

HISTORY OF PLANNED WEATHER MODIFICATION ACTIVITIES AND RESEARCH
AT THE ILLINOIS STATE WATER SURVEY, 1947-1978

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INTRODUCTION

The Atmospheric Sciences Section of this state agency has its roots in weather modification. In fact, the initiation of weather-related research and services, which began at the Water Survey in 1947, occurred largely as a result of the weather modification interest of Lester Pfister, a grower of seed corn located near Bloomington in central Illinois. Mr. Pfister had heard about weather modification and wanted to test and use it for obtaining more rain on his seed corn fields scattered around El Paso, located north of Bloomington.

This interest led to contacts with the Water Survey, and subsequently to the initiation of weather research and services. Four people (G. E. Stout, G. W. Farnsworth, F. A. Huff, and D. M. A. Jones) were soon hired. A raingage network and a war surplus 3 cm radar were installed by the Survey at El Paso, "to study and evaluate" rainfall. Although no seeding was ever pursued, Survey research into rainfall variability had been launched.

Now thirty years later, the Survey is involved in initiating another weather modification experiment in central Illinois. Again, our expectation is to be heavily involved in the evaluation side of the effort.

In the late 1950's, Water Survey scientists began working with one form of "weather modification," that being the reduction of evaporation and transpiration through use of monomolecular films, typically fatty alcohols like hexadecanol, spread on lakes and ponds and also applied in the root zone of plants (Roberts, 1961). This approach was thoroughly tested but did not prove to be a cost effective means of reducing evapotranspiration, particularly on large reservoirs.

Some of the first planning research related to the potential for cloud modification concerned short period (5 to 10 day) droughts. This work, done in the late 1950's, looked at the weather and cloud conditions during typical short term Illinois dry periods (Semonin, 1960).

THE FIRST EXPERIMENT

The first major experiment in weather modification conducted in Illinois occurred in 1960-1962. As a result of earlier research by B. Vonnegut and C. Moore, over 20 miles of charged wires were strung in geometric arrays in central Illinois. They were used to test whether highly charged "hot" wires could influence the electrical charge in clouds. The premise was that moving dust particles in the atmosphere would attach negative (or positive) charges

(ions) and carry these to clouds (Moore et al., 1962). Slight influences of the surface released charge were found at cloud base levels and in a few clouds, but basically the influences were too minor (Semonin et al., 1962). Much of the charge was carried to the ground and lost.

OTHER EARLY RESEARCH

During the early 1960's, Semonin and his associates performed considerable research in cloud microphysics. A Cloud Physics Laboratory was established and studies about drop interactions, electrical charges on drops, and coalescence were begun (Lindblad and Semonin, 1963). As part of this effort, aircraft data were collected in the early 1960's on atmospheric aerosols (Semonin, 1966). This basic cloud physics research that focused on planned weather modification has been sustained (Bradley and Semonin, 1969).

THE VANDALIA EXPERIENCE

A localized summer dry area centered around Vandalia (Fayette County) during 1964 had an impact on Water Survey scientists. The I. P. Krick organization proposed a ground-based seeding program in Fayette County, and Water Survey scientists were involved in an advisory capacity at the request of the county agent. Against our scientists' advice, money was raised and a 1-month seeding project was conducted. Heavy rains fell in the area (and the rest of the state) in mid-August, but no conclusions were drawn.

This activity helped Survey scientists realize they were going to have to serve as the State's experts in weather modification in the future. As such, the staff needed to be better informed in both the scientific, technical, and public issues.

FIRST EFFORTS AT STATISTICAL VERIFICATION

The scientific arguments during the 1965-1966 period over the results of Project Whitetop (Missouri), an experiment with summer cloud seeding, attracted the attention of Survey scientists. This controversy and the advent of a special AAAS Symposium on weather modification in 1966 led to a study (Changnon and Huff, 1968) dealing with statistical simulation of seeding effects in our dense rain gauge networks. Other research followed on the effect of natural variability on verifying rainfall modification (Huff and Shipp, 1969), and on the effect of sampling density on the evaluation of hail suppression (Changnon, 1968).

