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Meteo Dashboard

a decision support system for planning operation and maintenance activities at offshore wind farms

De Nederlandse offshore windenergieconferentie

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January 24, 2014

FLOW

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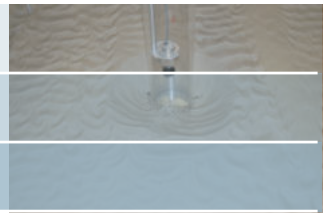
Meteo Dashboard for offshore wind farms

Consulting FLOW partners:
Eneco
RWE
Van Oord

Deltares; Bas Stengs, Reinier Tromp, Daniel Twigt, Reimer de Graaff and … many others
BMO: Gijs Hulscher

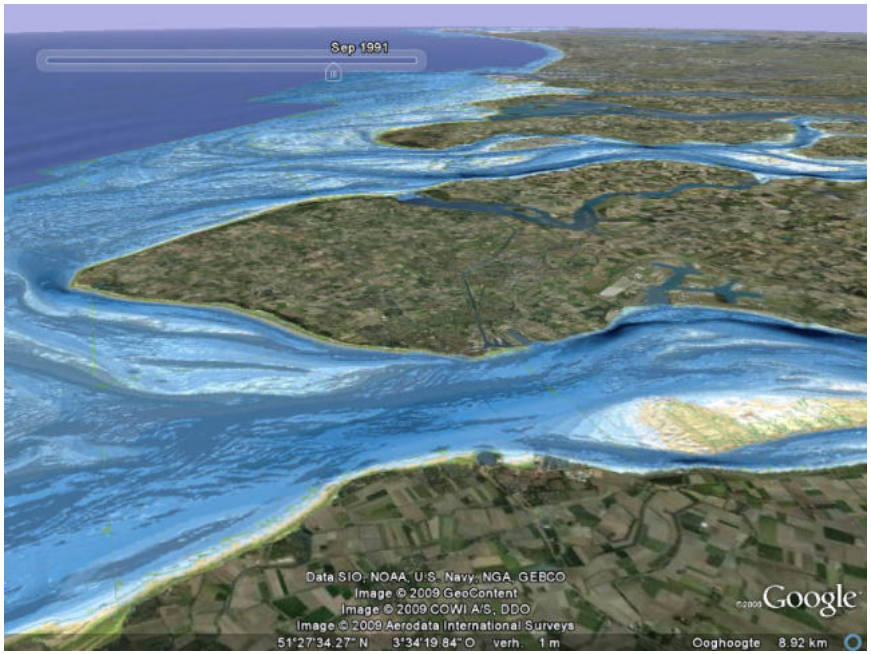
January 24, 2014

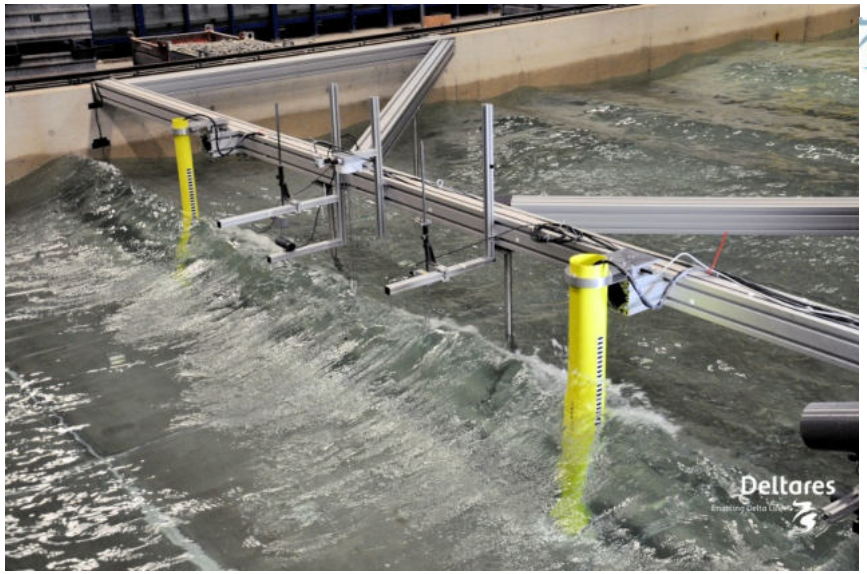
Intro

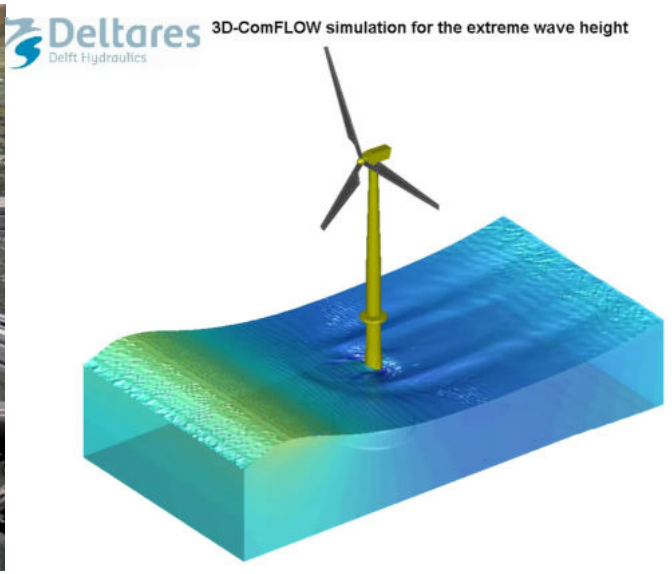


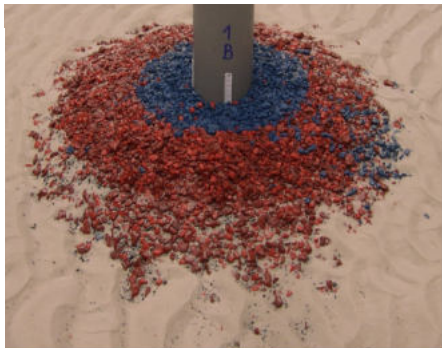
Deltares - Delta Engineering

- >850 fte
- Applied science
- Offshore wind
- International









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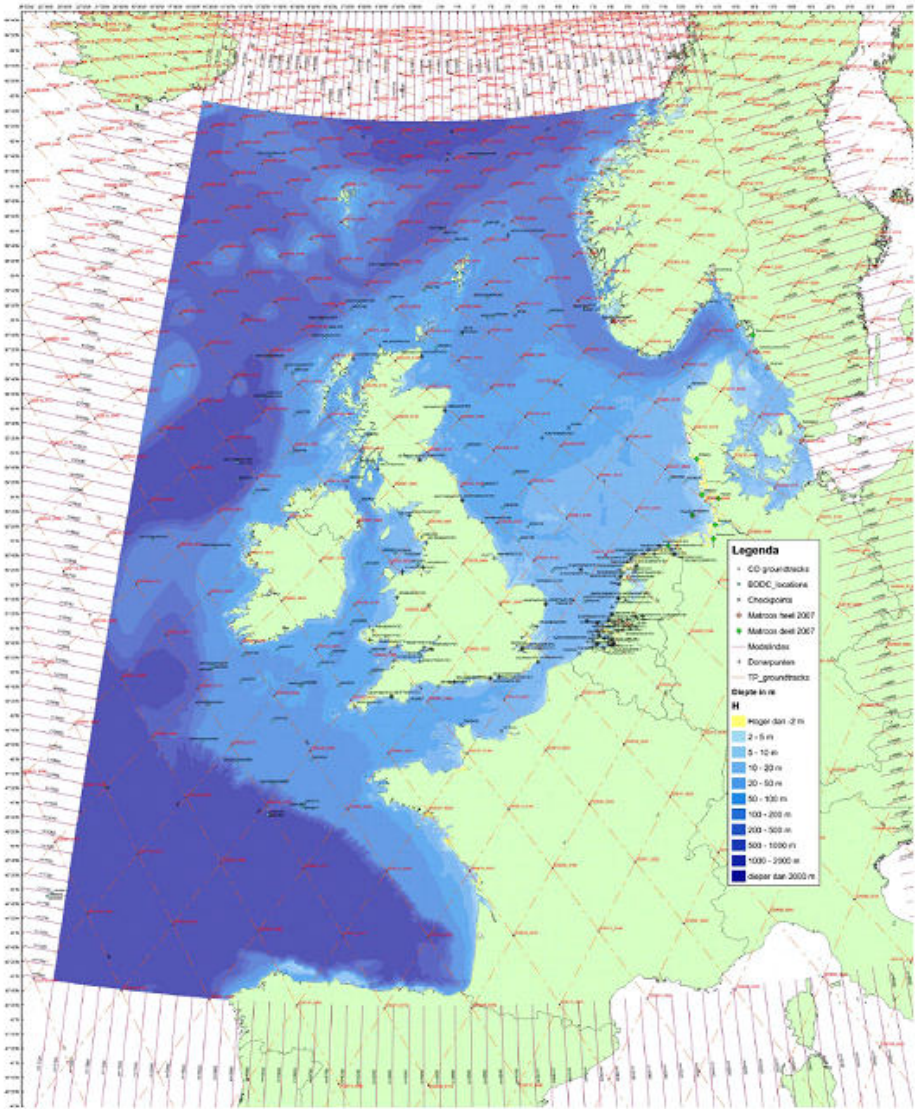
Forecasting system: Hydrodynamic model



