

Book Reviews

Climatic Atlas of the Indian Ocean, Part I: Surface Climate and Atmospheric Circulation; Part II: The Oceanic Heat Budget by Stefan Hastenrath and Peter J. Lamb (The University of Wisconsin Press, 1979). Part I xix pp, 97 charts, 6 tables. Part II xvii + 93 pp, 84 charts, 20 figs, 5 tables.

This two part climatic atlas of the Indian Ocean between latitudes 30°N and 30°S and longitudes 30°E and 120°E was compiled on the basis of approximately 4.5 million ship observations over the period 1911-70. The distinctive feature of this publication, which sets it apart from the various earlier marine climatic atlases for the region, is its fine spatial resolution, the chart isopleths being based on mean values of the various meteorological elements in one-degree-of-latitude by one-degree-of-longitude squares.

Part I, *Surface Climate and Atmospheric Circulation*, consists of a short introductory text (which includes both an account of the data sources and data processing and a brief general description of the main features of the charts) followed by the series of monthly or seasonal charts for the various elements and finally four tables which summarise the interannual variability of sea level pressure, resultant wind speed, sea surface temperature and total cloudiness in terms of standard deviations of the individual monthly means for ten degree squares. Charts are provided for the following:

- Sea level pressure (monthly)
- Resultant wind (monthly)
- Sea surface temperature (monthly)
- Sea-air temperature difference (January, April, July, October)
- Specific humidity (January, April, July, October)
- Total Cloudiness (monthly)
- Low clouds (January, April, July, October)
- Precipitation frequency (monthly)
- Directional steadiness of wind (January, April, July, October)
- Divergence (monthly)
- Vorticity (January, April, July, October)
- Curl of wind stress (January, April, July, October)

Part II, *The Oceanic Heat Budget*, also includes a brief introductory text which explains the basis for the heat budget computations, describes the large-scale features of the heat budget components as displayed in the subsequent charts and then summarises the annual variation of the heat budget components in terms of diagrams for twenty separate subregions of the Indian Ocean.

The charts depict the spatial variations of the individual heat budget components as follows:

- Net shortwave radiation (monthly and annual)
- Net longwave radiation (January, April, July, October)
- Net all-wave radiation (monthly and annual)
- Sensible heat flux (monthly and annual)
- Latent heat flux (monthly and annual)
- Net oceanic heat gain (monthly and annual).

This *Climatic Atlas of the Indian Ocean* was patterned after earlier companion volumes for the tropical Atlantic and eastern Pacific Oceans. The authors, Professor Stefan Hastenrath of the Meteorology Department of the University of Wisconsin and Dr Peter Lamb until recently Lecturer in Meteorology at the University of Adelaide, see their work as providing a background climatology for researchers in meteorology and oceanography. According to the summary description inside the cover of both Parts, it is also hoped that the atlas will find a wider use in marine biology, commercial fisheries, and shipping. Both expectations should be realised. The Hastenrath and Lamb atlas is probably the most homogeneous and most spatially detailed representation of the long-term climate of the tropical Indian Ocean presently available and it will certainly serve as a basic reference and point of departure for a wide range of studies of the monsoon region for many years.

I have few serious criticisms to offer. My main concern relates to the noisiness of the various isopleth patterns that have been produced (both computer and hand drawn) on the basis of the 60-year one-degree-grid-square means of the various climatic elements. While on the one hand it is sometimes reassuring to know that one is dealing with essentially unsmoothed data, there is, on the other, a distinct temptation to accept all the resulting fine structure in the maps as real. As the authors correctly point out, the fields of pressure and of elements such as cloudiness and precipitation frequency and derived quantities such as divergence are particularly noisy. If one were to take the charts at face value one would, for example, infer that the 60-year-mean zonal pressure gradient at 22°S, 80°E falls off from about 0.9 mb per 100 km in December to about

0.2 mb per 100 km in January and then increases again to near its December value in February. I feel confident no such variation in 60-year-mean-pressure fields exists and I feel equally confident that much of the detail in the other mapped fields such as sea surface temperature, sea-air temperature difference, specific humidity and the various derived quantities is also spurious. The point to be borne in mind by the user interested in the fine structure of the various fields over a limited area is that the charts in the atlas present a data set and not necessarily the best possible estimate of the true 60-year climatology. Indeed the details of many of the isopleth patterns will be seen as rather implausible by those familiar with the meteorology of the region. The text describing the chart features, particularly in Part I, appropriately concentrates on the broadscale features of isopleth patterns. There is, however, little in the discussion which is new or which could not have been stated equally well on the basis of any of the many other coarser-scale atlas presentations previously available.

