A Training Program for Weather-Modification Pilots

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Abstract

A training program that has been conducted since 1974 to educate pilots in the principles of weather modification is described. The program offers theoretical and practical instruction in cloud seeding, including on-the-job experience. Some benefits of the program are presented.

1. Introduction

There is accumulating evidence suggesting that certain local-weather conditions can, in some areas, be significantly altered by means of carefully controlled cloud seeding (American Meteorological Society, 1985). Although there is a need for further experimentation, many consider the possible benefits of certain weather-modification techniques to outweigh the risks and have chosen to carry out operational programs. If this cloud seeding is to be effective it must be properly applied. For airborne seeding operations this requires that the flight crews be trained and experienced in cloud-modification theory and practice. They are an integral part of the operational decision-making process and normally assume much of the responsibility for selecting seeding candidates. It is also their duty to target the seeding material and to conduct the flight operations in a safe manner. Unfortunately, most seeding pilots have had little formal meteorological training. A training program has been established to help remedy this situation.

Since 1974, University of North Dakota (UND), Departments of Aviation and Atmospheric Sciences, have conducted the Weather Modification Pilot Training Program (WMPTP). The objective of the program is to enable pilots to become a viable and effective component of weather-modification activities. This unique program was initiated under a National Science Foundation grant to provide the scientific background and technical knowledge necessary for conducting both operational and research weather-modification projects.

The primary sources of pilot trainees are the students enrolled in four-year and two-year aviation-related degree programs. Almost all pilot ratings, from private- to airline-transport pilot, are offered in conjunction with these programs.

2. Course structure

a. Curriculum

The WMPTP is structured as a year-long course for students enrolled at the university. An outline of the program curriculum is presented in Table 1. The program consists of two classroom courses offered sequentially in the fall and spring semesters, followed by a summer internship. Students receive four credit hours for each course and may participate in the program during any year of their studies. As a prerequisite, an introductory-level meteorology class is required. Classroom instruction is augmented by the presentations of guest lecturers in various subject areas. The text is *Weather Modification by Cloud Seeding* (Dennis, 1980).

b. Introduction to weather modification

The Introduction to Weather Modification course provides a comprehensive introduction to basic concepts of weather-modification applications and research in progress around the world. A historical perspective of weather modification is presented first, followed by a review of fundamental meteorological processes as they apply to weather modification. A more-detailed study of cloud physics is then given, along with an examination of cloud-seeding theories. Fog dispersal, precipitation-enhancement, and hail-suppression applications are discussed, and various dynamic- and microphysical-seeding hypotheses are presented. An introduction to the principles of weather radar, a basic support tool used on many projects, is also provided.

A strong emphasis is placed on the underlying scientific principles behind cloud-seeding theories for several reasons. In a broad sense, this knowledge helps the pilot understand the overall project objectives and how they are to be accomplished. This more-clearly defines the pilot's role in the operation and often results in a higher level of effort and dedication, and also helps the pilot understand the bounds of cloud-seeding operations.

A scientific background can also be a strong asset during the seeding operations. For example, an awareness of the basic morphology of cloud systems can help the pilot recognize or even anticipate changes in the storms. This allows the pilot time to react properly and dispense the seeding material more accurately in time and space. It is also crucial that a pilot be able to exchange technical information with other

TABLE 1. Training Program—course outline.

I. Introduction to Weather Modification
   A. History of weather modification
   B. Fundamentals of meteorology—review
   C. Cloud physics and seeding theory
   D. Introduction to weather radar
   E. Weather-modification today—programs and problems
II. Advanced Weather Modification
   A. Operational weather modification
   B. Cloud-seeding materials and equipment
   C. Seeding theory and practice
   D. Operational procedures
III. Internship

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seeding pilots and with project meteorologists. Storm characteristics and seeding instructions must be clearly communicated in a timely fashion; there is often little opportunity for clarification in flight.

The final major segment of the course is devoted to a review of current weather-modification programs and problems. This includes such issues as the legal, societal, economic, and environmental issues associated with weather modification.

c. Advanced weather modification

The advanced course proceeds from the theoretical framework developed in the introductory course to pilot training in the practical application of these scientific principles. Students enrolled in this course are commercial-, multiengine- and instrument- rated pilots. Topics include forecasting, seeding strategies, and evaluation techniques. Students are also instructed in the proper care and handling of seeding materials and in the maintenance and repair of seeding equipment. Another study area covers the identification of seeding opportunities; this involves the use of visual observations and limited in situ measurements of cloud characteristics to help estimate the possible seedability of various clouds. This is followed by a discussion of seeding techniques in terms of where to fly the aircraft and where to release the seeding material. Both below-cloud and cloud-top (in-cloud) techniques are covered.

