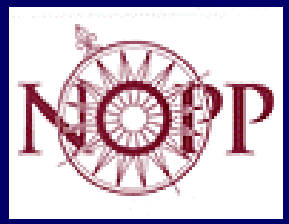
Update on Real Time Forecasting of Storm Winds, Waves and Surge

Hans C. Graber[1], Robert E. Jensen[2], Vincent J. Cardone[3], Andrew Cox[3], and Charles Grassl[4]

[1]University of Miami
[2]US Army Engineer Research & Development Ctr, Coastal Hydraulics Lab
[3]Oceanweather, Inc.
[4]International Business Machines (IBM)



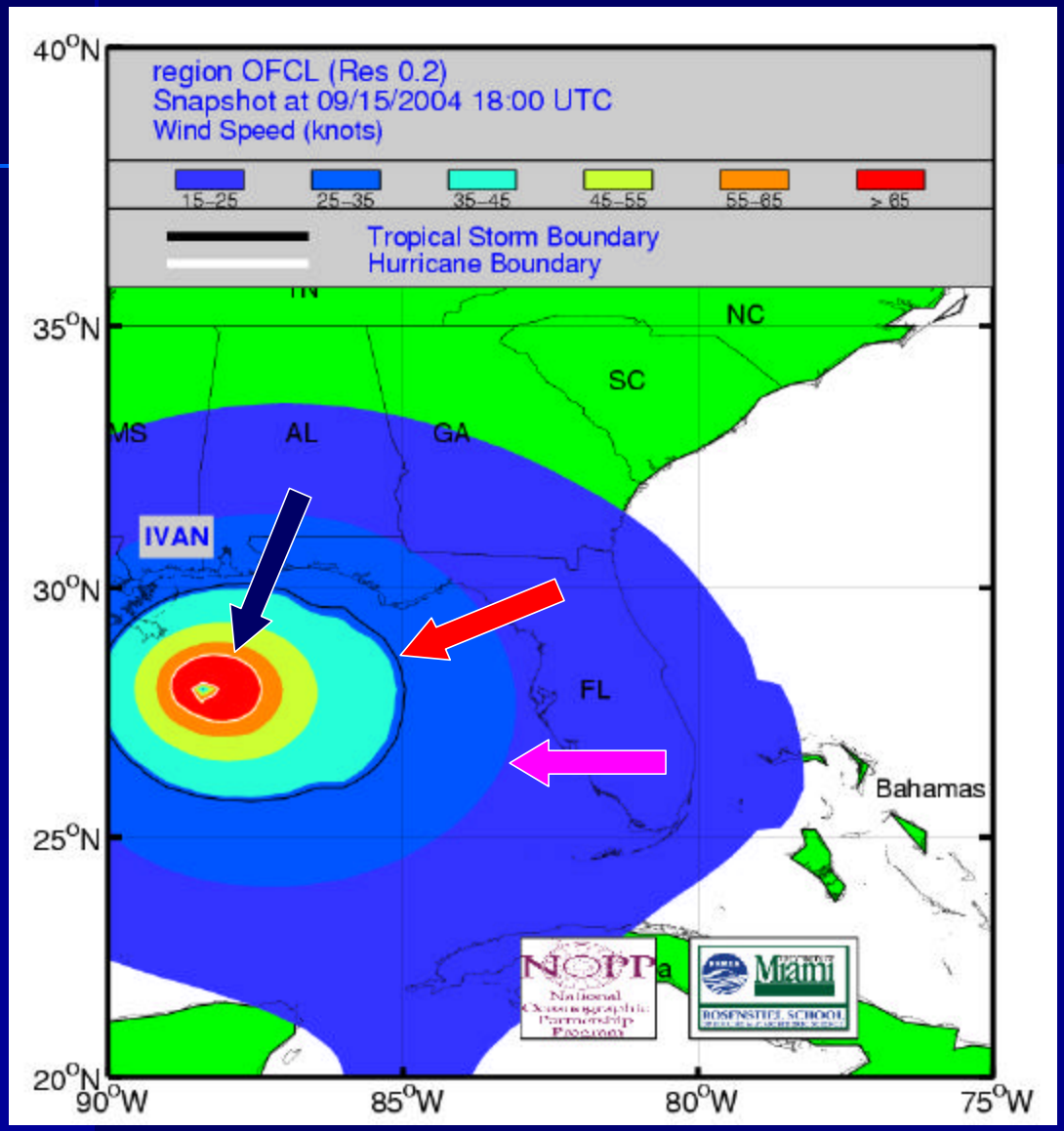
8th International Workshop on Wave Hindcasting and Forecasting
November 14-19, 2004
O'ahu Hawaii

Project Goals

This new and innovative forecast system for winds, waves and surge in tropical cyclones will generate:

- Improved information of the 5-day advisory for the National Hurricane Center (NHC) by providing:
  - better wind radii to minimize the extent of Hurricane Warnings (evacuating 1 mile of coastline = $1M)
  - better wave radii for more accurate marine advisories for ocean and offshore operations
- High resolution predictions of storm surge and subsequent flooding of streets and inundation of property.
- Risk factors from ensemble of forecasts with alternate storm tracks and intensity changes.

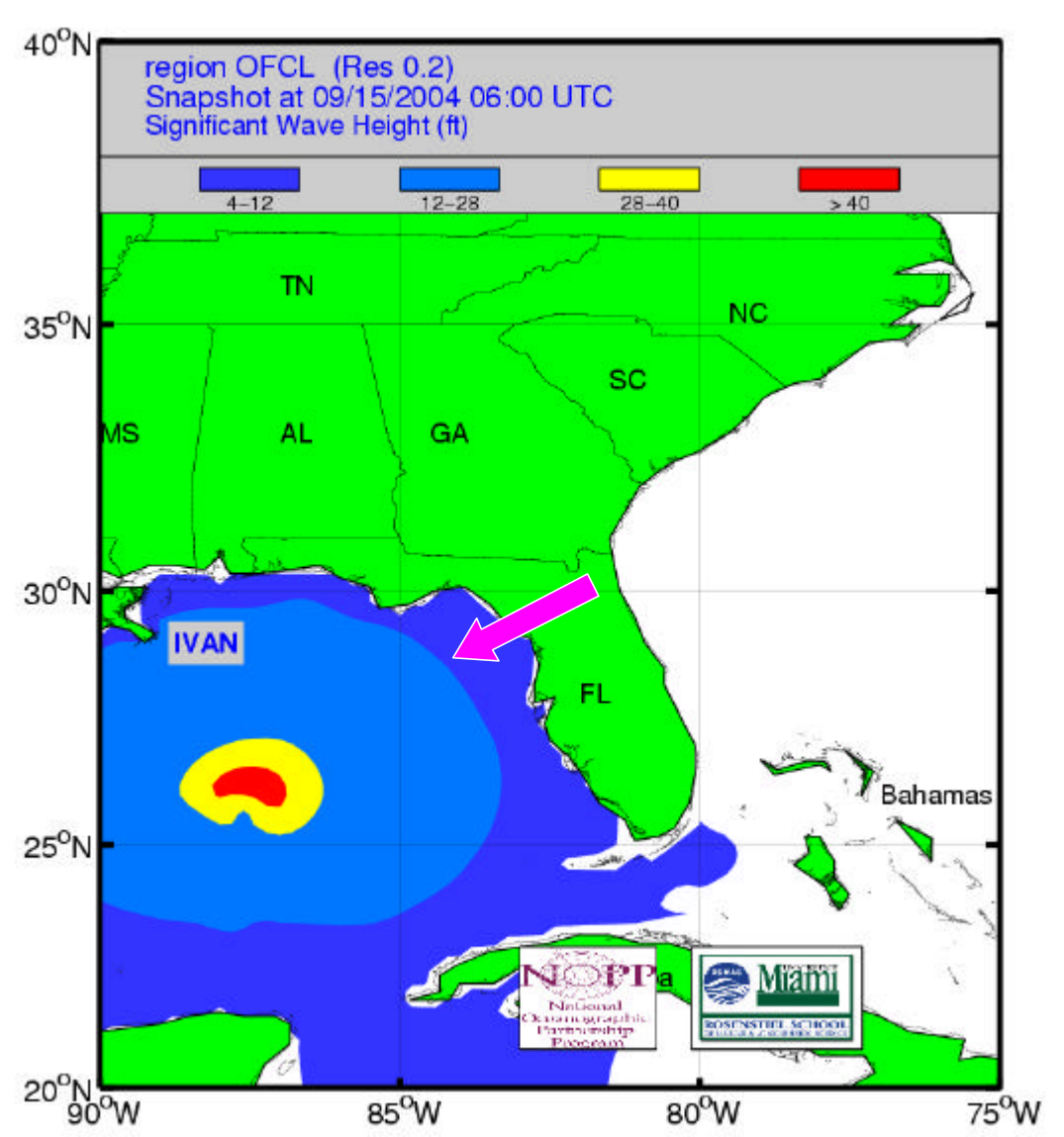
Wind Forecast



Threshold Radii for:

- Gale force
- Tropical Storm force
- Hurricane force

Wave Forecast



Threshold Radii for:

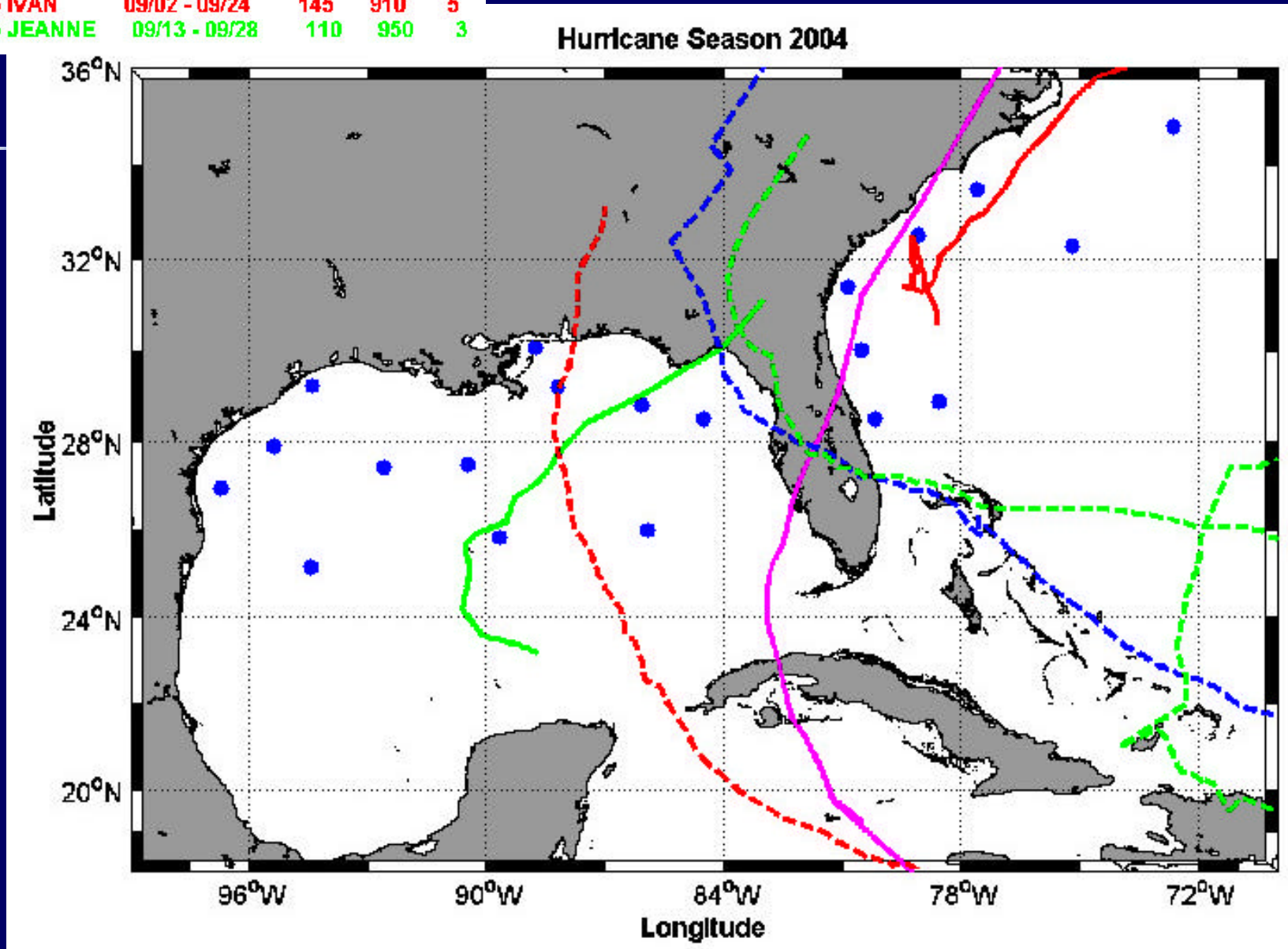
- 12 ft Wave Height

Critical for Marine Advisory

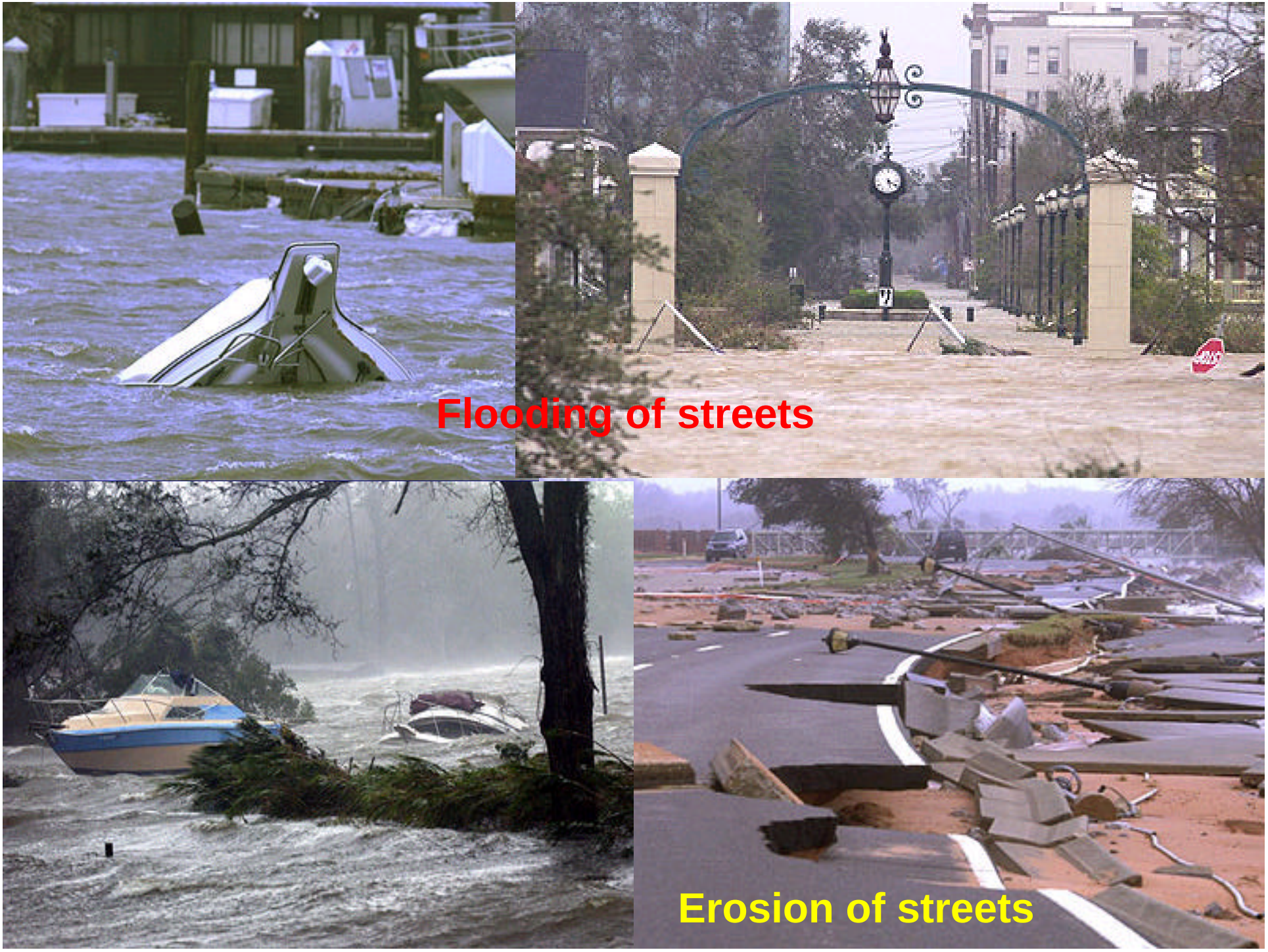
Our Focus During 2004 Hurricane Season

- Forecast system performed in fully automated, semi-operational mode, with special emphasis on Charlie, Frances, Ivan and Jeanne.
- The WINDGEN system performed extremely well during this hurricane season. System is ready for operational use.
- Wave and surge models coupled with radiation stress and correct physics and tidal dynamics added to storm surge predictions.
- Surge model integrated into forecast system to run in real-time.
- Coupled forecast system runs from initial ~4000 sec to ~200 sec per 24 hr model time.

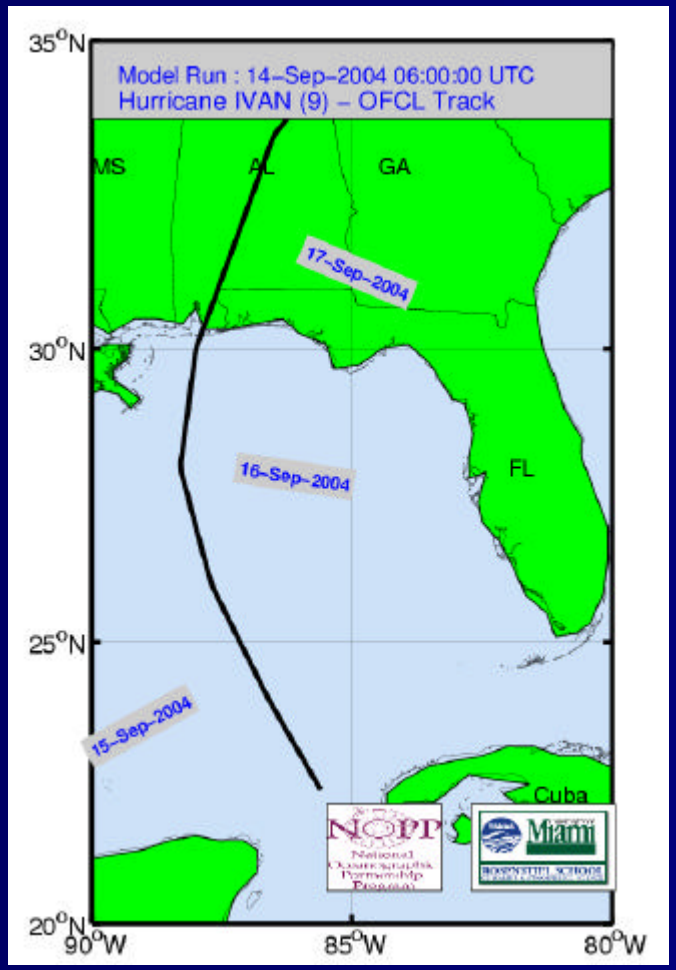
#	Name	Dates	Wind	Pres	Cat
1	Hurricane ALEX	07/31 - 08/06	105	957	3
3	Trop Strm BONNIE	08/09 - 08/12	55	1000	-
4	Hurricane CHARLEY	08/09 - 08/15	125	941	4
7	Hurricane FRANCES	08/25 - 09/09	125	935	4
10	Hurricane IVAN	09/02 - 09/24	145	910	5
12	Hurricane JEANNE	09/13 - 09/28	110	950	3



