Nuclear Winter Attracts Additional Scrutiny

Prodded by Congress, the Pentagon begins to examine the impact of soot on nuclear strategy

Last October, in a widely publicized press conference, a group of leading scientists presented an unusually harrowing portrait of the aftermath of a superpower conflict. At its heart was the novel theory that even a limited nuclear war will generate enough soot and dust to shield a substantial portion of the earth from sunlight, perhaps for months, potentially causing the extinction of numerous plants and animals, including man.

Although this announcement generated little government reaction at the time, it has since given rise to a host of official studies and a promise of additional research funds. It has also galvanized the Congress to demand what may effectively be the first formal environmental impact statement on the consequences of a nuclear holocaust. Similar provisions in the House and Senate versions of the latest defense bill order the Pentagon to produce a comprehensive public report by March 1985 on the latest scientific findings and their implications for nuclear weapons planning, procurement, deployment, targeting, and command, as well as for arms control and civil defense.

Congress approved the requirement after the Natural Resources Defense Council (NRDC), an environmental group in Washington, discovered that the government had by and large ignored the "nuclear winter" scenario depicted by the atmospheric and biological scientists last year. According to the scenario, an exchange of weapons with a total explosive force of 5000 megatons would set massive forest fires and generate voracious firestorms in virtually every major city, creating enough dust and soot to plunge the Northern Hemisphere into a lengthy period of icy darkness, with potentially cataclysmic biological consequences.* A climatic model suggested that a smaller exchange of 100 megatons, detonated in large cities, would also lead to a nuclear winter.

Despite the obvious relevance of these scenarios to military planning and civil defense, they were until recently unanticipated by the community of military officials and analysts who set U.S. nuclear strategy. "It really is a new thing," says Charles Zraket, chief operating officer for the MITRE Corporation, one of the Pentagon's principal contractors for nuclear command, control, and communications. "The Pentagon had either been totally unaware of this phenomenon, or it simply failed to consider it during planning. We at MITRE certainly never took it into account; I can say that first-hand." This assessment is corroborated by Richard DeLauer, the Pentagon's top scientist. "We should all perhaps be a little concerned that we did not recognize a little sooner the importance of the smoke to our calculation of nuclear effects," he told Carl Sagan, one of the participants in the nuclear winter study, in a recent letter.

Even after the study was published, few agencies exhibited interest in its implications for their work. "We have not done any work or studies relating to

*The theory is explained in detail in an article by R. P. Turco, O. B. Toon, T. P. Ackerman, J. B. Pollack, and Carl Sagan in the 23 December 1983 issue of *Science*, pages 1283–1292.

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the atmospheric or climatic effects of nuclear war," said an official of the Federal Emergency Management Agency (FEMA), the nation's civil defense headquarters, in a letter to NRDC on 14 March. Similar replies were received from the Arms Control and Disarmament Agency, the Air Force, the Strategic Air Command, and the North American Air Defense Command.

A notable exception was the U.S. Navy. In an internal memo dated 7 November, Vice Admiral J. A. Lyons, deputy chief of naval operations, wrote that "in the long term, the [results] deserve serious study to see what, if any, changes in U.S. targeting policy are required. In the short term, however, [the] implications are primarily political. I anticipate that the Soviets will make extensive use of these results, especially in Europe, to demonstrate the dangers of the arms race." Lyons proposed that the Navy conduct a careful nuclear targeting study, while simultaneously vigorously rebutting any Soviet propaganda.

Another notable exception was the Department of Energy, which recently committed $3 million for a 2-year study of the nuclear winter phenomenon to be jointly carried out by the weapons laboratories at Livermore and Los Alamos. "At the moment, the calculations are highly simplified, and there are numerous uncertainties," says Michael MacCracken, an atmospheric scientist at Livermore. He notes in particular the need to improve models of climatic change wrought by a nuclear war. The initial nuclear winter presentation, for example, stemmed from a one-dimensional climatic model, which generally neglected local and seasonal atmospheric variations, as well as the moderating impact of the oceans on cooling over land. A subsequent analysis took these factors into account but neglected the effects of dust, the consequences of smoke movement from one locale to another, and the impact of aerosol scattering (*Nature*, 1 March, p. 21). All of the authors acknowledged a pressing need for more realistic models.

A substantial new research effort is also under consideration at the climate office of the National Oceanic and Atmospheric Administration. Alan Hecht, the office's director, is preparing a 5-year research plan that may call for annual expenditures as high as $10 million. In addition to improving climate models, he says, "we want to determine the amount of material that a nuclear explosion sets afire, the amount of smoke generated by the fire, and the proportion lofted high enough to block out sunlight. To do this, we need some large fire experiments—accurate measurements from controlled forest burns, uncontrolled brush fires, or large urban fires."

