

# Turn Around, Don't Drown!

Even in Florida, people drive into ditches and canals!





# Turn Around, Don't Drown!

### Sometimes with DISASTROUS results!











## Tropical Cyclone Rainfall

Rappaport, Fuchs, and Lorentson (1999)

- Floods due to torrential rains (1970-1999) accounted for:
  - ► 292 deaths out of 510 (59%)
  - ► About 78% of children's deaths
  - Large loss of life due to flooding in particular tropical cyclones
    - Agnes, 1972 (114)
    - Alberto, 1994 (33)
    - Amelia, 1978 (33)
- No relationship apparent between intensity of tropical cyclone at landfall and the number of rainfall induced flood deaths

## Tropical Cyclone Rainfall

### Introduction

- Two features distinguish tropical rains from mid latitude rains
  - ► High temperature
  - ► High humidity (high liquid water content)
- Tropical Cyclones combine higher liquid water content with extreme convection
- Tropical Cyclones have the potential for extreme amounts of rain

## **Tropical Cyclone Precipitation**

### Factors to Consider

- Most rain occurs in the high wind area estimates are that not more than 50% is caught
- Movement, progression, size
- Widely differening values reported worldwide (trace to more than 100 inches (typhoon))
- Occurrence often in late stages away from tropics
- Logarithmic distribution with radius

# **Tropical Cyclone Precipitation**

Precipitation Intensity Profiles (from Simpson and Riehl)

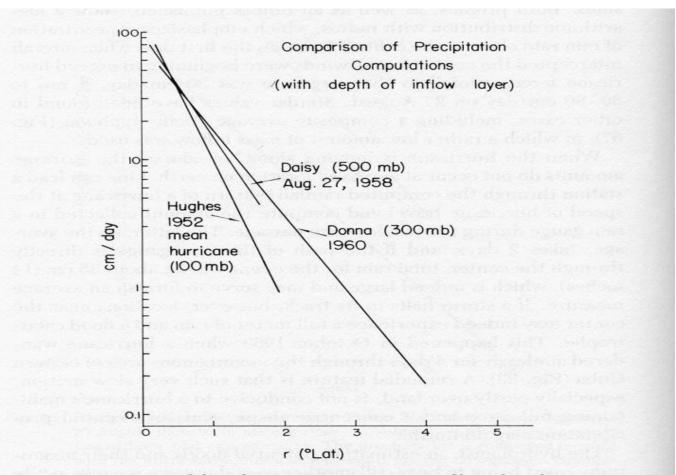


Fig. 67. Comparison of three hurricane precipitation profiles, plotted as in Figure 66. Hughes data from Pacific typhoons.

