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ATMOSPHERIC DYNAMICS

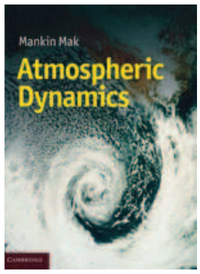
Mankin Mak, 2011, 500 pp., $80.00, hardbound, Cambridge University Press, ISBN 978-0-521-19573-7

This new textbook is a self-contained course on atmospheric dynamics, with a special emphasis on connecting the theoretical and observational aspects of the subject. The first five chapters are suitable for use as an introductory undergraduate course on atmospheric dynamics, and the later chapters are aimed at advanced students. The book’s underlying premise is that students often find the connection between theoretical dynamics and atmospheric observations somewhat tenuous. Elucidating this connection is a fine aim, and the book achieves it admirably. The reader will find many plots of observational data, each interpreted expertly by the author in the context of the relevant basic dynamical concepts and theory.

The author is well qualified to have written this book, having published widely and served as an editor of the *Journal of the Atmospheric Sciences*. He is now an emeritus professor in the Department of Atmospheric Sciences at the University of Illinois, and the contents of the book have developed from his many years of teaching there. Questions and exercises relating to the book chapters are available for download from www.cambridge.org/mak. Helpfully, full solutions are also available for authenticated lecturers.

A distinguishing feature of the book is that it focuses almost exclusively on the dynamics (and not the physics or numerical modeling) of the lower atmosphere (and not the middle atmosphere or upper atmosphere). Thus, consideration of topics such as radiative transfer, atmospheric chemistry, and cloud physics is either absent or minimal, as is consideration of the stratosphere and the higher atmospheric layers.

It is this tight subject focus that helps to set the book apart from the classic texts with which it will have to compete, such as those by Andrews, Holton, and Leovy (1987); Houghton (2002); and Holton (2004). The restriction of subject is not unreasonable, because tropospheric dynamics is a substantial topic on its own. However, the book would perhaps have benefited from the inclusion of sections on climate change and high-end numerical modeling. Topics such as these feature sufficiently prominently in contemporary atmospheric dynamics to have warranted some limited coverage, in my view. Also, discussion of the Rhines scale merits only a single paragraph in the book, and does not really address anisotropic zonal jet formation in the presence of the β-effect. This treatment seems too lean for such an important concept.



The scientific writing is generally clear and informative. Colorful metaphors are used rarely, but effectively, and they often involve some form of racing analogy! For example, in the commentary accompanying an instability analysis, we learn that “the constituent waves intensify as in a horse race” (pages 257–258). The differences between modal growth, transient growth, and optimal growth are explained using a track-and-field metaphor as follows (page 225):

> Intensification of an ensemble of disturbances according to their modal growth is like a marathon race in which the most unstable mode would be the eventual winner. Transient growth of a particular disturbance is more akin to sprint [sic]. Optimal growth is what one might call an intermediate distance race favoring the runner who has special ability [sic] for a specific distance.

A fascinating paragraph speculates on why the research community took so long to reach the current understanding of baroclinic instability (page 226). The possible reasons listed are that this particular instability is rather subtle; that it has several different aspects that could not be delineated in one go; and that gravity waves, which we now know to be superfluous and which we would filter out by using quasigeostrophic theory, greatly complicated the mathematical stability analysis.

The material in the book is generally well presented and illustrated. Costs have been kept low by using black-and-white figures, with eight pages of color figures bundled together in the middle of the book. Chapter 8, on instabilities, is very long and could perhaps have been split up into separate chapters to improve the readability. I found a small number of very minor scientific errors. For example, there is a missing prime in a $u'v'$ term in equation 4.8 (page 92). Also, the Reynolds number is defined to be the acceleration divided by the viscous force (pages 88 and 89), but strictly this definition should be scaled by a mass in order to obtain the correct dimensionless Reynolds number.

My main complaint about the book is that it does not appear to have been checked by a competent proofreader, if at all. Grammatical errors and peculiarities abound throughout the text. For example, the subject and verb frequently do not agree in number, as in "an extratropical cyclone which have scales $V = 10$ m s^{-1} and $L = 10^6$ m" (page 89). The definite and indefinite articles and possessive apostrophe are frequently missing, as in "Frictional force continually destroys kinetic energy . . ." (page 97); ". . . is known as Kelvin circulation theorem . . ." (page 60); and indeed twice in the track-and-field quotation above. Furthermore, we are told repeatedly that a quantity "conserves" instead of "is conserved," and that it "would conserve" instead of "would be conserved," and we are told the condition "for it to conserve" instead of "for it to be conserved" (pages 72, 141, 167, 190, 194, 207, and 214).

The widespread presence of grammatical errors is unfortunate, because the scientific content of the book is excellent. Although the errors are a relatively minor nuisance, they interrupt the flow of the book and they reduced the enjoyment I derived from reading it. It is clear that the blame for the errors must lie with the publisher for failing to have the text proofread adequately, and not with the author, who is a nonnative English speaker. In summary, although I would ultimately recommend the book wholeheartedly based on its scientific content, the recommendation comes with the caveat that careful users of English might be disappointed by the quality of the writing.

Incidentally, in an appendix on mathematical tools, the author wonders if there is an analytic expression for the trajectory of a dog chasing a postman. Starting from particular initial positions, the postman walks in a straight line and the dog always aims directly at him. There is indeed an analytic expression, and it is obtained by solving a second-order ordinary differential equation using the separation-of-variables technique. The solution is $x = a\,y^{3/2} + b\,y^{1/2} + c$, where $a \approx 0.11$ m$^{-1/2}$, $b \approx -3.04$ m$^{1/2}$, and $c \approx 11.05$ m.

—Paul D. Williams

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FOR FURTHER READING

Andrews, D. G., J. R. Holton, and C. B. Leovy, 1987: *Middle Atmosphere Dynamics*. Academic Press, 489 pp.

Holton, J. R., 2004: *An Introduction to Dynamic Meteorology, Volume 1*. Academic Press, 535 pp.

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