Poster session presentation at the 24th Conference on Hurricanes and Tropical Meteorology, Ft. Lauderdale, FL, May 30 2000

THE 1999 HURRICANE SEASON IN EAST CENTRAL FLORIDA - MULTIPLE STORMS WITH MULTIPLE IMPACTS

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1. INTRODUCTION

During the active 1999 Atlantic Hurricane Season, Hurricanes Dennis, Floyd and Irene threatened east central Florida, prompting the issuance of hurricane watches or warnings on three separate occasions. Hurricanes Floyd and Irene produced similar and significant impacts across the region, although the intensity and direction of approach of these two systems were starkly different.

The active hurricane season, combined with numerous changes brought on by NWS Modernization and new technology in 1999, presented a number of opportunities and challenges for the National Weather Service Forecast Office (WFO) in Melbourne, Florida. The Melbourne office had assumed full forecast responsibility for ten counties in east central Florida and adjacent coastal waters in March 1999 - three months prior to the start of the hurricane season. Therefore, WFO Melbourne was required to coordinate watches, warnings, and advisories with surrounding WFOs as well as the Tropical Prediction Center (TPC). This was also the first full hurricane season in which forecasters effectively utilized AWIPS (Advanced Weather Interactive Processing System).

This paper will review the three hurricanes, concentrating on the potential and realized impacts across east central Florida.

2. HURRICANE DENNIS (24 Aug - 07 Sep)

A tropical disturbance moved off the west African continent on 17 August with little or no development occurring as it moved across the Atlantic Ocean. Convection became more organized as it approached the southeastern Bahamas where it became the fourth named storm. Throughout Dennis' life cycle, however, westerly shear allowed only slow and unsteady development. A series of mid-latitude troughs kept Dennis on a northwest track toward the Florida peninsula. However, run to run model consistency of curving Dennis more northward with time produced high confidence that it would stay well offshore. While a hurricane watch and tropical storm warning were posted for WFO Melbourne's northern and central coastline for a period of 36 hours, official forecasts accurately kept the storm well offshore east central Florida.

Dennis was almost entirely a marine event, producing tropical storm force winds and rough seas over

the coastal waters. High confidence in the forecast track allowed WFO Melbourne forecasters to highlight the expected winds and wave heights over the coastal waters with good consistency from shift to shift while downplaying the threat to the Florida mainland. Rough surf and above normal high tides produced some beach erosion which caused little concern at the time. Rainfall associated with the hurricane was minimal and confined to coastal sections. However, an excessive rain event occurred over central Brevard county where locally over 150 mm of rain fell during the evening of 31 August in the wake of Dennis as it meandered off the North Carolina coast.

During its closest approach to the WFO Melbourne county warning area, approximately 130 n mi offshore Cape Canaveral on 29 August, Dennis roughly paralleled the Florida east coast and reached its maximum strength of 90 knots. WFO Melbourne issued short term forecasts (NOWCAST) every hour, providing the latest information on speed and direction of the hurricane based on trends from radar and satellite imagery from AWIPS workstations. This same effective approach was used during subsequent tropical systems to affect east central Florida.

3. HURRICANE FLOYD (07 Sep - 17 Sep)

One of the most powerful weather systems on record to threaten the central Florida peninsula, Hurricane Floyd presented TPC and WFO Melbourne with a unique set of logistical and forecasting challenges.

Like Dennis, Floyd also developed from a tropical disturbance that moved off the west African continent. It proceeded west across the tropical Atlantic with slow strengthening. Under the influence of a large mid-latitude trough, Floyd was pulled northwest and missed the northeast Caribbean islands. Floyd then turned due west as it fell under the influence of a large mid-latitude high pressure system. It was during this time that Floyd underwent a period of major strengthening, becoming a near-category 5 hurricane as it approached the central Bahamas. Concern mounted as this large powerful storm began to threaten central Florida.

