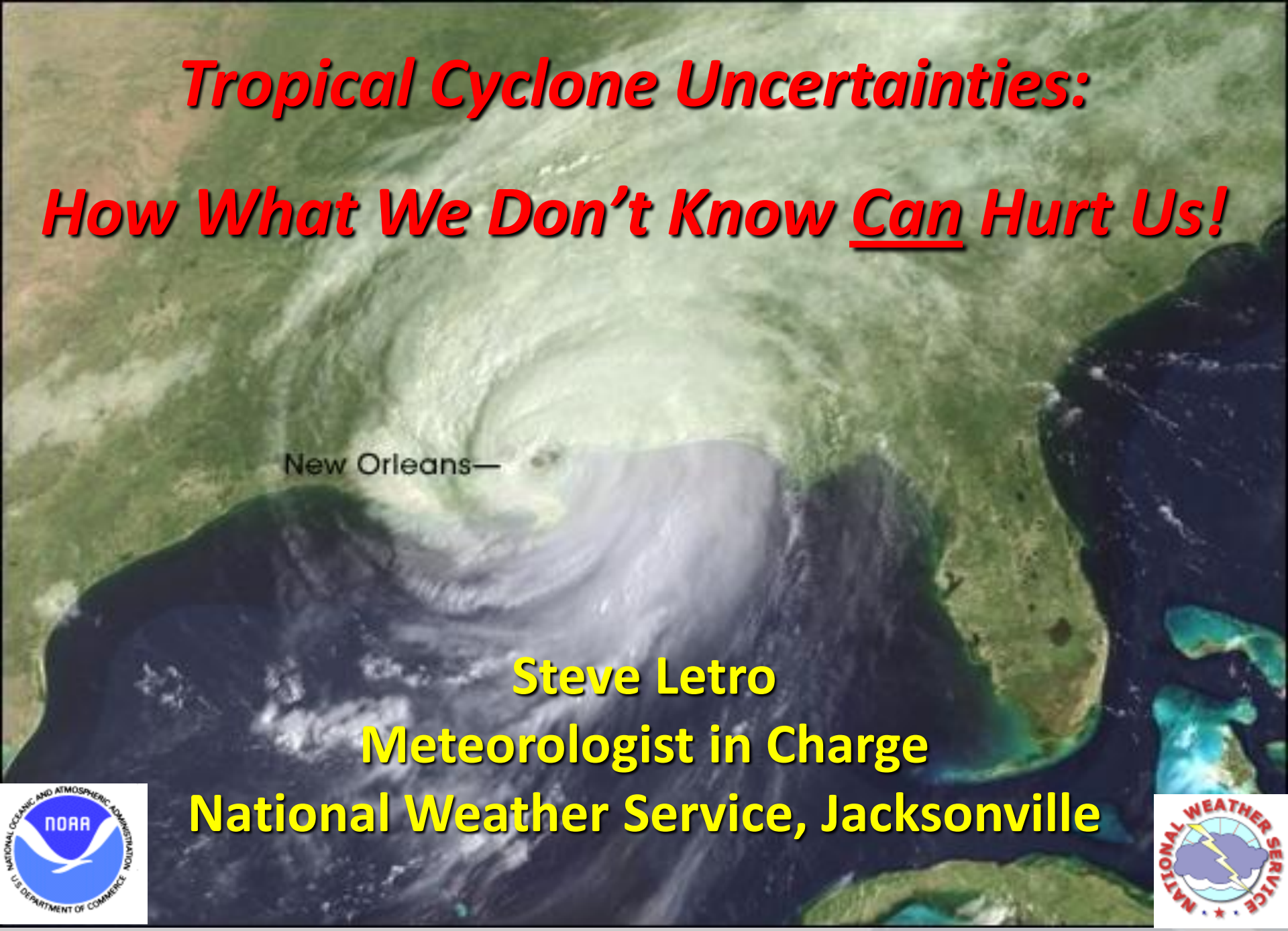
Tropical Cyclone Uncertainties:

How What We Don't Know Can Hurt Us!



Steve Letro
Meteorologist in Charge
National Weather Service, Jacksonville

The Ground Rules

- As Has Been Discussed, NHC Covers The Big Picture…
  - Where Will The Storm Go (and when)?
  - What Will It's Size & Intensity Be?

- Your Local NWS Forecast Office (WFO) Will Detail The Specific Impacts
  - What Specific Watches & Warnings Are in Effect?
  - Timing & Strength Of Winds, Storm Surge, Heavy Rainfall, Tornadoes
  - How Do The NHC Forecasts Translate Into Real Impacts For Your Area

The Nature Of The Beast

- It Must Be Stressed That The Connection Between NHC and WFO Products Do NOT Constitute A Symbiotic Relationship!

- Until Warnings are Actually In Place…WFO Products Are *Directly* Dependent On The NHC Track & Intensity Forecasts… NOT The Other Way Around!

This Relationship Carries An *Extremely* Significant Implication!!!

- Since The WFO Forecasts Are Based On The NHC Track and Intensity Forecasts…

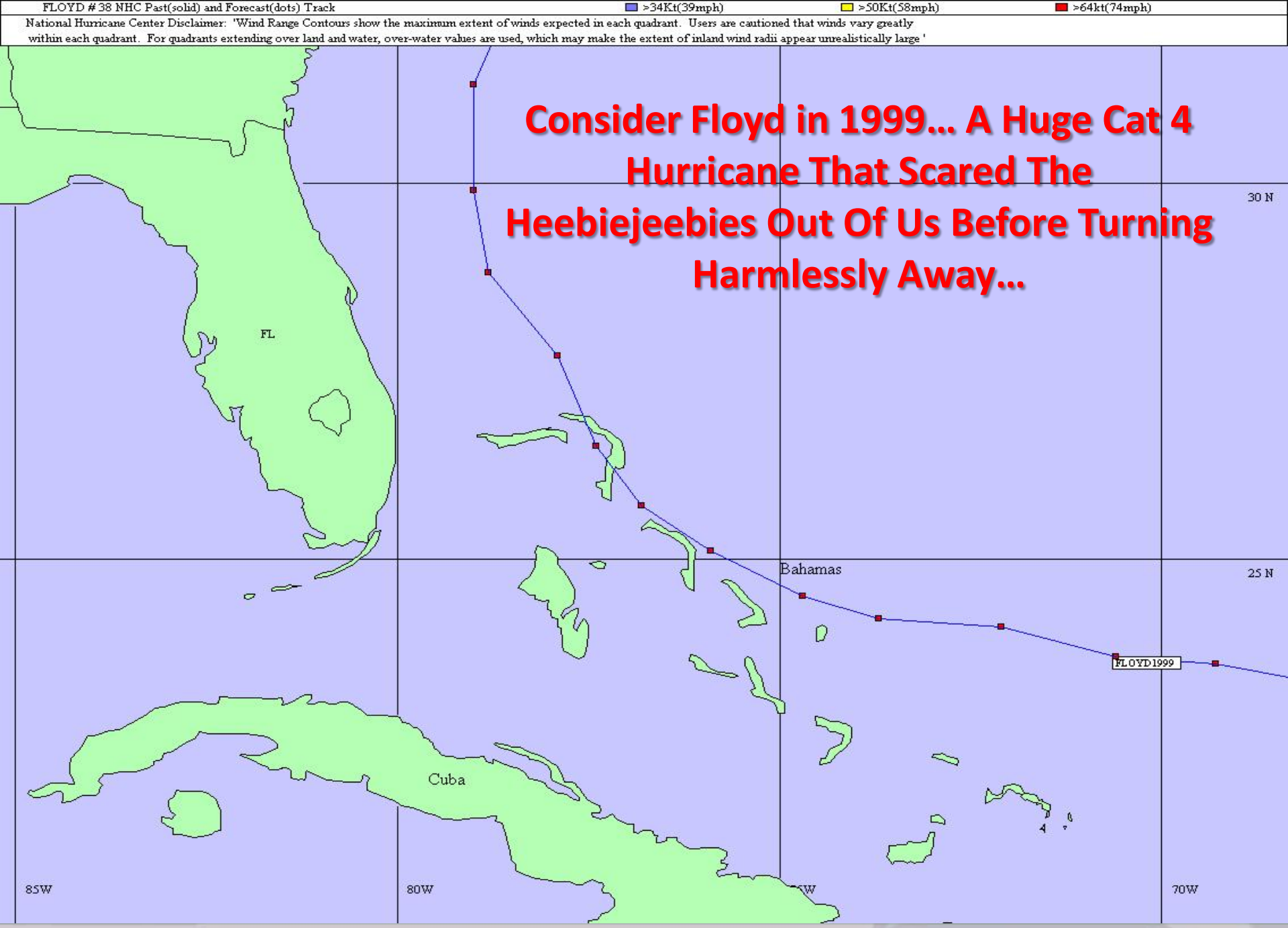
  … If The Track & Intensity Forecasts Are In Error… In Location, Timing, Magnitude or Strength… *All Other Forecasts Based On Them Will Probably Be In Error As Well*!

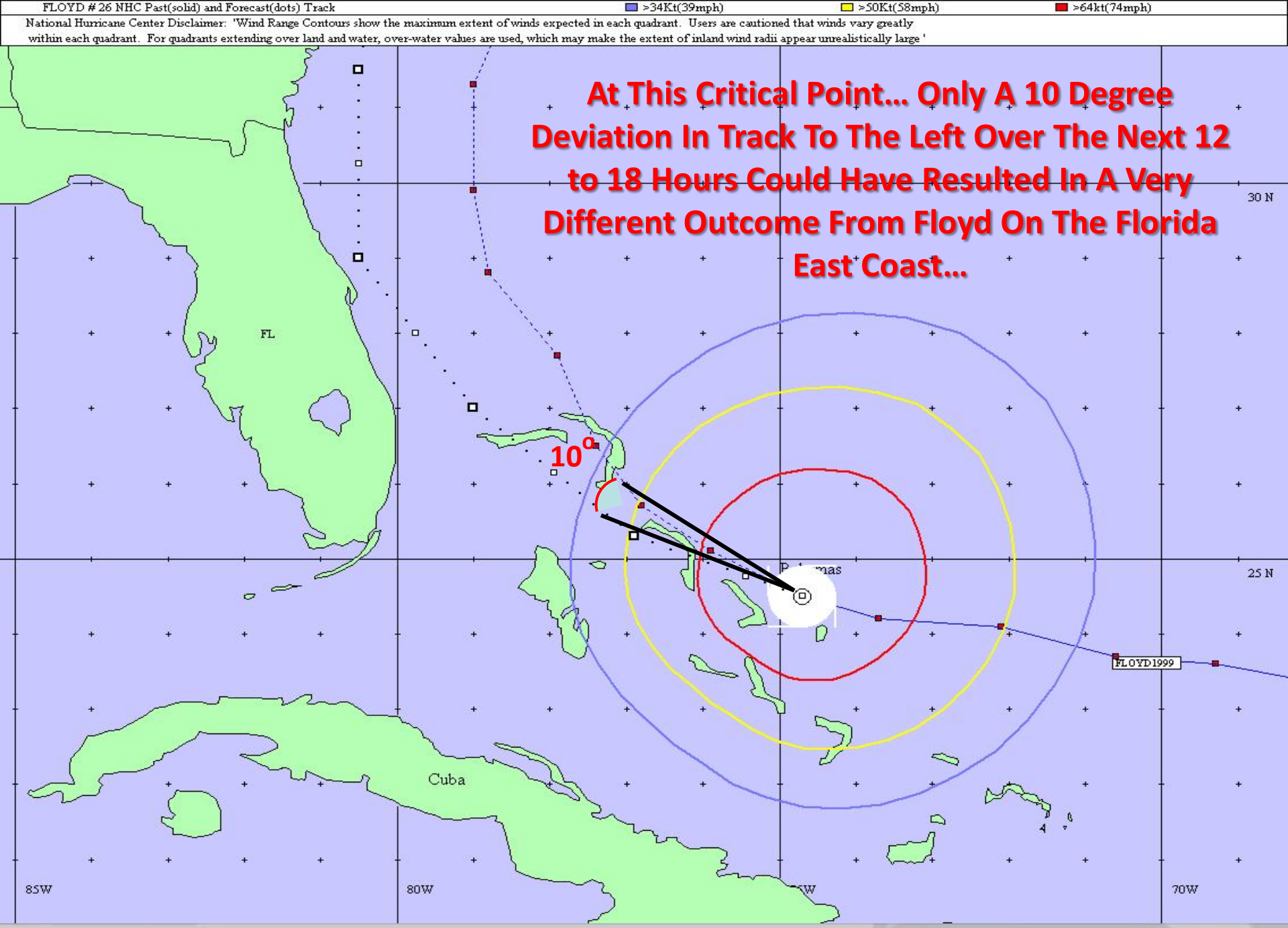
The Unfortunate Reality…

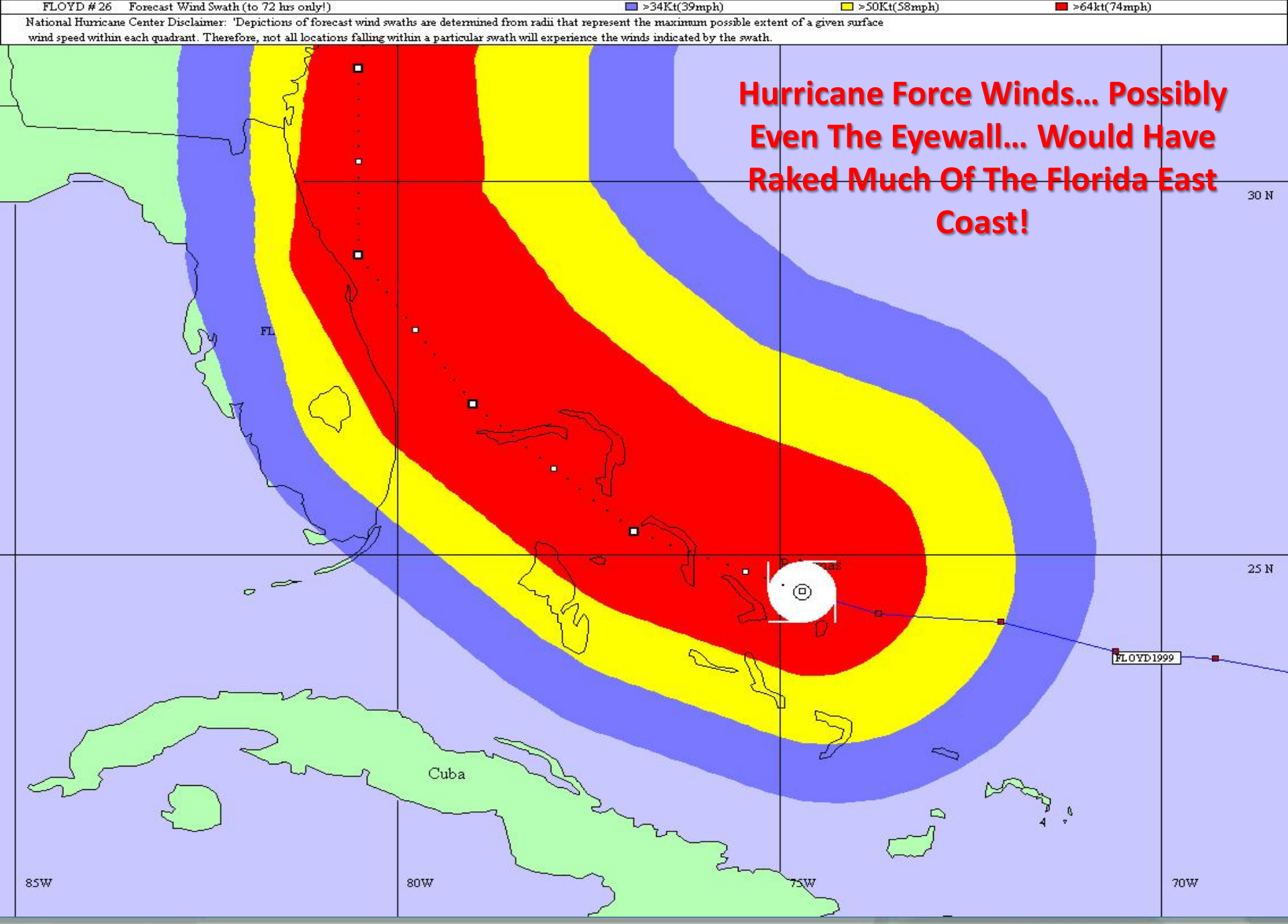
Virtually All Hurricane Forecast Parameters…

- ***Intensity***
- ***Motion***
- ***Size***
- ***Structure***

… Are Subject To Significant Uncertainties…
Which Will Be Reflected In Impact Forecasts


FLOYD # 38 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: 'Wind Range Contours show the maximum extent of winds expected in each quadrant. Users are cautioned that winds vary greatly within each quadrant. For quadrants extending over land and water, over-water values are used, which may make the extent of inland wind radii appear unrealistically large'
Consider Floyd in 1999… A Huge Cat 4 Hurricane That Scared The Heebiejeebies Out Of Us Before Turning Harmlessly Away…
FL
Bahamas
Cuba
FLOYD1999
30 N
25 N
85W
80W
70W

