Freely Available Simulation Toolset for Waves, Tides and Eddy Replication

FASTWATER

Investigators:

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School of Mathematics | Prof Chris Dent, Dr Amy Wilson

Supported by: EMEC PROTEUS MARINE RENEWABLES ORE CATAPULT

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Dr Peter McCallum

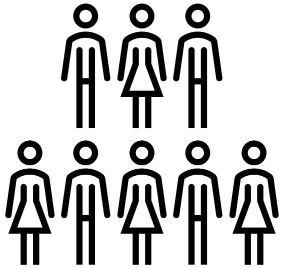
Dr Brian Sellar

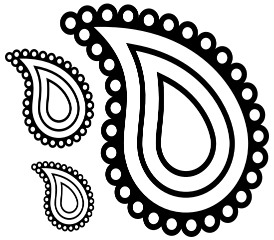
Funded by:

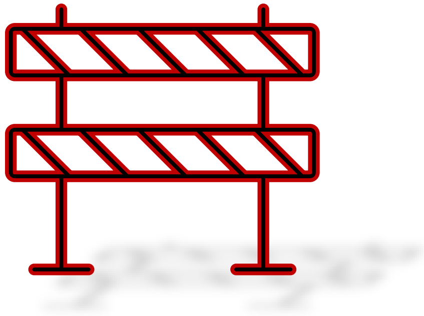
UKRI Engineering and Physical Sciences Research Council

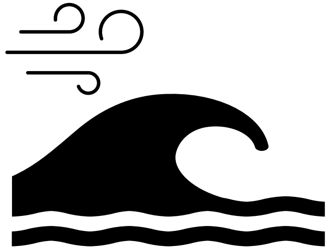
Supergen Offshore Renewable Energy

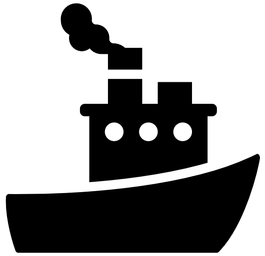
Barriers to the efficient exploitation of modelling tools to provide the right data at the right place at the right time for Tidal...







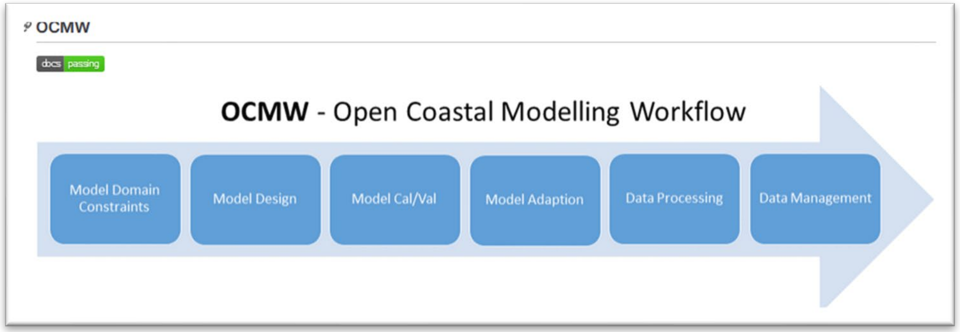


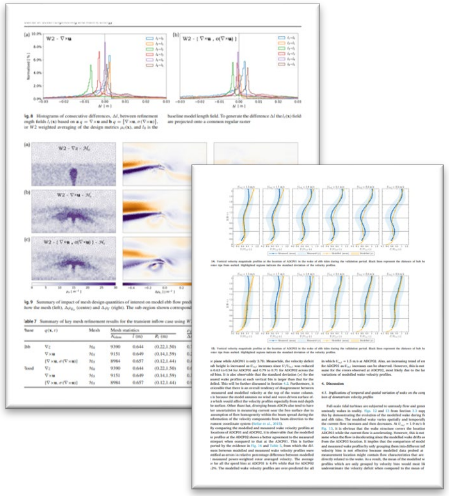


$$W = \int_{t_1}^{t_2} p(t)\,dt$$

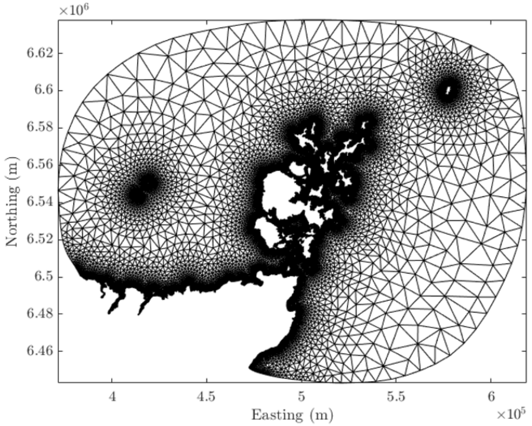
FASTWATER activities to reduce or remove some of these barriers…

