

Assimilation of Wave Imaging
Radar Observations for Real-time
Wave-by-Wave Forecasting

Merrick C. Haller
Alexandra Simpson

Oregon State University
Merrick.Haller@oregonstate.edu, 541.737.9141

Assimilation of Wave Imaging Radar Observations for Real-time Wave-by-Wave Forecasting

The Challenge: To develop and assess the performance of a novel wave-by-wave forecasting method for applications in wave energy converter (WEC) controls.

Partner: Dr. David Walker, SRI International

Role: Data assimilation expert

Partner: Dr. Patrick Lynett, University of Southern California

Role: Wave modeling expert

Technology Maturity

- Test and demonstrate prototypes
- Develop cost effective approaches for installation, grid integration, operations and maintenance
- Conduct R&D for innovative MHK systems & components
- **Develop tools to optimize device and array performance and reliability**
- Develop and apply quantitative metrics to advance MHK technologies

Deployment Barriers

- Identify potential improvements to regulatory processes and requirements
- Support research focused on retiring or mitigating environmental risks and reducing costs
- Build awareness of MHK technologies
- Ensure MHK interests are considered in coastal and marine planning processes
- Evaluate deployment infrastructure needs and possible approaches to bridge gaps

Market Development

- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain and communicate our national strategy
- Support development of standards
- Expand MHK technical and research community

Crosscutting Approaches

- Enable access to testing facilities that help accelerate the pace of technology development
- **Improve resource characterization to optimize technologies, reduce deployment risks and identify promising markets**
- Exchange of data information and expertise

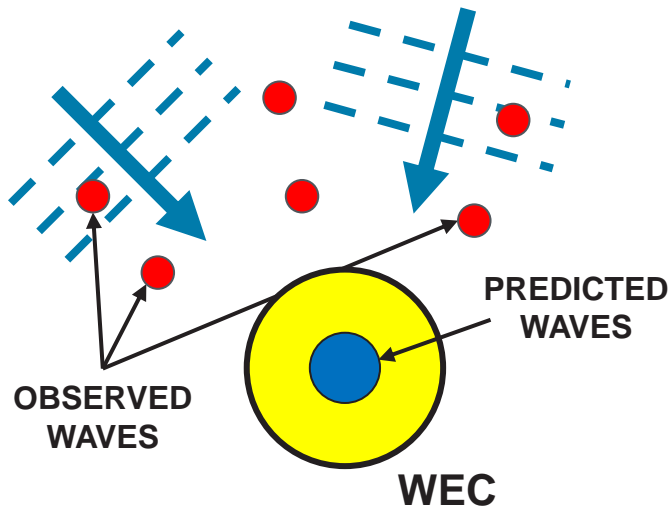
Technology Maturity

- Test and demonstrate prototypes
- Develop cost effective approaches for installation, grid integration, operations and maintenance
- Conduct R&D for Innovative MHK systems & components
- **Develop tools to optimize device and array performance and reliability**
- Develop and apply quantitative metrics to advance MHK technologies

