

# A Friday the 13<sup>th</sup> to Remember

## Hurricane Charley's Landfall in Southwest Florida



news-press.com: 24-HOUR COVERAGE OF ALL HURRICANE CHARLEY NEWS AND EVENTS


### THE NEWS-PRESS

SATURDAY, AUGUST 14, 2004 | PUBLISHED SINCE 1884 | news-press.com | FINAL | 50¢

#### Hurricane Charley tears through Southwest Florida

# DEVASTATED

Category 4 storm leaves several dead in Charlotte County; 145-mph winds ravage region, cause widespread destruction



■ Cecil Cavanaugh hugs his grandson, Jacob, 2, while taking a look through the home that Jacob and his mother live in with their grandmother in Suncoast Estates on Friday, Hurricane Charley ripped through the estates causing widespread damage.

More than 468,000 trying to cope without power

BY GRANT BOLLETTNER  
@news-press.com

INSIDE



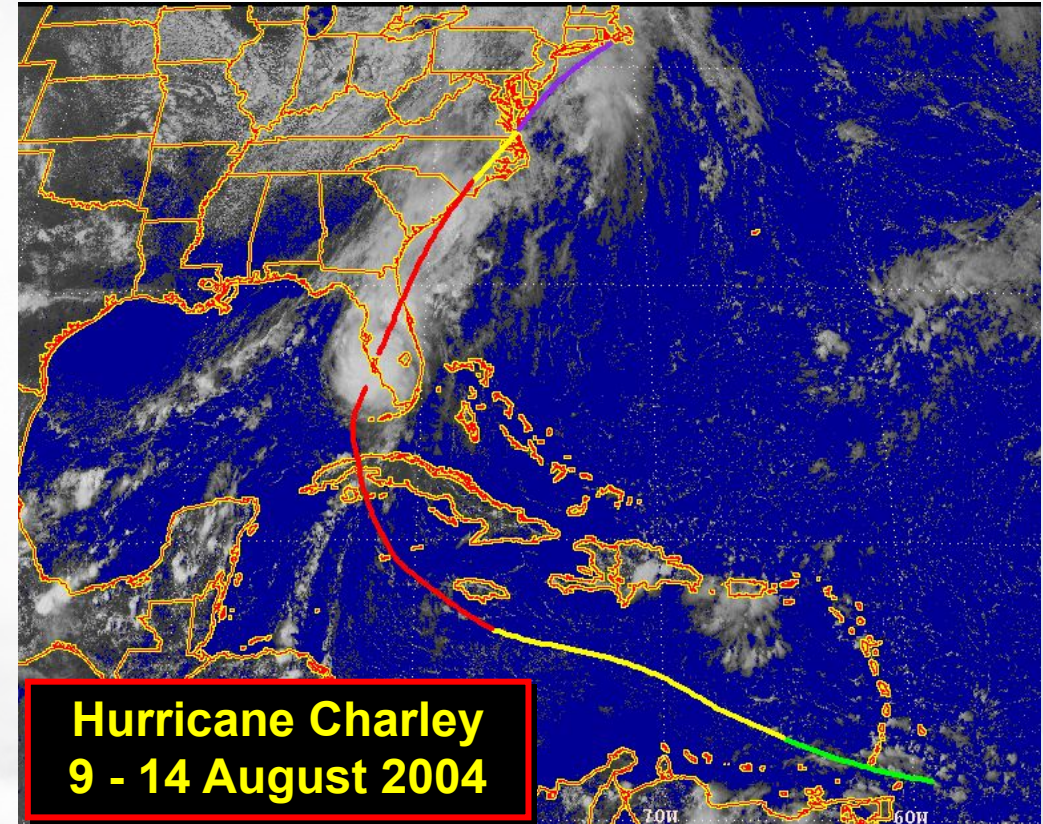
# Hurricane Charley

- System became a Tropical Depression on August 9<sup>th</sup> near the Windward Islands
- Became Tropical Storm Charley 18 h later over the eastern Caribbean Sea
- Steadily strengthen while moving across the Caribbean, reaching hurricane status on August 11<sup>th</sup>
- Landfall near Playa del Cajio, Cuba as a 120-mph Category 3 hurricane
- Eye crossed Cuba in about 90 minutes
- High-end category 2 hurricane when it moved into the Florida Straits

**BULLETIN**

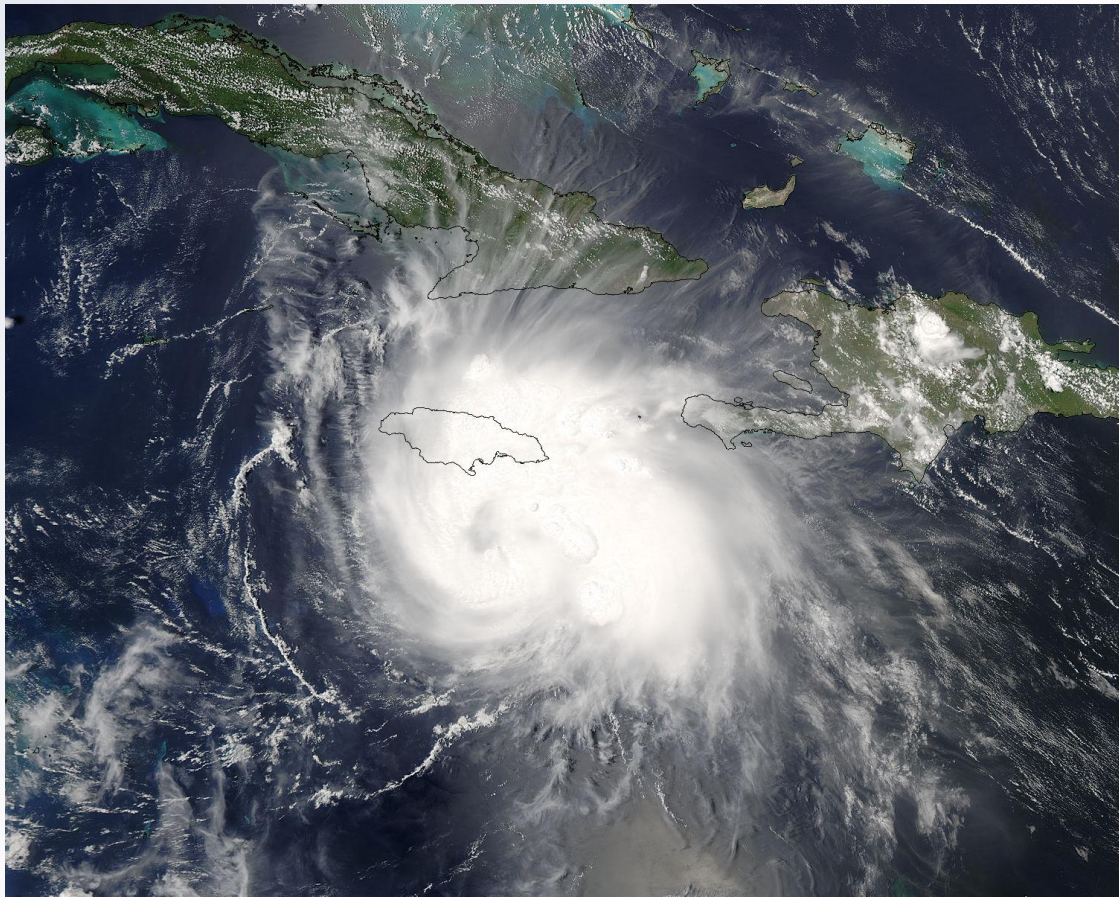
TROPICAL DEPRESSION THREE SPECIAL ADVISORY NUMBER 1  
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL  
145 PM AST MON AUG 09 2004

...THIRD TROPICAL DEPRESSION OF THE SEASON FORMS NEAR THE WINDWARD ISLANDS...

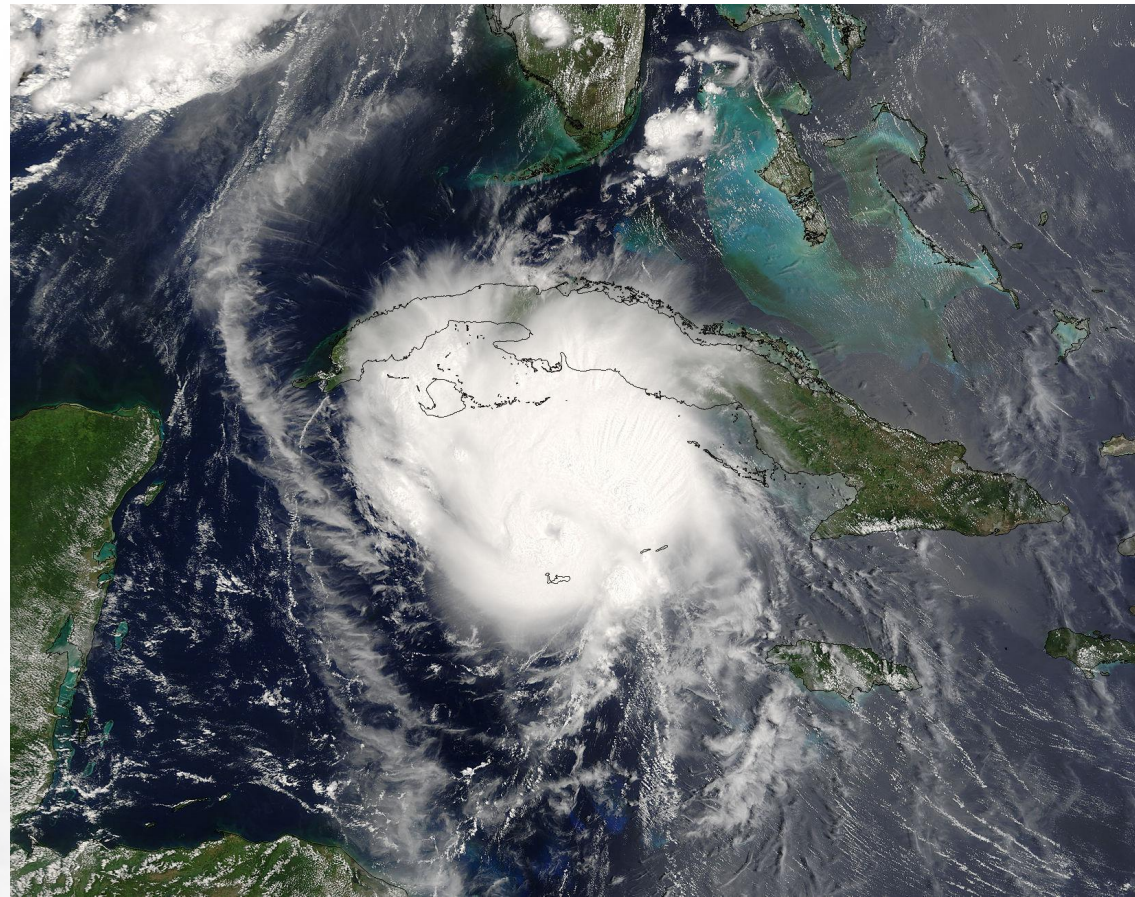


# Hurricane Charley

Compact but well organized



**August 11 - Near the time Charley  
Became a Hurricane**



**August 12 – Charley becomes better  
organized while approaching Cuba**

# Hurricane Charley

- **Rapidly strengthened in the hours before landfall**
  - 110-mph Category 2 to a 150-mph Category 4 hurricane in 5 hours
- **Landfall as a category 4 hurricane near Cayo Costa, Florida, on August 13, 2004**
  - Maximum winds 150 mph
  - Minimum pressure 941 mb
- **Landfall occurred about 50 h after Charley became a hurricane**
- **Strongest hurricane to hit the U.S. since Andrew (1992)**

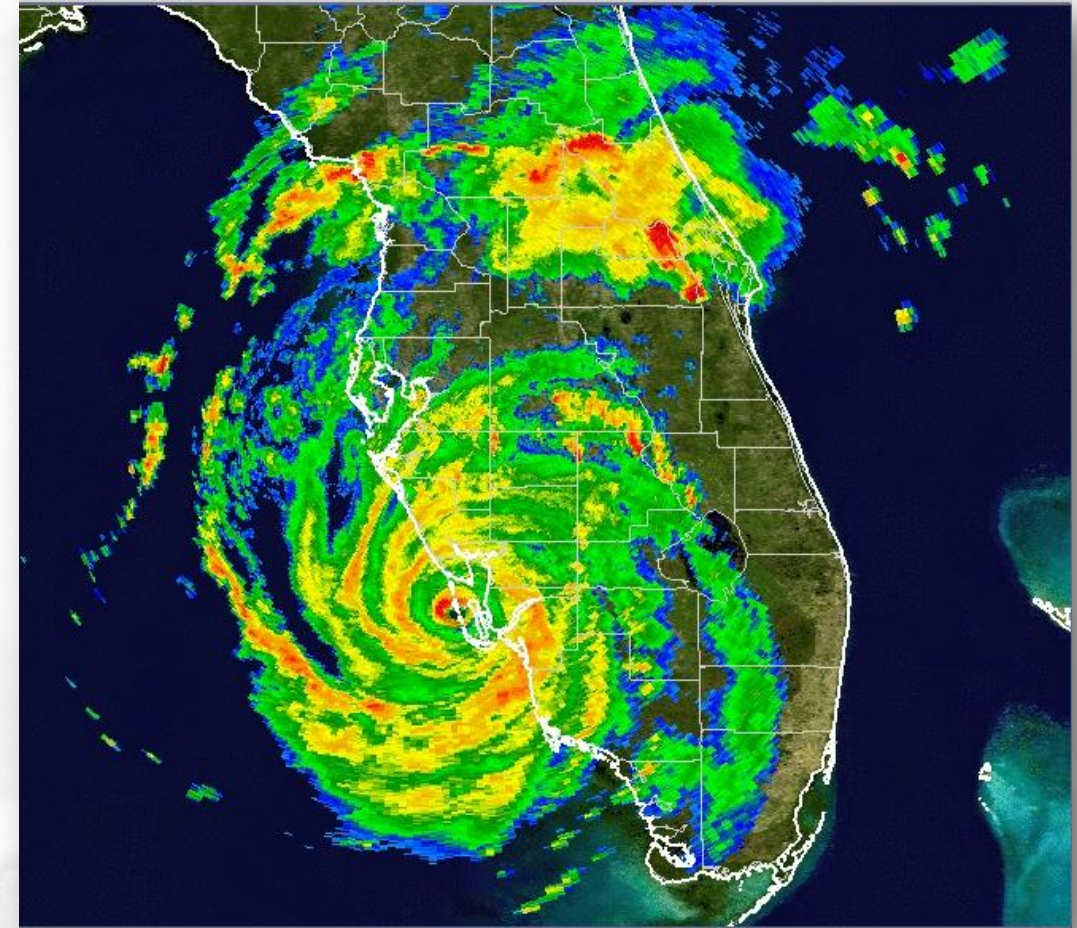
**BULLETIN**

HURRICANE CHARLEY ADVISORY NUMBER 19

NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL

5 PM EDT FRI AUG 13 2004

...CHARLEY MAKES LANDFALL AS A CATEGORY FOUR HURRICANE NEAR CHARLOTTE HARBOR FLORIDA...



# Hurricane Charley

- **Wind:**

- **Most instruments failed**
- **Observing site at Punta Gorda, measured 90 mph (78 kt) sustained winds and a gust to 112 mph (97 kt)**
- **Well inland, the observing site at Orlando Int'l Airport measured a sustained wind of 79 mph (69 kt) with a gust to 105 mph (91 kt)**

- **Storm Surge:**

- **6 to 7 ft on Sanibel and Estero Islands**
- **4.2 ft measured by a tide gauge in Estero Bay (near Fort Myers Beach)**
- **Storm surge of 3.4 to 3.6 ft was measured on tide gauges on the Caloosahatchee River, near Fort Myers**

- **Rainfall:**

- **9.88 inches Bud Slough, Florida (near Myakka State Park)**

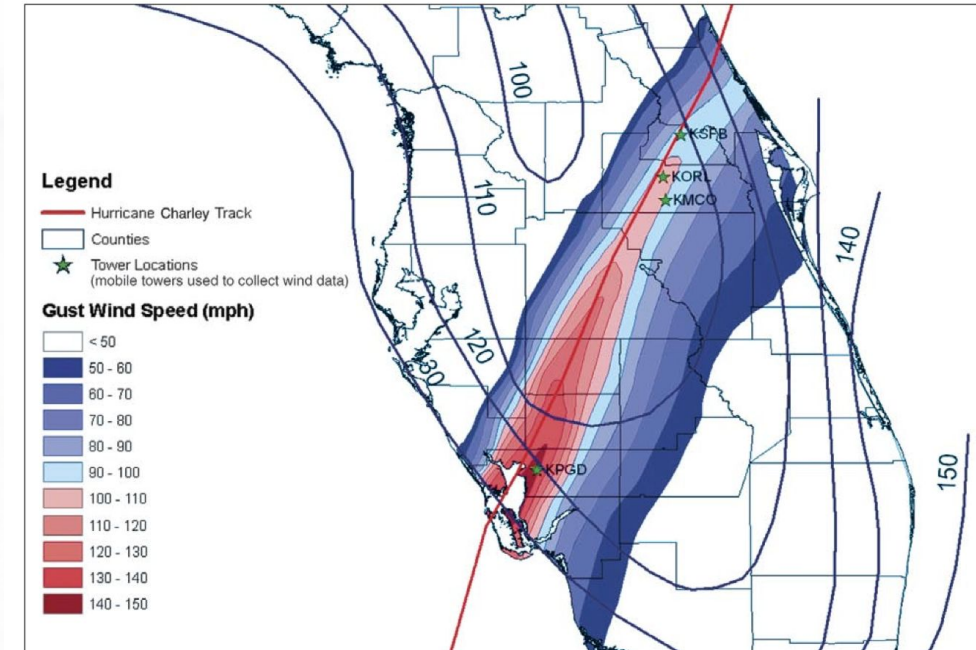


Figure 2. Hurricane Charley Wind Swath Map

FEMA Wind Gust Analysis

# Hurricane Charley

- **U.S. damage: \$25.4B\***
  - **2<sup>nd</sup> costliest at the time, now 16<sup>th</sup> costliest U.S. hurricane**
- **U.S. Fatalities: Total 35**
  - **Direct: 10 (9 in Florida)**
    - **8 Wind**
    - **1 Freshwater Flooding**
    - **1 Rough Surf**
  - **Indirect: 25**
    - **24 in Florida**
    - **1 in South Carolina**
    - **Causes in include falls (4), carbon monoxide poisoning (3), heart attack (3), electrocution (2), other power issues, accidents**



Punta  
Gorda



Orange County

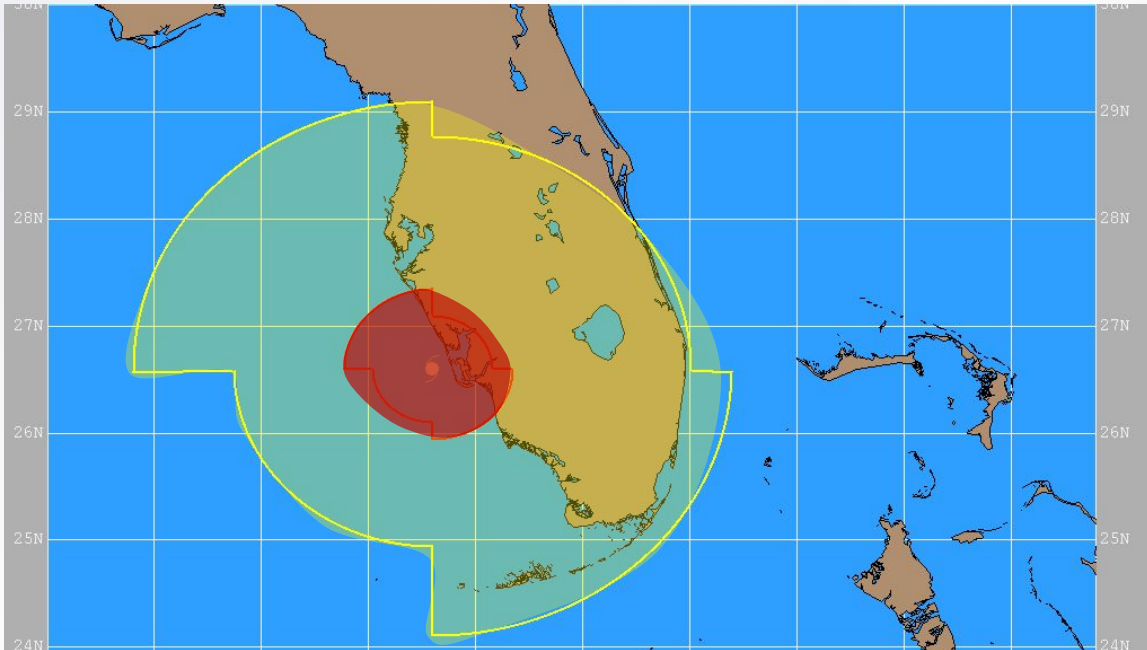
\*2023 Dollars

# Charley (2004) vs. Ian (2022)

Similar Strength but Different Very Different Impact Footprint

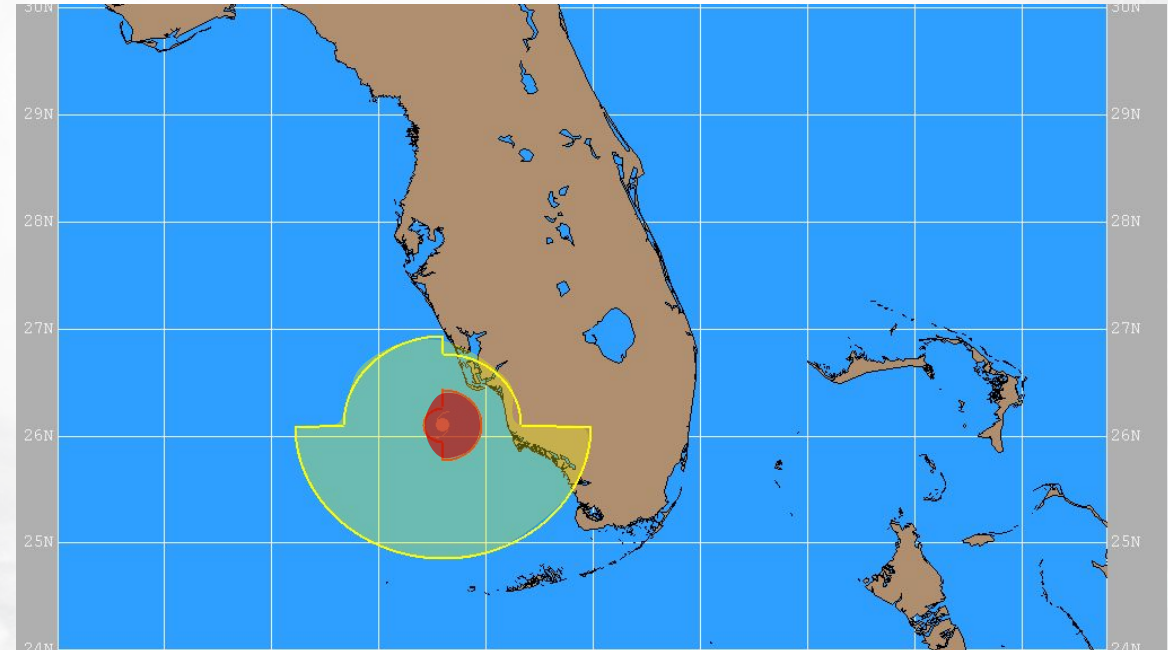
## Ian

- Size: TS winds ~ 150 miles (175 max)  
H winds ~ 36 miles (52 max)

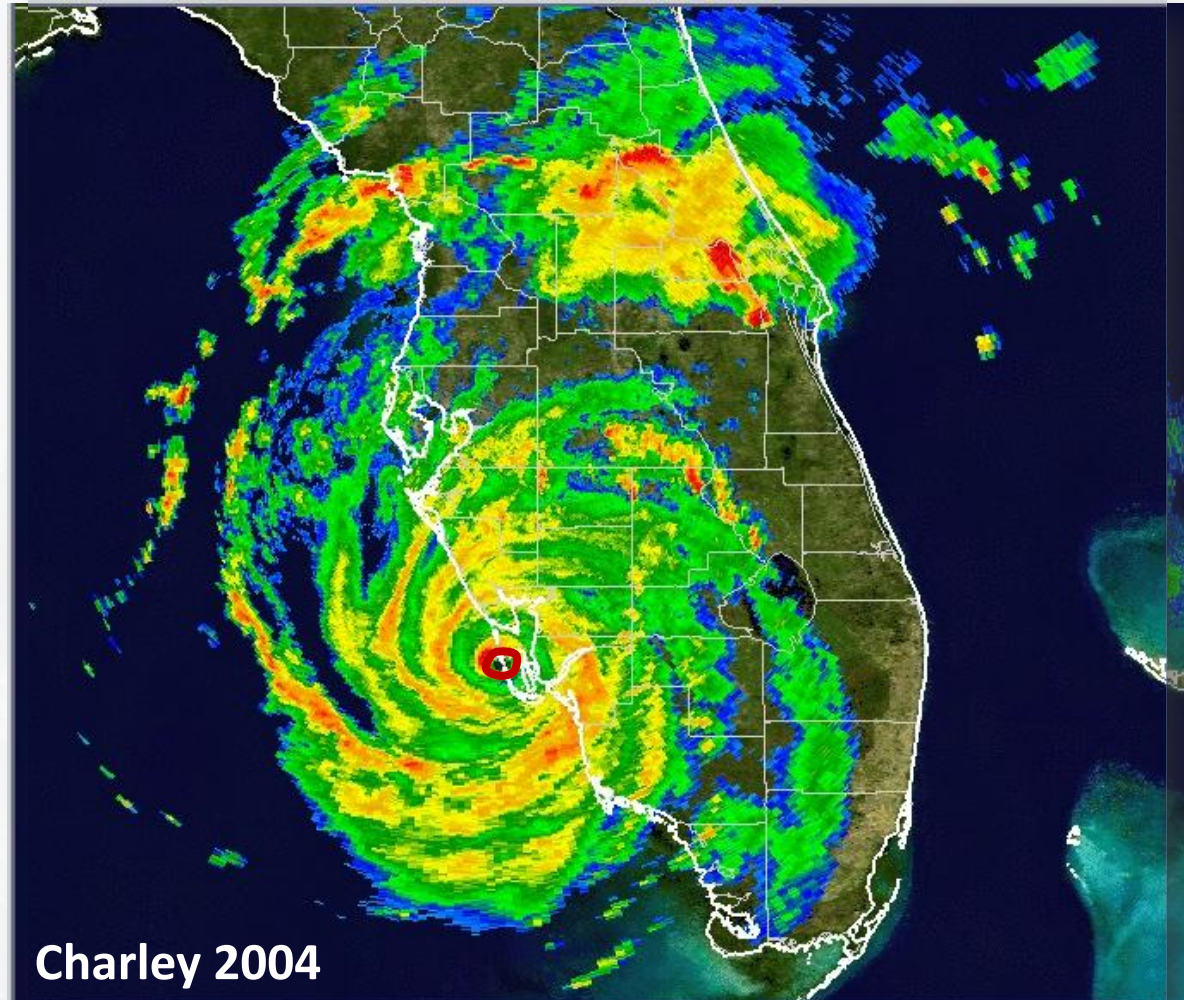


## Charley

- Size: TS winds ~ 70 miles (85 max)  
H winds ~ 17 miles (23 max)