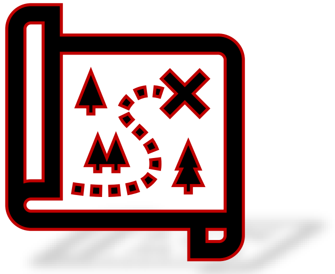
OPEN WORKFLOWS



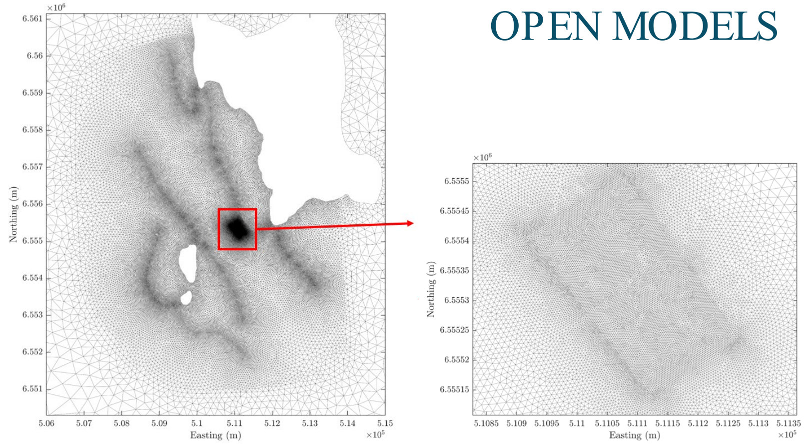


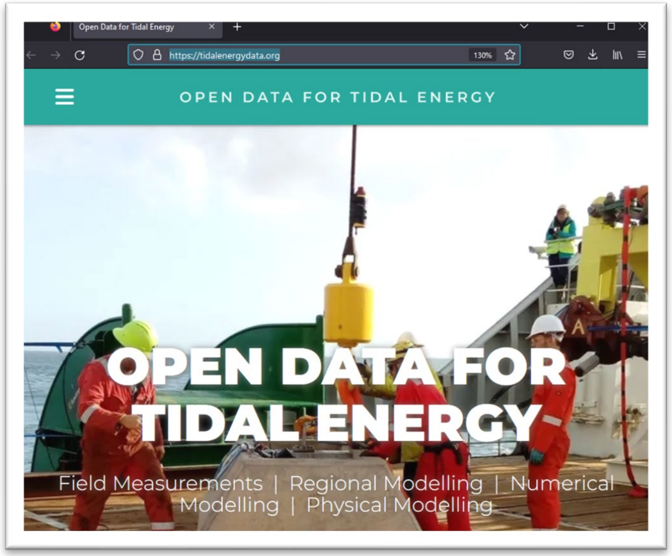
OPEN PUBLICATIONS



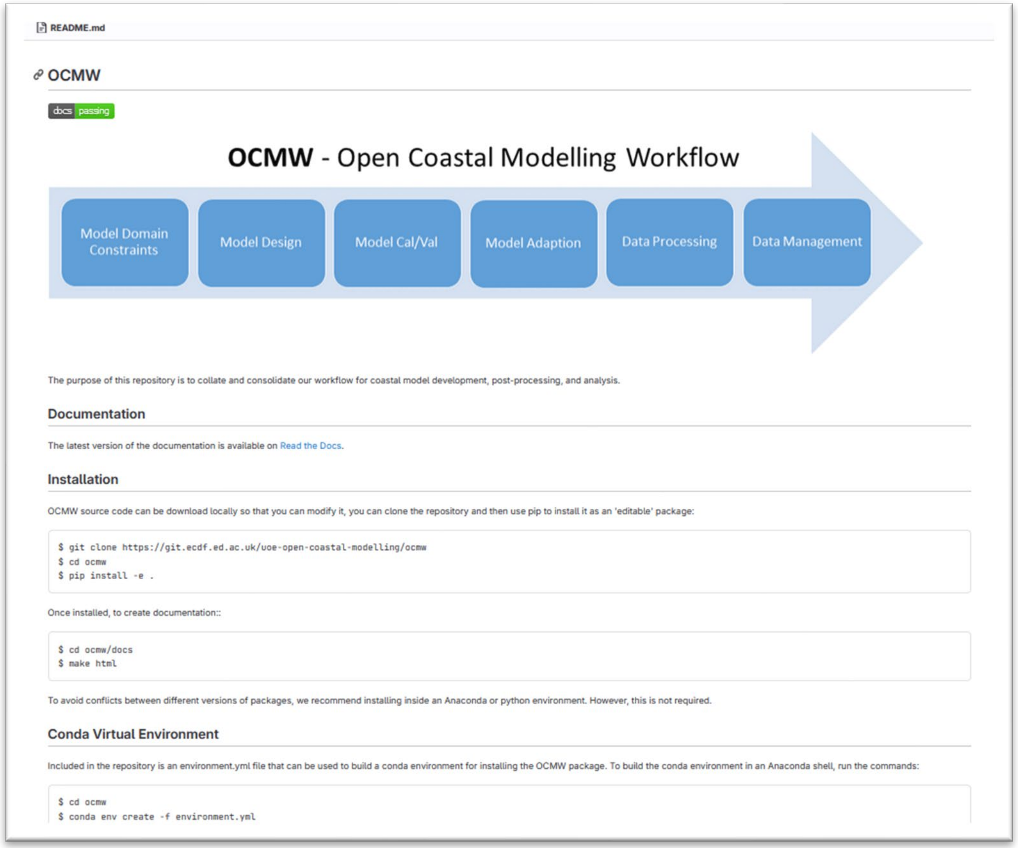


OPEN MODELS





OPEN DATA


README.md

OCMW

docs passing

OCMW - Open Coastal Modelling Workflow

Model Domain Constraints → Model Design → Model Cal/Val → Model Adaption → Data Processing → Data Management

The purpose of this repository is to collate and consolidate our workflow for coastal model development, post-processing, and analysis.

Documentation

The latest version of the documentation is available on Read the Docs.

Installation

OCMW source code can be download locally so that you can modify it, you can clone the repository and then use pip to install it as an 'editable' package:

```
$ git clone https://git.ecdf.ed.ac.uk/uoe-open-coastal-modelling/ocmw
$ cd ocmw
$ pip install -e .
```

Once installed, to create documentation::

```
$ cd ocmw/docs
$ make html
```

To avoid conflicts between different versions of packages, we recommend installing inside an Anaconda or python environment. However, this is not required.

Conda Virtual Environment

Included in the repository is an environment.yml file that can be used to build a conda environment for installing the OCMW package. To build the conda environment in an Anaconda shell, run the commands:

```
$ cd ocmw
$ conda env create -f environment.yml
```

SPEC

- Python library of model design, cal/val, and post-processing tools.
  https://git.ecdf.ec.ac.uk/uoe-open-coastal-modelling/ocmw
- On-line ReadTheDocs documentation.
  https://ocmw.readthedocs.io/en/latest/index.html
- Core tools solver agnostic

