An interactive global database of potential floating wind park sites

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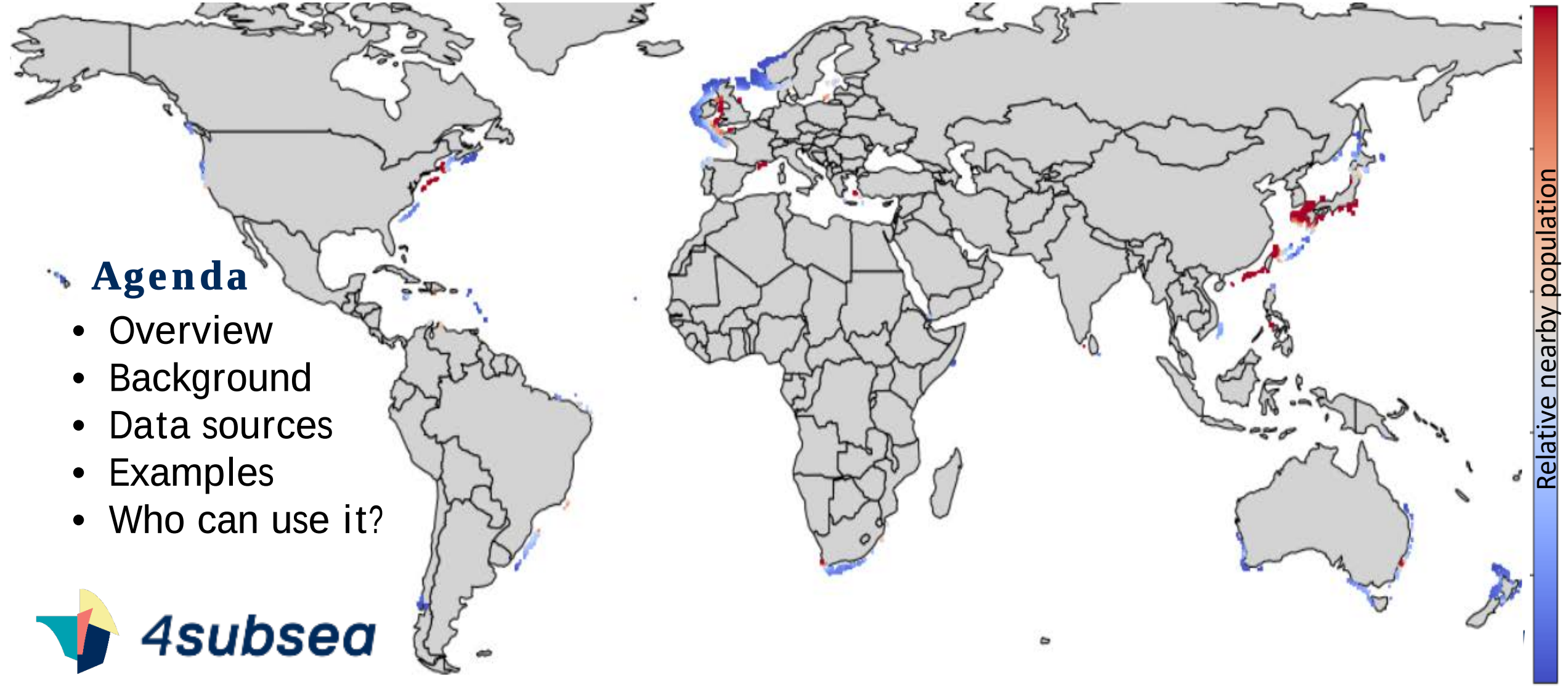
Overview of database

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?

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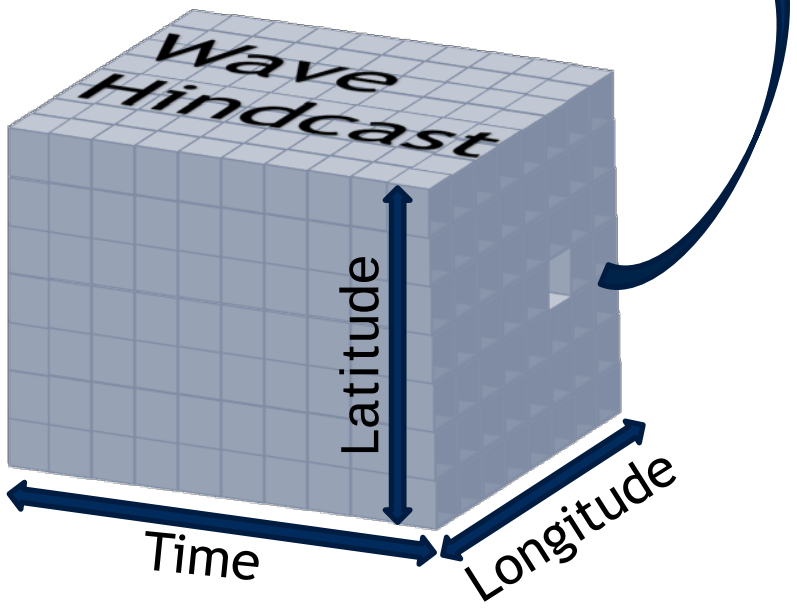
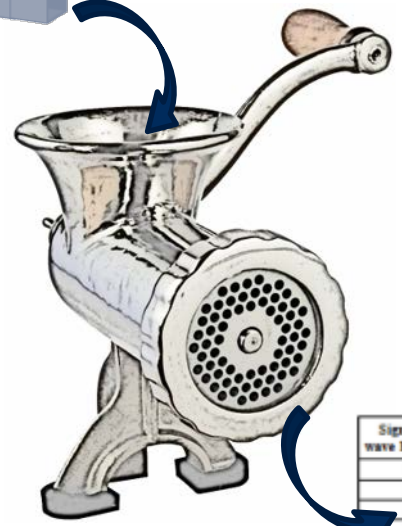
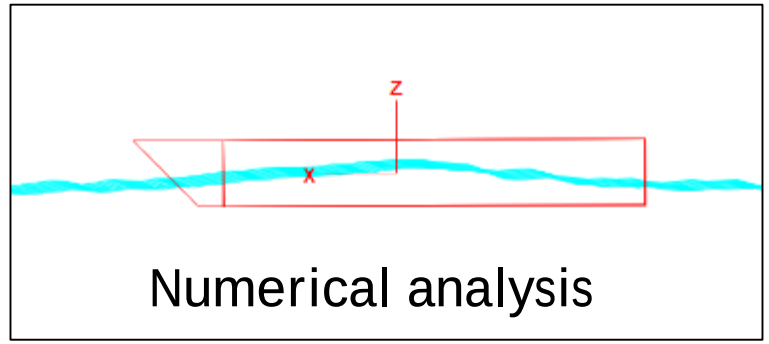
Metocean – typical use case







Metocean spec provides:

Significant wave height [m]	Peak period [s]																			
	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5
0.5	42	429	1172	1662	1634	1291	888	558	331	189	105	57	31	17					
1.5	2	109	964	3034	5260	6292	5902	4689	3317	2160	1325	778	443	246	135	73	39	21	11
2.5		2	76	578	1837	3373	4297	4248	3504	2532	1659	1009	581	320	171	89	46	23	11
3.5			2	47	320	1006	1881	2442	2436	2000	1419	900	523	285	147	73	35	16	7
4.5				2	33	206	635	1181	1519	1485	1179	787	475	257	128	60	27	12	5
5.5					3	22	133	396	715	888	829	619	388	212	103	46	19	7	3
6.5						5	35	85	243			485	320	191					
7.5						1	11	55	144			228	161	91			25		
8.5							1	18	68			83					18		1
9.5								1	16	22	45	55	45	27	12	4	1		
10.5									1	4	13	22	23	16	8	3	1		
11.5										1	3	7	10	9	5	2	1		
12.5												2	4	4	3	1			
13.5													1	2	1	1			
14.5															1				

2D Hs-Tp Scatter

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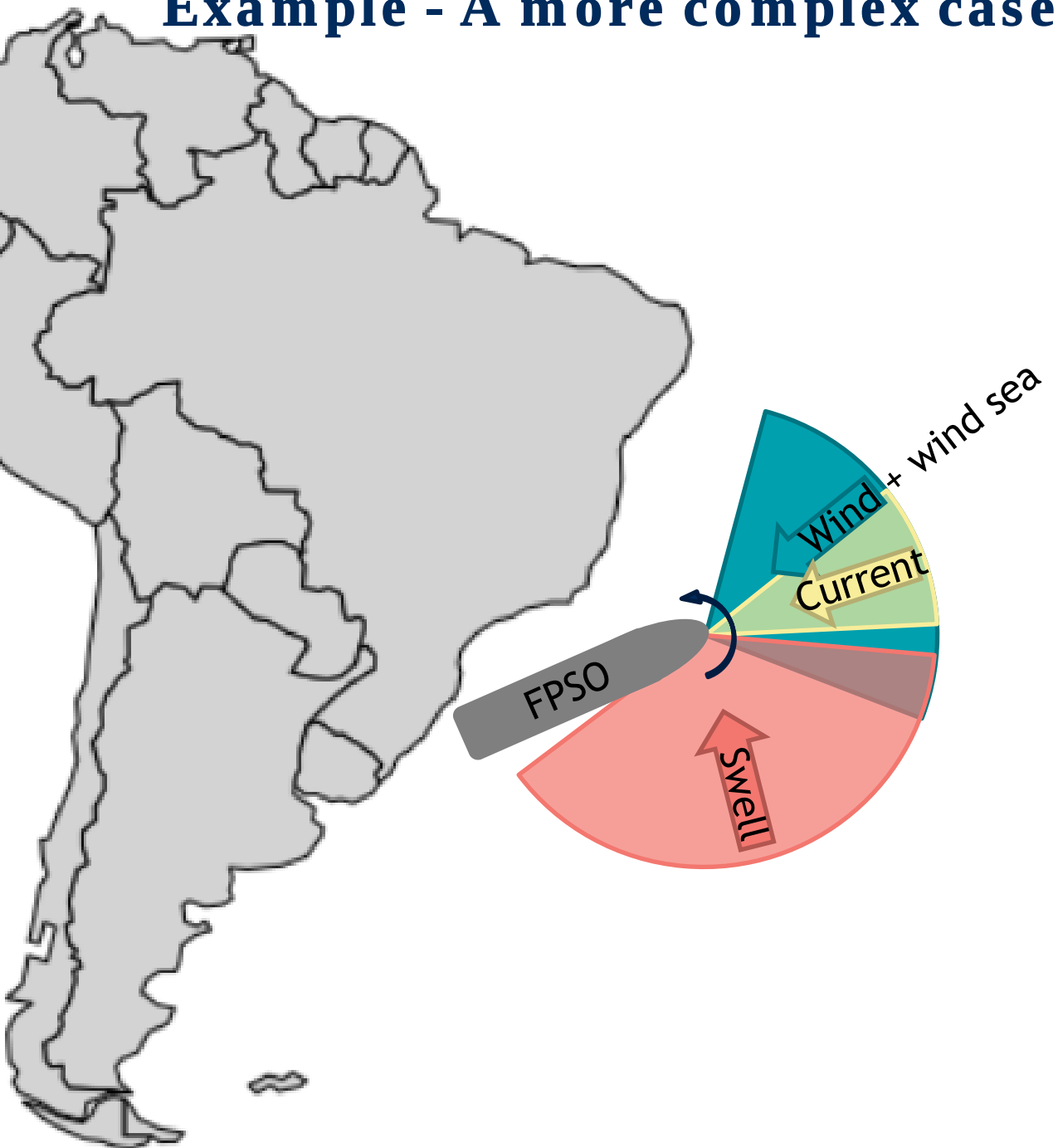
Example - A more complex case