Within 24 hours of Floyd's closest point of approach - 87 n mi offshore Cape Canaveral on 15 September - the forecast track indicated the potential for the western eyewall to reach the coastline. Local forecast products and information provided to emergency managers indicated a likelihood of category one hurricane conditions, but also stressed that a small deviation west of the expected track would bring very damaging category three winds ashore. Based on the strength of thehurricane, large radius of maximum winds, and uncertainty associated with the exact track, a massive coastal evacuation was ordered by local officials. For a number of reasons, the public heeded this advice in large numbers, partly due to the fact that the size of the hurricane filled television screens and that the local media dubbed Floyd "Andrew's big brother".

While tens of thousands of Florida residents prepared for the worst, a "race" was on between Floyd's onshore track and a mid-latitude trough that was forecast to pull Floyd northward. The real forecasting challenge was when that turn would commence. Fortunately, the eventual hurricane track featured a small shift east of the official forecast, thus limiting the most serious effects to damaging hurricane wind gusts along the immediate coast and severe beach erosion.

Around 09Z 15 September, the eye of hurricane Floyd passed directly over buoy 41010, located 120 n mi east of Cape Canaveral. Figure 1 shows the extremely high wave heights - in excess of 50 feet! - that were recorded. Although Floyd was a category 4 storm, maximum sustained winds reported by the buoy were less than 75 knots, with a peak gust of 92 knots. The winds were likely underestimated due to the buoy being sheltered in periodic wave troughs and otherwise not being in an upright position when measurements were taken. In fact, this powerful hurricane proved too much for buoy 41010 which broke free from its mooring and became adrift in the southwest Atlantic shortly after the eyewall passed overhead.

Meteorologists from the Range Weather Office at Cape Canaveral Air Force Station and the 45th Weather Squadron at Patrick Air Force Base were evacuated to WFO Melbourne, where they provided continuous weather support to the air base and the one billion dollars in space center assets at the Cape. As Floyd neared the Florida coast, WFO Melbourne implemented its office hurricane safety procedures, and several office members evacuated their families further inland. Representatives from the Platinum Coast Amateur Radio Society provided real time reports for inclusion into local products.

4. HURRICANE IRENE (13 Oct - 19 Oct)

In mid-October, Irene formed over the climatologically favorable western Caribbean and moved north-northeast across western Cuba. The flat lowlands of western Cuba did little to disrupt its circulation and Irene strengthened into a hurricane as it moved across the warm waters of the Florida Straits. The hurricane force winds, however, were limited to the storm's eastern hemisphere, and for the most part remained over water as Irene tracked north-northeast across the Florida Keys and the southern peninsula. Irene emerged into the Atlantic near Jupiter Inlet and traveled up the coast, just 30 n mi offshore the Cape on 16 October.

Local forecasts during Irene initially stressed the threat of heavy rainfall and a minimal threat of wind damage as the hurricane was expected to weaken to a tropical storm and pass over the central Florida interior. Evacuations of coastal residents were not ordered, in sharp contrast to large scale evacuations ordered weeks earlier due to Floyd. As Irene approached central Florida, however, the more eastward track allowed the system to maintain minimal hurricane intensity. This short term change in the track required quick modifications to local forecasts, strongly emphasizing imminent damaging wind gusts near the coast, and a reduced chance for flooding rains inland. As the center of Irene reached the Atlantic during the early morning hours, radar imagery indicated a reorganization of inner convective bands. These bands affected east central Florida coastal counties for over 12 hours as the center of the hurricane moved slowly up the coast. Although sustained winds did not reach hurricane force, wind gusts over 65 knots and rain totals over 120 mm were recorded across several coastal counties.

Excessive antecedent rainfall in the previous six weeks had produced widespread 250 to 350 mm of rain across the area. This saturated the ground and loosened root systems which allowed winds associated with Irene to be more destructive than expected. Higher seas likely prevented water from flowing out the inlets, resulting in higher water levels in the Indian River Lagoon. Combined with strong north winds allowing a long fetch down the river, many private docks and north-facing structures were

heavily damaged or destroyed by the piling water and resulting wind and wave action.

Minor beach erosion would be expected with a Category 1 hurricane passing just offshore. But the pounding the coastline took from the two previous offshore hurricanes - especially Hurricane Floyd - severely weakened the natural and man-made defenses erected to protect the dune line and nearby dwellings, producing a very vulnerable situation that went largely undetected. As a result, Irene produced severe beach erosion, exposing foundations to private homes and larger housing complexes along the beach, rendering some uninhabitable. So much sand was removed that multiple beach access points were closed until more sand could be brought in or stairways leading to the beach could be rebuilt or extended. All of these factors contributed to Irene being more destructive than expected and actually producing more damage than Floyd, even though wind speeds were very similar between the two storms.

