

Hurricane Camille: August 1969

Reconstruction of Hurricane Reconnaissance Aircraft Operations:

a Timeline

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Camille: "A Moment of Change"

The history of hurricane reconnaissance, the history of aircraft that have flown into tropical cyclones for reconnaissance, surveillance and or research purposes *(since WWII),* is currently unrealized – as it is represented in the public domain *(the universal public record; made up of the information contained in newspapers, magazines, books and the internet)*. The history of hurricane reconnaissance and the aircraft involved in it is much more comprehensive and convoluted than the public domain presents; with the history of Hurricane Camille just a very small example of this perception -vs- reality of history.

In 1969, despite a perceived air of business-as-usual in the Atlantic hurricane warning service and at the National Hurricane Center *(NHC)*, one unsuspecting seasonal storm materialized in the eastern Caribbean to make it all come crashing down, and then become the impetuous of renewal, the beginning of a new era for hurricane tracking, the evolution of tropical cyclone reconnaissance and the hurricane hunting aircraft so important to it.

Hurricane Camille became a turning-point in the evolutionary history of hurricane reconnaissance. In the fallout over the failures of the Atlantic hurricane warning and tracking network in the wake of the storm, due in part to the limitations and lack of capabilities attributed to the *(then)* various military hurricane reconnaissance aircraft assigned to fly the storm, new congressionally approved funding was appropriated to update, upgrade and improve the Atlantic hurricane warning and tracking network and especially the aircraft conducting reconnaissance flights. *(Mostly to the perceived level that the Government, and the public in general, believed the network was before the storm.)*

However, a recent scientific reanalysis of Hurricane Camille *(a technical article entitled;* ***"A Reanalysis of Hurricane Camille" BAMS Volume 97, No.3, March 2016****),* focused primarily on the intensity of the storm as it relates to its standing as the most powerful hurricane to strike the continental United States, based upon realigned storm data associated with on-going re-assessments of the NHC's *HUR*ricane *DAT*abase *(HURDAT)* computer database archive *(at the heart of modern hurricane forecast models),* the authors unwittingly perpetuated miss-leading, misconstrued and incorrect historical information about the reconnaissance operations flown during the storm *(drawn from incorrect or inaccurate internet references and seemingly official reports that further contained incorrect or misleading and in some cases biased information)* that were not verified *(or re-verified)* by deep archival research. This reanalysis of Camille additionally suffered from omitted information that has not yet made its way into the mainstream public domain, but was readily available through deep archival research, that would have aided the accuracy of their description of events that transpired during Hurricane Camille - that ultimately lends itself to the accuracy of their premises' and conclusions.

In this regard**,** this document ***"The Reconstruction of Hurricane Camille's Hurricane Reconnaissance Aircraft Operations: a Timeline"*** has been produced in an effort to more accurately present the historical hurricane reconnaissance operations conducted in Camille. This timeline reflects research containing information from US Navy and USAF Air Weather Service archival records as well as information provided by some of the US Navy and Air Force Hurricane Hunters that actually flew the reconnaissance flights on Camille. This timeline is the most comprehensive historical record of the reconnaissance aircraft activity conducted during Hurricane Camille and reveals additional information that corrects the misunderstood, misconstrued and or inaccurate historical information surrounding the recent reanalysis of Camille's intensity and track just prior to landfall.

It is hoped that this publication is influential in calling for a reanalysis of the most recent published reanalysis of Hurricane Camille, that at its core has fundamental historical flaws calling its premise's and conclusions into question.

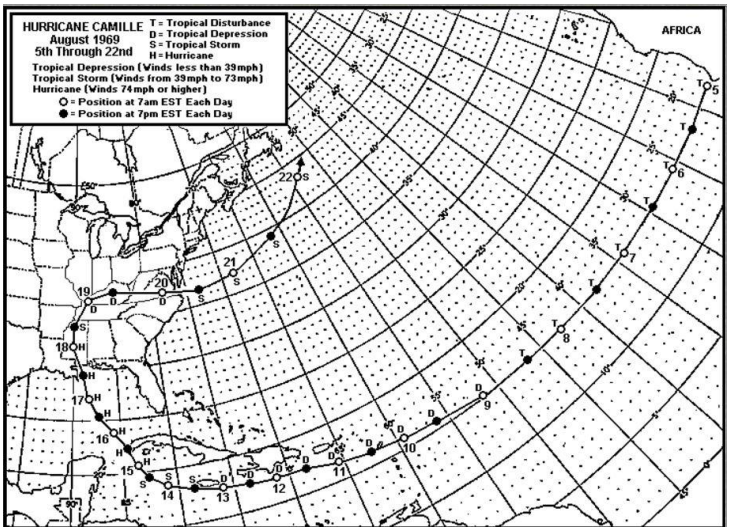
Hurricane Camille's Reconnaissance Aircraft Operations Timeline

Editorial Note: *this document is based upon deep archival research of USAF Air Weather Service headquarters, 9th Weather Reconnaissance Wing (previously 9th Weather Reconnaissance Group) and 53RD Weather Reconnaissance Squadron historical, operational, logistical and administration records, US Navy Hurricane Reconnaissance Squadron (VW-4) historical records and the recollections of US Navy & USAF squadrons personnel (and their flight log data) who actually flew on Camille as well as various government reports written in the aftermath of the storm – as well as other archival references. The following comprehensive timeline of the hurricane reconnaissance operations conducted in Hurricane Camille is further annotated with little known or unknown information surrounding the state of the hurricane reconnaissance aircraft tasked to fly this storm and the little – perceived general state of the Atlantic hurricane warning and tracking service (network) at the time Camille materialized in early August 1969 – that all has bearing on the accuracy of the recently published reanalysis of Hurricane Camille.*

Hurricane Camille (5-22 August 1969) was a Cape Verde type storm that was first detected by the Nimbus 3 weather satellite as a tropical disturbance near the Cayman Islands on 14 August 1969, and quickly moved through the western Caribbean and up into the Gulf of Mexico as it intensified – or so the public domain would have you believe. In actuality, components of the US Department of Commerce's Environmental Science Services Administration *(ESSA),* National Environmental Satellite Center *(Washington DC)* began tracking what would later become Camille as a tropical wave that rolled off the West African coast nine days earlier – as part of an NESC experimental program to track newly formed tropical waves that would eventually develop into mature hurricanes. Several existing operational and *(then)* new experimental meteorological satellites were employed in this effort including; the ESSA 8 and ESSA 9 *(sun-synchronous)* weather satellites, an experimental *(at the time)* Nimbus 3 *high resolution / Infrared radiometer – equipped* satellite and the NASA ATS-3 satellite *(equipped with the multi-color spin scan cloud camera)* were used to track developing storm *(cyclogenesis)* in the Atlantic day or night beginning in 1969. In general, the satellite surveillance program detected 39 tropical cyclones in their infancies, during 1969 alone, including 12 Atlantic hurricanes, 10 Eastern *(North)* Pacific tropical storms and hurricanes as well as 17 Western *(North)* Pacific typhoons.

(5 August) - on this day, the ESSA 9 satellite captured the telltale signs of an *"Inverted V"* cloud pattern of a tropical wave *(a low pressure trough that originally formed over the Abyssinian Plateau of Ethiopia, East Africa)* roll off the west coast of Africa, near Dakar, Senegal. The tracking of this wave continued westward for several days along the 15th parallel *(north)*, before a US Air Force reconnaissance aircraft was sent out to investigate the disturbance.

This is a NASA ATS-3 Satellite photo of a series of tropical waves that rolled off the west coast of Africa, near the coasts of Guinea and Sierra Leone, in July 1969. This view, with its east-west orientation, presents the synoptic-scale wave (cloud distribution) patterns or the "Inverted V" cloud patterns that are often associated with tropical waves that can development into tropical cyclones. Camille had a similar tropical wave cloud pattern look on 5 August 1969. ***Courtesy:*** *Barbados Oceanographic and Meteorology Experiment (BOMEX) program archive – circa 1969.*



The actual extended track of Hurricane Camille; from when it rolled off the West African coast, near Dakar, and tracked along the 15th Parallel (north) westward as a tropical wave into the Caribbean and ultimately the Gulf of Mexico.

(9 August) - USAF Weather Reconnaissance Flight: *Gull Hotel Synoptic Recon Flight*

On this day, ESSA 9 satellite imagery revealed a possible change in the tropical wave pattern that had been under surveillance since the 5th *(that would eventually give rise to Camille)* into a possible tropical depression. A USAF WB-47E Stratojet from the 53rd Weather Reconnaissance Squadron *(WRS)* in Puerto Rico flew a Gull Hotel synoptic reconnaissance *(investigative)* mission on this disturbance as it tracked towards the eastern approaches of the Lesser Antilles.

Air Force Gull Hotel synoptic reconnaissance tracks were established to detect low pressure fronts, east of the Windward Islands. This USAF weather reconnaissance / investigative mission *(having transitioned into Gull 7 – Cyclone)* intercepted the area of disturbed weather as it neared the eastern approaches of the Lesser Antilles, some 480 miles *(773 kms)* due east of the northern group of the Leeward Islands - specifically east of the area of Guadeloupe, Antiqua and Barbuda - and confirmed that the tropical wave had indeed transitioned into a tropical depression. Winds gusts of 20 mph *(32 km/h)* were recorded by the Air Force reconnaissance aircraft, with intermittent rains showers, but no evidence of further circulation.

A weather reconnaissance WB-47E Stratojet - USAF Photo

Note: *there has been much confusion within the public domain with regards to AWS WB-47Es having flown Gull Hotel missions. AWS personnel during these years (not necessarily associated with WB-47E operations) categorically say that the WB-47Es did not fly Gull Hotel Tracks, while little known post – Camille reports, AWS-HQ aircraft operational records and the general USAF history references of the B-47 suggest they did. Given specific references in aircrew recollections that they did, some particularly associated with Camille, it is represented here for the first time that WB-47E did fly Gull Hotel and Gull Cyclone flights during their operational history, and for this document specifically during Camille.*

(10 August) – moving due west, the tropical disturbance that would become Camille moved across the northern Leeward Islands, near Guadeloupe with gusty winds of 10 kts *(12 mph / 19 km/h)* and moderate gusty rains. It's at this time that the disturbance enters the Eastern Caribbean Sea.

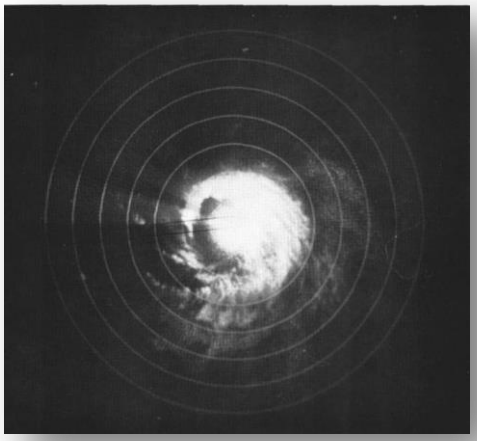
The tropical depression, over the next several days, continued in a westward progression and passed to the south of Puerto Rico. Later the center of the storm *(on the synoptic charts, aided by satellite imagery)* was fixed approximately 100 miles *(161 kms)* south of Cabo Beata, Hispaniola *(Dominican Republic and Haiti)* on 12 August. Over at the hurricane center, ESSA satellite images of this system were scrutinized by researchers questioning if this storm might

develop into a suitable candidate for their *"Project Stormfury"* hurricane modification experiment. However, it was later determined that the probability of this disorganized *(tropical)* area of disturbed weather intensifying into a hurricane was low, and if it did, would be too close to land to be seeded. Interest in this disturbance quickly waned and became of no further concern to the Stormfury meteorologists.

This depression would later brushed the south coast of Jamaica on the afternoon of 13th all under the watchful eyes of the various weather satellites involved in the little known cyclogenesis *(satellite)* study.

(14 August) - Navy Investigative Flight: *Navy 7 – Invest (11-14)* *[MH-1 / # 143198]*

Again, based upon satellite imagery of this tropical depression, and several other areas of low pressure disturbances extending down through the Bahamas and past Cuba into the Western Caribbean, several Navy reconnaissance aircraft were sent out to check them all. One of the aircraft, a Navy WC-121N Super Constellation *(flown by Lt. Michael Drew)* was sent out to investigate this disturbance in the early morning. Drew reconnoitre the previously identified tropical depression in an area some 60 miles *(97 kms)* to the southwest of Grand Cayman Island or approximately 480 miles *(773 kms)* south of Miami *or* 320 miles *(515 kms)* south of Havana Cuba.



Camille as it appeared on APS-20 radar scope of Navy 7 / Invest reconnaissance flight (143198) constellation on 14 August 1969 - US Navy photos

Since Drew's crew came across this disturbance before it developed into a named storm, his call sign *"Navy 7"* identifies this flight as the seventh Navy investigative mission for the month and first flight on this disturbance. Upon arrival to the area of the disturbance, Drew's aircraft radioed an air report at 1440z *(0940 local cdt)* with maximum sustained winds of approximately 52 kts *(60 mph / 96 km/h)* and a minimal surface pressure of 29.49" *(999 mb)* as well as its course and speed, moving *(forward)* towards the west-northwest at 13 mph *(21 km/h)*.

However, as Drew and his crew looked on, to their surprise, the dark rain-bands of ominous clouds that made up this depression, denoting a hint of a circulation, suddenly exploding into a tropical storm in a matter of minutes – before their very eyes. As Tropical Storm Camille sprang to life, Drew's Navy 7 flight issued their 14th message of the day, reporting the sudden change, notating its intensity was deepening with winds in excess of 55 kts *(64 mph / 102 km/h)* and a low pressure measurement of 29.14" *(988 mb)*. More than a 10 millibar drop in pressure occurred in little less than an hours' time.

Although this Navy reconnaissance aircraft had been in the air for only two hours, it was running low on fuel and Lt. Drew was forced to abandon any continued observations and returned to his base in Puerto Rico. Although Navy references suggest Navy 7 was low on fuel and had to withdraw from the scene, raw air reports *[actual radio communications from the aircraft at the time]* suggest that the aircraft's radar system broke-down and they were no longer capable of continuing their mission.

However, before the aircraft finally departed the scene, they took one last measurement of the storm, recording a pressure of 29.26" *(991 mb),* with sustained winds of 60 kts *(69 mph / 111 km/h)*, and an indication that the storm was intensifying and moving off towards the northwest, at 13 mph *(21 km/h)* forward speed - heading for the western extremes of Cuba. More importantly, this air report *(logged at 1519z / 1019 cdt),* verified to the hurricane center that this disturbance, with three observations of maximum winds between 50-60 kt over a 40-minute period, was now a tropical storm.

Note: *the 2016 reanalysis of Camille is said to have examined other meteorological data available on this storm, prior to this moment in Camille's more extended track. Presumably to have included land-based weather station information from Jamaica, Grand Cayman Island and weather balloons known to have been launched from Swan Island (220 miles / 354 kms southwest of Grand Cayman island). This "other" weather data apparently influenced the reanalysis effort to ultimately establish that Camille had actually become a tropical storm some 18-hours prior to the above mentioned Navy investigative flight on the 14th, despite the reports and observations of this crew.*

Having received the inflight weather data from Navy 7, the National Hurricane Center *(NHC)* issued its first advisory on this storm, naming it Camille. Forecasters at the NHC next ran a quick climatology pattern *(an early numerical model)* program that suggested the storm would pass over the western tip of Cuba and track into the southern Gulf of Mexico within the next 24 hours.

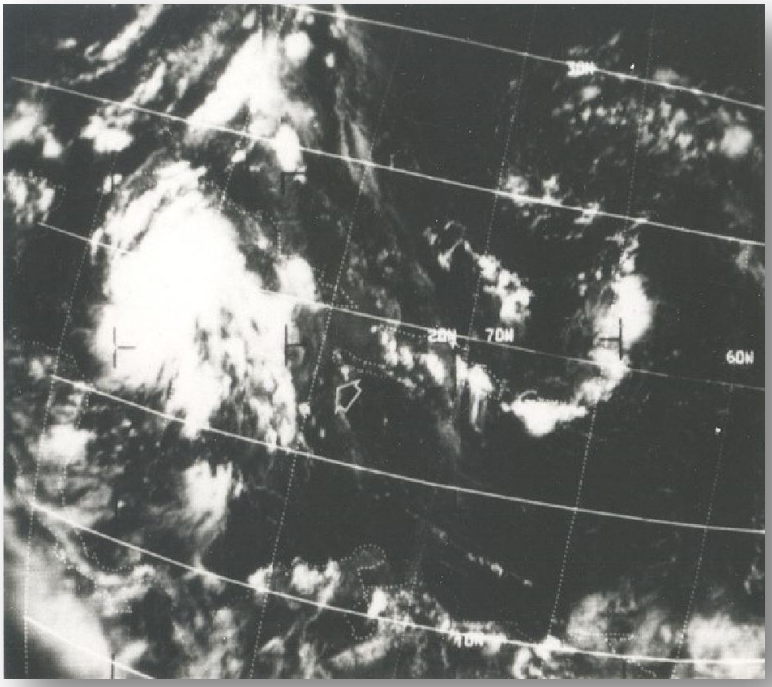
It was at this point that the NHC Director, Dr. Robert H. Simpson *(director between 1968-74)* contacted the Head of the Cuban Meteorological Service and gave the Director *(Dr. Mario Rodríguez-Ramírez)* the Navy 7 reconnaissance report and indicated that the storm *(now named Camille)* was about to bear down on Cuba. In the subsequent hours that passed, despite the obvious Cold War tensions between the US and Cuba, Rodríguez-Ramírez began sending Simpson meteorological data on the increasing effects of the approaching storm on Cuba, back to the hurricane center in Miami via teletype system.

A Navy VW-4 Hurricane Hunting Constellation 143198 that flew into Camille - US Navy Photo

(14 August; continues) - Navy Reconnaissance Flight: *Navy 1 / Camille (1-19)*
[MH-1 / # 143198]

With the abrupt departure of the Navy 7 aircraft, the storm was no longer under direct aircraft surveillance. Subsequently, being the only available Navy aircraft in Puerto Rico, MH-1 was made ready again, repaired and quickly directed back out into the storm. This Navy reconnaissance mission was tasked to provide radar monitoring of the storm throughout the late afternoon and into the evening and penetrate the eye to collect the last daylight center fix of the storm for the day. Tropical Storm Camille, was located 85 miles *(137 kms)* south-southeast of the south coast of the Ilse of Pines, Cuba. The crew of Navy 1 / Camille *(technically the first reconnaissance flight to fly on the named storm)* found a tightly wound storm, like a coiled steel spring ready to explode or release. Arriving at the storm, Navy 1 / Camille reported a storm fix that comprised a minimum pressure of 29.18" *(988 mb)* with winds of 65 kts *(75 mph / 120 km/h)* and still intensifying. Although these measurements were a clear indication that Camille had now become a minimal hurricane*, (with winds greater than 64 kts / 74 mph / 118 km/h)*, the hurricane center would not declare Camille a hurricane for another 6 to 7 hours.

Lingering around the periphery of the storm for several hours, Navy 1 / Camille periodically provided radar fixes of the storm, sending 19 different messages associated with the location of this storm. Early on in the mission, one of those messages from Navy 1 / Camille corrected the center position of the storm from one of its previous messages; reporting that the storm was actually 15 miles to the south of their pervious eye center position report.



ESSA 9 Satellite image of tropical storm Camille on 14 August 1969 – DoC Photo

The last daylight center fix of the day, said to have been at 0045z *(1945 cdt)*, reported a pressure of 29.44" *(997 mb)* with winds in excess of 60 kts *(69 mph / 111 km/h)*. The aircraft then left the storm with another Navy hurricane hunter aircraft arriving shortly to take its place.

(14-15 August) – Navy Reconnaissance Flight: *Navy 2 / Camille (1-25) [MH-4 / #137894]*

This Navy reconnaissance aircraft's mission was tasked to reconnoitre Camille throughout the over-night and capture the first daylight center fix of the next day; 15 August.

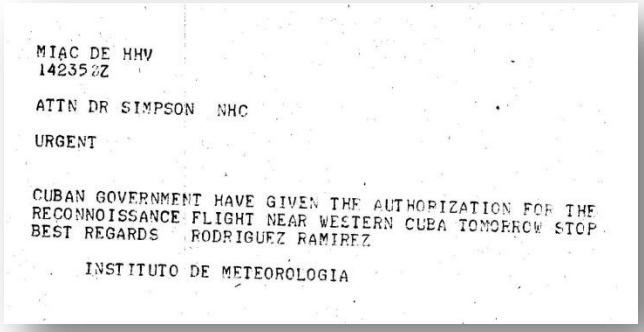
Upon arrival at the storm, Navy 2 / Camille reported a low pressure of 29.39" *(995 mb)* with flight level winds of 50 kts *(57.5 mph / 93 km/h)* at 0140 z *(2040 local cdt)*. The eye position fix was determined by radar and LORAN navigation, which was considered accurate to within 15 nm *(13 miles / 24 kms)*. The aircraft later penetrated the solid wall of clouds around the eye, with winds reported to be 55 kts *(63 mph / 102 km/h)* extending out from the center 109 nm *(125 miles / 201 kms)* at 1500 feet *(457 m)*. The pressure continued to drop throughout the night, later down to 29.26" *(991mb)* and winds increasing to 60 kts *(69 mph / 111 km/h)*. At 0600z *(0100 cdt)*, an extrapolated eye pressure of 28.85" *(977 mb)* was reported by this aircraft.

Although this flight was supposed to have remained in the storm until first light, it didn't. A member of the crew reports that during the flight, they got word of the pending Stormfury deployment, as Hurricane Debbie *(14-25 August 1969)* materialized as a potential candidate storm to be seeded. This particular crew had previously been designated as a Stormfury crew and would be deploying on the 15th or 16th for Puerto Rico. Thus, Navy 2 / Camille left the storm early and headed back to Jacksonville. It was the understanding of this crew, that an USAF aircraft would be arriving at Camille before daylight and believed that this aircraft could then make the first daylight fix of the day. Again, this did not happen.