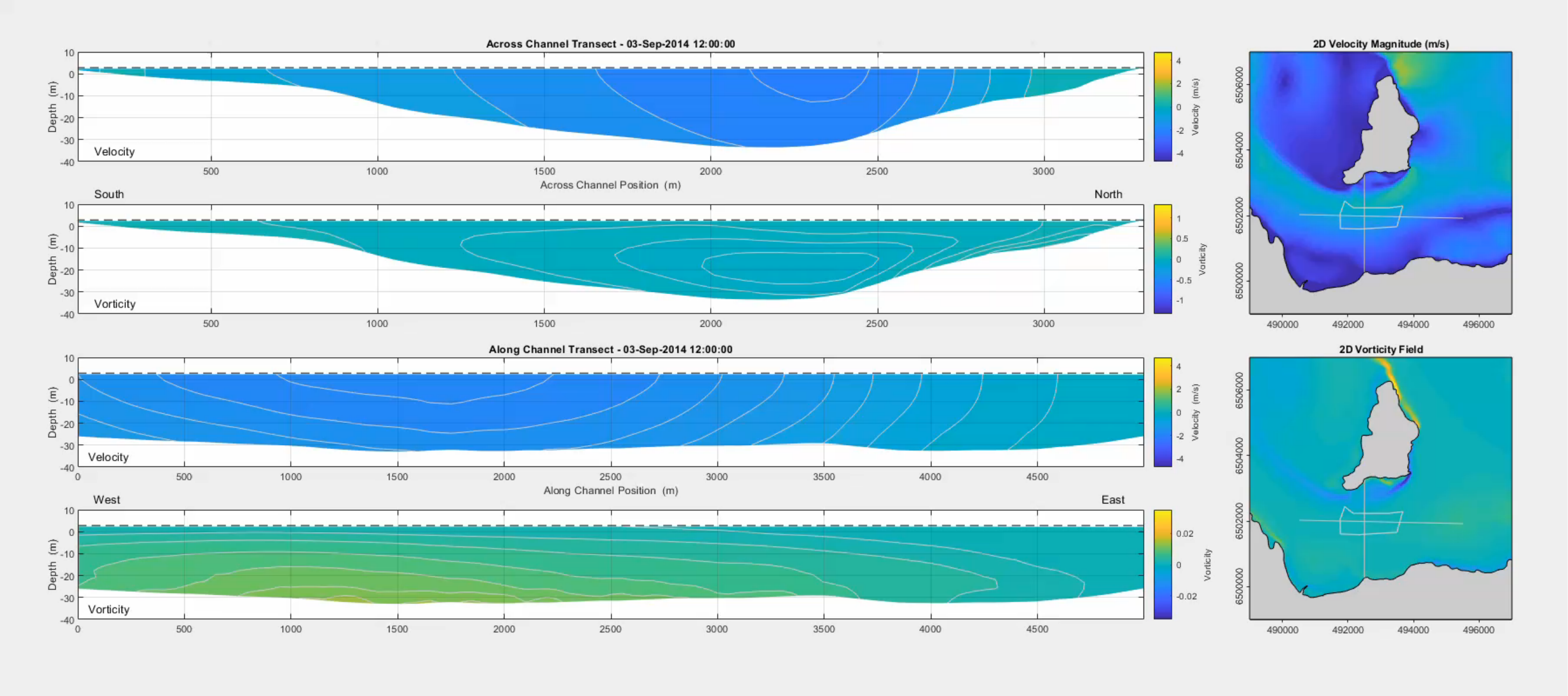
MESH

- Bathymetry manipulation and mapping tools.
- Mesh converters.
- Iterative mesh design (still ongoing)

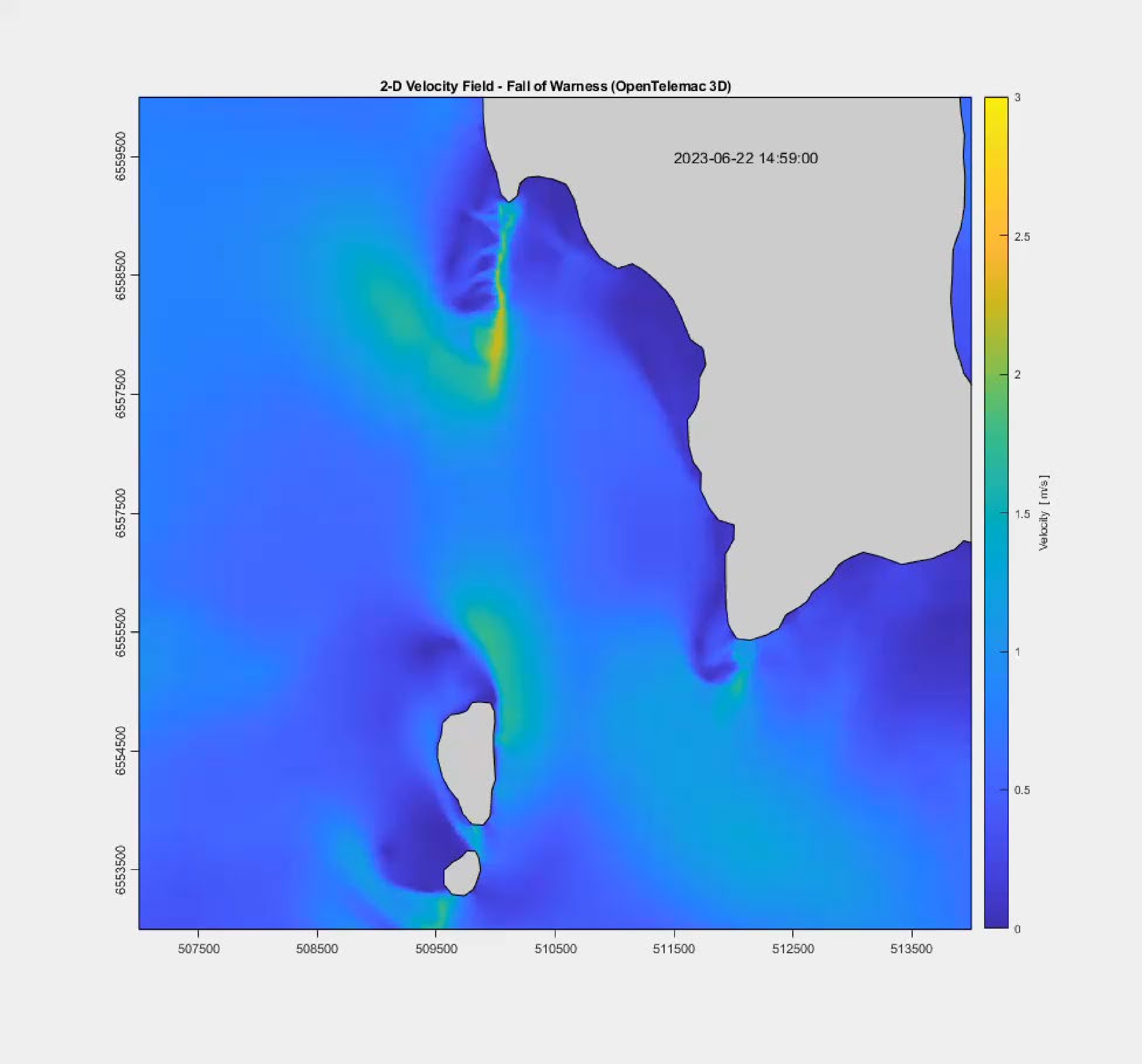
POST PROCESS

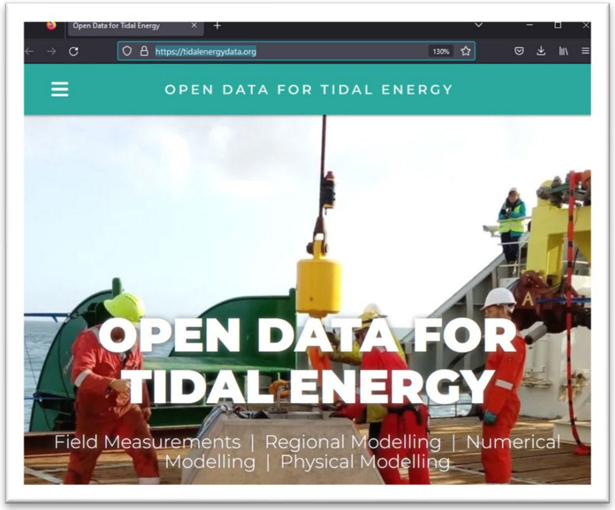
- Standard processing application scripts (e.g. data extraction by location, transect, polygon)
- Example post-processing scripts
  - flow characterisaton,
  - parameter calcs,
  - tidal energy calcs,
  - tidal analysis,
  - field mapping,
  - cal/val against ADCP data,
  - etc.

