# Forum

*Forum provides an opportunity for commentary on articles published in ESR and for the expression of opinion on any other subject that relates to energy problems. Contributions are invited. (For further information see the inside back cover.)*

## Controversy About Global Warming

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Debate among scientists is an essential part of scientific investigation. It stimulates careful examination of hypotheses and the assumptions upon which they are based, evaluation of the procedures used to test the hypotheses and caution with respect to the formulation of conclusions.

Such debate has been an active ingredient of research activities related to greenhouse gases and global warming for several decades. During the past six months, however, the debate within the American research community has suddenly become highly public and somewhat acrimonious. At the centre of the controversy is a short, unrefereed report released by the George C. Marshall Institute in Washington in late 1989 (Nierenberg *et al*, 1989). The Board of Directors of that Institute include three well-known senior American scientists: F. Seitz, past president of the National Academy of Sciences; R. Jastrow, former director of the Goddard Institute for Space Studies; and W.A. Nierenberg, former director of the Scripps Institute of Oceanography.

The Marshall report does not dismiss the global warming hypothesis as a fallacy. However, it does suggest that uncertainties surrounding climate model projections of the result of increasing atmospheric $CO_2$ concentrations are so large that the expected warming could well be non-existent. It also suggests that the 0.5°C warming observed globally during the past century may well be entirely due to a return to normal from an anomalous

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cool period in the 19th century. It implies that cool periods, or "little ice ages," have occurred in the 15th, 17th and 19th centuries as a result of decreased solar activity and may occur again in the 21st century. The report concludes that "current forecasts...do not appear to be sufficiently accurate to be used as a basis for sound national policy decision"; it suggests, however, that a $100 million investment into supercomputing facilities would help to provide, within 3-5 years, the information required for sound decisions.

The Marshall report is not the only sharp criticism of climate models and of the proponents of an immediate policy response to global warming to be aired in recent months. Dr. R. Lindzen, a well-respected expert in atmospheric dynamics at the Massachussetts Institute of Technology (MIT), has also publicly criticized modellers for inadequately dealing with the role of deep convection of tropical clouds as a negative feedback (Lindzen, 1990). He has strongly endorsed the Marshall report. Others who have recently expressed similar criticisms include Dr. P. Michaels (University of Virginia), J. Namias (Scripps Institute) and R. Newell (MIT) (Brookes, 1989).

The above criticisms appear, at least in part, to be precipitated by what the authors perceive as irresponsible statements by a number of international climatologists (Kerr, 1989). Furthermore, the authors are concerned about the rapid pace of development of intergovernmental discussion on global strategies to control greenhouse gas emissions. They have received considerable attention by White House Administration officials, as well as by a number of journalists. One such journalist went so far as to imply that the "political greens" pushing the climate change debate are "determined to put the world economy back in the red, using the greenhouse effect to stop unfettered market-based economic expansion" (Brookes, 1989). This sentiment was echoed by Dr. Jastrow of the Marshall Institute, who indicated to reporters that he has "little respect for the vociferous people who are insisting, without a look at the [solar] evidence, that the Earth is getting steadily hotter" and suggested that "they are motivated by an anti-growth, anti-business ideology" (Berry, 1989).

*Reaction to the Marshall report has been swift and heated*

Reaction to the Marshall report, and its supporting critics, from the leading members of the climate change research community has been swift and no less heated. The prestigious International Council of Scientific Unions/World Meteorological Organization (ICSU/WMO) Joint Scientific Committee has dismissed the report as poor science. Several American researchers have referred to it as "noisy, junk science" and "nonsense" and have complained that the criticisms originate with non-experts in the global climate system research field and have not been subject to the normal peer-review process (Roberts, 1989). Somewhat calmer reactions point out: that the statements about uncertainty are valid but not new; that uncertainty cuts two ways (i.e., the problem may also be bigger than we think it is); that, despite a major boost in modelling research, uncertainty will give way to under-

standing only very slowly and certainly not to the degree, or within the five years, demanded by the critics; and that the conclusion of the Marshall report, with respect to a moratorium on policy response, is not justified by the scientific arguments it raises. Perhaps most damaging to the scientific basis of the report is a letter from Dr. M. Stuiver to the editor of *Science* (Stuiver, 1990). Dr. Stuiver, an internationally recognized expert on relationships among solar activities, carbon-14 in tree rings and climate, states that the authors of the report erred in adding a 50-year shift to the solar modulated changes in atmospheric production of carbon-14. (Such a shift is appropriate for tree ring analysis due to the lag of the carbon reservoir's response to those changes.) He "hesitantly" suggests that **increased** solar activity may be likely in the next century, but hastens to add that the "relationship between solar activity and climate is tenuous at best."

While the current public debate appears to be restricted to the US research and policy response communities, the shock waves are reaching well beyond American political borders. Some suggest the report was a significant factor in US reticence, at the Noordwijk ministerial meeting last November, to accept international efforts to promote goals for the control of greenhouse gas emissions. It has also raised questions about scientific uncertainties and the need for policy responses in other countries; e.g., what is the current state of understanding and what is an appropriate role for the science community in advising policy makers?