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

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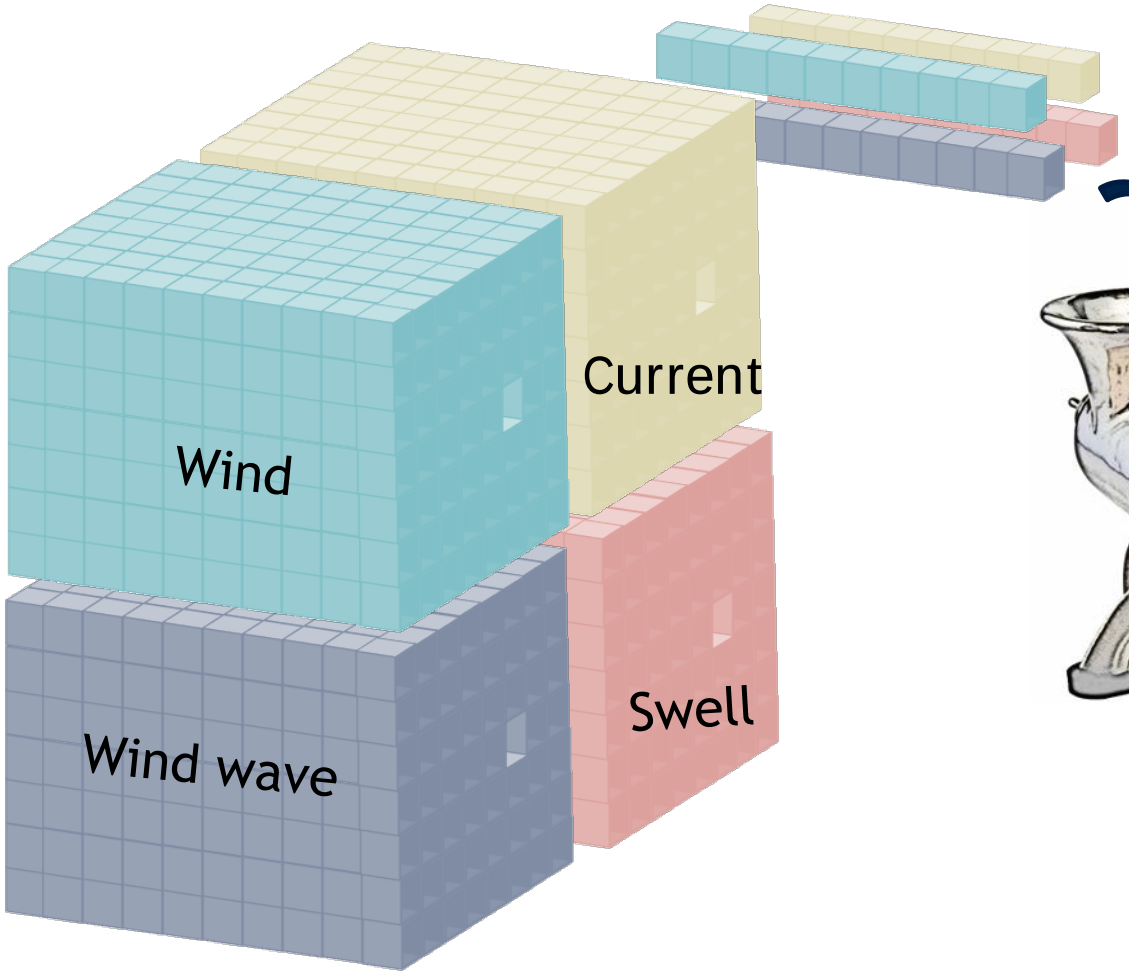
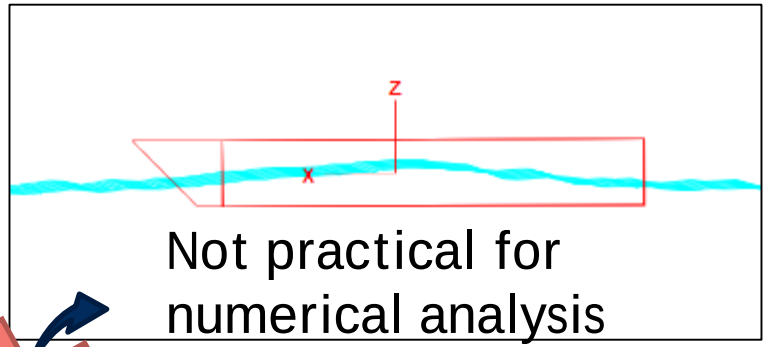
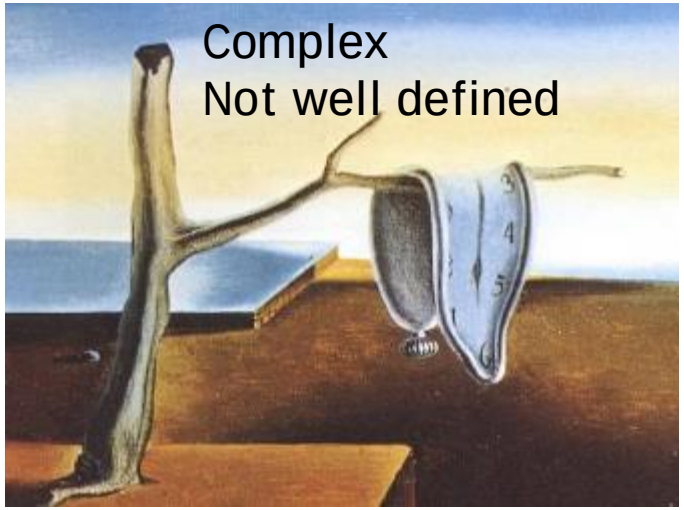
Metocean - A more complex case



Cannot recover time series info



Not practical for numerical analysis



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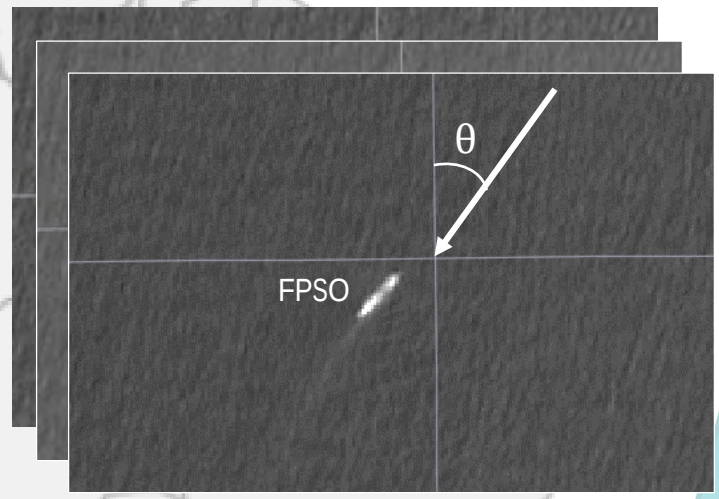
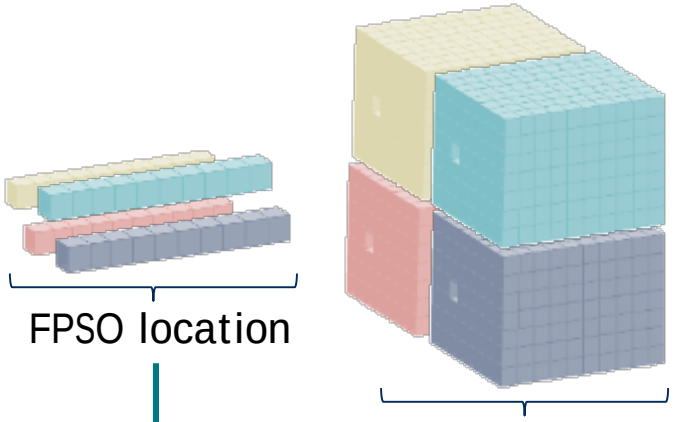
Example - A proper analysis approach

Find FPSO heading from satellite photos



Process local weather time series from global weather hindcast data

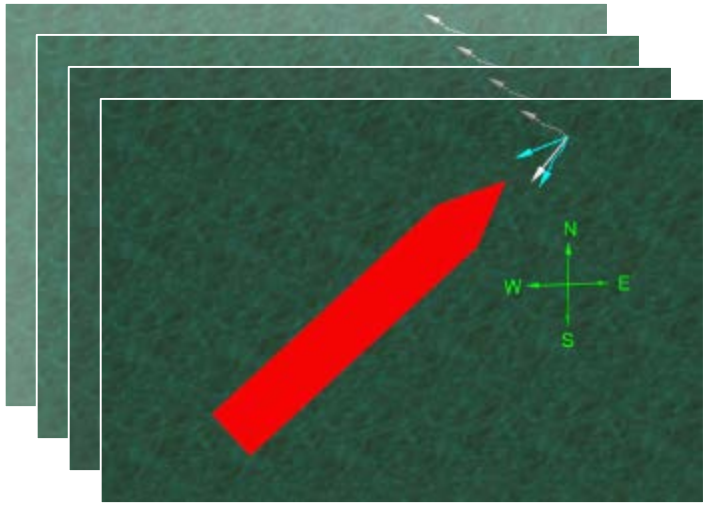


- Wind wave
- Swell
- Current
- Wind

Develop heading model

$$\theta = f(U, C, W)$$

Numerical analysis of combined long term distribution



Simulataneous:

- Wind wave
- Swell
- Current
- Wind

✚

- Vessel heading estimate

Building the database:

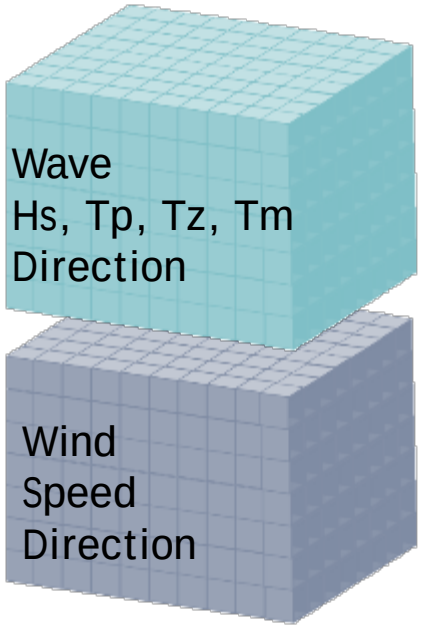
Global sea wind and wave hindcast

Copernicus CMEMS:

- GLOBAL_ANALYSIS_FORECAST_WAV_001_023
- WIND_GLO_WIND_L4_NRT_OBSERVATIONS_012_004

Funded by the European Union

Copernicus



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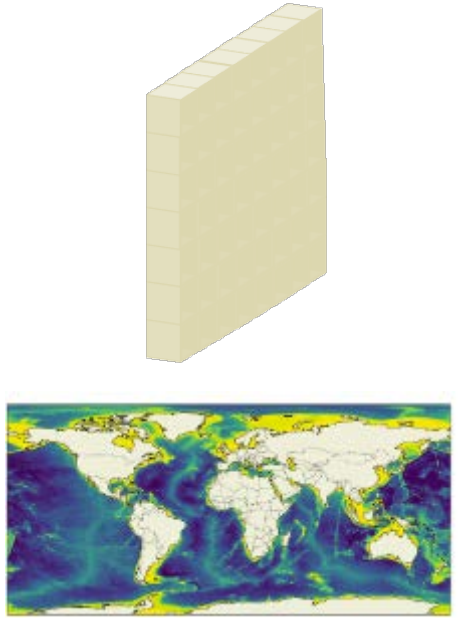
Global sea water depth

British Oceanographic Data Centre:

- GENERAL BATHYMETRIC CHART OF THE OCEANS (GEBCO)

BODC British Oceanographic Data Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL



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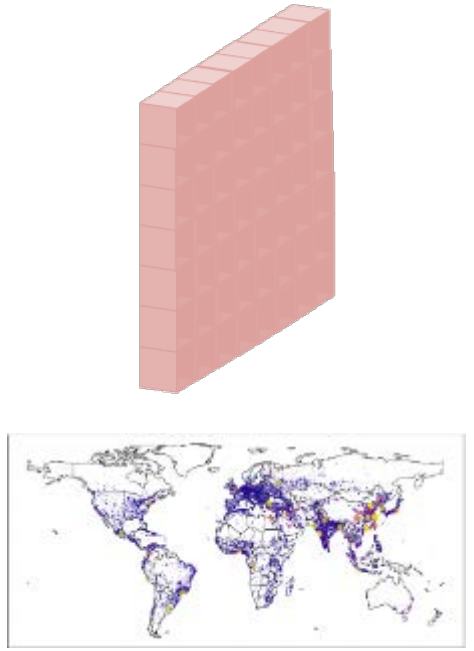
Global sea distance to population centra

Geonames.org:

- Coordinates and population of world cities with population > 15000

GeoNames



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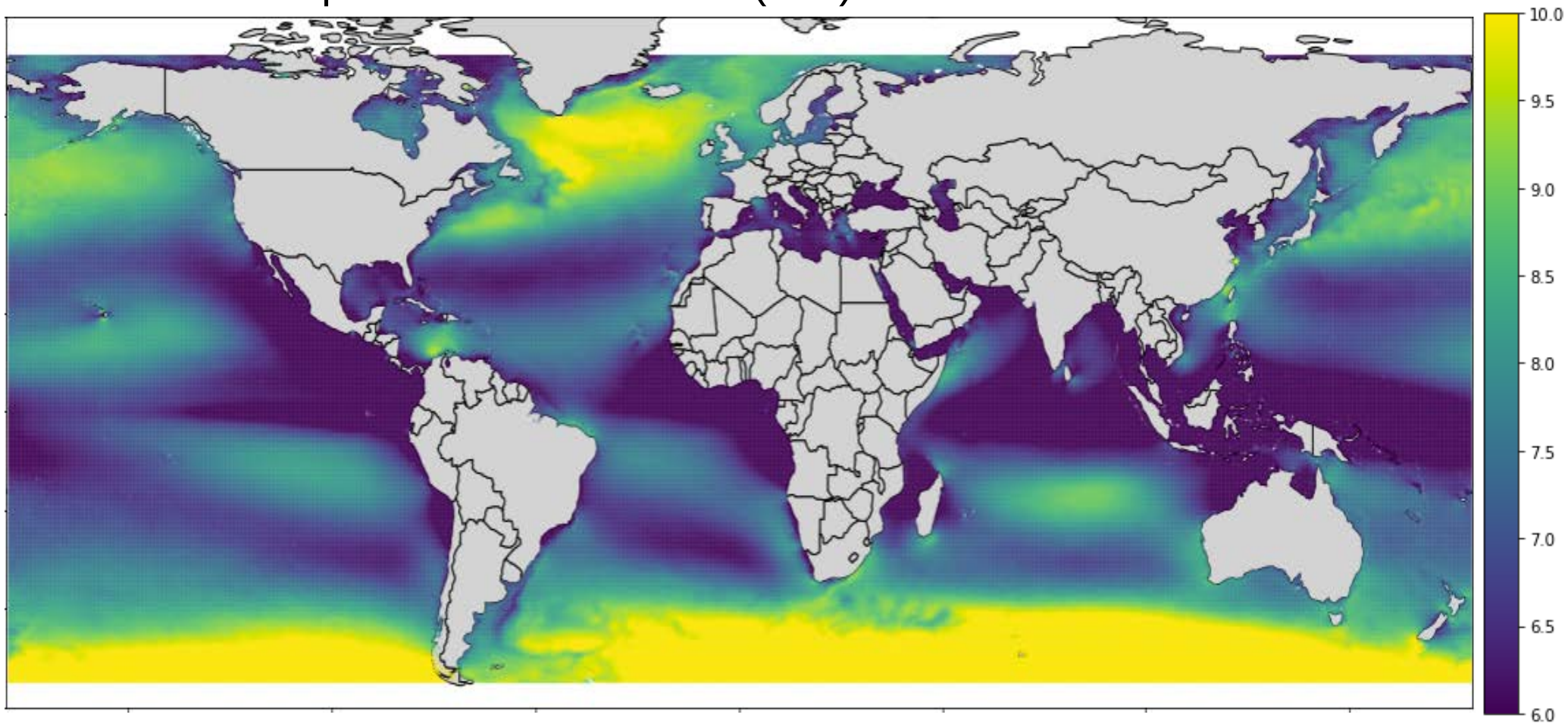
What can it do

