NOAA's Recent Development and Test for Sea Level and Waves Measurement Systems

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Introduction

Center for Operational Oceanographic Products and Services (CO-OPS):

CO-OPS manages the National Water Level Observation Network (NWLON) and Physical Oceanographic Real-time System (PORTS®), which provide critical water level and meteorological data for marine navigation, coastal hazards monitoring, climate research, and habitat preservation across the nation.

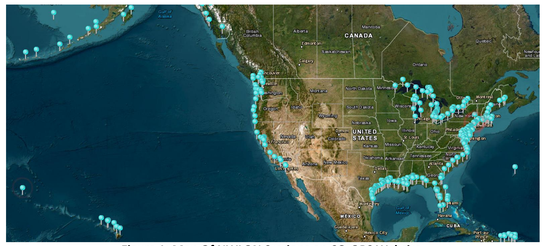


Figure 1: Map Of NWLON Stations on CO-OPS Website

Why is water level and waves data important?

Accurate, real-time measurements can equip communities with the data they need to make informed policy and personal decisions to protect people and their property during coastal storms or flooding events.

Project Objective:

Development and test of two low cost, quick deployable water level and waves measurement systems for coastal hazards monitoring and increasing spatial coverage in water level monitoring.

Test Systems

Table 1: Sensor Overview

Sensor Name	E+H Microwave Radar (Currently Used Sensor)	Vega C22 Radar (Test Sensor)	RBR Duet 2 Pressure Sensor (Test Sensor)
Type:	Radar	Radar	Pressure + internal logger
Picture:			
Application:	Real-time observation, above surface, remote sensing	Real-time observation, above surface, remote sensing	Post-measurement analysis, subsurface, in-situ
Approx. Cost	$4,700	$1125	$5,000
Signal Frequency	26 GHz	80 GHz	H/A
Max Range	40 m	15 m	100 m
Sample Rate	1 Hz	1 Hz	1 Hz

Test Site 1 Methods and Results

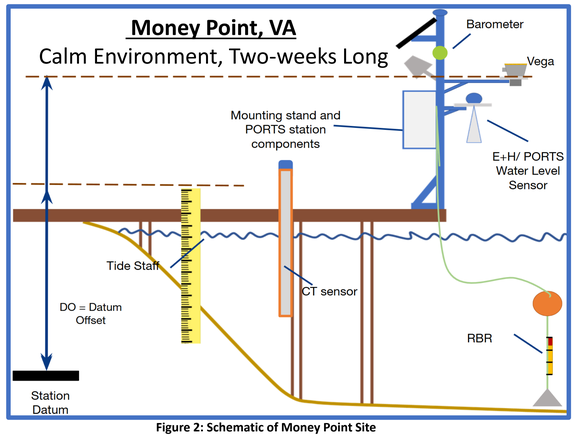


Figure 2: Schematic of Money Point Site

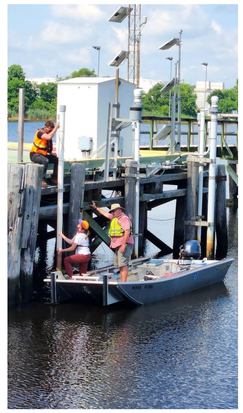


Figure 3: Picture of Money Point Site

Methods

- Data was vertically referenced using the station datum and tide staff readings
- Data analyzed and clean using same procedure as the NWLON

