

A Friday the 13th 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 grandmother 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



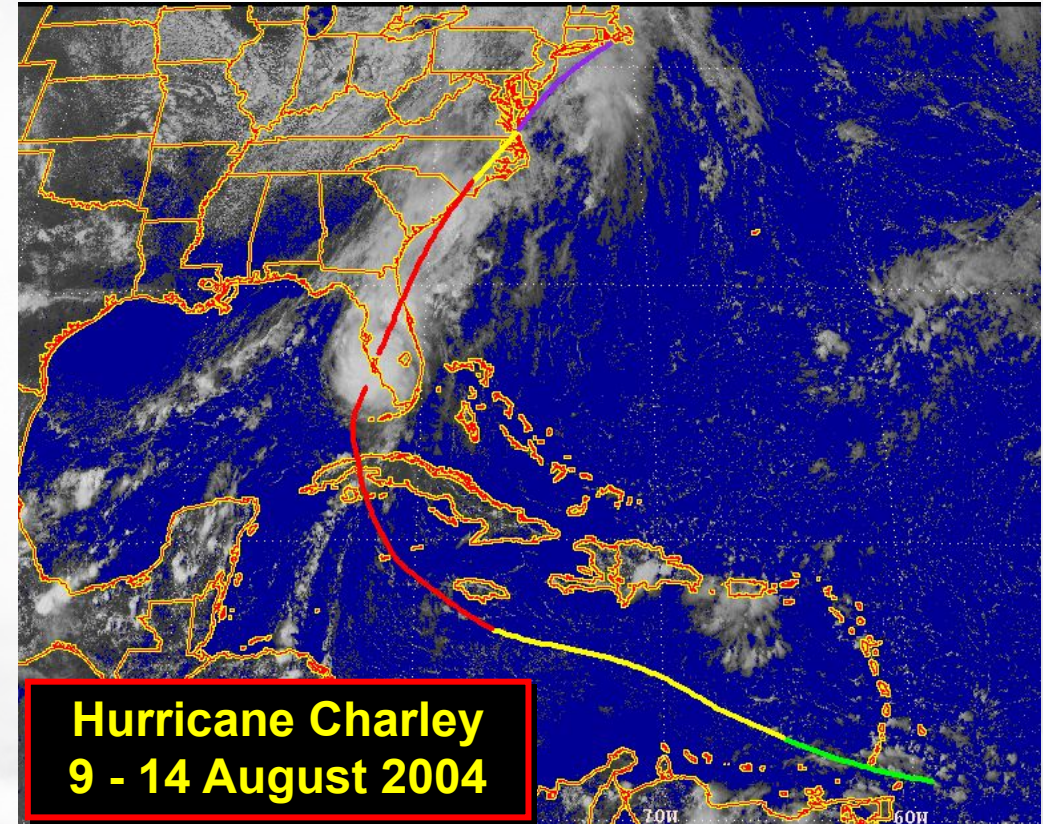
Hurricane Charley

- System became a Tropical Depression on August 9th 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 11th
- 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

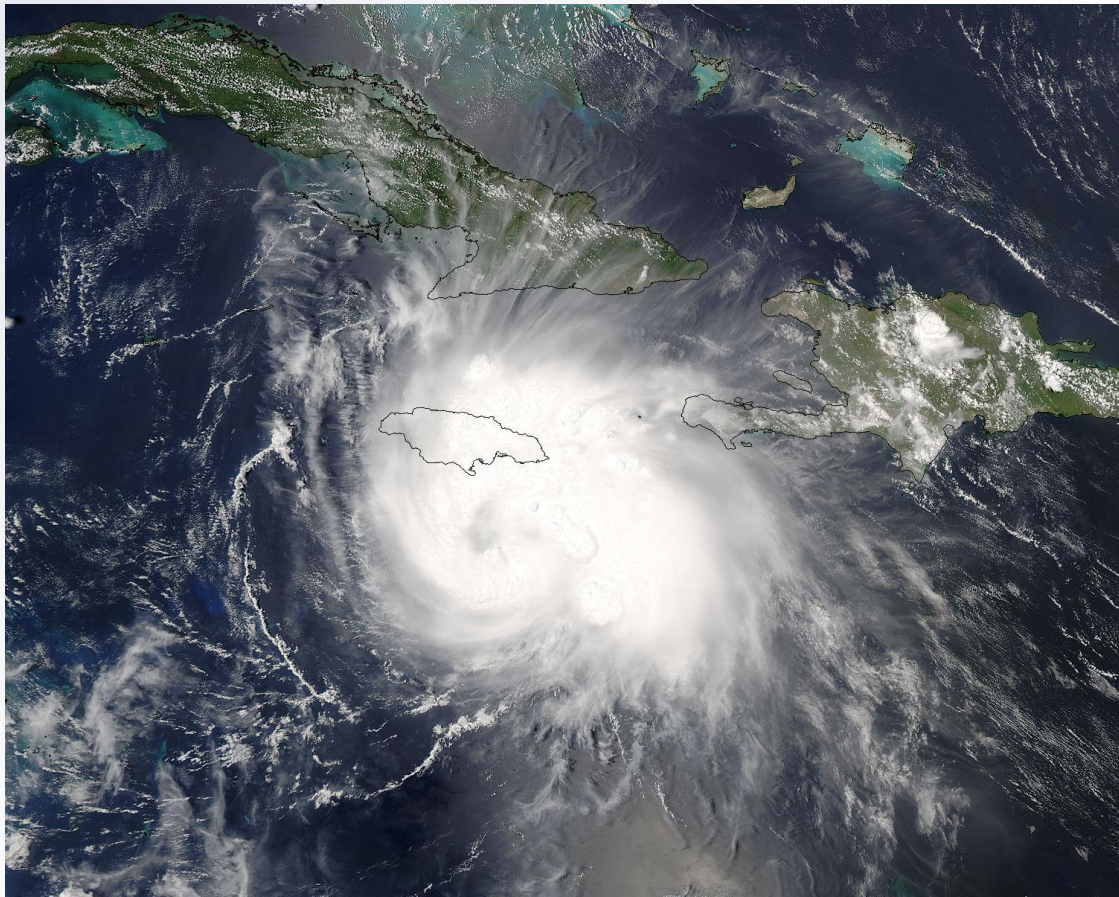
TROPICAL DEPRESSION THREE SPECIAL ADVISORY NUMBER 1
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL
145 PM AST MON AUG 09 2004

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

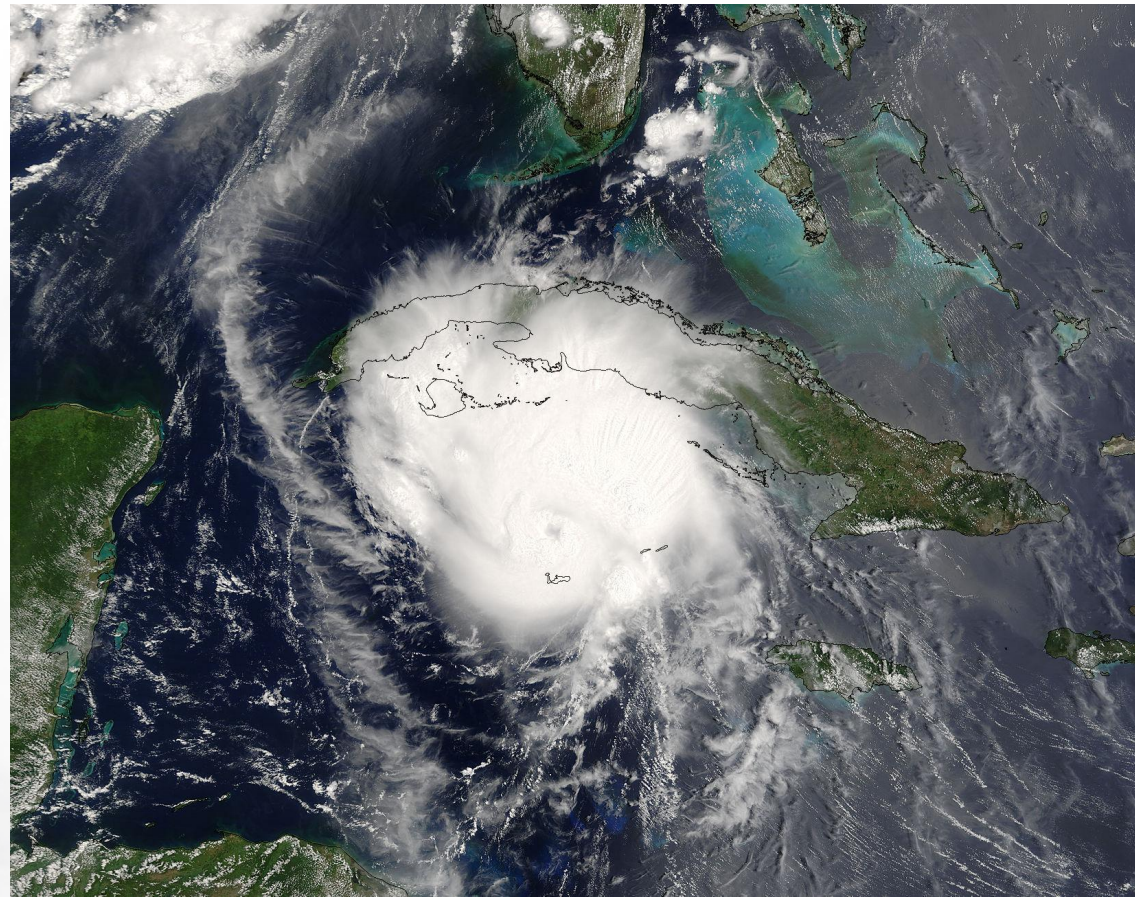


Hurricane Charley

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)**

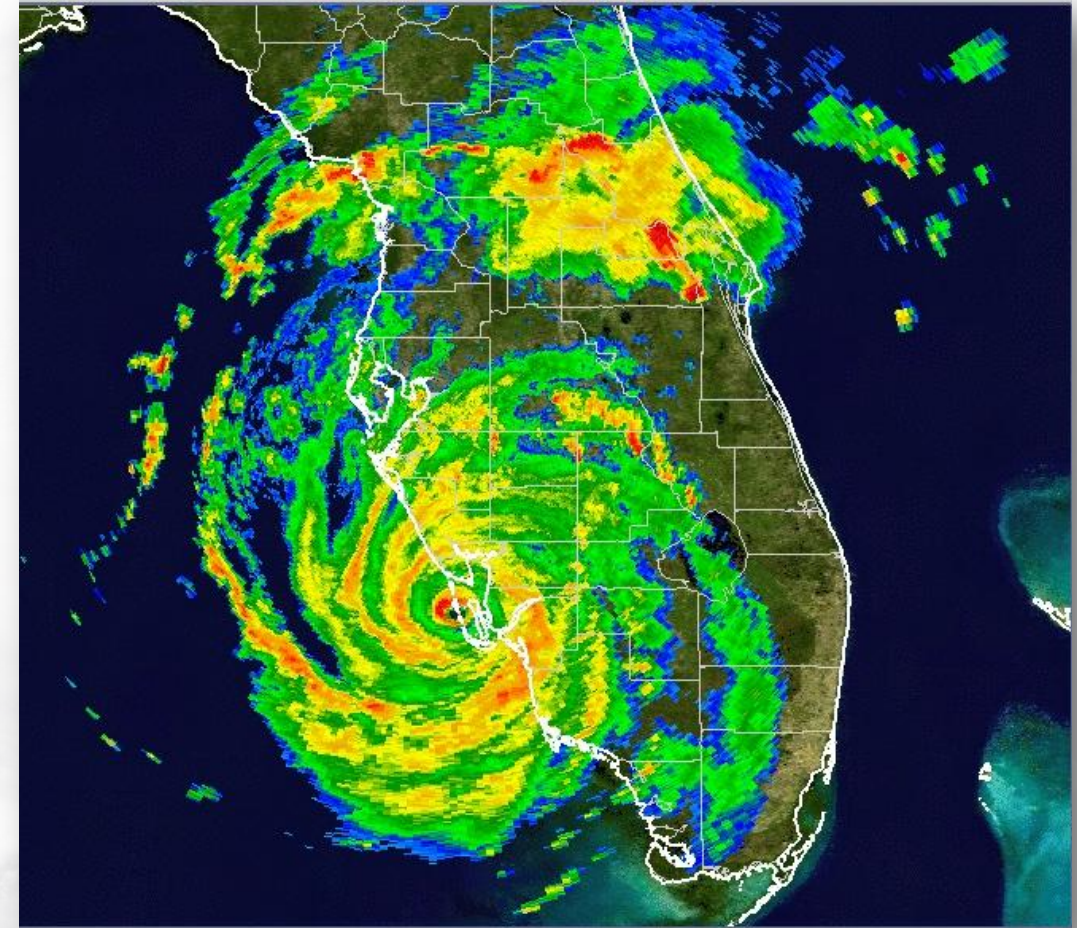
BULLETIN

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)

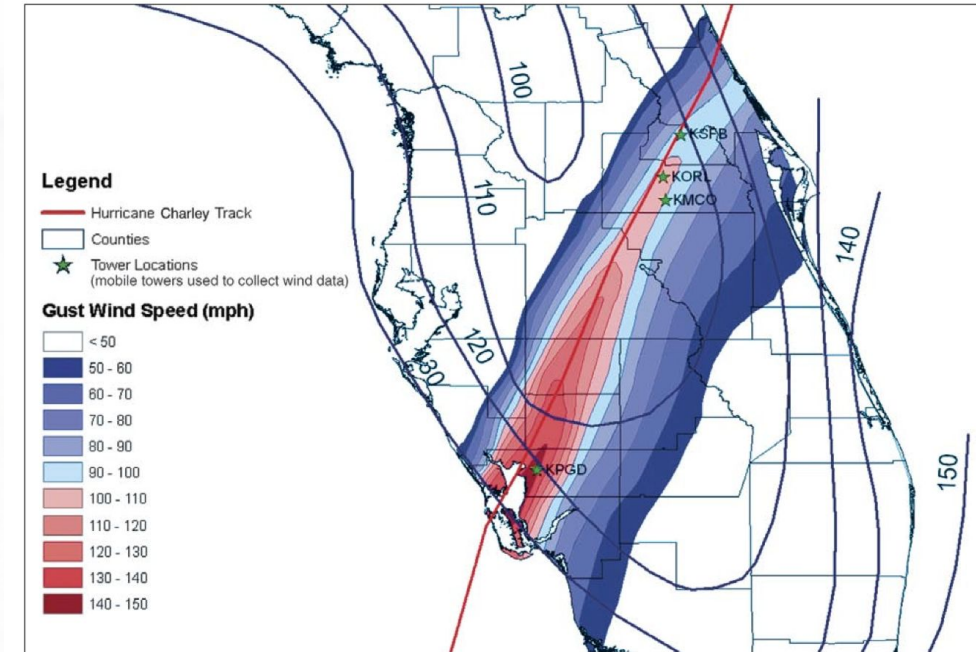


Figure 2. Hurricane Charley Wind Swath Map

FEMA Wind Gust Analysis

Hurricane Charley

- **U.S. damage: \$25.4B***
 - **2nd costliest at the time, now 16th 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

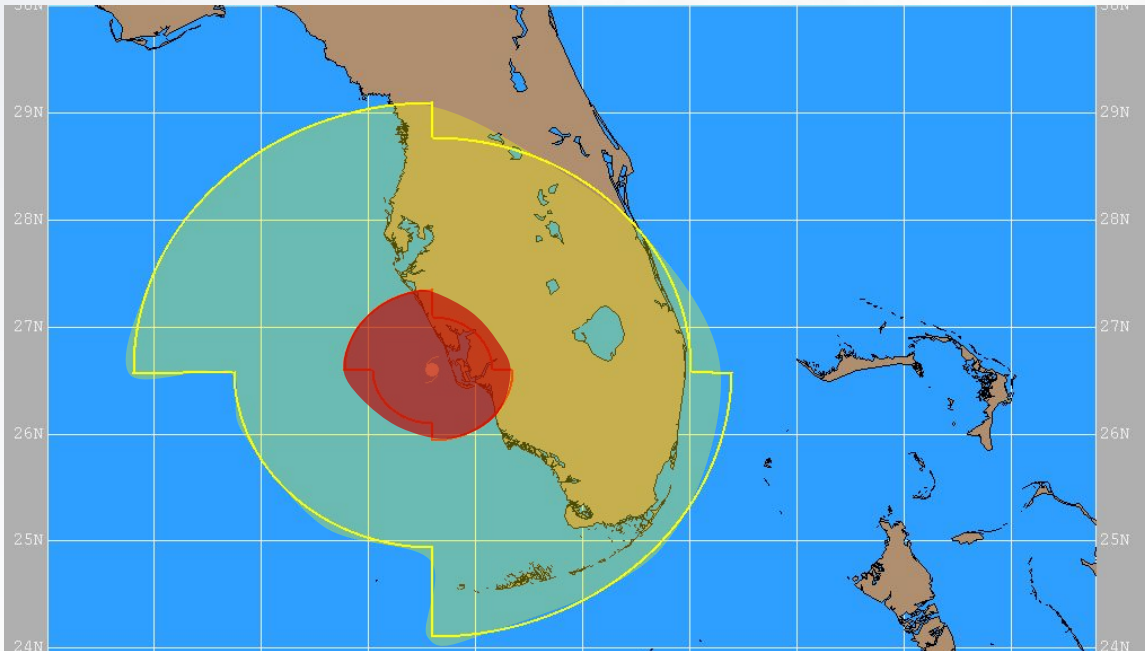
*2023 Dollars

Charley (2004) vs. Ian (2022)

