

***The Satanic Gases* by Patrick J. Michaels and Robert C. Balling, 2000, Cato Institute, USA, 224 pages, US\$10.95, ISBN 1-88257-792-2.**

In teaching a basic Earth System Science course, it is hard to find books that contain anything more than a doom and gloom approach based on predictions made by global circulation models. Prior experience in industry has taught me that you need to look at all the available geologic and geophysical data as well as use computer models. With respect to *The Satanic Gases*, I was happy to see that the authors considered the effect of water vapor (approx. 31 C out a total of 33 C) in the total greenhouse effect. In addition, they explained the relationship of stratospheric cooling to the greenhouse effect and briefly talked about the decreasing rate of methane gas increases to the atmosphere. The authors note that the Earth's climate has recovered from past periods of continental glaciation (i.e., icehouse conditions) rather than remaining stuck there as some theories predict.

The Satanic Gases is made up of thirteen chapters, most of which are very short and to the point. It opens with an overview of the authors intentions and then a first chapter discusses the gloom and doom approach of most of those working in global warming. This chapter also introduces the scientific paradigm of global warming, that General Circulation Models (GCMs) produce a realistic picture of the atmosphere as carbon dioxide concentrations increase. This paradigm also holds that the warming caused by the increased CO₂ concentrations will cause drastic changes in the earth's climate, which will be catastrophic to the environment.

In the second chapter, the authors offer a brief history of the global warming debate and the Intergovernmental Panel on Climate Change. This is helpful to understanding the current debate because it provides a more complete picture than is presented in the newspapers or on TV.

In the third chapter, the authors give a quick review of the mechanics of the earth's climate, and include comments on stratospheric cooling. They also include a section on the general stability of the earth's climate, which most books on global warming do not address. They point out that if the earth's climate were subject to runaway cooling as has been suggested by some writers on global warming, than the climate should have remained in a permanent ice age since at least the last major glacial activity during the Pennsylvanian, if not earlier. In other words, some major factors that affect the climate have not been considered in the debate on global warming.

The fourth chapter describes general circulation models and how these complex programs work. Also included is a discussion of the problems of quantifying many processes that affect climate, such as cloud cover and its effect on albedo. The GCM models project linear temperature increases indefinitely into the future. However, CO₂ concentrations are increasing exponentially. If a direct correlation between CO₂ concentrations and temperature increases exists, the linear increases do not fit. However, the authors note a tendency for the greenhouse response to level off or "damp down", so that later increases in CO₂ concentrations do not have as large an effect as earlier ones.

One criticism I have of *The Satanic Gases* is that because much of the debate on global warming is over which evidence of the global warming theory is valid, it might have been beneficial to include a discussion on what evidence should be considered conclusive proof of a theory. For example, an article by Oreskes, Scrader-Freechette and Belitz in *Science* (v. 263, 4 Feb. 1994) suggests that models cannot provide proof of global warming because closed mathematical formulas are used to represent open, complex, natural systems and that the

solutions to these formulas in the GCMs are not unique. This issue needs to be considered in more detail because of the apparent confusion on this point.

The fifth chapter offers a discussion of the warming observed in instrumental records and systematic errors, such as the urban heat island effect and the difficulty of reconciling land and ocean temperature records. The authors also discuss the disparity between the land temperature records and satellite temperature records.

Chapter 9 presents an interesting discussion of the relationship between weather and mortality. As part of this discussion, they note that more people die from extreme cold spells than from extreme hot spells. The authors also note the effect of technology, (i.e., the development and spread of air conditioning), which has lowered the stress associated with extreme heat spells. By lowering this stress, the number of deaths related to heat spells has been reduced.

Chapter 10 discusses how adding CO₂ to the atmosphere should make the planet greener. The authors state that the increased CO₂ levels of the atmosphere will result in most plants thriving. Supporting this, a study by Knapp and Soule (*Annals of the Assoc. of Am. Geographers*, 96, v. 86 (3), p. 387-411) suggests that an increase in woody plants, with big increases in big sagebrush and Western Juniper in Central Oregon, is related to rising CO₂ levels in the atmosphere. This can be qualitatively observed in much of Central Oregon by the number of young Western Juniper relative to mature trees and the increasing density of trees. Knapp and Soule note a 41% increase in tree density occurred in their study area between 1960 and 1994. To determine if long-term suppression of wildfires has been the cause of the new tree growth, they compare wildfire frequency in the study area and find no apparent relationship between it and the increased density trees in the Central Oregon desert.

This book is recommended for anyone with an interest in the climate change/global warming debate. It explains complex concepts and processes in language that students and those not closely involved in this debate can understand. Another reason to recommend this book is that in a highly politicized subject like this, it provides a different perspective than is available in most textbooks. Therefore, this book should at least be available in all college libraries. It should also be part of the recommended reading for all classes that are studying the climate change/global warming issue.

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