Project 
Hailswath

Origins of Project Hailswath
In May 1965, the Interdepartmental Committee on Atmospheric Sciences, which serves as a coordinating group for federal meteorological activities, asked the National Science Foundation to prepare plans for a national program of hail suppression. The National Science Foundation, acting with the National Center for Atmospheric Research, called in a group of advisors to report on hail modification activities throughout the world. After this symposium, a committee headed by Dr. Verner Suomi of the University of Wisconsin began planning for the establishment of a national program of research to reduce hail. Also, a one-month field program was proposed as a pilot study, for the summer of 1966, foreshadowing a national program, but not considered a part of it. This project was named “Project Hailswath.”

The National Science Foundation provided the funds for Project Hailswath to bring together a number of scientists whose fields of work bore on the hail question, and Dr. Richard A. Schleusener, Director of the Institute of Atmospheric Sciences, South Dakota School of Mines, was appointed coordinator and administrator of the project.

Aims of Project Hailswath
The principal aim of Project Hailswath was to find out what practical and scientific problems are encountered in carrying out certain lines of hail modification activities in the field. This was to involve the collaboration of many groups of scientists coming together to take a combined look at a single set of weather phenomena, and to provide a forum for an active exchange of views and data among the participants.

Other aims were:
1) to observe and endeavor to explain the differences in appearance, physical constitution, structure, and precipitation between seeded and unseeded clouds;
2) to try out various seeding techniques, including massive seeding with silver iodide;
3) to test and evaluate a number of instruments and observational techniques currently under development;
4) to furnish samples of hailstones and of rain from seeded and unseeded storms for physical and chemical analysis; and
5) to test the use of mobile task forces for observing hailstorms over a considerable area.

Participants in Project Hailswath
Project Hailswath is a joint effort of twenty-three separate groups. Five of these are agencies of the Federal government and one an agency of a state government; nine universities are represented; and seven private organizations of a research or commercial character were on the team. A list of participating organizations and personnel is given in Table 1.

---

1 Supported by NAF Contract NSF-C461.
2 National Center for Atmospheric Research, Boulder, Colo.
4 Atmospheric Sciences Research Center, State University of New York, Albany.
5 Institute of Atmospheric Sciences, South Dakota School of Mines & Technology, Rapid City.
6 National Center for Atmospheric Research, Boulder, Colo.

Hailswath Steering Committee makes plans for field operations. Left to right: Dr. W. E. Howell, Dr. A. S. Dennis, Dr. V. J. Schaefer, Dr. G. G. Goyer and Dr. R. A. Schleusener.

Bulletin American Meteorological Society
Table 1. Participating organizations and personnel.

<table>
<thead>
<tr>
<th>Identification number</th>
<th>Organization</th>
<th>Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subcontractors:</strong></td>
<td><strong>Colleges and Universities</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Chadron State College</td>
<td>M. D. Smith*, J. Hawk</td>
</tr>
<tr>
<td>2</td>
<td>Colorado State University</td>
<td>L. O. Grant*, R. L. Steele, D. Whitman</td>
</tr>
<tr>
<td>3</td>
<td>Fresno State College</td>
<td>M. L. Williams</td>
</tr>
<tr>
<td>4</td>
<td>Macdonald College—McGill University</td>
<td>R. H. Douglas</td>
</tr>
<tr>
<td>6</td>
<td>University of Chicago</td>
<td>M. DeSantis</td>
</tr>
<tr>
<td>8</td>
<td>University of Toronto</td>
<td>H. P. Weber*, A. C. Byram</td>
</tr>
<tr>
<td><strong>Private</strong></td>
<td>Atmospherics Incorporated</td>
<td>T. J. Henderson*, D. W. Duckering, J. Schafer</td>
</tr>
<tr>
<td>12</td>
<td>Weather Science, Inc.</td>
<td>D. R. Booker*, L. W. Cooper, R. Cook</td>
</tr>
<tr>
<td><strong>Participants not under contract:</strong></td>
<td><strong>U. S. Government</strong></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Air Force Cambridge Research Lab., Bedford, Massachusetts</td>
<td>R. Cunningham*, J. Church, M. Glass, F. Spatola</td>
</tr>
<tr>
<td>19</td>
<td>U. S. Forest Fire Laboratory, Missoula, Montana</td>
<td>D. Fuquay*, G. Stav</td>
</tr>
<tr>
<td>20</td>
<td>U. S. Naval Ordnance Test Station, China Lake, California 93557</td>
<td>P. St. Amand*, P. T. Jorgensen, N. Webb, T. Wright</td>
</tr>
<tr>
<td><strong>Universities</strong></td>
<td>University of Wyoming</td>
<td>F. Young</td>
</tr>
<tr>
<td>22</td>
<td>Olin Mathieson Chemical Corporation, East Alton, Illinois</td>
<td>P. S. Brown</td>
</tr>
<tr>
<td><strong>Private</strong></td>
<td>Crop-Hail Insurance Actuarial Assn.</td>
<td>F. E. Borton</td>
</tr>
<tr>
<td>23</td>
<td>Institute of Atmospheric Sciences, South Dakota School of Mines &amp; Technology, Rapid City, South Dakota</td>
<td>Practically all IAS staff members were involved in some capacity.</td>
</tr>
</tbody>
</table>

