Book Reviews

Earthquakes by Bruce Bolt, W. H. Freeman and Company, 1993.

It is always nice to again meet an old friend, but the pleasure is striking when you find that, while retaining her/his personality and qualities, she/he appears younger and more up-to-date. This is the case for the classic *Earthquakes: A Primer*, that made its first appearance in 1978 and returned in 1993, having incorporated more basic concepts and new data.

The chapters have been rearranged in a more natural order, and there is a new one dealing with the earth's deep interior. All chapters have been revised and include fresh material (totalling 90 pages) including aspects of recent important earthquakes: 1979 Imperial Valley (U.S.A.), 1983 Coalinga (U.S.A.), 1985 Michoacan (Mexico), 1985 Quintay (Chile), 1988 Spitak (Armenia), 1989 Loma Prieta (U.S.A.), 1989 Newcastle (Australia), 1990 Manila (Philippines); the 1980 eruption of Mount Saint Helens; and the Mammoth Lakes 1980–1985 earthquake swarm. Inportant additions include: a section addressing quiet gaps in earthquake zones, the role of seismograph arrays, a more extensive treatment of transform faults, examples of fault plane solutions from different kinds of faulting, a graph of energy vs. magnitude, a table of acceleration vs. frequency for given displacements, an introduction to the concept of seismic moment, schematics of tilt and displacement meters, a discussion on the important role of liquefying wet sand in ground failure and tips for hazard reduction at home. Other important additions dealing with earthquale prognosis are: the role of paleoseismology, an introduction to earthquake probability calculations, an account of the Parkfield experiment, and a discussion on acceptable risk.

Some major revisions are: the schematic representation for Love waves in the widely known figure (1.9) that illustrates the ground motion due to different wave types, has been improved; an appendix treating to obtain fault planes from first motions, has replaced the one concerning seismic instrumentation of large structures; the accounts of the 1976 Guatemala, and 1977 Romania earthquakes have, for some reason, been deleted, and I missed the outstanding namazu-e print which was the first picture in the primer, as well as some presentable fault pictures. A couple of minor changes worth noticing are that the old impressive photo showing the aftermath of the 1964 tsunami at Kodiak, Alaska, has been replaced by a truly terrifying one showing the 1946 tsunami arriving at Hilo, Hawaii, and, on the lighter side, the artist's conception of Chang-Heng contemplating his seismoscope has been replaced by a photograph of a model of it, and from behind the seismoscope Bruce Bolt himself contemplates the reader, as if wondering whether his contributions to seismology will be remembered as long.

On the whole, this is a well written, accurate, and entertaining book, even surpassing the first version (which was quite good). Eminently suited as an introductory book, it can very well set the basis for further specialized studies, and is accessible as a reference book for working seismologists and an invaluable aid for them when delivering introductory talks (usually in great demand after felt earthquakes).

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Handbook for Hydrology, Editor-in-Chief David R. Maidment, McGraw-Hill, New York, 1993; US $110.50.

This new handbook for hydrology replaces the 1964 *Handbook of Applied Hydrology* of Ven Te Chow. As the new editor, D. R. Maidment states in the preface that a large amount of new knowledge has been gained in the various fields of hydrology since that time, disseminated over numerous journals, textbooks and reports. Thus the need for a completely new handbook became apparent. As a matter of fact, over the last three decades hydrology has become one of the fastest growing scientific disciplines, as witnessed for example by the ever-increasing size of the hydrology section at AGU meetings. This trend will most likely continue, as increased water usage due to population growth and other anthropologically induced adverse impacts on groundwater and surface water resources and on global climatic conditions will require sophisticated scientific and technical approaches and solutions. The interdisciplinary field of hydrology, which comprises such various subdisciplines as fluid mechanics, civil and agricultural engineering, meteorology, oceanography, chemistry, computer science, but also geophysics—some of the methods of exploration geophysics are increasingly being used for the detection of groundwater resources and contamination—is most likely the science to provide solutions for many pressing environmental problems of the future.

This new handbook presents an excellent overview of the state-of-the-art in modern hydrology. It consists of 29 chapters, each of which is written by experts in their subdisciplines. As with most handbooks, the material is mostly geared for the professional on the job. However, most of the chapters are written at a general level that also should make them very useful as reading material for students of hydrology and other water-related disciplines. The material presented is very up-to-date and references through 1992 are included. It is the reference lists at the end of each chapter which usually comprise between 100 and 200 references that make this book such a valuable source.

It is impossible here to discuss the book's entire content, which exceeds 1200 pages (for an exact page number one has to total the number of pages for each chapter). The handbook comprises essentially four sections: Hydrological Cycle, Chapters 1–10; Hydrological Transport, Chapters 11–16; Hydrological Statistics, Chapters 17–20; Hydrological Technology, Chapters 21–29.

The ten chapters of the section on the Hydrological Cycle cover the various phenomenological aspects of the flow of water through the phases of the hydrological cycle. This section will be particularly valuable to scientists interested in the fundamental physics of the water cycle on both the global and regional scale and it illustrates the interdisciplinary nature of hydrology. Four chapters are devoted to climatology, precipitation, evaporation, and infiltration that will be of particular interest to meteorologists and to agricultural scientists. The other six chapters of the section deal with general groundwater flow and various aspects of surface water flow, such as the movement of snow and ice, streamflow in rivers and movement of floods and various methods of flow routing. The latter attempts to predict the magnitude and the location of a flood wave along a watercourse as a function of time during catastrophic weather conditions or after a dam failure.

The emphasis of the six chapters in the section on Hydrological Transport, is on water quality, contaminant transport in surface and groundwater, the effect of land-use changes on hydrological processes, and sediment transport in rivers. The lengthy chapter on water quality, written by scientists at the U.S. EPA, supplies a very solid introduction into the chemistry of natural and polluted groundwater and a description of the processes that affect water quality. The physical mechanisms of solute transport in the unsaturated zone, which are essentially for the understanding of irrigation practices, soil contamination, and for the prediction of leachate processes from landfills and industrial waste disposal sites, are described in another chapter. Once these contaminants have reached the groundwater table, they are affected by physical and chemical mechanisms pertinent to the saturated zone, as outlined in a subsequent chapter. These chapters should also be highly interesting to researchers working in oil reservoir engineering and modeling, since many of the basic principles of hydrological solute transport will also apply to the migration of oil (and water during secondary recovery operations) in a rock formation.

The section of Hydrological Statistics begins with a chapter discussing general aspects of statistical distributions, hypothesis tests, and multiple regression. This is followed by a more specific chapter on the frequency analysis of extreme events (rainfall, flooding). Log-normal, Gumbel and Weibull distributions and methods of regionalization are introduced (some of these techniques may be of particular interest for the geophysicist reader working in earthquake prediction). A detailed chapter on hydrological time series analysis discusses the particular methods used in this field, such as auto- and cross-correlation, autoregressive (AR and ARMA) models. The reader more familiar with ordinary geophysical time series analysis will notice the peculiarities of hydrological time series which often show seasonal and annual cycles that require special filter techniques. A presentable review of some statistical computer software packages (SPSS, SAS, BMDP) for this purpose is provided at the end of the chapter. In the final chapter of this section stationary geostatistical methods, such as semi-variogram analysis and kriging, that have originated from the mining industry but, to my knowledge, have not found their due respect in regular geophysics, are discussed.

The section addressing Hydrological Technology comprises chapters that discuss a variety of subjects, such as computer methods for modeling surface and subsurface flows, general advances in hydrological computation and data acquisition, remote sensing, hydrological forecasting methods, and hydrological design techniques for water use, urban drainage and flood control and groundwater pollution control. While some of these chapters will be of more interest to civil and environmental engineers and urban planners than to academic researchers, they are very revealing as to how many of the basic scientific principles of hydrology, as discussed earlier in the book, can be efficiently used to find practical solutions for some of our environmental problems.

