Reviews

ARCHER, D. 2006. *Global warming: understanding the forecast.* Oxford, Blackwell Publishing. 256pp. ISBN 978 1405140393, ISBN-10 1405140399, paperback. £24.99/ US$39.95.

Given the latest assessment (February 2007) by the Intergovernmental Panel on Climate Change (IPCC), David Archer's book is timely and provides the scientifically literate person with much of the background necessary for understanding global warming and the contributory role of human activities. A strength of the book is that it covers risk assessment and the decision-making process involved in formulating policy to both ameliorate and adapt to climate change through the 21st century. This includes consideration of economics, human psychology, international relations and other areas not typically covered in a physical science book. *Global warming: understanding the forecast* is organized into three parts, 'The greenhouse effect', 'The carbon cycle' and 'The forecast', each chapter within which begins with a short overview of the main points and concludes with brief 'take-home points', problem questions ('projects') and further reading. Some of the projects involve working with numerical models (e.g. radiative transfer, carbon cycling), accessed via the World Wide Web. There is both a glossary and a list of constants and symbols given towards the end of the book. The main points are illustrated by line diagrams, a few black-and-white photographs and images, and several color plates.

The organization of the book reflects Archer's expertise as a 'computational ocean chemist': for about the first one-third to one-half of the text, the emphasis is on the physical climate process of the greenhouse effect, rather than the contemporary-period outcome of interacting physical climate processes highlighted by the book's main title. Although there is some discussion of global warming in the brief first chapter ('Humankind and climate'), it is too general to prepare the reader for the details of physical climate processes that follow (e.g. black bodies, energy balance, band saturation), and raises more questions than it answers. For example, it would have been helpful for the author to state, however briefly, why the cutting of tropical forests releases CO_2 into the atmosphere yet higher-latitude forests 'appear to be taking up atmospheric CO_2'. The difference between weather and climate is not tackled in any depth until chapter 6. However, it is not until chapter 11 – the first chapter in part III, and out of a total of 13 chapters – that Archer gives us details about recent temperature trends and comparisons with the past proxy record; information that provides the much-needed context for the first one-third or so of the book. I contend that one does not need to be presented, first and foremost, with all the nitty-gritty about the layer model (chapter 3), the vibrational modes of CO_2 (chapter 4) or adiabatic processes in the atmosphere (chapter 5), before being told the differences between temperature trends and changes, the role of volcanic activity and solar-output variations in surface temperature, or how and why climate has changed over long timescales. This mismatch of the book's title and its emphasis increases the possibility that a person who wants to read all about global warming and its relationship to past patterns of climate change will give up long before getting to that part of the book. This is not to say that the physical processes are unimportant; on the contrary, they are critical to a true understanding of the reasons for global warming and our present climatic state. However, they would have been better placed after the material currently presented in chapter 11, and framed within the global warming context.

Archer's book betrays a split personality in terms of the quality of the material that is presented. Although the first one-third or so gives much useful information about the Earth's energy balance and how greenhouse gases interact with radiation, it suffers from deficiencies in scientific precision, flow of logic and the accuracy with which some important concepts are explained. To this reader, the most disturbing concept, used throughout the book, is that of 'IR light', meant to describe the thermal infrared (longwave) radiation emitted by the Earth and its atmosphere (there is even a 'microwave light' but this comes much later in the book). In effect, 'light' becomes a substitute term for radiation, despite the fact that, strictly speaking, light comprises only a small part of the electromagnetic spectrum. Not that this would necessarily be all bad, but the author also uses the terms 'radiation' and 'energy' interchangeably with 'light', and without really defining them. Then, in chapter 3, we see the first appearance of 'outgoing earthlight', which could be reflected solar radiation but is implied to be outgoing longwave radiation. This confusion in terminology and concepts continues into chapter 4 with the following statement: 'Light of this intensity [about 700 cycles cm^{-1}] that shines from the surface of the Earth is absorbed by the CO_2 in the atmosphere (Fig. 4.4). The CO_2 in the atmosphere then radiates its own light at this frequency'. However, it culminates in chapter 5 where we have increasing CO_2 concentrations 'raising the altitude in the atmosphere where light on average escapes to space . . .' and 'light appears to originate from the coldest part of the atmosphere, at the tropopause'. A reader not previously exposed to the principles of Earth's radiation balance and energy budget, and relying on Archer's book to learn all about this material, likely would be thoroughly confused by the end of chapter 5.

