Deltares

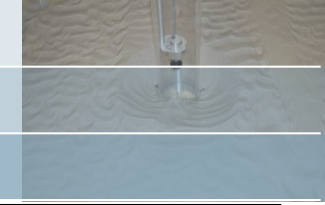
Enabling Offshore Life

Wind and wave forecasting for the southern North Sea basin

User representative: Deltares

(Deltares Offshore Team: Klaas Jan Bos, Sofia Caires, Niels Jacobsen, Bo Paulsen, Jan-Joost Schouten, Tim Raaijmakers, Hendrik Jan Riezebos, Thijs Robijns, Tom Roetert, Pim van Steijn, Greta van Velzen,… **)**

Deltares' activities in offshore wind



Hydrodynamics

- **Metocean/environmental conditions (waves, currents, water levels)**
- **Operational forecasting systems (for installation and O&M)**
- **Wave loads / impacts on foundations**

Need for

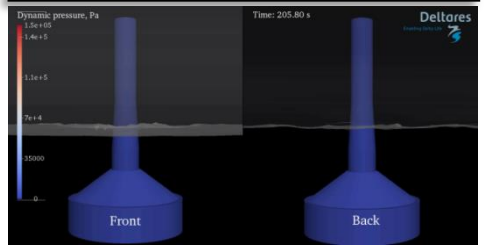
- Forecast accuracy (Reinder)
- Uncertainty quantification (Reinder & Anne)
- Efficient sampling (input reduction) techniques (Anne)

Geotechnics

- Geotechnical design of foundations (e.g. cyclic liquefaction)
- Pile installation techniques (impact-driving, vibrating)
- Cable burial techniques (jetting, ploughing, trenching, self-burial)
- External threats to electricity cables (anchors, fishnets, objects)

Morphology & morphodynamics

- Offshore geology, seabed characteristics
- Scour and scour protection for all kinds of foundations
- Bed level changes due to morphodynamics (e.g. sand waves)
- Cable routing and site selection in morphodynamic areas