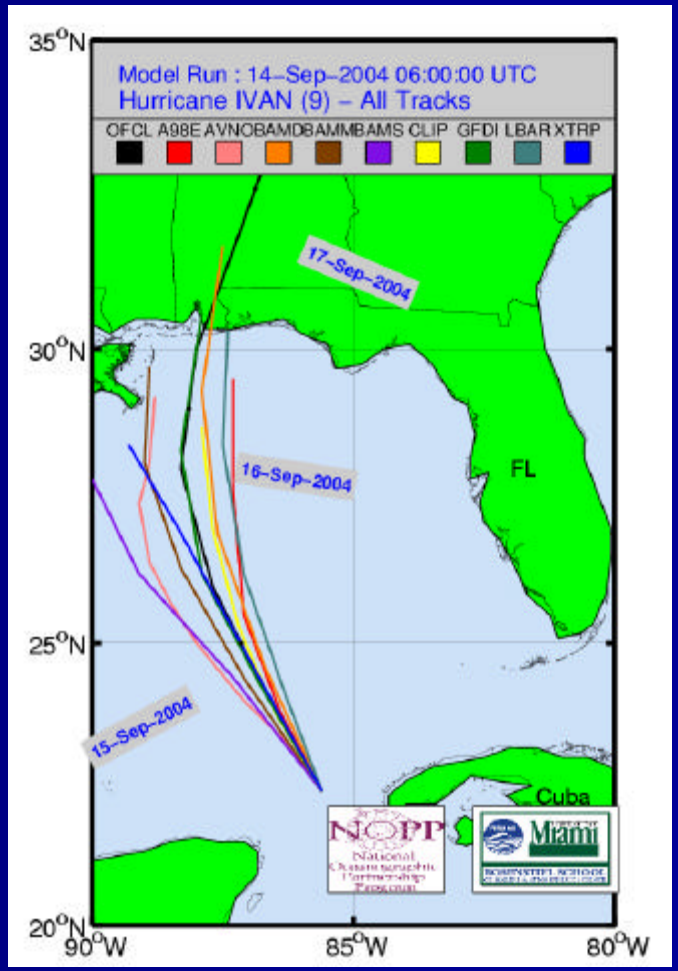

Impact of Ivan

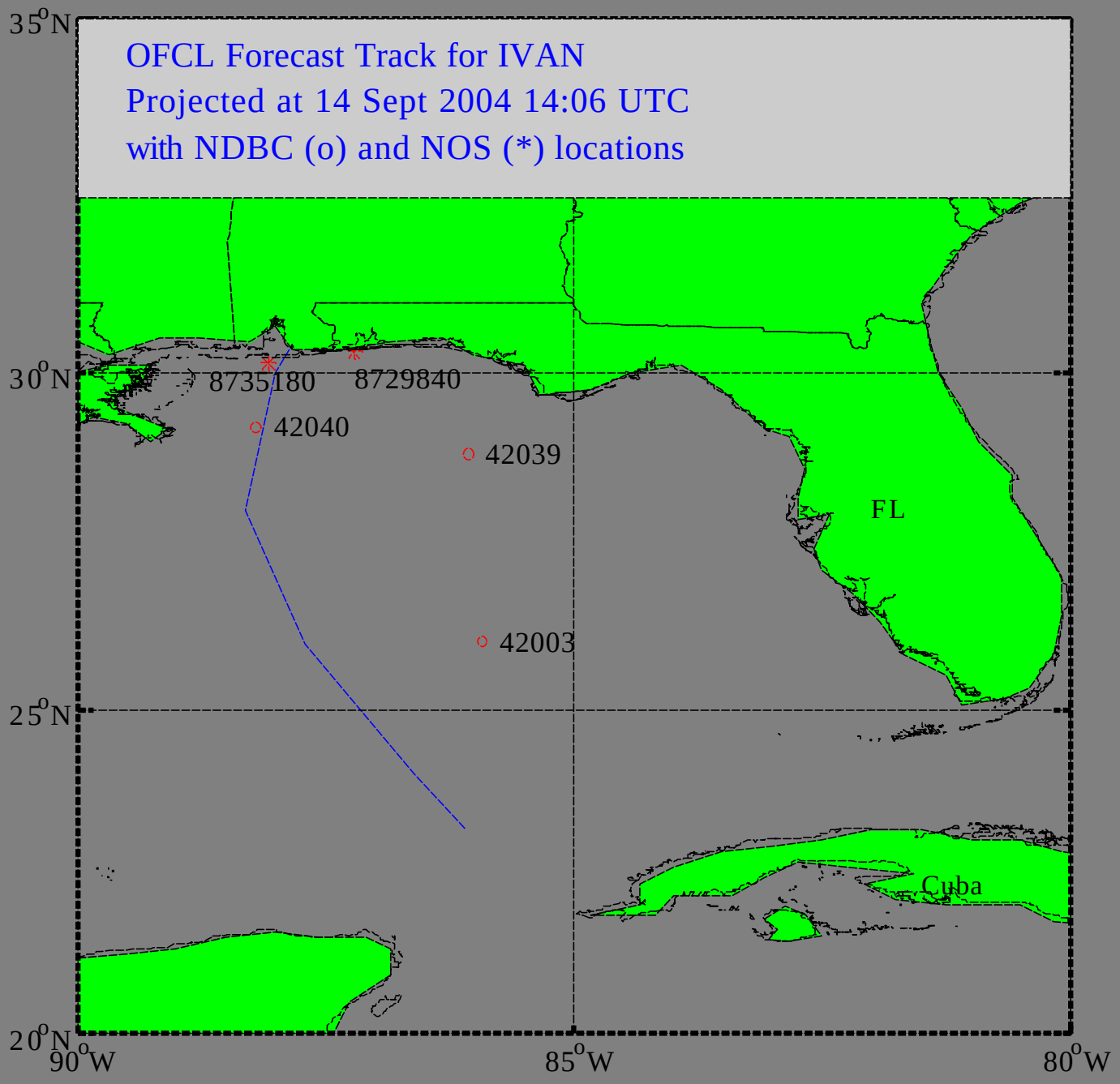

Flooding of streets
Erosion of streets

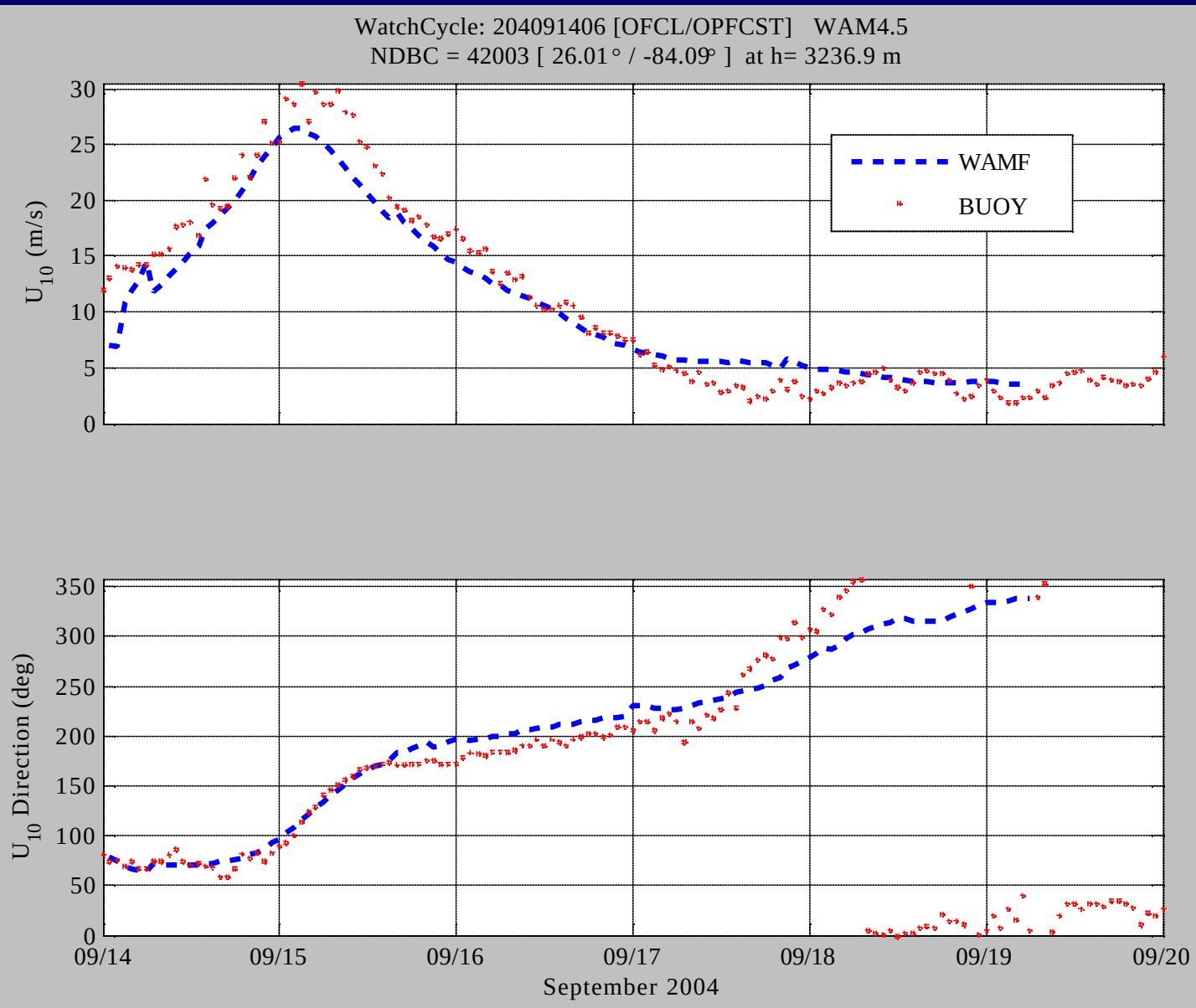
Ivan's Track

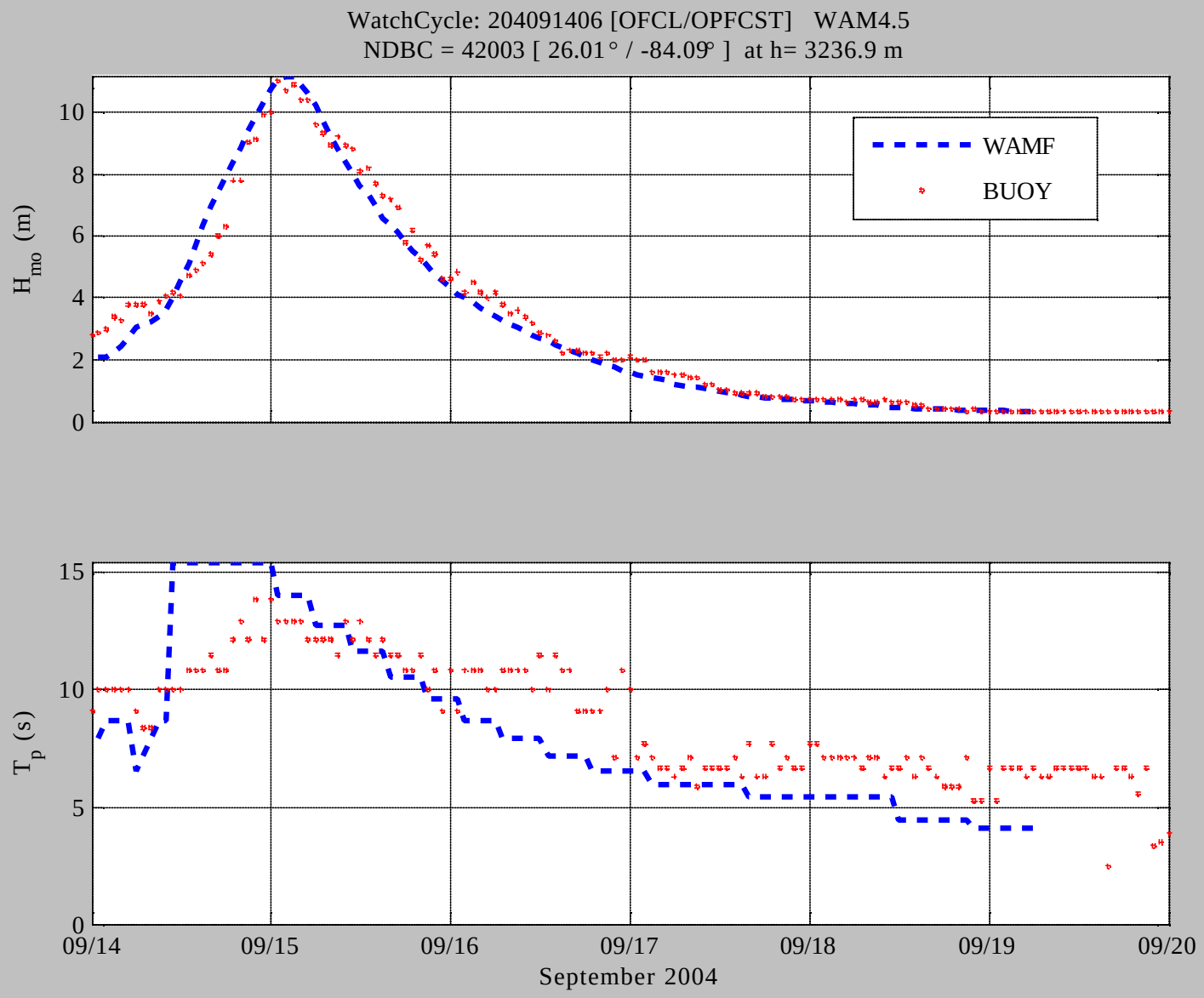


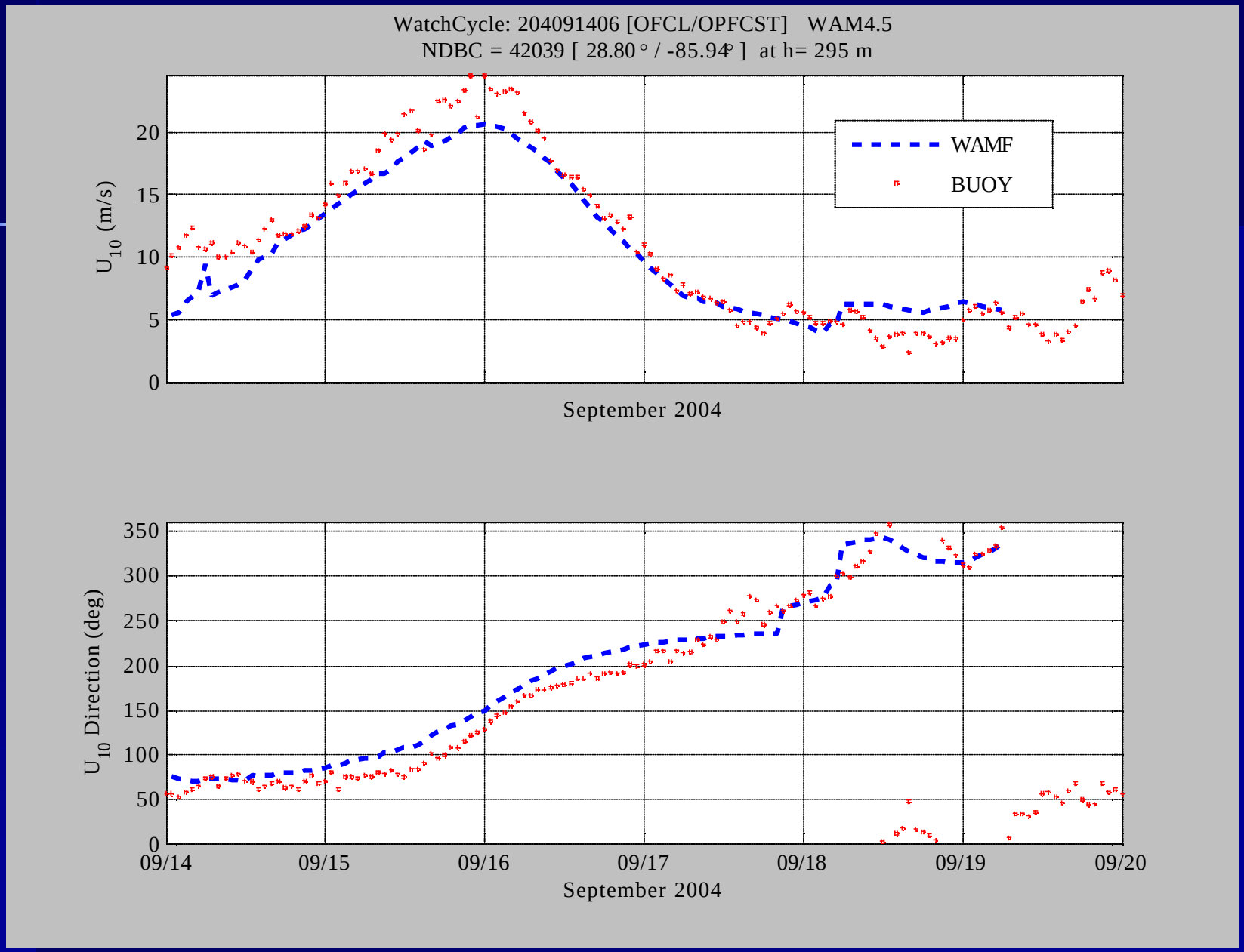