DCSM

- Grid size: 1.5’ by 1.0’ (~2 km)
- Grid dimensions: 1120 x 1260 cells
- Bathymetry based on NOOS gridded data set
- Tidal constituents from global tidal model (GOT00.2) on open boundaries
  - > 8 main constituents
  - > 16 smaller diurnal and semi-diurnal constituents
  - > Annual constituent Sa
- Tide Generating Forces (TGF) included (amplitude of effect TGF about 10 cm)

red line: DCSM v5 model boundary

every 10th line plotted

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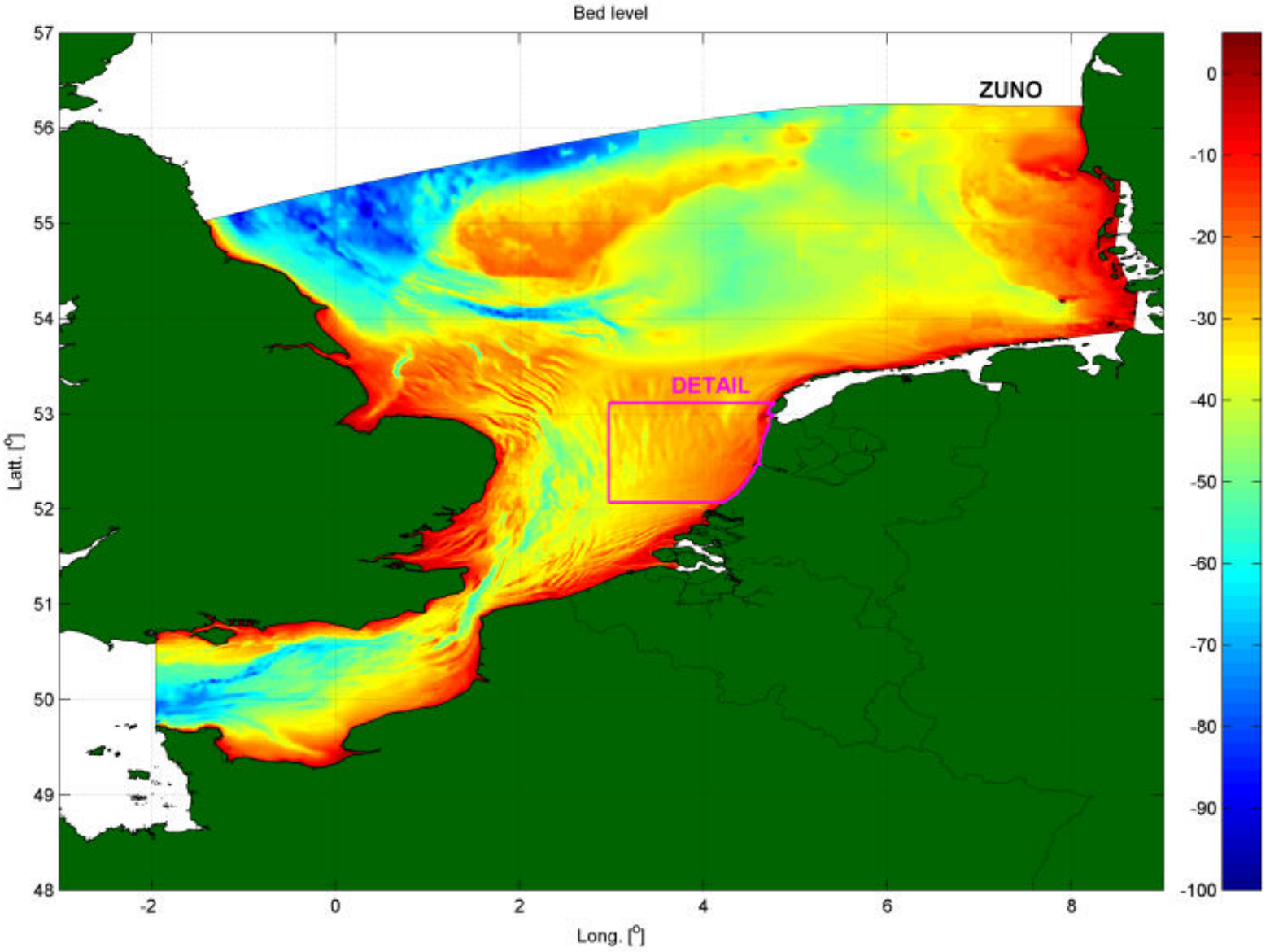
Forecasting system: Wave model



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Meteo Dashboard - Proposed system

The objective: is to develop a decision support system for operation and maintenance activities of offshore wind farms, in order to minimize costs of MWh from offshore wind.

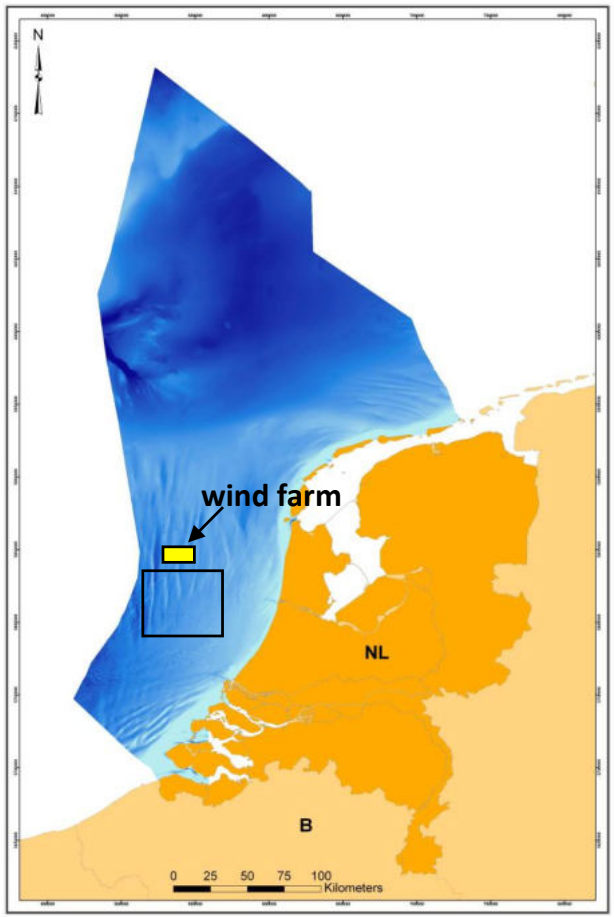
1. **Meteo Dashboard**: an integrated software system that collects, stores and presents all relevant measured and forecasted meteo- and hydrodynamic data, in support of the decision making process of installation and maintenance activities at the OWP

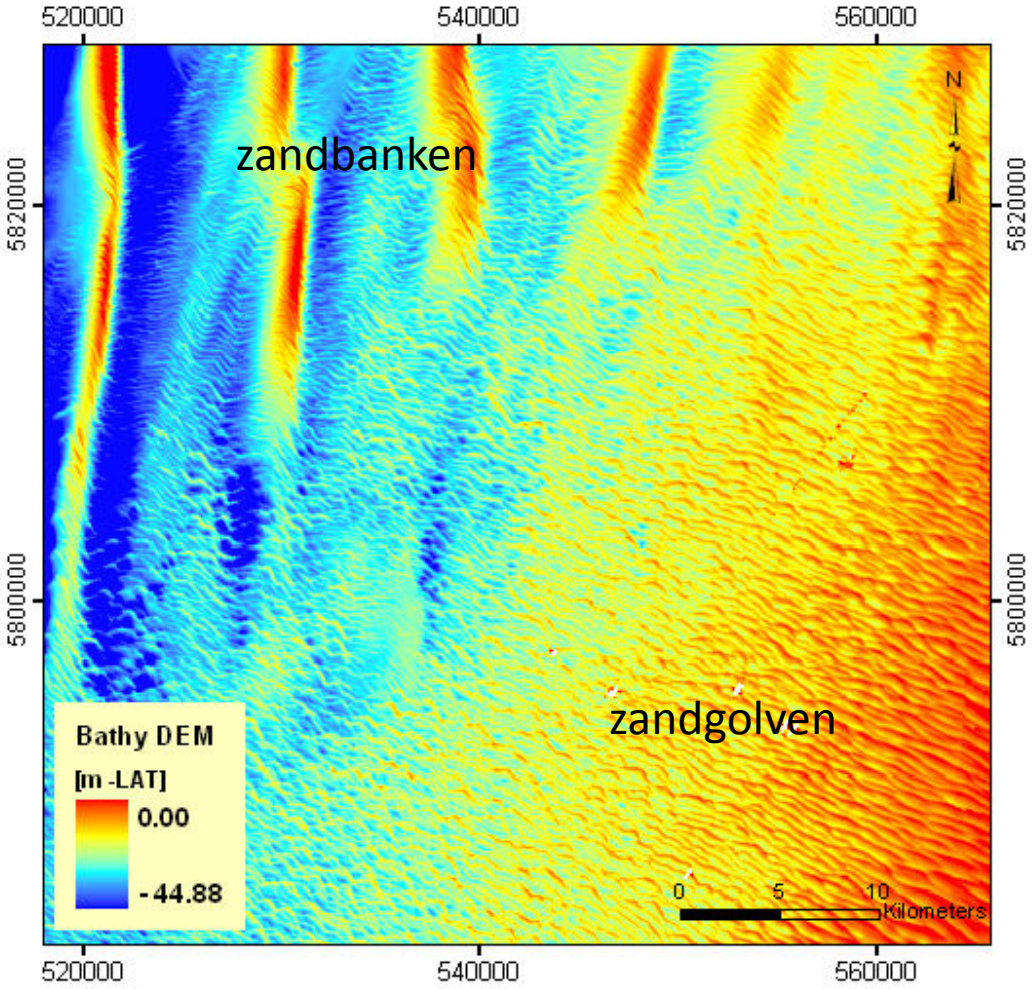
2. **Forecasting System**: a high-resolution hydrodynamic modelling system that provides forecasts of waves, currents and water levels at each wind turbine location in the offshore wind farm, on the basis of meteo- and offshore boundary conditions from various sources

