DIME
Modelling and observations of extreme sea states for offshore renewable energies

DURATION: 52 months (2017-2021) | **BUDGET:** €1,664K

TECHNOLOGIES

STAGES OF THE VALUE CHAIN

Design O&M

CONTEXT

ORE systems deployed at sea are exposed to extreme waves that can jeopardize their mechanical structure. If these extreme waves are caused to break, the risk to the turbines is further increased. **It is therefore essential to better understand and characterise sea states in the event of storms in order to optimise the design of renewable energy converters such as floating wind turbines.**

OBJECTIVE

To improve the characterisation of extreme sea states with breaking waves by combining observations and modelling

MAIN ACHIEVEMENTS

- Identification of a new criterion for wave breaking
- Development of an engineering methodology to better estimate the forces induced by breakers on fixed wind turbine masts
- Development of a new parameterisation of wave breaking statistics based on an analytical approach and incorporating key physical ingredients such as the kinematic wave breaking criterion and sea state irregularity
- Documentation of the occurrence statistics and properties of breakers under storm conditions through measurement campaigns conducted from a lighthouse at sea

CONCLUSION

DIME has enabled the development of extreme sea state simulation tools and the develoment of recommendations contributing to the revision of design standards for offshore renewable energy technologies.

RESOURCES GENERATED

- **Proven protocol** for instrumenting offshore structures to study wave/structure interactions
- **Phase resolved wave model** for wave breaking
- **Laws** for breaker statistics
- **Database** from giant wave measurement campaigns (geometry and kinematics) off North Brittany initiated in winter 2017 and still ongoing in the DIMPACT project
- **Recommendations** for the revision of the design standards

PARTNERS

This project benefited from a €551K French government grant, managed by the National Research Agency under the Investments for the Future Programme (ANR-10-IEED-0006-14).

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LIST OF SCIENTIFIC PUBLICATIONS FROM THE PROJECT

2021

- Varing *et al.* **A new definition of the kinematic breaking onset criterion validated with solitary and quasi-regular waves in shallow water.** *Coastal Engineering*, 164, p. 103755
  -> doi.org/10.1016/j.coastaleng.2020.103755
- Stringari *et al.* **Deep neural networks for active wave breaking classification.** *Scientific Reports*, 11(1), pp. 1-12
  -> doi.org/10.1038/s41598-021-83188-y
- Stringari *et al.* **A New Probabilistic Wave Breaking Model for Dominant Wind-sea Waves Based on the Gaussian Field Theory.** *Journal of Geophysical Research: Oceans*, 126(4), p.e2020JC016943
  -> doi.org/10.1029/2020JC016943
- Stringari *et al.* **Remote Sensing Observations of Dominant Breaking Waves in Intermediate to Deep Water from a Lighthouse During Storm Conditions.** *Remote Sensing*
  -> 10.20944/preprints202103.0538.v1

2020

- Ayet *et al.* **On the Impact of Long Wind-Waves on Near-Surface Turbulence and Momentum Fluxes.** *Boundary-Layer Meteorology*, 174(3), pp. 65-491
  -> doi.org/10.1007/s10546-019-00492-x
- Guimarães *et al.* **A data set of sea surface stereo images to resolve space-time wave fields.** *Scientific Data*, 7(1), pp. 1-12
  > doi.org/10.1038/s41597-020-0492-9
- Platzer *et al.* **Wave group focusing in the ocean: estimations using crest velocities and a Gaussian linear model.** *Natural Hazards*, 104, pp. 2431-2449
  -> doi.org/10.1007/s11069-020-04279-z
- Ruju *et al.* **Spectral wave modelling of the extreme 2013/2014 winter storms in the North-East Atlantic.** *Ocean Engineering*, 216, p. 108012
  -> doi.org/10.1016/j.oceaneng.2020.108012
- Varing *et al.* **Spatial distribution of wave energy over complex coastal bathymetries: development of methodologies for comparing modeled wave fields with satellite observations.** *Coastal Engineering*, p. 103793
  -> doi.org/10.1016/j.coastaleng.2020.103793

2019

- Filipot *et al.* **La Jument lighthouse: a real-scale laboratory for the study of giant waves and their loading on marine structures.** *Philosophical Transactions of the Royal Society A*, 377(2155), p.20190008
  -> doi.org/10.1098/rsta.2019.0008
- Papoutsellis *et al.* **Modelling of depth-induced wave breaking in a fully nonlinear free-surface potential flow model.** *Coastal Engineering*, 154, p. 103579
  -> doi.org/10.1016/j.coastaleng.2019.103579

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- Pianezze *et al.* **A new coupled ocean-waves-atmosphere model designed for tropical storm studies: example of tropical cyclone Bejisa (2013–2014) in the South-West Indian Ocean.** *Journal of Advances in Modeling Earth Systems*, 10(3), pp. 801-825
  -> doi.org/10.1002/2017MS001177

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