

## **CASE STUDY 2**

### **WEATHER MODIFICATION: THE EVOLUTION OF AN R&D PROGRAM INTO A MILITARY OPERATION**

Weather Modification:  
the Evolution of an R&D Program into a Weapon System

In an obscure Vietnamese publication on the history of the battle of Dien Bien Phu, the following notation appears under the entry for April 23, (1954)

The General Staff of General Navarre sent a radio message to (General) Cogny informing him that on April 24, 150 baskets of activated charcoal and 150 bags of ballast would be flown from Paris for the making of artificial rain aimed at impeding our movement and supply. (1)

Assuming the event took place as reported, it had no known effect or consequences. It is interesting to recall that french forces apparently had initiated the use of chemical agents in World War I in a similarly amateurish fashion.<sup>(2)</sup> On this occasion the consequences were fortunately not the same.

In <sup>the</sup> summer of 1972, however, it was reported that the United States had been using weather modification techniques in the Indochina War from 1967 through 1972 in an effort to increase rainfall as an adjunct to military operations. (3) Several U.S. Congressional Hearings then followed, both in the Senate and the House, and in one of these two years later in 1974, an official administration confirmation of the program was made (4). With these events as stimuli weather and climate modification and environmental warfare entered onto the scene of international concern and coincidentally also rapidly into international negotiations. Pressure from the US Congress, which was at the time concerned with several exotic forms of US military usage in the Indochina theater was one factor. But a more important one was probably the coincidence of the ongoing but lagging US/USSR SALT (Strategic Arms Limitation Talks) and the felt political need in both the US and the USSR to provide for new agreements at forthcoming summit meetings that were anticipated in the middle-1970's. This situation served to direct more government attention to the subject than might otherwise have occurred.

There is a small but useful literature on the international implications of weather modification including its potential use as a weapon (5), going back to Gordon MacDonald's alerting paper in 1968 (6). Nevertheless a synoptic study by the US National Academy of Sciences (NAS) in 1973

entitled Weather and Climate Modification, Problems and Prospects contained some few scattered paragraphs concerning military aspects of weather modification, amounting, in total, to perhaps a single page of material among its 258 pages. (7). There were brief summaries of the interests of the US military services in weather modification;

A portion of the United States Navy program in weather modification is devoted to the logistic and flight support of the joint N O A A/ Navy research program on hurricane modification (Project Stormfury). In addition, it supports studies of cloud and fog dissipation and the development of pyrotechnic seeding devices. The Office of Naval Research has for many years supported several basic research programs in atmospheric electricity, some of which are relevant to the possibility of artificially modifying lightning from thunderstorms.

The United States Army is involved in studies of fog dissipation, atmospheric electricity, and convective cloud dynamics.

The United States Air Force is similarly interested in the dynamics of convective cloud systems that affect the flight of aircraft and missiles and the dissipation of fogs and low stratus clouds. It has also participated in Project Stormfury. During the course of this study, no attempt was made by the Panel to examine classified experimental programs or to ascertain the existence of classified experimental programs in weather modification.

and there was a very brief reference to use in war:

In considering the prospect of controlled weather modification, we are acutely aware that just because science and technology may develop the capability to modify weather there is no reason to assume that society should automatically use that capability. Weather modification appears to be one way of achieving certain goals... possible applications of weather modification for aggressive military purposes provide further urgent reasons for pursuing international agreement on activities that could seriously affect the weather of regions beyond national borders. (Emphasis in original).

What is altogether remarkable in this is the admission by the National Academy of Sciences Review Panel that "... no attempt was made... to ascertain the existence of classified experimental programs" — no less the actual experience of US military usage — despite the fact that the Academy study was published in 1973, a full three years after the first disclosure of such operations in 1970 in the Pentagon Papers, and a year after their further disclosure in 1972. In addition the National Science Foundation (NSF), held the statutory responsibility to support research and evaluation in the field of weather modification, and "... serves as coordinator of the entire Federal effort in weather modification", and the NSF's "Special Commission on Weather Modification is expected to play a major role in treating matters of national weather modification policy

within the Government structure." (8) The preface to the NAS Review Panel's study itself noted that

... there were distressing but persuasive indications brought to light in the July 1972 Hearings on Prohibiting Military Weather Modification (S.R. 281) before the Subcommittee on Ocean and International Environment of the Senate Committee on Foreign Relations that operational weather-modification activities were carried out in Southeast Asia in support of military operations during the late 1960s. (The record of these hearings must rank among the more astounding testimony ever presented before the Congress.) (9)

Nevertheless the Academy study clearly avoided any examination of these questions at the same time as it could afford the presentation of lengthy appendices and detailed statistical analyses of individual examples of weather modification experiments. (10)

The compromising effects of that negligence can be demonstrated by an even more serious event that took place at the same time involving a National Security Council study:

A special interagency panel recently completed a year-long analysis of the potential ecological and environmental dangers of weather modification and no information about the Air Force rainmaking activities in Southeast Asia was provided to it. The panel was headed by Herman Pollack, director of the State Department's Bureau of International Scientific and International Affairs.

The report, which also dealt with civilian uses of weather modification, was handed over to the White House staff of Henry A. Kissinger, President Nixon's adviser for national security. One source said the members concluded, in effect, "that they couldn't make a really useful report because most of them did not have access to the classified information." (11)

It required the press and then the Congress to perform the function for which the government's own scientific advisory apparatus existed but abdicated its responsibility, and it remained for a 1975 Canadian working paper to the United Nations Conference of the Committee on Disarmament (CCD) in Geneva to present a list of 19 types of direct and indirect modification techniques aimed at the atmosphere, oceans, and land which could conceivably be used as methods of environmental warfare. (12)

In the relevant literature which does exist, one topic has, however, escaped attention entirely. That is a description of the way in which a specific research and development program and the context of government policy and decisions regarding it, albeit with overlapping civic utilities, evolved into an operational weapons system. Other authors have discussed potential mechanisms of environmental warfare, weather and climate modification, or

What is additionally remarkable is that the Chairman of the National Academy panel and the author of this preface was Thomas F. Malone, who in all likelihood was fully acquainted with the military operations and decisions behind them from his long experience as a consultant to the Defense Science Board on questions dealing with weather.

have concentrated on international aspects of peacetime uses of weather modification. It seems more useful, however, rather than to make general hypothetical statements about the possibility of causing earthquakes or of melting the polar ice-cap some time far off in the future, to describe a process that has already taken place and to indicate the extreme ease and rapidity with which an entirely new form of warfare — with enormous long range implications — came into use

#### The Development of a Context for an R&D Program in One Nation

The beginning of experimental weather modification is credited to the first forced precipitation of rain—"cloud seeding" — by Vincent Schaefer using dry ice in 1946. The following year the same effect was demonstrated by Bernard Vonnegut using silver iodide crystals (13). Attention by the Dept. of Defense was rapid: a report of a Panel on Meteorology of the Defense Department's Research and Development board was however, sceptical of claims for the new technology. Public attention in connection with military usage was also rapid and set a pattern of extravagant and fanciful images of power and danger that would continue for twenty years:

Army, Navy and Air Force are spending close to a million dollars a year on weather modification and their tremendous interest suggests that military applications extend far beyond visiting a few showers upon an enemy. It does not require a sharp mind to figure out that wartime storms might readily be infected with virulent bacteriological and radiological substances. (14)

In 1953 a President's Advisory Committee on Weather Control was established to determine "the extent to which the United States should experiment with engage in, or regulate activities designed to control weather conditions". A US Navy officer, Capt. H.T. Orville, became chairman of this Advisory Committee, and its report to the President in 1957 contained several security deletions. (15) The report, <sup>however,</sup> apparently led to a "major cut in research support across the board by (the) Defense Department", and it was in the following year that the National Science Foundation, a civilian agency, was designated the "lead agency" for research in weather modification. (16) If the recommendations of this committee regarding the military utilization of weather modification was negative, it would have been quite notable at the time. Another civilian advisory committee had urged the full and rapid development of instruments of Chemical and Biological warfare by the US Army in 1955, (17) and this was by and large the nature of the recommendations of nearly every single presidential scientific advisory committee in the years 1954 to 1960, irrespective of the particular military-technological issue in question. (18) Orville stated that "If an unfriendly

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nation gets into a position to control the large-scale weather patterns before we can, the results could be more disastrous than nuclear warfare." (19) Orville also reported that the USSR

... had conducted numerous unpublicized but still detectable experiments apparently aimed at finding ways to speed melting of polar icecaps; and has even offered to join the United States in a project to turn the Arctic Ocean into a sort of warm water lake by melting the polar icecap.

This may have referred to the 1957 Soviet suggestion to build a dam across the Bering Strait, to pump warmer Pacific water into the colder Arctic, and at times to reverse the flow to "cancel out" the Greenland, Labrador and other cold ocean currents (20). Such a scheme, which would have changed wind, rainfall, and climatological patterns across the entire western hemisphere and the entire northern hemisphere as well, can only be considered simple mindedness of the most heroic, epic, and monstrous proportions, in the very worst tradition of the attempt to apply any technology, without consideration of consequences. As we will see, it was instrumental in prompting the largest weather modification R&D program in the Dept. of Defense. Besides that, it was the most excellent ammunition for those who were only too delighted to be able to point to a Soviet "weather threat." Dr. Edward Teller — a frequent participant of many of these campaigns — could serve up the following vision to a US Senate Preparedness Subcommittee: "Please imagine, a world... where the (Soviets) can change the rainfall over Russia... and influence the rainfall in our country in an adverse manner." (21) Dr. Henry G. Houghton of the Dept of Meteorology, Massachusetts Institute of Technology, spelled out this image in somewhat more detail:

I shudder to think of the consequences of prior Russian discovery of a feasible method of weather control... International control of weather modification will be essential to the safety of the world as control of nuclear energy is now. Unless we remain ahead of Russia in meteorology research the prospects for international agreements on weather control will be poor indeed. An unfavorable modification of our climate in the guise of a peaceful effort to improve Russia's climate could seriously weaken our economy and ability to resist." (22)

Weather warfare scenarios were presented, and concepts of "meteorological deterrence and parity" were invoked. Members of Congress themselves also joined the chorus of exhortation. Senator L.B. Johnson (then Chairman of a Senate Committee on Space) told the Congress "From space one could control the earth's weather, cause drought and floods, change tides and raise the level of the seas, make temperate climates frigid." (23)

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A U.S. congressman, speaking on behalf of legislation to provide funds for weather modification experimentation, offered among his reasons for supporting the bills the following:

In the fourth place, we need this legislation and appropriation because we must beat Russia to the punch... America could become as subject to Russia's whims as a rat in a laboratory to an experimenter. If Russia beats us to the punch on learning how to control the natural laws governing weather changes, they could conceivably produce a drought over our whole continent or a disastrous flood. We know that the Russians are devoting great energy and scientific talent to learning how to control the weather. It is urgent that the United States not fall behind in this race. (24)

The extravagant and near-hysterical language was not atypical of certain political quarters in the United States in the late 1950's, as it had also been some half dozen years earlier. It was the period, however, in which the "Red Threat" of a previously relatively undifferentiated political context took on new dimensions of a military/technological character. It was the period of numerous analogous alarms: the "sputnik", an anticipated "missile gap", space warfare, and others. The allegation of Soviet military research efforts in some particular area — in this case totally unsubstantiated — with the promise of the direst consequences should the US come in second in the race was a common component of this genre.

The peak of hysteria would seem to have been reached in a 1960 article in the U.S. Naval Institute Proceedings. Its theme repeated some sixteen times in an eight page article was succinct: "the threat".

The lowest price for procrastination in this regard (immediate establishment of a rigorous atmosphere research program) will be political, economic, social and military paralysis. The highest price will be absolute obedience to the leaders in the Kremlin. (25)

It was nothing less than a matter of pure survival. The other side's intent to use the capability as a weapon — immediately as it obtained that capability, without any need of special provocation — was stated as a certainty. All that mattered was who obtained the capability first, the US or the USSR. The other side was working hard at the problem and it was "ahead". No evidence had to be supplied to support that claim, which duplicated numerous analogous claims that were made year-in, year-out in testimony for annual budget appropriation requests for the Department of Defense, or for various of the military services; only the claim, or the suggestion that the other side was "ahead" in this or that area

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of research. Moreover, ones own research was innocent, while a similar claim on the part of the antagonist was "largely propagandistic," a theme which would also be retained for many years.

"Officials say current Pentagon research... is limited to rain-making, rain suppression, and hail and fog dispersal. The latter is useful in controlling flying weather... The Soviets claim their weather research is only for peaceful purposes - a claim the Pentagon calls 'largely propagandistic'. A spokesman says the Soviets are conducting extensive work on weather alteration which could be used in military operations." (26)

Should the other side achieve the capability first, it would be used for that very reason, and the West would be defenseless, doomed, destroyed. An infinitely more balanced assessment in a military periodical in 1975 still put a heavy emphasis on Soviet efforts: "Scientists, especially in the USSR, are working on methods for altering weather and climate. This branch of science has a vast potential for good — as for catastrophe," and claimed that the Soviet weather modification program was the "busiest" in the world. (27) The article pointed out that government witnesses have stated "that America will not use climate modification schemes as weapons, but have refused to rule out all weather modification techniques, carefully distinguishing between climate and weather." The military quickly introduced its two most reliable objections, the verification issue, and "defensive" uses. "How would one nation detect enemy violations? Should a country be banned from making or dispersing fog to rescue encircled troops?" The U.S.Navy, in its appropriations justifications claims that it is doing "defensive" weather modification research: "Potential enemies... (may)... produce environmental conditions which benefit their own forces or limit the effectiveness of our forces." Suggestions to ban the use of weather modification for war or to remove relevant R&D from military sponsorship were reported to have "encountered considerable opposition from the Pentagon", which in fact they had, though this was now after the US use of weather modification in Indochina had been publicly acknowledged by the government. (28)

These is no publicly available information by which one can assess whether the US had any conception of the nature or scope of a Soviet military weather modification program in the 1950's and 1960's. Brief summaries of the USSR's civilian R&D program were published in the Weather Modification Annual Reports published by the National Science Foundation, and then in the Summary Reports, Weather Modification of the National Oceanic and Atmospheric Administration (NOAA) when that agency was formed in 1969 to become the nations lead agency for R&D in this area. (29) Unclassified USSR studies in the basic and applied meteorological sciences



were also available for study. (30). On the other hand, public descriptions of US military weather modification interest or R&D programs seemed quite formidable; if anything they seemed to get notably calmer with the years. The first hurricane seeding experiments under Project Stormfury, utilizing military aircraft and the collaboration of the military services, began in 1961. (31) In 1963 Adm. William F. Raborn, previously responsible for the Polaris SLBM development program and then Deputy Chief of Naval Operations for Development, included the following description in an article titled "New Horizons of Naval Research and Development"

The possibilities for the military employment of the "weather weapon" may be as diverse as they are numerous. An ability to control the weather could introduce greater changes in warfare than those which occurred in 1945 with the explosion of the first nuclear weapons.

A severe storm or hurricane striking a naval force may well inflict greater damage than could an enemy. The capability to change the direction of destructive storms and guide them toward enemy concentrations may exist in the future arsenal of the naval tactical commander.

Ground, sea, air, and amphibious operations might be supported by the dissipation of fog or clouds, or by the production of rain or drought. Conversely, the creation of solid, low overcasts might be used to conceal troop concentrations, movements, and task force deployments. Large-scale weather control techniques might be used to cause extensive flooding in strategic areas or even to bring a new "iceage" upon the enemy. By influencing the ionosphere and atmosphere simultaneously, magnetic, acoustic, and pressure effects might be generated in such a way that oceanwide sweeping of mines would occur.

