IMPROVED OFFSHORE AND COASTAL WAVE FORECASTING

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2ND INTERNATIONAL WORKSHOP ON WAVES,
STORM SURGES AND COASTAL HAZARDS
NOVEMBER 11, 2019; MELBOURNE, AU
US embraces offshore wind power

Predicted $300 billion investment over next decade
MOTIVATION

Mid-Atlantic states – 10 active lease areas

Serving 45% of Nation’s population and energy needs
Commonwealth of Virginia developing the first offshore project in US Federal Waters

Virginia has committed to procuring 200+ turbines by 2022
MOTIVATION

Accurate / timely wave forecasts critical for safe and economical operations

OBJECTIVE

Increase forecast accuracy to provide measurable improvement to offshore and coastal operations
A new forecasting approach:

• Ingest operational forecasts
• Assimilate buoy observations
• Integrate 35 years of wave research
• Latest computing advancements

Significant gains in accuracy and run efficiency
FOLLOW THE ENERGY... TRACE THE WAVE SYSTEMS!
Wave Component

A specific sea or swell peak in a directional (2D) wave spectrum

Gerling (1992)
Hasselmann et al. (1994, 1996)
Hanson & Phillips (2001)
Tracey, Tracey and Hanson, 2007
Portilla et al. (2009)

...
TEMPORAL WAVE SYSTEM TRACKING

NOR’IDA: November 2009, North Carolina NDBC 44056
SPATIAL WAVE SYSTEM TRACKING

van der Westhuysen, Hanson and Devaliere, 2013
WAVE FORECASTING RE-IMAGINED

Wave System Approach

- Buoy data assimilation
- Nearshore wave model
- Hi-resolution nearshore bathymetry (FEMA, USGS, USACE)

Modern Computing Techniques

- Data Fusion – Merging data from the WWW
- Artificial Intelligence – Advanced machine learning algorithms
- State-of-the-Art Cloud Computing – Fast and efficient computing
DATA ASSIMILATION

- Bulk Hs Assimilation (v. 1)
- Buoy bulk parameters
- Propagated through model wave systems

Data Assimilator Results

![Wave Height vs Date](image)

- Buoy
- Assimilated
- WAVEWATCH
12-H FORECAST VALIDATION

STATION 44100 DUCK NC

- NDBC 44100 Observations
- WaveWatchIII - Accuracy 86%
- Nessie - Accuracy 94%
12-H FORECAST VALIDATION

NOAA WAVEWATCH III

86% Accurate

ASSIMILATED

94% Accurate

Accuracy (%) | 86
---|---
RMS | 0.99
Bias (ft) | -0.54
R2 | 0.94

Accuracy (%) | 94
---|---
RMS | 0.65
Bias (ft) | -0.06
R2 | 0.94
BULK ASSIMILATOR (v.1)
Hs FORECAST IMPROVEMENT

Wave System Assimilator (v. 2) Coming Online
NEARSHORE MODEL

- Synthesizes 35 years of wave research
- Operates on assimilated wave systems (Hs/Tp/Dm)
- High computational efficiency

Used to explain extreme wave events at a commercially important UK LNG terminal
DATA FLOW SUMMARY

AZ CLOUD

Winds WeatherFlow Web API

Hi Res Bathy – Binary File

Waves WW3/SWAN NCEP OPeNDAP

Tides WWW Tide/Current Predictor- Text File

Buoy Obs NDBC – SOFAR

ACUSEA

• Data fusion
• Data assimilation
• Nearshore model
• AI model

Surf Forecast

Offshore Wave Forecast
NESSIE SURF FORECAST

Mobile-friendly online site

Operational Domains

- Virginia
- North Carolina
- New Jersey
- Florida
- Hawaii

Validation

The Surf Community helped us build an Outstanding Product...
OFFSHORE VIRGINIA WIND ENERGY AREA FORECAST

In partnership with...
- VA Dept Mines, Minerals and Energy
- Old Dominion University
- SOFAR Ocean Technologies
- WeatherFlow

A Portable Forecast Technology using Low-Cost Drop-in Buoy Observations
WHAT’S NEXT?

• Wave system assimilator v.2
WHAT’S NEXT?

- Wave system assimilator v.2
- Machine learning advancements
WHAT’S NEXT?

- Wave system assimilator v.2
- Machine learning advancements
- Multiply portable forecast domains!
QUESTIONS...