

Review of Recent Hurricane Research

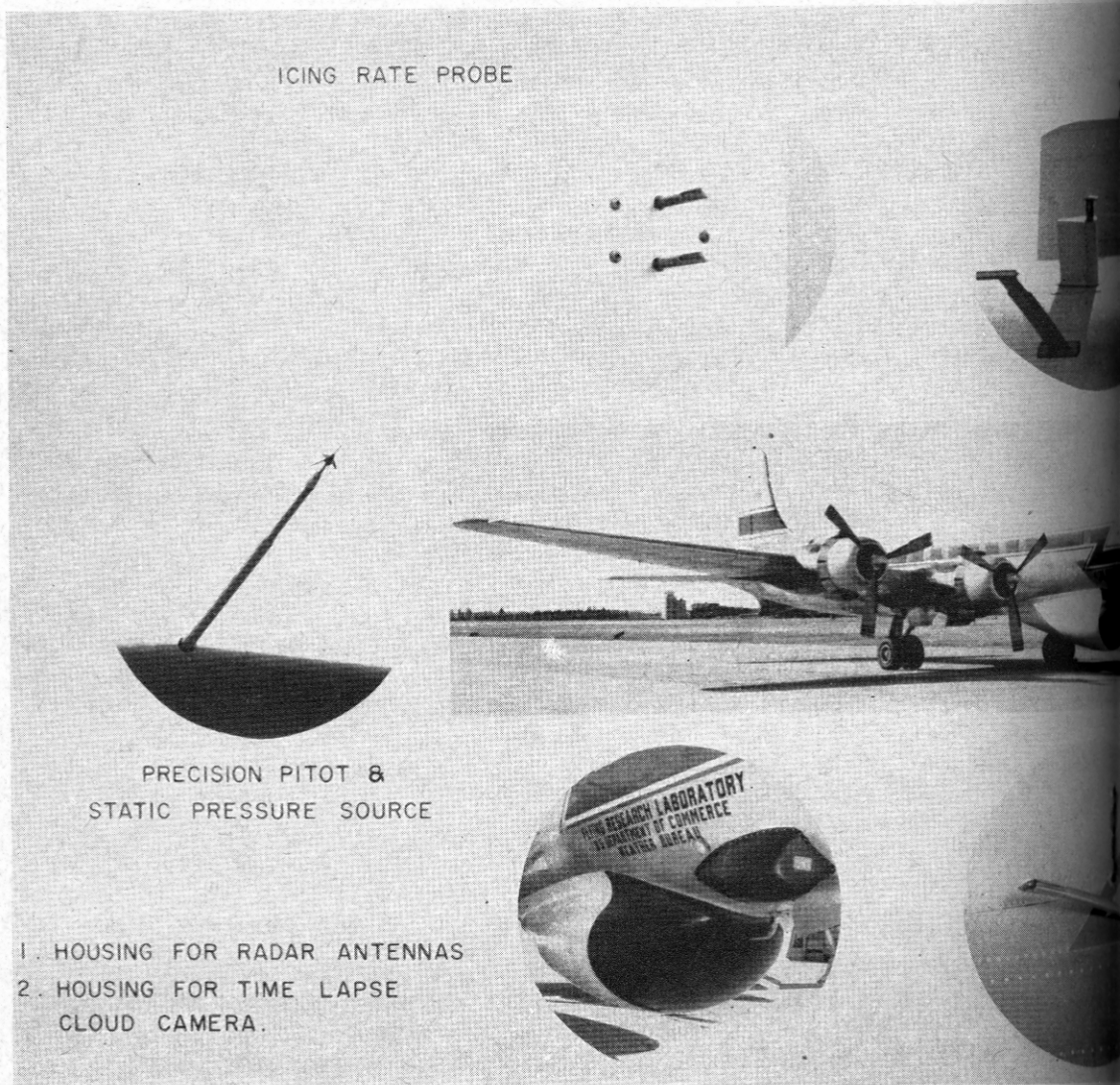
ROBERT CECIL GENTRY, *Acting Director, National Hurricane Research Project, Miami*

DATA COLLECTION

THE West Indies network has been expanded by adding a station at Bogota, Colombia. The West Indies network is a cooperative effort of several foreign countries and our own. The government of Colombia is establishing this station at Bogota with assistance from the National Hurricane Research Project of the Weather Bureau. The

addition of this station makes a total of nine which have been established since the start of the intensified effort for research on hurricanes.

