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EDITORIAL

Taking Action on Global Warming

The global warming debate is now over—at least the science part of it. The planet is warming because of us and the greenhouse gases we produce. The National Academy of Sciences (NAS) and the United Nations have concluded that a strong relationship exists between human activity and observed temperature increases (United Nations Intergovernmental Panel on Climate Change 2001; NAS 2001; NAS 2006). In 2005, national science academies of the G-8 countries as well as China, India, and Brazil issued a joint statement that the science of global warming was "sufficiently clear to justify nations taking prompt action" (NAS 2005). Specifically, the academies called for "identifying cost-effective steps that can be taken now to contribute to substantial and long-term reduction in net global greenhouse gas emissions." They warned that "delayed action will increase the risk of adverse environmental effects and will likely incur a greater cost."

The media, trained to present both sides of any issue, still too often frames global warming as an on-going debate, even though there is no published, peer reviewed science that refutes the linkage between recent warming and greenhouse gas emissions. Given our training, even scientists with expertise in global warming will generally be very cautious and place undue emphasis on the uncertainties and need for further study. That leaves the serious issue of global warming, and what can be done about it, to those with less knowledge and sometimes questionable political agendas that may not serve the society's best interests.

Global warming is becoming the most significant environmental problem modern civilization has ever faced. Most of us, being in the business of assessing human and ecological effects from chemical pollution, probably have not spent much time reading global warming science studies. If you do read these studies they point to one obvious conclusion. If we continue to emit greenhouse gases exponentially, temperatures will simultaneously increase, causing wide-scale impacts to life on earth for generations to come. Even with highly aggressive actions, equivalent to ten Kyotos, it will take more than a century before the global rise of carbon dioxide can be reversed (United Nations Intergovernmental Panel on Climate Change 2001).

As shown in Figure 1, ice core gas studies of carbon dioxide and temperature going back 400,000 years (and beyond) have demonstrated strong correlations with carbon dioxide and temperature (Fedorov *et al.* 2006). There has been no time in the past several hundred thousand years where there was as much carbon dioxide as now, and *never* a case where carbon dioxide increased as rapidly as it has over

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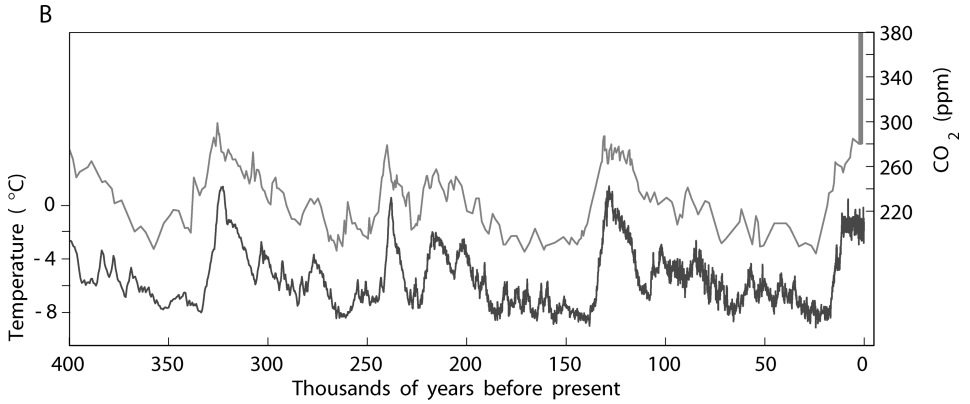

Figure 1. Fluctuations in temperature and in the atmospheric concentration of carbon dioxide over the past 400,000 years as inferred from Antarctic ice-core records. From A. V. Fedorov et al., SCIENCE 312:1485–1489 (June 9 2006). Reprinted with permission from AAAS.

the last century (Brook 2005; Siegenthaler *et al.* 2005; Spahni *et al.* 2005). Al Gore dramatically makes this point in the movie *An Inconvenient Truth.*

As I write this editorial in late July 2006, the U.S. has just experienced a coast to coast heat wave, where the temperatures in all contiguous 48 states were far above average for several days. Heat-related deaths were reported in California, Illinois, Missouri, and Pennsylvania. Temperatures in Europe also broke 100 degrees, reminiscent of the 2003 heat events where more than 30,000 people died (Patz *et al.* 2005). The wide spread hot weather events of 2003 and 2006 were characterized as simply "unusual" by the media and weather experts, but more extreme temperature episodes and heat-related mortality are precisely what scientific organizations, including the U.S. Environmental Protection Agency, have predicted (as early as the mid-seventies) as the planet continues to warm (NAS 1992). Projections indicate that heat-related deaths in major U.S. cities could double from 2,000 per year to 4,000 per year by 2050, even with full acclimatization such as that afforded by air conditioning (Kalkstein and Greene 1997).

