

TTAPS estimates that a 5,000 MT nuclear war that included cities as targets would produce 225 million tons of smoke and Dr. Teller remarks that the estimated weight of water vapor in northern latitudes from 30° to 70° is 10,000 times that figure. Its residence time of one week would be less than the 10 days required to establish conditions of extreme cold. On this basis, he claims that a mass of naturally-occurring water several thousand times that of war-induced smoke would be available to wash it out.

The US National Centre for Atmospheric Research, using a model that includes oceans and winds, found the extent of predictable temperature reduction to be two to ten times less severe than that predicted by TTAPS, depending on the season.

Dr. Teller and some of his colleagues at Lawrence Livermore assert that the calculations on which the nuclear winter theory are based do not properly take account of the major cleaning effects of water vapor that are themselves smoke-induced, nor the influence of the oceans and winds during the time needed for smoke to spread world-wide. While not excluding the possibility of nuclear winter, Teller considers arguments for it to be "dubious rather than robust." He does agree that a decrease in temperature of 5-6 degrees in latitudes 30°-70° North (one-tenth of that suggested by TTAPS) could lead to crop failure and famine but he argues that "speculative theories" of world-wide destruction — even the end of life as we know it on Earth — when used as a call for a particular kind of political action, serve neither the good reputation of science nor dispassionate political thought.

Dr. S. Fred Singer, one of the most outspoken critics of the nuclear winter hypothesis, is vice chairman of the US National Advisory Committee on Oceans and Atmosphere. Although his views have run into heavy criticism by proponents of the nuclear winter theory, some of them could be pertinent. He has stressed for example, the "extreme difficulty" of making global predictions of the environmental effects of a nuclear exchange. The range of uncertainties, he says, is so great because of the set of basic assumptions and "what has been left out in discussion of the physics of the situation." Predictions, he says, are not particularly useful.<sup>11,12</sup>

According to Singer the assumptions used in the TTAPS study virtually guarantee the occurrence of a nuclear winter. They specify:

- 1) Sufficient smoke to cut off nearly all sunlight;
- 2) Sufficient injection altitude to allow the smoke to survive;
- 3) Uniform distribution through latitudes 30° to 70° North; and

- 4) Explicit neglect of any "greenhouse effect" which would counteract surface cooling (for example, by specifying smoke particles that yield negligible opacity to heat.)

He provides evidence<sup>13</sup> indicating that:

- a) The lifetime of smoke will be affected by the fact that lofting to an altitude of more than 5 km is unlikely, except in special atmospheric conditions. (Deliberately set large forest fires involving 16,000 hectares in Chapleau, Northern Ontario, in August 1985, however, produced a "mushroom cloud" that was estimated to have reached an altitude of 6 km);
- b) As a rule, and especially in the presence of wind, smoke below 5 km altitude will usually be removed by rainout in a matter of days;
- c) Non-uniform, low-lying smoke could produce a greenhouse effect;
- d) There should be a greatly enhanced greenhouse effect, even if smoke clouds reach a higher level; and
- e) The intrinsic opacity of smoke to infra-red radiation could be greatly affected by a shift in size distribution.

Dr. Singer points out that 200 thousand million tons of particulate matter are injected annually into the atmosphere. He says that, on the basis of a recent analysis of the NRC baseline scenarios, he has to conclude that any major climatic effects would be short-lived, that surface temperature changes would be minor, and that there would be neither deep freezes nor quick freezes. His further and highly controversial conclusion is that there would, instead, be an appreciable likelihood of surface warming . . . a nuclear summer.

## STRATEGIC IMPLICATIONS

Two other critics of the TTAPS hypothesis are strategic analyst Francis P. Hoerber, a member of the US President's General Advisory Committee on Arms Control and Disarmament; and Robert K. Squire, formerly of the Lawrence Livermore National Laboratories, who has worked for two decades in the field of arms control.

In a recent article in the *Strategic Review*,<sup>14</sup> they point out that the original thesis of nuclear winter, as put forward by Dr. Sagan and others, rested on a highly simplified model of an enormously complex phenomenon. They question how computers that