...  
We already have taken our first steps toward developing an environmental warfare capability. We are using satellite weather data from Tiros II for current, tactical operations and more accurate, long-range weather predictions. Some experiments in fog dissipation have shown promise, and some exploratory research has been conducted on ways to change the heading of major storms. For these reasons — and because our advances in science make it reasonable — we are now engaged in planning a ten-year, comprehensive study of the atmosphere, a study which we will designate ATMOS. This plan will be coordinated with our TENOC oceanographic studies. (32)

The House Committee on Science and Astronautics in praising the weather photographs of the Tiros Satellite program that Adm. Raborn had referred to added another flourish: they "... could lead to an early weather control capability... which would provide the United States with a great deterrent to war." (33). Adm. Raborn's language combines description, prognostication and presumably the hope of achieving (with no indications of fear of) —<sup>and</sup> with the relative degrees of these compo-

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nents remaining indecipherable — an extraordinary range of very powerful capabilities. The consequences of finding a statement of this nature authored by the senior military officer responsible for R&D programs in one of the Soviet Military services is inconceivable. A 1972 statement by USAF <sup>Gen.</sup> Robert T. March was a good deal more restrained.

Lastly, contributions of military R&D to weather research will focus on what might be the least appreciated of all the disciplines. Military R&D programs in meteorology include weather observing and forecasting, weather-data processing and dissemination, meteorological equipment development, computerized flight planning, atmospheric research, the Standard Atmosphere, and fog dissemination. These topics will be reviewed and discussed in terms of both present and future inputs. (34)

There is also an extremely important point to be noted here which applies to many different R&D programs. Those who had raised the spectre in the late 1950's in Congress of Soviet weather R&D programs did not supply any evidence for the military nature of that program. None was necessary for that audience; the intent was simply taken for granted. However, on scientific grounds, the same basic research would serve for both "civil" and "military" applications, for "defensive" and "offensive" ones. As early as 1961 a RAND report on weather modification emphasized the complexity of atmospheric processes and the interrelationship of modification and prediction. Two of the most expert government advisors in the area of weather modification have been absolutely explicit on this question in the context of the US research program:

Dr. Robert W. White, Administrator of the National Oceanic and Atmospheric Administration:

"It is not possible to draw clear distinctions between research and technological development on weather modification for hostile and non-hostile purposes." (35)

Dr. Thomas F. Malone, Chairman, National Academy of Sciences Review Panel on Weather and Climate Modification:

"I do not think military research should be explicitly prohibited because (a) it is almost impossible to differentiate between research directed at beneficial use and research directed at fashioning geophysical weaponry; (b) our national civilian effort in this field would be seriously disrupted because we freely intermingle military and civilian resources; and (c) our military forces must have expert scientific competence to fulfill their role in providing national security." (36)

Without contradicting the above assessments, the US Dept. of Defense has, however, argued for the maintenance of its own weather modification R&D

programs.

"The DoD research and development effort in weather modification is conducted because of two major defense interests: (1) protecting personnel and resources against weather hazards, thus improving our operational capabilities; and (2) guarding against technological surprise by increasing our understanding of the capabilities any potential adversary might possess in this area. ...

The DoD must retain the option to conduct RDT&E in those areas of atmospheric sciences, including weather modification, which offer the greatest potential contribution to solving problems associated with weapons systems and tactical and strategic operations. In the existing structure of our government, mission-oriented executive departments can ill afford to have their programs directed by, or priorities established by, another government agency. (37)

These same issues can be examined in two other ways. The first is via the question of expenditure levels for military weather modification programs. Around 1960, just when the grandiose claims were being made for the potentials of military weather modification, there were several claims that US Dept. of Defense funding for "weather modification" amounted to less than two million dollars per year. Even in 1960 this would have to be considered a trifling sum. However this amount was only the "unclassified" funding, and there was no way to know what fraction of the total it was.

News reports of classified military weather modification activities indicate that the costs reported by the Defense Department are only a fraction of total DOD weather modification expenditures. ... classified weather modification activities are not included in table 2. (Agency Funding for Weather Modification) and, as indicated earlier, these may be substantial." (38)

The question of what the military budget for weather modification is, classified or unclassified, would also seem to matter a good deal on a matter of definition: which meteorological research was considered directly relevant to weather modification, or even more, intended to directly support a program in it. For example: To what degree does knowledge obtained in such operations as the massive sea-state and atmospheric interaction studies known as "GLOMEX," "BOMEX," "NORPAX" (39) or in weather satellite programs (40) contribute to the understanding of suitable conditions for weather modification, or of its effects? Such studies entail very large expenditures, and are often jointly funded by a military service (the U.S. Navy, for example) and the National Science Foundation. They are also often programmed as part of such international ventures as the International Decade of Ocean Exploration.

... the Foundation has supported a number of research projects jointly with units of the Department of Defense but ... none of these was of a classified nature. The jointly supported projects ... might be divided into two groups for purposes

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of discussion. In the first group are research projects... of interest to the Foundation for their potential contribution to the advancement of basic scientific knowledge, and at the same time... of interest to the Department of Defense for their potential contribution to its mission...

In the second group are research projects, normally on a larger scale, in which joint support includes the physical involvement of manpower or equipment or facilities of one of the supporting agencies. Projects in this group typically are supported by a number of agencies as in the case of the International Geophysical Year, the International Indian Ocean Expedition, and the International Years of the Quiet Sun, each of which represented a national commitment to support an international research program. Current programs of this type are the Antarctic Research Program and the newer Global Atmospheric Research Program (GARP). A major research project undertaken by the US under the aegis of GARP is the Barbados Oceanographic and Meteorological Experiment (BOMEX) in which five other departments and agencies, in addition to Defense and the Foundation, are participating. A similar program, a precursor to GARP, was the Line Islands Experiment in the Pacific in 1967, in which a number of the same agencies, including Defense and the Foundation, participated. (41)

One can also ask to what degree the general interest in weather phenomena by the traditional military services is relevant to "modification". (42) It may be relevant to a very considerable degree, nevertheless it is clear that the above mentioned three military or combined military/civilian large scale meteorological research programs:

- sea state and atmospheric interaction studies;
- meteorological satellite programs;
- weather prediction for routine military operations;

all have major intrinsic purposes of their own. Their planing and funding as research programs may have had no intention to provide information for adaptation in a weather modification program. On the other hand, such programs as Project Stormfury, the turning or dissipation of hurricane centers, are completely identical to the often suggested use of the same weather phenomena as a weapon. (43). In addition, if one looks at the Air Force Defense Research Sciences Program and the description of one of its thirteen budgetary sub-elements, Atmospheric Sciences, one discovers that the paragraph describing its duties contains the following missions: ... to improve environmental prediction techniques used to support various military functions; and to modify the environment to enhance military operation." (44) The knowledge gained in the first is necessary to accomplish the second. From the point of view of capability, it probably would not matter if the mission definition did not contain the latter half of the statement. Similarly the crucial question is not the amount of funding that

is rigorously defined as for "modification", or the portion that is classified, or which agency carries it out, but the intention of the program that gathers the knowledge base, and its utilization and application. (45)

Another way in which this question can be examined in some detail is through what is probably the major relevant project that was funded by the US Dept. of Defense. Beginning in 1969, ARPA, the Advanced Research Projects Agency in the U.S. Department of Defense, began funding a project called "Nile Blue (Climate Modification Research)." The  
official statement describing that project **states:**

Since it now appears highly probable that major world powers have the ability to create modifications of climate that might be seriously detrimental to the security of this country, the NILE BLUE subproject was established in FY 70 to achieve a U.S. capability to

1. evaluate all consequences of a variety of possible actions that might modify the climate;
2. detect trends in the global circulation which foretell changes in the climate either natural or artificial;
3. determine, if possible, means to counter potentially deleterious climatic changes.

Dr. Lukasik. Basically, what we are attempting to do is to learn as much as we can about how world climate is determined so that we can predict the effects of modification man might make in the environment. In order to do this we must first devise a realistic and workable mathematical model of the world's climate which will make it possible to calculate future states very quickly. This is where the need for a very powerful and fast computer comes in. Once we have a dependable simulation model, then we can begin to introduce changes into it — for example, increasing the amount of water that is evaporated into the atmosphere from a newly created large inland area — and find out what effect this would have on the world's climate. When we have achieved this capability we will be able to evaluate, in advance, the effects of such environmental changes as the announced Soviet proposals to create large inland seas in the arid regions of Central Asia and to melt large portions of the arctic ice along the northern reaches of the U.S.S.R.

I think I should mention that, although a number of Government organizations are engaged in weather prediction and weather research, these areas are by no means synonymous with the study of climate modeling and modification. They are related, of course; the Nile Blue program depends heavily on the numerical models and techniques developed for weather prediction, adapting and extending them as required for the long-term stability required for climate prediction. Because of this dependence, continuous scientific interaction is maintained with the weather research activities of the military services, National Oceanic Atmospheric Administration, National Science Foundation, and so forth both as a source of information for the ARPA program and as a possible recipient of technical spin-off relevant to their concerns. (46)

In testimony in the following year before the Senate Foreign Relations Committee the Dept. of Defense gave the following justification for the Nile Blue program, by then renamed Climate Dynamics.

(b): What is the justification for ARPA's sponsorship of the project? Why shouldn't Climate Dynamics be transferred to a civilian agency?

The Soviet Union has invested considerable effort and resources in developing a well organized and extensive program in climate modification research. The Director of the Soviet Hydrometeorological Service has declared that active modification of climate is an objective of this research. A number of specific projects have been proposed to alleviate the harsh Russian climate with attendant benefits to agriculture, navigation, and resource exploitation. These include removal of the Arctic pack ice, damming of the Bering Straits, and diversion of Siberian rivers.

These programs clearly might affect the climate of other parts of the world, including the United States and its allies. Even marginal changes in temperature and rainfall could drastically damage agriculture, shipping, and indeed the entire economy. Military operations would also be impacted if the boundaries of pack ice, the ice-free seasons of naval bases, the frequency of obscuring clouds, etc. were altered. Thus climatic changes are clearly potentially grave threats to national security, and have consequent implications for military planning

For these reasons, it is incumbent upon the DOD to develop a capability to predict the climatic effects of foreign actions and to detect modifications which may be in progress. With a scientifically credible detection capability, world opinion and the instruments of national power may be mobilized to reverse actions damaging to the national interest. These specialized national security questions are incompatible with the missions of the civil agencies, whose meteorological programs center on weather prediction and basic research in atmospheric physics. (47).

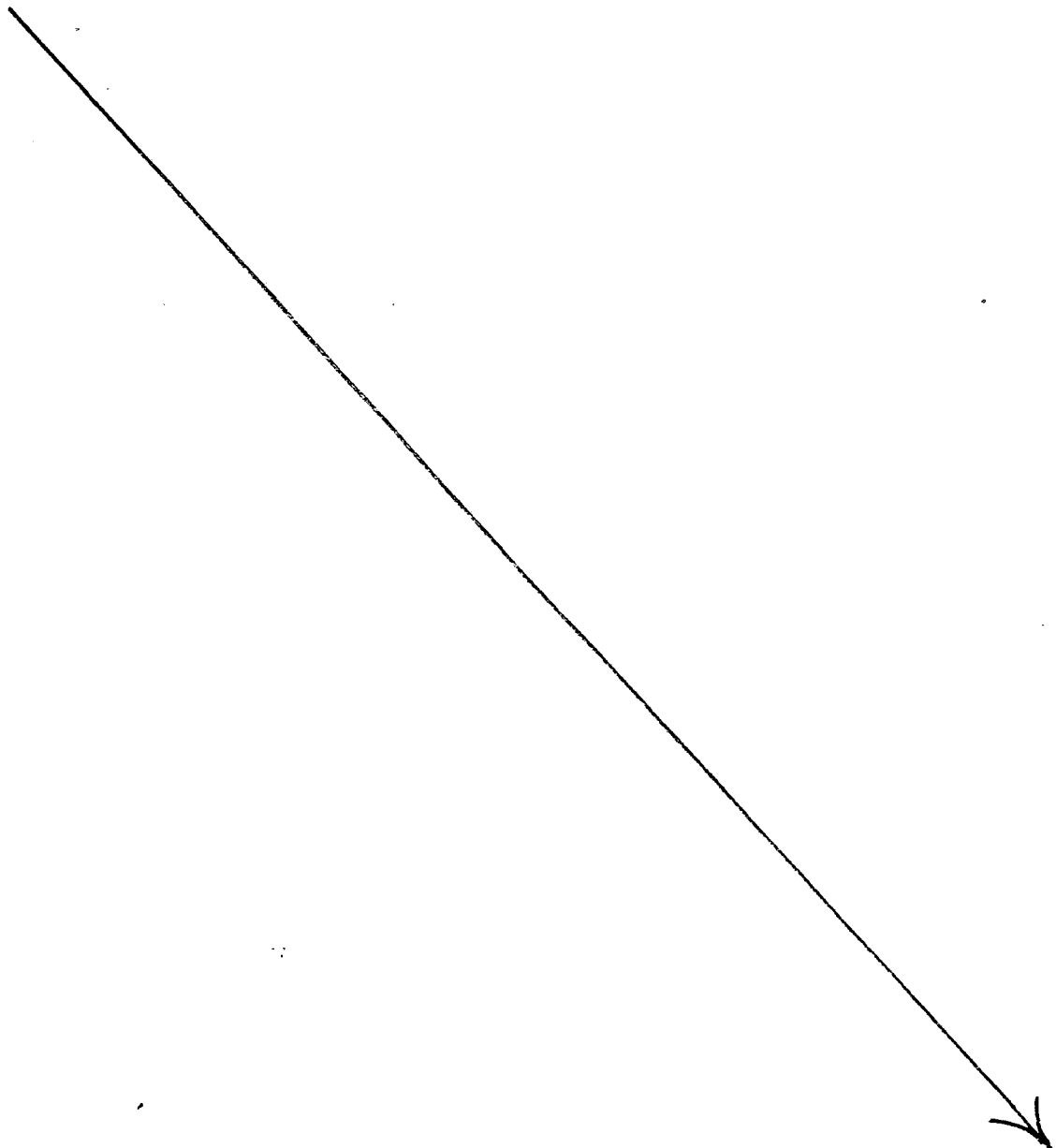
There are several important points to be noted here:

- The Nile Blue program was an attempt to perform very large-scale theoretical global climate modeling, and was carried out by the major US military advanced-R&D agency.
- It began several years after military weather modification operations were initiated by the US Air Force in Indochina but probably had little or no direct relation to them. (The program could, however, conceivably have been catalyzed by thoughts of the possible spread of international interest in weather and climate modification in subsequent years should knowledge of the US military operations become public.)
- It was not justified in relation to any of the more often referred-to limited weather modification programs of interest to the military services, but was related to the grandiose Soviet schemes involving the Bering Straits and the northward flow of Siberian rivers to the Arctic. 1969 was more than ten years after the first Bering Straits suggestions, but closer to the time the USSR began discussing major river diversions.

- Such schemes would unquestionably produce extremely serious and real international problems were they ever attempted, but these are not essentially military problems. (The significance and danger of the Soviet proposals are discussed in a later section of this chapter.)
- It is possible that a global climate modeling research project could not have been initiated before a requisite amount of computer capability was provided — which was in fact an integral part of the program.
  - There was a great amount of "civilian" overlap in the R&D program.
  - Finally, of interest to understanding other parts of this study is simply the fact that ARPA was the agency involved. It was ARPA's institutional role within the US Department of Defense to be responsible for very advanced research that did not readily fit into any of the individual military service missions (Army, Air Force or Navy), as well as being still too far removed from weapon application. (48) At the same time however ARPA also contained a branch that was concerned with R&D for "counterinsurgency" military operations — Project Agile, which was established in mid-1961 — and was paradoxically the agency in the Dept. of Defense that was instrumental in rapidly putting into field operation in Indochina several other irregular or "exotic" forms of warfare: herbicide operations against both crops and forests, and the use of forest fires. All of these programs were applied extremely rapidly, with very little testing, with even less thought or knowledge of possible consequences, and in contravention of international rules of warfare.