2D & 3D MODELS

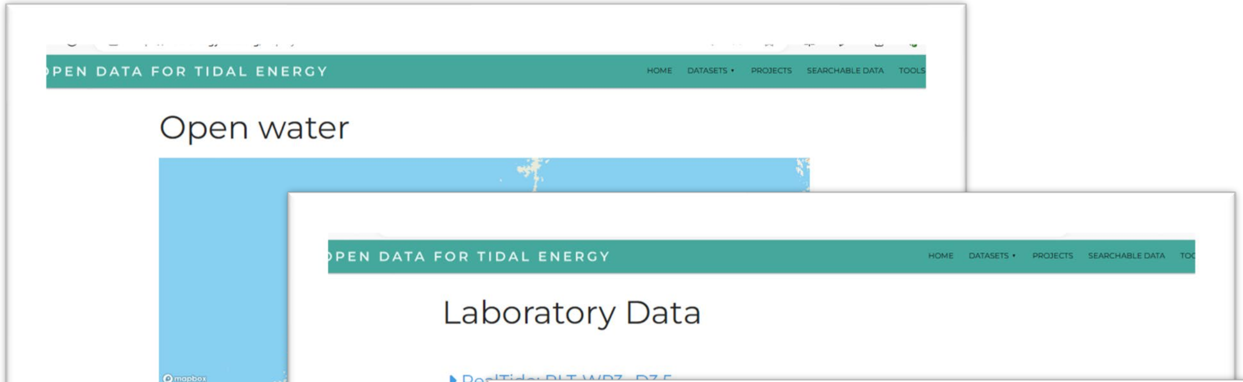

Across Channel Transect - 03-Sep-2014 12:00:00
Velocity
Depth (m)
Across Channel Position (m)
Velocity (m/s)
South
North
Vorticity
Along Channel Transect - 03-Sep-2014 12:00:00
Along Channel Position (m)
West
East
2D Velocity Magnitude (m/s)
2D Vorticity Field

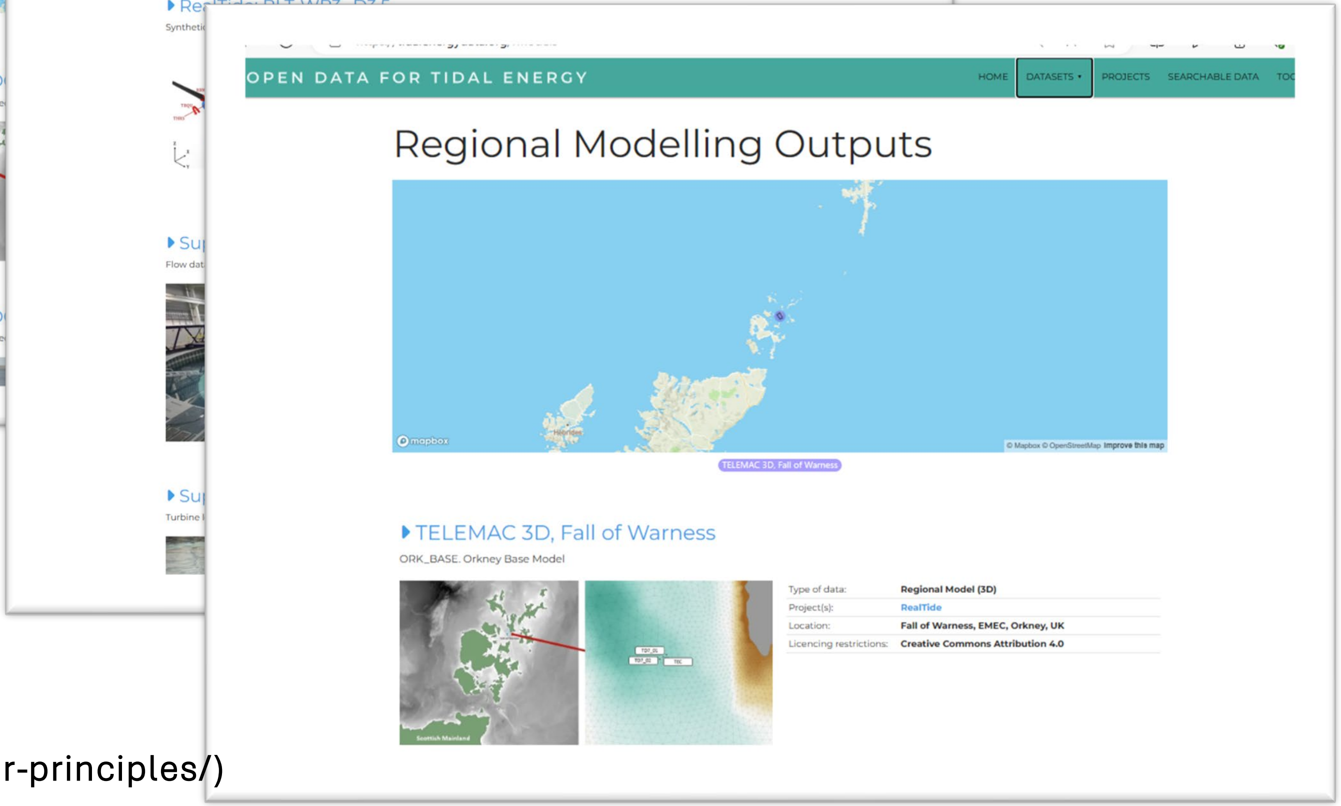
2D & 3D MODELS


2-D Velocity Field - Fall of Warness (OpenTelemac 3D)
2023-06-22 14:59:00
6559500
6558500
6557500
6557500
6555500
6554500
6553500
507500
508500
509500
510500
511500
512500
513500
Velocity [m/s]
3
2.5
2
1.5
1
0.5
0



https://tidalenergydata.org
(Moving to *eng.ed.ac.uk* Q2 2024)





Collate and serve open data sets:

- *in situ* measurements,
- physical models,
- numerical simulations

Standard data formats + metadata

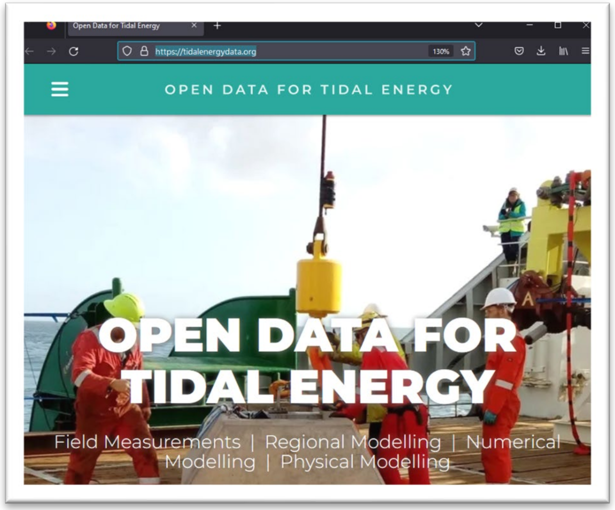
Aim to meet FAIR data principles (https://www.go-fair.org/fair-principles/)

