

Book reviews

Climate Process and Change by Edward Bryant (Cambridge University Press, 1997). ISBN 0-521-48440-5. \$29.95.

This book is a comprehensive review of information about climate processes and climate change, with assessment of impacts on health and ecosystems. The degree of technical detail is suitable for university students or science graduates, and scientific jargon has been minimised or clearly explained where necessary. Ted Bryant's style is clear and concise. The text is easy to read, the diagrams are enlightening, and he is not afraid to express personal opinions about controversial issues. A list of one to four key references is given for each subsection and these are collated at the end of each chapter, along with a neat set of concluding comments.

An informative introductory chapter gives the reader an overview of some basic statistical concepts and the earth's climatic history. Bryant claims that there is little in the published literature about the uncertainties of enhanced greenhouse warming, a comment made by a number of greenhouse sceptics. However, I note that uncertainties are dealt with explicitly in each chapter of the Second Assessment Report from the Intergovernmental Panel on Climate Change (IPCC 1995 – Houghton et al. 1996). This report represents the 'consensus' views of over 400 authors from 26 countries, and it is essential reading for anyone interested in greater detail about past and future climate change.

The body of Bryant's book is split into three parts: 1 Processes, 2 Change and 3 Impacts. Part 1 covers climatic processes influenced by the sun, the earth's atmosphere, the global radiation budget, circulation patterns, global climate models, urban climates, the role of oceans and the El Niño Southern Oscillation (ENSO). This is a very detailed and balanced description of processes referred to in later chapters.

Within Part 1, the subsection on tropical cyclones covers many important aspects, but could have been improved by showing the basic global distribution of cyclone formation regions; a pattern with interesting zonal asymmetries related to ocean temperature. Superseded IPCC 1990 / 1992 reports and publications prior to 1993 are cited as the most relevant references for the composition of the atmosphere, and for general circulation models (GCMs). Consequently, examples of model validation are based on older 'slab ocean' models rather than current 'coupled ocean-atmosphere' models

which generally perform better. Citation of results from the IPCC 1995 report would have been much more relevant. The ENSO subsection is very informative and topical, given the recent prolonged El Niño conditions from 1990-95. I found the five precursors to failure of the Walker circulation particularly interesting. Bryant states that the 1990-95 El Niño conditions are unprecedented, having a theoretical chance of once in 1500-3000 years. However, I believe this finding is controversial since it has been challenged and counter-challenged (Trenberth and Hoar 1997).

Part 2 deals with scales of climate change from Pleistocene Ice Ages to modern interannual variability, and measured trends in temperature and precipitation. It also addresses causes of climate change external to the earth, factors internal to the land-ocean-atmosphere system, geological factors, random factors which sometimes resonate, and human factors related to pollution of the air and water (notably the enhanced greenhouse effect and ozone depletion).

Within Part 2, the role of the North Atlantic in past climate change is highlighted. Bryant concludes that 'we should not be putting as much emphasis upon global climate change as upon climate change in crucial trigger regions. The North Atlantic Ocean is certainly one of these trigger regions that bears close monitoring and increased research effort'. The link between astronomical cycles and worldwide floods and droughts is also interesting. A clear relationship exists between regional rainfall and the 11-year sunspot cycle and the 18.6-year lunar cycle, both of which are weakly correlated with the Southern Oscillation. It is concluded, however, that 'associations between climate and astronomical cycles for much of the southern hemisphere are of minimal practical significance'. There is also an excellent discussion of factors causing Ice Ages.

Bryant cites the IPCC 1995 report only when discussing observed changes in temperature and precipitation, anthropogenic greenhouse gases, discrepancies between observed and GCM-simulated warming, and GCM limitations. Again, superseded IPCC 1990 / 1992 or publications prior to 1993 are cited as the most relevant references for the uncertainty about past warming and GCM-simulated climate projections. It is not clear why the IPCC 1995 report was not cited in these subsections because it contains more recent information about the state of the science. With regard to uncertainty about global warming of the past century and recent satellite records, readers should see Jones et al. (1997) and Prabhakara et al. (1998) for the latest views.

