3B.1 HIGHLIGHTS OF THE 2007 ATLANTIC AND EASTERN NORTH PACIFIC HURRICANE SEASONS -- A YEAR OF EXTREMES IN THE ATLANTIC BASIN

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1. INTRODUCTION

The Atlantic hurricane season of 2007 was marked by the presence of two powerful Category Five Hurricanes on the Saffir/Simpson Hurricane Scale (SSHS; Simpson 1974) Dean and Felix. These hurricanes made landfall in the Yucatan Peninsula and Nicaragua, respectively as Category Five Hurricanes. The season was also marked by Humberto which was the only hurricane to affect the United States. These three systems were characterized by their rapid intensification. In contrast, the rest of the cyclones were short-lived and weak and most of them remained out to sea. Neverthereless, rainfall associated with weaker systems like Hurricane Noel and Tropical Storm Olga killed about 188 people in Hispaniola and devastated portions of eastern Cuba.

The eastern North Pacific produced fewer than long-term average number of tropical storms and hurricanes. Henriette was the only hurricane of the Pacific basin that made landfall in Mexico this season, resulting in nine deaths. The tracks of the 2007 Atlantic and eastern North Pacific named cyclones can be found at htpp://www.nhc.noaa.gov

2. Selected Cyclone Summaries

a. Hurricane Dean originated from a well-defined tropical wave that crossed the west coast of Africa on 11 August. The wave was associated with a closed surface low even before entering the Atlantic, but strong easterly shear kept the system's convection displaced from an elongated circulation center for a couple of days. By about 0600 UTC 13 August, however, the circulation became better defined and sufficiently connected to the deep convection to consider the low a tropical depression about 350 n mi west-southwest of Praia in the Cape Verde Islands. Embedded in a strong easterly current, the depression initially moved westward at about 20 kt. The environment was still characterized by easterly shear, and the depression took 30 h to reach storm strength; this occurred at 1200 UTC 14 August, when the system was centered about 1250 n mi east of Barbados. Although the cyclone's satellite presentation remained ragged, Dean strengthened early the next day as it turned to the west-northwest, still moving briskly.

Dean would continue on this heading, to the south of a deep-layer ridge of high pressure, for the next seven days. The easterly shear gradually abated, and by late on 15 August well-defined convective banding had developed around the center and microwave data showed the formation of a partial eyewall. Shortly thereafter, infrared satellite imagery began to show an eye, and Dean became a hurricane early on 16 August about 480 n mi east of Barbados. As the upper-level outflow became more pronounced, Dean reached an intensity of 80 kt by 1200 UTC that day, but the eyewall then disappeared and the strengthening trend temporarily halted. Dean entered the Caribbean Sea on 17 August, with its center passing between Martinique and St. Lucia around 0930 UTC. The northern eyewall, accompanied by sustained winds of about 85 kt, passed directly over Martinique. Dean strengthened rapidly in the eastern Caribbean Sea, and its winds increased from 80 to 145 kt (category 1 to category 5 on the Saffir-Simpson Hurricane Scale) in the 24 h ending at 0600 UTC 18 August. At 1200 UTC that day, Dean's minimum central pressure was 923 mb. During this period of rapid deepening Dean's forward motion slowed to about 15 kt; its heading, however, remained remarkably constant throughout the Caribbean as high pressure was maintained to the north of the hurricane, while a mid- to upper-level low over south Florida on 18 August retreated westward in tandem with the tropical cyclone.

