Guiding the waves

Radac is actively engaged in innovative developments through joint industry projects, harnessing a collaborative approach and a keen thirst for knowledge. Customer-centric, it thrives on working closely with clients, understanding their needs, and delivering effective solutions. While product development is significant, the company's core lies in fostering knowledge and insights. This article sheds light on its contribution to a joint industry project (JIP) and the profound insights gained throughout the endeavour.

The Offshore Operation Advisory System (OOAS) Project, elevating operational efficiency

The joint industry venture with partners such as Marin (Maritime Research Institute Netherlands), Acta Marin, SMST, Next Ocean, and MO4 aims to improve the operability of vessels involved in the installation, O&M phase and decommissioning of offshore wind farms, by giving upfront advice for the planning and execution of critical offshore operations. This improves efficiency, reduces downtime, lowers LCoE and reduces the CO_2 footprint of offshore operations.

A very high level of accuracy can be obtained by developing a method to monitor the 2D wave spectra onboard, and by including non-linear effects of the DP system, gangway/crane, anti-roll tank and ship's condition in the advice.

Radac's main contribution to the project is to provide highly accurate seastate data with unique directional wave radar, the so-called WaveGuide5 Direction Onboard2, which is the standard in the offshore wind market. Originally designed for floating turbines, the system accurately measures wave height, wave period, 2D spectrum, and surface current.

The company adapted the technology to cater to Offshore Support Vessels (OSVs) which were a critical element to the greater concept of this JIP. Radac's wave radar systems provided 2D wave spectra and current information around the vessel. This level of detail is necessary to achieve sufficient accuracy for validation of the model and as feed for the model itself.

Wind, waves and current are crucial factors affecting the feasibility of offshore operations involved with installation and exploitation of offshore wind farms. They cause wave frequent ship motions and movement that may prohibit safe execution of the operation. For Offshore Support Vessels that transfer personnel and spare parts to wind turbines, this directly affects operability. With operation and maintenance costs making up some 25 to 30% of the total costs of a wind farm, and day rates of OSVs in the order of 40kEuro/day, a drop in workability may lead to serious delays and increase in LCoE.

Maintenance and support vessels are not the only things affected. Operations such as the installation of templates, foundation and blades with floating installation vessels, cable laying, trenching or monitoring operations with ROVs are also limited by ship motion and environmental conditions.

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Therefore, forecasting whether an operation is feasible in the expected environmental conditions and accurately monitoring these is crucial for safe execution and efficient planning of operations.

The project delivered a system that provides operational advice to crew and operators in several planning phases based on a generic approach that combines vessel motions, or DP behaviour, with equipment limitations, both crane and gangway, detailed weather forecast and measurements, including sea, swell, current). The system was tested and validated on Acta Marine's OSV Acta Auriga.

Acta Auriga

During the project, which ran from the end of 2020 until the second half of 2023, the wave radar of Radac provided one of the main reference sensors. Previous projects showed the need for onboard measurement of crossed environmental conditions, such as wind, waves, swell and current, interface to ship systems that affect motion and the modelling of non-linear motion behaviour.

As the wave radar system consist of three downlooking FMCW radars, two radars slightly tilted, to obtain the highest accuracy possible, a clear view to the water surface is needed. Therefor the preferred installation location is at the bow of a vessel or underneath a helideck.

Intriguingly, the Acta Auriga, an OSV participating in the OOAS Project, featured an Ulstein X-bow, which is not the ideal shape for a downlooking radar. This presented the company with a challenge to ensure accurate measurements.

As the bridge has overhanging wings on both sides, there is a perfectly clear view to the water surface. The issue is that the interference of the 93.4 m hull with the waves will be measured too. By installing the system on both starboard and port sides, they aimed to mitigate interference from the vessel's hull with the waves. Rigorous testing and comparisons with nearby buoys validated the system's effectiveness, further solidifying Radac's reputation as a reliable reference sensor provider.