The subsection on 'missing' carbon dioxide is at odds with the IPCC 1995 report, particularly since the central estimate of the missing sink (1.3 ± 1.5 Gt) is actually 20%, not 50%, of total anthropogenic emissions (7.1 ± 1.1 Gt). IPCC 1995 states that the atmosphere stores 3.3 ± 0.2 Gt per year, the oceans absorb 2.0 ± 0.8 Gt and forests absorb about 0.5 ± 0.5 Gt. A recent paper (Houghton et al. 1998) puts the missing terrestrial sink at 1.8 ± 1.5 Gt. Carbon dioxide fertilisation of the biosphere is not discussed by Bryant until the final chapter on ecosystem impacts, yet it may be large enough to offset tropical deforestation, ruling out the need for the so-called 'Great Northern Absorber' referred to by Bryant. The role of sulphate aerosols is a controversial issue dealt with reasonably well. However, no mention is made of the high uncertainty in radiative forcing from both direct and indirect aerosol effects, the latter being possibly as large as the greenhouse gas forcing, but in the opposite direction.

Unfortunately, there is no discussion of the IPCC projections of greenhouse gas emissions and concentrations, the associated transient global warming projections, and the dependence of global warming on assumptions about global climate sensitivity and sulphate aerosol projections. Relevant information appears in the IPCC 1992 and 1995 reports. Bryant's regional climate change scenarios for Australia come from a superseded 1990 CSIRO document, which has since been updated in 1991, 1992 and 1996. Readers should use CSIRO (1996) for Australian scenarios.

It is conjectured that 'these changes bode well for the agricultural productivity of the continent', and that regional impacts based on GCMs and past climatic analogues can be considered 'benign'. However, this is at odds with IPCC impacts assessments (Watson et al. 1996; Watson et al. 1998), although the latest of these was unavailable to Bryant at the time of writing the book.

A good summary of caveats on enhanced greenhouse warming is given toward the end of Part 2. To the list of six points about climate change scenarios, I would add that uncertainties still surround modelling ENSO, biospheric feedback, ocean circulation, clouds and aerosols, so scenarios will continue to be updated as the science progresses.

Part 3 presents a detailed assessment of two sectors likely to be affected by climate impact: health and ecosystems. Health aspects include the history of disease and climate change, physiological stress, vector-borne diseases like malaria, water-borne diseases like cholera, respiratory diseases like asthma, natural hazards like fire and flood, the increase in UV radiation due to ozone depletion, and new diseases. Ecosystem issues include the effect on plants of past and future changes in climate, carbon dioxide and UV radiation effects on plants, and the feedback effect that plants have on climate.

The health chapter is well researched. While Bryant could not draw on the most recent regional health impact assessments (Watson et al. 1998), the information supplied is reasonably comprehensive. The issue of global food supply is not addressed, yet this may be the most important impact on health since projected decreases in agricultural yield in low latitude developing countries may lead to an extra 64-372 million people at risk of hunger by the year 2060 (Rosenzweig and Parry 1994). Ozone depletion, changes in UV radiation and skin cancer are covered thoroughly, and could be supplemented with more recent results (Kane 1998). Ecosystem impacts are also covered well, but the assumption that 'a greenhouse warmed world will be more benign for plant growth' is rather simplistic. The IPCC 1995 impact assessment (Watson et al. 1996) points to a general reduction in biological diversity and more recent assessments (Watson et al. 1998) note that coastal ecosystems, like coral reefs, are particularly at risk. Watson et al. (1998) state that 'in the tropics and subtropics, where crops are near their maximum temperature tolerance and where dryland, non-irrigated agriculture dominates, yields are likely to decrease'. Assessments included the beneficial effects of carbon dioxide fertilisation of the biosphere, but excluded the impact of increasing extreme events like flooding, fire and disease. Clearly, the effect of climate change on plants is unlikely to be benign.

