

# the science of global climate change



The photographs from the Apollo missions show earth glowing in the stillness of space like a blue-white opal on black velvet. Cool and beautiful, it hurries along in the Sun's gravitational embrace. The earth is our home, our whole wide world.

Our enfolding blanket of air, our atmosphere, is both the physical condition for human community and its most compelling symbol. We all breathe the same air. Guarding the integrity of the atmosphere—without which complex life could not have evolved on this planet—seems like common sense. Yet a broad consensus of modern science is that human activity is beginning to alter the earth's atmospheric characteristics in serious, perhaps profound ways. For the past century, researchers have been gathering and verifying data that reveal an increase in the global average temperature. Until recently, scientists could not say with great confidence whether or not this phenomenon was in any way the result of human activity or entirely the result of natural changes over time.

To deal with the difficulty of making precise measurements and arriving at definite conclusions, the World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC) to seek a clear explanation of the causes and possible impacts of this global climate change.<sup>1</sup> Because of the large number of scientists involved in the IPCC and its process of consultation, its reports are considered widely as offering the most authoritative scientific perspectives on the issue. IPCC's findings have met with general—but because

of remaining uncertainties, not complete—agreement within the wider scientific community.

In 1996, the IPCC issued its Second Assessment Reports, which summarized the current state of knowledge. The first of these reports concluded that *"the balance of evidence suggests that there is a discernible human influence on global climate."*<sup>2</sup> The Third Assessment Reports, approved in early 2001, found even stronger evidence and concluded, *"most of the observed warming over the last 50 years is likely to have been due to the [human-induced] increase in greenhouse gas concentrations"* (italics added).<sup>3</sup>

The IPCC offers convincing evidence that there exists if not a clear and present danger then a clear and future one, and that coming changes will affect all aspects of the environment and societal well-being. Based on measurements taken over both land and sea, the global average surface-air temperature has increased by about one degree Fahrenheit since 1860, building up as the Industrial Revolution was hitting full stride. While this is hardly a frightening increase for a particular geographic location, the temperature change is global in extent, so one must read it against the background of the earth's average temperature during historic times. According to IPCC, the rate and duration of warming in the twentieth century appears to be the largest in the last one thousand years. The twentieth century also experienced precipitation increases in mid- and high-northern latitudes; drier conditions in the subtropics; decreases in snow cover, mountain glaciers, and Arctic sea ice; and a rise of four to eight inches in mean sea level.<sup>4</sup>





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The “greenhouse effect,” though complex in detail, is simple enough in outline. Not considering the internal heating due to radioactive decay and volcanism, the earth draws its thermal energy from the Sun. Atmospheric gases form a protective cover that makes our planet hospitable to life, transmitting visible light, blocking out harmful high-energy radiation like ultraviolet rays, and keeping temperatures comfortable by moderating the escape of heat into space. However, the precise mix of these gases is quite delicate, and changing that mix alters the atmosphere’s properties. An increase in the relative abundance of the greenhouse gases (carbon dioxide, methane, chlorofluorocarbons, tropospheric ozone, and nitrous oxide) causes the earth to trap more of the Sun’s heat, resulting in what is called “global warming.” Since the beginning of the industrial period, the IPCC reports, the concentration of the principal greenhouse gas, carbon dioxide, has increased by 30 percent and is now greater than at any time in the past 20 million years.<sup>5</sup> The presence of methane (150 percent increase) and nitrous oxide (16 percent increase) is also growing. The result is the small but alarming temperature rise science has detected.<sup>6</sup>

What causes greenhouse gases to accumulate in the atmosphere? Emissions from cars and trucks, industry and electric plants, and businesses and homes are the largest part of the answer, although

other factors such as deforestation contribute. The Industrial Revolution was built on furnaces and engines burning fossil fuels (coal, natural gas, oil, and such derived products as gasoline and heating oil). These fossil fuels now power the U.S. and global economy. Although some of the smoke particles and other pollutants (such as sulfur dioxide) now streaming from chimneys and tailpipes can actually cool the earth if they take an aerosol form, the great bulk of our emissions are contributing a warming influence. Reflecting upon studies completed since its last report in 1996, the IPCC says, “There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.”<sup>7</sup>

