ATMOSPHERIC WATER RESOURCES OF

THE WASATCH FRONT, UTAH 1/

By

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Introduction

Since that auspicious day in 1946 when Vincent Schaefer provided the first clear-cut evidence that man could modify the weather on a major scale by his dry-ice seeding of supercooled stratus clouds, the art and science of weather modification has developed into an accepted industry. Despite this growth and acceptance, many questions remain unanswered and the responses to seeding have not been proven beyond some reasonable doubts. Several reasons for this situation seem apparent. Firstly, the great majority of the progress in weather modification has been made on operational seeding programs. Under operational conditions, research answers are incidental to the operation. Secondly, the state of the art in hydrologic and meteorologic instrumentation has been sufficiently near its infancy, that the instruments needed for the proper evaluation of changes due to cloud seeding have not been available.

The present paper will be directed toward the unique portions of the Utah studies, rather than to cover the details of the studies.

Objectives

The objectives all apply to the Wasatch Front Area. They are as follows:

1. To determine the feasibility of increasing water supplies by cloud seeding.
2. To develop more effective methods of cloud seeding.
3. To develop better equipment and methods for evaluating the effects of cloud seeding.
4. To evaluate and delineate the area affected by cloud seeding under different synoptic conditions and generator placement locations.
5. To determine the unique characteristics of the storm systems.
6. To make the best possible estimate of the efficiency of precipitation mechanisms associated with these storms.

Experimental Network

The experimental network of measuring devices is in a state of flux at the present time. It is composed of a network of weighing type telemetering precipitation gages, snow pillows, temperature sensors, air pressure sensors, nuclei sensors and perhaps wind sensors.

The general area and locations of the sensing equipment may be seen in Figure 1. Primary evaluation will be made by means of the precipitation sensors.

Two radio controlled silver iodide generators to be operated by North American Weather Consultants will be located on the peaks of the Wasatch Front and two more in the valley west of the Front as shown in Figure 1.

The "treated" area will be that area where samples of the precipitation contains silver in concentrations above background. We do not presently know where these areas will be but preliminary wind studies indicate they will probably be in a northeasterly direction from the generators.

The precipitation catch in the gages in the treated area will be compared to those outside by the Mann-Whitney nonparametric test. The details of this test will not be discussed in this paper.

1/ The work reported in this paper was supported by the U. S. Bureau of Reclamation.

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Special Equipment

Silver Iodide Generators. Remote radio controlled silver iodide generators developed by North American Weather Consultants and described by Elliott (1960) will be used for seeding a unit installed on the Wasatch Front is shown in Figure 2. This generator emits about 10^{15} silver iodide crystals per second in the size range between 0.01μ and 0.05μ if the smoke is quenched at the proper temperature and consumes about 1/10 gallon of 2 percent silver iodide in acetone per hour.

Precipitation Gages. The precipitation gages used were developed at Utah State University to measure both rain and snow in remote locations and transmit the reading back to the central readout location. The assembly for measuring precipitation is shown in Figure 3. The gages have a resolution of about one part in 2500.

Readout Equipment. The readout equipment was also developed at Utah State University. This equipment can be programmed to automatically interrogate the various sensing equipment at 60 decibels below noise, clean up the signal, read the datum and record it on a print-out and on magnetic tape. The readout could also read directly into a computer. A front view of this equipment may be seen in Figure 4. Reading time is a few seconds per station with the actual time depending on signal strength from the remote location.

Temperature Sensors. These units were also developed at Utah State University and consist of a bimetalic strip which moves as temperature changes. One sensor is shown in Figure 5. Temperature sensors are available for both air temperature direct or remotely.

Air Pressure Sensors. These units are adapted from a conventional microbarograph, Figure 6, or from aneroid bellows to telemetry. The sensitivity with telemetry is much greater than with the ordinary recorder chart.

Snow Pillows. The most promising of the snow pillows still being tested are metal plates four feet square with either a butyl rubber or thin metal diaphram and the intervening space filled with an antifreeze solution. These may be seen in Figure 7. The results from the smaller pillows seem to be equal in every way to those from the 12-foot pillow. Testing will continue on these units before a decision is made on which will become our standard. There is presently no difference between the two 4-foot pillows.

Radar. The radar units being used are T-9 Trackers. They will be used in two particulars. The first is the PPI display of the precipitation bands and centers or cells. The second is to track transponder bearing balloons being used to study small scale circulations.

Design of the Experiment

Definitions. A storm condition is said to be seedable whenever either .01 inch or more precipitation falls at one or more of the westernmost precipitation gages or an echo on the radar larger than one mile across appears in the vicinity of these gages.

Target area can mean either (a) an area where the silver content of the precipitation is above background. (b) A fixed area selected as the most probable to be affected by seeding. (c) That area above a stream gaging station on which the silver content of the precipitation exceeds background most frequently.

The effects of cloud seeding will be evaluated in three fashions. The first evaluation will determine whether or not cloud seeding significantly increases or decreases precipitation. If precipitation is significantly affected, this evaluation must then be able to show whether or not there is a carry-over in the effects of silver iodide from one storm to the next.

