



Copernicus Marine Service: Mocean use case

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Our Team

Team spread across three locations + remote

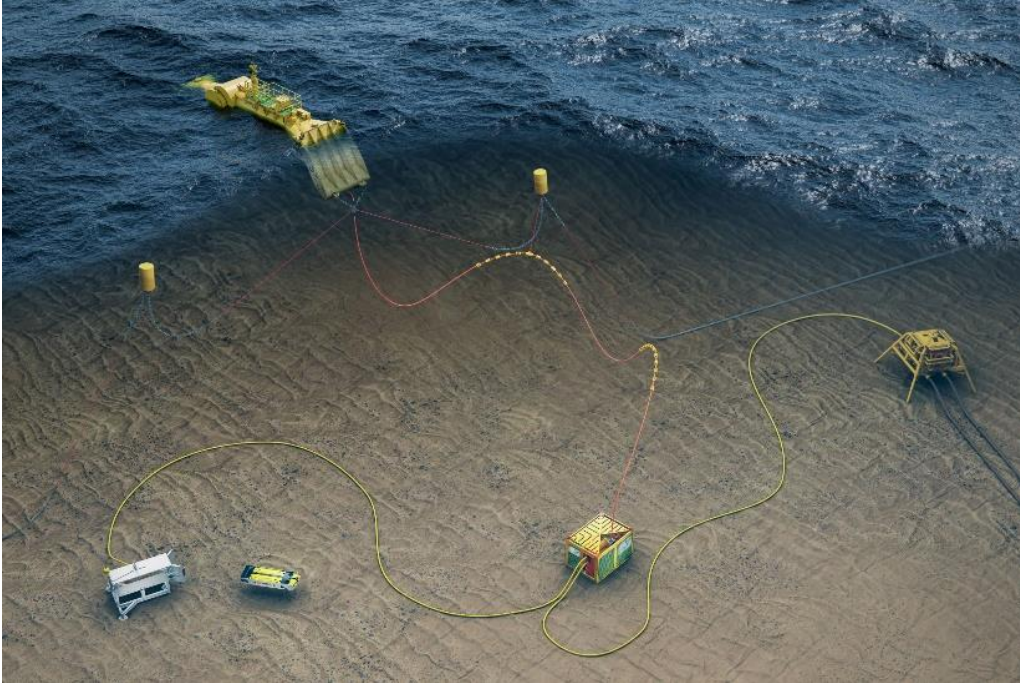
Now a team of ~ 25 people



How it works: At sea



Technology



blueSTAR

- **Small-scale**
- Subsea tiebacks, CCS tiebacks, residential robotics, marine awareness.

