ABSTRACT

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Carbon dioxide (CO_2) fluxes, within the ocean and over the interface between ocean and atmosphere (sea-air), have been studied in the Arctic Ocean, the Greenland Sea and the Southern Ocean (the Atlantic sector). These oceans are important in the global carbon dioxide cycle due to sinking surface water that transports CO_2 to greater depths. The polar seas have an ice cover throughout the year, and for this reason they are particularly sensitive to a temperature increase, in a case of a climate change. An increase in temperature could result in melting of the sea ice, and consequently the conditions for deep-water formation and biological production would change. Subsequently this could lead to changes in the CO_2 fluxes in the polar oceans. For this reason it is important to study the processes in the ocean, both physical and biological, and their impact on the CO_2 fluxes. Some of the atmospheric CO_2, which is a product of human activity (anthropogenic CO_2) through the use of fossil fuels etc, is sequestered in the ocean.

In this thesis the oceanic sequestering of anthropogenic CO_2 is discussed, and quantification of the sequestering in the Arctic Ocean is performed. For all the studied areas sea-air CO_2 fluxes and transformation of dissolved inorganic carbon are related to physical features (e.g. ice cover, marginal ice zone and fronts) and biological activity (e.g. primary production). Different approaches to calculate the CO_2 fluxes are applied. Comparisons between results, related to both the different methods and different regions, are discussed.

In the Barents Sea and the Greenland Sea there was a significant uptake of atmospheric CO_2, based on calculations. When combining the CO_2 uptake with volume transports, the total uptake of atmospheric CO_2 in the Barents Sea is estimated to 0.009 Pg C yr^{-1}. The Greenland Sea acted as an atmospheric CO_2 sink during the whole year that amounted to 0.015 Pg C yr^{-1}. In the Southern Ocean two separate approaches for the calculation of sea-air CO_2 fluxes were performed. The calculated sea-air CO_2 fluxes indicated both atmospheric CO_2 sinks and sources. The high physical and biological variability in the area can explain these differences. A discussion about the importance of time scale in the determination of sea-air CO_2 fluxes is included in the thesis.

The estimated new production in the three polar oceans was of the same order of magnitude. For this reason the hydrographic characteristics, rather than biological production, seem to be the dominating influence on the oceanic CO_2 fluxes.

In the Arctic shelf seas the deep-water formation is an important mechanism for sequestering of anthropogenic CO_2 in the Arctic Basin. The total sink of anthropogenic CO_2 in the Arctic Ocean is estimated to 0.026 Pg C yr^{-1}, which is about 1% of the global oceanic uptake of anthropogenic CO_2.

KEY WORDS: oceanic carbonate system, Arctic Ocean, Greenland Sea, Southern