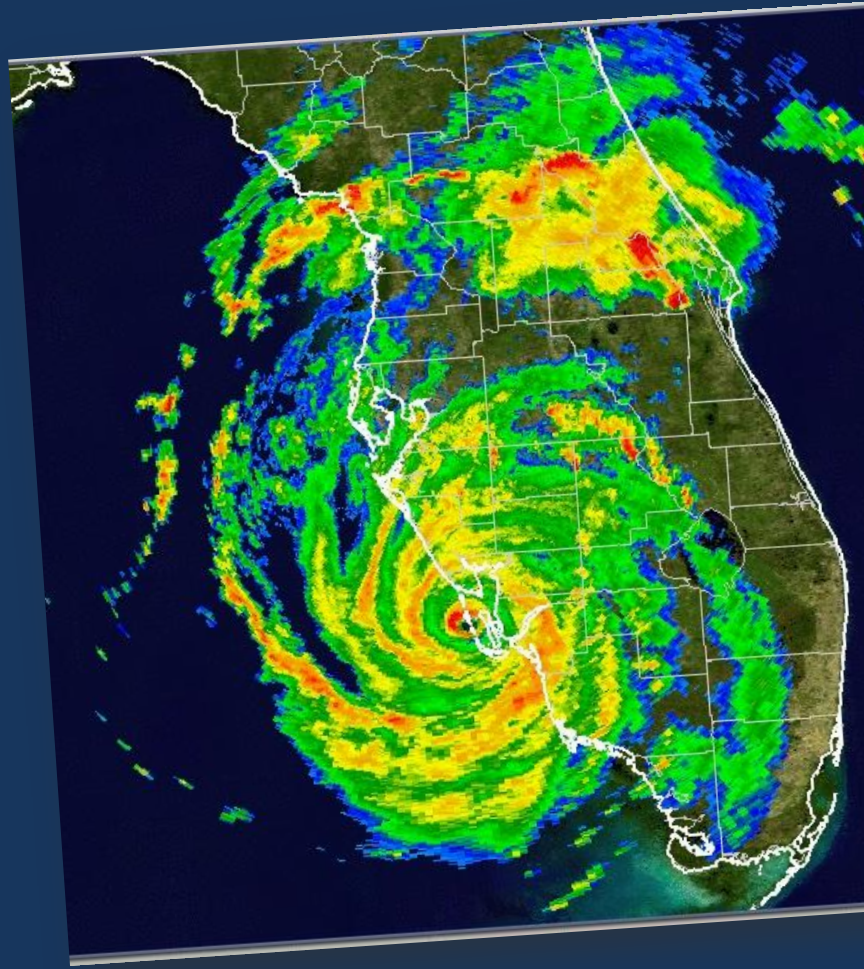


A Friday the 13th to Remember

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 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
@newspress.com

INSIDE



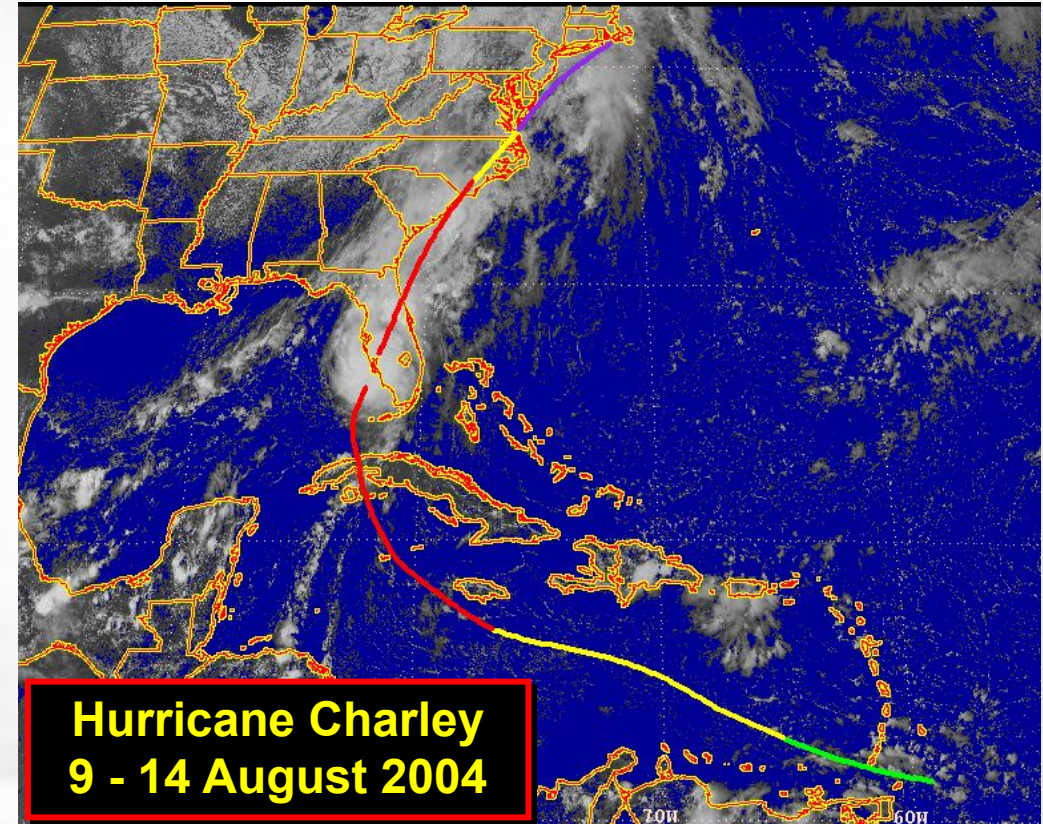
Hurricane Charley

- 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

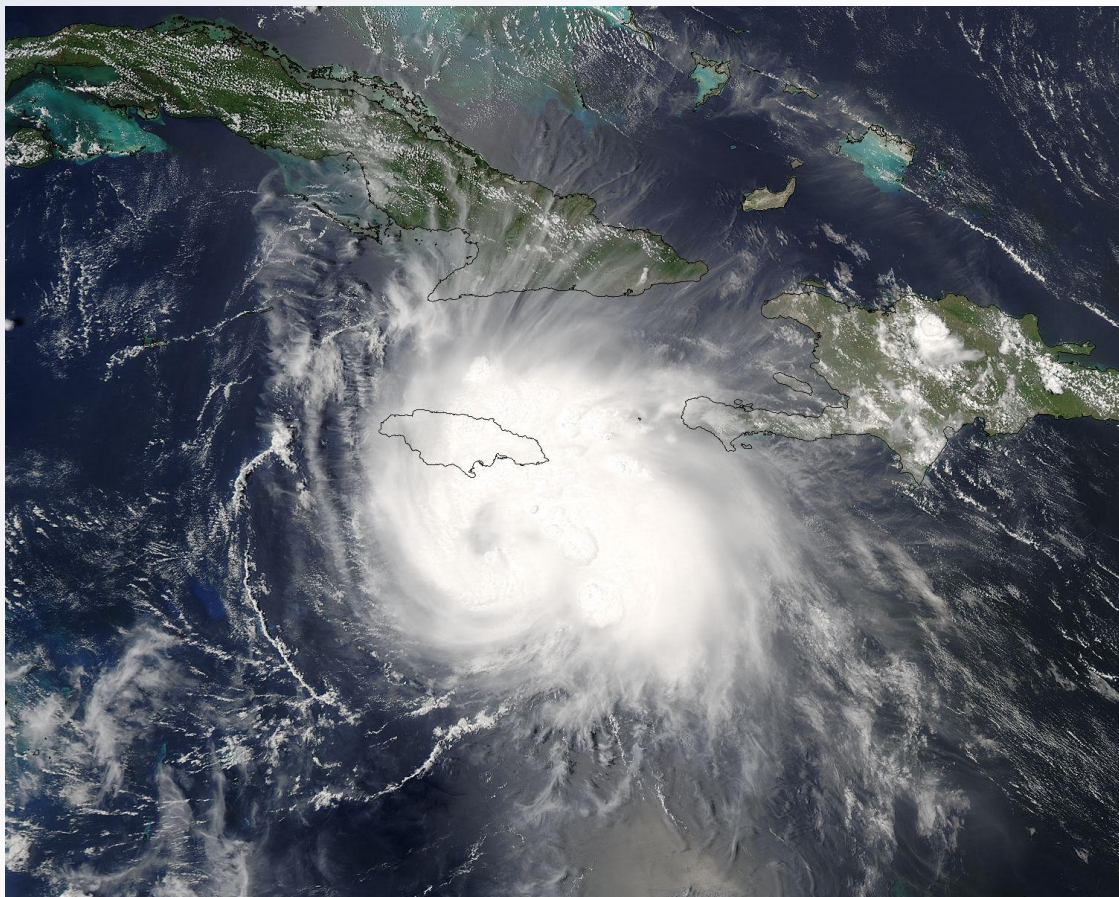
TROPICAL DEPRESSION THREE SPECIAL ADVISORY NUMBER 1
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL
145 PM AST MON AUG 09 2004

...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)**

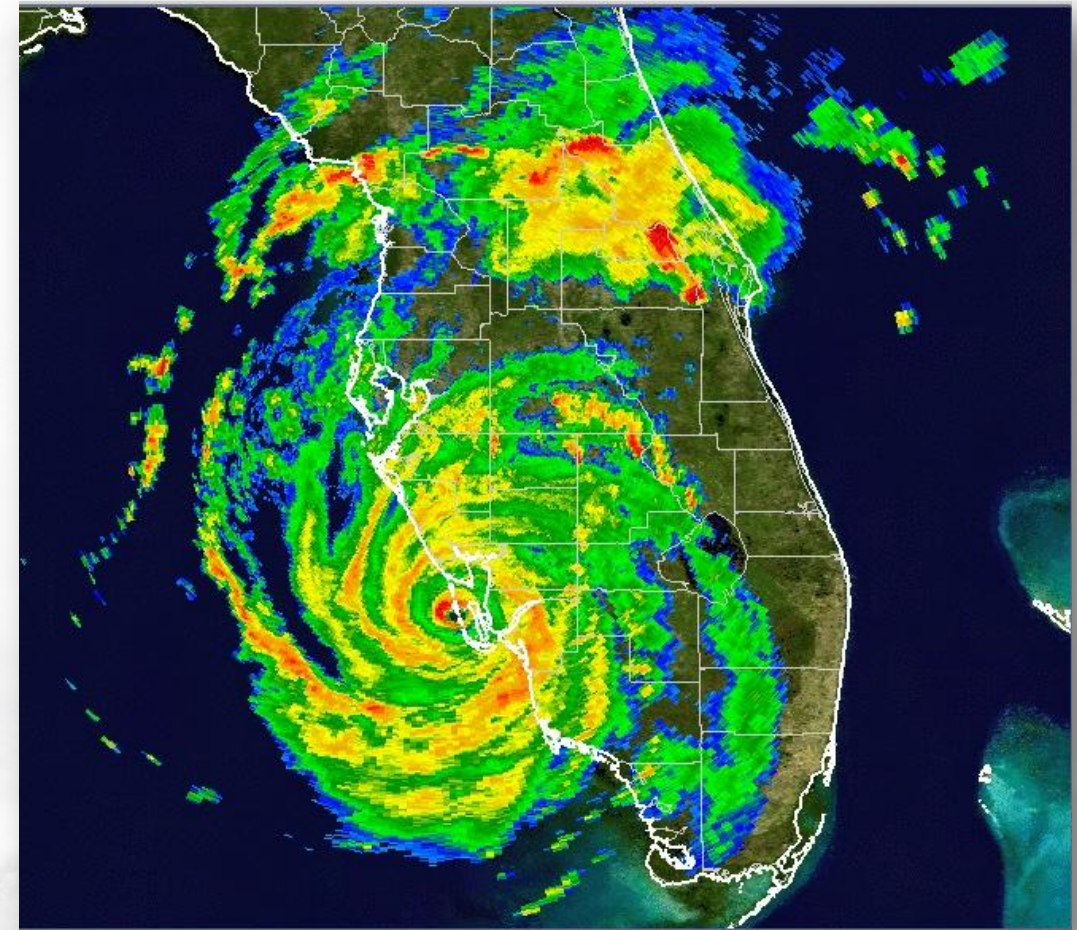
BULLETIN

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)**

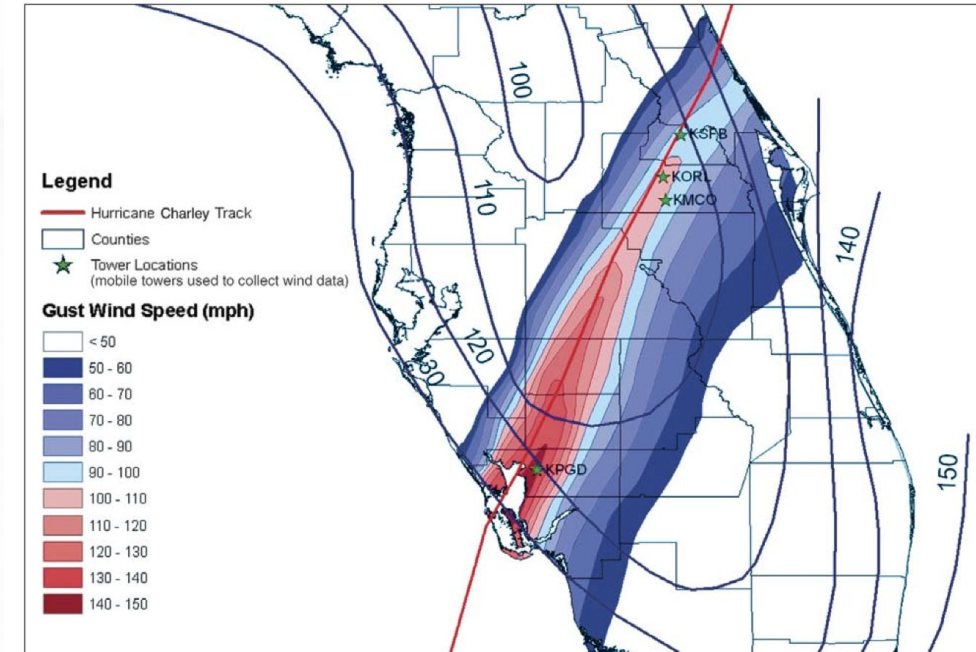


Figure 2. Hurricane Charley Wind Swath Map

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

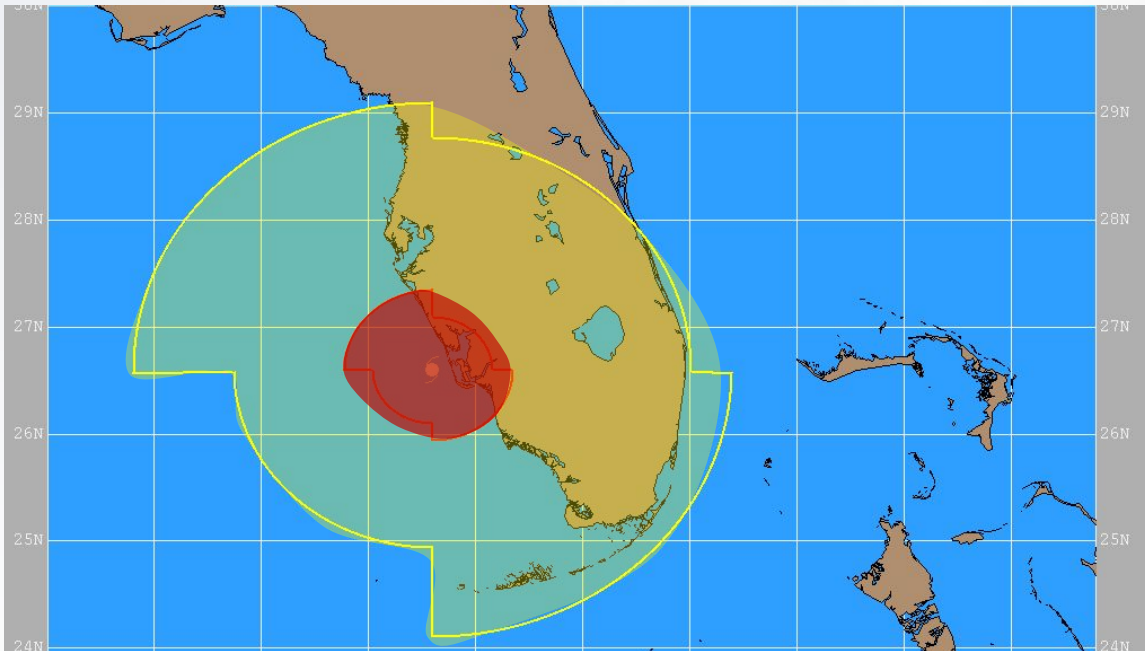
*2023 Dollars

Charley (2004) vs. Ian (2022)

