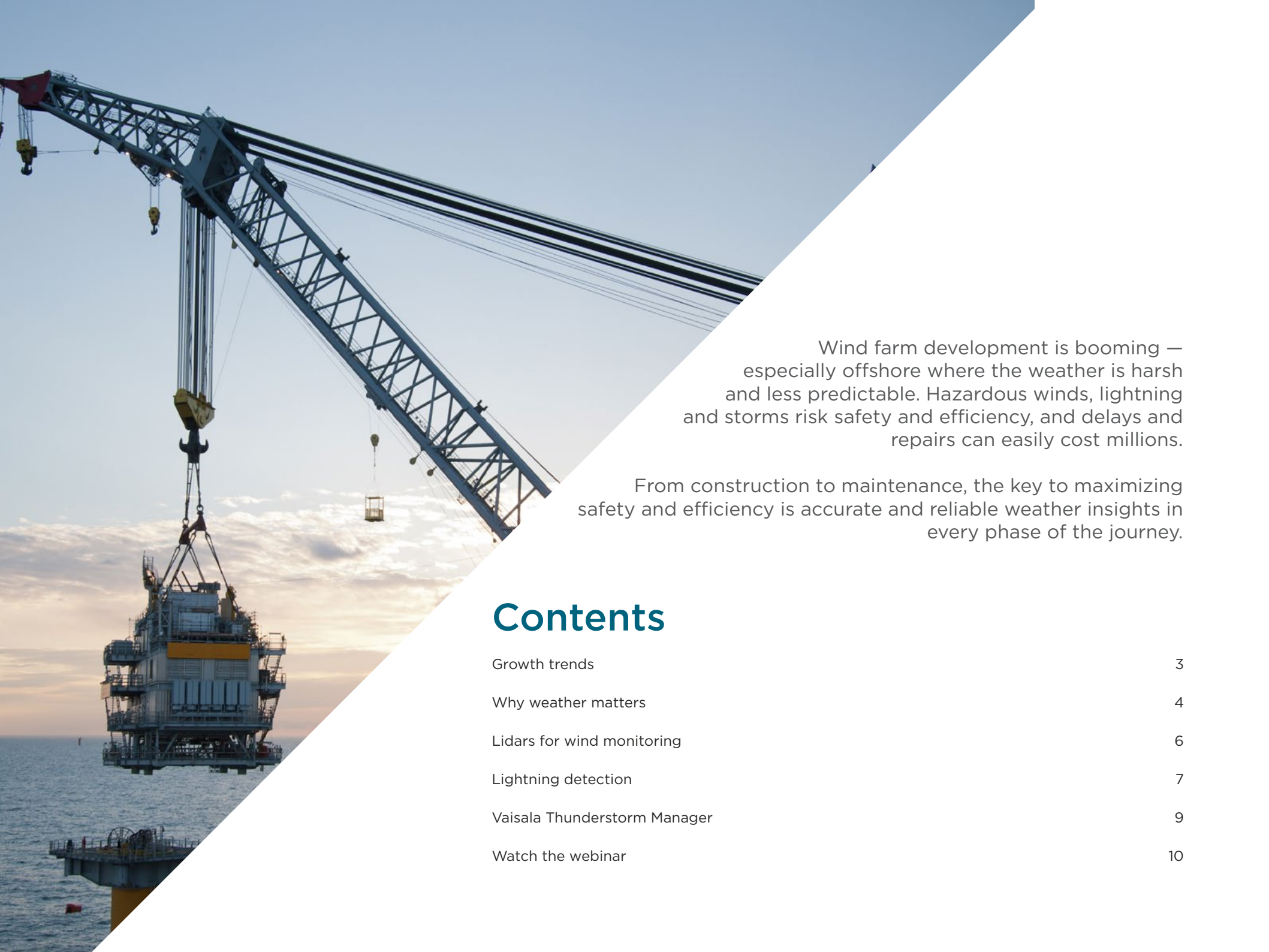


VAISALA

Port to sea

Optimizing offshore wind farm construction and maintenance operations with more accurate weather insights





Wind farm development is booming — especially offshore where the weather is harsh and less predictable. Hazardous winds, lightning and storms risk safety and efficiency, and delays and repairs can easily cost millions.

From construction to maintenance, the key to maximizing safety and efficiency is accurate and reliable weather insights in every phase of the journey.