The Nile Blue program made use of what was at the time the world's largest computer, ILLIAC IV, the construction of which had also been funded by ARPA. It would have to be considered of inestimable value if someone had decided for once to anticipate the environmental effects of a proposed very large scale man-made technological intervention. One can only hope that this is actually why the program was initiated. As already indicated, as early as 1961 a RAND report on weather modification emphasized the complexity of atmospheric processes and the interrelation of modification and prediction. Perhaps it is also of interest that the only two reports that deal with weather and climate prepared by the US Central Intelligence Agency that have been publicly released deal with similar broad considerations of weather, climate, food production, etc. (49) It is unlikely, however, that the program was quite so benign. In 1962, years before the Nile Blue Program was initiated, ARPA had contracted for a classified research project with the title "Some' Upper Atmosphere Aspects of Chemical Geophysical Warfare." (50)

Clearly, the same information base described in the ARPA Nile Blue program could also eventually provide the ability to carry out attempts at weather modification. It is inherent in the nature of the information. We have already noted the contention that "their" research is "military," but "ours" is just civil, even that funded by military programs. It is interesting in view of the stated description of the Nile Blue program that by 1975 it was reported that "The National Science Foundation gradually is taking over ARPA's weather/climate research." (51) The NSF also jointly funds a substantial portion of oceanographic research that has direct military application. This again impacts on the questions of the importance — or not — of the amount of funding, its source (which agency funds it out), its classification (public or secret), or the publicly presented rationale for the program.





Weather Modification Used in War: 1967-1972.

Despite the great magnification of "the threat" from a potential opponent that was expressed in 1958 to 1960 in the United States, it was the United States that was the first nation to use weather modification as a weapon in war. This took place in an extensive program in the Indochina Theater from 1967 to 1972. (52) It was this program that prompted the extreme efforts at government secrecy and to hinder US Senate hearings in 1972, even though the program had by then already been compromised in 1970 during the release of authoritative government documents in the Pentagon Papers, and in greater detail in 1972 in the public press. The program was not halted until it was so compromised, and it is interesting that it was able to continue for five years, over the territory of several different nations (Laos, Cambodia, North and South Vietnam) and with the knowledge of its existence available to some 1,400 persons, before its disclosure.

In December 1966 the United States Joint Chiefs of Staff submitted to President Lyndon Johnson three proposed plans — A, B, and C — for future military operations in Indochina. All of them included as point 4:

LAOS Operations — Continue as at present plus Operation **POP EYE** to reduce trafficability along infiltration routes.

Authority/Policy Changes — Authorization required to implement operational phase of weather modification process previously successfully tested and evaluated in same area.

Risks/Impact — Normal military operational risks. Risk of Compromise is minimal. (53)

On February 21, 1967, after TET, in a review of possible escalatory actions, the three plans were resubmitted, and all contained as point 8: "Cause Interdicting rains in or near Laos".

"The discussion section of the paper dealt with each of the eight specific option areas noting our capability in each instance to inflict heavy damage or complete destruction to the facilities in question." (54)

When these documents were published in the press versions of the Pentagon Papers there was no immediate public response, although they did catch the attention of one or two members of Congress, in particular Senator Pell.

Dept. of Defense testimony subsequently described the 1966 testing phase of the program as follows:

In 1966, the Office of Defense Research and Engineering proposed a concept of using these known weather modification techniques in

selected areas of Southeast Asia as a means of inhibiting enemy logistical operations.

During October 1966, a scientifically controlled test of the concept and seeding techniques was conducted in the Laos Panhandle. The test was conducted under the technical supervision and control of personnel from the Naval Ordnance Test Station (now Naval Weapons Center), China Lake, Calif., using in-theater resources. Fifty-six seedings were conducted, and over 85 percent of the clouds tested reacted favorably. On November 9, 1966, the Commander in Chief, Pacific (CINCPAC) reported the test completed and concluded that cloud-seeding to induce additional rain over infiltration routes in Laos could be used as a valuable tactical weapon.

.....  
The desired effects of rainfall on lines of communication are naturally produced during the height of the monsoon season just by natural rainfall. The objective was to extend these effects over a longer period. It was neither necessary nor desirable to increase the total rainfall above the levels experienced during a normal heavy monsoon season. In fact, the normal variations in total annual rainfall were greater than the variations we could induce.

.....  
It is the consensus of the scientific community that the techniques employed could not be used to create large uncontrolled storm systems accidentally or purposely.

.....  
With the success of the pilot program and the considerations just presented, the operational phase began on March 20, 1967, and was conducted each subsequent year during the rainy southwest monsoon (March-November) until July 5, 1972.

.....  
The program was authorized three WC-130 and two RF-4C aircraft with associated crews and maintenance personnel. These aircraft provided two WC-130 and one RF-4C sorties per day, when required. However, these aircraft, which operated out of Thailand, were not dedicated exclusively to the cloudseeding missions. The WC-130's also conducted tropical typhoon reconnaissance and tactical weather reconnaissance support missions. The annual cost of the total program was approximately \$3.6 million covering operation and maintenance temporary duty pay, and seeding materials. (55)

The objective of the program was described as follows:

Increase Rainfall Sufficiently in Carefully Selected Areas to Deny the Enemy the Use of Roads by:

- (1) Softening Road Surfaces
- (2) Causing Landslides Along Roadways
- (3) Washing out River Crossings
- (4) Maintain Saturated Soil Conditions beyond the Normal Time Span. (56)

The purpose of the effort was to increase rainfall during the normal monsoon season, and thus to disrupt Vietnamese logistics. 2,600 weather modification sorties were flown. Evidence presented by the Department of Defense

indicates the effects were minimal — rainfall during the monsoon season averages about 21 inches and the induced rainfall is said to have been an additional two to three inches.

The number of aircraft involved in the program was very small: five. The total costs of the program for ~~six~~ years of operations was also very small by Vietnam expenditure standards: \$27 million. Thailand, the nation from which the aircraft operated, was not informed.

The Royal Lao Government had given approval for interdiction efforts against the trail system and we considered this to be part of the interdiction effort. The Royal Thai Government to my understanding was not informed. (57)

The code names of the program Operations Popeye, Intermediary, Compatriot, all referred to the same program: "When the code names... were uncovered they were changed." (58) At one time some 1,400 people had the security clearance enabling them to know of the operation.

However, only one person in the Dept. of State was reportedly informed, the Undersecretary of State for Political Affairs. No one in the US Arms Control and Disarmament Agency was informed of the operation. The Dept. of Defense could not report who in the Office of the President had "approved or cleared" the programs, or whether information on the programs had been provided to the office of the President only "... for information or whether it was for approval". (59) The list of major personnel who were informed of the program was reported by the Department of Defense as follows:

The following categories of personnel were informed in varying degrees as to the operation and its scope:

- White House
- Congress of the US — Chairmen of DoD Jurisdictional Committees
- Secretary of Defense
- Deputy Secretary of Defense
- Director of Defense Research and Engineering
- Limited members of the staff of the Office of the Secretary of Defense
- The Joint Chiefs of Staff
- Commander-in-Chief Pacific
- Commander, US Military Assistance Command, Vietnam
- Commander, Seventh Air Force
- Limited members of staff supporting these officers
- Operational crews and supporting personnel
- Secretary of State and limited supporting staff
- Director of CIA and limited supporting staff

DoD can verify that information was given to its personnel and the Chairman of its Jurisdictional Committees. Categories of non DoD personnel listed represent DoD's best estimate of those informed. (60)

The four Chairmen of the Committees of Congress with primary responsibility for the operations of the Dept. of Defense (House and Senate Armed Services,

and House and Senate Appropriations) were, however, apparently not informed until December 1971 by Director of Defense Research and Engineering John S. Foster, on order of Sec. of Defense Laird. In 1972 a National Security Council Interagency Panel, known as the "Pollack Committee" after the name of the State Dept. Official who was its chairman, had carried out a year-long study on the potential ecological and environmental dangers of weather modification. The NSC Panel had requested information on the military operations in Southeast Asia, and despite the "Secret" classification of its own study, it had been denied any information on the operations. (61)

"One former high-ranking official said in an interview that by the end of 1971, the program, which had been given at least three different code names since the middle 1960's, was under the direct control of the White House. ... 'This kind of thing was a bomb and Henry restricted information about it to those who had to know'. ... referring to Henry A. Kissinger, the Presidents adviser on national security." (62)

Dept. of Defense witnesses appearing before the Committee on Foreign Relations of the US Senate in July 1972 after these disclosures still refused to answer any questions on the grounds that the subject was classified. They replied that "the position of the Department of Defense is that it will not comment on operational uses in this area", and replied with "The same answer Mr. Chairman" to all questions related to Southeast Asia. (63)

Information regarding the actual genesis of the idea for the program is extremely sparse. Hersh reports the following:

The first experimental rain-making mission was flown by the CIA in South Vietnam in 1963,\*) but it was not until 1965 that a group of Air Force scientists officially was ordered to start thinking of ways to turn nature into a military tool

'We all sat down in a big brain-storming session,' said one of the scientists who participated at the Air Force Cambridge Research Laboratories at Hanscomb Field near Bedford, Mass. 'The idea was to increase the rain and reduce the trafficability in all of Southeast Asia.'

Within a year, the Air Force and CIA began a highly secret rain-making project over the Ho Chi Minh Trail in Laos, known as 'Operation Pop-Eye'. There were heated protests from the State Department, and eventually a directive from the Secretary of Defense Robert S. McNamara ordering a halt to the project. Instead, well-qualified sources said last week, 'it went underground — into the dark.'

From 1969 through at least early this year, weather warfare was a covert operation being directed by the Joint Chiefs of Staff with White House acquiescence. (64)

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\*) As noted previously, this use by the CIA in 1963 was for the purpose of controlling Buddhist demonstrations in Saigon.

Dr. Gordon MacDonald's summary of the process, which he labeled "A Bureaucratic Nightmare" in an official US government study, added several important additional details.

While the overall impact of rainmaking in Southeast Asia appears on the whole to have been minor, the manner in which the operation was conducted provides useful insight into the operation of the Governmental bureaucracies dealing with technical issues.

Early in 1966, the National Academy of Sciences published a report which in a general way indicated that under some conditions rain could be induced when otherwise it would not have fallen. As a result of work conducted mainly at the Naval Ordnance Test Station in China Lake, California, together with the Academy's favorable view on rain-making, the Office of Defense Research and Engineering proposed a concept of using rainmaking techniques in Southeast Asia as a means of inhibiting the logistical operations of the North Vietnamese along the Ho Chi Minh Trails. In October 1966 tests using specially designed seeding equipment developed at China Lake were conducted in the Laos Panhandle. It is not clear from the unclassified literature whether these tests had either NSC or State Department authorization, although a reading of the relevant Congressional hearings indicate that the State Department was not informed.

In November 1966, the Commander in Chief, Pacific, reported the tests completed and forwarded the results to Washington for evaluation by the Defense Department. The only persons outside the Security establishment given access to the data were members of the staff of the then-existent Office of Science and Technology and the President's Scientific Advisory Committee. This latter group recommended to President Johnson against the operational use of rainmaking techniques. The reasons were both technical and political. The results of the tests that had been conducted were inconclusive with respect to the efficacy of rainmaking, and the military usefulness of increased precipitation was doubtful. Most importantly, over the years close cooperation and exchange of weather data among almost all countries has been achieved. Meteorological data secured by other countries is of great aid to weather forecasting in the United States and the forecasts have a high economic value, certainly measured in the tens of billions of dollars. If it became known that the United States were using meteorological techniques as a weapon of war, then these cooperative efforts might be threatened with consequent economic penalties.

The White House, presumably through the then-National Security Advisor, Walt W. Rostow, authorized an operational phase which began on March 20, 1967, and was conducted each subsequent year during the rainy Southeast Asia monsoon season until July 5, 1972. The areas seeded were over Laos, Cambodia, and North and South Vietnam. Because the program was considered so politically sensitive, responsibilities for the program were lodged within that part of the Joint Chiefs of Staff responsible for covert operations. Reporting was instituted to limit knowledge of the program and the flights were reported through normal channels as reconnaissance flights. Special communications channels were used to describe the actual operations.

Since about 1,400 people were given access to information about the project over the six-year period, leaks appeared in the press; and in September 1971, Senator Claiborne Pell of Rhode Island as chairman of the Subcommittee on Oceans and the International Environment requested the Department of Defense to provide information with respect to the program. By December DOD had replied that the relevant chairmen of the committees of Congress with primary responsibility for the Defense Department had been informed.

.....

Finally, on March 20, 1974, the Defense Department provided Senator Pell's Subcommittee with a top secret briefing on weather modification activities in Southeast Asia. ... The story of rainmaking as a weapon of war became public when the top secret hearings were declassified on May 19, 1974. (65)

It is these 1974 declassified Senate Hearings from which the previous pages have been quoting. The "... part of the Joint Chiefs of Staff responsible for covert operations..." referred to by MacDonald is the office of the Special Assistant for Counterinsurgency and Special Activities, SACSA, an agency that has traditionally had very close operating links to the US Central Intelligence Agency. (66) The cloud seeding operations were flown by the Air Weather Service of the Air Force. The exact role of the CIA in these operations is unclear. One of the former government officials interviewed by Hersh commented that "the agency (CIA) was calling all the shots", (67) but these interviews supplied contradictory information at many points, and MacDonald makes no mention of the CIA in his report. It is clear, however, from Congressional testimony by the US Dept. of Defense that the CIA was also involved at least to some degree in various aspects of the program. One witness alleged that there had been additional classified weather modification programs than those reported to the Senate in 1974, (68) When the Dept. of Defense witnesses were asked about this both in 1974 and 1976, they replied that they could only reply concerning Dept. of Defense activities, and that the Senate Committee "... might check with another government agency". (69) Finally the Dept. of Defense reported that

"Our research did reveal that an examination into the possibilities of using soil destabilizing compounds to inhibit infiltration over roads took place in the late 1960's: however, the limited field tests conducted had discouraging results, and the project was abandoned." (70)

These attempts to spread so called "emulsifiers" over portions of the **Laotian** Ho Chi Minh trail were apparently carried out by the CIA, and were opposed for operational reasons by the Air Force which felt that it endangered their flight crews. (There was no mechanical dispensing unit, and the spreading mechanism required shoveling the compound in large quantities by hand out of the open door of a low-flying C-130 aircraft.) The tes-

tifying Air Force officer offered the judgement that in this case "I think sound military judgement prevailed and came to the same conclusion". (71)

There was one other innovation that was carried out as a portion of the program. Particular chemicals were added to the seeding units so as to produce on acidic rain and these flights took place over North Vietnam in particular in 1967 and 1968 in an attempt to foul radar antennae that directed Vietnamese surface-to-air missiles. (72) There is no evidence as to whether the procedure had any effect in its alleged role, and the flights over North Vietnam were a relatively small proportion of the total program, presumably due to the vulnerability of the aircraft.

The lessons of this history, in terms of policy process, are extremely interesting. At the same time they are very clearly outside the routine patterns and processes of military R&D weapon development and application. Military interest in weather modification had developed only 16 years before and R&D efforts were relatively minor despite the grandiose claims sometimes made for the potential military benefits or threats. In addition the culmination in use in Indochina was probably to a large degree independent of that ongoing R&D program, although the technology and techniques used in the field were developed by US Navy scientists and technicians in the preceding years. It was the war in Vietnam that provided the overriding context in which decisions regarding many military programs were made in quite extraordinary ways. In this case there was very great interest in the Office of the Director, Defense and Engineering to find innovations developed by the Dept. of Defense's basic or applied sciences R&D funding that could very rapidly be applied in the field in Vietnam and contribute to <sup>the</sup> US military effort. (73) The involvement of the CIA was also certainly unique.

