Session 16

Peter Bacopoulos

University of Central Florida

ADCIRC Hurricane Forecasting Model

Topic Description

An existing model of the St. Johns River is forced with freshwater river inflows, astronomic tides, pressure variations, and wind stresses. Results from a 122-day simulation show that the effects of the offshore and local meteorological forcings far outweigh the influence from freshwater river inflows with respect to an accurate prediction of the water surface elevations for the St. Johns River. In addition, a model of the Loxahatchee River estuary displays the impact of tidal flats and the Atlantic Intracoastal Waterway (AIW) on the tidal behavior occurring within the Loxahatchee River estuary, on a water-level and velocity-residual basis. The overall goal seeks to describe the AIW and the Indian River lagoon in an effort to develop a tidal model for the entire east coast of Florida, providing a hydrodynamic connection between the St. Johns River and the Loxahatchee River estuary. This research will lead to furthered scientific understanding of tidal circulation through the AIW, extending into the South Atlantic Bight.

Speaker Biography

Peter Bacopoulos is a PhD student in the Coastal Hydroscience Analysis, Modeling, and Predictive Simulations (CHAMPS) Laboratory at the University of Central Florida, specializing in the research area of model development and application. While his dissertation topic deals with the development and application of a tidal model for the entire east coast of Florida, his ongoing activity in the CHAMPS Laboratory has allowed him to gain exposure and experience towards developing and applying models of storm surge for various coastal areas of Florida.

A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Peter Bacopoulos

Scott C. Hagen, Ph.D., P.E.

Yuji Funakoshi

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Coastal Hydroscience Analysis, Modeling & Predictive Simulations Laboratory

CHAMPS Lab

http://champs.cecs.ucf.edu

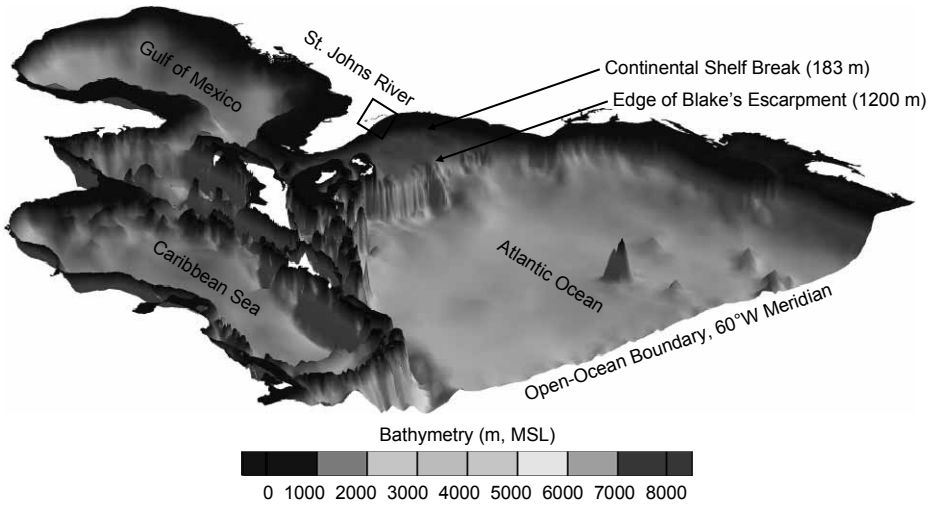
Presentation Outline

- Mesh Development for St. Johns River
  - Large-Scale Approach (i.e., WNAT Model Domain)
  - Local-Scale Approach (i.e., Inlet-Based Domain)
- Tidal Performance
- Application of Additional Model Forcings
- Examination of Model Response
  - River Inflows; Local Pressure/Wind Forcings
- Open-Ocean Boundary Elevation Forcings on Inlet-Based Mesh
- Conclusions and Future Work

WNAT Model Domain

Open-Ocean Boundary in Deep Ocean (i.e., along 60°W Meridian)

Includes St. Johns River up to Lake George

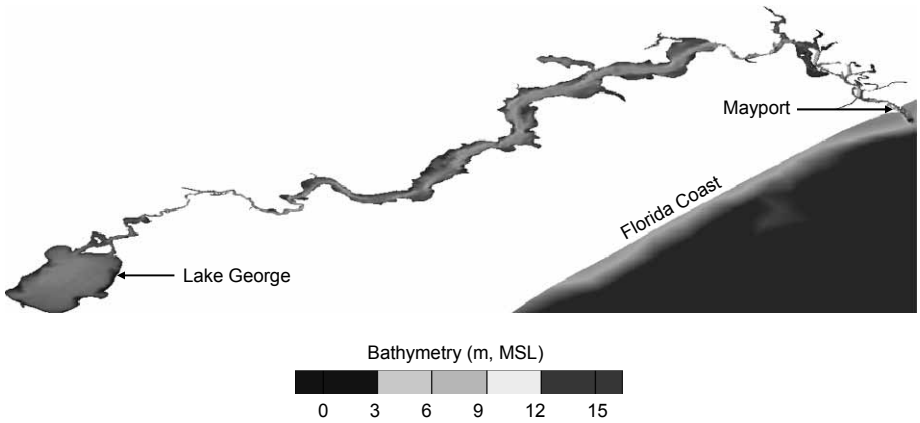


A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

St. Johns River

Longest River (500 km) Contained Wholly Within Florida

Slow-Moving River With Low Slope (2.2 cm/km)



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Large-Scale Approach (WNAT-SJR Mesh)

75,436 Nodes

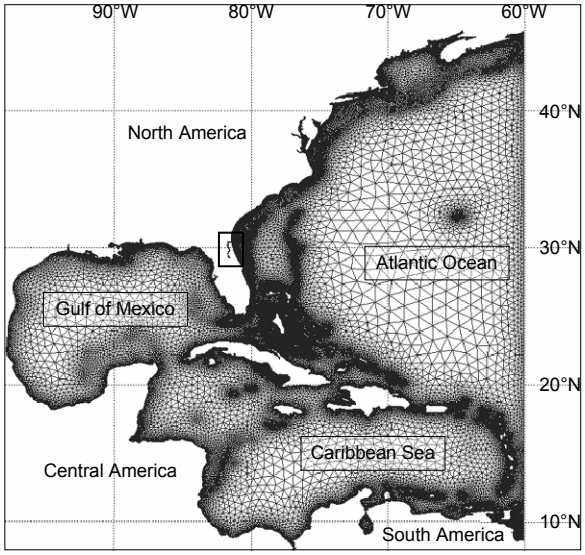
138,622 Elements

Maximum Element Size

160 km (Deep Ocean)

Minimum Element Size

50 m (St. Johns River)



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Local-Scale Approach (SJR-Inlet Mesh)

24,218 Nodes

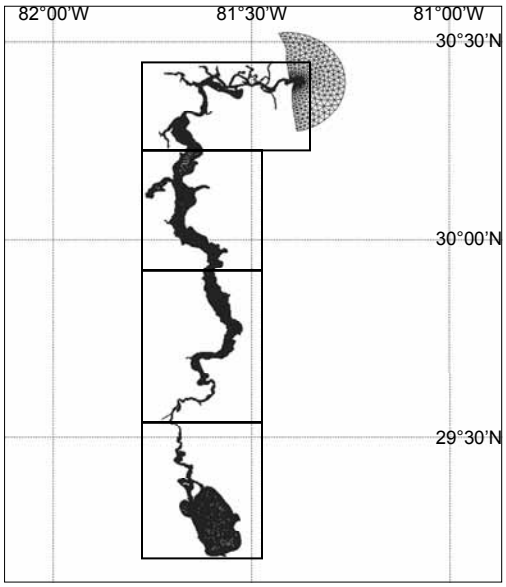
43,265 Elements

Maximum Element Size

2 km (Open-Ocean Boundary)

Minimum Element Size

50 m (St. Johns River)



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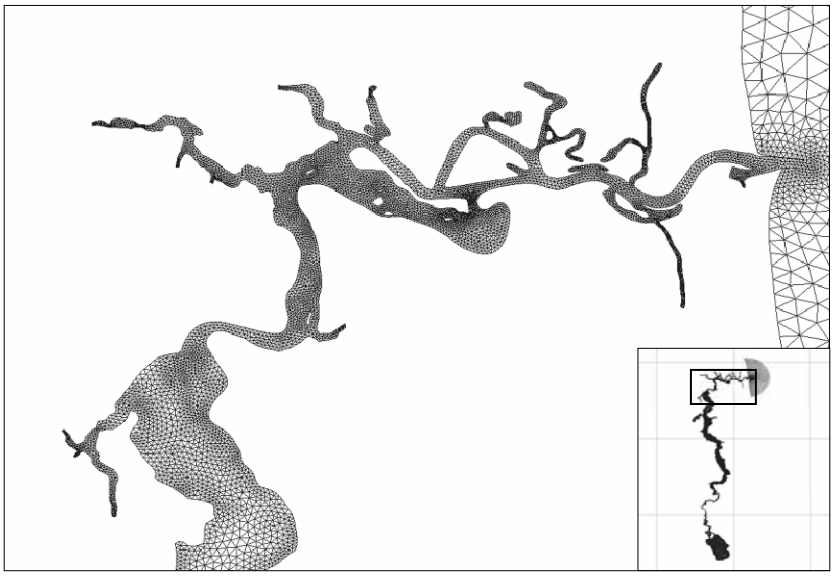
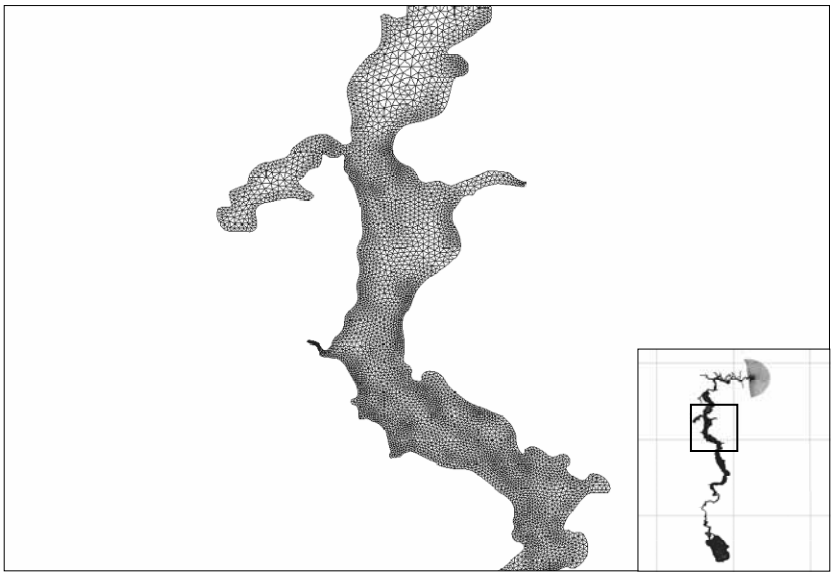
Local-Scale Approach (SJR-Inlet Mesh)



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Local-Scale Approach (SJR-Inlet Mesh)



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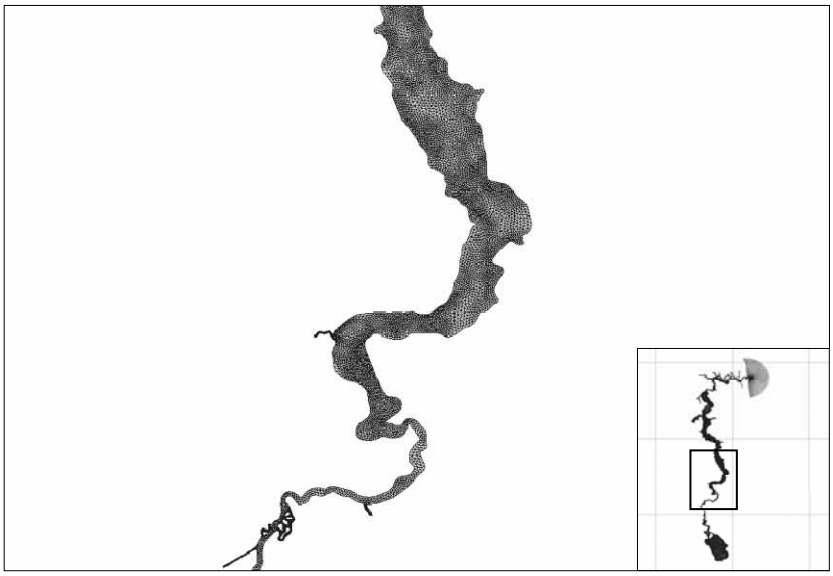
Local-Scale Approach (SJR-Inlet Mesh)



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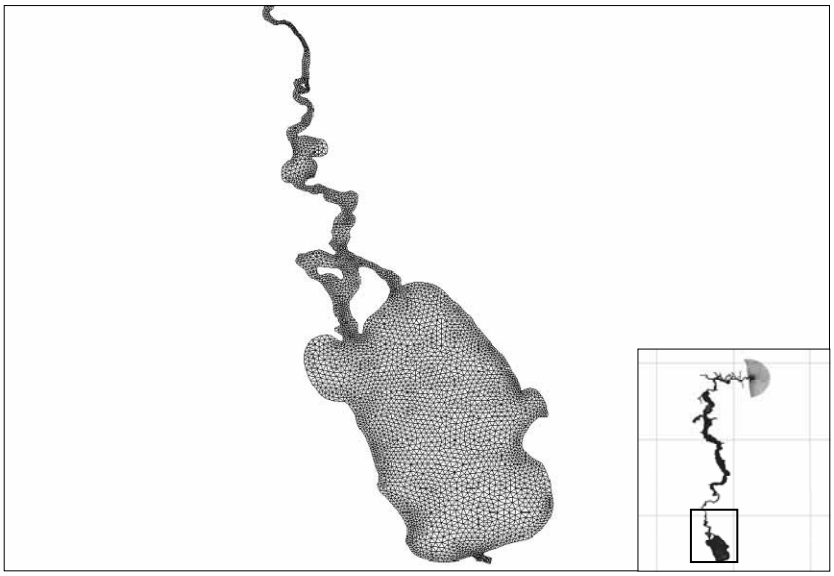
Local-Scale Approach (SJR-Inlet Mesh)



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Model Documentation and Initialization

ADCIRC-2DDI: Advanced Circulation Model for Shelves, Coasts, and Estuaries, Two-Dimensional, Depth-Integrated Option

Solves the Shallow Water Equations in their Full Nonlinear Form

Employs the Standard Quadratic Parameterization of Bottom Friction

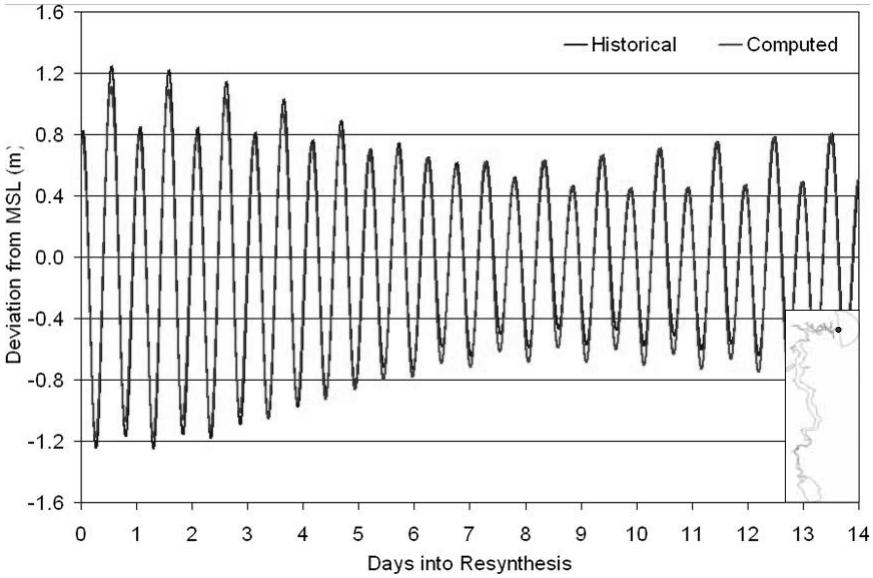
Allows for the Wetting and Drying of Elements

Tidal Simulations:

- 90-Day Run Length; 20-Day Forcing Ramp; 5-Second Time Step
- Open-Ocean Boundary Elevation Forcings: K_1; O_1; M_2; S_2; N_2; K_2; Q_1
- Harmonic Analysis on Last 45 Days of Simulated Water Surface Elevations

A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Tidal Resynthesis: WWTD, Mayport Naval Station



