

Learning From The Past...



...Surveying The Future Coastal Currents and Waves along the Texas Coastal Bend: Measurements and Model Comparisons

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Outline

- Motivation/Questions
- Observations
 - Experimental Geometry
 - General Metocean Conditions during Deployment
 - Correlations
- Applications/Questions
 - Assessment of Model Performance and Investigation of Nearshore Currents
 - Long Term Wave Climate and Computation of Inundation Datums
- Proposed Additional Observations
- Conclusions



Study Location





Current profilers: Xylem (Sontek) Argonaut SL500 (500khz, 2-D)

Bob Hall Pier, North Padre Island, Corpus Christi, Texas

Map/sattelite imagery from Google





Instrument Installation











Experimental Geometry

Offshore Looking Sensor

Current profile: 10-120 m in 11m cells Average currents: 21-109m



Nearshore Looking Sensor Current profile: 1.50-51.5 m in 5m cells

Average currents: 21.5-46.5m



Water Depth: 244" (620 cm)

measurements for 4/9/2014 3:00-4:00 PM CST pwl = 6.54+/0.0.2m above station datum



Wave & Longshore Current

General Metocean Conditions (6/9/2014-12/31/2015)

- Meteorological conditions from NWLON station
- Ocean conditions from project current profilers



Variable	Median	Range
Significant Wave Height	0.73m	0.1-2.0m
Typical Wave Period	5.9s	2.0-11.6s
Nearshore Longshore Current [m/s]	0.00 m s ⁻¹	[-0.9 m s ⁻¹ , 0.8 m s ⁻¹]
Offshore Longshore Current [m/s]	-0.03m s ⁻¹	[-1.0 m s ⁻¹ , 0.9 m s ⁻¹]

Longshore Current Correlations (Pearson)



Correlation of longshore currents with along shore winds:

- Nearshore longshore current = 0.76 (p = 0.00)
- Offshore longshore current = 0.80 (p = 0.00)

Correlation of longshore currents with significant wave height:

- Nearshore longshore current = 0.14 (p = 0.00)
- Offshore longshore current = 0.10 (p = 0.00)

Other Correlations:

- Significant wave height and across shore currents = 0.06 (p = 0.00)
- Cross-shore wind square & significant wave height = 0.42 (p = 0.00)

Longshore Currents

Comparison of Longshore Current with Alongshore Wind



Comparison of Nearshore and Offshore Longshore Current





Offshore Longshore Current

• TABS Network (GERG)

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- Correlation = 0.69
- Differences during large wave events (Dolly) & frontal passages







Арр



October 13, 2014		
Longshore current 0.46 ft/s North		
Cross-shore current 0.14 ft/s West		
Significant wave height 3.39 ft		
Typical wave period 7.2 sec		
Water level -0.31 ft		
Water Temperature 82.8 °F		
Air Temperature 86.4 °F		
Wind Speed 19.0 mph		
Wind Direction 308 ° from North		









- App/website for general users (Near Shore Conditions App) <u>http://cbi-apps.tamucc.edu/bhpwave/</u>
- More detailed info: <u>http://lighthouse.tamucc.edu/overview/260</u>



NGOFS Comparison

0.4

0.8

0

Observed Current (m/s)

Bob Hall Pier Longshore Current Comparison 1 RMSE=0.14m/s 0.8 (without correction) 0.6 R-Squared = 0.725 Predicted Current (m/s) RMSE = 0.0515 0.4 **Comparison with** 0.2 $y = 0.4^*x + 0.0016$ NOAA's Northern 0 **Gulf of Mexico** -0.2 **Operational Forecast** All data -0.4 -Linear Correction Model System (NGOFS) • Wind Over 20 mph -0.6 v=x line 6/19/14 - 3/6/2015 -0.8 -0.8 -0.6 -0.4 -0.2 0.2 0.6



Hydrodynamic Models

Performance Comparison for 3 realtime hydro models: *Longshore Currents* (9/19/2014-9/19/2015)