A subsequent post-flight summary, reported at 0707z *(0307am edt)*, indicated that the initial eye position fix was determined by penetration, with the remaining radar fixes acquired by radar and LORAN navigation procedures. The overall report indicated that Camille was increasing in intensity with max sustained winds in excess of 65 kts *(75 mph / 120 km/h)* extending out from the center for more than 45nm *(52 miles / 83 kms)* at 1500 feet *(457 m)*. This is generally within the characteristics of a full-fledged hurricane, but this report still did not prompt NHC to upgrade Camille to hurricane status.

As the storm neared Cuba, Simpson wanted a continuous flow of reconnaissance data to track the storm. An USAF Reconnaissance plane from Puerto Rico was tasked next to fly a reconnaissance flight on the storm. But due to delays in getting the aircraft off the ground in Puerto Rico and timing concerns with this aircraft's arriving on station would be limited in their mission due to Cuban area flight restrictions; the hurricane center inserted another aircraft reconnaissance mission for this same timeframe.

As it is generally known, Cuba does not permit US military aircraft to operate within its territorial airspace. Hurricane hunting aircraft are no exception. *(It's been said that Navy hurricane reconnaissance aircraft were specifically not permitted to fly within 30 nm [35 miles / 56 kms] of the Cuban coast)* However, with prior authorization, ESSA's Research Flight Facility *(RFF)* research aircraft were often allowed to fly through Cuban airspace in pursuit of hurricanes. Criteria for such flights encompass receiving Cuban Government approval and that ESSA must share any and all storm data acquired during these hurricane flights. Thus, Simpson requested that an ESSA DC-6 be permitted to chase Camille into Cuban airspace, as required, in an effort to capture the storm's landfall in Cuba. Within 30 minutes of Simpson's request, Director Rodríguez-Ramírez telexed a full clearance for the ESSA RFF aircraft to operate within Cuban territory.



MIAC DE HHV
142350Z

ATTN DR SIMPSON NHC

URGENT

CUBAN GOVERNMENT HAVE GIVEN THE AUTHORIZATION FOR THE RECONNOISSANCE FLIGHT NEAR WESTERN CUBA TOMORROW STOP
BEST REGARDS RODRIGUEZ RAMIREZ

INSTITUTO DE METEOROLOGIA

Actual teletype communication from the Cuban Institute of Meteorology giving permission for a ESSA research aircraft to penetrate Cuban airspace to chase down "Camila" as the Cuban weather agency called Camille. – NOAA NHC

Note: *point-of-fact; the actual issue associated with US Military aircraft and Cuban airspace encompasses the fact that Cuba requires all aircraft (military aircraft included) operating in and around its territory to contact Havana's air traffic control center and report their position. In doing so, Havana ATC will then query that aircraft making contact (or will contact the US FAA's Miami ATC) for the aircraft's flight plan. Due to the state of US – Cuban relations in 1969, Miami ATC and US Military aircraft were "not" permitted to provide flight plans of US Military aircraft movements to the Cuban Government. Thus, the restrictions mentioned above. US Military aircraft crews are actually instructed not to communicate with Cuban ATC, while operating through Cuban airspace – which can run the risk of punitive action by Cuban Forces.*

(15 August) - ESSA RFF Reconnaissance Flight: *ESSA 1 - Camille (1-18) [# N6540C]*

The subsequent Cuban-approved ESSA DC-6 *(special)* reconnaissance flight took place in the early morning of the 15th, sometime between 5:00 am and 11:00 am local cdt time. The ESSA DC-6 was flown by RFF Chief Pilot Fred Werley and RFF Director *(pilot)* Howard Mason, with a cadre of RFF technicians and sensor operators on board. The aircraft took off from the aircraft's operating base in Miami and would later recover back there after its nearly 10-hour long mission.

ESSA 1 encountered Camille about 480 miles *(772 kms)* southwest of Miami. Upon reaching the area, ESSA 1 penetrated the storm at 1500 feet *(457 m)* and located the center by winds *(method)* and garnered a central pressure via dropsonde in the eye. The aircraft's first vortex fix was reported at 1100z *(nearly 0600 local cdt time)* with an approximate surface pressure in the range of 28.67" *(971 mb)* and winds of 90 kts *(104 mph / 167 km/h)*, located in the southwest section of the eyewall. These measurements were indicative of a fully-fledge hurricane.

ESSA 1; the ESSA Research Flight Facility hurricane research aircraft (# N6540C) that flew into Camille on the morning of 15 August 1969. Courtesy: NOAA Central Library

The ESSA 1 Camille flight reported a number of fixes on the storm during its 9.6-hour mission. Later at 1232z *(0732 local cdt)* the research DC-6 reported a further low pressure reading of 28.61" *(969 mb)* with winds in excess of 85 kts *(98 mph / 158 km/h)*, moving *(forward)* at 10 mph *(16 km/h)*. By mid-morning, the aircraft positioned Camille approximately 220 miles *(354 kms)* west-southwest of Key West *(Florida)* with the lowest pressure reading of the flight, consisting of 28.47" *(964 mb)* with winds of 100 kts *(115mph / 185 km/h)* at 1519z *(1019 local cdt)*. Soon after this air report, the aircraft left the storm and headed back towards Miami.

In a subsequent post-flight summary report, ESSA 1 reported that winds of at least 50 kts *(58 mph / 93 km/h)* extended out 50nm *(58 miles / 93 kms)* from the center. The aircraft reported characteristics of *"rapid eye change"*, early evidence of what would become an unusual phenomenon observed in Camille by other aircraft, subsequently dubbed as *"Eye Pulsing".*

ESSA 1 aircraft (# N6540C) that flew into Camille Courtesy: NOAA Central Library

However, in retrospect, there is a strange disconnect between the stated goals of this proposed ESSA flight *(as outlined above)* and what actually happened. Although it has been stated that the purpose of the special ESSA flight was to provide tracking coverage of this hurricane as it entered Cuban waters and to collect vital storm data before and after it passed over the Western tip of Cuba, that didn't specifically happen. Camille made landfall in Cuba on the evening of the 15th and moved over its western tip into the southern *(eastern)* Gulf of Mexico overnight on the 15th-16th. The ESSA flight occurred very early on the morning of the 15th when the storm was still some distance to the south of Cuba and Cuban airspace.

As it was, US military aircraft did eventually fly on Camille close to landfall in Cuba and in some cases those aircraft came very close to or actually did violated Cuba's airspace in pursuit of the storm. As previously indicated an USAF 53rd WRS WB-47E flew an investigation flight into the tropical wave that would become Camille on the 9th of August. What is not generally known is that it appears another WB-47E reconnaissance flight was planned for Camille to take place in the early morning of the 15th, instead of the ESSA aircraft flight. Based upon the comment by a

Navy 2 / Camille crewman, a USAF plane was scheduled to relieve the Navy reconnaissance flight in Camille in the early morning of the 15th. However, the previous Navy 2 aircraft reconnaissance flight reported conditions suggesting that Camille was intensifying *(or had intensified)* into a minimal hurricane. Given the Stratojet's known hurricane reconnaissance limitations within the strict confines of the hurricane mission requirements, the WB-47E reconnaissance mission seems to have been cancelled, with the ESSA aircraft taking the WB-47's place in the rotation of aircraft through the storm. A subsequent USAF C-130B flight *(to be designated Gull 1 / Camille)* was inserted into the schedule to back fill the open gap later in the day. This could explain why the ESSA plane did not fly on the storm near or over Cuba near landfall as originally envisioned *(via statements made)* by Simpson at the hurricane center.

Special Note: *despite US Air Force public relations efforts (still found in the public domain) promoting the 53rd Weather Reconnaissance Squadron (WRS) flying hurricanes with their sophisticated WB-47E Stratojets between 1963 and 1969, the reality is that the USAF's WB-47E were not very well suited for the hurricane (or tropical cyclone) reconnaissance mission. The WB-47Es had a long list of airframe and instrument limitations that prevented it from being a viable hurricane reconnaissance platform. These limitations included; the fact that the aircraft's wings were too long and flexible to withstand the moderate to severe turbulent environments of tropical cyclones and the initial weather reconnaissance crews that flew the WB-47E found them difficult to control during low-level and mid-level storm penetrations, forcing them to fly at much higher operating altitudes, above 30,000 feet or higher in hurricanes. USAF WB-47E normally flew the periphery of tropical cyclones between 300mb / 30,000 ft / 9,166m and 200mb / 38,662 ft / 11,787m.*

In fact, there is some evidence to suggest that the structural limitations of the WB-47 airframe, limiting the aircraft's operational effectiveness in the hurricane reconnaissance mission, may have been known when the USAF's AWS first acquired the aircraft back in 1963 – based upon earlier (1958) restrictions of B-47 Bombers from "rough air penetrations". (AWS archival records indicate that the hurricane center was duly informed [in 1964] that the AWS would no longer be able to provide low-level / mid-level hurricane reconnaissance in Atlantic hurricanes) The aircraft further had a problematic communications suite and could not report storm fixes while in the environment of the storms. With a shorter range (mission endurance) than the WB-50Ds they replaced, the WB-47Es on station duration was shorter and limited their ability to adequately fulfill the hurricane mission's primary requirements.

Not many understand that the USAF Air Weather Service's confidential primary mission of these weather reconnaissance aircraft was that of air sampling; as part of a worldwide effort to monitor Soviet and Chinese nuclear (weapons) technology advancements for the Atomic Energy Commission / Dept. of Energy. Its secondary mission was world-wide synoptic weather reconnaissance. In these missions, the WB-47E performed quite well. However, in its more public (auxiliary) taskings of tropical cyclone reconnaissance, the WB-47Es were marginal at best. Coupled with a problematic revolver-type (automatic) dropsonde dispenser, with an additional high-failure rate of the (then) AMT-13 dropsondes it utilized, combined to rob the WB-47Es of what little effectiveness they had in the Atlantic hurricane reconnaissance role. Thus; the WB-47Es were basically regulated to the outer periphery of the storms, providing little more than radar tracking of the hurricanes, while other regional weather reconnaissance aircraft (with the US Navy) and Air Force augmenting hurricane reconnaissance aircraft, conducted most of the eye penetrations at lower and mid-levels altitudes throughout the 1960s.

Between 1960-65, the AWS's Atlantic hurricane mission was augmented first by the remaining AWS WB-50Ds, flown by flight-crew elements of the 55th WRS (McClellan AFB, California), 56th WRS (from Yokota Japan) and then later (1965-69) by the AWS C-130B weather reconnaissance capable Hercules, initially flown by a detachment of the 55th WRS and then by a 53rd WRS detachment out of Puerto Rico.

Although the Air Force AWS was forced to utilize the Stratojets more aggressively in the Western (North) Pacific tropical cyclone reconnaissance operations, due to lack of augmenting reconnaissance aircraft during this period of the late 1960s, in the Atlantic the WB-47Es were relegated to flying mostly investigative flights on tropical depressions, reconnaissance flights in weak tropical storms and hurricanes (in the periphery) and or more moderate hurricanes with open eyes.

Ultimately the limitations of the USAF's so-called primary hurricane reconnaissance aircraft reduced the perceived hurricane reconnaissance aircraft capabilities (and capacity) of the Atlantic hurricane warning service by more than half – despite the perceived understanding of the various components of the US Government and the general public at large. As you will see, this lack of available capable hurricane reconnaissance aircraft factored in the overall final failure of the hurricane warning network during Camille in 1969.

It's also important to understand for the record, regarding the hurricane reconnaissance operations flown on Camille and the conduct of the forecasters at the hurricane center, that it was at this time *(after the reports of the storm by ESSA 1)* that the hurricane center's new numerical hurricane forecast model*(s)* began suggesting the future trajectory of the storm. The computer model*(s)* had the storm eventually swinging *(recurving)* towards the north-northeast. Simpson, by noon on the 15th, began posting hurricane warnings all along the Florida Panhandle, from Apalachicola to Fort Walton Beach. It would be this over-reliance on the new computer model*(s)* by the hurricane center, combined with the inherent problems in the hurricane reconnaissance aircraft and their availablity, that were at the roots of the Atlantic hurricane warning service's failures in the forecasting of Camille in August of 1969.

***(15 August: continues*) –** USAF Reconnaissance Flight: *Gull 1 / Camille (1-8)* [#62-3492]

Shortly after the ESSA aircraft arrived on-station in Camille, a USAF reconnaissance aircraft, a C-130B flown by Capt. Marvin A. Lillie and his co-pilot Capt. Robert L. Clark, left Puerto Rico en route to the western Caribbean and a rendezvous with Camille. This aircraft had been one of only three AWS weather reconnaissance capable C-130B Hercules that were made available to augment the 1969 hurricane season by the AWS's 9th Weather Reconnaissance Wing at McClellan AFB, California.

As previously discussed, the 53rd WRS actually operated a number of WB-47E Stratojets as their primary weather reconnaissance aircraft since in 1963, albeit with significant limitations in flying the hurricane reconnaissance mission. And although the perception was that the squadron had been assigned five of the AWS's original weather reconnaissance capable C-130B Hercules in 1965, specifically to help counter the limitations of their WB-47Es and augment the seasonal hurricane mission, demands on existing and added AWS operations, missions and taskings around the world, forced the 9th Wing to utilize any and all available aircraft assigned to any of its operating units on higher priority *(military)* operations - flown by a mix of weather reconnaissance squadron elements and other Wing detachments - some times to the detriment of the hurricane reconnaissance mission in the Atlantic.

USAF C-130B Hurricane Hunter #3492 that flew into Camille as Gull1 / Camille reconnaissance flight - USAF Photo

Known in the public domain to have been equipped for weather reconnaissance since 1965, the AWS C-130Bs were in fact basically the same as any transport C-130B Hercules, only minimally weather reconnaissance capable, by today's standards. The first five AWS C-130B's weather reconnaissance modification comprised little or no flight – level instruments, only the repositioning of existing aircraft pressure and radar altimeters readouts *(incorporated into a weather officer's position in the aircraft),* the addition of a AN/AMR-1 Dropsonde Recording System that was compatible with AN/AMT-6 radiosondes *(dropsondes)* and added external wing-mounted fuel tanks. That's all !

In fact, the aircraft were not even officially designated WC-130B *("W" for Weather-bird or weather reconnaissance configured)* at the time of Camille, despite newspaper stories and aircrews suggesting that there were WC-130s used during the tracking of Camille. According to 9th Wing archival records, the original 5 AWS C-130B weren't designated "WC-130B" officially until after Camille, in the wake of the post-storm fallout and AWS's unplanned and *(forced)* quick retirement of its WB-47E fleet on 25 August 1969. It was at this same time that the AWS additionally announced that it was going to procure 11 fully – equipped *"WB-130Bs"* to replace

the now acknowledged less capable WB-47Es. However, 53rd WRS Herk crews often referred to their aircraft as WC-130s well before August 1969.

The dropsonde operator's station and dropsonde equipment in the early AWS C-130Bs – located in the cargo compartment of the aircraft. – USAF Photo

Thus, during August 1969 and the USAF hurricane reconnaissance aircraft operations into Camille, only two of the original five AWS C-130B aircraft *(#3492 & #3495)* were available for reconnaissance flights in the Atlantic. A third aircraft *(#3494)* was assigned to support Project Stormfury *(for cloud physics monitoring)* and was not permitted to support the reconnaissance of Camille. A forth aircraft *(#3493)* had been in maintenance since 6 July 1969 and didn't return to the squadron until early October 1969. *(during this period, there was an on-going requirement for all AWS C-130Bs to fly to Charleston, South Carolina for structural wing truss-mount inspections, for repairs or replacement, every 600 flight hours, which seriously complicated mission scheduling of the 5 aircraft)* The fifth aircraft *(#3496)* was missing from the squadron with no explanation. It's believed that this plane had been *"borrowed"* by the 9th Wing and was flying a classified project somewhere out of Texas at the time.

The USAF C-130B aircraft assigned to conduct a reconnaissance mission of Camille on this day was designated *"Gull 1 - Camille"* or the first tropical cyclone reconnaissance flight by the USAF into the named Hurricane Camille. The aircraft departed Puerto Rico and later encountered the storm to the southeast of the western tip of Cuba, just after 1700z *(12 noon local cdt)* on the 15th. The aircraft, at this point in the storm's track towards Cuba, coupled with the overall size of the storm, the direction they had come from Puerto Rico and normal hurricane reconnaissance procedures, actually caused the Herk to come very close to the threshold of Cuban airspace. There was even some discussion amongst the crew if they would violate Cuban territory by penetrating the storm's eye. However the aircraft's navigator *(Capt. Ed Anderson)* assured the cockpit that they had about 10 nm *(12 miles / 19 kms)* to spare, and the decision to penetrate the storm was made.

A USAF C-130B Hurricane Hunter Hercules that flew Atlantic hurricane reconnaissance missions – USAF Photo

Once inside the storm, the Gull 1 / Camille crew found a central pressure of 28.53" *(966 mb)*, reported at 1820z *(1320 local cdt),* and 80-90 kts *(92 mph / 148 km/h - 104 mph / 167 km/h)* winds at flight level captured during their penetration. *(They were unable to get sea surface winds, visually, due to a thick under-cast of clouds blocking view of the sea)* However, at this time, the eye of the storm was very well defined *(on radar)*, closed in all quadrants and really tight visually - too small to actually maneuver in. Lillie and Clark could only provide time enough to deploy one dropsonde before heading back out of the storm. The eye was determined to be in the neighborhood of 8 -10 nm *(9 miles – 12 miles / 15 kms - 19 kms)* across.

During the second penetration of the eyewall, on the way out of the eye, the aircraft almost hit a darken area within the eyewall, potentially a *"Mesovortice" (tornado like vortex or a vertical shaft of large hail)* embedded in the eyewall, that forced the aircraft though an area of severe turbulence. This turbulence was so rough that it caused the aircraft to experience an electrical short that took out the aircraft's radar as well as its two primary HF *(shortwave)* Radios. The crew of the hurricane reconnaissance Hercules were now blind as well as mute with the swirling turbulence called Camille all around them.

Given that the crew's primary orders on this mission were to repeatedly penetrate the storm's eye at 6-hour intervals, without both the radar and the primary communications to transmit storm reports, the crew were incapable of continuing the reconnaissance flight and the plane's commander *(Lillie)* gave the order to aborted the mission.

Note: *Air Weather Service Manual 55-11 [for reconnaissance aircraft] strictly prohibits the reconnaissance of tropical cyclones without minimal standard equipment and procedures available to safely conduct a mission. With the radar and radios out, and unable to determine surface winds visually, the mission was over under these regulations.*

The crew and aircraft headed for the nearest landfall *(in US Territory)*, making their way to Florida. Eventually putting-down at McCoy AFB near Orlando, where they thought they could find maintenance services to aid in the needed repairs to their aircraft. *(Oddly enough, on approach to McCoy, the Hercules encountered localized thunderstorms, producing strong turbulence and lightning. The Herk was actually struck by lightning in the nose-radome causing further damaged to the aircraft.)* But unfortunately, quick repairs were not forthcoming. The McCoy base maintenance department did not have the compatible replacement parts to support the repair of their model of aircraft. They were for all intents and purposes grounded and would not be able to continue flying Camille for more than two days; leaving the hurricane center without the needed eye fix data vital to their forecasts.

(15-16 August) - Camille crossed the western tip of Cuba during the over-night period of August 15th / 16th *(starting between 8-9 pm local cdt and taking about 3 hours to transition over land)* making landfall somewhere between Cape San Antonio and Guane; with a land-based lowest pressure reading of 28.52" *(966 mb)* – according to a reference cited by the Instituto de Meteorología de Cuba. Although the winds had been reduced to 80 kts *(92 mph / 148 km/h)* with higher gusts *(some in the neighborhood of 112 kts or 129 mph / 208 km/h)* during the crossing of the Cuban mainland, Camille quickly strengthened as she passed through the eastern Yucatan Channel and entered the eastern *(southern)* Gulf of Mexico - encountering its infamous warm waters that seems to energize hurricanes. At 0200z *(2100 local cdt time)*, Camille was approximately 250 miles *(402 kms)* south-southwest of Key West.

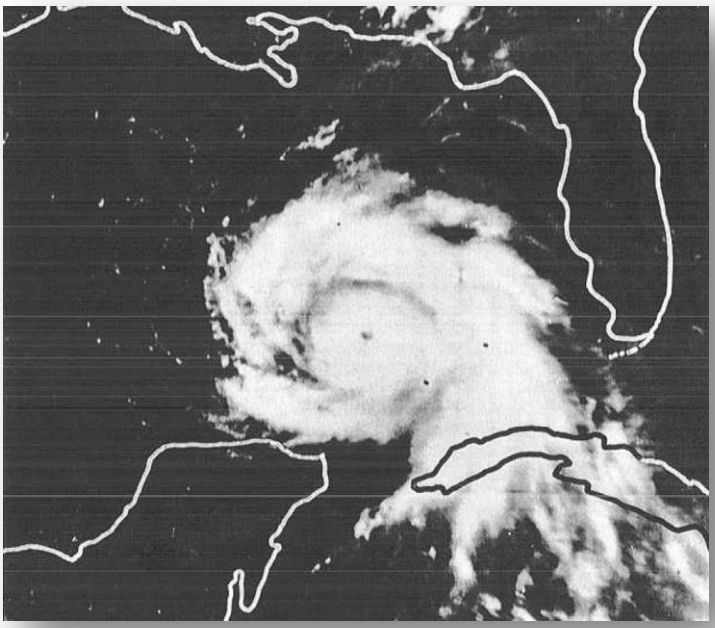
(16 August) - Navy Reconnaissance Flight: *Navy 3 / Camille (1-25)* [*MH-2* / #137892]

With the sudden abort of the USAF reconnaissance flight, so early in its planned mission, a Navy reconnaissance flight was hastily arranged and took off for Camille late in the evening of the 15th. Having missed the last daylight fix of the day before landfall in Cuba, this Navy flight's 12-hour mission was to radar-track the storm overnight as it made its way across western Cuba and into the Gulf of Mexico. Then capture the first daylight fix in the morning of the next day; 16 August.

