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REVIEW

An Introduction to Dynamic Meteorology. By JAMES R. HOLTON. 2nd edn. Academic Press, 1979, 391 pp. $22.00.

Substantial advances in our understanding of the larger scales of atmospheric motion have been made over the past thirty or so years. The formulation of the quasi-geostrophic approximations to the governing equations has led to both a clear theoretical picture of the development of transient mid-latitude weather systems and a qualitative understanding of the time-averaged circulation of the extra-tropical troposphere and stratosphere. Parallel advances have been made in tropical meteorology. On the more practical side, the same period has witnessed the development of numerical modelling, both for weather prediction and the simulation of climate.

An introduction to the resulting theory of dynamical meteorology is to be found in Professor Holton's book. The first edition appeared in 1972 and set out to present the current status of this theory in a form largely suitable either for final-year undergraduate students, or for post graduate students entering the subject with no formal background in meteorology. Quasi-geostrophic theory provided, where possible, a central unifying theme. The success of the author's approach is evidenced by the widespread popularity of the first edition as a teaching aid and reference work, and the appearance within seven years of a second edition which comprises a refinement (albeit involving a rewrite of nearly 50 % of the text) rather than a major reorganization of the first.

The opening four chapters introduce the necessary basic fluid dynamics and elementary meteorology. The major theme is never far from the discussion, the derivation of each fundamental equation being followed by a scale analysis using typical observed values for synoptic-scale mid-latitude waves. While this approach fails to reveal the interdependence of the various scaling approximations which features in a formal derivation of the quasi-geostrophic system, it does provide perhaps the easiest of introductions for the student. Indeed, the overall presentation of the introductory material is commendably clear, and enhanced, as is the whole of the text, by the inclusion of numerous problems of various degrees of difficulty.

An account of the planetary boundary layer is followed by a good central chapter entitled 'The Dynamics of Synoptic Scale Motions in Middle Latitudes'. This includes a description of the observed structure of these motions, completion of the derivation of the quasi-geostrophic system including a discussion of the omega equation, and an application to an idealized model of a developing baroclinic system. A more elementary and formal chapter on linear wave theory follows.

The next chapter, on numerical prediction, is disappointing. Much of the discussion concerns filtered models, and the space spent on the solution of the barotropic vorticity equation, including a detailed treatment of relaxation techniques, seems inappropriate. The primitive equations are introduced, but as in the first edition it is written that 'time steps in primitive equation forecasts must be considerably shorter than those allowed for a quasi-geostrophic model with equal horizontal resolution'. Efficient integration techniques render this statement incorrect, and have not been

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shown to cause any significant deterioration in forecast quality. In contrast with the rest of the book the overall treatment here seems rather dated.

The topic of baroclinic instability reappears in the next chapter, which begins with a stability analysis for the two-level model. It is a matter of personal preference whether such a model is more suitable for an introductory text than that proposed originally by Eady, but the lack of any reference to the latter is surprising. The presentation is nevertheless generally clear, and followed by a useful discussion of the balances of temperature and vorticity in the growing wave. Sections on the energy balance and on frontogenesis are also included.

An account of the general circulation follows. The dynamics of zonally symmetric circulations are very well described and good introductions to laboratory and numerical modelling are given. There is, however, no discussion of the mechanisms by which orography and diabatic heating force the climatically important quasi-stationary perturbations of the circumpolar circulation. The essential qualitative results of the classical studies by Charney & Eliassen and Smagorinsky, may be presented in terms of the quasi-geostrophic concepts introduced earlier in the text, and their inclusion would have complemented the discussion of transient-wave development. Quantitative aspects of the theory are, on the other hand, still far from certain, and the author's passing association of the Asian and North American winter jets with a purely thermal mechanism seems premature.

The final chapters provide short accounts of stratospheric dynamics and tropical meteorology. The quality of the discussion here reflects the important contributions to research and teaching that the author has made in these fields, succinct accounts being given of some quite recent theoretical developments. A number of useful appendices complete the book.

Overall, the careful presentation of introductory material and clear discussion of dynamical principles make this an excellent basic account of dynamical meteorology. The ordering of material is perhaps lacking in formality, but is suited to the reader keen to encounter some meteorology as soon as is practical. The success of the first edition was well deserved, and the second edition should prove equally popular.

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