

## Book reviews

### **Images in Weather Forecasting** edited by M. Bader (Cambridge University Press, 1995). ISBN 0 521 451116. 498pp. \$A215.

The aim of this book is to provide an up-to-date manual for meteorologists to aid in the interpretation of satellite and radar imagery, and as such is intended to provide a contemporary update to the classic manuals of Ralph Anderson and Roger Weldon. The book is magnificently presented, as is necessary for an 'image led' (to quote the editors) publication, and as one would hope given the price. It has major contributions from Anderson, Weldon, Brown, Wickham, Scorer, Austin, Carlson, Grant, Monk, Kurz, Young, Rasmussen, Purdom, Agee, Hall, McCallum, Waters, Parsons, Gurka, Roesli and Turner, as well as contributions from many other authors, and so its lineage is unparalleled. The large number of authors does lead to some changes of style and continuity, and some perhaps unavoidable overlap of content, but careful attention to consistency of presentation, in what must have been a very difficult editing task, has minimised these features.

The introduction discusses the role of imagery in weather forecasting, and how it may supplement other data sources for a forecaster, either by providing the basis for bogus observations to be used in synoptic-scale analysis, for mesoscale analysis, or for monitoring NWP model evolution. Then follow eight major chapters; Satellite Imagery, Radar Imagery, Synoptic Scale Cloud and Moisture Patterns, Fronts and Waves, Depressions in Mid-Latitudes, Convective Cloud Patterns, Fog and Low Cloud, and Orographic and Polar Phenomena.

Chapters 1 and 2 summarise the physics of satellite and radar imagery, and for a forecaster or other non-specialist in the field of remote sensing provide a good summary of why images look the way they do, and what the images represent.

Chapter 3 (Synoptic Scale Cloud and Moisture Patterns) is an overview coordinated by Ralph Anderson, and contains some excellent examples of visible, infrared, and water vapour imagery for the same case. The main features in these images are related to NWP model analyses (including derived fields such as vertical motion and vorticity), and conceptual models such as the 'conveyor belt' or 'deformation zone' kinematic models. While some of the material is repeated later in greater depth, I found this a most enjoy-

able chapter to read. A practice used throughout the book of shading cloud areas grey on synoptic charts makes relating the features in the satellite imagery and corresponding synoptic charts easy.

Chapter 4 (Fronts and Waves), describes a range of frontal cloudbands, mostly over the UK. The cloudbands in the satellite imagery and the rainbands in the radar imagery are related to conveyor-belt conceptual models and to NWP output. A very informative feature is the description of the life-cycle of some of these frontal cloudbands, with accompanying synoptic charts, quasi-geostrophic diagnosis from NWP output, cross-sections, and isentropic relative flow diagrams at different stages from formation through maturity to decay. Several examples of 'split cold-fronts' are shown in detail and I think these will become the primary reference for this frontal model, as this section is very well presented.

Chapter 5 (Depressions in Mid-Latitudes) is the longest in the book (143 pages) and describes Young's cyclogenesis classification scheme, where 'cva maxima' have different interactions and cyclogenesis outcomes depending on the upper flow configuration. The cases are clearly explained and rigorously presented, with a summary section. The inclusion of a section on non-developing cases will be welcomed by forecasters who often feel that the literature abounds with extreme events, but neglects the many 'lesser' cases which present significant forecast problems. A lack of water-vapour imagery in this section is a disappointment after the presentation in Chapter 3, but perhaps reflects the fact that many of the cases shown were relatively old. As Young's classification scheme has not been previously published in the open literature, it is very welcome; however, this section may drag for some readers as many of the classification types are subdivisions of the 'instant occlusion' genre. Most of the cases are for the North Atlantic, and I can't help wondering if they can be translated to other parts of the world. Separate sections on mid-latitude cyclogenesis resulting from interaction with tropical lows, and on polar lows, conclude this section.

Chapter 6 (Convective Cloud Patterns) provides a change of style and location, with sections describing severe thunderstorms and mesoscale convective complexes. Many of the cases are from the United States, reflecting the different forecasting problems of different geographic locations. Sections on convective cloud patterns

over oceans (the synoptic environment of open and closed cells etc.) and on the topographic initiation of convection are also included.

