Evaluation of Wave Model Performance in a North Carolina Test Bed

Eve-Marie Devaliere
University of North Carolina / US Army Corps of Engineers, Field Research Facility

Jeffrey L. Hanson
US Army Corps of Engineers, Field Research Facility

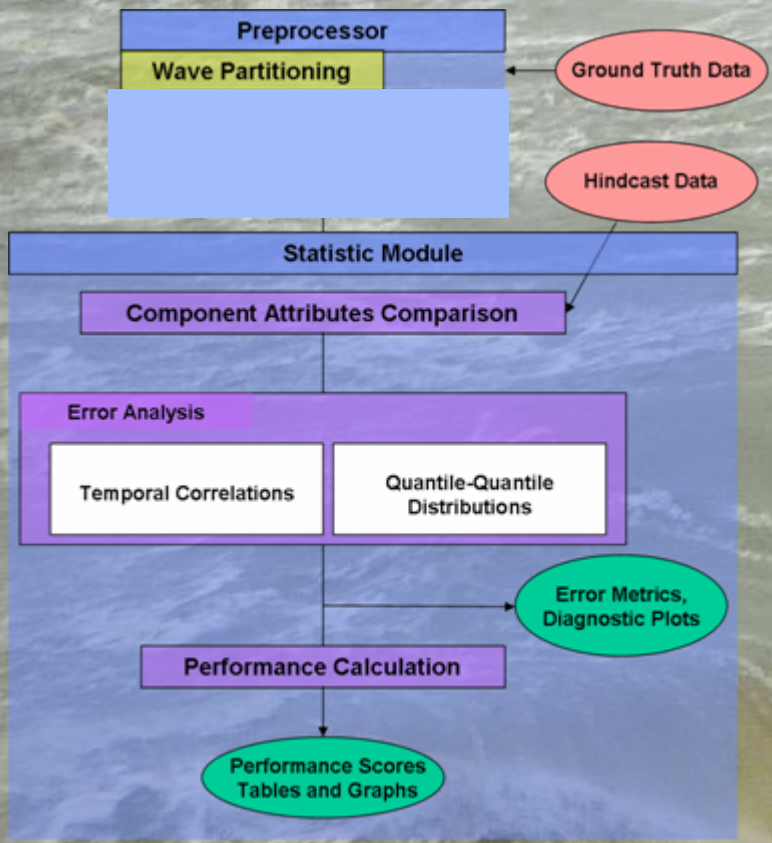
Rick Luettich
University of North Carolina, Institute of Marine Sciences

Motivation

- Morphos: Evaluate large temporal- and spatial-scale models:
  - Statistically reduce millions of model estimates to meaningful measure of prediction skill
  - Retain sufficient level of detail to identify model strengths and deficiencies
- COMET: Optimize NC SWAN forecast application (NWS)
- NC-FMP: Optimize NC SWAN to assess hurricane coastal flooding risk (FEMA)

Methodology

❖ **Instrumented modeling test bed in the Carolinas**



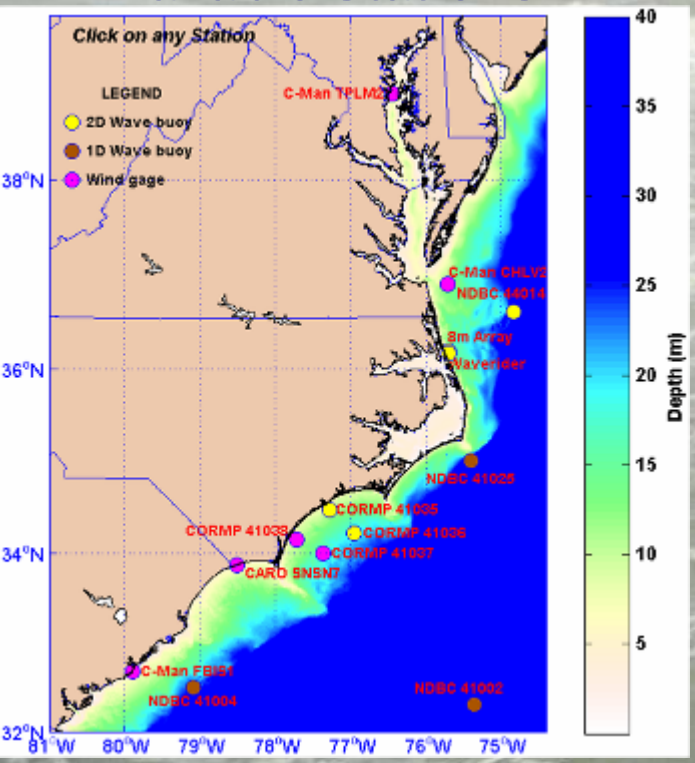
❖**Benchmarking Module based on Wave Model Evaluation and Diagnostics System (WaveMEDS) approach (Hanson et al., 2006) :**

