INSTITUTIONEN FÖR MARINA VETENSKAPER

Carbon Cycling in Baltic Sea Sediments
– In situ investigations with benthic landers

Madeleine Nilsson
Institutionen för marina vetenskaper
Naturvetenskapliga fakulteten

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Abstract Coastal seas, estuaries and continental shelves are the connection between land and the open ocean, and due to high productivity and strong influence from land a majority of the marine organic carbon (OC) cycling and preservation in sediments occurs in these areas. Sediments are hotspots in the C cycle also since they constitute a link between the biogeochemically active C pool and the C pool that cycles on much longer timescales, and benthic processes will thus have an effect on atmospheric CO_2 levels. To accurately predict future atmospheric CO_2 levels it is of great importance to understand how C is recycled and preserved in sediments of coastal seas and estuaries.

This thesis investigates benthic OC cycling in the Baltic Sea with emphasis on understanding and quantifying the recycling and preservation of OC. The investigations were made in situ using advanced benthic chamber landers that incubate an area of sediment and overlying water. By discrete water sampling or continuous measurements by sensors it is possible to detect the concentration change of a solute over time resulting from early diagenetic processes in the sediment. Dissolved inorganic carbon (DIC) fluxes were measured in the incubation chambers and used as a proxy for OC oxidation. Moreover, the vertical distribution of OC in the sediment solid phase together with sediment accumulation rates were used to quantify the OC preservation or burial.

It was found that OC recycling rates in Baltic Sea sediments are much larger and burial rates lower than previously thought. In total 96 % of the OC that deposits on the sea floor is recycled back to the water column. However large variations between the different Baltic Sea sub-basins were observed as well as between different bottom types. The highest OC recycling rates (~ 32 mmol m^{-2} d^{-1} on average) were observed in the deep accumulation areas of the Baltic Proper, where also the lowest burial efficiency (burial rate/deposition rate) was found (2.5–3.5 %). OC recycling rates in general tended to increase with increasing water depth, and so did the OC oxidation efficiency, i.e. the DIC flux per available OC in the reactive sediment surface layer. This was largely explained by focusing of fresh labile OC along the depth gradient within the basin. It was estimated that nearly half of the OC that deposits on shallow bottoms in erosion-transportation areas of the Baltic Proper is resuspended and redistributed to deeper calmer accumulation parts of the basin. Oxygen in the overlying water had no significant effect on the OC recycling rates as found from observations before and after a so-called major Baltic inflow.

During the thesis work the benthic chamber landers have been updated with regard to control of quality and performance of the sediment-water incubations. The measured benthic fluxes can now be determined with higher accuracy and reliability of chamber functioning, and still enable an efficient full lander deployment-incubation-recovery cycle in one day. One major step forward was the installation of conductivity sensors to determine chamber volume from the dilution of salinity resulting from a small injection of MQ water. The benthic landers used in this work are considered to be one of the most suitable systems available in the field today. The outcome of this in situ study improves the understanding of the carbon cycle and its dynamics in the Baltic Sea.