

C. Cycle of carbon and related compounds

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1. Interview with Prof. Dr. H. de Baar



Photo: Frank van Driel

The role of carbon in coastal seas

Over the past few decades, rising CO₂ concentrations in the atmosphere and the associated effects of this have led to a significant boost in fundamental research on carbon cycles and the cycles of related chemicals in coastal areas, says Professor Hein de Baar. He works at the Royal Netherlands Institute for Sea Research (NIOZ) and the University of Groningen and leads various projects within the LOICZ-NWO Programme. Coastal areas are naturally very

productive areas and that means that a lot of carbon is sequestered by algae and then broken down. Knowledge about the pathways and fate of carbon in coastal areas is vital for ensuring that the right measures can be taken in the future.

What is the relationship between seawater and carbon dioxide?

De Baar: Our research was on the carbon cycle of the entire North Sea and how CO₂ is sequestered from the atmosphere into the sea. That is a natural, but very slow process. As more CO₂ dissolves in the water, the water's chemistry changes. Certain dissolved forms of CO₂ function as a buffer for the pH. If the pH changes then a different environment will develop. What effect will this have on the organisms in the water? We investigate whether this is good or bad for the organisms. The highest biological productivity is in the coastal seas. In the middle of the open ocean hardly anything grows or lives. The water there is crystal clear due to the lack of life. Changes in the CO₂ concentration are therefore dependent on the location. In the ocean the changes are minor, but along the coast, in the Marsdiep near Texel, these changes in CO₂ concentration and pH can be considerable. We examine the natural fluctuations over the course of the year in relation to the gradual increase in CO₂ over the longer term.

When did you start the research?

During the first trips in 2001 and 2002 we measured that the North Sea sequesters three times as much CO₂ per square kilometre at three times as fast a rate than occurs in the Atlantic Ocean. Since then we have performed these measurements once every three years and this observation remains unchanged. These results have been incorporated in two different computer simulation models that were funded by LOICZ. Both models give roughly the same outcome. The validity of these models has been demonstrated with each set of measurements collected. That is good news because a model that works well demonstrates that you have a good understanding of the underlying mechanisms. However, we have not finished yet.

Why do you see such large differences in the CO₂ concentration between the North Sea and the Atlantic Ocean?

The water in the Atlantic Ocean takes up less CO₂ than that in the North Sea. We think that a biological pump underlies these differences. The southern North Sea along the Dutch coast has an average depth of 50 metres but the northern North Sea has a depth ranging from 400 to 800 metres, therefore far deeper. In the summer, the northern part becomes stratified with warm water at the surface and cold water in the deeper parts. The algae in the upper layer sequester the CO₂. If the algae die or are eaten, the material containing carbon ends up in the deeper layer where it is decomposed by bacteria and CO₂ is released again. The deeper water is replenished from the Atlantic Ocean. A sort of conveyor belt exists with deep water entering the North Sea at the Shetland Islands and then flowing back there again about a year later after a large detour. Deep water with a low CO₂ concentration therefore flows in at the Shetland Islands and deep water with a slightly elevated CO₂ concentration flows out again into the Atlantic Ocean.

Is the ocean sink capacity for CO₂ stable?

In 1957, the American researcher Roger Revelle theoretically calculated that the sink capacity of the oceans decreases over time. And that has proven to be the case. There are two possible complications for this: the interaction with the sea floor and exchanges with the Wadden Sea. In the open ocean, the seafloor does not play a role due to its great depth being separated from surface waters.

What does this mean for the future?

Our hypothesis is that these fluctuations will not have any significant effect in the shorter term (100 years). The variations concern the budget of where the fossil fuel CO₂ is being stored: the balance between fossil fuel CO₂ in the oceans and fossil fuel CO₂ in the atmosphere. That is currently about fifty-fifty. According to Revelle, we can expect that increasingly less will be sequestered by the oceans, so the CO₂ concentration in the atmosphere will increase even more rapidly than it has the past century. We have received funding for a new project from NWO in which three PhDs will do further research on CO₂ sequestration in the North Sea. This is a good move because it is a long-term issue.

Is this CO₂ research a specialism in which the Netherlands is playing the leading role?

All of the countries bordering the North Sea bear a responsibility for monitoring it. We need to set up a joint knowledge base. We are now taking part in an initiative for a wide-ranging report on the state of the North Sea and climate. Ideally such a report will next be published again every seven years with the newest insights and measurements, just like the IPCC producing a new report once every about seven years. Worldwide scientists bundle the knowledge they have acquired and draw their conclusions about the latest developments in climate change. Several years ago a similar report about the Baltic Sea was already published and very well received. Such a scientific status report needs to be published for the North Sea as well.