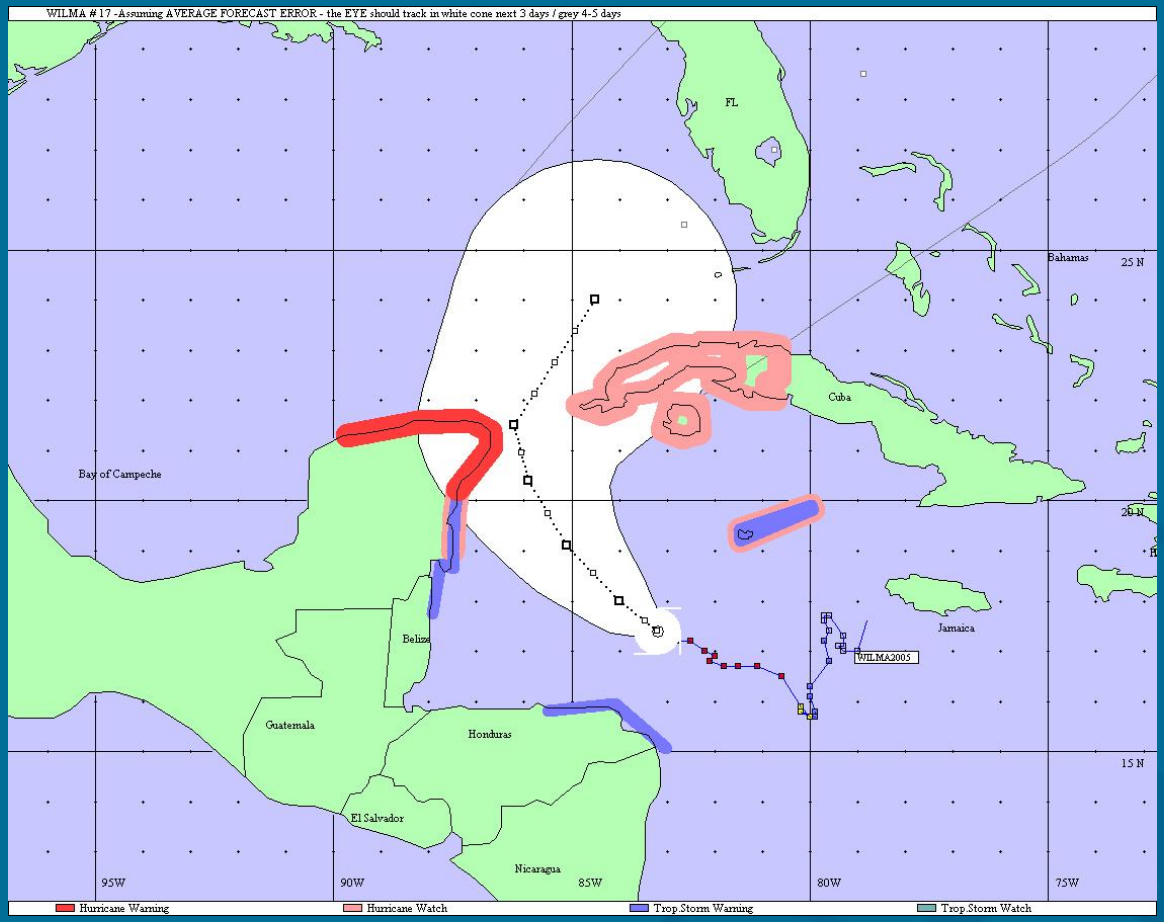

FLOYD # 26 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: 'Wind Range Contours show the maximum extent of winds expected in each quadrant. Users are cautioned that winds vary greatly within each quadrant. For quadrants extending over land and water, over-water values are used, which may make the extent of inland wind radii appear unrealistically large'
At This Critical Point… Only A 10 Degree Deviation In Track To The Left Over The Next 12 to 18 Hours Could Have Resulted In A Very Different Outcome From Floyd On The Florida East Coast…
10°
FL
Cuba
FLOYD1999
30 N
25 N
85W
80W
70W


FLOYD # 26 Forecast Wind Swath (to 72 hrs only!)
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: 'Depictions of forecast wind swaths are determined from radii that represent the maximum possible extent of a given surface wind speed within each quadrant. Therefore, not all locations falling within a particular swath will experience the winds indicated by the swath.
Hurricane Force Winds… Possibly Even The Eyewall… Would Have Raked Much Of The Florida East Coast!
30 N
25 N
FLOYD1999
Cuba
85W
80W
75W
70W

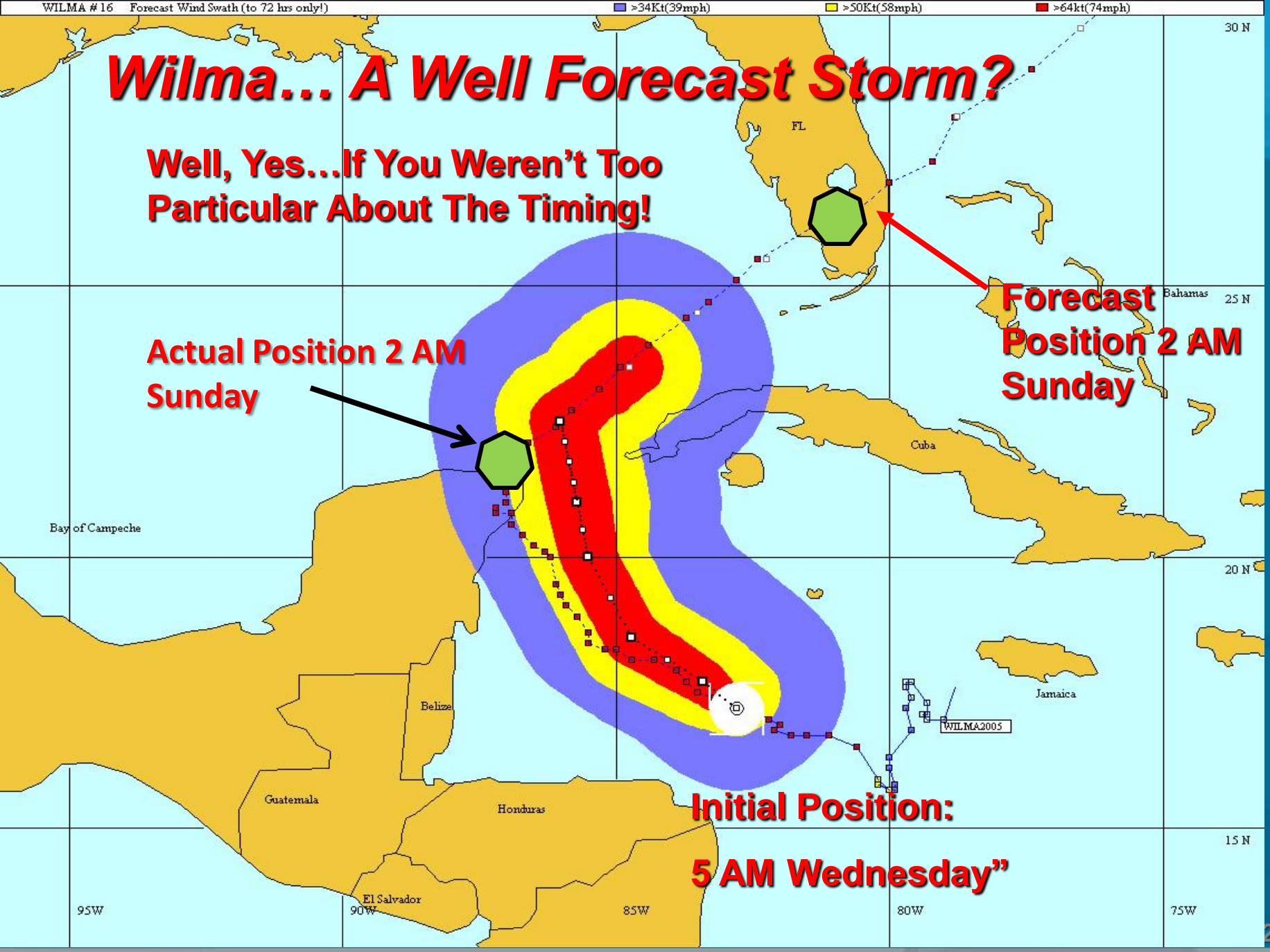
A Lesson From The Now Familiar "Cone Of Uncertainty"

We Know About Uncertainties Left Or Right Of The Track…

… But The Cone *Also* Reflects Uncertainties *Forward Or Backward*… i.e., Forward Speed!



5/21/2008


WILMA # 16 Forecast Wind Swath (to 72 hrs only!)
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
Wilma… A Well Forecast Storm?
Well, Yes…If You Weren't Too Particular About The Timing!
Actual Position 2 AM Sunday
Forecast Position 2 AM Sunday
Initial Position: 5 AM Wednesday"
FL
Bahamas
Cuba
Jamaica
Bay of Campeche
Belize
Guatemala
Honduras
El Salvador
WILMA2005
30 N
25 N
20 N
15 N
95W
90W
85W
80W
75W

In Frances' Case…The Storm Slowed Down…

… But Occasionally A Storm… Such As Opal In 2005, Or Charley In 2004… Speeds Up…

In Fact, Charley Was Close To The Classic Nightmare Scenario… A Storm Speeding Up… And Also Intensifying!

5/21/2008

The Result????

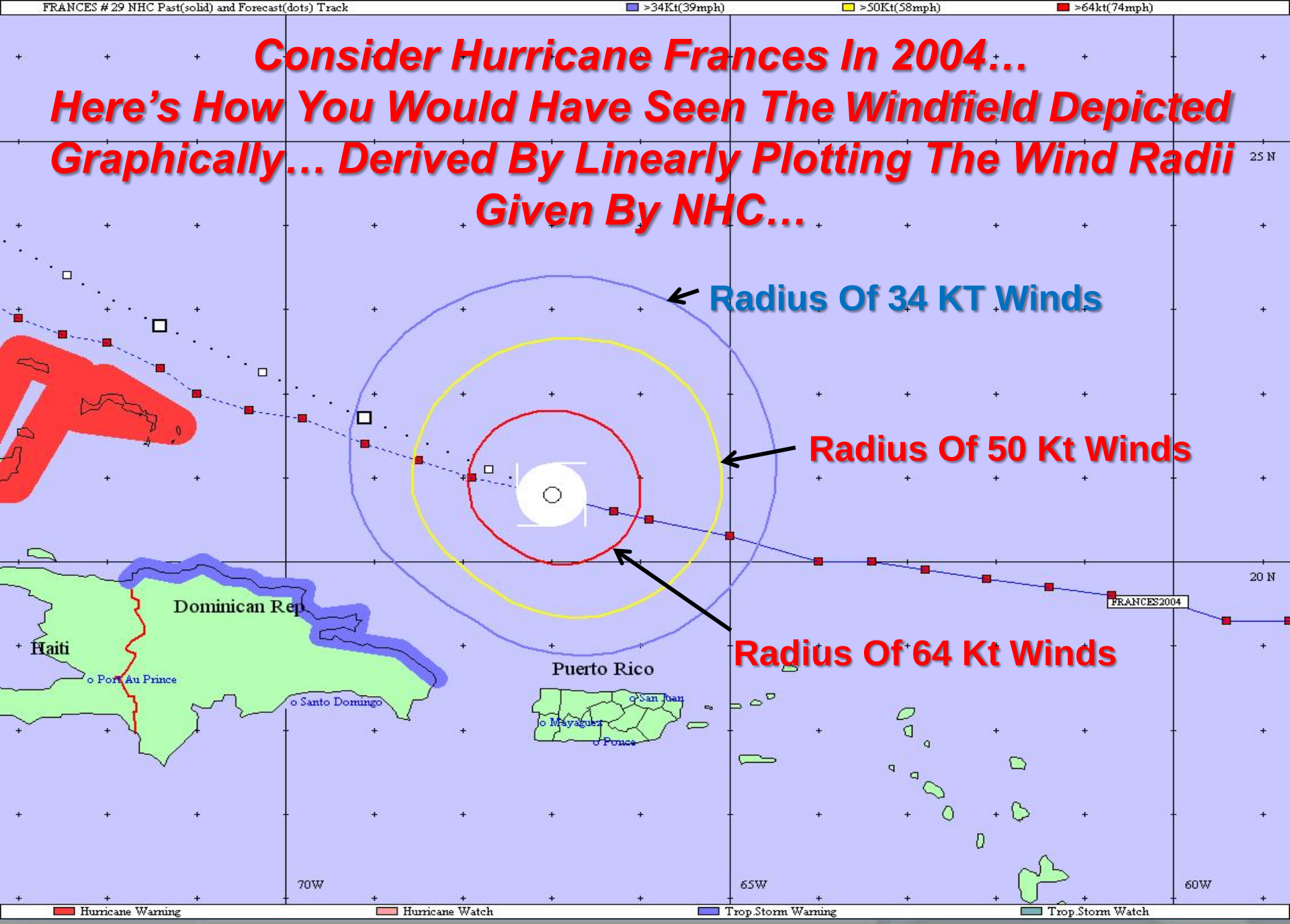
Uncertainties In The Storm's *Speed* Of Motion Are As Great As The *Direction…*

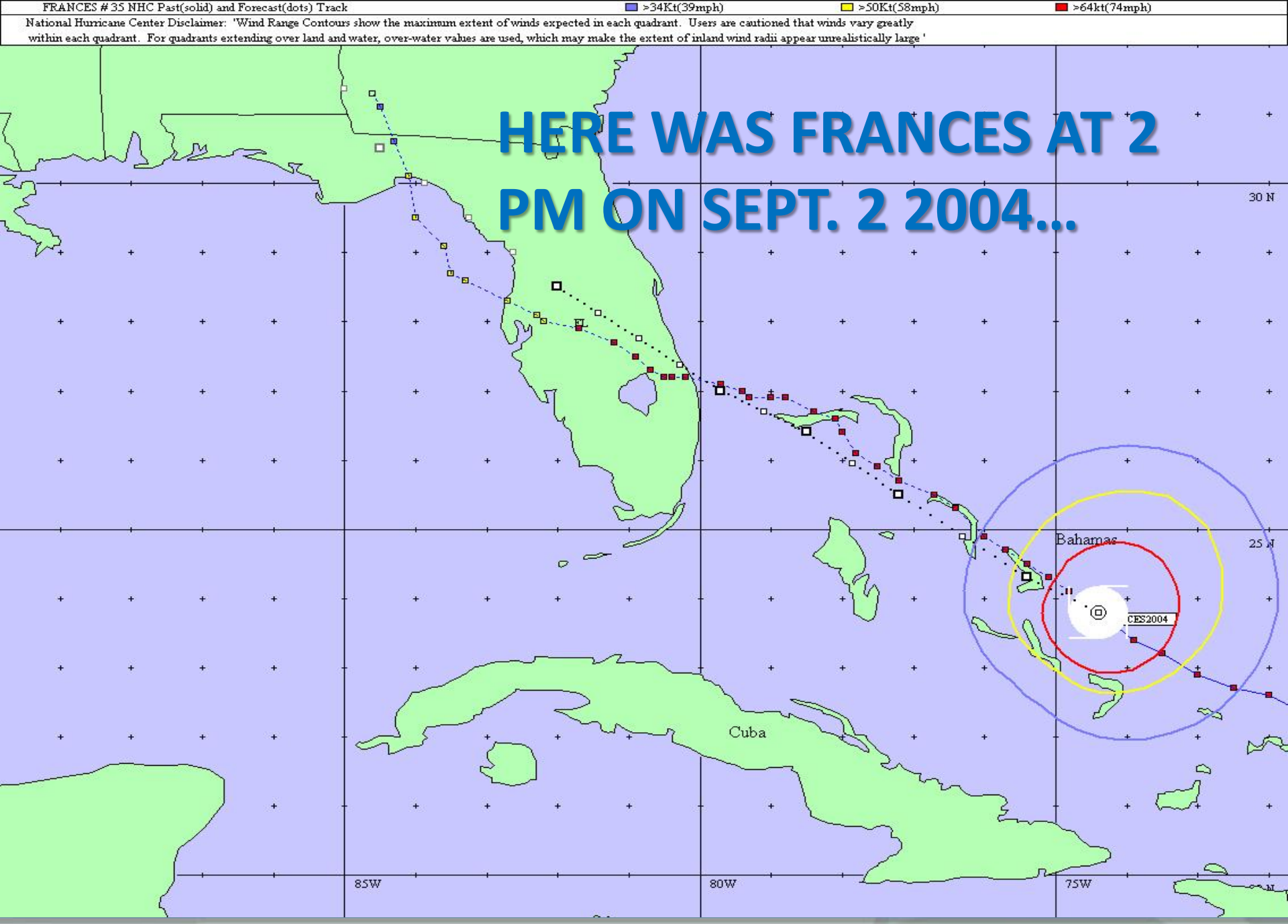
And Can Wreak Just As Much Havoc On Specific Wind Forecasts!