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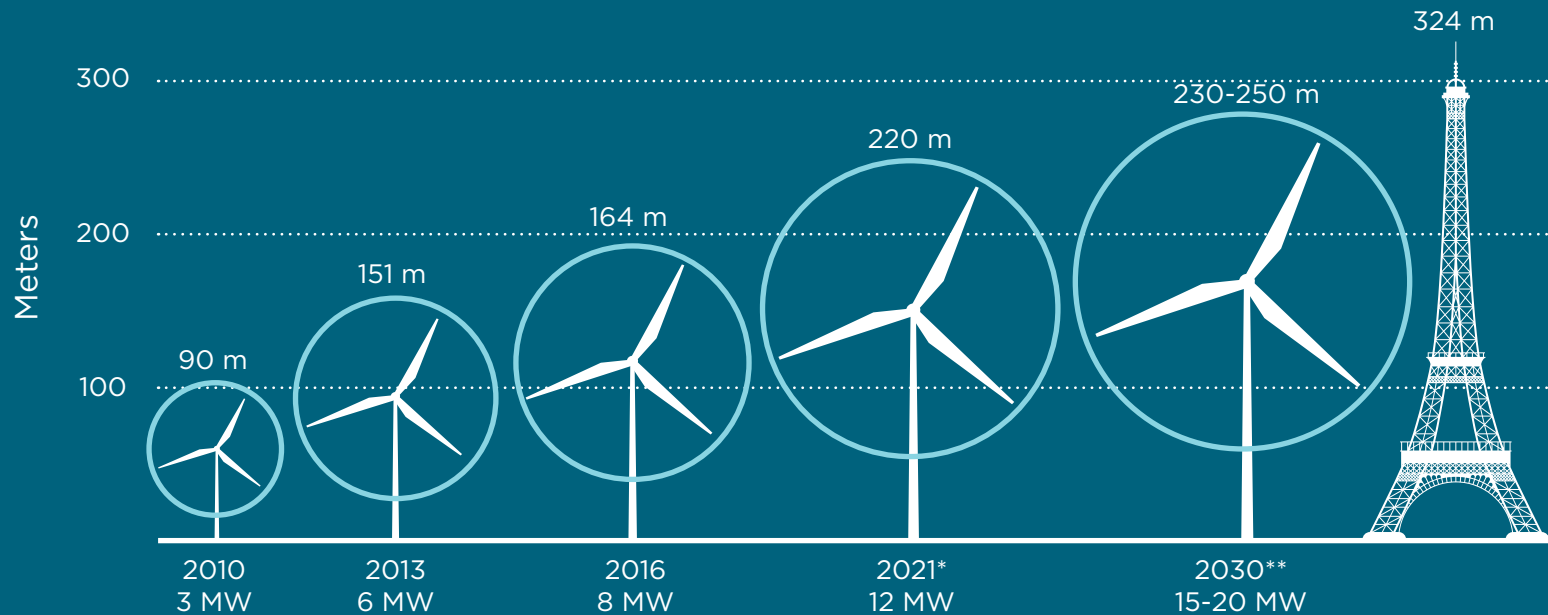
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Growth trends

The acceleration of offshore wind farm development is expected to last for several years. Not only are more wind farms being built offshore, but the scale of the farms and equipment are growing as well. Taller and more efficient turbines, bigger farms, and construction cranes that reach new heights all reflect industry growth and demand — total investments are estimated to top US \$800 billion by 2030.

With so much at stake, wind farm construction needs to be as efficient as possible to meet timelines and maximize return on investment.

Turbine growth drives bigger wind farms, higher capacity and lower costs**



** GWEC Market Intelligence, June 2020

Why weather matters

Strong winds are a boon for wind farms but pose major safety and efficiency challenges during construction and maintenance, as do lightning and storms. Delays and accidents have a significant impact on costs and timelines, so weather data is crucial for success.

Accurate historical weather data and modeling helps decision makers to plan operations, but does not provide real-time insights for quick action or help you understand when to pause to avoid dangerous weather conditions.