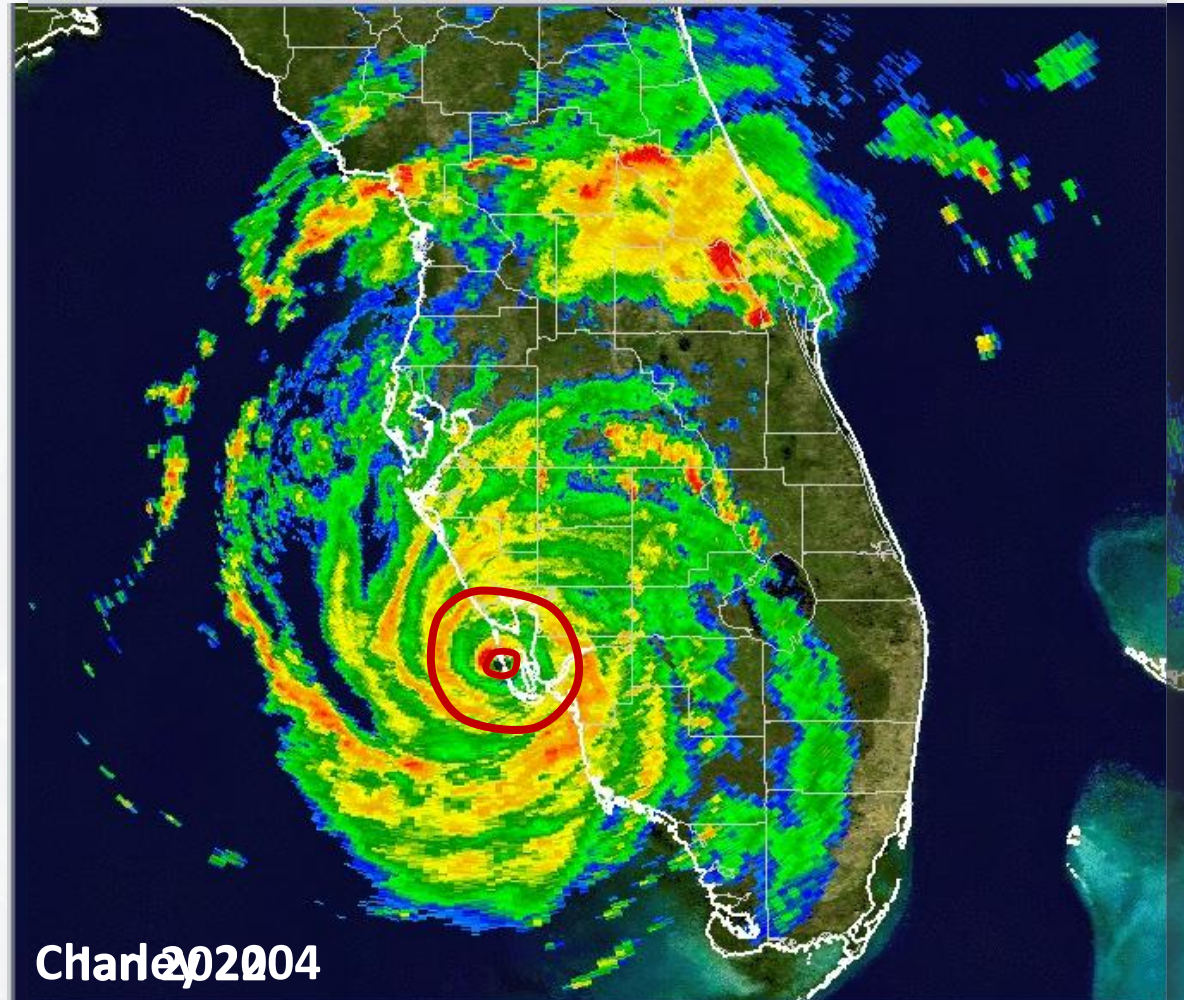
# Differences in Core Size (Radius of Maximum Winds)



Charley: Radius of Maximum Winds ~ 6 n mi



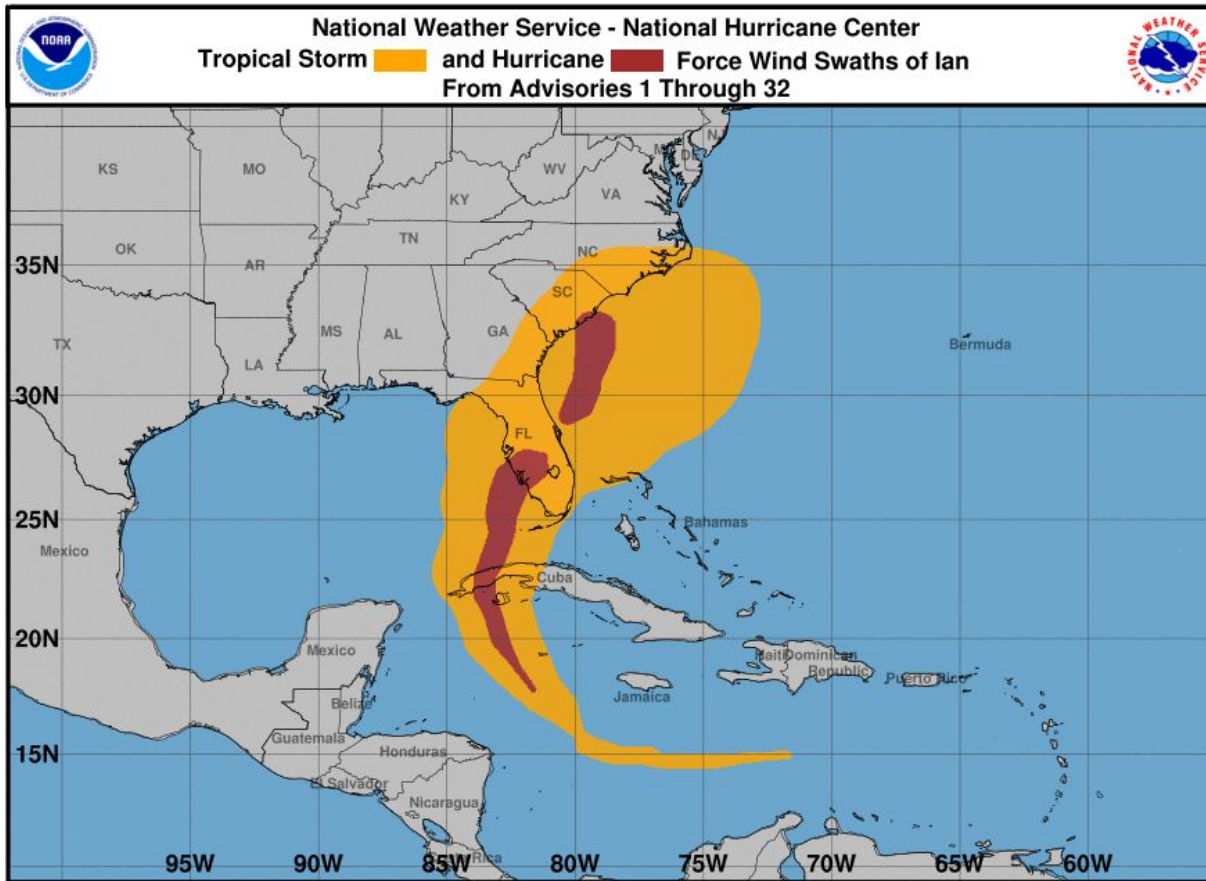
# Differences in Core Size (Radius of Maximum Winds)



**Charley: Radius of Maximum Winds ~ 80mmi**

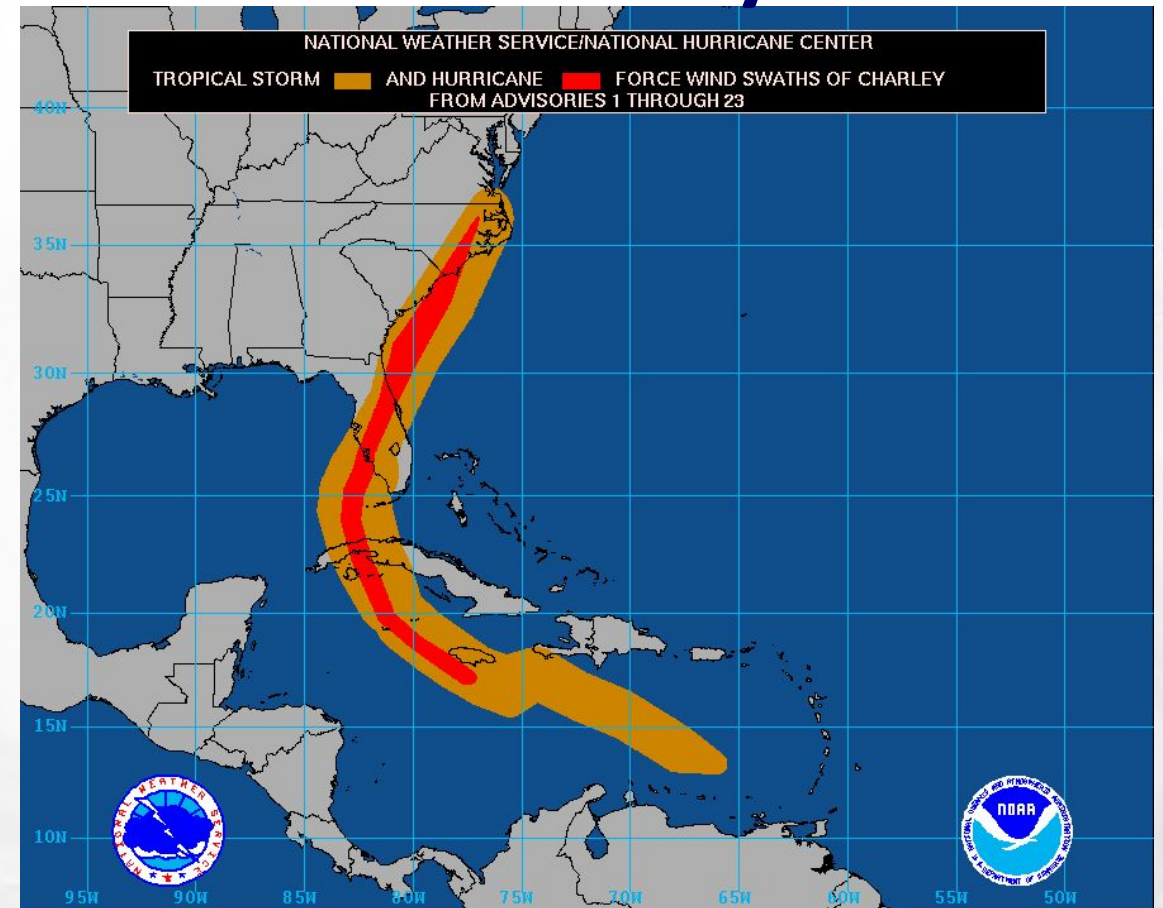
# Charley – Narrow Swath of Extreme Winds but More Inland Penetration

## Ian



Ian's slower forward speed allowed the storm to weaken faster so less inland wind penetration occurred

## Charley



Charley's fast forward speed resulted in hurricane-force winds crossing the entire Florida Peninsula. Extreme wind damage occurred in Arcadia and Orlando

# Charley Wind Damage

Captiva



Turner Agri-Civic  
Arcadia



Getty Images



Terry Allen Williams

Courtesy of Preston Cook

**Captiva**



**Punta Gorda**



Thomas Bender, Herald Tribune  
**Arcadia Civic Center**



Courtesy of Preston Cook

**Orange County**

# Improved Building Codes Implemented in the 1990s Likely Reduced Wind Damage

Wind Damage during Charley (2004) from two homes in Punta Gorda



Home built in 1961 (pre-Florida building codes)

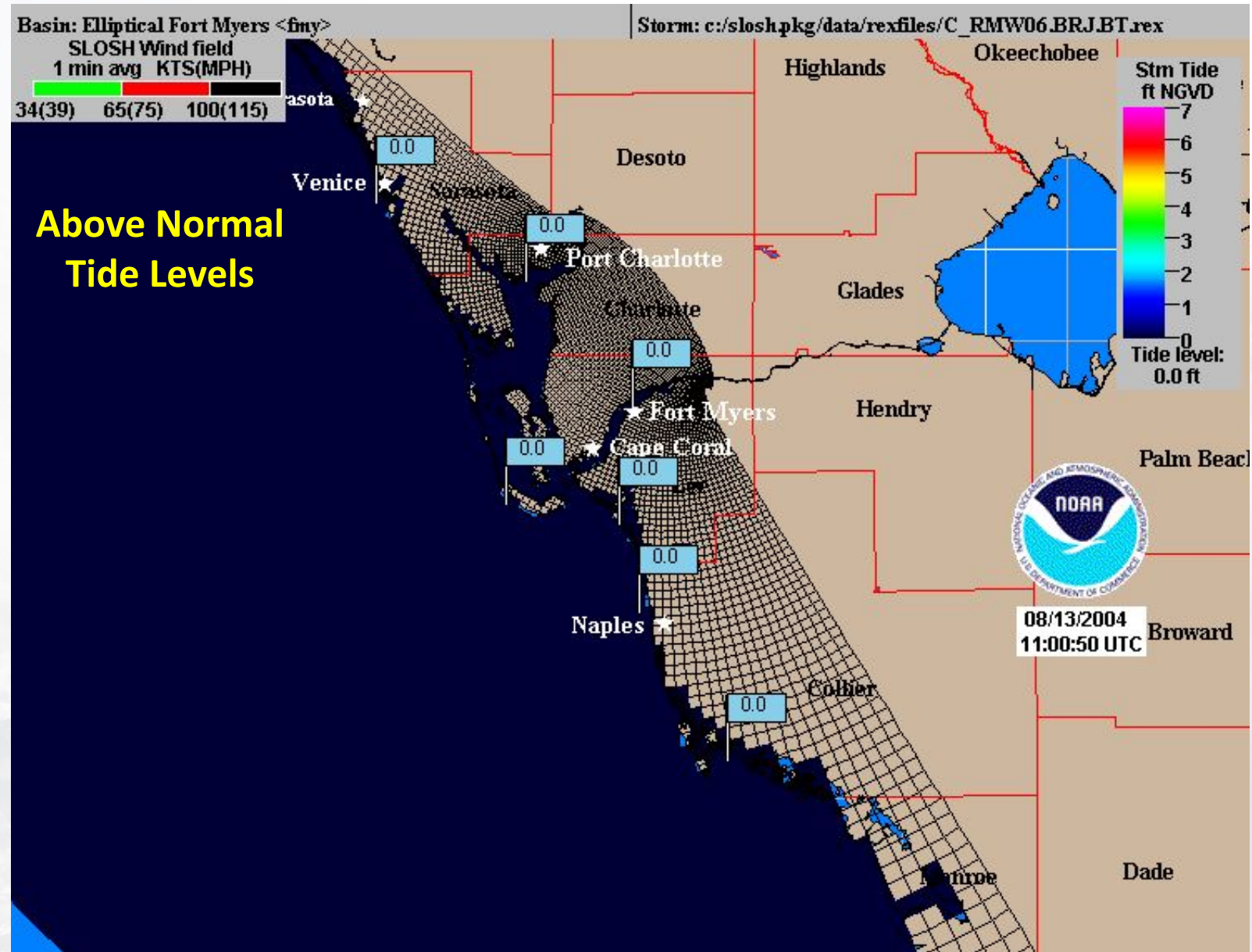


Model home (2004) in Punta Gorda Isles

Lessons learned from Charley likely mitigated wind damage from Ian (2022)

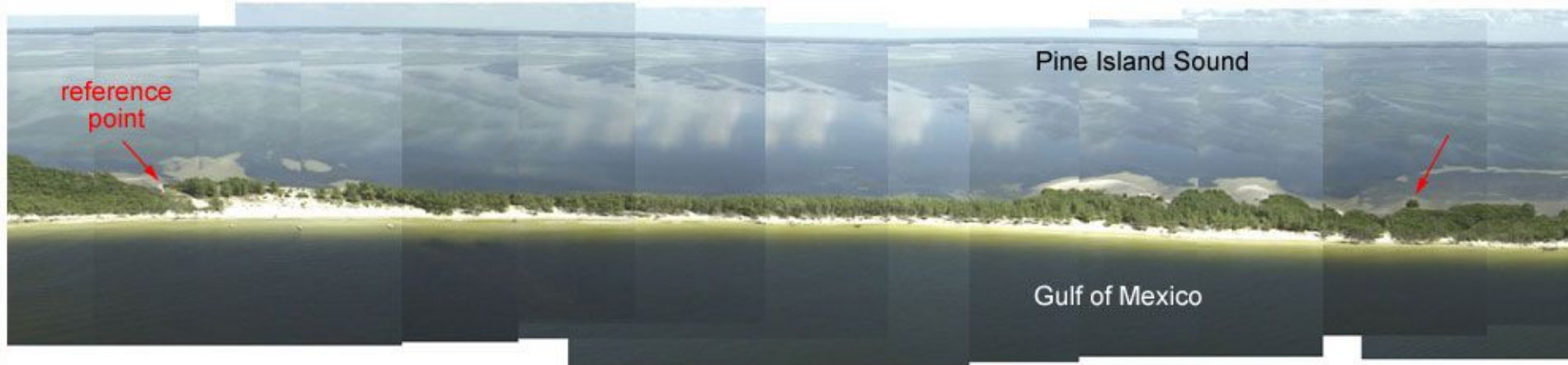
# Charley's Small Core Limited its Storm Surge Footprint

- Peak storm surge of 6 to 7 ft on Sanibel and Estero Islands
- 4.2 ft measured by a tide gauge in Estero Bay (near Fort Myers Beach)
- Storm surge of 3.4 to 3.6 ft was measured on tide gauges on the Caloosahatchee River, near Fort Myers

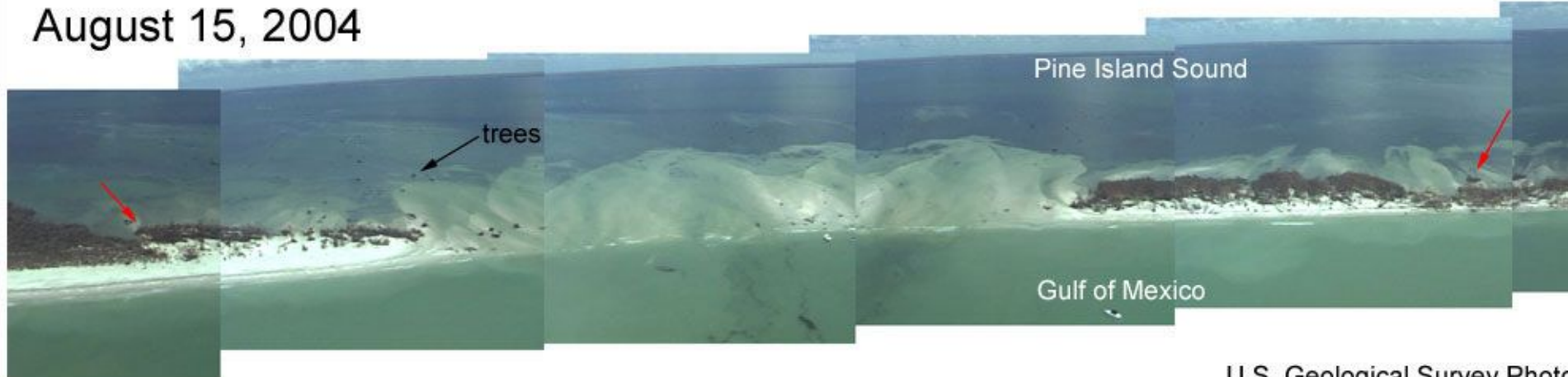


# Charley's Storm Surge Caused Breach in North Captiva

North Captiva Island, FL  
September 29, 1999



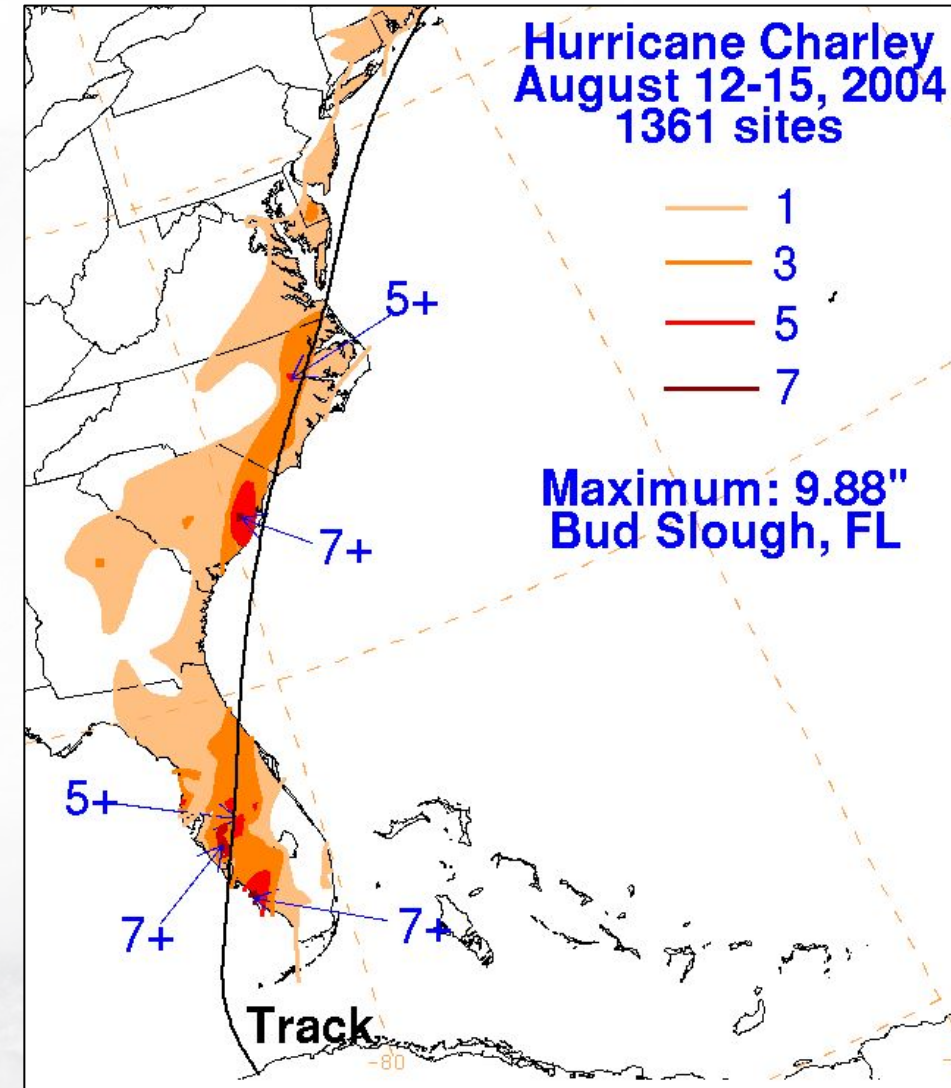
August 15, 2004



U.S. Geological Survey Photo

# Fast Motion of Charley Limited Rainfall Potential in Florida

- Charley's forward speed of about 20 mph kept rainfall totals relatively low across the Florida Peninsula
  - Center only took less than 7 hours to cross the peninsula
- Swath of the 3–6 inches fell from from southwest Florida across Orlando to near Daytona Beach
- Maximum 9.68 inches at Bud Slough





# Charley Produced 9 Tornadoes in Florida

- Tornadoes mostly occurred in central Florida closer to the path of Charley due to the storm's small size
- Strongest in south Daytona Beach that produce a quarter-mile track of F-1 damage



Red dots were preliminary tornado reports

# Changes to NHC Products Since 2004

TWOAT  
TROPICAL WEATHER OUTLOOK  
NWS/TPC NATIONAL HURRICANE CENTER MIAMI FL  
530 AM EDT MON AUG 9 2004

FOR THE NORTH ATLANTIC...CARIBBEAN SEA AND THE GULF OF MEXICO...

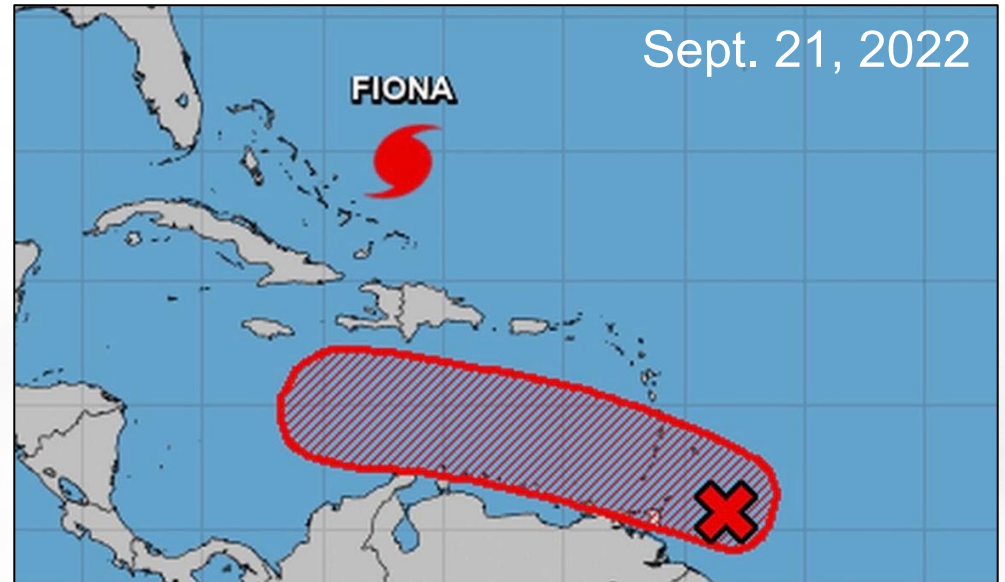
THE REMNANTS OF TROPICAL DEPRESSION TWO ARE CENTERED IN THE EXTREME SOUTHEASTERN GULF OF MEXICO ABOUT 75 MILES NORTH OF CANCUN. THIS SYSTEM CONTINUES TO SHOW SIGNS OF ORGANIZATION AND COULD RE-DEVELOP INTO A TROPICAL CYCLONE LATER TODAY. AN AIR FORCE RESERVE RECONNAISSANCE AIRCRAFT IS SCHEDULED TO INVESTIGATE THE SYSTEM THIS AFTERNOON.

A TROPICAL WAVE IS CENTERED ABOUT 150 MILES EAST OF THE WINDWARD ISLANDS. THIS SYSTEM IS MOVING WEST-NORTHWESTWARD AT ABOUT 25 MPH...AND THERE ARE NO SIGNS OF TROPICAL CYCLONE FORMATION AT THIS TIME. HOWEVER... THUNDERSTORMS ASSOCIATED WITH THIS SYSTEM ARE BEGINNING TO SPREAD ACROSS PORTIONS OF THE LESSER ANTILLES.

ELSEWHERE...TROPICAL STORM FORMATION IS NOT EXPECTED THROUGH TUESDAY.