Similar Strength but Different Very Different Impact Footprint

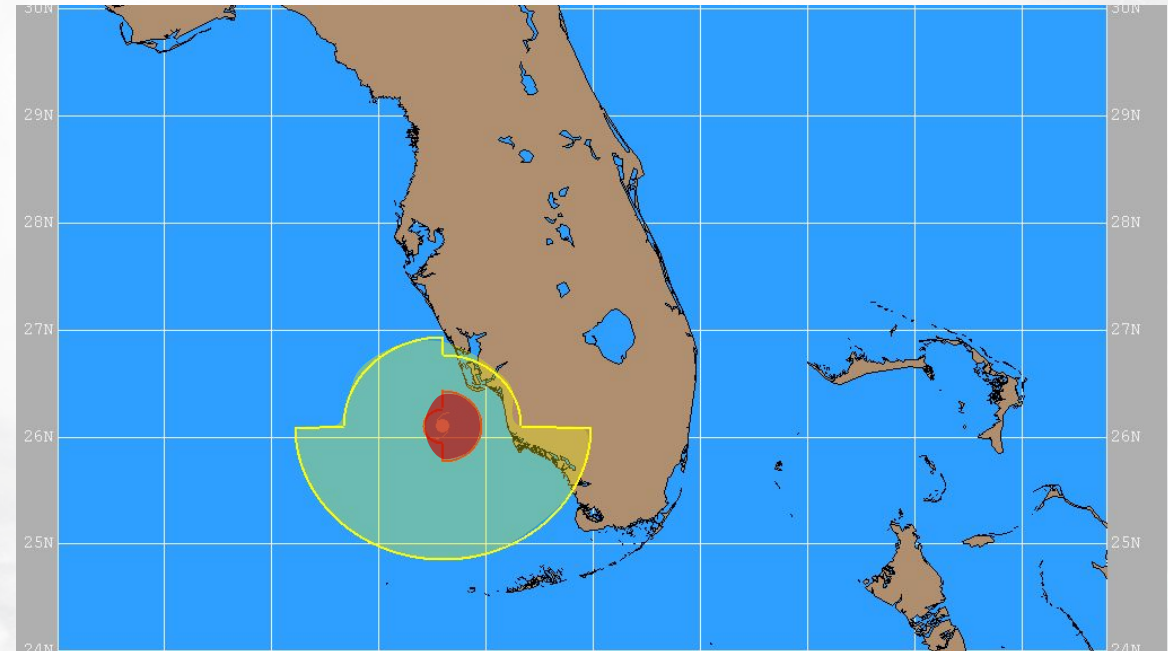
Ian

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

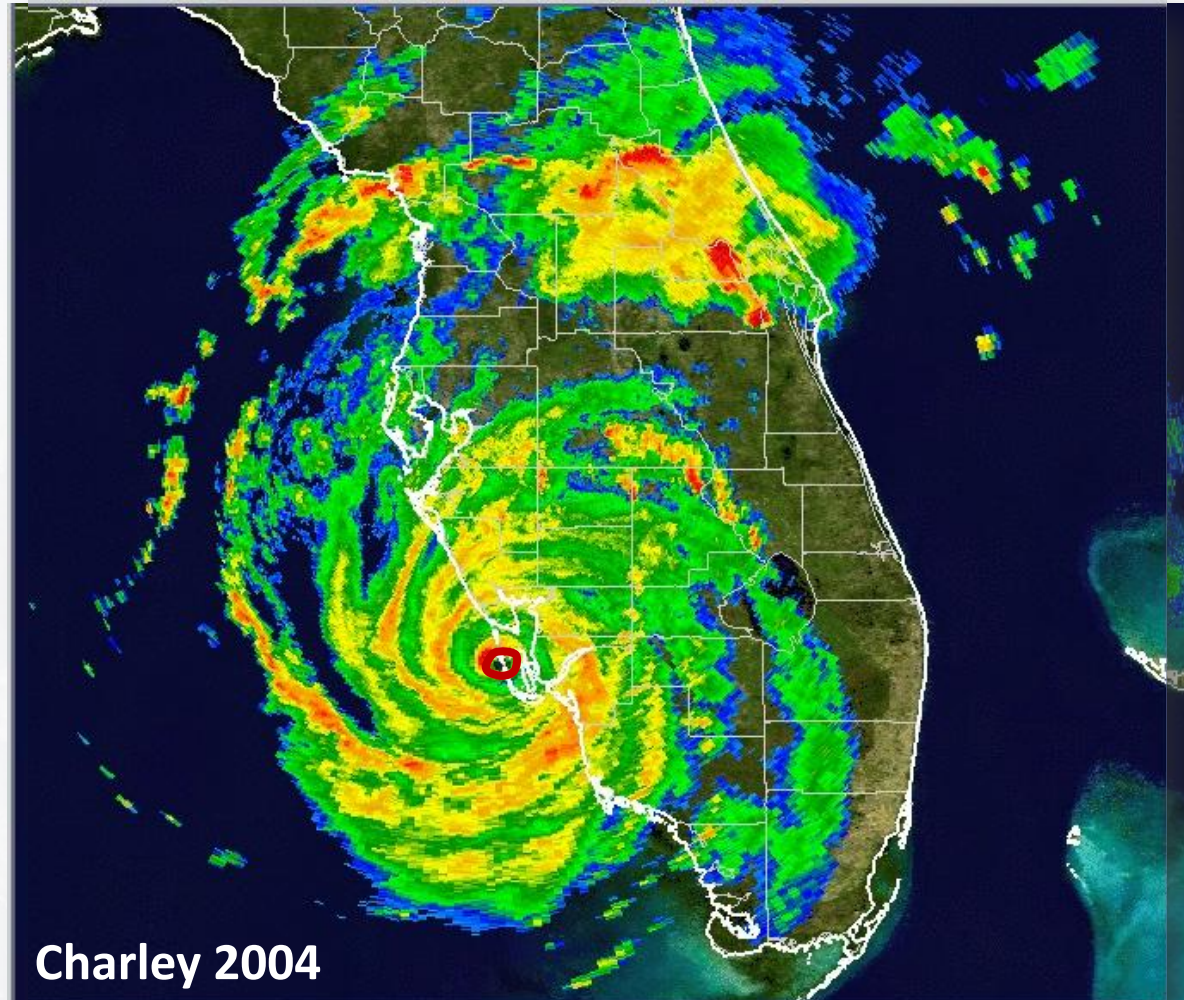


Charley

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

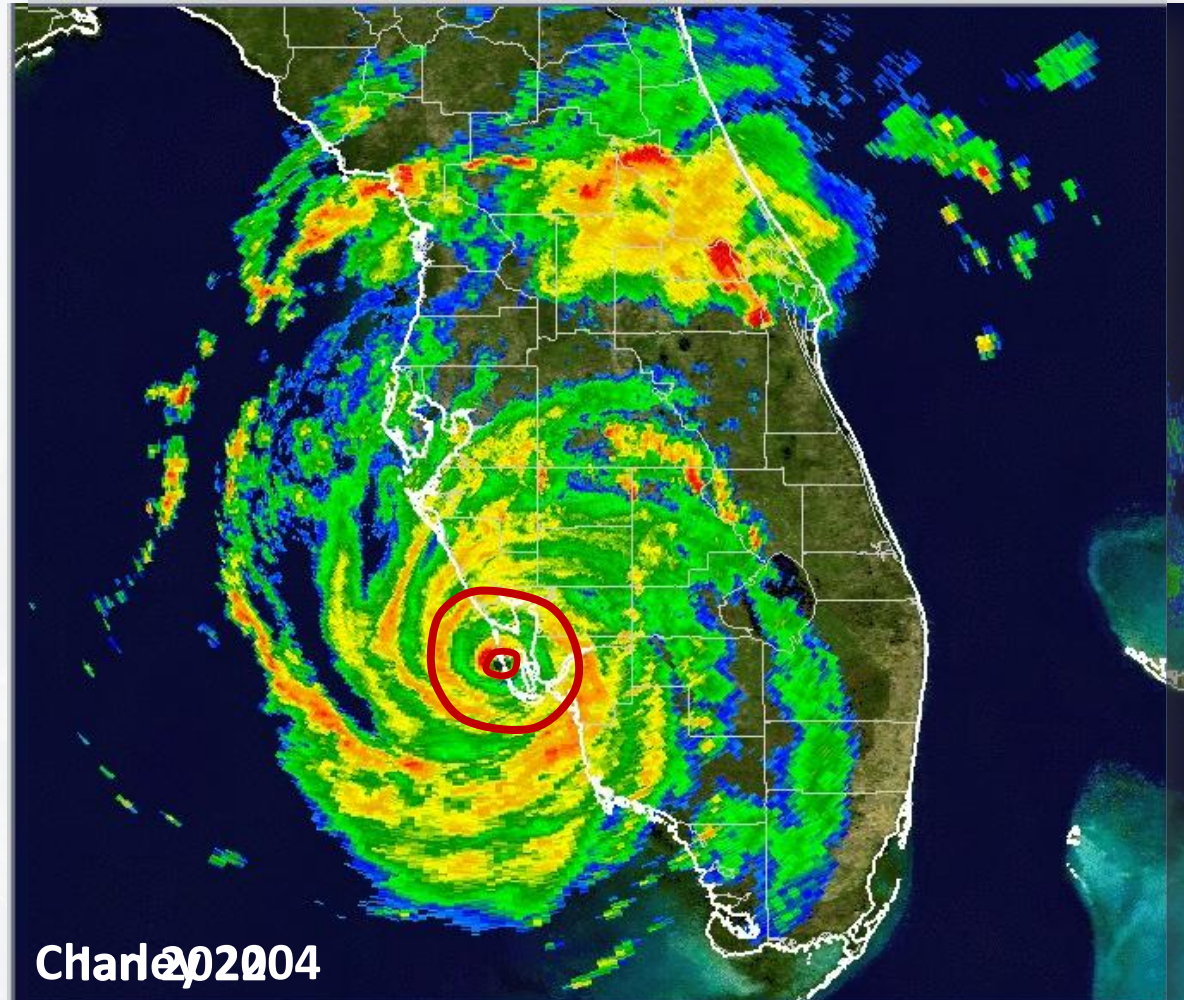


Differences in Core Size (Radius of Maximum Winds)



Charley: Radius of Maximum Winds ~ 6 n mi

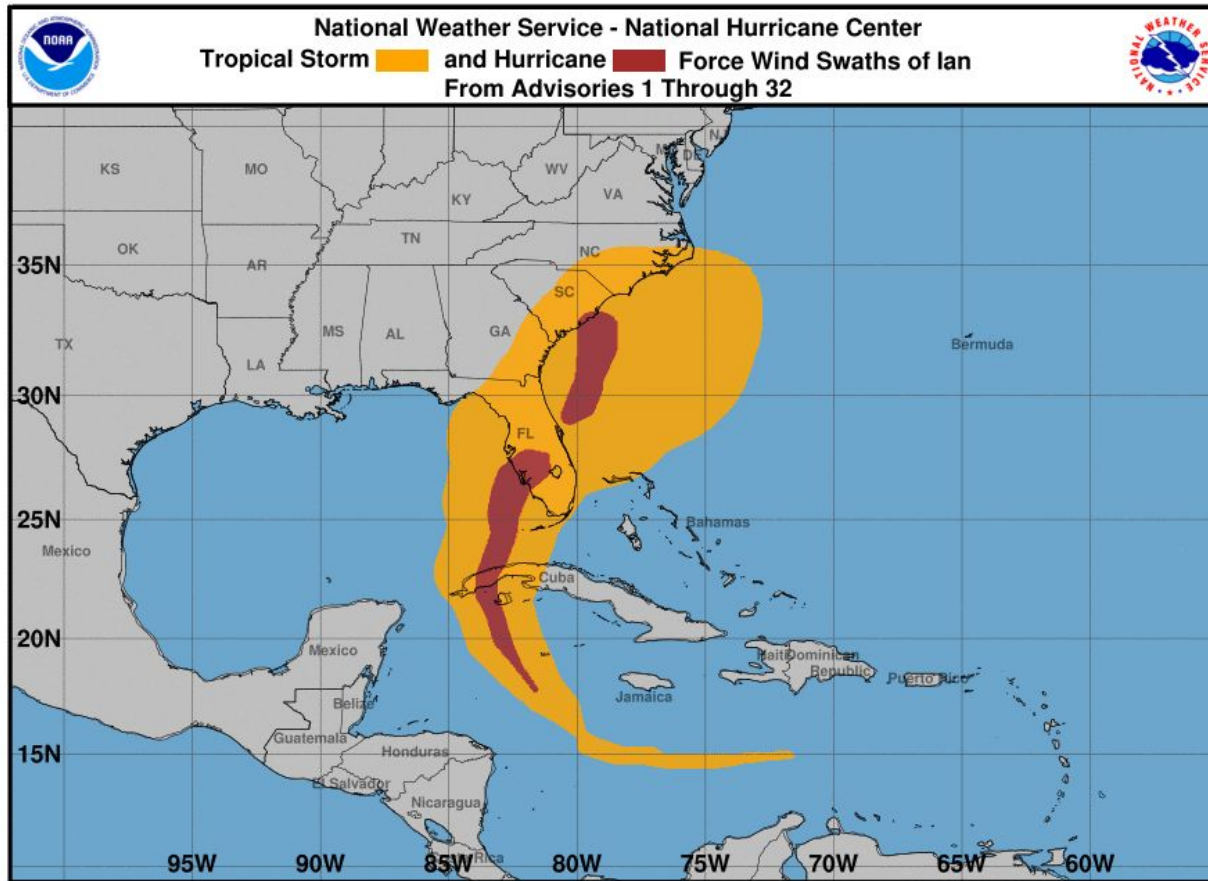
Differences in Core Size (Radius of Maximum Winds)



Charley: Radius of Maximum Winds ~ 80mmi

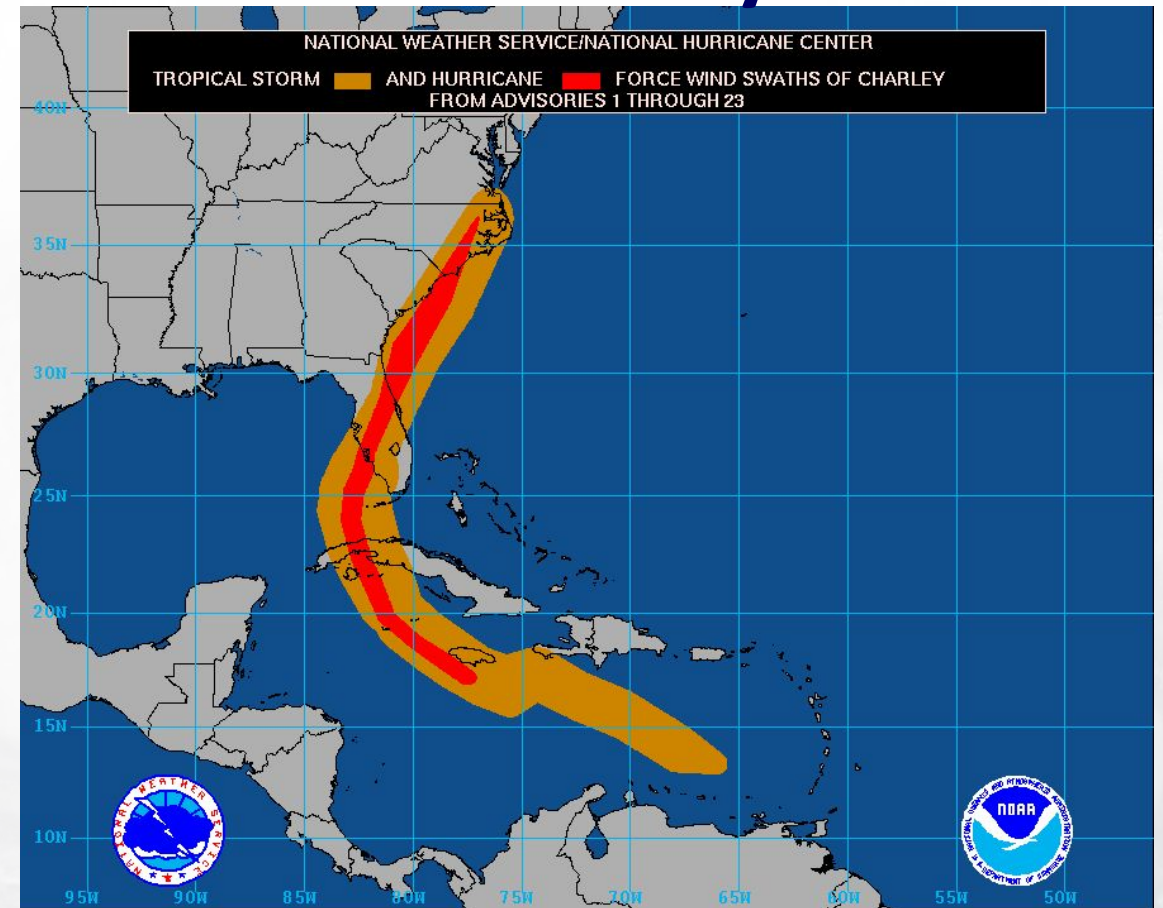
Charley – Narrow Swath of Extreme Winds but More Inland Penetration

Ian



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

Charley



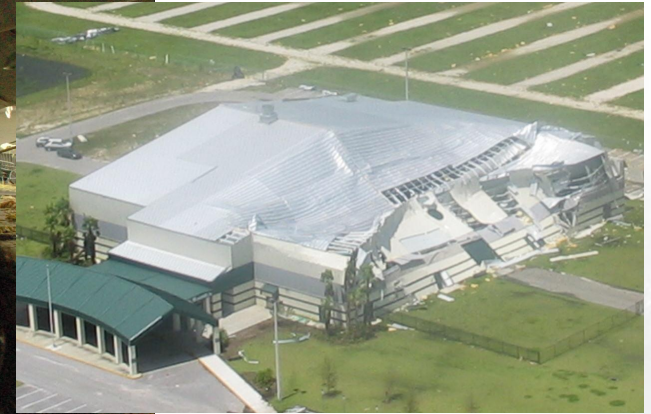
Charley's fast forward speed resulted in hurricane-force winds crossing the entire Florida Peninsula. Extreme wind damage occurred in Arcadia and Orlando

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)

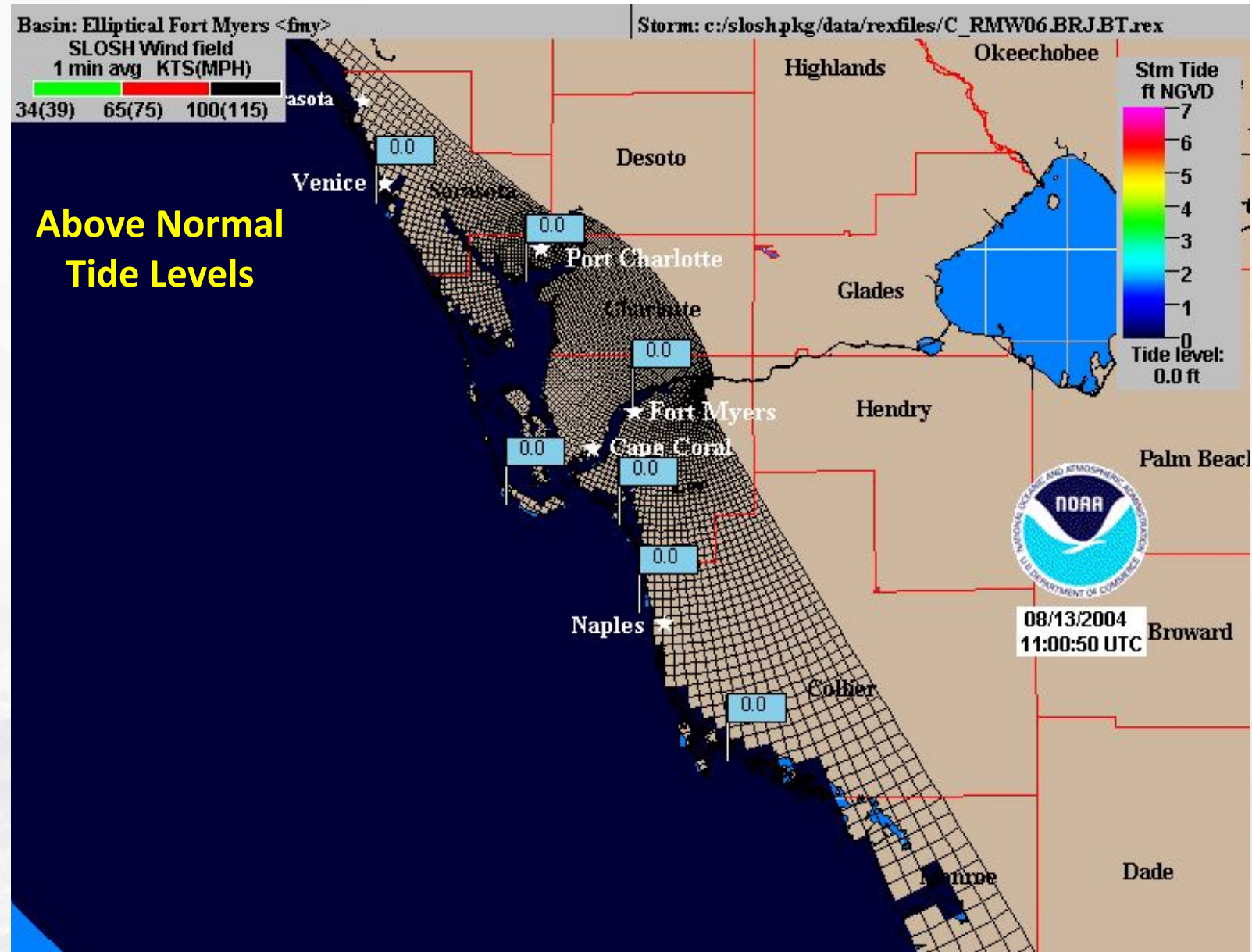


Model home (2004) in Punta Gorda Isles

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

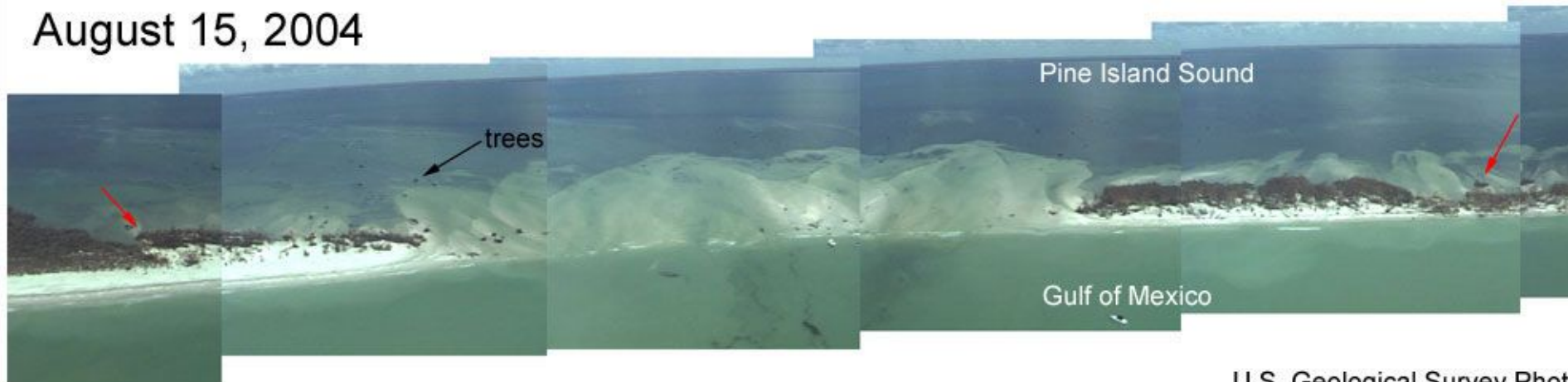


Charley's Storm Surge Caused Breach in North Captiva

North Captiva Island, FL
September 29, 1999



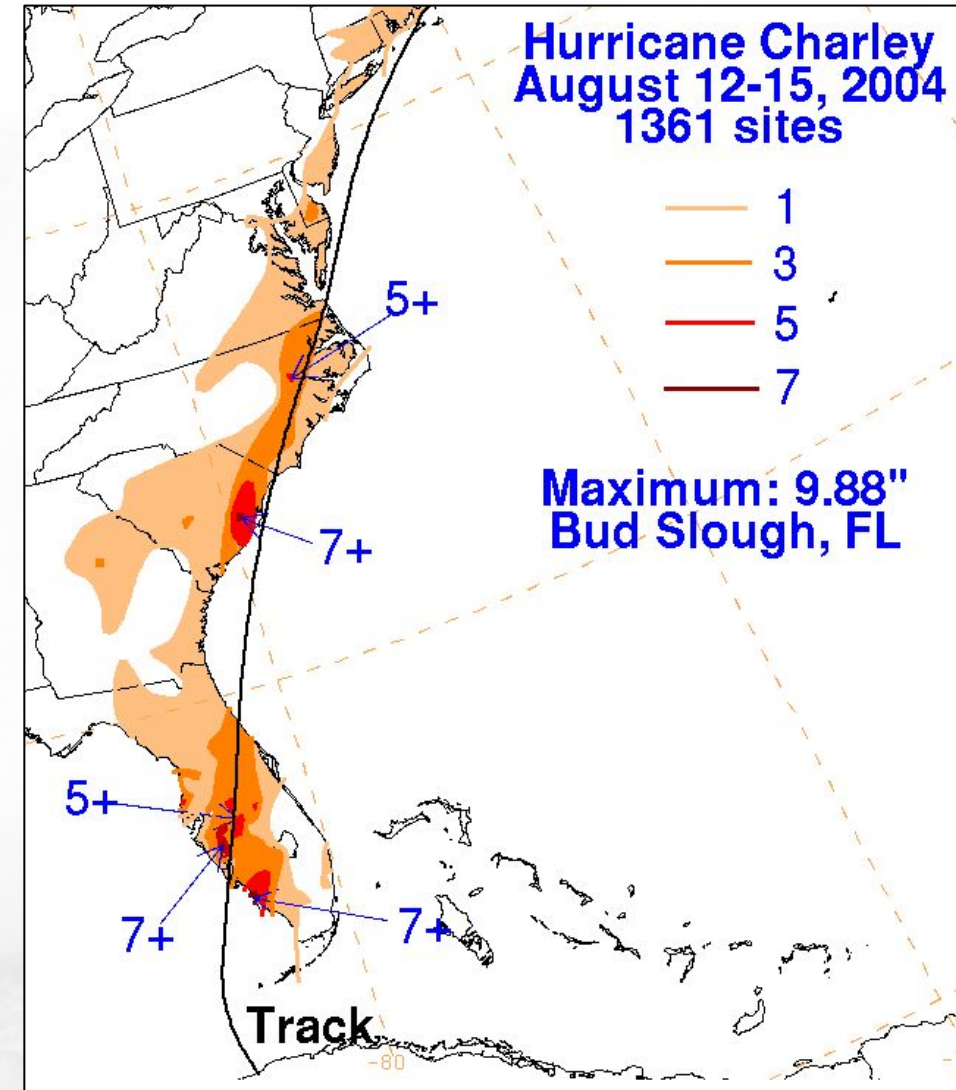
August 15, 2004



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...