Even minor delays are expensive for offshore wind farm activities: Weather can pause or halt operations, costing

€200K per day or more

Weather impacts all operations

Helicopters • Cranes • Vessels • Outdoor crews

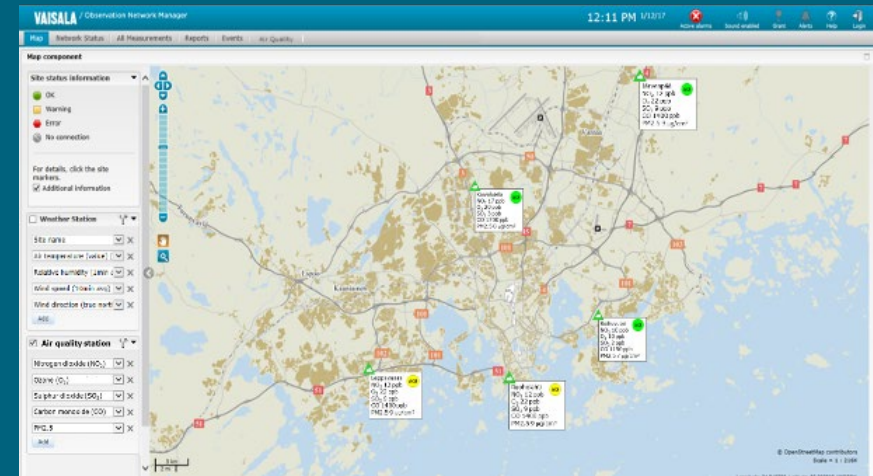
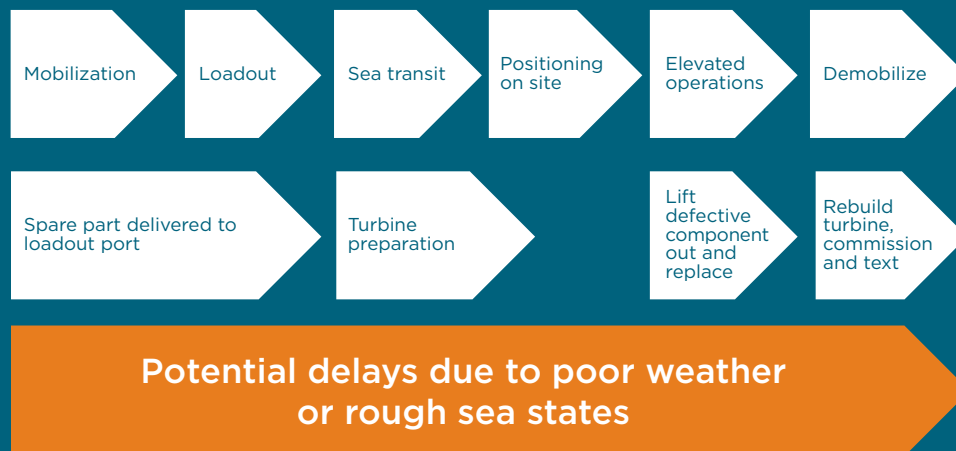


Delays: The WoW factor

Poor weather conditions impact every phase of offshore operations. These waiting on weather (WoW) delays occur throughout the year, most often during the winter months.

The WoW factor plays a significant role in the total cost of construction and maintenance work, as it can vary from 10% to 50% of operational time depending on location, distance from the shore, and time of year.

The most challenging weather conditions are related to wind, waves and thunderstorms. Accurate and reliable weather detection is critical — but to be actionable, the observations must be local and in real time.



Sources: Improving Offshore Wind Performance Through Better Use of Jack-up Vessels in the Operations and Maintenance Phase, 2014
U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study, 2017

Lidars for wind monitoring



Wind monitoring is essential to crane operation. Crane operators often rely on generic wind forecasts and in-situ wind measurements performed by cup or sonic anemometers installed on top of the crane. However, the data from these sources is often incomplete and not accurate enough.

WindCube® lidars are known the world over as the gold standard in accurate wind measurements. Trusted for decades, the third-party certified wind lidar helps improve local and short-term weather forecasting with continuous observations.

WindCube vertical profiling lidar is a compact, lightweight and rugged remote sensing device. A highly refined, mature offshore technology, the WindCube provides unrivalled wind measurement capabilities and services for accurate, real-time 3D wind data.