Offshore surveying

- Seismic, sonar and other hydrographic surveys

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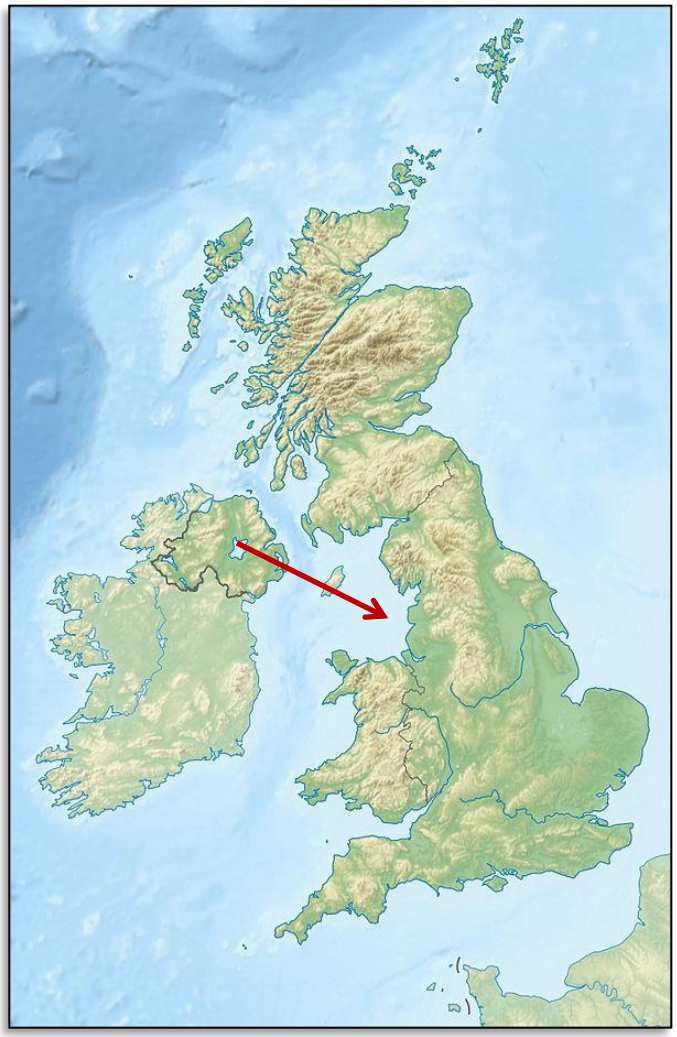
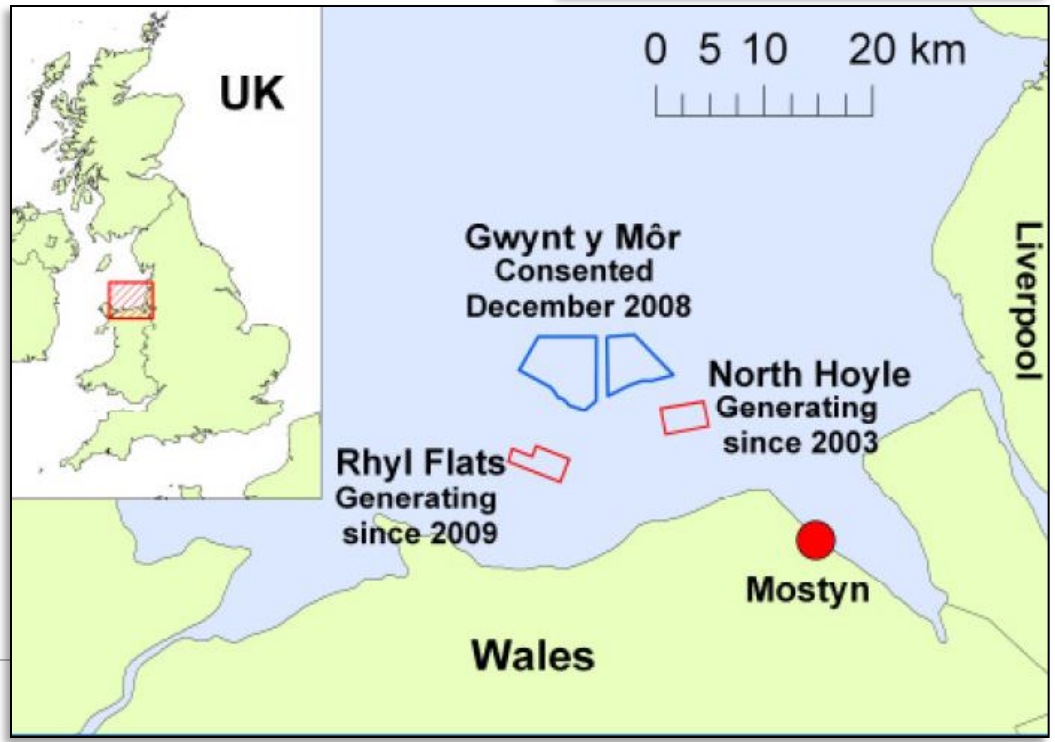
Meteo Dashboard 4 Irish Sea (Innogy)



RWE's offshore wind Farm in the Irish Sea:

- Rhyl Flats
- North Hoyle
- Gwynt y Môr



Meteo Dashboard

The Meteo Dashboard: is a decision support system for operation and maintenance activities of offshore wind farms, consisting of two components:

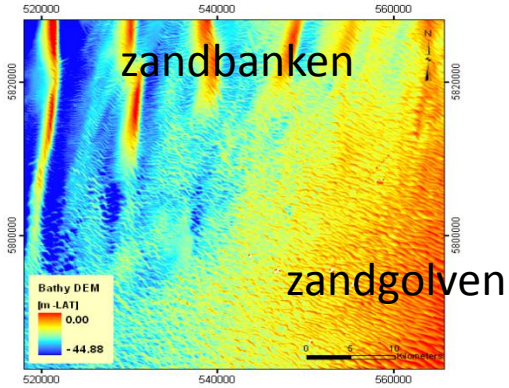
1. **Forecasting System**: a high-resolution hydrodynamic modelling system that provides forecasts of

   1.0 waves, currents and water levels

   2.0 vessel movements + human performance indicator

   3**.0 …**

   at each wind turbine location in the offshore wind farm, on the basis of input meteo and boundary (wave) data from various sources.



