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Global Climate Models and Their Limitations

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1.1 Model Simulation and Forecasting

1.1.1 Methods and Principles

J. Scott Armstrong, a professor at The Wharton School of the University of Pennsylvania and a leading figure in forecasting, has pointed out that forecasting is a scientific discipline built on more than 70 years of empirical research, with its own institute (International Institute of Forecasters, founded in 1981), peer-reviewed journals (*International Journal of Forecasting* and *Journal of Forecasting*), and annual International Symposium on Forecasting. The research on forecasting has been summarized as scientific principles, currently numbering 140, that must be observed in order to make valid and useful forecasts (*Principles of Forecasting: A Handbook for Researchers and Practitioners*, edited by J. Scott Armstrong, Kluwer Academic Publishers, 2001).

When physicists, biologists, and other scientists who are unaware of the rules of forecasting attempt to make climate predictions, their forecasts are at risk of being no more reliable than those made by non-experts, even when they are communicated through complex computer models (Green and Armstrong, 2007). In other words, when faced with forecasts by scientists, even large numbers of very distinguished scientists, one cannot assume the forecasts are scientific. Green and Armstrong cite research by Philip E. Tetlock (2005), a psychologist and now professor at the University of Pennsylvania, who "recruited 288 people whose professions included 'commenting or offering advice on political and economic trends.' He asked them to forecast the probability that various situations would or would not occur, picking areas (geographic and substantive) within and outside their areas of expertise. By 2003, he had accumulated more than 82,000 forecasts. The experts barely, if at all, outperformed non-experts, and neither group did well against simple rules" (Green and Armstrong, 2007). The failure of expert opinion to provide reliable forecasts has been confirmed in scores of empirical studies (Armstrong, 2006; Craig *et al.,* 2002; Cerf and Navasky, 1998; Ascher, 1978) and illustrated in historical examples of wrong forecasts made by leading experts, including such luminaries as Ernest Rutherford and Albert Einstein (Cerf and Navasky, 1998).

In 2007, Armstrong and Kesten C. Green of the Ehrenberg-Bass Institute at the University of South Australia conducted a "forecasting audit" of the IPCC *Fourth Assessment Report* (Green and Armstrong, 2007). The authors' search of the contribution of Working Group I to the IPCC "found no references … to the primary sources of information on forecasting methods" and "the forecasting procedures that were described [in sufficient detail to be evaluated] violated 72 principles. Many of the violations were, by themselves, critical."

Green and Armstrong found the IPCC violated "Principle 1.3 Make sure forecasts are independent of politics." The two authors write, "this principle refers to keeping the forecasting process separate from the planning process. The term 'politics' is used in the broad sense of the exercise of power." Citing David Henderson (2007), a former head of economics and statistics at the Organization for Economic Cooperation and Development (OECD), Green and Armstrong state, "the IPCC process is directed by non-scientists who have policy objectives and who believe that anthropogenic global warming is real and dangerous." They thus conclude:

> The forecasts in the Report were not the outcome of scientific procedures. In effect, they were the opinions of scientists transformed by mathematics and obscured by complex writing. Research on forecasting has shown that experts' predictions are not useful in situations involving uncertainty and complexity. We have been unable to identify any scientific forecasts of global warming. Claims that the Earth will get warmer have no more credence than saying that it will get colder.

Scientists working in fields characterized by complexity and uncertainty are apt to confuse the output of models—which are nothing more than a statement of how the modeler believes a part of the world works—with real-world trends and forecasts (Bryson, 1993). Computer climate modelers frequently fall into this trap and have been severely criticized for failing to notice their models fail to replicate real-world phenomena by many scientists, including Balling (2005), Christy (2005), Essex and McKitrick (2007), Frauenfeld (2005), Michaels (2000, 2005, 2009), Pilkey and Pilkey-Jarvis (2007), Posmentier and Soon (2005), and Spencer (2008).