- generalized inputs
- automated data selection and execution

⇒**AutoMEDS**

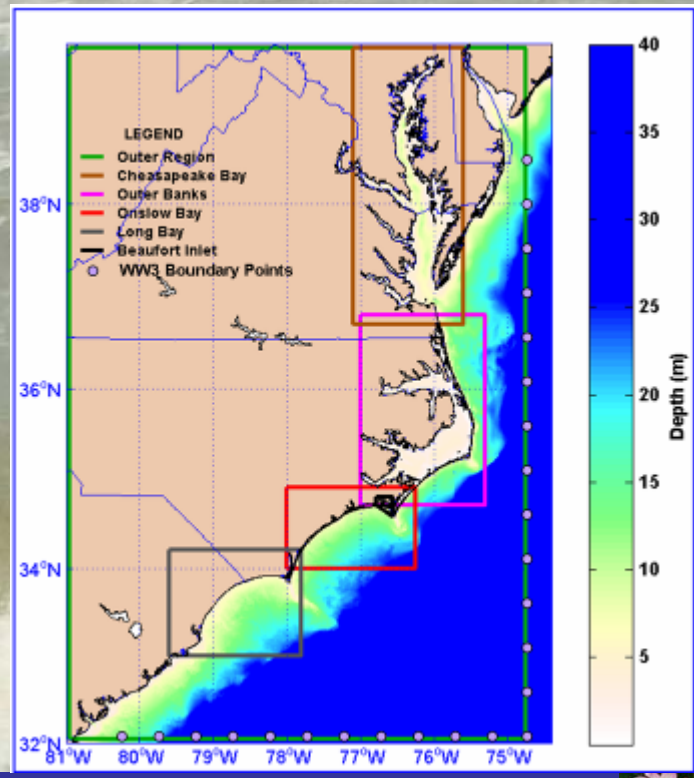
Methodology (Cont)

Available Stations



SWAN Application :

- 4 Different Settings
  - ✓ Wave Watch III Boundary Points
  - ✓ Spatial Resolutions
  - ✓ Stationarity
  - ✓ Wave Forecasted Wind
  - ✓ Dissipation Terms
- 2 Inner Domains



Event Month	Peak θ_p		Peak T_p		Peak H_s	
	North	South	North	South	North	South
March 07	54	180	7.6	9.1	2.46	4.95
May 07	88	60	13.6	14.7	4.52	5.74
July 07	128	230	5.4	6.7	2.16	2.22
September 07	64	120	7.6	9.1	2.32	2.68

Conclusions

- Carolinas test-bed very successful in conducting SWAN sensitivity analysis
- Anticipate AutoMEDS and test-bed stations to be extensively used by coastal model developers to validate and fine tune model improvements
- Preliminary results from SWAN application
  - Excellent results with default settings
  - Domain resolution can be reduced
  - Model instabilities occur

SWAN Demonstration

- SWAN Settings used in our Default Run

Settings	Default Run	
	Outer	Inner
Resolution	3.5 km	500 m
Friction	On=>JONSWAP	On=>JONSWAP
Stationary/Non-Stationary	Quasi-Stationary	Quasi-Stationary
Diffraction	Off	Off
Breaking	On	On
Quadruplet	On	On
White-Capping	On=>Kommen	On=>Kommen
Setup	Off	Off
Triad	Off	Off