The center of Dean passed about 180 n mi south of Puerto Rico early on 18 August, and continued west-northwestward in the direction of Jamaica. By 1200 UTC that day, microwave imagery showed a concentric eyewall structure. As the inner eyewall eroded over the next 12 h as shown in Fig.1, Dean's maximum sustained winds decreased from 145 kt to 120 kt (Category 4). Interestingly, the central pressure fell slightly during this time, dropping below 920 mb for a short period early on 19 August. Dean remained a Category 4 hurricane as its center passed within about 80 n mi of the south coast of Haiti during the morning of 19 August, and within about 20 n mi of the south coast of Jamaica that evening. Dean's intensity as it passed Jamaica is estimated to be 125 kt, although reconnaissance data suggest that Dean's strongest winds remained just offshore. On 20 August Dean moved away from Jamaica over the deep warm waters of the northwestern Caribbean. The convective structure that day was dominated by a single eyewall, and under light shear, shear Dean began to strengthen as it approached the Yucatan Peninsula. As the eyewall contracted, Dean regained Category 5 status near 0000 UTC 21 August, and was still deepening when the center made landfall near the town of Majahual in the Costa

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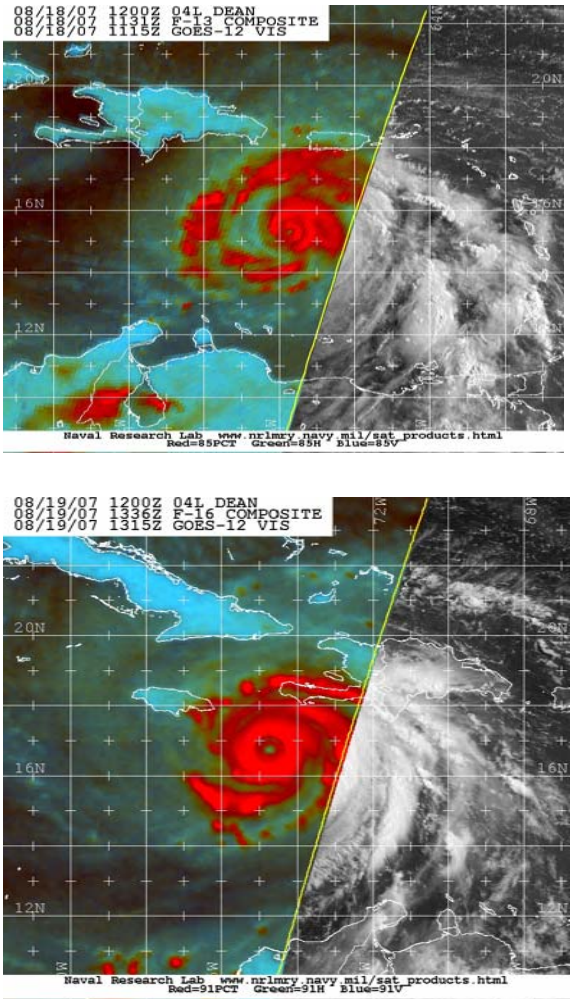

Fig. 1. Microwave images of Hurricane Dean at 1131 UTC 18 August (top) and 1336 UTC 19 August (bottom). In the first image, Dean has an inner 25 n mi diameter eyewall that is just beginning to erode; the intensity at this time is 145 kt. Roughly 24 h later, the inner eyewall has almost completely disappeared, with the predominant eyewall now 55 n mi in diameter; over this interval the intensity decreased to 125 kt. (Images obtained from NRL Monterey Tropical Cyclone Homepage archive, accessible from http://www.nrlmry.navy.mil/tc_pages/tc_home.html)

Maya tourist region of the Yucatan near 0830 UTC that day. At the time of landfall, Dean is estimated to have had a minimum central pressure of 905 mb and maximum sustained winds of 150 kt, making it the first land-falling Category 5 hurricane in the Atlantic basin since Andrew of 1992. Dean weakened as it moved across the Yucatan Peninsula, emerging into the Bay of Campeche around 1900 UTC. Although Dean maintained hurricane strength throughout its 10-h passage over land, its inner core convective structure was largely disrupted. Aircraft reconnaissance data in the Bay of Campeche showed that the cyclone's radius of maximum wind had expanded to roughly 55 n mi, and Dean was only able to recapture a small fraction of its former strength. Deep-layer high pressure along the northern coast of the Gulf of Mexico kept Dean on its west-northwestward track until 1200 UTC 22 August, when the cyclone turned to the west. Dean made its seond landfall at 1630 UTC that day near the town of Tecolutla, Mexico, about 90 n mi northeast of Veracruz, as a Category 2 hurricane with winds of 85 kt. Dean weakened rapidly after landfall, becoming a depression by 0000 UTC 23 August, and dissipating over the mountains of central Mexico shortly thereafter.

