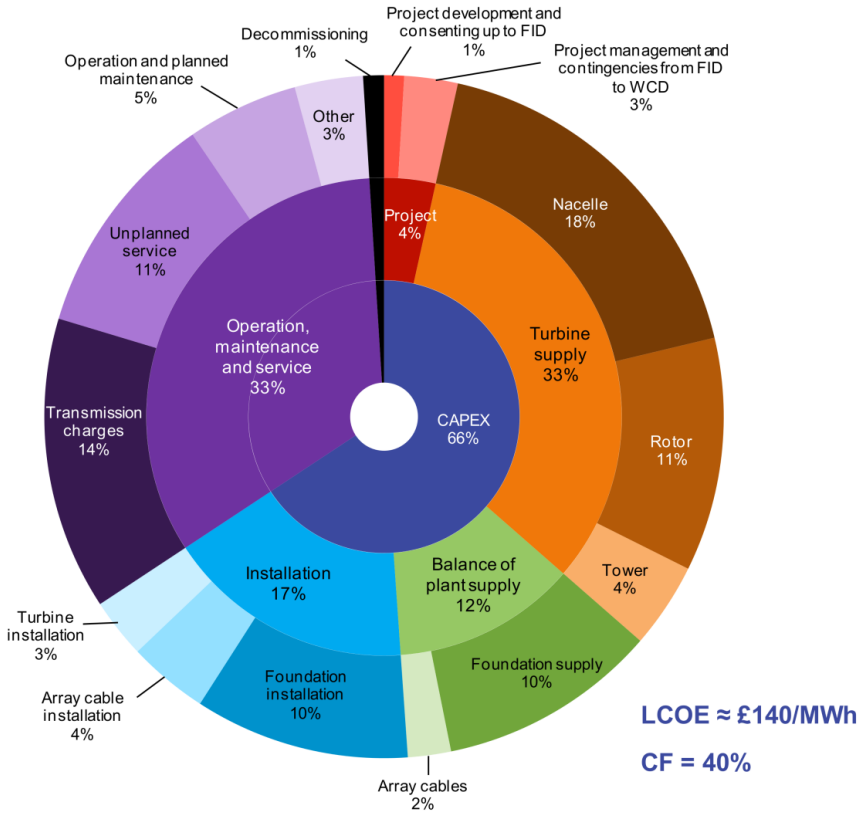
University of Exeter

Machine Learning for Low-Cost Offshore Modelling (MaLCOM)

Ajit C Pillai

Supergen Autumn Assembly 2022

Background



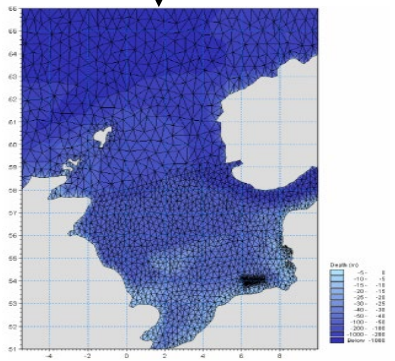
- Installation, inspection, operation, and maintenance activities at ORE sites are governed by **strict weather limits**
- Weather delays have significant impacts:
  - Wikinger Wind Farm: **£17 million** additional cost due to inaccurate forecasts during installation
- Weather forecasts used in decision making currently provided by numerical models
- **More accurate, turbine-specific forecasts can provide improved decision-making during installation, operation, and maintenance processes**

Aims and Objectives

To demonstrate a **ML model framework** that can **integrate met-ocean sensor networks** and **physical models**, to **improve** the provision of met-ocean data

