LETTERS

"Nuclear Winter" Calculations

The description by Turco *et al.* of the possible global consequences of multiple nuclear explosions" (23 Dec 1983, p. 1283), represents an important attempt to quantify the effects of a nuclear war on global climate. In common with other preliminary studies (*1*), the numerical model simulations of Turco *et al.* suggest that heating of the earth's surface by solar radiation might be drastically reduced by the dust raised in high-yield nuclear blasts and by smoke from city and forest fires ignited by the blasts. However, in view of uncertainties in important inputs to the models and in many of the physical processes involved, as well as inadequacies in the models themselves, the predictions of a nuclear winter must be viewed as a possible, rather than the definite, outcome of a nuclear war. While this caveat has generally been made in scientific articles on the subject, and has been reemphasized in an excellent report by the National Academy of Sciences (*2*), it is often neglected in communications with the general public.

To further underscore the tentative nature of the nuclear winter predictions, I list below some of the scientific uncertainties associated with the numerical model calculations (*3*).

1) The amounts of material that would burn are not well quantified (for example, How widespread will forest fires be in winter?).

2) There are large uncertainties about the quantities of smoke particles that would be emitted into the atmosphere from various types of fires. On the basis of limited field data available (*4*), it appears that Turco *et al.* may have overestimated these emissions.

3) Clouds generally form above large fires, and these clouds often produce rain. This provides a mechanism for the prompt removal of some of the smoke particles, which would further reduce the effective (widespread) emissions of smoke.

4) The radiative properties of smoke particles are not well known. In view of the complex nature of smokes, these properties need to be established by field studies of the plumes from large fires.

5) Widespread smoke will change the radiative properties of clouds. Possible effects include enhanced absorption of terrestrial (long-wave) radiation by smoke particles when they are covered with water, decreases in the average size of cloud droplets (*5*), and decreases in the ice content of clouds (*6*). In view of the profound effects that clouds have on the radiative balance of the earth, these effects should be included in numerical simulations of the effects of smoke particles on atmospheric temperatures.

While some of these effects would tend to diminish the predicted decreases in temperature at the earth's surface, others would tend to enhance the lowering in surface temperatures. Clearly, at this juncture, there are too many uncertainties and simplifications in the numerical simulations of the effects on climate of a nuclear war to place much reliance on their predictions. Reduction of these uncertainties will require dedicated research efforts to better quantify the amounts and nature of the smoke particles from various types of fires, the rates of removal of smoke particles from the atmosphere (particularly prompt removal), and the radiative properties of smokes and clouds affected by smoke, as well as to improve numerical models of global climate. The importance and urgency of the problem dictates that these research tasks be given top priority.

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References and Notes

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2. *The Effects on the Atmosphere of a Major Nuclear Exchange* (National Academy Press, Washington, D.C., 1984).
3. A more detailed discussion of the scientific uncertainties is given in P. V. Hobbs, L. F. Radke, D. A. Hegg, *ICSU-SCOPE Workshop on the Nuclear Winter Scenario, Proc. 9th Intern. Cloud Physics Conf. (1984)*, Tallinn, Estonia, in press.
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Diagnostic Ultrasound

Our initial report on increased frequency of sister chromatid exchanges (SCE's) after in vitro exposure of human lymphocytes to pulsed diagnostic level ultrasound (*1*) has been confirmed and extended in publications from five laboratories in the United States and elsewhere (*2–4*). The increase has now been detected after continuous wave insonation and after in vivo exposure (*4*). The

frequency of SCE's increased with acoustic power in a critical range (*3*).

Free radicals are generated in aqueous solutions by pulsed ultrasound (*5*); their products have also been identified in the DNA thymidine of animal cells exposed to continuous wave insonation (*6*). The bioeffects of ultrasound responsible for the increased SCE frequency and some of the other findings described in more than 700 publications since 1950 (*7*) may well be the result of free radical release.

The failure of Ciaravino *et al.* to confirm our results (15 Mar., p. 1349) might be accounted for by many factors. Among these are the high degree of interobserver variation in their SCE scoring, their high SCE baseline values, and the fact that their critical acoustical power range was not verified and was not systematically varied. These and other variables may account for the failure of some laboratories to reproduce results of others, leading to the confusion in this field.

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The following points are pertinent to Bases' letter.

1) Interobserver variation in SCE scores is expected and is the reason why controls were included. The SCE rate in our experiments did not increase above control values for any of the three independent scorers.

2) SCE baseline values vary considerably from laboratory to laboratory; for example, they were 3.28 for Kakati *et al.* (*1*), 16.3 for Lambert *et al.* (*2*), and 27.33 for Dutrillaux *et al.* (*3*). Our SCE baseline values were well within this range.

3) The dosimetry for our experiments was accomplished by Paul Goodwin, staff physicist at Albert Einstein College of Medicine, who also was involved in making dosimetric determinations for Liebeskind *et al.* (*4*). The intent of our experiments (*5*) was to duplicate exactly the experimental conditions of the Liebeskind *et al.* study (*4*) with a well-defined, nonvarying field from a specific diagnostic ultrasound device. Our earlier attempts to verify their results with our equipment had been unsuccessful (*6*).

4) The Albert Einstein group declined to score the slides that we made on their premises with their equipment.

5) Bases suggested that we undertake "independent double-blind scoring by recognized experts . . ." of our slides (*7*). The coded slides were sent to William Morgan (at the University of California Medical Center, San Francisco); his evaluation agreed with ours.

6) Bases then suggested (*8*) that we send the slides to David Jacobson-Kram (George Washington University) for evaluation. His scoring agreed with ours.

7) The results of Martin *et al.* (*9*) are negative ["χ^2 tests . . . were not significant. . . ." (*9*, p. 993)], as are the results of most of the studies in this area (*10*).

8) Makino *et al.* (*11*) used a Bransonic 12 cell disrupter that produces a continuous sound wave at a frequency of 20 kilohertz; their study thus has little relevance to diagnostic ultrasound.

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Murine Retroviral Vectors and Human Gene Therapy

In his excellent and timely article, "Prospects for human gene therapy" (26 Oct. 1984, p. 401), W. F. Anderson discusses some of the possible difficulties surrounding the envisaged future use of retroviral vectors in attempts to correct human genetic defects. Such vectors unfortunately appear to have a strong propensity for deleting or rearranging their own sequences. One way in which such structural alterations might arise is through recombination events with homologous endogenous viruses already present in the cellular genome. In addition to the possible loss of vector-born