Wave Height Performance

Run	Storms			
	March	May	July	September
	Default			
R0: Default	0.77	0.86	0.72	0.89
	Friction			
R1: Collin Friction	-0.02	-0.03	-0.05	-0.05
R2: Madsen Friction	0	0	0	0
R3: Friction Off	-0.06	-0.08	-0.1	-0.08
	Stationary / Non-Stationary			
R4: Outer Non-Stat Full Resolution	-0.06	0	-0.07	-0.03
R5: Outer Non-Stat. ½ Resolution	0	0	+0.07	-0.02
R6: Outer Non-Stat ¼ Resolution	-0.33	0	0	-0.02
	Triad			
R7: Triad on Inner Domains	0	0	0	0
R8: Triad on All Domains	0	0	0	0
	Resolution			
R9: 2x Resolution on Outer Domain	0	0	-0.05	0
R10: 2X Resolution on All Domains	0	0	0	0
R11: ½ Resolution on Outer Domain	0	0	+0.09	0
R12: ¼ Resolution on Outer Domain	0	0	+0.09	0
R13: ½ Resolution on All Domain	0	0	+0.09	0
	Off			
R14: Quadruplets Off	-0.06	-0.04	+0.04	-0.09
R15: Breaking Off	0	0	0	0
R16: White-Capping Off	-0.64	-0.71	-0.69	-0.62

Why are results so much better for Outer Domain Quarter Resolution during the July Storm?

UNC INSTITUTE of MARINE SCIENCES

Default (R0)

Quarter Resolution Outer (R12)

Component Summary

SWAN Wave Performance Table For default July Storm ~ July
Stations : 41035, 41025, 41036, 41004, 17mWvr2, 8mArra2

Components	hs	tp	dir
Young Swell	0.68		0.61
Mature Swell	NaN	NaN	NaN
Total	0.72	0.7	0.87
Total Performance: 0.75			
Full Spectrum	0.71	0.64	0.6

SWAN Wave Performance Table For July Storm ~ Quart Res Outer ~
Stations : 41035, 41025, 41036, 41004, 17mWvr2, 8mArra2

Components	hs	tp	dir
Young Swell	0.82		0.87
Mature Swell	NaN	NaN	NaN
Total	0.81	0.88	0.86
Total Performance: 0.85			
Full Spectrum	0.82	0.81	0.55

Station Summary

TC SWAN Wave Station Summary
For default July Storm From July 2007 to July 2007

Stations	hs	tp	dir
8mArra2	0.35		0.05
17mWvr2	0.45		0.02
41036	0.87	0.91	0.89
41025	0.69	0.85	NaN
41035	0.82	0.91	0.9

TC SWAN Wave Station Summary
For July Storm ~ Quart Res Outer From July 2007 to July 2007

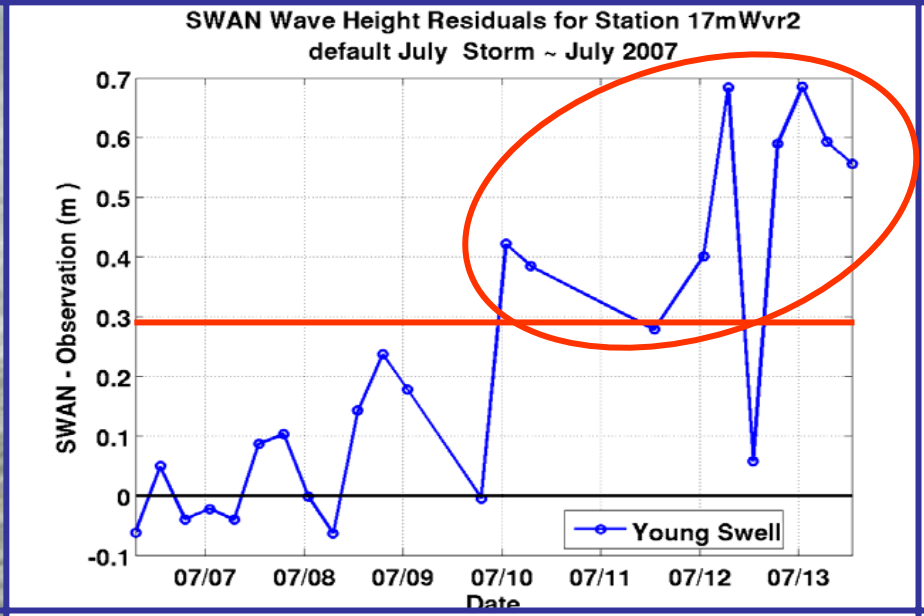
Stations	hs	tp	dir
8mArra2	0.79		0.86
17mWvr2	0.84		0.78
41036	0.86	0.91	0.89
41025	0.7	0.85	NaN
41035	0.82	0.91	0.9