The techniques used for computation of the heat budget components and the various other derived quantities are fairly standard. Hastenrath and Lamb have, however, chosen to employ an earlier approach to computation of the net shortwave radiation component in preference to the fairly widely adopted Budyko-type formulae that have been used by the majority of workers in recent years. Bearing in mind the other

uncertainties, it is a little surprising, however, to find that values of the Linke Turbidity factor were estimated individually for each one-degree square for each month! The authors employ a drag coefficient CD of 2.8×10^{-3} for computation of the wind stress (the large value being chosen to compensate for underestimation of the stress inherent in their method of approximating the average square of the wind speed) but only 1.4×10^{-3} for computation of the sensible and latent heat fluxes. Of course, the charts can easily be redrawn for other assumed values of the transfer coefficients.

The atlas is nicely presented, and the black isopleths on the brown base charts are clear and well labelled with only very few obvious labelling errors. Some users would probably have preferred inclusion of the ten-degree latitude and longitude lines in addition to the tiny crosses at their intersection on the base charts and, for an atlas that makes a point of the high spatial resolution employed in the data presentation, it would have been nice if the continental coastlines and islands had been drawn with a little more care. Unfortunately, also, misalignments of up to about 100 km between the isopleth patterns and the base maps occur on a few charts. These, however, are minor criticisms. It is a good atlas which should be widely known to all those concerned with the meteorology of the Indian Ocean.

J. W. Zillman

Rainbows, Halos, and Glories by Robert Greenler.
Cambridge University Press, 1980) x + 195 pages,
125 figs, 102 plates, 2 tables.

As the author says in his Preface, this is a book about beautiful things that can be seen in the sky, things that can be seen without special equipment or special location, things that can be seen by anyone who sees. It is a book about rainbows in all their forms, primary, secondary and super-numerary rainbows, white rainbows, red rainbows, reflected rainbows, rainbows on water surfaces, dewbows and lunar rainbows; about haloes, sundogs, moondogs, Parry arcs, sun pillars, circumzenithal arcs, subsuns, anthelic arcs, crepuscular rays, the twilight wedge, coronas, glories, iridescence, Bishops Rings, the heiligenschein, mirages, Fata Morgana, the Green Flash and many other rare and common and beautiful things that may be seen in the sky. It is a fairly personal book. The author, who is a Professor of Physics at the University of Wisconsin-Milwaukee, has had a life-long interest in observing and understanding the various

phenomena described in his book and he has indeed, as he mentions in his Preface, travelled to the ends of the earth to obtain many of the superb photos that are included. A theme of the book is that the world is full of fascinating things that most of us have never seen — obvious things that exist before our eyes, but that we never see. Greenler seeks, by describing and explaining these things, to encourage those who have never looked to see and to share with them the pleasure which he himself has derived from viewing the world of nature with an inquiring mind.

The book contains seven chapters dealing in turn with Rainbows (Ch. 1), Ice crystal refraction effects (Ch. 2), Ice crystal reflection effects (Ch. 3), Complex displays, past and present (Ch. 4), Scattering (Ch. 5), Diffraction (Ch. 6) and Atmospheric refraction (Ch. 7).

Chapter 1 provides a good general account of the rainbow drawing mainly on the simple

geometrical arguments of Descartes' original treatise of 1637. Greenler avoids the use of mathematics completely in his discussion of the rainbow. He chooses rather to rely on a series of simple sketches to illustrate the ray paths involved in the primary (42°) and secondary (51°) bows and a variety of more complex rainbow phenomena such as hyperbolic fog bows, reflected rainbows, reflected light rainbows and so on. He explains the origin of the colours of the rainbow including unusual red and white rainbows and the lunar rainbow. He reports observations of supernumerary fog bows and includes illustrations of both artificial and natural infrared rainbows. The chapter is, however, relatively thin on information on the rich history and mythology of the rainbow such as may be found in Boyer (1959) or Graham (1975). There are fifteen attractive colour photos including one rainbow puzzle photo which is also used as the jacket illustration.

Chapters 2, 3 and 4 deal with ice crystal phenomena. Chapter 2, the longest in the book, is concerned solely with refraction effects including the 22° and 46° haloes, parhelia, and the wide variety of coloured arc formations whose appearance depends on both the types and orientations of the individual ice crystals. Chapter 3 deals first with reflection effects (sun pillars, the parhelic circle, ...) and then with combined refraction-reflection phenomena. Chapter 4 then examines a number of the outstanding halo displays of history from the famous Danzig phenomenon of 1662 and the St Petersburg complex of 1790 to some of the more spectacular recorded Antarctic displays of modern times. The treatment, though essentially non-mathematical, is quite comprehensive, drawing heavily on Greenler's own work in the field. In particular, Chapters 2 to 4 include some 40 or so computer simulations of the various phenomena based on work undertaken by Greenler and his colleagues over recent years as well as 43 colour photos, almost half of which were taken by the author. These include some of the most beautiful halo photos ever published. All the well-known halo features are represented along with a number of rare and obscure phenomena. Greenler's computer simulations provide a unique insight into the possible origin of the famous Parry arcs and he throws some doubt on Tricker's (1972) suggestion as to the type of crystal producing the Parry arcs. Chapter 3 includes an excellent tabular summary of ice crystal types and the more 25 different optical effects that may be produced.