Pilot project: **Tromp Binnen**, concession of RWE

Forecasting system: Marine bedforms North Sea

Bed Topography NCP





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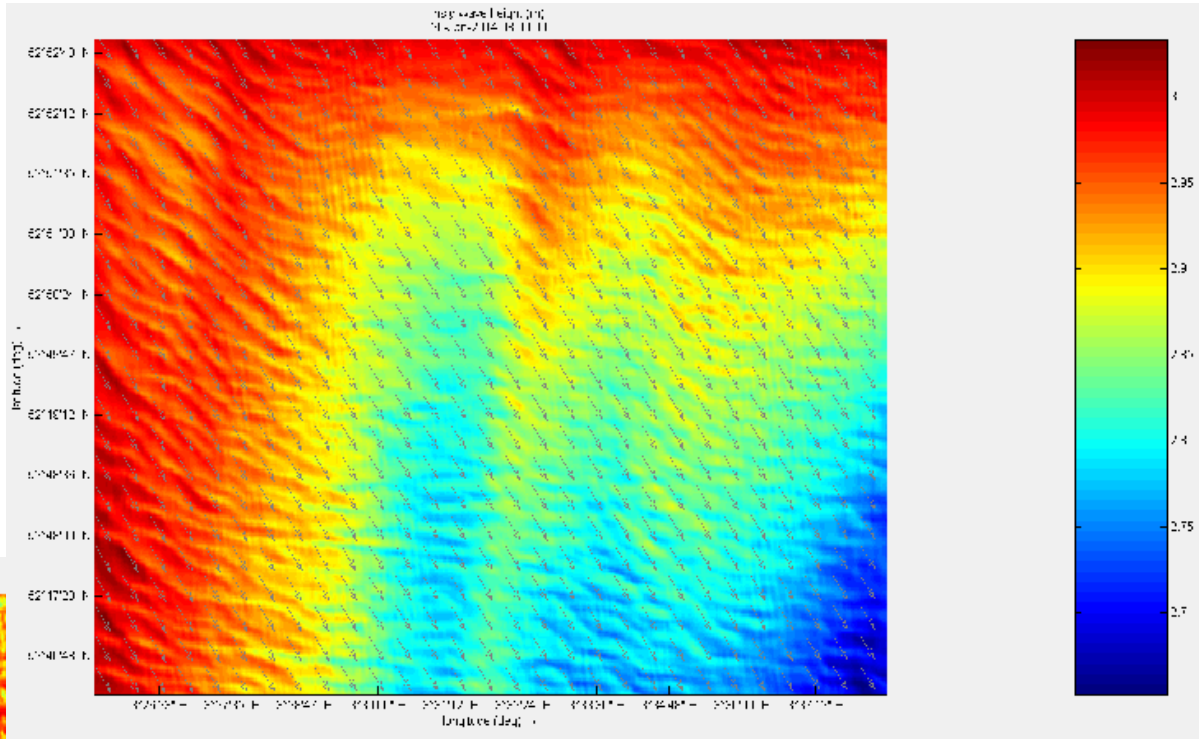
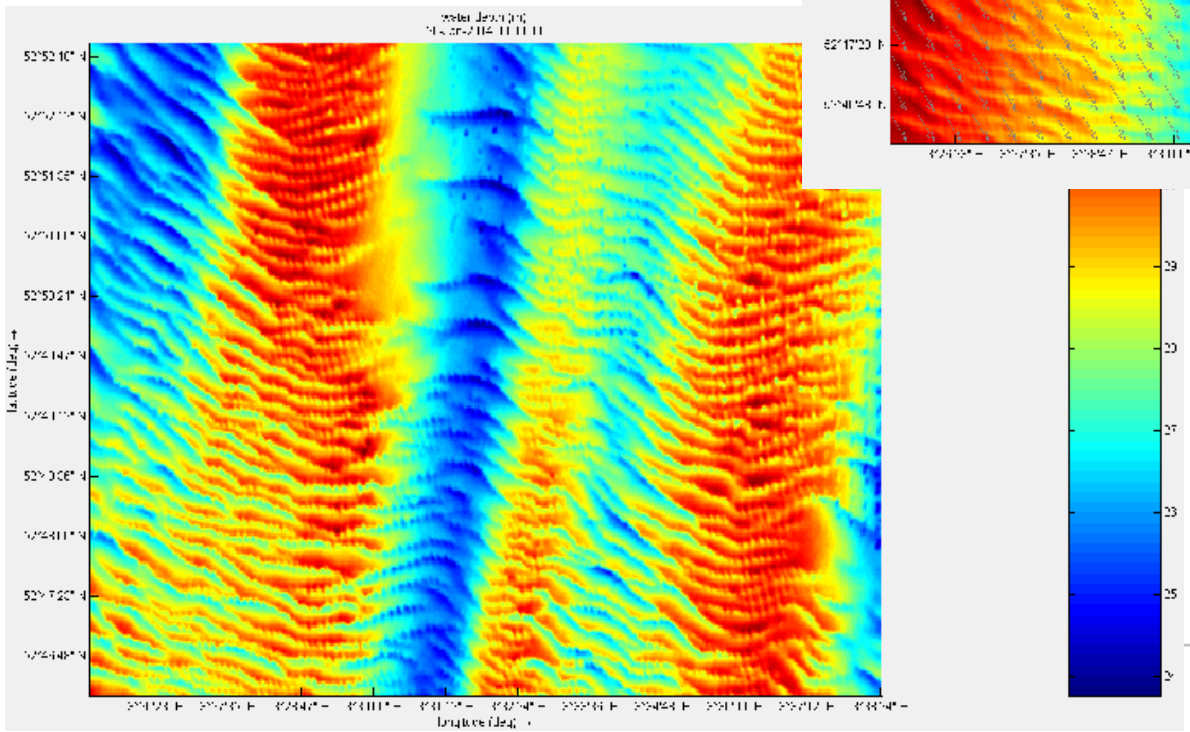
Waves @ Sea: effect of bed variations on waves





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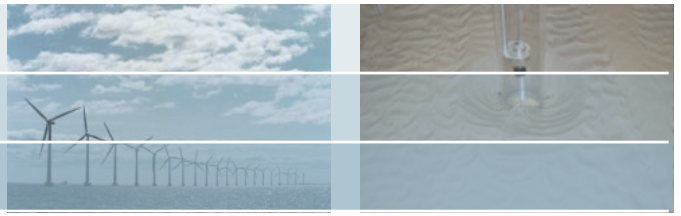
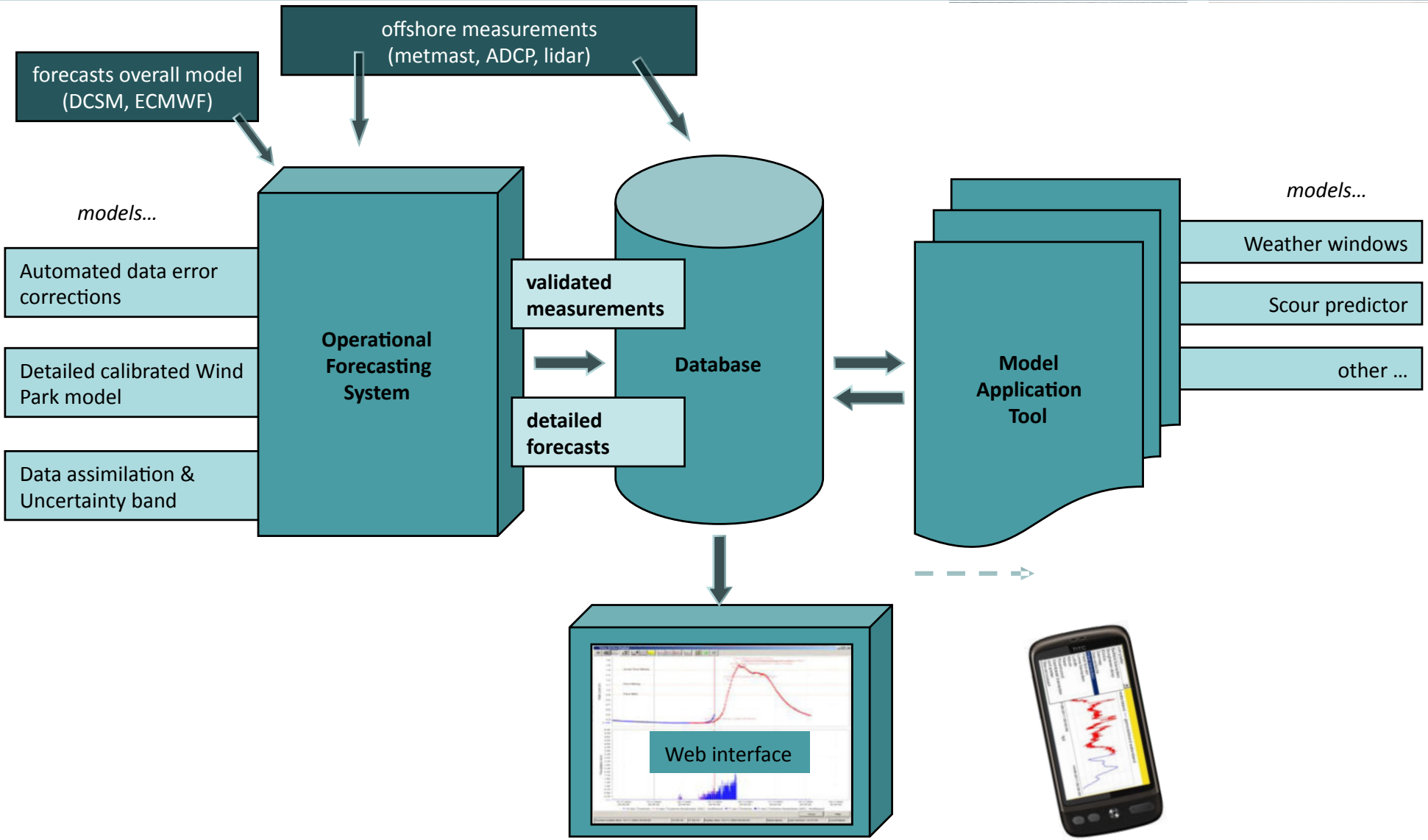
Meteo Dashboard – initial project