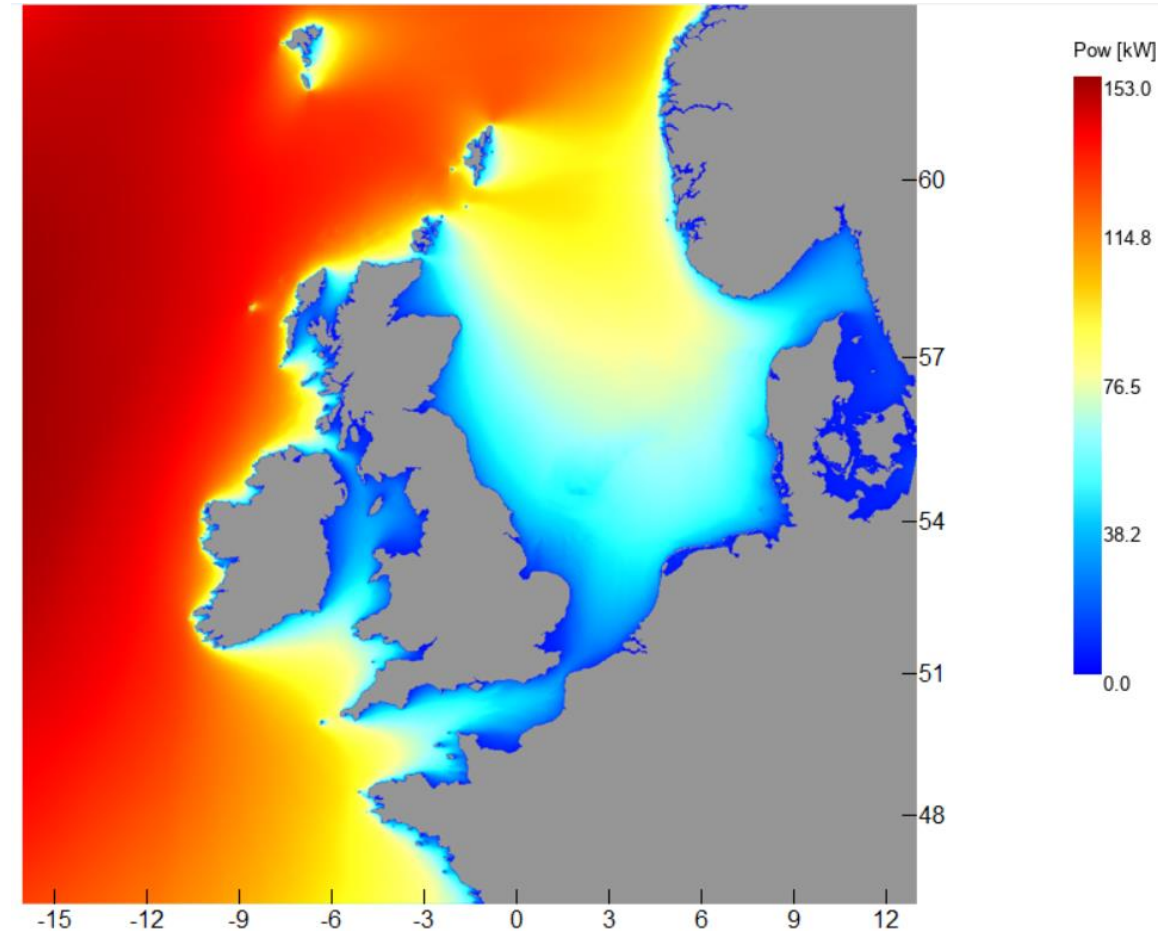


blueHORIZON

- **Mid-scale to grid-scale**
- Utility-scale machine designed for deployment in wave farms off the coast

Site assessment

- One of the most important questions we want to answer is what locations are the most suitable for the deployment of our devices?
- There are several factors to consider when performing a site assessment, e.g.
 - What is the power production potential?
 - How extreme are the sea conditions?
 - What are the operations costs?
- To provide a convenient way for our Commercial Team to view and download basic wave data statistics we have developed several in-house infographic software tools.



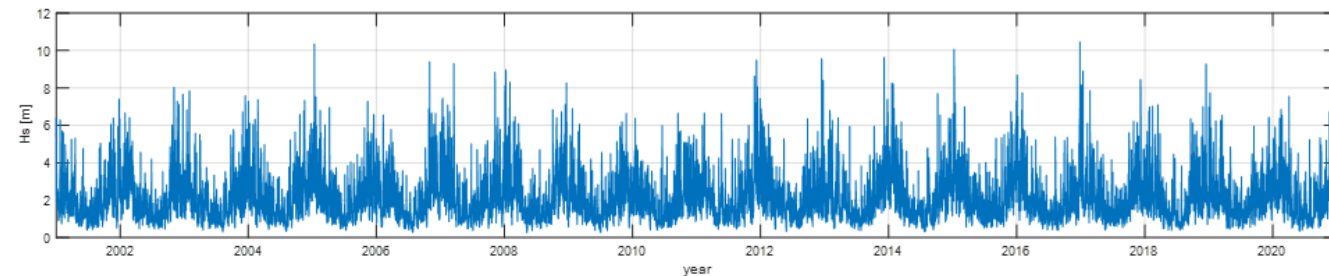
Historical data for power assessment



- Using various numerical modelling techniques, we can compute the average power production for a number of sea states, creating a **power matrix**.
- Then we download a long time series of wave data (12-20 years) which allows us to compute key site statistics:
 - Annual Energy Production
 - Continuous Available Power