Canadian science writer Lawrence Solomon (2008) asked many of the world's leading scientists active in fields relevant to climate change for their views on the reliability of computer models used by the IPCC to detect and forecast global warming. Their answers showed a high level of skepticism:

- Prof. Freeman Dyson, professor of physics at the Institute for Advanced Study at Princeton University and one of the world's most eminent physicists, said the models used to justify global warming alarmism are "full of fudge factors" and "do not begin to describe the real world."

- Dr. Zbigniew Jaworowski, chairman of the Scientific Council of the Central Laboratory for Radiological Protection in Warsaw and former chair of the United Nations Scientific Committee on the Effects of Atomic Radiation, a world-renowned expert on the use of ancient ice cores for climate research, said the U.N. "based its global-warming hypothesis on arbitrary assumptions and these assumptions, it is now clear, are false."

- Dr. Richard Lindzen, professor of meteorology at the Massachusetts Institute of Technology and member of the National Research Council Board on Atmospheric Sciences and Climate, said the IPCC is "trumpeting catastrophes that couldn't happen even if the models were right."

- Prof. Hendrik Tennekes, director of research at the Royal Netherlands Meteorological Institute, said "there exists no sound theoretical framework for climate predictability studies" used for global warming forecasts.

- Dr. Richard Tol, principal researcher at the Institute for Environmental Studies at Vrije Universiteit and adjunct professor at the Center for Integrated Study of the Human Dimensions of Global Change at Carnegie Mellon University, said the IPCC's *Fourth Assessment Report* is "preposterous ... alarmist and incompetent."

- Dr. Antonino Zichichi, emeritus professor of physics at the University of Bologna, former president of the European Physical Society, and one of the world's foremost physicists, said global warming models are "incoherent and invalid."

Dyson has written elsewhere, "I have studied the climate models and I know what they can do. The models solve the equations of fluid dynamics, and they do a very good job of describing the fluid motions of the atmosphere and the oceans. They do a very poor job of describing the clouds, the dust, the chemistry, and the biology of fields and farms and forests. They do not begin to describe the real world that we live in" (Dyson, 2007).

Many of the scientists cited above observe computer models can be "tweaked" to reconstruct climate histories after the fact. But this provides no assurance that the new model will do a better job of forecasting future climates, and it points to how unreliable the models are. Individual climate models often have widely differing assumptions about basic climate mechanisms but are then "tweaked" to produce similar forecasts. This is nothing like how real scientific forecasting is done.

Kevin Trenberth, a lead author along with Philip D. Jones of Chapter 3 of the Working Group I contribution to the IPCC's *Fourth Assessment Report*, replied to some of these scathing criticisms on the blog of the science journal *Nature.* He argued "the IPCC does not make forecasts" but "instead proffers 'what if' projections of future climate that correspond to certain emissions scenarios" and then hopes these "projections" will "guide policy and decision makers" (Trenberth, 2007). He says "there are no such predictions [in the IPCC reports] although the projections given by the Intergovernmental Panel on Climate Change (IPCC) are often treated as such. The distinction is important."

This defense is hardly satisfactory. As Green and Armstrong (2007) point out, "the word 'forecast' and its derivatives occurred 37 times, and 'predict' and its derivatives occurred 90 times in the body of Chapter 8 of the Working Group I report, and a survey of climate scientists conducted by those same authors found "most of our respondents (29 of whom were

IPCC authors or reviewers) nominated the IPCC report as the most credible source of forecasts (not 'scenarios' or 'projections') of global average temperature." Green and Armstrong conclude, "the IPCC does provide forecasts."

Green and Armstrong subsequently collaborated with Willie Soon in conducting validation tests of the IPCC forecasts of global warming (Green, Armstrong, and Soon 2009). To do so, they tested whether the warming-trend forecasts used by the IPCC are more accurate than the standard benchmark forecast that there will be no change. They tested the IPCC's "business as usual" 0.03˚C p.a. forecast and the no-change forecast from one to 100 years ahead on a rolling basis over the period of exponentially increasing human CO_2 emissions from 1851 to 1975. The procedure generated 7,550 forecasts from each of the forecasting procedures.