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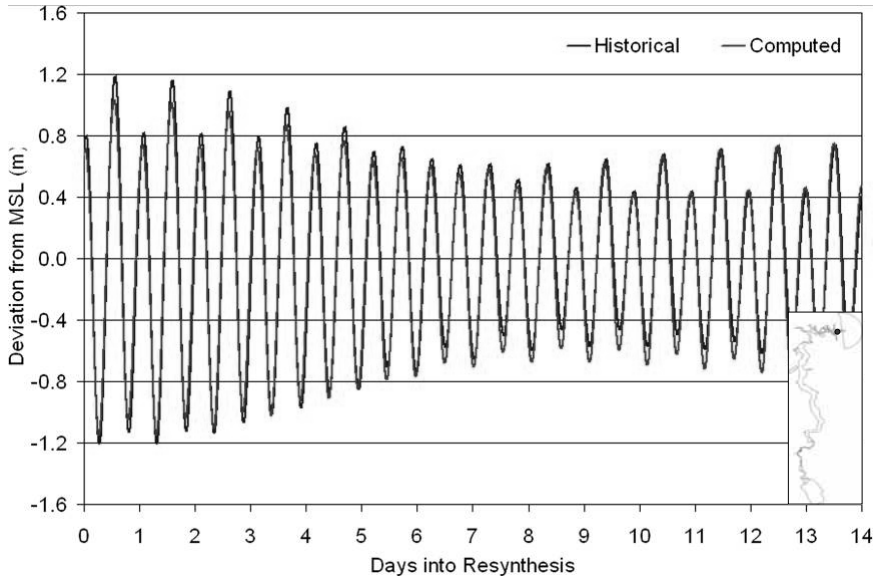
Tidal Resynthesis: Bar Pilots Dock



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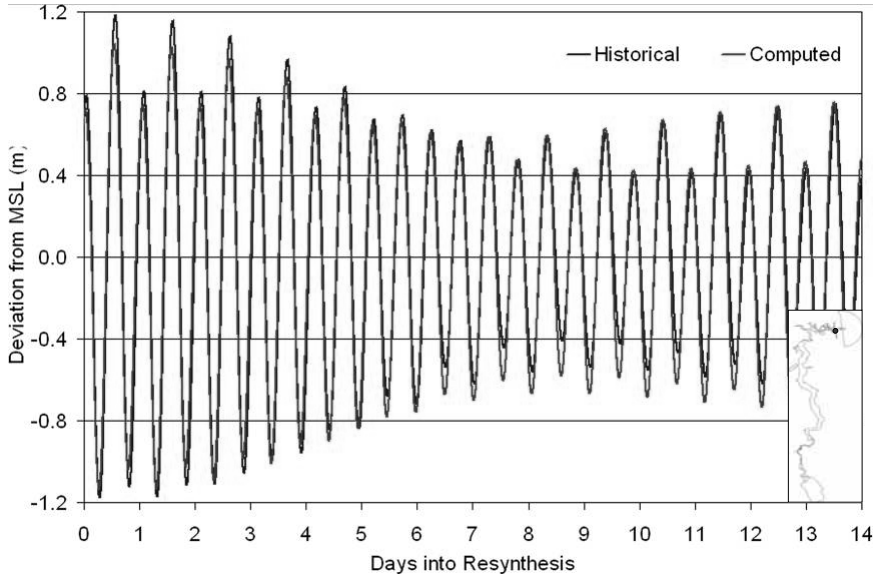
Tidal Resynthesis: Mayport



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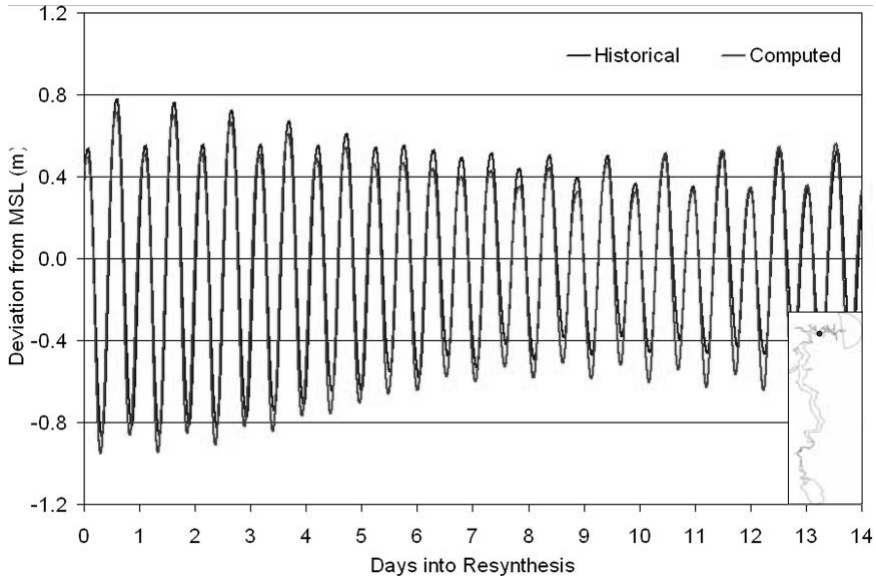
Tidal Resynthesis: Dame Point



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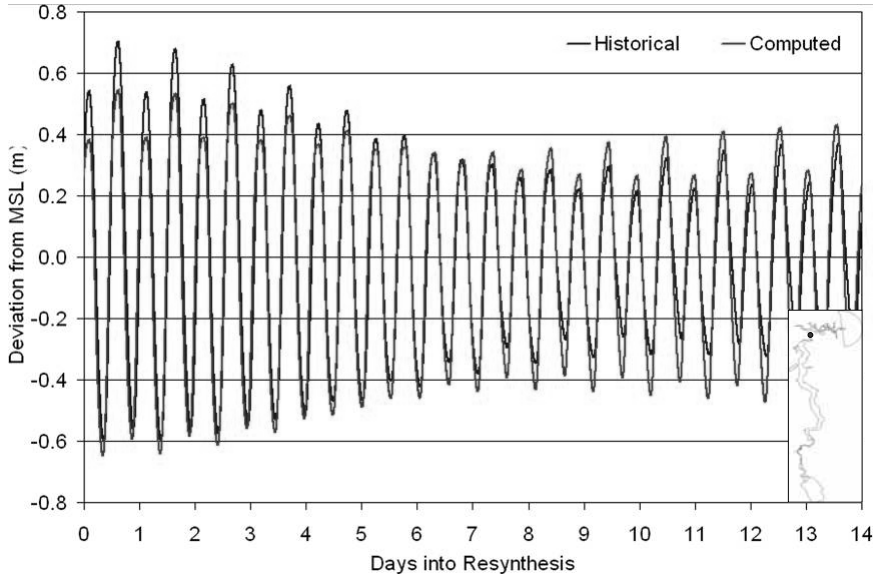
Tidal Resynthesis: Longbranch



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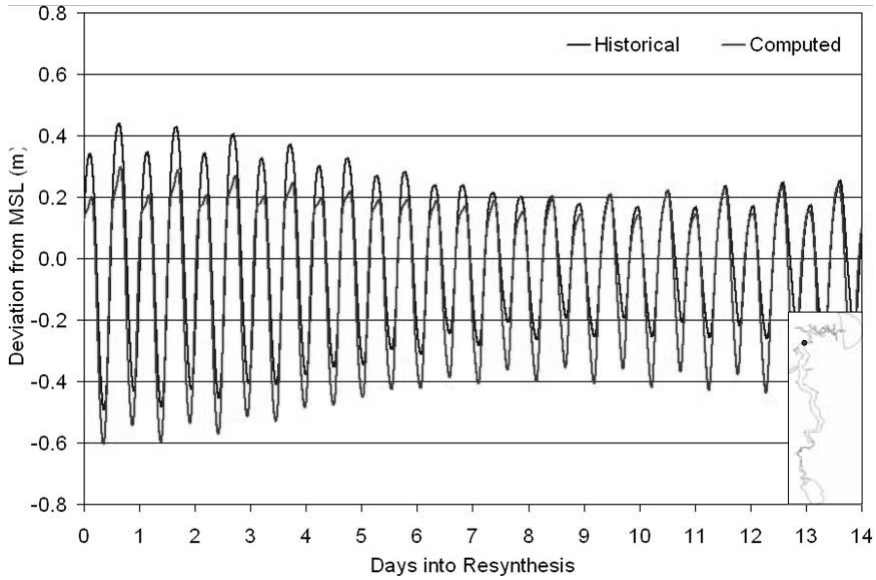
Tidal Resynthesis: Main Street Bridge



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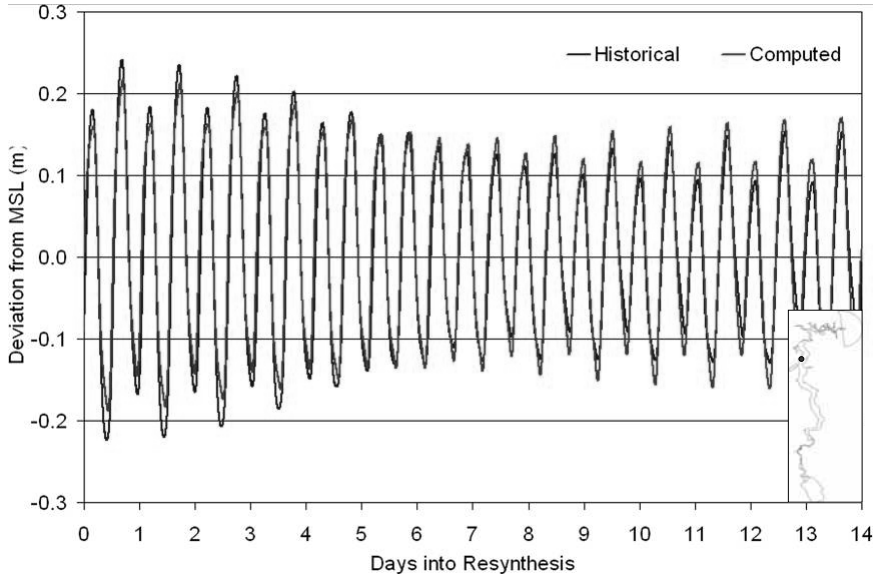
Tidal Resynthesis: I-295 Bridge, West End



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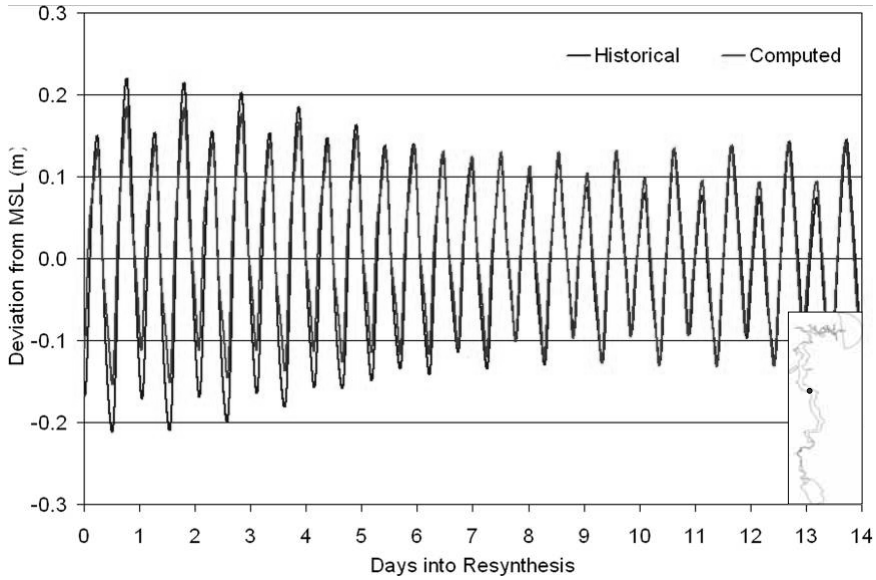
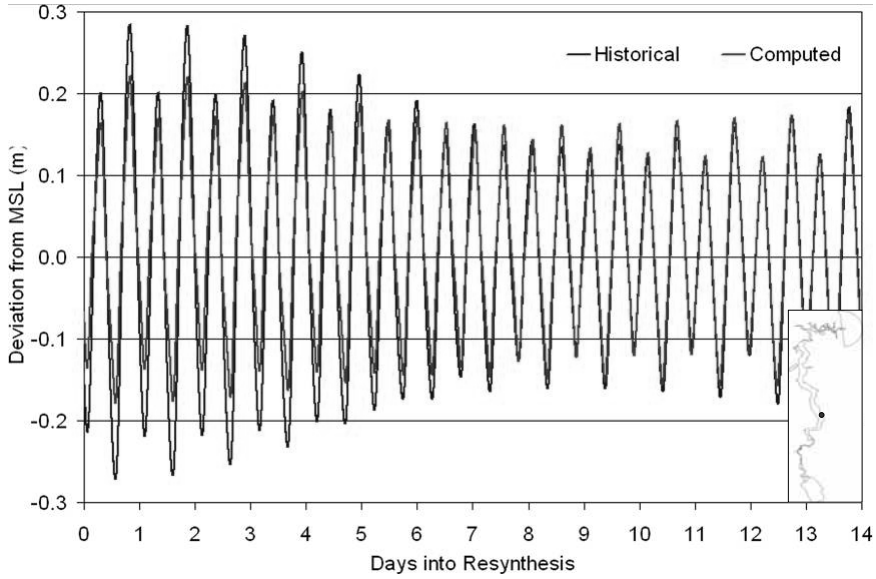
Tidal Resynthesis: Red Bay Point



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Tidal Resynthesis: Racy Point



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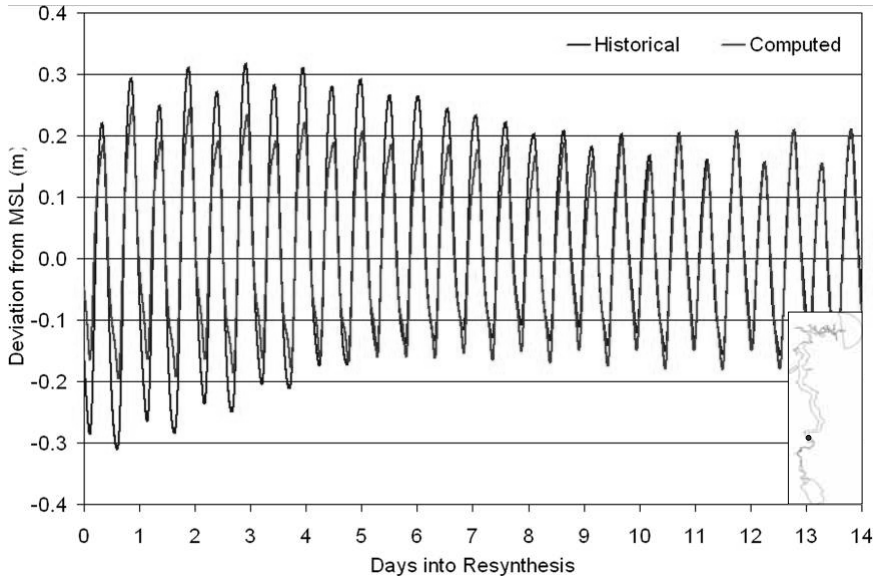
Tidal Resynthesis: Palatka



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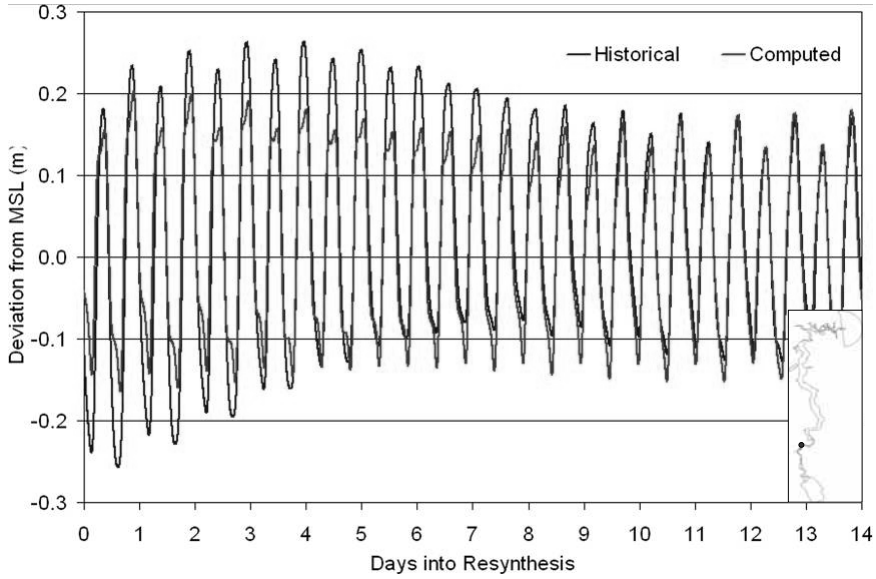
Tidal Resynthesis: Buffalo Bluff