Weather modification was not the only example of an entirely new category of weapon system with enormous long range military and arms control implications that was introduced in Vietnam, and ARPA, the Advanced Research Projects Agency, was the agency directly involved in introducing several others of these. The first of these was Herbicides. In July 1944, President Roosevelt had resisted a suggestion advanced by some US scientists to attempt to destroy the Japanese rice crop. (74) However in 1946 the official US Merck Report on biological warfare efforts during WWII stated that

"only the rapid ending of the war prevented field trials in an active theatre of synthetic agents which would, without injury to human or animal life, affect the growing crops and make them useless." (75)

In this case personnel from the Forest Fire Laboratory of the US Forest Service at Missoula, Montana, were sent to Vietnam to aid in the program.

"ARPA funded the US Forest Service to determine the technical feasibility of destroying large areas of jungle growth by fire. The active phases of this part of the project were conducted in 1966 and 1967." (86)

The Forest Service prepared a classified report "Forest Fire as a Military Weapon." These efforts were reported by the government as essentially unsuccessful; however press reports at the time reported fires lasting weeks and there were other indications that the program was more successful than officially indicated. (87) ARPA was also responsible for a small program using very large area blast effect Fuel Air Explosives. There were also other programs for which ARPA was not responsible, such as the use of gas, Napalm and Cluster Bomb Unit — antipersonnel munitions. (88) Many of those munitions: defoliants, crop herbicides, Napalm, gas, and cluster munition antipersonnel bombs were all area weapons. These programs often started on a relatively small scale but rapidly increased in magnitude; weather modification in fact differed by starting at relatively close to its peak annual levels of usage. In all of these cases the decisions to initiate use were made in secret. Consideration and analysis for the most part followed the initiation of field operations rather than preceded it. The war in Vietnam also <sup>witnessed</sup> very large scale field operations of markedly questionable judgement, such as secret bombing campaigns of neighbouring countries (Cambodia), "open-fire" zones, mass population transfers; it was a war in which anything and everything seemed applicable. (89) All of these programs — the technological ones and the tactical ones — shared one thing in common: either total secrecy or secrecy as long as was managable.

If we return to the decision making process on military weather modification in particular, MacDonald's description states that the Presidents Science Advisory Committee (PSAC) recommended against use. The consideration within the government must have been extremely brief however; the Joint Chiefs of Staff reported the 1966 Laos trials completed in November 1966, and requested approval for an operational program in December 1966 and on February 21, 1967. President Johnson's National Security Advisor, Walt Rostow, approved the program in time for it to begin on March 20, 1967. There cannot have been much time given over to consideration. According to Hersh's interviews

"Repeated State Department protests about the project led to a re-evaluation by the Pentagon, a former Defense Department official said, 'and McNamara killed it'." (90)



MacDonald does not report either of these events, and there is no public record of Sec. McNamara's cancellation order. The former Secretary of Defense has not spoken about the issue publicly. MacDonald referred to the situation as "a bureaucratic nightmare", but it is not clear if this included the secret countermanding of an order by the Secretary of Defense. The record of the sorties flown under the program does not indicate any major interruption in the program. (91). Regarding other aspects of decisionmaking on Vietnam, Bernard Brodie has written that

.... most of the people whom McNamara gathered around him had so much prestige because of their special skill in this special area (systems analysis) that they were very free in giving advice in various areas that had nothing to do with systems analysis. And their advice was often accepted. It is, I think, another example of the price we usually pay when a certain kind of competence becomes unduly prestigious. I am referring particularly to the results in Vietnam. (92)

There are no indications, however, that this judgement applied also to the decisions on the use of weather modification in the war.

When the U.S. Senate began its queries in September 1971, and continued these in March 1972, the government was noncooperative and actively obstructive. In an effort to confirm or disprove the reports that the US was using weather modification as part of its military operations in Southeast Asia, Senator Pell, on September 23, 1971, wrote to the Pentagon requesting specific information about such activities. After four months of correspondence, the Defense Department declined to answer the Senator's questions on the grounds that such replies would endanger the national security.

On July 26 and 27, 1972, in a further effort to obtain information, the Subcommittee on Oceans and International Environment conducted hearings. During those hearings, the Defense Department witness admitted that he was under specific instructions not to discuss the operational uses of weather modification techniques for military purposes in Southeast Asia. "Chief among the reasons for this inconclusive result were DOD's and the National Security Council's strong reservations about a total ban on the use of weather modification." The Department of Defense was even able to modify a proposal at the June 1972 U.N. Conference on the Environment through a representative of the Department present with the U.S. delegation. The recommendation required all governments to "carefully evaluate the likelihood and magnitude of climate effects and disseminate their findings... (and to) consult fully other interested states when activities carrying a risk of such effects are being contemplated or implemented." The U.S. was successful in having the language

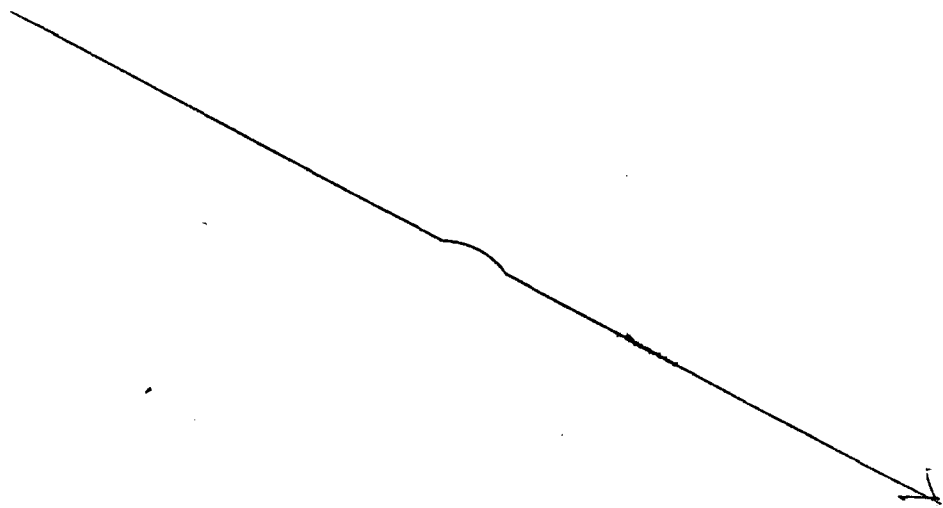
banning weather modification as it is on the decisions to initiate use of it.

In March 1972, Senator Pell introduced a resolution that urged the Executive to seek an agreement with other countries prohibiting the use of weater modification as a weapon of war. An interagency group was set up to prepare a coordinated response, though in fact the views of NSC dominated. Basically, the position of the Executive was that the Under Secretaries' Committee had undertaken a study of weather modification in the spring of 1971, but that the study was not yet completed and therefore it had come to no conclusions with respect to military uses of weather modification. The reasons for this result included DOD's and NSC's strong reservations and the fact that members of the study group and most of the members of the Under Secretaries' Committee were not cleared for information with respect to the South-east Asia operations and were not aware of them except through speculation in the press. The extreme level of classification made any meaningful investigation of the military uses of weather modification impossible even though the officials involved were in high positions within their respective agencies.

While the Executive study led to no action, hearings on the Pell resolution were held in July 1972, with Government officials in their OMB-cleared testimony opposing enactment of the resolution. The Senate, however, in July 1973, overwhelming adopted a slightly modified version of the Pell resolution by roll-call vote. The Executive Branch did not respond to the resolution so the issue was next joined at Secretary of State Henry Kissinger's confirmation hearings in September 1973 when the Secretary-designate was asked about the Senate resolution. The Secretary's reply came in the form of a November letter stating that it was not yet possible to provide a coordinated Executive Branch response to the Senate resolution.

Senator Pell continued his pursuit of the issue by calling for further hearings in January 1974. As before, the Executive representatives were less than forthcoming. However, the Department of State assured the Committee that the President had directed the Department of Defense to carry out a study of the military aspects of weather and other environmental modification techniques. Needless to say, Senator Pell and the public witnesses took a somewhat dim view of the Defense Department studying its own activities. (96).

In an exchange with Secretary of Defense Schlesinger in March 4, 1974, only two weeks before the Dept. of Defense finally provided the Senate Committee



on Foreign Relations with a classified briefing on the Southeast Asian activities, Senator Pell made clear that the Dept. of Defense was then the sticking point in altering government policy.

Senator Pell. I am also very interested, as you know, in this question of unorthodox weaponry, geophysical modification, weather modification. I am curious to know what the reason is for the Defense Department's reluctance to move in the outlawing of those weapons or does this come into the idea of new weapons development?

Secretary Schlesinger. Well, I am not fully versed in an answer, Senator. Once again I think one has to indulge in gradations. May I go off the record here.

(Discussion off the record.)

Senator Pell. There has been a good deal of thought given to it. As you know, the North Atlantic Assembly adopted a resolution to this effect unanimously. The Senate adopted one, I think, 82 to 10 to move in this direction. If rainmaking is excluded other things may not be excluded. Rainmaking can be used for two purposes. It may be used for getting rid of a cloudcover to rescue people. On the other hand, it can be used for aggressive purposes. What we are saying here is to use it for aggressive purposes would be wrong. I think every administration wants to find more areas of agreement that they can point to with pride. What I have not been able to understand is why your Department has been the sticking point on this really for several years. It really is just DOD.

Secretary Schlesinger. It is a relatively new subject for me. I think it is a question of definitions, what should be excluded and what should not be excluded. You mentioned aggressive use. I think that brings us to the question of offensive versus defensive use. If one uses rainmaking in order to interdict roads that may be offensive, but someone would regard it as defensive and as far less destructive inherently than the use of other ways of interdiction.

Another source of support for the use of weather modification as a weapon came from the Weather Modification Association, an extremely small professional group with a membership of 152 persons nearly all of whose members were actively occupied in weather modification activities being carried out by various government agencies, military and civil:

In considering a position for the Weather Modification Association to take on the use of weather modification as a weapon of warfare, care is needed to avoid purely emotional or speculative considerations. Any expression of position may serve as an input to the formulation of national policy, and therefore requires a well balanced and scientific basis. ...

At present the real capabilities of weather modification are in the nature of overall marginal increments of precipitation, or marginal decrements of hail, or very local effects such as clearing of fog over airports. Some of the possible uses of weather modification as instruments in the conduct of war in the foreseeable future would be along the lines of clearing airports, impeding enemy traffic and limiting enemy commerce. Since the effects of these uses on men, animals, and ecology in general are much milder and more transient than those of guns, bombs, defoliants, and napalm, there is reason to argue for the use of localized weather modification where possible, as a humane replacement for modern weaponry. (98)

Anyone familiar with the development of Chemical and Biological weaponry and argumentation in its favour will instantaneously recognize the precisely similar general arguments here:

- implicit or explicit labeling of arguments in opposition to weapon development and use as "emotional,"
- its own recommendation put forward as "scientific,"
- the claim that use is innocuous,
- an extremely narrow framework, ruling possible further developments, more serious or more widespread use, out of consideration as "speculative," though one knows this to be the historical process with every newly introduced weapon system,
- the claim of relative "humaneness" for this weapon as against others, (together with)
- the pretense that this weapon category would be a "replacement" for other weapons, rather than an increment to them, used together with all the existing once to increase their total lethality,
- the blind eye turned to the historical experience that the most innocuous weapon use, or uses for ostensibly special circumscribed situations, are often purposely presented to win approval for the entry of the new weapon system into the armory.

One notes Sec. Schlesinger's quick turning of the question into "offensive" or "defensive" uses, and one official quoted by Hersh replied with the standard reply: "What's worse, dropping bombs or rain?" (99)

In addition it is notable that a recommendation for the use of weather modification as a weapon seems incapable of the minimal sophistication required to conceive of the quite real possibility that the use of weather modification for civil purposes within one state might easily be sufficient cause for war between neighboring states. An excellent group of studies in the early and mid-1970's set out in great detail the international implications of the use of weather modification in civil applications within one nation on its neighbours, as well as the less "marginal" applications of weather or climate modification as weapons that have already been considered. (100)

#### An Attitude of the Past — and the Future

Though this study is concerned with overt military programs, it might be worth looking for a moment at this additional context. In 1975, Weiss reported that

"Over sixty nations have experimented with modifying the weather, and

at least a quarter of these either have or are considering an operational program in some aspects of weather modification." (101)

It is not difficult to find announcements such as the following:

"Use of satellite and sounding rocket data to develop a mathematical map of Brazil's atmosphere in the hopes of gaining knowledge that will permit Brazil, by seeding or other methods, to initiate basic climatological changes, particularly in areas of the nation that experience heavy rainfalls over a short span of time followed by prolonged dry periods. Data on which to base the model are being collected by the CIA institute from both U.S. satellite and Brazilian sounding rockets." (102)

"'Weather Modification — India's new weapon' ... India will soon enter the exciting new world of weather modification, which seeks in the long run to control weather and tailor it to man's needs." (103)

By 1970 developing nations were already being enjoined to employ commercial weather modification services. (104) Yet the step to charges of military implications could be shorter than at first imagined. This can quickly be demonstrated in three ways.

The first was already noted in the attention given to various large-scale Soviet project proposals by ARPA. If the weather modification is large enough and is continued for a long enough period of time, its affects could be considered "strategic" on neighboring or even on distant states. (We will return to this in the discussion which follows in a moment.) Secondly, it appears that in some years, US military services carried out requests for weather modification on behalf of several developing nations. The US Air Force and the US Navy collaborated in a project with the Phillipine government in 1969 called Gromet II whose purpose was rain enhancement. (105) "Other operational attempts to assist in drought mitigation were conducted by the Air Force in Panama, Portugal, (in the Azores) and Okinawa." (106) It is notable that there are very major US military facilities in all of these locations, and both the military and the US government may have been anxious in these circumstances to offer its technical aid to the host government. Several African nations suffering drought and mass starvation in the Sahel requested cloud-seeding assistance from the United States shortly after the seeding of the Azores area, but these requests were denied. The US Navy had reportedly tried to aid India in 1967 with cloud seeding operations at a time of drought, but apparently with little success. The US Navy did however carry out requests for weather modification on behalf of some additional number of developing nations. The total extent of these activities is not publicly known and they must be considered to have been extremely short sighted, if for no other reason than to avoid accusations against the United

States by nations neighboring to the one in which the operations were carried out.

Thirdly, the model for direct charges of interference in weather (aside from the acknowledged US program in Indochina) — in one case so as to purposefully harm another state and in the second case as an unplanned consequence — already exists.. In both cases the changes were made against the United States. In the first case Lowell Ponte claimed "... that the Central Intelligence Agency and the Pentagon cooperated in a program to seed clouds near Cuba so that they would drop their rain before reaching the island, thus causing a drought." The efforts allegedly took place "... in 1969 and 1970 in order to damage Cuba's sugar crop." (107) The US Department of Defense replied that "We have never conducted weather modification around Cuba." (108) In the second case the director of the geographical research center of the University of Mexico implied that the United States was to blame for the disastrous effects of Hurricane Fifi over Honduras in 1974 by having diverted the course of the hurricane at an earlier stage. (109) He claimed that the normal course of hurricanes circling inside the Gulf of Mexico was to find them terminating and dissipating in the Rio Panuco area of Mexico. However, he contended that the effort by the United States to alter Fifi's course (by silver iodide cloud seeding) so that it would not hit the coast of Florida and cause economic damage there, had caused the hurricane to stabilize over Honduras for several days. The question of a Hurricane's dynamics and eventual pathway after an attempt to divert it can be debated. That is not the point. The point is exactly that the situation becomes indeterminate and ambiguous, and that an effort to prevent economic damage in one area by weather modification techniques may cause — to use the Honduras example — extensive loss of life elsewhere. In the case of Hurricane Fifi 8,000 people reportedly died and extremely widespread devastation of the major agricultural crop of a small underdeveloped nation took place.