Chapters 7 (Fog and Low Cloud) and 8 (Orographic and Polar Phenomena) are rather shorter than the other chapters. The fog chapter provides an informative summary of fog detection techniques which local forecasters could use.

In summary, I'm not sure that the book achieves its stated (very high) aims, but it certainly does provide a magnificent reference, and I loved poring through it. Many of the examples are better presented in this book than anywhere else that I have seen, particularly for the simultaneous presentation of images from more than one satellite channel, radar, synoptic chart analyses, and conceptual models. The changes of continuity, the overlap of subject matter, and occasional references to diagrams many pages from the one being read can be slightly irritating, but with the range of subject matter and a multitude of contributors, the editors have done well to minimise these problems. These quibbles are minor, and the book certainly achieves many of its aims. Every forecast office should have one. I'll certainly refer to it, and it will be much-quoted, but it will not be the only resource necessary in this field.

**Graham Mills**

*Graham Mills is a meteorologist in the Regional Meteorology Group of the Bureau of Meteorology Research Centre with a long interest in the analysis and forecasting of weather systems.*

**Climate Sensitivity to Radiative Perturbations: Physical Mechanisms and their Validation** edited by Herve LeTreut (Springer-Verlag, 1996). ISBN 3 540 604340. Hardcover. DM 198.00.

This book is a collection of papers from a NATO Workshop held in Paris in July 1994 and has been published by Springer as part 34 of their Global Environmental Change Series. The objectives of the workshop were to pin down the meaning of 'climate sensitivity' and review and evaluate various methods used to validate climate models. The 24 papers are divided into three sections: (1) General Issues and Methodologies; (2) Cloud and Water Feedbacks in Atmospheric Models; and (3) Feedbacks in Coupled Ocean-Atmosphere Models. The papers in each section are not connected to each other and in a couple of cases don't

really seem to fit in with the workshop's stated aims. As a number of the papers come from a workshop on the FANGIO program (which was an integral part of the meeting), there is some concentration on the method of determining a model's climate sensitivity by comparing the results from two simulations with imposed global SST anomalies of plus or minus 2K. While this technique is only an approximate surrogate for determining a model's true climate sensitivity, it has highlighted the problems in the parametrisation of cloud and the underlying hydrological cycle. There is also some discussion of the recent controversy over anomalous cloud absorption of short wave radiation and its ramifications for GCMs.

The main purposes of a collection such as this are to disseminate information on work in progress, to present details which are unlikely to appear in the peer-reviewed literature, or to collect a number of important contributions on a particular subject into one volume. The work reported in this volume is at least two years old, but even so represents a reasonable sample of current work in this field. Although many of the contributions are short, most contain reference lists to enable the interested reader to pursue further details on the topics presented. One problem with a book of workshop papers is that often the onus of ensuring that the papers satisfy the normal editorial standards is left to the individual authors. In some cases, sloppy preparation becomes embedded in the final work, as in a couple of papers in this volume. In one instance, the paper makes much more sense when you realise that two pages have been swapped in the collation!

While I would not regard this collection of papers as a definitive study into climate sensitivity or model validation, there are some interesting papers, and I found most to be worth at least a careful perusal. There are a number of highlights. The first section contains some interesting articles on methodology. Duvel, Morcrette and Klinker present a useful way of validating a model's simulation of cloud and its interaction with long wave radiation by comparing the statistical properties of Meteosat and model-derived brightness temperatures. Andronova and Schlesinger develop a feedback analysis based on the concept of a graphical tree linking all of a model's inputs with its outputs, and demonstrate this technique by applying it to a two-layer radiative-convective model. The approach looks interesting but appears to be labour intensive and would require more information to apply than can be gleaned from the paper. Kärner demonstrates the advantages of applying two different stochastic models to time series of different satellite data.

In a comparison of a number of AMIP models with four cloud climatology datasets, Weare shows that several models have cloud seasonal cycles that lead the observed climatologies by two months, while others show good seasonal behaviour but do not produce the correct spatial patterns. He concludes that all models require substantial improvement in cloud simulation. I certainly agree with this, but not with his other conclusion about the way to compare model cloud with satellite data, which seems to contain a typographical error. Lindzen's discussion on some aspects of the water vapour budget in the models and how they compare with the real world is a more up-to-date version of the presentation he gave in Australia a couple of years ago, and is certainly worth reading.