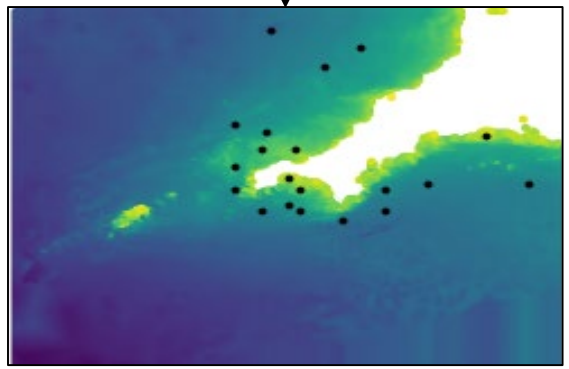
Spatiotemporal wave distribution

Physics-based models



High-fidelity
High-computational cost

In-situ Observations



Relatively reliable
Sparse data set

Objective: Develop **machine learning** models to act as surrogates that learn the **nonlinear mapping** from fixed points to spatially distributed wave data across a region.

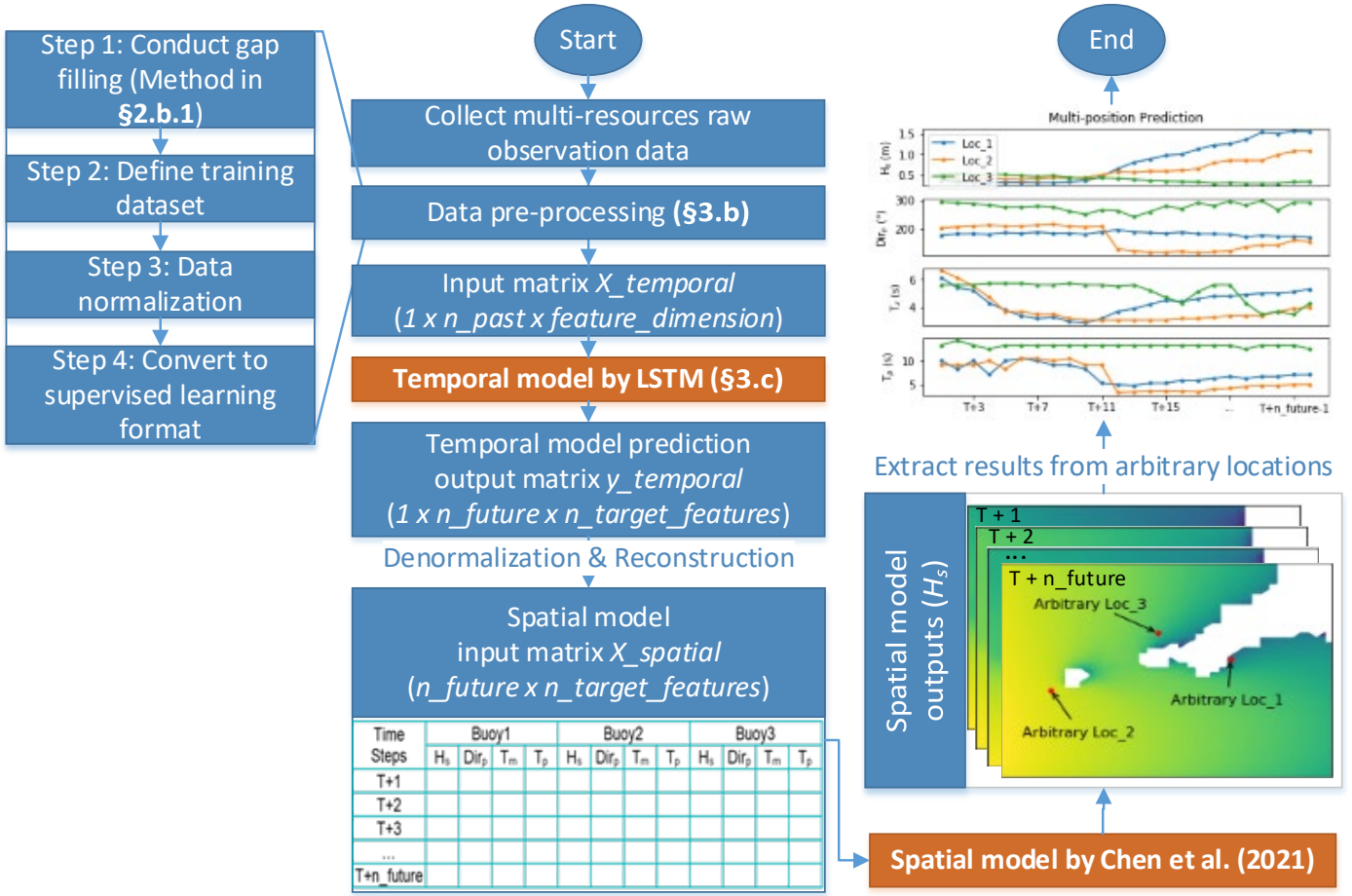
Model Framework Overview