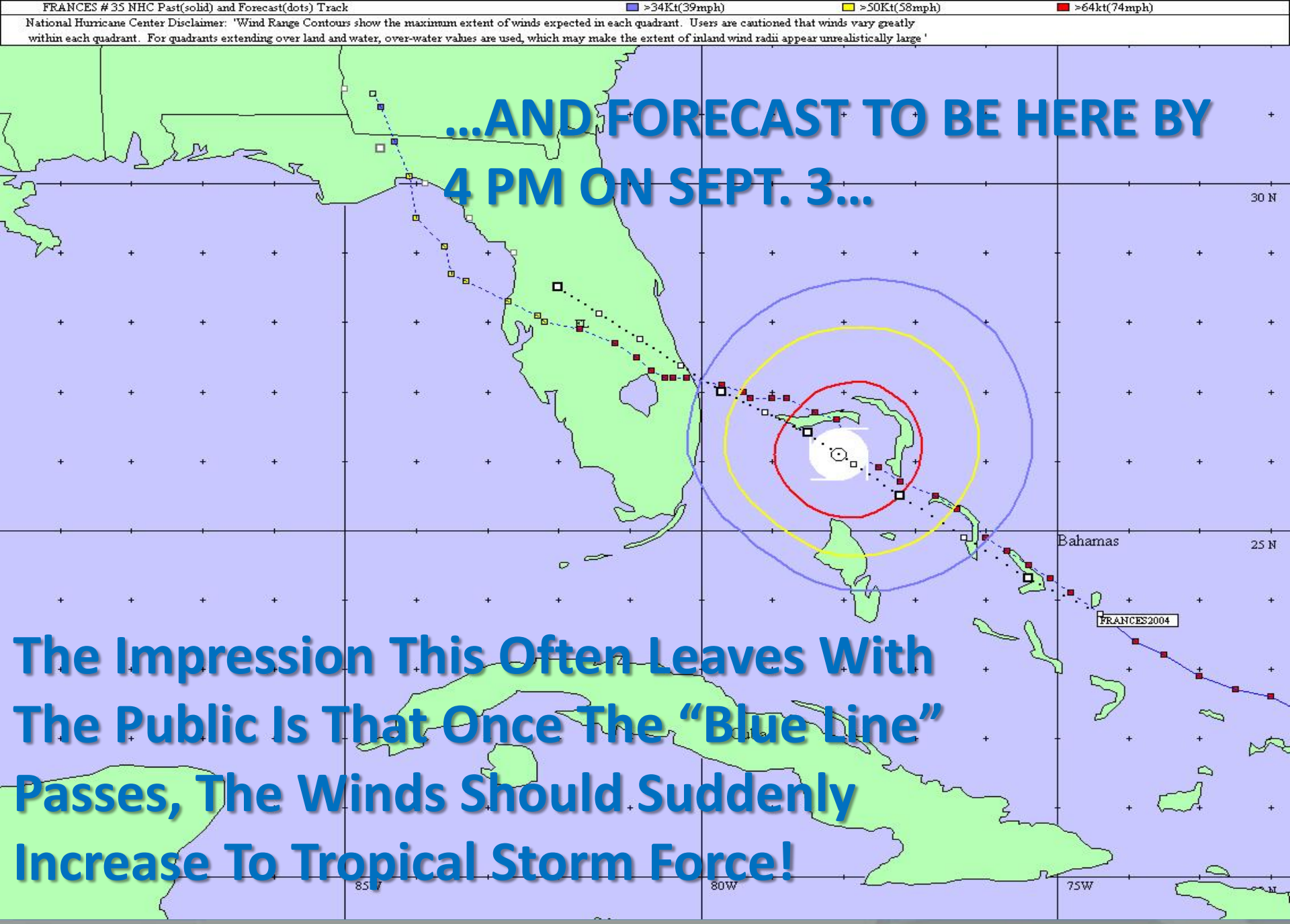
Another Critical Real-Time Forecast Problem…

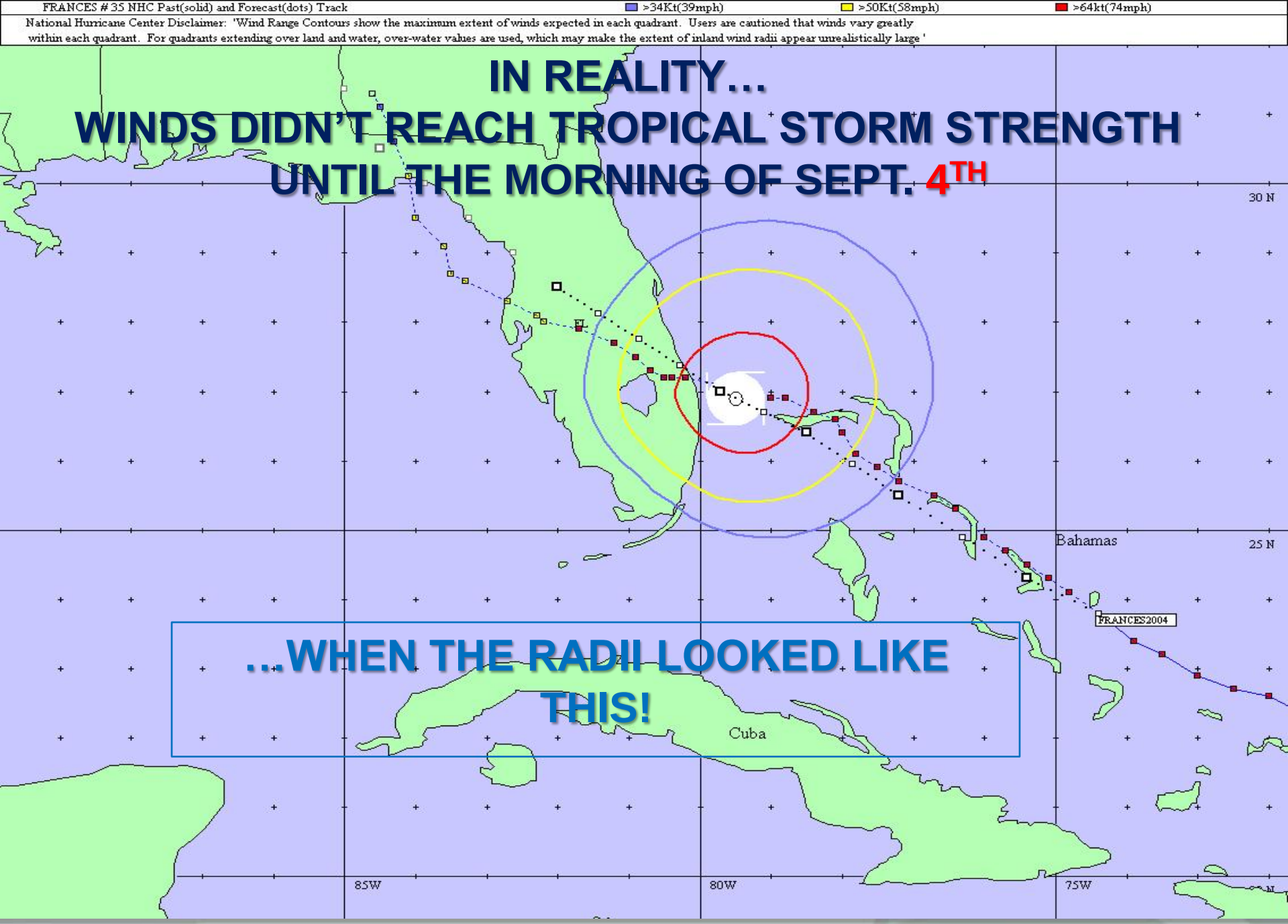
A Large Percentage Of Key Decisions Are Based on Forecasts of The Hurricane's Overall Windfield… Current And Forecast!

Unfortunately… In Any Given Storm, That Windfield Is Probably Going To Contain Some Of The More Significant Uncertainties… Until The Storm Is Knocking At The Door!


FRANCES # 29 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
Consider Hurricane Frances In 2004…
Here's How You Would Have Seen The Windfield Depicted Graphically… Derived By Linearly Plotting The Wind Radii Given By NHC…
Radius Of 34 KT Winds
Radius Of 50 Kt Winds
Radius Of 64 Kt Winds
25 N
20 N
FRANCES2004
Dominican Rep
Haiti
o Port Au Prince
o Santo Domingo
Puerto Rico
o San Juan
o Mayaguez
o Ponce
70W
65W
60W
Hurricane Warning
Hurricane Watch
Trop.Storm Warning
Trop.Storm Watch


FRANCES # 35 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: 'Wind Range Contours show the maximum extent of winds expected in each quadrant. Users are cautioned that winds vary greatly within each quadrant. For quadrants extending over land and water, over-water values are used, which may make the extent of inland wind radii appear unrealistically large'
HERE WAS FRANCES AT 2 PM ON SEPT. 2 2004...
30 N
25 N
Bahamas
Cuba
CES2004
85W
80W
75W


FRANCES # 35 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: 'Wind Range Contours show the maximum extent of winds expected in each quadrant. Users are cautioned that winds vary greatly within each quadrant. For quadrants extending over land and water, over-water values are used, which may make the extent of inland wind radii appear unrealistically large'
...AND FORECAST TO BE HERE BY 4 PM ON SEPT. 3...
30 N
25 N
Bahamas
FRANCES2004
85W
80W
75W
The Impression This Often Leaves With The Public Is That Once The "Blue Line" Passes, The Winds Should Suddenly Increase To Tropical Storm Force!


FRANCES # 35 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: 'Wind Range Contours show the maximum extent of winds expected in each quadrant. Users are cautioned that winds vary greatly within each quadrant. For quadrants extending over land and water, over-water values are used, which may make the extent of inland wind radii appear unrealistically large'
IN REALITY…
WINDS DIDN'T REACH TROPICAL STORM STRENGTH UNTIL THE MORNING OF SEPT. 4TH
30 N
25 N
Bahamas
FRANCES2004
…WHEN THE RADII LOOKED LIKE THIS!
Cuba
85W
80W
75W

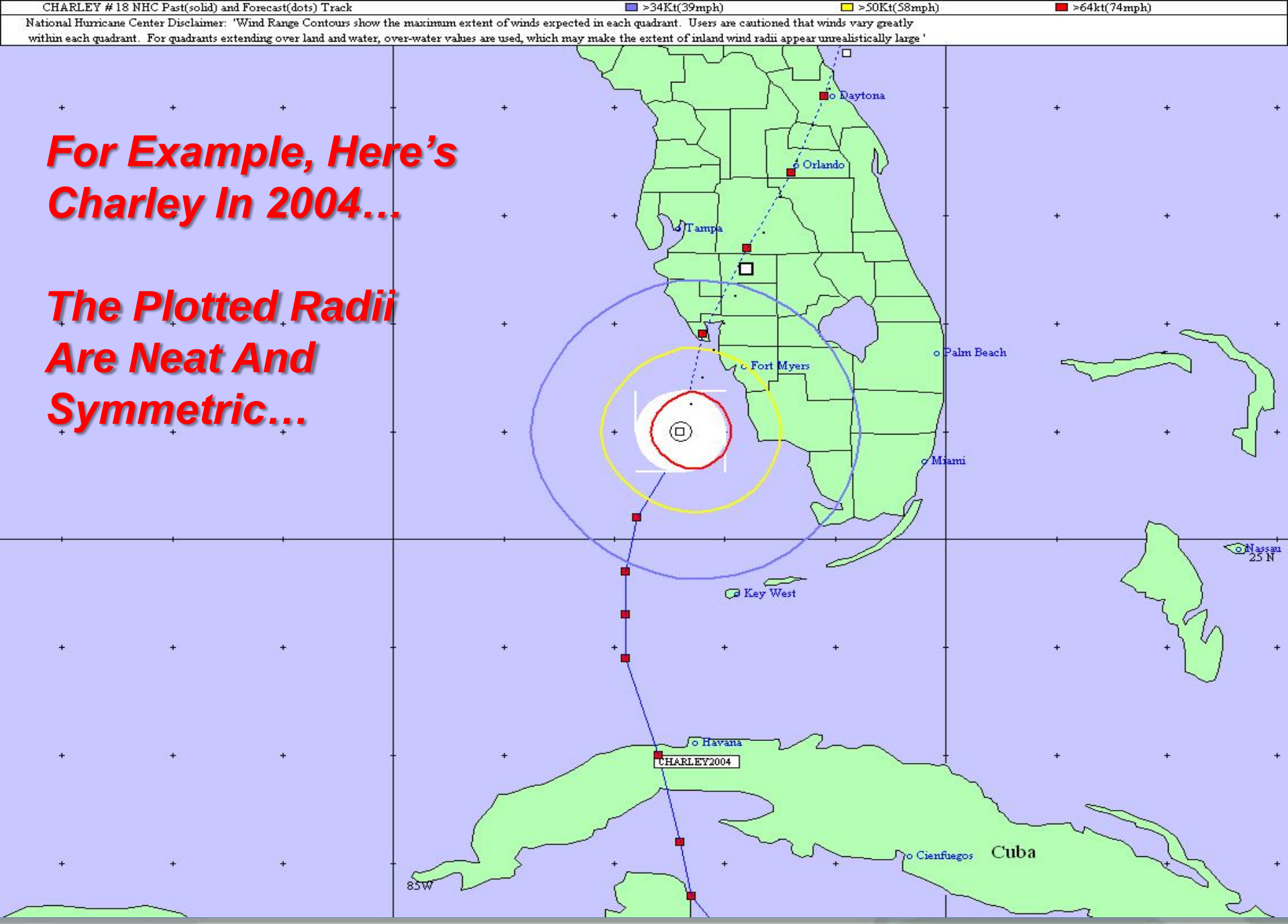
SO WHAT HAPPENED????

As In The Case Of Wilma, One Important Factor Was That The Storm Slowed Down… But There's Really More To Forecasting Winds Than Just Getting The Motion Right!

The Relevant Facts…

A Hurricane's Wind Field Is Usually Neither Symmetric NOR Uniform, Even Though Automated Plot Programs Often Make Them Look That Way!

This Makes The Winds Very Difficult To Measure And Even More Difficult To Forecast Specifically At Any Given Location!



For Example, Here's Charley In 2004…

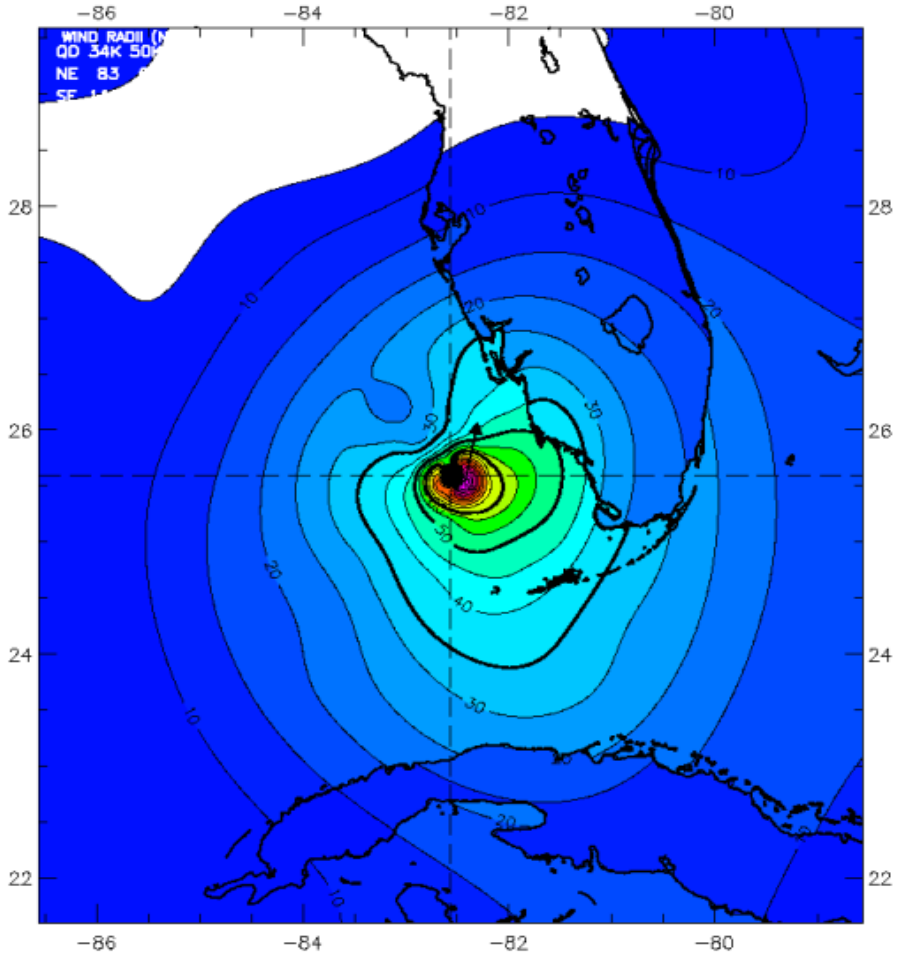
The Plotted Radii Are Neat And Symmetric…

…When In Reality The Observed Wind Field Using All Data Sources Actually Looked Like This…

Hurricane Charley 1630 UTC 13 Aug 2004

Max 1–min sustained surface winds (kt) for marine exposure

Analysis based on MOORED_BUOY from 1220 – 1220 z; GPSSONDE_SFC from 1219 – 1701 z;
SHIP from 1220 – 1220 z; TOWER_LD_TO from 0000 – 0000 z;
AFRES_FLT adj. to surface from mean height 3168 m from 1219 – 1219 z;
GPSSONDE_WL150 from 1219 – 1219 z; GPSSONDE_MBL from 1219 – 1701 z;
DRIFTING_BUOY from 1300 – 1300 z; GOES from 1302 – 1302 z; CMAN from 1230 – 1230 z;
1630 z position interpolated from 1522 Vortex; mslp = 964.0 mb



Observed Max. Surface Wind: 118 kts, 8 nm SE of center based on 1658 z AFRES_FLT sfc measurement
Analyzed Max. Wind: 114 kts, 9 nm SE of center
Experimental research product of:

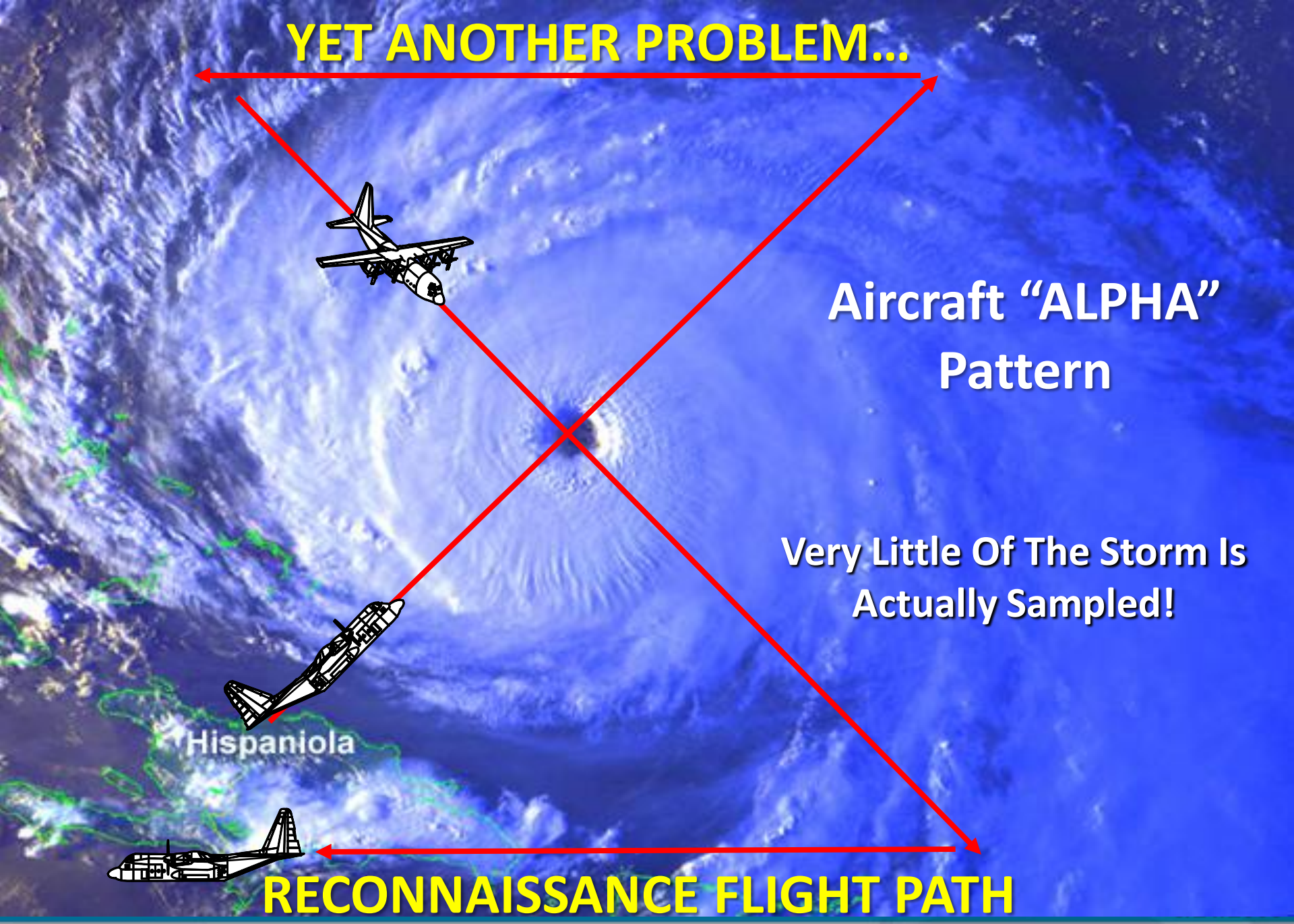
NOAA / AOML / Hurricane Research Division

The Relevant Facts…

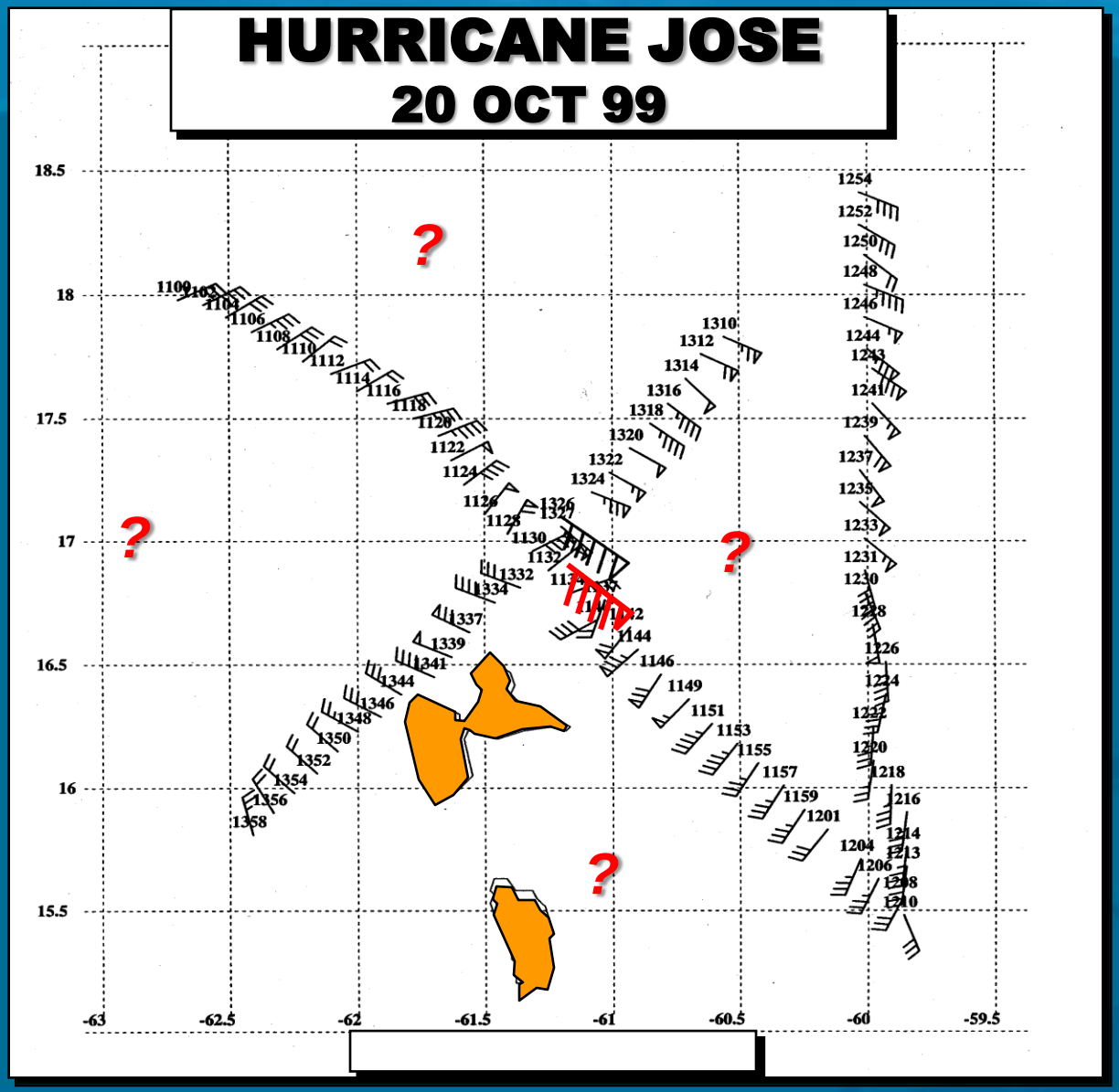
Consider The Problems Involved With Simply *Determining* Accurate Wind Radii To Begin With… Especially At Distance From Any Coastal Observing Systems…

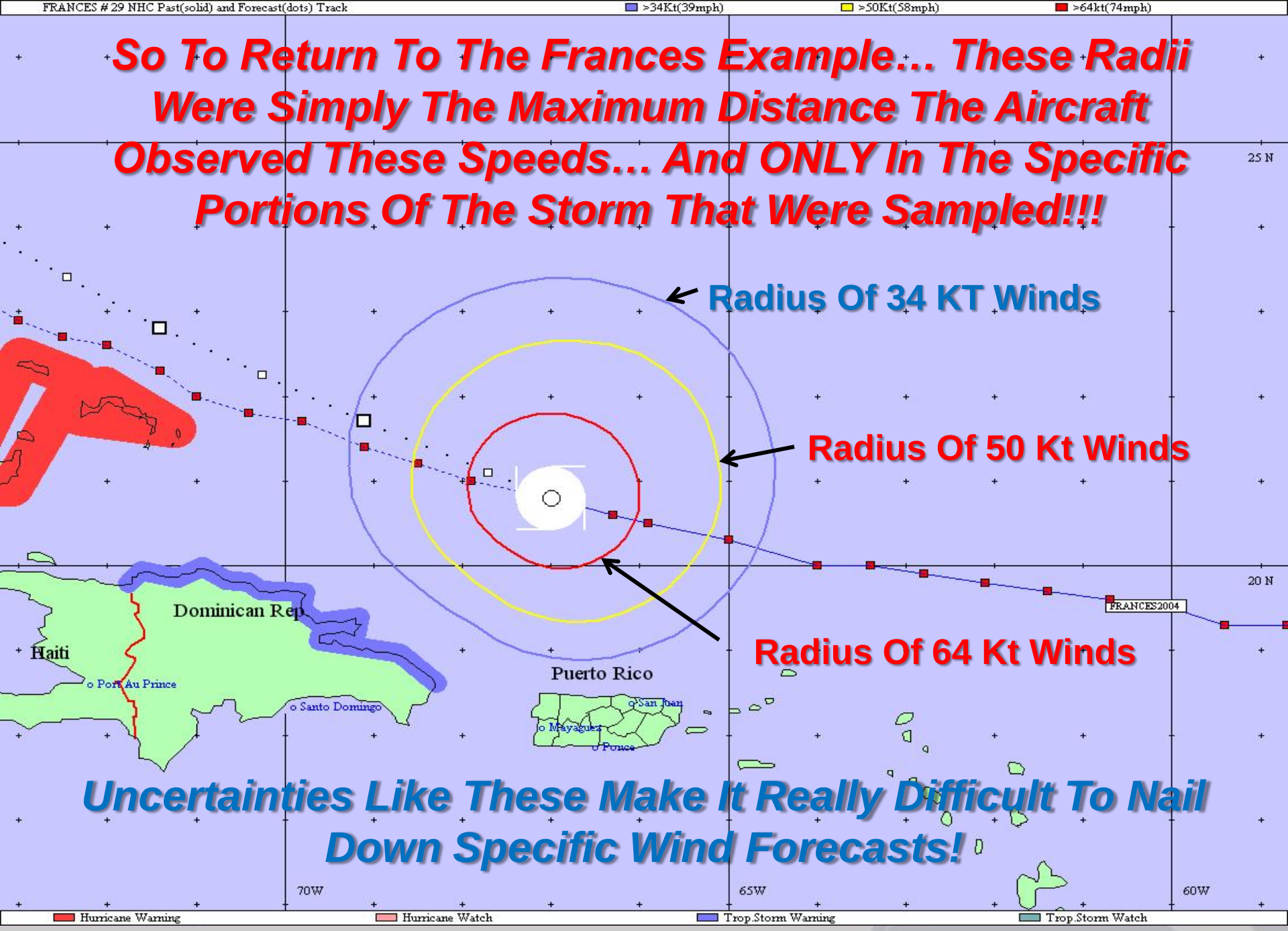
The Primary Method Of Measuring Winds Is Via Aircraft Reconnaissance… Which Takes Place Over Water And Usually Does Not Measure Surface Winds

So… Unless You Live 1500 Feet Or More Above The Open Ocean… The Radii Are Probably *Not* Going To Provide You The Most Accurate & Useful Information


YET ANOTHER PROBLEM…
Aircraft "ALPHA" Pattern
Very Little Of The Storm Is Actually Sampled!
Hispaniola
RECONNAISSANCE FLIGHT PATH

Minute Observations Plot




FRANCES # 29 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
So To Return To The Frances Example… These Radii Were Simply The Maximum Distance The Aircraft Observed These Speeds… And ONLY In The Specific Portions Of The Storm That Were Sampled!!!
Radius Of 34 KT Winds
Radius Of 50 Kt Winds
Radius Of 64 Kt Winds
25 N
20 N
FRANCES2004
Dominican Rep
Haiti
o Port Au Prince
o Santo Domingo
Puerto Rico
o San Juan
o Mayaguez
o Ponce
Uncertainties Like These Make It Really Difficult To Nail Down Specific Wind Forecasts!
70W
65W
60W
Hurricane Warning
Hurricane Watch
Trop.Storm Warning
Trop.Storm Watch

We Do Feel Your Pain…

We All Want To Know When The Winds Will Reach Specific Speeds In Our Specific Areas As Far In Advance As Possible, But…

Forecasting Winds At Specific Locations… Especially At Time Frames of More Than About 24 Hours… Requires Accurate Measurements *And* Prediction Of:

- **The Hurricane's Wind Field**
- **Storm Motion (Direction/Speed)**
- **Changes In Size & Intensity**

…*Each* Of Which Are Going To Have Uncertainties…

Is There ANY Good News Here???

Yes! New Technologies Are Gradually Improving The Quality Of The Observed Wind Fields…

Even More Important… As The Storm Gets Closer… The WFO's Are Able To Bring The Full Weight Of Their Local Expertise… Enhanced Observational Ability… And Communications Resources To Bear

The Forecast Paradigm Shift…

Once The Storm's Circulation Comes Within Range Of Land-Based Radar and Other Observational Networks, The Emphasis Of The WFO Products Shift…

At This Point They Are NO LONGER Keyed Solely Off The NHC Forecasts… But From Actual Observed Data And WFO Forecaster Expertise As Well

This Allows For More Detailed And Accurate WFO Products…

And Also Point Out The Importance Of Considering Hurricane Wind Structure … Especially If You Are Taking The Output From Plotted Programs *TOO* Literally!

What You Need To Know…

Wind Forecasts From Plotted Programs Basically Assume A Linear Increase In Surface Winds From The Outer Portion Of The Storm To The Center…

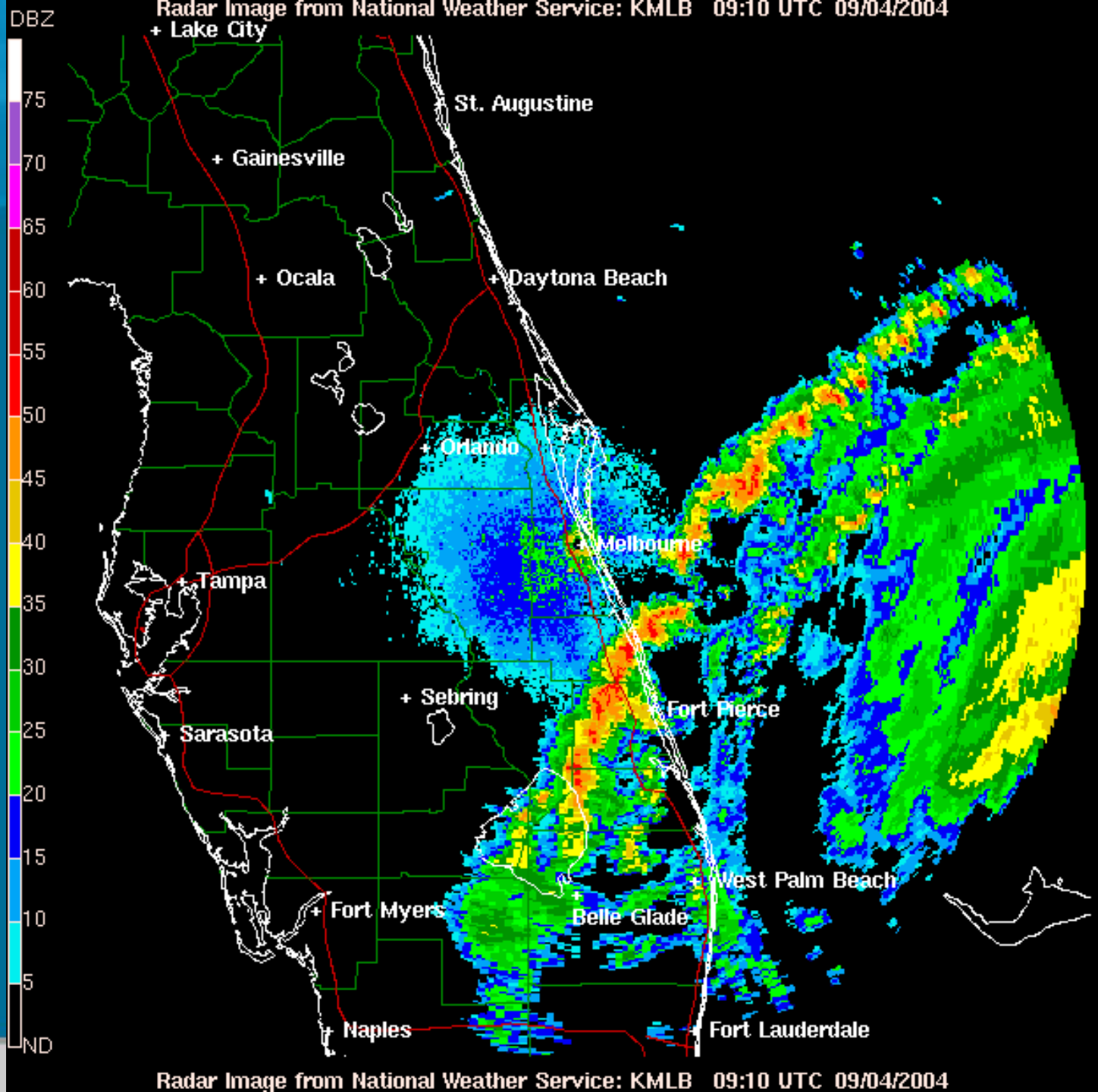
Unfortunately, This "Linearity" *Does Not Really Exist* In Nature!

