gists this book provides an excellent basis for the management of wild sheep. There can be no doubt that *Mountain Sheep* will prove of considerable value to all those interested in mammalian behavior, ecology, and evolution. It will stand as the definitive text on wild sheep for many, many years.

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Atmospheric Modeling

Numerical Weather Prediction. GEORGE J. HALTINER. Wiley, New York, 1971. xviii, 318 pp., illus. $10.95.

Numerical weather prediction is the forecasting of a state of the atmosphere from a known initial state by solving the hydrodynamic equations governing atmospheric phenomena. The idea of such forecasting is old. However, although the basic principles of atmospheric dynamics have long been known, their successful application for the prediction of large-scale motion in the atmosphere awaited the construction in the last two decades of sophisticated numerical models of the atmosphere based on theoretical and observational studies of the characteristics of atmospheric motions. The development of electronic computers and the system of the meteorological observation have also contributed to the success.

In this book, the physical and mathematical considerations which have been and should be taken into account for successful development and integration of an atmospheric model are well described. In the atmosphere there are many modes of wave motions and oscillations. One should know the behavior of each mode of waves and its role in the prediction of the large-scale field of the atmosphere. In many models, the primitive equations are simplified so that only the factors that are primarily important for the change in the meteorologically significant waves are retained. Such an approximation can be made systematically by means of scale analysis. It may be desirable that the simplified system satisfy some integral constraints regarding vorticity and energy which are fulfilled by the primitive equation system. Understanding of the growth of large-scale waves as a result of the instability of the atmosphere is also important for proper modeling. Numerical integration schemes have to be formulated carefully so that both linear and nonlinear computational instabilities can be avoided. The aforementioned important subjects in this field have been discussed sporadically in various journals in many years. It is good that they are now treated in a single book. This book will be useful and handy for the numerical modelers in the field of dynamic meteorology in general, and the methodology summarized in it will be full of suggestions for scientists working with numerical models in other fields.

There are underdeveloped areas in numerical weather prediction. One problem concerns the atmospheric waves in the tropics. Another important problem is how to incorporate the ensemble effect of cumulus convection into a large-scale model. Those are briefly mentioned and some parameterization schemes of convections are explained, but the so-called convective adjustment method which is currently used with success in some big models is not introduced.

A question that may naturally arise is the limit of deterministic prediction—how far ahead and how accurately can one compute the future state of the atmosphere? An answer to this question cannot be found in this book. If the problem of predictability had been included I would have enjoyed reading the book more. At any rate, I welcome its publication.

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Chemical Exchanges

Bioinorganic Chemistry. A symposium, Blacksburg, Va., June 1970. RAYMOND DESSY, JOHN DILLARD, and LARRY TAYLOR, Eds. American Chemical Society, Washington, D.C., 1971. x, 436 pp., illus. $14. Advances in Chemistry Series, vol. 100.

These lectures on bioinorganic chemistry will be useful to chemists who seek examples of biological problems (nitrogen fixation, metal ion effects on nucleic acid structure, metalloenzymes, heme proteins, and other metalloproteins such as ferredoxins or ceruloplasmin) to which to apply knowledge of inorganic chemistry and techniques such as nuclear magnetic, electron paramagnetic, and proton magnetic resonance and complex kinetic analysis. Correspondingly, a biologist may find approaches that are more useful than the analyses usual in enzymology (enzyme isolations, cofactor and intermediate identification, and kinetic and inhibitor studies). These analyses are becoming analogous in value to the descriptive observations of anatomists or embryologists in a time when cellular and molecular approaches can be taken; though useful and important, they are not sufficient to open up new concepts.

One is impressed with the probable truth of what several of the authors imply: that inorganic chemistry is far more important to biology than has thus far been recognized in biological dogma and training, and may turn out to be as important as the organic side. Thus the curious political separations and territorial antagonisms of inorganic, organic, and physical chemists, biochemists, biological chemists, and biologists gradually have been diminished by the logic of the chemical and biological questions themselves. A chemist (Williams) now expresses his excitement at the reasonable way in which certain ions have been selected through evolution for special roles.

The volume reflects a continually increasing interest among protein chemists and enzyme mechanists in probing the mechanisms of inorganic ion catalytic groups and inorganic reactions, in contrast to a preoccupation with kinetics, protein structure, and mechanisms of reactions involving organic molecules. Chemists (some of whom may be in awe of enzymes or may not believe in them) may be stimulated by descriptions (such as that given by Breslow in this volume) of the development of model compounds for enzymes, not only for the inherent interest of enzymes but as they point the way toward the development of selective catalysts.

Some of the articles (Caughey's, for example) are fairly concise presentations largely of the authors' own work. Some (such as that by Williams) are rambling, enthusiastic, and speculative. Authors were motivated to spend more time in model building, speculation, commentary on the importance of problems, and prediction of useful approaches (as do, for example, Williams and Rabinowitz) than a scientist usually feels allowed to do in preparing a review.

The book will be a useful addition to biochemistry and chemistry libraries—more so to the latter, for much of the material in it is already available