The Impact

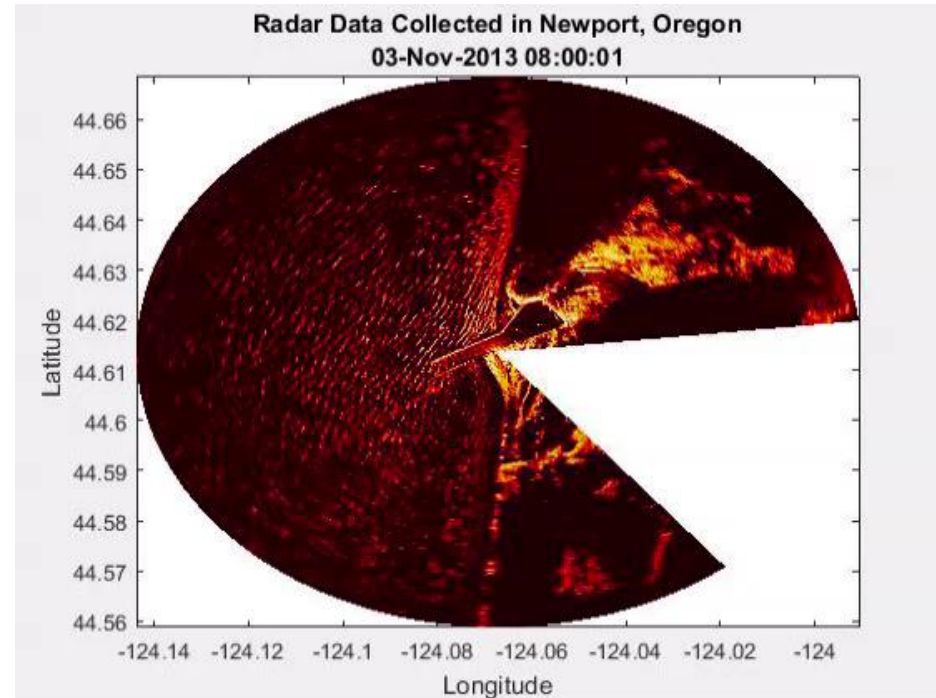
- Existing theory demonstrates that feed-forward WEC control schemes can improve energy capture by 100–300%
- This potentially lowers the cost-of-energy for WECs with active control schemes
- Project Endpoint: demonstrate a forecasting system that enables real-time forecasting of wave parameters *on a wave-by-wave basis* for a forecast horizon of at least 30 seconds.

Approach to wave forecasting:



1. Make observations around WECs
2. Use physics-based wave model to propagate forward in time and space

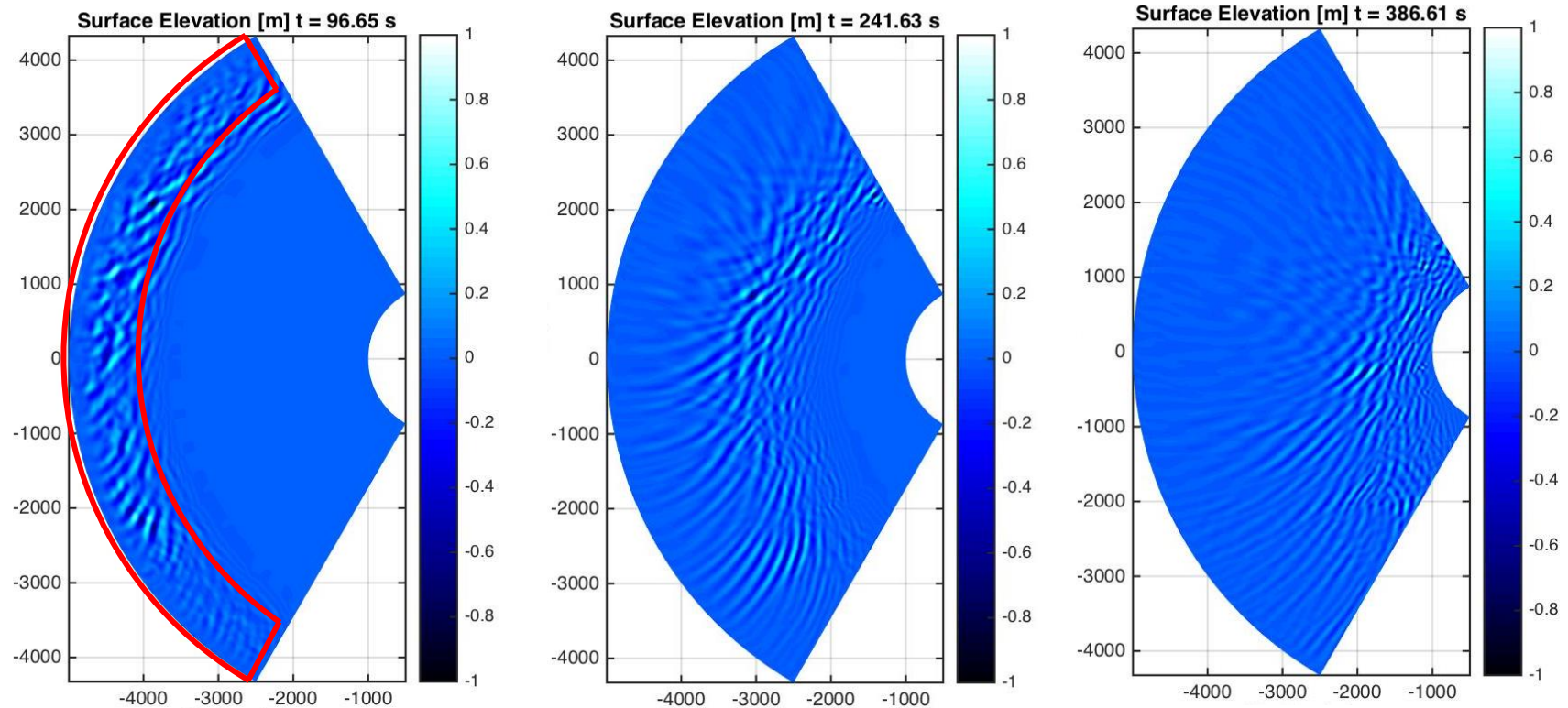
Adapted from Fusco & Ringwood, 2010



Radar.mp4

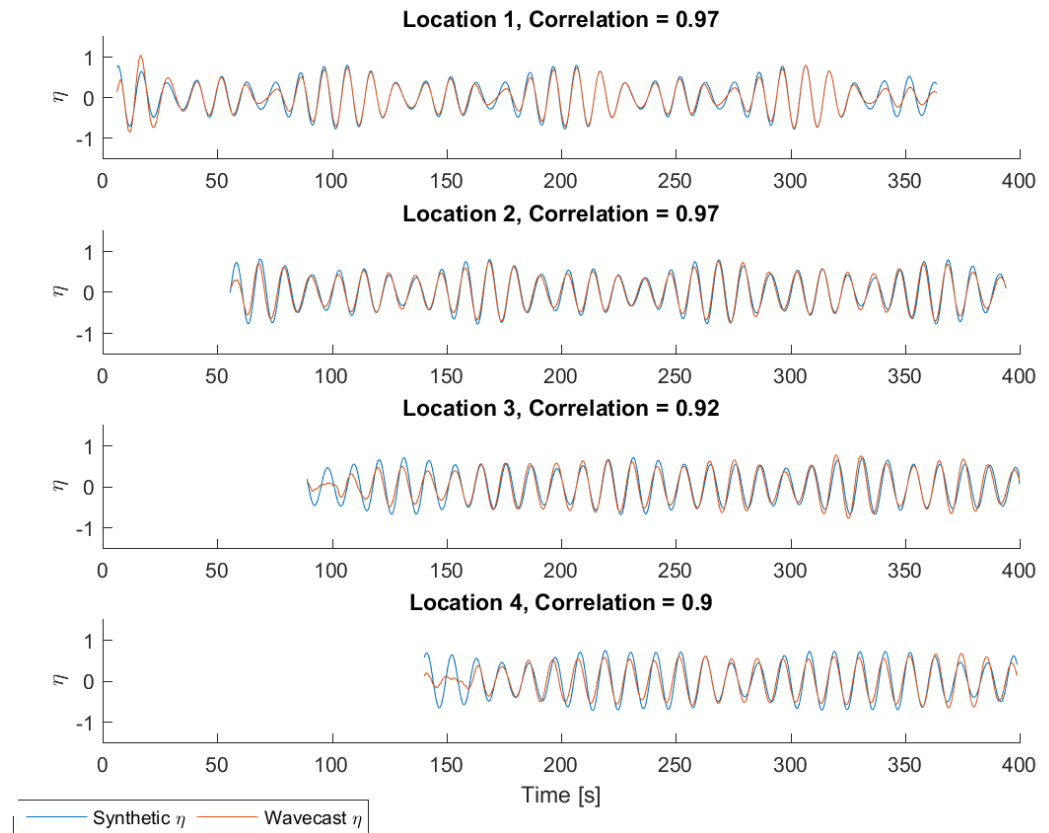
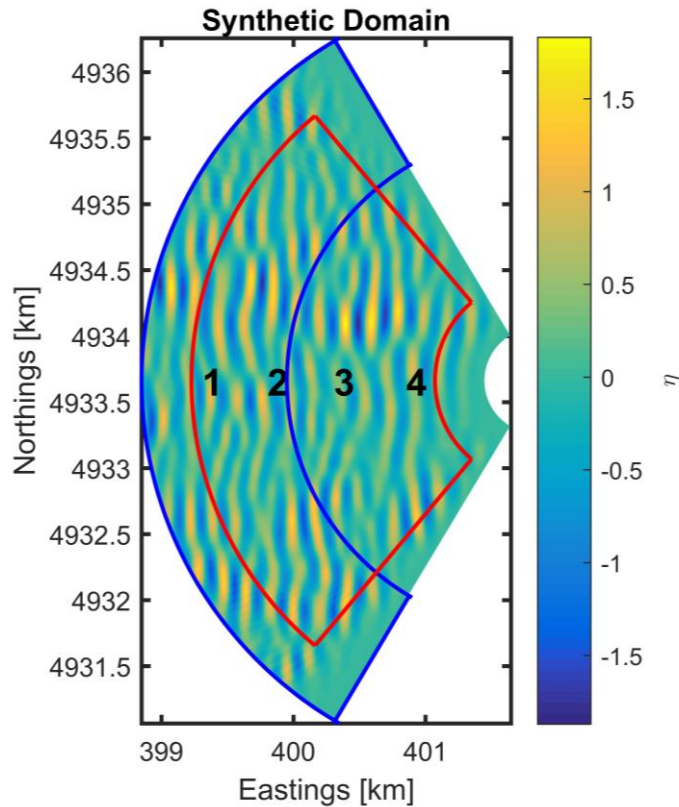
Wave Model Domain