Ensemble of Tracks

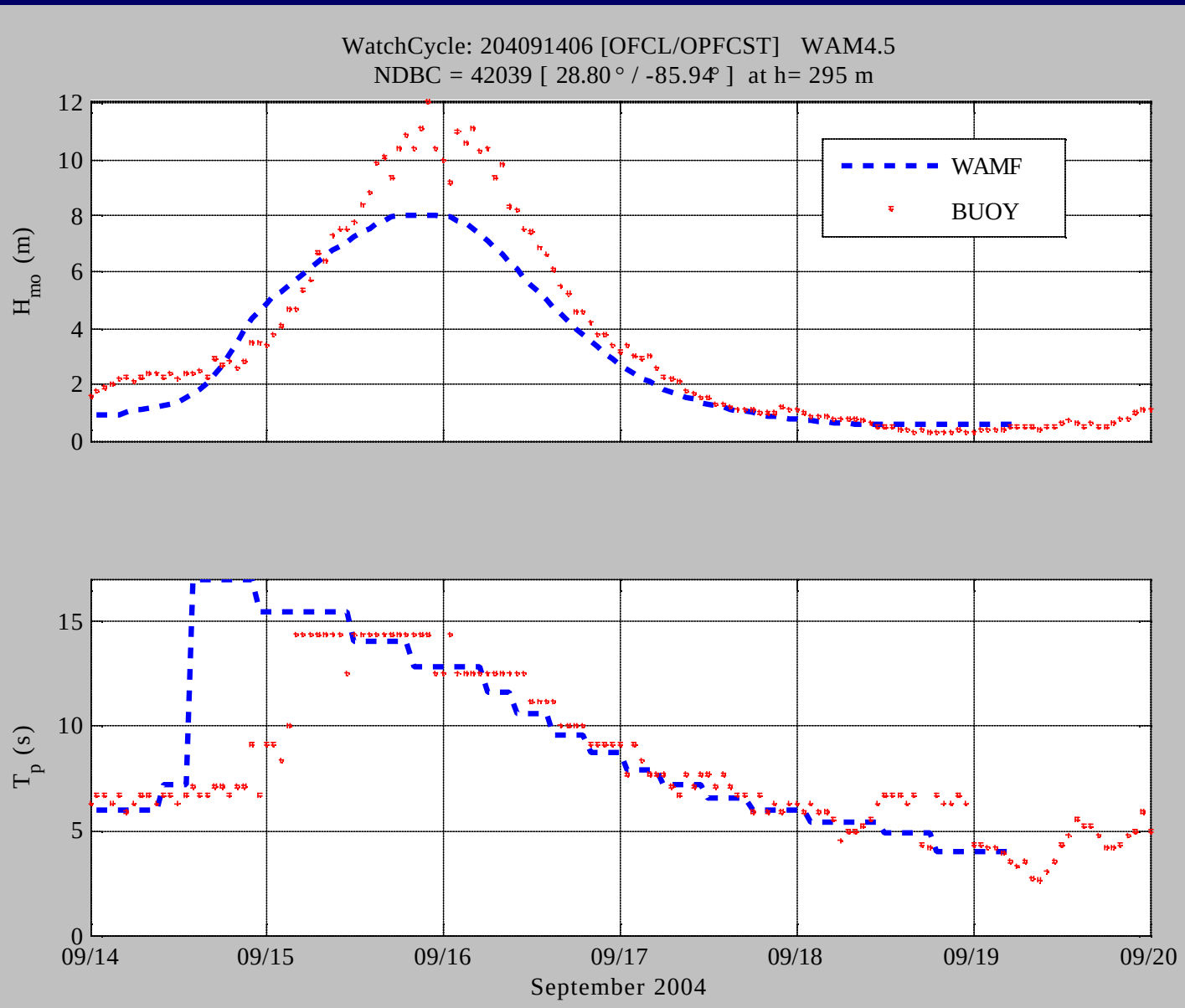


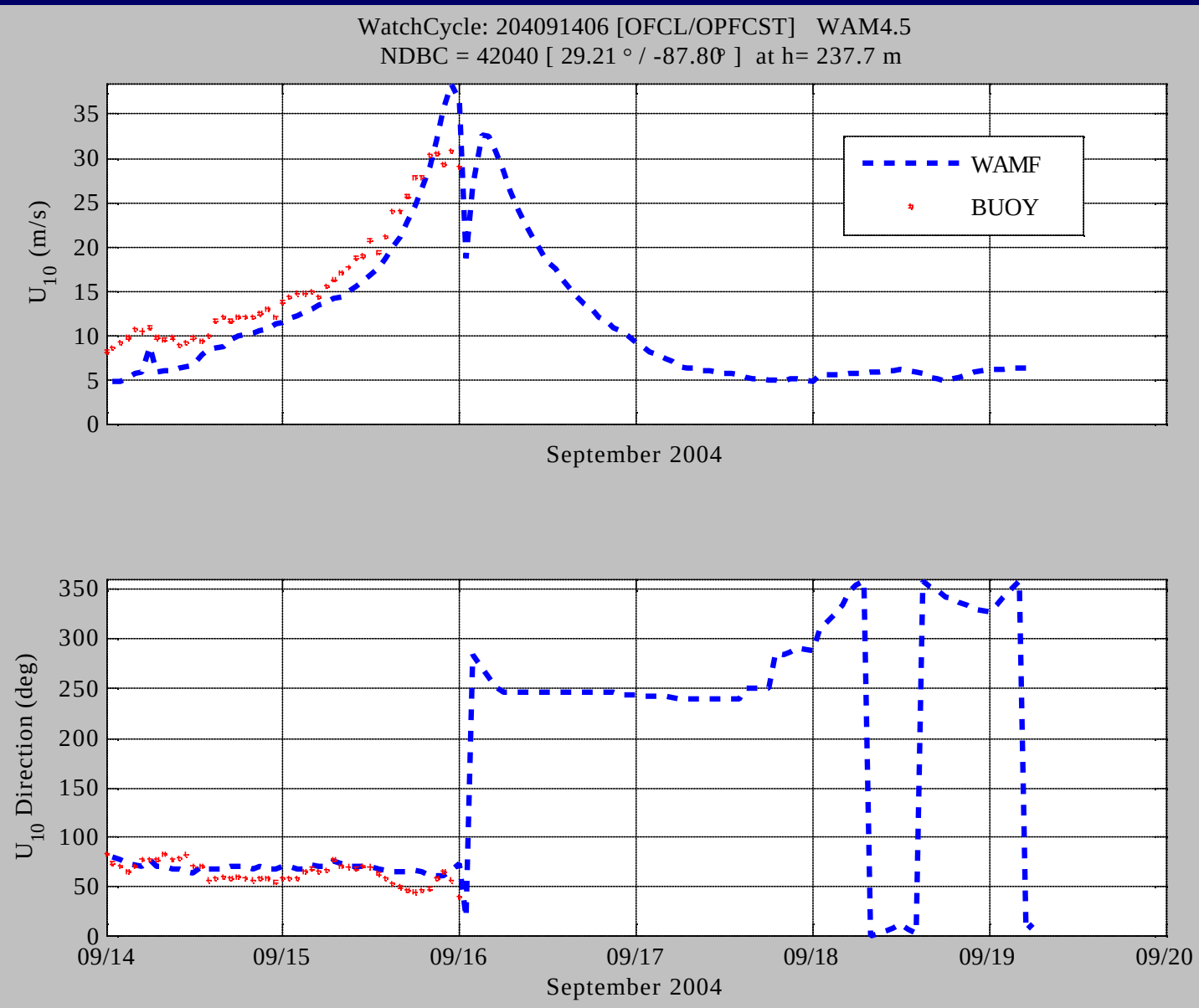

OFCL Forecast Track for IVAN
Projected at 14 Sept 2004 14:06 UTC
with NDBC (o) and NOS (*) locations
35°N
30°N
25°N
20°N
90°W
85°W
80°W
8735180
8729840
42040
42039
42003
FL