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Caustics, Catastrophies and Wave Fields by Yu. A. Kravtsov and Yu. I. Orlov, Springer Series on Wave Phenomena, vol. 15, Springer, 1993.

This is a second book of these authors translated into English, and, in fact, a natural continuation of the first one, *Geometrical Optics of Inhomogeneous Media.* The presentation of the subject is however self-contained. It is essentially a review of the literature on singularities of the asymptotics of wave fields. It is perhaps the only facile reading on this topic presently available. The main merit of this book however consists in the fact that it offers a non-post-Soviet reader (how else can I designate this category of scientists) an invaluable survey of Soviet research on the subject, most often published in Russian and in quite obscure journals. Even though the second author deceased in 1982, some posterior literature is presented and listed in the references.

After a brief introduction (Chapter 1) the authors present the ray theory, including complex rays and introduce the main protagonist of the book, ray field envelopes alias caustics. Each geometrical construct is endowed with a volume and a physical interpretation. On the other hand the duality of rays and waves, so essential for the construction of ray fields, is ignored.

In Chapter 3 the rays are lifted—as a mathematician would say—to the phase space in order to smooth out the singularities. This allows a rudimentary introduction to Lagrangian manifolds and phase (or generating) functions. Caustics now appear as singularities of the Lagrangian projections which allows their classification and application in diffraction integrals. Chapter 4 dives to a greater depth. Selected diffraction integrals are presented in some detail and uniform asymptotic expansions are constructed. Chapter 6 introduces Maslov theory and Chapter 7 presents a less familiar alternative developed by Orlov and J. M. Arnold. In Chapter 8 phase functions and diffraction integrals edge diffraction problems are presented. Chapter 9 introduces an example of a diffraction integral with a nonpolynomial phase, derived from the familiar solution for a circular caustics in terms of Bessel functions. Chapter 10 contains a handful of mixed additional results, in particular complex caustics.

The book encompasses a wide range of phenomena. One of its flaws is an excessive pursuit of bibliographic completeness such that in some cases it leads the authors to present second-rate papers at the expense of more fundamental facts. Some interesting ideas are barely mentioned without a sufficient explanation—just to mention the quasi-isotropic approximation. It is disappointing to me that after so many years it has been unnoticed that the time-domain approach to diffraction integrals leads to numerically more tractable expressions.

The presentation, however, follows a very clear underlying philosophy. In particular, the wavelength is often used in discussions of the limits of applicability of asymptotic approximations, which in part explains the authors' predilection for the frequency domain.

The translation is far from perfect. Names are systematically misspelled, e.g. Pearcey, Stavroudis, Gilmore or Duistermaat.

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Foundations of Anisotropy for Exploration Seismics by K. Helbig, Handbook of Geophysicsl Exploration, eds. K. Helbig and S. Treitel, Seismic Exploration, vol. 22, Pergamon, 1994; £75.00, US $120.00.

Many struggling, solitary years of anisotropy supporters have finally brought this subject to the attention of seismologists and exploration geophysicists. Anisotropy is now accepted as a matter-of-course in this milieu. The time is right for a readable textbook on anisotropy addressed to geophysicists. Enter Helbig.

Helbig's book is well written. The author avoids being suspected of mathematical deviations, which is often unpopular in exploration geophysics. This is however impossible in anisotropy, as can be seen from the book. There is no theorem or lemma in his book, but there are many drawings, boxed statements, bottom lines and even FORTRAN codes for those who might be intimidated by the algebra (incidentally, why FORTRAN, these people already use C and C++, don't they?).

Helbig takes a very critical view of anisotropy. He first explains why and when it must be taken into account. More disparingly, he does not conceal his dislike for anisotropy, even though it has occupied him life long. "Anisotropy is a nuisance. Many well-established procedures work as long as anisotropy can be safely disregarded." Well, this could be said about any sophistication, elasticity as compared with the scalar equation is the first case in point. I have always been unhappy with the peculiarity of *S* waves. Their degeneracy disappears if you take into account anything but linear isotropy. They are presumed to approximate some waves in nonlinear or anisotropic media, but the transition is extremely fine and seldom discussed.

Ergo, if Helbig recommends anisotropy, there must be good reason for it.

The book introduces the reader to the basic geometrical concepts used in the study of anisotropy. It also presents a self-contained course of linear elasticity. These two subjects are then utilized to present a detailed analysis of physically realizable cases of anisotropy. After a general discussion additional tricks are presented: decoupling of slowness equations in symmetry planes and the use of squared slowness components to reduce the order of the equations. There is a chapter concerning anisotropy due to fine periodic layering and another chapter treating the anisotropy in exploration seismics. An abundance of Helbig's own work has been expended, as well as some old and long forgotten endeavors.

Helbig's book is addressed to exploration geophysicists. This explains the omission of the hottest anisotropic subject of the last decade: surface waves in anisotropic media. Lothe and Alshits are quoted only once, and their papers listed in the references are outdated, while other papers in this field by Lothe, Barnett, Chadwick and Parker are not even mentioned.

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High-pressure Research: Application to Earth and Planetary Sciences, eds. Yasuhiko Syono and Murli H. Manghnami, Geophysical Monograph, vol. 67, Terra Scientific Publishing Company, Tokyo/American Geophysical Union, Washington D.C., 1992; US $79.00.

This book collects the papers presented at the fourth U.S.-Japan seminar related to high-pressure research. The seminar was held in Ise, Mie-ken, Japan, in January 1991, under the title "High-pressure Research in Mineral Physics: Application to the Earth and Planetary Sciences." The proceedings volume includes 60 reviewed papers from those presented at the seminar sessions. The papers comprise approximately 500 pages.

Each paper has been written independently, as is standard in a proceeding volume. The material is divided into six parts, preceded by a brief table of contents as follows.

1. Generation of High Pressure and Temperature
   1.1. Multi-anvil System—6 papers;
   1.2. Diamond Anvil Cell Technique—3 papers.
2. Measurements of Physical and Chemical Properties—7 papers.
3. Elasticity and Equation-of-state in Relevance to the Earth's Mantle—9 papers.
4. High Pressure Behavior of Silicates
   4.1. Phase Changes in the Upper Mantle—5 papers;
   4.2. Hydrogen in Silicate Minerals—5 papers;
   4.3. Melting and Elemental Partition—5 papers.
5. Core and Planetary Materials—8 papers.
6. Phase Transitions
   6.1. Theory—3 papers;
   6.2. Experiments—5 papers;
   6.3. Amorphization—4 papers.

The experimental papers cover approximately five of the six parts of the volume, one part encompassed by theoretical papers.

Notwithstanding the fact that the volume is dedicated to the earth and planetary high-pressure research, it contains vast material of interest to many branches of science. Geologists, mineralogists, and earth and planetary researchers will find certain parts of the material very valuable; engineers interested in high-pressure apparatus construction will also be satisfied. I recommend this volume to all Earth and Planetary Science libraries, as well as to many independent researchers.

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Geologic Evolution of the Red Sea by Robert G. Coleman, Oxford Monographs on Geology and Geophysics, vol. 24, Oxford University Press, 1993.

