Improving How Scientists Communicate About Climate Change

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Science meets policy in the most important challenge of our time: global warming. Yet even the most basic facts of this issue (e.g., that the world is warming and that human activity is the dominant cause) are obscure to some decision makers who need to understand them. How can climate scientists be more effective at communicating what they know, how they know it, and how sure they are of it?

The need for scientists to communicate more effectively about climate change is urgent. For people to take climate change seriously and support appropriate responses, they need to feel sure it is happening and is caused primarily by humans. But while the rise in global temperature is a fact (see, e.g., *Intergovernmental Panel on Climate Change (IPCC)* [2007], which calls the warming "unequivocal"), 56% of Americans believe there is a lot of disagreement among scientists about whether global warming is even occurring. And while every authoritative scientific body attributes most of the warming of the past 50 years to human activity [see, e.g., *IPCC*, 2007; *American Association for the Advancement of Science*, 2006], only 41% of Americans believe that humanity is the dominant cause (42% believe it is due about equally to natural and human causes), according to an April 2007 poll by ABC News, *The Washington Post*, and Stanford University.

Why is there an understanding gap? There is plenty of blame to go around, from general scientific illiteracy, to the media's failings, to a disinformation campaign [e.g., see *Union of Concerned Scientists*, 2007] designed to sow doubt. But the focus in this article is on scientists, who in general have not been effective communicators. It is not your fault. You were not trained for this role and generally are not rewarded for it. In fact, your scientific training tends to work against your ability to communicate simply and clearly to nonscientists, and there are disincentives for popularizing science. But with knowledge comes responsibility, and if you are willing, there are many ways to improve your ability to communicate. As someone who has spent two decades helping scientists improve their communication of global change issues, I have some suggestions to offer.

Recommendations to Scientists

One recommendation is to stop speaking in code. Words that seem perfectly common to scientists are still jargon to the wider world and always have simpler substitutes. Rather than "anthropogenic," you could say "human-caused." Instead of "spatial" and "temporal," try "space" and "time." When you talk about trends in degrees per decade, you are asking people to do math in their heads. Instead, try giving the total change over the full period of time. And know your audience; always use Fahrenheit for Americans.

Clearly state the settled scientific conclusions. Do not overdo "weasel words" and caveats. We know it is warming and we know it is due primarily to human activity. Say so. Saying human activity "contributes" to global warming makes it sound like human activity might be only a minor contributor. It would be more accurate to say "most of the warming…."

Clearly distinguish settled science from the details on which scientists frequently focus their attention. Avoid using the word "debate" in connection with climate change. It reinforces the mistaken notion that there is a debate about basic issues that are settled science. When referring to the whole issue, try something like "the urgent challenge of human-induced climate disruption" rather than "climate debate."

Words That Mean Different Things to Scientists and Lay People

Scientists use many words that mean something very different to much of the public. For example, scientists frequently use the word "enhance" to mean increase, but to lay people, enhance means to improve or make better, as in "enhance your appearance." So the "enhanced greenhouse effect" or "enhanced ozone depletion" sounds like a good thing. Try "intensify" or "increase" instead.

"Aerosol" means small atmospheric particle to scientists but means "spray can" to lay people. "Positive" connotes good and "negative" connotes bad to nonscientists. So "positive trends" or "positive feedbacks" sound like good things. Instead of "positive trend," try "upward trend." Instead of "positive feedback," try "self-reinforcing cycle." "Radiation" is about X rays and Chernobyl for much of the public; try "energy" instead. "Fresh" means pure and clean, like fresh-smelling laundry; so instead of saying water will become "fresher," try "less salty."

To people unfamiliar with the scientific method, a "theory" is just an unsubstantiated hunch, opinion, conjecture, or speculation. In this usage, theory is synonymous with what scientists might call a hypothesis. To scientists, theory means something very different. Instead of saying "according to theory," you might say, "according to our physical understanding of how this works," and refer to the evidence on which it is based. I suggest avoiding the use of the word "theory" to refer to things as well established as the greenhouse effect or the human intensification (not enhancement) thereof.

Scientists use the word "sign" to denote positive or negative values, but to most lay people, sign means an astrological sign or a stop sign. Rarely does it mean the plus or minus sign. So talking about a "sign error," or "not even having the sign right," is inexplicable. "Values" means something different too, as in "family values." And "regime" has political connotations. "Bias" connotes unfair and deliberate distortion or political influence, so referring to "data bias" might be confirming the suspicion that scientists are biased. "Error" means wrong or incorrect, so referring to error bars sends the wrong message. "Manipulation" and "scheme" have negative connotations.

Be very careful in referring to "risk" and "uncertainty." Depending on the context, a "risk" often connotes a low-probability event, something that might happen but is not likely, such as the risk of one's house burning down. Thus, in this context, global warming is not a risk but a reality. Similarly, to the public, "uncertainty" generally means we do not know if something will happen, so uncertainty about future warming is taken to mean that it might not warm at all; it might even cool, for all we know. But that is not what scientists mean; they mean there is a range of possible warming, depending on the level of emissions and how sensitive the climate is to those emissions. So instead of "uncertainty," try using "range."

Then there are acronyms. SST means sea surface temperature to scientists, but to the public, it's a supersonic airplane like the Concorde. PDF is a probability density function to scientists, but to the public it's the portable document format. THC means thermohaline circulation to scientists, but it's the active ingredient in marijuana to those members of the public who would recognize it at all.

These problems are not limited to climate science. For much of the public, the word "ecology" means environmentalism rather than a scientific discipline. And "discipline" is about keeping children in line rather than a field of study. "Organic" means grown without chemicals rather than carbon-based. "Nutrients" are always a good thing, as is "enrichment." "Fixing" nitrogen? Is it broken? And "exotic" generally has positive connotations.