In summary, Ted Bryant's book gives an excellent and detailed account of climate processes, time scales of climate change, factors causing Ice Ages, and impacts on health and ecosystems. However, inadequate reference has been made to the IPCC assessments of climate change and impacts, and outdated sources have been used in some sections. A rather optimistic slant is placed on climate change impacts which contrasts with that from the IPCC. For a comprehensive assessment of climate change impacts over a range of sectors including agriculture, water resources, forestry, coastal zones, fisheries, human settlements, ecosystems, health, integration and research needs, Watson et al. (1998) is an excellent source. Nevertheless, *Climate Process and Change* represents a very useful contribution to climatological literature, written in a very concise and interesting style.

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Environmental Oceanography, 2nd edition by Tom Beer (CRC Press, 1996). ISBN 0-8493-8425-7. \$130.

Everyone has their own definition of environmental oceanography, but most will be intrigued by the topics Tom Beer opted to include (or omit) in the second edition of his book entitled *Environmental Oceanography*. Some pretty arcane topics are included, and some important environmental issues get very short shrift. There is a discussion of fractal dimensions, a paragraph on cabbeling (a special case of water mixing), a discussion of Z-transforms, a listing of 49 coefficients for a tidal filter, and a list of equipment required for an environmental field survey. Missing are substantial discussions of environmental topics such as risk assessment, ecotoxicology, sediment quality, dredged-material disposal, marine pests, biodiversity, ecosystems approaches to evaluation and resource management, fisheries assessment and management, the oceans role in the global CO₂ budget, climate variability, environmental monitoring, and environmental management.

The chapter headings reveal a strong physical bias: Coastal Oceanography, Shore Processes, Waves, Tides, Water Composition, Water Circulation, Boundary

Layers, Mixing, Coastal Meteorology, Estuaries and Reefs, Direct and Remote Sensing, Data Analysis, and Coastal Assessment. Biological and chemical oceanography make cameo appearances as subheadings under Water Composition (Nutrients, Water Quality, and Phytoplankton and Zooplankton each get a page). On page 311, Dr Beer writes 'until now, I have described mainly physical processes...', finally introducing a short, final chapter on Coastal Assessment that touches on cost-benefit analysis, risk analysis, environmental reporting, aquatic ecosystems, pollution, and consulting. Most of these topics deserve at least a chapter to themselves, and their brief treatment here is the weakest aspect of the book.

The main strengths lie in crisp prose and good, simple explanations of some tricky physical processes that use illustrations to good advantage. The discussion of tides and water circulation is exemplary. An excellent feature of the book is the Further Reading sections found in each chapter. The references Dr Beer chooses to cite here are the books that both managers and research oceanographers should have in their libraries.

Dr Beer sprinkles the book with case studies and anecdotes intended to entertain while imparting wisdom by example. In some of these, it is difficult to determine his objective. One describes a legal conflict over the use of Bass Strait between fishermen and oil & gas interests, touches on irrelevant details about the database software used, and concludes with the statement that 'After 5 days of court hearings the matter was privately, and confidentially, settled out of court'. Others are more seriously deficient: they set poor examples and miss out on opportunities to provide guidance on common but difficult issues. In the poor example category, Dr Beer reports that he was horrified to discover that wave calculations for a jetty design were based on winds measured at 9 am and 3 pm – horrified because he feared that biases in the wave climatology (caused by including afternoon sea breezes) would result in an overly conservative design. But he does not tell us how to collect unbiased samples or estimate how important the bias might be, or discuss other sources of error in setting design standards. In the missed example category, Dr Beer discusses his contributions as a consultant to the Ok Tedi mine project in Papua New Guinea. Of concern is that there is sufficient rainfall so that the Fly River can transport millions of tonnes of mine tailings. Fortunately, 'mining operations did not begin until 1987, so the worst El Niño [drought] conditions of the past century [until this year] did not disrupt operations.' Less fortunately, the discharge of 80,000 tonnes/day of tailings into tributaries of the Fly River has led to changes in the fluvial environment, an expensive dredging program, and litigation. Dr Beer misses an excellent opportunity to discuss the issues associated with this controversial development.

