

Book reviews

El Niño - Southern Oscillation and Climatic Variability by Rob Allan, Janette Lindesay and David Parker (CSIRO Publishing, 1996). ISBN 0-643-05803-6. \$110.00.

This is a handsome book that provides a thorough summary of both historical and very recent climatological research involving the El Niño/Southern Oscillation. The authors introduce the reader to the propagational characteristics of El Niño Southern Oscillation (ENSO) phases, which evolve in response to the interaction between the annual cycle and the quasi-biennial and lower frequency components of surface pressure and sea-surface temperature anomalies. Importantly, the authors point out that there are also periods when low frequency components of the Southern Oscillation Index (SOI) are especially weak or strong at decadal to multi-decadal frequencies.

The book and atlas contain nine chapters covering an Introduction; Data and Methods; Oceanic, Atmospheric and Hydrological Variable Responses to ENSO; ENSO teleconnection patterns; Impacts; Appendices; References; Histories of selected ENSO phases; and the Filtered Normalised Monthly Anomalies of Surface Pressure and Sea-Surface Temperature since 1871, the prime purpose of the atlas.

A surprising feature of the book is the sumptuous historical summary, presented as the Introduction, of early research into the Southern Oscillation and seasonal climate forecasting. This work (and the appendices) probably provides the most concise but thorough collation available of early climate forecasting research (especially involving the Southern Oscillation) and includes rare and interesting photographs of scientists whom we are only now recognising for their foresight.

The large Introduction takes the reader very rapidly from the historical perspective to more recent developments such as fully coupled ocean-atmosphere models, including a fine description and schematic diagram of delayed oscillator behaviour of a coupled ocean-atmosphere over the Pacific basin. Current work on seasonal forecasting is described, including an interesting schematic of (Webster's) 'predictability-gap' or 'predictive barrier' of the austral autumn (although the diagram may confuse readers as it refers to the 'spring (i.e. northern hemisphere spring) frailty period'.

The book provides a thorough technical discourse of the longer term fluctuations of ENSO teleconnections in the climate system. There is a useful elaboration presented of Bjerknes' (1969) descriptions of sea-surface temperature (SST) fluctuations over the equatorial Pacific and no less than 47 cited papers on research on spatial distributions of simultaneous and lagged seasonal climatic correlations with ENSO variables.

Dr Allan is well known for his remarkably thorough literature reviews and this book is no exception. There are some 833 cited references in this book, most of which appear by the end of the Introduction! In this respect, the book would also make an ideal first reference for the beginning student seeking to better understand aspects of this rapidly developing science.

However, I imagine a newcomer to this field of climate science may be a little put off by the over-use of acronyms and jargon which appear in the book (especially in the Data and Methods section). In the Chapter dealing with ENSO Teleconnection Patterns, terms such as 'EOFs' are introduced without any explanation. ('EOF' means 'empirical orthogonal functions'). I would strongly urge the addition of a Glossary to explain the many technical terms and acronyms used in this branch of science.

I found Chapter 5 (Wider Terrestrial and Marine Environmental Impacts) a little flimsy, although in fairness to the author of this Chapter it appears it was only meant to be a brief introduction to the subject. However, I may take issue with statements like 'such (climate) forecasts are most useful on an industry-wide basis rather than at the individual farm scale'. This may not be the case. Considerable research in the agricultural science literature in Australia and elsewhere is focussing on the relevance of climate forecasting to agricultural production. There may be an ongoing problem here, in that the wider climate science community is not aware of these publications.

My only slight misgivings concern the 'Impacts and Applications' section in Chapter 8. At first appraisal, the maps in this chapter contradict those found earlier in the book (in Figures 36 and 37) in that, for example, none of the El Niño or La Niña impact maps illustrated shows any ENSO impact over Europe. However, El Niño and La Niña responses over regions such as Europe are found when referring to the earlier Figures 36 and 37 and this presents a little confusion. The ENSO impact maps may have had a little more relevance if extended from one austral autumn to the next rather than over a calendar year.

