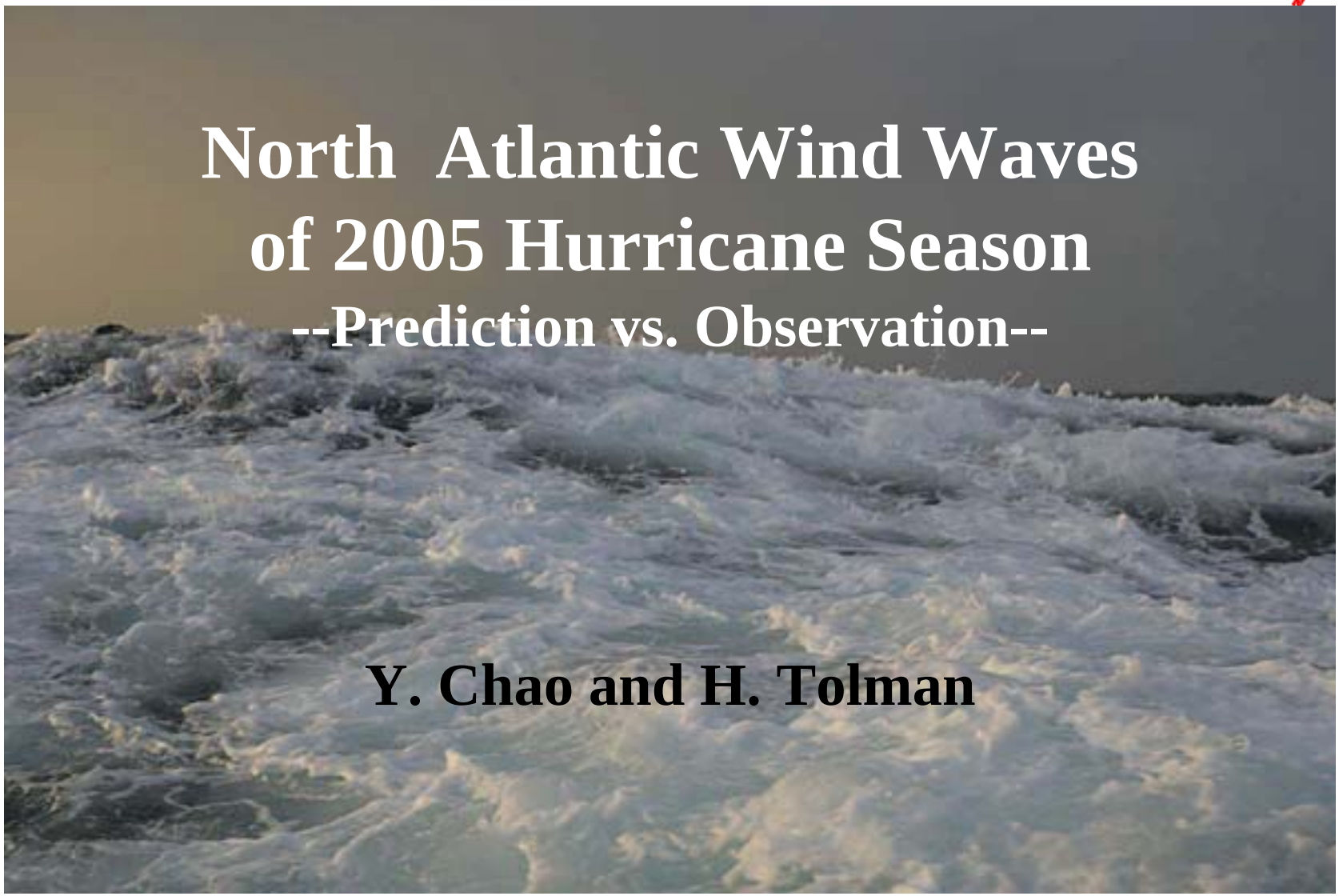


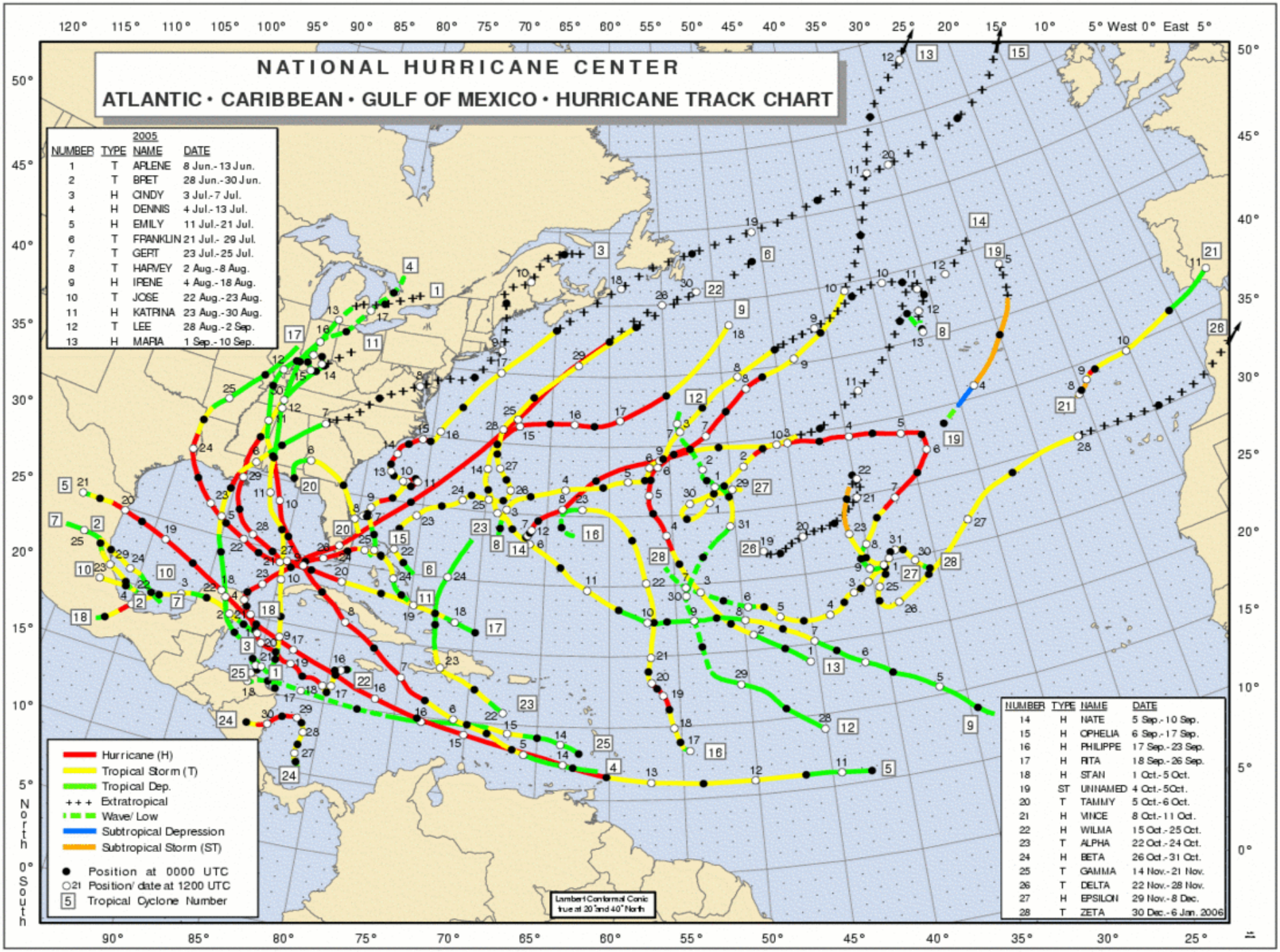
North Atlantic Wind Waves of 2005 Hurricane Season

--Prediction vs. Observation--

Y. Chao and H. Tolman

Why 2005?

