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WEATHER RECONNAISSANCE

Report on Hurricane Reconnaissance Operations
During 1944

by Major I.I. Porush

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SUBJECT: Transmittal of Report for Publication.

TO: Commanding Officer
AAF Weather Wing
Asheville
North Carolina

1. Reference is made to paragraph 2, letter, this office, file 461, subject, "Paper on Forecasting Tropical Cyclones," dated 14 April 1945. The "Report on Hurricane Reconnaissance Operations During 1944," has been edited by this office and is submitted herewith.

2. It is recommended that this report be submitted to the editors of Air Force, published by Headquarters, Army Air Forces, for publication.

1 Incl:
Report on Hurricane Reconnaissance with Forward.

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HURRICANE RECONNAISSANCE

FORWARD

Wartime restrictions on radio transmission by ships at sea eliminated an important source of weather information over ocean areas. Since hurricanes form and spend most of their life history over water, forecasters were compelled to find other sources of weather data to provide adequate warnings of the approach of these dangerous storms. The violent nature of hurricanes reported by observers on land and sea discouraged aircraft flights into these areas, with the result that aircraft reconnaissance of tropical cyclones was relatively unknown until 1943, despite the rapid advance of this type of weather observing in other areas. A few accidental flights into hurricanes had been successfully completed by experienced pilots in the past and their reports generally indicated that these storms were less dangerous to aircraft in flight than was originally anticipated.

During the 1943 hurricane season, exploratory missions by aircraft with weather trained personnel had been planned into tropical storms and successfully completed. Reports from these flights revealed that routine hurricane reconnaissance could be accomplished by experienced instrument pilots operating suitable types of aircraft.

In 1944, Headquarters Army Air Forces assigned four aircraft and crews to the Army Air Forces Weather Wing for hurricane reconnaissance. Their primary mission was to provide weather reports in storm areas to determine the intensity, location, and extent of the storms. These aircraft were under the operational control of the Army Hurricane Weather

Incl #1 2

Officer at Miami, Florida. Flights were directed into all suspected and known tropical disturbances, as determined from synoptic weather charts.

Areas covered by the Army Hurricane Reconnaissance Unit included the entire Gulf of Mexico and Caribbean Sea, and the western Atlantic Ocean, from Bermuda to Cayenne, French Guiana on the northeast coast of South America. Strategic deployment of the aircraft to bases in the United States, Caribbean Islands, Bermuda and Panama was accomplished as required by the particular weather situations.

The 1944 hurricane season proved to be an exceptionally active one, and provided the reconnaissance crews with more than ample material for studying the effect of hurricanes on aircraft in flight. A total of forty eight missions were flown into ten tropical storms and hurricanes occurring during this season. Reconnaissance flights by this unit were made into all stages of development of these storms, providing valuable information on the changes in flying characteristics as their intensity increased.

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REPORT ON HURRICANE RECONNAISSANCE OPERATIONS DURING 1944

This summary of the operation of the Army Hurricane Reconnaissance Unit during 1944 was prepared after an informal meeting of the personnel of this unit at the end of the hurricane season, to determine the flying characteristics and operational difficulties encountered in performing hurricane reconnaissance missions. It is believed that this summary will be helpful to crews who might perform reconnaissance missions of this type in the future.

Four B-25D aircraft, equipped with extra gas tanks for long range cruising, were used during the entire season. It is the opinion of the pilots of the Reconnaissance Unit that this type of aircraft is most suitable for sustained hurricane reconnaissance operation. A B-3 drift meter was the only special equipment installed because there was insufficient time to permit installation of other meteorological equipment which might have been used for research purposes. This type of drift meter is considered essential to insure accurate wind measurements under turbulent air conditions. The installation of a true altimeter would aid in the determination of the intensity and extent of the storm by making possible the computation of pressure at flight level.