Radiometer soundings are being taken at selected Caribbean stations during this hurricane season. These observations of the terrestrial radiation are secured by means of a



ICING RATE PROBE

PRECISION PITOT &
STATIC PRESSURE SOURCE

1. HOUSING FOR RADAR ANTENNAS
2. HOUSING FOR TIME LAPSE CLOUD CAMERA.

DC-6 Meteorological Probes

small device attached to the radiosonde box. The observations are conducted as part of a joint project between the U. S. Weather Bureau and the University of Wisconsin. It is expected that this series of observations over the Caribbean will provide information on the important problem of the radiation processes in the atmosphere and will afford insight into the energy processes which prevail during periods of disturbed weather which sometimes lead to the formation of hurricanes. The infra-red radiation studies at the University of Wisconsin are directed by Dr. V. Suomi who has been a leader in the program which

is now securing radiation observations from satellites. The radiation data collected during orbits of the satellite Explorer VII are being used for comparison with the data collected from the radiometer soundings. The soundings are made at the following stations: Weather Bureau Airport Stations at Miami, Florida, and San Juan, Puerto Rico; Cooperative Hurricane Observation Stations at Curacao, Grand Cayman, and Sint Maarten; the Naval Air Station at Trinidad, and Albrook Air Force Base, Canal Zone.

IN ASCENDING ORDER

1. VORTEX THERMOMETER.
2. ROSEMOUNT TOTAL TEMPERATURE PROBE.
3. PAPER TAPE LIQUID WATER CONTENT METER.
4. HOT WIRE TYPE WATER CONTENT METER. (Above housing)



AIR INTAKE & EXHAUST FOR
INFRA-RED HYGROMETER SYSTEM

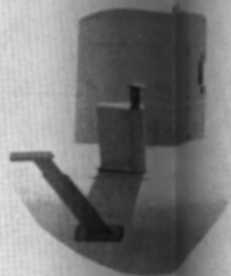
REVERSE FLOW THERMOMETER

Data recording pods are again being carried by the hurricane reconnaissance planes of the Air Force stationed at Bermuda. This is a cooperative effort of the Air Weather Service and of the Weather Bureau. These pods are modified wing tanks which contain photopanel for photographically recording the data measured during flights into hurricanes by the Air Force planes. Data collected in this manner during the 1959 season have proven to be very valuable additions to the data library of the National Hurricane Research Project. This is another of the means which is being used to extend the primary data collection of NHRP at minimum expenditure and risk.

The three new research planes instrumented by the Weather Bureau for the National Hurricane Research Project have been used during this season for reconnaissance of hurricanes and other circulations in the tropics. The three planes are: two DC-6's which are rented by the Weather Bureau, and one B-57 jet which is bailed to the Weather Bureau by the Air Force. These airplanes are successors to the three aircraft formerly furnished and operated by the Air Weather Service of the Air Force, two B-50's and one B-47. The new planes' instrumentation systems have been modernized based on the experience of the three-years operation of the older reconnaissance aircraft.

New weather search radars, WSR-57, are either installed or in the process of being installed at Brownsville and Galveston, Texas; Lake Charles and New Orleans, Louisiana;

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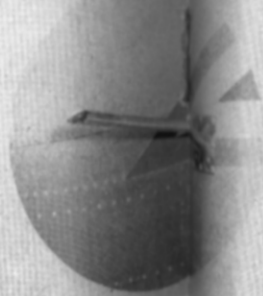


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REVERSE FLOW THERMOMETER

Apalachicola, Tampa, Miami, Key West, and Daytona Beach, Florida; Charleston, South Carolina; Wilmington, North Carolina; Washington, D. C.; Atlantic City, New Jersey, and New York, N. Y. Older but equally powerful radars are operated by the Weather Bureau at Nantucket, Massachusetts; Hatteras, North Carolina; and San Juan, Puerto Rico. Weather radars are now scanning the coastal areas from Portland, Maine, to Brownsville, Texas.

When a storm is approaching, Weather Bureau radar specialists have been manning radar sites of the Air Defense Command as necessary to augment coverage of the Weather Bureau's own radar. Arrangements have also been made to obtain observations from radars at the Air Force Atlantic Missile Range stations.

The Weather Bureau's hurricane warning service continues to depend on Air Force and Navy reconnaissance planes for reports on location, intensity, and movement of hurricane and tropical storms at sea. Detachment 3 of the Air Force 55th Weather Reconnaissance Squadron, with headquarters at Kindley Air Force Base, Bermuda, and the Navy Hurricane Hunters of the Airborne Early Warning Squadron Four, which is now based in Puerto Rico, have continued to make their reconnaissance sorties into tropical cyclones.

CURRENT RESEARCH

One experiment being conducted at Miami this summer is designed to determine if air motions in the lower and upper layers of the troposphere can be used to ascertain when rain should occur. The mean winds for the layers 3- to 10,000 and 37- to 42,000 feet are used in computing divergence and vorticity for those layers for southeastern United States and the Caribbean area. The hypothesis is that convergence in the lower layer and divergence in the higher layer should correspond to areas of heavier rainfall because such patterns would cause larger amounts of ascending air motion. Likewise, convergence in the upper layer and divergence in the lower layer

should be associated with sinking motions and little or no precipitation. To test the hypotheses the vorticity and divergence patterns computed from the winds are compared with amount of rainfall activity observed by the long-range radars. So far, results are encouraging.

