BOOK REVIEWS

Theory of Planetary Atmospheres. An Introduction to Their Physics and Chemistry, by Joseph W. Chamberlain, Academic Press, New York, 330 pp.

With a catchy title like 'Theory of Planetary Atmospheres. An Introduction to Their Physics and Chemistry' and the reputation of the author so well established by his classic work, 'Aurora and Airglow' back in 1961, I was quite eager to read and review this book. Having read it, I must say I now have a feeling of disappointment. Some of it may be, and I hope it is, because of too high expectations on my part but much of it comes from the notions I have of what should be treated in a book on the theory of planetary atmospheres.

I put myself in the place of a graduate student interested in the physics and chemistry of the atmospheres, excited about all the new discoveries being constantly reported in popular magazines about the other planets and eager to pursue research in one of these intriguing new areas. I then asked myself what would I expect in a book of this subject. A few pacing topics came to mind immediately: what processes are responsible for the formation of a planetary atmosphere? What is the current state of the atmosphere on the Earth and other planets: size, composition, dynamical state,. . . ? Why the differences? What are the theories of atmosphere structure, evolution, and dynamics? How well do these theories explain the current state, structure, and dynamics of the atmosphere of the Earth and planets and the differences among them? What are the principal intriguing questions in atmosphereric physics and chemistry and what areas of inquiry should therefore be pursued?

Chapter One very appropriately deals with the vertical structure of an atmosphere: hydrostatic, radiative, and convective equilibria, the various atmospheric layers from the troposphere to the exosphere and their properties and a brief description of the atmospheres on the other planets. Chapter Two starts with Euler's equation of motion and 27 pages later ends with a discussion of Benard's problem on Jupiter. In between there are brief but good discussions of Navier-Stokes, geostrophic winds, Hadley, thermal wind, planetary waves, molecular and eddy diffusion and peculiarities of atmospheric circulation on Venus, Mars, and Jupiter.

From Chapter Three on, it is strictly aeronomy with one chapter devoted to remote sensing of planetary atmospheres by radiation.

Reading these chapters, it becomes quickly very clear that this is the author's own area of interest. In the chapter on Stratosphere, a basic description of the ozone chemistry is followed by a detailed treatment of the NO_x and ClO_x problems with some description of the stratospheric circulation as deduced from ^{14}C measurements. Curiously the whole question of stratospheric dust and its possible effect on global climate is not mentioned.

The chapter on planetary astronomy contains an excellent treatment of radiative transfer in optically thick atmospheres with an elegant description of methods used to retrieve information on the structure of planetary atmospheres by the techniques of photometry, polarimetry, and spectroscopy.

The discussion on the ionosphere of the earth is standard and good but for the other planets, the author has been overtaken by events and the information is pre-Pioneer Venus and pre-Voyager. Airglow, aeronomy, exosphere are treated with expertise, and the book ends with a very brief discussion (8 pages) of "Atmospheric Evolution and Climate."

Having just put down the book, I do not know for whom this book is written. It would be an excellent text for planetary aeronomers, but unfortunately (or fortunately) the planetary spacecraft move faster than the process of writing, printing, and distributing a textbook. A student of planetary atmosphere in general will still not know what the opposing views are about evolutionary histories of the atmospheres of Earth, Mars, and Venus; the problem of the relative absence of water on Venus and Mars, climatic changes on Mars, the red spot of Jupiter, Io's atmosphere (where does it come from and where does it go?), organics on Titan (fact or fantasy); effect of solar activity on Earth's weather (has the subject finally achieved scientific maturity?); Ice Ages on Earth (should we start believing Milankovitch, Hayes, Eddy, . . . ?). What is the fundamental problem with our assessment of the ozone situation? There is some discussion of these questions in the last chapter and elsewhere but barely enough to whet our appetites.

