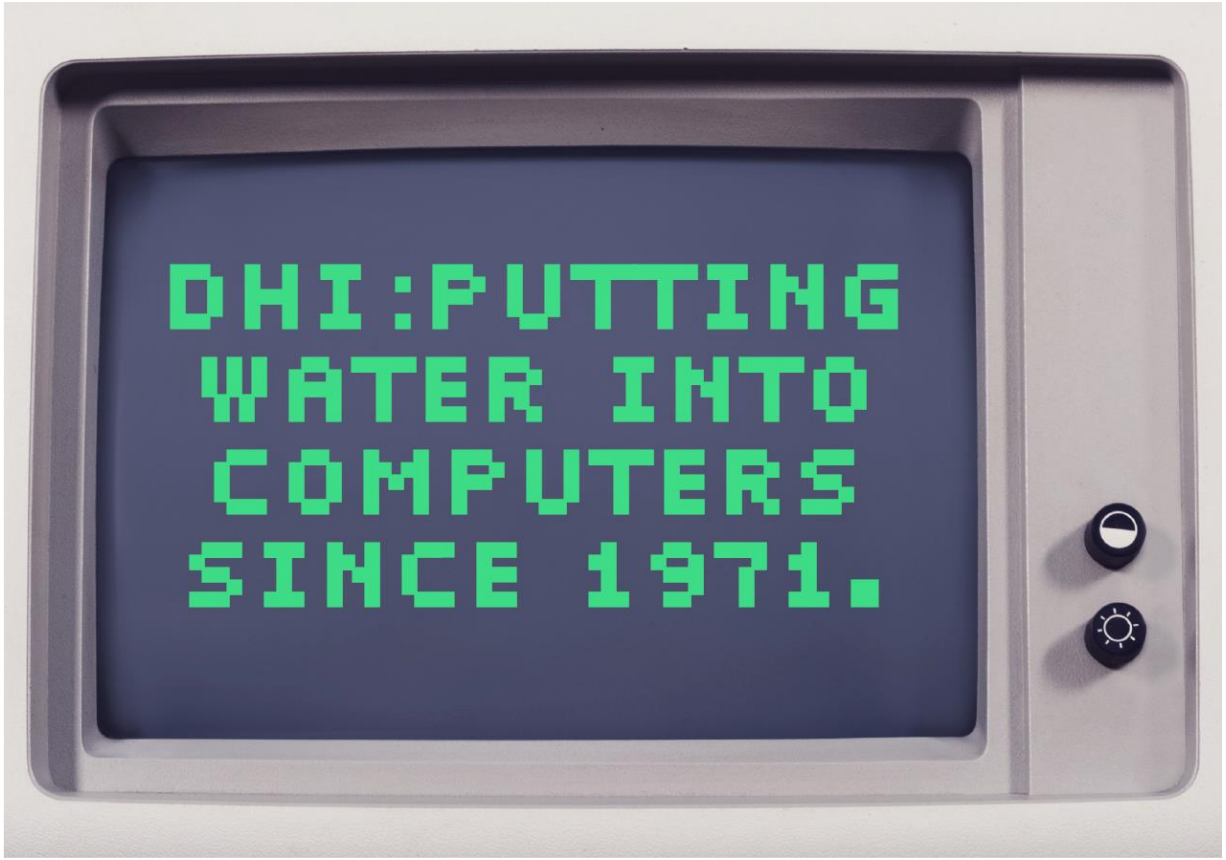
Developing solid foundations in Metocean Data

Nick Elderfield
MD, DHI UK

Smarter data
Integrated software
Considered solutions



28 years in offshore wind

- Working in offshore wind since 1991
- Supporting wind farms in Europe, America and around the World
- R&D led approach to improve wind farm projects

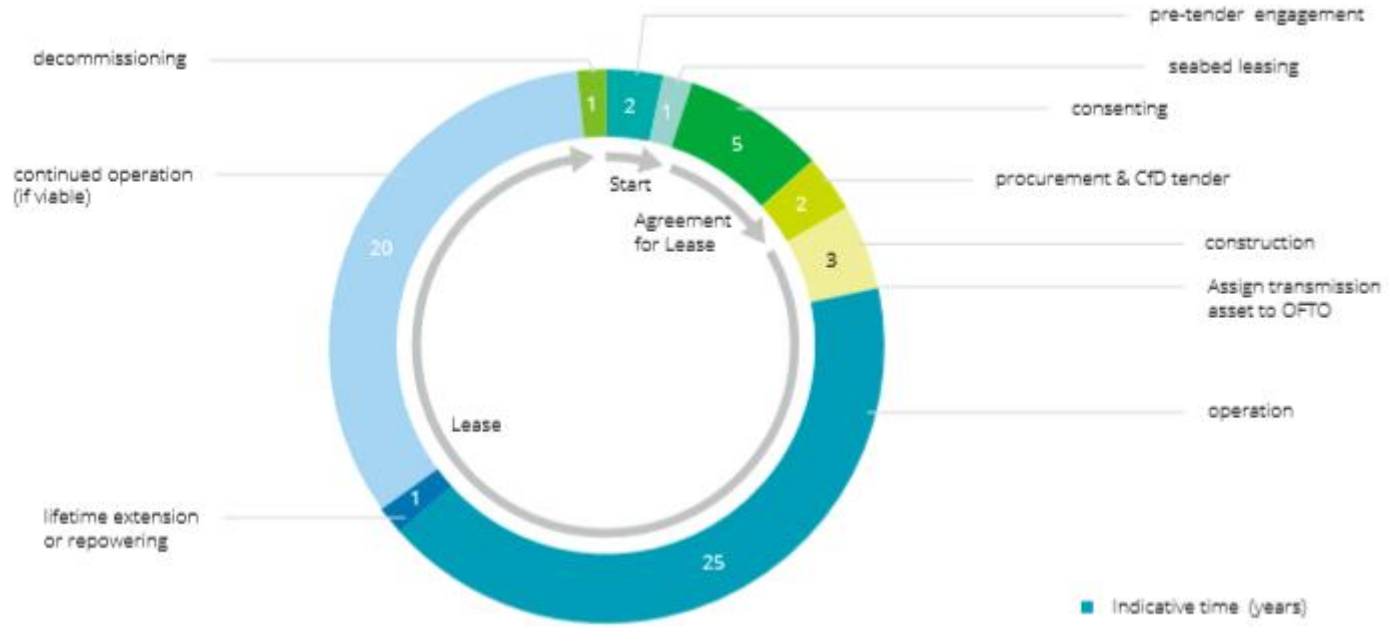
28 years in offshore wind

Our clients in the UK

- Consultants
- Contractors
- Utilities
- Developers
- Authorities

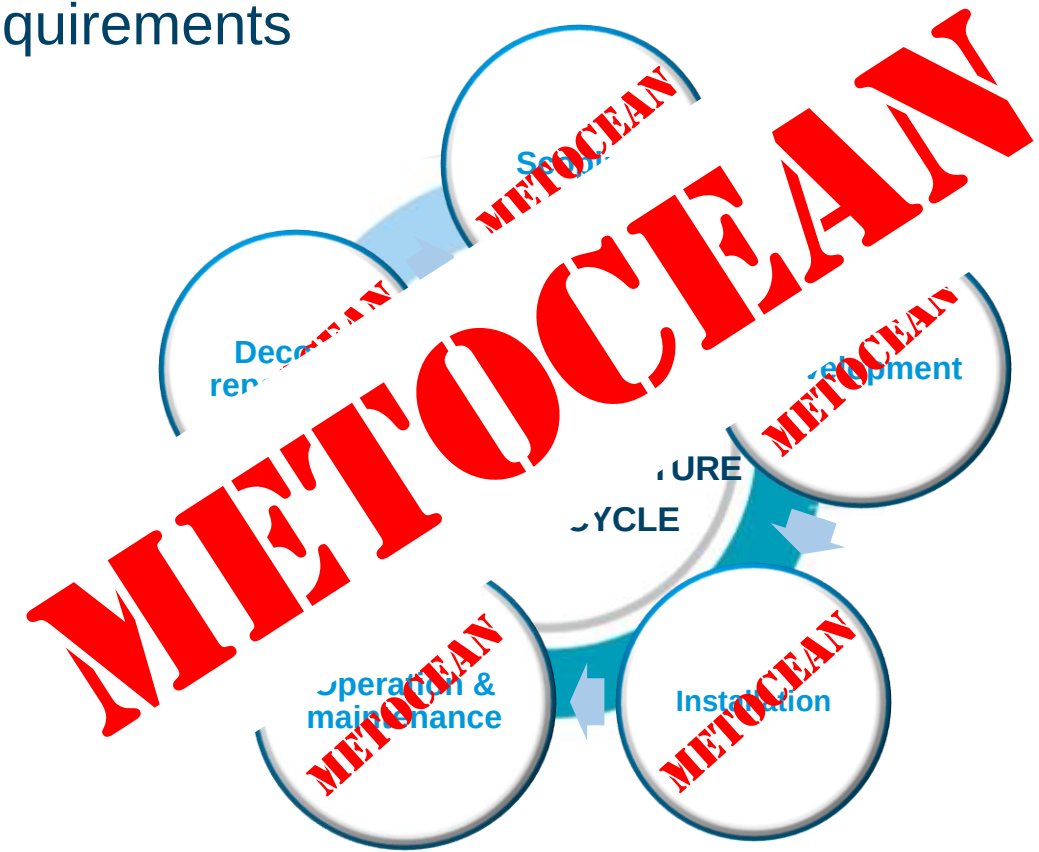
DHI

Offshore Wind Project Lifecycle



Source: The Crown Estate

Typical Wind Farm Service Requirements



What is Metocean Data?