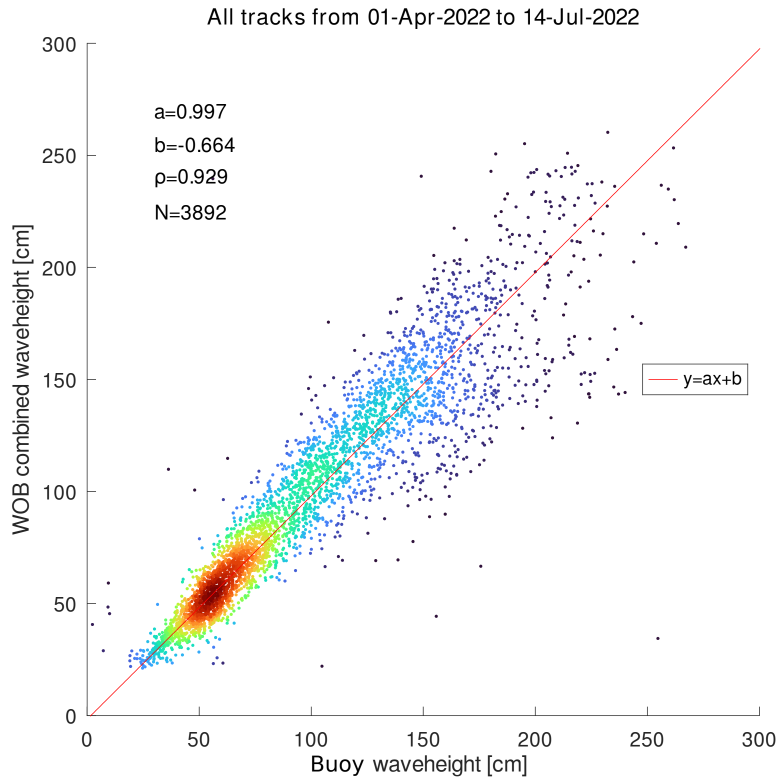
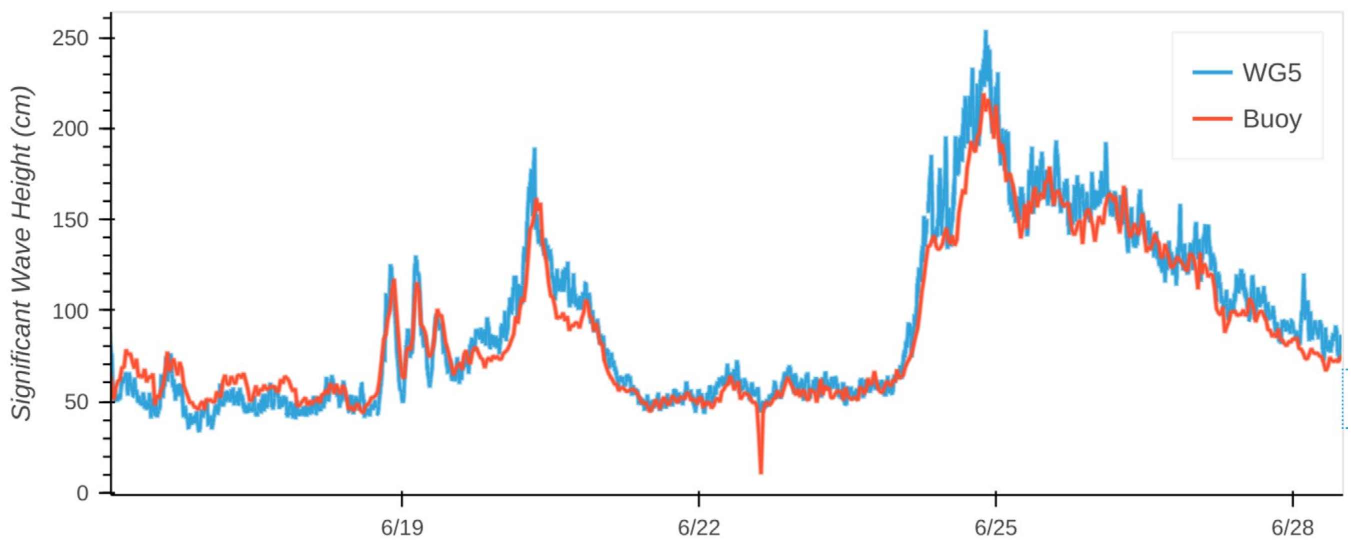


Figure 1 Linear regression on the wave heights

Comparison with the buoy

During Acta Auriga's operation on an offshore wind farm, a waverider buoy was also deployed nearby for an extended period, allowing for a meaningful comparison. The study spanned over one and a half years. Distinct variations in measurements between the port and starboard wave radar were observed

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based on the vessel's different headings. Notably, when the bow faced into the waves, both port and starboard sensors showed considerable agreement.

Conversely, when the waves approached perpendicular to the vessel's side, significantly higher waves were detected on one side compared to the other, which aligned with expectations. Overall, the two wave radar systems effectively averaged out the wave data across all situations.

Graph 1.1 illustrates the significant wave height (Hm0) of the buoy alongside the combined data from the port and starboard WaveGuide Direction Onboard systems. Both trends and wave heights appear to align remarkably well. An explanation for the differences in wave heights between the buoy and wave radar could be attributed to location variations. As the buoy remains fixed in the offshore wind farm, the vessel's movement from one side to another naturally introduces disparities. Consequently, both buoy and waveradar can be accurate for the specific spots they measure.

To gain deeper insight into the data's accuracy, a correlation plot was generated (Graph 1.2). This plot shows the wave rider buoy data on the x-axis and the combined wave radar data on the Y-axis. For perfect agreement, the correlation coefficient (a) should equal 1. Impressively, over the 1.5-month comparison period, the correlation stood at a remarkable factor of 0.97. This level of accuracy matches statistical expectations, confirming the systems' excellence as reliable reference sensors.

Statistically, if two identical sensors were placed in the same sea state but not at the exact same position, a similar correlation would be expected. For instance, a set of waves passing one sensor first and reaching the other after a certain time delay. While avoiding delving into intricate statistical discussions, these results are indeed exceptional, underscoring the efficacy of our systems as highly dependable reference sensors.

2D spectrum

In addition to serving as a reference sensor, Radac played an important role in providing the 2D spectrum data. This information was crucial for optimising vessel workability. While Hm0, significant wave height, is the main wave parameter used in many contracts, having data on wave direction, period, and energy in the 2D spectrum proved vital.

The Acta Auriga, responsible for choosing the appropriate landing platform in specific DP positions, benefited greatly from this data and the advice given by the tool. Understanding the distribution of wave energy based on frequency and direction enabled the vessel to make well-informed decisions, especially when handling challenging swell conditions.

As the OOAS Project progressed, Radac's contributions proved instrumental in developing the advisory tool. By providing accurate 2D spectrum information and functioning as a reliable reference sensor, Radac helped advance operational efficiency, thereby bolstering the energy transition towards a sustainable offshore wind industry.

Radac's participation in the joint industry project exemplifies its commitment to collaborative growth and knowledge expansion. With the OOAS Project, the company showcased its expertise through the WaveGuide Direction Onboard and its contributions to optimising operational efficiency and safety in the offshore wind sector.

As the industry continues to evolve, Radac remains a pioneering force, driving innovation, and contributing significantly to the ongoing energy transition.

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