Similar Strength but Different Very Different Impact Footprint

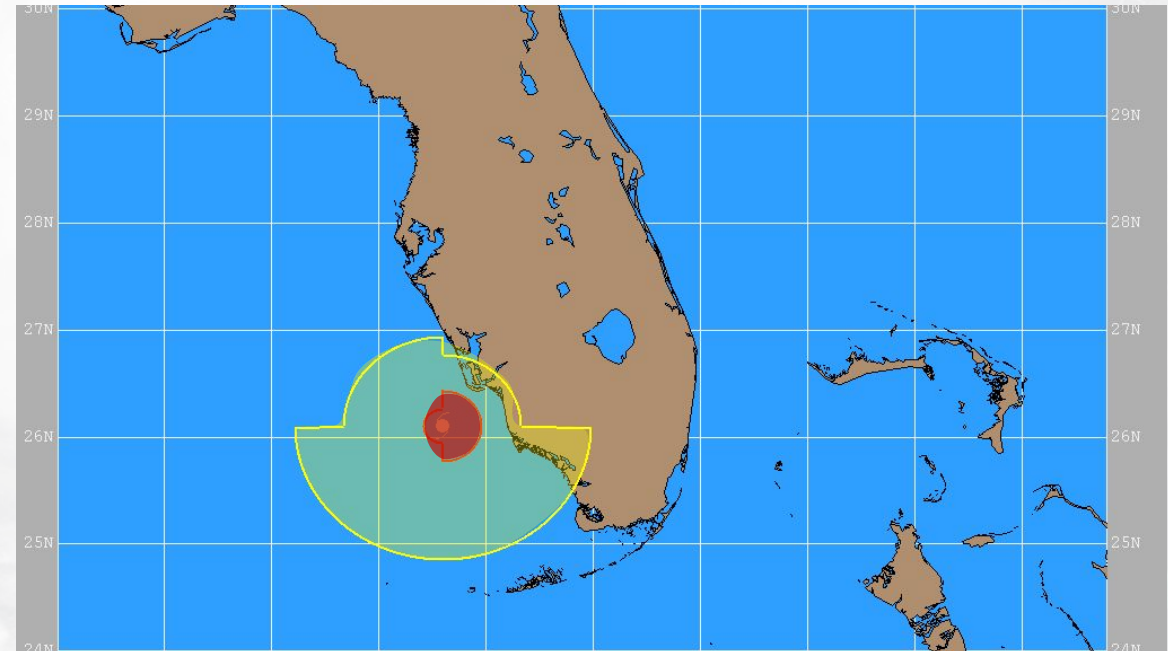
Ian

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

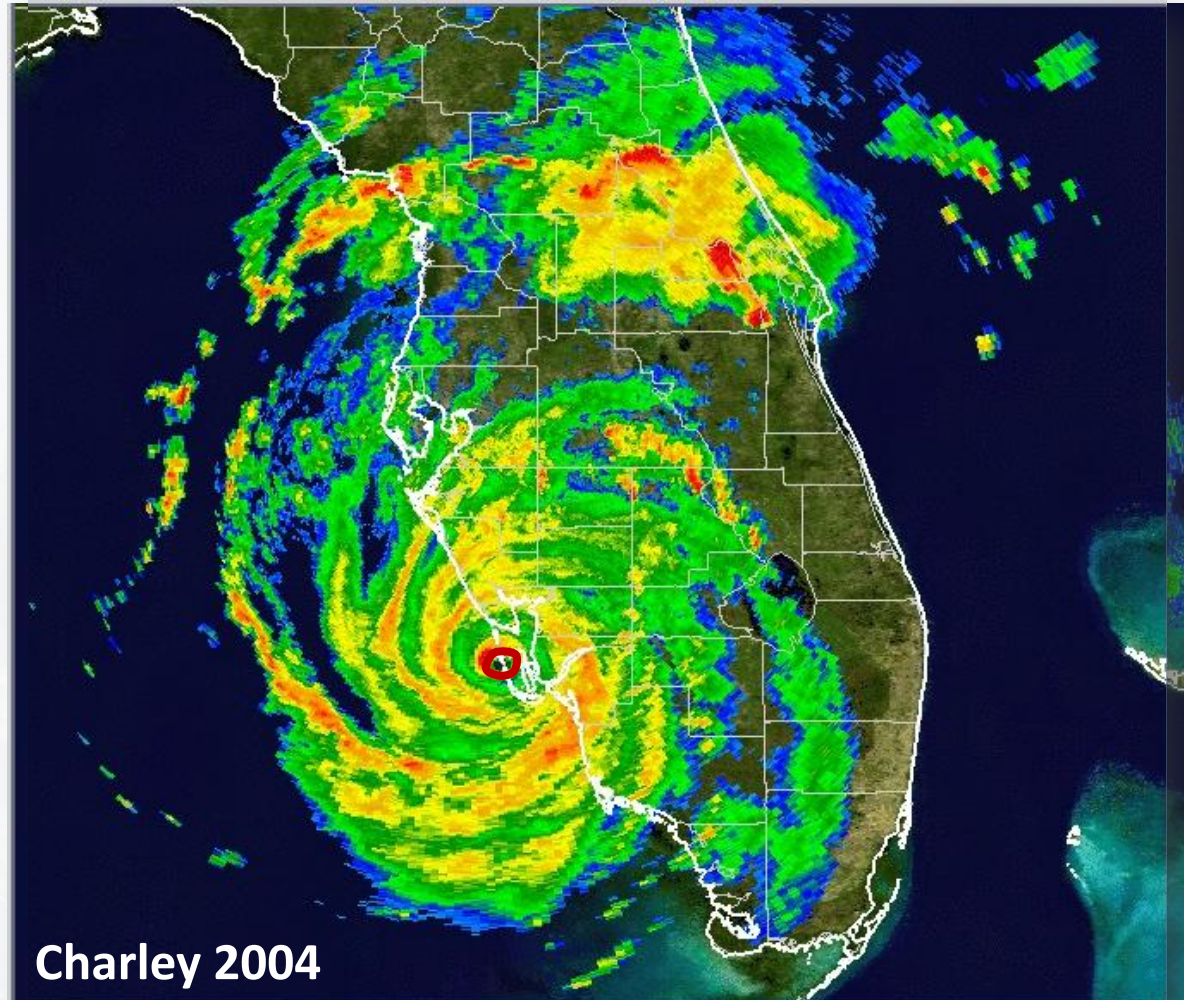


Charley

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

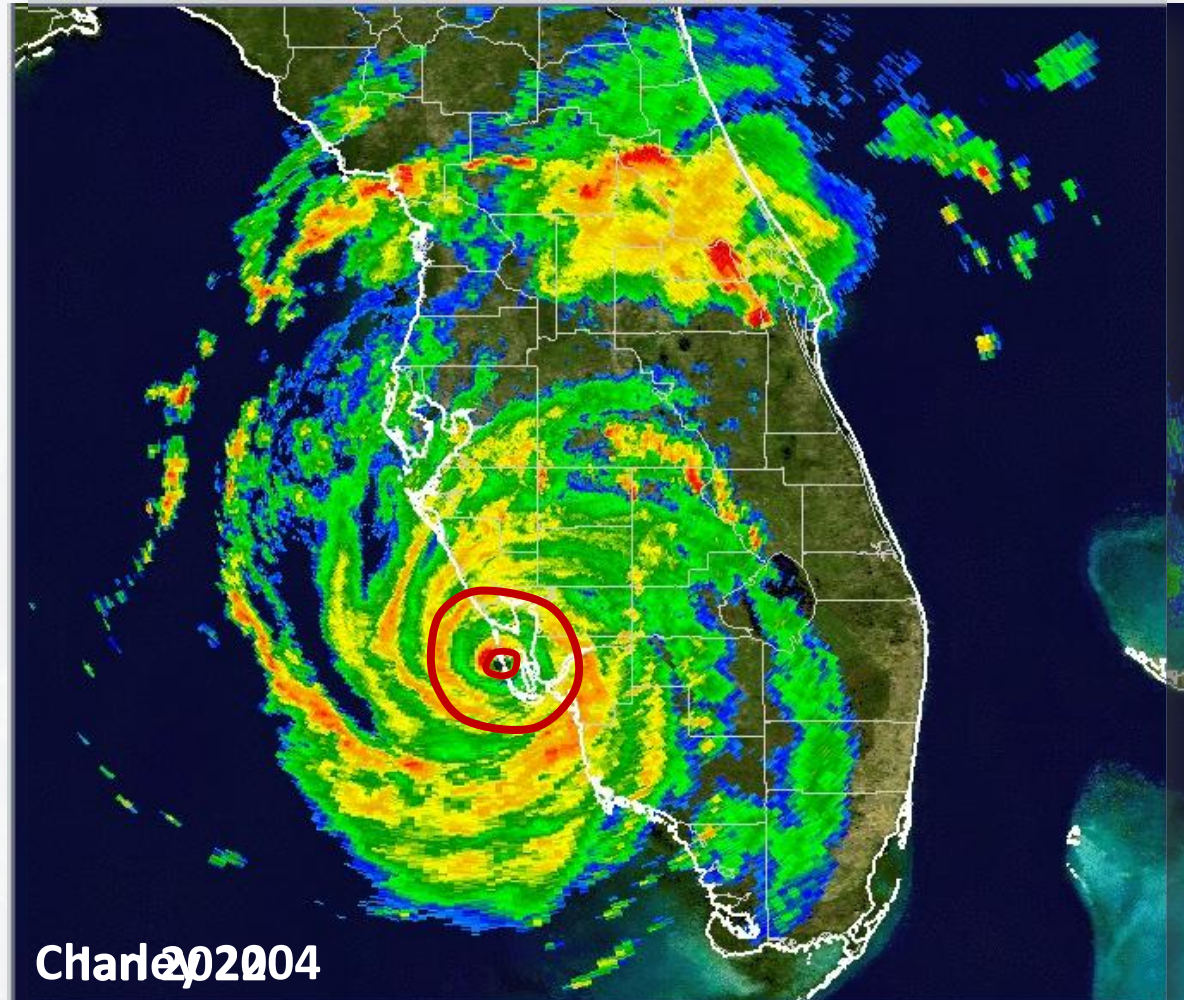


Differences in Core Size (Radius of Maximum Winds)



Charley: Radius of Maximum Winds ~ 6 n mi

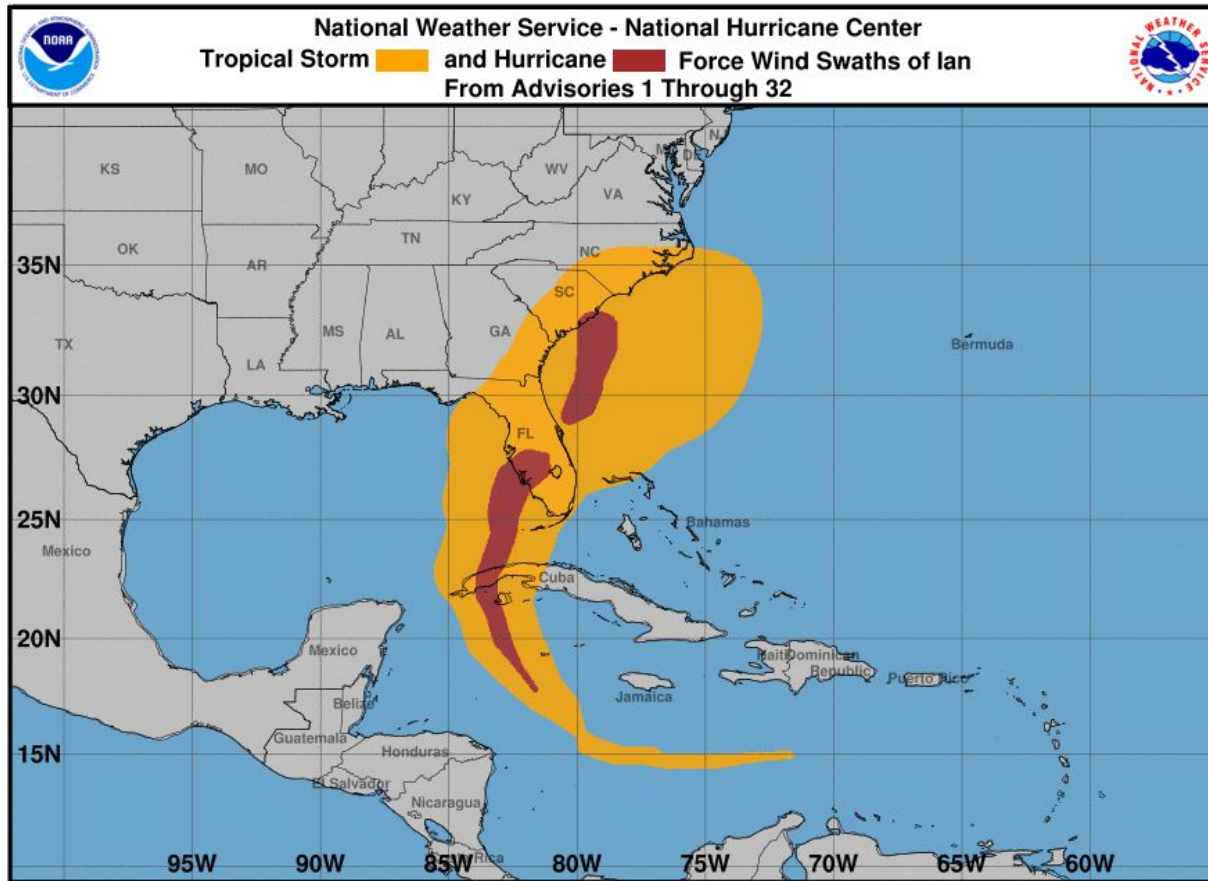
Differences in Core Size (Radius of Maximum Winds)



Charley: Radius of Maximum Winds ~ 20mi

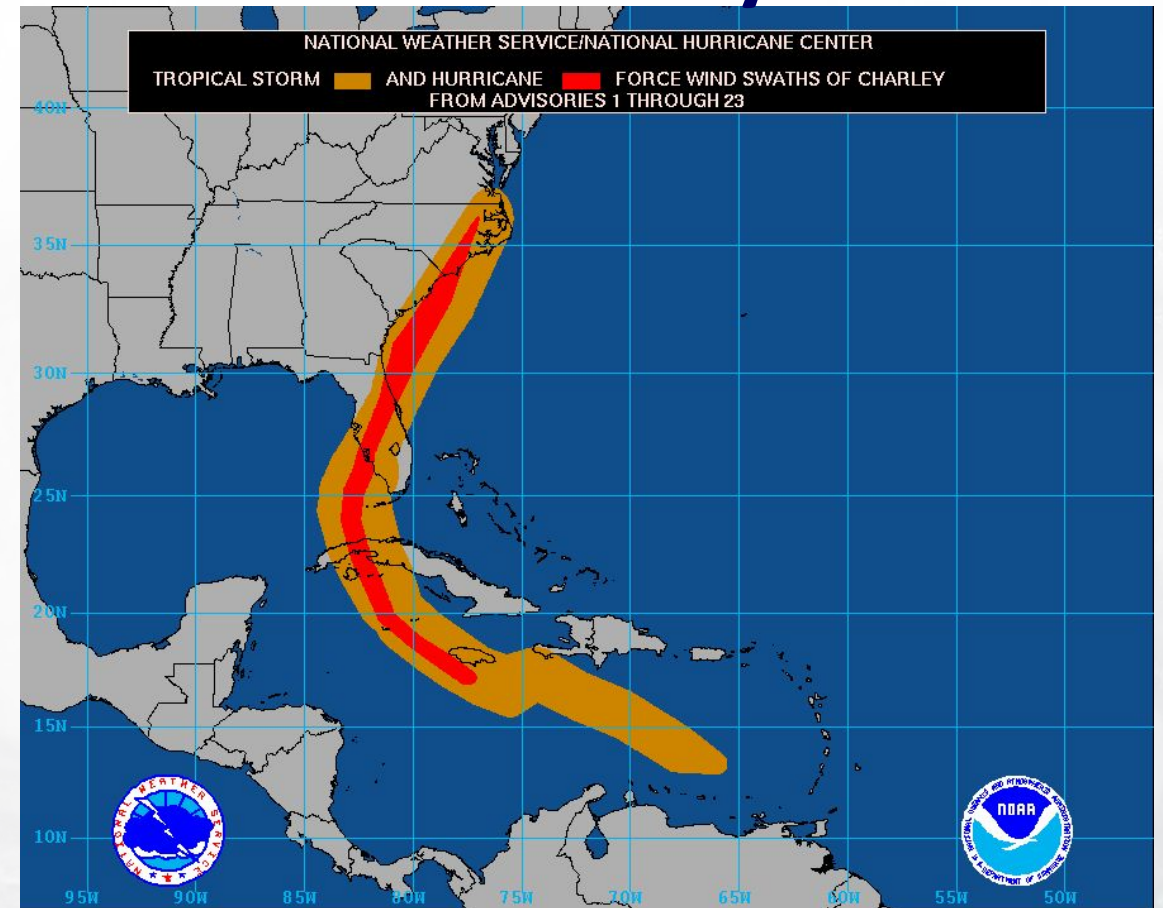
Charley – Narrow Swath of Extreme Winds but More Inland Penetration

Ian



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

Charley



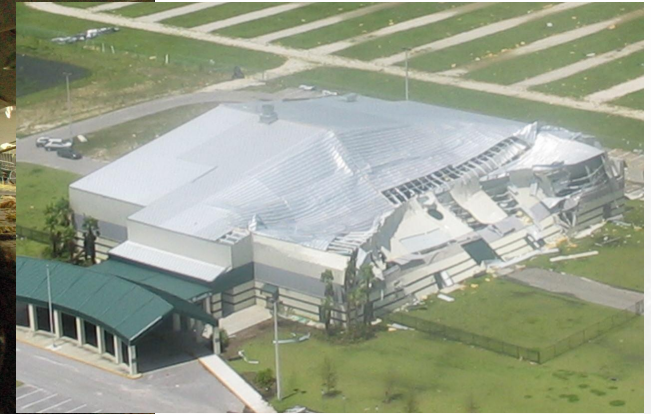
Charley's fast forward speed resulted in hurricane-force winds crossing the entire Florida Peninsula. Extreme wind damage occurred in Arcadia and Orlando

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)

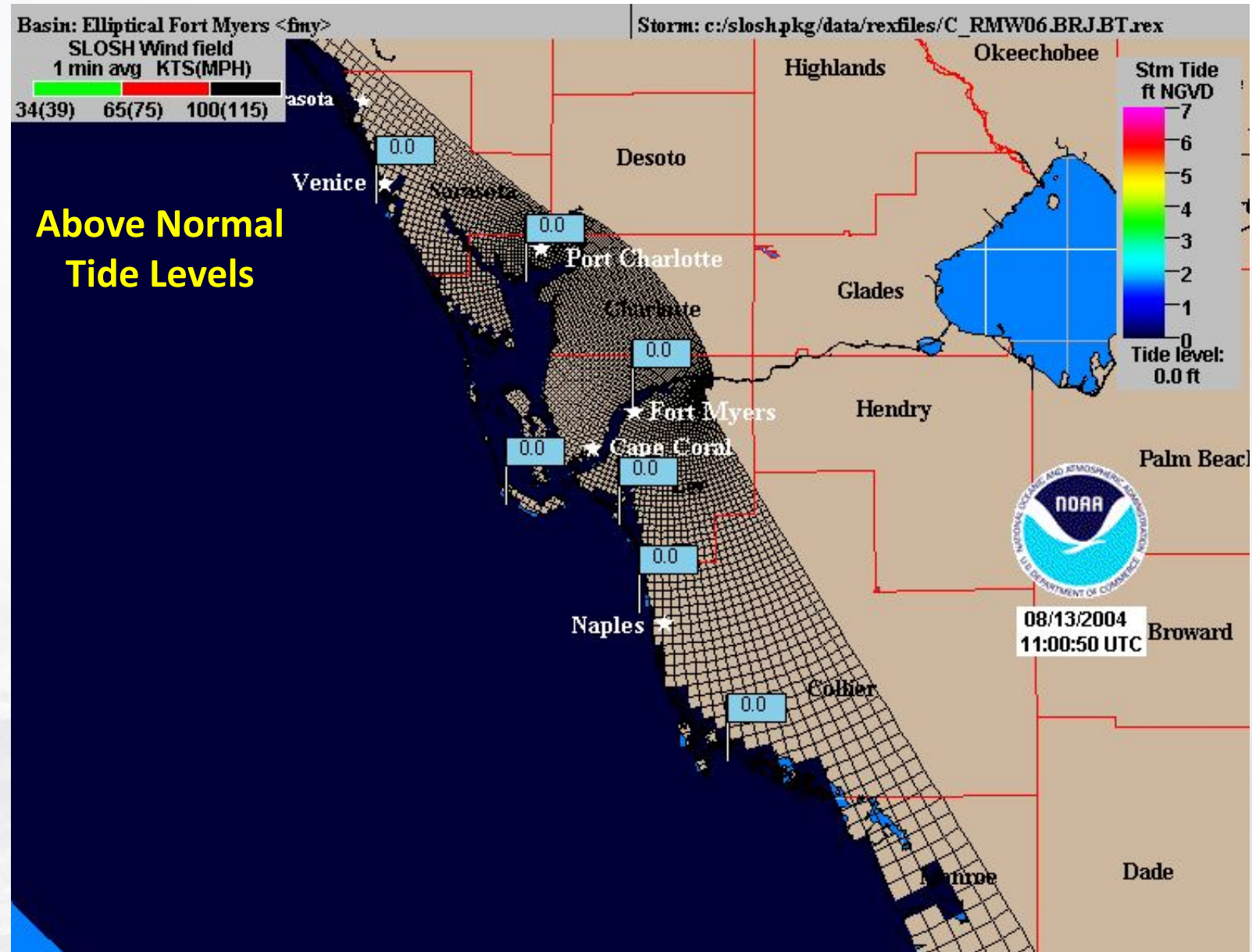


Model home (2004) in Punta Gorda Isles

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

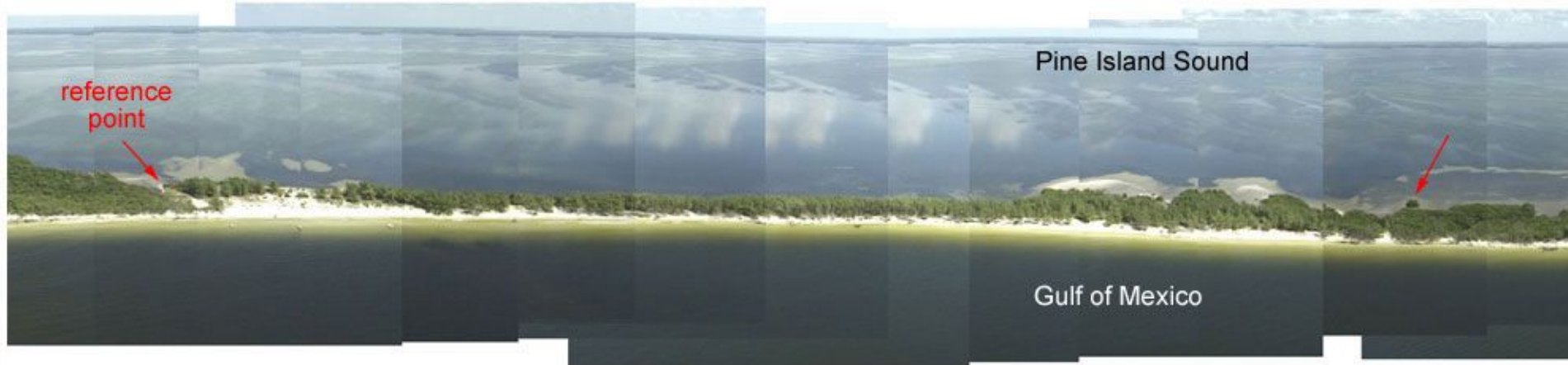
Charley's Small Core Limited its Storm Surge Footprint

- 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

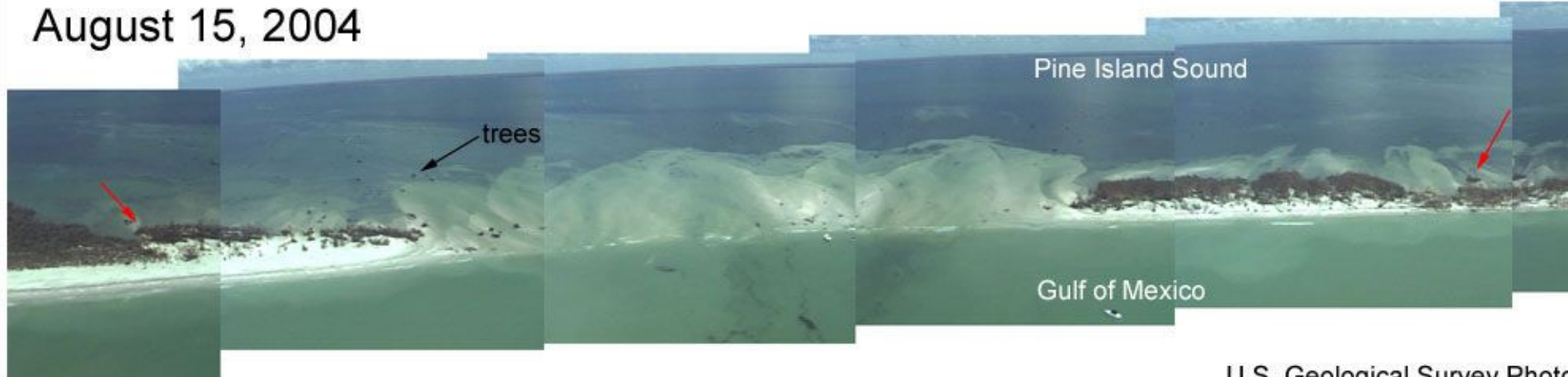


Charley's Storm Surge Caused Breach in North Captiva

North Captiva Island, FL
September 29, 1999



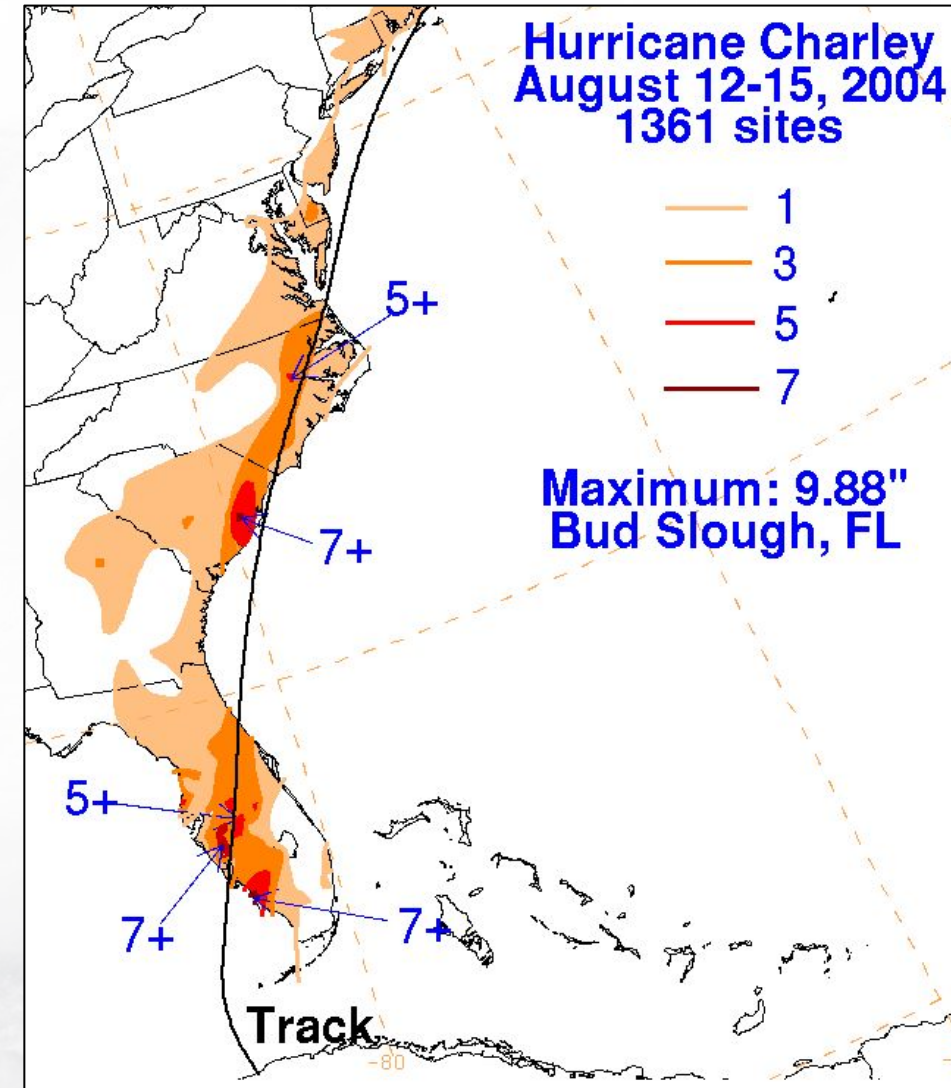
August 15, 2004



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...