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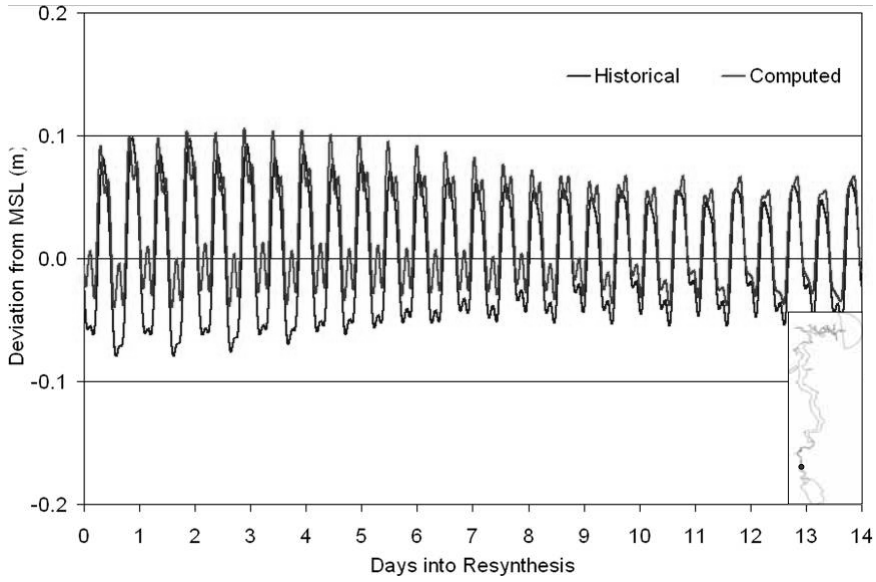
Tidal Resynthesis: Welaka



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

2005 Atlantic Storm Tracks

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122-Day Simulation: Meteorology, Tides, River Inflows

122-Day Run Length (June 1, 2005 – September 30, 2005)

3-Day Forcing Ramp; 2-Second Time Step

Large-Scale Approach (i.e., WNAT-SJR Mesh Application)

Local-Scale Approach (i.e., SJR-Inlet Mesh Application)

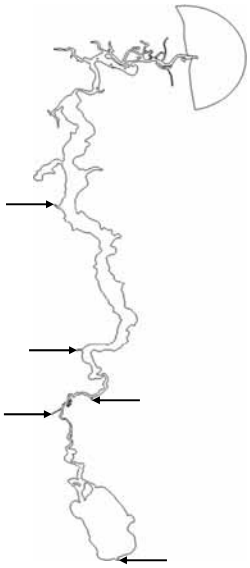
Open-Ocean Boundary Elevation Forcings:

K_1; O_1; M_2; S_2; N_2; K_2; Q_1

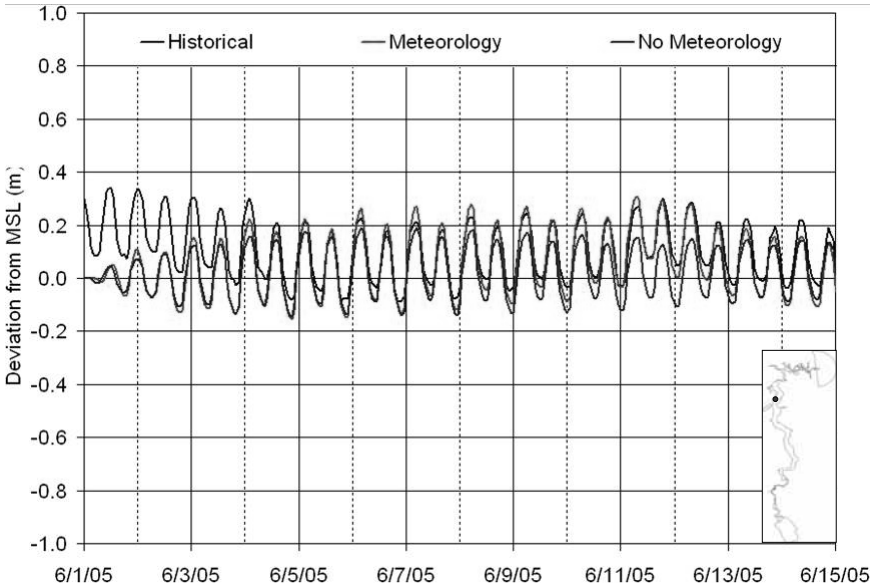
River Inflows: USGS Gage Data

Surface Forcings: 1-Hour Pressures & Winds

Provided by Oceanweather Inc.



WNAT-SJR Mesh Application: I-295 Bridge, West End



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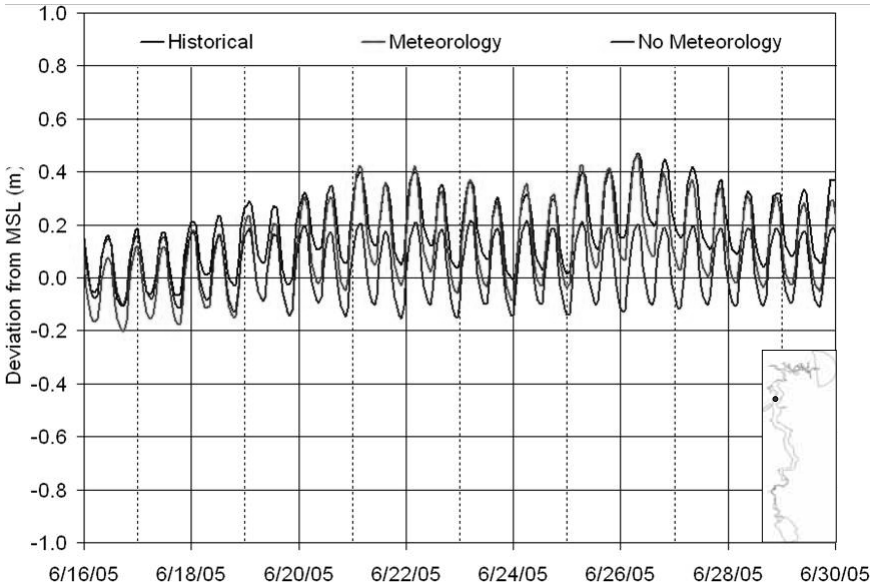

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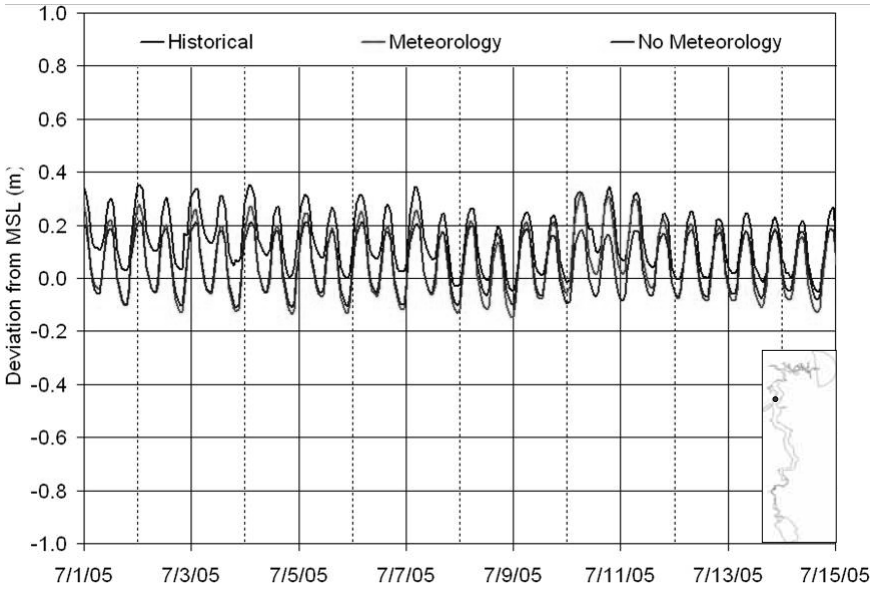

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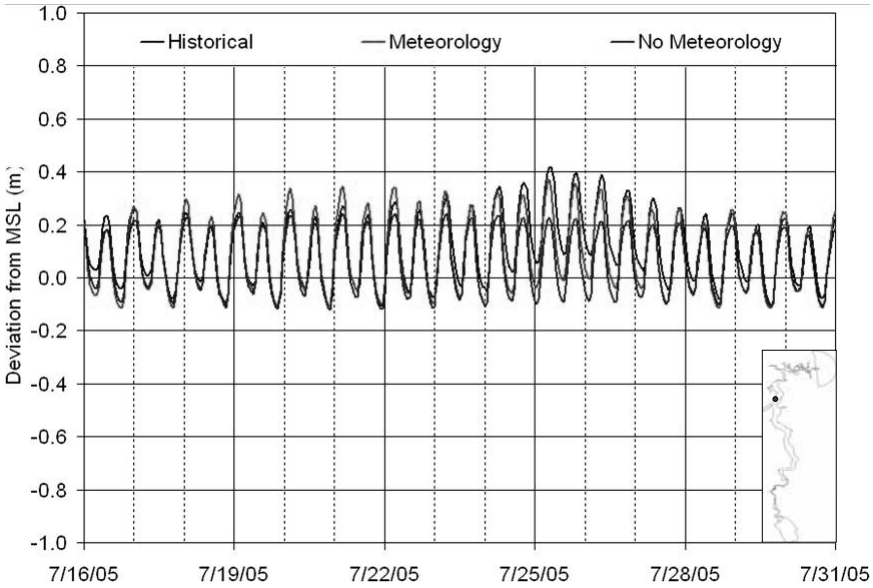

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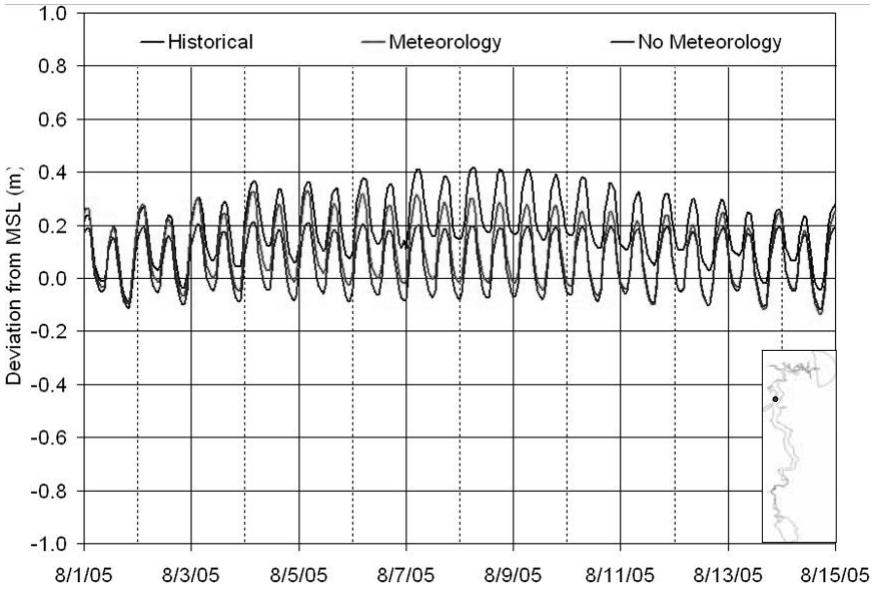

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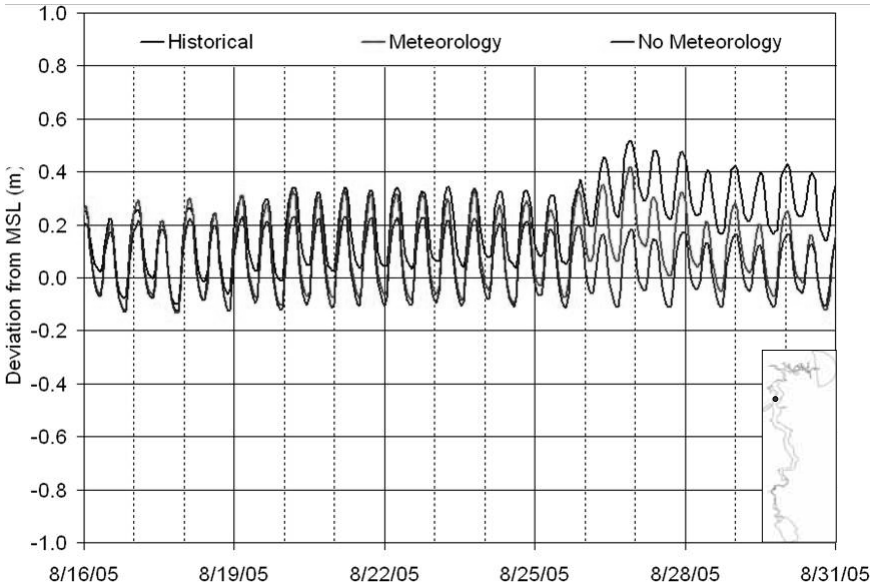

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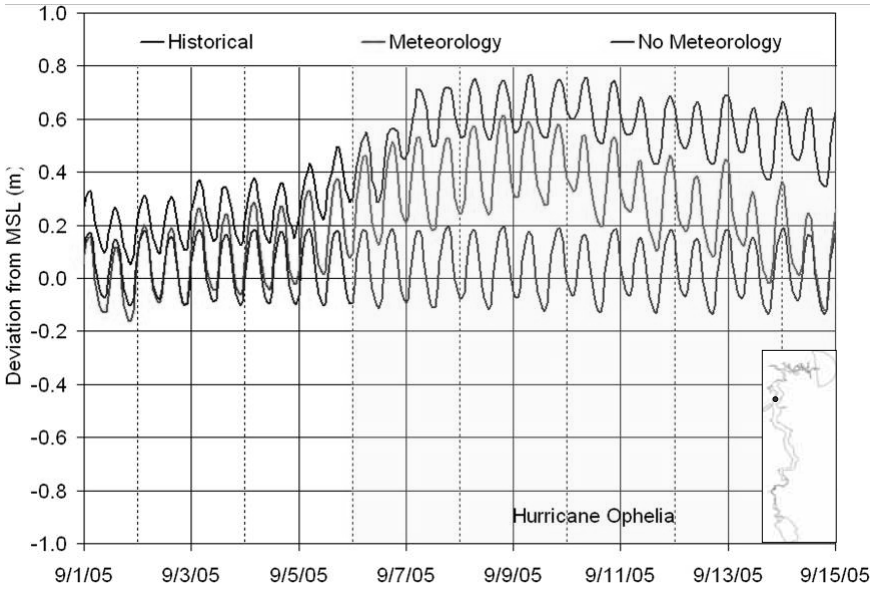

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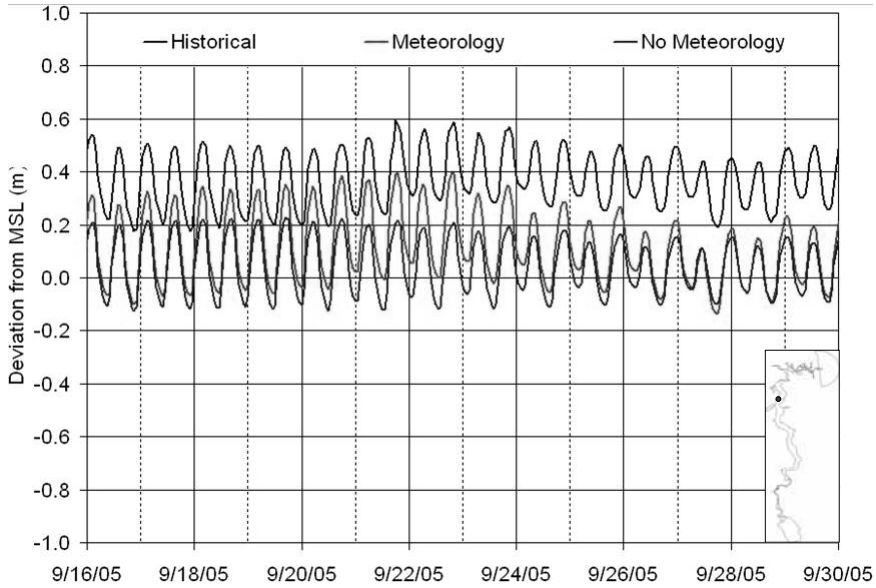
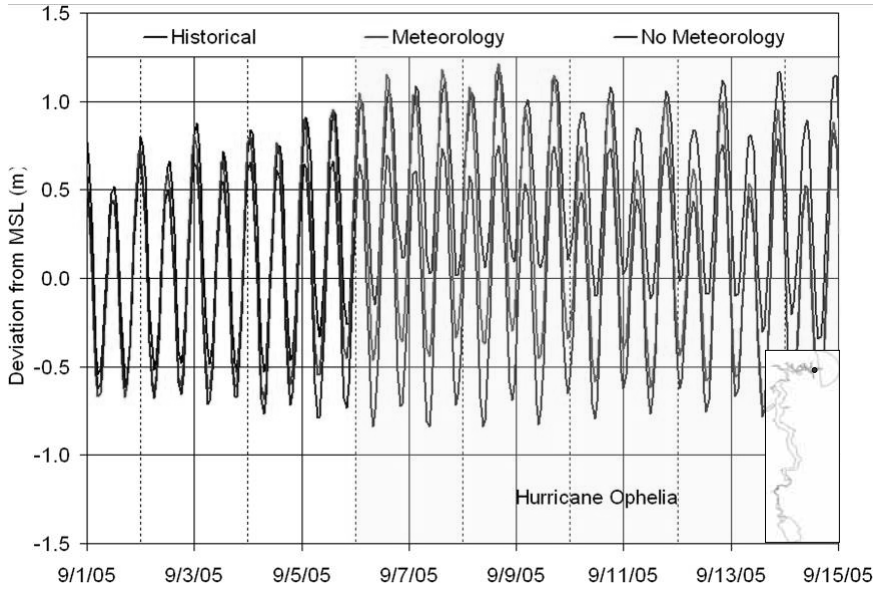


