

Book reviews

Cambridge Monographs on Mechanics. Topographic Effects in Stratified Flows by Peter G. Baines (Cambridge University Press, 1995). ISBN 0521435013. \$120.00.

This monograph is a comprehensive, orderly discourse on our present knowledge of the flow of stratified fluids over and around topography. The book is a significant contribution to the literature on geophysical fluid dynamics and will be an invaluable reference for students and research workers in engineering, dynamical meteorology and physical oceanography. The monograph does not address the influence of background rotation on such flows and thus the material is not directly applicable to large characteristic length-scale atmospheric (greater than tens of kilometres) or oceanic (greater than several hundred metres) motions.

The book focuses on a careful development of the theoretical underpinnings of the subject. The presentation is also rich in laboratory experimental examples of the various physical phenomena discussed. One fact that cannot escape the reader is that the author, Dr Baines, combines a mastery of the analysis involved with an outstanding facility in laboratory experimentation, a combination very rare indeed in the scientific community. While the author does provide numerous examples of observations of natural flows exhibiting the phenomena at hand, this aspect is not a central thrust of the monograph.

The basic equations of motion, including their applicability to the atmosphere, and the appropriate boundary conditions are discussed in Chapter 1. The flow of a single-layer fluid (i.e. a homogeneous fluid) with a free surface is considered in Chapter 2; applications here are related to flows in natural streams, canals and channels of various types. In Chapter 3, the effects of a second homogeneous layer surmounting the first are discussed. One example addressed is the topic of exchange flows, in which the layers are flowing in opposite directions; this is exemplified by the sudden opening of doors or windows separating air of different temperatures (i.e. densities). Chapter 4 considers the case of many layers and leads naturally to the behaviour of disturbances in continuously stratified media. In particular, the

stability of stratified flows with vertical shear is considered, with a discussion of the requirement that the Richardson number be greater than 0.25 at all levels for stability. The important topic of critical layers and critical levels is also discussed; excellent laboratory examples of the phenomena are presented.

The heart of the monograph is the material in Chapters 5 and 6. Chapter 5 considers the flow of a continuously stratified fluid over two-dimensional obstacles; in other words, flows which are independent of the coordinate along the axis of the topography. Extensive experimental results for a variety of geometries are presented, and theoretical analyses (including Long's model) are discussed. The rather good understanding of such flows is demonstrated. The dynamics of down-slope windstorms and in particular the one of 11 January 1972 (near Boulder, Colorado) are considered in some detail.

Chapter 6 discusses the flow over three-dimensional topographic features. This configuration offers a number of new phenomena compared with the two-dimensional case in that now the flow can go around as well as over the topography. Numerous examples of atmospheric lee waves and vortex streets forced by mountains are presented.

Chapter 7 discusses the similarity criteria for the physical (laboratory) modelling of atmospheric flows in complex terrain. Finally, the material presented earlier is used to describe the means whereby subgrid-scale orographic effects can be parametrised in global weather forecasting models.

This monograph will be an important reference for many years to come for students and researchers concerned with the effects of stratification on flows in complex terrain. The scientific community will eagerly await the possibility of Dr Baines writing a similar monograph on the effects of topography on stratified flows but also including the effects of background rotation. Dr Baines is to be congratulated for this very fine piece of work.

Don L. Boyer

Don Boyer is Professor and Chair of the Department of Mechanical and Aerospace Engineering at Arizona State University.

Atmospheric Ozone as a Climate Gas: General Circulation Model Simulations edited by W.-C. Wang and I.S.A. Isaksen (Springer-Verlag, 1995). ISBN 3-540-60009-4. DM278.

Only relatively recently has it become clear that observed ozone layer depletion might significantly affect global climate, both through direct radiative feedback and through chemical coupling between ozone and other greenhouse gases, so producing an indirect radiative feedback. To address this concern, several international workshops have been conducted during the 1990s with the focus on ozone as a climate gas. This book summarises the work of one such NATO workshop, held in Lillehammer, Norway, in June 1994. The objectives of the workshop were to document current knowledge about atmospheric ozone and its impact on climate, to discuss the scientific issues concerning chemical and climate aspects of ozone, and to identify the research needed for developing coupled chemistry-climate models. The book does a good job of recounting what must have been a very worthwhile workshop.