As a part of NOAA's effort, the Defense Nuclear Agency is planning to increase its funding for fire research from roughly $600,000 to $1 million annually. Prior to the nuclear winter revelation, the agency had essentially overlooked the climatic consequences of massive fires, concentrating instead on how they might be created. This will soon change, according to Marvin Atkins, the agency's deputy director for science and technology. The overall government plan will be submitted to the White House for approval in September.

The Pentagon, which was largely caught unawares by the "nuclear winter" presentation, has been critical of the assumptions in the climatic models developed to date. As MacCracken says, "most of these scenarios are simply not very convincing to people who work in this area." Richard DeLauer, for example, objects to the depiction of scenarios involving the deliberate targeting of cities, which he describes as neither "credible" nor "moral." He and others correctly note that nuclear weapons are today aimed primarily at nuclear weapons and associated military targets. But Sagan replies that many military targets are near large population centers, that some key industries in urban centers are also targeted, and that smaller nuclear powers, such as France, primarily target cities. The present *Force de Frappe* "may itself be sufficient to trigger a global Nuclear Winter," Sagan recently wrote in *Foreign Affairs*.

Another Pentagon argument is that any plausible conflict would exploit less than 5000 to 6500 megatons, the primary estimate used in both the initial nuclear

Soviets Offer Little Help

When Vice Admiral John Lyons, the deputy chief of naval operations, drafted a memo on the "nuclear winter" press conference last October, he noted that Dr. Vladimir Alexandrov of the Soviet Academy of Sciences had presented an extremely advanced climate model, representing "a quantum jump in detail over the work of [Carl] Sagan and his colleagues." It appears that "considerable scientific and computational resources have been devoted to this problem by Soviet academicians," Lyons wrote.

Actually, says Richard Turco, a coauthor of the original "nuclear winter" paper in *Science*, the Alexandrov presentation was "a very weak piece of work, crude and seriously flawed." Turco, an atmospheric scientist with R&D Associates in Marina del Rey, says that the sophisticated Soviet climate model is actually "a primitive rendition of an obsolete U.S. model." Starley Thompson, a scientist at the National Center for Atmospheric Research who coauthored a second major article on nuclear winter, agrees. "Alexandrov's model, which was developed in the United States in the early 1970's, contains a number of defects, and one of his major conclusions is apparently incorrect," Thompson says. In truth, Turco told *Science*, "the Soviets have contributed little to the international 'nuclear winter' study effort thus far, and quite a few people are extremely disappointed."

Turco explains that he and 20 other Western scientists were highly optimistic about potential Soviet contributions when they went to a recent conference in Leningrad sponsored by the International Committee of Scientific Unions. In particular, they hoped to see data on Siberian forest fires, as well as unclassified data on Soviet atmospheric bomb tests, of the type freely available to scientific researchers in the United States. They also hoped to learn the details of a much-discussed Soviet fire experiment. "Instead, we sort of got a rehash of Alexandrov's work. Not only that, but there was no evidence of experimental planning," Turco says.

Turco now suspects either that the Soviets are incapable of contributing meaningful scientific information, or that their goal is to manipulate the issue for potential political gain. How the latter might be accomplished is unclear, as nuclear winter is clearly a global, not a uniquely Western, threat. Recently, the Defense Nuclear Agency decided to take a detailed look at Soviet views of the nuclear winter phenomenon, as part of an ongoing analysis of Soviet research on nuclear effects. But the analysis, to be written by Science Applications Inc., will be classified.—**R.J.S.**

winter presentation and a forthcoming report by the National Academy of Sciences. Most experts agree that this dispute can only be resolved by experience. A final and clearly legitimate complaint is that all of the models developed thus far assume no geographical overlap between nuclear detonations. In practice, each side would explode at least two and probably more warheads on a given target, just for insurance. This analytical defect may be eliminated in forthcoming studies by Livermore. The entire issue is also scheduled for a thorough review by a newly formed Defense Science Board nuclear winter task force.

Zraket believes that the discovery of nuclear winter has a number of important implications beyond its potential use for propaganda and nuclear targeting revisions. "Assuming that it withstands additional scrutiny, nuclear winter suggests that it is not possible to build a command, control and communications network for a protracted war involving large numbers of nuclear weapons—as some have urged. If you feel—as some do—that a nuclear war can successfully be fought for months, then this should dissuade you. It will reinforce the existing belief that a first strike makes no sense, because it may be suicidal. And it renders the notion of a real civil defense program, which is already in disrepute, even more disreputable."

Zraket, of course, does not have his finger on the nuclear button. The extent to which these views are shared by those who do should become evident in March 1985, with the release of the report that Congress has now ordered.

—R. JEFFREY SMITH