This is a relatively short book which contains 186 pages and which consists of an Introduction followed by eight chapters, an Epilogue, very comprehensive References and an Index. The book is nicely presented and contains some good illustrations including a number of appropriate field photographs. The author, in his Preface, indicates that this book was intended to provide an overview of the geology of the Red Sea and form a comprehensive review of what has already been accomplished. In this the book is a success, and does indeed provide an excellent reference tool for those intending to work in this area. However, if a more detailed study is required, particularly in the fields of sequence stratigraphy and sophisticated tectono-stratigraphic basin analysis, then this book itself may not be the answer. Fortunately though, the author has superbly referenced such detail in the main body of text and the book thus serves as a platform for further progress on the part of the reader.

The *Introduction* is subtitled "Historical Aspects of Geologic Studies in the Red Sea Basin" and is a short section. The first few pages are devoted to a list of the available, regional scale geological maps of the Red Sea area and a very brief discussion of their content. These pages are then followed by an indication of the history of the major advances made in the field and a note of the most significant publications to date. Whilst only seven pages long, this section is one of the most useful in the entire book and provides the reader with a huge wealth of key references.

The first chapter in the book, *Geomorphology*, is also short and has sections on: the Shape of the Red Sea Basin; Red Sea Islands; Coral Reefs and, Axial Troughs. The bulk of this chapter examines the first two of these through short descriptive texts accompanied by satellite images and aerial photographs. The latter two sections are extremely short and lack detail.

The second chapter, *Stratigraphy*, is a far more detailed account of the lithostratigraphy and, albeit in more general terms, the chronostratigraphy of the region. Five main groups or associations are discussed: Basement Sediments; Pre-Rift Sediments: Syn-Rift Sediments; Evaporites and, Post Evaporite Marine Sediments. Each of the sections are well constructed and the lithostratigraphy from a number of geographically diverse areas has been synthesized and placed in context. Chronostratigraphic information, predominantly from the fossil record, is also presented and a wide range of useful references are neatly placed in the text. However, no detailed maps showing the distribution of the various associations are presented, and the summary stratigraphic diagrams lack detail and effective correlation. This spoils an otherwise excellent chapter.

The chapter on the *Volcanic History* is the largest and most detailed chapter in the book, reflecting the author's own experience in this field. The chapter contains good descriptions of outcrop distribution, stratigraphy of the volcanic sequences and any known age constraints for the five major volcanic provinces as well as providing a section on xenoliths and their implication for the petrogenesis of the Red Sea mantle. Each section of this chapter is well interspersed with photographs of outcrops, mainly as low level aerial obliques, and a few maps which are, unfortunately, not particularly useful. There is also an absence of good figures and tables to illustrate the volcanic stratigraphic correlation across the main area, and whilst these are reasonably well covered in the text, a key diagram or table would be quite easier to follow. This contrasts strongly with the section on petrogenesis which presents abundant data as AFM diagrams, Total Alkalis vs. Silica diagrams, REE plots and a variety of trace element ratio plots.

The next chapter, *Age Relationships*, is extremely short and is little more than an expanded list of radiometric dates and relative ages based on fossil evidence. The chapter is so short that it actually appears out of context; it would have been better to incorporate the age data into the preceding two chapters, perhaps as stratigraphic correlation diagrams annotated with relevant dates and references.

Red Sea Structure is an excellent chapter which covers discussion of the key structural elements in a number of domains, both the pre-rift and present-day disposition. The text is backed up by a good number of relevant diagrams and maps and there is good reference to primary literature sources. The various models proposed to explain the structural evolution of the region are also reviewed, although more use of geophysical data could have been made.

Geophysical Outline is a series of short sections, each covering an aspect of geophysics. Within each section the availability of data is indicated and the models erected from these data are introduced. This chapter is suitably set out, starting with the smaller scale structural syndromes revealed by the magnetic data and then progressing to the larger wavelength features revealed by the gravity, seismic and heat flow data. A picture is gradually built up of the overall structure in the context of crustal thinning, intrusion, underplating and finally genuine rifting and the generation of new oceanic crust. This leads neatly into the next chapter, *Red Sea Plate Tectonics*. This is a short chapter in which the previous five chapters are brought together and synthesized. Good use is again made of key references.

The final chapter is devoted to a discussion of the *Economic Aspects of the Red Sea*. This is a fairly predictable section which deals with the two main topics of relevance: heavy metal sulphide deposits and hydrocarbon accumulations. Neither of these sections contain any new data, although the stratigraphic correlation diagram in the hydrocarbon section is a welcome relief after reading the second and third chapters.

In summary, this book is generally very well presented and is an excellent precis of the current knowledge. The book also provides the reader with excellent references for further study of the geology of the Red Sea region. I have no hesitation in recommending this book to all workers who need either of these tools.

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Morphology of the Rocky Members of the Solar System by E. Uchupi and K. O. Emery, Springer-Verlag, 1993; US $99.00.

The book contains XXIV + 394 pages illustrated by as many as 150 black/white figures (as a philatelist I must add: plus decorative reproductions of the post stamps devoted to space research; they are placed at the end of each chapter).

The initial part, numerated by the Roman numbers, starts with the Foreword written by R. S. Dietz, Professor of Geology Emeritus from Arizona State University. He presents an enthusiastic opinion of the authors of the book. Both of them are professors from the Woods Hole Oceanographic Institution, Department of Geology and Geophysics, Massachusetts. The Preface by the authors, their Acknowledgements, and finally the very detailed Table of Contents conclude this part of the book.

The main text opens with a short "Introduction" noting the history of planetary sciences (there are numerous historical notes throughout the book). "Introduction" is followed by two general chapters "Origin of the Solar System" and "Morphology of Planets and Satellites"; totalling 36 pages. I am surprised as to why the rotation periods of as many as 9 satellites from these listed in Table 1 are denoted by question marks: the rotation of these satellites, synchronous with their revolution, is rather undoubtful at present (Hyperion is an exception).

The next five chapters, comprising about 220 pages, give a detailed description of the hypsometry and morphology of the terrestrial planets, namely Earth, Moon, Mercury, Venus and Mars. The chapter concerning the Earth is the largest one. The authors divide the morphological provinces of the rocky planets into three categories: endogenic (caused by plate movements), exogenic (caused by external processes such as weathering, erosion, transportation, and deposition from earlier rock surfaces), and exotic (formed by bombardment by planetesimals and comets). A description of the planetary surfaces follows the above division. The material is illustrated with many specially chosen pictures of the surface features photographed from space as well as by the maps and tables.

The chapter "Outer Planets and Satellites" occupies nearly 70 pages. As the giant planets lack the well-defined surfaces, this chapter mainly presents a description of the morphology of the satellites. The photographs chosen are the most representative from the Voyagers missions. I recommend a comparison of this chapter of the "Morphology of the Rocky Members of the Solar System" with the book "Satellites of the Outer Planets" (D. A. Rothery, Clarendon Press Oxford, 1992).

The last chapter "Summary and Conclusions," 26 pages, presents comparisons of planetary features as well as some discussion related to the problems of planetary evolution.

The book imparts the results; it does not discuss the methods by which the results have been reached. As a consequence of this descriptive form the reader will find no mathematical or physical formulae. At first glance it is somewhat unexpected for geophysicists or for planetary scientists, but upon reflection one can see that the formulae are completely unnecessary in a book of this type. On the other hand, an essential part of the material is the photographs and maps which have been excellently fitted to the text.

An extensive list of References as well as an exhaustive, 16-page Index can be extremely useful for the reader. According to the authors (see Acknowledgements), the bibliography contains nearly 1000 citations, of which half date from 1984 forward. The reader will find the references superbly updated; e.g., they include the recent results of Magellan's mission to Venus. The Index, among other key words, provides a list of the names of many planetary surface features.