Weather forecasters and we should discuss these heat waves in the context of global warming facts. The script might be as follows. Heat waves in the future will be more intense and last longer. Nine of the ten warmest years ever recorded have occurred in the past decade. The National Academy of Sciences just recently concluded with a high level of confidence that the last few decades of the 20th century were warmer than any comparable period in the last 400 years and possibly in the past 2,000 years (NAS 2006). As shown by Figure 2, models projecting 100 years into the future indicate more warming will occur from greenhouse gases, particularly in the Arctic and more northern latitudes (United Nations Intergovernmental Panel on Climate Change 2001). As evidenced by higher Arctic temperatures, thawing tundra, retreating glaciers, reduced sea ice, and rapidly altered ecosystems, scientists have concluded that global warming is now well underway (Chapin III *et al.* 2005; Lindsay and Zhang 2005; National Snow and Ice Data Center 2005; Stroeve *et al.* 2005; Rignot and Kanagaratnam 2006; Walker 2006). Scientists who study global

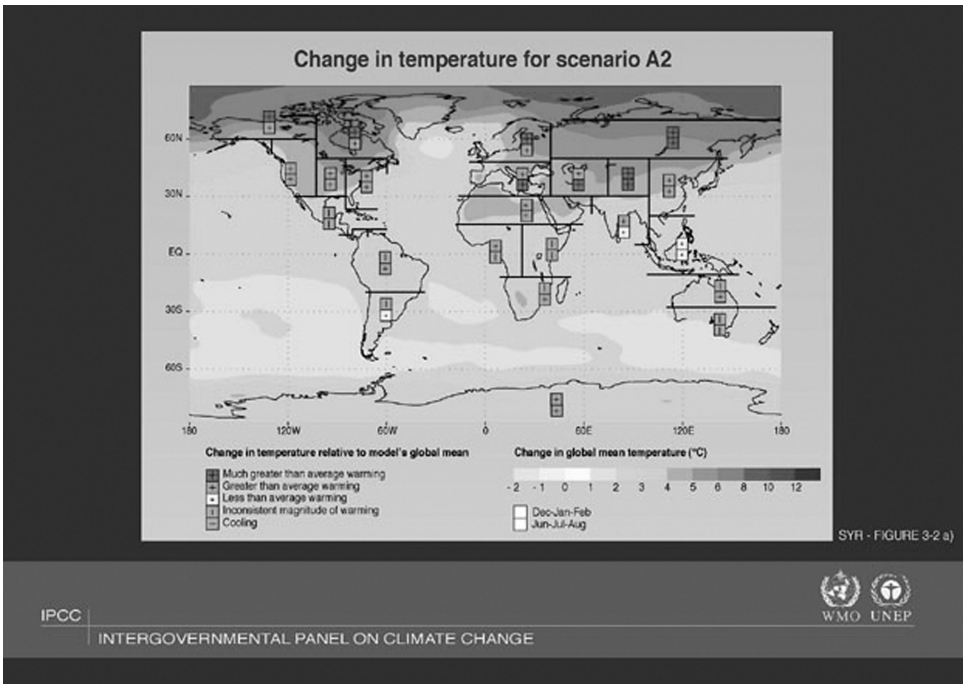

Figure 2. Projected temperature increases by 2001 for one modeling scenario. United National Intergovernmental Panel on Climate Change, 2001.

warming are concerned that increased warming will cause weather to change, leading to droughts, floods, and effects on crop yields.

The global warming problem is similar to the concern raised in the late 1970s from the destruction of the ozone layer caused by chlorofluorocarbons (CFCs). But global warming will be a more challenging problem to solve given the current worldwide dependence on fossil fuels, whose consumption is expected to increase by 50% within the next 25 years. Early on, well before the satellite data became available showing a large seasonal decline in the Antarctic ozone layer, the future Nobel laureate, Sherwood Rowland, would tell audiences that continuing to use CFCs would be carrying out a dangerous and unnecessary experiment on all life on earth.

We must now bring an end to the global warming experiment. As scientists we have an ethical responsibility to communicate concerns regarding global warming to wider audiences. We should recommend specific actions to address the problem, such as increasing energy efficiency, expanding renewable and nuclear energy, and promoting carbon sequestration. Last year, when senior governmental officials were repeatedly asked by the media if there is a link between hurricane intensity and global warming, which had been reported in several peer-reviewed studies including those of their own agency, they either avoided answering the question directly or simply answered "no." An important opportunity was missed to be open and forthright with the public. The science shows that there will be more Katrina-magnitude hurricanes

as the oceans continue to warm (Knutson *et al.* 1998; Knutson and Tuleya 2004; Emanual 2005; Webster *et al.* 2005).

If scientists do not step forward, the global warming debate will continue to be fueled by the press and good, cost-effective solutions unnecessarily delayed. Global warming should not be left for future generations and their scientists to solve. This is our issue and we must face it head on.

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