Cuba

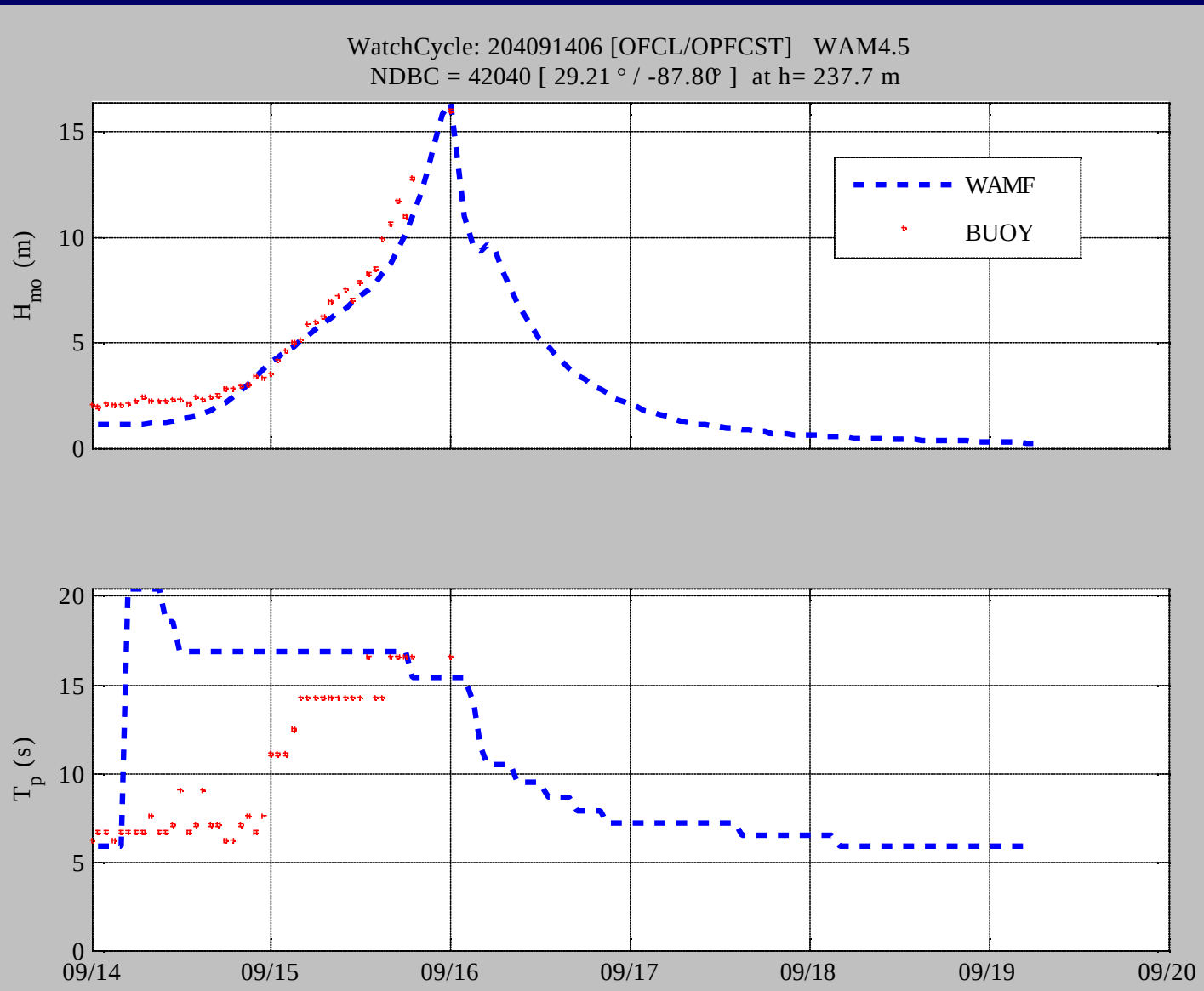

WatchCycle: 204091406 [OFCL/OPFCST] WAM4.5
NDBC = 42003 [26.01° / -84.09°] at h= 3236.9 m
WAMF
BUOY
U10 (m/s)
U10 Direction (deg)
0
5
10
15
20
25
30
50
100
150
200
250
300
350
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004