* Principal scientist.
Radar antenna against background of large CB in east part of Hailswath Project area, 24 June 1966.


Myron Plooster, National Center for Atmospheric Research, adjusts special equipment for measuring electrification effects.

Outline of the field program

The special capabilities of the groups participating in Project Hailswath were superimposed on the "Rapid" Project of the Institute of Atmospheric Sciences, sponsored by the U. S. Bureau of Reclamation. The "Rapid" Project is an experimental cloud-seeding project for increasing rainfall, and involves a randomized cross-over design. Before the project began operation, target areas were designated in the vicinity of Rapid City, South Dakota, such that on a given day one of two areas could be selected at random for seeding and the other area could be kept uncontaminated as a control area. On "go" days—those for which severe local storms and possible hail were predicted—one or another of these two areas was seeded with silver iodide from aircraft and from ground-based generators, and sometimes with dry ice from an airplane; but only those persons whose assignments required that they be in on the secret were told beforehand which area was seeded.

The dual-Nike radar of the Institute of Atmospheric Sciences near Rapid City was used to track the showers, direct and control the airplanes used for seeding and observation, and take data on the size and intensity of individual showers. At the same time, scientists pursued their own particular programs of investigation, both in the air and on the ground.

Aircraft coordination was accomplished from the Institute radar by use of interrogator equipment added to the NIKE radar and use of standard aircraft transponders on project aircraft. The aircraft operations were coordinated successfully with normal FAA air traffic control.

Hailswath participants moved from Rapid City to Fort Collins, Colo., for two operational days to determine the problems encountered in use of mobile task forces. While in Colorado, Project Hailswath was super-
imposed on the hail research project of Colorado State University, sponsored by the National Science Foundation.

On the evening of each "go" day, the participants assembled to present the data in hand, hear and discuss reports from each observer, argue the indications that one area or the other had been seeded, and finally to hear the report of what seeding had actually been done.

On the last day of the project, July 9th, all of the participants met for a critique. They reviewed accomplishments, discussed problems, and made recommendations and plans for future work.

At the conclusion of the month of field work, task chiefs assigned to cover fourteen major aspects of the work prepared preliminary reports of accomplishments within each of these tasks and an inventory of data for certain days that have been designated for detailed case study. A final report, based on elaboration of the preliminary data so far in hand, is planned for October, and a final critique of participants is planned for November.

Accomplishments of Project Hailswath

Project Hailswath has been highly successful in bringing together many of the outstanding leaders in hail modification and cloud physics research. As expected, many problems of a practical nature have been encountered. Most of the group leaders have expressed the opinion that, if they come back for a similar program another year, it will be with a great head start in getting on with the work. A large factor in this success has been the cooperation among scientific and administrative personnel of these several participating government agencies at all levels.

Coordination of project aircraft was accomplished. On one day, twelve separate airplanes made research flights, and the maximum number of aircraft in the air at any given time was eight.

No major difficulties were encountered in moving the task force from Rapid City to Fort Collins.

As the project progressed, emphasis was given to concentrating the attention of all observers to one particular cloud system.

Suitable weather occurred for observations of thunderstorms and hail. On both days that Hailswath participants were in Colorado, suitable conditions existed for a "test case." While at Rapid City, ten "go" days occurred; six of these gave hail at the ground within a 50-mile radius of Rapid City.

It is planned to analyze the data from two "go" days as case studies, and to present the data from three other days in the final report.

It was fully realized from the beginning that firm conclusions concerning the effects of cloud seeding on hail and rain amounts could not be gained from a limited number of cases in a one-month pilot study. Such conclusions will evolve only from continuing field programs which will require years of effort.