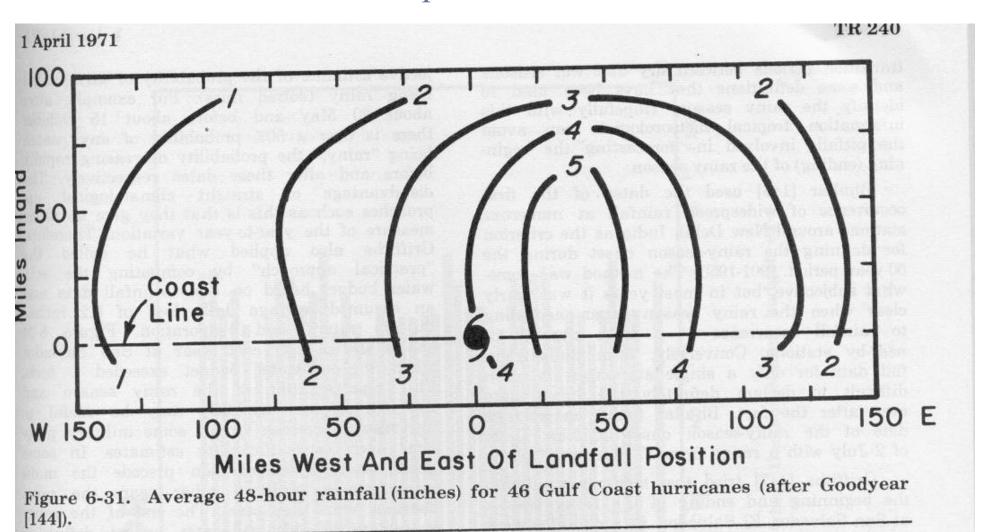
## Tropical Cyclone Rainfall

### Characteristics

- Extremely heavy rainfall
  - ► Eye wall
  - Spiral bands
- Dry side and wet side (Goodyear 1968)
- Average maximum for Gulf coast landfalling tropical cyclones and hurricanes... almost 6 inches
- Slightly inland from the coast
- 25 to 50 miles to the right of the storm track
- Varies tremendously with storm speed

# Average 48 hr Rainfall

46 Gulf coast tropical storms and hurricanes



## Tropical Cyclone Rainfall Patterns

### **Torrential Rains**

- Typically 5 to 12 inches of rain in a hurricane
- Varies greatly depending on storm speed and size
- Extreme rainfall rates
  - ▶ 1.3 inches of rain in 10 minutes at Miami 1947
  - ▶ 6 inches of rain in one hour near Ft. Lauderdale 1947
  - ▶ 6 inches of rain in one hour at Hialeah 1947
  - ▶ 16.4 inches of rain in a few hours near Blountstown in 1926
  - ► 38.7 inches of rain in 24 hours at Yankeetown in 1950
  - ▶ 43 inches of rain in 24 hours at Alvin, TX, in 1979

# **Tropical Storm Alberto**

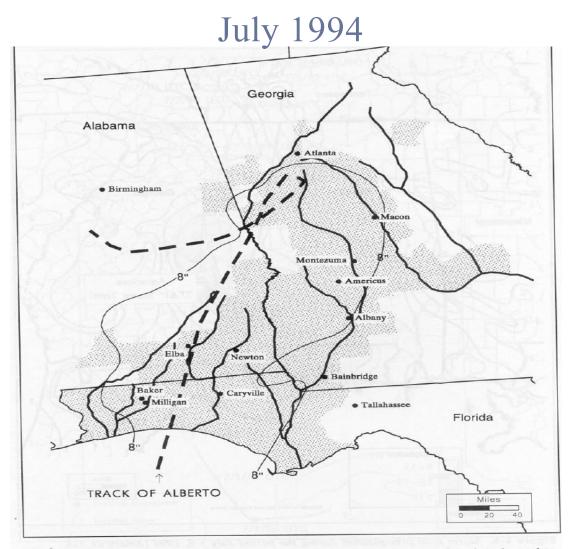
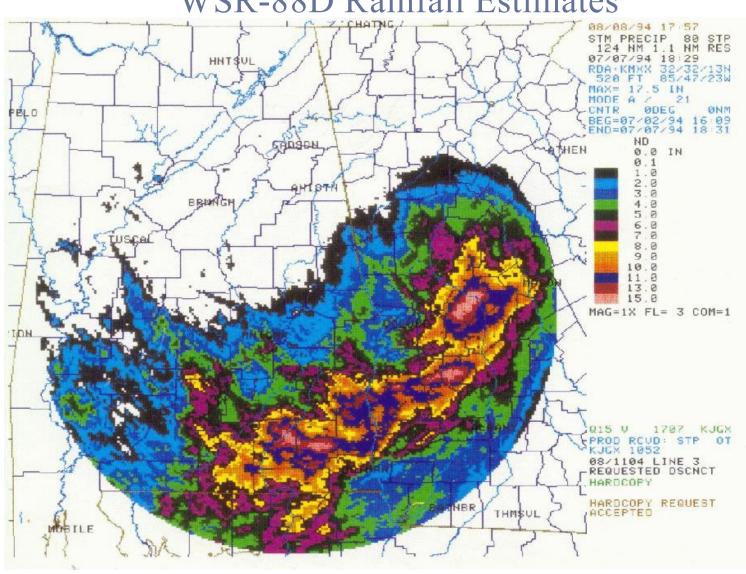


Figure 1-5. Composite showing Alberto's inland track (dashed line), the 8-inch isohyet, the 78 counties declared Federal disaster areas (shaded), and the five major river systems.