- Forecasting methodology divided into two models that are coupled:

  1. Spatial Nowcasting
  - Relate the conditions at point locations to the conditions throughout the model domain

  2. Temporal Point Forecasting
  - Use the conditions at the in-situ measurement locations to forecast future conditions at the same location

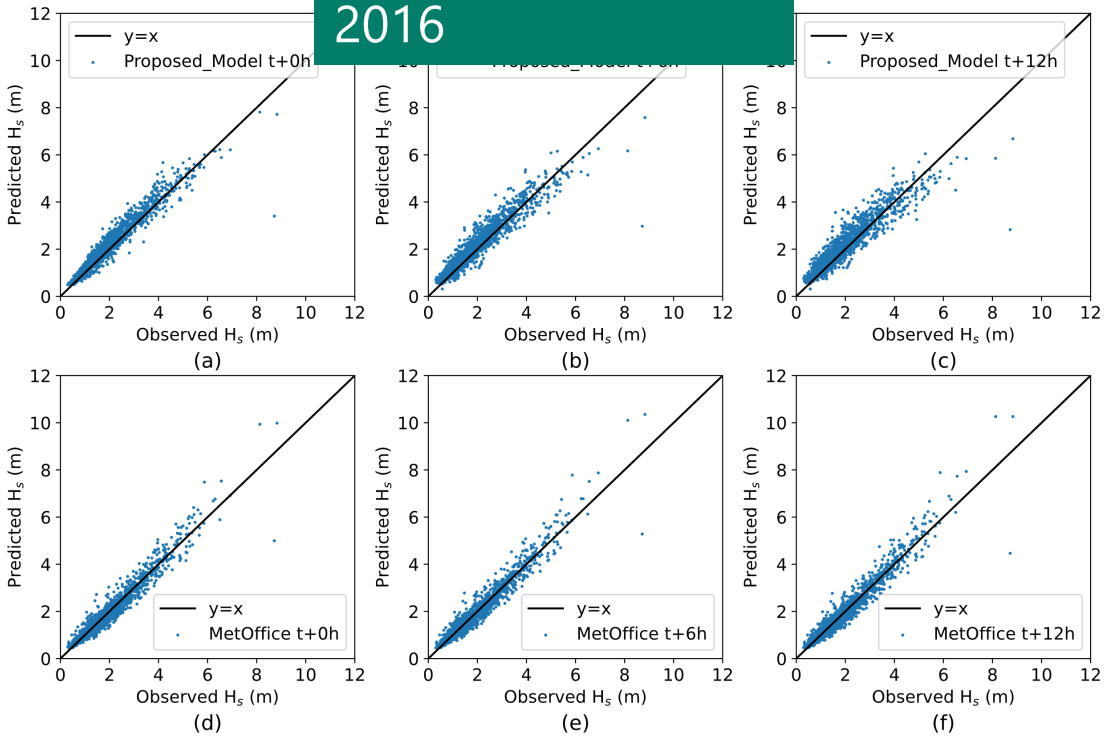
- Coupling models enables spatial forecasting