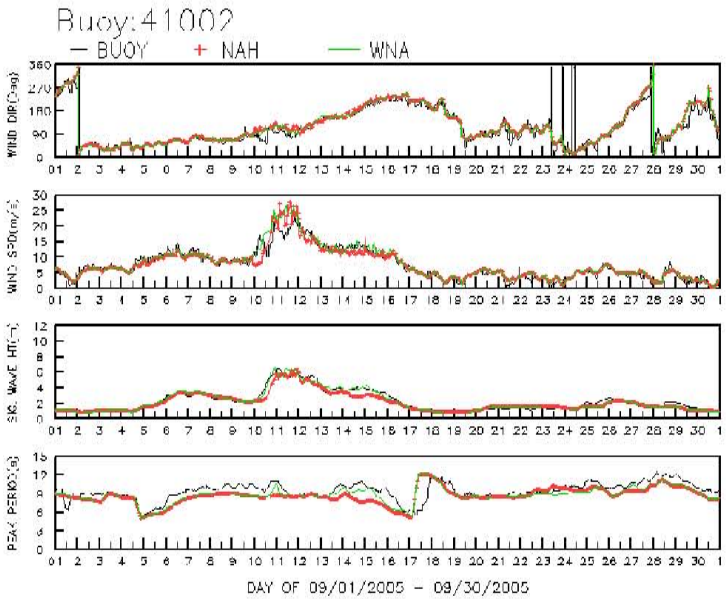
The year 2005 Atlantic hurricane season has been remarkable for its early beginning and late ending and for a great number of storms as well as the intensity of the hurricanes. There was a record of 27 named tropical storms, of which 14 were hurricanes. Many of these storms have created enormous high waves disastrous to the coastal areas and marine related activities. The purpose of present study is to evaluate accuracy of NCEP operational wave models on predicting wave conditions caused by these storms.

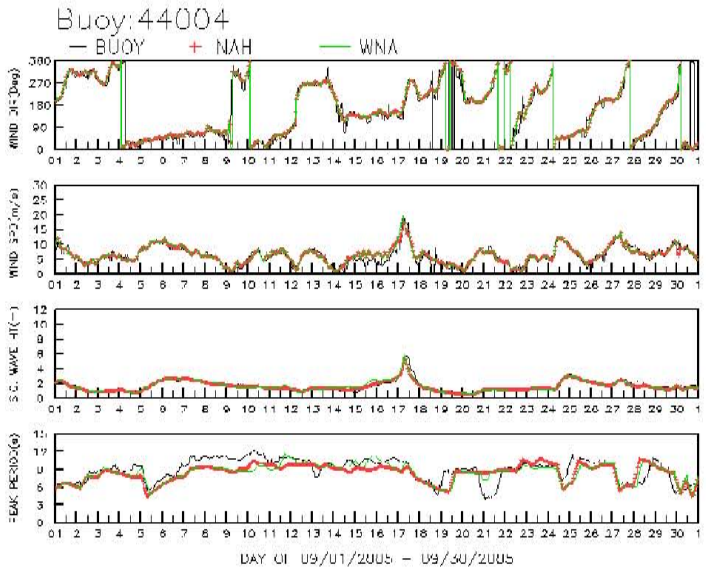

NATIONAL HURRICANE CENTER
ATLANTIC • CARIBBEAN • GULF OF MEXICO • HURRICANE TRACK CHART
2005
NUMBER TYPE NAME DATE
1 T ARLENE 8 Jun.-13 Jun.
2 T BRET 28 Jun.-30 Jun.
3 H CINDY 3 Jul.-7 Jul.
4 H DENNIS 4 Jul.-13 Jul.
5 H EMILY 11 Jul.-21 Jul.
6 T FRANKLIN 21 Jul.- 29 Jul.
7 T GERT 23 Jul.-25 Jul.
8 T HARVEY 2 Aug.-8 Aug.
9 H IRENE 4 Aug.-18 Aug.
10 T JOSE 22 Aug.-23 Aug.
11 H KATRINA 23 Aug.-30 Aug.
12 T LEE 28 Aug.-2 Sep.
13 H MARIA 1 Sep.-10 Sep.
NUMBER TYPE NAME DATE
14 H NATE 5 Sep.-10 Sep.
15 H OPHELIA 6 Sep.-17 Sep.
16 H PHILIPPE 17 Sep.-23 Sep.
17 H RITA 18 Sep.-26 Sep.
18 H STAN 1 Oct.-5 Oct.
19 ST UNNAMED 4 Oct.-5Oct.
20 T TAMMY 5 Oct.-6 Oct.
21 H VINCE 8 Oct.-11 Oct.
22 H WILMA 15 Oct.-25 Oct.
23 T ALPHA 22 Oct.-24 Oct.
24 H BETA 26 Oct.-31 Oct.
25 T GAMMA 14 Nov.-21 Nov.
26 T DELTA 22 Nov.-28 Nov.
27 H EPSILON 29 Nov.-8 Dec.
28 T ZETA 30 Dec.-6 Jan. 2006
Hurricane (H)
Tropical Storm (T)
Tropical Dep.
Extratropical
Wave/ Low
Subtropical Depression
Subtropical Storm (ST)
Position at 0000 UTC
21 Position/ date at 1200 UTC
5 Tropical Cyclone Number
Lambert Conformal Conic
true at 20°and 40° North
120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65° 60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° 5° West 0° East 5°
50° 45° 40° 35° 30° 25° 20° 15° 10° 5° North 0° South

