

Why Carl Sagan's 'nuclear winter' scenario is an unscientific fraud

by Robert Gallagher, Beth Moore, and Ned Rosinsky

On Oct. 31 and Nov. 1, a wide-ranging coalition of environmentalist and population-control organizations sponsored a conference bankrolled by the Rockefeller Foundation on "The World After Nuclear War: Conference on the Long-term World-wide Biological Consequences of Nuclear War." Astronomer Carl Sagan and biologist Paul Ehrlich announced the results of a supposed scientific investigation of this subject conducted by a task force of over 100 scientists worldwide.

The claim popularized by Carl Sagan at this congress was that nuclear war of even modest proportions would lead to devastating climatic effects, which he dubs the "nuclear winter." His assertion is that a dramatic fall in temperature globally of as much as 40 degrees centigrade will threaten to destroy the biosphere and make man extinct. The scenario upon which he bases his results calls for a 5,000 megaton nuclear detonation. However, he asserts that even 100 megatons would lead to the same consequences. Despite the fact that his claims are in some cases unsubstantiated, and are in general incompetent, he has already received the type of media play-up aimed to create mass hysteria. Sagan is directly deployed to discredit any attempts at civil defense or anti-ballistic missile defense with his "end of the world" scenario.

Sagan is pushing the Pugwash proposal for a massive build-down which would limit the Soviet Union and the United States to 500 warheads each, i.e., less than 100 megatons. Not only would this proposal, if implemented, allow a war-winning advantage to any third party coming into the nuclear scene or to either superpower who wished to violate the treaty, but of course it would be totally unacceptable to either side. Sagan's only purpose can be to render the West impotent in face of the escalating Soviet threat.

Briefly, the Ehrlich-Sagan claims are that *in addition* to the immediate destruction wrought by a U.S.-Soviet nuclear exchange, a war would throw up into high altitudes of the atmosphere enough dust and soot to block out 98 percent of solar radiation in the mid-latitudes of the Northern Hemisphere for weeks to months—with the result that average temperatures would plummet 15 to 25 degrees centigrade, photosynthesis would cease, and there would occur widespread extinction of plant and animal life (especially vertebrates).

We document elsewhere in this Special Report that this

project was instigated by the Soviet-controlled Pugwash Conference on Science and World Affairs. This article demonstrates that the "scientific results" announced are a hoax, based on a methodologically invalid computer study and faked data.

Sagan's claims

The conference organizers have made available a "Summary of Findings" and two papers by Sagan and Ehrlich that have reportedly been rejected as incompetent by several scientific journals, including *Science*. (There are reports that political pressure is being applied to *Science* to publish them anyway.) Sagan's paper, "Global Atmospheric Consequences of Nuclear War," is the entire basis of their claims. It states that "the most probable first-order (postwar) effects" of a nuclear exchange of 5,000 megatons total explosive power are:

- 1) The creation of a cloud of dust and smoke that would encircle the earth within one to two weeks.
- 2) The reduction of solar radiation to "a few percent" of what it is on a sunny day "for weeks to months."
- 3) The fall of average land temperature by 15 to 25 degrees centigrade "for weeks to months."
- 4) Average doses of radioactivity of about 100 rad in Northern Hemisphere mid-latitudes (e.g., the United States).

On the basis of these assertions, Ehrlich and his collaborators project catastrophic results for the biosphere. The fourth point is dealt with later in this article. The projected effects on temperature and the amount of sunlight reaching the earth's surface are entirely based on these assumptions:

- 1) That dimensional-based computer weather modeling and forecasting (especially the one-dimensional radiative convective modeling used by Sagan) are valid;
- 2) That a nuclear exchange will create a *uniform* dust-smoke blanket over the earth;
- 3) That a nuclear attack on cities, industry, and military targets will create firestorms in cities and forests; and
- 4) That such firestorms would send smoke up into the troposphere and stratosphere.

If any one of these assumptions proves invalid, the entire Sagan "analysis" fails. We shall show that assumptions 1 and 2 are invalid, and that assumptions 3 and 4 are probably invalid as well.

Firestorms

A ground-based nuclear explosion throws tons of dust high into the atmosphere as an immediate effect. As Sagan states, however, a "nuclear winter" would not occur unless 225 million tons of smoke particles are released into the atmosphere by firestorms. In order to produce this much smoke, Sagan assumed that every city hit would go up in a firestorm and that there would be firestorms in forests close to all targets.