I found this book rich in well collected and systematized information. Therefore I am sure it will be useful on the desks of planetologists, geophysicists, and geologists interested in comparative planetology.

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Remote Sensing by Fourier Transform Spectrometry by Reinhard Beer, Chemical Analysis, vol. 120, John Wiley & Sons, 1992.

For planetary remote sensing from space there is a couple of physical measurements in the visible and long-wave regions. Whereas in the earthly observation from space the visible data are usually obtained, however, in the electromagnetic region, the Fourier transform spectrometers (FTS) play an important role in remote sensing of planetary atmospheres and surface.

In this context "Remote Sensing by FTS" merits attention not only as an introduction to the implementation of FTS but also as an overview to the case studies of remote sensing from space and air.

Chapter 1 of the book is a good introduction to the reader with respect to the terminology used throughout, allowing for a short divergence on the standard units. It ends with an introduction to the Michelson interferometer, in addition to both integral and discrete Fourier transforms.

In Chapter 2 some elementary comments on the properties of an idealized FTS are yielded in comparison with equally ideal grating spectrometers, introducing the concepts of étendue, multiplexing, spectral resolution, modulation efficiency, and tool of imaging spectrometers.

Chapter 3 describes the physical and chemical processes of remote sensing, in order to discuss the spectral origins to be measured. Putting the emphasis on atmosphere bounded by surface, based on radiative transfer, the absorption and emission processes are discussed in the domain of atmospheric physics and chemistry of remote sensing. Indeed, some of the relevant knowledge is playing an important role in numerical weather forecasting and the long-term climatology.

In Chapter 4 real FTS are discussed. After an allowance for a novel approach to the determination of signal-to-noise ratio for FTS, the next important topic concerns the interferogram sampling crucial to the success of FTS. Following them, some widely used optical configurations for a remote sensing system are provided.

Chapter 5 provides a short survey of four such existing and one planned FTS intended for different purposes and operating in different surroundings. For example, the five are below. The Voyager IRIS FTS, CFHT FTS, The Spacelab 3 Atmos FTS, the Mark-IV Ballon/Aircraft FTS, and the EOS TES FTS.

In Chapter 6 the discussion concerns short remarks about the remote sensing environments in which such a system should survive and operate. In other words the utilization of FTS in remote sensing will give rise to substantial modification before it is to be mounted on a telescope, aircraft, balloon, and spacecraft. Furthermore, some authors' experiences helpful to potential users are provided.

Finally, in Chapter 7 a concise discussion regarding general observation is provided, in addition to an appendix pertaining the optimum filters.

In summary, this book presents a brief compendium of the basic concept of the theoretical and practical aspects of FTS. It is highly recommended not only for remote sensing scientists who are interested in FTS, but also for any departmental library.

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Wave Propagation in the Ionosphere by K. Rawer, Developments in Electromagnetic Theory and Applications, vol. 5, Kluwer Academic Publishers, 1993; Dfl. 295.00, US $175.00, UK £116.00.

To explain the famous Marconi's radio experiment in 1901 Kennelly and Heaviside postulated in 1902 the existence of the ionized layer in the upper atmosphere, the ionosphere. Thus the relationship between the ionosphere and radio waves historically spans nearly a century. Over the years progress in the study of waves in the ionosphere has been uneven. The direct experimental evidence for the existence of the ionosphere in 1925, and expeditious developments in radio communication in the 1930s, spurred the rapid progress in ionospheric research. An overall grasp of the behavior of the ionosphere and its effects on radio waves has been gained during that time. In the 1950s and 1960s the new impetus produced major advances in experimental studies of the ionosphere using satellites and rockets, in the plasma physics, and in the use of computers, led to important developments in the study of radio propagation, acoustic-gravity and plasma waves in the ionosphere. In the 1980s new experimental techniques were introduced, to mention only the incoherent scatter radar and artificial heating of the ionosphere. Concurrently, remarkable progress was discerned in the theory of waves in the ionosphere, in particular in nonlinear wave propagation, scatter propagation, and ionospheric plasma instabilities.

Professor Karl Rawer witnessed and significantly contributed to the progress in ionospheric research for nearly six decades. This earned him the full authorization to write a book reflecting developments of wave propagation study over this period. Many important textbooks and monographs pertaining to waves in the ionosphere have been published in the past and recently, from the famous Ratcliffe's book to the excellent monographs by Budden and Booker (this last book appeared in the same series as Rawer's book). Rawer's book differs from all others in that it is organized to reflect, to some extent, the history of ionospheric research.

Wave Propagation in the Ionosphere is not a textbook, although its first draft was based on a series of lectures given by the author at the Université Catolique de Louvain in 1975. It is not easily accessible to undergraduate students and even graduate students who will find too many brachylogies, which make it difficult to comprehend some parts of the book. The terminology used in Rawer's book is unconventional which might be confusing for readers new in the field and accustomed to the generally accepted nomenclature. For instance, the author consequently uses the designations "ionic" and "electronic" instead of the "extraordinary" and "ordinary" waves. Yet two other examples, "generalized" dielectric dyadic is used for "relative" dielectric dyadic or tensor, and the "index vector" instead of "refractive index vector." Some theorems, important from the point of view of didactics, are omitted, to mention only the Martyn's or Breit and Teuve's theorems. Moreover, the book contains a rather scanty reference list. With few exceptions it is limited to the reference books, textbooks and conference proceedings issued before 1989. One will need to seek more recent and extensive bibliography in other texts.

The book is divided into four parts: Part A presents an outline of wave propagation in cold plasma. In Part B more practical aspects of radio wave propagation are discussed. Warm plasma is considered in Part C and nonlinear effects and plasma instabilities in Part D. Seven appendices conclude the book. Three appendices introduce the reader to the dyadic algebra and eigenvalues of dyadic. A dyadic is a mathematical tool used throughout the book. Two of these appendices ("Ray tracing" and "Partial reflection and penetration") could safely be included within the main body of the book without losing its consistency.

While deriving the refractive index formula, Rawer uses Försterling's formulation, based on the eigenvalue concept, instead of Appleton's approach which, although more popular, is less general and elegant. It is interesting to note that Försterling did not bother to publish the formula, and only in 1927 his collaborator Lassen published it with due reference to the initiator. Appleton's original paper was published within the same year, however without derivation of the refractive index formula which appeared in 1932. Rawer advocates using the name "Appleton-Lassen formula" for the cold plasma refractive index, instead of the more popular "Appleton-Hartree formula" title.

Propagation of radio waves of various frequencies is considered in Part B. This part also includes an introduction to acoustic-gravity waves in the atmosphere and propagation of radio waves in the structured, irregular ionosphere. However, a very important issue of wave propagation in the ionosphere with random electron concentration fluctuations is discussed very briefly, in my opinion inadequately for a book seriously dealing with waves in the ionosphere.

The validity of cold plasma approximation is rather limited. In particular this approximation breaks down for plasma wave velocity of the order of thermal velocity, and for electromagnetic waves near resonances. Discussion of effects associated with the plasma temperature can be found in Part C which, however, contains several inexact statements. For instance, one can gain an impression that the Landau damping and spatial dispersion are synonymous. In fact, the spatial dispersion has a broader connotation and is related to any transport process.

Various nonlinear processes and plasma instabilities are briefly described in the concluding part D. The material in this part is very condensed. This was unavoidable since the author had the ambition to fit into 100 pages various broad topics, on each of which a separate book could be written. Most thorough is a chapter on the incoherent scatter technique and results obtained with this powerful method.

Wave Propagation in the Ionosphere is an encyclopedia offering abundant information dished up in a condensed, sometimes simplified form, accompanied by interesting historical background.