FORECASTER FRANKLIN

**In 2004, the Outlook was a text product only covering 1 to 2 days. Less than 12 h before the system that became Charley, development was not expected**

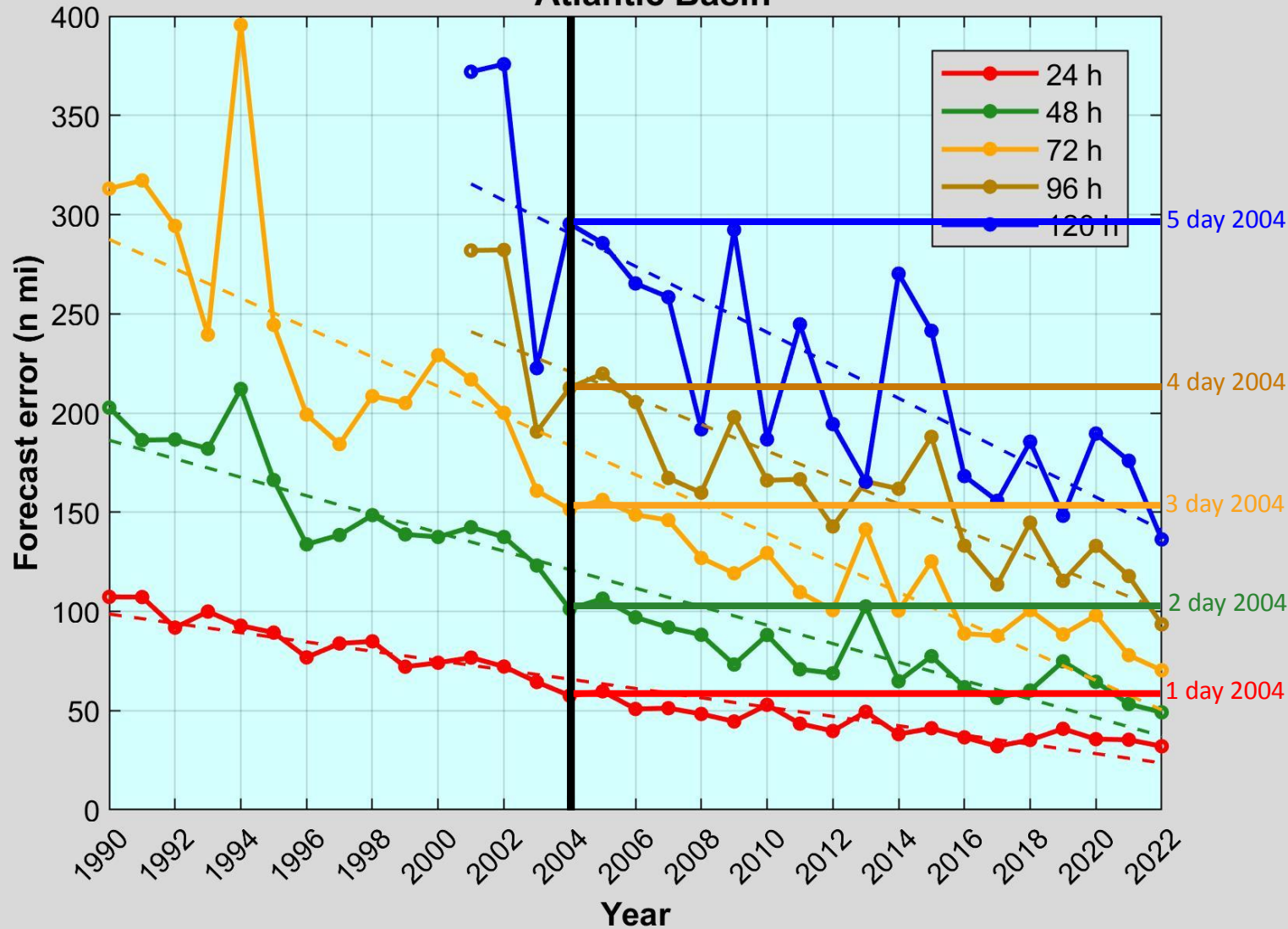


**Tropical system heading toward Caribbean is likely to become hurricane, with Florida in its long-term path**

**In 2022, the system that became Ian was introduced into the Outlook 3 ½ days before formation. Media outlets discussed the possibility of Florida impacts a week before.**

# Atlantic Track Error Trends

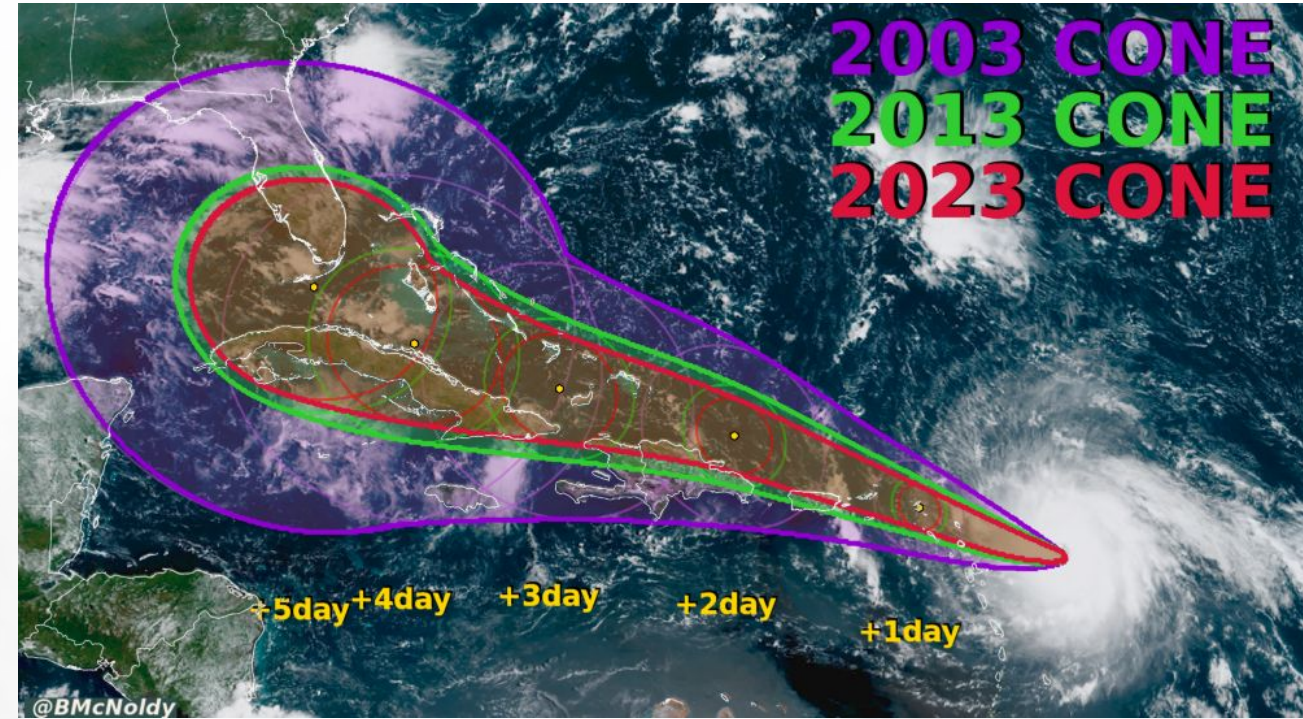
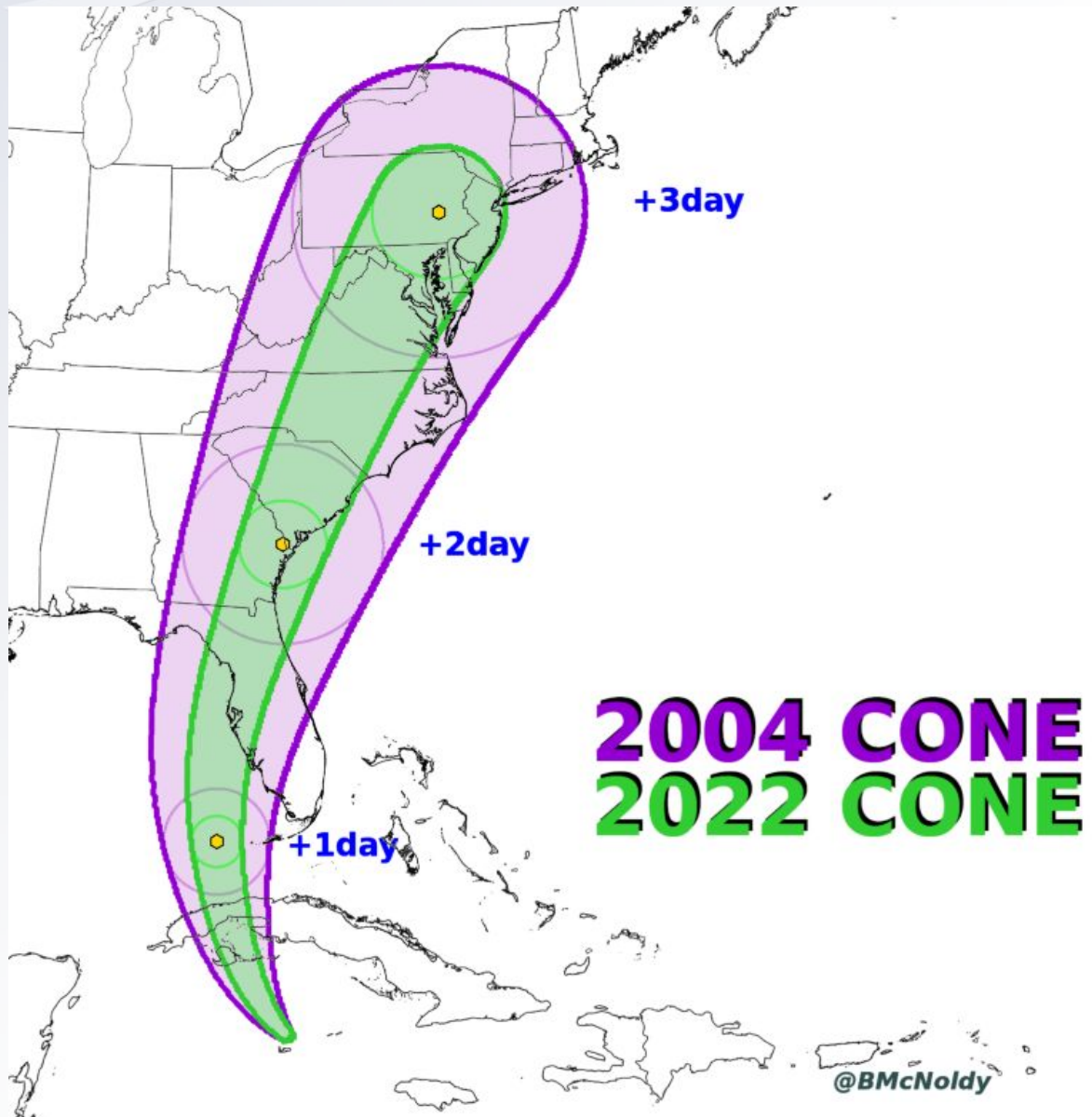
NHC Official Track Error Trend  
Atlantic Basin



Average track errors have been cut in half since 2004.

This results in about an additional day to a day in a half of predictability.

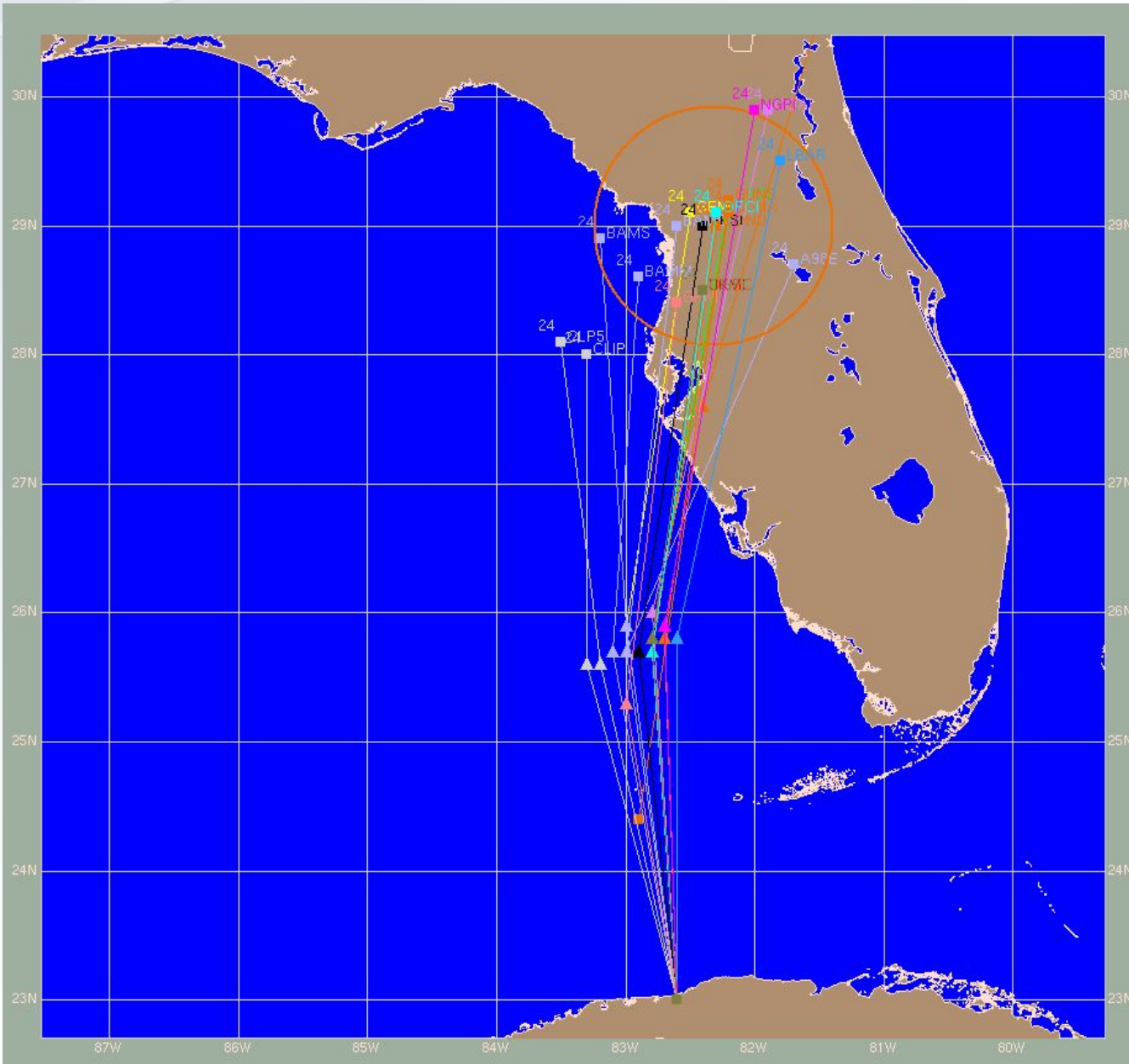
# Evolution of the NHC Forecast Cone



- Cone size decreased dramatically from its inception until the early 2010s.
- Much smaller reduction during the past decade.

# Charley Track Guidance

About 12 hour before landfall, guidance was still showing a track toward the west-central coast of Florida.



## St. Petersburg Times

WEATHER: High 85, low 76. Sun. Clear and dry. SATURDAY, August 14, 2004

# A HARD TURN

**145 MPH WINDS:** With an unexpected jog east, Hurricane Charley devastates Southwest Florida.  
**GOING HOME:** After tense day, Tampa and St. Petersburg get less than inch of rain, 30 mph winds.  
**BACK TO SEA:** Storm pummels Orlando and Daytona Beach area before heading into the Atlantic.

- 3:45 p.m. One Charley-made landfall at Sanibel Island
- 145 Estimated surface wind, in mph, at landfall
- 5 Diameter of eye, in miles, at landfall
- 28.94 Maximum sustained winds, in mph, at landfall (Hurricane Andrew was 27.23 inches)
- 7 Storm surge, in feet, at Charlotte Harbor
- 30 Estimated wind, in mph, Friday in Tampa and St. Petersburg
- 0.25 Rainfall, in inches, Friday in St. Petersburg
- \$15-billion Preliminary estimate of damage to the state
- 160 Homes destroyed in Lee County
- 1.9-million People evacuated in 11 counties Thursday
- 272 Business open statewide, as of Friday night
- 21,980 People in shelters Friday night through Saturday in Pasco, Hernando and Citrus counties
- 50 Homes boarded in Pasco after an 11-hour outage at Manatee Nuclear Station
- 5,000 National Guardsmen to be on duty in Berkeley
- 12,852 Governor ordered evacuation of Florida to leave by 10 p.m. Thursday
- 20 Charley was a Category 4



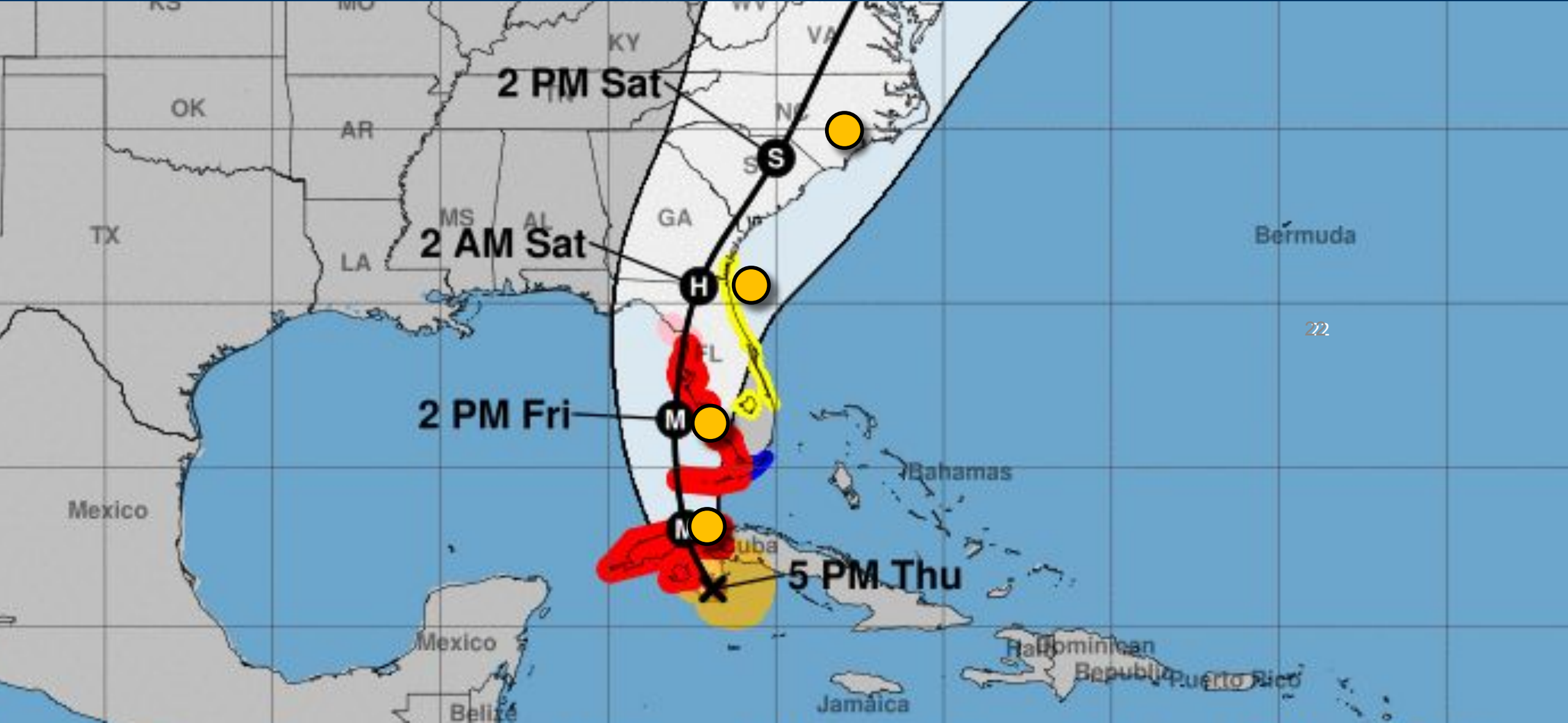
Steve Brooks looks out the window from what's left of his mobile home at a park in Punta Gorda. "It was pretty scary," said Brooks, who sheltered in his car during the worst of the storm.

**Intensity surprises southwest coast**  
**Why Charley turned**  
**Tampa Bay relieved as storm brushes by**

By JAMES THOMPSON  
 Southeastern Hillsborough County evacuated the storm, and...  
 "It was pretty scary," said Brooks, who sheltered in his car during the worst of the storm.

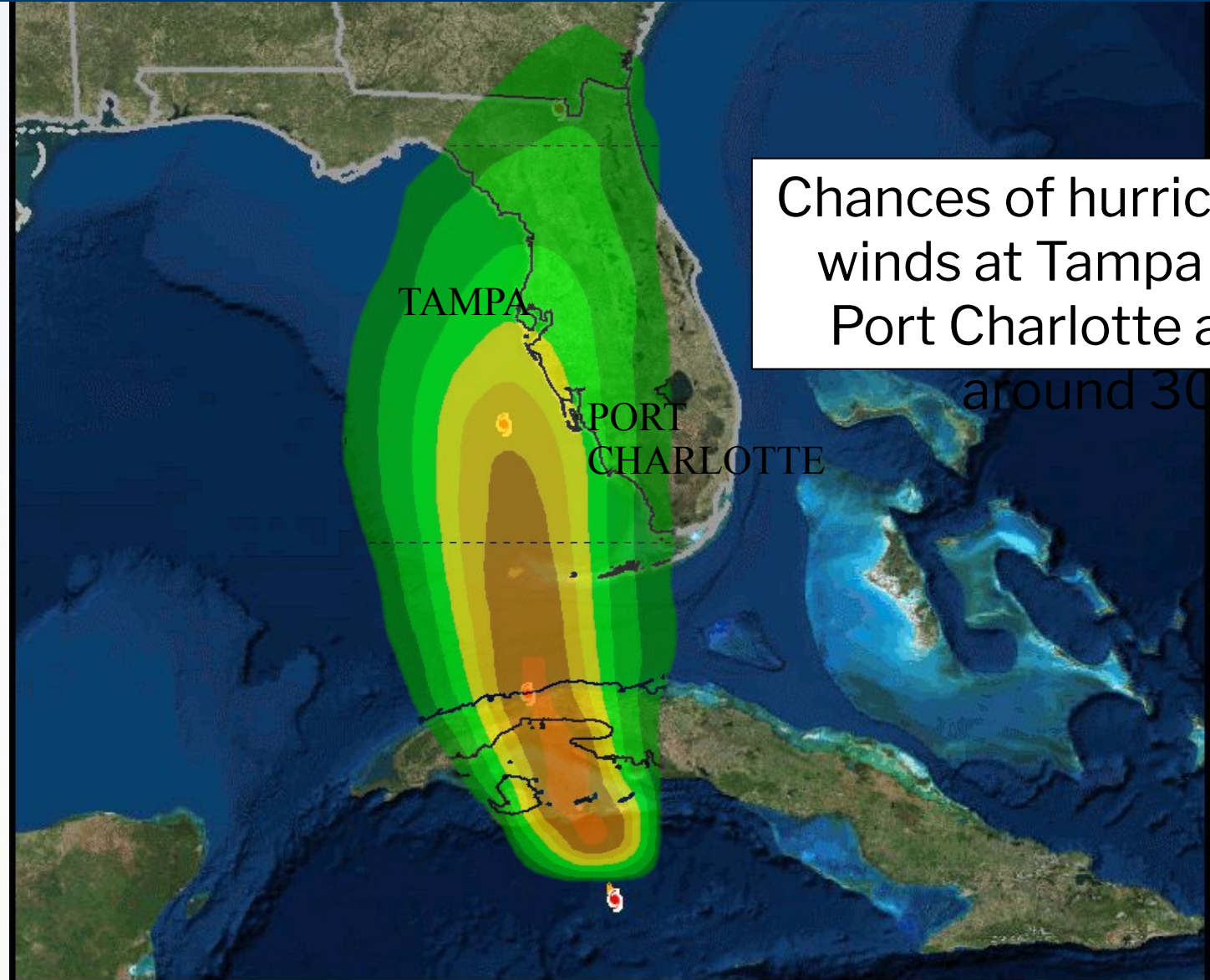
# HURRICANE CHARLEY (2004)