The main hurricane forecasts issued by the Weather Bureau for the general public are for 12 to 24 hours in advance, to warn people to evacuate threatened areas and to make last minute preparations prior to the onslaught of hurricane force winds. Because of the time lag inherent in observing, collecting, and analyzing data, and in preparing hurricane advisories, it is necessary to make a forecast for a period extending 30-36 hours after the time of data observations, in order for the forecast to be for 24 hours after it is received by the public. The National Hurricane Research Project is working in cooperation with the Travelers Research Group to develop a technique for forecasting hurricane motion for 36 hours in advance. This technique is being checked during this hurricane season.

The climatology of North Atlantic tropical cyclone movements has been brought up to date by George W. Cry, Office of Climatology, U. S. Weather Bureau. He has prepared a paper which contains tabulations by months of 24-hour tropical cyclone movements in 68 selected areas covering most of the North Atlantic Ocean, and that section of North America affected by these storms. The frequency of tropical cyclone passages through each area, and month and year of storm origin or detection in each area are also shown. Nine additional charts are presented in this study to depict those portions of the tropical cyclone tracks containing complete loops and the areas of recurvature or change in direction of storm movement.

"A numerical experiment on the development of a tropical cyclone," by Dr. A. Kasahara of the University of Chicago, has recently been completed. This report deals with a model of a tropical cyclone constructed on the basis of the conservation of momenta

(radial and tangential), mass, water, water vapor, and heat in the hydrostatic system. The horizontal and vertical eddy exchange processes for momentum, moisture and heat are included in the equations in order to incorporate the planetary frictional layer into the model. The effects of the surface boundary (Prandtl layer) are simulated by the boundary conditions for the equations which permit the evaluation of surface drafts, sensible heat transport, and the evaporation of water vapor from the earth's surface. Energy sources of the model are the latent heat of condensation released during the ascent of moist air and the sensible heat transported from the ocean surface. The balance of total energy may be obtained with the sinks of energy due to frictional dissipation and atmospheric radiation processes.

Recent studies at the University of Miami, Radar Laboratory, have been directed toward better interpretation of radar presentations of tropical cyclones. A recent study made by Mr. Harry Senn of that group has attempted to identify typical radar patterns which may be useful in forecasting hurricane motion or hurricane intensification. In several storms of the last ten years, echoes that resemble a carrot in shape have occurred along the forward periphery of a hurricane. In the studies that Mr. Senn has made, these "carrot-shaped" echoes have been typical of storms which have moved in similar fashion. Preliminary indications suggest that identification of these or other typical echoes may be useful in forecasting hurricane motion or in identifying changes in hurricane motion at an early stage.

A typhoon research group in Japan was enlarged several months ago following the typhoon disaster which killed so many people in the islands of Japan. This group has been working in cooperation with the National Hurricane Research Project of the United States for some time and has prepared a film to be used for educational purposes in Japan. While the movie, of course, has a Japanese sound track, a considerable portion of the footage of the film was taken either by the National Hurricane Research Project of the

United States or by the Air Weather Service of the U. S. Air Force. Copies of this film have been sent to the National Hurricane Research Project as partial fulfillment of some contract work being done by the Japanese group.

The Hydrologic Services Division of the Weather Bureau has been working on presentations of different parameters in hurricanes (both actual and idealized) in such a manner as to assist the U. S. Corps of Engineers in assessing surge-producing potential of storms. These studies indicated that, at least along the northern portion of the Atlantic seaboard, it is entirely possible for middle latitude storms to have a higher surge-producing potential than hurricanes at the same latitude. In consequence, work is now being done on development of "typically severe" parameters of middle latitude storms (winds, pressure, etc.). These studies are being made to help the engineer make the choice of a "design storm," one against which it will be economically justifiable to construct coastal protective works.

In recent years there have been cases of tornadoes being associated with hurricanes. To determine how serious a problem this may be to the forecaster, studies are being conducted of tornadoes associated with hurricanes and tropical storms by R. C. Schmidt, Chief District Meteorologist, Washington National Airport, Weather Bureau, and Banner I. Miller, one of the research meteorologists at the National Hurricane Research Project, Miami. Some preliminary indications of the study by Schmidt suggest that the chances of tornadoes in hurricanes appear to increase when air from a second source penetrates well into a hurricane circulation and that they are less likely when the air circulating through the hurricane is composed of homogeneous tropical air. However, since tornadoes and hurricanes have been reported in only a small percentage of the cases when non-homogeneous air enters into the circulation, further stratification will be attempted. In some of the storms studied for the Florida area by Miller, it has been determined that the hurricanes have occurred in the homogeneous air.