WNAT-SJR Mesh Application: Bar Pilots Dock



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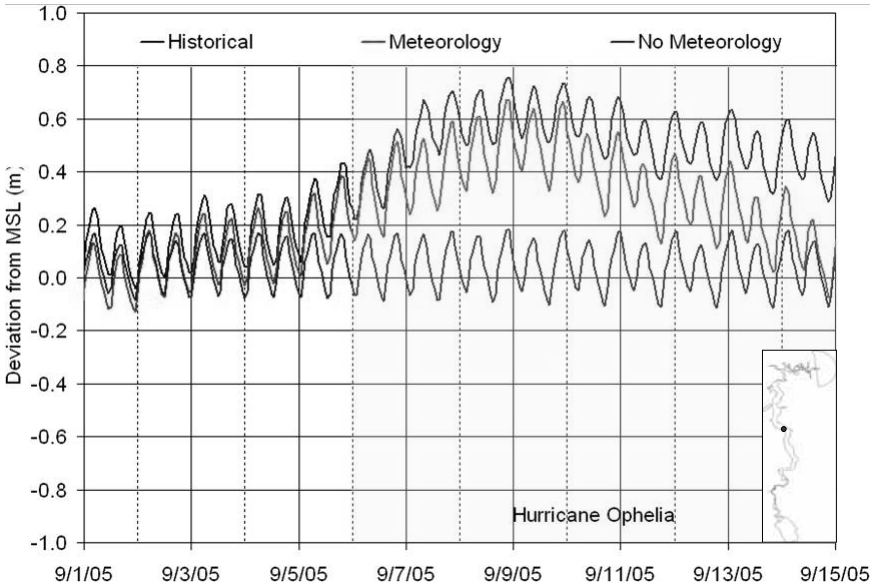

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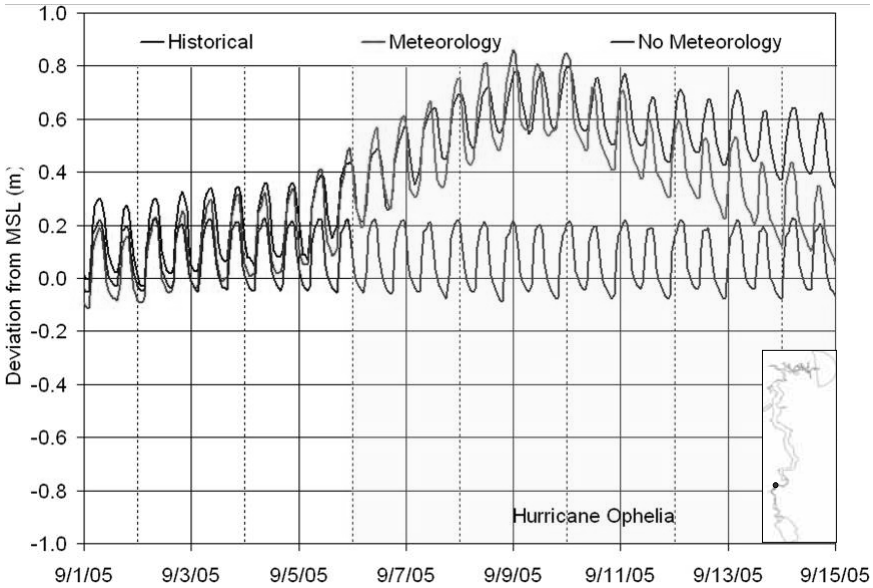

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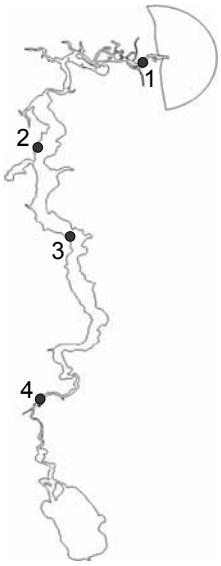
Root Mean Square Error (cm)

Station Index	122 Days (6/1/05 – 9/30/05)	
	No Meteorology	Meteorology
1	23.3453	16.7626
2	23.0519	15.6998
3	18.5399	11.1101
Station Index	**Ophelia (9/6/05 – 9/15/05)**	
	No Meteorology	Meteorology
1	55.7610	26.3891
2	53.9525	20.2039
3	48.8029	12.2997
4	50.0542	10.2633



122-Day Simulation: Meteorology, Tides, River Inflows

122-Day Run Length (June 1, 2005 – September 30, 2005)

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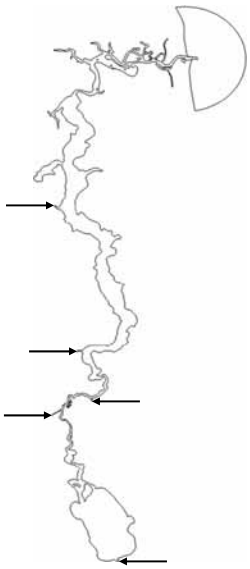
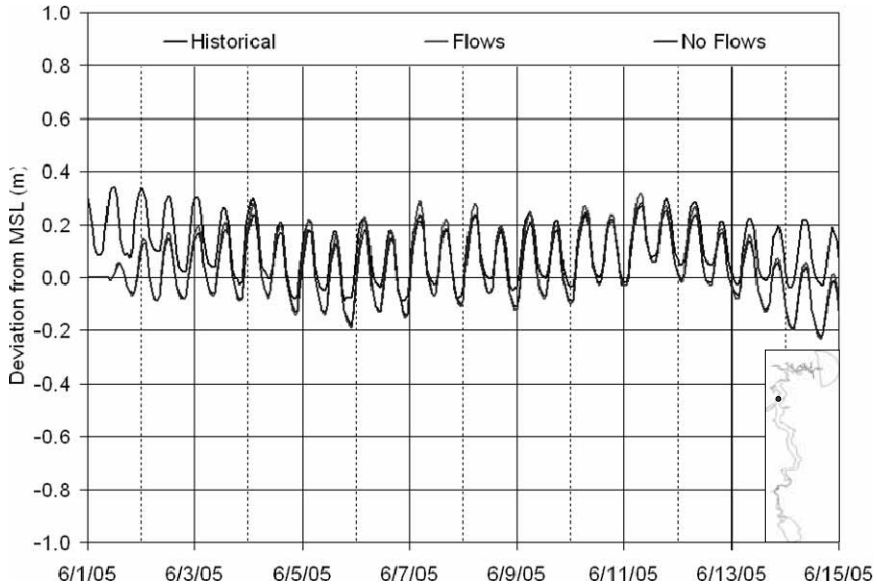
Provided by Oceanweather Inc.



WNAT-SJR Mesh Application: I-295 Bridge, West End



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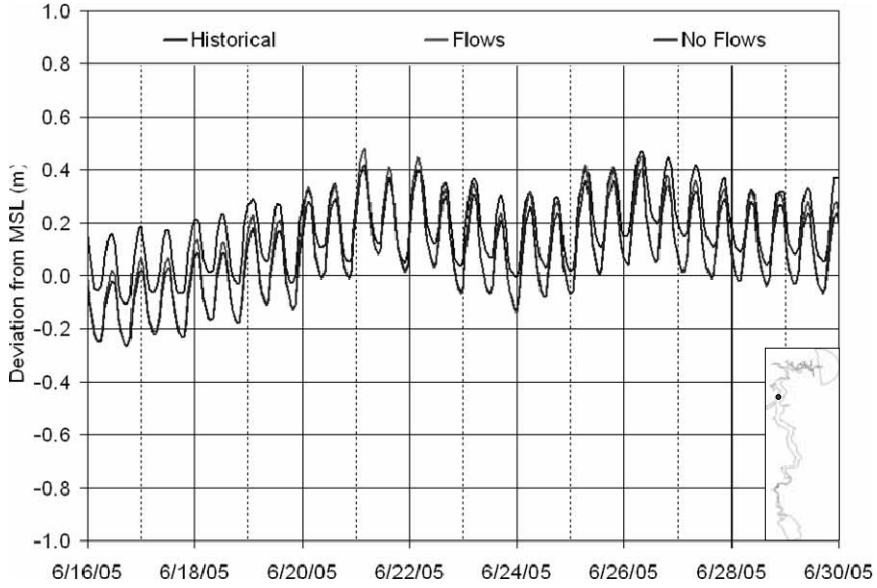
WNAT-SJR Mesh Application: I-295 Bridge, West End



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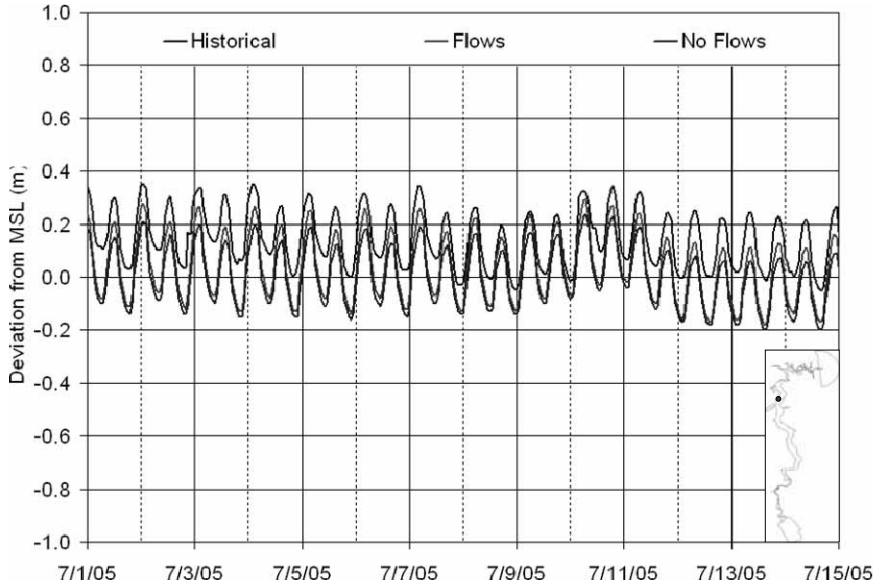
WNAT-SJR Mesh Application: I-295 Bridge, West End



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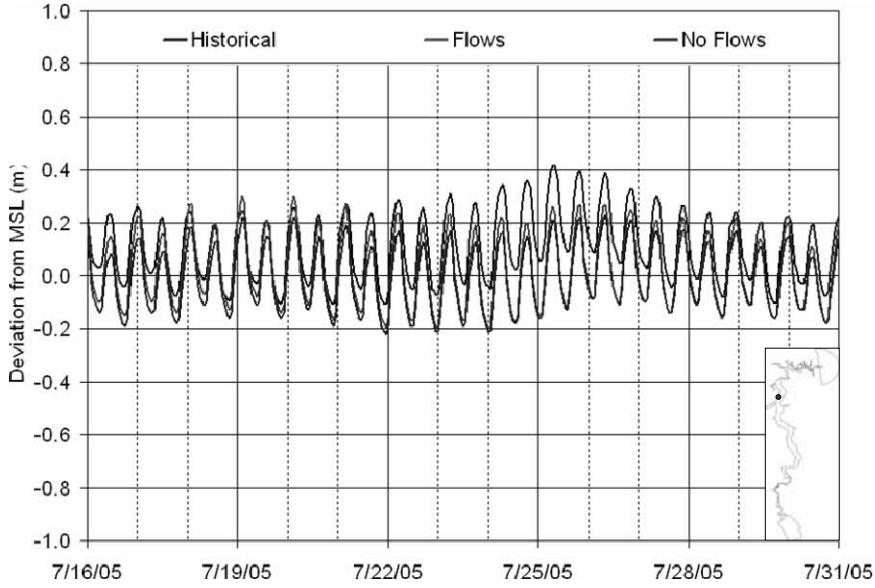

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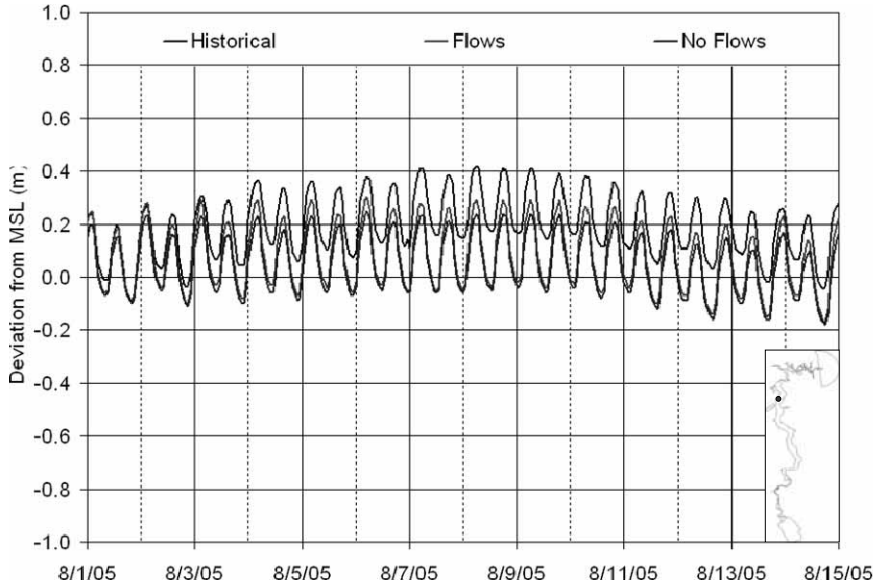

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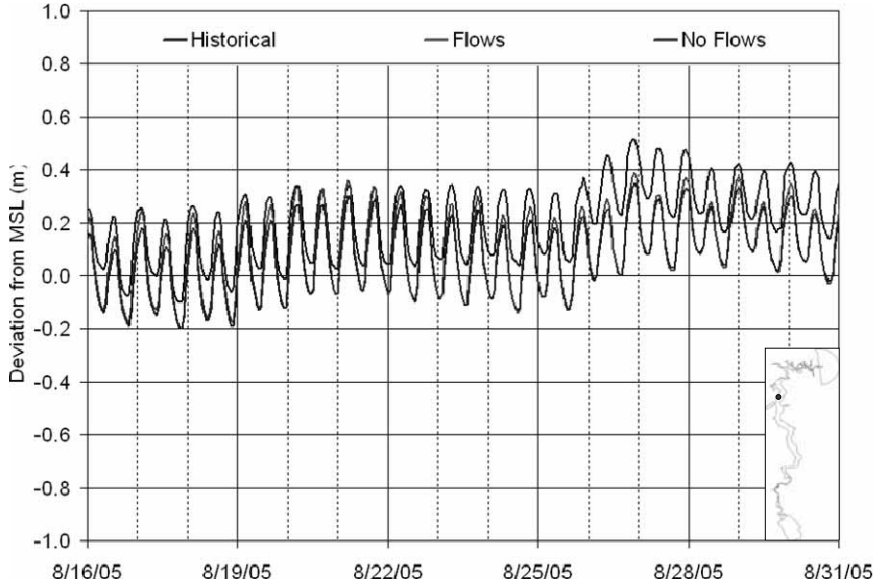

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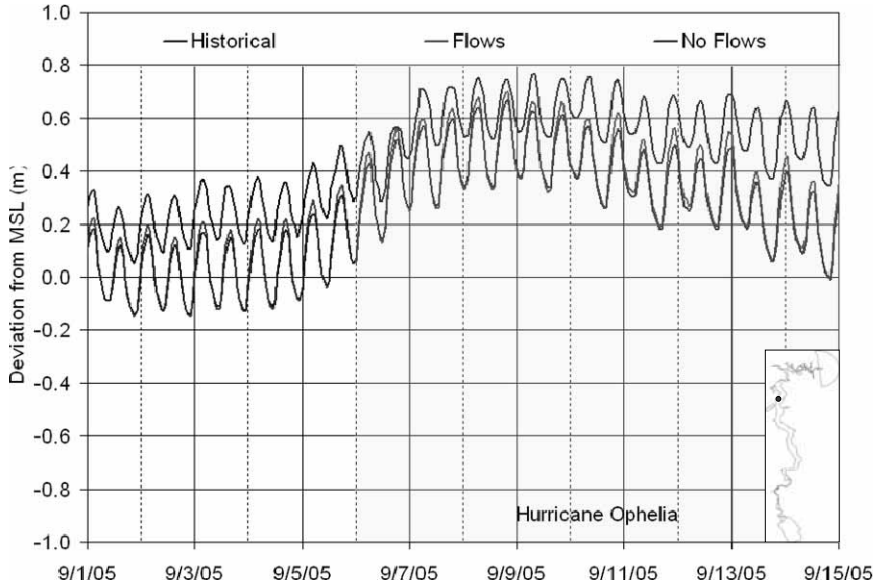