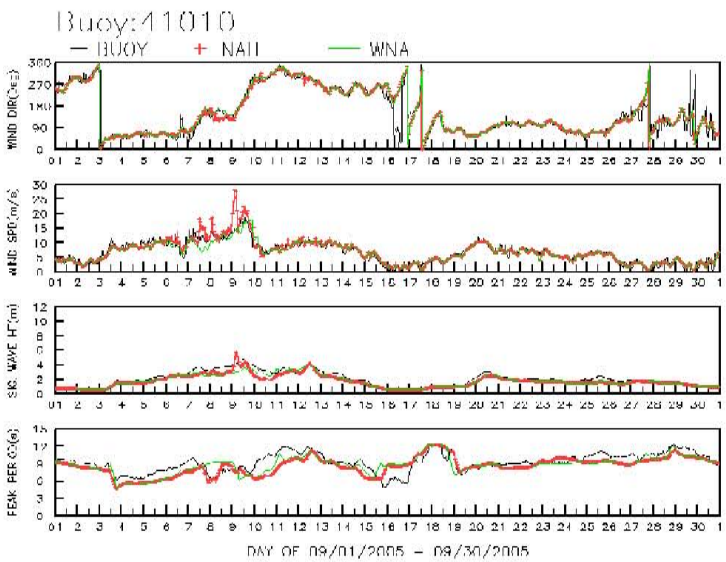
Methodology

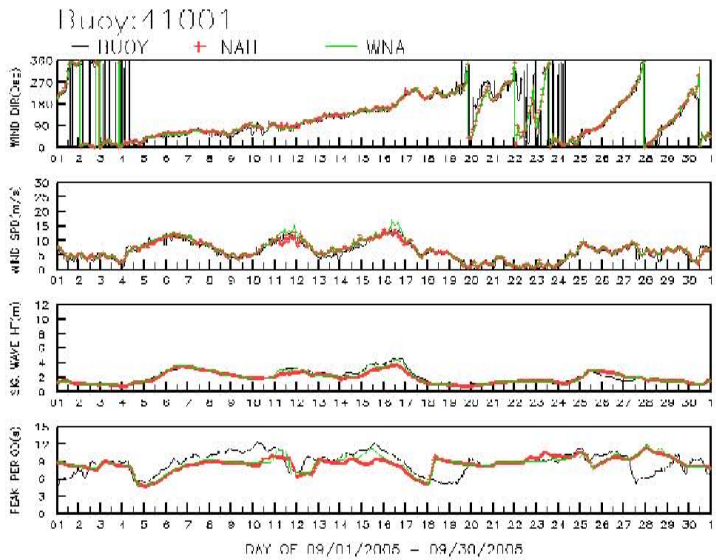
- Identify storms that caused the peak significant wave height to be above 2 meter – based on deep water (>200m) buoy data time series.
- Evaluate time lag and peak wave height differences between predicted and observed.
- Evaluate spectral peak wave period differences between predicted and observed at the occurrence of wave height peaks.
- Reveal a problem of using buoy measurement to validate model predicted hurricane winds and waves.