*Don't focus on the skinny black line.*



# HURRICANE CHARLEY

*Would alternate scenarios help?*

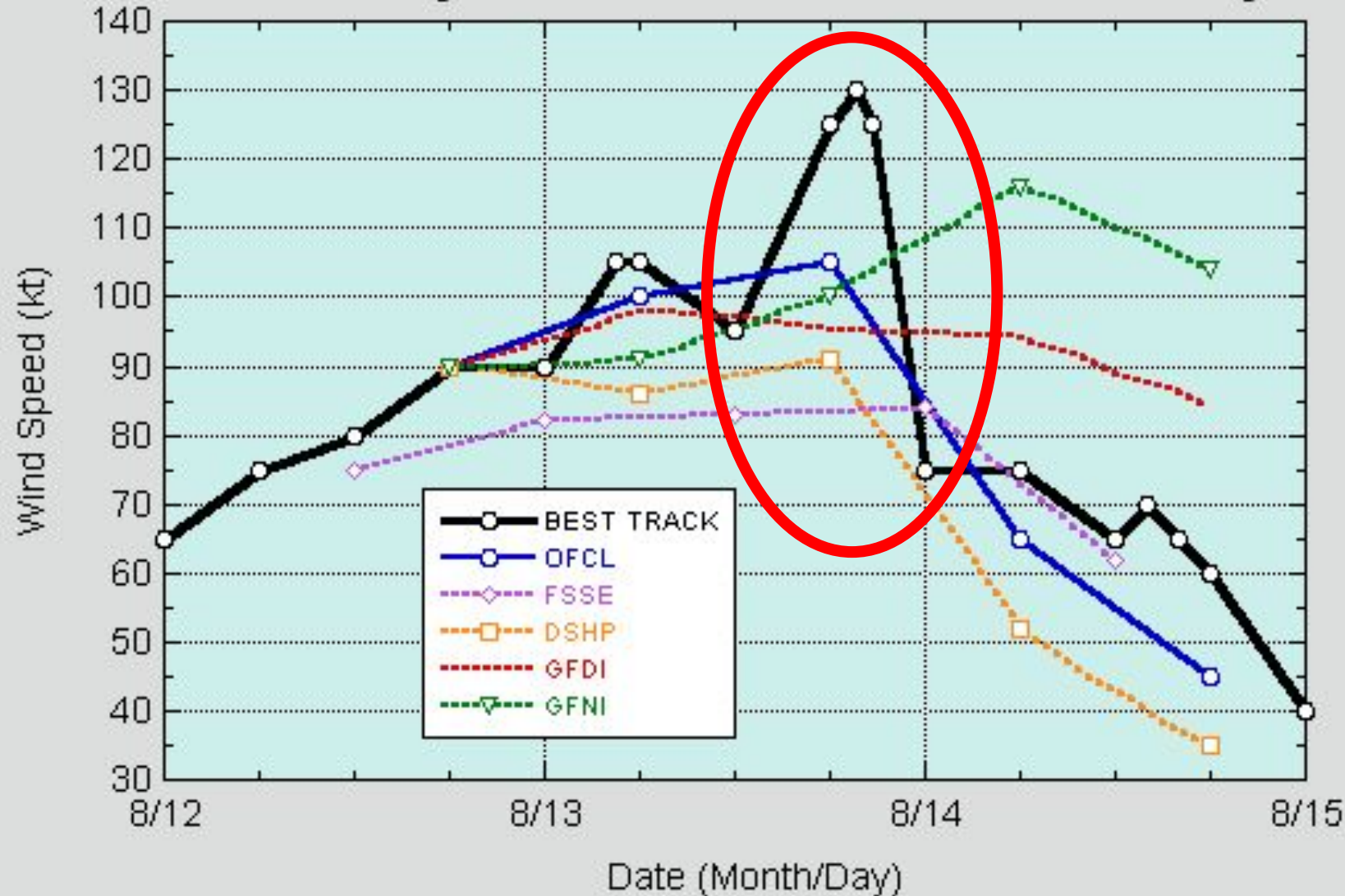


Chances of hurricane-force winds at Tampa Bay and Port Charlotte are both

around 30%

# Hurricane Charley Intensity Forecasts

## Intensity Guidance for Hurricane Charley

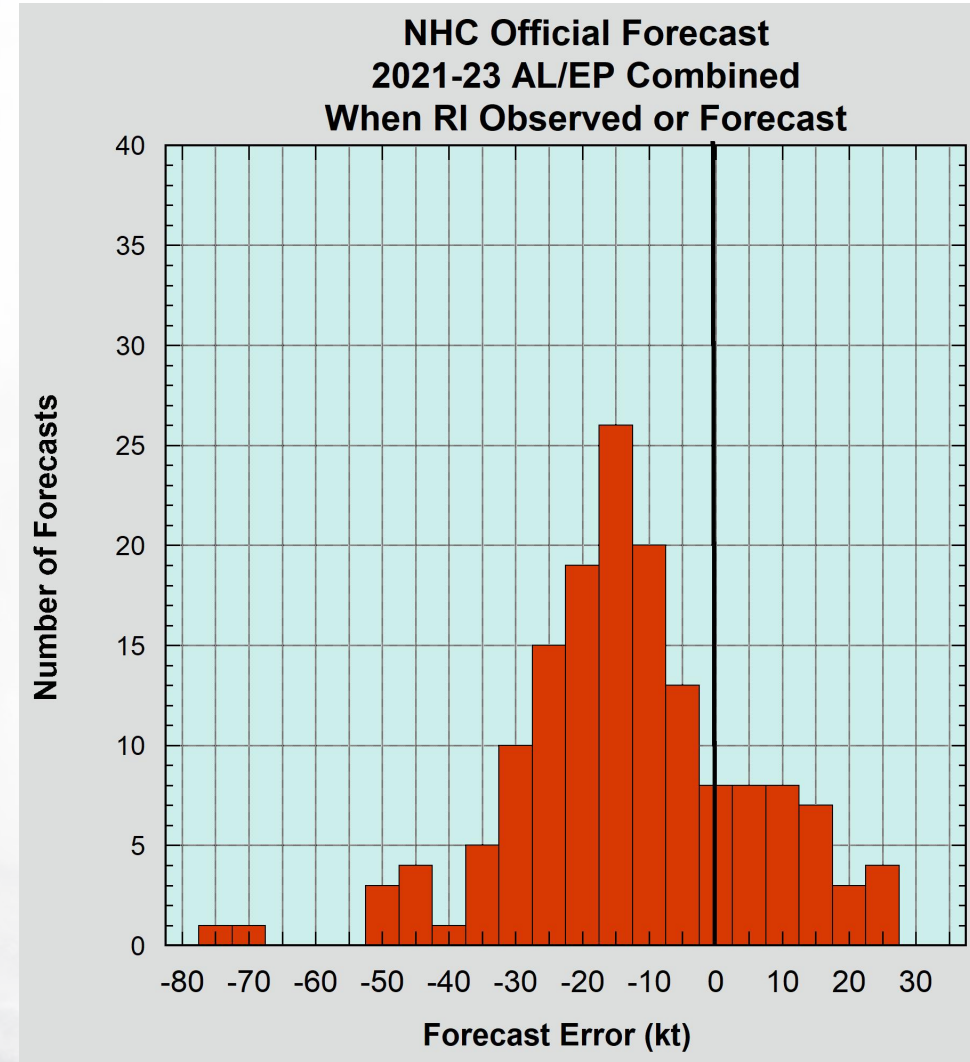
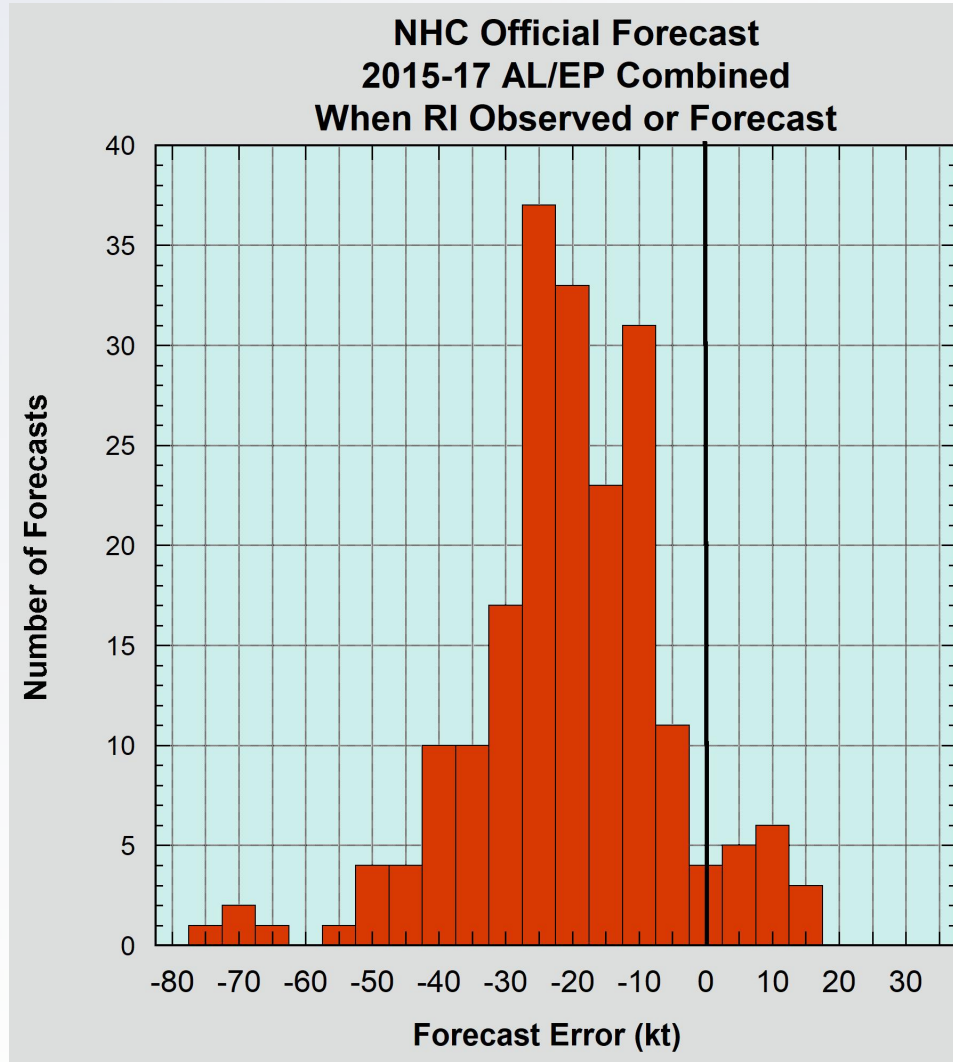


Model and official forecasts did not anticipate the rapid intensification of Charley just prior to landfall in southwest Florida.

NHC mentioned the possibility of Charley becoming a major hurricane about 36 h prior to landfall.



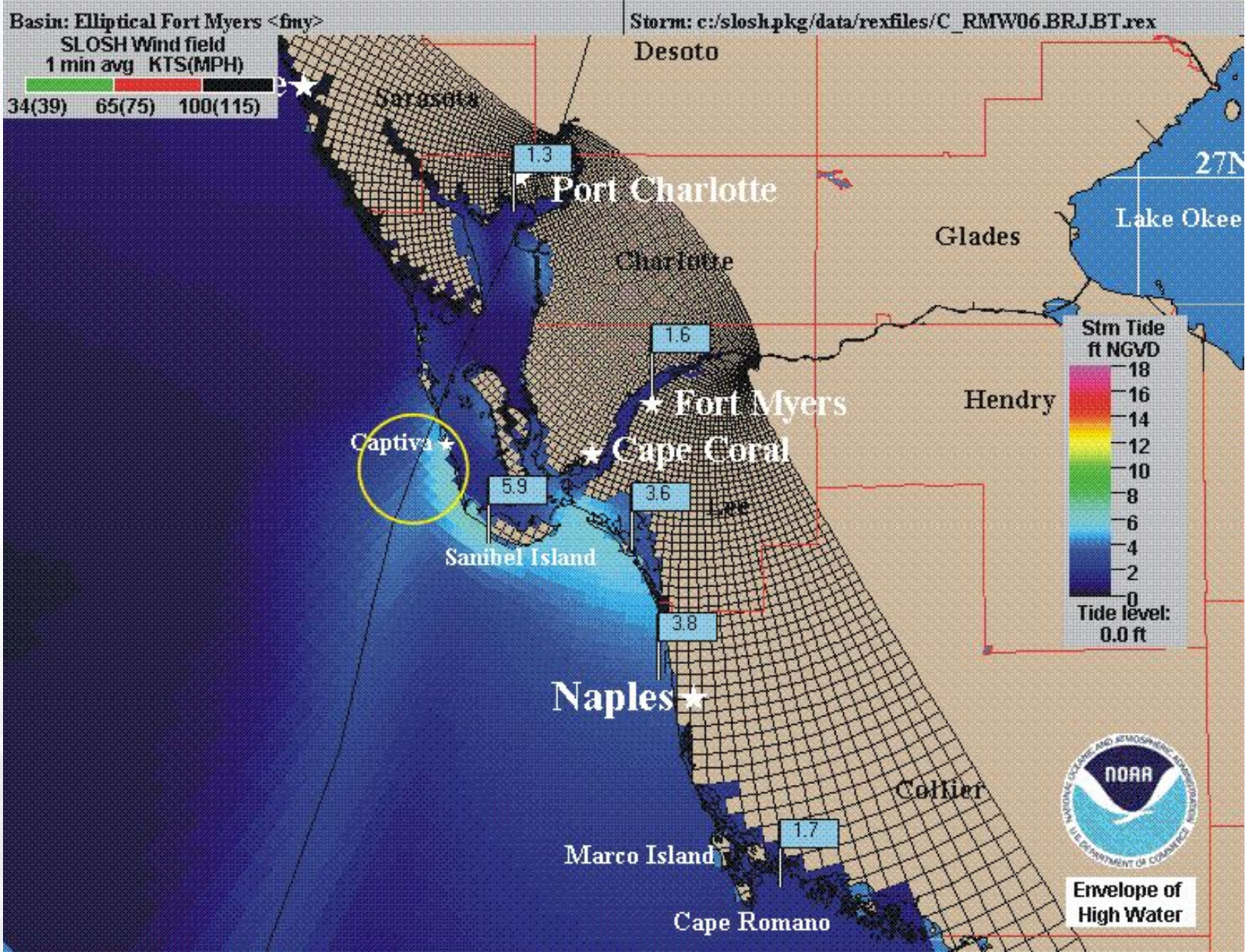
# Progress in Forecasting Rapid Intensification



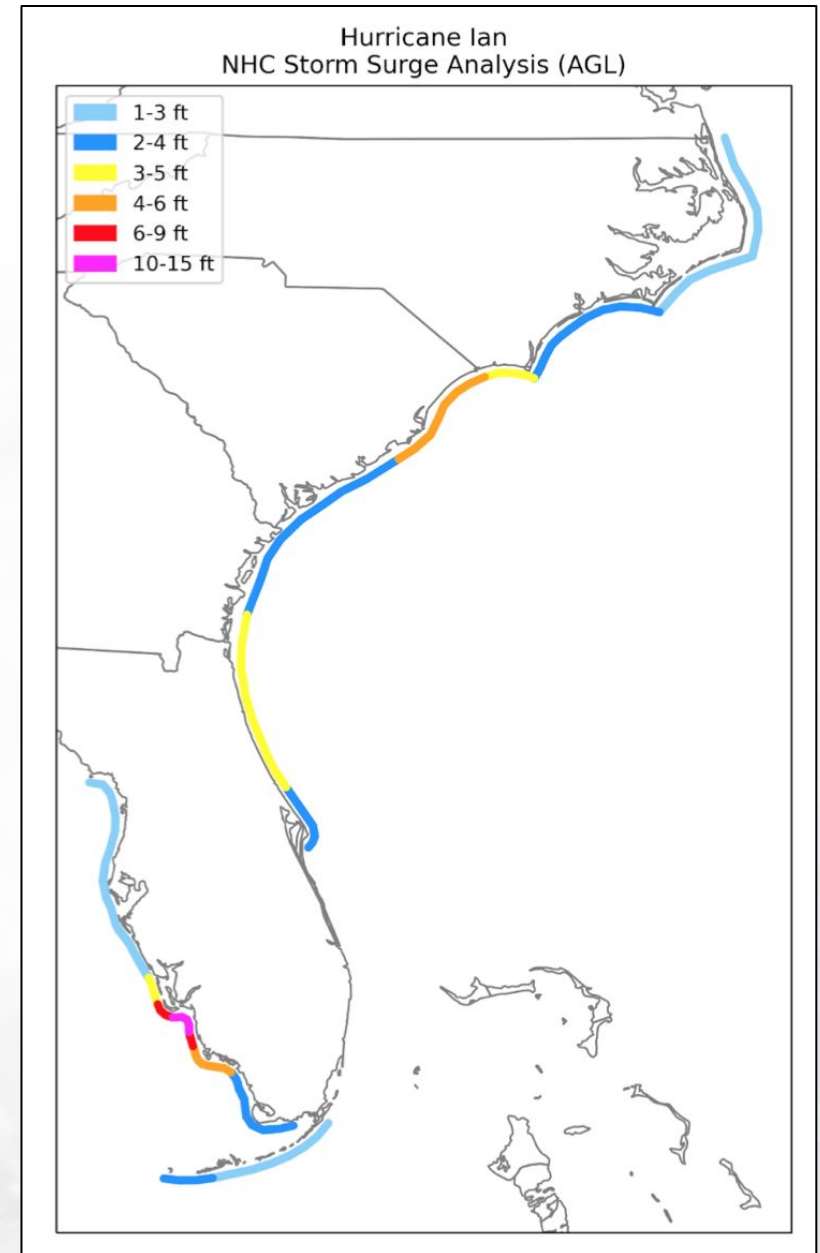
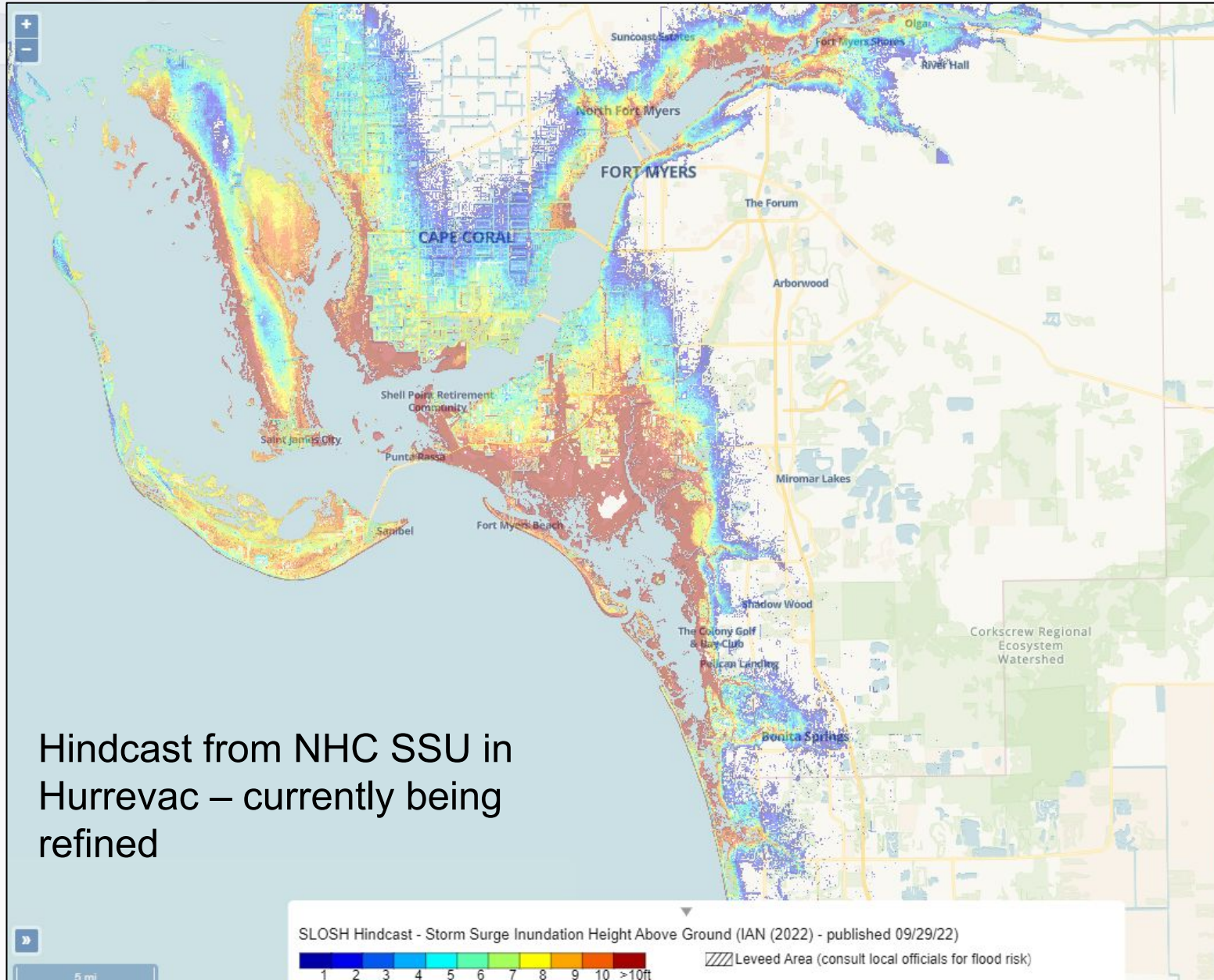
NHC's 24-h intensity forecast error during rapid intensification events has been reduced from 20 kt to 12 kt since 2015-2017

# Created After Charley to Show the Storm Surge Potential from a Similar Strength, but Bigger Storm

Potential Storm Surge Flooding Map and Storm Surge Warning introduced since 2004



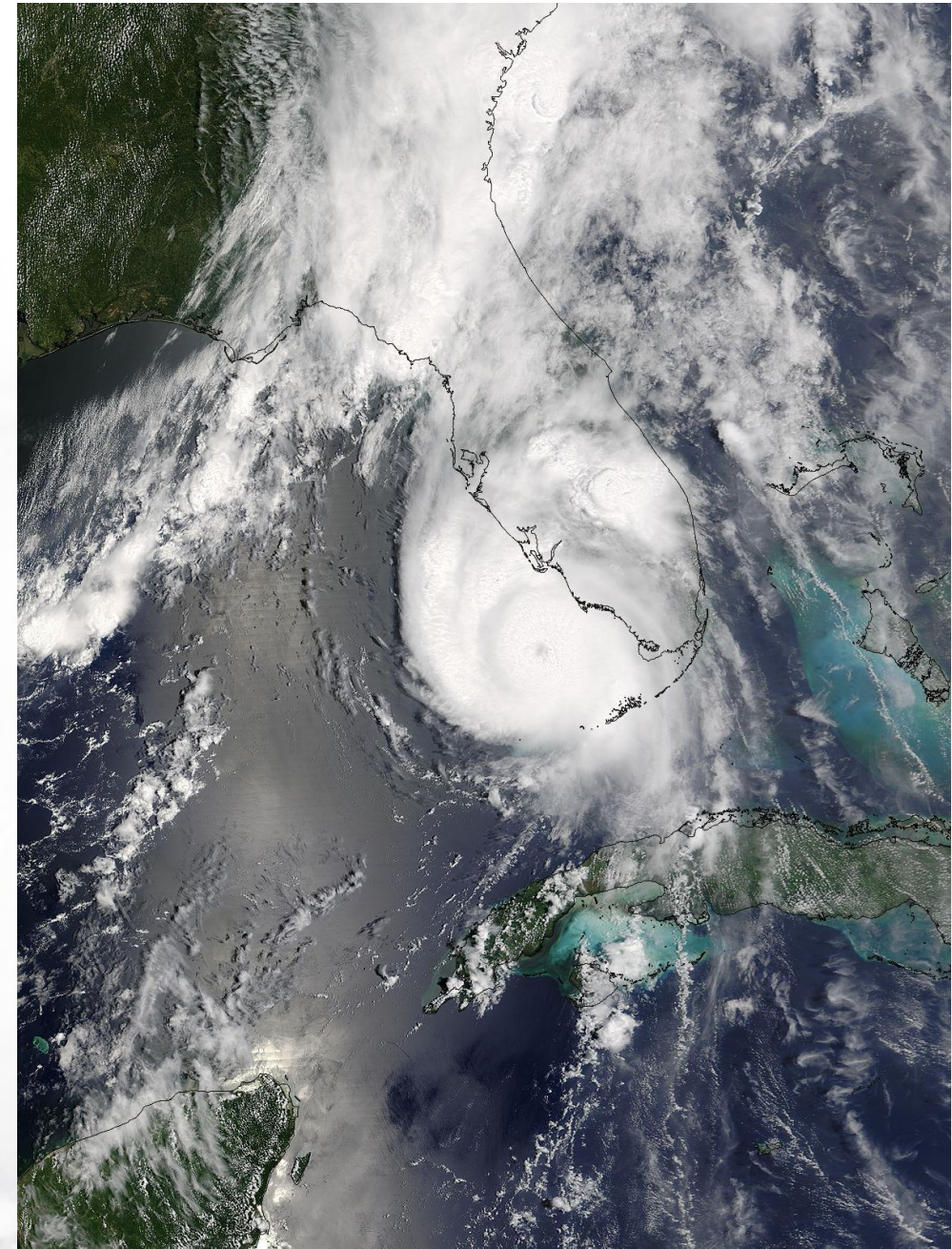
# Rough Estimate of Ian's Storm Surge Footprint



# Questions/Comments



Billy Wagner (EM), Max Mayfield (NHC Director), Richard Pasch (Hurricane Specialist), and myself on the NHC operations floor on August 11, 2004, two days before Charley's landfall.



# HURRICANE CHARLEY

*Would alternate scenarios help?*



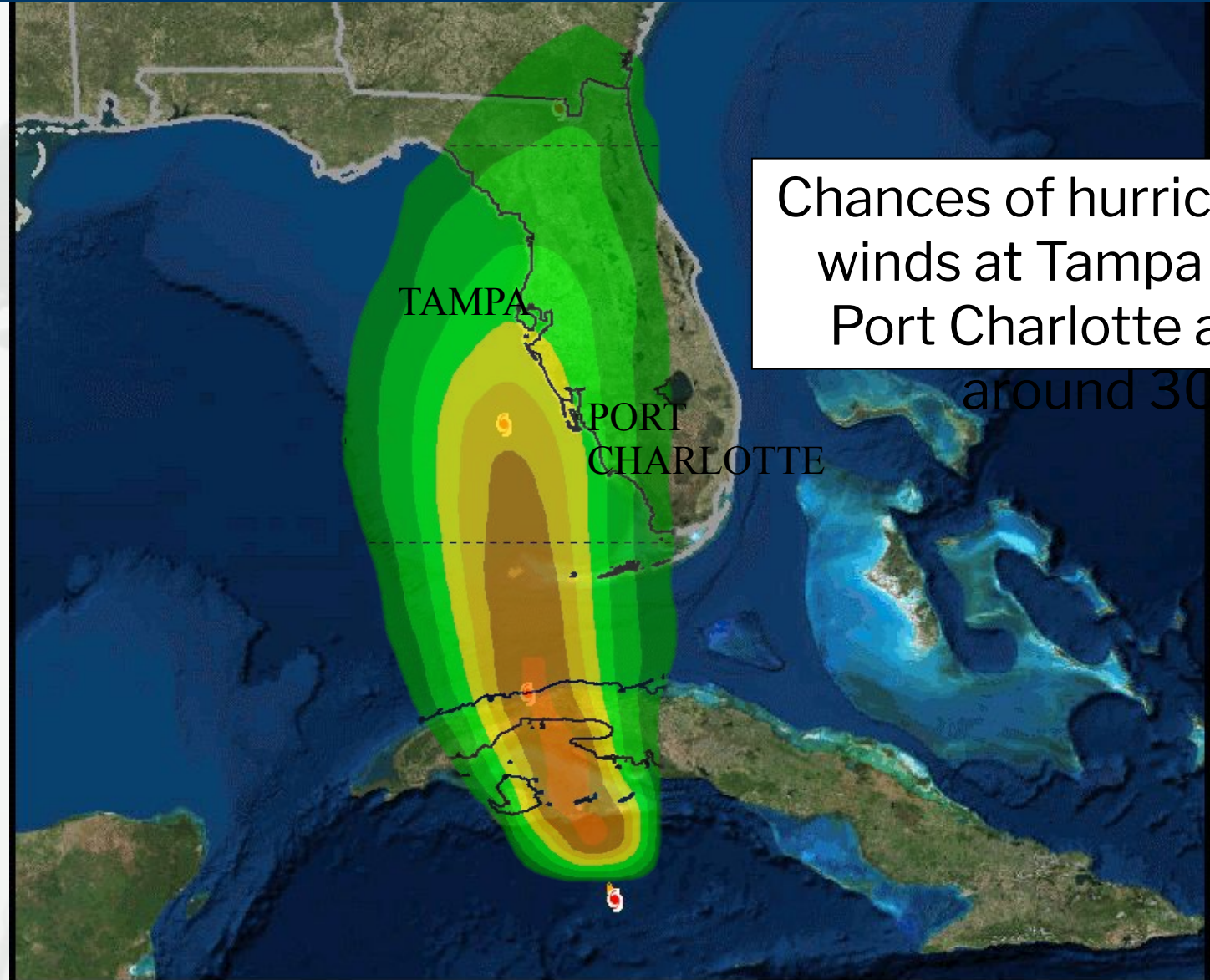
# HURRICANE CHARLEY

*Would alternate scenarios help?*



# HURRICANE CHARLEY

*Would alternate scenarios help?*



Chances of hurricane-force winds at Tampa Bay and Port Charlotte are both

around 30%

WEATHER: High 85, low 75, 60% chance of rain

SATURDAY, August 14, 2004

# A HARD TURN

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**GOING HOME:** After tense day, Tampa and St. Petersburg get less than inch of rain, 30 mph winds.

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Time Charley made landfall at Sanibel Island
- 145**  
Sustained surface wind, in mph, at landfall
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Barometric pressure, in inches, at landfall (Hurricane Andrew was 27.23 inches)
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Storm surge, in feet, at Charlotte Harbor
- 30**  
Highest winds, in mph, Friday in Tampa and St. Petersburg
- 0.25**  
Rainfall, in inches, Friday in St. Petersburg
- \$15-billion**  
Preliminary property damage estimate for the state
- 160**  
Homes destroyed in Lee County
- 1.9-million**  
People ordered to evacuate in 11 counties Thursday
- 272**  
Shelters open statewide, as of Friday night
- 21,980**  
People in shelters Friday night in Pinellas, Hillsborough, Pasco, Hernando and Citrus counties
- 50**  
Homes boarded in Pinellas shelter at Watering Park
- 5,000**  
National Guardsmen to be on duty by Sunday
- 12,852**  
Generators delivered to Florida by Lowe's since Tuesday
- 20**  
Miles Charley was from Tampa before it was upgraded to Category 4



Steve Brooks looks out from the window from what's left of his mobile home at a park in Punta Gorda. "It was pretty scary," said Brooks, who sheltered in his car during the worst of the storm.

## Intensity surprises Southwest coast

**By CHASE SQUIPES, BLAKE DENNIS, TAMARA LUSH and CRAIG FITTMAN**  
Times Staff Writers

**PUNTA GORDA** — With a Searson's hotel, Hurricane Charley slammed ashore at the mouth of Charlotte Harbor on Friday and cut a swath of destruction through Southwest and Central Florida, demolishing buildings, snapping palm trees and tossing airplanes around like toys.

The Category 4 storm pounded Lee and Charlotte counties with winds of more than 145 mph. Then it pummeled inland, wringing still more havoc.

"It was flat rocking and rolling," said R.W. "Bill" Caldwell III, a former Gulfport resident who rode out the storm on the Lee County Island community of Boca Grande. "It was absolutely ferocious."

Hardest hit was idyllic Captiva



**INSIDE**  
**VIEW OF THE DAMAGE:** Photos from Charlotte County, 13A  
**NO BUCKS GAME:** The preseason opener against the Bengals will be rescheduled for Friday or Monday, 1E  
**ON THE WEB:** Go to [www.actionnews.com](http://www.actionnews.com) to get updates on storm impact and cleanup efforts, to view reader photos (and send in your own), and to share stories on how you spent Friday.

## Tampa Bay relieved as storm brushes by

**By JAMIE THOMPSON**  
Times Staff Writer

By nightfall, Tampa Bay had one concern: Going home.

Rejoice for a punch, Pinellas and Hillsborough counties received only a glancing blow from the powerful Category 4 storm that pummeled Charlotte Harbor with 145 mph winds.