The creation of a firestorm is not easy. The searing heat from the detonation of a nuclear warhead over a target will ignite much of the exposed flammable material within a considerable area, starting numerous small fires. But immediately following the radiation wave, the blast wave will generate winds of terrific strength that will blow out many of these fires. The firestorms in Hiroshima and Nagasaki were considerably smaller than those that occurred in Tokyo or Hamburg, where hours to days of systematic bombardment built up the storm.

Second, in both Hiroshima and Nagasaki, the principal exposed flammable materials were crowded buildings constructed out of paper and wood. In the United States and the Soviet Union, most inner-city buildings are constructed with brick, concrete, and steel. It would first be necessary to knock them down and break them up to expose the flammable material in order to get a firestorm going.

The case of Dresden is illustrative. The attacks involved three stages: 1) Pathfinder aircraft dropped flares to designate targets for the bombers; 2) the bombers came in with high-explosives to break up the brick buildings, to expose the flammable material inside; 3) bombers then came in with incendiary bombs (thermite), which burn at high temperatures with their own oxygen supply, with or without the presence of flammable material. During the incendiary bombing, other aircraft dropped more high explosives to "stoke the fire."

Such an effect could only be achieved with multiple nuclear detonations over a period of at least hours. According to the classic government study "The Effects of Nuclear Weapons" by Glasstone and Dolan (1977, Department of Defense and Department of Energy), a minimum of eight pounds of flammable material per square foot area is needed to produce a firestorm. Therefore, according to a report published by the Office of Technology in 1979, there isn't enough flammable material in cities to fuel a firestorm:

Some believe that firestorms in the U.S. or Soviet cities are unlikely because the density of flammable materials ("fuel loading") is too low—the ignition of a firestorm is thought to require a fuel loading of at least 8 lbs./ft.² (Hamburg had 32), compared to fuel loading of 2 lbs./ft.² in a typical U.S. suburb and 5 lbs./ft.² in a neighborhood of two-story brick rowhouses.

Regarding Sagan's assumption that nuclear attacks on cities and missile silos would result in firestorms in forests,

most missile silos are in deserts or wheat fields, and most forests near cities are sufficiently far away to require a militarily ineffective attack on the periphery of the city to ignite the forest at all.

Weather modeling

Let us assume now, for the sake of investigating Sagan's other assumptions, that somehow 225 million tons of smoke particles get up into the troposphere and stratosphere from firestorms ignited by nuclear blasts. Sagan assumes that within one to two weeks this material will distribute itself uniformly around the globe, or at least around the Northern Hemisphere. This is a completely arbitrary assumption.

Such a blanket at tropospheric or stratospheric altitudes would set up a tremendous temperature gradient between the layers of the atmosphere above and below. This in itself would tend to tear the dust-smoke cover apart. It is preposterous to assume that such a cover could remain intact, absorbing energy from the sun, and not begin to exhibit non-linear collective particle effects that would form structures between which sunlight would pass to the earth, thereby permitting photosynthesis and some warming.

Existing weather models have no way of representing non-linear processes. For this reason, the Voyager satellite data on Jupiter overturned every theory of atmospheric processes on that planet. The satellite's revelation of huge organized structures (vortices, etc.) sweeping around the planet at fantastic speeds literally blew out close to a century of formally linearized hydrodynamic theory.

The model used by Sagan is the epitome of bad weather models. While arguing that a nuclear exchange will produce drastically new atmospheric conditions, he bases his analysis on the one-dimensional radiative convective model—which assumes present-day circulation patterns. Furthermore, this model disregards latitude and longitude, the two most important dimensions for weather modeling, since the atmosphere resembles a two-dimensional fluid streaming over the surface of the earth. In a draft paper delivered at the Third International Conference on Nuclear War at Erice, Sicily in August and available as a pre-print, Michael C. MacCracken of Lawrence Livermore National Laboratory criticized these models with the following remark:

One-dimensional models can also only represent vertical heat transport with a simple lapse rate limitation and do not consider horizontal transport, the hydrologic cycle, or cloud formation processes. . . . The inability to treat the horizontal distribution of land . . . and ocean . . . is an extremely important simplification, since it is likely that air flow from one region to the other will be accelerated by the greatly increased temperature differences between the two surface types and thereby moderate temperature changes over land. . . . The one-dimensional approach will overestimate the hemispheric average radiative and climatic impacts.