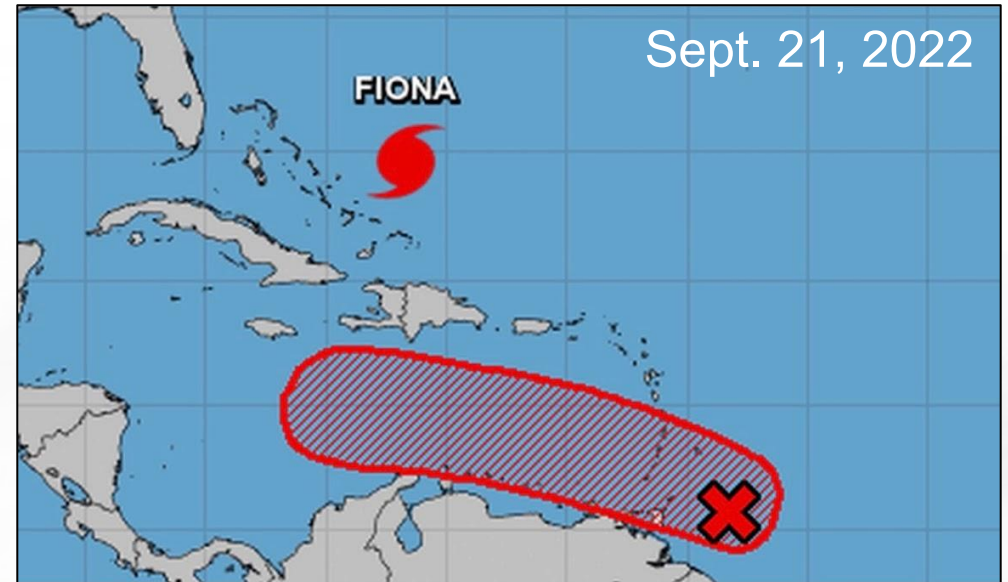
THE REMNANTS OF TROPICAL DEPRESSION TWO ARE CENTERED IN THE EXTREME SOUTHEASTERN GULF OF MEXICO ABOUT 75 MILES NORTH OF CANCUN. THIS SYSTEM CONTINUES TO SHOW SIGNS OF ORGANIZATION AND COULD RE-DEVELOP INTO A TROPICAL CYCLONE LATER TODAY. AN AIR FORCE RESERVE RECONNAISSANCE AIRCRAFT IS SCHEDULED TO INVESTIGATE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

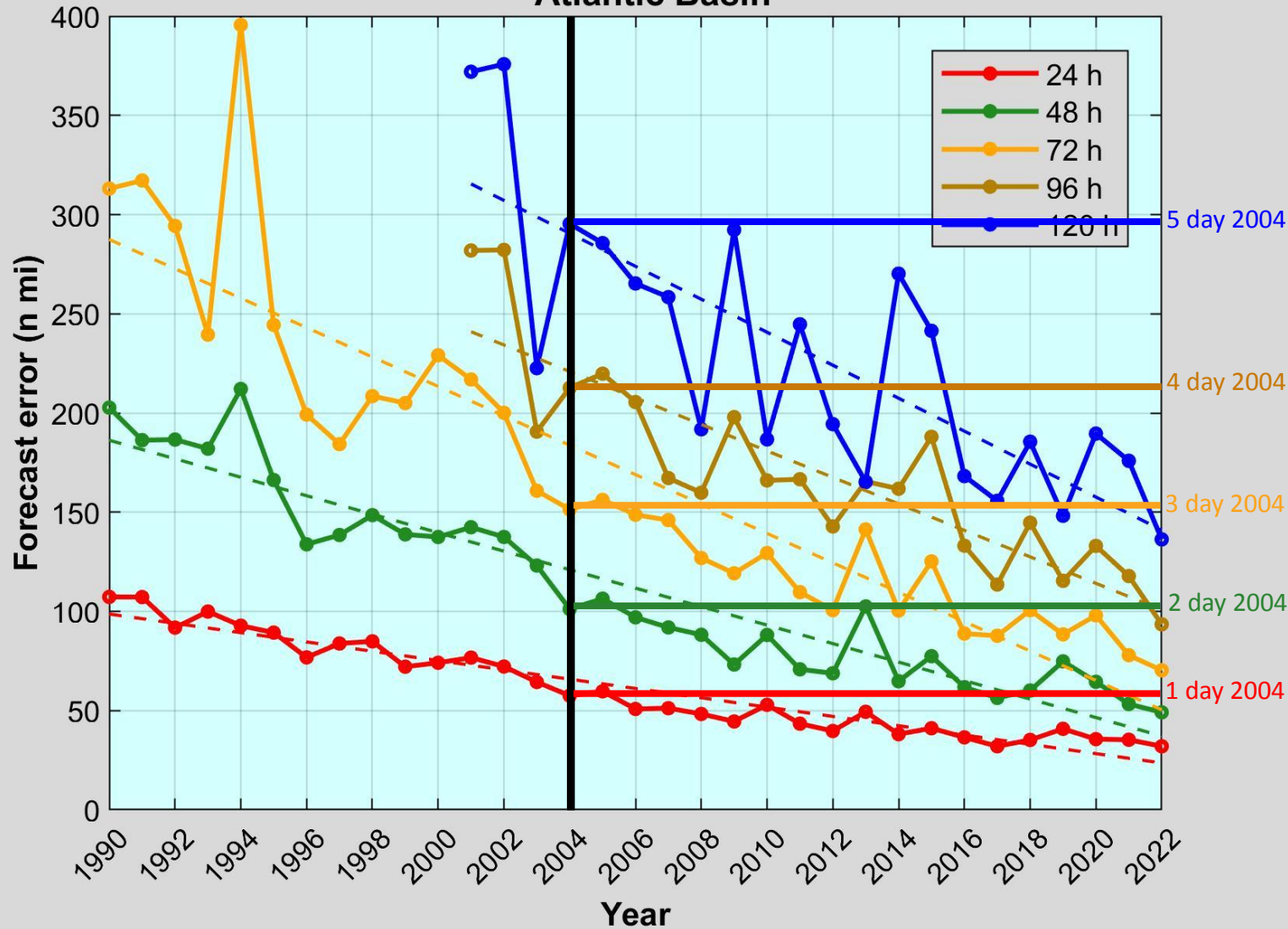


Tropical system heading toward Caribbean is likely to become hurricane, with Florida in its long-term path

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

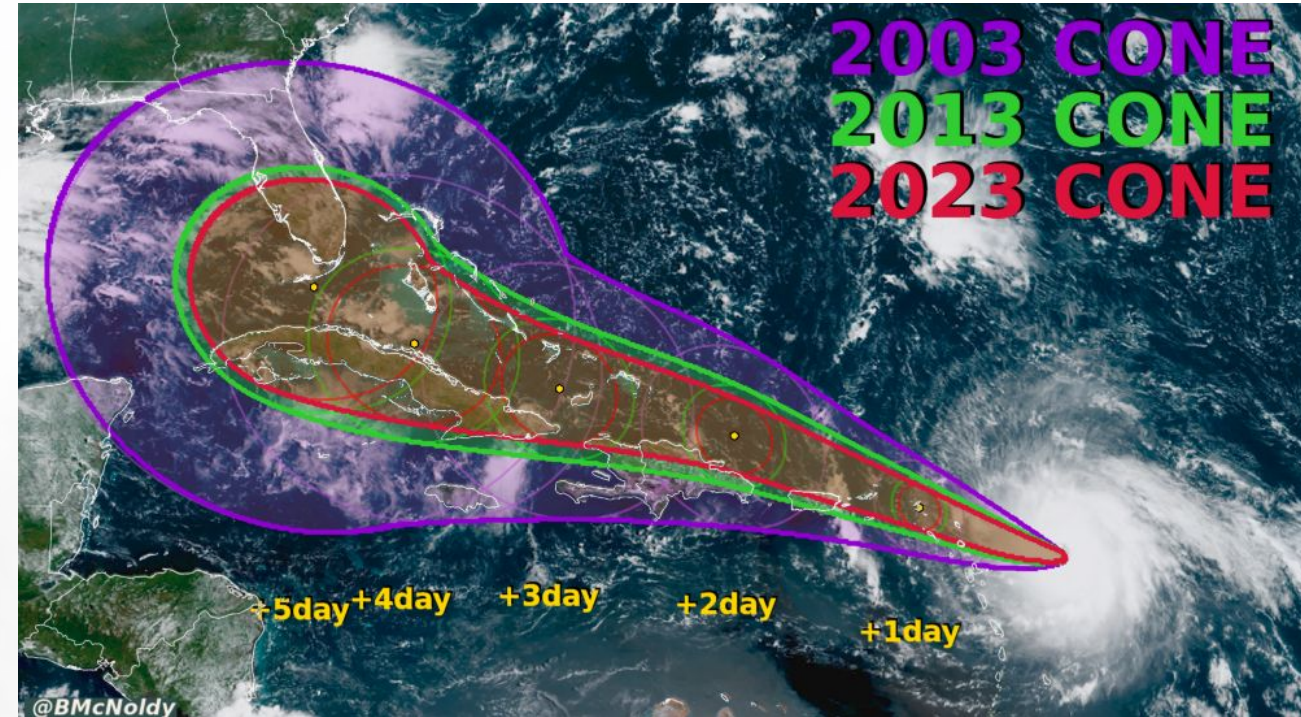
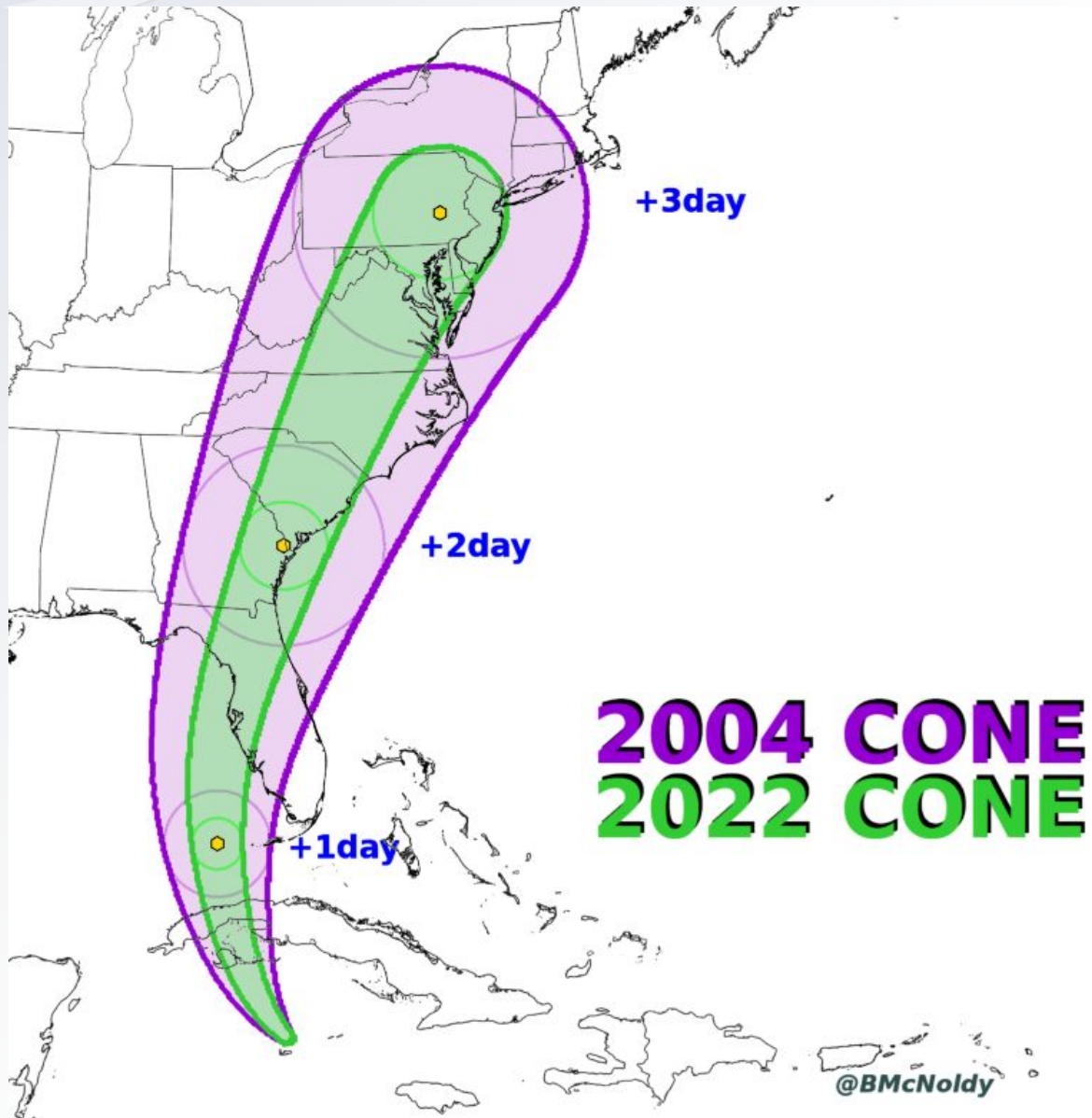
NHC Official Track Error Trend
Atlantic Basin



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.

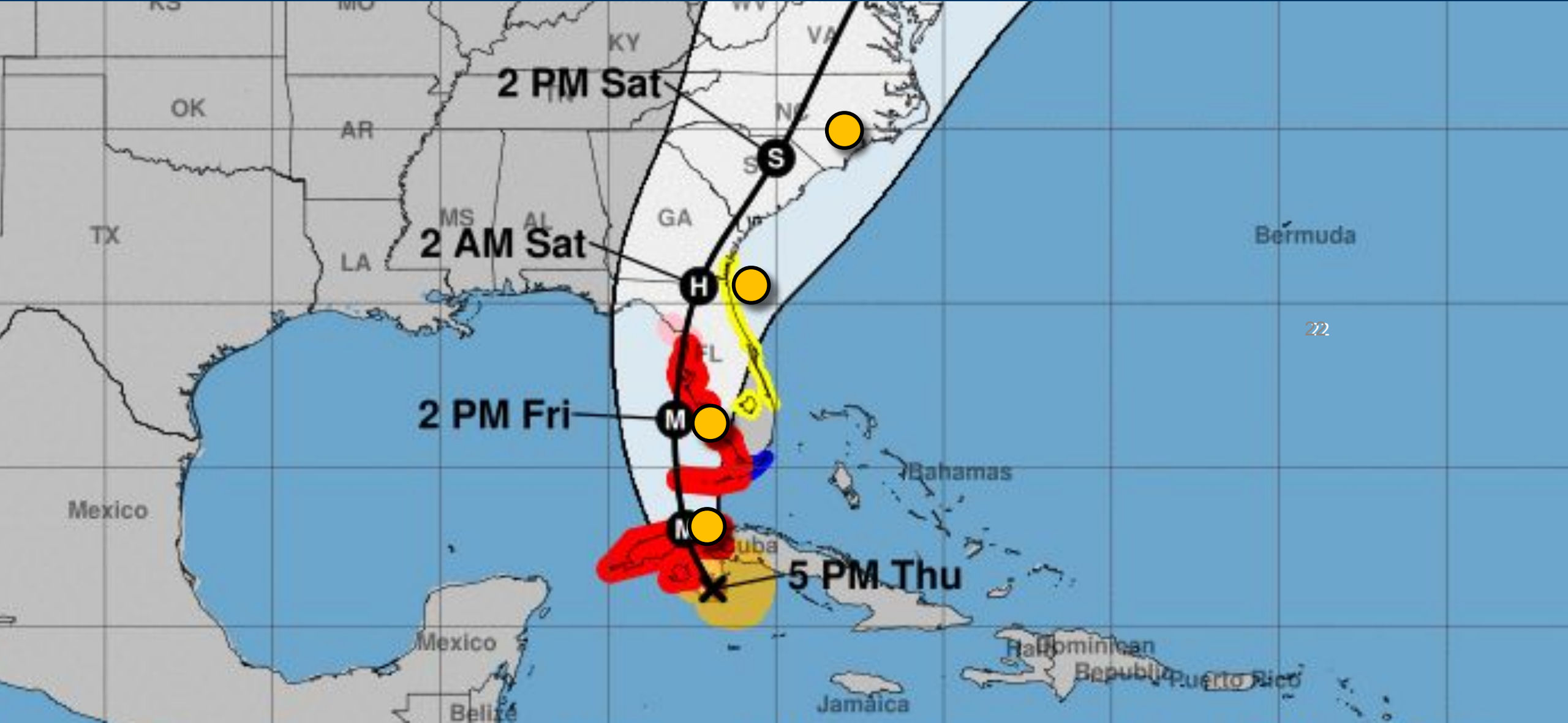
Evolution of the NHC Forecast Cone



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

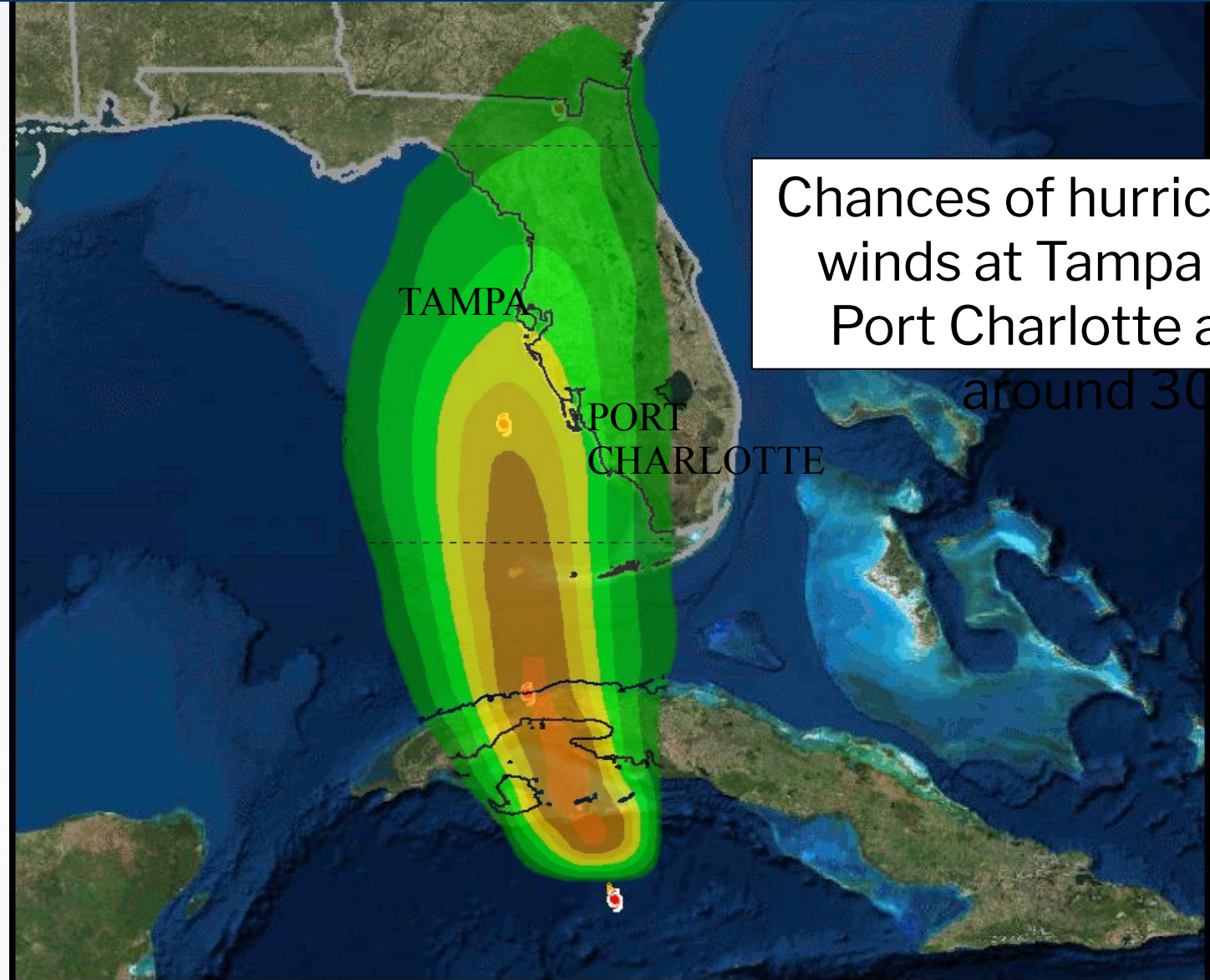
HURRICANE CHARLEY (2004)

Don't focus on the skinny black line.



HURRICANE CHARLEY

Would alternate scenarios help?

