Reply

—Paul R. Epstein
Center for Health and the Global Environment,
Harvard Medical School,
Boston, Massachusetts

—James J. McCarthy
Museum of Comparative Zoology,
Harvard University,
Cambridge, Massachusetts

Pielke et al. (2005) recognize the problem of the growing instability in the climate system, but question that the increase in weather-related damages is an indicator. They assert: "at present it is premature to attribute trends in disaster costs to *anything other* than characteristics of and changes in societal vulnerability" (italics ours).

An increase in societal vulnerability to extreme weather events can arise through a change in exposure (as with maladaptive behavior) or through an increase in the frequency or intensity of extreme weather (Vellinga and Mills 2001). We wrote that both increasing coastal populations and real estate prices have increased exposure to weather-related disasters *and* that the number of extreme weather events has risen worldwide. We do not attempt to quantify the relative importance of these factors in the well-documented increase in insured and uninsured losses from weather-related disasters. We believe our statement is balanced and true to the current literature.

In support of their position of there being little or no role for climate change in the weather-related disaster cost trend they cite eight papers, six of which were published before the 2001 Intergovernmental Panel on Climate Change (IPCC) Third Assessment. Among these, Smit et al. (2000) state: "One possibility is that [weather] variability increases with climate change, but there is no consensus on changing variability (Houghton et al. 1996)."

Statements like this were correct in 2000. However, in 2001 the IPCC Third Assessment documents many changes in climate variability indices—more intense and persistent hot spells, increases in heat indices, more intense precipitation over some land areas, the increased risk of drought in a few areas (confidence estimates of "likely" or 66%–90% chance), and higher minimum temperatures and reduced diurnal temperature ranges over most land areas ("very likely" or 90%–99% chance) (Houghton et al. 2001). The World Meteorological Organization (2004) made explicit the connection between an energized climate system and more extreme weather.

We believe, with Evan Mills (Mills 2005a,b), that trends cited in the IPCC Third Assessment Report (TAR) are overly cautious in estimating the true costs. Extreme events falling below $5 million before 1996 and $25 million thereafter are excluded, and the aggregate of these may equal the totals listed in insurance statistics. In addition, weather-related losses have been increasing at a more rapid rate than others, *and* insurer withdrawal from risky areas, higher deductibles, lower limits, etc., would affect insured losses negatively. We join Changnon (2003) in calling for government–industry partnerships to better assess the compounding issues resulting in the rising costs associated with weather extremes.

Finally, the costs of biological sequelae of weather extremes—water-, mosquito- and rodent-borne "disease clusters" (Epstein 1999) and plant pests—can be delayed or hidden. The range and incidence of agricultural pests and pathogens are related to climate and extreme meteorological events (Rosenzweig et al. 2001). Most recently, soybean spores are thought to have been introduced into the United States by Hurricane Ivan (Stokstad 2004), one of the four in the fall 2004 to hit Florida. The fungal disease has been confirmed to be present in 11 states, and the U.S. Department of Agriculture (USDA) estimates it will cost American farmers from $240 million to $2.0 billion per year during the first year of its ex-

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tensive establishment within the major U.S. soybean production regions (Livingston et al. 2004).

We attempt no rank ordering of social vulnerabilities versus climate variability and severity because we think it premature. Both aspects are changing, and the relative importance of each varies from locale to locale, from region to region, and across developing and developed economies. We fully agree with Adger et al. (2003) that efforts are needed to promote enhanced resilience to both the present and future climate. We conclude that by developing the proper incentives for measures like distributed power generation with clean sources of energy we can further adaptation and reduce vulnerability to catastrophes, improve public health, and advance the transition to new technologies (Mills 2005). The task is to harmonize adaptation with mitigation and do it in such a way as to stimulate the global economy.

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