Section 2 represents the realisation that the cloud scheme in a GCM reflects the shortcomings of the underpinning hydrological cycle. Del Genio argues that validation for GCMs should be based on process studies: the model should be forced to reproduce real variability and then the model simulation should be dissected to try to understand the underlying physical mechanisms. One of his conclusions is that there is currently no fundamental basis for predicting relative humidity on large spatial scales, and that this lies at the heart of the inability to ascertain even the sign of cloud feedback. Most of the rest of the papers in this section consider the effects of different parametrisations on individual models. These range from the use of prognostic versus diagnostic cloud in the ECMWF model to the effects of different convection schemes or the addition of a land-surface scheme in some of the French GCMs. Senior and Mitchell demonstrate that it is not sufficient for a model to accurately simulate the ERBE cloud forcing data; cloud feedback, which describes how the radiative effect of cloud varies with a change in climate, can still not be validated adequately.

Section 3 is meant to cover feedbacks in coupled models. The emphasis is on the effects of various aspects of cloud parametrisation on climate simulations. Meehl discusses the impact on a coupled AGCM-OGCM system of competition between the super greenhouse effect of increased atmospheric moisture and the increased albedo in areas of strong convection. Randall, Fowler and Dazlich present a study of the oceanic meridional energy transport implied by a number of AMIP models; they also describe how their new prognostic cloud scheme improves their GCM simulation. Royer, Chauvin and Timbal considered a number of factors which influence the land-sea thermal contrast and thus affect the monsoon. LeTreut et al. describe a series of climate simulations including both the direct and indirect aerosol forcing. They found

that the largest effect was due to aerosol modifications to the parametrisation of warm cloud physics. The last 2 papers are more to do with the real world than modelling. Schlesinger and Ramankutty recently discovered a 65 to 70-year oscillation in the temperature records since 1765, and argue that it must be an internal oscillation of the atmosphere-ocean system. The last paper (on orographic precipitation on the Black Sea coast) seems out of place in the ocean-atmosphere section, if not in the volume as a whole.

In summary, this is not a book for someone looking for a thorough discussion of the meaning of climate sensitivity or a comprehensive review of validation techniques for climate models. It does, however, represent a useful sample of the current work in this area.

**Lawrie Rikus**

*Lawrie Rikus is a scientist working on the parametrisation of cloud and radiation in the Bureau of Meteorology Research Centre.*

**Clouds, Chemistry and Climate**  
edited by P.J. Crutzen and V. Ramanathan, NATO ASI Series I: Global Environmental Change, Vol. 35 (Springer-Verlag, 1996). ISBN 3 540 60433 2. Hardback, 261 pp., DM 160.00.

I generally find the rather eclectic nature of the NATO ASI Series publications to be both refreshing and revealing, since the series format encourages a high-quality summary of the current state of science, but with an explicit encouragement for the authors to highlight controversial issues and points of view in a more open way than is possible in the normal peer-reviewed literature. This volume is no exception, as might be expected when the volume editors are both very well known and respected atmospheric scientists, one (Crutzen) being a current Nobel Laureate. The quality of the other participants in the NATO Advanced Research Workshop from which this volume arose is similarly high, resulting in a collection of chapters that is as authoritative as it is informative, with most of the authors only too happy to adapt to the ASI format by commenting extensively on gaps in knowledge and where they see the next areas of progress being made.

The eclectic nature of the volume results in part from the fact that such a broad topic was addressed: current knowledge and questions about the relationships between clouds, chemistry and climate can hardly be compressed into a mere 260 pages, no matter how erudite the writers. Moreover, the restriction that only scientists from NATO countries take part in the ASI Series meetings adds an additional arbitrary condition to the selection of participants, and thus to the range of topics covered. The resultant sense to me, at least, of a certain arbitrary selectivity and separation between the subjects addressed is heightened by the camera-ready format of the publication, which clearly defines each chapter as a separate entity by virtue of varying fonts, citation and graphics styles. A final observation is that the ARW took place in March 1994, so that a review of the volume in 1996 already makes some of the content dated, so fast is the science advancing. Examples are the chapters dealing with CEPEX and the GRIP/GISP2 ice cores activities: both sets of experiments subsequently have been reported and analysed in much greater detail than was possible at the time of the NATO ARW.