The Strongest Surface Winds In A Hurricane Occur In The Convective Bands…And There Are Lulls Between The Bands Where Winds Will Decrease Temporarily.

Here's A Radar Loop Of Frances' Landrall…

Note The Motion and Changes in the Bands and The Areas Of Weaker Echoes Between Them!

The Strong Winds Are In The Bands… With Much Lower Winds In Between



THIS IS THE REALITY OF HURRICANE WINDS…

NOTE THE RAPID FLUCTUATIONS IN WIND SPEED ASSOCIATED WITH BANDS

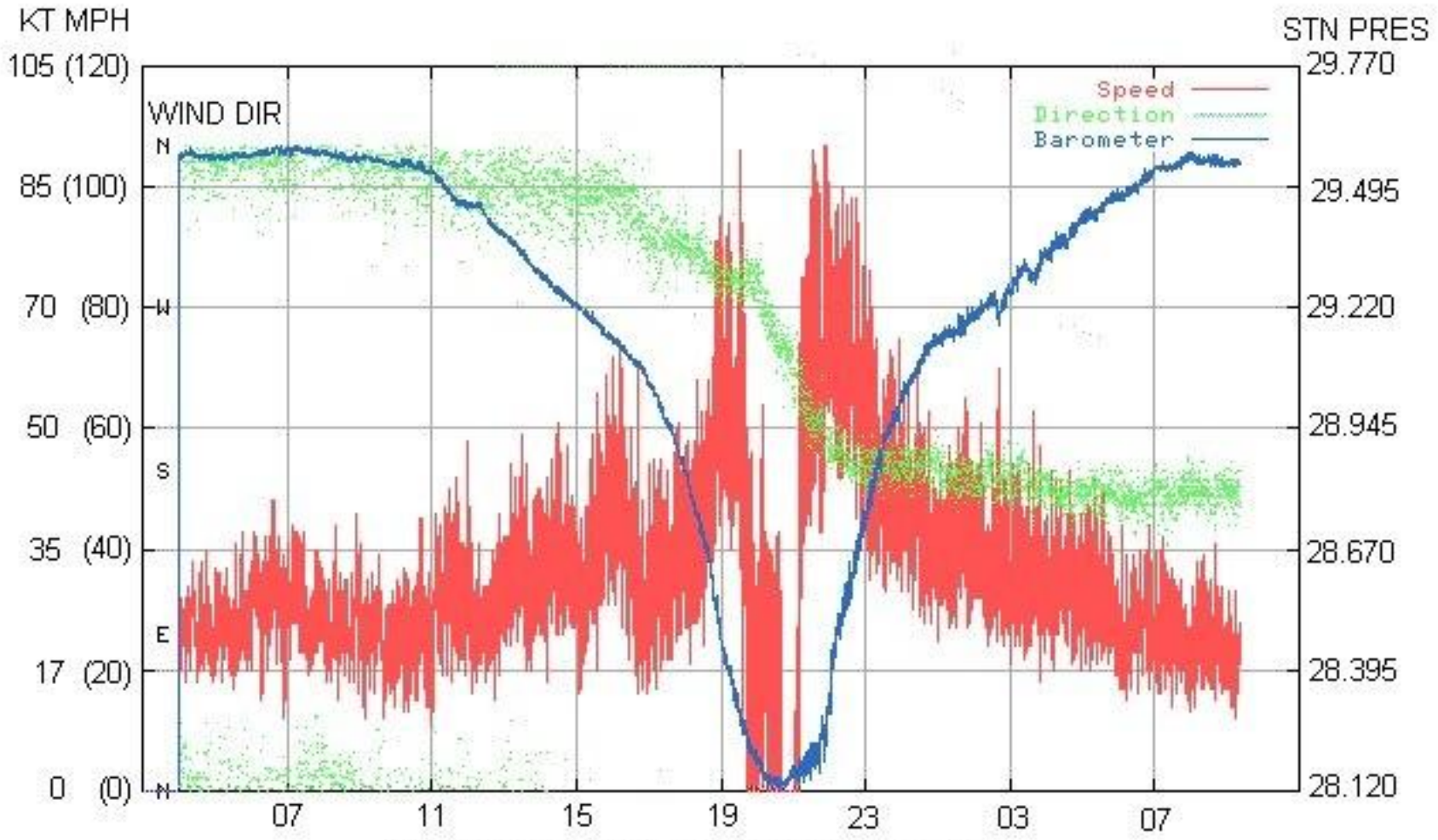


Image courtesy of Kuentos Communications, Inc.
http://www.guam.net

The Result…

The Beginning And Ending Of Winds Of Certain Strengths At Any Specific Location Is Critically Dependent On These Bands… Which Are Constantly Moving, Evolving And Changing…

SPECIFIC WIND FORECASTS WILL BE ACCURATE IF…AND ONLY IF…

- **The Track Forecast Is Correct In Both Timing And Position.**
- **The Intensity Forecast *And* The Current & Forecasted Wind Radii Are Actually Accurate**
- **It Is Clearly Understood That The True Nature Of The Hurricane Windfield Is Complex Not At All Uniform!**
- **Unfortunately, The Probability Of All The Above Conditions Existing Simultaneously Is Very Low.**

Probably The Best We Can Expect From The Automated Plots Alone Are Rough Estimates Of The Time Frame When Any Specific Strength Of Wind Might Be Possible…

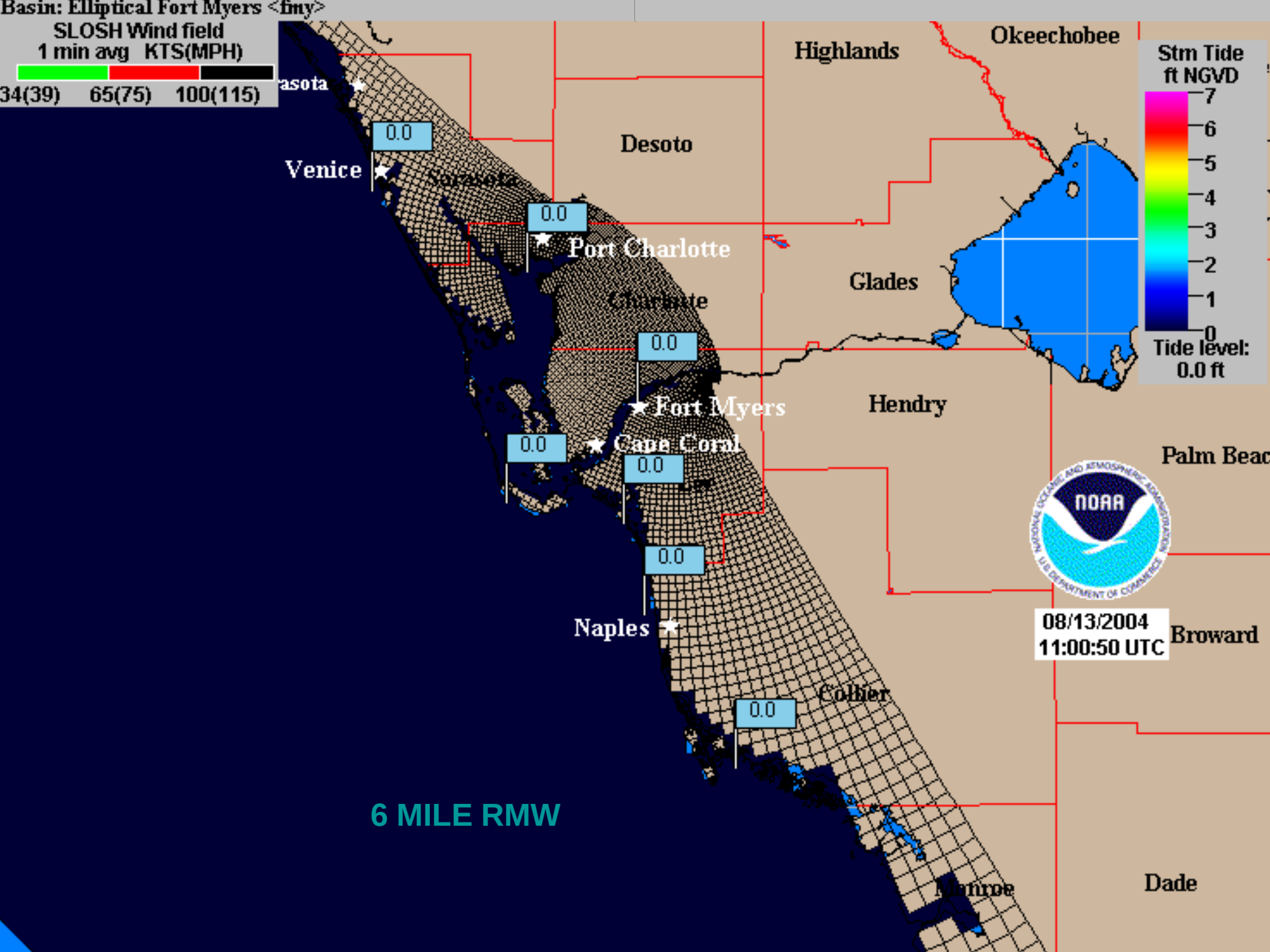
Even Then… This Is Critically Dependent On The Accuracy Of Both The Track Forecast, The Strength And The Wind Radii As Well As The Placement, Strength, Motion And Evolution Of The Bands!

The Closer We Get To Landfall… The More Specific The WFO Can Be… Often Allowing For Life-Saving Last Minute Preparedness Fine-Tuning

So Far, We've Concentrated On Uncertainties Associated With Wind Forecasts… But How Do They Affect Forecasts Of *Other* Storm Impacts?

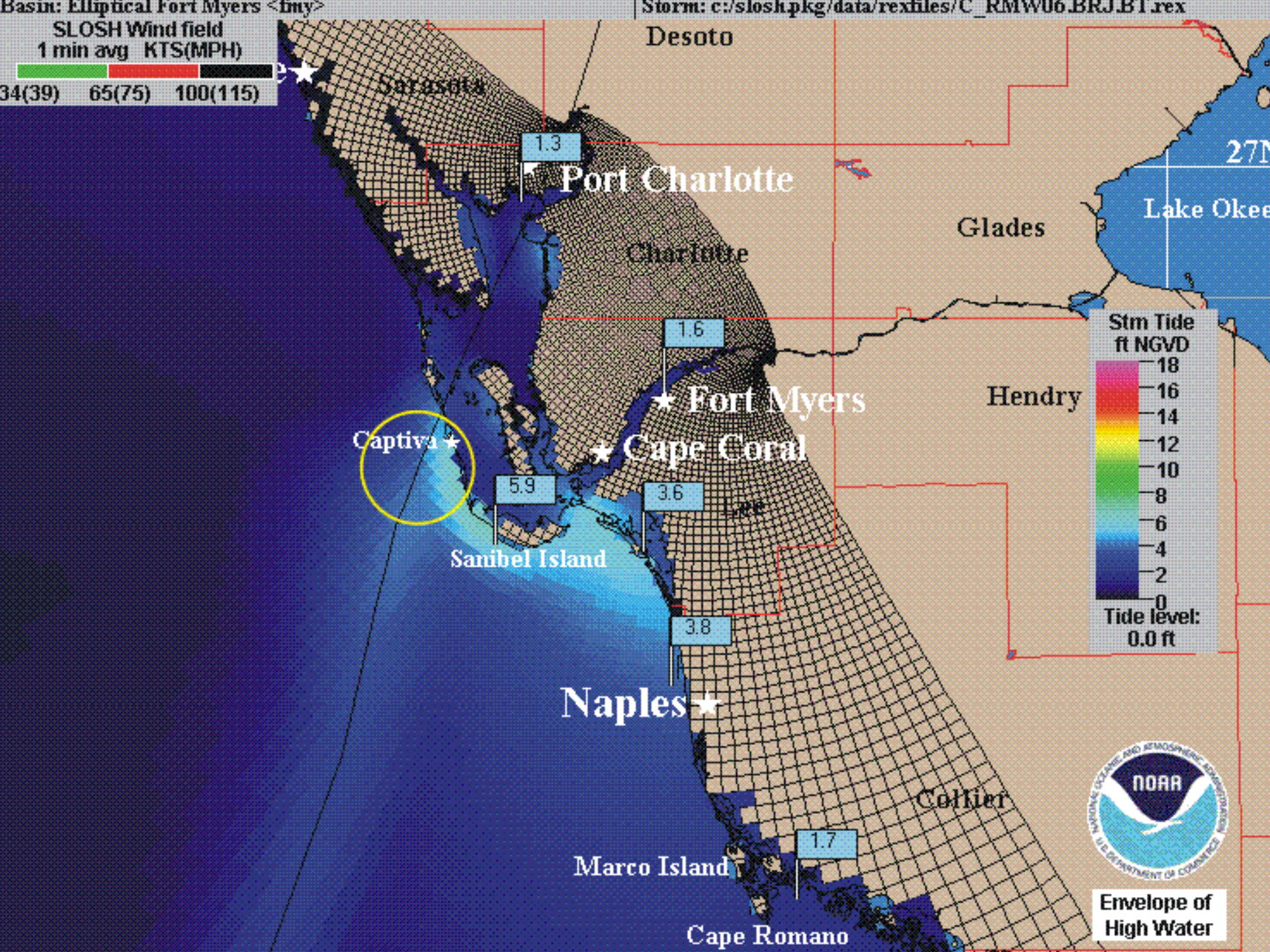
Uncertainties In Storm Structure Can Also Play A Major Role In Storm Surge…

Despite Making Landfall As A Cat 4 Hurricane, Due To It's Small Size, Charley Produced Only About A 6 to 7 Foot Storm Surge…


Basin: Elliptical Fort Myers <fmy>
SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)
Stm Tide
ft NGVD
7
6
5
4
3
2
1
0
Tide level:
0.0 ft
Highlands
Okeechobee
Desoto
Glades
Hendry
Palm Beac
Broward
Dade
Collier
Monroe
Venice
Sarasota
Port Charlotte
Charlotte
Fort Myers
Cape Coral
Naples
0.0
0.0
0.0
0.0
0.0
0.0
NOAA
08/13/2004
11:00:50 UTC
6 MILE RMW

With This In Mind…

Let's See How Charley's Surge Might Have Changed If The Radius Of The Maximum Winds Was Increased From the Observed 6 Miles to a Maximum of 24 Miles…

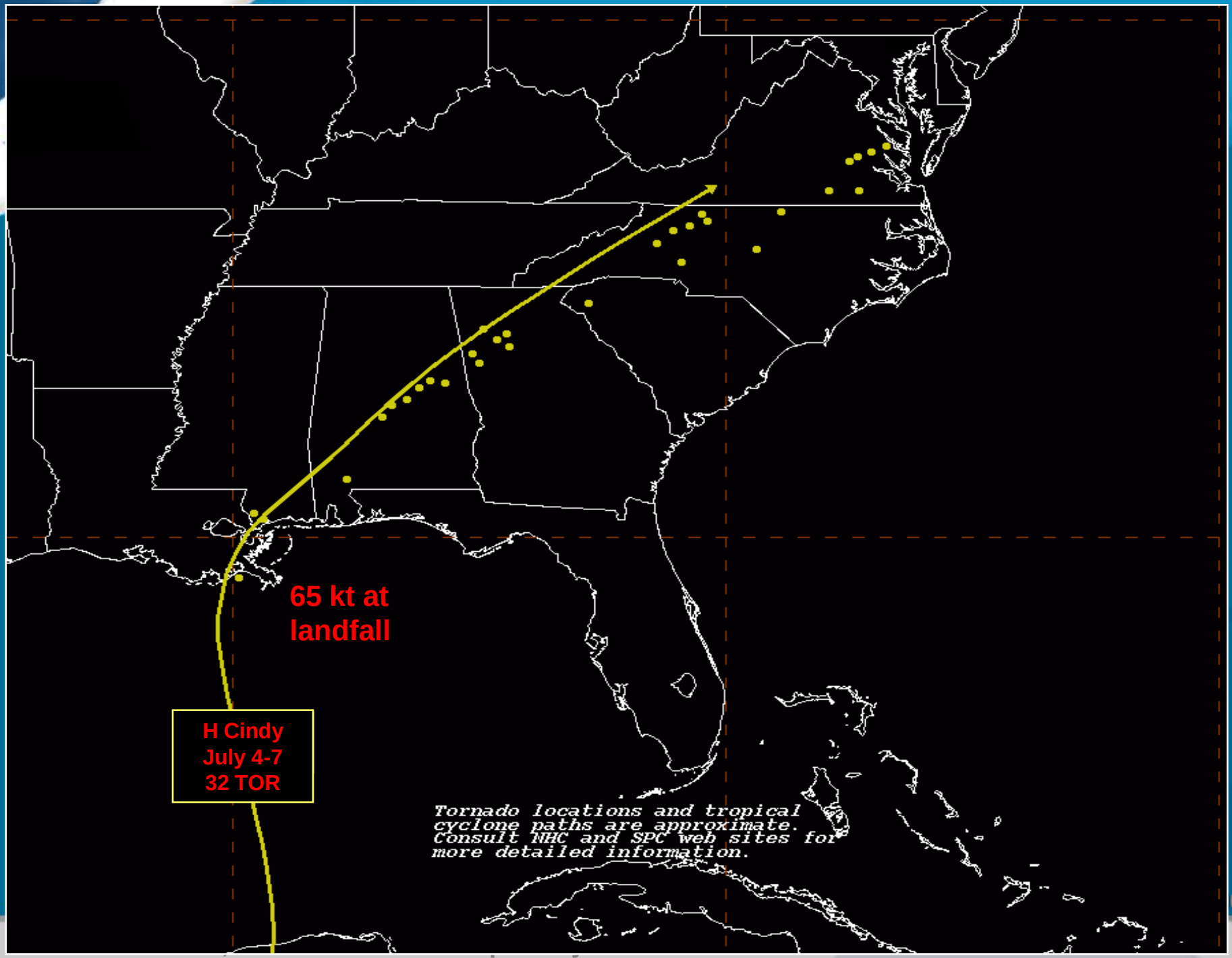

Basin: Elliptical Fort Myers <fmy>
Storm: c:/sloshpkg/data/rexfiles/C_RMW06.BRJ.BT.rex
SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)
Desoto
Sarasota
1.3
Port Charlotte
Charlotte
Glades
Lake Okee
1.6
Fort Myers
Hendry
Captiva
Cape Coral
5.9
3.6
Sanibel Island
3.8
Naples
Collier
1.7
Marco Island
Cape Romano
Stm Tide
ft NGVD
18
16
14
12
10
8
6
4
2
0
Tide level:
0.0 ft
NOAA
Envelope of
High Water