2. **Dashboard**: an integrated software system that collects, stores and presents all relevant measured and forecasted meteo- and hydrodynamic data, in support of the decision making process of installation and maintenance activities at the OWP.

Dashboard - Components

Accuracy &Uncertainty

Transformation matrices based on efficient sampling (input reduction)

forecasts overall model (DCSM, ECMWF)

Earth Observations (Modis, Sentinel)

offshore measurements (metmast, ADCP, lidar)

High resolution bathymetry

models…

Automated data error corrections

Detailed calibrated Wind Farm model

Data assimilation & Uncertainty bands

Operational Forecasting System

validated measurements

detailed forecasts

Database

Model Application Tool

models…

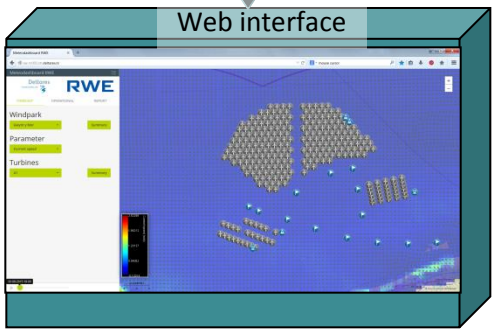
Weather windows

Scour predictor?

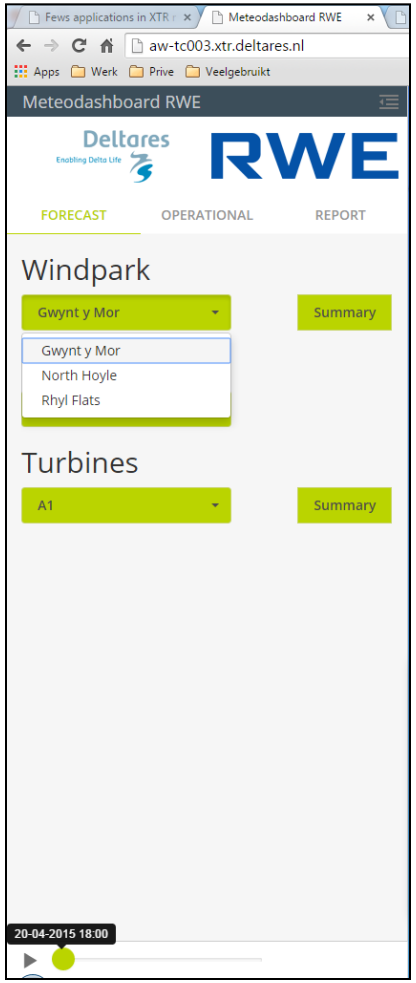
RAO/Vessel movements?

