In the past few years, a sea change has taken place in the United States and the world in the public’s perception of climate change, which has been followed by calls for action on climate change by reducing carbon dioxide (CO$_2$) emissions, with wide-ranging environmental, energy, economic, societal, and political implications. Accompanying this change, a slew of popular science books on climate change has been published. Most of these books have focused on explaining the physical science of climate change, usually linking fossil fuel burning to the increase in atmospheric CO$_2$ concentration in passing. Yet, as the climate problem is fundamentally a CO$_2$ problem, there has been a major gap in explaining this problem in the context of the grand global carbon cycle—a wonder of Earth’s biogeochemical balance. Tyler Volk’s book, CO$_2$ Rising: The World’s Greatest Environmental Challenge, fills this gap in a fascinating way.

Perhaps the most distinct characteristic of the book is its “Lagrangian” approach to the carbon cycle—that is, it follows the fate of a few individual carbon atoms: Dave, Coalleen, Oiliver, Methaniel, and Icille. The names are mostly self-evident: Coalleen is a carbon atom originating from coal burning, Oiliver from oil, and Methaniel from methane in natural gas. Dave was named after the pioneering carbon-cycle scientist Dave Keeling, whose measurement of atmospheric CO$_2$ concentration at Mauna Loa, Hawaii, starting in 1958 has epitomized the issue of global warming. The rising CO$_2$ curve is often referred to as the Keeling Curve and is considered one of the greatest observational discoveries of the twentieth century. Icille is a carbon atom trapped in an Antarctic ice core, which has provided direct evidence of CO$_2$ change over the glacial–interglacial cycles. This approach of tracing individual atoms has occasionally appeared in traditional biology textbooks, but Volk’s wide-ranging application in the context of the global carbon cycle is unprecedented and refreshing. He traced these atoms from limestone to bicarbonate dissolved in the ocean, to an oak leaf, to a glass of beer, to a lion, to a rice grain in Bangladesh, and to bacteria in the body.

This is a short book, but packed with information, consisting of 10 chapters: (1) “Introducing the CO$_2$ molecule and its carbon atom”; (2) “From a molecule in beer to the great cycle of carbon in the biosphere”; (3) “The worldwide increase of CO$_2$”; (4) “Fossil-fuel carbon atoms join the biosphere”; (5) “Carbon’s fluxes and its rate of increase”; (6) “Time capsules in ice”; (7) “Wealth, energy, and CO$_2$”; (8) “How high will the CO$_2$ go?”; (9) “Reining in the CO$_2$ increase”; (10) “The ultimate fates of our carbon atoms.”

Compared to many other popular science books on climate change, this book is “challenging” to read, in most part because the global carbon cycle is a complex issue that
involves many fields of knowledge, including atmospheric sciences, geology, chemistry, physics, and biology. Indeed, it is admirable that somebody is even attempting to explain the deeper complexity of the carbon cycle in simple language such as the “fast carbon cycle” through the biosphere and the “slow carbon cycle” through the rocks. The Lagrangian approach with named carbon atoms certainly helps tremendously in focusing the reader’s interest. However, it may be a bit overused, so that after following a few chapters, though still fascinated by the stories of the “actors,” the reader may be at a loss in catching up with the understanding of the overall carbon balance. Here is where the “Eulerian” approach comes in to help: tracking the carbon fluxes and pools, the way much of the carbon science is done and normally presented. The book also nicely discusses the carbon cycle this way, although blending the two approaches has proven challenging, as any student in fluid dynamics may have learned.

While global carbon cycle science is inherently challenging to explain in simple terms, Volk has done a superb job in the last four chapters explaining the linkage of wealth, energy, and CO₂, and their future change. By presenting simple data on gross domestic production (GDP), energy, and CO₂ for the U.S., Europe, Japan, China, India, Africa, and the overall world average, it is shown clearly how development is linked to energy use and CO₂ emissions, thus revealing the striking fact of how modern industrialized civilization is linked to the CO₂ problem. This leads naturally to an extremely simple yet powerful way of predicting how future CO₂ levels will rise, assuming the anticipated development. In achieving this projection, the author brought in the concept of “airborne fraction” of CO₂ (i.e., approximately half of the anthropogenic CO₂ emissions have been absorbed by the natural carbon sinks in the ocean and on land, and only half remain in the air, as evidenced by Mauna Loa CO₂ and emissions data). Although still a simplified assumption (as these sinks will likely weaken), such depth is already unusual among the books like this. To predict future CO₂ levels, Volk puts out three scenarios [“Frozen-2010 Technology” (aka, business as usual), “Central Trend,” and “Constant Fossil Fuel”] that capture the essence of the more complicated Integrated Assessment Modeling results, but the assumptions are immediately comprehensible to a lay person. The graphs are straightforward and easy to understand.

Toward the end of the book (chapter 9), Volk introduces some proposals to mitigate climate change—such as geoengineering and carbon sequestration—when the individual atoms are again called upon to represent the processes (such as Methaniel being buried into a saline aquifer in Kentucky). He also delves into social and even psychological aspects of how to deal with climate change. In discussing these aspects, he presents the issues, rather than telling the reader the solution. Good examples include the dilemma of inequality between developed and developing countries, who controls how to engineer the climate, and even philosophical questions such as whether our fossil-based economy could have been replaced by a biomass energy route or whether the historical path has provided a unique opportunity for innovation.
Although the subject is not an easy one, the book’s style is very approachable, in part because of the storytelling with the individual atoms. More importantly, Volk writes not as an authority (though he has done important research on the topic, especially the biological aspects), but rather as an inquisitive person trying to discover and understand the global carbon cycle as it relates to climate change. This is most evident in the last few chapters. As the author stated, the book includes a large number of graphics that are very helpful. Unfortunately, probably due to the color originals, printouts of many pictures are not as clear as they could be if redrawn in black and white. For example, the different kinds of molecules containing carbon atoms are difficult to distinguish, especially when stitched together with photos. In comparison, the bar and line plots are clear and very helpful in conveying their meaning.

Overall, this book is an excellent introduction for undergraduate students and the general public with a keen interest in knowing more about climate change. It is equally informative for scientists and professionals specializing in different fields who would like to have an interdisciplinary view of the wonderful carbon cycle.

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