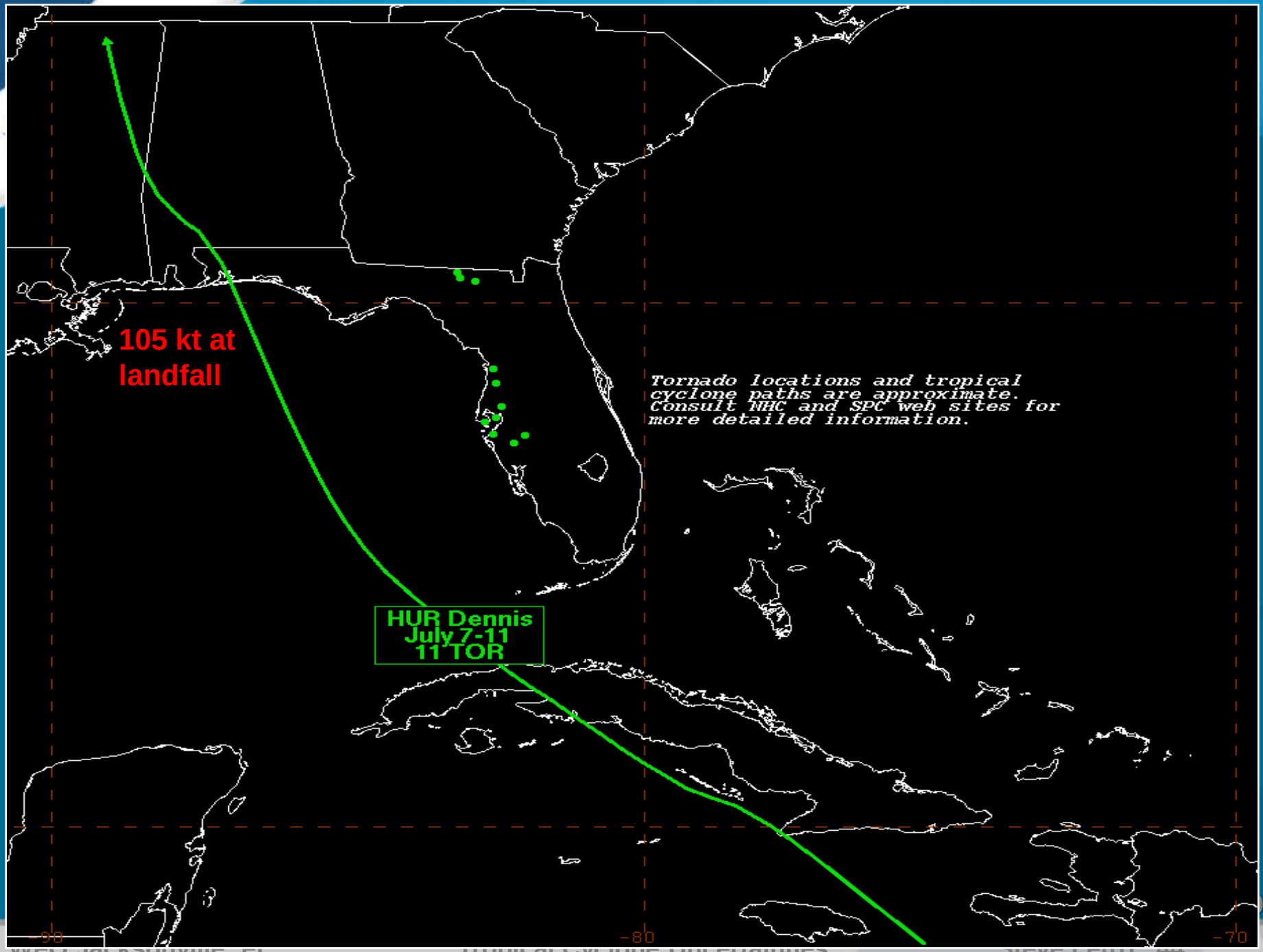
How About Another Threat That Tropical Cyclones Bring…

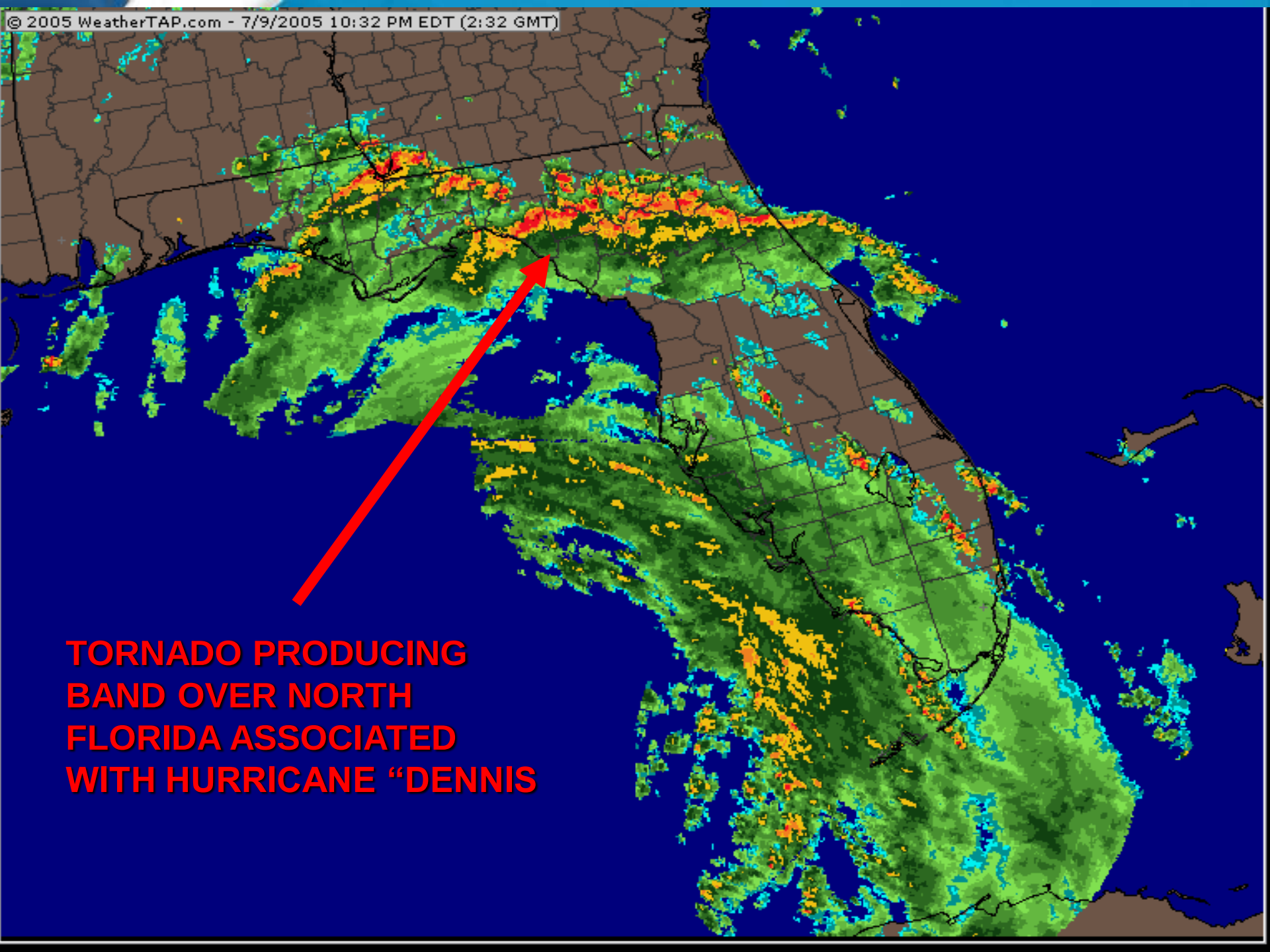
Tornadoes!

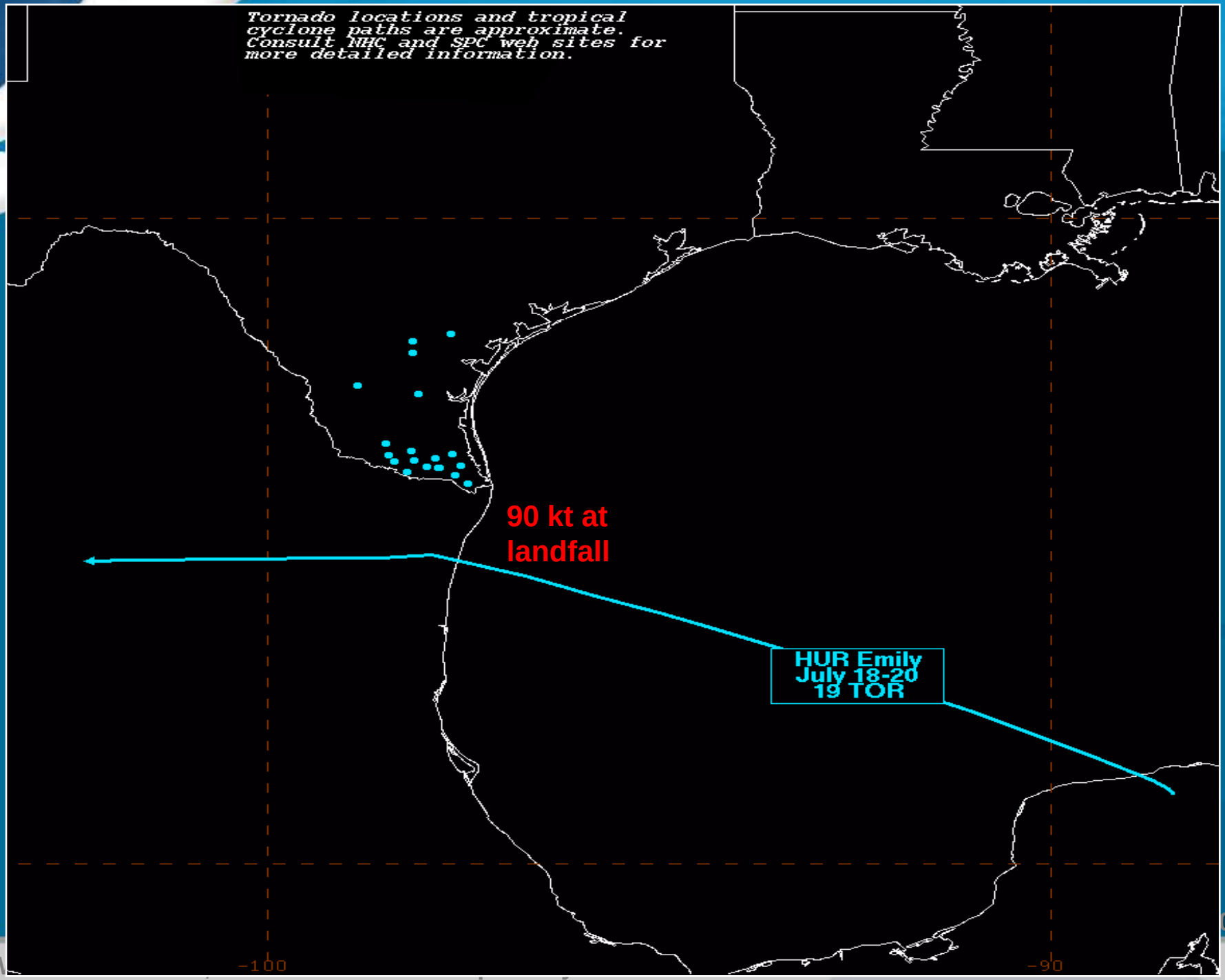
Tornadoes

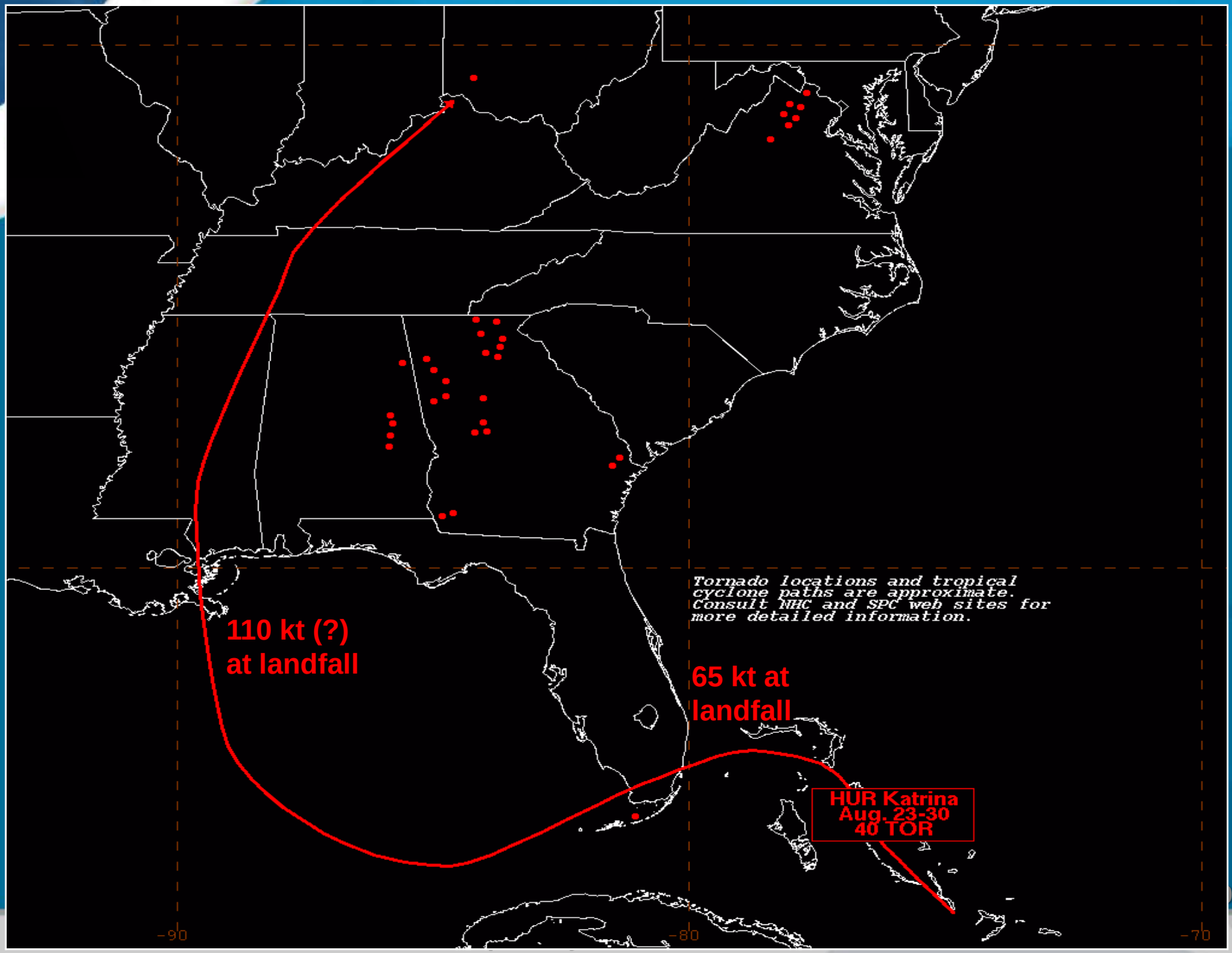
- **Tornadoes With Hurricanes:**
- **Nearly 60% Of Hurricanes That Made Landfall (1948 To 1986) Spawned At Least One Tornado**
- **Most Tornadoes Form In The Northeast Quadrant Of A Hurricane…Often In Rainbands Well Away From The Center**