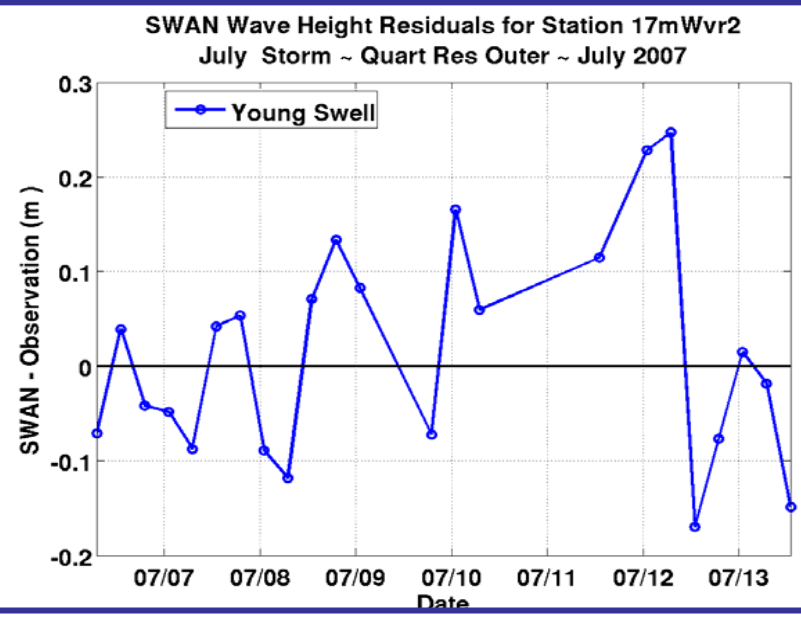
UNC INSTITUTE of MARINE SCIENCES

Default (R0)

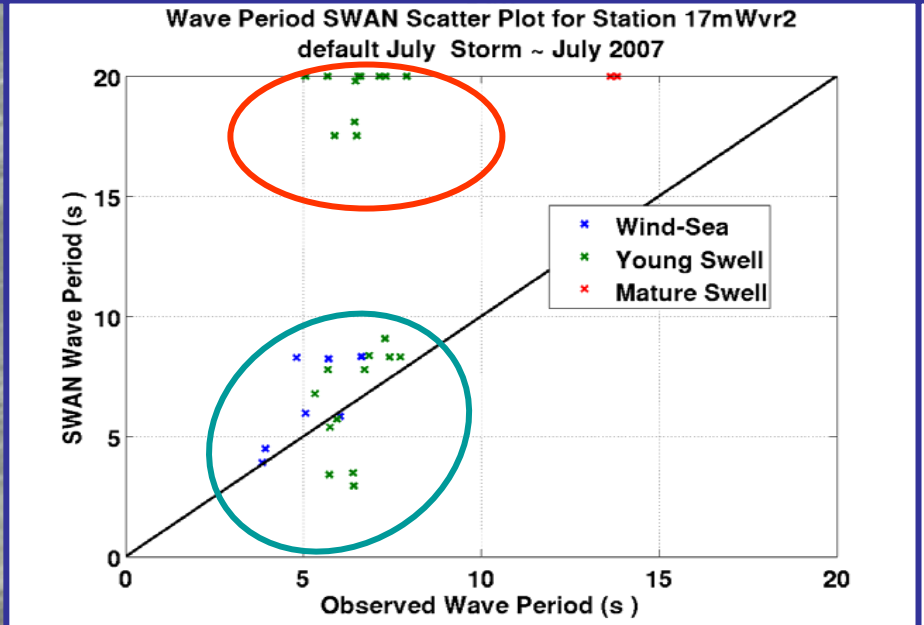
Quarter Resolution Outer (R12)

