

Another exchange on climate change

Steve Sherwood, in his article "Science controversies past and present" (PHYSICS TODAY, October 2011, page 39), finds similarities between the cautious reception of global warming and those of Copernicus's heliocentric solar system and of Einstein's general relativity; by the comparison, he implies that global warming is in very good company. But erroneous ideas met similar receptions. For examples, see the article "Pathological science" by Irving Langmuir and Robert N. Hall (PHYSICS TODAY, October 1989, page 36).

Then Sherwood complains that claims such as "global warming having stopped in 1998" can be trivially falsified by looking at the data. So I looked at the data. While I agree that the conclusion is overstated, I found no falsification. The mean global temperature has not increased much since 1998, but in view of the part that noise plays in global temperatures, the result is not yet significant. However, another decade without considerable further warming would require a serious reexamination of the present global warming models.

In the next article, "Communicating the science of climate change" (PHYSICS TODAY, October 2011, page 48), Richard Somerville and Susan Joy Hassol tell us how to sell their radical view of climate change to a dismissive populace. In a strange parallel to Madison Avenue sales jargon, they provide a list of terms and concepts that are supposed to incite the populace to buy their views. Also, they suggest that one should cultivate vivid comparisons. For example, in connection with the report that the Greenland icecap is now believed to be melting at the rate of 220 km³/year, they argue that the rate should be compared to the annual water use of "the entire city of Los Angeles . . . [of] about one

cubic kilometer." In that spirit, I can describe that melting rate by noting that a year's melting raises the sea level a little less than 1/32 of an inch. And the global temperature increase of about 0.8 °C in the past century is about the same as one experiences by moving 50 miles southward anywhere in the central US from Minnesota to Louisiana.

In their radical position on the effects of warming, Somerville and Hassol argue that the world must shut down all processes that transfer carbon dioxide to the atmosphere so that the emissions (their figure 5) are "approaching zero by midcentury." Since shutting down all fossil-fuel burning by 2050 would probably do as much damage to the economy as the warming and thus wreck the production and supply of food and shelter to the 8 billion humans who will be occupying our planet, I was concerned about the acceptance of that position. But my concern was muted by the public-opinion survey shown in their figure 1, which demonstrates that for good reasons or bad, the American people are not buying the position that one has to shut down civilization to save it.

The models used to predict future global climate means are molded to fit past climate. However, global climate is the average of local climates, which are known to be chaotic and are hence unpredictable in principle.

Thus the century and a half of good climate measurements on which the projections of the future are based are seriously affected by unpredictable but fundamental noise that limits the usefulness of those projections. The limitations to global warming prediction are clearly understood in the excellent 1000-page report *Climate Change 2007: The Physical Science Basis*,¹ by the Intergovernmental Panel on Climate Change (IPCC), which reflects the contributions of about 500 authors—including Sherwood and Somerville—and another 500 reviewers.

In that bible we learn that the mean energy transfer from Earth's surface is about 492 W/m² (page 96), whereas the forcing from CO₂ added by industrialization is only 1.6 W/m² (page 32), with little uncertainty in either number. That small CO₂ forcing leads directly to only a fraction of the 0.8 °C global temperature increase in the past century. The

more general view is that positive feedbacks that amplify the direct CO₂ contribution account for the temperature increase we perceive. Thus while most concerned scientists—perhaps 98%—believe that industrial CO₂ has led to some warming, some very good scientists do not find the necessary feedbacks plausible and conclude that the increased CO₂ cannot be responsible for most of the perceived warming.

I find the spectrum of informed scientific beliefs reflected sensibly in the projections described in the IPCC report. Assuming no effective CO₂ control and an increase from about 390 ppm today to 1250 ppm by 2100, the IPCC scientists project (page 13) a likely temperature increase of 3.4 °C but with a one-in-six (one standard deviation) likelihood that the temperature increase will exceed 5.4 °C and cause serious harm and a one-in-six chance that it will be less than 2.0 °C and be innocuous or even beneficial.

In the face of uncertainty, the only broadly acceptable response is one that causes as little harm as necessary but does significant good if the dangers are as great as most of us fear. I suggest that a carbon or CO₂ tax best fits that bill.²

References

1. S. Solomon et al., eds., *Climate Change 2007: The Physical Science Basis—Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge U. Press, New York (2007), available at <http://www.ipcc.ch>.
2. See, for example, W. D. Nordhaus, *New York Review of Books*, 27 October 2011, <http://www.nybooks.com/articles/archives/2011/oct/27/energy-friend-or-enemy>.