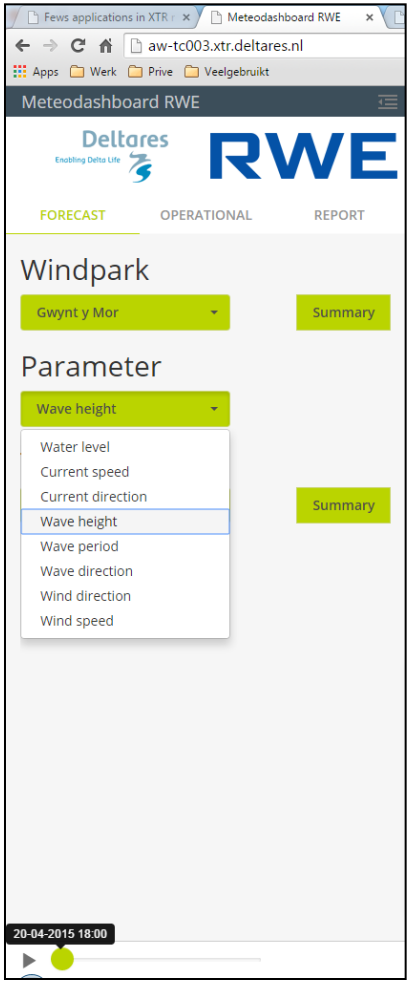
Human factor? etc…

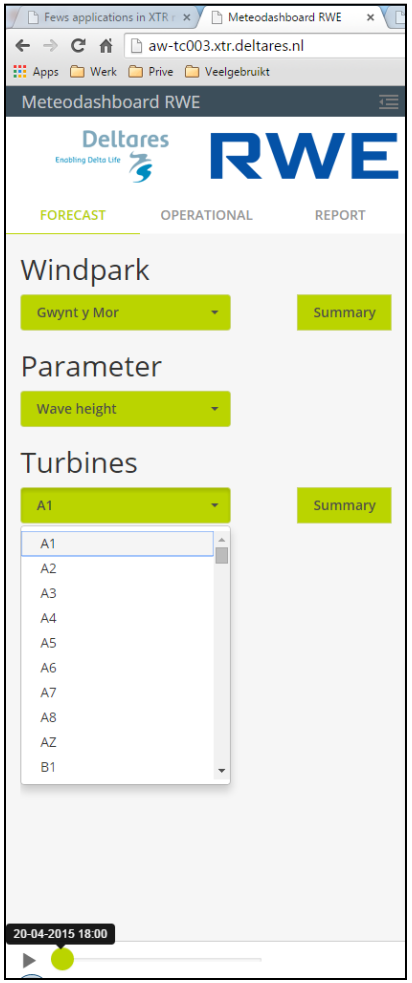
Web interface



Wind farm, parameter and turbine selection







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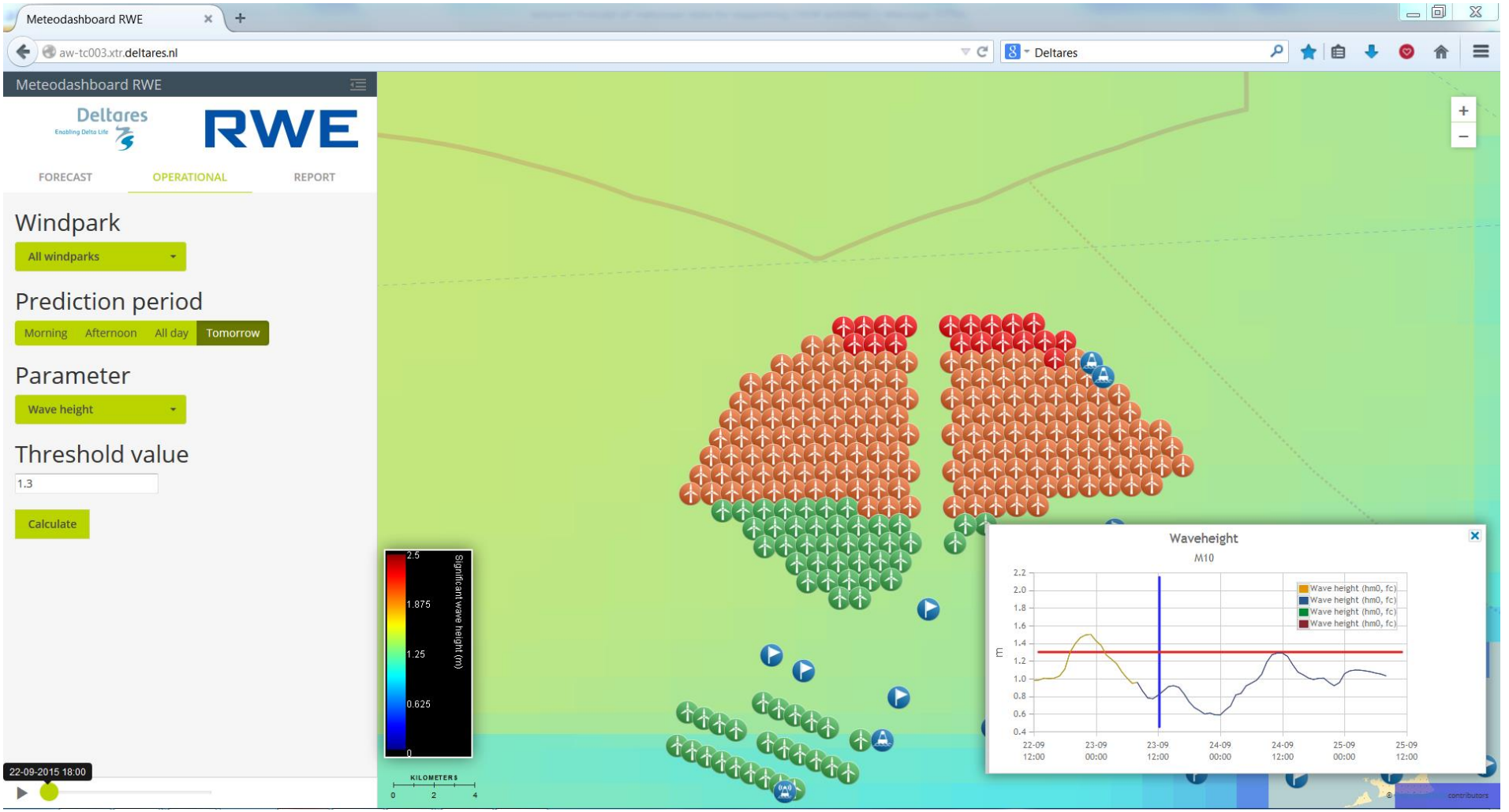
Operational tab, O&M partly possible



