Book reviews

The Guinness Book of Weather Facts and Feats (2nd edn) by Ingrid Holford. (Guinness Superlatives Ltd, England, 1982) 253 pp. £8.95 net.

Many years ago, following one exceptionally warm winter spell in Victoria, the Melbourne *Age* newspaper published a series of tables presenting just about every weather record imaginable. The data were presented under a heading referring to the concurrent warm spell 'Is it due to the bomb?' So my interest in weather records was kindled. This interest was further fostered by the publication, some time later, of a small book by Ashton and Maher on *Australian Forecasting and Climate*. I kept these items in my possession for some years and there were not too many facts and figures contained therein that I did not absorb.

Given this longstanding fascination with unusual weather events, it was with considerable enthusiasm that I approached Ingrid Holford's *The Guinness Book of Weather Facts and Feats*. I was to be disappointed.

The book is broken up into chapters presenting a range of weather-related topics including temperature, pressure, wind, weather charts, clouds, rain, snow, hail, and weather forecasting. The overall treatment, however, is superficial, the presentation is sloppy, there is a strong bias in the material towards central England and also to recent events, a number of rash generalisations are made, there are typographical errors, and the most serious deficiency of all — obvious inaccuracies in the data presented which cast doubt on the rest of the information given.

To give a few examples of the above:

- On page 29, reference is made to a spell of seven consecutive days during which the temperature exceeded 32 °C at Melbourne, Australia (26 June to 2 July 1976). The temperature has never exceeded 32 °C in Melbourne at that time of the year.
- Also on page 29, a spell of three consecutive days during which the temperature exceeded 37.8 °C at Melbourne, Australia is mentioned as having occurred in December 1979. Certainly, this is not an event to be tabulated under the heading 'Notable long sequences of high maximum temperatures'. In 1908, Melbourne experienced a spell of six such days. Did not the author have access to such data?
- Similarly, on page 39 a table 'Notable minima in North America' is presented. The data given are restricted to the USA and Canada and there is no indication whether or not they are actual records, or a randomly selected set of low temperature events. I suspect the latter is the case in the light of the previous example, but the reader has no way of establishing it. This sloppy approach to data presentation is repeated throughout the book.
- On page 7 the author announces that the premier units given in the book for measuring temperature would be Fahrenheit 'because most English speaking people still think in these terms'. I doubt this is true for Australia. In any case, why then does she present on page 40 a summary of British weather from the London Weather Centre which presents temperature data using the Celsius unit exclusively?
- It would seem to be an easy thing to provide an orderly set of about a dozen photographs covering the main cloud types. Nevertheless, Chapter 11 (Clouds) does not do this. The photographs given seem to be randomly selected — as a result several important cloud types are not included.
- With regard to typographical errors (almost unforgivable in a 2nd edition), page 73 includes a diagram referring to 'most dangerous gradient' when 'most dangerous quadrant' is obviously intended. On page 121 is the suggestion that cumulonimbus clouds range in base from 15 feet to 6500 feet when 1500 feet to 6500 feet is intended.
- With regard to rash generalisations, the caption associated with a photograph on page 124 reads 'Cirrus increasing and thickening near the horizon to altostratus. Almost certain sign of rain to come', while the caption associated with a photograph on page 171 reads 'Random cirrus, which if it starts to spread over the whole sky, may herald the end of a drought'.
- My final illustration of the overall poor quality of this book — and I could have given many more — is found on page 170 where we read that 'Australia faced its worst drought in living memory by 1980' — what exactly is one expected to understand by the phrase 'living memory'? In any case there would be many who would dispute, on the basis of hard data, the validity of highlighting that particular drought.

The book does present a reasonably interesting, if rather disjointed, historical account of a number of

aspects of meteorology and this is a somewhat redeeming feature. Nevertheless, because of its complete failure in the area of presenting weather data I would suggest, without reservation, that it is not worth purchasing.

H. Stern

The Climatic Record in Polar Ice Sheets ed. G. de Q. Robin. (Cambridge University Press, 1983) $84.00.

The physical and chemical properties of polar ice have become important sources of climatic information complementing that from tree rings and ocean sediments as well as bridging the gap between their time scales. The climatic signals in all such 'proxy' data result from complex processes and are diluted by environmental noise. This book reviews the processes acting on polar ice, the techniques of data extraction and interpretation, the measurements made on the most important cores, and the climatic features deduced for Antarctica and Greenland. Background information on the ice sheets, their dynamics and their history is also provided by leading experts.