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■ **I very much enjoyed** the two articles dealing with climate change, one by Steve Sherwood and the other by Richard Somerville and Susan Joy Hassol. Being an experimentalist, I follow what the data tell me; in the face of the overwhelming evidence, I have no doubt that humans are affecting global climates.

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Without consistent logic, it's easy for new evidence to shatter "notions that make us feel safe," as Sherwood states. When we don't feel safe, we often fight back to preserve our sense of safety. To that concern, add the consumerism common to many Western lifestyles. Flawed logic makes it easy to justify choices that involve, for example, the use of more and more energy, even when the evidence says such a choice is causing harm. Asking Westerners to change their lifestyle puts them in an uncomfortable place. Yet that is where we need to be if we are to make the necessary changes to limit future human-caused climate change.

The entire article by Somerville and Hassol discusses the important issue of communication. Without efficient and effective communication, the connections between human-caused climate change, logic, notions of safety, and lifestyles will be lost. As the authors state, 97% of those most actively publishing in the field of climate change agree that it's human caused (from their reference 4). That is no doubt a consensus, yet the public thinks otherwise. Imagine if the US Congress voted with a combined 97% agreement on an issue! No one would claim a lack of consensus. Yet why do people consider there is no consensus in the scientific community regarding climate change? Poor communication and information manipulation lead to the logic fallacies that allow people to continue to make lifestyle choices with negative consequences simply because they need to feel safe.

To approach this whole topic from a different perspective, what harm would it do to reduce our consumption of natural resources and production of carbon dioxide, other greenhouse gases, and harmful airborne particulates? Choices that preserve the diversity of plants, animals, cultures, and habitats are much more beneficial than harmful. The core question we need to ask ourselves is whether we want our choices, and hence our actions, to enhance or

harm the world. Do we or don't we take action? I choose to take action.

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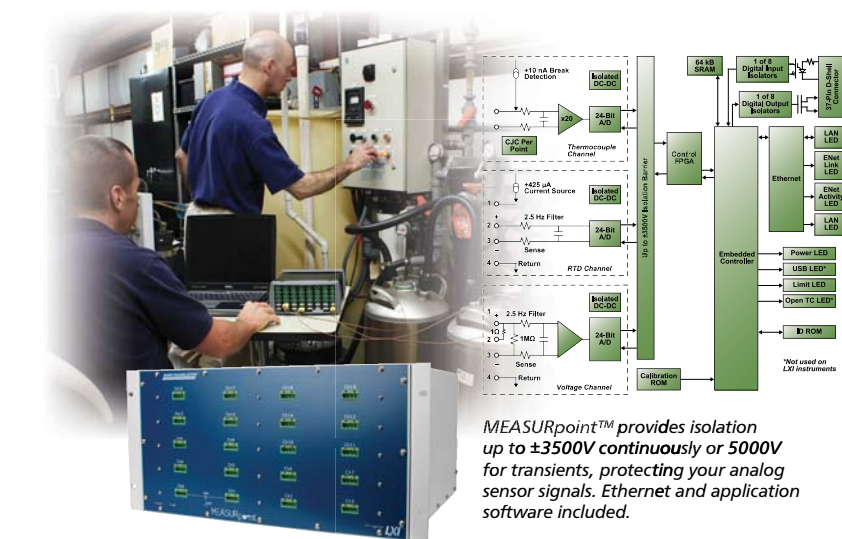
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■ **In the October 2011 issue** of PHYSICS TODAY, Steve Sherwood and, in a separate article, Richard Somerville and Susan Joy Hassol decry the reluctance of the general public to accept that anthropogenic release of greenhouse gases into the atmosphere is the primary driver of current global warming.

Yet neither article even mentions nuclear power as potentially the major vehicle for the reduction of greenhouse gas emissions.

If the reduction of annual carbon dioxide emissions to near zero by mid-century is necessary, as Somerville and Hassol show in their figure 5, then development of nuclear power at the fastest imaginable rate would seem to be the only measure remotely equal to the task. People have appreciated by now that the limited and unsteady power generation afforded by windmills and solar panels cannot cope with

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