Aust. Met. Mag. 34 (1986) 77-79

Book reviews

The biogeochemical cycling of sulfur and nitrogen in the remote atmosphere

eds J. N. Galloway, R. J. Charlson, M. O. Andreae and H. Rodhe (D. Reidel Publishing Co., The Netherlands, 1985). ISBN 90-277-2130-0. Pp xiii + 249, $US39.00

Despite the evident unity of planet earth as a complex of swirling atmosphere, superficial ocean and terra firma (all containing biota); how many scientific observers look at this world without the blinkers of their background disciplines limiting their view and hence their understanding? Atmospheric physicists tend not to talk to forest ecologists; marine phycologists usually, though with effort, can talk to oceanographers but only extraordinarily talk to geologists who in turn exchange few thoughts with biochemists and microbiologists.

A curious feature of this limited interchange is an inappropriate modesty and consequent lack of involvement outside of one's own direct field. 'What can I, a mere microbiologist (or whatever), contribute to the explication of a major global biogeochemical cycle?' The answer is, *inter alia,* perhaps a great deal; and every chapter of *The biogeochemical cycling of sulfur and nitrogen in the remote atmosphere* exemplifies this point.

Whilst the volume is the product of 24 specialists meeting for four days in Bermuda in 1984 for a Nato Advanced Research Workshop where they assembled a 'status quo' summary of knowledge and identified important areas for further study, it is also the clearest justification I have ever read for that awkward word — biogeochemistry. For a biogeochemical cycle is truly the linking of the animate and inanimate world in so far as they transform the chemical state of a chosen element — in this case sulfur and nitrogen.

It really is relevant to global emission that cattle urinate on approximately 15 per cent and sheep on approximately 30 per cent of their total grassed areas whilst natural or unhusbanded species of herbivores urinate more evenly over their territories. Local accumulations of urine promote volatilisation of ammonia and inhibit absorption by vegetation and soil micro-organisms. As vast areas of once forest or savannah country are cleared by humans for livestock production, nitrogen cycling in those areas will adjust in response.

Inside the arctic circle, once an area remote from human influence but no longer, the phenomenon of arctic haze in winter and spring is a composite of natural and unnatural (anthropogenic) aerosols, dominantly sulfate. The human contribution to sulfate, characterised by traces of industrial heavy metals such as Vanadium and Manganese, is the result of industry far to the south producing sulfur dioxide in very large amounts. Now, as a consequence, the entire arctic area is not suitable for measurements of the 'natural' levels of atmospheric sulfate; and Antarctica must be used as an alternative site to provide concentrations which may be inferred to be similar to those in pre-industrial times in the arctic atmosphere.

However, the sources of 'natural' atmospheric sulfate in Antarctica and elsewhere appear to be much more difficult to identify and quantify than the unnatural ones in the arctic. Who would easily imagine, for example, that sulfate in the sea must essentially be transformed by unicellular algae and perhaps bacteria to low molecular weight reduced sulfur gases (such as dimethyl sulfide) in order to become sulfate in the atmosphere? Yet this is precisely the route described in this volume. As a consequence, the minute concentrations of sulfuric acid found in bands in inland antarctic ice cores would appear to originate in the prolific summer growth of phytoplankton around Antarctica. This growth apparently produces sulfur gases, as by-products of metabolism, which leave the ocean surface to be oxidised to sulfur dioxide and then to sulfuric acid in the atmosphere and eventually to be deposited over the vast ice-covered continent.

Nitrogen offers equally complex transformations. It is comforting from a biological point of view to find quantitative evidence that nitrogen can be gained or lost by the same soil ecosystem depending on an array of factors such as moisture content, acidity, oxygen concentration, etc. It is also reassuring and impressive that all these factors are being increasingly faced up to and measured when fluxes of nitrogen gases are assessed.

The book, in dealing with the cycles of nitrogen and sulfur, follows a logical and well-signposted format of five parts which comprise (1) Emissions to the atmosphere, (2) Transformations in the atmosphere, (3) Transport through the atmosphere, (4) Deposition from the atmosphere and (5) Overview and summary.

This layout and a comprehensive index allowed me to locate topics quickly. The chapter bibliographies are excellent and there is an author index too; so specific points can be readily followed up in the literature. However, the problem-directed format for the book — reaching for the unknown — rather than an information-centred format — summarising the known — means that the volume is best suited to

those interested in unsolved problems, that is, active researchers. An indication of this is the uneven spread of figures throughout the volume. Some sections have none at all and those that are included encompass a wide range of complexities. A few more well chosen figures to bridge these gaps would have helped this reader, but the book remains an essential guide to what eminent researchers in sulfur and nitrogen biogeochemistry consider should be studied next.