County officials lifted evacuation orders in Pinellas, Hillsborough, Pasco, Hernando, Citrus and Manatee counties on Friday evening.

Power wasn't lost, little if any damage was reported and streets didn't flood.

"We were very, very lucky," said Charlie Paxton, meteorologist with the National Weather Service.

St. Petersburg and Tampa received less than an inch of rain, and winds topped out at about 30 mph, Paxton said.

**NOTE TO OUR READERS ABOUT TODAY'S EDITION**  
We have made some changes to today's newspaper in order to provide the latest and most comprehensive coverage of Hurricane Charley. Local news and advertising from throughout our region appears within an enlarged B section. Also, today's business report appears within the A section, and we have summarized the financial market listings to make room for additional storm coverage.

**CELEBRATED CHEF JULIA CHILD DIES**  
The cookbook author and television star turned French cooking into prime-time entertainment and was a force on the culinary front for more than 40 years. She would have been 92 on Sunday, **TIME** 2, 4A



SATURDAY | AUGUST 14, 2004

BROWARD METRO EDITION

WWW.SUN-SENTINEL.COM | 35C

# 'NIGHTMARE SCENARIO'

HURRICANE CHARLEY CUTS A DESTRUCTIVE PATH ACROSS FLORIDA



**HARROWING EXPERIENCE:** Dale Wright and his wife, Roni, embrace after Hurricane Charley's winds tossed them from the second floor of their Port Charlotte town house on Friday. Staff photo/Mike Stocker

## Everyone you turn, devastation

**BY CHRISY MCKENRY**  
Times Staff Writer

**PORT CHARLOTTE** — For 45 minutes, Bill and Mary Turse, 60, huddled in one small bedroom of their home, wondering whether they would live or die.

"Metal crashed on metal. Glass broke. Bookshelves toppled.

The house groaned and creaked as the malevolent eye of Hurricane Charley passed within miles of their home, devastating much of the town.

"I just held onto him and said, please let it stop," said Mary Turse.

They emerged to total devastation. Sky where the roof used to be. Kitchen supplies flung into the bedroom. Living room furniture and all their possessions strewn around a wreckage they hardly recognized as their home.

The Turseellos and some of their neighbors had decided to ride out the storm at home, listening to the television and the radio.

"I just wanted to be close to my house, to my stuff," said

## Storm surge packs a powerful punch

In addition to high winds and powerful rain, Hurricane Charley hit the Port Charlotte area with storm surge flooding of 10-15 feet. The surge is going to be the main killer," said Max Mayfield, director of the National Hurricane Center in Miami.

Map area: **FLORIDA**

**Category 4 hurricane flood surge zone**

**Winds of eye: 7 miles**

**Map area:** Venice, Sarasota, Northport, Port Charlotte, Punta Gorda, Charlotte Harbor, Citrus County, Cape Coral, Ft. Myers, Lee County.

Surge waves have been known to reach 5-10 feet above storm surge.

**CHARLEY'S LANDFALL 3:45 P.M.**

**HOW STORM SURGE FORMS**  
The heaviest flooding occurs on the inner side of the hurricane.

The surge strikes the coastline near where the hurricane's eye makes landfall.

**STORM SURGE CARRIES THE MOST DANGER, 24A**

The dome of water is pulled upward by the storm's low pressure and can measure 100 miles wide.

Source: NOAA National Hurricane Center, Florida Emergency Management

Staff photo/Steve Heston/epic; David Niblick; R. Scott Horner

## Damage estimates put at \$15 billion; at least 3 die in storm

**BY KEN KAYE AND LINDA KLEINHEIM**  
Times Staff Writers

Hurricane Charley gut-punched Gulf Coast towns with 145-mph winds and a devastating storm surge, then chewed up the homes and businesses of thousands of people as it sliced its way through the archipelago and amusement park playgrounds of Orlando on Friday night heading for Daytona Beach and more nourishment in the Atlantic Ocean.

"This is the nightmare scenario that we've been talking about for years," said Max Mayfield, director of the National Hurricane Center in Miami-Dade County.

The first estimates of damage came in at a staggering \$15 billion. At least three people died.

By 11 p.m. Friday, Charley had charged through Orlando with 100-mph gusts and a deluge of rain and was 10 miles southwest of Daytona Beach, hurtling forward at 25 mph. Hurricane warnings were posted all the way up to the North Carolina coast.

It was the state's most catastrophic hurricane since Andrew left \$40 billion in damage (adjusted to 2004 dollars), mostly in south Miami-

**SPECIAL HURRICANE SECTION**  
PAGE 21A

**ONLINE**  
For up-to-the-minute updates on tropical weather, visit [sun-sentinel.com](http://sun-sentinel.com)

**Julia Child**  
1912-2004  
America's favorite French chef dies at 91.  
**OBITUARIES, 7B**

**IRAQ WAR**  
Truce halts offensive against cleric al-Sadr's forces in Najaf. **13A**

**VICTIMS MOURNED**  
Three boys who died in a turnpike crash are laid to rest. **1B**

**HYDE ON OLYMPICS**  
Opening Ceremonies are Greek theater without the drama. **1C**

**INDEX**  
SPORTS  
BUSINESS  
ENTERTAINMENT  
CLASSIFIEDS  
ADVERTISING





# Looking Back at the 2004 Hurricane Season

## Hurricane Ivan

Bonnie  
Aug 11, 2004  
3:15pm EDT

Charley  
Aug 13, 2004  
2:55pm EDT

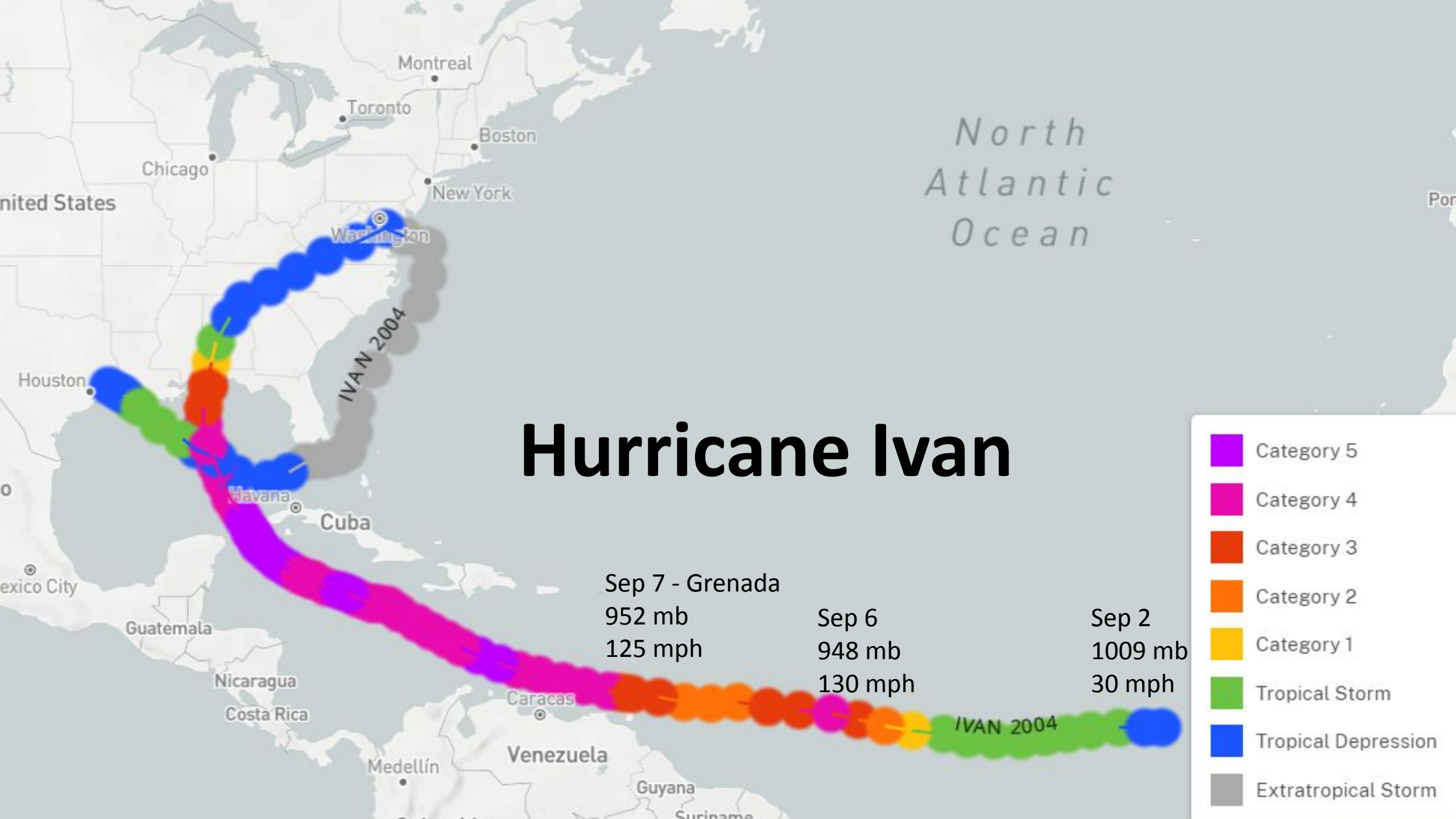
Jeanne  
Sep 24, 2004  
3:15pm EDT

Frances  
Sep 01, 2004  
3:15pm EDT

Ivan  
Sep 11, 2004  
3:15pm EDT

John Cangialosi  
National Hurricane Center





# Hurricane Ivan

- Category 5
- Category 4
- Category 3
- Category 2
- Category 1
- Tropical Storm
- Tropical Depression
- Extratropical Storm

Sep 7 - Grenada  
952 mb  
125 mph

Sep 6  
948 mb  
130 mph

Sep 2  
1009 mb  
30 mph

IVAN 2004

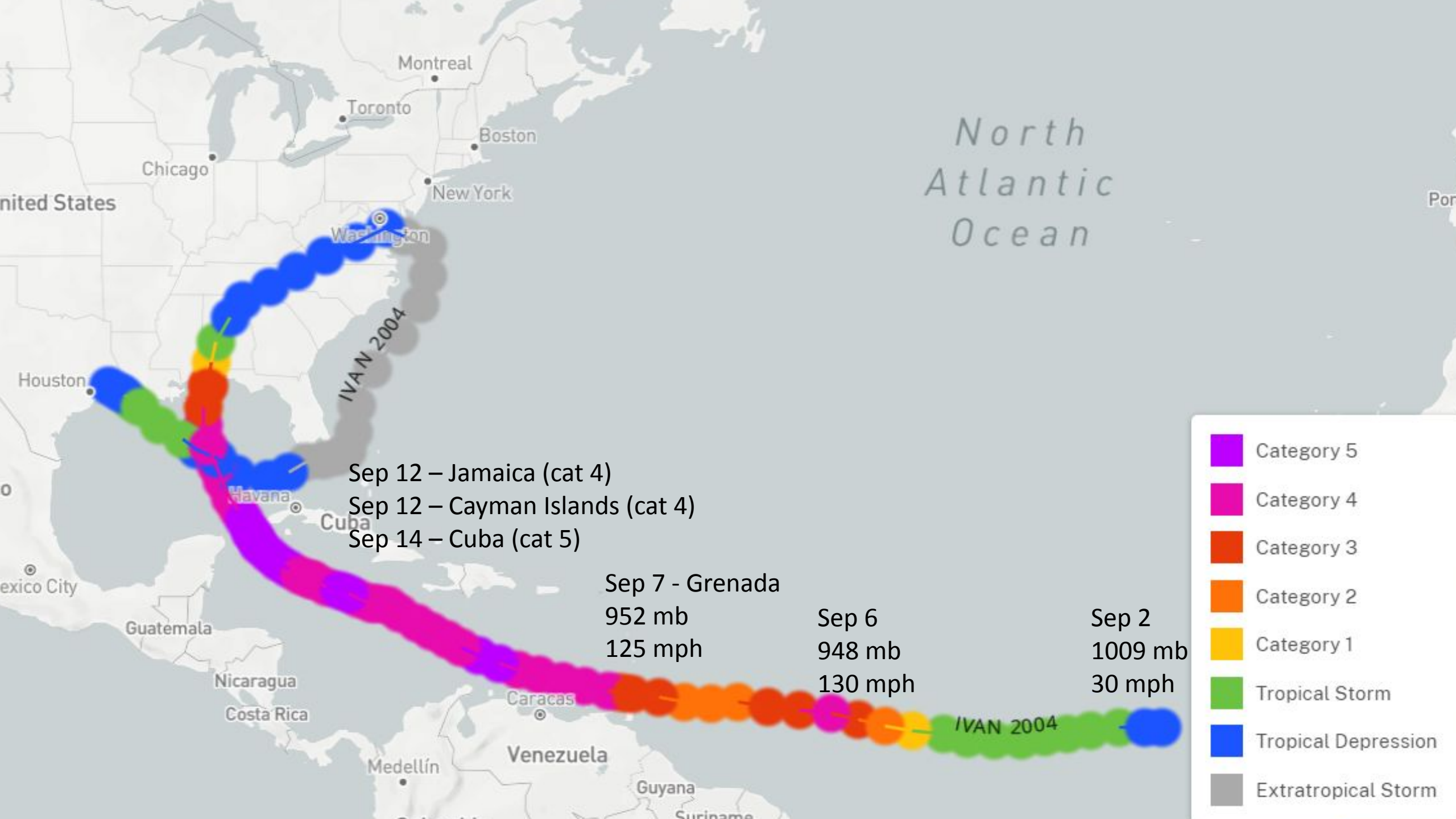
IVAN 2004

North  
Atlantic  
Ocean

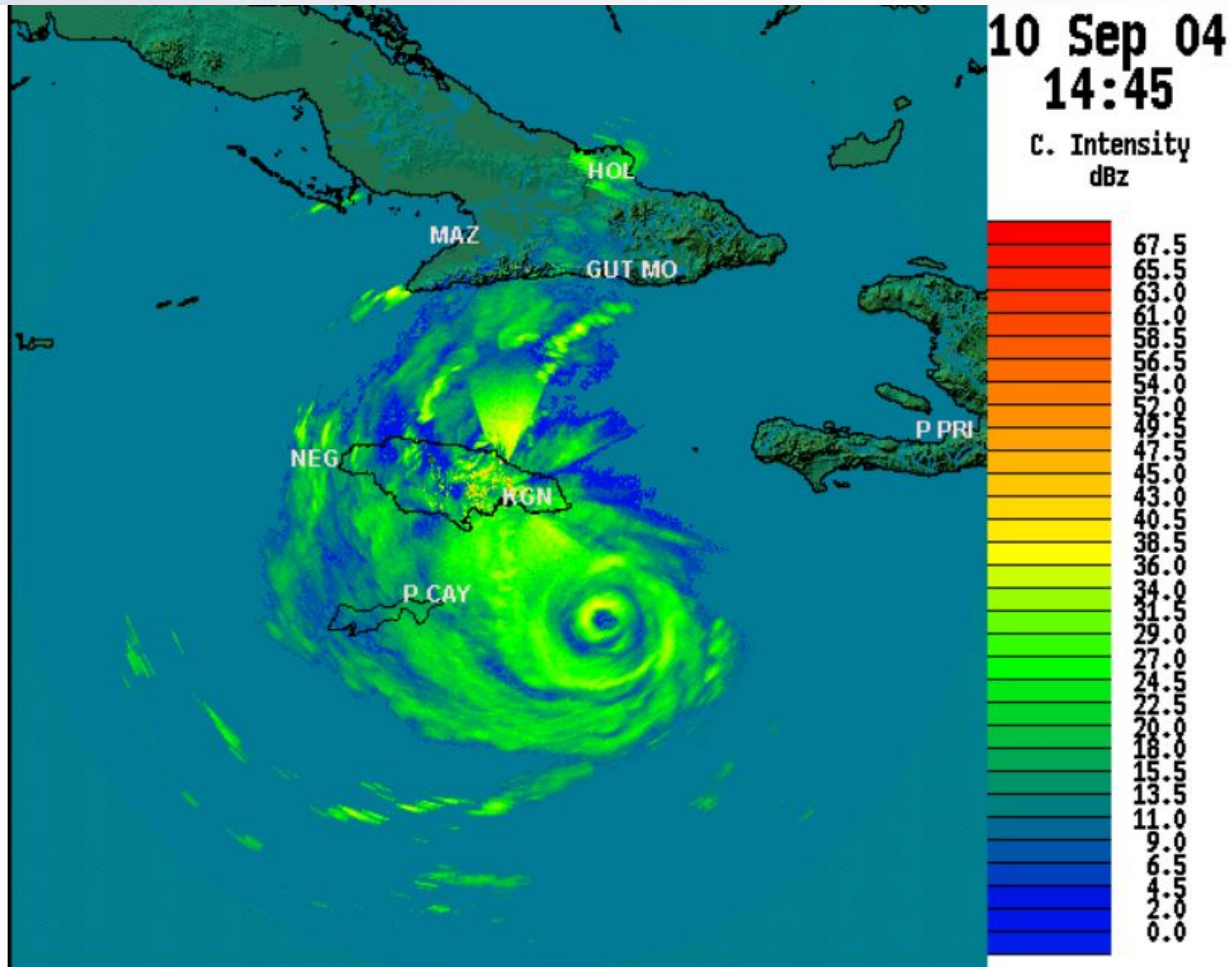
# Grenada Strike



- 39 fatalities
- More than 14,000 homes were destroyed
- ~ 80% of the nutmeg trees were destroyed
- 17th century prison was damaged allowing many of the inmates to briefly escape
- Ivan was the worse hurricane to strike the island since Hurricane Janet in 1955



# Jamaica/Cayman Island Strikes

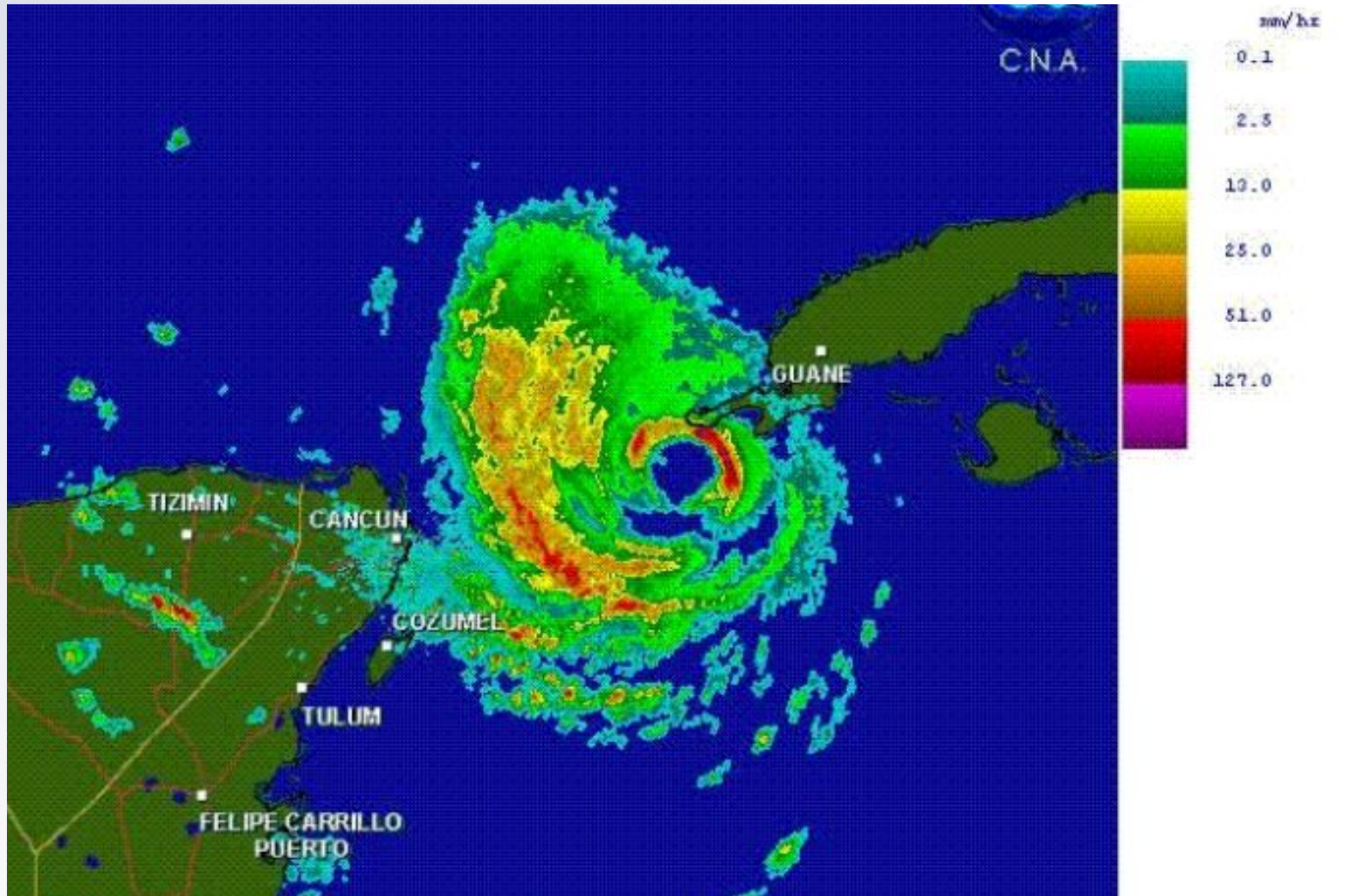


- Eye passed 20 miles south of the Jamaica, ~50,000 homes damaged/destroyed. 17 fatalities
- Eye passed 22 miles south of Grand Cayman, ~95% of the homes damaged/destroyed. 2 fatalities

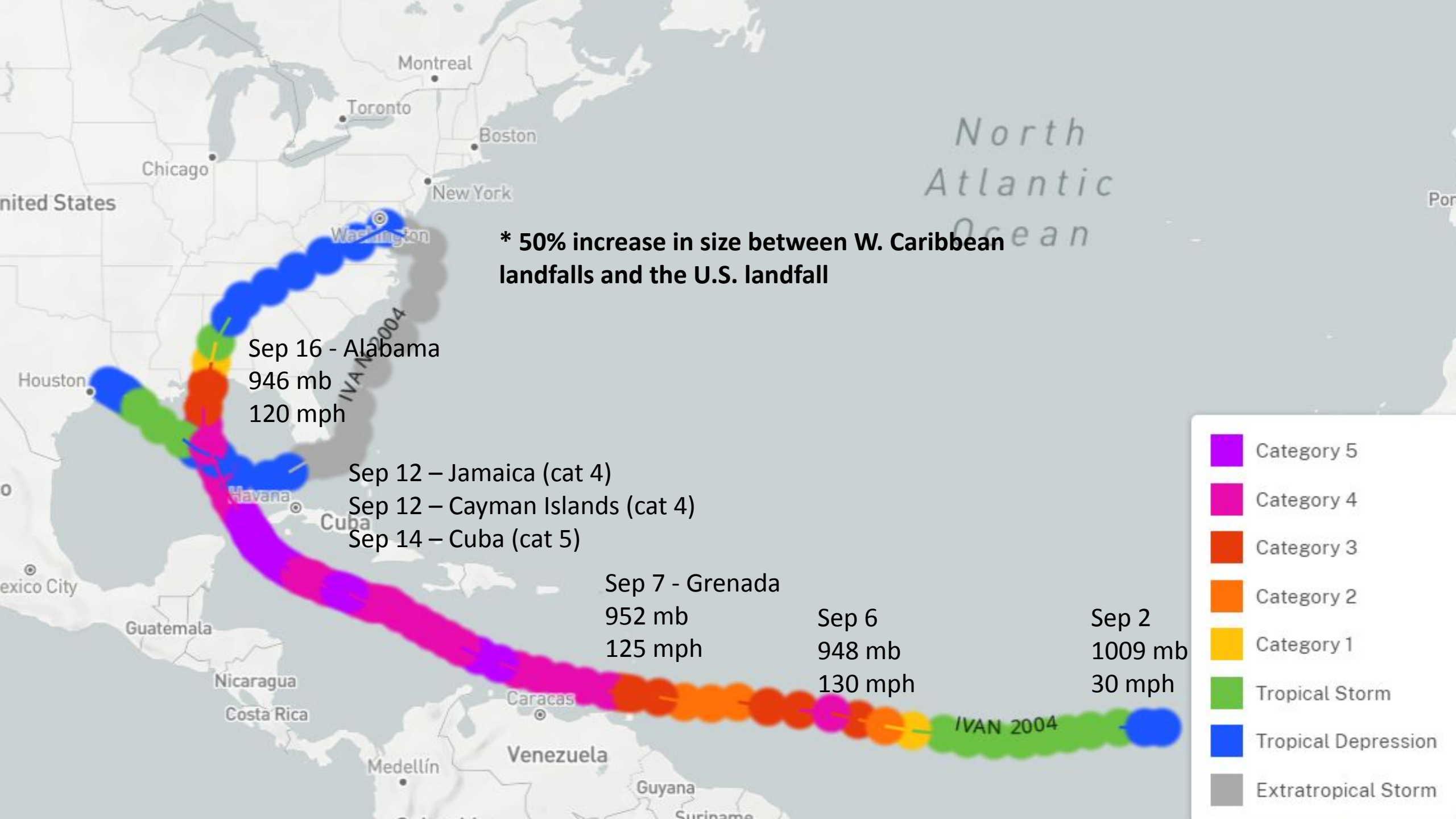


*Cayman Islands*

# Cuba Strike



- Eye passed 15 miles southwest of Cabo San Antonio
- ~\$ 1.1 billion in damage



**\* 50% increase in size between W. Caribbean landfalls and the U.S. landfall**

Sep 16 - Alabama  
946 mb  
120 mph

Sep 12 - Jamaica (cat 4)  
Sep 12 - Cayman Islands (cat 4)  
Sep 14 - Cuba (cat 5)

Sep 7 - Grenada  
952 mb  
125 mph

Sep 6  
948 mb  
130 mph

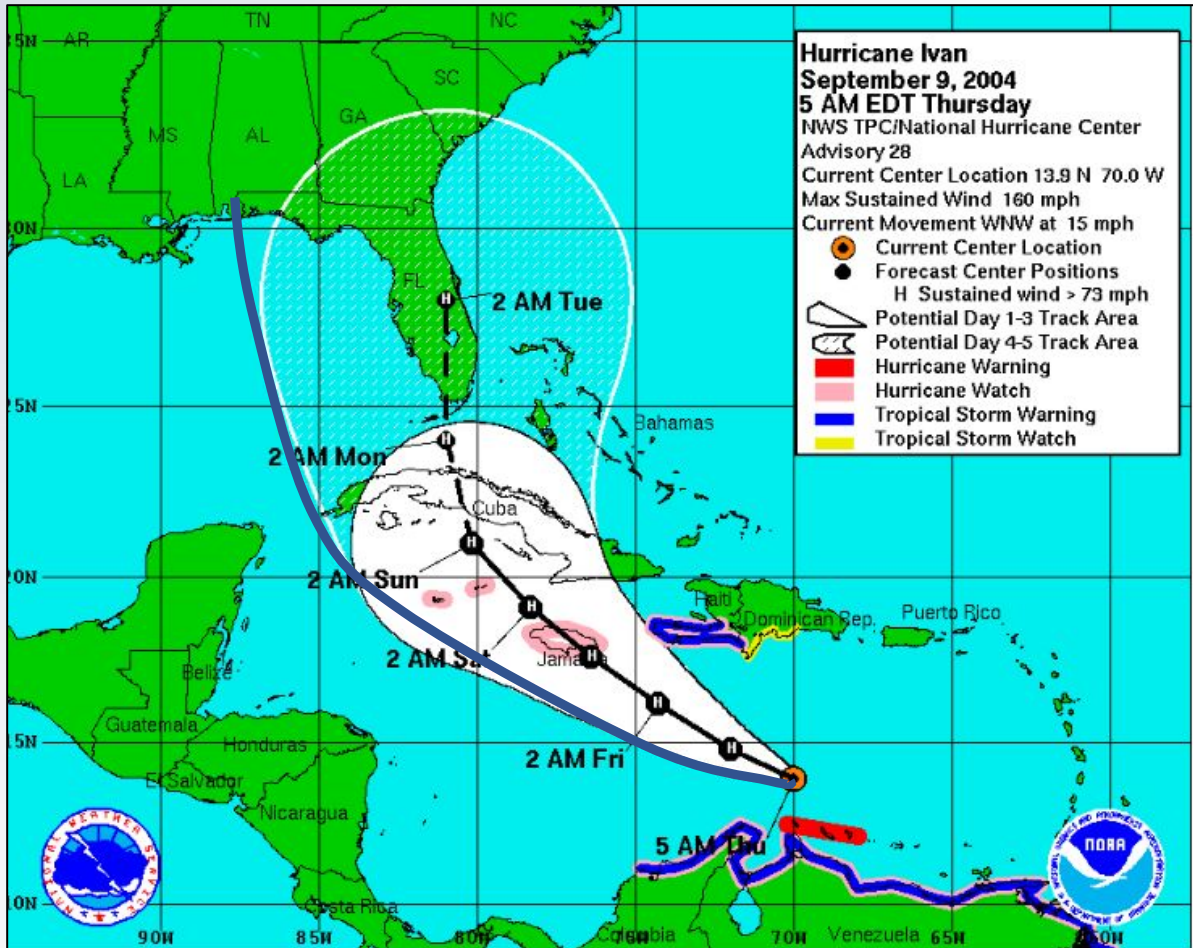
Sep 2  
1009 mb  
30 mph

- Category 5
- Category 4
- Category 3
- Category 2
- Category 1
- Tropical Storm
- Tropical Depression
- Extratropical Storm