The Green, Armstrong, and Soon validation test was a weak one, in that the IPCC forecasts were tested against historical data (HadCRUt3) the IPCC modelers knew exhibited a warming trend. Green, Armstrong, and Soon therefore were surprised to find the errors from the IPCC warming trend forecasts were nearly eight times greater than the errors from the no-change forecasts. For the longer 91 to 100 years-ahead forecast horizons, the IPCC errors were nearly 13 times greater for the 305 forecasts. The no-change forecasts were so accurate in the validation test that the authors forecast annual global mean temperatures will be within 0.5˚C of the 1988 figure for the next 100 years. For public policy and business planning purposes, it is hard to see that any economic benefit could be obtained from forecasts that were less accurate than forecasts from the no-change model. The implication of the Green, Armstrong, and Soon forecasts is that the best policy is to do nothing about global warming. Their findings did not, however, stop the claims that "we are at a turning point" and "it is different this time."

If public policy to address global warming is to be made rationally, it must be based on scientific forecasts of (1) substantial global warming, the effects of which are (2) on balance seriously harmful, and for which (3) cost-effective policies can be implemented. Armstrong, Green, and Soon (2011) refer to these logical requirements of policymaking as "the 3-legged stool" of global warming policy. A failure of any leg would invalidate policies. To date, there are no evidence-based forecasts to support any of the legs.

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1.1.2 Computational Issues

To commemorate the publication of the 100th volume of the journal *Climatic Change*, Norman Rosenberg (Rosenberg, 2010) was asked to contribute an overview paper on progress that had occurred since the journal's inception in the interrelated areas of climate change, agriculture, and water resources. Rosenberg accepted and at the age of 80 conducted his review quite admirably.

He began by noting the "overarching concern" of the volumes he edited was "to gain understanding of how climatic change affects agricultural production, unmanaged ecosystems and water resources; how farmers, foresters and water managers can strengthen these sectors against the negative impacts of climatic change and capitalize on positive impacts if any; how they can adapt to impacts that cannot be so modified or ameliorated and how they can contribute directly or indirectly to mitigation of anthropogenic climatic change—as, for example, through soil carbon sequestration and the production of biomass to substitute in part for the fossil fuels that are adding CO_2 to the atmosphere."

Rosenberg writes in his closing paragraph, "it seems difficult to say with assurance that the 'state-of-the-art' in projecting climatic change impacts on agriculture and water resources and unmanaged ecosystems is, today, that much better than it was 30 years ago," noting "the uncertainty and lack of agreement in GCMs is still too great." He reported, "much can and has been learned about possible outcomes," but "for actual planning and policy purposes we are still unable to assure those who need to know that we can forecast where, when and how much agriculture (as well as unmanaged ecosystems and water resources) will be affected by climatic change."

A similarly pessimistic commentary on the state of climate modeling appeared in 2010 in *Nature Reports Climate Change.* Kevin Trenberth, head of the Climate Analysis Section of the National Center for Atmospheric Research in Boulder, Colorado (USA), writes that one of the major objectives of upcoming climate modeling efforts will be to develop "new and better representations of important climate processes and their feedbacks." The new work, Trenberth wrote, should increase "our understanding of factors we previously did not account for ... or even recognize."

In expressing these sentiments, Rosenberg and Trenberth gave voice to the concerns of many scientists who are skeptical of the reliability of GCMs. Such concerns should not be misinterpreted as "denial." Trenberth, at least, would deny being a "skeptic" of the theory of anthropogenic global warming. It is, rather, the humility of true scientists who—attempting to comprehend the complexity of the world of nature and its innermost workings—are well aware of their own limitations and those of all seekers of scientific truths. Although much has been learned, as Rosenberg and Trenberth outline in their respective essays, what is known pales in comparison to what is required "for actual planning and policy purposes," as Rosenberg describes it, or "certainty" as Trenberth puts it.