Flown by CDR. Paul Siverly *(with LT. Manfred "Fred" Staab as primary navigator)* the Navy flight had to thread its way around thunderstorms surrounding the hurricane, while keeping an eye on their position relative to the threshold of Cuban Airspace. Staab has reluctantly admitted to

having violated Cuban airspace on this flight several times, from as little as a wingtip to as much as several miles. But due to the storm's proximity to land, the structural limitations of the aircraft and squadron mandated flight restrictions, it was completely unavoidable. And in retrospect, did not seem to have ruffled the Cubans too much, who seemingly had their attentions focused elsewhere.

Arriving at the storm around 0500z *(0000 or 12 midnight local cdt)* the eye's position was determined by radar triangulation to be 510 miles *(821 kms)* south of Panama City, Florida. It was noted that the eyewall was solid in all quadrants and down to 8 nm *(9 miles / 15 kms)* across, too small to penetrate given VW-4's squadron doctrine or flight restrictions. The VW-4 *"Squadron Operations Doctrine" (a hurricane hunting rules of engagement if you will)* established restrictions on the penetration of hurricanes in particular situations that would endanger or risk the safety of the flight crews.



Nimbus 3 satellite image of Camille / at 0500z (12 midnight) on 15 August 1969, while in the Gulf of Mexico. This satellite passed directly overhead of Camille, with an almost vertical view straight-down into the storm's eye. – NOAA NHC

This Squadron Operations Doctrine prevented aircraft flight crews from conducting penetrations of hurricanes when the maximum winds *(the intensity)* of storms were over 120 kts *(138 mph or 222 km/h)*.

The squadron doctrine further limited crews to *"no penetrations"* of any storm when the diameter of the eye was less than 15 miles *(24 kms)* due to insufficient turning *(orbiting)* radius to safely maneuver within the eye. If an aircraft found itself in this limiting situation, the risk of catching a wing in the intense and very narrow wind field of the eyewall clouds could be very catastrophic.

As apply described by Navy Hurricane Hunter *(ret)* CAPT. Paul Tilson; *"….. the problem was that if the aircraft's wing was traveling in the same direction as the wind field, the wind coming over the rear of the out-board wing would stall and consequently force the wing downward, causing the aircraft to roll over onto its back (inverted) - crashing the plane into the eyewall. If the aircraft's wing was against the direction of travel of the wind field of the eyewall clouds, the aircraft's maximum speed of 180 kts (207 mph / 333 km/h), combined with the wind speed of the eyewall clouds (in the case of Camille at peak; 190 kts or 219 mph / 352 km/h) would exceed the wing's maximum designed structural limits or a speed of 295 kts (340 mph / 546 km/h) by 75 kts (86 mph / 139 km/h) and tear the wing off the aircraft. Neither of these options was desirable and adherence to these flight restrictions was not voluntary ….."*

Although a few Navy flights have been known to have flown *(occasionally)* in a storm with an eye as tight as 8 miles *(13 kms)* in diameter, including the dangerous flight into Hurricane Cleo *(21 August – 5 September 1964),* it's these few storms that proved the rule rather than the exception.

Radar photo of Hurricane Cleo 1964 – US Navy / VW-4 Photo

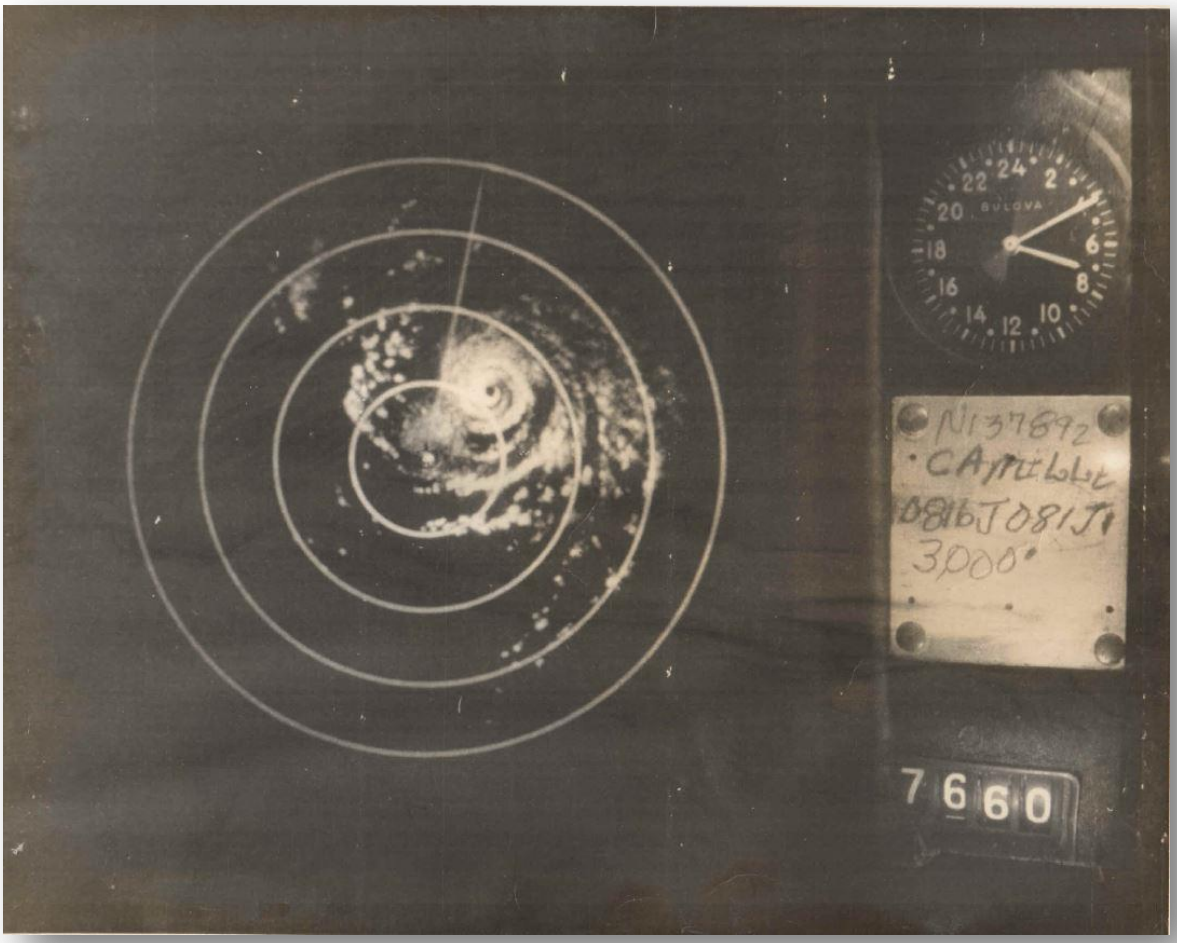
In Cleo, on the 24 August 1964, a super Constellation *(MH-1 / # 137891)* got into the storm's eye only to find that there wasn't one, in the conventional sense. Winds there, in excess of 125 mph *(201 km/h)*, lashed the plane from all directions at once. Trying to turn in less than 8 miles *(13 kms)* across, the turbulence eventually took its toll on the aircraft. First the left wingtip fuel tank was torn off, then eventually the right, throwing the whole plane out of balance. The aircraft nearly rolled over on its back, while inside the fuselage several members of the crew were flung about and injured. After a very harrowing flight, the pilots managed to get control and get the aircraft safely out of the storm for an emergency landing back in Puerto Rico, only to find a shopping list of damages to the aircraft. Most important was the fact that the Constellation's airframe was hopelessly twisted, effectively causing the whole aircraft to be scrapped in-place. Never to be flown again.

Note: *the actual "doctrine" document was not formally written, codified or published until shortly after Camille, by CDR Alvin "F" Marsh during his stint as Commanding Officer of VW-4 in early 1970. However this doctrine or restrictions did previously exist in squadron's (safety) memos, word-of-mouth indoctrination instructions and pilot training materials since Cleo 1964. There is even some evidence to suggest that these flight limitations of the aircraft were known within the squadron since the introduction of the Constellation aircraft into hurricane hunting back in the 1950s, but never became much of a specific issue until the near-loss of an aircraft in Hurricane Cleo back in 1964.*

Photo of the Navy Constellation MH-1 / # 137891 damaged during a flight into Cleo 1964 - US Navy / VW-4 Photo

Although Bob Simpson would go on to mercilessly criticize the Navy crews, and the squadron command, for not penetrating Camille at critical moments in the forecasting of this hurricane *(actually making public statements in essence questioning the Navy crews' courage, fortitude and their sense of duty for their unwillingness to penetrate the storm)* he was fully aware of the Squadron Doctrine *(aircraft limitations and restrictions)* for years prior to Camille. As late as the approval of the 1969 "*Atlantic Hurricane Warning; Hurricane Operations Plan",* changes were made to this plan to accommodate the limitations of the Navy reconnaissance aircraft to provide coverage for the hurricane center's mission requirements. Simpson knew of the Navy aircraft limitations and yet he made these derogatory statements anyways in the wake of the storm.

Given that by all accounts Camille was a severe hurricane, the conditions were ripe for CDR. Siverly to execute a seldom used *(very)* low-level penetration procedure on this storm. Utilizing this little-known procedure of Navy Hurricane Hunters, Siverly guided the large constellation down to within 300 feet *(91.4 m)* of the sea surface and penetrated the storm under it's boundary-layer and up into the eye. After gathering a sea-level pressure measurement of 27.99" *(948 mb)*, at 0545z *(0045 local cdt)* and surface winds of approximately 100 kts *(115 mph / 185 km/h)*, the Navy aircraft slowly spiraled up through the eye of the storm, to between 10,000 and 12,000 feet *(3048m – 3858 m)* before exiting through the side of the eyewall of Camille.



A radar image of Camille from Navy 3 / Camille Constellation's APS-20 Radar Scope at 0710z (0210 local cdt) on the morning of 16 August 1969. Courtesy of Ken Solberger, Pilot VW-4

During this flight, while orbiting outside the storm just 60 nm *(69 miles / 111 kms)* to the south of San Antonio *(Cuba),* the radar operator and on-board aerologist began studying a particular anomaly visible on the aircraft's APS-20 radar scope; Camille's eye was *"pulsing"*. One sweep of the radar scope arm, the eye appeared 15 miles *(24 kms)* across, the next 30-second sweep, it was less than 8 miles *(13 kms)* across. It looked like the eye of Camille was actually breathing. This *"storm pulsing"* phenomenon was so unusual, never before seen by the more experienced members of the crew, that Siverly actually got out of his seat in the cockpit and went to the back of the plane to view it on the radar scope for himself.

Note: *recalling this eye pulsing phenomenon 48 years later, CDR. Siverly said that he had never seen anything like it before that time and had never seen it again after Camille. Asked if it could have been an electronics glitch, Siverly said that (at the time) there was much discussion amongst the radar operators (and technicians) and the on-board aerologist, with the general consensus being that it was a physical meteorological anomaly that had never been seen before, but certainly not a radar systems glitch. This pulsing phenomenon would be seen again later in Camille's track as the storm neared landfall in the continental United States.*

Over the course of the mission, Navy 3 / Camille continued to radio in radar fixes. At 0640z *(0140 local cdt)*, the eye's position was determined by radar triangulation with similar measurements as before.

At 0815z *(0315 local cdt)* Navy 3 / Camille provided a maximum surface wind speed derived by estimating sea surface conditions via the *"Landing Light"* procedure. This procedure comprised the pilot turning on the landing lights, which on a Constellation are always pointed downwards unless adjusted forwards for landings. At night, these landing lights were very bright and once directed at the water below, provided the on-board Aerologist a good view of the sea surface conditions and a good read of the winds over the ocean towards a surface wind speed measurements - through all 4 quadrants of the storm. Thus at this time, winds of 70 kts *(81 mph / 130 km/h)* extending out 34 nm *(39 miles / 63 kms)* from the center were captured, with 50 kts *(58 mph / 93 km/h)* winds extending out 50 nm *(58 miles / 93 kms)* from the center.

Although this Navy flight provide numerous radar fixes during the night, it was the day's first-light storm fix early on the morning of August 16th which was made all the more important as a gage of the storm after having crossed the western tip of Cuba. The early morning fix, logged at between 1200z - 1300z *(between 0700 - 0800 am local cdt)*, established that Camille had regained her previous day's intensity of 100 kts – plus *(115 mph / 185 km/h - plus)* maximum winds and a low pressure of approximately 29.41" *(996 mb)* within 35 nm *(40 miles / 65 kms)* east of the eye.

The detailed report further established winds in excess of 80 kts *(92 mph / 148 km/h)* extending out 35 nm *(40 miles / 65 kms)* from the center *(in the eastern quadrant)* 50 kts *(58 mph / 93 km/h)* winds outward 85 nm *(98 miles / 157 kms)* from the center *(in the eastern quadrant)* and 30 kts *(35 mph / 56 km/h)* winds extending out 200 nm *(230 miles / 370 kms)* from the eye in the eastern quadrant. Feeder bands extended outward from the eyewall well over 130 nm *(150 miles / 241 kms)*.

Again, as stipulated in the last air report from this aircraft, the 25th message sent during the flight, radioed in at 1712z *(1212 pm local cdt)* the diameter of the eye was tight, as little as 8 miles *(13 kms)* across, which did not provide feasible conditions for the Navy aircraft to penetrate the storm. By comparison, the eye of Hurricane Debbie *(14 -25 August 1969)*, an average size Atlantic hurricane *(just a few days later)* was approximately 25 miles *(40 kms)* in diameter when it was first seeded by Stormfury on the 18th.

(16 August: continues) - by early Saturday morning, Camille was located 420 miles *(676 kms)* southwest of Pensacola *(Florida)* moving north-northwestward at approximately *12 mph (19 km/h).* The 8 am *(est)* public advisory put out by the hurricane center was based largely upon the overnight Navy 3 / Camille observations as well as various ship reports from vessels in the Gulf of Mexico, land-based weather stations *(like those in Cuba)* and the ESSA 8 satellite data, inputted into the hurricane center's numerical forecast models. The 8 am computer generated public forecast still suggested that the storm would eventually recurve further to the northeast and head for the panhandle of Florida. But as we subsequently know now, that's not ultimately what Camille did.

Note: *During the 1969 hurricane season, the National Hurricane Center introduced a new fully computerized (analog) forecast model called the "HURRAN" or* ***Hurr****icane* ***An****alog (technique), to aid in hurricane forecasting by giving dynamical guidance to the NHC's long-range forecast predictions. The HURRAN utilized a (then) recently developed* ***Hur****ricane* ***Dat****abase (or HURDAT) that comprised all hurricane aircraft reconnaissance data (tracks, characteristics and climatology) of the US Weather Bureau, since WWII and all historical hurricane data since 1886 (in some cases since 1851) – stored in a numerical database, that was interfaced with the HURRAN computer model. The computer model compared the (then) current storms under observation with those historical hurricanes with similar tracks, approaches to the same given sector of the US Coast and or those storms with particular (latitudes & longitudes) positions, to aid and provide guidance to forecasters preparing 24 to 72 hour forecasts of approaching hurricanes.*

By all accounts the HURRAN was utilized operationally in 1969. However, several post-Camille reports have suggested that the HURRAN was in fact only experimental in 1969 – seemingly wanting to lessen the expectations of the computer forecast model's less than stellar performance in Camille. Subsequent historical type reports about Camille go as far as saying that the HURRAN was experimentally operational in the 1969 season and go on to show no evidence of the predicted re-curvature towards the Florida Panhandle on charts and graphs. It's also known that another computer forecast model, known as "NHC-67", a statistical model that relates tropical cyclone to large-scale observed (and predicted) atmospheric conditions in the surrounding synoptic environment to the storm, was also utilized in the forecasting of Camille and combined provided questionable results in the overall tracking of Camille.

Now in retrospect, it's questionable as to whether the Hurricane Center relied too heavily on its computer models during the tracking of Camille and became too intransigent in its belief that the storm would recurve towards Florida - as most of its public warnings bare out until mid-morning on the 17th.

The fact is that from the moment Camille became a hurricane, it maintained an almost steady unwavering course directly towards the Mississippi coast. As demonstrated by Navy Hurricane Hunter CAPT. *(ret)* Paul Tilson's comments on the subject; *"…… During the 1969 hurricane season, the National Hurricane Center introduced a new computer tracking model with much fanfare. Although we tracked Camille traveling "straight as a string," the whole time we were in the storm, we were receiving hurricane warning messages which warned of a re-curve to the east as per the model, rather than the actual data we were reporting. As a result, the west coast of Florida from Apalachicola to Naples was warned of the approach of Camille, but nothing west of Apalachicola was warned. The result was that the first warning Mississippi and Louisiana got was when the remote weather station south of New Orleans recorded hurricane-force winds ……"*

The Hurricane Center was so convinced that Camille would eventually turn toward the northeast and head for the Florida panhandle, that on the afternoon of 15 August 1969, it sent an ESSA / Weather Bureau technician to the USAF's Tyndall AFB, in Panama City *(Florida),* to utilize the base's AN/FPS-64 EW / GCI *(SAGE)* radar system *(operated by the 678th Radar Squadron)* to track the storm as it turned and approached the panhandle of Florida.

Special Note: *the Alternative Forecast; although the Hurricane Center with all its expertise continually forecasted a turn toward the Florida Panhandle as late as the early morning of the 17th, an "alternative forecast" was determined and posted by a USAF AWS weather station on the morning of the 16th; that went far towards saving people's lives in Mississippi.*

On the morning of 16 August 1969, Capt. James T. Holland, commanding officer of the AWS's detachment 22 of the 24th Weather Squadron, at the Kessler AFB Weather Station, notified his senior base command of the approaching storm, still some 400 miles (644 kms) away. Based upon his own independent evaluation and analysis of the hurricane (from weather data available to him) Capt. Holland determined that Camille would not turn to the east towards Florida, but would instead continue to track north and impact Mississippi coast late the next day.

His warning to the base command subsequently initiated a full and immediate base –wide alert, declaring "hurricane alert condition 4" at 10:00 cdt on the morning of 16 August 1969. Under "HurCon 4", all base personnel mobilized to secure the facility against the approaching storm and to take necessary precautions to protect the base, its personnel and their families - more than 24-hours before the Hurricane Center would reach the same conclusions. It was in those 24-hours that Kessler took the precautions to minimise the dangers from the storm. Flyable (status) aircraft were deployed inland (bugged out) to Barksdale AFB in Louisiana, some 311 miles (500 kms) northwest of Keesler. All base buildings were boarded up and the rest of the based secured from flying debris. All families on the base were mandatorily moved to safe storm shelters setup in the base's movie theaters, service club (buildings) and mess halls. More importantly; the base's motor pool and base hospital were staffed up and put on full-alert (duty) to support transport and medical aid to any on-base injuries caused during the storm and to subsequently aid the surrounding civil communities in the wake of the storm. Media photos in the immediate aftermath of the storm show Air Force personnel from Keesler in base trucks and equipment aiding in rescue and cleanup after the storm.

Capt. Holland would later receive the USAF's Meritorious Service Medal (as well as a promotion to Major) for his early and accurate forecast of Camille that saved countless lives.

Another unusual aspect of Camille that was additionally not forecast to have happened occurred sometime during the day on the 16th, potentially between 1pm and 8pm local cdt time. At this time, Camille slowed down considerably, then stopped it forward progression and began wobbling in place approximately *380 miles (612 kms)* south of Panama City, Florida. It's been suggested that this stalling effect was caused by competing internal forces struggling to steer the storm in various directions at once. However, some contend that this is evidence of the results of cloud seeding operations having been conducted on hurricanes secretly throughout the 1960-70s. As part of a program to wage a secret weather war on Cuba, US military aircraft conducted cloud seeding operation on Camille.

***Note**: it has been recently established in an online article; **"The Unrealized History of the Military's Utilization of Weather as a Weapon, the Real Father of Weaponized Weather and the Secret Hurricane Modification Program Nobody Has Ever Heard Of."** by David Reade, P-3 Publications; that Camille may have been secretly seeded by US aircraft as part of an on-going covert program to create weather as a weapon in support of the Cold War.*

***See:** http://p-3publications.com/PDF/TheUnrealizedHistoryofWeaponizedWeather2015.pdf*

Between 1960 -1975, elements of the US Military conducted weather modification operations to develop weather as a weapon against the former Soviet Union in the Cold War. Applied applications of this development program included tactical rain-making in Southeast Asia, drought relief efforts around the world, drought producing operations against perceived soviet satellite countries and most importantly, the weaponization of hurricanes *(and other convective storms)* as a viable weapon in a hot-war with the Soviets.

Since 1961, various US Military aircraft were utilized to seed Atlantic hurricanes to develop a secret powerful cold war weapon. Operationally, hurricanes were seeded to intensify them and then steer the storms towards Cuba, in a concerted effort to inflict as much storm damage as possible on the island-nation, as a means to disrupt its economy that was already teetering on the brink of collapse. These secret hurricane seeding efforts were not associated with or were seemingly the knowledge of Project Stormfury, whose main mission was to develop a means by which to weaken hurricanes. As part of this secret hurricane modification effort, US planes would have seeded Camille sometime on the 15th to intensify and steer the storm towards Cuba. However, it's unclear if the secret seeding effort allegedly conducted on Camille had any effects on the storm. As Navy weather modification projects conducted though-out the 1960s and 1970s have demonstrated, cloud seeding operations had a less than 50/50 chance of success, if there was even any way to determine success. Like Project Stormfury, it was near impossible to determine the effects of cloud seeding on hurricanes up against the variation of changes that hurricanes go through naturally during their normal life cycle. Though, the US Military did conducted the secret hurricane seeding operations between 1961 and 1975, there must have been some measure of success to justify these efforts, not to mention the cost of a program like this for such a long period of time.