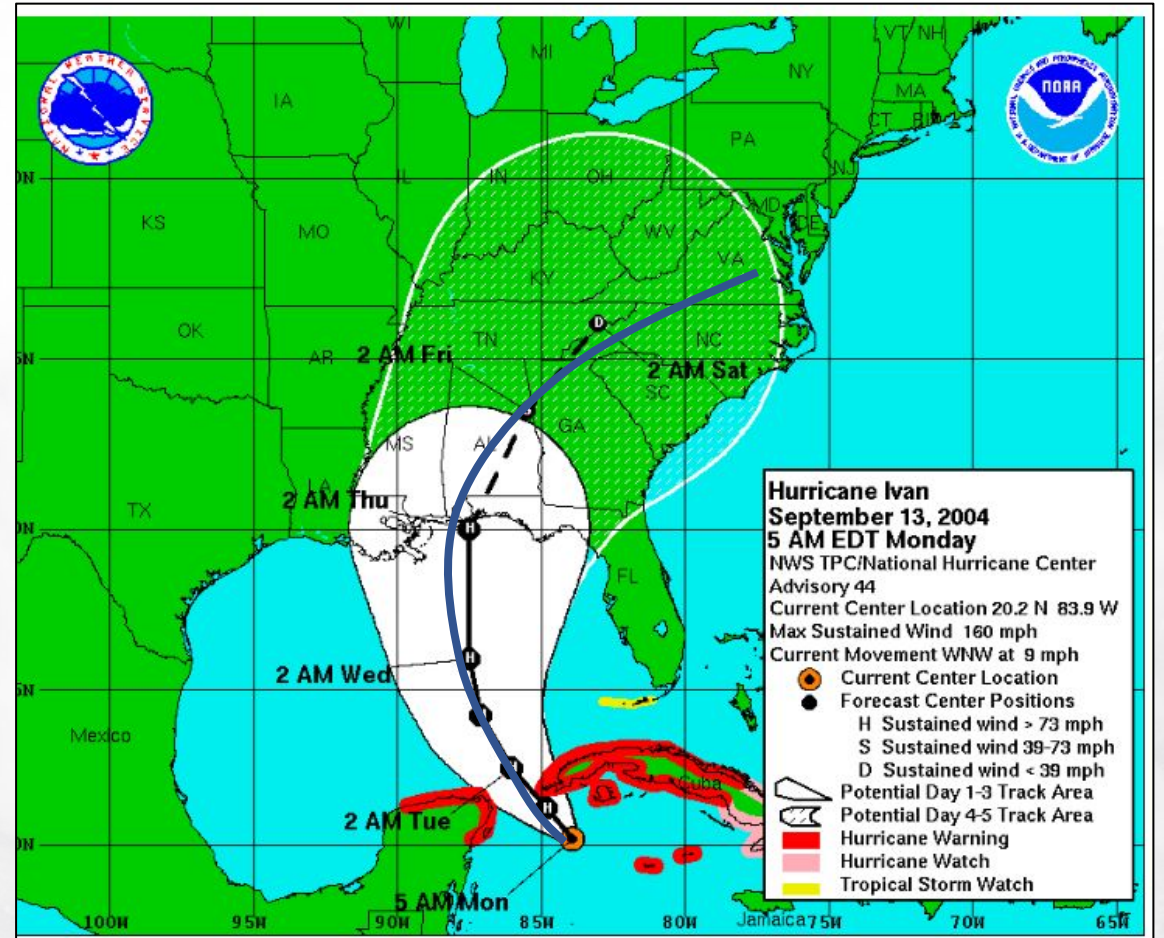
North Atlantic Ocean

IVAN 2004

# NHC Forecast



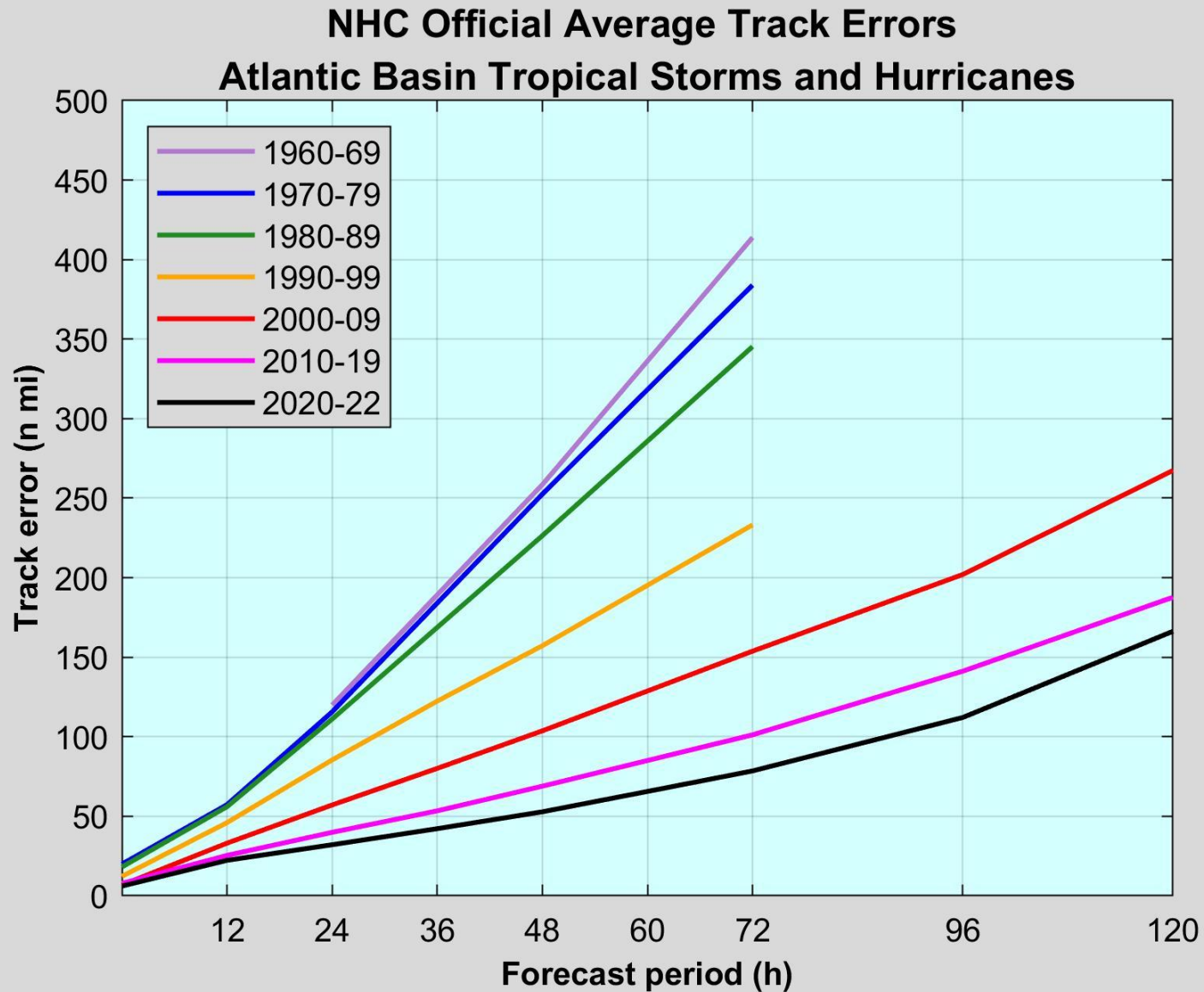
Sep 9 - 5 am (Adv 28)



Sep 13 - 5 am (Adv 44)

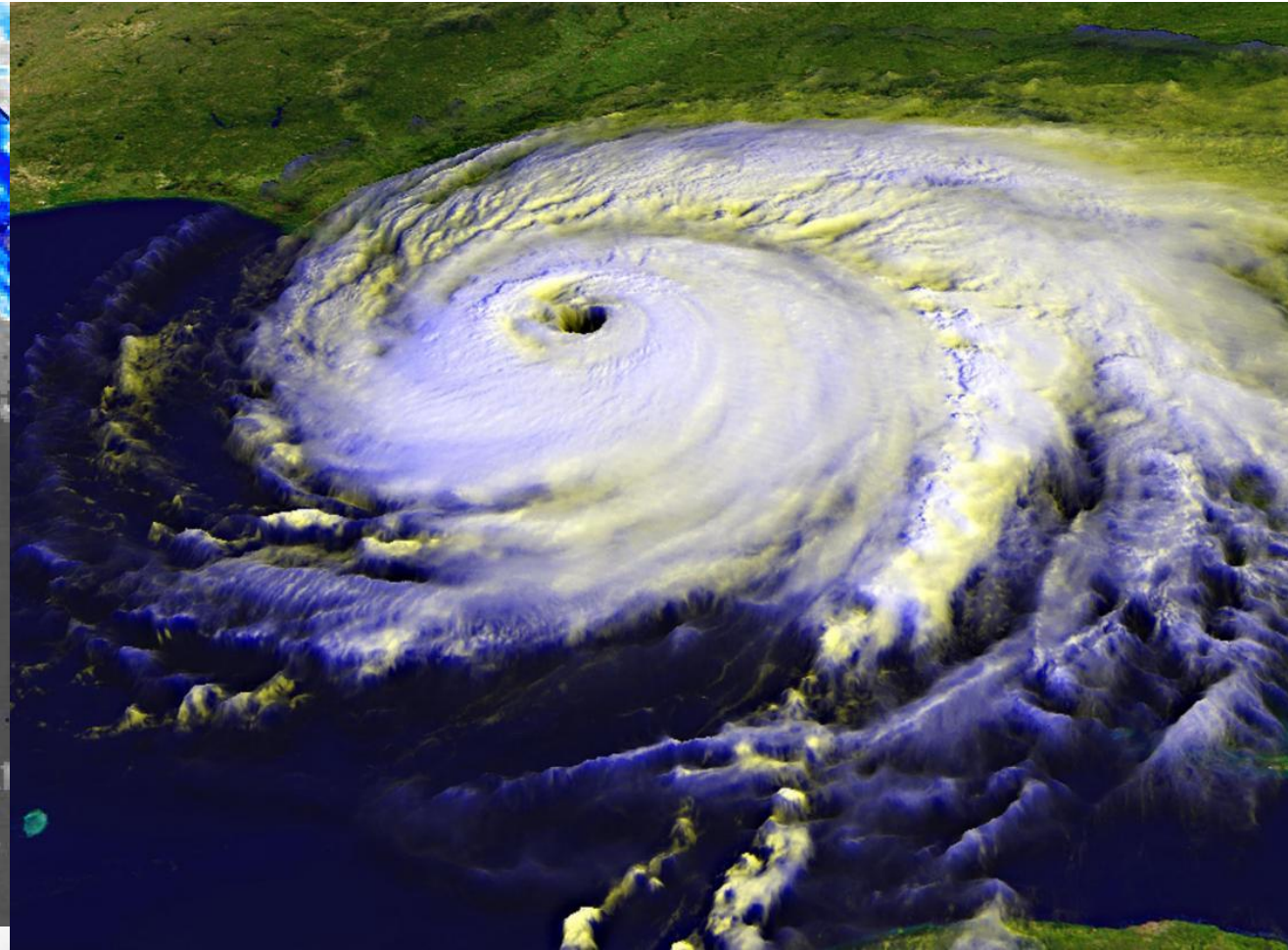
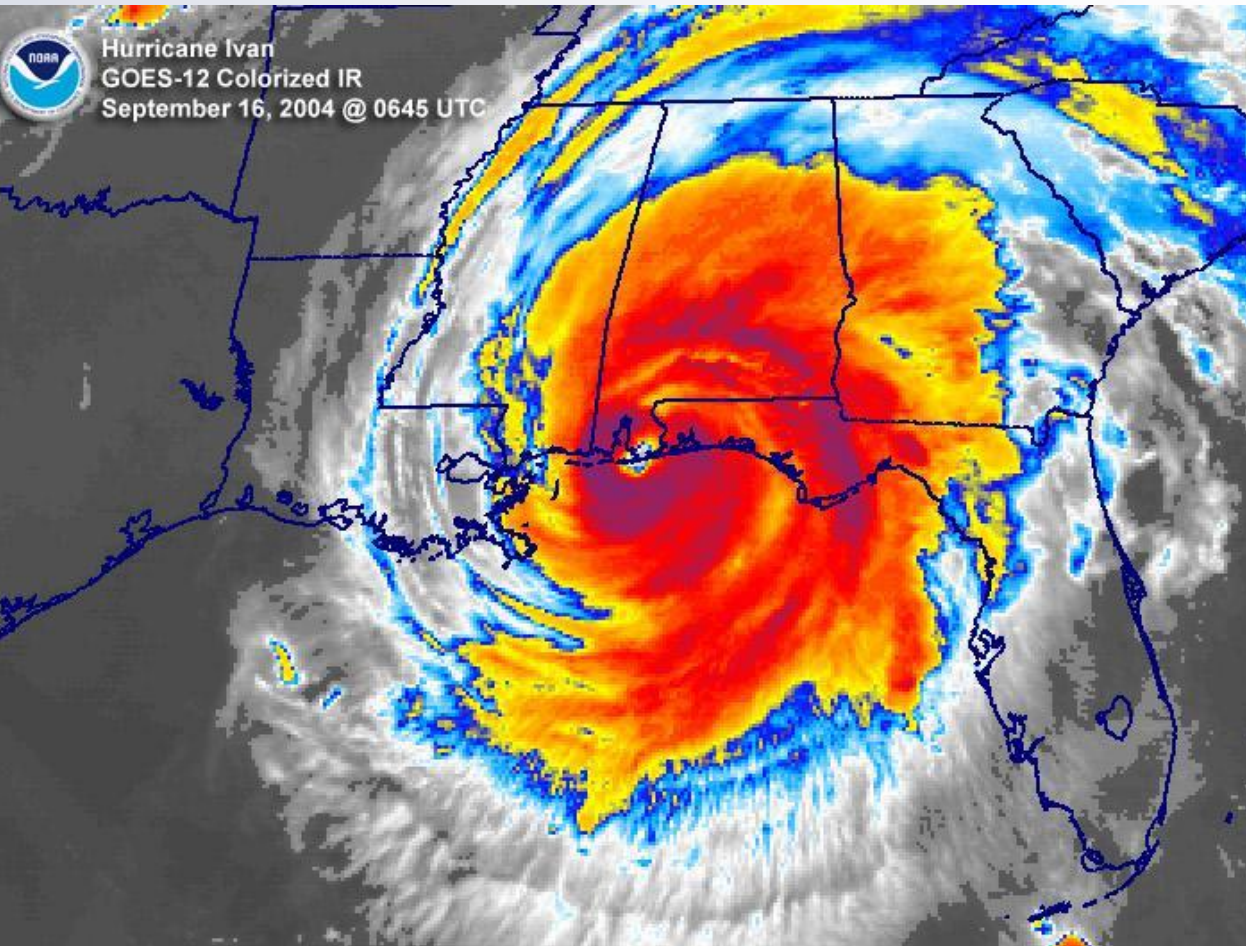


# Track Forecasting Progress



NHC track errors are 40-50% lower now than they were then!

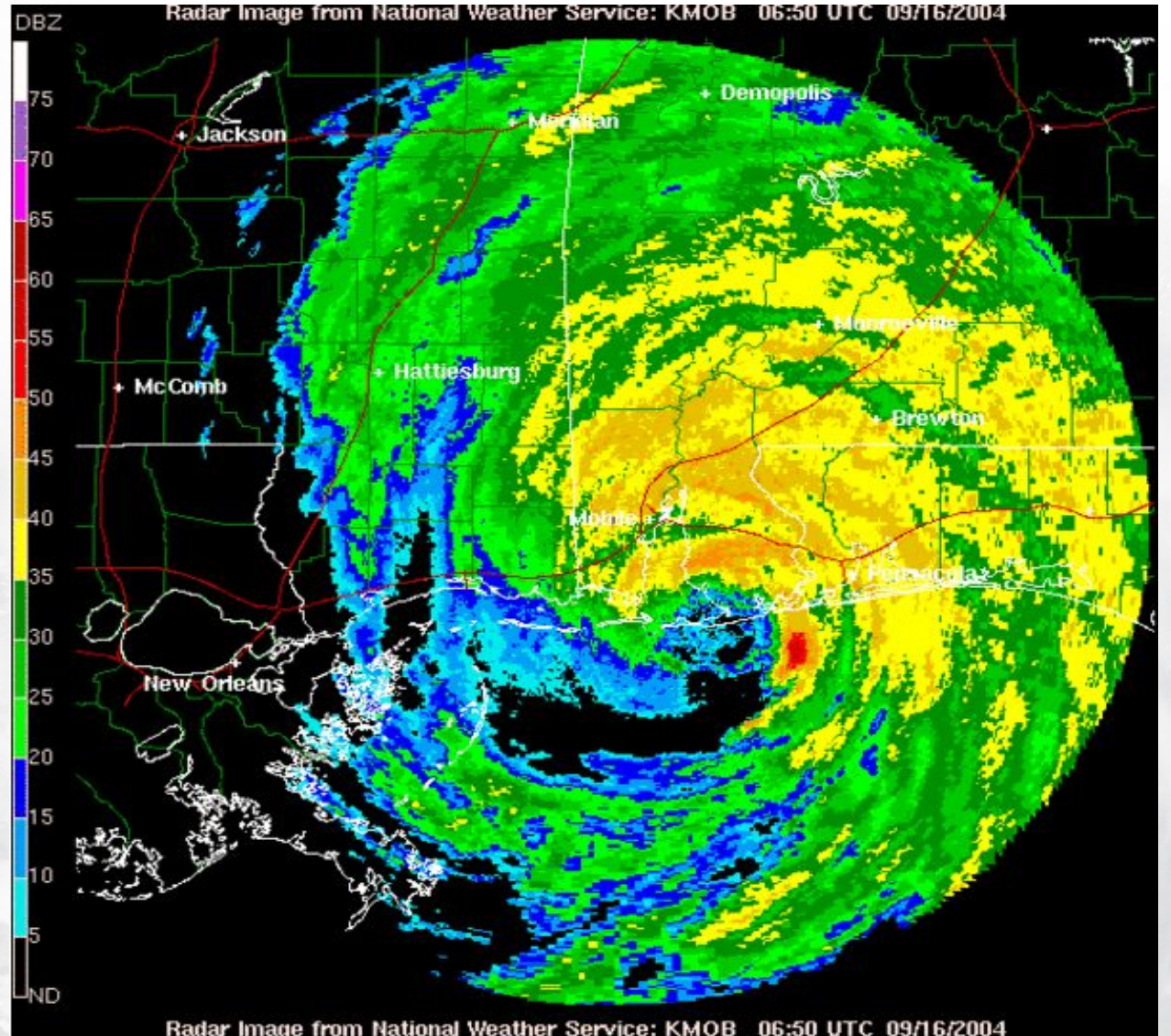
# Hurricane Ivan at the Alabama Landfall



*Official Landfall – Pine Island Beach, Alabama  
Category 3 – 120 mph winds  
0650 UTC 16 September*

# U.S. Impacts

- - *Ivan The Terrible*
- 25 direct fatalities – 14 in FL, 8 in NC, 2 in GA, and 1 in MS
- 32 indirect fatalities
- ~32 billion dollars of damage due to the combination of storm surge, inland flooding, wind damage and tornadoes

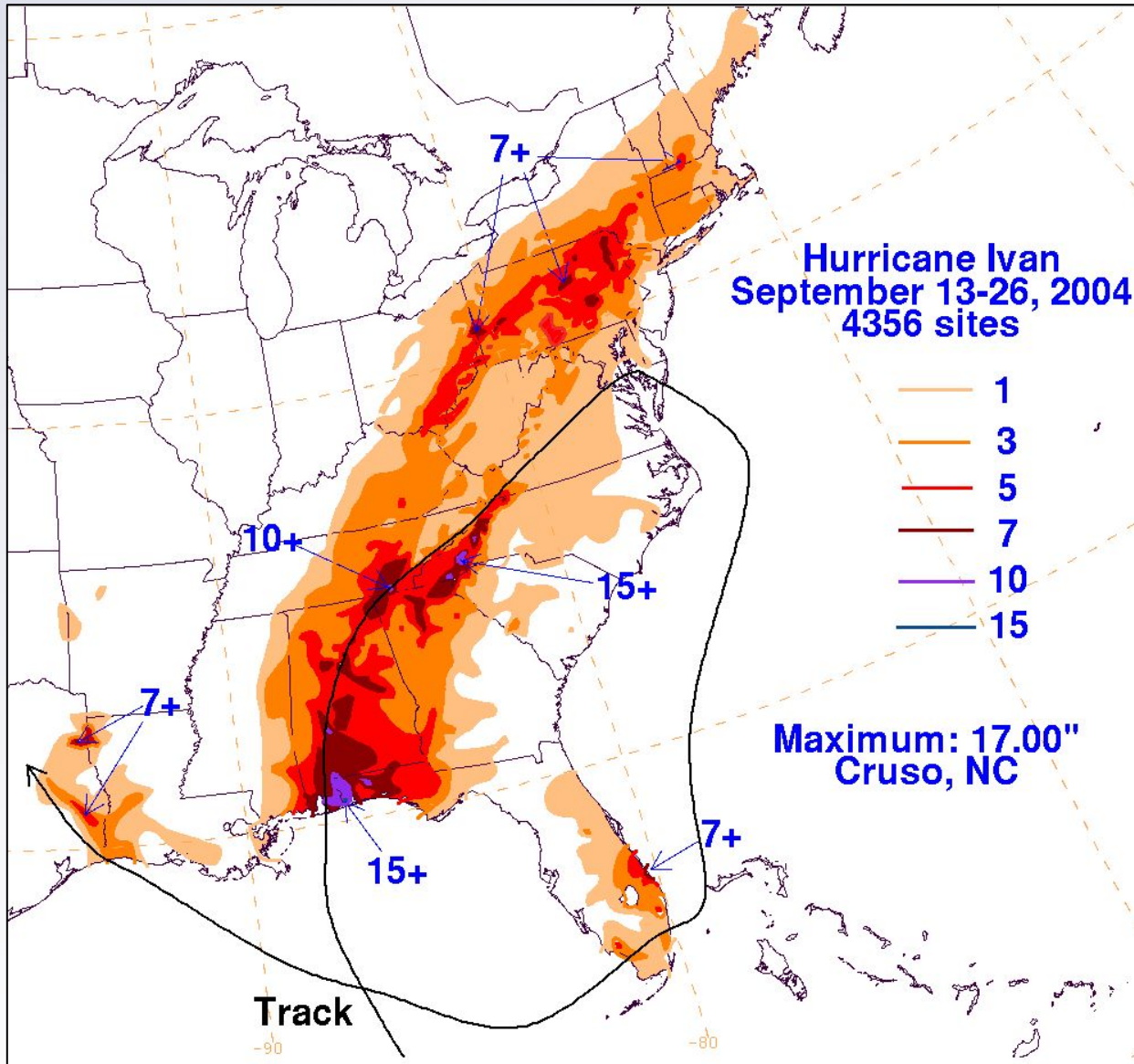


# Storm Surge



- Storm surge was generally in the 10-15 ft range from Destin, FL to Mobile Bay, AL
- Extensive coastal damage, portions of Interstate 10 was damaged, bridge collapse
- Perdido Key, FL was essentially leveled.