Nevertheless, the prime features of the atlas are the newly developed mean sea-level pressure and sea-surface temperature anomaly maps that appear in Chapter 9. Here we see, for the first time, a complete history of the evolution of all aspects of ENSO behaviour. In this sense the reader may investigate for themselves (with the aid of the enclosed CD) the differing propagation effects across the Indo-Pacific region and elsewhere, to help, for example, enable further insight into ENSO and other phenomena. In this respect, the book is far more than a useful reference work, but also provides hitherto unavailable data that may give further impetus to ENSO research worldwide.

The text accompanying this atlas contains remarkably few typographical errors (there may be one on p.8), making the general text a pleasure to read. I am sure this atlas/CD will become a benchmark reference and data source for all those involved in climate and oceanographic research.

Roger Stone

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The Mount Pinatubo Eruption: Effects on the Atmosphere and Climate edited by Giorgio Fiocco, Daniele Fu'a and Guido Visconti (Springer-Verlag, 1996). ISBN 3-540-61281-5. DM180.

The book is a collection of papers (22 in all) contributed by 'experts' at a NATO Advanced Research Workshop on 'The effects of the Mt Pinatubo eruption on the atmosphere and climate', held in Rome, from 26-30 September 1994. Most of the atmospheric effect of the June 1991 Pinatubo eruptions is generally regarded to have ended by late 1993 (the effect of the eruptions on the Filipino people is still being felt through periodic mudslides), so a Workshop held some three years after the event seems appropriate.

A book with such a definitive title should be a tempting read for any student or researcher in the atmospheric sciences. After all, the June 1991 sequence of Pinatubo eruptions was a cataclysmic event seen by millions of

people around the world and affecting the lives of thousands whose misfortune it was to live in the shadow of the volcano. For the atmospheric science community, as has been said a number of times, the Pinatubo eruption provided a unique opportunity for measuring the effects of a global perturbation on the climate system.

So what have we learned and what does this book tell us? Well, the big-picture results are all to be found within the book's pages: it seems that the earth's surface cooled by about 0.2°C (regionally much larger), the lower stratosphere warmed everywhere from the South Pole to 60°N, and by over 1°C near the equator, the net radiative impact of the eruption was about -2 Wm⁻², column ozone first increased by 2% then decreased by about 5-6% from the equator to 10°S, aerosol optical depth (measured at 0.55 µm) peaked at around 0.3 and perhaps 20 Mt of SO₂ was released into the stratosphere. Of course, I have glossed over the details in stating these results – perhaps the most interesting of these is that while column ozone decreased in the later months following the eruptions, it actually increased between 28-32 km (it decreased in the height range 16-28 km), making interpretation of column ozone changes difficult. The excellent papers in this book provide the reader with plenty of detail and lucid explanation for the physical and chemical processes responsible for the global atmospheric effects of the June 1991 Pinatubo eruptions.

There is much valuable data and information presented in the papers describing the LIDAR measurements of the Pinatubo aerosol cloud. The ground-based LIDAR network is perhaps our most valuable tool for monitoring the stratospheric aerosol layer. Uchino describes a Japanese initiative, 'Effects of the Pinatubo Eruption on Climate – EPIC' using the global LIDAR network. There are some very interesting comparisons made between the decay of the Pinatubo aerosol layer with that of the El Chichon layer. Godin et al. show comparative decay rates of Pinatubo and El Chichon (for 55 months after eruption). They estimate e-folding residence times in the mid-stratosphere (20-25 km) of seven months for both; from 15-20 km it is 12 months for Pinatubo and eight months for El Chichon. Jager estimates the stratospheric e-folding time of the Pinatubo eruption at 10.3 months. Uchino estimates the e-folding time at eight months and Fiocco et al. estimate a half-life time of 194 days for the decay of the aerosol integrated backscatter obtained from measurements made by the LIDAR at Thule (76.5°N). There is no attempt by the Editors to consolidate these estimates, and the authors do not appear to have collaborated in their findings, so it is quite satisfying to see such good agreement.

The topic of regional climate change due to volcanic eruptions is discussed by several authors (Jones and Kelly, Paolucci et al., Graf, Kondratyev). There appears to be some similarity in the regional cooling pat-

terns observed after several explosive eruptions and progress in simulating the dynamical fields in mesoscale models is being made. It seems that correct specification of the aerosol optical thickness is crucial. The papers by Graf and Hansen et al. provide very good descriptions of the current state of modelling the effects of large volcanic eruptions on the climate. Model predictions of the magnitude of the surface cooling (Hansen et al., Jones and Kelly) are overestimated by a factor of 2 or so, but the timing and duration of the cooling is good.

