COMPREHENSIVE PICTURE OF EARTH'S CLIMATE SYSTEM

Physics of Climate

José P. Peixoto and Abraham H. Oort
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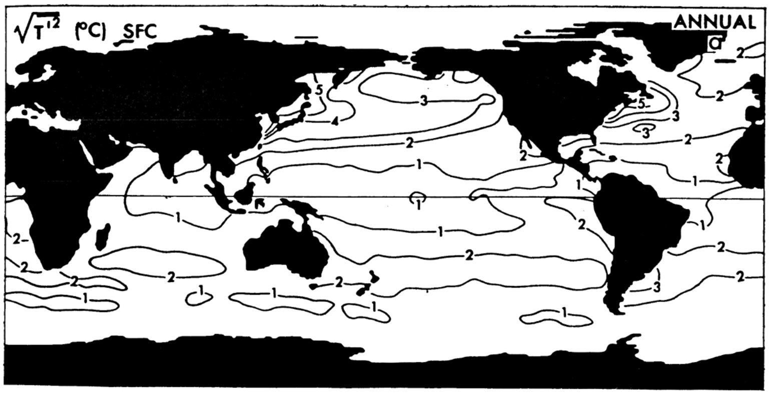
Reviewed by Curt Covey and Karl E. Taylor

This book fills a long-standing need. Several recent journal reviews and books address either past climate changes or theoretical predictions of future climates, notably global warming from a human-enhanced greenhouse effect. These works give relatively little attention, however, to observations of the present-day climate. Such observations have accumulated in great numbers over the past few decades. During this time weather balloons have been launched twice a day simultaneously from hundreds of stations around the world, merchant ships and dedicated oceanographic expeditions have collected a smaller but still impressive data set, and satellites have observed cloud cover, sea ice and numerous other variables. (The data will increase by orders of magnitude in coming years through expanded satellite coverage and international programs such as the ongoing World Ocean Circulation Experiment.)

José Peixoto and Abraham Oort draw heavily from their own compilations of such data to present, in over 200 charts and graphs, a comprehensive picture of Earth's climate system. *Physics of Climate* is much more than an atlas or descriptive text, however. The first 20% focuses on the mathematical description of feedbacks among different components of the climate system and the fluid-dynamical and radiation-transport equations that govern the evolution of the oceans and atmosphere. These equations, which form the basis of numerical weather prediction and three-dimensional global climate modeling, are derived from a starting point familiar to readers conversant with classical physics [including fluid dynamics at the level of the first chapter in Landau and Lifshitz's book *Fluid Mechanics* (Pergamon, New York, 1959)]. A brief concluding chapter describes the application of these equations to mathematical climate modeling.



Global distributions of the daily standard deviation of ocean temperature at the surface in °C. (From *Physics of Climate*.)

The heart of the book deals with observed flows of conserved quantities within the atmosphere and the oceans. Mass, momentum and energy are addressed in forms traditional to geophysical fluid dynamics. Mass and momentum budgets are presented in terms of stream function and angular momentum, respectively, while the small fraction of potential energy that is actually available for conversion to kinetic energy is separated out explicitly. The authors derive the appropriate conservation equations from the equations of motion presented earlier. In addition, they present flows of entropy and of atmospheric water in its various phases. Theoretical climate modelers will now be delighted to have on hand a synthesis that places observations in this context.

Each page is densely packed with mathematical derivations or observational facts. With few exceptions—mainly in the discussion of radiation transport—the information is clearly described and well organized. However, the book's sheer volume will probably intimidate beginners. Instructors of first-year graduate courses would do better to use a shorter text, such as John T. Houghton's *The Physics of Atmospheres* (Cambridge U. P., New York, 1986). This and other textbooks also cover two topics missing from *Physics of Climate*: comparative planetary atmospheres and linear stability analysis of the equations of motion. Those who make their way completely through *Physics of Climate*, however, will emerge with a firm foundation for reading the technical literature. Furthermore, those of us with more experience but less time than students will find this book a superb reference. It belongs on the shelf of anyone seriously interested in meteorology and climatology.

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