Reviews

ARMSTRONG, R.L. and E. BRUN, *eds.* 2008. *Snow and climate: physical processes, surface energy exchange and modelling*. Cambridge, etc., Cambridge University Press. 256pp. ISBN-10: 0-521854-54-7, ISBN-13: 978-0-52185-454-7, hardback, £65/US$130.

The long-awaited book *Snow and climate*, with the more descriptive subtitle *Physical processes, surface energy exchange and modelling*, provides an excellent overview of its subject. Edited by R.L. Armstrong and E. Brun, it has a list of 16 expert contributors. The five chapter titles are 'Introduction', 'Physical processes within the snow cover and their parameterization', 'Snow–atmosphere energy and mass balance', 'Snow-cover parameterization and modelling' and 'Snow-cover data: measurement, products and sources'. There is some overlap in subject matter between the different chapters.

A brief introduction offers a good guide to the content of the book. Chapter 2 is a very good summary of the current state of snow physics, providing a more in-depth treatment of the subject than the other chapters. This fulfils a need, as, whilst the basics of climatology are at hand from many other sources, an overview of the current status of snow science is not currently available from any single source. The chapter does a good job of explaining the basic processes that are relevant in the context of snow in the climate system. Whilst it does not (and probably does not intend to) give the latest results of the microstructure of snow and erroneously states that 'microstructure based thermal conductivity laws are not available', it does give a balanced and solid overview. The sections on water flow in snow and the radiative properties of snow, in particular, have the right level of detail and are excellently presented.

I liked chapter 3 on snow–atmosphere exchange most. It starts by defining what surface energy and mass balance means in terms of an ever changing snow cover and goes on to present current theory and parameterizations. The problematic role of atmospheric stability versus spatial heterogeneity of the boundary layer is discussed in a way that displays the advanced understanding of the authors. The most original contribution is the discussion of surface exchange over snow for diverse parts of the globe: this compilation of model and measurement results sheds particular light on the role of snow cover within diverse local climates.

Chapter 4 on snow-cover modelling links most directly to the book title. It discusses the role of snow in current General Circulation Models (GCMs), and how difficult it is to create a model that entirely recreates the effect of snow cover on the climate. The importance of the problem is reflected by the fact that two authors reproduce and discuss the same graph of climate model sensitivity to snow in two different sections of the chapter. Given the brevity of the volume, the sections dealing with future snow and climate interactions can only offer a partial view compared to the most recent Intergovernmental Panel on Climate Change report (Solomon and others, 2007), which is not discussed in the book at all. However, the chapter does introduce the most important issues, such as albedo, longwave radiation and moisture feedback. It also discusses the inability of current GCMs to correctly reproduce snow-cover spatio-temporal dynamics during fall and spring in northern latitudes. While this inability is termed 'not understood', the same problem is discussed again in the last chapter, where the correct explanation for the model shortcoming (with the correct reference) is offered.

Chapter 5 presents conventional methods for sampling the snow cover, such as snow depth, snow-cover extent and snow water equivalent, focusing on simple, in situ and satellite measurements. The satellite section and, in particular, the discussion of visible and microwave sensors is succinct and interesting. The compilation of available snow data sources is also useful, providing detailed information about data providers such as the US National Snow and Ice Data Center. This is a valuable source for any researcher trying to find large-scale snow data.

The book is a mixture of introductory and review text containing a good quantity and quality of references. However, the bulk of the text is based on work before 2003, and more recent developments are only sporadically included. This may be a disadvantage in the fast-moving climate field, where the community has now moved to smaller-scale predictions of future snow and climate.

The style of presentation is such that most important principles (and equations) are stated but not derived or explained in detail. Sometimes a more in-depth discussion of accepted versus 'still in debate' findings would be warranted, for example in the context of advective transport in snow. Here the authors state an equation under the assumption that local equilibrium between the phases is reached, which is not an appropriate assumption for the examples that they discuss, i.e. water or air transport in snow. In addition, the discussion of snow ventilation is too long, compared to the discussion of other important processes. At the end, the correct general conclusion that it is not such an important process is offered.

Overall, the book is a brief yet concise and very useful update of current progress in the field. I expect the text to become a standard reference for climatologists occupied with snow or for young snow scientists at advanced undergraduate or graduate level. The text is very well written and enjoyable to read.

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