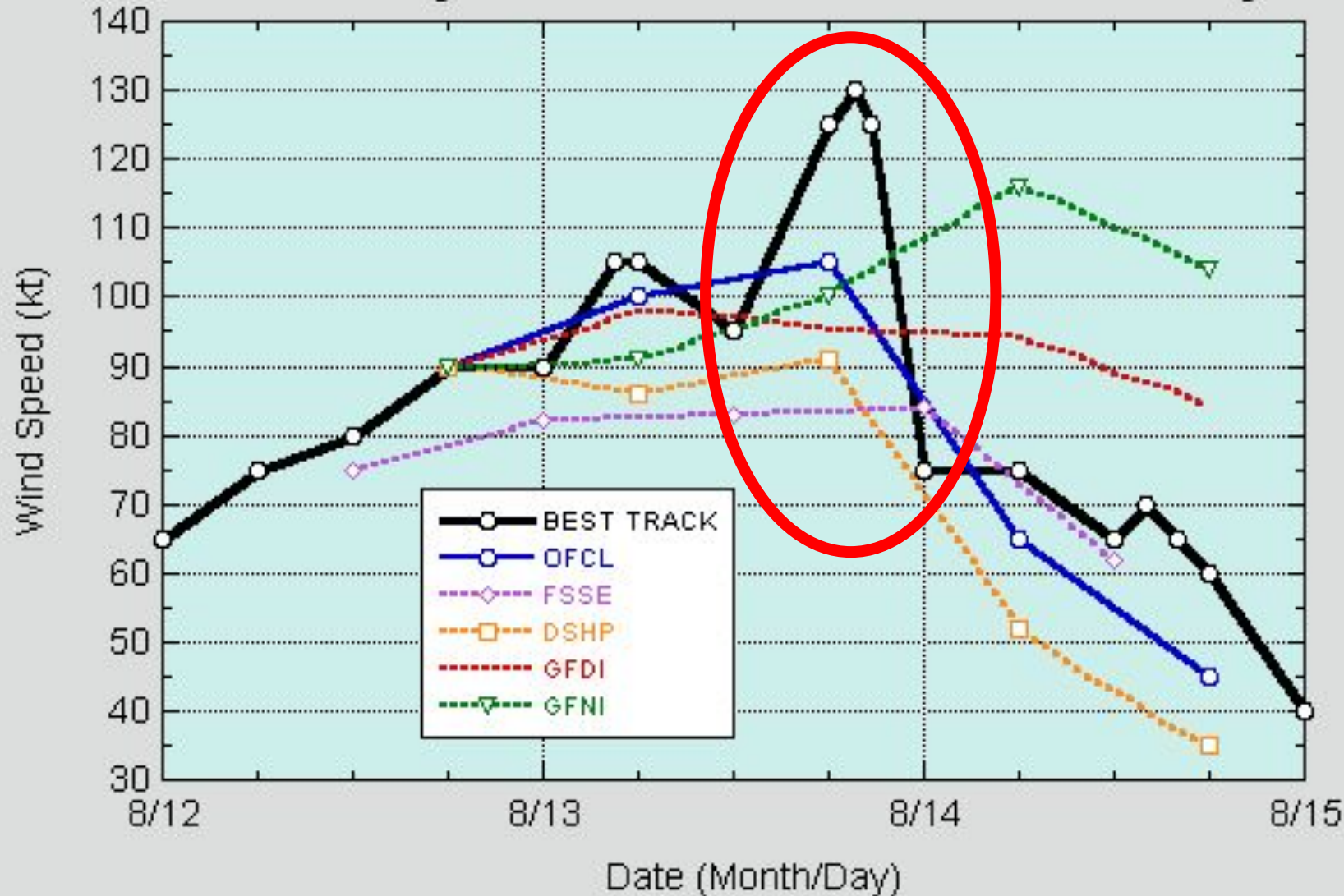


Chances of hurricane-force winds at Tampa Bay and Port Charlotte are both

around 30%

Hurricane Charley Intensity Forecasts

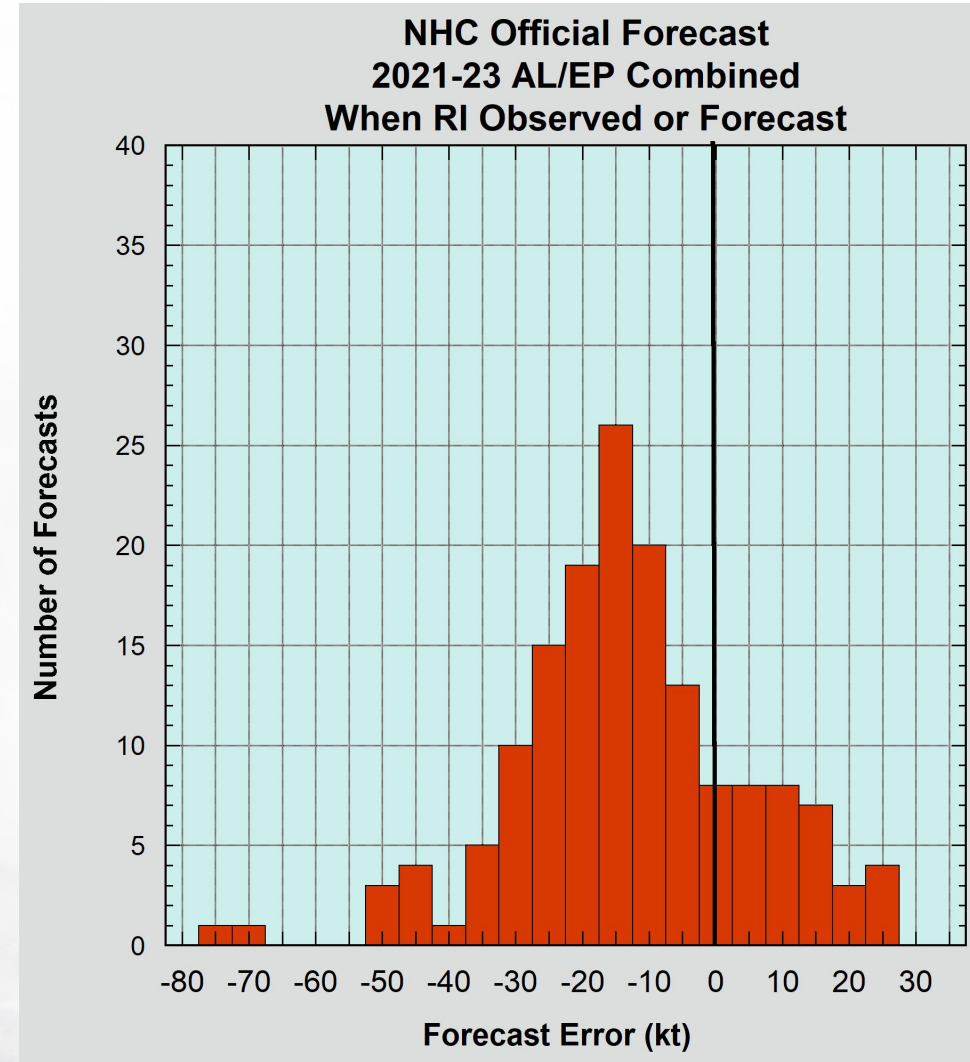
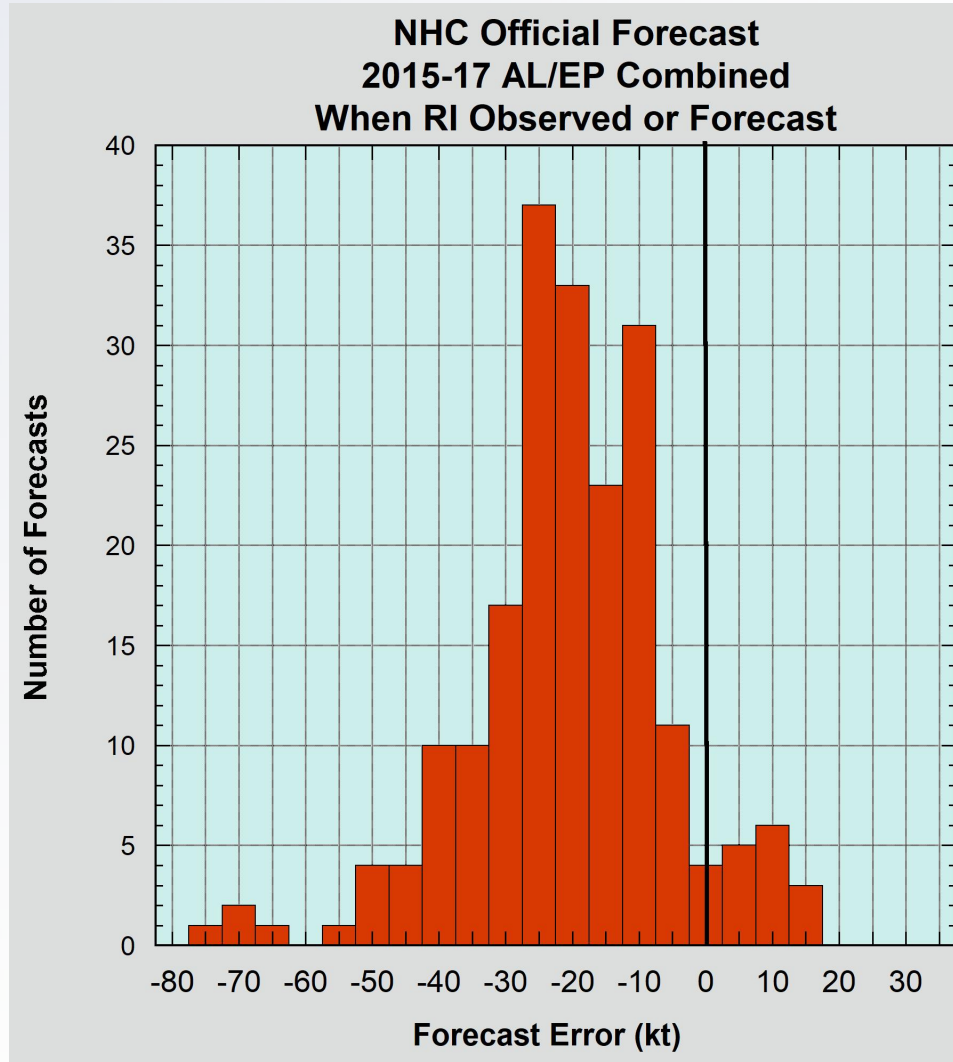
Intensity Guidance for Hurricane Charley



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.

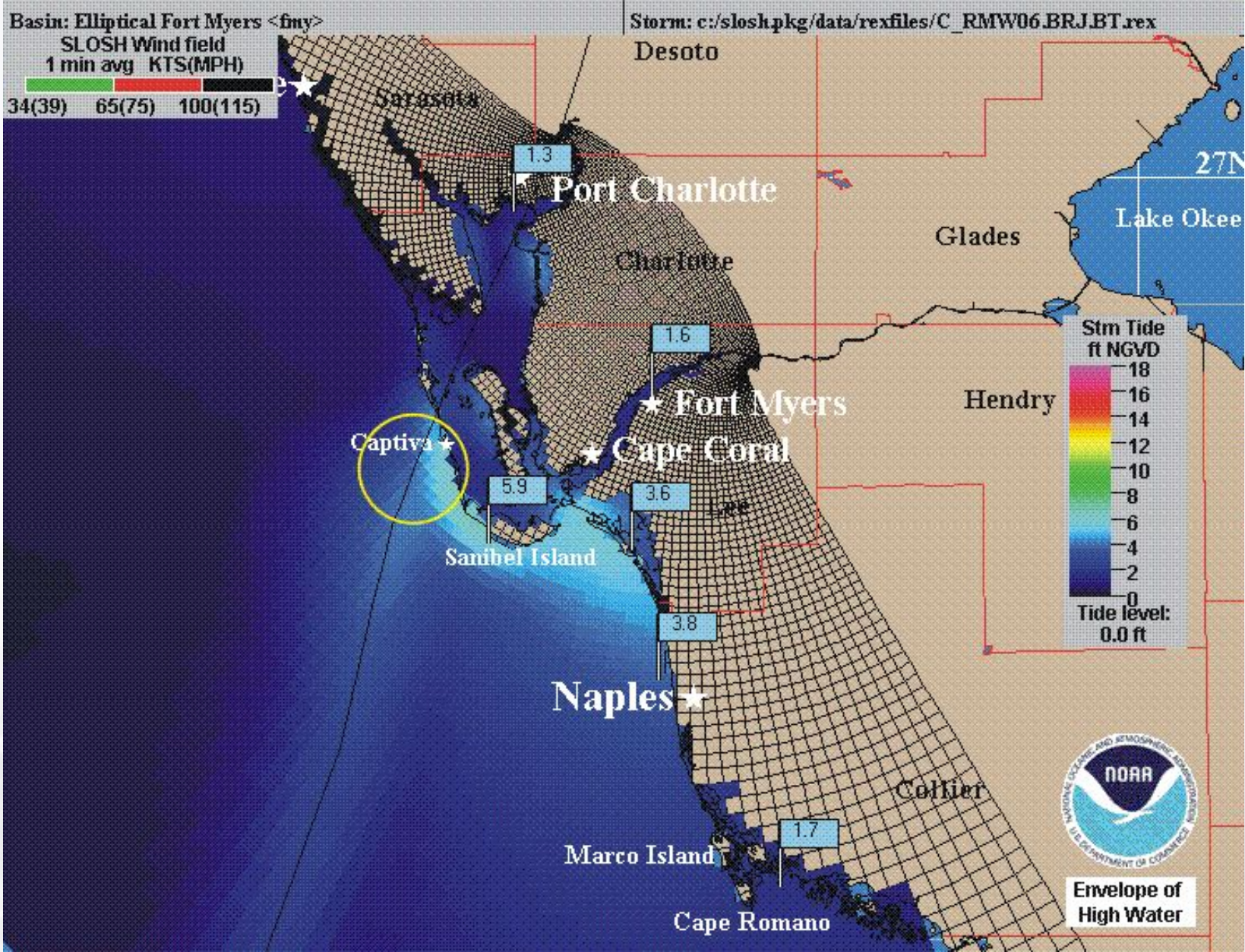
Progress in Forecasting Rapid Intensification



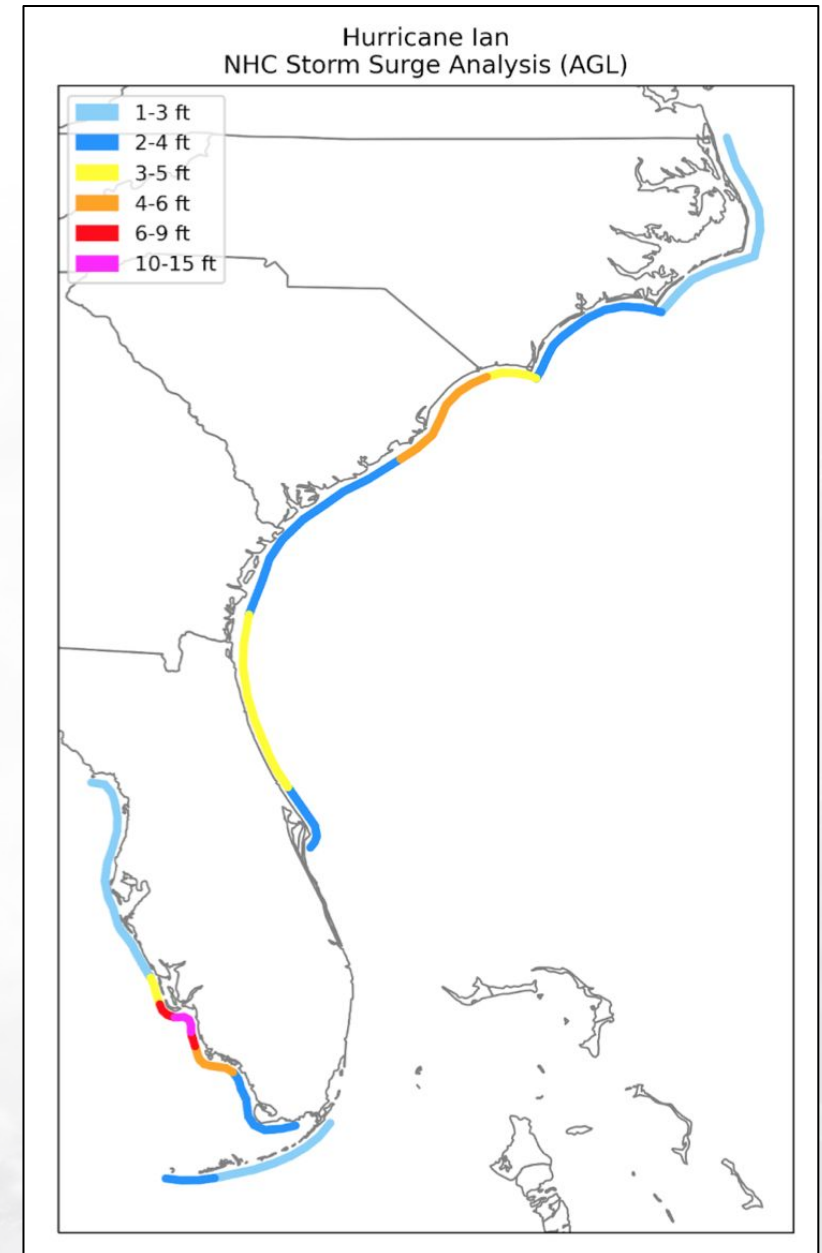
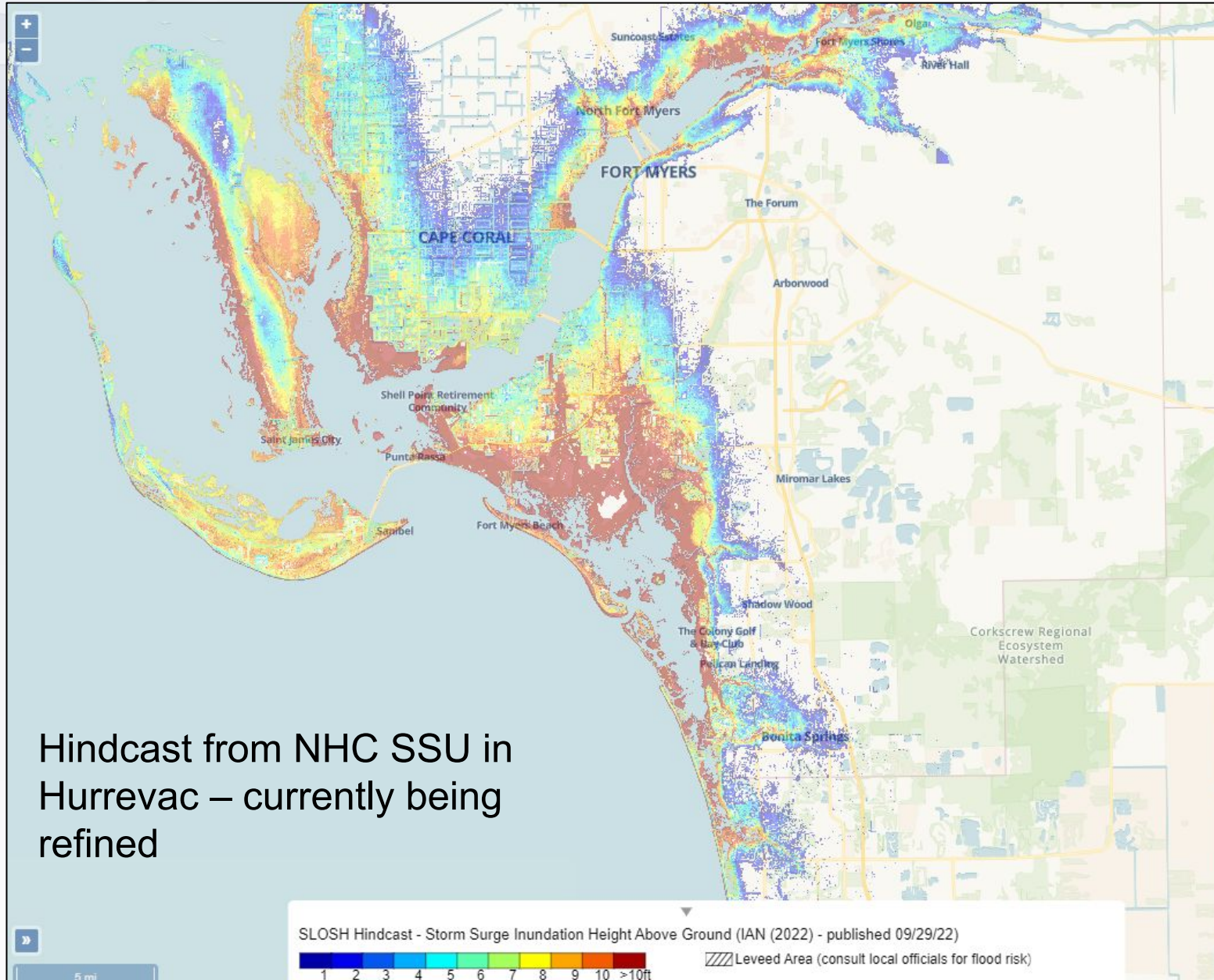
NHC's 24-h intensity forecast error during rapid intensification events has been reduced from 20 kt to 12 kt since 2015-2017

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



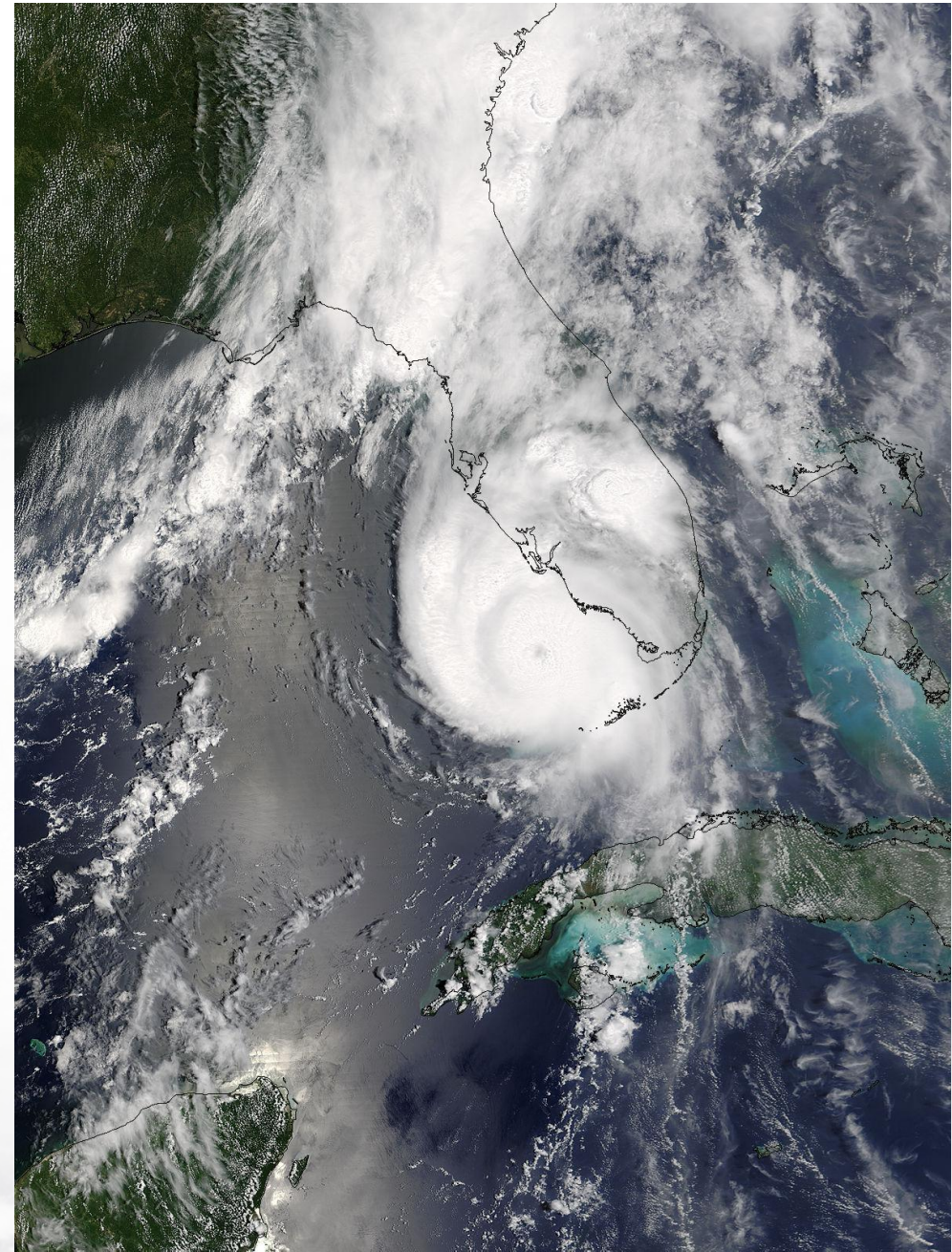
Rough Estimate of Ian's Storm Surge Footprint



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?