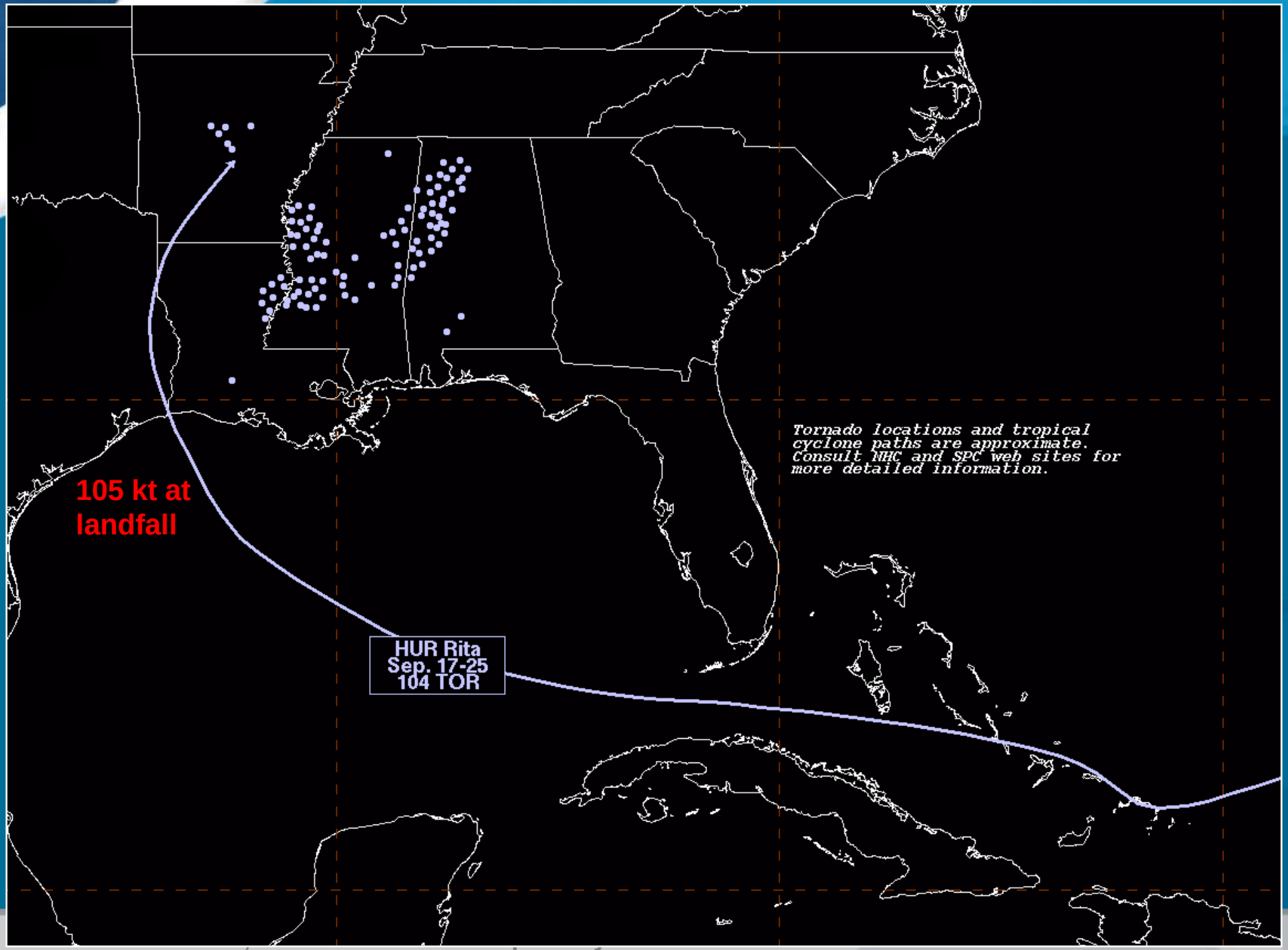

65 kt at
landfall
H Cindy
July 4-7
32 TOR
Tornado locations and tropical
cyclone paths are approximate.
Consult NHC and SPC web sites for
more detailed information.

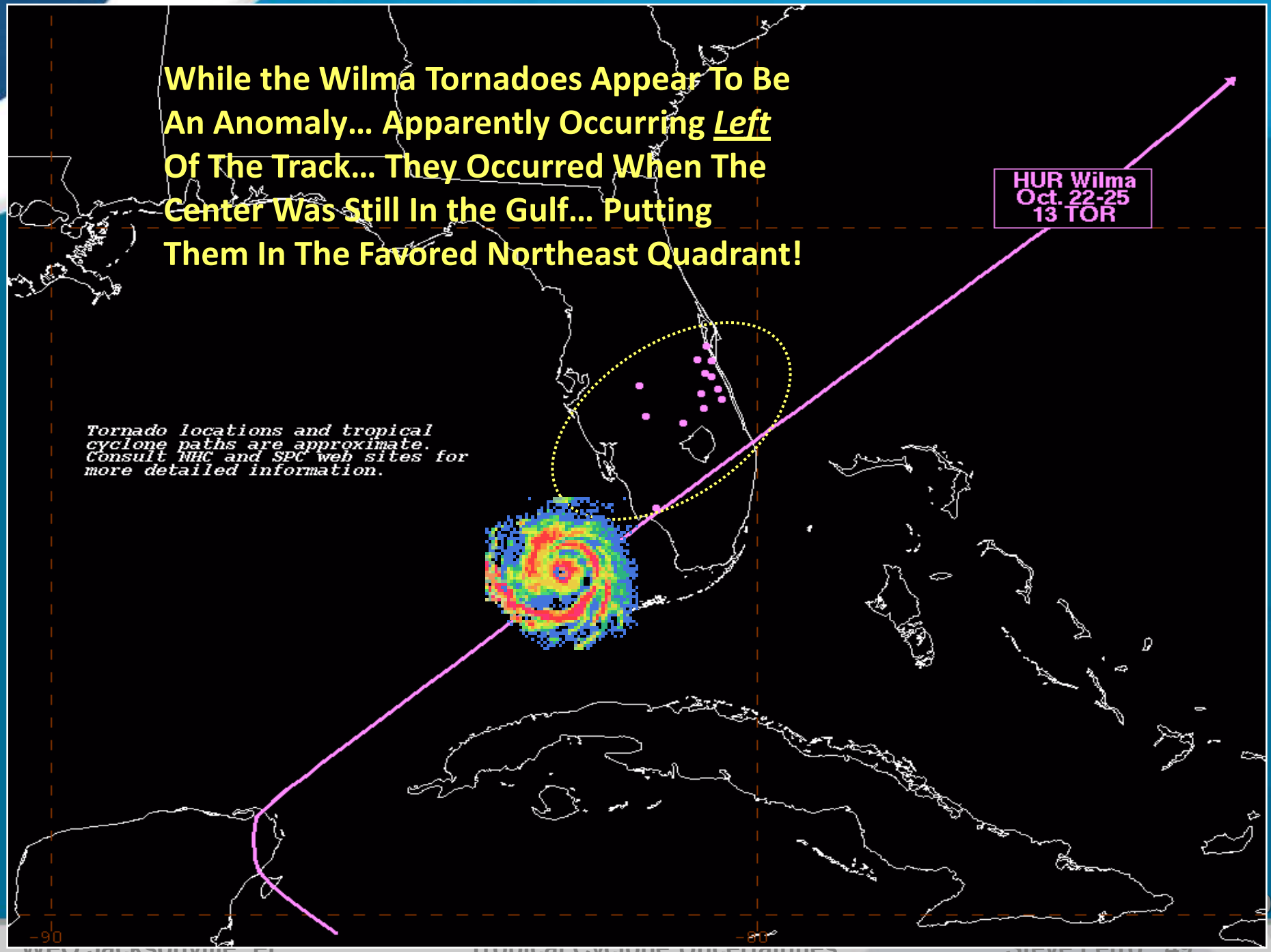

105 kt at landfall
Tornado locations and tropical cyclone paths are approximate. Consult NHC and SPC web sites for more detailed information.
HUR Dennis
July 7-11
11 TOR
-90
-80
-70


© 2005 WeatherTAP.com - 7/9/2005 10:32 PM EDT (2:32 GMT)
TORNADO PRODUCING
BAND OVER NORTH
FLORIDA ASSOCIATED
WITH HURRICANE “DENNIS


Tornado locations and tropical cyclone paths are approximate. Consult NHC and SPC web sites for more detailed information.
90 kt at landfall
HUR Emily
July 18-20
19 TOR
-100
-90


Tornado locations and tropical cyclone paths are approximate. Consult NHC and SPC web sites for more detailed information.
110 kt (?) at landfall
65 kt at landfall
HUR Katrina Aug. 23-30 40 TOR
-90
-80
-70


105 kt at
landfall
HUR Rita
Sep. 17-25
104 TOR
Tornado locations and tropical
cyclone paths are approximate.
Consult NHC and SPC web sites for
more detailed information.


While the Wilma Tornadoes Appear To Be An Anomaly… Apparently Occurring *Left* Of The Track… They Occurred When The Center Was Still In the Gulf… Putting Them In The Favored Northeast Quadrant!
HUR Wilma
Oct. 22-25
13 TOR
Tornado locations and tropical cyclone paths are approximate. Consult NHC and SPC web sites for more detailed information.

So… At Least For Tornadoes, It Appears That The "Traditional" Correlation With Development In The Northeast Quadrant Actually Works Pretty Well…

…For Once!

Finally… There Is The Issue Of The Substantial Role Uncertainty Plays In The Seasonal Forecasts

Based On the 2004 & 2005 Seasons, The Early Season Forecast For '06 Of Another Hyperactive Season With Well Above Normal Landfall Probabilities Created A Nearly Unprecedented Level of Angst and Apprehension

The Early Season 2006 Forecast Looked Grim…

- **NAMED STORMS: 17**
- **HURRICANES: 9**
- **MAJOR HURRICANES: 5**
- **U.S. STRIKES ?**
- **U.S. HURRICANE STRIKES: ?**
- **MAJOR U.S. HRCN STRIKES ?**

The 2006 Season Final Tally…

- **NAMED STORMS: 9**
- **HURRICANES: 5**
- **MAJOR HURRICANES: 2**
- **U.S. STRIKES 2**
- **U.S. HURRICANE STRIKES: 0**
- **MAJOR U.S. HRCN STRIKES 0**
- **Only 2 weak tropical storm landfalls!**

What Happened in 2006???

Most Of The Blame (or credit) For The Quieter Season Went To The Unexpectedly Rapid Development of an El Nino Event In The Pacific.

El Nino Usually Creates Wind Shear Which Inhibits Tropical Cyclone Development

But… Some Facts To Consider…

- **The Best Correlations Between El Nino and Decreased Atlantic Basin Activity Are During Strong El Nino's… Which This One Wasn't.**

- **The Best Correlations Between El Nino and Decreased Hurricane Activity Usually Don't Occur Until After The Event Is Fully Established… Which It Wasn't Until Late In The Season**

So, Let's Move On To 2007, When The Official Forecast Looked Equally Ominous…

- **NAMED STORMS: 13-17**
- **HURRICANES: 7-10**
- **MAJOR HURRICANES: 3-5**

This Menacing Prediction Was Based On The Fact That El Nino Was Gone, And In Fact, Was Replaced By A Developing La Nina. Combined With Anticipated Warm Ocean Temperatures, The Outlook Was Grim...

The Final Tally For 2007…

- **NAMED STORMS: 15**
- **HURRICANES: 6**
- **MAJOR HURRICANES: 2**
- **U.S. STRIKES 4**
- **U.S. HURRICANE STRIKES: 1**
- **MAJOR U.S. HRCN STRIKES 0**

From The Standpoint of Pure Numbers, This Would Be Considered A "Busy" Season!

But… Let's Take A Closer Look…

- Of The Total, 5 Of These Systems Were Subtropical In Origin… Such Systems Rarely Attain Great Strength, and indeed, None Of Them Reached Hurricane Force!

- 9 Of These Systems Never Produced Sustained Winds Of More Than 60 MPH… Which Would Barely Qualify As Even Severe Thunderstorms!

Some Interesting Statistics…

- 1969 Generated 12 Hurricanes…Including 5 Majors and 1 Cat 5… Despite Being An El Nino Season...
- The 2004 Season Was Actually A "Warmer" El Nino Season Than 2006… Yet Produced Spectacularly Different Results
- The 2007 Season… A La Nina Season In The "Warm" AMO Phase… Produced 5 Hurricanes And 2 Majors…The Same As The Supposed 2006 "El Nino" Season (with the caveat that the 2 majors in '07 were both Cat 5's)... And Similar ACE (~ 80)
- It Could Reasonably Be Argued That ENSO Phase In And Of Itself Tells Us Very Little About The Likelihood Of Actual Strikes!

So… In The Wake Of Yet Another Season That Did Not Meet Expectations…And This Time With No El Nino To Blame… What Happened???

"Although El Nino Appears To Be A Primary Cause For … Reduced TC Activity, Highly Variable Circulation Features Not Linked To El Nino Also Helped To Suppress Activity"

Bell, Blake, Landsea et al… "The 2006 North Atlantic Hurricane Season – A Climate Perspective"

Clearly There Are Other Things Going On That Have Just As Much… If Not More Uncertainty Than ENSO Phase!

This Brings Us To Yet Another Important Factor In The Strange (but welcome!) Saga Of the Relatively Benign 2006 & 2007 Hurricane Seasons

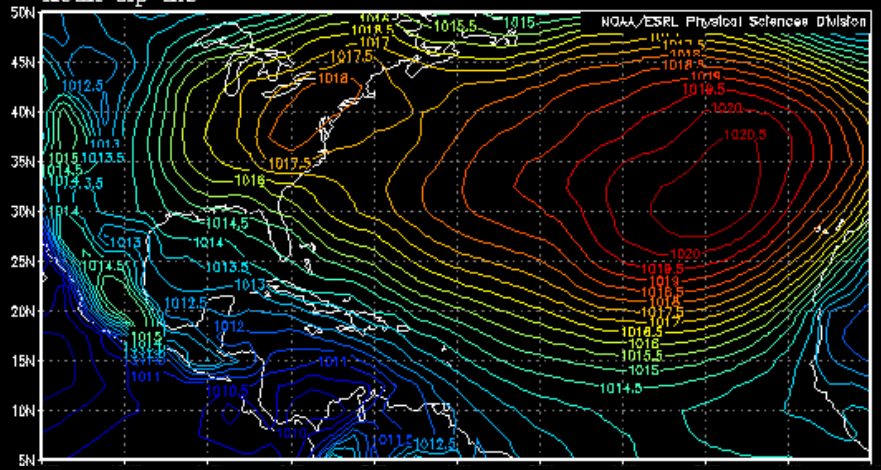
The Importance of Atmospheric Currents That Steer Hurricanes… Highly Dependent on The Position, Size and Strength of the Atlantic, or Bermuda High Pressure System

If There Are Storms… The Next Logical Question Is Whether There Is Any Interseasonal Predictability In The Atlantic High

Let's Take A Look At The Mean Positions Of The Atlantic High During The Peaks Of The Recent Hurricane Seasons Themselves…

Averaged SLP In August –October, 2004-2007

lon: plotted from −110 to −10
lat: plotted from 5.0 to 50.0
t: averaged over Aug 1 2004 to Oct 31 2004
lev: 0
Mean slp mb



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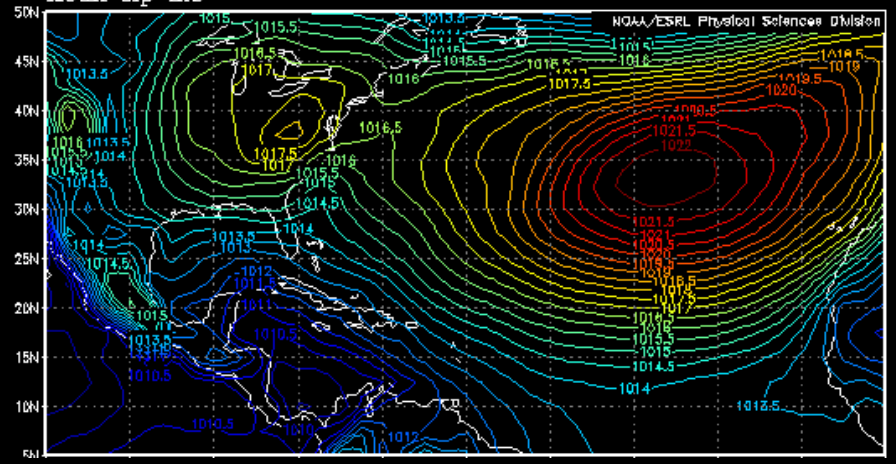
Mean slp mb



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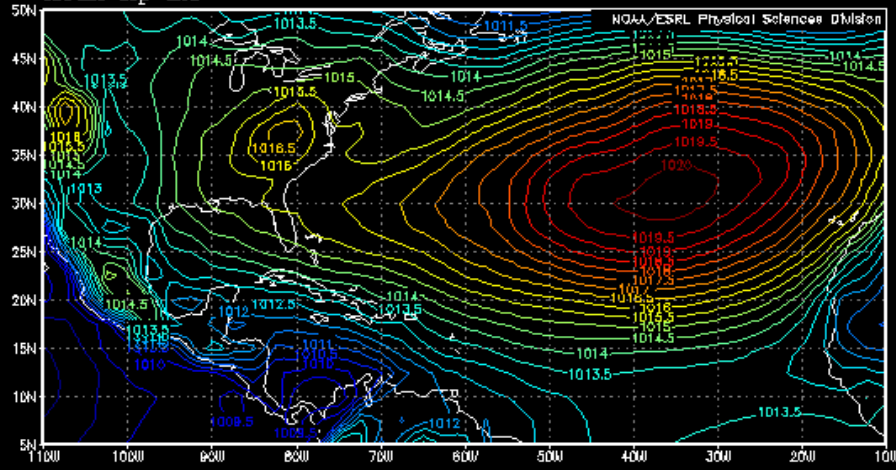
t: averaged over Aug 1 2006 to Oct 31 2006
lev: 0
Mean slp mb



lon: plotted from −110 to −10
lat: plotted from 5.0 to 50.0
t: averaged over Aug 1 2007 to Oct 25 2007
lev: 0
Mean slp mb