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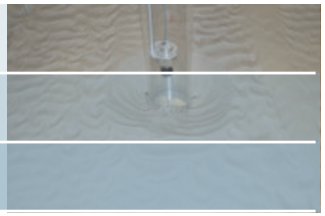
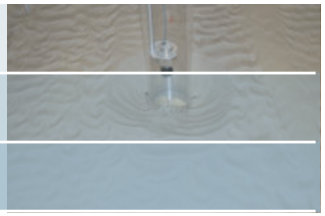
Meteo Dashboard: research questions



- which hydrodynamic parameters are required?
- what information should be presented in the Dashboard?
- what output will be required to smartphones (as app)?
- Is storage of forecast preferred?
- what is the preferred sampling/storage interval?
- is output at each wind turbine required?

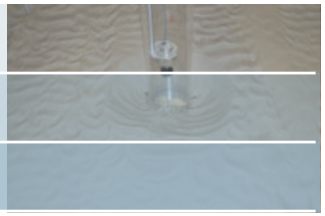
- what data sources can be used for forecasting?
- is detailed modelling adding value to forecasts in wind farm?
- in what way can accuracy estimates of the forecasts be used in the decision making process?
- will the stored data provide a reliable source of data for fatigue analysis of individual wind turbines?

Forecasting system



- 48-hours forecast of wave parameters (H_s, T_p, T_m, Dir) per turbine
- 48-hours forecast of water level and current per turbine
- 48-hours forecast of wind parameters
- Storing measurement data in database
- Storing 0-hours forecasting (per turbine) in database
- Determination of weather windows (based on criteria)
- Presentation of measurements and forecasting at Dashboard (app)
- Presentation of weather windows at Dashboard (app)
- Client-server software system with FEWS application

Forecasting system: Validation



- Validation of parameters during non-storm period of the year (measurement stations, see a.o. next slide):
  - Water level
  - Currents
  - **Wave height**
  - **Wave period**
- Forecast period: spring & summer 2013 / 2014
- Compare with measurements, a.o. Tromp Binnen Met Mast

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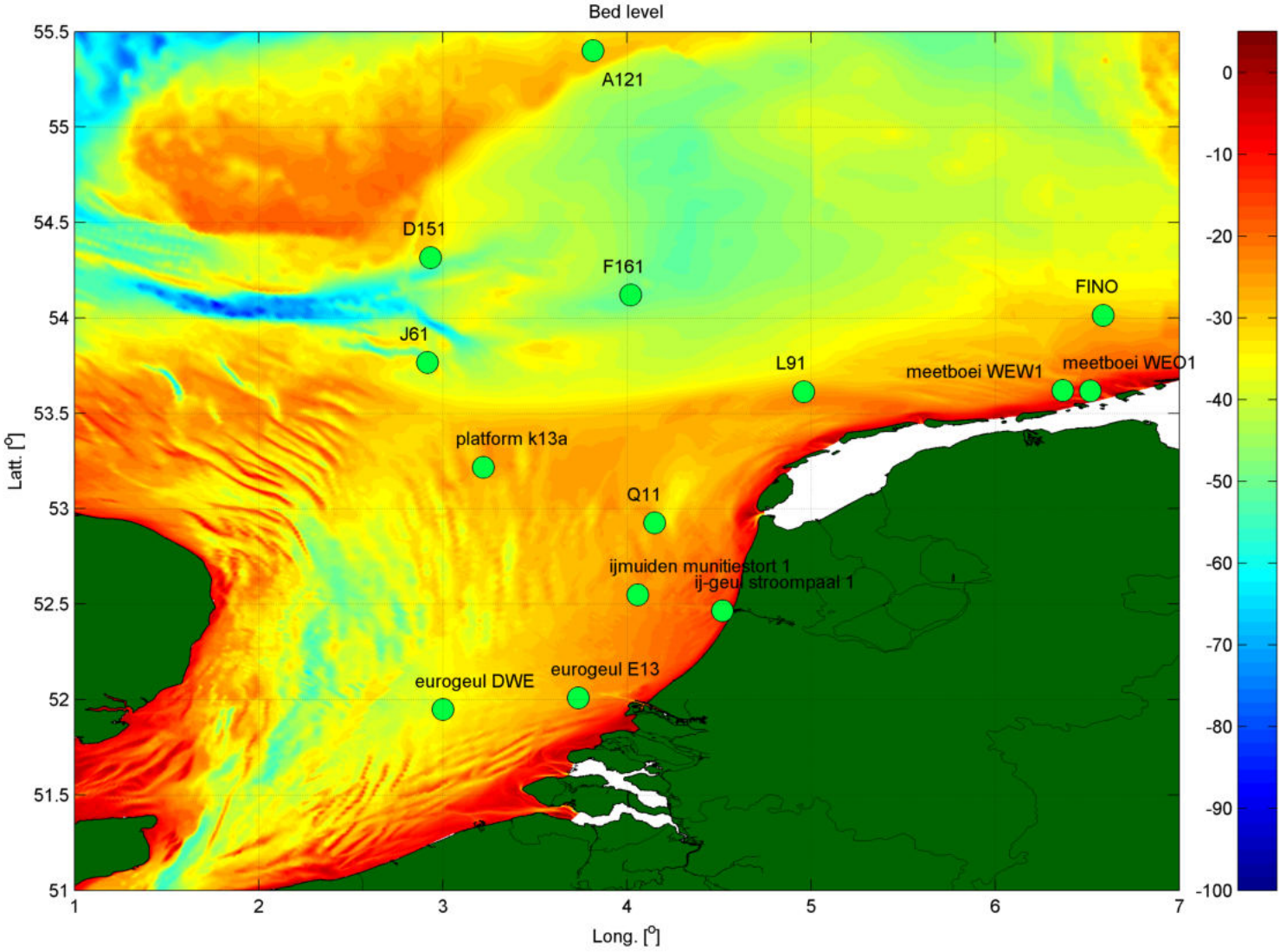
Forecasting system: Validation



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  - **Wave height**
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- Forecast period: spring & summer 2013
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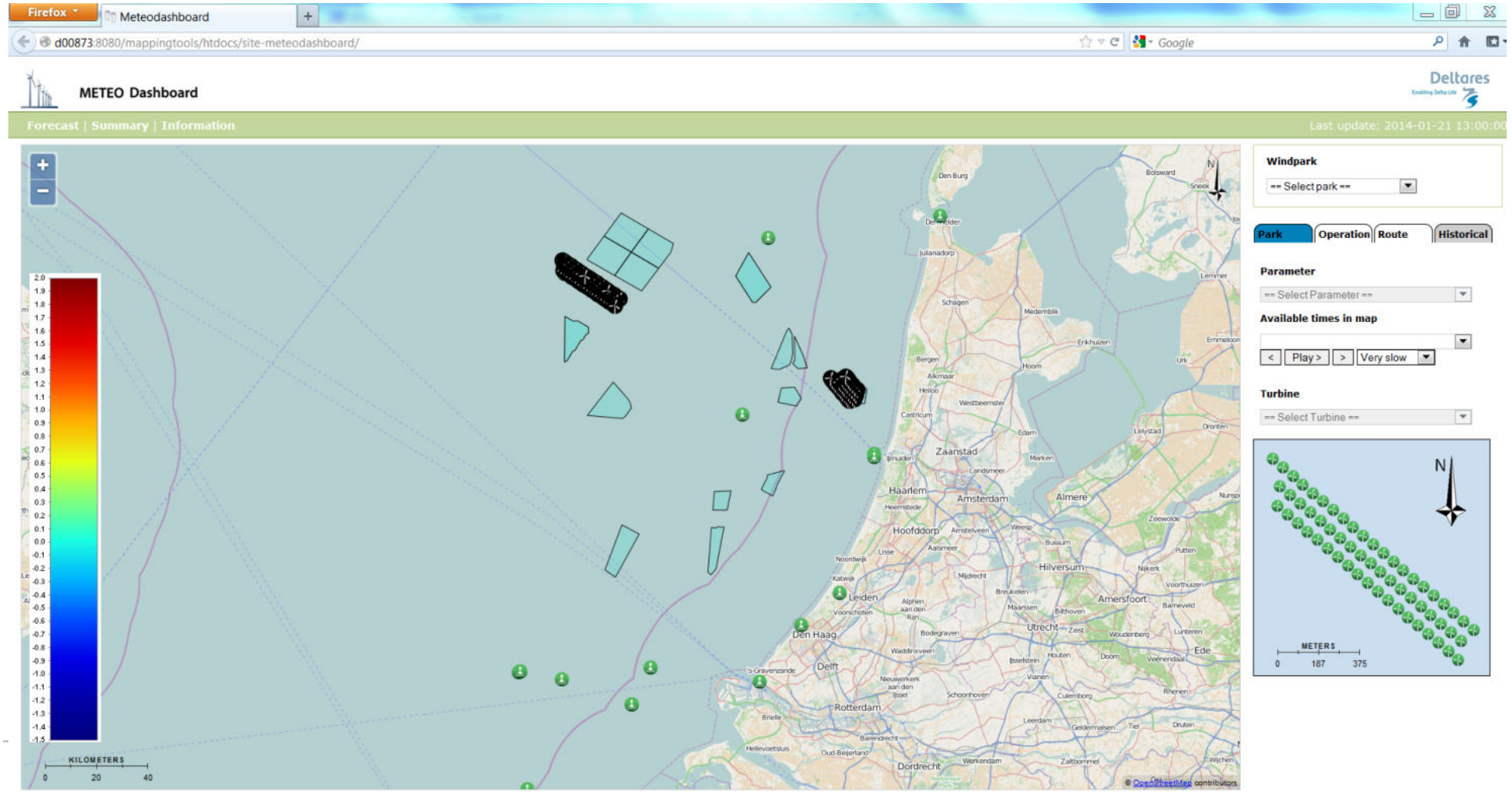
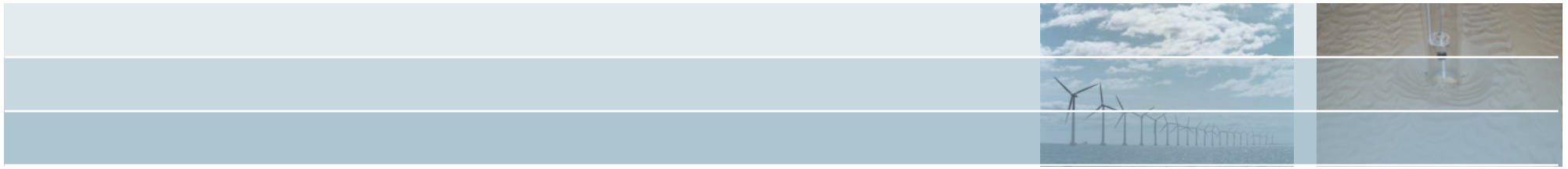
Demo Meteo Dashboard