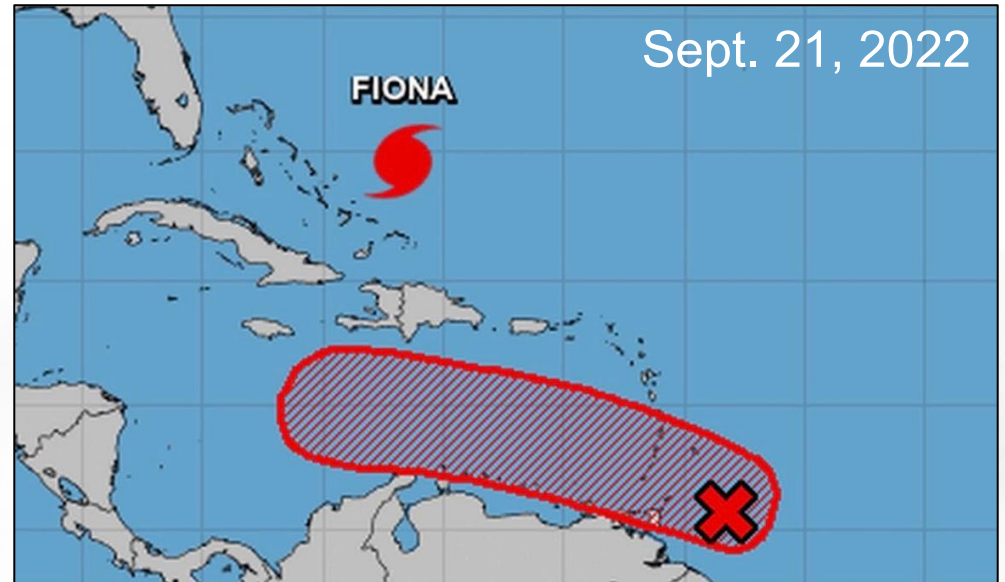
THE REMNANTS OF TROPICAL DEPRESSION TWO ARE CENTERED IN THE EXTREME SOUTHEASTERN GULF OF MEXICO ABOUT 75 MILES NORTH OF CANCUN. THIS SYSTEM CONTINUES TO SHOW SIGNS OF ORGANIZATION AND COULD RE-DEVELOP INTO A TROPICAL CYCLONE LATER TODAY. AN AIR FORCE RESERVE RECONNAISSANCE AIRCRAFT IS SCHEDULED TO INVESTIGATE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

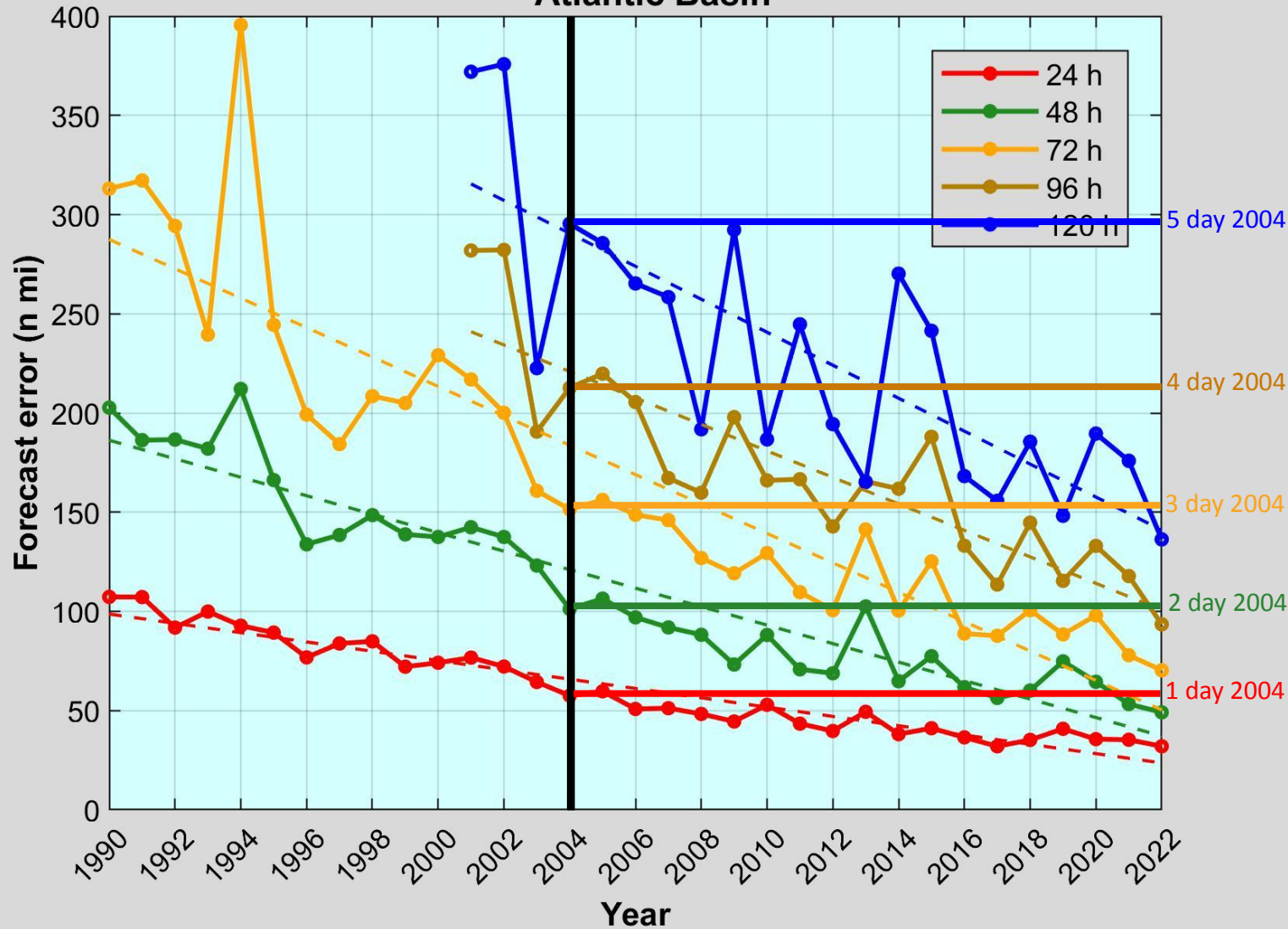


Tropical system heading toward Caribbean is likely to become hurricane, with Florida in its long-term path

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

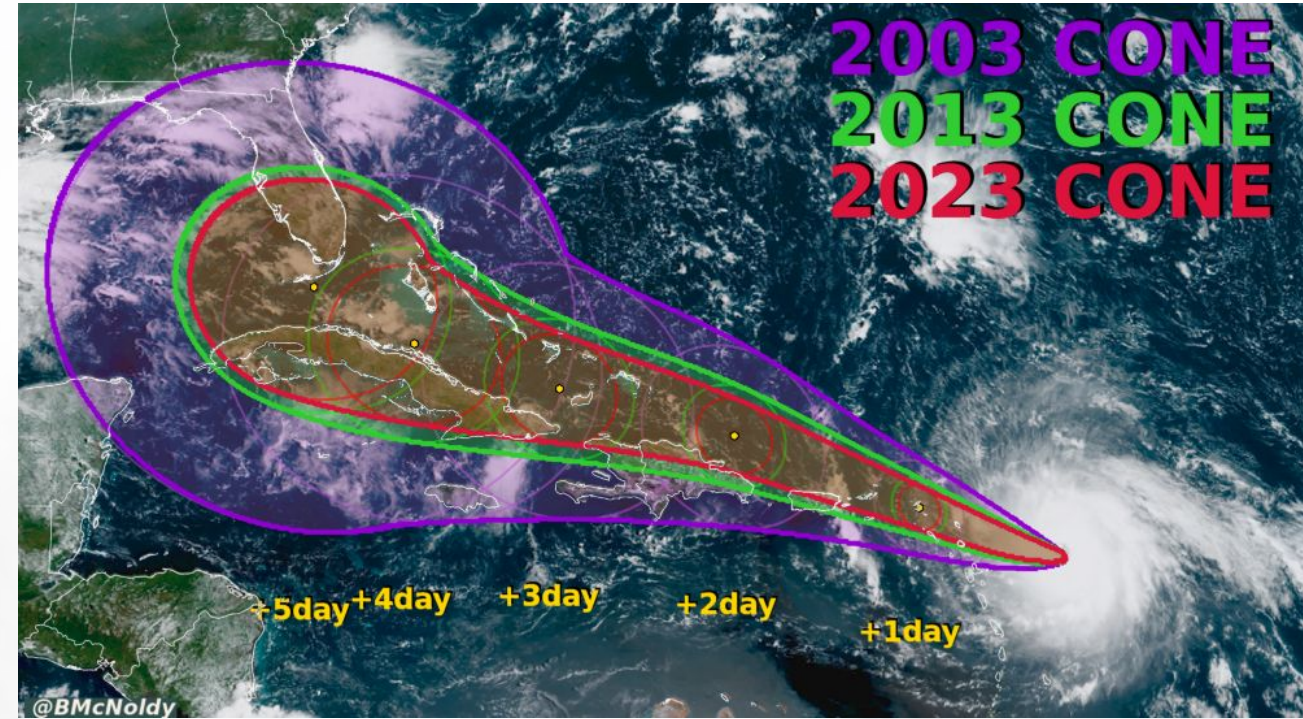
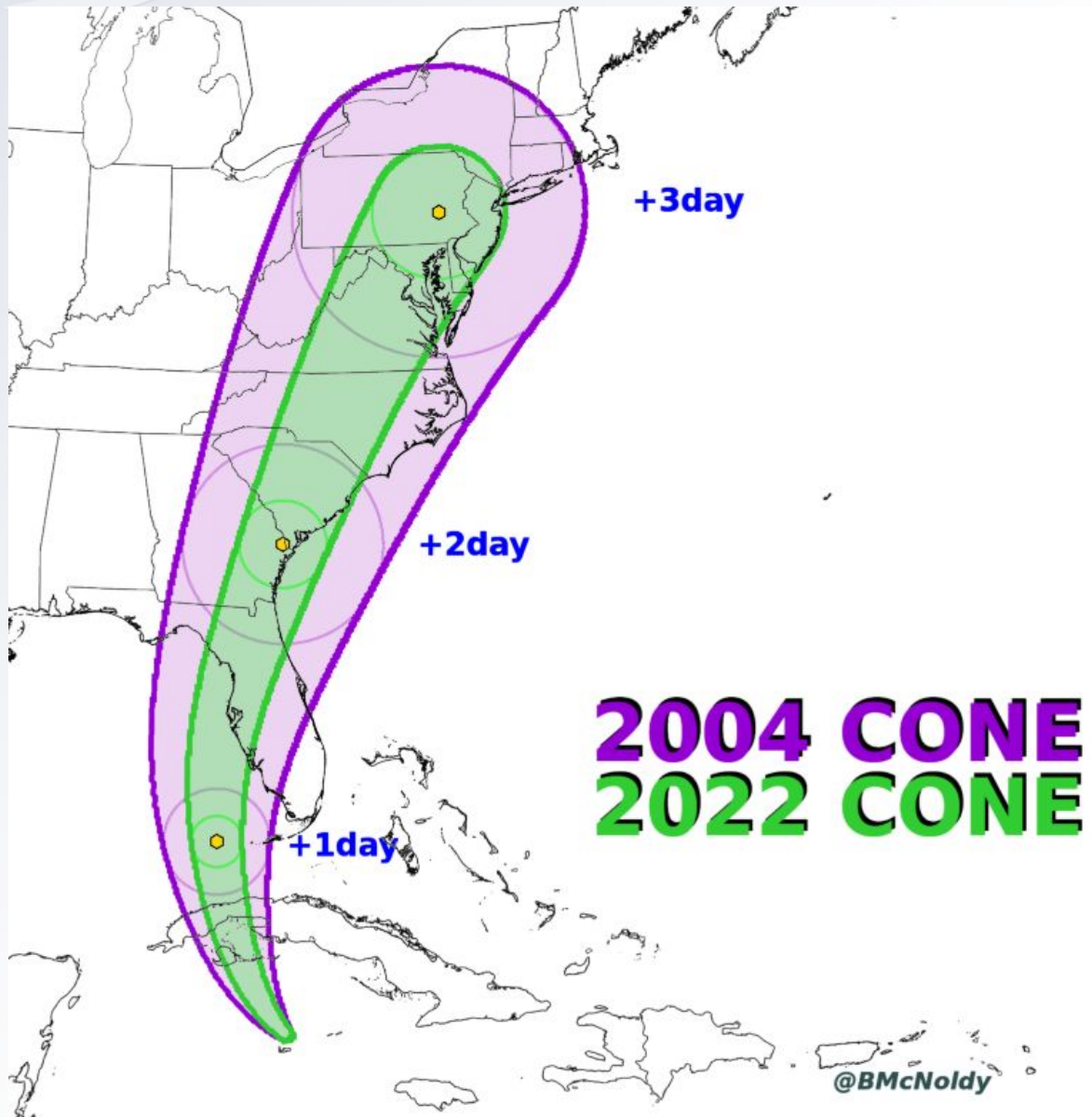
NHC Official Track Error Trend
Atlantic Basin



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.

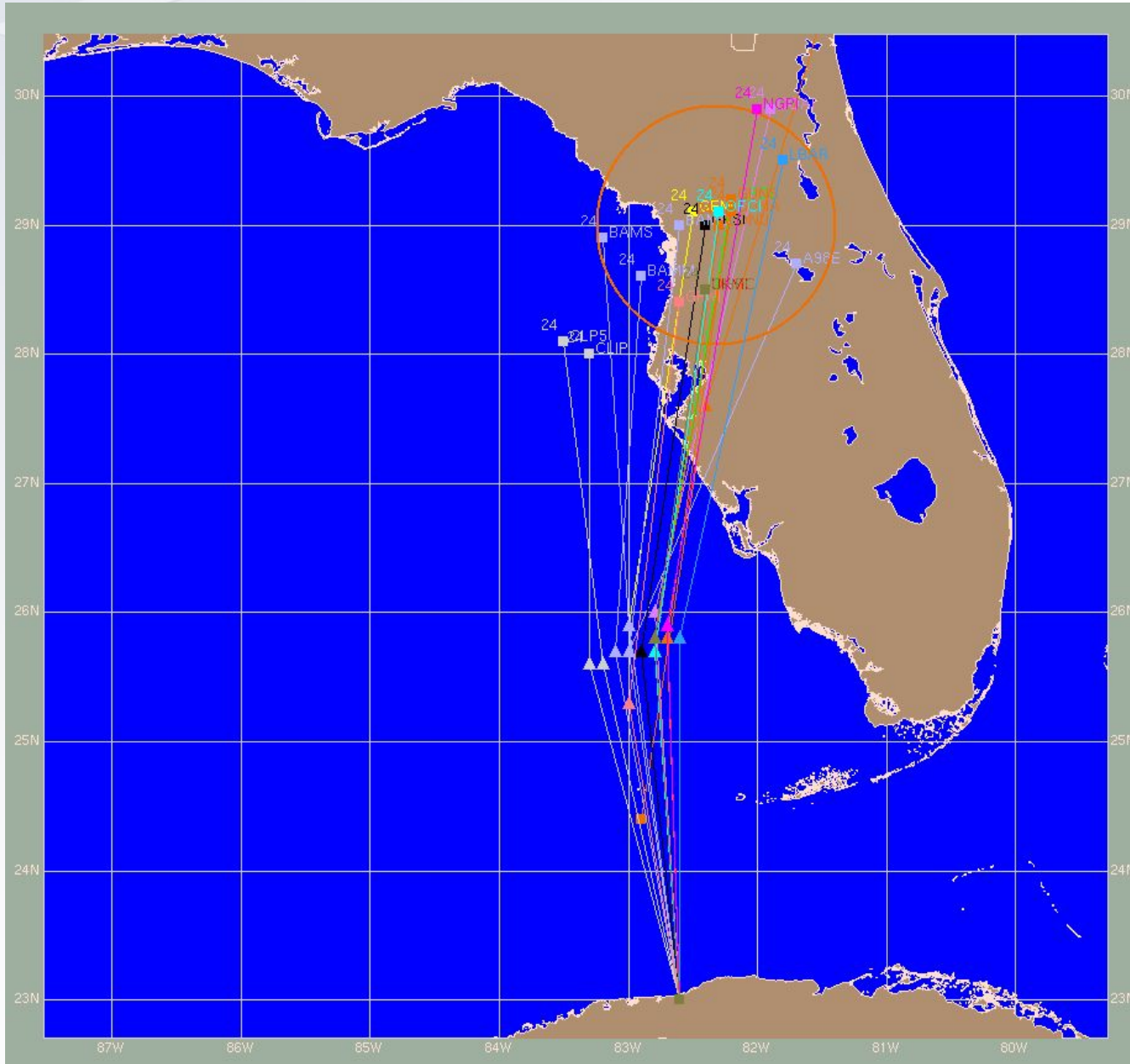
Evolution of the NHC Forecast Cone



- 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 65, low 55, 10% chance of rain. 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.

145 mph winds, 14 ft surf, at landfall

5 mph winds, 14 ft surf, at landfall

28.94 mph winds, 14 ft surf, at landfall

7 mph winds, 14 ft surf, at landfall

30 mph winds, 14 ft surf, at landfall

0.25 inch of rain, 14 ft surf, at landfall

\$15-billion in damage to the state

160 homes destroyed in Lee County

1.9-million people evacuated in 11 counties

272 homes open to the public

21,980 people in shelters

50 homes destroyed in Pinellas County

5,000 National Guardsmen to be in state by Sunday

12,852 homes destroyed in Pinellas County

20 homes destroyed in Pinellas County



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 as storm brushes by

BY DAVID BOYD
IN THE NEWS The storm's intensity surprised many as it brushed the west coast of Florida.

It was a surprise when Hurricane Charley, a Category 4 storm, brushed the west coast of Florida. The storm's intensity surprised many as it brushed the west coast of Florida. The storm's intensity surprised many as it brushed the west coast of Florida.

Why Charley turned

INSIDE The storm's path was influenced by a combination of factors, including a low-level jet stream and a high-level jet stream.

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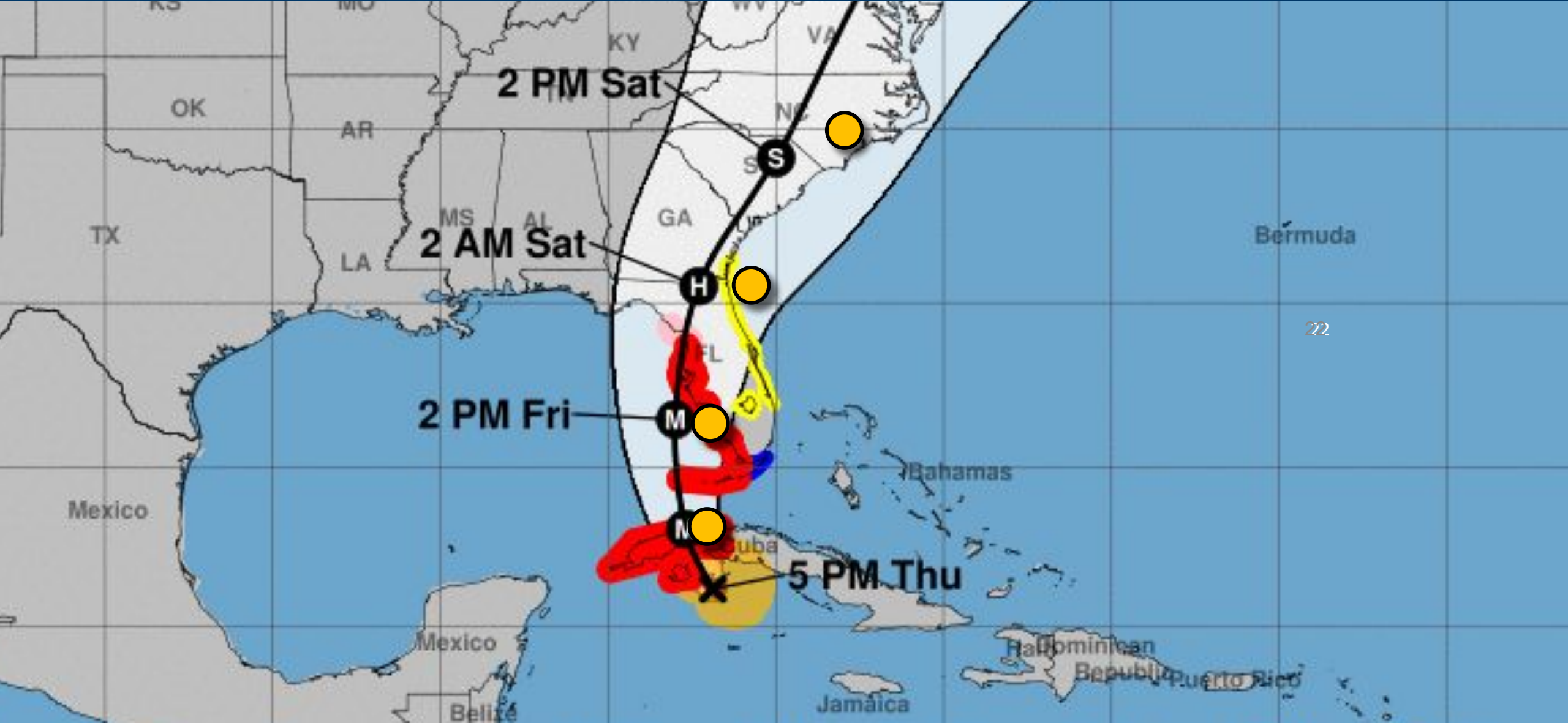
Tampa Bay relieved as storm brushes by

BY JAMES THOMPSON
IN THE NEWS Tampa Bay residents were relieved as the storm brushed by.

Tampa Bay residents were relieved as the storm brushed by. Tampa Bay residents were relieved as the storm brushed by. Tampa Bay residents were relieved as the storm brushed by.

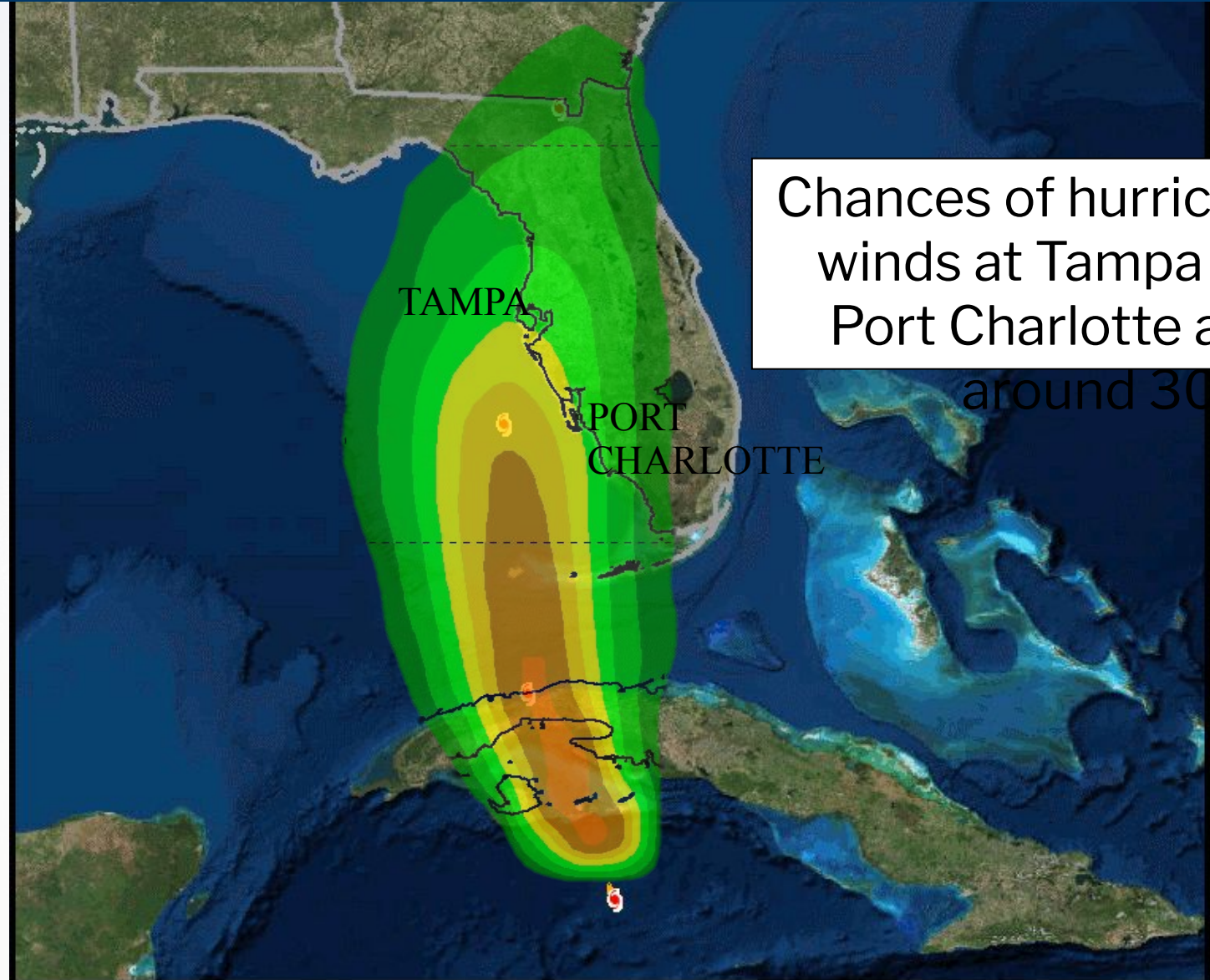
HURRICANE CHARLEY (2004)

Don't focus on the skinny black line.