Example – Time series

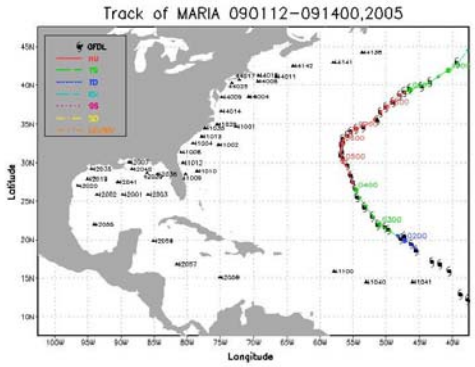


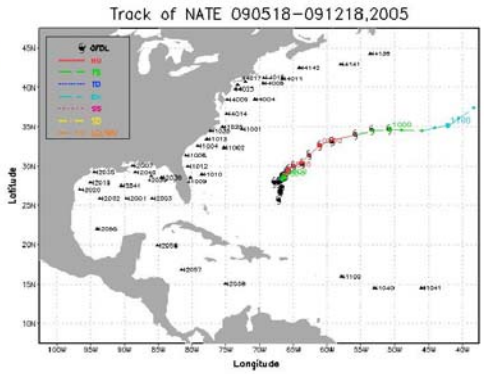


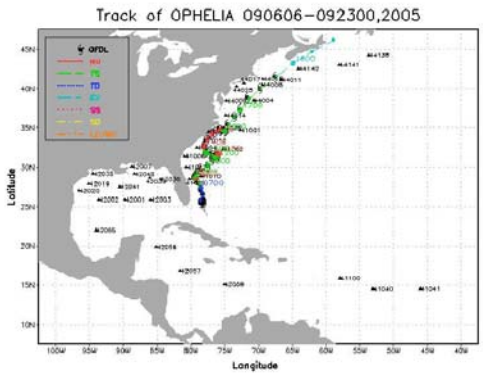


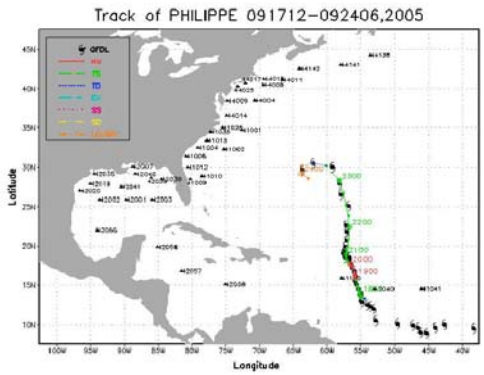


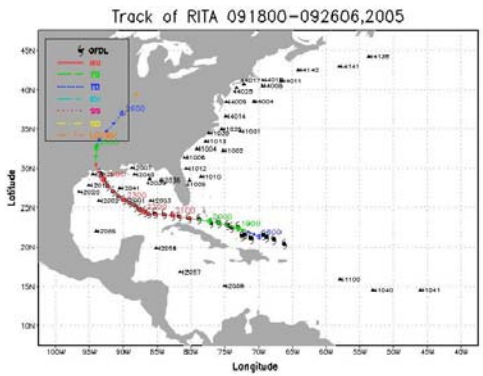
Example – Hurricane Tracks, 200509



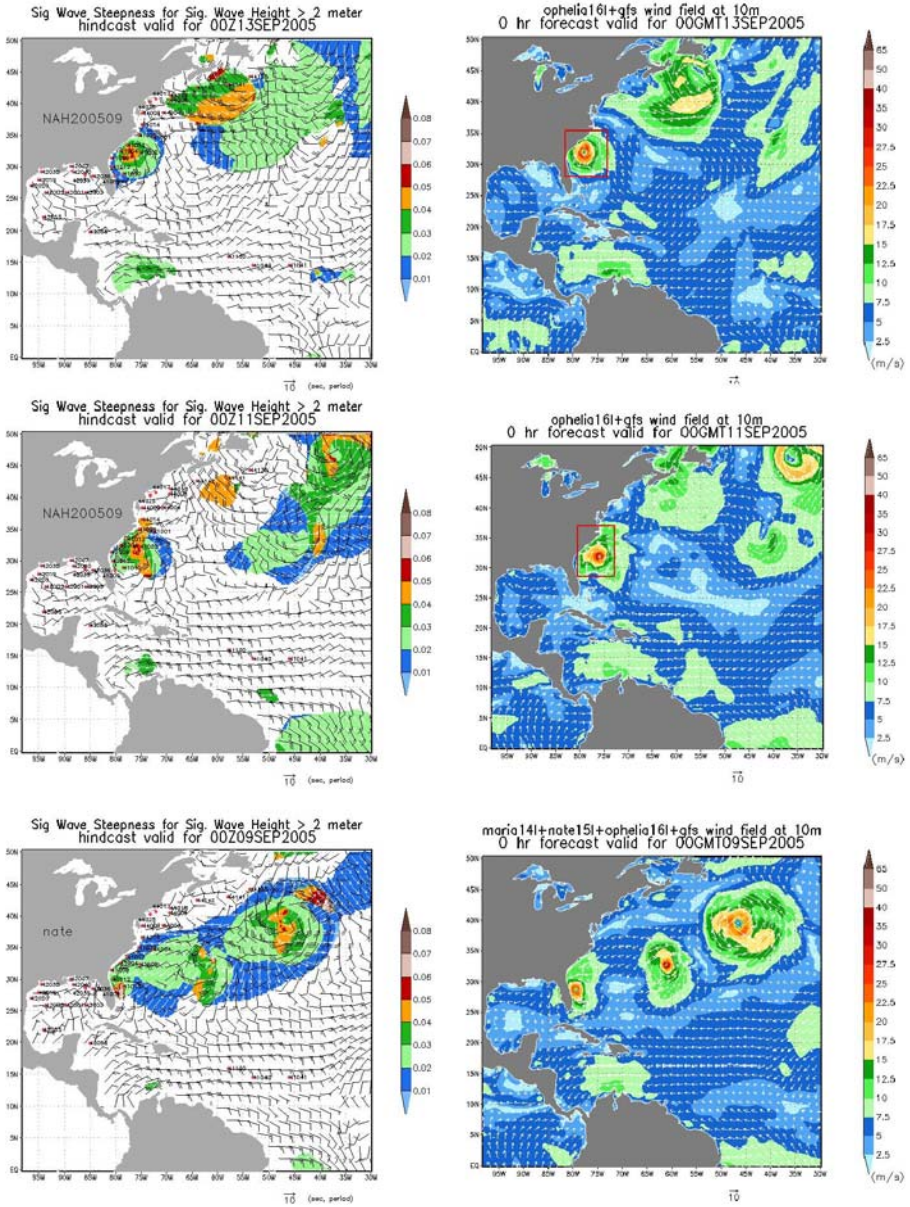








Example – Winds and Waves

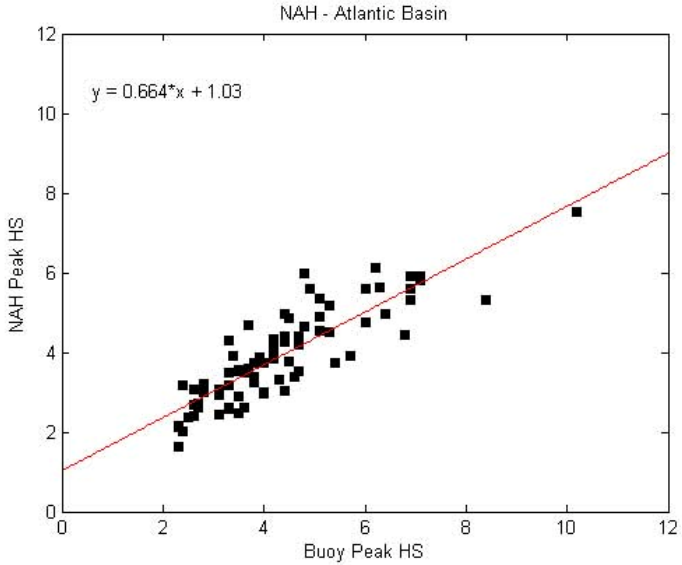


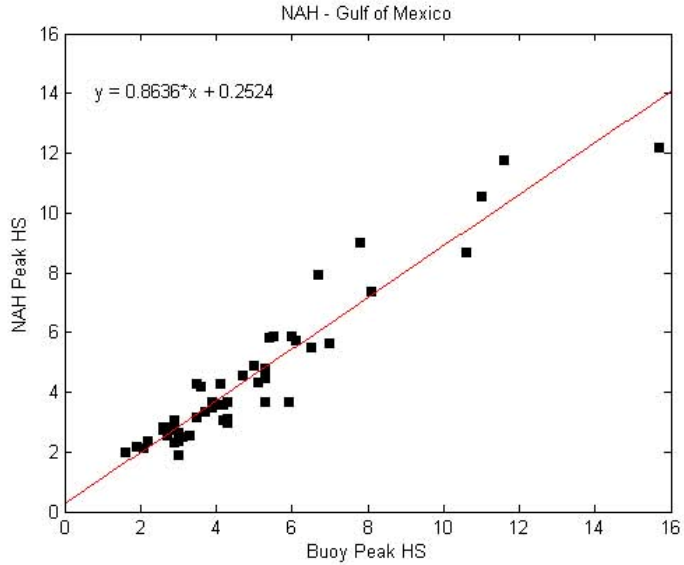
Example – A Partial List of Result

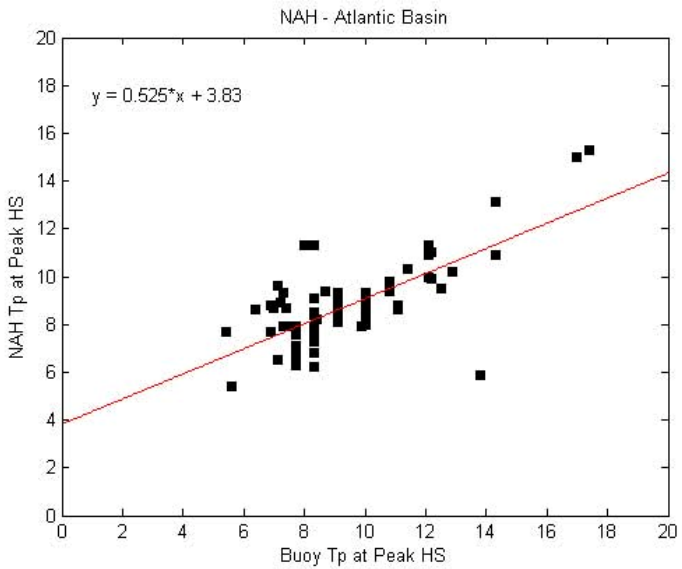
Buoy ID	Buoy Peak Hs(m)	Buoy Time mmddhh	NAH Peak Hs(m)	NAH Time mmddhh	WNA Peak Hs(m)	WNA Time mmddhh	Name Of TS/HUR	NAH Hs (%)	NAH Lag (Hr)	WNA Hs (%)	WNA Lag (Hr)	Buoy Tp (sec)	NAH Tp (sec)	WNA Tp (sec)	NAH Tp (%)	WNA Tp (%)
41001	3.7	90621	3.58	90619	3.59	90617	Nate	-3.2	-2	-3.0	-4	10	8.4	8.3	-16.0	-16.8
	3.6	91111	2.63	91113	3.13	91109	Ophelia	-26.9	2	-13.1	-2	7.1	9.6	11.0	35.7	54.6
	5.4	91610	3.72	91613	4.44	91613	Ophelia	-31.1	3	-17.8	3	10	8.3	8.6	-16.9	-13.8
	3.2	92508	3.00	92511	3.12	92511	Philippe	-6.3	3	-2.5	3	9.1	8.0	8.0	-12.2	-11.6
41002	3.6	90613	3.48	90616	3.15	90615	Nate	-3.3	3	-12.5	2	10	8.1	8.3	-19.1	-17.3
	7.1	91023	5.92	91108	6.41	91110	Ophelia	-16.6	9	-9.7	11	11.1	8.6	9.3	-22.2	-16.3
	3.0	92520	2.45	92611	2.47	92608	Philippe	-18.3	15	-17.7	12	10	9.3	9.1	-7.4	-9.4
41010	4.9	90909	5.58	90905	3.58	90913	Ophelia	13.9	-4	-26.9	4	8.3	8.4	7.2	1.7	-13.3
	4.7	91208	4.18	91211	4.16	91210	Ophelia	-11.1	3	-11.5	2	12.1	10.9	11.1	-10.0	-8.1
	3.3	92009	2.59	92013	2.76	92015	Philippe	-21.5	4	-16.4	6	8.3	9.1	9.1	10.0	9.2
	2.7	92508	1.72	92514	1.68	92515	Philippe	-36.3	6	-37.8	7	11.4	9.6	9.5	-15.8	-16.8
44004	2.7	90600	2.73	90605	2.76	90605	Nate	1.1	5	2.2	5	7.7	7.1	7.1	-8.3	-7.6
	6.9	91706	5.30	91708	5.87	91707	Ophelia	-23.2	2	-14.9	1	10.8	9.7	10.1	-10.5	-6.7
	3.5	92500	3.06	92423	3.03	92423	Philippe	-12.6	-1	-13.4	-1	10.8	6.9	6.9	-36.0	-35.9