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Finally, as I learned in school, a theory is supposed to explain the observed facts with the help of fundamental principles. Not all observed facts are, of course, explainable by theories at any given time. The situation becomes more complicated when the rate at which the observed facts are increasing (kbits/sec) exceeds our ability to formulate or modify the theories. In such a case, what a theorist can do is to describe the system, explain its static and dynamic state by theories and hypothesis, bring out the opposing views, identify critical problem areas, suggest diagnostic measurements and sometimes even predict the outcome. Chamberlain has done this, to some extent, for the upper atmosphere, but not for the *whole* atmosphere. The fact that the book is dedicated "to O_3, N_2O, ClO, CCl_4, CF_2Cl_2,. . . and many others of our effluent society" and not to O_2, N_2, H_2O, CH_4, NH_3, H_2, He, the principal constitutents of the planetary atmospheres, speaks for itself.

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Food, Climate and Man, Edited by Margaret R. Biswas and Asit K. Biswas, 1979: John Wiley & Sons (New York, Chichester, Brisbane, Toronto). pp. 285, 42 Figures 41 Tables.

This well-presented volume of the Wiley-Interscience Series of Monographs, Textbooks and Advances in Environmental Science and Technology has nine chapters commissioned from specialist authors. The aim of the editors was to assemble a multidisciplinary study of the world issues which have been debated at the U. N. world conferences from Stockholm in 1972 to Buenos Aires in 1978. These are the years since the world food crisis of 1972–73 appeared to illustrate dramatically the gloomy forecasts of 'The Limits of Growth' (1972) by the Club of Rome. They have seen a wave of studies and commentaries on the food prospects for the human race and much speculation on the gloomy themes of climatic change. These years have also seen the wave of exaggerated journalistic prophecies about the 'Green Revolution' turn to widespread attacks, as the programme of improvement of crops and of their agronomy lost momentum among the social and political obstacles to change.

The editors believe that the solutions to mankind's food problems will not be found by direct studies of agriculture, climate or socio-economic affairs, but rather by studies of their interactions. The title 'Food, Climate and Man' clearly implies this intention and some of the authors make effective attempts to discuss their themes from all three aspects. The Preface by Mustafa Tolba, Executive Director of UNEP, raises good arguments for strategies to be based on better care of our environment. However, his quotation from the Bucharest Conference "that only where the poor have a more satisfactory existence will the rate of population growth – itself a major contributing factor in environmental problems – begin to slow down" and his assertion that "the international community must develop mechanisms to distribute surpluses from the favored regions" both take too little heed of the analyses in the following chapters. The first of these items of political dogma is being overtaken by events in areas of greatest population stress, such as Java and Nepal, while the second ignores agricultural geography, in that the genuinely 'favoured areas' for agricultural production are where major irrigation resources have been developed in climates offering year-round growing seasons. These are, paradoxically, still zones of poverty in the world's five largest irrigation areas of the Ganges, Indus, Nile, Tigris and Euphrates.

The precarious balance of the world grain trade is emphasised in the first chapter by Kenneth Hare of Toronto University. He puts the direct effects of ambient climate on the world grain supply into perspective by reminding us that the dramatic coincidences of adverse weather in 1972–73 caused only a 1% drop in world cereal production, exaggerated by the need for a 3% annual increase to meet rising demand. The subsequent controversy over meteorological trends emphasised that "meteorology has no skill on the time scales that matter for farm strategy".

David Norse of OECD makes an impressive response to the editorial request to integrate the analyses of agricultural, climatic and human factors, including the very difficult considerations of livestock production. He balances the emotive statement that in 1975 the developed countries fed to livestock more grain than the total estimated human consumption in India and China, with the

salutory reminder that "a major reduction in the use of grains for livestock feed could greatly increase the availibility of food, provided that there was a parallel increase in the ability of grain deficit developing countries to purchase the resultant grain surplus at prices which would encourage continued production of this surplus".

The treatment of Water and Food Production by Gunnar Lindh of Lund University is less impressive. It is unnecessary to clutter a brief description with tables of arbitrary 'coefficients' from which no deductions are made. Apart from a summary description of global water distribution, there is no discussion of climate and no reference to the effects of climatic variability on agricultural production. Lindh does, however, emphasise both the large potential which remains for irrigation development, and its very high capital costs; also that the costs for renovating existing irrigation areas averages about one quarter of that of establishing new systems.

