

Book reviews

Analysis of Climate Variability edited by H. von Storch and A. Navarra (Springer-Verlag, Berlin, 1995). ISBN 3-540-58918-X, xvii + 334 pp., DM 138.00.

This book comprises a series of lectures given at a European Commission Autumn School in 1993. At first glance, the text appears to be simply a collection of individual chapters. While there is some attempt at cross-referencing, the individual chapters tend to retain the perspective of the contributing authors; in fact, most are reviews or summaries of the authors' published works. A closer reading of the text does reveal a certain coherence between the sections.

The text is divided into an Introduction and three main sections. The ordering of these sections (if it reflects the order in which the lectures were presented) is difficult to follow. EOF analyses are used in Chapters 3 and 5 and more extensively in Chapter 6 as a tool for reducing dimensionality and defining characteristic spatial patterns, yet the major description of these techniques *per se* is not found until Chapter 13 in the final section on Pattern Analysis. Chapter 5 also describes a number of models for reconstructing climate data from proxy sources. The calibration and verification of these models could be linked to the discussion in Chapters 8 to 10.

The first of the two introductory chapters sets the historical context for climate research and highlights some of the peculiar difficulties of the subject in comparison with most of the rest of the physical sciences, i.e. the idea of climatology as a 'one experiment' science. This theme is carried further in the second introductory chapter and together with the interrelated nature of climatological data is shown to lead to a number of 'misuses' or poor interpretations of statistical analyses.

The first major section ('Analyzing the Observed Climate') deals with a wide range of statistical techniques, data types and time and space-scales. Chapters 3 to 5 are essentially concerned with the longest time-scales. Chapter 3 begins with a brief introduction to spectral analysis and then Hasselmann's stochastic climate model is explored. The model is shown to reproduce the essential spectral characteristics of the observed climate record. Chapter 4 is a comprehensive summary of historical observational data and the processing performed on these to produce homogeneous time series. The time evolution of these data is then compared with

that produced by a number of 'greenhouse' model simulations to detect signs of climate change. Chapter 5 then highlights the greater difficulties involved in extending these time series back into the past using proxy data, with tree rings as an example. This chapter also discusses methods involving EOF analyses and multiple regression which are used to reconstruct spatial patterns of climate variability from a number of proxy sources. The final chapter of this section is a detailed examination of the teleconnections between atmospheric variability, sea-surface temperature anomalies and rainfall in various regions on seasonal or interannual time-scales. Again, eigenvector and simple cross-correlations techniques, described in detail in Chapters 12 and 13, are used extensively in this chapter.

The middle section on 'Simulating and Predicting Climate' is more varied in its subject matter, although the main emphasis is on the validation of simulated or predicted climate. In this regard, three chapters stand out as perhaps the most important for researchers in climate variability, namely Chapters 8, 9 and 10. Chapter 8 examines traditional univariate and multivariate methods of testing the output of GCM simulations, either to validate the climatology of such models or to test differences between 'control' and 'anomaly' runs. Chapter 9 emphasises permutation and Monte Carlo techniques, applied in this case to observed teleconnection patterns. Chapter 10 gives a good introduction to the topic of forecast evaluation, discussing many of the popular scoring methods currently in use. Cross-validation techniques, which have received much attention in the literature recently, are mentioned only briefly.

The other two chapters offer a more indirect assessment of GCM models through the concept of 'downscaling', or the attempt to deduce 'weather' from climate models by comparison of the large-scale model circulation with that observed. Chapter 7 discusses the application of this idea to the simulation of the 'Lamb weather classification types' for northwest Europe. Chapter 11 deals with the use of an observationally based stochastic precipitation model in the downscaling of precipitation in large-scale models.

The final section on Pattern Analysis deals with the fundamental problem of analysing the large space-time arrays of data typically encountered in climatological studies. In Chapter 12, relatively simple methods of describing spatial structure such as one-point teleconnection maps and circulation indices are first described before a brief introduction to the more general multivariate eigenvector technique, that of Singular Value

Decomposition or SVD. Principal components or EOFs and Canonical Correlation are then described in more detail in Chapter 13. This chapter is similar in tone to Chapter 2 (also by von Storch) and attempts to de-mystify some of the jargon and misconceptions that abound in the use of these techniques, in particular the interpretation of EOFs and the merits of rotation. These two chapters, particularly Chapter 13, are extensively referenced and need to be read in conjunction with some of the earlier chapters.

The final two chapters are concerned with the analysis of temporal variability using Singular Spectrum Analysis (SSA) and its multivariate extension (MSSA) (Chapter 14), and Principal Oscillation Patterns (POP) (Chapter 15). These are new and relatively complex techniques that have not yet been widely used in climate research outside of the original research groups. Both are extensions to the time domain of the eigenfunction techniques described in Chapters 12 and 13 using lagged cross-covariance matrices, and are used to search for oscillatory behaviour. This leads to the possibility of forecasting the evolution of the systems under study.