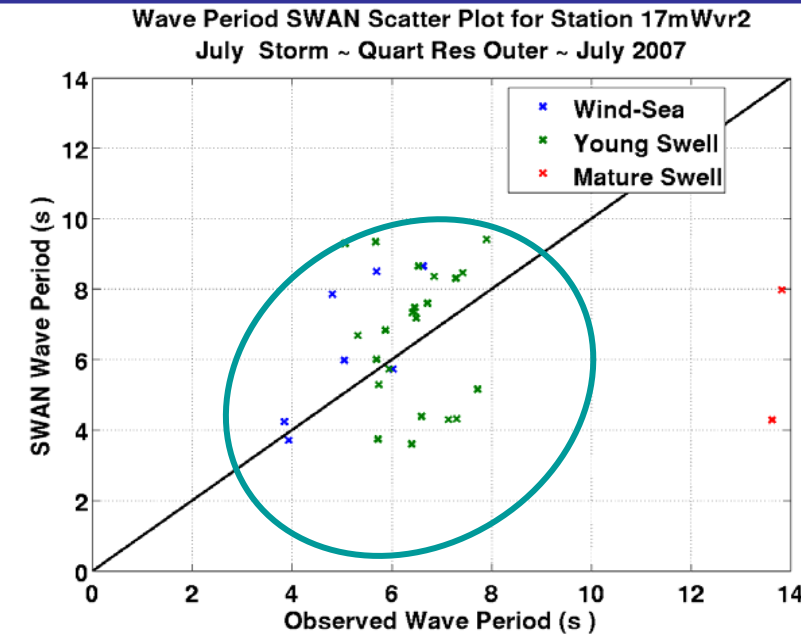
Wave Height Residual





Wave Period Scatter



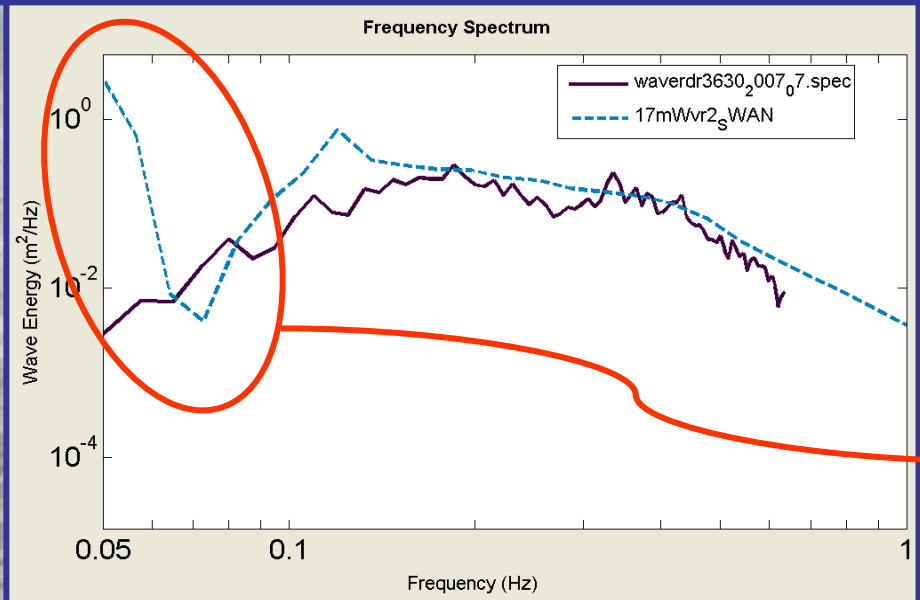


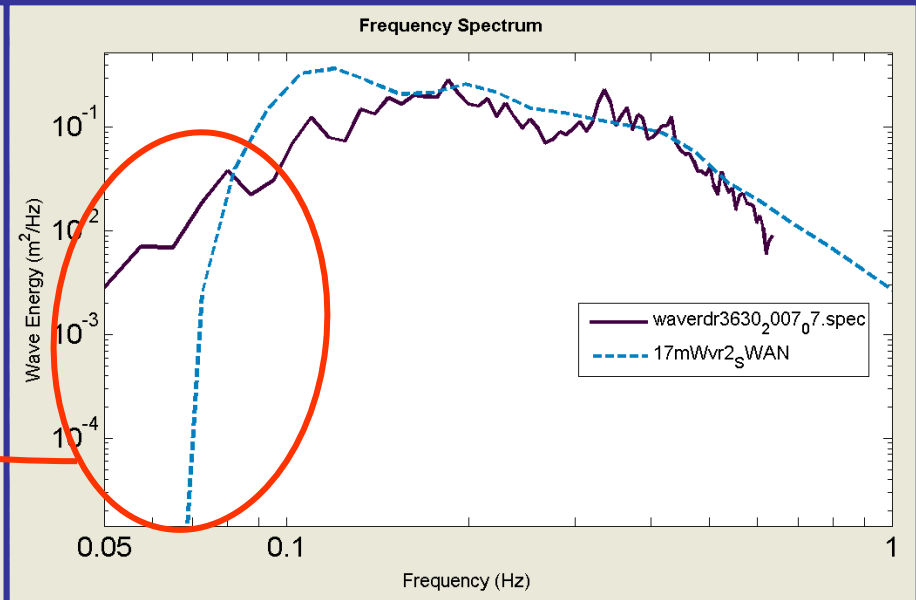
UNC INSTITUTE of MARINE SCIENCES

Default (R0)