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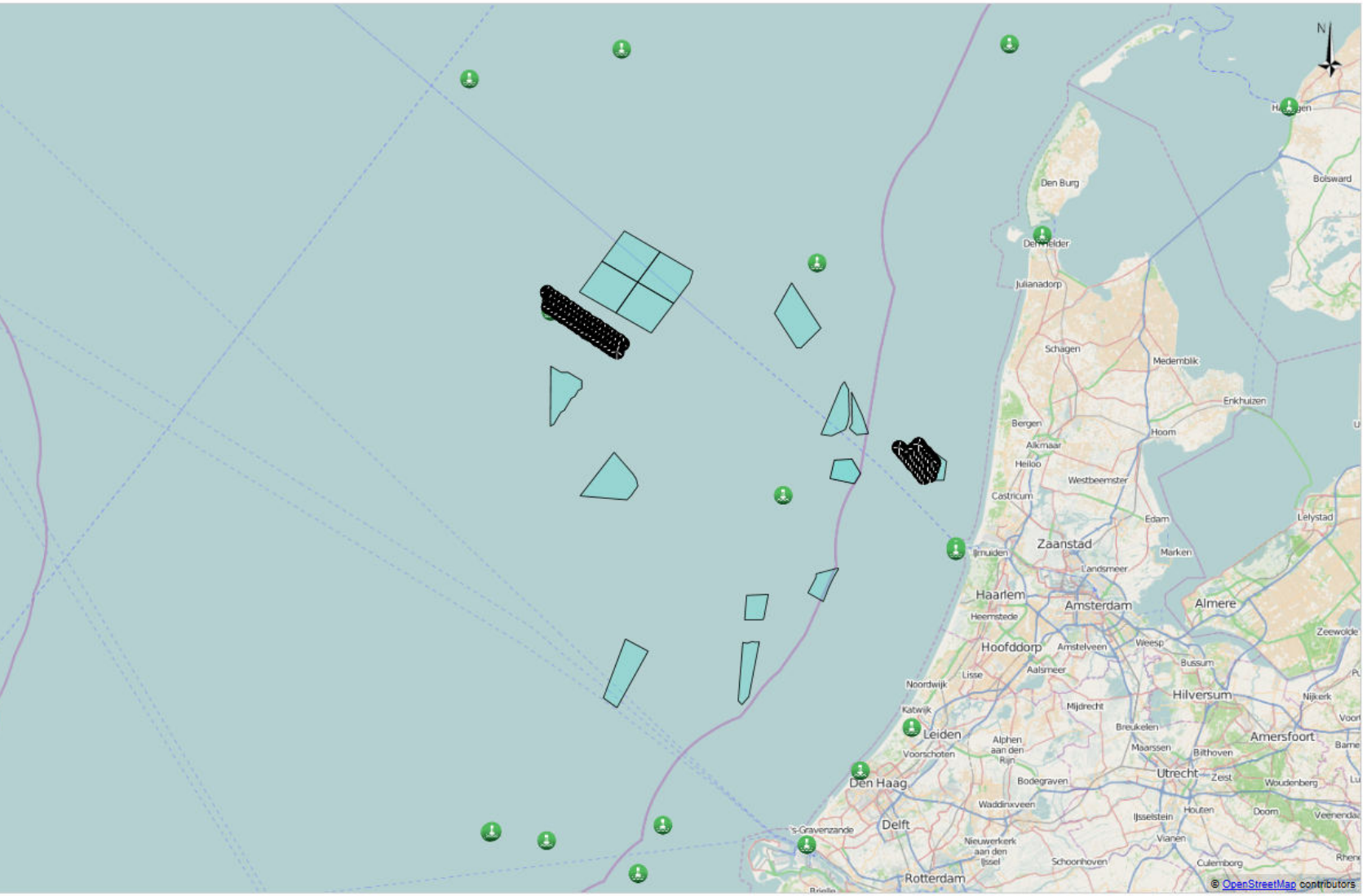
Information

Last update: 2013-12-20 01:00:00



Windpark

Tromp binnen windpark

Park | Operation | Route | Historical

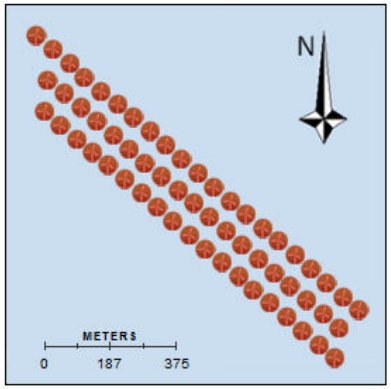
Date:

01/07/2014 Set

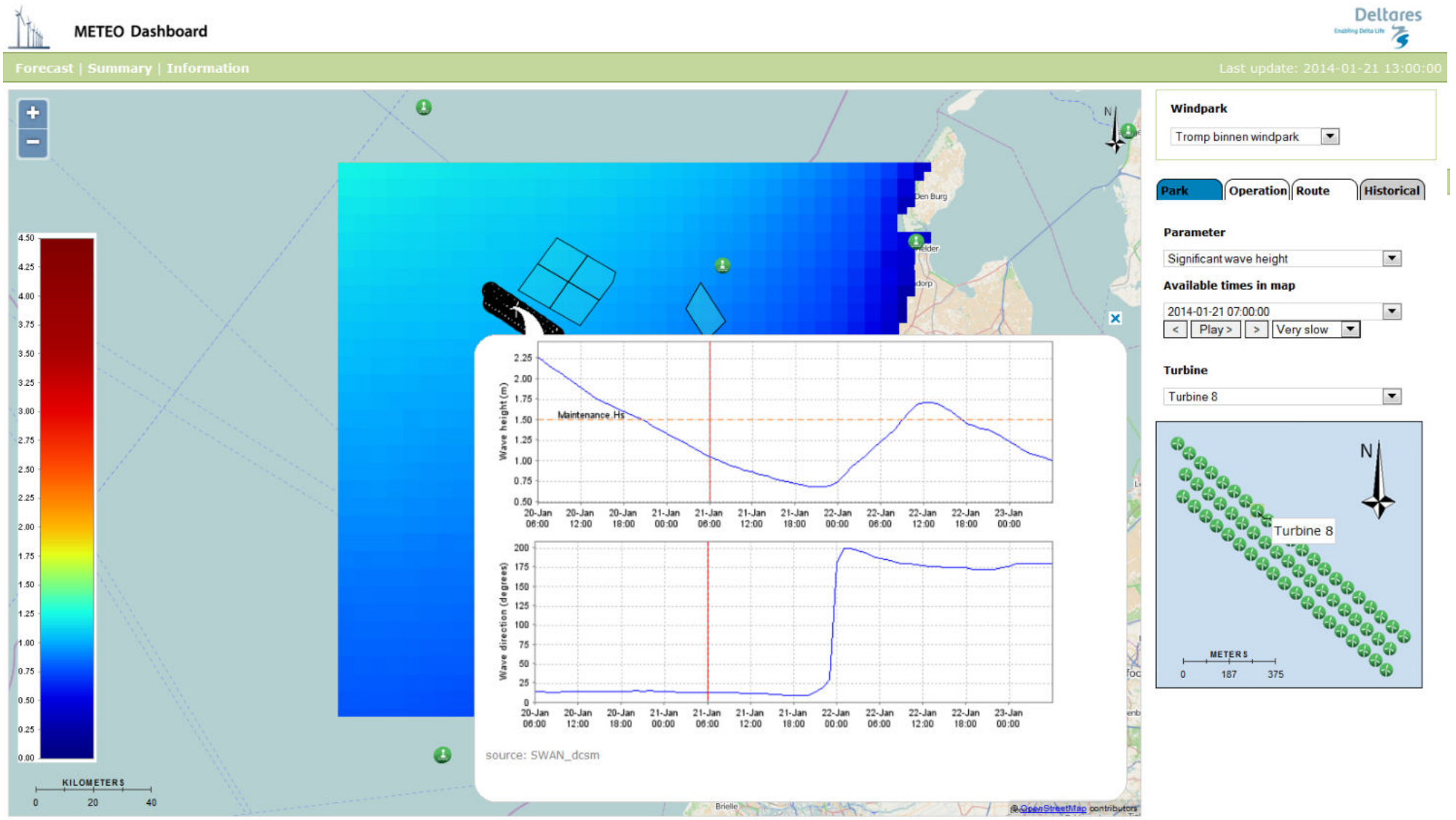
Parameter

== Select Parameter ==

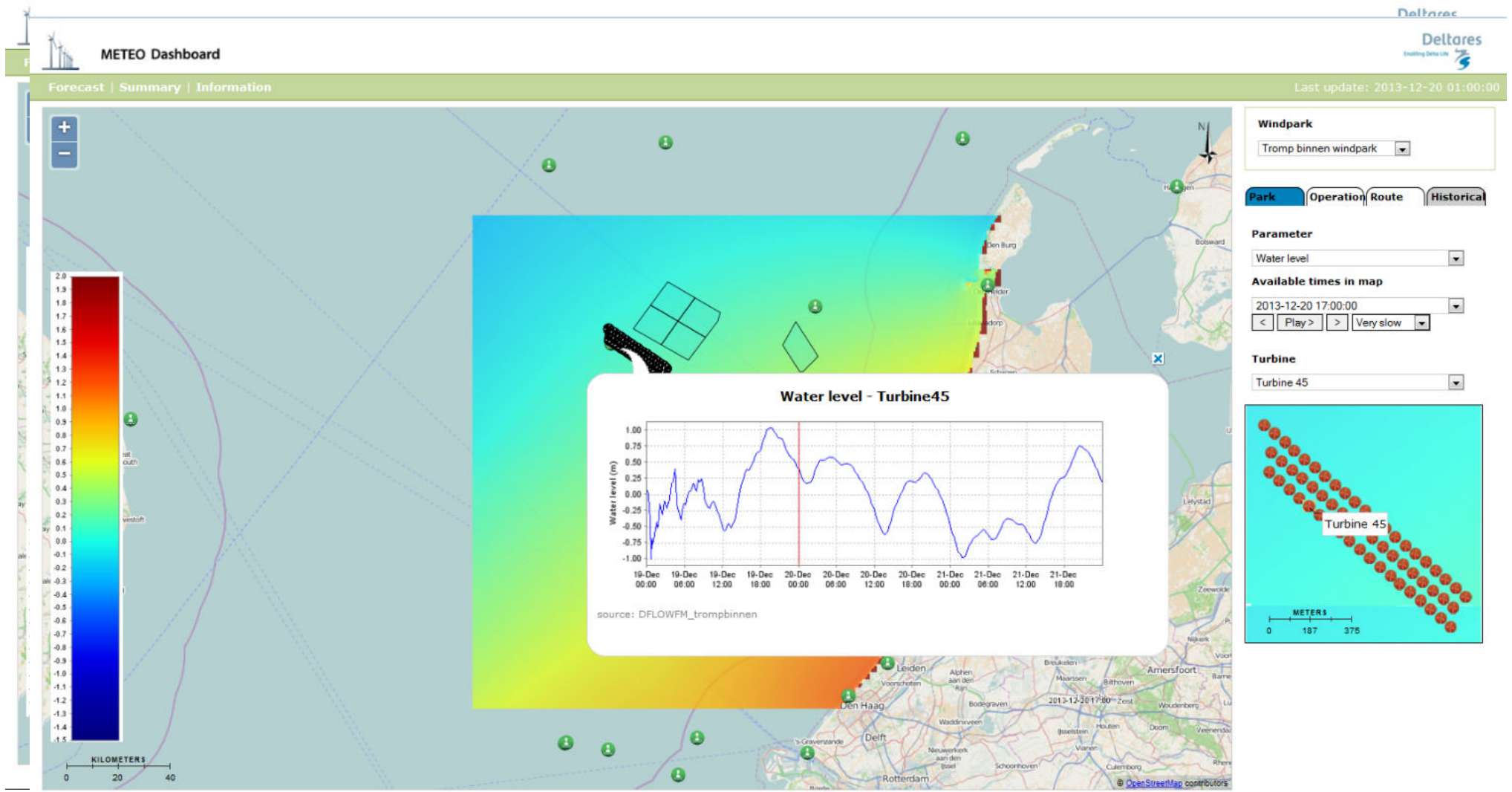
- == Select Parameter ==
- Significant wave height
- Mean wave period
- ----
- Water level
- Current velocity
- ----
- Wind speed
- ----
- Summary