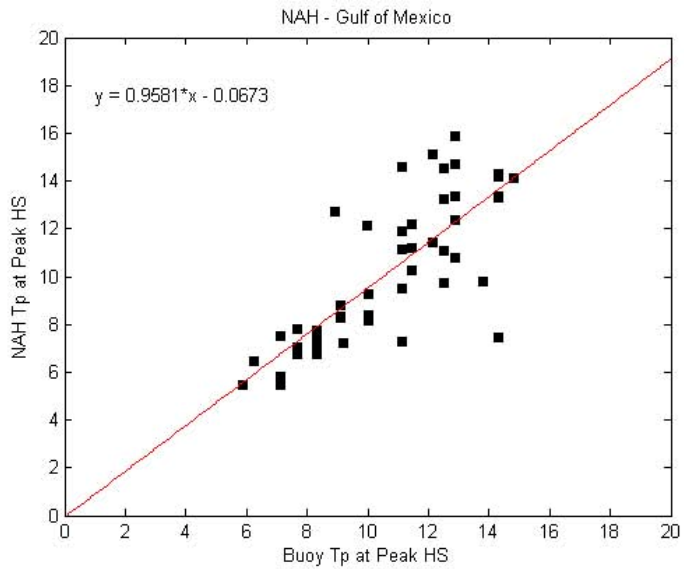
Statistical Summary
for
2005 Hurricane Wind Waves

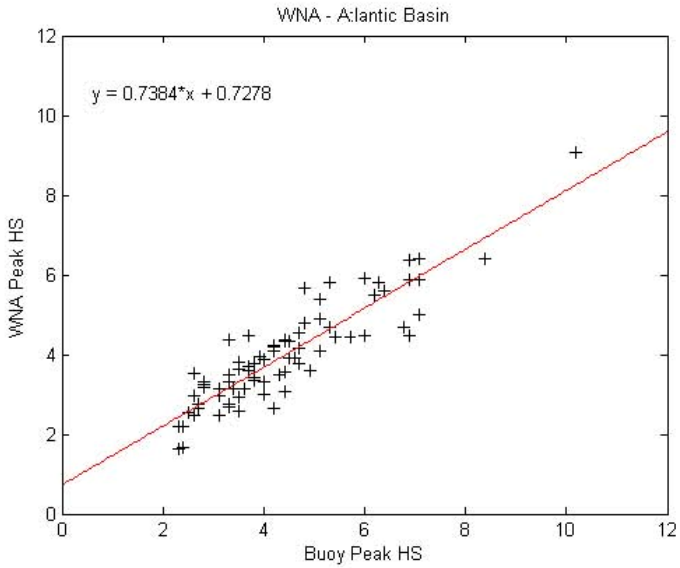
Next Slide

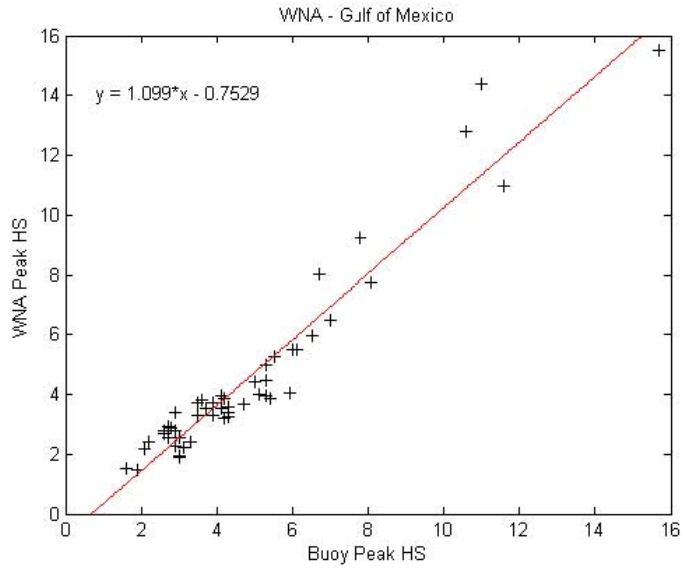

NAH - Atlantic Basin
y = 0.664*x + 1.03
NAH Peak HS
Buoy Peak HS
0
2
4
6
8
10
12

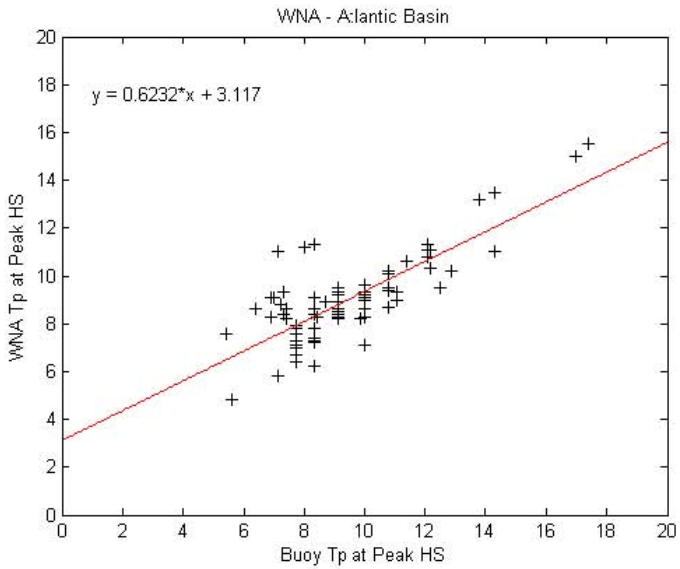

NAH - Gulf of Mexico
y = 0.8636*x + 0.2524
NAH Peak HS
Buoy Peak HS
0
2
4
6
8
10
12
14
16

