ate nearly as much smoke as the 6,500 MT of the baseline scenario, when distributed over much larger rural areas.

DISCUSSION

The NRC Committee stressed the uncertainties in its calculations of vertical distribution of smoke and the subsequent fates of the various materials. The Committee stressed that accurate detailed forecasts of the way the atmosphere might behave are difficult to achieve. The duration of any effects, it stated, lie beyond the present state of knowledge. It warned that some future study, conducted at a time when the data and modelling techniques have been improved, could produce quite different analyses and conclusions. It nevertheless found there was a clear possibility that great portions of the land areas of the northern temperature zone (and perhaps a large segment of the planet) could be severely affected.

The Canadian committee reached similar general conclusions that major, if temporary, climatic upsets would follow nuclear war. It found the data provided by various models to be plausible but emphasized that the uncertainties are formidable. Even so, the report states, "a *prima facie* case has been made that nuclear winter will indeed follow a wide-range of attacks."

Dr. Kenneth Hare, a climatologist of world renown who chaired the Royal Society Committee, identifies some of the unknowns that are crucial to any proper understanding of the problem. Speaking of the hypothetical situation if missile silos in North Dakota near the Canadian border were attacked, he says: "If there are ground bursts, then clearly you are going to have a lot of vaporization. You would have to take each vapor separately. Most vapors are surprisingly disinclined to self-coagulate and precipitate. It has first to coagulate. It will remain a vapor, and therefore not fall, until you provide condensation nuclei." Many particulates, including some components of smoke, at first show no inclination to join with water vapour. Others attract water and thus contribute to the formation of droplets. Some that are similar in crystalline form to ice, such as silver iodide, have been successfully used for seeding clouds of water vapour to alleviate drought but, as Dr. Hare pointed out, such similarity is not essential. Platelets of clay, floating round in the atmosphere, can perform the same function.

One of the major climatic problems seen as resulting from a nuclear exchange is a colossal inversion layer, caused by smoke aloft that absorbs solar energy, gets warm, and puts an effective "lid" on all weather systems.

What would nuclear winter be like in Canada? If an attack occurred in winter, the implications for weather and vegetation would be far less serious than for one in summer. "Take a typical winter," says Dr. Hare, "Set a big high cold system over the Great Lakes and you have North America looking like nuclear winter. It is rehearsed *every* winter." Crops might not suffer, but there could be darkness 24 hours a day.

In summer, the consequences would be horrendous. Dr. Thomas Hutchinson, professor of botany at the University of Toronto and a member of the Royal Society committee, points out that crops are extremely sensitive to sudden temperature switches, and especially vulnerable to sudden frosts and extended cold periods. "If there is a drop in temperature of any more than two degrees, wheat production is pretty well out over the whole growing season. It will reduce the growing season to the point where you cannot produce a crop. Severe frosts in the middle of the growing season would be devastating."

Dr. Hutchinson explains that many Canadian plants are adapted to cold. At certain times in the year they react to certain stimuli and in their own way prepare for drops in temperature. In the spring, as they start to grow again, they lose the ability. Temperature tolerance is not just a problem of the colder latitudes. "If you look at the tropics," says Dr. Hutchinson, "you will find a lot of plants that cannot even tolerate temperatures as low as 10 C. A lot of them will be killed."

How long can the Earth's own heat reserves protect a plant? In some cases, for less than one day. Professor Hutchinson explains that the damage is done by formation of ice crystals within cells. In relatively temperate climates plants (and some animals) reduce their water content in winter and thereby increase the concentration of dissolved chemicals. It is, he explained, the equivalent of adding anti-freeze. Other plants, such as those in alpine and arctic tundra that are subjected regularly each year to minus 40 C, have a self-securing mechanism that eliminates water from their cells.

Could the whole concept of nuclear winter be just a scare? "The whole thing is scenario-dependent," says Dr. Hutchinson. "None of the groups say this or that will happen. None of them are prepared to state the sequence of detonations that could take place. They look at a wide range of scenarios. At the lower end, you can get out of nuclear winter. There will be some scenarios where the numbers and sizes of detonations will be small, too dispersed or too high to cause a major climatic problem. A detonation has to be at or near the ground to project dust and smoke into the upper atmosphere."