- Provides accurate, local wind vertical profiling up to 300m with 20 simultaneous heights measured per second
- Includes WindCube Insights — Fleet visualization software, an easy-to-use, secure, cloud-based tool that provides real-time insights and simple management



WindCube Insights — Fleet visualization software

“69 - 75% of weather down time is caused by the lifting operation, in which the wind speed is the dominant factor.”



“Weather Down Time Analysis for Offshore Wind Farm Installations,” Yohannes Tekle Muhable, Cristian Petcu, Philippe Rigo and Jean David Caprace, 2016

Lightning detection



Thunderstorms and lightning pose significant operational risks for wind turbine installation vessels (WTIV), helicopters and ports.

Lightning is extremely powerful and extremely hot. It carries thousands of times more electricity than household electricity, is hotter than the surface of the sun, and quickly heats up the surrounding atmosphere to create the sound of thunder. Thunderstorms can bring severe

weather including strong winds and large waves, risking worker safety as well as crane and turbine damage.

It is recommended to stop crane activity when thunderstorms are near, but this can cause delays. Lightning and thunderstorm detection and alerts help decision makers to more accurately determine when to stop and resume operations to maximize uptime — safely.

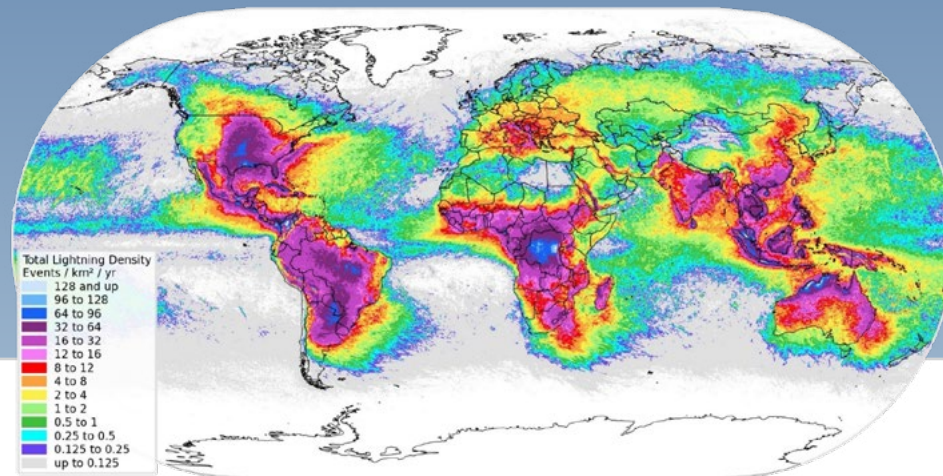
Benefits of proper lightning threat management

- Increase safety for workers
- Increase weather windows
- Increase efficiency while managing lightning threats
- Decrease cost of delays
- Decrease potential for asset damage
- Avoid unnecessary risk for personnel, components and assets



Helicopters can trigger lightning.

Lightning detection systems help you optimize route planning for safer, more efficient flights.



Current and future wind parks located in lightning prone areas

Vaisala global and US lightning detection networks

Lightning detection networks provide excellent quality warning information for ports and offshore operations. Vaisala is the most trusted lightning information provider, delivering quality data to offshore operations including wind energy operators and manufacturers, global cargo vessels, and defense agencies with a global presence.

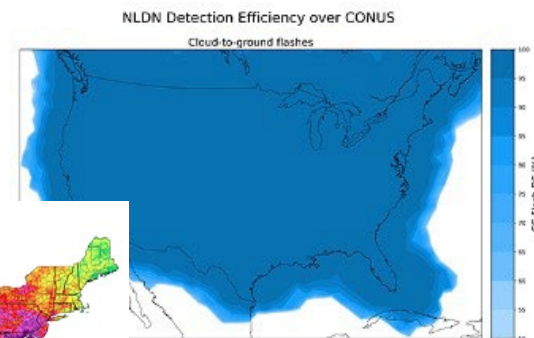
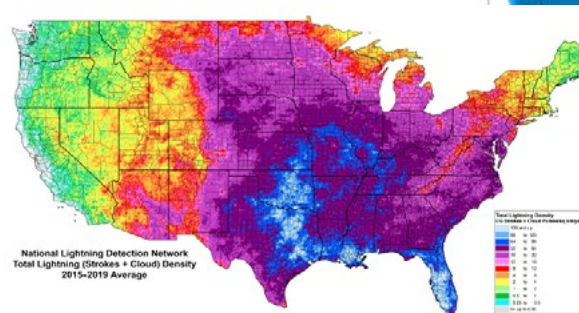
Vaisala provides the highest quality data for any location in the world with our GLD360 Global Lightning Network or our US National Lightning Detection Network (NLDN).

