Atmospheric Thermodynamics. Craig F. Bohren and Bruce A. Albrecht. 402 pp. Oxford University Press, New York, 1998. Price: $65.00 (cloth) ISBN 0-19-509904-4. (Reviewed by Daniel V. Schroeder.) Published in Am. J. Phys. **68** (12), 1159–1160 (2000), <http://dx.doi.org/10.1119/1.1313524>.

Why does thermodynamics have a reputation for being so abstract? Applications of thermodynamics abound, in fields ranging from engineering to biology to meteorology. Yet our undergraduate thermodynamics courses for physics students tend not to cover many applications. Moreover, the applications we do discuss tend to be pretty esoteric—paramagnetism and liquid helium and white dwarf stars—the sorts of things found only in physics laboratories, or outside our solar system. I often wonder whether declining enrollments in our upper-division physics courses aren't caused, at least in part, by the apparent irrelevance of these courses to students' everyday lives.

Few writers are better at explaining the physics of everyday life than Craig Bohren, author of *Clouds in a Glass of Beer* and *What Light Through Yonder Window Breaks?*, two delightful paperbacks on "simple demonstrations in atmospheric physics" (Wiley, 1987 and 1991). In *Atmospheric Thermodynamics*, Bohren and coauthor Bruce Albrecht provide not only clear verbal explanations of all sorts of everyday thermal phenomena, but also back up their explanations with mathematics, at a level suitable for anyone comfortable with calculus and an occasional differential equation.

Ever wonder how much you can cool air by evaporation? Under what conditions will atmospheric convection occur? At what altitude will cumulus clouds form? Why don't clouds fall from the sky? Or do they? Why does our comfort depend so much on humidity, in cold weather as well as warm? Why does warm air "hold" so much more water vapor than cold air? Why does humidity have such a large effect on nighttime temperatures? How do cloud droplets turn into rain drops? When will a cloud form on your breath? Why is visibility so poor when the humidity is high? Answers to these questions and many others will be found in this book.

Although the book emphasizes applications to Earth's atmosphere, it also does much more. Intended as a textbook for undergraduates majoring in meteorology, it is a fairly complete introduction to classical thermodynamics and kinetic theory. (There is no statistical mechanics.) Ideal gases, adiabatic processes, phase transformations, properties of mixtures, and elementary transport theory are discussed in detail. In addition to the meteorological applications there are many others, generally drawn from the everyday world: automobiles, heat pumps, cooking, glaciers, and so on.

The book's strengths include its vivid kinetic explanations, careful rebuttals of common misconceptions, well-researched biographical asides, and fascinating, open-ended, end-of-chapter questions and problems. Despite the book's formal appearance, the writing is lively and often humorous. The preface alone is worth reading just for a good laugh (actually several). Elsewhere in the book we encounter an analogy between heat capacity and capacity for holding one's liquor, a eulogy for the dozens of dead equations of state, the story of a recent recipient of the Darwin Award, and a disclaimer that the U.S. Standard Atmosphere is "a composite atmosphere designed by a committee, not a column of air preserved in a long glass tube in Boulder, Colorado."

Any book so interesting and quirky is bound to have faults; this book has several. The mathematical derivations tend to be poorly motivated and awkwardly presented. Occasionally there are careless overgeneralizations, true for the application at hand but not in other situations. The book has too few easy problems, limiting its usefulness to students who are new to the subject.

The most noticeable quirks, though, are in matters of terminology and notation. In a long-winded (and very entertaining) diatribe at the end of Chapter 1, the authors correctly point out that many other books use the word *heat* in confusing ways. They then throw the baby out with the bathwater and declare that they will never use the word *heat* as a noun. (They don't quite keep the promise.)

Similarly, in Chapter 3 there is a lengthy discussion of the evils of the usual thermodynamic notation for differentials and partial derivatives. So, in an effort to make the notation look more like what students see in first-year calculus, the authors insert a dt under each differential, turning it into a rate of change. Whether the familiarity of this notation makes up for the distraction of bringing time into the equations is debatable. More frustrating to me was the lack of subscripts showing which variables are being held fixed in partial derivatives. At best, this practice forces the reader to scribble lots of notes in the book's narrow margins. At worst, it leads the authors to derive an incomplete formula for the temperature dependence of the latent heat on page 197.

But please don't let these blemishes dissuade you from reading this book. Every physics teacher will benefit from its insights. Students will also enjoy it, especially if they've already worked through a more conventional thermodynamics textbook. For any *AJP* reader who is curious about the world we live in, *Atmospheric Thermodynamics* offers a fascinating tour of a rich and relevant field of applied physics.

Daniel V. Schroeder was trained in elementary particle theory at SLAC, but has grown to love thermal physics while teaching and writing about it over the last several years. He teaches at Weber State University in Ogden, Utah.