The second evaluation will show whether or not cloud seeding significantly alters the precipitation on a preselected geographic area and whether or not there is any significant carry-over.

The third evaluation will determine whether or not there is significant effect of cloud seeding on streamflow under the conditions of the experiment.

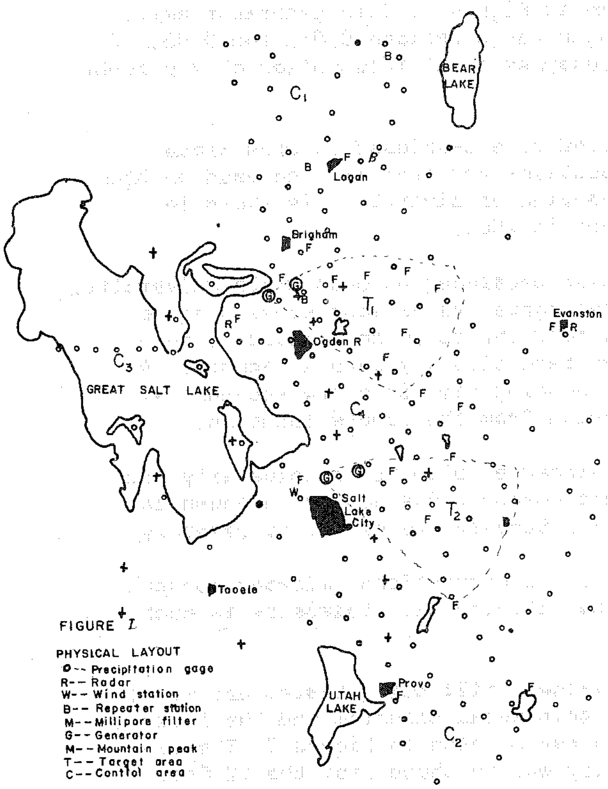

Figure 1. The general area and general physical layout of the atmospheric water resources along the Wasatch Front, Utah.

Figure 2. The remote radio controlled silver iodide generator atop the Wasatch Front near Bountiful Peak (right background).

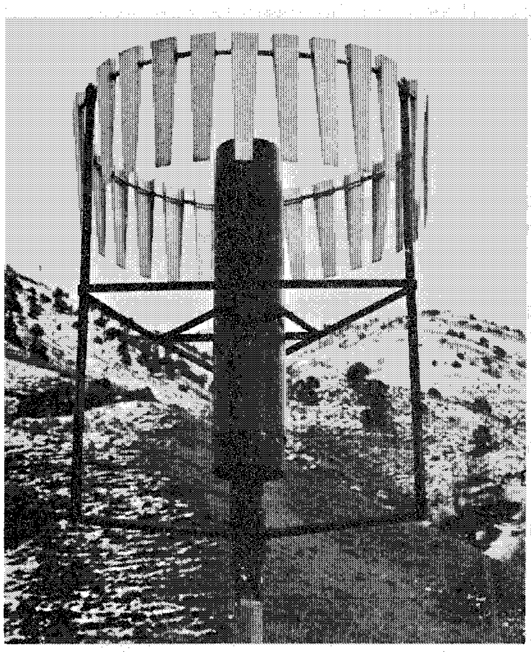

Figure 3. The remote telemetering weighing type precipitation gage developed at Utah State University. The installation has three parts, the catchment, the antenna, and the electronics.

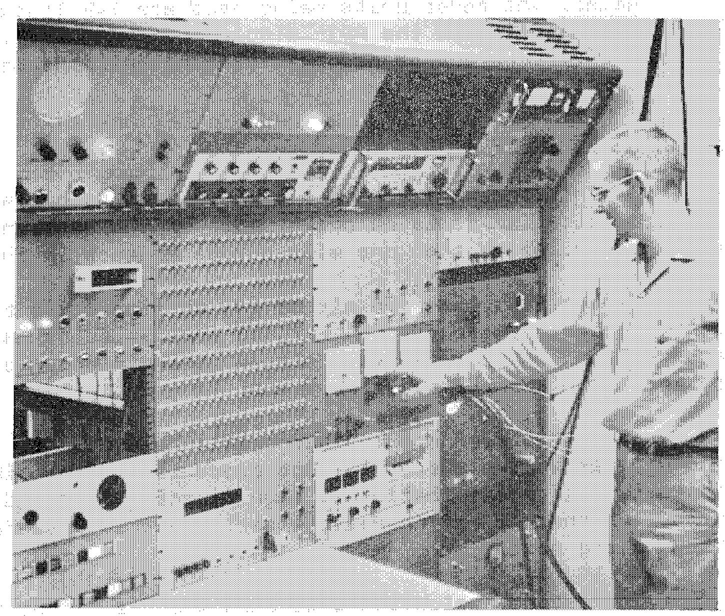

Figure 4. The automatic-tracking filter readout system developed at Utah State University. Remote parameters may be automatically printed out in a preprogrammed sequence or on an individual manual basis.

