the next decade to provide greater advance warning for tornado strikes and more accurate estimates of hurricane landfall, saving lives and property.

Recognizing the need to involve the private sector as well as all levels of government, the Administration has developed a variety of partnerships. The 18 June Review discusses the Federal Emergency Management Agency's Project Impact. In addition, the Partnership for Advancing Technology in Housing, led by the Department of Housing and Urban Development, will make durable, disaster-resistant housing more readily available to people at all income levels. Public-Private Partnership 2000, co-sponsored by the National Science and Technology Committee, the Institute for Business and Home Safety (representing the insurance industry), and more than 20 other nonprofit organizations, has held more than a dozen forums to seek opportunities for reducing our nation's—and our world's—vulnerability to natural disaster.

Working together, we are building a sustainable society that will be much more resilient to natural hazards. I appreciate the contribution of the timely Review in helping us tell this story.

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Effect on the Biosphere of Elevated Atmospheric CO_2

The report "Net primary production of a forest ecosystem with experimental CO_2 by enrichment" by E.H. DeLucia *et al.* (14 May, p. 1177) provides excellent and much-needed experimental work on the responses of the terrestrial biosphere to elevated atmospheric carbon dioxide (CO_2). However, we are concerned about the report's last statement (also appearing in the abstract), which extrapolates measurements of net primary production (NPP) from this one experiment to the world's forests as a whole, suggesting that they could absorb as much as 50% of the projected fossil fuel emissions of CO_2 in 2050. This projection gives a misleading, perhaps erroneous, picture of the role of the terrestrial biosphere in the global carbon cycle.

First, NPP is not the appropriate measurement to apply when considering the net uptake (or release) of CO_2 by the terrestrial biosphere on a biome or larger spatial scale and over several decades. The most appropriate concept is net biome production (NBP) (*1*), which includes not only NPP, but also losses of carbon resulting from heterotrophic respiration, fires, insect-induced mortality, logging, and other natural and human-induced disturbances (*2*).

In contrast to global terrestrial NPP, which is about 60 picograms of carbon per year, global terrestrial NBP is about ± 1 or 2 picograms per year.

Second, there is considerable difficulty in extrapolating up in time and space from a single experiment based on a step-change in CO_2 concentration over a young, rapidly growing stand of trees, as noted by the authors of the report immediately before the final statement.

Third, applying the same methodology for extrapolation as used in this report, we conclude that the world's forests should now be taking up at least 3 picograms of carbon per year of fossil-fuel emissions. This is significantly higher than current estimates of terrestrial carbon sequestration [for example, (*3*)] and is inconsistent with atmospheric inverse calculations, as well as with estimates of oceanic carbon uptake.

In the current, post-Kyoto international

political climate, scientific statements about the behavior of the terrestrial carbon cycle must be made with care, especially extrapolations from stand-level experiments or observations.

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Response

NPP is the difference between total, annually integrated photosynthesis (gross primary production) and plant respiration and therefore represents the rate of carbon uptake from the atmosphere by ecosystems (*1*). By assuming that all forests of the world are similar to our young, fast-growing stand of loblolly pine, we attempted to constrain an estimate of the maximum net increment of NPP when the atmosphere contains 560 parts per million of CO_2. Our value for forest uptake, 50% of the anticipated CO_2 emissions from fossil fuels in the year 2050, indicates that forests will not solve the global warming problem for us. And, as Bolin *et al.* indicate, actual long-term carbon storage will be much less than NPP, owing to the activity of soil microbes, fires, human land-use changes, and so forth, which act to return CO_2 to the atmosphere.

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Schlesinger's observation that treaty negotiators for the Kyoto Protocol need to keep in mind the complexities of a full accounting of carbon emissions when calculating mitigation credits is spot-on. Negotiators need additionally to be mindful of the effects of CO_2 mitigation on other greenhouse gases, such as N_2O and CH_4. Carbon sequestration in soils can lead to concomitant changes in microbial habitats and populations that could offset or perhaps accentuate any credit provided by carbon sequestration per se. Research that simultaneously assesses the effects of mitigation strategies on all relevant trace gases is required.

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CORRECTIONS AND CLARIFICATIONS

In the report "An infrared spectral match between GEMS and interstellar grains" by J. P. Bradley *et al.* (10 Sept., p. 1716), two authors' affiliations were inadvertently interchanged. The correct affiliations are George J. Flynn, State University of New York, Plattsburgh, NY 12901, USA, and Donald E. Brownlee, Department of Astronomy, University of Washington, Seattle, WA 98195, USA.