Innovating Fast Wave Emulator

MIKE Powered by DHI, UK & Ireland Symposium 2023
Date: 13 June, 2023
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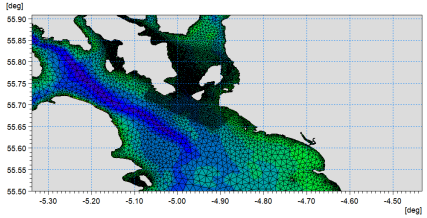
Fast models – Why?



Tendering phase, coastal wave transformation, site assessment, feasibility studies, owners engineer QA, climate change downscaling, workability, ensemble-based uncertainty etc.

Ambition: 40 years of point based local wave hindcast data in 1-2 hours with modest reduction of accuracy

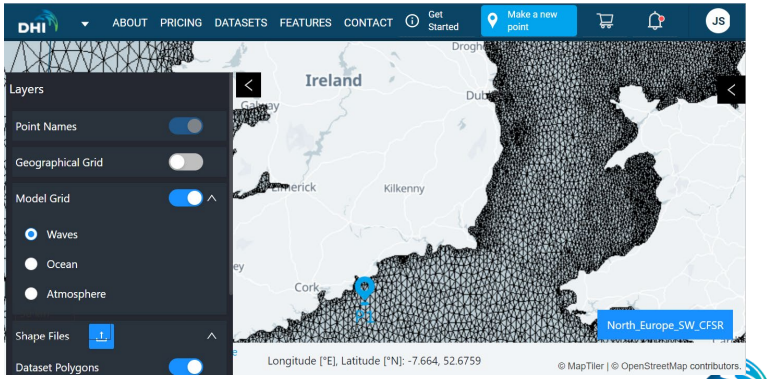
Meant for a quick assessment of nearshore wave conditions

For detailed spectral wave transformation modeling DHI recommends MIKE 21 SW

Fast Wave Emulator

- Speedy set up time
- Speedy simulation time
- Reduced computational cost
- User is not required to maintain hardware
- Link to DHI's Metocean Data Portal

- Which innovation path are we on?



Foundation

Summer 2021:

- DHI expertise and MIKE Powered by DHI recognition
- MIKE engines and cloud infrastructure, developer and domain competence
- Ongoing significant R&D projects
- Close relations to commercial clients and two specific tenders out for delivering a fast wave transformtion tool (both from major offshore contractors)

Go decision

August - December 2021:

- We won one of the tenders to deliver bespoke solution -> user value confirmation
- DHI and contractor client agreed to co-create using DHI's Innovation Lab
- DHI accellerated investment and resource allocation for bespoke solution development

Building the prototype – ingredients for succes!

January - December 2022

- Client value creation at the core
- Thorough UX design up-front
- Simple, robust and adaptable solution
- Succesful collaboration between Clients and DHI's scientific and software experts

Transparency

Trust

Communication

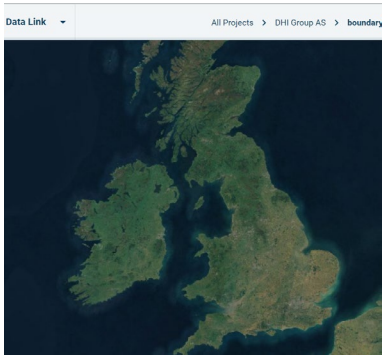
Flexibility

Scale investment – Broadening to more applications

January – now 2023

- Debugging to enhance smooth user experience
- Optimizing performance
- Tighter integration with Metocean data portal, Data Link, Mesh Builder, MIKE Zero
- Dissemination, pilot testing and launch preparations