# **Tropical Storm Alberto**

### WSR-88D Rainfall Estimates



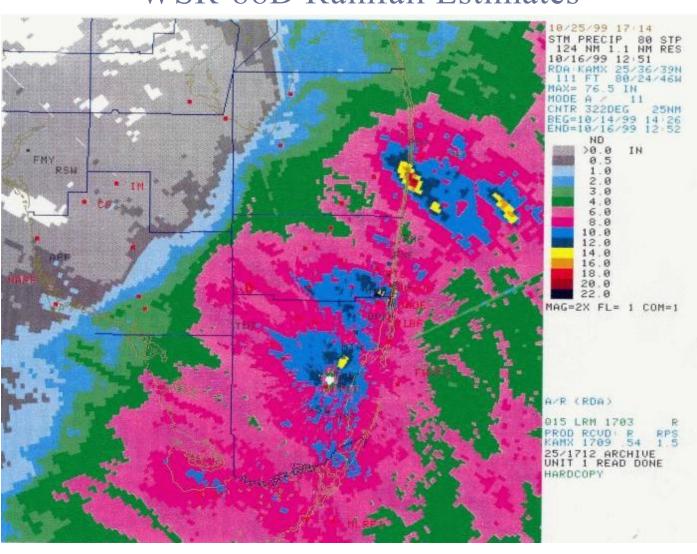
## WSR-88D Doppler Radar

#### Factors to Remember

- Reflectivity-Rainfall Relationships Z-R
  - ► Used to be only TWO authorized Z-Rs
    - Standard Z-R Z=300R^1.4
      - Pretty good for thunderstorms and "normal" convection
      - Terrible for "low topped warm" convection
    - Tropical Z-R Z=250R<sup>1</sup>.2
      - Works for purely tropical cases
      - In some storms overestimates
      - New research suggests the tropical Z-R is too heavy handed
  - ► When using WSR-88D rainfall estimates, especially for tropical cyclones, find out which Z-R is in use!
    - Standard Z-R will grossly underestimate tropical rains
    - Tropical Z-R will grossly overestimate normal convection especially north of 30 degrees N.