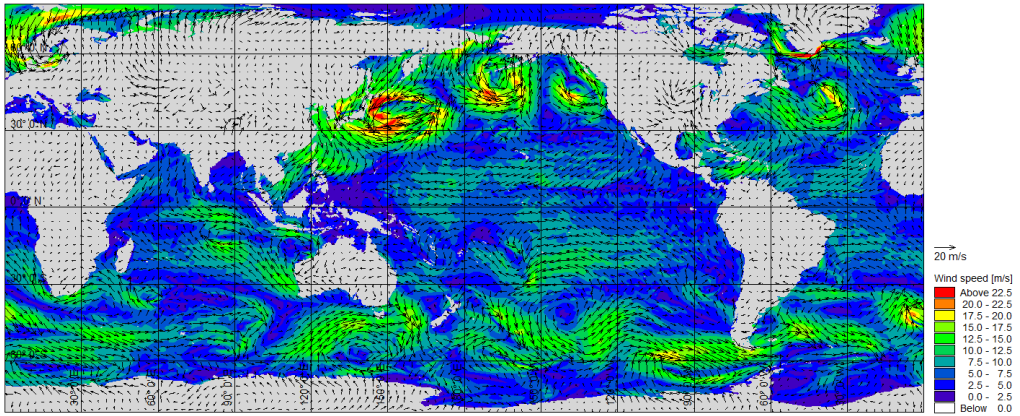
Meteorological and **Ocean**ograpic Data - Metocean Data

- **Wind**
- **Waves**
- **Water levels**
- **Currents**

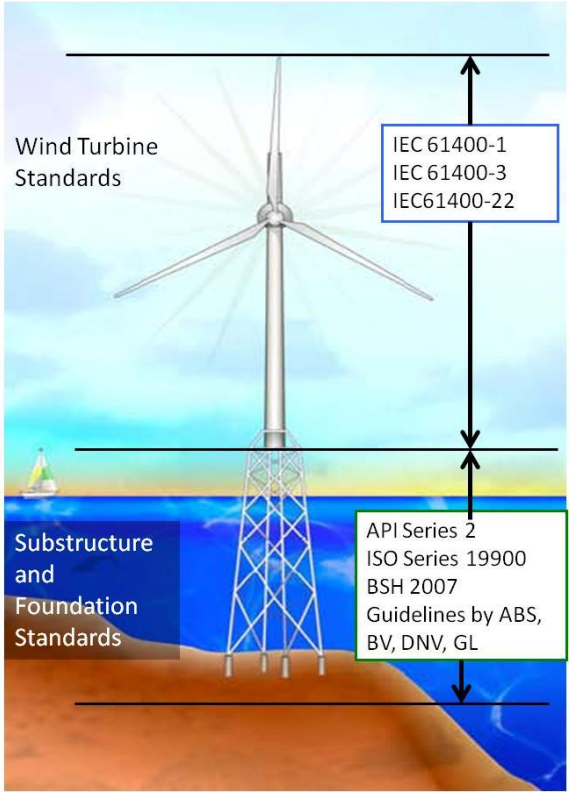
- **Sea ice, marine growth, other oceanographic parameters**

Meteorological and **Ocean**ographic Data - Metocean Data

- Metocean data available as:
  - Measurements
  - Numerical model data
    - Hindcast
    - Forecast



Why is it important?



By Musial, W. D.; Sheppard, R. E.; Dolan, D.; Naughton, B. - http://permanent.access.gpo.gov/gpo41492/57880.pdf

Innovation No.1
On Demand Access to Metocean data

Metocean Data Portal

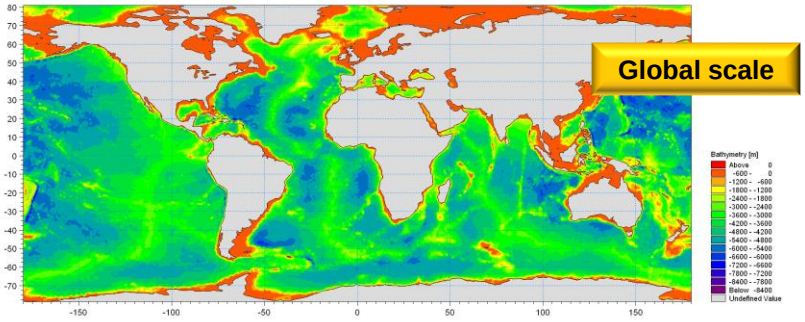
Instant access to worldwide Metocean data

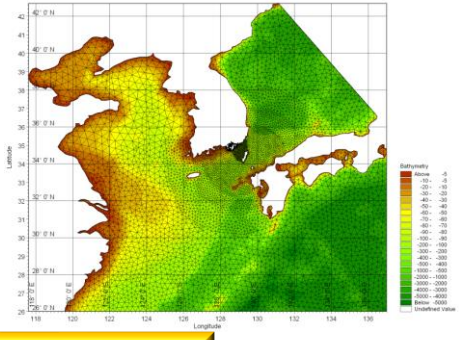
Data from high-resolution local or regional models, to global coverage datasets

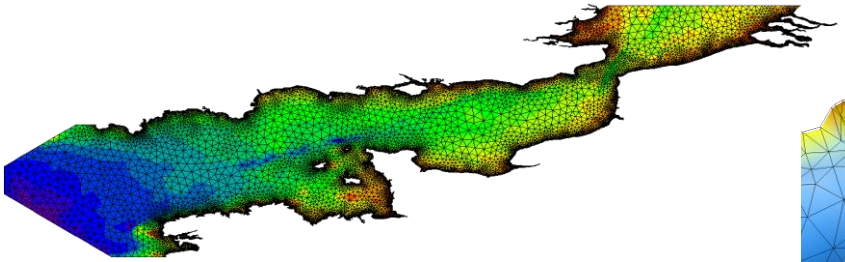
On-demand calculations of commonly requested analytics

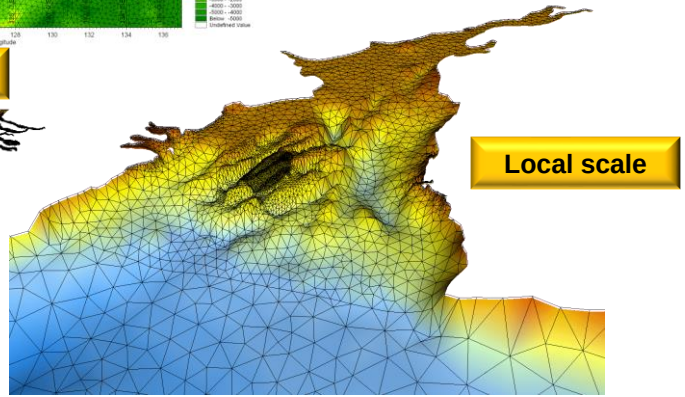
Continuously-improving Metocean data

DHI pioneered metocean down-scale modelling







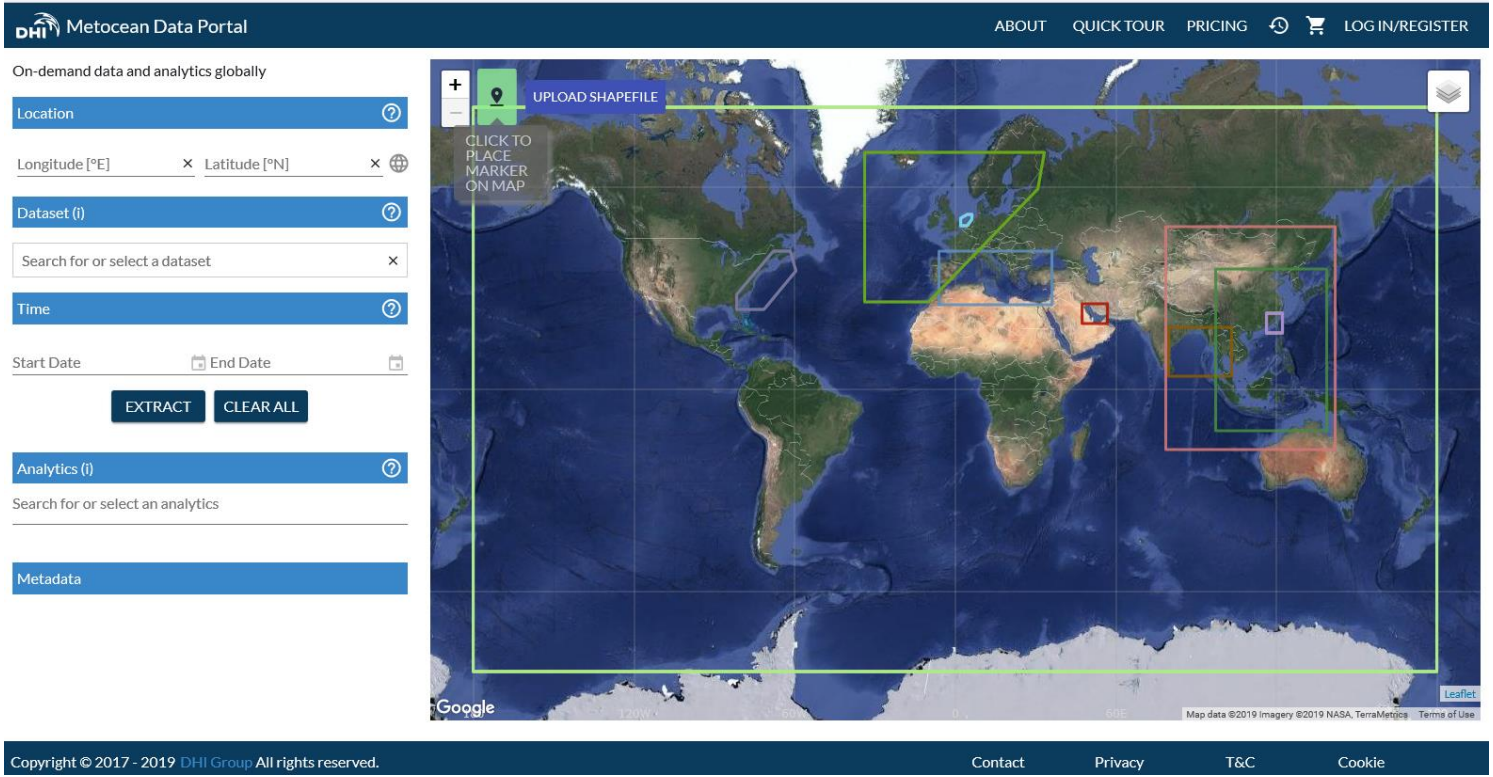


MIKE
Powered by DHI

DHI

Data on-demand or via an API

Quality Data at your fingertips!



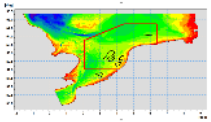
~ 40 years of hindcast data!

www.metocean-on-demand.com

Netherlands Enterprise Agency

http://offshorewind.rvo.nl/

Database Area



Sign: Below

Percentile: 50

Duration [hours]: 1

Threshold(s) (up to 6 values, comma separated)

Conditional Dataset

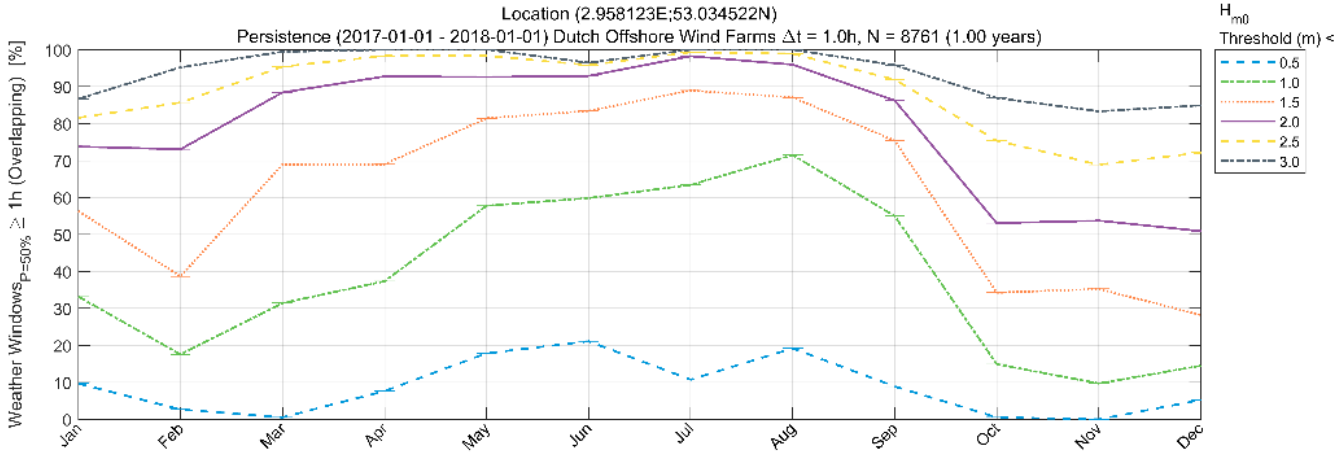
Conditional Variable

Sign

Threshold (1 value)

DOWNLOAD

UPDATE



“We challenged DHI to provide a world-class metocean database to allow developers to optimise their designs in the tender stage.