THE UNIVERSITY of EDINBURGH
School of Engineering

FASTWATER

Freely Available Simulation Toolset for Waves, Tides and Eddy Replication

THE UNIVERSITY of EDINBURGH
School of Mathematics

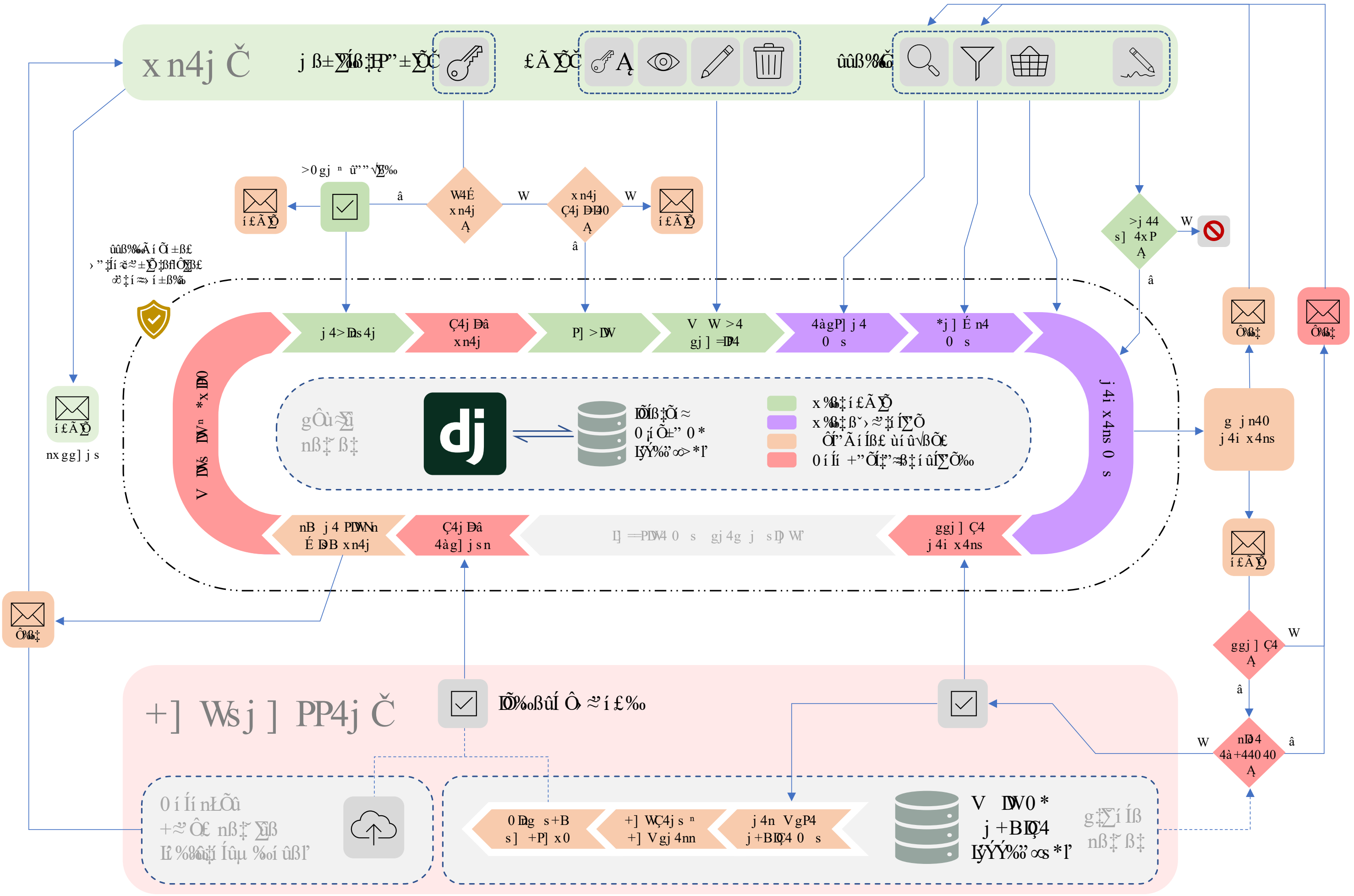


Searchable Data "is hard"...

Prototype process being implemented on Eleanor Cloud service.

Based on linked Public (frontend web service) and Private (backend data processing) VMs.

Django webservice data request passed to background process that extracts and serves up time-limited password protected data to user.



ACCESS HI-RES DATA (>0.5HZ)

APPLY FILTER CLEAR FILTERS

Dataset
ADCPTD7_Dep1

Starting from (UTC)
18 / 09 / 2014 00 : 00

Elasped time
88 hours mins

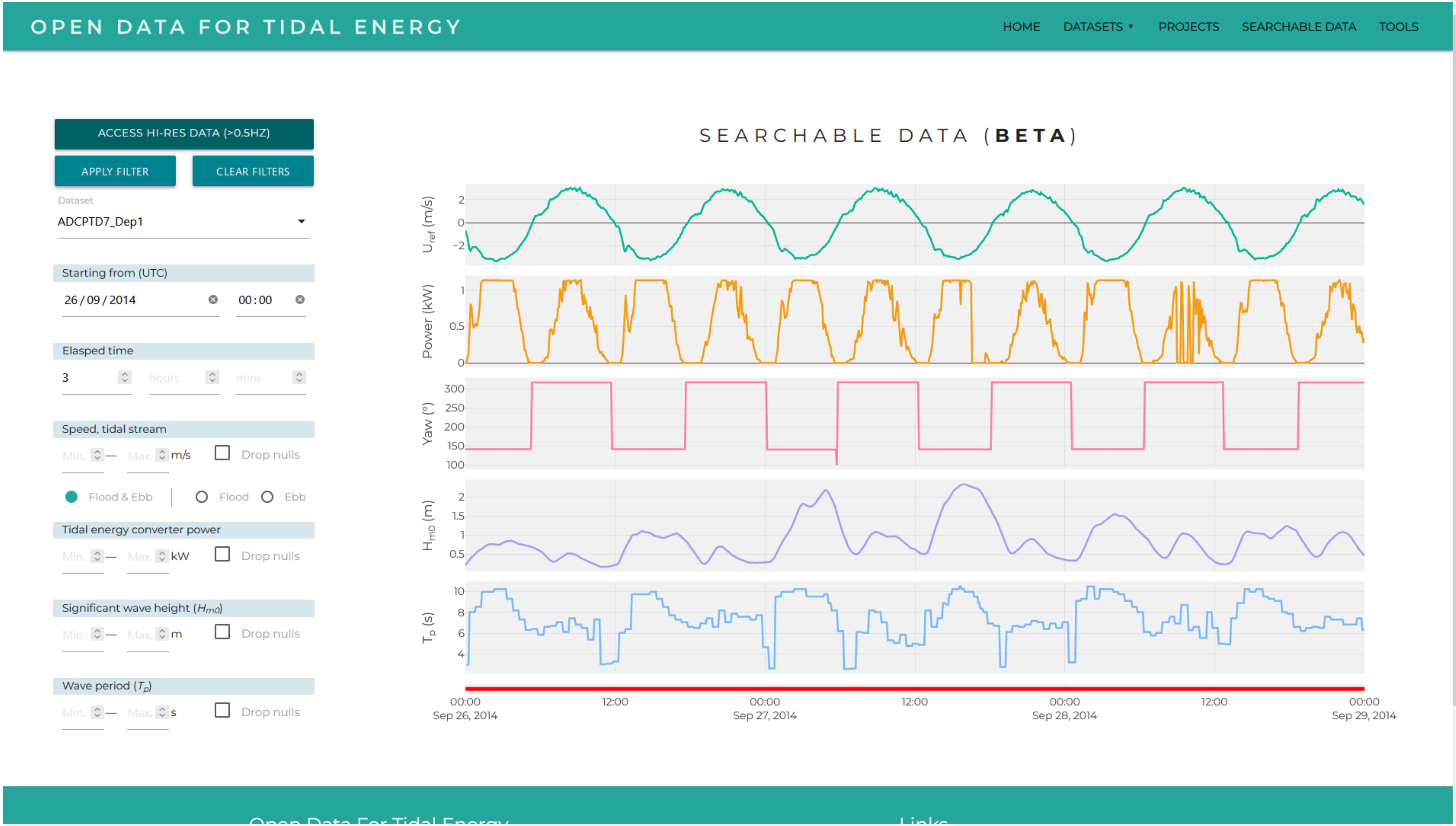
Speed, tidal stream
Min. — Max. m/s Drop nulls
Flood & Ebb | Flood Ebb