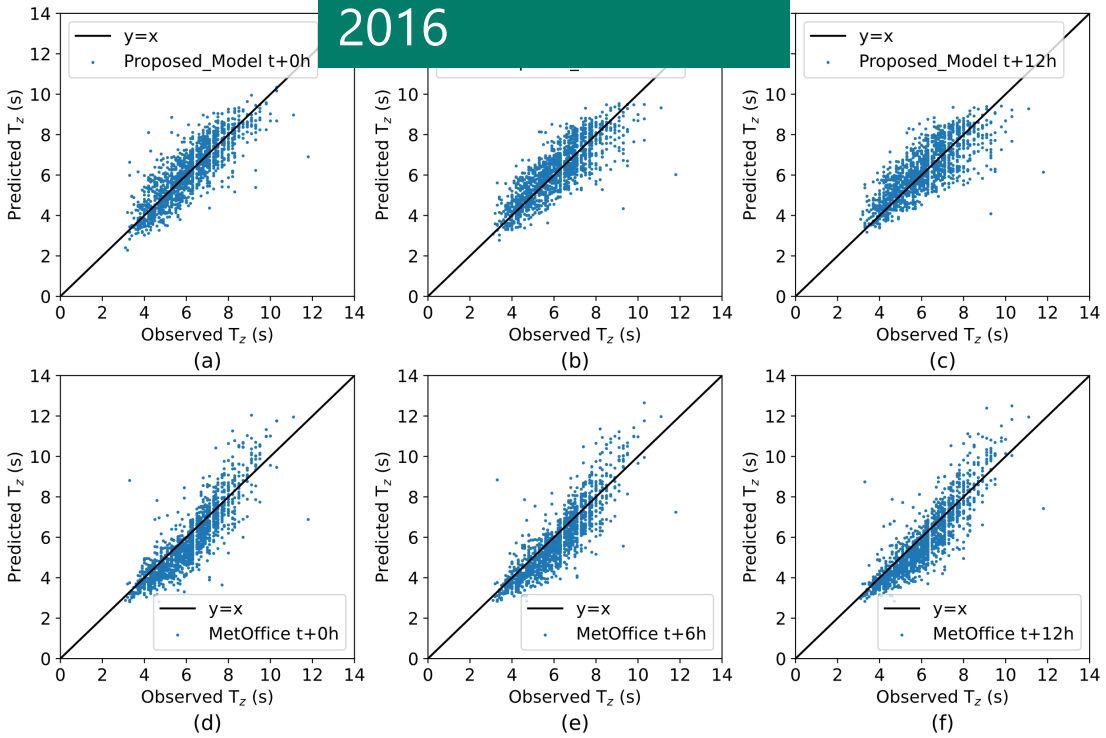
Spatiotemporal Results - WaveHub

University of Exeter

WaveHub, Hs, 2016



WaveHub, Tz, 2016



- The proposed model has a similar level of accuracy as the UKMO model
- The proposed model show increased scatter with increased forecast lead time, but not apparent for the UKMO model

Summary

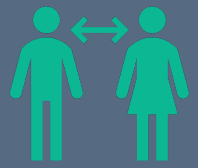
- A **machine learning** forecasting framework integrating **in-situ buoy observations** and a **surrogate regional numerical wave model** have been proposed and testing.
- The forecasting framework has **similar level of accuracy** with **Met Office** physics-based forecasting model, but requires only much **less computational resources**
  - Less than 30 s on 1 CPU to get 12-hour spatial wave prediction with half-hour interval over two years.

H_s Forecast	WaveHub		FabTest	
	Proposed Framework	Met Office Forecast Model	Proposed Framework	Met Office Forecast Model
1-hour ahead	0.9083	0.9210	0.7409	0.8163
12-hour ahead	0.8581	0.9258	0.6978	0.8114

Ongoing and Future Work

University of Exeter

- Industrial case studies considering turbine access
- Work with partners to develop an optimized system
- Design for operation with autonomous vessels



- Improved sensors/sensor networks and integration
- Improved/alternate physics-based models

- Incorporating satellite data sets
- Mobile sampling/measurements
- Consider other applications for accurate nowcast wave data
- Improve historical data

University of Exeter

Supergen ORE Hub and Royal Academy of Engineering are gratefully acknowledged for supporting this work.

Supergen

Offshore Renewable Energy

Royal Academy of Engineering