animal's physiological control systems can operate. These chapters synthesize the old and new literature. The authors point out many questions that remain to be answered, such as those concerning periodic arousals from hibernation, the mechanisms inducing hibernation, the responsiveness of the hibernating animal to external stimuli, circadian rhythmicity during torpor, and the control of thermogenesis and the distribution of heat during arousal. Important literature on circadian rhythmicity during torpor has been overlooked in these chapters, and there is no treatment of circannual rhythmicity. All in all, however, the chapters provide an excellent overview of major issues in the physiology of hibernation.

Chapters 8 and 9, by Willis, cover an enormous literature on cellular and biochemical adaptations associated with hibernation, and they reveal the lack of general and unchallenged conclusions on the subject. Perhaps broad generalizations are the exception rather than the rule at the cellular and biochemical level, for very different solutions to the problems of functioning at low temperature may have evolved in different species. However, some variability in experimental observations may result from technical difficulties in isolating components of the integrated hibernation physiology in vitro. It is difficult to interpret which differences in results are a consequence of culture and assay and which are true evolutionary differences. Willis comments that in interpreting the results of in vitro work "one must erect a framework in the context of which the isolated observations may achieve relevance, hoping meanwhile that the structure thus erected does not turn out to be a hanging scaffold." The control of brown fat metabolism, a subject on which major progress has been made in recent years, is not discussed.

In chapters 10 and 11 Lyman presents some interesting but more peripheral and seldom reviewed literature on cell cycles, aging, and resistance of the tissues of hibernating animals to disease, parasites, radiation, and malignancy.

In chapter 12 Wang comprehensively reviews endocrine mechanisms associated with hibernation. The hypothalamic-pituitary axis is very much involved in hibernation physiology and should be studied in detail. It is remarkable that so little study has been devoted to the relationship between reproductive endocrinology and hibernation, for the reproductive cycle and the hibernation cycle appear to be tightly linked.

Chapter 13, on respiration and acid-base state in hibernation, is a wonderfully clear treatment by Malan of a difficult subject. In addition to reviewing the literature Malan clearly and convincingly relates his hypothesis that a self-induced acidosis may play an important role in the inhibition of cellular metabolism during hibernation and a direct role in resetting the thermoregulatory system.

The concluding chapter, on recent theories of hibernation, is a provocative and critical discussion by Lyman of various attempts to synthesize explanations of the evolution and the mechanisms of hibernation. The exciting and controversial work on hibernation "trigger" is examined closely.

This book is an excellent progress report on hibernation research and sets before us a future agenda. But it makes one realize that at least another generation of researchers will have to match the wide-ranging contributions of Lyman before the conclusive book on mechanisms of hibernation can be written.

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Cloud Processes

Cloud Dynamics. Proceedings of a symposium, Hamburg, Aug. 1981. E. M. AGEE and T. ASAI, Eds. Terra Scientific Publishing, Tokyo, and Reidel, Boston, 1982 (distributor, Kluwer Boston, Hingham, Mass.). viii, 424 pp., illus. $49.50. Advances in Earth and Planetary Sciences.

This book is intended to serve "as a brief introduction to the study of cloud dynamics with primary emphasis on current international research efforts," and despite the drawbacks of such multiauthored volumes one must regard it as meeting this somewhat limited goal pretty well.

The book is divided into two sections, on shallow convection and deep convection, and each section has an introduction by Agee. In the section on shallow convection, he reviews the classical results of the laboratory experiments of Benard and the subsequent theoretical treatment of Rayleigh and some of its more modern refinements. Agee then illustrates various types of shallow convection in the atmosphere with radar and satellite observations. The review will probably be difficult for the nonmeteorologist because it contains a lot of jargon, but it should serve as a useful primer or refresher for those with some background. It could perhaps have been improved by putting greater emphasis on physical insight (explaining the physical reasons for a critical Rayleigh number for the onset of convection, for example, and discussing why the circulation pattern for convective cells in gases is expected to reverse from that in liquids) than on listing of results.

Subsequent papers considerably expand this introductory material with both observational and theoretical treatments of the distribution, structure, and convective instability of horizontal rolls, cloud streets, and bands. Two papers treat the effects of long-wave radiation on layer clouds (where radiative cooling can profoundly affect the upper few hundred meters of the cloud) and on trade wind cumuli (where radiative interaction appears to produce a noticeable though generally small enhancement of the cloud energetics).

Two papers not particularly specific to shallow convection are included in the first section of the book. The first, by Emanuel, is a highly readable treatment of his application of similarity theory to small-scale downdrafts within cumulus clouds. Recent observational studies have given clear evidence that air is entrained into some clouds through the top, rather than the sides, and is subsequently mixed through the cloud by penetrative downdrafts. Such mixing has important microphysical as well as dynamical implications, and Emanuel's analysis is probably the most successful application of similarity principles to cumulus convection. In the second paper, Betts summarizes a new concept, the saturation point. In unsaturated air the saturation point is the familiar lifting condensation level. However, with cloudy air Betts shows how a generalization that includes the idea of a sinking evaporation level can be useful in studying the thermodynamics of cloudy air, mixing of cloud with the environment, and thermodynamic equilibrium structure and instability. Like most of the papers in the book, Betts's paper is a summary of published or soon-to-be published journal articles. In the present case, though one can get the gist of things from the version in the book, the more complete discussion in the original journal article is quite a bit easier to follow.

The section on deep convection starts off with an introduction on thunderstorm structure and geographic distribution. Severe storms are given the most emphasis, with results from the Thunderstorm Project and the work of Newton and of

Browning and collaborators up to the mid-1960's highlighted. There is no discussion or even mention of the more recent extensive research programs in Alberta, Oklahoma, and Colorado. It is too bad that the author does not mention the theoretical work of Moncrieff and Raymond or several recent review articles and books on the subject, since none of this important work is mentioned in the other papers in the section.

The application of numerical models to the study of cloud dynamics, though not covered by Agee, is illustrated in two other papers. Bennetts and Bader use a three-dimensional model to understand the way in which neighboring storm cells can interact to produce an enhanced rainfall at the ground. Ray, Klemp, and Wilhelmson attempt to model a particular storm that was observed with a multiple-Doppler radar network. The amount of agreement between theory and observation is quite impressive (though here is another case where the original journal articles are more satisfying reading). Both studies are good examples of how cloud modeling can be used as an additional tool to gain physical insight into cloud processes.

Case studies of particular storms are given by Curić (Yugoslavia), Held (South Africa), and Lin and Pasken (United States), and Battan summarizes his case for the variable nature of storm updrafts. The detection of tornadic storms using satellite imagery and the prediction of severe hailstorms as opposed to flash floods in southern France are also discussed. Seliga and collaborators review the use of radar differential reflectivity, which they regard as a very promising technique for studying convective storms. And Abshaev reviews the experimental methods used to study hailstorms in the Soviet Union; equipment, techniques, and formulas are given, but there is practically no discussion of physical results.

There are numerous typographical errors and omissions in many of the papers. The English is often rather poor in papers by authors from non–English-speaking countries. No technical editing appears to have been done. Though the book contains an index, a more complete one would have been desirable, for there is no cross-referencing between the various papers.

Though the book does not fill the need for a unified treatment of cloud dynamics that summarizes the important results, it should nevertheless be greeted with some enthusiasm. It is an informative collection of recent results over a broad range of topics. And, despite the drawbacks noted, in this day of specialization it should prove interesting and useful to the expert in the field as well as to those in other fields who are looking for an overview.

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