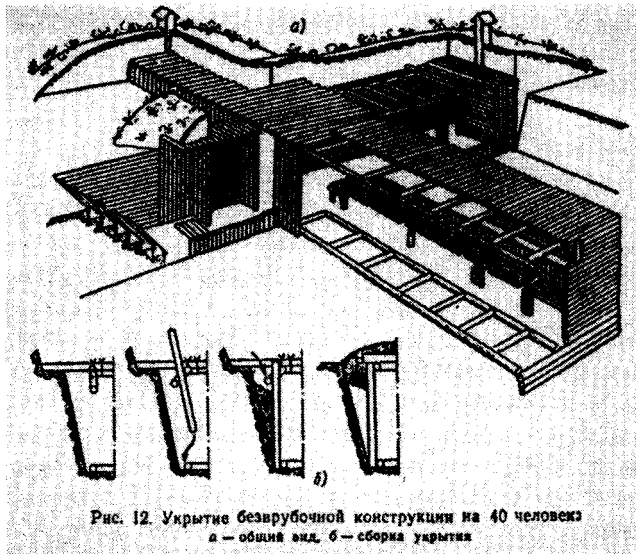


Рис. 12. Укрытие безрубной конструкции на 40 человек
а — общий вид, б — сборка укрытия

Soviet design for a blast shelter constructed out of wooden poles. This crude shelter could effectively protect 40 people against the effects of nuclear radiation.

To expose the fallacious premises upon which Sagan's paper is based, MacCracken replicated many of Sagan's calculations at Livermore and produced graphs of temperature over time similar to Sagan's. MacCracken's comment on the graphs threw Sagan's entire "analysis" out the window:

Assuming normal wintertime scavenging rates for the soot, the change in land surface air temperature as a function of time after the exchange is shown. . . . Because we are using a one-dimensional model, these results can only loosely be interpreted in terms of a change in the *annual average hemispheric land surface temperature* as a function of time [emphasis added].

In other words, MacCracken asserts that the only meaningful figure for temperature change from a dust-soot atmospheric cover derivable from one-dimensional analysis would be an average over 365 days. In both MacCracken's and Sagan's studies this would be a net change in temperature somewhere between zero and five degrees centigrade.

One-dimensional models are typically used to study the shifts of the atmosphere from one equilibrium state to another in response to a perturbation. The specific path that the system takes between equilibrium states—the sharp dip in temperature which Sagan predicts—is not taken seriously, except by him.

The effects predicted in the past by weather models have by and large not occurred. In 1950, C. D. Smith in *Monthly Weather Review* analyzed the effects of smoke clouds created by a group of 60 forest fires in British Columbia and 37 in Alberta. The smoke was observed a week later over the Northeast United States in columns 3,000-5,000 feet thick at the tropospheric altitudes required by Sagan. Observers

found the clouds make the sun appear a different color in some regions: "Some of the stations reporting unusually dark conditions during the day with a few experiencing reduction of light to nighttime darkness."

Instead of following constant pressure surfaces in their movement—as assumed by present day modelers—the clouds followed constant potential temperature surfaces. Smith reported that they *raised* temperature minimums and did not significantly lower the average temperature:

Mr. Sigmund Fritz of the U.S. Weather Bureau investigating the effect on the temperature at Washington on Sept. 26 and 27 has made preliminary estimates that the maximum temperature was lower than it would have been by about 10 degrees Fahrenheit and the minimum temperature higher by a smaller amount.

Furthermore, dust clouds thrown up by volcanic eruptions have never produced the sharp drops in temperature that any tinkerer can get out of a radiative convective model.

Biological effects of nuclear war

The fourth point of the Sagan study, projecting that each fully exposed individual after a nuclear explosion will receive 100 rads of radiation is a lying exaggeration of the consequences of radiation from fallout, perpetrated to terrorize the population.

Dr. Helen Caldicott of Physicians for Social Responsibility (PSR) rails about "epidemics" of cancer following radiation exposure, but the overall rate of cancer among Hiroshima survivors has been but 3 percent over the expected—an increase, but hardly the overwhelming catastrophe she predicts. Likewise in the soap-opera *The Day After*, all the characters exposed to radiation are presumed to be dying, when in fact, the majority of people exposed to radiation within even the limited shelter shown in the film could be expected to recover within several months.

One of the more extreme examples is the farm girl who panics and runs out of the basement shelter for a few minutes, several days after the bombing. She subsequently becomes very ill and collapses with bleeding, implying that she must have received a radiation dose of several hundred rems (450 rems will kill 50 percent of the population; one rem is the human dose given by approximately one rad of radiation). However, to receive this dose within several minutes of exposure an outdoor radiation level of 6,000 rads per hour would be required, and since the radiation level after several days would be only one hundredth of the post-bombing level, the original post-bombing level would presumably have been 600,000 rads per hour. This is more than 50 times the maximum level expected immediately downwind from the largest bombs in present arsenals!