*Not all of the science surrounding the global warming issue is uncertain*

First, it should be noted that not all of the science surrounding the global warming issue is uncertain. For example, based on extensive literature reviews and results from scientific workshops (e.g., WMO/UNEP Intergovernmental Panel on Climate Change, in press) it appears that:

- evidence for the increasing concentration of greenhouse gases in the atmosphere is irrefutable;
- very few experts would deny that an equivalent doubling of $CO_2$ concentrations over pre-industrial levels is highly probable within the next century;
- ice cores show a remarkable correlation between changes in concentration of greenhouse gases and the Antarctic air temperatures during the past 160,000 years;
- all climatologists agree that the natural greenhouse effect is a real and primary factor in a life-supporting planet and that increased concentrations of greenhouse gases will cause some additional warming; most agree that such warming could be very significant;
- there appears to be a consensus, backed by historical observations and physical intuition, that such warming will be amplified in polar regions in winter seasons and accompanied globally by increased evaporation and precipitation; and
- most also agree that the Earth has warmed during the past century.

The above conclusions deal exclusively with the primary

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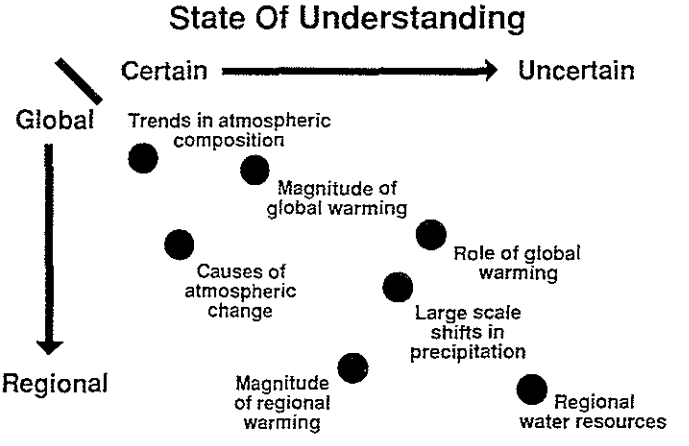
causes and consequences of climate change on global scales. But, as illustrated in the accompanying Figure, since attention is focused on continental and small spatial scales, on secondary and lower order effects of global warming and on magnitudes and rates of change, the complex feedbacks and dynamics internal to the climate system become increasingly important and uncertainty increases. It is here that critics touch on legitimate concerns about poor understanding of processes and the appropriateness of parameterizations used to simulate such processes in climate models. Hence the concern about uncertainty is less one of whether or not global warming will occur than of the characteristics of such a warming as it appears. Most uncertain, yet perhaps most critical to understanding the consequences for ecosystems and society, are the changes in regional precipitation and water availability patterns.

The uneasiness about policy action in an environment of uncertainty, as expressed by the American critics, may be at least in part attributable to scientific preoccupation with proof. Scientists usually insist that the acceptability of a hypothesis depends on supporting evidence being significant at least to the 95%, if not the 99%, level. While such conditions are valid and necessary in the scientific process, they become obstacles to dealing with

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issues at the practical or trans-scientific level. Practical questions deal with much more than the scientific probability of an event and its consequences. They also deal with ecological, economic, social and ethical values and costs associated with an event. Society is constantly confronted with such questions and decisions are made, consciously or subconsciously, by a process of risk assessment and value judgements. How do the risks and consequences of taking action to deal with an event that doesn't happen compare with those of not anticipating an event that does occur? In many cases the uncertainties involved may be much greater than those confronted in the climate change debate. Yet

the questions demand answers.

The same risk analysis approach appears appropriate in dealing with questions of policy response strategies related to climate warming. In this, science can help to provide the technical assessment and contribute to the analysis of the options. The final decisions, however, are not scientific, but value-laden policy responses that should help to group strategies into three primary categories. The first category includes responses where risk assessment leads to a virtual consensus that inaction is much riskier than action. In this case immediate action is justified. The second category includes those where action is equally risky to or more risky than inaction. In this case action is ill-advised or must be delayed pending better information. The third category, between the other two, is the largest group of response questions, where consensus on relative risks cannot be achieved and further discussion and debate are required to resolve action strategies. Such discussions are not only the responsibility of policy makers and their advisors, but must involve all sectors of society in seeking solutions to the questions.

*Uncertainty by itself is not a valid reason for inaction*

The above analysis in no way suggests that our scientific knowledge is sufficient to deal fully with the climate change issue. In fact, the need for increased research, to reduce uncertainties and to better understand the probabilities and the consequences, is urgent. Without this refined knowledge, certain actions that may be critical in dealing with the issue may never be acceptable to the policy maker because of high costs of implementation. The conviction that such actions are needed may come too late! However, it is equally clear that uncertainty by itself is not a valid reason for a policy choice of inaction. Many actions are indeed already justifiable and needed now.

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