

the article has been submitted. Presumably, it will be published if it passes muster.) The *Foreign Affairs* article, according to Turco, unfairly compares TTAPS's annual average temperatures with NCAR's July temperatures. He argues that all variables should be "normalized" to permit a fair comparison.

Schneider finds little merit in this plea. The NCAR modelers chose to look at July because it is the time of year when the temperature shift should be greatest. The worst acute effects NCAR predicts are spot incidents of quick freezing in the first week or two after a nuclear exchange.

■ **Manipulating the models.** When investigators looked into the assumptions for smoke production in the TTAPS model, they found that wildfires are given too much credit for blackening the sky. But as this variable went down, others went up. Rathjens and his colleague Ronald Siegel write: "There has been a tendency, as estimates of fuel and smoke are reduced, to increase estimates of the blackness of the smoke in a way that substantially offsets the other changes. We are not persuaded of the justification of these increases, and feel that they may convey a misleading sense that little has changed." In an interview, Rathjens referred to this tinkering as "a pretty sharp practice."

Sagan declines to respond to this comment, but Turco regards it as ill informed. While people are assuming a lower volume of smoke, they also have been compelled to increase its blackness because it includes more soot, he says. In addition, data reported at a recent meeting of the Royal Society in London suggests that soot is many times more absorptive of light than had been recognized before.

■ **Freezing to extinction.** Schneider says, "Human extinction should never have been brought up." The notion of a frozen, dead planet following a nuclear war has "zero credibility."

Turco argues that this view is based on "feelings" rather than facts, because no one can prove or disprove that extinction would occur. He concedes that it may be necessary to reduce the estimates of freezing in the TTAPS original paper by as little as 10%. At most, the revision may be a factor of 2. He thinks humanity probably would not be eliminated. Sagan thinks it would.

■ **A nuclear winter threshold.** In the original *Foreign Affairs* article, Sagan argues that the atmosphere can absorb a limited amount of smoke before crossing a "threshold" beyond which lies the apocalypse. He translates the threshold into bomb blasts: a few hundred over cities or 2000 to 3000 open blasts outside cities. To Sagan, this implies that nuclear arsenals must be reduced by 90 to 99%.

Thompson and Schneider find no evidence to support a threshold theory, dismissing it as "an artifact of a simplified model."

In general, atmospheric scientists put credence in NCAR's model because it describes events in three dimensions, rather than one, which TTAPS did. Unlike the TTAPS version, it incorporates the warming effect of the oceans. For these reasons, it is not surprising that NCAR's winter is milder.

Some questions about the data will never be resolved. However, the federal government is financing research to narrow the range of uncertainty in several areas, including the optical properties of smoke and patterns of plume and cloud behavior over large fires. Funding has grown from less than \$1 million in 1983 to a level of \$5.5 million annually today. The next general review of this program will occur in late February or early March, according to a spokesman for the Defense Nuclear Agency.

Berkeley Changes Tack on Reactor

The University of California, Berkeley, has announced that it will close down the research reactor on campus that was the target of criticism because it was used on occasion for military-related research. University officials insist the decision was made without regard to the protest.

In early December, Berkeley physics professor Charles Schwartz challenged the university administration to respond to a series of charges generated by the discovery that the reactor had been used for experiments for military contractors, including tests of radiation effects on missile components (*Science*, 2 January, p. 23).

University officials insist that the decision to close the reactor was prompted by the prospect of using the site for a badly needed new computer science facility. Berkeley vice chancellor Roderic B. Park says that internal and external reviews of the 1-megawatt research reactor had revealed "low usage" of the facility for teaching and research and made clear that "something would have to be done. But we didn't see where the money would come from." Clearing of the reactor site would require a costly decommissioning process.

Two things happened to change the situation, he says. Studies done for a new computer facility pointed to the existing reactor installation as the favored site for the building. And funds became available from the

A major issue to be addressed is whether the government should begin to study the biological effects of a large smoke pall, a research topic that has not been well financed to date.

In December, researchers converged on a dramatic open fire experiment in the National Forest near Los Angeles. They hoped to sample smoke at various heights and observe cumulus cloud formation above the blaze. An accident caused a delay and a rainstorm intervened, leading to disappointing results.

Meanwhile, the National Academy of Sciences is reviewing its role. Members of a panel cochaired by George Carrier of Harvard and Vice Admiral William Moran—authors of the Academy report on nuclear winter—met in Washington on 14 January to decide whether to enter the fray again. They will discuss the new data from NCAR and write a decision memo for Frank Press, president of the Academy. ■

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University of California system that could be used to pay some costs of the reactor decommissioning. University officials say that a recommendation was made in early December by engineering dean Karl S. Pister to close down the reactor.

Substantial uncertainties remain on timing and finance. Funds still have to be raised and plans drawn for construction of the building to replace the reactor. Sources in the engineering school say that obtaining permission from the Nuclear Regulatory Commission to decommission the reactor will take at least 6 months. Dismantling of the reactor probably could not begin before the end of the year. The decommissioning and site-clearing process could take 2 to 4 years and cost \$3 million. Funding depends on action by the University of California regents. And Berkeley's nuclear engineers will want firm assurances of an alternative source of neutrons before the reactor is turned off.

Commenting on the university's explanation of the decision on the reactor, Schwartz said he was sure the "all those elements" were considered, but he noted that the Berkeley city government was planning to hold hearings on the reactor and that there was "a clear political concern." He said it was hard to avoid the conclusion that the reactor's continued operation would cause "considerable embarrassment." He said the university's decision could be "properly called a victory for antinuclear sentiment in the community and is of interest elsewhere."

■ JOHN WALSH