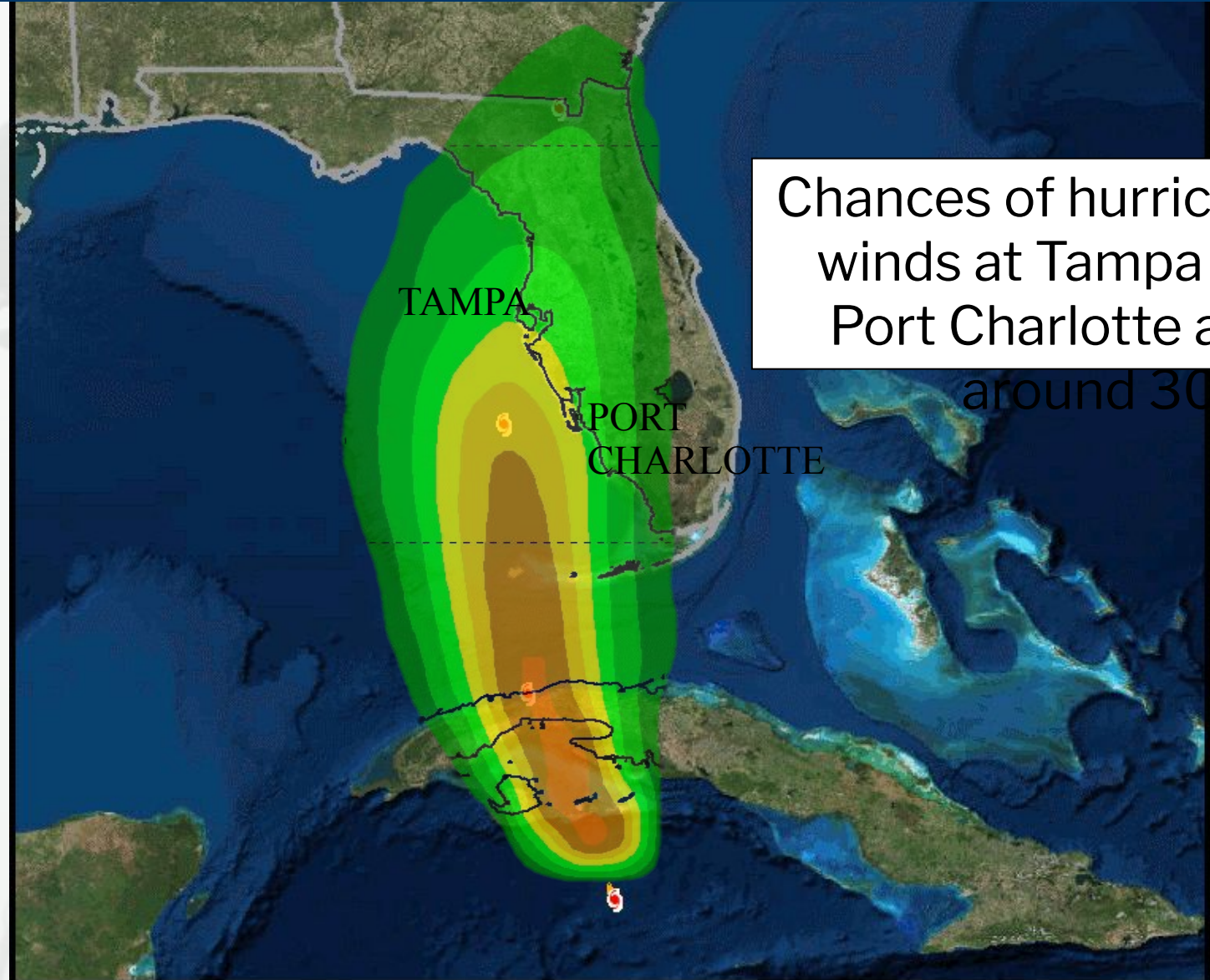
HURRICANE CHARLEY

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%

Looking Back at the 2004 Hurricane Season

Hurricane Ivan

Bonnie
Aug 11, 2004
3:15pm EDT

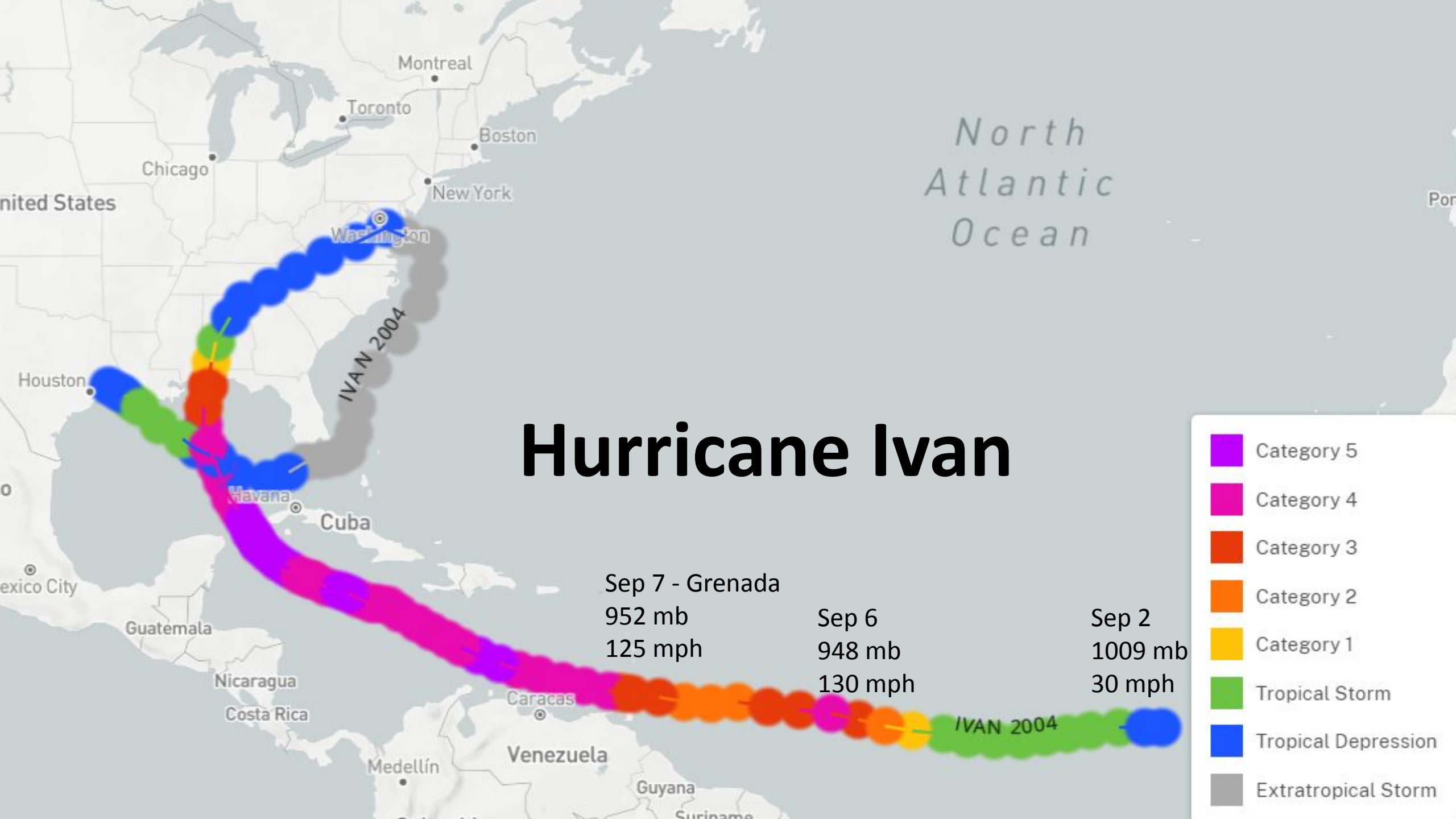
Charley
Aug 13, 2004
2:55pm EDT

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

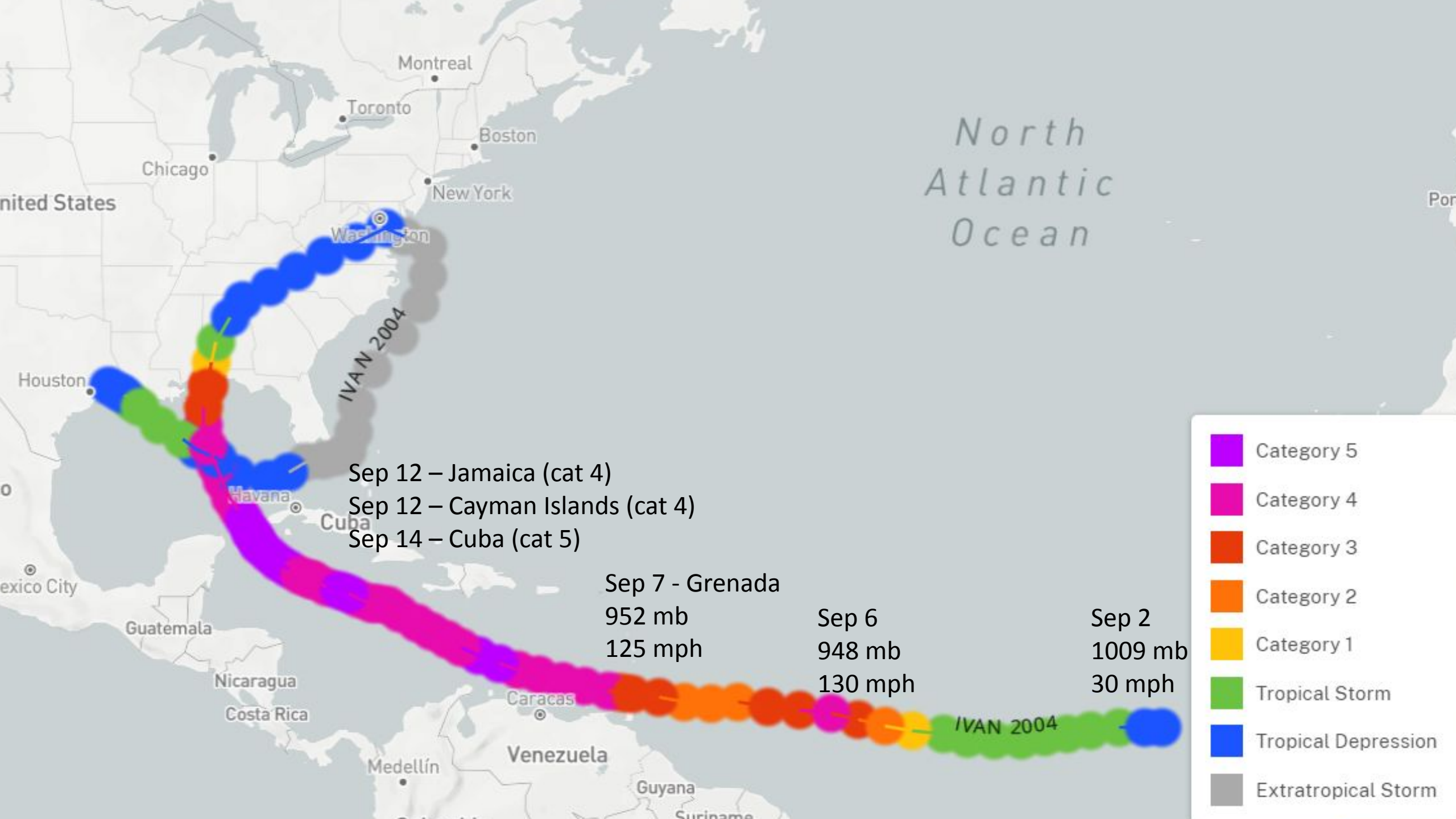
Sep 2
1009 mb
30 mph

IVAN 2004

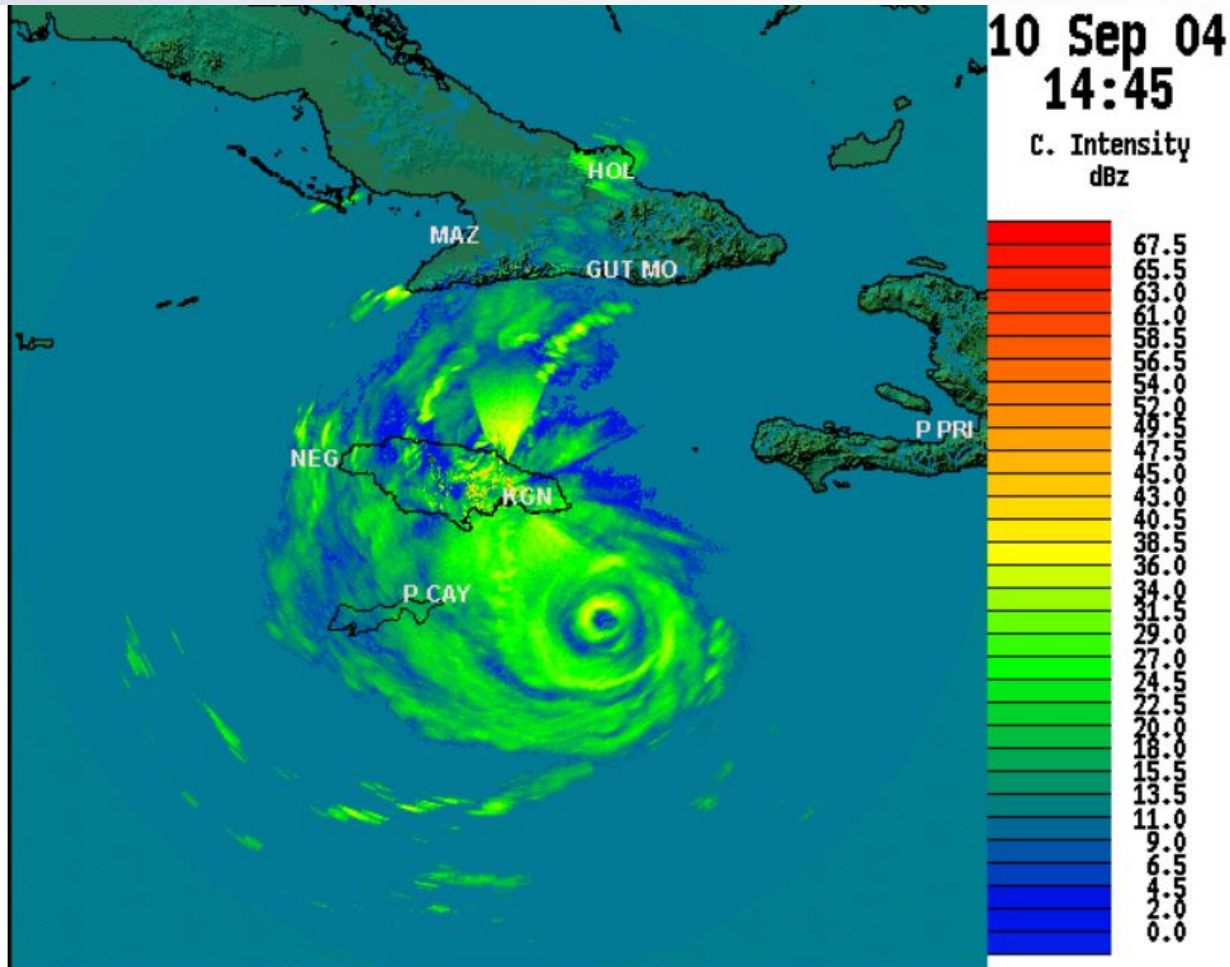
Grenada Strike



- 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

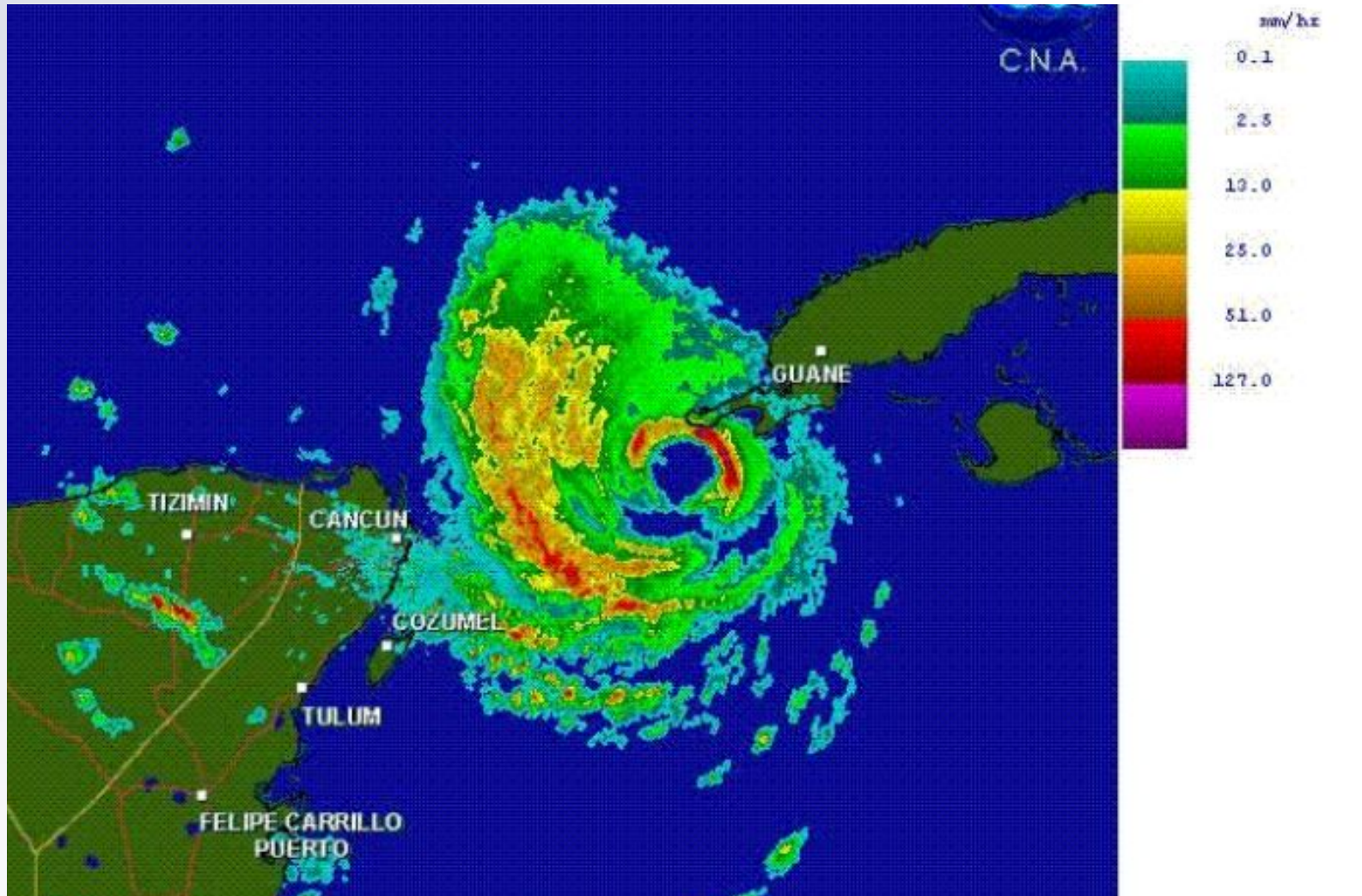


- Eye passed 20 miles south of the Jamaica, ~50,000 homes damaged/destroyed. 17 fatalities
- Eye passed 22 miles south of Grand Cayman, ~95% of the homes damaged/destroyed. 2 fatalities

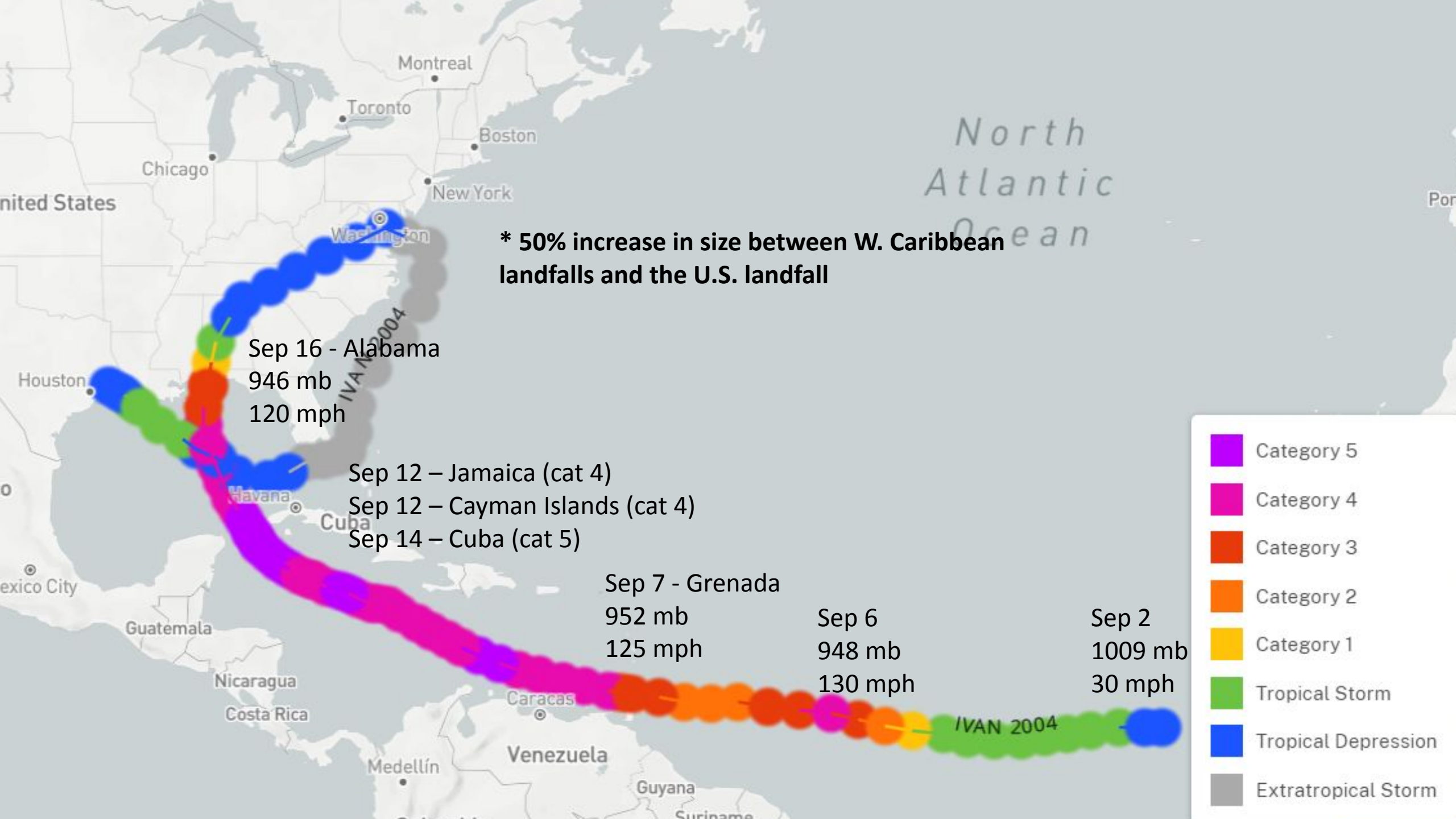


Cayman Islands

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)