Tidal energy converter power
Min. — Max. kW Drop nulls

Significant wave height (H_{m0})
Min. — Max. m Drop nulls

Wave period (T_p)
Min. — Max. s Drop nulls

SEARCHABLE DATA (**BETA**)


OPEN DATA FOR TIDAL ENERGY
HOME
DATASETS ▾
PROJECTS
SEARCHABLE DATA
TOOLS
ACCESS HI-RES DATA (>0.5HZ)
APPLY FILTER
CLEAR FILTERS
Dataset
ADCPTD7_Dep1
Starting from (UTC)
26 / 09 / 2014
00 : 00
Elasped time
3
hours
mins
Speed, tidal stream
Min. — Max. m/s
Drop nulls
Flood & Ebb
Flood
Ebb
Tidal energy converter power
Min. — Max. kW
Drop nulls
Significant wave height (Hm0)
Min. — Max. m
Drop nulls
Wave period (Tp)
Min. — Max. s
Drop nulls
SEARCHABLE DATA (BETA)
Uref (m/s)
Power (kW)
Yaw (°)
Hm0 (m)
Tp (s)
00:00
Sep 26, 2014
12:00
00:00
Sep 27, 2014
12:00
00:00
Sep 28, 2014
12:00
00:00
Sep 29, 2014
Open Data For Tidal Energy
Links

ACCESS HI-RES DATA (>0.5HZ)