HURRICANE CHARLEY

Would alternate scenarios help?

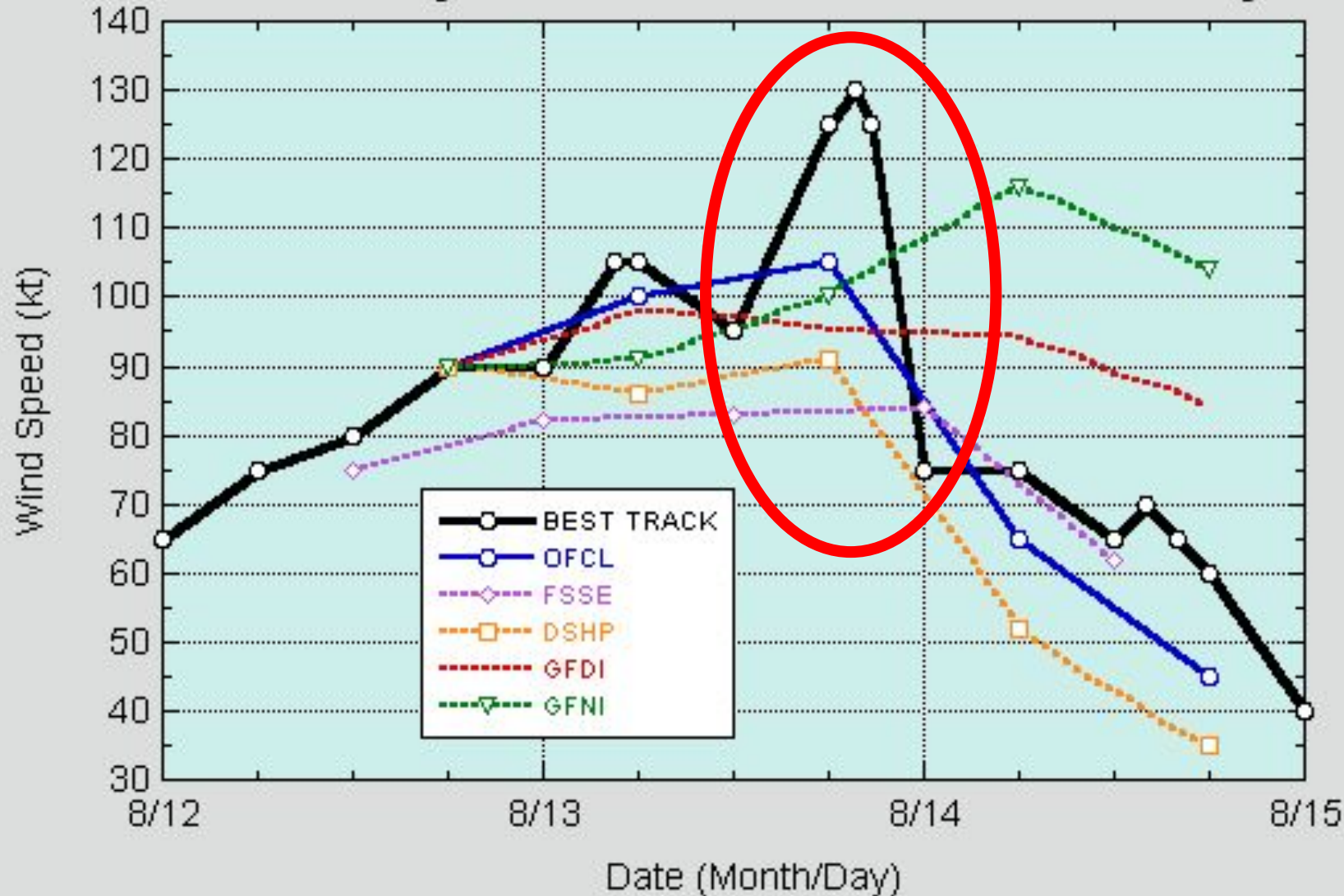


Chances of hurricane-force winds at Tampa Bay and Port Charlotte are both

around 30%

Hurricane Charley Intensity Forecasts

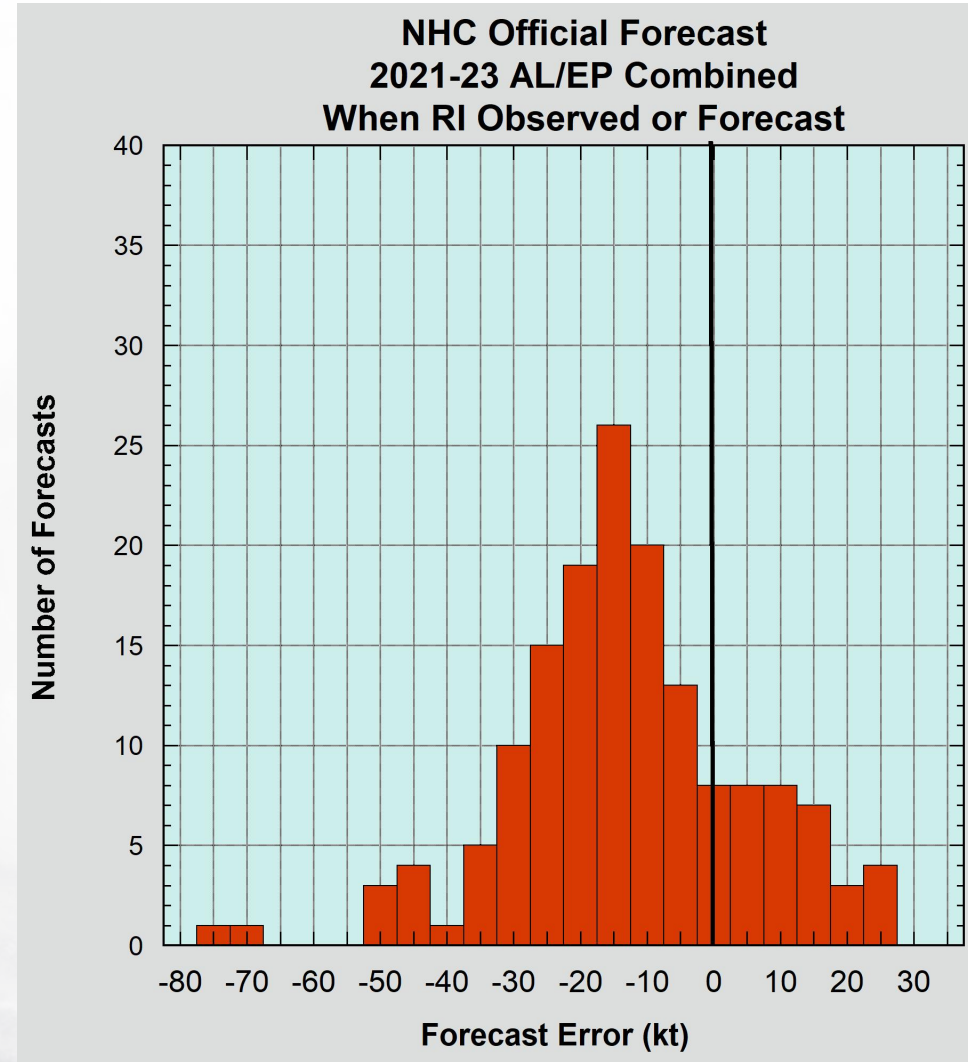
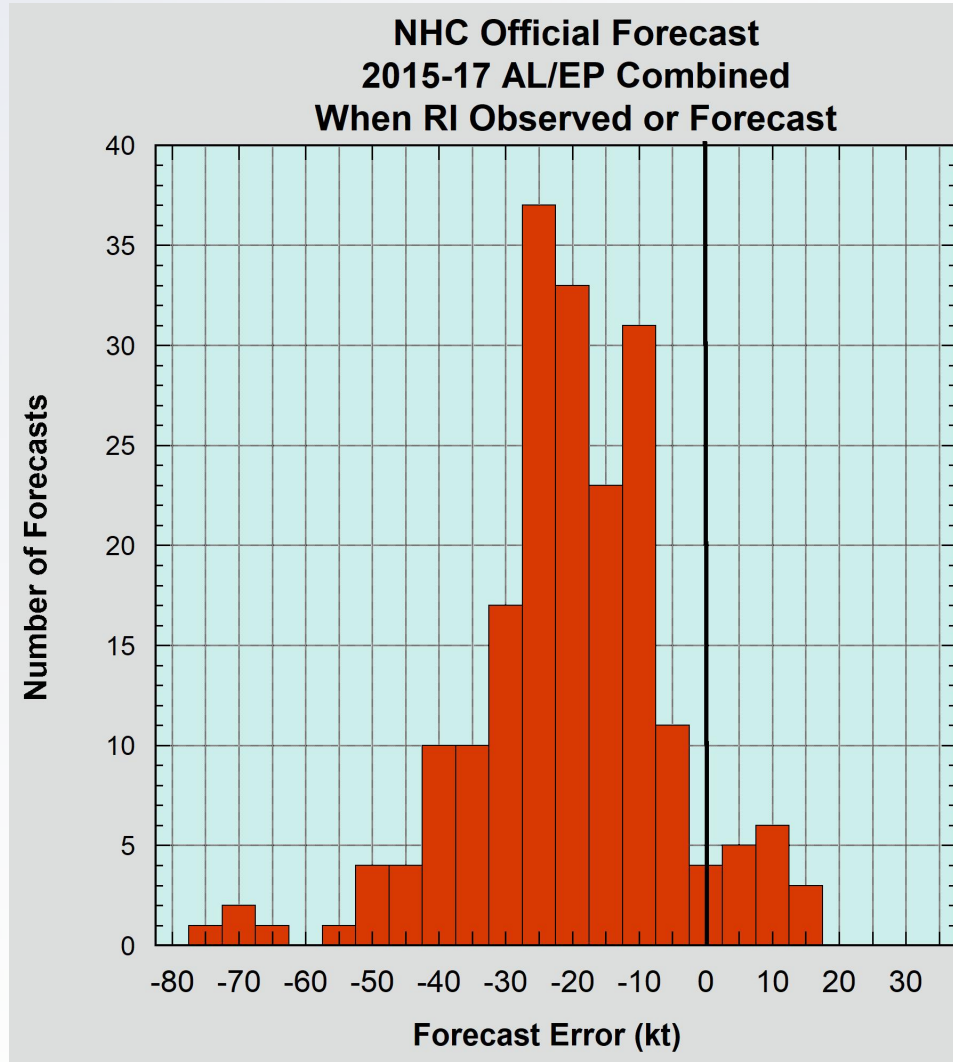
Intensity Guidance for Hurricane Charley



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.

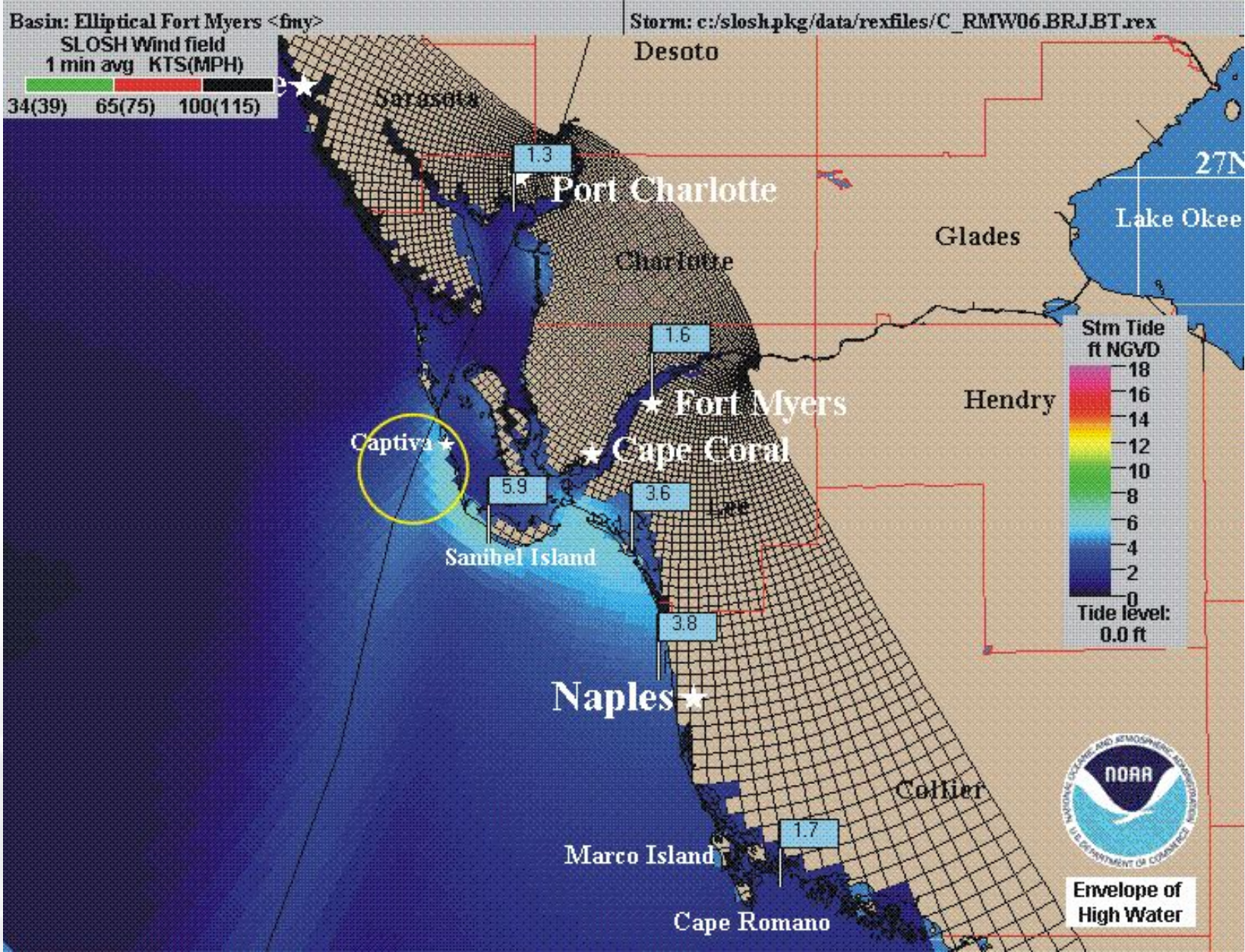
Progress in Forecasting Rapid Intensification



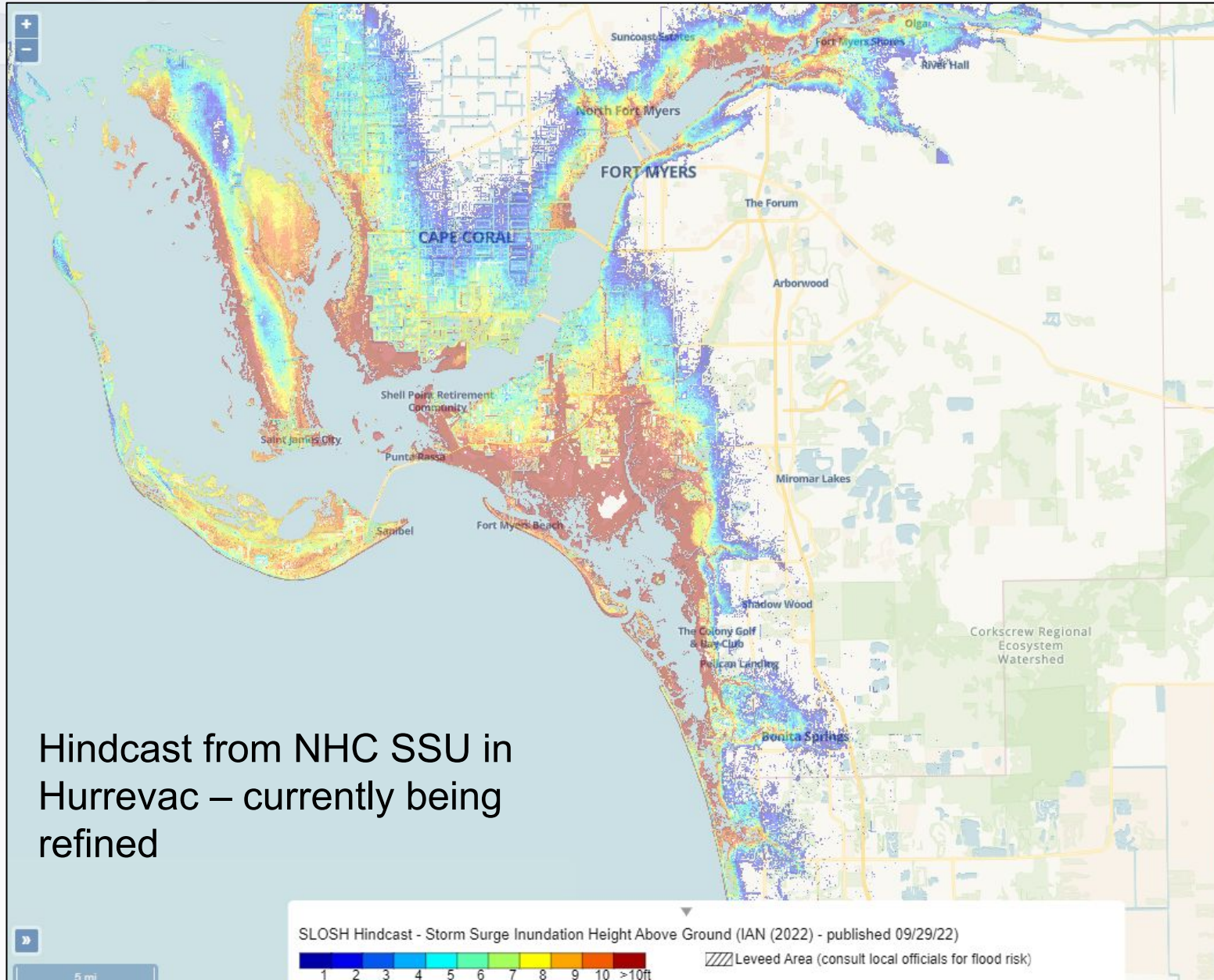
NHC's 24-h intensity forecast error during rapid intensification events has been reduced from 20 kt to 12 kt since 2015-2017

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

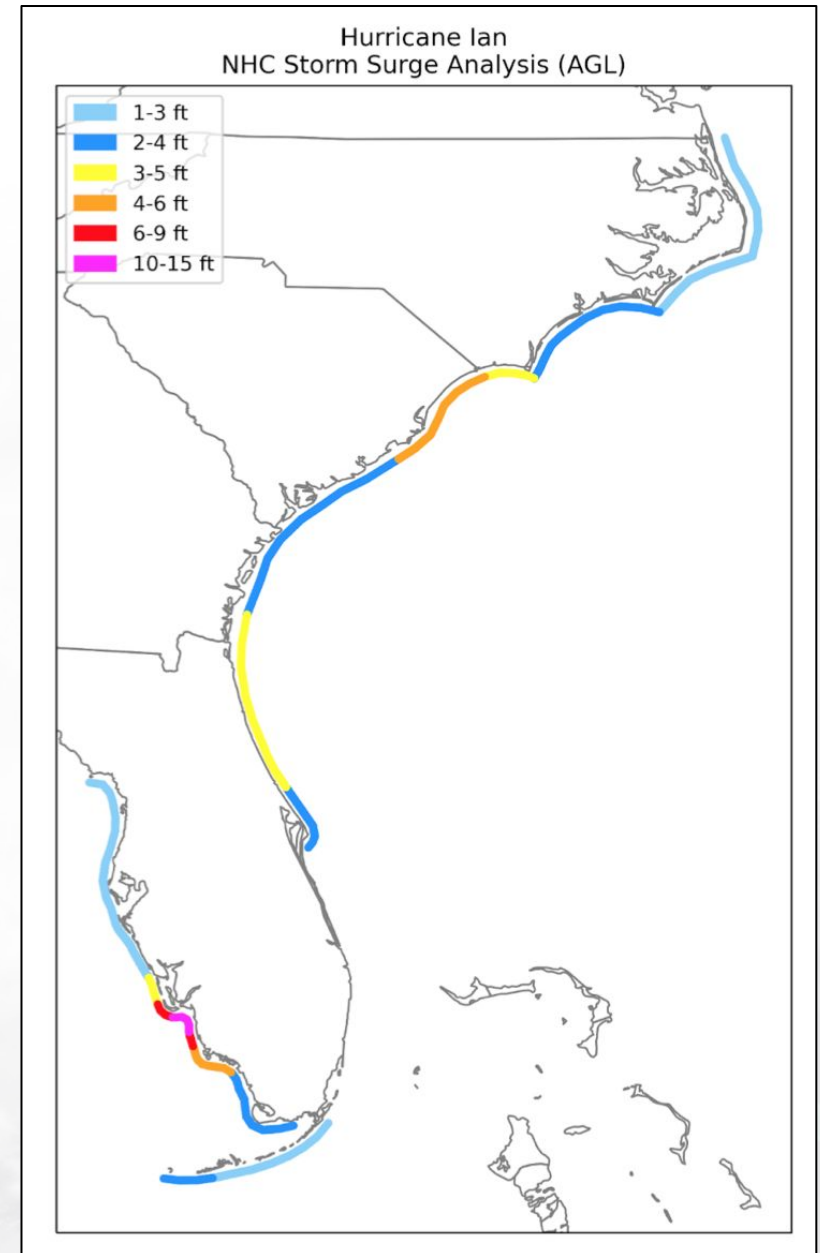
Potential Storm Surge Flooding Map and Storm Surge Warning introduced since 2004



Rough Estimate of Ian's Storm Surge Footprint



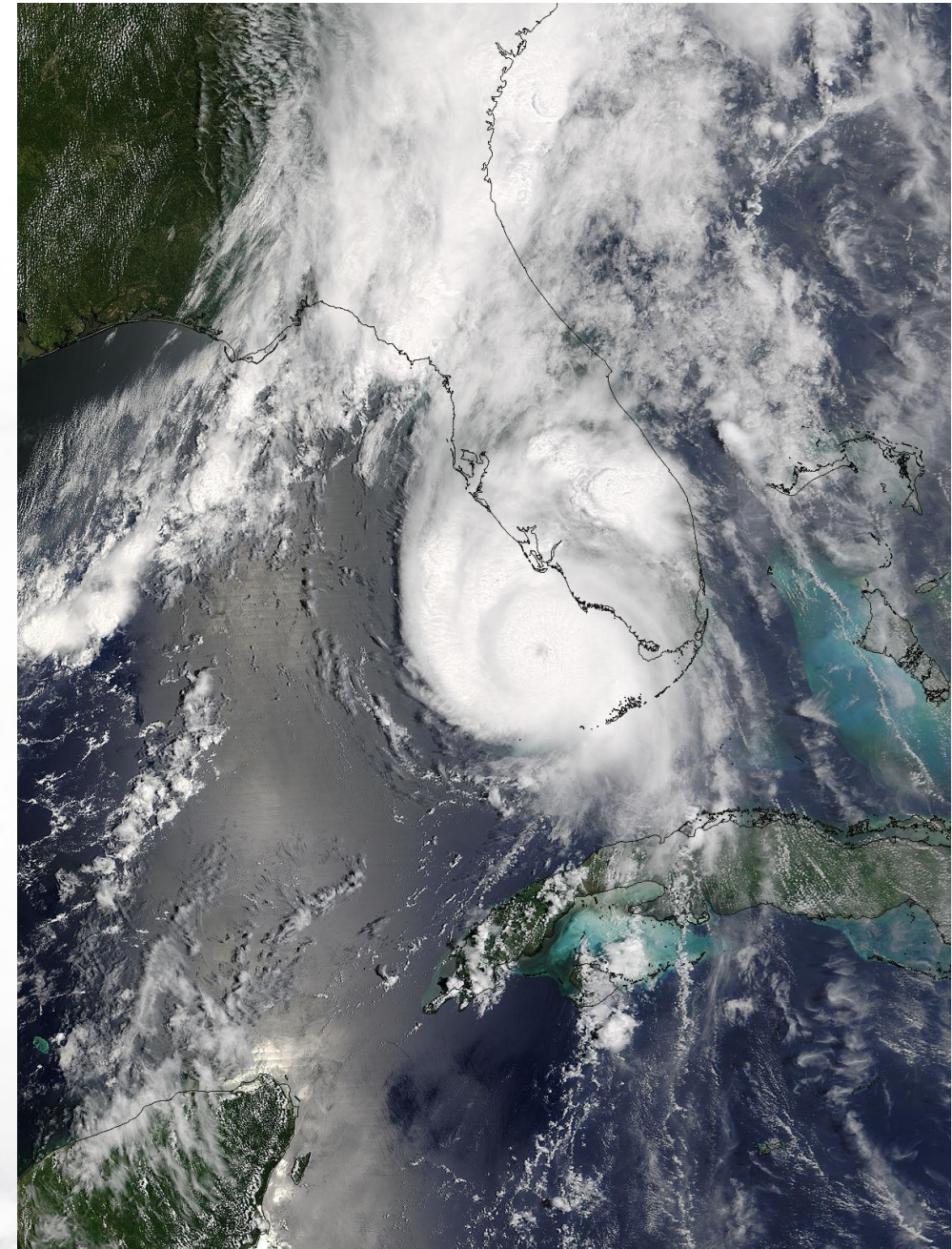
Hindcast from NHC SSU in Hurrevac – currently being refined



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?