However, both of these examples are single non-continuous events, and they pale into triviality in comparison to the Soviet Unions proposals for programs with major international long-duration effects.

The USSR has reported plans to divert the flow of some rivers from their present course which flows north and empties into the Arctic Ocean and instead to turn their flow south to the Aral and Caspian Basin. (110) Diversion of this sort would mean that the fresh water that normally flows into the Arctic and freezes at a more rapid rate than salt water would no longer be available.

These changes are large enough to raise possible implications in the area of climatic change and some initial calculations have suggested that diversion of the northward flowing rivers on a sufficiently large scale could initiate melting of the Arctic Ocean ice pack.

Inflow of Pacific water into the Arctic Basin is estimated to be 300,000 m<sup>3</sup>/sec. The total flow of fresh water is estimated at 160,000 m<sup>3</sup>/sec., of which 100,000 m<sup>3</sup>/sec. is contributed by the rivers of the USSR. The rivers mentioned in the plan, the Ob, Yenisei and Pechora contribute 30-35,000 m<sup>3</sup>/sec. A significant decrease in the inflow of fresh water would increase the salinity of the first few hundred meters of Arctic water, thereby decreasing ice formation, lowering the albedo and raising the temperature. One school of thought hypothesizes that such a change might result in an ice free Arctic during the summer. If this did occur, the semi-permanent low pressure belt, the subtropical high pressure belt and the inter-tropical convergence zone would experience a northward shift. If the general circulation was changed in this manner, the following climatic changes could occur:

1. an increase of precipitation north of 70<sup>0</sup> latitude;
2. shift of monsoon rains into arid areas;
3. melt of some areas of perma frost;
4. decrease of precipitation in the zone between 40<sup>0</sup> and 50<sup>0</sup> north, with a probable increase in evaporation;
5. some rise in sea level. (111)

While the alterations which could result in these terminal changes could produce local benefits, they could also cause a dislocation of agriculture in the entire northern hemisphere and in three of the worlds major grain producing nations: the USA, Canada and the USSR, and a resulting possible disaster in many of the thickly populated, highly developed countries. This, in turn, would have unknown effects on mankind in general.

Even a small diversion of 5 to 15% of the flow of the rivers mentioned could have far reaching effects. Therefore, this or any other plan of action which might result in a climatic change should at the very minimum be carefully studied and delayed until man is confident and can predict the results, which might not be observable until several decades have passed. In 1979 a meeting of government experts under the joint auspices of the World Meteorological Organization and the United Nations Environment program proposed that:

States should ensure that an assessment is made of the environment consequences of prospective weather modification activities under their jurisdiction or control which are likely to have an effect

on areas outside their national jurisdiction, and, either directly or through WMO, make the results of such an assessment available to all concerned States. (112)

This is something that the USSR has certainly not done.

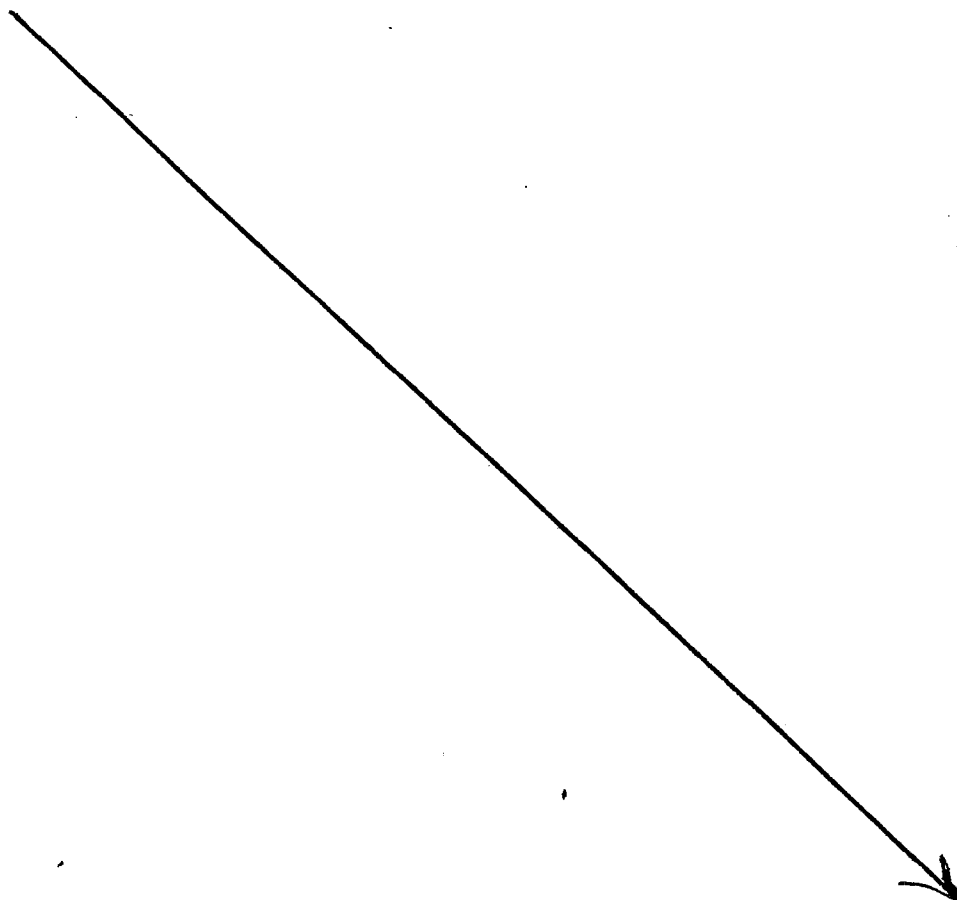
The motivation to push ahead with such developments — if not quite such sizable ones — and to run the risk of the potential consequences comes from a wide variety of sources: from the USSR, from developing nations, from the WMO and UNEP, and on occasion even from the United States. In an address before the United Nations in September 1961, President John F. Kennedy proposed a four-point program for the peaceful use of outer space to be developed under the auspices of the United Nations. One part of the program consisted of an international collaborative effort "in weather prediction and eventually in weather control." Some day this may be recognized to have been as short sighted a proposal as President Eisenhower's "Atoms for Peace" proposal is now recognized to have been in regard to nuclear weapons proliferation. The General Assembly responded with a unanimous resolution calling upon Member States, governmental and nongovernmental organizations, to develop programs which would advance the state of the atmospheric sciences leading to a surer knowledge of the basic physical forces affecting climate, to the improvement of weather forecasting and to the exploration of the possibilities and limitations of large-scale weather modification.

In 1971, the World Plan of Action for the Application of Science and Technology to Development recommend weather modification among an absolute cornucopia of other ways to raise agricultural and resource productivity. (113) There must be literally twenty different ways to achieve the same end of increased rates of development. If so, is it absolutely necessary to push ahead with all twenty, if the other nineteen would achieve the same end and at the same time are innocuous, while one contains the kind of military and international implications indicated in the literature? From what we know of past historic behavior, the chances of abuse of anything with promise of short term reward in its abuse that is developed to the point of operational utility is nearly 100 percent. One must not do everything just because it becomes physically or technically possible to do it. Few social attitudes from the recent historical past, in particular this attitude towards application of new technology, are more certain to end man as a species if not brought into perspective and brought under control. Weapon development in general — and weather modification as a weapon in particular — is only one example of the social application of such technical



possibilities. Others exist entirely in the civilian, non-military sphere. The concept of estimation of risk, and balance of benefit and risk — including long term risk and the absolute necessity to include the possibility of weapons application on the cost side — in short, "technology assessment," finally made its initial inroad into government planning in the 1970's. It is a concept that should not be foreign to suggestions made for the sake of development either. Quite often when there are obvious military applications, there will be extensive pressure from military research directorates or research groups to push civil applications as well, to popularize the technology, to make it acceptable and conventional, to broaden the research base, to develop independent centers of institutional pressure. (114)

There is no reason for "development" to be coopted in this process. In fact, it would seem to be a particularly perverse outcome. There are other ways to achieve the same ends, without the same enormous risks. The analysis of alternative solutions, often ones already at hand without the development or employment of new technology, is an integral part of technology assessment.



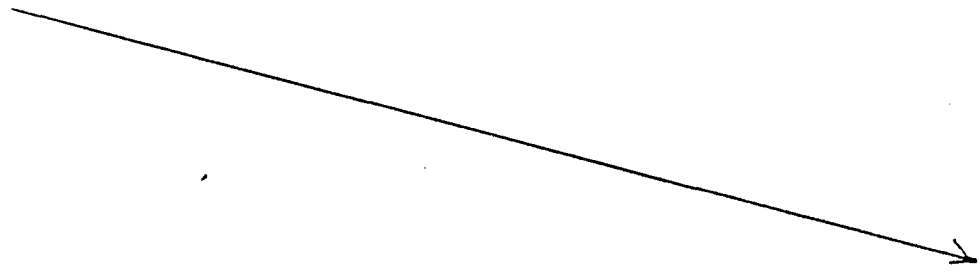
The Interactions of International Negotiations

The points of interest to this paper in the treaty negotiation process would be any insights it would provide about the attempts to control arms races via control of weapon development.

In July 1972 Senator Pell's Subcommittee on Oceans and International Environment of the Foreign Relations Committee held hearings on a proposed resolution to express the sense of the Senate that the Government should seek international agreement on a treaty prohibiting the use of any environmental or geophysical modification activity as a weapon of war. At that time, a State Department official, presenting the position of the Executive Branch, observed that "it goes without saying that the Administration would not use techniques for climate modification for hostile purposes even should they come to be developed." He did not, however, make a similar statement concerning weather modification techniques, but said that the Government considered "that the factual basis itself is insufficient to make possible any fundamental decisions on whether a treaty dealing with military aspects is feasible and desirable." It therefore recommended against adoption of the proposed resolution as premature. The National Academy of Sciences had already urged the Government to initiate a United Nations resolution to this effect.

Although Senator Pell did not obtain a vote on his resolution in 1972, in November the North Atlantic Assembly adopted a similar proposal, recommending to the NATO members a treaty to prohibit the use of geophysical modification, "except for peaceful purposes and for the betterment of mankind, and for purposes which have no effect on the ecological balance." Then, with the bipartisan support of 18 other senators, Pell reintroduced his resolution in 1973. In July, the Senate adopted it by a vote of 82-10. The resolution "call(ed) upon the U.S. government to seek the agreement of other governments to a treaty prohibiting the use of any environmental or geophysical modification activity as a weapon of war, or carrying out any research or experimentation directed thereto."

The Department of State's spokesman, recalling that Secretary Kissinger had assured the Senator that the matter would be looked into "to determine how the Executive Branch might be responsive" to the Pell resolution, announced that the President had "directed that a study of the military aspects of weather and other environment-modification techniques be undertaken." Further steps by the Administration would be decided "subsequent to the findings of this study and (an inter-agency) review of these findings." The Defense Department was given sole authority for conducting the study. The President's directive had been issued so recently before the hearings, however, that the Defense witness did not yet know its terms or who would be directing it. (115)



On July 3, 1974, at one of the SALT summit meetings between Soviet Party Secretary Brezhnev and U.S. President Nixon, the two countries issued a joint statement saying that they would initiate discussions on the subject of environmental modification.

On August 21, 1975, the United States and the USSR submitted a draft treaty to outlaw weather or other environmental modification as a weapon to the United Nations Conference on the Committee of Disarmament, the CCD. (116) The draft treaty consisted of nine articles and was presented to the CCD on the last week of its 1975 session. The proposed treaty prohibited nations from engaging in "military or other hostile use of environmental modification techniques having widespread, long lasting, or severe effects as the means of destruction, damage or injury to another state." All the ratifying nations would also be committed "not to assist, encourage or induce any state, group of states or international organization to engage in such activities." There were a series of crucial ambiguities both in the July 1974 joint US-USSR statement, and in the 1975 draft treaty. It developed that the official use of the phrase "climate modification" meant something different from "weather modification," "... the distinction is that climate modification is a long term permanent effect: weather modification is a short term temporary effect." This distinction is used in the relevant scientific community and it was made clear in official US testimony that the choice of words in the joint 1974 statement was conscious and deliberate; "... through those statements they were not saying anything with reference to (weather) modification techniques. Further

"... these communiqués are drafted rather carefully and would suggest that we weren't necessarily looking for ways to eliminate the use of environmental modification techniques, but only dealing with some of the dangers that might flow from their use."

Put bluntly by Dr. Weiss,

"... we need a ban on the future use of weather and climate modification for hostile purposes. The United States—Soviet statement of last July on the use of environmental modification for military purposes is a useful initiative. But we need to be careful that we do not end up with a partial agreement with the Soviets which bans the techniques neither side was planning to use and legitimizes the use in warfare of the weather modification techniques that are more nearly ready for use." (117)

It did not appear that this situation had been essentially changed in the 1975 US—USSR draft treaty. The emphasis on "techniques having widespread, long lasting or severe effects" immediately suggested to observers that the language and perhaps the intent and the effect would be to ban only those modification activities that could cause catastrophes, not those with short lived effects or those concentrated on a small geographic area. Again the focus seemed to be on "exotic" forms of warfare, the earthquakes, tidal waves, modification of the ozone layer, production of drought and climatic changes, etc., relatively further off in the future, and that the draft treaty would probably not ban exactly the sort of weather modification that the United States had carried out in the Indochina Theater. (118)

The administration kept sending letter of clarification to Congress, which appeared to remove the ambiguities, but in the end apparently did not. The first letter, on September 1975 from the Director of the U.S. Arms Control and Disarmament Agency, Dr. Fred Iklé, to Representative Gilbert Gude of the U.S. House of Representatives, stated

... the current parallel U.S. and Soviet texts would lead to the prohibition of any substantial or significant military or other hostile use of environmental modification techniques. ... The second article of the draft convention defines the term "environmental modification techniques" to include weather as well as climate modification techniques. Distinctions that are sometimes drawn between the weather and the climate would not in any way exclude weather modification from the prohibition of the draft convention. Thus, hostile uses of weather modification techniques having widespread, long-lasting, or severe effects would be prohibited.

There were still the caveats, "substantial or significant", and the "... widespread, long lasting, or severe effects...", which would obviously be open to various interpretations. Further clarification was given on September 24, 1975, in a second letter from Dr. Iklé:

The term "environmental modification techniques", as used in the draft, encompasses all forms of weather modification, including precipitation modification, and the dispersal or creation of fog. The Convention would prohibit any hostile use of such techniques having widespread-long-lasting or severe effects as the means of destruction, damage or injury to another State Party. Thus, the Convention would permit the non-hostile use of weather modification techniques, for example fog dispersal to facilitate the launch or recovery of aircraft at one's own airfields, since this does not constitute use as a means of destruction, damage or injury. (119)

However during 1976, still within the tenure of the Ford administration (and Henry Kissinger as Secretary of State), the Arms Control and Disarmament Agency published a small booklet, "Environmental Warfare; Questions and Answers", which contained the following:

and Dr. Iklé as the Director of ACDA)

(Question) Would attempts at rainmaking, such as those undertaken by the United States in the Viet-Nam war, be prohibited by this convention?

(Answer) The governing phrase is "widespread, long-lasting, or severe effects". If rainmaking techniques could be employed in such a way as to have effects of the described magnitude, then they would be prohibited. (120)

### Discussion and Lessons

This study has sketched a process that began in the early and mid-1950's. The military literature and public and Congressional commentators described both the most dire consequences if a military weather modification capability should be developed by the USSR, as well as a great cornucopia of possible military applications for US forces. John von Neuman, one of the most influential American science advisors to the Dept. of Defense, stated in 1965

Present awful possibilities of warfare may give way to other even more awful. After global climate control becomes possible, perhaps all our present involvements will seem simple. We should not deceive ourselves: once such possibilities become actual, they will be exploited. It will therefore, be necessary to develop suitable new political forms and procedures.

