

Nuclear winter

Has winter become fall?

Blacksburg, Virginia

Two years of intensive computer modelling have substantially refined the concept of "nuclear winter" but the diverse opinions on its strategic and diplomatic implications suggest that any real impact on US defence policy is still some years away. A conference* last week that included representatives from universities, government and the military heard sharply differing views on the importance that should be attached to the results so far obtained.

There was a consensus that although models have become increasingly sophisticated and useful, there is still great uncertainty about the source terms for the quantity of dust and smoke that would be injected into the atmosphere following a nuclear exchange. Beyond that, pre-established positions dominated. Colonel Terry Hawkins, representing the Pentagon, agreed that the possibility of nuclear winter was a "sideshow" that was simply another reason to avoid nuclear war, and repeated the familiar Pentagon line that the present policy of deterrence through strength is the best interim policy. But Hawkins did use the idea of nuclear winter to support a transition to defensive weapons as a long-term aim through the Strategic Defense Initiative (SDI). Others, believing SDI to be destabilizing, argued exactly the opposite.

Robert Simmons of the Arms Control and Disarmament Agency agreed that the threat of nuclear winter was a further reason for disarmament. Maurice Roesch III, assistant director of the White House Office of Science and Technology Policy (OSTP), said that it was necessary to understand the phenomenon "before we go too far trying to understand policy implications" and made clear his view that understanding had not yet been reached.

Others, such as Thomas Malone, former secretary-general of the International Committee of Scientific Unions' Scientific Committee on Problems of the Environment (SCOPE), emphasized that nuclear winter had attracted much interest in non-combatant countries such as India, which would in future take a much greater interest in nuclear war doctrines of the superpowers and catalyse "worldwide moral indignation" over nuclear weapons.

SCOPE last year produced the most thorough study yet of climatic effects of nuclear weapons. But George Rathjens of Massachusetts Institute of Technology strongly criticized "irresponsible" misrepresentation of the science of nuclear winter ("the worst example in my memory"), while making it clear that he was referring to popular press coverage and public statements by the populist scientists rather than to the research papers themselves.

And some pointed out that a nuclear war between the superpowers would be quite damaging enough to developing countries because of the loss of trade, even without nuclear winter.

Ambassador Richard Butler, Australia's representative at the Geneva arms talks, made an impassioned plea for the superpowers to live up to their commitment to abandoning nuclear weapons altogether and said the changes now occurring in the Soviet bureaucracy make it possible to start work on "a new fabric of security for the forthcoming post-nuclear age".

More sophisticated recent three-dimensional interactive global circulation models tend to predict smaller temperature drops in continental interiors than the one-dimensional model of Turco, Toon, Ackerman, Pollack and Sagan (*Science* **222**, 1283-1292; 1983).

The latest results from the global circulation model at the National Center for Atmospheric Research at Boulder, Colorado, continue the trend. Preliminary results reported by Stephen Schneider and Starley Thompson at a Defense Nuclear Agency technical review from a model incorporating microphysics effects to coagulate smoke and dust particles, remove them by precipitation and allow the changed particle size distribution to affect radiative transfer terms, predicted an average temperature drop in the Northern Hemisphere for a 180 terragram smoke injection at close to 12 degrees centigrade, about 3 degrees less than a similar model without the microphysics package. The results are likely to be referenced in a forthcoming but delayed report on nuclear winter requested by Congress from the Department of Defense.

Russell Seitz, currently at Harvard University, quoted Schneider as referring to the new simulations (together with new estimates of fuel loading by George Bing of Lawrence Livermore Laboratory that suggest 60 terragrams would be a more plausible smoke injection for a medium-sized conflict) as indicating that "nuclear fall" would be a more appropriate description of climatic changes after a nuclear exchange.

Richard Small of Pacific Sierra Research Corporation presented an analysis of fuel loadings resulting from a strictly counterforce exchange that predicted a maximum of 3 terragrams of smoke in the atmosphere, not enough to produce any nuclear winter effect. But Small agreed it was "prudent" to consider policy implications.

George Carrier of Harvard University said that trends in modelling suggest that for a nuclear exchange in the Northern

Hemisphere to devastate agriculture in the Southern Hemisphere "almost all the as yet unknown parameters will have to come out on the serious side", unless agricultural systems are even more sensitive to climate effects than is now recognized.

Others drew attention to other possible long-term consequences of a nuclear exchange. Michael McCracken of Lawrence Livermore Laboratory said that precipitation over land might be significantly reduced by even relatively small smoke injections, possibly leading to a failure of the monsoon.

Mark Harwell of Cornell University, a co-author of last year's SCOPE report on nuclear winter, reiterated that even the more modest temperature drops predicted by the latest models would still have disastrous consequences for agriculture given the effects of spatio-temporal variation, and pleaded for more research support for biological effects. The great majority of US federal support for nuclear winter research (nominally \$5.5 million in the current fiscal year) is for geophysics work, although the National Science Foundation still has \$100,000 uncommitted that could be diverted to biology.

Much discussion centred on the proposal, put forward by Senators Proxmire and Hatfield, that the United States and the Soviet Union should establish a joint commission to study nuclear winter. Alan Hecht of the National Oceanic and Atmospheric Administration, who drew up the US research plan before the topic was taken over by OSTP, spoke favourably of the potential of Soviet scientists to contribute to nuclear winter research, although the disappearance a year ago of Soviet researcher Vladimir Aleksandrov had done nothing to make collaboration easier. But he complained of the difficulty of gaining access to top Soviet scientists.

Large-scale experiments on fires are thought to be one area where collaboration might be fruitful; observations of deliberate forest burns are also being planned with the Canadian Forestry Service. Work on computer modelling is complicated by the Department of Defense's insistence that Soviet citizens should not have access to US supercomputing expertise, currently a source of friction between the Pentagon and the National Science Foundation. Administration officials strongly prefer to work on developing lower level contacts than a commission would imply, however, most probably under the auspices of the 10-year old US/Soviet bilateral agreement on environmental cooperation, which has a working group on atmospheric research chaired by Hecht. A final decision on whether to pursue that option has yet to be made.

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* Nuclear Winter: strategic implications, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 6 March 1986.