Today however, hurricane researchers reject any mention of secret hurricane seeding operations and will only accept *(the policy- established in 1983)* that cloud seeding has no effect on hurricanes whatsoever and that in the case of Camille, the storm merely experience internal fluctuations that caused it to stall and rotate around on itself, during its track towards the continental US.

Whatever did occur in Camille at this time in its evolution, it was not forecasted or predicted by the hurricane center. Additionally, it was at this point that Camille began to defy the Center's computer forecast models and came off the rails as to where they suspected it was going to go and how intense the storm was going to become. This situation, as we will see, became even more complicated as limitations and problematics in hurricane reconnaissance aircraft capabilities failed to provide the perceived required information for the hurricane center to forecast the storm to its expectations.

(16 August: continues) - Navy Reconnaissance Flights: *[different aircraft flights]*

Though-out the day on the 16th and into the early morning of the next day, a series of Navy reconnaissance aircraft flew on the Camille out of NAS Jacksonville. Some of these aircraft were actually part of a contingent of WC-121N Super Constellations that were assigned to and participated in Project Stormfury, that would later support the seeding of Hurricane Debbie *(14-25 August 1969)* as well as other Stormfury associated seeding projects. Hurricane Debbie was seeded on the 18th and 20th of August 1969 out of Puerto Rico.

Special Note: *although not generally known or perceived by the general public, VW-4 only had six WC-121N Super Constellations in the early months of 1969 and only 5 operational aircraft at the time that Camille materialized in August. One of the six Navy hurricane reconnaissance Constellations was down for periodic maintenance and unavailable for flight operations at the time of Camille. The majority of the remaining aircraft, as previously discussed, four were committed to Project Stormfury and deployed to Puerto Rico on the 16th and 17th, in time to participate in the experimental cloud seeding of Hurricane Debbie on the 18th & 20th of August. This left only one operational Navy squadron aircraft at NAS Jacksonville available to carry out the Navy's shared responsibility of hurricane reconnaissance in the whole of the Atlantic Basin, that included the western Atlantic, western Caribbean Sea and Gulf of Mexico.*

Additionally, despite perceptions to the contrary, including those by the authors of the recent reanalysis of Camille, the US Navy and the USAF for the first-time in 1969 shared the responsibility for hurricane reconnaissance in the Atlantic Basin equally; as stipulated in the Hurricane Warning Network, Hurricane Operations Plan - 1969. By 1969, due to limitation factors in aircraft capabilities, the USAF and US Navy instituted a "shared" reconnaissance responsibility in the Atlantic basin (Caribbean and Gulf of Mexico) on an equal basis, to provide both investigative and reconnaissance missions – rather than the previous years' operations where the military services were assigned defined areas of responsibility (AORs) within the Atlantic.

Some of the Navy Constellations in fact delayed their departures from Jacksonville to specifically reconnoitre Camille on their way to Puerto Rico for the Stormfury deployment. They staggered their departures in 6 to 8 hour intervals to provide radar reconnaissance coverage over the storm for most of the next 24 hours. However, due to flight restrictions associated with their deployment to Puerto Rico and conditions of the storm, these reconnaissance aircraft were only able to provide radar fixes on the storm and extrapolated eye measurements from storm conditions in the different quadrants around the hurricane. No penetrations of Camille's eye were conducted by these Navy aircraft.



Some of the positions within the Navy Constellations, including Navigation, Radar and Aerology stations – US Navy Photos

At this point in Camille's track, satellite imagery suggests that the central eye diameter was further down to between 8-11 miles *(13–18 kms)* across or much too small for Navy Constellations to orbit in. Thus, from the time Camille left the Cuban coast behind, Navy aircraft were incapable of conducting eye penetrations of the storm. From that point onwards, it would be more than 18-hours before the first of 3 eye penetrations by the USAF could be conducted.

(16 August: continues) – USAF Reconnaissance Flight: *Gull 2 / Camille A&B [#62- 3495]*

Despite various versions of the origin of this aircraft and misinformation surrounding its flight operations, the reality is that this reconnaissance flight was flown by Capt. Robert Y. Foerster and his crew. Their aircraft had been the only other USAF C-130B assigned to support the hurricane season reconnaissance mission in 1969.

Foerster and his aircraft had been in fact previously tasked with supporting Project Stormfury at the time Camille materialized on the scene. There was some initial reluctance on the part of the Stormfury group for the aircraft to get involved in the reconnaissance operations into Camille, given that its dropsonde capabilities were greatly needed for the Stormfury reconnaissance and seeding effort of Debbie as it neared Puerto Rico. However, due to the damaged sustained by Lillie and Clark's Hercules during their first foray into storm, Foerster and his aircraft were released by Project Stormfury to support the more urgent reconnaissance of Camille at the behest of Bob Simpson who was now under pressure at the hurricane center dealing with a lack of eye center data on the storm. Thus, during the morning of the 16th, Foerster left Ramey AFB in Puerto Rico and headed towards the Gulf of Mexico and the waiting Camille.

Given the issue of available aircraft for the Camille reconnaissance mission, Foerster's aircraft would make two different reconnaissance flights into Camille on the 16th. For clarification in this document, the first mission into the storm will be designated Gull 2 / Camille *(A)*. This mission reached Camille in the early-afternoon, penetrated the storm's eye and reported a vortex fix at 1835z *(1335 local cdt).* The report fixed the center with a central pressure of 26.81" *(908 mb)* via dropsonde *(from 10,000 feet / 3048m or 700 mb)* and winds in excess of 140 kts *(161 mph / 259 km/h)* calculated via the aircraft's radar in Doppler *(navigation)* mode.

AWS C-130B Hurricane Hunter #3495 that flew into Camille as Gull 2 / Camille – USAF Photos

It was this USAF reconnaissance flight that fixed the storm's center as being *380 miles (612 kms)* south of Fort Walton Beach *(Florida)* and showing clear signs of rapid deepening.

Note: *Capt. Frederick "Fred" Foss Jr., the ARWO on this flight, reports that there were actually two dropsondes dropped in the eye at this time. The eye being so tight (approximately 8 miles / 13 kms across) they could barely circle within it. The first dropsonde, that measured 908 mb, quit two-thirds of the way down to the sea-surface. Foss requested a second drop and Foerster came around again within the eye to deploy another dropsonde. It's believed by Foss that this dropsonde operated properly and actually captured a reading of 905 mb. However they only reported the 908 mb measurement in their initial vortex message.*

The vortex message additionally reported a closed eye in all four quadrants up to and above *30,000 feet (9144m)*, a 11 degrees C temperature and rising in the eye at 10,000 feet *(3048m)*. A subsequent air report message indicated a temperature of 20.3 degrees C in the eye at 7600 feet *(2317 m)*.

After the initial eye penetration, Foerster subsequently left the storm and headed on to McCoy AFB in Florida. His aircraft was actually carrying all the spare parts and a replacement nose-radome needed to fix Lillie and Clark's Hercules stuck on the ground there in Orlando. And in so doing, permitted the next chapter in the continued aircraft reconnaissance operations conducted in Camille to unfold.

After dropping off the needed Hercules parts and taking on a full fuel load, Foerster left McCoy and headed back to Camille, to capture one more center fix in Camille for the day. For clarification in this document, this second mission into the storm will be designated Gull 2 / Camille *(B).*

It was just going twilight when the aircraft reached Camille and Foerster made two passes through the storm's eye, deploying only one dropsonde. The eye was down to approximately 5 miles *(8 kms)* across and Gull 2 / Camille could not orbit within it. Foerster could only pass through the eye. The reported vortex message from Gull 2 / Camille *(B)* reported a central pressure of 26.72" *(905 mb)* via dropsonde at 0016z *(1916 local cdt)* with maximum sustained flight-level winds at 140 kts *(161 mph / 259 km/h)* from between 8,000 and 9,000 feet *(2438m – 2743m)* and maximum sustained surface winds, measured by radar Doppler *(navigation) mode*, of *160 kts (184 mph / 296 km/h)* 20 nm *(23 miles / 37 kms)* from the center of the eye.

As previously discussed, the 905mb was actually captured several hours earlier during the Gull 2 / Camille *(A)* flight. Recalling the events 48 years later, ARWO Fred Foss suggested that the dropsonde measurement during this flight *(Gull 2 / Camille B)* was no less than 26.72" *(905 mb)* and that was the pressure they reported at the 0016z. At the time, this pressure measurement was the lowest hurricane surface pressure and the highest winds speeds ever measured by a hurricane reconnaissance aircraft in the Western Hemisphere.

Note: *the previous Atlantic hurricane lowest pressure record was set in 1935, during that year's Labor Day Hurricane, with a pressure of 26.31" (891 mb) and maximum sustained winds in excess of 200 mph (322 km/h) and higher gusts up to 250 mph (402 km/h). However, there were no aircraft reconnaissance flights into the eyes of hurricanes in 1935 and the only reliable storm measurements (the only available measurements) were from land-based instruments. But in retrospect, at Camille's latitude, the air would have been slightly heavier than that near the keys, which essentially translates to the pressure captured in Camille being close to or slightly more intense than the 1935 storm in some regards. But the 1935 storm's hurricane - force winds only extended out over a 30 mile (48 kms) wide area, with an eye diameter of only 7 miles (11 kms). Camille's hurricane force winds extended out over an area 175 miles (282 kms) in diameter with an estimated eye diameter of 10-11 nm (11.5 –13 miles) at landfall. It's interesting to note, that the 1935 hurricane has also been recently revised. Reanalysis has now proposed that the storm had only a low pressure measurement of 26.34" (892 mb) and 185 mph (298 km/h) winds.*

The 0016z Gull 2 / Camille *(B)* report on the storm indicated that Camille was back on the move again, with a forward speed of 12 mph *(19 km/h)* and was continuing to intensify or deepen. Maximum wind estimates were in excess of 160 kts *(184 mph / 296 km/h)* extending out 50 miles *(80 kms)* in all directions from the center – as reported in a number of *(official)* post-Camille reports and public domain articles.

However, raw archival air reports *(the actual aircraft radio transmissions from hurricane hunting aircraft in Camille)* from this flight indicate that the actual maximum surface winds were reported as 170 kts *(196 mph / 315 km/h)* 40 nm *(46 miles / 74 kms)* from the eye, while maximum flight level winds were between 140 -150 kts *(161mph – 173 mph / 259 km/h – 278 km/h)* 20 nm (*23 miles / 37 kms)* from the eye. *(it was normal procedure for Air Force hurricane reconnaissance aircraft to collect flight level wind speeds within a 100-mile radius around the center of a tropical cyclone at an altitude of 10,000 feet.)*

Author's Note: *although there are countless public domain references regarding Hurricane Camille and what happened during and after the storm, there are some references that are just grossly incorrect and require significant correction as to not allow this misinformation to continue and confuse the general public at large. One public domain reference (in a published historical book) suggests that the above documented USAF flight was flown by a WP-3 Orion aircraft. In actuality the earliest model of WP-3 Orion consisted of the "WP-3A Orion" that served with the US Navy Hurricane Hunters between 1971-1974 and did not exist at the time of Hurricane Camille and thus could not have flown this particular flight.*

A word about aircraft communications: one of the unrealized elements or misperceived notions of hurricane reconnaissance during this moment in time, with regard to Atlantic hurricane warning service *(network)*, is that the Navy and Air Force reconnaissance aircraft did not actually communicate directly with the hurricane center. Unlike hurricane reconnaissance operations of today, the Navy and Air Force reconnaissance aircraft only communicated directly with various *"monitors"*, from the respective military services, who would then interpret, analyze or edit the aircrafts storm data and in-turn relay the hurricane reconnaissance aircraft's observations and measurements directly or indirectly to the hurricane center – actually to the CARCAH at the hurricane center – via teletype.

Note: *the CARCAH or the Chief of Aerial Reconnaissance Coordination, Atlantic Hurricanes; is a position within the National Hurricane Center that is responsible for the preparation and coordination of the hurricane "plan-of-the-day" reconnaissance operations, and scheduler of required weather reconnaissance aircraft, from participating services, to carry out the plan.*

Teletype was used to send and receive electromechanical typed messages from point-to-point and or to multiple points over various communications channels or networks; including those reserved specifically for meteorological information.

In the case of the US Navy, their hurricane reconnaissance aircraft sent verbal *(voice) "air report"* communications, via the aircraft's on-board HF radios, to Navy monitors. During Camille, the Navy hurricane hunter's communications monitor was a division of the base operations communications central at NAS Jacksonville in Florida, who received and then relayed the aircraft air reports *(via teletype)* to the Fleet Weather Facility *(annex)* at Jacksonville. They in-turn relayed the interpreted reconnaissance aircraft's air report teletype messages to various Navy weather-related commands and agencies as well as to the hurricane center's CARCAH via several different teletype networks associated with the dissemination of weather information within the US Navy at-large.

The US Air Force hurricane reconnaissance aircraft, during Camille, communicated with an US Air Force Aeronautical station complex *(of the AWS)* weather monitor at Charleston, South Carolina, who received plain-voice coded air reports via radio and converted them into teletype messages. *(that's why when you actually look at the teletype air reports, they often contain a large number of miss-spellings in the messages)* The transcribed tele-typed messages were then sent out to various weather-related departments, via weather teletype networks, including the CARCAH at the hurricane center.

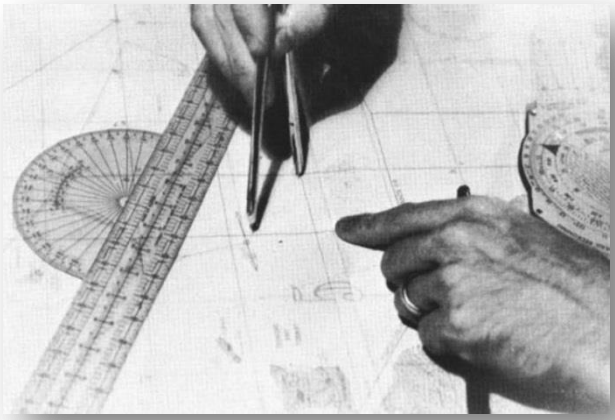
US Navy hurricane reconnaissance Communications Monitor – US Navy Photo

This communications process existed at the time of Camille, because the hurricane reconnaissance aircraft were not actually working directly for the hurricane center, nor the Atlantic hurricane warning service. The Navy and Air Force reconnaissance aircraft collected hurricane reconnaissance data specifically for their respective service's requirements, which was then subsequently provided semi-directly to the hurricane center. Case in point, the Navy hurricane reconnaissance aircraft specifically flew at 1500 feet *(457 m)* or lower in hurricanes to gather sea-surface conditions in support to Naval Fleet sea-going operations. The Navy aircraft also collect oceanographic data and other specific marine information than that of the Air Force. The Air Force penetrates hurricane at much higher altitudes, at *10,000 feet (3048m)*, and was directly concerned with storm condition effects on tactical aircraft operations and its network of worldwide air bases in the path of these tropical cyclones. This is why there was never more than one Navy weather reconnaissance / hurricane reconnaissance squadron *(at any one time)* in the Atlantic between 1946-75 and why the tropical cyclone reconnaissance missions in the Air Force were never more than an *"auxiliary"* tasking to USAF Weather Reconnaissance squadrons.

Foerster's recollections of this particular flight *(to this author 48 years later)* included his surprise when the hurricane center, within 20 to 30 minutes of their initial air report, began questioning their wind and pressure measurements – via the monitor. They couldn't believe the low pressure measurement and wind levels, probably because these aircraft reports were not consistent with the data flowing from the hurricane center's computer models.

This was typical during the late 1960s, that as storms seemingly became more frequent and intense, the hurricane center found the reconnaissance aircraft's vortex messages difficult to believe, where-by the hurricane center either didn't except them outright or would alter them in the center's formation of its subsequent forecasts, warnings and advisories. Both Navy and Air Force weather officers were totally aware of this trend, but did not complain much about it.

One of the issues that affected this process of *"unbelievable"* reading from the reconnaissance aircraft, was communications. Because of the previously mentioned communications process, the hurricane center could not immediately ask for corroborative runs / drops or restatements in a timely manner, before issuing their time-based warnings and forecasts. There was always a delay in the *"monitors"* relaying requests and information.



US Navy hurricane reconnaissance navigator plotting a hurricane. – US Navy Photo

Additionally, the hurricane center automatically perceived navigational errors in the reconnaissance aircraft air reports and fixes; especially the Navy's reports. In fact, under Simpson's reign, the hurricane center expected Navy hurricane reconnaissance aircraft fixes to be off by as much as 45nm *(46 miles / 74 kms)*. With regards to Camille, the hurricane center believed that some of the Navy center fixes had the storm further toward the west – as compared to the positions derived by satellite observations and or the center's computer models.

In the hurricane center's defense, later inertial (*and eventually GPS)* navigation systems did greatly improve the accuracy of the tracking of tropical cyclones in the years after Camille, and new navigation systems were part of funded upgrades to hurricane reconnaissance aircraft and on-board systems in the wake of the storm. However, at the time of Camille, the hurricane reconnaissance aircraft were equipped with the accepted technology of its day, which was a sight better than what they had during WWII.

Due to USAF flight regulations governing crew rest requirements of what had become a very long and busy day, Foerster turned his aircraft eastward and headed towards the South Florida coast and a touchdown at Homestead AFB, near Homestead, Florida. Before flying back to Puerto Rico the next evening *(17 August)*, the crew apparently made a day trip visit to the Hurricane Center. Capt. Foss, the ARWO on the flight, remembers talking with Bob Simpson and his wife Joanne there. They subsequently didn't takeoff for Puerto Rico until early evening, arriving back to Ramey well before midnight on the night of the 17th.

(17 August) – Navy Reconnaissance Flight: *Navy 4 / Camille (1-25) [MH-5 / #137896]*

The next reconnaissance flight into Camille, conducted by a Navy aircraft, took place just after midnight on the 16th and carried through till the early morning. Constellation MH-5 arrived at Camille and radioed in its first fix of the storm at 0552z *(0052 local cdt)*, when the storm was positioned 310 miles *(574 kms)* south-southeast of Pass Christian *(Mississippi)* with sustained winds of 130 kts *(150 mph / 241 km/h)* and higher gusts in excess of 148 kts *(170 mph / 274*

km/h) that drove 40 foot *(12 m)* deep ocean swells towards the shores of the northern Gulf of Mexico - according to spectral wave data from the Navy's NOMAD buoy.

Note: *the Navy's Oceanographic & Meteorological Automatic Device (NOMAD) were open-sea tethered weather stations deployed in the Atlantic, Caribbean Sea, Gulf of Mexico and the Eastern (north) Pacific during the 1960s. One NOMAD was moored (in 1875 fathoms) approximately in the dead center of the Gulf of Mexico, at 25:00 North x 90:00 West. Although early buoys were developed in the late 1950s by the Navy, the NOMAD buoy in the Gulf of Mexico, during Camille, was part of an ONR / NRL research program conducted throughout the 1960s associated with Navy hurricane research - where NOMAD buoys were placed in the expected paths of hurricanes to capture important meteorological and oceanographic data on the storms. Camille passed the Gulf of Mexico NOMAD within 156 nm (179 miles / 288 kms) to the east of the buoy at 17 / 0000z -or- the night of the 16th on or about 1900 local cdt.*

US Navy NOMAD in central Gulf of Mexico circa 1969 - US Navy Photo

Between 0552z and 0700z *(0052 and 0200 local cdt)* Navy 4 / Camille reported radar eye location fixes from an altitude of approximately 10,000 feet *(3048m)*. At 0644z (*0144 local cdt)*. Navy 4 reported that Camille was a well-organized storm with a well-defined tight eye on radar, estimated to be less than 10 miles *(16 kms)* across with winds in excess of 150 -160 mph *(241 km/h – 258 km/h)* near the center and an extrapolated surface pressure of 29.44" *(997 mb)* - having circumnavigated around the storm, in all four quadrants at the 700mb altitude. The aircraft encountered spiral-bands extending out 231 miles *(373 kms)* southeast of the center, spreading north – encompassing the eye. The very dense eyewall was closed in all four quadrants, estimated to be between 5 -10 nm *(5.8 – 11.5 miles / 9.3 – 18.5 kms)* thick, with the eye fluctuating between 9 -11 miles *(14.5 – 18 kms)* in diameter. Coupled with the high winds *(over the restrictive 120 kts)*, the tight eye of the storm prohibited the aircraft from penetrating the storm.

Despite the fact that the newly available Nimbus 3 *(infrared-capable)* Satellite, permitting night-time views of the Camille, was semi-operational and providing imagery on the storm, NHC hurricane experts *(in Miami)* and ESSA satellite experts *(in Washington)* disagreed greatly over the interpretations of the imagery coming in from the satellite and what they represented, especially during the critical period overnight on the 16th / 17th of August. The satellite data to the experts in Washington suggested that Camille was weakening between 12 mid-night on the 16th and 0300 local cdt in the early hours of 17th. The hurricane center interpretation of the same satellite data was the opposite, that Camille was maintain its intensity, with signs of additional intensification. The hurricane center at this time began thinking that Camille was becoming a severe dangerous storm. The continuous Navy radar reconnaissance coverage of the storm overnight additionally confirmed the NHC forecaster's assessment.

However; it was still the belief of the hurricane center that the storm would soon veer away from the Louisiana coast and head towards the panhandle of Florida.