David Pimental of Cornell has assembled a formidable amount of information relevant to the energy inputs to agriculture into a well-organized and readily assimilable presentation. His summary of the sociological aspects of the world food problem is terse but accurate. "Man must solve the ultimate problem of population numbers: in the meantime he must 'buy time' while science hurries to develop technology for new energy sources and more effective population controls." He shows clearly the intensive energy consumption of modern agricultural technology, including that of pumped irrigation. In the production of the 15 crops which provide 90% of the world's food for man, the energy inputs from hand labour, bullock and tractor technologies are compared. World shortage of fossil energy will become a limiting factor in food production long before the most optimistic forecasts of the end of population growth. Pimental's strategy guidance is that the developing countries should cconcentrate their agricultural energy inputs on the yield-enhancing factors such as fertilizers and improved seeds rather than on labour saving by mechanization, while they 'buy time' to implement population controls.

The first editor, Margaret Biswas, contributes two chapters. On 'Energy and Food Production' the factors described by the previous authors are extrapolated to demonstrate that the world cannot be fed by using the North American system of food production. The alternatives offered are, however, not very convincing. Spreading of fertilizers thinly to use only the largest step in the response curve is a minor factor in the overall logistic and economic problems of tropical agriculture, while bio-gas and single-cell protein are useful contributions but not solutions. On 'Environment and Food Production' the philosophy of careful husbandry of the environment is outlined. While conference delegates have been telling each other this for two decades or more, the use of toxic chemicals increases with little improvement in the efficiency of their employment. The case for integrated control of pests and diseases is sketched and the grim statistics of losses of food to rodents are quoted, but without discussion of the remedies.

Victor Kovda of the USSR, writing on 'Soil Reclamation and Food Production' takes up the environmental arguments for soil protection. Man's suicidal lack of care has already destroyed or seriously degraded some 20 Mkm^2 of formerly productive soils, exceeding in area the 14 to 15 Mkm^2 in current arable use. The basic technologies for conservation and for reclamation are well known, but they need skilled diagnosis and the adaptation of technologies for local economic viability. Such skills are in desperately short supply in developing countries. Kovda sets out a summary of reclamation methods in more detail than will be needed by non-technical readers but the soil problems are so vast and urgent that all who enter the debate on the world food problem should read this chapter. A proposal for eleven 'national-regional applied research institutes' surprisingly makes no reference to the existing highly-effective chain of International Institutes supported by some 40 major donors of the 'Consultative Group for International Agricultural Research' chaired by the World Bank. Indeed the need for one of Kovda's suggested institutes, a centre for research and training on irrigation and drainage development with small-scale farmers, is already under discussion by the Consultative Group.

Helmut Landsberg tackles the much disputed and often emotional subject of 'The Effects of Man's Activities on Climate' with a refreshingly factual survey of what is known and what needs to be known. Clear descriptions of the energy exchanges by which deforestation affects local climate, the effects of large-scale overgrazing, as in the Sahel, the climates of large cities, the impact of large power stations and the increase of carbon dioxide and of aerosols in the upper atmosphere are illustrated by good diagrams. All lead to the conclusion that man's activities are indeed developing on a scale which may significantly affect global climate in addition to the measurable effects on local climate, so that prudence would indicate the need for purposeful study.

The chapter on 'Climate, Agriculture and Economic Development' disappointingly misses the opportunity presented by the rest of the book. The second Editor deplores the dearth of economic studies linking climate and development. From the familiar observations that most of the poorer countries lie within the tropical belt and have in common a strongly skewed social distribution of land, the argument wanders into a superficial survey and condemnation of 'racialist theories' taking several pages to reach the nub of the matter, the basic historical attitudes to food production in the high and low latitudes respectively. While temperate-zone countries improved their agriculture and secured their food supplies as a basis for industrialization, those in the tropical climates continue to neglect their rural areas, in spite of much recent lip-service to the importance of agricluture. That recent high growth rates of tropical populations now present their governments with a food-production task of formidable dimensions has been emphasised throughout the book.