However, within a year of his remarks, the United States initiated the first recorded use in warfare, covertly, of a new weapon technology never before used, for which there were quite enormous implications, almost inestimable dangers, of the extensive use in either military or civil applications. Within a short time there was built up a sufficient degree of interest in this new form of warfare by the US military for them to actively oppose proposals between 1972 and 1974 for international measures to prohibit its use as a weapon. The interest was not so strong, however, that it prevented the relatively rapid achievement of a treaty. The degree of restraint that this imposed will remain to be seen in the future.

/Discussion to be further enlarged./

1. Vietnamese Studies, No.3, Contributions to the History of Dien Bien Phu, Hanoi Xunhasaba, March 1965, p. 201.
2. Julian P. Robinson, The Problem of Chemical and Biological Warfare. Vol. I: The Rise of CB Weapons, SIPRI, Stockholm International Peace Research Institute, Stockholm: Almqvist & Wiksell, 1971, p. 129.
3. D.Shapely, "Rainmaking: Rumored Use Over Laos Alarm Arms Experts, Scientists", Science, 176 (4040), June 16, 1972, pp. 1216-1220;  
D.Greenberg, "Vietnam Rainmaking: A Chronicle of DOD's Snow Job." Science and Government Report, June 16, 1972  
S.Hersh, "Rainmaking Is Used as Weapon by U.S.," New York Times, July 3, 1972.  
See also the U.S.Senate Hearings in reference (4) below, particularly Weather Modification, 1974, pp. 87-123.

Earlier, in 1963, the U.S.Central Intelligence Agency had apparently attempted to artificially produce rain over Saigon to control Buddhist street demonstrations (see reference 17). It is difficult to know how to categorize this event even in a theater of war. If it had occurred without any subsequent full scale weather modification operations, it could again perhaps best be considered as an excellent example of a trivial covert operation that could serve to pry open an entire new area of warfare if the two sides at war were even approximately evenly matched in capability, exactly in the way that chemical warfare operations began in WW I and quickly escalated.

4. US Congress, Senate, Committee on Foreign Relations, Subcommittee on Oceans and International Environment, Hearing: Prohibiting Military Weather Modification, Washington, DC: US Govt. Printing Office, 26-27 July 1972, 162 pages.

US Congress, Senate, Committee on Foreign Relations, Report: Prohibiting Environmental Modification as a Weapon of War, Report no. 93-270. Washington, DC: US Govt. Printing Office, 27 June 1973, 7 pages.

US Congress, Senate, Committee on Foreign Relations, Subcommittee on Oceans and International Environment, Hearing: Weather Modification, Washington, DC: US Govt Printing Office, 1974, 123 pages.

US Congress, House, Committee on Foreign Affairs, Hearing: Weather Modification as a Weapon of War, Washington, DC: US Govt. Printing Office, 24 September 1974, 39 pages.

US Congress, House, Committee on International Relations, Subcommittee on International Organization, Hearing: Prohibition of Weather Modification as a Weapon of War, Washington, DC: US Govt. Printing Office, 29 July 1975, 51 pages.

5. E.B.Weiss, "The International Legal and Political Implications of Weather Modification," Third Conference on Weather Modification, American Meteorological Society, Boston, 1972, pp. 232-236.

E.B.Weiss, "International Responses to Weather Modification," International Organization, 29 (3), Summer 1975, pp. 805-836.

E.B.Weiss, "Weather as a Weapon," (in) Air, Water, Earth, Fire: The Impact of the Military on World Environmental Order, A Sierra Club Special Publication, International Series, No.2, May 1974, pp. 51-62

E.B.Weiss, "Weather Control: An Instrument for War?: Survival, 17 (2), March-April 1975, pp. 64-68.

R.F.Taubenfeld, and H.J.Taubenfeld, "The International Implications of Weather Modification," The Bulletin of the Atomic Scientists, 25 (1), January 1969, pp. 43-46.

Several books, the first more specifically, also deal with weather modification as a potential weapon:

N.Seshagiri, The Weather Weapon, New Delhi, National Book Trust, 1977

O.S.Halacy Jr., The Weather Changers, New York, Harpar & Row, 1968

Lowell Ponte, The Cooling, Englewood Cliffs New Jersey: Prentice Hall Inc 1976.

6. G.J.F. MacDonald, "Geophysical Warfare, How to Wreck the Environment," (in) Unless Peace Comes; A Scientific Forecast of New Weapons, Nigel Calder (Editor), London; Allen Lane, The Penguin Press, 1968, pages 165 to 183.

7. Weather and Climate Modification, Problems and Progress: National Academy of Sciences, Washington, D.C., 1973; see pages 16-17, 23-4.

8. US Congress, House, Committee on Government Operations, Government Weather Programs (Military and Civilian Operations and Research) First Report, March 17, 1985, pp. 83-85: 143 89th Congress, First Session, House Report 177.

In establishing the NSF Commission and NAS Panel on Weather and Climate Modification in 1964, Leland Haworth, then Director of NSF, wrote that

"Together with the growing realization of the limitations of cloud seeding have come advances both in the technology of measurement and computer capability and in the understanding of the basic processes of the atmosphere. These advances have opened up other weather modification possibilities, some of which may cause subtle long-range climatic changes that would have widespread social and economic effects."

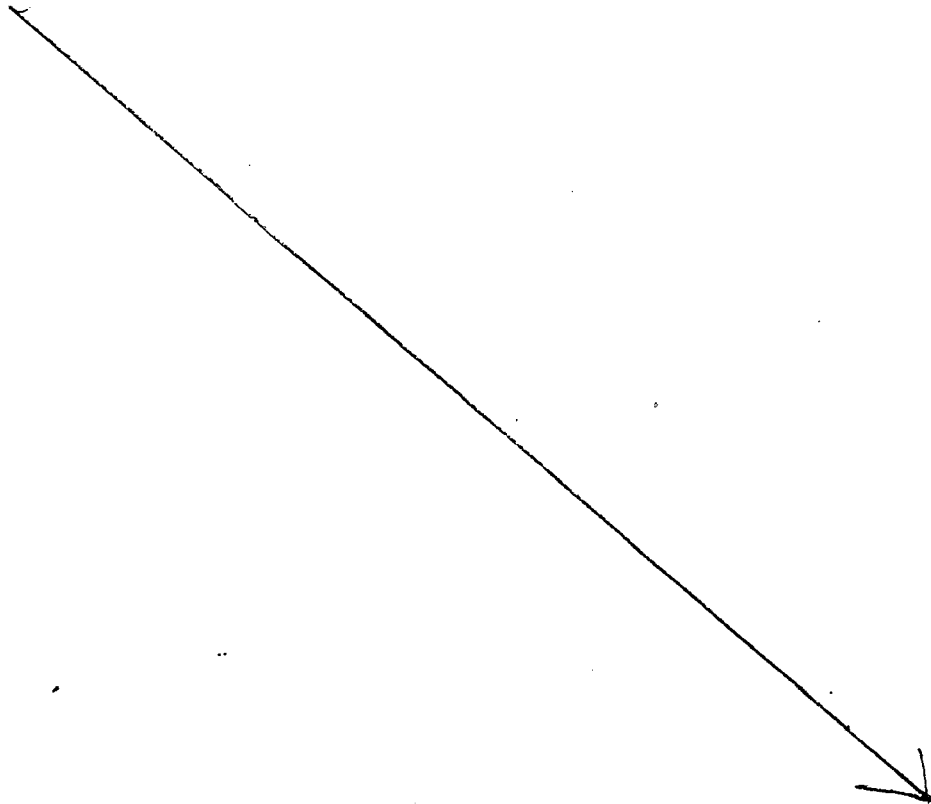
9. Weather and Climate Modification, Problems and Progress, op.cit. p. XIV

10. From 1954 to 1970, Dr. Thomas F.Malone was Director of the Travelers Weather Service and Travelers Weather Research Center, and from 1956 to 1970 additionally its Director of Research. The Travelers Research Center (and then Corporation) was one of the major contractors of classified Dept. of Defense weather related R&D. He became a Special Consultant to the Office of Naval Research (Geophysics Branch) in 1950-1953, a Member of the Dept. of Defense Scientific Advisory Board, 1954-1960, a Consultant to the Presidents Scientific Advisory Committee, 1961-1966, and held "White House Clearance as well as Other Clearances of Interest to the Executive and Defense Departments (Secret level DOD)"

In June 1969, Dr. Malone presented a paper entitled "Current Developments

in the Atmospheric Science and some of their Implications for Foreign Policy" at a joint meeting of the Policy Planning Council of the US Dept. of State, and a Special Panel of the Committee on Science and Public Policy, National Academy of Sciences. The topic of the meeting was The Potential Impact of Science and Technology on Future US Foreign Policy. There is literally not a single word in Dr. Malone's paper which mentions military weather modification programs; not even the benign mention that such a thing exists, and that it might also on some occasion potentially impact on "... Future US Foreign Policy". It is unavoidable that one wonders if the Chairman of the National Academy Panel with responsibility for its report, and the author of the above mentioned paper is not someone of Dr. Malones caliber — with full cognizance of all military weather modification programs, classified and unclassified — precisely to assure that mention of military programs is omitted when discussion of foreign policy implications is relevant and even the central issue.

11. Seymour M. Hersh, " '67 Order to End Rainmaking Reported", New York Times, July 4, 1972.
12. "Canada; A Suggested Preliminary Approach to Considering The Possibility of Concluding a Convention on The Prohibition of Environmental Modification for Military or Other Hostile Purposes", CCD/463, Aug. 5, 1975. The list was also reprinted in the Bulletin of the Atomic Scientists, 32(5), May 1976, pp. and in Seshagiri, The Weather Weapon, op. cit. pp 37-40.





13. For sources on the history of weather modification, see
  - <sup>↑</sup>H.R.Byers, "History of Weather Modification", in W.N.Hess (Ed.) Weather and Climate Modification, New York: Wiley 1974, Chapt.1
  - L.M.Hartman, "History of Weather Modification", in US Congress, Senate, Committee on Commerce, Weather Modification and Climate Control, Washington, D.C. US. Govt. Printing Office, 1966, 89th Congress, 2nd Sess. Senate Report 1139.
  - R.E.Morrison, "History of Weather Modification", in US Congress, Senate, Committee on Commerce, Science, and Transportation, Weather Modification: Programs, Problems, Policy and Potential, Washington D.C. US Govt. Printing Office, 95th Cong. 2nd. Session, May 1978, pp. 25-55.
  - R.E.Huschke, "A Brief History of Weather Modification Since 1946", Bulletin American Meteorological Society, 44:7 (July 1963) 425-429.
14. Fortune Magazine, February 1948, p. 109, quoted in Lowell Ponte, The Cooling, op.cit.
15. US Congress, Senate, Committee on Inter-State and Foreign Commerce, Weather Modification Research, Hearing, Washington D.C. US Govt. Printing Office, March 18-19, 1958; Lowell Ponte quotes Capt. Orville as reporting "that the Dept. of Defense was studying 'ways to manipulate the charges of earth and sky and so affect the weather' by means of 'an electronic beam to ionize or de-ionize the atmosphere over a given area'.... Capt. Orville also discussed ongoing US Air Force experiments with 'sodium vapor, ejected from jet planes to intercept solar radiation' over enemy countries and rain their weather. (The Cooling, op. cit. pp. 168-169.)
16. Weather Modification: Programs, Problems, Policy and Potential, 1978 op. cit. p. 36.
17. The "Ad Hoc Advisory Committee on Chemical Corps Mission and Structure" produced the "Miller Report," referred to by the name of its chairman O.N.Miller, in August 1955; see "Chemical and Biological Warfare, History of International Control and U.S.Policy", Robin Romero and Milton Leitenberg in Chemical and Biological Warfare, A Special Issue, Scientist and Citizen, 9 (7) Aug-Sept. 1967, p. 138, and The Problem of Chemical and Biological Warfare, Vol. 2, CB Weapons Today, Robinson, J.P., SIPRI, 1973, p. 194.
18. Dr. James R.Killian Jr. Sputnik, Scientists, and Eisenhower; A Memoir of the First Special Assistant to the President for Science and Technology, The MIT Press, Cambridge, 1977
19. Quoted in Col. R.B.Rigg, "Deluge or Drought," Army, 11 (5), December 1960, pp. 50-54.
20. Ponte places these Soviet ideas even earlier, and suggests that they played a more important role in DDO Thinking:

"The Dept. of Defense has been fascinated by climate modification since the early 1950's, when US military intelligence learned of a Soviet plan to rain climate in the United States. The plan was to build a jetty 50 miles or more long out from near the eastern tip of Siberia. The jetty would contain several atomic powered jumping stations which would .... But Pentagon planners worried and started studies of ways to change climate". Lowell Ponte,

- 21. From 1963 to 1965 Dr. Teller subsequently served on The Committee on Atmospheric Sciences, and on the Panel on Weather and Climate Modification of the US National Academy of Sciences, National Research Council.
- 22. Quoted in R.B.Rigg, 1960, op. cit. and D.S.Halacy Jr. , 1968, op. cit.
- 23. Quoted in L.Ponte, The Cooling, op. cit. p. 169. Ten years later the same conceptions were repeated  
 "... the advent of military man in space is inevitable...  
 And in time he may actually be able, with a whole host of scientific aids, to control the weather with all the tremendous military and social consequences this implies."

Hanson W. Baldwin, "Space Holds High Military Potential", New York Times, September 20, 1966.

- 24. Weather Modification Research, March 1958, op. cit. pp. 18-22.
- 25. Comm. W.J.Kotsch, "Weather Control and National Strategy," US Naval Institute Proceedings, 86(7), July 1960, pp. 74-81  
 It would seem possible that there is another parallel here. The 1955 CBW advisory committee had also urged the Army Chemical Corps to carry out a public relations campaign to "achieve a more candid recognition of the proper place of CBW." That campaign given the name "Blue Skies", was begun in 1958. It is possible that some of the articles on weather warfare which appeared about this time in the U.S. military journal literature were motivated by a similar thought.
- 26. "Weather as Weapon? Studies Begun," Chicago Tribune (AP), January 5, 1975, p. 6.
- 27. A.M.Horton, "Weather Modification, A Pandora's Box?", Air Force Magazine, 58(2), 1975, pp. 36-40.
- 28. P.Stanford, "Is the Pentagon Tinkering Too Much with the Weather," Parade (Washington Post, Weekly), May 5, 1975.
- 29. For example, Weather Modification, Seventh Annual Report, 1965, National Science Foundation, pp. 25-26. Summary Report, Weather Modification, FY 1969, 1970, 1971, US Dept. of Commerce, NOAA, pp. 8-10.
- 30. For example, Y.S.Sedanov, (Ed) Cloud Physics and Weather Modification, Proceedings No. 19, Main Administration of the Hydrometeorological Service, Council of Ministers of the USSR, Institute of Experimental Meteorology. Moscow 1970 (published in English translation by the Israel Program of Scientific Translations, Jerusalem, 1974).
- 31. Brief surveys of the US military service programs also appeared in the Weather Modification, Annual Reports of the National Science Foundation. See for example, the Seventh Annual Report, 1965, pp. 43 to 49. See also Prohibiting Military Weather Modification, 1972, op. cit. pg 37-39, and Government Weather Program, 1965, op. cit. pp. 62-69 on Project Stormfury see, Summary Report, Weather Modification, FY 1969, 1970, 1971, pg.41-42 and Summary Report, Weather Modification FY, 1972, pp. 76-83.