Metaphors

Another way scientists can be more effective in communicating is to use metaphors. For example, when people ask how it is possible to predict climate 50 years from now when we cannot even predict the weather 2 weeks from now, they are obviously confusing weather and climate. You might compare this with what happens when you turn on the burner under a pot of water; while you cannot predict the time or place of any particular bubble, you can say with certainty that the water will be boiling in about 10 minutes. Similarly, while we cannot predict the age of death of any particular person, we can say with confidence that the average age of death for people in the United States is 77. Climate, like the average age of death, is a statistical average that is predictable based on large-scale

forces, while weather is subject to chaotic forces that make it inherently more difficult to predict.

How can scientists respond when people say that climate has always changed, so the current warming is probably also natural? A good metaphor that reveals the fallacy of this thinking is that just because lightning strikes have long caused forest fires does not mean fires cannot also be caused by a careless camper. And of course, there are many lines of evidence that show that the current warming is due primarily to human activity.

The ever popular metaphor of loaded dice provides a good response to the question of how global warming is affecting various weather phenomena. When people ask if global warming is responsible for the recent streak of heat waves, floods, wildfires, and intense hurricanes, you can say that by loading the atmosphere with excess greenhouse gases, we are loading the dice toward more of these extreme weather events. The data show this is already occurring for many phenomena; and models have long projected these changes.

Reframing

Rather than accepting the premise of a poorly framed question, reframe it. When people ask if global warming can be blamed for a particular hurricane, heat wave, fire, or flood, a simple "no" does not respond to the essence of the question. What they really want to know is whether global warming is having an effect on such events, and the science suggests that it is. You can reframe such questions to explain that global warming is increasing the chances of such events occurring, and you can also explain some of the connections.

Policy makers are finally grappling with the climate challenge, and they require comprehensible scientific input to inform their deliberations. Clear communication from scientists has never been more critical. Will scientists rise to this challenge and meet their responsibility to society?

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(Editor's Note: Please also see the Forum by Syun-Ichi Akasofu on page 108.)

NEWS

Increases Proposed for U.S. Energy Department, But EPA Funding Would Be Cut

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The Bush administration's proposed fiscal year (FY) 2009 budget request would cut the U.S. Environmental Protection Agency's (EPA) funding to US$7.14 billion, a decrease of $330 million, or 4.4%, from the 2008 funding level. However, the administration's proposed budget request for the U.S. Department of Energy (DOE) would boost that agency's funding to $25 billion, an increase of $1.07 billion over 2008.

The EPA budget request would allow the agency to "continue to deliver environmental results today, as well as keep EPA on course to deliver a cleaner, healthier tomorrow," according to EPA administrator Stephen Johnson. "This budget represents government at its best: It helps EPA meet our environmental goals while being responsible stewards of taxpayers' dollars."

However, U.S. Sen. Barbara Boxer (D-Calif.) criticized the budget at a 27 February hearing of the U.S. Senate Committee on Environment and Public Works. Boxer said the proposed budget represents a 26% decline in overall EPA funding since the enactment of the Bush administration's first EPA budget. She said the budget proposal "undermines EPA's ability to carry out its mission and would leave the agency less able to protect public health than it was when the Bush administration first entered office."

At that same hearing, U.S. Sen. James Inhofe (R-Okla.) noted that half of the administration's proposed cuts are congressional priorities, such as the Clean Water State Revolving Fund to prevent water pollution, which would drop to $555 million, a decrease of $134 million. "Since the administration knows Congress will restore many of the proposed cuts, this allows the administration to increase other programs; and at the end of the day, no hard decisions are made," he said.

The proposed budget for the EPA science and technology account would increase to $763.5 million, $3.5 million above the FY 2008 enacted budget. Within this account, funding for homeland security programs—including funding for the Water Sentinel and Decontamination line items—would be $73.9 million, an increase of $19.8 million above the FY 2008 enacted level. However, funding for the climate protection program would drop $6.9 million, to $11.4 million, and there would also be cuts for clean air, clean water, and human health and ecosystems research.

The agency's Environmental Programs and Management account would increase slightly, to $2.34 billion, and it would include increases for the air toxics and quality line item as well as for compliance, enforcement, and water quality protection. However, funding for geographic programs, including those for Puget Sound and San Francisco Bay, would be cut sharply. The budget also would cut funding for information exchange/outreach (including zeroing out funding for environmental education) and for programs related to endocrine disruptors, underwater storage tanks, and water ecosystems.

Within the Superfund account, homeland security line items again would receive increases: funding for decontamination and laboratory preparedness and response programs would increase $12.5 million, to $59.5 million. However, funding for Superfund audits, evaluations, and investigations and for enforcement would drop $4.32 million, to $7.16 million.

Department of Energy Budget

The administration's proposed FY 2009 budget for DOE is $25 billion, an increase of $1.07 billion over the FY 2008 appropriation.

DOE secretary Samuel Bodman said the budget "furthers President Bush's comprehensive strategy to increase energy, economic, and national security by focusing on accelerating technological breakthroughs, expanding traditional and renewable sources of energy, and increasing investment in scientific discovery and development." He said the budget "enables the department to continue to lay the foundation for a clean, safe, secure, and reliable energy future for all Americans."

The Office of Science would receive $4.7 billion, 18.8% above the enacted FY 2008 appropriation. Hefty increases are slated for basic energy sciences, which would receive $1.56 billion (a 23.5% boost) and would include $406.3 million for Materials Sciences and Engineering research programs, $177.6 million for the Spallation Neutron Source, and $93.3 million for the National Synchrotron Light Source II. Other areas that are proposed to receive funding increases include high-energy physics ($804.9 million, up 16.8%), biological and environmental research ($568.5 million, up