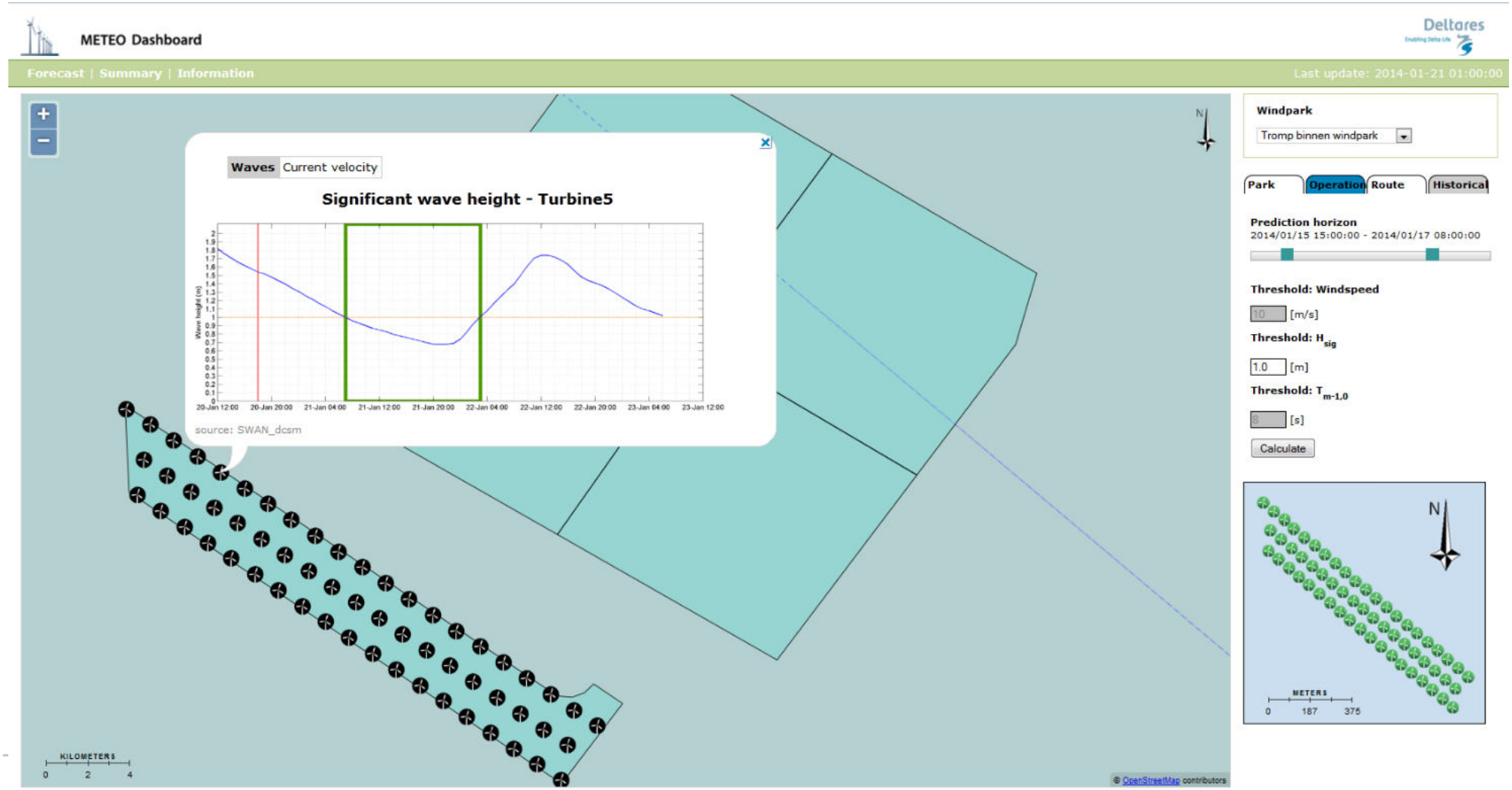
Parameter – significant wave height



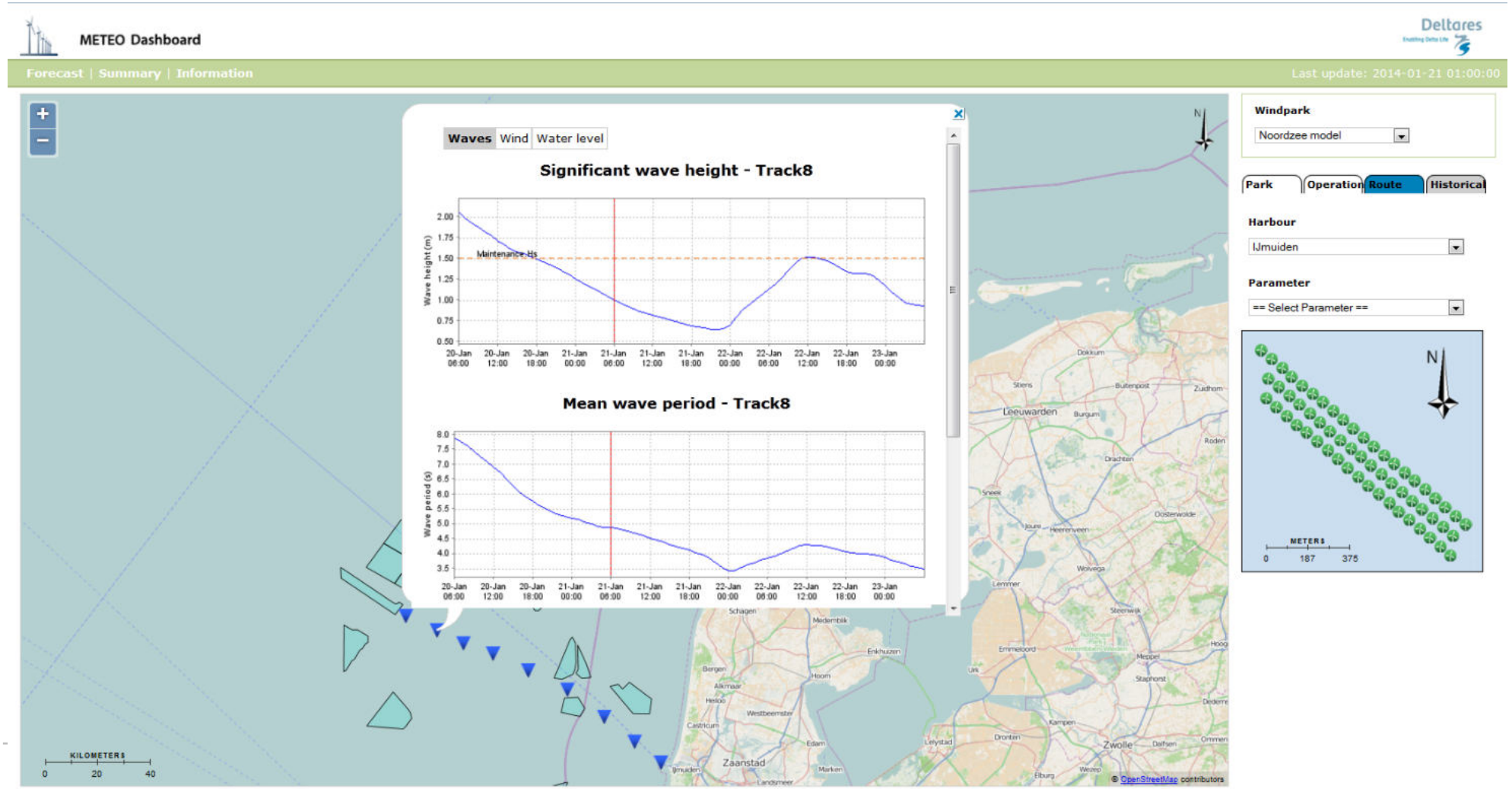
Parameter – water level



Operation


METEO Dashboard
Deltares
Forecast | Summary | Information
Last update: 2014-01-21 01:00:00
Waves
Current velocity
Significant wave height - Turbine5
source: SWAN_dcsm
KILOMETERS
0 2 4
© OpenStreetMap contributors
Windpark
Tromp binnen windpark
Park
Operation
Route
Historical
Prediction horizon
2014/01/15 15:00:00 - 2014/01/17 08:00:00
Threshold: Windspeed
10 [m/s]
Threshold: H sig
1.0 [m]
Threshold: T m-1,0
8 [s]
Calculate
N
METERS
0 187 375

Route 1/2


METEO Dashboard
Deltares
Forecast | Summary | Information
Last update: 2014-01-21 01:00:00
Waves
Wind
Water level
Significant wave height - Track8
Maintenance Hs
Wave height (m)
Mean wave period - Track8
Wave period (s)
20-Jan 06:00
20-Jan 12:00
20-Jan 18:00
21-Jan 00:00
21-Jan 06:00
21-Jan 12:00
21-Jan 18:00
22-Jan 00:00
22-Jan 06:00
22-Jan 12:00
22-Jan 18:00
23-Jan 00:00
Windpark
Noordzee model
Park
Operation
Route
Historical
Harbour
IJmuiden
Parameter
== Select Parameter ==
N
METERS
0
187
375
KILOMETERS
0
20
40
Leeuwarden
Zaandstad
Zwolle
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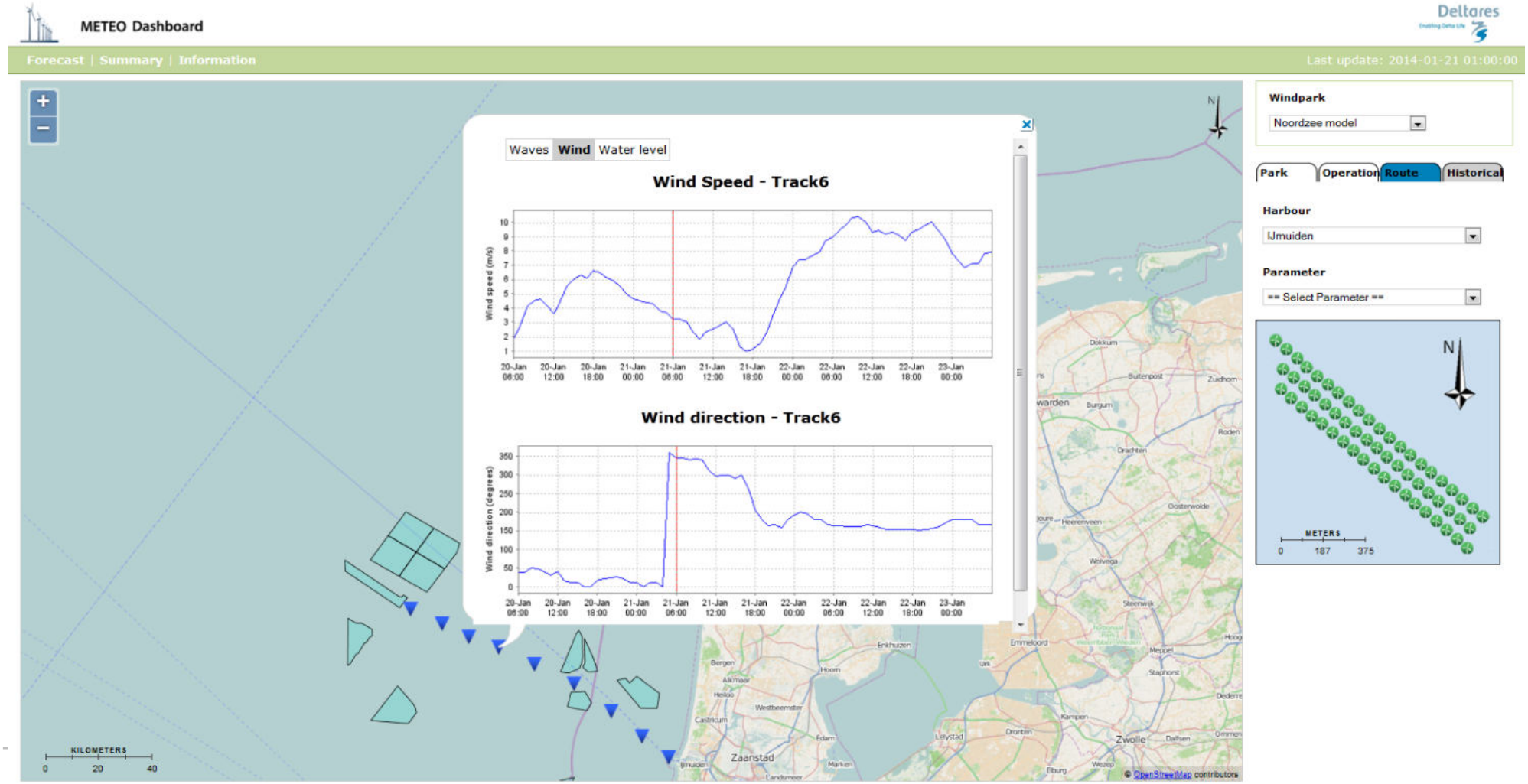
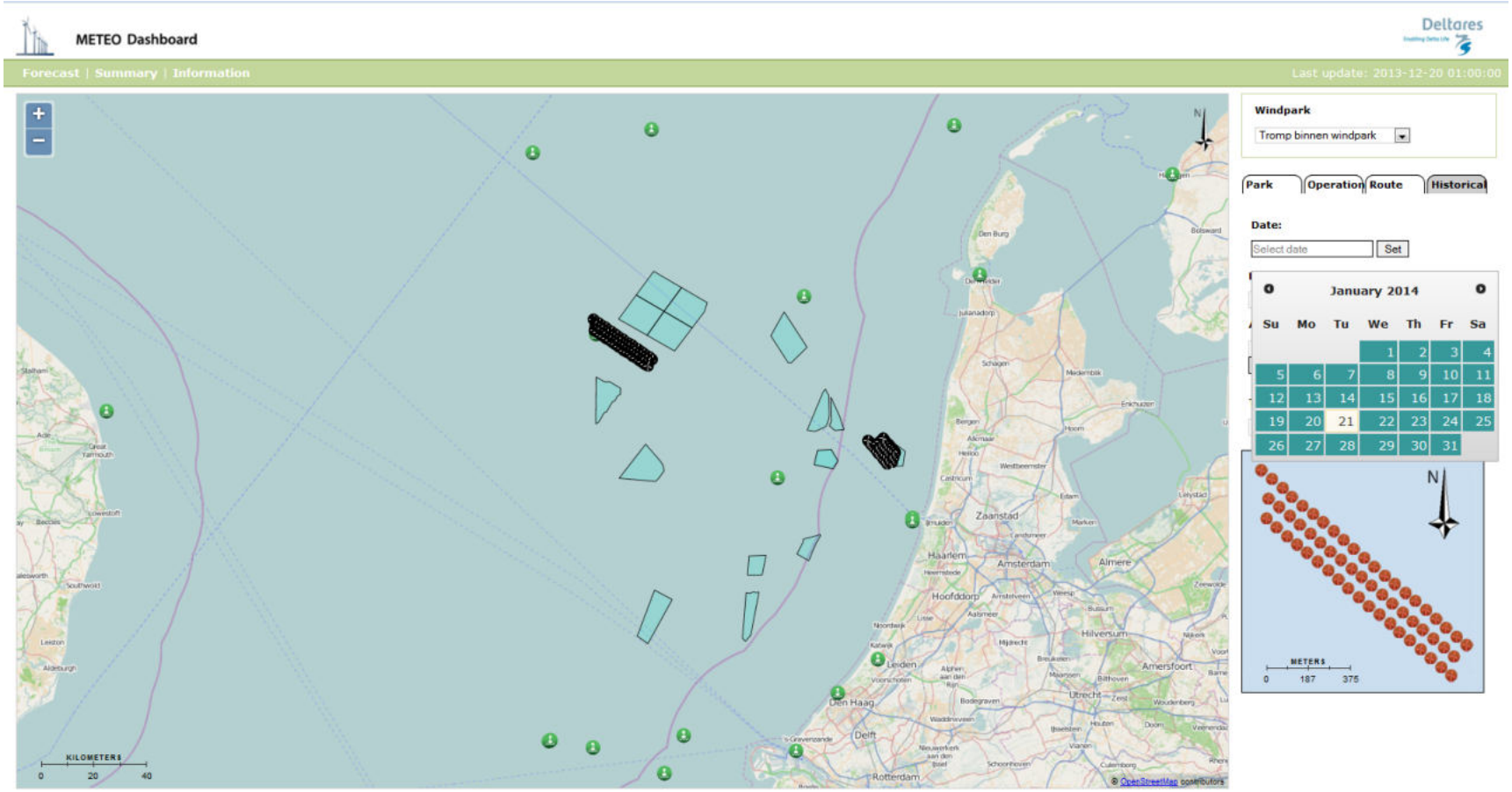
Route 2/2


