Three decades of contactless wave measurement

From early challenges measuring waves in harsh marine conditions to real-time data for offshore wind, Radac's 30-year history has been shaped by the practical problems its technology was built to solve.

During an operational meeting for an offshore wind farm in the North Sea many years ago, a frustrated project manager strode into the conference room. He had just dispatched a crew transfer vessel (CTV), basing his go-ahead on a regional weather model that indicated a workable 'weather window'. However, the reality offshore was different.

Once the CTV arrived at the location, the actual sea state deviated so significantly from the forecast that the ship was forced to turn back. The decision to sail cost the project thousands of euros in vessel chartering fees and wasted fuel with zero work accomplished.

Sitting at that very conference table was Radac founder Tom van der Vlugt. For him, this incident underscored a critical and persistent pain point within the industry: regional weather models simply do not always offer the level of certainty required for operations at the actual worksite.

Asset managers, offshore installation managers and vessel captains need reliable, local wave measurements alongside forecasts when deciding whether it is safe and practical to proceed.

The company marks its 30th anniversary this year. Looking back, the unique sensors the company provides to the modern offshore wind sector today weren't simply dreamt up at a drawing board. Instead, every single technology has been forged in real-world operational challenges, originating from specific customer inquiries and maritime problems.

Much of that work has involved collaboration with oceanographic and maritime institutions, including the Dutch Directorate-General for Public Works and Water Management (Rijkswaterstaat) and the Maritime Research Institute Netherlands (MARIN).

The practical lesson in Togo

Before contactless radar technology was available for wave measurement, instruments generally had to be placed in the water. Van der Vlugt encountered the difficulties firsthand during a measurement campaign at a pier in Lomé, Togo, in the 1970s.

The task was seemingly straightforward: to measure local wave heights using a resistance wire. The team built a 15 m steel measurement frame for installation at the end of a jetty, using oil drums to keep it afloat while moving it into position. During installation, a tethering rope snapped and the structure drifted away in the strong tidal current. In a moment of desperation, Van der Vlugt jumped into the water to catch it and used a long rope to help bring the assembly back to shore.

The episode left a lasting impression. Measuring waves was one challenge; getting equipment into position and keeping it working in a harsh marine environment was another. The ocean is an unforgiving medium. His first lessons were learnt.

Swell in the Eurogeul

The move towards radar measurement was prompted by a problem at the Port of Rotterdam. Deep-draught bulk carriers and ore ships entering through the Eurogeul could use the channel safely only around high tide. Long-period swell created a risk of the vessels touching the seabed. As ships needed several hours' notice before committing to the approach, Rijkswaterstaat sought a swell prediction system offering at least six to eight hours of warning.

That meant measuring incoming waves well before they reached the Dutch coast. The offshore Auk oil platform in the North Sea was identified as a suitable position to provide the necessary warning time.





The WaveGuide Direction installed at an offshore wind farm



The motion compensated version of the wave radar installed on the bridge of a vessel

There was a difficulty, however: wave buoys available in the early 1980s could not adequately measure the low-frequency waves associated with long swell, while other instruments, including floats and pressure sensors, faced demanding sea conditions.

In the 1980s, engineers explored frequency-modulated continuous-wave (FMCW) radar mounted on the platform structure. It could continuously measure water surface elevation without contact and capture the low-frequency movement required for the swell assessment. Unlike a moored wave buoy, a platform-mounted instrument was not at risk of breaking free and drifting away during winter storms. The development offered a way to obtain measurements without repeatedly deploying equipment into the sea.

The Delta Works

The Eurogeul work focused on swell height and period. Construction of the Oosterscheldekering (Eastern Scheldt Storm Surge Barrier), part of the Dutch Delta Works, raised a different question: wave direction. Engineers assessing loads on its concrete piers and steel gates needed to understand how waves would strike the barrier. Would wave energy hit the structure at once or arrive in smaller, phased sections because waves were travelling in different directions?

At the time, van der Vlugt was working for Rijkswaterstaat. He and his colleagues collaborated with the Netherlands Organisation for Applied Scientific Research (TNO) on this directional wave climate. Their research resulted in the SWAP-method (Standard Wave Analysis Program), which calculated wave direction using pitch and roll, the dynamic slope, of the water surface. The method was applied to Datawell wave buoys.

However, to van der Vlugt's frustration, the Dutch Rijkswaterstaat knowledge, world-leading at that time, failed to reach the broader maritime market. Driven by an entrepreneurial desire to commercialise this expertise and share it globally across the offshore sector, he founded Radac.

His founding vision was to translate the principles of the directional wave buoy into a radar system. The underlying geometry is straightforward: three measurement points define a plane. Three synchronised downward-facing radars arranged in a triangle can therefore be used to accurately calculate the changing slope of the water surface in real time. This innovation provides highly reliable and accurate information about wave height, period and direction without sensors in the water. This was an important step in the company's development.

Radars on vessels

A further problem came from MARIN, which needed accurate 'sea truth' during hydrodynamic research and vessel trials. This meant measuring the waves a vessel was actually encountering, rather than relying on a forecast or a distant observation. Previously, obtaining those measurements could mean stopping a voyage, deploying a wave buoy, collecting data and retrieving it before continuing.

In response to this request, Radac developed a bow-mounted radar with motion compensation. Its algorithms separate the vessel's heave, pitch and roll from the movement of the water surface, so the vessel's own motion does not distort the wave measurements.

One of the very first deployments of this pioneering onboard system was on a container ship operating between China and Europe. The system allowed wave conditions to be recorded continuously during the voyage and compared with the structural fatigue experienced by the hull, without stopping to deploy a buoy.

Innovation for floating wind

That experience with moving vessels became relevant to floating offshore wind. During the TetraSpar Demonstrator project, turbine manufacturer Siemens Gamesa needed detailed wave data measured from the floating turbine foundation itself.

A floating foundation moves in response to wind thrust and waves, so measurements from a conventional fixed radar would not account for the movement of the structure. The engineering teams also wanted directional information for the turbine's active control systems and structural digital twins, rather than wave height alone.

The solution brought together the triangular three-radar arrangement developed for fixed platforms and the motion compensation used in vessel trials.

The resulting 'Directional Onboard' system accounts for movement of the floating foundation and is unique in the world. With that motion compensated for, it can calculate the two-dimensional wave spectrum and wave direction from a moving structure. The same approach can be used on vessels, where direct measurement of directional waves may help teams understand the conditions they are operating in.

Real-time wave data on the worksite

These developments have a common starting point: a practical need for wave information where work is taking place. That mission began with van der Vlugt as an oceanographic pioneer, jumping into the sea in Togo, solving swell forecasts for the Eurogeul, and pioneering 3D radar technology to bring Rijkswaterstaat's knowledge to the global market.

The pioneering work has continued under Rolf van der Vlugt, Tom's son, who has led the company over the past decade. The shift towards vessels and floating foundations extends the original interest in contactless measurement into situations where both the sea and the measurement platform are moving.

Today's offshore wind sector operates on the edge of engineering complexity, with teams optimising workability limits around turbines rated at 15 MW or above. In this environment, captains, offshore asset managers and project managers cannot rely on forecasts only; they demand exact, localised wave spectra. Building on 30 years of expertise, Radac continues to close the loop: connecting Tom's founding vision with Rolf's modern leadership to deliver the accurate, real-time data needed right where decisions are made: on the worksite.

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