Preface

Ice cover is an essential element in cold climate lakes. To a large degree it isolates the water body from the atmosphere and sunlight and slows down physical and biological processes. In the boreal zone, tundra, and mountain regions the ice cover is seasonal, while in very high altitudes and high polar latitudes perennially ice-covered lakes are found. Ice formation results in different ice types and stratigraphy, which further influence the ice properties. Ice sheets of freshwater lakes are poor in impurities. However, they may possess liquid layers or inclusions, which serve as habitats of biota. Freezing of lakes also brings both practical advantages and problems to human living conditions in cold regions. It is of great interest to know the physics and ecology of lake ice, to monitor and predict ice conditions in lakes, and to evaluate what can be the impact of climate changes to lake ice seasons.

The present book, *Freezing of Lakes and the Evolution of their Ice Cover*, provides the status of knowledge in the physics of lake ice and the interactions between the ice cover and the liquid water body underneath. Historical developments in lake ice research are also discussed. Chapter 1 gives a brief overview and presents the research fields. The Chap. 2 contains the classification of ice-covered lakes, and in Chap. 3 the structure and properties of lake ice are presented. Ice growth and melting are treated in Chap. 4, while the following chapter focuses on ice mechanics. Chapter 6 goes into the more exotic environment of pro-glacial lakes. The last three chapters consider important lake topics related to the presence of ice in lakes. Chapter 7 contains the physics of the water body beneath lake ice, Chap. 8 discusses the winter ecology of freezing lakes and the lake ice interface toward the society including the impact of climate change on lake ice seasons. The book ends with a brief closing chapter and a list of references. Examples of research problems for student learning are listed throughout the book.

The underlying idea behind the book has been to include the whole story of lake ice into a single volume. There is a crying need for such synthesis, as winter limnology research and applications are increasing and, apart from review papers, no comprehensive monograph exists on this topic in English. The author has contributed to lake ice research since the 1980s. In particular, his topics of interest have been lake ice structure and thermodynamics, light transfer in ice and snow, ice mechanics in large lakes, and lake ice climatology. Mathematical modeling of ice growth, drift, and decay are covered in this research.

This book has grown from the author's research, collaborative visits to several universities and research institutions, and intensive international courses—winter schools—in lake ice and winter limnology. These visits concern in particular the Estonian Marine Institute of Tartu University (Tallinn, Estonia), Institute of Limnology of the Russian Academy of Sciences (Sankt Petersburg, Russia), Institute of Low Temperature Science of Hokkaido University (Sapporo, Japan), Leibniz-Institute of Freshwater Ecology and Inland Fisheries (Berlin, Germany), Marine Systems Institute of Tallinn University of Technology (Tallinn, Estonia), Northern Water Problems Institute of the Russian Academy of Sciences (Petrozavodsk, Russia), and the State Key Laboratory of Coastal and Offshore Engineering of Dalian University of Technology (Dalian, China). The winter schools have been arranged in Lammi Biological Station and Kilpisjärvi Biological Station of the University of Helsinki, in the Saroma-ko field site of the Hokkaido University, and in the Dalian University of Technology. Very recently, the author joined the Global Ice Modeling Project of the Global Lake Ecological Observatory Network (GLEON).

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