FOUR NEW PROJECTS

The nation's interest in weather modification grew during 1967-1968, and the Water Survey's growing interests and our large precipitation data base led

us to propose three research projects related to weather modification. They were all funded by federal agencies.

The first of these (funded by NSF) dealt with the effect of natural rainfall variations on the design and verification of precipitation experiments (Huff, 1969). This project was rooted in use of our dense raingage network data. Among many useful results was the proposed use of the area-depth curve as a verifying tool (Huff, 1968). The research also addressed the design issue of rainfall experiments (Schickedanz and Huff, 1971) and the effect of seeding well beyond the target area (Schickedanz and Huff, 1970).

The second project proposed during this period was funded by the Bureau of Reclamation (which was just getting its large weather modification program under way). This project also involved study of historical network rainfall data but focused solely on the issue of rainfall rates and their variations as one means of investigating and verifying precipitation modification (Huff et al., 1969).

A third project grew out of involvement in Project Hailswath, a national effort involving all those with interests and expertise in hail. The project was conducted in South Dakota during July 1966. It reflected the national interest in hail suppression that was just developing. Survey staff members had participated in Hailswath, primarily looking at surface hail losses and hail patterns. This interest in surface hail patterns and hail losses was largely an outgrowth of our previous years of research on hail for Crop-Hail Insurance Actuarial Association (Changnon, 1969a). A research project was developed out of this background and it focused on the issue of hail suppression experiments from a statistical standpoint, the use of radar to measure surface hail and the effects of seeding, and the development of instrumentation to better measure hail (Changnon, 1969b). This project, funded by NSF, led to three successive projects concerning hail suppression including forecasting, field operations, societal-environmental issues and modeling. These four hail suppression projects lasted 10 years. They culminated in the Design of an Experiment to Suppress Hail (DESH) in Illinois (Changnon and Morgan, 1976). Another aspect of our hail suppression research included involvement in the National Hail Research Experiment during 1971-1974. The Survey staff did a design-evaluation study (Schickedanz and Changnon, 1971) for NHRE, operated a radar system and studied echoes (Mueller and Changnon, 1974), and operated a dense hailpad network (Morgan and Towery, 1974).

ECONOMIC EFFECTS FROM WEATHER MODIFICATION

Prior research into crop-yield-weather relationships (Changnon and Neill, 1967) provided a basis for studies that hypothetically considered the potential benefits and disbenefits from precipitation modification. Hence, a 2-year study was proposed and funded by the Bureau of Reclamation. It involved modeling of a range of possible precipitation changes in Illinois and then ascertainment of the various resulting yield changes in corn and soybeans (Huff and Changnon, 1972). This study was the precursor of several more studies of the potential impacts of planned weather modification on man and the environment (Changnon, 1972).

PRECIPITATION ENHANCEMENT PROGRAM

The studies during the 1967-1970 period dealing with a variety of weather modification topics, led the Survey to consider a major experiment dealing with precipitation enhancement. We had developed sufficient knowledge, interest, and equipment to deal with this topic, particularly because of a refocus and reorganization of research activities during the 1969-1971 period.

After careful deliberation, the staff chose precipitation modification as one of two major research goals for the 1970's.

The planned project was labeled the Precipitation Enhancement Project, or PEP (Changnon, 1973). PEP was designed to address two major issues in a 5-year period, 1971-1975. The first question was, "Can we do it?" In this subject area we planned to investigate the modification potential using cloud modeling and atmospheric data collected from extensive cloud studies (aircraft and radar) during 2 summers, a fall, winter, and a spring season. There was also to be a cloud-related study of possible extra area effects. Other studies concerned the issue of seeding materials and devices.