DHI exceeded our expectations.”

Ben de Sonneville, Senior Consultant, BLIX Consultancy BV, On behalf of the client RVO.nl

On-demand data and analytics globally

Location

Longitude [°E] Latitude [°N]

Dataset (i)

Global, Wave Parameters (Integrated), MIKE 21 Spectı

Time

Start Date 1/1/1979

End Date 31/3/2019

EXTRACT CLEAR ALL

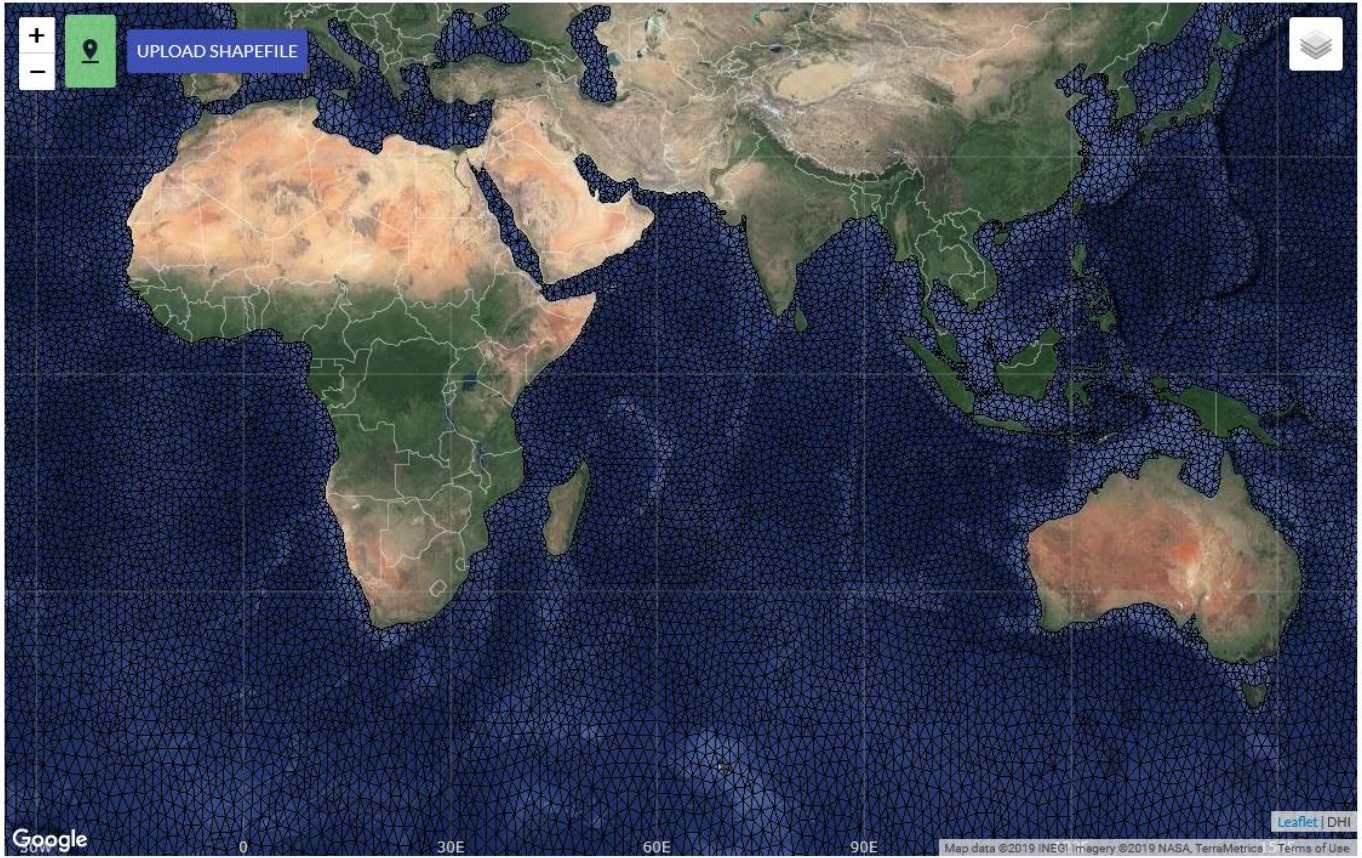
Analytics (i)

Search for or select an analytics

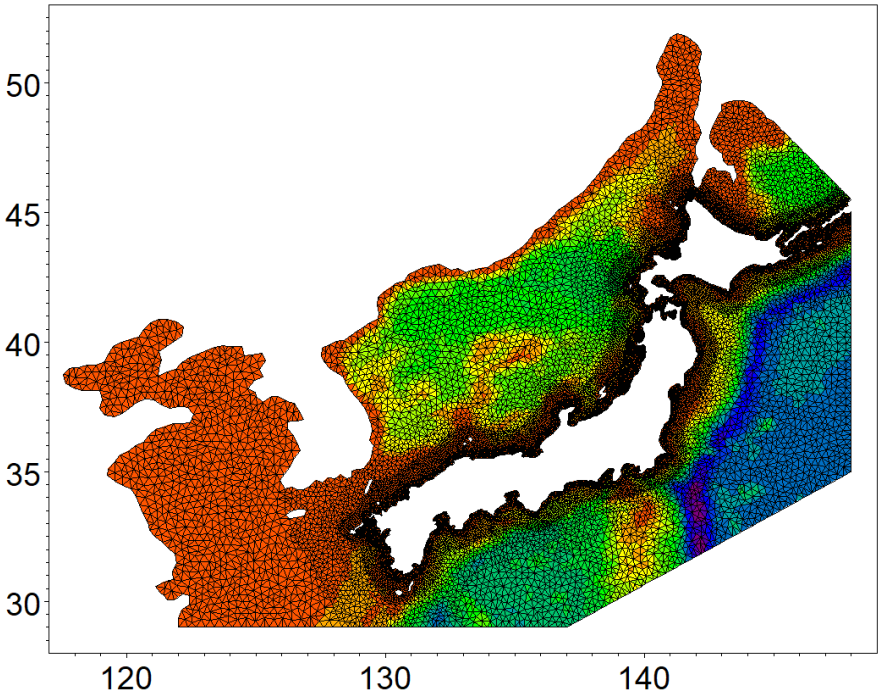
Metadata

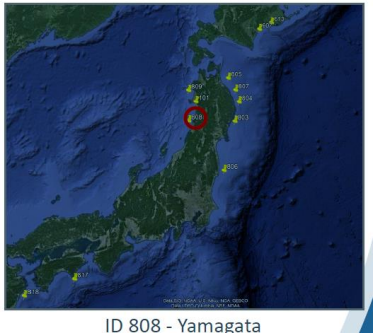
General Coverage Variables

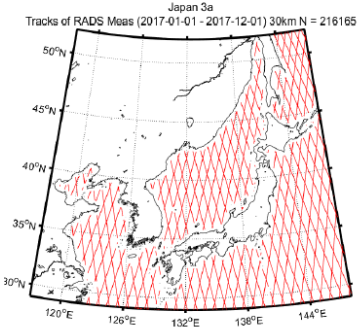
Title	Global, Wave Parameters (Integrated), MIKE 21 Spectral Wave Model (SW), DHI
Geographical	Global

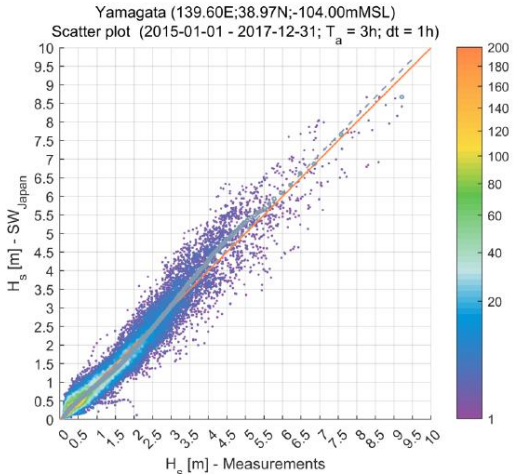


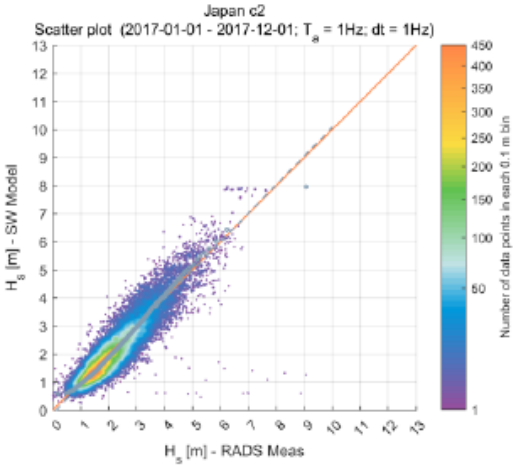
Breaking News: Japan & South Korea Coverage Extended