The ice cores include a number of passive tracers that have originated in lower latitudes. Their varying concentrations reflect the intensity of the meridional exchanges at the time of their deposition. Another group of important indirect clues to the climatic past is to be found in the composition of the air bubbles enclosed in the ice, especially their CO_2 content. Although this book mentions all these in passing, it is focused on the basic climatic parameters, surface temperature and precipitation. Their past values can be inferred from the present temperatures inside the ice sheet, from the isotopic composition of the ice, and from the total gas content of the englacial air bubbles.

The isotopes of prime interest are the heavier forms of oxygen (^{18}O) and hydrogen (deuterium, D or ^{2}H). Their progressive depletion with increasing latitude can be explained in terms of the 'Rayleigh process', better known to meteorologists as pseudo-adiabatic condensation/sublimation with immediate removal of the liquid or solid phase. This yields a linear relationship with the ambient temperature, somewhat modified by the origin and phase history of the water vapour. Although the temperature strictly applies to the free atmosphere it turns out to be correlated with the surface temperature. That correlation makes it possible to construct temperature averages for intervals of the order of 10 a; a somewhat higher time resolution can be achieved, in principle, by spatial averaging of adjacent cores.

On the other hand, in regions of moderate to high accumulation the seasonal variation of isotopic composition is well preserved in the accumulating snow. This makes it possible to infer the age of the snow and ice layers as well as the annual rates of accumulation, using as checks weakly radioactive layers contaminated by fallout from nuclear bomb tests.

The older ice buried deep in the ice sheets poses additional problems. In general it was deposited at some distance from the borehole site at an elevation that could have been substantially higher or lower (hence, colder or warmer) than the present ice sheet surface. The past elevation can be inferred from the total gas content of the ice which gives the atmospheric pressure that prevailed when the ancient snow was compressed into impermeable ice by further superimposed snow. An algorithm separating the associated 'topographic' change in temperature from the purely climatic changes in ice sheet surface temperature with time represents one of the major Australian contributions to the book (D. Jenssen). Another (W. F. Budd and N. Young) is the use of the palaeo-temperatures preserved in the isotopic record as the boundary condition in time-dependent solutions of the heat conduction equation, to account for the present-day ice temperatures measured in the boreholes. Allowance must be made moreover for the heat flow from and into the bedrock and for the changing shape of the ice sheet. These calculations point the way towards the construction of complete ice sheet histories from sets of well-distributed cores.

For this ultimate task the book provides all the basic tools. The first two chapters are a good introduction to ice sheet glaciology. Chapter 3 describes the relevant processes and measuring techniques, while Chapter 4 is a detailed survey of the existing temperature, isotope, and accumulation data for different regions of Antarctica and Greenland. After the joint analysis of the principle data sets in Chapter 5 the book ends with a discussion of their climatic implications (Chapter 6). Some reservations must be recorded about its second section which examines local temperature-isotope relationships. The variance share explained by a linear regression is not given by the correlation coefficient r but by its square, and the expression $r/(1-r)$ cannot serve as a general definition of the signal-to-noise ratio because it fails for negative correlations. Leaving this aside, the interpretation of common broad ice core features will command general agreement, but the correlation of finer details must be regarded as controversial and will only be settled when more definite dates have been assigned to the deeper ice layers. This has become possible with new techniques for counting small numbers of radioactive isotope atoms with linear particle accelerators or lasers, but their extensive use on ice cores remains to be made.

All told this book can be highly recommended both as an introduction to its topic and as an exposition of its most complex problems and solutions. The workshops on which the book is based took place in Cambridge some years ago, but the editor has used the intervening time well to extend their deliberations also into further recesses of the

topic and bring the discussion up to date. The result is an outstanding monograph which will serve as a standard reference for many years to come as further ice cores are being laboriously won from the resistant polar environment.

U. Radok

Dynamical Meteorology: An Introductory Selection ed. B. W. Atkinson. (Methuen, 1981) Pp ix + 228.

Dynamical Meteorology: An Introductory Selection is an unusual dynamical meteorology text book. It has very few equations and those it does have are not at all daunting for the non-mathematician.

Is this then just another shallow geography and climatology view of the atmosphere? Not at all. Although aimed primarily at 'geographers, hydrologists, climatologists and others . . . interested in the effects and distribution of weather and climate', but without strong mathematical backgrounds, the authors are not deterred from successfully tackling the more complex theoretical dynamical meteorology. They make frequent recourse to physical analogy to make their points clear.