The second question being addressed during the first five years of PEP was "Should we do it?" This involved four areas of research including the environmental issues. This involved the study of silver in rainfall and streamflow (since silver iodide was the likely seeding material, Gatz, 1975), and the effect of more rain on small game animals, a study to be done by the Natural History Survey. Further economic studies addressed the effect of increased rainfall on water supplies (Huff, 1973), a public attitude "social" study, and a legal or legislative activity.

PEP began in 1971 and was ended in 1973, well before its completion, with a major reduction in the support from the Bureau of Reclamation. At that time, certain aspects of the project were essentially completed. A portion of the environmental work was done (Havera, 1973); all the economic-water resources work was completed (Huff, 1973), and we had designed a state law that had been implemented (Ackermann *et al.*, 1974). The public attitudes research was later accomplished in 1974 as part of the DESH (hail) program under NSF sponsorship.

On the atmospheric side of PEP, some of the 1- and 2-dimensional cloud modeling was initiated and later completed in METROMEX (Ochs and Ceselski, 1973), and the statistical study of extra area effects was done (Schickedanz, 1974). Cloud flights during a portion of one summer (1973) were accomplished (Ackerman, 1974), and subsequent funding from NSF allowed us to study the aircraft-cloud data in 1977-1978. Essentially PEP ended in 1974. The follow-on 5-year field experiment in precipitation enhancement, assuming that first phase (1971-1975) gave good answers, was to have occurred in the 1976-1980 period. It was never launched, and the growing problems with federal management of weather modification were studied (Changnon, 1975).

HIPLEX

With their reduced budget and other regional assignments, the Bureau of Reclamation focused their interest in cumulus cloud modification on the High Plains Experiment (HIPLEX). This was initially conceived to be a 3-site effort in the Great Plains, and in the fall of 1974 the Bureau of Reclamation approached the Water Survey about designing HIPLEX. After 10 years of design-related research, we agreed and a design study was performed (Ackerman *et al.*, 1976). Subsequent research, primarily addressing the statistical evaluation of HIPLEX, was pursued during 1976-1977 (Achtemeier *et al.*, 1977). No further projects involving HIPLEX were sought as we had learned all that was of use to Illinois through the design effort.

INTERACTIONS WITH AGRICULTURAL INTERESTS

In parallel with the Survey's research were other activities which were to influence the Survey's weather modification program. In 1972 farmers in central Michigan started a cloud seeding project involving Irving Krick's organization.

The impact of this ground-based seeding project on the Michigan Agricultural Station led Dr. Sylvan Wittwer, Experiment Station Director, to become concerned about weather modification. He was also Chairman of the North Central Committee (NC-94) which had the charge, "Weather Information for Agriculture." At the 1974 meeting of the NC-94 Committee, of which Professor Changnon was a co-representative from Illinois, Dr. Wittwer charged the NC-94 Committee to provide information and consider research about weather modification. Professor Changnon was put in charge of a subcommittee that had two responsibilities: one was to develop a policy-planning statement for the experiment station directors in the North Central region, and the other was to develop a public information document about weather modification. A planning document for the North Central Region was prepared and it essentially said, "Definitive experiments addressing precipitation modification and hail suppression are essential for the central and eastern Midwest." Subsequently, the subcommittee developed a public information document (Bark, 1976).

Dr. Wittwer subsequently distributed this planning document at an experiment station director's meeting in March 1975. The directors of four states (Ohio, Indiana, Michigan, Illinois) indicated a desire to discuss and plan further about "an experiment". These directors, plus Dr. William C. Ackermann, Chief of the Water Survey, and Professor Stanley A. Changnon, met in Chicago in June 1975. It was decided that an experiment should be planned because all were interested, and that the experiment should address precipitation management, not hail suppression. The Water Survey was assigned the prime responsibility for preparing a planning document to organize the effort until such time as the project experiment was launched.