Example: Global data – Mean Wind

Mean wind speed at 10 m elevation (m/s)



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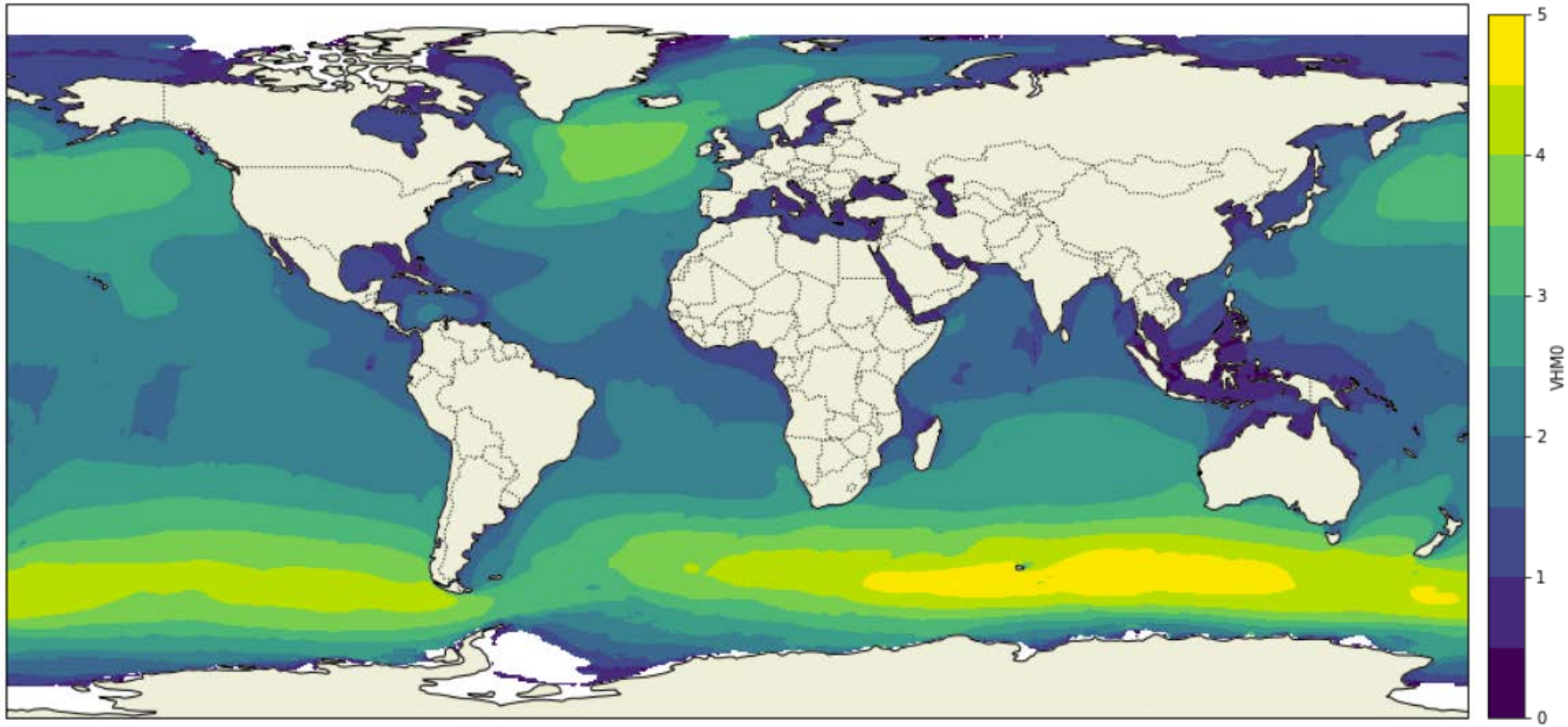
What can it do

Example: Global data – Mean Hs

Mean significant wave height (m) contours



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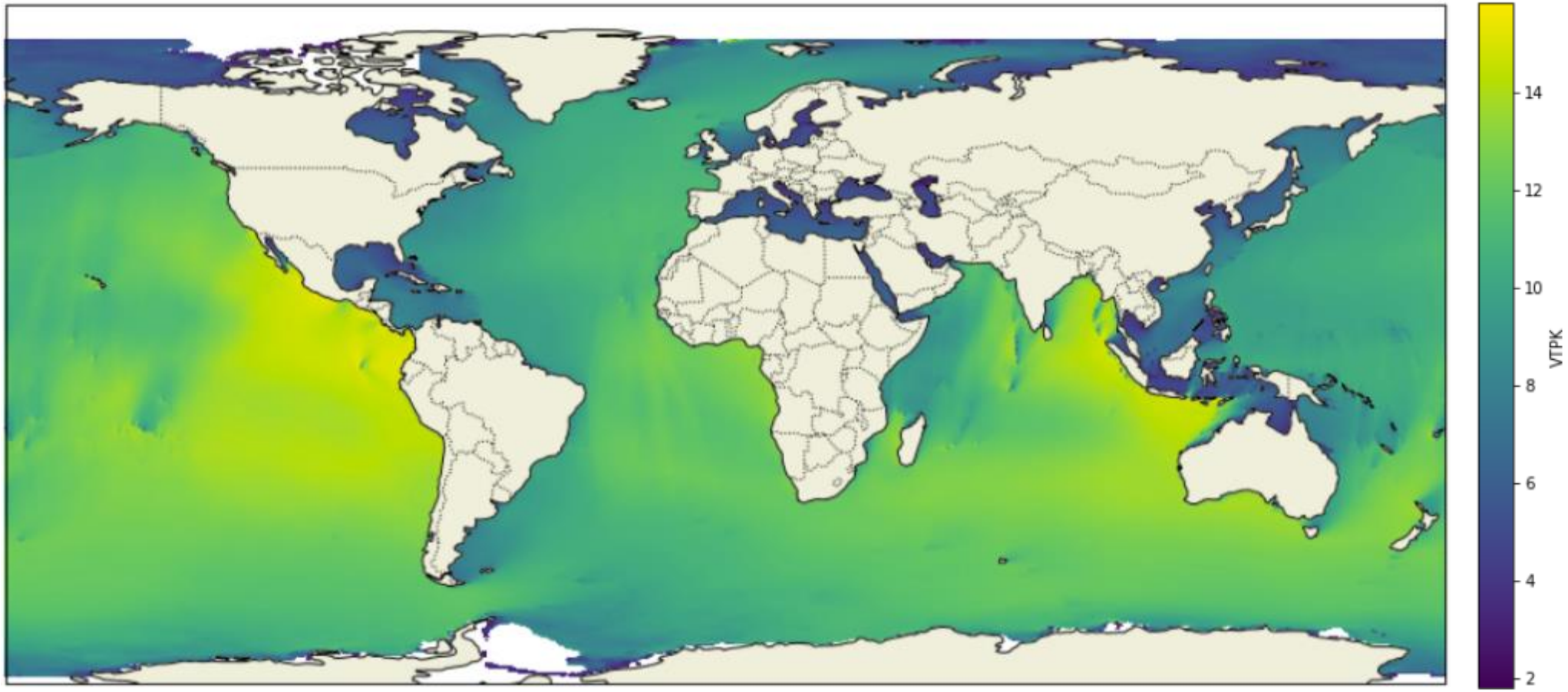
What can it do