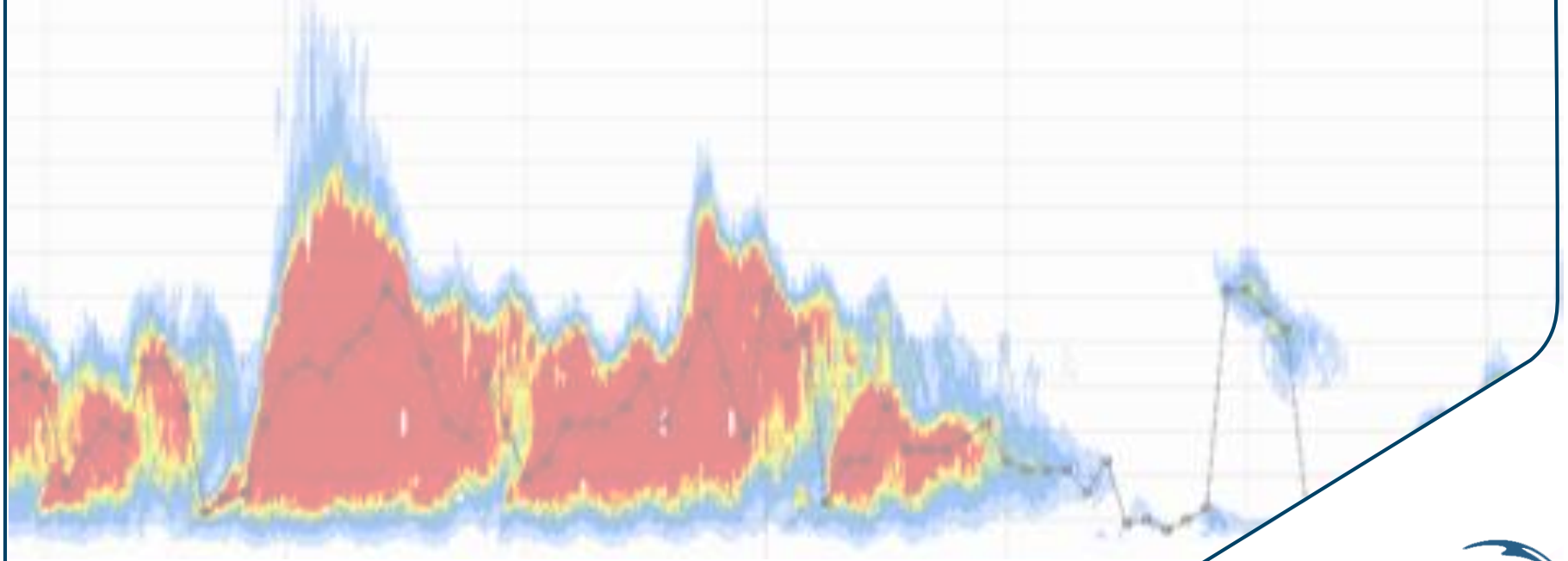

ID 808 - Yamagata







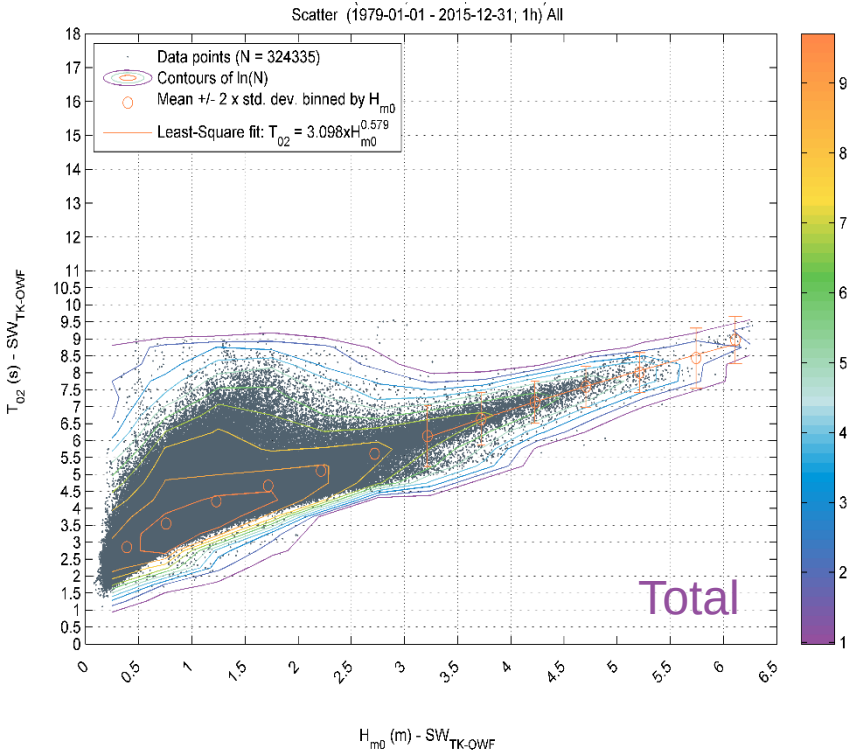
Innovation No.2
Moving away from “Parameters”

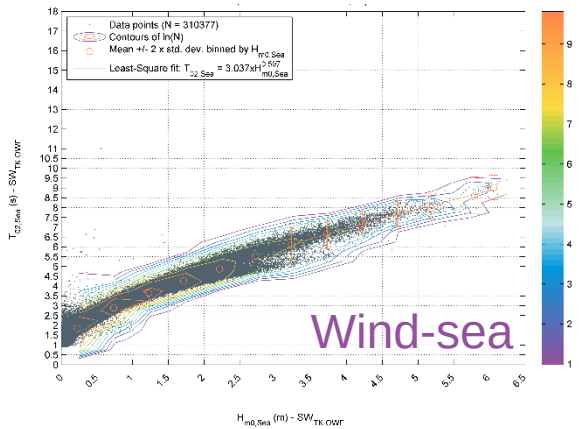


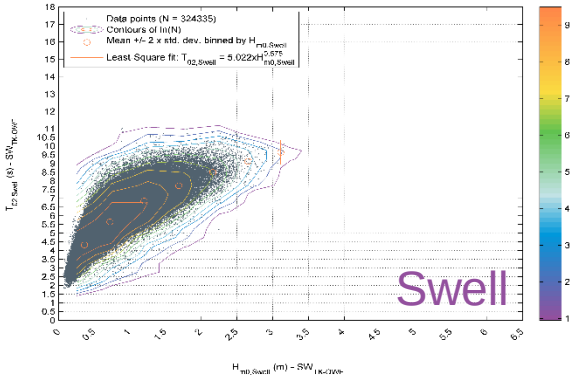
Typical list of parameters for waves

Item	Description	Parameter	Unit	Notes
1	Sign. Wave Height	Significant wave height	meter	
2	Peak Wave Period	Wave period	second	
3	Wave Period, T01	Wave period	second	
4	Wave Period, T02	Wave period	second	T02 ~ Tz, where Tz is the mean crossing period
5	Mean Wave Direction	Mean Wave Direction	degree	defined with respect to true North (coming from)
6	Dir. Stand. Deviation	Directional Std. Dev	degree	
7	Sign. Wave Height, w	Significant wave height	meter	wind-sea partition of sea state
8	Peak Wave Period, w	Wave period	second	wind-sea partition of sea state
9	Wave Period, T01, w	Wave period	second	wind-sea partition of sea state
10	Wave Period, T02, w	Wave period	second	T02 ~ Tz, where Tz is the mean crossing period, wind-sea partition of sea state
11	Mean Wave Direction, w		Mean Wave Direction	degree defined with respect to true North (coming from), wind-sea partition of sea state
12	Dir. Stand. Deviation, w		Directional Std. Deviation	degree wind-sea partition of sea state
13	Sign. Wave Height, s	Significant wave height	meter	swell partition of sea state
14	Peak Wave Period, s	Wave period	second	swell partition of sea state
15	Wave Period, T01, s	Wave period	second	swell partition of sea state
16	Wave Period, T02, s	Wave period	second	T02 ~ Tz, where Tz is the mean crossing period, swell partition of sea state
17	Mean Wave Direction, s		Mean Wave Direction	degree defined with respect to true North (coming from), swell partition of sea state
18	Dir. Stand. Deviation, s	Directional Std Dev	degree	swell partition of sea state
19	Surface elevation	Surface Elevation	meter	relative to mean-sea-level
20	Wind speed	Wind speed	m/s	CFSR modelled wind speed at 10m above mean-sea-level
21	Wind direction	Wind Direction	degree	CFSR modelled wind speed at 10m above mean-sea-level, defined with respect to true North (coming from)