Table 2: Money Point Results

Sensor	Vega	RBR
Mean Difference	-9 mm	13 mm
RMSE	10 mm	14 mm

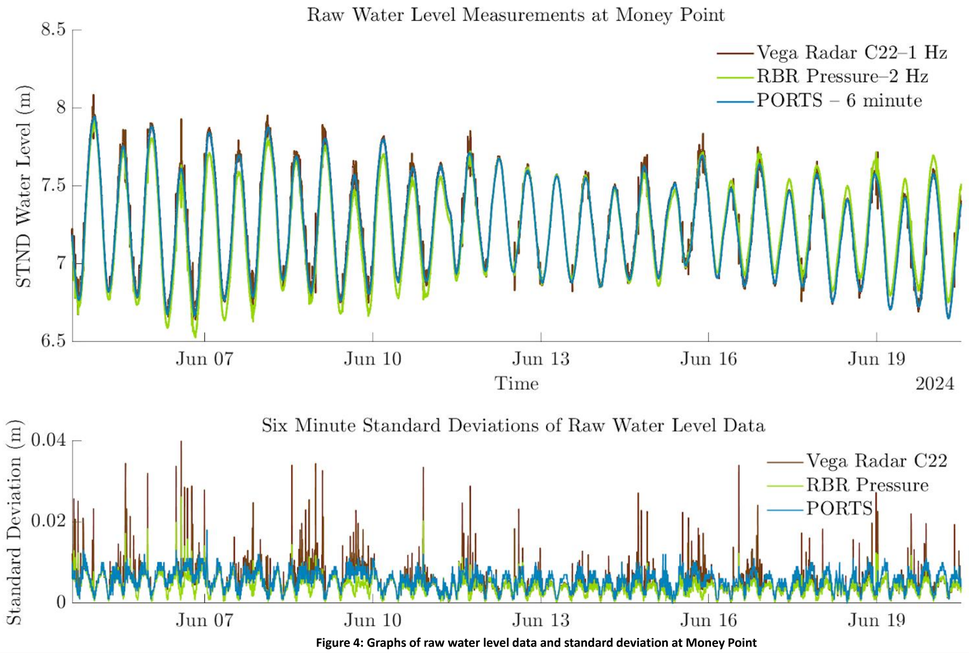


Figure 4: Graphs of raw water level data and standard deviation at Money Point

Test Site 2 Methods and Results

Duck, NC

Open Ocean Environment, Only Vega Tested, Three-week long test



Figure 5: Picture of Duck Site

Methods

- Vertically referenced data with high precision tape measure, and analyzed and cleaned data using same procedure as the NWLON
- Wave data calculated through a python code using Welch method Fourier analysis

Table 3: Duck Results

Sensor	Vega
Water Level Mean Difference	22 mm
Water Level RMSE	21 mm
Waves Avg Wave Height Difference	9 mm

Update from Initial Test

- Initial 3 weeks of data results seen in *Figure 6* motivated installation of improved sensor mount.
- Sensor performance improved significantly with new mount/installation; dropouts no longer and issue

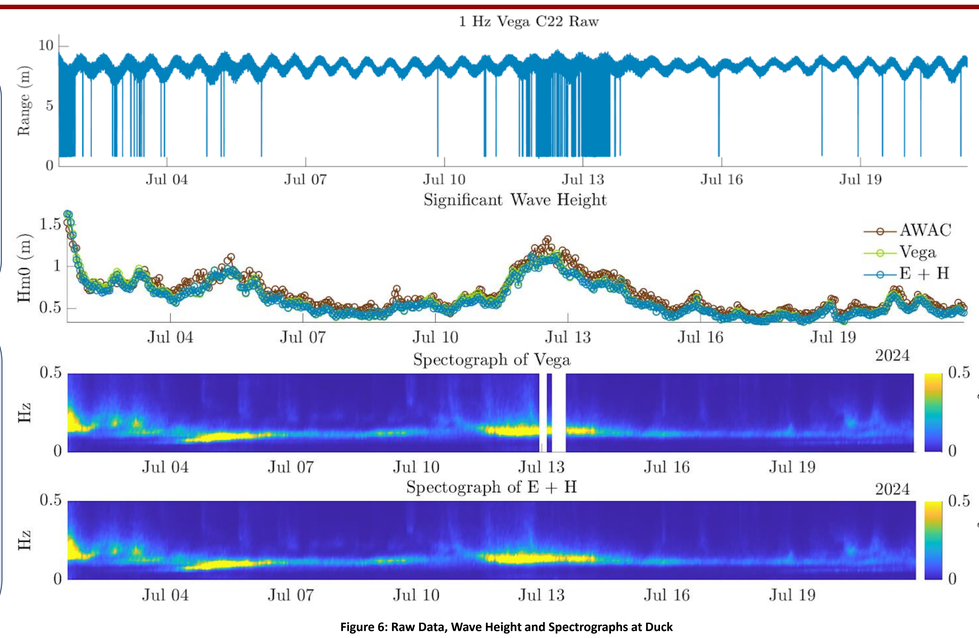


Figure 6: Raw Data, Wave Height and Spectrographs at Duck

Conclusion and Future Work

RBR: The RBR performed well at monitoring water levels in a calm environment. However, more work must be done on improving deployment techniques and lengthening the RBR deployments without power outage issues.

Vega: The Vega did well monitoring water level and waves in both calm and open ocean environments. After modifying the mount to be more stable and extend further from the pier edge, dropouts no longer became an issue.

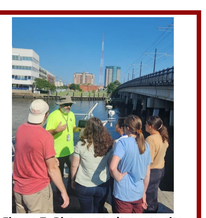


Figure 7: Picture at alternate site

References

1. L. A. Fiorentino, D. Ilogho, R. Heitsenrether and W. Hensley, "Update on NOAA's Development and Test of Measuring Waves with a Radar Tide Gauge," *OCEANS 2023 - MTS/IEEE U.S. Gulf Coast*, Biloxi, MS, USA, 2023

2. Ashley Miller & Audra Luscher (2019) NOAA's national water level observation network (NWLON), Journal of Operational Oceanography