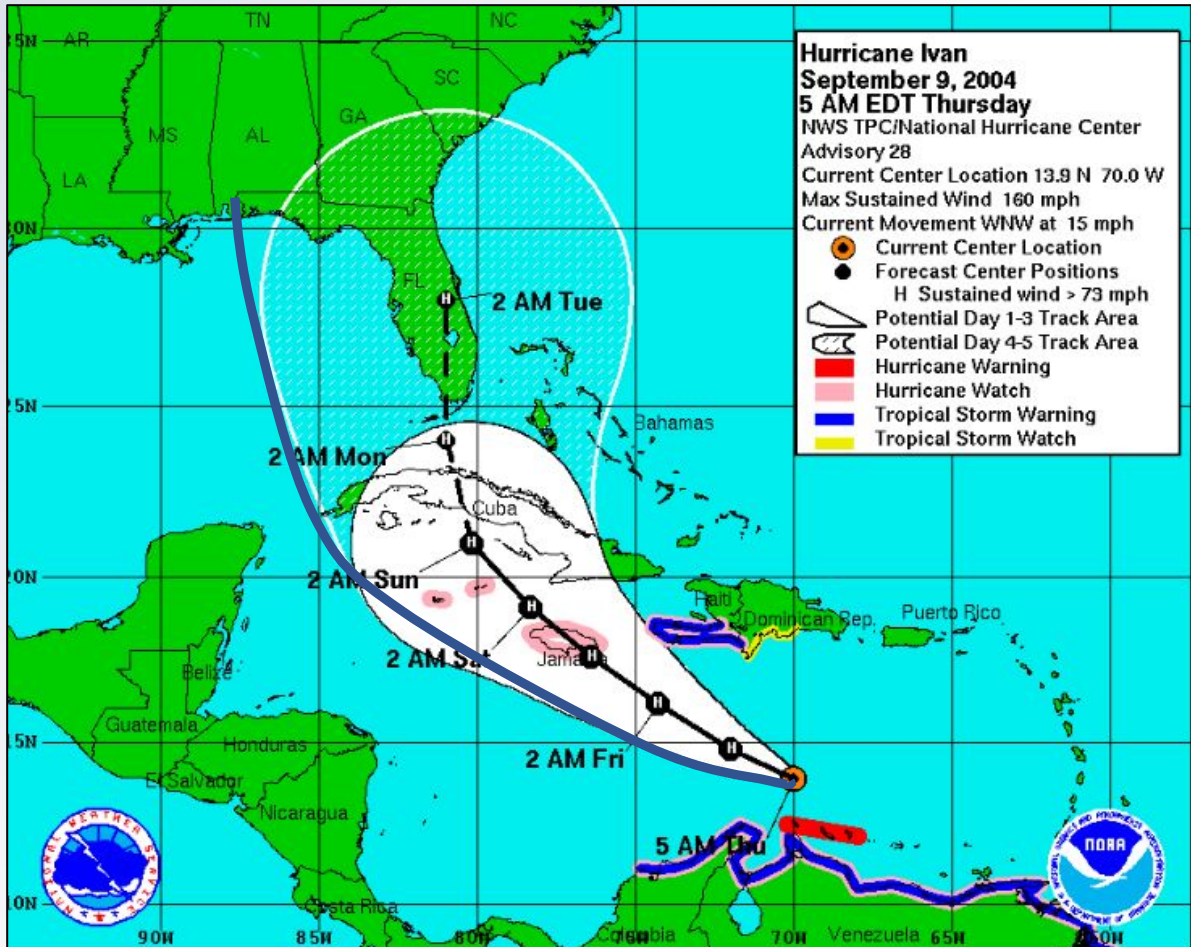
Sep 7 - Grenada
952 mb
125 mph

Sep 6
948 mb
130 mph

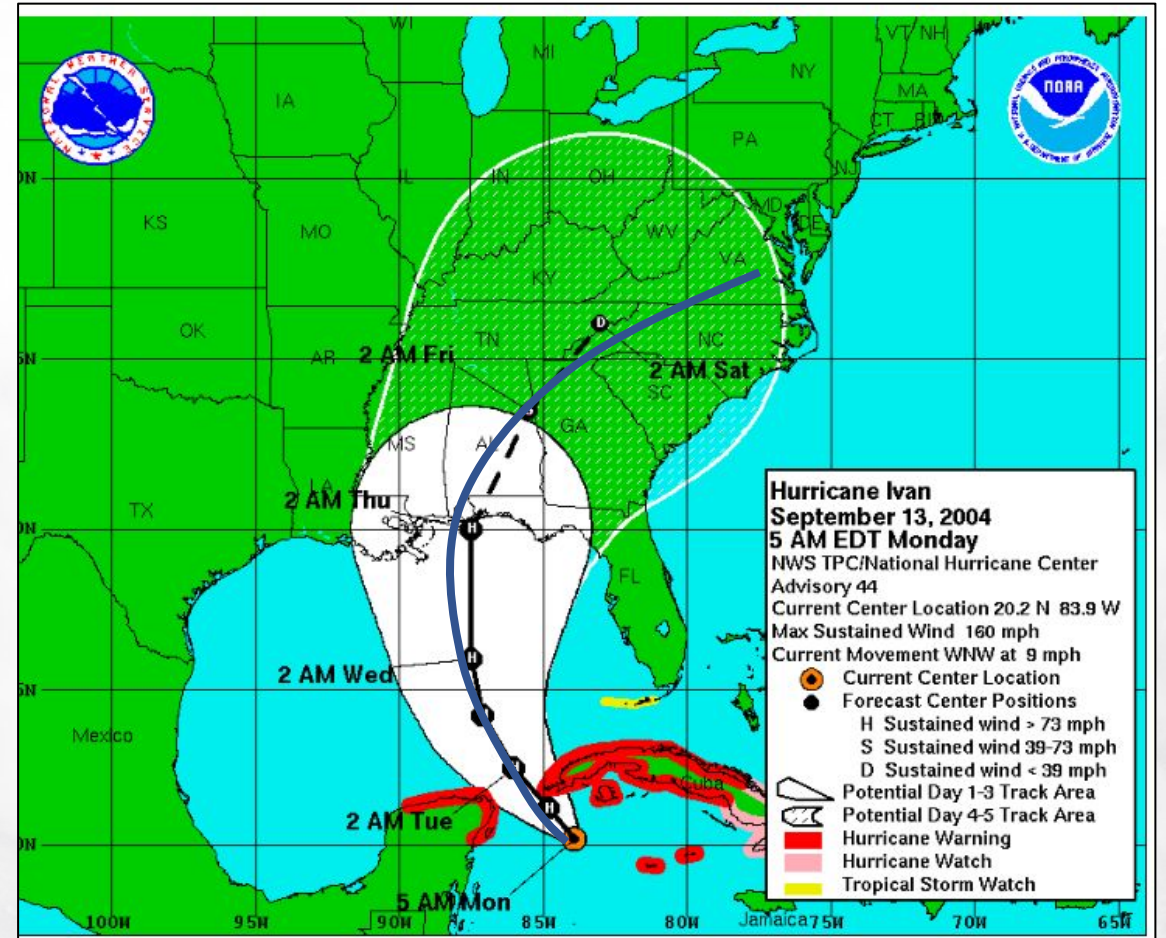
Sep 2
1009 mb
30 mph

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

NHC Forecast

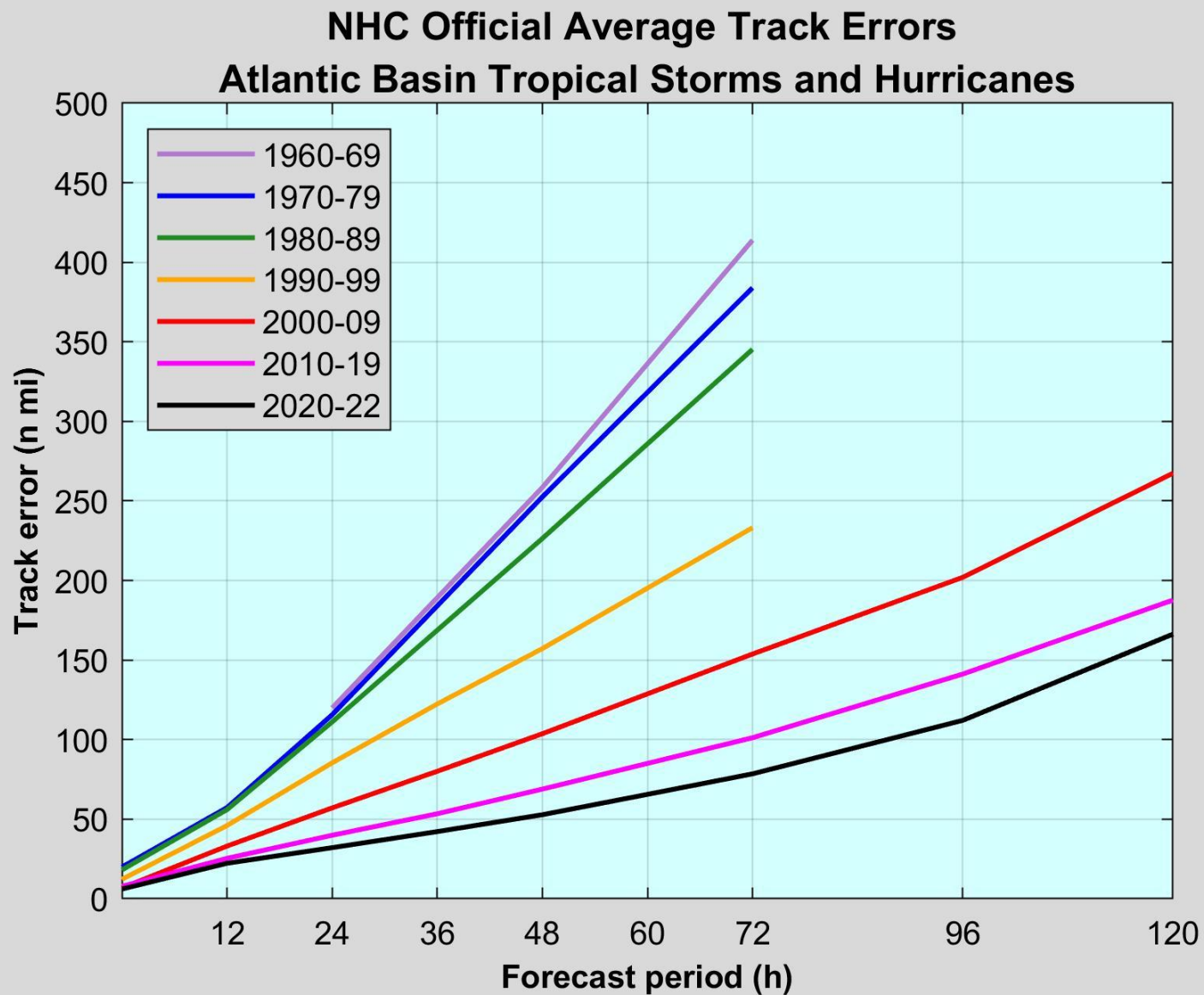


Sep 9 - 5 am (Adv 28)



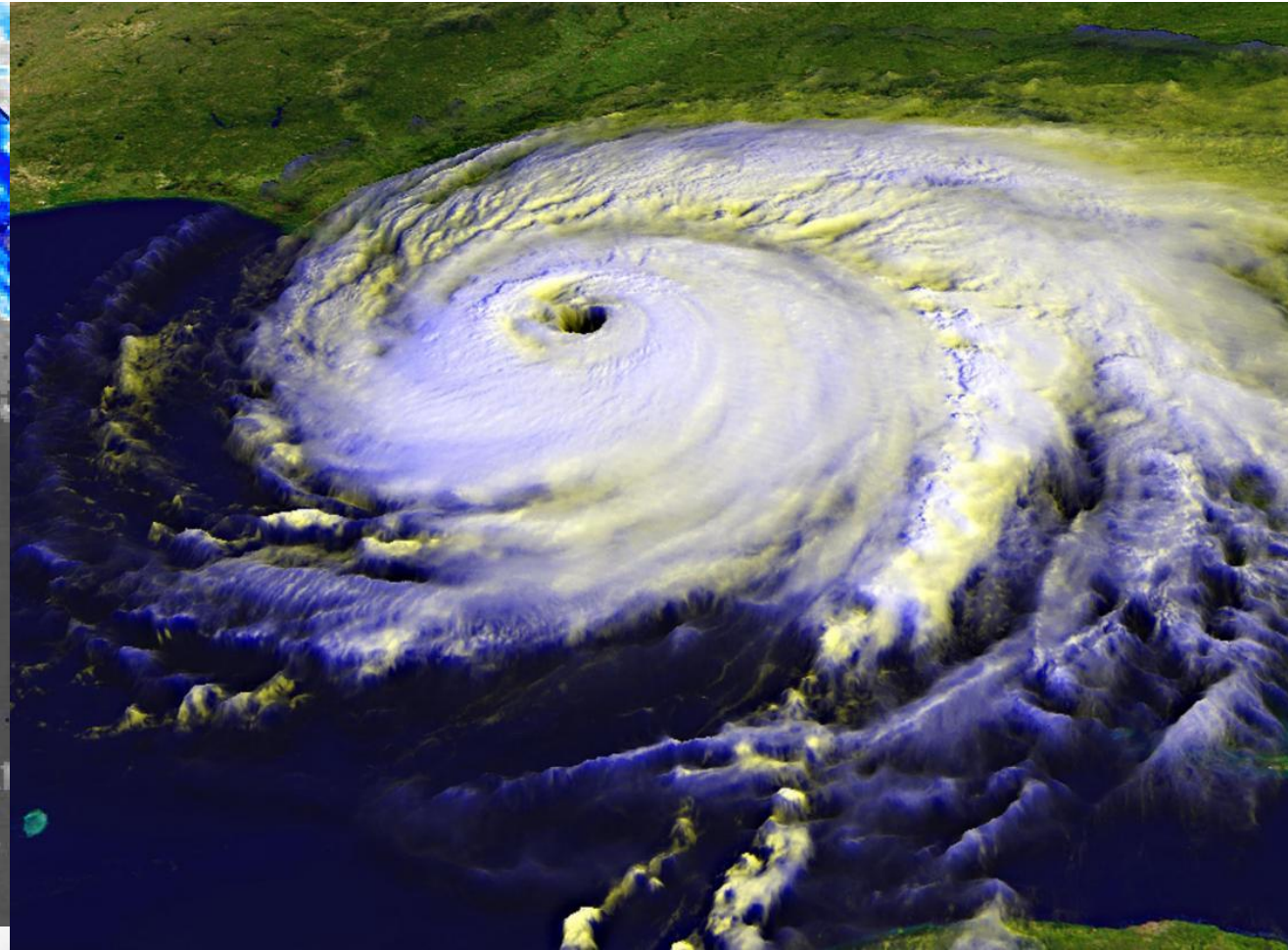
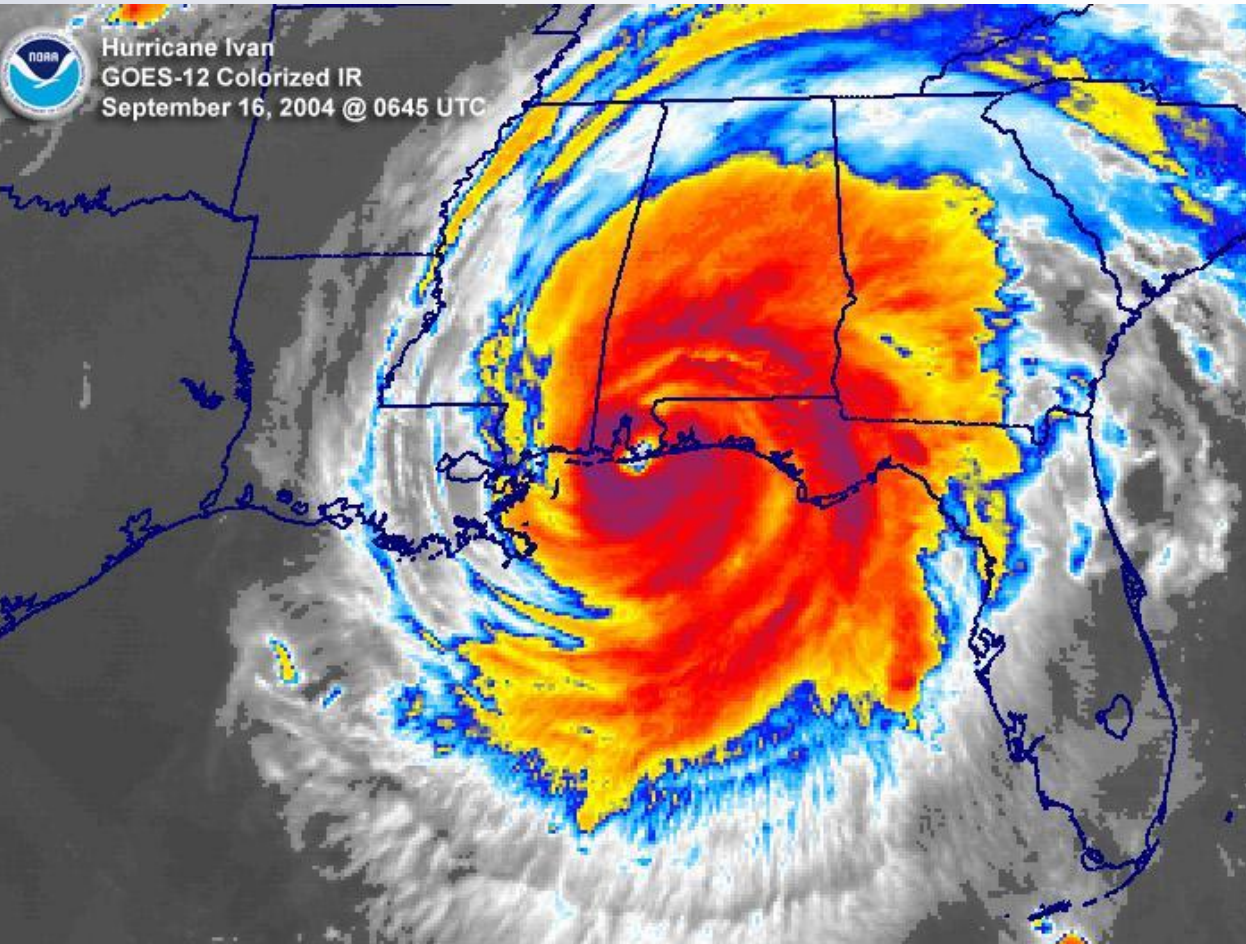
Sep 13 - 5 am (Adv 44)