Hs (m)	Te (s)																					
	1.5	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	21.5	22.5
0.25	0.01	0.03	0.18	0.95	2.08	2.72	2.77	2.43	1.95	1.52	1.19	0.90	0.71	0.56	0.44	0.36	0.28	0.22	0.18	0.15	0.13	0.11
0.75	0.12	0.31	1.50	7.64	16.63	21.75	21.95	18.86	15.24	12.31	9.59	7.32	5.72	4.59	3.54	2.86	2.29	1.89	1.57	1.28	1.07	0.93
1.25	0.33	0.83	3.90	20.16	41.83	56.36	56.07	47.57	38.99	31.02	24.14	19.17	14.63	11.34	9.36	7.38	6.03	4.90	4.06	3.35	2.82	2.36
1.75	0.65	1.59	7.06	36.40	78.96	98.23	99.28	87.63	69.68	55.35	44.36	34.35	26.95	21.26	17.10	13.68	11.31	9.11	7.70	6.28	5.19	4.35
2.25	1.07	2.55	11.25	57.06	122.56	151.27	150.62	130.62	104.60	87.35	67.98	52.22	41.00	33.36	27.04	21.64	17.78	14.61	11.75	10.27	8.52	7.01
2.75	1.60	3.71	16.27	80.72	167.13	199.41	199.32	173.26	145.33	121.48	96.10	76.52	58.09	48.41	38.06	30.37	25.45	20.43	16.82	14.62	12.09	10.25
3.25	2.24	5.09	21.57	107.91	215.88	245.58	258.53	221.89	191.17	153.32	121.46	98.60	77.42	62.90	51.69	41.33	33.21	28.08	23.20	19.34	15.82	13.79
3.75	2.98	6.57	27.62	140.16	260.77	316.31	312.68	274.10	230.21	185.19	151.49	123.38	99.21	79.53	64.56	51.18	42.95	35.84	29.31	24.89	21.15	17.90
4.25	3.80	8.37	34.10	168.94	309.13	352.51	352.11	326.42	273.89	230.11	191.30	146.97	122.22	101.69	81.33	67.82	53.79	43.69	37.13	30.65	26.69	22.18
4.75	4.78	10.23	41.28	199.22	360.94	398.02	405.01	373.68	328.19	267.96	216.60	182.03	146.78	117.81	94.27	77.87	63.99	53.80	45.41	37.11	31.72	27.12
5.25	5.89	12.31	48.85	234.33	372.23	455.07	460.51	392.17	321.02	291.13	237.61	198.40	168.94	134.27	114.33	93.99	75.64	64.29	52.92	45.48	36.86	32.47
5.75	6.92	14.47	57.03	267.03	439.60	510.63	501.64	461.51	387.67	329.93	283.46	233.49	190.84	156.77	133.27	108.65	89.53	75.04	61.42	52.08	44.07	37.27
6.25	8.14	16.88	65.90	303.30	487.57	555.61	538.91	493.41	409.94	373.24	311.93	246.51	220.16	189.79	148.84	125.43	103.15	84.05	72.04	61.35	50.93	43.13
6.75	9.63	19.38	73.44	329.10	554.59	626.91	585.81	545.50	465.22	421.37	330.74	277.01	243.01	203.01	167.37	140.71	117.57	93.02	84.12	67.42	58.19	49.39
7.25	11.07	21.75	82.15	368.30	571.52	644.02	654.32	604.75	513.26	423.41	375.71	299.31	272.08	218.56	186.78	158.30	124.58	111.09	91.64	77.77	66.32	56.46
7.75	12.46	24.37	91.87	404.56	668.26	699.95	665.93	632.45	530.72	483.32	391.93	334.00	287.82	245.70	194.23	159.28	142.73	122.73	103.02	85.31	72.75	61.83