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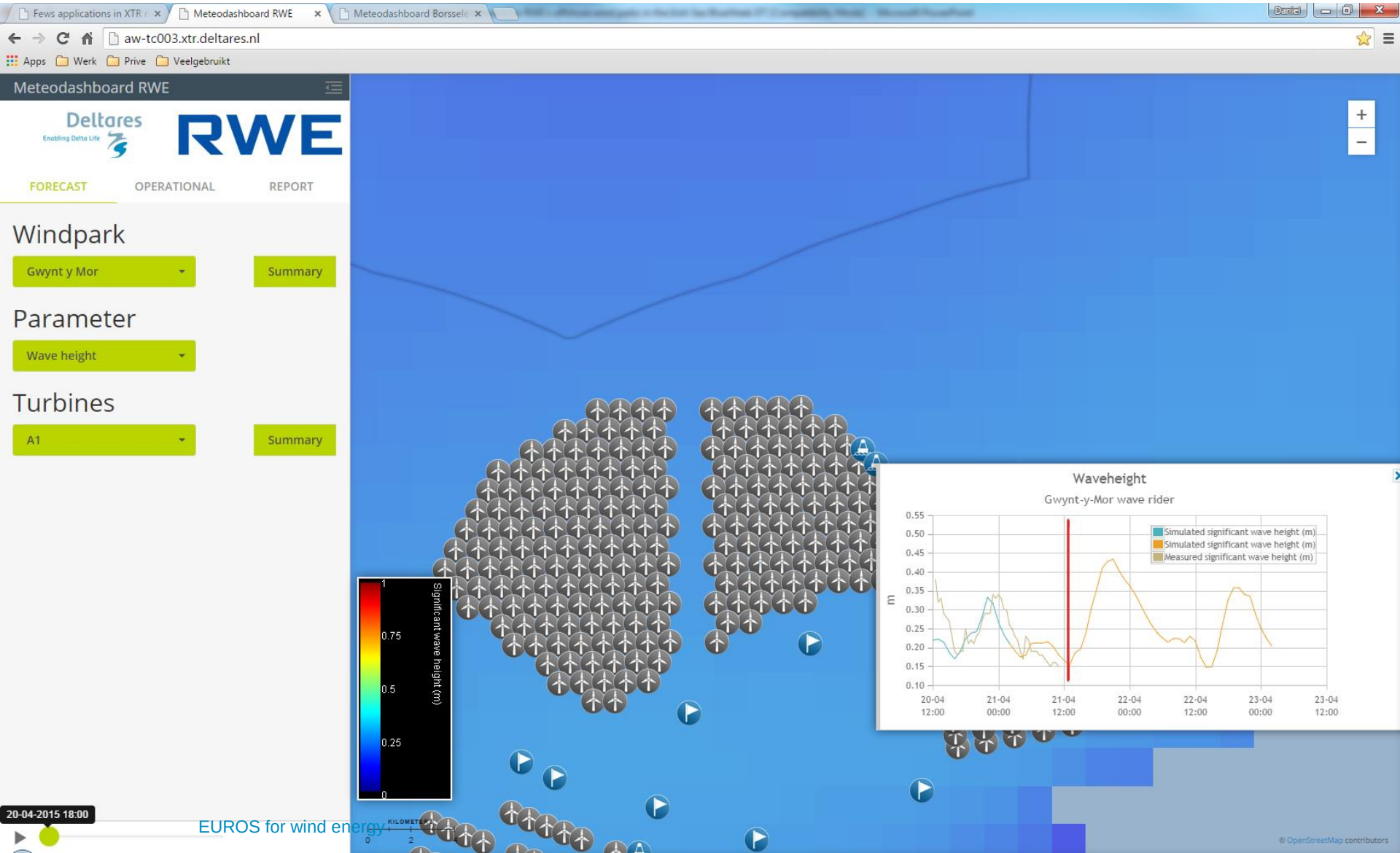