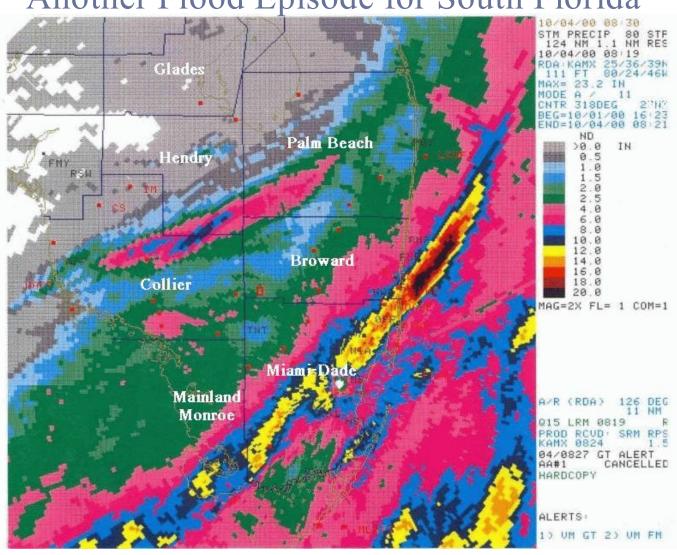
# Hurricane Irene

### WSR-88D Rainfall Estimates



## Oct.3,2000 Disturbance

Another Flood Episode for South Florida

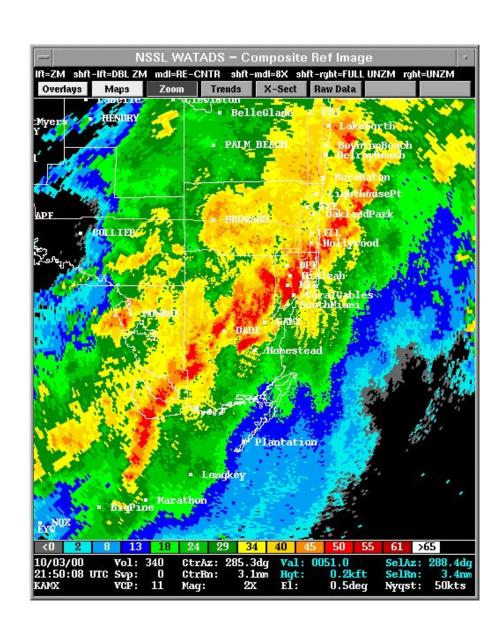


## What was the difference?

Irene 1999 event and the Oct. 3, 2000, disturbance event

- Oct. 3 more localized to Miami-Dade County
- More rain (up to 17.5 inches, mostly 14-16 max)
- Shorter time period (most fell in less than 18 hours)
- Urban setting
- Train echo effect over a localized area
- Drainage poor in areas that used to be a swamp

## TRAIN ECHO EFFECT



## Tropical Cyclone Rainfall Patterns

Dry or low-rainfall hurricanes

- Usually fast moving
- 1941 Miami hurricane dropped less than .5 inch
- Andrew 1992 produced 7.5 inches at Tamiami Airport in Miami, but most amounts less than 4 inches

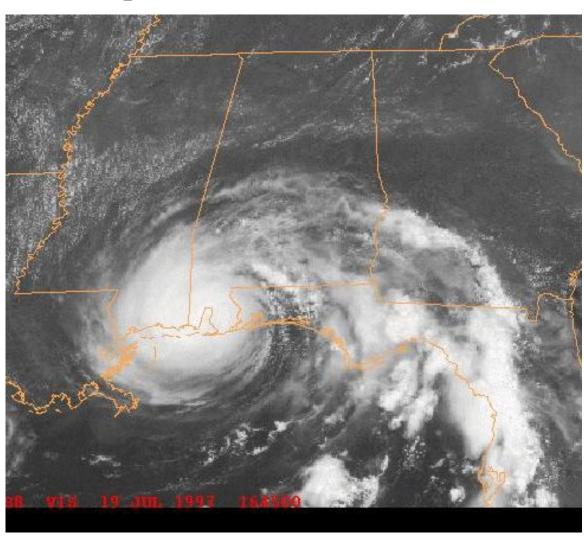
## Tropical Cyclone Rainfall Pattern

### Flooding

- Many of Florida's disastrous floods are the result of tropical cyclone rainfall
  - ► Hurricane Dora 1964 23.73 inches at Mayo... disastrous flooding N Florida including Live Oak
  - ► October 1924 hurricane 23.22 inches at Marco Island...flooding lasted for days
  - ► September-October 1948 widespread flooding around Lake Okeechobee (Clewiston, LaBelle) lasted for days
  - ► Tropical Storm Alberto 1994 Apalachicola River
  - ► Tropical Storm Jerry 1995 Collier County
  - ► Hurricane Irene 1999 Southeast Florida