Whatever the extent, severity, or geographical distribution of global warming impacts, the problem is expected to disproportionately affect the poor, the vulnerable, and generations yet unborn. Projected sea level rises could impact low-lying coastal areas in densely populated nations of the developing world. Storms are most likely to strain the fragile housing infrastructure of the poorest nations. The migration of diseases could further challenge the presently inadequate health care systems of these same nations. Droughts or floods, it is feared, will afflict regions already too often hit by famine, hunger, and malnutrition. Because the number of days with high heat and humidity are likely to increase, heat stress





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impacts will also increase, especially among the elderly, the sick, children, and the poor.<sup>8</sup>

The scientific reports of the IPCC portray the long-term challenge global climate change poses. Its findings, while not complete, are widely accepted in the scientific community. In June 2001, the National Academy of Sciences released a report, prepared at the request of President Bush, summarizing a prestigious panel's understanding of global climate change and an assessment of the work of the International Panel on Climate Change. The panel said that "greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities. . . ." It also found that "we cannot rule out that some significant part of these changes are also a reflection of natural variability. . . . Because there is considerable uncertainty in current understanding of how the climate system varies naturally and reacts to emissions of greenhouse gases and aerosols, current estimates of the magnitude of future warming should be regarded as tentative and subject to future adjustments (either upward or downward). . . ." The report noted that while the full implications of climate change remain unknown, the panel "generally agrees with the assessment of human-caused change presented in the IPCC Working Group I scientific report."<sup>9</sup>

Please visit [www.ipcc.ch](http://www.ipcc.ch) for updated information on the IPCC Fourth Assessment Report "Climate Change 2007."

## NOTES

- 1 To date [as of 2001], the IPCC's work represents the most authoritative estimates and prognosis of current and future climate change data. This statement utilizes the following Second and Third Assessment Reports by the IPCC:  
1996a: *Climate Change 1995: The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, eds. J. T. Houghton, L. G. Meira Filho, B. A. Callander, N. Harris, A. Kattenberg, and K. Maskell (Cambridge and New York: Cambridge University Press).  
1996b: *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, eds. R. T. Watson, M. C. Zinyowera, and R. H. Moss (Cambridge and New York: Cambridge University Press).  
1996c: *Climate Change 1995: Economic and Social Dimensions of Climate Change. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, eds. J. P. Bruce, Hoesund Kee, and E. F. Haites (Cambridge and New York: Cambridge University Press).  
1996d: *The IPCC Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the UN Framework Convention on Climate Change* (Geneva: World Meteorological Organization/United Nations Environment Programme).  
2001a: *Climate Change 2001: The Scientific Basis*, eds. J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. van der Linden, X. Dai, K. Maskell, and C. Johnson (Cambridge and New York: Cambridge University Press).  
2001b: *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, eds. J. McCarthy, O. Canziani, N. Leary, D. Dokken, and K. White (Cambridge and New York: Cambridge University Press).  
2001c: *Climate Change 2001: Mitigation*, eds. O. Davidson, B. Metz, R. Swart, and J. Pan (Cambridge and New York: Cambridge University Press).
- 2 IPCC, 1996a, 5.
- 3 IPCC, *Climate Change 2001: The Scientific Basis*, 10.
- 4 *Ibid.*, ch. two.
- 5 *Ibid.*, 7.
- 6 *Ibid.*
- 7 *Ibid.*, 10.
- 8 IPCC, *Climate Change 2001: Impacts, Adaptation, and Vulnerability*.
- 9 National Academy of Science, *Climate Change Science: An Analysis of Some Key Questions* (Washington, D.C., June 7, 2001).