APPLY FILTER CLEAR FILTERS

Dataset
ADCPTD7_Dep1

Starting from (UTC)
26 / 09 / 2014 00 : 00

Elasped time
3 hours mins

Speed, tidal stream
0 — Max. m/s ☑ Drop nulls

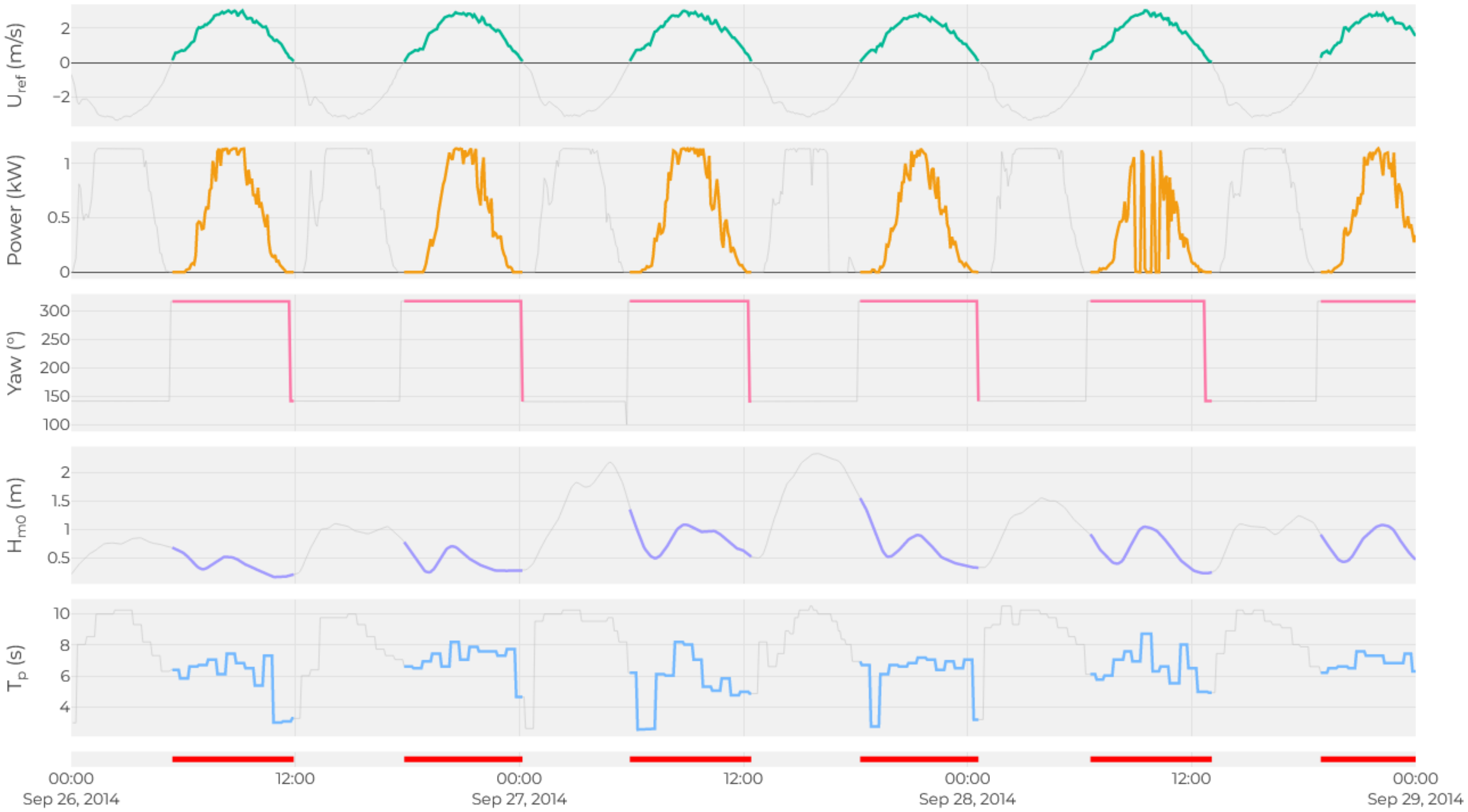
○ Flood & Ebb | ● Flood ○ Ebb

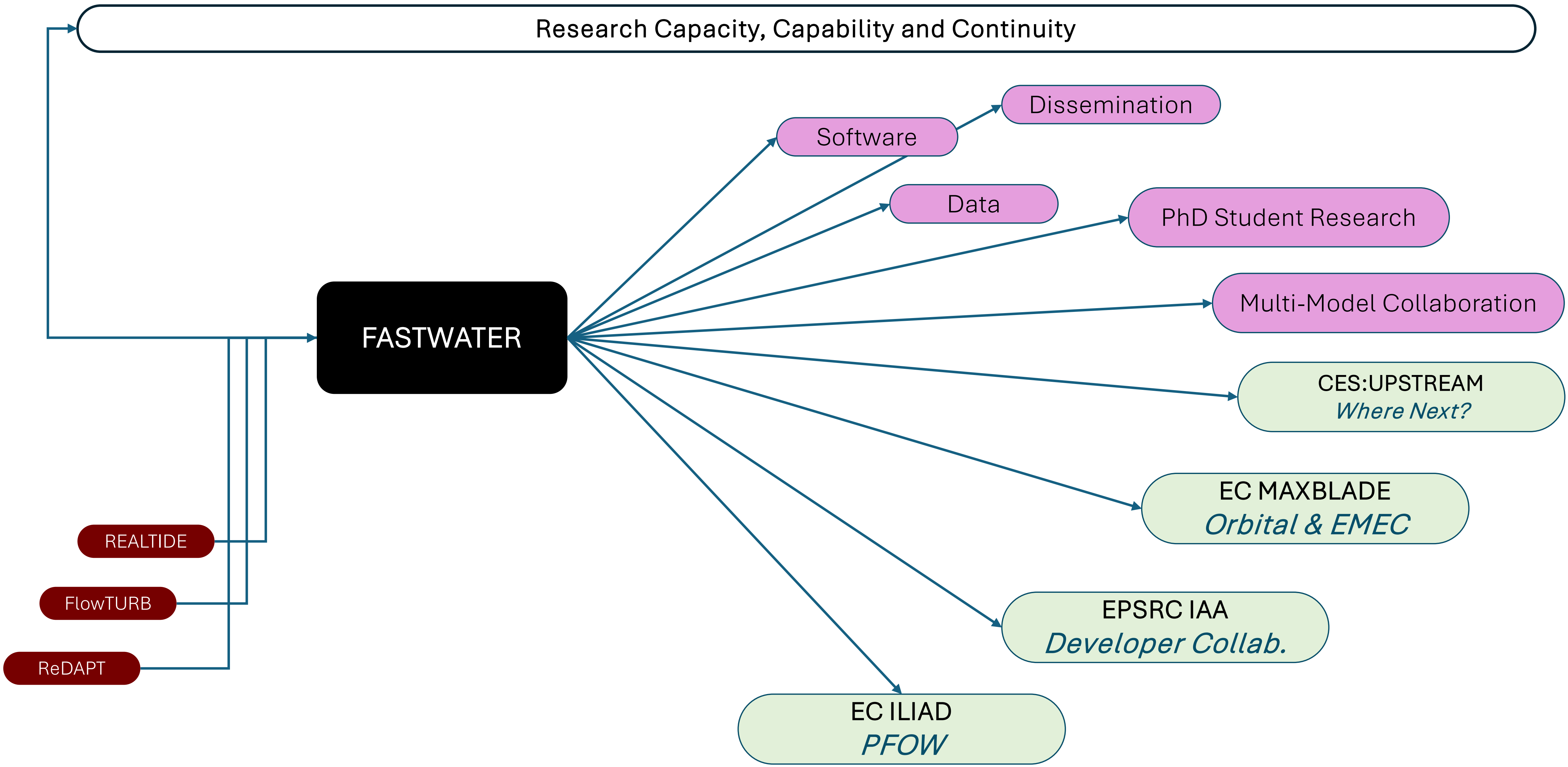
Tidal energy converter power
Min. — Max. kW ☐ Drop nulls

Significant wave height (H_{m0})
Min. — Max. m ☐ Drop nulls

Wave period (T_p)
Min. — Max. s ☐ Drop nulls

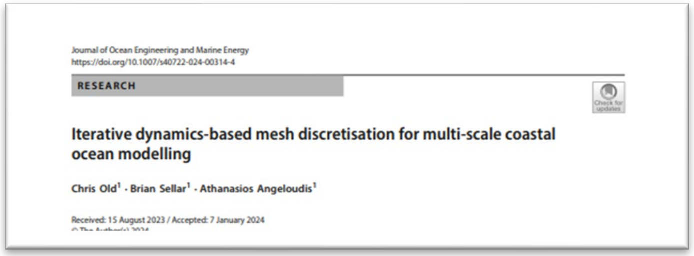
SEARCHABLE DATA (**BETA**)




Research Capacity, Capability and Continuity
FASTWATER
Software
Dissemination
Data
PhD Student Research
Multi-Model Collaboration
CES:UPSTREAM
Where Next?
EC MAXBLADE
Orbital & EMEC
EPSRC IAA
Developer Collab.
EC ILIAD
PFOW
REALTIDE
FlowTURB
ReDAPT

OPEN PUBLICATIONS

Underpinning techniques

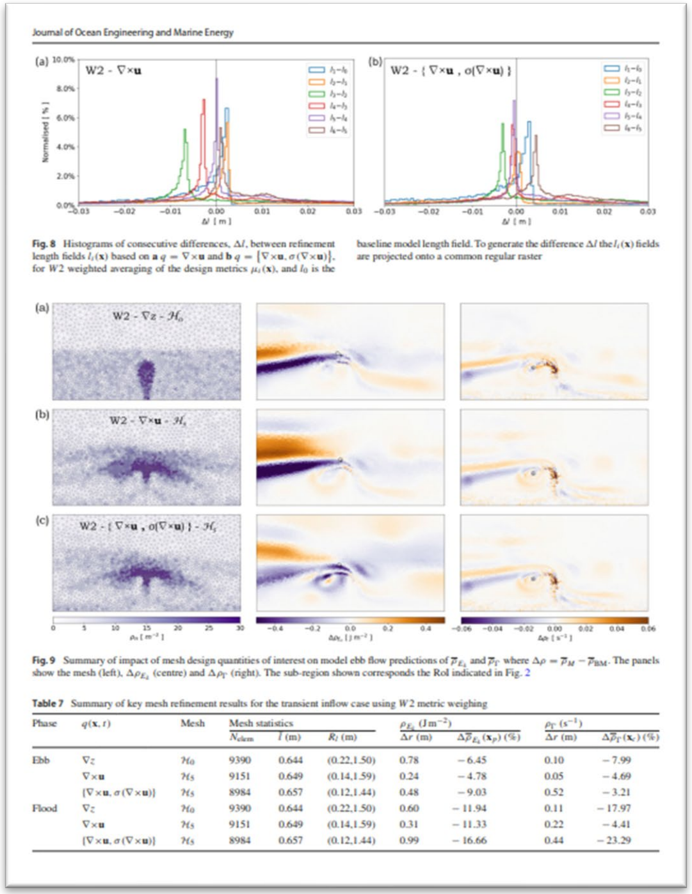

Journal of Ocean Engineering and Marine Energy
https://doi.org/10.1007/s40722-024-00314-4