Based largely on reports provided by the meteorological services of the affected countries, the number of direct deaths associated with Dean is estimated to be 32, with 14 occurring in Haiti, 12 in Mexico, 3 in Jamaica, 2 in Dominica, and 1 in St. Lucia. Remarkably, the deaths in Mexico occurred in the states of Hidalgo, Puebla, Veracruz, and San Luis Potosi, in association with Dean's second (weaker) landfall.

b. **Hurricane Felix** formed from a tropical wave that departed the coast of Africa on 24 August. The wave moved westward across the tropical Atlantic for several days while producing a persistent area of disorganized cloudiness and showers. The shower activity increased in organization beginning on 29 August accompanied by a gradual increase in low-level vorticity. It is estimated that a tropical depression formed around 1200 UTC 31 August about 195 n mi east-southeast of Barbados.

The depression initially moved westward, then made a west-northwestward jump that was possibly due to reformation of the center. As a westward motion resumed, the cyclone became a tropical storm around 0000 UTC 1 September about 60 n mi south of Barbados. The center of Felix passed over Grenada about 0845 UTC 1 September, then moved across the southern portion of the Caribbean Sea embedded in deep-layer easterly flow. Felix quickly strengthened, becoming a hurricane near 0000 UTC 2 September while centered about 155 n mi east of Bonaire in the Netherlands Antilles. Felix moved just north of due west on 2 September, with its center passing 35-45 n mi north of the Netherlands Antilles. Very rapid strengthening occurred during the day, with the maximum sustained winds increasing to 145 kt by 0000 UTC 3 September – Category 5 on the Saffir-Simpson Hurricane Scale. The central pressure reached a minimum of 929 mb at 0700 UTC 3 September - a 64-mb fall in 32 h. An eyewall replacement cycle began later that day, with Felix weakening to a Category 3 hurricane and the central pressure rising to 953 mb. This was followed by re-intensification at the end of the cycle, and it is estimated that Felix regained Category 5 status just before landfall near Punta Gorda, Nicaragua at 1200 UTC 4 September.

Felix weakened rapidly to a tropical storm over northern Nicaragua less than 12 h after landfall. The cyclone decelerated and turned west-northwestward, and

it weakened to a remnant low over northern Honduras early on 5 September. The low briefly emerged over the Gulf of Honduras later that day. However, no re-development occurred before it moved into Belize and Guatemala. While the remnant low dissipated over eastern Mexico late on 6 September, the residual cloudiness and showers moved westward into the Pacific and could be tracked until 9 September.

Media reports indicate that Felix caused 130 deaths in Nicaragua and Honduras, along with 70 others missing. While detailed figures on how many were killed in each country are not available, the reports suggest that the majority of the deaths were in Nicaragua. Felix's landfall in Nicaragua caused severe damage to structures from winds and storm surge along the coast from Puerto Cabezas northward.

c. Hurricane Humberto's genesis can be traced to the remnants of a frontal trough (the same front that spawned Gabrielle) that moved over the southeastern Gulf of Mexico on 5 September. Eventually the slow-moving trough was located over the northwestern Gulf of Mexico on 11 September, and convection increased markedly near the trough axis that day a couple hundred n mi south of Galveston, Texas. Although thunderstorms diminished that night, a weak surface low formed along the trough. A tropical depression formed early on 12 September, about 100 n mi south of Galveston, Texas, when convection re-fired near the low. The depression became a tropical storm within the next three hours and moved slowly to the north. Intense thunderstorm activity in well-defined spiral bands formed near Humberto, and the small tropical cyclone rapidly strengthened just offshore of the upper Texas coast. Later that night, the system turned to the north-northeast due to steering around a large mid-level high over the southeastern United States. Radar data indicate that the storm became a hurricane just south of High Island, Texas very early on 13 September, and the cyclone reached an estimated peak intensity of 80 kt as it made landfall a few hours later just east of High Island in the McFaddin National Wildlife Refuge. The hurricane moved over extreme southeastern Texas and southwestern Louisiana, weakening into a tropical storm about 65 n mi west-northwest of Lafayette, Louisiana. It became a depression near Alexandria, Louisiana late on 13 September, and dissipated the next day over central Mississippi.