As for Sagan's 100 rads, what he does not say is that even according to the Physicians for Social Responsibility, that is

a level at which no medical treatment would be necessary. Moreover, the figure is based on a series of fallacies.

First, Sagan assumes that half the explosive power of warheads in a nuclear war would be from nuclear fission, creating radioactive fallout. But in a paper delivered at the cited Erice conference on nuclear war, Joseph B. Knox of Lawrence Livermore Laboratories presented documentation that the fission fraction (the energy yield from fission in a nuclear explosion) was as low as .39, or 22 percent lower than Sagan's .5 figure. That means Sagan's estimate of radiation exposure of 100 rads as an average for the northern hemisphere middle latitudes is 22 percent too high.

Second, Sagan assumes no protection from fallout, and he also assumes eating of contaminated food. In reality, a hundred pound sack of wheat and a bottle of vitamin pills, stored in the shelter to prevent contamination, will feed one person for months. Since fallout by definition is particulate, it is effectively screened out by soil, hence very little of it gets down into the water table, and ground water would have a very low level of radiation. As for the body's ability to concentrate radioactive iodine from the air, the simple precaution of swallowing a few iodine tablets causes the body to eliminate any further ingested or inhaled iodine, so it will not accumulate in the thyroid gland.

This brings us to Sagan's other assumption—one shared with the makers of *The Day After*: virtually no civil defense planning.

Civil defense

The scenario in *The Day After* is typical of Pugwash and PSR horror stories: There is no shelter program, little food storage, little radiation detection equipment, and the population is ignorant of such basic survival knowledge as fallout protection measures. The one family in the movie which does take basic civil defense measures survives well, but then the father is shot by a band of squatters on his land. The implication is that civil defense measures, even if they work, are futile. But what of the possibility that everyone had access to the shelters that this family had? This possibility is not even suggested in the movie, but it is a real possibility, in fact a necessity.

The case of Hiroshima is frequently cited as evidence of the overwhelming destructive power of nuclear weapons; however, if simple and basic shelters had been available to the residents of Hiroshima, not a single life would have been lost. Hiroshima had no warning of an attack: The bomb caught the population in the middle of morning rush hour with thousands of people out in the streets. The city was constructed primarily of flimsy wooden huts which were closely crowded together, producing the density of flammable material needed to create a firestorm. The population in any case had no knowledge of nuclear destruction, and thus was totally ignorant of possible preparations. U.S. cities do not have the density of flammable material needed to sustain a firestorm (as cited above); adequate shelters could be pro-

vided for the great majority of the current population at or near their homes with simple technologies; and the rest of the population, located in crowded sections of cities, could be safely defended in large buildings.

A frequent fear raised by PSR is that people in shelters would be asphyxiated or roasted by fires overhead. On the contrary, of the residents caught in the firestorm in Hamburg during World War II, 85 percent survived in bunkers despite the fire.

Carsten M. Haaland, of the Energy Division of Oak Ridge National Laboratory, a leading researcher and developer of civil defense technology, recently commented on the effectiveness of civil defense at the annual meeting of the American Civil Defense Association:

In the book titled *Nuclear Freeze!*, allegedly written by Senators Kennedy and Hatfield, there are several pages devoted to a table listing American cities and their populations. It is stated that these cities and their populations would be totally destroyed by nuclear airbursts that appear, according to my examination, to be bursts at altitudes that would produce the same blast overpressure directly beneath the weapons as at Hiroshima, namely, 40 psi. In order for these populations to be destroyed, it must be assumed that the people are totally uneducated on defense against nuclear weapons, totally unwarmed, and totally without blast shelters. Unfortunately, that would be the actual state of the situation for most people in America today. What I find to be reprehensible about this book is that nowhere is it stated that if people were in shelters even as crude as the small pole shelter [a Soviet design using wooden poles covering a trench dug in the earth, and covered with a layer of soil], not one person would be killed or injured by the effects of these nuclear weapons.

It should be emphasized that the Soviet population is regularly drilled on evacuation and civil defense procedures. Ample provision is made for shelters, even emergency prefabricated shelters which can be quickly assembled.

Certainly there would be great destruction of industrial plants, infrastructure, and stored supplies such as oil and food. The best protection against this type of loss is, first, to redouble the capital stock through an economic expansion program based on the technology of beam weapons, and second to immediately begin storing vital supplies such as grain in decentralized locations.

Haaland estimates that the total cost for Civil Defense for the great majority of the U.S. population would be \$50 billion, or averaging \$250 per person. This is a small fraction of the total annual military budget, and once in place would need considerably less input in following years.

"Destabilizing," say the Pugwashers. How is it that the Soviets are doing precisely this, and that is not considered destabilizing?