An example of risk assessment (pages 49 and 327) involves the impact on a coral reef of mining waste. Dr Beer focuses on the physical fate of the material, concluding with a model that only 1 km of reef would be subjected to 'severe' impact. Discussion of environmental effects is limited to the statement that 'reefs suffer severe impact at deposition rates greater than 10 mg/cm²/day'. A thousand questions about the focus of the study, the methodology, and the results are left begging, and the reader is not particularly rewarded for his interest by the conclusion that 'such scientific investigations are only of value if the government permits offshore tailings disposal' or the fact that it is 'not accepted practice in certain parts of the world'.

In a review problem (2.5), Dr Beer asks readers to calculate sediment loss based on the change in a beach profile over the course of a year. He then erroneously implies that this loss corresponds to the annual alongshore transport rate when, in fact, his example represents the divergence in alongshore transport rate. I suppose this is a minor point, but it promulgates a common misconception, rather than providing would-be managers with good background information. Worse, this and most of the other examples tend to trivialise the difficulties of forming and answering well-posed questions in environmental oceanography.

Dr Beer has a tendency to make sweeping statements without the caveats most readers of technical texts expect. While this style makes the book quite easy to read, some are fairly shocking if taken at face value:

Particularly scenic pieces of shoreline can best be managed by their being declared a marine park (p. 48).

...pollution loadings in estuaries need to be related to the flushing ability of the estuary. In many cases, this is recognised by permitting liquids to be discharged in a 'one in twenty' discharge (p. 241).

Nevertheless, one should be pragmatic and realise that the role of a model in impact assessment is to confirm that the proposed development will not harm the environment. If development proceeds and there is no overt harm to the environment, then the model was valid (i.e., predicted adequately for the purpose for which it was used) even if subsequent work indicates quantitative inaccuracies (p. 329).

These statements, if taken seriously, are inflammatory; otherwise they just seem shallow.

In all fairness, *Environmental Oceanography* is intended to provide environmental managers and administrators with an expanded glossary of coastal marine processes and analysis tools. It accomplishes this, but provides an odd mix, from which key ingredients are missing. Environmental managers will have to look hard to find the scattered discussions of manage-

ment issues. Researchers will find the cursory treatment of techniques and methods inadequate. Teachers are likely to be disappointed with the lack of background theory. Ecologists are likely to be annoyed by the scant attention paid to biological processes and problems. In the end, what Dr Beer actually offers is an entertaining, brisk, and sometimes glib introduction to physical oceanography with occasional nods to environmental themes.

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Climates & Weather Explained by Edward Linacre and Bart Geerts (Wiley, 1997). ISBN 0-415-12520-0. \$63.95.

I know better than to place any importance in the title of a book. Still, I reacted with mild scepticism to this title. Here we have a book that goes beyond an 'introduction' and on to an 'explanation'. As a researcher in Atmospheric Science, this struck me as being somewhat arrogant, and as a lecturer, this struck me as being quite ambitious. The authors have undertaken an even greater challenge by trying to satisfy both students of geography/climatology and students of meteorology.

While it's foolish to judge a book by either its title or cover, it seems that we've now arrived at a point where we can no longer judge a book by the text itself. *Climates and Weather Explained* takes a step beyond the classic role of a text book by being supplemented with a CD-ROM that includes (as its back cover notes):

- over 170 additional scientific 'Notes', 40 illustrations and more tables,
- interactive multiple choice, self-assessment and practical exercises,
- hypertext presentation and extensive cross-referencing,
- extended glossary and keyword searching
- a gallery of meteorological photographs.

The CD-ROM is certainly an impressive and priceless addition to a basic text book. The material is available from the World Wide Web, as well. We're seeing another step being made in undergraduate education.