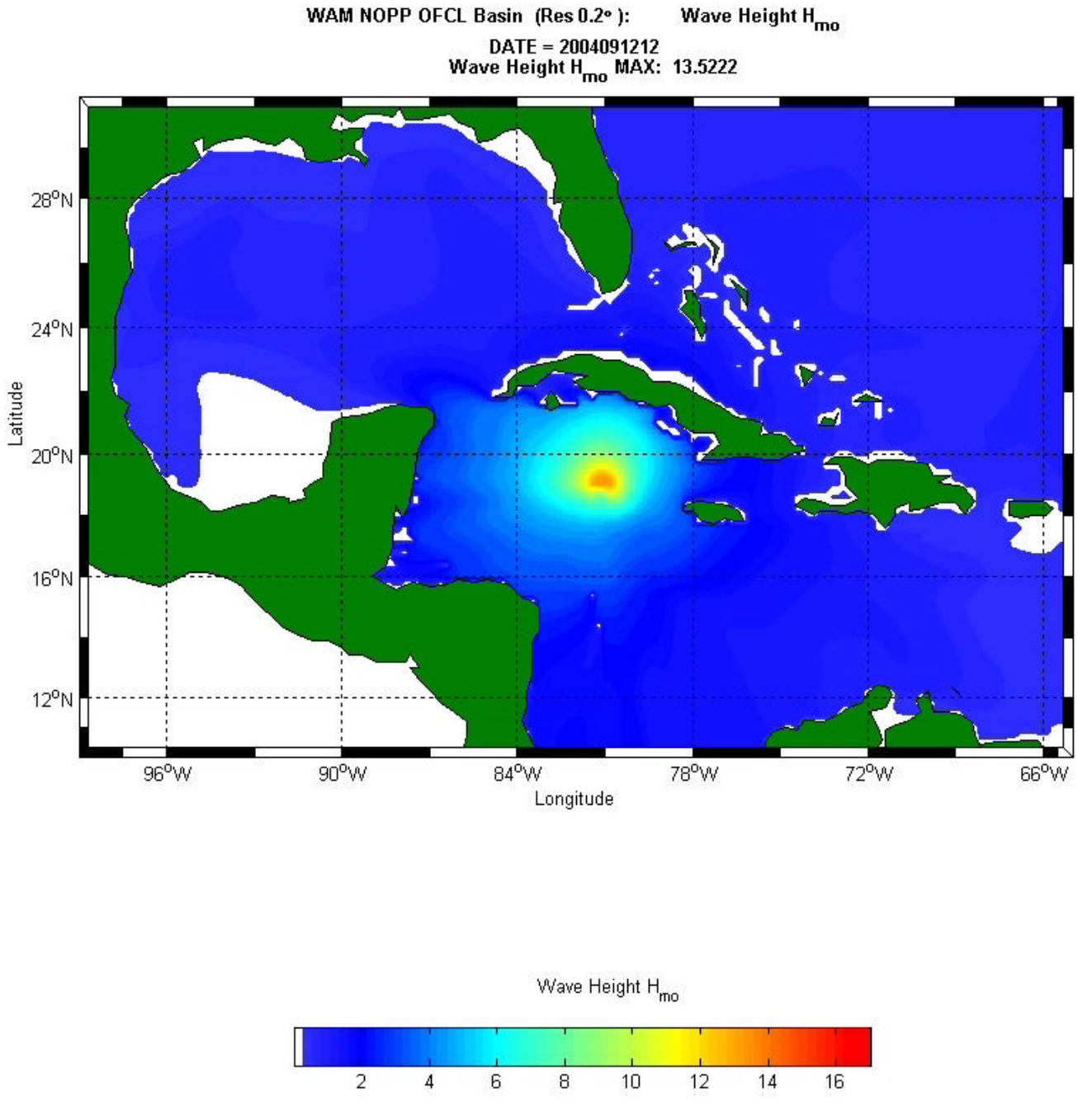

WatchCycle: 204091406 [OFCL/OPFCST] WAM4.5
NDBC = 42003 [26.01° / -84.09°] at h= 3236.9 m
WAMF
BUOY
H_{mo} (m)
T_p (s)
0
2
4
6
8
10
0
5
10
15
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004


WatchCycle: 204091406 [OFCL/OPFCST] WAM4.5
NDBC = 42039 [28.80° / -85.94°] at h= 295 m
WAMF
BUOY
U10 (m/s)
0
5
10
15
20
September 2004
U10 Direction (deg)
0
50
100
150
200
250
300
350
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004

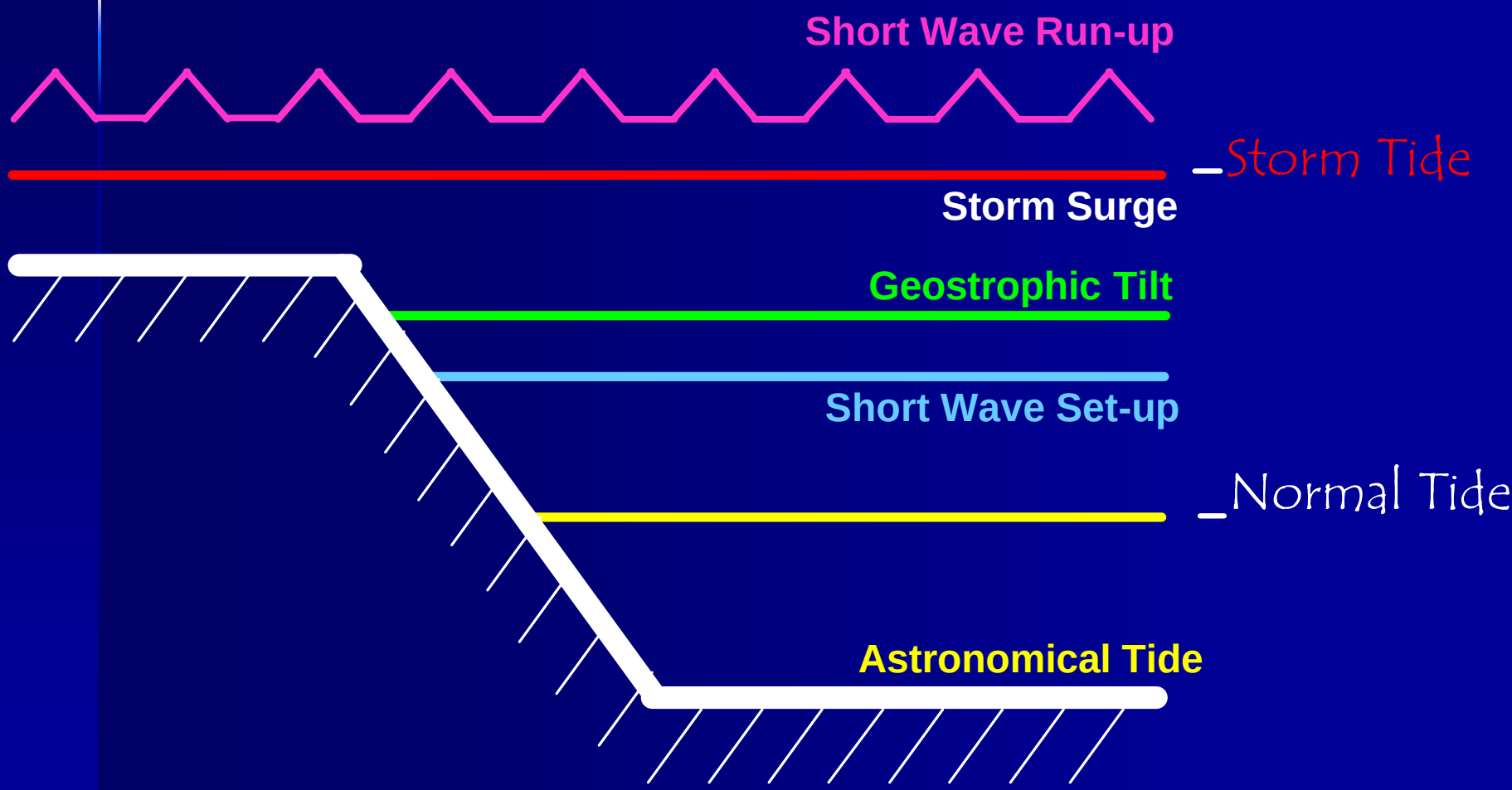

WatchCycle: 204091406 [OFCL/OPFCST] WAM4.5
NDBC = 42039 [28.80° / -85.94°] at h= 295 m
WAMF
BUOY
H_{mo} (m)
T_p (s)
0
2
4
6
8
10
12
0
5
10
15
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004


WatchCycle: 204091406 [OFCL/OPFCST] WAM4.5
NDBC = 42040 [29.21 ° / -87.80°] at h= 237.7 m
U10 (m/s)
0
5
10
15
20
25
30
35
WAMF
BUOY
September 2004
U10 Direction (deg)
0
50
100
150
200
250
300
350
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004