This book was an enjoyable and fascinating read covering a wide variety of the physical processes governing the interaction of explosive volcanic eruptions with the atmosphere and climate system. There is little difficult mathematics in the book for the reader to comprehend but the plethora of complex physical, chemical, radiative and dynamical processes discussed makes the read both challenging and rewarding. Most of the results presented are mature – little controversial material is presented. The subject of the relation (if any at all) between El Niños and volcanic eruptions is avoided altogether, apart from comments regarding isolating the effects of these perturbations in climate signals. While the book presents a wealth of information on the character and effects of the Pinatubo aerosols, it also offers a whole set of new and interesting questions. For example, while satellite observations suggest the aerosols reached 40 km, there is little indication that any warming took place at these heights (or indeed above about 30 km).

On the downside, there is not much cross-referencing of material in the book, which is perhaps understandable for a collection of papers. The book does not have an holistic feel to it, though I suspect it will be a very valuable source of material on the Pinatubo aerosol cloud. There is no paper on TOMS SO₂ or AVHRR aerosol optical depths. This is a shame in the first case, as there is still much discussion over the exact magnitude of the atmospheric SO₂ injections due to Pinatubo (e.g. Grainger et al. report an estimate of 12.7 Mt of SO₂ based on ISAMS measurements, while Bluth et al. (1992), estimated 20 Mt using TOMS data).

On the upside, the strength of the book is definitely in the LIDAR papers, and none of the papers is poor. I found them all worthwhile reading. The papers on modelling the effects of the eruption on climate are written by acknowledged authorities on the subject, while stratospheric effects (physics, chemistry and dynamics) are ably handled by W.B. Grant, J.K. Angell, K. Labitzke, H. van Loon, D.J. Hofmann and S. Solomon.

For those thinking of purchasing their own copy of this book, here are some details: there are four chapters divided (broadly) into the following topics: 'Characterization of the aerosol cloud' (eight papers), 'Measured or simulated effects on temperature' (four papers), 'Measured or simulated effects on ozone' (six

papers), and 'Measured or simulated effects on climate' (four papers). There are 82 authors (but 31 of these are on the paper by Hansen et al.). The book is hardback, has 310 pages, has an author index, a subject index and is published by Springer in the NATO Advanced Science Institute Series. References can be found at the end of each paper; no attempt has been made to collate these into a single list, which is a pity in my opinion. I am informed that the price for the book is DM 180.00 (Gulp!).

Fred Prata

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Greenhouse: Coping with Climate Change edited by Willem Bouma, Graeme Pearman and Martin Manning (CSIRO Publishing, 1996). ISBN 0-643-05688-2. \$A89.95 \$US89.95

Greenhouse: Coping with Climate Change presents a set of 38 papers, comprising some three-quarters of those originally delivered at GREENHOUSE 94. This conference, organised jointly by Graeme Pearman of CSIRO and Martin Manning of NIWA, was planned with considerable thought to provide concise but definitive reviews of a wide range of climate change topics, with several papers addressing specific issues of relevance to Australia, New Zealand and the Pacific Islands, primarily but not exclusively relating to anthropogenic increases in greenhouse gases in the atmosphere.

The delay in publication highlights a recurring problem with conferences that lead to formal publications. Either the papers are written and submitted well before in order that proceedings can be distributed at the conference, in which case they are often under-reviewed, gain nothing from exchanges at the meeting and have limited circulation; or they are reviewed and edited after the meeting with inevitable delay but more general circulation. The latter procedure was adopted for GREENHOUSE 94 with each paper peer reviewed, revised and edited. As a result, it has taken two years to produce what is still a set of proceedings, since the papers are written individually and lack the cross-linkages of a book, but as proceedings

they are authoritative, well written and provide an immensely useful and detailed account of many facets of this multi-faceted field. They deserve wide circulation.

