corals are under intense pressure from a myriad of localized stresses related to coastal development and population pressure. In addition, widespread bleaching and mortality of corals are occurring with increasing frequency as the consequences of rising temperatures. Furthermore, studies indicate that corals and other calcifying marine organisms are subject to geochemical stresses from rising CO_2 concentrations in seawater (*4*).

Another biological source of paleoclimate records are tree rings, which have the potential to yield information on many aspects of tropical climate, from the Asian monsoon and El Niño to the factors controlling the storage of carbon in tropical forests (*5*). The use of tree rings from tropical trees is relatively new, but is moving into the phase where continental-scale collections must be made and analyzed. Massive felling of the commercially valuable timber of old-growth timber such as teak raises the possibility that, by the time scientists are able to sample them, many of the old trees containing the most valuable information will already have been sent to the sawmills.

Paleoarchives provide a wealth of information about past variability of the climate system relevant to future concerns. Thus, we call for an internationally coordinated effort designed to rescue endangered natural archives of past environmental variability and initiate large-scale observational and experimental campaigns to investigate the processes recorded in these natural archives.

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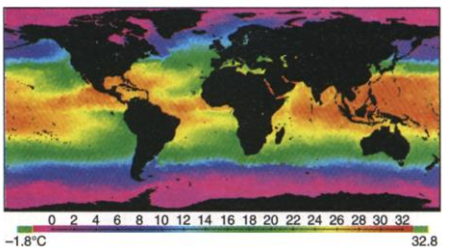
Climate Variability and Global Warming

ALTHOUGH UNCERTAINTIES IN GLOBAL warming are many and varied, they are not as great as stated in the recent U.S. National Research Council (NRC) report (*1*). As Richard A. Kerr notes in his News of the Week article, President George W. Bush seized upon these uncertainties to justify the administration's limited response ("Bush backs spending for a 'global problem,'" 15 Jun., p. 1978). Specifically, Bush "emphasized that the contribution of natural climate variability to the past century's warming is uncertain," to quote Kerr.

Unfortunately, in the NRC report, two aspects of natural climate variability are conflated. First, there is natural variability that is tied to external forcings, such as variations in the Sun, volcanoes, and the orbital variations of Earth around the Sun. The latter is the driving force for the major ice ages and interglacial periods. Second, there is natural variability that is internal to the climate system, arising, for instance, from interactions between the atmosphere and ocean, such as El Niño. This internal variability occurs even in an unchanging climate.



CREDIT: NOAA/NESDIS

Sea surface temperature anomalies recorded in maps such as this color-enhanced one from 23–26 June 2001 reveal El Niño events, which are part of a natural variability that is internal to Earth's climate system.

In the NRC report and in its summary, natural variability is said to be "quite large," but both kinds of variability are treated as if they are internal. Glacial to interglacial swings are discussed without mention of the known causes. Several lines of evidence, from the instrumental and paleoclimate records (*2*) and from climate models (*3*), strongly suggest that the recent increase in global mean temperature is beyond that possible from internal processes and thus must be caused by an increase in heating. This reasoning also puts limits on how large aerosol cooling could be. Further, known causes such as changes in the Sun and volcanic activity in the past 50 years have, if anything, led to cooling in this interval, leaving only the human-caused increase in greenhouse gases as the culprit. This reasoning has also been quantitatively confirmed with climate models (*3, 4*).

A consequence of mistreatment of natural climate variability in the NRC report is that the caveats are overstated. Natural climate variability is dealt with much more thoroughly in the recent Intergovernmental Panel on Climate Change (IPCC) assess-

ment (*4*), which was developed over about 3 years (versus 1 month for the NRC report). The summary from the IPCC is that "[t]here is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

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Earth System Science Sentiments

I AM IN ALMOST COMPLETE AGREEMENT WITH John Lawton's discourse on "Earth system science" (Editorial, 15 Jun., p. 1965). However, I was taken aback by the obvious lack of reference to geology as a constituent. By definition alone, geology should have been featured prominently in the discussion. And then I realized that the "Earth system science" described by Lawton is "geology." We don't need a new name because this is not a new discipline. The points made are still valid—we need to broaden the perspective and redesign our institutions to more fully use this new definition and allow the old science of geology to flourish.

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"THERE ARE, AS FAR AS I AM AWARE, NO undergraduate degree courses in [Earth system science]," says John Lawton in his Editorial. I am, in fact, a graduate of just such a program! Stanford University established its Earth Systems Program (http://pangea.stanford .edu/ESYS/) when I was a sophomore, allowing me to graduate in 1994 with a B.S. in Earth systems. When I was in the program, Earth systems students took classes in biology, geology, and economics, in addition to classes in mathematics, physics, and chemistry. The program offered several "tracks," or concentrations within the major program.

A number of other colleges including Southern Utah University, Cornell, California State University Monterey Bay, and Seoul National University (*1*) have established similar interdisciplinary Earth science programs. Having such a breadth of exposure has served me well in several jobs and now in graduate school. I agree with Lawton's call for further institutional support for an integrated systems approach to Earth science, in the name of planetary health.

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1. Web sites for the programs mentioned are as follows: Southern Utah State University, http://www.suu.edu/ sci/physci/earth.html; Cornell, http://www.geo.cornell.edu/ses/SES_home.html; California State University Monterey Bay, http://csumb.edu/academic/ descriptions/essp.html; and Seoul National University, http://sees.snu.ac.kr/bken/index.html

CORRECTIONS AND CLARIFICATIONS

REPORTS: "New ages for the last Australian megafauna: continent-wide extinction about 46,000 years ago" by R. G. Roberts *et al.* (8 Jun., p. 1888). In note 27, one of the digits in the URL for the supplementary material was incorrect. The correct URL is www.sciencemag.org/cgi/content/full/292/5523/1888/DC1

TABLE OF CONTENTS: (8 Jun., p. 1788). The painting with the caption "Megafauna overkill" was not from the report by R. G. Roberts *et al.*, as indicated. Like the painting that accompanied S. Pimm's book review in the same issue (p. 1841), it is a reconstruction of Eocene biota from Wyoming by Rebecca Horwitt.

PERSPECTIVES: "Open windows to the polar oceans" by P. Lemke (1 Jun., p. 1670). Sensible heat was erroneously defined as "the amount of energy necessary to change a liquid to a vapor at constant temperature and pressure." This expression is the explanation for latent heat. Sensible heat is the energy necessary to produce a particular temperature change in a mixture of liquid and gas, excluding any energy required for a phase change.

Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 6 months or issues of general interest. They can be submitted by e-mail (science_letters@aaas.org), the Web (www.letter2science.org), or regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.