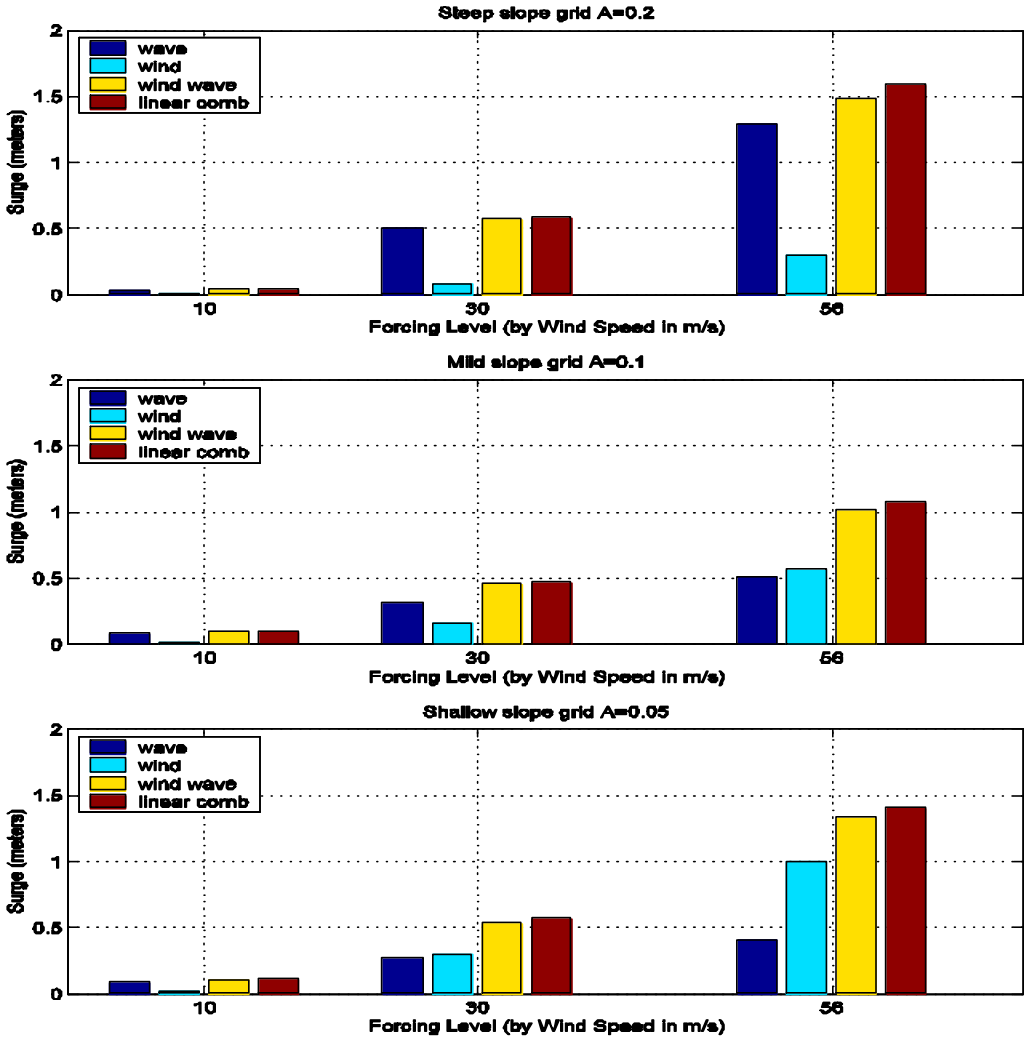

WatchCycle: 204091406 [OFCL/OPFCST] WAM4.5
NDBC = 42040 [29.21 ° / -87.80°] at h= 237.7 m
H_mo (m)
T_p (s)
WAMF
BUOY
0
5
10
15
20
09/14
09/15
09/16
09/17
09/18
09/19
09/20


WAM NOPP OFCL Basin (Res 0.2°): Wave Height H_{mo}
DATE = 2004091212
Wave Height H_{mo} MAX: 13.5222
28°N
24°N
20°N
16°N
12°N
Latitude
96°W
90°W
84°W
78°W
72°W
66°W
Longitude
Wave Height H_{mo}
2
4
6
8
10
12
14
16