METEO Dashboard
Deltares
Forecast | Summary | Information
Last update: 2014-01-21 01:00:00
Waves
Wind
Water level
Wind Speed - Track6
Wind speed (m/s)
Wind direction - Track6
Wind direction (degrees)
20-Jan 06:00
20-Jan 12:00
20-Jan 18:00
21-Jan 00:00
21-Jan 06:00
21-Jan 12:00
21-Jan 18:00
22-Jan 00:00
22-Jan 06:00
22-Jan 12:00
22-Jan 18:00
23-Jan 00:00
Windpark
Noordzee model
Park
Operation
Route
Historical
Harbour
IJmuiden
Parameter
== Select Parameter ==
N
METERS
0
187
375
KILOMETERS
0
20
40
Zaanstad
Zwolle
Lelystad
Emmeloord
Meppel
Steenwijk
Wolvega
Heerenveen
Drachten
Dokkum
Leeuwarden
Burgum
Buitenpost
Zuidhorn
Roden
Oosterwolde
Staphorst
Dedemsvaart
Kampen
Dronten
Elburg
Hoorn
Enkhuizen
Alkmaar
Castricum
Edam
Volendam
Marken
Landsmeer
Westbeemster
Heiloo
Bergen
Uitgeest
Wijdewormer
Wormerveer
Purmerend
Monnickendam
Weesp
Naarden
Bussum
Huizen
Blaricum
Laren
Hilversum
Baarn
Soest
Amersfoort
Nijkerk
Harderwijk
Putten
Ermelo
Nunspeet
Elspeet
Vaassen
Apeldoorn
Epe
Heerde
Hattem
Oldebroek
Wezep
Dalfsen
Ommen
Hasselt
Zwartsluis
Genemuiden
Kampen
Urk
Schokland
Noordoostpolder
Emmeloord
Marknesse
Rijnsburg
Voorschoten
Wassenaar
Leiden
Oegstgeest
Katwijk
Noordwijk
Noordwijkerhout
Lisse
Hillegom
Sassenheim
Voorhout
Warmond
Leiderdorp
Alphen aan den Rijn
Boskoop
Waddinxveen
Zoeterwoude
Rijnsburg
Valkenburg
Rijnsburg
Leiden
Delft
Rijswijk
Wassenaar
Voorschoten
Zoetermeer
Pijnacker
Nootdorp
Rijswijk
Delft
Leiden
Alphen aan den Rijn
Gouda
Waddinxveen
Boskoop
Zoeterwoude
Rijnsburg
Valkenburg
Katwijk
Noordwijk
Noordwijkerhout
Lisse
Hillegom
Sassenheim
Voorhout
Warmond
Leiderdorp
Oegstgeest

historical



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Google
Favorites
Meteodashboard
Deltares intranet
Meteodashboard
Page
Safety
Tools

METEO Dashboard

TABEL MET OUTPUT SAMENVATTING

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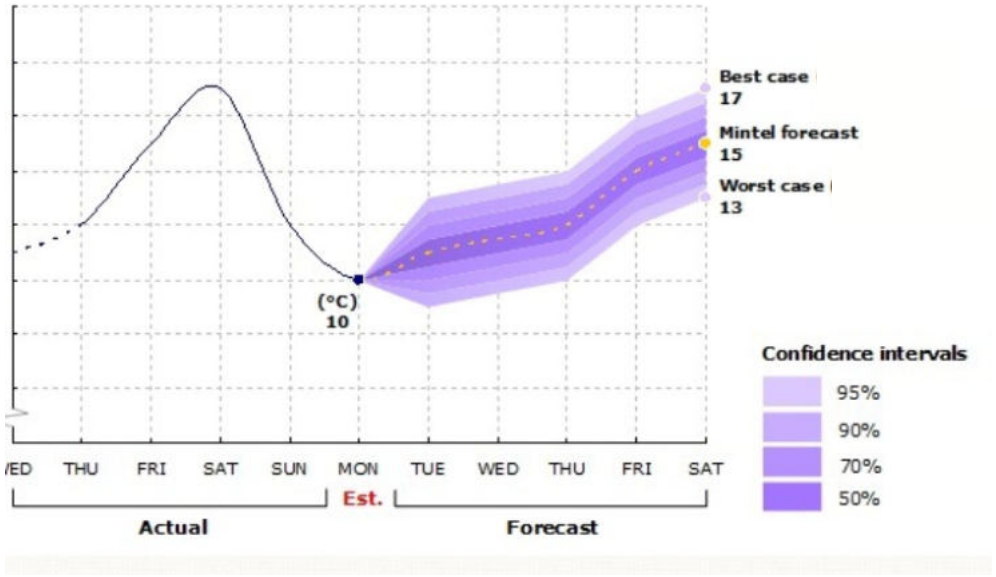
Summary Turbine 21								
GFS 04-12-2013	We 14	We 14	We 14	We 14	Thu 15	Thu 15	Thu 15	Thu 15
	00:00	06:00	12:00	18:00	00:00	06:00	12:00	18:00
Windspeed [m/s]	4.0	5.0	6.0	7.0	6.0	5.0	6.0	7.0
Sign. wave height H_{sig} [m]	0.4	0.3	0.2	0.3	0.4	0.6	1.5	1.8
Wave direction	↗	↑	↗	↗	→	↘	↘	↓
Mean wave period $T_{m-1.0}$ [s]	3.0	4.0	3.0	2.0	3.0	4.0	3.0	4.0
Swell wave height H_{E10} [m]	0.3	0.4	0.5	0.2	0.3	0.8	0.2	0.7
Water level [m+MSL]	1.0	2.0	1.0	2.5	2.0	1.5	1.0	1.7
Currents [m/s]	0.3	0.4	0.6	0.8	1.0	1.1	1.2	0.6
Current direction	↑	↗	↗	→	↘	↘	↓	↓

Park	Operation	Route	Historical

Done
Local intranet | Protected Mode: Off
100%

wish list – to do list - future developments

- Further optimise forecasts using data-assimilation
- Analyse accuracy of forecasts applying different boundary conditions (GFS)
- Coupling with scour tool
- Coupling with SCADA system
- Coupling with Tromp Binnen metmast and Eneco's lidar bouy
- Integrate other environmental parameters, e.g. visibility, air temperature, etc.
- Make applicable for installation phase of offshore wind farms
- Integrate different vessel types (RAO's)
- And ???



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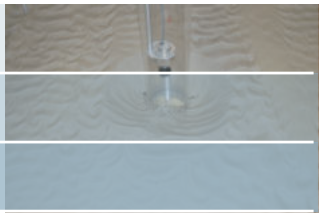

Questions ?

or Ideas?

Contact details:

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Janjoost.schouten@deltares.nl

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