After the critique, a review committee agreed that the data available looked promising with respect to beneficial modification of hailstorms. Emphasizing that data available were preliminary, subject to revision on more complete analysis, and that differences could have occurred by chance, the box score for 10 "go" days of field operations showed the following:

1) Hail—
Areal extent of hail in the seeded target was less than that in the non-seeded target on four days, greater on 1 day, tied on 1 day, and were zero in both areas on 4 days.

2) Rain—
Total rainfall amounts averaged over the rain-gauges in the seeded areas was 0.46 inch, and 0.30 inch in the non-seeded areas.

On some occasions, indications of seeding were found in the appearance and constitution of clouds in the seeded areas, and silver iodide particles were detected.
The project enjoyed a high degree of cooperation and understanding from the inhabitants of the experimental area, including the services of many of them as volunteer rain and hail observers. Although many residents of the area have expressed concern as to how eventual weather control should be managed so as to resolve conflicts of interest between those who want more rain at a given time and those who want less, there was a preponderance of opinion among farmers and ranchers that research aimed at applying weather control to useful purposes should be pursued.

**Suomi committee reviews Project Hailswath**

On Friday, 8 July, scientists from Dr. Suomi's committee met at the School of Mines and Technology to continue their planning.

On July 9th, they attended the critique of Project Hailswath to gain a first-hand impression of the results of the program so far.

---

**news and notes**

**Tropical meteorology meeting at NCAR**

More than forty of the nation's leading atmospheric scientists gathered at the National Center for Atmospheric Research (NCAR) in Boulder 8-12 August to plan a series of experiments designed to gain new knowledge about the basic mechanisms of the tropical atmosphere.

They represented many organizations, including the National Academy of Sciences, the Environmental Science Services Administration (ESSA), the National Aeronautics and Space Administration (NASA), the Department of Defense, and eight leading U. S. universities, as well as NCAR.

The scientists presented and evaluated ideas for observational experiments designed to fit into an integrated program of tropical meteorological experiments to be conducted over the next five to ten years. This program will attempt to coordinate the individual experiments so that each one not only will be valuable in itself, but also will contribute to a comprehensive body of knowledge about the behavior of the tropical atmosphere on every scale. At present the tropical zones, which are a key region in attempting to understand the global behavior of the atmosphere, represent one of the least adequately observed regions of the earth.

One proposed experiment, developed by visiting scientists working with the NCAR scientific staff, calls for a program of meteorological observations to be conducted in 1967 in the Line Islands, south of Hawaii near the Equator. The plan is for an intensive series of conventional weather observations, including radiosonde observations of the upper atmosphere, to be made from ground stations on the islands, from a shipboard station, and from research aircraft. These conventional observations, along with observations made by ESSA and NASA using polar-orbiting meteorological satellites, will be used to evaluate high-resolution photographs taken by the new ATS-B Advanced Technological Satellite, which is expected to be in orbit by then. The ATS-B will have a synchronous orbit, which means that it will remain stationary with respect to the Earth, moving in the same direction and with the same speed as the Earth's rotation. It will be positioned over a point in the central Pacific Ocean south of Hawaii and will provide continuous observations of cloud patterns in this region.

The meeting at NCAR began on Monday (8 August) with reviews of various aspects of tropical meteorology. The scientists then organized themselves into three working groups, each of which considered a particular aspect of the proposed experiments.

The first group, whose chairman was Dr. Colin S. Ramage of the University of Hawaii, discussed the proposed Line Island experiment and made plans to conduct the experiment in 1967.

The second group, chaired by Dr. Noel La Seur of Florida State University, considered a long-term program to investigate tropical convection and medium-scale disturbances in the tropics.

The third group, with Dr. Jule Charney of the Massachusetts Institute of Technology as its chairman, discussed requirements and opportunities for observations of large-scale atmospheric motions in the equatorial zone.

The week was devoted both to lectures on various aspects of tropical meteorology and to planning sessions of the working groups. Several experiments, which appeared to have individual value and also to represent a logical sequence when considered as a group, were judged to be worthy of further study and evaluation.

There is a growing recognition on the part of the atmospheric sciences community of the need for large-scale programs such as this one. They promise to provide observational data and scientific insights which are necessary for development of numerical techniques by which computers can be used to make long-term global weather forecasts and to test proposed methods for modifying weather and climate.

Such programs are expected to culminate in a global atmospheric research project, tentatively planned for 1972. This project would be an exercise in international cooperation similar to the International Geophysical Year (IGY), although it would have to be conducted on an even larger scale than that of the IGY.

(More news and notes on page 842)