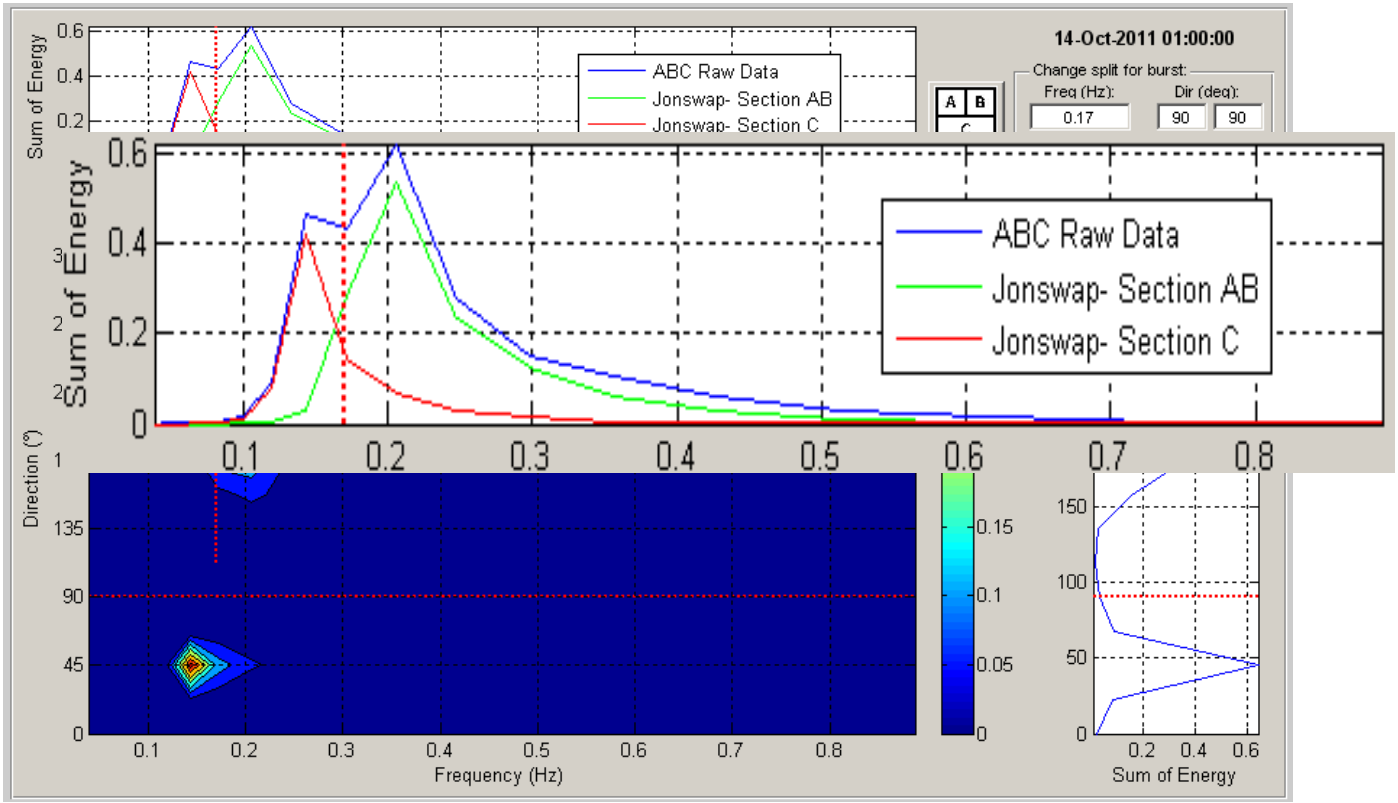
Typical list of parameters



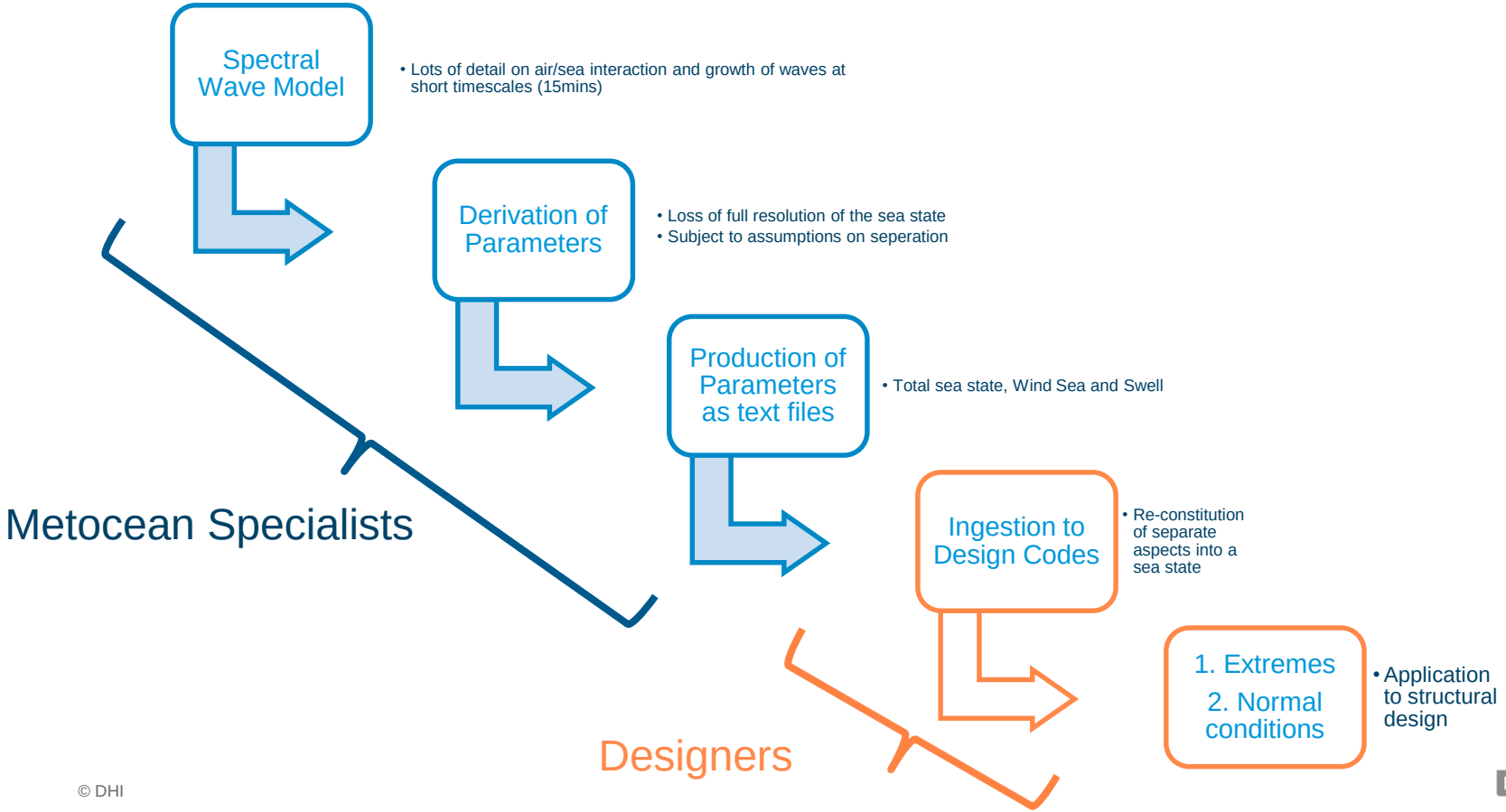




Spectrum from spectral wave model



Process tree for interaction between specialisms



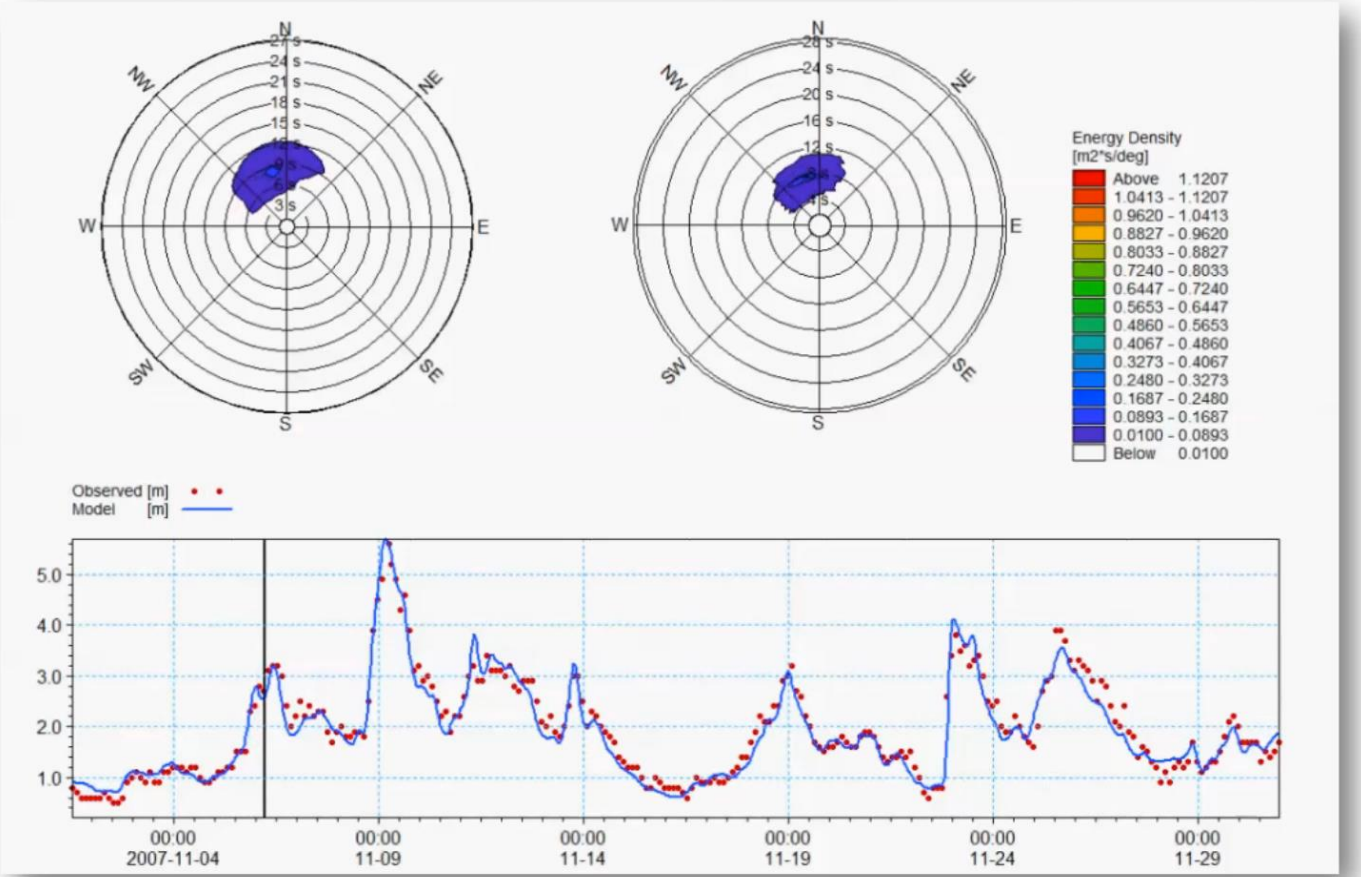
IEC 61400-3-1

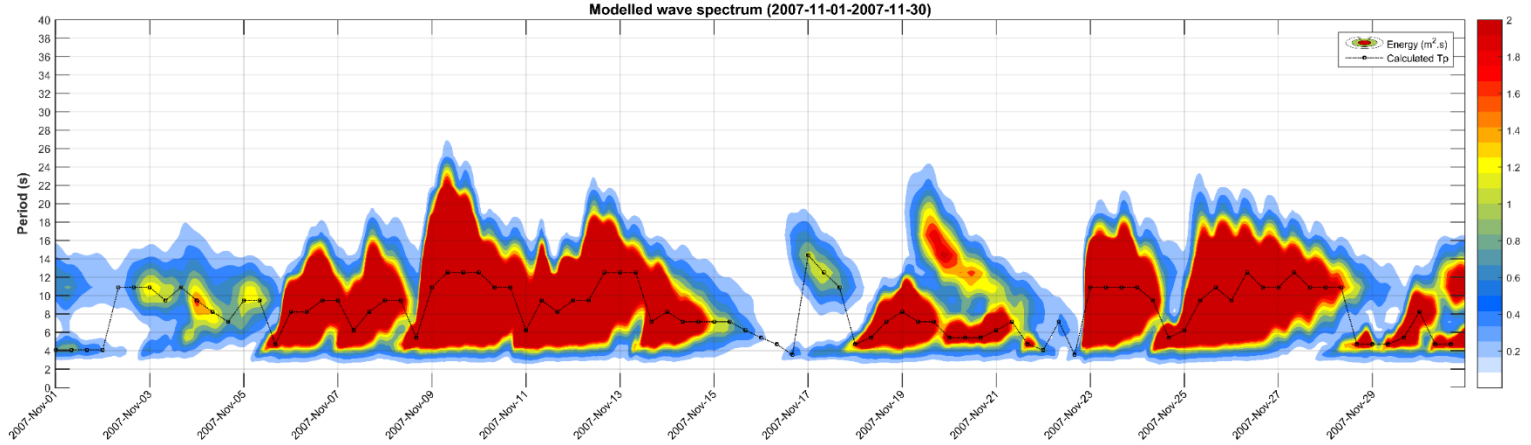
6.4.4.2 Assessment of normal wave conditions

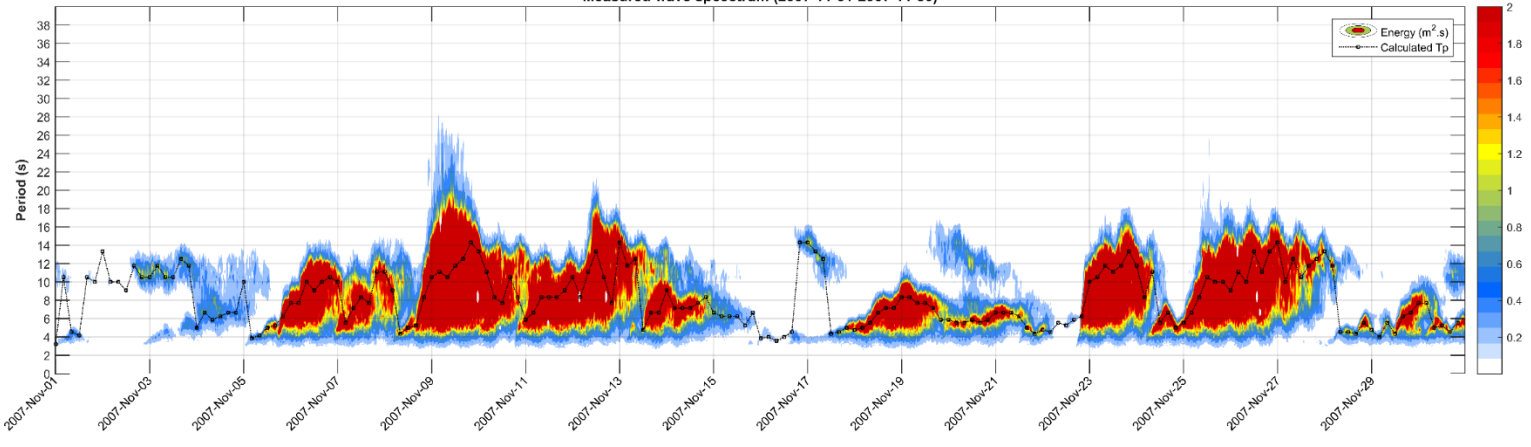
There is no requirement for assessment of site-specific wave spectra and directional spreading and the standard formulations provided in ISO 19901-1 may be assumed. Where appropriate and reliable measurements exist, site-specific wave spectra and the directional spreading function may, however, be assessed as the basis of design and/or design verification of an offshore wind turbine.