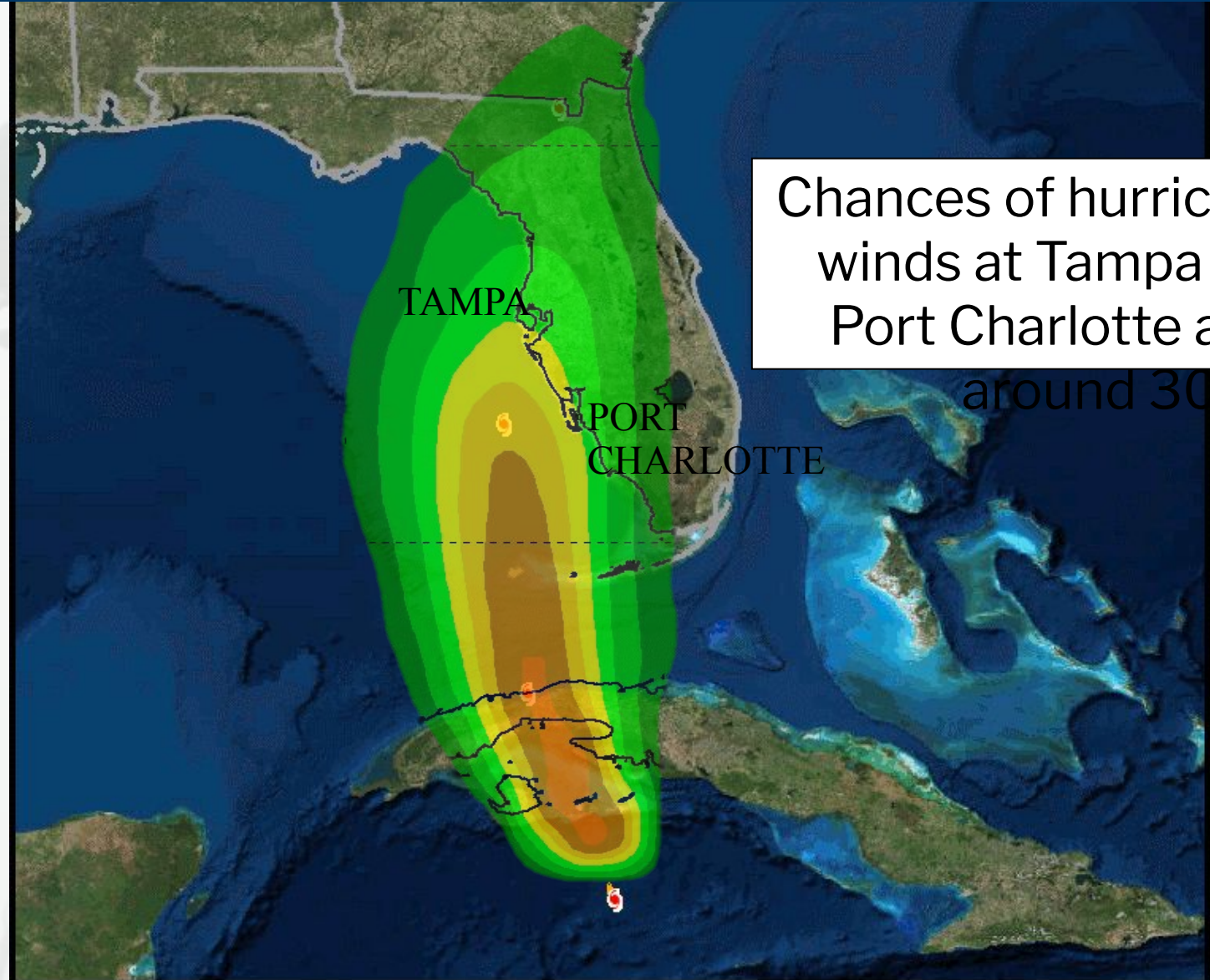
HURRICANE CHARLEY

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

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.**
Time Charley made landfall at Sanibel Island
- 145**
Sustained surface wind, in mph, at landfall
- 5**
Diameter of eye, in miles, at landfall
- 28.94**
Barometric pressure, in inches, at landfall (Hurricane Andrew was 27.23 inches)
- 7**
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 east of Category 4 hurricane 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 SQUIRES, BRUCE DEWITT, 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 pummed 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 Island, where 100 homes were destroyed, according to a preliminary survey by Lee County officials.

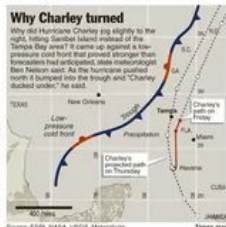
Three fatalities were reported, but emergency officials were still trying to assess whether more people were killed or injured. Few were traffic accidents. The third was an unidentified Fort Myers 20-year-old who stepped outside to smoke a cigarette. A bus was run off a hill, Lee County officials said.

Gov. Jeb Bush estimated the property damage would exceed \$15 billion, but the state's chief financial officer, Tom Gallagher, urged caution.

"Anyone who gives you a number is making it up," Gallagher said.

About two hours after Charley's 3:45 p.m. landfall near Captiva, President Bush declared a state of emergency.

Please see **CHARLEY 12A**.



INSIDE
Q&A: What if your car got gutted? How can you avoid repairs? **PAGE 10A**

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, **16C**

ON THE WEB: Go to www.actionnews.com to get updates on storm impact and cleanup efforts. To view reader photos land 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.

Beyond 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.

Please see **BRACED 11A**.

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. **TIMES 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 Fort Charlotte town house on Friday. Staff photo/Mike Stocker

Everyone where 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. Glasses 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 Turseles 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 Robert Angel of Tarpon Springs, who sought safety in a Lakeland motel. "I spent hundreds of dollars to be in the center of a hurricane. Our house is safe, but now I'm in a motel."

Officials were hoping that residents would not see their effort to flee as wasted, saying Tampa Bay could have just as

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: **FLORIDA**

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

CHARLEY'S LANDFALL 3:45 P.M.

Port Charlotte

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

CHARLEY'S STORM SURGE REACHED 10-15 FEET ABOVE SURGE

HOW STORM SURGE FORMS

The heaviest flooding occurs on the downwind 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.

See text

Source: NOAA National Hurricane Center, Florida Emergency Management

Staff photo/Helen Hemingway, David Niblick, K. Scott Horner

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

BY KEN KAYE AND LINDA KLEINHEIST
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.

CHARLEY (CONTINUES ON 16A)

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**

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

NEWS, TRAFFIC & WEATHER **2A** SUN-SENTINEL.COM WEATHER TODAY **90** TONIGHT **79** SUNDAY **91** WEATHER PAGE ON BACK OF LOCAL

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Looking Back at the 2004 Hurricane Season

Hurricane Ivan

Bonnie
Aug 11, 2004
3:15pm EDT

Charley
Aug 13, 2004
2:55pm EDT

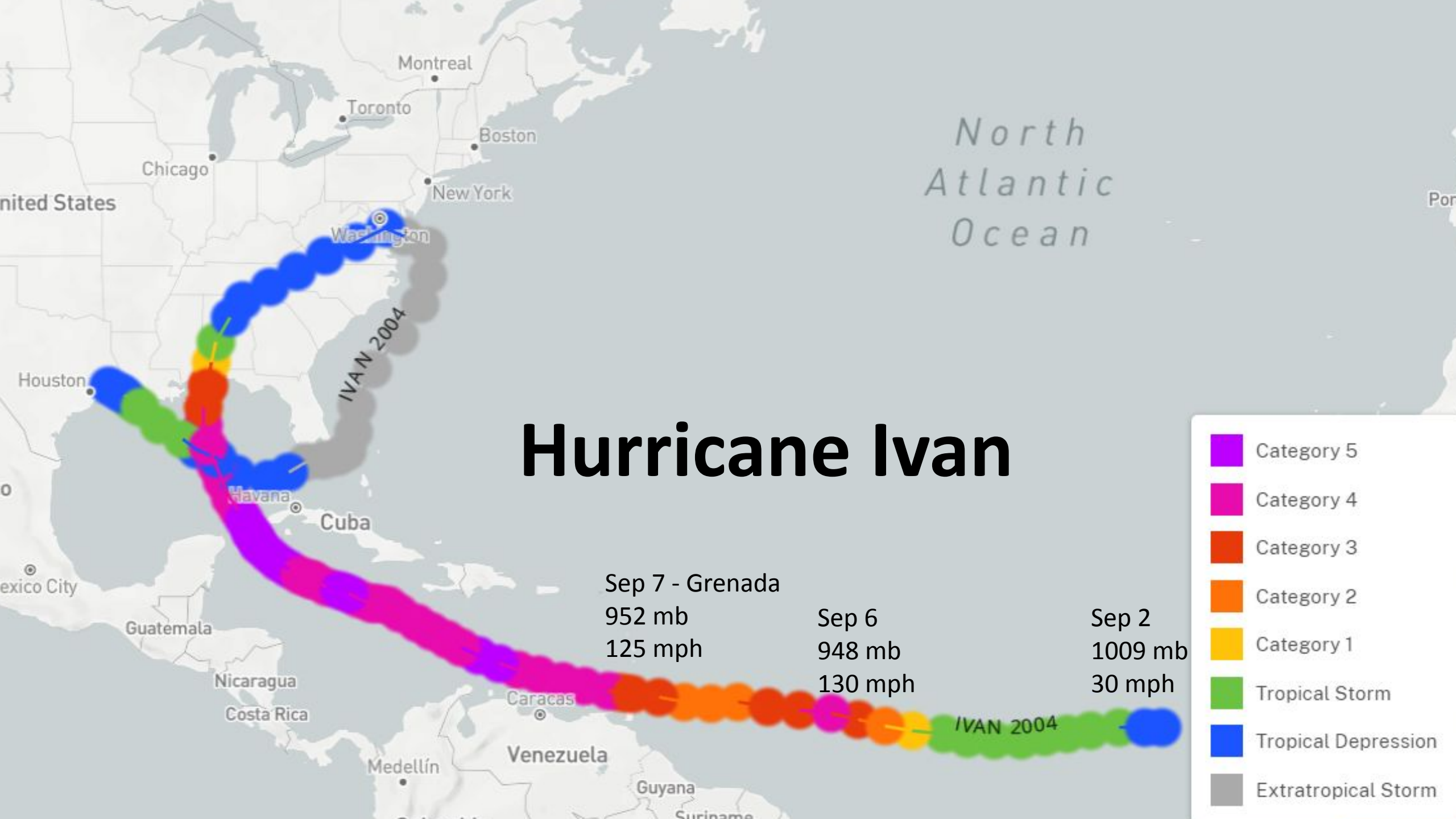
Jeanne
Sep 24, 2004
3:15pm EDT

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

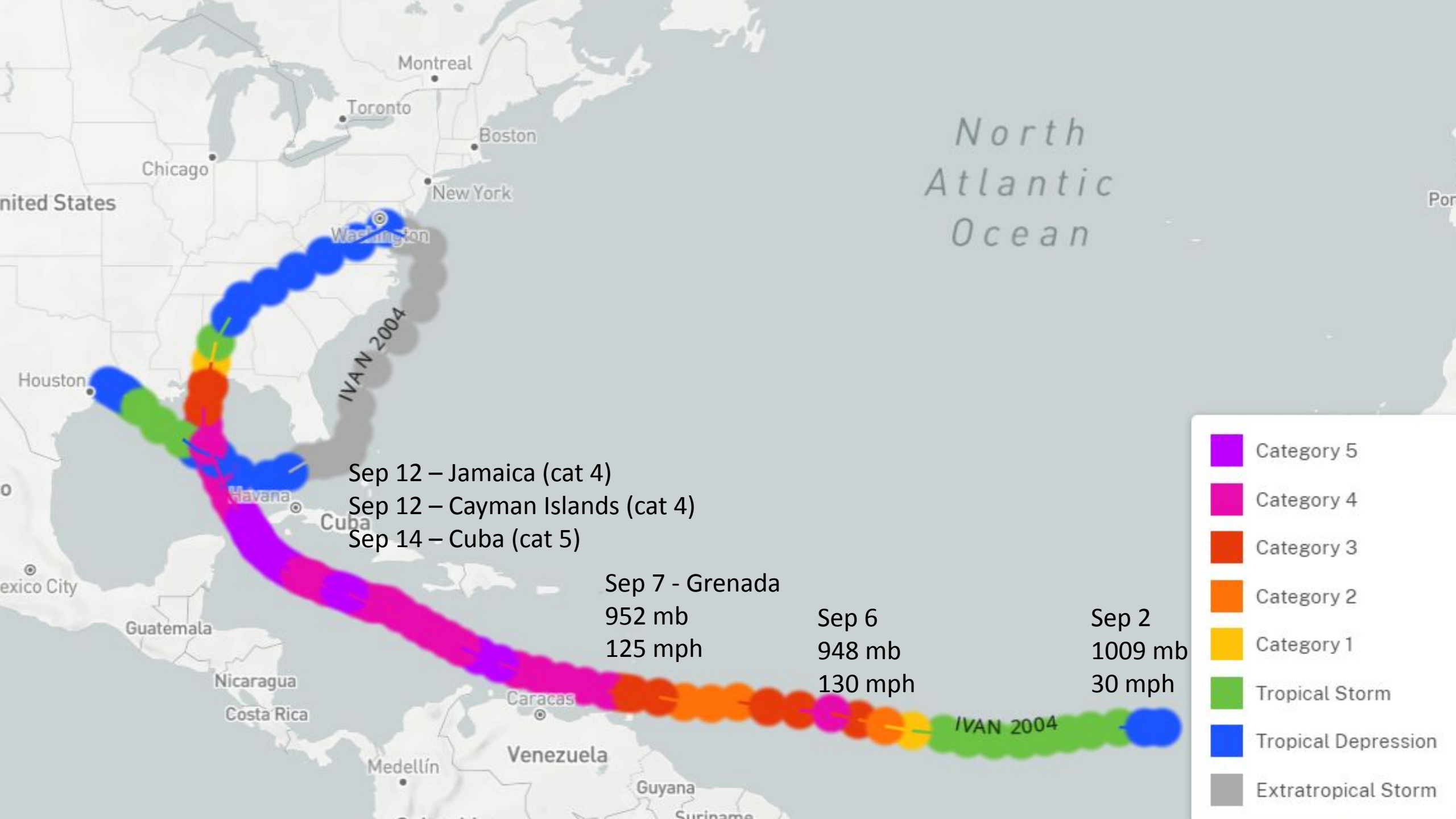
1009 mb
30 mph

IVAN 2004

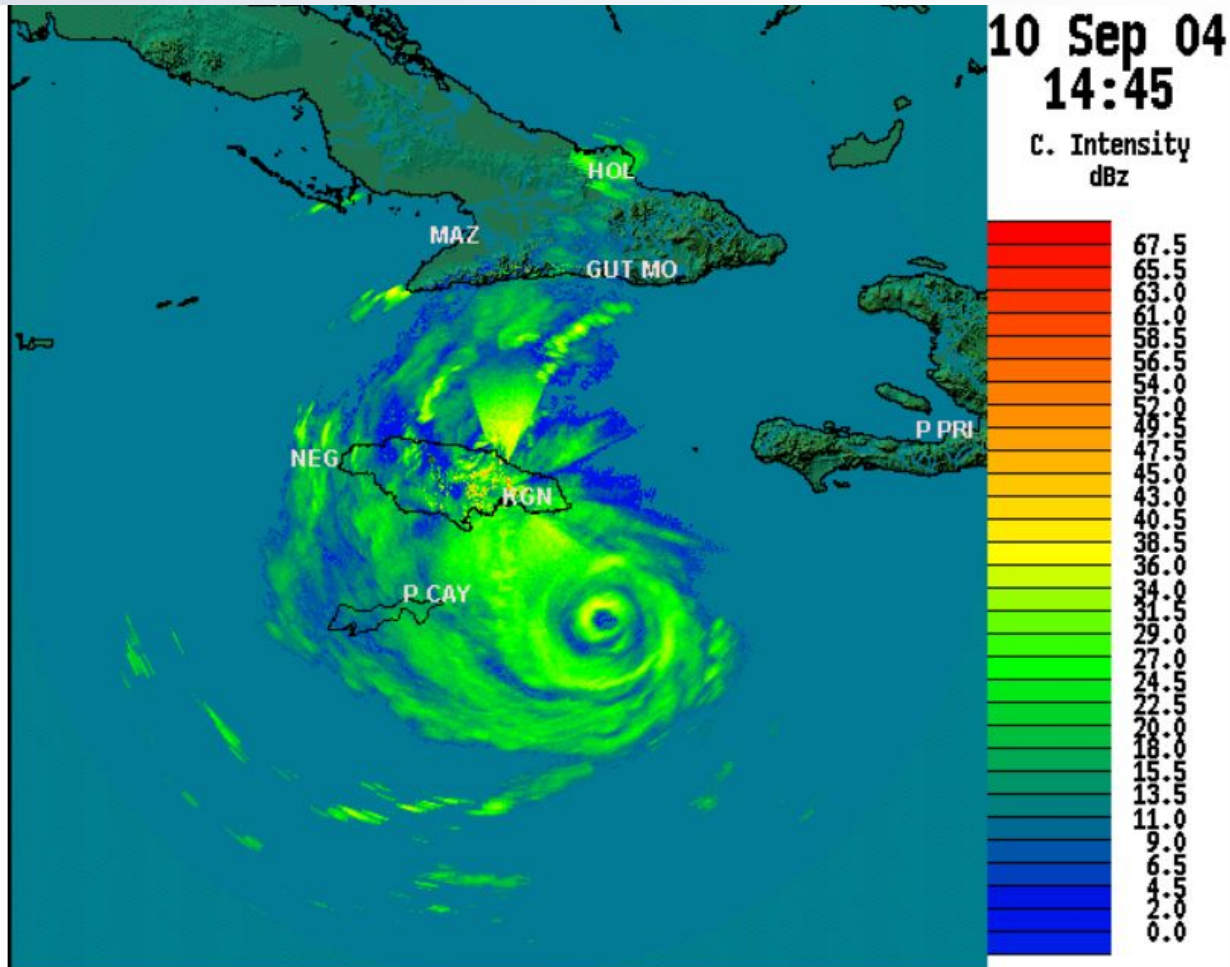
Grenada Strike



- 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

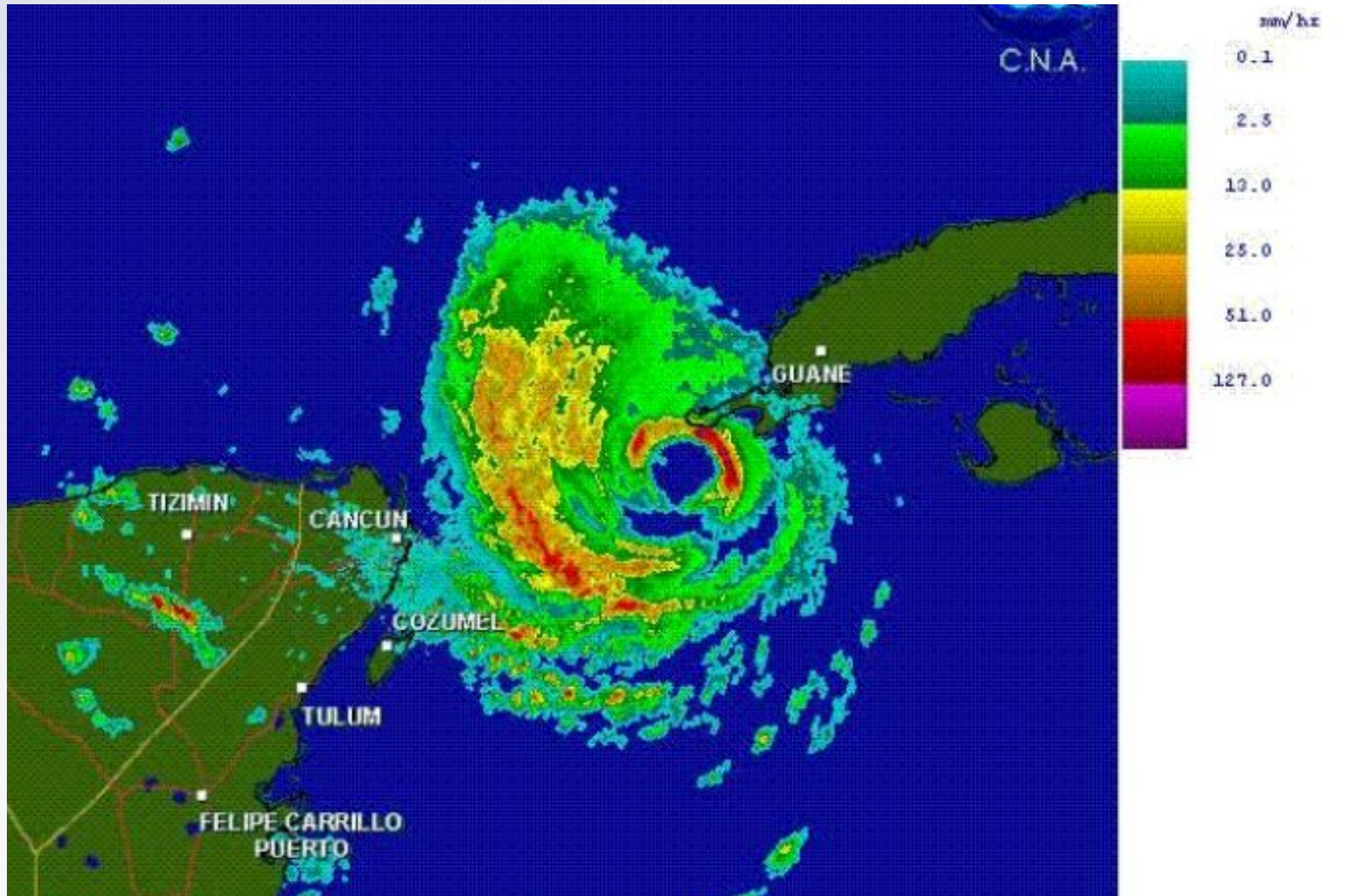


- Eye passed 20 miles south of the Jamaica, ~50,000 homes damaged/destroyed. 17 fatalities
- Eye passed 22 miles south of Grand Cayman, ~95% of the homes damaged/destroyed. 2 fatalities