However, these are not substantive criticisms in the face of the wealth of valuable scientific knowledge and insight contained in the book: the content, though selective, is excellent since, as noted above, the scientists involved are all of the highest calibre and are experts in their fields. The Workshop discussions covered topics including modelling of clouds in GCMs, observations of cloud microphysical properties, the water vapour cycle, troposphere-stratosphere exchange, in-cloud transport and tropospheric ozone, paleo-climate and clouds, and the role of anthropogenic sulfate aerosols as agents of climate forcing. Particular highlights included discussion of the roles of cirrus and the life cycle and effects of ice crystals in the upper troposphere, and the discussions of the relationships between tropical SSTs, deep convection and clouds.

The specific chapter titles are (starting from Chapter Two): Microphysical and Dynamical Control of Tropospheric Water Vapor; Interactions of Radiation and Microphysics (of cirrus); Lifetimes of Ice Crystals in the Upper Troposphere and Stratosphere; Abrupt Climate Changes: A Global Perspective from Ice Cores; GCM Studies and Parameterization (of clouds); The Central Equatorial Pacific Experiment (with additional remarks on mechanisms for the regulation of tropical SST); Stratosphere-Troposphere Exchange and Its Role in the Budget of Tropospheric Ozone; Enhanced Shortwave Radiative Forcing due to Anthropogenic Aerosols; and Satellite Observations of Upper Tropospheric Aerosols.

These generally excellent written discussions

and analyses of specific scientific issues are complemented by Chapter One, which provides valuable rapporteurs' summaries of the general Workshop discussions on seven distinct topic areas. This, together with the extensive reference lists provided with most of the other chapters, ensures that the book will serve as a useful reference work.

In summary, this is not a book for everyone, as its selectivity, structure and hybrid style are well removed from those of a traditional advanced scientific text. However, for those like me who are grappling with aspects of the clouds, chemistry and climate issue, but cannot hope to keep abreast of developments in the diversity of scientific areas involved, this book provides a most informative summary of selected key scientific topics by a group of international atmospheric scientists whose qualifications for this task are impeccable.

**Greg Ayers**

*Dr Gregory Ayers is a Senior Principal Research Scientist at CSIRO's Division of Atmospheric Research. He has wide research interests in atmospheric chemistry and physics, including photochemistry of ozone and aerosol effects on clouds and climate.*

**Satellite Remote Sensing of the Oceanic Environment** edited by I.S.F. Jones, Y. Sugimori and R.W. Stewart (distributed by Earth Ocean and Space, PO Box 363, Glebe, NSW 2037). ISBN 4 915342 10 7, AU\$150.00.

This hard-back volume is a collection of selected papers presented to the First PORSEC Conference held in Okinawa during 1992. Each paper has been modified by the author to provide a volume with thirteen distinct chapters each addressing an appropriate theme. Each chapter also includes an introduction which is designed to give some background material to the following contributions.

This book will best suit those interested in gaining an overview of the use of satellite data in marine research. A majority of the chapters give detailed descriptive accounts of a wide range of applications, while a few of the contributions give advanced detail of data analysis techniques.

However, by and large, this is not a technical reference. In some cases the field has advanced rapidly over the last four years and some of the sections are already out of date. In particular, the lack of information on Topex/Poseidon data applications, the Along Track Scanning Radiometer, and soon (hopefully) SeaWiFS, is unfortu-

nate. Given that PORSEC has a Pacific flavour it is not surprising that all the applications cover that geographical area.

The structure of the book is rather awkward as the early chapters focus on particular instruments while later chapters deal with a geophysical parameter or phenomenon. This has meant that topics expected in one chapter are dealt with elsewhere, and the cross-referencing is not sufficiently adequate to enable easy navigation through the book. For example, the altimeter section only makes passing reference to ocean currents and the wind waves chapter only has a smattering of scatterometry.

I found Chapter 1 to be the weakest of the thirteen chapters. Much of the detail given is misleading and several sections are difficult to read as they are rather disjointed and include grammatical and typographical errors.

In Chapter 2, the sections dealing with the skin-bulk temperature difference, computing velocity fields and warm eddy detection are all well-balanced articles. The earlier sections do not attain the same standard, and the section on atmospheric correction only deals with multi-angle techniques and not the more common single channel or differential absorption techniques. The last two sections on ocean colour are somewhat out of place – they would have been better suited to Chapter 12.