GREENHOUSE 94 was one of a series of national and international conferences springing from a 1985 UNEP/WMO meeting held in Villach, Austria, from which a statement was issued that continuing anthropogenic increases in atmospheric greenhouse gases would probably lead to significant global warming. By that time a consensus was emerging among climate scientists that our ability to model the climate system numerically had developed to the point at which climate change was progressing from an area of academic research to one which could play a significant role in the determination of policy and the development of responses. In 1987, CSIRO and the Australian Commission for the Future held a major national meeting, GREENHOUSE 87, with the key objective of stimulating research into likely impacts of climate change in Australia and New Zealand, the proceedings of which, *Greenhouse: Planning for Climate Change*, were published in 1988. The following year CSIRO held a third national meeting on Greenhouse and Energy, with proceedings published in 1990 under that title.

Since 1985, there has been a significant increase in support for research, both nationally and internationally; this has broadened and deepened the national science base for our understanding of climate change and has enabled Australia and New Zealand to play an important role internationally in the IPCC. There has also been a change in emphasis increasingly towards research on impacts and responses. The science base for climate change and climate variability is still in many respects inadequate, but the twin threat implied by greenhouse gases and rising world population are such that policy, indeed at time politics, must now play a leading role. It is vital in these circumstances to maintain effective communication between the scientists, sociologists and economists concerned with climate change on the one hand, and between researchers and policy makers on the other. GREENHOUSE 94 was a part of this communication, and *Greenhouse: Coping with Climate Change* should provide on-going stimulus for further cooperation.

The present proceedings are divided into three sections of eight science, ten impacts and 20 response papers, broadly in line with the current emphasis on response.

The eight science papers cover the role in climate change of the following: changes in atmospheric composition, clouds and the sulfur cycle, the terrestrial biosphere, modelling, Oceania and Antarctica, observed variability in climate and sea level, ocean processes and sea level, and scenarios for Australia and New Zealand. These papers are rich in content and in this review there is room only for passing comment, hopefully to lead the reader to the original. There has been real progress in

climate science in recent years but much remains in this complex field and it would be quite wrong to imagine that the science is done and only the policy remains, as we show by brief summaries of selected topics from the science papers.

Ice-core records have been improved recently; they show both the natural long-term variability from pre-industrial times and the anthropogenic changes of the last two centuries. Current long-term trends based on observations and budget estimates including sources and sinks are fairly well-defined, but recent anomalies in growth rates of CO₂ and CH₄ show that our understanding is still insufficient to predict interannual variations in growth rates. The anticipated warming due to increasing concentrations of greenhouse gases is in part (possibly substantially) offset by cooling due to aerosols, although the quantitative contributions of aerosol and aerosol-cloud processes to climate forcing are geographically patchy due to the short life-time of aerosols and are still highly uncertain. Interaction between the terrestrial biosphere and the lower atmosphere is complex and comparison of climate model simulations with observations shows deficiencies in the simulated land surface radiation and energy budgets, with significant model biases in annual net radiation and individual radiation components and a large range of variation in monthly and annual evaporation and sensible heat flux. There is a particular need for long-term observations that can be used for model validation, although this is being addressed.

Atmospheric water vapour makes a large contribution to the natural greenhouse effect and with aerosols as nuclei may significantly affect albedo through changes in cloud cover and cloud type, and yet even entire systems of clouds are too small to be resolved in current climate models. Better incorporation of the physics, chemistry, biology, ... into climate models demands increased resolution and hence greater computing power and storage and will need the next generation of super or massively parallel computers. Palaeorecords of climate change which show quasi-regular glacial-interglacial cycles over the last few million years do not provide a close parallel to greenhouse warming as both primary forcing and its spatial distribution differ, but the most recent warming events suggest that major biotic changes are likely. The interaction of climate with biological and geological settings is still poorly understood, and vastly improved ecological and landscape models of change will be needed. The oceans store and transport huge quantities of heat, water and carbon, and profoundly influence climate. In spite of substantial progress in observing and modelling the oceans over the past decade, a better understanding of global ocean circulation and its interaction with the climate system is needed for more realistic forecasts of future climate.

Ten papers on the impacts of climate change range over the following topics: pastures, soils and land systems, planted forests, pests, weeds and diseases, native biota, coasts, flooding and urban infrastructure, water and electricity. Although it is not yet possible to produce reliable predictions of regional climate change, we can produce suites of plausible future climates or scenarios which, even if they do not include what will come to pass, can at least be used for guidance in impact studies. Although much remains to be done, this essential work is continuing to assess the likely consequences of climate change.