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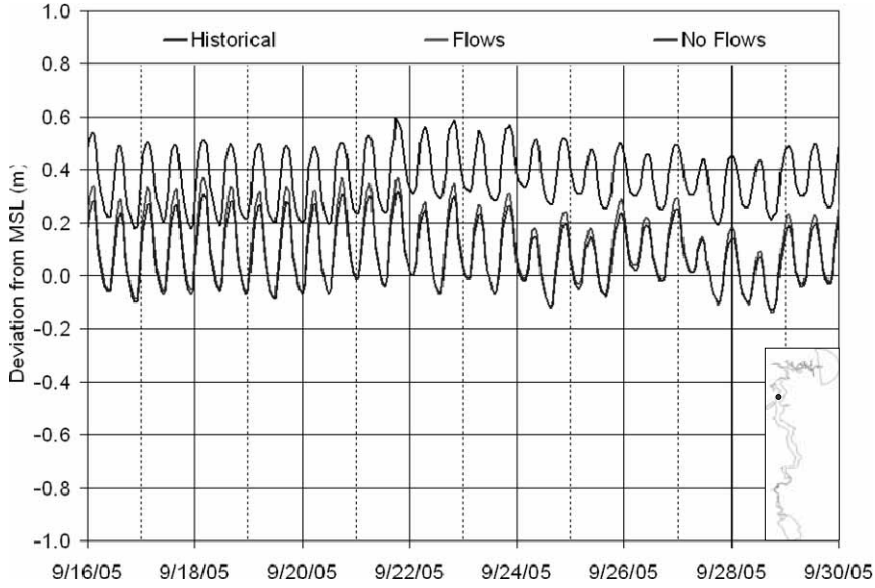

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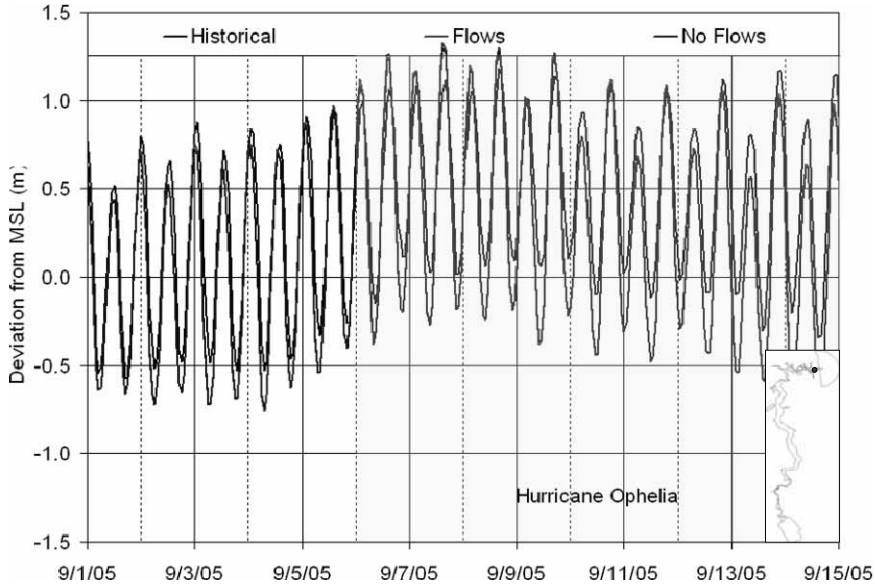
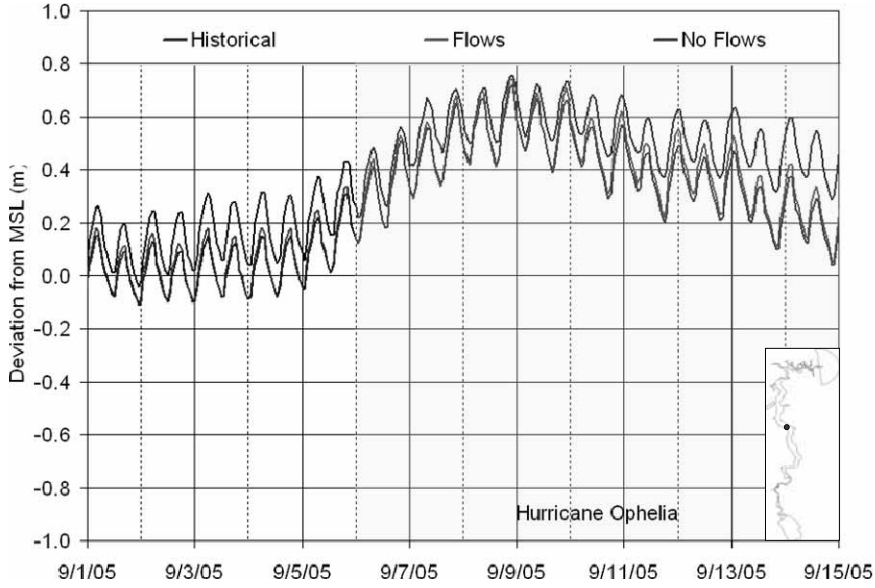
WNAT-SJR Mesh Application: Bar Pilots Dock



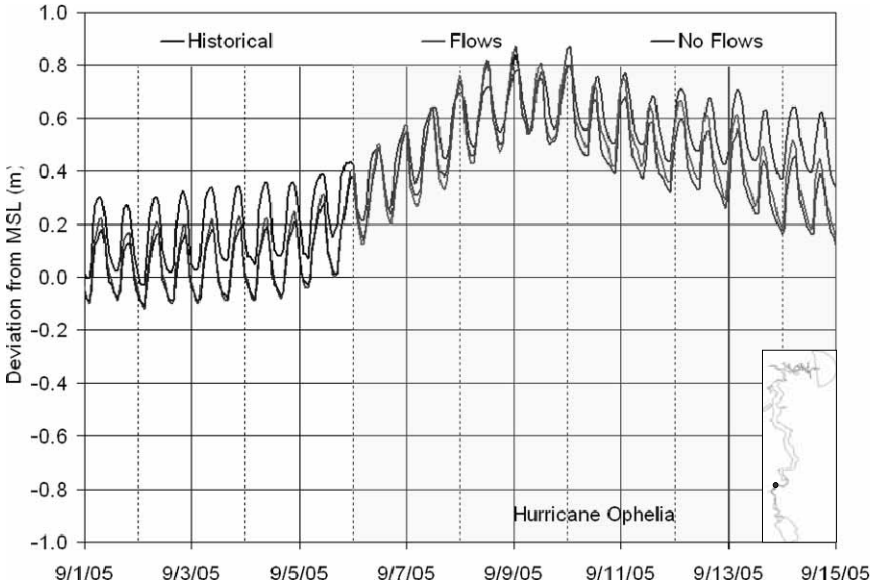
A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

WNAT-SJR Mesh Application: Red Bay Point



University of Central Florida http://champs.cecs.ucf.edu

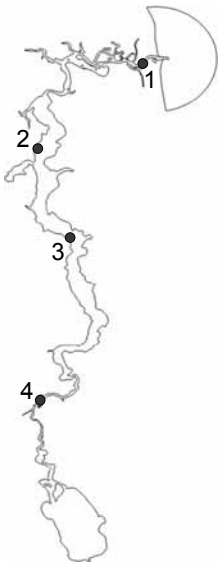
WNAT-SJR Mesh Application: Buffalo Bluff



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Root Mean Square Error (cm)

Station Index	122 Days (6/1/05 – 9/30/05)	
	Flows	No Flows
1	16.2375	16.7626
2	17.6231	15.6998
3	14.0271	11.1101
Station Index	Ophelia (9/6/05 – 9/15/05)	
	Flows	No Flows
1	26.0590	26.3891
2	22.1526	20.2039
3	14.6067	12.2997
4	12.7395	10.2633



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122-Day Simulation: Meteorology, Tides, River Inflows

122-Day Run Length (June 1, 2005 – September 30, 2005)

3-Day Forcing Ramp; 2-Second Time Step

Large-Scale Approach (i.e., WNAT-SJR Mesh Application)

Local-Scale Approach (i.e., SJR-Inlet Mesh Application)

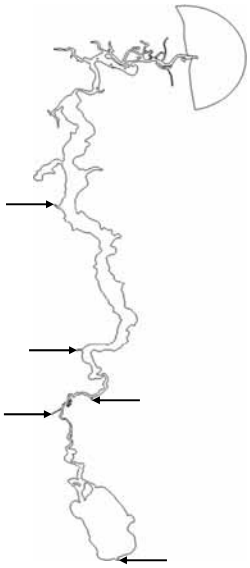
Open-Ocean Boundary Elevation Forcings:

K_1; O_1; M_2; S_2; N_2; K_2; Q_1

River Inflows: USGS Gage Data

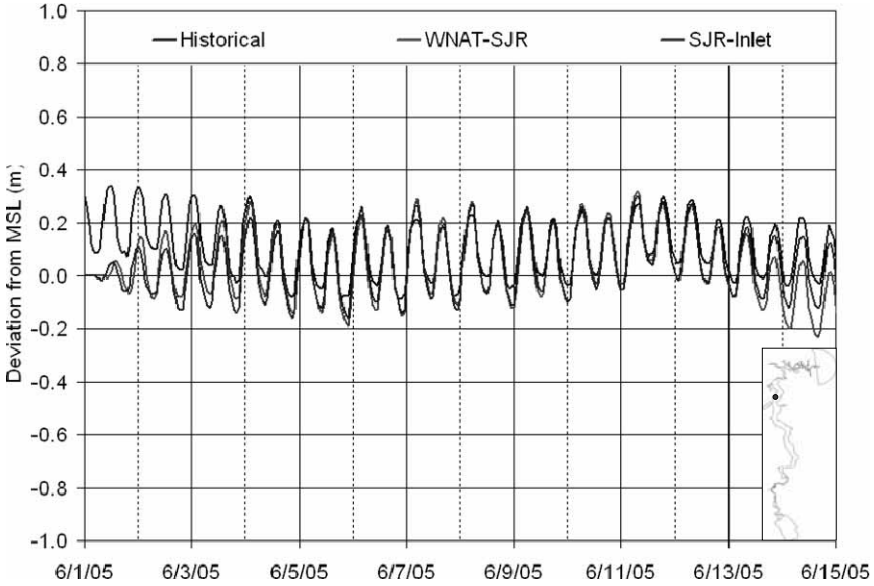
Surface Forcings: 1-Hour Pressures & Winds

Provided by Oceanweather Inc.



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Domain Extent Sensitivity: I-295 Bridge, West End



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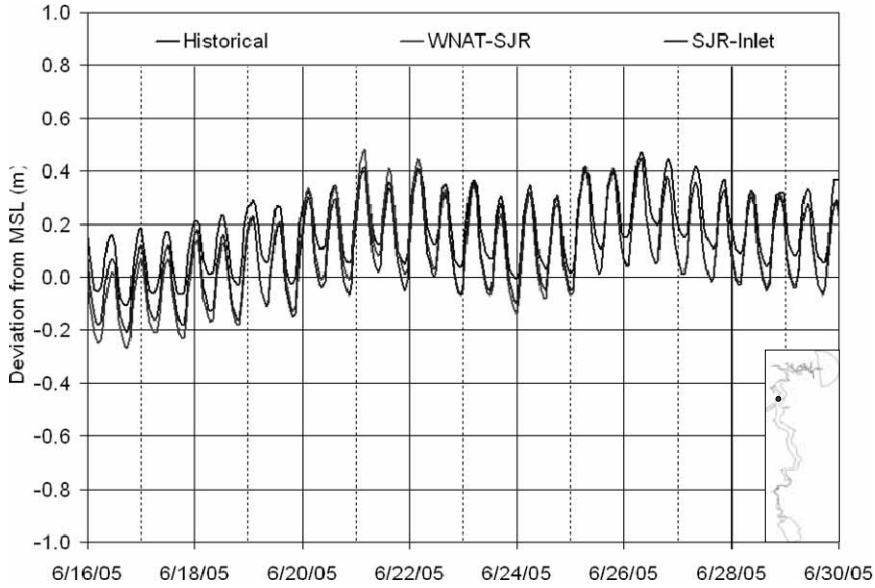

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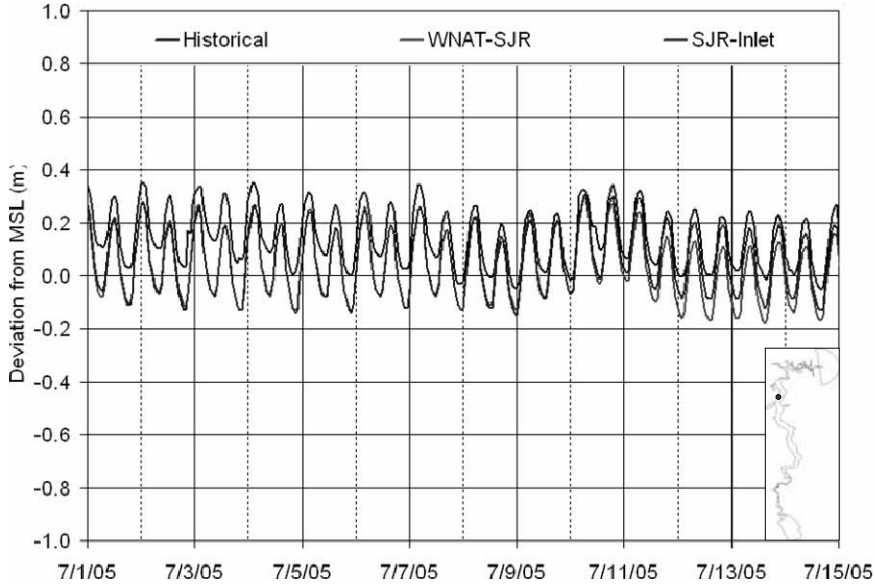

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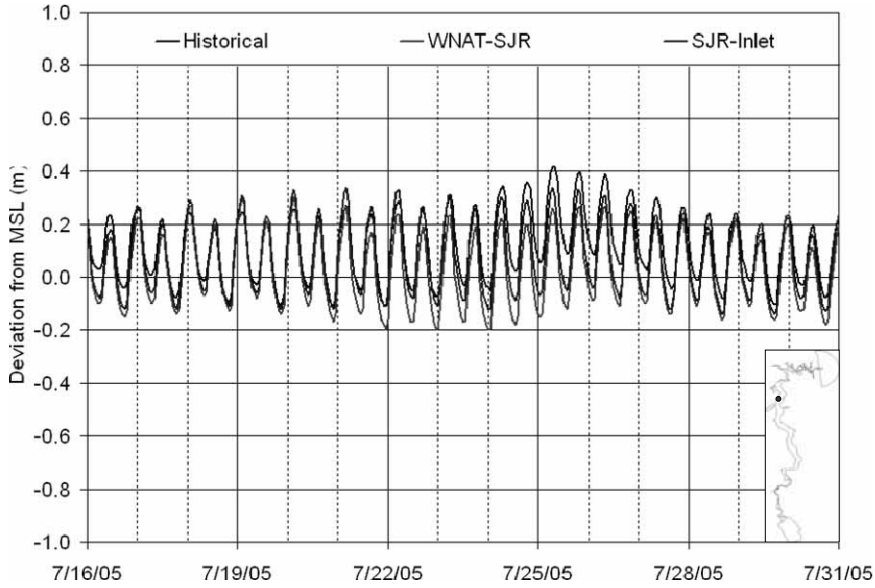

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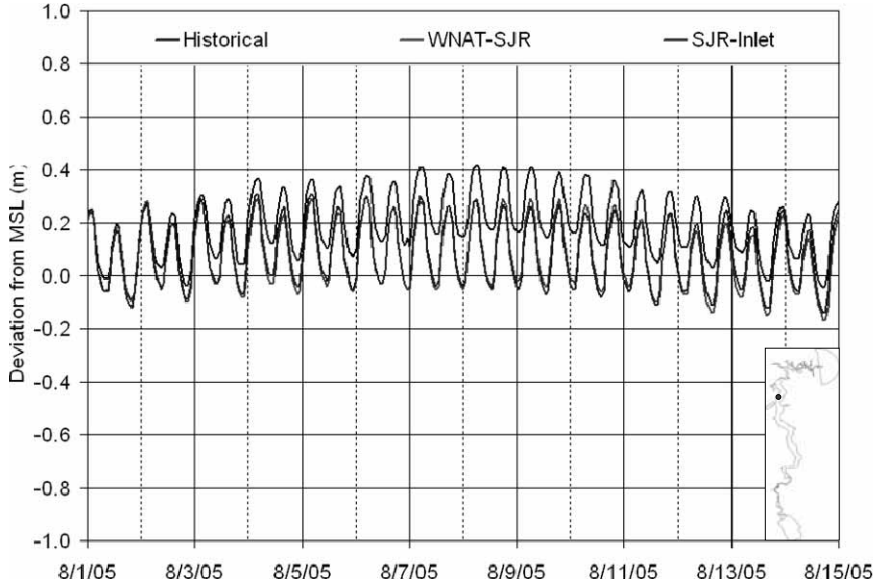