1. Reconstruction in outer annulus
2. Propagation forward in space and time



Synthetic validation of Wavecast

→ demonstrates feasibility of forecast capability



Predicted.mp4

- Project Initiation Date: **Oct. 1, 2014**
- Project Completion Date: **Dec. 31, 2016**
- On schedule, no slips in milestones, project is over
- Passed the Go/No-Go decision in October of 2015

Budget History					
FY2015		FY2016		FY2017	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$174.760k	\$57.118k	\$266.283k	\$73.033k	\$57.046k	\$0
			DOE Project Total:	\$498.089k	
			Cost-share Project Total:	\$130.151k	20.7% of total

- No significant variances from planned budget (other than 3-month No-Cost-Extension for additional analysis)
- 100% of budget expended to date

Collaborators: David Walker, SRI International
Patrick Lynett, University of Southern California

Communications and Technology Transfer:

- **International graduate student research/networking**
→ **i.e. the future**
International Network on Offshore Renewable Energy Meetings:
Naples, Italy (2015); Friday Harbor, WA (2016)
Young Coastal Scientists and Engineers Conference Meeting: Queens Univ.,
2016
- **Academic conference** → **our work has applications beyond MHK**
American Geophysical Union Ocean Sciences Meeting, New
Orleans, LA, 2016
- **Industry** → **Marine Energy Technology Symposium (2016)**
NNMREC Annual Meetings, Portland, OR (2015, 2016)
Marine Energy Technology Symposium (2016)
- **A. Simpson has received two oral presentation awards
(METS 2016, YCSEC 2016)**

FY17/Current research:

- This project completed

Proposed future research:

- Test improvements made possible with additional wave model physics
- Collect additional field data for verification (potential collaboration with Re Vision Consulting, Sacramento, CA)