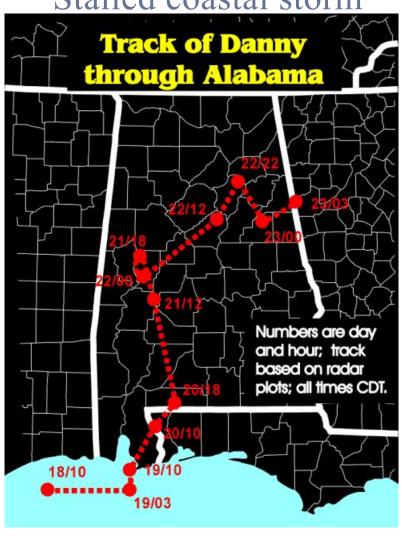
# Hurricane Danny

Example of a stalled coastal storm



# Hurricane Danny





# Hurricane Danny

## Rainfall Analysis



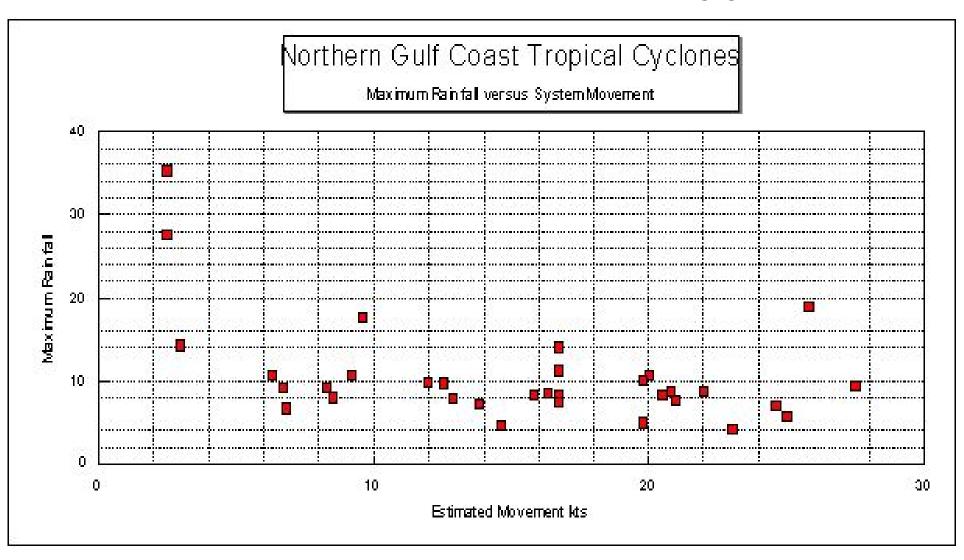
## Kraft Rule of Thumb (old)

### 1960s

- Estimated Maximum Rainfall for hurricanes affecting the U.S. Gulf of Mexico coast
- Max Precipitation = 100 / Speed (kts)
  - ► Example... Andrew max precip forecast 100/17.5 = 5.7 inches
  - ► Actual max was 7.5 inches at Tamiami Airport
  - Good for a first guesstimate