Technically, the book has been very well prepared and edited; it appears to be almost free of typographical errors and the figures, taken from many different sources, are reproduced in a clear and consistent manner. Those beginning research in the field of climate will find much of the current areas of research and the relevant statistical methodologies well summarised. More experienced researchers may find useful ideas from the topics outside their immediate area of interest and also obtain a broader view of the entire field of climate research.

Wasył Drosdowsky

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Climatic Variations and Forcing Mechanisms of the Last 2000 Years

edited by P.D. Jones, R.S. Bradley and J. Jouzel (NATO Advanced Science Institutes Series I, Vol. 41. Springer-Verlag, Berlin, 1996). ISBN 3-540-60695-5. x + 649 pp., DM 378.

This year may be remembered for the announcement by atmospheric scientists, through the consensus of the IPCC, that there is now a discernible human influence

on global climate. While the type and extent of climate change will emerge through continued direct observations, clues to the significance and causes of climate change and variability may already lie in the archives (natural and historical) that have accrued over the last 2000 years. This is the topic of the latest NATO Advanced Science Institutes Series proceedings, from a meeting in Tuscany in 1994.

The period of the last two millennia is probably the most relevant to the climate of today and the near future (and is the subject of a major International Geosphere-Biosphere Programme initiative). It contains the industrial era, some notable (and debatable) climatic events in the last 1000 years and a period of relative climatic stability beforehand. It is also the period for which the best dated, high-resolution proxy and observational records exist.

The editors have previously edited major works on paleoclimate reconstruction. This book has a clear structure where the sections (dendrochronology, ice cores, corals, historical evidence, varved sediments, forcing factors, conclusions) open with an introductory chapter followed by specific chapters by leading experts. Many attended the ATRIC workshop ('Australian Tree Rings, Ice cores and Corals'), organised by Roger Francey, and held at CSIRO Division of Atmospheric Research in Aspendale in February this year.

Dendroclimatology is described in detail. The chapter by K. Briffa et al. addresses the techniques and difficulties in obtaining long-term climate information from tree rings. Methods of identifying and removing the many non-climatic influences which exist in even the best tree-ring series (measured as ring width or wood density), without nullifying the evidence of climate change are summarised. To the tree-ring novice, these heavily statistical approaches can be overwhelming; yet the authors explain them methodically and concisely. Other proxy records presented in this book may benefit from similar techniques. F. Schweingruber et al. discuss ring latewood densities which are showing great promise as new density measurement techniques evolve. Although limited to high northern latitude conifers, ring densities offer extra, if not superior, information to ring widths as they are good indicators of summer temperatures. G. Jacoby et al. present the North American dendroclimatology evidence. B. Luckman combines the tree and glacier evidence and pleads a strong case against spatial and temporal generalisation of climate trends of the last several centuries. M. Hughes and L. Graumlich present an impressive paper on precipitation reconstruction for the western USA, and D. Stahle and M. Cleaveland give evidence from the southeastern USA. The well-known Huon pine work of E. Cook et al. and the chapter by R. Villalba et al. extend the discussion to the southern hemisphere.

Ice core evidence begins with a spectral interpretation by J. White et al. of the Greenland GISP2 core water isotopic record, which detects the North Atlantic Oscillation. J. Jouzel et al. use global hydrological models to assess the relationships that underpin the use of water isotopes (in ice sheets and other media) as quantitative temperature proxies. The temperatures derived from ice cores were found to be within about 30 per cent of reality for large climate changes (glaciations) but are less certain for the last 2000 years when the effects of vapour sources, seasonal bias and snow redistribution have a higher relative influence. These effects may be part of the cause of inconsistencies between the Antarctic Peninsula ice core records (D. Peel et al.) and the previously unseen isotopic swings in a new record from the Plateau Remote ice core (East Antarctica) by E. Mosley-Thompson. High-altitude ice cores extend the records to the temperate regions (L. Thompson) and show great similarity between records from China and Peru. D. Fisher finishes this section with a comparison of Greenland and Canadian ice core climatic indicators.

The environmental records now emerging from corals (reviewed by J. Cole) can be found in their C and O isotopes, trace elements and banding. Cole stresses the important role of tropical archives, since they are near the source of much climate variability. Evidence from both sides of the Pacific covering the past several hundred years at high resolution is given by J. Lough et al. and R. Dunbar et al.

The section entitled 'historical evidence' contains only two chapters, although these are of new work (historical evidence is covered extensively in other review texts). R. Brazdil analyses temperature and precipitation over the last 800 years in the Czech lands, and Italian river flood history is discussed by D. Camuffo and S. Enzi. Both records are sometimes at odds to the patterns established by Hubert Lamb.

Lacustrine varves are organic and mineral sediment layers, whose thickness and composition are related to deposition processes controlled partly by climate. German and North American evidence is presented by B. Zolitschka and J. Overpeck.