Chapter 5, on scattering phenomena, is fairly short. It provides a simple qualitative discussion of the origin of the blue of the sky, the colour of the night sky, crepuscular and anticrepuscular rays, the twilight wedge, ice blink and water sky, and so on. Several of the plates are new but the

content of the chapter is fairly standard for elementary texts on atmospheric physics.

Chapter 6 discusses a range of diffraction phenomena, including the corona, iridescence, Bishops Ring, the Specter of the Brocken, the glory and the heiligenschein. Several excellent photos are included.

Finally, Chapter 7 provides a well-illustrated treatment of the various types of mirages and a series of excellent photos including some of the Fata Morgana mirage over the Arctic Ocean. Chapter 7 also discusses the twinkling of stars and ends with a short account of the well-known but rarely-observed green flash.

Rainbows, Halos, and Glories is a significant contribution to the literature on meteorological optics, a field of physics which attracted much attention around the end of the last century but which has developed rather little over the last fifty or so years. Greenler's book, however, concentrates mainly on description and simple verbal or diagrammatic explanation of the various phenomena and does not attempt to elaborate the mathematical presentation of the theory along the lines of some of the earlier classical texts such as Pernter and Exner's (1922) *Meteorologische Optik*, the relevant chapters of the *Handbuch der Geophysik* (Linke and Möller 1942-61), Humphreys' (1940) *Physics of the Air* or, more recently, Tricker's (1970) *Introduction to Meteorological Optics*. The level of the treatment is about the same as Dietze's (1957) *Einführung in die Optik der Atmosphäre* or the recent Scientific American collection on *Atmospheric Phenomena* (Lynch 1980) although Greenler's book is not as comprehensive in the range of atmospheric phenomena described. The colour plates, however, are superb and, for this reason alone, Greenler's book stands out from its predecessors. The only comparable collection of halo photos of which I am aware is to be found in Scorer's (1972) *Clouds of the World*.

It is a very readable book. The presentation is clear and logical and the style is relaxed and personal. It is difficult not to be at least a little captivated by the author's obvious enthusiasm for his subject. The diagrams and plates are excellent and the overall layout good. There are some typographical errors but they are relatively few and far between. The inclusion of a number of puzzles adds interest to the book, the list of approximately 80 specific and general references is adequate, and the index is excellent.

In summary, although the topic is rather specialised and the professional readership will be limited, this is a most attractive book which I hope will reach a wider audience. I would recommend it to anyone who wishes to gain a deeper appreciation of the fascinating variety of optical phenomena that appear in the skies. Greenler's book may not replace Minnaert's (1954) classic

on *The Nature of Light and Colour in the Open Air* but there is no doubt that it supplements it beautifully.

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J. W. Zillman

The Hurricane and Its Impact by Robert H. Simpson and Herbert Riehl (Basil Blackwell Publisher, 1981). £19.50. Hardbound. 398 pages.

Australian meteorologists and inhabitants of our northern states have long been aware of the difficulties in observing and monitoring tropical cyclones in our region, and in predicting their future behaviour. More recently, the devastation caused by cyclones such as Tracy in 1974 have made the more southerly citizens increasingly conscious of these phenomena and, as exploitation of Australia's vast northern resources — both overland and offshore — builds up and permanent and tourist tropical populations explode, the impacts of tropical cyclones are becoming of increasing concern to decision makers in government and industry.

Professors Simpson and Riehl have long and distinguished careers in tropical meteorology, and are world experts in tropical cyclones, from both operational and research viewpoints. Their new book, which was originally conceived as a revision of Dunn and Miller's *Atlantic Hurricanes*, but has outgrown it, is claimed to be **the definitive text** on tropical cyclones **throughout the world** and to serve 'as a reference for technical users, including architects, professional engineers and building contractors, those concerned with planning and management problems in the coastal zone, and those involved in disaster preparedness' as well as being directed towards undergraduate instruction.

