NRC Panel Envisions Potential Nuclear Winter

An expert panel of the National Research Council (NRC) has concluded that a major nuclear war could potentially result in a substantial period of darkness and markedly lowered temperatures on the earth's surface, with a severe impact on surviving plants and animals, including man.

This scenario, which has come to be known as a "nuclear winter," was first envisioned only a few years ago. But since then, it has been a topic of intense scientific interest. Some military planners suggest that if true, it could render useless much civil defense planning, transform a nuclear first strike into a suicidal act, and eliminate hope of escaping the adverse effects of a major nuclear conflict anywhere on the globe (*Science*, 6 July, p. 30). Consequently, "nuclear winter" has lately become a topic of increasing political controversy, with experts such as Edward Teller asserting that it is unlikely and others such as Carl Sagan suggesting that it is all but certain.

On 11 December, the NRC waded into this debate with a report that essentially endorses the notion that a "nuclear winter," created by the atmospheric injection of massive amounts of light-absorbing dust and soot from nuclear detonations, is possible. More than earlier studies, however, it emphasizes the extensive uncertainties behind existing predictions of the climatic aftermath of a nuclear war. As panel chairman George Carrier, a professor of applied mathematics at Harvard University, explains, "Our present knowledge is simply insufficient to make a definitive statement about the state of the atmosphere that would result from such an exchange. Nevertheless, when one makes plausible estimates, the results look very worrisome and one can't rule out the possibility that the impact might be very severe. Consequently, it has to be taken seriously."

Unlike most NRC panels, which usually analyze relevant literature, Carrier's group conducted its own research. Specifically, it envisioned that a major nuclear exchange could involve half of the world's present arsenals, or roughly 6500 megatons. It assumed that all of these weapons would be aimed at military, not civilian targets, but that one-fourth would detonate in cities that happened to contain such targets. It assumed that the resultant forest and urban fires would loft enormous quantities of dust and soot into the earth's atmosphere, and that some would linger there for anywhere from weeks to months.

"Estimation of the amounts, the vertical distributions, and subsequent fates of these materials involves large uncertainties," the panel says. "Furthermore, accurate detailed accounts of the response of the atmosphere, the redistribution and removal of the depositions, and the duration of a greatly degraded environment lie beyond the present state of knowledge." After incorporating its best estimates in a one-dimensional climatic model, however, the panel concluded that "there is a clear possibility" that much of the land areas of the northern temperate zone could suffer a temperature reduction of perhaps 10° to 25°C, lasting for weeks, as well as subnormal—but less extreme—temperatures that might persist for months. "The impact of these temperature reductions and associated meteorological changes on the surviving population, and on the biosphere that supports the survivors, could be severe, and deserves careful independent study."

In its modeling, the panel made a particular effort to address a major criticism of earlier studies—namely, that the climatic models were implausible, either because they depicted deliberate targeting of cities or because they failed to consider geographical overlap between nuclear detonations. Carrier says that the panel was able to consult with several targeting experts on the panel itself, including two retired admirals and a former National Security Council staff member, as well as others. "The result is that our targeting scenario does conform to general military planning," he says. "I don't pretend that this is how a war will occur, but all of the elements here are realistic."

The panel deliberately omitted discussion of other worrisome consequences of a nuclear war, such as prompt radiation, blast, and thermal effects, as well as long-term radioactive fallout and an expected shortage of medical facilities. At the behest of its sponsor, the Defense Nuclear Agency, it also declined to assess the consequences of a more limited nuclear exchange. However, it noted that "any war scenario that subjects . . . city centers to nuclear attack, even one employing a very small fraction of the existing nuclear arsenal, could generate nearly as much smoke as in the 6500-megaton baseline scenario." In short, even a small exchange could potentially create some "nuclear winter" effects.

The report indicates that despite all the uncertainties, the postwar world would be decidedly grim. Large-scale fires would be prevalent in both urban and forested areas, emitting large quantities of carbon monoxide, nitrogen oxides, and organic compounds, as well as noxious chemicals, such as PCB's, dioxins, and dibenzofurans. The amount of soot expected to survive swift atmospheric scavenging is estimated by the panel at anywhere between 20 and 650 million metric tons, with an intermediate level of 150 million metric tons. Total darkness might result in some areas. Atmospheric ozone could be diminished by as much as 17 percent. "Although Southern Hemisphere effects would be much less extensive, significant amounts of dust and smoke could drift to and across the equator as early as a few weeks after a nuclear exchange," the panel says.

Richard Turco, an atmospheric scientist with R&D Associates in California and one of the principal authors of a less equivocal study of nuclear winter in *Science* last December, characterizes the NRC report as a "weak endorsement of our work. While it doesn't exactly confirm what we did, it indicates clearly that there were no oversights of a simple nature that would tend to explain all this away." The significance, he says, lies in the fact that it was prepared and reviewed by a group with diverse expertise and political orientation. "In a sense, it legitimizes this problem as a topic for additional research," he says.

Michael MacCracken, an atmospheric scientist at Lawrence Livermore National Laboratory, agrees. "It was easy for many people to dismiss the phenomenon of nuclear winter when it was first envisioned. This study will help pull people up to the current level of understanding: namely, that it is possible for this to happen, and that there is no fatal flaw that negates the work performed to date."

—R. JEFFREY SMITH