- NGOFS (NOAA): Northwest Gulf Operational Forecast System
- ROMS (TAMU): Regional Ocean Model System
- HYCOM (Navy): Hybrid Coordinate Ocean Model







Comparison

Model	RMSE (m/s)	Bias (m/s)	CF (<0.26 m/s)		
Bob Hall Pier Comparisons					
NGOFS	0.13	0.00	95.0%		
ROMS	0.14	-0.01	93.4%		
HYCOM	0.15	-0.01	91.5%		
TABS D Comparisons					
NGOFS	0.16	0.09	91.4%		
ROMS	0.19	-0.04	82.7%		
HYCOM	0.20	0.11	84.4%		



NGOFS Surface Current

Predictions

Coastal Bend Surface Currents 08-Jan-2015 03:00:00 UTC





NGOFS Surface Current Predictions

Coastal Bend Surface Currents 08-Jan-2015 03:00:00 UTC





NGOFS Surface Current Predictions

Coastal Bend Surface Currents 08-Jan-2015 03:00:00 UTC





- 1. Surface Current Difference = Maximum Nearshore Current (0 - 2.3 km) -Minimum Further Offshore Current (2.5 -21.7km) > 0.14 m/s
- 2. Narrow shoreline feature as identified by SOM



Time series of the Currents Differences

88 events identified by current difference criterion 70 retained (80%)



NGOFS Surface Current Predictions

Coastal Bend Surface Currents 31-Oct-2015 03:00:00 UTC





NGOFS Surface Current Predictions

Coastal Bend Surface Currents 17-Jun-2015 03:00:00 UTC





 Current pattern identified for 70 events ~5% of predicted current maps for 12/1/2014 – 11/20/2015

Conditions	Number of Cases	Median Prior Peak Wind (Direction)	Median Shoreline Feature Width	Median Peak Shoreline Current	Median Minimum Current
Frontal Passages	20	12 m/s (10°)	9.1 km (3.1–16 km)	0.41 m s⁻¹ (0.9<3.9 km)	0.15 m s ⁻¹
Strong Southeasterlies	7	10 m/s (150°)	11.8 km (7.5-26 km)	0.29 m s⁻¹ (1.0<4.2 km)	0.08 m s ⁻¹
Current Reversals	43	9 m/s (130°)	11.8 (1.8-24 km)	0.22 m s ⁻¹ (1.4 <6.8 km)	0.03 m s ⁻¹



Use relationship between significant wave height (H_{m0}) and water level standard deviation (σ) *: $\hat{H}_{m0} = \alpha \sigma$



*See: Park, Heitsenrether & Sweet (2014) Water Level and Wave Height Estimates at NOAA Tide Stations from Acoustic and Microwave Sensors, J. Atm. Oc. Tech 31, 2294-2308. Also Park & Gill (1995), Shih & Rodgers (1981).



- Historical reconstruction of significant wave height: swh = 6.406 (stdev of water levels) + 0.1186
- Applied to hourly data from Bob Hall Pier 9/1/2003-8/31/2015



Tidal Datums & Still Water Level Flooding Frequencies Bob Hall Pier, Texas



Tidal Datums & Estimated Total Water Level Flooding Frequencies, Bob Hall Pier, Texas



Statistics based on NOAA Datums and data collected 09/01/2003-08/31/2015

Tidal Datums & Estimated Total Water Level Flooding Frequencies, Bob Hall Pier, Texas



Statistics based on NOAA Datums and data collected 09/01/2003-08/31/2015



Ongoing Proposals

Use of high resolution and IR cameras to monitor beach and surf for wet/dry line, rip currents, hydrodynamic model verification



- Measured currents strongly correlated to alongshore nearshore wind
- Comparison of measurements with operational models (NGOFS, HYCOM, ROMS)
- Identification and characterization of nearshore current
- Wave measurements allowed to compute coastal inundation frequencies



Questions/Suggestions?

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- The CBI field crew and information technology team are gratefully acknowledged for efficiently and creatively resolving problems during the project.