A random set of examples of the agricultural difficulties of tropical climates is not balanced by any description of their high productivity under scientific development, through temperatures which favour rapid growth rates and all-year-round multiple cropping. A more convincing account is given of the depressing effects of low standards of human health on agricultural output in the tropics. The conclusion that "climate is an important parameter that should be considered in any theory of economic development" will appear astonishingly naïve to agriculturalists and to climatologists, but it may perhaps be a necessary message for economists.

The 'Future of Man' is the bold title of the final essay by Aurelio Peccei, President of the Club of Rome, whose latest computer model 'Moira', an acronym formed from the godess of destiny, predicts an increase in world food problems. This conclusion will not surprise any tropical agriculturalist who has travelled widely and recently in the developing countries. In 1976, when the Population Reference Bureau of Chicago estimated that world population passed the 4000 million total, military spending was estimated at $\$3 \times 10^{11}$ p.a. Peccei comments that this "torrential growth rate in numbers and monstrous overkill capacity" hardly offers a sporting chance of a normal life to the generations to come. The remedy must be on the same global scale, in which "150 egocentric national sovereign states, conceived at the time of the stage coach, have become dangerous and costly obstacles to rationalization". The challenge facing our generation is to reach a higher order of culture and organization. He believes that there is much hope for improving of human quality and development of a sense of global responsibility.

To cover the immense scope of the title in 285 pages the editors opt for a highly selective commentary on a decade of international conferences. Much of the material is therefore familiar, but some of the authors have succeeded in objectively summarising world progress. Overall, however, the opportunity is missed to summarize the action needed in the next decade. Neither international aid nor the efforts of the governments of developing countries as yet gives over-riding priority to the development of food production in the tropical areas of subsistence agriculture into which most of the next billion of humanity will be born. Unless this is achieved there will be little opportunity for man to attain the destiny of which Aurelio Peccei believes him to be capable.

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Three from the WMO

The World Meteorological Organization, centered in Geneva, Switzerland, is responsible for the publication of many climate-related memoranda, technical notes, conference proceedings, monographs and other publications. Although most are of high quality, there is some considerable variability in writing style, utility, and comprehensiveness of various reports. This general description is particularly applicable to describe a recent publication of the WMO: *Proceedings of the World Climate Conference: A Conference of Experts on Climate and Mankind,* Geneva, 12–23 February, 1979, WMO No. 537, 1979, 791 pp. (Distributed by Unipub, 345 Park Avenue South, New York, N.Y. 10010 in the United States for a price of $40.00).

The World Climate Conference was an extraordinary event. It brought together hundreds of delegates from dozens of nations for two weeks of meetings on climate. As the sub-title of this journal, it covered the description, causes and implications of climate and climatic change. This reviewer was in

attendance, but did not present a paper and thus feels no conflict of interest in reviewing the conference proceedings. The first week of the conference involved plenary sessions, where experts from many disciplines and nations presented papers to the several hundred assembled for the meeting. Some abbreviated discussion (which is very difficult when there are hundreds of people in the audience and only tens of minutes allotted for discussion) took place after each paper, although extended discussions continued to all hours in the lobbies, hotel rooms and restaurants of Geneva.

The conference proceedings are primarily the written versions of these twenty-six presented papers, plus summaries of the declaration and working group reports, all of which are provided in the 791 pages of WMO No. 537. The working group reports and the conference declaration were worked out by a limited number of invited participants who stayed on for the second week of the conference to work in smaller groups in order to draft various supporting documents. In addition to the Declaration of the World Climate Conference, are supporting documents on Climate Data, Applications of the Knowledge of Climate, the Influence of Society on Climate Change and Variability, Impacts of Climate Change and Variability on Society, and Research on Climatic Change and Variability. There is also a list of participants, which may prove very useful since their addresses are generally listed and often such addresses can be tedious to track down.