MIKE Powered by DHI



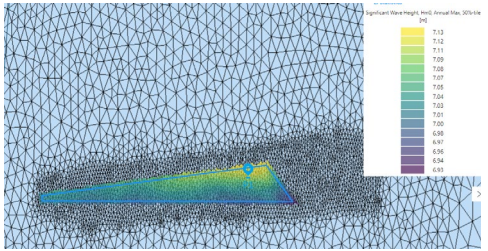
MOOD

Communication

Flexibility

Downscaling methodologies

Local Numerical Modeling

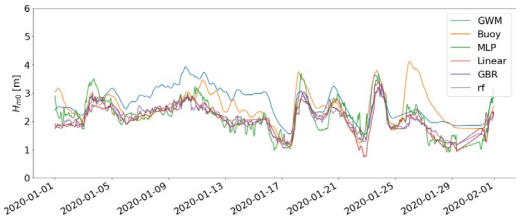


Complexity

high-resolution

low-resolution

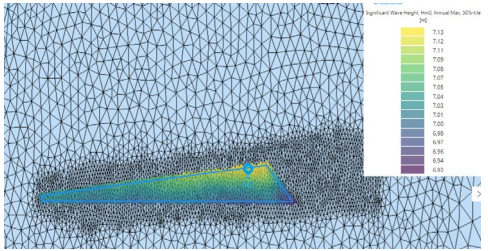
Speed



Statistical Downscaling

Downscaling methodologies

Local Numerical Modeling



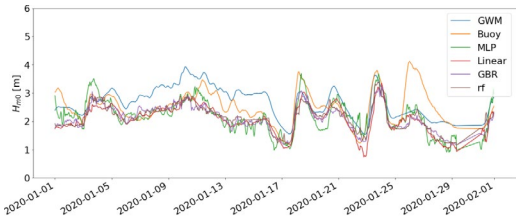
Complexity

high-resolution

low-resolution

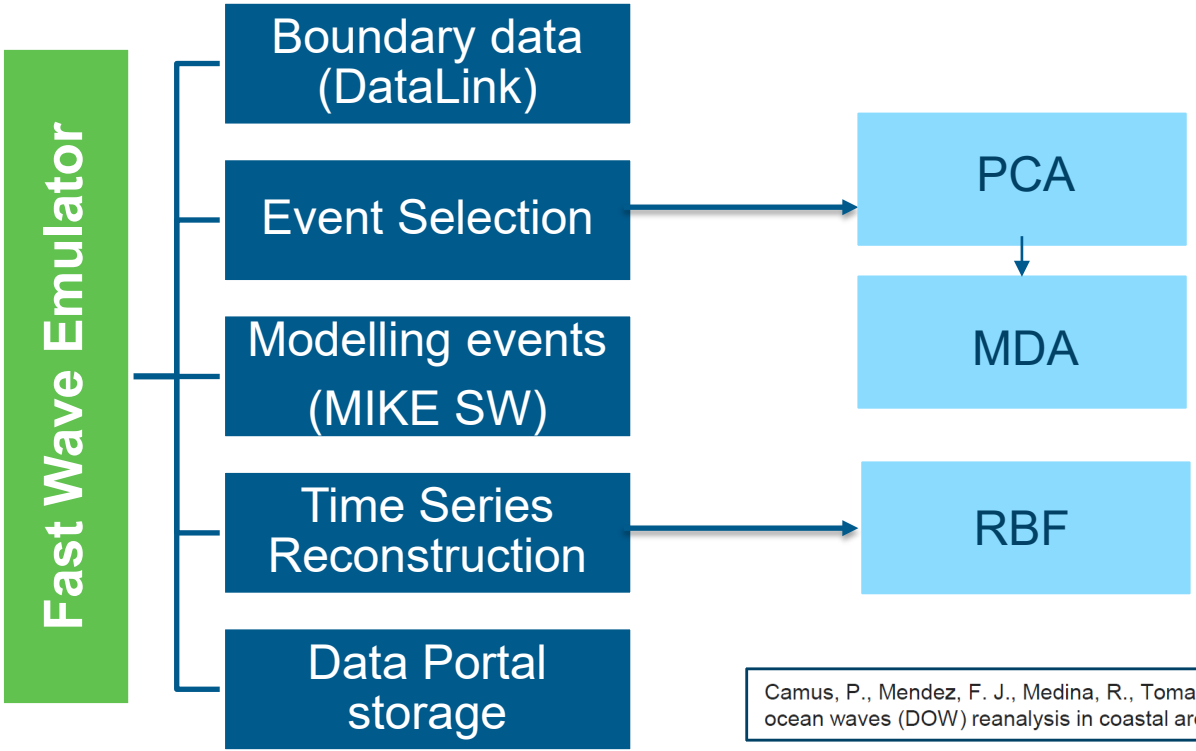
Fast Wave Emulator

Speed



Statistical Downscaling

Fast Wave Emulator – How does it work?