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Auroral Plasma Dynamics, ed. Robert L. Lysak, Geophys. Monogr. Ser. vol. 80, American Geophysical Union, Washington D.C., 1993; US $57.00.

This book is the 80th volume in a current Geophysical Monograph Series being published by the American Geophysical Union (AGU). Most of the papers presented in this monograph are based on contributions to a Chapman Conference on Auroral Plasma Dynamics, which was held in Minneapolis in October 1991. The program of the conference was covered by sessions on Global Auroral Morphology, Active Experiments, Particle Acceleration, Parallel Electric Fields, Magnetosphere-Ionosphere Coupling, Substorms and Aurora, and Waves and Turbulence.

The main goal of this book is to present the advances made in auroral research in the last 10 years so far as a previous similar AGU Monograph, "Physics of Auroral Arc Formation," was published about 12 years ago.

Remarkable progress in auroral physics has been made during this last decade, especially in the experimental investigations executed with the help of satellite missions such as Dynamics. Explorer, S3–3, Japanese Akebono and the Swedish Viking satellite. The latest achievements of these experimental investigations as well as the current theoretical ideas related to the observations, are presented in this volume.

The monograph contains 27 (over 290 pages) original papers combined into 5 lengthy sections.

The first section "Optical, Ultraviolet and X-Ray Observations of the Aurora" contains 5 papers concerned with ground-based, balloon and satellite observations of the various auroral forms.

The title of the second chapter is "Auroral Currents, Convection, and Fields." The 12 articles comprising this section are devoted to high-latitude electrodynamics, acceleration regions, plasma flows associated with an auroral arc and double layers.

The 3rd chapter, "Electron Acceleration" contains 5 papers regarding the effects of an electric potential along the magnetic field on charged particles. There are both some experimental studies and theoretical papers.

The fourth section, "Ion Acceleration" contains 7 original papers which present the models of the ion acceleration and experimental results of the ion precipitation processes in the various magnetosphere/ionosphere regions.

The volume closes with the chapter "Waves in the Auroral Zone." This section contains 6 papers and pertains to various processes connected with wave observations, wave-particle interactions and investigation of emissions observed by various so-under receivers.

In summary, taken as a whole this monograph is a reflection of our knowledge of auroral processes. The articles of this book are primarily concerned with experimental results of the auroral phenomena and reflect advances in instrumentation on satellite and sounding rockets.

The papers are very well illustrated by numerous schematic drafts, graphic panels and false-color plates.

In general, I found this volume to be an informative and useful resource for professional scientists interested not only in auroral processes but in ionosphere/magnetosphere physics as well.

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Tsunamis in the World, ed. Stefano Tinti, Advances in Natural and Technological Hazards Research, vol. 1, Kluwer Academic Publishers, 1993; U.S. $82.50, Dfl. 135.00, UK £54.00.

This book is a collection of papers presented at the fifteenth International Tsunami Symposium held in 1991 as a part of IUGG General Assembly. A report of the meeting by Bernard (U.S.A.) and 15 scientific papers are included. The papers are from 10 different countries; 3 from North America, 2 from Russia, 6 from Europe and 4 from Asia and the Pacific region. As the title indicates, the book actually reflects tsunamis in the world. The papers are grouped into three categories, "Observations," "Generation, Propagation and Run-up," and "Hazard Reduction." Alternatively, the papers can be grouped as oceanographic (3 papers), coastal engineering (3 papers), historical and geological (4 papers), seismological (3 papers) and hazard assessment (2 papers) aspects of tsunamis, on the basis of traditional classification.

There are five papers in the "Observation" category. Gonzalez (U.S.A.) and Kulikov (Russia) analyzed the tsunami waveforms from the 1988 Alaskan earthquake recorded on a pressure gauge set on the deep ocean bottom. The earthquake was strike-slip type, hence the tsunami amplitudes are very small (1–3 cm) in the deep ocean and, showed a dispersive character, because it was not a shallow-water wave. They developed a linear dispersion theory from a dipole source (uplift and subsidence produced by a strike-slip fault) and estimated the source parameters by a nonlinear least-squares fitting of data. This is a very new and interesting way to combine theory and observation. Gusiakov and Osipova (Russia) described their recently-compiled historical tsunami database for the Kuril-Kamchatka region. The database includes 8000 earthquakes and 124 tsunamis in the last 250 years. Based on this earthquake/tsunami database, they concluded that regional tsunami warnings must be made for earthquakes with $Ms > 7.0$. Dawson *et al.* (UK) presented a good summary of recent research on tsunamis from the Storegga submarine landslides in the Norwegian Sea, one of the largest submarine slides in the world. They showed evidence of tsunamis that occurred 7000 years ago in Scotland, Norway and Iceland, and compared the observed run-ups with numerical computations. Tinti and Saraceno (Italy) compiled a catalog of 21 volcanic tsunamis in Italy. The oldest one is from the A.D. 79 eruption of Vesuvius, which destroyed the town of Pompei. Moreira (Portugal) described historical tsunamis that affected the Portuguese coast, including the famous Lisbon earthquake in 1755. He also compiled precursory phenomena to the 1755 earthquake observed in Spain and Portugal.

Five papers are grouped as "Generation, Propagation and Run-up." Zhdanov (Russia) developed an analytical solution of tsunami generation by rigorously combining elasto-dynamic (seismological) and hydrodynamic (oceanographic) equations. He then discussed the effects of source depth, duration and rise time. The paper includes an excellent review of his previous work.

Imamura *et al.* (Japan) analyzed the tsunami data from the 1990 Mariana earthquake recorded on bottom pressure gauges. The tsunamis recorded in the deep ocean were compared with numerical simulations. Sandoval and Farreras (Mexico) calculated, both analytically and numerically, the normal modes of the Gulf of California due to incoming tsunamis. The results show that the longitudinal modes have characteristic periods comparable to tides, whereas the transverse modes have those comparable to tsunami periods. They further compared the results with the observed spectra of the 1960 Chilean and 1964 Alaskan earthquake tsunamis, and concluded that only transverse modes were excited by these tsunamis. Nadai and Tsuji (Japan) reported their experiments of an oblique reflection of a solitary wave at a vertical wall. A solitary wave is a typical nonlinear wave and its interesting behavior has been theoretically predicted. A solitary-type wave has been observed in shallow water, e.g., from the 1983 Japan Sea earthquake tsunami. Their experimental results reflect some disagreement with theoretical prediction, leaving room for future research. Camfield (U.S.A.) discussed the dynamic response of caisson-type structures to tsunamis. He illustrated concepts of structural rotation and foundation failure.

The following five papers are in "Hazard Reduction" category. Tinti (Italy) applied statistical analysis to the Italian earthquake catalog, which covers the last 2000 years, and estimated the tsunami probability and its regional variation. The highest probability, with a return period of 28 years, was found for Calabria and eastern Sicily. Kuran and Yalciner (Turkey) summarized and discussed historical earthquakes in Turkey. The long history of documented damage shows some interesting features such as a migration of large earthquakes along the North Anatolian Fault or disturbance of water in lakes. The authors pointed out the future tsunami potential in the Marmara Sea, the Aegean Sea (north and south) and the eastern Mediterranean Sea. Raymond *et al.* (French Polynesia) described TREMORS, their integrated seismic observation/analysis system. It features a 3-component long-period seismograph with wide-dynamic range digital recorder, automated phase detection, location and seismic moment determination. These are probably all the analyses one can make with a single station record. The system has been in operation at Papeete and examples are also shown. Shuto (Japan) redefined "tsunami intensity." Unlike earthquake intensity and magnitude scales, "tsunami magnitude" and "tsunami intensity" have been used with some confusion. For example, the definition of the widely-used Imamura-Iida's tsunami "magnitude," *m*, is closer to the intensity scale. The new definition of "intensity" is based on tsunami height (i.e., more quantitative than earthquake intensity scale), but descriptions of damage are also given, based on an extensive dataset of tsunami damage mostly from Japan. Simoes *et al.* (Portugal) compared three different algorithms to estimate azimuth from 3-component seismograms. They revealed that earthquakes in Gorringe Bank, a possible tsunami source, can be accurately identified by analyzing a land-based 3-component seismogram and thereby reduce false alarms.

