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MASS BALANCE OF THE CRYOSPHERE: OBSERVATIONS AND MODELLING OF CONTEMPORARY AND FUTURE CHANGES

Jonathan L. Bamber and Antony J. Payne, Eds., 2004, 662 pp., $130.00, hardbound, Cambridge University Press, ISBN 0-521-80895-2

In the words of the editors of *Mass Balance of the Cryosphere,* "the cryosphere can loosely be defined as all frozen water and soil on the surface of the Earth. This definition encompasses a diverse range of ice masses with a vast spectrum of spatial and temporal characteristics. It ranges from ephemeral river and lake ice to the quasi-permanent (on a millennial timescale) ice sheets of Antarctica and Greenland. Included in the definition is seasonal snow cover and permafrost." The cryosphere is an integral part of the Earth's climate system and interacts with the other subsystems (atmosphere, oceans/hydrosphere, biosphere, pedosphere, lithosphere) by multiple feedback processes, one of which is the much-discussed issue of global sea-level rise. Two key components of the cryosphere, on which this book focuses, are land ice (ice sheets, ice caps, and glaciers) and sea ice, which "represent, at any one time, by far the largest component of ice on the planet, both by volume and area, yet respond to climate change over timescales ranging from seasons to millennia." Therefore, in the sense of the book, the term cryosphere is used in a narrower sense to describe land ice and sea ice only.

Again in the words of the editors, the goal of *Mass Balance of the Cryosphere* is "to provide, in a single volume, a comprehensive, up to date and timely review of our state of knowledge about the present-day mass balance of the cryosphere from observations and how it might change over the next millennium based on the latest modelling studies. The book is designed as a reference text covering all aspects of both the theory and practice of measuring and modelling the mass balance of land and sea ice." In order to achieve this ambitious goal, 23 designated experts from across the community of cryosphere sciences have contributed as authors, so that the gathered knowledge is at the best possible level. The book is structured into an introduction, a conclusion (both authored by the editors themselves), and 15 main chapters, clearly grouped into five parts. Each chapter ends with a comprehensive list of references, and an index helps in finding information on any relevant topic throughout the book.

Part I deals with "Observational Techniques and Methods" and consists of the chapters "In Situ Measurement Techniques: Land Ice" (by Hagen and Reeh), "In Situ Measurement Techniques: Sea Ice" (by Wadhams), and "Remote-Sensing Techniques" (by Bamber and Kwok). Complementary to part I, part II is concerned with "Modelling Techniques and Methods," and comprises the chapters "Modelling Land-Ice Surface Mass Balance" (by Greuell and Genthon), "Modelling Land-Ice Dynamics" (by van der Veen and Payne), and "Modelling the Dynamic Response of Sea Ice" (by Hibler).

After these two methodological parts, the book turns to reviewing the current understanding of the present and future mass balance of the cryosphere. Part III, "The Mass Balance of Sea Ice," features the chapters "Sea-Ice Observations" (by Laxon, Walsh, Wadhams, Johannessen, and Miles) and "Sea-Ice Modelling" (by Flato). Part IV, titled "The Mass Balance of the Ice Sheets," contains the chapters "Greenland: Recent Mass Balance Observations" (by Thomas), "Greenland: Modelling" (by van de Wal), "Mass Balance of the Antarctic Ice Sheet: Observational Aspects" (by Bentley), and "Antarctica: Modelling" (by Huybrechts). The final section, part V, treats "The Mass Balance of Ice Caps and Glaciers" with the chapters "Arctic Ice Caps and Glaciers" (by Dowdeswell and Hagen), "Glaciers and Ice Caps: Historical Background and

Strategies of World-Wide Monitoring" (by Haeberli), and "Glaciers and the Study of Climate and Sea-Level Change" (by Dyurgerov and Meier).

I think it is safe to state that the editors' goal of providing a comprehensive reference text on the present and future mass balance of the cryosphere, understood as land ice and sea ice, has been fully achieved. There is no comparable up-to-date book which assembles a similar amount of knowledge and information. The integration of the contributions from different authors into a coherent volume is very well done. The book has a clear structure and a logical thread that guides the reader through the chapters. Naturally, some different writing styles and illustration types appear, but on the whole the reader does not suffer significant interrupt experiences. The weight of the contributions—on average about 40 pages long—is reasonably balanced, with the exception of the somewhat overwhelming 110-page chapter on sea-ice modeling (Hibler), and, on the other end of the range, the relatively short (16 pages) chapter on in-situ measurement techniques for sea ice (Wadhams), which exclusively focuses on ice thickness.

The book is of a very high production quality, robust, agreeably typeset in Cambridge University Press' LaTeX 2ε style, with excellent figures (partly in color) and nicely displayed equations. Besides its high scientific value, it is therefore a great pleasure to read it. *Mass Balance of the Cryosphere* will be relevant and serve as a reference for years to come, and it should not be missing on any shelf of (or at least should be accessible to) researchers and advanced students in the field of cryosphere sciences.

—RALF GREVE

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