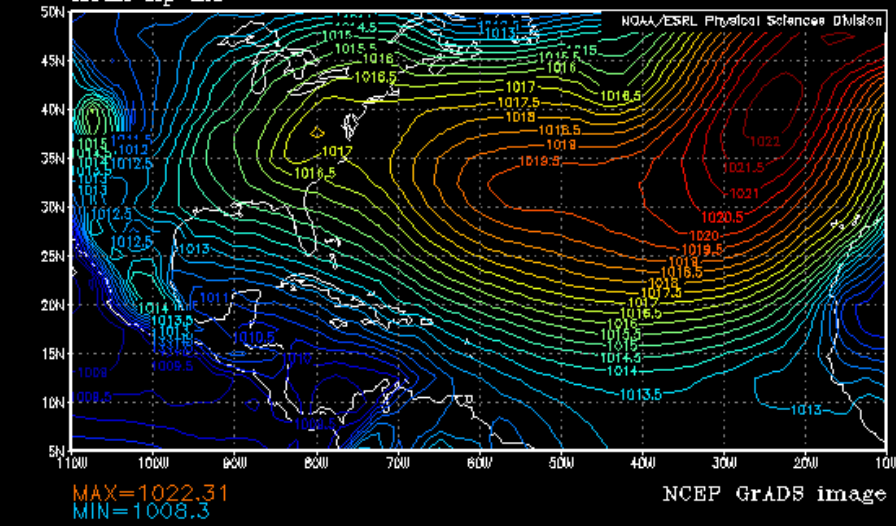
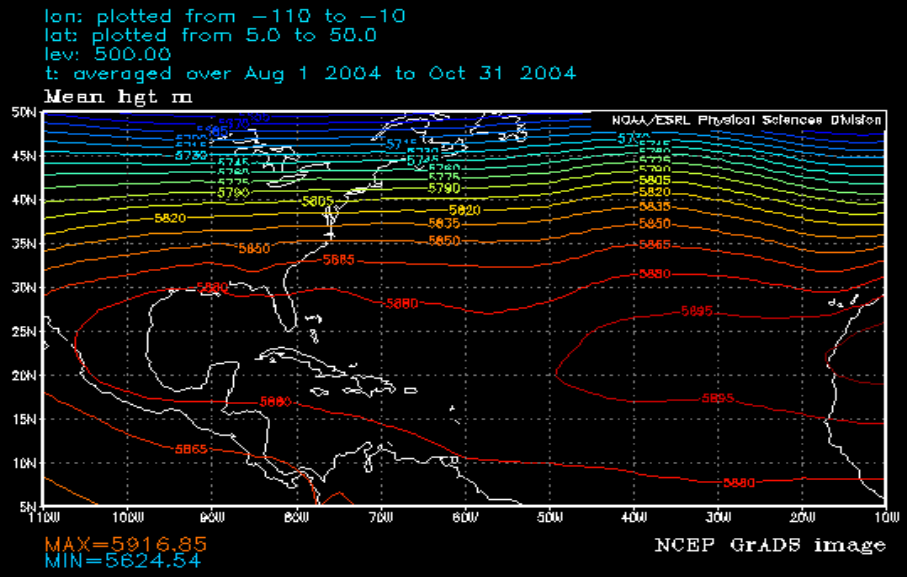
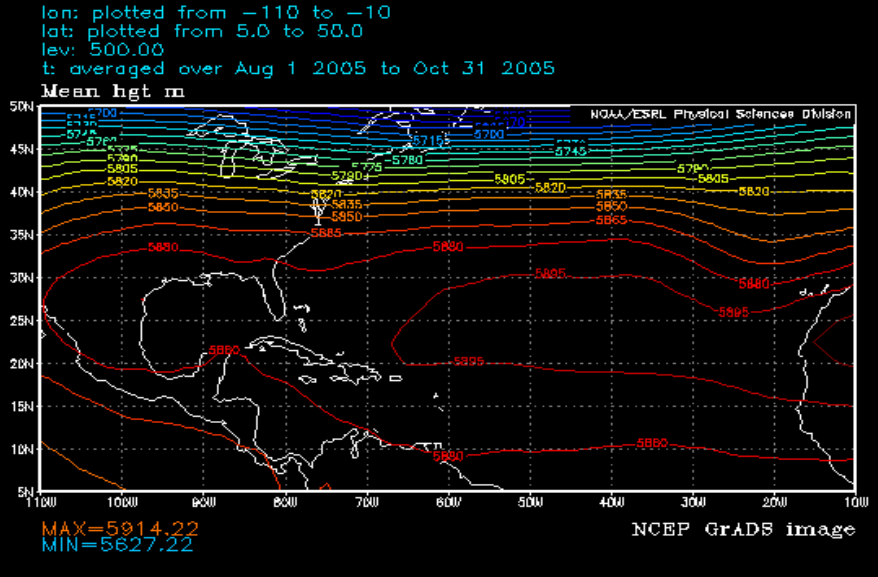
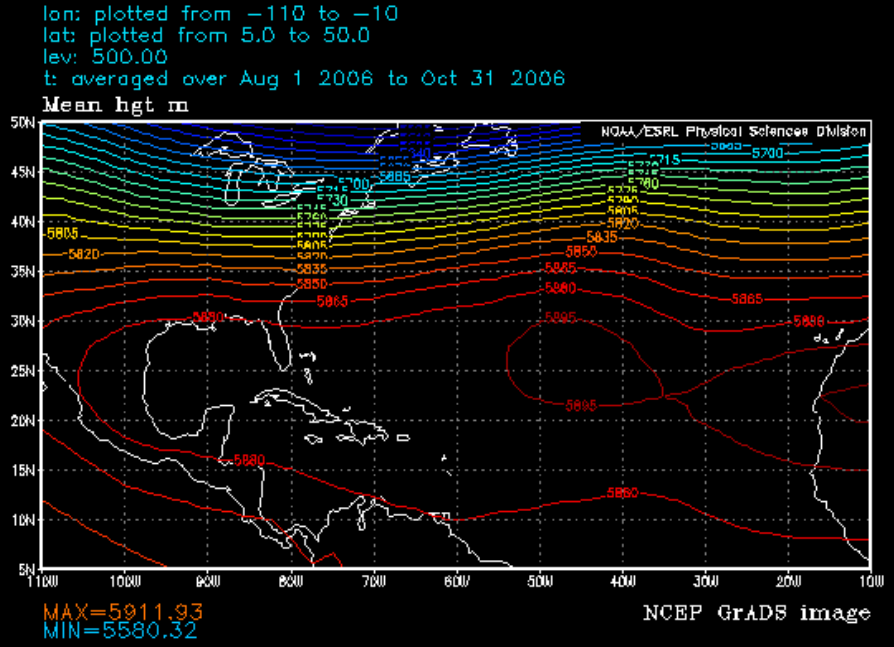


Image provided by the NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, from their Web site at http://www.cdc.noaa.gov/.

Averaged 500 MB Heights Aug.-Oct. 2004-2007







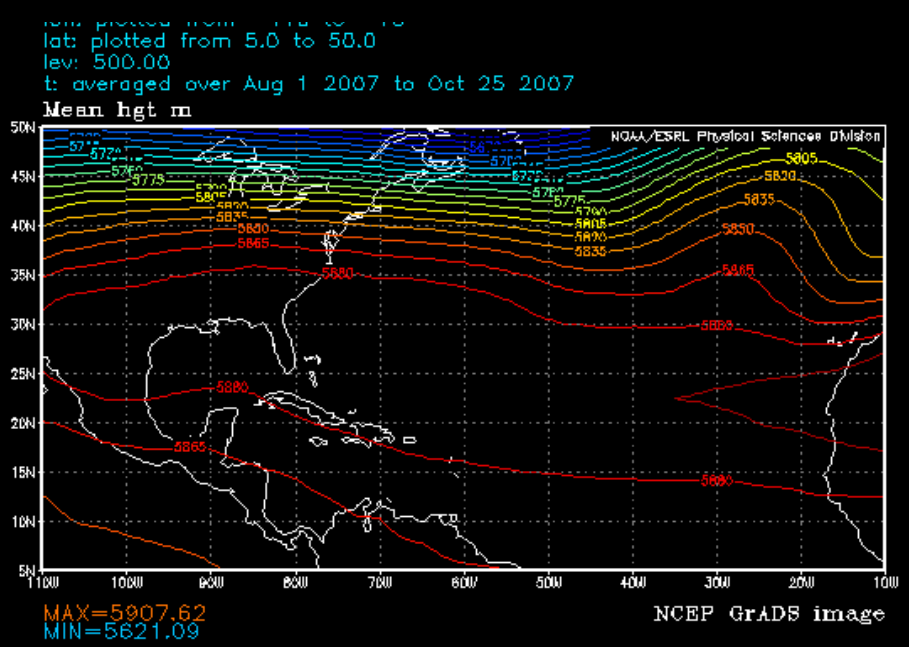
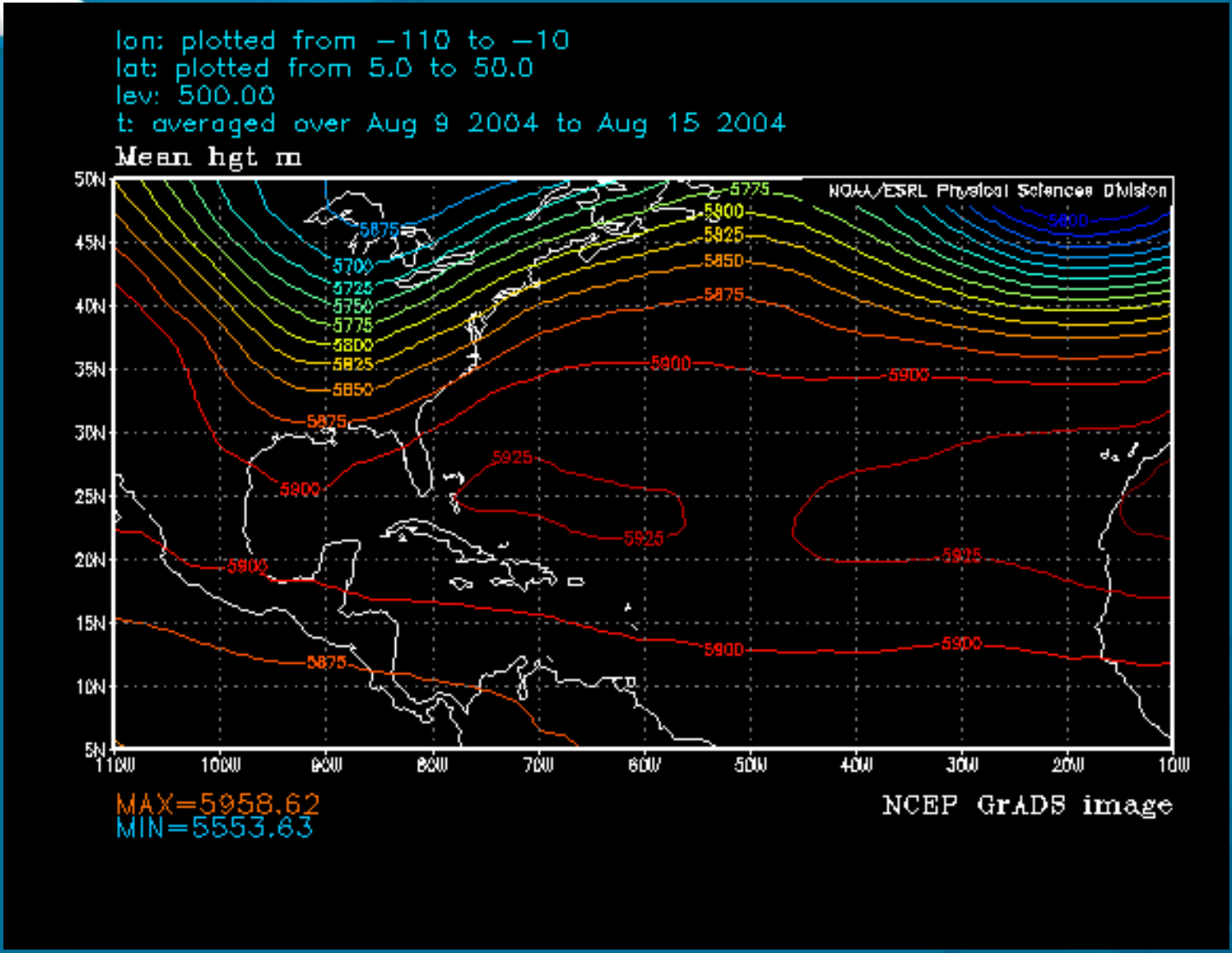


Image provided by the NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, from their Web site at http://www.cdc.noaa.gov/.

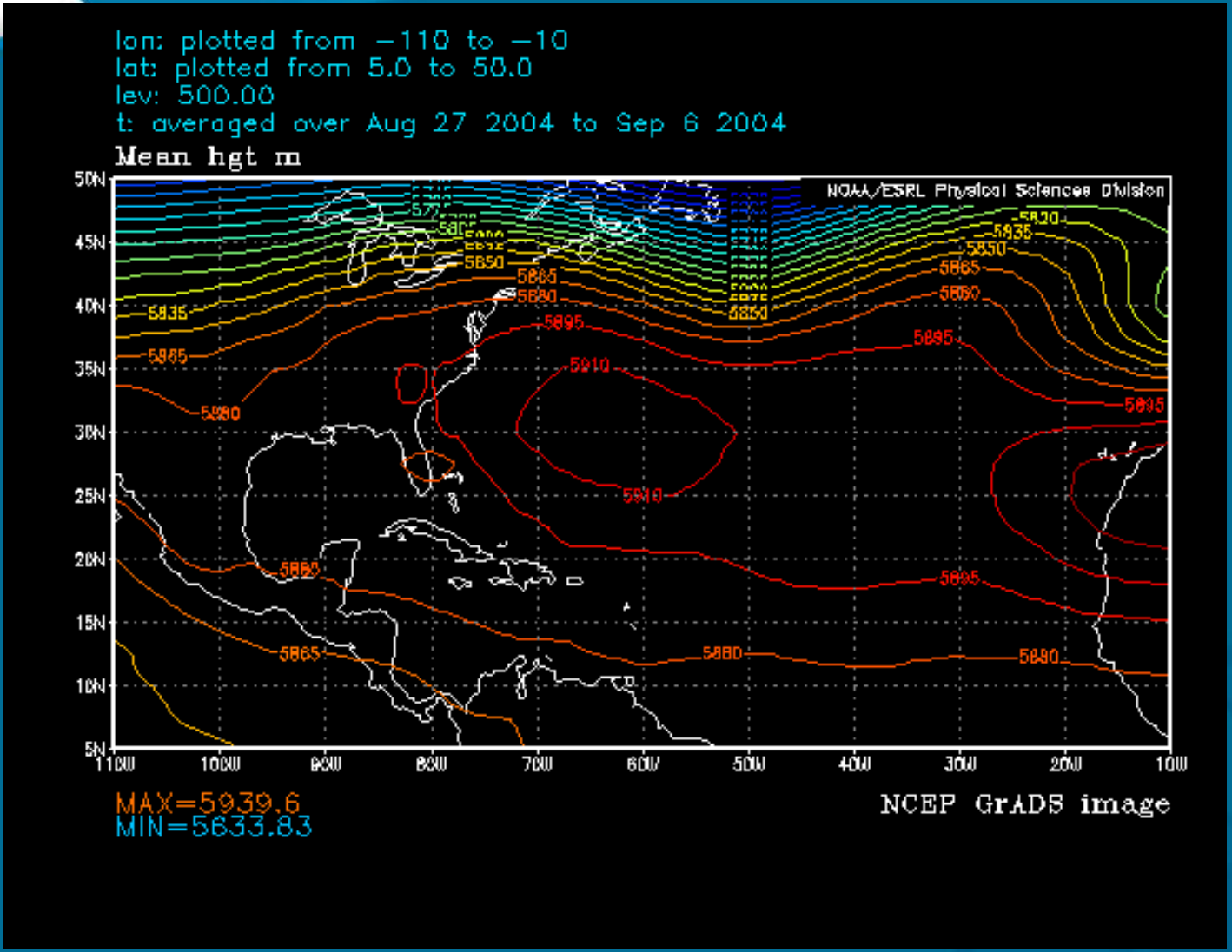
The Preceding Slides Show Us That Even During The Hurricane Season Itself… There Are Not A Lot Of Significant Differences Between Years With Numerous U.S. Strikes (2004 & 2005), and Those With Few (2006-07)

A Look At INTRA Seasonal Changes However, Tells A Very Different Story!

Mean 500 MB Pattern In Early August, 2004…



Mean 500 MB Pattern Just Two Weeks Later…



So What Is The Message?

In Addition To The Problems With Inter Seasonal Predictability Of Such Key Large Scale Parameters As ENSO Phase, AMO, etc… There Is Also A Great Deal Of Intra Seasonal Variation In These And Other Parameters Between Various Sections Of The Basin As Well

The Result Is That Seasonal Activity Is Ultimately Determined By The Phasing Of These Parameters In Time And Space… Which Is Currently Beyond The State Of The Science On Both Inter- And Intra-Seasonal Scales

Whether Or Not A Season Is "Active" …From A User Perspective… Is Dependent On Both The Number Of Storms AND Where They Go… More Specifically… Whether They Get Hit!

From What We've Seen… There Are Clearly Still Major Uncertainties In The Evolution Of Any Particular Season… Even When The Forecasts Are "Right"!

The End!

THIS PRESENTATION IS AVAILABLE AT:

www.weather.gov/jax