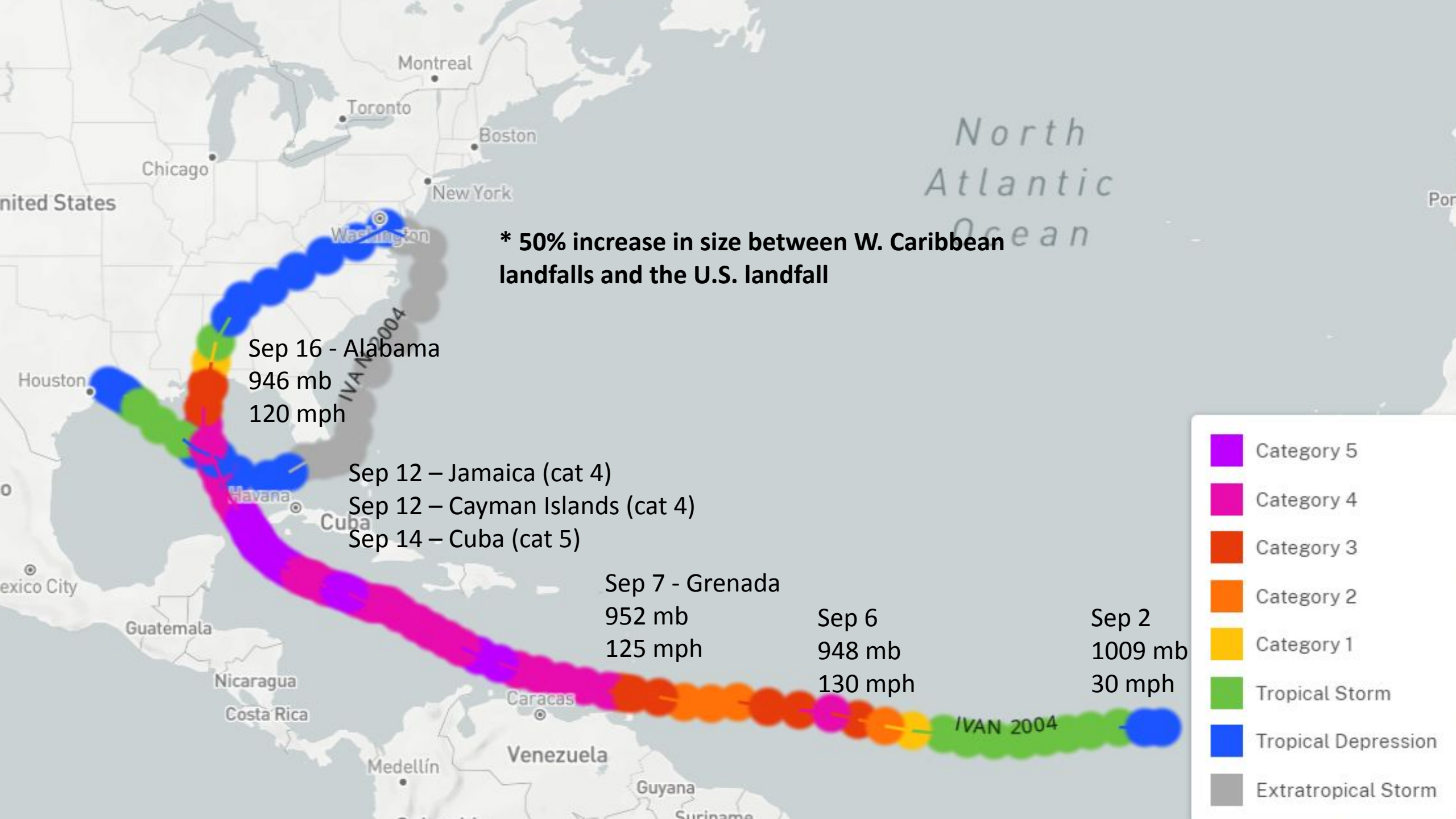


Cayman Islands

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

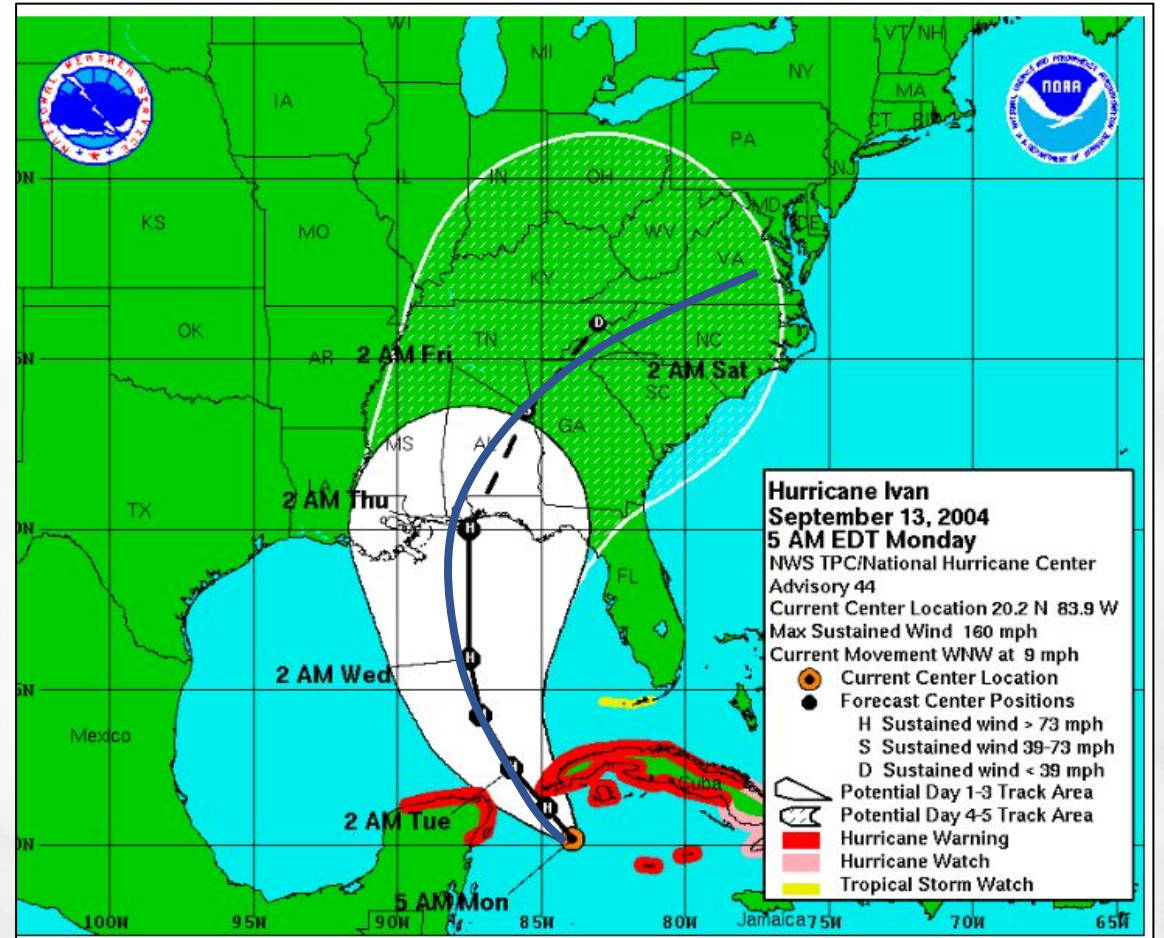
Sep 2
1009 mb
30 mph

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

NHC Forecast

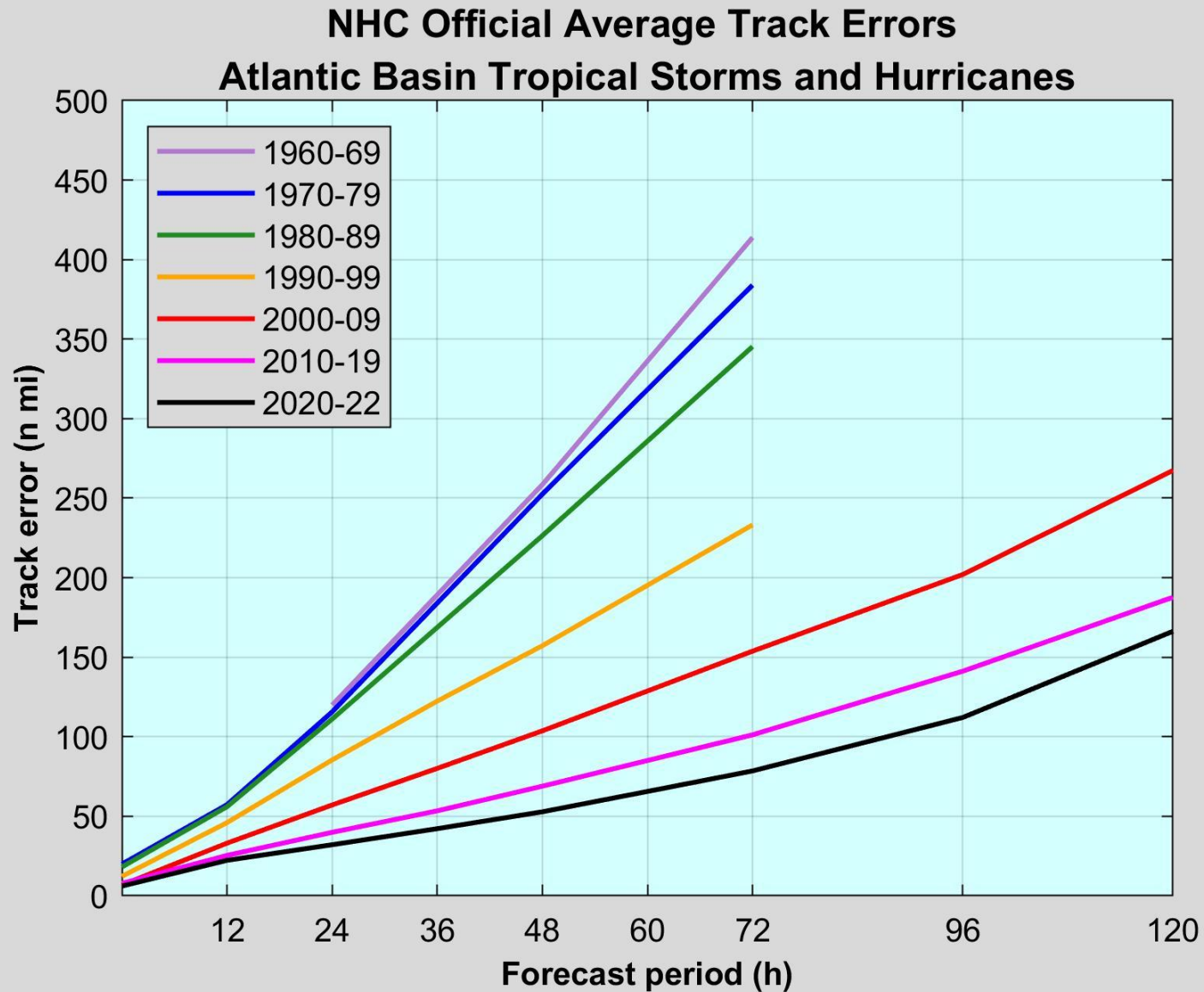


Sep 9 - 5 am (Adv 28)



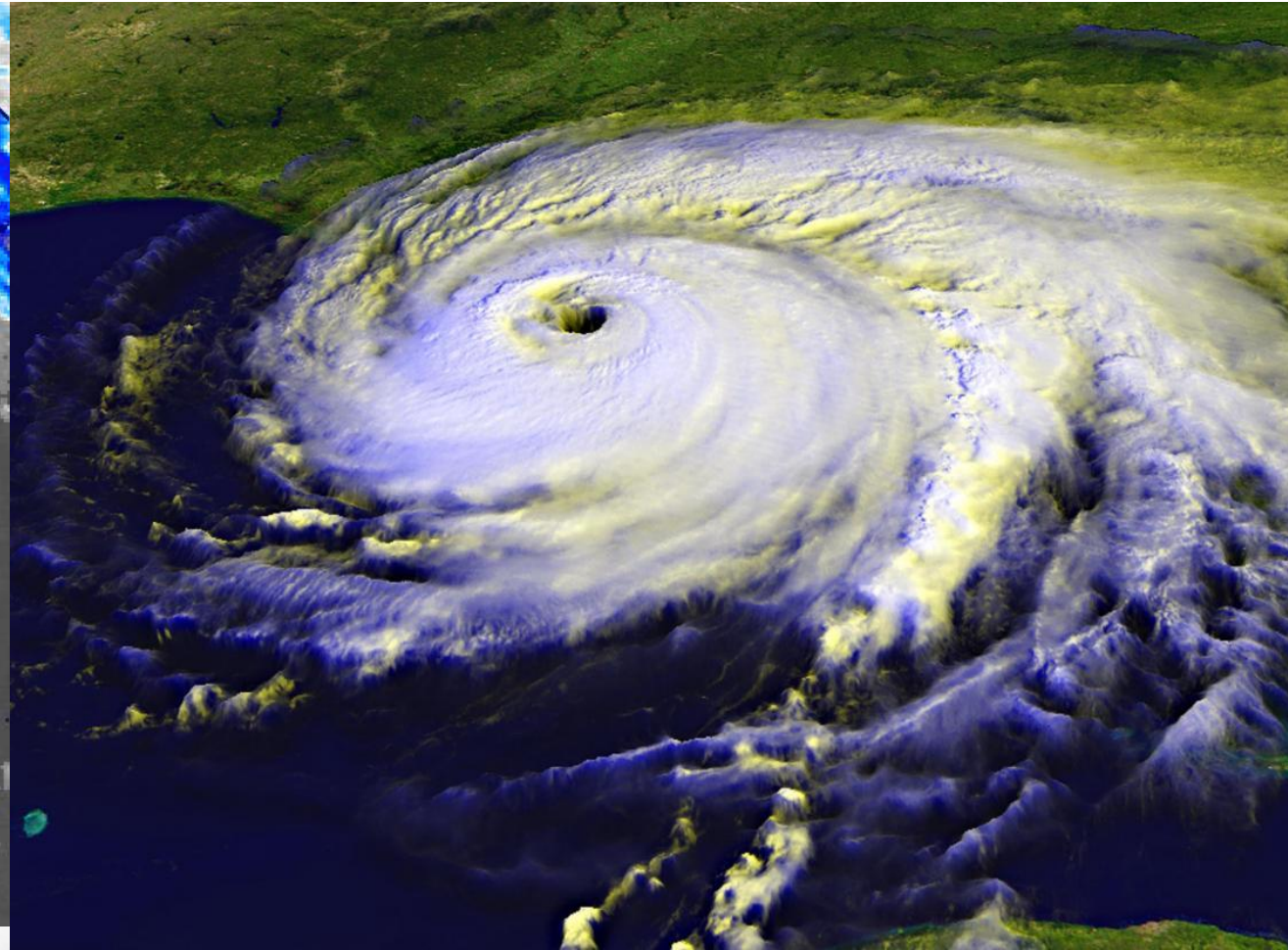
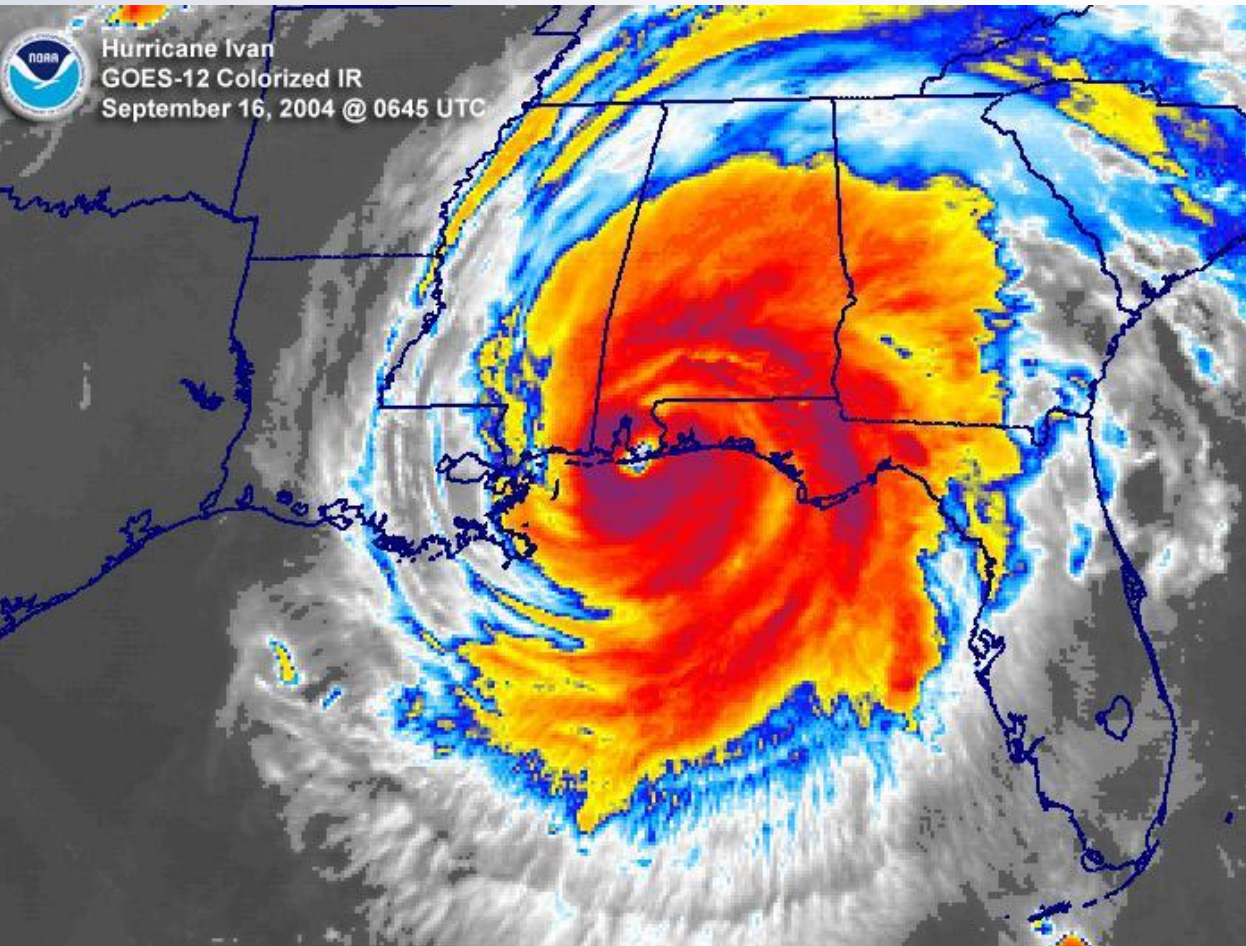
Sep 13 - 5 am (Adv 44)