Again Chapter 3 starts off poorly. The introduction is weak and the next section states that the constants in Planck's Radiation Law are dependent on surface emissivity!! This section should at least refer to the Rayleigh-Jeans approximation. In spite of this start, the chapter does give a good description of some applications of SSMI data. Some cross-referencing to scatterometer techniques for surface wind determination would have been useful.

The next chapter deals with satellite radars and is one of the most detailed chapters in the book. It gives a good account of the theory of microwave reflection from the ocean surface and describes several applications of the data. The chapter also provides sufficient information and references to be a useful reference itself for those interested in radar data applications. The later sections provide a valuable overview of the measurement of surface waves and wind using scatterometers.

Chapter 5 deals with altimeters and, after a poor introduction, gives some detailed analyses of data from the GEOSAT altimeter. Unfortunately there is little information on the use of altimeter data in ocean current determination – one of the great advances in satellite oceanography over the past few years. Of course this omission is directly linked to the advent of data from Topex/Poseidon, which were not available till after the PORSEC conference.

The sixth chapter is entitled 'Marine Wind' and includes several contributions describing the derivation and applications of winds from the SSMI passive microwave radiometer. The last section describes applications of winds derived from an active side-looking radar on a Russian satellite. Here the chapter title is misleading, as I would expect to find sections here on winds derived using scatterometer and SAR instruments.

I found Chapter 7 the most interesting and generally informative chapter of the entire book – even if it is somewhat out of place in an ocean remote-sensing volume. The chapter contains a good description of radiative processes in climate research and each section gives a well-balanced account of an important component of radiative forcing. These include water vapour, aerosols, clouds and volcanic aerosols.

The chapter on air-sea interaction is well developed and describes the many varied aspects of this field from wind and waves through to surface heat fluxes, precipitation and evaporation. Some detailed analyses of remotely sensed data are included in several of the contributions. The following chapter gives some good examples of radar data applications to the measurement of waves, including the use of SAR in oil pollution detection. Chapter 10 also concentrates on the use of radar data in sea-ice applications. The three contributions all give an interesting and complete description of how radar data can be applied in polar regions.

Chapter 11 deals with the remote measurement of surface currents using both passive and active sensors. This is a well-structured chapter and provides a good description of the use of AVHRR, CZCS and other satellite radiometers in surface current measurements. The contributions dealing with altimeter data are restricted to those from GEOSAT but give an indication of what information can be derived from such datasets.

The penultimate chapter would have been better entitled 'Ocean Colour Applications' by including those relevant sections in Chapter 2 to precede the existing five contributions. These five are all well balanced and give a good insight into the potential of ocean colour data in fisheries research. The final section on applications to the Japanese fishing industry is exciting in that it shows the great potential of these data in the management of marine resources. Part of Chapter 13 would have been better included in Chapter 12, as it deals with a specific application of ocean colour data, while the remaining sections of the thirteenth chapter deal with coastal applications of infrared data.

Unfortunately the volume contains many typographical errors, the cross-references are poor, and the index inadequate. For example, the running titles for Chapters 3, 4 and 5 contain spelling

errors. The list of contents could have been more comprehensive, allowing easier searching for selected topics. For instance – I searched the index for ‘ocean colour sensors’, was directed to ‘ocean colour’ which did not exist, and found the topic under ‘colour sensors’. This was the only index for ocean colour, and none of the subtopics directed me to Chapter 12, which covers all the detailed applications of ocean colour data. I also found that many of the page numbers in the index are in error by one page.

In summary the book is like the curate’s egg – good in parts. The chapter introductions, which the Preface admits is an unusual approach, often do not do justice to the following contributions. They contain errors in fact and in some cases a lack of detailed knowledge of the chapter topic is evident. Many of the papers give basic

descriptions of the application of remote-sensing data while others display the authors’ intrinsic knowledge of the subject by including highly mathematical approaches to their subject. Many of the chapters are quite descriptive and give a good insight into the many different applications of satellite data. Most of these papers give sufficient references both for further reading and for sources of analytical detail.

**Ian Barton**

*Ian Barton is with the CSIRO Division of Atmospheric Research and is located at the Marine Laboratories in Hobart. His research program is based on the analysis of satellite data for use in oceanography and atmospheric research and he undertakes a coordinating role for satellite data reception and applications within CSIRO.*