8.25	14.10	27.32	104.16	411.05	677.35	750.40	719.52	679.01	585.00	506.12	433.35	362.71	313.63	258.45	230.03	186.27	160.82	130.35	117.06	95.71	82.39	72.27
8.75	15.74	30.13	111.59	469.29	699.92	790.46	752.27	653.17	598.38	538.34	465.74	387.24	336.23	267.41	238.44	202.67	173.42	144.97	125.79	108.16	92.00	77.47
9.25	17.70	33.48	124.79	484.59	755.60	825.79	816.78	736.05	672.76	555.43	504.78	444.10	381.26	296.58	254.37	224.02	190.46	161.48	141.15	114.71	98.41	84.69
9.75	19.48	36.97	135.22	504.26	779.37	891.46	862.80	800.83	699.86	611.08	512.24	455.74	371.31	328.62	276.13	241.27	196.89	169.09	146.60	119.94	112.00	93.73
10.25	21.65	40.08	143.65	530.25	829.80	894.55	874.57	793.59	746.90	620.42	545.36	483.25	398.57	340.31	289.53	257.58	214.32	177.60	163.42	131.64	120.67	99.88
10.75	23.83	43.35	152.62	572.13	897.13	934.84	941.81	865.61	765.87	657.99	581.00	505.75	416.65	334.76	312.25	268.51	238.37	206.02	170.41	146.70	129.77	114.22
11.25	26.31	46.52	170.47	624.34	938.97	1002.29	949.82	929.32	782.12	670.25	612.82	516.89	461.84	403.22	345.05	281.01	249.56	200.98	178.20	160.34	135.12	124.93
11.75	28.32	50.28	178.06	617.00	915.65	1046.58	1026.72	944.78	840.18	730.02	646.80	548.26	475.19	420.31	356.85	302.78	266.35	221.73	192.31	169.11	144.02	129.38
12.25	30.44	55.07	187.17	681.82	949.29	1093.97	1096.05	966.98	881.05	769.38	663.44	567.38	497.16	421.15	373.04	318.12	279.01	232.15	212.07	186.94	157.19	137.51
12.75	33.10	56.86	203.42	717.96	1021.84	1110.04	1062.15	1005.95	905.99	798.51	664.08	610.16	533.78	446.74	395.44	327.15	293.49	264.39	216.20	195.63	164.14	147.37
13.25	35.80	62.37	210.61	737.76	1055.53	1175.43	1104.97	1040.93	913.74	837.82	717.60	593.99	542.22	450.31	418.81	355.86	304.42	277.51	235.63	207.68	177.48	155.85
13.75	38.54	66.00	223.20	743.67	1106.36	1232.41	1157.22	1079.93	925.51	829.38	708.73	658.33	561.78	516.66	425.01	370.81	314.73	279.19	246.94	218.60	191.04	162.20
14.25	41.82	69.68	236.82	808.34	1118.14	1244.77	1225.83	1083.16	994.72	833.92	778.97	664.51	586.69	496.90	442.70	401.56	347.79	300.02	262.97	222.02	197.29	180.41
14.75	43.87	74.71	245.83	795.06	1194.70	1313.76	1269.40	1134.27	1015.24	903.48	795.62	651.78	589.47	530.98	469.69	418.72	350.55	307.56	273.97	236.22	210.02	182.35
15.25	47.11	78.37	261.92	813.48	1204.54	1311.49	1241.44	1203.48	989.64	925.00	800.87	684.13	606.77	561.26	496.11	421.05	366.33	335.32	296.73	262.97	224.84	194.29

