**Book Review**

*Turbulent Flows*
by Stephen B. Pope
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Reviewed for *Geophysical and Astrophysical Fluid Dynamics*
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Prof. Stephen Pope, an engineer at Cornell University, has written an excellent text for graduate students that will also serve experts well. His book is obviously the result of years of reflection on the problem of turbulent flows, and he has also given much attention to the organisation of the book and how to make it accessible to students. The book is divided into two parts: 'Fundamentals' and 'Modelling and Simulation'. Each is broken up into easily digestible morsels: the first part begins with a quick overview of what features turbulent flows may have, and quickly moves to the fundamental equations of fluid dynamics. Pope then reviews basic concepts of probability theory as applied to turbulent flows, followed by the Reynolds decomposition and a derivation of the mean-flow equations. There is also a nice chapter on the scales of turbulent motion. The rest of the first part is devoted to phenomenology, with one chapter on turbulent jets and another on wall-bounded flows.

The second part is the meatiest, and is devoted to the most popular types of closure models and ways of simulating turbulent flows: DNS, turbulent-viscosity, Reynolds-stress-based closures, PDF methods, and large-eddy simulations. Not surprisingly, the chapter on PDF methods is one of the best, as Prof. Pope is in large part responsible for their development and popularisation. Reactive flows are only treated in passing (though they are Pope's specialty), but this is fine for an introductory book, and also is less relevant for GAFD's readership. Pope does a wonderful job at always keeping in mind the merits of each model, and also clearly defines the criteria that should be used for applicability.

From the point of view of physicists, the book will appear somewhat anomalous. They will not find in it lengthy discussions of that workhorse, homogeneous turbulence (though it and its isotropic cousin are introduced); deviations from the Kolmogorov spectrum are not discussed; and two-dimensional turbulence gets no special treatment. It is just not that kind of book. As an engineer, Pope is less interested in the microstructural features and nonlinear genesis of turbulence and more in deriving tractable equations, that is, closures for the mean flow equations. His comment on coherent structures illustrates the point: “The mind imbued with Newtonian mechanics seeks simple deterministic explanations of phenomena. Only in a very limited sense can coherent structures 'explain' the behavior of near-wall turbulent flows. [...] The goal of developing a quantitative theory of near-wall turbulence based on dynamical interaction of a small number of structures has not been attained, and is likely unattainable.” (p. 323). Perhaps, but also it may be that physicists have always had a lower standard for what is 'attainable,' as even a qualitative understanding of some features of turbulence is better than none at all, though it may be of little use to engineers. Neither does Pope seem to put much faith into fashionable Proper Orthogonal Decomposition (POD) techniques, briefly reviewing the concept but reiterating his doubts.

The book is complemented by a very nice index, an author index, and a serviceable bibliography (which does not claim to be exhaustive). Particularly agreeable is the 14-page index of notation, subcategorised into roman, greek, etc. In such a vast book, this is a life saver. Students might appreciate the exercises at the end of each section (which usually further develop a section's theme), and will certainly be thankful for the ten appendices reviewing basic (mostly mathematical) concepts (Dirac delta function, characteristic functions, diffusion processes...). This reviewer only wishes that every author was as thoughtful as Pope when producing textbooks.