Organic Carbon Associated with Iron Oxides

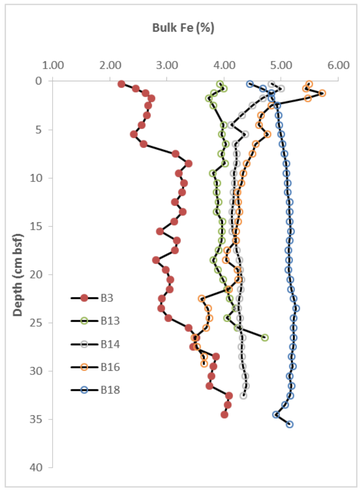
To better constrain the efficiency of the carbon burial in the Barents Sea we analysed the fraction of organic carbon bound to iron oxides (OC-Fe). Iron oxides have a strong influence on organic carbon stabilization due to its high sorption capacity. Organic carbon adsorbed to oxides can bypass the shallower oxic degradation regimes. Therefore, reactive iron phases may serve as a efficient sink for organic carbon in marine sediments.

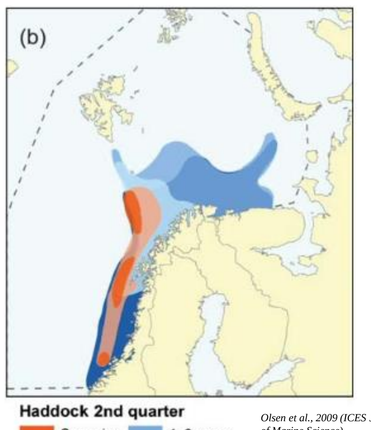




Questions and Outlook

- **What happens to the OC in the west and the $CaCO_3$ in the east?**
- **Does sea ice reduction lead to lower OC and higher $CaCO_3$ values in the east?**
- **Will OC burial less efficient in a sea ice free future?**
- **Is the carbon burial efficiency high under the ice despite low or slow marine productivity?**





Olsen et al., 2009 (ICES Journal of Marine Science)

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