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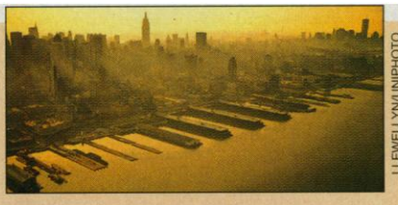
LETTERS

Light and Gravity



LLEWELLYN/UNIPHOTO

Correspondents this week shed light on the management of national laboratories in China, the purpose and appropriate use of math and science test scores, Earth's supply of fossil fuels and global warming (at right, urban smog), NASA's research in the life sciences (which often involves microgravity) and collaboration with other institutions, and progress in the challenging field of antisense oligonucleotide research.

Reducing Greenhouse Gases

The Perspective "The United Nations climate convention: Unattainable or irrelevant" by Pekka E. Kauppi (1 Dec., p. 1454) says that the goal of stabilizing greenhouse gas concentrations at less than twice the preindustrial level is probably unattainable. Kauppi writes (p. 1454) that "reasonable emission scenarios indicate that a doubling of the greenhouse gas concentrations is inevitable in the 21st century." Such scenarios require continued growth in rate of fossil fuel consumption. With the current rate of CO_2 emissions, well more than a century could pass before atmospheric CO_2 concentrations doubled. But fossil fuel reserves and recent estimates of undiscovered producible fossil fuels indicate that we lack the fuel resources to maintain even *current* fuel consumption rates beyond another half-century (*1*).

If these estimates are correct, it is continued growth in fossil fuel consumption rate that will be unattainable after the early decades of the coming century. In this case, decline in rate of greenhouse gas emission during the coming century is not only attainable, but inevitable.

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1. C. D. Masters, D. H. Root, E. D. Attanasi, *Science* **253**, 146 (1991); C. B. Hatfield, *J. Geol. Educ.* **42**, 432 (1994).

Response: Since the year 1800, humans have released 220 to 250 pentagrams (1 pentagram = 10^{15} grams) of C from fossil reserves into the atmosphere. This has been the main reason for the recorded increase of atmospheric CO_2 by 30% (*1*). Current annual emissions of fossil C are about 6 pentagrams.

The reservoir of all fossil fuel occurrences in the Earth's crust is estimated to amount to some 25,000 pentagrams of C (*2*). The C reservoir in fossil fuels that may become technically and economically recoverable in the foreseeable future has been estimated at 3500 pentagrams (*2*).

Improved geological knowledge, improved technology, and changing prices have tended to increase the fossil energy reserves (*2*). Although the conventional petroleum reserves, which were the focus of the article by Masters *et al.* (*3*), are relatively small, coal reserves are larger. They account for more than half of all fossil reserves (*2*). After 100 years, the reserves of conventional cheap petroleum will have become scarce, but there is likely to be lots of coal left.

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1. U. Siegenthaler and H. Oeschger, *Tellus* **39**, 140 (1987); U. Siegenthaler and J. L. Sarmiento, *Nature* **356**, 119 (1993).
2. N. Nakicenovic *et al.*, in *Climate Change 1995: Impacts, Adaptation, and Mitigation: The Report of Working Group II of IPCC* (Cambridge Univ. Press, Cambridge, UK, in press), chap. B.
3. C. D. Masters, D. H. Root, E. D. Attanasi, *Science* **253**, 146 (1991).

NASA's Life Science

In the News & Comment article "Will NASA's research reforms fly?" (17 Nov., p. 1108) Andrew Lawler does not misquote me [in saying that the National Aeronautics and Space Administration (NASA) did "some really poor research" in the life sciences (p. 1109)], but does "underquote" me. I would like to state my firm support for the "Research Institute" concept of Daniel