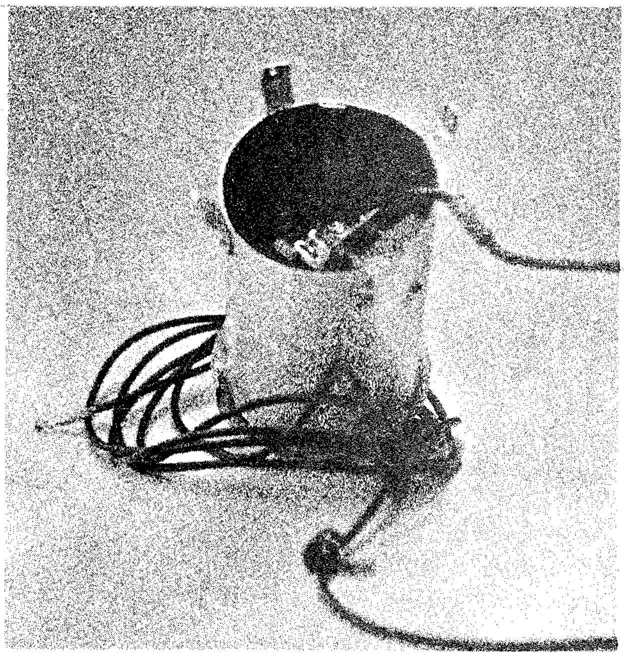

Figure 5. One of the telemetering temperature sensors developed at Utah State University.

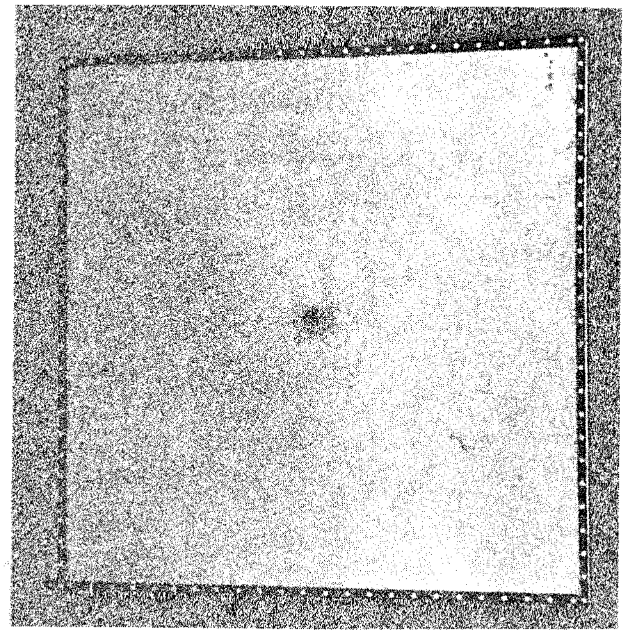

Figure 7. One of the 4-foot metal snow pillows adapted to telemetry by Utah State University.

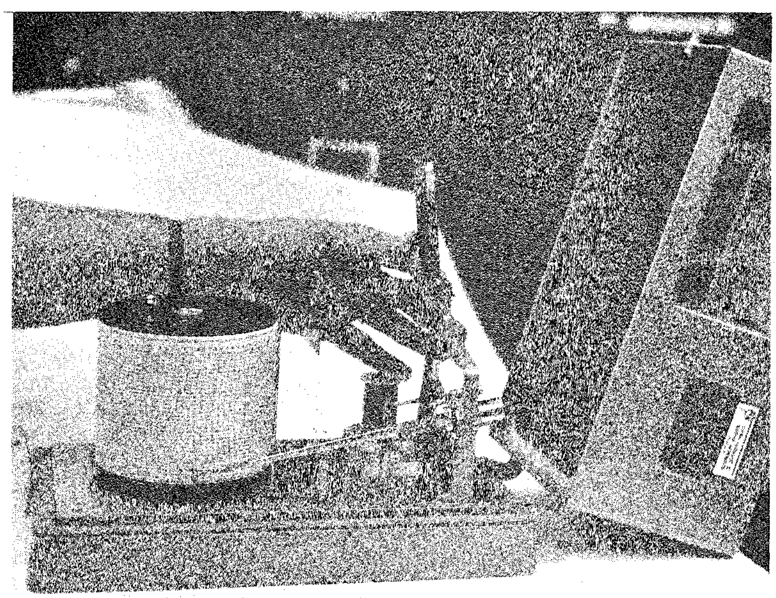

Figure 6. An actinometer adapted to telemetering by Utah State University. The precision with telemetering is greater than with the conventional analog chart.

Physical Evaluations. To support the statistical evaluations physical evaluations will be made to aid in understanding the processes accompanying the seeding of storms.

REFERENCES

Elliott, Robert D. 1960. Seeding of West Coast Winter Storms. J. Irrig. and Drain Div., ASCE Proc. Paper 2396:329-371.