Maarten H. P. Ambaum

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This is a fully revised version of the textbook with the same title originally published in 2010. The author is a professor at the University of Reading with strong background in theoretical physics.

There are already a handful of textbooks on atmospheric thermodynamics around. However, this book stands out among them by virtue of its unique features, as was already noticeable in the first edition: the book introduces atmospheric thermodynamics from a point of view of basic physics. The book does not restrict itself to the narrow topics of thermodynamics, but instead, as the book title suggests, it tries to cover every possible topic in physics that is necessary for defining the thermodynamic state of the atmosphere. Thus, the book includes the two chapters on radiative transfer: a careful derivation of the Stephan–Boltzmann law is especially unique, because such a discussion of the subject is often omitted even from textbooks on radiative transfer. The chapter on the treatment of cloud drops could be considered a good introduction to the cloud microphysics: the chapter presents how a liquid droplet can be formed under a supersaturated state (the Köhler effect), the rate at which it grows by absorbing available water vapour, and finally, how it grows even larger through a process of collision and coalescence with other droplets.

Contemporary researchers tend to consider the basic knowledge of physics as something just to pick and use, like recipes out of cooking books. Unfortunately, however, both are very different. If a recipe does not work, what you have cooked will probably neither look nor taste good. On the contrary, the application of the wrong physics often produces a reasonable number. Thus, we always need to know the underlying source of knowledge and the limits. This book is written in this spirit: it introduces undergraduate-level knowledge of thermodynamics (or more precisely, thermal physics) to graduate-level atmospheric-science students, who are preparing themselves for their own research. Chapters and sections are well arranged so the book can also be helpful to senior researchers who wish to refresh their knowledge of thermodynamics.

Another challenge for writing a textbook on thermodynamics for atmospheric science is the fact that the problems that atmospheric scientists are attempting to solve are no longer ‘inside a box’, as is implicitly assumed in standard physics textbooks. The atmosphere is always in move: it is far from being in equilibrium, for to be in equilibrium there must be no motion. Therefore, to start with, the book needs to explain how and why we can still talk about all the thermodynamic variables, such as temperature, pressure, etc. in the atmosphere, when it is not at all in equilibrium. There is quite a gap to be bridged between the classic topics of thermodynamics and dynamics in order to combine them properly for applications in atmospheric science; however, this book does this well. The concept of *local thermodynamic equilibrium* is introduced right at the beginning of the book (p. 5), and the transport of thermodynamic variables is discussed in Section 3.7. The contribution of gravity in thermodynamics, which is normally not covered in standard physics textbooks, is the focus of Chapter 4, with a section dedicated to the concept of hydrostatic balance. This section of the book concludes with global maps of geopotential height and height differences to suggest how this basic concept is more explicitly exploited in weather diagnoses. After

completing a parcel stability analysis, and introducing the Brunt–Väisälä frequency, the author explains in Section 4.4 that the true oscillation rate of the atmosphere is provided by the internal gravity-wave dynamics, presenting its explicit dispersion relation. The Bernoulli function is then introduced as a natural extension of the moist static energy in Section 4.5, whilst Section 4.6 shows how some basic knowledge of thermodynamics is exploited in defining vertical coordinates.

The first two chapters introduce the basics of the thermodynamics of the ideal gas with a well-balanced description from both macroscopic and microscopic perspectives, but by avoiding unnecessary complex descriptions of statistical mechanics – these come later in Chapter 4. From there, the book develops the basic knowledge of the thermodynamics with the atmospheric applications in mind. The book concludes with the applications of the thermodynamics to the climate dynamics (Chapter 11). Here, a short but self-contained introduction to the so-called minimum and maximum entropy production principles is presented. Of course, it merely constitutes an entry point to a vast domain of investigations. However, even with a very succinct introduction, the author does not fail to suggest inherent limitations of both principles.

The strength of the book is that it sticks to the basics. I would say that it amply covers everything that a student might need to know about descriptions of the thermodynamic state of the atmosphere. Some readers may notice that many atmospheric thermodynamics variables are not mentioned (e.g. liquid–water equivalent potential temperature). However, most of us would be busy with mastering different details. In short, this is a book for every atmospheric scientist to read from the beginning to the end. The book has been substantially revised from the original edition, with a number of interesting new topics, so it is worth investing in a new copy, especially if you are planning to make this a core text in an academic course.

Jun-ichi Yano

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