32. Vice Adm. William F. Raborn, "New Horizons of Naval Research and Development", US Naval Institute Proceedings (January 1963) pp. 40-47.
33. US Congress, House, Committee on Science and Astronautics, National Meteorological Satellite Program, House, Report No. 1281, 87th Cong., 1st Sess. Washington D.C., Govt. Printing Office, 1961, p. 5.
34. Brig. Gen. Robert T. Marsh, "The Issues Before US: National Security" Astronautics and Aeronautics, 10:12, (December 1972), pp. 32-34.
35. Quoted in Lowell Ponte, The Cooling, op.cit. pp. 171-172.
36. Prohibiting Military Weather Modification, 1972, op. cit. p. 85
37. Letter from Malcolm R. Currie, Director, Defense Research and Engineering, US Dept. of Defense, November 12, 1973, in Need For a National Weather Modification Research Program, Report to the Congress, US General Accounting Office, B-133202, August 23, 1974, p. 46.

Argueing from the point of view of international law and anxious to prevent the compromising of international research cooperation by military R&D programs, others have also concluded that it would be desirable to keep at least certain military and civilian weather R&D programs separate:

For the United States, one of the issues is whether to merge military and civilian meteorological satellite programs under military management or to retain separate systems, since the amalgamation of the two programs would save money. The military meteorological information system is itself being centralized within the United States and becoming more independent of foreign bases. Military management of all U.S. meteorological satellites would endanger the World Weather Watch (WWW) and the Global Atmospheric Research Program. It would cause countries to be anxious over how much of the data gathered about the weather system was being fed into the WWW and to fear that, for reasons of national security, the United States might at some point curtail the transmission of data from weather satellites, which others had come to depend upon.

Seyom Brown, et.al. Regimes for the Ocean, Outer Space, and Weather. Washington, D.C., The Brookings Institution, 1977, p. 236.

38. R.G. Fleagle, et. al., Weather Modification in the Public Interest, American Meteorological Society, 1974, 86 pages. Government testimony in the 1972 and 1974 Senate Hearings referred to in reference (4) above, was extremely ambiguous as to whether or not there was classified military research in this area, with officials stating that they were ordered not to discuss the question in open hearing. In the 1972 Senate Hearing, the Dept. of Defense claimed that there was no classified weather research, but climate research was unmentioned.

Question 4: Is there any classified weather modification research going on at present? If so, what is its extent, its budget, and its purpose? Do the China Lake Naval Ordnance Laboratory, or the Air Force Cambridge Research Laboratories play a role? If so, what is it?

Answer: No classified weather modification research is being conducted.

(Prohibiting Military Weather Modification), 1972, op.cit. p. 53

In any case the testimony would appear to have been false, as indicated by the subsequent disclosures of the programs in Indochina.

- 39. - S.Montgomery, "BOMEX Aims for Improved Weather Prediction," Under Sea Technology, 10 (5), May 1969, pp. 80-83.
- R.G.Fleagle, "BOMEX: An Appraisal of Results," Science, 176 (4039), June 9, 1972, pp. 80-83.
- G.Wick, "Where Poseidon Courts Aeolus (NORPAX)," New Scientist, 57 (829), January 18, 1973, pp. 123-126.
- Rear Adm. P.D.Gallery, "BOMEX: Showing the Close Relationship Between Oceanography and Meteorology," Data on Defense and Civil Systems, 14 (5), May 1969, pp. 26-37.
- "Navy's Role in BOMEX," Naval Research Reviews, 22 (3), March 1969 pp. 10-17.
  
- 40. - "USAF Admits Weather Satellite Mission," Aviation Week and Space Technology, 98 (11), March 12, 1973, p. 18.
- "Weather Coverage," Aviation Week and Space Technology, 99 (20), November 12, 1973, p. 11.
- J. Gordon Vaeth, Weather Eyes in the Sky: Americas Meteorological Satellites, New York, The Ronald Press Company, 1965
  
- 41. Leland J. Haworth, Director, National Science Foundation, Letter to Congressman Robert W. Kastenmeier, US House of Representatives, April 22, 1969, 5 pages.  
 The legislation which established the National Science Foundation in 1950 provided that the Foundation, "... at the request of the Secretary of Defense, ... initiate and support specific scientific research activities in connection with matters relating to the national defense by making contracts or other arrangements (including grants, loans, and often forms of assistance) for the conduct of scientific Research" (Public Law 81-507; Section 3(a)(3) ) In 1968 the act was amended to the effect that any such research initiated at the request of the Secretary of Defense or the Secretary of State should be unclassified, and should be financed solely by funds transferred to the NSF for that purpose by the Dept. of Defense or State.
  
- 42. Rear Adm. C.O.Holmquist, "Long-Range Weather Prediction," U.S.Naval Institute Proceedings, 99(11), November 1973, pp. 45-50.  
 The following is a good example:  
 "How Hercules does something about the weather...  
 High-altitude weather reporting is rapidly assuming a new strategic significance. Last-minute reports of the weather along the route of an airborne task force or of the cloud cover above the target of an amphibious assault can add immeasurably to the nation's ability to contain brush fire wars on a world-wide basis. To meet this need the Air Weather Service of Military Air Transport Service is now operating five WC-130s — the new weather bird version."  
 Advertisement for Lockheed C-130 Hercules, Army, 13, No.9, April 1963, p. 5.
  
- 43. See ref. 31 above for sources on Project Stormfury

↙  
[ See pg 45-a ]

~~43. See ref. 31 above for sources on Project Stormfury.~~

44. U.S. Congress, Senate, Committee on Appropriations, Department of Defense Appropriations for Fiscal Year 1972, Hearings, 92<sup>nd</sup> Congress, First Session, Washington D.C. U.S. Govt. Printing Office, 1971, pp/ 674-678.

45. The general question of the adaptability of R&D knowledge derived in R&D programs for different purposes—"offensive" and "defensive," "military" and "civilian" is discussed in more detail in another of the case studies in this volume, that on (C))BW R&D.

46. Department of Defense Appropriations Hearings for RY 1972, op. cit. pp. 647-656 and 739-742; and for Fiscal Year 1973, pp. 817-819. The third capability listed in the project description apparently refers to active means of counter-modification, rather than to diplomatic initiative to forestall the original intervention.

47. Prohibiting Military Weather Modification, 1972, op. cit. p. 53.

48. The Advanced Research Projects Agency (ARPA) is a separately organized, civilian staffed, research and development agency of the DOD under the direction and supervision of the DDRE. It was created in 1958 in response to an urgent need for centralized management of selected research projects, especially those not definitely identified with a particular weapons system, military mission, or military service. Generally, its goal is to determine to the feasibility of a technique or system. Then the project is transferred to one of the military services.

The director of Defense Research and Engineering (DDRE) is the principal adviser and staff assistant to the Secretary of Defense in the functional fields of scientific and technical matters; basic and allied research; research, development, test, and evaluation of weapons, weapons systems, and defense material; and design and engineering for suitability producibility, reliability, maintainability, and materials conservation. He supervises all research and engineering activities in the Department of Defense.

49. A Study of Climatological Research as it Pertains to Intelligence Problems, 1975, 36 pages.

Potential Implications of Trends in World Population, Food Production, and Climate, Central Intelligence Agency, OPR-401, Aug. 1974, 51 pages.

50. The project was carried out by the Geophysics Corporation of America. Notice of the classified projected appeared in the Technical Abstracts Bulletin(TAB) for 1962, which ordinarily remain classified.

51. A.M. Horton, 1975, op. cit.

52. The major sources are:

(a) Weather Modification, 1974, op. cit. (see ref. 4)

(b) the news reports by Seymour Hersh in the New York Times; see ref. 3 and 62 and 64 below.

(c) Two articles by Dr. Gordon F. MacDonald:

"Weather Modification as a Weapon," Technology Review, 78:1 (October-November 1975) 57-63.

"Intentional and Unintentional Modification of the Atmosphere," Commission on the Organization of the Government for the Conduct of Foreign Policy, June 1975, Appendixes, Volume I, pp. 6160-176.

Also see the remaining sources noted in footnotes (3) and (4) above, as well as the following sources:

- John Gliedman, "Weather Modification in North Vietnam", Chapter 5 in Terror from the Sky: North Vietnam's Dikes and the US Bombing, pp. 69-82, 168-172, August 1972.
  - "US Military Weather Modification Activities in South-East Asia", Congressional Record, Senate, 120 (20 May 1974): S8574-S8575.
  - "Military Rainmaking Confirmed by US", Science News 105 (25 May 1974): 335.
  - Colin Norman, "Pentagon Admits Viet Nam Rainmaking", Nature 249, (31 May 1974): 402.
  - Peter J. Ognibene, "Making War with the Weather", New Republic 168 (30 September 1972): 12-14.
  - L.J. Sheehan, "Atmospheric Visibility in Southeast Asia", Office of Aerospace Research Reviews 8:3 (May-June 1969): 12-13.
53. The Pentagon Papers: The Defense Department History of United States Decisionmaking on Vietnam. The Senator Gravel Edition, Volume 4, Boston, Beacon Press, 1971, p. 421.
54. Ibid, p. 146.
55. Weather Modification, 1974, op. cit. pp. 92-93.
56. Ibid, p. 89
57. Ibid, p. 11
58. Ibid, p. 112
59. "Mr Doolin: I know that information on this operation was sent to the White House. Whether it was for information or whether it was for approval, I do not know. I have been unable to find out". Ibid, p.115.
60. Ibid, p.114.
61. Ibid. pgs 117,120.
62. Seymour M. Hersh, "Rainmaking is Used as Weapon by US", New York Times, July 2, 1972. (Also appeared in the International Herald Tribune, July 4, 1972 as "US Forces Secretely Wageing First Meteorological Warfare",)  
In his monumental study of Henry Kissinger in the White House published in 1983, Hersh describes the Digital Information Relay Center maintained by the Joint Chiefs of Staff, which Kissinger used to maintain communications with various secret combat operations in Southeast Asia such as this one, and from which Secretary of Defense Melvin Laird and his staff were prevented entry by armed guards. (The Price of Power, Kissinger in the Nixon White House, Seymour M. Hersh, New York, Summit Books, 1983, p.182)
63. Prohibiting Military Weather Modification, 1972, op. cit., pp. 40-53. The appearance of the Dept. of Defense witnesses produced the pathetic situation of the Subcommittee Chairman asking the witness "Could you give me a little help?", and the witness replying "I regret that I am unable to, sir".
64. Seymour M. Hersh, "Pentagon: Weather as a Weapon of War", New York Times, July 9, 1982.

65. G.J. MacDonald, "Intentional and Unintentional Modification of the Atmosphere", op. cit. p. 173-175.
66. The only detailed description of the operations of SACSA in the Joint Chiefs of Staff is in a book by a former US Air Force Colonel who held the position for nine years: L. Fletcher Pro. ty, The Secret Team, Englewood Cliffs, New Jersey, Prentice-Hall Inc. 1973.
67. S.Hersh, "Rainmaking is Used as Weapon by US", op. cit.
68. US Congress, Senate, Committee on Foreign Relations, Prohibiting Hostile Use of Environmental Modification Techniques, Hearing, 94th Congress, Second Sess., January 1976, p. 20-21.
69. Ibid, p. 22-23, and Weather Modification, 1974, op. cit. pgs 120, 123.
70. Ibid, p. 23.
71. Senator Pell: One final and specific query here. Do you know anything about the dropping of emulsifiers on tracks in the Laotian Panhandle  
.....  
General Furlong: I heard that there was to have been such a proposal. I have heard that it did not work very well and that we did not do any more of it. I do not think it was done by DOD  
.....  
Senator Pell: So it may have been attempted, but it was not under the Defense Department jurisdiction  
General Furlong: No, Sir. First of all, it just would not work, and secondly, it would be dangerous for the crews, and third, we did not want to do it. .... I think sound military judgement prevailed and came to the same conclusion.  
Weather Modification, 1974, op. cit. p. 123.
72. S.Hersh, "Rainmaking is Used as Weapon by US", op. cit.
73. "DDR&E Looks for Solutions to Next Vietnam", Space/Aeronautics, 46:5, (October 1966) pp. 25, 30, 34..  
R.B.Kalisch and T.P.Baker Jr. "DOD Basic Research and Limited Conflict", Office of Aerospace Research Reviews, 7:7 (July 1968), pp. 10-11  
"Pentagon Stresses Tactical Gear to Meet Needs of Vietnam Conflict", Electronics, 40 (Jan. 9, 1967): 135-138.  
"Fighting Guerillas From the Lob", Time, 69, (October 7, 1966) pp. 69-70  
There was even a Science Advisor seconded to the US Military Assistance Command in Vietnam by the Office of the D.D.R.& E.
74. US Congress, Senate, Committee on Foreign Relations, Chemical-Biological-Radiological Warfare and its Disarmament Aspects: A Study, 86th Congress. August 29, 1960, p.
75. George W. Merck "Report to the Secretary of War", The Military Surgeon 98:3 (March 1946): 239
76. Dr. Arthur Galston, personal communication, April 26, 1972.
77. Chemical-Biological-Radiological Warfare and its Disarmament Aspects: A Study, op. cit. p.

78. Ibid, p.
79. Congressional Record, August 26, 1970, S-14240 to S-14248.
80. For thorough reviews of the US Herbicide operations in Vietnam see:  
Julian Perry Robinson, The Problem of Chemical and Biological Weapons Vol. 1, The Rise of CB Weapons, SIPRI, Stockholm International Peace Research Institute, Stockholm, Almqvist & Wiksell, 1971, pp.162-185.  
Arthur H. Westing, Ecological Consequences of the Second Indochina War, SIPRI, Stockholm International Peace Research Institute, Stockholm, Almqvist & Wiksell, 1976, pp. 22-40.  
See also: Arthur H. Westing, Herbicides as Weapons, A Bibliography, Political Issues Series, 3:1, Center for the Study of Armament and Disarmament, California State University, Los Angeles, January 1974, 36 pp.
81. It is ironic that ARPA turned to the US Department of Agriculture's Crops Protection Branch, Agricultural Research Service to learn in greater detail about defoliation techniques and how to destroy crops. On January 30, 1963, ARPA issued Order 424 to the US Department of Agriculture. Order 424 directed the Agricultural Research Service to evaluate new herbicides or combination of herbicides for killing tropical and subtropical vegetation, to develop methods of evaluating herbicides on different woody species, to determine the effects of environment on behavior and effectiveness of toxic herbicides, to determine optimum dates and rates of application, to relate the percentage of defoliation to horizontal and vertical obscuration, to develop methods for improved application techniques that provide better distribution patterns, and to obtain the botanical information needed so that correlations might be made between vegetation indigenous to the continental United States, Puerto Rico, and Southeast Asia. This large order was filled by the USDA by November 1967.
82. For example, Forests of Southeast Asia, Puerto Rico, and Texas, Agricultural Research Service, US Dept. of Agriculture, CR 12-67, September 1967, 350 pp.  
Research Report: Response of Tropical and Subtropical Woody Plants to Chemical Treatments, Agricultural Research Service, US Dept. of Agriculture, CR-13-67, February 1968, 193 pp.
83. Assessment of Ecological Effects of Extensive or Repeated Use of Herbicides, Midwest Research Institute, 1967 (Prepared for ARPA).  
F.H.Tschirley, An Assessment of the Ecological Consequences of the Defoliation Program in Vietnam, Department of Agriculture, Report, Saigon: 12 April 1968. (See also Science no. 163 (1969): 779-786.)  
US Library of Congress, Legislative Reference Service, Science Policy Research Division, A Technological Assessment of the Vietnam Defoliant Matter: A Case History, Report to the Sub-committee on Sciences, Research and Development of the Committee on Science and Astronautics, US House of Representatives, Washington, DC: US GPO, 8 August 1969.  
R.Bells and F. Denton, Evaluation of Chemical Crop Destruction in Vietnam RAND Corporation, RM-5446-ISA (ARPA)
84. The Effects of Herbicides in South Vietnam  
Part A - Summary and Conclusions  
Part B - Working Papers.  
National Academy of Sciences, Washington D.C., 1974.
85. Ecological Consequences of the Second Indochina War, 1976, op. cit. pp. 46-47.