Example: Global data – Mean Tp

Mean wave peak period (s)



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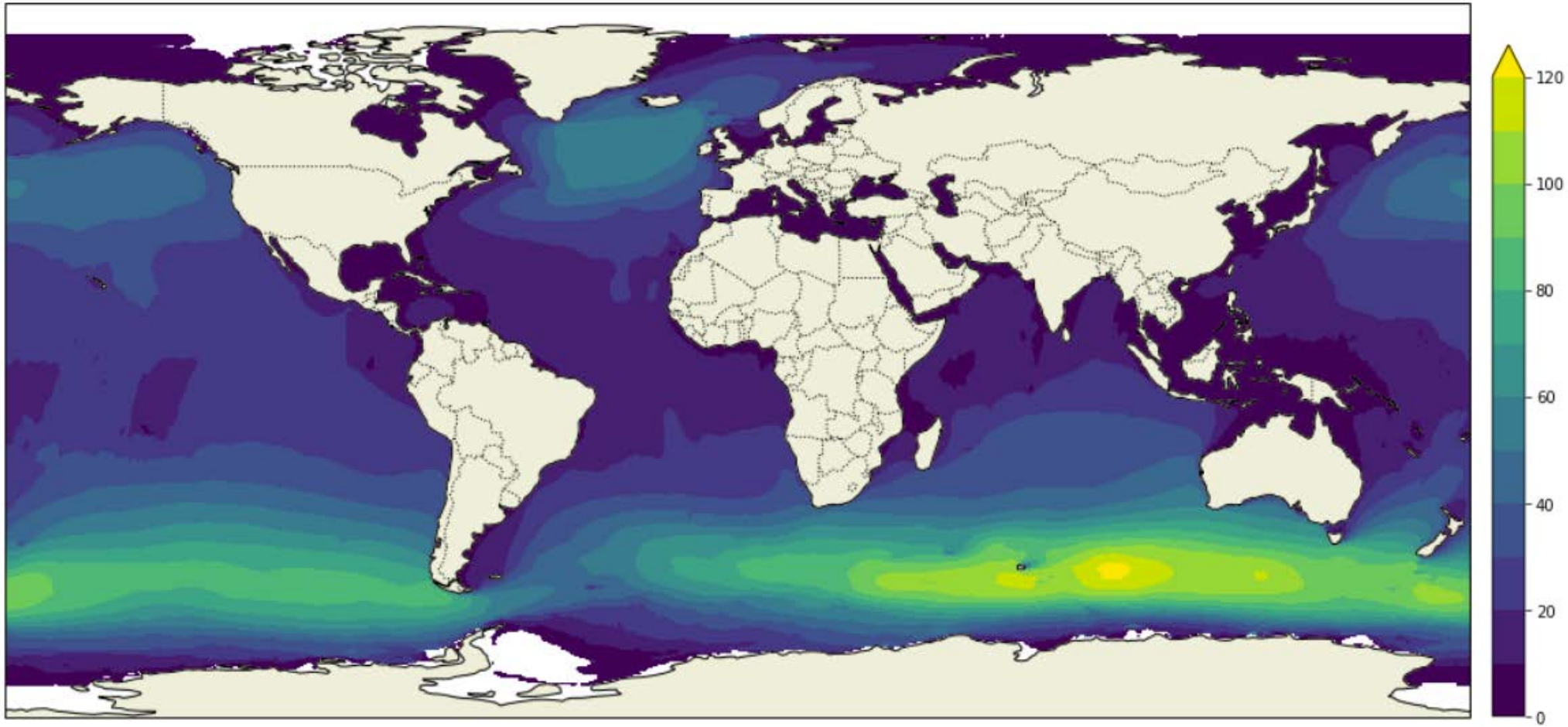
What can it do

Example: Global data - Wave energy map

$$P = \frac{\rho g^2}{64\pi} H_{m0}^2 T_e$$

Mean wave energy contours (kW/m wave crest)



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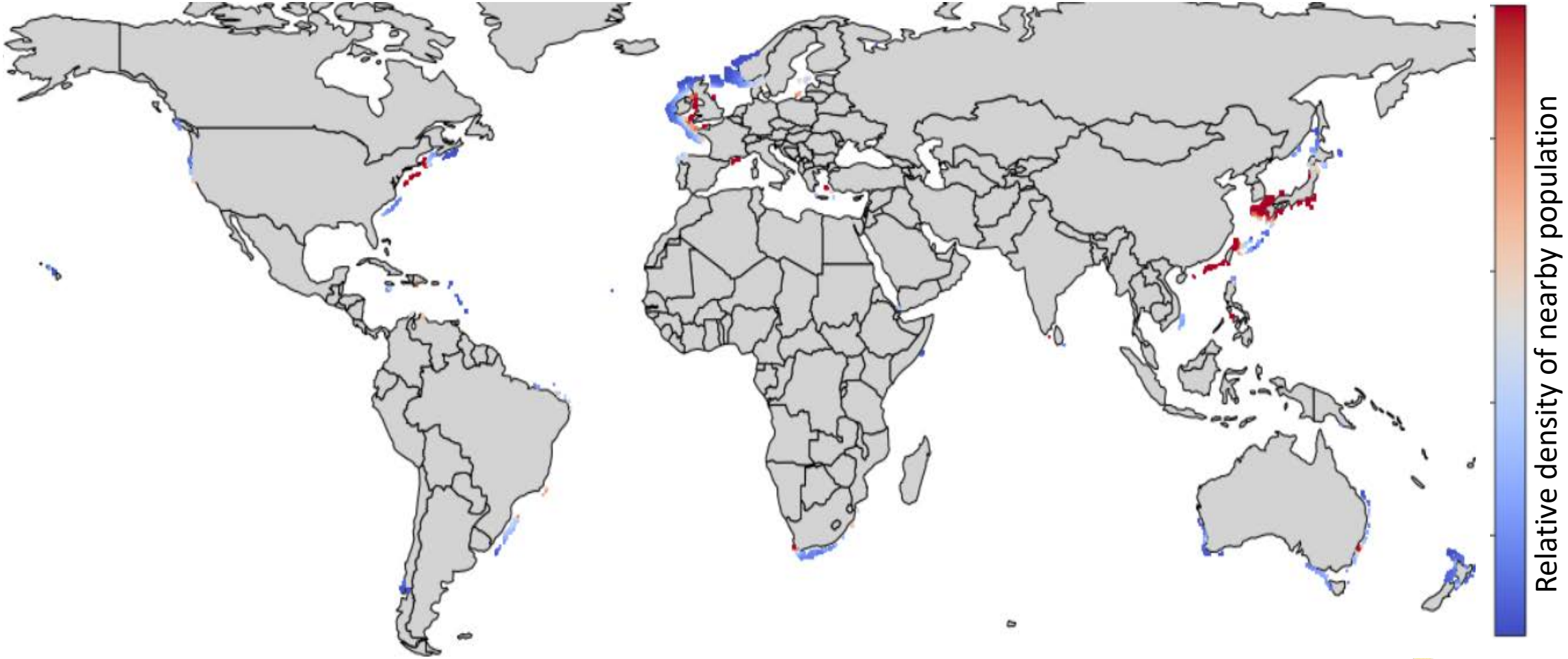
Floating wind locations:
(First example revisited)

