CONF-871101--42

NUCLEAR WINTER: THE IMPLICATIONS FOR CIVIL DEFENSE*

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*Based on work performed at Oak Ridge National Laboratory operated for the U. S. Department of Energy under contract No. DE-AC05-840R21400 with Martin Marietta Energy Systems, Inc., under Interagency Agreement No. 1457-1457-A1 with the Federal Emergency Management Agency.

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ABSTRACT

"Nuclear Winter" is the term given to hypothesized cooling in the northern hemisphere following a nuclear war due to injection of smoke from burning cities into the atmosphere. The voluminous literature on this subject produced since the original paper in 1983 by Turco, Toon, Ackerman, Pollack, and Sagen (TTAPS) has been reviewed. The widespread use of 3-dimensional global circulation models have resulted in reduced estimates of cooling; 15-25 deg. C. for a summer war and a few degrees for a winter war. More serious may be the possibility of suppression of convective precipitation by the altered temperature profiles in the atmosphere. However, very large uncertainties remain in input parameters, the models, and the results of calculations,

We believe the state of knowledge about nuclear winter is sufficiently developed to conclude:

- Neither cold nor drought are likely to be direct threats to human survival for populations with the wherewithal to survive normal January temperatures.
- The principal threat from nuclear winter is to food production, and could present problems to third parties without food reserves.
- Loss of a crop year is neither a new nor unexpected threat from nuclear war to the U.S. and the Soviet Union. Both have at least a year's food reserve at all times. Both face formidable organizational problems in distributing their reserves in a war-damaged environment.

The consequences of nuclear winter could be expected to fall more heavily on the Soviet Union than the U.S. due to its higher latitude and less productive agriculture. This may be especially true if disturbances of rainfall amounts and distribution persist for more than a year.

NUCLEAR WINTER: THE IMPLICATIONS FOR CIVIL DEFENSE

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In 1983, a study[1] was published on the climatological effects of injection into the atmosphere of hundreds of millions of tons of smoke and dust by a large nuclear war. This study, called TTAPS (from the initials of its authors; Turco, Toon, Ackerman, Pollack, and Sagan), predicted temperature depressions of 40 to 60 centigrade degrees (called "Nuclear Winter") for some plausible values of the input parameters. Some cited these results as proof that nuclear war is unsurvivable, and hence civil defense unfeasible.

After 4 years of additional research, it is generally believed possible for some range of heavy nuclear attacks directed against cities that significant but not lethal climate alteration will ensue for at least a few weeks.[2]

Three-dimensional global circulation models being developed and used at Livermore, Los Alamos, and the National Center for Atmospheric Research for a reasonable attack size seem to be converging on a temperature depression of the order of 10-15 deg. centigrade, averaged over all land areas of the temperate region of the northern hemisphere. Temperature depressions as large as 25 deg. centigrade are predicted in the interiors of continents for attacks in the summertime. Winter time wars produce temperature depressions of only a few degrees. All the models suggest the possibility of episodes of freezing temperatures in the interiors of continents in the mid- to high latitudes for attacks occurring even in July. Summertime and springtime

attacks do not produce cold temperatures significantly worse than those seen in normal January conditions at the latitude of interest.[2]

Work at Livermore and Los Alamos raises the possibility of substantial reduction of convective precipitation due to suppression of convection in the troposphere by heating of smoke in the upper troposphere. This raises the possibility of drought as a major consequence of climatological disturbance from nuclear war. Suppression of convective precipitation occurs at much lower levels of smoke loading in the atmosphere than is required for significant temperature depression.[3] The reduced scavenging of smoke due to its lofting from solar heating suggests that significant levels of smoke could persist for many months after the attack.[2,3,4] This raises the possibility that rainfall disruption, at least of the rainfall patterns, could occur in the second year after a war.