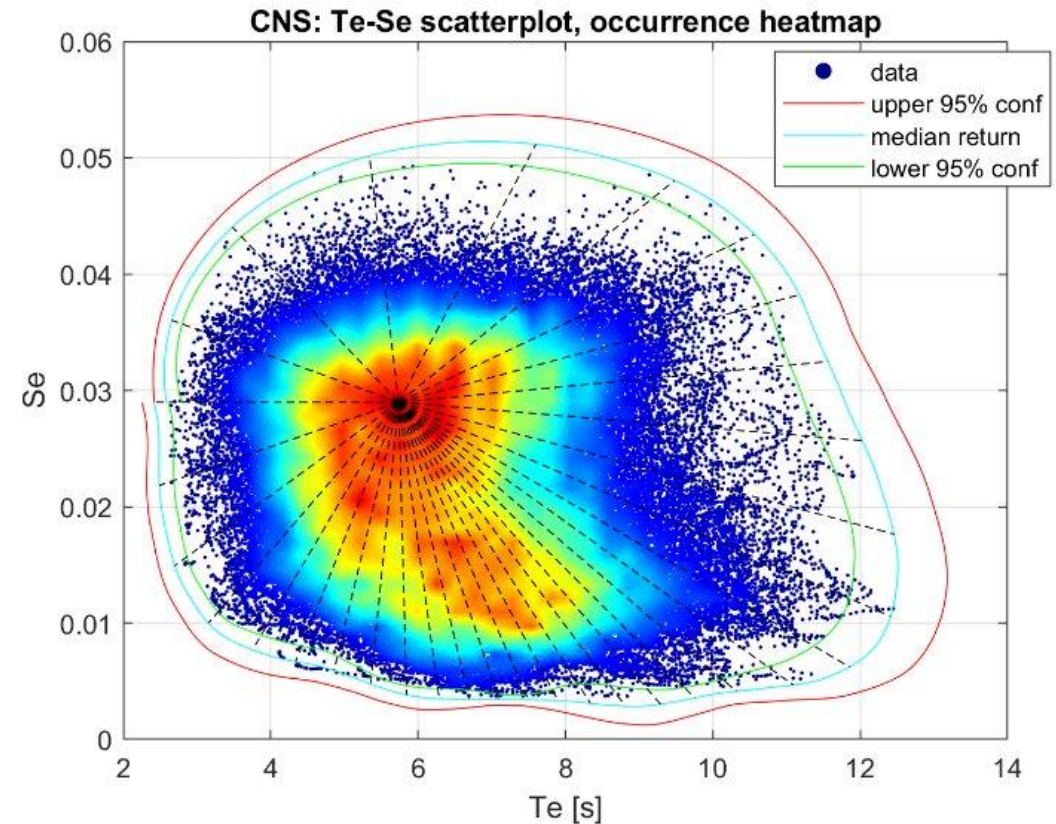
Example of the power matrix



20-year time series of the Hs data

Historical data for extreme wave statistics

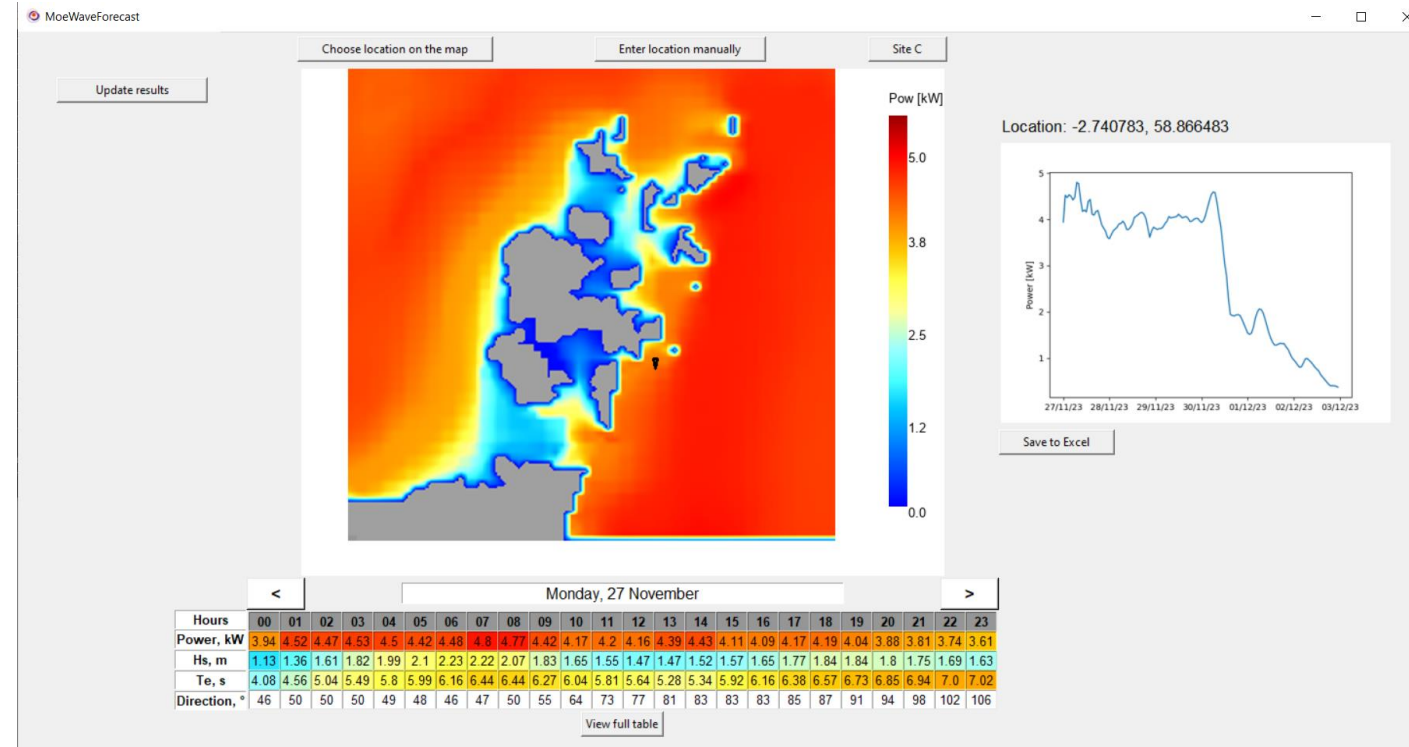
- The goal of extreme wave analysis is to predict the '100-year wave' - the most extreme sea state occurring within the next 100 years.
- This can be done by extrapolating wave data time series (collected over a shorter period of 20-40 years) to a 100-year return period by fitting it to the Generalised Pareto Distribution.
- Using tank test data, it is possible to find the relation between the extreme sea states and hinge responses. That allows us to assess the survivability of the device in various locations.



Extreme contour in Se-Te bivariate space.

Forecast data

- We are also using forecasting data to predict the sea conditions around Orkney where we were deploying one of our devices.
- The sea state forecast data helps us to predict the hourly power production a few days into the future which is essential for the device management performed by our Operations team.



Copernicus Marine Products used at Mocean

We are currently using 3 Copernicus Marine Products:

For site assessment using historical data:

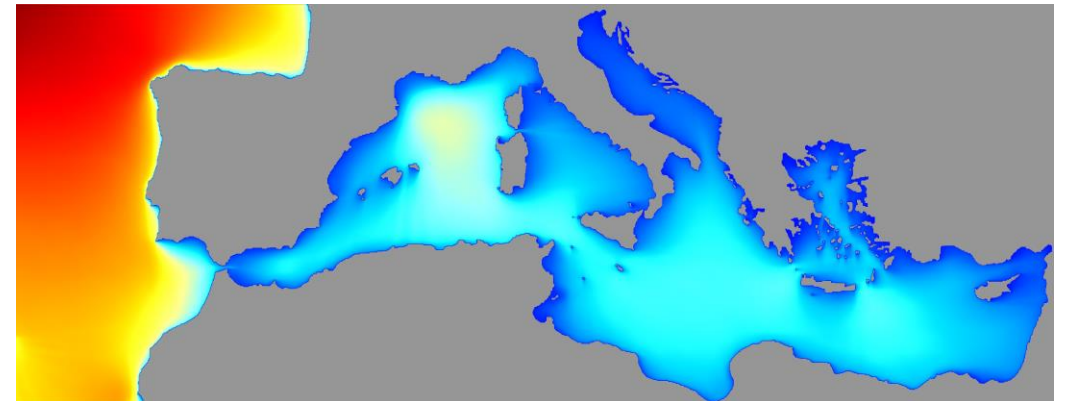
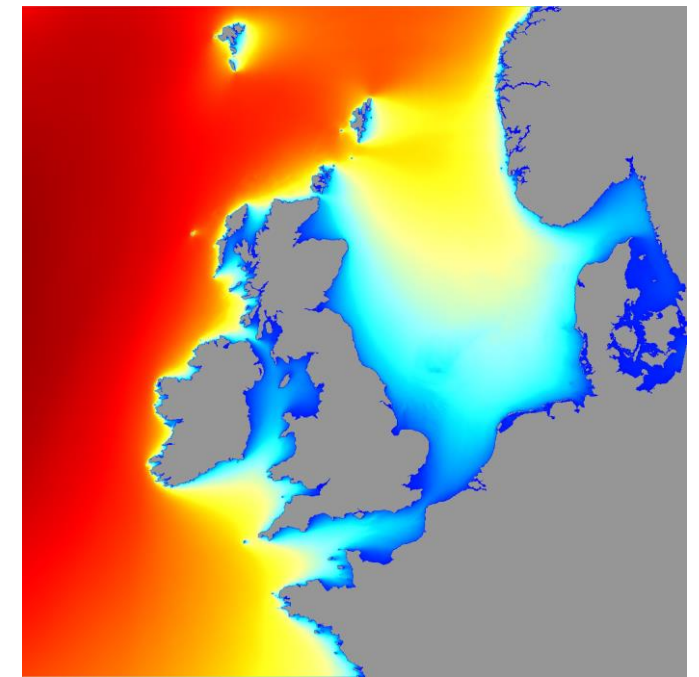
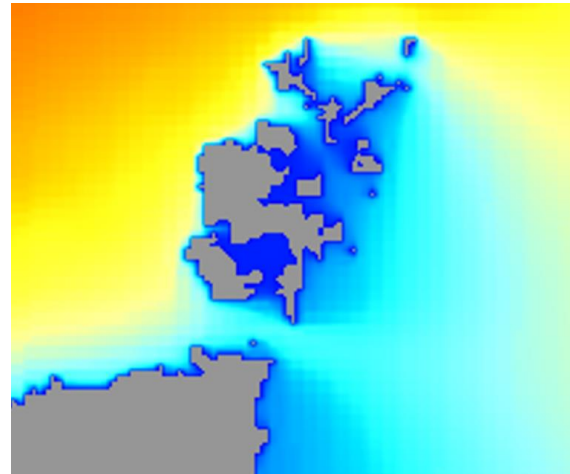
- “Atlantic- European North West Shelf- Wave Physics Reanalysis”
- “Mediterranean Sea Waves Reanalysis”.

For forecasting in our test locations:

- “Atlantic - European North West Shelf - Ocean Wave Analysis and Forecast”

In the future we are also planning to use:

- “Atlantic -Iberian Biscay Irish- Ocean Wave Reanalysis”
- “Global Ocean Waves Reanalysis”



Advantages of Copernicus Marine Service products

- The data has high spatial and temporal resolution which helps us to produce nice-looking infographic plots and heat maps for our wave analytics software.
- Wave data is available for a lot of geographical areas.
- Easy access to the data. Integrating the CMEMS API into our in-house software tools gives real-time access to the wave data which is frequently used by our Commercial and Operations teams.