Track Forecasting Progress



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

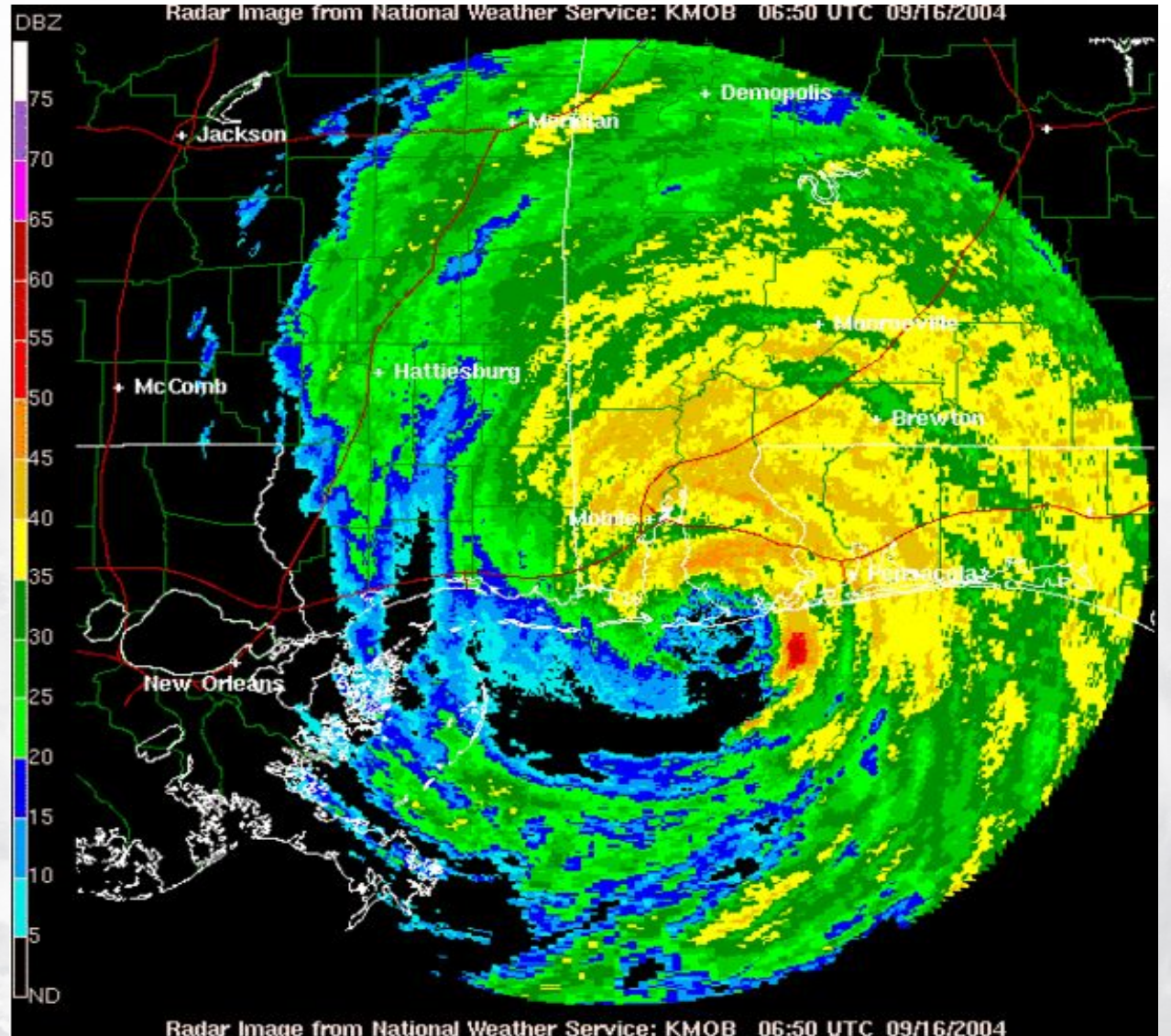
Hurricane Ivan at the Alabama Landfall



*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

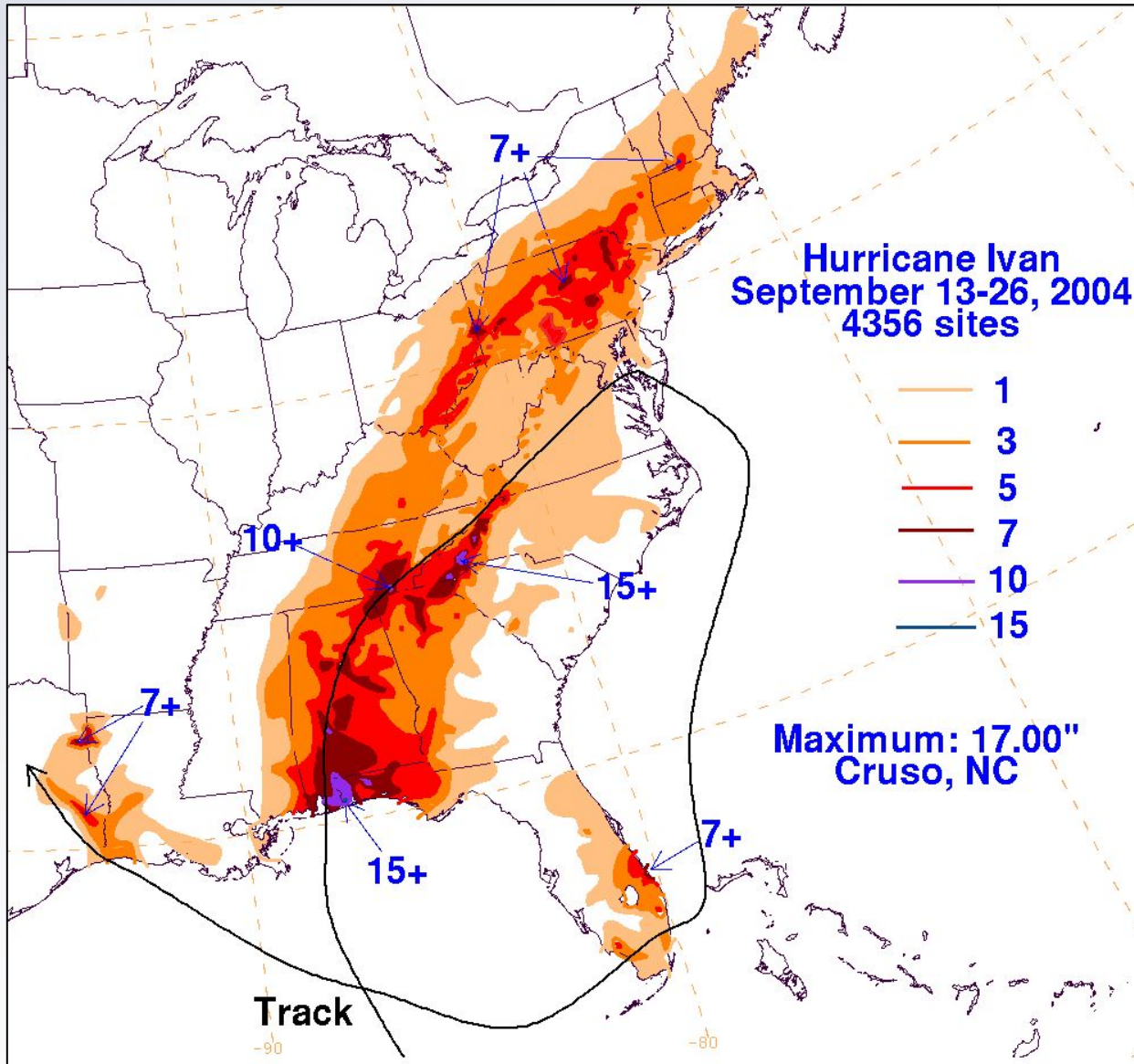


Storm Surge



- 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

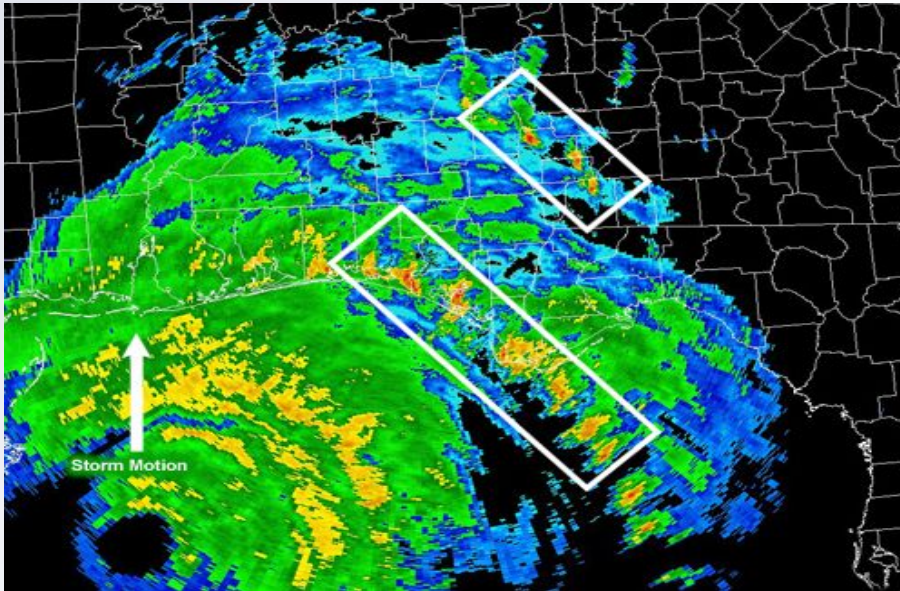
Wind Damage



Pensacola, FL

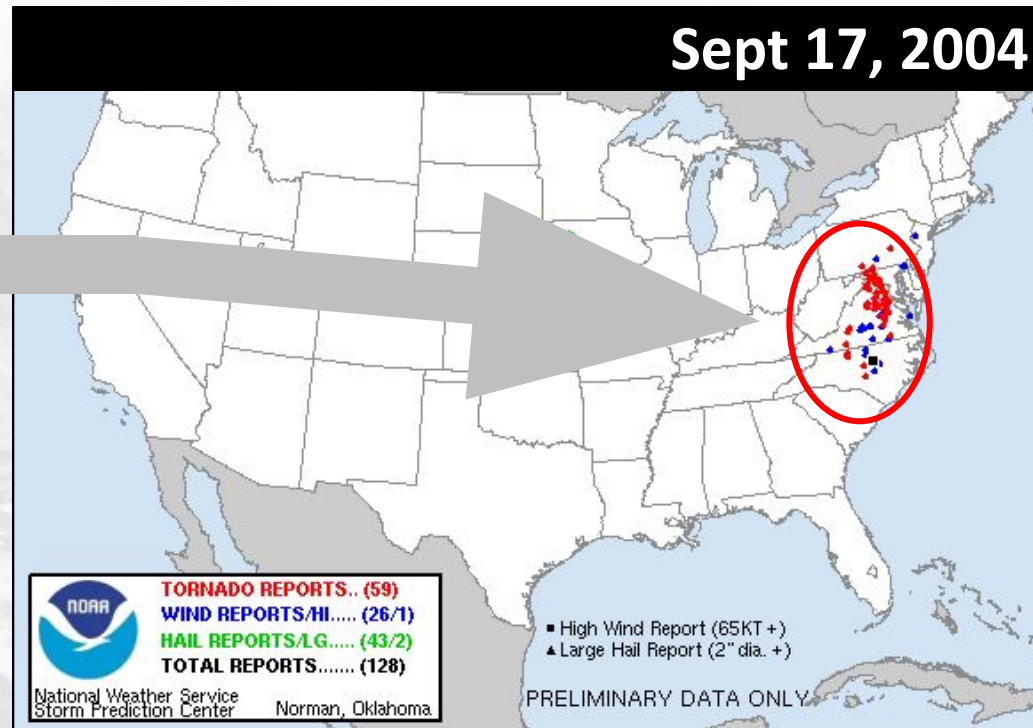
Peak wind gust – 145 mph in Baldwin County, Alabama

Ivan caused a tornado outbreak!

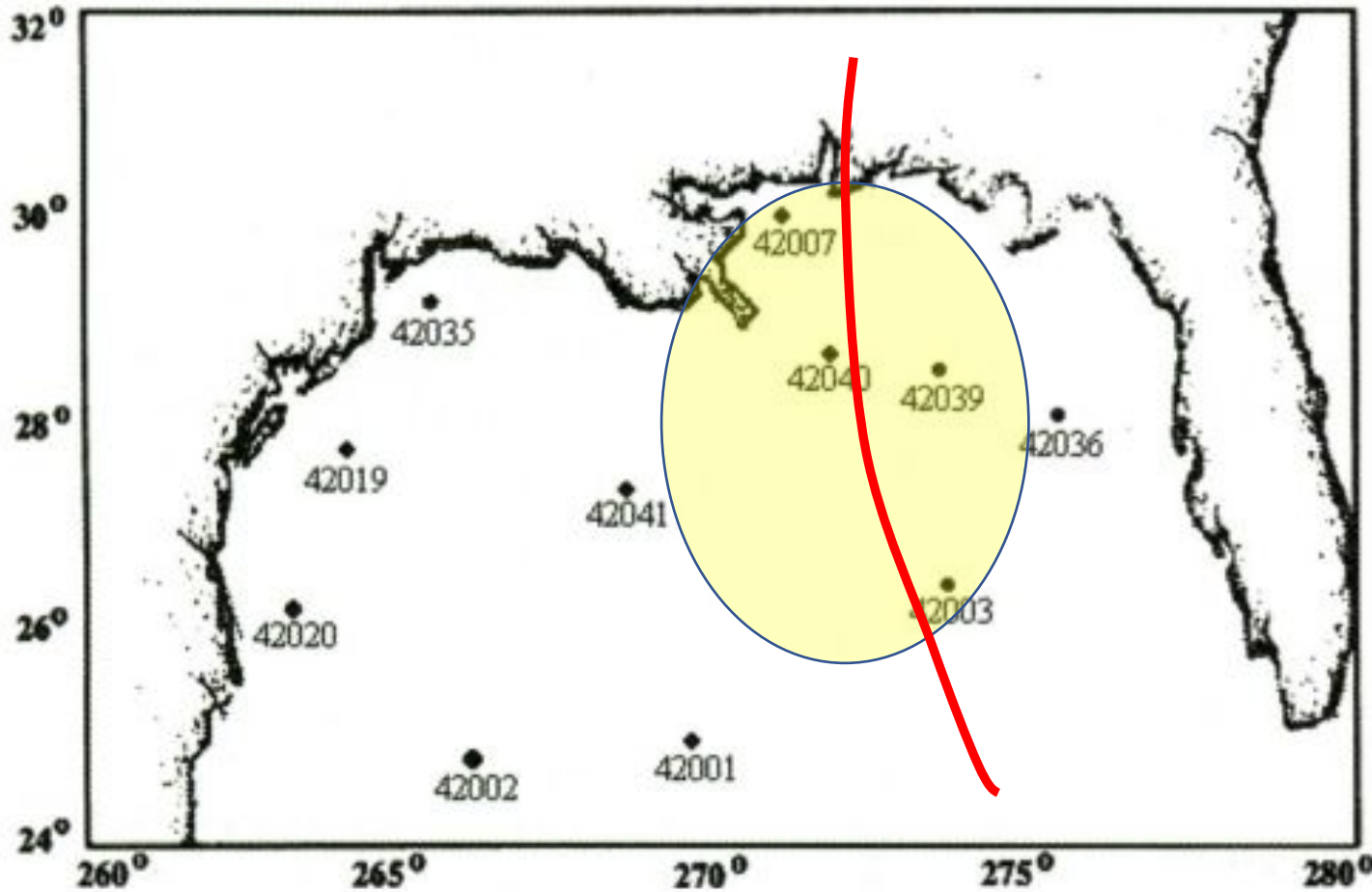


Tornado “outbreak”

Hurricane Ivan (2004)
– 117 Tornadoes



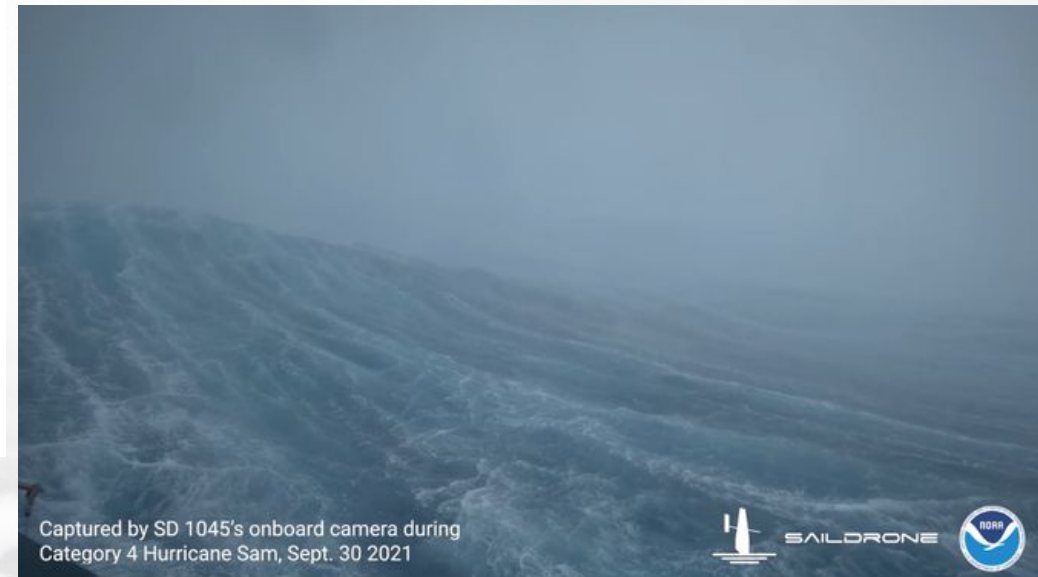
Marine Hazards



Panchang and Li, BAMS 2006

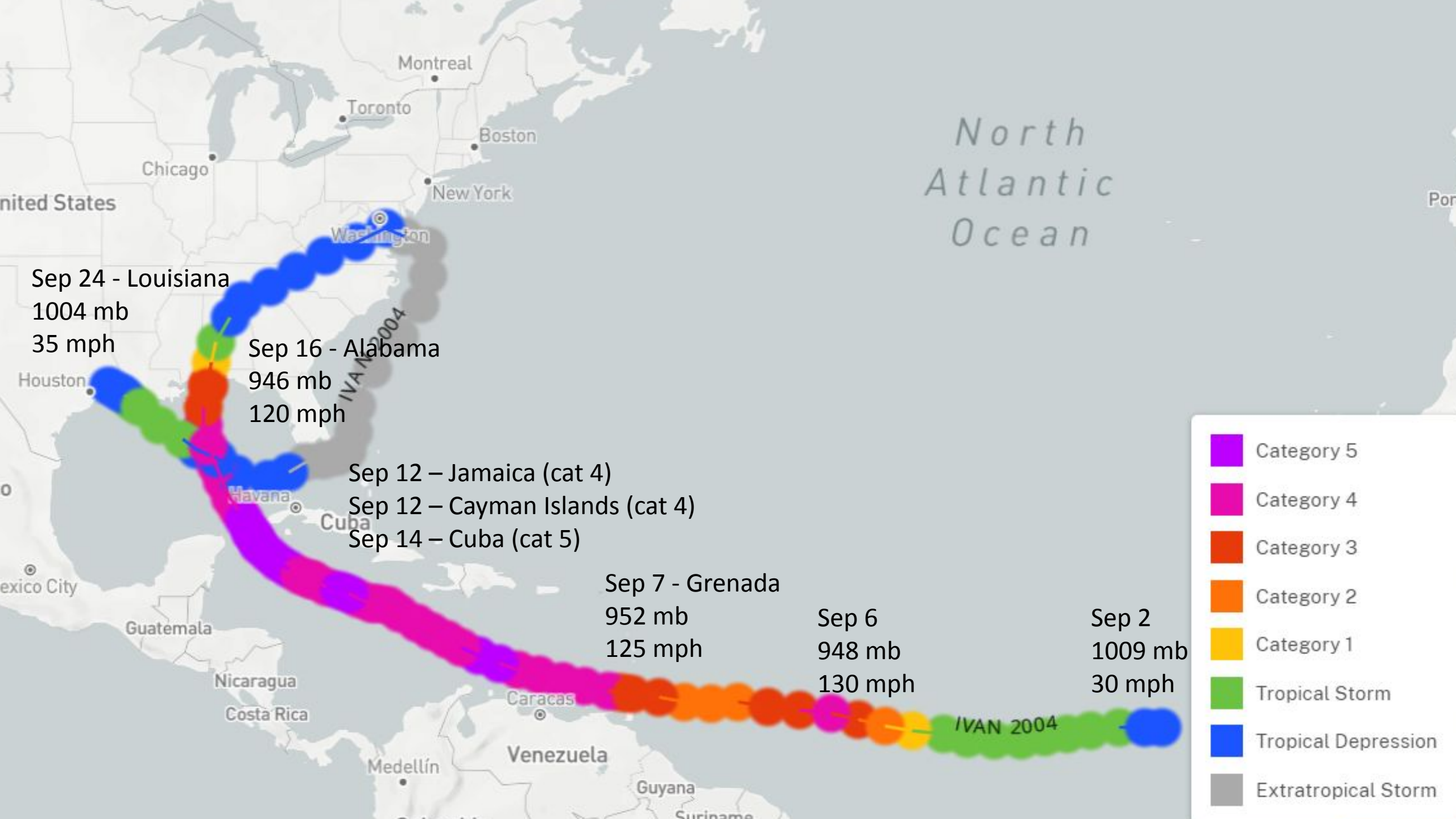
* Largest waves recorded (up to that time) at NOAA buoys 42003, 42007, 42039, and 42040.

* 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 but the damage done is a devastating reality for residents of the area.

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 as a powerful storm system moved through the Southeastern United States...

Record-setting rain inundates region



A flooded car sits in a high pool of water that has been bashed by three powerful gusts.

Widespread flooding strands thousands

Heavy rain has inundated the region, with record-setting amounts of precipitation falling over a wide area...

Awash in storm misery

From the Gulf to the mountains, Ivan soaks Southeast



Rescue workers help those who are stranded in Florida, Va.

N.C. mountain turns to mud

Heavy rain has turned the mountains of North Carolina into a mudslide, with roads washed away and homes destroyed...

8 die as Ivan's rain pounds mountains



Rescue workers help those who are stranded in Florida, Va.

Massive floods inundate Georgia; at least 5 dead

Heavy rain has inundated Georgia, with massive flooding and at least five deaths reported...

Lebanon Daily News advertisement featuring sports, valley life, and a murder suspect story.

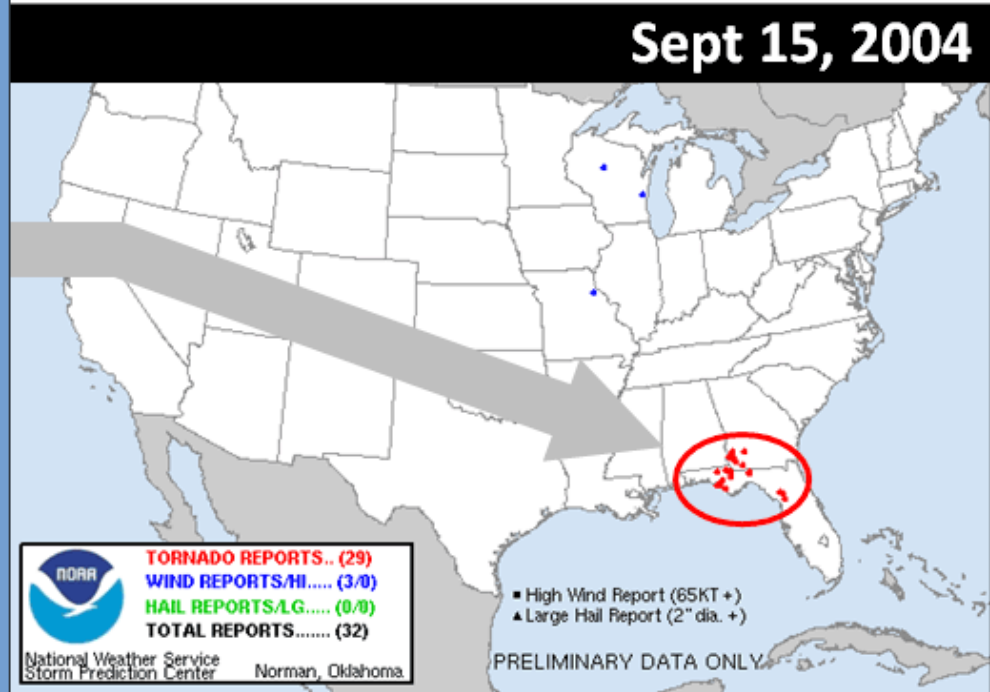
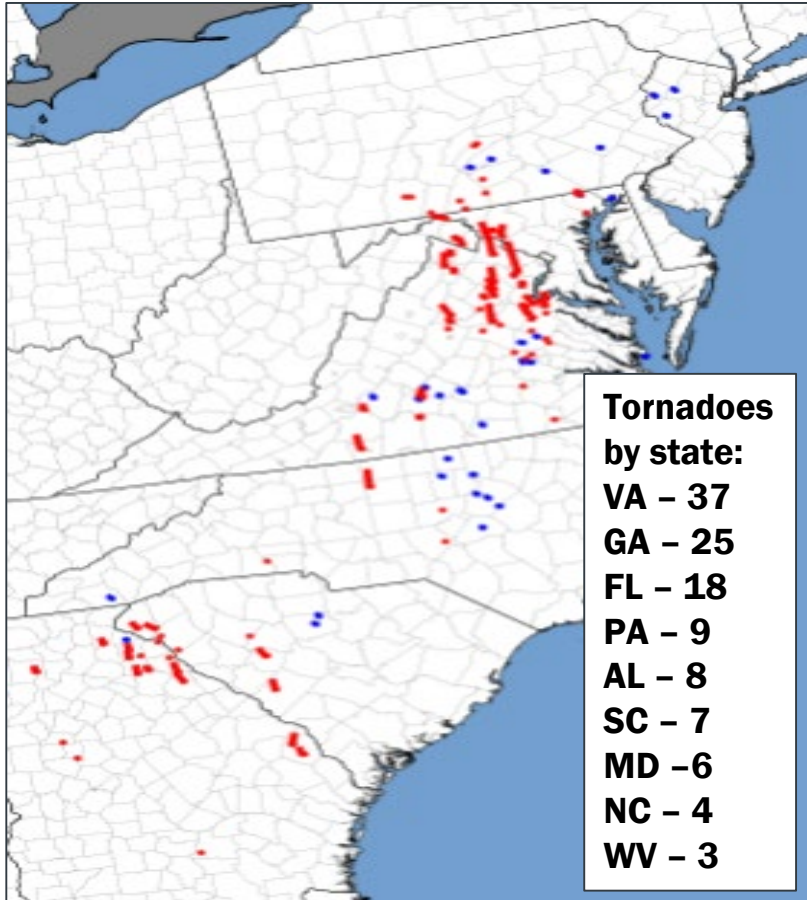
The Daily Times advertisement featuring sports final, Ivan remnants, and a girl assaulted on a bus.

The State advertisement featuring campaign 2004, hurricane Ivan's impact, and a Jefferson nickel story.

