

Dr. Hutchinson, by the way, is one of those who does not like the term nuclear winter. "None of us like it," he says, "It is too dramatic. It conjures up a certain sort of image. It also distracts attention from other important things like changes in precipitation and changes in ultraviolet radiation, the generation of toxic chemicals and acid pollutants. We have to get used to the fact that, if we get into this, we are going to be living in a thin acid fog. We are going to have very many nasty toxic chemicals produced by plastics that are burned. Things look really grim, if we get into a major nuclear exchange."

Dr. Hare summed up: "I think that some people feel that there may be a terrible bomb dropped on Toronto or Montreal or Vancouver and the rest of the country might suffer a bit from fall-out. Instead, we have to consider the possibility of enormous numbers of these bloody great bombs dropping on our cities."

Dr. Andrew Forester, scientific director of the Royal Society study, author of most of it and editor of all of it, was asked whether he had any personal doubts about the nuclear winter concept, and admitted that there had to be. "But," he said, "I detect a growing consensus, that a nuclear winter, after a nuclear exchange, is more likely than less likely. That impresses me because, when you go to a conference with a lot of people who are experts and you detect a growing feeling that nuclear winter is a possibility, then you have to be persuaded, no matter what your own intuitive feelings may be. It is my perception that nuclear winter will be less severe than was originally proposed but that there is more and more certainty that, given the right conditions, winter will occur. It is both good news and bad news."

What also strikes Dr. Forester as "persuasive," he says, is when scientists from the US Lawrence Livermore National Laboratories and Los Alamos National Laboratory, both specializing in nuclear weapons, present simulation models which suggest that nuclear winter would occur.

CRITICS OF THE THEORY

The nuclear winter concepts presented by Crutzen and Birks, by TTAPS, by Aleksandrov and others all contained their qualifications, regarding both facts and assumptions, yet they have still not gone unchallenged. Dr. Edward Teller, often referred to as the father of the US H-bomb and a member of the staff of the Lawrence Livermore Laboratory; Dr. S. Fred Singer of George Mason University, Virginia; Dr. John Maddox, editor of the

prestigious British scientific journal, *Nature*; and Dr. C.H. Kearny are among many who have expressed varying degrees of skepticism about the nuclear winter theory.

A major concern about "nuclear aftermath" has been that, when the dust and smoke did disappear, reappearing sunlight would contain new dangers for all living things on earth. One of its components is ultraviolet radiation, "light" of a waveband too short to be visible to human eyes but exceedingly dangerous in large doses to all living things. Ultraviolet light is normally absorbed in the upper layers of the atmosphere by a super-active form of oxygen (three atoms in a molecule, instead of two) called ozone. It is widely accepted by the scientific community that, if large quantities of chemically-active combustion products were suddenly injected into the upper atmosphere, they would react with the ozone there and eliminate it.

Estimates are that it would take between two and three years after the smoke disappeared to replace the ozone layer and that great harm could be done to all living things in the meantime. Dr. Teller⁹ acknowledges that there would be increases in ultraviolet light, because of the elimination of ozone and that this could, in addition to causing damage to vegetation, result in serious sunburn, and increased incidence of skin cancer and possible damage to sight, if no protective action were taken. He argues, however, that the progressively increasing accuracy of delivery systems is leading to the development of much smaller warheads that would not have the energy release needed to carry combustion products into the stratosphere (the threshold appears to be around 1 MT and there is an increased leaning towards warheads of three to five tenths of a megaton for the US and somewhat larger for the USSR).

Dr. Teller remarks that the nuclear winter theory itself depends on the precept that smoke generated by burning forests and cities will be distributed in the troposphere. Such smoke-laden air, he admits, could raise the temperature at the top of the troposphere from approximately minus 50C or minus 60C to plus 5C. Surface temperatures could drop to minus 30C, because of the absorption by smoke of solar energy. But they might not!

Unlike absorption of ultraviolet radiation, he says, forecasting the behavior of smoke depends on a knowledge of far more complex meteorological phenomena, many of which are imperfectly understood, and on bases for smoke estimation that are at present uncertain. The average residence time for water vapor in the atmosphere is little more than a week and studies made of the disappearance times of man-made smoke also suggest a residence time of one week or less.