READINGS

ATMOSPHERE, CLOUDS, AND CLIMATE
David Randall, 2012, 288 pp., $27.95, paperbound, Princeton University Press,
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For those of us who, perversely, spend our days studying climate and then go home and spend our leisure time reading about climate, there is no doubt that David Randall's *Atmosphere, Clouds, and Climate* is a great read. It is a whirlwind tour of grad-school topics, with sprinklings of historical context, related fields, and advanced topics that keep the pages turning. This book is part of the *Princeton Primers in Climate*, though, so we are not the intended audience. Instead, this book is aimed at college undergraduates according to the preface, and at "students, researchers, and scientifically-minded general readers" according to the back cover. Bearing in mind these audiences, how effective is this book?

The breadth of this slim volume is impressive. Basic processes like radiative transfer, condensation, and turbulence are covered, as are climatic features like monsoons. Cumulus convection is covered in detail, and nicely tied to large-scale phenomena like the Hadley-Walker Circulation and ENSO. Climate feedbacks are described, surpassing the expected thumbnail view using the ice-albedo feedback as an example to include more nuanced (and more interesting) effects like the fixed-anvil temperature hypothesis for tropical cirrus longwave effects and the shortwave effects of low-level clouds. Predictability gets its own chapter, as do coupled processes. All this is achieved in just over 200 paperback pages, and with uncommon succinctness and clarity.

Throughout my reading of the book, I tried to channel my past self: an undergraduate physics major who has a vague notion about climate (and/or clouds) being an interesting topic for graduate study. The broad scope of the book provides a survey of topics that could help a prospective graduate student hone their personal statement. More than that, the book opens the door to the climate system by providing physical reasoning for many fundamental atmospheric processes. One clear strength of this book is that its arguments are consistently presented in terms of energy and mass, for which the science or engineering student should have developed some understanding and intuition. Incorporating moist thermodynamics can get messy, but is dealt with deftly here, for example by using moist static energy instead of introducing the arcane "temperatures" that have perplexed more than just graduate students over many years.

The tone is conversational, and the language is kept simple with as little jargon as possible. These are good features for a book aimed at novices. It is terse, though, with jokes and puns averaging about one per chapter (yes, I kept track). A cynic might ask whether, in an age of Twitter and YouTube, today's undergraduates have the tenacity to reach the end of the book. Those who do, I think, will be well rewarded. They might be drawn toward the field of climate science, too, as there are a few baited hooks within the pages: allusions to using the world's most powerful computers, the allure of studying chaotic systems, the adventure of wading into the

world of big data, and the applicability to important societal issues. These are the lures that climate science has at its disposal for recruitment.

As for researchers and scientific-minded general readers, the breadth and clarity of the book should satisfy most. For those in other fields looking to better understand climate science, this book will pair well with some of the popular accounts of the field, allowing the reader to gain a deeper appreciation for the physical science. Graduate students in other disciplines, especially those whose work might be related to climate science, will likely reap the greatest benefits from a careful reading. Nonexperts who teach undergraduate courses on climate should cull from this book useful analogies and explanations, and for small classes this would make a terrific supplementary text to complement a course.

The book has some weaknesses, but they probably vary depending on what the reader is expecting. Experts will undoubtedly feel their own topic has been short-changed, but there is no way around that, even across the whole series of primers in climate. Casual readers might think the text is too dry, but this book is not a history lesson, memoir, nor a narrative account, and it makes no claims to be so. There are historical references that help illustrate the concepts being discussed, but there are no stories or personal accounts or biographical sketches of the founders of the field. Some of the end notes, references, and further reading suggestions will guide interested readers to other sources, and both popular and technical literature is included. Given the brevity of most sections, however, readers might need a little more help. An annotated "further reading" section could have provided that extra nudge toward the most appropriate reading on each topic. Similarly, the final chapter, "Frontiers," could have been expanded. After the expeditious survey of the first eight chapters, it would have felt better to slow down and ruminate on future directions and challenges. The last chapter is only a fleeting glance toward the wider world of current and future research.

I have never read a book like *Atmosphere, Clouds, and Climate*. At the level presented, there is no better description, to my knowledge, of the role that clouds play in the climate system. The clarity and authority that Randall brings to the work are obvious in every chapter. A wide spectrum of readers will be satisfied by this book, but hopefully not so satisfied that they stop here. This book is, as a primer should be, an initiation to a vast field, providing the tools and motivation necessary to take the next steps.

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