An interactive global database of potential floating wind park sites

EERA DeepWind 2018
Trondheim 2017-01-17

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Overview of database
Example: All global locations with:
- 100 < Water depth < 300 (Deep draught floater)
- Mean wind speed > 9.5 m/s @ 100 m elevation
- Distance to infrastructure (population) < 200 km
- Sorted by nearby population density

Agenda
- Overview
- Background
- Data sources
- Examples
- Who can use it?
Metocean – typical use case

Latitude

Metocean spec provides:
- 2D Hs Tp Scatter

Numerical analysis

Wave Hindcast

Single location

Longitude

Time

Metocean spec provides:
- 2D Hs Tp Scatter
Example - A more complex case

Consider the following case:
• Long term motion analysis of a passive turret moored FPSO

How it works:
• FPSO orients with direction of wind, current and waves, but mostly wind and current
• Motions are largest in waves from side
• Swells common with directions offset from local wind direction

Proper analysis requires:
• Distribution of simultaneous:
  • Vessel heading,
  • Wind, current and wave directions,
  • Wind wave and swell Hs and Tp

Metocean typically provides:
• 2D Hs - Tp scatter
• Independent wind, wave, current distributions
Metocean - A more complex case

Cannot recover time series info

Not practical for numerical analysis

Complex
Not well defined
Example - A proper analysis approach

Find FPSO heading from satellite photos

Develop heading model

\[ \theta = f(U, C, W) \]

Process local weather time series from global weather hindcast data

- Wind wave
- Swell
- Current
- Wind

Numerical analysis of combined long term distribution

Simultaneous:
- Wind wave
- Swell
- Current
- Wind
- Vessel heading estimate
Building the database:

**Global sea wind and wave hindcast**

Copernicus CMEMS:
- GLOBAL_ANALYSIS_FORECAST_WAV_001_023
- WIND_GLO_WIND_L4_NRT_OBSERVATIONS_012_004

**Global sea water depth**

British Oceanographic Data Centre:
- GENERAL BATHYMETRIC CHART OF THE OCEANS (GEBCO)

**Global sea distance to population centra**

Geonames.org:
- Coordinates and population of world cities with population > 15000
What can it do
Example: Global data – Mean Wind

Mean wind speed at 10 m elevation (m/s)
What can it do
Example: Global data – Mean Hs

Mean significant wave height (m) contours

Generated using E.U. Copernicus Marine Service Information
What can it do
Example: Global data – Mean Tp

Mean wave peak period (s)

Generated using E.U. Copernicus Marine Service Information
What can it do
Example: Global data - Wave energy map

Mean wave energy contours (kW/m wave crest)

\[ P = \frac{\rho g^2}{64\pi} H^2_{m0} T_e \]
Floating wind locations: (First example revisited)

- 100 < Water depth < 300 (Deep draught floater)
- Mean wind speed > 9.5 m/s @ 100 m elevation
- Distance to infrastructure (population) < 200 km
- Sorted by nearby population density

Generated using E.U. Copernicus Marine Service Information
Floating wind locations:

- $100 < \text{Water depth} < 300$ (Deep draught floater)
- Mean wind speed $> 9.5 \text{ m/s} @ 100 \text{ m elevation}$
- Distance to infrastructure (population) $< 200 \text{ km}$
- Sorted by annual mean wind speed (10 m elevation)
Floating wind locations:
Some interesting areas

- 100 < Water depth < 300 (Deep draught floater)
- Mean wind speed > 9.5 m/s @ 100 m elevation
- Distance to infrastructure (population) < 200 km
- Sorted by annual mean wind speed (10 m elevation)

Generated using E.U. Copernicus Marine Service Information
Example of possible data views:
- With the magic of Python (and some patience)

Simple aggregated views:
- Sorting based on mean or annual max: Hs, Tp, wind speed, water depth, etc..
- Ranking sites by some fitness function (high wind, low wave, near shore, etc)

Utilizing the full hindcast:
- Seasonal waiting times for marine operation with some operational limit (Hs, Tp, Wind speed)
- Power factor of some specific wind turbine (based on binning of wind speeds)
- Estimated site LCOE (with some clever cost model)
- Etc..

Proposed use cases:
- Resource assessment
- Feasibility studies
- Preliminary site optimization / analyses
- Operational/maintenence planning
- Etc..
Who can use it:

- All data sources are publically available

- In principle, the combined product can be made publically or commercially available:
  - E.g. complete global coverage
  - .. or on a location by location basis
  - Full hindcast time series
  - .. or aggregated properties (e.g. mean, max)

- Access and availability is not yet decided
  - (Remember, dataset more or less a bi-product of another work)
  - Please make contact if the dataset can be useful for you - we will arrange something!
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Sources – Wind/wave hindcast

- This study has been conducted using E.U. Copernicus Marine Service Information
- Copernicus CMEMS: http://marine.copernicus.eu/
Sources – Water depth:

- GEBCO 2014 water depth database:
  - https://www.bodc.ac.uk/data/hosted_data_systems/gebco_gridded_bathymetry_data/
Sources – Population density:

- Geonames.org database of world cities with population > 15000:
  - [http://download.geonames.org/export/dump/cities15000.txt](http://download.geonames.org/export/dump/cities15000.txt)
Share ideas, move forward