RESEARCH

Iterative dynamics-based mesh discretisation for multi-scale coastal ocean modelling

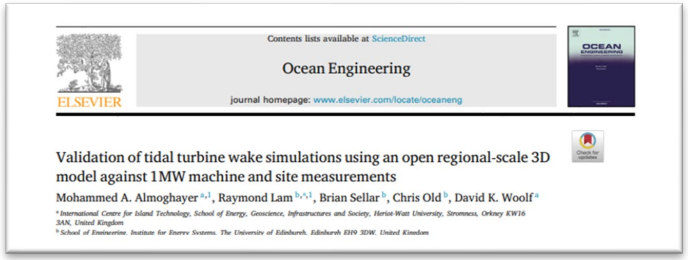
Chris Old[1] · Brian Sellar[1] · Athanasios Angeloudis[1]

Received: 15 August 2023 / Accepted: 7 January 2024



https://doi.org/10.1007/s40722-024-00314-4

Full-scale applications

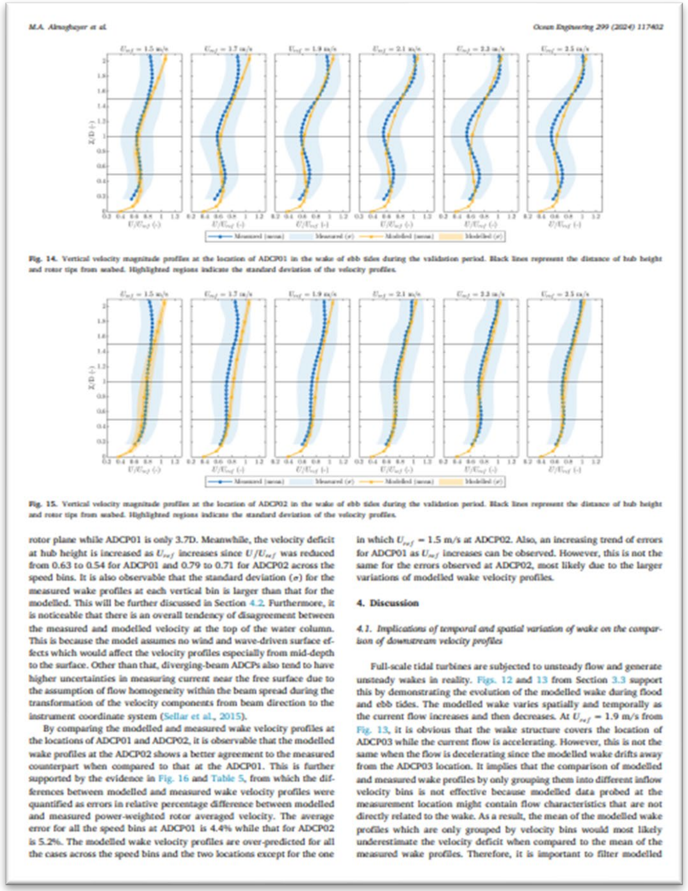

Contents lists available at ScienceDirect

Ocean Engineering

journal homepage: www.elsevier.com/locate/oceaneng

Validation of tidal turbine wake simulations using an open regional-scale 3D model against 1MW machine and site measurements

Mohammed A. Almoghayer[a,1], Raymond Lam[b,*,1], Brian Sellar[b], Chris Old[b], David K. Woolf[a]



https://doi.org/10.1016/j.oceaneng.2024.117402

Open Data Access

High resolution bathymetry related to CES lease sites

In situ measurements (EMEC, CES – current, waves, acoustic)

2-D / 3-D models for Scottish waters (constructs + simulation data)

Searchable Model Data

Prototype Cloud service to be extended to include model data requests.

Link frontend web service with backend implementation of OCMW toolbox.

Model based resource assessment and site characterisation

Turbine-based yield estimated using Cal/Val 2-D/3-D model data

Array Modelling

2-D / 3-D embedded turbine array hydrodynamic models

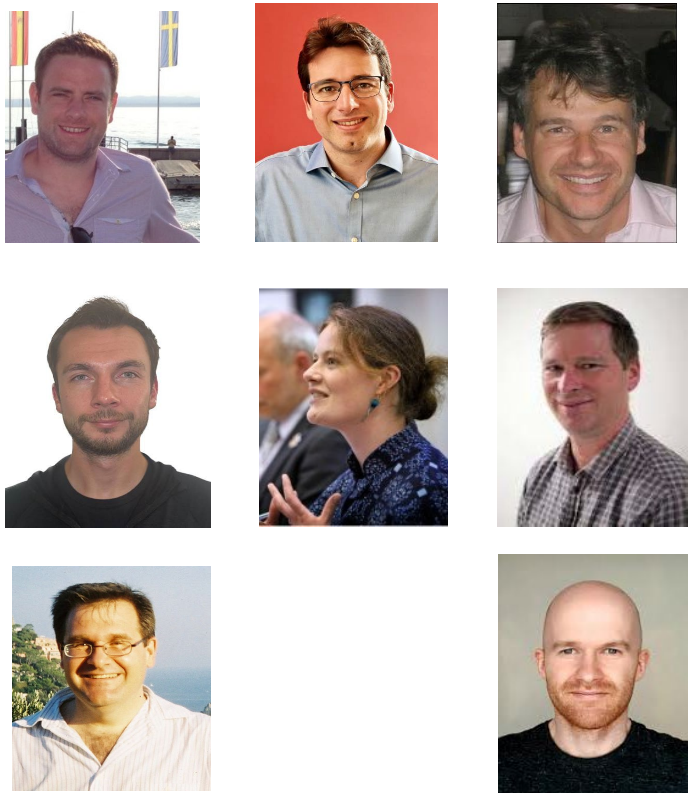
Array-Array interaction assessment (relates to changes in site lease model)

CES-UP : STREAM

Crown Estate Scotland – University of Edinburgh Partnership:

SUPPORTING TIDAL RESOURCE, ENERGY-YIELD & ARRAY MODELLING

An Interdisciplinary Team…



CES:UPSTREAM – Targeted Workshops Coming Soon Q2 & Q3 2024…