Book review

An Introduction to Dynamic Meteorology (Fourth Edition) by James Holton (Elsevier Academic Press, 2004). ISBN 0-12-354015-1, CD-ROM ISBN 0-12-354016-X, 535 pp, $140.80.

Since the first edition of James Holton's *An Introduction to Dynamic Meteorology* in 1972, it has become one of the standard introductory texts on dynamical meteorology for students at the senior undergraduate and early postgraduate levels. The book was substantially rewritten for the second and third editions, but the text of the fourth edition does not differ much from that of the third edition. The main change in the new edition is the addition of a compact disk containing exercises and demonstrations utilising the MATLAB package. This is a useful addition and contains some insightful animations.

To test the book's claim as an introduction, I imagined reading the text without prior meteorological knowledge. This was to see whether the arguments were sufficiently comprehensible for someone with a basic understanding of physics and mathematics to teach themselves dynamical meteorology. I think Holton passes the test as well as can be expected from a single book. In fact, Holton's is one of the few books that does not merely deduce the physics from the equations, but attempts to fully explain what the equations are saying, turning each important equation into a story. In some cases, I feel the arguments are not completely convincing, or include limiting caveats, but the very attempt to give a full explanation distinguishes this book from the plethora of texts on dynamical meteorology.

The book mostly follows a logical pattern, beginning with the formulation of the primitive equations in a rotating reference frame. Holton develops the different topics in the coordinate system he thinks most appropriate. Height, pressure, and the logarithm of pressure are all used as vertical coordinates at various stages, with the Boussinesq approximation used extensively to simplify problems later in the book when using height coordinates. The vorticity equation is treated early in the book in preparation for quasi-geostrophic theory, which is used as a basis to explain extra-tropical cyclogenesis. Later in the book, a two-layer model is also used to examine this topic.

I have always found it problematic to know where to position the topic of the planetary boundary layer in a course on dynamical meteorology. Holton sandwiches it between the chapter on the vorticity equation and the chapter on quasi-geostrophic theory. I felt this was a poor choice because it broke up the natural flow of topics. Further, Holton's approach to turbulence is basic; there is no attempt at Monin-Obukhov similarity theory, and no discussion of practical applications.

Following quasi-geostrophic theory, Holton moves on to linear perturbation theory and a study of the various types of atmospheric waves. Holton does a generally good job of explaining physically how different types of waves manage to propagate cohesively. Semi-geostrophic theory is introduced to analyse frontal dynamics in the chapter on mesoscale circulations. Some of the topics in this chapter, such as flow over orography, severe storms and tropical cyclones, appear to be perfunctorily treated. After a long chapter on the difficult topic of the dynamics of the general circulation of the atmosphere, Holton tackles tropical dynamics, including equatorial waves using a standard shallow-water approach. There is a chapter on middle-atmosphere dynamics in which some interesting stratospheric and mesospheric phenomena are tackled. These include sudden stratospheric warmings and the quasi-biennial oscillation. The final chapter of the book is on numerical modelling. I felt this chapter was a weak point in the book with a rushed approach. For example, there is less than a page devoted to physical parametrisation, and Holton only touches on the extremely important topic of data assimilation.

The layout of the book is of a high standard: diagrams are clear and well-labelled; problems, MATLAB exercises and references are given at the end of each chapter, and there is a manageable bibliography. Answers to selected problems are included. One obvious criticism from an austral perspective is that Holton neglects the southern hemisphere by using the terms positive and negative to describe vorticity, rather than cyclonic and anticyclonic. Holton also refers to flows as moving southward or northward when equatorward and poleward would apply to both hemispheres. From a personal perspective, I feel Holton does not give the breakdown of the ageostrophic wind into its various components the detail and depth I feel this topic warrants. The other conclusion that comes to mind is that Holton is much stronger and more detailed in dealing with larger scale phenomena than smaller scale ones.

Overall, I would highly recommend this book as an introduction to dynamical meteorology but suggest that extra reading on turbulence, mesoscale circulations and numerical weather prediction might be needed to supplement it.

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