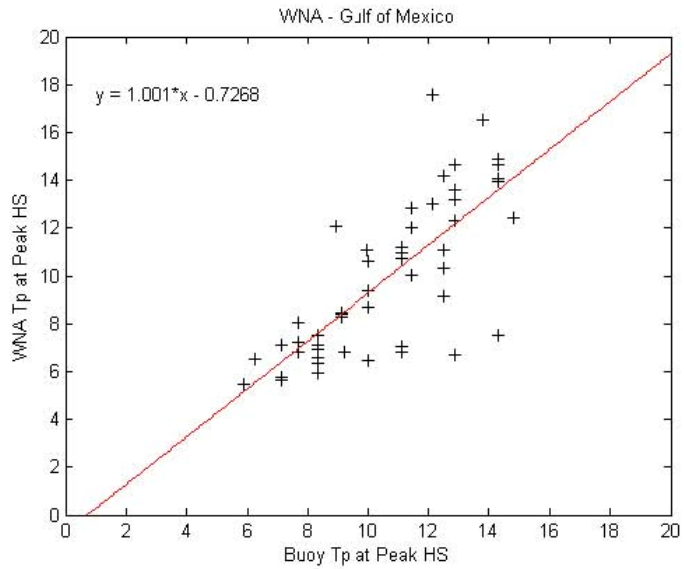

NAH - Atlantic Basin
y = 0.525*x + 3.83
NAH Tp at Peak HS
Buoy Tp at Peak HS
0
2
4
6
8
10
12
14
16
18
20

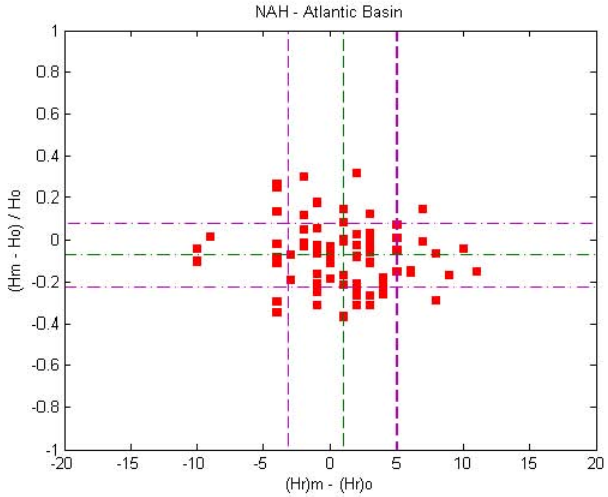

NAH - Gulf of Mexico
y = 0.9581*x - 0.0673
NAH Tp at Peak HS
Buoy Tp at Peak HS
0
2
4
6
8
10
12
14
16
18
20

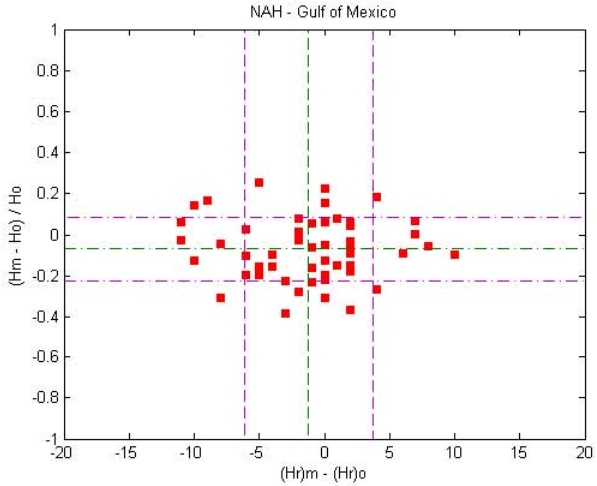

WNA - Atlantic Basin
y = 0.7384*x + 0.7278
WNA Peak HS
Buoy Peak HS
0
2
4
6
8
10
12

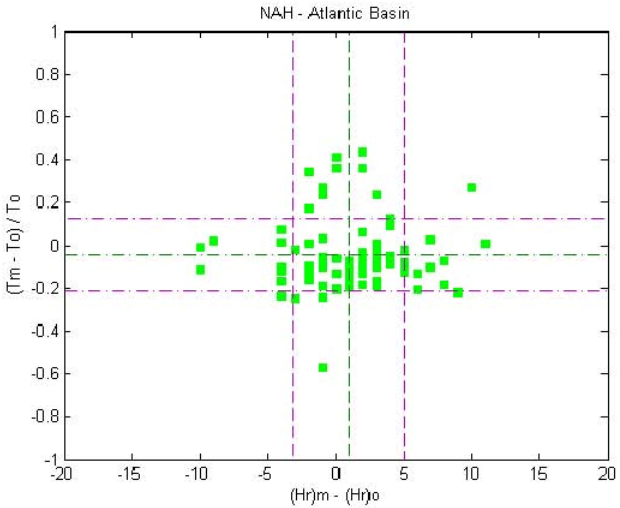

WNA - Gulf of Mexico
y = 1.099*x - 0.7529
WNA Peak HS
Buoy Peak HS
0
2
4
6
8
10
12
14
16

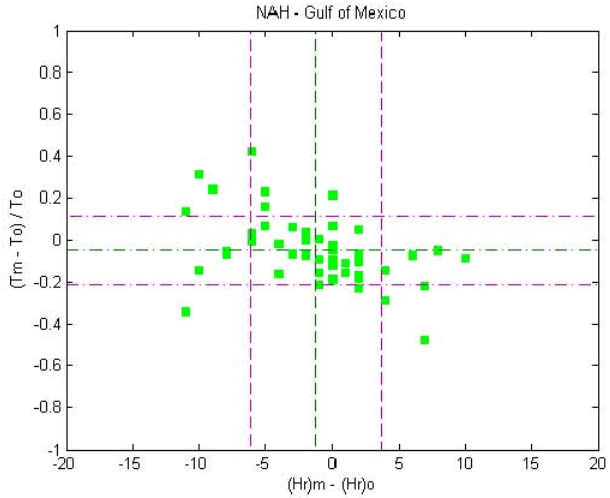

WNA - Atlantic Basin
y = 0.6232*x + 3.117
WNA Tp at Peak HS
Buoy Tp at Peak HS
0
2
4
6
8
10
12
14
16
18
20

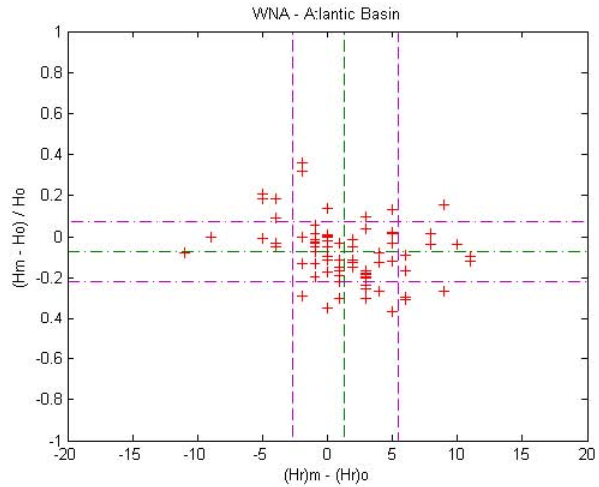

WNA - Gulf of Mexico
y = 1.001*x - 0.7268
WNA Tp at Peak HS
Buoy Tp at Peak HS
0
2
4
6
8
10
12
14
16
18
20

