

unknown or little understood before 1970—are at the center of atmospheric research, domestic regulation, and international affairs. With regard to international affairs, witness the broad effect on US–European relations of the Bush administration’s rejection of the Kyoto Protocol on climate change.

Atmospheric pollution emerges from almost every form of human activity, so it is clear that attempts to limit pollution must be comprehensive. Efforts to extract an understanding of the causes and consequences of pollution, particularly global warming, reach backward into the earliest epochs of Earth’s history and project forward a century or more.

Mark Jacobson’s new undergraduate textbook *Atmospheric Pollution: History, Science, and Regulation* captures important parts of the vast panorama of science and human experience related to the atmosphere. Jacobson is an associate professor of civil and environmental engineering at Stanford University. His recent work on the role of soot in global warming is groundbreaking. His book covers a field so large that no previous text has satisfactorily reflected the full array of problems and issues, particularly as an introduction for science majors. Jacobson’s book also falls short of that objective, but may be the best available.

Starting with a basic introduction to Earth’s geologic history, atmospheric structure, composition, and chemistry, Jacobson discusses the origins of smog, its effects, and global efforts to regulate it. Some details of smog chemistry are discussed at too great a length, but the narrative is clear, the figures have strong pedagogic value, and the photographs are thoroughly engaging. Too little is said about regional smog and its long-range transport, a problem that now assumes transcontinental scale, and too much is said about aerosol-related air pollution. The latter is understandable because aerosols are at the center of Jacobson’s recent research.

The text is highlighted with interesting stories that dig deeper than most anecdotes. For example, similar books often note that Thomas Midgley Jr invented both tetraethyl lead and chlorofluorocarbons. The use of tetraethyl lead as a gasoline additive was responsible for widespread lead poisoning in children and chlorofluorocarbons cause ozone depletion. Some books note the irony that this prolific inventor, who suffered from polio later in life, died by entanglement in a hoist he had designed to lift

his body upright in bed. But few, if any, have delved into the interesting, relevant, and unfortunate details of the decision, by Midgley and others, to pursue tetraethyl lead over other, possibly safer, alternatives. Such historical notes richly complement the scientific details.

After a discussion of meteorology that is advanced enough that it may confuse some beginners, Jacobson moves on to comprehensive chapters on indoor air pollution, acid deposition, ozone depletion, and acid rain. The strongest of these chapters treats ozone depletion. The weakest, on global warming, contains only a skimpy discussion about the impacts of temperature increase and other climate changes. More problematically, the scientific details in that chapter are sometimes outdated.

Overall, the book carefully builds a framework for understanding atmospheric issues, and that framework provides a solid basis for examining what might be done to address those issues. The problems at the end of each chapter are simple, yet instructive. The text doesn’t condescend with oversimplification and is only occasionally too difficult for a beginning science major.

My one disappointment is that regulation too often receives cursory treatment. The subtitle of the book suggests a balance in the content that is not really achieved. In particular, only one sentence addresses the landmark emissions trading provision of the 1990 Clean Air Act amendments. Furthermore, little in the sections on ozone depletion and global warming reflects the potential impacts of proposed or implemented policies. *Atmospheric Pollution* is not a resource for understanding air-pollution policy, but it is a well-rounded introduction to problems of the atmosphere and offers rich material for students contemplating their solutions.

Michael Oppenheimer
Princeton University
Princeton, New Jersey

An Introduction to Seismology, Earthquakes, and Earth Structure

Seth Stein and
Michael Wyssession
Blackwell, Malden, Mass., 2003.
\$34.95 paper (498 pp.).
ISBN 0-86542-078-5

Seismology is the study of earthquakes and Earth structure using the

waves that accompany quakes and other Earth vibrations. Analysis of those seismic waves is the basis of most current knowledge about our planet’s interior. Seth Stein and Michael Wyssession, two highly regarded seismologists, have written a massive book that is a welcome addition to the handful of seismology texts appropriate for graduate or advanced undergraduate study. But with its enormous quantity of material, often presented in detailed figures, and its emphasis on deep-Earth examples, *An Introduction to Seismology, Earthquakes, and Earth Structure* is a valuable reference for specialists as well.

The text covers the meat and potatoes of seismology—seismic-wave propagation, Earth structure, and earthquake sources. Much more is presented, though, including plate tectonics, signal processing, seismometry, and inverse theory. An extensive appendix outlines matrix algebra, vector calculus, and even principles of computer programming. Each chapter ends with a brief discussion of classic and current references, followed by homework problems. Some of those problems are designed to be solved with computers. Answers to odd-numbered problems are in the back of the book, and solutions to all of them are available to instructors over the Internet.

Stein and Wyssession begin their book with an introduction on the societal implications of earthquakes, which, worldwide, cause significant economic disruption and an average of more than 10 000 deaths per year. The authors then present the basic seismological theory, beginning with a rather long section that discusses waves on a string. That treatment is followed by a more traditional development of waves in elastic solids, moving from stress and strain to wave equations. The book fully treats reflection and transmission of waves, including conversions between compressional and shear waves.

Theory, starting with reflection and refraction techniques, is then applied to determine Earth structure. Stein and Wyssession pay particular attention to waves that travel through, bounce off, or refract around Earth’s core. That’s perhaps not surprising, because Wyssession’s research is in deep-Earth structure. The development of wave propagation is followed by a welcome section on the implications of seismological results—particularly Earth’s radial velocity structure—for the composition of the crust, mantle, and core.