Most of the papers are easily readable to nonexperts; detailed reference lists are given for those readers who are interested in more details. As described above, this book shows a diversity of tsunamis; tsunamis are not limited to earthquakes in the Pacific Ocean.

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Tidal Hydrodynamics, ed. Bruce B. Parker, John Wiley and Sons, 1991; US $98.00.

This book contains extended and peer reviewed versions of papers presented in the International Conference on *Tidal Hydrodynamics*, held at Gaithersburg in 1988. The focus, following the title, is on the rich dynamics and phenomenology of the tides in the hydrosphere, touching broader geophysical issues only incidentally.

The advent of new observational platforms, especially satellites, increased computational power, numerical algorithms, and data communication has brought a new research impetus to this old branch of physical oceanography. This new vigor is reflected throughout the book, making it a welcome addition to the literature, despite the rather uneven quality of the papers.

Altimetry and innovative pressure and current meter gauges complemented and extended traditional observational platforms providing substantive observational data sets for the deep ocean. The challenge of data interpretation and assimilation is pursued in some of the papers using relatively high resolution numerical models for the world oceans. The approach taken ranges from combining data and dynamical information *ab initio* in order to synthesize and extend the data (as expounded for instance by Schwiderski), to probing the data in order to extract dynamical information. An example of the latter is Platzman's estimates of basin normal modes eigenvalues from admittances derived from observations. It is to be noticed that, despite the now available data sets and modeling innovations, an unequivocal validation of our conceptual models of the world ocean tides by the data remains still elusive and challenging.

The interplay of the deep ocean tides and the shelf regions, straits and semi-enclosed basins is beginning to be explored. In this book very little is said on this issue. Instead, a valuable review and examination of tides in shallow waters are included. Nonlinear, dissipative tidal effects are examined, mostly in shelfs and estuaries. In some of these papers, results depend on nonlinear effects derived from empirical bottom dissipation parameterizations, and caution must be exercised in the interpretation of these results.

Baroclinic tidal effects and interactions are examined in several papers on internal tides. These tides are considered for a variety of setups, particularly shallow water, in their own right, in their coupling with the barotropic tides, and in topographic interactions. This subset of papers is a good snapshot of the current work taking place on the topic.

Godin's update of techniques and results in the analysis of tides demonstrates that even one of the oldest endeavors in tidal hydrodynamics has benefited from new or renewed data analysis algorithms.

Mankind's fascination with tidal phenomena and its impact on man's activities at sea have driven a great deal of the work done in this area. Practical applications of tidal modeling and prediction are discussed in the closing section of the volume.

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An Introduction to Marine Biogeochemistry by Susan M. Libes, John Wiley and Sons, New York, 1992, US $59.95.

The analysis and forecasting of biogeochemical perturbations caused by both natural and anthropogenic factors on time scales ranging from a few months to several decades has lately become an urgent problem to be solved, especially pertaining to marine pollution. Therefore, any contribution to this topic in the form of a well-written textbook at the advanced undergraduate or early postgraduate level should be appreciated by the oceanographic community. Susan Libes' textbook is precisely such a contribution. It addresses the hot topic of marine pollution in some 50 pages, comprising the last of thirty chapters. The foregoing chapters present a balanced account of the more basic aspects of marine biochemistry. Thus, the first six chapters (about 100 pages) constitute Part 1 of the book. They deal with various aspects of the physical chemistry of seawater, dwelling especially on exchanges between lithosphere, hydrosphere, and atmosphere. The following six chapters (again about 100 pages) constitute Part 2 of the book. They discuss the redox chemistry of seawater, and consider the constraints introduced by organic matter. In particular, chapter 11 deals with trace elements in seawater, and chapter 12 acts as a bridge to the following nine chapters (Part 3, about 160 pages), treating the chemistry of marine sediments: classification of sediments, clay minerals, the pH of seawater, biogenic silica, evaporites, hydrogenous minerals, hydrothermal deposits, and the global pattern of sediment distribution are among the topics discussed. Part 4, encompassing chapters 22–27 (150 pages), addresses organic biogeochemistry. In particular, chapter 26 investigates the current theory regarding the origin of petroleum in the marine environment. Part 5, comprising chapters 28 and 29 (80 pages), concentrates on questions related to isotope geochemistry: use of radio-isotopes in the study of marine processes, the use of stable isotopes in the study of paleoceanography. As noted above, the final chapter (Chapter 30, being Part 6) investigates marine pollution.

The book contains selected problems at the end of each of the six parts, as well as a list of references for suggested further reading. The latter are unfortunately not quite current. Particularly in the active area of marine pollution, more recent references would have been in order. Actually, recent measurements and their interpretation in this field have been completely ignored. There are thirteen appendices, a glossary, and a detailed index, informative tables, diagrams, and figures. The overall production is fine.

The author states that the book is designed for a one-semester course in marine chemistry. I believe that students might find this bulky volume (more than 730 pages) somewhat difficult to digest in such a short time, even though the author avoids carefully to touch on questions envolving sophisticated mathematical modeling of biogeochemical processes. Of course, redox reactions and steady-state models are employed to explain the biogeochemical cycling of nutrients and trace elements, but hydrodynamic modeling is essentially lacking. From the point of view of ecohydrodynamics, the crude data acquisition and sampling with only intuitive interpretation is not sufficient for a deeper understanding of the dynamical processes and anthropogenic signals involved. Thus, to study the significance and consequences of anthropogenic factors perturbing the biogeochemistry of the marine environment, it is necessary to develop hydrodynamic models. This point of view is not adequately conveyed to the reader.

Despite these few shortcomings, Susan Libes' work is an excellent introductory text to marine biogeochemistry, and may safely be used by instructors as a reference text on the subject.

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Global Atmospheric Circulations: Observations and Theories by R. Grotjahn, Oxford University Press, 1993, US $65.00.

The global circulation of the atmosphere is an object of increasingly intensive study. The huge growth of global circulation modeling as a scientific tool, and the heightening perception of climate change and possible anthropogenic influences on it as major practical problems, mean that many atmospheric scientists are involved in studying various aspects of the global circulation and their sensitivities to imposed conditions. Yet there is a dearth of good student texts covering the field. Many dynamical meteorology texts give no more than a brief chapter on the global circulation. Other relevant material is often scattered through the volume and does not form a coherent account for the purposes of global circulation studies. Therefore, when playing with his global circulation model, how is the young scientist to know whether his results are reasonable or not? Is a particular circulation sensitivity relevant to the real system, or is it merely an artifact of a particular model or parametrization scheme?

Accordingly the present book is a most welcome addition to the material available. It provides observations of the global circulation, helping our young researcher to verify whether his model is reproducing various aspects of the real circulation correctly, and it provides a theoretical account of the basis of the observed circulation. Such a theoretical understanding is an essential prerequisite to judging whether simulated model sensitivities are believable or not. At the heart of the book is a series of five major chapters, focusing on zonal average observations, momentum and energy relationships, observed nonzonal fields, theories of zonal fields and theories of nonzonal fields, respectively. The development is expounded clearly, with a good level of algebraic detail, and plenty of references and illustrations.