- 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



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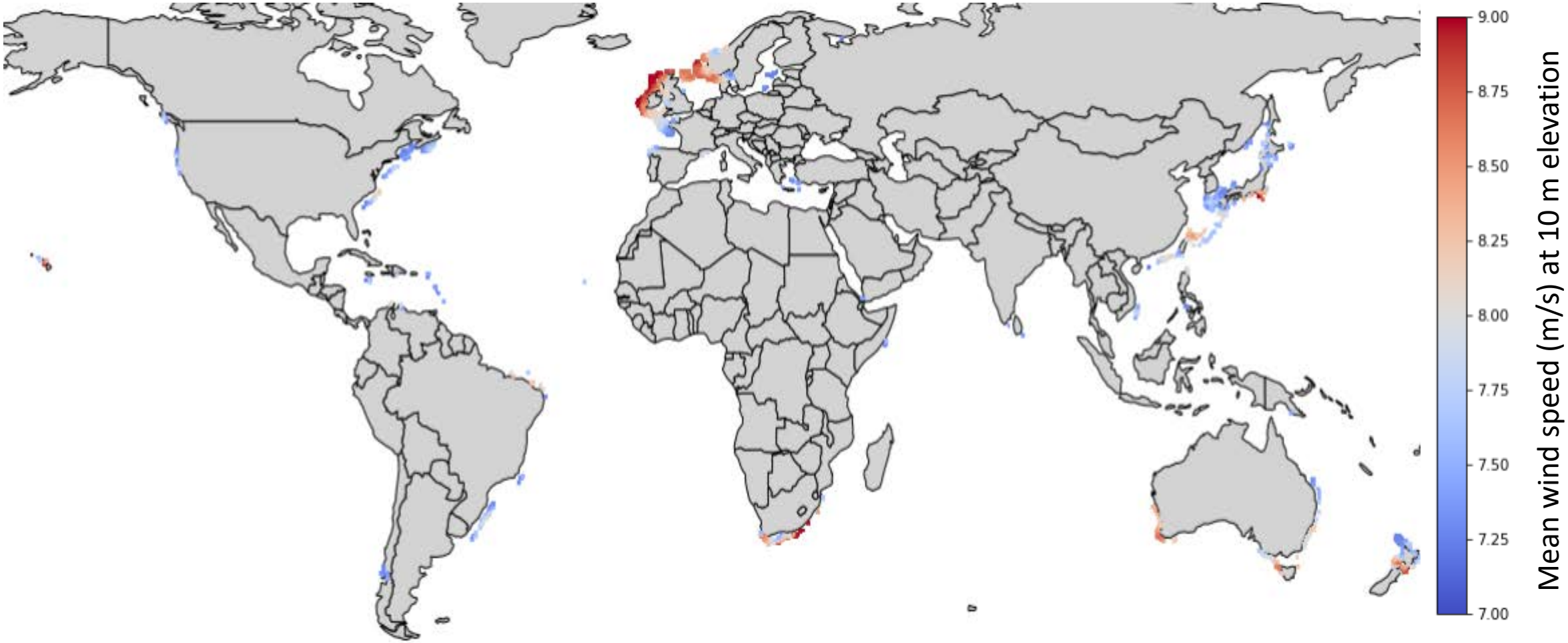
Floating wind locations:

- 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)



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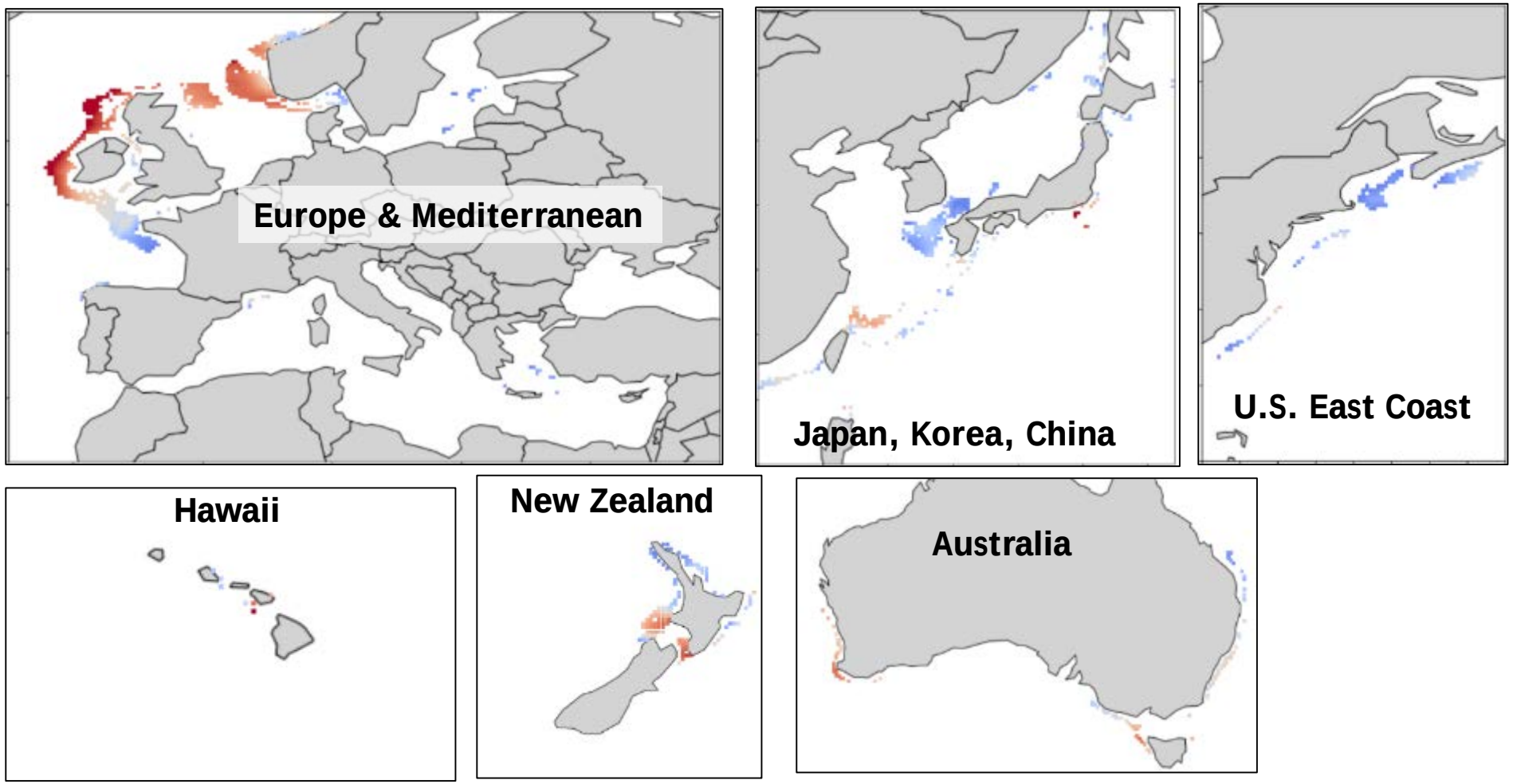
Floating wind locations:
Some interesting areas

- 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)



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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..