# Rainfall



- Locally rainfall amount of 15-17 inches occurred near the landfall spot.
- Large swath of rain greater than 5 inches occurred along the track from the deep south to New England.
- Widespread flooding occurred due to saturated grounds from other hurricanes just a few weeks prior

# Flooded!



North Carolina



Florida

September 2004



Pennsylvania

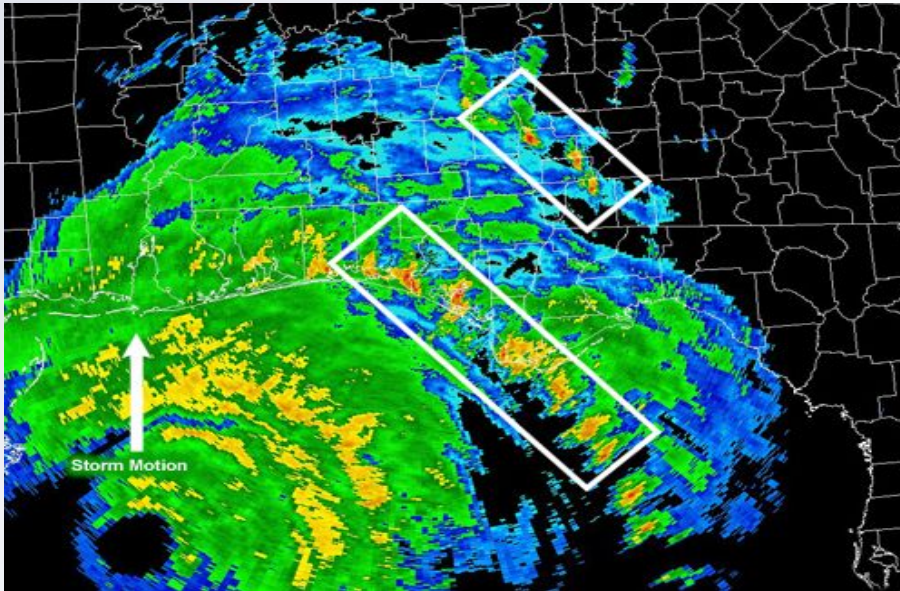
# Wind Damage



*Pensacola, FL*

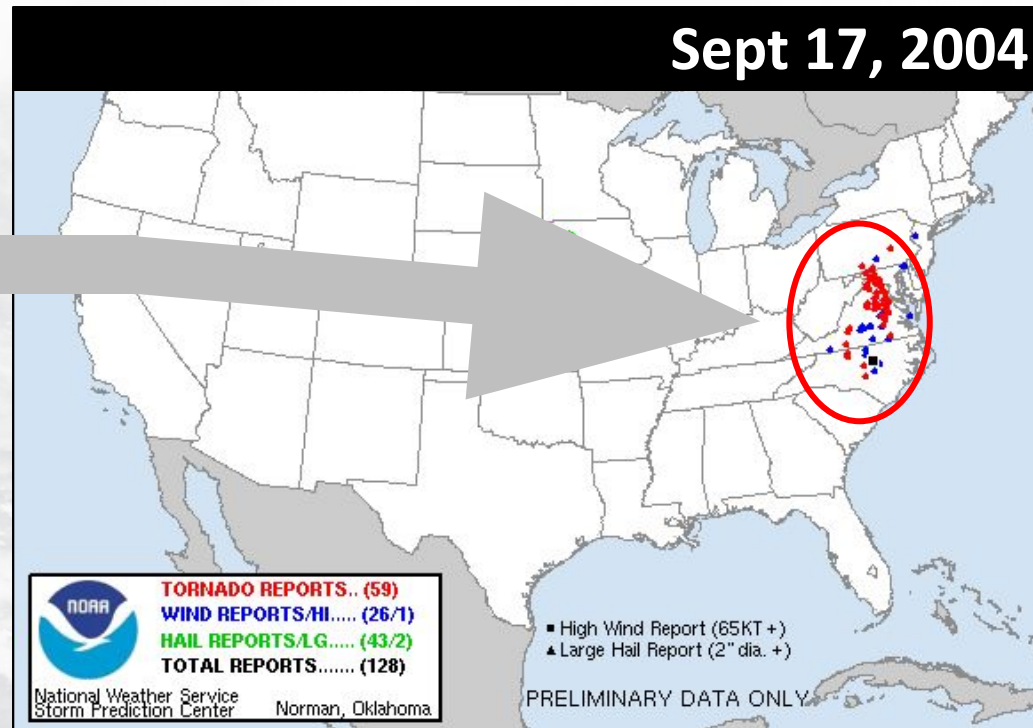
Peak wind gust – 145 mph in Baldwin County, Alabama

# Ivan caused a tornado outbreak!



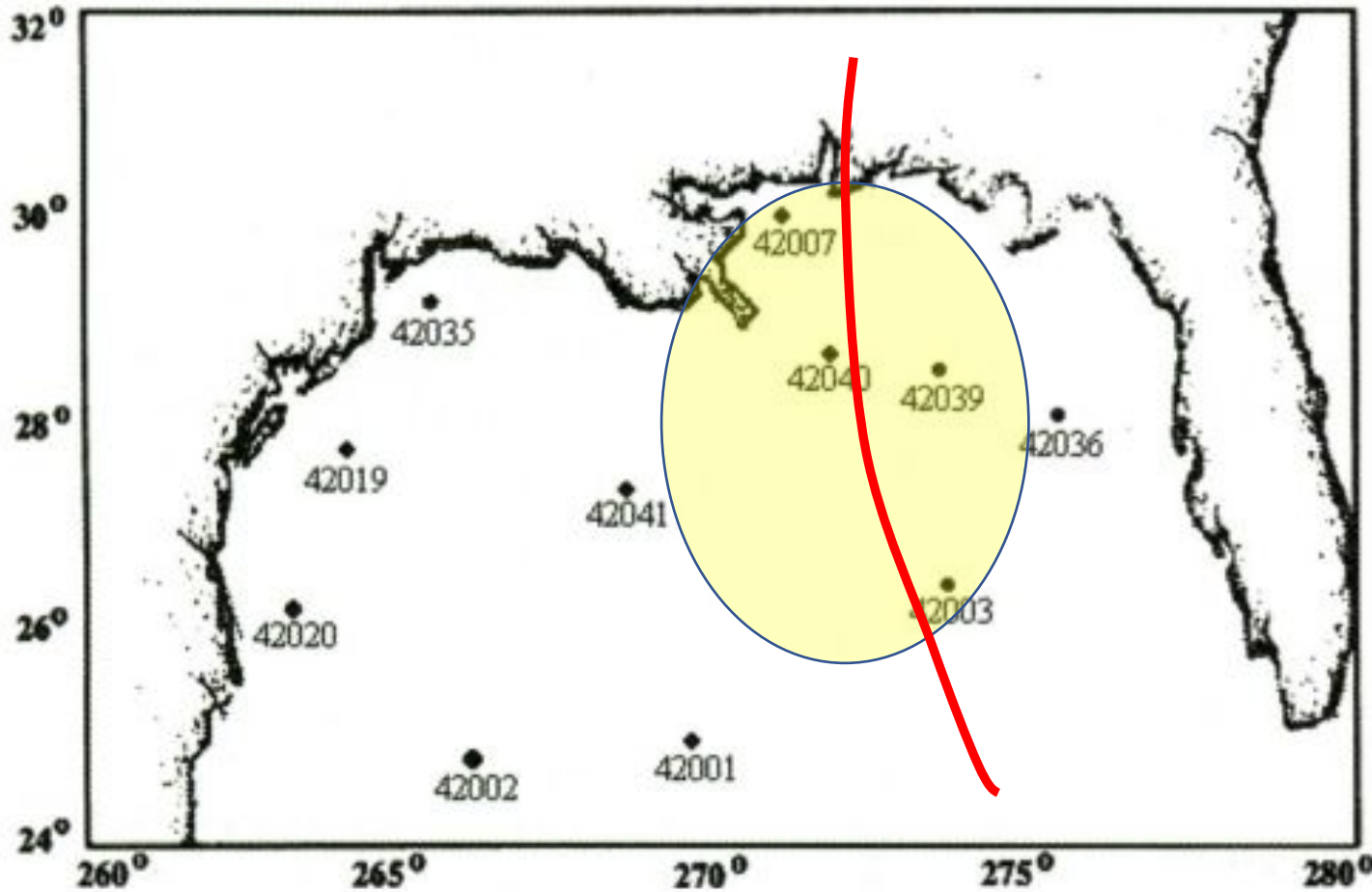
## Tornado “outbreak”

Hurricane Ivan (2004)  
– 117 Tornadoes





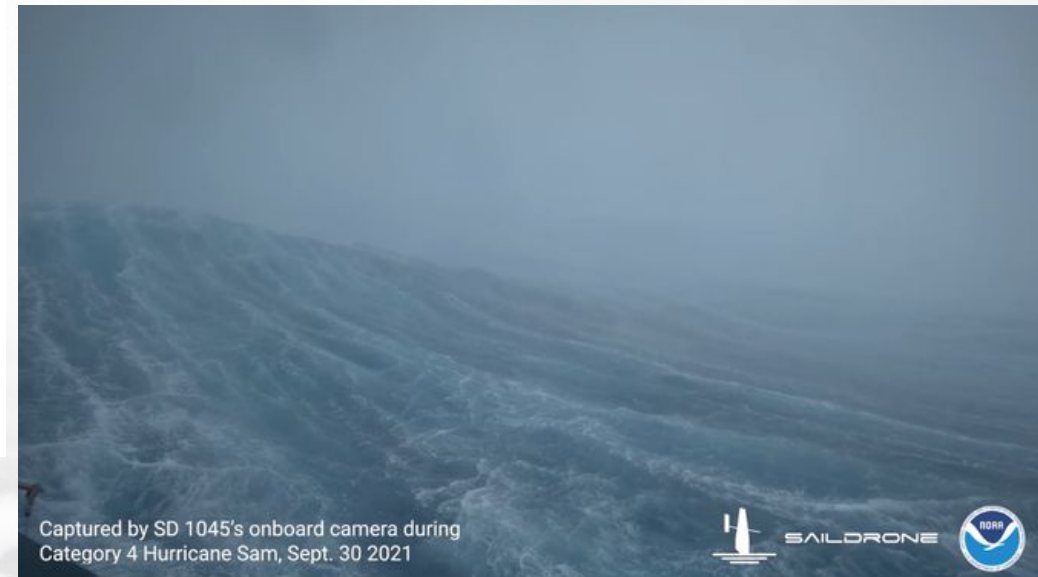
# Marine Hazards



*Panchang and Li, BAMS 2006*

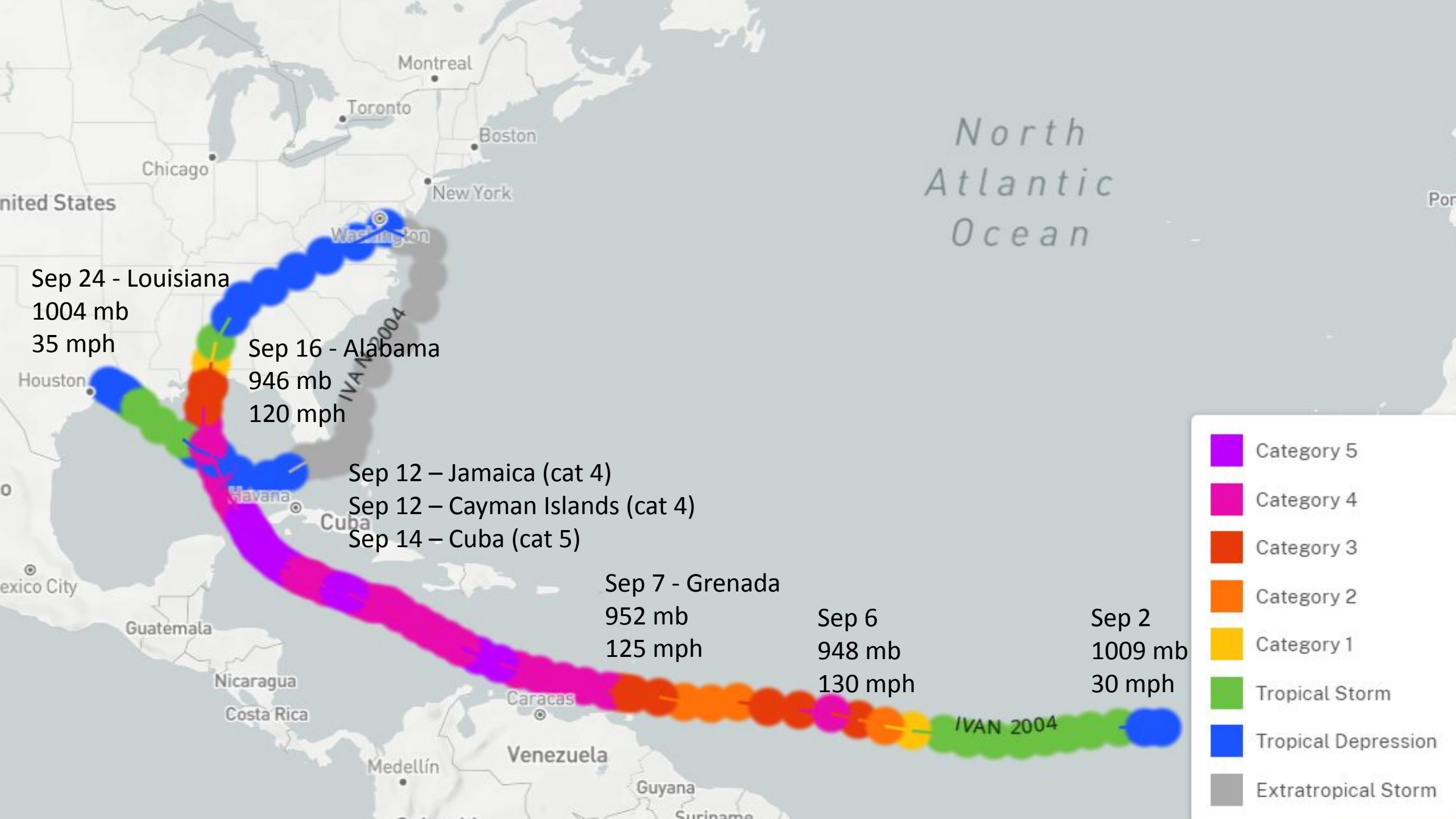
\* Largest waves recorded (up to that time) at NOAA buoys 42003, 42007, 42039, and 42040.

\* Peak was at NOAA buoy 42040 where wave heights reached 52.5 ft!



Captured by SD 1045's onboard camera during Category 4 Hurricane Sam, Sept. 30 2021





# Unfortunate Causalities

- In total, Ivan was responsible for 92 direct fatalities

39 in Grenada

25 in the U.S.

17 in Jamaica

4 in the Dominican Republic

3 in Venezuela

2 in Cayman Islands

1 in Tobago and Barbados

## **U.S Fatalities**

Tornadoes – 7

Storm Surge – 5

Rainfall – 8

Wind – 3

Surf - 2

# 20th Anniversary of Hurricane Ivan's Inland Impact

Fred McMullen, WCM, NWS WFO Pittsburgh

Mike Bilder, Hurricane Prog. Mgr, FEMA Region 3



NATIONAL HURRICANE PROGRAM

Ivan slams Va. in Southern rampage

Bedford County Henry County High School Football



Southwest of Roanoke, debris is the size of a refrigerator that has been damaged by a suspected tornado...

Storm pounds East at least 12 are killed

Apparent tornadoes hit 2 S.W. Va. areas

At least 12 people were killed and hundreds of thousands of people were injured in a series of storms that swept through the Southeastern United States...

Record-setting rain inundates region



A flooded car sits in a high pool of water that has been caused by heavy, persistent rain.

Widespread flooding strands thousands

Heavy rain in the Southeast has caused widespread flooding, stranding thousands of people and causing significant damage to property and infrastructure.

Awash in storm misery

From the Gulf to the mountains, Ivan soaks Southeast



Regions which include from the mountain peaks in Florida, Va., to the Gulf of Mexico.

N.C. mountain turns to mud

Heavy rain in North Carolina has turned mountain roads into mud, causing significant damage and stranding many people.

8 die as Ivan's rain pounds mountains



Children stay dry as they wait for rescue in a flooded area in the mountains of North Carolina.

Massive floods inundate Georgia; at least 5 dead

Heavy rain in Georgia has caused massive flooding, inundating large areas and causing the deaths of at least five people.



Bush woos donors, reaches out to women

President George W. Bush is reaching out to women donors and supporters, highlighting their importance in his administration.

Men from 200 women carried out as waters rise and hundreds evacuate

In a rescue operation, men were carried out of a flooded area as hundreds of people evacuated to higher ground.

Forecast

Weather forecast for the region, including temperature and precipitation predictions.

Lebanon Daily News advertisement featuring a coupon for \$60 worth of savings and a sports section preview.

The Daily Times advertisement featuring a sports final score and a coupon for \$50 worth of savings.

The State advertisement featuring campaign 2004 results for DeMint vs. women voters and a coupon for 45 miles.

Culpeper Star-Exponent advertisement featuring a headline about Remington being ravaged by a tornado.

Lebanon Daily News advertisement featuring a headline about a murder suspect returning to county and a coupon for \$50 worth of savings.

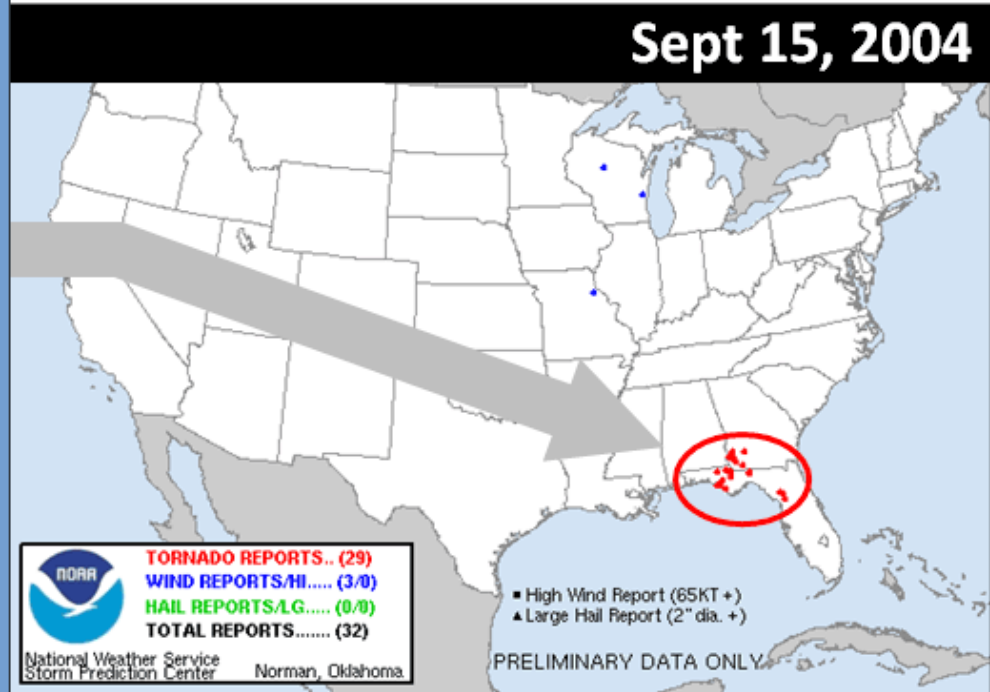
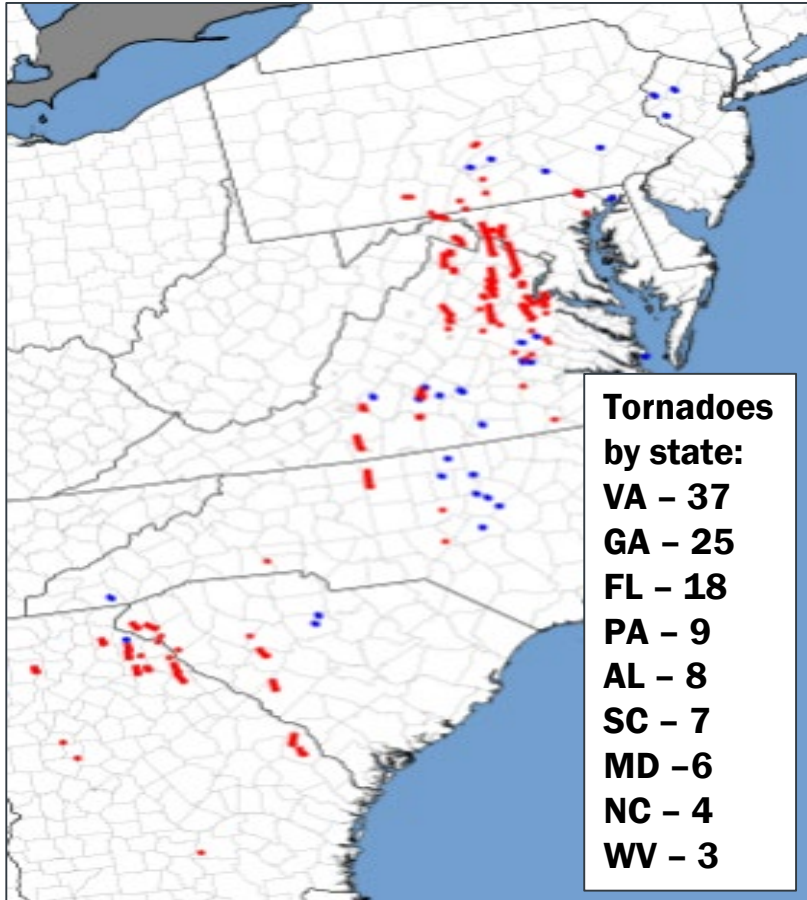
The Daily Times advertisement featuring a headline about Ivan remnants bringing flooding and a coupon for \$50 worth of savings.

The State advertisement featuring a headline about Ivan charging inland and a coupon for \$50 worth of savings.

Culpeper Star-Exponent advertisement featuring a headline about tornadoes everywhere and a coupon for \$50 worth of savings.

# Ivan Tornado Outbreak – Sept. 15-18

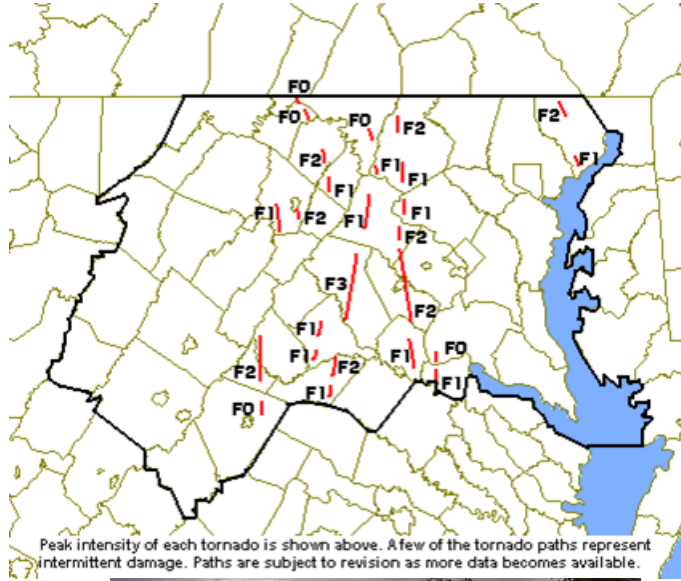
- One of the worst tornado outbreaks in tropical cyclone history and Mid-Atlantic history!
- 117 tornadoes hit 9 states, over 3 days, with 8 fatalities.
- Apex on Sept. 17 (57 tornadoes / 49% of outbreak)



Source: Matt Elliott/SPC; NHC



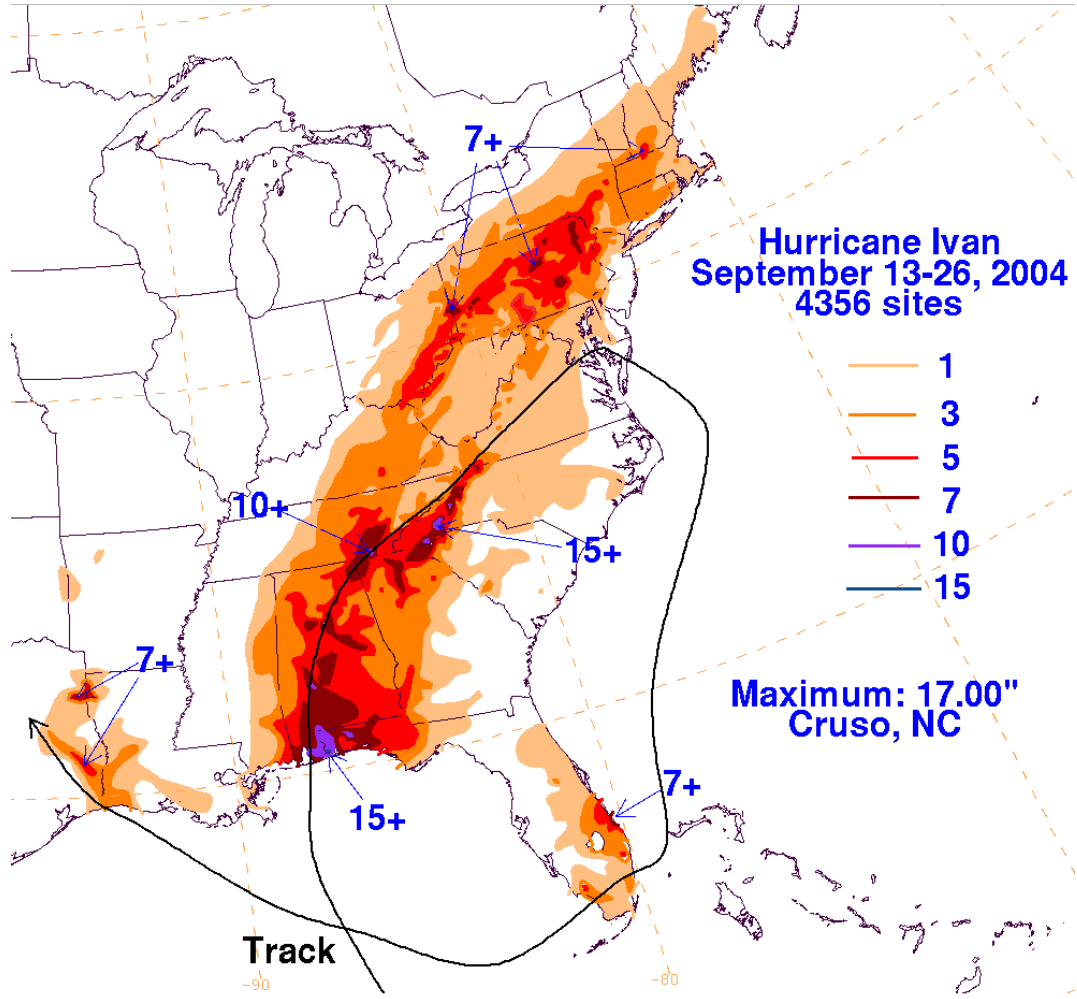
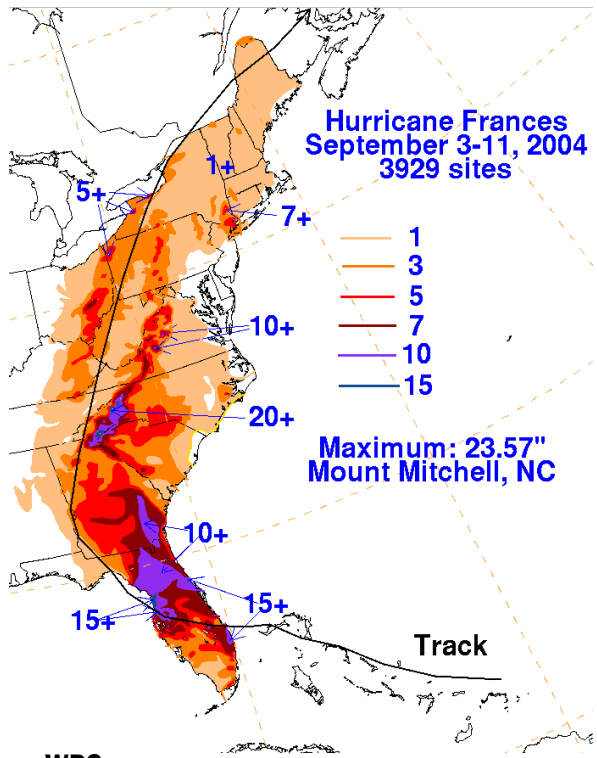
# Ivan Tornado Outbreak in the DMV



Source: WFO Baltimore/Washington



# Frances & Ivan Rainfall

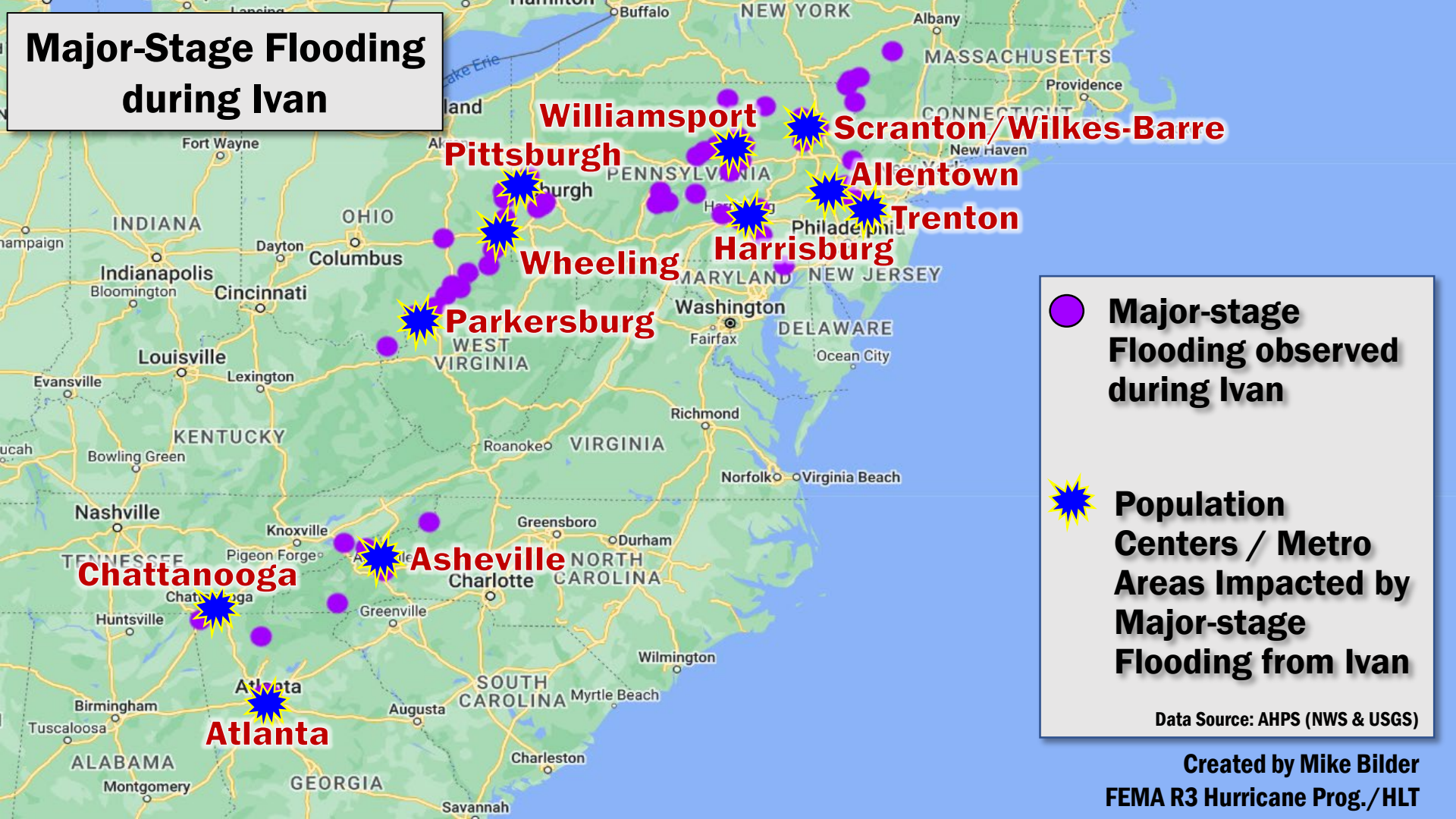




Source: WPC





# Major-Stage Flooding during Ivan



-  Major-stage Flooding observed during Ivan
-  Population Centers / Metro Areas Impacted by Major-stage Flooding from Ivan