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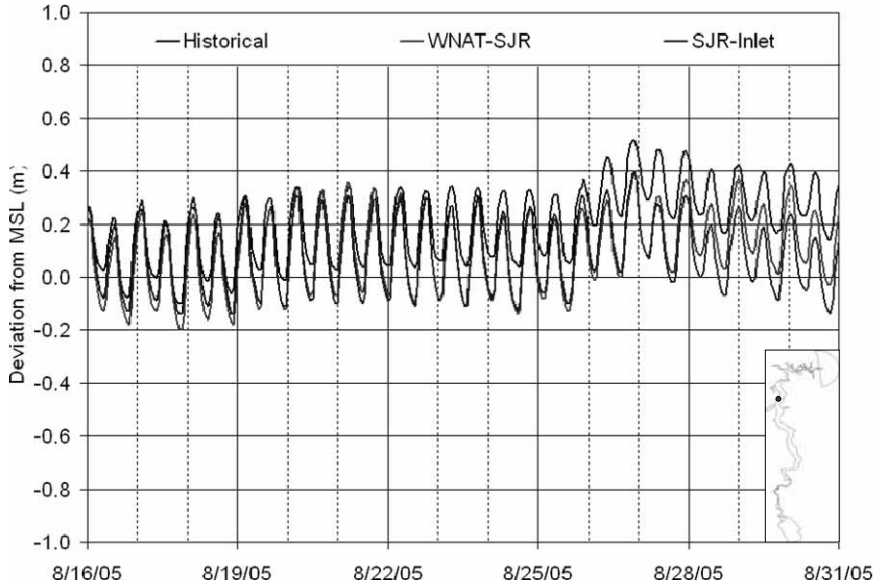

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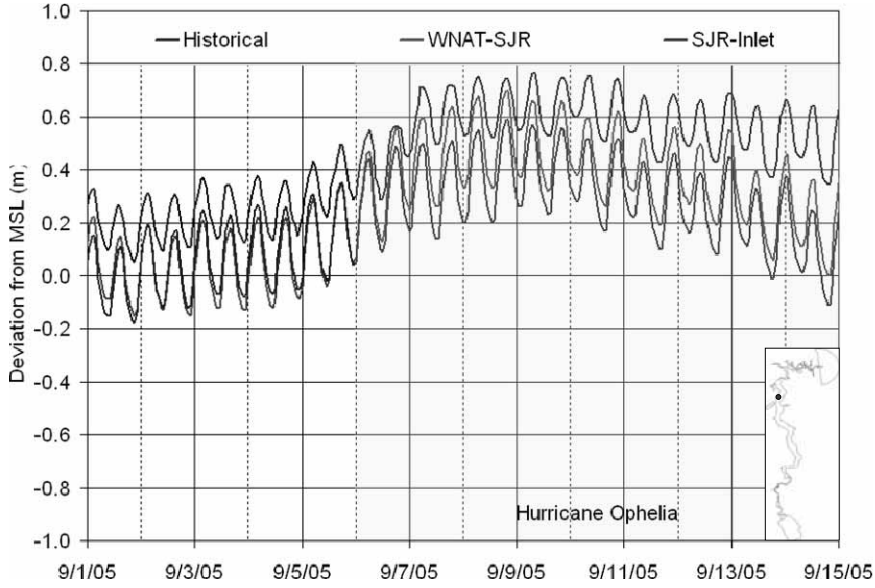

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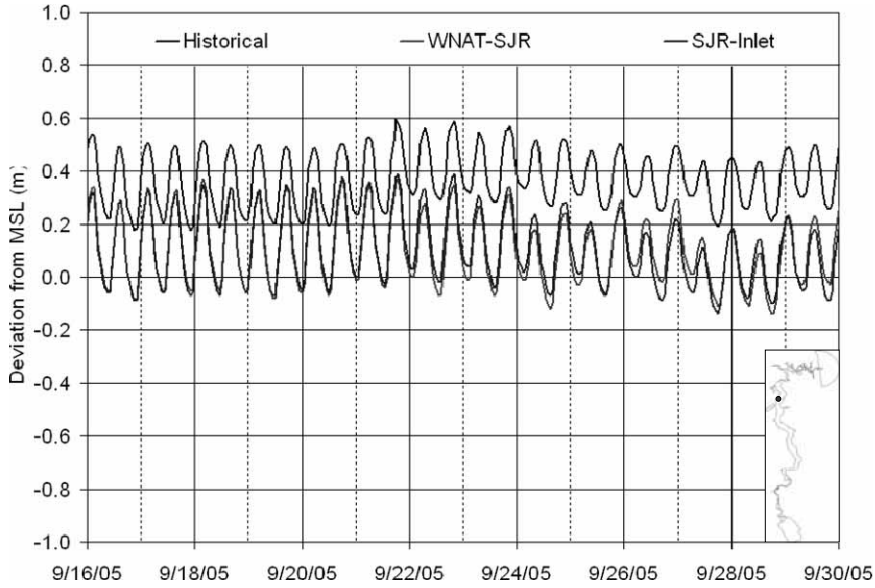

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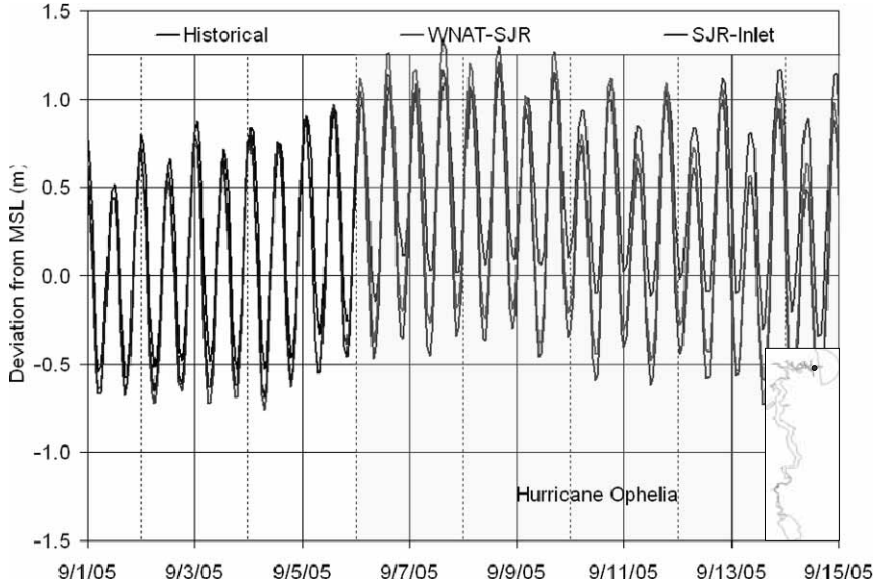

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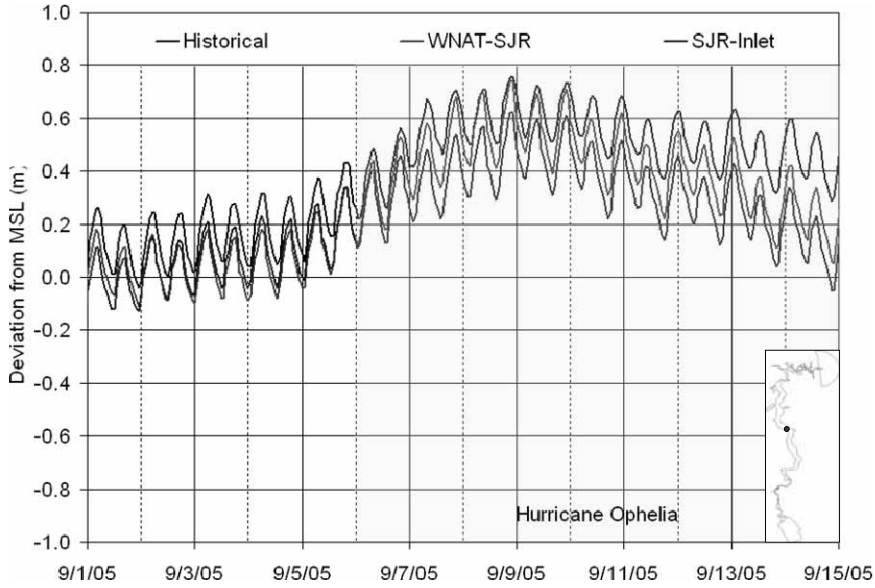

A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

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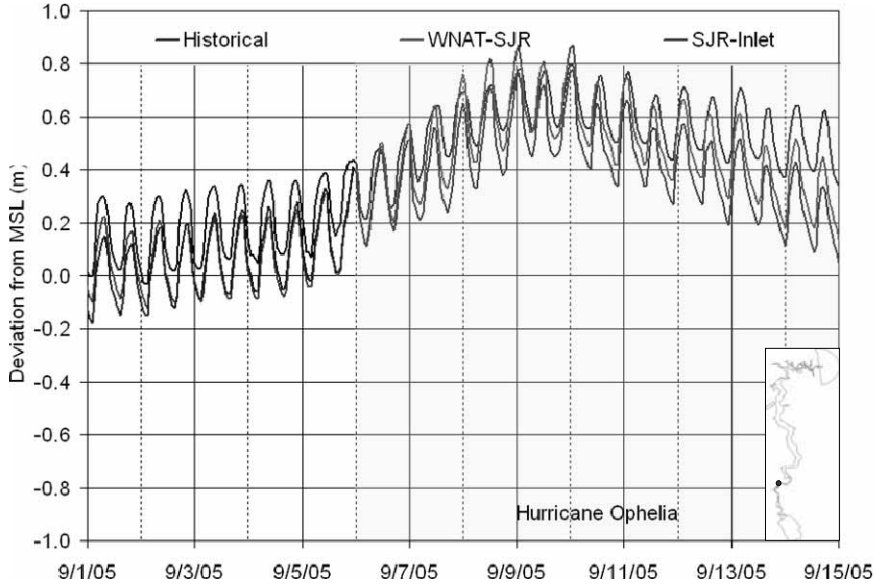

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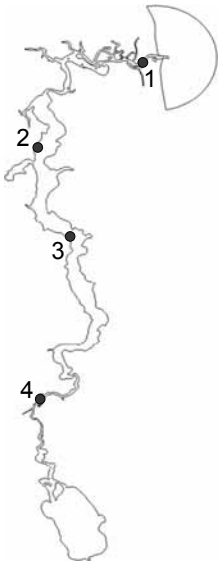
Root Mean Square Error (cm)

Station Index	122 Days (6/1/05 – 9/30/05)	
	WNAT-SJR	SJR-Inlet
1	16.7626	17.8790
2	15.6998	16.3841
3	11.1101	11.4466
Station Index	Ophelia (9/6/05 – 9/15/05)	
	WNAT-SJR	SJR-Inlet
1	26.3891	35.4856
2	20.2039	29.4767
3	12.2997	21.1140
4	10.2633	16.8139



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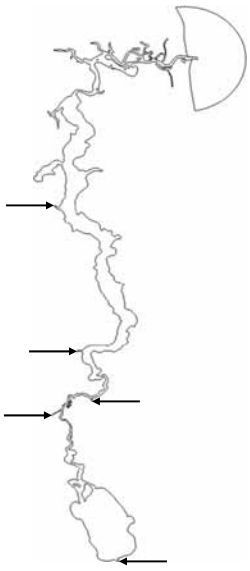
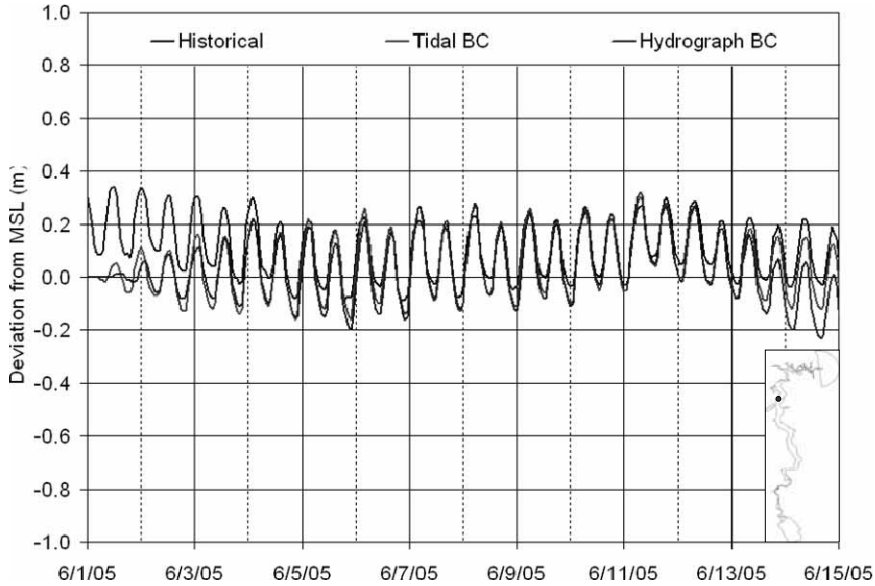


SJR-Inlet Mesh Application: I-295 Bridge, West End



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

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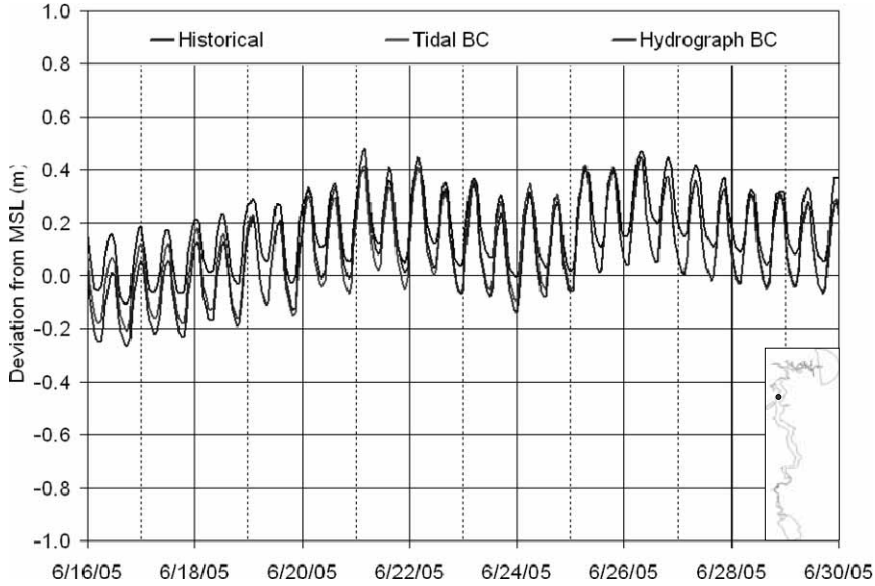

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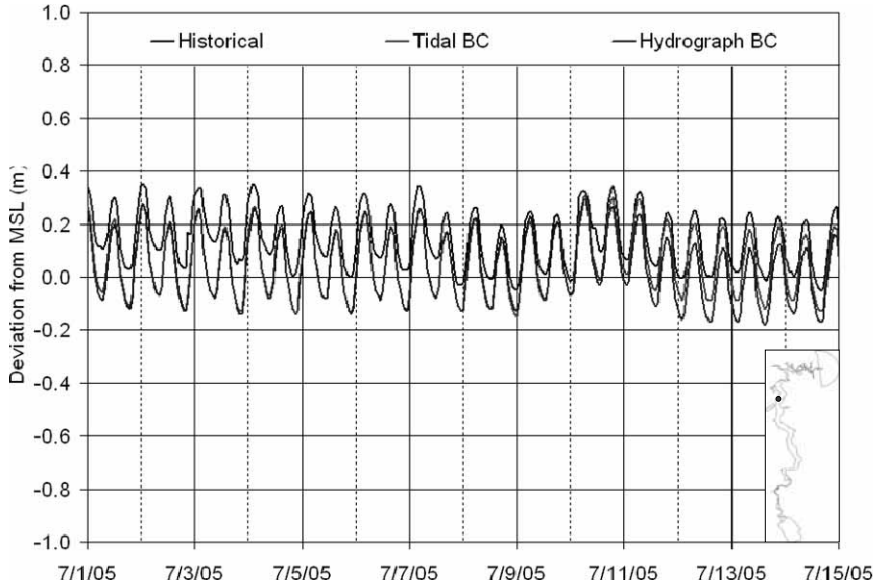

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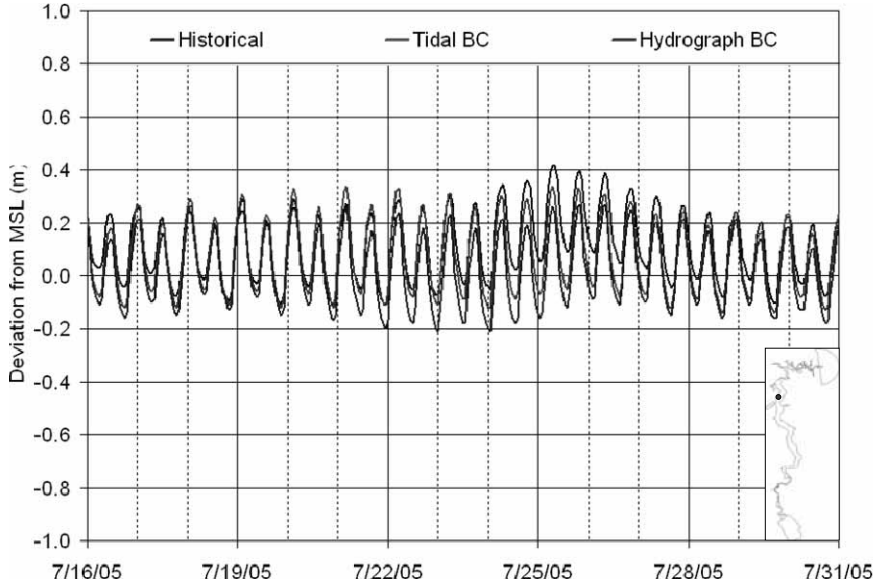