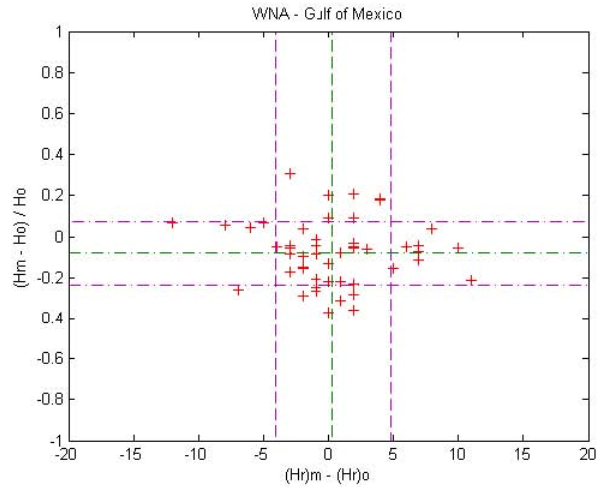

NAH - Atlantic Basin
(Hm - Ho) / Ho
(Hr)m - (Hr)o

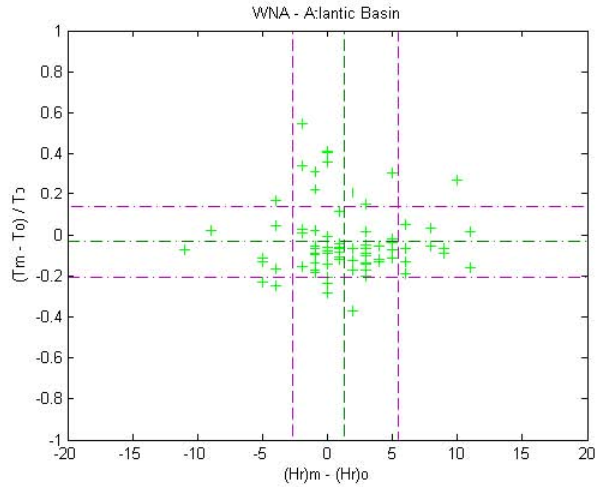

NAH - Gulf of Mexico
(Hm - Ho) / Ho
(Hr)m - (Hr)o

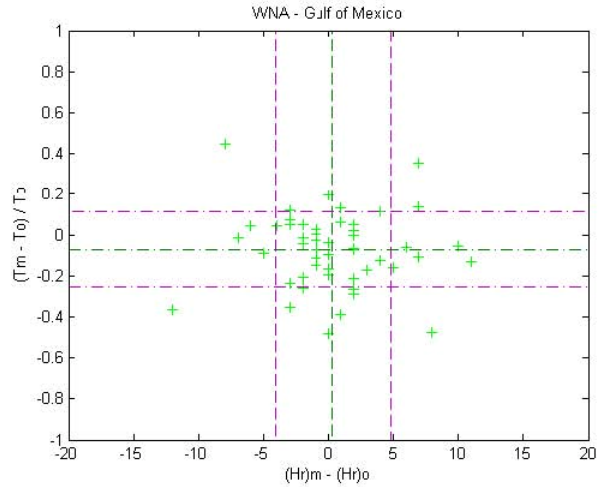

NAH - Atlantic Basin
(Tm - To) / To
(Hr)m - (Hr)o


NAH - Gulf of Mexico
(Tm - To) / To
(Hr)m - (Hr)o


WNA - Atlantic Basin
(Hm - Ho) / Ho
(Hr)m - (Hr)o


WNA - Gulf of Mexico
(Hm - Ho) / Ho
(Hr)m - (Hr)o

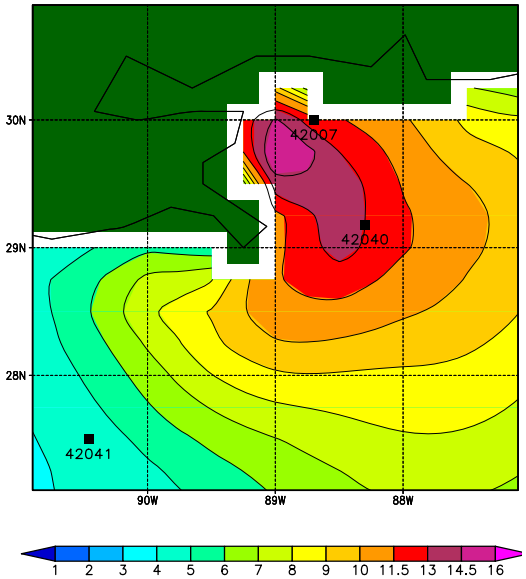

WNA - Atlantic Basin
(Tm - To) / To
(Hr)m - (Hr)o

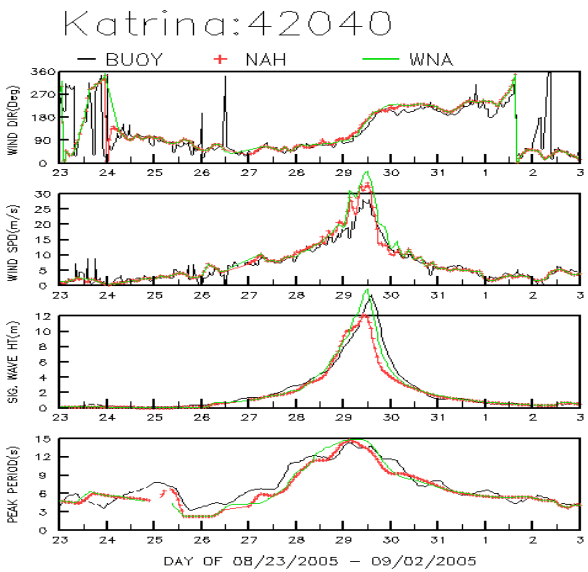

WNA - Gulf of Mexico
(Tm - To) / To
(Hr)m - (Hr)o

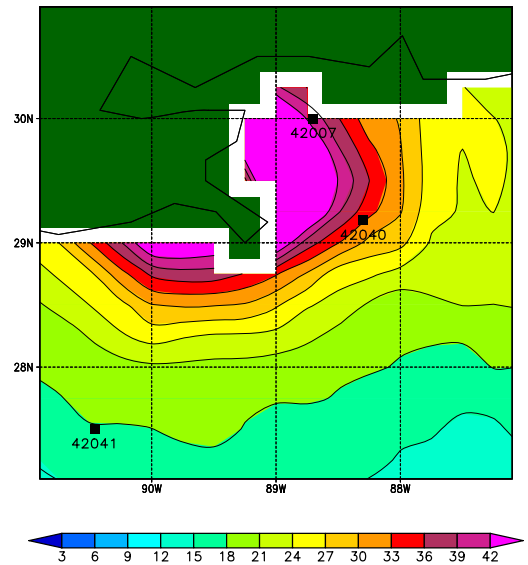
Concluding Remarks

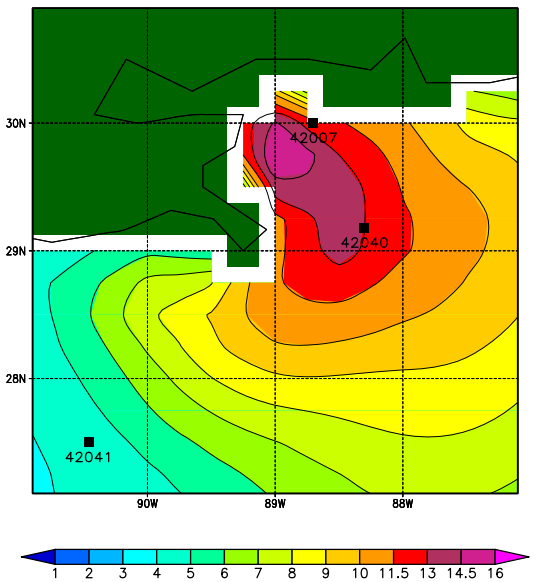
- Deviation of model predicted peak wave heights and simultaneous spectral peak periods from buoy measurements is within 20% ; Time lag on the occurrence of the peak wave height is within ± 5 hours. Mostly under-predicted. Bias is acceptably small but scatter on wave period is considerable.