An integral part of the instruction in this course is safety, both on the ground and in the air. Acetone-based seeding solutions are corrosive, highly flammable liquids, and seeding pyrotechnics are class-C explosives. Great care must be taken to avoid personal injury or property damage from these substances.

Also critical is instruction on safe flying in the weather conditions suitable for cloud seeding. This is particularly true for strong summertime convective clouds. Through all stages of their flight training, pilots are taught to avoid thunderstorms by at least 30 km. Unfortunately, the seeding aircraft must often be "positioned" in close proximity to mature storms (within a few kilometers) in order to target the seeding material. These missions can only be safely conducted by knowledgeable air crews, whose training is a key objective of this program.

In addition to the classroom instruction, the advanced course offers hands-on training in many aspects of seeding operations. This includes flight training in seeding techniques and equipment operation, and physiological training, which is directed toward understanding and surviving in the flight environment. Other equipment such as a Doppler weather radar and a rawinsonde system are used to familiarize students with the operation of ground-support facilities.

d. Internship

The third phase of the WMPTP is the summer-internship program in which students, who have completed the classroom courses, receive an opportunity to apply their knowledge and gain on-the-job cloud-seeding practice. Interns are placed as copilots with operational seeding programs for an entire season, flying with experienced weather-modification pilots on actual cloud-seeding missions. One such program is the North Dakota Cloud Modification Project. This is a nonrandomized, summer, convective-cloud, seeding project with a primary emphasis on hail-damage reduction and a secondary emphasis on rainfall increase. The operations are conducted from 1 June through 31 August, whenever suitable clouds are present within the target area. This is the type of training that cannot be done in a classroom; slides and lectures are no substitute for the experiences of this type of flying.

TABLE 2. Number of students in WMPTP and pilot placements.

Year	Completed Classes	Positions filled by interns		Positions filled by graduates
		Copilot	Command Pilot	Command Pilot
1975	12	0	7	0
1976	24	15	3	4
1977	11	5	6	7
1978	16	10	0	11
1979	25	9	5	8
1980	24	13	1	16
1981	33	13	0	20
1982	26	10	0	11
1983	17	10	0	13
1984	19	12	0	17
1985	24	13	0	18
1986	15	11	0	13
Totals	246	121	22	138

3. Benefits of the program

The WMPTP offers a number of benefits to weather modification users. The most important of these is that the graduates of the program form a pool of properly trained pilots. Weather-modification contractors draw upon this pool for projects within the United States and abroad. Table 2 shows the number of trainees who have completed the course and the pilot positions that have been filled by these graduates. Note that during the early years of the program, many of the students completed their internships as command pilots.

TABLE 3. WMPTP graduate experience—cumulative number of years employed in weather modification.

Cumulative years employed in weather modification	Number of graduates
0	62
1	45
2	19
3	7
4	5
5	3
6	0
7	0
8	0
9	2
10	0
11	1
	144

This was due to the shortage of trained personnel. Table 3 shows how long the program graduates have continued in the field. Thirty-seven pilots have participated in programs for two or more years. Six graduates have also served as crew members on various airborne research programs in weather-modification and other related programs. These figures underscore the active role of these trained pilots in the weather-modification industry. The pilots generally stay in the field for only a short time, as they find more-secure positions elsewhere.

Other benefits of the program go to the projects where pilot interns participate as a second crew member. Having two qualified weather-modification pilots in the aircraft allows the pilot in command to concentrate fully on flying the plane and delivering the seeding material. The second crew member can assume other duties such as communications and data logging. Accurate records of aircraft location, seeding events and other information are critical to an evaluation of the seeding efforts. Two observers are also better than one for monitoring cloud development, searching for seeding opportunities, and maintaining flight safety.

Projects may also benefit from this training program by having well-informed pilots. The longevity of a weather-modification project depends a great deal on how it is perceived by the public. The exchange of information between the sponsoring agency and the affected citizens is crucial (Farhar, 1977). During the operational season, the pilots are often relied on to answer questions, provide information, and generally represent the project. Therefore, it is advantageous to employ pilots who are knowledgeable in the subject of weather modification.

The pilots also derive a great deal of personal benefit from the training in terms of work experience and employment opportunities. Weather-modification contractors actively recruit these specially trained pilots, giving them an advantage over other pilots in filling these positions. In addition, the work experience and the experience gained by flying in potentially hazardous weather conditions helps give them a competitive edge for positions in the airline industry. Many of the pilots who were once seeding clouds are now safely transporting passengers for air carriers and commuter companies.

4. Summary

In light of a favorable response from the industry and an apparent sustained need for this training, the University of North Dakota intends to continue the WMPTP. The author welcomes inquiries from any readers who are interested in further details of the course syllabus or other aspects of the program.

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