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Who can use it:

- All data sources are publically available

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

- Access and availablilty 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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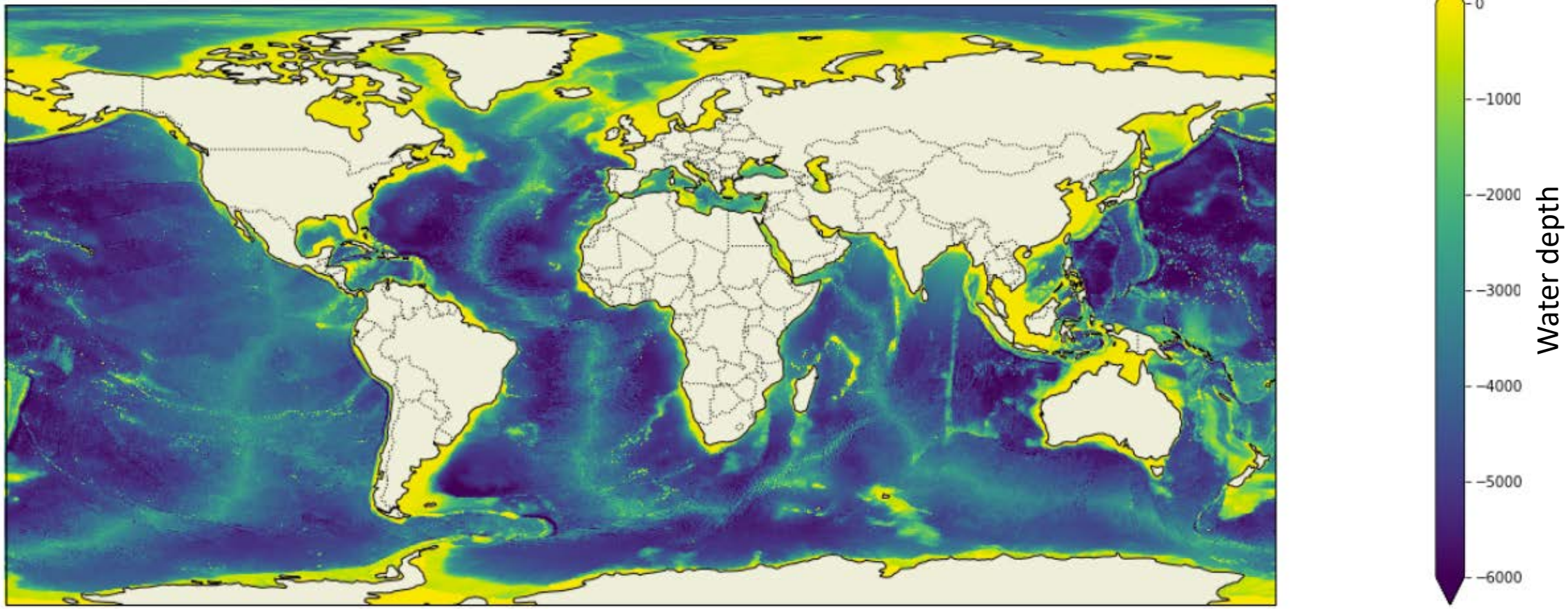
Sources – Wind/wave hindcast

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

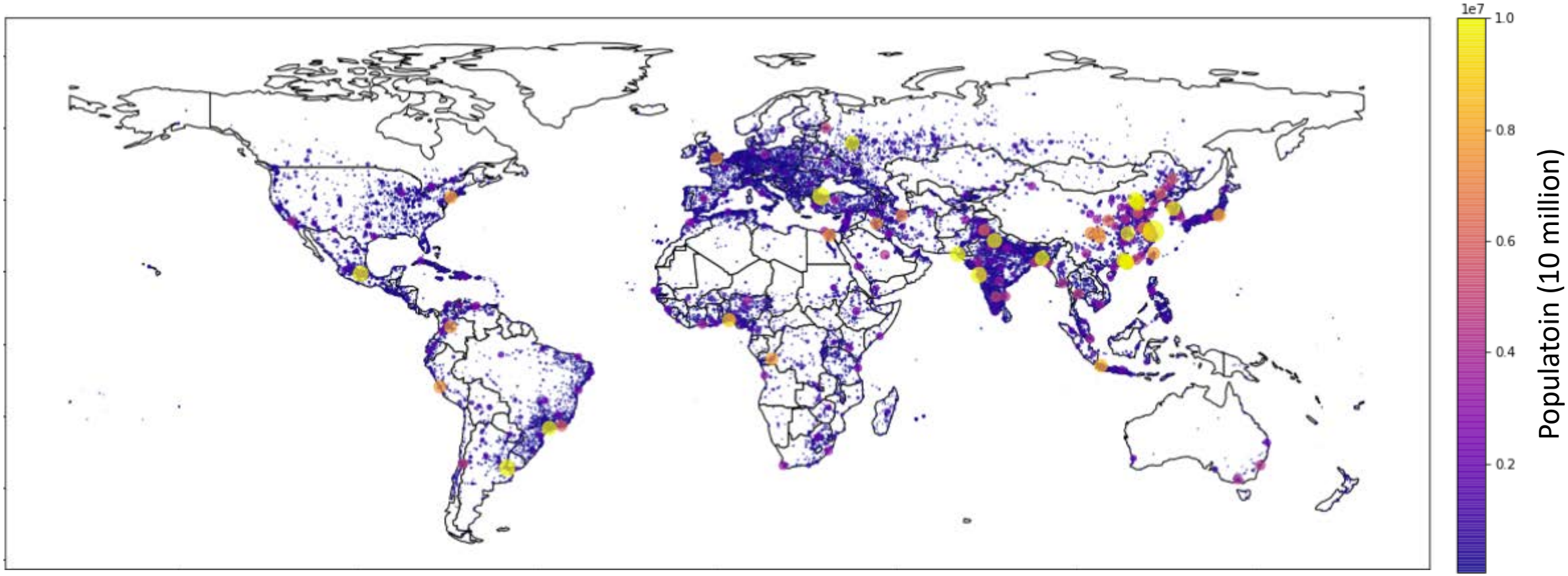
Sources – Water depth:

- 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

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move forward
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