86. Letter from S.J.Lukasik to Representative Les Aspin, September 17, 1973. See also R.B.Bachelder and H.F.Hirt, Fire in Tropical Forests and Grasslands, ES-23, Natick, Army Laboratories Earth Sciences Division, 1966.
87. "B-52's Drop Fire Bombs on Red Sanctuary Near Cambodia." St. Louis Post Dispatch, Jan. 28, 1967.  
 "Blow to a Stronghold: Forest Fires Razing Red Haven." St. Louis Dispatch, Apr. 12, 1968.  
 "Cong Flee Blazing Jungle Stronghold." Sunday Times (London), Apr.14, 1968.  
 D.Shapley, "Technology in Vietnam: Fire Storm Project Fizzled Out." Science, 177 (July 21, 1972), pp. 239-241.  
 R.Reinhold, "US Attempted to Ignite Vietnam Forests in 66-67," New York Times, July 21, 1972.  
 See also the summaries of this program and references in  
 - The Ecological Consequences of the Second Indochina War, 1976, op.cit. pg. 58-59.  
 - Arthur H. Westing, Weapons of Mass Destruction and the Environment, SIPRI, Stockholm International Peace Research Institute, London, Taylor and Francis, 1977, p. 52.  
 Personal interview with one of the Forest Fire Laboratory personnel involved in the program in Vietnam, 1967.

88. Michael Krepon, "Weapons Potentially Inhumane: The Case of Cluster Bombs," Foreign Affairs, 52:3 (April 1974): 595-611.

89. Richard Dean Burns and Milton Leitenberg, The Wars in Vietnam, Cambodia and Laos, 1945-1982; A Bibliographic Guide, Santa Barbara, California ABC-CL IO Information Services, 1984.

90. Seymour M. Hersh, "McNamara Order to End Rainmaking in '67 Reported", New York Times, July 4, 1972.  
 Hersh adds a quotation from "a former high-ranking Air Force official who had served in both administrations", i.e. Johnson and Nixon's) ... "Within the various enclaves of the Government 'the official added' there are interpretations and interpretations — even of White House orders."

91. Sorties and cloud seeding units expended for program.  
 (Supplied by Department of Defense)

Year	Sorties Flown	Units Expended
1967	591	6,570 (including 1,017 over NVN)
1968	734	7,420 (including 98 over NVN)
1969	528	9,457
1970	277	8,312
1971	333	11,288
1972	139	4,362 (Laos, Cambodia, SVN)

Totals 2602 47,409

Weather Modification, 1974, op. cit. p. 102.

92. Bernard Brodie, in Science, Technology and Warfare, (ed.) Lt.Col. M.D.Wright and L.J.Paszek, May 1969, Office of Air Force History, p. 175.
93. D. Shapley, "Rainmaking: Stockholm Stand Watered Down for Military," Science, 176 (4042), June 30, 1972, p. 1404.
94. D.S. Greenberg, "Pell Urges Ban on Military Weather Control," Science and Government Report, 1 (22), January 12, 1972, p. 4.
95. Fiscal Year 1974 Authorization for Military Procurement, Research and Development, etc. Hearings, Committee on Armed Services, Part 1, April-May 1973, pp. 984-988.
96. "Intentional and Unintentional Modification of the Atmosphere," 1975, op. cit. p. 174.
97. US Congress, Senate, Committee on Foreign Relations, US-USSR Strategic Policies, Hearing, 93 Congress, 2nd Sess., March 4, 1974, pp. 56-57.
98. Minutes of the 29-30 March, 1973 meeting of the Weather Modification Association, Extract, Statement approved at the Weather Modification Association meeting 14 September, 1973; (membership at the time, 153 persons). The position of this Association was very similar to that taken by the American Chemical Society in its support for chemical weapons in 1960 to 1969, a position which the ACS then sharply altered. The American Chemical Society is a body with a very much larger membership, but it nevertheless maintained its pro-C.W. policy orientation as long as C.W. remained a topic that only came to the attention of a small number of interested professionals. With the use of C.W. agents by the United States in the Vietnam Theatre, both as herbicides and as gases, and with the pressure for international negotiation that followed the position of the ACS on C.W. changed drastically.
99. "Rainmaking Is Used As Weapon by US," op. cit.
100. See the papers, mostly by Dr. Edith Brown Weiss, referenced in 5 above, as well as the papers by Gordon J. MacDonald (reference 52) and the U.S. Senate and House Hearings (reference 4)
101. E.B.Weiss, "International Responses...", 1975, op. cit. A provisional Summary of International Weather Modification Activities prepared by the US National Oceanic and Atmospheric Administration (NOAA) for the years 1947 to 1973, listed activities in 25 different countries. The World Meteorological Association was also to begin keeping a registry of weather modification activities in the mid-1970's. Brief summaries of some national programs appear in the new annual Summary Report, Weather Modification published each year by the US Dept. of Commerce.
102. C. Brownlow, "Brazil Emphasizing Space Programs," Aviation Week and Space Technology, 104:24 (December 16, 1974) 16.
103. "Weather Modification, India's New Weapon," Times of India, March 25, 1973.  
(The use of the word "weapon" is presumably not meant here to be a military weapon, but a "weapon" against India's natural problems.)

104. "If Your Country Needs Water  
For Agriculture  
For Power Generation  
For Municipal Use  
For Forestry  
"Get the Full Facts on Cloud Seeding for Water Production with WECO's  
Exclusive New Weathercord."  
Advertisement, Ceres (FAO), 4:1 (January-February 1971): 58
105. Detailed results of the Gromet II project in the Phillipines are reported in John Gliedman, Terror From The Sky, op. cit. pp. 77-80.
106. Weather Modification: Programs, Problems, Policy, and Potential. Report, US Senate, Committee on Commerce, Science, and Transportation, 95th Cong. May 1978, pp. 307.
107. "Pentagon Denies It Tried to Change Cuba's Weather," New York Times, June 28, 1976. Ponte's own article in the New York Times some two months earlier ("War of the Weathers," April 12, 1976) did not contain the charge, nor did his book The Cooling, which was released soon after, and the quotations of the allegation are taken from the newspaper report of its denial.
108. In 1972 the Dept. of Defense replied in a written reply to a question by Senator Pell as follows: "DOD has not engaged in any weather modification over Cuba": Prohibiting Military Weather Modification, 1972, op. cit. p. 45.
109. "Blames U.S. for a Disaster," Ithaca Journal (Agence France-Press) July 16, 1975, p. 2.  
In 1965 Asst. Sec. of State Harland Cleveland had stated  
We won't want other nations modifying our weather, and so we will certainly have to accept some restraints on our freedom to modify theirs.  
Similarly, Secretary of State William P. Rogers stated on January 26, 1971 that:  
We are anxious to apply weather modification technology, as it becomes operational, to the problems of developing countries. We are also alert to the need to consider international arrangements to deal with the implications of this new phenomenon.
110. -P.M. Borisov, "Can We Control The Arctic Climate", Bulletin of the Atomic Scientists, 25(3), March 1969, pp. 43-48  
-A. Biryukov, "Revouting Rivers", New Times, No.6, 1971, pp. 26-27.  
-"Water in Wrong Places," Nature, vol. 231 (May 21, 1971), p. 140  
-Theodore Shabad, "Soviet Rivers to Grain Land," New York Times, October 29, 1973.  
-"Remaking the Map: Russias Ambitions Plans to End its Water Shortage", US News and World Report, Sept. 12 (1977), pp.  
-W. Sullivan, "Irrigation Expected to Stem Flowing of Rivers Into Seas", New York Times, Febr. 15, 1979  
-John Gribbin, "Will The Russians Soon be Able to Hot Up Some Cold Fronts?", The Guardian, July 16, 1981.

The political philosophy of the USSR lends itself to a degree of exuberance which in the early post-revolutionary years might have been considered bravura, but with the present knowledge of environmental consequences can only be considered a kind of euphoric madness. The following example which includes an explicit suggestion of manmade climate control for the entire planet Earth was included — with a perverse irony — in a recent Soviet publication entitled The Economic Consequences of Disarmament:

For these and similar reasons Soviet economists and political scientists engaged in disarmament studies unequivocally equate the advent of general and complete disarmament with the dawning of a new millennium in human history. The end of war and preparations for war will enable man to create the material conditions needed for a qualitative leap in his control of his natural environment, his economy and his social system. Armed with resources that previous generations have wasted on programs of destruction and devastation, man will refine his scientific knowledge and technology to such a point that he will achieve total mastery of nature. Control of the climate of the earth will be but one of his accomplishments. \* Human power in this new era will become too great to remain earth-bound. Having conquered the natural processes of his own planet and submitted them to his will, man will extend his command to outer space and begin the colonization of other worlds. What greater successes will follow can be only imagined.

\* Iu. Sheinin. "Razornzhenie i nauchno-tekhnicheskii progress" in Akademiia Nauk SSSR, Ekonomicheskie problemy razornzheniia, pp. 212-213.

111. Data derived from H.H.Lamb, in Weather, 25:10 (October 1970): 447-455.
112. Draft Document Concerning Cooperation Between States in Weather Modification, prepared by WMO/UNEP Meeting of Experts Designated by Governments on the Legal Aspects of Weather Modification, Geneva, Sept. 17-21, 1979, in Weather Modification, 1979, op. cit. p. 151-152.
113. World Plan of Action for the Application of Science and Technology to Development, Prepared by the Advisory Committee on the Application of Science and Technology to Development (ACAST) for the Second United Nations Development Decade, United Nations, New York, 1971, 286 pages.
114. This is precisely the danger of what has been called "dual-purpose" technologies in some studies. See for example David Krieger, Disarmament and Development: The Challenge of the International Control and Management of Dual-Purpose Technologies, Foundation Reshaping The International Order, Feb. 1981, in which Environmental Modification is one of seven technologies examined. It is not uncommon for proposals dealing with development to discuss weather modification as a desirable procedure to be attempted. Other examples are: "Doing Something About the Weather", Chapt. 15 in Blueprint for Peace; Being the Proposals of Prominent Americans to the White House Conference on International Cooperation, R.N.Gardner (ed.), McCraw-Hill Book Co., New York, 1966, pp. 323-336, and J.Bandyopadhyaya, "Climate as an Obstacle to Development in the Tropics", International Social Science Journal, 30(2), 1979, pp. 339-352.

115. Edith Brown Weiss, "Weather As A Weapon", in Air, Water, Earth, Fire: The Impact of the Military on World Environmental Order, Sierra Club, International Series No.2, May 1974, pp. 51-62.  
A useful summary of the national and international recommendations and proposals that preceded the joint draft treaty can be found in the section "Prohibition of Environmental Means of Warfare," pages 432 to 436 of World Armaments and Disarmament, SIPRI Yearbook, 1975.
116. R.L.Homan, "Moscow, Washington Present Environmental Warfare Pact," Washington Post, August 22, 1975; "U.S. and Soviet Offer a Pact on Weather," New York Times, August 22, 1975; Prohibition of Weather Modification as a Weapon of War, Hearing, Subcommittee on International Relations, House of Representatives, July 29, 1975.
117. Weather Modification as a Weapon of War, op. cit. (pages 13, 19 to 21 in particular). Dr. Weiss's wary reading of the 1974 joint US-USSR statement continued  
We also need to recognize the limits of the statement. The statement calls only for the "most effective measures possible to overcome the dangers of the use of environmental modification techniques for military purposes." This implicitly suggests that it is possible to use techniques of environmental modification for military purposes in acceptable ways. The problem is that the statement explicitly refers to climate modification in the text and not to weather modification which is the more imminent problem. It is left ambiguous in the statement whether the use of weather modification techniques raises "dangers" which need to be overcome.  
See also Lawrence Juda, "Negotiating a Treaty on Environmental Modification Warfare: The Convention on Environmental Warfare and its Impact Upon Arms Control Negotiations," International Organization, 32:4 (Autumn 1978): 25-41.  
For the USSR's view on the treaty see Ye.K.Fedorov, "Banning the Military Use of Environmental Alteration Techniques," in Scientific Aspects of Political Talks, Scientific Research Council on Peace and Disarmament, (USSR), Moscow, Nauka Publishers, 1981, pp. 61-85.
118. In June 1975 the USSR initiated a series of statements that were to remain a puzzle for over a full year, calling for new international accords between "the big powers" to ban "new types of mass annihilation weapons and systems to deliver them." The first such call came in an address by Secretary Brezhnev on June 13, 1975. (C.S.Wren, "Brezhnev Calls for Accord Against Terrifying Arms", New York Times, 14 June 1975.) This was followed by various Soviet commentators all through June and by a proposal to French President Giscard d'Estaing on October 16, 1975, ("'Exotic Weapons Proposal' by Brezhnev Puzzles West", International Herald Tribune, 17 October 1975.) Soviet Foreign Minister Gromyko formally presented the proposal in a letter to UN Secretary-General Waldheim on September 23, 1975, which even contained a draft treaty, without naming the weapons in mind. (Pravda, 25 September 1975, English translation, Novosti Press Agency Daily Review, 25 September 1975.) On August 7, 1974, the USSR had requested the UN General Assembly to discuss a "Prohibition of Action to Influence the Environment and Climate for Military and Other Purposes...". In submitting this proposal, the Soviet Union stated that "there was a real danger that the achievements of science and technology would be used to create new types of weapons of mass destruction and to devise new means of waging war."

This language was indistinguishable from sentences in the appeals for controls on new and unidentified weapon systems which the USSR began in mid-1975, and many interpretations of these appeals therefore assumed that the USSR had weather and climate in mind here as well.

Soviet spokesmen refused to supply any public explanation as to what they had in mind, and there were even suggestions that perhaps there were no concrete ideas behind the proposals. However, in August 1976, the USSR finally presented its ideas. A "new weapon of mass destruction" was to be considered "new" if it was so in respect to at least one of three criterias: "the means, target, or nature of its effect", and the "Human Environment" was listed as a target. Soil, water, bodies, atmosphere, stratosphere, etc., were all included — showing a distinct overlap with environmental warfare. ("On Definitions of New Types of Weapons of Mass Destruction and New Systems of Such Weapons", Conference of the Committee on Disarmament, CCD/514, 10 August 1976, 2 pages, mimeographed, and Annex, 2 pages, mimeographed. See also, R. Zhelaznov "Means of Mass Destruction Must be Banned", Pravda, 9 September 1976, translation in full, Novosti Press Agency.)

In an address to the 25th Party Congress (CPSU) early in 1976, Brezhnev surprisingly used very similar phraseology to that about "new weapons of mass destruction" to call for the banning of new US strategic delivery systems such as the Trident II submarine missile and the M-X ICBM:

We have persistently and repeatedly suggested to the United States not to stop at the limitation of existing types of strategic weapons... we have proposed an agreement on banning the creation of new and even more destructive weapon systems, in particular, new submarines of the Trident type with ballistic missiles and the new strategic B-1 bombers in the United States and similar systems in the Soviet Union.

At least one source at the time directly linked this with Brezhnev's June 1975 proposals: "Brezhnev had inaugurated this Soviet effort in June 1975 when he proposed that the great powers conclude 'an agreement on a ban on manufacturing new categories of mass destruction weapons'". (Soviet World Outlook, CAIS, University of Miami, 1:3 (15 March 1976): 6.) This misinterpretation, however, presumably based at least in part on the vagueness of Soviet phraseology, took place before the USSR's August 1976 clarification of its 1975 proposals.

119. Congressional Record, House, 21 October 1975, H 10179-10180.
120. "Environmental Warfare; Questions and Answers," US Arms Control and Disarmament Agency. Publication 83, 1976, p. 7.