The Survey prepared an initial planning document for PACE (Precipitation Augmentation for Crops Experiment) in the fall of 1975, and it was distributed among staff members at the four experiment stations during the winter. In the spring of 1976, Dr. Ackermann and Professor Changnon visited each of the four

universities for on-day meetings with "interested staff members". At about this same time, Dr. Robert White, Administrator of NOAA, was informed of our planning activities and he responded by indicating that NOAA might also be interested.

OPERATIONAL USE OF WEATHER MODIFICATION IN ILLINOIS

While the above mentioned PACE planning processes were taking place, other events were occurring which would influence the Water Survey activities and others interested in weather modification. The moderate drought in Illinois during the spring and summer of 1976, led a group of agri-businessmen and farmers in the Mattoon, Illinois, area to initiate a cloud seeding project. They turned to the Water Survey for advice and guidance, and Professor Changnon's presence as Chairman of the Illinois Weather Modification Board provided a second area of interaction. The Illinois Experiment Station Director, Glenn Salisbury, and Professor Changnon met with the supporters of this program in July 1976 and agreed to attempt to evaluate the seeding program using the project radar data and data from a dense raingage network that would be installed, operated, and analyzed by the agricultural extension personnel and the Water Survey. Such a project was conducted, and an evaluation, admittedly limited, was conducted (Changnon and Towery, 1976).

Further dry weather in 1977 led this same group in the Mattoon area, plus groups in two other counties in Illinois, to employ cloud seeding during 1977. Three projects were pursued, but the Survey's efforts to evaluate the programs were foiled by the lack of quality radar data from the two largest projects. Two projects were conducted during the summer of 1978. The presence of these projects brought increased interest in weather modification to the citizens and agricultural interests in Illinois, and our expertise and knowledge in the field, gathered since 1966, allowed us to provide expert guidance for these projects.

TECHNOLOGY ASSESSMENT OF HAIL SUPPRESSION

The Survey's broad interests in weather modification and its impacts led to a proposal to perform a technology assessment of hail suppression in 1975. A group of experts from around the nation including economists, political scientists, businessmen, sociologists and environmentalists, as well as meteorologists, worked on the project. NSF funded this major effort and the project was launched in August 1975 and completed in 1977. It helped solidify the Survey's national role as having broad, general interests in the field (Changnon et al., 1977).

PACE

The interest of NOAA in PACE, beginning with discussions during the summer of 1976, was important. It also essentially put our progress and the interests

of the agricultural group at a standstill while NOAA made decisions as to whether or how to become involved in PACE.

Dr. Wittwer, Dr. Ackermann, and Professor Changnon made two visits to discuss PACE with the leaders of the RANN program of NSF during the fall of 1976. At the second of these visits, Dr. Wilmot Hess and Dr. Merlin Williams of NOAA attended and described the promising results from their Florida Project. At this stage, some encouraging proof of enhancement of precipitation was considered important and desirable to support the concept that there was hope for convective cloud modification in the Midwest. In subsequent months during 1977-1978, the NSF weather modification program was greatly reduced and shifted from the RANN Program to a basic research program. During May 1977, the experiment station directors and Professor Changnon visited with USDA representatives in Washington to inform them of PACE and to seek their blessings. No financial support from USDA was expected nor offered, but encouragement was given.

Further discussions with NOAA continued during the summer of 1977. The Water Survey staff interacted with NOAA's scientists, and the Survey developed an extensive project design document by the fall of 1977. Meetings with NOAA leaders, NSF leaders, and agricultural experiment station directors were conducted in 1977 and 1978 for planning and coordination. The agricultural effort during the pre-experimental period (for determining the meteorological likelihood of modification) was to be minimal, and extensive agricultural research would occur during the experiment.

Subsequently, the Water Survey prepared two research proposals (to NSF and to NOAA) related to funding for a 1978 field effort. This proposed effort involved a NOAA P-3 aircraft, two Survey radars, special radiosonde releases, and the subsequent analyses of the data. This represented the first of a two or three year "feasibility study". NOAA funded a part of this 1978 effort and NSF declined. The field program went forward during June and July 1978. Further pre-experimental efforts are planned for 1979.

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