Track Forecasting Progress



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

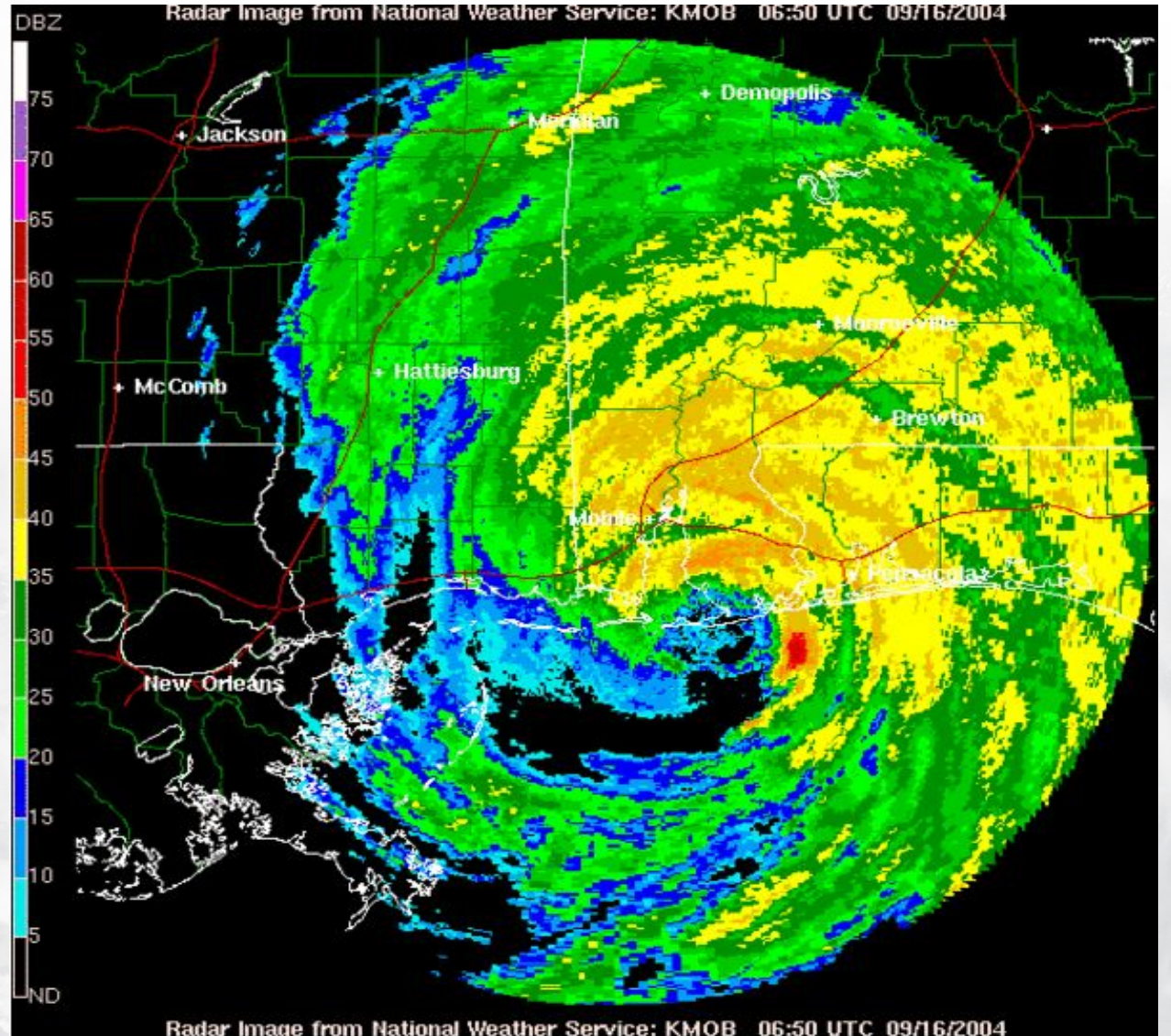
Hurricane Ivan at the Alabama Landfall



*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

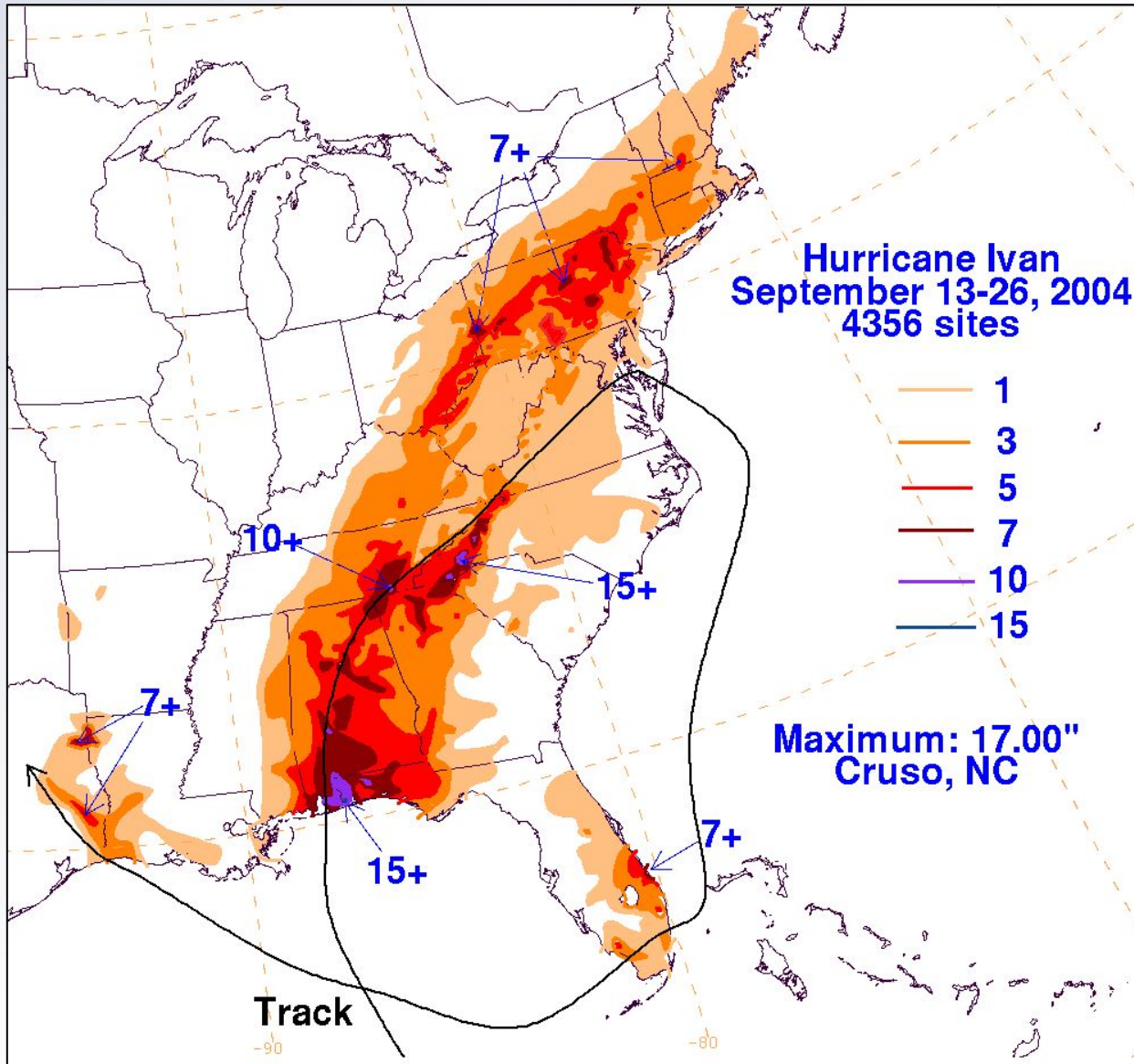


Storm Surge



- 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

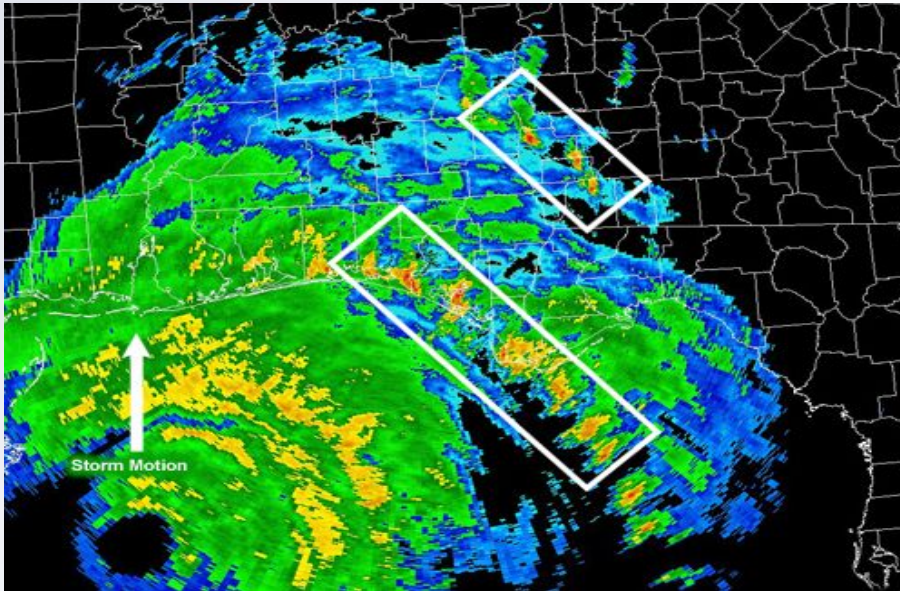
Wind Damage



Pensacola, FL

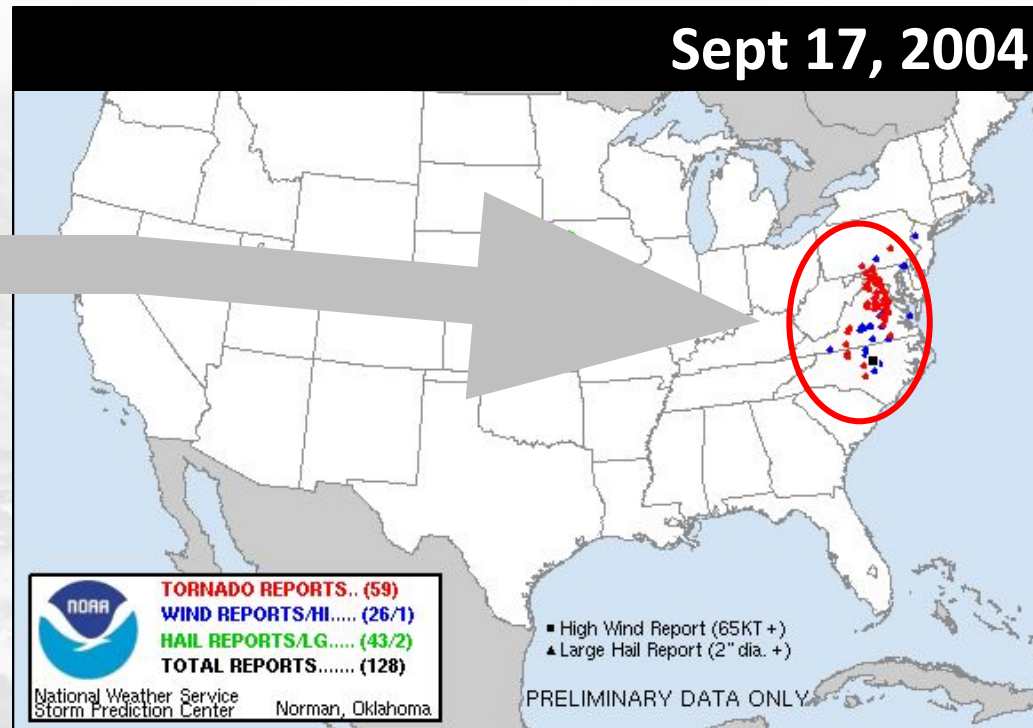
Peak wind gust – 145 mph in Baldwin County, Alabama

Ivan caused a tornado outbreak!

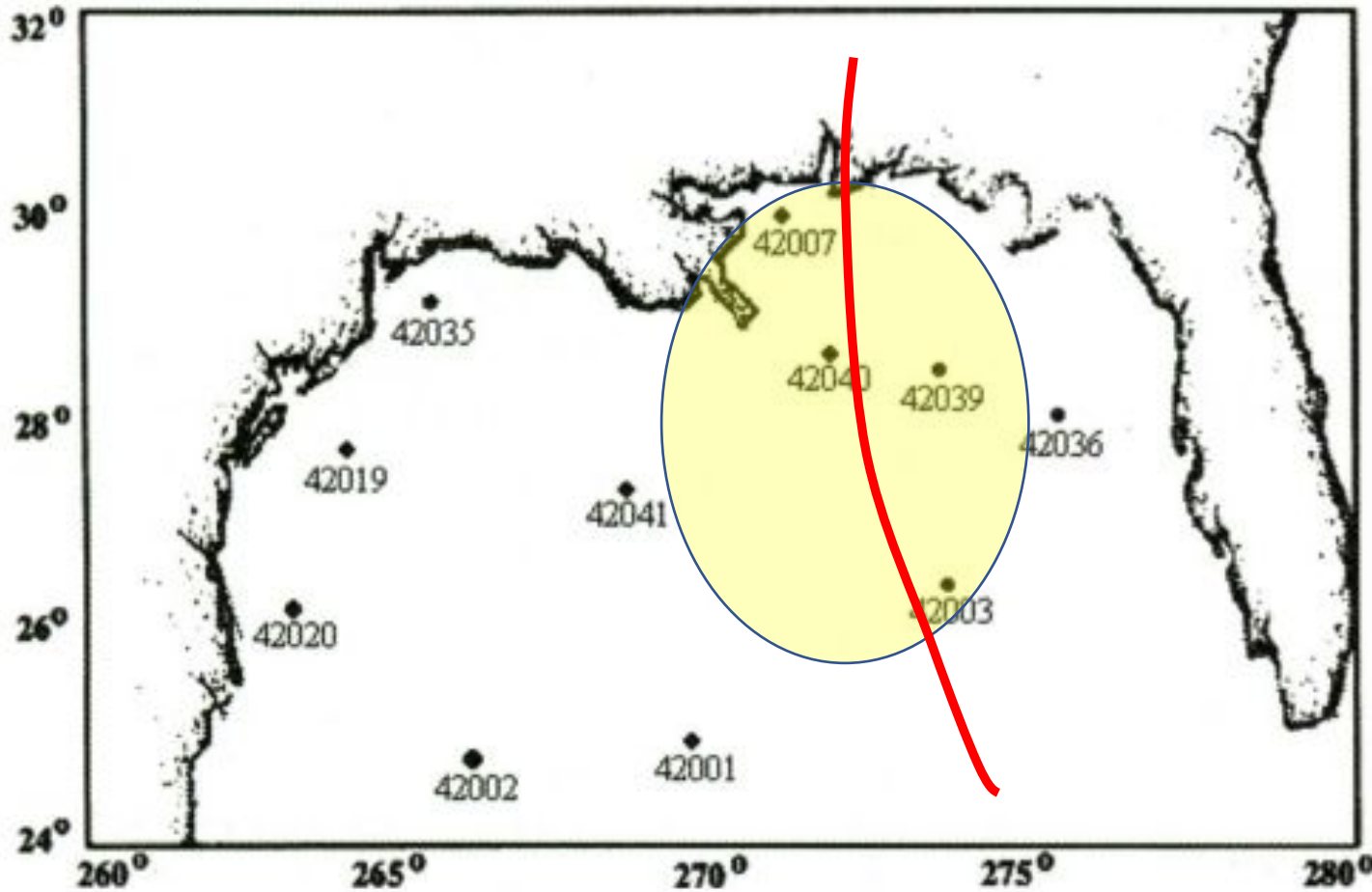


Tornado “outbreak”

Hurricane Ivan (2004)
– 117 Tornadoes



Marine Hazards



Panchang and Li, BAMS 2006

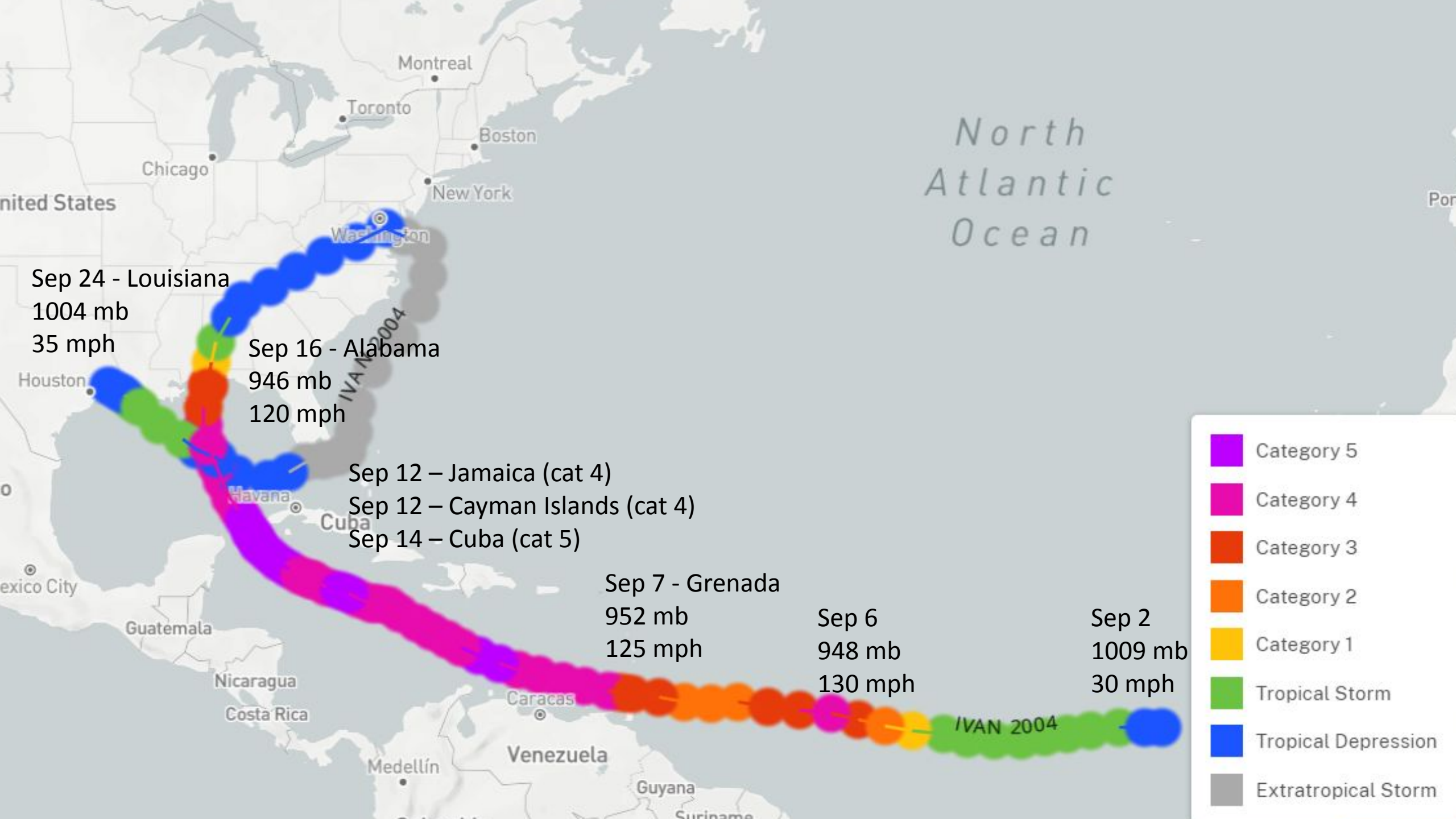
* Largest waves recorded (up to that time) at NOAA buoys 42003, 42007, 42039, and 42040.

* 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



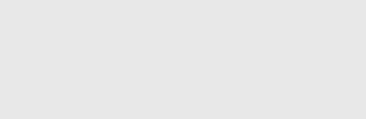
Storm pounds East at least 12 are killed

At least 12 people were killed and hundreds of thousands of people were left without power as a powerful storm swept through the Southeastern United States...

South Coast of North Carolina stands in the wake of the storm that has caused the damage to be estimated between \$100 million to \$1 billion.

Awash in storm misery

From the Gulf to the mountains, Ivan soaks Southeast



North Carolina A giant deluge hit the state as Ivan's rain-soaked waters poured down the mountains...

N.C. mountain turns to mud

North Carolina's mountain regions are being hit by a deluge of rain and mudslides, with some areas receiving over 20 inches of rain...

Awash in storm misery

From the Gulf to the mountains, Ivan soaks Southeast



Massive floods inundate Georgia At least 5 dead

Massive floods inundate Georgia

At least five people were killed and thousands of people were left without power as a powerful storm swept through the Southeastern United States...

8 die as Ivan's rain pounds mountains

COMPLETE STORM COVERAGE 8-10A, 1B



President drops in on Charlotte for weather rally, city faces power

Bush woos donors, reaches out to women

President George W. Bush is expected to visit Charlotte for a weather rally and to meet with donors and women's leaders...

Lebanon Daily News advertisement featuring a large headline 'TRAIL OF DESTRUCTION' and 'Ivan barrels north', along with a coupon for \$60 in savings.

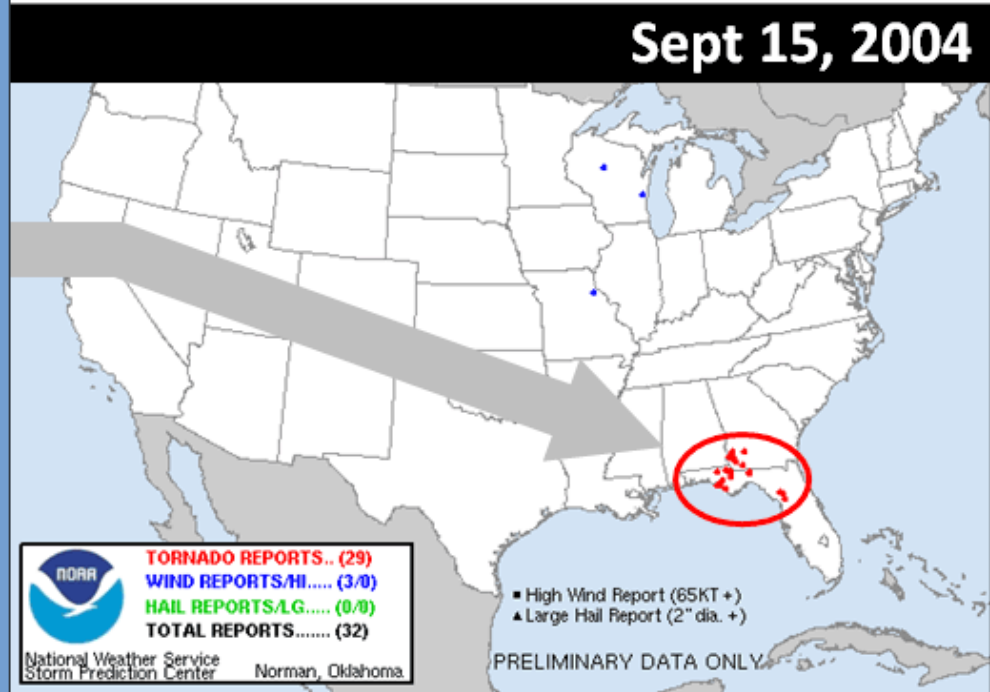
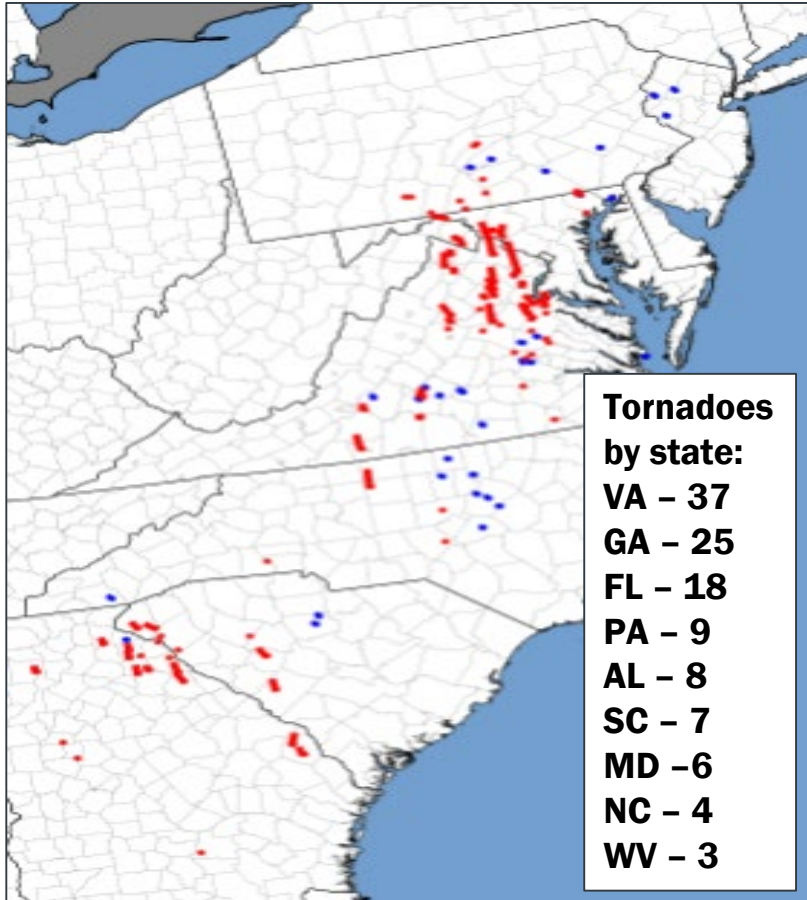
The Daily Times advertisement featuring a large headline 'Ivan remains bring Md. flooding to wind' and 'Murder suspect to return to county'.

The State advertisement featuring a large headline 'Ivan charges inland after bashing Gulf Coast' and 'DeMint woos women voters'.

Culpeper Star-Exponent advertisement featuring a large headline 'Remington Ravaged' and 'Tornadoes everywhere across area'.