The focus is very clearly on the earth's troposphere. Despite the title, rather little is said about the circulation of the middle or upper atmosphere, and even less about the circulation fo the atmospheres of other planets. It is an advanced text in the sense that it is not self-contained. It would be essential to know something of dynamical meteorology before embarking on this book. The basic governing equations are not quoted, but the analysis of chapter 4 onwards is derived from them; the reader is referred to Holton's dynamical meteorology text to begin the analysis (the old 1979 edition unfortunately!). On the other hand, the book is an excellent reference for many results which are not easily found in other current texts. The analysis of atmospheric energetics is one such example.

My disquiet about this book is whether the student will be able to navigate through the detail to attain a comprehensive understanding of the global atmospheric circulation. For example, the derivation of the zonal kinetic equation, equation (4.12), (4.13) does not expose the fundamental dependence of kinetic energy generation on upward heat fluxes, a dependence which is easily related to basic thermodynamic principles. The question arises as to what constitutes a "theory" of the global circulation. The observed circulation is the product of many complex processes and feedbacks, described in terms of highly intractable nonlinear differential equations. Certain idealized approximations can be made to yield more tractable analytical problems which convey some insight; chapters 6 and 7 are largely concerned with such models. But these idealized models can only be verified by comparison with the more complete and more intractable models. In atmospheric dynamics, a reasonably complete theory involves a hierarchy of models, which may range from the highly qualitative conceptual model to the extremely elaborate global circulation model. The notion of hierarchies of models receives minimal emphasis in the text, and this makes it hard to structure the material.

As an example, considerable simplification of the governing equations, and therefore some insight into approximate, idealized models can be gained by the use of the quasi-geostrophic equations. The discussion of energetics and of the Eliassen-Kuo equation for the mean meridional circulation can both be reduced to their leading order terms, at least in the midlatitudes, using the quasi-geostrophic approximation. Yet this approximation does not receive a mention until the last major chapter, devoted to theories of nonzonal fields, and even then it is assumed that the reader already knows what the approximation involves. The be sure, the quasi-geostrophic approximation is not uniformly valid for the whole sphere, and it is only an approximation even at middle and high latitudes. But the simplification it introduces to many problems makes understanding of the fuller analysis considerably more accessible. It is a most valuable element in any hierarchy of models or theories. What is equally worrying is that in chapter 7, which is based on the quasi-geostrophic assumption, the limitations and implications of the approximation are not set out, but left for the reader to pursue through cited references. Discussion in chapter 5, concerning the maintenance of steady zonal asymmetries implicitly involves the quasi-geostrophic assumption (for example, by equating the *divergent* wind with the *ageostrophic* wind) but fails to make this theoretical basis obvious to the reader.

It is churlish to dwell on minor imperfections and typographical errors. Doubtless the author is only too acutely aware that the two parts of plate 1 are transposed, and this will be rectified in the next printing. One is more worried about mis-statements of fact, which ought to be corrected and are not. For example, the rotation period of Jupiter is quoted as "around 11 or 12 hours." In fact, it is 9.925 hours, a value which has been known to an accuracy of better than 5% since soon after the invention of the telescope!

In conclusion, this is a useful and timely book. Any research student or research scientist whose work involves the terrestrial global circulation, and who already has a sound grounding in dynamical meteorology, will find the text invaluable. It brings together a great deal of material which otherwise must be sifted out of large volume of original papers. I am less certain whether a Bachelor or Master level student, whose grasp of basic dynamical theory is likely to be less secure, would be advised to start their study of the global circulation with this book. But they should certainly be aware of it as their studies progress.

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Energy and Water Cycles in the Climate System, eds. Erhard Raschke and Daniela Jacob, NATO ASI Series, Series I: Global Environmental Change, vol. 5, Springer Verlag, 1993

Water is perhaps the one molecule whose formula can be quoted by the general public. Despite this familiarity, as a chemical compound water possesses rather unusual physical properties. There are these properties which make water the source of life on earth and the molecule which, residing in all of its three phases in the atmosphere, determines world climate. Water vapour in the atmosphere is the principal natural greenhouse gas which absorbs long-wave, infrared radiation emitted by the earth's surface, preventing surface temperatures from falling well below freezing. In both its liquid form, as cloud water droplets, and as solid ice crystals in high cirrus clouds, water is highly efficient at reflecting short-wave solar radiation back to space. In deep convective cloud systems, water serves as a medium to transport momentum and heat to higher levels in the atmosphere. Energy and water cycles in the atmosphere are thus strongly linked. Furthermore water makes up 70% of the surface of the earth. Due to their large heat capacity, the oceans have an important role as a buffer to temperature change. These processes are the basis of our understanding of world climate.

Energy and Water Cycles in the Climate System represents the proceedings of the NATO Advanced Study Institute on Energy and Water Cycles, held in Germany during 1991. The fifteen lecturers from various European countries, who participated in this course, have each contributed a chapter to the book relating to their specific research interests. The resulting publication of 467 pages does not dwell heavily on theory but presents detailed information on the current state of knowledge relating to cloud processes, atmospheric radiation, precipitation, ocean circulation, surface fluxes and remote sensing. In certain chapters minor linguistic mistakes do occur, though the text is generally prepared in an easily readable style.

The book consists of the following chapters: Chapter 1 deals with thermodynamics of the atmosphere and the water cycle, while global climate modeling is the topic of chapter 2. Chapter 3 describes the properties of clouds and their interaction with radiation. Convection and large-scale cloud processes are the topics of chapter 4. Chapters 5 and 6, by the same contributor, concern remote sensing of clouds from satellite observations. In chapter 7 we read about methods for assessing global precipitation whereas chapter 8 addresses the problems of data assimilation from the viewpoint of statistical analysis. Chapter 9 discusses fluxes of energy, water and momentum from the ocean surface and chapter 10 presents ocean circulation modeling. Measurements of air-sea fluxes are described in chapter 11. Chapter 12 is a review of the current state of knowledge concernig sea-ice interactions in polar regions. In chapter 13, the role of the soil-vegetation-atmosphere interface on the hydrological cycle is addressed. Chapter 14 pertains to the planetary boundary layer, turbulence and mixing processes. Chapter 15, the one chapter which is the combined work of several authors, focuses on transport and phase transitions of water in the global hydrological cycle.

Energy and Water Cycles in the Climate System is a comprehensive compilation of the combined work of many specialists. It presents the most recent results of researchers' involvement with physical processes in the atmosphere and on the earth's surface which determine global climate. It is a useful reference book for any scientist concerned with climate research.

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The Use of EOS for Studies of Atmospheric Physics, eds. J. C. Gille and G. Visconti, Intern. School of Physics "Enrico Fermi", vol. CXV, North Holland, 1992; US $250.00, Dfl. 400.00.

The book is a collection of papers presented at the Course held in Varenna on Lake Como, Villa Monastero, on 26 June to 6 July, 1990. Speakers represented mainly Italian, U.K. and U.S. laboratories, but important contributions were made by Canada, Japan and Norway. In general, the subject focusing the attention of presentations and discussions was EOS—the Earth Observing System; the centerpiece of NASA's Mission to Earth imitative. EOS consists of a space-based observing system, a Data and Information System (EOSDIS) and a scientific research program. As a sizeable interdisciplinary program, EOS may become one of the most important scientific efforts in the early decades of the 21st century, aimed at observing the main components of the Earth System. The outcome of the program should enhance the capability of the scientific community to predict future changes in the Earth system and to identify specific dangers.