The section on forcing factors covers solar variability (recently back in the headlines and reviewed here by J. Beer et al. and J. Lean), volcanism (A. Robock and M. Free) and trace gases in ice cores (D. Raynaud et al.). Incorporation of these factors in coupled climate models and their success, or otherwise, in explaining observed climate is discussed by D. Rind.

The book concludes with an analysis of the spatial scales over which climate change of different periods is expected to influence (H. Diaz), and the best locations and numbers of proxies for detection (R. Bradley; P. Jones and K. Briffa). A chapter outlining recommendations for future work is presented by the editors.

There is a tendency for some of the authors to extend their discussion to time periods earlier than the last 2000 years and into the last glacial epoch. Although this may give the reader a wider perspective, it may also be an indication that some of the proxies perform better for more significant climate changes. There is also occasional broadening of the meaning of 'climate records' to 'environmental conditions' when controls other than temperature and precipitation cannot be excluded from the proxies. A final observation (which relates to my opening comment) is that few authors make firm conclusions about the detection of the human climatic influence.

This is the 41st NATO ASI Series I proceedings in only five years. It has fewer errors (although is not error-free) and is better produced than earlier ASI books. Although aimed as an advanced reference text for students and researchers, the price will probably exclude it from their personal collections (and even from some libraries). However, it offers good value considering the calibre of the authors and the wide range of up-to-date information in its 650 pages.

D. Etheridge

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The Weather and Climate of Australia and New Zealand by Andrew Sturman and Nigel Tapper (Oxford University Press, 1996). ISBN 0-19-553393-3. 476 pp., \$59.95.

As an American meteorologist with an interest in synoptic meteorology who moved to Australia to perform climate change research six years ago, I have come to understand and appreciate the unique characteristics of the climate and weather in Australia. Apart from having learned that the wind rotates around highs and lows in the opposite direction, I was unfamiliar with many features of the weather and climate in this region, such as cool changes and the lack of warm fronts. Having access to this book would have helped me understand Australian weather much more easily and quickly.

The *Weather and Climate of Australia and New Zealand* is intended to be used as an undergraduate textbook with a particular emphasis on the local weather and climate characteristics. Since most northern hemisphere textbooks only give a cursory glance at southern

hemisphere climate and even less on the differing weather systems, this book clearly fills a void. In addition, it supplies information on the regional weather, both from a local and global viewpoint. The book is divided into four sections, starting with the global-scale, working down through synoptic-scale and sub-synoptic-scale phenomena, and ending with climate change and variability.

The section on the global perspective presents standard information on the structure and composition of the atmosphere and some of the underlying physics, such as radiative heat transfer and energy balances. This is followed by a discussion of the global circulation, but with an emphasis on features which are important to the Australasian region, such as the Australian monsoon and the SPCZ.

The largest section of the book deals with synoptic-scale processes and phenomena. Starting with definitions of various measured and derived quantities, this section then presents the concept of atmospheric stability and how it changes and affects the weather. This is followed by an explanation of how clouds form and how air masses can be identified (although, as mentioned in the text, this is not done any more). After discussion of the theory of horizontal motion and various types of wind approximations, a general description of synoptic weather systems is presented. The key chapter in this section is an in-depth discussion of the weather systems affecting Australia and New Zealand, both mid-latitude (such as pre-frontal troughs) and tropical, including a good description of the Australian monsoon. This section finishes with a quick look at weather forecasting.

Mesoscale and smaller circulations are discussed in the next section, again with a focus on examples important to Australia and New Zealand, such as orographic and land-sea effects. A unique aspect of this book is the extensive discussion of the surface energy balance and its agricultural implications.

The section on climate change and variability discusses the past climate of the region, beginning with the geological record and ending with the instrumental record. In addition, it discusses causes of climate variability in the region, focussing on the impact of ENSO. The book ends with a look at anthropogenic climate change issues, leading up to the development of climate change scenarios and a discussion of the impacts of climate change for both Australia and New Zealand.

The book has six appendixes dealing with units, notation, constants and conversions. In addition, there is a good glossary of terms, an up-to-date chapter-by-chapter list of references and further reading, and an index.

The only minor problems I had with the book are the use of technical terms and concepts without definition (such as potential vorticity and isentropic flow), the lack of more complete technical discussion of the equations (most of which are presented in boxes and are not crucial to reading the text), and the occasional unclear figure where data presented are not labelled. Although I had no trouble understanding these, I suspect most non-specialists would be confused and lost.

Upon completing the book, I came away with a broad understanding of the unique aspects of the weather and climate of the region. The book is quite suitable for the beginning undergraduate level and presents the material in a way that is easy to understand since it uses local phenomena to illustrate the various topics. In addition, I think scientists and others who want to learn more about the weather and climate of the region will find this text useful. I suspect I will use this book as a general reference in the years to come.

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