Global Lightning Network GLD360

- Detects on average more than 2 billion events every year
- Global uninterrupted detection identifies 100% of thunderstorms and enables extended coverage for weather radar networks, including oceans
- Provides tracking of thunderstorm movements and enables nowcasting with Lightning Threat Zone
- Location accuracy: 1.0 km

National Lightning Detection Network (NLDN)

- Total lightning detection with 90% lightning type classification accuracy
- >95% cloud-to-ground flash detection efficiency
- Location accuracy: better than 100m
- The most scientifically validated network



1,084,890,070 events detected
2015-2019

Vaisala Thunderstorm Manager

Vaisala Thunderstorm Manager is a web-based lightning threat management system designed to increase certainty by providing accurate, consistent, clear lightning alerts. Proximity alerts and their distance criteria are critical for determining levels of danger as well as when the danger has passed.

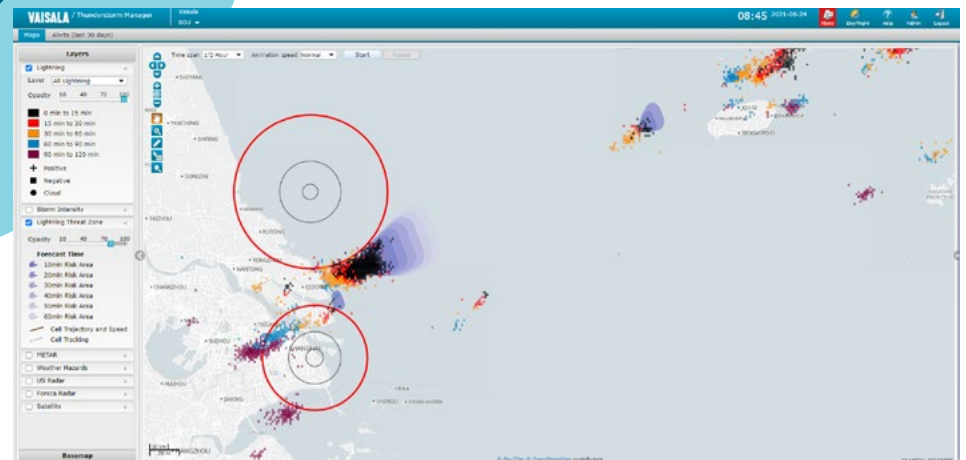
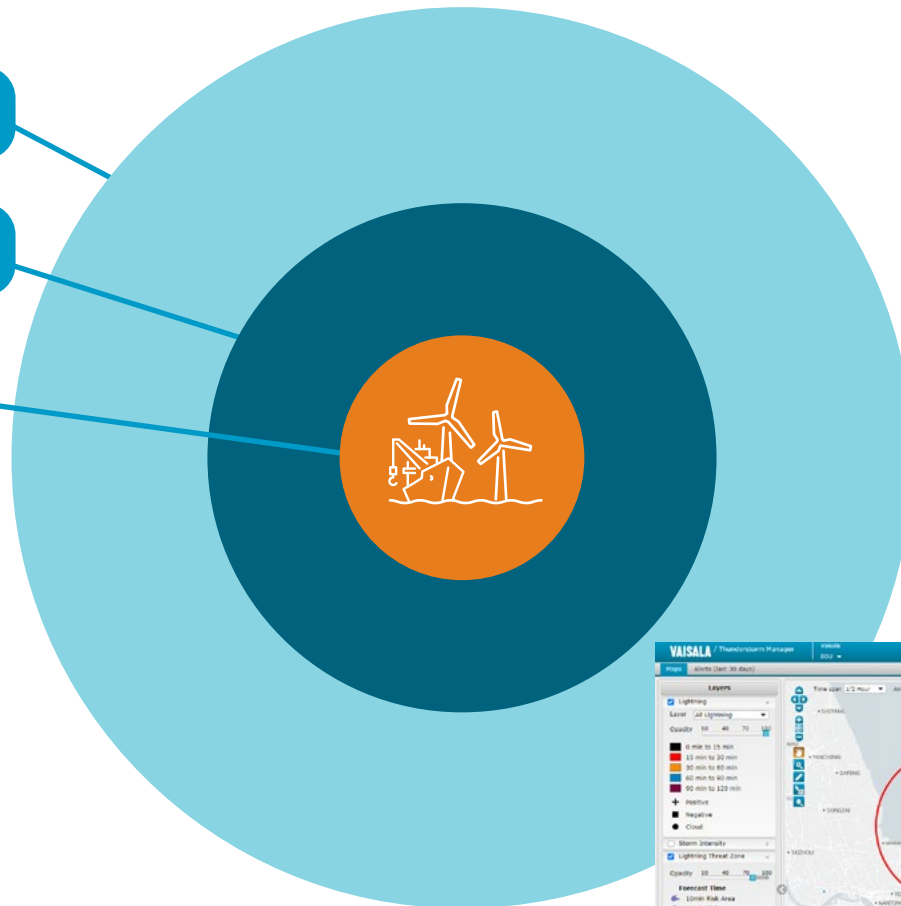
Using GLD360 data, Thunderstorm Manager detects all lightning activity in real time and activates alerts when lightning occurs inside a proximity ring. Alerts can be sent via email and SMS text messages, and can even trigger horns and flashing lights outdoors to warn workers of a lightning threat.