The book divides its 15 chapters into five parts. Part 1 (*The nature and importance of the hurricane: an overview*, 24 pages) briefly summarises the remainder of the book: why we are interested in these phenomena; their life cycle; relevant climatologies; naming conventions; and physical economic, and social impacts. Parts 2 and 3 (*The worldwide setting*, 70 pages, and *The hurricane event*, 94 pages) concentrate on meteorological aspects: the atmospheric heat engine; detailed climatologies; and theoretical mechanisms and

observational aspects of their evolution, structure, movement, intensification and decay. Part 4 (*The hurricane impact*, 80 pages) addresses the impacts of hurricane-associated winds, seas and floods. Finally, Part 5 (*Planning coexistence with the hurricane hazard*, 84 pages) deals with preparedness and the challenges of risk reduction; the unique nature of the tropical cyclone forecasting problem and the various tools available to attempt their solution; and possible modification of tropical cyclones. Another Chapter in Part 5 is devoted to dramatised narrations of events relating to the history of a fictitious recent Caribbean hurricane through the eyes of a hurricane forecaster and a Florida coastal resident, and a short account (narrator Riehl?) of a reaction to a near miss of Puerto Rico by a 1945 hurricane.

Six appendixes are included: a glossary; units and conversion factors; the Saffir-Simpson damage potential scale; hurricane climatology for the US coastline; global occurrences, 1958-78; and nomograms for wave and tidal computation. The six page index although adequate is not as comprehensive as I would have hoped.

References are given at the end of each chapter, but I was disappointed by the omission of a bibliography which a text, aimed, at least in part, to undergraduate study of a topic which has received enormous attention by researchers over recent years, warrants.

Each section is well illustrated with examples drawn from many real tropical cyclone events; but it is here that I found the major, perhaps inevitable, weakness in the book from an Australian user's viewpoint: a bias towards the northern hemisphere, most particularly towards the Caribbean. This bias applies generally throughout. At times the authors remember the

other half of the world, for example by explaining the hemispheric difference in cyclonic motion; but frequently we are completely forgotten and, for example, poleward is replaced by northward; troughs are defined as systems with northerly winds on the west side and south to southwest winds on the east; storm surge profiles show maxima to right of landfall, viewing from the sea; the bulk of the climatological discussion relates to the northern hemisphere, etc.

The only significant use of a southern hemisphere cyclone is that of **Tracy** as an example of the value of satellite data in monitoring and prediction. Unfortunately **Tracy** is also used in Chapter 5's (*The life cycle*) section on favoured areas and seasons of development as an example of a devastating hurricane in the Coral Sea (where they are said to be **rare** and **small!**). Indeed this whole Australian section is superficial and erroneous: there is no indication of seasons of development; it maintains that 'cyclones from the Pacific are **rare**' and illustrates one of these with a chart (taken from *Atlantic Hurricanes*) showing a 1940 cyclone with a track not unlike **Ada's** and **Althea's**. This figure is also used to show that Pacific cyclones may be 'about half the size of the continent', but the last closed isobar, surely well beyond the region of even gale force winds, encompasses an area no bigger than Queensland. Perhaps the authors have a concept of hurricane size different from mine, as elsewhere we learn that super typhoons can be as big as the whole continent. Later, in the discussion of hurricane tracks over land, we also learn that **Tracy** 'crossed the whole Australian desert toward southeast after destroying Darwin'!

The book may be a useful general reference for some northern hemisphere users, in that Simpson and Riehl have attempted to draw together a wealth of material relating to all aspects of tropical cyclones. But I gain the impression of hasty

preparation and inadequate revision and cross-checking. Only two chapters were written jointly and the individual preparation of the others was apparently so rigidly adhered to that in one chapter, one author cites the other via 'personal communication'. There are instances of looseness in expression, and conflict throughout the book while some of the several typographical errors I noted are particularly confusing. I also found reference to 'faraway Sidney, Australia' in the hurricane forecasters narrative!

One other disappointment was in the authors' use of units. Their special introductory note maintains that the book uses SI units 'except in connection with those *few topics* of which the preponderance of current literature, research, and basic understanding, mainly in engineering, still depends on earlier forms of metric or English units for effective communication' (my italics). But from the first page of the text onwards, I was confronted with an unsystematic use of a bewildering mixture of units, probably reflecting the current level of acceptance of SI in the USA: wind speeds in mph, kt, mps, m/sec; rainfall in inches, cm, mm; wind pressure in pounds per square feet; distances in miles and km; ocean depth in fathoms; sometimes alone, sometimes with one or more equivalents; and sometimes within a line of each other; and once with the quaint mixture of 'the fastest-mile surface wind speed is 50 mps'. Many figures, too, were adapted from other sources, with the non-SI units retained.

I was hopeful that this book would become a valuable addition to the libraries of Australian technical users, decision makers, and undergraduates; I regret that it does not fit the bill.

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