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

Ivan Tornado Outbreak – Sept. 15-18

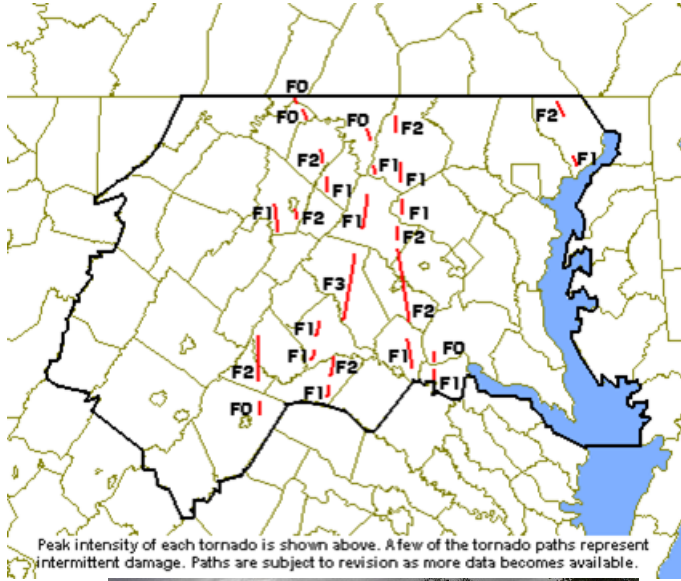
- One of the worst tornado outbreaks in tropical cyclone history and Mid-Atlantic history!
- 117 tornadoes hit 9 states, over 3 days, with 8 fatalities.
- Apex on Sept. 17 (57 tornadoes / 49% of outbreak)



Source: Matt Elliott/SPC; NHC



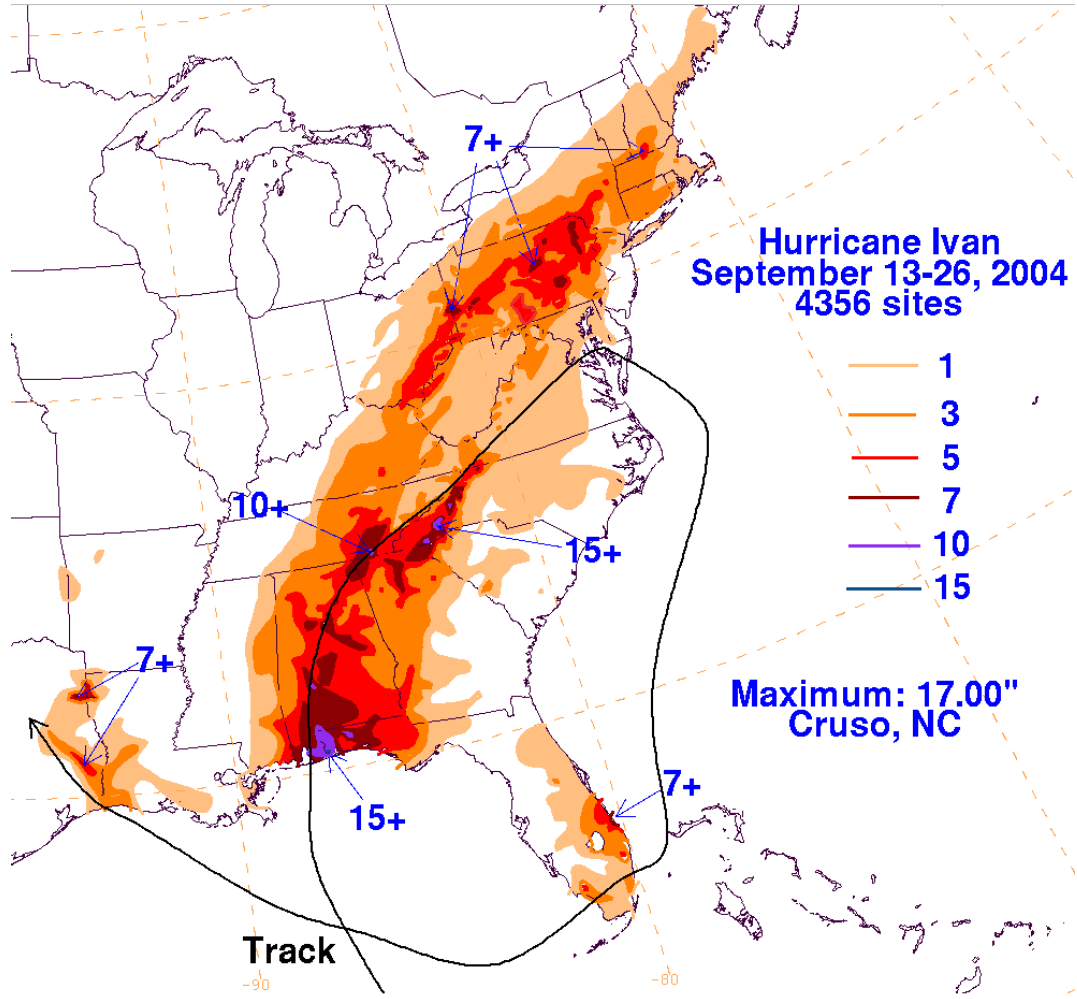
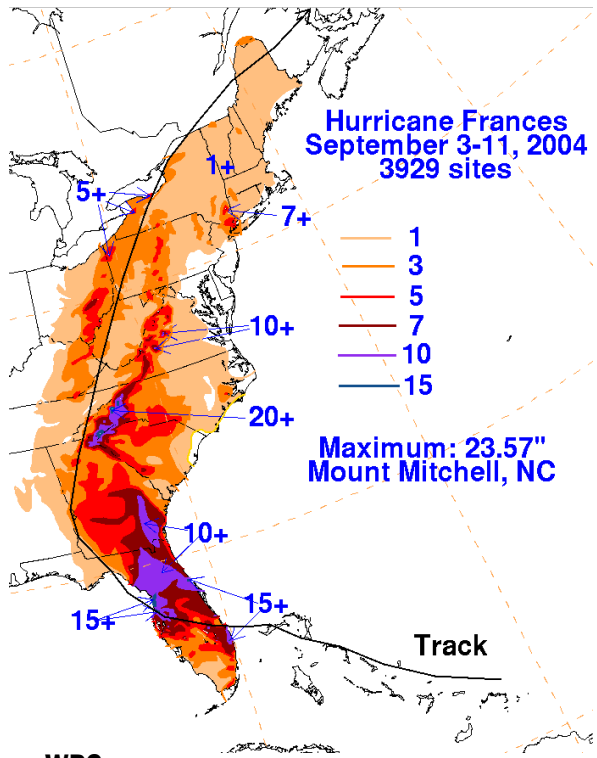
Ivan Tornado Outbreak in the DMV



Source: WFO Baltimore/Washington



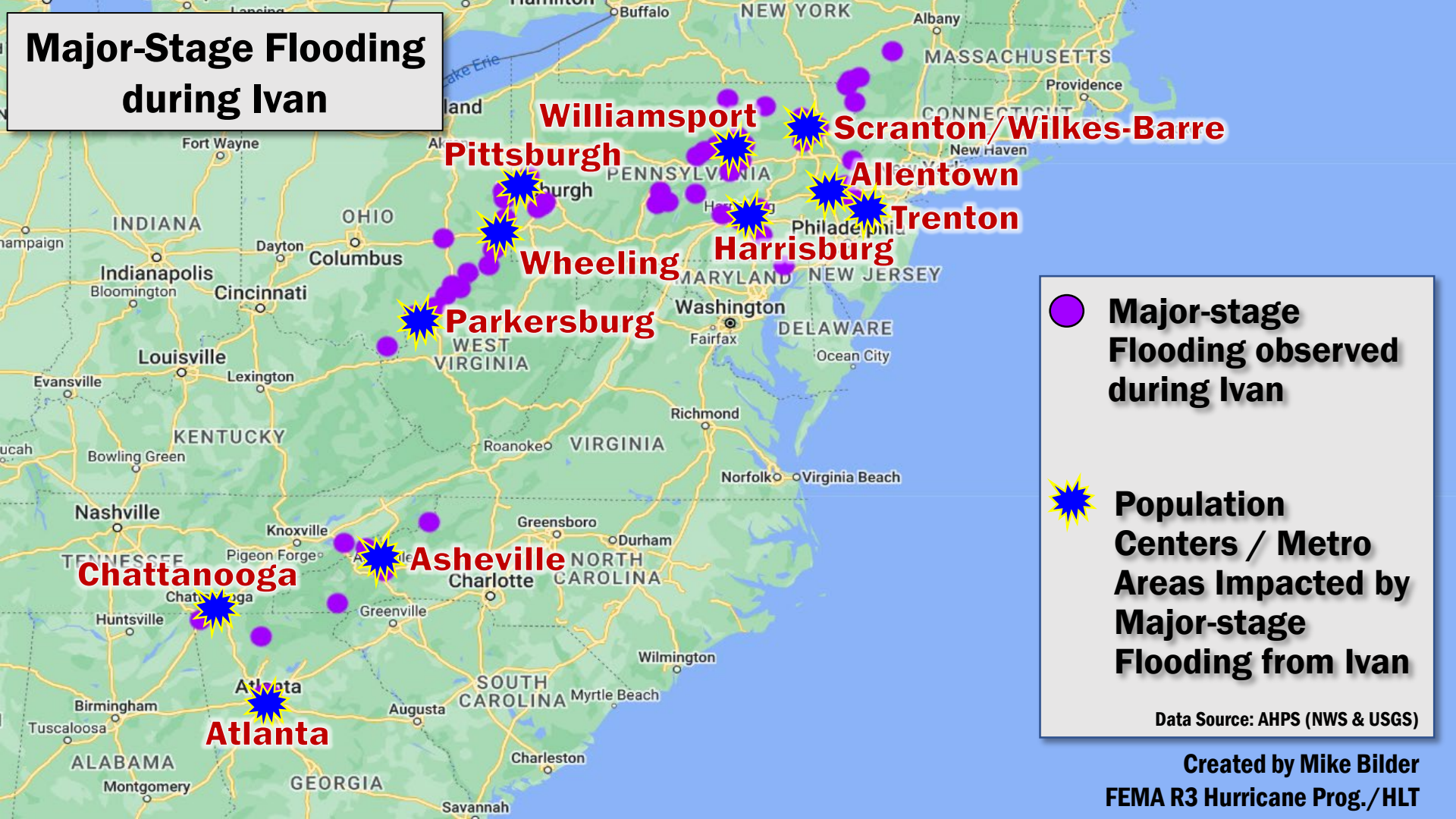
Frances & Ivan Rainfall





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



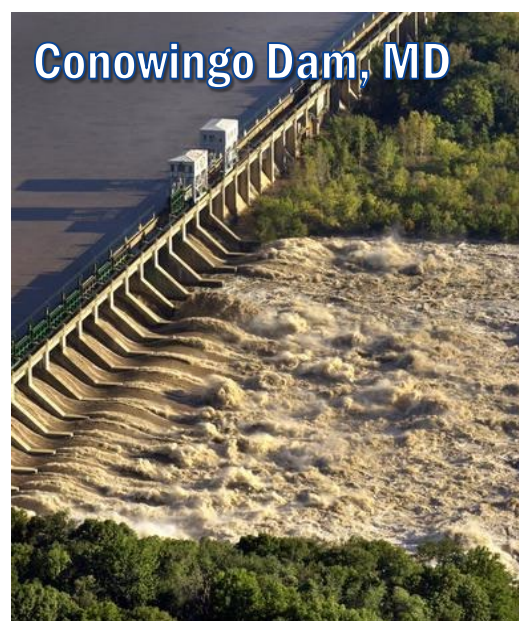
Pittsburgh, PA



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

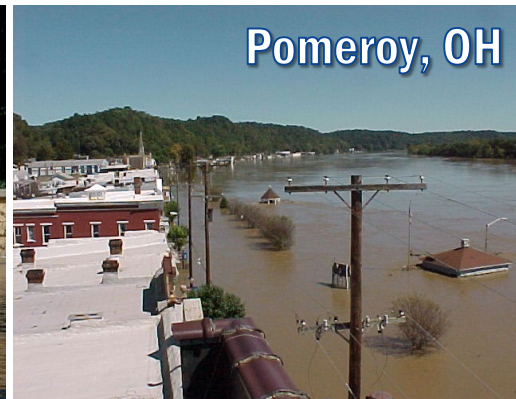


Photo Credit: Jake Mecklenborg; WFO Pittsburgh; WRTF; Michael Stahl

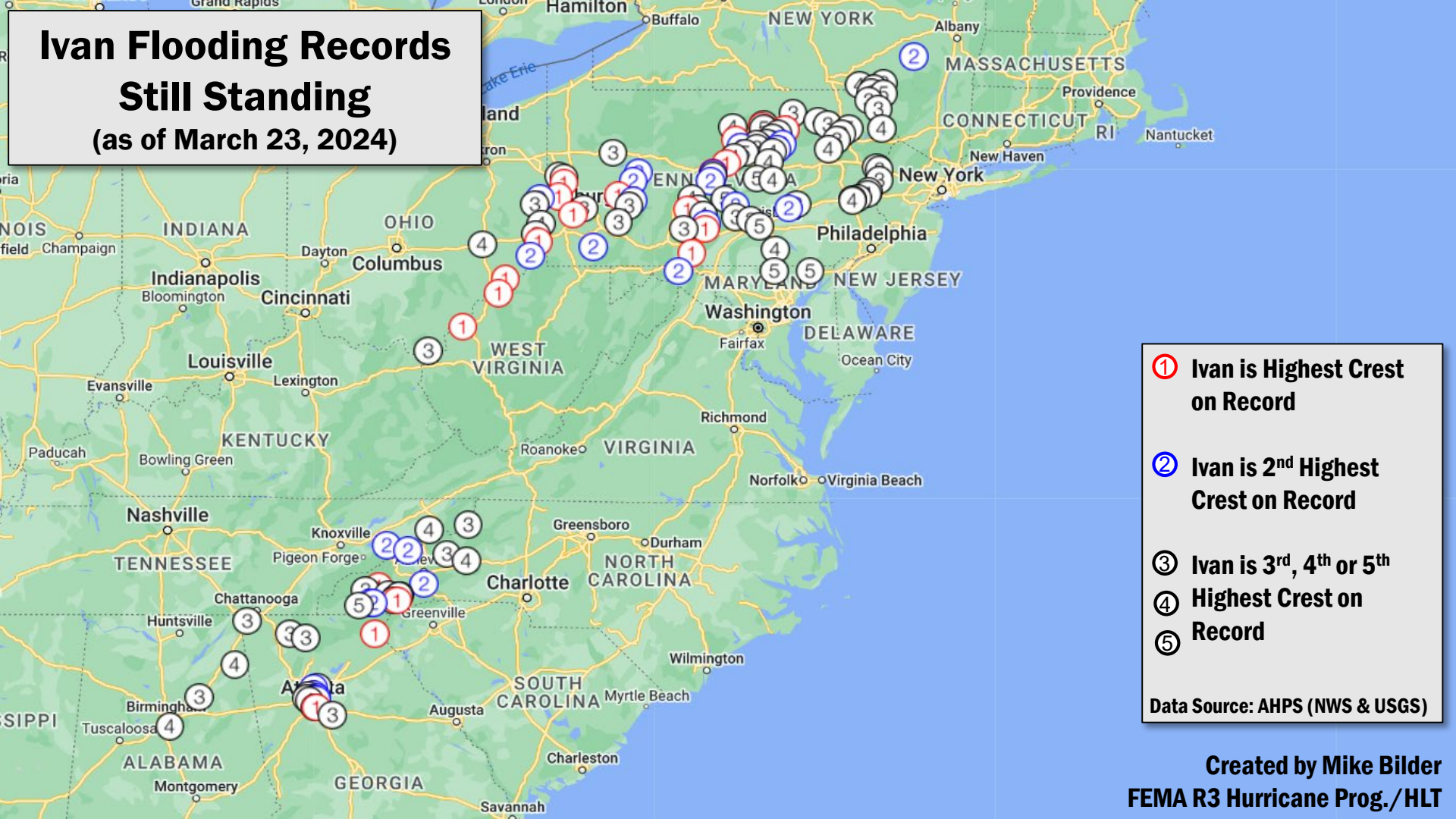


Debris Flow in Macon Co., NC



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 2nd Highest Crest on Record

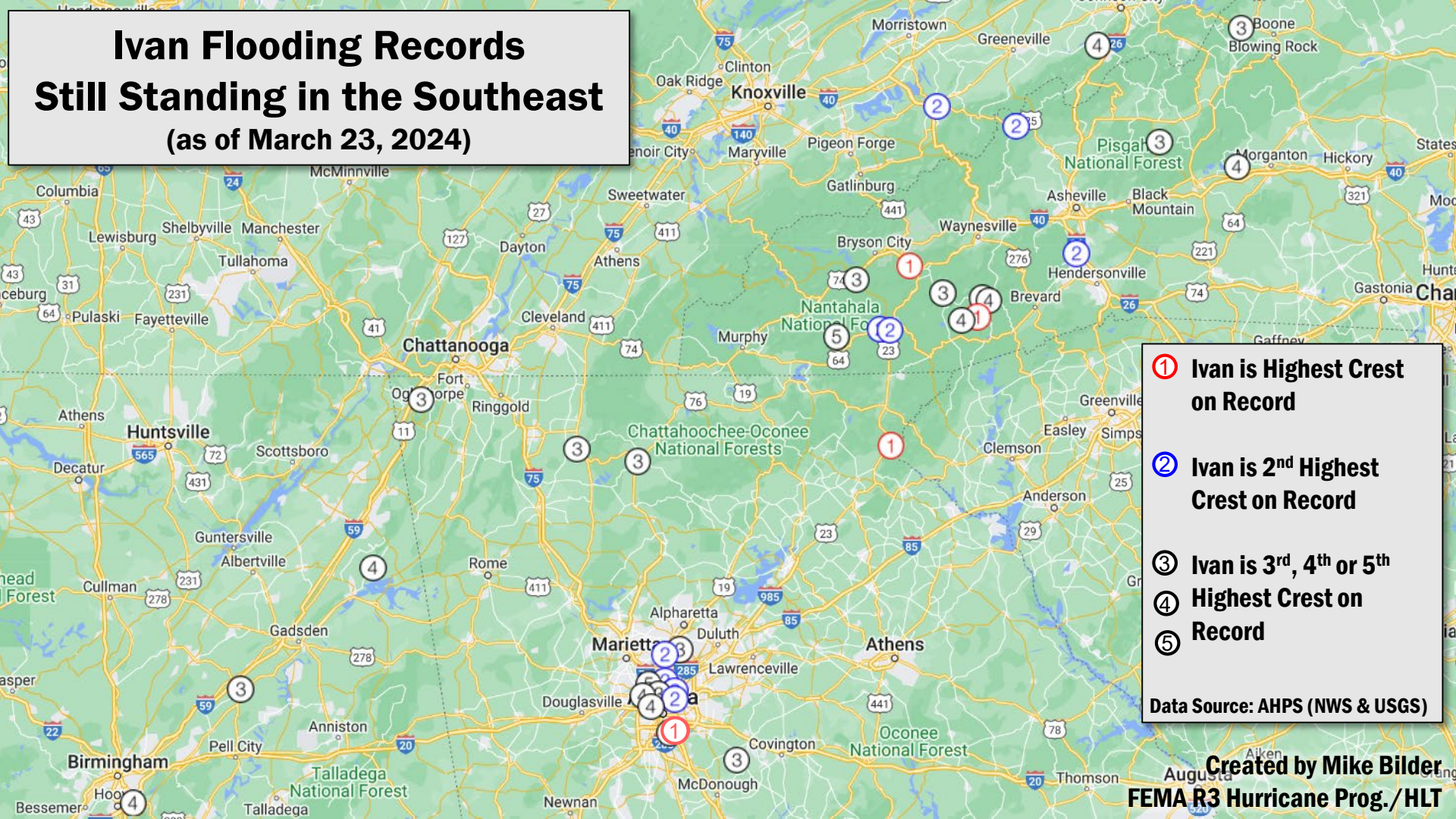
③ Ivan is 3rd, 4th or 5th Highest Crest on Record

④ Highest Crest on Record

⑤ Highest Crest on Record

Data Source: AHPs (NWS & USGS)

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



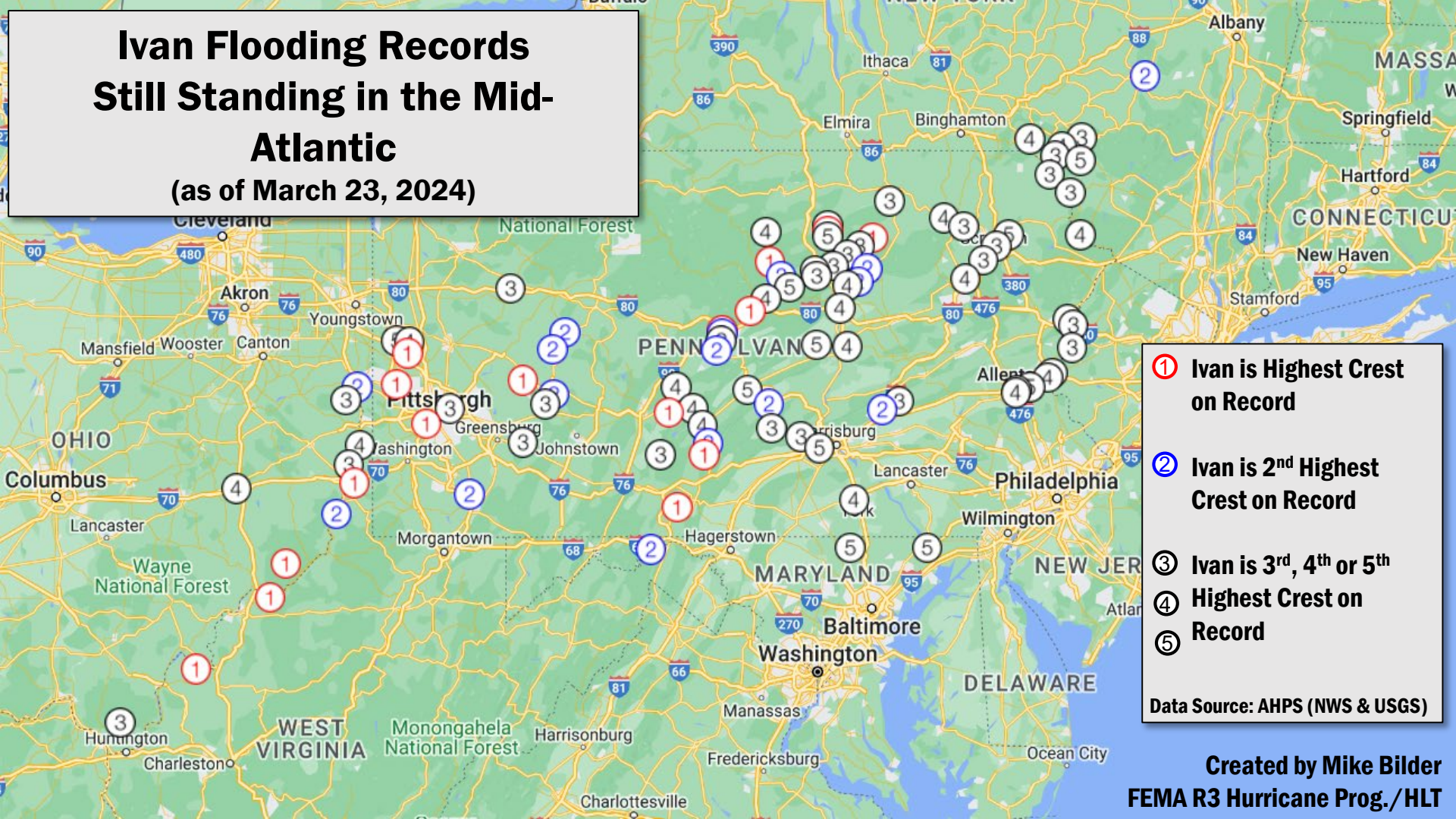
- ① Ivan is Highest Crest on Record
- ② Ivan is 2nd Highest Crest on Record
- ③ Ivan is 3rd, 4th or 5th
- ④ Highest Crest on Record
- ⑤ Record

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 2nd Highest Crest on Record
- ③ Ivan is 3rd, 4th or 5th
- 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

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