The vast scope of subjects covered is apparent from the list of the supporting documents and reports of the working groups hammered out the second week. This scope is reflected in the various authored papers, most of which are of high quality. On the other hand, as mentioned earlier, they are highly diverse in writing style, clarity of English, comprehensiveness, relevance to the assigned subject and, unfortunately in a few cases, state-of-the-art accuracy. Of particular interest to this review is the extremely comprehensive, well-written and well-documented paper 'Global Aspects of Food Production', by M. S. Swaminathan, Indian Council of Agricultural Research, New Delhi, India. For a subject of such complexity Dr. Swaminathan does an admirable job of touching on many of the most important issues. Also particularly clear and well-written are the papers on 'Global Ecology and Man', by Professor Bert Bolin, Department of Meteorology, University of Stockholm, Sweden; 'Climatic Variation and Variability: Empirical Evidence from Meteorological and Other Sources' by F. Kenneth Hare, Institute for Environmental Studies, University of Toronto, Canada; the two papers on 'Human Activities That Affect Climate' and 'Energy and Climate' by Drs. Munn and Machta, and Williams, Hafele and Sassoon; and there is a stimulating and sobering report by Robert W. Kates, Graduate School of Geography, Clark University, Worcester, Massachusetts, on 'Climate and Society: Lessons from Recent Events'. Finally, at least to this reviewer not previously familiar with the issues, the paper on 'Climate, Health and Disease' by Dr. Wolf H. Weihe, Biological Central Laboratory, University Hospital, Zurich, Switzerland, was particularly enlightening. He pointed out how important climatic factors can be in controlling disease vectors such as insects and in regulating physiological processes of humans and animals which affect disease susceptibility.

Despite the high degree of variability inevitable in any document with as many authors as the World Climate Conference Proceedings, this collection of papers is a remarkably valuable set. No serious student of climatology should permit his institution's library to go without this Report. It is a valuable enough reference that I believe most climatologists should probably have a copy in their own personal library.

Faced with the recent need to write a review article on the interactions between climate and food systems, I came across two additional World Meteorological Organization publications (both available from Unipub in the U.S.). Both proved quite useful, although probably they will prove a bit technical and jargonistic for non-specialists interested in food/climate problems. The first is Technical Note No. 151, *Crop–Weather Models and Their Use in Yield Assessments*, by Wolfgang Baier, WMO No. 458, 1977 ($18.00 U.S. from Unipub). It is the most comprehensive little (48 pages) work I have seen summarizing various modeling techniques which relate weather variables to crop yields. Dr. Baier considers a wide range of crops under many different conditions. Not only are the applications of such models listed, but the limitations in their utility and the data bases needed to derive and verify them are also clearly stated. The text suffers in spots from jargon, which may limit its applicability to wider audiences, but this seems a small problem in view of the very careful statements about the use and development of weather information in crop modeling.

If there is a serious shortcoming in this Note it is probably a lack of feeling given the reader for the possible effect of hybrid crops on weather sensitivity. This sensitivity appears implicitly for each

regression equation, but the information presented cannot help us much to select, among the whole variety of available crop strains, those with wide adaptability to a changing climate. This is particularly important, in view of the potential of CO_2-induced climatic changes, for which an inventory of the relative effects of climatic fluctuations on various hybrid-crop strains would seem useful in designing strategies to deal with climatic fluctuations, whether of natural or anthropogenic causes. It is my hope that such a project may very well be in Dr. Baier's, or some other WMO author's, next monograph.

Another WMO technical note (No. 144) related to food and climate issues is *Rice and Weather* by G. W. Robertson, WMO No. 423, 40 pp., 1975 (Unipub). This very useful report describes in summary detail some of the principal factors involved in rice production in a number of climatic zones around the world. It gives a good feeling for the complexity of weather/rice relationships, stressing that many interactive factors, and their timing, are important influences on rice yields. The report does mention some of the effects of altering crop strains on the vulnerability of the yields of those strains to weather variability, although it does not provide a complete catalogue which would be useful for planning for minimum yield variation in the face of climatic variability. The only negative remark one might make about this report is that it tends to be jargonistic in many places, but this deficiency is made up by the fact that basic conclusions and much of the information is presented in language understandable to those who are not experts in rice production.

These three reports are typical of many of the WMO publications, which provide a valuable set of background documents for both professional climatologists and those whose areas of interest are dependent on weather and climate. It is to be hoped that the WMO will continue its policy of producing useful publications, available at reasonable prices.

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