In this perspective, the book plays an extremely important role as a source of information regarding the scientific background of EOS, its observing tools and systems of data dissemination. This knowledge is necessary to all research centers and individual scientists who may join the program or who are potential users of EOS data. For many groups the book may open new prospects in their research planning for the next decade. In this respect, the book is worthy of the attention of a wide circle of the scientific community.

But the book is not only a thorough review of information concerning EOS. It is something considerably more. Presenting the scientific background of EOS, the book becomes a compendium of the present status of knowledge on main Atmospheric Physics issues connected to climate formation and change. It may be used as a handbook, because each issue is presented in the form of a complete course, including fundamentals, and supplemented by references. The total number of references cited in individual chapters exceeds 700. The broad scope of topics discussed makes a detailed critical review by a single referee impossible. We will try only to present a general observation of the content which may be useful for potential readers.

The subject of the book is delivered within 25 chapters of 33 authors, with a very informative and comprehensive introduction written by the editors.

Four parts of the book: the Overview, The Troposphere, The Climate, The Middle Atmosphere—are organized such that discussion of physical problems is followed by a presentation of remote sensing approaches developed for EOS, in application to a specific group of Earth system elements.

In the first part ("Overview") we find the presentation of general background and basic information on EOS, including a short review of planned spacecrafts, observing systems and data dissemination networks.

The second part: "The Trophosphere" includes chapters related to the atmospheric chemistry and thermodynamic processes, as well as to the corresponding measuring techniques: correlation spectroscopy for tropospheric pollution measurements (MOPITT system), tropospheric emission spectrometer (TES), and infrared sounding (AIRS system).

Part 3, "The Climate" considers the problems of global and regional climate modeling, satellite cloud observations, and different remote sensing techniques for climate studies, moderate and high resolution imaging spectrometry and intermediate thermal IR radiometer.

Part 4 is devoted to the Middle Atmosphere. The first chapter refers to the Fundamentals of Atmospheric Dynamics (as challenge for EOS). Thereafter, problems of transport and chemical processes in the Middle Atmosphere are discussed, as well as different advanced remote sensing techniques for this domain (limb observations in different infrared intervals).

In the concluding chapter we find ample material addressing submillimeter hetorodyne spectroscopy (for Middle-Atmosphere remote sensing applications). This chapter is supplemented by 3 Appendices with a catalogue of spectra, theoretical background and data pertaining to the codes used for absorption coefficients calculations.

Summarizing, the volume may be very interesting and useful for scientists who specialize in different areas of atmospheric physics and remote sensing. They will find, in the book, not only a contribution to their specialized studies, but also interfaces with other specific areas of atmospheric science. Additionally, the interdisciplinary approaches are often extremely creative.

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Fundamentals of Atmospheric Energetics by Aksel Wiin-Nielsen and Tsing-Chang Chen, Oxford University Press, 1993, US $55.00.

This is a well written textbook of atmospheric energetics for students of graduate courses in atmospheric sciences, and its content is rich enough to also make it a useful manual for professionals in this field, particularly those who are not involved directly in energetics research but who desire to extend their knowledge of this subject.

The book consists of the Preface, 17 chapters (1. Introduction, 2. Some Elementary Considerations, 3. Basic Aspects of Atmospheric Energy, 4. Available Potential Energy, 5. Barotropic and Baroclinic Flow, 6. Transport of Sensible Heat and Momentum, 7. Zonal and Eddy Energies, 8. Wavenumber Representations, 9. Divergent and Nondivergent Flow, 10. Interaction Among Waves, 11. Energetics and Predictability, 12. Energetics in an Open Domain, 13. Energetics and Some Special Phenomena, 14. Quasiperiodic Variations of Atmospheric Energetics, 15. Energetics of the Tropics: Planetary Scale, 16. Energetics of the Tropics: Synoptic

Scale, 17. Energetics of the Southern Hemisphere), Problems, Exercises with Answers, Bibliography, Author Index and Subject Index; collectively 376 pages.

As can be seen from this list, approximately half of the book's content is devoted to the basic concepts and methods used in studying the energetics of atmospheric phenomena, while the balance presents applications of these tools to particular but important cases. The authors are attentive to the didactic side of the book, which as a whole is written clearly and takes into account the needs and intellectual possibilities of a typical student. The calculations, usually simple in principle but often cumbersome in details, can be easily followed. The authors avoid the use of too advanced mathematics, for instance they don't consider orthogonal expansions other than ordinary or spherical harmonics in the horizontal and one particular Sturm-Liouville-type set in the vertical. The leading ideas and main problems are well pointed out. The only serious discomfort for the reader may follow from frequent changes of the meaning of certain symbols; one must be careful not to become confused. Of course we often encounter the problem of dealing with more notions than we have symbols for, but more consistency in that point, as well as supplying the volume with a Symbol Index, would certainly be very helpful. Other minor drawbacks are the sporadic appearance of non-SI units and perhaps the use of the somewhat misleading term "vertical mean flow" (which suggests mean flow in the vertical direction) instead of "vertically averaged flow" (to which the text in fact refers); also the Subject Index perhaps could be more inclusive. A good solution, from a didactic point of view, is separating the 13 problems conceived as training in thinking about the subject, from exercises of simply computational type. The bibliography containing 179 entries completed with an Author Index makes the book a convenient reference for a wide spectrum of users.

The book should find its place in libraries of Physics and Earth Science departments of universities and other scientific institutions, as well as in many personal book collections of scientists dealing with the physics of planetary atmospheres.

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Eddy Structure Identification in Free Turbulent Shear Flows, eds. J. P. Bonnett and M. N. Glauser, Fluid Mechanics and Its Applications, vol. 21, Kluwer Academic Publishers, 1993; Dfl. 295.00, US $174.00, UK £117.00.

This book collects a selection of papers presented at the IUTAM Symposium held in Poitiers France in the autumn of 1992. The subject matter is data processing techniques used to identify the large eddy structures in turbulent shear flows. The single and two point hot wire detectors of the past have given way to arrays of anemometers feeding data into high-speed computers which perform sophisticated data analyses in an attempt to educe the coherent structures. More recently, the same techniques have been applied to flow fields produced by computer simulations of turbulence (DNS). These papers cover recent technical advances including conditional sampling, wavelet transform analysis, pattern recognition analysis, proper orthogonal decomposition analysis, and stochastic estimation techniques. There is an informative review by Ferre and Giralt pertaining to the general problem of turbulence signal analysis, and an outstanding review of eddy structures in manipulated channel flow simulations by Savill *et al.*

It is by now well recognized, that in shear flow turbulence coherent structures are the prime agents of turbulent eddy transfer and energy generation and that the study of these structures promises to provide a deeper understanding of the turbulence process. Physical theory requires a basis in observations and an understanding of these structures requires the design of sophisticated identification and analysis techniques. This is a particularly difficult task in the case of laboratory flows compared with data analysis of another turbulent fluid: the earth's atmosphere, perhaps the most intensively observed turbulent fluid. Because of the large scale of atmospheric flow (a million times larger than a typical laboratory device) and the presence of natural tracers such as clouds, not to mention thousands of daily weather observations, the coherent structures in this flow, e.g., the midlatitude cyclone, have become familiar. Meteorology is so centrally involved with understanding its coherent structures that meteorologists have long since adopted what is the new orthodoxy in the study of laboratory turbulence.

While active research in data acquisition and analysis continues in meteorology, in the study of laboratory turbulence, data acquisition and processing are central challenges and these papers reveal substantial progress in addressing these problems. On the other hand, the reader anticipates that data analysis should be motivated and guided by theoretical understanding. This important interaction is missing, making this book less useful than it might have been.

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