(17 August: continues) - Navy Reconnaissance Flight: ***Navy 5 / Camille*** *[MH-2 /#137892]*

This Sunday morning found Camille approximately 250 miles *(402 kms)* south of Mobile, Alabama, with all indications of further intensification expected throughout the day. Camille had become a very dangerous storm as it slowly moved towards the mouth of the Mississippi river and still had not recurved towards Florida as the hurricane center models had predicted. By 9 am local cdt time on the 17th, the hurricane center issued its #14th Advisory statement on the storm. At this time, it had dropped all mention of the Florida panhandle *[in the strike zone]* and increased its warnings for a potential strike along the Mississippi coast – less than 15-hours away.

The next reconnaissance flight into Camille was a Navy Constellation MH-2. By all accounts this flight is *"Undocumented"* in the official records of the hurricane center *(storm wallet)* and in the public domain at-large. For this document, we will call this reconnaissance flight; *"Navy 5 / Camille"*. Navy archival records indicate that there were at least 5 separate Navy reconnaissance missions flown into Camille by VW-4 totalling 38.6 flight hours, not including the Navy 7/ Invest investigative flight on the 14th.

US Navy VW-4 Constellation MH-2 / 137892 - US Navy Photo

From very early morning to just before noon, 1200 z - 1700z *(0500 - 1200 local cdt)* this Navy hurricane reconnaissance aircraft, the last of four Navy Constellations deploying to Puerto Rico for Project Stormfury, provide a number of radar fixes of the Camille.

Unfortunately, the intensity of the storm and the fact that this aircraft was just dropping by on the way to its Stormfury deployment, meant that this aircraft only made a few reports on the storm. The first few air reports comprised the initial daylight fixes of Camille at 1215z and 1230z *(0715 and 0730 am local cdt)*. Additional fixes during the flight only reflected eye location reports via radar. The Navy 5 / Camille aircraft departed the storm sometime before noon and headed for Puerto Rico.

(17 August: continues) - Navy Reconnaissance Flight: ***Navy 6 / Camille*** *[MH-4 / #137894]*

This reconnaissance flight, also not documented in the official records of the hurricane center *(storm wallet)* and in the public domain at-large, was the last Navy reconnaissance flight to fly on Camille. For this document, we will call this reconnaissance flight; *"Navy 6 / Camille"*.

US Navy VW-4 Constellation MH-4 / 137894 - US Navy Photo

This Navy hurricane reconnaissance aircraft, the last squadron Constellation at NAS Jacksonville not deploying to Puerto Rico for Project Stormfury, provided a number of radar fixes of Camille between 1700 z and 0000 z *(1200 noon - 1900 / 7:00pm local cdt)*. This

unknown Navy flight overlapped the period of the next USAF Gull flight and terminated just before another unknown USAF reconnaissance aircraft flew on the storm.

During this mission, Navy 6 / Camille parked *(orbited)* in clear areas between rain bands approximately *35-50 miles (56-81 kms)* out from the eye, in different quadrants around the storm, between storm radar fixes. These orbit areas themselves had sustained flight level winds in excess of *145 kts (167 mph / 269 km/h).*

Navy Hurricane Hunters (VW-4) pre-flight brief for another hurricane mission - Public Domain Photo

Although more than three members of the Navy crew that flew this flight confirm their recollections with flight log book entries, official US Government (*including ESSA / NOAA)* post-Camille reports', tracking charts and storm fixes listings *(reproduced in the most recent reanalysis of Camille)* do not represent any of the storm measurements or fixes derived from this last Navy reconnaissance flight. In post-storm analysis by the Hurricane Center, the fixes from this Navy aircraft flight are missing too and seemingly were not evaluated by the most recent reanalysis of Camille.

This point alone invalidates the findings of the most recent reanalysis of Camille, given that the authors were not privy to this invaluable flight information associated with the complete operational history of the reconnaissance operations or the data collected on the storm during the fullness of its track.

At this critical juncture in the forecasting of Camille, the maximum winds were estimated to be in the neighborhood of 200 mph *(322 km/h)* and the eye was established to have been very tight or between 10 and 12 miles (16-19 kms) across. Navy crewmen from this flight report that Camille looked like a giant water spout with a very dense eyewall; a wall of water surrounding the eye that seemingly could not be penetrated. The aircraft crew's recollections from this flight reported an extrapolated central pressure of 26.62 *(901.45 mb)* and sustained winds of 190 mph *(306 km/h)* at flight level just below 10,000 feet, some distance from the center, with sustained gusts over 200 mph *(322 km/h)*.

There is no question that Camille was a uniquely severe storm, and one of the most unusual observations that this aircraft crew also made was the *"Pulsing"* of Camille's eye as seen on their APS-20 radar scopes, during the period when Camille was believed to be at peak intensity.

The onboard Aerologist is quoted to have said that; *"…… The eye of Camille seemed to "pulse" between five and seven miles in diameter ….." (later the storm's eye pulsed between 7 and 10 miles / 11 – 16 kms in diameter) again, almost like the eye of the storm was breathing….."* This experienced Navy hurricane reconnaissance crew had never seen anything like this before and it's not sure if anyone has seen this since.

Note: *the Eye Pulsing observations made by the Navy Hurricane Hunter crews in Camille are certainly an interesting phenomenon, whether they are an organic meteorological phenomenon, an electronic radar glitch or a visual representation of known natural characteristics of hurricane processes. The fact of the matter is that no meteorological research study has ever been undertaken to verify or explain what the Navy eye pulsing observations represent to-date.*

In the consensus of some of the Navy crewmembers, at the time that they flew this flight, Camille had maintained its severe intensity throughout the flight or to about 0000z *(1900 / 7:00pm local cdt)* when the aircraft left the storm. At that time, this Navy aircraft was within a few short miles off the toes of Louisiana's foot or just east-southeast of the Mississippi river delta - just east of Garden Island Bay – or approximately 60 nm *(69 miles / 111 kms)* south of the Mississippi coast.

USAF C-130B Hurricane Hunter #3492 was also Gull 3 / Camille – USAF Photo

(17 August: continue) - USAF Reconnaissance Flight: *Gull 3 / Camille (1-4) [#62-3492]*

The next reconnaissance flight into Camille comprised Capt.*(s)* Lillie & Clark's second flight into the storm; designated Gull 3 / Camille. In the 24 hours since Foerster's crew delivered spare parts, repairs were urgently mounted to get the Hercules back in the air to fly a much needed reconnaissance of Camille and to collect center / eye data, as she began to bear down on the Mississippi coast.

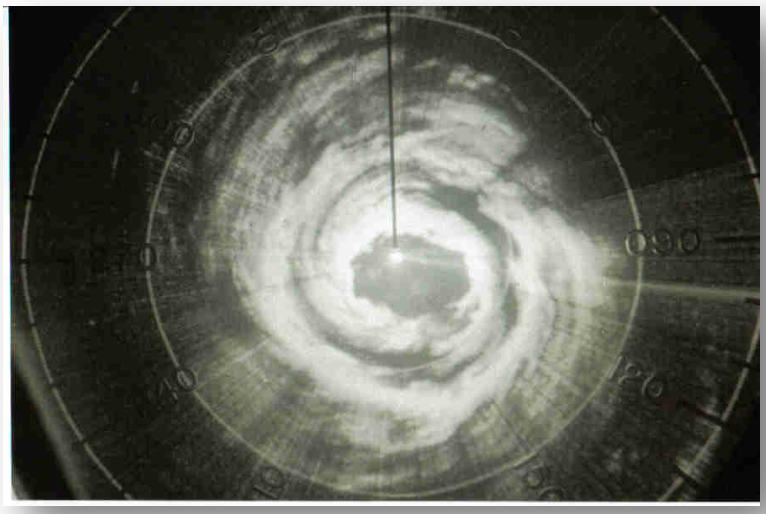
Late in the morning *(about 1618z or 1118 local cdt)*, Gull 3 / Camille took off from McCoy and headed out towards Camille, arriving near the storm shortly before 1800z *(1300 local cdt.)* By this time Camille was approximately 155 nm *(178 miles / 286 kms)* southeast of New Orleans and the intensity of the storm was evident as Lillie and Clark fought their way through severe turbulence in the outer reaches of the storm, towards the eye.

At one point they came across a clear area, 50 miles *(80 kms)* across, approximately 15 nm *(17 miles / 27 kms)* from the center of the storm's eye. They could see all the way to the sea's surface in this clear zone. They reported this clear area to NHC, extrapolating a sea surface wind speed *(visually)* in excess of 174 kts *(200 mph / 322 km/h)* from approximately 10,000 feet *(3048 m)* above. This clear area found by the Gull 3 / Camille aircraft crew is indicative of a *"moat"* that separates the inner and outer eyewalls during an eyewall replacement cycle *(ERC)* whereby an outer, newer eye forms some distance from the older, inner central eye. This phenomenon's most visible feature is the occurrence of two eyes, also known as concentric eyewalls *(aka double eyewalls)*. The ERC is a rare feature of mature, extremely powerful and intense tropical cyclones.

However, at the time of Camille, they were rarely observed and little understood. They manifest themselves in approximately 10% of all tropical cyclones; or 50% in most intense hurricanes and in 10% of all severe tropical storms.

Once this phenomenon was studied and understood concentric eyewalls were found to occur at a point in the tropical cyclone's evolution, during or just after a period of increased deepening, when outer eyewall clouds form at some distance from the storm's center or old center eye. The maximum sustained winds within the inner eyewall, gradually shift outwards through the clear-air areas between the cloud formations to form a new outer eyewall. The older inner eye ultimately dissipates as the newer eyewall contracts towards the center squeezing it out of existence. This process is accompanied by an associated weakening as the new eye begins functioning as the old.

A fuller understanding of the ERC came in the 1990s, primarily through previous studies re-evaluating the hurricane modification research of Project Stormfury, that differentiated the naturally occurring ERC phenomenon –vs- that which was artificially induced through cloud seeding associated with Stormfury. It's been said that the subsequent discovery of these concentric eyewalls and the investigation into this eyewall replacement phenomenon, led to the questioning of the Stormfury hypothesis and its seeding results.



Double eyewalls seen in Hurricane Debbie on 20 August 1969 - Public Domain Photo

The existence of the phenomenon itself, a feature of a hurricane's natural dynamics, caused the previous Stormfury results to be measured against this naturally-occurring phenomenon. Thus, the successes of the Stormfury experiments, in this view, became suspect and renewed criticism and scientific doubt into the hurricane seeding process in the light of the concentric eyewall phenomenon.

Concentric eyewalls were officially first observed in Typhoon Sarah *(21 March - 5 April 1956)* and again during the extended life cycle of Hurricane Donna *(29 August – 22 September 1960)*. Although in retrospect, they have been occasionally seen is some tropical cyclones since the beginning of hurricane reconnaissance flights in WWII, both in the Atlantic and Pacific. Under Project Stormfury, the concentric eyewalls, aka double eyewalls were observed in a number of intense storms including Hurricanes; Beulah *(3-22 September 1967)* and Debbie *(14-25 August 1969)* and during hurricane research flights in Hurricanes Gilbert *(8-29 September 1988)* and Andrew *(16 -28 August 1992).*

Note: *space-based remote-sensing satellites also subsequently confirmed the phenomenon of concentric eyewalls in unmodified hurricane, revealing that concentric eyes were more common than previously thought as a natural process of intense tropical cyclone development.*

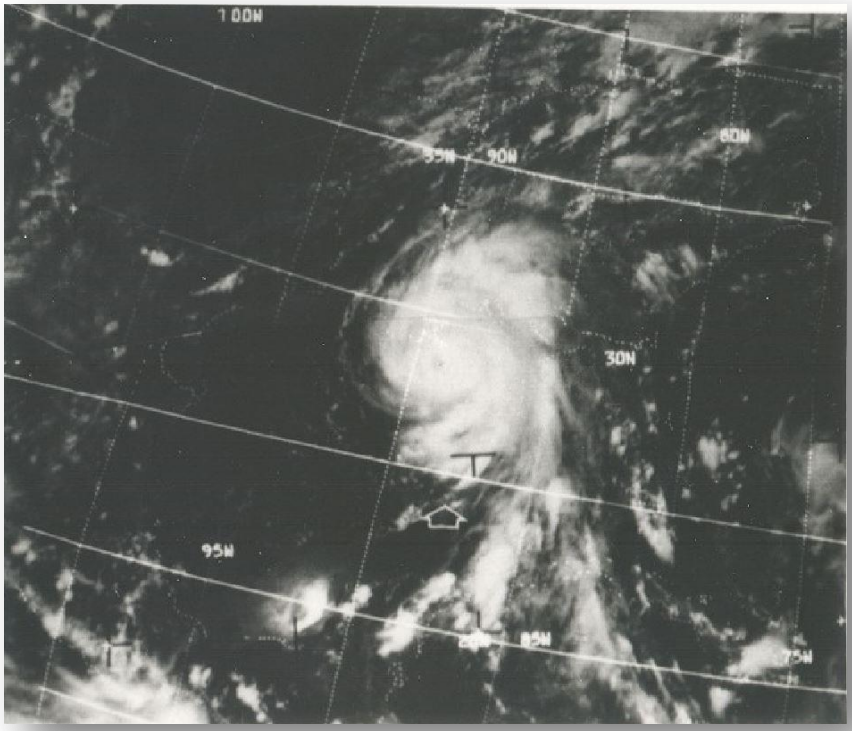
In modern Hurricanes like Ivan *(2-24 September 2004)***,** the storm was observed to not only have had concentric eyewalls, but is believed to have underwent several eyewall replacement phases during its 14-day trek across the Caribbean and into the Gulf of Mexico. Later in 2005, Hurricane Katrina *(23-31 August 2005)* was observed with double eyewalls as it crossed into the Gulf of Mexico and seemed also to be undergoing another eye-replacement cycle during landfall near New Orleans.

The recent reanalysis of Camille suggests that an eye replacement cycle occurred in Camille. The article states that it occurred much later on the 17, near or at landfall and that the storm was in a process of weakening at landfall due to the process of the proposed eyewall replacement cycle. In fact, their whole premises for downgrading or justifying Camille as the second most-powerful storm to have struck the continental United States, is partly based upon their assertion that the ERC was occurring at or near landfall.

However, the last Navy *(Navy 6/ Camille)* and Air Force *(Gull 3/ Camille)* reconnaissance aircraft observations clearly establishes the presence of a double eyewall *(ERC phase)* phenomenon occurring earlier in the day on the 17th. By 1pm local that afternoon *(1815z / 1315 local cdt)*, Gull 3/ Camille reported observations indicative of an ERC in progress. From it's meager flight report at this time, the storm's inner eye was approximately 2-3 *miles (3.2 - 4.8 kms)* in diameter and the outer eye more than 11 miles (18 kms) in diameter. It is believed that ERCs take on average 8-10 hours to complete. *(as referenced by professional technical papers from the hurricane research community)* Even at its maximum duration, considering the margins of the distances of the two eyewalls in Camille reported by Gull 3, suggests that the storm was already several hours into the ERC. Camille at that time was still more than 11 hours from landfall. Additionally, it is indicative of a storm coming out of an ERC to begin deepen in intensity, which for Camille would have been approximately two or three hours before landfall, Thus, establishing that Camille could only have been intensifying at landfall.

As Gull 3 / Camille began penetrating the eyewall clouds outside the *(inner)* eye, the crew experienced severe turbulence that tossed them around violently, before reaching the center of the storm and breaking into the clear eye. Immediately, the Hercules began to experience a series of problems that caused great concern towards the safety of the crew and the continuation of the mission. It all started with an engine warning light that suggested that the engine-driven *(electrical)* generator had failed on the #4 engine. A generator failure of this nature can often escalate into a very hot fire in a matter of minutes or even seconds that is difficult to put out with the on-board engine fire suppression system, if at all. Having no choice in the matter, Lillie initiated an emergency engine shut-down of the #4 engine. The emergency engine shut-down procedure in a hurricane, for the flight crew, comprises an immediate abort of the mission and focus directly on safely executing an exit from the eye and the storm in general. In fact, they actually had two engine emergencies; one was the shut-down of #4 engine, the other an apparent loss of oil pressure on engine # 3. Given that #3 engine continued to function normally, it was believed the problem to be just a faulty oil pressure gage *(instrument)*, but they could not take the risk of losing a second engine in middle of such a severe hurricane.

Having slowly gained a little altitude within the eye, to compensate for the loss of an engine, Lillie and Clark were then able to escape the center and retreated back to that clear area they had encountered earlier. Upon assessment of the loss of #4 engine and the engine oil pressure situation on #3, they opted for an emergency landing at the nearest airfield. Since the storm was now between them and Florida, Texas was the closest place to set down and they left Camille behind them and headed out across the Gulf of Mexico for the Lone Star state.

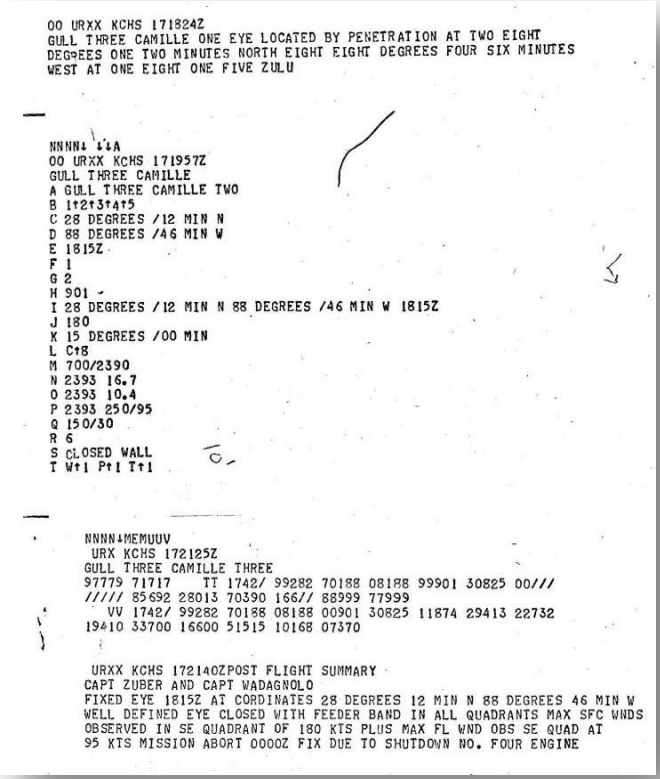


An ESSA 9 Satellite image of Camille at 1957z (1457 / 2:57 pm local cst) on the afternoon of 17 August 1969, shortly before the flight of USAF reconnaissance mission Gull 3 / Camille ended in Texas. At this time the eye of Camille was down to approximately 5 miles (8 kms) in diameter. This photo was taken in conjunction with an NESC study of hurricane cyclogenesis; to visually track storms from their birth to death. – NOAA NHC

Although in a very dangerous position, the onboard weather officers did managed to grab a snapshot sounding *(via dropsonde)* of the storm's eye before Lillie made the command decision to abort the mission and withdraw from the storm to seek safety and an eventual emergency landing in Texas. Reported at 1815z *(1315 local cdt)*, this vortex message established a new central eye pressure of 26.61" *(901 mb)* and extrapolated surface winds in excess of 180 - 190 kts *(or about 207-219 mph / 333-352 km/h)* near the center, extending out 60 miles *(97 kms)* from the eye - somewhat within the speed range of some tornados. With measurements of 26.61" *(901 mb)* and 185 kts *(213 mph / 343 km/h)* average winds, Camille became the *"new"* most intense hurricane on record in the Western Hemisphere.

A word about this low pressure measurement. In the most recent reanalysis effort of Camille, the authors extensively reanalyzed this measurement, due to notional evidence in the 1969 Hurricane Center's records of the 901mb reading having been thrown out and somehow replaced with a 905 mb reading *(which we now know came from the USAF Gull 2 / Camille reconnaissance flight some 20-hours earlier)* without explanation during the hurricane center's routine post-storm re-evaluation process.

The reanalysis authors then go through an extensive postulation as to how or why this change in the lowest pressure measurement was achieved by the earlier hurricane forecasters and offer 3 possible methods of how it could have been arrived at – recommending one of them as being the most likely.



00 URXX KCHS 171824Z
GULL THREE CAMILLE ONE EYE LOCATED BY PENETRATION AT TWO EIGHT
DEGREES ONE TWO MINUTES NORTH EIGHT EIGHT DEGREES FOUR SIX MINUTES
WEST AT ONE EIGHT ONE FIVE ZULU

NNNN↓ ↓↓A
00 URXX KCHS 171957Z
GULL THREE CAMILLE
A GULL THREE CAMILLE TWO
B 1↑2↑3↑4↑5
C 28 DEGREES /12 MIN N
D 88 DEGREES /46 MIN W
E 1815Z
F 1
G 2
H 901 -
I 28 DEGREES /12 MIN N 88 DEGREES /46 MIN W 1815Z
J 180
K 15 DEGREES /00 MIN
L C↑8
M 700/2390
N 2393 16.7
O 2393 10.4
P 2393 250/95
Q 150/30
R 6
S CLOSED WALL
T W↑1 P↑1 T↑1

NNNN↓MEMUUV
URX KCHS 172125Z
GULL THREE CAMILLE THREE
97779 71717 TT 1742/ 99282 70188 08188 99901 30825 00///
///// 85692 28013 70390 166// 88999 77999
VV 1742/ 99282 70188 08188 00901 30825 11874 29413 22732
19410 33700 16600 51515 10168 07370

URXX KCHS 172140ZPOST FLIGHT SUMMARY
CAPT ZUBER AND CAPT WADAGNOLO
FIXED EYE 1815Z AT CORDINATES 28 DEGREES 12 MIN N 88 DEGREES 46 MIN W
WELL DEFINED EYE CLOSED WITH FEEDER BAND IN ALL QUADRANTS MAX SFC WNDS
OBSERVED IN SE QUADRANT OF 180 KTS PLUS MAX FL WND OBS SE QUAD AT
95 KTS MISSION ABORT 0000Z FIX DUE TO SHUTDOWN NO. FOUR ENGINE

Note: *the recognized world record lowest pressure reading at the time of Camille, comprised 25.90" (877 mb) captured by USAF reconnaissance aircraft dropsonde in Super Typhoon Ida in the Western Pacific on 24 September 1958. This measurement would be superseded by Super Typhoon Tip (5-19 October 1979) with the lowest surface pressure of 25.69" (870 mb) on 12 October 1979 during peak intensity. The measurement was captured by a USAF Pacific typhoon reconnaissance aircraft via dropsonde. At the time Tip was the largest tropical cyclone on record with the largest circulation pattern of more than 1200 nm (1381 miles / 2220 kms) in diameter. Maximum winds were in the neighborhood of 160 + mph (258 + km/h).*

A copy of USAF Gull 3 / Camille eye fix / air report at 1815z on 17 August 1969. - NOAA NHC

Stating, in their BAMS article; *"….. there is no documentation on why the 901-mb sea level pressure was rejected, nor was the decision clarified after contacting the surviving NHC hurricane forecasters from the 1969 hurricane season. …… There are two questions about the "901-mb" sonde that are likely unanswerable. ……..."*

If these scientists had taken a more comprehensive historical / archival approach to these questions, then they would have actually secured the answers so ever present in their minds. The reality is that the USAF aircraft measurement of 901 mb was *"a mistake"*, due to a miscalculation made by the aircraft's dropsonde operator during what turned out to be a very stressful flight.