Camus, P., Mendez, F. J., Medina, R., Tomas, A., & Izaguirre, C. (2013). High resolution downscaled ocean waves (DOW) reanalysis in coastal areas. *Coastal Engineering*, *72*, 56-68,

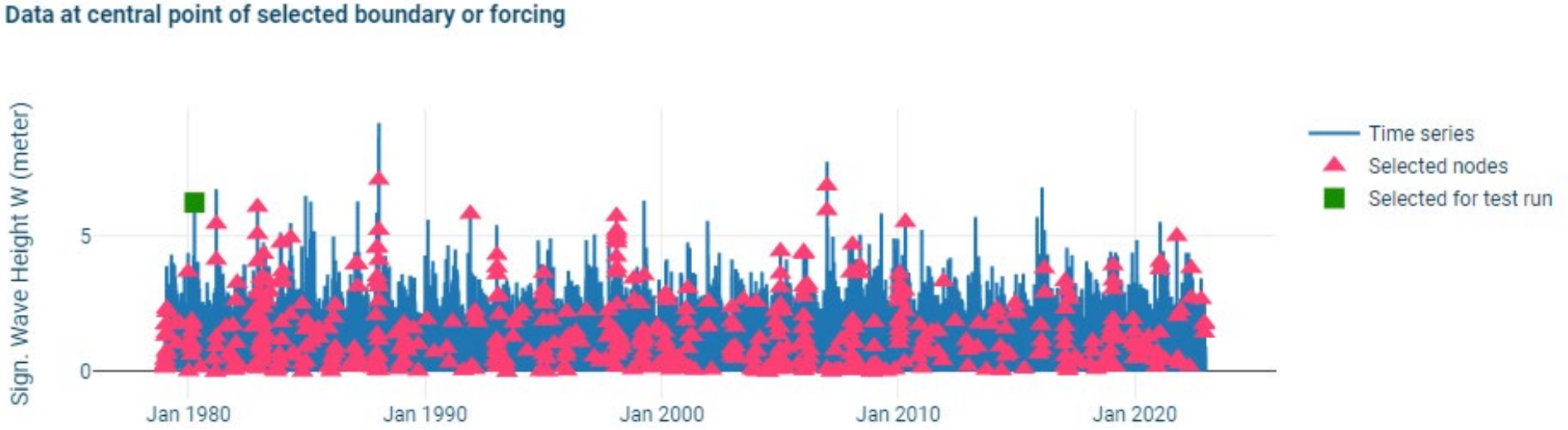
Mike SW: Mike by DHI Spectral Waves Model
MDA: Maximum Dissimilarity Analysis

PCA: Principal Component Analysis
RBF: Radial Based Function

Event Selection

Maximum Dissimilarity Algorithm (MDA)

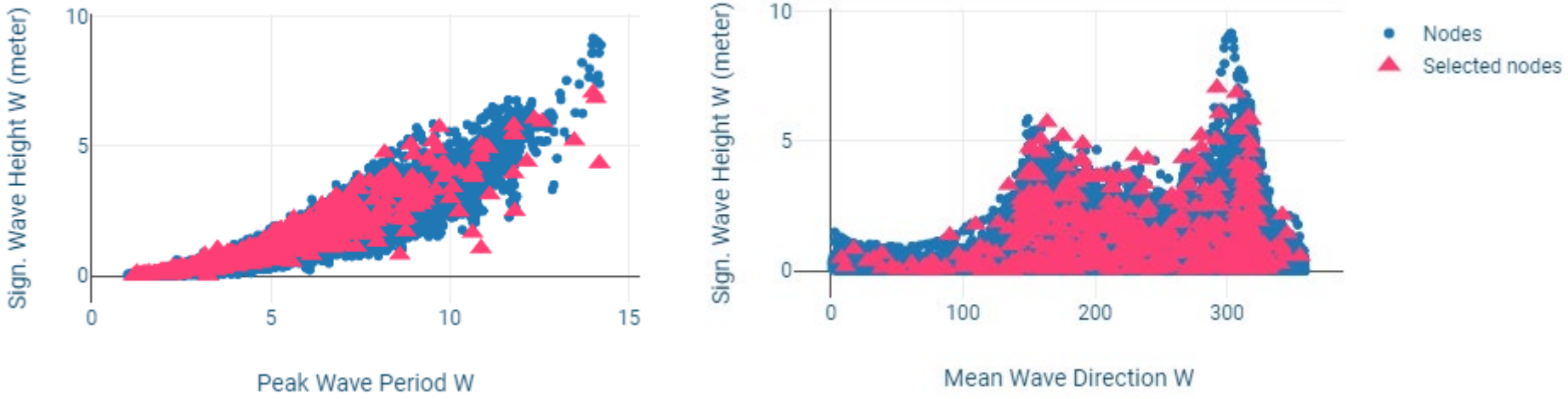
Selection of the most dissimilar events for modelling such that the variation on the metocean parameters can be captured



