CARAVELE

Wind characterisation for offshore renewable energy applications

DURATION: 46 months (2017-2021) | **BUDGET:** €1,752K

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CONTEXT

The characterisation of the wind still suffers from uncertainties in the spatial description associated with small-scale turbulent structures, e.g. orographic effects. Furthermore, the vertical wind speed profile is based on semi-empirical relationships derived from ground-based observations. **Thus, improved wind characterisation is crucial to reduce uncertainties in resource assessment and wind turbine design.**

OBJECTIVE

To improve the characterisation of extreme winds by combining atmospheric models with satellite and in situ observations

MAIN ACHIEVEMENTS

- Extrapolation of surface winds from satellite data at the height of wind turbine nacelles
- Capturing the spatial variability of wind fields from high-resolution synthetic aperture radar (SAR) observations and coupling to wind forecast models
- Wave tank tests equipped with wind tunnels to study air-sea interactions during extreme events
- Improving the accuracy of atmospheric models by combining them with SAR observations, using machine learning methods

CONCLUSION

CARAVELE has developed new tools and improved existing models that can be used to: determine wind farm siting areas, estimate the wind resource, produce high resolution forecasts for offshore operations, and characterise extreme winds for wind turbine design.

TECHNOLOGIES

STAGES OF THE VALUE CHAIN

Preliminary studies | Design | O&M

RESOURCES GENERATED

- **Methodology** for optimising the deployment of sensors to determine farm siting areas
- **Algorithm** for extracting high-resolution wind features from SAR images
- **Methods** for extrapolating surface wind speeds from satellite data to the height of the wind turbine nacelle
- **Short-term wind forecasting** model using the method of analogues
- **Database** of extreme conditions in wave tanks equipped with wind tunnels

PARTNERS

France Energies Marines, Ifremer, IPSL, OceanDataLab, EDF, CLS, École des Ponts ParisTech, CNRS, Naval Energies, CICESE, RSMAS

This project has benefited from €583K French state funding, managed by the National Research Agency under the Investments for the Future Programme (ANR-10-IEED-0006-26).

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LIST OF SCIENTIFIC PUBLICATIONS FROM THE PROJECT

2021

- Platzer *et al.* **Probability Distributions for Analog-To-Target Distances.** *Journal of the Atmospheric Sciences,* 78, pp. 3317-3335
  -> doi.org/10.1175/JAS-D-20-0382.1
- Stringari *et al.* **A New Probabilistic Wave Breaking Model for Dominant Wind-Sea Waves Based on the Gaussian Field Theory.** *JGR Oceans*, 126, e2020JC016943
  -> doi.org/10.1029/2020JC016943

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
- 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

2019

- Mouche *et al.* **Copolarized and Cross-Polarized SAR Measurements for High-Resolution Description of Major Hurricane Wind Structures: Application to Irma Category 5 Hurricane.** *Journal of Geophysical Research: Oceans*, 124, pp. 3905-3922
  -> doi.org/10.1029/2019JC015056

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INVESTIR L'AVENIR