How to subdue a *HURRICANE*

by Louise Purrett

In some sciences, a researcher can enter the laboratory, gather his materials and combine them at will. In other areas, such as meteorology, the experimenter must wait for suitable conditions to develop naturally.

Project Stormfury was inaugurated in 1962 by the Departments of Commerce and Navy, and headed by Dr. R. Cecil Gentry of the National Oceanic and Atmospheric Administration's Hurricane Research Laboratory. It aims at learning the dynamics of hurricanes and developing techniques for diminishing their force by seeding them with silver iodide crystals. Unfortunately, nature has been none too cooperative, providing only two hurricanes suitable for seeding experiments in the nine years of the project's operation.

Hurricanes break up naturally once they reach the shore, and to observe effects of seeding, the storm must be monitored before and after seeding under conditions as uniform as possible. Therefore, seeding must be conducted on hurricanes that will remain far from land. Also, in the early phases of the program, the researchers were uncertain as to the effects of hurricane seeding and so avoided storms likely to approach populated areas.

Through 1966, the rule was that seeding would be limited to storms passing through a part of the Atlantic from which no hurricane on record had ever struck a highly populated coastal area within a day and a half. Hurricane Beulah, in 1963, was the only one to qualify. In 1967, the standards were relaxed to include any storm in the southwestern North Atlantic, as long as there were at least nine to one odds that the storm's center would stay 50 miles from populated areas for one day. The following year the test area was expanded to include the Caribbean and Gulf of Mexico. On the average, six hurricanes appear in the Atlantic each year. Even with the looser requirements, however, a second suitable storm did not develop until August 1969—Hurricane Debbie.

> "[In Florida in 1926] two hurricanes showed what a Soothing Tropic Wind could do when it got a running start from the West Indies." *

Despite the paucity of seedable hurricanes, project scientists have not been idle. Considerable progress in development of theoretical models of hurricanes has been made by researchers at the Hurricane Research Laboratory. The 1971 hurricane season has begun, and Project Stormfury will be on the alert from Aug. 4 through Oct. 31 for seedable storms. If such a storm does materialize, seeding will be conducted in accordance with refined theory.

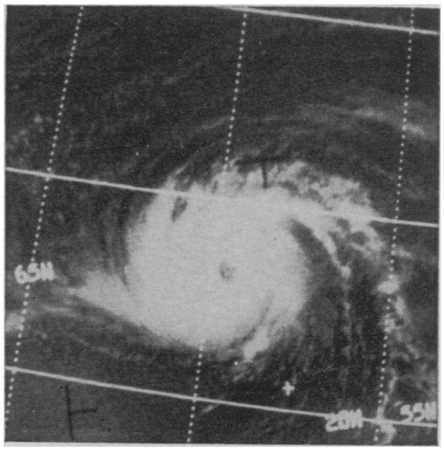
A hurricane draws its energy from convection in the atmosphere. Warm, moist air spirals toward the storm center and flows upward in a band of clouds (the eyewall) surrounding the calm eye of the storm. Surface pressure in the center of the eye is low, but rises rapidly toward its periphery. High temperature and pressure gradients are responsible for the hurricane's most destructive winds, winds that commonly reach 100 miles per hour. If the gradients are reduced, the winds will likewise diminish.

In rainmaking, silver iodide particles provide nuclei around which water vapor in the cloud can condense to form raindrops. The theoretical basis for the hurricane seeding is essentially the same. Seeding of clouds outside the eye should transform supercooled water droplets into ice crystals, and the transformation would generate heat, thus smoothing out the temperature gradient. The temperature increase would result in pressure—and therefore wind—decreases.

Seeding of Beulah and Debbie had produced encouraging results (SN: 12/13/69, p. 551). Soon after seeding, the central pressure of Beulah's eye rose and the area of maximum winds moved away from the storm center.

* Frederick Lewis Allen: ONLY YESTERDAY; New York; Harper & Bro.; 1957.

"Hitting the Gold Coast early in the morning of Sept. 18 [the second 1926 hurricane] piled the waters of Biscayne Bay into the lovely Venetian developments, deposited a five-masted steel schooner high in the street at Coral Gables, tossed big steam yachts upon the avenues of Miami. . . ." *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Debbie: Results were encouraging.

Hurricane Debbie was seeded five times in an eight-hour period on two days. Before the first seeding, on Aug. 18, winds at 12,000 feet were 98 knots. After seeding, they had decreased to 68 knots. There was no seeding on Aug. 19, and the winds reintensified. Seeding on Aug. 20 was followed by another drop in wind intensity—from 99 knots to 84.

