

Book reviews

Flow and Transport in the Natural Environment: Advances and Applications, edited by W.L. Steffen and O.T. Denmead (Springer Verlag 1988) ISBN 3 540 19452 5. Pp 384, DM120.00.

This volume is a Proceedings from the International Symposium of Flow and Transport in the Natural Environment which was hosted in Canberra in September 1987 by the CSIRO Division of (now Centre for) Environmental Mechanics to celebrate the opening of the second stage of its headquarters, the F.C. Pye Field Environment Laboratory, twenty-one years after the opening of the first stage.

The Symposium, and this volume, are somewhat unusual from a couple of points of view. First, the subject matter, though linked by the common theme evident from this title, is rather broader than that of the specialist conferences we are used to attending these days. In fact, the scope of the material covered was predetermined essentially by the research activities of the host Division. Broadly, these areas are flow and transport in soils, (vegetation) canopy transport processes and micrometeorology. Second, the format was fixed fairly rigidly, with a series of invited review papers (featuring scientists from the Division, but also including contributions from a number of overseas scientists), most of which were followed by an invited commentary paper. The review papers are generally pretty well what one would expect: up-to-date overviews of the chosen topics. On the other hand, the commentaries fulfil several purposes and so are potentially more variable in content. The commentators were intended to invite and lead discussion on the main review paper, to provide an overview of poster papers (the only form of uninvited contribution) related to the review topic and were also allowed to some extent to 'push their own barrow'. In general, input from the poster sessions tends to end up hidden within the commentaries, perhaps partly due to the editorial policy of trying to avoid reference to the poster contribution itself, and partly because of the natural tendency on the part of the commentators to have their contributions prepared before hand. As a result, what was a significant part of the Symposium makes no real impact on the Proceedings.

Because of the breadth of the material covered it is difficult for me to comment in detail on the quality of the reviews and commentaries so I shall

confine myself to some brief impressions of the major review papers.

There are five papers relating to flow through permeable media, mainly soils. That by Jury on solute transport and dispersion highlights the recent recognition of the limitations of the diffusion equation approximation and the move towards more general stochastic theories which parallels similar trends in the treatment of turbulent transport. Philip's paper on analytic approaches to unsaturated flow deals, on the other hand, with the more classical mathematical problems of solving a strongly non-linear diffusion equation. He emphasises the importance of analytic solutions in gaining understanding of the fundamental structure of the flow. These papers are followed by White's review of the field measurement of the physical properties of soil, in which he emphasises the problems due to spatial variability and the difficulty in selecting an appropriate length-scale on which to make the measurements. Later in the volume, Rose and Hairsine review the processes of water erosion, a slightly different aspect of soil water transport. This is followed by a paper by Smiles and Kirby essentially applying the analytic theory of soil water flow to filtration processes.

Moving above ground, there are three papers reviewing processes at the interface between the soil and the atmosphere. Raupach deals with properties of the turbulent flow within the canopy and the implications for the transfer of scalars and momentum. Again the emphasis here is on the recognition of the importance of coherent structures and the consequent failure of gradient transfer concepts. The paper by Jackson covers attempts to evaluate and verify the surface energy balance on a regional scale through satellite remote sensing. He concludes that at present remote sensing does not adequately account for fluxes over areas with partial canopy cover. Finally in this group, there is the paper by Cowan which deals with the connection between plant (stomatal) physiology and gas exchange (including water vapour).

The final group of papers deals with flow and transport in the atmospheric boundary layer. Finnegan examines the effect of topography on the mean flow and turbulence in the boundary layer, concentrating on the near-surface flow where shear dominates thermal effects. Wyngaard on the other hand reviews the convective boundary layer, where persistent large-scale coherent structures dominate the turbulence. He points out that this structure has important implications for scalar transport, leading again to the breakdown

of gradient transfer ideas. Research on wakes and drag behind surface-mounted obstacles and hills in the boundary layer is reviewed by Taylor. There are two papers dealing with transport processes in the boundary layer. That by Willetts treats particulate transport and soil erosion, while Weil gives an overview of recent advances in understanding and modelling plume dispersion.

Overall, the volume represents an interesting and wide-ranging collection of papers. The material covered, although presently up-to-date will inevitably be superseded, and I think most individuals will be content to make use of a library copy.

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Lectures on Air Pollution Modeling, edited by Akula Venkatram and John C. Wyngaard (American Meteorological Society, Boston, 1989). ISBN 0 933876 67 X. Pp 390, US\$45.00.

This book is based on the 'Short Course on Air Pollution Modeling' held in San Diego, California 17-21 March 1986 sponsored by the American Meteorological Society. The Introduction by John Wyngaard defines the field: the physics and application of air pollution modelling on scales up to about 50 km.