There are still very large uncertainties in the climatological consequences of nuclear war. Some of these are due to the limits on resolution of the models used. There is insufficient information on the production and optical properties of smoke from combustion of urban environments. An irreducible uncertainty is the nature and severity of a nuclear war. There is no method to predict in advance the size of an attack or the fraction landing on cities.

We have drawn some implications for civil defense of the possibility of nuclear winter:

<u>Neither cold nor drought is likely to be a direct threat to human survival</u>.

A population which has the wherewithal after an attack to survive

its local January climate will not be endangered by the cold from nuclear winter. For that portion of the population not equipped with sufficient cold weather clothing for the local climate, expedients of crowding into shelters, and improvisation of cold weather clothing are available.

Supplies of potable water are estimated to be adequate in almost all areas of the U. S. even under drought conditions if electric power can be restored to water pumps.[5]

The principal threat of nuclear winter is to agriculture.

There is a high likelihood, for a sufficiently severe war, of heavy losses of agricultural productivity for the crop year in which a spring or summer nuclear attack occurs. There are likely to be episodes of freezing temperatures in the mid- to high latitudes in the interiors of continents during the summer growing season. In addition, there is a likelihood that rainfall will be disrupted; either suppressed significantly or substantially altered in pattern.

Nuclear winter does not present an entirely new threat from nuclear war to the U. S. or the Soviet Union.

Both countries could reasonably expect to lose agricultural productivity in a springtime or summertime war due to fallout either killing the early crops by radiation or keeping the farmers out of the fields when they should be conducting time-sensitive operations. Both countries are believed to have at least a year's supply of grain in storage at all times.

The possibility exists for reduced agricultural production in the second year due to the disturbance of rainfall patterns. This probably poses less

threat to the United States than the Soviet Union even with a damaged agricultural economy given its larger normal production and better rainfall distribution.[6]

The consequences of nuclear winter would fall more heavily on the Soviet Union.

The Soviet Union is at a higher latitude than the United States and occupies a larger continent. It could be expected to see more severe temperature excursions. Under normal circumstances, the Soviet Union has difficulty in meeting its agricultural production targets due to marginal climate and managerial deficiencies.

REFERENCES

1. Turco, R. P., O. B. Toon, T. P. Ackerman, J. B. Pollock, and Carl Sagan, 1983b, "Nuclear Winter: Global Consequences of Multiple Nuclear Explosions," Science 222, 1283-1292.

2. Thompson, S. L., and S. H. Schneider, 1986, "Nuclear Winter Reappraised." Foreign Affairs, Summer 1986, 981-1005.

3. Ghan, S. J., M. C. MacCracken and J. J. Walton, 1985, "Climatic Response to Large Summertime Injections of Smoke into the Atmosphere: Changes in Precipitation and the Hadley Circulation," Lawrence Livermore National Laboratory, Report UCRL-92324.

4. Malone, R. C., L. H. Auer, G. A. Glatzmaier, M. C. Wood, and O. B. Toon, 1986, "Nuclear Winter: Three-Dimensional Simulations Including Interactive Transport, Scavenging and Solar Heating of Smoke," Jour. Geophys. Res. 90, 5597-5613.

5. Hobbs, B. F. and Y Luo. "The Impact of Prolonged Interruptions of Rainfall upon Water Supply in the U.S.: River Basin Level Analysis of Supply Availability for Central Domestic Irrigation and Other Uses." Report submitted to the Oak Ridge National Laboratory by Dept. of Systems Engineering, Case Western University, Cleveland, OH, April 1987.

6. National Defense University "Crop Yields and Climate Change to the Year 2000", vol. 2, Climate Model and Technical Appendixes. Report on the Second Phase of a Climate Impact Assessment, conducted by the National Defense University, U.S. Dept. of Agriculture, Defense Advance Research Projects Agency, National Oceanic and Atmospheric Administration Institute for the Future, Fort Leslie J. McNair, Washington, DC 20319 -6000, 1986.