Ivan Tornado Outbreak – Sept. 15-18

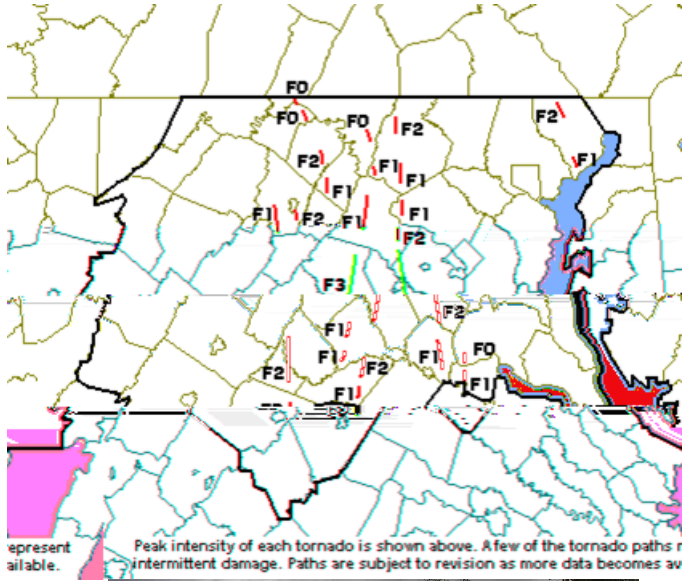
- One of the worst tornado outbreaks in tropical cyclone history and Mid-Atlantic history!
- 117 tornadoes hit 9 states, over 3 days, with 8 fatalities.
- Apex on Sept. 17 (57 tornadoes / 49% of outbreak)



Source: Matt Elliott/SPC; NHC



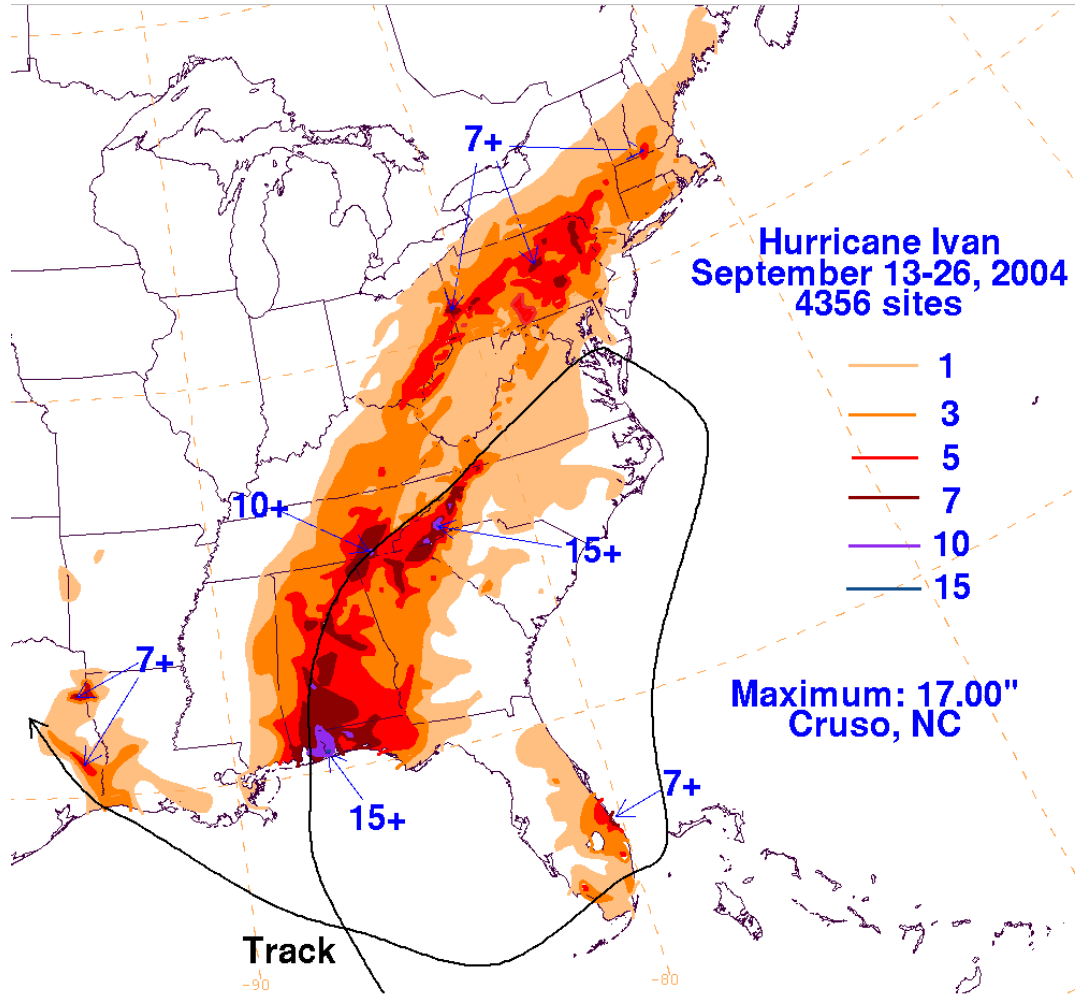
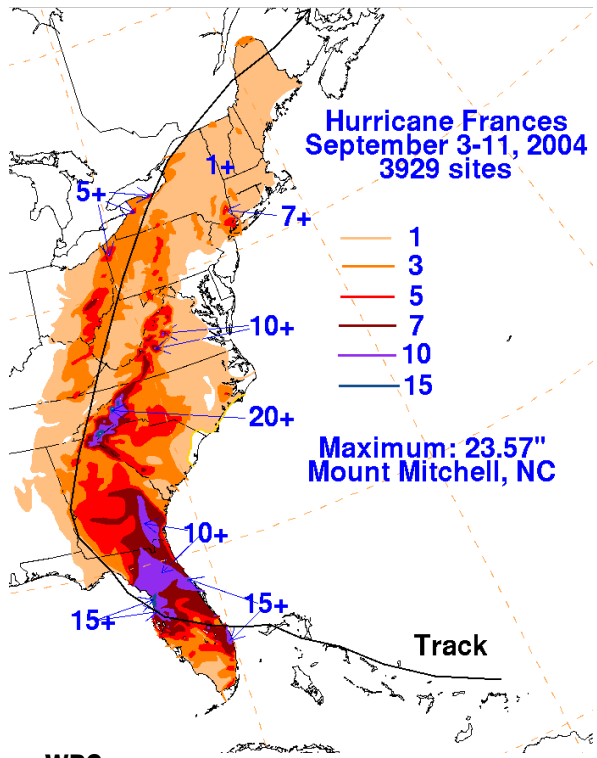
Ivan Tornado Outbreak in the DMV



Source: WFO Baltimore/Washington



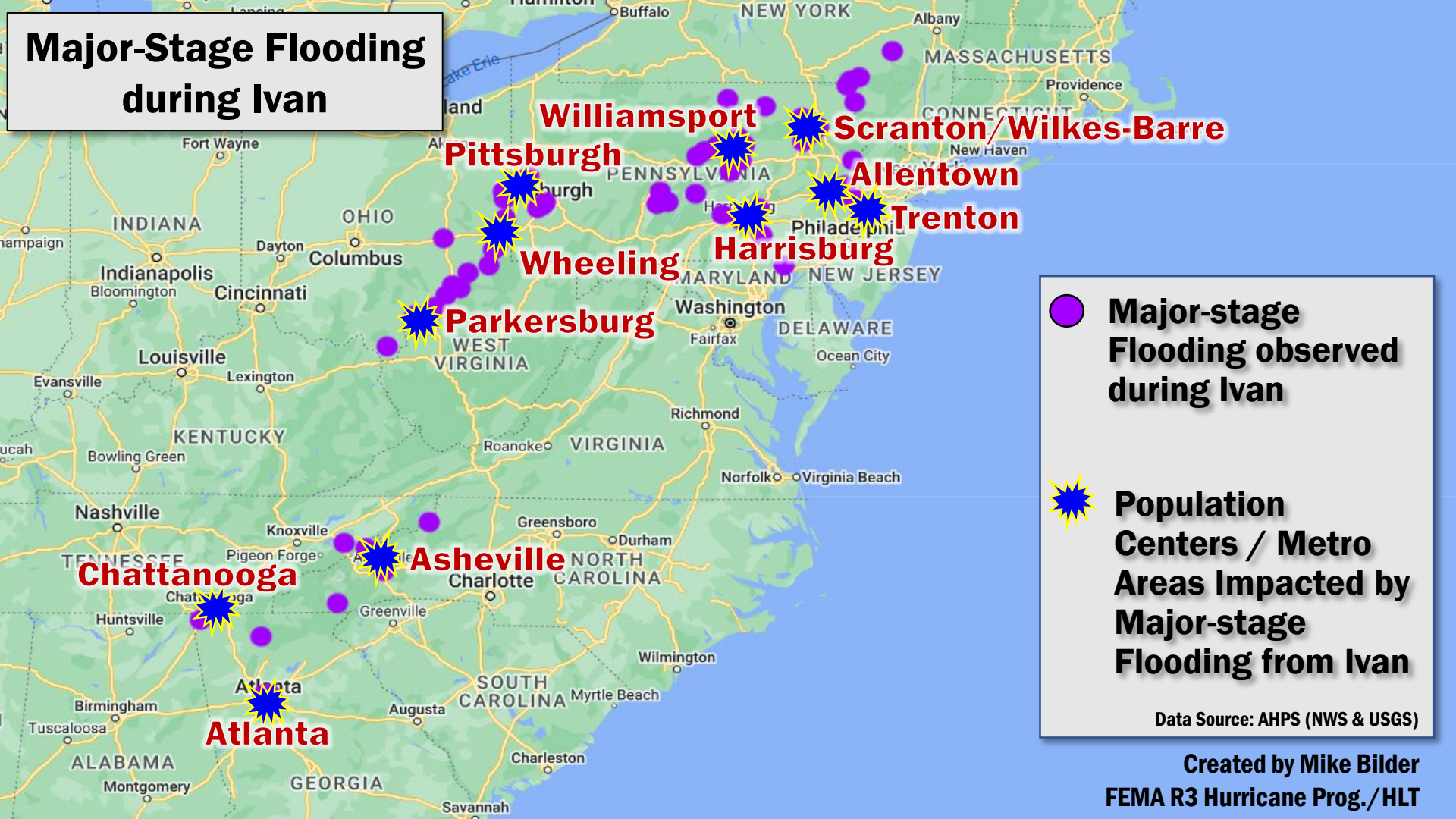
Frances & Ivan Rainfall





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)



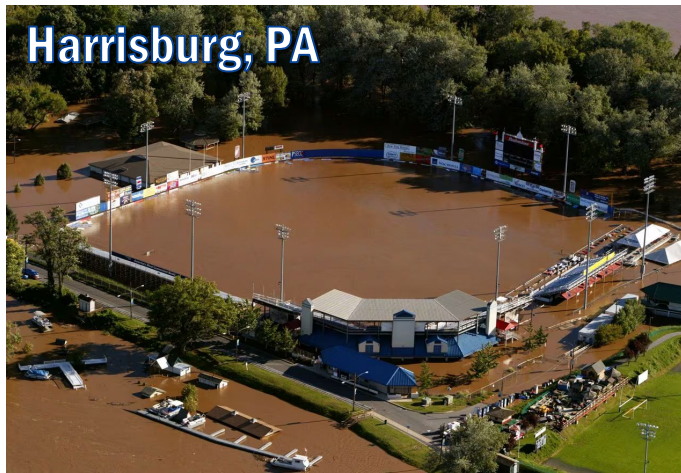
Ivan's Inland Flooding in PA, MD & NJ



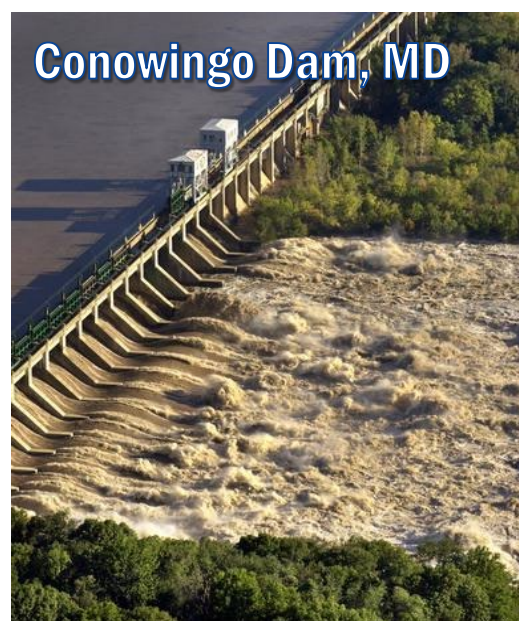
Pittsburgh, PA



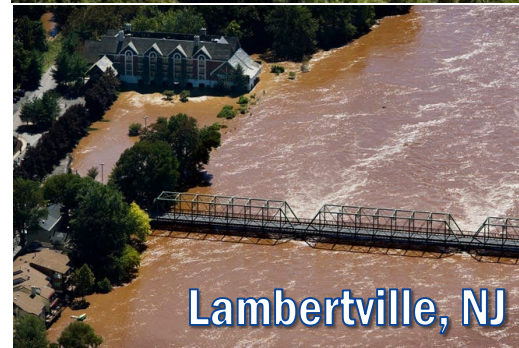
Pittsburgh, PA



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

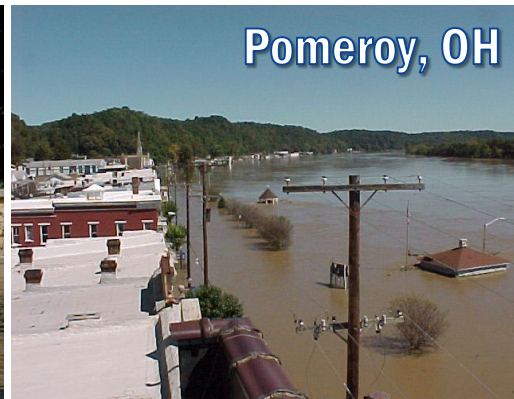


Photo Credit: Jake Mecklenborg; WFO Pittsburgh; WRTF; Michael Stahl

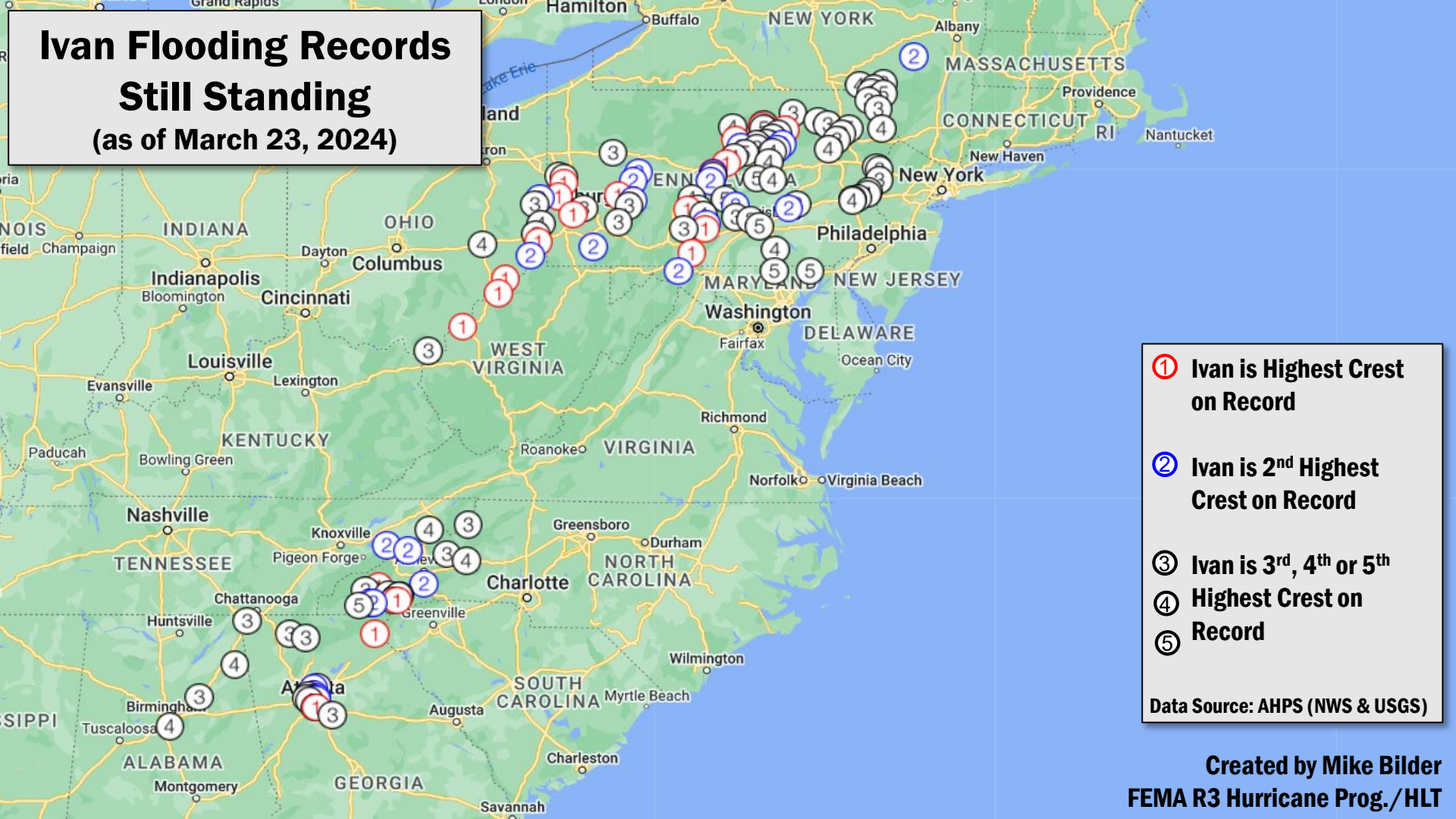


Debris Flow in Macon Co., NC



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)

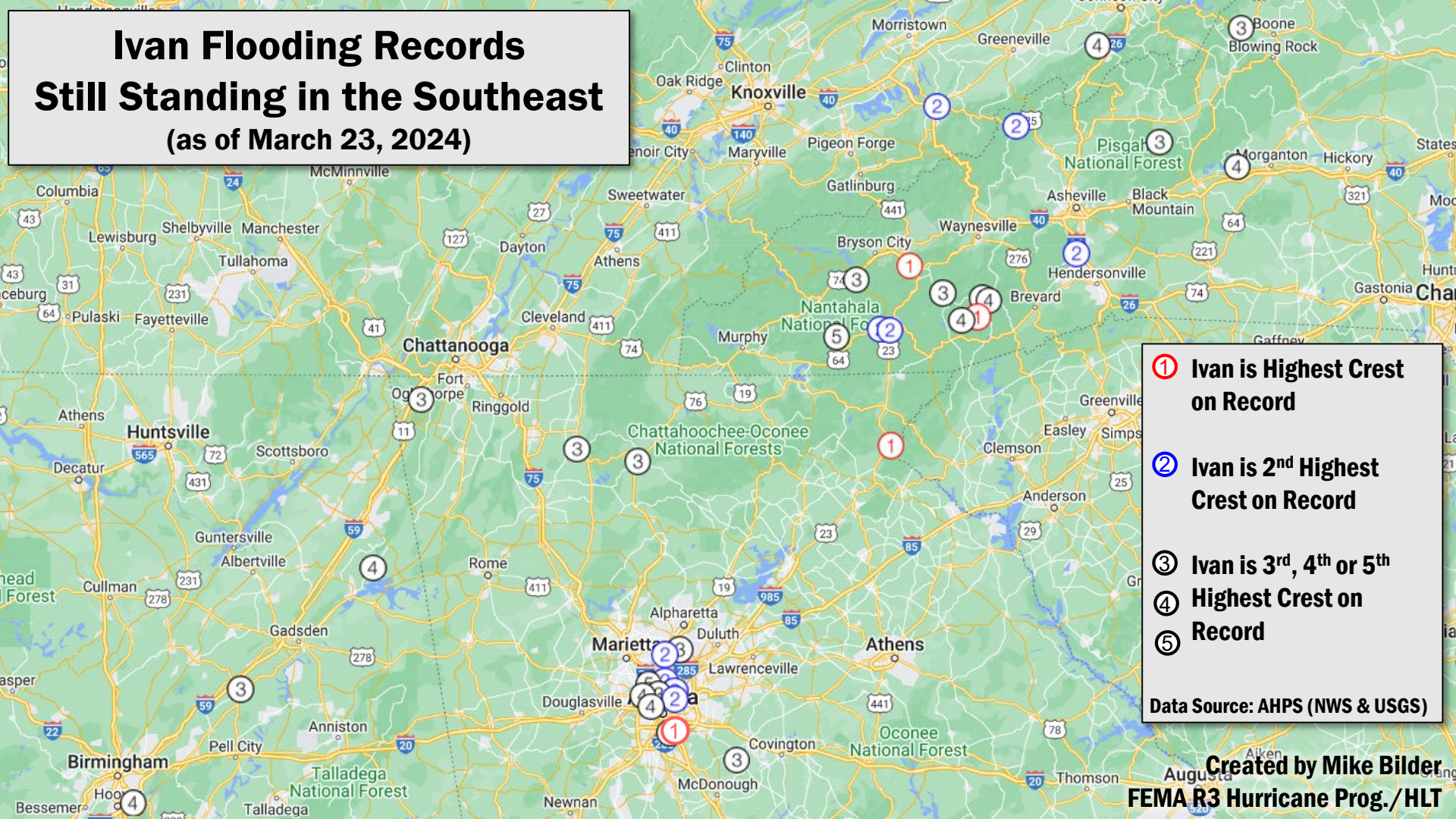


- ① Ivan is Highest Crest on Record
- ② Ivan is 2nd Highest Crest on Record
- ③ Ivan is 3rd, 4th or 5th
- ④ Highest Crest on Record
- ⑤ Record

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)



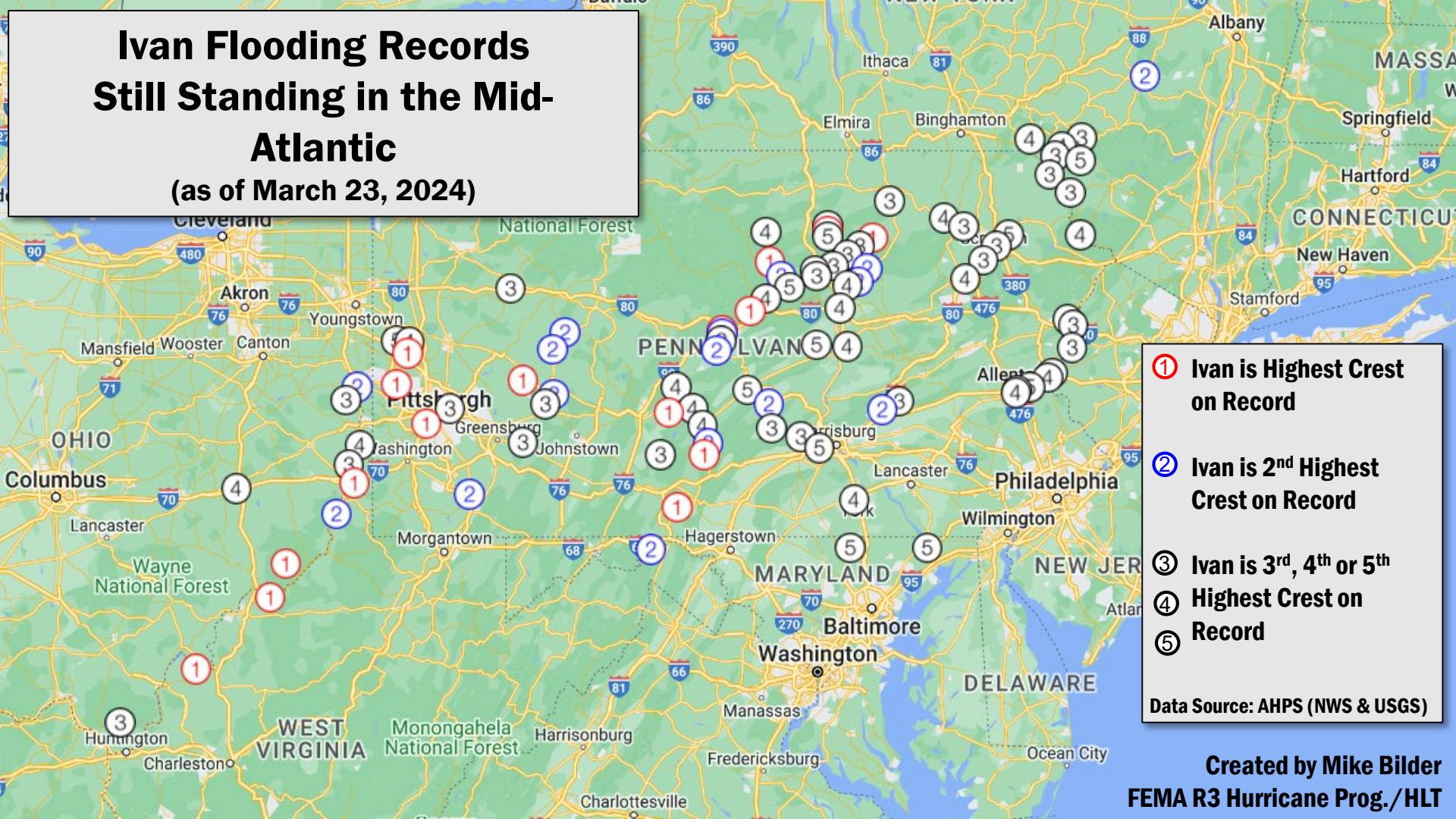
- ① Ivan is Highest Crest on Record
- ② Ivan is 2nd Highest Crest on Record
- ③ Ivan is 3rd, 4th or 5th
- ④ Highest Crest on
- ⑤ Record

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)

Created by Mike Bilder
FEMA R3 Hurricane Prog./HLT

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...

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NATIONAL HURRICANE PROGRAM