Climates and Weather Explained is set up as introductory material for undergraduate students. One of the aims, as stated in the preface, was to integrate the topics of meteorology and climatology to reflect the nature of

atmospheric science. As the authors note, the presentation of the material is largely arbitrary as much of it is interdependent given the complexity of the discipline. The authors have been successful in this aim, although it has come at a price.

The authors have assumed that the students essentially know no traditional science. The basic text is virtually chemistry-free, physics-free and maths-free. The actual text does not mention such basic blocks of information as the fact that atmospheric pressure roughly drops off exponentially with altitude or the role that conservation of momentum has on the winds. There is only a superficial quantitative aspect to the actual text book. Most of this material has been shifted to the CD-ROM.

As a lecturer I respect the call for such a text. We are being asked to teach at such a level and need a suitable text book. I find it a great challenge to teach some aspects of Atmospheric Science assuming no scientific background. The authors often do a commendable job in presenting material at this level. At times, however, we are left with awkward explanations, as well. One passage in the first chapter reads:

Thus, the difference between 5 degrees C and 10 degrees C is written as 5 K, and is equal to the temperature difference between 41 degrees F and 50 degrees, whereas a temperature of 5 degrees C does not equal 9 degrees F.

The basic linear formula to convert Celsius to Fahrenheit isn't in the actual text – it's been pushed off to the CD-ROM. There is a reference to Note 1.K right there, and the CD-ROM has exercises, as well. But unless the student is reading the text right next to a computer, she or he is at a loss. Would a student know whether 120 degrees F is a reasonable surface temperature from that passage?

That is but one of a number of examples where I found the basic writing of the text to be difficult. I appreciate that the text was never designed fully to stand alone given all the material and resources placed on the CD-ROM. Still, I do not like it when the actual passages in the text require a trip to the computer. I read a few of the chapters while in coffee shops with no access to the supplemental material. This luxury is lost to the students. For some students, a slow web connection will seriously damage the readability of this text.

The CD-ROM, on the other hand, has impressed me tremendously. The authors have taken this space to complete an introductory course in either climatology or meteorology. The scientific notes on the CD-ROM are typically concise but provide the depth missing in the text book. While I sometimes wished that the authors would expand on the science more to allow the students to appreciate the material better, these notes often are of

greater depth than what is found in normal introductory texts. The CD-ROM has even allowed the authors to move beyond a classic text book and include possible experiments and self tests with answers. I find the CD-ROM to be a very positive part of the package. It will be fun to see how this technology develops. It shouldn't be much longer until such supplements are interactive and engage the students even more.

The split between the text and the CD-ROM has left some technical problems. The actual text is an inconsistent reference. You will not find the hydrostatic equation or ideal gas law listed in the index or table of contents. There is a good search engine on the CD-ROM, but that isn't always available. Another aspect of the text that needs to be considered is its aesthetics. There are no colour pictures in its 432 pages, not even the cover. I'm sure this was a budgetary decision, but it must have some impact on a student's interest. More condemning, however, I often found the text to be merely explanations. Having moved the supplemental material off to the CD-ROM, we are left with little sense of intrigue or challenge. Atmospheric Science, which I find fascinating, has been presented as a series of well cross-referenced articles almost suitable for a newspaper. I respect that details must often be omitted because of the scientific constraints. Still, what remains needs to inspire the student to refer to the CD-ROM at the very least. A fascinating picture of a tropical cyclone doesn't do much good if it's in a gallery that the student won't even bother to look at.

One final aspect of the text which should be noted is that it is heavily focussed on southern hemisphere meteorology and climate. The authors do a fine job of using local examples to illustrate their points in hopes of holding a student's attention a little longer.

Since I've never written a text book, I find it difficult to be too critical of such an effort. Indeed, *Climates and Weather Explained* must have been a huge undertaking considering that it is bridging two fields as well as providing a supplemental CD-ROM. As a lecturer, though, I can assess whether I would consider using this text and under what circumstances. In spite of the extra dimensions allowed by the supplemental CD-ROM, I believe that there are texts out in the market already which remain better suited for an introductory course in Atmospheric Science.

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