Each crew consisted of pilot, co-pilot, navigator, weather officer, radio operator, engineer and crew chief. None of the crew members had experienced hurricane flying prior to this season. The first pilots had approximately fifteen hundred hours flying experience with about seven hundred to one thousand hours in B-25 type aircraft. White instrument cards were held by all first pilots. (Only one crew was necessary for each aircraft, since maintenance requirements usually allowed them sufficient time on the ground for resting between missions.)

Operational efficiency of the aircraft was about 50 to 75% except during one month, when major repairs grounded all of the aircraft for about three weeks and resulted in only 0 to 25% efficiency. Navy Reconnaissance supplemented the operations of the four Army aircraft, resulting in one to three flights daily into suspected and confirmed tropical cyclones during the entire season.

The Army Hurricane Weather Officer at Miami determined the approximate routes to be flown, after coordination with the Navy and Weather Bureau Hurricane Liaison Officers at Miami. Variation of flight plan, to obtain a maximum of information on the location, intensity and extent of the storm was made during the flight on the recommendation of the weather officer aboard the aircraft. Observation of clouds, weather and surface winds over the ocean were made by the weather officer. The position of the aircraft and wind measurements were determined by the navigator, who relayed this information to the weather officer by interphone. The weather officer coded the observation in WAF-2 and relayed the message to the radio operator for transmission to the Miami Hurricane Center.

Flying conditions encountered in the storm areas varied with each storm, and with the maturity and sector of the same tropical cyclones, but some consistent characteristics were observed which permit certain generalizations to be made regarding the type of weather found.

The outer edges of all tropical cyclones were characterized by stratiform clouds, usually consisting of a high overcast of cirrostratus and lower deck of stratocumulus clouds with bases at about 2,000 feet and tops about 5,000, indicating stability of the atmosphere, and resulting in relatively smooth flying between these layers.

On some occasions a squall line was encountered south of the storm center, consisting of extensive cumulonimbus activity about 25 to 75 miles in width. This squall line extended as far as 400 miles south of the storm center in some cases and had a rather sharp beginning and ending when flying across its width.

Within the storm area, clouds consisted of many irregular layers of stratocumulus and altostratus, with cumulus built up between these clouds. The tops of these cumulus varied between 8,000 and 12,000 feet and occasionally extended to above 20,000 feet. More cumulus and cumulonimbus activity was found in the formative and immature stages of storms than in the mature stages. This is probably due to the shearing-off of any extensive vertical development by strong winds found in mature hurricanes. In practically all cases, the southwestern quadrants of the storm offered the most favorable flying conditions in the approaches to the storm area and often within the storm itself.

At no time was a perfectly clear storm center encountered. There were instances near the center of the storm when breaks were found in the upper cloud decks through which sunlight was visible; but wind measurements, which are considered more reliable than cloud observations in locating the storm center, did not confirm the existence of a calm center. Most storms had very small centers, and it was very improbable that it would be encountered by an aircraft flying at 200 mph or more. It is believed that the installation of an absolute altimeter on the aircraft would aid considerably in locating the exact center, by using it in conjunction with the pressure altimeter for computing actual pressures.

Some storms were characterized by extreme turbulence, while in others flying was relatively smooth. One crew flew two missions into the Wilmington hurricane of August 1944 while it was still over the Atlantic and found absolutely no turbulence. Wind speeds were recorded up to 80 mph in this hurricane. All four of the crews flying a total of seven missions into the great Atlantic hurricane of 7 to 15 September 1944 reported extremely violent turbulence within 100 miles of the storm center. Wind speeds of 150 mph were reported in this hurricane. Severe turbulence was also encountered within 25 miles of the center of the Florida hurricane of October when it was just south of the Isle of Pines. Winds of 120 mph were reported in this storm.

It is the opinion of the crew members that turbulence, encountered in the formative and immature stages of storm development, is almost entirely due to vertical convection within cumulonimbus and cumulus clouds. This also accounts for the turbulence experienced in the squall line associated with mature hurricanes. Turbulence encountered in the formative and immature stages of the hurricane was negligible and no more severe than the type found in average thunderstorms.