Modelled Spectra

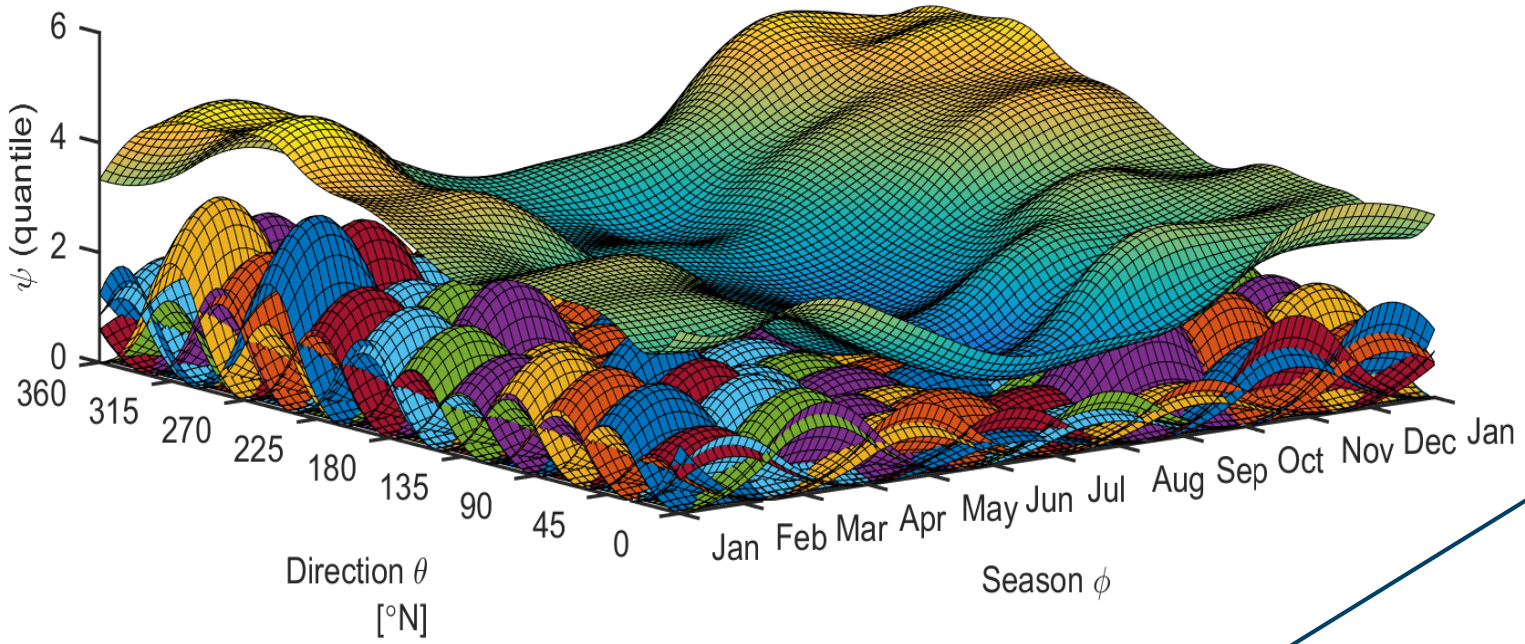
Measured Spectra



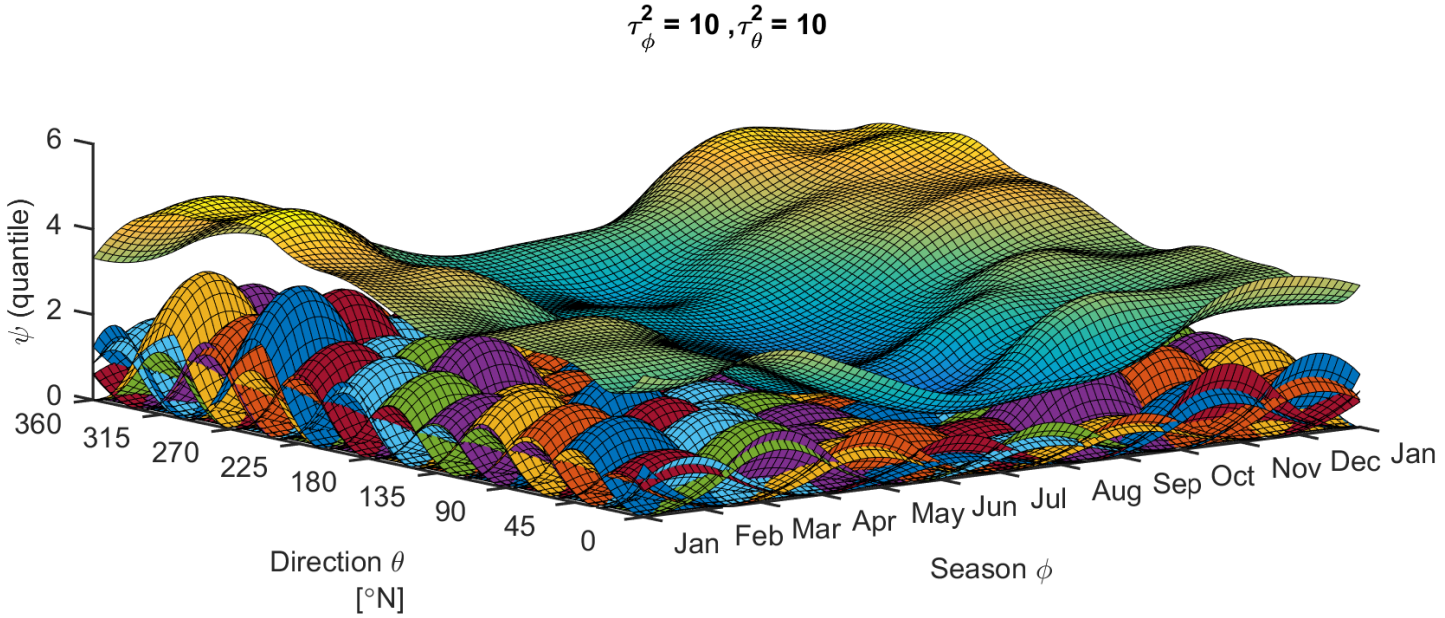

Modelled wave spectrum (2007-11-01-2007-11-30)
Period (s)
Energy (m².s)
Calculated Tp
2007-Nov-01
2007-Nov-03
2007-Nov-05
2007-Nov-07
2007-Nov-09
2007-Nov-11
2007-Nov-13
2007-Nov-15
2007-Nov-17
2007-Nov-19
2007-Nov-21
2007-Nov-23
2007-Nov-25
2007-Nov-27
2007-Nov-29


Measured wave spcectrum (2007-11-01-2007-11-30)
Period (s)
Energy (m².s)
Calculated Tp
2007-Nov-01
2007-Nov-03
2007-Nov-05
2007-Nov-07
2007-Nov-09
2007-Nov-11
2007-Nov-13
2007-Nov-15
2007-Nov-17
2007-Nov-19
2007-Nov-21
2007-Nov-23
2007-Nov-25
2007-Nov-27
2007-Nov-29