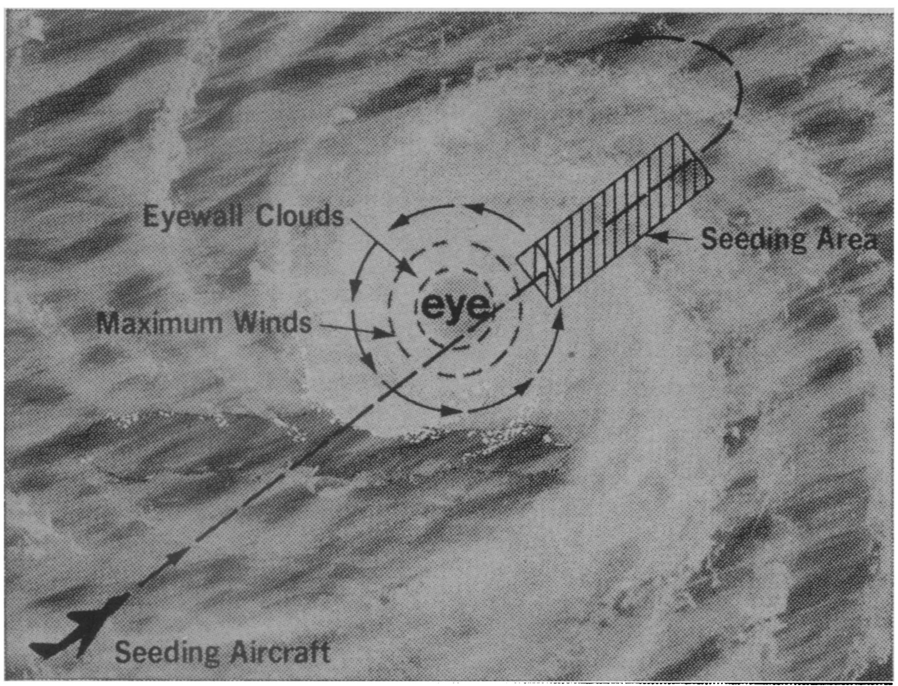
In Debbie, seeding began at the area of maximum winds and continued to surrounding rainbands—curved bands of clouds with heavy precipitation that are found some distance from the storm's eye. Though there had been large drops in wind intensity, subsequent calculations show that much greater results may be obtained by seeding further out from the area of maximum winds.

Simulated seedings of mathematical models of hurricanes have shown that, during intensification of the storm, the area of maximum heating was much closer to the storm center than the area of maximum surface winds. As the storm developed, the ring of maximum wind moved inward more rapidly than the heating maxima, and when the two coincided, the storm began to decay. From this, Dr. Stanley L. Rosenthal inferred that "at least for the model storm, heating at radii less than that of the surface wind maximum is favorable for intensification and that the reverse is true for heating at radii greater than that of the surface wind maximum."

Seeding simulations in 1969 seemed to verify this idea. Calculations showed that seeding outside the area of maximum winds resulted in decreases in intensity. Further, these decreases were of greater magnitude and longer duration than those observed when seeding crossed the maximum winds, as in seeding of Hurricane Debbie.

This year, the clouds outside the hurricane's eye will be seeded five times at two-hour intervals. Seeding runs will begin about two miles farther out from the center than in previous experiments. According to new theory developed from the laboratory work, freezing of supercooled water by seeding is only the trigger that sets off a chain reaction. The release of heat from the transformation of water to ice into the ascending air in the smaller clouds outside the eyewall would increase cloud buoyancy and cause a more vigorous ascending motion. As the air rises, it expands, cools, and its water vapor condenses, releasing additional heat.

Growth of the outer-layer clouds and the addition of large amounts of heat in the area outside the most intense clouds in the eyewall would reduce the great differences in temperature and pressure. All these changes encourage the formation of a new eyewall surrounding the original one at a larger radius. This new eyewall draws off inflowing air before it can reach the old one. The energy formerly concentrated in a tight ring around the center is thus dispersed over a greater area, causing a decrease in maximum winds. Instrumented aircraft will monitor the area from four hours before the first seeding until six hours after the final seeding.



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For greatest effect, seeding will begin outside the ring of maximum winds.

Other experiments are also planned. Rainbands may constitute an important link in the development of simple cumulus convective activity into a mature hurricane. Such a rainband would be seeded and monitored. Another experiment involves seeding a number of rainbands in an inflow sector at distances of 40 to 70 miles from the center. The purpose, like that of the principal experiment, is to disperse the storm's energy over a larger area. In a fourth experiment lines of tropical cumulus clouds that have many characteristics of hurricane rainbands will be seeded.

Though loss of life from hurricanes has decreased since the beginning of this century, they still rank high among weather killers, and property damage has risen sharply. During the five-year period 1925-29, hurricanes caused less than $400 million in damage. For the period 1960-64, hurricane damages were nearly $1.2 billion. In 1970, a single hurricane—Celia—caused an estimated $454 million damage. As more and more expensive buildings are constructed in coastal areas, the cost of hurricane damage is expected to continue to rise.

In spite of nature's lack of cooperation in providing suitable hurricanes for experimentation, Project Stormfury scientists estimate that if Federal hurricane modification research continues at the present level for a decade and if, in that time, one severe hurricane can be weakened so that its damage is reduced by as little as 10 percent, the investment would have been returned tenfold. □