As reported by Arnold L. Sugg and Leonard G. Pardue, *("the Hurricane Season of 1969" in the February 1970 issue of Weatherwise)* an error occurred in the conversion procedures of raw dropsonde data into useable weather information that went into the vortex messages sent by the Gull 3 /Camille aircraft, – which was subsequently and quickly reported by the press nationwide. Instead of the 901 mb / 26.61" pressure reading reported, the actual pressure measurement recorded by Lillie & Clark's aircraft comprised ***918 mb or 27.11",*** at the same altitude and parameters presented in the aircraft's original vortex message.

Further; the editor of the February 1970 issue of Weatherwise *(David M. Ludlum)* reports on the editorial page *(the contents page)* of the same issue, that he received notification from the United States Environmental Data Service indicating that the lowest sea-level pressure measurement recorded in Hurricane Camille had been corrected to reflect the 905 mb / 26.73" value acquired from the earlier USAF reconnaissance flight on 16 August 1969. The letter stated that a review conducted by US Air Force personnel, and the National Weather Records Center, of the procedures for reducing [dropsonde] data used in arriving at the original 901 mb measurement *(i.e. as set forth in the USAF's Air Weather Service Manual 105-1, the 8 August 1966 edition, Section 2-28 Sea Level Pressure procedures)* were not fully employed.

This information is consistent with and is somewhat verified by the recollections of the Co-pilot of the USAF Gull 3 / Camille aircraft, Lt. Col *(then Capt)* Robert L "Bobby" Clark *(ret)*. Clark *(in a phone conversation with this author in September 2016)* reports that within a week or two after Hurricane Camille, the flight's dropsonde operator realized he had made a mathematical miscalculation of the dropsonde data during the mission – during a routine review of the processes and procedures employed on the reconnaissance flight. It was then realized that the dropsonde measurement originally reported was *"way to low"*. It's obvious that the correction was subsequently reported to all the relevant agencies *(like the hurricane center)* and other organizations. But the 901 mb had already been disseminated in the press and forever remained in the public domain as the reported lowest pressure measurement in the storm.

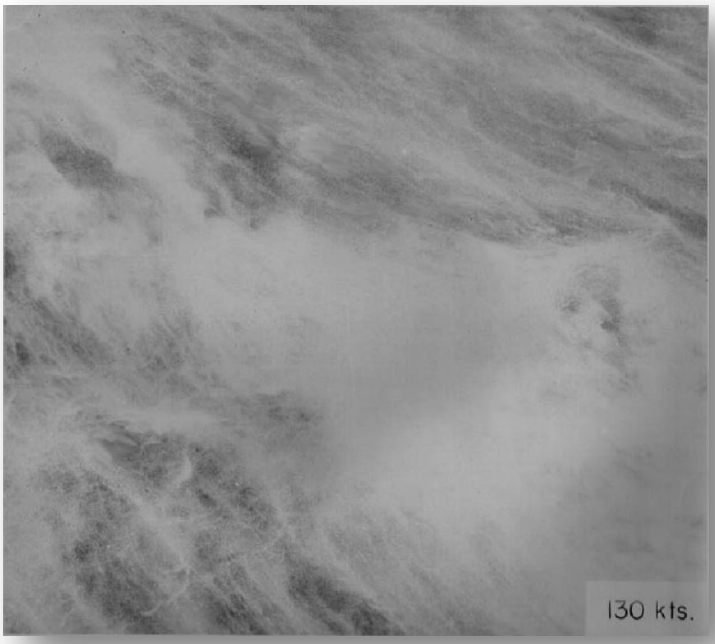
To give credit where credit is due, the reanalysis authors did correctly figured the actual barometric pressure for Camille at 1815z on 17 August 1969 *(to within one or two millibars of pressure)* with scant available information and a notionally faulty dropsonde measurement.

A word about this flight's wind measurements. As previously mentioned, the USAF C-130Bs used on the reconnaissance of Camille were rudimentarily equipped for weather reconnaissance with virtually little or no flight-level measuring instruments and a limited dropsonde system *(providing just pressure, temperature and humidity soundings)* with no wind direction or speed capabilities. *(wind measuring dropsondes were not developed until the mid-1970s)* Thus, the wind measurements collected on these Air Force reconnaissance flights into Camille were captured via two approved methods; either visually, utilizing a sea-state wind - speed guide *(a pictured guide of sea-surface sea-state pictures corresponding to known wind speeds)* or by the use of the limited Doppler *(navigation)* mode on the standard C-130 AN/APN-59B Radars.

Note: *the standard C-130 Hercules radar for the USAF in the 1960s was the AN/APN-59B navigation and search radar. In fact, this was the standard radar unit for all transport / cargo C-130 (all models) as well as a variety of other USAF aircraft. The APN-59B was actually a complicated electronic system to logistically maintain and often failed. (the APN-59B had one of the highest maintenance hours for repair of any other electronic system in USAF inventory and the lowest reliability of any system, with just a mere 18 hours of operation before it failed and ceased to function. That figure was even lower for APN-59Bs serving in weather reconnaissance squadrons) The radar system had several different modes, with the weather (avoidance) mode utilized by the weather reconnaissance aircraft to display intense areas of adverse weather (heaviest precipitation) on weather reconnaissance flights – which it was not really well suited for. However, the system's Doppler (navigation) mode could provide measurements that could be used to determine rough wind speeds.*

Although the USAF Gull 2 / Camille reconnaissance flight on the 16th utilized the Doppler mode on the aircraft's AN/APN-59B radar, to calculate the storm's wind speeds, the Gull 3 / Camille flight on the 17th utilized the visual sea-surface sea-state guide method *(aka the US Navy's "Wind Estimations from Aerial Observations of Sea State" guide)* to determining the storm's maximum surface winds. The Weather Officer on that flight determined the surface winds to have been approximately 180 - 190 kts *(or about 207-219 mph / 333-352 km/h)*.

According to Co-pilot Bobby Clark, the sea-surface sea-state at the time was something that more experienced members of the crew had never seen before and was literally off the chart – with regards to the visual sea-state guide at their disposal. The visible sea-surface sea-state of Camille at this time was well beyond the maximum 130 kts *(150 mph / 241 km/h)* image represented in the guide. The flight's veteran Air Reconnaissance Weather Officer, Capt. Charles *"Chuck"* Zuber *(who was actually an ARWO Instructor and was instructing & qualifying ARWO Capt. George E. Wadagnolo during this flight)* estimated the maximum surface winds on this mission, to be between 180 to 190 kts *(or about 207 - 219 mph / 333 - 352 km/h)* and being significantly beyond the 130 kts visual cues from the sea surface - sea state guide.

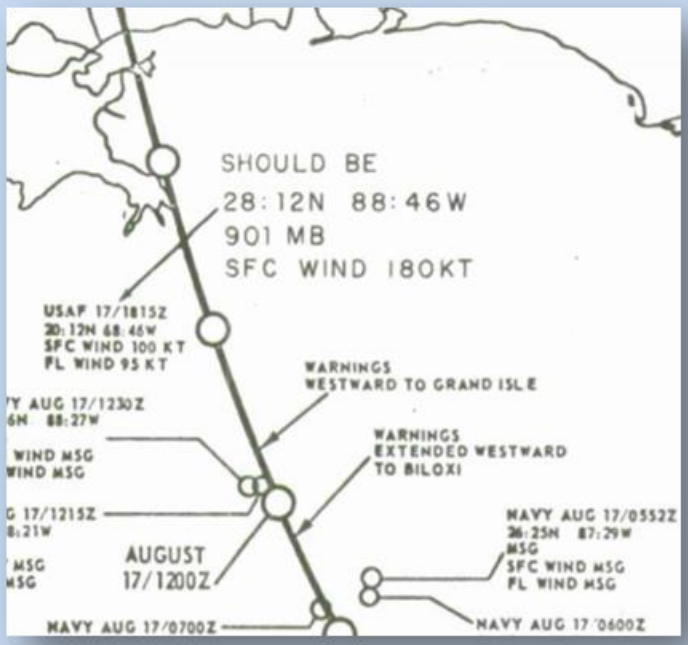


The maximum sea-surface sea-state guide image of 130 kts (150 mph / 241 km/h) from "the US Navy's Wind Estimations from Aerial Observations of Sea State" Guide (by Charles Neumann). The in-flight Weather Officer, Capt. Zuber, onboard the Gull 3 / Camille reconnaissance flight in the early afternoon of 17 August 1969, used a similar sea - surface sea-state guide to fix the maximum surface winds for Camille. – courtesy Charles Neumann

Despite the sometimes' perceived *(modern)* impression that the dropsondes utilized in Camille also gather wind data, and if these dropsondes were faulty in gathering true barometric pressures, than the wind measurement on that flight were faulty too, information presented here establishes that the measurements of pressure and winds were obtained by different methods and processes that correspond to the standard *(accepted)* procedures for obtaining hurricane data at that time in 1969.

A subsequent summary air report by the weather officers on Gull 3 / Camille *(at 2140z)* indicated that maximum surface winds were *(visually)* estimated to be more than 180 kts *(207 mph / 333 km/h)* in the southeast quadrant of the storm with 95 kts *(109 mph / 175 km/h)* estimated flight-level winds also in the southeast quadrant of the storm.

Special Note: Bad Chart *- in the recent reanalysis of Camille; The "Best Track Positions" chart on page 370 of the BAMS issue with "A REANALYSIS OF HURRICANE CAMILLE", has a flaw in it for this flight as well as doesn't represent the "undocumented" hurricane reconnaissance flights presented in this historical review. The chart in question, copied verbatim from the Department of Commerce's report "HURRICANE CAMILLE: A Report to the Administrator" ; lists coordinates for the Gull 3 / Camille flight at 1815z on the afternoon of the 17th, as being 20:12 (north), - 68:46 (west). These coordinates are wrong ! Further the listed wind speed measurement is wrong and doesn't even provide the pressure reading for that timeframe's air report. The reality is that the coordinates for the storm presented on this chart in the reanalysis article are actually the coordinates for an area of open sea 160 kms north of Punta Cana, Dominican Republic and have nothing to do with where Camille was at the time.*



The true and correct coordinates (and storm data) for Gull 3 / Camille at 1815z on the afternoon of the 17th are reflected in another government report, Lincoln Laboratory: technical note 1970-5, "Report on Weather Radar Study" (see page 6 /14). That report, published in the wake of Camille, actually provides the correct coordinates of the storm and storm data as reported by this flight, as 28:12 (north), - 88:46 (west), with 901 mb and 180kts winds, as an added note to the original summary of the Best Track Positions chart from the "Report to the Administrator" and the "Reanalysis of Hurricane Camille".

The Gull 3 / Camille Mission abort occurred at approximately 1900z *(1400 / 2pm local cdt).* The reconnaissance flight itself terminated at 2054z *(or 1554 / 3:54pm local cdt)* in Texas on 17 August 1969, after only 4.6 hours in the air and less than 1 hour in the storm.

Camille was at this point approximately 145 nm *(166 miles / 269 kms)* south of the Mississippi Coast or 120 miles *(193 kms)* southeast of New Orleans. It's was just a little while later at approximately 2054z *(1554 / 3:54pm local cdt)* on 17 August 1969 that Camille was believed to have been at peak intensity and seemingly maintained this intensity with little fluctuations until making landfall along the Mississippi coast just before midnight.

Back at the Hurricane Center, it was soon after 3pm *(est)* on the afternoon of the 17th when Bob Simpson got the word that the USAF Hercules reconnaissance aircraft had experience an in-flight emergency and had to aborted their mission. This was one of those critical moments in the tracking of Camille, that for approximately the next 10 or more hours, until the storm came ashore somewhere in Mississippi *(around mid-night)* the NHC would have "*no"* in-stiu or center storm data from a hurricane reconnaissance aircraft. This situation was further compounded by the fact that for an extended period *(over approximately 24 hours between the 16th and the 17th or approximately 20-hours between the USAF Gull 2 and Gull 3 flights)* Simpson had received little or no center storm data to support accurate forecasting and tracking of this hurricane.

Between approximately 8am on the 16th, until early afternoon on the 17th, Simpson at the hurricane center had little or no viable eye data on this storm, during a critical period in the forecasting of this hurricane; due to the *(perceived)* inability of Navy reconnaissance aircraft to penetrate the storm's eye, combined with the previous premature aborts of the Air Force reconnaissance aircraft, due to inflight emergencies brought on by the severity of the storm itself. Ultimately, the hurricane center's forecasters at this time could not predict with any accuracy where Camille would make landfall along the Mississippi and or Louisiana coastlines.

Dr. Robert "Bob" Simpson

Maj. General Russell K. Pierce Jr.

Note: *Simpson is on the record regarding this view. Apparently Simpson helped edit (and added comments to) a book entitled "Cat 5; the story of Hurricane Camille, Lessons unlearned from America's most violent hurricane" by Ernest Zebrowski & Judith A. Howard. In this book Simpson expressed his view that; he did not have enough aircraft reconnaissance data at particular points in the tracking of Camille. That he "….. did not have viable (strong) airplanes, with accurate instruments [instrumentation] and experienced and fearless crews to fly into the storm …..". Additionally there is some indication, in the post-storm reports by various US government agencies, that there had been perceived delays in dispatching of hurricane reconnaissance aircraft and or difficulties in maintaining reconnaissance flights during the storm that affected the hurricane center's ability to forecast the storm.*

Finally, after days of little or no central eye storm data on Camille, and the prospect of no available reconnaissance aircraft to provide information to help predict a landfall area, Simpson desperately called for help. He picked up a phone and called the Commanding General of USAF's AWS Headquarters at Scott AFB *(in Illinois)*, Maj. General Russell K. Pierce Jr, and requested additional hurricane reconnaissance support from the nearest available aircraft the USAF had. General Pierce said he would see what he could do and contacted the USAF AWS's 9th Weather Reconnaissance Wing at McClellan AFB *(California)*.

The McClellan Wing, in-turn, then directed one of its WB-47E weather reconnaissance aircraft from the 53rd WRS to immediately proceed to the Gulf of Mexico and conduct an emergency, last – minute, reconnaissance of Camille. By 5pm local cdt time *(2200z)* on the 17th, the eye of Camille was approximately 90 nm *(104 miles /167 kms)* to the south of the Louisiana coast or approximately 125 nm *(144 miles / 231.5 kms)* southeast of New Orleans.

(17 August: continues) - The Last USAF Reconnaissance Flight into Hurricane Camille

It's important to understand that previously, this reconnaissance flight was relatively unknown to the history of Hurricane Camille. For the purpose of this document, we will call this reconnaissance flight; *"Gull Cyclone / Camille"* denoting a special reconnaissance flight.

Although there are references to the flight having occurred, mostly from a number of statements and references traced back to Dr. Simpson himself, like the proceeding last Navy reconnaissance flights into Camille, no record of this flight exists in the Hurricane Center's Storm Wallet or records. However, for those references that do exist, there are at least three different versions as to where the aircraft in question came from and when it flew into the storm. Some versions suggest an aircraft came from AWS-HQ in Illinois, another from the 9th WRW in California or from Texas, where the 5th AWS C-130B was believed to have been secretly flying from. In another case, an effort was made to explain away the flight altogether. The following information about this reconnaissance aircraft flight is expressed here for the first time.

Not generally known by the public, at this time in 1969, is that the 53rd WRS's WB-47E normally flew "*Gull Alfa"* synoptic weather reconnaissance tracks, daily back and forth between Ramey AFB, Puerto Rico and McCoy AFB, Orlando Florida. It's been suggested that this Gull Alfa track mission was established in the wake of the Cuba Missile Crises as a show of force towards Cuba. In their minds, B-47s were known for having tactical nuke capabilities, and daily flights around their eastern coast by a potential nuclear capable delivery platform would have instilled a certain amount of trepidation on the part of the Cuban regime.

Although not a track specifically associated with hurricanes, this synoptic weather reconnaissance flight would report weather observations along its course, including hurricanes if they were in close proximity to it. This was the case during Camille. For example, a Gull-Alfa WB-47E filed 11 observations of Camille between 1510z -1937z on 14 August 1969.

AWS WB-47E Stratojet circa 1969 - USAF Photo

With a lack of available hurricane reconnaissance aircraft on the evening of 17 August, the AWS WB-47Es were the only aircraft in the region to respond so quickly to the hurricane center's emergency, despite their limitations.

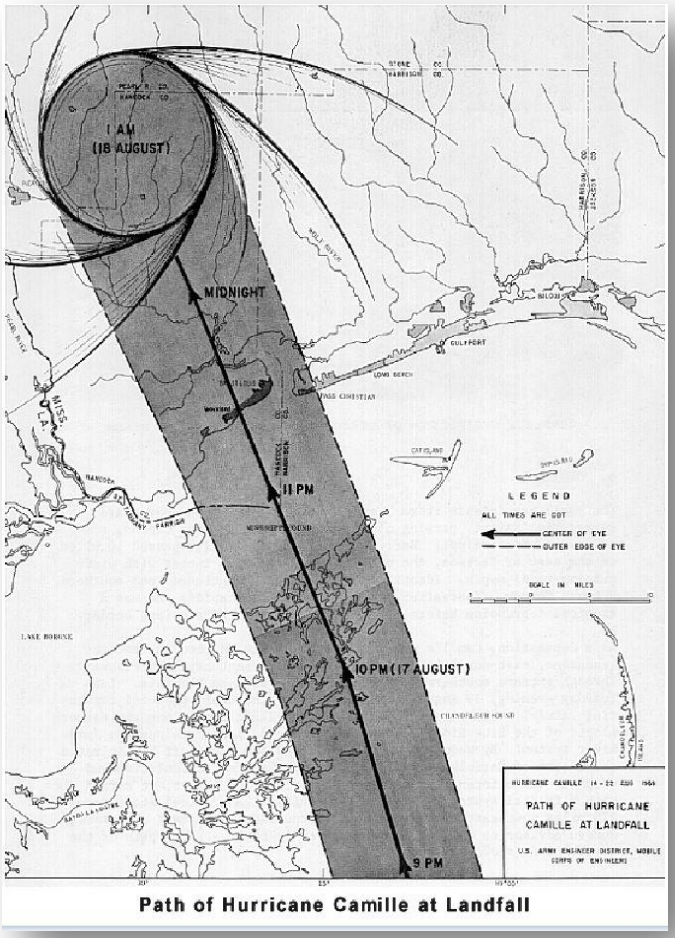
Note: *this statement is not actually correct. There was one other aircraft that could have been made available on the early evening of 17 August 1969; the C-130B piloted by Foerster that was still in South Florida. It didn't leave Florida to return to Puerto Rico until after 6pm local est. This aircraft, given the emergency, could have easily been re-directed back into Camille at any point during the afternoon or early evening on the 17th. But it wasn't. This aircraft was essentially committed to Project Stormfury at this time and scheduled to fly during the hurricane modification seeding event the next day, 18 August 1969 out of Puerto Rico.*

Thus, in the few–short hours before landfall, an AWS WB-47E *(Gull Cyclone / Camille)* was diverted from its Gull Alfa track and flew into or over Camille. The flight occurred on or about *0000z technically now 18 August 1969 or 1900 / 7pm local cst on the 17th,* when the storm was centered less than 100 miles *(161 kms)* south of Gulf Port Mississippi, moving north-northwest at 15 mph *(24 km/h)*. About this same time, Camille's winds were battering the unincorporated areas *(mostly uninhabited areas)* of Plaquemine's Perish, near Blind Beach, or near the mouth of the Mississippi River delta – in the vicinity of Breton Sound.

A pressure of 26.62" *(901.5 mb)* with surface winds between 178 kts *(205 mph / 330 km/h)* and 182 kts *(209 mph / 336 km/h)* were extrapolated from flight-level measurements aboard the aircraft from approximately 30,000 feet *(9144 m)***.** By 0200z *(2100 local cdt)* Camille continued northward, her eye tracking over Chandeleur Sound *(over some of the Chandeleur Islands)* and over eastern areas of St. Bernard's Parish near the eastern extremes of Lake Borgne, before setting her eye on the Mississippi coastline.

