



Global Warming: Understanding the Forecast, D. Archer,
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It has been argued that the current controversy surrounding global warming is a result of the scientific community not doing enough to educate the general public about the state of our scientific understanding. Indeed, translating the results from such disparate fields as climatology, electromagnetic physics, biology, and geology in a manner easily grasped by nonscientists is a formidable task. This task usually involves separating out (1) what is known and unknown, i.e., what is the current state of knowledge; (2) what is knowable and unknowable, i.e., what are the uncertainties and the limits of our basic approach; and (3) what do we do about it—implications for policy. Oftentimes, people trained in one of these aspects may have only a passing knowledge of the others. Of course, this does not limit them from having very strong opinions on the matter, particularly when it comes to the implications of the science for policy.

The book *Global Warming: Understanding the Forecast* addresses these issues at the level of an introductory undergraduate basic science course. The approach is aimed at a level where no science background is assumed and the math that is presented is basic algebra. The text is filled with examples from everyday life and, whenever possible, results are shown in a graphical nature. One of the truly wonderful things about the book is that each chapter ends with selected projects rather than the usual assignments focusing on simply solving an equation for a single unknown variable. These projects often reference the accompanying website (www.understandingtheforecast.org) where the reader can explore some of the topics in the text by altering the parameters of various radiative and global climate models.

The text consists of three primary parts: The Greenhouse Effect, The Carbon Cycle, and The Forecast; these are divided into 13 chapters, the bulk of which (six) are focused on the greenhouse effect. Following an introductory chapter, Part I is basically all of global climatology in approximately 60 pages. Needless to say, some very important aspects of the climate system are only referenced in passing or ignored all together. The first three chapters discuss electromagnetic emission and absorption, develop a simple layer model to discuss the greenhouse effect, and then examine the role of altering greenhouse gases on the layer model. The primary focus is on carbon dioxide.

The next chapter discusses the temperature structure of the atmosphere and adiabatic processes. Following this is a chapter

entitled “Heat, Winds and Currents,” the purpose of which is to outline general circulation processes. This chapter begins by discussing the difference between weather and climate and issues related to the nonlinear nature of the climate system and role of averaging. Part I ends with a discussion of the feedbacks in the climate system.

Part II is a discussion of the carbon cycle, consisting of three chapters: “Carbon on Earth,” “Fossil Fuels and Energy,” and “The Perturbed Carbon Cycle.” Taken together, these chapters explain the basic chemistry of carbon, the general nature of the global carbon cycle, fossil fuel consumption and use by different countries, and the implications of changes in carbon for different sectors of the carbon cycle.

The final part entitled “The Forecast” offers a discussion of the temperature record and climate change focusing primarily on the past 1000 years. Next, the implications of global warming on various other aspects of the climate system are briefly discussed. These include sea level change, the biosphere, human impacts, and precipitation regimes. The book ends with a chapter outlining the policy aspects focusing on the Kyoto Protocol. Conservation and alternative energy sources are given a brief nod as possible options.

The goals of this book are admirable. The book suffers, however, from a lack of good organization. Many of the topics seem out of place and make appearances at strange times. This could severely hamper the understanding of the basic climate system for someone with little or no background in the subject. There are many examples of this, for example: Hadley circulation is presented in the “Feedback” chapter in a discussion of water vapor feedback. The obvious location for this section would have been in the chapter entitled “Heat, Winds and Currents,” where the basics of circulation processes are detailed. Another odd placement is the discussion of Milankovitch cycles embedded in the carbon cycle chapter. It is foreseeable that a student might think that orbital cycles primarily impact the carbon cycle and not have an appreciation for their role in the general climate system. In fact, the author begins the chapter on “The Perturbed Carbon Cycle” with a discussion of the ozone hole and how it has nothing to do with the carbon cycle. The author points out why he is doing this, and it is well known to anyone who has taught an undergraduate course on the subject that students are often confused by the relationship between the two, but it does strike the educated reader as an odd decision to place the discussion

here and not in a more general chapter. This points out the need for a general climate chapter near the beginning of the book to alleviate these concerns. Another option would be to conclude each section with a synthesis of the material and an outline of how it fits into the following section. As it is, each chapter ends with a few sentences of "Take Home Points." In addition, the ending of the book is a bit abrupt.

Given the complexity of covering a vast amount of material in a short book, the author had to make a decision as to whether to cover a few aspects in great detail or attempt to cover a lot in scant detail. Here, the latter option was chosen. Each topic is given a couple of paragraphs before moving on to the next, often with little insight as to the connections between them. Even given this approach, several topics are deserving of more in-depth treatment. The role of the biosphere is one such topic. Other than a brief discussion of photosynthesis and respiration and the general amounts of carbon cycling through the biosphere on an annual basis, there is approximately one page in the "Perturbed Carbon Cycle" chapter examining the impacts of changes in the vegetation on global climate. Considering that the role of the biosphere is one of the largest unknowns in the current science (which is mentioned in the book), it seems that a general discussion of the role of land cover and land use change might be in order.

Tropical deforestation is mentioned in passing, but other land use implications for carbon cycling are generally missing. For some perspective, the space detailing the role of biological impacts due to perturbed carbon cycles is equally split between discussion of the difficulty of modeling ecological succession in a changing climate and the sensitivity of coral bleaching. An obvious connection between the changing climate, the biosphere, and the economics involved with global warming would be the implications of agricultural production and food supply. This

topic is again only briefly mentioned, focusing on some general possibilities related to crop yield.

This book would be a difficult book on which to base a class, particularly if it were the only book used. It is so brief that students would likely be confused if they had no background in the subject. If they did have background in the subject, the level would probably be too low. The book does, however, provide a very necessary bridge between general Earth Science texts and policy literature aimed at undergraduates. The book does attempt to address each of the three tasks outlined at the beginning of this review, although the role of uncertainty is given the weakest treatment. This has to be weighed, of course, with the general goal of the book, and an in-depth analysis of model sensitivity would not serve that goal well. The majority of the book is spent on the science of global warming. Given that, it does not cover the material as well as several other books currently available at the introductory undergraduate level. The true benefit of this book is that at least it attempts to focus on the policy ramifications of global warming. More detail could be used here, in that this is such a short book that one would expect it could not cover the climate system in sufficient detail; therefore the subject could be better served by cutting back even more and focusing on the policy implications.

Overall, this book is a pleasure to read, and even given the shortcomings outlined above, it should be considered as a supplementary text for an introductory undergraduate course focusing on the climate system.

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