biota, nor of the relationships between genome function, physiology and ecology in the Antarctic. Rather, it comprises a series of typically well-written, well-informed, and well-reasoned papers, conveying foremost the fascinating depth of current understanding of some key issues in Antarctic biology. They make good reading both for those directly concerned with Antarctic biology, and those less so, and would provide a nice basis for a graduate class in the topic. One imagines that some of these reviews will become standard citations for the issues in hand, and that those citations may well have long half-lives.

This said, to someone who is not deeply immersed in the Antarctic literature, these papers seem to beg one overriding question. Why does Antarctic biology sometimes seem to remain so disconnected from much of biology at large? Time and again, papers in this volume provide convincing arguments as to the wider implications of Antarctic science, particularly in the context of some of the pressing issues facing humanity (most obviously climate change). And yet, time and again, I found myself wondering why connections were not being drawn more strongly to the wider literature, and why only by reading a volume explicitly on Antarctic biology was I finding some of the best examples there seem to be to illustrate my lectures and writing on biodiversity at large. Perhaps addressing those issues would also make for a good thematic journal issue (if not an edited book).

KEVIN J. GASTON

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Deep-Time Perspectives on Climate Change: Marrying the Signal from Computer Models and Biological Proxies

Edited by M. Williams, A.M. Haywood, F.J. Gregory & D.N. Schmidt
The Geological Society, 2007.
ISBN 1-86239-240-4, £95 (fellows £57)

In recent years, the development of new proxies, approaches and data interpretation techniques has significantly improved the possibilities and accuracy of reconstructing past environments from geological records. Hand-in-hand with this progress a rapid increase in the number of climate simulations is available from a broad range of General Circulation Models (GCM) which contributes to a much better understanding of future and past climate change. Although highly complex, climate models still represent a simplification of the real world and their performance and reliability have to be validated using proxy data from past climate records. Bringing together the two groups of "data collectors" and modellers and facilitating their interaction is the major aim of this book on deep-time perspectives on climate change. The high-quality printed book, nearly 600 pages thick, unites climate modelling, palaeoceanography and palaeontology to address fundamental events in the climate history of the Earth over the past 600 million years. However, the vast majority of the 26 peer-reviewed articles are related to the last 70 million years, clearly reflecting how data availability and our knowledge about the Earth System decreases the further back we go along the geological time scale.

The book focuses on different aspects of palaeo-environmental science such as proxy methods, the controlling mechanisms of climate change, extreme climate modes and climate transitions. Most contributions are written in a review-style, which makes this book a valuable source for up-to-date literature search and global palaeo-data syntheses. Examples of such very useful literature and data compilations are a comprehensive review of Phanerozoic climate modes, controls and geological proxies by Vaughan, a review of the Early Permian fossil record of Gondwana by Stephenson *et al.* and a discussion of the role of marine organic carbon reservoirs during the Early Palaeozoic Icehouse by Page *et al.* Price & Grimes and Hart bring together terrestrial and marine geological records documenting Late Cretaceous climate variability. For the Neogene, Dowsett presents a summary of Pliocene global sea surface datasets, whereas Fauquette *et al.* and Jiminez-Moreneo *et al.* provide a more regional compilation of Miocene and Pliocene vegetation data for the Mediterranean. A meaningful discussion on the potential use and application of selected palaeoceanographic proxies in reconstructing past sea surface conditions can be found in Lawrence *et al.* (alkenones), Kucera & Schoenfeld (foraminifera), and Lear (Mg/Ca palaeothermometry).

Many contributions in this book concentrate on geological transitions or climate extremes and discuss their controlling mechanisms. Vannier describes the Early Cambrian origin of complex marine ecosystems and the role of ecosystem-build-up processes versus non-biological factors. Armstrong compares Cenozoic and Ordovician glaciation and proposes a unified theory, which rejects the axiom that Ordovician glaciation was unique in Earth History. Twitchett discusses triggers for mass extinction at the Permian-Triassic boundary and critically reviews the runaway greenhouse model. The termination of the Mesozoic, characterized by another mass extinction at the Cretaceous–Tertiary boundary, is surprisingly not the subject matter of a separate contribution in this book. Cenozoic changes from greenhouse to icehouse climate conditions are presented in a considerable detail. Unfortunately, most Paleogene to Neogene contributions focus on palaeoceanographic proxies only, whereas compilations of terrestrial palaeobiological datasets are mostly restricted to the Mediterranean. Sluis *et al.* and Coxall & Pearson, respectively, present a thorough and well-written review of 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.

ULRICH SALZMANN

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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.