The intensification rate in Humberto was one of the highest that has ever been observed for an initially weak tropical cyclone. It is estimated that the cyclone strengthened from a 25 kt low into an 80 kt hurricane within 24 hours. This rapid increase in intensity is rare, and only three other storms (Celia 1970, Arlene and Flora 1963) have intensified more in 24 hours from below tropical storm strength. The rapid formation of a hurricane near the shore has long been a concern emphasized by the National Hurricane Center in its outreach and preparedness talks. Humberto serves as a rare, important example.

There was one death in Bridge City, Texas directly associated with Humberto. In addition, 12 injuries were reported in southeastern Texas.

d. Hurricane Henriette originated from a tropical wave that departed the west coast of Africa on 20 August and moved uneventfully across the tropical Atlantic. The wave produced some convection in the Caribbean Sea but reached Central America on 28 August before any significant development could occur. By 29 August the wave had moved westward into the eastern North Pacific basin, producing disorganized showers and thunderstorms, and later that day a small area of low pressure developed in association with the wave about 350 n mi southeast of Acapulco, Mexico. Convection with the low improved in organization early on 30 August, and by 0600 UTC that day the system became a tropical depression about 315 n mi southeast of Acapulco.

During the next 36 h, Henriette slowly strengthened and continued west-northwestward parallel to the Pacific coast of Mexico, with its center passing roughly 40-50 n mi offshore. Despite not making landfall during this period, the storm brought heavy rainfall to portions of the coast, especially near Acapulco.

Henriette turned westward and away from the Pacific coast of Mexico late on 1 September as the subtropical ridge built westward over northern Mexico. By 0600 UTC the next day, Henriette had reached an intensity of 55 kt while centered about 95 n mi southwest of Manzanillo, Mexico. The storm remained just shy of hurricane strength for the next two days as it headed generally northwestward, passing about 175 n mi west of Cabo Corrientes on the Pacific coast of Mexico. At about 0600 UTC 4 September, Henriette reached hurricane status as it turned north-northwestward toward the Baja California peninsula, ahead of a mid-latitude trough approaching the west coast of the United States. The hurricane reached its peak intensity of 75 kt at 1200 UTC that day while centered about 75 n mi south-southeast of Cabo San Lucas, Mexico. Henriette made landfall near San Jose del Cabo, at about 2100 UTC 4 September with maximum winds near 70 kt. Continuing north-northwestward, Henriette emerged over the Gulf of California early on 5 September. The brief interaction with land caused a slight weakening, but Henriette remained a category 1 hurricane for most of that day. Very late on 5 September, however, Henriette began to weaken. It made its final landfall along the Gulf of California coast of mainland Mexico, near Guaymas, at about 0000 UTC 6 September with an estimated intensity of 60 kt. Henriette deteriorated quickly over land and dissipated over the mountains of northwestern Mexico shortly after 0600 UTC that day.

Media reports indicate at least nine fatalities in Mexico are directly attributable to Henriette. Six of these deaths occurred near Acapulco due to mud slides induced by heavy rains while the center of Henriette passed just

offshore. Two fishermen perished near the coast of Sonora in the region where Henriette made its final landfall, and one person died in the surf along the southern Baja California peninsula.

3. Acknowledgments

The description of the tropical cyclones is based on the Tropical Cyclone Reports prepared by hurricane specialists at the National Hurricane Center.

4. References

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