- Only the red dot events are modelled (500 events selected in this example)
- Not shown here is parameters for wave direction, wave spreading or sea/swell split

User verifies selected points

User can do quality control of the selected nodes by making scatter plots of the data. User can also select more data points



- User can select more nodes by clicking on the chart
- Not shown here is parameters for wave direction, wave spreading or sea/swell split

Time Series Reconstruction - Radial Basis Function (RBF)

Reconstruction of the full timeseries using interpolation between the modelled events

RBF - Radial Basis Function

- $\varphi = \varphi(r)$
  - $r = \|x - x_i\|$ - Euclidian distance
  - x_i - centers
  - Gaussian RBF - $\varphi = e^{-\varepsilon^2 r^2}$
  - ε_i - shape parameters

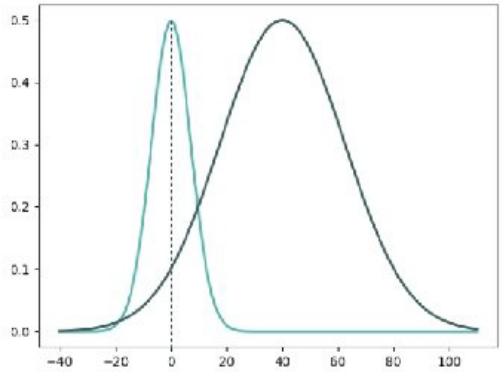


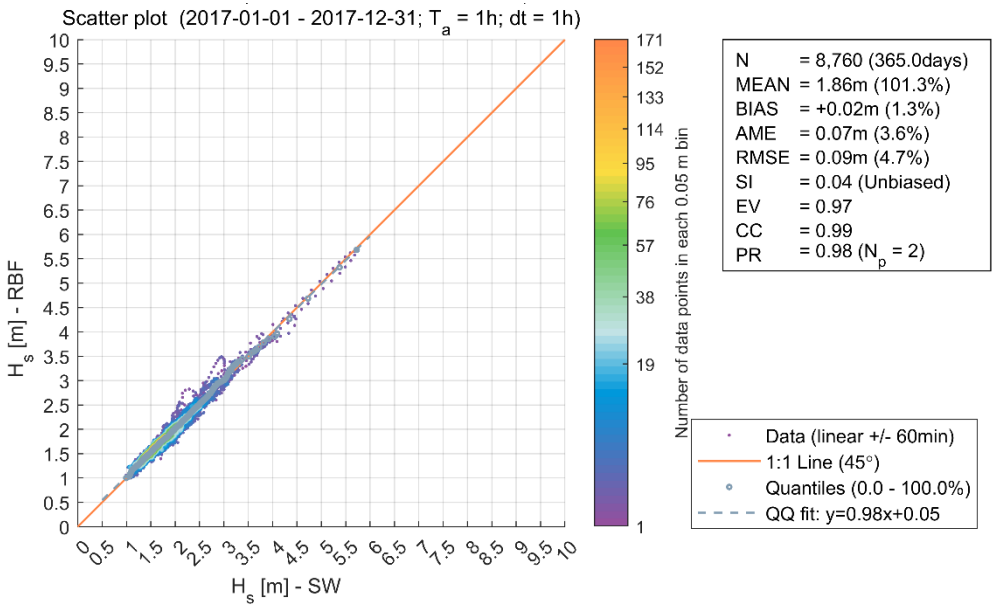
Figure 1.
- ε^2=0.01
- ε^2=0.001

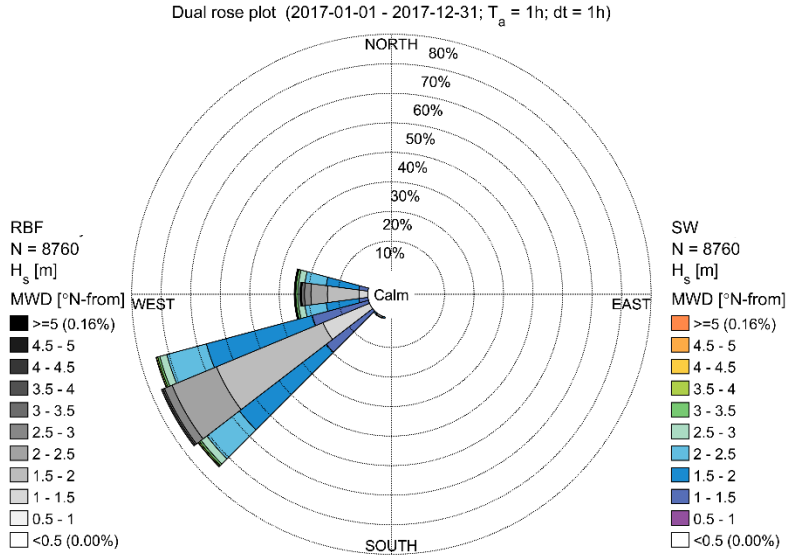
- RBF Interpolant, given by a linear combination :

$$\phi(x) = \sum_{i=1}^{N} \lambda_i \varphi(\|x - x_i\|, \varepsilon_i)$$

Comparison - Significant Wave Height

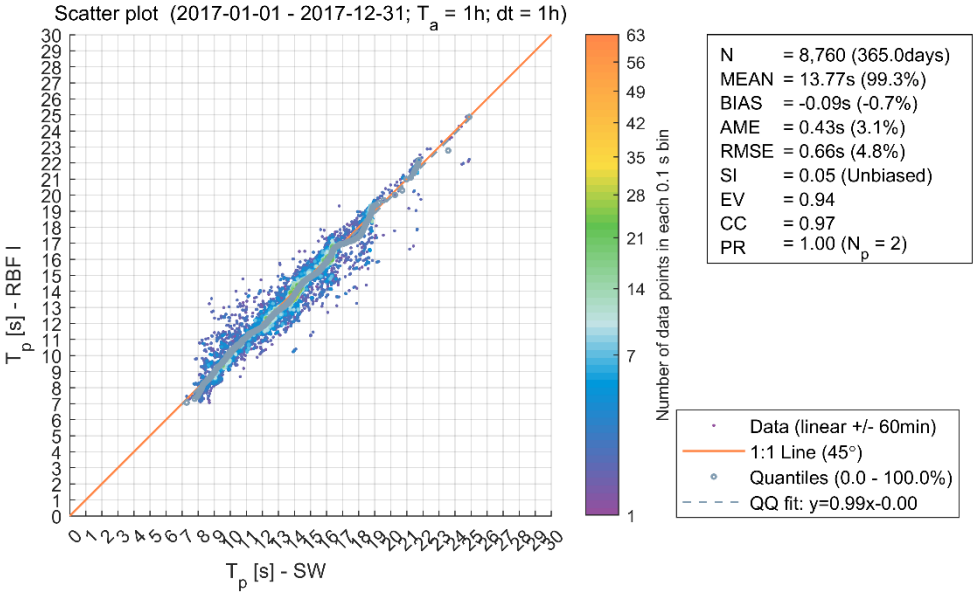
1 year fully modelled data vs reconstructed data using 100 time steps