Note: *unlike the original AWS C-130B, the service's WB-47E were equipped with flight-level instruments associated with its onboard AN/AMQ - 19 Improved Airborne Automatic Meteorological Data Collection System, providing flight level measurement of weather parameters. The data on this storm would have been automatically recorded and radioed to the AWS monitor station in Charleston, South Carolina for analysis and relay to the hurricane center's CARCAH.*

(17-18 August) – on or about midnight; *(some say approximately 11:44 pm local cdt or 0444z)* Camille's eye passed inland *(made landfall)* on the Mississippi coastline, along a stretch of beach in an area between Clermont Harbor and Bay St. Louis *(Mississippi),* near Waveland – to the west of Pass Christian, Gulfport and Biloxi Mississippi - in Hancock County.



Path of Hurricane Camille at Landfall

Chart of Camille's landfall track across the Mississippi coastline

According to some witnesses at the time, the eye of Camille was no more than 12 miles *(19 kms)* in diameter and extended from about the middle of Bay St. Louis bay, to approximately 5 miles *(8 kms)* west of Clermont Harbour. Pass Christian, Gulfport and Biloxi Mississippi, to the east of landfall, never experienced the passing of the eye and remained in the right front *(eastern)* quadrant of the storm, during Camille's passage inland. Although the recently revised estimate of maximum sustained winds has been re-established at 175 mph *(282 km/h)* by the reanalysis authors, wind measurements reported at the time both off-shore and on the coast put the highest sustained winds in excess of 175 kts *(201 mph / 323 km/h)* with higher gusts.

The various unofficial *(or unaccepted)* wind measurements at landfall generally ranged between 150 and 190 mph *(241 - 306 km/h)* before most of wind anemometers at ground - zero of the storm were torn way and did not survived the onslaught.

Wind reports of 183 mph *(295 km/h)* are more than likely, with the actual highest sustain wind speeds experience at landfall much stronger and higher gusts over 200 mph *(322 km/h)* at landfall. In the judgement of military and civilian *(National Bureau of Standards)* structural engineers, who investigated the damages from other national disasters and hurricanes, in the decades before Camille, had never seen anything like the destruction they observed in the aftermath of this storm. Even Bob Simpson commented on the destruction and said *"….. we will never know the maximum velocity of the winds in Hurricane Camille, but in the face of my experience and observations I would conservatively estimate that they [Camille's maximum sustained winds] ranged at about 200 mph ……. This is the threshold of tornado intensity….."* on the order of / or surpassing 175 kts or 200 mph *(322 km/h).*

Images of the damage wrought by Hurricane Camille in August 1969 – Public Domain Photos

To the NBS inspectors, this was a very severe hurricane. Most areas of storm damage suggested extrapolated sustained winds of 165 kts *(190 mph / 306 km/h)* with higher gusts of 182 kts *(209 mph / 336 km/h)* although some of these areas showed definite evidence of severe damage from wind speeds.

One unofficial report of 230 mph *(370 km/h)* winds, potentially an extended gust, was measured before the anemometer that measured it ceased to function. No *(official)* wind anemometers survived Camille's forces at landfall to record the actual intensity of the highest winds. Only anecdotal and extrapolated estimates have been provided instead to propose what the actual intensity of the storm could have been at landfall.

However, there are several surviving wind records of Camille that are available to realize the full intensity of the storm at or near landfall. They comprises a sustained wind gust of over 172 mph *(277 km/h)* recorded on an off-shore oil rig, 90 nm *(104 miles / 167 kms)* southeast of New Orleans, on the western side of the Marine Pass Block 299 area of the Gulf of Mexico.

Note: *Marine Pass Block 299, approximately 70 -100 miles (113 - 160 kms) from the Mississippi coast, is an offshore energy field, roughly 7.2 square miles (or about 1845 hectares) in size, off the Louisiana coast - that contains various raw natural resources such as oil, natural gas and sulfur.*

Image of a Trans-world Drilling Company (Jack-up) Drilling Rig similar to Rig #50 - Courtesy Trans-World Drilling Co.

The drilling platform, the Trans-world Drilling Company Rig #50, was located on the western section of Marine Pass Block 299, or less than 40 miles *(64 kms)* east of Venice / Boothville, Louisiana. At the time of Camille's passage by the Rig, her eye was within 15 miles *(24 kms)* to the west-southwest of Rig #50, several hours before landfall.

As part of an ongoing *"Oceanographic Data Gathering Program"*, established by a consortium of *(eight)* Petroleum Companies operating in the Gulf of Mexico, oceanographic and meteoro-logical data was collected on Gulf of Mexico hurricanes *(between October 1968 and November 1971)* including comprehensive oceanographic and meteorological data captured on Camille in 1969.

As part of the program, monitoring equipment was mounted on 6 offshore petroleum drilling rigs and production platforms along a 260 mile *(418 km)* section of the Louisiana coastline. The data collected comprised wave heights, wind speeds and direction, temperature and humidity as well as barometric pressures.

The Trans-world rig *(station #1)* captured a maximum wind speed of 172 mph *(277 km/h)*, at an elevation of 100 feet *(30.5 m)*, at 2230z *(or 1730 local cdt)* on 17 August 1969. Another rig, to the west of Rig #50, *(station #2 on Delta Block 133)* captured a wind speed of 45 kts *(52 mph / 84 km/h)* and higher gusts as Camille's eye passed 48 miles *(77 kms)* to the east-northeast of this platform.

Unfortunately, the Rig 50's Easterline Argus wind speed recorder, left running on the abandoned platform *(that measured that sustained wind gust upwards of 172 mph / 277 km/h),* ceased to function when the strip chart paper jammed during the recording of the measurement – or so it's been said.

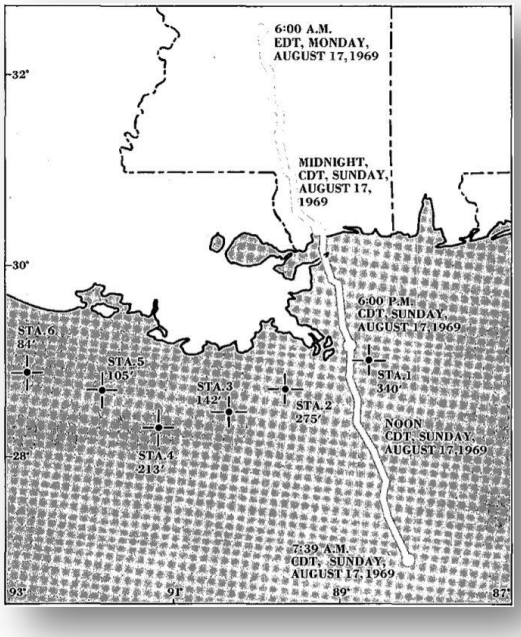


Chart rendering the position of Oceanographic Data Gathering Program stations, including Trans-world Drilling Company Rig #50 (Station #1), on the western section of Marine Pass Block 299, relative to the track of Camille that passed just 15 miles (24 kms) to the west-southwest of rig.

In actuality, as established in *"a Re-examination of Hurricane Camille"* by Arnold R. Hull, from the Environmental Data Service *(NOAA / DoC)* technical report published in *"Wind and Seismic Effects": the proceedings of the 7th Joint Panel Conference of the US-Japan Co-operative Program in Natural Resources (20-23 May 1975)*; Hull indicates that the abandoned rig was subjected to series of 5 *(episodic)* extreme waves, one at least 72.2 feet *(22 m)* high *(from crest to trough).* As the Rig shuddered under the pounding of these waves, salt water penetrated the structure of the rig and flooded the main electrical panel to the platform, cutting all power. All measuring devices stopped functioning. *The chart did not jam.*

Hull goes on to explain that the wind measuring system on Rig #50 *(including a Bendix Aero-vane)* came apart in the violent winds, with only the center section assembly surviving the on-slaught, still attached to the Rig's tower. Hull suggests analysis of the destruction of this equipment is indicative of much higher wind speeds that failed to be recorded due to the power loss.

***Note**: there is ODGP data to suggest that Rig #50, as well as at least two other monitoring stations, also collected meteorological pressure measurements as Camille passed between the three stations - Rig #50 having captured a pressure reading in the neighborhood of 26.84 (909 mb) which was a mere 15 miles (24 kms) to the east-northeast of Camille's center.*

Mississippi Power Company Headquarters, in Gulfport, Mississippi approximately 18 miles (29 kms) to the east of Camille's eye at landfall - Public Domain Photo

A later mathematically calculation of the 172 mph *(277 km/h)* wind speed *(by Dr. Vince J. Cardone of Oceanweather Inc)* when reduced down to the standard 30 foot *(9m)* adjusted sea level elevation, utilizing the 1 to 7 power rule, constituted an approximate sea surface estimate of sustained wind measurement of 115 mph *(185 km/h)* and an additional gust on the order of 144 mph *(232 km/h)* - according to a report written by the National Bureau of Standards entitled *"In The Wake of the Storm"*.

Herbert Saffir, of *"Saffir-Simpson Scale"* fame, was actually on the ground in Mississippi after Camille, conducting a detailed survey of the destruction. In his analysis of one area of damaged, he actually verified an incident of a sustained wind speed of 172 mph *(277 km/h)* at landfall. Saffir analyzed the failure of ½" thick window glass in a series of window breaks on the Mississippi Power Company Building, in Gulfport, approximately 18 miles *(29 kms)* to the east of Camille's eye at landfall, that was built to withstand 150 mph *(241 km/h)* winds. He was able to test the glass to destruction and determined a sustained wind speed of at least 172 mph *(277 km/h)* or higher was required to break the glass windows. *(as established in Saffir's report entitled "The Nature and Extent of Structural Damage Caused by Hurricane Camille")*

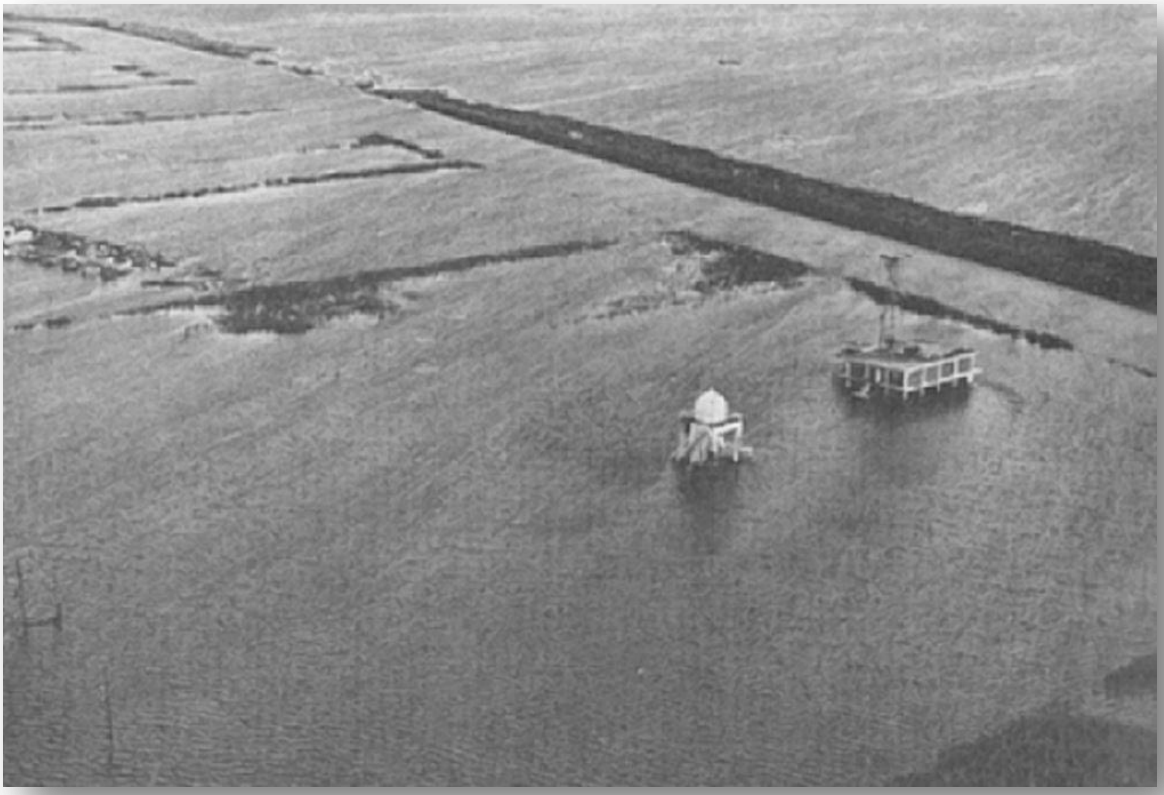
A Mississippi Air National Guard *(Air)* Station, *(then)* located at the Municipal Airport in Gulfport *(3 miles / 6 kms from downtown Gulfport)* measured 100 mph *(160 km/h)* sustained winds with various gusts ranging between 150-175 mph *(241 – 282 km/h)* from Camille. The airport was located just 25 miles *(40 kms)* to the east of the storm's landfall.

Another military airfield, Bates Field, located 13 miles *(21 kms)* west of the City of Mobile *(Alabama)*, near Pascagoula *(Mississippi)*, recorded a high wind speed of 170 mph *(274 km/h)* at 0330z or 2230 local cdt. Bates Field was a US Coast Guard training facility in 1969, and is less than 50 miles *(80 kms)* northeast of Biloxi.

At Biloxi, the Keesler AFB's base weather station clocked winds in excess of 81 mph *(130 km/h)* at landfall, with a high gust up to 129 mph *(208 km/h)*, at a time that the base weather *(radar)* station held Camille on its scopes, just 25 nm *(or about 30 miles / 47 kms)* to the west of the station.

A weather radar image of Hurricane Camille at landfall, taken at 11:44 pm local cdt by the base weather station at Keesler AFB in Biloxi. At the time, Camille was just 25 nm (30 miles / 47 kms) due west of the base's FPS-77 weather radar dish.

Less perceived reliable sources of measured wind speeds in excess of 150-200 mph *(241- 322 km/h)* were reported in areas near Long Beach, Waveland and Bay St. Louis, the western parts of Gulfport as well as different locations in eastern Louisiana. A high wind measurement of 107 mph *(172 km/h)* was captured by the US Weather Bureau *(radar)* station at Boothville *(Louisiana)* as Camille passed to the east of the station - while the SS Cristobal *(tied-up at Pilottown, also to the west of Camille's eye)* measured a high 160 mph *(257 km/h)* gust.



The US Weather Bureau (radar) station at Venice - Boothville (Louisiana), just 14 miles (23 kms) to the east-southeast of Pilottown, at the mouth of the Mississippi River, was flooded during passage of Camille. At 3 foot (1m) below sea-level, the observatory and associated radar station experience a storm surge of 15 feet (4.6 m) above normal sea-level. The floor of the main level of the facility was 12 feet (3.7 m) above the ground. Retreating to the upper level of the observatory, the 5 weathermen on-site during the storm experienced chest-high flood waters on the upper most level until finally receding several hours after the storm passed. The last weather measurements recorded by the observatory, before power was lost (at 6:40pm local cdt), was a low pressure of 28.34" (959.7 mb) and sustained winds of 107 mph (172 km/h). This pressure measurement is consistent with the 28.04" (949.6 mb) captured on the SS Cristobal anchored at Pilottown at 0000z or 1900 local cdt, on the evening of the August 17th. - Public Domain Photo

The lowest pressure for Camille was officially established at 26.72" *(905 mb)*, in the wake of the storm, which was actually obtained by a USAF reconnaissance plane near the center of the storm, more than 28 hours before landfall. The subsequent recently revised pressure for Camille at landfall is now 26.84" *(909 mb)* based upon a *(now)* semi-official 26.87" *(909.9 mb)* measurement which was record near the eastern extent of the storm's eye during landfall.

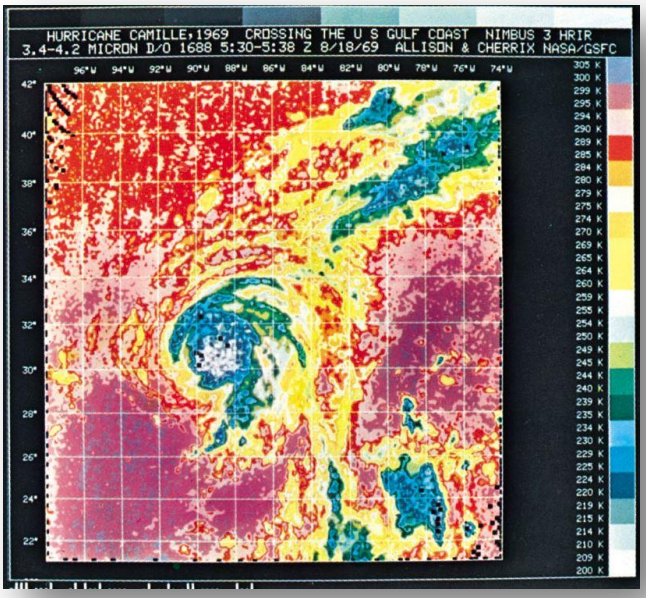
This reading comprises a measurement the recent reanalysis of Camille authors re-discovered captured during landfall by a gentlemen by the name of Charles A. Breath Jr., residing at the time near the west end of the Bay St. Louis Bridge, in the North Beach area of Bay St. Louis on the eastern side of Camille's eye. Breath's Aneroid Barometer captured a measurement of 26.87" *(909.9 mb)* near landfall on the evening of the 17th. The US Weather Bureau checked and verified the accuracy of the barometer, but there was another measurement of 904 mb, by

Breath sometime later *(by another marine-type barometer)* as the eye passed his location. The unit was found to be slightly out of calibration with the adjusted measurement made consistent with the first.

However; to reinforce the reanalysis author's premise that Camille was undergoing ERC at or near landfall, the barometric pressure at landfall needed to be rising, not falling. The author's themselves in their reanalysis established the land-falling *(Breath)* pressure measurement at 909 mb. Compared with the actual Gull 3 / Camille pressure measurement at 1815z, known to be in the vicinity of 918 mb *(also suggested by the Reanalysis authors own reanalysis and assertions)* means that since 1815z the pressure of Camille actually dropped by nearly 9-10 millibars – which is not consistent with a storm undergoing an ERC at or near landfall.

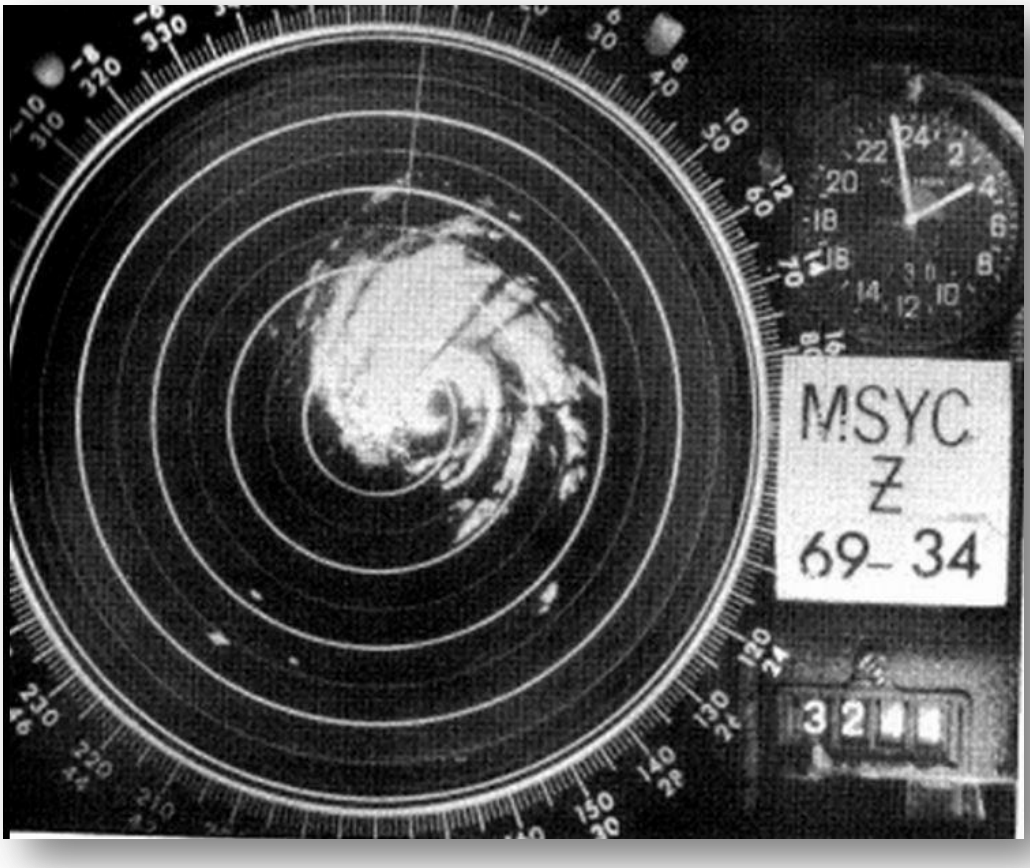
For the Record: *other unofficial or unaccepted low pressure measurements of Camille at landfall included a 27.14" (919 mb) and a 26.49" (897mb) in Bay St. Louis. The official storm surge height for Camille was officially established at 24.6 feet (7.5m), despite the fact that different areas of eastern Louisiana experienced much higher levels of surge in the neighborhood of 28 to 31 feet (8.5 m – 9.5 m). One of those areas that saw extreme flooding were in the communities of Venice and Boothville (La), along the Mississippi Delta, in Plaquemine's Parish.*

All totalled, there were 258 fatalities (with 68 missing), 2,095 injured and 4,375 people left homeless by Camille.



A NIMBUS III HRIR (Colored) image of Camille (taken at 0530z 18 August 1969 or 0030 local cdt.) making landfall along the Mississippi coast. – NOAA NHC

The 2016 reanalysis of Camille in reality produced only minor changes in the overall scope of the storm. The early establishment of cyclogenesis of the depression into a tropical storm was extended back 18 hours. The semi-official 200 mph *(322 km/h)* and 26.61" *(901mb)* measurements were ultimately reduced to 175 mph *(280 km/h)*, with a revised 26.84" *(909 mb)* pressure, found in the periphery of the eye via more modern or precise pressure–to-wind relationship ratios and comparative analysis. These revised parameter officially establishes Hurricane Camille as the second most intense hurricane on record to have made landfall in the continental United States, in the lee of the 1935 Labor Day Hurricane.