Abstract

Current profiles and wave measurements were collected along the Texas Coastal Bend taking advantage of the infrastructure of Bob Hall Pier located near Corpus Christi, Texas. Measurements included significant wave height, typical wave period, average along and cross-shore currents and current profiles for the period of June 2014 through fall 2015. The instruments are installed near two inlets and associated sensitive avian and aquatic habitat. Measurements during the duration of the observations will be presented and correlated with local conditions, in particular the influence of atmospheric forcings during frontal passages and strong southeasterly flow. The measurements will also be used to compare the performance of several operational hydrodynamic models including the recently deployed Northern Gulf of Mexico Operational Forecast System (NGOFS). Finally model nowcasts are used to illustrate nearshore current patterns. The instruments continue to provide near real-time data invaluable to facilitate the prediction of oil movement and the deployment of protection measures in case of oil spill. The data is also leading to a better understanding of sediment transport along the coast and more specifically for the periodic renourishment and maintenance of the nearby popular beaches located along Mustang and North Padre Island. Other applications include providing information appropriate for search and rescue situations, reporting surf conditions and alerting beach-goers to conditions favorable to the onset of rip currents.

Alternate Study Location Slide





Offshore Looking Sensor Deployment Geometry I-Beam & winch for offshore looking sensor Pier Pile Pier Pile Sensor I-Beam NWLON Pile







Offshore Looking Sensor Experimental Geometry

Interference up to 15-20m



Picture from Sontek (http://www.sontek.com/productsdetail.php?ADP-Acoustic-Doppler-Profiler-4)



Offshore Longshore Current





Offshore Longshore Current

Offshore longshore current defined by currents ~ 21-65m from the offshore looking sensor





Argonaut SL500 Specifications

	SL3000	SL1500	SL500
Sampling Range ¹	0.1 to 5m (0.3 to 17 ft)	0.2 to 20m (0.7 to 66 ft)	1.5 to 120m (5 to 400 ft)
Minimum Channel Width	0.75m (2.5 ft)	1.50m (5 ft)	6.5m (21 ft)
Acoustics -Horizontal Beam Width ²	1.4°	1.4°	1.4°
-Vertical Beam Width ²	1.4°	2.9°	3.8°
-Side Lobe Suppression ³	>60dB	>60dB	>60dB
PowerPing Hi-Precision	✓	\checkmark	n/a
SonTek TrueCompass/Tilt	n/a	✓	✓
<u>Water Level</u> -Vertical Beam Range	0.1 to 5.0 m (0.3 to 17 ft)	0.15 to 10m (0.5 to 33 ft)	0.2 to 18.0m (0.7 to 59 ft)
-Accuracy	(depth < 3 m): ± 0.3 cm (0.01 ft) (depth \geq 3 meters): $\pm 0.1\%$	(depth < 3 m): ±0.3 cm (0.01 ft) (depth ≥ 3 meters): ±0.1%	(depth < 6 m): ±0.6 cm (0.02 ft) (depth ≥ 6 meters): ±0.1%
-Pressure Sensor (Accuracy)	n/a	0.25%	0.25%
-Wave Height Spectra	n/a	Optional	Optional
Power -Input	7-15 VDC	7-15 VDC	7-15 VDC
-Consumption ⁴	0.5 – 0.7 W	0.5 – 0.7 W	0.7 – 1.0 W
Physical -Weight in Air	1.2 kg (2.6 lb)	2.4 kg (5.3 lb)	6 kg (13.2 lb)
-Weight in Water	0.3 kg (0.7 lb)	0.2 kg (0.5 lb)	1.1 kg (2.5 lb)
-Pressure Rating (Max Depth)	30 m (98 ft)	30 m (98 ft)	30 m (98 ft)
-Mounting Plate Dimensions	28 x 25 x 1 cm (11" x 8" x 0.4")	Integrated Mount	35.5 x 22.9 x 1.5 cm (14" x 9" x 0.6")