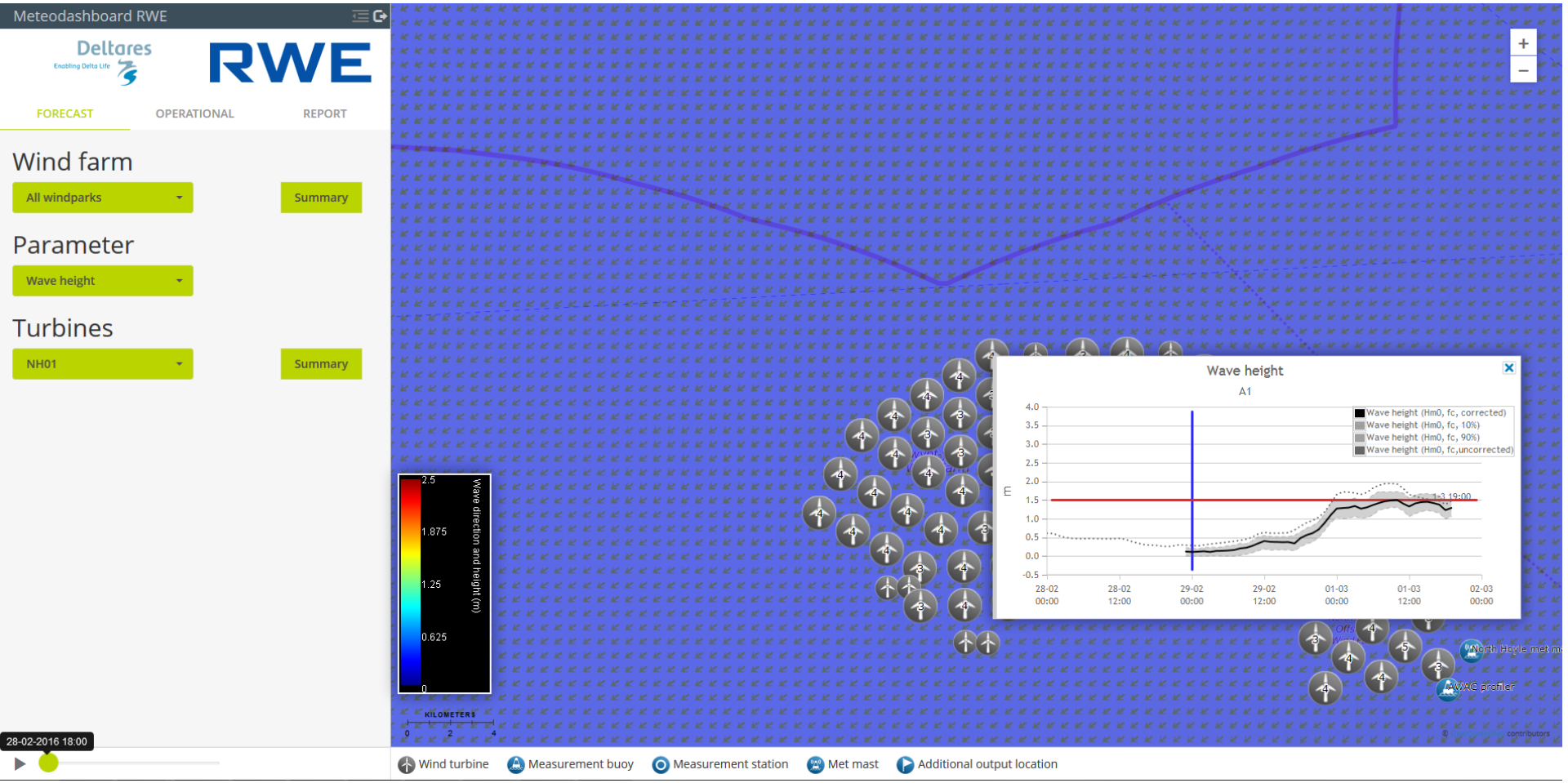
Viewing measured and forecast time series