The solution also improves situational awareness by visualizing storm tracking and forecasting movements with Lightning Threat Zone.

Information Ring
30 miles / 48 km

Warning Ring
15 miles / 24 km

Alarm Ring
5 miles / 8 km



The weather affects maritime operations more than any other factor. We'll help you master it.

Weather and environmental insights are the greatest catalysts for successful maritime operations— onshore and offshore.

From sensors to systems and digital services, Vaisala provides actionable insights that empower stakeholders to confidently meet new challenges and harness new opportunities.

Our globally trusted maritime weather solutions enable remarkable efficiency gains, digital transformation, the protection of people and investments while supporting clean and responsible operations.

Why Vaisala?

We are scientists and explorers driven by passion, relentless curiosity, and the desire to create a better world. Our 85+ years of innovation and global impact are reflected in our guiding principles for maritime:



Master the weather, master the sea

Vaisala enables stakeholders to harness incredible new possibilities while facing increased severe weather risks driven by climate change. We do this by providing the most advanced weather and environmental insights available anywhere. Guided by our weather measurement expertise, we're advancing maritime operations and empowering today's leaders to master the sea like never before.



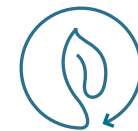
Currents of innovation

Maritime is evolving, and the currents of innovation are taking us to a more sustainable and weather-aware industry. Vaisala is the world's most trusted partner for helping maritime leaders navigate this evolution. Fueled by our proven scientific leadership and innovative spirit, we have led the way in providing unparalleled weather and environmental solutions across a multitude of industries for generations. We give maritime stakeholders the most comprehensive weather intelligence available so they can innovate across their entire ecosystem to protect of people, resources, and infrastructures.



Oceans of insight

The maritime industry is a complex ecosystem, with valuable information to be found everywhere. In the atmosphere. In the water. In the movements and topographies of the sea. In complex offshore and onshore hubs of commerce. Vaisala's integrated, end-to-end weather solutions are uniquely capable of transforming oceans of information into concrete, practical insights to enable better decision making. These insights turn uncertainty into confidence, risk into readiness, and potential into power. Our preeminent weather technologies give maritime stakeholders a new competitive advantage: the ability to derive previously unattainable insights from everything around them.



Champions for sustainability

Vaisala partners with maritime stakeholders to support a proactive, informed approach to navigating sustainability initiatives. Our unsurpassed onshore and offshore weather intelligence helps the maritime industry achieve cleaner and more responsible operations, stay ahead of regulatory pressures, and confidently manage risks related to extreme weather. This partnership also strengthens the health of Earth's oceanic ecosystems and the communities of which we are all part.

Watch the webinar

See our webinar presentation to hear in-depth discussion on these and more key topics—plus exclusive use cases—discussed by the experts.

[Watch the webinar](#)

Learn more about the about the technology that gives you the power of complete weather awareness.

vaisala.com/offshoreweather

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