The book grew out of a series of articles entitled 'Introduction to Dynamical Meteorology' which appeared in *Weather* between January 1978 and April 1979. The series has been creditably edited by B. W. Atkinson, linking chapters have been added, and some extra topics, originally missing, have been included.

After an introductory chapter by Atkinson, there are two clear chapters by H. A. Panofsky introducing the reader to the fundamentals of atmospheric hydrodynamics and thermodynamics. R. S. Harwood next considers divergence and vorticity and their interrelationship, including the concept of potential vorticity. This leads, in turn, to explanations of Rossby waves, the lee trough and heat lows. The concepts of convergence and divergence follow, with consequential vertical motions and cloud in a mid-latitude cyclone. Although these concepts are generally clearly presented, the section on the lee trough leaves the reader in some confusion because the effect of the variation of the Coriolis parameter with latitude has not been included.

The next five chapters were not included as part of the *Weather* series but have been added to present a more coherent picture of the dynamics of the atmosphere. M. A. Pedder describes in three chapters the practical aspects of analysis to highlight the three-dimensional dynamic and kinematic structure of synoptic-scale motion in the atmosphere. A case study of anticyclonic development over the British Isles is presented and the results are explained qualitatively in terms of quasi-geostrophic theory.

Two chapters by Atkinson follow. The first is on atmospheric waves, a topic not covered in the original series. It starts with a good description of waves and their properties and of the perturbation approach to their solution. This is then applied to deduce properties of sound waves, inertia waves, Rossby waves and baroclinic waves. This part is uncharacteristic of the rest of the book in that the physical meaning and relevance of the different wave types is not always clear. For example, we are told that 'inertia waves are due to the rotation of the earth' then, after the phase speed is given, that 'a stationary wave pattern of streamlines could exist'. This is all very well if the reader is familiar with the physical properties and relevance of inertia waves in the atmosphere, but not very enlightening otherwise.

The next chapter (again by Atkinson) rounds off the first part of the book and prepares the way for the remainder. Atkinson gives the reader an historical perspective of the milestones of dynamical meteorology from 1850 to 1950 and brings the discoveries to life by quoting from original papers and correspondence.

The remainder of the book deals with more complex aspects of the atmosphere. Again it is presented in such a way as to make it comprehensible to the lay person or, indeed, to the professional whose sphere of expertise is elsewhere.

In chapters ten and eleven E. R. Reiter and A. Ibbetson examine the spectrum of atmospheric motions and aspects of the description of atmospheric turbulence, respectively. Discussion by A. A. White on atmospheric energetics follows. The principles of kinetic, internal, potential, and available potential energy are developed and their application is built up from a single particle, to a volume of fluid and, finally, to the global atmosphere.

The following two chapters cover the two most significant developments of dynamical meteorology in the last thirty-five years, viz. trough-ridge systems as slant-wise convection (baroclinic instability) and numerical modelling of the atmosphere. They are lucidly summarised by J. S. A. Green and A. J. Gadd respectively. Green takes us through the properties of waves again, pointing out where the simple wave theory fails to adequately describe the observed behaviour of the atmosphere. He introduces the concept of slant-wise convective overturning and examines its consequences for atmospheric energetics and vertical motions. He examines constraints on the flow and deduces properties of the baroclinic waves (wavelength, momentum transfer, orientation of the trough axis, etc.). This chapter covers a difficult concept extremely well and is recommended reading for anyone wishing to gain an understanding of this topic.

Gadd's chapter on numerical modelling, while taking eleven pages, only has eight equations, and then most of these are on finite differencing. Reference is made to earlier chapters, wherein the primitive equations were developed and objective analysis schemes considered. The problems of

choosing coordinates and boundary conditions and of solving the equations are discussed. The physical processes inherent in the equations are briefly examined, along with subgrid-scale processes and the need for parameterisation. Again, the uninitiated reader should gain a good basic understanding of the theory and problems of numerical modelling from this chapter.

The final chapter, 'Epilogue: a perspective of dynamical meteorology', written by J. Smagorinsky, draws together the threads from the rest of the book.

Dynamical Meteorology: An Introductory Selection, more than any other book or compilation available, comes closest to the goal of 'simplifying' the atmosphere for the non-specialist, without compromising the physics. The editor is to be congratulated on his efforts. This book is recommended reading, not only for lay people and those starting their careers or studies in meteorology, but also for those who are 'experts' in the field. Not only would it most likely improve their understanding of the atmosphere, but, hopefully, would act as a reminder that it is possible to present difficult concepts in a manner which makes them accessible to all.

Ian Bell