Meteodashboard RWE
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Enabling Delta Life
RWE
FORECAST
OPERATIONAL
REPORT
Wind farm
All windparks
Summary
Parameter
Wave height
Turbines
NH01
Summary
Wave height
A1
Wave height (Hm0, fc, corrected)
Wave height (Hm0, fc, 10%)
Wave height (Hm0, fc, 90%)
Wave height (Hm0, fc,uncorrected)
m
28-02 00:00
28-02 12:00
29-02 00:00
29-02 12:00
01-03 00:00
01-03 12:00
02-03 00:00
Wave direction and height (m)
2.5
1.875
1.25
0.625
0
KILOMETERS
28-02-2016 18:00
Wind turbine
Measurement buoy
Measurement station
Met mast
Additional output location
North Hoyle met m
WAG profiler

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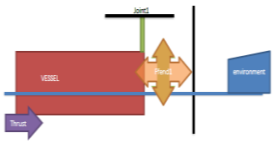
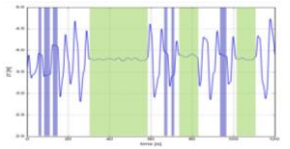
CTV vessel pushing against the wind turbine



This is schematized as follows in the numerical model of MARIN



Calculated time trace of the bow motion w.r.t. to the wind turbine. In the green area the technicians can be transferred to the OWT.

Meteodashboard RWE

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Meteodashboard RWE

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RWE

FORECAST OPERATIONAL REPORT

Windpark

All windparks

Prediction period

Morning Afternoon All day Tomorrow

Parameter

Wave height

Threshold value

1.3

Calculate

22-09-2015 18:00

Significant wave height (m)

2.5 1.875 1.25 0.625 0

KILOMETERS

0 2 4

Waveheight

M10

Wave height (hm0, fc)

Wave height (hm0, fc)

Wave height (hm0, fc)

Wave height (hm0, fc)

m

2.2 2.0 1.8 1.6 1.4 1.2 1.0 0.8 0.6 0.4

22-09 12:00 23-09 00:00 23-09 12:00 24-09 00:00 24-09 12:00 25-09 00:00 25-09 12:00

Environment

Vessel performance

Performance

Vessel response function

Human response function

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