Turbulence encountered near the center of mature hurricanes, is believed to be due mainly to the extremely gusty character of the winds. Horizontal wind velocity variations may amount to 50 to 75 mph in gusts when average velocities are over 100 mph. This results in buffeting of the aircraft, giving the effect of vertical turbulence, but is actually much more dangerous because it causes the plane to yaw violently from side to side with the wings level, tending to cause loss of control of the aircraft. The lower the altitude the more pronounced was this effect. For this reason mature hurricanes of large diameter with winds above 100 mph are considered to be unsafe for aircraft flying within 75 to 100 miles of the center at altitudes below 3,000 feet. This is particularly true if the aircraft has high stall characteristics or low cruising speeds.

When flying the type of turbulent air found in mature hurricanes, it was found advisable to strive only to hold wing level flight. It was not found advisable to attempt to hold a definite altitude. Turbulence of any type was not considered to be serious for short periods of time, but prolonged flight under these conditions tired the pilot and made it appear as though it was becoming more severe as time passed.

Heavy rain was encountered in tropical storms during immature and mature stages. The intensity of the rainfall was found to be greater than that encountered in ordinary weather flying. Crews have emerged from the hurricane area completely soaked, even in supposedly water tight planes. The only effect of heavy rain on instrument flying is filling of the pitot tube with water, causing air speed and altimeter instrument error by blocking the passage of air through the pitot-head. Application of pitot heat usually prevented this from occurring.

Sustained operation through unusually heavy rain created certain problems which may not occur when only an occasional flight is made under these conditions. These effects are listed below:

1. Wet Magneto Rotors: In the five months of operation, each aircraft required about three changes of the magneto rotors. Very rough engines on takeoff indicated this trouble.

2. Quantities of water found in the cannon plug of the electrical wiring from the oil temperature thermocouple to the junction box of most aircraft caused errors in, or complete failure of the oil temperature gauge.

3. Each fifty hour inspection revealed large amounts of water in side the sparkplug shields. In order to prevent the water from affecting the ignition, neoprene harnesses were used, and Dow-corning compound (glass paste) was applied to the top of each sparkplug at the point where the ignition cigarette is inserted. This kept water in the harness from coming in contact with the sparkplug. Water in the harness shielding is harmless if kept out of contact with an open wire or sparkplug.

4. Collection of water in various compartments of the aircraft was of little importance. Several gallons of water accumulated in the lower floor of the fuselage along the plate which covers the lower turret opening in the B-25. Small amounts of water also collected in the rear tips of the engine nacelles. Small holes were drilled through the metal at the lowest point of the fuselage and nacelle to allow this water to drain out.

5. Rain entering the airscoop caused rough engines due to additional leaning of an already low fuel-air mixture in some instances. Advancing the mixture control to full rich caused the rough engines to smooth out in all cases. The condition of the engine and carburetors

determined the extent of this effect.

6. Pitot heat was applied at all times when flying in rain to prevent moisture from clogging the pitot lines. Erratic altimeter readings and lowering of indicated air speed resulted from clogged pitot lines.

7. Cylinder head temperatures dropped from a normal reading of 180°C to below 100°C in a very short time due to cold rain hitting the cooling fins. This sudden drop of cylinder head temperature is dangerous because cracked cylinders may result. In some cases it was found advisable to boost RPM and manifold pressure to keep the cylinder head temperature up. A constant watch of the temperature was maintained, and power added when engine temperature begins to drop. Wheels were dropped when the speed resulting from the addition of power was considered excessive. In severe turbulence due to gustiness, it was not considered advisable to extend the wheels on the B-25 type aircraft.

8. After all flights through heavy rain it was recommended that parachutes be inspected. Repacking was found to be necessary long before the date this was due.