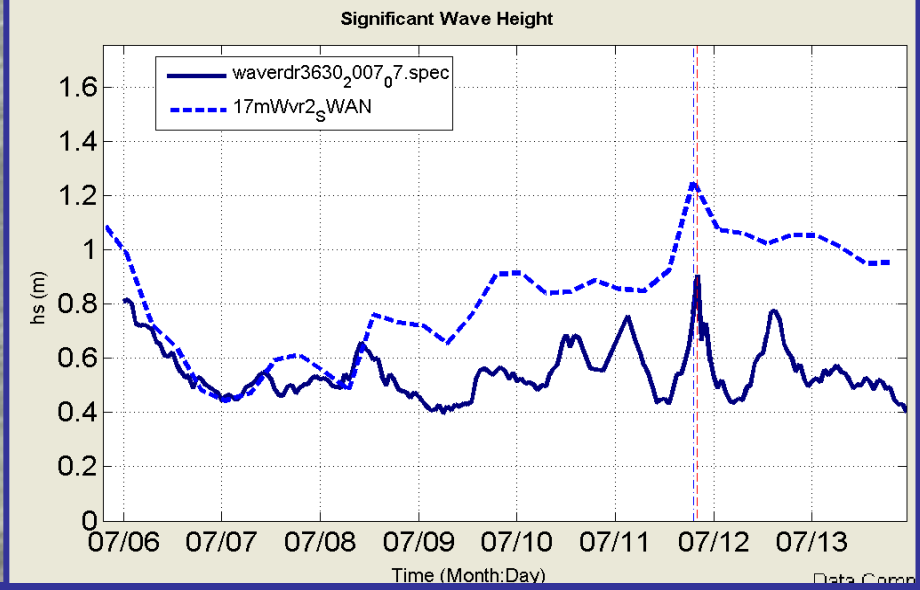
Quarter Resolution Outer (R12)

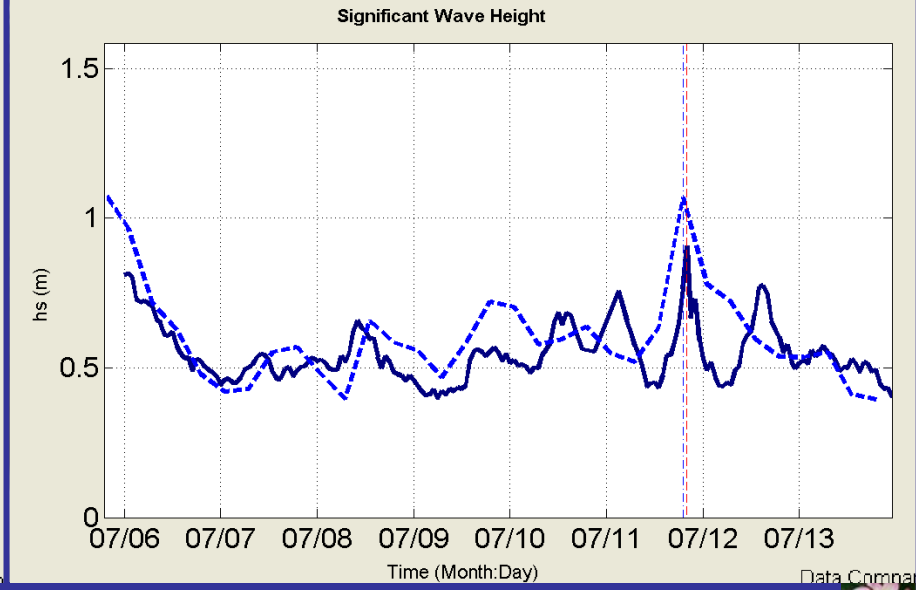
Frequency Spectrum





Significant Wave Height





Related Projects

- IOOS: Validating ADCIRC circulation model
- Operational Implementation: update statistics and performances on FRF web site
- More AutoMEDS development:
  - Circulation and beach morphology
  - GUI interface available in Matlab™
  - On line module

UNC INSTITUTE of MARINE SCIENCES

Thank you!

Questions???