

Review

BARRY, R. AND GAN, T.Y. (2011) *The global cryosphere: past, present and future*. Cambridge, Cambridge University Press. 498pp. ISBN-10: 0-521769-81-7 (hb), 0-521156-85-8 (pb), ISBN-13: 978-0-521-76981-5 (hb), 978-0-521-15685-1 (pb), hardback £80, paperback £42.50

'Cryosphere', as the authors of *The global cryosphere: past, present and future* point out, is a term describing the portions of the Earth's surface where water is in its frozen state. The term was introduced in 1923 but was still absent in a 1972 version of Webster's dictionary. Since then the 'cryosphere' has come a long way, to the extent that the production of a book claiming to cover it all, as this one does, necessarily requires a massive effort. This the authors have delivered in an impressive 500-page volume, which includes references to many websites and a 100-page list of papers.

The book is divided into four main parts, 'The terrestrial cryosphere', 'The marine cryosphere', 'The cryosphere past and future' and 'Applications'. An attractive aspect is the perspective provided by the historical background, which introduces most sections. One sees a strong emphasis on the ongoing revolution provided by remote sensing. The use of words is efficient, as it must be for so much information to be crammed into a finite volume.

Part I, 'The terrestrial cryosphere', is the longest, comprising about half of the entire text. Its coverage is necessarily broad, as indicated by the headings: snowfall and snow cover, avalanches, glaciers and ice caps, ice sheets, frozen ground and permafrost, and finally freshwater ice, most with a half-dozen or more subheadings. Focusing on my own area of expertise, glaciers and ice sheets, one sees both positive and negative points, which may be illustrative of other parts of the book. A few negative points in this part illustrate the impossibility of satisfying the opinions of the specialists in any sub-field, including opinions on exactly which work should be referenced (a complete reference list would more than fill the entire book). But as an example, the list of surge dates for Variegated Glacier, Alaska, does not include the two most recent in 1995 and 2003–04, although my impression is that the authors have generally done a reasonable job of including references to recent work, a major problem in a rapidly evolving field. Incidentally, note that figure 3.2c of Variegated Glacier is labeled 'photographer unknown', while in fact it is one of a pair of famous Austin Post photos reproduced in all editions of the Paterson/Cuffey textbook (most recently Cuffey and Paterson, 2010) to show the glacier before and after the 1963–64 surge. There would be merit in including a list of textbooks here as is done in the sea-ice section.

There are some other issues with part I. One could argue with the statements that feature tracking can give ice flux (one must also know thickness), or that 'pressure on the ice (below 50 m) causes plastic flow'. Also, in my opinion the discussion of glacier basal motion (or 'sliding') should start with a statement of what is known about the morphology of glacier beds, and the role of water. Any illustrative formulas (which perhaps are unnecessary in such a book) should be presented in that context. The general problem is that in this topic not enough distinction is made between theory and observation. In the authors' defense, these problems also

tend to be true in the literature. On the positive side, it is correctly noted that the deformation of subglacial sediments is sometimes an important mechanism of glacier motion. (It is sometimes dominant.) Also on the positive side, the glacier and ice-cap section ends with a useful summary of the regional changes throughout the world.

Are the criticisms of part I significant, or, as much as anything, mentioned to show that the reviewer has read at least part of the book? Whatever the answer, it is certain that in the 200 pages of part I the authors have succeeded in making a massive amount of information readily accessible.

Part II, 'The marine cryosphere', is about 75 pages long and consists of two main sections, 'Sea ice' and 'Ice shelves and icebergs'. One-third of this is taken up by a useful description of sea-ice characteristics, and there is also a detailed section on trends in ice extent and thickness. There is a problem with the first equation of the subsection on sea-ice models, which seems to be dimensionally incorrect. Part II, like part I, is packed with information.

Part III, 'The cryosphere past and future', is about 30 pages long and is divided into two main sections, the cryosphere in the past, and the cryosphere in the future (the latter is of course discussed in the context of global warming). 'Past' in this section means the entire history of the Earth. This is an excellent idea because it puts the present cryospheric changes in their proper perspective. Both here and elsewhere there are brief but useful summaries, which are particularly valuable in a book like this containing so much detail. Finally, part IV deals relatively briefly with some of the interesting effects of the cryosphere and its changes.

This book is obviously a unique and valuable reference source for researchers and others wishing to have quick access to the entire field of cryospheric sciences. But there are issues which raise the question of how suitable it is as a course textbook. On the positive side it grew out of courses taught at two universities, and the authors early state their intent to support the observations presented with explanations of the relevant processes. They are often successful in this aim, but not always. Some of the issues raised above can serve as examples. Another example is the implication (not the direct statement) that frost heaving is solely due to the density difference between ice and water, while in reality the process is much more complicated and interesting. My personal feeling is that with suitable guidance from an instructor the book would be a good text, but not for a course focused more on fundamental processes and less on details. At any rate, there are few alternatives. It is clear that the real strength of the book is its encyclopedic coverage of the cryosphere and the changes that it has undergone and is undergoing. In terms of cost per bit of information, it must be a bargain.

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REFERENCE

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