Data Source: AHPS (NWS & USGS)



# Ivan's Inland Flooding in PA, MD & NJ



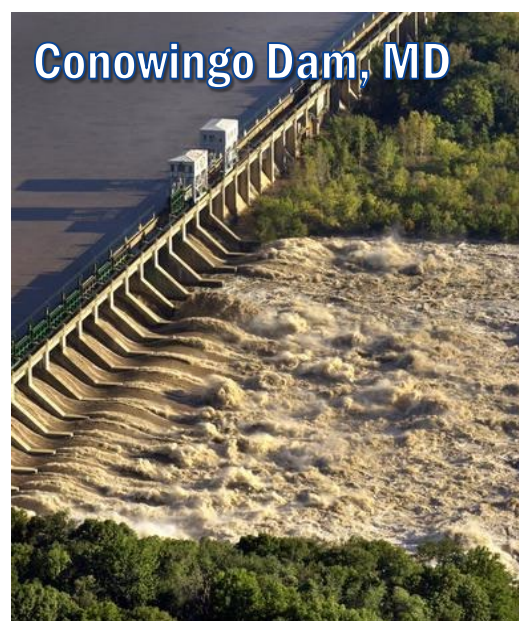
Pittsburgh, PA



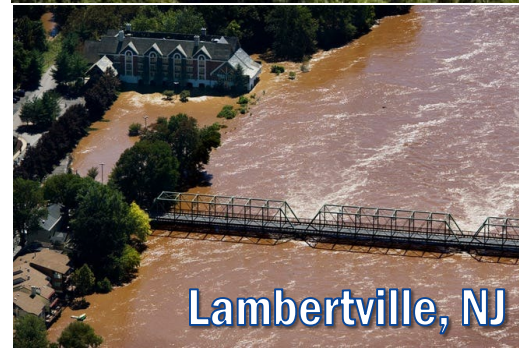
Pittsburgh, PA



Harrisburg, PA



Conowingo Dam, MD



Lambertville, NJ

Photo Credit: T. Kruckewitt; Carnegie Mellon Univ.; Sean Simmers / *Penn Live*; Richard Hertzler / *NEW ERA*; Michael Mancuso / *AP Photo*



# Ivan's Inland Flooding in WV & OH

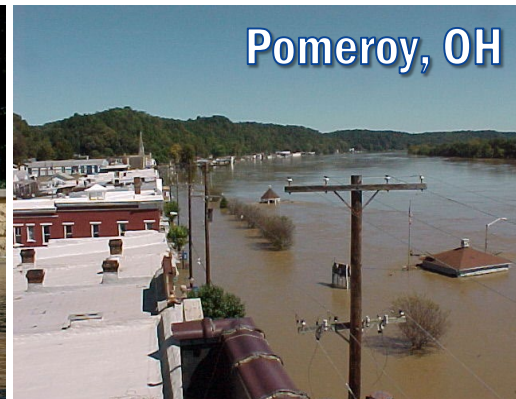


Photo Credit: Jake Mecklenborg; WFO Pittsburgh; WRTF; Michael Stahl

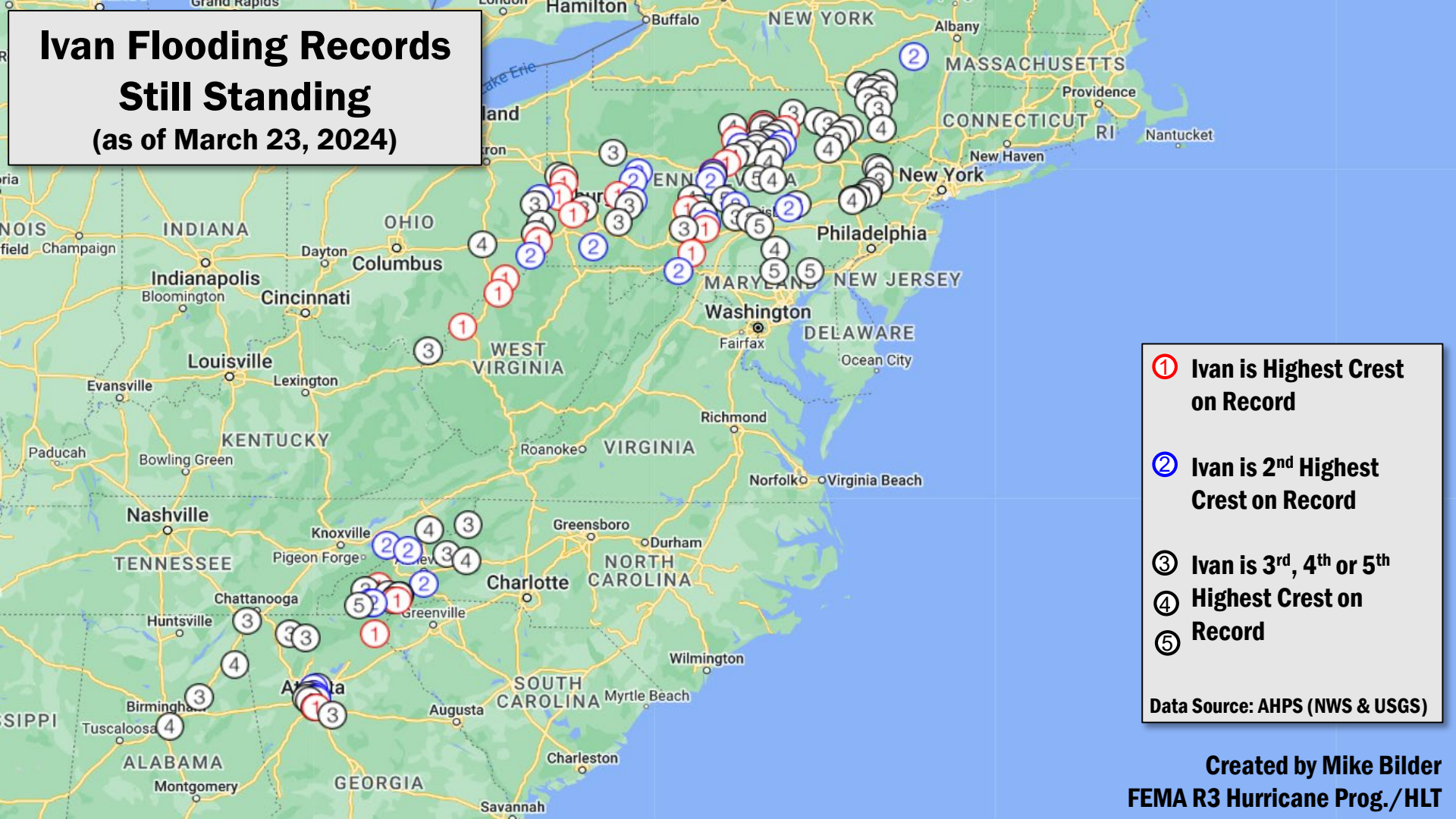


# Debris Flow in Macon Co., NC



**The southern mountains of NC, incl. Macon County, received the highest rainfall totals during both Frances and Ivan. The massive debris flow from the peak of Fishhawk Mountain hit Peaks Creek community in the middle of the night, destroying about 15 homes in a matter of seconds, killing four people and seriously injuring several more.**

# Ivan Flooding Records Still Standing (as of March 23, 2024)

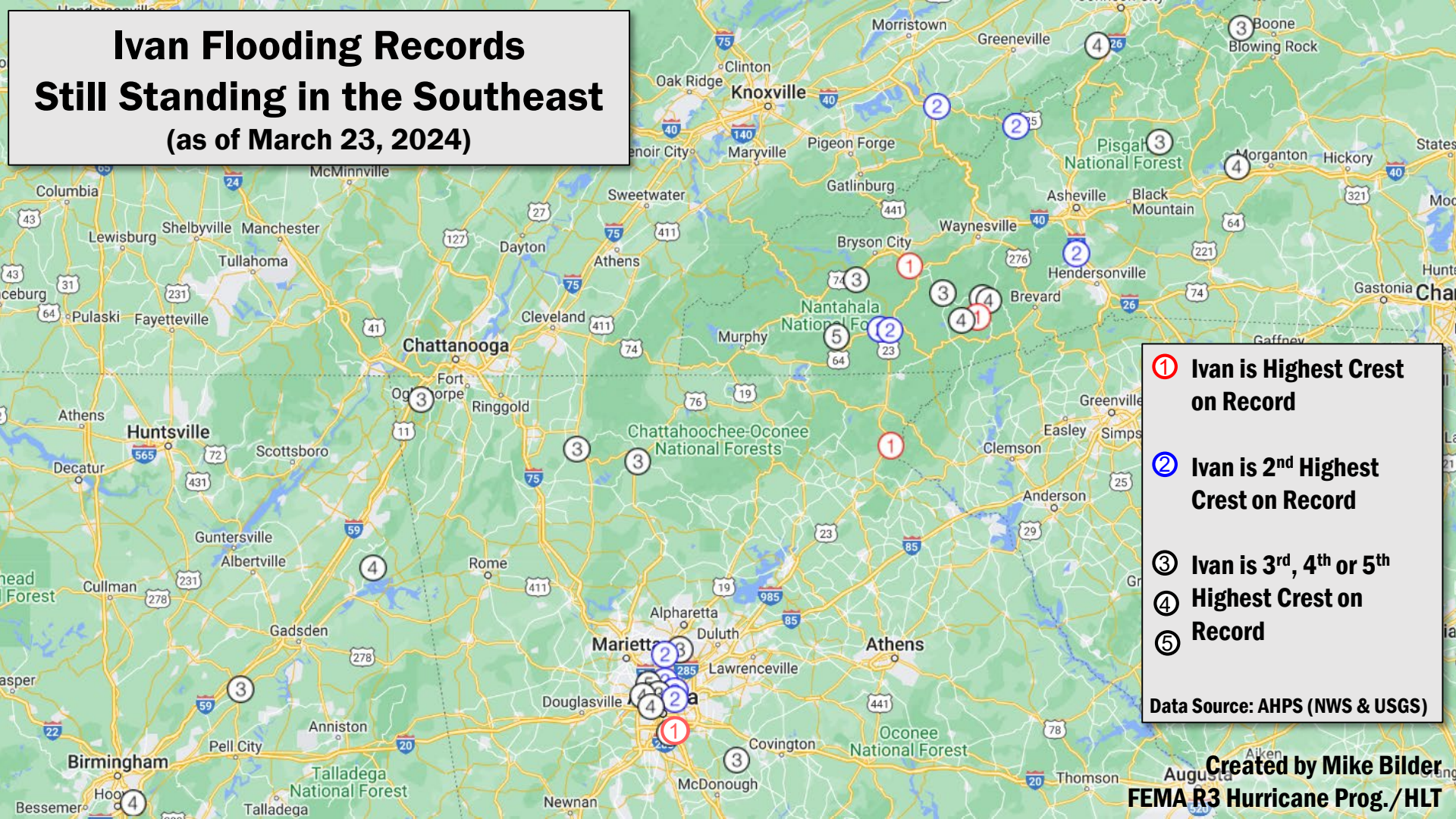


- ① Ivan is Highest Crest on Record
- ② Ivan is 2<sup>nd</sup> Highest Crest on Record
- ③ Ivan is 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup>
- ④ Highest Crest on Record
- ⑤ Record

Data Source: AHPS (NWS & USGS)

Created by Mike Bilder  
FEMA R3 Hurricane Prog./HLT

# Ivan Flooding Records Still Standing in the Southeast (as of March 23, 2024)



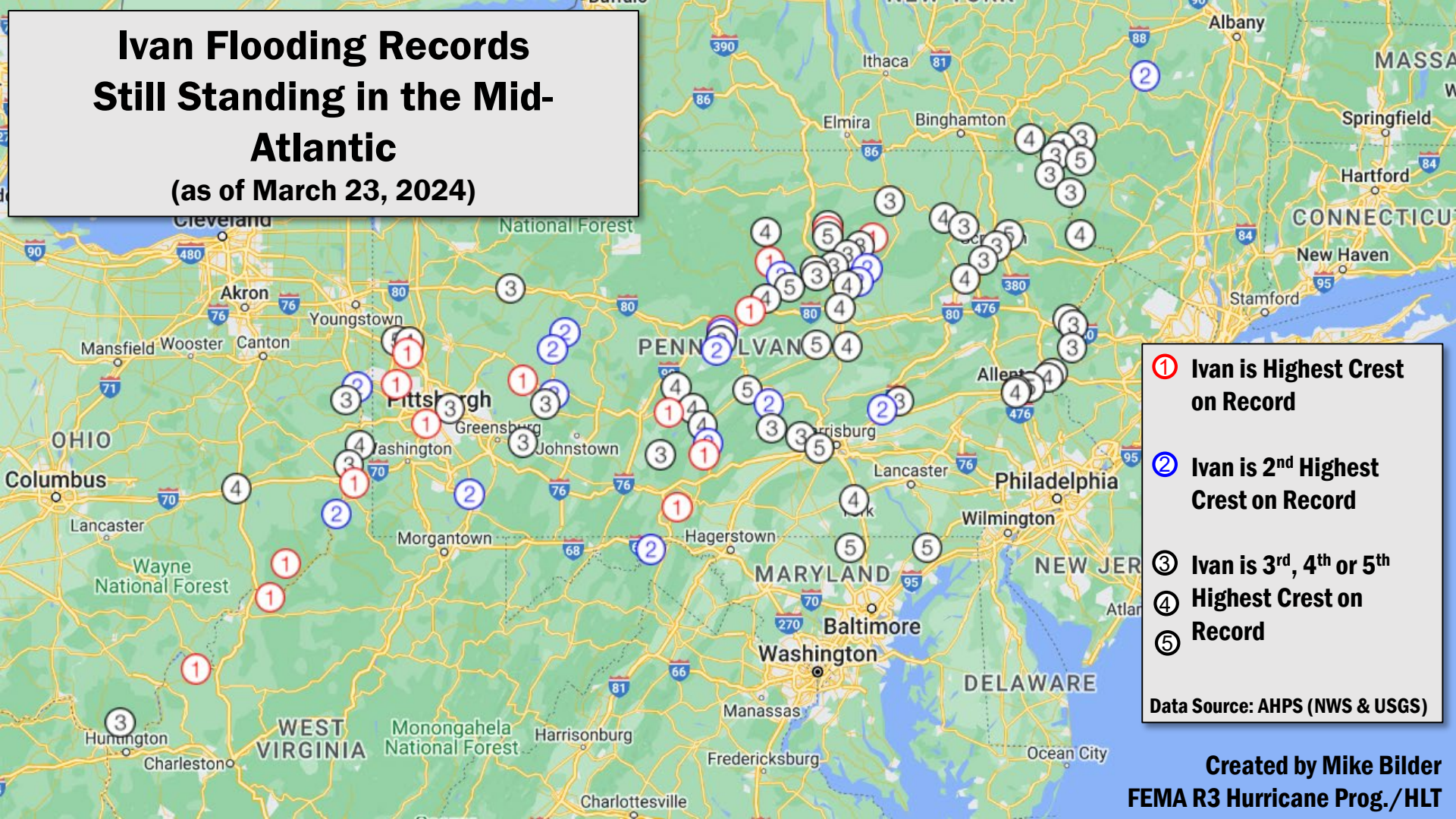
- ① Ivan is Highest Crest on Record
- ② Ivan is 2<sup>nd</sup> Highest Crest on Record
- ③ Ivan is 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup>
- ④ Highest Crest on Record
- ⑤ Record

Data Source: AHPs (NWS & USGS)

Created by Mike Bilder  
FEMA R3 Hurricane Prog./HLT

# Ivan Flooding Records Still Standing in the Mid-Atlantic

(as of March 23, 2024)



- ① Ivan is Highest Crest on Record
- ② Ivan is 2<sup>nd</sup> Highest Crest on Record
- ③ Ivan is 3<sup>rd</sup>, 4<sup>th</sup> or 5<sup>th</sup>
- ④ Highest Crest on Record
- ⑤ Record

Data Source: AHPS (NWS & USGS)

# Ivan vs. Other Tropical Cyclone Floods on the upper Ohio River

|   | Hazel (1954) |           | Agnes (1972) |           | Ivan (2004) |           |
|---|--------------|-----------|--------------|-----------|-------------|-----------|
|   | Stage        | In Top 5? | Stage        | In Top 5? | Stage       | In Top 5? |
| Ohio River at Pittsburgh                | Major        | No        | Major        | 4         | Major       | No        |
| Ohio River at Dashields Lock & Dam      | Moderate     | No        | Major        | 4         | Moderate    | No        |
| Ohio River at Montgomery Lock & Dam     | Major        | 5         | Major        | 3         | Major       | No        |
| Ohio River at East Liverpool            | Major        | No        | NA           | NA        | Major       | No        |
| Ohio River at Wellsville                | NA           | NA        | NA           | NA        | Major       | 2         |
| Ohio River at New Cumberland Lock & Dam | Major        | No        | Major        | No        | Major       | No        |
| Ohio River at Steubenville              | NA           | NA        | NA           | NA        | NA          | NA        |
| Ohio River at Wellsburg                 | Major        | 5         | NA           | NA        | Major       | 4         |
| Ohio River at Pike Island Lock & Dam    | NA           | NA        | Major        | 2         | Major       | 3         |
| Ohio River at Wheeling                  | Major        | No        | Major        | No        | Major       | No        |
| Ohio River at Moundsville               | NA           | NA        | Major        | No        | Major       | No        |
| Ohio River at Powhatan Point            | NA           | NA        | NA           | NA        | Major       | 2         |
| Ohio River at Hannibal Lock & Dam       | NA           | NA        | Major        | No        | Major       | No        |
| Ohio River at Willow Island Lock        | NA           | NA        | NA           | NA        | Major       | 1         |
| Ohio River at Marietta Pumphouse        | NA           | NA        | NA           | NA        | Major       | No        |
| Ohio River at Parkersburg               | Minor        | No        | Minor        | No        | Major       | No        |
| Ohio River at Belleville Lock           | NA           | NA        | NA           | NA        | Major       | No        |
| Ohio River at Racine Lock               | NA           | NA        | NA           | NA        | Major       | 1         |
| Ohio River at Pomeroy                   | NA           | NA        | Minor        | No        | Major       | No        |
| Ohio River at Point Pleasant            | NA           | NA        | Minor        | No        | Moderate    | No        |
| Ohio River at RC Byrd Lock              | NA           | NA        | NA           | NA        | Minor       | No        |
| Ohio River at Huntington                | NA           | NA        | NA           | NA        | Minor       | No        |

Ivan dominates the upper Ohio River, especially below Wheeling, WV.

Data Source:  
AHPS (NWS & USGS)



# Ivan vs. Other Tropical Cyclone Floods on the Susquehanna River

|   | Agnes (1972) |           | Eloise (1975) |           | Ivan (2004) |           | Lee (2011) |           |
|---|--------------|-----------|---------------|-----------|-------------|-----------|------------|-----------|
|   | Stage        | In Top 5? | Stage         | In Top 5? | Stage       | In Top 5? | Stage      | In Top 5? |
| Susquehanna River near Waverly                    | Major        | 4         | Major         | No        | Moderate    | No        | Major      | 1         |
| Susquehanna River at Towanda                      | Major        | 1         | Major         | 3         | Moderate    | No        | Major      | 2         |
| Susquehanna River at Meshoppen                    | Major        | 2         | NA            | NA        | Moderate    | 4         | Major      | 1         |
| Susquehanna River at Wilkes-Barre                 | Major        | 2         | Major         | 3         | Major       | 4         | Major      | 1         |
| Susquehanna River at Bloomsburg                   | Major        | 3         | Moderate      | No        | Moderate    | No        | Major      | 1         |
| Susquehanna River at Danville                     | Major        | 1         | Moderate      | No        | Moderate    | No        | Major      | 2         |
| Susquehanna River at Sunbury                      | Major        | 1         | Moderate      | 3         | Moderate    | 4         | Moderate   | 2         |
| Susquehanna River at Harrisburg                   | Major        | 1         | Major         | No        | Major       | No        | Major      | 5         |
| Susquehanna River at Marietta                     | Major        | 1         | Major         | No        | Major       | No        | Major      | 4         |
| West Branch Susquehanna River at Bower (Mahaffey) | Unknown      | 2         | NA            | NA        | NA          | NA        | NA         | NA        |
| West Branch Susquehanna River at Hyde             | NA           | NA        | NA            | NA        | Unknown     | 1         | NA         | NA        |
| West Branch Susquehanna River at Karthaus         | Action       | 2         | NA            | NA        | NA          | NA        | NA         | NA        |
| West Branch Susquehanna River at Renovo           | Major        | 3         | Action        | No        | Moderate    | No        | NA         | NA        |
| West Branch Susquehanna River at Lock Haven       | Major        | 2         | Minor         | No        | Major       | 4         | NA         | NA        |
| West Branch Susquehanna River at Jersey Shore     | Major        | 1         | Minor         | No        | Major       | 5         | NA         | NA        |
| West Branch Susquehanna River at Williamsport     | Major        | 1         | Moderate      | No        | Moderate    | No        | NA         | NA        |
| West Branch Susquehanna River near Muncy          | Major        | 1         | Major         | No        | Major       | 4         | NA         | NA        |
| West Branch Susquehanna River at Montgomery       | Major        | 1         | Major         | No        | Major       | No        | Moderate   | No        |
| West Branch Susquehanna River at Allenwood        | NA           | NA        | NA            | NA        | NA          | NA        | NA         | NA        |
| West Branch Susquehanna River at Watsontown       | Major        | 1         | NA            | NA        | Moderate    | 4         | NA         | NA        |
| West Branch Susquehanna River at West Milton      | Major        | 1         | Major         | 5         | Major       | No        | Major      | No        |
| West Branch Susquehanna River at Lewisburg        | Major        | 1         | Moderate      | No        | Moderate    | No        | Moderate   | No        |

**Agnes and Lee still dominate the Susquehanna, although Ivan hit the West Branch much harder than Lee.**

Data Source: AHPS (NWS & USGS)

# Ivan vs. Other Tropical Cyclone Floods on the Delaware River

|   | Connine & Diane (1955) |           | Ivan (2004) |           |
|---|------------------------|-----------|-------------|-----------|
|   | Stage                  | In Top 5? | Stage       | In Top 5? |
| Delaware River at Lordville   | NA                     | NA        | Moderate    | 3         |
| Delaware River at Callicoon   | NA                     | NA        | Major       | 3         |
| Delaware River at Barryville  | Major                  | 2         | Moderate    | 4         |
| Delaware River at Matamoras/Port Jervis                             | Major                  | 3         | Minor       | No        |
| Delaware River at Montague  | Major                  | 1         | Moderate    | No        |
| Delaware River at Tocks Island                                      | Major                  | 1         | Major       | 4         |
| Delaware River at Belvidere   | Major                  | 1         | Moderate    | No        |
| Delaware River at Easton  | Major                  | 1         | Major       | 5         |
| Delaware River at Riegelsville                                      | Major                  | 1         | Major       | No        |
| Delaware River at Frenchtown  | Major                  | 1         | Major       | No        |
| Delaware River at Stockton  | Major                  | 1         | Moderate    | No        |
| Delaware River at New Hope-Lambertville Bridge                      | Major                  | 1         | Major       | No        |
| Delaware River at Washington Crossing                               | Major                  | 1         | Moderate    | No        |
| Delaware River at Trenton   | Major                  | 2         | Moderate    | No        |
| Delaware River at Newbold Island                                    | NA                     | NA        | Moderate    | No        |
| Delaware River at Burlington  | NA                     | NA        | Moderate    | No        |
| Delaware River at Bridesburg  | NA                     | NA        | NA          | NA        |
| Delaware River at USCG Station Washington Street                    | Moderate               | No        | NA          | NA        |
| Delaware River at Marcus Hook                                       | NA                     | NA        | NA          | NA        |
| Delaware River (East Branch) at Margaretville                       | Minor                  | No        | Moderate    | No        |
| Delaware River (East Branch) at Pepacton Reservoir / Downsville Dam | NA                     | NA        | Moderate    | 3         |
| Delaware River (East Branch) at Downsville below Pepacton Dam       | Below                  | No        | Major       | No        |
| Delaware River (East Branch) at Harvard                             | NA                     | NA        | Major       | 4         |
| Delaware River (East Branch) at Fishs Eddy                          | Minor                  | No        | Major       | 3         |
| Delaware River (West Branch) above Delhi                            | Below                  | No        | Moderate    | No        |
| Delaware River (West Branch) at Walton                              | Minor                  | No        | Minor       | No        |
| Delaware River (West Branch) at Cannonsville Reservoir              | NA                     | NA        | Moderate    | 4         |
| Delaware River (West Branch) at Hale Eddy                           | Minor                  | No        | Minor       | No        |

**Connie & Diane still dominate the mainstem Delaware River, although Ivan dominates both the East and West Branches in NY.**

**Data Source:  
AHPS (NWS & USGS)**



# Flooding Testimonials from PA, WV & OH

- At least 12 deaths in Pennsylvania from inland flooding, including a man swept away by flooding after clinging to a tree for 45 minutes. One person suffered a heart attack and another adult and a 2-year-old girl drowned.
- In Marietta, OH, streets were underwater near the river and about 200 people had to leave their homes in what could be the city's worst flooding since 1959.
- The 126-year-old Rinard Covered Bridge over the Little Muskingum River near Bloomfield, OH "literally disappeared."
- All around West Virginia, flooding and mudslides had blocked more than 200 roads and damaged hundreds of houses, authorities said.
- About 1,700 people were out of their homes in eastern Ohio.



# Special Thanks to...

**Matt Elliott**  
**Jared Rackley**

**David Manning**  
**Jacob Feuerstein**

**Chris Strong**

**Fred McMillen**

**Warning Coordination Meteorologist**  
**NWS WFO Pittsburgh**  
**fred.mcmullen@noaa.gov**  
**(412) 952-2665**

**Mike Bilder**

**Hurricane Prog. Manager / HLT Lead**  
**FEMA Region 3**  
**michael.bilder@fema.dhs.gov**  
**(267) 738-9463**



**NATIONAL HURRICANE PROGRAM**