J. Fluid Mech. (2003), *vol.* 478, *pp.* 344–345. © 2003 Cambridge University Press
Printed in the United Kingdom

BOOK REVIEW

Turbulent Flow: Analysis, Measurement and Prediction. By P. S. Bernard & J. M. Wallace. Wiley, 2002. 1999. 497 pp. ISBN 0 471 33219 4. $100.00 or £69.95 or €111.20

J. Fluid Mech. (2003), *vol.* 478, DOI: 10.1017/S0022112002003464

Several books on turbulence have appeared over the last few years, and in most cases publication of the author's name was unnecessary because it could be guessed from the contents. Authors are, of course, allowed a point of view, but it is amazing how many different, nearly orthogonal, points of view there are about a phenomenon which is governed by Newton's innocent-looking, linear second law of motion, with a little help or hindrance from viscosity. One thing is certain: turbulence is not 'the last great unsolved problem of classical physics': Navier and Stokes converted it to a problem in arithmetic and today it is a problem in computer design. However, since the last-named problem has not been solved – present-day computing power restricts Direct Numerical Simulations to low Reynolds numbers and simple geometries – turbulence studies are driven by the need to produce simplified prediction methods for engineers and earth scientists. The three main branches of these studies are listed as the subtitle of this book.

The two authors have somewhat different areas of interest in turbulence, and the book has been constructed from material from two different, but complementary, graduate courses at the University of Maryland. 'Constructed' is meant as a compliment: the book is not just two sets of lecture notes shuffled together. The contents are in general what one would expect – chapters on the main types of turbulent flow, on the analysis of homogeneous turbulence (sheared or unsheared), and on Reynolds-stress modelling. The treatment seems to me to be excellent: for example there is a very judicious discussion of the relative merits of the logarithmic law and the newly resurrected power law for describing the inner layer of a wall flow. One chapter that does not quite come off is the combined discussion of experimental and numerical methods: indeed the product of the two is the same, but there is no useful analogy between the techniques. As is required of a modern textbook, there is a (40 page) chapter on large-eddy simulation, including a careful discussion of the main obstacle to industrial use of LES, the difficulty of treating the near-wall region where there *aren't* any large eddies. The meteorologists, who invented LES, generally assume a value for the coefficient of surface shear stress based on the velocity at the first mesh point from the surface, but neither this nor its near-equivalent the 'instantaneous log law' will give engineering accuracy. There is a welcome emphasis on transport of scalars, which is at least as important in engineering and the earth sciences as momentum transport as such. Two complete chapters are devoted to the subject and there are many references to it throughout the book.

Chapter 12, the last, is titled 'Turbulence Theory'. One cannot hope for an exact theory of turbulence that is simpler than Newton's laws, so what is meant here is any turbulence model based on mathematical, rather than empirical, assumptions. As the authors say, these models are confined to the small-scale, nearly-but-not-quite-universal, motion. Therefore their relevance to prediction of the larger, Reynolds-stress-carrying, eddies is doubtful. Even the dissipation transport equation, when it appears in an engineering turbulence model, is modelled as if it represented the rate of energy transfer from the large eddies – which it does: unfortunately the authors do not mention this rather important point.

The book is well produced, as one would expect from Wiley, and by current standards the price is reasonable for a 500-page book with many illustrations. The misprints are trivial and the only serious slip-up is that figure 4.26(b) appears twice, once labelled 4.26(a): since the shape of the plots in 4.26(b) is compatible with one's expectations of 4.26(a) this is mildly disorienting.

Of the recent books on turbulence, this is probably the best for classroom use or private study. But may it be long before DNS becomes the standard method of predicting turbulence; because the present mix of 'analysis, measurement and prediction' is what the second author in his dedication calls "so much fun".

P. Bradshaw