The course is said to have arisen from the frustrations felt by Dr Akula Venkatram that his field as a whole was not advancing as it should. The field was failing to respond to the times: new understanding of the physics of the lower atmosphere and of dispersion within it needed to be applied more widely in air quality modelling. What better way to help rectify this than to bring together leaders in the subject and have them present their insights and demonstrate how this understanding can be used to solve practical problems.

The result is a book of considerable success. While it is a specialist's book it is not solely of interest to the dispersion modeller. The student of the planetary boundary layer, particularly the daytime convective layer, will find rich material here. If read in conjunction with the collection of papers published in *Journal of Climate and Applied Meteorology* in 1985 (vol. 24, no. 11 November 1985, pp. 1111-1207: Workshop on

Updating Applied Diffusion Models) the student will be accessing most of the modern understanding of dispersion in the lower atmosphere.

There are eight chapters (lectures) in the book, all of interest. The first 'Structure of the PBL', is by the master of the field, J.C. Wyngaard. It is insightful, personal and helpful in bringing together aspects relevant to the dispersion modeller.

Chapter 2, 'Analysis of Diffusion Field Experiments', is by G.A. Briggs who is best known for his work on plume rise. Over the past several years, however, he has concentrated on dispersion, with an interest in testing the laboratory results of Deardorff and Willis in the field. The chapter discusses the applicability of scaling laws, earlier descriptions of dispersion, and presents recommended procedures founded on measurements, which can be applied to practical dispersion problems. The emphasis is naturally on convective conditions since it is in these conditions that the greatest advances have been achieved over recent years.

The next two chapters are by the important and influential practical dispersion modeller, J.C. Weil: 'Plume Rise', and 'Dispersion in the Convective Boundary Layer'. I think it is these two topics in particular that would have motivated Dr Venkatram most strongly. Despite advances over the past twenty years in these areas, some agencies and consultants continue to use the formulae of Bosanquet and others which were empirically derived for conditions vastly different from most of present practical interest. As discussed by Jeffrey Weil, plume rise is now founded on a good theoretical basis. He spends most space discussing plume penetration of elevated inversions and the effects of ambient turbulence on final rise. It is clear that more work needs to be done on the latter in convective conditions.

Of much interest in the second chapter by Dr Weil is a description of how understanding of dispersion in the convective boundary layer can be cast into a practical form which is little different from the familiar Gaussian plume equation. The discussion is perhaps too simplified but more detail is available in other publications.

Chapters 5 and 6 are by Dr Akula Venkatram: 'Dispersion in the Stable Boundary Layer', and 'Topics in Applied Dispersion Modeling'. The first is simply too brief. This may reflect more on the relative lack of progress with the topic, or it may be just that the author has made a personal selection. The latter chapter is a collection of a few favourites: a simple, practical approach to dispersion in a shear-dominated boundary layer (actually, in chapter 5, not 6); modelling dispersion in the coastal boundary layer, which includes a laborious derivation of the height of the thermal internal boundary layer; and a discussion of dispersion in complex terrain, including a readily followable presentation of the WRAP and LIFT

models for plume impingement and flow over isolated terrain features which were developed by the author. The chapter concludes with a discussion of uncertainty in modelling dispersion in the atmosphere.

'Concentration Fluctuations in Dispersing Plumes', by R.I. Sykes discusses Gifford's fluctuating plume model, statistical two-particle models, and the probability distribution of the concentration field. A brief review of applications concludes the lecture. This is a rapidly advancing topic and the reader would do well to consider the most recent literature using the chapter as a solid introduction.

The final chapter is 'Concentration Fluctuations Within a Laboratory Convectively Mixed Layer', by J.W. Deardorff and G.E. Willis. These authors, by their careful laboratory simulations and analyses of convection experiments, have been instrumental in most of the advances in boundary-layer meteorology since their first paper on the subject in 1974. This chapter, probably the last publication by the authors together since both have now retired, appears to be all new material on a topic that is assuming increasing importance. Air quality agencies are slowly

coming to grips with the need to consider not the highest or second highest pollutant concentration as a licensing or regulatory goal — this is virtually impossible to predict by our modelling approaches — but rather to express goals in terms of probabilities of occurrence. This acknowledges the observation that peak values may exceed a mean by an order of magnitude or more. Data on the intermittency of the turbulence, dispersion and concentrations are needed and this chapter makes some progress.

Overall then, this is a book I highly recommend to people involved in atmospheric dispersion. I think it will succeed in its aim of raising the standard of dispersion modelling. The book says nothing about dense-gas dispersion, dispersion in wakes and a number of other topics. However the subjects that are covered are generally very well done, and are easily read. The book will prove to be a useful reference for years to come.

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