Hurricane Seeding: A Quest for Data

Cloud-seeding operations on the recent hurricane Debbie in the Atlantic were called a failure in some press reports, which implied that the purpose of the seeding was to reduce the storm's intensity and its potential for destruction. Pained weather scientists involved in the seeding operation deny this. R. Cecil Gentry, director of the National Hurricane Research Laboratory in Miami and head of Project Stormfury, which carried out the seeding program, says the purpose of the seeding operation was to acquire data on the nature of and changes in hurricane structure and position, rather than to modify or destroy the force of a specific storm. He says the cloud seeding project was "an operational success."

On 18 and 20 August, the Department of Defense and the Environmental Science Services Administration (ESSA), the two principal federal groups participating in Project Stormfury, seeded the eye wall of hurricane Debbie, about 460 to 650 miles off of San Juan, Puerto Rico, with a ton of silver iodide crystals. The seeding of hurricane Debbie was the first attempt at multiple seeding of hurricane clouds. The cumulus clouds surrounding the hurricane eye wall were seeded five times at 2-hour intervals each day to determine whether their modification would cause a measurable change in the hurricane itself. Theoretically, injection of silver iodide particles into the hurricane clouds should transform supercooled water droplets into ice crystals. This transformation should result in a sudden release of the latent heat of fusion of the droplets. If injected into proper areas of a hurricane, the heat may cause redistribution of the storm's energy and a reduction in maximum wind velocities.

Gentry estimates that it will take 2 or 3 months to evaluate the large amount of recorded film and magnetic tape that was collected in the cloud-seeding operation. Gentry told *Science* he is reluctant to predict the results of the seeding of hurricane Debbie. Minor changes, he said, were observed in the structure of the clouds and in the storm's mechanisms, but he declined to attribute these changes directly to the seeding operation. "The changes were of a type that could have occurred naturally, so I'm cautious about setting up any cause-and-effect relationships," he said.

Project Stormfury, an interdepartmental project that costs an estimated $500,000 annually, began full operation in 1962 to study means of hurricane modification by cloud seeding. Today seeding is authorized in the southwestern Atlantic, the Caribbean Sea, and the Gulf of Mexico. Since the program began, experiments have been performed on only two major storms—hurricane Esther in 1961 and hurricane Beulah in 1963—and no definite conclusions were drawn from either experiment. "We have some clues, but no real answers," Max William Edelstein, a Navy technical adviser assigned to the project, said. Edelstein said that a hurricane, to qualify for seeding under Project Stormfury, must have a well-defined eye, winds better than 75 miles per hour, and a location where the probability is small—10 percent or less—that the hurricane will come within 50 miles of a populated area during the ensuing 24 hours. These three requirements are not always met in a single hurricane. A case in point is Camille—the hurricane that holds the all-time record for strong winds affecting the U.S. mainland—which hit the Gulfport, Mississippi, coastal area in August at speeds of 190 miles per hour. Camille was not seeded because it was predicted to be within 24 hours of land at all times.

Scientists concede that research on hurricane modification is still in the early stages, and that no one is yet sure whether man can significantly change a hurricane's direction or force with seeding techniques. A major obstacle in determining whether cloud seeding is an effective means of modifying hurricanes is that nature has not provided many hurricanes of a size, position, and velocity suitable for experiment.

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proposed. On this matter of timing, Newell says, is "where we part with the scientific community. They say that if we get locked into this large technological program, with the unforeseen technical and budgetary problems that may arise, we will say, 'Mr. Science, Mr. Applications, you wait a little while. We'll get to you later.' This is what the scientists are apprehensive about." The apprehensiveness is no doubt a carry-over from the attitude many scientists held toward Apollo, which they viewed as having too little merit, scientifically or otherwise, to justify its high ($24 billion) cost. The Integrated Program culminating in a Mars landing would cost more than twice as much as Apollo.

A few months ago, the Academy's Space Science Board, chaired by Harry H. Hess of Princeton (who died of a heart attack on 25 August), wrote to DuBridge about the question of a manned flight to Mars. This letter's contents have not been divulged, but apparently the board recommended that no new Apollo-type program, with development tied to a fixed and fast-paced schedule, be undertaken. Yet the letter seems to have been worded vaguely enough to allow for a wide latitude of opinion among the board members.

For example, two of those whom *Science* interviewed, Wolf Vishniac of the University of Rochester and Luis W. Alvarez of the Lawrence Radiation Laboratory, said that they are largely in agreement with NASA's Integrated Program plans. Vishniac says that the NASA budget should be allowed to rise gradually from its present level of less than $4 billion to between $5 and $6 billion (according to Newell, if NASA is to attempt a manned Mars mission in the early 1980's, the agency budget would have to be increased to between $7 and $8 billion a year by the end of the 1970's).

However, Gordon J. F. MacDonald of the University of California at Santa Barbara, who is also a member of the board, says that for the next few years a space budget of $2½ to $3 billion would be adequate. This would allow NASA to carry on good planetary and space applications programs and to retain its existing manned flight capability long enough to determine whether man really does have a useful role to play on space missions, MacDonald says. "My intuitive feeling is that it [man's role] is going to be very limited," he adds.