Innovation No. 3
Advanced Extremes
J-EVA



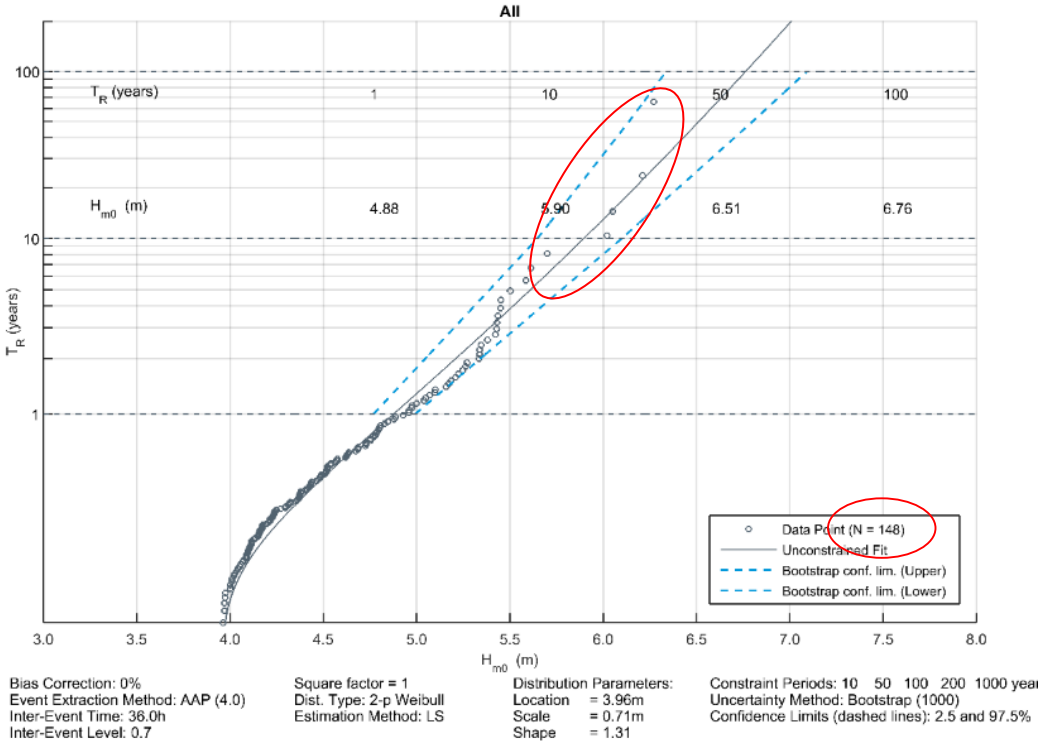
Advanced Extremes Analysis
DHI J-EVA



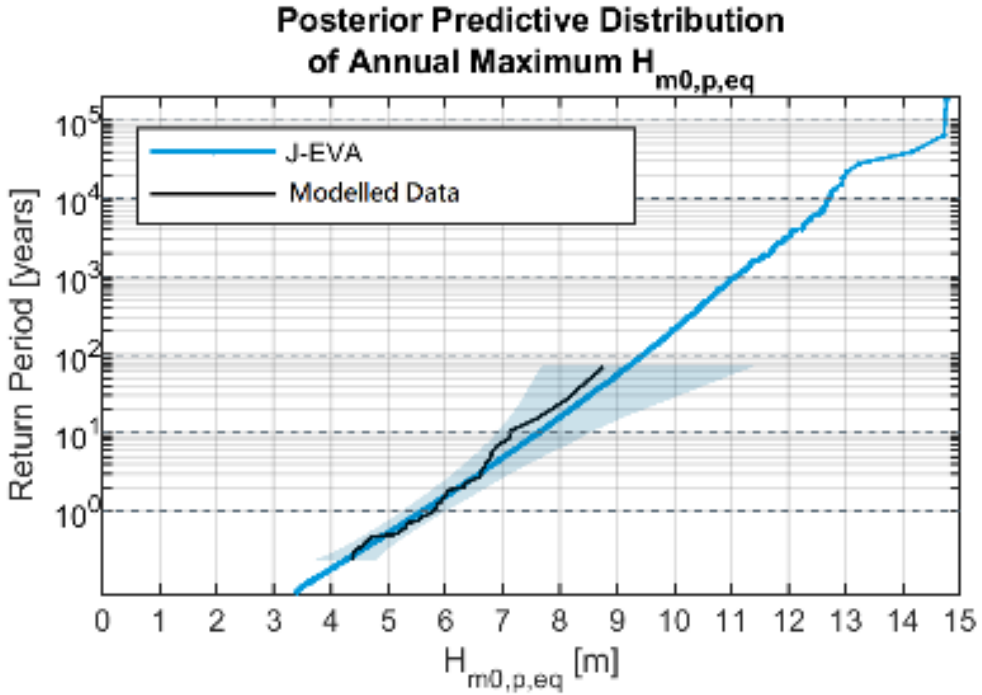
Directional-seasonal extreme value analysis of North Sea storm conditions
Hans Fabricius Hansen, David Randell, Allan Rod Zeeberg, Philip Jonathan

Advanced Extremes Analysis
DHI J-EVA

- Dealing with the tail of a distribution
- High or unknown uncertainty in the estimates
- Typically deal with this by providing bootstrapped confidence intervals

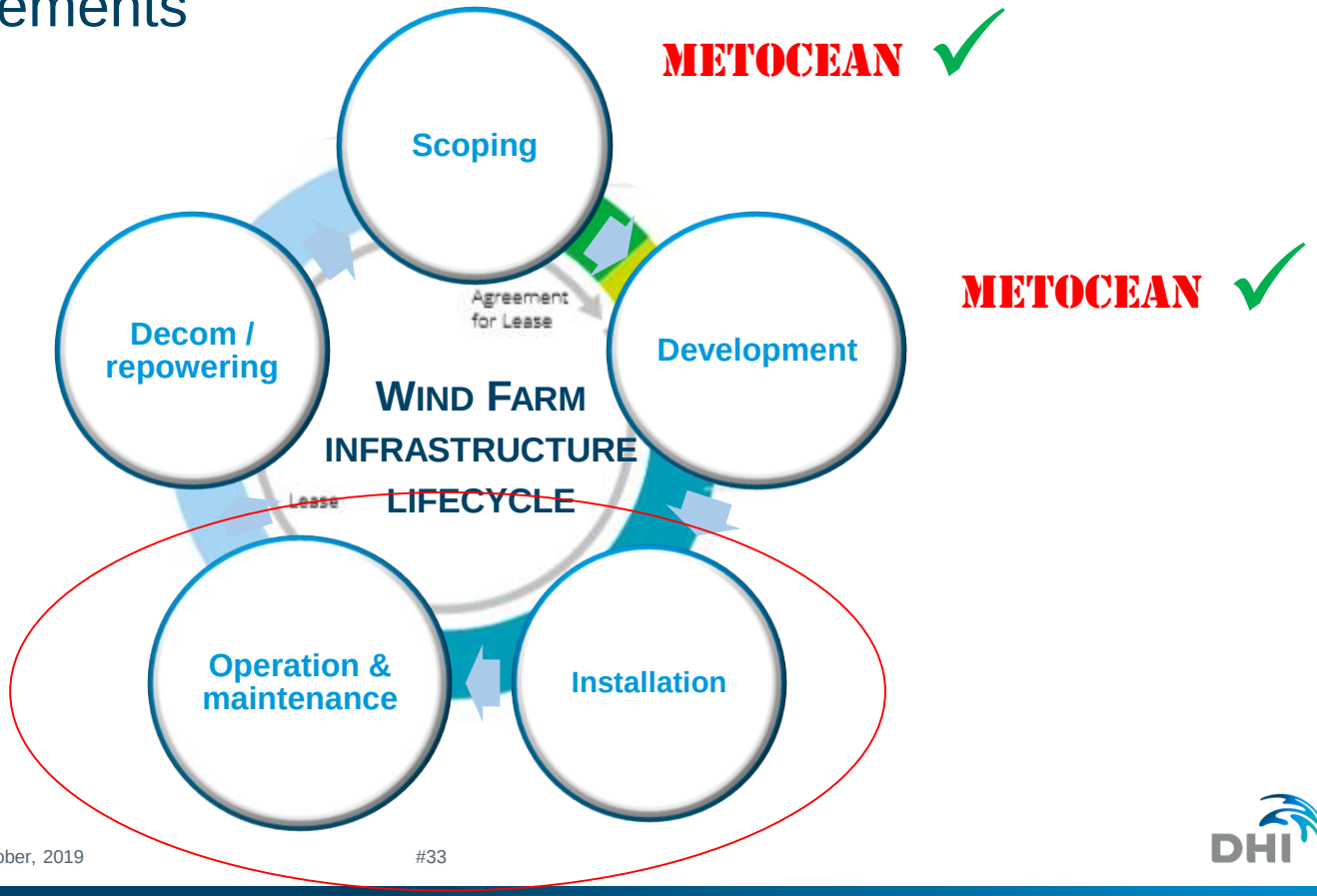


Advanced Extremes Analysis
DHI J-EVA

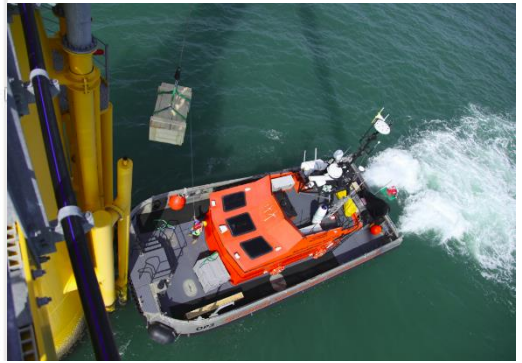


Innovation No. 4
Making more of data

Typical Wind Farm Service Requirements



The art of staying still….

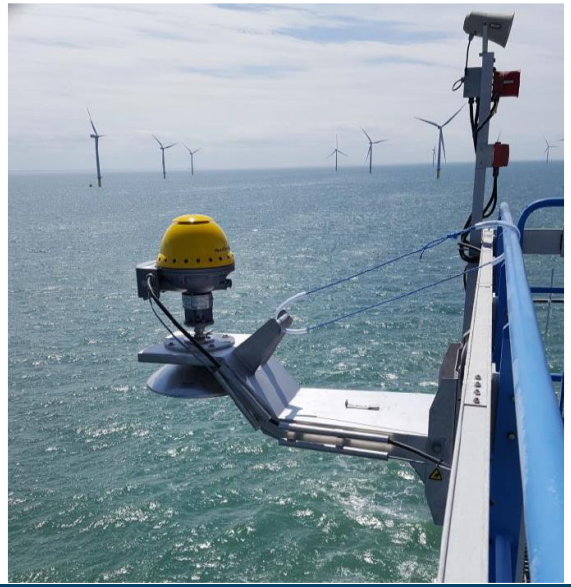


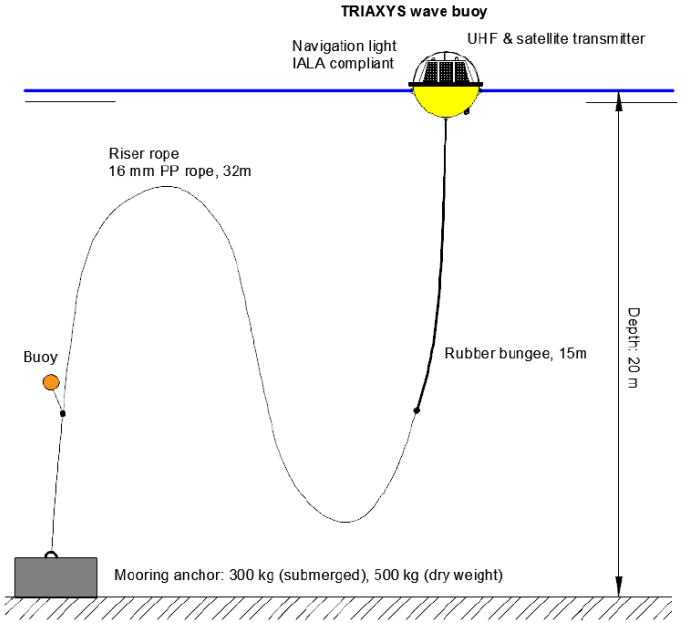
Forecasting for Installation and Operation

- Metocean *prediction* (wind, currents, waves)
- Vessel characteristics
- Requirements and thresholds for operations
- Informed decision on
  - Location
  - Timing
  - Equipment and vessel requirements
  - Man-time

