



UNIVERSITY OF GOTHENBURG

**Fluxes and transformation of carbon in the
Siberian shelf seas under changing environment**

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AKADEMISK AVHANDLING

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Abstract

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The Arctic is especially vulnerable to the increased air temperature caused by emissions of greenhouse gases to the atmosphere, carbon dioxide being one of them. In this thesis, both fieldwork and modelling of the East Siberian Arctic Shelf (the Laptev Sea and the East Siberian Sea) have been carried out to investigate the carbon system in this region.

Fieldwork in 2008 revealed two distinct hydrological regimes in the East Siberian Sea, one in the western area and one in the eastern area. The western area is dominated by freshwater from rivers flowing into the East Siberian Sea but also from the Lena River plume coming from the Laptev Sea. Nearly all waters in this area are supersaturated with respect to carbon dioxide compared to the atmosphere due to mineralization of substantial amounts of terrestrial organic matter coming from thawing permafrost and coastal erosion. This excess carbon dioxide may be a potential source to the atmosphere and thus increase the atmospheric greenhouse gas content, a positive feedback mechanism. The eastern area is dominated by inflow of Pacific-derived waters that are clear, salty and nutrient rich and therefore favour primary productivity. Phytoplankton consumes carbon dioxide that lowers its partial pressure ($p\text{CO}_2$) making it undersaturated compared to the atmosphere and the Eastern East Siberian Sea becomes a sink for atmospheric carbon dioxide. In addition, the Laptev Sea had supersaturated $p\text{CO}_2$ equal to an excess of dissolved inorganic carbon of around $\sim 5 \times 10^{12}$ gC, which is in the same order as for the Western East Siberian Sea. This excess is also a potential source of carbon dioxide to the atmosphere that could enhance climate change.

Modelling work with a one-dimensional, time dependent coupled physical biogeochemical model confirms this conclusion for the late summer when the $p\text{CO}_2$ in the seawater increases due to mineralization and water mixing. Model simulations for the Laptev Sea were utilized to investigate the net annual sea-air flux caused by different forcings; doubled atmospheric partial pressure of carbon dioxide; 4°C air temperature increase; doubling the concentration in the runoff of dissolved organic carbon or nutrients; increasing the river discharge by 25 %; increasing the wind speed by 10 % or a combination of these forcings. The result revealed decreasing uptake of carbon dioxide when changing the river properties except for the increase of nutrients when the uptake of carbon dioxide increased. The uptake also increased with the changed forcings in air temperature, wind speed and atmospheric partial pressure of carbon dioxide, separately and in combination.

KEY WORDS: Climate change, Carbon system, Carbon dioxide, Arctic Ocean, Siberian shelf seas