Stein and Wyssession thoroughly describe earthquake sources and include

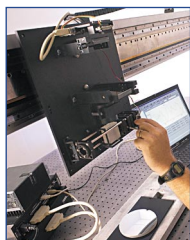
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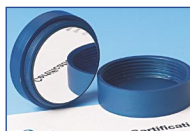
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a useful account of body and surface waveform modeling. Also notable is their discussion of ground deformation during the entire earthquake cycle, and new deformation mapping techniques, such as those using interference of space-based radar images.

The material on plate tectonics highlights one of Stein's research specialties, the thermal evolution of the lithosphere. The text offers a clear and complete explanation of how a single physical process—the cooling of the lithosphere at mid-ocean ridges—controls ocean depth, plate thickness, and heat flow.

The description of the heating of oceanic plates as they reenter the mantle at subduction zones is likewise well developed. The mathematical descriptions of the lithosphere lead naturally to a clear explication of the forces that drive tectonic plates. The book presents, as well, extended and appreciated discussions of faulting, friction, and crustal strength.

The clear, precise, but sometimes long-winded style of the book reflects its comprehensive nature. The lengthy, thorough discussions contrast with the elegant brevity of Peter Shearer's *Introduction to Seismology* (Cambridge U. Press, 1999). On some topics, the book's very thoroughness renders it unwieldy, and the mathematical formalism is sometimes more complicated than necessary. Look elsewhere for a quick refresher on Snell's law—even the subscripts have subscripts.

The book's numerous figures are a key asset. Those illustrations, available online, often seem to have been constructed particularly for the text. In many cases, they compactly convey large amounts of detailed information. For example, a number of figures illustrate the surprising complexity of the interaction of seismic waves with material having jumps or gradients in wave velocity. That complexity is better conveyed by Stein and Wysession's book than any other text I know of.

An Introduction to Seismology, Earthquakes, and Earth Structure is a very good text with an up-to-date point of view. It's a bit expensive for a course textbook, but it is quite versatile. The large amount of material covered makes the book useful for several different courses. As the basis for a standard seismology course, it would work best for the more tenacious student. The text is appropriate for a geophysically oriented plate-tectonics course or for a course on time-series analysis and inverse theory with examples and homework problems taken from geophysics. All in all, it is

an indispensable reference for serious students of solid-Earth geophysics.

Heidi Houston
University of California
Los Angeles

New Books

Acoustics

Shock Focussing Effect in Medical Science and Sonoluminescence. R. C. Srivastava, D. Leutloff, K. Takayama, H. Grönig, eds. Springer-Verlag, New York, 2003. \$79.95 (226 pp.). ISBN 3-540-42514-4

Underwater Acoustic Modeling and Simulation. 3rd edition. P. C. Etter. Spon Press, New York, 2003 [1991]. \$150.00 (424 pp.). ISBN 0-419-26220-2

Astronomy and Astrophysics

Concise Catalog of Deep-Sky Objects: Astrophysical Information for 500 Galaxies, Clusters and Nebulae. W. H. Finlay. Springer-Verlag, New York, 2003. \$39.95 paper (248 pp.). ISBN 1-85233-691-9

Dark Matter in Astro- and Particle Physics. H. V. Klapdor-Kleingrothaus, R. D. Viollier, eds. Proc. conf., Cape Town, South Africa, Feb. 2002. Springer-Verlag, New York, 2002. \$249.00 (663 pp.). ISBN 3-540-44257-X

Energy Conversion and Particle Acceleration in the Solar Corona. K.-L. Klein, ed. *Lecture Notes in Physics* 612. Springer-Verlag, New York, 2003. \$62.00 (319 pp.). ISBN 3-540-00275-8

Extreme Ultraviolet Astronomy. M. A. Barstow, J. B. Holberg. *Cambridge Astrophysics Series* 37. Cambridge U. Press, New York, 2003. \$90.00 (390 pp.). ISBN 0-521-58058-7

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Galaxies at High Redshift. I. Pérez-Fournon, M. Balcells, F. Moreno-Inertis, F. Sánchez, eds. Proc. sch., Santa Cruz de Tenerife, Tenerife, Spain, Nov. 1999. Cambridge U. Press, New York, 2003. \$95.00 (275 pp.). ISBN 0-521-82591-1

Galaxies: The Third Dimension. M. Rosado, L. Binette, L. Arias, eds. *Astronomical Society of the Pacific Conference Series* 282. Proc. conf., Cozumel, Quintana Roo, Mexico, Dec. 2001. Astronomical Society of the Pacific, San Francisco, 2002. \$57.00 (552 pp.). ISBN 1-58381-125-7

Gamma-Ray Burst and Afterglow Astronomy 2001. G. R. Ricker, R. K. Vanderspek, eds. *AIP Conference Proceedings* 662. Proc. wksp., Woods Hole, Mass., Nov. 2001. AIP, Melville, N.Y., 2003. \$198.00 (594 pp.). ISBN 0-7354-0122-5

Gravitational Lensing: An Astrophysical Tool. F. Courbin, D. Minniti, eds. *Lecture Notes in Physics* 608. Springer-Verlag,