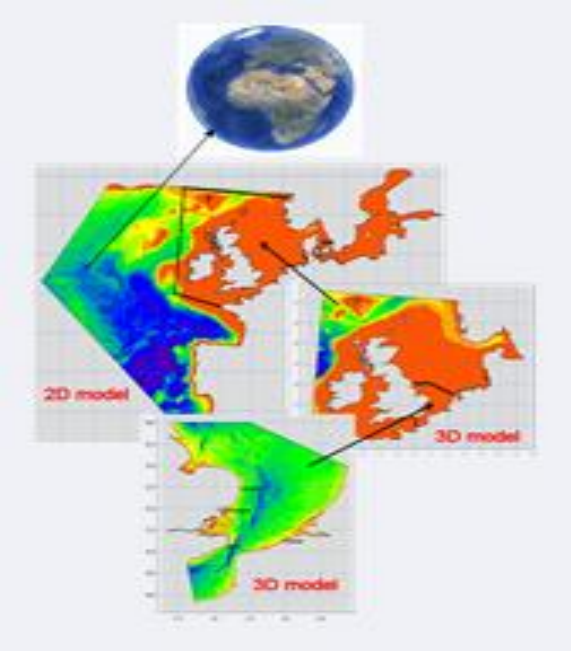
Smarter data

London Array

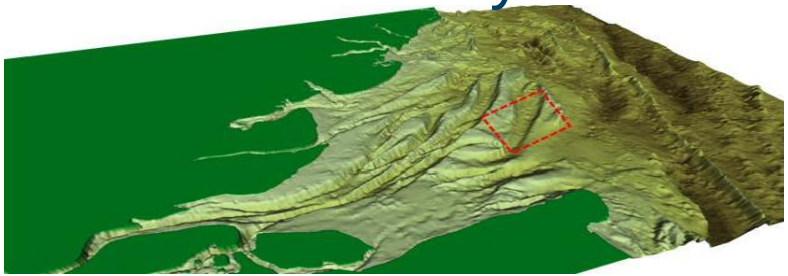


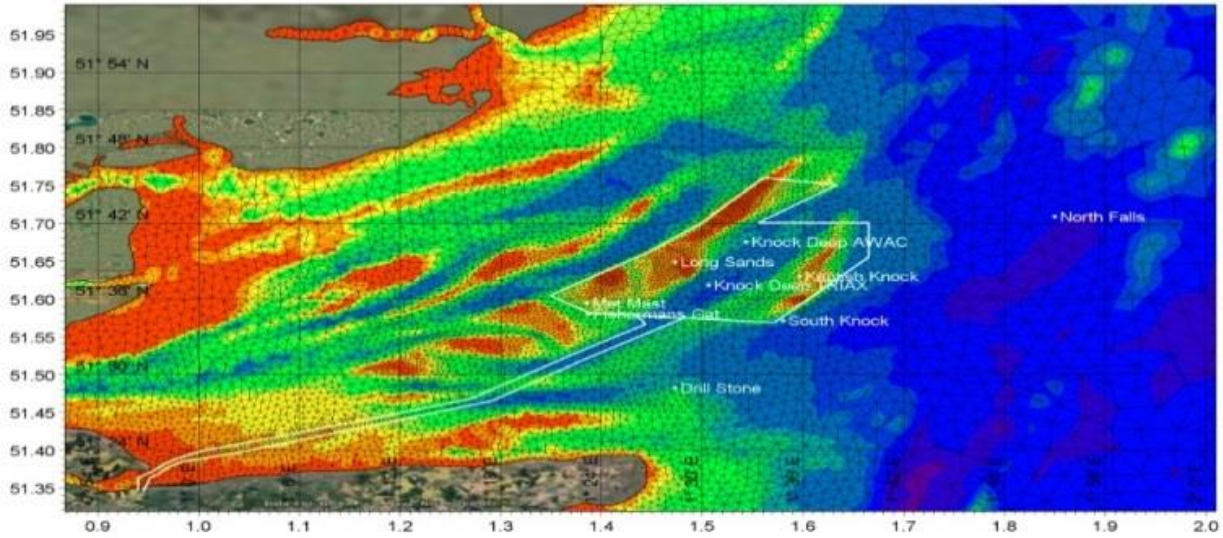


Integrated software

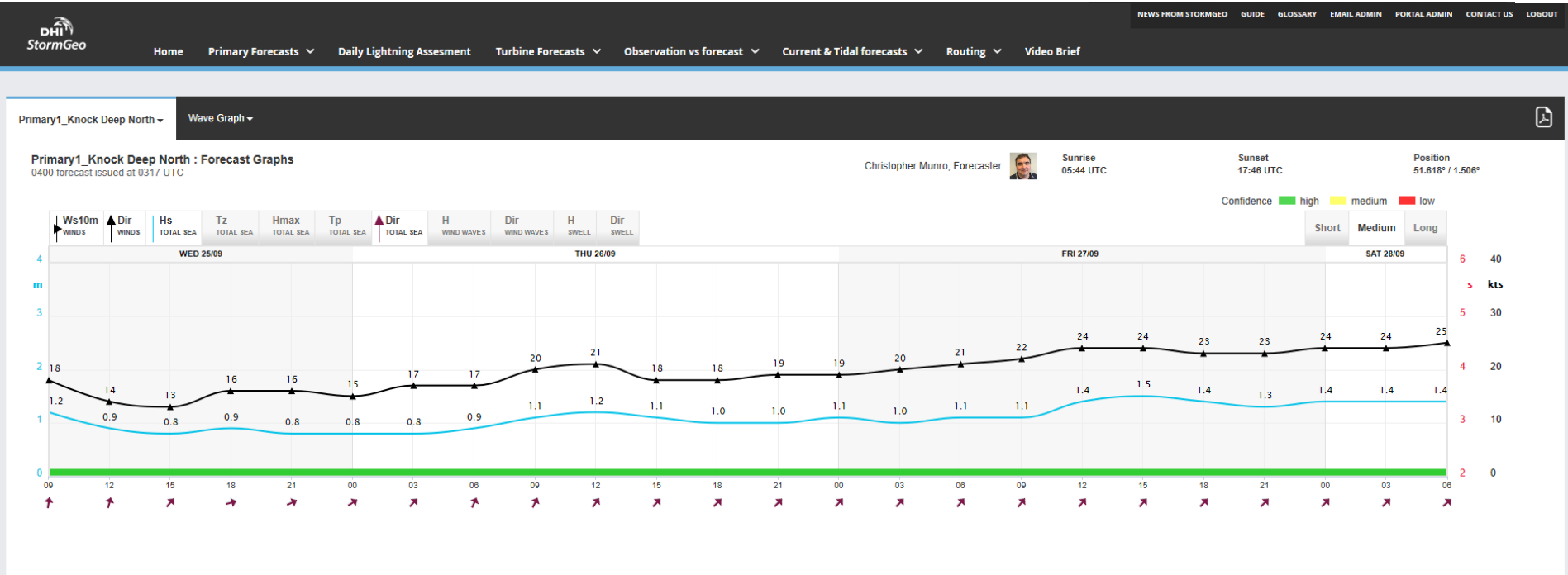


London Array

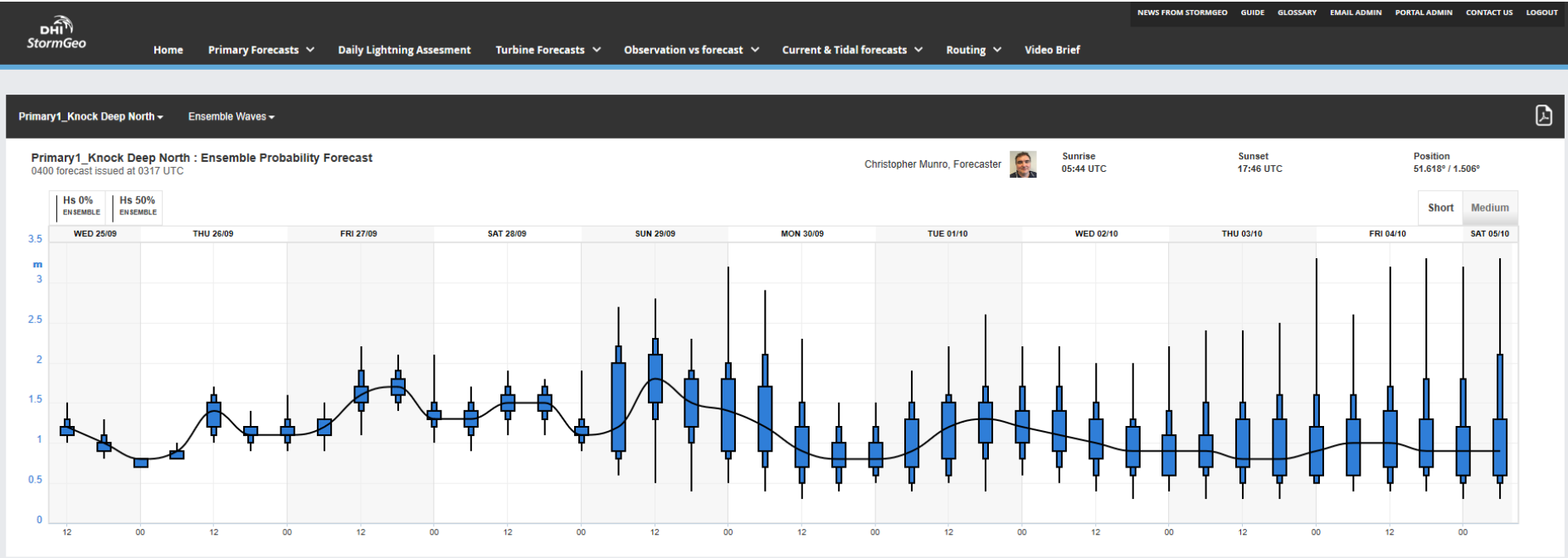




Considered solutions



Considered solutions



Considered solutions

Waterforecast by DHI

London Array Ltd. API Documentation

The HTTP API is read-only and have these methods.

- Stations - `/la1/stations`
- Variables - `/la1/variables/{station}`
- Timeseries data - All variables `/La1/values/{station}`
- Timeseries data - Selected variable `/La1/values/{station}/{variable}`

Stations

A10

Variables

Sign. Wave Height (Hm0/Hs) - Total

Timeseries data

Datetime is formatted according to the ISO 8601 standard e.g. 2019-09-25T10:06:30.099Z

Chart JSON

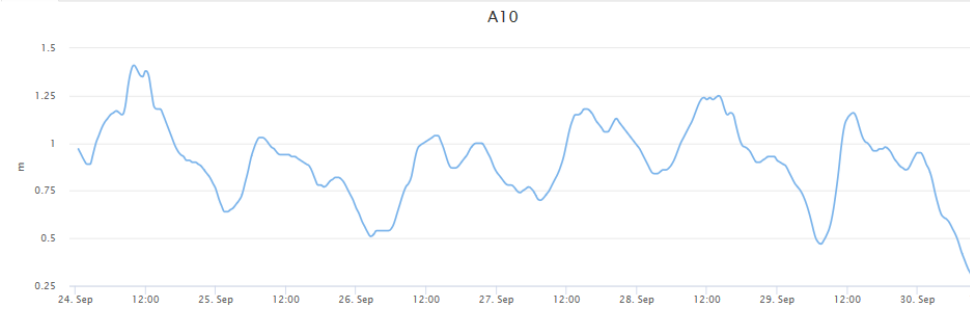


Chart JSON


```
{
        "station": {
                "name": "A10",
                "slug": "a10",
                "longitude": 1.45765,
                "latitude": 51.578557
        },
        "name": "Sign. Wave Height (Hm0/Hs) - Total",
        "unit": "m",
        "forecastids": [
                {
                        "forecastId": "2019-09-25T00:00:00Z",
                        "start": "2019-09-24T00:30:00Z",
                        "end": "2019-09-28T12:00:00Z"
                },
                {
                        "forecastId": "2019-09-24T12:00:00Z",
                        "start": "2019-09-28T12:30:00Z",
                        "end": "2019-09-30T12:00:00Z"
                }
        ],
        "data": [
                [
                        "2019-09-24T00:30:00Z",
                        0.97
                ],
                [
                        "2019-09-24T01:00:00Z",
                        0.94
                ],
                [
                        "2019-09-24T01:30:00Z",
                        0.91
                ],
                [
                        "2019-09-24T02:00:00Z",
                        0.89
                ],
                [
                        "2019-09-24T02:30:00Z",
                        0.89
                ],
                [
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                ],
                [
                        "2019-09-24T03:30:00Z",
                        1
                ],
                [
                        "2019-09-24T04:00:00Z",
                        1.04
                ],
                [
```

Considered solutions

Thank you for your attention …

nje@dhigroup.com