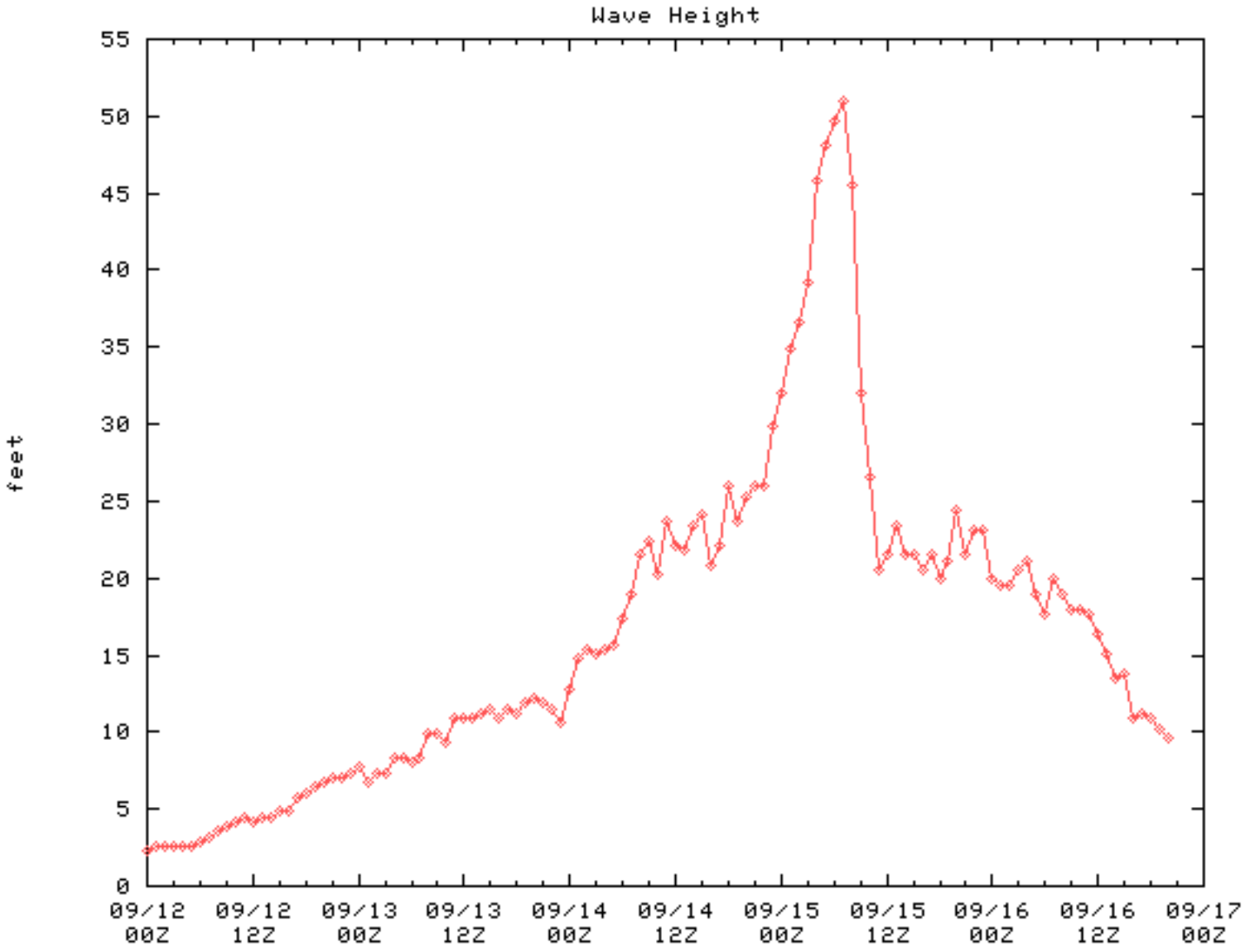

Fig.1