Storm Surge and Storm Tide



Wave Effect on Storm Surge Simulations

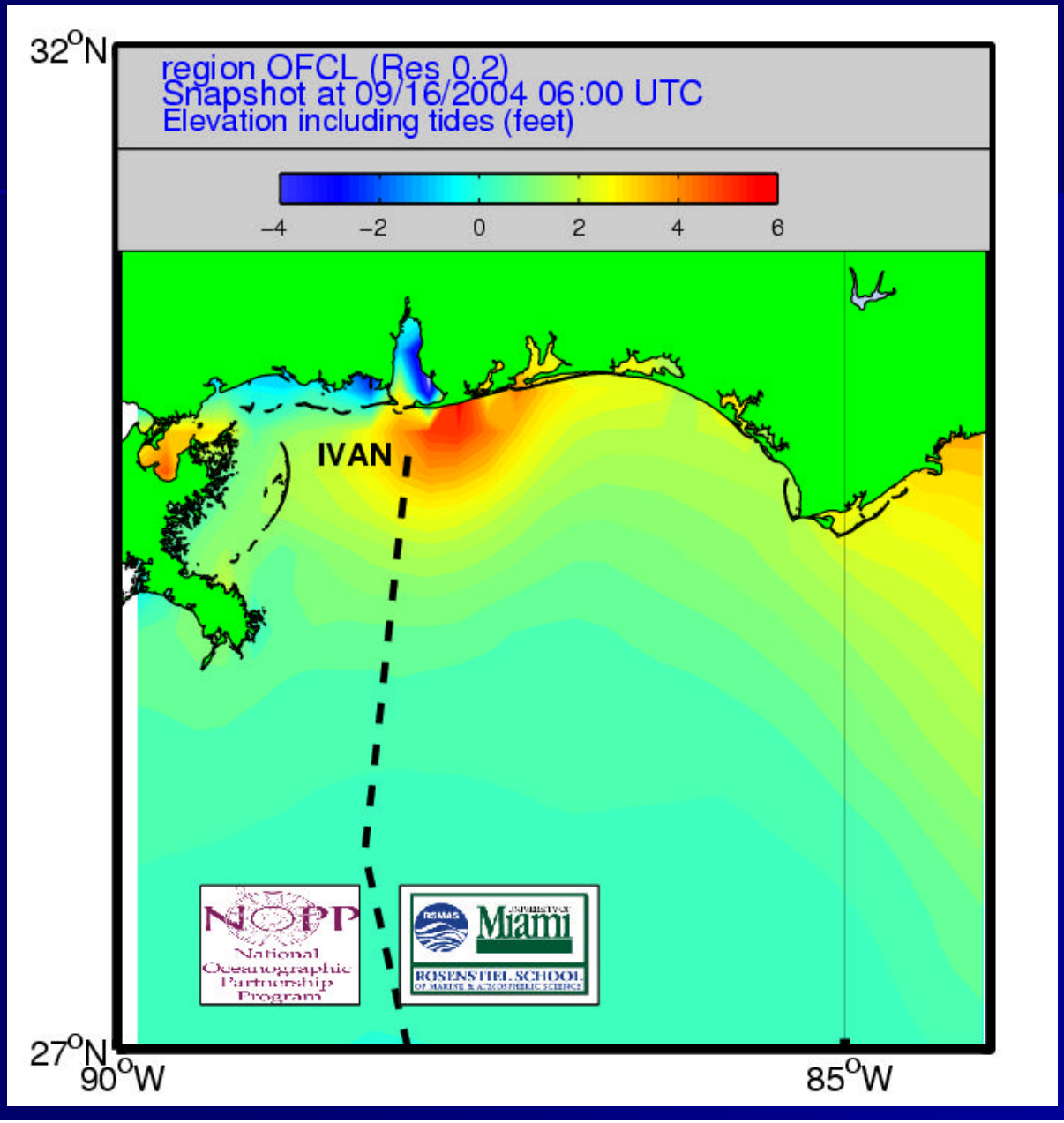


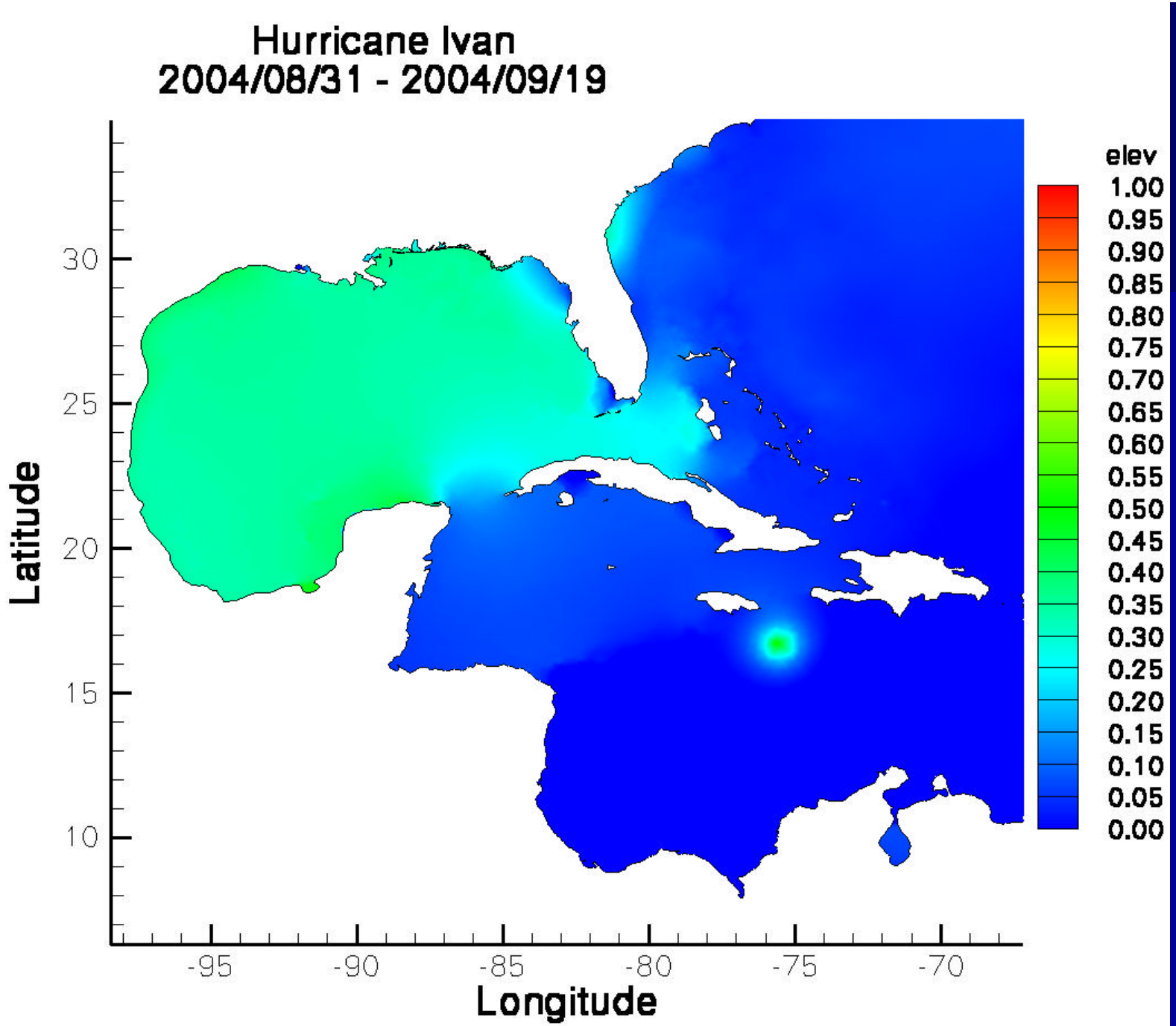
Steep Slope

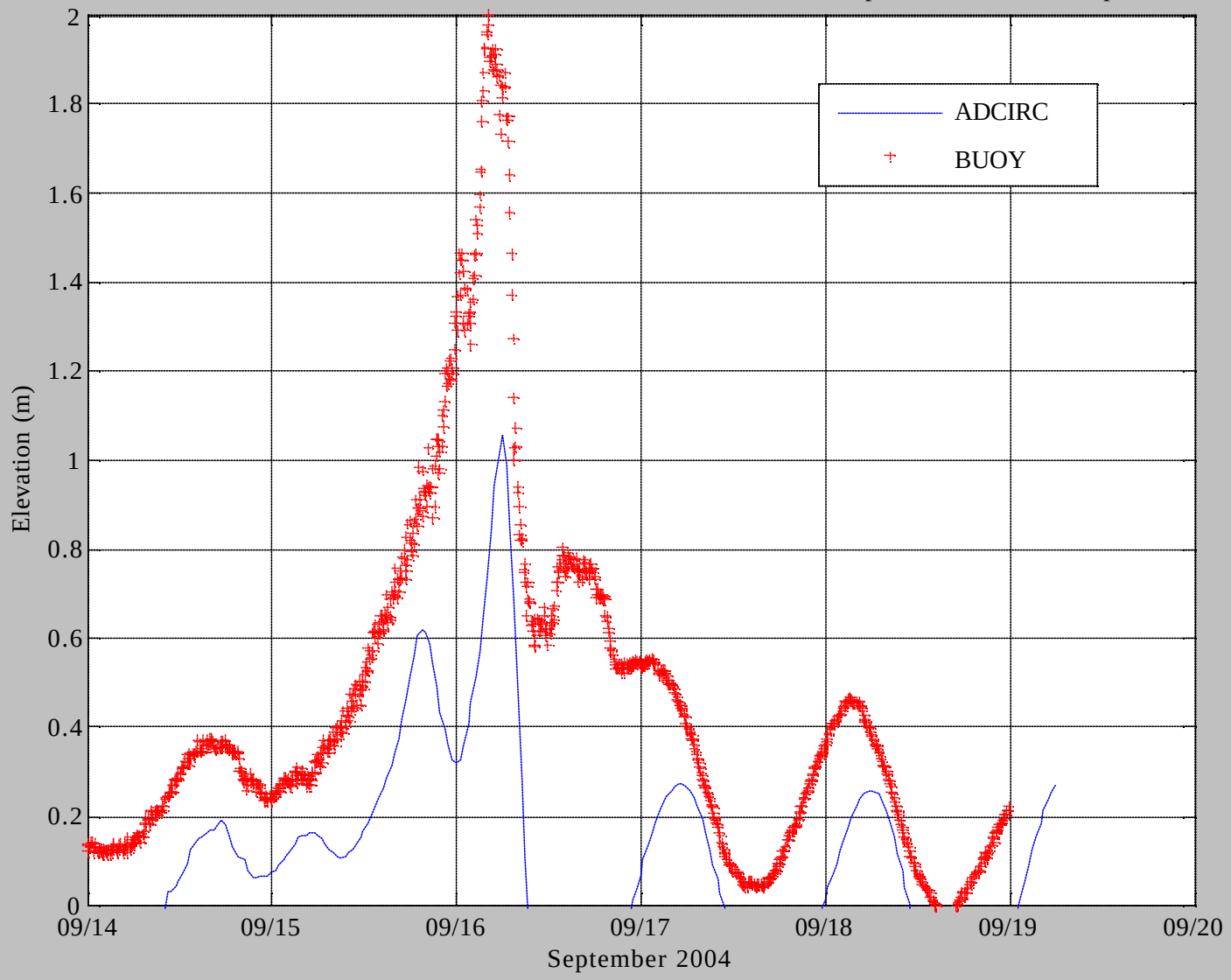
Mild Slope

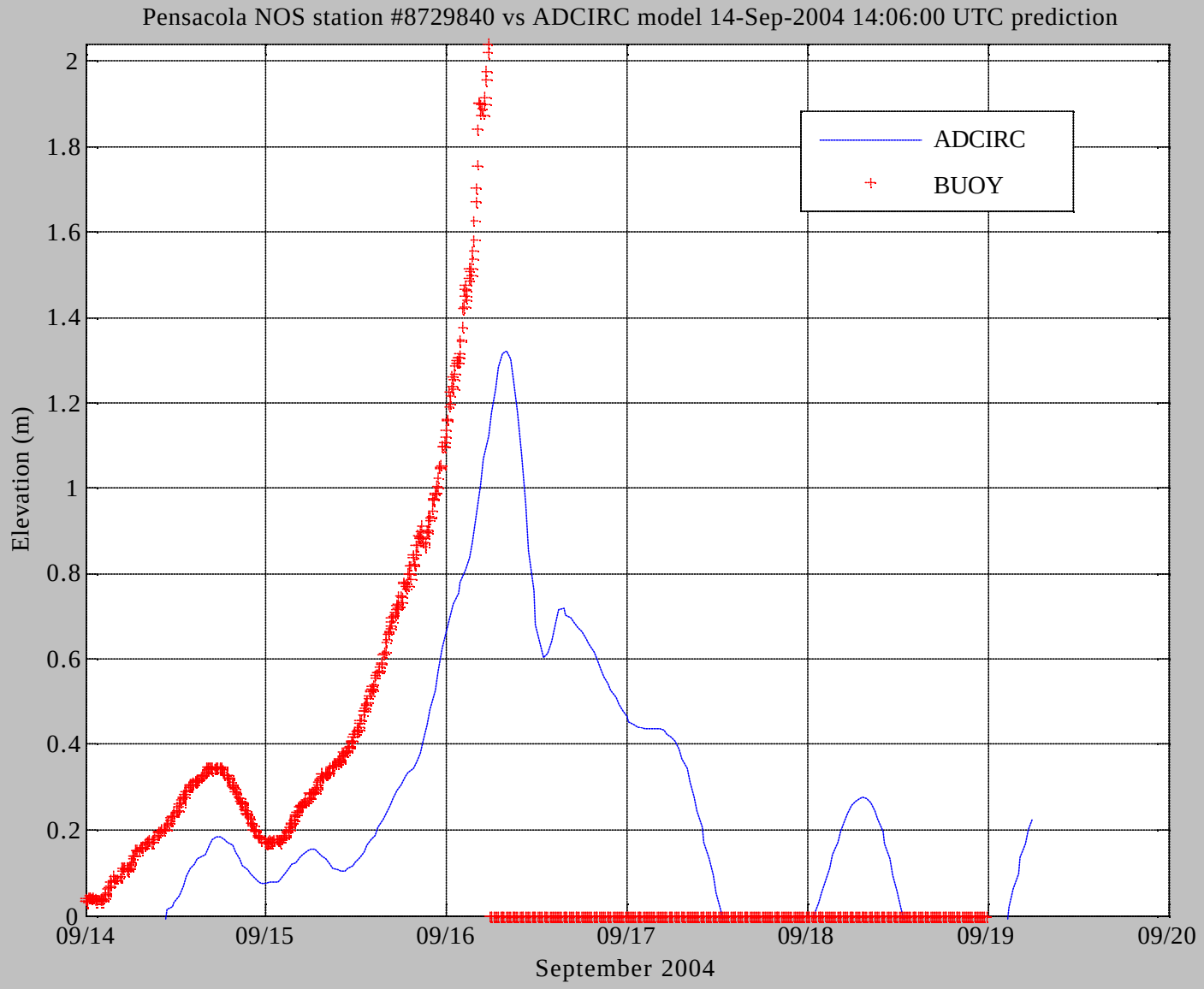
Gentle Slope

Real-Time Storm Surge Forecast




Hurricane Ivan
2004/08/31 - 2004/09/19
Latitude
30
25
20
15
10
-95
-90
-85
-80
-75
-70
Longitude
elev
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00


DAUPHIN ISLAND, AL NOS station #8735180 vs ADCIRC model 14-Sep-2004 14:06:00 UTC prediction
ADCIRC
BUOY
Elevation (m)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004


Pensacola NOS station #8729840 vs ADCIRC model 14-Sep-2004 14:06:00 UTC prediction
ADCIRC
BUOY
Elevation (m)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
09/14
09/15
09/16
09/17
09/18
09/19
09/20
September 2004

Summary

- Very successful implementation and performance of forecast system in an “operational sense”.
- Information of threshold wind and wave radii was timely and routinely available on website.
- Five day forecast of winds, waves and surge along official track compared qualitatively well with buoy and radar data.

What's next?

- Full analysis of 2004 hurricane season: Detailed comparison of winds, waves and surge with observations.
- Make necessary changes in model interfaces and physics.
- Test new wave growth model based on lab/aircraft data for hurricane force winds.
- Optimize further computational speed of forecast system.
- Compute ensemble of alternate track forecasts for risk analysis.

Florida's Nightmare


The End