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REVIEWS

An Introduction to the Theory of Climate. By A. S. MONIN. Reidel, 1986. 261 pp. Dfl 165.00 or £45.75.

During the last several decades scientific interest in the problem of climate change has grown to the extent that it now receives as much attention from research scientists as the more traditional problem of weather forecasting. This rapid growth has been spurred on by recent advances in the understanding of past climate changes inferred from paleoclimatic evidence, and by growing concern over the climate warming that will accompany the increasing atmospheric concentrations of carbon dioxide and other greenhouse gases associated with industrial activity. The economic and social disruption that could follow man-induced climate changes can be minimized if these changes can be predicted in sufficient detail.

An understanding of climate change must be built on the base of traditional meteorology and oceanography, but requires that they be integrated with elements from a number of other disciplines. On decadal and longer timescales changes in ground hydrology and vegetation associated with global climate change are probable and have a direct effect on agriculture and water resources. Ocean temperatures, cloudiness and atmospheric humidity may change substantially, and their interactions must be adequately modelled. The problem of climate change not only stresses the limits of current knowledge in a wide variety of subdisciplines within the geosciences, but requires that they be integrated into a holistic understanding. This holistic view, even more than the new challenges within the subdisciplines, is what characterizes the modern approach to climate modelling.

In this book Monin seeks to introduce the reader to the problem by briefly discussing the principal elements of the climate system and how they are currently modelled. The first six chapters of the book are devoted to discussion of the important physical processes. The book begins with a short but reasonably detailed introduction to the astronomical factors controlling the distribution of insolation on the Earth's surface. This is followed by a somewhat longer chapter on radiative processes, including sections on the carbon cycle, aerosols and ozone. The following chapter addresses the general circulation of the atmosphere in 25 pages. Chapter 5 gives the world ocean a considerably longer discussion with particular emphasis on mid-ocean eddies. Relatively little attention is given to the deep thermohaline circulation that plays an important role on the longer timescales usually associated with the climate problem. The tour of the elements of the climate system is completed by a short chapter on the land.

The remainder of the book, about the last quarter, is devoted to a discussion of climate modelling. Chapters are presented on similarity theory for climates of planetary atmospheres, one-dimensional models, two-dimensional models, and finally three-dimensional general circulation models of climate. The detailed numerical models chosen for discussion in the final chapter are those of the Geophysical Fluid Dynamics Laboratory in the US and of the Oceanology Institute and the Siberian Branch of the Academy of Sciences in the USSR.

Mastery of such a broad array of topics and their presentation in a balanced fashion presents a considerable intellectual challenge to the author of a modern book about climate. If the book is to be of reasonable length, the author is required to make choices about the topics included and the amount of detail that can be indulged

in with each. To prepare a book that touches on appropriate topics with a consistent level of detail requires care and personal judgement. Monin has done a good job of presenting an introduction to the elements necessary for a theory of climate. The quantitative approach is a strong feature of the book. It is clearly and authoritatively written.

There are, nonetheless, a few things that could be improved. While sketches of a number of subproblems are presented, the connections between these in the context of the climate problem are not adequately explored. Too often equations are introduced without prior or subsequent development. Sometimes solutions are given without a discussion of the significance of the result. For a book that is meant to provide an introduction to the climate problem for the working scientist, too few useful references are given that would lead the reader into the literature. Moreover, this Reidel publication is a translation of a Russian language version published several years ago. There are no references to articles published later than about 1980 and most of the references are from the mid 1970s. Much has happened in this field since then, so that the book is already somewhat out of date.

D. L. HARTMANN

Principles of Combustion. By KENNETH K. KUO. Wiley-Interscience, 1986. 810 pp. £52.70.

This book is based on the graduate lectures that the author has developed over a number of years. He remarks on the relatively small number of texts that can be used to back up courses in general combustion studies, which naturally sets one thinking about the books on one's own shelves. The three that I consult regularly are all excellent and large (in content and, in two cases, in physical volume too).

It is therefore salutory to note how well Professor Kuo's book supplements these three favourites; without detracting one iota from the excellence of the latter, one sees why he found it necessary to write it. Nevertheless, the need to cover such a wide range of disciplines from the physical sciences in order to make sense of combustion makes it inevitable that one text will not please all of the people all of the time, and certainly does not ease the task of an author in deciding what to put in and what to leave out. In its essentials this book deals with the construction of theoretical models of behaviour in, mostly, gaseous systems. The objective is to understand, and to predict, the behaviour of such systems and thence to design them. Regular calls are made on experimental information or observation in order to help with the modelling processes, but it is not a book on experimental techniques.

Just over the first quarter of the text is taken up with well-directed reviews of chemical thermodynamics, chemical kinetics and derivations and listings of the conservation equations for multicomponent reacting systems. These chapters contain a number of tables that provide important information about the magnitudes of a variety of physical quantities such as specific heats, enthalpies of formation and so on; SI units are used throughout, except that energies are quoted in calories rather than joules.

Each chapter ends with a collection of examples for the reader to tackle and there are also several examples of a more extensive kind, called projects. This style is continued throughout the book, as is the very useful habit of interpolating remarks, descriptions and comments on the mathematical or computational techniques that are being used to acquire results at that point in the text.

Evidently it is necessary to penetrate some way into the book before encountering combustion as a real process in all its rich complexity. This may give the reader the impression that one must undergo a long apprenticeship before being allowed to get to grips with real problems, and of course this is true! Whether one puts this kind of foundation material in Appendices, or 'up-front' as in the present case, is a matter of taste; the fact that it *is* there adds to the value of the text as a reference or aide-mémoire.

When the reader does meet combustion it is certainly a head-on encounter, since it arrives in the form of detonation waves. There are still no wholly satisfactory theoretical models of either detonation structure or of detonation evolution and so it is clear that there are to be no compromises here. Observations play a large role in the chapter on detonations and deflagrations. The reader can be forgiven for coming to the conclusion that explanations are plentiful and quite detailed, whilst not noticing that sound theoretical models of real events are absent, the distinction between an explanation and a theoretical model being of the essence.

From this point on the book settles into a substantial and very accessible account of a variety of topics starting with laminar flames of both pre-mixed and diffusion type. There is a long chapter on turbulent flames that is both up to date and also, incidentally, a useful dictionary that gives detailed meaning to the quite substantial jargon that (necessarily) has grown up in this particularly complex field. Multiphase flows are included through descriptions of burning sprays and combustion in fluidized beds. Ignition as a phenomenon of special importance has a chapter to itself, and there is an extensive account of the boundary-layer flow of chemically active gases.

This last fact prompts the remark that this is a book that will appeal to readers of *JFM*. The fluid mechanics is given its proper status alongside the chemistry and thermodynamics: properly so, since these matters are indivisible, a fact that is not always clear from other texts on combustion (the three already on my shelves are not guilty of this solecism). Amongst the many excellent features in the book it is a pity to find no mention of the asymptotic-analytical methods that have been and are being developed so successfully in many parts of the world. Exploitation of these ideas in studies of flame stability and chemical kinetics, and the connection that this makes with nonlinear systems theory, is a most important area of development. As remarked earlier on, you cannot please all of the people all of the time, certainly (especially?) not in combustion. These omissions do not detract from the value of Professor Kuo's account of the subject; my other three books are there to fill in the gaps, and are happily joined now by a fourth.

J. F. Clarke