
Preface

Preamble

More than half a century ago, Roger Revelle and Hans Suess, both scientists at the Scripps Institution of Oceanography in La Jolla, California, published what has become the classic paper on the possible future effects of human activities resulting in increasing the content of carbon dioxide (CO₂), a “greenhouse” gas, in the atmosphere. Their 1957 paper included the statement

Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years. This experiment, if adequately documented, may yield a far-reaching insight into the processes determining weather and climate.

Roger and Hans thought we were going to make only a minor modification of Earth’s climate with this addition of fossil carbon. However, the experiment was more complex than they realized. The addition of CO₂ to the atmosphere is only one of several changes humans are making to planet Earth. Over the past two and a half centuries since the beginning of the Industrial Revolution, human activities have become increasingly important in affecting conditions on the surface of the Earth. Five human-driven factors are forcing regional and global environmental change:

1. Increasing levels of atmospheric greenhouse gases;
2. Clearing of forests for agriculture and construction of buildings and roads on a scale such as to affect the amount of the Sun’s energy reflected or absorbed by our planet;
3. Replacement of plants that freely transpire and return water to the atmosphere by water-conserving plants that grow faster and now form the basis for our food supply in many parts of the world;
4. Overuse of fertilizers and pesticides in agriculture; and
5. Mining of minerals and extraction of petroleum, natural gas, and coal with concomitant release of nutrients and poisonous materials into the environment.

All of these are closely related to the growth of the human population on the planet, the development of civilization, and the need for increasing food supplies. Of these five, only the first has been seriously addressed in attempts to assess its effect on future climate change. This is because greenhouse gas concentrations have a global effect. The other factors have regional effects but may, over the long run, have irreversible global implications.

To assess the global effects of the addition of greenhouse gases to the atmosphere, an Intergovernmental Panel on Climate Change (IPCC) was established in 1988. Its parents are the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), both agencies of the United Nations. Their thrust has been to document factors related to climate, and to make projections about what changes might be expected until

the end of this century. The IPCC is an extremely conservative group to which climate scientists are advisory. It has issued four reports, the most recent of which projects a global temperature rise between 1.1 °C (2 °F) and 6.4 °C (11.5 °F) by the end of this century, accompanied by a sea-level rise between 18 and 59 cm (7–23¼ in.). These may not sound like large changes, but when the Earth was 6.4 °C cooler there was half a mile of ice over Chicago. Unfortunately, many climate scientists and most of the general public do not realize that even if there were concerted efforts undertaken to reduce greenhouse gas emissions and mitigate their effects, climate change would not end in 2100. Geochemists who have studied the CO₂ system are aware that, depending on the magnitude of the perturbation, the effects may continue for tens to hundreds of thousands of years.

How to Read This Book

This book is intended for the layperson in the United States, although I hope that my scientific colleagues and those elsewhere might also find it interesting and amusing. It is organized to provide first an introduction to concepts that are important in thinking about changes on planet Earth. Then follows a general description of how the climate system works. Finally there is a series of chapters that discuss each aspect of the climate system, how they have varied over time, and whether or not human activity can affect them.

Depending on how much you already know, you can skim familiar topics to see if they contain something you didn't know; things you are thoroughly familiar with you can skip altogether; I was already working on my Ph.D. before someone explained to me that it is a waste of valuable time to read something you already know.

Most Americans, even those with an engineering background, have difficulty thinking in terms of the "metric system" used in the rest of the world. The Fahrenheit temperature scale is still used in only two countries: the US and Belize; the rest of the world uses the Celsius (= Centigrade) system. Accordingly, although the citations of data in the text will be in metric terms, where appropriate I include their US or Fahrenheit equivalents in parentheses.

When appropriate a timeline is given at the end of each chapter, followed by suggested reading "if you want to know more."

I also suggest music you may want to listen to while thinking about what you have read, and I suggest "libations" to aid your thinking.

I also found access to the Internet is more useful than pages of references to the technical literature. Where particularly appropriate I refer to some specific Internet sites, and at the end I list some books for those who wish to delve further into the science of climate change and other topics covered in this book. Also, the reader can find many useful illustrations and diagrams on the Internet by 'Googling' a topic. Googling for illustrations of "Siccar Point" will bring up a host of pictures of that (geologically) famous place; similarly, typing in the name of someone mentioned in this book, such as W. Broecker, and using *Google Scholar*, will bring up a list of publications, some of which may be downloaded for free. However, there is a caveat about using the Internet for investigating climate change. The number of websites that present disinformation or misinformation, particularly regarding carbon dioxide, greatly exceeds those presenting scientifically valid information. Someone wants to keep you burning as much fossil fuel as possible.

Pairings

Strong coffee will be helpful throughout the book if you are a daytime reader. However, if you like to read in the evening, you may wish to skip my specific recommendations for a libation and settle for more general solutions. The earlier chapters pair well with a California Chardonnay or a French Chablis, the middle chapters with a substantial red, such as Merlot or Pinot Noir, and the later chapters with Cabernet Sauvignon or a fine Bordeaux. Toward the end you may require a Cognac, Armagnac, or a Marc. There will be individual sections where stronger drink, such as Scotch, Bourbon, or even a Martini is simply called for.

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