Scenarios have recently begun to become available, as yet in limited and tentative form, which begin to relate greenhouse parameters with the frequency and intensity of tropical cyclones, storms, floods, coastal waves and droughts. These scenarios are vital for improved assessments of likely urban and coastal damage, erosion and stress on animals and plants, all of which are dominated by extreme climate events. They are very demanding requirements for the current generation of models, not least because GCMs must parameterise all physics at scales below several hundred kilometres. As model resolution and physics improve, there will be a demand for better scenarios leading to improved impact assessments. However, at present we can do little more than make informed guesses about such questions as the effects of climate change on preferred locations for planted forests or coastal wave directions and amplitudes. Models are essential both as tools for assessing possible consequences of climate change and as tools in management; and they must be set up to yield clear and testable predictions allowing model validation against data observed under a range of conditions to uncover the defining parameters.

Current models are often crudely empirical and unduly specific, as for example forestry models based on measurements at a single site; and while young trees will probably grow faster as CO₂ concentrations and temperatures rise, this increase is unlikely to be sustained in older trees unless nitrogen and perhaps phosphorous are supplied externally. Coastal responses will depend on a combination of sea-level rise and extreme storm/wave events and both improved modelling of coastal morphodynamics and better coastal monitoring are needed, neither yielding to the other in importance. Research on impacts is of little value unless it affects the strategies of policy makers, and the record to date is not good. An exception is flooding, where flow return periods are widely incorporated into land-use and development policies and this underlines the advantage to be obtained from further research on flood damage to urban infrastructure and on climate change impacts on flood return periods. There has been little quantitative research on the impact of climate change on pests,

weeds and diseases, or on the response of species and ecosystems more generally. If species are unable to change habitat fast enough in changing climate they may need to be relocated artificially, with enormous management and land-use consequences.

There are two ways of responding to climate change: mitigation, where the severity is lessened by changing the cause; and adaptation, by adjusting to the changed conditions. Ann Hendersen-Sellers gives rousing advocacy for adaptation as a straightforward, highly robust and all pervasive strategy for coping with climate (or any other) change. She notes in support that climate varies more rapidly with geography and season than through time and that human and natural adaptation has obviously been successful. The balance between adaptation and mitigation may not always be so simple: we now slip-slop, wear hats and cover our children for beach play, but few would go back to the unfettered release of CFCs and then there are deeper ethical questions involved in the increase of sugar harvests by high use of fertilisers to bring in marginal land and insecticides to control climate-related increases in pests, when a significant part of the chemicals will be washed onto the Great Barrier Reef.

Policy makers are troubled by the compound uncertainties of future impacts and present day variability, and while they regard scientific research aimed at reducing these uncertainties as important, they believe that it should be carried out in partnership with policy making to minimise potential impacts of climate change. There is space for one more comment only. A disadvantage of the proceedings format is that apparent disagreement between papers in the volume remains unresolved: thus, a unilateral carbon tax involves considerable costs to Australia without noticeable effect on global emissions (McKibbin and Pearce); but, taking account of carbon emissions, economic growth and employment, and with appropriate use of carbon tax revenues there is a *prima facie* case for such a tax (Common and Hamilton).

The volume is well produced and remarkably free from error, although 'coal use' comes as a surprise in 'coastal impacts'.

I see this as a book written by technicians (scientists, sociologists and economists, if you like) for technicians and I ticked off the work near my own field and read with considerable interest (as much as I could) the work in more distant fields. This was great for me, but I consider that two components were missing from the book, which were necessary for it to have comparable value for the planners and policy makers listed in the flyer under readership. The major deficiency is a linking overview and assessment of the papers as a whole. Most papers call for better observations, better modelling of the physics, chemistry, biology, sociology, economics ..., more computing power. We have neither the money

nor the people to mount such a program; choices must be made. Someone will set priorities, and while aware of the difficulties, I doubt that we trust the policy makers and politicians to make the decisions for us. This is an opportunity lost; and with a year-old government which among its early actions abolished the National Greenhouse Advisory Committee which distributed limited but extremely useful research funds, something more was needed. The other shortfall? Those same pol-

icy makers will find navigation around the volume unnecessarily difficult, and for \$89.95 some might have expected an index.

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