Carbon Dioxide and a Changing Climate

A National Research Council view of the carbon dioxide greenhouse includes inevitable climatic warming but no certain disasters

In an admittedly conservative report,* the National Research Council's (NRC's) carbon dioxide assessment committee accepts the scientific consensus that increasing atmospheric carbon dioxide will warm the earth's climate during the next century but cautions that there is no need for panic. Understanding of the carbon dioxide greenhouse effect in particular and climate change in general is too rudimentary to warrant precipitous action now. The research community may have 20 years to ponder the problem before anything as drastic as curtailment of fossil fuel burning need be contemplated. Indeed, the committee finds that the most practical reaction of society may be adjustment to climate change rather than prevention.

The future foreseen by the committee begins with two fundamental points—the continuing increase in atmospheric carbon dioxide and its ability to trap heat in the lower atmosphere—and proceeds into increasingly uncertain territory. Burning of oil, gas, and coal will undoubtedly continue to push the concentration of carbon dioxide ever higher in the coming century. This increase will dwarf any contribution from the destruction of tropical forests or other biomass sources. There is a 50 percent possibility that, by sometime between 2050 and 2100, the present-day carbon dioxide concentration—340 parts per million—will have doubled; there is a 95 percent probability that the concentration will reach 540 parts per million by 2100. This estimated carbon dioxide increase is lower than some previous projections because of lower expectations of world economic growth, higher energy costs, and the somewhat arbitrary assumption that biomass sources are currently contributing a significant portion of the carbon dioxide.

The committee is pessimistic about the chances of avoiding these large increases in carbon dioxide and the consequent warming. Agreement among nations on a control strategy seems difficult, the report notes, especially when risks and benefits of climate change are so unevenly distributed. An Environmental Protection Agency report released in early October investigated the likely control options and concluded that "it is extremely unlikely that any substantial actions to reduce CO_2 emissions could or would be taken unilaterally." Both reports note that increasing concentrations of trace gases such as methane, and the chlorofluorocarbons, which are used as refrigerants and propellants, would add to the problem of controlling emissions from fossil fuel burning, because trace gases may eventually have as large an effect on climate as carbon dioxide (*Science*, 24 June, p. 1364).

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Repeating the previously reported conclusions of a subcommittee (*Science*, 13 August 1982, p. 620), the NRC committee says that a doubling of carbon dioxide, if maintained indefinitely, would warm the surface of the globe 1.5° to 4.5°C, most likely 1.5° to 3.0°C. The comings and goings of the ice ages of the past million years have involved changes only 6° or 7°C. The uncertainties that contribute to this range of warmings include the interaction of ocean and atmosphere, and changes in cloud type and distribution, all of which deserve further study, according to the committee.

The committee foresees no drastic effects of this warming in the next few decades. The much discussed collapse of the West Antarctic Ice Sheet into the sea with a consequent 5- to 6-meter sea level rise most likely would not occur for several centuries, if it ever did. Before then, ocean warming and ice cap melting could raise sea level at a rate of about 70 centimeters per century, compared with the 15-centimeter rise of the past century. The committee is hopeful that society can adjust to such changes by protecting the most valuable coastal real estate with dikes and making an orderly retreat from less defensible ground.

The maximum anticipated warming of the next two decades is expected to have minimal effects on rain-fed crops, in America at least. Productivity losses due to decreases in rainfall and increases in evaporation will be more or less offset by gains due to growth stimulation by higher carbon dioxide concentrations. In the next century, farmers will adjust to the further warming by modifying varieties, changing crops, or moving themselves, the latter admittedly being harder on the farmer than on the nation.

The committee could not be so sanguine about the prospect for the water-poor western states, where agriculture depends on irrigation. A 2° warming combined with a 10 percent decrease in precipitation would decrease runoff into rivers between 40 and 76 percent, depending on the region of the west considered. "The impact would be especially severe in the Missouri, Rio Grande, Upper Colorado, and Lower Colorado regions," the report notes, "where even current water requirements would exceed the supplies after climatic change by between 20 and 270%." Much of the irrigated area in these regions might have to be abandoned, although abandonment of irrigated land for other reasons is not a new experience, the committee notes.

The NRC report issues no clarion call to action. "In our judgment, the knowledge we can gain in coming years should be more beneficial than a lack of action will be damaging. . . . Our stance is conservative: we believe there is reason for caution, not panic." The watchwords for now should be "research, monitoring, vigilance, and an open mind." Not that the committee is entirely at ease with this approach. The projected warming would "carry our planet into largely unknown territory." Researchers have little idea whether extreme variations in climate will increase or decrease in frequency, how smoothly the transition to a very warm climate will go, or whether the entire climate system might abruptly jump to another mode of operation. "In our calm assessment we may be overlooking things that should alarm us."

—RICHARD A. KERR

*Committee members are: W. A. Nierenberg (chairman), P. G. Brewer, L. Machta, W. D. Nordhaus, R. R. Revelle, T. C. Schelling, J. Smagorinsky, P. E. Waggoner, and G. M. Woodwell. Copies of the report, *Changing Climate*, are available from the National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20418, $29.50 each, prepaid.