- NAH seems not perform better than WNA – problem of insufficient coverage of buoy measurements on validating highly intense, rapidly varying winds and waves in a relatively small area (next slide)

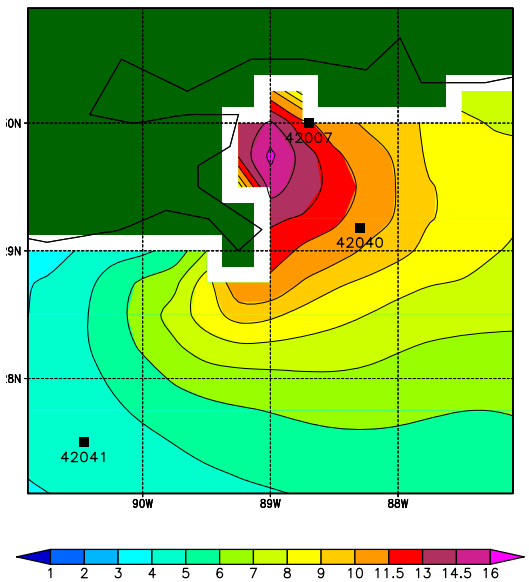
A Problem


30N
29N
28N
42007
42040
42041
90W
89W
88W
1 2 3 4 5 6 7 8 9 10 11.5 13 14.5 16

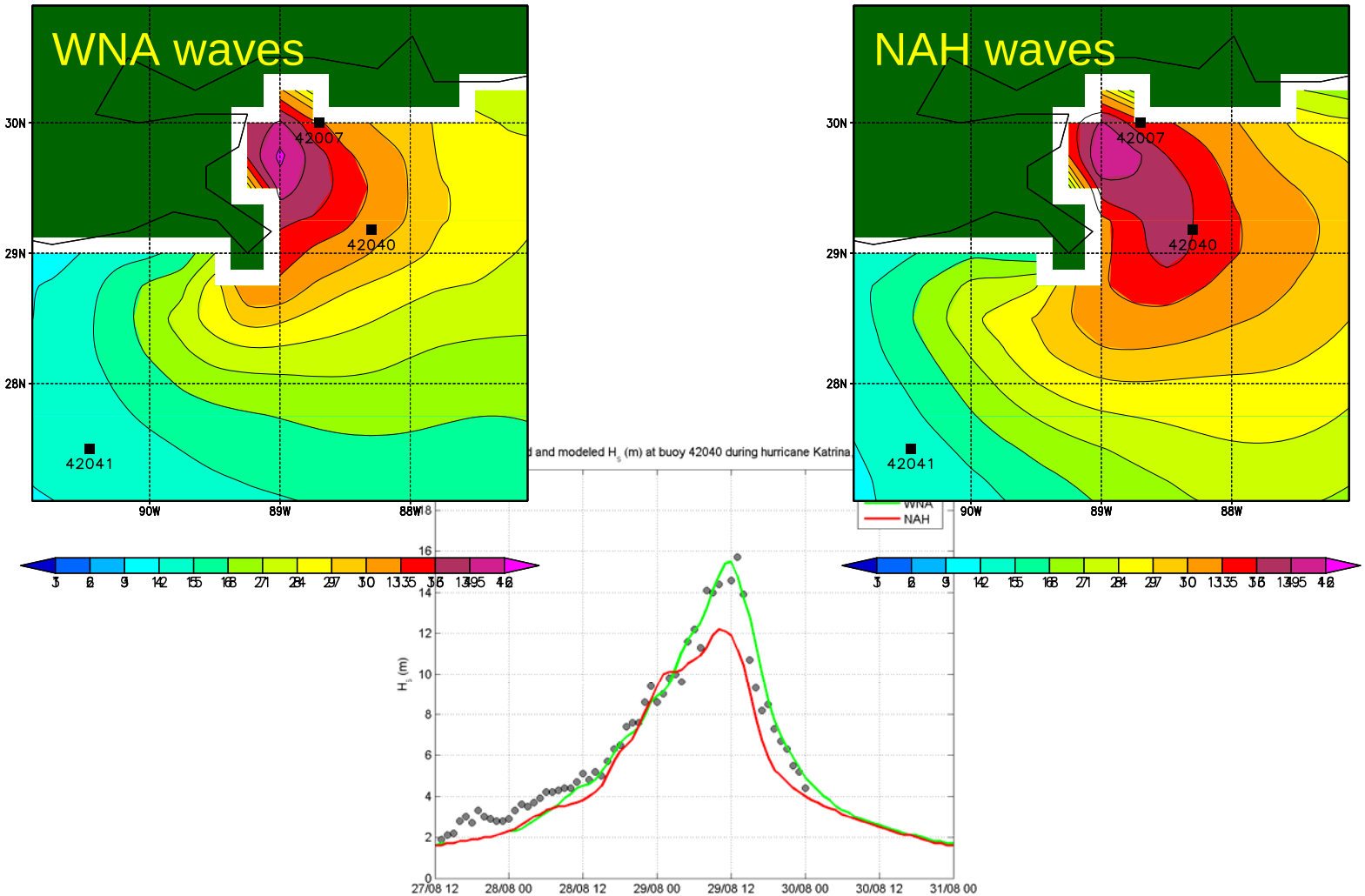

Katrina:42040
BUOY
NAH
WNA
WIND DIR(Deg)
WIND SPD(m/s)
SIG. WAVE HT(m)
PEAK PERIOD(s)
DAY OF 08/23/2005 – 09/02/2005


30N
29N
28N
42007
42040
42041
90W
89W
88W
3 6 9 12 15 18 21 24 27 30 33 36 39 42


30N
29N
28N
42007
42040
42041
90W
89W
88W
1 2 3 4 5 6 7 8 9 10 11.5 13 14.5 16


42007
42040
42041
90W
89W
88W
1 2 3 4 5 6 7 8 9 10 11.5 13 14.5 16

A Problem



Katrina and the Biloxi buoy


The End