The most common results of turbulence encountered over an extended period were:

1. Loosened rivets along the nose section below the pilot and co-pilot's window.

2. Cracked engine ring cowling.

3. Cracks in the vertical stabilizer.

4. Loosened control cables. (It is recommended that a thorough cable tension check be made every 100 hours).

Rain static and thunderstorm activity caused unsatisfactory air to ground communications when flying within storm areas. In order to eliminate excessive delays and to insure that all reports were received from storm areas, radio operators were instructed to repeat the transmission of all reports not receipted for by one of the selected ground stations as soon as it could be contacted. In many instances this contact could not be made until the aircraft left the storm area.

Occasionally the trailing wire antenna weight or "fish" was broken loose in periods of turbulence. Additional weights were carried to replace those lost. Large sparks were seen to arc between sections of the antenna wire in lightning areas around thunderstorms. Radio operators were instructed to wind in the trailing wire during flights through areas of lightning.

Radio reception and transmission was found to be better at altitudes above 7,000 ft than below 4,000 ft.

PROCEDURES IN FLYING THE STORM

The primary purpose of hurricane reconnaissance was to determine the position, intensity and extent of tropical cyclones. Locating the storm center by aircraft reconnaissance was found to be most accurate by a flight completely around the storm near the center. Weather conditions near the storm center, however, were usually most unfavorable for safe flying, and at a safe altitude above 2,000 ft., clouds obscured the sea surface preventing the Navigator from obtaining the required drift readings.

The recommended procedure for hurricane reconnaissance was, therefore, to fly around the periphery of the storm. This was accomplished when the storm did not cover too large an area, and was not too far from the base from which the aircraft departed or its destination. Flying around the periphery of the storm had the following advantages: 1) a minimum of instrument conditions were encountered, and more frequent observations were possible, 2) radio transmission was usually more favorable, 3) more accurate navigation, resulted in correct positions for weather observations, 4) tailwind was experienced during entire flight, 5) the pressure altimeter was a more accurate indication of the true altitude.

In circumnavigating the storm, a heading was maintained toward the storm until it had been determined from wind measurements that the aircraft had entered the storm circulation. A downwind heading was then established from this point and maintained until the wind direction was found to be nearly perpendicular to the flight path, and the course was again changed so that the aircraft headed with the wind. This procedure was continued until a north, south, east, and west wind component had been found.

Other procedures used included flying a straight course across the storm near the center, and circumnavigation near the center. These were the only possible methods when the storm was of large diameter or was distant from the bases of arrival and departure of the aircraft. It was not possible to maintain a contact flight under these conditions, and wind measurements could not be made near the storm center except at infrequent intervals below 3,000 ft., when breaks were found in the lower clouds.

It was found that a flight altitude between 3,000 and 5,000 ft., was best for reconnaissance within the storm area by B-25 aircraft. This altitude was sufficiently high for safe flight, and there were usually sufficient breaks in the lower clouds to permit visual observation of the sea surface for drift determination. On several flights it was necessary to descend to 1,000 ft., in order to establish this visual reference. Since the central pressure of the storm was not usually known with sufficient accuracy, the altimeter was reset to 28.5 inches or lower when flying on instruments in mature hurricanes.

Drift readings were made with the B-3 drift meter, and wind velocity and direction determined on the B-6-B computer, from three headings. When drift angles exceeded those allowed for on the B-6-B computer, the wind was computed by taking one half the air speed and doubling the resulting quantity to determine the actual wind velocity.

Surface winds were estimated by visual reference to the sea surface.

Navigation on hurricane reconnaissance flights was performed entirely by dead reckoning. This was usually accurate because of the frequent drift readings, although in very strong winds, there was always the possibility of error. Clouds above the aircraft prevented the use of celestial navigation, and static interfered with radio navigation.

The perfect safety record of the Hurricane Reconnaissance Unit is satisfactory evidence that sustained flights through hurricanes can be successfully made in B-25 type aircraft, provided that the pilot has had sufficient flying experience. In most storms the flight conditions were no more dangerous than flying through ordinary thunderstorms, while in others, especially in the great Atlantic hurricane, a high degree of flying proficiency was essential for the successful completion of the mission.

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