available data and hypotheses regarding the Palaeocene–Eocene Thermal Maximum and Eocene–Oligocene greenhouse to icehouse transition. The Oligocene–Miocene boundary is characterized by a shift toward cooler climates and Pfuhl & McCave discuss the importance of opening of seaways and the inception of a full Antarctic Circumpolar Current. The Miocene was a critical time of palaeoceanographic reorganization in which the closure of the Panama Isthmus played a key role. Schmidt reviews causes and consequences of the closure of the Central American seaway and provides a comprehensive compilation of both marine and terrestrial proxy data. The book ends with a paper by Ravelo *et al.* reviewing marine proxy evidence for Northern Hemipshere glaciation and the role of a shoaling thermocline as a critical threshold.

The book is a very successful attempt to marry the signal from computer models and biological proxies. However, it also gives the impression that in deep-time palaeoenvironmental science, climate modelling is clearly the weaker partner in this young marriage. Only about five articles of the book have a clear focus on climate simulations and data-model comparisons, whereas many contributions of "data collectors" only marginally refer to climate models. Deep time modelling is a challenging task, as the number of proxy data for boundary conditions strongly decreases with geological age. Therefore, in contrast to the Quaternary, the number of "deep-time" modellers is rather limited. Sohl & Chandler provide a challenging and careful combined data/model approach to simulate Neoproterozoic palaeoclimate. Kiehl describes opportunities and limitations of computer models simulating Late Palaeozoic palaeoclimates. Haywood *et al.* give a comprehensive overview on their mid-Pliocene climate modelling exercises, which clearly demonstrates the rapid progress in deep-time modelling and data-model comparison techniques in recent years. Markwick gives impressive examples of how biological proxy data can be processed and synthesized in a Geographical Information System to define climate boundary conditions and facilitate data-model comparisons. Hill *et al.* presents not only a new Pliocene model of the mid-Pliocene East Antarctic Ice Sheet, but also a thorough data-model comparison for Polar Regions.

In conclusion I can highly recommend this book to anyone who is interested in getting a comprehensive overview of deep-time palaeoenvironments and climate modelling. The book is very useful for "data collectors" who need an update or summary on state-of-the-art deep time geology and also to modellers for whom it provides a rich source of data to validate and test their simulations. Given the differences in scientific approaches, languages and techniques, the liaison between "data collectors" and modellers represent a major challenge for both scientific communities. Despite these difficulties the editors succeeded in producing a coherent and valuable publication, which is a promising start to a hopefully happy and long-lasting relationship.

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Snow and Climate: Physical Processes, Surface Energy Exchange and Modeling

Edited by R.L. Armstrong & E. Brun
Cambridge University Press, Cambridge, 2008
ISBN 9780521854542, 256 pages, £65

Sixteen established scientists from the fields of hydrology, glaciology and climatology have gathered to write this book on snow-climate interactions. We all know that this interaction is complex (snowdrift!) and that there are many ways and tools to study it, from detailed field observations on snow plots not larger than half a football field to global climate models with grid sizes that are easily as large as a million football fields. This wide range of scales and possible scopes has not deterred the authors and their efforts have resulted in the very readable *Snow and Climate*.

The book begins with a short introduction on snow formation and how snow, once deposited at the surface of the Earth, interacts with climate. Chapter 2 delves deeper into the physical processes governing ice crystal formation, snowpack and snow grain characteristics, snow metamorphism and grain classification, followed by heat, water, air and radiative transfer in snow. Chapter 3 deals with the mass and energy exchange between snow pack and atmosphere. Initially, the level of detail is greater here than in Chapter 2, but the level of mathematics always remains moderate and accessible. I particularly liked the sections describing multiple-month example time series of energy and mass balances of various types of snow surfaces. It is in these sections that the material really comes alive.

Chapter 4 updates us on the art of snow cover modelling. A strikingly long list of existing snow models and GCM snow routines is presented. Apart from being useful in itself, the length of this list clearly stresses the need for the continuation of snow model inter-comparison projects such as SNOWMIP. One such model is used by the authors to illustrate the sensitivity of an alpine snow cover to changes in snow physical parameterizations (albedo, surface roughness). Perhaps unsurprisingly, the sensitivities turn out to be quite large and we must conclude that, in spite of their realistic looking output, snow models can still be improved. Of course, this would require new and original validation experiments, especially from the polar regions where *in situ* data are sparse. Finally, Chapter 5 describes available snow cover data, measurement devices, snow stratigraphic studies and remote sensing applications.