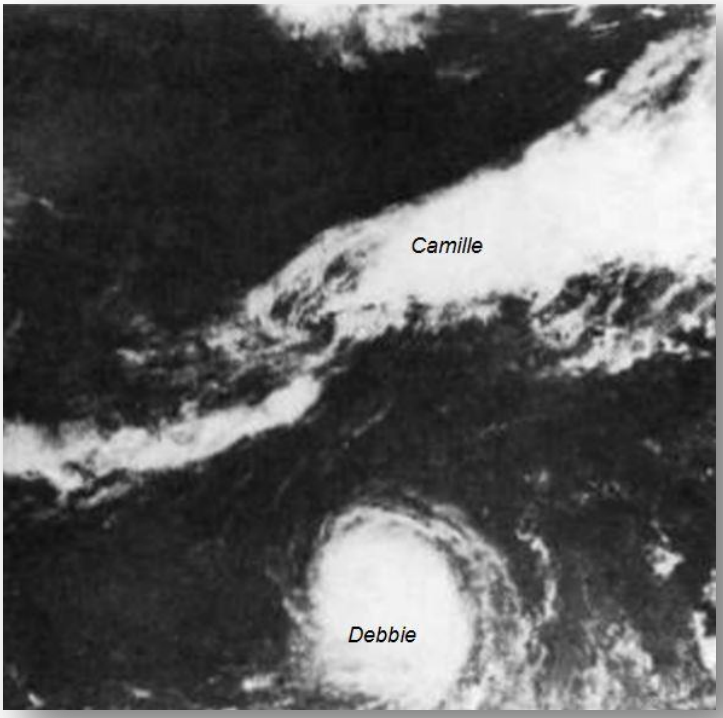
New Orleans weather radar image of Hurricane Camille at 0400z on 18 August 1969 – or- actually 2300 (11 pm) local cdt on 17 August 1969, near landfall along the Mississippi coast. – Public Domain Photo

Given the *"unrealized"* aircraft reconnaissance flights conducted on the storm, the USAF reconnaissance aircraft ordered by Simpson at the last possible minute, the issues related to ERC occurrence and pressure measurements, the Reanalysis of Camille is fundamentally flawed and needs to be re-evaluated as to its premises and conclusions.

(22 August 1969) - USAF Reconnaissance Flight: *Gull 4 / Camille (1-11) [#62-3494]*

Previously unknown to the public domain history of Camille, there was one more additional USAF reconnaissance flight conducted on Camille before the official tracking of the storm came to an end. Although there is no redeeming evidence in this previously unknown Camille reconnaissance flight to support the arguments and conclusions of this document, it is presented here for the sake of full disclosure regarding the timeline of aircraft reconnaissance operations conducted on Camille.

By 20 August 1969, after having dumped more than 30 inches *(762 mm)* of rain on areas of Kentucky, West Virginia and Virginia, causing un-forecasted severe *(flash)* flooding, Camille passed seaward *(transitioned)* into the North Atlantic Ocean – near Norfolk, Virginia. As it passed offshore, the subsequent remnants of Camille re-attained tropical storm status and struck out towards the east-northeast. The storm's forward momentum was estimated at between 25-35 mph *(40 – 56 km/h)* with winds in excess of 45 kts *(56 mph / 90 km/h)*.



Late on the 21st, Camille's stronger upper level environment began to interact with the upper levels of Hurricane Debbie, that was fast approaching from the southwest and expected to meet up far out into the North Atlantic. It's been said; *"…. that without this upper level influence from Camille, Debbie would have passed very close to Bermuda and would made landfall somewhere in Southern Newfoundland …."*. Camille kept Debbie away from land, and further eastward far out to sea. It was during this period of interaction, early on the morning of 22 August, that an USAF hurricane reconnaissance C-130B flew into Camille.

21 August 1969; (at 10:20 am est) Hurricanes Camille and Debbie in the North Atlantic near Bermuda. This satellite image was taken by NIMBUS III. - NOAA photo

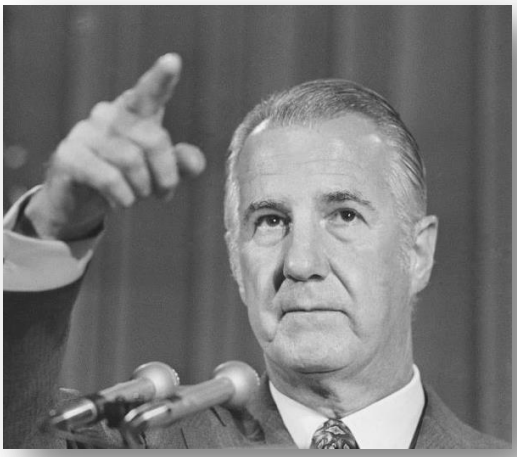
An Air Force Hercules, designated Gull 9 / Debbie, had been sent out to fly a reconnaissance mission into Hurricane Debbie. Because of sparse ship reports in the vicinity of Camille, and to understand more about the interaction between the two storms, the hurricane center directed this aircraft to make a survey of Camille - which was not far away at the time. Thus, at 0619z *(0400 local Newfoundland time)* Gull 9 / Debbie transitioned into *"Gull 4 / Camille"*, via an air report message sent by Gull 9 / Debbie 8 at that time.

Note: *in actuality another aircraft was tasked to fly Camille at this time. Gull 10 / Debbie, had been tasked with the reconnaissance of Camille, but had a subsequent inflight event (a lightning strike) and the crew had to abort the mission very early in the flight. Later having had a quick inspection and repair, Gull 10 / Debbie was then sent out later into Debbie to fill-in where Gull 9 / Debbie had left off.*

The Gull 4 / Camille flight into Tropical Storm Camille made up most of the 12-hour long reconnaissance mission of the day and issued 11 observation reports on the storm. During the time in the storm, sustained winds were reported to be in excess of 60 kts *(69 mph / 111 km/h)*

near what was presumed to be the center and a pressure of 27.63" (*935.65 mb)* in the suspected center and 29.92" *(1013 mb*) out along the periphery. Later on in the day, after Gull 4 had left the storm, Camille ceased to exist when it lost all tropical characteristics and was absorbed by a cold frontal system out over the North Atlantic, approximately 175 miles *(280 kms)* southeast of Cape Race, Newfoundland.

(20-21 August 1969: post-storm) – within a few short days after the storm's landfall, Simpson toured Camille's ground-zero areas to assess the level of damage and to evaluate the hurricane center's landfall, storm surge and wind speed forecasted predictions. *(It was during this tour of the devastation in the aftermath of Camille that Simpson came up with the concepts that would later become the* ***"Saffir-Simpson Hurricane Sustained Wind Speed / Potential Damage Scale"*** *in 1973)* However, just by *happenstance* during his tour, Simpson ran into Vice-President Spiro Agnew, who had been dispatched to the region by President Nixon to report on what resources were needed in the form of Government relief.



20-21 August 1969; Agnew toured the damaged region by USAF helicopter and then on the ground at specific devastated areas wrought by Camille. – Public Domain Photos

During this encounter, Simpson frankly expressed his long-held views on the flaws in the Atlantic hurricane warning network that prevented him from accurately forecasting hurricanes – like Camille. He specifically expressed that the existing hurricane reconnaissance aircraft capabilities were antiquated and inadequate for the modern needs of the hurricane center. He actually specifically highlighted the inaccuracy of current *(at that time)* aircraft meteorological systems, sensors, instruments and limitations of the various reconnaissance platforms *(or airframe limitations)* and the lack of available reconnaissance aircraft *(both from the USAF and the Navy)* for requested missions. With regards to Camille flights, he specifically mentioned to Agnew the *[perceived]* unwillingness and outright refusal of Navy aircrews to penetrate the storm at critical times in the storm's forecasting. Simpson ultimately illustrated that for more than 25 hours, he *(Simpson)* had little or no center eye storm data to adequately forecast the storm and its landfall, to warn the public.

In later post-storm reports and newspaper comments, Simpson extended his criticism of the hurricane reconnaissance operations in Camille, to additionally include a lack of timely communications of storm data, inaccurate positioning reports and storm intensity measurements that NHC had actually refused to except when reported by reconnaissance aircraft.

Note: *it was actually Simpson that first expressed a long-held view that the lack of consistency in hurricane (weather) reconnaissance aircraft instruments and weather measurement systems between the USAF and the Navy, (and in some cases between different aircraft within each of these same services) as well as the limitations of some of these weather reconnaissance aircraft ability to fly storms, contributed to the NHC's forecast errors (track, intensity and landfall predictions) during the 1960s. Unfortunately, in light of these statements, the actual specific hurricane center forecast errors for 1969 seem to have been misplaced and are unavailable; but generally (on average) suggest that in the 24-hour predictions, landfall errors ranged from 87 nm (100 miles / 161 kms) in the Atlantic to 100 nm (115 miles / 185 kms) in the Gulf of Mexico. Track forecast positions were off by 129 nm (148 miles / 239 kms) and that most of all Camille's center fixes were off by 27 nm (or 31 miles / 50 kms). Simpson specifically suggested that more than half of all the hurricane center's forecast errors were attributed directly to the inaccuracy of aircraft reconnaissance. Obviously, the military hurricane reconnaissance aircrews would beg-to-differ with Dr. Simpson's comments.*

The facts are, that the hurricane center's forecasting of Camille had been lacking in its accuracy. Forecasted winds expected to be upwards of 160 mph *(257 km/h)*, were at least 30 % higher in the neighborhood of 200 mph. Storm surge projections forecasted by the center were also short of mark, with predicted 15-20 foot *(4.6 – 6.1m)* surges expected, exceeded by upwards of 30 foot *(9.1 m)* surges in several locations. Although the domain of the National Weather Service, the organization that forecasts the remnants of hurricanes once they have made landfall, no official forecast was given on expected levels of torrential rainfall that came from the remnants of Camille as it moved through areas of southwestern Virginia, West Virginia and Kentucky. No warnings were issues on the potential flooding that did occur from more than 30 inches *(762 mm)* of rain over the Blue Ridge Mountains of Virginia, sparking the James River *(flash)* Flood incident and subsequent devastating mudslides.

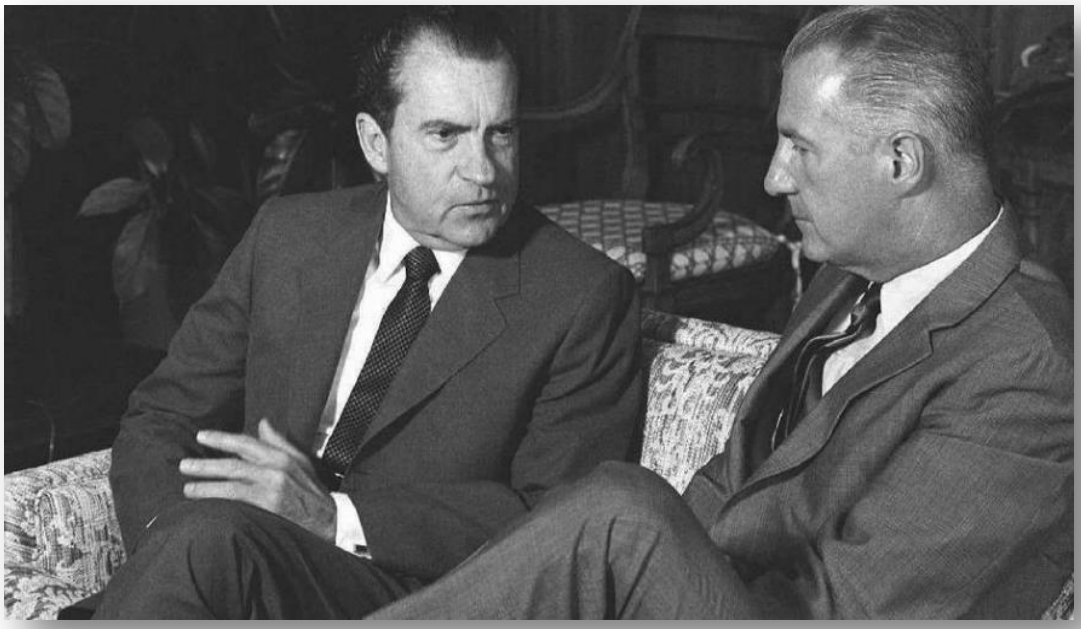
One of the overlooked criticisms of the hurricane center's forecasting was the miss-forecasting of the landfall of Camille. Up until early morning on the 17th, the hurricane center was still looking for the storm to recurve towards the northeast and make landfall along the Florida Panhandle – as their forecast models had indicated early on. So by later in the morning, when it became clear that Camille was going to defy the model and track straight into Mississippi, the hurricane center *(by 9am est)* began dropping all mention of the panhandle and raised warnings for the Louisiana and Mississippi coasts.

However as the center began raising the alarm, for people living in low-lying areas of the Louisiana and Mississippi, it was already too late. Those areas *(often below sea level)* began to flood as high waves and surf, preceding the hurricane, pushed storm surge towards the coast earlier in the day. Had the hurricane center realized that Camille was tracking straight for the Mississippi coast a day earlier, the evacuation of these areas might have been successfully executed.

So there was adequate motivation for Simpson to divert attention away from the short comings of how the hurricane center forecasted the storm and blame the forecasting failures on the hurricane reconnaissance aircraft, when he spoke to Agnew. He essentially killed two birds with one storm.

Simpson, with his wife Joanne, in the hurricane center circa 1968-69 – Public Domain Photos

In the wake of the encounter with Simpson, Agnew was quoted in the press as having stated, that the forecasting of Camille was *"inadequate"* blaming it on discrepancies of the military aircraft that conducted the reconnaissance of the storm. Later on the 25th of August, Agnew reported his conversation with Simpson to President Nixon, during a meeting on the devastation of the hurricane, at San Clemente *(California)*. Later that day, Nixon is quoted in the press as saying; *"…… that he was greatly concerned that the federal government could not have done better at predicting the storm [Camille] better …….. could not forecast the storm's intensity [better] ……"* and suggested that the White House would conduct an investigation in to the suggested forecasting failures in Camille.



President Nixon and Vice-President Agnew at San Clemente on 25 August 1969

Robert White, the Administrator for ESSA / the Weather Bureau, the agency that governed the hurricane center, was called to the White House to speak with the President about the situation. The White House inquiry subsequently turned into a DoC internal study to review *(essentially)* the whole of the Atlantic hurricane warning network, which spawned a number of associated post-storm reviews and studies at the Weather Bureau / ESSA, DoC and DoD *(Navy and USAF)*.

Nixon at news conference with the US Press

Simpson's outspoken comments caught many by surprise and caused a fire-storm of finger-pointing within the military *(the various government services and DoD)* and the Department of Commerce, all the way up to the White House. His most acrimonious comments, reserved for the Navy hurricane hunters, reverberated within the Navy Department, and put the Navy in a compromising position with the press and general public as well as its relationship with Congress, for several years to come.

Once the press picked up Simpson's inferences, public opinion began to question the Navy's *(the VW-4 Squadron's)* ability to successfully accomplish their assigned hurricane reconnaissance mission. It may have even contributed to a growing rift between the Navy and the ESSA / NOAA joint hurricane research operations, which by 1973-74 eventually lead to the Navy's total withdrawal from Project Stormfury and the whole business of hurricane reconnaissance by early 1975.

However on the flipside of this post-Camille fallout questioning of the forecasting of Camille and the effectiveness of hurricane reconnaissance capabilities within the Navy, USAF and ESSA RFF itself, ultimately led to more funding toward new and improved US military hurricane reconnaissance aircraft. Which in-turn, lead to a turning-point in the history of hurricane reconnaissance in the United States.

Ultimately, the result of all the reviews and studies established that although the Navy had capable radar *(and other meteorological instruments)* for the hurricane mission, their aging Constellation airframes had too many limitations and that they needed a new viable replacement platform. The USAF on the other hand, was seen as having adequate aircraft / airframes in the C-130, but just lacked reliable meteorological and radar systems and having limited number of actual aircraft available for the hurricane mission.

Thus; on 25 August 1969 the USAF AWS actually announced *(officially)* that it was unilaterally retiring all its remaining WB-47Es *(approximately 24 aircraft)* as being inadequate to fly the hurricane mission and additionally announced a plan to acquire 11 additional C-130Bs *(at this moment in time officially designating them WC-130B)* for the hurricane mission. They subsequently also announced proposed studies to look at upgrading the WC-130s weather reconnaissance capabilities and new radar systems capabilities to support the hurricane reconnaissance mission. These two projects would become known as the *"Seek Cloud" (radar)* and *"Seek Storm"* (*WR capability)* programs.

WP-3A Orion (#149674); the first new Navy hurricane hunting aircraft introduced in 1971. – US Navy / VW-4

The influx of new funding for the Navy permitted them to pursue a planned *(unfunded)* replacement to the hurricane hunting Constellations. The replacement aircraft came in the form of four modified weather reconnaissance variants of the famous Lockheed P-3 Orion; dubbed the *"WP-3A Orion"*.

Although established as a hurricane reconnaissance aircraft, the WP-3A Orion was actually configured as multi-mission meteorological and oceanographic research platform, that besides carrying out operational weather and hurricane reconnaissance, also conducted winter-storm and ice reconnaissance as well as various cloud-seeding operations. The WP-3A were used by the Office of Naval Research for various meteorological and oceanographic research projects between 1971-75.

In fact, it was during a storm several weeks after Camille, Hurricane Inga *(20 September – 15 October 1969)* that the Navy conducted a unique evaluation *"fly-off"* between a proposed upgraded version of the WC-121N, a transport C-130 Hercules and an Air Test P-3A Orion *(all Lockheed products)* as a viable replacement, follow-on, Navy Hurricane Reconnaissance aircraft for VW-4. During the storm's track off the south coast of Bermuda, the Naval Air Test

Center's *(Patuxent River, Md.)* Service Test Division, conducted a qualification exercise with all three planes flying repeated trailing – formation penetrations through Inga's eye. More than 20 *(total)* penetrations were flown during the exercise to evaluate parameters within the hurricane's environment that included the various aircraft's flying qualities, handling performance, propulsion systems operations, airframe structural integrity and abilities to handle payloads equal to the weight of operational equipment to be installed on the fully-functioning aircraft. The evaluation also examined various human-factors, such as temperature, humidity and air-conditioning in the cabin's working environment of a hurricane mission and various objective factors, such as noise fatigue associated with the engine noise. Although all the aircraft performed well enough, it was the P-3 Orion that was singled out and was subsequently adopted as the Navy's follow-on *(replacement)* hurricane reconnaissance aircraft.

NOAA WP-3D Orion developed for Hurricane Research – circa 1976 - NOAA Photo

ESSA, soon-to-be reorganized as NOAA in the wake of Camille *(on 3 October 1970)*, garnered new funding that would lead to the development of the Lockheed WP-3D Orion hurricane research aircraft, replacing the older ESSA DC-6 aircraft. When they were delivered in 1975-76, they were the most sophisticated instrumented aircraft ever employed in the business of hurricane research and reconnaissance.

Subsequently, where the Navy Hurricane Hunters only received ridicule in the local and national press, the Air Force hurricane hunting crews that participated in Camille received medals. On 12 September 1969, both Capt*(s)* Marvin Lillie and Robert Foerster received Distinguished Flying Crosses awarded to them for their airmanship during their reconnaissance flights into Camille. Each of the remaining crewmembers of the two aircraft received air medals.

Capt(s) Marvin Lillie and Robert Foerster during their awards ceremony to receive Distinguished Flying Crosses for their efforts flying into Hurricane Camille. They were decorated by AWS Commanding General Russell K. Pierce Jr and MAC General Jack J. Catton. – USAF Photos

Later in April 1970 Lillie and Foerster were announced by the USAF as nominees for the coveted Harmon International Trophy, given for the most outstanding achievements in flying, for their efforts flying into Hurricane Camille. *They did not win.*

Closing Remarks

As previously stated, due to the volume of unrealized and omitted information on the actual history of hurricane reconnaissance operations conducted in Camille, the lack of hurricane reconnaissance information derived on those undocumented flights, a fundamental misinterpretation of the true history of Hurricane Camille and a perceived cursory or superficial historical research effort by the authors, have all combined to call into question the validity of the premises and conclusions presented in the recent reanalysis of Camille.

This document was originally produced as a direct rebuttal to the reanalysis of Camille, but in other ways it provides the Meteorological [Hurricane] Research Community with a lesson towards the understanding of the importance of having an actuate historical prospective when dealing with seemingly scientific issues and subjects. The history of Camille is unrealized to the hurricane research community that in this case sought to change that history without first really understanding it. That history has a fundamental influence on the meteorological community's work on a daily basis and an appreciation of this history is tantamount to success.

There is another point here to stress. If the reanalysis of Camille, its premises and conclusions, had remained within the Meteorological community with their prescribed method of building on other people's work, it may have led to the eventual corrections of its flawed components. However, the reanalysis of Camille *(article)* spilled over into the mainstream public domain, which includes the History community of this author. The reanalysis of Camille has been universally accepted as factual information and was widely disseminated within the public domain – fundamentally altering the history of Camille forever. The first thing that people will find when they look up anything on Camille on the internet *(now)* is that it was not as

devastating or as intense as once believed. What does that say to the people that went through the storm and survived or to the relatives of those that didn't ?

In this age of *"fake news"* and *"historical fiction"* being accepted as historical fact, those times when the *"truth"* is actually known, it's important to point these *"facts"* out to correct the public's perception and present the true history.

As the ancient scholars have lamented over the ages; there is a fundamental need to understand history, so as not to suffer the pains of repeating it.

The End