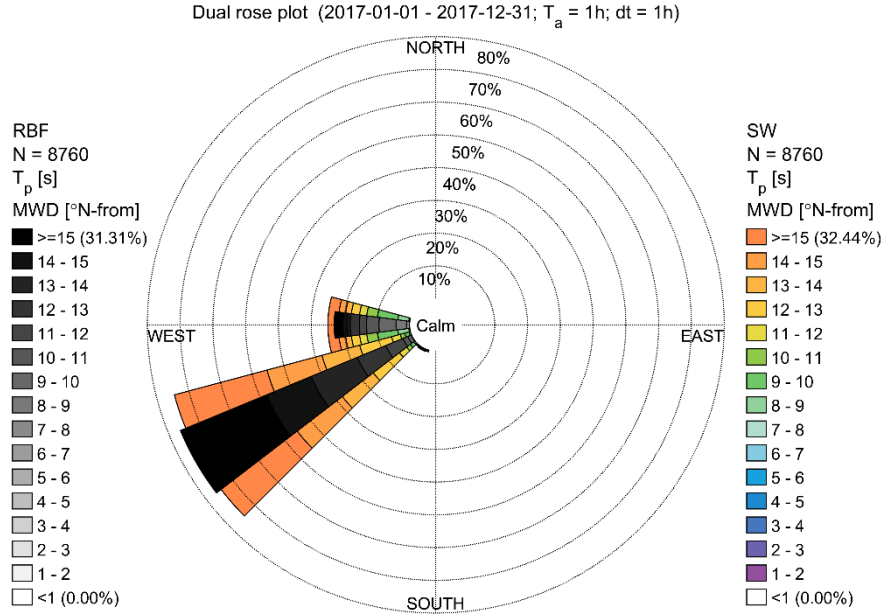




Comparison- Peak Wave Period

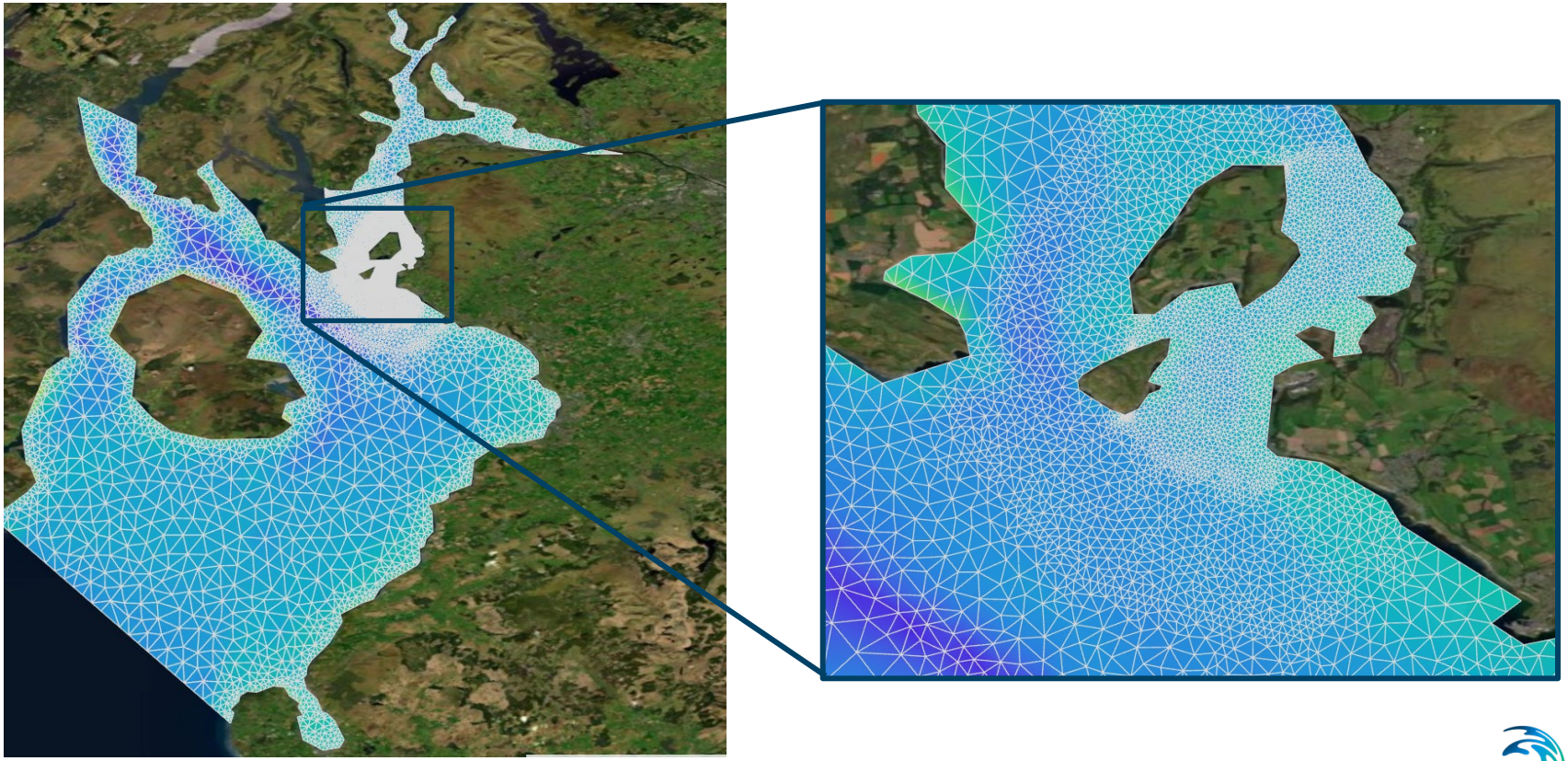
1 year fully modelled data vs reconstructed data using 100 time steps