Remote sensing techniques are justifiably treated more extensively, as satellites ensure a global coverage and are our main tool in detecting changes in the snow cover.

At just over 200 pages the authors have deliberately chosen not to exhaustively discuss all aspects of the snow cover in numerous geographical areas. For example, the reader will look in vain for 'Greenland' in the index, and Antarctica is only mentioned on a single page. An exhaustive treatment would have been impossible in a single volume anyway, as each of the chapter subjects could easily fill a bookshelf by itself. Rather, the authors have chosen to provide us with the latest development in snow research, an appealing selection of applications and examples, and an up-to-date list of references and URLs where the reader can start his/her own literature search if required.

In my view, the contents of this book are a very good overview of what every serious climate scientist, both modeller or experimentalist, should know about snow and its interaction with the atmosphere. In combination with its fine layout, this makes it worth the rather steep 100 euro (£65) investment.

MICHIEL VAN DEN BROEKE

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Trends in Antarctic Terrestrial and Limnetic Ecosystems: Antarctica as a global indicator

Edited by D.M. Bergstrom, P. Convey & A.H.L. Huiskes
Springer, Dordrecht, 2006.
ISBN 978-1-4020-5276-7, 369 pp, US$119

In this age of electronic publishing some scientists seem to think that the monograph has lost its value. I would disagree, still seeing an important role for well organized and researched synthesis volumes that provide whole fields with a baseline against which to measure progress and understanding. This is one such key book, providing an outstanding summary of what has been achieved in the SCAR international research programme Regional Sensitivity to Climate Change in Antarctic Terrestrial and Limnetic Systems (RiSCC) and integrating this with earlier data.

The terrestrial and freshwater scientists have less than 0.3% of the continent to research, together with the sub-Antarctic islands. Despite this limited footprint the biological questions posed by the fauna and flora of these areas have interested scientists for the last 150 years. The thesis of this programme, which ran for just over five years, was that as well as having intrinsic value these ecosystems could also help in understanding the impacts of climate change at a much more general level. The book is edited by three well known international scientists and consists of 16 chapters in which all three editors have played a major part. Convey has contributed to eight, Bergstrom to six and Huiskes to three! Another 36 authors assisted them and this demonstrates very well how the RiSCC programme brought the community together in a way that had not been achieved before. Given that terrestrial and freshwater science has generally not been as strongly funded as marine science for many years it is interesting to see also that the chapter authorship comes from 12 countries, a surprisingly wide range of active contributions. Indeed, they claim that over 200 papers were produced in the five years of RiSCC by scientists from 18 countries.

The chapters are organized along functional lines, with a scene-setting initial chapter, describing why Antarctica should be seen as a useful global indicator, and a final conclusions chapter. Chapter 2 by Bergstrom *et al.* describes the physical setting in terms of the elements of importance to biology, with an emphasis on biodiversity and colonization processes and their controls. I was surprised to see in Fig. 2 a map of the distribution of *Acaena magellanica* in which the Falklands was not included, despite possessing widespread stands of the tetraploid form.

Chapter 3 by Hughes *et al.* entitled "Colonisation processes" provides an excellent overview of the dispersion transport systems for all the major groups, emphasising the importance of molecular techniques in determining the origins of particular species and the problems for establishment. This also points up one of the major concerns of RiSCC which was the introduction of alien species, a subject to which they devote the whole of Chapter 10. Indeed, given the 2005 paper by Frenot *et al.* on biological invasions it might be supposed that this latter chapter simply covered the same ground. There is, of course, considerable overlap but there is also considerable new material drawn together as case studies and some crystal ball gazing into future scenarios. Despite the efforts of the authors there are still interesting papers missing - for example on introduced salmonids on Kerguelen (Ayllon *et al.* 2004).

Biogeography in Chapter 4 (Chown & Convey) is a short but masterly overview of a complex subject, suggesting how modern techniques can provide new perspectives and where human visitation can be shown to play a crucial role in driving change through introductions.

The chapters on life history traits by Convey *et al.* (Chapter 6) and on physiological traits by Hennion *et al.* (Chapter 7) are especially rewarding in the way they attempt to cut across the traditional plant and animal lines to look for the more general features.

There are three different approaches to lakes dealing with biogeography in Chapter 5 (Gibson *et al.*), lakes in the landscape in Chapter 11 (Quesada *et al.*), and lake systems and climate change in Chapter 13 (Lyons *et al.*). All three are excellent and show just how much research has gone into the aquatic systems, especially those accessible to the American and Australian scientists. I was especially pleased to see how the authors had taken a bipolar approach to