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Uncertainties About Global Warming

Virtually everyone, children included, is concerned about global climate change and especially about the greenhouse effect. They have learned of increases in the atmospheric concentration of carbon dioxide. They have been told repeatedly that temperatures will increase 9°F. Political pressure is mounting to take action regardless of cost, and to take action now. But how good is the evidence, and how likely is there to be substantial global warming arising from anthropogenic causes? When might it happen? If the situation is analyzed applying the customary standards of scientific inquiry one must conclude that there has been more hype than solid facts. Some of the questions include: Are the computer models that predict large-scale warming rigorous? What has been the effect on climate of anthropogenic additions of greenhouse gases? Will atmospheric concentrations of CO_2 double by the middle of the next century.

Modeling of global climate is being carried out intensively by at least 14 different groups. They have largely concentrated on examining effects of doubling the atmospheric content of greenhouse gases. As might be expected, the answers they get are functions of the models they employ. The spread is from 1.5° to 5°C; that is, there is great uncertainty. In addition, if one examines some of the scientific articles on the subject, one finds virtually unanimous agreement that the models are deficient. For example, they do not adequately incorporate effects of clouds, which are expected to increase with warming. Clouds have both negative and positive effects on warming. Clouds exert a negative effect on temperature in part by reflecting sunlight off into space. They have a positive effect by trapping heat from below. The sensitivity of computer models to the properties of clouds was illustrated in a recent paper.* When the water content of clouds was recognized in the model, the predicted global average warming dropped from 5.2° to 1.9°C.

What have been the warming effects, if any, of anthropogenic gases? The typical answer is 0.5°C. But the answer depends on what time interval is chosen. There was substantial increase in temperature from 1880 to 1940. However, from 1940 until the 1960s, temperatures dropped so much as to lead to predictions of a coming ice age. New precise satellite data raise further questions about warming.† From 1979 to 1988 large temperature variability was recorded on weekly to multiyearly time scales, but no obvious temperature trend was noted during the 10-year period.

A fashionable estimate of the time when doubling of atmospheric CO_2 will occur is the middle of the next century. But past predictions of energy usage have been notoriously inaccurate. At the current rate of emissions of CO_2 the future doubling time would be of the order of 200 years. For a doubling to occur by 2050 would require a very large continuing exponential increase in CO_2 emissions. What fuels would be burned? Has the potential availability of the necessary fossil fuels been adequately considered? The large easily produced reserves of oil are in the region of the Persian Gulf. The principal reserves of coal are in the Soviet Union, the United States, and the Peoples Republic of China. Most of the less developed countries (LDCs) are comparatively bereft of fossil fuels. Yet the typical prediction of global emissions of CO_2 assumes large-scale enhanced expansion of burning by LDCs. Ten years from now (or before), when the Organization of Petroleum Exporting Countries is in full control of prices, who will be able to buy expanded amounts of oil? Not impoverished LDCs. Will the Soviet Union, the United States, or China be willing to ship to LDCs large amounts of coal gratis?

Production of oil in the United States is dropping rapidly, and imports are expanding. Were current trends of imports and trade deficits to continue, a crisis in energy usage and a sudden decrease in CO_2 emissions from automobiles is possible.

What should be the national response to the above uncertainties? Even were there to be a negligible greenhouse effect, we should be taking actions. For example, we should induce conservation and enhanced energy efficiency by increasing taxes on fuels, especially gasoline. We should greatly expand efforts to develop renewable resources, including biomass. But whatever we do should be based on well-thought-out long-range goals. It should not result from a half-baked political response.—PHILIP H. ABELSON

* J. F. B. Mitchell, C. A. Senior, W. J. Ingram, *Nature* **341**, 132 (1989). † R. W. Spencer and J. R. Christy, *Science*, p. 1558.