

Preface

This book is the product of our joint efforts to present the biogeochemistry of the Baltic Sea from a unique perspective, “through carbon dioxide glasses.” We are convinced that this view advances our understanding of the organic matter production and mineralization processes that constitute the basic biogeochemical transformations in the sea and that trigger many secondary processes. The term “understanding” here means to be able to describe transformations as a function of time, to identify the controlling variables and finally to deduce the kinetics of the considered process. This allows us to explain the current biogeochemical status of the Baltic Sea but, more important, is a requisite for the use of numerical models to realistically predict the development of the ecological status of the Baltic Sea in a changing environment. Current biogeochemical models using state-of-the-art process parameterizations have increased our comprehension of the functioning of the Baltic Sea ecosystem and of the complex relationship between biogeochemistry and hydrography. Nonetheless, model simulations of the carbon cycle and thus of the marine CO₂ system either have failed to simulate the seasonal and regional patterns of the CO₂ system or were able to reproduce them only by invoking biogeochemical assumptions yet to be verified by observations. Therefore, investigations of the marine CO₂ system, which is intimately connected to all biogeochemical processes, have two functions: Identification of gaps in our process understanding and filling the gaps by improving the process parameterizations.

A recognition of the importance of studying the CO₂ system in the Baltic Sea developed during the past 25 years of related research carried out at the Leibniz Institute for Baltic Sea Research. The accumulation of a huge amount of data during 14 years of automated CO₂ measurements made from a cargo ship has provided the basis for several publications. This refers also to studies of the deepwater CO₂ accumulation in connection with the Institute’s long-term observation programme. Here we present a synoptic view of the collected data and the gain in knowledge by connecting the results of previously published process studies to an overall picture. We consider our book as a contribution to the biogeochemical discussions within the Baltic Earth Network which is a scientific network for regional Earth system science for the Baltic Sea region (www.baltic.earth). We also hope that it will guide

the inclusion of the carbon cycle into biogeochemical models and the integration of CO₂ measurements into Baltic Sea monitoring programs, such as proposed by the BONUS project INTEGRAL.

The cooperation between the authors in writing this book is also worthy of mention. Whereas BS was able to draw extensively on his own decades-long research in different fields of chemical oceanography, JDM is a Ph.D. student and thus at the beginning of his scientific career. His skills in dealing with large amounts of data and in the creative visualization of the inherent information were essential to the success of the investigations and the presentation of their results. The bridge between our generations enabled many fruitful and inspiring discussions from which both the book and we profited.

Regarding the automated surface CO₂ measurements on a cargo ship, we are much obliged to the Finnish Environmental Institute (SYKE), which has been using the cargo ship since 1993 for automated fluorescence (chlorophyll *a*) measurements and for taking samples for the analysis of nutrient concentrations within the Algaline Project. Due to the institute's generous cooperation, we were able to make use of the same infrastructure for the deployment of our own measurement system. Furthermore, our Finnish partners made nutrient data available for CO₂ data analyses and for use in this book. During 2012–2016, the operation of our CO₂ measurement system was generously funded by the German Federal Ministry of Education and Research (BMBF) in the frame of the German contribution to ICOS (Integrated Carbon Observation System) (Grant Numbers 01LK1101F and 01LK1224D).

We also thank the Swedish Agency for Marine and Water Management and the SMHI (Swedish Meteorological and Hydrographical Institute) for ready access to their monitoring database.

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At the IOW, we are indebted to many of our colleagues, especially B. Sadkowiak, who constructed the automated measurement system's hardware and ensured proper operation of the system. We are also grateful to the Monitoring team for their regular collection of samples for total CO₂ investigations, and to the staff of the IOW's CO₂ lab for performing the respective analyses.

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