## **Extreme Rainfall**

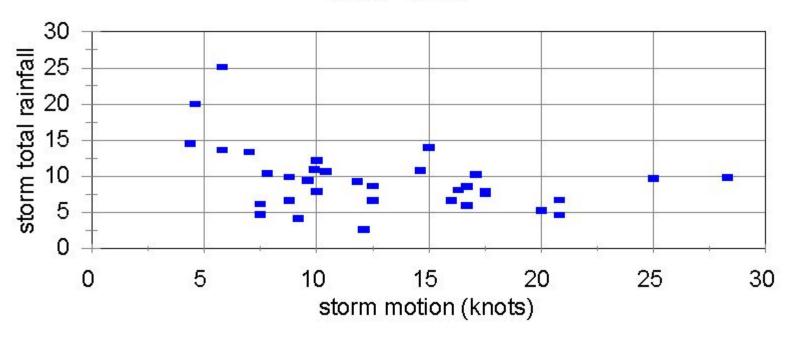
## Northern Gulf Coast LCH-AQQ



## **Extreme Rainfall**

## Florida Peninsula AQQ-JAX Tropical Cyclone Rainfall

1960-1998



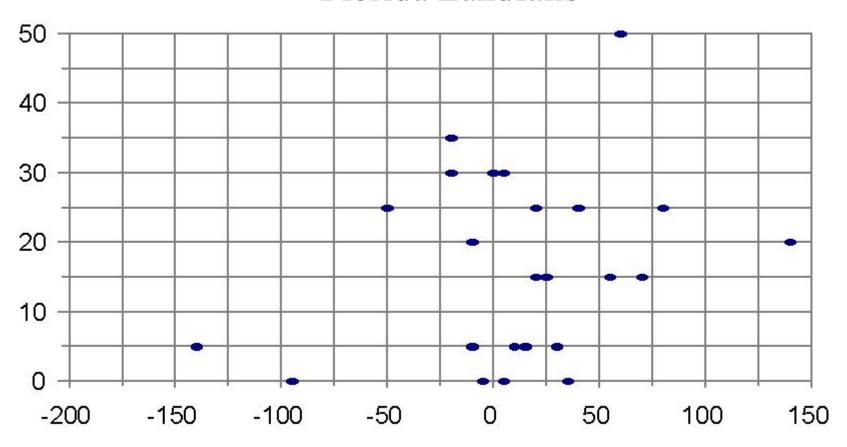
## **Extreme Rainfall**

### Regression Results

- Remove Outliers below 6 knots movement
- Gulf Coast landfall R = -0.039(movement) + 9.75
  - Standard deviation 3.3 inches
- Florida landfall R = -0.063 (movement) + 9.37
  - ► Standard deviation 3.2 inches

## **Extreme Rainfall Distribution**





## Position of Extreme Rainfall

### What have we learned?

- Gulf Coast and Florida Peninsula Landfalls
  - ▶ 50 miles west (left) and up to 100 miles east (right) and up to 100 miles inland of landfall spot
  - ► Approximately 9-10 inches +/- 3 inches in RFQ (6 kt <movement<30 kt)
  - ► At least double forecast amounts movement less than 6 kt
- Greatest extreme rainfall threat usually removed from the track of the center of the tropical cyclone
- Tendency of public to focus on track of the center

# NWS Guidance for Tropical Cyclone Rainfall

Primarily the Responsibility of the WFO

- NHC and HPC provide general QPF
- Local WFO provides specifics down to the county level
  - Coordination with local Water Districts and Corps of Engineers
  - ► Flood Watches
  - River Flood and Flash Flood Warnings
  - ► Short Term Forecast Updates and Flood Statements based on WSR-88D trends
  - ► GET THE MESSAGE TO THE PUBLIC

## **FLOOD WATCH**

### Uncommon Product for Florida

- Conditions are favorable for heavy rains and flooding during the watch period
  - Soil moisture high
  - Ground water level high
  - ► High runoff potential
  - ► Large amounts of rainfall likely
  - Poor drainage
  - Canals or rivers high and little capacity left to handle more runoff
- Make preparations now for future flood problems

## Urban Flood Advisory

### **Intermediate Product**

- Product Issued for nuisance type flooding rains
- Flooding of underpasses and low lying areas
- Flooding of normally poorly drained areas
- Issued as a Flood Statement (FLS)

## FLASH FLOOD WARNING

### Uncommon Emergency Product

- Flooding is imminent or has been reported
- Means that water will be or is now entering homes and businesses
- Requires immediate action to protect life and property
- Dangerous driving conditions
- Most deaths due to floods are because people insist on attempting to drive through flood waters
- Doesn't take much water depth to float vehicles

## South Florida after Hurricane Irene







Sun-Sentinel online

## **National Weather Service**

Weather Forecast Office 11691 SW 17th Street Miami, Florida 33165 305-229-4502

http://miamiweather.info

En español http://eltiempoenmiami.info