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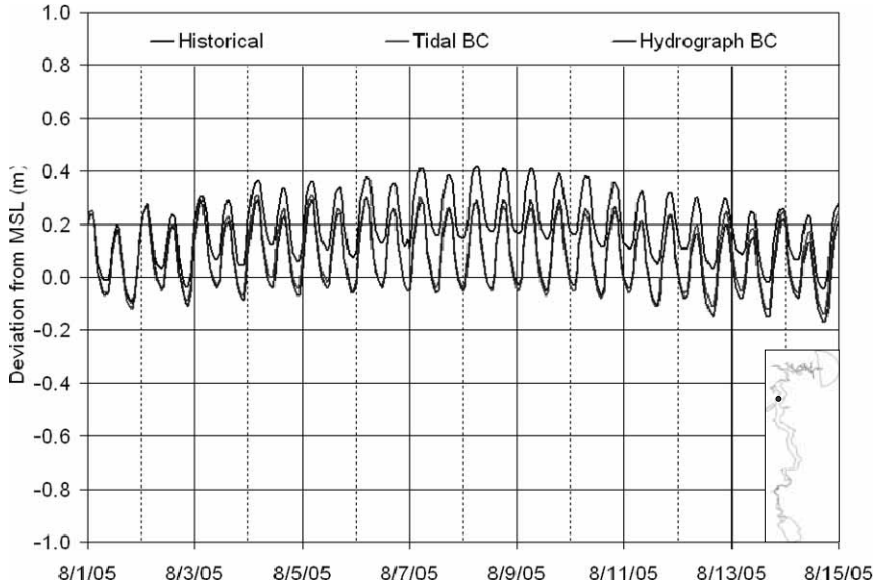

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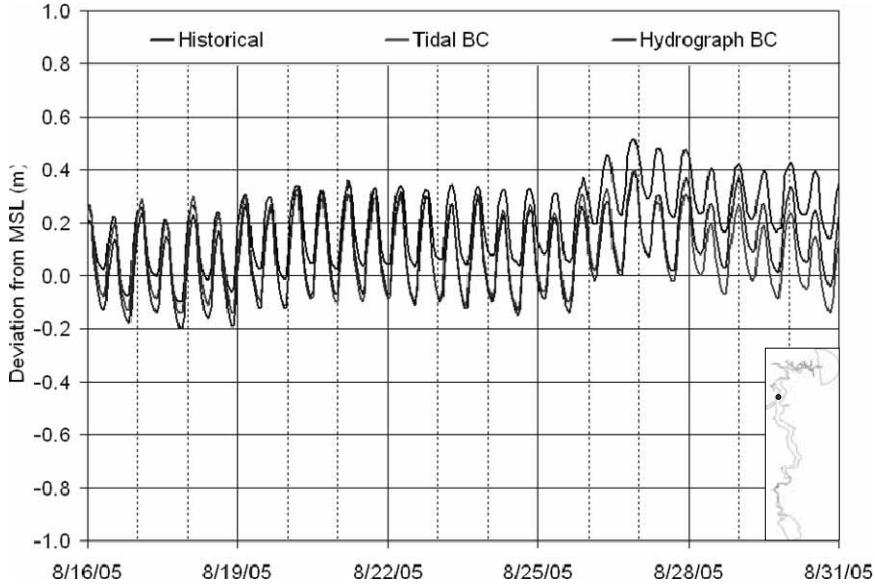

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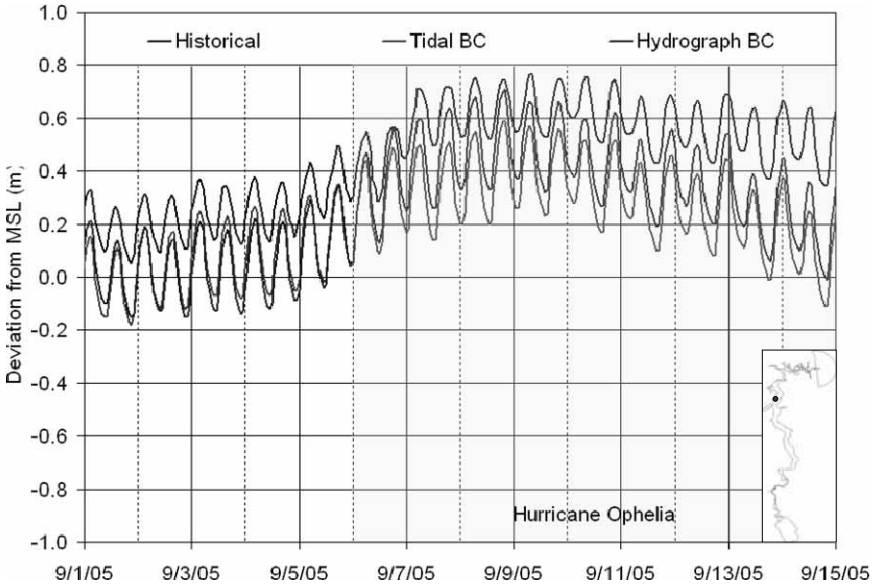

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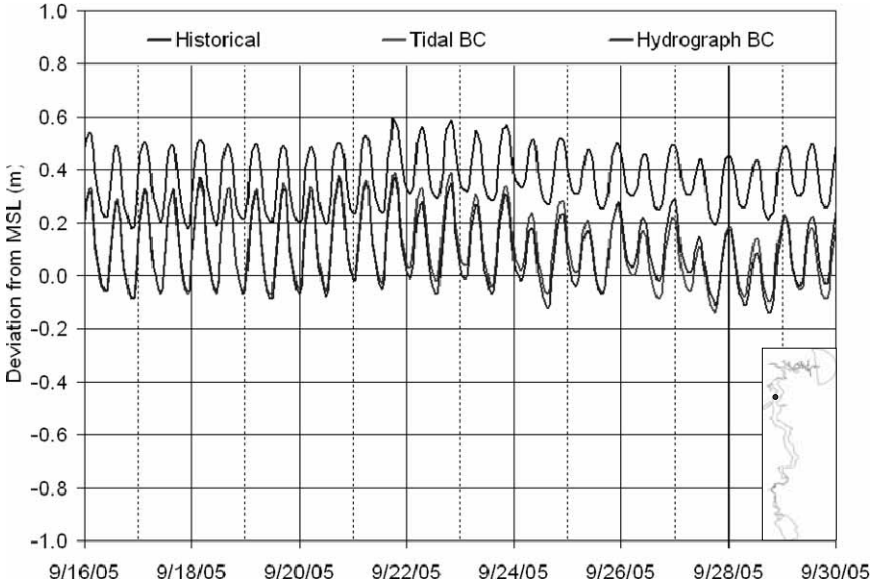

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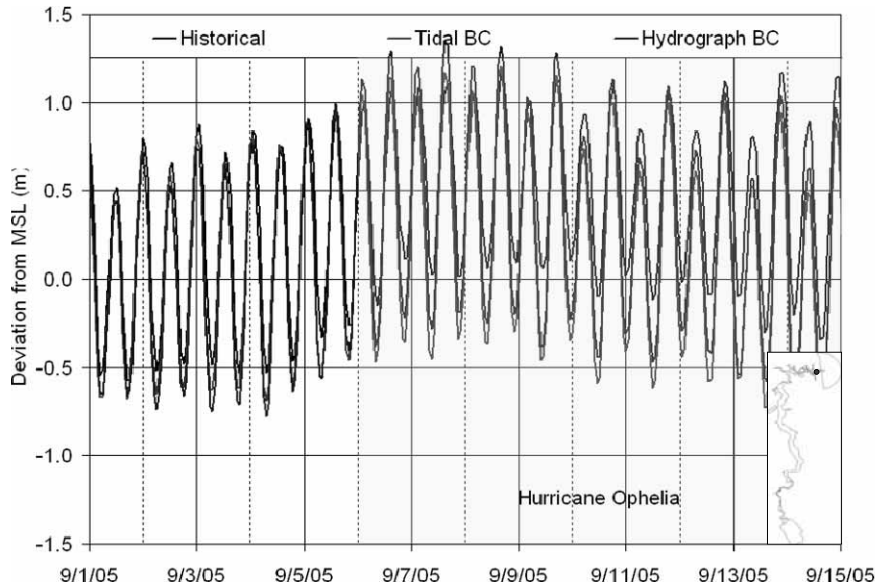

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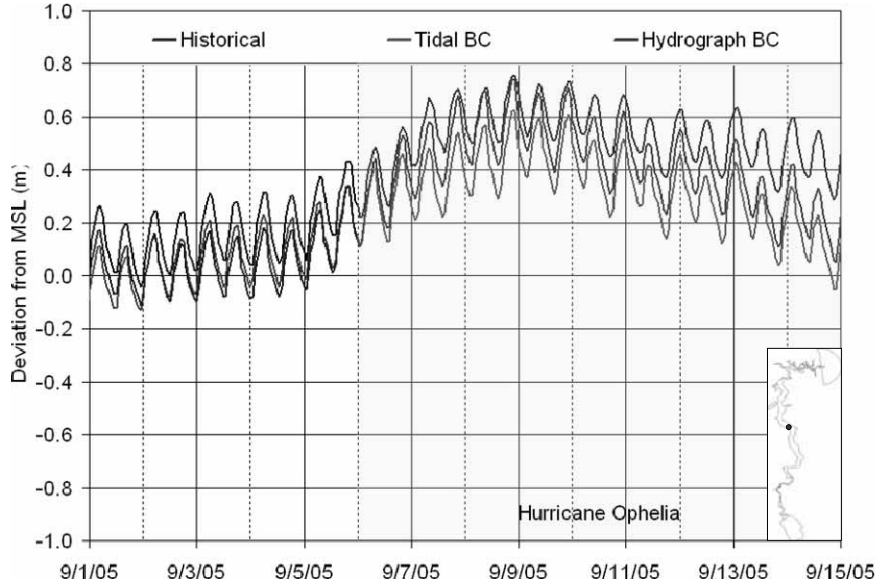

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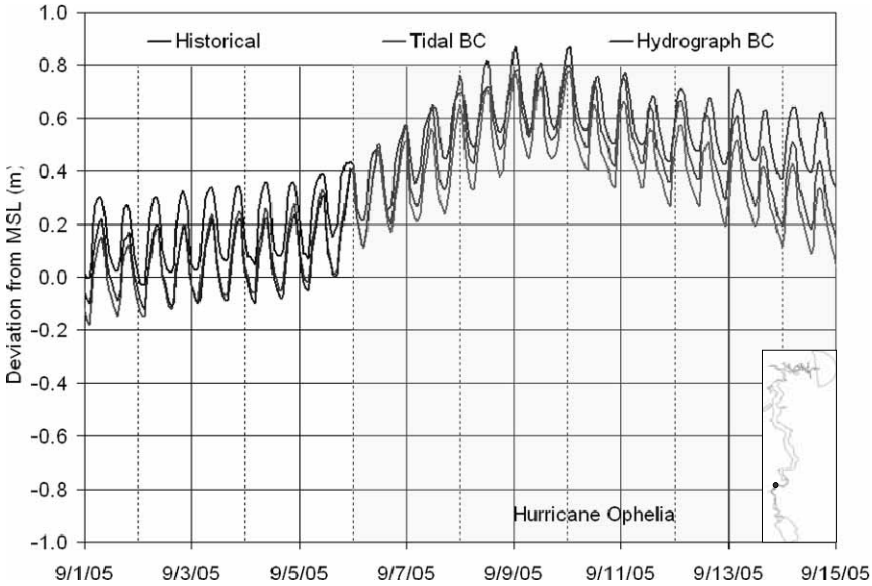

A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Root Mean Square Error (cm)

Station Index	122 Days (6/1/05 – 9/30/05)		
	WNAT-SJR	Tidal BC	Hydrograph BC
1	16.7626	17.8790	16.1939
2	15.6998	16.3841	15.9926
3	11.1101	11.4466	11.3935
Station Index	**Ophelia (9/6/05 – 9/15/05)**		
	WNAT-SJR	Tidal BC	Hydrograph BC
1	26.3891	35.4856	26.0957
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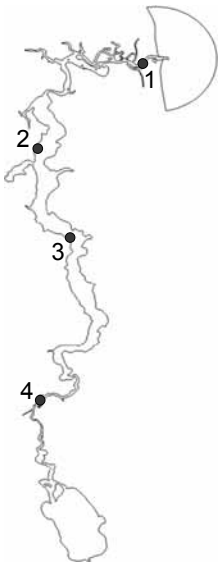
4	10.2633	16.8139	10.2078



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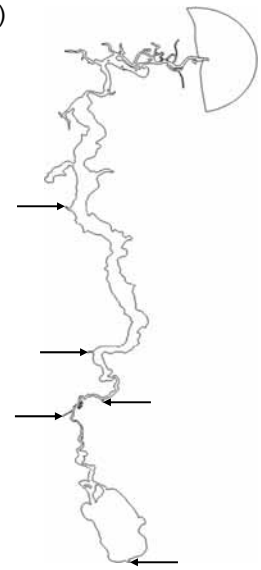
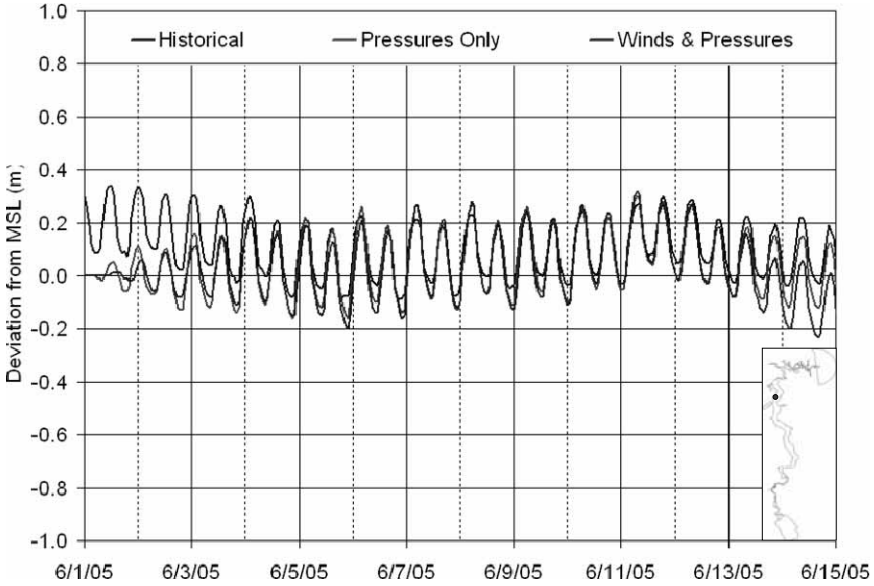


SJR-Inlet Mesh Application: I-295 Bridge, West End



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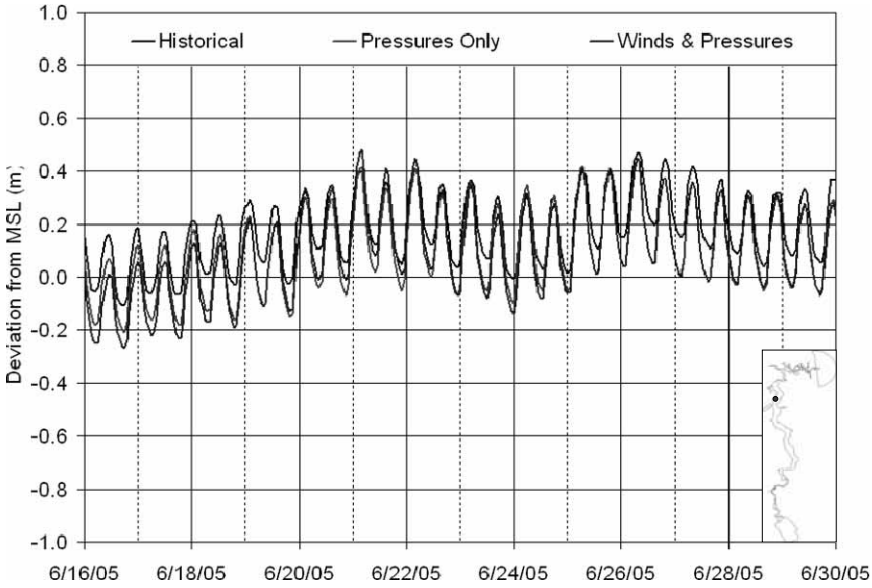