Despite the importance of the radiation balance to understanding climate and climate change, Archer also makes the description less easy to follow than it might be otherwise by his ordering of sub-topics. For example, in chapter 2, he mentions Kirchhoff's law (but does not give the formula) before discussing the Stefan–Boltzmann equation; also, he misses the opportunity to explain the black-body curves of the Sun and Earth (shown in figure 2.6) by reference to Planck's or Wien's laws. There are some distressing errors in the first half of the book. For example, figure 6.4 shows the top-of-the-atmosphere solar radiation receipt as a function of latitude and time of year, yet we are told instead that it's 'a sort of map of the intensity of solar heating . . . for every square meter on the ground'. The discussion of air circulation around high- and low-pressure systems (figure 6.10 and p. 63) excludes any mention of centripetal acceleration necessary for the balance of forces above the friction layer. There is considerable use of non-standard terms. For example, on p. 61 we are told that Coriolis acceleration is all of the following: a 'fake force', a 'magic force' and a 'fudge force'; but we are not told exactly why. On p. 42 we

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have 'wispier layers called the mesosphere and the exosphere', whereas on p. 60 there are 'wisps' of oceanic phytoplankton distribution shown in satellite imagery. Gases are 'terrible black-bodies' rather than being gray bodies.

The quality of the material that is presented improves abruptly in chapter 7, which covers feedbacks in the climate system, and thereafter (e.g. the carbon cycle, orbital forcing of glacials and interglacials, fossil fuels and energy consumption). I learned, or relearned, much useful information in this second half or so of the book: the material is, for the most part, important and insightful, particularly the last chapter (chapter 13) on decision-making and public policy related to climate change. Even so, some of the climate physical processes invoked in chapter 12 ('The forecast') are too generalized or overstated (e.g. 'Sulfate aerosols cool by scattering light'; 'More rain begets more hard rain'; '[Tropical] cyclone intensity depends on the way that winds are blowing with altitude, whether they tear a tropical storm apart or allow it to grow into a full cyclone'; and the period between 14 000 years ago and the 'depths of the [last] glacial climate' is referred to as 'a bit earlier than that'). There is a glibness to some statements that is highly distracting (e.g. 'Melting of an ice sheet in place is slow because it takes a long time for the atmosphere to carry that much heat up there'; and 'ice can melt pretty quickly if it has a mind to'). Also, there are a few inconsistencies and errors. On p. 163 we are told 'There is CO_2 released from tropical reforestation', whereas on p. 174 there is 'Carbon uptake by reforestation'. The mountains in the 'North American Pacific Northwest' are referred to as the Sierras; they are the Cascades. Moreover, to this geographer reviewer, there is a lack of geographic differentiation to the discussion of likely future climate patterns, despite presentation of the color global maps that show modeled temperature and precipitation output. At times, even the author seems unsure of what he really thinks: 'I guess my personal feeling is that the spread of tropical diseases is a serious threat'.

In summary, *Global warming: understanding the forecast* contains much useful information on the crucial issue of our time: global warming and the enhanced greenhouse effect, and the options available to us to either ameliorate or live with climate change. However, the text organization and emphasis does not reflect the book's main title, and the treatment of topics is uneven. The first one-third of the book is disjointed and of poorer quality than what comes afterwards, by being confusing, imprecise and containing inadequate explanations of phenomena and a considerable number of errors. However, if the reader can 'hang in there' until chapter 7 – or read chapter 11 right after the opening chapter and then proceed with chapter 2 onward – then what comes in the second half of the book is highly informative, even illuminating and insightful.

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