Meteorologists will find that their craft is well integrated into the book and not superimposed on to it. Back trajectories for air masses, transport models, tracer studies and transfer calculations are used where appropriate. This seems to be a feature of the book overall — any technique which can help answer a question is employed. No wonder 26 authors and four editors were required! The price is US $39. This should translate into about A$80. At that, it is fair value in these inflated times.

Harry Burton

Harry Burton is a scientist with the Antarctic Division of the Australian Department of Science who is currently studying the marine microbiological contribution to atmospheric sulfur in Antarctica.

Climate and Circulation of the Tropics

by S. Hastenrath (D. Reidel Publishing Co., The Netherlands, 1985). ISBN 90-277-2026-6. Pp xxii + 455, $US79.00

This is a good book in which all scales of tropical weather systems are discussed in some detail, but with an emphasis on the larger-scale circulations and climate. In addition to the normal topics covered in this type of book, there is a chapter on ocean circulation. This fits in very well with the later discussions on climate variability, particularly the El Nino — Southern Oscillation phenomenon. The final chapters deal with the problem of human impact on climate, and look at very long-term climatic variability.

The book is generally well presented and readable. Each chapter concludes with a 'synthesis' which I found most useful. However, there are too many old diagrams and references used. Also the author chose to define the symbols used with each set of equations and diagrams, rather than adopt a consistent set of symbols for use throughout the book. I feel that this detracted from the overall presentation. I was surprised that only one satellite picture was used, this being a very old composite (1971). I feel satellite pictures illustrating tropical weather systems could have been used to greater advantage and also brought the book more up to date. Very few results from numerical studies are presented. Perhaps this reflects how far the modelling of the tropical atmosphere is behind mid-latitude modelling. The author has drawn upon an enormous body of literature and the reader can pursue any topic through use of the references. In one chapter alone there are in excess of 250 references.

The Australian reader will be very disappointed to find that there is very little reference to the Australian tropics. In the discussion of the monsoons, northern Australia is simply dismissed as part of the 'Greater Indonesian Region'! However, there are very good descriptons of tropical weather climatology over Southeast Asia, Central and South America, and Africa. I suspect that the author has little knowledge of the Australian tropics compared with other regions.

After the introduction, the book begins with a discussion of diurnal variations in the tropics. All of the material presented is quite old and the discussion is very qualitative. This is an indication of how little work has been done in this area in recent times. The author correctly points out that the long-term and large-scale implications of diurnal and local forcings in the tropics have received remarkably little attention. I got the impression that this chapter was presented first to 'get it out of the way' so that the author could tackle the better documented aspects of tropical weather and climate.

After a brief chapter on planetary-scale circulations, in which momentum and energy budgets are discussed, a quite comprehensive chapter on ocean circulations follows. This sort of information is usually absent from books on tropical meteorology, but has its place in a book of this type in which climate is discussed in depth, since the oceans are known to play such an important role in determining climate. A chapter on heat and water budgets naturally follows on from the section on ocean circulations. The next chapter covers all documented regional tropical weather circulations. I found the treatment of the trades and the transition into the ITCZ very good. The discussion of the location of the maximum area of precipitation in relation to the region of lowest pressure is illuminating. A climatology of weather systems follows in chapter 7 in which synoptic-scale weather systems from easterly waves to tropical cyclones are reviewed. As in the chapter on diurnal variations, little new material is presented. That which is, results from investigations which followed the GATE and MONEX experiments.

The remainder of the book is devoted to climate. The chapter on interannual variability of the atmosphere-ocean system concentrates on the El Niño — Southern Oscillation phenomenon, although other interannual variabilities, which are not related to the Southern Oscillation, are described. There appears to be very little understanding of possible mechanisms. A chapter on climate prediction follows. The author correctly points out that climate prediction is of far greater importance than daily weather forecasts in the tropics, but that there is very little skill shown in the former area at present.

The last three chapters make interesting reading. Chapter 10 deals with the implications of the human impact on climate and the last two chapters look at climate changes which have occurred over very long periods. These chapters put the whole story of climate in the tropics in perspective.

Mark Williams

Mark Williams is acting Regional Director at the Darwin Office of the Bureau of Meteorology.