A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

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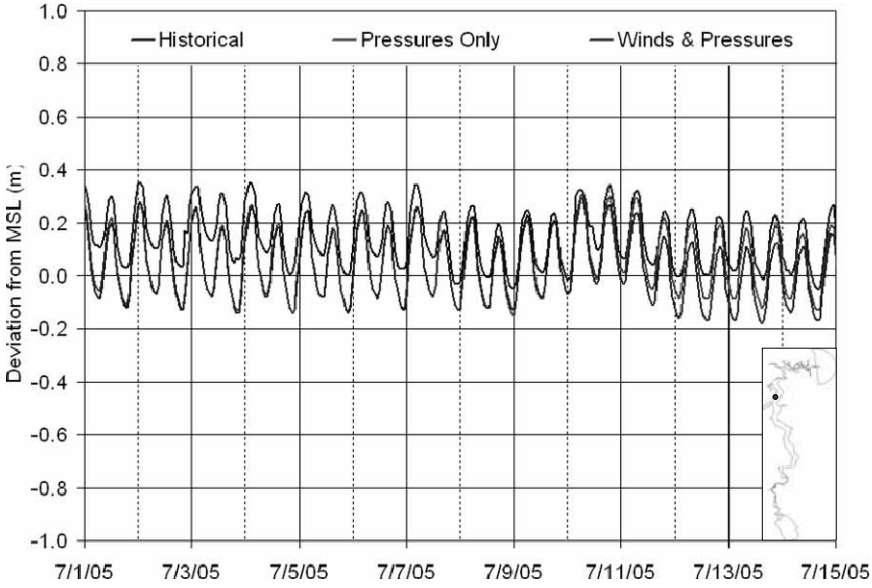

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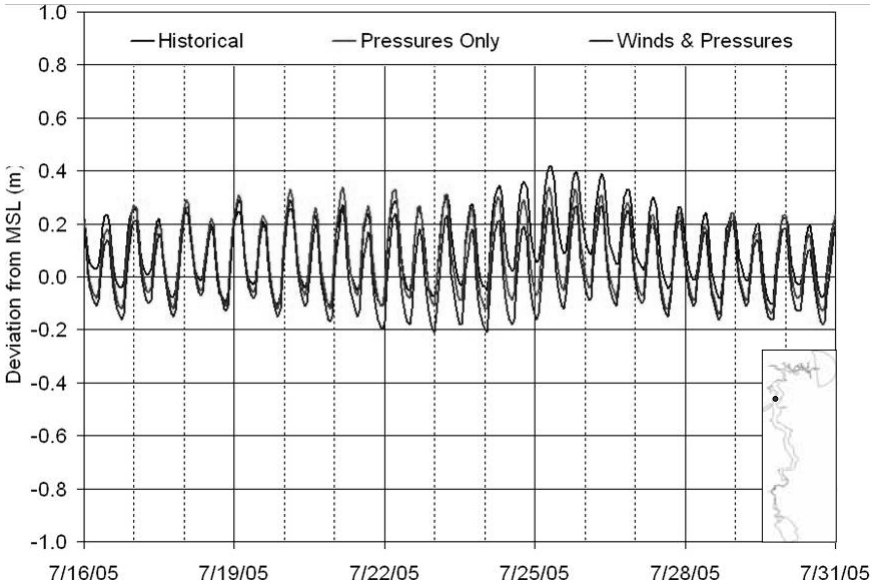

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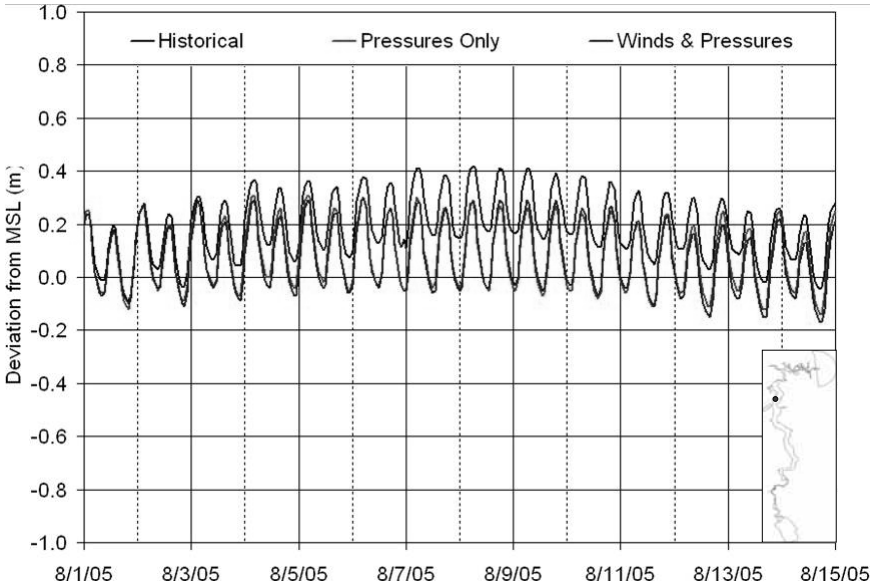

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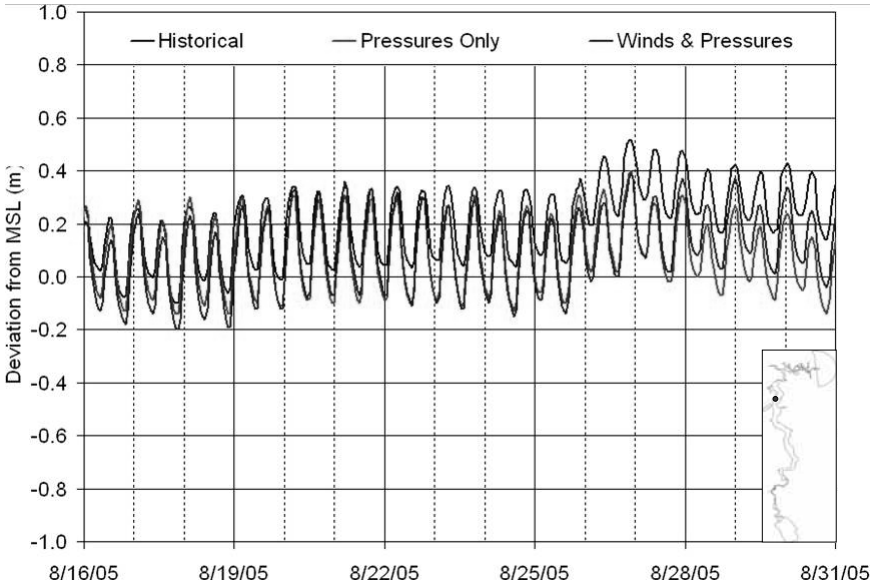

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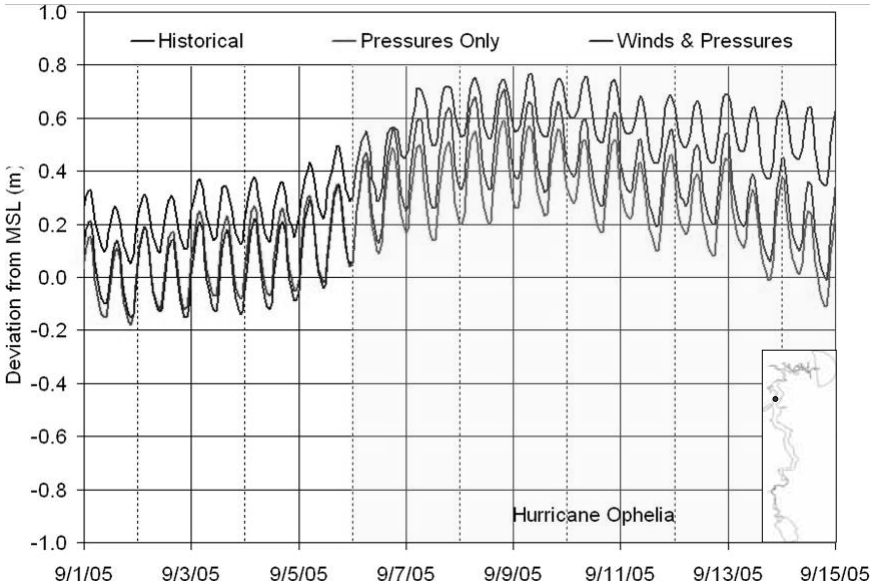

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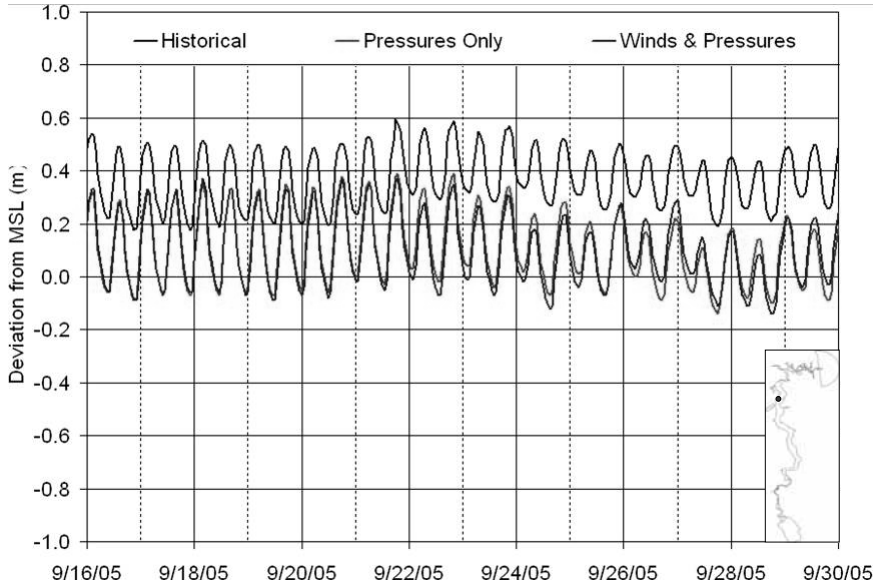

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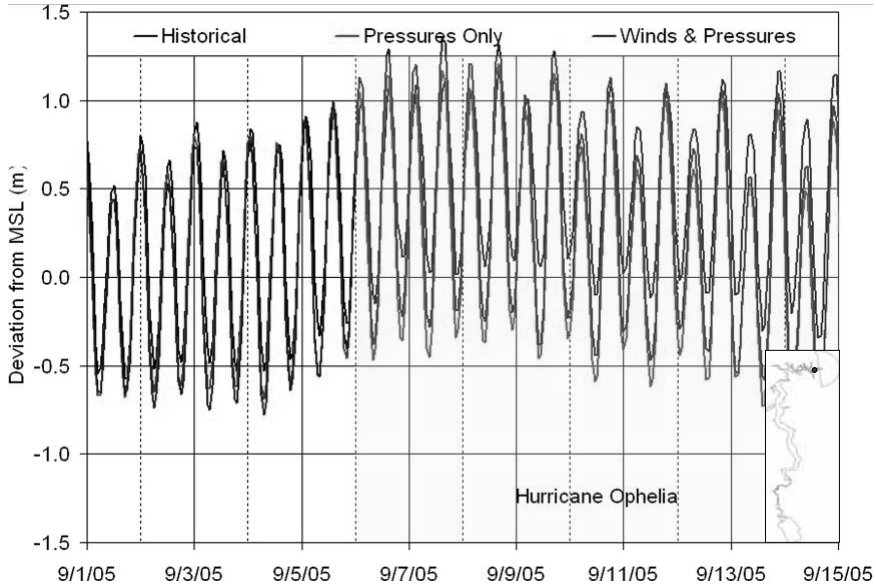

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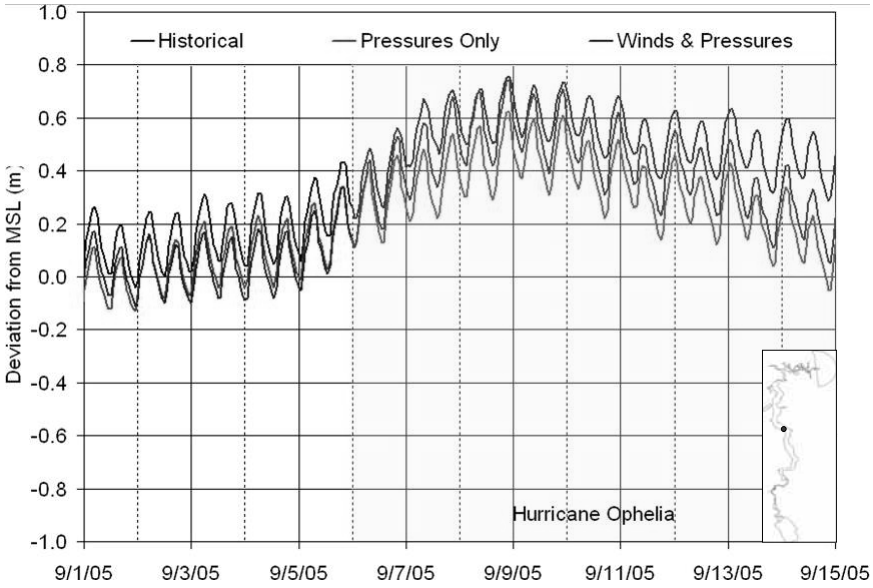

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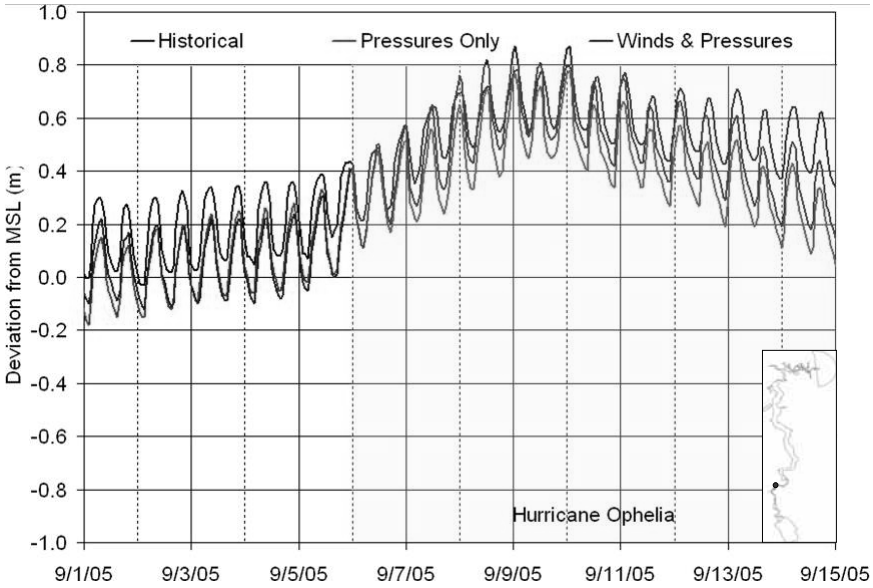
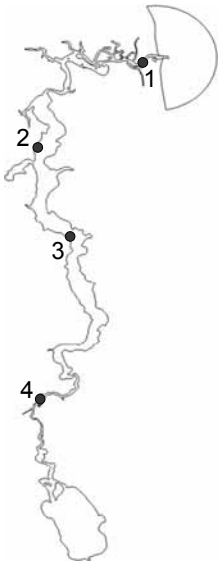


University of Central Florida http://champs.cecs.ucf.edu

Root Mean Square Error (cm)

Station Index	122 Days (6/1/05 – 9/30/05)	
	Pressures Only	Winds & Pressures
1	16.4928	16.1939
2	15.8762	15.9926
3	11.1041	11.3935
Station Index	**Ophelia (9/6/05 – 9/15/05)**	
	Pressures Only	Winds & Pressures
1	30.4350	26.0957
2	25.7576	20.3059
3	17.6485	12.3589
4	14.2969	10.2078



A Prototype for Real-Time Forecasting from the Deep Ocean into River and Estuary Systems

Conclusions

Meteorology Dominates the 122-Day Hindcast for the St. Johns River

Tides are Equally Important to Include in the Numerical Model

River Inflows are Relatively Insignificant in the St. Johns River

Local-Scale Approaches are Appropriate for Non-Tropical Weather Conditions

- Tidal Forcings Alone are Adequate as Boundary Conditions
- Surface Forcings (i.e., Winds & Pressures) Alone are Sufficient

Large-Scale Approaches are Necessary for Tropical Weather Events

- Deep-Water Surge is More Fully Captured in Ocean Basin
- Local-Scale Domains Require Hydrograph Elevation Boundary Conditions

Future Work

Model Calibration (e.g., Sensitivity to Adjustments in Wind Drag Coefficient)

Investigation of Non-Linear Wind/Pressure Interaction

University of Central Florida http://champs.cecs.ucf.edu

Acknowledgement

National Oceanic & Atmospheric Administration
U.S. Department of Commerce

Office of Hydrologic Development

National Oceanographic Partnership Program
Promoting Partnerships for the Future of Oceanography

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