As was the workshop, the book is divided into two parts: the scientific presentations (Part 2), and working group recommendations on four topics (Part 1), these being (i) upper tropospheric/lower stratospheric climatology, (ii) chemical transport modelling, (iii) global climate modelling, and (iv) issues relevant to the development of coupled chemistry-climate models.

Part 1 commences with the climatology session summary (chair: V. Mohnen) which examines the global observational requirements for documenting changes in the vertical distribution of upper tropospheric and lower stratospheric ozone. It discusses requirements for ozone sonde, lidar and UV-B networks, aircraft and satellite measurements, what is needed for lightning climatology and emission quantification and for the detection of trends in stratosphere-troposphere exchange.

Next follows the chemical modelling session summary (chair: O. Hov), which deals with the issues perceived to be of most importance for improving chemical modelling capabilities, and the observational and laboratory studies required to resolve them. It considers subgrid-scale transport, heterogeneous chemistry, the chemistry of the oxides of nitrogen, the hydroxyl and perhydroxy radicals and the hydrocarbons, chlorine and bromine-catalysed lower stratospheric ozone loss, liquid phase ozone chemistry, and the representation of radiative transfer. Because this

section relates the modelling uncertainties to the observational and laboratory study requirements for resolving them, it comprises a very useful overview.

A rather brief summary of the climate modelling session (chair: H.-F. Graf) considers issues to do with radiative forcing (our ability to calculate the radiative forcing due to ozone changes, given limited knowledge of those changes, and the utility of the concept of radiative forcing), subgrid-scale parametrization of physical processes such as stratosphere-troposphere exchange, and so-called simulation aspects, which include chemical and dynamical feedbacks and the current inability of climate models to mimic the atmosphere's interannual variability.

Perhaps the pick of the crop, the final session summary (chair: J. Penner) deals with the issues relevant to the development of coupled chemistry-climate models. It identifies the variables to be included in interacting chemistry-climate models and the current problems with stand-alone GCMs and chemical transport models (CTMs). It notes the regions where consistency between GCMs and CTMs is important, outlines a strategy for assessing error propagation in coupled models, and proposes a number of near-term projects aimed at both assessing the importance of coupling in the chemistry-climate system, and identifying those areas where problems are likely to arise.

Part 2 contains 25 papers presented at the workshop. While most of these deal with only one of the above four topics, several address two or more. A crude breakdown reveals about a dozen dealing with ozone climatology, a similar number with climate modelling, somewhat less with chemical modelling, but only a few which consider coupled models. Most of the modelling papers are well worth reading. Perhaps the most informative of the remainder are those by De Muer et al. on an analysis of Uccle ozone sonde data, Mohnen on challenges in tropospheric ozone, Ravishankara on laboratory chemistry and Stolarski et al. on satellite ozone trends. In all they comprise a useful collection, although naturally these workshop papers tend to be updates or reviews, rather than reports of substantially new science.

Overall, the book largely satisfies the workshop's stated objectives. Being a product of a NATO workshop, it understandably lends a somewhat European perspective to the issues, but this serves to provide a good feel for the scope of relevant activities underway in Europe, and for the status of individual modelling endeavours at a number of the national centres. Of the papers presented, perhaps there is a larger proportion dealing with ozone observations than a modeller would prefer to see, but the collection is quite well balanced from a generalist's perspective, and puts

into a broader context the modelling issues covered at the workshop. The book is a good source of references on the topics covered, and while the information presented is no doubt perishable, it is still well short of its 'use by' date.

At 278 DM (say 250 AUD) not many will want to obtain a personal copy, but given the increasing interest in the subject, it is a worthy purchase for any dedicated atmospheric sciences library, and it is certainly worth reading if you are either a

specialist in the field, or a generalist in search of a very readable account of the state of the art in modelling ozone as a climate gas, and where the field is heading.

Roger Atkinson

Roger Atkinson has spent the last ten years in ozone monitoring and research. He currently shares his time between the Ozone Science Unit of the Bureau of Meteorology's Atmosphere Watch Section and the Ozone Program of the Cooperative Research Centre for Southern Hemisphere Meteorology, Melbourne.