Under development for next release of FWE

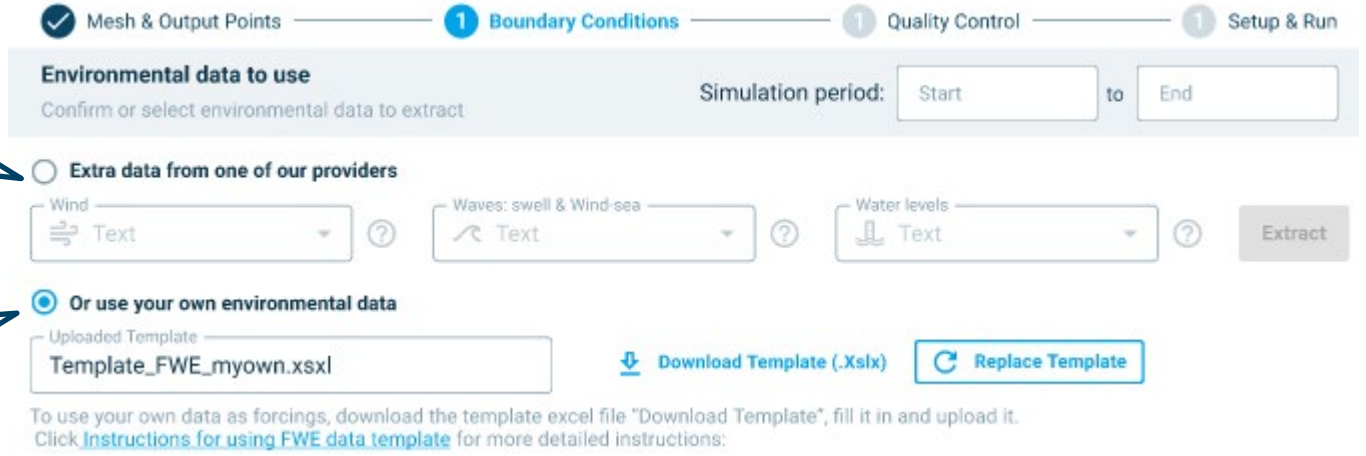
Assisted meshing



Option for user provided boundary conditions

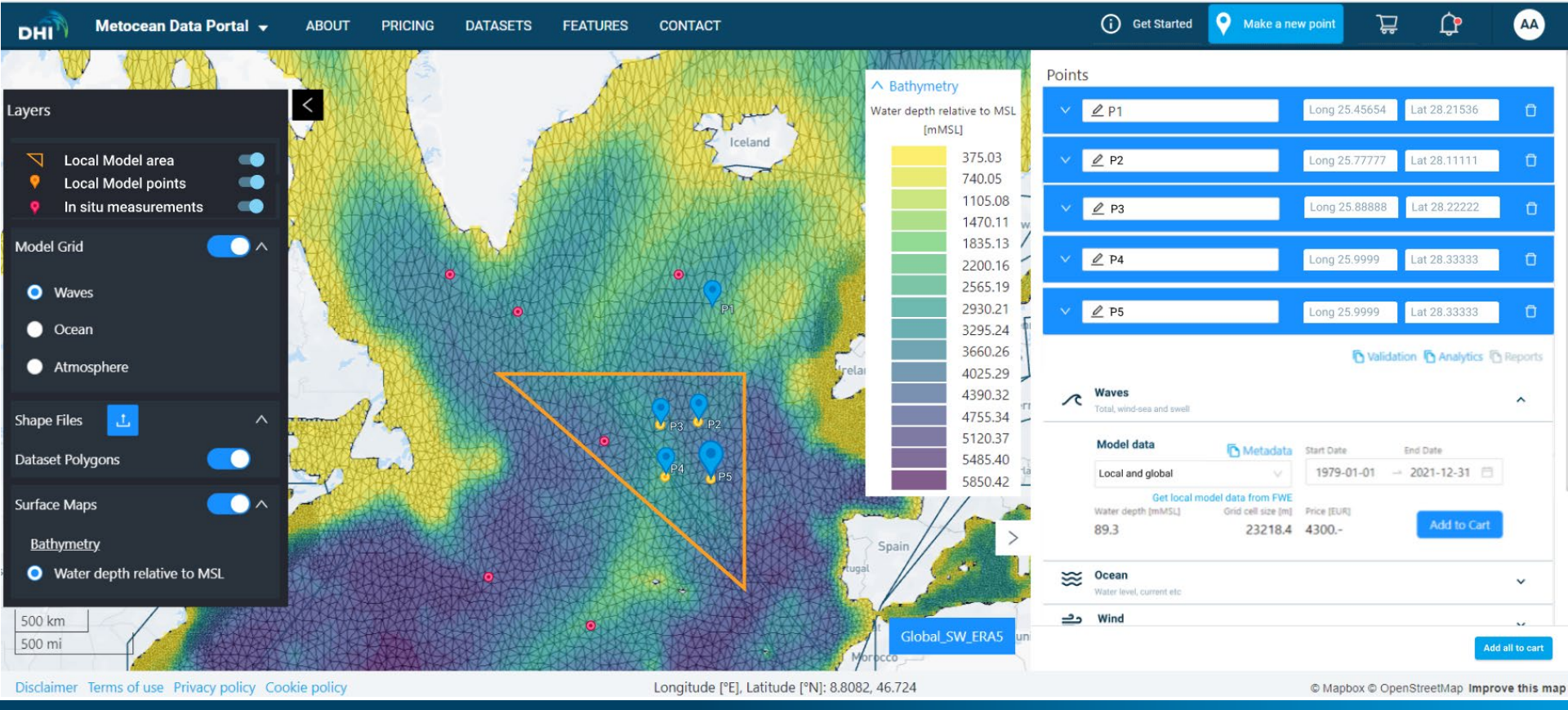
Existing feature:
Provided by DHI

New feature:
Provided by User



Datetime (dd/mm/YYYY HH:	Wind Spe	Wind Dire	Sign Wave	Peak Wav	Mean Wa	Directiona	Sign Wave	Peak Wav	Mean Wa	Directiona	Water level [m]
01/01/1900 00:00	10.0	0.0	1.0	5.0	0.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 01:00	10.0	45.0	1.0	5.0	45.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 02:00	10.0	90.0	1.0	5.0	90.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 03:00	10.0	135.0	1.0	5.0	135.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 04:00	10.0	180.0	1.0	5.0	180.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 05:00	10.0	225.0	1.0	5.0	225.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 06:00	10.0	270.0	1.0	5.0	270.0	40.0	2.0	12.0	270.0	30.0	1.0
01/01/1900 07:00	10.0	315.0	1.0	5.0	315.0	40.0	2.0	12.0	270.0	30.0	1.0

Integration with MetOcean On Demand (MOOD)



Demo

Microsoft Teams

Firth Of Clyde Demo

2023-06-12 15:55 UTC

Recorded by
Pierre Brink Swiegers

Organized by
Pierre Brink Swiegers